imc CRONOS

Manual

Edition 14 - 2025-03-10

imc CRONOScompact (CRC)

imc CRONOSflex (CRFX)

imc CRONOS-XT (CRXT)

imc Test & Measurement GmbH • Voltastr. 5 • 13355 Berlin • Germany

Disclaimer of liability

The contents of this documentation have been carefully checked for consistency with the hardware and software systems described. Nevertheless, it is impossible to completely rule out inconsistencies, so that we decline to offer any guarantee of total conformity.

We reserve the right to make technical modifications of the systems.

Copyright

Open Source Software Licenses

Some components of imc products use software which is licensed under the GNU General Public License (GPL). Details are available in the About dialog.

A list of the open source software licenses for the imc measurement devices is located on the imc STUDIO/imc WAVE/imc STUDIO Monitor installation medium in the folder "*Products\imc DEVICES\OSS*" or "*Products\imc DEVICEcore\OSS*" or "*Products\imc STUDIO\OSS*". If you wish to receive a copy of the GPL sources used, please contact our tech support.

Notes regarding this document

This document provides important notes on using the device / the module. Safe working is conditional on compliance with all safety measures and instructions provided. The manual is to be used as a kind of reference book. You can skip the description of the modules you do not have.

Additionally, all accident prevention and general safety regulations pertinent to the location at which the device is used must be adhered to.

These instructions exclusively describe the device, **not how to operate** it by means of **the software**!

If you have any questions as to whether you can set up the device / module in the intended environment, please contact our tech support. The measurement system has been designed, manufactured and unit-tested with all due care and in accordance with the safety regulations before delivery and has left the factory in perfect condition. In order to maintain this condition and to ensure safe operation, the user must observe the notes and warnings contained in this chapter and in the specific sections applicable to the concrete device. Never use the device outside the specification.

This will protect you and prevent damage to the device.

Special notes

Warning

Warnings contain information that must be observed to protect the user from harm or to prevent damage to property.

Note

Notes denote useful additional information on a particular topic.

Reference

A reference in this document is a reference in the text to another text passage.

Table of contents

1 General introduction

1.1 Tech support

If you have problems or questions, please contact our tech support:

Phone: (Germany): **+49 30 467090-26**

E-Mail: hotline@imc-tm.de

Internet: https://www.imc-tm.com/service-training/

Tip for ensuring quick processing of your questions:

If you contact us **you would help us**, if you know the **serial number of your devices** and the **version info of the software**. This documentation should also be on hand.

- The device's serial number appears on the nameplate.
- The program version designation is available in the About-Dialog.

Product Improvement and change requests

Please help us to improve our documentation and products:

- Have you found any errors in the software, or would you suggest any changes?
- Would any change to the mechanical structure improve the operation of the device?
- Are there any terms or explanations in the manual or the technical data which are confusing?
- What amendments or enhancements would you suggest?

Our tech support 6 will be happy to receive your feedback.

1.2 Service and maintenance

Our service team is at your disposal for service and maintenance inquiries:

Phone: (Germany): **+49 30 629396-333** (Mon.-Fri.: 9.00 - 12.00 and 13.00 - 17.00)

E-Mail: service@imc-tm.de

Internet: https://www.imc-tm.com/service

Service and maintenance activities include, for example calibration and adjustment, service check, repairs.

1.3 Legal notices

Quality Management

imc Test & Measurement GmbH holds DIN EN ISO 9001 certification since May 1995 and DIN EN ISO 14001 certification since November 2023. You can download the CE Certification, current certificates and information about the imc quality system on our website: https://www.imc-tm.com/quality-assurance/.

imc Warranty

Subject to the general terms and conditions of imc Test & Measurement GmbH.

Liability restrictions

All specifications and notes in this document are subject to applicable standards and regulations, and reflect the state of the art well as accumulated years of knowledge and experience. The contents of this document have been carefully checked for consistency with the hardware and the software systems described. Nevertheless, it is impossible to completely rule out inconsistencies, so that we decline to offer any guarantee of total conformity. We reserve the right to make technical modifications of the systems.

The manufacturer declines any liability for damage arising from:

- failure to comply with the provided documentation,
- inappropriate use of the equipment.

Please note that all properties described refer to a closed measurement system and not to its individual slices. A liability claim requires particularly careful handling of the unprotected individual slices (e.g. CRXT slices).

Guarantee

Each device is subjected to a 24-hour "burn-in" before leaving imc. This procedure is capable of detecting almost all cases of early failure. This does not, however, guarantee that a component will not fail after longer operation. Therefore, all imc devices are granted liability for a period of two years. The condition for this guarantee is that no alterations or modifications have been made to the device by the customer.

Unauthorized intervention in the device renders the guarantee null and void.

Notes on radio interference suppression

Devices of the imc CRONOS system family satisfy the EMC requirements for an use in industrial settings.

Any additional products connected to the product must satisfy the EMC requirements as specified by the responsible authority (within Europe[1]) in Germany the BNetzA - "Bundesnetzagentur" (formerly BMPT-Vfg. No. 1046/84 or No. 243/91) or EC Guidelines 2014/30/EU. All products which satisfy these requirements must be appropriately marked by the manufacturer or display the CE certification marking.

Products not satisfying these requirements may only be used with special approval of the regulating body in the country where operated.

All lines connected to the devices of the imc CRONOS system family should not be longer than 30 m and they should be shielded and the shielding must be grounded.

Note

The EMC tests were carried out using shielded and grounded input and output cables with the exception of the power cord. Observe this condition when designing your setup to ensure high interference immunity and low jamming.

[1] If you are located outside Europe, please refer the appropriate EMC standards used in the country of operation.

Cables and leads

In order to comply with the value limits applicable to Class B devices according to part 15 of the FCC regulations, all signal leads connected to devices of the imc CRONOS system family must be shielded.

Unless otherwise indicated, no connection leads may be long leads (< 30 m) as defined by the standard IEC 61326-1. LAN-cables (RJ 45) and CAN-Bus cables (DSUB-9) are excepted from this rule.

Only cables with suitable properties for the task (e.g. isolation for protection against electric shock) may be used.

ElektroG, RoHS, WEEE, CE

The imc Test & Measurement GmbH is registered with the authority as follows:
WEEE Reg. No. DE 43368136
valid from 24.11.2005

Reference

https://www.imc-tm.com/elekrog-rohs-weee/ and https://www.imc-tm.com/ce-conformity/

FCC-Notice

This product has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult our tech support or an experienced technician for help.

Modifications

The FCC requires the user to be notified that any changes or modifications made to this product that are not expressly approved by imc may void the user's authority to operate this equipment.

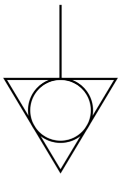
1.4 Explanation of symbols

CE Conformity

see CE chapter 1.2 6

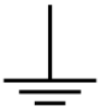
No household waste

Please do not dispose of the electrical/electronic device with household waste, but at the appropriate collection points for electrical waste, see also chapter 1.2 6.



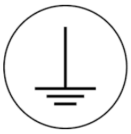
Potential compensation

Connection for potential compensation



Grounding

Connection for grounding (general, without protective function)



Protective connection

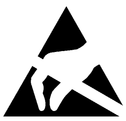
Connection for the protective conductor or grounding with protective function

Attention! General danger zone!

This symbol indicates a dangerous situation;
Since there is insufficient space for indicating the rated quantity at the measuring inputs, refer to this manual for the rated quantities of the measuring inputs before operation.

Attention! Injuries from hot surfaces!

Surfaces whose temperatures can exceed the limits under certain circumstances are denoted by the symbol shown at left.



ESD-sensitive components (device/connector)

When handling unprotected circuit boards, take suitable measures to protect against ESD (e.g. insert/remove ACC/CANFT-RESET).

Possibility of electric shock

The warning generally refers to high measurement voltages or signals at high potentials and is located on devices suitable for such measurements. The device itself does not generate dangerous voltages.

DC, Direct Current

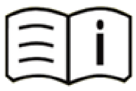
Supply of the device via a DC voltage source (in the specified voltage range)

RoHS of the PR China

The limits for hazardous substances in electrical/electronic equipment applicable in the PRC are identical to those in the EU. The restrictions are complied with (see chapter 1.2 6). A corresponding "China-RoHS" label is omitted for formal/economic reasons. Instead, the number in the symbol indicates the number of years in which no hazardous substances are released. (This is guaranteed by the absence of named substances).

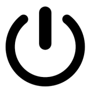
Labeling integrated energy sources

UxxRxx are integrated in the symbolism. "U" stands for the installed UPS energy sources, if 0 = not installed. "R" stands for the installed RTC energy sources, if 0 = not installed. You can download the corresponding data sheets from the imc website:
https://www.imc-tm.com/about-imc/quality-assurance/transport-instructions/



Observe the documentation

Read the documentation before starting work and/or operating.



On/Off

On/Off button (no complete disconnection from the power supply)

1.5 History

Amendments and bug-fix in manual Edition 14

Section	Amendments
Quarter bridge	Notes added for device-side addition of the quarter bridge.
Service	Link set to the updated imc service form 2025

Amendments and bug-fix in manual Edition 13

Section	Amendments
Storage media	updated description of recommended handling
Strain gauge measurement modes	wording, formulas and graphics revised

Amendments and bug-fix in manual Edition 12

Section	Amendments
Batteries	new battery labeling on the name plate

Amendments and bug-fix in manual Edition 11

Section	Amendments
Device overview	new imc measurement devices added: imc ARGUS*fit*
EtherCAT	FAQ concerning transmission of Power over EtherCAT added
UNI2-8 231	In the drawing, the screw terminal number for ±IN was wrong.

2 Safety

This section provides an overview of all important aspects of protection of the users for reliable and trouble-free operation. Failure to comply with the instructions and protection notes provided here can result in serious danger.

imc CRONOS-XT may only be operated as a completely closed system.

Responsibility of the operator

Devices of the imc CRONOS system family are for use in commercial applications. The user is therefore obligated to comply with legal regulations for work safety.

Along with the work safety procedures described in this document, the user must also conform to regulations for safety, accident prevention and environmental protection which apply to the work site. If the product is not used in a manner specified by the manufacturer, the protection supported by the product may be impaired.

The user must also ensure that any personnel assisting in the use of the devices of the imc CRONOS system family have also read and understood the content of this document.

Operating personnel

This document identifies the following qualifications for various fields of activity:

- *Users of measurement engineering*: Fundamentals of measurement engineering. Basic knowledge of electrical engineering is recommended. Familiarity with computers and the Microsoft Windows operating system. Users must not open or structurally modify the measurement device.
- *Qualified personnel* are able, due to training in the field and to possession of skills, experience and familiarity with the relevant regulations, to perform work assigned while independently recognizing any hazards.

Warning

- **Danger of injury due to inadequate qualifications!**
- Improper handling may lead to serious damage to personnel and property. When in doubt, consult qualified personnel.
- Work which may only be performed by trained imc personnel may not be performed by the user. Any exceptions are subject to prior consultation with the manufacturer and are conditional on having obtained corresponding training.

Special hazards

This segment states what residual dangers have been identified by the hazard analysis. Observe the safety notes listed here and the warnings appearing in subsequent chapters of this manual in order to reduce health risks and to avoid dangerous situations. Existing ventilation slits on the sides of the device must be kept free to prevent heat accumulation inside the device. Please operate the device only in the intended position of use if so specified.

Danger

Lethal danger from electric current!

- Contact with conducting parts is associated with immediate lethal danger.
- Damage to the insulation or to individual components can be lethally dangerous.

Therefore:

- In case of damage to the insulation, immediately cut off the power supply and have repair performed.
- Work on the electrical equipment must be performed exclusively by expert electricians.
- During all work performed on the electrical equipment, it must be deactivated and tested for static potential.

Injuries from hot surfaces!

- Devices from imc are designed so that their surface temperatures do not exceed limits stipulated in EN 61010-1 under normal conditions.

Therefore:

- Surfaces whose temperature can exceed the limits under circumstances are denoted by the symbol shown at left.

The click mechanism allows CRFX- or CRXT slices to be quickly connected and disconnected. The click connections should always be secured to prevent unintentional unlocking.

In a wet environment, even low voltages can lead to dangerous flow through the body. For this reason, assemble the CRXT modules with special care, ensuring that the seals are clean and greased (e.g. with Vaseline) and use the supplied connecting elements. In a wet environment, no special modules with a protection degree lower than IP67 may be used.

Industrial safety

We certify that imc CRONOS systems in all product configuration options corresponding to this documentation conforms to the directives in the accident prevention regulations in "Electric Installations and Industrial Equipment" (DGUV Regulation 3)*. This confirmation applies exclusively to devices of the imc CRONOS system family, but not to all other components included in the scope of delivery.

This certification has the sole purpose of releasing imc from the obligation to have the electrical equipment tested prior to first use (§ 5 Sec. 1, 4 of DGUV Regulation 3). This does not affect guarantee and liability regulations of the civil code.

For repeat tests, a test voltage that is 1.5 times the specified working voltage should be used to test the isolation for the highly isolated inputs (e.g. measurement inputs for high-voltage applications).

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* previously BGV A3.

Observe notes and warnings

Devices from imc have been carefully designed, assembled and routinely tested in accordance with the safety regulations specified in the included certificate of conformity and has left imc in perfect operating condition. To maintain this condition and to ensure continued danger-free operation, the user should pay particular attention to the remarks and warnings made in this chapter. In this way, you protect yourself and prevent the device from being damaged.

Read this document before turning on the device for the first time carefully.

Warning

Before touching the device sockets and the lines connected to them, make sure static electricity is diverted to ground. Damage arising from electrostatic discharge is not covered by the warranty.

3 Assembly and connection

3.1 After unpacking...

Check the delivered system immediately upon receiving it for completeness and for possible transport damage. In case of damage visible from outside, proceed as follows:

- Do not accept the delivery or only accept it with reservations
- Note the extent of the damage on the packing documents or on the delivery service's packing list.
- Begin the claims process.

Please check the device for mechanical damage and/ or loose parts after unpacking it. The supplier must be notified immediately of any transportation damage! Do not operate a damaged device!

Check that the list of accessories is complete :

- AC/DC-power adaptor (not for racks) with cable and pre-assembled plug
- Getting started with your imc measurement device (printed)

Note

File a claim about every fault as soon as it is detected. Claims for damages can only be honored within the stated claims period.

3.2 Before commissioning

If components are brought into the operating room from a cold environment, condensation may occur. Wait until the CRXT slices are adapted to the ambient temperature and absolutely dry before clicking them together to form a system.

The click mechanism allows CRFX- or CRXT slices to be quickly connected and disconnected. The click connections should always be secured to prevent unintentional unlocking.

Good radiation and convection conditions must be ensured to prevent heat build-up inside the device. The devices must not be operated if there is a danger of explosion or if they are exposed to aggressive chemicals.

Existing ventilation slits (e.g. CRFX modules) must be kept unimpeded to avoid heat buildup in the device interior.

Ambient temperature

The limits of the ambient temperature cannot be strictly specified because they depend on many factors of the specific application and environment, such as air flow/convection, heat radiation balance in the environment, contamination of the housing / contact with media, mounting structure, system configuration, connected cables, operating mode, etc. This is taken into account by specifying the operating temperature instead. Furthermore, it is not possible to predict any sharp limits for electronic components. Basically, reliability decreases when operating under extreme conditions (forced ageing). The operating temperature data represent the extreme limits at which the function of all components can still be guaranteed.

3.3 Notes on connecting

3.3.1 Precautions for operation

Certain ground rules for operating the system, aside from reasonable safety measures, must be observed to prevent danger to the user, third parties, the device itself and the measurement object. These are the use of the system in conformity to its design, and the refraining from altering the system, since possible later users may not be properly informed and may ill-advisedly rely on the precision and safety promised by the manufacturer.

Note

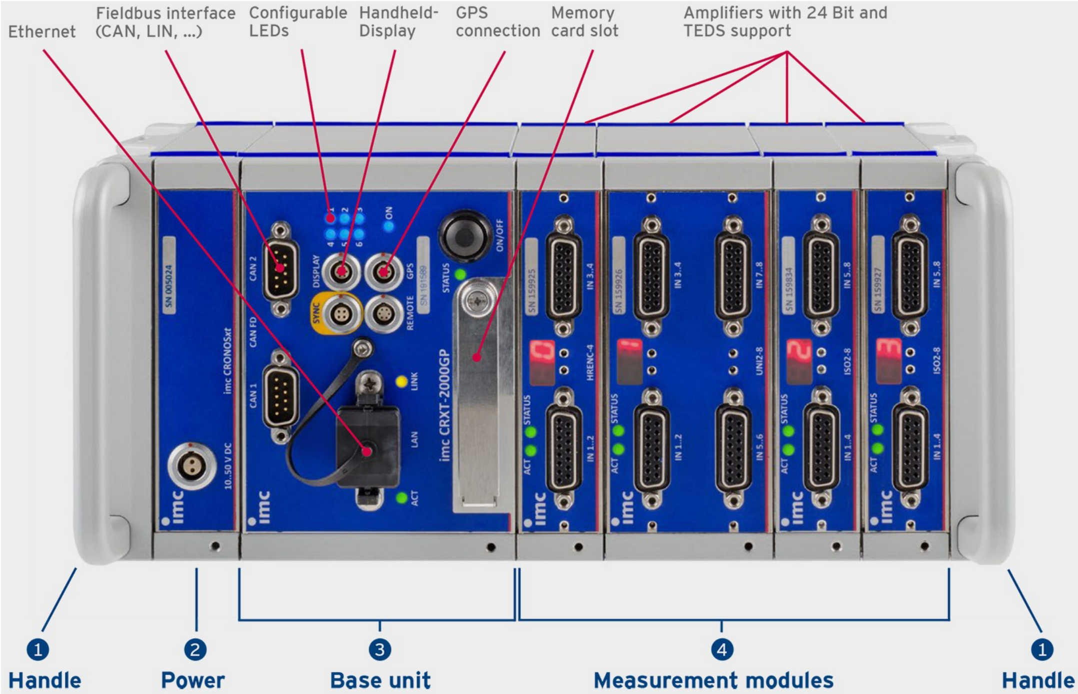
If you determine that the device cannot be operated in a non-dangerous manner, then the device is to be immediately taken out of operation and protected from unintentional use. Taking this action is justified under any of the following conditions:

- the device is visibly damaged,
- loosed parts can be heard within the device,
- the device does not work,
- the device has been stored for a long period of time under unfavorable conditions (e.g. outdoors or in high-humidity environments).

1. Observe the specs in the chapter "Technical Specs 318" and the application hints about the individual system in order to prevent damage to the unit through inappropriate signal connection.
2. Note when designing your experiments that all input and output leads must be provided with shielding which is connected to the ground ("CHASSIS") at one end in order to ensure high resistance to interference and noisy transmission.
3. Unused, open channels (having no defined signal) should not be configured with sensitive input ranges since otherwise the measurement data could be affected. Configure unused channels with a broad input range or short them out. The same applies to channels not configured as active.
4. To measure voltages >60 V use adequate plug.
5. In case you are using a removable storage medium,
   please be aware that before you remove it
   (if the device is switched on), the button 21 must be pressed to ensure that storage medium can be safely removed. Please read the instructions in the chapter "removable storage 20".
6. Be aware that during a running measurement, modules should not be disconnected from the system (hot plug functionality is not supported during a running measurement).
7. Avoid prolonged exposure of the device to sunlight.
8. Make sure that there is sufficient space at the ventilation slits.
9. Note that parts that are not explicitly intended to be carried may be warmer than the handles.

   For CRFX, the following also applies:
   The use of handles is mandatory for safe use. In the event of deviations, other suitable methods must be used to ensure acceptable protection against burns. Under normal conditions, the surface temperature of the enclosure/housing does not exceed the limits for accidental contact according to IEC 61010-1. The handles also prevent the lateral plug contacts from being touched during a measurement, thus preventing accidental discharge (ESD) into the lateral plug contacts. ESD in the lateral plug contacts can lead to a crash of a running measurement (destruction does not take place).

CRXT System design



Warning With CRXT the following precaution for operation applies:

With CRXT, operation without handles is not permitted.

The CRXT device may only be disassembled into its slices in a controlled environment and must also be clicked together to form a closed CRXT device in a controlled environment. Only complete (closed) CRXT devices may be used in a non-controlled environment.

For the correct use of the imc click mechanism please observe to the instructions in the chapter "CRXT Attachment mechanism". The rubber seals must be clean before connecting CRXT modules together.

3.3.2 Potential difference with synchronized devices

When using multiple devices connected via the **SYNC socket** for synchronization purposes, ensure that all devices are at the same voltage level.

Note

The yellow ring on the SYNC socket indicates that the socket is shielded from voltage differences.

3.3.3 Fuses (polarity-inversion protection)

The supply input of all devices listed in this manual is provided with a maintenance-free reverse polarity protection.

Reference

In the chapter "Technical Specs" you will find information on the fuse or the overcurrent limitation of the individual devices, if applicable.

The supply voltage for external sensors wired out from the voltage channels is equipped with maintenance-free electronic fuses (current-limiters).

The incremental counter channels provide a supply voltage for external sensors, which is not protected and should be provided with an external fuse in order to be used!

3.3.4 Start of operation CRFX

3.3.4.1 Networking and power supply

All of the system's individual building blocks, both the imc CRONOS*flex* base unit and also each individual imc CRONOS*flex* measurement module, have their own LEMO sockets for an ultra-wide 10 to 50 V range of DC power input; additionally, each have two RJ45 network jacks (IN/OUT) 77 for connecting the EtherCAT system bus. Both lines have robust connection terminals which provide both mechanical attachment to modules (locking snap) and electrical connection without any additional cables. By this means, multiple directly attached modules can be jointly powered by a single DC source which is always connected at the "far left" or "first" module 32. If multiple power sources are accidentally connected to the same block of modules, then a latch circuit ensures that only the first module on the left receives the power.

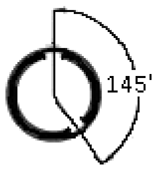
With the **introduction of the 48 VDC power adaptor** for the imc CRONOS*flex* system (CRFX base unit and the CRFX input modules), the power supply socket on the device has been changed so that the 48 VDC power adaptor can only be used with imc CRONOS*flex* systems and not with other imc measurement devices with an input supply voltage of 10..32 VDC. You can identify the 48 VDC power adaptor at the **blue protective sleeve** at the LEMO.1B plug (LEMO.PHG.1B.302), see the following Fig. 19 The 15 VDC or the 24 VDC power adaptors are equipped with a **black protective sleeve** at the LEMO.1B plug and can also be used with imc CRONOS*flex* systems. The use of those power adaptors with imc CRONOS*flex* is not recommended. The imc CRONOS*flex* system have an input supply voltage range of 10 .. 50 VDC. With regard to EN 61326-1 and EN 61010-1, the DC supply inputs are not specified for connection to a DC mains supply. DC networks are particularly extensive supply installations in the industrial sector. For these, increased safety margins are assumed for expected transient overvoltages in the event of a fault. This is comparable to the safety categories CAT II..IV in AC mains voltage systems.

Note

The +pin is marked with a red dot!

input power supply socket LEMO.1B (female) for a connection with 24 VDC power adaptor (1 guide notch, LEMO.EGG.1B.302)

input power supply socket LEMO.1B (female) for a connection with 48 VDC power adaptor (2 guide notches, LEMO.EGE.1B.302)



plug-type (male):		power adaptor:	plug-type (female):	
			LEMO.EGG.1B	*LEMO.EGE.1B*
			1 coding notch up to 8/2011	2 coding notches as of 9/2011
LEMO.FGG.1B	1 coding key	15 V, 24 V	fit	fit
LEMO.FGE.1B	2 coding keys	48 V	fits only with ACC/FGG-ADAP-PHE	fit

If the imc CRONOS*flex* base unit runs with 48 VDC power supply rather than the 24 VDC power supply, it is possible to operate a larger number of modules or a module with more power consumption directly with one power adaptor. The power consumption of the modules can be as high as 149 W with a 48 VDC power supply. If you want to benefit of the Power over EtherCAT (PoEC) function 40 a minimum voltage of 42 VDC is necessary.

For all previously delivered imc CRONOS*flex* systems with the LEMO.EGG.1B power supply socket (with one guide keyway), to be powered in future with 48 VDC, use the adaptor cable "CRFX adaptor cable for the supply LEMO.1B (article number: 13500151, order code: ACC/FGG-ADAP-PHE)" and the 48 VDC power adaptor.

Note

This adaptor cable may only be used with imc CRONOS*flex*. For devices with the 10..32 VDC input voltage range (imc C-SERIES, imc SPARTAN, ...), use of this adaptor cable and the 48 VDC power unit can damage or destroy the devices.

power adaptor 48 V up to 150 W (with blue protective sleeve at the plug) article no. 13500148

All imc CRONOS*flex* base units and Input Modules having the changed power supply plug can be continued to be powered with the 24 VDC power adaptor (without adaptor cable).

Reference imc CRONOS-XT

The imc CRONOS-XT description can be found in the following chapter: imc CRONOS-XT 81

3.3.4.2 Main switch

The imc CRONOS*flex* base unit has a central main switch by which the complete block of directly clicked (stacked) modules is activated/deactivated. Independently powered, spatially distributed modules and subsystems (blocks) 36 are activated/deactivated directly via their power supply connections.

3.3.4.2.1 Remote control of the main switch

As an alternative to the manual main switch on the device's front panel, a remote-controllable electric contact can be used to switch the device on and off. The socket designated **"REMOTE"** provides this contact: connecting the signals "SWITCH" and "ON" switches the device on, connecting "SWITCH" to "OFF" switches the device off. Any switch or relay contact used for this purpose must be able to bear a current of approx. 50 mA at 10 Ω max. The reference voltage for these signals is the primary voltage supply.

The signal "**SWITCH1**" serves to run the device with the switch permanently bridged: when "**ON**" and "**SWITCH1**" are connected, the device starts as soon as an **external supply voltage** is provided.

If this supply is interrupted, an internal buffer keeps the **base unit** activated for the appropriate buffer duration in order to close the measurement and files, and then the device deactivates itself. This type of operation is specially designed for use in a vehicle, permanently couples to the ignition and not requiring manual control.
Pinout: LEMO.1B.306 socket 514

Short description of the signal:

Signal	Function	Connection	Remarks
SWITCH	switch signal / reference	connect to ON / OFF	Power up from internal battery is supported!
SWITCH1	activation only from external power supply	connect to ON / OFF	static, permanently jumpered: for automatic activation upon application of an external supply

3.3.4.3 Power over EtherCAT (PoEC)

imc CRONOS*flex* Modules are compatible with Power over EtherCAT (PoEC), meaning they can receive power completely from the EtherCAT connection cable and consequently no longer need their own power supply line. This is especially attractive for decentralized satellite modules positioned somewhere remote and inaccessible, and having no other outside line than the CAT5 cable. Thus, centrally remote-controlled activation/deactivation of these satellites is achievable by means of PoEC.

3.3.4.4 Storage media in the device

This section describes how to handle the storage media of the imc measurement devices and how to use them with imc STUDIO.

The storage media are exclusively for data acquisition with imc STUDIO.

Storage media with verified performance can be purchased as accessories from imc. Hard drives are ordered with the device and can only be installed subsequently by imc.

Note — Manufacturer and Age of the storage medium

- imc has no way to affect the quality of the removable storage media provided by the various manufacturers.
- Storage media which come with newly purchased devices have been inspected in the framework of quality assurance and have passed the relevant tests.
- We expressly declare that the use of removable storage media is at the user's own risk.
- imc and its resellers are only liable within the framework of the guarantee and only to the extent of providing a substitute.
- imc expressly declines any liability for any damages resulting from loss of data.

3.3.4.4.1 For devices of the firmware group A (imc DEVICES)

Swapping the storage medium

Pressing the button signalizes to the system that you intend to remove the storage medium. Once this is done, the device stops access to the storage medium. If you were to remove the drive without prior announcement, it could produce defective clusters. If the storage medium is removed while a measurement is in progress, the data records are not completed. Therefore, always proceed as follows when swapping the storage medium:

1. **Important!** Before removing the storage medium from the measurement device, first announce the procedure to the system by pushing the button, in order to **avoid damage** to the storage medium.
2. Once the LED blinks, remove the storage medium.
3. Insert the new storage medium. Devices indicate by a short flash that the new drive has been successfully recognized.

Hot-Plug (exchanging the storage medium during a measurement)

It's possible to exchange the storage medium during a running measurement. This makes it possible to carry out a measurement without a PC practically without any limitations. It is only necessary to check the amount of memory available using imc Online FAMOS. To do this, use the function `DiskFreeSpace` belonging to the group "*System*". You can set an LED, for instance, or a digital output or a beeper to be activated when less than the minimum amount remains. One convenient solution would be to have a readout of the remaining space outputted by a display variable, which would indicate by a display on the device how the remaining memory decreases.

While swapping the storage medium during a running measurement, the data are stored in the measurement device's internal memory. If you complete the process within the specified RAM buffer duration, this is certain to work without any loss of data (see in the imc STUDIO manual "*Setup pages - Configuring device*" > "*Storage options and directory structure*" > "*RAM buffer time*"). Note that not only the time for the swap must be buffered, but that the buffered data must also be transferred to the new disk once the swap has been completed.

Swapping the storage medium

1. **Important!** Before removing the storage medium from the measurement device, first announce the procedure to the system by pushing the button, in order to **avoid data loss and damage** to the storage medium. The LED will **shine continuously** in green.
2. Once the device is ready for removal of the storage medium, the LED **blinks**.
3. Remove the already full storage medium.
4. No announcement is necessary for inserting a storage medium.

3.3.4.4.1.1 Storage media

Storage media	Description
CF Cards (Compact Flash)	For devices of group A4 and A5 95: The device group exclusively uses CF cards for storage medium.

<table>
<tr><th>Storage media</th><th>Description</th></tr>
<tr><td>USB Storage Medium</td><td>Concerning devices with USB (see "Device overview 95"). Memory sticks or external hard drives can be connected at this terminal.

Do not use multiple storage media at the same time! Devices belonging to group A6 95 have two USB terminals and a slot for the ExpressCard. However, the device can use only one data storage medium. The system determines which one it is upon activation, and there is no fixed order of precedence among the media. For this reason, delete any which you do not wish to use for the measurement before switching the device on.
With USB, the Hot-Plug 21 functionality is available. Make sure that sufficient time is available for swapping the storage medium. How much time is required for de-registering and re-registering with the system depends on the particular storage medium and on the number of channels. As an orientation value, we recommend at least 30 s, even for simple configurations!

Do not use USB hard drives with external power supply
Please do not use any USB hard drive which has an external power supply. Such a drive may not be connected at the imc USB-port. Otherwise, when the measurement device is powered down, the imc USB-port's current limiting mechanism may be destroyed.</td></tr>
<tr><td>ExpressCard</td><td>Applicable to devices having ExpressCard slot (see "Device overview 95").

Remove any connected USB storage medium! Devices belonging to group A6 95 have two USB terminals and a slot for the ExpressCard. However, the device can use only one data storage medium. The system determines which one it is upon activation, and there is no fixed order of precedence among the media. For this reason, delete any which you do not wish to use for the measurement before switching the device on.
With ExpressCards, the Hot-Plug 21 functionality is available.
</td></tr>
<tr><td>CFast</td><td>Concerning devices with CFast slot (see "Device overview 95").

Remove a connected USB storage medium! The device can use only one data storage medium. The system determines which one it is upon activation, and there is no fixed order of precedence among the media. For this reason, delete any which you do not wish to use for the measurement before switching the device on.
With CFast cards, the Hotplug 21 functionality is available.
</td></tr>
<tr><td>SSD</td><td>Applicable to devices having a hard drive (see "Device overview 95").

With SSD hard drives, Hot-Plug 21 is not possible! If the SSD is used in a frame for removable data carrier, it can be exchanged while the device is deactivated.
SSD hard drives appear in the device software as a hard drive and an be read out via the Explorer-shell 23.
Due to the formatting, the content of the SSD in the PC is not displayed when the SSD is connected directly in the PC. SSD hard drives can only be formatted in the device 26.
In addition to the SSD, a CF/CFAST-card can be inserted in the measurement device and used alternatively.
</td></tr>
</table>

3.3.4.4.1.2 Data transfer

The internal storage medium can be accessed **directly via Windows Explorer**. Alternatively, the storage medium can be inserted into a **card reader** on the PC (suitable for large amounts of data due to faster transfer).

Warning

- Do **not use force** to insert or remove the device storage medium.
- During a **running measurement** having a high sampling rate, you should **never** try to **access the storage medium in the device** using the Windows Explorer shell. Otherwise, this additional burden could cause a data overflow.

Note

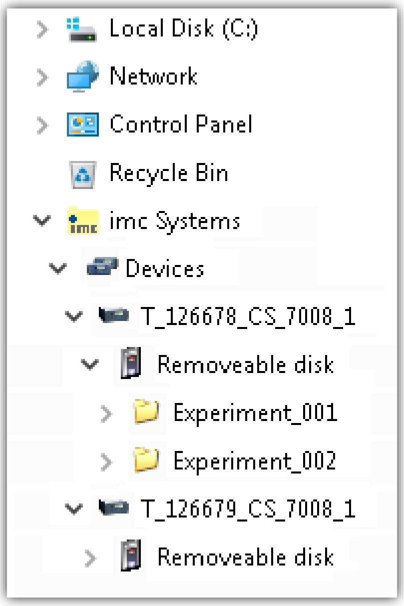
A tip on **interval saving**: Supposing the system's power supply suffers an outage during a measurement, it would not be possible to guarantee that the data file on the storage medium is terminated properly. This may lead to a failure to record the last measurement taken. Saving at intervals is a way to reduce this risk.

Access via Windows Explorer

The menu item "*Data (Device)*" () causes the Windows-Explorer to start while indicating the device selected.

Ribbon	View
Extra > Data (Device) ()	Complete
Home > Data (Device) ()	Standard

Access via "*imc Systems*" - an Explorer shell extension



While installing the operating software, if the option "*Extension for Windows-Explorer*" is activated, you are able to copy, display or delete the files of measured data saved within the device (e.g. on the removable storage medium). The method of doing this is the familiar one under Windows.

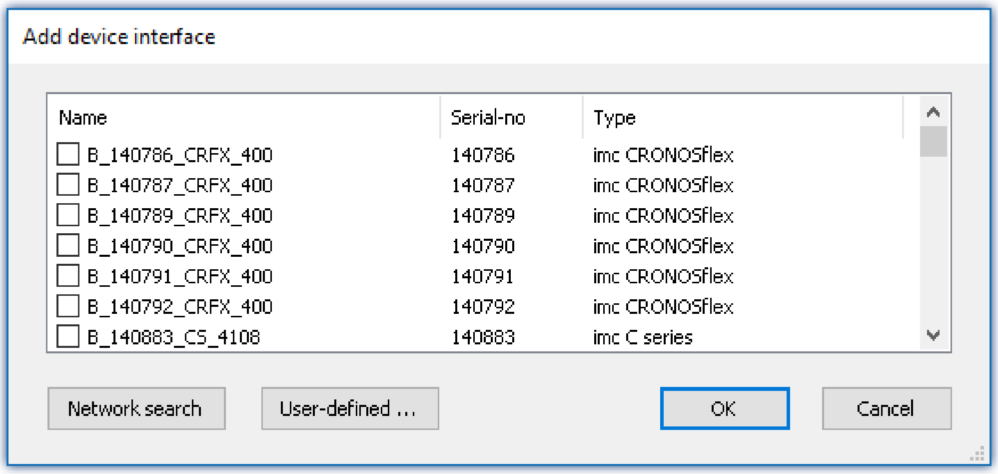
This function is independent of the device software. As well, selection of the devices in the tree diagram is independent of the device list in the operating software.

In order to get access to your device's storage medium, you must first add it to the tree diagram (see "*imc Systems - Adding a device* 24"). Subsequently, you are able to navigate to the desired data in the storage medium and thus to work with them.

Even if you have already been connected with the device by means of the imc STUDIO software, it is still not listed in the Explorer. It's possible to measure with one device while copying data from another.

- Click on "*Devices*" under "*imc Systems*" to highlight that entry.
- Open the context menu over the "*Devices*"-area and select "*Add*".

The "*Add device interface*" dialog appears:



Add Device interface

Search for devices	Description
Network search	"*Network search*" causes the system to search the network for any suitable devices. How long this will take depends on how many devices are connected and on the network type. Ultimately, the devices found are listed. Select your measurement device and confirm your selection with "*OK*". The measurement device is then available.
User-defined	In a structured network (network with routers, Internet, ...), imc devices could not be integrated by means of a network search. With the knowledge of the IP address or of the domain name (DNS name), it is now possible to integrate a device into the list.

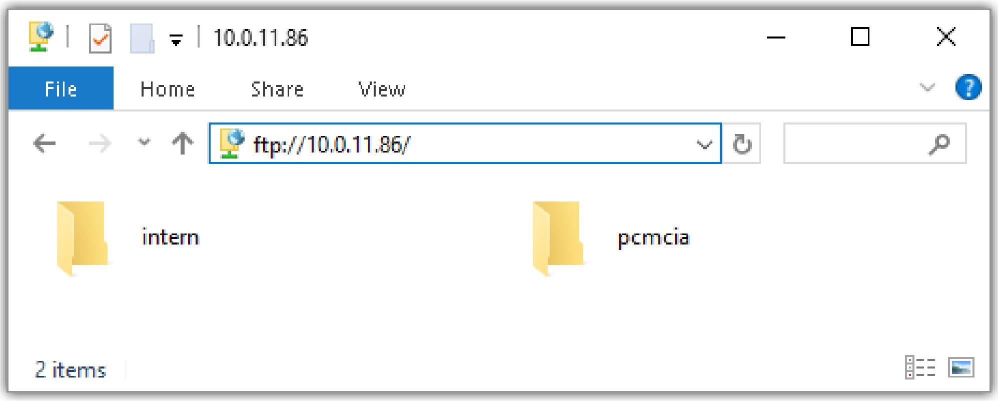
Reference

More information is presented in the imc STUDIO manual in the section: "*Setting Up - Connect the device*"

- General: "*Device connection via LAN*"
- "*Connection via a direct address*"

It is also possible to access the device's internal data via FTP, as well as to transfer data. Other goals are to change the configuration of devices via FTP and to restart the device for measurement with the altered configuration. Application areas include test drives, where there is no way to connect the devices directly with the device software. The Diskstart/Autostart capabilities are applied and enhanced. For this purpose, the device is usually configured for autostart. Upon activation, the configuration is loaded and the measurement, as well as data transmission, starts automatically.

Start the explorer and enter "*ftp://*" and the IP address of the device:



Note

- In general it is a read only operation. If you intend to delete files via FTP, you have to add "*imc@*" between "*ftp://*" and the IP address:
  Example: ftp://imc@10.0.10.219
- Furthermore, a password can be assigned to protect access via FTP. This password is entered into the device properties.

Warning

The following limitations apply when accessing the storage media in a device via an FTP-client:

- The device can't delete folders, accessed by a FTP-client.
- It is not possible to replace the storage medium during measurement (Hot-Plug).

3.3.4.4.1.3 File system and formatting

Storage media with the file systems FAT32 and FAT16 (maximum 2 GB) are supported. It is recommended that a memory card be formatted 26 and possibly partitioned before use.

Note Routine formatting protects the memory card

Routine formatting is recommended

Take every opportunity to format the storage medium. **Recommendation:** at least every **six months**.

In this way, any **damaged storage medium** can be detected and repaired if possible. A damaged file system may cause **data loss**. Or the **measurement system may fail to start** correctly.

In order to avoid data loss, any data still needed should first be saved!

Using a data storage medium in different devices

There are no known limitations. But it is recommended to always format the medium whenever transferring it in order to avoid data loss.

Additional notes

- To select the appropriate file system for the respective application, observe the notes on the data rate and on "*Avoidance of Data Overflow* 26".
- No limitations regarding the currently available storage medium volumes are known.
- The maximum filesize is 2 GB. In case a signal would exceed that limit, use interval saving.

Notes General restrictions applicable to file systems

Please observe the general restrictions regarding the respective file systems.

The formatting can be performed directly in the PC's hard drive by the Windows operating system, or in the device using the Explorer shell.

Note Recommendation

- **imc recommends formatting in the device:** In comparison to formatting by Windows, this provides higher data writing rates for high-speed channels.
- Only **one(!)** partition may be created. Multiple partitions may cause the measuring device not to recognize the storage medium.

Warning Please back up the data first

Formatting causes all data on the storage medium to be deleted. Before performing the formatting, ensure that all data have been saved on a different storage medium.

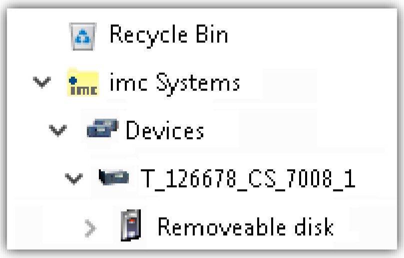
Note — Cluster size - Avoidance of Data Overflow

The size and number of assignment units (clusters) and thus also the file system 26 used have a substantial effect on the storage medium's speed! Small clusters can dramatically reduce the speed! If high data rates are required, it is normally recommended to have a size of 8 kB/cluster.

The optimum size of the clusters must be determined for each storage medium separately. For all of them, the following applies:

- **Few channels having a high data rate**
  If a few channels having a high data rate are being recorded, then **large clusters** on the data carrier provide better advantage. Formatting with FAT32 on the PC and drive sizes < 8 GB creates disadvantageously small clusters, which in conjunction with the full aggregate sampling rate can lead to a data overflow.
  Whenever using cards of up to 8 GB, always use the formatting by the device.
  In the device, cards larger than 512 MB are formatted with 8 kByte clusters and cards larger than 4 GB are formatted with 16 kByte clusters. Cards of up to 1 GB can alternatively be formatted by the PC with FAT16. With cards of 16 GB onward, there is no difference whether the formatting is done in the PC or in the device.
- **Very many channels with a low data rate**
  If hundreds of channels having a low data rate (e.g. CAN channels) are saved, the exact opposite is rue. Here, **small clusters** are an advantage. This means that drives with up to 8 GB should in such cases be formatted in the PC with FAT32.

Formatting in the device (Recommended)



For **formatting in the device**, navigate via the Explorer shell "*imc Systems* 23" to the desired device.

There, open the properties of the drive: context menu > "*Properties*" (not via the Navigation pane in the Explorer).

Go to the Property dialog under the tab: "*Tools*".

Start the formatting by clicking on "*Format now!*".

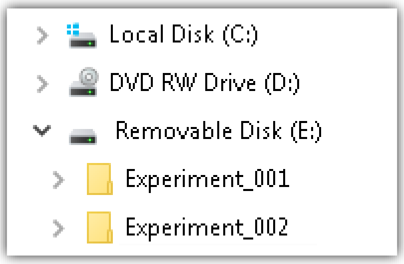
The device performs the formatting according to the following rule:

Drive size	Cluster size	File system
<= 512 MB	2 kB	FAT16
<= 4 GB	8 kB	FAT32
> 4 GB	16 kB	FAT32

Note

Formatting the storage medium is not allowed if an experiment whose data are to be saved internally has just been prepared.

Formatting using the Windows-Explorer



To perform **formatting of a storage medium via the Windows-Explorer** 25, navigate to the desired storage medium. Run the formatting by means of the context menu, for example.

Select one of the following two file systems: "FAT32" or "FAT" ("FAT16").

The file system "FAT32" is designed for media **larger** than 32 MB. Under no circumstances can smaller media can be formatted to "FAT32". With "FAT32", Windows generates 4 kByte clusters when the drive size is up to 8 GB, which is inconvenient for high-speed writing rates.

SSD hard drives are inherently formatted with Ext2 and for that reason **can not be formatted directly in the PC** , but only in the device 26.

However the Ext2 format offers these advantages:

- Mistaken duplicate occupation of individual clusters is not possible.
- Integration into the operating system is accomplished much more quickly than with FAT32.
- Higher writing output than with FAT32.

3.3.4.4.1.4 Known issues and limitations

Known issues and limitations	Description
If the memory card can not be read under Windows	The memory cards must first be partitioned (formatted) under Windows. Windows automatically generates the correct partitioning information. Subsequently, the memory card should be formatted again in the device. When in doubt, please contact our tech support 6.
The system won't recognize the data storage drive	• Answer 1: Check the file system: The device supports FAT32/FAT16 26. • Answer 2: If there are two storage media simultaneously plugged into your device, only one media will be detected (e.g. USB and CFast). Only the first plugged media will be detected.
File system becoming gradually slower	As the count of folders increases, so does the time required by the system to access the data. In consequence, the data saving procedure becomes slower and data loss becomes possible. For this reason, creating more than 1000 folders is to be avoided.
Errors in accessing the storage medium	Errors can have the following causes, among others: • The data rate is too high, the storage medium can't keep up and data overflow results. • The storage medium is full. The device signalizes any error by flashing this LED. Its further responses depend on whether or not the device is connected to the PC. • If no PC is connected, for instance in cases involving automatic self-start capability, the **button lights continuously**. At the end of an experiment, always check for this if measurements are taken without PC aid. • If the PC is connected to the measuring device, imc STUDIO documents the error with an **message in the Logbook** and switches the LED off. Any one-time data overflow only shows up in the Logbook, since the LED is reset afterwards. If data overflow occurs repeatedly, The LED is activated again, the PC records the message again, and as a result the LED **blinks intermittently**.
Data overflow due to improper cluster size	• With a storage medium formatted by Windows to FAT32 26, data overflow can occur if a high aggregate sampling rate is generated by a few high-speed channels. • With a storage medium formatted in the device 26, data overflow can occur if a high aggregate sampling rate is generated by very many low-speed channels.

3.3.4.5 Saving data in case of power outage

In case of an outage or interruption of the system's DC power supply, an internal buffer battery in the base unit ensures that any running measurement is ended in a controlled manner, that all measured data are safely transferred to the internal data storage and that the associated files are correctly closed. This procedure can take up to several seconds. Subsequently, the system shuts down automatically.

The standard-equipped system's internal supply buffering extends to the base unit, not the imc CRONOS*flex* Modules which are either directly stacked or connected by cable, and is provided for the purpose of preserving the data integrity under any conceivable operating circumstances.

Additional buffering for the entire system, including the imc CRONOS*flex* Modules, so as to ensure uninterrupted measurement operation even during phases of power failure, is also possible in conjunction with the optional UPS supply module which comes with the carrying handle. This makes mobile battery operation possible, or even bridge over power during vehicle starting processes. With UPS operation of this type, it is possible to set a so-called "buffer time": this time period specifies after how long a continuing power outage is no longer to be backed up, and thus when closure of the measurement and automatic deactivation are to be initiated.

3.3.4.6 Stabilized device supply and UPS (Power Handle)


Power Handle

Comprehensive systems with correspondingly high performance requirements can, in conjunction with low supply voltage and thus a high resulting current (e.g. 12 V in a vehicle), exceed the amperage capacity of the module terminal connections (max. 3.1 A). For this reason the possibility is provided to equip the left carrying handle with an optional supply unit, which generates a constant high system supply voltage of 50 V at max. 100 W from the 10 V to 50 V wide range supply voltage.

This not only makes it possible to reliably supply very large systems, but also to use the measurement modules' PoEC capabilities across the entire wide voltage supply range: according to PoEC specs, for PoEC functionality a minimum supply voltage of 42 V on the network line is required. This is provided by the supply unit in the handle for the entire 10 V to 50 V range. The optional handle 36 can additionally be equipped with a UPS function to ensure the device's operation even during a power outage. UPS units are available with a choice of either lead or Li-ion batteries.

3.3.4.7 Isolation and grounding concept

3.3.4.7.1 Isolation

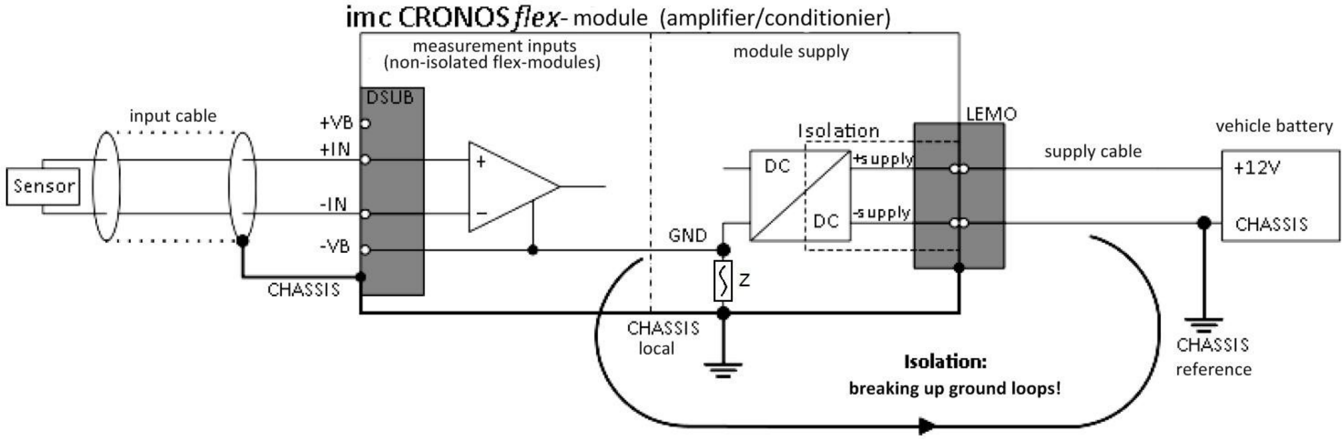
The imc CRONOS*flex* Modules' supply inputs are each isolated from the frame (CHASSIS) and measurement electronics. This ensures in particular that in spatially distributed systems, where no common CHASSIS or ground voltage for all subsystems can be assumed, neither uncontrolled ground loops nor compensation currents occur. Neither the base unit's supply input, nor the voltage it supplies to the measurement modules, is isolated. In a distributed system, therefore, the base-system's housing (CHASSIS), and the directly connected amplifiers, as well as their supply voltage level are to be seen as the central reference voltage (neutral point), to which the distributed satellites and their respective frames and supply voltages may each have a voltage differential. For the purpose of controlled grounding, each of the imc CRONOS*flex* Modules has a dedicated grounding contact on the lower part of its front panel.

Since the various housing frames and their reference grounds have a connection to the network cables via the shielding, it may be necessary to use network cables whose shielding has contact on only one side. In especially demanding applications, such as installation on board rail vehicles, where high static as well as dynamic ground differentials can exist across the various wagons, it is also possible to use fiber optic network converters for a pure optic EtherCAT system bus connection. Appropriate mechanically integrated converter modules for CRONOS*flex* are in preparation.

Concerning the isolation of imc CRONOS*flex* Measurement Modules' electronics from their respective frames, there are different options: modules both with isolated measurement inputs (e.g. ISO2-8) and without isolated measurement inputs (e.g. UNI2-8) are available.

3.3.4.7.2 Grounding concept

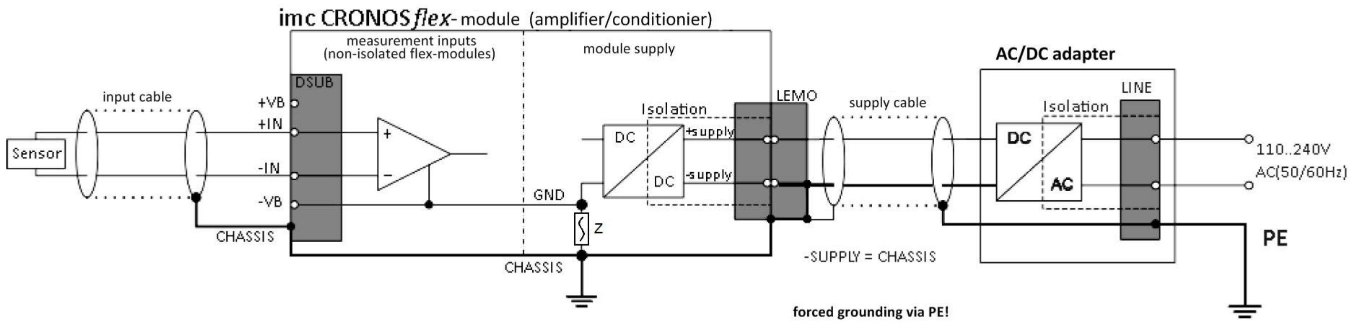
Isolated power inputs avoids ground loops in distributed topologies



Z describes a high-impedance connection that capacitively short-circuits RF interference.

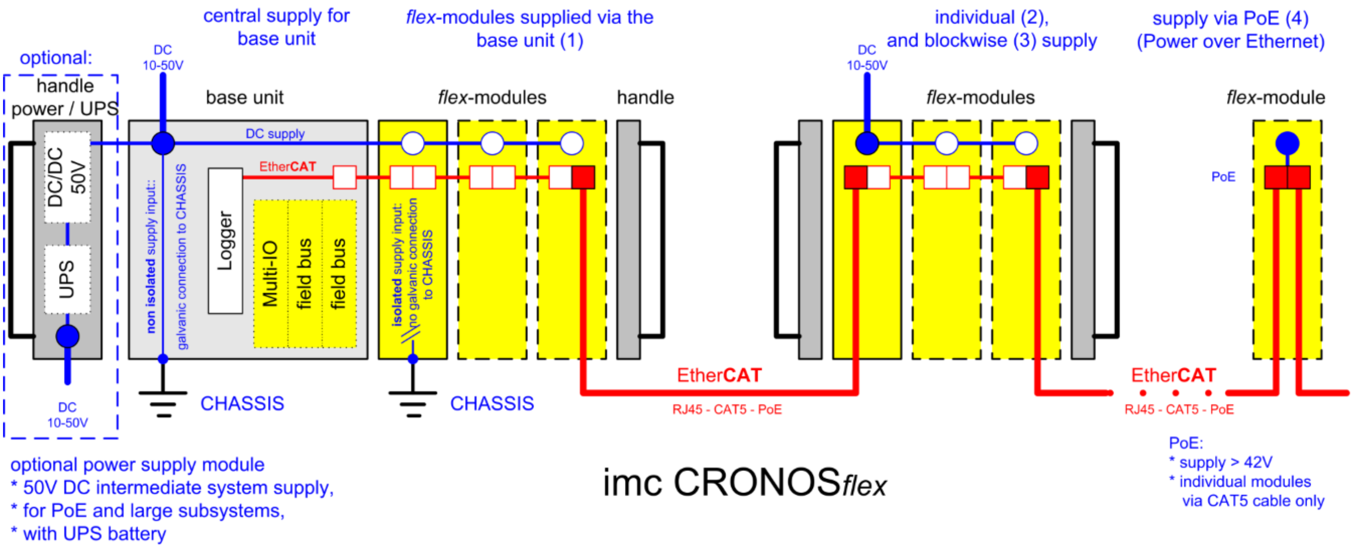
With stationary installations and the use of (already isolated) AC/DC adaptors, any system ground differentials between the device and the central or local power supplies may not be relevant. The big issue in such a case, in contrast to mobile, in-vehicle applications, is from where to obtain a reliable ground voltage. Since it is convenient to use the AC power supply's protection ground line as the ground voltage, the LEMO-terminated AC/DC adaptors for imc CRONOS measurement devices are designed so that the protection ground line is connected all the way through to the LEMO plug's housing, thus securing the device's voltage level to protection ground. Additionally, in the AC/DC-adaptor's LEMO-terminal (not the device's LEMO-socket!), the reference ground of the power adaptor is connected with the housing's (CHASSIS) protection ground: Since the AC/DC power adaptor is already isolating, as is the power input, this supply voltage's reference would not initially be defined and can be set arbitrarily. In particular for reasons of suppressing HF (high-frequency) interference signals stemming from the AC/DC switching power adaptor, direct grounding is normally advisable.

Forced grounding via the AC/DC adaptor's safety ground



3.3.4.8 Power supply options (CRFX)

3.3.4.8.1 Overview of power supply options



(1) via the imc CRONOS*flex* base unit

- for modules directly attached to the base unit
- multiple measurement modules operable at one base unit
- activation/deactivation via central main switch on the base unit
- in particular with low supply voltage and (12 V) and high resulting current, the plugs' maximum current carrying capacity (3.1 A) must be taken into account, which can limit the maximum size of a module block powered in common: max. 37.2 W (12 V)
- an optional supply module in the leftmost carrying handle ensures a common power supply for any size of blocks by providing a constant voltage of 50 V at max. 100 W for any input voltage between 10 to 50 V

(2) individual power supply

- for modules which are connected by CAT5 network cables across a wide area
- 10 V to 50 V DC via LEMO.1B socket
- activation/deactivation by connection of the power supply

(3) joint supply of a module substack

- a block can consist of: a base unit with signal conditioners, a block of purely signal conditioners and/or a block with a power supply module (the Power Handle)
- The power supply for stacked modules must always come via the LEMO-socket through the outer left module (looking at the conditioner terminals, the display and model plaque are on the left), the LEMO terminals of the other modules are then disconnected. A module's LEMO-socket is always deactivated whenever its neighbor to the left is directly connected via a module's plug-in connector. For the supply of the leftmost module within a block, the actual voltage is the higher of either the voltage applied to the LEMO or the voltage passing through the previous block's patch cable.
- activation/deactivation by connection of the power supply
- The maximum block-size depends on how high the supply voltage is (see above).

(4) via the Ethernet network cable

- according Power over EtherCAT (PoEC)

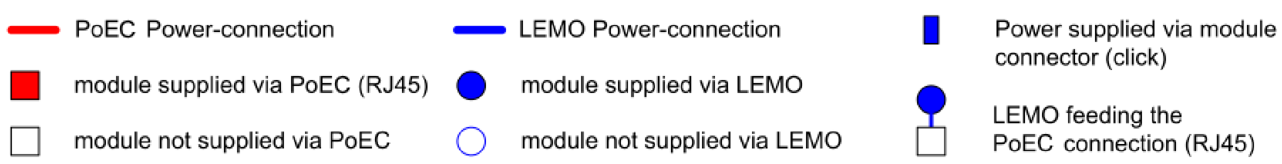
- PoEC – supply is also supported for multiple modules each connected via CAT5 network cables, however not for module substacks
  Maximum: 350 mA, corresponding to PoEC power: 16.8 W (48 V) or 17.5 W (50 V)
- activation/deactivation via power supplying module, e.g. central main switch on Base Unit
- minimum supply voltage of the module fed via network cable (base unit or measurement module): 42 V DC (e.g. optional AC/DC power adaptor with 48 V)
- An optional supply module in the left handle provides a constant voltage of 50 V adequate for PoEC, for any input voltages of 10 V to 50 V.
- Standard 230 V AC adaptor for PoEC can be used

3.3.4.8.2 Rules governing supply configurations

For the supply of imc CRONOS*flex* Modules (CRFX) via the LEMO socket, the modules' plug-in (clicking) connectors, or via PoEC, the following rules apply:

- current limit of module plug-in connectors: 3.1 A
- current limit for PoEC via network cable: 350 mA
- The PoEC supply lines are conducted via RJ45, but not via the module connector.
- The local supply for a stacked block of directly connected imc CRONOS*flex* Modules always comes from the leftmost module's LEMO socket: pin-encoding on the module connector distinguishes which neighboring module is connected "on the left" and blocks the module's own LEMO supply connection.
- A block's leftmost module obtains its power either from its LEMO terminal (which is connected in all cases) or from the voltage at the network cable's (RJ45 network cable's) PoEC line, whichever voltage is greater.

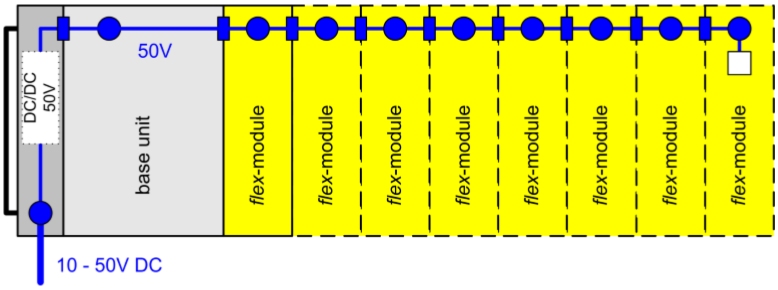
As a result, there are a number of different typical application topologies, presented below. The diagrams used employ the following symbols:



3.3.4.8.3 Directly stacked modules

imc CRONOS*flex* Modules can be stacked directly using a click-mechanism, thus not requiring extra power supply or cabling. Any signal conditioning modules directly connected to a base unit are jointly activated/deactivated by the base units main switch.

Directly connected imc CRONOS*flex* Modules with extra device power supply: stacked by "click"-mechanism



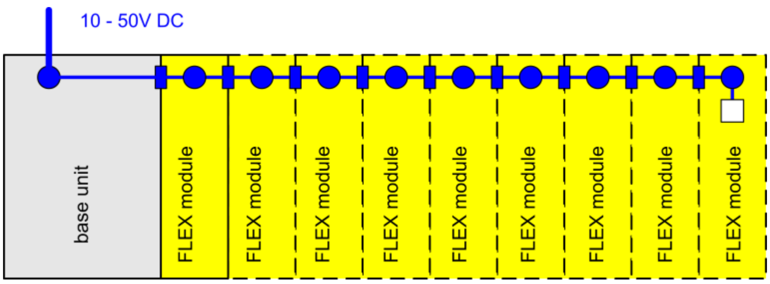
The current-carrying limit on the Module connector also limits the amount of signal conditioning modules which can be stacked directly. The higher the supply voltage is set, the less this limit matters, since the modules' (constant) power consumption leads to correspondingly low currents. The optional supplemental supply unit will convert the 10 V to 50 V input voltage to a fixed intermediate circuit voltage of 50 V at max. 100 W.

Thus, using the supplemental supply unit is the recommended configuration, especially in applications where only low voltage power supply is available (12 V vehicle) and extensive, primarily centrally-concentrated systems are set up.

If the supplemental supply is not used, then the wide-range (10 V to 50 V) rated supply voltage is used to power the modules, which means that at low voltages and correspondingly high currents there may be a maximum size for directly stacked module blocks to observe. However, this constraint by no means applies to the overall system, only to stacked blocks!

A distributed system of multiple, separately powered module blocks connected to each other by network cable is an easy way to circumvent any block-size limitation.

Directly connected imc CRONOS*flex* Modules without extra device power supply: stacked by "click"-mechanism



Note

Make sure that the overall power consumption does not pass the available power consumption.

Example

For 24 V, the maximum size of a block is 6 to 11 modules, depending on the module type. For a supply voltage of 12 V (vehicle battery), the limit is about 3 to 5. For each satellite block consisting only of signal conditioners without a base unit, one additional module is allowed, since the first connection carried by the plug-in connector is to the second module.

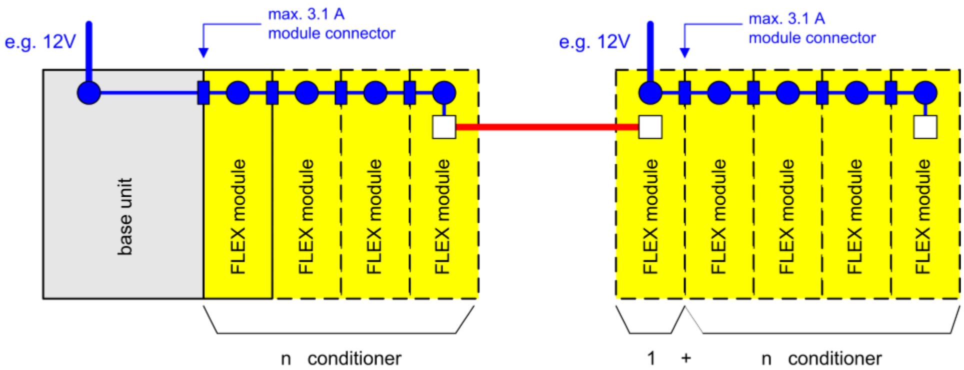
3.3.4.8.4 Overall system consisting of multiple blocks

For various reasons, it may be desirable or necessary to divide up a large block into multiple smaller blocks or even individual modules:

Example

- widely spaced placement in remote locations
- splitting up an unwieldy block into multiple (for instance, stacked) blocks at one central location
- the module connector's current limit (3.1 A) for a contiguous block has been reached, especially in the case of low DC supply voltage (e.g. 12 V in a car)
- the power limit of a DC supply source, for instance, a 60 W AC/DC adaptor has been reached

Distributed, separately supplied blocks of imc CRONOS*flex* Modules



Separately powered individual signal conditioners or conditioner blocks are activated/deactivated by connecting their respective supply voltage. They are not coupled to the base unit's global main switch.

The exact power data for the various conditioner types, and their resulting maximum count of directly stacked modules, appear in the detailed technical specs or in overview table 148. Otherwise, a convenient, interactive "Configurator" based on MS Excel is available, with which it is easily possible to check the supply needs and limits of any system topology.

The current at the module connector is prevented from exceeding the current limit by fuses (PTC). The trigger threshold for these fuses is temperature-dependent, and designed that even at maximum temperature, the rated current can be delivered reliably. For this reason, the trigger thresholds at lower temperatures or before the system is fully warmed up are typically higher. In case of overload, any directly connected conditioners are electrically disconnected, but not the base unit providing power, since its supply current is not carried by the module connectors.

3.3.4.8.5 Supplemental device power supply (Power Handle)

In order to provide adequate reserve power for any new modules attached, as well as sufficiently high voltage for PoEC operation, the optional power supply module Power Handle is available. As a DC/DC converter, it generates from an input voltage of 10 to 50V a constant, stabilized 50V supply able to power a large block of modules or a complete system.

The central main switch 46 of the connected base unit also indirectly controls the activation/deactivation of the supplemental supply power. The Power Handle does not have a separate pushbutton for activation/deactivation, but instead it has a (LEMO) Remote terminal.

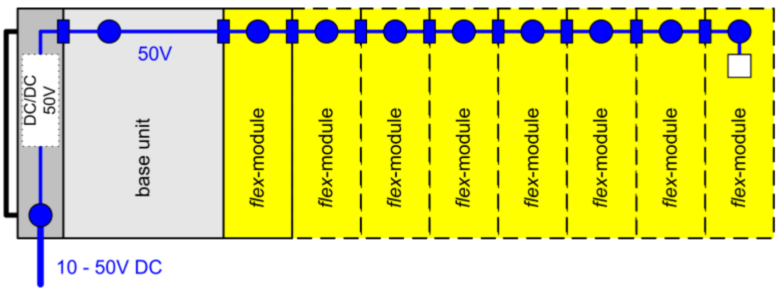
Remotely controlling the main switch of the system's supplemental power supply

As an alternative to manual activation and deactivation by means of the directly attached base unit's main switch, there is another controllable contact available for use at the socket designated "REMOTE". The Remote-Switch contacts respond similarly to the green push button on the base unit: Briefly connecting the signals "SWITCH" and "ON" activates the device, while connecting "SWITCH" with "OFF" deactivates it. Any button or relay contact used for this purpose must be able to conduct approx. 50 mA of current at max. 10 modules. The reference voltage for these signals is the primary power supply.

The signal "SWITCH1"serves to run the device with the switch continuously bridged: When "ON" and "SWITCH1" are connected, the device starts as soon as the external supply voltage is applied.If there is an outage of the supply voltage, the overall device's internal buffering is active for the duration of the buffer time constant set, and then switches off automatically. This operation mode is particularly designed for in-vehicle use, with fixed coupling with the ignition, and without manual control.

The additional contact "MUTE" (6) serves the purpose of muting the internal buzzer if necessary, by bridging the voltage to the reference voltage (5). The buzzer beeps to indicate that the external main power supply has failed and that the system is currently running on the internal buffer battery. This is very helpful for monitoring purposes, but can cause annoyance if acoustics measurements are involved. The beeping only begins 10 sec before elapse of the buffer time constant, meaning "soon" before the impending forced deactivation and (as of Revision 2 of the modules) can be completely suppressed by means of the MUTE signal. Before that, or in cases when longer time constants are set, reflecting typical applications of independent battery power, the beeping is suppressed as a rule, since it is usually not desired (similarly to a battery-powered Notebook).

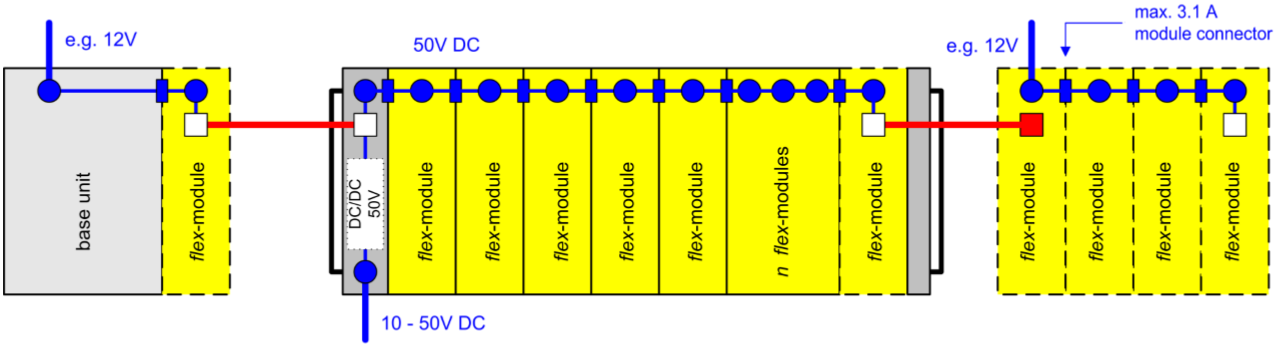
Supplemental device power supply (CRFX-HANDLE-POWER) for system power supply by means of 50 V intermediate circuit



Note

Make sure that the overall power consumption does not pass the available power consumption.

Supplemental device power supply for remotely installed conditioner block



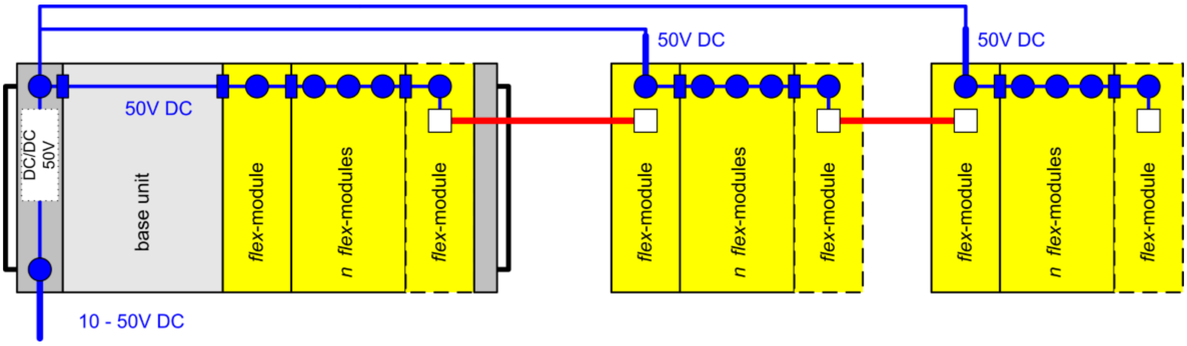
In conjunction with the supplemental power supply, a block only of conditioners can be activated not only by connecting the local power supply, but remote activation can be achieved by means of the connecting network cable. This means that this isolated island of modules can also be switched on/off by the base unit's main switch. However, this only applies to contiguous blocks powered by the supplemental supply.

When the supplemental supply is used and a large block is subdivided into multiple smaller blocks which are each to be supplied separately, then it depends on the size of these blocks whether they can be directly run on lower supply voltage (smaller blocks), or whether (in the case of larger blocks) they require higher voltage. In such cases, multiple parallel 50V output socket on the supply unit makes it possible to use them to supply additional satellite blocks with five 4-pin LEMO sockets on the rear side of the handle to supply additional satellite blocks.

Reference

Please see the pinout here 506 of the: Additional output supply sockets: LEMO 1B.304

Supplemental device power supply can supply multiple blocks



3.3.4.8.6 Overview of available operation and remote control modes

The power supply module (Power Handle) does not have its own main switch, but can be switched on/off in three ways:

- Manual main switch of a connected base unit
- REMOTE-terminal on the Power-Handle
- A controlling PoEC voltage delivered from outside to the Power-Handle's RJ45 jack "IN" (particularly for operating a blocks of dedicated conditioner modules, without a base unit!)

In conjunction with a connected base-unit, deactivation is not accomplished directly but instead always by means of a "Shutdown"-signal communicating with it. This provides both the ability to stop the measurement in a controlled way and reliable conclusion of data saving to the device, and thus total data integrity.

In consequence, the following possible scenarios lead to activation of the Power-Handle and the module block connected to it:

- The base unit whose push button is pressed is connected (regardless of the base-unit's Remote terminal!),
- a push button connected to the Power-Handle's Remote terminal ("SWITCH") is pressed,
- an external power supply (LEMO) is applied and a switch connected to the Remote terminal is closed ("SWITCH1"),
- an external power supply (LEMO) is applied, and additionally, a PoEC voltage higher than 3V is applied at the Power-Handle's EtherCAT terminal ("IN").

The power supply module switches itself off under the following conditions:

- The base unit is connected and after having been active it has been powered down and has deactivated itself. This in turn may be initiated in particular when, after an outage of the external power supply, the UPS buffer duration has elapsed and the base-unit has received a "Shutdown"-command from the Power-Handle.
- No base-unit is connected but only conditioning modules, and the voltage level of a PoEC voltage applied at the Power Handle's EtherCAT terminal ("IN") falls to below 2V.
- No base-unit is connected; sudden deactivation upon elapse of the UPS buffer duration in case of UPS operation, or in response to pressing the push button or throwing the Remote-terminal's switch.
- The Reset button on the front panel is pressed.

Note

During operation, a base-unit connected to the power supply unit receives a Shutdown-command if:

- a push button connected with the module's own Remote terminal is pressed,
- a switch connected with the module's own Remote terminal is opened, or
- in case of UPS operation, the UPS-buffer duration has elapsed.

3.3.4.8.7 Charging the internal battery of a Power-Handle having UPS-functionality

System power supply units (Power-Handles) having additional UPS functionality, i.e. an internal buffer battery, only charge up the battery if they are switched on. This is by intentional design, in particular for purposes of in-vehicle applications, in order to prevent accidental draining of a vehicle battery due to the considerable current draw for charging.

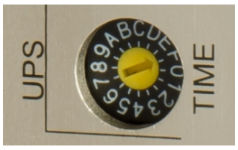
Therefore, if a Power-Handle having a UPS battery is to be charged separately from its measurement system, for instance in preparation for the buffer or in order to refresh it, by means of an AC/DC adaptor, while the rest of the system remains in the vehicle, then this Power-Handle module must be activated in "Stand Alone" mode. Since it doesn't have its own manual main switch, this can be accomplished by means of its REMOTE-terminal's remote control signals, for instance by bridging Pins 1 and 2.

Terminal connection Power-Handle:
(CRFX/HANDLE-POWER, CRFX/HANDLE-UPS-L, CRFX/HANDLE-LI-IO-L)

- Power supply: LEMO.EGE.1B.302 (female) multicoded
- Auxiliary output: 5x LEMO.1B.304 (female) (rear side of the handle)
- System bus (EtherCAT): RJ45 Buchse (EtherCAT IN)
- Remote control: LEMO.1B.306 (female)
- Module socket: 20 pin (System bus and power supply)

Position	Buffer duration
0	none
1	1 sec
2	2 sec
3	5 sec
4	10 sec
5	30 sec
6	1 min
7	2 min
8	5 min
9	10 min
A	30 min
B	1 h
C	2 h
D	5 h
E	10 h
F	maximum

The Power Handle provides the functioning of the overall system including all additional modules even during a power outage, thanks to battery buffering. UPS buffering is available with either lead batteries (CRFX-HANDLE-UPS-L) or Li-ion batteries as well as with extended battery capacity (CRFX-HANDLE-LI-IO-L). The supply module is protected by a non-resetable 20 A fuse at its input.



Both handles (CRFX-HANDLE-LI-IO-L and the CRFX-HANDLE-UPS-L) are equipped with a switch to set the buffer duration (table).

[1] no use with imc EOS

Short-circuit proof

Since theoretically any amount of imc EOS and imc CRONOS*flex* Modules could be connected to the supply module, the supply module comes with a power limiting circuit with long-term short-circuit protection. This circuit limits the power consumed to approx. 100 W.

When this limit is surpassed, the output voltage is cut, and then is enabled again after about 4 seconds. If the overload or short-circuit has still not subsided by that time, the system wait another 4 seconds etc. During the "waiting period", the supply module's Power-LED flashes at one-second intervals. The LED, designated "**LIMIT**" at the front of the Power Handle, is yellow if the output power consumption is more than 80 W and the LED will be red if the power consumption is more than 95 W.

Note

- The LED, designated "POWER" at the front of the Power Handle, is yellow in case of an operation in battery mode.
- If the Power Handle is connected to a imc EOS or a CRFX base unit please make sure that the LEMO supply socket is connected with the Power Handle! The supply of a block of modules always comes from the leftmost module (first module).

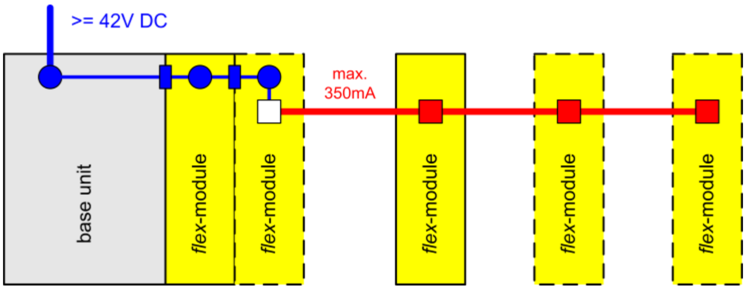
Reference

The meaning of the LEDs are described in the manual chapter: "Rechargeable accumulators and batteries".

3.3.4.8.8 Power over EtherCAT operation

imc CRONOS*flex* Modules can also be powered just from the network cable (EtherCAT-system bus), without any separate supply source. For this purpose a minimum voltage of 42 V is required, with a maximum current of 350 mA to be delivered.

PoEC - Supplying imc CRONOS*flex* Modules only via the network cable, without separate power source

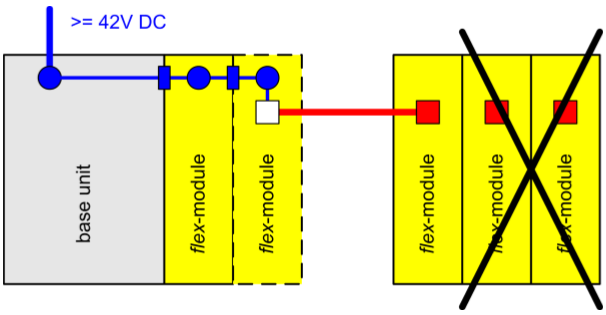


Depending on the power consumption of the module type used, up to three imc CRONOS*flex* Modules can be powered jointly. The overview table below 148 states the respective power consumption specs.

Since the PoEC supply lines are only available with at the RJ45 sockets, but not at the module plug-in connectors, multiple PoEC-powered modules must be mutually connected with network cables and not directly clicked together.

PoEC - Supplying of imc CRONOS*flex* modules:

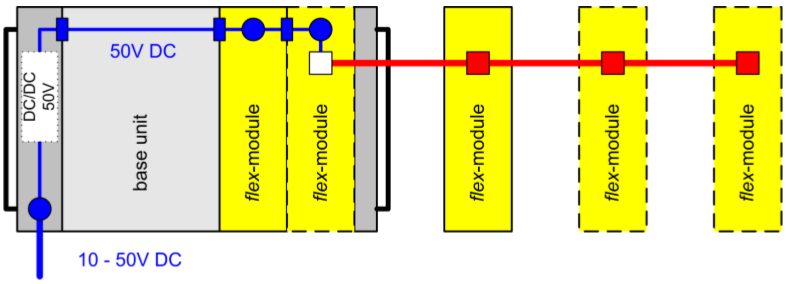
Instead of "snapping on", connection via network cable



PoEC-supply of one or more modules ensures indirect activation/deactivation through the supplying unit and thus, for example, remote switching by the base unit's main switch.

Since a minimum voltage of 42 V is required for the use of PoEC, the supplemental power supply can make this possible, if (for example on board a vehicle) the available voltage is insufficient, or if no 48 V AC/DC adaptor can be used.

Supplemental device supply for use of PoEC with low supply voltage



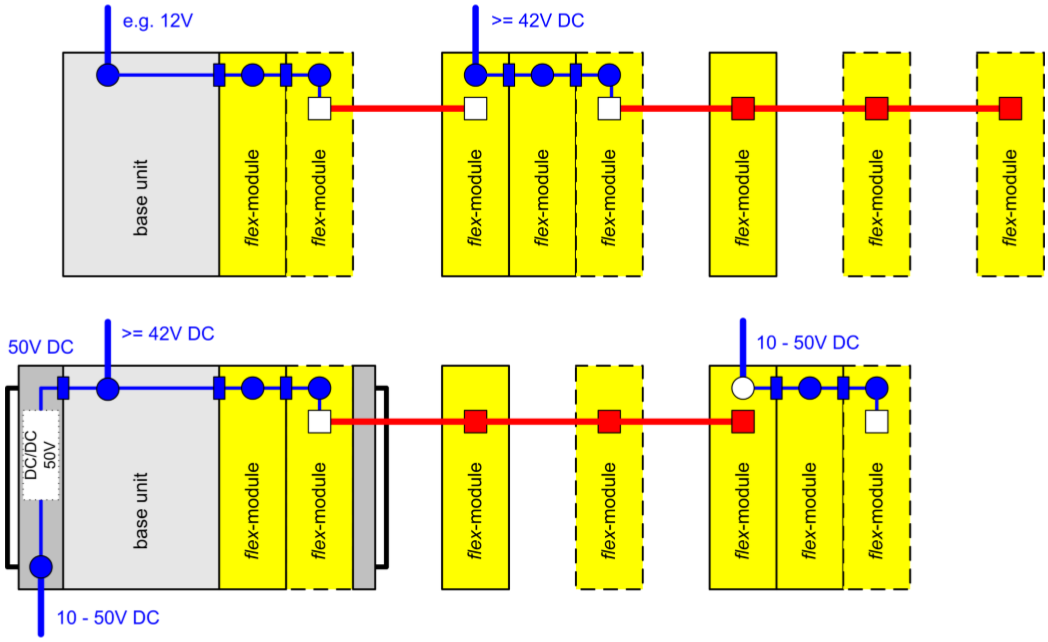
Note

The imc CRONOS*flex* CRFX/WFT-2 module does not support the PoEC operation.

3.3.4.8.9 Operation with multiple (varying) supply voltages

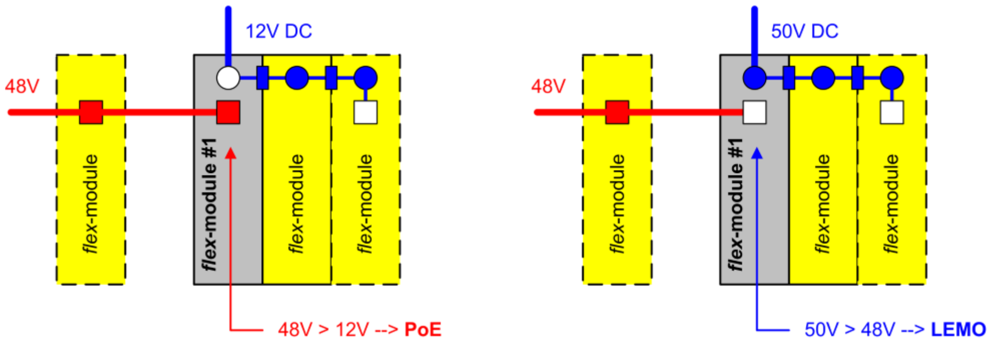
The minimum voltage requirement of 42 V for PoEC pertains to the respective module or block which supplies the PoEC module. This does not necessarily need to be the first block with the base unit, but it can be adequate for a purely signal-conditioning block as the PoEC-module's "predecessor" to deliver the voltage, or to be equipped with a 50 V supplemental supply.

PoEC requires at least 42 V just at the PoEC providing block



In operation with multiple supply voltages of various magnitude, a module's "leftmost" module can be a special case: Here, the rule is that the first module supplies itself from the higher of the two voltage sources (LEMO or PoEC on RJ45 patch cable). All of the block's other modules are supplied from the LEMO terminal in any case, which must be connected to the first module since PoEC supply cannot, as a matter of principle, be transmitted via direct click-together of modules. For the user, the significance is only that the block's first module, along with all others to its left, counts toward the maximum amount of PoEC modules supported.

PoEC – "far left" module in each block is supplied with the highest available voltage



3.3.4.8.10 PoEC-operation in stationary environment

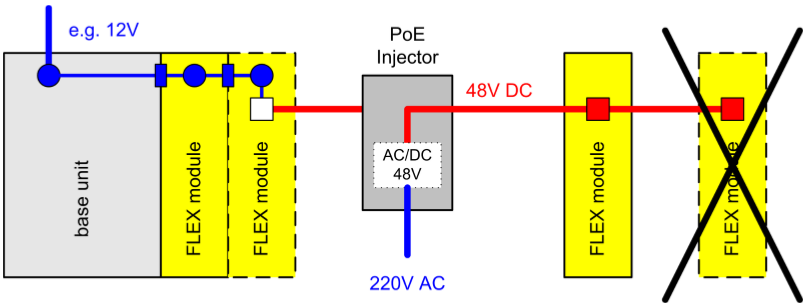
If PoEC-operation is intended for a stationary application where 220 V AC power supply is available, then a simple AC/DC adaptor with a 48 V DC output is available and is sufficient to power the entire system.

Note that other devices belonging to the imc CRONOS family or the imc C-SERIES are also equipped with LEMO plug, but are usually not compatible with the high supply voltage of 48 V: For these devices, the upper limit is generally 32 V !

The AC/DC-adaptor's plugs 18 having 48 V DC output are denoted. Keyway coding prevents plugging into imc C-SERIES devices, for example, in which 32 V is the upper limit. imc CRONOS*flex* modules have a keyway-coded socket which is designed to be compatible both with the coded plugs of the AC/DC-adaptor having the 48 V DC output, as well as with the adaptors for the 32 V.

Other applications can be imagined where there is already a DC system supply for other reasons, and a single PoEC module is to be integrated into the system: For this purpose, a standard "PoEC Injector" can be used, which is also available as an optional accessory. This special AC/DC adaptor is connected into a network, here the EtherCAT-system bus, via two RJ45 terminals. It separates the PoEC supply lines (not the network communication lines!) and supplies a 48 V. In accordance with IEEE 802.3, these injectors can only be used for "point-to-point" connection with a single device, even if the supply power would be sufficient for multiple modules. The reason is that according to PoEC specs, communication is set up with the device supplied for the purpose of adjusting the power parameters. Since, in contrast to standard injectors, the CRONOS*flex* system makes no use of such functions, this limitation to a single directly connected PoEC-module only applies in conjunction with an AC-injector, but not for CRONOS*flex* in general.

PoEC-operation with PoE injector (48 V PoEC AC/DC-adaptor)



As a rule, imc CRONOS*flex* also allows connection for a chain of PoEC-supplied modules (via individual network cables), as long as the total power is adequate. The maximum this can be is 50 V · 350 mA = 17.5 W. Depending on the module type, this is adequate for one to three imc CRONOS*flex* Modules.

Other applications can be imagined where a large number of modules is to be supplied via PoEC, e.g. because they are installed at a far distance (up to 100 m), and are badly accessible and without an available AC outlet. If this can not be solved by means of an additional supply module which would need to be located at a central position where AC/DC 48 V is available, then such a topology can also be achieved with a larger number of individual PoEC injectors.

3.3.5 Start of operation CRXT

Reference Start of operation

Please find in the following chapter a detailed description: imc CRONOS-XT (CRXT) 81.

3.3.6 Start of operation CRC, CRSL

3.3.6.1 Modularity

CRC systems

The devices belonging to the imc CRONOS*compact* (CRC) are modular systems. A variety of signal conditioners and digital I/O modules can be combined to a system.

Warning Changing modules

Changing modules is only permitted for users trained by imc or imc service and in agreement with imc! Devices having HV modules (HV-2U2I etc.) do not support exchanging of modules (device safety!).

The following constraints, however, apply:

- Within the device, the necessary supply voltage is made available by a central power supply unit. A maximum supply current is specified for each supply voltage. The allowable current load on the voltage supply line is different for each module type. In addition, the power for the supply of an external sensor (e.g. supply of a strain gauge measurement bridge) must be taken into consideration. The supply power required by the power supply unit is tested at the factory. In the process, the power consumption of the modules ordered is taken into account. Power reserves can be requested from imc, if desired. If modules are subsequently added to a system which has already been shipped, it is absolutely necessary to check whether enough reserve power is available! As a matter of principle, only trained service personnel should install new system modules!
- Individual modules are distinguished by "module addresses". These module addresses must be configured prior to installing the module (e.g. DIP-switch, rotary switch, soldered jumpers). Previously existing addresses of other modules must be taken into account. If the same module address appears multiple times, conflicts will arise and the modules affected will either not be recognized by the device software at all or only incorrectly. This generally leads to errors which are hard to identify!
- The addresses of the module DI16-DO8-ENC4 can't be changed and are set to: DI4-16 (Addr. 1), DO8 (Addr. 0). That has to be considered, when addressing other digital modules (DI-16, DO-8, ENC-4). The variant of this multiboard with an additional DAC-4 will need an additional address. A further multiboard DI16(8)-DO8-ENC4(-DAC4) can be added without gap.
- For safety reasons high voltage modules (HV4U, HV2U2I etc.) are **not to be changed** by a customer!

CRSL systems

The devices of the imc CRONOS-SL (CRSL) series are factory configured devices. You can freely combine signal conditioning and digital I/O modules into one system. However, you **cannot** add new modules after delivery of an imc CRONOS-SL system, as for example with imc CRONOS*compact*.

3.3.6.2 Power supply

Measurement devices of the imc CRONOS system family are powered by a DC supply voltage which is supplied via a 2-pin LEMO-plug.

Device	LEMO plug type designation	Size
imc CRONOS-SL2/-SL4	FGG.**1B**.302.CLAD.62ZN	(middle)
imc CRONOS*compact*	FGG.**2B**.302.CLAD.82ZN	(big)
imc CRONOS*flex*	FGE.**1B**.302.CLAD.52ZN (with 2 coding keys 18) *	(middle)

The permissible supply voltage range with is 10 V to 32 V DC. The standard product package includes a desktop supply unit with 15 V DC (<60 W) or 24 V DC (<150 W). On the input side the AC-voltage of the desktop supply is 100 V to 240 V 50/60 Hz. Measurement devices of imc CRONOS*flex* family are powered by LEMO terminal for an ultra-wide 10 to 50 V range of DC power 18 input. With regard to EN 61326-1 and EN 61010-1, the DC supply inputs are not specified for connection to a DC mains supply. DC networks are particularly extensive supply installations in the industrial sector. For these, increased safety margins are assumed for expected transient overvoltages in the event of a fault. This is comparable to the safety categories CAT II..IV in AC mains voltage systems.

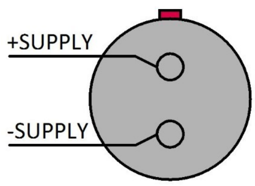
Note Desktop supply unit

Please note, that the operation temperature of the desktop supply is prepared for 0°C to 40°C, even if your measurement devices is designed for extended temperature range!

The package also includes a cable with a ready-made LEMO-plug which can be connected to a DC-voltage source such as a car battery. When using this, note the following:

- Grounding of the device must be ensured. If the power supply unit comes with a grounding line, it would be possible to ground the system "by force", by making a connection from this line to the plug enclosure (and thus to the device ground). The table-top power supply unit is made to allow this.
  This manner of proceeding may not be desirable because it may be desirable to avoid transient currents along this line (e.g. in vehicles). In this case the ground-connection must be made to the device directly. For this purpose a (black) banana jack ("CHASSIS") is provided.
- The feed line must have low resistance, the cable must have an adequate cross-section. Any interference-suppressing filters which may be inserted into the line must not have any series inductor greater than 1 mH. Otherwise an additional parallel-capacitor is needed.

Pin configuration:



The +pin is marked with a red dot.

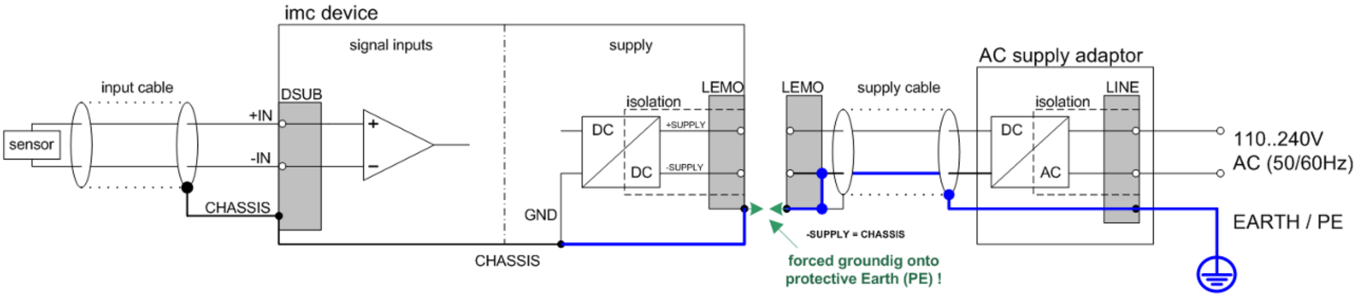
* starting from September 2011 18, imc CRONOS*flex* Modules and Base Units (see type label)

3.3.6.3 Grounding, shielding of the devices

In order to comply with Part 15 of the FCC-regulations applicable to devices of Class B, the system must be grounded. Grounding is also the condition for the validity of the technical specifications stated.

3.3.6.3.1 Grounding with the use of the included power adaptor

The DC-supply input on the device itself (LEMO socket, female) **is galvanically isolated** from the housing (CHASSIS): -SUPPLY input is not connected to CHASSIS internally. That means the decive's internal power supply circuitry comprises isolating DC/DC converter.

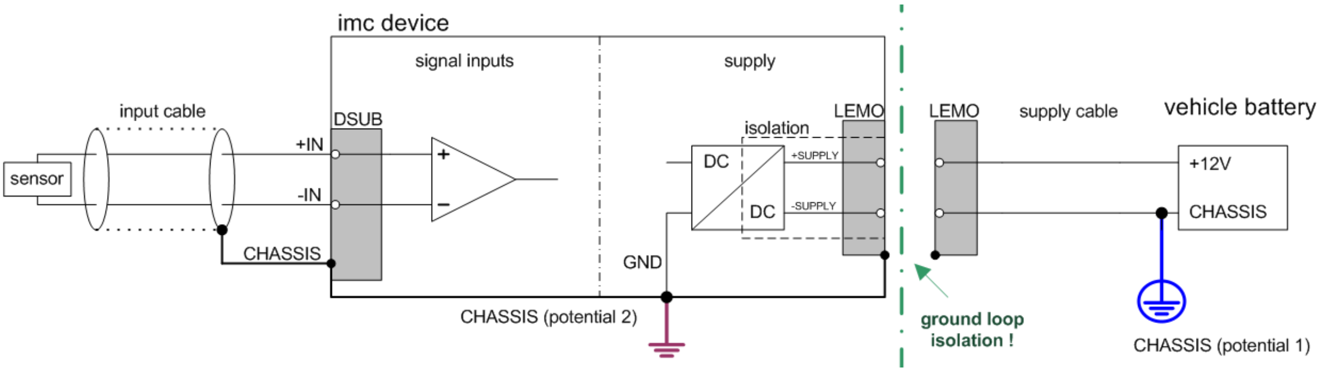


imc CRONOS-SL and imc CRONOScompact with desktop power supply unit

Use of the desktop power supply unit, included in the package, ensures proper grounding via the plug's protective earth terminal: the supply voltage's (-) pole as well as the shield and plug enclosure are connected to the cable's ground.

3.3.6.3.2 Grounding with power supplied by a car battery

If the power supply (e.g. car battery) and the measurement device are at different voltage levels, then if they were connected by the supply line, it would cause a ground loop. For such cases, the isolated internal device power supply ensures separation of the two voltage levels. The ground reference for the measurement device must then be established in a separate step.



imc CRONOS-SL and imc CRONOScompact powered by an isolated DC-voltage source (e.g. battery)

For running on an isolated DC power supply source (e.g. battery), either the grounding socket terminal, a grounding contact on the device ("CHASSIS"), or the CHASSIS contact on the imc signal plugs must be used.

Isolated power inputs avoids ground loops in distributed topologies

With stationary installations and the use of (already isolated) AC/DC adapters, any system ground differentials between the device and the central or local power supplies may not be relevant. The big issue in such a case, in contrast to mobile, in-vehicle applications, is from where to obtain a reliable ground voltage. Since it is convenient to use the AC power supply's protection ground line as the ground voltage, the LEMO-terminated AC/DC adapters for imc measurement devices are designed so that the protection ground line is connected all the way through to the LEMO plug's housing, thus securing the device's voltage level to protection ground. Additionally, in the AC/DC-adapter's LEMO-terminal (not the device's LEMO-socket!), the reference ground of the power adapter is connected with the housing's (CHASSIS) protection ground: Since the AC/DC power adapter is already isolating, as is the power input, this supply voltage's reference would not initially be defined and can be set arbitrarily. In particular for reasons of suppressing HF (high-frequency) interference signals stemming from the AC/DC switching power adapter, direct grounding is normally advisable.

3.3.6.3.3 Shielding

Also, all signal leads to the device must be shielded and the shielding grounded (electric contact between the shielding and the plug housing "CHASSIS").

To avoid compensation currents, always connect the shielding to one side (potential) only.If the imc DSUB block screw terminal plug is used, the shielding should be connected to the pull-relief clamp on the cable bushing. This part of the conductor-coated plastic plug housing has electrical contact to the device's housing, just as Terminals 15 and 16 (labeled: "CHASSIS", to the left and right of the imc-plug cable bushing) do; but is preferable to the "CHASSIS" terminals for optimum shielding.

3.3.6.4 Main switch

Switch on

The **device's main switch** is a **power-on button** with a built-in "POWER"-LED which must be pressed down for approx. 1 sec. to achieve activation, indicated by the "POWER"-LED flashing. If the device boots correctly, three short beep-tones are emitted.

Switch off

To switch the device off, press the power-on button again down for approx. 1 sec, what will cause a constant blinking of the "POWER"-LED. This causes the device to not be deactivated abruptly during a running measurement. Instead, any files on the internal hard drive involved are closed before the device switches off by itself. This process takes up to 10 sec. Holding the power-on button down is not necessary!
If no measurement is currently running, it takes only approx. 1second for the device to be deactivated.

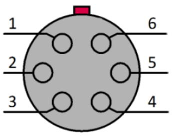
Some older imc measurement instruments may be equipped with a rocker-switch as main switch. It must be pressed down to the "ON"-side (upper portion) for approx. 1 sec to achieve activation, indicated by the "POWER"-LED flashing (e.g. CRONOS-PL devices). To switch the device off, press the rocker switch down on the OFF-side (lower portion) for approx. 1 sec.

3.3.6.5 Remote control

As an alternative to the manual main switch, imc devices can be switched on or off remotely with a wiring of the corresponding signals of the remote plug. There are several functions and operating modes available. The most common operating mode, available for all types, is the basic ON/OFF push button action performed with one single temporarily closing contact: connecting the signals "ON/OFF" and "SWITCH" for at least a short time, activates the device. The following table lists imc devices and the corresponding socket type.

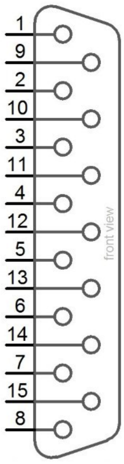
imc device	Remote socket
CRONOS*compact* (CRC), CRONOS-SL (CRSL), SPARTAN (SPAR)	DSUB-15
CRONOS*flex* Base and the Power Handle (CRFX)	LEMO.EGG.1B.306 (6-pin, middle big)
C-SERIES (CL)	LEMO.EGG.0B.306 (6-pin, small)

Pin configuration



view on device front

LEMO Pin	Signal name	Remarks
1	ON/OFF	LEMO Pin 1 and Pin 3 are internally bridged, two operating modes are supported: SWITCH and SWITCH1
2	SWITCH1	automatic activation when external power supply is connected, → permanently jumpered to ON/OFF, e.g. in vehicle
3	ON/OFF	
4	SWITCH	activation, deactivation like a push button, → briefly jumpered to ON/OFF, like the main switch
5	MUTE_GND	
6	MUTE	muting the UPS buzzer, only with the CRFX Power Handle



view on device front

DSUB-15 Pin	Signal name	Remarks
1	RESET	immediate deactivation without saving, will cause lost of data
9	OFF	
2	SWITCH	activation, deactivation like a push button, → briefly jumpered to ON/OFF, like the main switch
10	ON	
3	SWITCH1	automatic activation when external power supply is connected, → permanently jumpered to ON/OFF, e.g. in vehicle
11, 4 und 12	n.c.	
5	MUTE	muting the UPS buzzer, e.g. for acoustic applications
13	ON/OFF	
6, 14, 7, 15, 8	n.c.	

Note

When the SWITCH and ON/OFF signals are bridged with a switch, the device remains permanently on. In this case, the main switch has no effect.

3.3.6.6 UPS

Devices with DC supply input are equipped with an uninterruptible power supply (UPS). This allows for a continuous operation unaffected by temporary short-term outage of the main power supply. This type of operation is particularly useful for operation in a vehicle, permanently attached to starter lock and main power switch and thus not requiring manual control. Activation of UPS buffering is indicated by the power control LED (PWR) changing from green to yellow. With many imc measurement devices, active UPS buffering is additionally indicated by an acoustic buzzer signal.

The UPS provides backup in case of power outage and monitors its duration. If the power outage is continuous and if it exceeds the specific device's "buffer time constant", the device initiates an automatic shutdown sequence, which equals manual shutdown procedure: Any current active measurement is automatically stopped, data storage on flash card or internal harddisk is completed by securely closing all data files, and finally the device is actually switched off. This entire process may take a couple of seconds.

Thus, a typical application of this configuration is in vehicles, where the power supply is coupled to the ignition. A buffer is thus provided against short-term interruptions. And on the other hand, deep discharge of the buffer battery is avoided in cases where the measurement system is not deactivated when the vehicle is turned off.

If the power failure is not continuous but only temporary, the timer that monitors blackout duration is reset every time the main supply has returned to valid levels. The buffer time constant is a variable device parameter that can be configured according to system size and battery capacity. It can usually be written into the device under software control and is preconfigured to reasonable default values upon delivery (see description in the software manual).

Reference

For the UPS module of the imc CRONOS*flex* series (optional handle with UPS 36), buffer time constant is set with a manual switch accessible on the front panel.

3.3.6.6.1 Buffering time constant and maximum buffer duration

The buffer time constant is a permanently configurable device parameter which can be selected as a order option. It sets the maximum duration of a continuous power outage after which the device turns itself off.

The maximum buffer duration is the maximum (total) time, determined by the battery capacity, which the device can run on backup. This refers to cases where the self-deactivation is not triggered; e.g., in case of repeated short-term power-interruptions. The maximum buffer duration depends on the battery's current charge, on the ambient temperature and on the battery's age. The device automatically deactivates itself just in time to avoid deep discharge of the battery.

Note

The buffer time constant can be changed using the imc operating software.

Reference

- See description in the manual of the imc operating software:
  > Operation > User Interface > Device - menu > Properties...: Entry UPS

3.3.6.6.2 Charging power

The charging power depends on the device type, its hardware configuration, and the amount and type of rechargeable batteries installed. For this reason, there are a variety of combinations with charging power between 2.4 W and 16 W.

3.3.6.6.3 Take-over threshold

The voltage threshold at which the storage battery takes over the power supply from the external source is approx. 9.75 V. The take-over procedure is subjected to an hysteresis to prevent oscillating take-over. This would be caused by the external supply's impedance. This inevitable impedance lets the external supply rise again, right after take-over to internal buffering. Hysteresis in the take-over threshold will prevent oscillations due to this effect. If, during supply from of the buffering battery, the external supply voltage rises as high as 10.9 V , the external voltage takes over again from the buffering battery.

If you check these thresholds, note that when the supply voltage is overlaid with a high frequency interference or ripple-voltage, the minima are of key importance. In fact, the overlying interference could be caused by feedback from the device itself.

Note

- The voltage specification refers to the device terminals. Please consider the voltage drop of the supply line, when determining the voltage supply.
- During activation the supply voltage must be above the upper take-over threshold (≥11 V).

3.3.6.6.4 Rechargeable accumulators and batteries

3.3.6.6.4.1 NiMH batteries

The lead-gel batteries are replaced by a solution with NiMH batteries. For you as a user, this change does not represent a significant change in his previous operation of the device. The battery type is marked on the device type plate: "**Contains NiMH Battery**" so that the devices can be distinguished externally.

Reference

- Please find here the technical specs - UPS with NiMH batteries 331.
- Devices from the imc CRONOS system family delivered by imc after November 2022 will have a "battery label" 10 on the nameplate for integrated energy sources.

Lead-gel batteries

Devices build before 2017 come with the optional UPS-Function containing maintenance-free **lead-gel batteries**. Charging these internal backup batteries is accomplished automatically when the activated device receives a supply voltage. Due to the inevitable leakage of charge we recommend that the device be activated for 6 to 9 hours at least every 3 months to prevent the batteries from dying.

In case the UPS is used a lot (many discharge and recharge cycles), the life time depends on how much (deep) it has been discharged (is the UPS buffering only for a short time or is the UPS discharged completely every time?). The manufacturer specifies 200 cycles @100% discharging and 1200 cycles @ 30% and 25°C ambient temperature. (that should be true in general for all Pb batteries.)

Do **not** throw the lead-gel accumulators in the household garbage.

3.3.6.6.4.2 Li-ion batteries

Devices can be equipped with an UPS supply unit, based on large capacity Li-ion batteries that allow for very long backup buffer duration. Devices with Li-ion batteries are equipped with power supply input circuitry that is galvanically isolated from the device housing (CHASSIS). Note that all instructions regarding grounding and shielding for devices with isolated power supply input apply. Li-ion UPS modules feature intelligent charging control. Charging of the batteries is performed automatically when the device is switched on and receives an external supply voltage.

The Li-ion batteries (Smart Batteries) are accessible for exchange, with a keyed insertion mechanism, secured against reversed polarity. They are installed at the bottom of an imc CRONOS*compact* (CRC) device. With imc CRONOS*flex* (CRFX) the Li-ion batteries are accessible on the rear side of a handle: CRFX/HANDLE-LI-IO-L.

imc CRONOScompact with two Li-ion battery packs
The batteries are equipped on the bottom.

imc CRONOScompact with two Li-ion battery packs
The batteries can be inserted easily, the connections are protected against polarity reversal.

Note

- Due to the inevitable leakage and self-discharge of the Smart Batteries we recommend a regular recharging cycle at least every 3 months that a device has not been in use (device must be switched on for charging).
- imc recommend maintenance every 2 to 3 years and for extended temperature range every 1 to 2 years

Do not deposit Li-ion batteries in domestic recycling containers!

Reference Li-ion battery

Please find here technical specs! 337

Notes on Li-ion Smart Batteries:

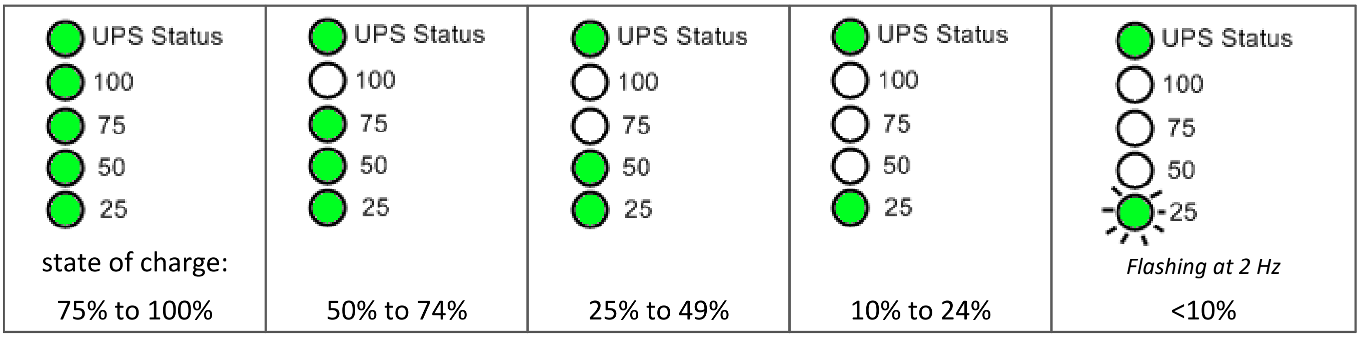
- Failing to adhere to the recommended temperature ranges for storing, charging and discharging will not render the battery pack unsafe but will reduce its life expectancy and capacity.
- If Smart Batteries are stored in low charge state (<10%) they will age faster.
- When storing discharged Smart Batteries, internal deep discharge protection circuitry may get activated. This will cause the following charge cycle to run through a reactivation procedure, starting with a very low charging current. This may prolong the required charging time.
- Prolonged storage of discharged batteries is not recommended and may cause irreversible damage to the battery!
- The battery may temporarily deactivate itself in response to:
  -excessive temperature
  -excessive discharge current (e.g. due to short circuit)
  -insufficient cell voltage (to prevent discharge)
  Otherwise the UPS is operable as long as the battery does not prevent discharge.
- Once the passive temperature fuse has been triggered, it cannot be reset and thus renders the battery pack unusable. The rated temperature may not be exceeded!
- For safety reasons, the Li-ion batteries may not be exposed to temperatures exceeding 100°C!

Note

In order to preserve maximum life expectancy of the Smart Batteries they should be recharged at least every 3 months. The device must be switched on for charging!

State of charge indicator of the Li-ion batteries

The state of charge of the Li-ion batteries is indicated by different signal patterns of the LEDs. The position of the LEDs on your measurement device can differ from the pictures below. The following signal patterns can be interpreted as follows:



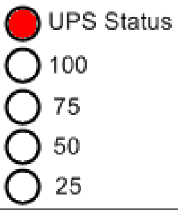
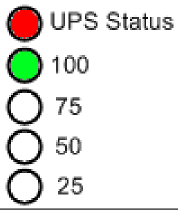
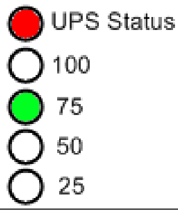
During active charging the last active one of the four green status LEDs flashes at a rate of approx one second. In contrast to this, the warning signal at very low state of charge (<10%) consists in the lowermost ("25") flashing at an even faster rate.

The UPS Status LED is bicolor. In case of an error it flashes red.

Error Conditions

If the UPS Status LED flashes alternating red and green, a long term continuous battery operation is inhibited due to high battery temperature of 60°C ≤ ϑ <75 ±5°C (1) . In this case, the buffer time constant of the UPS is reduced to 15 seconds, regardless of the configured setting. Thus, in case of an outage of the external power supply automatic shutdown procedure will already be initiated after 15 seconds, stopping the current measurement, storing all data and turning off the device.

The following error conditions are indicated by LED signal patterns:

<table>
<tr>
<td>Battery is not present or cannot be detected
</td>
<td>Internal Error (UPS may not be operable)
</td>
<td>Battery operation is inhibited and the UPS is not operable ϑ ≥ 75 ± 5°C (2)
</td>
</tr>
</table>

(1) ±5°C due to tolerances of internal temperature measurement of the battery

(2) Internal protection circuitry prevents discharge at temperatures above ϑ ≥ 75 ± 5°C. The UPS may only be operable again once the batteries have cooled down to 65°C.

The following picture display the front of devices with integrated Li-ion batteries. The exact position of status LED can differ between each system.

CRC Rack

CRC portable housing

CRFX Power Handle (Li Ion)

3.3.6.7 Storage media in the device

This section describes how to handle the storage media of the imc measurement devices and how to use them with imc STUDIO.

The storage media are exclusively for data acquisition with imc STUDIO.

Storage media with verified performance can be purchased as accessories from imc. Hard drives are ordered with the device and can only be installed subsequently by imc.

Note	Manufacturer and Age of the storage medium

- imc has no way to affect the quality of the removable storage media provided by the various manufacturers.
- Storage media which come with newly purchased devices have been inspected in the framework of quality assurance and have passed the relevant tests.
- We expressly declare that the use of removable storage media is at the user's own risk.
- imc and its resellers are only liable within the framework of the guarantee and only to the extent of providing a substitute.
- imc expressly declines any liability for any damages resulting from loss of data.

3.3.6.7.1 For devices of the firmware group A (imc DEVICES)

Swapping the storage medium

Pressing the button signalizes to the system that you intend to remove the storage medium. Once this is done, the device stops access to the storage medium. If you were to remove the drive without prior announcement, it could produce defective clusters. If the storage medium is removed while a measurement is in progress, the data records are not completed. Therefore, always proceed as follows when swapping the storage medium:

1. **Important!** Before removing the storage medium from the measurement device, first announce the procedure to the system by pushing the button, in order to **avoid damage** to the storage medium.
2. Once the LED blinks, remove the storage medium.
3. Insert the new storage medium. Devices indicate by a short flash that the new drive has been successfully recognized.

Hot-Plug (exchanging the storage medium during a measurement)

It's possible to exchange the storage medium during a running measurement. This makes it possible to carry out a measurement without a PC practically without any limitations. It is only necessary to check the amount of memory available using imc Online FAMOS. To do this, use the function `DiskFreeSpace` belonging to the group "*System*". You can set an LED, for instance, or a digital output or a beeper to be activated when less than the minimum amount remains. One convenient solution would be to have a readout of the remaining space outputted by a display variable, which would indicate by a display on the device how the remaining memory decreases.

While swapping the storage medium during a running measurement, the data are stored in the measurement device's internal memory. If you complete the process within the specified RAM buffer duration, this is certain to work without any loss of data (see in the imc STUDIO manual "*Setup pages - Configuring device*" > "*Storage options and directory structure*" > "*RAM buffer time*"). Note that not only the time for the swap must be buffered, but that the buffered data must also be transferred to the new disk once the swap has been completed.

Swapping the storage medium

1. **Important!** Before removing the storage medium from the measurement device, first announce the procedure to the system by pushing the button, in order to **avoid data loss and damage** to the storage medium. The LED will **shine continuously** in green.
2. Once the device is ready for removal of the storage medium, the LED **blinks**.
3. Remove the already full storage medium.
4. No announcement is necessary for inserting a storage medium.

3.3.6.7.1.1 Storage media

Storage media	Description
CF Cards (Compact Flash)	For devices of group A4 and A5 95: The device group exclusively uses CF cards for storage medium.

<table>
<tr><th>Storage media</th><th>Description</th></tr>
<tr><td>USB Storage Medium</td><td>Concerning devices with USB (see "Device overview 95"). Memory sticks or external hard drives can be connected at this terminal.

Do not use multiple storage media at the same time! Devices belonging to group A6 95 have two USB terminals and a slot for the ExpressCard. However, the device can use only one data storage medium. The system determines which one it is upon activation, and there is no fixed order of precedence among the media. For this reason, delete any which you do not wish to use for the measurement before switching the device on.
With USB, the Hot-Plug 21 functionality is available. Make sure that sufficient time is available for swapping the storage medium. How much time is required for de-registering and re-registering with the system depends on the particular storage medium and on the number of channels. As an orientation value, we recommend at least 30 s, even for simple configurations!

Do not use USB hard drives with external power supply
Please do not use any USB hard drive which has an external power supply. Such a drive may not be connected at the imc USB-port. Otherwise, when the measurement device is powered down, the imc USB-port's current limiting mechanism may be destroyed.</td></tr>
<tr><td>ExpressCard</td><td>Applicable to devices having ExpressCard slot (see "Device overview 95").

Remove any connected USB storage medium! Devices belonging to group A6 95 have two USB terminals and a slot for the ExpressCard. However, the device can use only one data storage medium. The system determines which one it is upon activation, and there is no fixed order of precedence among the media. For this reason, delete any which you do not wish to use for the measurement before switching the device on.
With ExpressCards, the Hot-Plug 21 functionality is available.
</td></tr>
<tr><td>CFast</td><td>Concerning devices with CFast slot (see "Device overview 95").

Remove a connected USB storage medium! The device can use only one data storage medium. The system determines which one it is upon activation, and there is no fixed order of precedence among the media. For this reason, delete any which you do not wish to use for the measurement before switching the device on.
With CFast cards, the Hotplug 21 functionality is available.
</td></tr>
<tr><td>SSD</td><td>Applicable to devices having a hard drive (see "Device overview 95").

With SSD hard drives, Hot-Plug 21 is not possible! If the SSD is used in a frame for removable data carrier, it can be exchanged while the device is deactivated.
SSD hard drives appear in the device software as a hard drive and an be read out via the Explorer-shell 23.
Due to the formatting, the content of the SSD in the PC is not displayed when the SSD is connected directly in the PC. SSD hard drives can only be formatted in the device 26.
In addition to the SSD, a CF/CFAST-card can be inserted in the measurement device and used alternatively.
</td></tr>
</table>

3.3.6.7.1.2 Data transfer

The internal storage medium can be accessed **directly via Windows Explorer**. Alternatively, the storage medium can be inserted into a **card reader** on the PC (suitable for large amounts of data due to faster transfer).

Warning

- Do **not use force** to insert or remove the device storage medium.
- During a **running measurement** having a high sampling rate, you should **never** try to **access the storage medium in the device** using the Windows Explorer shell. Otherwise, this additional burden could cause a data overflow.

Note

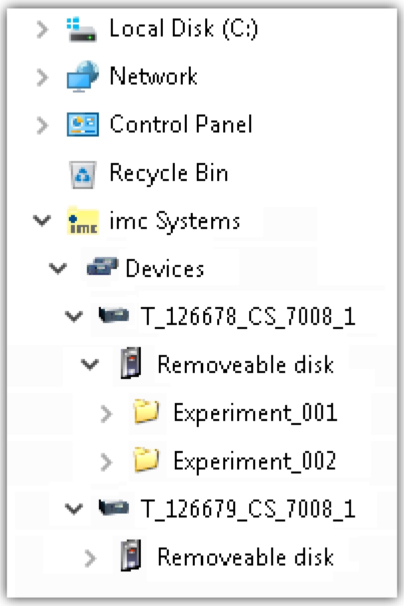
A tip on **interval saving**: Supposing the system's power supply suffers an outage during a measurement, it would not be possible to guarantee that the data file on the storage medium is terminated properly. This may lead to a failure to record the last measurement taken. Saving at intervals is a way to reduce this risk.

Access via Windows Explorer

The menu item "*Data (Device)*" () causes the Windows-Explorer to start while indicating the device selected.

Ribbon	View
Extra > Data (Device) ()	Complete
Home > Data (Device) ()	Standard

Access via "*imc Systems*" - an Explorer shell extension



While installing the operating software, if the option "*Extension for Windows-Explorer*" is activated, you are able to copy, display or delete the files of measured data saved within the device (e.g. on the removable storage medium). The method of doing this is the familiar one under Windows.

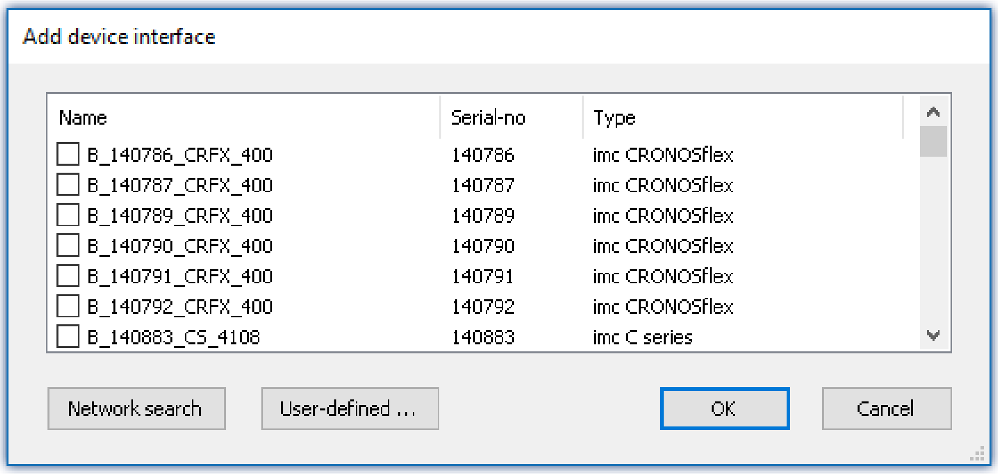
This function is independent of the device software. As well, selection of the devices in the tree diagram is independent of the device list in the operating software.

In order to get access to your device's storage medium, you must first add it to the tree diagram (see "*imc Systems - Adding a device* 24"). Subsequently, you are able to navigate to the desired data in the storage medium and thus to work with them.

Even if you have already been connected with the device by means of the imc STUDIO software, it is still not listed in the Explorer. It's possible to measure with one device while copying data from another.

- Click on "*Devices*" under "*imc Systems*" to highlight that entry.
- Open the context menu over the "*Devices*"-area and select "*Add*".

The "*Add device interface*" dialog appears:



Add Device interface

Search for devices	Description
Network search	"*Network search*" causes the system to search the network for any suitable devices. How long this will take depends on how many devices are connected and on the network type. Ultimately, the devices found are listed. Select your measurement device and confirm your selection with "*OK*". The measurement device is then available.
User-defined	In a structured network (network with routers, Internet, ...), imc devices could not be integrated by means of a network search. With the knowledge of the IP address or of the domain name (DNS name), it is now possible to integrate a device into the list.

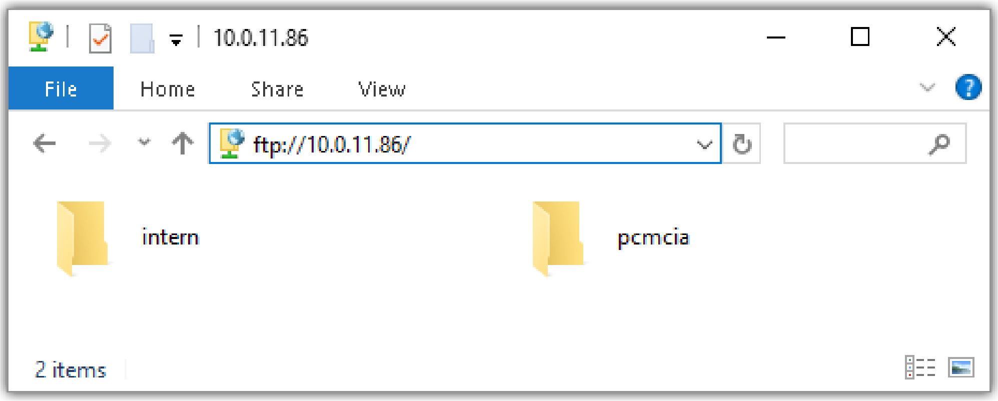
Reference

More information is presented in the imc STUDIO manual in the section: "*Setting Up - Connect the device*"

- General: "*Device connection via LAN*"
- "*Connection via a direct address*"

It is also possible to access the device's internal data via FTP, as well as to transfer data. Other goals are to change the configuration of devices via FTP and to restart the device for measurement with the altered configuration. Application areas include test drives, where there is no way to connect the devices directly with the device software. The Diskstart/Autostart capabilities are applied and enhanced. For this purpose, the device is usually configured for autostart. Upon activation, the configuration is loaded and the measurement, as well as data transmission, starts automatically.

Start the explorer and enter "*ftp://*" and the IP address of the device:



Note

- In general it is a read only operation. If you intend to delete files via FTP, you have to add "*imc@*" between "*ftp://*" and the IP address.
  Example: ftp://imc@10.0.10.219
- Furthermore, a password can be assigned to protect access via FTP. This password is entered into the device properties.

Warning

The following limitations apply when accessing the storage media in a device via an FTP-client:

- The device can't delete folders, accessed by a FTP-client.
- It is not possible to replace the storage medium during measurement (Hot-Plug).

3.3.6.7.1.3 File system and formatting

Storage media with the file systems FAT32 and FAT16 (maximum 2 GB) are supported. It is recommended that a memory card be formatted 26 and possibly partitioned before use.

Note Routine formatting protects the memory card

Routine formatting is recommended

Take every opportunity to format the storage medium. **Recommendation:** at least every **six months**.

In this way, any **damaged storage medium** can be detected and repaired if possible. A damaged file system may cause **data loss**. Or the **measurement system may fail to start** correctly.

In order to avoid data loss, any data still needed should first be saved!

Using a data storage medium in different devices

There are no known limitations. But it is recommended to always format the medium whenever transferring it in order to avoid data loss.

Additional notes

- To select the appropriate file system for the respective application, observe the notes on the data rate and on "*Avoidance of Data Overflow* 26".
- No limitations regarding the currently available storage medium volumes are known.
- The maximum filesize is 2 GB. In case a signal would exceed that limit, use interval saving.

Notes General restrictions applicable to file systems

Please observe the general restrictions regarding the respective file systems.

The formatting can be performed directly in the PC's hard drive by the Windows operating system, or in the device using the Explorer shell.

Note Recommendation

- **imc recommends formatting in the device:** In comparison to formatting by Windows, this provides higher data writing rates for high-speed channels.
- Only **one(!)** partition may be created. Multiple partitions may cause the measuring device not to recognize the storage medium.

Warning Please back up the data first

Formatting causes all data on the storage medium to be deleted. Before performing the formatting, ensure that all data have been saved on a different storage medium.

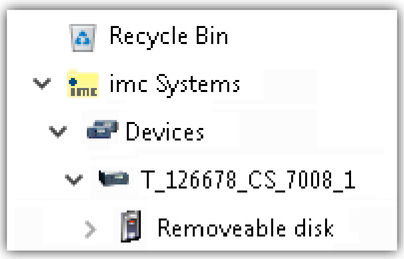
Note Cluster size - Avoidance of Data Overflow

The size and number of assignment units (clusters) and thus also the file system 26 used have a substantial effect on the storage medium's speed! Small clusters can dramatically reduce the speed! If high data rates are required, it is normally recommended to have a size of 8 kB/cluster.

The optimum size of the clusters must be determined for each storage medium separately. For all of them, the following applies:

- **Few channels having a high data rate**
  If a few channels having a high data rate are being recorded, then **large clusters** on the data carrier provide better advantage. Formatting with FAT32 on the PC and drive sizes < 8 GB creates disadvantageously small clusters, which in conjunction with the full aggregate sampling rate can lead to a data overflow.
  Whenever using cards of up to 8 GB, always use the formatting by the device.
  In the device, cards larger than 512 MB are formatted with 8 kByte clusters and cards larger than 4 GB are formatted with 16 kByte clusters. Cards of up to 1 GB can alternatively be formatted by the PC with FAT16. With cards of 16 GB onward, there is no difference whether the formatting is done in the PC or in the device.
- **Very many channels with a low data rate**
  If hundreds of channels having a low data rate (e.g. CAN channels) are saved, the exact opposite is rue. Here, **small clusters** are an advantage. This means that drives with up to 8 GB should in such cases be formatted in the PC with FAT32.

Formatting in the device (Recommended)



For **formatting in the device**, navigate via the Explorer shell "*imc Systems* 23" to the desired device.

There, open the properties of the drive: context menu > "*Properties*" (not via the Navigation pane in the Explorer).

Go to the Property dialog under the tab: "*Tools*".

Start the formatting by clicking on "*Format now!*".

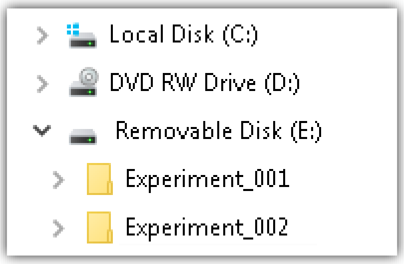
The device performs the formatting according to the following rule:

Drive size	Cluster size	File system
<= 512 MB	2 kB	FAT16
<= 4 GB	8 kB	FAT32
> 4 GB	16 kB	FAT32

Note

Formatting the storage medium is not allowed if an experiment whose data are to be saved internally has just been prepared.

Formatting using the Windows-Explorer



To perform **formatting of a storage medium via the Windows-Explorer** 25, navigate to the desired storage medium. Run the formatting by means of the context menu, for example.

Select one of the following two file systems: "FAT32" or "FAT" ("FAT16").

The file system "FAT32" is designed for media **larger** than 32 MB. Under no circumstances can smaller media can be formatted to "FAT32". With "FAT32", Windows generates 4 kByte clusters when the drive size is up to 8 GB, which is inconvenient for high-speed writing rates.

SSD hard drives are inherently formatted with Ext2 and for that reason **can not be formatted directly in the PC** , but only in the device 26.

However the Ext2 format offers these advantages:

- Mistaken duplicate occupation of individual clusters is not possible.
- Integration into the operating system is accomplished much more quickly than with FAT32.
- Higher writing output than with FAT32.

3.3.6.7.1.4 Known issues and limitations

Known issues and limitations	Description
If the memory card can not be read under Windows	The memory cards must first be partitioned (formatted) under Windows. Windows automatically generates the correct partitioning information. Subsequently, the memory card should be formatted again in the device. When in doubt, please contact our tech support 6.
The system won't recognize the data storage drive	• Answer 1: Check the file system: The device supports FAT32/FAT16 26. • Answer 2: If there are two storage media simultaneously plugged into your device, only one media will be detected (e.g. USB and CFast). Only the first plugged media will be detected.
File system becoming gradually slower	As the count of folders increases, so does the time required by the system to access the data. In consequence, the data saving procedure becomes slower and data loss becomes possible. For this reason, creating more than 1000 folders is to be avoided.
Errors in accessing the storage medium	Errors can have the following causes, among others: • The data rate is too high, the storage medium can't keep up and data overflow results. • The storage medium is full. The device signalizes any error by flashing this LED. Its further responses depend on whether or not the device is connected to the PC. • If no PC is connected, for instance in cases involving automatic self-start capability, the **button lights continuously**. At the end of an experiment, always check for this if measurements are taken without PC aid. • If the PC is connected to the measuring device, imc STUDIO documents the error with an **message in the Logbook** and switches the LED off. Any one-time data overflow only shows up in the Logbook, since the LED is reset afterwards. If data overflow occurs repeatedly, The LED is activated again, the PC records the message again, and as a result the LED **blinks intermittently**.
Data overflow due to improper cluster size	• With a storage medium formatted by Windows to FAT32 26, data overflow can occur if a high aggregate sampling rate is generated by a few high-speed channels. • With a storage medium formatted in the device 26, data overflow can occur if a high aggregate sampling rate is generated by very many low-speed channels.

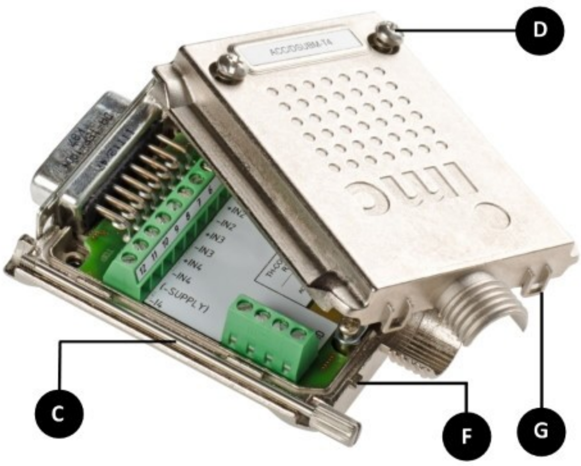
3.3.6.8 Signal connection

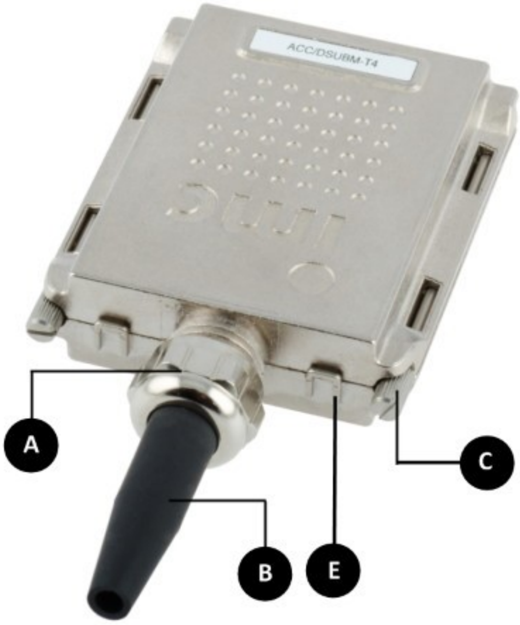
For devices with DSUB-15 connection technology, the convenient imc terminal plugs for solderless screw terminal connection are available as optional accessories.

ACC/DSUBM-xxx: snap the nose into the slot

Open the Metal plug:

1. Unscrew the cable fitting (cable gland) [A]
2. Remove the bend protection [B]
3. Unscrew the lid screws [D]
4. Lift the lid in the DSUB connection area and unfasten the nose of the slot





A: Cable fitting (cable gland)
B: Bend protection
C: Fastening screw for the devices' front panel
D: Lid screws
E: Locking key (Nose / Slot)
G: Slot
F: Nose

Close the Metal plug:

1. Assemble the lid by snapping the nose into the slot (see the picture above)
2. Audible click when the lid snaps in the front of the DSUB pod
3. Insert the bend protection
4. The pressure nut must be screwed back on
5. The lid screws can be tightened

Reference	Pin configuration

Please find the pin configuration of each available plug in the chapter: Pin configuration 495.

4 Maintenance and servicing

imc recommends performing a service check every 12 months. An imc service check includes system maintenance in accordance with the service interval plan as specified by the manufacturer and a complete function test (maintenance, inspection and revision).

Maintenance (*repair*) work may only be carried out by qualified personnel from imc Test & Measurement GmbH.

For service and maintenance work, please use the service form that you download from our website and fill out: https://www.imc-tm.com/service

Reference Device certificates and calibration protocols

Detailed information on certificates, the specific contents, underlying standards (e.g. ISO 9001 / ISO 17025) and available media (pdf etc.) can be found on our website, or you can contact us directly.

4.1 Cleaning

- Always unplug the power supply before cleaning the device. Only qualified personnel 11 are permitted to clean the housing interior.
- Do not use abrasive materials or solutions which are harmful to plastics. Use a dry cloth to clean the housing. If the housing is particularly dirty, use a cloth which has been slightly moistened in a cleaning solution and then carefully wrung out. To clean the slits use a small soft dry brush.
- Do not allow liquids to enter the housing interior.
- Ensure that the ventilation slots on the housing - depending on the housing type - remain free.
- If you clean the **rubber seals of your CRXT modules** with commercially available household cleaning products, please follow the respective cleaning instructions of the manufacturer. The seal is thus protected against premature aging because no air can reach the seal. Before connecting **CRXT slices** together (Attachment mechanism 87), the rubber seals must be clean and greased (e.g. with Vaseline).

4.2 Storage

As a rule, the measurement device can be stored at temperatures ranging from -40°C to +85°C. Special care is required when storing individual CRXT slices. The rubber seals on the sides must be handled and maintained with care. Before storage we recommend that the rubber seals are cleaned (see Cleaning) and greased. The seal is thus protected against premature aging because no air can reach the seal. CRXT slices should preferably be stored as a closed CRXT unit.

4.3 Transport

When transporting, always use the original packaging or a appropriate packaging which protects the device against knocks and impacts. Transport CRONOS components / slices preferably as a closed device. If transport damages occur, please be sure to contact our tech support. Damage arising from transporting is not covered in the manufacturer's guarantee. Possible damage due to condensation can be limited by wrapping the device in plastic sheeting.

The represented handling label for lithium ion batteries can be attached also independently printed on the package (e.g. by gluing on the package or in a transparent unlabeled document bag). Note however that the form and the format are accurately given by IATA and the expression has to take place in color. Format: 120 x 110 mm.

5 Start of operation Software / Firmware

5.1 Installation - Software

The associated measurement engineering software imc STUDIO, the configuration and operating interface for all imc instruments, provides the devices with exceedingly versatile functionality. It achieves comprehensive total solutions for everything from laboratory tests through mobile data logger application all the way to complete industrial test stations.

Use of the software requires a license, subject to the purchase order and configuration (see e.g. imc STUDIO manual product configuration / license).

In order to be able to install or uninstall imc STUDIO products, you must be registered with a user account possessing administrator rights to the PC. This applies to the overwhelming majority of all installations of Windows. However, if you are only logged on to your PC without administrator rights, log off and log back on with an administrator user account. If you do not possess an administrator user account, you will need the support or your system administrator or IT department.

You will find a detailed description to the installation of the software in the adequate manual or getting started.

5.1.1 System requirements

The minimum requirements of the PC, the recommended configuration for the PC, the supported operating system are mentioned in the data sheets and the imc STUDIO manual.

5.2 Connect the device

There are multiple ways to **connect the imc measurement devices with the PC**. In most cases, the **connection via LAN** (local area network, Ethernet) is implemented. See section "*Connecting via LAN in three steps* 67" for the **quickest way to connect** PC and measurement device.

But there are also other connection types:

- WLAN
- LTE, 4G, etc. (via appropriate routers)

These are described in a separate chapter in the software manual: "*Special options for connecting to the device*".

The devices use the **TCP/IP protocol** exclusively. With this protocol, some settings and adaptations for your local network may be necessary. For this purpose, the support of your network administrator may be necessary.

Recommended network configuration

The latest and high-performance network technologies should be used to achieve the maximum transfer bandwidth. This means especially 1000BASE-T (GBit Ethernet). GBit Ethernet network devices (switches) are downward compatible, so that imc devices that only support 100 MBit Fast Ethernet can also be operated on them.

The cable length between the switch and a PC or a device should be less 100 m. Use a shielded cable. If the length of 100 m is exceeded, then you have to insert another switch.

If the system is being integrated into an existing network, you must ensure that the minimum data rate can be guaranteed. Under some circumstances, this may require using switches to subdivide the network into separate segments in order to govern the data traffic in a targeted way and thus optimize the data rate.

In very demanding applications, you might consider grouping multiple GBit Ethernet devices via even higher-performance sections lines of the network (e.g. via 5 GBit Ethernet) and to connect these groups to NAS-components, for instance, via these lines.

When such imc devices are included which use network-based PTP-synchronization (e.g. CRXT or CRFX-2000GP), then it is necessary to use network switches which fully support this protocol on the hardware side. Appropriate network components are also available as imc accessories (e.g. CRFX/NET-SWITCH-5) and are then electrically and mechanically fully compatible with the imc systems.

5.3 Connecting via LAN in three steps

The most common case is described below: the PC and the device are connected via cable or network switch. The device's IP address must be set in the PC's address range. Subsequently, the device can be connected with the PC. If a connection has ever been established previously, the software recognizes the device's hardware configuration. In that case, experiment configurations can be prepared without any connection to the device.

Step 1: Connecting the measurement device

To connect via LAN there are two options:

1. The measurement device is connected to an **existing network**, e.g. via network switch. Only with a switch is it possible to run multiple devices.
2. The measurement device is connected directly to a network adapter on the PC (**point-to-point**).

In a LAN, the first case is typically implemented. Modern PCs and network switches are usually equipped with Auto-MDI(X) automatic crossover recognition, so that it is not necessary to distinguish between crossed and uncrossed connection cables. Thus both cable types can be used.

Step 2: IP-configuration

Start imc STUDIO. Click the "*Device interfaces*" button ( ) to open the dialog for configuring the IP address of the device.

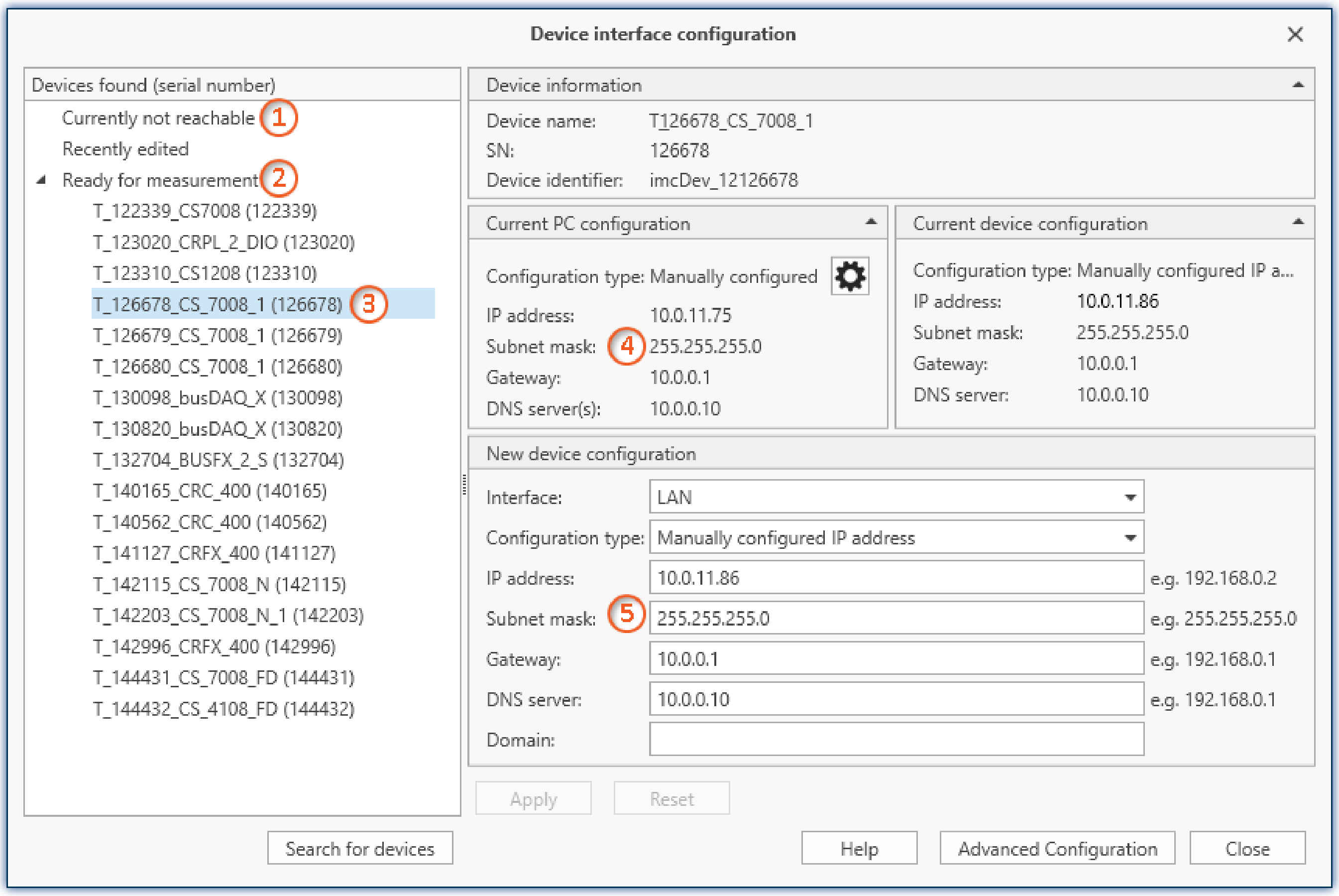
Ribbon	View
Setup-Configuration > Device interfaces ( )	Complete

If this **button** is **not present** in the view, it is also possible to open the dialog after a device search if it failed to find any new devices. Subsequently, a prompt appears asking whether to search for devices with an inappropriately configured network interface. Close this message box by clicking "*Yes*".

Once the dialog starts, the system automatically searches for all devices in the network. In the tree diagram, all available devices are indicated. If the device appears among the group "*Currently not reachable*" ①, it is necessary to modify the device's LAN-settings. If the device appears among the group "*Ready for measurement*" ②, you can leave the settings as they are or review them.

If there is any IP-conflict, devices affected will not be listed.

Select the device for making modifications ③.



Display of measurement devices found and of the IP address

Set the **IP address manually** if you are not using DHCP. The device's IP address ⑤ must match with the PC's address ④. To conform to the network mask, only the device portion may be different (see example).

Example

In the example shown, the fixed IP 10.0.11.75 with subnet mask 255.255.255.0 is selected for the PC. For measurement devices, any numbers would be suitable which begin with 10.0.11. and then do not contain 0, 75, or 255. The 0 and the 255 should not be used, if possible, due to their special significance. The 75 is the computer's number.

Example for IP settings	PC	Device
IP address	10 . 0 . 11 . 75	10 . 0 . 11 . 86
Network mask	255 . 255 . 255 . 0	255 . 255 . 255 . 0

If the configuration type: "*DHCP*" is used, **the IP address is obtained automatically** from the DHCP-server. If it is **impossible to obtain any setting values** via DHCP, the **alternative values are used**. These could lead to errors in the connection (different networks, same IP addresses, etc.).

If there is a **direct connection** between the device and the PC by a cable, then **DHCP should not be used**.

In order to apply the changes, click on the button "*Apply*". Wait for the device to restart and then close the dialog.

Note	Connection via modem or WLAN

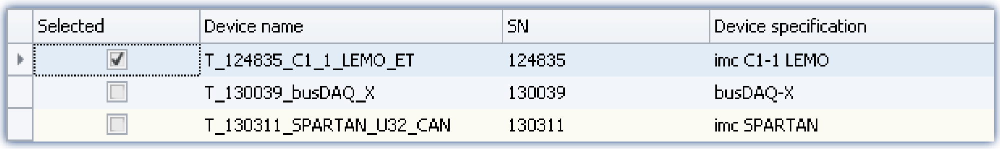
If the connection to the device is established via a modem or WLAN, start the program "*imc DEVICES Interface Configuration*" by clicking on the button: "*Advanced Configuration*" (see previous figure). An exact description is found in the software manual chapter: "*Setting Up - Connect the device*" > "*Special options for connecting to the device*".

Step 3: Integrating a device into an experiment

Now you are ready to add the device to the imc STUDIO experiment. If your device is unknown to the system, first perform the "*device search*".

Ribbon	View
Home > Search for devices ( )	all
Setup-Control > Search for devices ( )	Complete

Select the desired device: Once you click in the checkbox "*Selected*" for the desired device, it is ready to use in the experiment.



Selected	Device name	SN	Device specification
☑	T_124835_C1_1_LEMO_ET	124835	imc C1-1 LEMO
☐	T_130039_busDAQ_X	130039	busDAQ-X
☐	T_130311_SPARTAN_U32_CAN	130311	imc SPARTAN

You can also select multiple devices for your experiment.

Now the device is "*known*". After the next program start it is available for selection. For further information, see the documentation on the component "*Setup*".

Reference	Time zone

Now check whether the correct time zone is set for the device. For more info, see the description of the software manual under the keyword "*Device properties*".

5.4 Firmware update

Every software version comes with matching firmware for the hardware. The software only works with devices having the right firmware.

Once the program connects up with the unit, the device's firmware is checked. If the software version doesn't match the device's firmware version, you are asked if you want to perform a firmware-update.

Note

The firmware update is only required if the software was obtained as an update. If you obtained your hardware equipment together with the software, no firmware update is necessary.

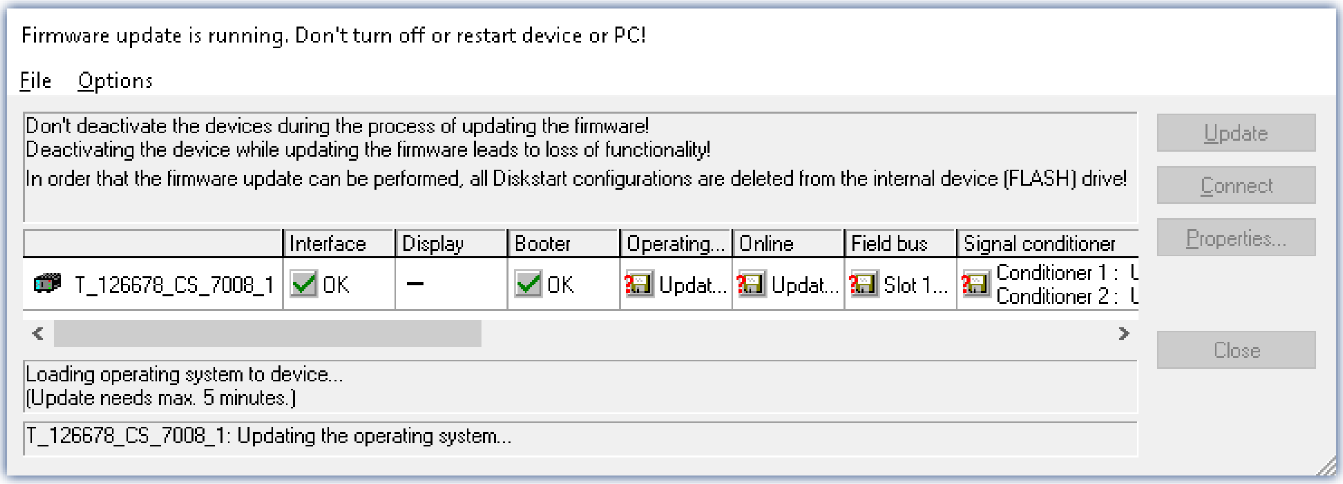
Warning Do not interrupt the firmware update!

Be absolutely certain to observe the following:

1. Under no circumstances should the device or its power supply be deactivated during the firmware update!
2. The network connection may not be interrupted. Use a cable connection, not WLAN!

Depending on the device type, the following components are loaded automatically: Interface-firmware (Ethernet, modem, ...), booting program, amplifier firmware, firmware for the signal processors.

The dialog for the firmware-update looks like this:



Start of the firmware update (example of a single device)
The state of the components of the firmware is diaplayed in the list.

Component	Description
Interface	Interface-Firmware (Ethernet)
Booter	Start-up program for the device upon switching-on
Operating system	Device operating system
Online	Online-functions and hard drive controller
Display	Operating system of the connected displays
Fieldbus	Fieldbus interfaces (e.g. CAN etc.)
Signal conditioners	Amplifiers

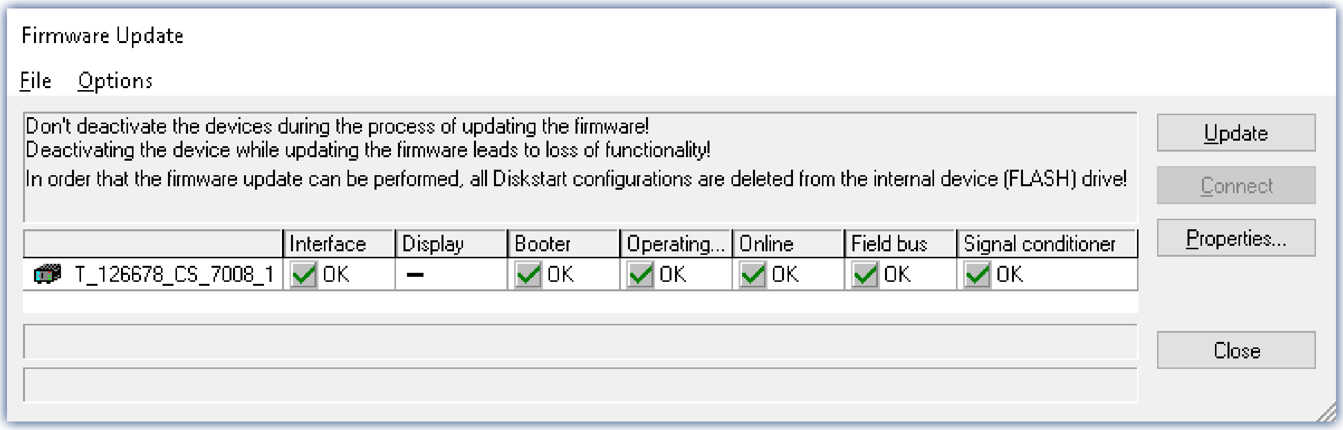
The following symbols for the individual firmware components appear in the list:

Symbols	
	not current
✓	firmware conforms to current standards
	error occurred during update procedure
—	this option is not available on the device

If no status indicators are displayed, no connection could be made to the corresponding device.

The duration of the update depends on the number of amplifiers (can last up to several minutes). You will be informed on the progress.

You are notified when the firmware setup concludes successfully, as shown below:



Conclusion of the firmware update (example of a single device)

Choose "*Close*". The device can now be used with the product software.

Warning **Be sure to observe in case of error**

- For a variety of reasons, the firmware update sometimes does not conclude properly, for example due to interruption of the power supply. For instance, the "handshake signal" at the end of the procedure may be missing. In this case, no measurement channels would be displayed initially. However, restarting the device and its software and performing the firmware update again usually restores everything to normal. It may be necessary to call the menu function "Update all components" in the Firmware update dialog's Options menu. This scenario only results in permanent damage in the most rare cases, and it is very worthwhile to repeat the procedure before sending a device in for repair.
- Behaviour under error condition, Windows cuts off the network connection without the user's knowledge; but this can be prevented using the PC's Control Panel.
  Background: During the firmware updates there is no data transfer for a few minutes and thus no network activity; Windows detects inactivity of the connection and the following mechanisms are set in motion:
  a) Windows' energy saving mode switches the LAN adapter off, consequently interrupting the network connection!
  b) Windows switches to the next LAN adapter if there is one (some PCs have multiple adapters in order to, for instance, to access services in parallel that are accessible via separate networks.)
  c) Other scenarios are feasible, e.g. if switches are activated, which can also respond to missing data traffic.

If an error message is posted during the firmware update, leave the device on and contact our tech support 6. The firmware update may be continued with guidance from the tech support.

Note

Firmware logbook

The "*File*" menu offers a function for working with the firmware log file. Every action taken during a firmware update plus any errors which may occur are recorded in a log file. This log file can be displayed with menu "*File*" > "*Show log file*".

Update all components

The "*Options*" menu offers the option to "*Update all components*". This makes it possible to earmark all the components of the selected device for an update. The function is only to be used in compliance with instructions from the tech support.

6 Properties

6.1 What does imc CRONOS-series have to offer?

The following is a short introduction into the philosophy of the device's design and operation, intended to get you off to a good start in working with devices of the imc CRONOS-series.

imc CRONOScompact-400-08
robust portable housing

imc CRONOS-SL-4

imc CRONOSflex Base Unit with imc CRONOSflex modules

Concept

The imc CRONOS-SL and the imc CRONOS*compact* systems are compact measurement devices for physical quantities. Those systems offer direct connection of many sensor types, as well as multi-channel data acquisition and vast capabilities of real-time data processing, all within one handy device structure. The measurement devices accomplishes the measurement independently. That means: the PC only configures with the operating software imc STUDIO the experiment. With this concept it is possible to start the measurement automatically after turning on the device.

The imc CRONOS*flex* and imc CRONOS-XT are modular systems providing an unprecedented degree of flexibility in configuring an integrated measurement and control solution. The system does not require any mounting rack or mainframe: both the base unit and the measurement modules (amplifiers or signal conditioners) are self contained, but are easily stacked together by means of a robust "click-mechanism". To complete the portable system or even to expand the input supply options of the system handles can be stacked to the modules by means of the mechanism. The CRFX-modules can be connected through standard network cables, allowing a spatially distributed system topology with up to 100 m between individual modules.

With signal bandwidths of up to 48 kHz per channel, and an aggregate sampling rate of up to 2 MSample/s, imc CRONOS*flex* covers the frequency range of virtually all physical, mechanical, and electromechanical signals. Amplifiers with integrated signal conditioning are available for all common sensor types.

Conditioning

The devices of the imc CRONOS-series can be outfitted in adaptation to their intended application. For analog signal conditioning, there are channels for voltage/current, temperature, bridge measurement, displacement or rotation speed etc., as well as inputs for current-fed sensors
(IEPE-inputs). The isolated digital inputs complete the range of plug types offered.

For the output of alarm signals or for controlling external devices in response to measurements, there are also digital outputs with up to 1 A driver strength.

The connections for the inputs and outputs take the form of DSUB plugs located on the device's back panel and ordered by sensor types and channels. To simplify the handling of the signal lines, the system comes with special screw terminals to which the lines can be directly connected.

TEDS sensor recognition

The imc concept for TEDS (Transducer Electronic Datasheet) extends the IEEE P1451.4. Upon request, clip-on TEDS 104 memory chips can be connected onto any sensor connection cable. imc CRONOS-system's parameters are then set automatically either directly form the TEDS or using the sensor database imc Sensors. You can find a detailed description for a adoption of TEDS in the imc STUDIO manual.

Real-time calculations with imc Online FAMOS

imc Online FAMOS enables calculation of various measurement quantities by the device. The extensive functions library additionally enables the creation of test procedures with open and closed-loop control functions.
https://www.imc-tm.com

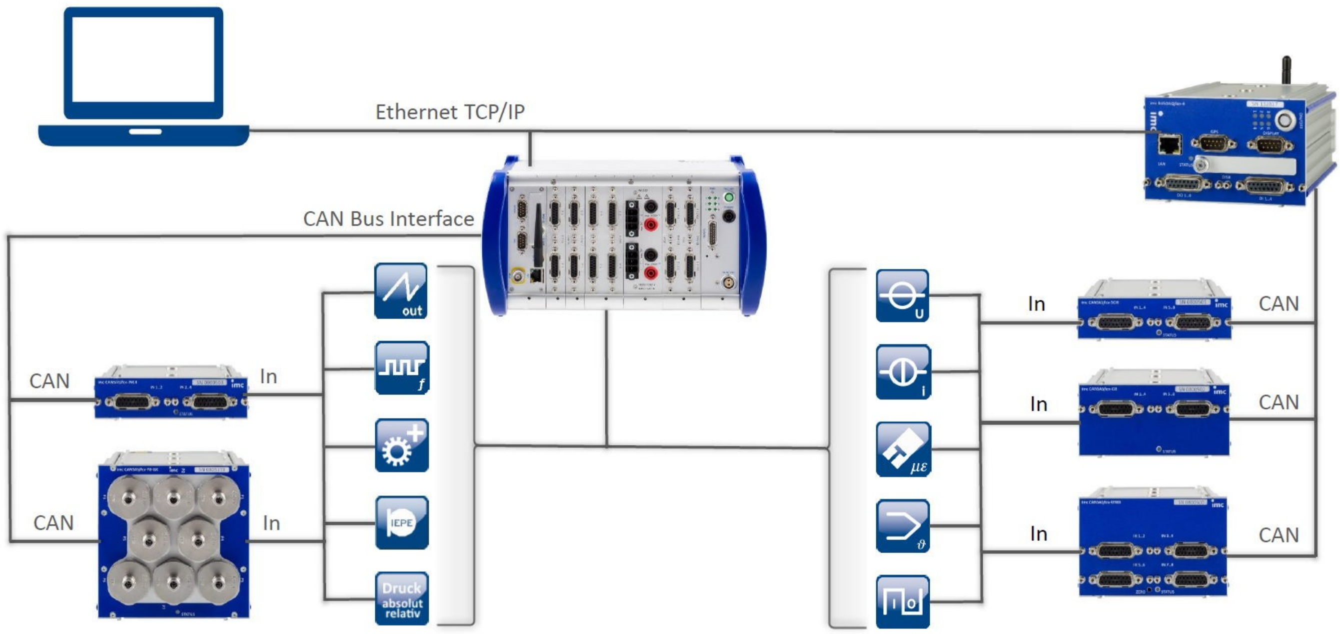
Trigger

Devices of the imc CRONOS-series can use threshold values, etc., to detect a digital event on any measurement channel, making measurement data monitoring easily possible.

The digital events defined can be directly assigned to a digital output and/or combined with each other to form trigger events. Up to 48 independent triggers are available, so that complex measurement tasks can be solved without needing very many steps. Triggers can be defined and assigned to any channel.

Fieldbusses

There are different fieldbusses (CAN FD, FlexRay, Profibus, ...) possible to connect with devices of the imc CRONOS-series. To expand via the CAN Bus even more it is also possible to connect imc CANSAS modules.



Example system with two measurement devices and a couple of CANSAS modules integrated via CAN-Bus.

Different imc measurement devices in an experiment

Devices of the imc CRONOS-series, C-SERIES, imc BUSDAQ and imc SPARTAN can be used with the same software. A mixed mode with different devices is possible.

Display

A PC is not absolutely necessary for operating devices of the imc CRONOS-series. If you program an autostart in devices of the imc CRONOS-series, it will begin a measurement independently. If you have a Display unit, you can use the built-in touch pad to start a measurement and save the data. Here you find the [description of the Display] 103 and find here the DSUB-9 pin configuration.

PC-operating software imc STUDIO

If you use the PC-operating software imc STUDIO, then you have practically unlimited curve display, triggering and data storing capabilities at your disposal. Together with imc Online FAMOS, you can obtain from raw data any type of result data desired and display them.

6.1.1 imc CRONOSflex Description of the system

6.1.1.1 Building Block Principle Maximizes Flexibility

The inherently modular construction of imc CRONOS*flex* eliminates the constraints of a predefined system size or configuration 35, found in usual data acquisition systems. Integrated modules free the user to design – and redesign – their system as required: small and compact one day; a large number of channels, of different sensor types with tailored signal conditioning the next. Today a centralized bench top system; tomorrow a decentralized system with satellite modules each assigned to a remote measurement site. The flexibility of imc CRONOS*flex* allows the reuse of system components to build the optimal solution in a matter of seconds; the system's scalable and expandable architecture eliminates the need for exact planning when purchasing equipment for a specific application. Based on EtherCAT, the system bus 76 to connect the central base unit with measurement modules, it is possible to both connect the measurement modules directly to a central unit, and/or to set up a spatially distributed system by means of standard Ethernet network cables (RJ45, CAT5) 77. The resulting measurement system can be managed from a PC (also connected via an Ethernet LAN or WLAN) which serves as the configuration tool and repository for measured data.

However, the system can also work autonomously without a control PC: either starting immediately upon being powered, or automatically at a specified time according to a pre-set autostart configuration. In either case, the recorded data may be saved to the device's storage (hard drive, flash card or USB media), or to a network drive. Data can be retrieved from a remote device directly (removable storage media), or via the network if there is a (temporary) outside connection.

Technical specs of the base unit 321

6.1.1.2 System bus

The selection of EtherCAT as the system bus provides the user with the advantage of being able to set up a distributed measurement system with standard CAT 5 network cables, including those in an existing Ethernet infrastructure. EtherCAT's software protocol is an established industry standard which supports deterministic transfers and synchronization mechanisms, guaranteeing precisely synchronized measurements throughout the network.

6.1.1.3 Modular components "click" together

The individual modules are constructed to form a tight mechanical connection "with a click", while being electrically connected to the imc CRONOSflex data bus and, if desired, power. When added or removed, hardware modules are also automatically included/excluded by the imc STUDIO software. An optional powered handle unit can be attached to the stack in the same manner as imc CRONOSflex Modules, optionally containing a stabilized 50 V system power supply unit with buffered uninterruptible power supply (UPS). When "clicking together (connecting the components)" 76 modules in this way, you create a portable, centralized measurement system which can subsequently be customized both in terms of the module types and quantity.

6.1.1.4 Assignment of the module address

The imc CRONOS*flex* modules are configured by the device software just as signal conditioner modules within the imc CRONOS*compact* frame; each module requires a unique identifier, which allows identification of each physical input channel with its respective channel name and settings. However, unlike CRONOS*compact*, CRONOS*flex* measurement modules are automatically recognized and numbered in the user activated identification procedure. This module number is displayed on the modules front panel, and is retained until the next system-identification process. This ensures that modules, along with their names and configurations, remain uniquely assigned, even if other imc CRONOS*flex* Modules are added or removed from the system, or if the physical order changed.

The flexible modularity of the system and the robust connection mechanism make it possible to easily assemble customized measuring systems from a pool of basic units and measuring modules in seconds. This method of operation is supported in address management by the fact that an imc CRONOS*flex* module stores the number (address) assigned to it together with an identifier of this controlling base unit when the number is assigned. Several such "address configurations" can be stored. A measuring module can thus assume the appropriate number depending on the currently connected base unit or the current system configuration without the need to reassign the module address each time.

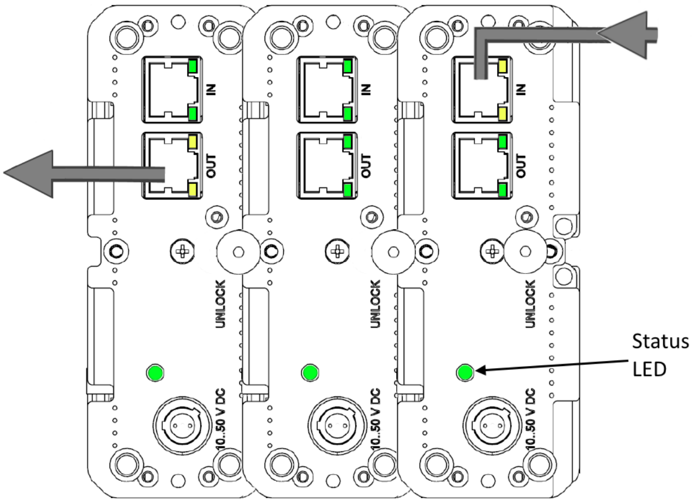
Reference

For a description of the necessary settings in the operating software please refer to the imc software manual.

6.1.1.5 Internal system-bus: network cables

For connecting the imc CRONOS*flex* base unit and multiple imc CRONOS*flex* Modules together to form a single imc CRONOS*flex* system, besides the power supply an internal system bus is necessary. It is based on standard network hardware and the real-time -Ethernet protocol "EtherCAT". The bus has a line-shaped topology where each module has both an input and output terminal to the bus. For modules directly stacked by the click mechanism, the bus as well as the supply lines is connected by means of the modules' plug-in connectors. Accordingly, for the EtherCAT bus the system features priority and blocking circuitry, which only enables the RJ45 network terminals provided for external cabling if no directly docked module is detected. Indicator LEDs on the network sockets support the wiring process and status diagnostics.

Network terminals and status LED on the rear module panel



Constant yellow lights on the terminals indicate the system expects connection of an external network or patch cables, where the bus line originating at the base unit is connected at "IN" terminals and the line leading outward to any further bus subscribers is connected to the "OUT" terminal.
The last imc CRONOS*flex* Module in the system's "OUT" terminal then stays unoccupied; the bus is not circuited as a ring.

Green flashing terminal lights indicate bus activity, not necessarily in the sense of actually proceeding measurement but also in the sense of previously started modules which have recognized the neighboring modules to which they are connected either via external cables or by direct module stacking. In this case, the respective green-blinking RJ45 sockets are empty, and no longer occupied by cables.

Status LED

- Normal operation: the Status LED shines green
- Error: LED shines red!
  (possible causes: problems communicating with the ECAT master, or ESD problems.
- Power ON/reboot: LED first shines yellow, then red, then the status LED flashes green for approx. 5 s, then the initialization phase starts
- Initialization phase: LED flashes for approx. 10 s to 15 s yellow;

  subsequently normal operation should be indicated by constant green shining

6.1.1.6 Distributed measurement system

For even more flexibility, the EtherCAT based imc CRONOS*flex* system can be physically distributed using standard cables (RJ45, CAT5). Additional measurement modules can be connected, individually and as local blocks of modules which are locally clicked together, but remote from the base unit. The combination of these two connection techniques, centralized "clicked" stacks and distributed cable connected modules and substacks, allows any imaginable topology of measurement locations to be joined together into a logically integrated, centrally controlled, data acquisition and control system.

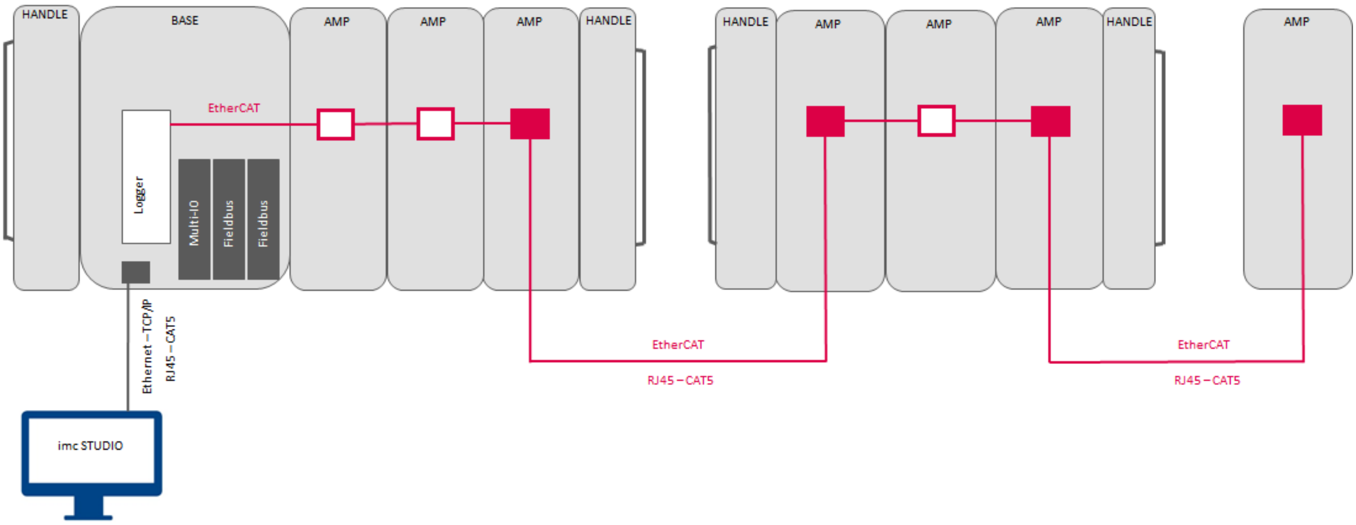
The spatial distribution of such a measurement system can extend to distances of 100 m between any two components. This makes it possible to place measurement modules in close proximity to local measurement sites and sensors, in many cases drastically reducing the amount of wiring required.

Consider as well that long signal cables, especially carrying weak analog measurement signals, are generally much more sensitive to electrical interference problems than the error-tolerant network connections used by imc CRONOS*flex*. Consequently, a distributed system topology can benefit from a more flexible and cost effective setup, with improved signal quality.

6.1.1.6.1 System structure and components

A complete system always consists of a central imc CRONOS*flex* base unit and a flexible amount of imc CRONOS*flex* modules (AMP). The imc CRONOS*flex* base unit is available as a variety of models 321. With either one or two fieldbus interfaces (each with two nodes), as well as an optional Multi-IO extension, which provides digital inputs and outputs plus incremental counter measurement channels and analog outputs.

imc CRONOS*flex* as a decentralized, distributed measurement system



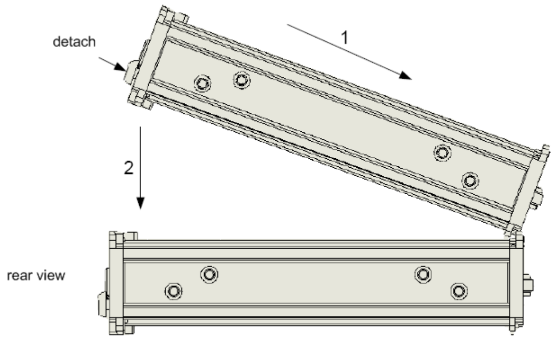
6.1.1.6.2 Use with imc CRONOScompact

One additional use for the flex-series' signal conditioning modules is in conjunction with an imc CRONOS*compact* system: in contrast to CRONOS*flex* system, CRONOS*compact* is a "rack"-based series 89 of devices, which can accommodate several conditioners as plug-in modules in a device frame. These "CRC-plug-in modules" do not have either their own housing nor their own power supply, and are not spatially distributed.

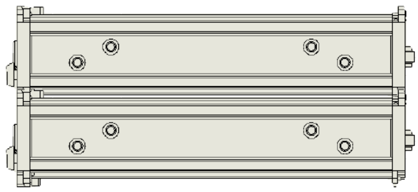
6.1.1.7 Attachment mechanism

Stacking of the imc CRONOS*flex* Modules

1. Hook tongue into the groove



2. Press modules together

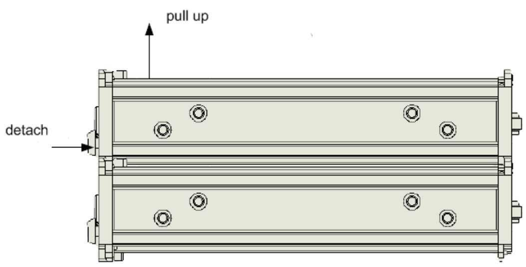


You will here a "clicking" sound after successfully connecting the modules.

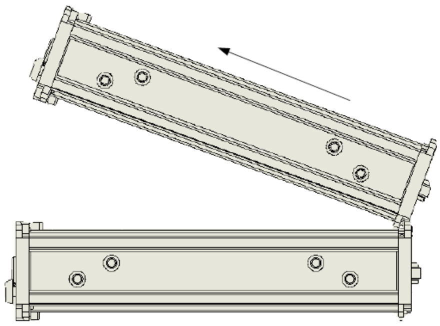
After successfully clicking the modules together, you should hear a "click sound".
The modules are now mechanically locked and electrically connected!

Detaching modules from the stack

1. Detaching



2. Pull tongue out of groove



Note Handling

- Be aware that **during a running measurement**, modules should not be disconnected from the system (hot plug functionality is not supported during a running measurement).
- To avoid damage: Before clicking together or removing modules and power handles, disconnect the supply lines and switch the system off, in order to ensure that the system is disconnected from the supply voltage.
- The **CRFX handles** are mandatory for the safe transport and handling of a module block: e.g. CRFX/HANDLE-L (left, 11900008) and CRFX/HANDLE-R (right, 11900007).
- A **maximum total length** of 85 cm of attached (clicked) modules should not be passed!
Mounting elements *can* be used for more stability.
- The sizes (drawings) of all available modules are listed in a separate document (data sheet). The dimensions, the distances of the bore holes for available mounting elements are also stated in this separate document.

Description of the mounting systems

6.1.2 imc CRONOS-XT

An imc CRONOS-XT (CRXT) system is composed of a base unit plus a power supply module and one or more CRXT modules as well as the system sealing handles (left and right). The individual modules are constructed to form a tight mechanical connection. At the same time, the "click" establishes an electrical connection to the system bus and the power supply. Clicking (or releasing) the CRXT slices together is only allowed in a controlled environment. The resulting measurement system can be manged from a PC which serves as the configuration tool and repository for measured data. Additional fastening elements are recommended for particularly harsh conditions. Please refer to the CRXT base unit data sheet for vibration specifications and IP protection level.

The CRXT slice with the weakest specification is decisive for the entire CRXT system.

The power supply of a CRXT system is provided exclusively via the power socket (Fig. 1 item A) by the POWER Module. If the supply voltage fails, an internal buffer keeps the base unit of the device active for a few seconds to complete the measurement save data files and then automatically shuts itself off. Short-time buffering to ensure data integrity is always a standard part of the system.

Main switch

The CRXT base unit has a central main switch (Fig. 1 item B) by which the complete block of directly clicked (stacked) modules is activated/deactivated. As an alternative to the manual main switch on the device's front panel, a remote-controllable electric contact can be used to switch the system on and off. Both the extended POWER module (CRXT/POWER-X) and the base unit are equipped with a REMOTE socket.

Fig. 1: CRXT/POWER and CRXT/2000

Legend:

A	power socket
B	main switch
C	REMOTE socket
D	cap of the data storage slot
E	grounding

Reference

Please find here technical details 326.

Pin configuration XT-Con: Power supply, Remote, SYNC, Display and GPS 515

6.1.2.1 CRXT/POWER-X functions

Within an imc CRONOS-XT device the POWER-X module fulfills the function of an extended system supply. It can be used as an alternative to the simple POWER module, which only provides the simple supply voltage feed via XT-Con socket. The POWER-X module offers the following extended functions:

- Voltage converter for internal 34 V DC link
- Available interface for connection of distributed EtherCAT-based amplifiers of the imc CRONOS series (CRXT and CRFX)
- Support of Power-over-EtherCAT (PoEC) for distributed CRXT systems
- centrally remote controlled switching on of distributed amplifier blocks

6.1.2.2 Voltage converter

In the sense of a "Step-Up" converter the connected supply voltage is raised to a constant device-internal intermediate circuit of 31 V to 35 V. This allows in particular the operation of larger devices with low supply voltages, such as the 12 V on-board power supply in vehicles, since the currents via the module click connectors (subject to limits) are reduced accordingly.

6.1.2.3 EtherCAT system bus wit XT

The internal EtherCAT system bus of the device is provided to the outside via M8 sockets, thus enabling the operation of distributed systems. These can be composed of a master device (base unit with or without further amplifier modules) and spatially separated blocks of amplifiers (slaves). CRXT amplifier blocks must in turn be equipped with a POWER-X module. Such distributed systems can also be combined from slices of imc CRONOS-XT (CRXT) and imc CRONOS*flex* (CRFX). This means that distributed *flex* amplifier modules can be operated on an XT device and a *flex* base unit can also be combined with an XT amplifier block (with POWER-X). Suitable connection cables with mixed connection technology (M8 to RJ45) are available.

Networking via EtherCAT can also extend over several stages:
A further slave can be connected to a slave block via cable (EtherCAT IN/OUT).

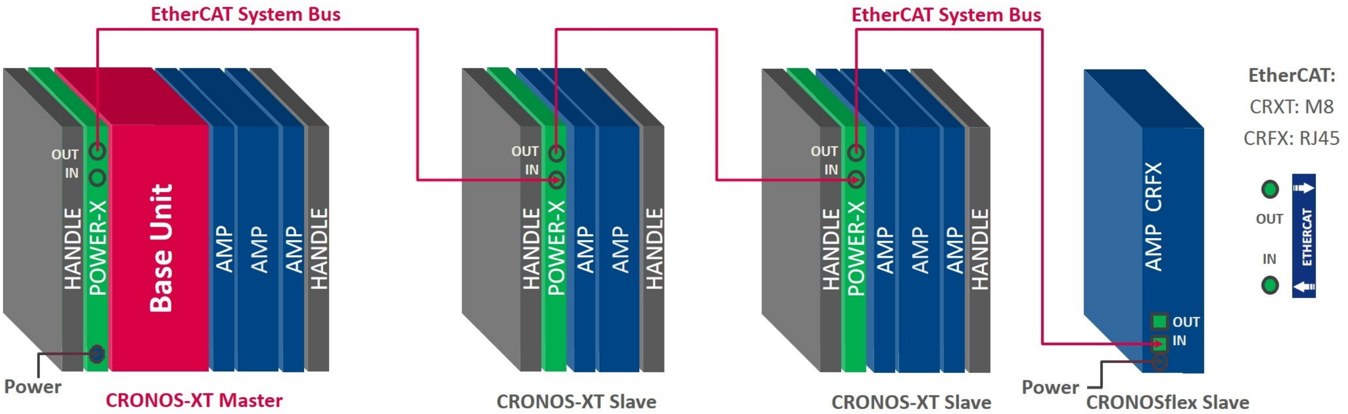


Fig. 2: distributed system configuration with CRONOS-XT and CRFX components

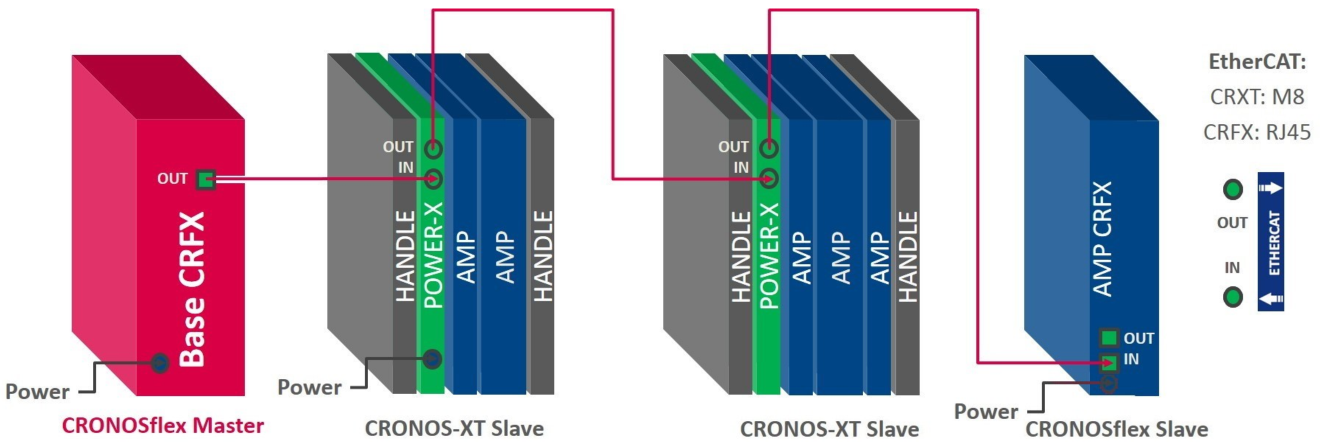


Fig. 3: distributed system configuration with a CRFX Base Unit, CRONOS-XT and CRFX components

Note — Notes concerning the EtherCAT System bus

- The internal EtherCAT system bus **directly provided** at the POWER-X serves exclusively for networking with the EtherCAT-based components of imc CRONOS. General EtherCAT **components of third party suppliers** are not supported!
- The CRONOS-XT base unit can be equipped with an EtherCAT **slave fieldbus interface**. However, this interface **is not related to** the EtherCAT system bus (master) described here, which is accessible at the POWER-X module and allows networking of imc modules.
  The ECAT slave interface does NOT **directly** provide the internal system bus, but rather forms a **decoupled** interface to the overall system: This slave interface (with its own interface processor) then allows selected channels of the overall CRONOS device, in the sense of a complex slave subsystem, to be exchanged with a **foreign external** EtherCAT master (automation systems, e.g. TwinCAT)!

Power over EtherCAT (PoEC)

Via the EtherCAT system bus interface, the imc components involved can also be supplied via Power-over-EtherCAT (PoEC) using the same cable. This makes a separate supply connection for remote amplifiers generally unnecessary. The available operating supply power exchanged between the imc CRONOS-XT slices can be sufficiently large (max. 1.5 A).

Remote controlled switch-on (REMOTE)

The distributed amplifier units can be switched on remotely via the central main switch of the base unit. Although this function uses PoEC signals, it is independent of whether remote modules are actually supplied via PoEC.

Furthermore, the POWER-X module has its own REMOTE socket (XT-Con) with control signals for switching on and off. In connection with an XT base unit, its main switch is decisive for manual switch-on, but the REMOTE connection of the base is not effective.

6.1.2.4 Switching on and off

The POWER module does not have a separate push button for switching on and off, rather the main switch (push button) of the base unit installed in the same device is decisive. The device (or an amplifier block) combined with the POWER-X module switches on when

- the button of the base unit (if available) is pressed.
  The REMOTE connection of the base is not considered!
- a button connected to the REMOTE socket of the POWER-X is pressed.
- a switch connected to the REMOTE socket of the POWER-X is closed and at the same time an external supply via the XT-Con socket is present.
- a PoEC voltage is present at the module's own EtherCAT input socket (≥30 VDC). This mode is especially relevant for the operation of distributed amplifier blocks.
  If an external supply (10 to 35 VDC) is available via the XT-Con socket at the same time, the block connected to the POWER-X is only supplied via the XT-Con socket, while the PoEC signal may only control the power-on.

Accordingly, power off is controlled by the main switch of the adjacent base unit, as well as the control options, which are also supported for amplifier blocks:

- pressed button via REMOTE socket on the POWER-X
- open switch via REMOTE socket on POWER-X
- a PoEC voltage at the EtherCAT input socket drops to <25 VDC.

Switching on of a distributed system

When operating a master device (with one POWER-X) together with a unit of amplifiers (with another own POWER-X), the master device always provides a "valid" PoEC voltage at the EtherCAT interface (M8) at power-on thanks to the 31 V voltage converter. The amplifier expansion block connected via this cable is therefore switched on and off remotely via the PoEC signal. The actual supply of the slave system can be done either via the XT-Con socket or via PoEC, which then has to be considered as part of the output power of the master system.

Remote socket

The assignment of the REMOTE socket of the CRXT/POWER-X is identical to the CRXT base unit (Fig. 1 item C 81) except for pin 5 and pin 6. A static switch (between pin 1 and pin 2) or a push button (between pin 3 and pin 4) can be connected for switching on and off (In the following section you will find the pin assignment 515).

6.1.2.5 LED status indicators

The CRXT/POWER-X module is equipped with two multi-color LEDs that provide information about various operating states:

"POWER"-LED	State
green	operation without special limitation of the output power, device is supplied by external supply voltage 10 V to 35 VDC
yellow	operation with particularly limited output power, device is supplied via external supply voltage <10 VDC
alternately flashing green and yellow	Operation without special limitation of output power, device is powered by PoEC due to an external supply voltage <10 VDC
red ("LIMIT"-LED is off)	An error has occurred. The following causes are possible: - Device is shut down, but cannot switch off, e.g. because the remote switch is closed or PoEC voltage is present. - Output voltage is less than 26 VDC and therefore too low (hardware defect) - internal error

"LIMIT"-LED	State
green	current output power at less than 80 % of the permissible output power
yellow	current output power between 80 % to 95 % of the permissible output power
red	current output power over 95 % of the permissible output power; there is a risk of forced shutdown due to overload
red flashing	the short-circuit protection of the device has deactivated the output voltage for 4 seconds; the output voltage is then switched on again

6.1.2.6 Technical performance (CRXT/POWER-X)

6.1.2.6.1 Output voltage and connection of additional measuring modules

The CRXT/POWER-X module boosts any external supply voltages (via XT-Con sockets) in the range of 7 to 31 VDC high to a constant output voltage of 34 VDC. If the external supply voltage is higher than 31 VDC, it is passed on to the output unregulated.

A PoEC voltage, fed into the EtherCAT input socket is passed to the output if its level is higher than 31 VDC and the external supply voltage at the XT-Con socket is lower than 10 VDC. At a PoEC level lower than 31 VDC the output voltage is increased to constant 31 VDC.The output voltage is available at the lateral "click" mechanism that connects to the adjacent device block as well as at the EtherCAT output socket. The available output power is divided between both sockets.

Reference

Technical Specs 330

6.1.2.6.2 Output-side overcurrent protection

To protect against overloads caused by a configuration of unacceptably large systems, the POWER-X module has two independent current limiting circuits:

1. Short circuit protection (response time 10 to 30 ms)
2. static overload protection (reaction time approx. 1 second)

The **short-circuit protection** limits the output current to approx. 2.5 A (=85 W @ 34 VDC). If this limit is exceeded, the output voltage is cut off after approx. 10 to 30 ms and is only enabled again after approx. 4 seconds. If the short-circuit has not yet been eliminated, the system waits another 4 seconds and so on. During this "wait" the "LIMIT" LED of the Power Module flashes red every second.

The overload protection continuously evaluates the current output power and initiates a shutdown process after 10 seconds if the permissible static output power of 70 W is exceeded. The "LIMIT"-LED lights up yellow at an output power >80 % and red at an output power >95 % of the maximum permissible static output power.

6.1.2.6.3 Fuse

The CRXT/POWER-X module is protected by a non-resettable 16 A fuse at the input.

6.1.2.7 Attachment mechanism (CRXT)

Stacking the modules

1. Check the greased rubber seal for cleanliness
2. Make sure that the blue slider (protective function) is in position "open" (the blue handles of the slider are not aligned with the cooling fins of the housing)
3. Hook the front side of the modules into each other
4. Compress the rear side of the modules
5. For checking press the locking rocker and
6. Check the protective function: the blue handles of the slider are in alignment with the cooling fins of the housing, see Fig. 4 88

Detaching modules

1. Release the protective function and press the locking rocker
2. Detach modules from each other

Protective function

Until May 2020 the locking rocker was equipped with a locking screw so that the rocker cannot be operated. As of May 2020 the rocker will be equipped with a **locking slide in blue color**. With this slider the rocker can be fixed without tools.

Warning

All sliders *respectively locking screws* should be tightened before switching on the system.

Note

- During operation respectively powered device: modules should not be disconnected from the system To avoid damage:
  Before clicking together or removing modules, switch off the system and disconnect the supply lines. (hot plug functionality is not supported during a running measurement).
- A **maximum total length** of 0.5 m of attached (clicked) modules should be observed!
- The **rubber seals** must be greased and clean so that the system is well sealed.
- The **CRXT handles** are mandatory for the safe transport, handling and sealing of a module block.

Sealing, IP rating and environmental specs

A single base unit or single CRXT slices cannot achieve an IP protection level at first because it is left open at the side. The given specifications are always only valid for a complete in a controlled environment clicked (closed) CRXT system. Only after it has been combined with a CRXT base unit (plus power module), CRXT slices if applicable, and the final sealing handles to form a complete CRXT system, sealing and environmental properties can be determined. The specification for shock, vibration and IP degree of protection applicable to the entire device is then derived from the weakest specification of the CRXT slices used in this combination (given in the technical data sheets of the respective CRXT slices). They assume that the individual CRXT slices are each mounted in conjunction with the additional stabilizing interconnect brackets (included in the standard accessories supplied).

According to IEC 60529 the Ingress Protection (IP) rating refer to protection classes provided by a housing, the protection of the electrical parts within the housing shell. If all functionally accessible contacts of the sockets are also to be protected, the corresponding plugs must be connected to all sockets. In many cases, a protective cover can also be used alternatively on unused sockets.

Reference

The sizes (drawings) of all available modules are listed in the data sheets of the modules and the base unit. The dimensions, the spacing of threadings for available mounting elements are stated in this separate document: "Description of the mounting systems".

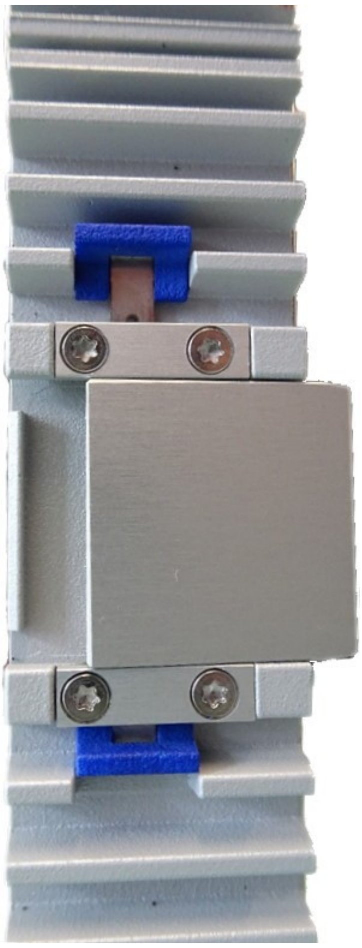


Fig. 4 shown: open, unlocked state

Note

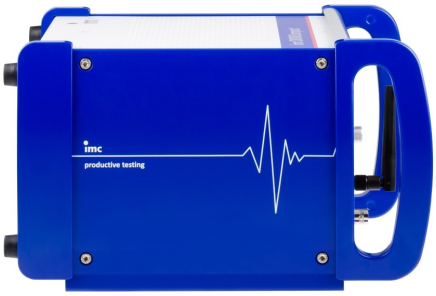
For the protective function: The blue handles of the slider have to be in alignment with the cooling fins.

6.1.3 imc CRONOScompact (CRC)

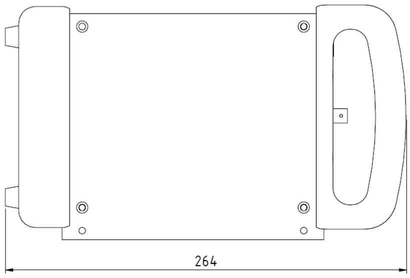
imc CRONOS*compact* (CRC) is a modular and compact measurement system which is available in a variety of housing sizes and designs. It consists of a base system in the form of a portable or 19" rack housing which can be equipped by the user with plug-in amplifier and/or conditioning modules to achieve quick and easy modifications.

front imc CRONOScompact

rear view



lateral view

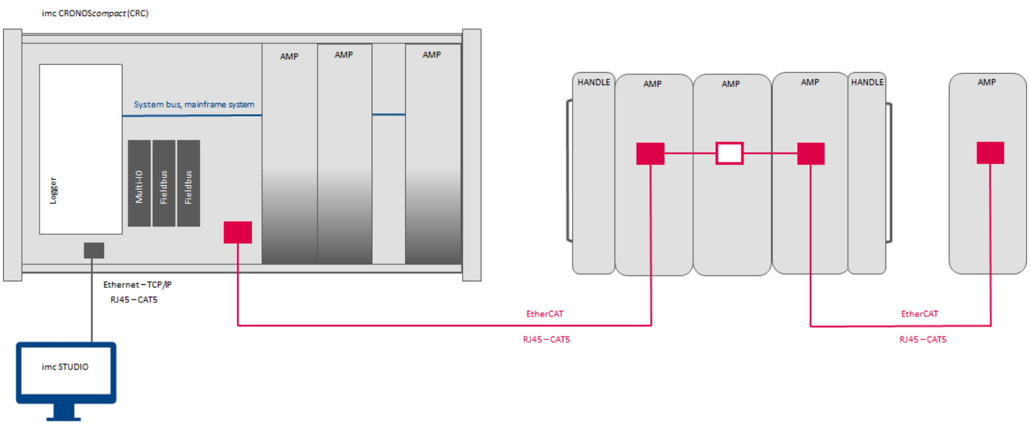


dimension

Device types

Devices belonging to the "GP" series can additionally be equipped with a "CRFX-Interface" (extension module "CRC/CRFX"). It operates as an EtherCAT master, interfacing to external CRONOS*flex* modules (amplifiers). These modules can be distributed in a decentralized setup, and with their channels they increase the system's total aggregate sampling rate to up to 2000 kHz.

Devices equipped with a "CRFX-Interface" are also referred to as "CRC-2000G(P)" such as in the manual and technical documentation. However, such systems are not listed as a particular sales item but rather they can be assembled from CRC-400GP devices of any model or size plus the additional "CRFX-Interface" (only available for order as a factory option), as desired.



As with the CRONOS*flex* system, in this environment, too, the "external" signal conditioners are fully supported by and integrated into operating software (imc STUDIO). There are no appreciable differences between operation and administration of "internal" CRC plug-in modules and "external", distributed imc CRONOS*flex* Modules.

Note

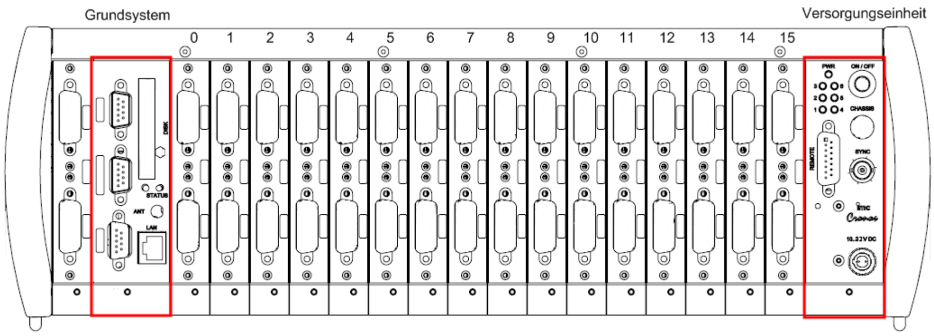
The power supply of a connected CRFX module 40 out of a CRC system is not possible (no PoE 40)

Which address is useful for a new module in an equipped CRC device?

The individual modules of an imc CRONOS device are distinguished from the measuring system by module addresses (hardware and software). These module addresses must be set before the module is installed (HEX switch). The module addresses of the other modules in the device must be taken into account. If module addresses are assigned twice or several times, this leads to conflicts and the affected modules are not or not correctly recognized by the device software. This leads to errors that are difficult to identify!

The possible slots, combinations of "CRC plug-in modules" and restrictions are described in this chapter. First an example with a device that is equipped with modules that are 4 TE (=20.32 mm) wide, i.e. occupy a slot in your imc CRONOS*compact* device. The following instructions for setting the module address of a module in an already equipped device must be observed:

1. the supply unit is configured in the device ex factory. The supply unit must not be subsequently replugged!



2. The numbers 0 to 15 on the cover plate (see Figure above) of your imc CRONOS*compact* device correspond to the module addresses ex works. The module address 0 to F of a module is set via a HEX switch on the "CRC plug-in module".

Note

The module address (0 to F) set on the module with the HEX switch must match the slot position (see cover plate 0 to 15)!

Attention! Do not break the security seal!

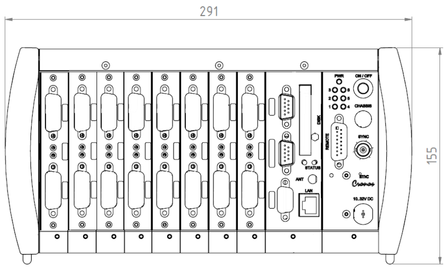
The modules (e.g. HV2-4U) with security seal (under the cover strip) were checked in the measuring system for compliance with the safety regulations according to DIN EN 61010-1 before delivery and subjected to a high-voltage test. After the success of these final tests, the module is sealed. If the security seal is broken, safe operation can no longer be guaranteed. Any intervention, such as a temporary removal of the module, requires a renewed security test.

Reference

You can find here further features 331 and technical details.

6.1.3.1 CRC-400(GP)-08

CRC-400(GP)-08 (front view)

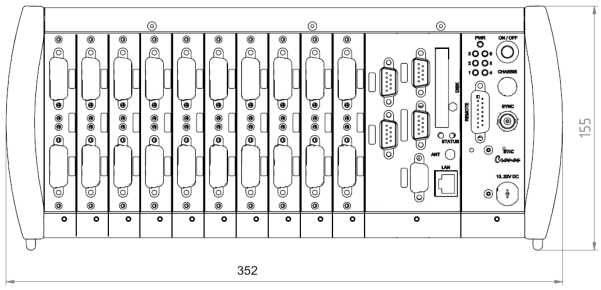


CRC-400(GP)-08

CRC-400(GP)-08 has the dimensions of half of a 19" rack and weighs approx. 7 kg (max. 9 kg).

6.1.3.2 CRC-400(GP)-11

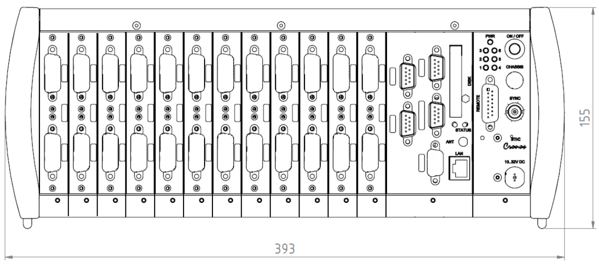
CRC-400(GP)-11 (front view)



CRC-400(GP)-11

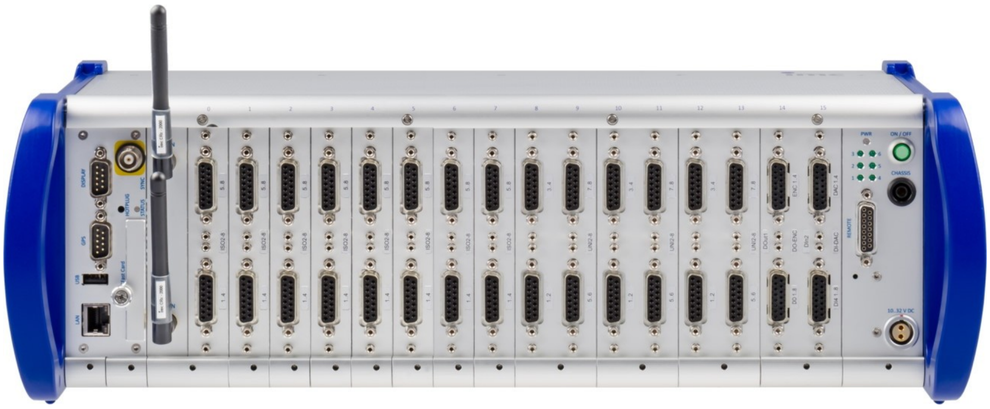
6.1.3.3 CRC-400(GP)-13

CRC-400(GP)-13 (front view)

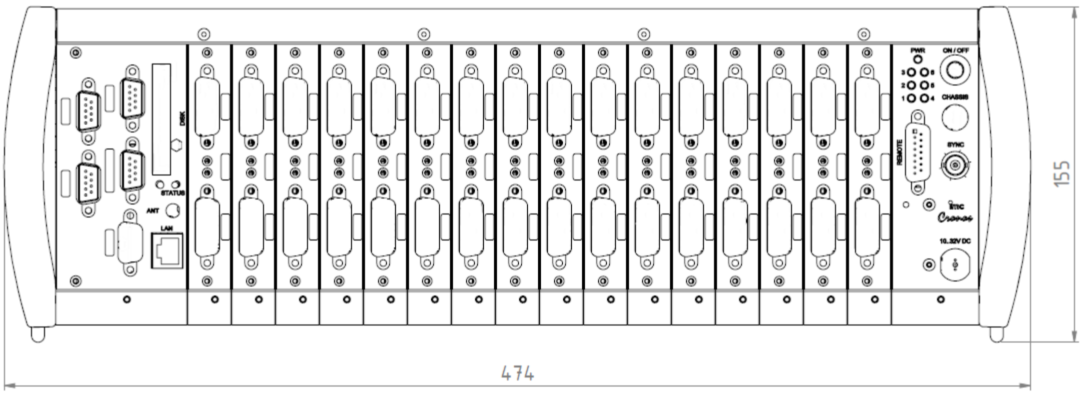


CRC-400(GP)-13

6.1.3.4 CRC-400(GP)-17



CRC-400(GP)-16



CRC-400(GP)-17

Note

This housing variant can be equipped with analog, digital and fieldbus modules (see list of the modules 148) and combined freely. The number of used analog respectively digital modules may not exceed 16.

The battery is situated on the bottom side of the measurement device. It is possible to order two battery sets for this housing and for the imc CRONOScompact-400(GP)-17 91 housing model. In contrary to the CRC-400(GP)-08 or the CRC-400(GP)-11. In those housing models only one batty pack will fit. The charging level can be indicated on the front of the device by four LEDs. The charging level is described here 50.

imc CRONOScompact with two Li Ion battery packs

6.1.3.5 CRC-400(GP)-RACK

All terminal connections (and the handholds) are situated on the front of a imc CRONOS*compact* RACK, only on one side of the RACK (as per standard). An alternative configuration e.g. the supply connection, the SYNC- and remote connection can be situated at the opposite side of the module's inputs.

There are 16 free slots in a CRONOS*compact* AC- and DC-RACK. Your system can be freely configured with analog, digital and fieldbus modules. Exception #1: totally 16 analog or 16 digital modules, e.g. 16 analog and two digital modules. Exception #2: the SYNTH-8 317 module, this module will be detected as a fieldbus module.

Note AC-RACK

- The stated amount of free slots (16 free slots) can only be achieved if the AC supply unit is situated on the rear panel of the RACK. The DC supply unit will stay at the front.
- The power adaptor that is integrated in a CRC-AC-RACK should not be used in extended temperature ranges!

6.1.4 imc CRONOS-SL

imc CRONOS-SL are highly compact, super- robust mobile measurement systems, for applications in rough environments. They conform to MIL STD810F, one of the highest standards for temperature, pollution protection, and shock resistance. The imc CRONOS-SL systems fulfill the IP65 degree of protection. Please find here a short IP65 description 113 and the use with the imc plugs.

The signal conditioning, AD-conversion, online processing and data storage are integral components of the measurement system. This makes imc CRONOS-SL ideal for measurement tasks in experiments or long-duration test, or monitoring tasks e.g. on board vehicles, machines or in outdoor measurement sites, where regular measurement equipment fails.

Technically, the SL systems have the same possibilities as imc CRONOS*compact*. However, the designations CRONOS-SL-2 and -4 indicate that two or respectively four measurement amplifiers with up to 16-, or 32 channels can be configured. The device properties are stated here 338.

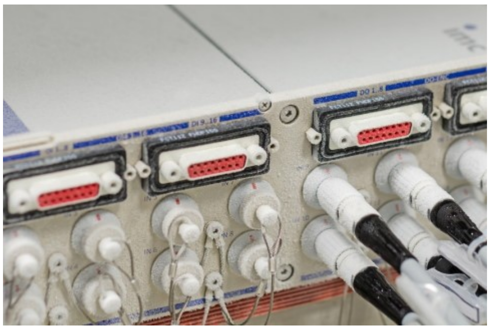
6.1.4.1 imc CRONOS-SL-2

imc CRONOS-SL2 (front view)

Dimension (W x H x D):
286 x 80 x 350 mm

Weight: approx. 6,5 kg

Max. number of amplifiers: 2
(16 max. analog channels)



imc CRONOS-SL2 (back view)

Signal plugs (**backplane**):
DSUB-15 for analog and
4x DSUB-15 for DI-DO-ENC

or 16x LEMO 7-pin

6.1.4.2 imc CRONOS-SL-4

imc CRONOS-SL-4

Dimension (W x H x D):
286 x 116 x 352 mm

Weight: approx. 8 kg

The sockets on the device side require suitable plugs to be terminated for tightness, or alternatively suitable sealing protective caps.

6.2 Device overview

Some of the capabilities discussed in this document only pertain to certain device models. The associated device groups are indicated at the respective locations. The groups are shown in the following table.

— not available ● standard ○ optional
CRXT imc CRONOS-XT CRFX imc CRONOS*flex* CRC imc CRONOS*compact*

imc device	**SPARTAN**	**BUSDAQ**	**BUSLOG*flex***	**BUSDAQ*flex***	**SPARTAN-R SPARTAN-N**	**CRSL-N CRC-400**	**C1-N C-SERIE-N**	**C1-FD C-SERIE-FD**	**CRFX-400**	**CRFX-2000**	**CRC-2000G**	**CRC-400GP**	**CRFX-2000G**	**CRFX-2000GP**	**CRXT**	**EOS**	**ARGUS*fit***
Driver package	imc DEVICES															imc DEVICE*core*	
Firmware group	**A**															**B**	
Device group	**A4**				**A5**					**A6**	**A7**					**B10**	**B11**
SN[1]	13				14					16	19					4120	416
TCP/IP Interface [MBit/s]	100				100					100	1000					1000	1000
Sampl.Rate[2] [kHz]	400				400					2000 / 400 [3]	2000 / 400 [3]	2000 / 400 [3]	2000	2000	2000	4000	5000
STUDIO Monitor supported	●				●					●	●					—	—
Connections[4]	4				4					4	4					—	—
Signal processing in the device																	
Online FAMOS	o	o	—	o	o	●	●	●	●	●	●					—	●
Preprocessing original channel	●	—	—	—	●	●	●	●	—	●	●	●	—	—	—	—	—
Preprocessing monitor channel	●	—	—	—	●	●	●	●	—	●	●	●	—	—	—	—	●
Data Storage																	
CF	●				●					—	—					—	—
Express Card	—				—					●	—					—	—
CFast	—				—					—	●					—	—
USB	—				—					●	●	●	●	●	—	—	—
microSD	—				—					—	—					—	●
Storage on network drive	●				●					●	●					—	—
Internal hard disk	o	(o)[5]	—	—	o	o	—	—	o	o	o					●	—
Synchronization																	
DCF	●				●					●	●					—	—
IRIG-B	—	—	●	●	●					●	●					●	●
GPS	●	●	—	(●)[6]	●					●	●					—	●
NTP	—	—	●	●	●					●	●					●	●
PTP	—				—					—	—	●	—	●	●	—	—
Phase offset correction	—	—	●	●	●					●	●					●	●

1 Extend serial number range by four digits (three for imc EOS)
2 Max. aggregate sampling rate (see data sheet)
3 2000 via EtherCAT else 400
4 Number of imc STUDIO Monitor-connections or imc REMOTE (as of 14xxxx) connections
5 not available for imc BUSDAQ-2
6 not available for imc BUSDAQ*flex*-2-S

6.3 Miscellaneous

This chapter describe imc specific solutions and expansion possibilities of your measurement device.

6.3.1 Sampling rate

Among the measurement device's physical measurement channels, up to two different sampling times can be in use. The smallest possible sampling time is 10 µs, corresponding to a channel sampling rate of 100 kHz (sampling frequency). The aggregate sampling rate of the system is the sum of the sampling rates of all active channels.

The aggregate sampling rate can take a maximum value of 400 kHz with devices of group A4 to A5 95.

The aggregate sampling rate can take a maximum value of 2 MHz via EtherCAT else 400 kHz with devices of group A7 95. This maximum aggregate sampling rate (2 MHz via EtherCAT) can only be achieved when not using the process vector variables, without any trigger, and only in 16-bit mode! A CRFX / DAC-8 module contributes 5 kHz and 16 bits per channel, regardless whether it is used in the experiment.

The sampling rates of the **virtual channels** computed by **imc FAMOS** do not contribute to the aggregate sampling rate. Along with the (maximum of) two "primary" sampling rates, the system can contain additional "sampling rates" resulting from the effects of certain data-reducing imc Online FAMOS functions (ReductionFactor RF).

Note

There is one constraint when selecting **two different sampling rates**: **Two sampling rates** having the ratio **2:5** and lower than 1 ms are not permitted (e.g. 200 µs and 500 µs). Any attempt to set sampling rates which do not comply with this rule will cause an error message to be posted:

"The two active sampling intervals may not be in a ratio of 2:5.   Error number: 365"

Note — Note for imc CRONOS*flex*/CRONOS-XT

For CRFX/CRXT modules, the following limitations apply due to the CRFX systembus's 5 kHz bus rate:

- A CRFX/CRXT-channel sampling at a slower rate than 5 kHz produces the same data load on the systembus as a 5 kHz channel. Thus for instance, 20 channels sampled at 100 Hz produce a load of 100 kHz on the systembus instead of 2 kHz.
- With 2 kHz channels, the resulting data load per channel is 10 kHz due to the 2:5 ratio.
- DIO- and DAC modules 276 support a maximum sampling rate of 5 kHz, even though 100 kHz can be set in the software.

Note — Note for GPS channels

Due to system limitations, **GPS channels** for determining the fastest sampling rate in the system are not taken into account. For an working configuration, at least one other channel (fieldbus, digital or analog) must be sampled at the same or faster sampling rate.

Reference

Please consider the specifications in chapter "Technical Specs 321" and the description of the channels configuration in the software operating manual.

6.3.2 Filter settings

Theoretical background

The filter setting is especially important in a signal-sampling measurement system: the theory of digital signal processing and especially the **sampling theorem** (Shannon, Nyquist) state that for such a system, the signal must be restricted to a limited frequency band to ensure that the signal has only negligible frequency components beyond one-half of the sampling frequency ("Nyquist-frequency"). Otherwise, "aliasing" can result – distortions which cannot be removed even by subsequent filtering.

The imc device is a sampling system in which the sampling time (or sampling rate) to be set is subject to this condition. The low pass filter frequency selected thus hinges on how band-limited the signal to be sampled at that rate is.

The control AAF for the filter setting stands for "Automatic Anti-aliasing Filter", and automatically selects the filter frequency in adaptation to the sampling rate selected. The rule this is based on is given by:

AAF-Filter frequency (-80 dB) = sampling frequency · 0.6 = Nyquist frequency · 1.2

AAF-Filter frequency (-0.1 dB) = sampling frequency · 0.4 = Nyquist frequency · 0.8

General filter concept

The imc system architecture is actually a two-step system in which the analog signals are sampled at a fixed "primary" sampling rate (analog-digital conversion with Sigma-Delta ADCs). Therefore a fixed-frequency analog low pass filter prevents aliasing errors to this primary rate. The value of this primary rate is not visible from the outside, depends on the channel type and is generally greater than or equal to the sampling rate which is selected in the settings interface.

The filter to be set is realized as a digital filter, which offers the advantage of precise characteristic and matching with respect to magnitude and phase. This is especially important for the sake of matching of channels which are jointly subjected to math operations.

For any data rate to be set in the system configuration (f_sample), then digital anti-aliasing filters (low pass filters) ensure compliance with the conditions for the Sampling Theorem. Three cases can be distinguished.

Implemented filters

Filter-setting "Filter-Type: without":

Only the (analog) anti-aliasing filter, matched to the primary data rate is in effect.
This setting can be useful if maximum bandwidth reserves are to be used and there are known limitations on the measured signal's spectral distribution, which justify not performing consistent filtering.

Filter-setting "Filter-Type: AAF":

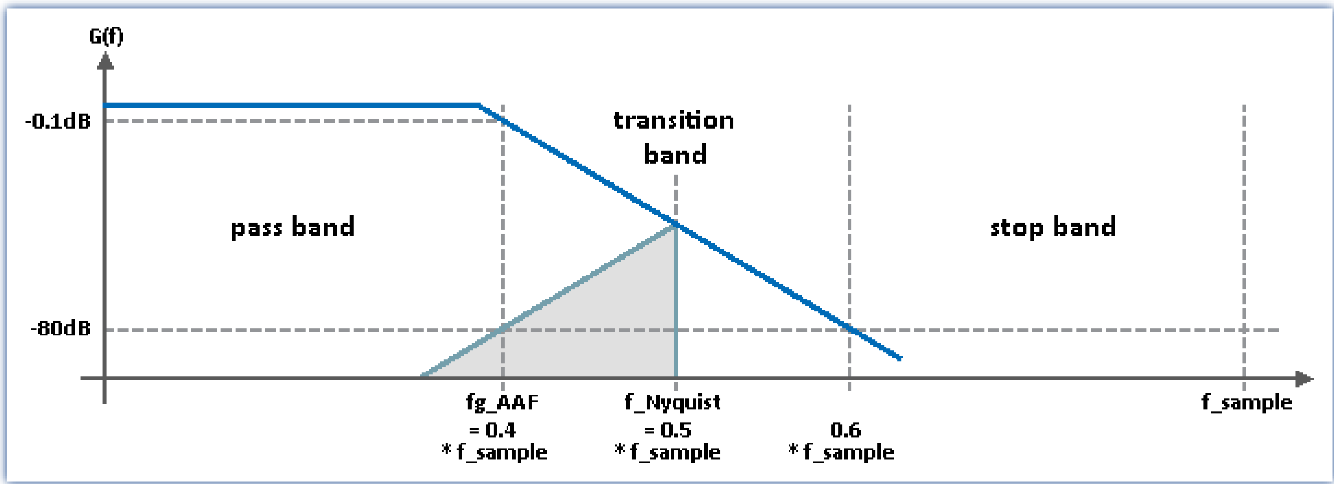
The (digital) anti-aliasing filters are elliptical Cauer filters. Their "tight" characteristic curve in the frequency range makes it possible to have the cutoff frequencies approach the sampling and Nyquist frequencies much closer without having to make a compromise between the bandwidth and freedom from aliasing.

The automatic selection of the cutoff frequency in the setting "AAF" is based on the following criteria:

- In the pass band, a maximum (AC-) gain uncertainty of 0.06% = -0.005 dB is permitted. The pass band is defined by the cutoff frequency at which this value is exceeded.
- The stop band is characterized by attenuation of at least -80 dB.
  This damping is considered sufficient since discrete disturbance frequencies can never reach 100% amplitude: the input range is mostly filled by the useful signal.
- The transition band is typically situated symmetrically around the Nyquist-frequency. This ensures that the aliasing components reflected from the stop band back into the pass band are adequately suppressed, by at least -80 dB. Remnant components from the frequency range between Nyquist-frequency and stop band limit only reflect back into the range beyond the pass band (pass band to Nyquist), whose signal content is defined as not relevant.

The criteria stated are fulfilled with the Cauer-filters by the following configuration rule:

- fg_AAF (-0.1 dB) = 0.4 · f_sample
- Characteristics: Cauer; Filter-order: 8th order



Filter-setting "Filter-type: Low pass" (band pass and high pass):

A low pass frequency can be set manually, which satisfies the application's requirements. In particular, a cutoff frequency significantly below the Nyquist frequency can be set which guarantees eliminating aliasing in any case, though consequently "sacrificing" the corresponding bandwidth reserves.

with fg_AAF (3 dB) = f_sample / 4	attenuation at Nyquist-freq.:	1/64	= -36 dB
with fg_AAF (3 dB) = f_sample / 5	attenuation at Nyquist-freq.:	1/244	= -48 dB
with fg_AAF (3 dB) = f_sample / 10	attenuation at Nyquist-freq.:	1/15630	= -84 dB

- Characteristics: Butterworth, 8th order (48 dB/octave)

Other possible filter settings are "*band pass*" and "*high pass*" - both 4th order.

6.3.3 Synchronicity

If certain channels are to be correlated to each other, for instance, for the purpose of computing the power, it's vitally important that there not be a phase-offset between them, in other words, that they be captured synchronously.

One of the main features of devices of the imc CRONOS system family is that it can provide this synchronicity, even for channels of different types and different sampling rates. The condition for this is, that the channels be configured with the same filter setting. The low-pass filters always cause a defined additional phase-offset. For a 1 kHz low pass Butterworth filter, this phase-offset corresponds to a frequency-independent, constant "group delay" which is 663 µs (for frequencies well below the cutoff frequency).

Note

Note that two channels having different sampling rates and both configured with the filter setting Anti-Aliasing-Filter do not have the same filter frequency!

6.3.3.1 Delay

In order to ensure the **synchronization** of all of a system's active channels, all amplifiers' channels are artificially prolonged to the duration of the slowest amplifier's processing time.

Example

Channels having the following amplifiers are involved in a measurement (experiment): BR-4 and UNI-8, UNI2-8.

The specific delays up to the "Process vector" are:

- UNI-8, UNI2-8: 1 ms
- BR-4: 3 ms

This means that the total delay up until the display is set at 3 ms. All channels with less delay (process vector) are "artificially" prolonged to the total delay in order to ensure signal synchronization.

Note Exception

OSC-16 is not compensated since its sampling rate and the associated digital delays is too large.

6.3.3.2 CRC and CRSL

The total digital delays for the various signal conditioners for CRC and CRSL base systems:

Module	Delay
SC2-32	10*Ta (max 5 ms)
ICPU-16	1 ms
LV-16	2 ms
ISO2-8	2 ms
HISO-8	2 ms
UNI-4	2 ms
UNI2-8	1 ms
DCB2-8	1 ms
LV3-8	1 ms

Module	Delay
ICPU2-8	1 ms
AUDIO-4 (CRC)	2 ms
ISOF-8	1 ms
FRQ	3 ms
HRENC	60 µs@50 ksps; 200 µs@20 ksps; 400 µs@10 ksps; 400 µs@5ksps; 1ms@2ksps; 2ms@1ksps;
DIOINC	3 ms
ENC-4	3 ms
OSC-16	>10 ms (without compensation)

The displayed delay is the largest single delay of an amplifier involved in the measurement.

6.3.3.3 CRFX and CRXT

The total digital delays for the various signal *conditioners* for base systems CRFX and CRXT:

Module	Delay
BR4	420 µs
ISOF-8	460 µs
ACI-8	460 µs
WFT-2	100 µs
ISO2-8	810 µs
HISO-8	770 µs
UNI-4	440 µs; 1 ms@1 ksps...
DCB2-8	610 µs
UNI2-8	460 µs
LV3-8	460 µs
AUDIO2-4	440 µs
Qi-4	440 µs
FRQ	800 µs
HRENC	600 µs

The displayed delay is the largest single delay of an amplifier involved in the measurement.

6.3.4 Synchronization

Synchronization with other devices

In order to synchronize the device to an absolute time reference and/or synchronize multiple imc devices (even of different types) use the SYNC terminal. That connector has to be connected with other imc devices or a DCF77/IRIG B signal generator.

Synchronization with GPS

The measuring device can be synchronized to absolute time using a GPS receiver 107 connected to the GPS socket.

Note

- To use the SYNC input, IRIG B must be supported. SYNC use with BUSDAQ*flex* (serial number circle 13...) is therefore additionally possible.
- The yellow ring on the SYNC socket indicates that the socket is shielded from voltage differences.
- See also chapter *Synchronization* in the imc software manual.

Reference

Technical details: synchronization 341

6.3.4.1 Optical SYNC Adapter: ACC/SYNC-FIBRE

One fundamental feature of all imc measurement devices, is their ability to synchronize multiple devices, even of differing models, and to operate them all in concert. The synchronization is typically accomplished by means of a Master/Slave process via the electrical SYNC-signal, which terminates on the devices at a BNC socket.

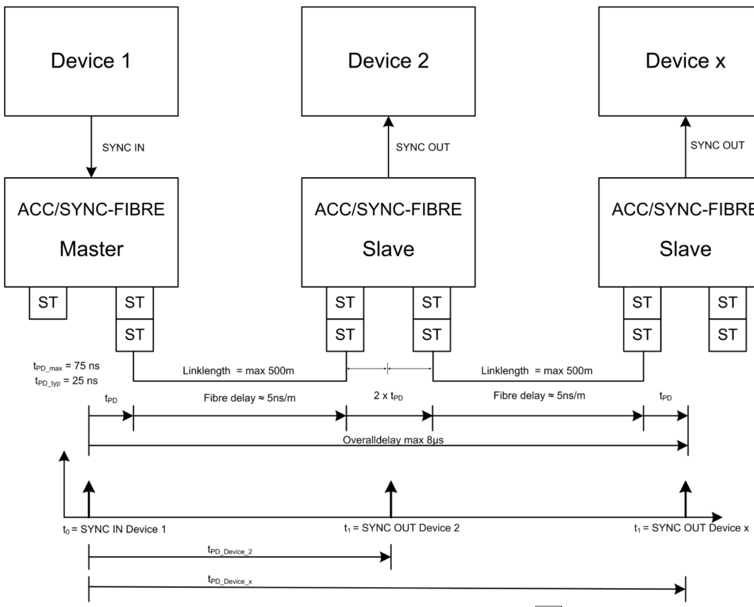
In areas of high electrical interference, or where long-distance signal transmission is needed, the signal can be conducted via fiber optic cabling with total isolation and no interference. For this purpose, the externally connectable optical SYNC adapter ACC/SYNC-FIBRE is available.

When this adapter is used, the BNC socket is not, but rather one of the DSUB-9 sockets for the GPS, DISPLAY or MODEM, which then conducts both the isolated electrical SYNC signal and additionally a supply voltage which is required by the adapter, as well as supplying directional indication (Master to Slave).

For this reason, any imc measurement devices used must be remodeled in accommodation to one of the DSUB-9 sockets. Once either the MODEM or the GPS socket has been remodeled, it is no longer usable for its original purpose. For the GPS socket, this does not apply. Even parallel operation is possible (via Y-cable), if the GPS-data are only used for the position data and the adapter is used for the SYNC signal.

For whichever signal (adapter or BNC) is currently connected, both the electrical and the optical mode can be used, however not both at the same time.

The plug is designed for the extended environmental range. The imc measurement devices used with this adapter require some modification.

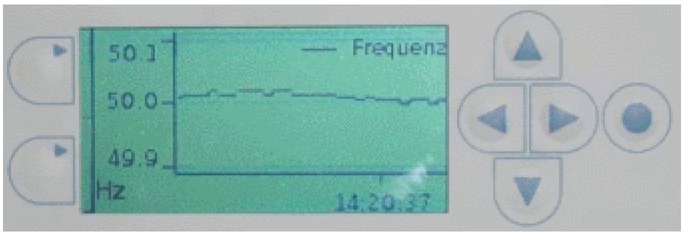


Find here technical details: ACC/SYNC-FIBRE 485

6.3.5 Operation without PC

To operate your imc measurement device, you don't necessarily need a PC. Your device will start the measurement independently, if an autostart has been prepared. Using the display, you can use its keyboard to control the measurement. The display serves as a comfortable status indicator device and can replace or complement the imc operating software when it comes to controlling the measurement. It can even be used where no PC can go.

The Display can be connected or disconnected at any time without affecting a running measurement. This makes it possible, to check the status of multiple devices running simultaneously one at a time.



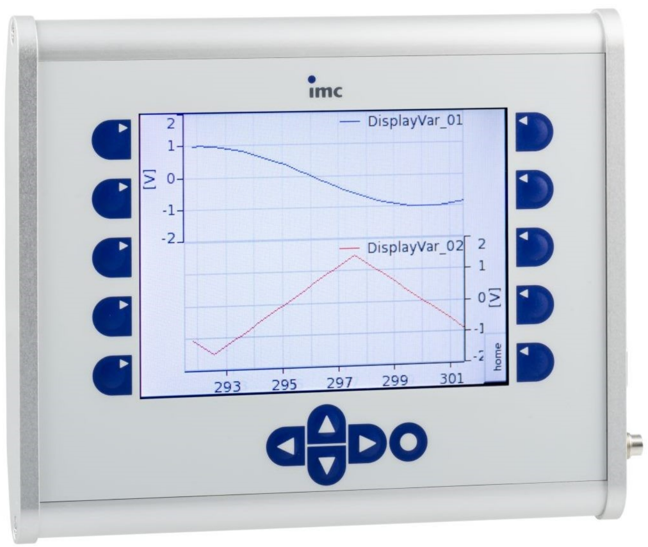
integrated display, only with CL and PL devices

imc CL-xx devices are equipped with an integrated display.

The Display's interaction with the measurement device is handled by means of virtual Display variables or bits, which can either be evaluated for the purpose of status indication or set in order to affect the measurement process.

Detailed descriptions of the functions are presented in the chapter *Display* of the imc software manual.

6.3.5.1 Graphical display



The imc graphical display allows the user to interact with a running measurement process by displaying system status and allowing parameter adjustments via the membrane touch panel.

If the measurement device is prepared for opening a particular configuration upon being activated, it's possible to carry out the measurement without any PC. The Display serves as a convenient status indicator.

The **description of the control elements** and their function can be found in the imc STUDIO manual chapter "*imc Display Editor*".

Properties:

- 320 x 240 pixels in 65536 colors
- Housing dimensions approx. 306 x 170 x 25 mm; Readout screen size: approx. 11.5 cm x 8.6 cm
- Bore diameter for Display fixing: diameter core hole 5.11 mm, diameter exterior 6.35 mm (1/4" - 20 UNC),
- Weight: approx. 1 kg, more properties see chapter "Technical Specs 474".

- The Display is controlled by a serial RS232 connection. The update frequency can't be changed. It depends on the load of the device, which is at best 15 Hz.
- The Display must be powered via the 3-pole Binder socket.

6.3.6 LEDs and BEEPER

6 Status LEDs and a beeper are provided as additional visual and acoustic "output channels". They can be used just as standard output channels in imc Online FAMOS by assigning them the binary values "0" / "1" or functions taking the Boolean value range. Interactive setting and Bit-window display for these output channels is neither especially useful nor supported. It is not possible to deactivate the beeper by software. The beeper indicates the starting buffering period of the UPS.

6.3.7 imc Plug & Measure

6.3.7.1 TEDS

imc Plug & Measure is based on the TEDS technology conforming to IEEE 1451.4. It fulfills the vision of quick and error-free measurement even by inexperienced use. TEDS stands for Transducer Electronic Data Sheet and amounts to a spec sheet containing information about a sensor, a measurement location and the measurement technology used. It is stored in a memory chip which is permanently attached to the sensor, and can be read and processed by the measurement equipment. Besides this, the memory also include a number (unique ID) by which the sensor can be uniquely identified.

A TEDS sensor or a conventional sensor equipped with a sensor recognition memory unit is connected to the device. The sensor recognition contains a record of the sensor's data and the measurement device settings. The device reads this info and sets itself accordingly. Any inapplicable sensor information is rejected, and a notification is posted accordingly. For more information, refer to the software user's manual under "*Read sensor information*".

Note	Used TEDS chip (storage)

Full sensor TEDS support, including the DS2431 type used in most current IEPE sensors, is only available for modules of the imc CRONOS*flex* (CRFX) and imc CRONOS-XT (CRXT) device platforms.

6.3.7.2 MMI-TEDS

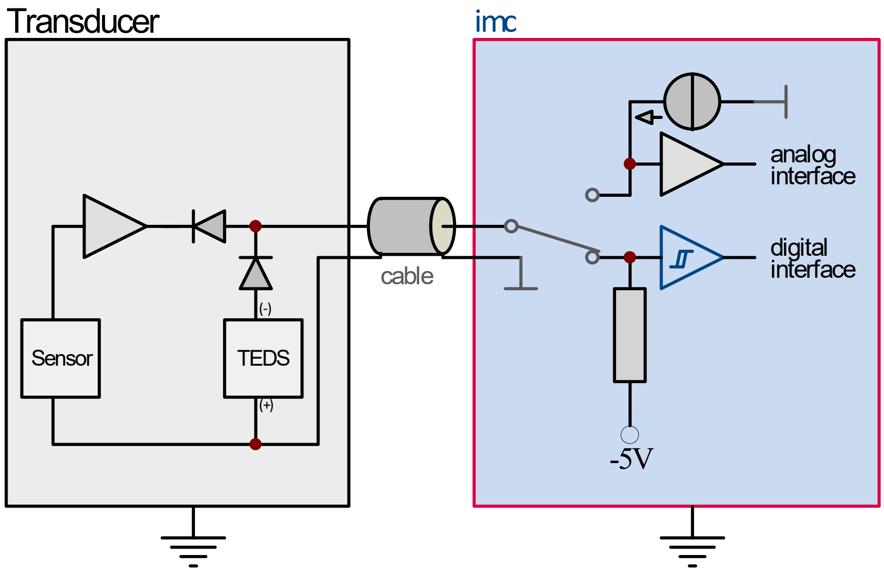
Mixed **M**ode **I**nterface-TEDS, abbreviated **MMI-TEDS** in accordance with IEEE 1451.4. is available in multiple varieties. imc STUDIO supports the following models:

- Class I interfaces are designed for constant current-fed piezo-electrical sensors and use these sensors' quasi standard (integrated electronic piezoelectric IEPE / ICP transducer)
- Class II interfaces are designed for bridge sensors and other sensors.

Class I MMI

A MMI-TEDS in accordance with IEEE 1451.4. Class I Mixed Mode Interface is a memory chip containing an electronic spec sheet directly connected with the sensor's signal lines. This means that the sensor is supplied with power, its signals are carried, and the information in the memory chip is accessed all via the same lines. The sensors are commonly fed with a constant current of approx. 4 mA and are connected via a coaxial cable having a BNC terminal.

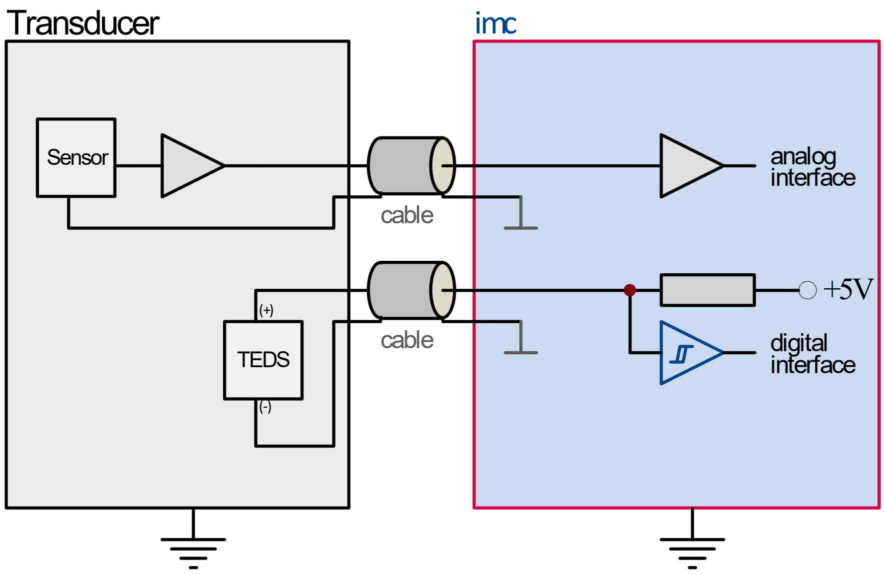
For access to the memory chip, the sensor's reference is connected to a digital interface and supplied with a positive voltage of approx. 5 V, which requires the sensor to be installed having isolation. A technical solution to avoid this limitation is in preparation.



A Class I Mixed Mode Interface receives/ sends TEDS data and analog signals on the same line

Class II MMI

With this model, the TEDS information is transferred over an additional line. The reference ground is connected via the sensor's supply line.



A Class II Mixed Mode Interface receives/ sends TEDS data and analog signals on different lines. The sensor is not influenced.

6.3.7.3 Particular advantages and applications

- Quick and error-free measurement device setting
- Reduction of routine work
- Recordable measurement channel parameter recommendations (sampling rate, filter settings, etc.)
- Standardization of channel designations for particular sensors used
- Verification of calibration data and their validity
- Quick and unambiguous traceability of calibration data per ISO9000
- Monitoring of calibration intervals
- Measurement device-independent sensor administration
- Sensor identification - CHIP - ACC/TEDS-CHIP; TEDS-Chip on conductor; dimension: 8 mm x 5 mm
- Sensor identification - CHIP-D - ACC/TEDS-CHIP-D; TEDS-Chip on conductor with 10 cm pigtail plug

6.3.7.4 Sensor administration by database

In the administration of sensor information, the user is supported by imc SENSORS (sensor database for the *imc Plug & Measure technology*).

Along with import of information from TEDS, parameters values can also be transferred from the sensor database by means of drag&drop.

Sensor information can be transferred via the measurement device software from the sensor database to the sensor recognition and vice versa.

For more advanced sensor administration, the sensor database supports barcode reading devices. imc SENSORS makes the use and administration of many different sensors quick, easy and economical by the use of TEDS and *imc Plug & Measure*.

imc SENSORS is a software expansion for our imc operating software. But *imc Plug & Measure* also functions as a stand-alone application. imc SENSORS is designed to make a sensor's data quickly and comprehensively available.

This makes it possible to:

- administer sensors in a central database
- parameterize a measurement channel
- trace the calibration history
- inspect the spec sheet

In conjunction with TEDS-capable measurement amplifiers for imc CRONOS System family, imc SENSORS supports modern TEDS sensors in accordance with IEEE 1451.

Especially recommendable for this purpose is the amplifier UNI2-8, to which a wide variety of sensors can be connected directly.

Note

Incremental counter channels neither support TEDS nor information exchange with imc SENSORS.

6.3.8 GPS

At the GPS socket it is possible to connect a GPS-receiver. This makes it possible to achieve absolute **synchronization to GPS time**. If the GPS-mouse has reception, the measurement system synchronizes itself automatically. **Synchronization with a NMEA source** is possible. The precondition for this is that the clock must return the GPRMC-string along with the one-second-interval clock signal.

All **GPS information** can be **evaluated** and subjected to **subsequent processing** by imc Online FAMOS.

GPS signals are **available as**: process vector variables and fieldbus channels.

GPS information	Description
pv.GPS.course	Course in °
pv.GPS.course_variation	Magnetic declination in °
pv.GPS.hdop	Dilution of precision for horizontal
pv.GPS.height	Height over sea level (over geoid) in meter
pv.GPS.height_geoidal	Height geoid minus height ellipsoid (WGS84) in meter
pv.GPS.latitude pv.GPS.longitude	Latitude and longitude in degree (Scaled with 1E-7)
pv.GPS.pdop	Dilution of precision for position
pv.GPS.quality	GPS quality indicator 0 Invalid position or position not available 1 GPS standard mode, fix valid 2 differential GPS, fix valid ...
pv.GPS.satellites	Number of used satellites.
pv.GPS.speed	Speed in km/h
pv.GPS.time.sec	The number of seconds since 01.01.1970 00:00 hours UTC. For this reason, it is no longer possible to assign the value to a Float-format channel without loss of data. This count of seconds can be transformed to absolute time under Windows and Linux.To do this, use the function below. `MySeconds = CreateVChannelInt( Channel_001, pv.GPS.time.sec)`
pv.GPS.vdop	Dilution of precision for vertical see e.g. www.iota-es.de/federspiel/gps_artikel.html (German)

Note

Scaling of the latitude and longitude

pv.GPS.latitude and pv.GPS.longitude are **INT32 values**, **scaled with 1E-7**. They must be **treated as Integer channels**, otherwise the **precision is diminished**.

By means of imc Online FAMOS, you are able to generate virtual channels from them. However, due to the reversal of the scaling, precision is lost:

```
latitude = Channel_001*0+pv.GPS.latitude *1E-7
```

Recommendation: Use the corresponding fieldbus channel: "*GPS.latitude*" or "*GPS.longitude*". Here, no scaling is required, so that the precision is preserved.

Sampling rate

Due to system limitations, GPS channels for determining the fastest sampling rate in the system are not taken into account. For an working configuration, at least **one other channel** (fieldbus, digital or analog) must be sampled at either the **same** sampling rate as the GPS-channel, or a **faster** one.

Internal variables; do not use

- pv.GPS.counter
- pv.GPS.test
- pv.GPS.time.rel
- pv.GPS.time.usec

GPS-Receiver

The **GARMIN GPS receivers** supplied by imc are set ready for operation and provide a 1 Hz or 5 Hz pulse, depending on the model.

The following conditions must be met in order to use other GPS receivers from imc devices:

- **RS232 port settings**
  - **Baud rate**: Possible values are 4800, 9600, 19200, 38400, 57600 or 115200
  - 8 bit, 1 stop bit, no flow control
- The following **NMEA strings** must be sent: ***GPRMC, GPGGA, GPGSA***. The order of the strings must be adhered to.
  Additional strings should be deactivated. If this is not possible, all other strings must be **before** the GPGSA string!
- The receiver must deliver a **1 Hz clock**.
- The rising edge of the clock must mark the second specified in the next GPRMC string.
- All three strings should be sent as soon as possible after the 1 Hz clock, so that there is sufficient time for processing between the last string and the next 1 Hz clock.

NMEA-Talker IDs

Supported NMEA-Talker IDs:

- GA: Galileo Positioning System
- GB: BeiDou (BDS) (China)
- GI: NavIC (IRNSS) (India)
- GL: GLONASS, according to IEIC 61162-1
- GN: Combination of multiple satellite systems (GNSS) (NMEA 1083)
- GP: Global Positioning System (GPS)
- GQ: QZSS regional GPS augmentation system (Japan)

DSUB-9 pin configuration 507

6.3.9 NET-SWITCH

The NET-SWITCH is a Network-Switch with PTP-Synchronization and compatible with imc BUSDAQ*flex* (BUSFX) housing (Click-mechanism and power supply).

Highlights:

- 5 Ethernet-Ports up to 1 GBit (1000BaseT)
- Supports PTP (Precision Time Protocol, IEEE 1588v2, end-to-end transparent clock)
- Synchronization of imc CRONOS*flex* (CRFX-2000GP) and imc CRONOS*compact* (CRC-400GP)
- Housing compatible with imc BUSDAQ*flex*: Click-mechanism / supply. Can be operated as:
    - Stand-Alone Switch
    - Directly connected with imc BUSDAQ*flex* devices (Note: imc BUSDAQ*flex* does not support PTP)
- 2-way redundant options for the power supply (10 to 50 V DC):
    - Module connector/locking slider
    - LEMO.0B
- Extended operating temperature range for industrial applications: -40 to +85°C

Click-mechanism (imc CANSAS*flex* / imc BUSDAQ*flex*):

- Modules joinable to module-blocks: mechanically and electrically connected (power supply)
- No tools or additional cabling required
- With guide grooves, magnetic catches and locking slider
- Both short and long housing versions joinable:
  with electrical connection: align on rear side; mechanically only: align on front side
- Direct connection of compatible CAN-logger: imc BUSDAQ*flex*

Reference

Technical specs 489

6.3.10 IRIG-B module

This external IRIG-B module can convert a time signal in IRIG format to the GPS format NMEA 0183 and thus be used for synchronization of different devices.

The expansion module exclusively supports amplitude modulated IRIG signals according to the standards IRIG-B1xx! This is why it can be used both to upgrade older imc device generations which provided no IRIG-B support at all, and to enhance current imc device generations with additional capabilities regarding modulated signals: While many up-to-date imc device series (CRFX, CRC, C-SERIES) offer IRIG-B synchronization via their standard BNC synchronization plug as a standard feature (including DCF-77 / IRIG-B auto-detection), this path only supports direct unmodulated TTL-signals (IRIG-B0xx).

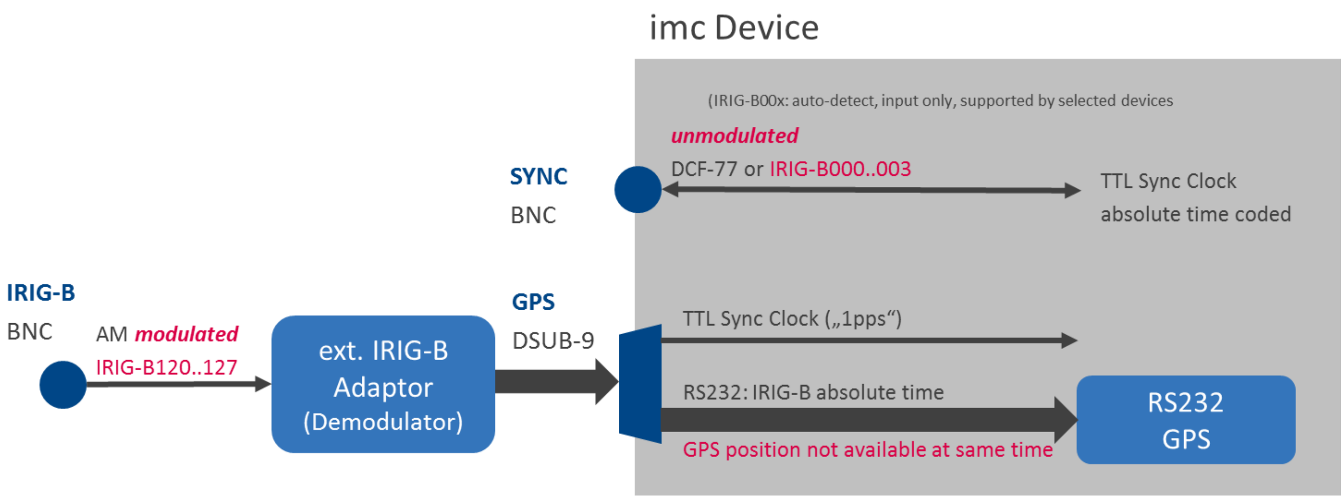
The definition of the various IRIG time codes is specified in the IRIG standard 200-98. This adaptor module supports sub-standards IRIG-B120 through B127. These are characterized by 100 pulses per second, AM (amplitude-modulated) sinusoidal signal, 1 kHz carrier frequency, BCD Time-of-Year.

The module's rear panel holds the DSUB-9 plug, which is connected to the measurement system's GPS plug via the included RS232 expansion cable. The pinout of the DSUB-9 plug directly conforms to the "GPS" connectors pin configuration, which is uniform to imc measurement systems.

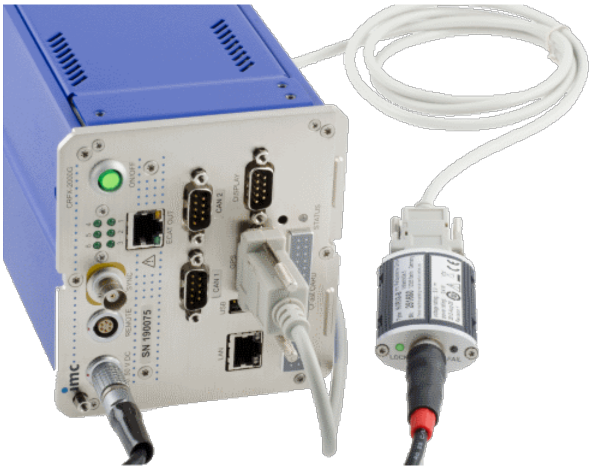
When using the IRIG-B adaptor in conjunction with this GPS port, absolute time information is captured via this RS232 interface, and additionally, synchronization of the device's system clock is performed by means of an additional clock signal ("1 pps") provided on a dedicated pin of the DSUB-9 terminal. While this occupies the port, simultaneous capture of GPS geo positioning information is not supported at the same time.

Note

The operating software (imc STUDIO) will denote the used synchronization type as "GPS", simply because the respective port is used to interface the IRIG-B module.



The module's front panel has one BNC plug and two LEDs. The LOCK LED shines when the input signal is synchronized with the IRIG-B module. If the input signal is not valid or not synchronized with the IRIG-B module, the FAIL LED shines.



The IRIG-B module comprises a realtime clock (RTC) with a backup battery, which is set to time and date according to the IRIG B-signal received. If the IRIG B year codes received equal "00" (depending on used sub-standard) these are ignored and only RTC time and day values are set, while the year continues to reflect the value resulting from counting since the last update with a valid year number. This means that the year number is incremented at the turn of the new year.

To monitor an imc measurement system's synchronization status, it is possible to use the imc Online FAMOS function "**IsSynchronized()**". Its return value is "1" if the device is synchronized to an external time reference; otherwise, a "0" is returned.

Loss of the external time signal is detected within 1 – 2 seconds. However, the process of restoring synchronization can last approx. 20 – 25 seconds.

Technical Specs of IRIG-B 486.

Optionally, the module can be factory installed in a measurement system.

6.3.11 WiFi connection

Measurement devices can optionally be equipped with a built-in WiFi (WLAN) adaptor. An alternative wireless network connection may especially useful in applications such as mobile test drives. Measurement devices can be equipped with WiFi adaptors conforming to the standard IEEE 802.11g, which achieve maximum gross transfer rates of 54 Mbit/s, more specifications see chapter Technical details: WiFi 487.

WiFi (WLAN) antenna for a CRx - 400 system (see device overview 95)

Each antenna of the corresponding system is labeled ex-factory at imc Berlin:

- *imc CRx - 400; antenna with SMA Male — only fits with devices with RP-SMA (SMA Female)*
- *imc CRx - 2000; antenna with RP-SMA plug (SMA Female) — only fits with devices with SMA Male*

WiFi (WLAN) antenna for a CRx - 2000G system

The "2000G" devices allow installation of optional WiFi (WLAN) adaptors conforming to the standard IEEE 802.11n, which by using multiple antennas provides higher data rates. Two externally connectable antennas are supported (standard SMA connection), which together achieve a data rate of 300 Mbit/s.

The WLAN antenna with an SMA male terminal is no longer offered by the manufacturer. imc has a modified substitute antenna from the same manufacturer (this affects systems shipped as of August, 2014). For this reason, imc has changed the connection terminals on the devices (SMA Male). Devices previously having RP-SMA (SMA Female) terminals will instead have SMA Male terminals in future.

There is a new label for the new antenna to differentiate:

WiFi (WLAN) antenna for CRx - 400 system

- *imc CRx - 400 Typ 2; antenna with RP-SMA plug (SMA Female) — only fits with devices with SMA Male*

The antenna labeled: "imc CRx - 2000" can be used for all imc CRONOS with built-in WiFi (WLAN) adaptor (SMA Female).

In order to make the label of the antenna for all devices uniform, we changed the label as follows:

Please pay attention to the terminal connection on your device!

WiFi antenna with RPSMA (female) is only compatible to RPSMA (male) on your device.

WiFi - antenna with RPSMA (female)

connection at your device RPSMA (male)

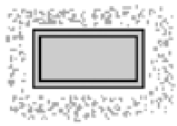
WiFi - antenna with SMA (male)

connection at your device SMA (female)

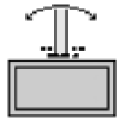
6.3.12 ACC/DSUB-XX-IP65 - protection class IP65

Protection classes serve the purposes of making classifications and identifications with reference to existing safety measures.

The first digit of the (**IP 6X**) protection type specifies:
- complete protection against ingress of dust



and the second digit (IP X5) specifies:
- protection against jets of water (from any direction)



Note

What must be done
to maintain a IP65-rated connector's protection degree after having been opened?

In order for an imc to retain its protective capability after having been opened and connected, be sure to keep the contact surfaces clean and dry while opening. This is because contaminations can cause damage to the sealing. Such damage can lead to failure of the sealing.

The screws closing the lid should be tightened in diagonal sequence, for instance, starting at the upper right, then bottom left, then top left and then bottom right. In the process, not all screws should be tightened all the way at first. Instead, tighten the screws so that the lid is pressed only lightly over the opening. This is necessary for ensuring that the lid is seated equally on all sides. Once all the screws have been tightened loosely, tighten them all completely, so that the lid is seated firmly and the connector is tightly sealed. This is to prevent spraying water or dust from penetrating.

The two PFLITSCH M12 x 1.5 cable connections seal cables with a diameter from 6.5 mm up to 9.5 mm.

For deviating cable diameters appropriate cable gland sets should be selected.

The seal is included in the imc IP65 specified connector shipment.

This ring is for the groove on your imc CRONOS-SL device's socket. To obtain a clean seal between the connector and the device, the sealing must be placed and glued into the groove.

Warning

- Ensure that the connector is not screwed on croockedly and that the sealing surface is clean and dry.
- Your imc CRONOS-SL device may already have such a sealing ring. In this case you can ignore the ring which comes with the connector.

6.3.13 ACC/DSUBM-ESD

When deploying measurement equipment in electromagnetically "polluted" industrial environments, careful installation and cabling is essential (proper grounding, shielding etc.). As an additional provision, this ESD filter plug can be applied between measurement amplifiers and the sensor installation. It is intended to suppress transient disturbance and discharge and thus make the system more robust and reliable. The plug is equipped with identical filter elements for each of the 15 DSUB pins, providing a "neutral" 1:1 connection from input to output. The uniform filter design makes it suitable for all types of measurement modules such as analog inputs, outputs, pulse counter, digital IO. While providing effective filtering and protection, it is not associated with any functional restrictions and in particular does not involve limitations of signal bandwidth within the relevant scope of the measurement.

Properties

ACC/DSUBM-ESD and the ACC/DSUB-ESD

- Retrofit adapter plug for suppression of conducted interference on measurement inputs
- Preventing possible malfunction of measurement amplifiers due to discharge and transient voltage spikes
- Passive HF filtering elements
- Easy retrofit for flexible solutions providing robust test and measurement under demanding industrial conditions
- Suitable for any type of imc modules equipped with DSUB-15 connectors
- No limitations to functionality and bandwidth within the relevant baseband of the measurement

Please finde here the technical details of the ACC/DSUB(M)-ESD page: 483. The technical details are valid for both variants: the plastic housng and the metal housing.

6.3.14 Storage Media

Alongside transfer to the PC, it is also possible to save measured data on removable data storage media. The operating software imc STUDIO allows free selection of data storage options (see the description of data storage in the operating software's user manual). imc measurement devices of a particular device group are compatible with particular data storage media, such as CF-Card, CFast-Card or USB data volumes. Storage media with verified performance can be purchased as accessories from imc. Hard drives are ordered with the device and can only be installed subsequently by imc.

imc device	serial no.	device group	CF	CFast	USB	microSD
CRONOS*flex* (CRFX-2000GP), CRONOS*compact* (CRC-400GP)	19XXXX	A7	-	✔	✔	-
CRONOS*flex* (CRFX-400), CRC-400, C-SERIES, SPARTAN	14XXXX	A5	✔	-	-	-
BUSDAQ*flex* (BUSFX)	13XXXX	A4	✔	-	-	-
ARGUS*fit* (ARGFT)	416XXX	B11	-	-	-	✔

Certain devices can be equipped with a hard drive (see chap. "device overview" in each manual). A distinction is drawn between **removable and internal storage media**.

Removable and internal storage media

Internal storage media can not be interchanged, but rather are permanently installed inside the device. They are usually magnetic or SSD harddrives. Use of such media is the best approach whenever the required storage capacity exceeds data volumes which removable media can provide. The internal storage media exclusively serve the purpose of data acquisition. Hard drives are ordered along with the device, and can only be retrofit by imc for existing equipment.

If both large storage capacity and interchangeability are required at the same time, a drive bay for 2.5" SATA hard drives can be used, see photo: CRC/HDD-FRAME 118. This means that the system displays this drive as a removable drive. Otherwise, this drive is displayed as internal storage. Irrespective of an eventually available hotplug capability, the drive can always be exchanged while the device is deactivated, so that the accumulated data can be conveniently analyzed or archived.

Guidelines for proper handling of the removable storage media

- **Always insert only one removable storage medium (e.g. either CFast or USB with CRFX-2000GP).**
  In the case of multiple installed storage options (CFast & USB) the device does only support one storage volume at a time. Which one is determined upon activation, and there is no fixed sequential order. For this reason, remove any data storage volumes which you do not wish to use for the measurement before activating the device. When one removable data storage volume is currently inserted and an additional one is then inserted, the status-LED flashes red one time to indicate that the removable volume can not be used.
- Ensure that sufficient time is available for the exchange. The time needed for registering and deregistering with the system depends on the data carrier and on the channel count. As a guideline value, we recommend at least 30 s, even for simple configurations.
- Formatting of the 1 TB SSD hard drive can only take place when it is inserted in the device. It is important that this hard drive is only formatted in FAT32.

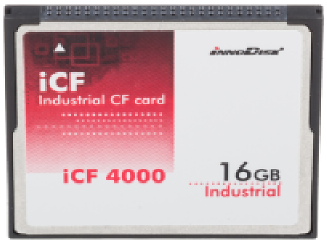
Exchanging the data carrier

In case you are using a removable storage medium, please be aware that before you remove it (if the device is switched on), the Hotplug button must be pressed to ensure that storage medium can be safely removed.

Reference Storage media in the device

The chapter: "*Storage media in the device*" in the software manual or also in the First steps with the imc device supplied describe the prescribed handling, correct replacement, formatting and much more with storage media.

Removable CF Storage Media Cards



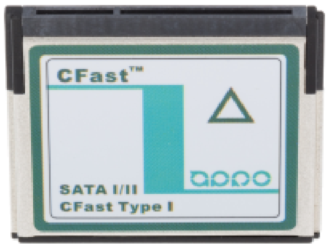
Overview of the available storage media

Order code	article number
ACC/CF-2.0-GB-ET	13500020
ACC/CF-8.0-GB-ET	13500079
ACC/CF-16.0-GB-ET	13500081
ACC/CF-32.0-GB-ET	13500137

Operating conditions - removable CF storage media

Storage temperature:	-65°C to 150°C	
Operating temperature:	-40°C to 85°C	condensation allowed (extended temperature range)
Shock protection	in operation 1000 g	

Removable CFast Storage Media Cards



conforming to CFast 2.0 specification

One major advantage of the CFast-format is its high transfer/write-speed. **CFast is not compatible with CF** (CompactFlash). Both storage media have roughly the same housing dimensions, but different connectors and are therefore not plug-compatible.

CFast is based electrically on the SATA Standard, while CF is based on the parallel IDE-ATA, so that the former offers significantly higher transfer speeds.

The CFast storage media are compatible with devices with a serial number (SN) > 190000 (device group A7)

Overview of the available CFast storage media

Order code	article number
ACC/CFast-8 GB ET	13500163
ACC/CFast-16 GB-ET	13500164
ACC/CFast-32 GB-ET	13500165
ACC/CFast-64 GB ET	13500260

Operating conditions - removable CFast storage media

Operating temperature:	-40°C to 85°C
Shock and Vibration	conforming to MIL-STD-810F

CFast Card Reader with USB 3.0

Order code	article number
FH/CARDREADER-CFAST-USB3	13300018

- Hot Swap, Plug & Play
- 1x micro USB 3.0
- 1x CFast Card Slot
- Supports CFast type I/II memory cards
- Data transfer rate up to 5 Gb/s
- Aluminium case (LxWxH: 82 x 60 x 12 mm)

Removable USB 2.0 Storage Media Cards

Overview of the available USB storage media for devices of the group A7

Order code	article number
ACC/USB-32,0 GB-ET	13500200

Operating conditions - removable USB storage media

Operating temperature:	-40°C to 85°C
Shock and Vibration	conforming to MIL-STD-810F

Note — USB hard disks with external power supply

When using USB hard disks with external power supply, this may not be applied to the USB port. This may destroy the current limitation of the imc USB port when the measuring instrument is switched off.

Note — Manufacturer and Age of the storage medium

- imc has no way to affect the quality of the removable storage media provided by the various manufacturers.
- Storage media which come with newly purchased devices have been inspected in the framework of quality assurance and have passed the relevant tests.
- We expressly declare that the use of removable storage media is at the user's own risk.
- imc and its resellers are only liable within the framework of the guarantee and only to the extent of providing a substitute.
- imc expressly declines any liability for any damages resulting from loss of data.

Flash storage media for ARGUS (microSD)

Overview of the available storage media

Order Code	article no.
ACC/MICROSD-256GB-ET	13500428
ACC/MICROSD-256GB-ET	13500449

Device extension: internal hard drive

Overview of the available hard drives

Order Code	article no.	device	operating temperature
CRC/400-SSD-960GB	11700298	CRC-400-x	0°C to 70 °C (commercial)
CRC/400GP-SSD-960GB	11700300	CRC-400GP-x	-40°C to 85°C (industrial)
CRC/400GP-SSD-480GB	11700299	CRC-400GP-x	-40°C to 85°C (industrial)
CRFX/400-SSD-960GB	11900282	CRFX-400	0°C to 70 °C (commercial)
CRFX/2000GP-SSD-960GB	11900284	CRFX-2000GP	-40°C to 85°C (industrial)
CRFX/2000GP-SSD-480GB	11900283	CRFX-2000GP	-40°C to 85°C (industrial)
SPAR/SSD-960GB	11300133	SPARTAN	0°C to 70 °C (commercial)

Notes

- The operating conditions of the device in which the hard disk is integrated apply (requires a slot).
- Approximately 14% of the total size is reserved for possible defragmentation and is therefore not available.

Removable frame - HDD-FRAME

Order Code	article number	remarks
CRC/HDD-FRAME	11700230	frame component for removable HDD/SSDs, max. 1 per CRC device, requires 1 slot
CRC/HDD-FRAME-R	11700231	variant for the imc CRONOS*compact*-RACK
CRFX/HDD-FRAME	11900223	frame component for removable HDD/SSDs, max. 1 per base unit, requires 1 slot

Housing/frame component for SSD 2.5" SATA Format, max. one per device, not hot-swap capable.

Notes

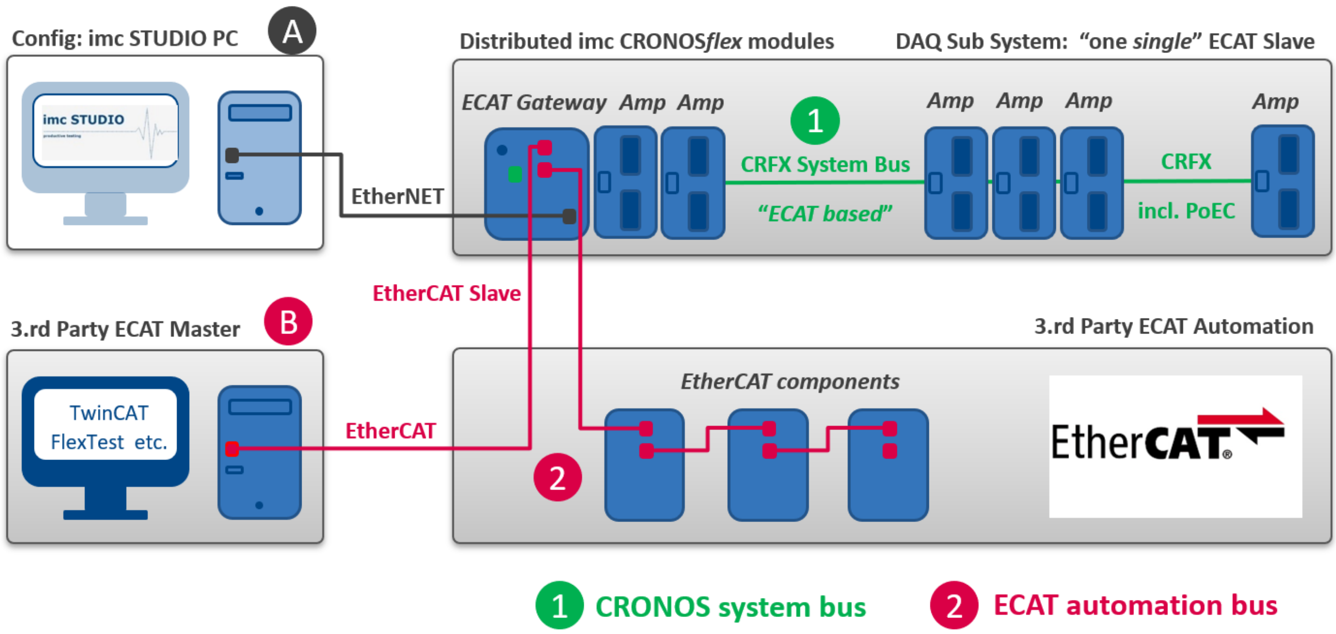
- In order to fit into the frame, the max. height of a hard drive should not be more than 9.5 mm.
- If you buy the storage media from a supplier other than imc, we can not guarantee the quality.

CRC/HDD-FRAME how to insert the SSD

6.3.15 CRFX/ECAT-GATEWAY

The imc CRONOS*flex* EtherCAT Gateway is a bus coupler that allows a number of imc CRONOS*flex* amplifier modules to be used within an EtherCAT-based automation or control system. imc amplifier components can thus be used in EtherCAT environments such as Beckhoff TwinCAT or MTS FlexTest, for example, without the need for a complete CRONOS data logger system (with base unit).

6.3.15.1 Application



A Configuration — **Configuration** of the imc sub system via imc STUDIO Software (PC via **EtherNET**)
→ Output ESI and A2L: Information for the EtherCAT Master
→ subsequently: connection no longer required (PC, imc STUDIO): **Auto-Start Mode**

B DAQ operation — **Data acquisition operation** via "external" EtherCAT test automation system
(e.g. TwinCAT Master) → no redundant parallel data acquisition via imc STUDIO

In connection with the gateway, the CRFX modules act as a data acquisition subsystem in the sense of an EtherCAT slave, without operating in the network of a complete CRONOS data logger. The individual modules are interconnected via the CRFX system bus. This CRONOS system bus is based on the "EtherCAT standard", uses network hardware and is spatially distributable via network cables (Power-over-EtherCAT). The protocol of the CRONOS system bus differs from the "EtherCAT Standard". It is not compatible with EtherCAT 3rd party systems, i.e. the CRFX modules cannot be operated in such an environment. The ECAT gateway establishes this connection, forming a single EtherCAT slave station.

The ECAT slave subsystem is configured once using imc STUDIO via EtherNET. Afterwards and during active operation this access is no longer necessary.

Typical applications are:

- Test benches
- Integration of CRFX modules in EtherCAT system environment, such as:
  - TwinCAT automation
  - MTS FlexTest
  - Horiba STARS Engine
  - FEV MORPHEE
  - Instron
- Use of WFT measurement wheels via CRFX/WFT-2 interface module in 3rd party environment

If the target systems implement real-time control, the resulting latencies (signal propagation times) of the system must be taken into account in addition to the sampling rates of the amplifiers (max. 5 kHz) and cycle times of the EtherCAT bus (e.g. 5 kHz or 1 kHz). These are in the order of <2 ms.

6.3.15.2 Configuration via imc STUDIO

The gateway and the connected modules are configured via imc STUDIO. For this purpose, an Ethernet connection between the gateway and the STUDIO PC must be established.

This configuration and also the Ethernet connection is typically required only once. After that the autostart functionality of gateway and amplifiers can be used. The last valid configuration stored in the device is then automatically loaded when the device is switched on and operation is started.

During configuration, the measuring channels must be set to the desired measuring mode, measuring range, etc.

For the filter setting AAF (automatic anti-aliasing) is to be selected and thereby the sampling rate of the channels is to be set exactly to the rate which is used on the EtherCAT bus as bus cycle, typically either 5 kHz or 1 kHz. Exactly then the AAF filter frequency is matched to the internal cycle rate of the data or pv variable corresponding to the bus cycle.

The actual update rate and thus the effectively utilized EtherCAT bus rate is limited to 5 kHz. If the EtherCAT bus cycle should be selected faster, then the internal rate of max. 5 kHz must still be configured at this EtherCAT gateway during channel configuration. With this rate actually new data are delivered at the bus and also the AAF filter must be adjusted to this rate.

Following the configuration, an A2L file must typically be exported. This file is used to configure the EtherCAT master system. After finishing the configuration, an Autostart configuration must be uploaded to the device (Diskstart), see imc STUDIO manual.

Key data

- Max. ECAT bus cycle: 5 kHz (200 µs), supported bus cycle: 5 kHz, 1 kHz, 500 Hz, 200 Hz, 100 Hz
- Max. number of channels respectively sampling rates:

	34 channels @ 5 kHz	(170 kHz sampling rate)
	128 channels @ 1 kHz	and lower

Reference

Find technical specs in the chapter "Technical Specs 491".

6.4 Fieldbus interfaces

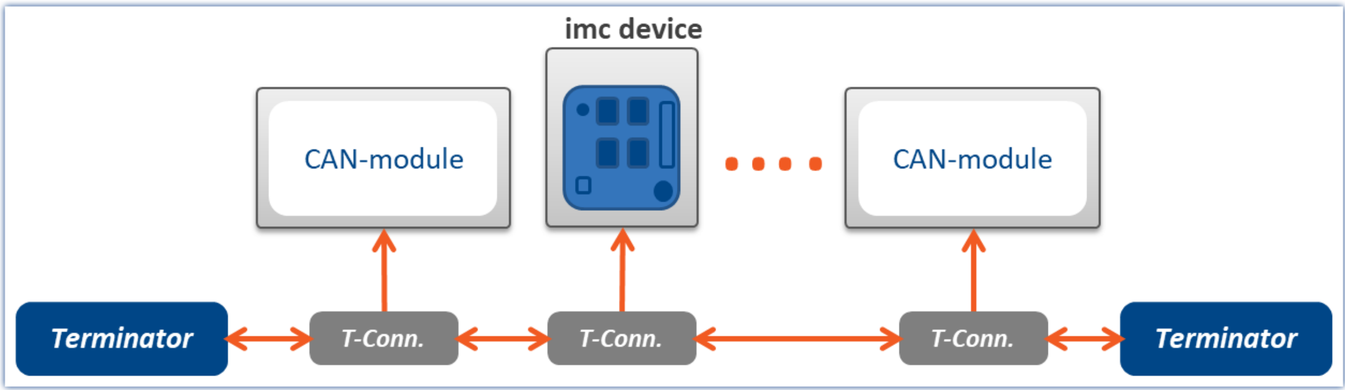
Along with the capture of data with the modular amplifiers, imc measurement devices can also collect data from digital bus systems. The data acquired using the bus systems are treated in the same way as other data, and can be synchronously stored and displayed along with these, and jointly subjected along with them to calculations. Depending on the software- and hardware configurations, targeted output of data on specific bus systems may also be possible. Depending on the software and the hardware equipment a purposeful expenditure of data to the adequate bus system is possible.

Note fieldbus connection options

The fieldbus connection options are configuration options, imc measurement systems can only be equipped ex-factory with those modules. An exchange or plug-in by the user is not allowed.

6.4.1 CAN, CAN FD

If your imc device is equipped with at least 2 nodes (DSUB-9), each of them is supposed to be connected with a Y-adaptor.



imc CRONOS System family with connected Y-adaptor

Note that for a transfer rate of 1 Mbit/s to the CAN-Bus the stub line of a tee-junction may only be up to 30 cm long. In general, the wiring within imc CRONOS System family is already 30 cm long. Therefore if an external tee-junction is connected, the junction must be connected straight into the terminal.

In this context it doesn't matter whether the other sensors are connected via tee-junction or not. The illustration simply shows the options available.

Find here the technical details 460 and the pin configuration 508 of the CAN-Bus interface.

Find here the technical details 461 and the pin configuration 508 of the CAN FD interface.

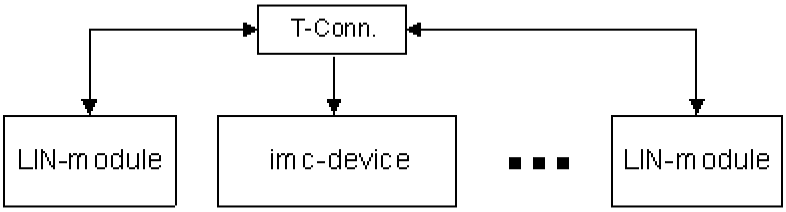
Connecting the terminators

- Terminator-resistance is 120 Ω as per CAN in Automation (CiA).
- If terminators are connected, then between Pins 2 and 7.
- Terminators are only applied at the ends of the bus; nowhere else in the line. The bus must always end at a terminator.

Note

With High-Speed CAN a termination on each node can be activated by software.

6.4.2 LIN



LIN-cabling

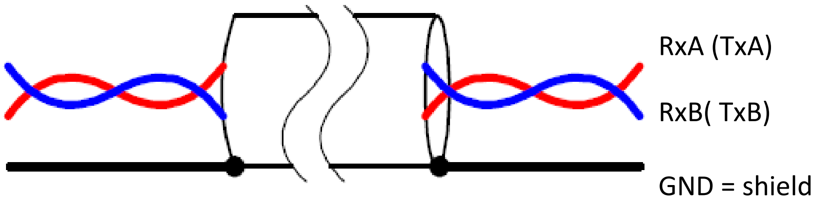
To the technical data 462 and the pin configuration 508 of the LIN-BUS interface.

6.4.3 ARINC

imc standard: DSUB-15

This pin configuration corresponds the suggested imc standard. Transmitting channels and any differing pin configuration can be considered as special order.

We recommend for the connection twisted and shielded wiring:



To the technical data 467 and the pin configuration 511 of the ARINC-Bus interface.

6.4.4 FlexRay

Standard 1x DSUB-9

Reference

To the technical data 463 and the pin configuration (optional 2x DSUB-9) 509 of the FlexRay interface.

6.4.5 XCPoE

Standard 1x RJ45

Reference

To the technical data 465 and the pin configuration 509 of the XCPoE interface.

6.4.6 PROFINET

Reference

To the technical data 464 and the pin configuration 512 of the PROFINET interface.

6.4.6.1 LED

PROFINET			
Parameter	**Value**		**Remarks**
Explanation NET LED	off		no supply no connection to the IO-Controller
	green		connection with IO-Controller established IO-Controller in RUN state
	green, 1 x blinking		connection with IO-Controller established IO-Controller in STOP state or erroneous IO data RT synchronization not completed
	green, blinking		network identification
	red		internal error in combination with red module status LED
	red, blinking once		station name not set
	red, blinking twice		IP address not set
	red, blinking three times		expected IO-Device identification deviates from real identification
Explanation MOD LED	off		no supply device not in initialization phase
	green		normal operation
	green, blinking once		diagnosis-event(s) available
	red		internal error in combination with red NET-LED
	alternating green, red		Firmware-Update. The device must not be switched off during the update. Otherwise it can lead to total failure of the device.
Explanation LEDs of the network socket	green (left)	yellow (right)	
	off	off	no connection
	on	off	100 Mbit/s connection
	blinking	off	100 Mbit/s connection, active
	off	on	10 Mbit/s connection
	off	blinking	10 Mbit/s connection, active

6.4.7 PROFIBUS

Reference

To the technical data 463 and the pin configuration 512 of the PROFIBUS interface.

6.4.8 MVB

EMD (Electrical Medium Distance) with duplicate interconnection providing redundant transmission for the bus via two differential lead pairs. Up to 32 devices can be connected across a distance of max. 200 m. The cables used are standard 120 Ω lines. The signals are connected by means of two DSUB-9 plugs. The shielding is connected directly to the device housing. The housing should be grounded if possible. Internally, the bus is electrically insulated from the device connected.

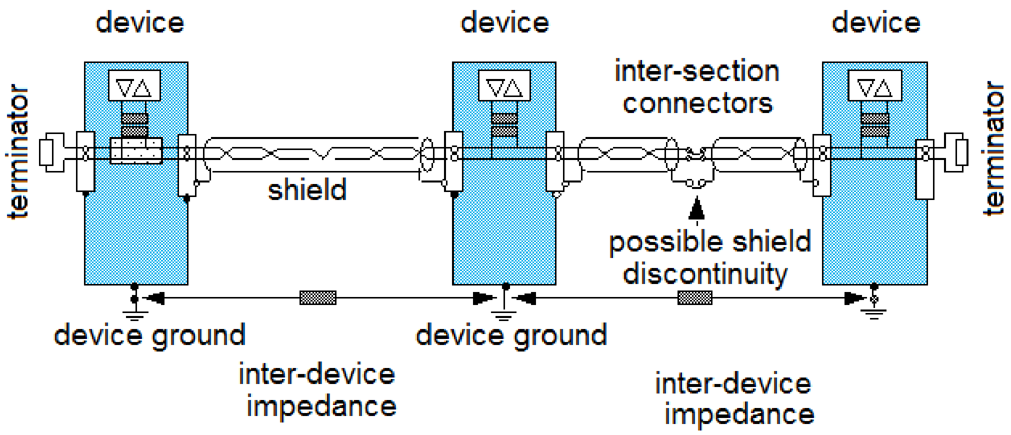
Reference

To the technical data 466 and the pin configuration 513 of the MVB-Bus interface.

6.4.8.1 EMD

EMD (Electrical Medium Distance) with duplicate interconnection providing redundant transmission for the bus via two differential lead pairs.

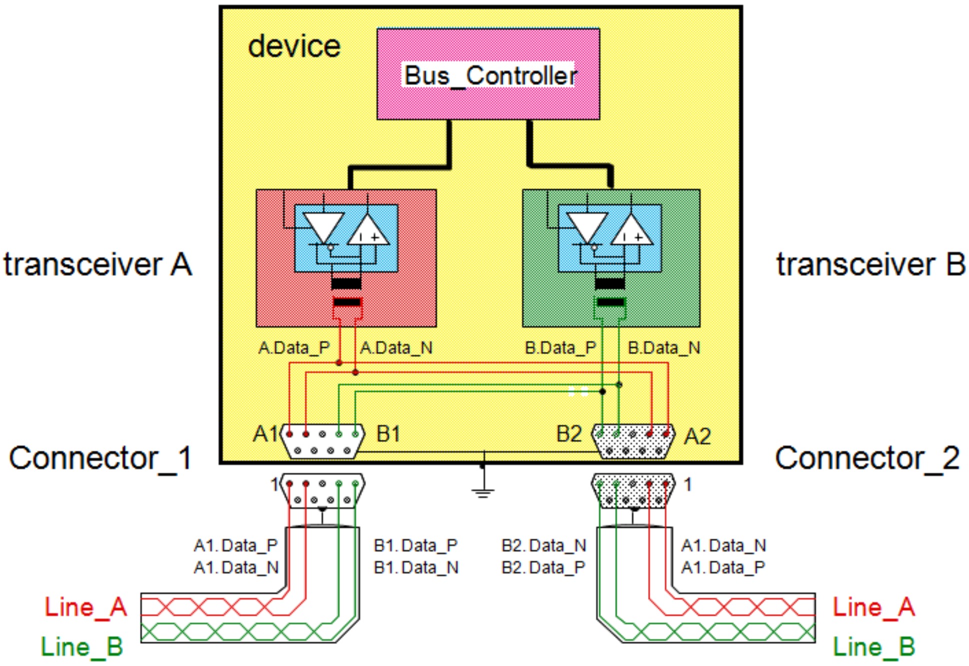
- Up to 32 devices can be connected across a distance of max. 200 m.
- The cables used are standard 120 Ω lines.
- The signals are connected by means of two DSUB-9 terminals.



MVB-bus cabling for EMD

The shielding is connected directly to the device housing. The housing should be grounded if possible.

Internally, the bus is electrically insulated from the device connected.

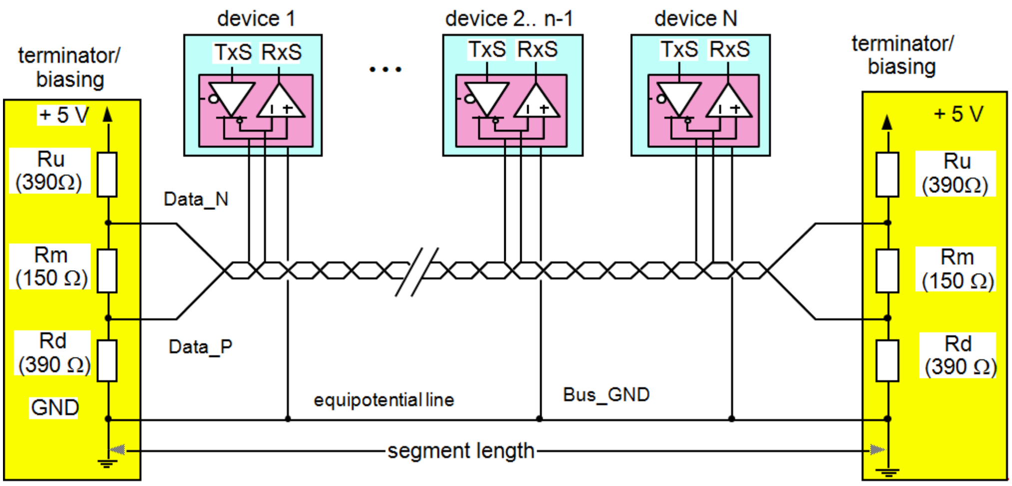


Internal wiring for EMD connection

6.4.8.2 ESD

ESD (Electrical Short Distance) RS485 sets up the connection without galvanic isolation. The variant ESD+ comes with galvanic isolation and is available from imc.

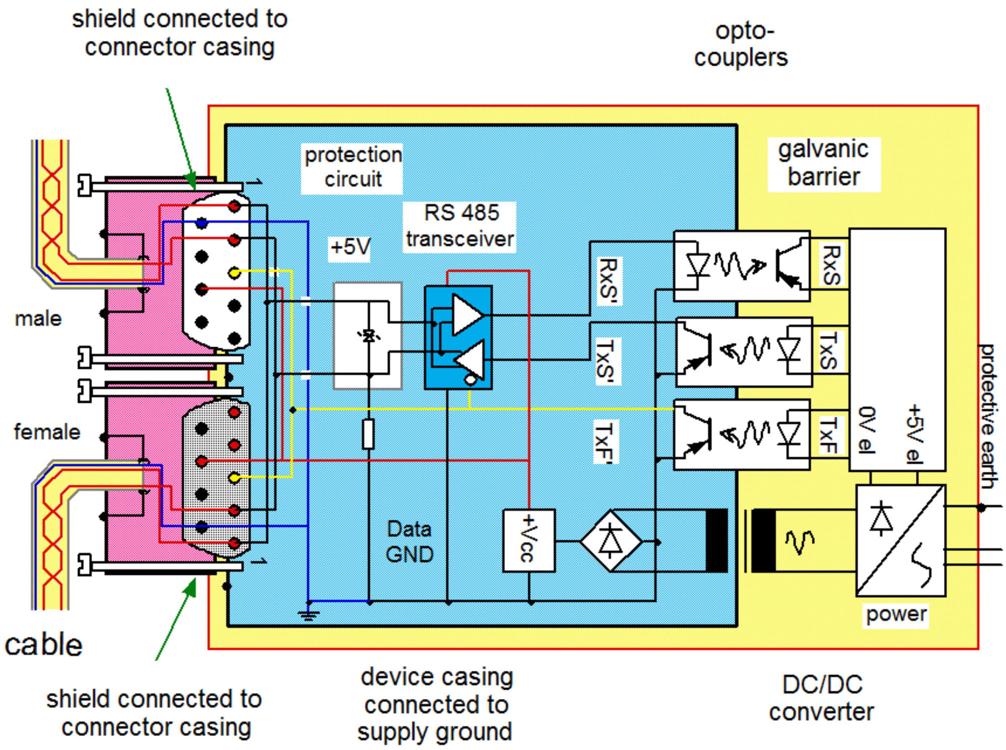
- Up to 32 devices can be connected across a max. distance of 20 m.
- Standard 120 Ω cable leads are used.
- Lines are connected via DSUB9 terminals.



MVB-Bus cabling for ESD

The shielding is connected directly to the device chassis, which should be grounded if possible.

Internally, the bus is galvanically isolated from the connected device.



ESD+ device with galvanic isolation

6.4.9 EtherCAT

The fieldbus module EtherCAT Slave Interface (imc ECAT-Slave-IF) provides the integration of imc CRONOS*flex* and imc CRONOS*compact* devices into an automation system based on EtherCAT fieldbus.

The complete imc CRONOS device is integrated as a slave into an EtherCAT fieldbus, which is operated by an external master.

Data from the imc measurement device are thus available throughout an EtherCAT system and integration of the device into other system environments is achieved. This interface is not limited to readout of data and variables from the imc system. Moreover, variables and system parameters of the imc system (Slave) can also be set and manipulated by the external EtherCAT Master, which allows for close interaction and further control schemes.

Reference

To the technical data 462 and the pin configuration 510 of the imc EtherCAT module.

7 Measurement types

7.1 Temperature measurement

Two methods are available for measuring temperature. Measurement using a **PT100** requires a constant current, e.g. of 250 µA to flow through the sensor. The temperature-dependent resistance causes a voltage drop which is correlated to a temperature according to a characteristic curve.

When measuring with **thermocouples**, the temperature is determined via the series of voltages of different alloys. The sensor generates a temperature-dependent voltage which is relative to the terminal point on the plug. To find the absolute temperature, the temperature of the terminal point must be known. This is determined with a **PT1000** directly in the terminal plug and requires a special plug type.

The measured voltage is converted into the displayed temperature value according to the characteristics of the temperature scale ITS-90.

Note — Making settings with imc software

A temperature measurement is a voltage measurement whose measured values are converted to physical temperature values by reference to a characteristic curve. The characteristic curve is selected using the "Correction" parameter on the " Measurement mode" tab. Amplifiers which enable bridge measurement, must first be set to the "*Voltage*" measurement mode in order for the temperature characteristics curves to be available for selection.

7.1.1 Thermocouples as per DIN and IEC

The following standards apply for thermocouples, in terms of their thermoelectric voltage and tolerances:

Thermocouple	Symbol	max. temp.	defined up to	(+)	(-)
	DIN IEC 584-1 (2014-07)				
Iron-constantan (Fe-CuNi)	**J**	750°C	1200°C	black	white
Copper-constantan (Cu-CuNi)	**T**	350°C	400°C	brown	white
Nickel-chromium-Nickel (NiCr-Ni)	**K**	1200°C	1370°C	green	white
Nickel-chromium-constantan (NiCr-CuNi)	**E**	900°C	1000°C	violet	white
Nicrosil-Nisil (NiCrSi-NiSi)	**N**	1200°C	1300°C	red	orange
Platinum-Rhodium-platinum (Pt10Rh-Pt)	**S**	1600°C	1760°C	orange	white
Platinum-Rhodium-platinum (Pt13Rh-Pt)	**R**	1600°C	1760°C	orange	white
Platinum-Rhodium-platinum (Pt30Rh-Pt6Rh)	**B**	1700°C	1820°C	n.a.	n.a.
	DIN 43710				
Iron-constantan (Fe-CuNi)	**L**	600°C	900°C	red	blue
Copper-constantan (Cu-CuNi)	**U**	900°C	600°C	red	brown

If the thermo-wires have no identifying markings, the following ***distinguishing characteristics*** can help:

- Fe-CuNi: Plus-pole is magnetic
- Cu-CuNi: Plus-pole is copper-colored
- NiCr-Ni: Minus-pole is magnetic
- PtRh-Pt: Minus-pole is softer

The color-coding of compensating leads is stipulated by DIN 43713. For components conforming to IEC 60584: **The plus-pole is the same color as the shell; the minus-pole is white**.

7.1.2 PT100 (RTD) - measurement

RTD (PT100) sensors can be directly connected in 4-wire-configuration. An additional reference current source feeds a chain of up to 4 sensors in series.

With the imc Thermo plug, the connection terminals are already wired in such a way that this reference current loop is closed.

Note

If fewer than 4 PT100 units are connected, the current-loop must be completed by a wire jumper from the "last" RTD to -I4.

If you dispense with the "support terminals" (±I1 to ±I4) provided in the imc Thermo plug for 4-wire connection, a standard terminal plug or any DSUB-15 plug can be used. The "current loop" must then be formed between +I1 (DSUB Pin 9) and -I4 (DSUB Pin 6).

7.1.3 imc Thermo plug (T4)

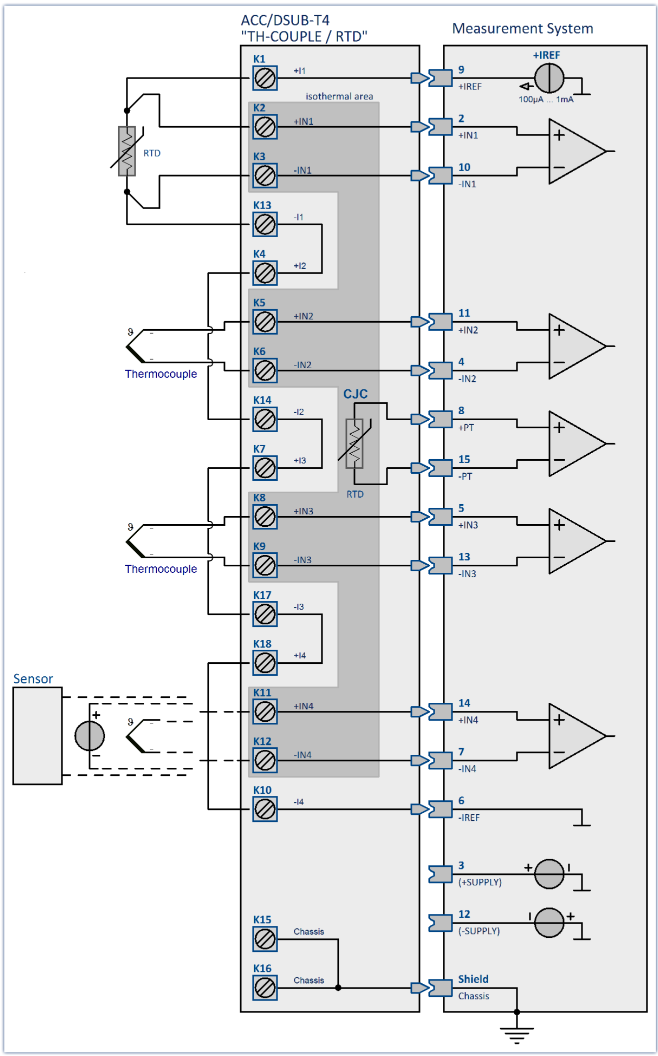
The imc Thermo plug contains a screw terminal block in a DSUB-15 plug housing with a built-in temperature sensor (PT1000) for **cold junction compensation**. This provides for direct connection of thermocouples of any type, directly to the differential inputs (+IN and -IN) without external compensation leads. That plug can also be used for **voltage** measurement.

The difficulty with thermocouple measurements are the "parasitic" thermocouples which inevitably form where parts of the contacts made of different materials meet. The temperature sensor measures the temperature at the connection terminal and compensates the corresponding "error"-voltage. Normally, the connection to this compensation point (inside the device) is made by special compensation leads or plugs made of material identical to the respective thermocouple type, in order not to create additional (uncontrolled) parasitic thermocouples.

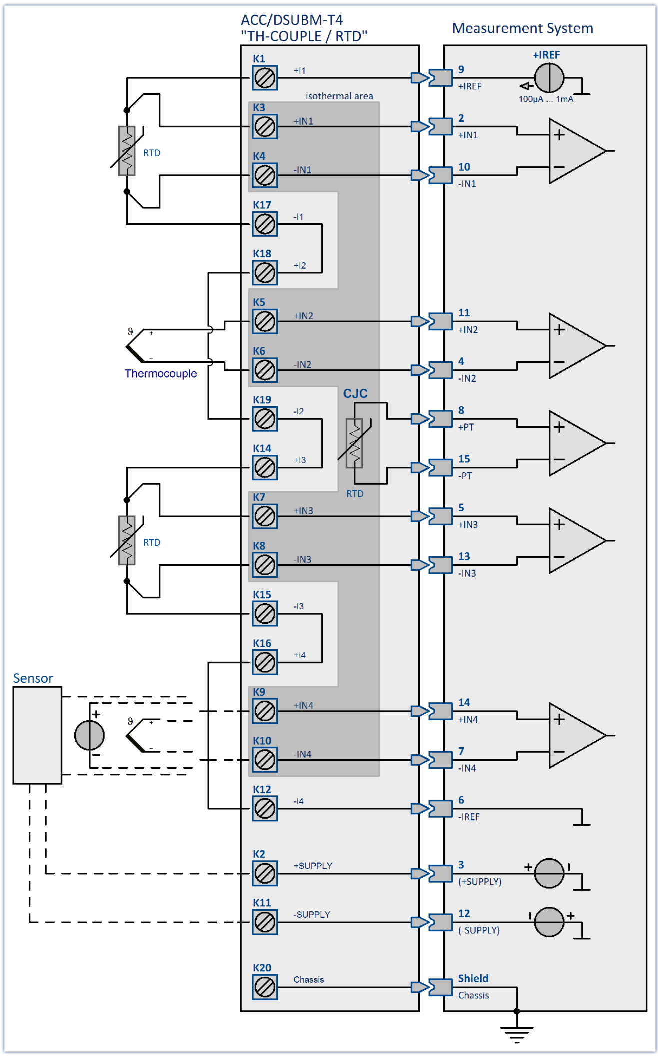
imc's system avoids the problem through the use of individual compensation sensors directly inside the plug, thus offering an especially simple, flexible and cost-effective connection solution.

7.1.3.1 Schematic: T4 plug

Plastic plug (ACC/DSUB-T4, discontinued)



Metal plug (ACC/DSUBM-T4)



7.2 Bridge measurement

This chapter describes the different bridge types and circuits of the bridge channels.

7.2.1 Definition of terms

Strain is the ratio between the original length of a structure and the change in length due to the effect of a force.

$$\varepsilon = \frac{dL}{L}$$

If a strain gauge is attached to a measuring object, the strain is transferred to the measuring grid of the strain gauge when the object is stretched. The change in length caused in the measuring grid causes a change in resistance. There is a proportionality between the change in length and the change in resistance:

$$\varepsilon = \frac{dL}{L} = \frac{dR/R}{k}$$

Legend:	
ε	strain
dL	change in length
L	original length
dR	change in resistance
R	resistance of strain gauge
k	Gauge factor (k factor), describing the ratio of relative length change to the change in resistance

The changes in the resistance caused by the strain are very small. For this reason, a bridge circuit is used to translate the changes in resistance into voltage changes. Depending on the circuit, from one to four strain gauges can be employed as bridge resistors.

Assuming that all bridge resistors have the same value, we have

$$V_a = V_e \cdot \frac{dR}{4 \cdot R} = \frac{V_e}{4 \cdot R} \cdot k \cdot \varepsilon$$

Legend:	
V_a	measurement voltage
V_e	excitation voltage

$$\varepsilon = \frac{V_a \cdot 4}{V_e \cdot k}$$

For concrete measurement tasks, the arrangement of the strain gauges on the test object is important, as well as the circuity of the bridge. On the "bridge circuit", you can select among typical arrangements. A drawing below this drop down menu shows the position of the strain gauge on your test object and the corresponding bridge circuit. Notes on the selected arrangement are displayed in a text box.

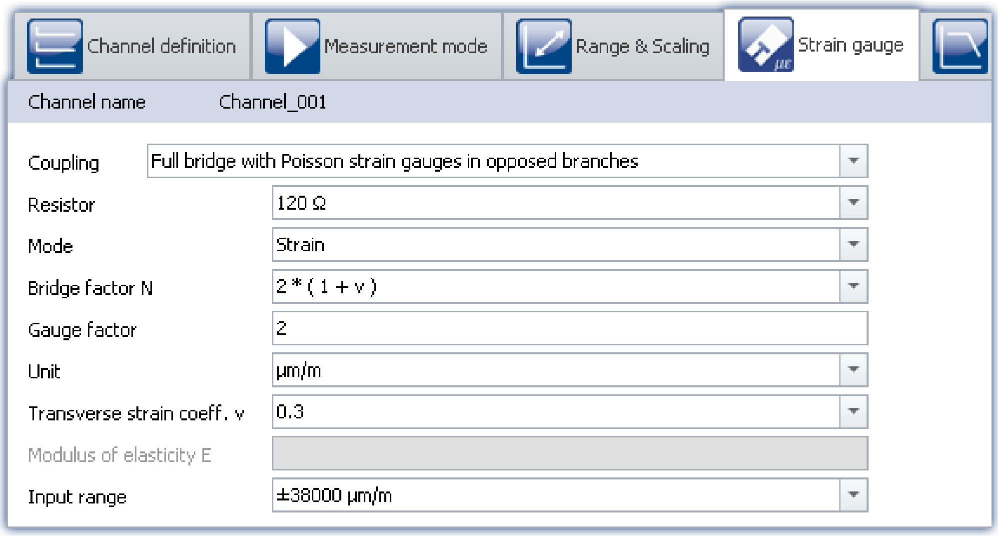
Note

For an easier operation, ranges that are unsuitable are hidden in the operating software.

Scaling for the strain analysis

It is possible to decide whether the strain or the mechanical stress should be determined. In the range of elastic deformation, the axial stress (force / cross section) is proportional to the strain. The proportionality factor is the modulus of elasticity.

Mechanical stress = modulus of elasticity · strain (**Hooke's law**)



By selecting the "Strain gauge" measurement mode, common bridge circuits and strain gauge arrangements are offered. The scaling can be set using the typical parameters for strain measurements such as K-factor or transverse strain coefficient.

Gauge factor (k factor)

The K-factor is the ratio by which the mechanical quantity (elongation) is transformed to the electrical quantity (change in resistance). The typical range is between 1.9 and 4.7. The exact value can be found in the spec sheet for the strain gauge used. If the value entered for this parameter is outside of this range, a warning message will appear but the module can still be configured.

Unit

When the strain is determined, the readings appear with the unit µm/m.
For the mechanical stress one can toggle between GPa and N/ mm^2.

1 GPa = 10^3 N/ mm^2

Note that the elastic modulus is always in GPa.

Transverse strain coeff.

(poisson's ratio): If a body suffers compression or tension and is able to be freely deformed, then not only its length but also its thickness changes. This phenomenon is known as transversal contraction. It can be shown that for each kind of material, the relative change in length is proportional to the relative change in thickness D. The transversal elongation coefficient (Poisson's ratio) is the material-dependent proportionality factor. The material constant is in the range 0.2 to 0.5.

In bridge circuits where the strain gauges are positioned transversally to the main direction of strain, this constant must be supplied by the user. The ratios for various materials are available in the list box. These values are only for orientation and may need to be adjusted.

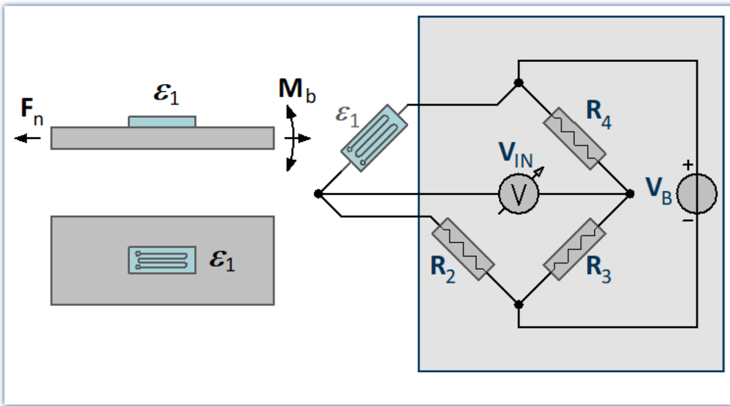
Elastic modulus

The elastic modulus E, is a material parameter characterizing how a body is deformed under the action of pressure or tension in the direction of the force. The unit for E is N/mm^2. This value must be entered for the mechanical stress to be determined The e-moduli for various materials are available in the list box. These values are only for orientation and may need to be adjusted.

7.2.2 Quarter bridge

7.2.2.1 Quarter bridge with internal completion resistor

This bridge circuit uses an active strain gauge and internal completion resistors for strain measurement of tension, compression or bending. The strain gauge is located in the uniaxial stress field on the measurement object. This strain gauge is supplemented by three passive resistors in the module (internal supplementary resistors) to form a full bridge.



	F_n	M_b	M_t
N	1	1	0

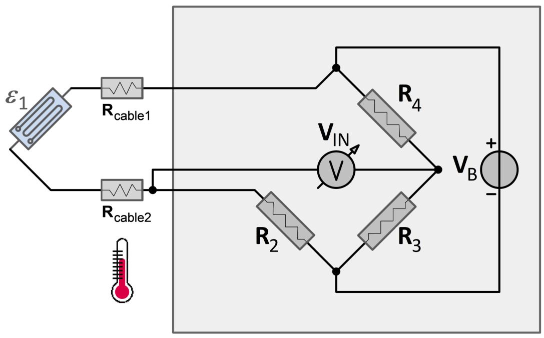
$$\varepsilon = \varepsilon_n + \varepsilon_b + \varepsilon_s$$

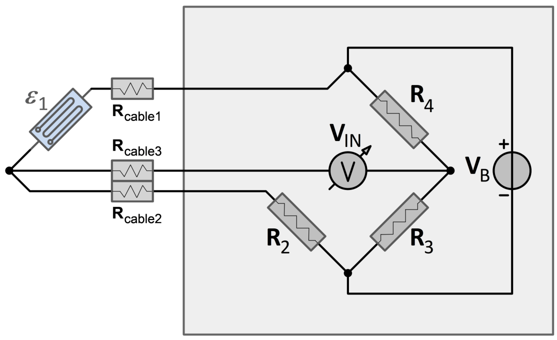
$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

$\varepsilon_s = f(\vartheta)$

The configuration does **not** compensate the thermal influence.

With the addition of R2 to the quarter bridge on the device side, the connection to the sensor resistor is possible in a two- or three-wire circuit.



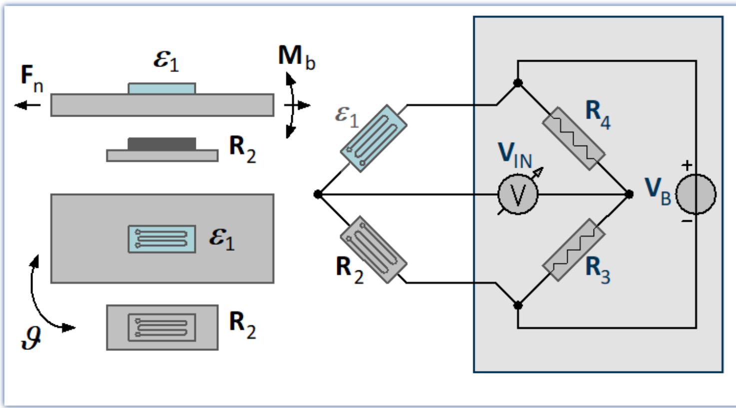


With the two-wire circuit, the temperature-related changes in the cable resistances R_{cable1} and R_{cable2} do not cancel each other out, which leads to a temperature drift in the measurement. In addition, it is not possible to take into account the signal reduction caused by the cable resistances. The two-wire circuit should therefore only be used if the cable resistances are very small (short cable length, large conductor cross-section) or only low measurement uncertainty is required. The three-wire circuit is preferable.

7.2.2.2 Quarter bridge - temperature compensated

This bridge circuit uses **an active strain gauge** and **a passive strain gauge** to compensate for the influence of temperature and for strain measurement of tension, compression or bending. The active strain gauge is located in the uniaxial stress field on the measurement object. The passive strain gauge is not under load and is mounted on a component made of the same material and at the same temperature as the active strain gauge.

This strain gauge is supplemented by two passive resistors in the module (internal supplementary resistors) to form a full bridge.



	F_n	M_b	M_t
N	1	1	0

$$\varepsilon = \varepsilon_n + \varepsilon_b$$

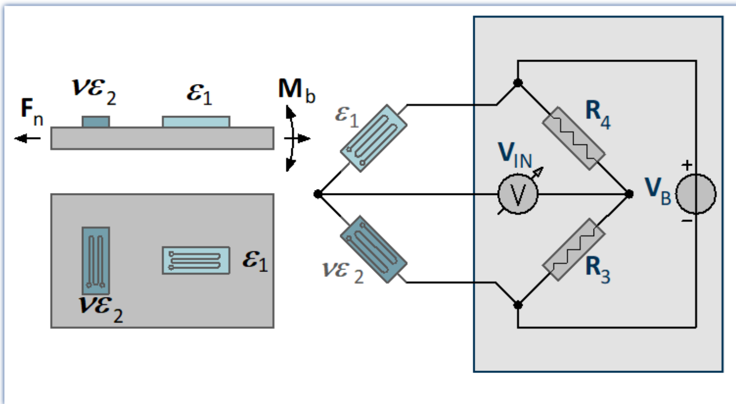
$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

The configuration does compensate the thermal influence (*insensitive to temperature changes*).

7.2.3 Half bridge

7.2.3.1 Poisson half bridge

This bridge circuit uses two active strain gauges for strain measurement of tension, compression or bending. The second strain gauge is positioned on the measurement object transverse to the main strain direction. The transverse contraction is utilized. For this reason, in addition to specifying the K-factor of the strain gauge, it is also important to specify the transverse strain coefficient of the material.



	F_n	M_b	M_t
N	$1+\nu$	$1+\nu$	0

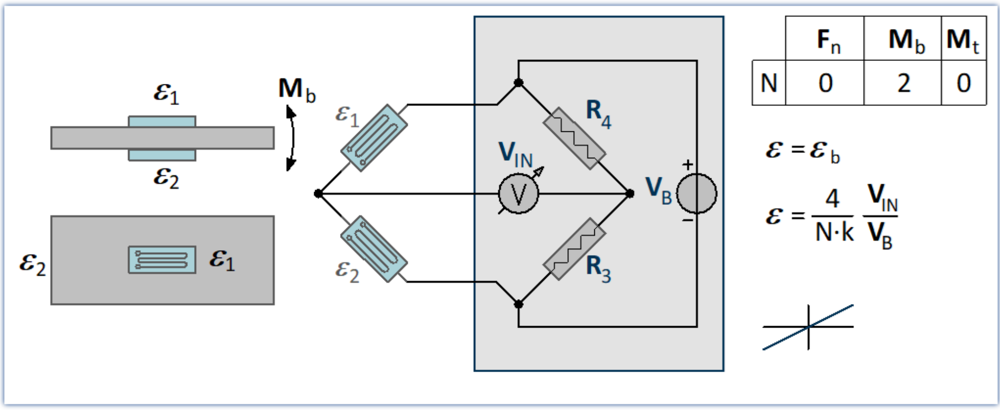
$$\varepsilon = \varepsilon_n + \varepsilon_b$$

$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

This configuration offers good temperature compensation.

7.2.3.2 Half bridge with two strain gauges in uniaxial direction

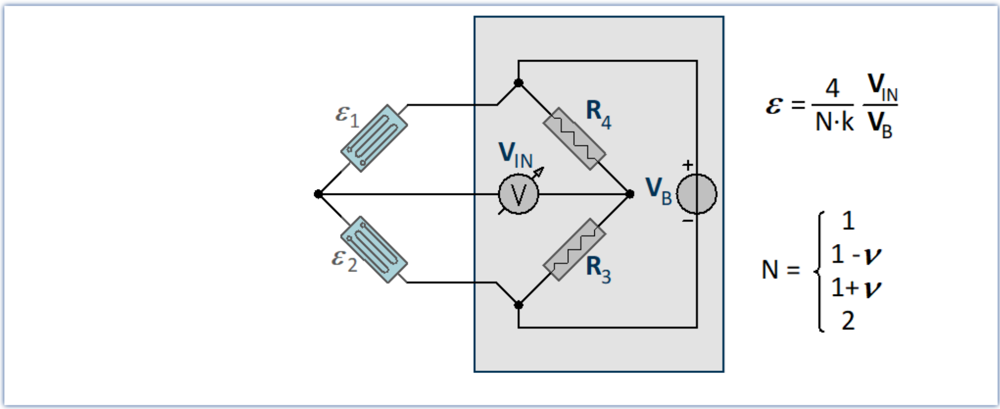
Two active strain gauges are placed along one axis under equal tension with opposite directions. Typical **bending beam circuit**: One strain is under compression and the other under equal tension. Double sensitivity for the bending moment, compensates for longitudinal forces, torsion and temperature.



Longitudinal forces, torsion and temperature changes are compensated.

7.2.3.3 Half bridge - general strain gauge

Freely configurable half-bridge circuit with bridge completion in the measuring device. N must be selected from a list.

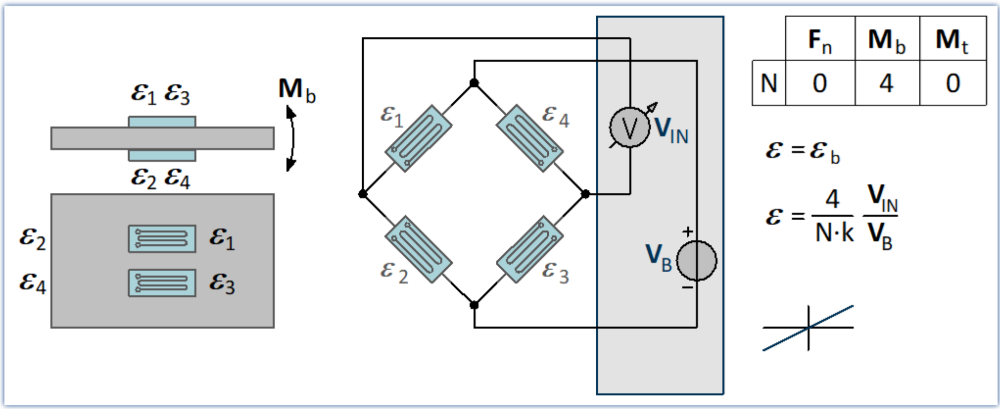


7.2.4 Full bridge

7.2.4.1 Full bridge with four strain gauges - bending beam

General full bridge circuit for the bending moment

This bridge circuit uses four active strain gauges. Two of them are under compression and two are under equal tension, located on opposite sides of the structure.



	F_n	M_b	M_t
N	0	4	0

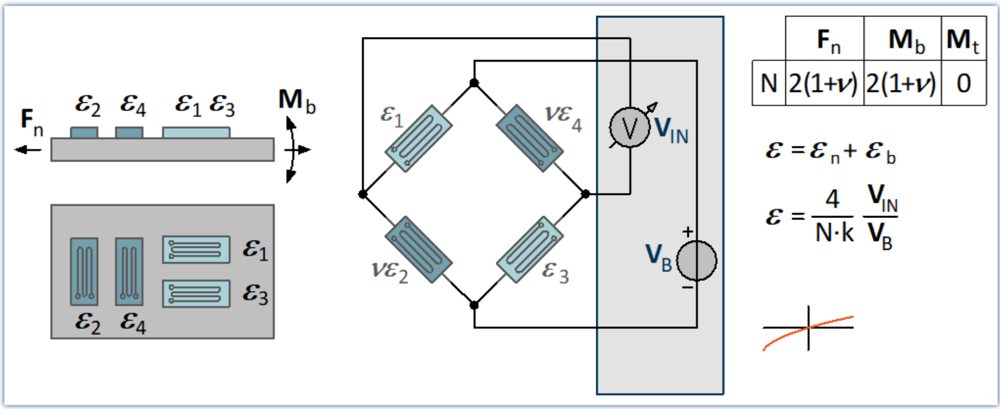
$$\varepsilon = \varepsilon_b$$

$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

The sensitivity of the bending moment is increased. At the same time, longitudinal force, torque and temperature are compensated for.

7.2.4.2 Full bridge consisting of two Poisson half bridges - installed on one side of the structure

This bridge circuit uses a full bridge with four active strain gauges. Two active strain gauges are supplemented by two transversely arranged strain gauges to form Poisson half bridges, which are located in the diagonally opposite bridge branches (*tension rod arrangement*). This circuit results in a high sensitivity by utilizing the transverse contraction and the normal strain with good compensation of the temperature influence. Strain measurement of **tension, compression or bending**.



	F_n	M_b	M_t
N	$2(1+\nu)$	$2(1+\nu)$	0

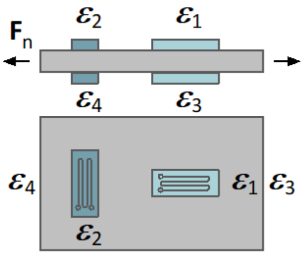
$$\varepsilon = \varepsilon_n + \varepsilon_b$$

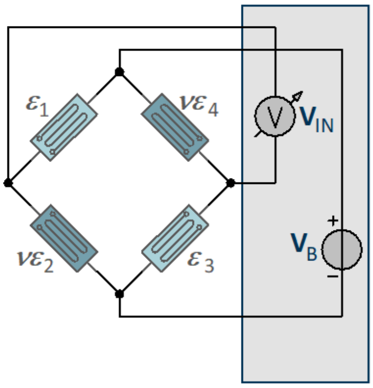
$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

In this circuit, the specification of the transverse strain coefficient of the material is important. The arrangement is **insensitive** to temperature changes.

7.2.4.3 Full bridge consisting of two Poisson half bridges - installed on opposite sides of the structure

This bridge circuit uses a full bridge with four active strain gauges. Two active strain gauges are supplemented by two transversely arranged strain gauges to form Poisson half bridges, which are located in the diagonally opposite bridge branches. This circuit results in a high sensitivity by utilizing the transverse contraction and the normal strain with good compensation of the temperature influence. Suitable for strain measurement of **tension or compression**.

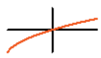




	F_n	M_b	M_t
N	$2(1+\nu)$	0	0

$$\varepsilon = \varepsilon_n$$

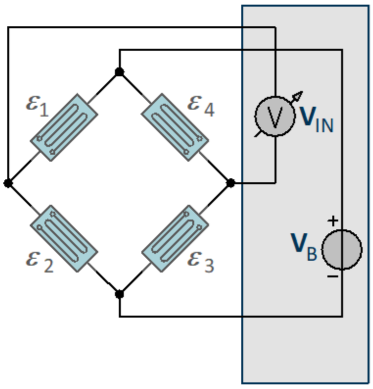
$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$



This circuit offers **good** compensation for temperature influences.

7.2.4.4 Full bridge - general strain gauge

Freely configurable full bridge circuit. The bridge factor N must be specified via list selection.



$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

$$N = \begin{cases} 1 \\ 1-\nu \\ 1+\nu \\ 2 \\ 2(1-\nu) \\ 2(1+\nu) \\ 4 \end{cases}$$

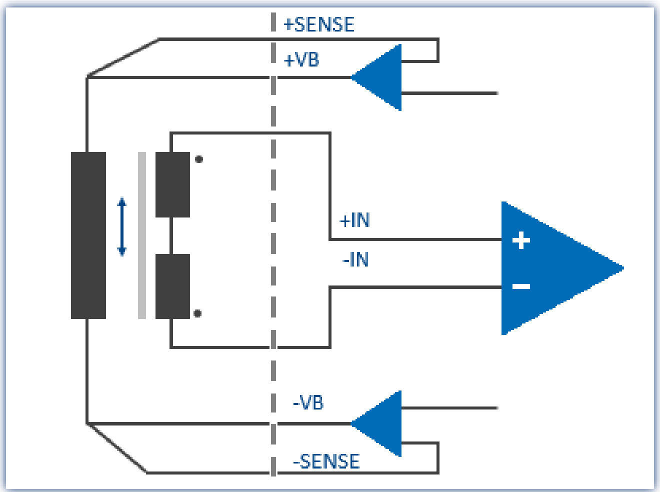
7.3 LVDT

LVDT and inductive displacement transducers are operated with carrier frequency mode bridge amplifiers such as module BR(2)-4 169.

LDVT (Linear Variable Differential Transformer) and RVDT (Rotary Variable Differential Transformer) are based on the transformer principle with an actively driven primary coil. They are configured as full bridge circuit where the two inversely phased secondary windings are compensating each other in the neutral position. Depending on type and winding ratios, the typical output signals are in the range of 200 mV/V but can also exceed 1000 mV/V.

In contrast, inductive displacement sensors do not possess any galvanically isolated primary but consist of two differential coils, wound in phase, that form an inductive half bridge circuit. Their signal range is typical 80 mV/V.

Full-Bridge

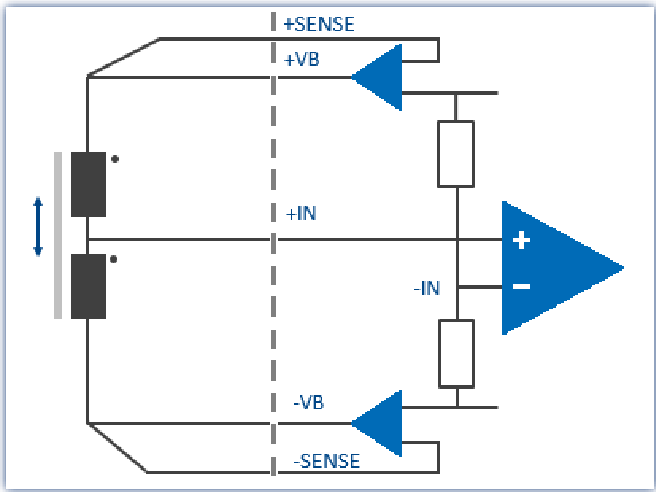


Typically 200 mV/V signal or even < 1000 mV/V.

Opposite winding directions of the two secondaries

Galvanically isolated primary / secondary

Half-Bridge



Typically 80 mV/V signal.

Uniform winding directions of the two coils.

7.4 Incremental Counters Channels

The incremental counter channels are for measuring **time** or **frequency**-based signals. In contrast to the analog channels as well as to the digital inputs, the channels are not sampled at a selected, fixed rate, but instead time intervals between slopes (transitions) or number of pulses of the digital signal are measured. ENC-4 description 301, description of the HRENC-4 308 and please find here the description of the DI16-DO8-ENC4. 283

The **counters** used (set individually for each of the 4 channels) achieve time resolutions of up to 31 ns (32 MHz); which is far beyond the abilities of **sampling procedures** (under comparable conditions). The *sampling rate* which the user must set is actually the rate at which the system evaluates the results of the digital counter or the values of the quantities derived from the counters.

Note Sampling rate for incremental counter channels

Only one sampling rate can be set per module.

7.4.1 Signals and conditioning

7.4.1.1 Mode

The various modes comprise the following measurement types:

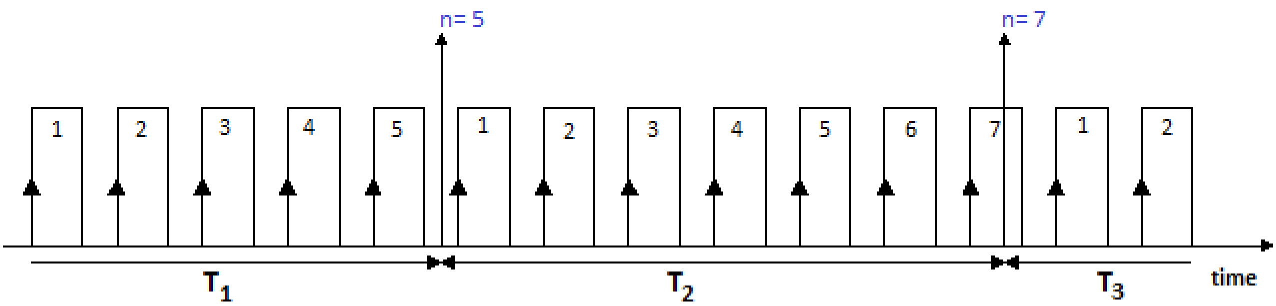
Event-counting	Time	Combined measurements
• events • distance(differential) • angle (differential) • angle (sum) • angle (abs 0-360°) • distance (sum)	• time • pulse time	• frequency • speed • RPM

Event-Counting

The following variables are derived from **Event counting**:

- events 144
- distance(differential) 144
- angle (differential) 144
- distance (abs.) 144
- angle (abs.) 144

The amount of events occurring within one sampling interval is counted. The event counter counts the sensor pulses within the sampling interval. **An event is a positive edge in the measurement signal which exceeds a user-determined threshold value**.

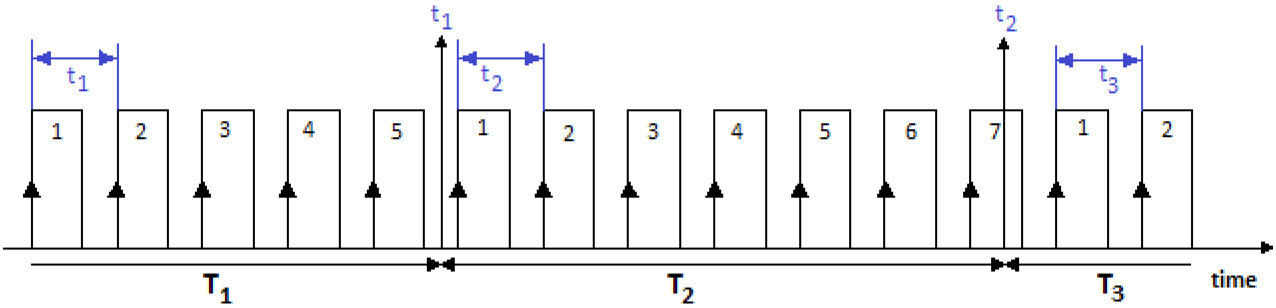


Time Measurements

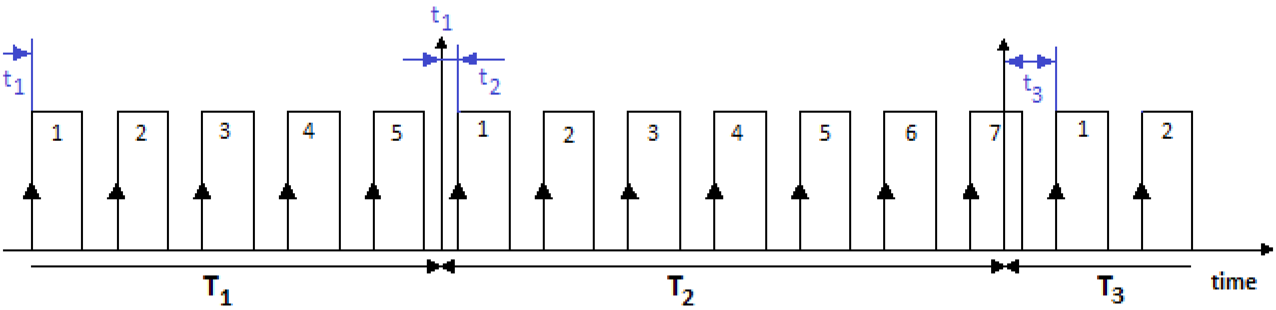
Exclusive measurement of **time** is performed as:

- time 145 (of two successive signal edges)
- pulse time 146 (time from the beginning of one sampling interval until the next signal edge)

Any other pulses occurring within the sampling interval are not evaluated for these measurement types.



time

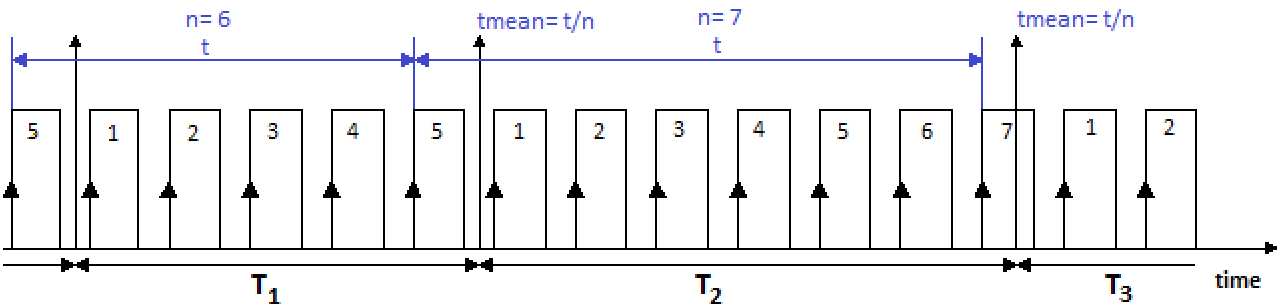


pulse time

Combination Mode

Determining a frequency and the derivative quantities RPM and velocity is based on the **combination of event counting and time measurement**. In other words, during a sampling interval, the number of events occurring as well as the time interval between the first and last event are measured:

- frequency 147
- speed 147
- RPM 147



The frequency is determined as the number of events counted divided by the time between the first and the last "complete" event in the interval. An event is complete when a positive edge is succeeded by a subsequent positive edge.

The frequencies must lie within the bandwidth of the module used. If the maximum frequency is exceeded during a measurement, the system returns the input range end value instead of the true measured values.

The derivative quantities displacement and angle measurement have the following settings:

- Choice of single-track and dual-track encoder 143
- Start of measurement with or without "Zero impulse" 143
- Number of pulses (per unit)

The frequency resolution of the measurement results depends on the input range selected.

Example CANSAS-INC4:

Input ranges and the corresponding frequency resolutions					
Index	**Input range**	**Frequency resolution**	**Index**	**Input range**	**Frequency resolution**
1	450 kHz	15,2588 Hz	8	3 kHz	119,2 mHz
2	200 kHz	7,6294 Hz	9	1,5 kHz	59,6 mHz
3	100 kHz	3,8417 Hz	10	750 Hz	29,8 mHz
4	50 kHz	1,907 Hz	11	450 Hz	14,9 mHz
5	25 kHz	0,9537 Hz	12	200 Hz	7,45 mHz
6	12,5 kHz	0,4768 Hz	13	100 Hz	3,73 mHz
7	7 kHz	0,2384 Hz	14	50 Hz	1,86 mHz

The scaling on the CAN bus is obtained by this formula:

Resolution = Clock / 2^{20+i}

i= index in the table above

Clock = 32.000.000 Hz

The formula comes from the oscillator and the integer calculation performed.

The resolution is the frequency resolution you see in the CAN bus message.

From the resolution you calculate: True Range = 32767 * Resolution.

Watch out: with i=1 you get a range > 450 kHz. That exceeds the limits of the comparator. So you can never go safely above 450 kHz!!

Example Example imc CANSAS INC4

Let Nominal (rounded) range = 200 Hz, thus i=12

Resolution = 32000000 / 2^{32} = 0.00745 Hz

True Range = 32767 * 0.00745 = 244.13 Hz

It will be OK to use true ranges instead of rounded ranges, if you figure out the range required for you measurement task.

The input ranges and resolutions for the RPM or velocity also depend on the number of encoder pulses set. If the number of pulses is known, the RPM and velocity values can easily be computed:

Parameter	Description
RPM	Input range = ([Frequency input range in Hz] * 60 / [Encoder pulses per revolution]) in RPM
	Resolution = ([Frequency resolution in Hz] * 60 / [Encoder pulses per revolution]) in RPM

Behavior in response to missing signal pulses

If a sequence of signal pulses is slowing down and then one sampling interval elapses without any pulse, no calculation can be performed for that sampling interval. In that case, the system assumes that the rotation speed is simply decreasing and an attenuating signal course is extrapolated. This "estimated" measurement value is then closer to the true value than the value determined from the preceding sampling interval. This technique has demonstrated its validity in practice.

Note

In extreme cases, the sensor does not return any more pulses, e.g. in case of a sudden outage. Then the algorithm generates an attenuation curve, meaning values > 0, even if the measurement object is actually no longer moving.

7.4.1.2 Measurement procedures

Measurement procedures	Description
Differential measurement procedures	The quantities derived from *event-counting*, **Events, Distance** and **Angle** denoted by the annotation **(diff.)** are "differential" measurements. The quantity measured is the respective change of displacement or angle within the last sampling interval. (positive or, for dual-track encoders, negative also) or the newly occurred events (always positive). If, for instance, the total displacement is desired, it must be calculated by **integration** of the differential measurements using imc Online FAMOS functions.
Cumulative measurements	The quantities derived from *event-counting*, **Distance** and **Angle** appearing with the annotation **(abs.)** are "**cumulative**" measurements. In cumulative measurements, the return value is the **sum** of all displacement or angle changes, or of all event which occurred.

7.4.1.3 Scaling

A **maximum** value must be entered under ***Input range*** (max. frequency etc, depend on mode). This **Maximum** determines the scaling factor of the computational processing and amounts to the range which is represented by the available numerical format of 16bits. Depending on the measurement mode (quantity to be measured), it is to be declared as an input range's unit or in terms of a corresponding max. pulse rate.

In the interest of maximizing the **measurement resolution** it is recommended to set this value accordingly.

The ***Scaling*** is a sensor specification which states the relation between the pulse rate of the sensor and it's corresponding physical units (sensitivity). This is also the place to enter a conversion factor for the sensor along with any physical quantity desired, for instance, to translate the revolutions of a flow gauge to a corresponding volume.

The table below summarizes the various ***measurement types' units***; the **bold**/*cursive* letters denote the (fixed) primary quantity, followed by its (editable) default physical unit:

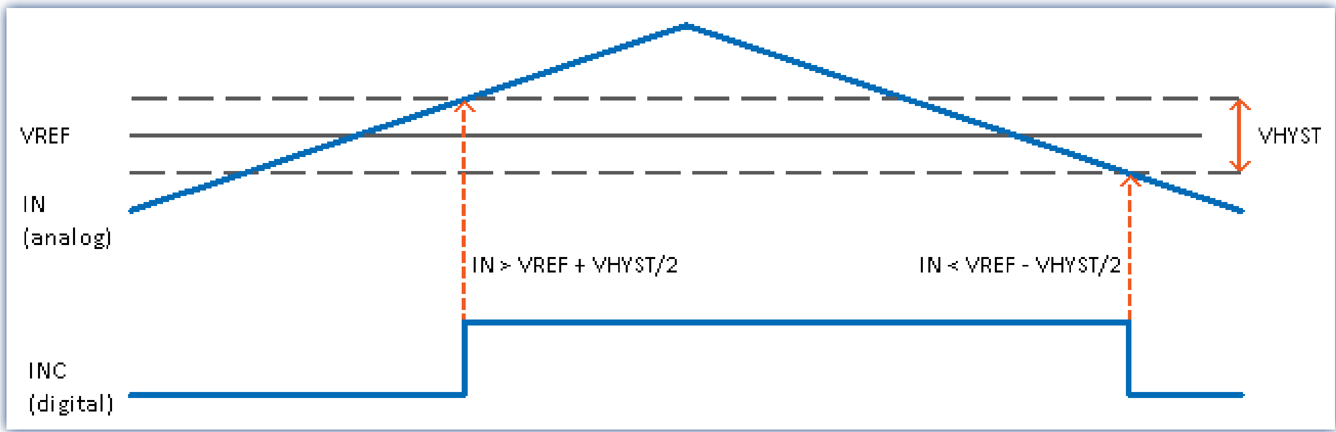
Measurement quantity	(Sensor-) scaling	Range	Maximum
Linear motion	**pulse**/*m*	m	m/s
Angle	**pulse**/*U*	U	U/min
Velocity	**pulse**/*m*	m/s	m/s
RPM	**pulse**/*U*	U/min	U/min
Event	**pulse**/*pulse*	1 pulse	Hz
Frequency	**Hz**/*Hz*	Hz	Hz
Time	**s**/*s*	s	s
Pulse time	**Hz**/*code*	Hz	Hz

7.4.1.4 Comparator conditioning

The incremental counters' special properties make **special demands for signal quality**: the very high resolution offered by the detector or counter means that even very short impulses can be captured and evaluated, which sampling-based measurement methods (such as for the digital inputs of the DI16 module) would not (or almost never) be able to detect. Therefore, the digital signals must have clear edges in order not to produce disturbed readings. Spurious impulses or contact bouncing can lead to artifacts such as enormous peaks in RPM-signals etc..

Simple sensors working on the principles of induction or photoelectric relays often emit unconditioned analog signals which must be evaluated according to a threshold condition. Aside from that, problems can occur even with conditioned encoder signals (e.g. TTL-levels) due to long cables, bad reference voltages, ground loops or interference. imc incremental counter channels are able to counteract these problems thanks to a special 3-stage conditioning unit.

First comes a high-impedance **differential amplifier** (± 10 V range, 100 kΩ) which enables reliable acquisition from a sensor even over a long cable as well as effective suppression of common mode interference and ground loops. Next, a (configurable) **smoothing filter** offers additional interference suppression adapted to the measurement situation. Lastly, a **comparator** with adjustable threshold and hysteresis serves as a digital detector. The (adjustable) **hysteresis** also serves to suppress interference.



The *digital signal* changes from **0 to 1** when the *analog signal* exceeds the **VREF + VHYST/2** threshold.

The *digital signal* changes from **1 to 0** when the *analog signal* falls below the **VREF - VHYST/2** threshold.

The size of the hysteresis represents the width of a range-band inside of which the signal can fluctuate (due to signal noise and interference) without an impulse being recorded.

Ranges:

- VREF (Threshold) = -10 V .. +10V
- VHYST (Hysteresis) = +100 mV...+4V
- Low pass filter: None, 20 kHz, 2 kHz, 200 Hz

7.4.1.5 Single-track / Dual-track encoder

The **single-track encoder** returns a simple pulse sequence. This means that the pulse count and the time between pulses can be determined, but not the rotation direction of the incremental counter.

A **dual-track encoder** returns two pulse sequences with a 90° offset. Along with the pulse frequency, the rotation direction can also be indicated as positive or negative. To configure a measurement with a dual-track encoder, set the parameter "***Counter signal***" which is on the Setup page "*Digital channels*" under the tab "*Encoder*", along with the desired "*Mode*".

Note Problems with two-point scaling of analog inputs

Affects both the devices belonging to the imc C-SERIES, and also any devices belonging to the imc SPARTAN and imc CRONOS families which are equipped with the digital multiboard: DI16-DO8-ENC4 or the DI8-DO8-ENC4-DAC4.

When an input is set to **dual-track encoder**, it is not possible to **calibrate** the scale with **two-point scaling** for any **analog inputs**. When you click "*Record*" to take a measurement, the following message appears: "*The device is not prepared to allow necessary initialization! Please execute menu action "Prepare" (device control)! imcDevices V2.x Adapter*"

However, the "*Prepare*" procedure does not solve the problem. Instead, temporarily set the incremental counter inputs of the modules affected to "*Single-track encoder*" in order to be able to measure the two data points used for two-point scaling.

7.4.1.6 Zero pulse (index)

The **zero pulse** starts the incremental counter channels' counter mechanism. This means the measured values are only recorded, if an event occurs at the **index-channel**. If measurement without a zero pulse is selected, the measurement starts directly upon starting the measurement.

The **index signal** is differential and set by the comparator settings of the **first** incremental counter channel of the module, even for modules that have several index tracks. The bandwidth is limited to 20kHz.

Note

- By default, the option "*Encoder w/o zero impulse*" is activated in imc STUDIO. If this option is deactivated and the zero pulse fails to appear, the encoder module does not start the measurement at all! In that case, the channels only return zero.

7.4.2 Mode (events-counting)

Mode - Events	Description
Events	The event counter counts the sensor pulses which occur during a single time interval (differential event counting). The interval corresponds to the sampling time set by the user. The maximum event frequency is about 500 kHz. **An event is a positive edge in the measurement signal which exceeds the user-set threshold value.** The derivative quantities displacement and angle measurement have the following settings: • Choice of single-track and dual-track encoder 143 • Start of measurement with or without "Zero impulse" 143 • Number of pulses (per unit)

Mode - Distance	Description
Distance (differential)	Path traveled within one sampling interval. For this purpose, the number of pulses per meter must be entered.
Distance (absolute)	Absolute distance. The differential distance measurement is converted to the absolute distance. By taking the zero impulse (the counter with no zero impulse should not be selected) into account, the absolute distance position is determined and indicated. Otherwise, the distance value is assumed to be 0° when the measurement begins.

Mode - Angle	Description
Angle (differential)	Angle traveled within one sampling interval. For this purpose, the number of pulses per revolution must be entered. The absolute angle can be calculated in imc Online FAMOS or determined by the mode Angle(abs).
Angle (absolute)	The differential angle measurement is converted to the **absolute** angle. By taking the zero impulse (the counter with no zero impulse should not be selected) into account, the absolute angle position is determined and indicated. Otherwise, the angle value is assumed to be 0° when the measurement begins.
Angle (sum)	The differential angle measurement is converted to the **cumulative** angle. In the process, any zero pulse is evaluated only one time. For this reason, angles which are > 360° are possible.

Note

When using incremental counter modules that work internally with a 16-bit counter, encoders with high pulse rates can lead to overflows. The count is always carried out with sign: 2^{16}= 65536, i. e. ±32767. With dual-track encoders the pulse number is quadrupled internally and leads to a maximum number of pulses per revolution of 8192. For encoders with more pulses per revolution, the hardware must have a 32 bit counter, e. g. imc CANSAS*fit*-ENC6, otherwise an event count must be carried out instead and converted with imc Online FAMOS.

7.4.3 Mode (time measurement)

Time measurement

The time measurement mode allows the definition of **edge conditions** between which the time interval is to be measured.

The following combinations are possible:

positive edge	>	negative edge:	(↑ > ↓)
negative edge	>	positive edge:	(↓ > ↑)
positive edge	>	positive edge:	(↑ > ↑)
The combination negative edge	>	negative edge:	(↓ > ↓) is not allowed

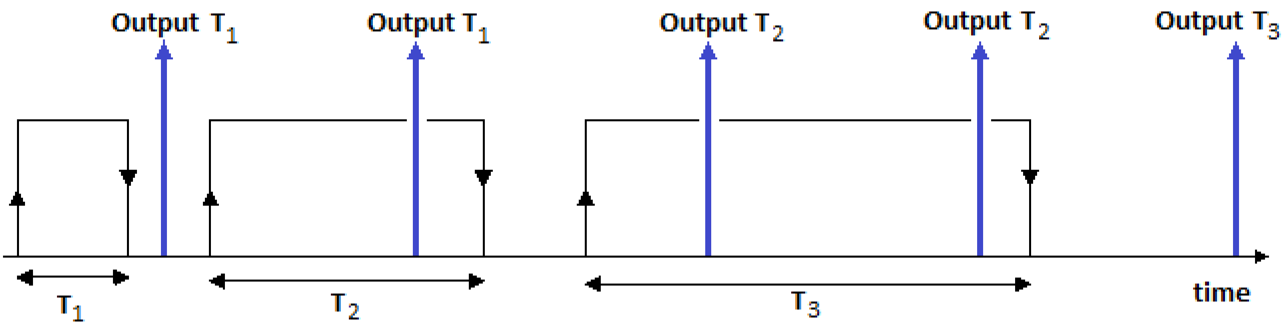
To ensure a high time resolution for the measurement results, suitable scaling must be set for the measurement. An **input range (INC4)** or **Max. time (s) (ENC-6)** specifies the maximum time interval which can be measured between the selected starting and stopping edge. **The time between the signal edges may not be greater than the selected input range.** If the maximum time interval is exceeded during measurement, the system returns the input value range end instead of the true measured value.

Input range	Time resolution	Input range	Time resolution
1 ms	31,25 ns	250 ms	8 µs
2 ms	62,50 ns	500 ms	16 µs
4 ms	125 ns	1 s	32 µs
8 ms	250 ns	2 s	64 µs
16 ms	500 ns	4 s	128 µs
30 ms	1 µs	8 s	256 µs
60 ms	2 µs	16 s	512 µs
120 ms	4 µs	30 s	1024 ms

Time resolution of INC4

The time resolution corresponds to the value of an LSB (Least Significant Bit).

During sampling intervals when no time measurement was possible (because either a starting or stopping edge was missing), the last valid return value continues to be returned until a time measurement is completed. If there is no valid return value, zero is returned. If more than one time measurement is completed during a single sampling interval (due to multiple starting and stopping edges), the last time measured is returned.



Above is illustrated a measured signal from which time readings are taken. Each reading starts at a positive edge in the signal and is stopped at a negative edge. The "up" arrows indicate the times at which the system returns a result. The returned values in this case are T1 –twice; T2 –twice; and T3.

Pulse Time

The point in time at which the edge is located within the sampling interval is determined. This information is needed by some functions in imc Online FAMOS, e.g. for determining the course of the RPMs from a pulse signal: OtrEncoderPulsesToRpm.

The measurement variable ***Pulse Time*** refers to phase-based data which is only relevant to special applications (particularly order-tracking analysis). It is required for subsequent online calculations. It represents the time between the last detected (asynchronous) pulse and the (synchronous) sampling time at which the counter readings were sampled and evaluated. The unit associated with this variable is called *Code*.

Note

The mode *Pulse Time* depends on the sampling rate. For all ENC-4 types, the entry is visible only if the sampling rate is equal or smaller 1ms. For HRENC-4 the sampling rate must be equal or less 100µs.

PWM

Pulse width modulation (PWM) is a type of modulation in which a technical variable (e.g. electrical current) switches between two values. In the process, the **duty cycle ratio is modulated at constant frequency**. PWM is also known as pulse duration modulation (PDM).

A good illustration of this modulation type would be a switch used to continually switch a heater on and off. The higher the ratio of the on-time to the off-time, the higher the average heating power is.

Measurement of PWM can not be performed directly with the device software. However, if the frequency is known, it is possible to perform it indirectly by time measurement with the following settings:

The **ratio** is the *Duration of HIGH (signal) level* over the *Period duration*.

The *Duration of HIGH (signal) level* is obtained by means of a **time measurement** from *positive to negative (signal) edge*.

The *Period duration* is the **inverse of the frequency**, which must be known.

$PWM= t_{pulse}/t_{Period\ duration} * 100\%$ or $t_{pulse} * f * 100\%$

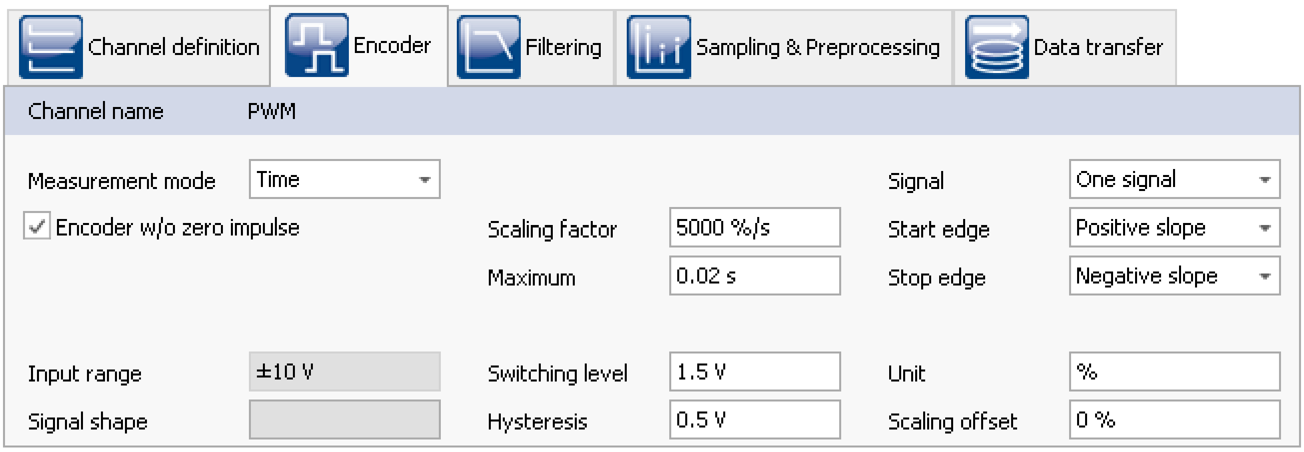
Example:

f= 50Hz, Pulse duration = 10ms

Scaling: $t_{pulse} * f * 100\%/ s = 5000\%/s$

at 10ms: 0.01s*5000%/s= 50%

This can be entered directly via the scaling:



Settings for PWM measurement in time mode

7.4.4 Mode (combined measurement)

Mode	Beschreibung
Frequency	Frequency is determined by means of a combination measurement 139. If the frequency was previously multiplied or divided, this can be reflected in the scaling value. The frequency is always unsigned, for which reason there is no dual-track encoder for it.
Speed	The sequence of pulses is converted to m/s by means of a combination measurement 139. Toward this end, the number of pulses per meter must be entered.
RPM	The sequence of pulses is converted to revolutions per minute by means of a combination measurement 139. Toward this end, the number of pulses per revolution must be entered.

8 Measurement Modules

8.1 Audio, Vibration and charge measurement

Analog, 4-channel amplifier available:			
Order Code	**CRFX, width:**	**CRC, CRSL and CRXT**	**function**
AUDIO2-4 148	61.62 mm	-	IEPE/ICP, voltage measurement
AUDIO2-4-MIC 150	61.62 mm	-	IEPE/ICP, microphone, voltage
QI-4 151	61.62 mm	-	charge measurement, IEPE/ICP, voltage

8.1.1 AUDIO2-4

The AUDIO2-4 has four individual, galvanically-isolated channels for the acquisition of:

- IEPE/ICP sensors (current-fed 4 mA)
- Voltage (AC and DC coupling)

Direct connection of IEPE/ICP sensors takes place via BNC plugs.

Reference

Technical details of the AUDIO2-4(-MIC) 343.

Highlights

- Per-channel galvanic isolation
- Robust and feedback-free signal acquisition
- Signal bandwidth 48 kHz
- Large signal-to-noise ratio (-110dB SNR)
- Low signal distortion (-115dB THD)
- High-precision measurements over broad voltage ranges
- Supports imc Plug & Measure conforming to IEEE 1451.4 (Class I mixed mode interface)
- Optional supply unit for a condenser microphone available (**AUDIO2-4-MIC** 150)

8.1.1.1 Voltage measurement

The input configuration is differential. It is possible to choose between AC and DC coupling. In the measuring ranges greater than ±2.5 V, an internal voltage divider is effective. The input impedance in these ranges is 1 MΩ, in all other ranges 10 MΩ. When the unit is switched off, the input impedance is always 1 MΩ.

8.1.1.2 Current fed sensors

The use of ICP™ e.g. DeltaTron-sensors® is supported by a 4 mA current source. The sensor information can be read directly from the sensor in accordance to the standard "TEDS - Transducer Electronic Data Sheets (IEEE 1451.4)".

Note

Once the TEDS information (CLASS1, content ="AC with current feed") has been imported, the only available setting for the coupling type is "AC with current feed". In order for DC or AC coupling to be displayed as options, the channel must be disassociated from the sensor information:

imc STUDIO: Setup page: "*TEDS*" -> "*Reset channel's sensor information*"

Next to each measurement input on the CRFX/AUDIO2-4 module's **front** panel, there is an **LED** for the purpose of **probe breakage recognition** in the measurement mode/coupling "AC with current fed" as of imc STUDIO 5.2 R15 "IEPE".

8.1.1.3 Bandwidth

The channels' max. sampling rate is 100 kHz (10 µs sampling interval). The analog bandwidth (without digital low-pass filtering) is 49 kHz (-3 dB).

8.1.1.4 Connection

The signals are connected via BNC, in case of using a AUDIO2-4.

8.1.2 AUDIO2-4-MIC

The AUDIO**2**-4**-MIC** complies the AUDIO2-4 amplifier by providing an **additional supply voltage for microphones**.

AUDIO**2**-4**-MIC** is equipped with four **LEMO**.1B.307 sockets. Switching between the AUDIO**2**-4 amplifier's BNC sockets and the LEMO sockets is performed using the software, by **selecting microphone** as the input coupling.

Front: CRFX/AUDIO2-4-MIC

Direct connection of ICP-compatible sensors (ICP®, Deltatron®, Piezotron® sensors) takes place via BNC sockets.

LED's BNC: In case of an error, such as cable breakage and short circuit a LED beside each BNC socket will shine and signalize the error case. In case of a missing connection to the sensor the LED will shine permanently.

LED's LEMO: (as of Revision 2) Beside each LEMO socket (microphone supply) there is a LED in order to monitor the polarization voltage. During normal operation the LED will not shine.

The supply voltages can be set channel-by-channel and are bipolar. ±14 V bipolar corresponds to 28 V unipolar (±60 V$_=$ 120 V unipolar). The supply voltages need to be adapted to the input range. For peak signal levels from 5 V onward, a supply of ±60 V is recommended, if your microphone supports this. The polarization voltage is 200 V.

Warning

When the polarization voltage resp. ±60 V supply voltages is active, there is danger of electric shock! It is also activated, if an Autostart experiment is used - configured with that supply voltage.

Reference

LEMO Pin configuration 505
Technical details of the CRFX/AUDIO2-4-MIC 343.

8.1.3 QI-4 for imc CRONOSflex (CRFX/QI-4)

The imc CRONOS*flex* measurement module **CRFX/QI-4** is specially suited for quasi-static as well as dynamic charge measurements. By means of piezoelectric sensors, it is possible to measure forces, pressure, acceleration, as well as to perform analysis of solid-borne noise such as that occurring in engine indication on vehicle test stands.

As an alternative to standard BNC plugs, triaxial terminals are available which allow the use of charge sensors with built-in TEDS (Transducer Electronic Data Sheet).

The module is additionally designed for acoustics measurements and vibration analysis. For this purpose, current-fed IEPE sensors such as ICP™-, DeltaTron®-, and PiezoTron® sensors are supported. Further, the module can be used for high-precision measurement across a wide voltage range.

The module features a very high signal-to-noise ratio and high fidelity. In combination with its large bandwidth of around 50 kHz and its 24-bit resolution, a wide scope of applications in the field of measurement engineering can be accomplished. The separate galvanic isolation for each channel provides for robust, interference-free signal capture.

Highlights

- Charge measurement with low drift over time, for quasi-static measurements
- Per-channel galvanic isolation
- High Signal-to-Noise ratio (-110 dB SNR)
- Low signal distortion (-115 dB THD)

Note

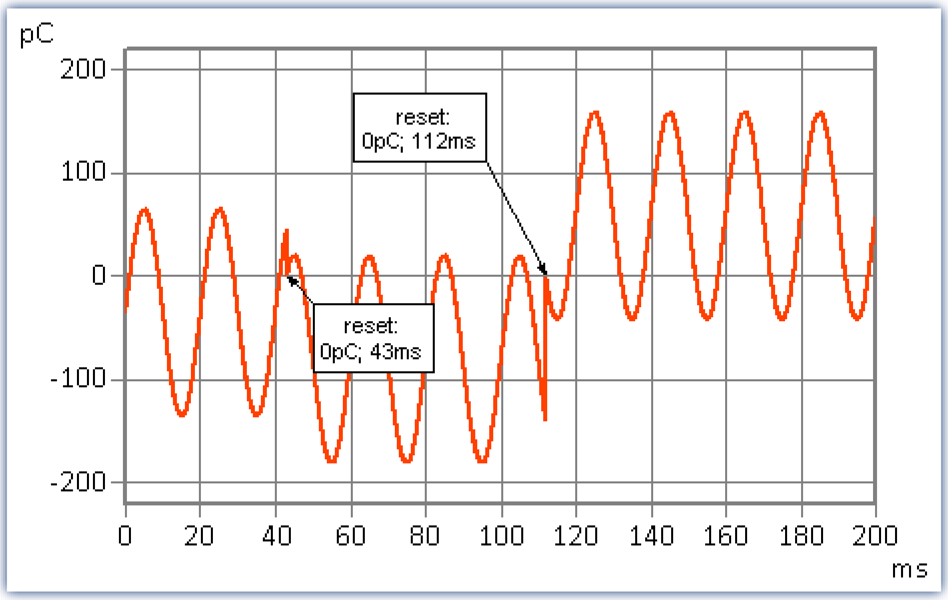
Next to each measurement input on the CRFX/QI-4 module's **front** panel, there is an **LED** for the purpose of **probe breakage recognition** in the measurement mode/coupling "**AC with current fed**", as of imc STUDIO Version 5.2 R15 the coupling is called "**IEPE**".

Find here the technical details of the CRFX/QI-4 347.

8.1.3.1 Reset the charge of the integrator

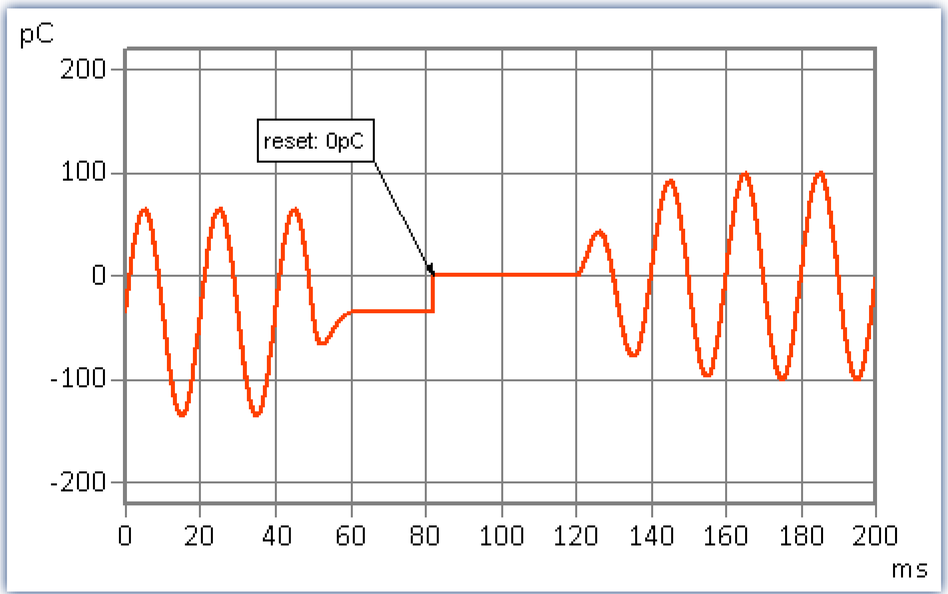
The QI-4 measurement module integrates the charge from the sensors. It is the time integral of the signal. Therefore the current displayed value of reading depends on the previous waveform. In order to delete this memory the reset of the integrator has to be used (via Software imc STUDIO, similar to bridge adjustment). The accumulated charge up to the reset time will be cleared - 0 C will be displayed. From this point on the charge can be measured corresponding to chosen measurement range independent from the charge that was captured before.

If you want to measure oscillation via a acceleration sensor you have to make sure that the sensor is steady at least for 10 s at the reset time otherwise a signal drift may occur.



Due to a changing signal at the measurement input during the two reset procedures at the two following particular moments 43 ms and 112 ms, the time value at those particular moments will be the new arithmetic mean (integration constant).

The reset procedure typically takes a few milliseconds if the red LED beside the BNC socket turns off. The LED will shine typically 0.4 s.



If the charge crosses the limits of the measurement ranges before the reset process a overdriving of the measurement input will be existent. Therefore a reset process has to be done two times in a priod of 30 s one after another.

8.1.3.2 Voltage measurement

The input configuration is differential. It is possible to choose between AC and DC coupling. In measurement ranges >±2.5 V a internal pre-divider is in effect. The differential input impedance is 1 MΩ, in all other ranges 10 MΩ. If your measurement device is de-activated, the impedance is always 1 MΩ.

8.1.3.3 Current fed sensors

The use of ICP™ e.g. DeltaTron-sensors® is supported by a 4 mA current source. The sensor information can be read directly from the sensor in accordance to the standard "TEDS - Transducer Electronic Data Sheets (IEEE 1451.4)".

Notes

Once the TEDS information (CLASS1, content ="AC with current feed") has been imported, the only available setting for the coupling type is "AC with current feed". In order for DC or AC coupling to be displayed as options, the channel must be disassociated from the sensor information:

imc STUDIO: Setup page: "*TEDS*" -> "*Reset channel's sensor information*"

Next to each measurement input on the CRFX/QI-4 module's **front** panel, there is an **LED** for the purpose of **probe breakage recognition** in the measurement mode/coupling "AC with current fed", as of imc STUDIO Version 5.2 R15 the coupling is called "IEPE".

8.1.3.4 Bandwidth

The channels' max. sampling rate is 100 kHz (10 µs sampling interval). The analog bandwidth (without digital low-pass filtering) is 49 kHz (-3 dB).

8.1.3.5 Connection

The connection is made via eight BNC sockets, four of which are for voltage measurement or optionally for ICP (**U**) and four for charge measurement (**Q**). The connections are labeled accordingly: U or Q

8.2 Bridge measurement amplifier

Analog, 4- and 8-channel amplifier available in:				
	CRFX, width:	**CRXT, width:**	**CRC,CRSL**	**function**
ACI-8 154	61.62 mm	--	--	dynamic strain measurement
BR2-4 169	43.3 mm	34 mm	1 slot needed	strain gauges, LVDT, voltage, IEPE/ICP
B-8 BC-8 168	61.62 mm 43.3 mm	64.5 mm 34 mm	2 slots needed 1 slot needed	strain gauges, voltage, IEPE/ICP
DCB2-8 DCB(C)2-8 156	61.62 mm 43.3 mm	64.5 mm 34 mm	2 slots needed 1 slot needed	strain gauges, voltage, IEPE/ICP

8.2.1 CRFX/ACI-8: 8 channel module for dynamic strain measurement

The ACI-8 is a module with 8 individually isolated channels, specifically designed for dynamic strain measurements with single strain gauge sensors. Unlike conventional bridge amplifiers it feeds the gauges with a constant current in 2 wire configuration. The measured signal is AC coupled and thus captures dynamic strain while suppressing any static signals originating from either the sensor or the cabling.

- Voltage mode with current fed sensors, AC coupled
- Assessment of dynamic strain with strain gauges

Highlights

- Channel wise galvanic isolation
- Signal bandwidth 0.5 Hz to 48 kHz
- Connection of strain gauges in 2-wire configuration
- Configurable internal connection of cable shield via rotary switch (case, input, not connected)
- Current source disable for diagnosis

Typical applications

- Dynamic strain measurement, in particular on rotating turbines
- Applications that involve high temperature resistant thermo cables with very high impedance
- Aerospace industry and power generation (aircraft, gas and steam turbines)

Reference

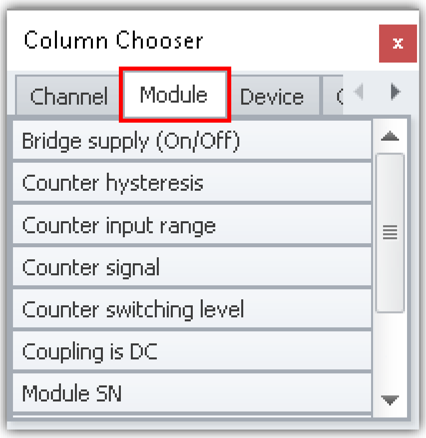
Technical details of the ACI-8 352.

8.2.1.1 Current source (bridge supply)

The current source (**bridge supply**) of the CRFX/ACI-8 module can be switched on and off. But first you have to add the switch in your user interface.

Please read the following chapter in the imc STUDIO manual: description of adding a column in the channel list: Section: Setup - Device (general) > "*Information and tips*" > "*Setup-layout*" > "*Showing and moving columns*"

Add on the setup page "*Analog Channels*" the following column: "*Bridge supply (On/Off)*". This column is a "Module" column:



In order to save this configuration and see the new column next time you use imc STUDIO it is necessary to save this view after adding the column. Additionally imc STUDIO will save in this configuration the last window you have opened before saving.

8.2.1.2 Bandwidth

The channels' **max. sampling rate** is 100 kSamples/s (10 µs sampling interval).

The **analog bandwidth** (without digital low-pass filtering) is 48 kHz (-3 dB). In AC mode the lower cut off frequency is 0.5 Hz.

8.2.1.3 Connection

Please find here the module's pin configuration: 3-pin LEMO 505 ERN.1S.303.GLN. The recommended LEMO plug is: FFA.1S.303.CLA.

8.2.2 DCB(C)2-8: Strain gauges, Voltage, IEPE/ICP

This bridge amplifier provides eight differential, analog inputs with integrated sensor supply for the measurement of resistive bridges or strain gauges, as well as voltage, current and IEPE/ICP-sensors.

A software selectable sensor supply is included, for powering of external sensors or resistive bridge / strain gauge networks. The DCB2-8 amplifier is also available in a compact version (DCB"C"2-8) with high-density DSUB-26 connections.

Technical details 365

8.2.2.1 Bridge measurement

The measurement channels have an adjustable DC voltage source which supplies the measurement of bridges such as strain gauges. The supply voltage for a group of eight inputs is set in common. The bridge supply is asymmetric, e.g., for a bridge voltage setting of VB=5 V, Pin +VB is at +VB=5 V and Pin -VB at -VB=0 V. The terminal –VB is simultaneously the device's ground reference.

Per default 5 V and 10 V can be selected as bridge supply. As an option ex-factory this amplifier can be build with 2.5 V bridge supply and/or 1 V bridge supply. Depending on the supply set, the following input ranges are available:

Bridge voltage [V]	Measurement range [mV/V]
10	±1000 to ±0.5
5	±1000 to ±1
2.5 (optional)	±1000 to ±2
1 (optional)	±1000 to ±5

Fundamentally, the following holds: For equal physical modulation of the sensor, the higher the selected bridge supply is, the higher are the absolute voltage signals the sensor emits and thus the measurement's **signal-to-noise ratio** and drift quality. The limits for this are set by the maximum available current from the source and by the dissipation in the sensor (temperature drift!) and in the device (power consumption!)

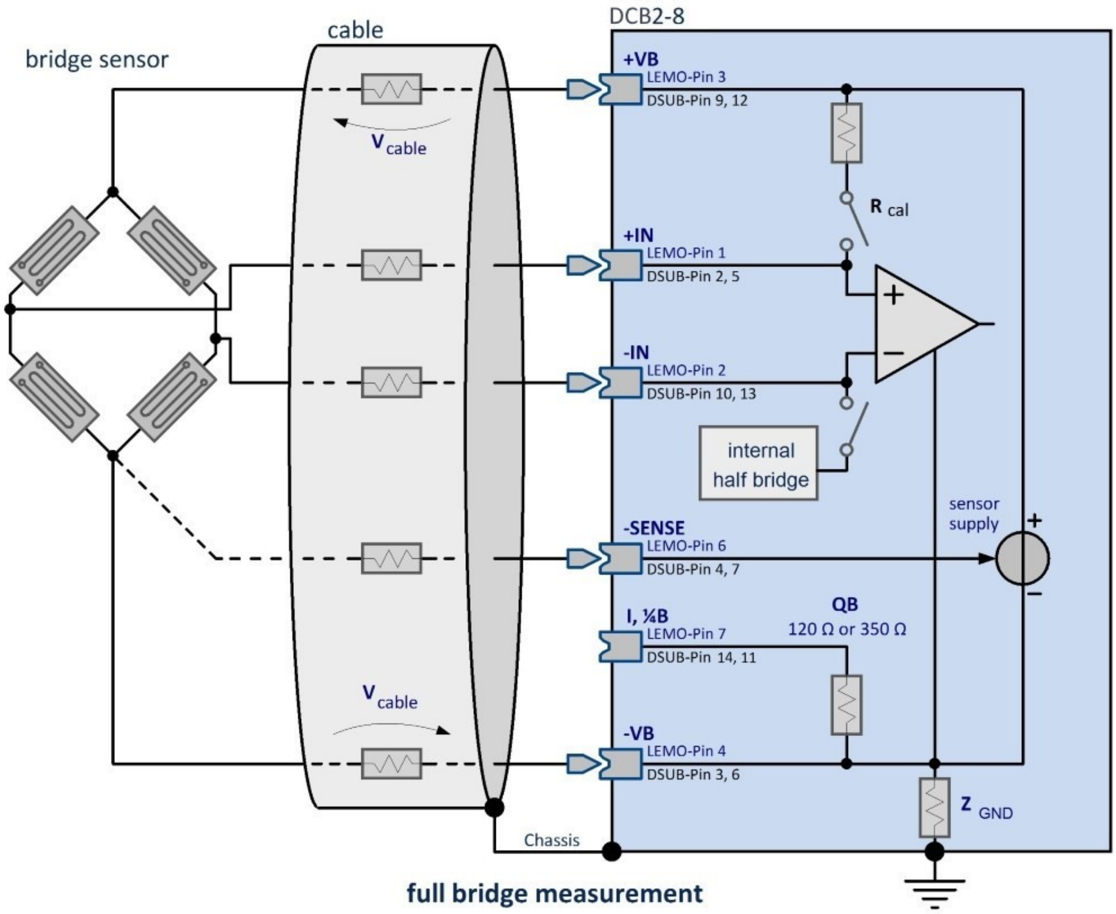
- For typical measurements with **strain gauges**, the ranges 5 mV/V to 0.5 mV/V are particularly relevant.
- There is a maximum voltage which the **potentiometer sensors** are able to return, in other words max. 1 V/V; a typical range is then 1000 mV/V.

Bridge measurement is set by selecting as measurement mode either *Bridge: sensor* or *Bridge: strain gauge* in the operating software. The bridge circuit itself is then specified under the tab Bridge circuit, where *quarter bridge, half bridge* and *full bridge* are the available choices.

Note

We recommend to angle a maximum range on the not used voltage measurement. An open entry in half- or quarter bridge mode can annoy the neighbor channels if this is also in half- or quarter bridge mode.

8.2.2.1.1 Full bridge

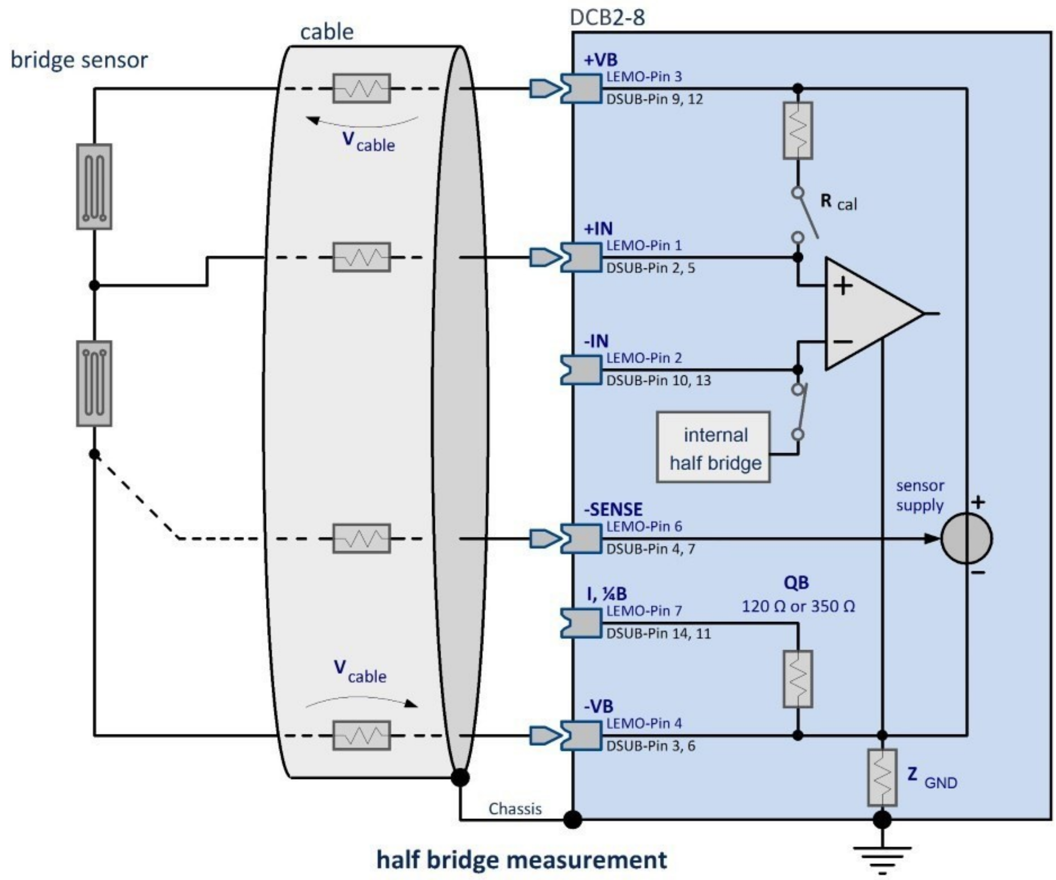


LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

Please note that the maximum allowed voltage drop along a cable may not exceed approx. 0.5 V. This determines the maximum possible cable length.

If the cable is so short and its cross section so large that the voltage drop along the supply lead is negligible. In this case the bridge can be connected at four terminals by omitting the Sense line.

8.2.2.1.2 Half bridge



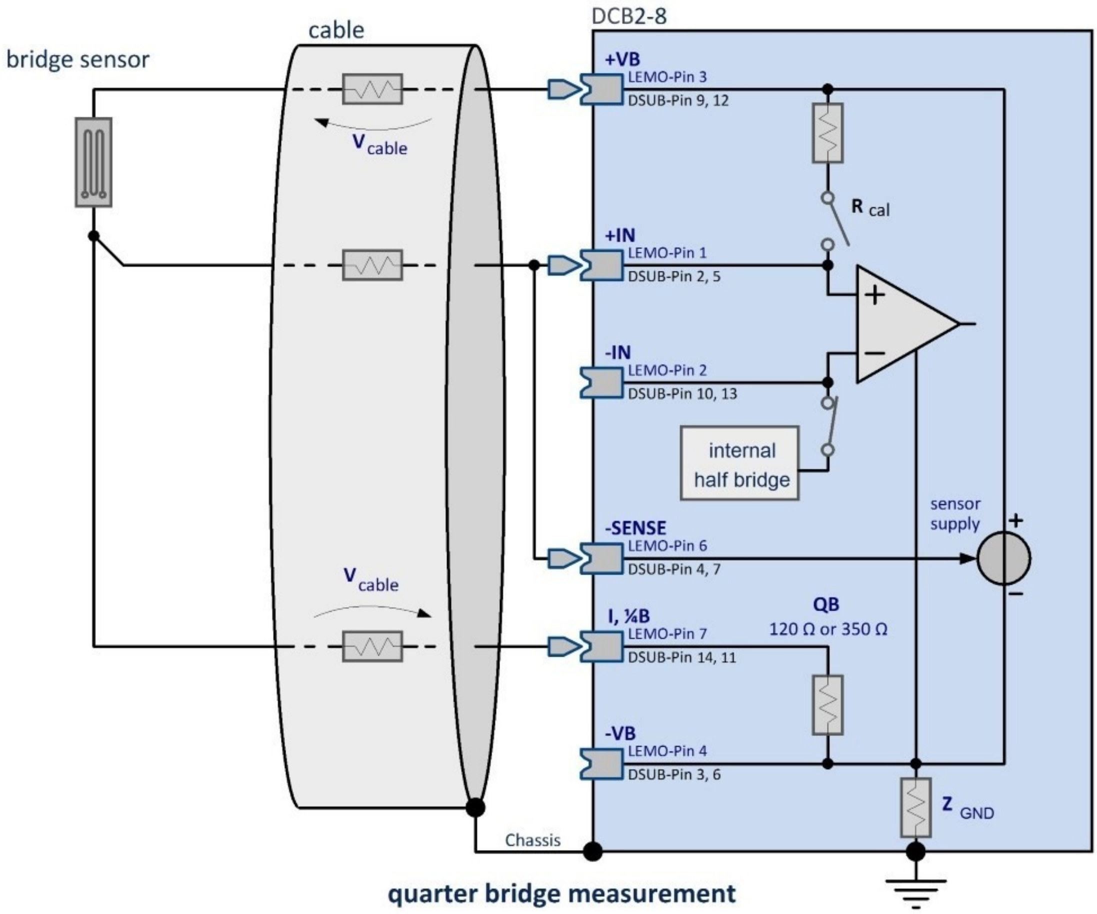
LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

A half bridge may consist of two strain gauges in a circuit or a sensor internally configured as a half bridge, or a potentiometer sensor. The half bridge has four terminals to connect. For information on the effect and use of the Sense lead SENSE, see the description of the full bridge.

The amplifier internally completes the full bridge itself, so that the differential amplifier is working with a genuine full bridge 157.

It is important that the measurement signal of the half bridge is connected to +IN. The -IN access leads to implausible measured values and influences the neighbor channels.

8.2.2.1.3 Quarter bridge



quarter bridge measurement

LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

A quarter bridge can consist of a single strain gauge resistor, whose nominal value can be 120 Ω or 350 Ω.

The amplifier internally completes an additional 120 Ω or 350 Ω quarter bridge switchable by software.

The quarter bridge has 3 terminals to connect. Refer to the description of the full bridge for comments on the Sense lead. However, with the quarter bridge, the Sense lead is connected to +IN and SENSE jointly.

If the sensor supply is equipped with the option "±15 V", a quarter bridge measurement is not possible. The pin *I_1/4B* for the quarter bridge completion is used for -15 V instead.

8.2.2.1.4 Sense and initial unbalance

The SENSE lead serves to compensate voltage drops due to cable resistance, which would otherwise produce noticeable measurement errors. If there are no sense lines, then *SENSE (F)* must be connected in the terminal plug according to the sketches above.

A bridge measurement is a relative measurement (**ratiometric procedure**) that calculates what fraction of the supplied bridge excitation voltage is given off from the bridge (typically in the 0.1% range, corresponding to 1 mV/V). Calibration of the system in this case pertains to this ratio, the bridge input range, and takes into account the momentary magnitude of the supply. This means that the **bridge supply's actual magnitude is not relevant** and need not necessarily lie within the measurement's specified overall accuracy.

Any **initial unbalance** of the measurement bridge, for instance due to mechanical pre-stressing of the strain gauge in its rest state, must be zero-balanced. Such an unbalance can be many times the input range (bridge balancing). If the initial unbalance is too large to be compensated by the device, a larger input range must be set.

Possible initial unbalance

input range [mV/V]	bridge balancing (VB = 2.5 V) [mV/V]	bridge balancing (VB = 5 V) [mV/V	bridge balancing (VB = 10 V) [mV/V
±1000	200	500	240
±500	2000	100	700
±200	40	400	60
±100	140	20	200
±50	200	70	10
±20	20	100	35
±10	30	14	50
±5	7	18	7
±2	9	3.5	10
±1	-	4.5	2
±0.5	-	-	5

8.2.2.1.5 Balancing and shunt calibration

The module offers a variety of possibilities to trigger bridge balancing:

- Balancing / shunt calibration upon activation (cold start) of the unit. If this option is selected, all the bridge channels are balanced as soon as the device is turned on.
- Balancing / shunt calibration via graphical user interface of device software (channel balance respectively amplifier balance)
- In shunt calibration, the bridge is unbalanced by means of a 59.8 kΩ or 174.66 kΩ shunt. The results are:

Bridge resistance	120 Ω	350 Ω
59.8 kΩ 174.7 kΩ	0.5008 mV/V 0.171 mV/V	1.458 mV/V 0.5005 mV/V

The procedures for balancing bridge channels also apply analogously to the voltage measurement mode with zero-balancing.

Note

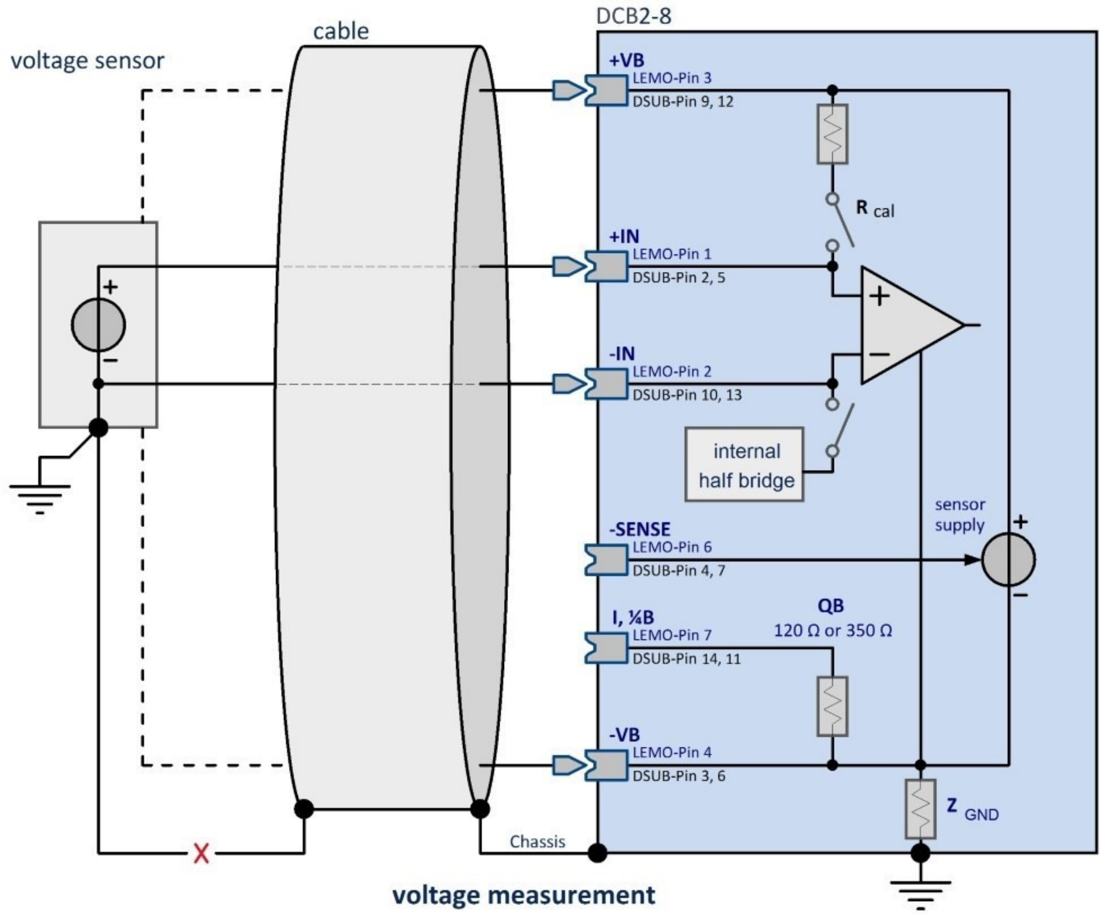
- We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

8.2.2.2 Voltage measurement

- Voltage: ±10 V to ±5 mV in 9 different ranges

The input impedance is 20MΩ. (1MΩ when switched off)

8.2.2.2.1 Voltage source with ground reference



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

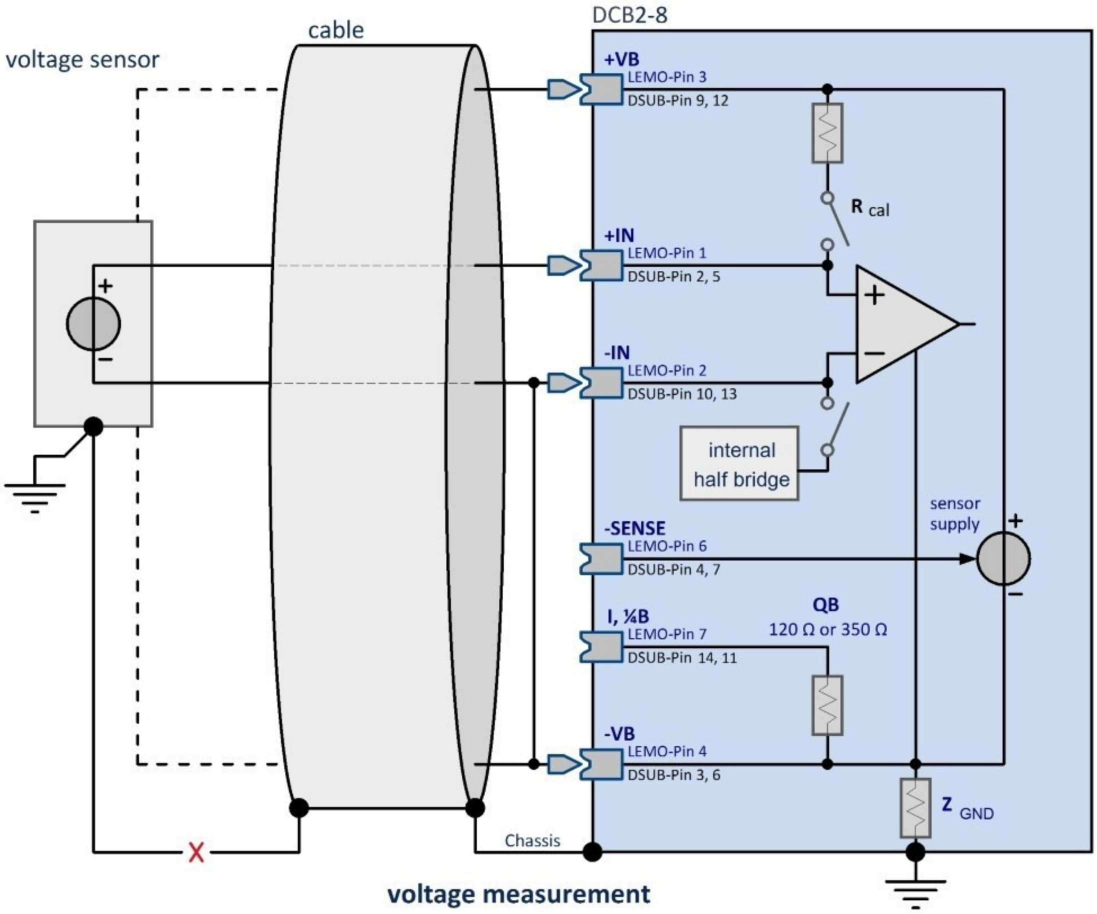
The voltage source itself already has a connection to the device's ground. The potential difference between the voltage source and the device ground must be fixed.

Example: The device is grounded. Thus, the input -VB is also at ground potential. If the voltage source itself is also grounded, it's referenced to the device ground. It doesn't matter if the ground potential at the voltage source is slightly different from that of the device itself. But the maximum allowed common mode voltage must not be exceeded.

Important: In this case, the negative signal input -IN may not be connected with the device ground -VB. Connecting them would cause a ground loop through which interference could be coupled in.

In this case, a genuine differential (but not isolated!) measurement is carried out.

8.2.2.2.2 Voltage source without ground reference



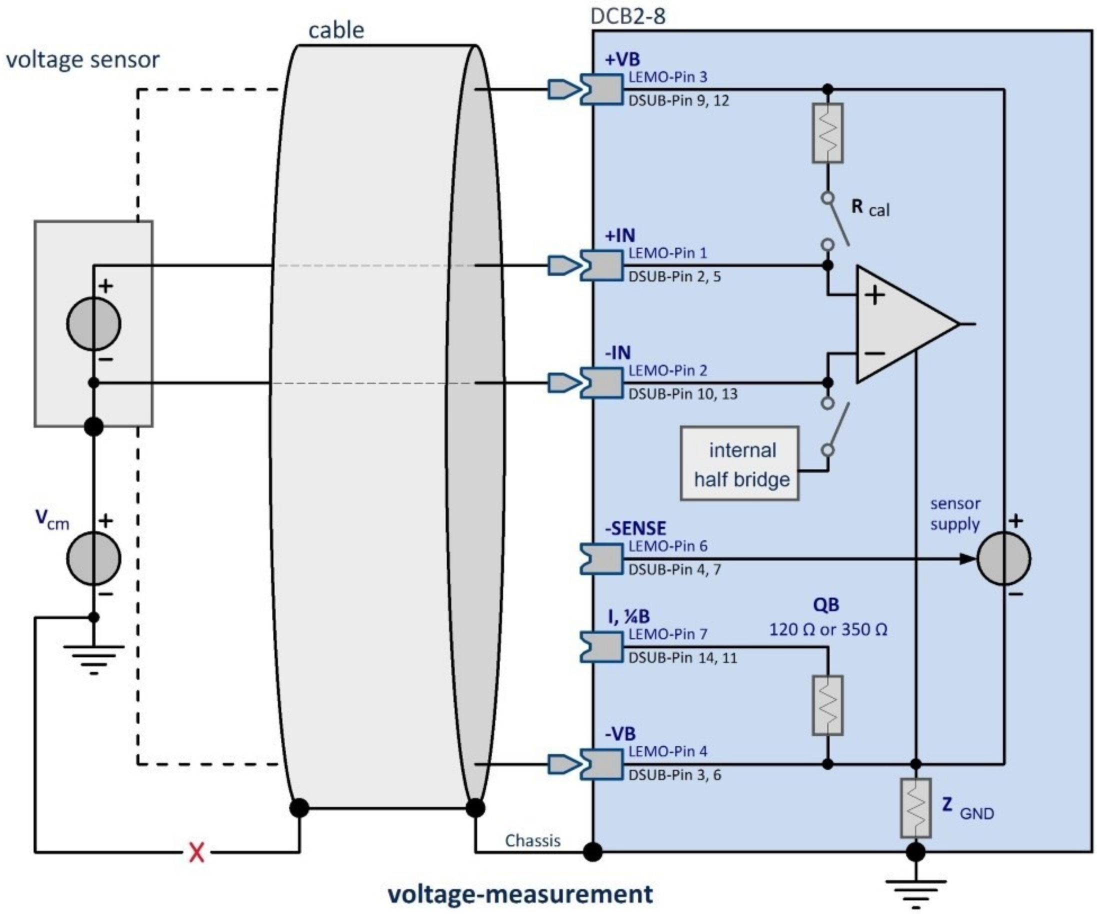
LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The voltage source itself is not referenced to the device ground but is instead isolated from it. In this case, a ground reference must be established. One way to do this is to ground the voltage source itself. Then it is possible to proceed as for "Voltage source with ground reference". Here, too, the measurement is differential. It is also possible to make a connection between the negative signal input and the device ground, in other words to connect -IN and -VB.

Example: An ungrounded voltage source is measured, for instance a battery whose contacts have no connection to ground. The module is grounded.

Important: If -IN and -VB are connected, care must be taken that the potential difference between the signal source and the device doesn't cause a significant compensation current. If the source's potential can't be adjusted (because it has a fixed, overlooked reference), there is a danger of damaging or destroying the amplifier. If -IN and -VB are connected, then in practice a single-ended measurement is performed. This is no problem if there was no ground reference beforehand.

8.2.2.2.3 Voltage source at a different fixed potential



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The common mode voltage (U_{cm}) has to be less than ±10 V. It is reduced by ½ input voltage.

Example: Suppose a voltage source is to be measured which is at a potential of 120 V to ground. The device itself is grounded. Since the common mode voltage is greater than permitted, measurement is not possible. Also, the input voltage difference to the device ground would be above the upper limit allowed.

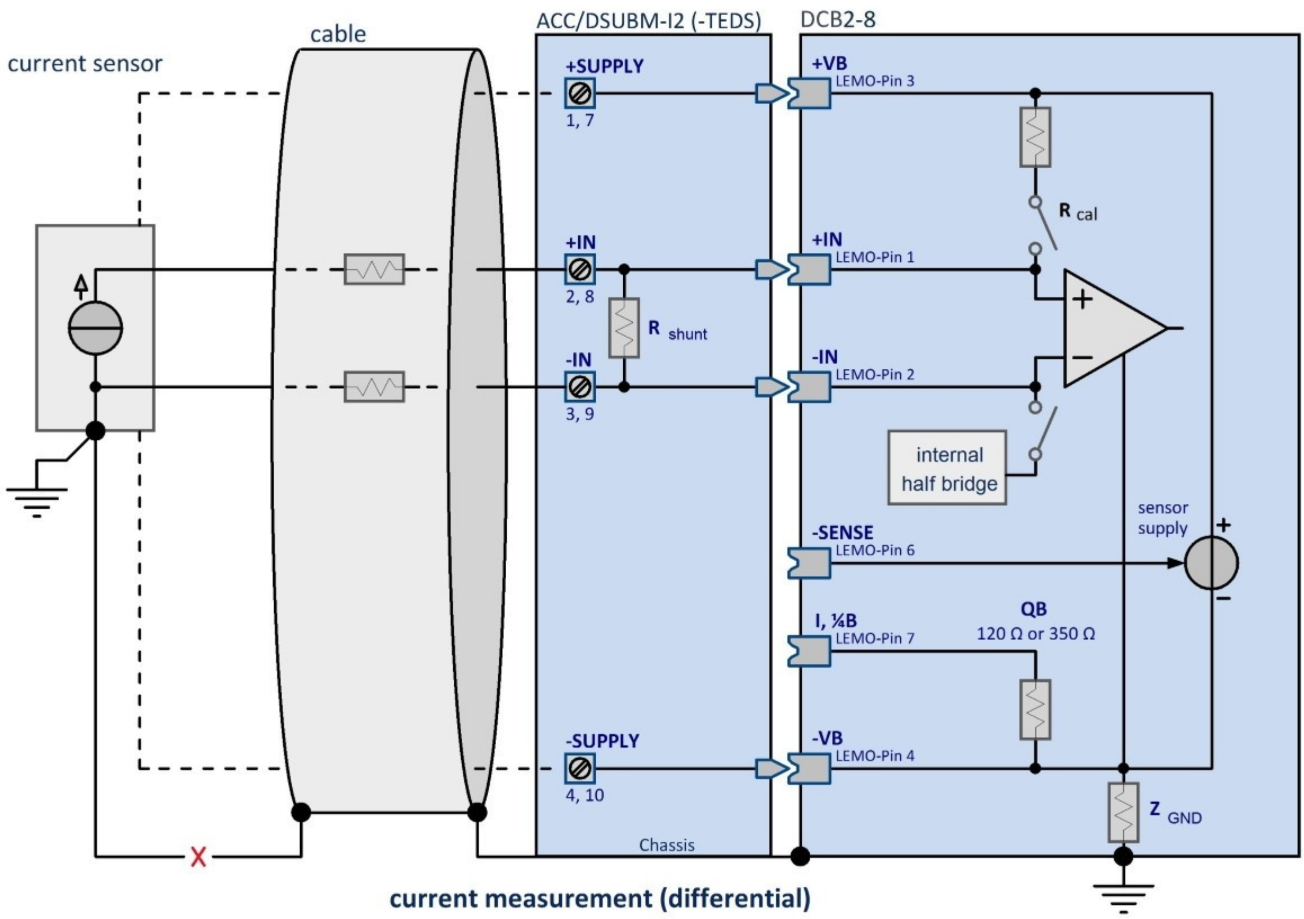
8.2.2.3 Current measurement

The current measurement is realized with shunt plug or with ground reference via the internal quarter bridge completion.

8.2.2.3.1 Differential current measurement

Note	Requirement
The following statements only apply for modules with DSUB sockets.	

- Current ±50 mA to ±1 mA



current measurement (differential)

LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

For current measurement could be used the DSUB plug ACC/DSUBM-I2. That plug comes with a 50 Ω shunt and is not included with the standard package. It is also possible to measure a voltage via an externally connected shunt. Appropriate scaling must be set in the user interface. The value 50 Ω is just a suggestion. The resistor needs an adequate level of precision. Pay attention to the shunt's power consumption.

The **maximum common mode voltage** must be in the range ±10 V for this circuit, too. This can generally only be ensured if the current source itself already is referenced to ground. If the current source is ungrounded a danger exists of exceeding the maximum allowed overvoltage for the amplifier. The current source may need to be referenced to the ground, for example by being grounded.

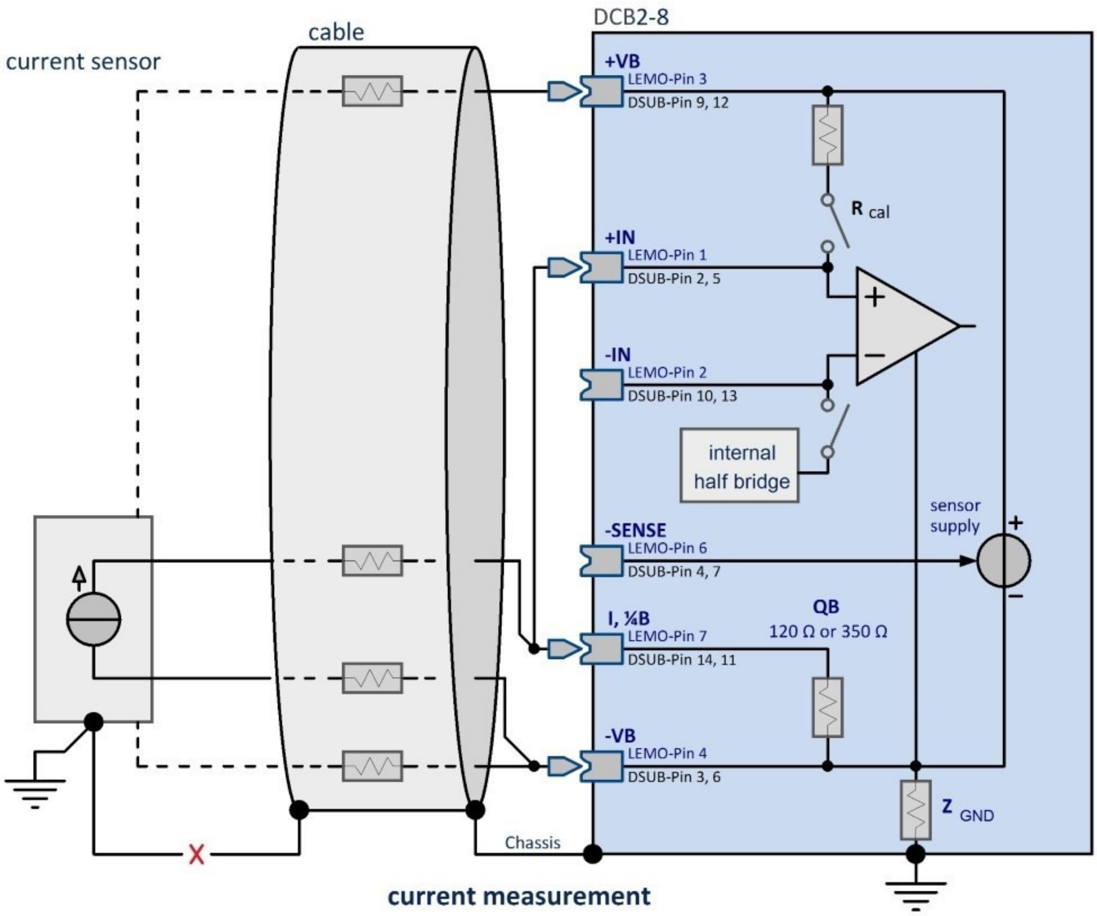
The sensor can also be supplied with a software-specified voltage via Pins +VB and -VB.

Note

Since in this procedure a voltage measurement at the shunt resistor is involved, it is necessary to configure the imc software for voltage measurement. The scaling factor is entered as 1/R and the unit set is A (0.02 A/V = 1/50 Ω).

8.2.2.3.2 Ground-referenced current measurement

- Current: ±50 mA to ±2 mA



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

In this circuit, the current to be measured flows through the 120 Ω shunt in the amplifier. Note that here, the terminal -VB is simultaneously the device's ground. Thus, the measurement carried out is single-ended or ground referenced. The potential of the current source itself may be brought into line with that of the units ground. In that case, be sure that the device unit itself is grounded.

In the settings interface, set the measurement mode to Current.

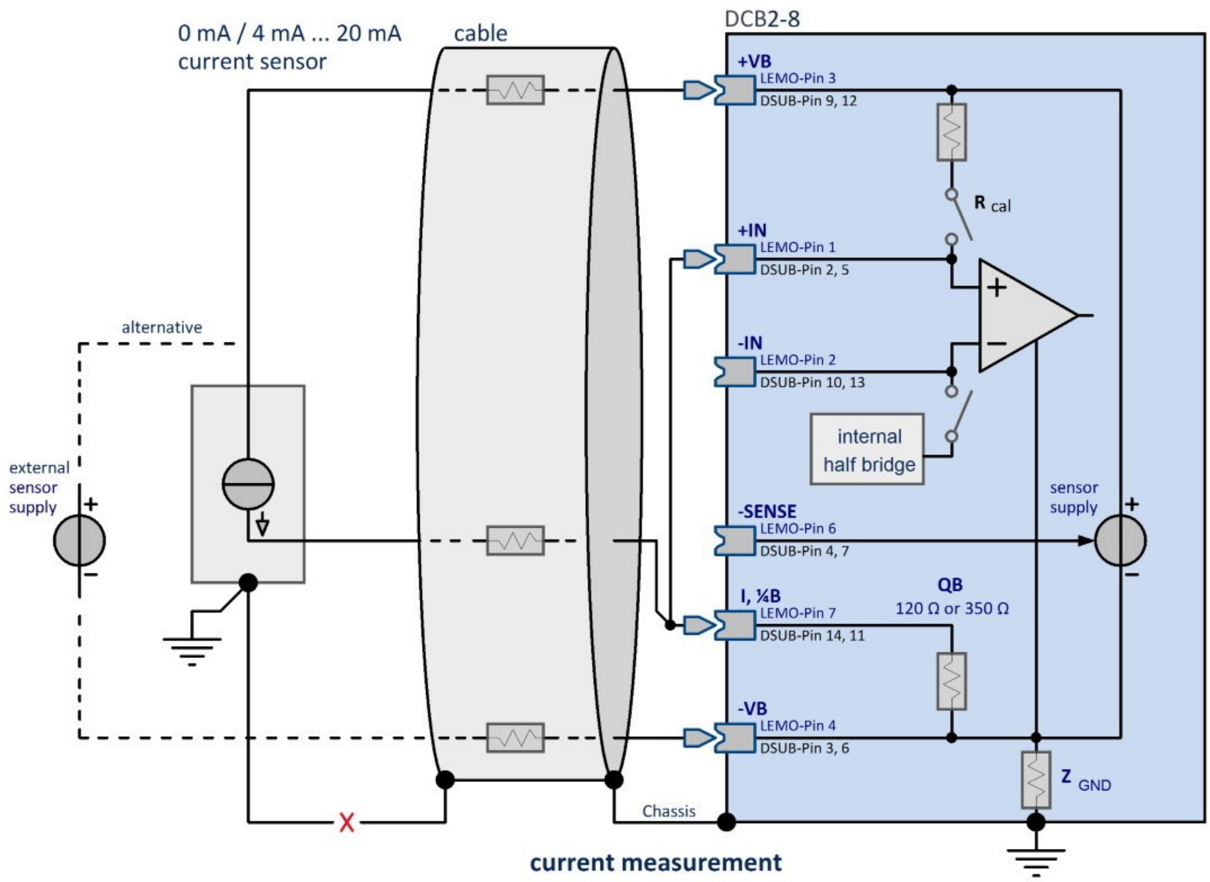
Note that the jumper between *+IN* and *+I; ¼Bridge* should be connected right inside the plug.

Note

For an (optional) sensor supply with ±15 V ground referenced current measurement is not possible. The pin *I;¼Bridge* is used as -15 V pin.

8.2.2.3.3 2-wire for sensors with a current signal and variable supply

- E.g. for pressure transducers 4 mA to 20 mA



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

Transducers which translate the physical measurement quantity into their own current consumption and which allow variable supply voltages can be configured in a two-wire circuit. In this case, the device has its own power supply and measures the current signal.

In the settings dialog on the index card *Universal amplifiers/ General*, a supply voltage is set for the sensors, usually 24 V. The channels must be configured for *Current measurement*.

The sensor is supplied with power via Terminals *+VB* and *+I;* $¼_{Bridge}$.

The signal is measured by the amplifier between *+IN* and *I; ¼*$_{Bridge}$. For this reason, a wire jumper must be positioned between Pins *+IN* and *I; ¼*$_{Bridge}$ inside the plug.

Note

There is a voltage drop across the resistances of the leadwires and the internal measuring resistance of 120 Ω which is proportional to the amperage. This lost voltage is no longer available for the supply of the transducer (2.4 V = 120 Ω · 20 mA). For this reason, you must ensure that the resulting supply voltage is sufficient. It may be necessary to select a leadwire with a large enough cross-section.

8.2.2.4 Current fed sensors

For the measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) 260.

Note DCB2-8 or B-8 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

8.2.2.5 Sensor supply

The channels are enhanced with an integrated sensor supply unit, which provides an adjustable supply voltage for active sensors. The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The supply voltage can only be set for all eight measurement inputs in common.

The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

Note

The voltage selected is also the supply for the measurement bridges. If a value other than 5 V or 10 V is set, bridge measurement is no longer possible!

8.2.2.6 Bandwidth

The channels' **maximum sampling rate** is 100 kHz (10 µs). The analog bandwidth (without digital low-pass filtering) is 5 kHz (-3 dB).

8.2.2.7 Connection

The following terminal connections are available:

- DSUB-15 connector (find here the pin configuration 497)
- LEMO (find here the pin configuration 504)
- DSUB-26-HD (find here the pin configuration 501)

The BC-8 uses 26-pin HD (High Density) DSUB connections. Those provide four channels for each DSUB connection.

8.2.3 B(C)-8: Strain gauges, Voltage, IEPE/ICP

The B(C)-8 is a compact bridge amplifier and is similar to the DCB(C)2-8 156 amplifier with an higher bandwidth of 48 kHz (-3 dB).

The description of the DCB(C)2-8 156 applies to the B(C)-8 with the exception of the bandwidth and filter.

Reference

Technical details of the B(C)-8 365

8.2.3.1 Connection

The following terminal connections are available:

- DSUB-15 plug (find here the pin configuration 497)
- LEMO (find here the pin configuration 504)
- DSUB-26-HD (find here the pin configuration 501)

The BC-8 uses 26-pin HD (High Density) DSUB connections. Those provide four channels for each DSUB connection.

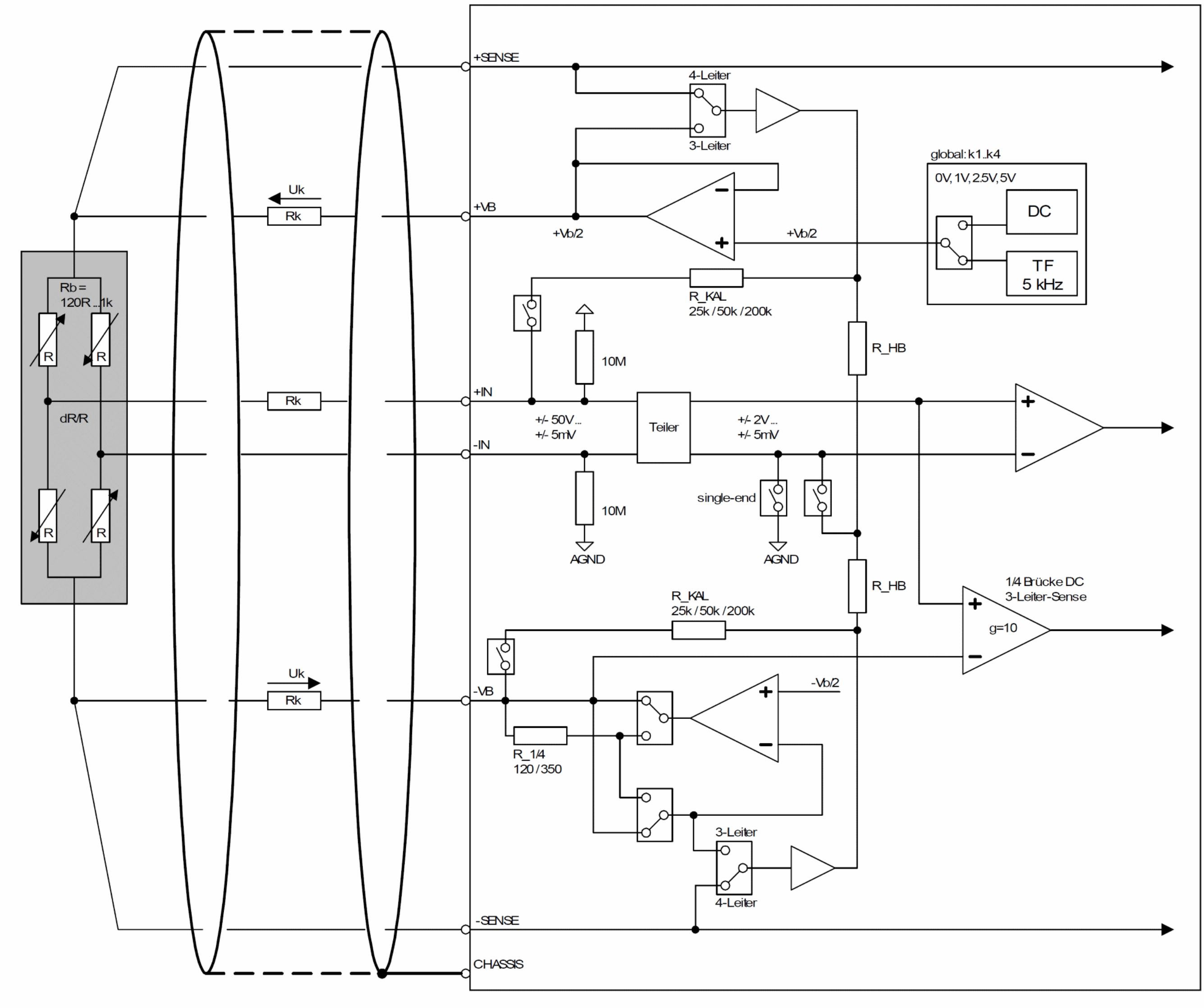
8.2.4 BR2-4: Strain gauges, LVDT, Voltage, IEPE/ICP

BR2-4 is an all-purpose bridge amplifier for four channels (also employable as a DC differential amplifier). It enables measurement of four bridges, load cells or strain gauges and inductive LVDTs, supplied with a software selectable choice of either DC or CF (AC carrier frequency) excitation, technical details 356

Highlights

- DC and Carrier frequency mode (5 kHz)
- Lead wire compensation with single and dual sense line configurations are supported (e.g. 5/6-wire-circuit with full bridge)
- Symmetric bridge supply of 1 V, 2.5 V, 5 V and with DC and CF (AC) mode
- Software selectable quarter bridge completion 120 Ω and 350 Ω switchable
- Cable breakage recognition

8.2.4.1 Bridge measurement



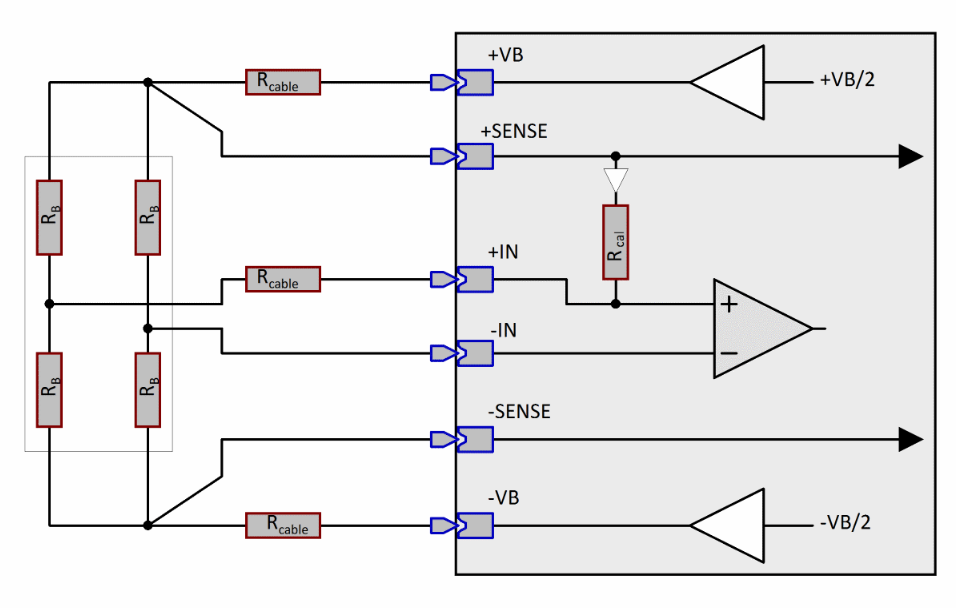
Block schematic

Sense line

The amplifier supports configurations with single-line sense, for compensation of symmetric cables: Just leave the unused sense line unconnected (+ or –SENSE): Internal pulldown-resistors provide defined zero levels to detect the SENSE configuration automatically. It will be shown at the balance dialog of imc software and allows probe-breakage recognition.

8.2.4.1.1 Full bridge

Connection scheme: Full bridge, double sense



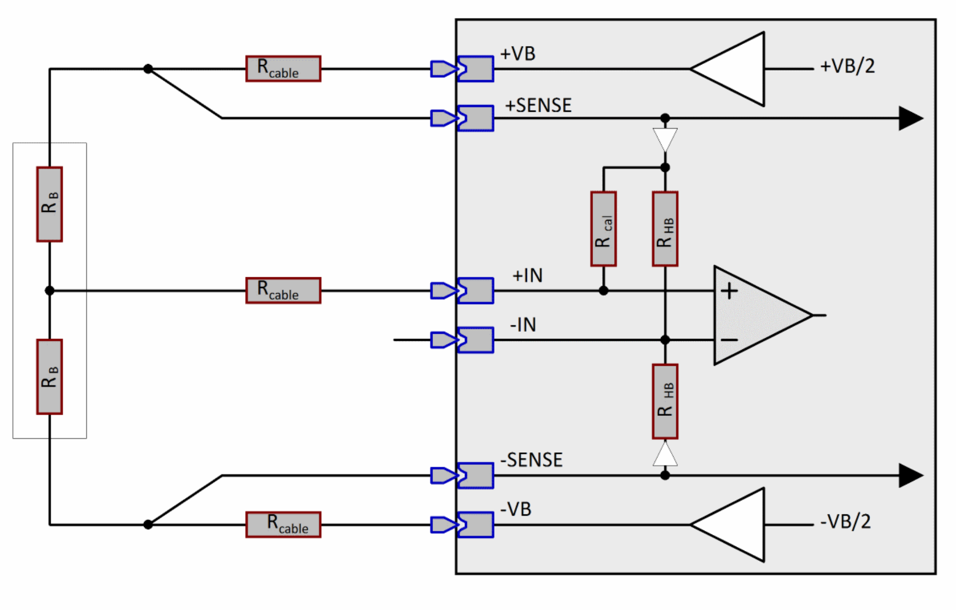
- 6-wire connection
- Both SENSE-lines, ±SENSE, used ("double sense").
  Compensation of the influence even of asymmetric cable resistances.
- Calibration resistor for shunt calibration;
  for long cables in CF mode, reduced precision due to phase errors

Connection scheme: Full bridge with single line-Sense, only DC mode

- Analogous to the corresponding half-bridge configuration

8.2.4.1.2 Half bridge

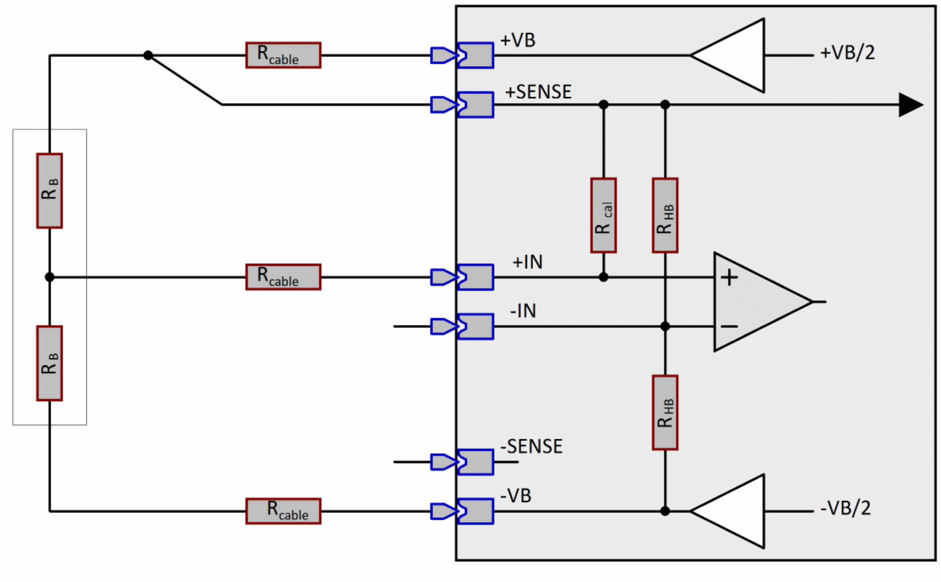
Connection scheme: Half-bridge, double Sense



Half-bridge, double Sense

- 5-wire connection
- Both SENSE-lines, ±SENSE, used (double Sense):
  Compensation of the influence even of asymmetric cable resistances.
- Calibration resistor for shunt calibration: shunt calibration of external half-bridge arm;
  for long cables in CF mode, reduced precision due to phase errors
- Internal half-bridge completion excitation is controlled by an internal, buffered SENSE line; therefore asymmetric cable is permitted without the resulting offset-drift!

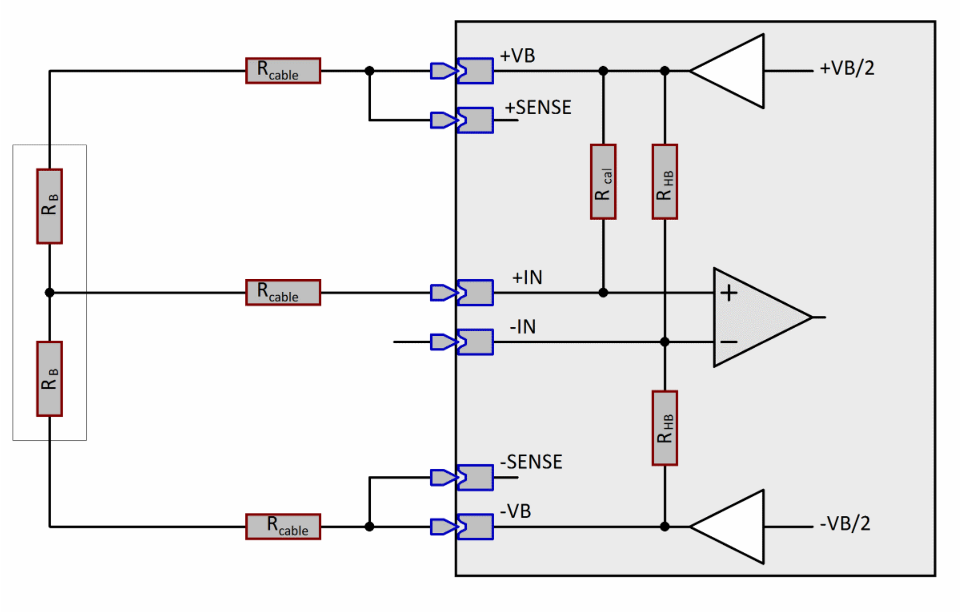
Connection scheme: Half-bridge, single line-Sense, only DC mode



Half-bridge, single line-Sense

- 4-wire connection
- Only one SENSE-line is used (single line-Sense):
  Compensation of the influence of symmetric cable resistances.
  +SENSE or –SENSE can be used, recognized automatically, unused SENSE left open.
- Calibration resistor for shunt calibration of external half-bridge arm;
  for long cables in CF mode, reduced precision due to phase errors.
- Internal half-bridge completion fed by ±VB, therefore symmetric cable required, otherwise not only incorrect gain correction but also corresponding offset drift!

Connection scheme: Half-bridge without single line-Sense

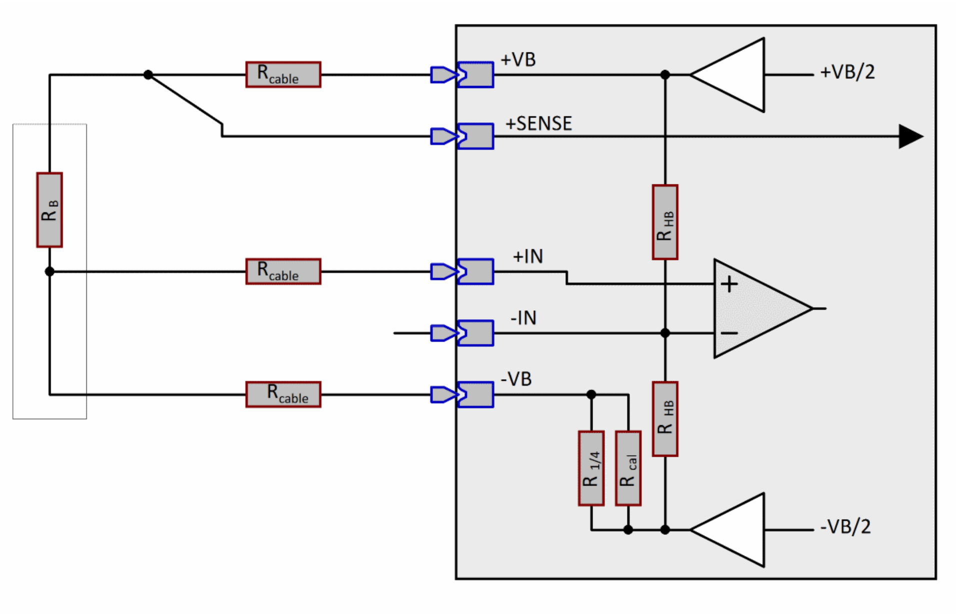


Half-bridge without single line-Sense

- 3-wire connection
- No SENSE-line used, SENSE terminals to be left open of jumpered to ±VB at the plug, in order to compensate the plug's contact resistance.
- Calibration resistor for shunt calibration on external half-bridge arm;
  for long cables in CF mode, reduced precision due to phase errors.
- Optional cable resistance calibration ("offline"):
  Cable resistance determined by means of shunt calibration and automatic calculation.
  Symmetric cabling required (also to +IN!).
  No acquisition of cable resistance drift, since it can only be performed offline before measurement.
- Internal half-bridge completion fed by ±VB, therefore symmetric cabling required, otherwise not only incorrect gain correction but also corresponding offset drift!

8.2.4.1.3 Quarter bridge

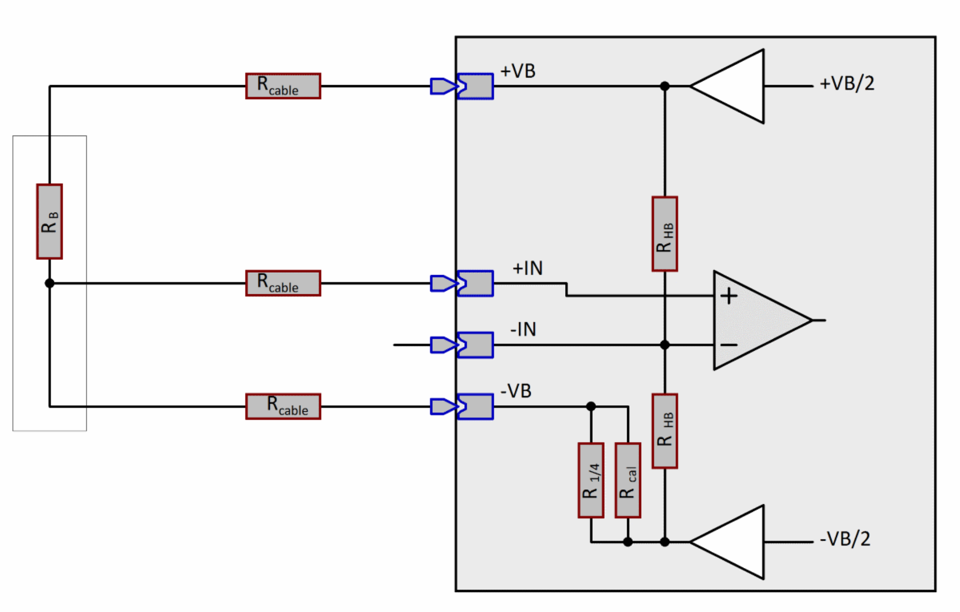
Connection scheme, quarter bridge, with Sense



Quarter bridge, with Sense

- 4-wire connection
- SENSE is used:
  compensation of voltage drop at symmetric cables
- Calibration resistor for shunt calibration: Shunt calibration at internal quarter-bridge completion. Shunt calibration can also be used with long cables in the CF mode!
- Symmetric cables required, otherwise corresponding offset drift!

Connection scheme: Quarter-bridge, without Sense



Quarter-bridge, without Sense

- 3-wire connection
- No SENSE-line is used, leave SENSE terminals open.
  +SENSE may also NOT be connected. Compensation of the plug contact resistance at VB is thus not possible (in contrast to the case of half-bridge 2-wire configuration).
- Symmetric cabling required, otherwise corresponding offset drift!
- Calibration resistance for shunt calibration: Shunt calibration at internal quarter-bridge completion.
  Shunt calibration can also be used with long cables in the CF mode!
- For DC: Compensation of gain error due to cable resistance at VB by means of measurement and automatic compensation of the voltage drop along the cable between –VB and +IN
  Online-compensation, capture also of cable drift (which must be symmetric!)

8.2.4.1.4 Background info on quarter-bridge configuration

In quarter-bridge configuration the external ¼-bridge branch is connected via three cables, where the two current-bearing leads "+VB" and "-VB" must be symmetric (same resistance, thus identical length and cross-section). Under these circumstances, their influence (in terms of the offset, not the gain) is compensated, so that no offset versus the (constant) internal half-bridge's potential arises.

If this symmetry condition is not met (e.g. if only two cables are used and the terminals "–VB" and "+IN" are directly jumpered at the terminal) the following offset drift would result due to the temperature-dependent cable resistance in series with the bridge impedance:

Assuming a (one-way) cable length of 1 m, we get:

Cu-cable: 0.14 mm², 130 mΩ/m, cable length l = 1 m	Cable Rk = 130 mΩ	
Temperature coefficient Cu:	4000 ppm / K	
Drift Rk:	0.52 mΩ / K	
Equivalent bridge drift (120 Ω bridge)	¼ 0,52 mΩ / (K *120 Ω)	= 1.1 µV/V / K
Example: Temperature change dT = 20 K	22 µV/V (dT =20 K)	

Cable resistance values which aren't ideally symmetric would have a proportionally equal effect: e.g., 500 m of cable with 0.2% resistance difference would cause the same offset drift of 1.1 µV/V / K.

Along with the offset, a gain uncertainty given by the ratio between the cable resistance and the bridge impedance must also be taken into account. For 120 Ω bridges, it remains under 0.1% for cable lengths of approx. 1 m:

Cu-cable, 0.14 mm², 130 mΩ/m --> cable Rk/Rb = 1/1000 for l = 0.9 m

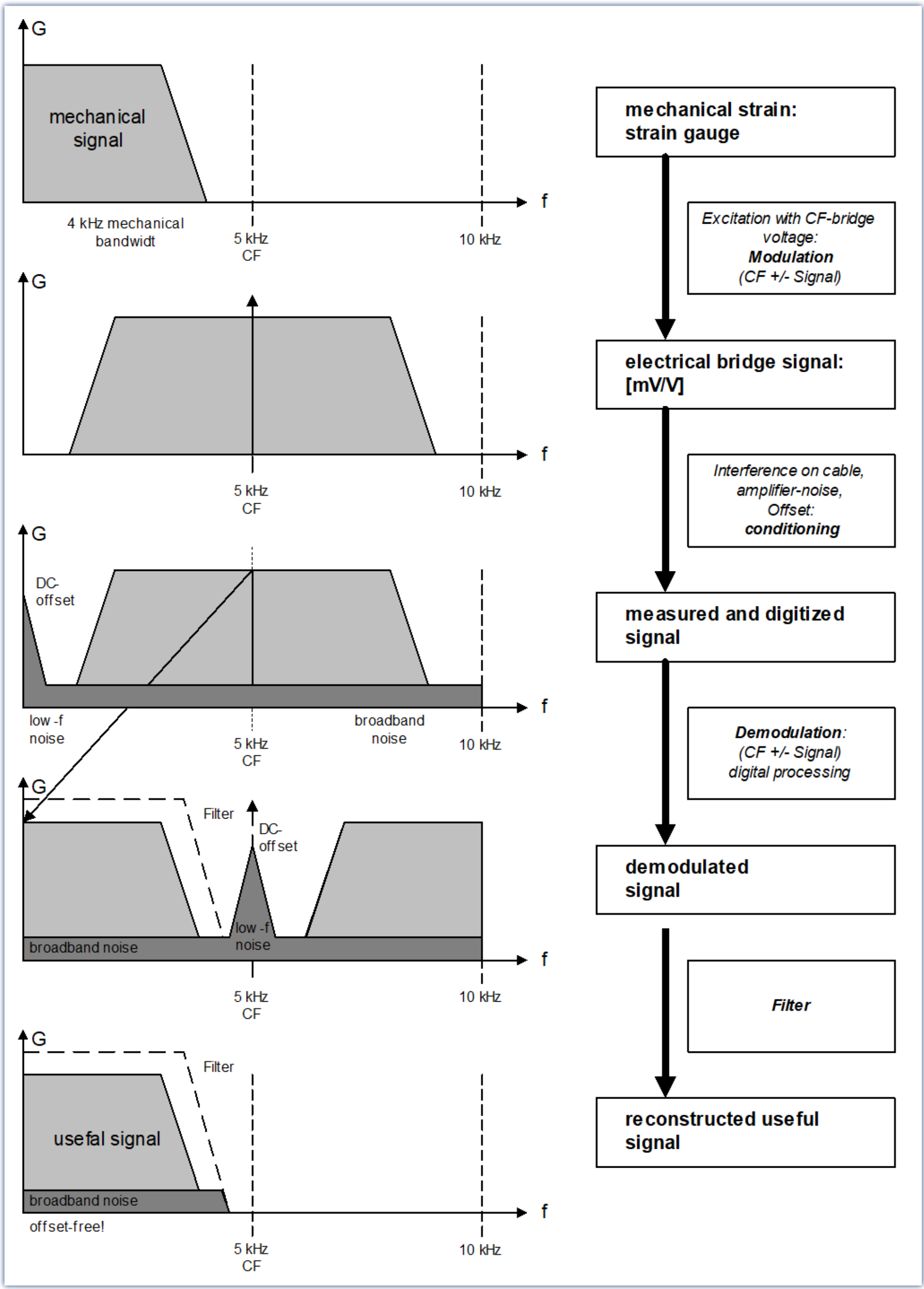
There are three different procedures for cable compensation:

- Connection of an additional 4th line: "+SENSE":
  - automatic calculated compensation on the condition of cable symmetry
  - online compensation procedure which also takes temperature drift into account
  - can be used with CF and DC-mode
- Evaluation of the voltage drop along the cable to "-VB" by means of measuring the voltage difference between the terminals "-VB" and "+IN":
  - automatic computed compensation on the condition of cable symmetry
  - online-compensation procedure which also accounts for temperature drift
  - only can be used for DC

8.2.4.2 Carrier frequency amplifier: Modulation principle

Operational principle for the effective suppression of low-frequency disturbances, e.g. 16 Hz, 50 Hz. These can work from the wiring or the measuring process and/or from low-frequency noise and offset drift and also from the process and the amplifier.

The following schematically description shows that carrier frequency amplifier is based on a modulation / demodulation process. This process support low-frequency and/or DC disturbances which are linked on electrical way. Carrier frequency amplifier is necessary for inductive sensors, e.g. LVDT.



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8.2.4.3 Overload recognition

Overload is indicated as double the value of the input range limit value. If the negative input range is exceeded, then in DC-mode, the doubled negative input range is indicated. In CF-mode, the doubled positive input range is always shown. The chapter: Overdriving a measurement range 258 describes the implemented behaviour to facilitate easy identification of overrange status.

8.2.4.4 Bandwidth

imc CRONOS*compact* and imc CRONOS-SL:

The channels' max. sampling rate is 20 kHz (50 µs). The analog bandwidth (without digital low-pass filtering) is 8.6 kHz (-3 dB) in DC mode and 3.9 kHz in CF mode (-3 dB).

imc CRONOS*flex*

The channels' max. sampling rate of a CRFX/BR2-4 is 100 kHz (10 µs). The analog bandwidth of the CRFX/BR2-4 (without digital low-pass filtering) is 14 kHz (-3 dB) in DC mode and 3.9 kHz in CF mode
(-3 dB).

8.2.4.5 Connection

DSUB-15 plugs can be used for the modules with DSUB connections, find here the pin configuration of the DSUB-plugs 497. LEMO plugs can only be used for modules with LEMO connections, please find here the pin configuration 504.

Note

±SENSE will be detected automatically by the BR-4, BR2-4 amplifier (as of imc firmware Version 2.7 R3 SP7).

8.2.5 LVDT-8: LVDT Bridge measurement

The CRC/LVDT-8 module is specially designed for LVDT measurements (Schaevitz coils according to the transformer principle and inductive half bridges).

Reference

- measurement description 137
- technical specs 362
- pin configuration: ACC/DSUBM-B2 497

8.3 Voltage, Current and Temperature

	CRFX width	CRXT width	Slots needed CRC, CRSL	Bandwidth	function
C-8 179	--	--	1	20 Hz	voltage, temperature, current (20 mA)
HISO-8-L 182, HISO-8-T-xL 182	81.9 mm	--	--	11 kHz	high isolated: voltage, current (20 mA), temperature
HV2-2U2I / HV2-4U 187	81.9 mm	--	2	48 kHz	high isolated: high voltage, current probe
ICPU2-8 196	61.62 mm	64.5 mm	2	48 kHz	voltage, IEPE/ICP
ICPU-16 199	--	--	4	6.6 kHz	voltage, IEPE/ICP
ISO2-8 200	43.3 mm	34 mm	1	11 kHz	isolated: voltage, current (20 mA), temperature, IEPE/ICP
ISO2-16-2T 200	61.62 mm	--	--		isolated: temperature
ISOF-8 205	43.3 mm	34 mm	1	48 kHz	voltage, current (20 mA), temperature, IEPE/ICP voltage
LV-16 209	--	--	2	6.6 kHz	voltage, current (20 mA), IEPE/ICP
LV3-8 210	43.3 mm	34 mm	1	48 kHz	voltage, current (20 mA), IEPE/ICP
OSC-16 213	--	--	2	1 Hz	isolated: voltage, current (20 mA), temperature
SC2-32 216	--	--	4	20 kHz	voltage, current (20 mA), IEPE/ICP

8.3.1 C-8: Voltage, temperature, current (20 mA)

This C-8 is a measurement amplifier for 8 channels measuring:

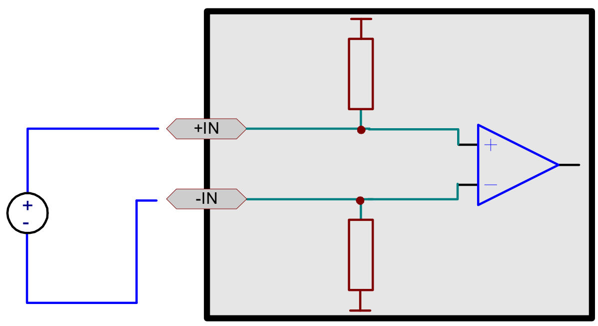
- voltages, current (20 mA) and
- temperature (thermocouple, PT100)

Technical details of the C-8 371 and the pin configuration of the DSUB-15: ACC/DSUBM-U4 497

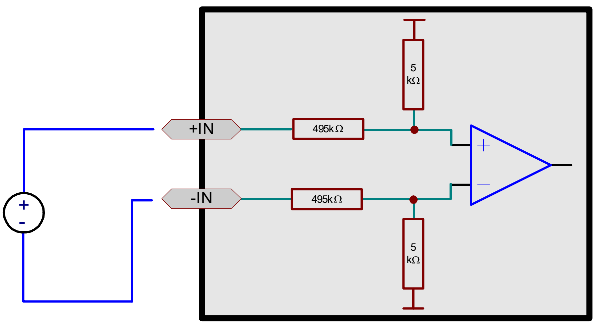
8.3.1.1 Voltage measurement

- ±50 V to ±2,5 V with divider
- ±1 V to ±5 mV without divider

A voltage divider is in effect in the voltage ranges ±50 V and ±2,5 V;
the resulting input impedance is 1 MΩ - even when the device is deactivated. The input configuration is differential and DC-coupled.



Voltage <2 V without divider



Voltages >1 V with internal divider

8.3.1.2 Temperature measurement

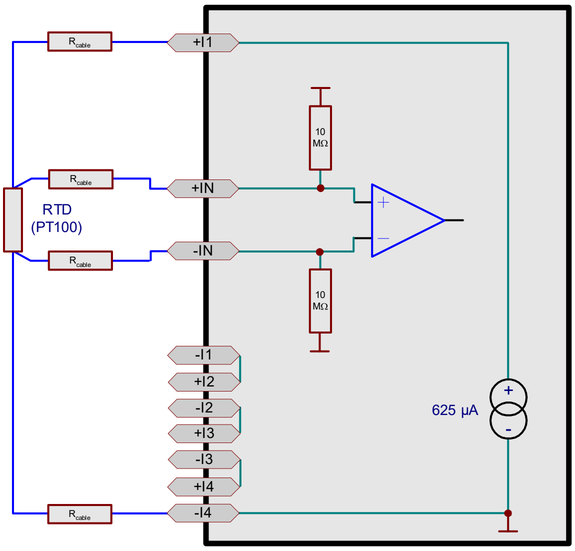
The C-8-module's channels are designed for measurement with thermocouples and PT100-sensors (RTD). Any combination of sensor types can be connected. Many common thermocouple types use linearization based on characteristic curves.

The cold-junction compensation for the thermocouple measurements is either built-in or is handled by the imc Thermoplug (DSUB-15) 128, depending on the device variety.

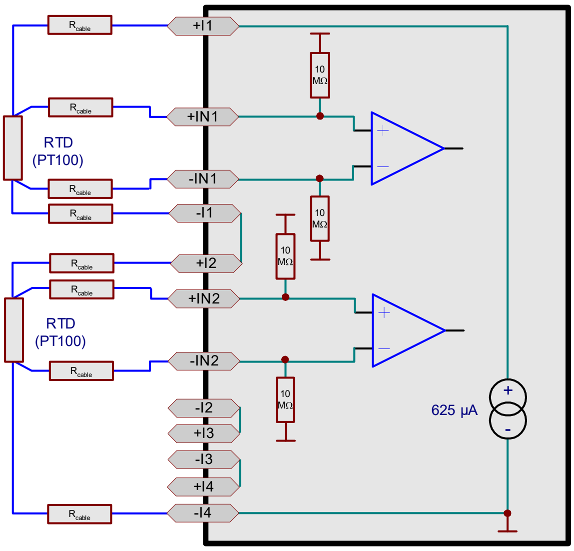
8.3.1.2.1 Measurement with PT100 (RTD)

Besides thermocouples, it's also possible to connect PT100 sensors directly in 4-wire-configuration. A (supplementary) reference current source feeds up to four sensors connected in series jointly.

When the imc Thermoplug is used, the connection terminals are already wired in such a way that this reference circuit is closed.



Example for one PT100(RTD) in 4-wire configuration



Example for two PT100(RTD) in 4-wire configuration

8.3.1.2.2 Thermocouple measurement

The thermocouples are connected with type-K Thermo-plugs into sockets of the same type of the amplifier (C-8-T, 3-pin thermo slot, type K, green). The reference point is at the terminal on the front panel, whose temperature signal is captured and evaluated by the device.

8.3.1.3 Optional sensor supply module

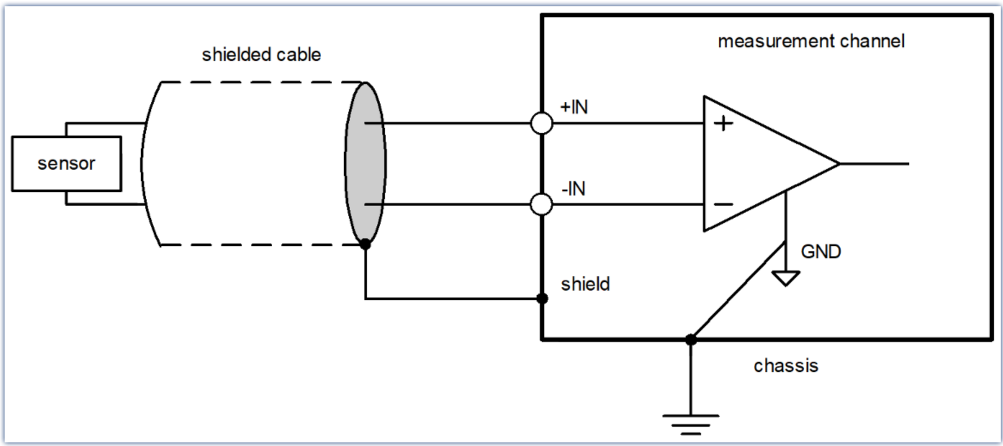
The C-8 can be enhanced with the sensor supply unit: SUPPLY, which provides an adjustable supply voltage for active sensors.

The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

Technical details of the sensor supply module 469.

8.3.1.4 Connection

The measurement inputs should be connected using a shielded cable in which both the positive and negative measurement inputs (+IN and -IN) are located inside the shielding. The shielding must be connected to the housing of the plug.



Pin configuration: standard (ACC/DSUB-STD) 497 or LEMO connection 504.

8.3.2 HISO-8-L, HISO-8-T-8L and HISO-8-T-2L: High isolated: Voltage, Temperature

The HISO-8 is an isolated, differential measurement amplifier with 8 analog inputs for measuring small voltage signals with high common mode isolation up to 800 V. The following signals and sensors are supported, depending on the chosen variant:

HISO-8 variant	supported measurement modes	LEMO REDEL
CRFX/HISO-8-T-8L	thermocouple measurement type K	LEMO.2P (2-pin)
CRFX/HISO-8-T-2L	thermocouple measurement type K	LEMO.2P (8-pin)
CRFX/HISO-8-L	voltage measurement (±50 mV to ±60 V) current measurement (20 mA) PT100, PT1000 measurement	LEMO.1P (5-pin)

Highlights

- Channel-wise isolated, galvanically-separated inputs
- High common mode isolation up to 800 V
- Overvoltage protection ±600 V (differential)
- High signal bandwidth of up to 11 kHz
- Each channel with its own adjustable filter (e.g., anti-aliasing filter) and simultaneous A/D converter

Typical applications

- Testing in e-mobility environments (e.g., electric and hybrid vehicles)
- Tests where full personal safety must be guaranteed even in case of hazards
- Measurements on high-voltage components, such as batteries, power electronics components and Power supply circuits; low-voltages, including signals on external current measurement shunts

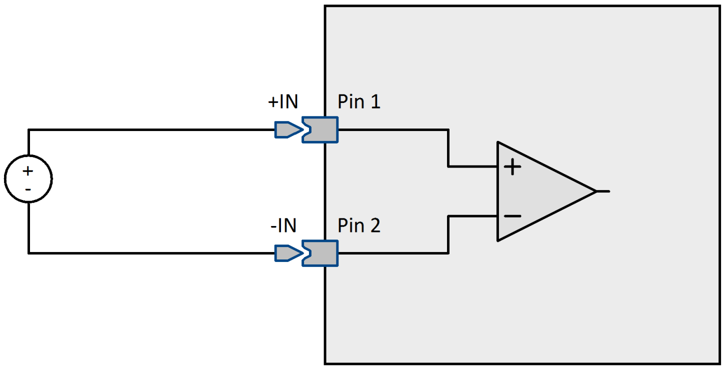
Reference

Please find here the LEMO.1P 506 and the LEMO.2P 506 pinning.

Technical details of the HISO-8 374.

Please consider the following chapter: General remarks on isolated channels 200.

8.3.2.1 Voltage measurement



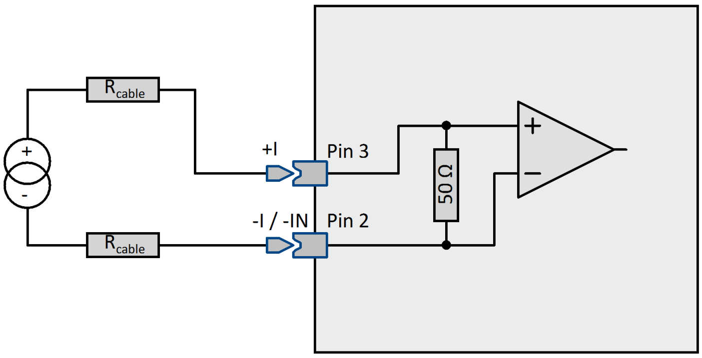
configuration for voltage measurement

Measurement ranges:
±50 mV to ±60 V

The differential input impedance is 6.7 MΩ in ranges up to ±2 V. For all other ranges and if the device is de-activated, the impedance is always 1 MΩ.

The inputs are DC-coupled. The differential response is achieved by means of the isolated circuiting.

8.3.2.2 Current measurement



configuration for current measurement

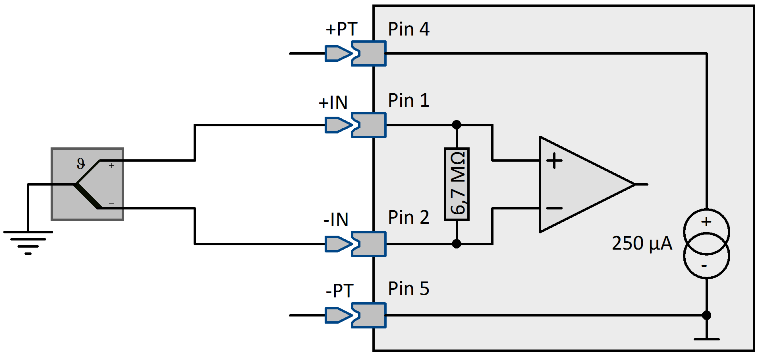
Measurement ranges:
±40 mA, ±20 mA, ±10 mA

The current is measured via an internal 50 Ω shunt. The current signal has to be connected to +I and -IN / -I.

8.3.2.3 Temperature measurement

The input channels are designed for direct connection of thermocouples and PT100 / PT1000 sensors.

8.3.2.3.1 Thermocouple measurement



configuration for thermocouples

Temperature ranges:
-270°C to +1370°C

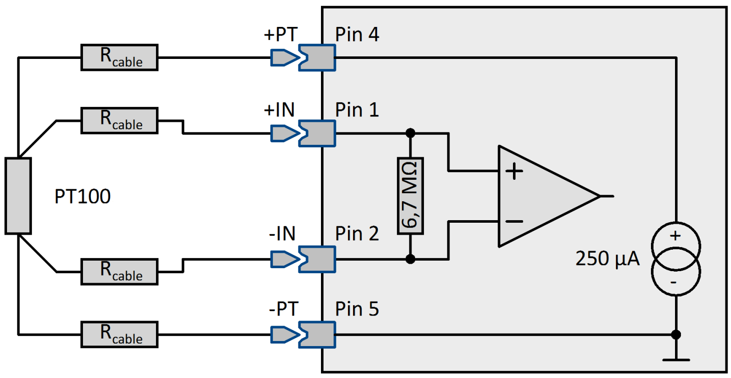
-270°C bis +1100°C

Thermocouple type K

Note

Note that the physical location is important. The precision stated in the technical specs applies for installation location in a thermally stabilized environment.

8.3.2.3.2 PT100 (RTD) - Measurement



configuration for PT100 (RTD) sensors

Measurement range:
-200°C to +850°C
-200°C to +250°C

A PT100 sensor is connected in a 4-wire configuration.
Each connected sensor is feed individually from a separate reference voltage supply.

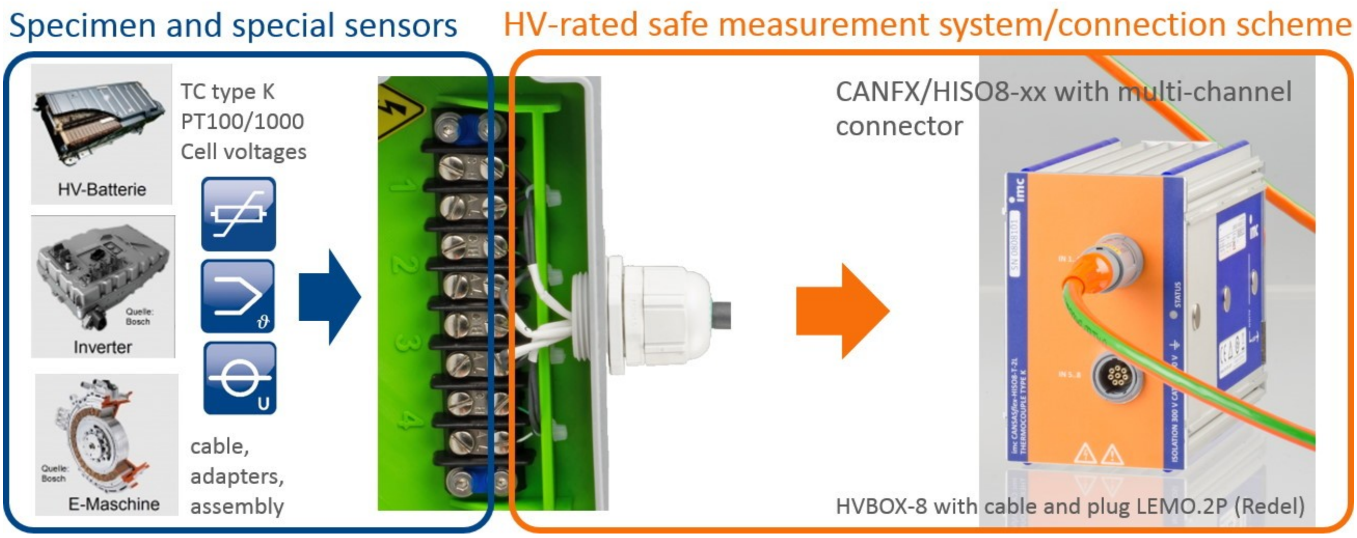
8.3.2.4 Bandwidth

The channels' **max. sampling** rate is 100 kHz (10 µs). The **analog bandwidth** is 11 kHz (-3 dB).

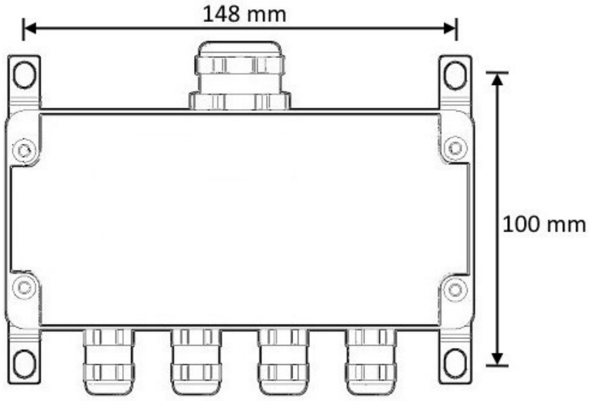
8.3.2.5 Connection box for high voltage (HV) modules

External HV connection box

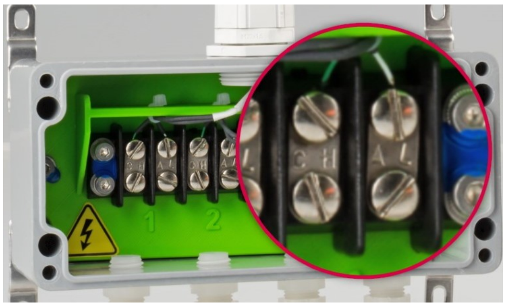
- with 10 m special HV cable via LEMO.2P (Redel)
- isolated screw terminals in polymer box
- sensor cable entry via cable gland (PG)
- serves as flexible and safe cabling interface to any arbitrary user cable
- clear division between fully specified, HV-rated **CRFX/HISO-8-T-2L** measurement module and suited HV-rated connectors on one side – and custom and application specific cables and sensors on the other side - that might comply with differing rules or regulations, under exclusive responsibility of the user



Mechanical drawings with dimensions - HVBOX-8:



Interior view



for the thermocouple variant: HVBOX-8-T-10M

as an example, two wires are enlarged
left + and right -
for the fourth thermocouple

Terminal		Lead Wire (Color Code)	
Signal / Material	**Label**	**IEC 585-3**	**ANSI**
(+) Ni-Cr	CH	green	yellow
(-) Ni-Al	AL	white	red

Symbols

Attention! Risk of electric shock. Dangerous voltages from the measuring sources may be applied to the terminals (HV on-board). Please observe the rated values!

Reference

Please find in the following chapter the technical specs of the connection box 379.

8.3.2.6 Connection

Reference HISO-8-xx

Please find here the LEMO pin configuration 506 of all available HISO-8 variants.

8.3.3 HV2-2U2I, HV2-4U High isolated: Voltage, Current probe

With this four-channel amplifier: HV2-2U2I, two channels are available for measuring voltages and two channels to measure with current clamps.

With the HV2-4U module variant four channels are available for measuring voltages.

Typical applications:

- Power measurements, measurements on electric motors, batteries, fuel cells, etc.

Reference

Technical details: HV2-2U2I 380, technical details: HV2-4U 384

8.3.3.1 High-voltage channels

The high-voltage channels are each equipped with an galvanically isolated amplifier. They enable direct measurement of voltages of up to 1000 V_{rms}, in accordance with the protection class CAT II, see technical Specs 380.

The measurement signal is connected directly to the device via a safety banana jack.

Warning

Each high-voltage module (HV2-2U-2I, HV2-4U) was inspected for compliance with the safety guidelines per DIN EN 61010-1 prior to delivery, and subjected to a high-voltage test. The module is sealed after having passed these final tests.

If the safety seal is damaged, safe work cannot be ensured.

Any intervention, for instance temporary removal of the module, makes re-inspection for safety.

8.3.3.1.1 Voltage measurement

- Voltage: ±1000 V to ±2.5 V in 9 different ranges

The inputs are DC-coupled and have a permanent input impedance of 2 MΩ. The differential response is achieved by means of the isolated configuration.

For the voltage measurement at common low voltage systems there is a reserve of the displayed value, therefore imc recommends the choice of the following measurement ranges:

- range = 250 V for 230 V-system +25 %
- range = 500 V for 400 V-system +40 %

8.3.3.2 Current measurement channels

Those current measurement channels are specially for the use of current transducers with voltage output (only the HV2-2U2I variant). Current Probes 188 and Rogowski Coils 189 can be transducer, which perform a power voltage conversion. Besides this kind of current measurement there is also the measurement of low voltage 192 signals possible within the respective measurement ranges. The following ranges are available ±5 V to ±250 mV. The differential inputs are DC-coupled and galvanically isolated.

Suitable current probe and Rogowski Coils can be delivered.

Note

- Use only current probes provided by imc, or have your own current probes modified by our customer service. Only then can error-free functioning be assured. imc will not accept responsibility for disturbances or damage sustained by the device if unauthorized probes are used.
- Whenever you connect a new current probe, read its TEDS information. The TEDS data are recorded along with the experiment and therefore need not be imported each time the same equipment is activated, see also the notes for making settings in the imc software 192.
- Amplitude and angle error of the external measurement transducer influence the measurement result and this mostly effect the power quality measurement.

8.3.3.2.1 Current measurement using Current Probes

Current Probes are compactly structured, electrically isolated sensors shaped like clamps, by which currents can be measured simply by encircling the conducting wire, without interrupting the circuit. The current under investigation is converted to a proportional voltage signal. Active sensors such as compensation transducers require their own power supply. In most cases, this is already provided by a battery in the Current Probe. Like Current Probes, Rogowski Coils enable contact-free measurement of current in a conductor by simply encircling it. In contrast to active Current Probes, Rogowski Coils don't require a power supply, but they can only measure AC-currents. To be exact, they measure the change in current, which makes integration of the signal necessary.

In both application cases, configuration of the measurement channel according to the type used is necessary. The Current Probes offered by imc come this way and will be detected by the imc operating software, see also the notes on making settings in the imc operating software 192.

Warning

- The measurement inputs are high-impedance and are not intended for direct connection of current transducers.
- The measurement signal can be accompanied by dangerous contact voltages.
  Please use only safety plugs.

8.3.3.2.2 Current measurement using Rogowski Coil

A Rogowski coil encircles a current conductor thus encompassing its magnetic flux field. By means of appropriate measurement engineering technology which is able to take the time integral of the encircled output voltage, it is possible to measure the current conducted. The measurement inputs of the HV2-2U2I are able to perform this integration when the Rogowski coil is connected with a TEDS or if the corresponding sensor information from the imc SENSORS database is used.

The Rogowski coil consists of a single wire which winds along the entire length of the loop. Due to design issues, not the whole magnetic field of the Rogowski coil is measured, since the winding stops at the coil's "node" (or the "buckle" of the loop/"belt"). This gap and the associated incomplete measurement of the magnetic field cause a certain measurement error whose magnitude depends on the conductor's position relative to the node; the closer the node, the greater the error.

As you can see in the following figure, the measurement error depends on where the conductor is located within the loop, in terms of the distance from the node at which the conductor passes perpendicularly through the plane of the loop. It can be shown that the optimum location for the conductor is across from the node.

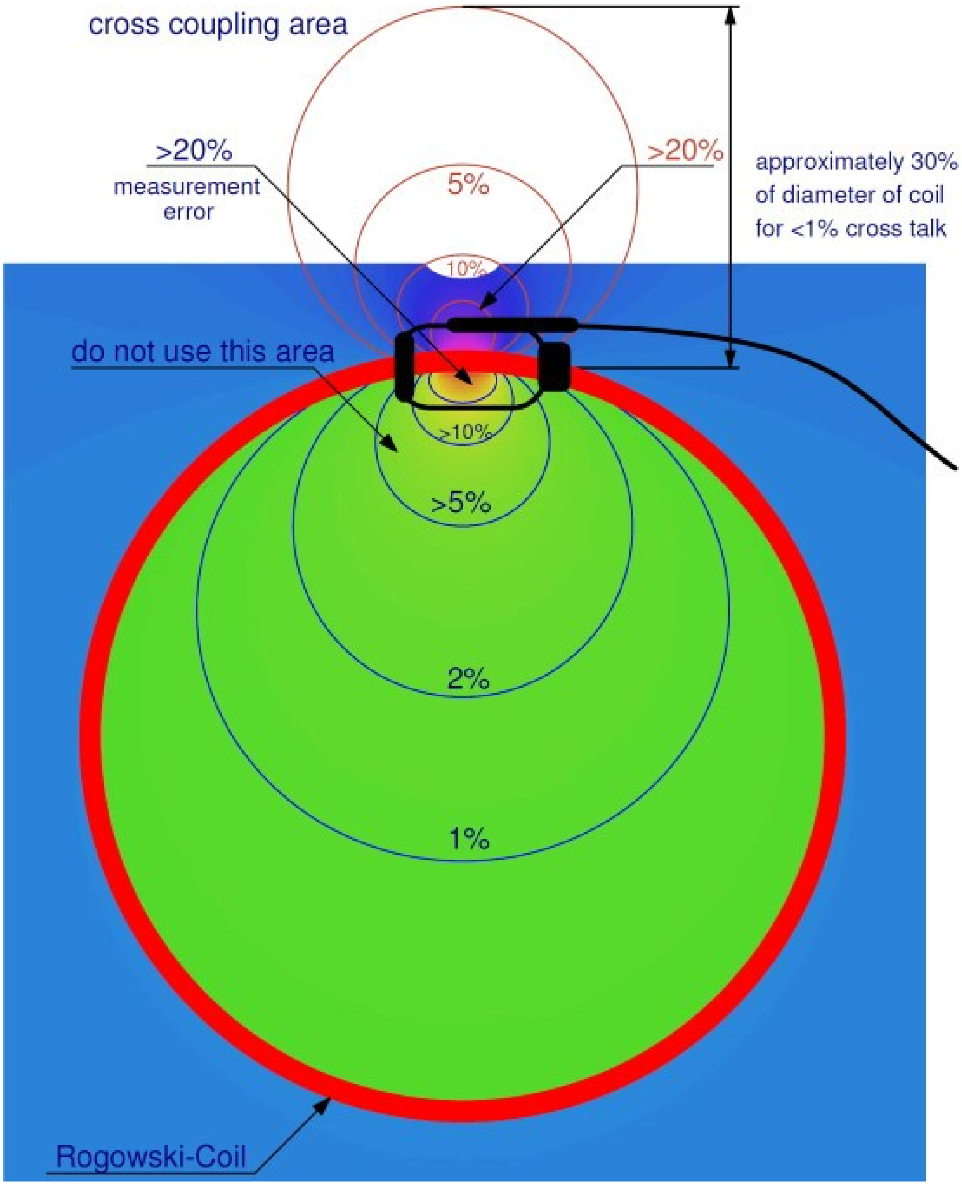


figure 1: measurement error in a Rogowski coil

Since the coil does not completely surround the conductor, only a part of the current is measured. In the one-third of area opposite from the node, the amount measured is ca. 98%. The sensor's sensitivity is calibrated at factory in the optimum position and is saved in the TEDS which is installed in the coil. This value is automatically used by the measurement system as the correction value. Thus, the measurement error at the optimum conductor position is less than 0.5%. The measurement uncertainty for HV2-2U2I is significantly less. (Bending the coil into an ellipse is not recommended.)

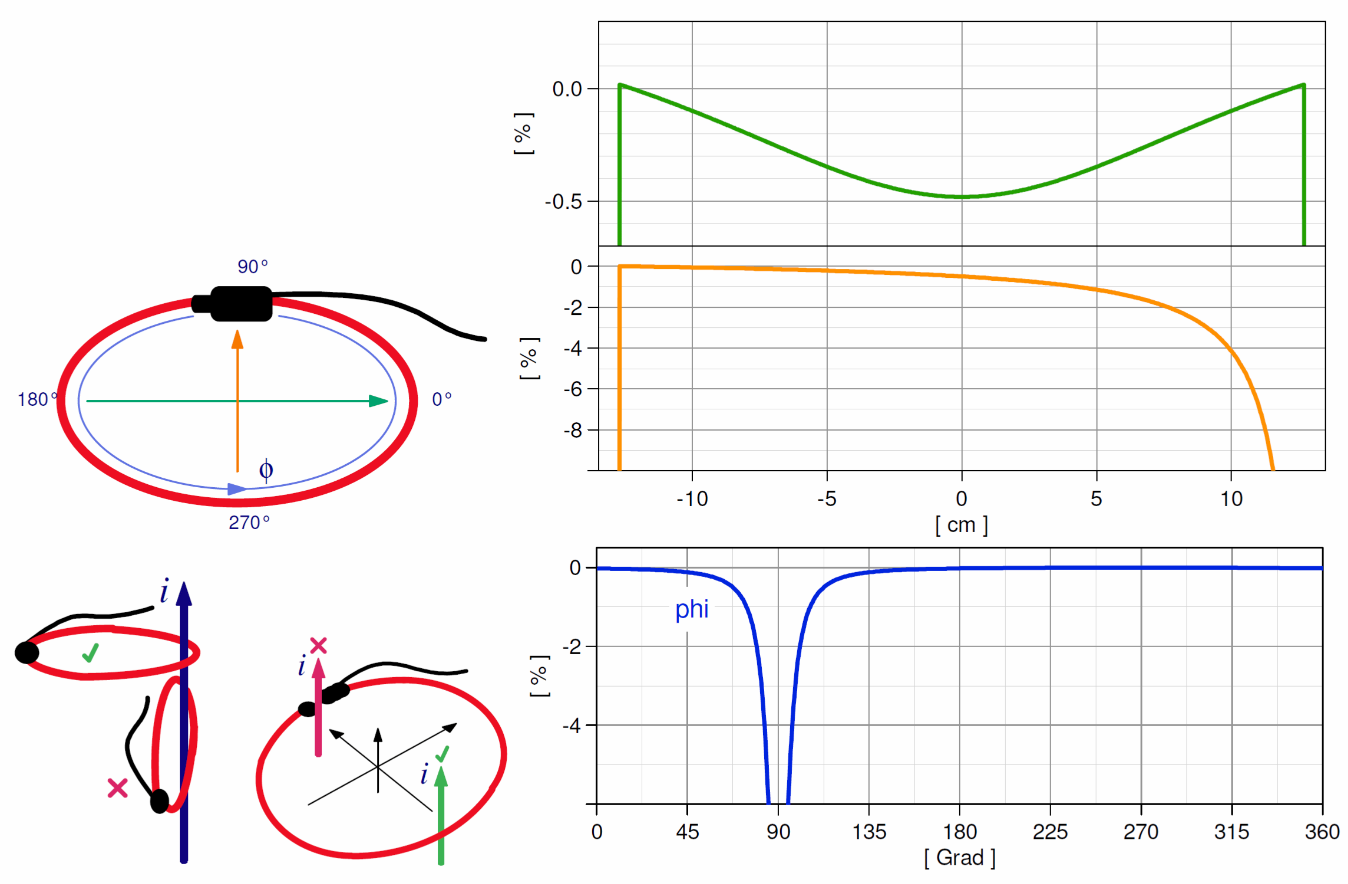


figure 2: location-dependent measurement error in a Rogowski coil for selected distances

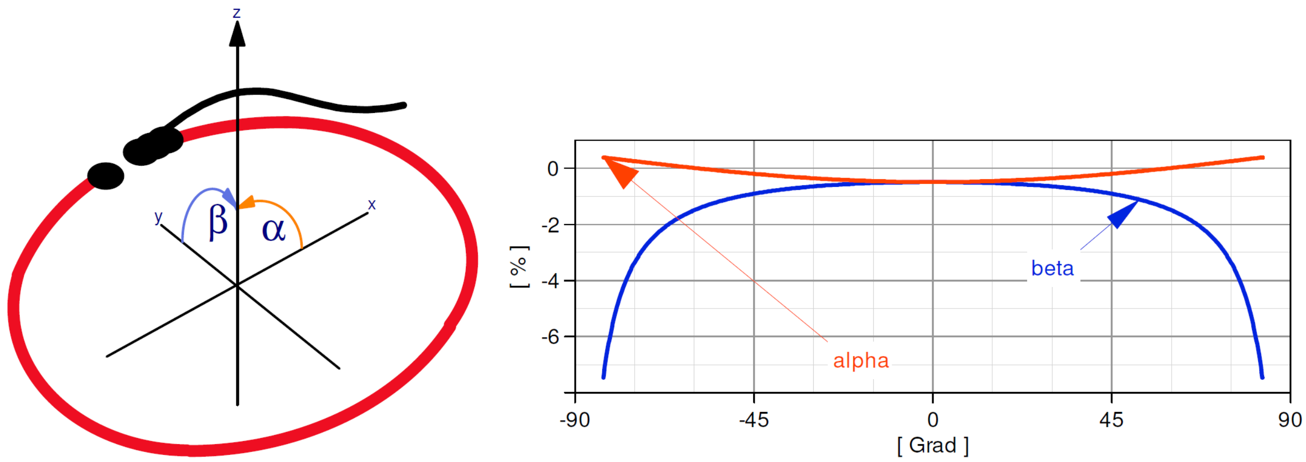


figure 3: Location-dependent measurement error in a Rogowski coil for different angles of inclination to the loop plane

An angle between the axis of the conductor and the plane of the loop also causes measurement error – especially if it causes the node to get near the conductor. This relationship is graphed in Fig. 3 for rotation in the angle b. (Figures 1 through 3 apply to a coil length of 80 cm / 32 inch. For loops having a length of 40 cm / 16 inch, the position dependency is greater and is approximated by Fig. 1 for equally-sized nodes.)

If there is an additional conductor in proximity to the node, its magnetic field also affects the sensor and thus distorts the measurement. For this reason, the node should be positioned in such a way as to maximize its distance from the conductor, see Fig. 1 189.

Note

For small measurement errors, observe the following rules:

- Place the conductor across from the loop node.
- Secure the loop in a plane perpendicular to the axis of the conductor.
- Keep the greatest possible distance between the loop node and other conductors.

Only alternating currents can be measured. The measurement bandwidth thus has only a lower cutoff frequency. For signal frequencies below or near this cutoff frequency, it is to be anticipated that there will be an amplitude- and phase error in reference to signals at the voltage measurement inputs. This phase error in particular will affect the measurement of power. HV2-2U2I has a very low lower cutoff frequency and low phase error, so that very good results are obtained at up to 1 Hz.

On the other hand, this high-pass response causes signal transient behavior which may last up to 30 s in the worst cases. This duration applies for signals which modulate to the measurement range maximum (e.g. 2 kA) and is is much less for lower instantaneous values of the current being measured.

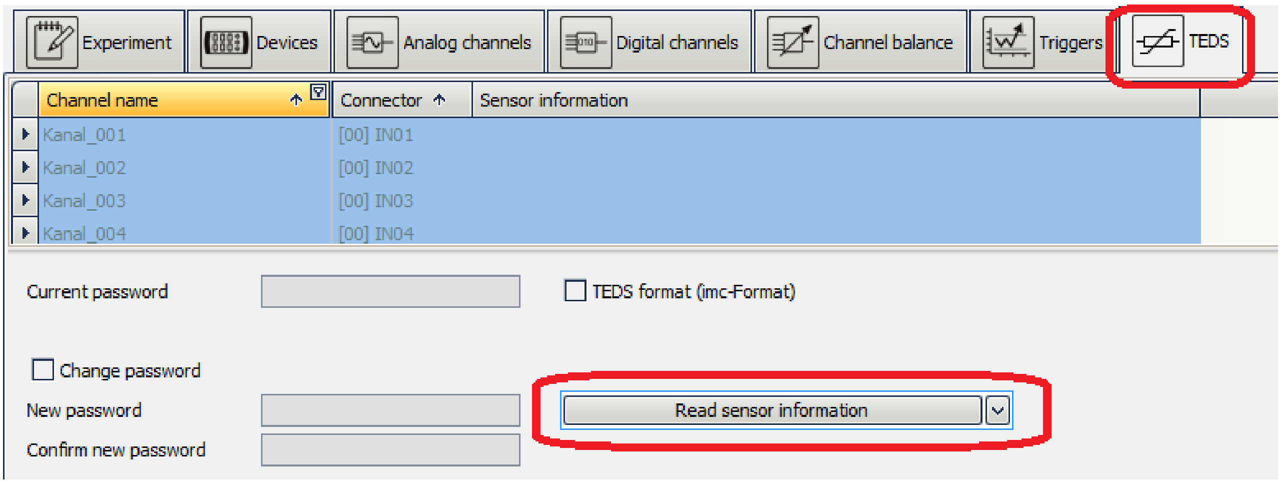
8.3.3.2.3 Notes on making settings in the imc software

Electrically, a current transducer (Current Probe or Rogowski Coil) always measures a voltage. The measurement device converts the captured voltage value to the corresponding current value by means of the Y-factor and unit supplied.

The current transducers provided by imc have been tested and supplied with TEDS which record the associated correction values. These correction values must absolutely be imported in order for the appropriate correction value and unit to be entered along with the experiment.

1. Connect the current transducer.
2. Start the imc operating software and connect the device with the PC.
3. Open the configuration dialog under *Settings / Configuration*
4. On the Base page of the dialog, select the current transducer connected
5. Import the transducer's sensor information from the transducer:

   With **imc STUDIO** click to *Read sensor information* at the TEDS page. The TEDS page can be loaded from menu *View \ Tool windows \ Layout repository*.



Reading the TEDS information in imc STUDIO

Notes

- The correction values of the individual sensors result in uneven input ranges.
- The available current input ranges result via the scaling factor of the transducer and the amplifiers' voltage measurement ranges (250 mV to 5 V). Only select the ranges, that are appropriate for your Current Transducer. There is no danger for the device with other ranges.
- The displayed input ranges take RMS values into account of up to a crest factor of 1.45. For instance, for a clamp probe of 2000 A RMS-value, an input range of at least 2000 A to 2500 A must be set for the purpose of full utilization.

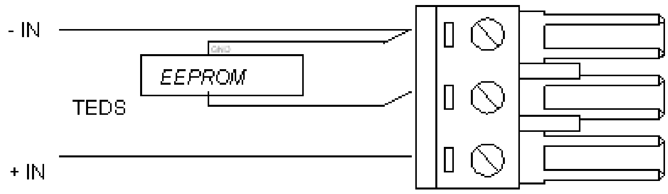
8.3.3.2.4 Voltage measurement

- Voltage: ±5 V to ±50 mV in 4 different ranges

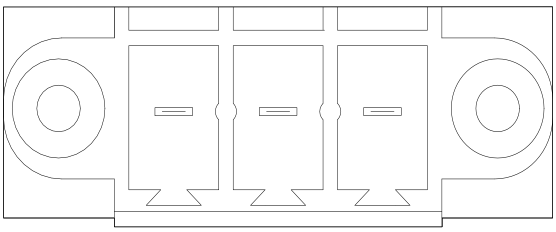
The isolated differential inputs are DC-coupled and have a permanent input impedance of 20 MΩ. Besides measurement with Current Probes, any other voltage signals can also be connected.

8.3.3.3 Pin configuration and cable wiring

Cable connection plug – Current measurement channels



Cable connection plug

Plug (female) in device	Signal	Definition
+ IN TEDS - IN 	+IN	Signal input
	-IN	Signal input
	TEDS	Transducer Electronic Data Sheet provides recognition of the current probe connected

Warning

In order to protect against touch-dangerous voltage the connector housing is always to be used!

8.3.3.3.1 Notes on the measurement setup

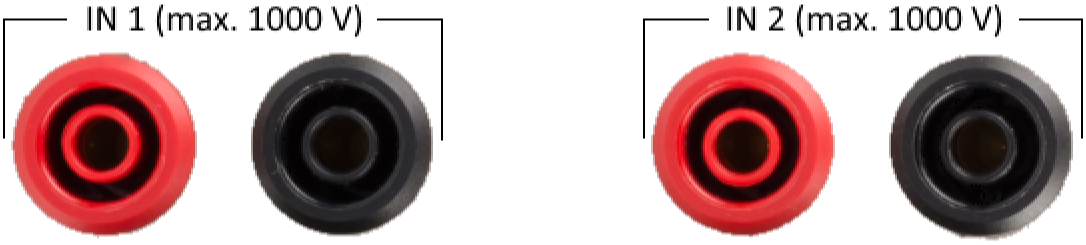
Measurement lines must be kept away from unshielded conductors, sharp edges, electromagnetic fields and other adverse environmental factors.

- Measurement line for the voltage: The measurement line's connection to the measurement object must be designed for the maximum occurring voltage. Before conducting the measurement, check the line leading to it in order to prevent the occurrence of dangerous touch voltages and short circuits. The use of flexible terminals makes special care necessary. It must be checked whether the mechanical connection is secure and what would happen if it is accidentally disconnected. For increased reliability, the lines should be secured at the measurement location. The fuse's breaking capacity must correspond to the expected error current at the measurement location.
- Measurement line for the current: The current probes must be connected in a mechanically secure manner. The aim should be to orient it orthogonally to the current rail or lead. This applies especially to current measurement coils operating according to the Rogowski principle.
- Measurement device: The device must be placed in such a way that no terminals can be accidentally disconnected.

8.3.3.4 Connection

8.3.3.4.1 Voltage

For voltage measurements of up to 1000 V_{rms}, safety banana jacks are provided:



The maximum permitted voltage to ground depends on the measurement site, please consider the data sheet 380

Only use connectors which are protected on all sides against touch.

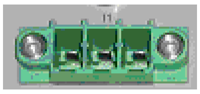
All the inputs are individually isolated. The voltage channels are built up with channel-wise galvanically isolated (potential-free) amplifiers. They allow the direct measurement of voltages up to 1000 V_{rms}. The permissible range of application (measurement in supply networks, nominal rated voltage etc.) depends on the relevant measurement category.

The analog bandwidth (without low-pass filtering) enables correct measurement of up to the 50 harmonic. The inputs are DC-coupled and have a permanent input impedance in the MΩ range. The differential response is achieved by means of the isolated configuration.

Note

For measurements on multi-phase systems, implement a connection scheme that is as symmetrical as possible: The (-) connections of the measurement inputs must also be routed with separate cables for each phase. If these measurement references belong to a common reference potential (e.g. N or PE), they must be connected at the test object and not bridged or looped through at the amplifier inputs.

8.3.3.4.2 Current



Current measurement is achieved contact-free by means of current probes. To connect these transducers, three-pin screw terminal block are provided.

Current probe MN71

Current transducer AmpFLEX A100

The current probes recommended by imc cover the range for low currents (<10 A) and for medium to high currents (5 kA to 10 kA). With probes having multiple input ranges, the input range set on the probe must also be correctly set by hand in the user's interface.

8.3.4 ICPU2-8: Voltage, IEPE/ICP

The measuring inputs (non-isolated, differential inputs) are used for voltage measurement and allow direct connection of any IEPE type sensors via BNC, such as ICP™, DeltaTron®, accelerometers or microphones, see technical details 386.

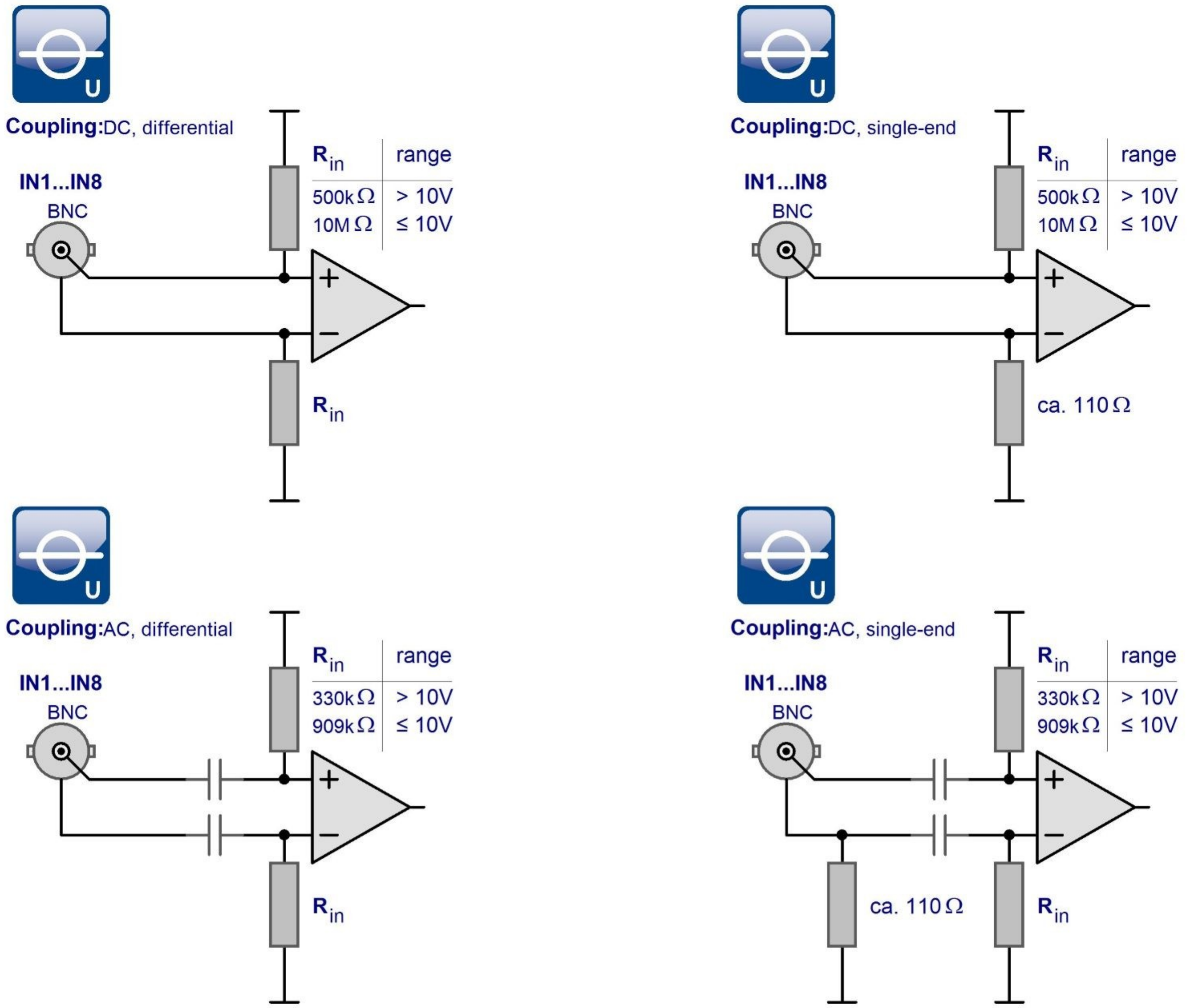
8.3.4.1 Voltage measurement

- Voltage: ±50 V to ±5 mV

In the voltage ranges ±50 V and ±20 V, a voltage divider is in operation; the resulting input impedance is 1 MΩ in DC mode and 0.67 MΩ in AC mode. In the voltage ranges ≤±10 V, by contrast, the input impedance is 20 MΩ in DC and 1.82 MΩ in AC mode. When the device is deactivated, it drops to about 1 MΩ.

With the AC coupled ICP-measurement the DC voltage is suppressed by a high pass filter of 0.37 Hz for all ranges ≤±10 V. For the ranges ≥±20 V the low pass cut-off frequency is 1 Hz.

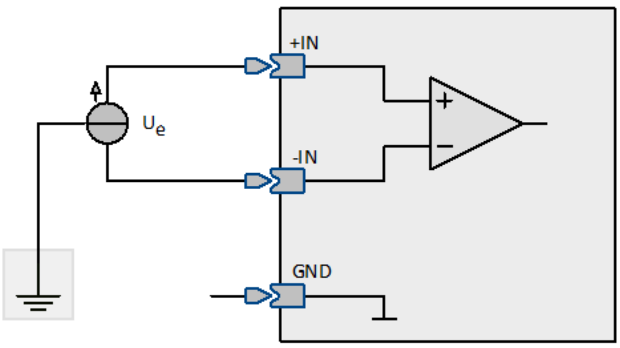
8.3.4.1.1 Input coupling



Note

- In the coupling mode "AC with current supply" respectively "IEPE", an open-circuit current-fed voltage of about 30 V is present at the BNC sockets, which can cause damage to other (non-current-fed) sensor types. For that reason, this mode should only be set for appropriate sensors. It is assured that no current feed is active when the device is started. This state remains in effect until the measurement is first prepared, no matter what is set in the user's interface.
- When a channel is not active, there will be no current-fed voltage in the settings mode AC with current feed as of firmware version 2.7 R3.
- As of imc STUDIO version 5.2 R15 the coupling mode "AC with current supply" is renamed to "IEPE".

8.3.4.1.2 Case 1: Voltage source with ground reference



The voltage source itself already is referenced to the device's ground. The voltage source is at the same potential as the device ground.

Example

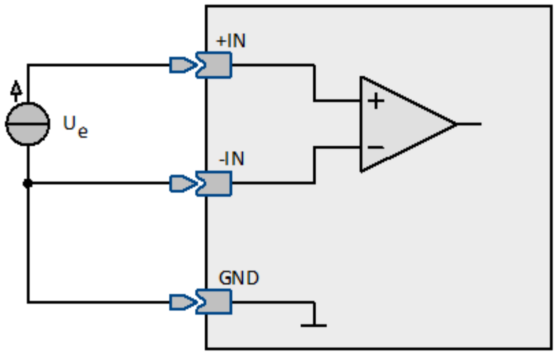
The measurement system is grounded. Thus, the input GND is at ground potential. If the voltage source itself is also grounded, it is referenced to the device ground. It isn't any problem if, as it may be, the ground potential at the voltage source deviates from the ground potential of the device itself by a few degrees. The maximum permitted common mode voltage must not be exceeded.

Note

In this case, the negative signal input -IN may not be connected to the ground contact GND in the device. Otherwise, a ground loop would result, through which interference could be coupled in.

In this case, a true differential (but not isolated!) measurement is performed.

8.3.4.1.3 Case 2: Voltage source without ground reference



The voltage source itself has no reference to the device's ground, but instead, its potential floats freely compared to the device ground. If a ground reference cannot be established, it's also possible to connect the negative signal input –IN to the ground contact GND.

Example

A voltage source which isn't grounded (e.g. a battery) and whose contacts have no connection to ground potential is measured. The measurement system is grounded.

Note

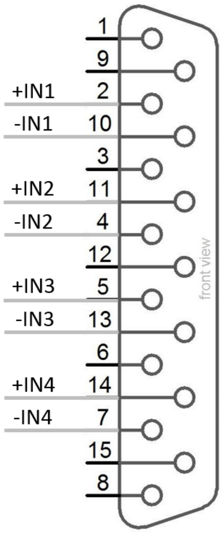
When –IN and GND are connected, be sure that the signal source's potential can actually be drawn to the device ground's potential without an appreciable current flowing. If the source can't be brought to that potential level (because it turns out to be at fixed potential after all), there is a risk of permanent damage to the amplifier. If IN and GND are connected, a Single ended measurement is performed. This isn't a problem unless a ground reference already existed.

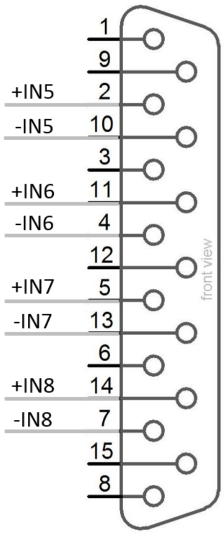
8.3.4.2 Bandwidth

The channels' **max. sampling rate** is 100 kSamples/s (10 µs sampling interval). The **analog bandwidth** (without digital low-pass filtering) is 14 kHz and with ICPU2-8: 48 kHz (-3 dB). In AC mode the lower cut off frequency is 0.37 Hz for all ranges ≤±10 V, else 1 Hz.

8.3.4.3 Connection

The terminal connections of the ICPU2-8 and of the ICPU2-8-70mHz (special version with 0.07 Hz cut-off frequency 386) are of the type BNC, see schematics 196. The ICPU2-8-**D**-70mHz is equipped with two DSUB-15 sockets:





Reference

Technical Specs 386

8.3.5 ICPU-16 Voltage, current-fed sensor

This model includes an internal ICP expansion, so that no external ICP-plug is necessary. The interconnections are of the type BNC. This means there is no possibility to measure current via the special DSUB terminal.

The ICPU-16 supports TEDS 104 (Transducer Electronic Data Sheet) as per IEEE 1451.4 Class I Mixed Mode Interface. According to this protocol, both TEDS data and analog signals are sent and received along the same line. Technical details of the ICPU-16 390.

8.3.5.1 Circuit diagrams

see ICPU2-8 196.

8.3.5.2 Voltage measurement

- Voltage: ±10 V to ±250 mV

The input impedance is 20 MΩ in DC and 1.82 MΩ in AC mode. When the device is deactivated, it drops to about 1 MΩ. With the AC coupled IEPE (ICP)-measurement the DC voltage is suppressed by a high pass filter of 0.37 Hz.

The input configuration is differential.

8.3.5.2.1 Case 1: Voltage source with ground reference

see ICPU2-8 196.

8.3.5.2.2 Case 2: Voltage source without ground reference

see ICPU2-8 196.

8.3.5.3 Bandwidth

The channels' max. sampling rate is 20 kSamples/s (50 µs sampling interval). The analog bandwidth (without digital low-pass filtering) is 6.6 kHz (-3 dB). In AC mode the lower cut off frequency is 0.37 Hz.

8.3.5.4 Connection

The interconnections are of the type BNC.

8.3.6 ISO2-8(-16)/-2T Isolated: voltage, current (20 mA), temperature, IEPE/ICP

The isolated voltage channels of the module ISO2-8(-16) have their **own isolated amplifier**, operated in the voltage mode.

Along with voltage measurement, current measurement via a shunt plug and temperature measurement via temperature plug ACC/DSUBM-T4 can be performed. The use of the ICP-expansion plug 260 is also possible, however it **cancels the isolation**.

Parameter	Value	Remarks
Measurement modes DSUB	voltage measurement current measurement thermocouples, RTD (PT100) IEPE/ICP (current fed sensors)	voltage plug ACC/DSUBM-U4 current plug ACC/DSUBM-I4 thermo plug ACC/DSUBM-T4 IEPE/ICP expansion plug ACC/DSUB-ICP4
Measurement modes LEMO	voltage measurement current measurement RTD (PT100)	single end (internal shunt)
Measurement mode CRFX/ISO2-8(-16)**-2T**	temperature measurement thermocouple measurement type K	

Reference

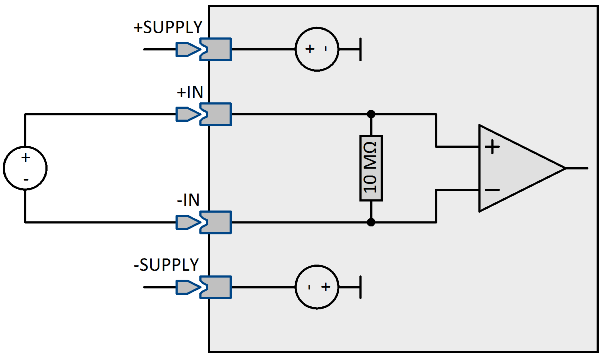
- Technical details of the ISO2-8 392
- Technical details of the ISO2-8(-16)-2T 398

8.3.6.1 Voltage measurement

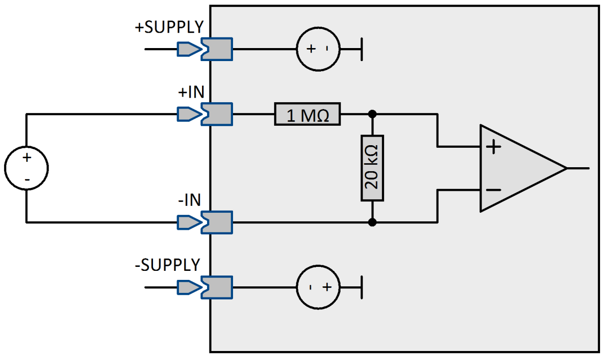
- Voltage: ±60 V to ±5 V with divider
- Voltage: ±2 V to ±50 mV without divider

An **internal pre-divider** is in effect in the voltage ranges ±60 V to ±5 V. In this case, the differential input impedance is 1 MΩ, in all other ranges 10 MΩ. If the device is de-activated, the impedance is 1 MΩ.

The inputs are DC-coupled. The differential response is achieved by means of the isolated circuiting.



configuration for voltages <5 V



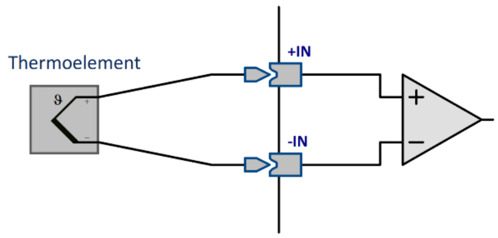
configuration for voltages >2 V with internal divider

8.3.6.2 Temperature measurement

The input channels are designed for measurement with **thermocouples and PT100**-sensors (RTD, platinum resistance thermometers). Any combinations of the two sensor types can be connected.A detailed description of temperature measurement is presented here 127.

Temperature measurement is performed with the imc plug ACC/DSUBM-T4 129. Thermocouples can alternatively be captured using two-pin thermo-plugs.

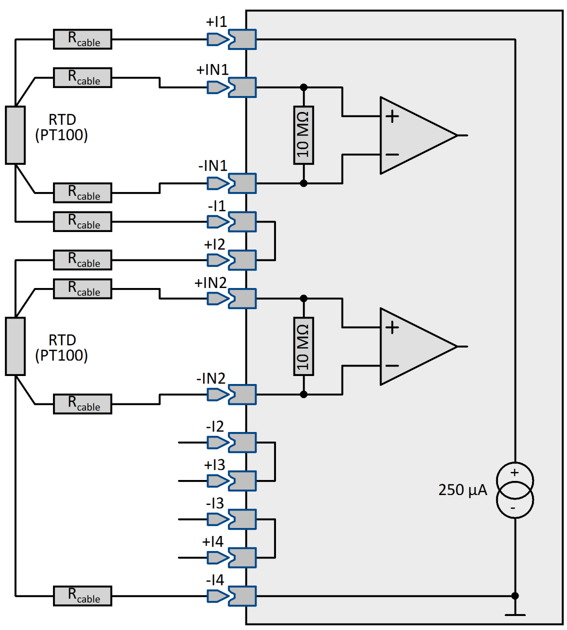
8.3.6.2.1 Thermocouple measurement



The common thermocouple types make use of linearization by characteristic curve.

The cold-junction compensation necessary for thermocouple measurements is built into the imc thermo-plug (ACC/DSUBM-T4 129).

8.3.6.2.2 PT100 (RTD) - Measurement



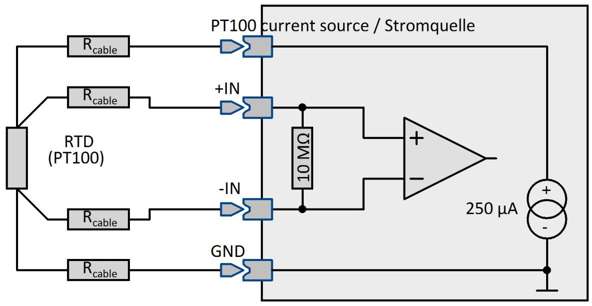
Along with thermocouples, **PT100** sensors can also be connected, in **4-wire configuration**. An extra reference current source feeds an entire chain of up to four serially connected sensors.

The imc-thermo plugs (ACC/DSUBM-T4) 499 has 4 contacts which are available for the purpose of 4-wire measurements. These current-supply contacts are internally wired so that the reference current loop is automatically closed when all four PT100 units are connected. This means that the –I contact of one channel is connected to the +I contact of the next channel (see the sketch imc thermo plug 129). Therefore, for channels not connected to a PT100 sensor, a wire jumper must be used to connect the respective "+Ix" and "-Ix" contacts.

Normal DSUB-15 plugs don't come with these extra "auxiliary contacts" for 4-wire connections. This means that you must take steps to ensure that the reference current flows through all PT100 units. Only "+I1" (DSUB(9), Terminal K1, "(RES.)") and "–I4" (DSUB(6), Terminal K10, "(GND)") are available as a contact or DSUB-15 pin, respectively. The connections "–I1 = +I2", "–I2 = +I3", and "–I3 = +I4" must be wired externally.

PT100 sensors are fed from the module and don't have or even require an arbitrarily adjustable reference voltage in the sense of an externally imposed common mode voltage. It is also not permissible to set one up, for instance by grounding one of the four connection cables: the PT100 reference current source is referenced to the device's frame (CHASSIS), and is thus not isolated.

Using the ISO2-8 with **LEMO connections** (**ISO2-8-L**) the following schematic could be helpful:



Each connected sensor is feed individually form a separate reference voltage supply.

8.3.6.3 Current fed sensors

At the DSUB-15 sockets, a permanent 5 V supply voltage for external sensors 274 is available. This voltage source is grounded to the measurement device's frame. The description of measurement with ICP sensors is presented here. 260 For the measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) 260.

Note ISO2-8 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

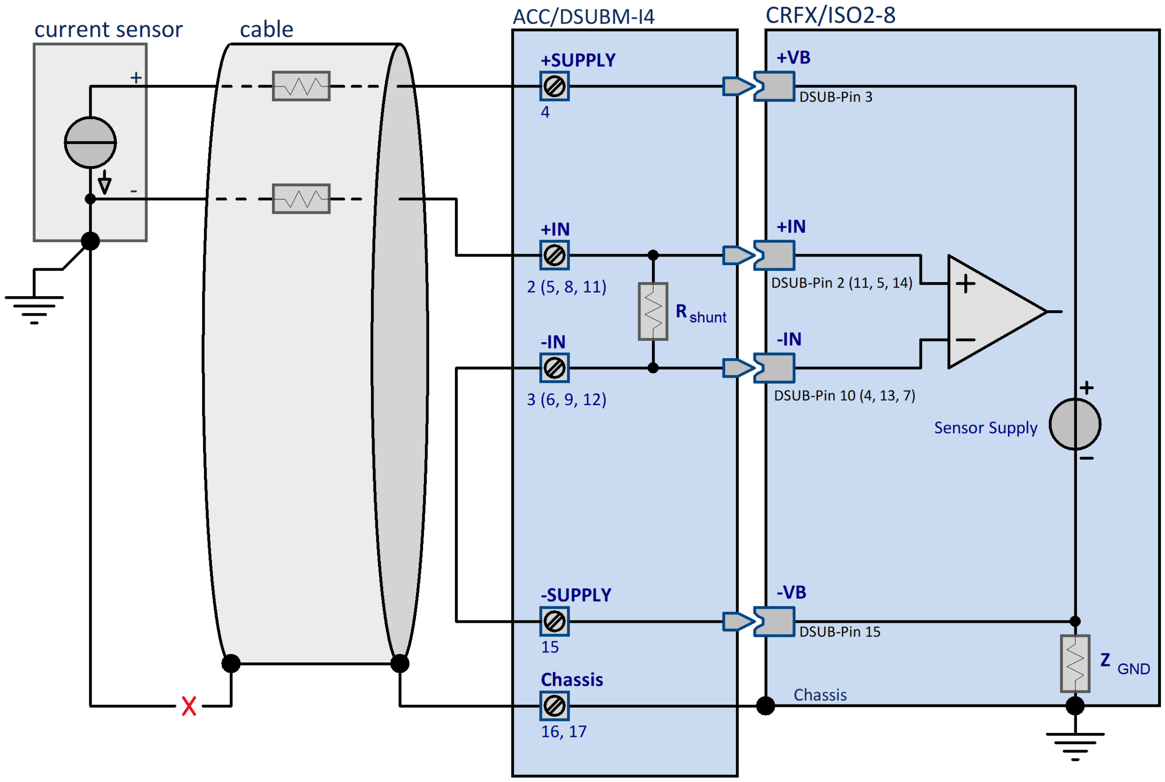
When using the two channel IEPE plug: ACC/DSUBM-ICP2I-BNC(-S/-F) in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used.

8.3.6.4 Current measurement

- Current: ±40 mA, ±20 mA, ±10 mA ... ±1 mA in 6 ranges

ISO2-8 amplifier with **DSUB-15**:

A special plug (ACC/DSUBM-I4) with a built-in **shunt** (50 Ω) is needed for current measurement. For current measurement with the special shunt-plugs ACC/DSUBM-I4, inputs ranging only up to max. ±50 mA (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.



current measurement

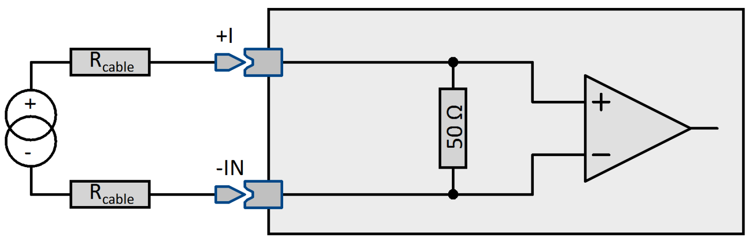
Note

Since this procedure is a voltage measurement at the shunt resistor, **voltage measurement** must also be set in the imc Software.

The **scaling factor** is entered as 1/R and the unit as A (e.g. 0.02 A/V = 1/50 Ω).

8.3.6.5 Current measurement with internal shunt

ISO2-8-L: ISO2-8 variant with **LEMO sockets**



8.3.6.6 Bandwidth

The channels' **max. sampling rate** is 100 kHz (10 µs). The **analog bandwidth** (without digital low-pass filtering) is 11 kHz (-3 dB).

8.3.6.7 Connection

Reference

Please find here DSUB-15 plugs, on page 497 or LEMO plugs, on page 504.

8.3.7 ISOF-8: voltage, current (20 mA), temperature, IEPE/ICP

The isolated voltage channels of the module ISOF-8 have their **own isolated amplifier**, operated in the voltage mode. Along with voltage measurement, current measurement via a shunt plug and temperature measurement via temperature plug ACC/DSUBM-T4 can be performed. The use of the ICP-expansion plug 260 is also possible, however it **cancels the isolation**.

Reference

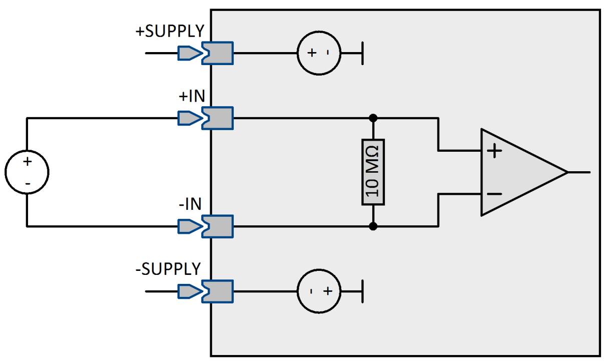
- Technical details of the ISOF-8 400
- Please find here DSUB-15 plugs, on page 497 or LEMO plugs, on page 504

8.3.7.1 Voltage measurement

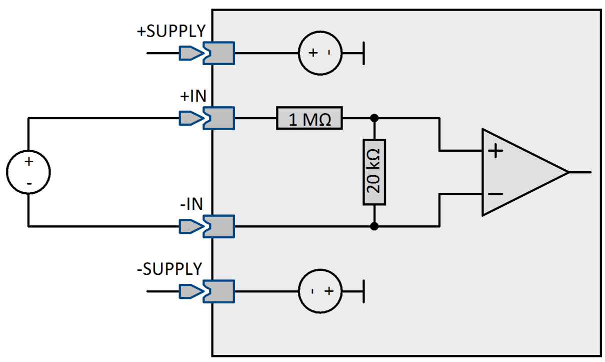
- Voltage: ±60 V to ±5 V with divider
- Voltage: ±2 V to ±25 mV without divider

An internal pre-divider is in effect in the voltage ranges ±60 V to ±5 V. In this case, the differential input impedance is 1 MΩ, in all other ranges 10 MΩ. If the device is de-activated, the impedance is always 1 MΩ.

The inputs are DC-coupled. The differential response is achieved by means of the isolated circuiting.



configuration for voltages <5 V



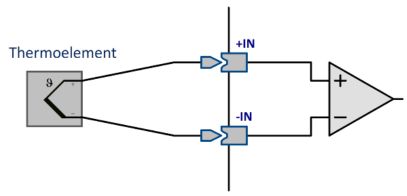
configuration for voltages >5 V with internal divider

8.3.7.2 Temperature measurement

The input channels are designed for measurement with **thermocouples and PT100**-sensors (RTD, platinum resistance thermometers). Any combinations of the two sensor types can be connected.A detailed description of temperature measurement is presented here 127.

Temperature measurement is performed with the imc plug ACC/DSUBM-T4 129. Thermocouples can alternatively be captured using two-pin thermo-connectors.

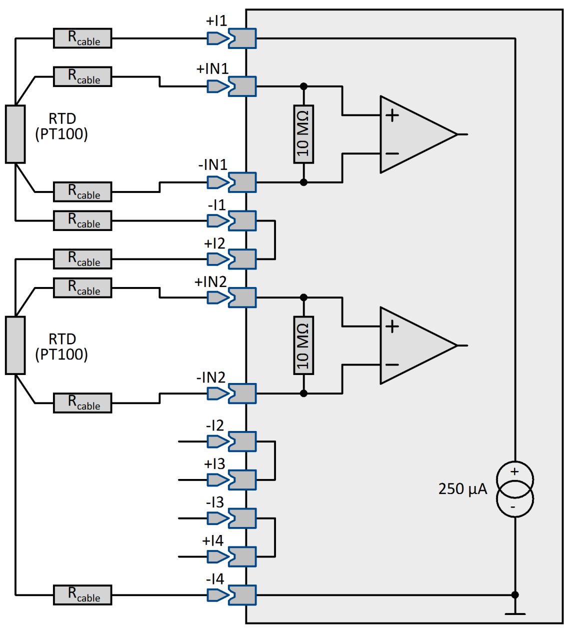
8.3.7.2.1 Thermocouple measurement



The common thermocouple types make use of linearization by characteristic curve.

The cold-junction compensation necessary for thermocouple measurements is built into the imc thermo-plug (ACC/DSUBM-T4 129).

8.3.7.2.2 PT100 (RTD) - Measurement



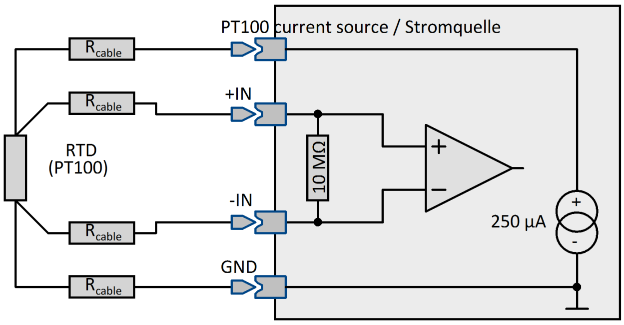
Along with thermocouples, **PT100** sensors can also be connected, in **4-wire configuration**. An extra reference current source feeds an entire chain of up to four serially connected sensors.

The imc-thermo plug (ACC/DSUBM-T4) 499 has 4 contacts which are available for the purpose of 4-wire measurements. These current-supply contacts are internally wired so that the reference current loop is automatically closed when all four PT100 units are connected. This means that the –I contact of one channel is connected to the +I contact of the next channel (see the sketch imc thermoplug 129). Therefore, for channels not connected to a PT100 sensor, a wire jumper must be used to connect the respective "+Ix" and "-Ix" contacts.

Normal DSUB-15 plugs don't come with these extra "auxiliary contacts" for 4-wire connections. This means that you must take steps to ensure that the reference current flows through all PT100 units. Only "+I1" (DSUB(9), Terminal K1, "(RES.)") and "–I4" (DSUB(6), Terminal K10, "(GND)") are available as a contact or DSUB-15 pin, respectively. The connections "–I1 = +I2", "–I2 = +I3", and "–I3 = +I4" must be wired externally.

PT100 sensors are fed from the module and don't have or even require an arbitrarily adjustable reference voltage in the sense of an externally imposed common mode voltage. It is also not permissible to set one up, for instance by grounding one of the four connection cables: the PT100 reference current source is referenced to the device's frame (CHASSIS), and is thus not isolated.

Using the ISOF-8 with **LEMO connections** (**ISOF-8-L**) the following schematic could be helpful:



Each connected sensor is feed individually form a separate reference voltage supply.

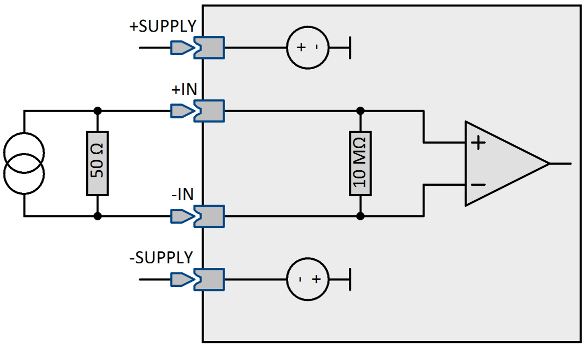
8.3.7.3 Current fed sensors

At the DSUB-15 sockets, a permanent 5 V supply voltage for external sensors 274 is available. This voltage source is grounded to the measurement device's frame. The description of measurement with ICP sensors is presented here. 260 For the measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) 260.

8.3.7.4 Current measurement

- Current: ±40 mA, ±20 mA, ±10 mA in 3 ranges

A special plug: **ACC/DSUBM-I4** with a built-in shunt (50 Ω) is needed for current measurement.



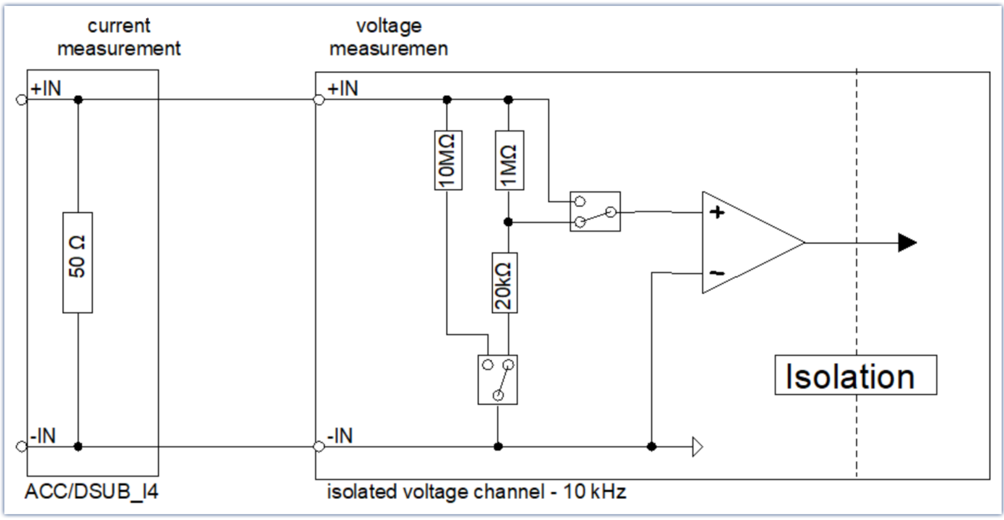
For current measurement with the special shunt-plugs ACC/DSUB(M)-I4, inputs ranging only up to **max. ±25 mA** (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.

Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc software interface.

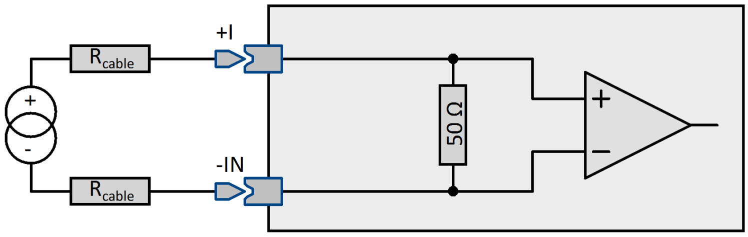
The scaling factor is entered as 1/R and the unit as A (e.g. 0.02 A/V = 1/50 Ω).

Input stage block schematic



8.3.7.5 Current measurement with internal shunt

ISOF-8-L: ISOF-8 variant with **LEMO plug**



8.3.8 LV-16 Voltage, Current (20 mA), IEPE/ICP

The LV-16 comes with 16 differential, non-isolated input channels which can be used for measuring voltage 209. In addition, current 209 measurement by means of a shunt plug and the use of an IEPE (ICP) 209-expansion plug are provided for. The channels each come with 5th order ("analog", fixed-configuration) anti-aliasing filters, whose cutoff frequency is 6.6 kHz.

Technical details: LV-16 Voltage, Current (20 mA), IEPE/ICP 407

8.3.8.1 Voltage measurement

- Voltage ranges: ±250 mV, ±1 V, ±2.5 V, ±10 V

The input impedance is 10 MΩ referenced to system ground or 20 MΩ differential. The inputs are DC-coupled. The corresponding connection terminal is designated ACC/DSUBM-U4 497

8.3.8.2 Current measurement

- Current ranges: ±5 mA, ±20 mA, ±50 mA

For current measurements, a special plug with a built-in **shunt** (50 Ω) is needed ACC/DSUBM-I4 497.

For current measurement with the special shunt-plugs ACC/DSUBM-I4, input ranging only up to max. ±50 mA (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.

Note

Configuration is carried out in the voltage mode, but an appropriate scaling factor is entered which allows direct display of current values (0.02 A/V = 1/50 Ω).

8.3.8.3 Current fed sensors

At the DSUB-15 sockets, a permanent 5 V supply voltage for external sensors 274 is available. This voltage source is grounded to the measurement device's frame. The description of measurement with ICP sensors is presented here. 260 For the measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) 260.

8.3.8.4 Bandwidth

The channels' **max. sampling rate** is 20 kHz (50 µs sampling interval). The **analog bandwidth** (without digital low-pass filtering) is 6.6 kHz (-3 dB).

8.3.8.5 Connection

The LV-16 module is normally equipped with four DSUB-15 connectors (4 channels / connector) and occupies two module slots in the system.

Pin configuration of the DSUB-15 497.

8.3.9 LV3-8: Voltage, Current (20 mA), IEPE/ICP

The LV2-8, LV3-8 is a universal amplifier for 8 channels, respectively, for voltage and current measurement tasks (20 mA), with sampling rates of up to 100 kHz per channel. The LV3-8 is a advanced development of LV2-8 and differ in the bandwidth (LV2-8: 14 kHz; LV3-8: 48 kHz). Unless any limitations are mentioned, the following description also applies to the LV3-8.

In particular, the high bandwidth of 48 kHz, the input ranges from 50 V to 5 mV and the low signal noise predestine this device for high-performance voltage measurements.

Reference

8.3.9.1 Voltage measurement

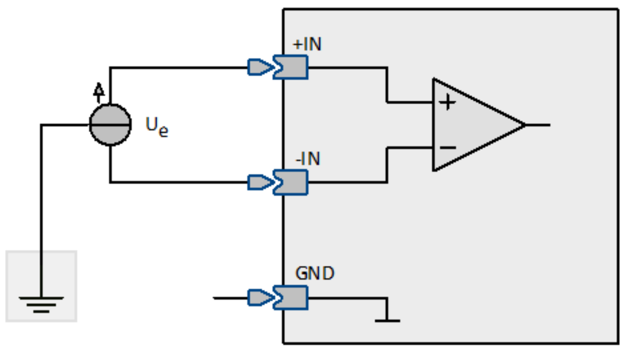
- Voltage: ±5 mV to ±50 V

In the voltage ranges ±50 V and ±20 V, a voltage divider is in operation; the resulting input impedance is 1 MΩ. In the voltage ranges ±10 V to ±5 mV, by contrast, the input impedance is 20 MΩ. When the device is deactivated, it drops to about 1 MΩ.

The input configuration is differential and DC-coupled.

8.3.9.1.1 Voltage source with ground reference

The voltage source itself already is referenced to the device's ground. The voltage source is at the same potential as the device ground.



Example

The unit is grounded. Thus, the input GND is at ground potential. If the voltage source itself is also grounded, it is referenced to the device ground.

It isn't any problem if, as it may be, the ground potential at the voltage source deviates from the ground potential of the device itself by a few degrees. The maximum permitted common mode voltage must not be exceeded.

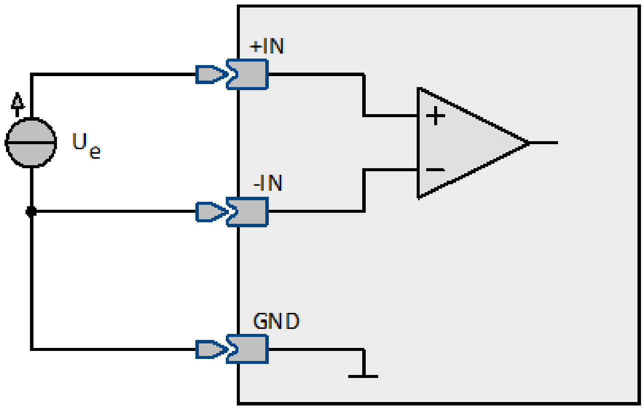
Note

In this example, the negative signal input -IN may not be connected to the ground contact GND in the device. Otherwise, a ground loop would result, through which interference could be coupled in.

In this case, a true differential (but not isolated!) measurement is performed.

8.3.9.1.2 Voltage source without ground reference

The voltage source itself has no reference to unit's ground, but instead, its potential floats freely vis-à-vis the device ground. If a ground reference cannot be established, it's also possible to connect the negative signal input –IN to the ground contact GND.



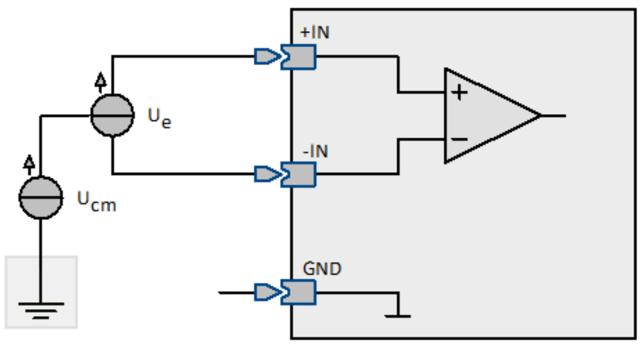
Example

A voltage source which isn't grounded (e.g. a battery) and whose contacts have no connection to ground potential is measured. The device is grounded.

Note

When –IN and GND are connected, be sure that the signal source's potential can actually be drawn to the device ground's potential without an appreciable current flowing. If the source can't be brought to that potential level (because it turns out to be at fixed potential after all), there is a risk of permanent damage to the amplifier. If IN and GND are connected, a single end measurement is performed. This isn't a problem unless a ground reference already existed.

8.3.9.1.3 Voltage source at other, fixed potential



In the input ranges <20 V, the common mode voltage Ucm must lie within the range ±10 V. It is reduced by one-half of the input voltage.

8.3.9.1.4 Voltage measurement: With taring

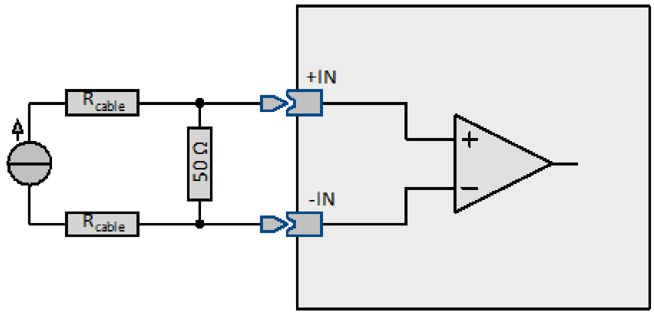
With voltage measurement, it's possible to tare a zero offset to restore correct zero. For this purpose, select the menu item *Settings -> Amplifiers (balance etc.)...*, and on the screen's index card *Common*, under *Balancing*, select the option *Tare* for the desired channel. The input range correspondingly is reduced by the amount of the zero adjustment. If the initial offset is so large that it's not possible to adjust it by means of the device, a larger input range must be set.

8.3.9.2 Current measurement

- Current: e.g. ±50 mA to ±1 mA

For current measurement, the DSUB plug ACC/DSUBM-I4 must be used. This plug is not included in the standard package. It contains a 50 Ω shunt.

In addition, voltage can be measured via an externally connected shunt. The appropriate scaling must be set in the user interface. The value 50 Ω is only a suggestion. The resistance should be sufficiently precise. Make note of the shunt's power consumption.



In this configuration, too, the maximum common mode voltage must be located within the range: ±10 V. This can generally only be assured if the current source is also already referenced to ground.

If the current source has no ground reference, there is a danger of the unit suffering unacceptably high overvoltage. It may be necessary to create a ground reference, for instance, by grounding the current source.

Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc operating software.

The scaling factor is entered as 1/R and the unit as A (0.02 A/V = 1/50 Ω).

8.3.9.3 Current fed sensors

At the DSUB-15 sockets, a permanent 5 V supply voltage for external sensors 274 is available. This voltage source is grounded to the measurement device's frame. The description of measurement with ICP sensors is presented here. 260 For the measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) 260.

Note LV3-8 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

When using the two channel ICP plug: ACC/DSUBM-ICP2I-BNC(-S/-F) in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used.

8.3.9.4 Bandwidth

The **max. sampling rate:** 100 kSamples/s (10 µs sampling interval) and **analog bandwidth**: 48 kHz (-3 dB).

8.3.9.5 Connection

Pin configuration of the DSUB-15 497 or the LEMO plug 504

8.3.10 OSC-16 Isolated: Voltage, current (20 mA), temperature

Parameter	Value	Remarks
Inputs	16	
Measurement modes OSC-16	 voltage measurement current measurement thermocouples, RTD (PT100)	recommended plug: ACC/DSUBM-U4 ACC/DSUBM-I4 ACC/DSUBM-T4

The OSC-16 has 16 isolated and differential input channels. They have enhanced isolation properties, with channel-to-channel isolation and common mode voltage of up to 60 V (with a test voltage of 300 V).

Highlights:

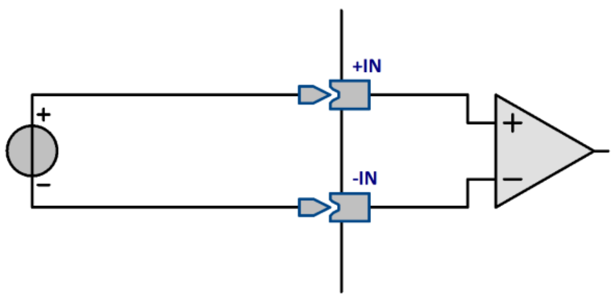
- Ideally for measurement with passiv sensors
- Optimal aliasing-free noise suppression of even 50 Hz interference
- Supports imc Plug & Measure

The OSC-16 is based on a scanner concept with block isolation, in which a multiplexer is combined with an isolated measuring amplifier. This scheme is very well suited to measure passive sensors. Application in conjunction witch active source and active temperature calibration devices in particular may impose particular limitations that are discussed in detail below.

Reference

Technical details OSC-16 415

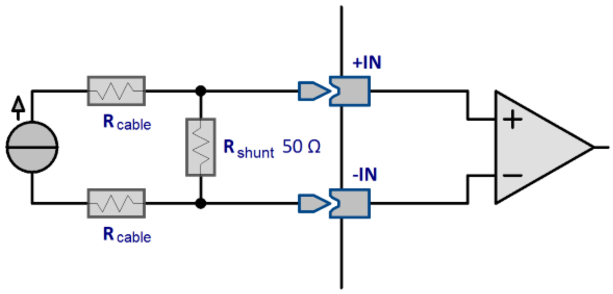
8.3.10.1 Voltage measurement



- ±60 V to ±50 mV in eleven ranges

The (static) input impedance in the ranges ≤±2 V is 10 MΩ, otherwise 1 MΩ. The input configuration is differential and DC-coupled. The standard connector is used for voltage measurement (ACC/DSUBM-U4); the thermo-connector (ACC/DSUBM-T4) is also supported. The connection schemes for isolated and non-isolated signal sources are indistinguishable.

8.3.10.2 Current measurement



- ±40 mA to ±1 mA in six ranges

relevant particularly for sensors with 0 mA to 20 mA or 4 mA to 20 mA output

For current measurement, a shunt is built into the imc shunt-plug (ACC/DSUBM-I4)

For current measurement with the special shunt-plugs ACC/DSUBM-I4, input ranging only up to max. ±50 mA (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.

Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc software.

The scaling factor is entered as 1/R and the unit as A (0.02 A/V = 1/50 Ω).

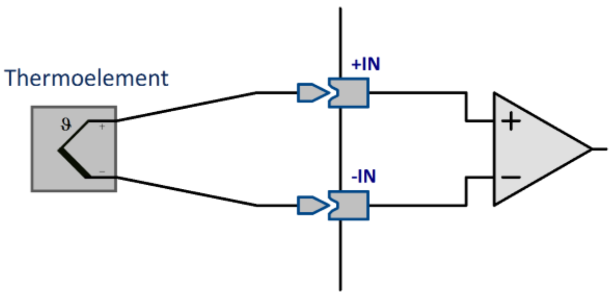
8.3.10.3 Temperature measurement

The input channels are designed for measurement with thermocouples and PT100-sensors. Any combinations of the two sensor types can be connected.

Reference

- For a full description about temperature measurement see here. 127
- PT100 or thermocouples can be measured with the imc plug ACC/DSUBM-T4 129. Alternatively thermocouples can be recorded with two pin thermo plugs.

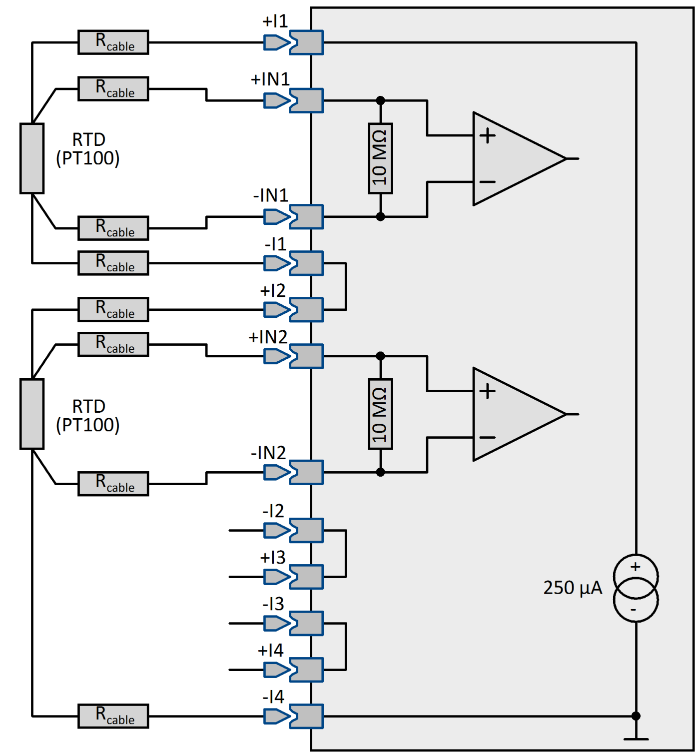
8.3.10.3.1 Thermocouple measurement



The common thermocouple types make use of linearization by characteristic curve.

The cold-junction compensation necessary for thermocouple measurements is built into the imc thermo-connector (ACC/DSUBM-T4 128).

8.3.10.3.2 PT100 (RTD) - Measurement



Along with Along with thermocouples, **PT100** sensors can also be connected, in **4-wire configuration**. An extra reference current source feeds an entire chain of up to four serially connected sensors.

The imc thermo plug has four terminals which are offered for a 4-wire measurement. These current-supply contacts are internally wired so that the reference current loop is automatically closed when all four PT100 units are connected. The -I contact of one channel is wired to the +I contact of the next channel, see the schematic of the imc thermo plug 129.

Normal DSUB-15 plugs don't come with these extra auxiliary contacts for 4-wire measurement. Make sure that the reference current flows through all PT100 measuring points. Only +I1 and -I4 are available as a contact or DSUB-15 pin. The connections -I1 = +I2, -I2 = +I3, and -I3 = +I4 must be wired externally.

PT100 sensors are fed from the module and don't have or even require an arbitrarily adjustable reference voltage in the sense of an externally imposed common mode voltage. It is also not permissible to set one up, for instance by grounding one of the four connection cables: the PT100 reference current source is referenced to the device's frame (CHASSIS), and is thus not isolated.

8.3.10.4 Connection

DSUB-15 plugs (CRC/OSC-16, CRSL/OSC-16-D), LEMO-plugs (CRSL/OSC-16-L) or thermocouple sockets type-K (CRC/OSC-16-T) are available.

Pin configuration of the DSUB-15 497.

8.3.11 SC2-32 Voltage, Current (20 mA), IEPE/ICP

The module SC2-32 comes with 32 differential, non-isolated input channels which can be used for measuring voltage. In addition, current measurement by means of a shunt plug and the use of an ICP-expansion plug are provided for.

The module is built as a "scanner" which enables the maximum aggregate sampling rate of 400 kHz to be distributed among the amount of activated channels (up to 32). The maximum sampling rate for a single channel can extend up to 100 kHz.

The channels each come with 5th order ("analog", fixed-configuration) anti-aliasing filters, whose cutoff frequency is 28 kHz (-3 dB). This means that for a channel sampled at 100 kHz, nearly aliasing-free measurement in the sense of the Sampling Theorem is ensured.

For low channel sampling rates (esp. when many channels are active), appropriately adapted (digital) low-pass filter are implemented. This procedure then no longer stringently adheres to the condition for the Sampling Theorem, since the cutoff frequency of the "primary" analog filter (28 kHz) is not adapted to the lower channel sampling rate; however, the properties of this affordable module are perfectly adequate for a number of applications.

- Input ranges: ±250 mV, ±1 V, ±2,5 V, ±10 V
- Analog bandwidth: 28 kHz (-3 dB); 20 kHz (-0,1 dB)
- Maximum aggregate sampling rate: 400 kHz
- High sampling rate per channel: 100 kHz for voltage channels
- Impedance: 20 MΩ differential
- Supports imc Plug & Measure

Along with voltage measurement, current measurement via a shunt plug, temperature measurement and the use of an ICP expansion plug are all provided for.

Technical details of the SC2-32 419.

8.3.11.1 Voltage measurement

- Voltage ranges: ±250 mV, ±1 V, ±2,5 V, ±10 V

The input impedance is 10 MΩ referenced to system ground or 20 MΩ differential. The inputs are DC-coupled. The corresponding connection terminal is designated ACC/DSUBM-U4.

8.3.11.2 Current measurement

- Current ranges: ±5 mA, ±20 mA, ±50 mA

For current measurements, a special plug with a built-in shunt (50 Ω) is needed (ACC/DSUBM-I4). Configuration is carried out in the voltage mode, but an appropriate scaling factor is entered which allows direct display of current values (20 mA/V = 1/50 Ω).

Note

For current measurement with the special shunt-plugs ACC/DSUBM-I4, input ranging only up to max. ±50 mA (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.

8.3.11.3 TEDS

The SC2-32 is supporting TEDS. The appropriate plugs are: for voltage ACC/DSUBM-TEDS-U4, for current ACC/DSUBM-TEDS-I4.

The DSUB 37-variant provides also the 5 V-supply - but there is no 37-pin plug for TEDS or current measurement available from imc.

8.3.11.4 External +5 V supply voltage

At the DSUB-15 plugs, there is a 5 V supply voltage available for external sensors or for the ICP-expansion plug. This source is not isolated; its reference potential is identical to the overall system's ground reference.

The +5 V supply outputs are electronically protected internally against short-circuiting and can each be loaded up to max. 160 mA (short-circuit limiting: 200 mA). The sensor's reference potential, in other words its supply-ground connection is the terminal "GND".

8.3.11.5 Optional sensor supply module

The SC2-32 can be enhanced with the sensor supply unit SUPPLY, which provides an adjustable supply voltage for active sensors.

The supply outputs are electronically protected internally against short circuiting to ground. The reference -potential, in other words the sensor's supply ground contact, is the terminal GND.

The technical specification of the SUPPLY 469.

8.3.11.6 Connection

The SC2-32 module is normally equipped with eight DSUB-15 plugs (4 channels / plug) and thus occupies 4 module slots in the system.

In custom devices, modules having two DSUB-37 connections can also be used.

In contrast to the normal configuration, in the DSUB-15 plugs belonging to the SC2-32 model, Pin1 is NOT connected to the device ground (CHASSIS), but to the DSUB-plug housing itself. When the imc terminal plug is used, this makes no difference, since in such cases the respective "CHASSIS"-terminals are connected appropriately. This must only be taken into account when using personally assembled, commercially available DSUB-plugs (for example, for connecting the cable shielding).

Pin configuration DSUB-15 497-plug and variety 8/2 502.

8.4 Universal measurement amplifier

Order Code	CRFX	CRXT	CRC CRSL	Channels per module	Remarks
	width	width	slots needed		
UNI2-8 218	61.62 mm	64.5 mm	2	8	voltage, current (20 mA), temperature, strain gauges, IEPE/ICP
UNI-4 240	43.3 mm	34 mm	2	4	**isolated:** voltage, current (20 mA), temperature, strain gauges, IEPE/ICP

8.4.1 UNI2-8: Voltage, Current (20 mA), Temperature, Bridge, IEPE/ICP

The UNI2-8 is a universal measurement amplifier with sampling rates of up to 100 kHz per channel. They are especially well suited to frequently changing measurement tasks. Practically every sensor- or signal type can be connected directly to any of the measurement amplifier's all-purpose channels. The input channels are differential and equipped with per-channel signal conditioning including filters.

To supply external sensors or bridges the module is equipped with a sensor supply 238 with an adjustable supply. Supports TEDS 104 (Transducer Electronic Data Sheets).

The measurement inputs whose terminals are DSUB plugs (ACC/DSUBM-UN2 499) are for voltage, current, bridge, PT100 and thermocouple measurements. In addition the use of an IEPE/ICP-expansion plug is possible. They are non-isolated differential amplifiers. They share a common voltage supply for sensors and measurement bridges.In the LEMO model, there is no thermocouple measurement or capture of IEPE/ICP sensor data.

Technical details of the UNI2-8 430.

8.4.1.1 Voltage measurement

- Voltage: ±50 V to ±5 mV; DSUB-plug: ACC/DSUBM-UNI2

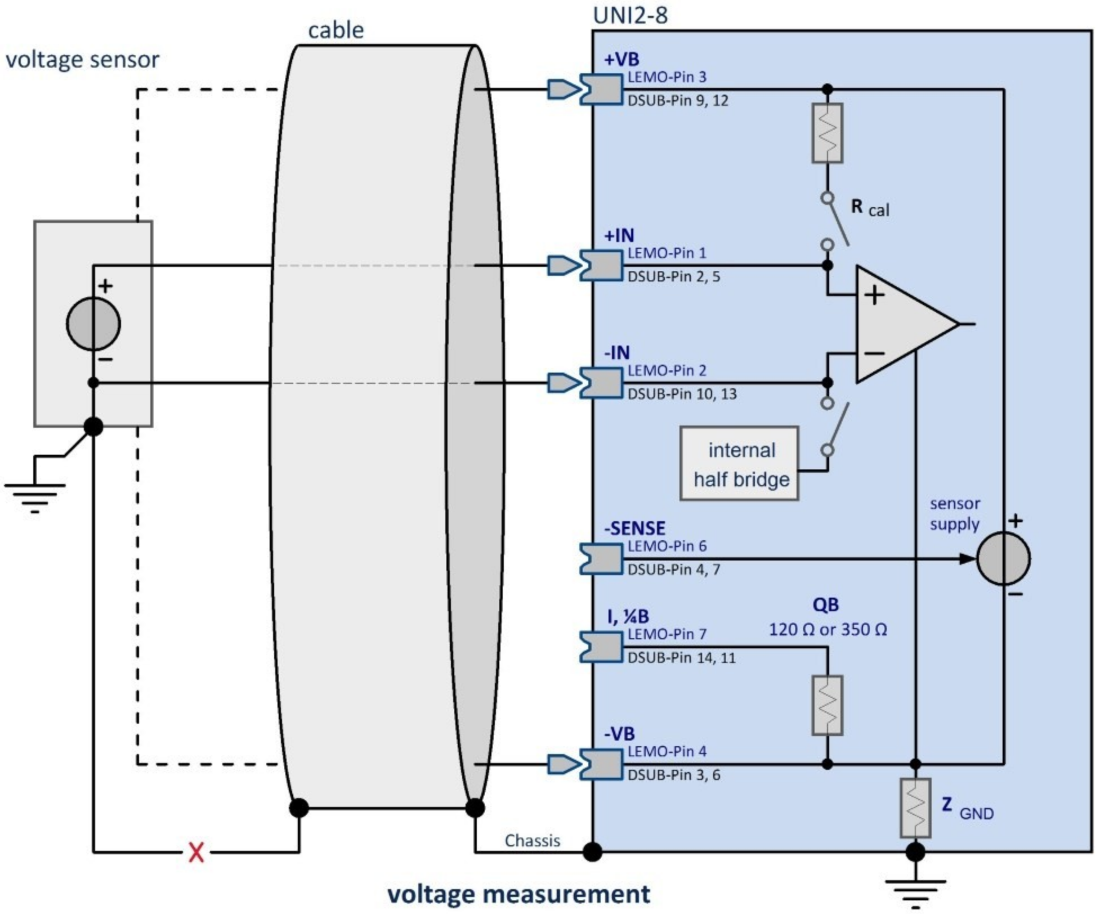
Within the voltage measurement ranges ±50 V and ±25 V, a voltage divider is in effect; the resulting input impedance is 1 MΩ.

By contrast, in the voltage ranges ±10 V and ±5 mV, the input impedance is 20 MΩ. For the deactivated device, the value is approx. 1 MΩ.

In the input ranges <25 V, the common mode voltage[1] must lie within the ±10 V range. The range is reduced by half of the input voltage. The input configuration is differential and DC-coupled.

1 The common mode voltage is the arithmetic mean of the voltages at the inputs +IN and -IN, referenced to the device ground. For instance, if the potential to ground is +10 V at +IN and +8 V at -IN, the common mode voltage is +9 V.

8.4.1.1.1 Voltage source with ground reference



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The voltage source itself already has a connection to the device's ground. The potential difference between the voltage source and the device ground must be fixed.

Example

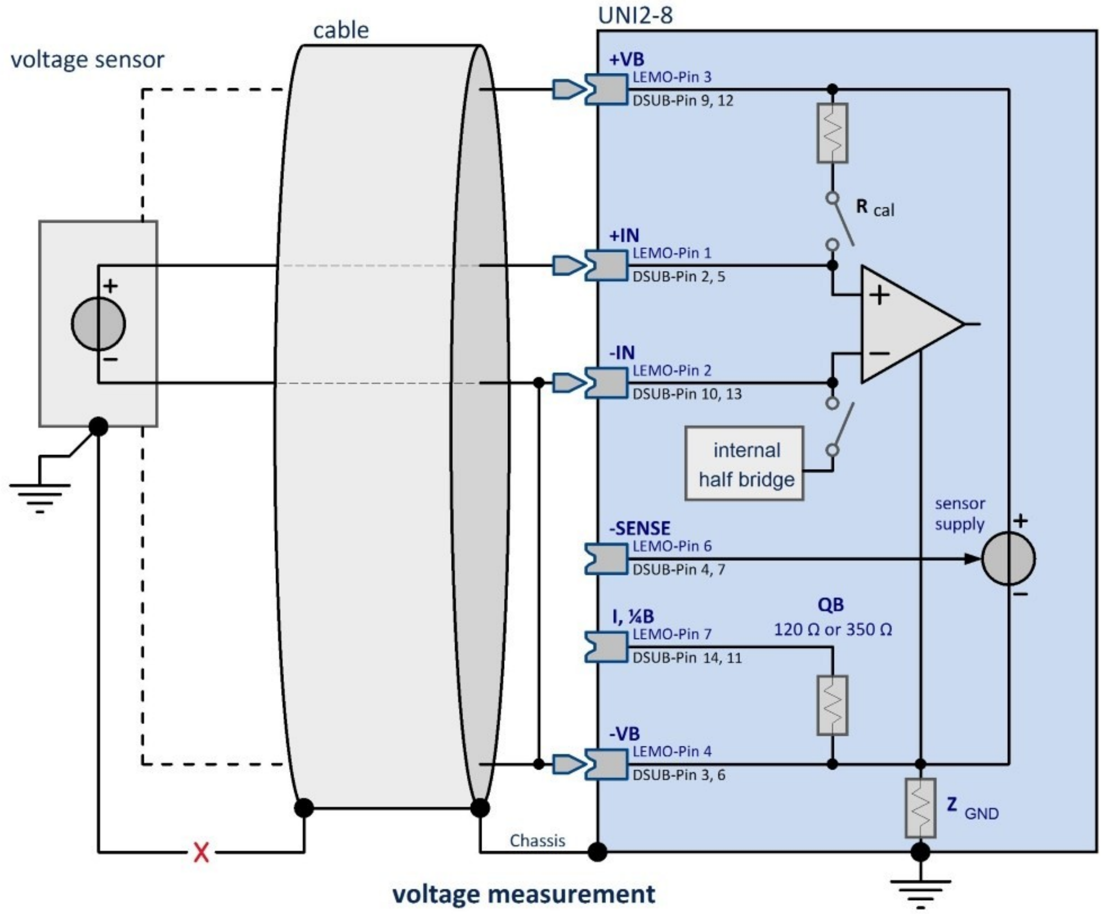
The device is grounded. Thus, the input -VB is also at ground potential. If the voltage source itself is also grounded, it's referenced to the device ground. It doesn't matter if the ground potential at the voltage source is slightly different from that of the device itself. But the maximum allowed common mode voltage must not be exceeded.

Warning

In this case, the negative signal input -IN may not be connected with the device ground -VB. Connecting them would cause a ground loop through which interference could be coupled in.

In this case, a genuine differential (but not isolated!) measurement is carried out.

8.4.1.1.2 Voltage source without ground reference



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The voltage source itself is not referenced to the amplifier ground but is instead isolated from it. In this case, a ground reference must be established. One way to do this is to ground the voltage source itself. Then it is possible to proceed as for Voltage source with ground reference 219. Here, too, the measurement is differential. It is also possible to make a connection between the negative signal input and the device ground, in other words to connect -IN and -VB.

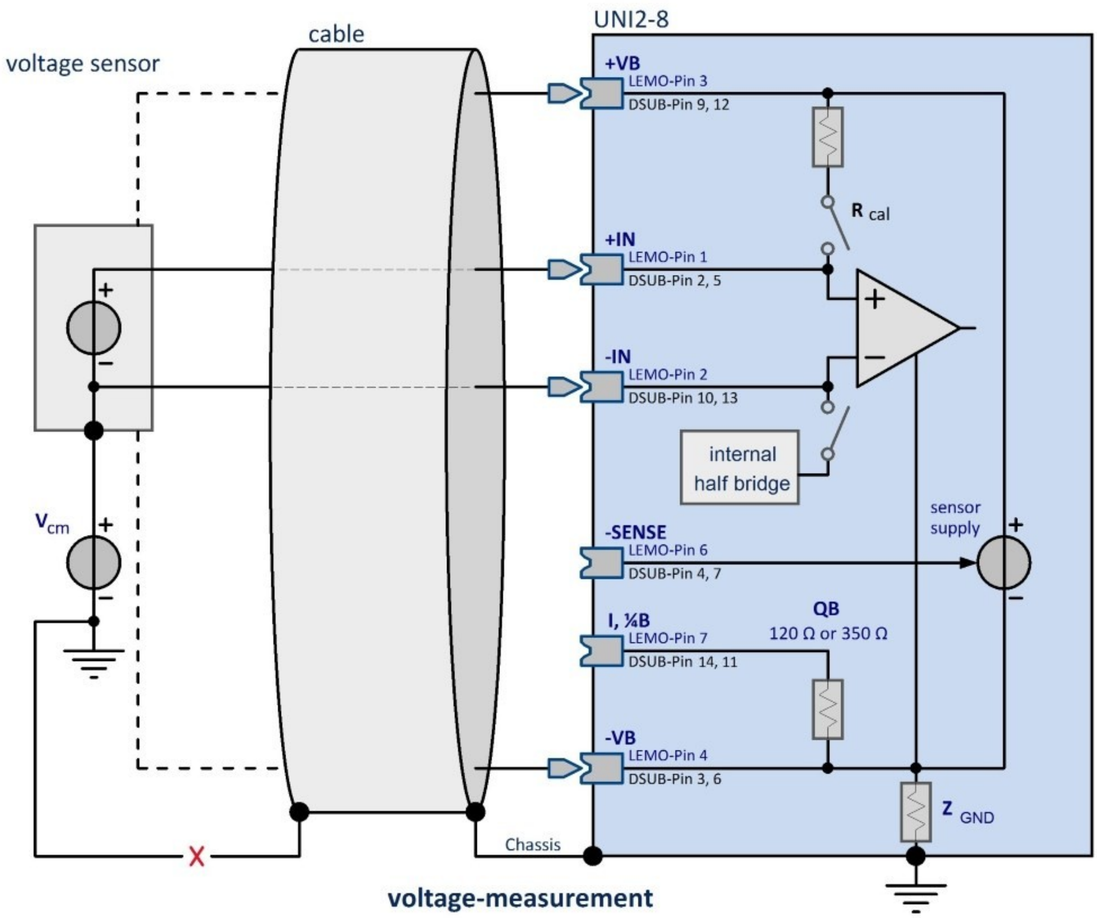
Example

An ungrounded voltage source is measured, for instance a battery whose contacts have no connection to ground. The device module is grounded.

Warning

If -IN and -VB are connected, care must be taken that the potential difference between the signal source and the device doesn't cause a significant compensation current. If the source's potential can't be adjusted (because it has a fixed, overlooked reference), there is a danger of damaging or destroying the amplifier. If -IN and -VB are connected, then in practice a single-ended measurement is performed. This is no problem if there was no ground reference beforehand.

8.4.1.1.3 Voltage source at a different fixed potential



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The common mode voltage (V_{cm}) has to be less than ±10 V. It is reduced by ½ input voltage.

Example

Suppose a voltage source is to be measured which is at a potential of 120 V to ground. The system itself is grounded. Since the common mode voltage is greater than permitted, measurement is not possible. Also, the input voltage difference to the amplifier ground would be above the upper limit allowed. For such a task, the UNI2-8 cannot be used.

8.4.1.2 Bridge measurement

Measurement of measurement bridges such as strain gauges. The measurement channels have an adjustable DC voltage source which supplies the measurement bridges. The supply voltage for a group eight inputs is set in common. The bridge supply is asymmetric, e.g., for a bridge voltage setting of VB=5 V, Pin +VB is at +VB=5 V and Pin -VB at -VB=0 V. The terminal -VB is simultaneously the device's ground reference.

Per default 5 V and 10 V can be selected as bridge supply. As an option the amplifier can be build with 2.5 V bridge supply. Depending on the supply set, the following input ranges are available:

Bridge voltage [V]	Measurement range [mV/V]
10	±1000 to ± 0.5
5	±1000 to ± 1
2.5	±1000 to ± 2

Fundamentally, the following holds: For equal physical modulation of the sensor, the higher the selected bridge supply is, the higher are the absolute voltage signals the sensor emits and thus the measurement's **signal-to-noise ratio** and drift quality. The limits for this are determined by the maximum available current from the source and by the **dissipation** in the sensor (temperature drift!) and in the device (power consumption!)

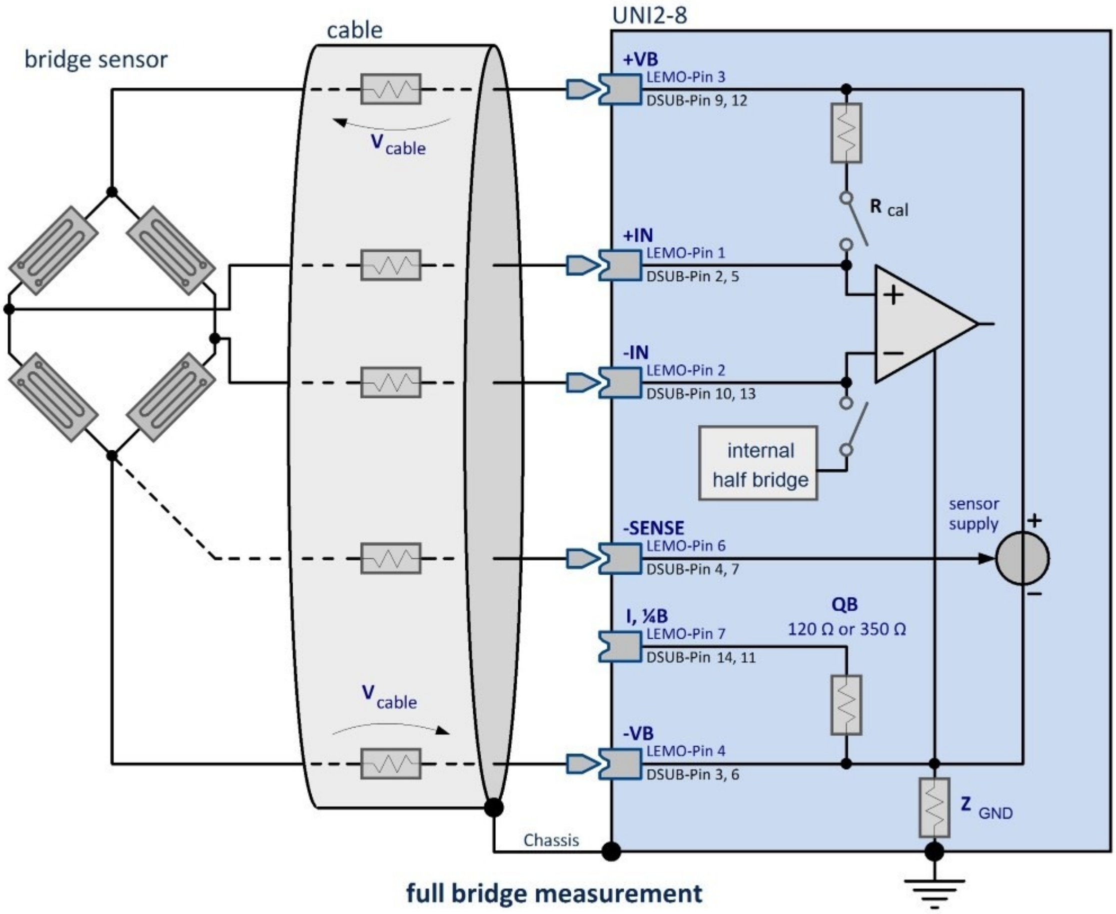
- For typical measurements with **strain** gauges, the ranges 5 mV/V to 0.5 mV/V are relevant.
- There is a maximum voltage which the **potentiometer sensors** are able to return, in other words max. 1 V/V; a typical range is then 1000 mV/V.

Bridge measurement is set by selecting as measurement mode either *Bridge: Sensor* or *Bridge: strain gauge* in the operating software. The bridge circuit itself is then specified under the tab Bridge circuit, where quarter bridge, half bridge and full bridge are the available choices.

Note

We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

8.4.1.2.1 Full bridge



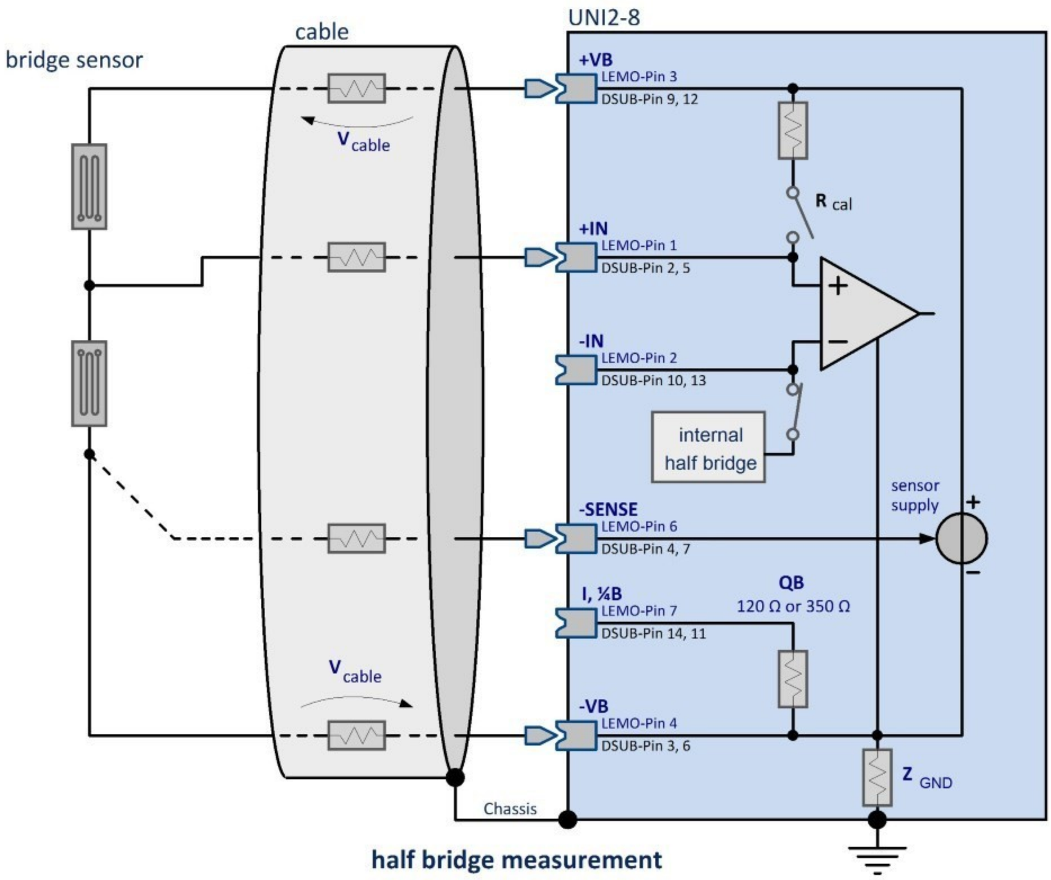
LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

A full bridge has four resistors, which can be four correspondingly configured strain gauges or one complete sensor which is a full sensor internally. The full bridge has five terminals to connect. Two leads +VB and -VB serve supply purposes, two other leads +IN and -IN capture the differential voltage. The 5th lead SENSE is the Sense lead for the lower supply terminal, which is used to determine the single-sided voltage drop along the supply line. Assuming that the other supply cable +VB has the same impedance and thus produces the same voltage drop, no 6th lead is needed. The Sense lead makes it possible to infer the measurement bridge's true supply voltage, in order to obtain a very exact measurement value in mV/V.

Please note that the maximum allowed voltage drop along a cable may not exceed approx. 0.5 V. This determines the maximum possible cable length.

If the cable is so short and its cross section so large that the voltage drop along the supply lead is negligible, the bridge can be connected at four terminals by omitting the Sense line.

8.4.1.2.2 Half bridge



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

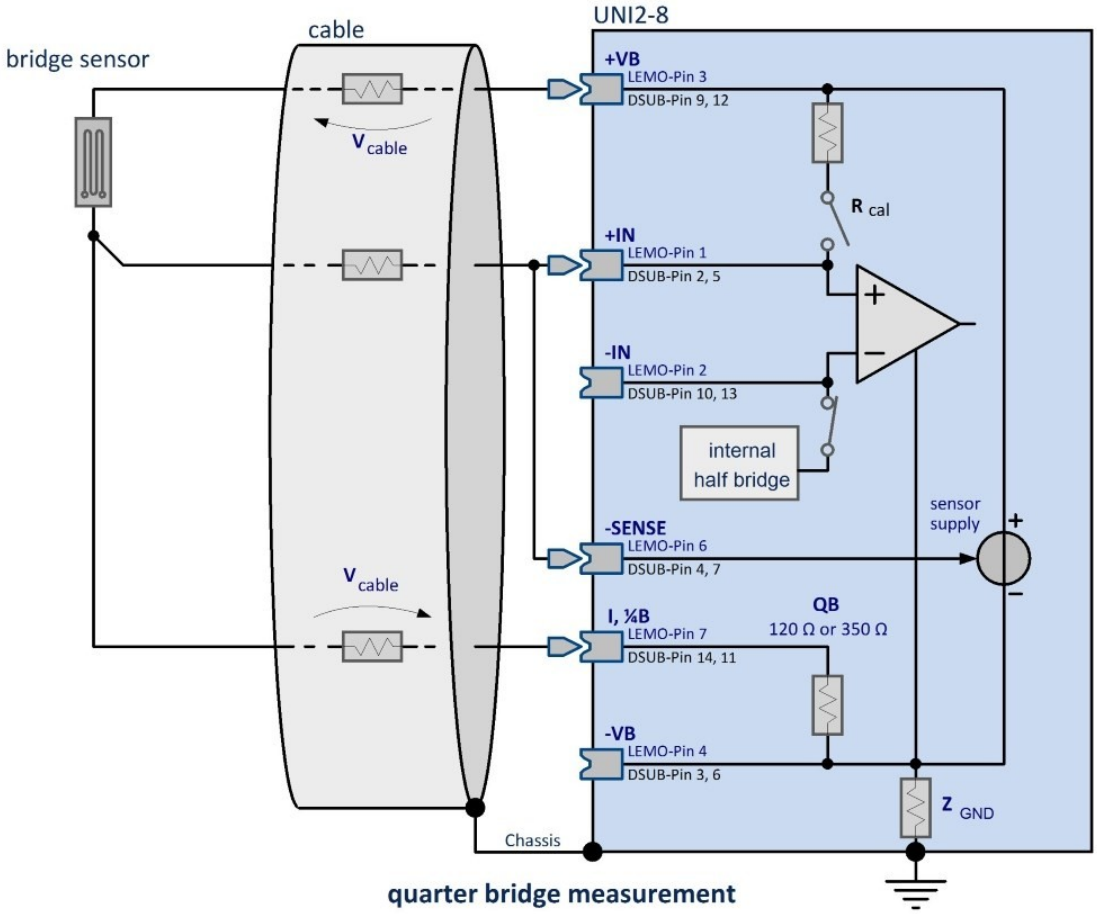
A half bridge may consist of two strain gauges in a circuit or a sensor internally configured as a half bridge, or a potentiometer sensor. The half bridge has 4 terminals to connect. For information on the effect and use of the SENSE lead, see the description of the full bridge 224.

The amplifier internally completes the full bridge itself, so that the differential amplifier is working with a full bridge.

Note

It is important that the measurement signal of the half bridge is connected to +IN. The -IN access leads to implausible measured values and influences the neighbor channels.

8.4.1.2.3 Quarter bridge



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

A quarter bridge can consist of a single strain gauge resistor, whose nominal value can be 120 Ω or 350 Ω. UNI2-8 internally completes an additional 120 Ω that can be switched to a 350 Ω quarter bridge.

For quarter bridge measurement, only 5 V can be set as the bridge supply.

The quarter bridge has 4 terminals to connect. Refer to the description of the full bridge 224 for comments on the SENSE lead. Note that at the quarter bridge the sense line is connected to +IN and -SENSE jointly. There is **no voltage drop** on the cable between the **quarter bridge and +IN and SENSE** because there is no current flowing into the high impedance inputs of +IN and SENSE. The current through the **quarter bridge** flows off **to I_1/4B** and causes a **voltage drop** there, which can be detected at **-SENSE**.

If the sensor supply is equipped with the option "±15 V", a quarter bridge measurement is not possible. The pin I_1/4Bridge for the quarter bridge completion is used for -15 V instead.

8.4.1.2.4 Sense and initial unbalance

The **SENSE** lead serves to compensate voltage drops due to cable resistance, which would otherwise produce noticeable measurement errors. If there are no sense lines, then **SENSE** must be connected in the terminal plug according to the sketches above.

A bridge measurement is a relative measurement (**ratiometric procedure**) that calculates what fraction of the supplied bridge excitation voltage is given off from the bridge (typically in the 0.1% range, corresponding to 1 mV/V). Calibration of the system in this case pertains to this ratio, the bridge input range, and takes into account the momentary magnitude of the supply. This means that the bridge **supply's actual magnitude** is not relevant and need not necessarily lie within the measurement's specified overall accuracy.

Any initial unbalance of the measurement bridge, for instance due to mechanical pre-stressing of the strain gauge in its rest state, must be zero-balanced. Such an unbalance can be many times the input range (bridge balancing). If the initial unbalance is too large to be compensated by the device, a larger input range must be set.

Possible initial unbalance

input range [mV/V]	bridge balancing (VB = 2.5 V) [mV/V]	bridge balancing (VB = 5 V) [mV/V	bridge balancing (VB = 10 V) [mV/V
±1000	200	500	240
±500	500	100	700
±200	40	400	60
±100	140	20	200
±50	200	70	10
±20	20	100	35
±10	30	14	50
±5	7	18	7
±2	9	3,5	10
±1	-	4,5	2
±0,5	-	-	5

8.4.1.2.5 Balancing and shunt calibration

The amplifier offers a variety of possibilities to trigger bridge balancing:

- Balancing / shunt calibration via user interface of the software (channel and/or amplifier balance)
- Balancing / shunt calibration via display 103 (see software manual)
- In shunt calibration, the bridge is unbalanced by means of a 59.8 kΩ or 174.7 kΩ shunt (between +VB and +IN). The results are:

Bridge resistance	120 Ω	350 Ω
59.8 kΩ 174.7 kΩ	0.5008 mV/V 0.171 mV/V	1.458 mV/V 0.5005 mV/V

The procedures for balancing bridge channels also apply analogously to the voltage measurement mode with zero-balancing.

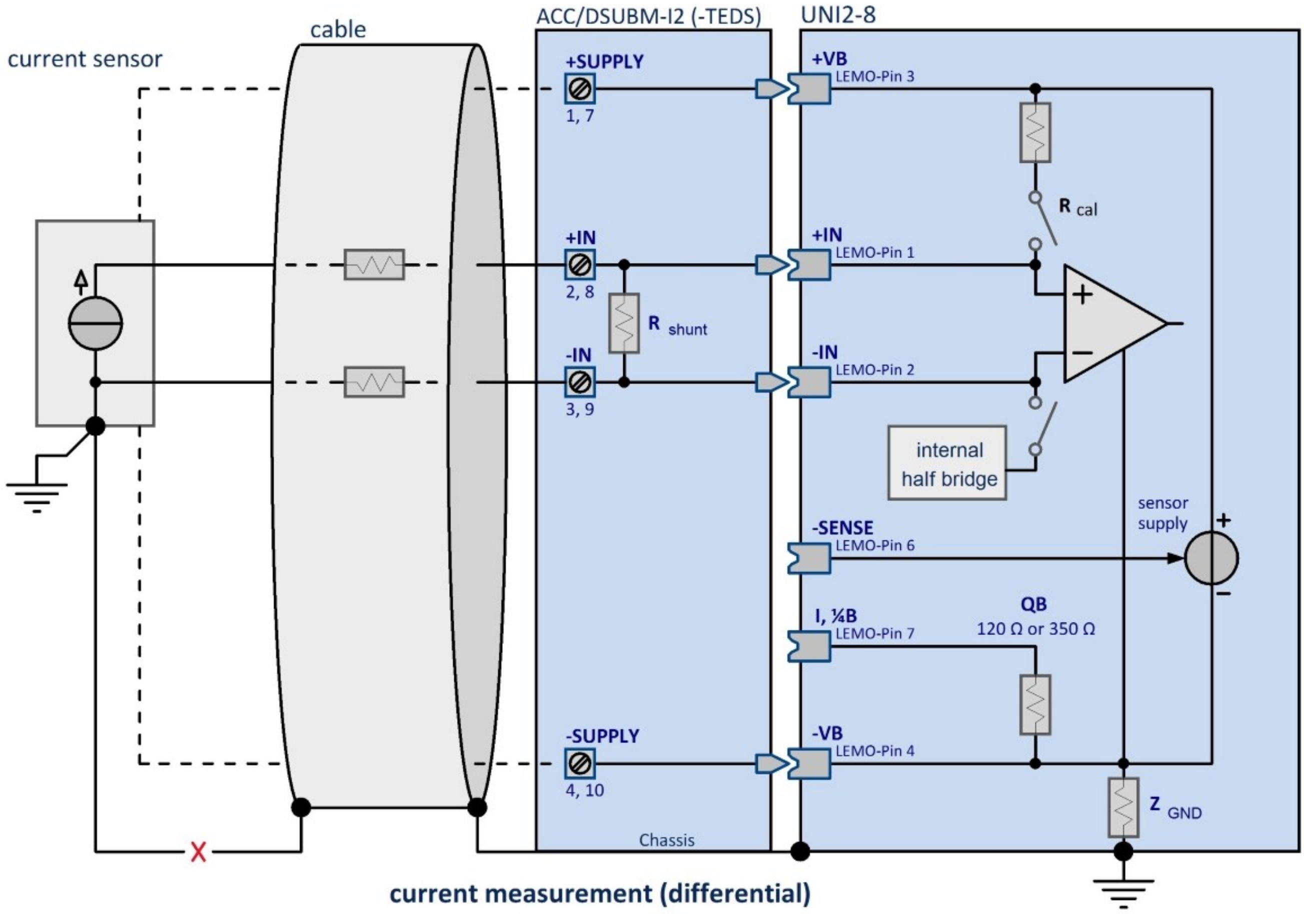
Note

- We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

8.4.1.3 Current measurement

8.4.1.3.1 Differential current measurement

Only for devices with DSUB-15 sockets in combination with imc plug ACC/DSUBM-I2 499.



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The ACC/DSUBM-I2 comes with a 50 Ω shunt and is not included with the standard package. It is also possible to measure a voltage via an externally connected shunt. Appropriate scaling must be set in the user interface. The value 50 Ω is just a suggestion. The resistor needs an adequate level of precision. Pay attention to the shunt's power consumption.

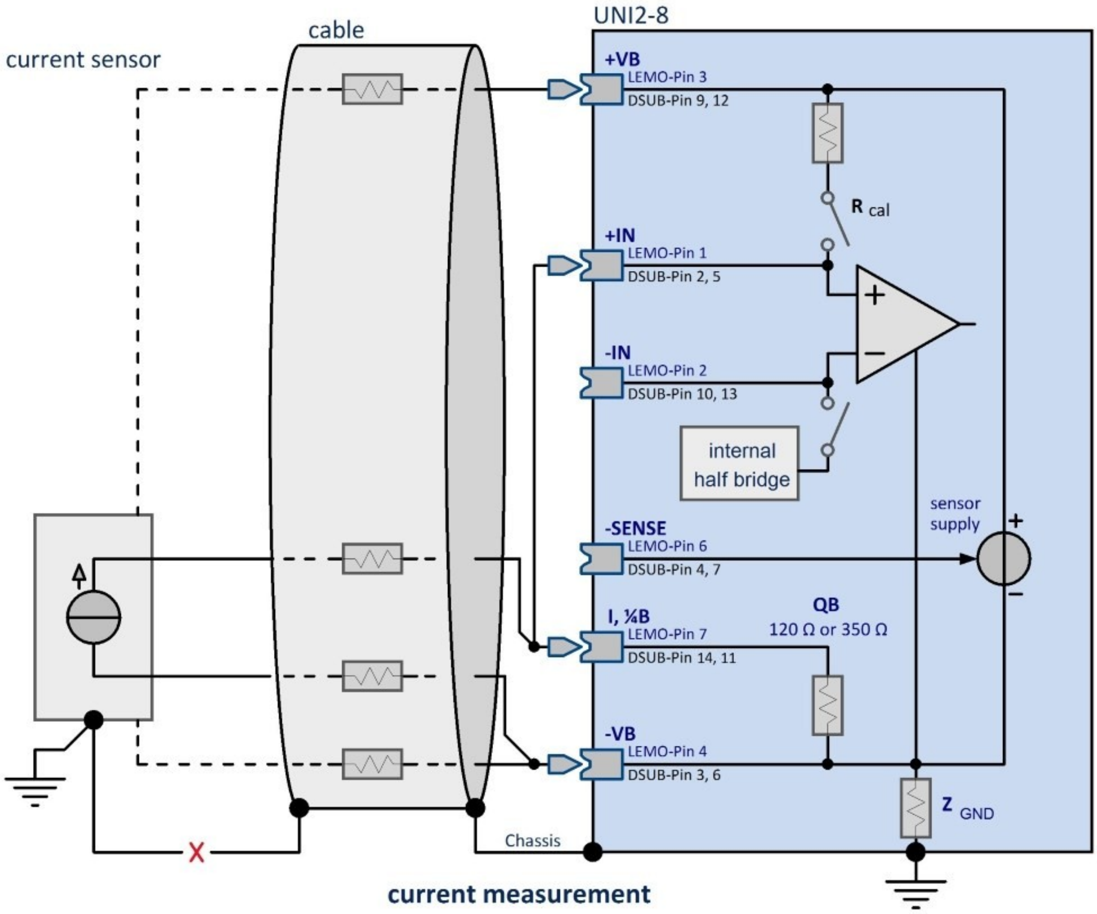
The maximum common mode voltage must be in the range ±10 V for this circuit, too. This can generally only be ensured if the current source itself already is referenced to ground. If the current source is ungrounded a danger exists of exceeding the maximum allowed overvoltage for the amplifier. The current source may need to be referenced to the ground, for example by being grounded.

The sensor can also be supplied with a software-specified voltage via Pins +VB and -VB.

Note

- Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc DEVICES interface.
- The scaling factor is entered as 1/R and the unit as A (0.02 A/V = 1/50 Ω).

8.4.1.3.2 Ground-referenced current measurement



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

- Current: e.g. ±50 mA to ±1 mA

In this circuit, the current to be measured flows through the 120 Ω shunt in the amplifier. Note that here, the terminal -VB is simultaneously the device's ground. Thus, the measurement carried out is single-end or ground referenced. The potential of the current source itself may be brought into line with that of the units ground. In that case, be sure that the device unit itself is grounded.

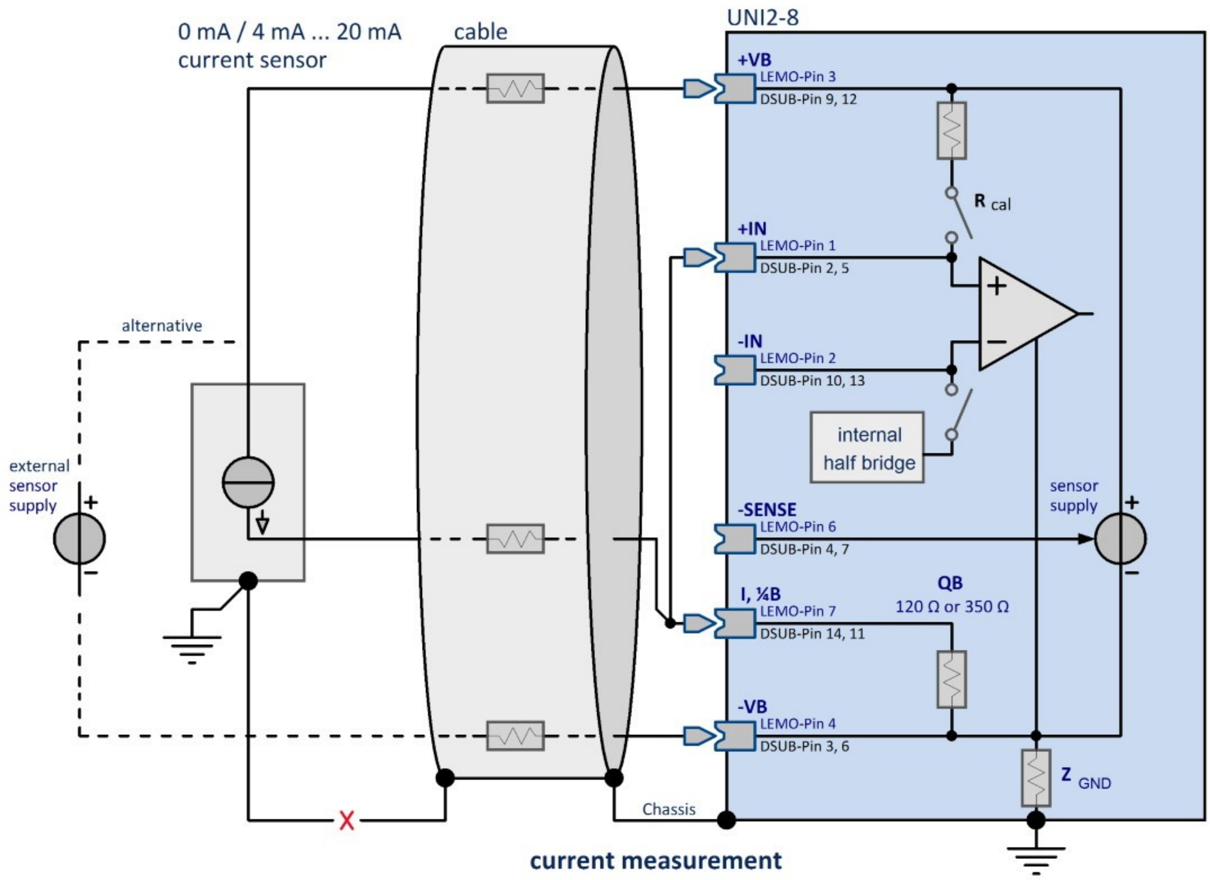
In the settings interface, set the measurement mode to current.

Note that the jumper between *+IN* and *+I; ¼Bridge* should be connected right inside the plug.

Note

For an (optional) sensor supply with ±15 V ground referenced current measurement is not possible. The pin I;¼Bridge is used as -15 V pin.

8.4.1.3.3 2-wire for sensors with a current signal and variable supply



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

- e.g. for pressure transducers 4 mA to 20 mA.

Transducers which translate the physical measurement quantity into their own current consumption and which allow variable supply voltages can be configured in a two-wire circuit. In this case, the device has its own power supply and measures the current signal.

In the settings dialog on the index card *Universal amplifiers / General*, a supply voltage is set for the sensors, usually 24 V. The channels must be configured for current measurement.

The signal is measured between +IN and -VB. A wire jumper must be positioned between pins +IN and +I, ¼Bridge inside the plug.

The sensor is supplied with power either via terminals +VB and +I; ¼Bridge or via an external sensor supply.

Note

There is a voltage drop across the resistances of the leadwires and the internal measuring resistance of 120 Ω which is proportional to the amperage. This lost voltage is no longer available for the supply of the transducer (2.4 V = 120 Ω * 20 mA). For this reason, you must ensure that the resulting supply voltage is sufficient. It may be necessary to select a leadwire with a large enough cross-section.

8.4.1.4 Temperature measurement

The amplifier channels are designed for direct measurement with **thermocouples** and **PT100-sensors**. Any combinations of the two sensor types can be connected.

8.4.1.4.1 Thermocouple measurement

The cold junction compensation necessary for thermocouple measurement is built-in the imc plug ACC/DSUBM-UNI2 (DSUB-15), ACC/TH-LEM-150 (LEMO) und im CAN/UINST-PT100 (ITT VEAM) and is measured automatically.

Note

- In the imc software user interface, the option isolated thermocouple (default setting) must be activated under Settings - Configuration - Amplifier. This only is available with Coupling DC.

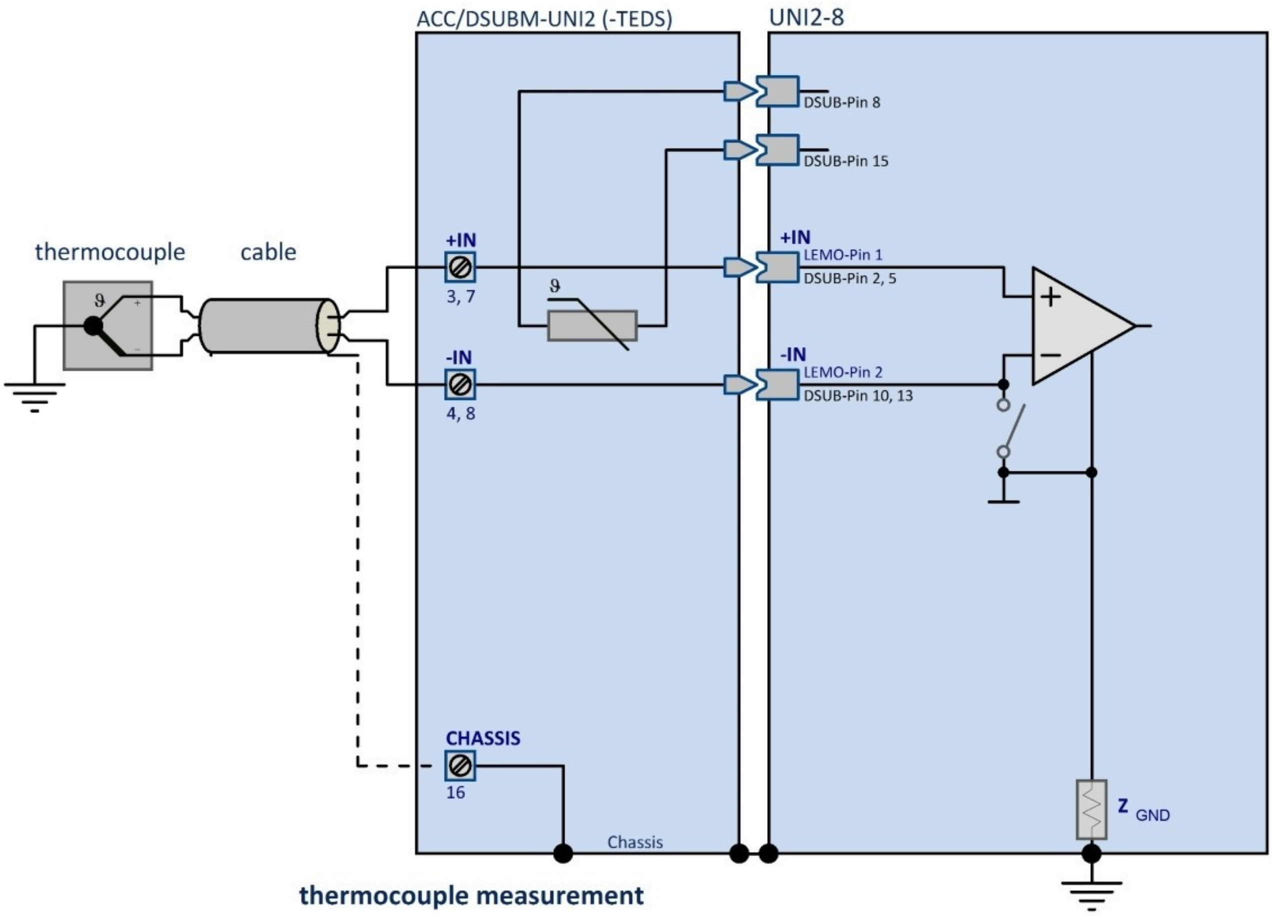
Reference

Please find here a description of the available thermocouples 127.

8.4.1.4.1.1 Thermocouple mounted with ground reference

The thermocouple is mounted in such a way that it already is in electrical contact with the device ground / chassis. This is ensured by attaching the thermocouple to a grounded metal body, for instance. The thermocouple is connected for differential measurement. Since the unit is grounded itself, the necessary ground reference exists.

In the operating software, don't activate the option "***Isolated thermo couple***" at the amplifier tab.



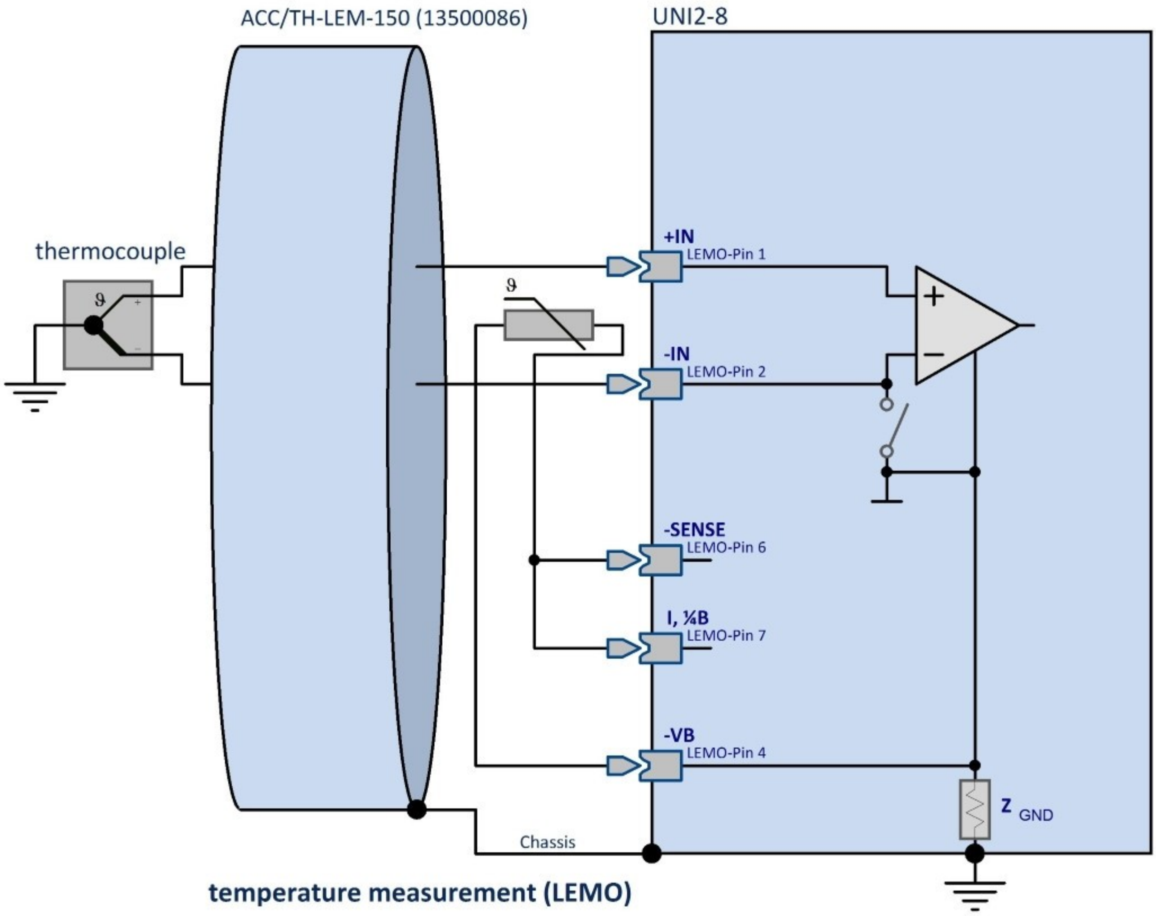
LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

It is not a problem if the ground potential at the thermocouple differs from that of the device units by a few volts. However, the maximum allowed common mode voltage may not be exceeded.

Note

- The negative signal input -IN may not be connected to amplifier ground point -VB. Connecting them would cause a ground loop through which interference could be coupled in.
- If you accidentally activate the option "Isolated thermocouple" on the Amplifier page, there is a danger that a large compensation current will flow through the thermocouple's (thin) line and the connector plug. Compensation currents are a danger with every single-ended measurement. For that reason, single-ended measurement is really only allowed -and only then really necessary- if the thermocouple has no ground reference of its own.

- Note that with **LEMO connection** 504 an external PT100 must be integrated in the connector as cold junction compensation. In addition, the ***ACC/TH-LEM-150*** connector is available as an accessory: a LEMO. 1B connector with integrated cold junction compensation.
  For ITT VEAM the integrated cold junction compensation ***CAN/UINST-PT1100*** is provided for the corresponding CAN/UINST-7 connector.

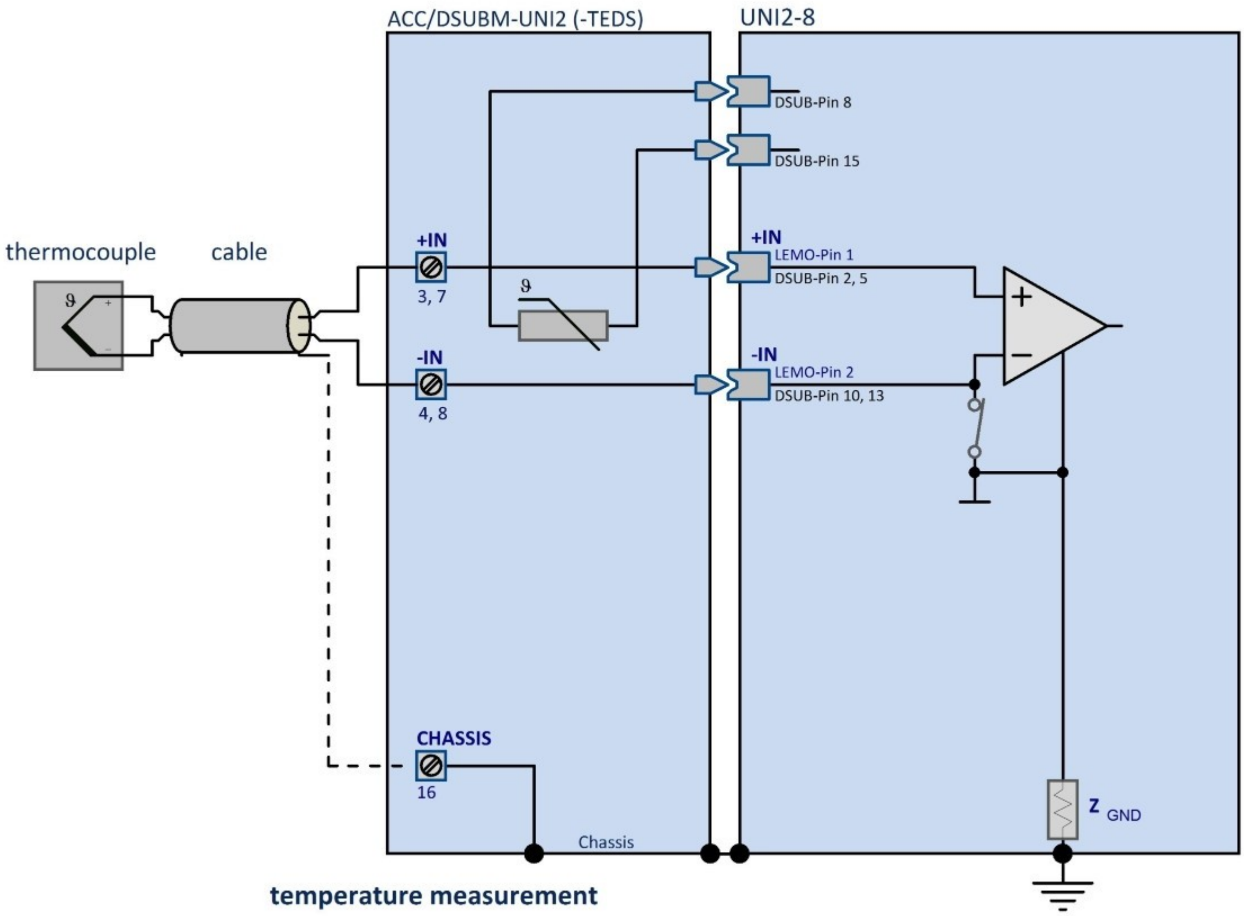


LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

8.4.1.4.1.2 Thermocouple mounted without ground reference

The thermocouple is installed with electrical isolation from the device's Ground / Chassis and is therefore not connected with the device's ground. This is achieved by, among other techniques, having the thermocouple adhere to non-conducting material. As a result, the thermocouple's voltage floats freely against the amplifier ground voltage.

In this case, the amplifier must provide the necessary ground potential.



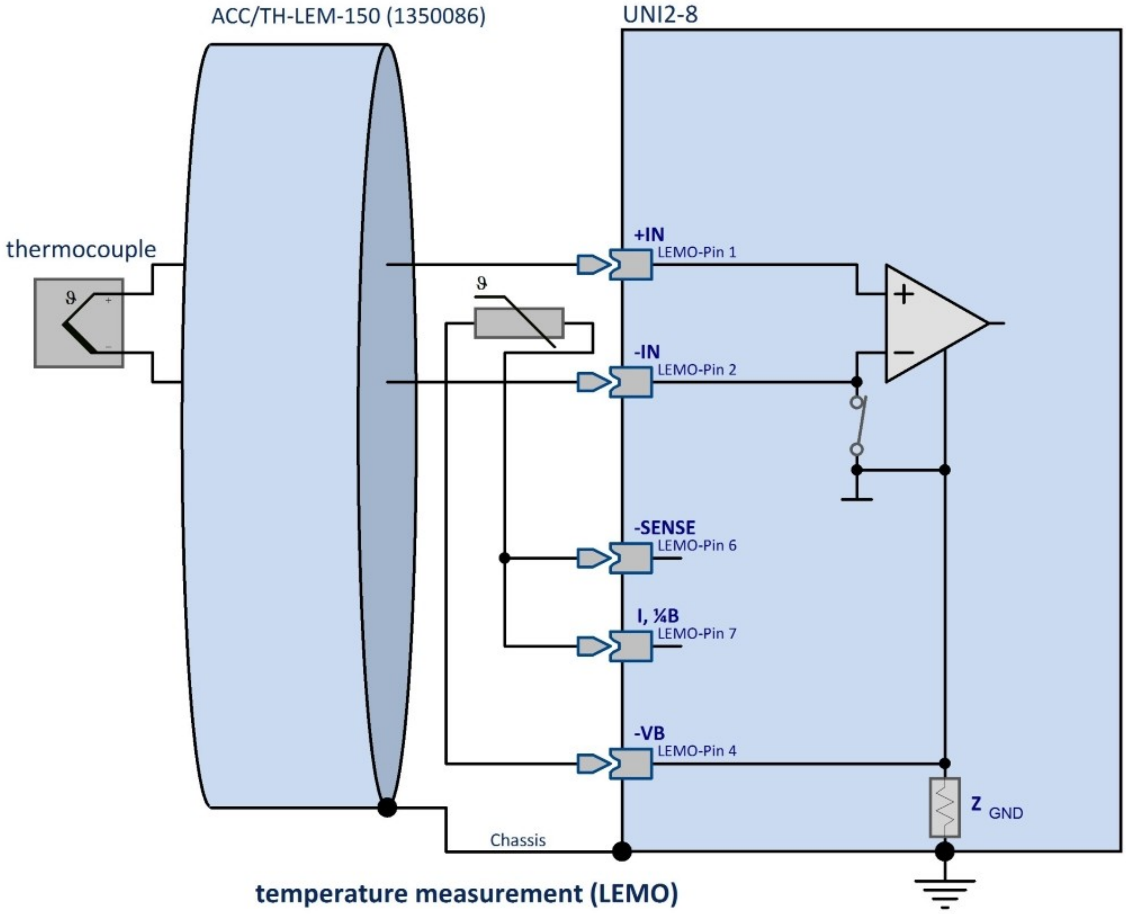
LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

In the operating software, activate "***Isolated thermo couple***" at the amplifier tab. In this measurement mode, the unit itself provides the ground reference by having Terminals -IN and -VB connected internally. This connection is only made in the Thermocouple mode and not with voltage measurements.

Warning The thermocouple itself may not be ground referenced!

If it was mounted with a ground reference, there is a danger that a large compensation current will flow through the thermocouple's (thin) line and the connector plug. Compensation currents are a danger with every single-ended measurement. For that reason, single-ended measurement is really only allowed -and only then really necessary- if the thermocouple has no ground reference of its own.

Note that with **LEMO connection** 504 an external PT100 must be integrated in the connector as cold junction compensation. In addition, the ***ACC/TH-LEM-150*** connector is available as an accessory, a LEMO. 1B connector with integrated cold junction compensation. For ITT VEAM the integrated cold junction compensation ***CAN/UINST-PT1100*** is provided for the corresponding CAN/UINST-7 connector.

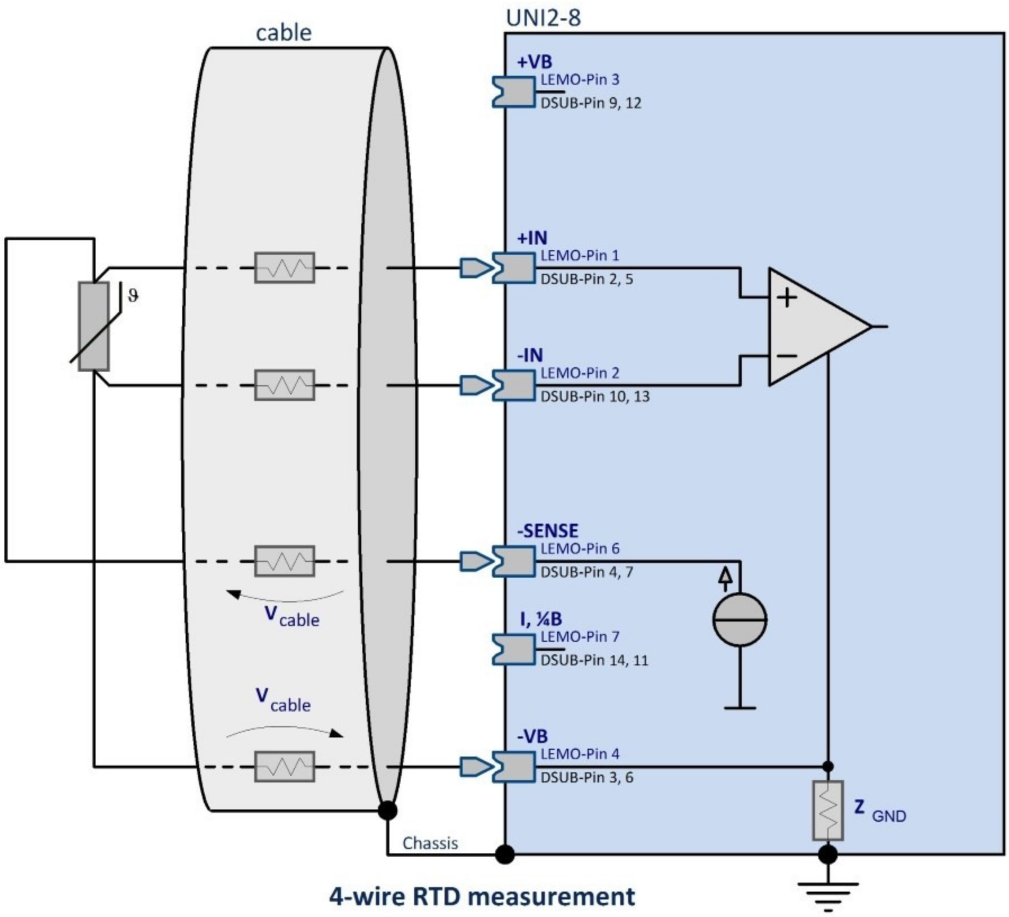


LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

8.4.1.4.2 PT100/ RTD measurement

Along with thermocouples, **PT100** can be connected directly in **4-wire-configuration** (DSUB-plug: ACC/DSUBM-UNI2 497). The 4-wire measurement returns more precisely results than the 3-wire measurement since it does not require the resistances of both leads which carry supply current to have the same magnitude and drift. The 2-wire measurement provides the most inaccurate results due to the cable resistances. Each sensor is fed by its own current source with approx. 1.2 mA.

8.4.1.4.2.1 PT100 in 4-wire configuration



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The PT100 is supplied with constant current via two lines (-SENSE and -VB). The other two serve as Sense-leads. By using the lines (+IN und -IN), the voltage at the resistor itself can be determined precisely. The voltage drop along the conducting cable thus does not cause any measurement error. The 4-wire configuration is the most precise way to measure with a PT100.

Note

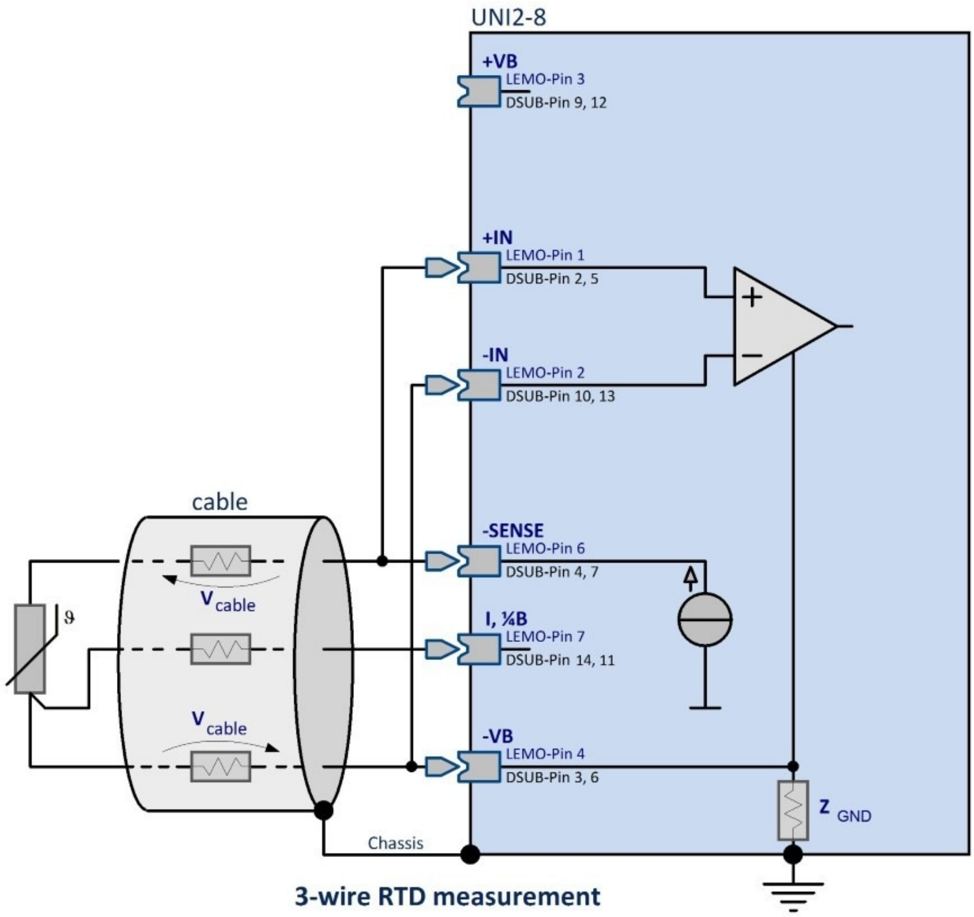
4-wire measurement is not possible with order option:

- sensor supply with ±15 V

8.4.1.4.2.2 PT100 in 2-wire configuration

PT100 in 4-wire configuration must be set in the software. The connection is the same as for the 4-wire configuration, but +IN must be connected to -SENSE and -IN to -VB via bridges in the plug. The **cable resistances** of the supply lines are recorded in addition to the RTD and **lead to the most inaccurate measurement** and are therefore not recommended.

8.4.1.4.2.3 PT100 in 3-wire configuration



3-wire RTD measurement

LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The PT100 is supplied with constant current via two lines (-SENSE and -VB). Another line (I, 1/4B) measures the voltage across the supply line and uses it to compensate for parasitic voltage drops. It is assumed that the resistances of the supply lines have the same size and the same temperature drift.

It is important, that the connection between +IN to -SENSE and -IN to -VB is made directly at the module.

Note

3-wire measurement is not possible with order option:

- sensor supply with ±15 V

8.4.1.4.3 Open sensor detection

The amplifier comes with the ability of open sensor detection.

Thermocouple: If at least one of the thermocouple's two lines breaks, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range in a defined pattern. The actual value reached depends on the particular thermocouple. In the case of Type K thermocouples, this is around -270°C. If the system is monitoring a cutoff level with a certain tolerance, e.g. Is the **measured value <-265°C**, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location.

The open sensor detection is also triggered if a channel is parameterized for "Thermocouple" and measurement starts without any thermocouple being connected. If a thermocouple is later connected after all, it would take the period of a few measurement samples for transients in the module's filter to subside and the correct temperature to be indicated. Note also in this context that any thermocouple cable's connector which is recently plugged into the amplifier is unlikely to be at the same temperature as the module. Once the connection is made, the temperatures begin to assimilate. Within this phase, the Pt100 built into the plug may not be able to indicate the real junction temperature exactly. This usually takes some minutes to happen.

RTD/Pt100: If the leads to the Pt100 are broken, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range, to about 200°C, in a defined pattern. If the system is monitoring a cutoff level with a certain tolerance, e.g. Is the **measured value <-195°C**, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location. In case of a short-circuit, the nominal value returned is also that low.

In this context, note that in a 4-wire measurement a large variety of combinations of broken and shorted leads are possible. Many of these combinations, especially ones with a broken Sense lead, will not return the default value stated.

8.4.1.5 Current fed sensors

For measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) 260.

Note	UNI2-8 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

8.4.1.6 User-defined characteristic curves

User-defined characteristic curves created e.g. by imc SENSORS, can be proceeded.

8.4.1.7 Sensor supply module

UNI2-8 channels are enhanced with a sensor supply unit, which provides an adjustable supply voltage for active sensors. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The supply voltage can only be set for all measurement inputs per module.

The supply outputs are electronically protected internally against short circuiting to ground. The reference - potential, in other words the sensor's supply ground contact, is the terminal GND.

The supply voltage can only be set for all measurement inputs in common. The voltage selected is also the supply for the measurement bridges. If a value other than 5 V or 10 V is set, bridge measurement is no longer possible!

8.4.1.8 Bandwidth

The channels' maximum sampling rate is 100 kHz(10 µs).

The analog bandwidth (without digital low-pass filtering) is 48 kHz (-3 dB).

8.4.1.9 Connection

Find here the pin configuration of the DSUB-15 plugs 497 and the LEMO-plugs 504.

8.4.2 UNI-4 isolated: Voltage, Current (20 mA), Temperature, Bridge, IEPE/ICP

This module offers maximum flexibility and versatility. The 4 channels allow the measurement of voltage and current and the connection of IEPE (ICP)-sensors and also the measurement of temperature (thermocouples, PT100 and PT1000), bridges and strain gauges (full-, half- and quarter bridge with internal completion: 120 Ω, 350 Ω and 1 kΩ).

Supply voltages of 0.25 V to 24 V can be configured separately for each channel, for the purpose of powering external sensors or of bridge measurement.

The channels are individually isolated for voltage, current and thermocouple measurement. Each channel is equipped with its own simultaneous A/D converter and adjustable filter (e.g. anti-aliasing filter).

Parameter	**Value**	**Remarks**
Measurement modes DSUB		ACC/DSUBM-UNI2 for all modes
isolated measurement modes:	voltage (differential)	
	current measurement	with shunt-plug (ACC/DSUBM-I2)
	Thermocouples	
non-isolated measurement modes:	voltage (single-end)	
	current measurement	with internal shunt
	bridge-sensor	
	strain gauges	
	PT100/PT1000 (3- and 4-wire connection)	
	current fed sensors (IEPE/ICP)	ACC/DSUB-ICP2, ACC/DSUB-ICP-BNC (ICP™-, Deltatron®-, Piezotron®-Sensors)
	Charge	with charge amplifier (ACC/DSUB-Q2), only with CRC, CRSL
Measurement modes LEMO		
isolated measurement modes:	voltage (differential)	
	thermocouples	with ACC/TH-LEM-150
non-isolated measurement modes:	voltage (single-end)	
	current	with internal shunt
	bridge-sensor	
	strain gauges	
	PT100/PT1000 (3- and 4-wire connection)	

Technical details of the UNI-4 421.

8.4.2.1 Voltage measurement (differential)

- Voltage: ±2.5 mV to ±60 V

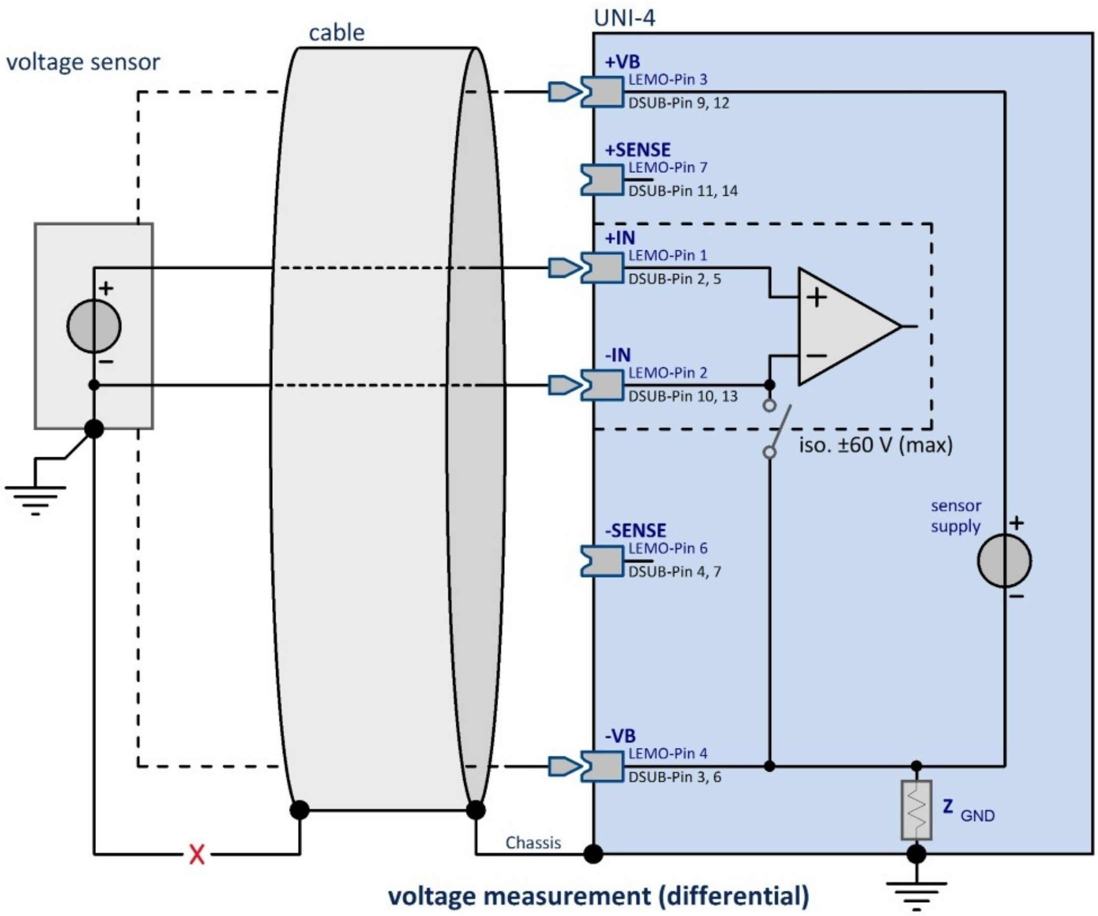
Within the voltage ranges ≥5 V a voltage divider is in effect;
the resulting input impedance is 1 MΩ.

Within the voltage ranges ≤2 V the resulting input impedance is 10 MΩ.

The input is differential and DC-coupled.

Note

When using an isolated channel (with or without supply), one should make sure that the common mode potential is "defined", one way or another: Using an isolated channel on an isolated signal source usually does not make sense. The very high common mode input impedance of this isolated configuration (>1 GΩ) will easily pick up enormous common mode noise as well as possibly letting the common mode potential drift to high DC-level. These high levels of common-mode noise will not be completely rejected by the amplifier's common-mode (isolation-mode) rejection.



voltage measurement (differential)

So, as a **general rule**: isolated amps should be used in environments where the common-mode level is high but "well defined" in terms of a low (DC-) impedance to (non-isolated) system ground (CHASSIS).

If, in turn, the signal source itself is isolated, it can be forced to a common-mode potential, which is the potential of the measurement equipment. This is the case with a microphone: the non-isolated power supply will force the common mode potential of the microphone and amp-input to system ground instead of leaving it floating, which would make it susceptible to all kinds of noise and disturbance.

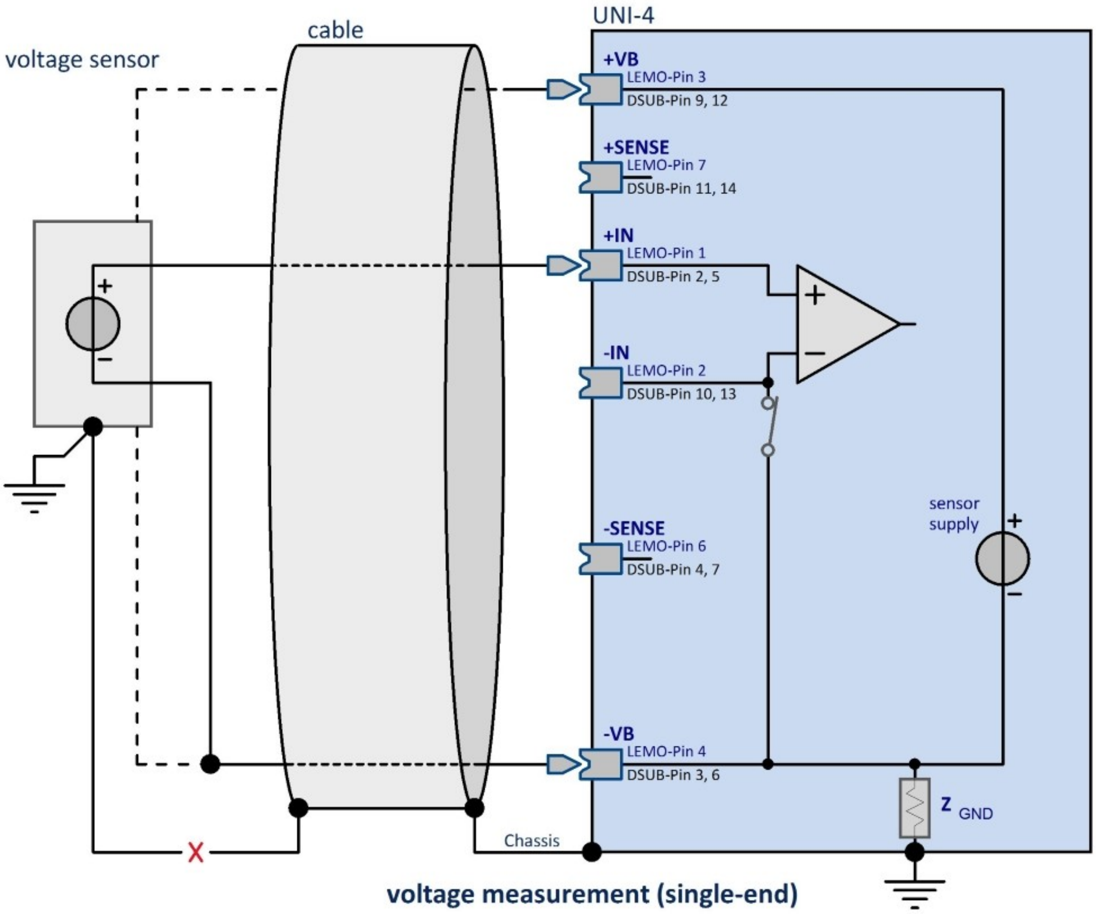
8.4.2.2 Voltage measurement (single-end)

- Voltage: ±2.5 mV to ±10 V

Within the voltage ranges ≥5 V a voltage divider is in effect;
the resulting input impedance is 1 MΩ.

Within the voltage ranges ≤2 V the resulting input impedance is 10 MΩ.

The input is DC-coupled.



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The voltage source itself is not referenced to the ground of the measurement system. The potential of the voltage source is floating free against the ground of the device. In this case, a ground reference must be established. One way to do this is to connect the voltage source with the system.

Example

An ungrounded voltage source is measured, for instance a battery whose contacts have no connection to ground. The device module is grounded.

Note

Important: When connecting active sensors that are supplied via +VB, a reverse current via the connection cable to -VB is generated. This reverse current creates a voltage drop across the cable impedance which influences the measurement result.

8.4.2.3 Bridge measurement

Measurement of measurement bridges such as strain gauges.

The measurement channels have an adjustable DC voltage source which supplies the measurement bridges. The supply voltage for each channel is set individually. The bridge supply is asymmetric, e.g., a bridge voltage setting of VB=5 V provide 5 V at pin +VB and 0 V at pin -VB. The pin -VB is simultaneously the device's ground reference.

Fundamentally, the following applies: For equal physical modulation of the sensor, the higher the selected bridge supply is, the higher are the absolute voltage signals which the sensor emits and thus the measurement's signal-to-noise ratio and drift quality. The limits for this are determined by the maximum available current from the source and by the dissipation in the sensor (temperature drift!) and in the device (power consumption!)

- For typical measurements with strain gauges, the ranges 5 mV/V to 0.5 mV/V are particularly relevant.
- There is a maximum voltage which the Potentiometer sensors are able to return, in other words max. 1 V/V; a typical range is then 1000 mV/V.

Bridge measurement is set by selecting as the measurement mode either Bridge: Sensor or Bridge: Strain gauge in the operating software. The bridge circuit itself is then specified under the tab Bridge circuit, where quarter bridge, half bridge and full bridge are the available choices.

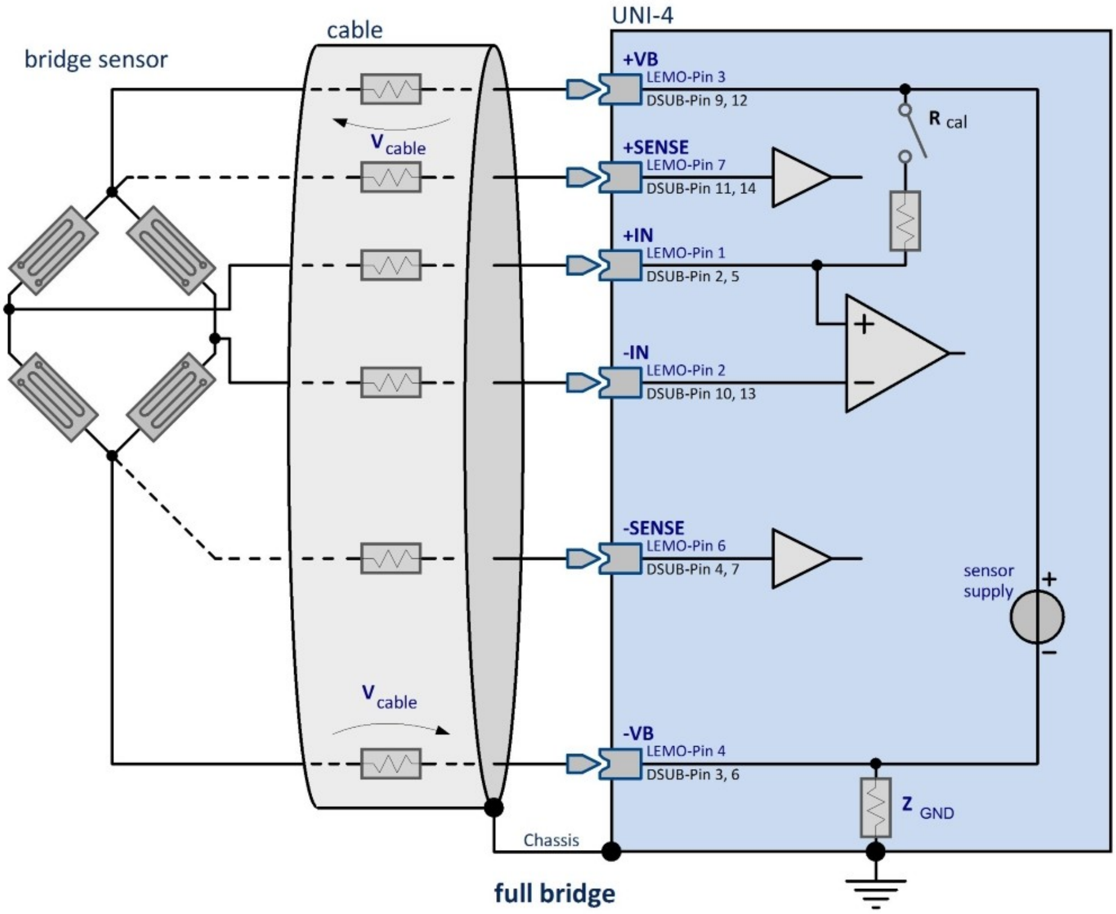
SENSE line:

In order to compensate unbalanced cable resistance in the supply lines measuring a full-bridge or a half-bridge, it is possible to connect two SENSE lines +SENSE and -SENSE for each case.

With balanced cable resistance in the supply lines, a connection of one SENSE line -SENSE is sufficient.

With bridge supply voltages ≥5 V, the connection configuration is automatically recognized by the UNI-4 in preparation for the measurement. Changing this configuration during a running measurement can lead to inaccuracy in the measurement result. With a bridge supply voltage <5 V, the connection configuration is also recognized and taken into account during the measurement.

8.4.2.3.1 Full bridge



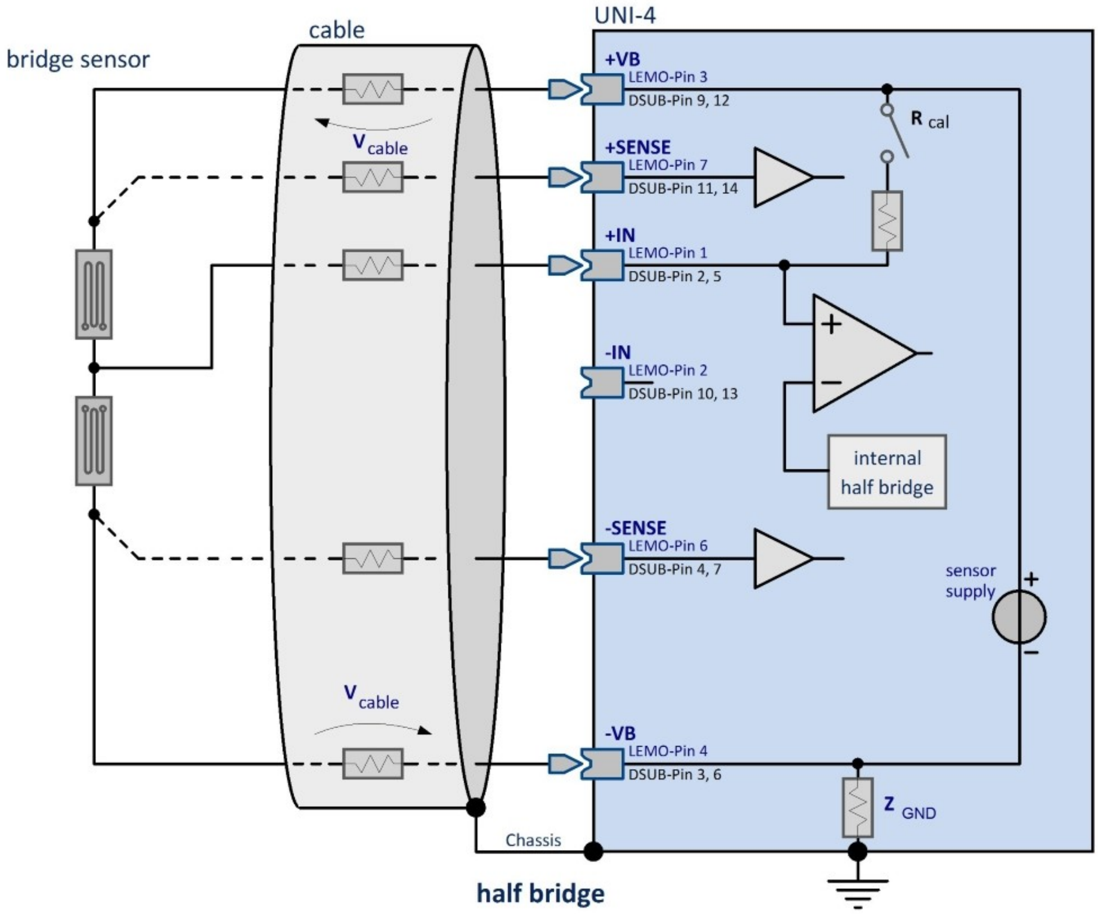
LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

A full bridge has four resistors, which can be four correspondingly configured strain gauges or one complete sensor which is a full sensor internally.

The full bridge can be connected with five wires or six. By means of the SENSE line, a voltage drop across the supply line can be detected. It is possible to determine the measurement bridge's actual supply voltage by means of the SENSE line in order to detect an exact measurement value in mV/V.

Please note that the max allowed voltage drop along one cable must never be greater than one quarter of the adjusted supply voltage. This determines the max cable length.

8.4.2.3.2 Half bridge



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

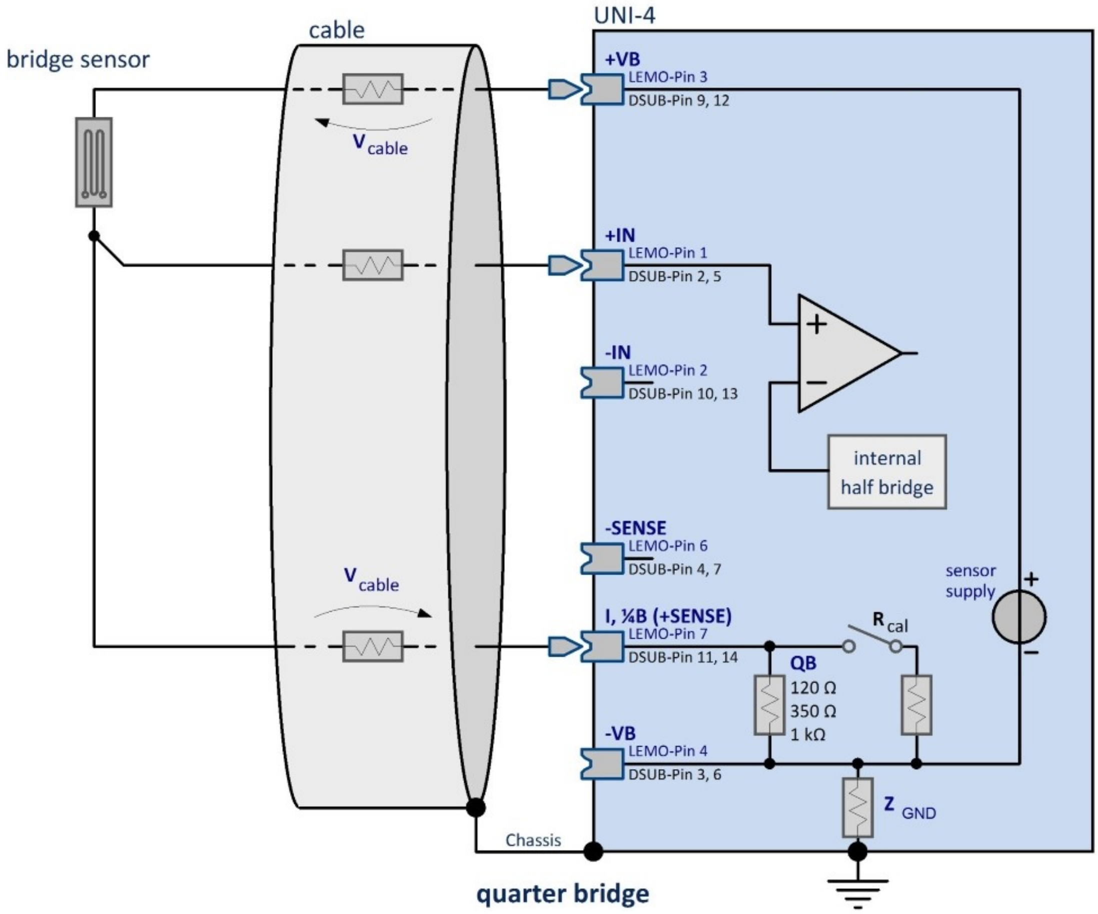
A half bridge may consist of two strain gauges in a circuit or a sensor internally configured as a half bridge, or a potentiometer sensor. The half bridge has four terminals to connect. For information on the effect and use of the SENSE lead, see the description of the full bridge 244.

The amplifier internally completes the full bridge itself, so that the differential amplifier is working with a full bridge.

Note

It is important that the measurement signal of the half bridge is connected to +IN. Using the -IN terminal leads to implausible measured values and affects the neighboring channels.

8.4.2.3.3 Quarter bridge



A quarter bridge can consist of a single strain gauge resistor: 120 Ω, 350 Ω or 1 kΩ.

The UNI-4 internally completes the quarter bridge that can be changed from 120 Ω to 350 Ω or 1 kΩ.

The quarter bridge has 3 wires to be connected. Refer to the description of the full bridge for comments on the SENSE lead.

8.4.2.3.4 Sense and initial unbalance

The **SENSE** lead serves to compensate voltage drops due to cable resistance, which would otherwise produce noticeable measurement errors. If there are no sense lines, then UNI-4 SENSE must be connected in the terminal plug according to the sketches above.

A bridge measurement is a relative measurement (**ratiometric procedure**) that calculates what fraction of the supplied bridge excitation voltage is given off from the bridge (typically in the 0.1% range, corresponding to 1 mV/V). Calibration of the system in this case pertains to this ratio, the bridge input range, and takes into account the momentary magnitude of the supply. This means that the bridge supply's actual magnitude is not relevant and need not necessarily lie within the measurement's specified overall accuracy.

Any initial unbalance of the measurement bridge, for instance due to mechanical pre-stressing of the strain gauge in its rest state, must be zero-balanced. Such an unbalance can be many times the input range (bridge balancing). If the initial unbalance is too large to be compensated by the device, a larger input range must be set. Please observe the UNI-4 data sheet 421.

Max possible initial unbalance

VB = 2.5 V		VB = 5 V		VB = 10 V	
input range [mV/V]	bridge-balancing [mV/V]	input range [mV/V]	bridge-balancing [mV/V]	input range [mV/V]	bridge-balancing [mV/V]
800	75	1.000 *	513 *	1.000 *	513 *
400	475	400	38	500 *	256 *
200	304	200	238	200	19
100	152	100	152	100	119
40	91	50	76	50	76
20	45	20	45	25	38
10	17	10	23	10	23
4.0	10	5.0	8.5	5.0	11
2.0	12	2.0	5.0	2.5	4.3
1.0	13	1.0	6.0	1.0	2.5
		0.5	6.5	0.5	3.0
				0.25	3.3

* configured with divider, input impedance (1 MΩ) will cause non-linearity

8.4.2.3.5 Balancing and shunt calibration

The amplifier offers a variety of possibilities to trigger bridge balancing:

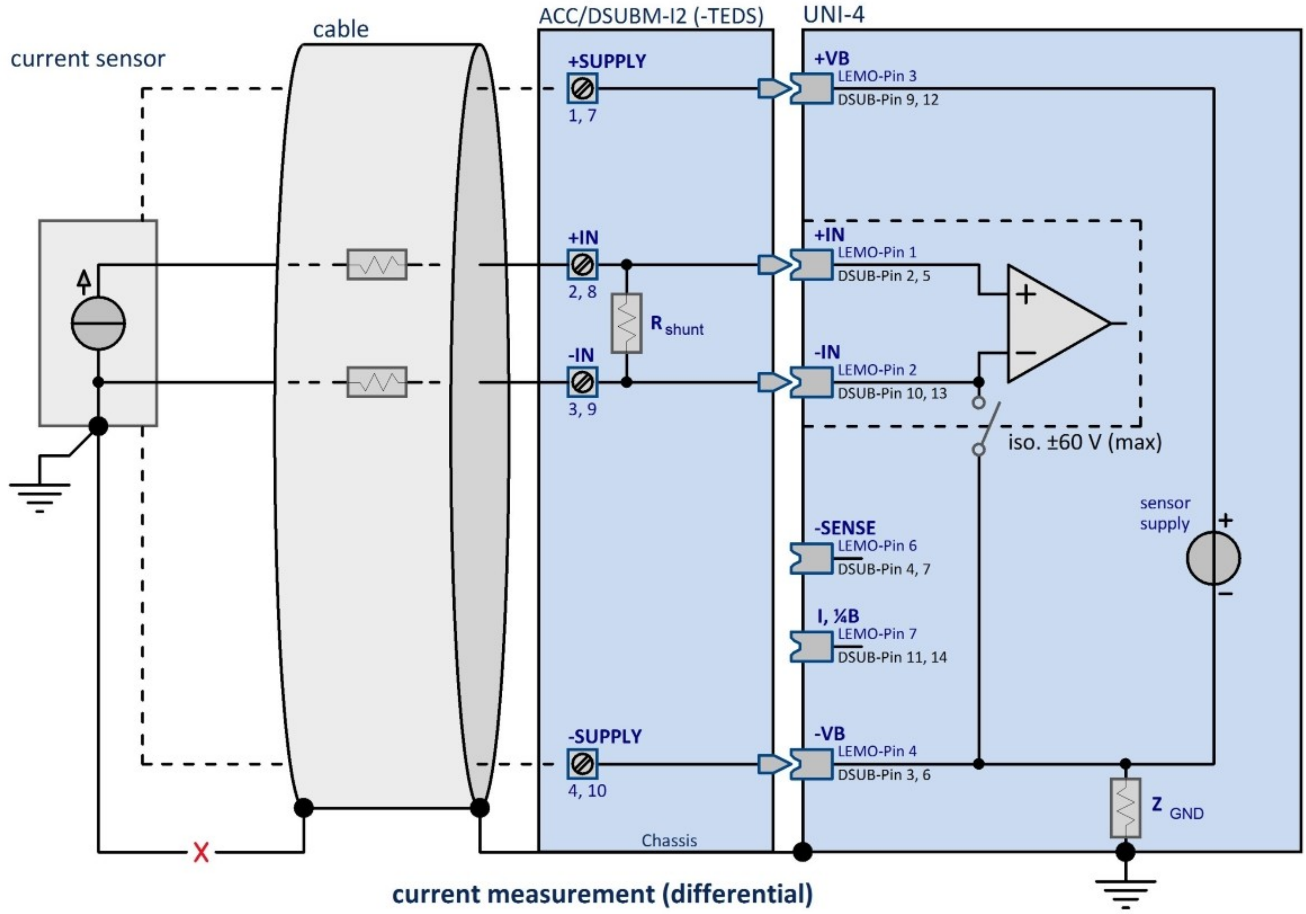
- Balancing / shunt calibration via graphical user interface of device software (channel balance respectively amplifier balance)
- Balancing / shunt calibration by means of the Display 103 (see software manual)
- In shunt calibration, the bridge is unbalanced by means of a 59.8 kΩ or 174.7 kΩ shunt (between +VB and +IN). The results are:

Bridge resistance	120 Ω	350 Ω
59.8 kΩ 174.7 kΩ	0.5008 mV/V 0.171 mV/V	1.458 mV/V 0.5005 mV/V

The procedures for balancing bridge channels also apply analogously to the voltage measurement mode with zero-balancing.

8.4.2.4 Current measurement

8.4.2.4.1 Differential current measurement



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

- Current: e.g. ±50 mA to ±1 mA

For current measurement, the DSUB plug ACC/DSUBM-I2 can be used. This plug comes with a 50 Ω shunt and is not included with the standard package. It is also possible to measure a voltage via an externally connected shunt. The appropriate scaling must be set in the user interface. The value 50 Ω is just a suggestion. The resistor must provide an adequate level of precision. Pay attention to the shunt's power consumption.

The maximum common mode voltage must also be reflected in this arrangement. In general, this can only be ensured if the current source itself is already referenced to ground. If the current source is ungrounded, there is a risk of exceeding the maximum allowed overvoltage for the amplifier. The current source may need to be referenced to the ground, for example by being grounded.

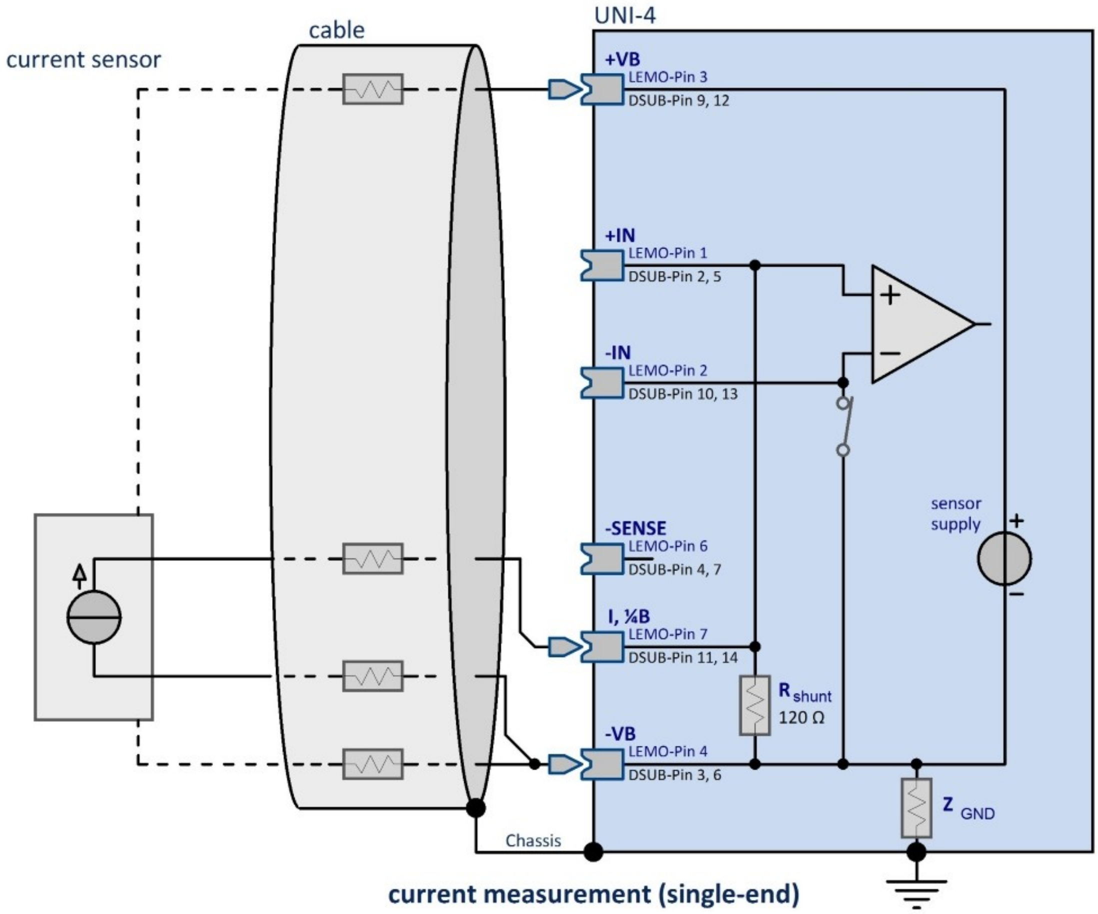
The sensor can also be supplied with a software-specified voltage via Pins +VB and -VB.

Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc operating software interface.

The scaling factor is entered as 1/R and the unit as A (0.02 A/V = 1/50 Ω)

8.4.2.4.2 Ground-referenced current measurement



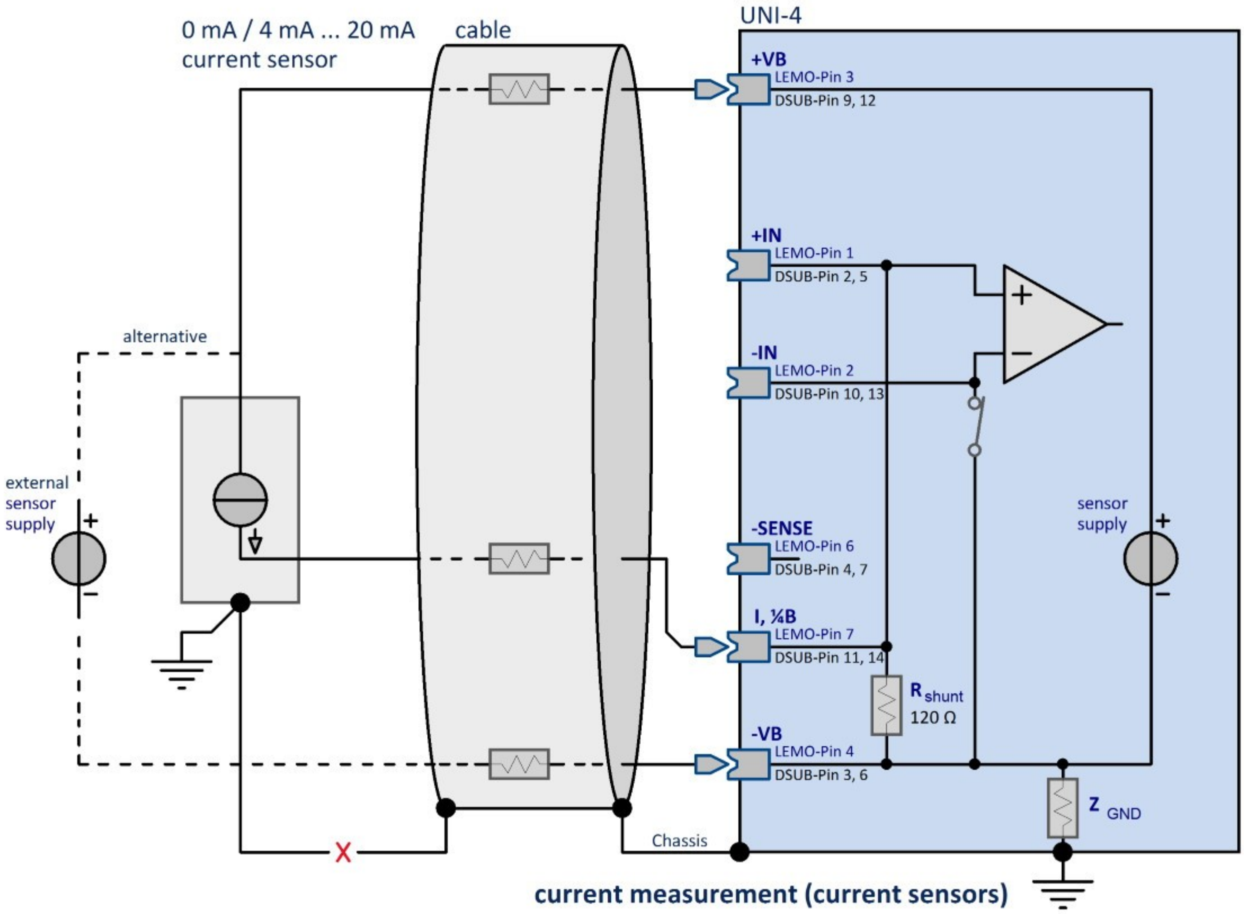
LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

- Current: ±50 mA to ±1 mA

In this circuit, the current to be measured flows through the 120 Ω shunt in the amplifier. Note that here, the terminal -VB is simultaneously the device's ground. Thus, the measurement carried out is single-end or ground referenced. The potential of the current source itself may be brought into line with that of the unit's ground. In that case, be sure that the device unit itself is grounded.

In the settings interface, set the measurement mode to Current.

8.4.2.4.3 2-wire for sensors with a current signal and variable supply



LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

- E.g. for pressure transducers 4 mA to 20 mA.

Transducers which translate the physical measurement quantity into their own current consumption and which allow variable supply voltages can be configured in a two-wire circuit. In this case, the device has its own power supply and measures the current signal. The channels must be configured for current measurement.

The sensor is supplied with power either via terminals +VB and I, 1/4B or via an external sensor supply.

Note

There is a voltage drop both across the resistance on the line side and across the internal measuring resistance of 120 Ω which is proportional to the amperage. This lost voltage is no longer available for the supply of the transducer (2.4 V = 120 Ω * 20 mA). For this reason, you must ensure that the resulting supply voltage is sufficient. It may be necessary to select a lead wire with a large enough cross-section.

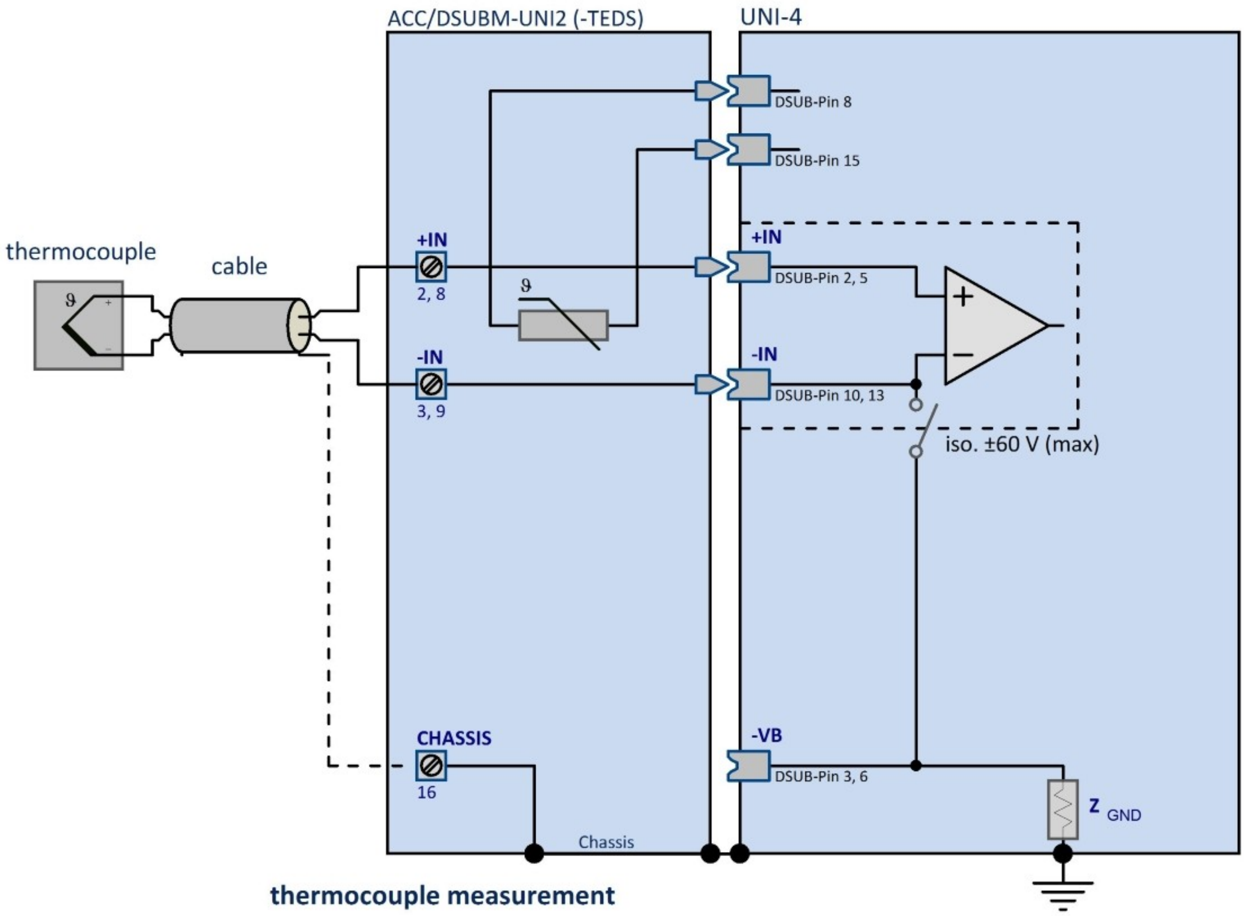
8.4.2.5 Temperature measurement

The amplifier channels are designed for direct measurement with thermocouples, PT100 and PT1000-sensors. Any combinations of the two sensor types can be connected.

Note

A temperature measurement is a voltage measurement whose measured values are converted to physical temperature values by reference to a characteristic curve. The characteristic curve is selected from the Base page of the imc software configuration dialog. Amplifiers which support a bridge measurement must first be set to voltage mode (DC), in order for the temperature characteristic curves to be available on the base page.

8.4.2.5.1 Thermocouple measurement

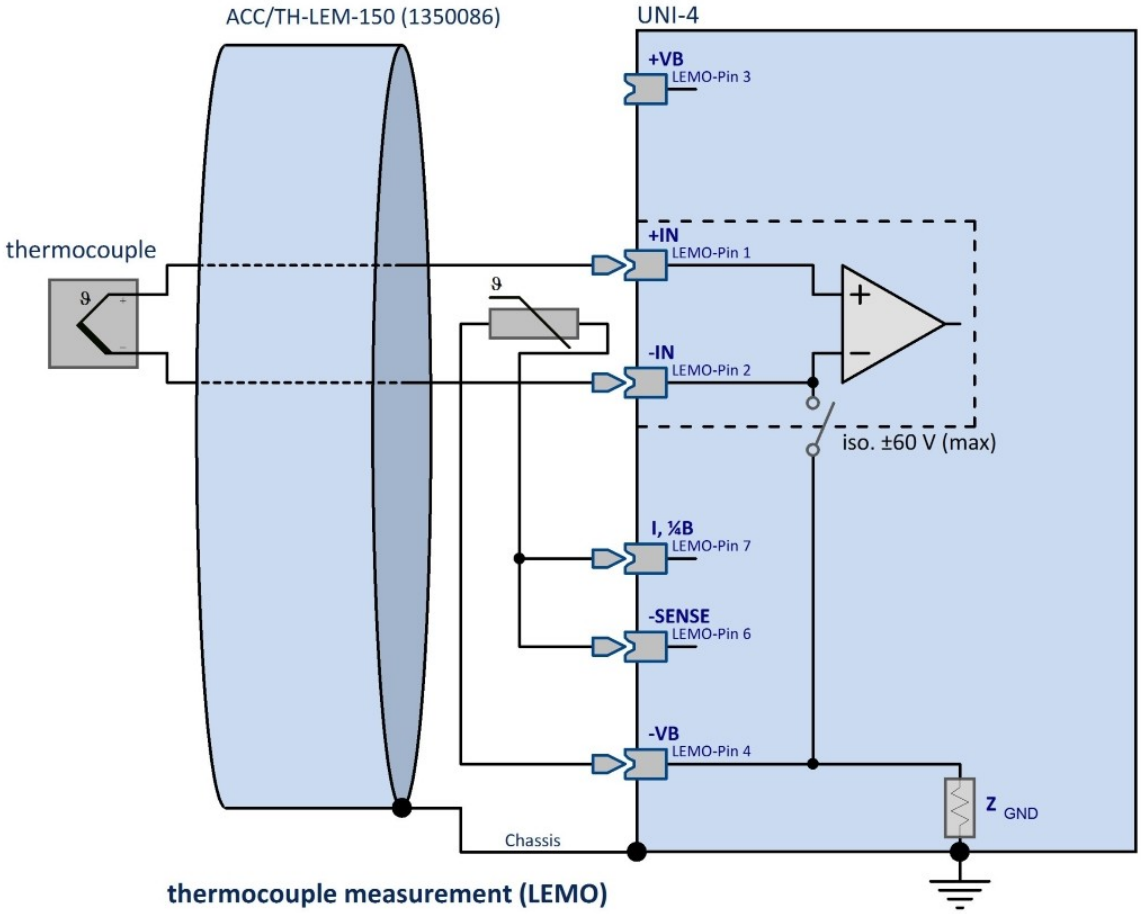


LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

The common types of thermocouples are supported by characteristic curve linearization.

When using standard UNI-4 DSUB variant we recommend the imc plug: ***ACC/DSUBM-UNI2***, with built-in cold-junction compensation.

Note that with **LEMO connection** 504 an external PT100 must be integrated in the plug as cold junction compensation. In addition, the ***ACC/TH-LEM-150*** plug is available as an accessory, a LEMO.1B plug with integrated cold junction compensation.



thermocouple measurement (LEMO)

However, if the temperature processes in the device's environment are not stable, a PT100 in the plug is absolutely necessary. This is certainly the case if:

- there is draught
- if the module is used on-board a vehicle
- if cables with terminals of different temperature are connected
- if the ambient temperature is fluctuating
- whenever reliable and precise measurement is required.

Notes

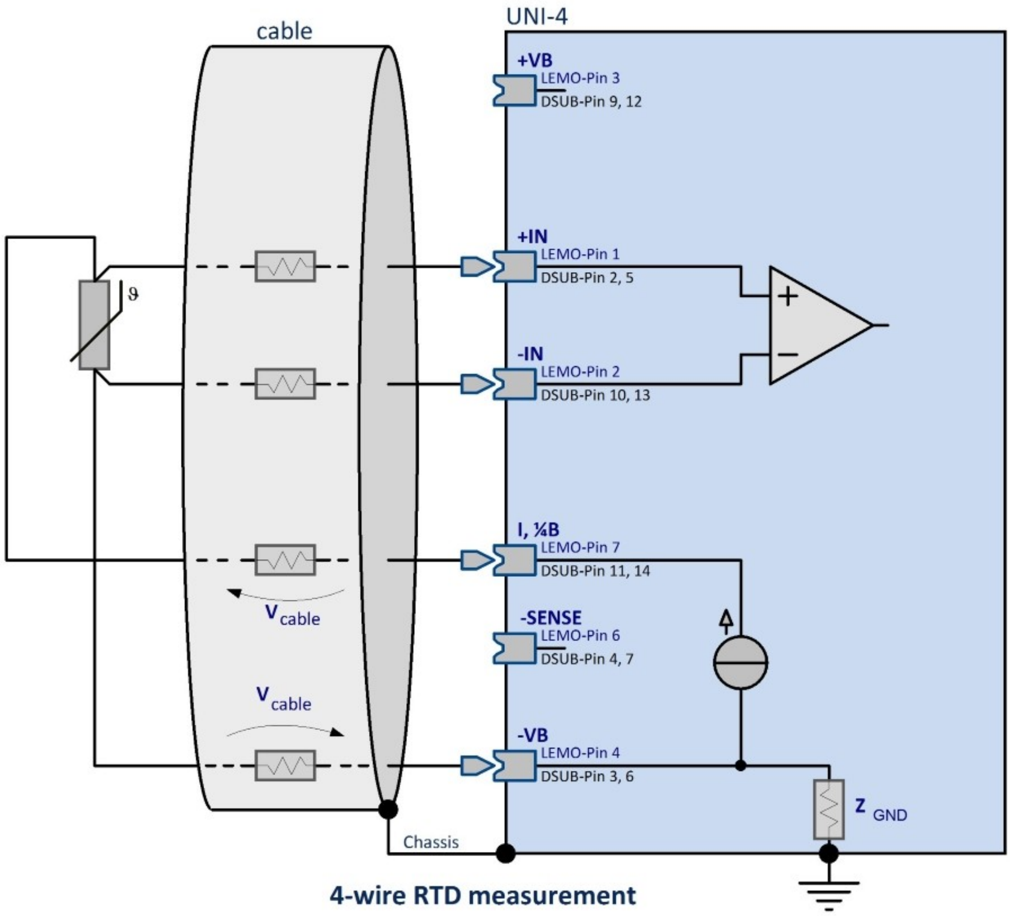
- In the imc software user interface, the option isolated thermocouple (default setting) must be activated under Settings - Configuration - Amplifier. This is only available with DC Coupling.
- Find here a description of thermocouples concerning DIN and IEC 127.

8.4.2.5.2 PT100-, PT1000 measurement

- DSUB-plug: ACC/DSUBM-UNI2 497

PT100/PT1000 can be connected in a 4-wire configuration or 3-wire configuration. The 4-wire configuration is the most precise way to measure with a PT100/PT1000. The 4-wire measurement returns more precise results since it does not require the resistances of both leads carrying supply current to have the same magnitude and drift. Each sensor is fed by its own current source with approx. 250 µA.

8.4.2.5.2.1 PT100 in 4-wire configuration



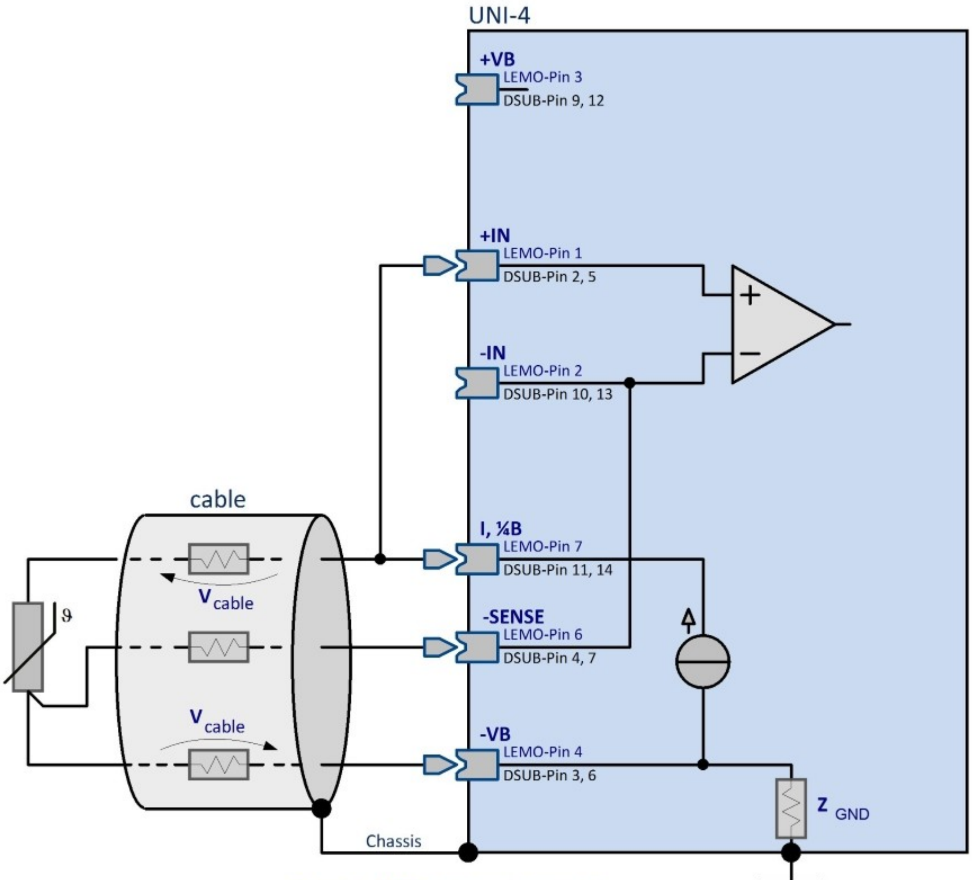
LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

Select in the software the PT100 in 4-wire configuration (input coupling = differential).

The PT100 is supplied by 2 lines. The other two serve as Sense-leads. By using the Sense-leads, the voltage at the resistor itself can be determined precisely. The voltage drop along the conducting cable thus does not cause any measurement error.

The 4-wire configuration is the most precise way to measure with a PT100. The module performs a genuine differential measurement.

8.4.2.5.2.2 PT100 in 3-wire configuration



3-wire RTD measurement

LEMO	is the 7-pin LEMO (standard pinning) 504
DSUB	15-pin DSUB standard pinning 497
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

Select in the software the PT100 in 3-wire configuration (input coupling = single-end).

The PT100 is supplied by 2 lines. An additional line serves as the Sense-lead. By means of the Sense-lead, the voltage at the resistor itself can be determined precisely. The voltage drop along the conducting cable thus does not cause any measurement error.

It is important that the connection between +IN to I_1/4B is made directly at the module.

3-wire configuration is not always as precise as 4-wire configuration. When in doubt, 4-wire configuration is preferable.

8.4.2.5.3 Probe-breakage recognition

The amplifier comes with the ability of probe-breakage recognition.

Thermocouple: If at least one of the thermocouple's two lines breaks, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range in a defined pattern. The actual value reached depends on the particular thermocouple. In the case of Type K thermocouples, this is around 270°C. If the system is monitoring a cutoff level with a certain tolerance, e.g. if the measured value is <-265°C, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location.

The probe-breakage recognition is also triggered if a channel is parameterized for "Thermocouple" and measurement starts without any thermocouple being connected. If a thermocouple is later connected after all, it would take the period of a few measurement samples for transients in the module's filter to subside and the correct temperature to be indicated. Note also in this context that any thermocouple cable's plug which is recently plugged into the amplifier is unlikely to be at the same temperature as the module. Once the connection is made, the temperatures begin to assimilate. Within this phase, the PT100 built into the plug may not be able to indicate the real junction temperature exactly. This usually takes some minutes to happen.

RTD/PT100: If the leads to the PT100 are broken, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range, to about 200°C, in a defined pattern. If the system is monitoring a cutoff level with a certain tolerance, e.g. if the measured value is <-195°C, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location. In case of a short-circuit, the nominal value returned is also that low.

In this context, note that in a 4-wire measurement a large variety of combinations of broken and shorted leads are possible. Many of these combinations, especially ones with a broken Sense lead, will not return the default value stated.

8.4.2.6 Current fed sensors

For measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) 260.

Note	UNI-4 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

8.4.2.7 Sensor supply voltage

UNI-4 channels are enhanced with a sensor supply unit, which provides an adjustable supply voltage for active sensors. This supply voltage is galvanically isolated. The selected supply voltage is set individually for each measurement channel.

The supply outputs are internally electronically protected against short circuiting. The reference potential, in other words the sensor's supply ground contact, is the terminal (clamp) -VB, that is internally bridged to clamp GND.

8.4.2.8 Bandwidth

The channels' maximum sampling rate is 100 kHz (10 µs).

The analog bandwidth (without digital low-pass filtering) is 48 kHz (-3 dB).

8.4.2.9 Connection

The module is equipped with DSUB-15 plugs (CRFX/UNI-4) or LEMO plugs (CRFX/UNI-4-L). Find here the pin configuration of the DSUB-plugs 497 and the LEMO-plugs 504.

8.5 Bridge Balancing or Taring

Almost all modern amplifiers have the ability to compensate for an offset. Besides the conventional bridge balancing 257, for normal voltage amplifiers this includes the capability to perform taring 256. With taring, the value indicated is simply subtracted, which means that the resulting input range is shifted. Taring is also available for bridge amplifiers, but we recommend bridge balancing instead, since it leaves the input range symmetrical.

The operating software imc STUDIO provides a Setup page for configuring and performing bridge balancing and taring.

- Page: Setup > "*Channel balance*" > Tab: "*Balance*"
- Here, you can perform the balancing procedure for one or more channels. Balancing then happens automatically on the amplifier card. If multiple channels are selected, each amplifier card is balanced in parallel, while a card's individual channels are balanced in series. This means that balancing either one or multiple amplifier cards takes the same amount of time.
- When performing balancing by means of the command "*Execute device action*", the balancing types defined here can be used.

Reference	Channel balance

Additional notes and descriptions appear in the imc STUDIO-manual in the section: "*Setup pages - Configuring device*" > "*Channel balance*"

8.5.1 Taring

The sensor's offset in the voltage mode is reset to zero (tare or zero-balancing). The value measured is subtracted from the indicated value. This amounts to a pure calculation, similar to manual input of an offset value on the Processing page in the Settings\Configuration dialog. This means that taring has no effect on the amplifier's electrical behavior.

Example:

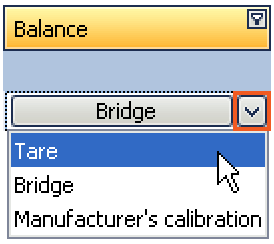
Input range = ± 10 V,

Value indicated before taring = 3 V

Input range after taring= -13 V to 7 V

Operation using the program imc STUDIO:

To perform an adjustment, first select the channel and in the column "*Balance*" using the button a right, the desired action.



Adjustment only starts once you click on the button after making your selection. The input range correspondingly is reduced by the amount of the zero adjustment. If the initial offset is so large that it's not possible to adjust it by means of the device, a larger input range must be set.

Note Notes on hardware: balancing with setted offset

Zeroing with adjusted offset leads to different results with CRFX/CRXT modules and amplifiers installed in imc CRONOS*compact*, imc C-SERIES or imc SPARTAN:

- CRFX/CRXT: Zeroing adjusts the channel in the physical unit, e.g. 0 bar. This applies to all modules for the acquisition of analog voltages with 16 or 24 bits, except UNI-4.
- imc CRONOS*compact*, imc C-SERIES, imc SPARTAN, CRFX/UNI-4: The electrical value is balanced, i.e. the entered offset is retained. After the adjustment, the physical value is displayed with a negative offset. This ensures that an offset entered subsequently is not overwritten. If you wish for the balancing to determine the offset, **only enter the factor**, and then subsequently balance the offset by means of the Balancing function. Adaptation to the behavior of CRFX/CRXT is in preparation.

8.5.2 Bridge balancing

A significant characteristic of bridge measurements is the fact that the actual measurement signal is attended by an offset which can be **multiples of the input range**. Measurement bridges, consisting for instance of wire strain gauges (WSGs), respond to minuscule changes in their components' resistance (in the µV/V = ppm = parts-per-million = 1E-6 range). The static initial asymmetry (offset) due to the components' production tolerances or assembly conditions, by comparison, can be in the range of mV/V, in other words in the range of the total input range or even multiples of it.

Since the offset also depends on the sensor connected it can't be calibrated for the device, but must be balanced **before starting the measurement**. The precondition for this is that the sensor used must be set up in the system the same way for the balancing as for the measurement and **may not be stimulated dynamically**.

Balancing the bridges restores the symmetry of the physical input range, which does not possible by means of taring 256.

8.6 Overdriving a measurement range

Generally, all conditioning modules (amplifiers) of the imc CRONOS series allow linear operation up to minimum 100% of the selected nominal full scale range. The numerical implementation of imc CRONOS data structures however, theoretically allows the representation of twice the nominal range (±2xFS).

The analog signal path usually allows for some additional overdriving margin, even without leaving the linear transmission range. Overdriving behavior is also determined by analog and numerical limits of the ADC and numerical limits of subsequent signal processing. Additionally, certain internal reserves in signal range are necessary to account for characteristic filter settling and overshoot, as well as calibration headrooms. All these aspects lead to slightly varying limits and behavior with respect to hard or soft saturation or increasing nonlinearities. These can depend on actual module type, chosen measurement mode and range.

To facilitate easy identification of overrange status, some imc CRONOS modules implement the following behaviour:

If some internal signal exceeds its allowable range, which will typically be the case at aprox 105% of full scale range (±1.05 x FS), then the output and displayed data value will be forced to exactly (±2 x FS). This serves an an explicit indicator for an invalid operating condition. It is intended as a "warning flag" to prompt the user for selecting an appropiate measurement range. As such it is considered an extra feature and benefit, that will assist in avoiding any invalid measurement data, as in an overdriving case, a relieable relation between displayed data and real world signals can no longer be guaranteed.

Additionally, in the case of BR2-4 169, the overrange "flagging" will incorporate a "monoflop" behaviour: any detected illegal overrange state will be extended and flagged to a minimum duration of 200 µs.

In this context, it is important to be aware, that any detected internal overdriving might refer to an unfiltered raw input signal, not yet subjected to digital filtering or other signal processing. This is why it is well possible, that a low pass (or AAF) filtered channel might still appears to be within the nominal range, while the raw input and thus internal nodes, containing significant high frequency content, could already exceed the allowable range. Such a case would be characterized by a displayed signal that would instantly jump from maybe 80% FS to 200% FS.

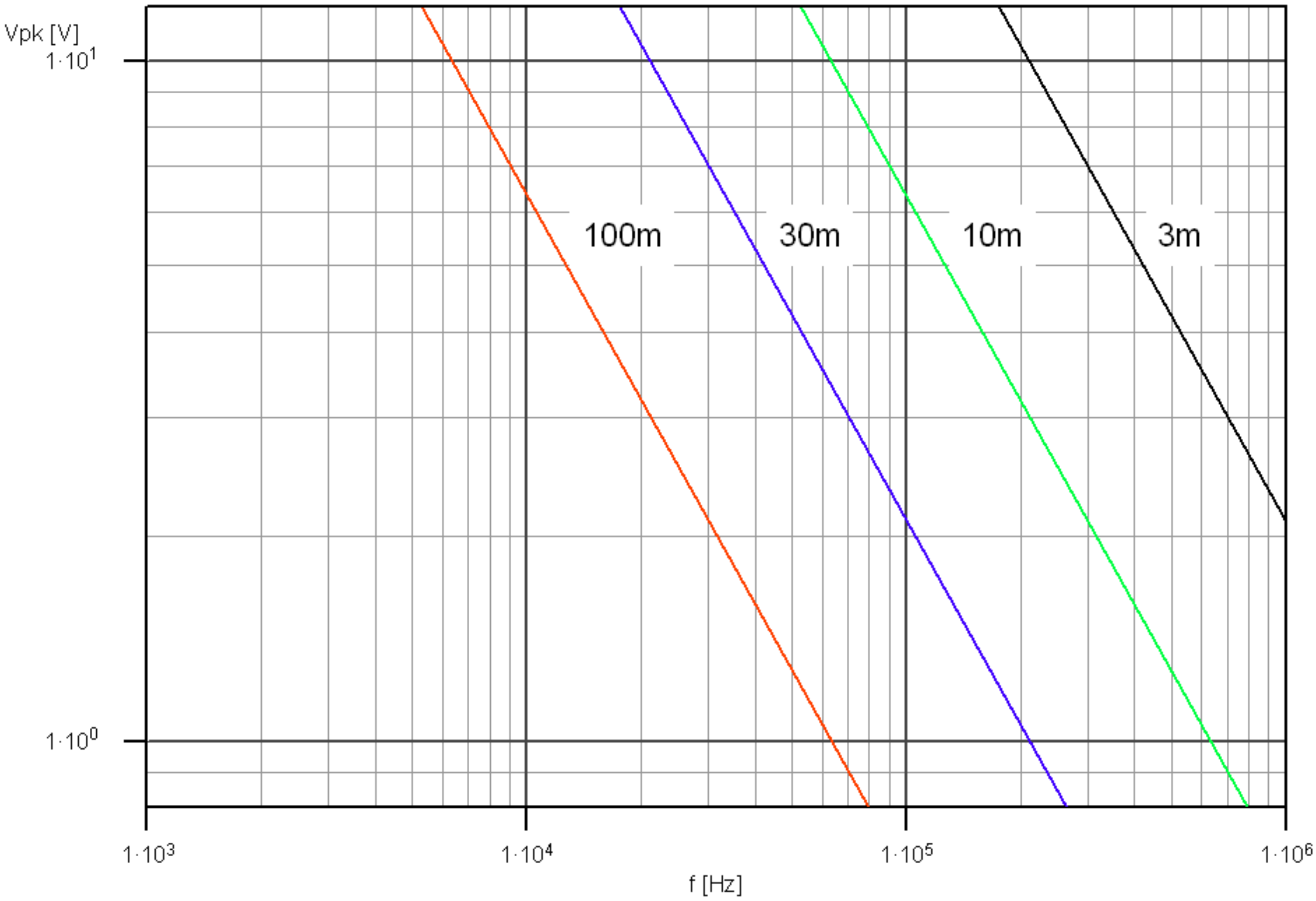
These type of overrange limitations are in fact a natural and inevitable charactersitic of any data acquisition and measurement system – either analog or digital. Especially when dealing with wide band signals, and low pass signal conditioning, it has to be guaranteed that analog and digital linear signal ranges are covered with sufficient headroom in all relevant stages of the signal chain.

In practical applications, this means that the measurement range has to be chosen by taking in account sufficient headroom margin, to cover the maximum levels under all expected conditions. If in doubt, an unfiltered measurement, temporarily deselecting any low pass or anti-aliasing filter, might unveil unexpected peak levels and verify a correct setting.

8.7 Measurement with current-fed sensors (IEPE)

With current-fed sensors (e.g. ICP™-, DELTATRON®-, PIEZOTRON®-, PIEZOBEAM®-sensors), the capacitive burden on the signal due to the cable capacitance can lead to clipped amplitudes for higher frequencies. To avoid signal distortion, try to:

1. keep the cable short,
2. use a low-capacitance cable,
3. use a less sensitive sensor.



Maximum signal amplitudes as a function of the signal frequency and the cable length, with a 4 mA feed and a capacitance of 100 pF/m.

8.7.1 Supply current

The exact magnitude of the supply current is irrelevant for the measurement's precision. Values of 2 mA tend to be adequate. Only in the case of very high bandwidth and amplitude signals in conjunction with very long cables, supply currents may be a concern, as considerable currents are need to dynamically charge the capacitive load of the cable.

dynam. current headroom:	I	= 4 mA
cable capacity (typ. coax-cable):	C	= L · 100 pF/m
max. signal slew rate (full-power):	dU/dt	= 5 V · 2 · π · 25 kHz
-> max. cable length:	L_{max}	= 4 mA / (100 pF/m · 5 V · 2 · π · 25 kHz) = 50 m

Up to a **max. cable length of 50 m**, no limitations are to be expected as long as the conditions above are fulfilled.

Find here the description of the ICP-plug 260 and here technical specs: ACC/DSUB-ICP. 480

8.8 Measure with IEPE/ICP expansion plug

In general, imc plug is a plug with imc housing (formerly plastic today metal), which enables the connection of the sensors to the inputs of the measuring amplifier via a DSUB-15 plug connection. A distinction is made between terminal plugs and expansion plugs. While a terminal plug makes the amplifier characteristics or a subset of them accessible, the use of an expansion plug allows the amplifier characteristics to be changed.

In order to fulfill different measuring tasks, imc provides a variety of measuring amplifiers. It should be noted that the properties of the measuring amplifier used are changed (in the desired way) by the connected expansion plug. This expansion must be made known to the measuring system via the operating software.

8.8.1 IEPE/ICP-Sensors

The IEPE/ICP-channels are specially designed for the use of current-fed sensors in 2-wire-configuration.

IEPE, Integrated Electronics Piezo Electric, is the standard for piezoelectric transducers. IEPE (ICP)-sensors are typically employed in vibration and solid-borne sound measurements and are offered by various manufacturers as solid-borne sound microphones or accelerometers under different (trademarked) product names, such as: PCB: ICP-Sensor, KISTLER: Piezotron-Sensor, Brüel&Kjaer: DeltaTron-Sensor. The commonly used name ICP (Integrated Circuit Piezoelectric) is actually a registered trademark of the American manufacturer "PCB Piecotronics".

This sensor type is fed with a constant current of typically 4 mA and delivers a voltage-signal consisting of a DC-component (typ. +12 V) superimposed with an AC-signal (max. ±5 V). Typical source resistance values (internal resistance) of ICP sensors are on the order of magnitude of max. 100 Ω.

8.8.2 ACC/DSUB-ICP2 and ACC/DSUB-ICP4

As a special accessory for voltage channels, an ICP expansion plug is available. This plug can be used to directly connect current-fed ICP-sensors also at voltage channels. The ACC/DSUB-**ICP4** is equipped with four channels and the ACC/DSUB-**ICP2** with two channels, see the DSUB-15 pin configuration 499.

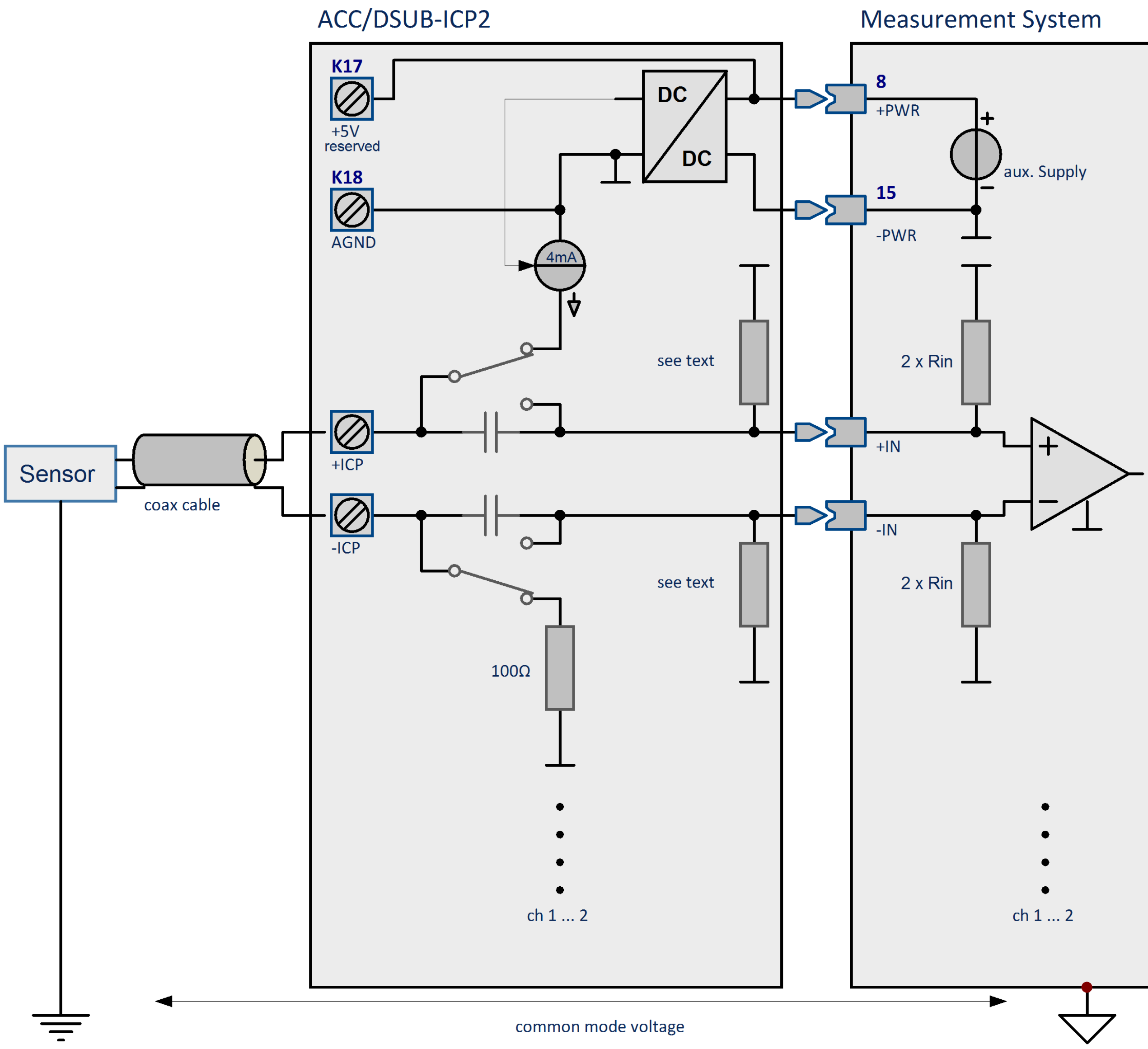
This (active) expansion plug having the same dimensions as the imc DSUB-plug, comes with additional conditioning equipment built into its housing and having the following **features**:

- Individual current sources for the current-fed IEPE/ICP-sensors
- Each source: 4.2 mA (typ.), voltage swing: max. 25 V, see technical details: ACC/DSUB-ICP 480
- Differential AC-coupling to block the signal's DC-component (approx. +12 V), typical with IEPE/ICP

- Each channel can be switched to DC-coupled voltage measurement or current-fed IEPE/ICP measurement (AC-coupled); ex-factory the **DIP-Switch** for each channel inside the plug is switched to IEPE/ICP measurement (AC-coupled)
- For the supply of this expansion plug, the amplifier used provides a voltage of 5 V. This voltage is short-circuit proof and independent of the voltage supply 167. The maximum load is 1.35 W. The ICP2 plug requires a maximum of 500 mW for its internal needs, the ICP4 plug requires 1 W. This means that the 5 V pin has 0.85 W or respectively 0.35 W available.

Note

The two channel plugs **ACC/DSUB-ICP2** in all variants can also be used with amplifiers that provide **four channels on one DSUB-15** socket. In this case only the **odd channel numbers (1, 3, 5, 7) can be used**.



DIP-Switch position ICP (DIP-Switch inside of the expansion plug):

- The AC-coupling is already provided by the ICP-plug, the **voltage channel is DC-coupled**.
- The measurement range must be adapted to the signal's AC-component, it can be adjusted within the range: ±5 V to ±250 mV
- The combination of the built-in coupling capacitor (2 x 220 nF corresponding to 110 nF diff.) with the impedance of the IEPE/ICP-plug (2 MΩ diff.) and the input impedance constitutes a high-pass filter. When connecting the plug or sensor, be aware of the transients experienced by this high-pass filter, caused by the sensor's DC-offset (typ. +12 V). It is necessary to wait until this phenomenon decays and the measured signal is offset-free!
- When the ICP-expansion plug is used, a considerable offset can occur (in spite of AC-coupling), which can be traced to the (DC-) input currents in conjunction with the voltage amplifier's DC input impedance. This remainder, too, can be compensated by high-pass filtering with imc Online FAMOS.

DIP-Switch position Volt (DIP-Switch inside of the expansion plug):

- The voltage channel is DC-coupled, the current source de-coupled.
- The voltage channel's input impedance is reduced by parallel connection with the IEPE/ICP-plug's impedance.

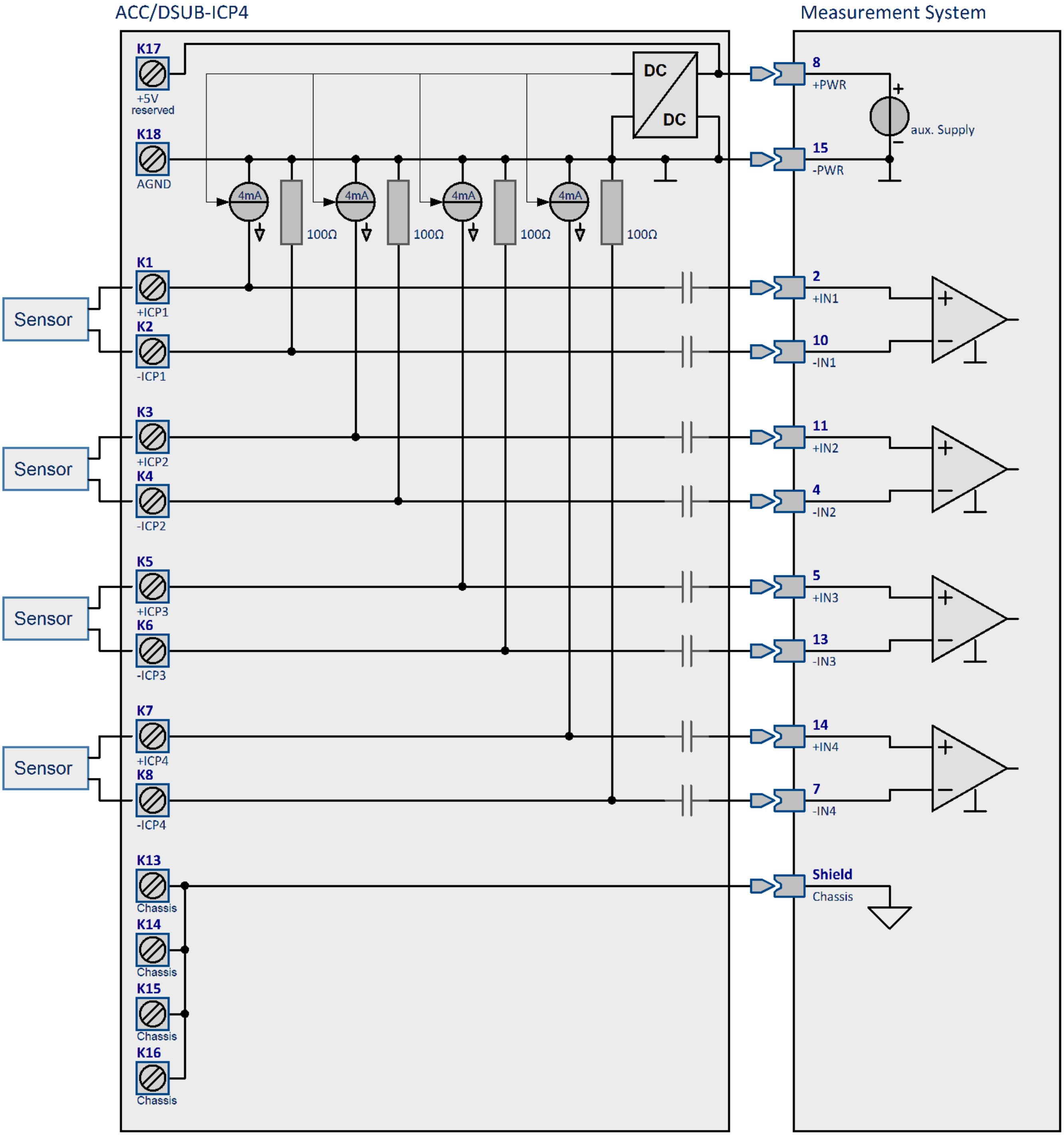
The voltage amplifiers' different input impedance values (with / without input divider) depend on the voltage range selected. The resulting high-pass cutoff frequencies and the time necessary for the 12 V-offset to decay to 10 µV are shown.

Range	diff. R_in	Result impedance	tau	fg	Settling (10 µV)
≥±5 V	1 MΩ	0.7 MΩ	73 ms	2.2 Hz	1.0 s
≤±2 V	10 MΩ	1.7 MΩ	18 ms	0.9 Hz	2.6 s

In terms of the shielding and grounding of the connected IEPE/ICP-sensor, note:

- We recommend using multicore, shielded cable, where the shielding (at the plug) is connected to the plug "CHASSIS", or can be connected to the pull-relief brace in the plug.

The following circuit schematic display an entire plug. The DIP switches are not included in order to achieve a more simple schematic.



8.8.3 ACC/DSUBM-ICP2I-BNC(-F,-S)

This expansion plug is used to extend imc measurement amplifiers with DSUB-15 sockets with an IEPE conditioning which allows the direct connection of 2 current-fed IEPE/ICP sensors, e.g. IEPE microphones, accelerometers of the type ICP™-DeltaTron®- or PiezoTron® etc.

The IEPE conditioning comprises 4 mA current supply and AC coupling and is channel-individually isolated. This ensures good ground loop suppression and allows operation of transducers that are either grounded or mounted with isolation towards CHASSIS ground.

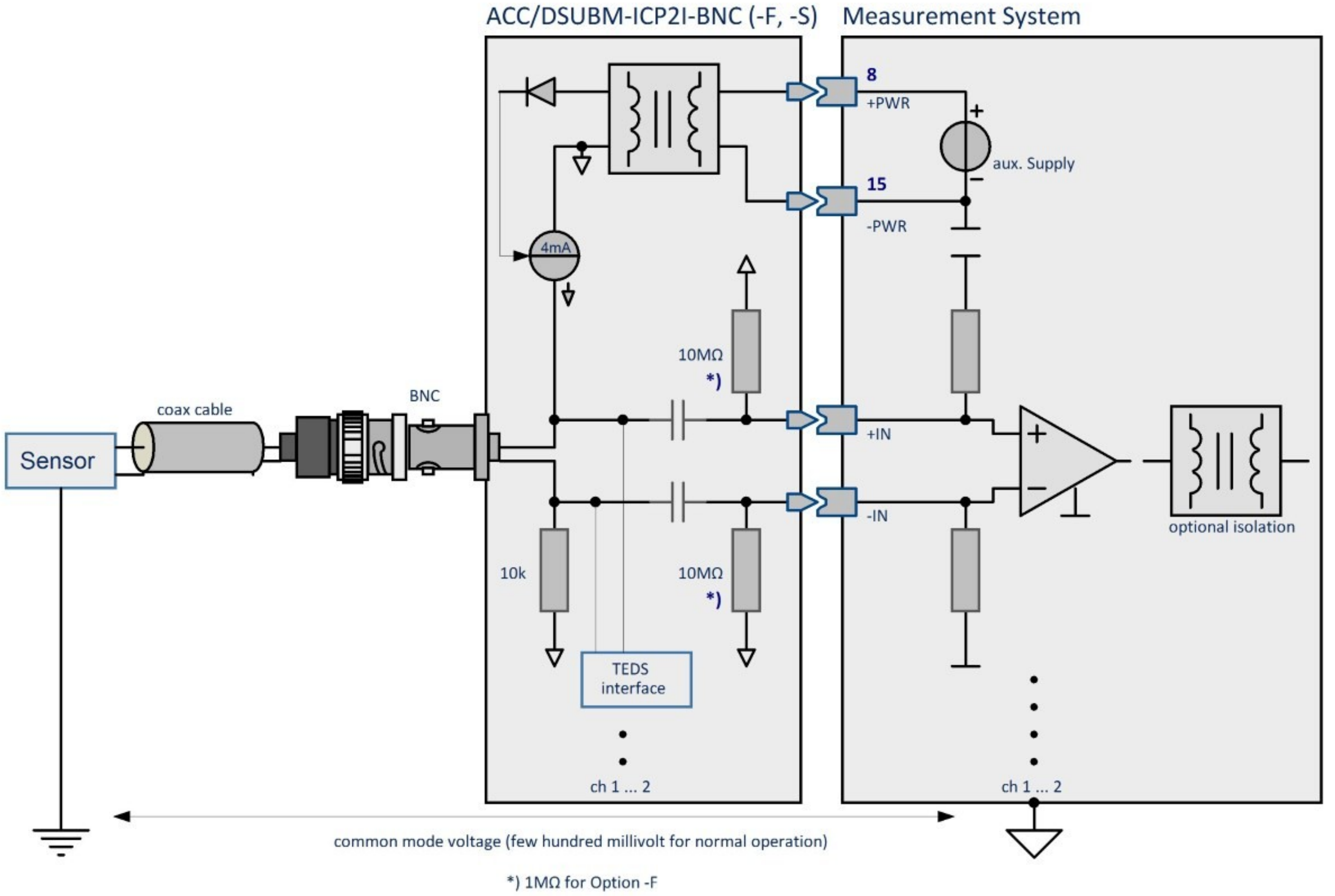
The expansion plug can be operated in conjunction with isolated and non-isolated voltage and bridge amplifier modules.

It has a TEDS interface for reading out information from the sensor, as long as it supports TEDS (Transducer Electronic Data Sheets according to IEEE 1451.4, Class I, MMI). Thanks to the isolated TEDS interface readout is also supported for grounded transducers as well as with triaxial sensors that have one single common ground lead. Furthermore (and independent from the sensor) the TEDS interface is also used to allow automatic detection of a connected plug by the involved amplifier (supported depending on amplifier type).

IEPE/ICP sensors deliver alternating AC signals which are superimposed on a static offset and decoupled by means of a high-pass ("HP", AC coupling, RC circuit). After connection and activation of the plug, full settling of this AC coupling can take well beyond 10 seconds.

Two variants of the expansion plug are available:

- The **S variant** (slow) achieves minimum cutoff frequency, thus limits the lower bandwidth of the sensor as little as possible. However, the transient response after plugging in (activation) can take longer (>10 seconds).
- The **F variant** (fast) settles faster (approx. 1 second) and therefore does not quite reach the minimum cutoff frequency, but with < 1 Hz is sufficient for very many applications in this form.



ACC/DSUBM- Expansion plug vs. dedicated ICP amplifiers

In contrast to dedicated IEPE/ICP mode amplifier types such as QI-4, AUDIO2-4 or ICPU2-8, this extension plug can provide IEPE support for more universal type amplifiers. This added flexibility comes at the expense of a somewhat limited handling comfort.

In particular it is important to be aware that the presence of the plug will dynamically change the properties and capabilities of the associated channel, which needs to be communicated to the host amplifier and the control software. The TEDS functionality is used for this detection process (independent of any sensor specific TEDS data!), which has certain implications for handling and operation.

Basic functionality (ICP-operation) does not require software support and has no associated requirements. However, for support of **sensor TEDS functionality** and for improved **offset performance** it is required that the plug is recognized and supported by the operation software. In particular this involves the activation of an additional digital high pass filter to remove some small residual offset that results from the high impedance AC coupling.

Supported amplifier types (full support vs. basic functionality)

Amplifier resp. Device family		CRFX, CRXT	CRC, CRSL	C-SERIES
UNI2-8	CS-7008-FD	✔✔	✔	✔
DCB2-8	CS-5008-FD	✔✔	✔	✔
B-8	--	✔✔	✔	✔
LV3-8	CS-1208-FD	✔✔	✔	✔
ISO2-8	CS-4108-FD	✗	✗	✗
ISOF-8	--	✗	✗	--
UNI-4	--	✔✔	✗	--
BR2-4	--	✗	✗	--
SC2-32	--	--	✗	--
LV-16	CS-1016-FD	--	✗	✗

✔✔ Software support with variant differentiation (-F/-S), full support of TEDS sensors including sensors of the type DS2431 and a improved offset performance

✔ Software support without variant differentiation (-F/-S), support of TEDS sensors except sensors of the type DS2431 and a improved offset performance

✗ only basic functionality (ICP-operation), no support of TEDS sensors and no improved offset performance

-- amplifier is not part of this device family

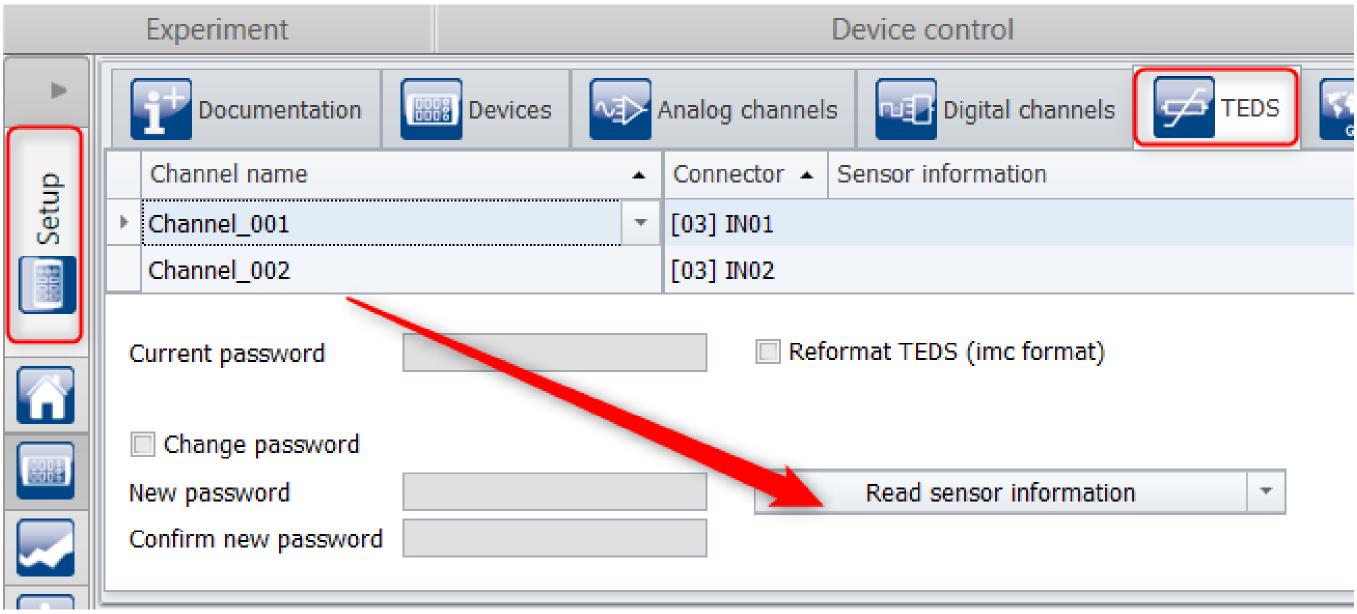
The variant differentiation (-S/-F) function is only supported in the CRFX and CRXT device platform:

- Amplifier types with full software support (especially UNI2-8, DCB2-8, B-8, LV3-8, UNI-4) also have matched transient response in the CRFX/CRXT context (digital high pass selected accordingly).
- In the CRC and C-SERIE context, on the other hand, although the lower AC cutoff frequency is determined by the connector variant (-S/-F), the settling time is relatively long for both variants because the additional digital high-pass is fixed at low cutoff frequency in both cases.
- The fast variant therefore does not settle quickly!
- On the other hand, in conjunction with amplifier types that do not offer software support (e.g. ISO2-8, ISOF-8, BR2-4, UNI-4 in CRC context, etc.), the extension plugs are not recognized at all and are therefore not extended with additional digital high-pass. Therefore the behavior is only determined by the analog RC time constants. Thus, both cutoff frequency and settling time are clearly differentiated in the sense of slow/fast, and the fast variant also settles fast. However, the improved zero point accuracy due to the digital high pass is omitted.

Reference

Technical Specs: ACC/DSUBM-ICP2I-BNC(-F,-S) 481

8.8.3.1 Plug recognition via TEDS function



Expansion plug without TEDS Information of the sensor

When using the IEPE/ICP-expansion plug without any sensor connected, or in conjunction with a simple passive sensor without any TEDS memory, the software acknowledges this procedure with "apparent" error messages which in reality, however, just reflect the fact that no **TEDS** data of the actual sensor are recognized.

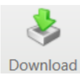
Typical **expected and normal "error"-messages** occurring in conjunction with valid recognition of the ICP-expansion plug:

6305 *The sensor is not connected correctly!*
Typically when a passive sensor is connected, or in case of short circuit.

6318 *The sensor is not connected directly, or is not making sensor information available!*
Typically when BNC terminal are left open / unused.

These two messages are actually the ***expected response*** to successful detection of the ***plug without sensor information!***

Triggering of plug recognition via "Download" (only CRC, C-SERIES)



With the **CRC/C-SERIES**, plug recognition is automatically triggered during the "**Download**" process. This only identifies the plug and error messages regarding non-existent sensor information 267 are omitted.

Therefor the measurement mode must be set to the compatible setting "*Voltage, DC-coupling*", otherwise an incompatible coupling is reported.

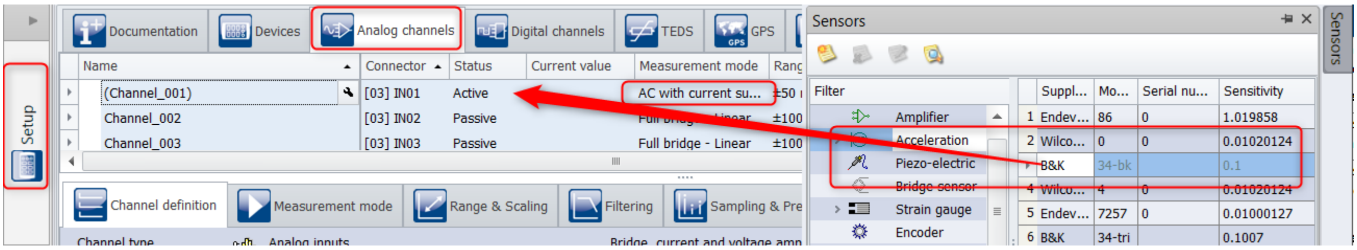
Note

The software is optimized so that the repeated execution of the *Download* function is only effective if the device settings have been changed. The plug attachment is not registered as a change in the device settings. In case of doubt it may therefore be necessary to force a new *download*, e.g. by switching a channel parameter back and forth.

Expansion plug in conjunction with/without TEDS-capable sensor

When a **sensor with its own TEDS memory** is connected, its read out properties are recognized, such as the scaling and the unit. Only in this case, where there is valid TEDS information about the sensor itself, the input coupling of the channel will be displayed as "*AC with current supply*".

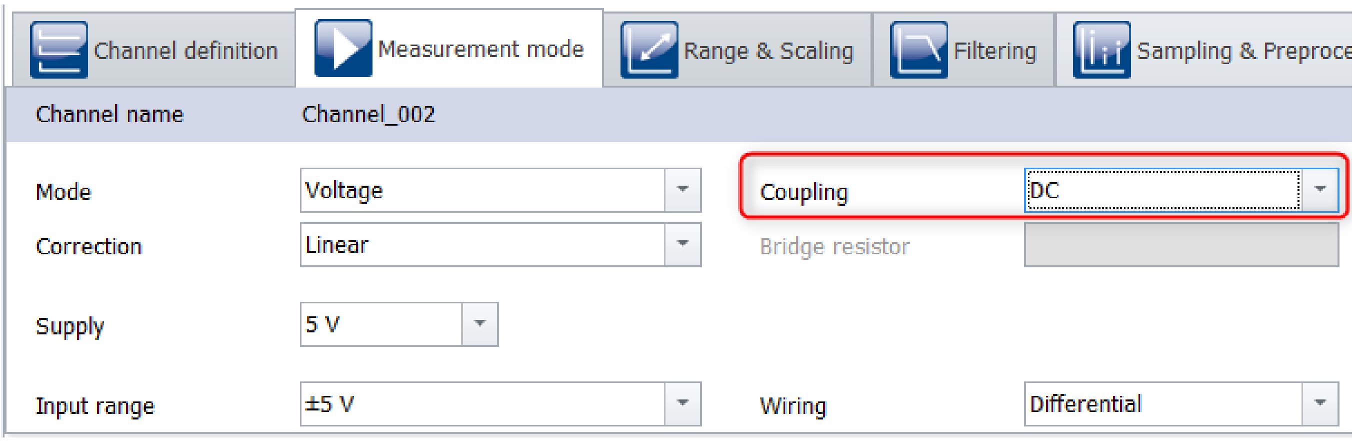
This AC coupling is also displayed if the sensor information is not read via TEDS, but when an ICP sensor is linked to the channel via the imc SENSORS database (drag&drop):



ICP expansion plug with TEDS information from the sensor or from the imc SENSORS database

IEPE/ICP-sensor without TEDS information

In the simple case of an IEPE/ICP-sensor ***without TEDS memory***, all of the amplifier's regular input couplings remain available, although among these, it is necessary to always select "***Voltage, DC-coupling***". All other couplings are invalid in connection with the expansion plug and cause the associated error messages to appear upon Download.



Erkannter ICP-Erweiterungsstecker, aber keine weiteren Sensorinformationen: Spannungsmodus DC-Kopplung

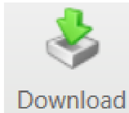
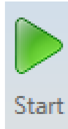
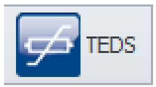
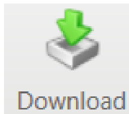
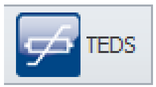
Note — ICP-sensor without TEDS

When using a simple **sensor without TEDS memory**, the recognition procedure will displayed with the messages above (#6305, #6318) 267, and the input coupling of the downstream amplifier will be displayed (*Voltage, DC-coupling*). However, the **expansion plug's AC-coupling and current feed**, as well as the digital high-pass filter, are actually in effect.

8.8.3.2 Software recognition

The ICP expansion plug supports ICP transducers with integrated TEDS memory (Class I MMI). The plug itself is also recognized via the TEDS functionality. The TEDS mechanism is used for plug recognition even when the actually used transducer that is connected to the plug does not support TEDS and does not incorporate any TEDS memory at all.

Depending on the device family involved, identification of the plug and the sensor, as well as resetting, are initiated/triggered by various circumstances:

Device family	Abbr.	Plug detection is caused by bei	Function
imc CRONOS*compact*, imc C-SERIES	CRC, CS, CL	Plug detection always takes place automatically every time the measurement is downloaded or under after changing the configuration upon start.	 
		Reading of sensor data, however, is only possible via the TEDS function. The plug recognition is then updated as well.	
imc CRONOS*flex*, imc CRONOS-XT	CRFX, CRXT	No physical identification upon download, neither plug nor sensor.	
		Time of identification can be controlled by the function: *"TEDS – read sensor information*" The system not only attempts to read the sensor-TEDS memory, but will also attempt to identify any intermediate expansion plug.	

Additionally, with all device families: Plug detection by the device itself, always upon ***Power-Up.***

8.8.3.3 Further information

Verifying successful plug recognition

The successful identification of the expansion plug can especially be seen in the fact that the attempt to configure a bridge mode (e.g., half-bridge) will lead to the following message upon download:

6328 *The input coupling set is not supported by the imc clamp terminal connected*!
(message for **CRFX**)

6329 *All channels of the connected imc clamp terminal require the same input coupling*: AC with current feed or DC!*
(message for **CRC/C-SERIES**)

---

* As of imc STUDIO version 5.2 R15 the input coupling has been renamed to: "IEPE".

Only with CRFX: Alternatively, you can obtain verification with CRONOS***flex*** by pulling out the plug, forcing a "*Download*" (e.g. toggling the input range and returning it to original setting). This will lead to the following message:

6334 The required imc clamp terminal ACC/DSUB-ICP is not connected!

This test only works with **CRFX!** With **CRC** and **C-SERIES** however, it is not possible to do a check in this way: Here, successful plug recognition cannot be checked explicitly, but instead a new plug recognition is forced with each Download procedure. Thus, the no longer present plug along with its information would be deleted.

Deleting/resetting the plug recognition

Conversely, in order to delete this "hidden" information about a recognized ICP expansion plug, the plug must be physically disconnected and (particularly with CRFX) TEDS readout function must explicitly be forced. This leads to the regular "error" message (expected and correct behavior!):

6319 Either the imc terminal plug is not connected correctly or is unsuitable for the sensor communication!

Thus, software is forced to verify the presence of the plug, which fails as expected and resets the status to "*without ICP expansion plug*".

Plug vs. Sensor info

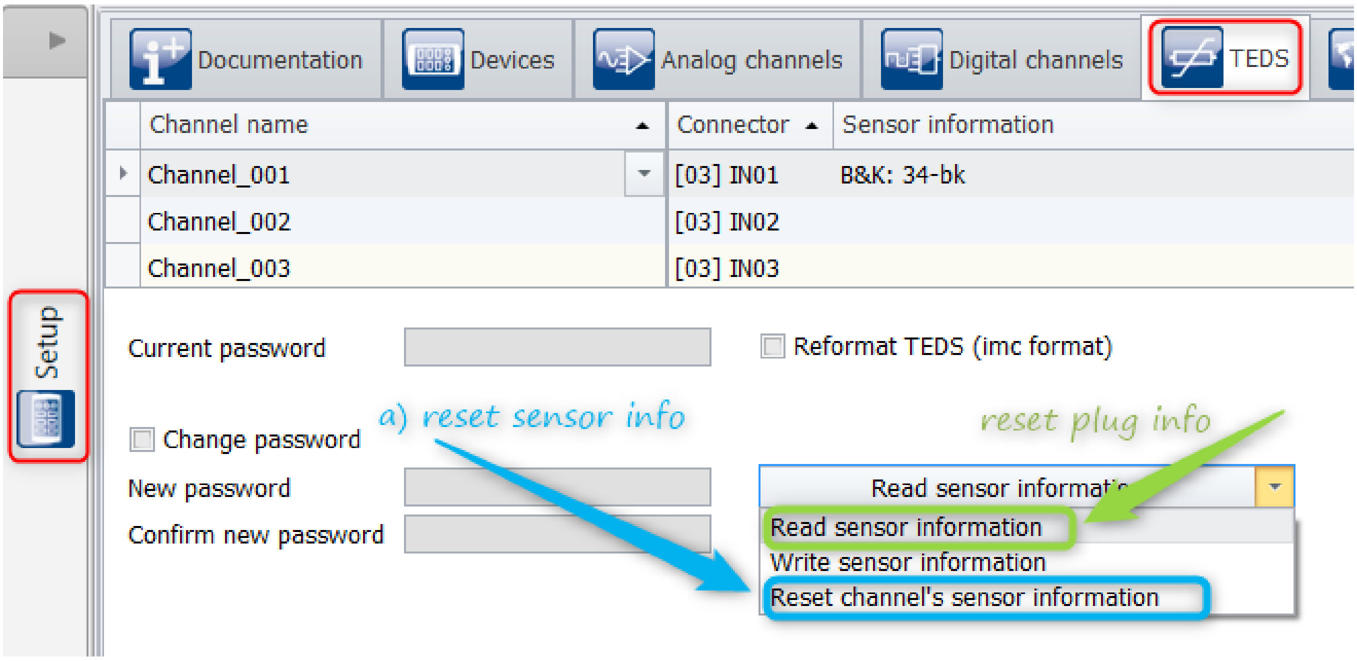
When resetting the recognition, there is a distinction between two stages:

a) Resetting the ***Sensor-information***

Using the TEDS-function "*Reset channel's sensor information*". This does **NOT** delete the **plug** information!

b) Resetting the **plug recognition**

By **unplugging the plug** and using the TEDS-function "*Read sensor information*". Only after completion of this process is the plug information deleted!



Reset sensor- and plug info

Special note regarding the **CRC/C-SERIES**: As long as no SENSOR data are used, but only the plug recognition is to be reset, it is sufficient in this case to unplug the plug and to force a repeat of the Download procedure. Not applicable to CRFX.

Firmware-Update / behavior upon starting

In all device families, as a rule the stand-alone device performs plug recognition **upon Power-Up.** in order to be able to take into account any plug-specific processes for possible autostart configurations. If this has not been successfully verified, an automatic measurement will not be started and a corresponding error message is stored on the onboard flash (device memory). Therefore the plug must always be plugged in correctly at the time of Power-Up.

In contrast to this, the following applies to a **firmware update**: When a firmware update is performed, **the plug should not be plugged** in! The firmware update may change the properties of the amplifier. The reboot during the firmware update causes a new readout and the verification described above is missing. For this reason, if you are prompted to perform a firmware update, ensure that any expansion plugs are disconnected, before clicking on "*OK*" to initiate the update.

8.8.3.4 List of possible error messages and their causes

Alongside the routine status messages described above, other errors can occur, e.g., in conjunction with the loading of experiments which had been created with expansion plugs connected, or in conjunction with TEDS information from the sensor itself. The following notes are intended to help in trouble shooting.

2363 Combination of coupling and input setting not allowed

Cause: The channel settings (generated via TEDS or expansion plug) contradict the module properties.

This condition can occur when a device (with default properties) is to be run with an experiment which had been created in conjunction with expansion plugs (other properties). In order to resolve the problem, restore the hardware setup associated with the experiment or modify your experiment /create a new experiment.

This can also happen, when sensor-TEDS cause inappropriate channel settings. In order to fix this problem reset the sensor information 270:
TEDS-function: "*Reset channel's sensor information*"

Alternatively, you can import the appropriate sensors (TEDS) with appropriate coupling:
TEDS-function: "*Read sensor information*"

or make settings via the sensor database:
in conjunction with imc SENSORS: drag&drop from the tool window "*Sensors*"

6305 The sensor is not connected correctly

In conjunction with the ICP expansion plug:

Correct recognition of the expansion plug, however without using a sensor having its own active TEDS-memory: not an error!

In conjunction with "normal" TEDS sensors (e.g., with the ACC/DSUBM-TEDS-xxx clamp terminals):

Cause: As described in the message. Most often, the issue is reversed polarity. Switch around the two contacts of the 1Wire chips and try again.

6310 After preparation of the device, the imc terminal plug at the channel was switched!

Cause: A plug with plug information had been detected in the past and is affecting the module properties (modes, correction values). Message 6310 indicates that the expected plug has been disconnected and replaced. If this happened intentionally, the sensor information can be reset: 270
TEDS-function: "*Reset channel's sensor information*".

6318 The sensor is not connected directly, or is not making sensor information available!

Cause: Reading of sensor information (TEDS) was unsuccessful.

In conjunction with the ICP expansion plug:

Correct recognition of an expansion plug, without connected sensor (BNC open): **not an error!**

In conjunction with "normal" TEDS sensors, or ICP sensors having their own active TEDS memory:

Possibly either the TEDS memory type (1Wire-type) or the format is not supported. For clarification, please contact the Hotline.

6319 Either the imc terminal plug is not connected correctly or is unsuitable for the sensor communication!

Cause: The reading of sensor information (TEDS) was unsuccessful because TEDS is not supported by the plug or by the amplifier, or the plug was disconnected.

In conjunction with ICP- (or Q) expansion plug:

When using the function "*Read TEDS sensor information*": In case of intentional disconnection of the plug for purposes of resetting the plug recognition: **not an error!** When attempting to recognize an actually connected plug: Possibly, this plug is not supported by this particular amplifier. For clarification, please contact the Hotline.

If the message appears in conjunction with the Downloading of a test, then evidently a previously recognized expansion plug has been disconnected. If that was done intentionally, then you should *explicitly reset the plug recognition by using:* 270

TEDS-function: "Read sensor information".

6328 The input coupling set is not supported by the imc plug connected!

Also: ***6329** All channels of the connected imc clamp terminal require the same input coupling: AC with current supply or DC! (The coupling mode "AC with current supply" has been renamed to "IEPE" as of imc STUDIO version 5.2 R15.)*

Cause: An expansion plug has been recognized which requires specific settings for the coupling (e.g., an ICP-plug requires either DC coupling or AC with current supply; no kind of bridge circuit would be allowed).

In order to fix the problem, make an appropriate setting for the amplifier: If you have already set the affected channels to "passive" for this purpose, then Downloading of the test is sufficient.

8.9 External sensor supply

8.9.1 CRFX/SEN-SUPPLY-4 module

The SEN-SUPPLY-4 module provides high-performance ±15 V power to operate 4 sensors. It is designed especially for the purpose of using modern Fluxgate current transducers such as LEM Ultrastab types as well as precision current clamp.

As a passive module it can be operated/combined with any amplifier types by hooking up to the amplifier inputs via patch cables (LEMO.1B).

It can be used both in conjunction with CRFX-modules (aggregate modules snapped together), as well as in stand-alone operation, and with amplifiers and devices belonging to other device families such as imc CANSAS, imc C-SERIES, etc.

Reference

- Technical Specs 470
- Pin configuration: LEMO 505 and DSUB-9 507

Click-mechanism and power supply

The signals for the EtherCAT system and power supply, which are routed on the module connector, are looped through the module, but not used. The module is supplied with power (20 V to 50 V DC) exclusively from the separate LEMO.1B (2-pin) socket and not from the click connector. This voltage also has no contact on the module connector.

The power supply input is compatible with the POWER-HANDLE or UPS-module for imc CRONOS*flex*: The supply for the SEN-SUPPLY-4 module is not routed through the supply line of the click connector. Instead, the permanently regulated and (in conjunction with UPS-function) buffered 50 V output voltage of the POWER-HANDLE can be used via one of its 5 auxiliary outputs ("AUX" on the rear panel, LEMO.1B.304; corresponding connection cables are available). The primary supply voltage of the POWER-HANDLE can always lie within the wide range of 10 V to 50 V DC suitable for vehicle use!

Status-LED

Each of the four supply connections has a status LED. This has two functions:

1. If an overload is detected, the status LED lights up red for at least two seconds, otherwise it lights up green.
2. Some sensors output the status of the sensor via a separate "Fail" port. The "FAIL" signal at the DSUB-9 socket is connected to the corresponding sensor connection: The LED lights up green when the "FAIL" signal = GND. If the voltage at the FAIL contact is not GND (0 V) or if the connection is open, the LED lights up red.

8.9.2 External +5 V supply voltage

For a majority of the imc measuring modules there is a **5 V supply voltage** available for an external sensors or for the IEPE/ICP expansion plug. This source is not isolated; its reference potential is identical to the overall system's ground reference.

The +5 V supply outputs are electronically protected internally against short-circuiting and can each be loaded up to max. 160 mA (short-circuit limiting: 200 mA, refer to the data sheet of the used module). The sensor's reference potential, in other words its supply-ground connection is the terminal "GND". The used pins 497 at the DSUB-15 plug Vcc=+5 V and GND fulfill a double function for amplifiers, that can be used for temperature measurement. They provide the supply for the build in cold junction compensation of the thermo plug (ACC/DSUBM-T4 129). In this case, the 5 V supply can not be used for external sensors.

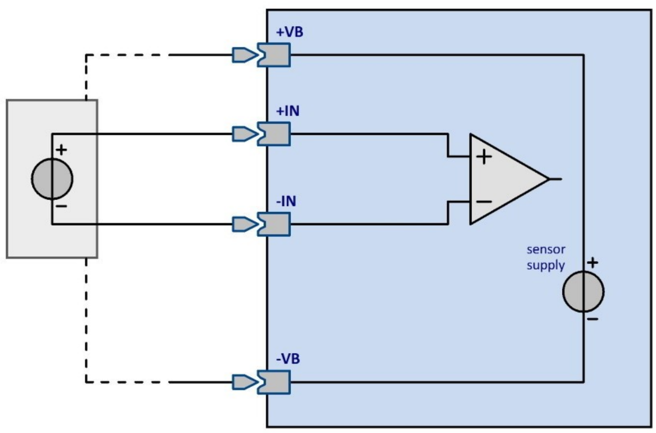
8.9.3 Sensor supply module

The SEN-SUPPLY module is available as a plug-in module (occupying one slot) with a selectable sensor supply voltage. Via a switch at the front panel of the module the supply voltage can be selected. There is a maximum power of 3 W available. Find here technical details of the SEN-SUPPLY 469 module.

Some modules can optionally be equipped with an adjustable sensor supply. This will not cause an enlargement of the width of those modules. In order to differentiate between the modules we add a suffix to the name of the module: "..-SUPPLY, e.g. ISO2-8-SUPPLY 395.

Note

Important: The settings are made via software interface. Make sure that the sensor supply is not set too high before connecting a sensor. Otherwise, the sensor could suffer damage.



The sensor supply is unipolar and can be led out with DSUB-15 plugs at +VB and -VB (or +SUPPLY and -SUPPLY, see typing label in your plug). Only five selectable settings are available per module. The configurations can be taken from the respective module data sheet. The voltage can be set globally for all channels of a module. All channels of a module form a channel group.

A bipolar supply voltage of ±15 V instead of the unipolar 15 V is available as special request. The sensor supply voltage is in this variant not isolated (to CHASSIS). This is also recommendable in most cases. With this **±15 V option** the pin 6 is the reference at least with the U4 plug 497.

Example

+15 V via pin 6: GND and pin 3: +VB (+SUPPLY), -15 V via pin 6: GND and pin 12: -VB (-SUPPLY), +30 V via pin 12: -VB -(SUPPLY) and pin 3: +VB (+SUPPLY). Each table with the pinning in chapter "*Pin configuration*" list in a foot note the reference, if there is a reference.

If an isolated, active sensor is both fed with an isolated supply and measured with an isolated channel, then (due to isolation drift or capacitive interference coupling) an uncontrolled common mode voltage will emerge unless a common mode voltage is imposed from outside (or, for instance, by targeted grounding) which may be too strong interference to suppress. Only if the sensor to be supplied with power is already affected with a common mode voltage due to the measurement setup, or if the -SUPPLY return lines are already exposed to uncontrolled ground loops, an isolated sensor supply may be advisable.

Note

The supply voltage is set on each channel group and does apply to **all inputs** of this group. For the number of channels per group is depending on the type of amplifier.

8.10 Fieldbus interfaces

The supported fieldbus interfaces available at imc are described in the chapter "Device properties". The devices are equipped with the desired fieldbus at the imc factory. Subsequent expansion or replacement is not planned.

Reference

- CAN, CAN FD 121
- LIN 122
- EtherCAT 126
- ARINC 122
- FlexRay 122
- XCPoE 122
- PROFIBUS 123
- Profinet 122
- MVB 124

8.11 DI, DO, DAC, HRENC and SYNTH

Digital modules	CRXT	Slots needed in CRC, CRSL:	Channels per module	Bandwidth	Remarks
DAC-8 300	--	1	8 8	50 kHz 5 kHz	analog outputs with CRC, CRSL with CRFX, see "digital CRFX modules" 276
DI2-16 279	✔	1	16	30 kHz	isolated: digital inputs
DO-16 293, DO-16-HC 296	✔	1	16	10 kHz 5 kHz	isolated: digital outputs with CRFX, see "digital CRFX modules" 276
DI16-DO8-ENC4 283	--	2	16 / 8 / 4	10 kHz / 500 kHz	isolated: digital in / out incremental counter channels
DI8-DO8-ENC4-DAC4 292	--	2	8 / 8 / 4 / 4	10 kHz / 500 kHz	isolated: digital in / out incremental counter channels + analog out
DIO-HV-4 280	--	2	4		high isolated: high voltage digital in / out
ENC-4 301	--	1	4		incremental counter channels
FRQ-4, FRQ2-4 307	--	1	4	500 kHz	frequency modulated signals
HRENC-4 308	✔	1	4	500 kHz	incremental counter channels

8.11.1 Digital CRFX Modules DIO, Pulse Counter and DAC

This family of modules provides in- and output of digital signals and extend imc CRONOS*flex* systems with the capability to control measurement environments such as test stands.

imc CRONOS*flex* DIO, Pulse Counter, DAC modules features and specs

	size	connector	digital I/O				DAC	pulse counter			
module name CRFX/xxx	width	standard connector	input Bits	high voltage	output Bits	high current	analog outputs	counter inputs	quadrature mode chan	counter frequency	analog sin/cos mode
Base Unit extension											
DI16-DO8-ENC4	+40mm	DSUB-15	16		8			4	2	32 MHz	
DI8-DO8-ENC4-DAC4	+40mm	DSUB-15	8		8		4	4	2	32 MHz	
flex modules: pulse counter											
HRENC-4	1	DSUB-15						4	4	256 MHz	●
flex modules: digital I/O, DAC (★)											
DI2-16	1	DSUB-15	16								
DI2-32	2	DSUB-15	32								
DI-16-HV (110V)	2	Terminal blocks	16	●							
DO-16-HC	1	DSUB-15			16	●					
DO-32-HC	2	DSUB-15			32	●					
DI2-16-DO-16-HC	2	DSUB-15	16		16	●					
DAC-8	1	DSUB-15					8				
DO-16-HC-DAC-8	2	DSUB-15			16	●	8				

Prosa:
Digital I/O: galvanically isolated, configurable to 24V / 5V(TTL/COMOS) Level, output: 0.7A sink, high current: sink and source 0.7A
Pulse Counter: full analog input conditioning (500 kHz analog bandwidth, differential input, analog filter, Software adjustable threshold levels)
modes: event counter, differential and absolute angle and displacement, time, pulse width (PWM), phase difference, frequency, speed, RPM

16-channel modules provide 16 Bit of the same type (DI or DO).

32-channel modules can be chosen as pure DO or DI type modules or as a combined one (16+16). Those modules are implemented as "Double-modules" acting as two logical modules with their respective IDs displayed on two 7-segment-displays.

The 7-segment-display at the front of each logical module display the assigned address in HEX format with the prefix "d". This "d" stands for digital module. Every added module will be recognized by the Base Unit and will be addressed automatically with the next free address. You can change this automatically assigned address via the imc operating software. Please find a detailed description in the software manual, see chapter of the "*Module properties*". The maximum amount of possible digital modules in on measurement system find here 321.

The modules that are integrated into a Base Unit are not equipped with a 7-segment-display at the front and are addressed ex-factory with "d0".

8.11.2 CRFX/DI-16-HV

16 digital input for high voltage (110 V / 24 V)

This imc CRONOS*flex* Module (CRFX/DI-16-HV) is equipped with digital inputs that can sample signals conforming to either 24 V or 110 V logic standards.

The connection is realized via 4 terminal blocks of 4 bits each. The logic standard of each group of 8 Bit can be set via a switch.

Highlights

- isolated 4 Bit groups
- input level is configurable

CRFX/DI-16-HV

Technical Specs: CRFX/DI-16-HV 456

A switch sets the logic standard (and thus threshold level) for each 8-bit group.

Logic-level	configuration	LOW level	HIGH level
24 V	switch of terminal (24 V)	<10.1 V	>15.1 V
110 V	switch to terminal (110 V)	<48.3 V	>56.3 V

The input stage has Schmitt-trigger characteristics, meaning switching thresholds with hysteresis. The thresholds specified correspond to the following cases:

- LOW-level: maximum signal level clearly identified as LOW; for the transition HIGH > LOW
- HIGH-level: minimum signal level clearly identified as HIGH; for the transition LOW > HIGH

The minimum hysteresis value is 0.4 V (TTL/CMOS-logic) or 1.6 V (24 V-logic).

The common reference ground of each 4-bit group is located at "0V_1", "0V_2", "0V_3" and "0V_4".

Internal pull-down-resistors provide a well-defined LOW-level in case of open inputs.

8.11.2.1 Data format, asynchronous polling mode

The system's names for the digital inputs are Din02_Bit01..16 and can be renamed in the usual way, if desired.

If the digital inputs are activated for data capture (as 16-bit ports), then, like all other channels, they generate a data stream at the corresponding sampling rate.

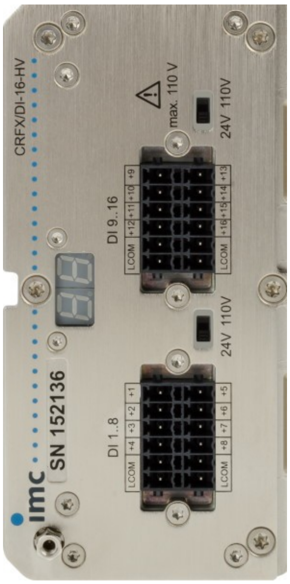
These can be displayed in **curve windows**, using any of the usual display styles, such as curve plots, waterfall, readout of single values, etc. Regarding the display, they are equivalent to any other channels. Of course, it is also possible to jointly display digital and analog channels in a shared curve window.

Available channels include both the individual bits ***DIn02_BIT01 ... DIn02_BIT16*** with a Boolean input range (1 / 0), as well as the complete ***16-bit port*** as channel ***DIn02***, which can assume values in the range 0 to 65535 (unsigned Integer).

Only synchronous data recorded in this form are available as a data set which can be saved to the hard drive.

An additional data reduction mode is available which only generates data upon transition to a new signal state. In this mode, processing of the data in imc Online FAMOS is only possible under limited circumstances.

8.11.2.2 Pin configuration



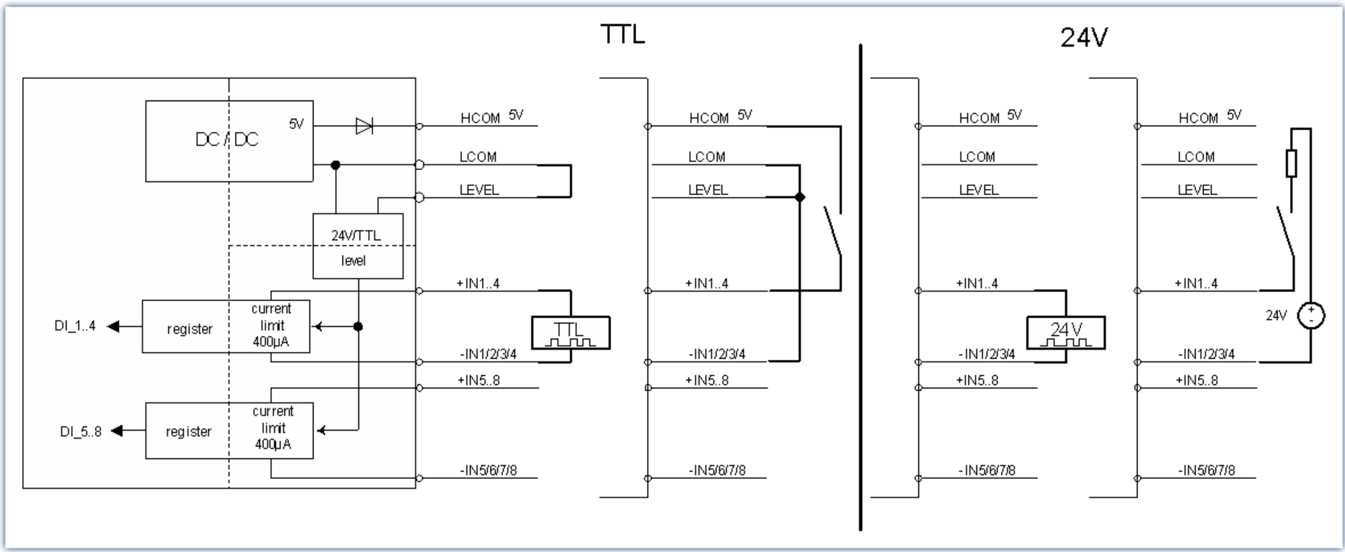
The common reference ground of each 4-bit group is located at LCOM

8.11.3 DI2-16: Digital Inputs

The DI2-16 possesses 16 digital inputs which can take samples at rates of up to 10 kHz. Every group of four inputs has a common ground reference (-IN1/2/3/4 or -IN5/6/7/8) and are not mutually isolated. However, this input group is isolated from the other input groups, the power supply and CAN-Bus.

Technical details of the DI2-16: Digital Inputs 439.

The pin configuration of the DSUB-15 plug: ACC/DSUBM-DI4-8 497.



8.11.3.1 Input voltage

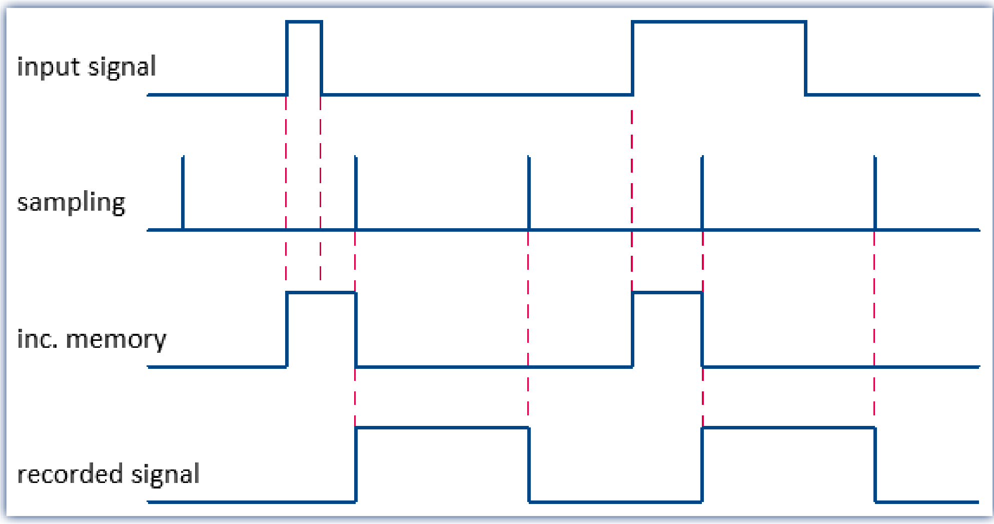
The input voltage range can be set for a group of 8 channels to either 5 V (TTL-range) or 24 V. The switching is accomplished by means of a jumper at the ACC/DSUB(M)-DI4-8 connector:

- If LEVEL and LCOM are jumpered, all 8 bits work with 5 V and a threshold of 1.7 V to 1.8 V.
- If LEVEL is not bridged with LCOM, 24 V and a threshold of 6.95 V to 7.05 V are valid.

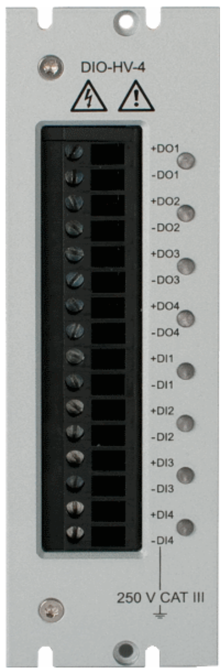
Thus, an unconnected connector is set by default for 24 V. This prevents 24 V from being applied to the voltage input range of 5 V.

8.11.3.2 Sampling interval and brief signal levels

The digital inputs can be recorded in the manner of an analog channel. It isn't possible to select individual bits for acquisition; all 8 bits (digital port) are always recorded. The hardware ensures that the brief HIGH level within one sampling interval can be recognized.



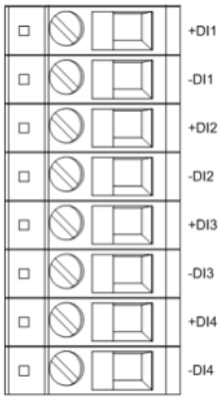
8.11.4 DIO-HV-4: Digital Inputs and Digital Outputs



The imc CRONOS*compact* CRC/DIO-HV-4 Module is equipped with 4 isolated digital inputs and 4 isolated digital outputs, build as relay contacts.

	**Warning !** **Do not damage the safety seal !** The DIO-HV-4 Module was inspected for compliance with the safety guidelines per DIN EN 61010-1 prior to delivery and subjected to a high-voltage test. The module is sealed after having passed these final tests. If the safety seal is damaged, safe work cannot be ensured. Any intervention, for instance temporary removal of the module, makes re-inspection for safety.

8.11.4.1 DIO-HV-4: Digital Inputs

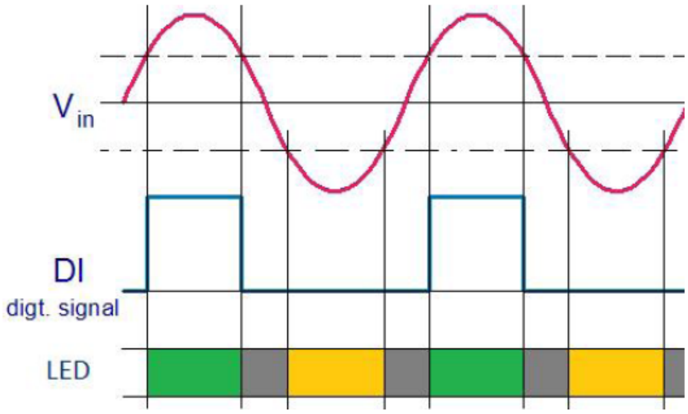


The four digital inputs are galvanically isolated in between each other and from the measurement system.

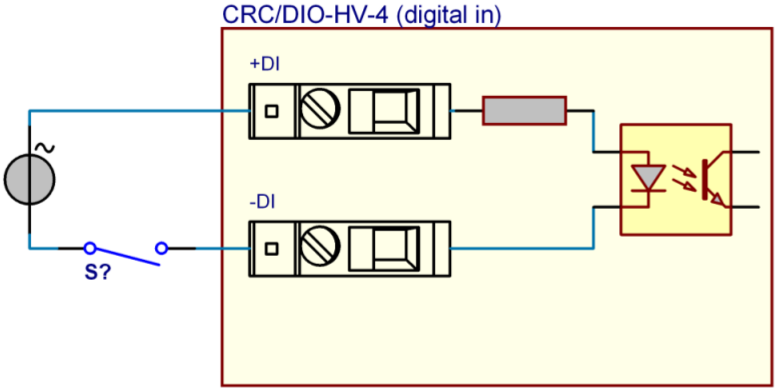
These mainly serve to process 230 V_{eff} voltages, but it is also possible to monitor lower DC or AC voltages.

Technical details: Digital Inputs 444

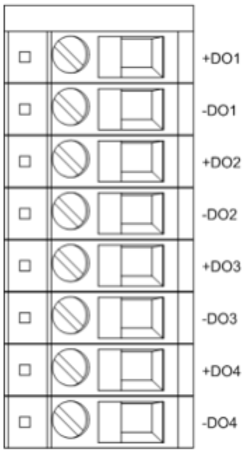
If the signal is above the switching threshold (typ. 16 V), the state of the input bit = 1 is displayed and the LED shines green. Below the switching threshold (typ. 16 V), the state is = 0 and the LED is off. Below – 16 V the LED shines yellow.



Digital input connection scheme for a 230 V voltage



8.11.4.2 DIO-HV-4: Digital Outputs



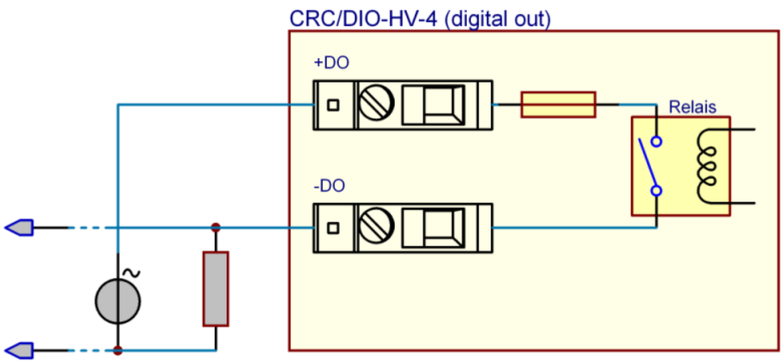
The four digital outputs are build as relays contacts.

The contact are insulated from the measurement system.

If a digital output bit is set, the relay contact closes and the LED shines.

Technical details: Digital Outputs 445

Example for a digital output with switched voltage and pull-down resistor.



The measurement module offers no internal reference voltage. That has to be connected externally.

8.11.4.3 DIO-HV-4: Connection

For the appropriate cable cross.sections, please see the technical specs
(PHOENIX spring-clasp 2,5-H/SA-5).

8.11.5 DI16-DO8-ENC4: Digital Multiboard

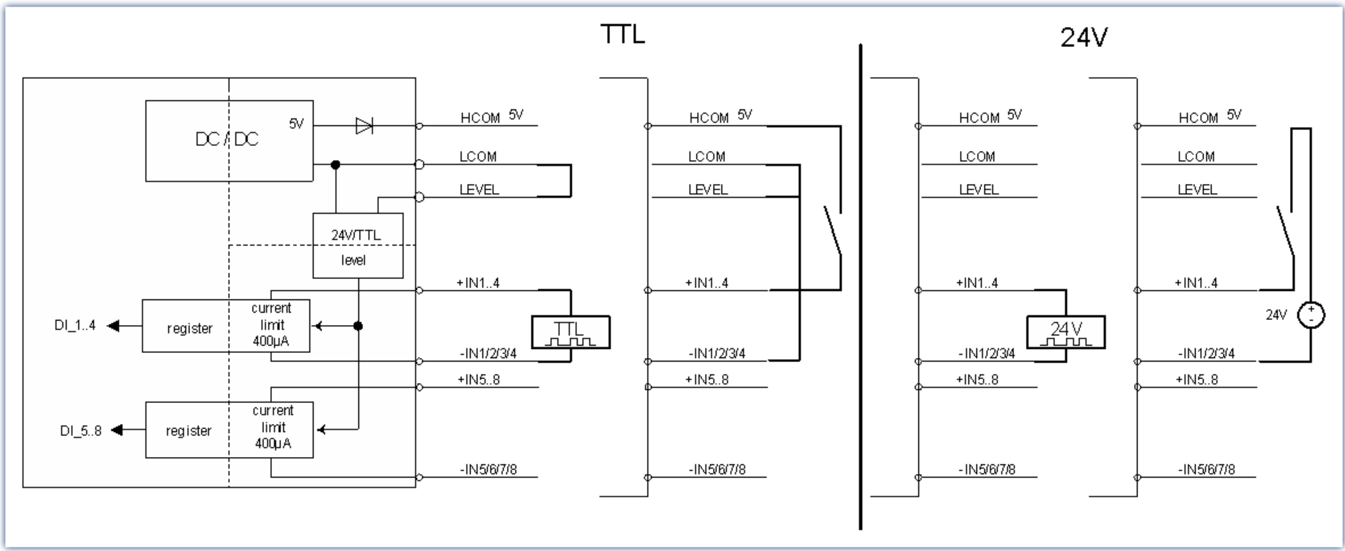
There are 16 binary inputs, 8 binary outputs and 4 incremental counter inputs available.

8.11.5.1 Digital Inputs

The DI potion possesses 16 digital inputs which can take samples at rates of up to 10 kHz. Every group of four inputs has a common ground reference and are not mutually isolated. However, this input group is isolated from the second input group, the power supply and CAN-Bus, but not mutually.

The technical specification of the digital inputs 440.

The pin configuration of the ACC/DSUB(M)-DI4-8 497.



Open inputs are set to have LOW voltage by means of pull-down resistors

8.11.5.1.1 Input voltage

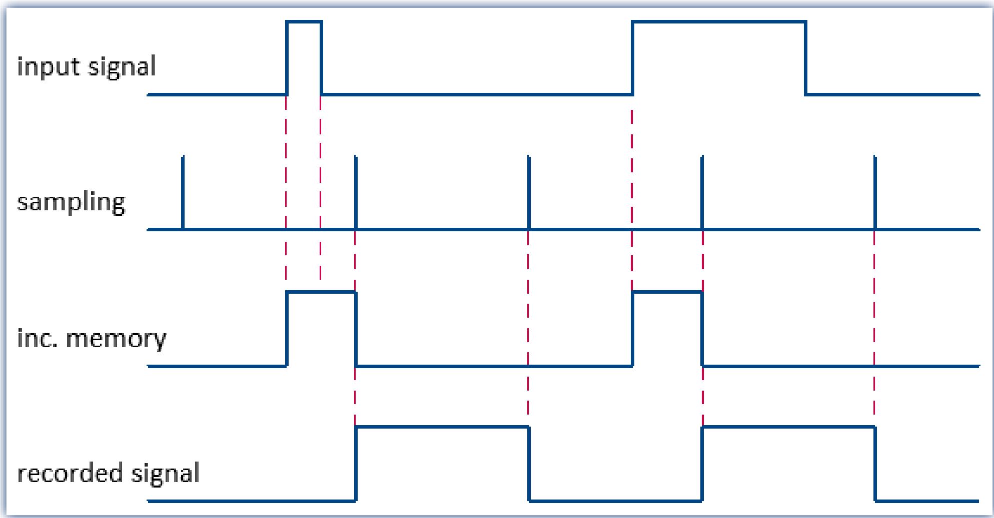
The input voltage range for a group of eight digital inputs can be set for either 5 V (TTL-range) or 24 V. The switching is accomplished by means of a jumper at the ACC/DSUBM-DI4-8 plug:

- If LEVEL and LCOM are jumpered, all 8 bits work with 5 V and a threshold of 1.7 V to 1.8 V.
- If LEVEL is not bridged with LCOM, 24 V and a threshold of 6.95 V to 7.05 V are valid.

Thus, an unconnected connector is set by default for 24 V. This prevents 24 V from being applied to the voltage input range of 5 V.

8.11.5.1.2 Sampling interval and brief signal levels

The digital inputs can be recorded in the manner of an analog channel. It isn't possible to select individual bits for acquisition; all 16 bits (digital port) are always recorded. The hardware ensures that the brief HIGH level within one sampling interval can be recognized.



8.11.5.2 Digital outputs

The digital outputs DO_01..08 provide galvanically isolated control signals with current driving capability whose values (states) are derived from operations performed on measurement channels using imc Online FAMOS. This makes it easily possible to define control functions.

Reference

The technical specification of the digital outputs 441.
The pin configuration of the ACC/DSUB(M)-DO8 497.

Important characteristics:

- available levels: 5 V (internal) or up to 30 V with external power supply
- current driving capability: HIGH: 15 mA to 22 mA LOW: 700 mA
- short-circuit-proof to supply or to reference potential HCOM and LCOM
- configurable as open-drain driver (e.g. as relay driver)
- default-state at system power-on:
  HIGH (Totem-Pole mode) or high-impedance (Open-Drain mode)

The eight outputs are galvanically isolated as a group from the rest of the system and are designed as Totem-Pole drivers. The eight stages' ground references are connected and are accessible as a signal at LCOM.

HCOM represents the supply voltage of the driver stage. It is generated internally with a galvanically isolated 5 V-source (max. 1 W). Alternatively, an external higher supply voltage can be connected (max. +30 V), which then determines the drivers' output level.

The control signal OPDRN on the DSUB plug can be used to set the driver type for the corresponding 8-bit-group either Totem-Pole or Open-Drain.

In Totem-Pole mode, the driver delivers current in the HIGH-state. In the Open-Drain configuration, conversely, it has high impedance in the HIGH-state, in LOW-state, an internally (HCOM) or externally supplied load (e.g. relay) is pulled down to LCOM (Low-Side Switch). With Open-Drain mode, the external supply driving the load, need not be connected to HCOM but only to the load.

Inductive loads (relays, motors) should be equipped with a clamp diode in parallel for shorting out switch-off transients (anode to output, cathode to positive supply voltage).

Power-up response:

0)	deactivated	high-Z (high resistance)
1)	power-up	high-Z (high resistance) High- and LowSide switch inactive
2)	first write access	With "Prepare measurement" following Reset or Power-up (setting procedure): activation of the output state with the mode set by the programming pin "OPDRN"

Example

wire jumper between programming pin "OPDRN" and LCOM (-> Totem-Pole driver type)
Initialization (first setting procedure) with 0 (LOW)
→ resulting startup sequence: High-Z → LOW, without intermediate HIGH state !!
Without further steps the default initialization state while preparing measurement is: "LOW".

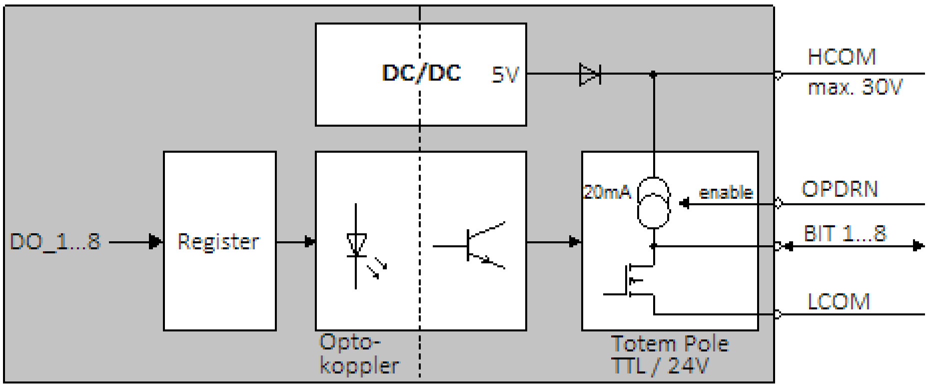
If a different state is desired, there are several options:

- Set the bit in imc Online FAMOS in the **control command "*OnInitAll*"**.
- Set the bit before the "Prepare" action via imc STUDIO. E.g. via the Data Browser or also automated via the **command "*Set variable*"**.

When "*preparing*" (reconfiguring) **imc Online FAMOS wins** and the value in the imc STUDIO variable is overwritten.

See: Manual imc STUDIO > "*Setup pages - Configuring device*" > "*Information and tips*" > "*Initial value for variables - Beginning the measurement - Jumps at the output*"

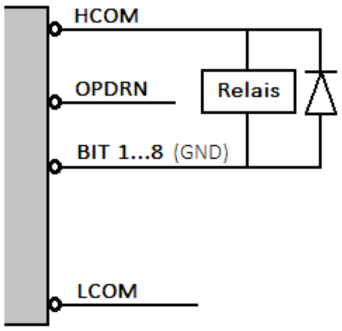
8.11.5.2.1 Block schematic



8.11.5.2.2 Possible configurations

5 V (internal)

Open Drain

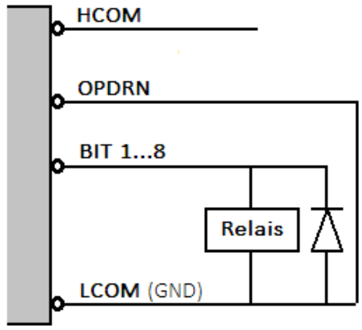


Device off: no continuity/high impedance (138 kΩ), 0 V at output

Device booting: no continuity/high impedance (138 kΩ), 0 V at output

After booting process:
no continuity/high impedance,
0 V at output, but all DO Bits = 1
DO Bit = 0 -> 5 V
DO Bit = 1 -> 0 V

Totem Pole



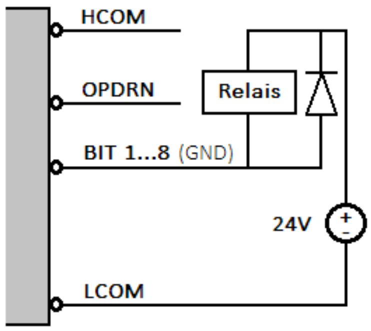
Device off: no continuity/high impedance

Device booting: no continuity/high impedance, 0 V at output

After booting process:
no continuity/high impedance,
0 V at output, but all DO Bits = 1
DO Bit = 0 -> 0 V
DO Bit = 1 -> 5 V

24 V

Open Drain

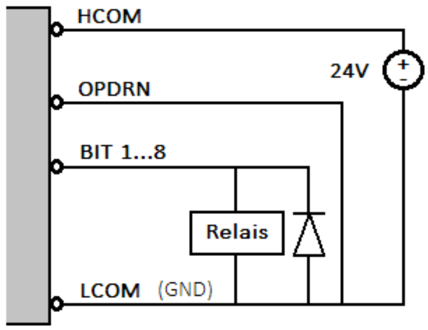


Device off: no continuity/high impedance (1.5 MΩ), 0 V at output

Device booting: no continuity/high impedance (1.5 MΩ), 0 V at output

After booting process:
no continuity/high impedance (1.5 MΩ),
0 V at output but all DO Bits = 1
DO Bit = 0 -> 24 V
DO Bit = 1 -> 0 V

Totem Pole



Device off: no continuity/high impedance (1.5 MΩ)

Device booting: no continuity/high impedance (1.5 MΩ), 0 V at output

After booting process:
no continuity/high impedance (1.5 MΩ),
0 V at output, but all DO Bits = 1
DO Bit = 0 -> 0 V
DO Bit = 1 -> 24 V

With **Totem Pole**, a maximum of **22 mA** load current is possible, totally independently of any externally connected voltage.

Open Drain is able to switch currents of up to **700 mA**. When using the internal 5 V power supply, note that the limit on total current at all outputs is 200 mA.

8.11.5.3 Incremental counter channels

You can find a general description in the chapter of the "*Incremental Counters Channels* 137".

Reference

The technical specification of the incremental counter channels 442.
The pin configuration of the ACC/DSUBM-ENC-4 497.

8.11.5.3.1 Sensor types, synchronization

Index signal denotes the synchronization signal SYNC which is globally available to all four channels in common. If its function Encoder w/o zero impulse is not activated, the following conditions apply: After the start of a measurement the counters remain inactive until the first positive slope arrives from SYNC. This arrangement is independent of the release-status of the Start-trigger condition.

The index signal is armed for each measurement!

Note

If a **sensor without an index track** (Reset signal) is used, ***Encoder w/o zero impulse*** **must be selected**, otherwise the counters will remain in reset-state and will never be started because the enabling start-impulse will never occur!!

Incremental encoder sensors often have an index track (index signal, zero marker pulse) which emits a synchronization-signal once per revolution. The **index signal** is differential and set by the comparator settings of the **first** Incremental counter channel of the module. Its bandwidth is limited to 20 kHz by a permanently low-pass filter. If the input remains open, an (inactive) HIGH-state will set in.

The measurement types Linear Motion, Angle, RPM and Velocity are especially well adapted for direct connection to incremental encoder sensors. These consist of a rotating disk with fine gradation in conjunction with optical scanning and possibly also with electric signal conditioning.

One differentiates between single track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B (C and D). By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported.

The actual time or frequency information, however, is derived exclusively from the A(C) -track!

The measurement types Event, Frequency, and Time always are measured by single-track encoders, since in these cases no evaluation of direction or sign would make any sense. The sensor must simply be connected to the terminal for Track A (C).

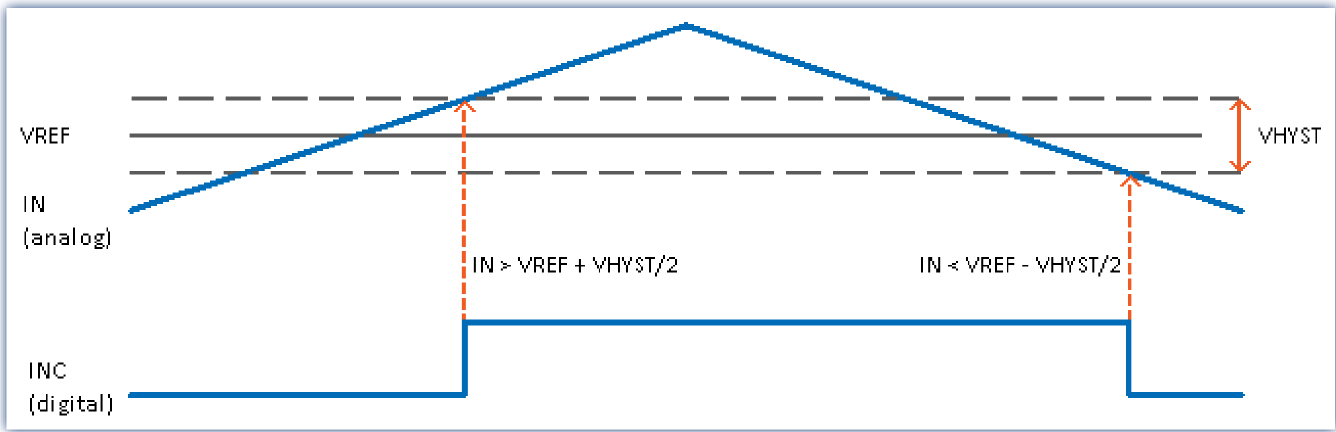
Since many signal encoders require a supply voltage, +5 V are provided at the connector socket for this purpose (max. 300 mA). The reference potential for this voltage, in other words the supply-ground connection for the sensor, is CHASSIS.

8.11.5.3.2 Comparator conditioning

The incremental counter channels' special properties make special demands on the signal quality: The very high time-resolution of the detector or counter means that even extremely short impulses which sampling measurement procedures (as at the digital inputs) would miss are captured and evaluated. Therefore the digital signals must have clean edges in order not to result in distorted measurements. Missed pulses or bounces could otherwise lead to drop-outs in the time measurements, or enormous "peaks" in the rpm-measurements.

Simple sensors such as those based on induction or photosensitive relays often emit only unconditioned analog signals which must be evaluated in terms of a threshold value condition. Furthermore long cables, ground loops or interference, can make the processing of even conditioned encoder signals (such as TTL-levels) difficult. The device, however, can counteract this using its special three-step conditioning unit.

To begin with, a high-impedance differential amplifier (±10 V range, 100 kΩ) enables reliable measurement from a sensor even along a long cable, as well as effective suppression of common mode interference and ground loops. A (configurable) filter (in preparation) at the next stage offers additional suppression of interference, adapted to the measurement set-up. Finally, a comparator with configurable threshold and hysteresis acts as a digital detector. The (configurable) hysteresis is an extra tool for suppressing noise:



If the analog signal exceeds the threshold VREF + VHYST/2. the digital signal changes its state (↑ : 0 ⇨ 1) and at the same time reduces the threshold which must be crossed in order to change the state back to 0 by the amount VHYST (new threshold: VREF - VHYST/2). The magnitude of the hysteresis therefore represents the maximum level of noise and interference that would not cause a spurious transition.

The threshold VREF is set to 1.5 V, the hysteresis VHYST is 0.5 V.
State transitions are therefore detected at the signal amplitudes:

1.75 V (← 0 → 1) and 1.25 V (↓ 1 → 0).

In future device versions, the threshold and hysteresis will be globally adjustable for all four channels within the range:

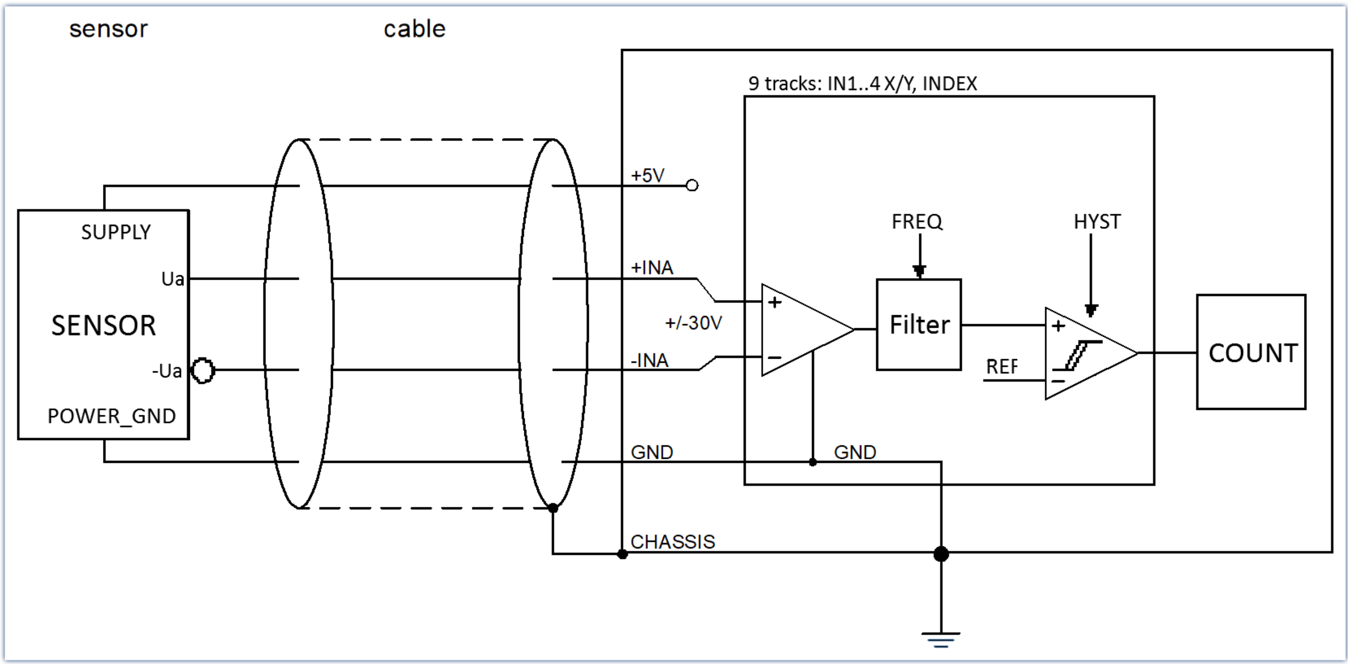
- VREF = ±10 V VHYST = +100 mV .. +4 V

Corner frequencies of the (2-pole) low-pass filter will be jointly configurable for both of a channel's tracks to the values: Low-pass filter: 20 kHz, 2 kHz, 200 Hz

8.11.5.3.3 Structure

Complete conditioning with individual differential inputs is provided for 4 tracks: they can be used for four channels with single-track encoders or for two channels with dual-track encoders.

Block schematic



Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B. By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported. The actual time or frequency information, however, is derived exclusively from the A-track!

Like the other channels, the Index-channel is fully conditioned. If its function is activated, it can take effect on all four channels.

8.11.5.3.4 Channel assignment

The plug used is the ACC/DSUBM-ENC-4 291. This plug enable all four incremental encoders to be connected at the same terminal.

As a prerequisite for the input differential amplifier to find the correct working point, the sensor must be ground referenced, i.e. it must have low resistance to ground (GND, CHASSIS, PE). This is not to be confused with the sensor's common mode voltage, which may be up to +25 V/-12 V (even for the –IN input!). It also does not matter that a differential measurement is configured for the high-impedance differential input. If this electrical connection to the system ground (CHASSIS) does not exist initially because the sensor is electrically isolated, then such a connection must be set up, for instance in the form of a wire jumper between the sensor's GND and POWER_GND contacts!

The 5 V (max. 100 mA, 300 mA upon request) supply voltage which the module provides at the terminals +5 V and GND can be used to power the sensors. If more voltage or supply power is needed, the sensor must be supplied externally, which means that it is absolutely necessary to ensure that this supply voltage is referenced to system ground!

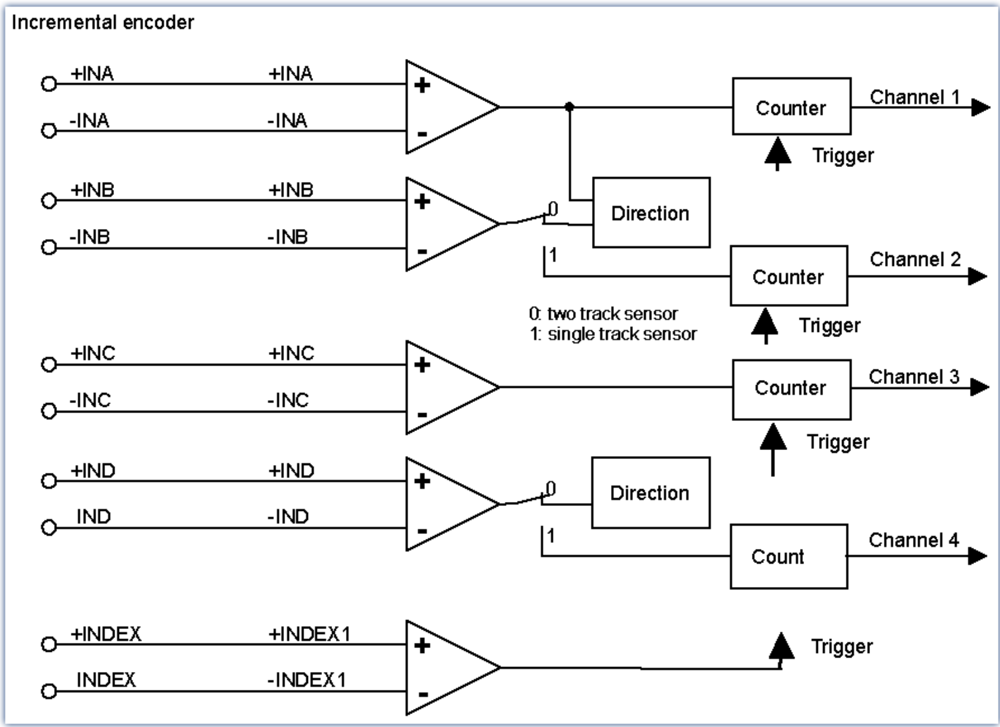
8.11.5.3.5 Incremental counter track configuration options

Mode	Channel 1	Channel 2	Channel 3	Channel 4
single-track encoder	•	•	•	•
dual-track encoder				
single-track encoder		shows signal value 0	•	•
dual-track encoder	•			
single-track encoder	•	•		shows signal value 0
dual-track encoder			•	
single-track encoder		shows signal value 0		shows signal value 0
dual-track encoder	•		•	

Reference

Please observe the notes on **two-point scaling** in the section "*Single-track / Dual-track encoder* 143".
Affects both the devices belonging to the imc C-SERIES, and also any devices belonging to the imc SPARTAN and imc CRONOS families which are equipped with the digital multiboard: DI16-DO8-ENC4 or the DI8-DO8-ENC4-DAC4.

8.11.5.3.6 Block schematic



8.11.5.3.7 Connection

See the connection description of the ENC-4 apply 305.
You can find here the pin configuration of the ACC/DSUB(M)-ENC-4 497.

8.11.6 DI8-DO8-ENC4-DAC4: Digital Multiboard

The digital multiboard is equipped 8 digital inputs, 8 digital outputs, 4 inputs for incremental encoders and 4 analog outputs.

The description of the digital inputs and outputs and the incremental counter part conform to the description of the DI16-DO8-ENC4 module 283 added by the contents of this chapter and another difference is that the number of digital inputs is limited to 8.

8.11.6.1 Analog outputs

The analog outputs DAC 01 to 04 provide 4 analog output channels to be used as dynamic control and actuator signals. The outputs can be defined as the results of calculations performed by imc Online FAMOS on data from combinations of measurement channels.

The pin configuration of the corresponding DSUB-15: ACC/DSUBM-DAC4 497.

The technical specification of the module DAC-4 443.

Highlights

- ±10 V level at max. ±10 mA driver capability and 250 Ω load
- ensured startup level 0 V without undefined transient states
- short-circuit protected against ground.

8.11.7 DO-16: Digital Outputs

The digital outputs DO_01..08 and DO_09..16 provide galvanically isolated control signals with current driving capability whose values (states) are derived from operations performed on measurement channels using imc Online FAMOS. This makes it easily possible to define control functions.

Reference

Technical details of the DO-16: Digital Outputs 446.
Find here the pin configuration of the DSUB-15: ACC/DSUBM-DO8 497.

Important characteristics:

- available levels: 5 V (internal) or up to 30 V with external power supply
- current driving capability: HIGH: 15 mA to 22 mA LOW: 700 mA
- short-circuit-proof to supply or to reference potential HCOM and LCOM
- configurable as open-drain driver (e.g. as relay driver)
- default-state at system power-on:
  HIGH (Totem-Pole mode) or high-impedance (Open-Drain mode)

The eight outputs are galvanically isolated as a group from the rest of the system and are designed as Totem-Pole drivers. The eight stages' ground references are connected and are accessible as a signal at LCOM.

HCOM represents the supply voltage of the driver stage. It is generated internally with a galvanically isolated 5 V-source. Alternatively, an external higher supply voltage can be connected (max. +30 V), which then determines the drivers' output level.

The control signal OPDRN on the DSUB plug can be used to set the driver type for the corresponding 8-bit-group: either Totem-Pole or Open-Drain:

In Totem-Pole mode, the driver delivers current in the HIGH-state. In the Open-Drain configuration, conversely, it has high impedance in the HIGH-state, in LOW-state, an internally (HCOM) or externally supplied load (e.g. relay) is pulled down to LCOM (Low-Side Switch). With Open-Drain mode, the external supply driving the load, need not be connected to HCOM but only to the load.

Inductive loads (relays, motors) should be equipped with a clamp diode in parallel for shorting out switch-off transients (anode to output, cathode to positive supply voltage).

Power-up response:

0)	deactivated	high-Z (high resistance)
1)	power-up	high-Z (high resistance) High- and LowSide switch inactive
2)	first write access	With "Prepare measurement" following Reset or Power-up (setting procedure): activation of the output state with the mode set by the programming pin "OPDRN"

Example

wire jumper between programming pin "OPDRN" and LCOM (-> Totem-Pole driver type)
Initialization (first setting procedure) with 0 (LOW)
→ resulting startup sequence: High-Z → LOW, without intermediate HIGH state !!
Without further steps the default initialization state while preparing measurement is: "LOW".

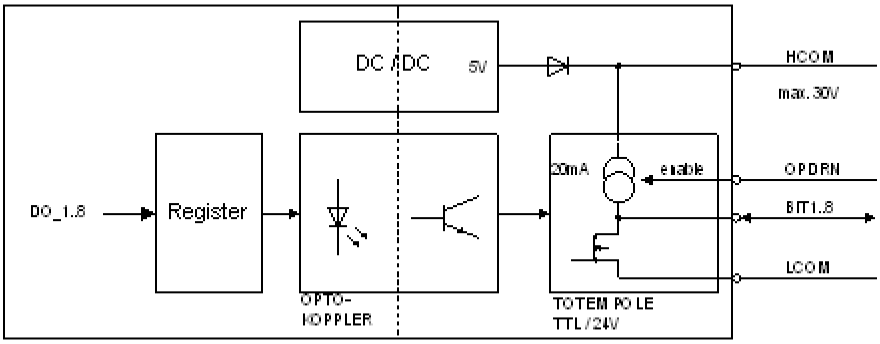
If a different state is desired, there are several options:

- Set the bit in imc Online FAMOS in the **control command "*OnInitAll*"**.
- Set the bit before the "Prepare" action via imc STUDIO. E.g. via the Data Browser or also automated via the **command "*Set variable*"**.

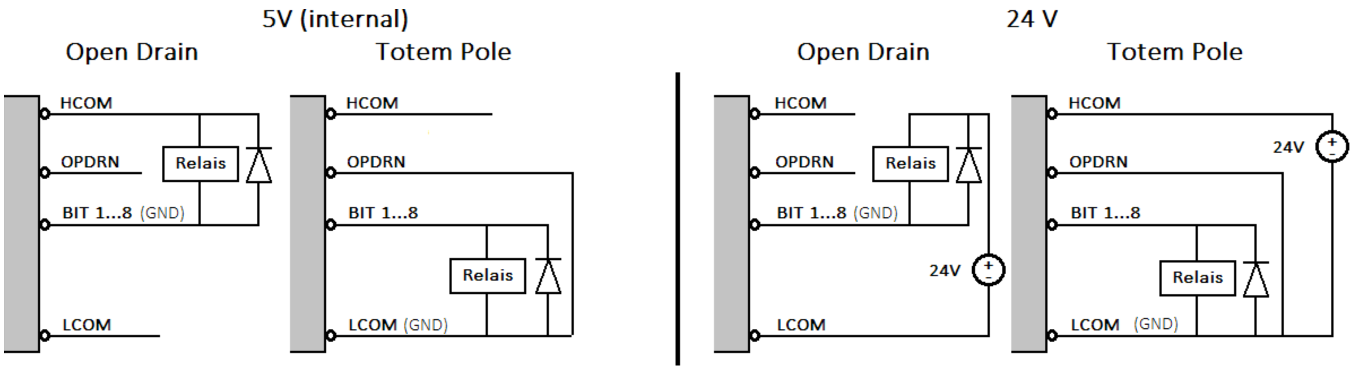
When "*preparing*" (reconfiguring) **imc Online FAMOS wins** and the value in the imc STUDIO variable is overwritten.

See: Manual imc STUDIO > "*Setup pages - Configuring device*" > "*Information and tips*" > "*Initial value for variables - Beginning the measurement - Jumps at the output*"

8.11.7.1 Block schematic



8.11.7.2 Possible configurations



With **Totem Pole**, a maximum of **22 mA load current** is possible, totally independently of any externally connected voltage.

Open Drain is able to set up to 700 mA current of each output. When using the internal **5 V** power supply, note that the limit on current at each output is **20 mA**.

8.11.7.3 Notes on exerting control through imc Online FAMOS

The maximum output frequency depends on the DO-16 unit's switching time. At 165 µs, the theoretical value is 6 kHz. If control is exerted from imc Online FAMOS, be aware that calls for output must be made sufficiently early. If long calculations are involved, for instance of FFTs or filters, the call will not be made in time.

A reliable output rate can only be achieved with the function "Synchronous Task" under imc Online FAMOS Professional, which halts the calculations with an interrupt.

If output is lined to a channel as the clock pulse provider, there is another effect which can be observed. For instance, a channel is sampled at 10 kHz and this is used along with the function Sawtooth for control purposes:
DOut02_Bit01=greater(SawTooth(Channel_02, 0, 1, 2), 0.5)

With a RAM buffering period of 10 s, the resulting FIFO size is 100,000 values. The system divides the FIFOS into 64 k blocks. If 64 k aren't enough, two blocks are set up. In such a case, imc Online FAMOS receives two values upon every FIFO call; this means that the pulse rate is divided in half. To prevent this effect, the RAM buffer duration must be reduced to 2 s, for example.

8.11.8 DO-16-HC Digital high current outputs

16 isolated control signals provide an enhanced current bearing capacity. The signals' states can be generated by imc Online FAMOS as the result of calculation operations or influenced by your measurement device's trigger mechanism. This makes it possible to create control commands by extremely easy-to-use means.

Fields of application:

- 24 V industrial applications and automotive (8 V to 28 V)

Benchmarks:

- Max. 0.7 A High-Side AND Low-Side drive, I_limit typ. 1.4 A
- Ext. supply voltage required: 8 V to 28 V
- With open-drain mode (low side drive): no external supply required!
- Programmable for High-Side, Low-Side and Totem-Pole: Pin "OPDRN":

open:	open drain (low side drive)	like DO-16
LCOM:	totem pole (complementary)	like DO-16
LCOM over 10 k:	open source (high side drive)	not supported by DO-16

- Configuration 5 V TTL / CMOS:
- internal 5 V supply used; external supply not necessary!
- internal 5 V not sufficient for operating High Side driver (≥8 V required!)
- therefore: operation in open-drain mode with external pull-up (typ. 1 k .. 10 K, min. 250R)
- due to diode decoupling of LCOM_1-4 / 5-8:
  → wire jumper LCOM = LCOM_1-4 = LCOM_5-8

2 x isolated 8-bit groups

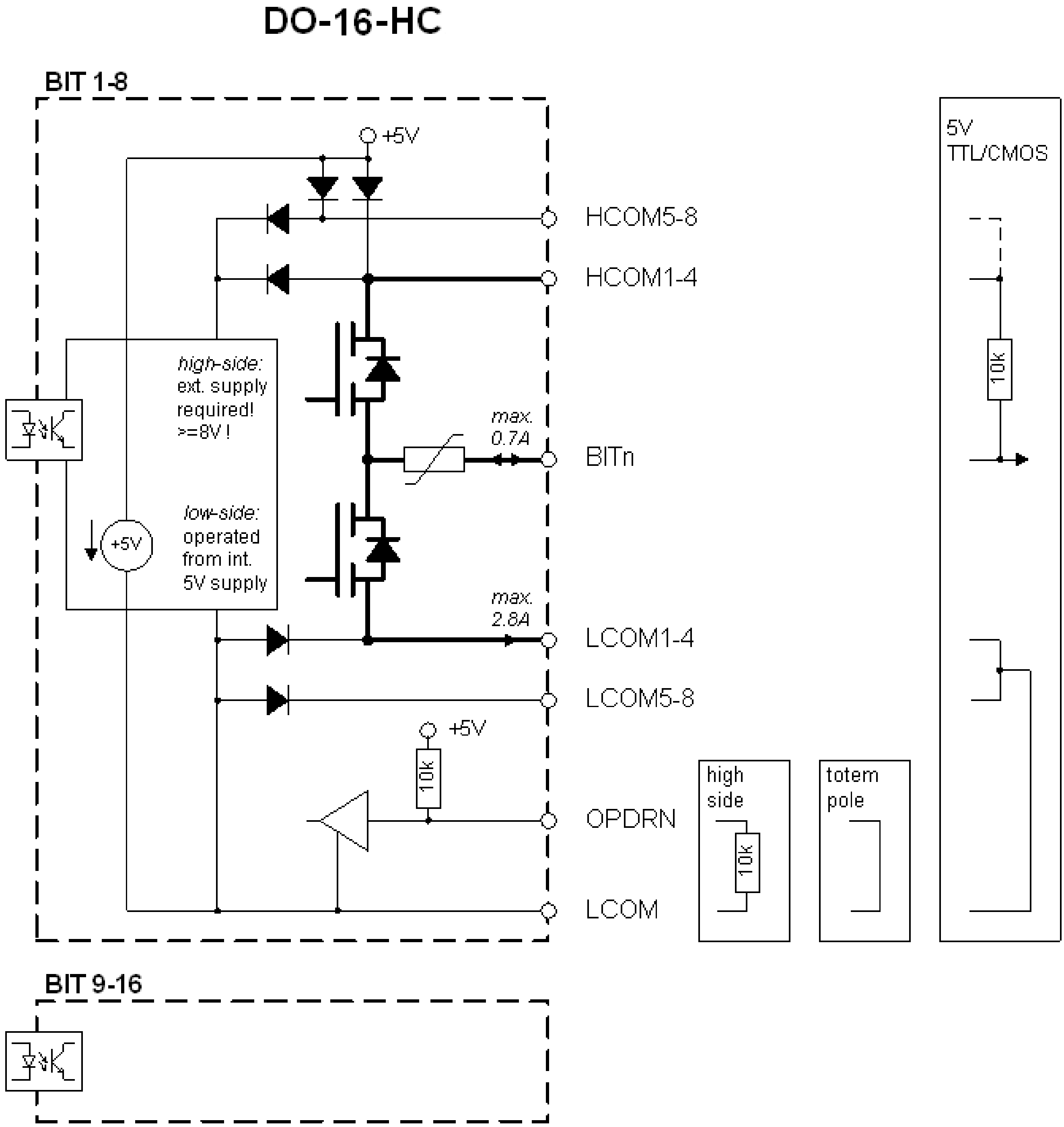
- DSUB plug separate HCOM and LCOM pins for 4 bits each
- xCOM_1-4 and xCOM_5-8 each blocked by diodes in order to achieve current sharing
- additional LCOM pin only for mode programming

Protection against:

- Short circuit I_limit typ. 1.4 A, max. 2 A (@25°C)
- Surge current
- Load dump / inductive load switching
- Current / capacitive load switching (typ. 2 x I_nom)
- Reverse battery: protection against reverse voltage between output
- no protection against reverse connection of LCOM – HCOM

Technical details of the DO-16-HC 447.
Pin configuration: ACC/DSUBM-DO-HC-8 499

8.11.8.1 Schematic diagram

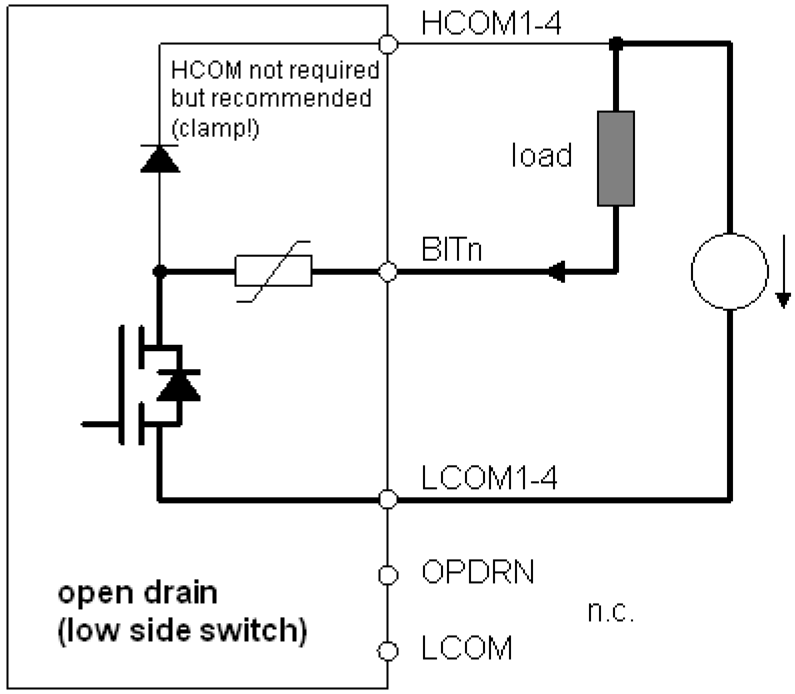


8.11.8.2 Configuration of driver mode

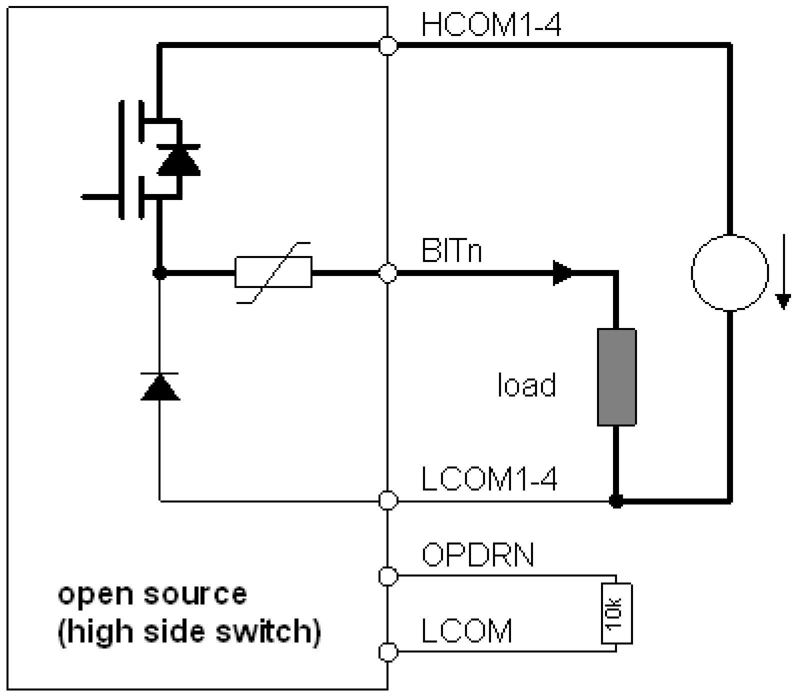
mode	active switch	OPDRN-Pin	driver supply	HCOM (supply)	required initial state for passive power-up	remarks
open drain	low side drive	float	internal	not required	1	
totem pole	complementary drive	LCOM	external	external (8 V to 28 V)	0	
open source	high side drive	LCOM via 10 k	external	external (8 V to 28 V)	0	

mode	active switch	OPDRN-Pin	driver supply	HCOM (supply)	required initial state for passive power-up	remarks
TTL / CMOS	low side drive	float	internal	internal (5 V)	0	ext. Pullup required

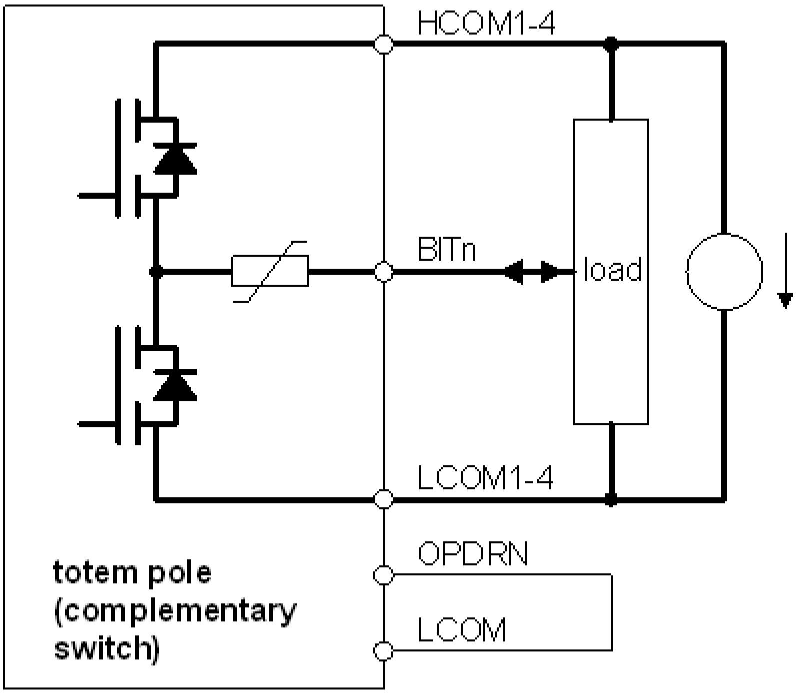
8.11.8.2.1 Open drain mode



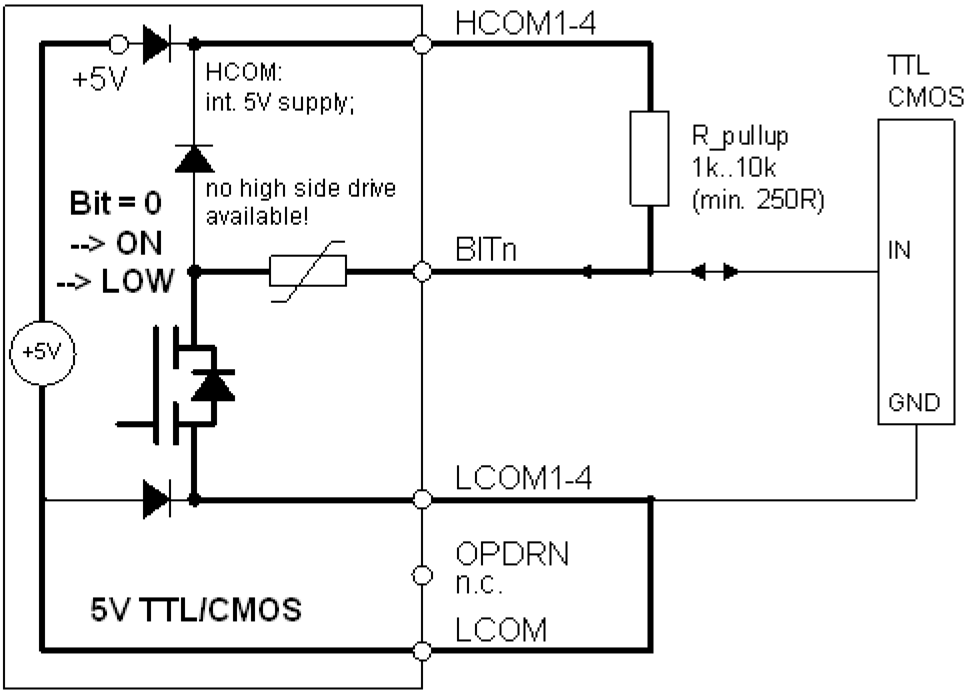
8.11.8.2.2 Open source mode



8.11.8.2.3 Totem pole mode



8.11.8.2.4 TTL / CMOS (5V) mode



8.11.9 DAC-8: Analog outputs

The analog outputs DAC 01 to 08 provide 8 analog output channels to be used as dynamic control and actuator signals. The outputs can be defined as the results of calculations performed by imc Online FAMOS on data from combinations of measurement channels.

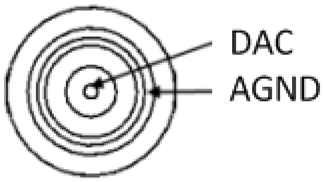
Highlights (DAC)

- ±10 V level at max. ±10 mA and 250 Ω driver capability
- ensured startup level 0 V without undefined transient states
- short-circuit protected against ground.

Technical details of the DAC-8: Analog outputs 438.

Pin configuration: Standard plug 497 (ACC/DSUBM-DAC4).

The **BNC variant**, e.g. CRFX/DAC-8-BNC or CRSL/DAC-8-BNC is configured as follows:



8.11.10 ENC-4 Incremental counter channels

The ENC-4 serves to measure signals representing time or frequency-based signals. In contrast to the analog channels as well as to the digital inputs, the channels are not sampled at a selected, fixed rate, but instead time intervals between edges (transitions) of the digital signal are measured.

The counters used (set individually for each of the 4 channels) achieve time resolutions of up to 31 ns (32 MHz); which is far beyond the abilities of sampling procedures (under comparable conditions). The "sampling rate" which the user must set is actually the rate at which the system evaluates the results of the digital counter or the values of the quantities derived from the counters. Find here the description of the incremental counter channels 137, the slope conditions here 144 and technical details here 448.

Notes

- The maximum number of incremental counter channels is set at 16 per device. It is not possible to integrate more than four ENC-4 into one system!
- The description in this chapter only applies for CRONOS-PL and CRONOS-SL. Please find here the description of the ENC-4 included in the CRC or CRFX digital multi-IO board 288

8.11.10.1 Sensor types, synchronization

Index signal denotes the synchronization signal SYNC which is globally available to all four channels in common. If its function Encoder w/o zero impulse is not activated, the following conditions apply: After the start of a measurement the counters remain inactive until the first positive slope arrives from SYNC. This arrangement is independent of the release-status of the Start-trigger condition.

If a **sensor without an index track** (Reset signal) is used, ***Encoder w/o zero impulse* must be selected**, otherwise the counters will remain in reset-state and will never be started because the enabling start-impulse will never occur!!
The index signal has to be connected to **CON2** (channels IN3 and IN4) !

Incremental encoder sensors often have an index track (index signal, zero marker pulse) which emits a synchronization-signal once per revolution. The **index signal** is differential and set by the comparator settings of the **first** Incremental counter channel of the module. Its bandwidth is limited to 20 kHz by a permanently low-pass filter. The input is located on Pin 6 and 13. If the input remains open, an (inactive) HIGH-state will set in.

The measurement types Linear Motion, Angle, RPM and Velocity are especially well adapted for direct connection to incremental encoder sensors. These consist of a rotating disk with fine gradation in conjunction with optical scanning and possibly also with electric signal conditioning.

One differentiates between single-track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B (C and D). By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported.

The actual time or frequency information, however, is derived exclusively from the A(C) -track!

The measurement types Event, Frequency, and Time always are measured by single-track encoders, since in these cases no evaluation of direction or sign would make any sense. The sensor must simply be connected to the terminal for Track A (C).

Since many encoders require a supply voltage, +5 V (max. 300 mA) is provided at the plug. The reference potential for this voltage, i.e. the supply-ground connection for the sensor, is CHASSIS.

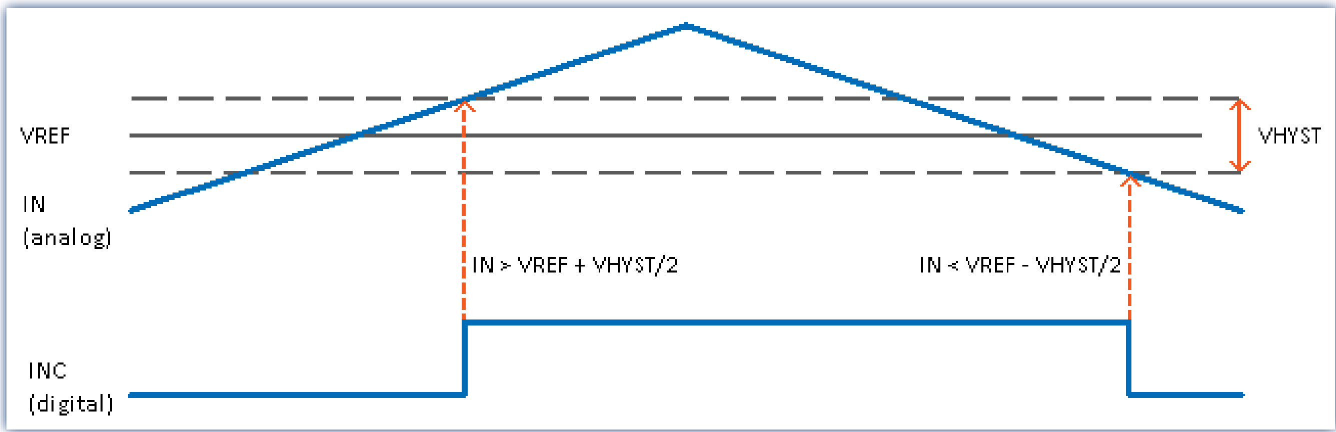
For the older module INK4, this *+5 V* supply voltage is not protected. It is the imc CRONOS-system supply itself and should be protected with an external fuse.

8.11.10.2 Comparator conditioning (threshold, hysteresis)

The incremental counter channels' special properties make special demands on the signal quality: The very high time-resolution of the detector or counter means that even extremely short impulses which sampling measurement procedures (as at the digital inputs) would miss are captured and evaluated. Therefore the digital signals must have clean edges in order not to result in distorted measurements. Missed pulses or bounces could otherwise lead to drop-outs in the time measurements, or enormous "peaks" in the rpm-measurements.

Simple sensors such as those based on induction or photosensitive relays often emit only unconditioned analog signals which must be evaluated in terms of a threshold value condition. Furthermore long cables, ground loops or interference, can make the processing of even conditioned encoder signals (such as TTL-levels) difficult. *imc CRONOS System family*, however, can counteract this using its special three-step conditioning unit.

To begin with, a high-impedance differential amplifier (±10 V range, 100 kΩ) enables reliable measurement from a sensor even along a long cable, as well as effective suppression of common mode interference and ground loops. A (configurable) filter (in preparation) at the next stage offers additional suppression of interference, adapted to the measurement set-up. Finally, a comparator with configurable threshold and hysteresis acts as a digital detector. The (configurable) hysteresis is an extra tool for suppressing noise:



If the analog signal exceeds the threshold VREF + VHYST/2. the digital signal changes its state (🡐 : 0 ⇒ 1) and at the same time reduces the threshold which must be crossed in order to change the state back to 0 by the amount VHYST (new threshold: VREF - VHYST/2). The magnitude of the hysteresis therefore represents the maximum level of noise and interference that would not cause a spurious transition.

The threshold VREF is set to 1.5 V, the hysteresis VHYST is 0.5 V.
State transitions are therefore detected at the signal amplitudes:

1.75V (↑ : 0 ⇒ 1) and ***1.25V (↓ : 0 ⇒ 1)***.

In future device versions, the threshold and hysteresis will be globally adjustable for all four channels within the range:

Threshold (VREF) = ±10 V	**Hysteresis** (VHYST) = 100 mV .. 4 V	Requirement: (|VREF|+VHYST/2) < 10 V

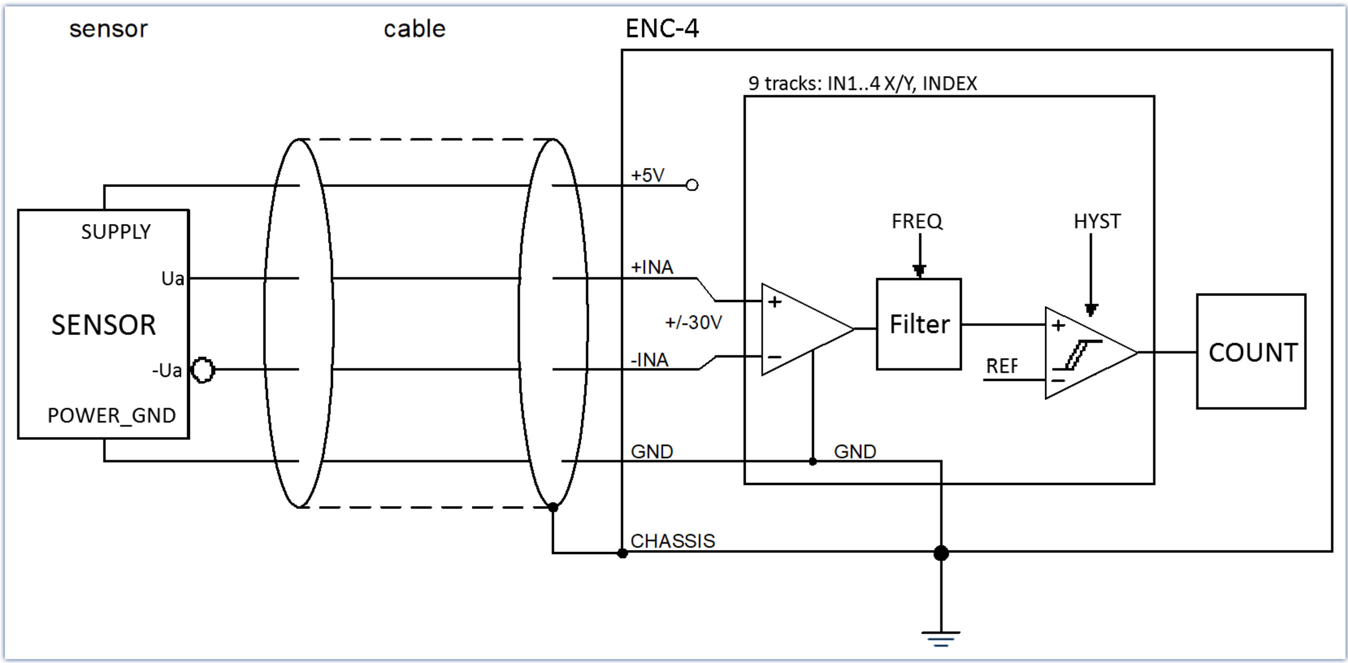
Corner frequencies of the (2-pole) low-pass filter will be jointly configurable for both of a channel's tracks to the values:

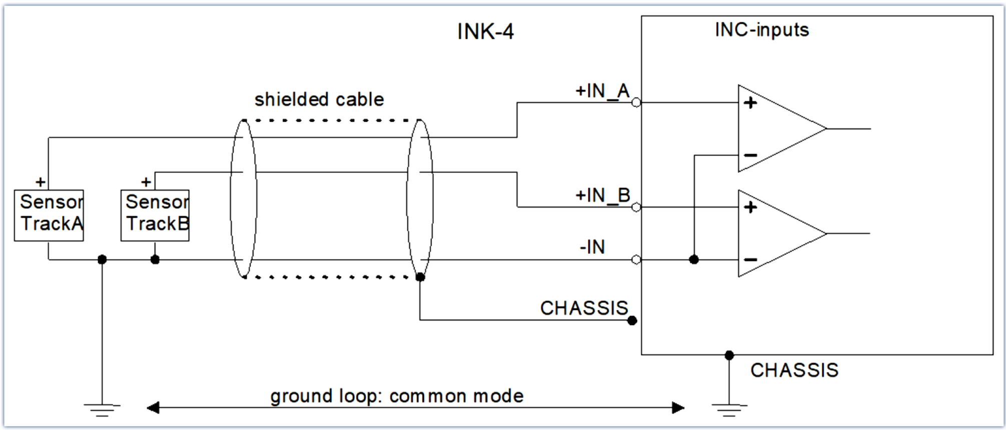
- Low-pass filter: 200 Hz, 2 kHz, 20 kHz or without (500 kHz bandwidth)

Structure

Complete conditioning is provided for all 8 tracks of the 4 channels: for each channel, the two tracks (A and B or C and D) of a dual-track encoders can be connected, in which case the differential inputs of each pair of tracks share a common reference (neg. input).

Block schematic

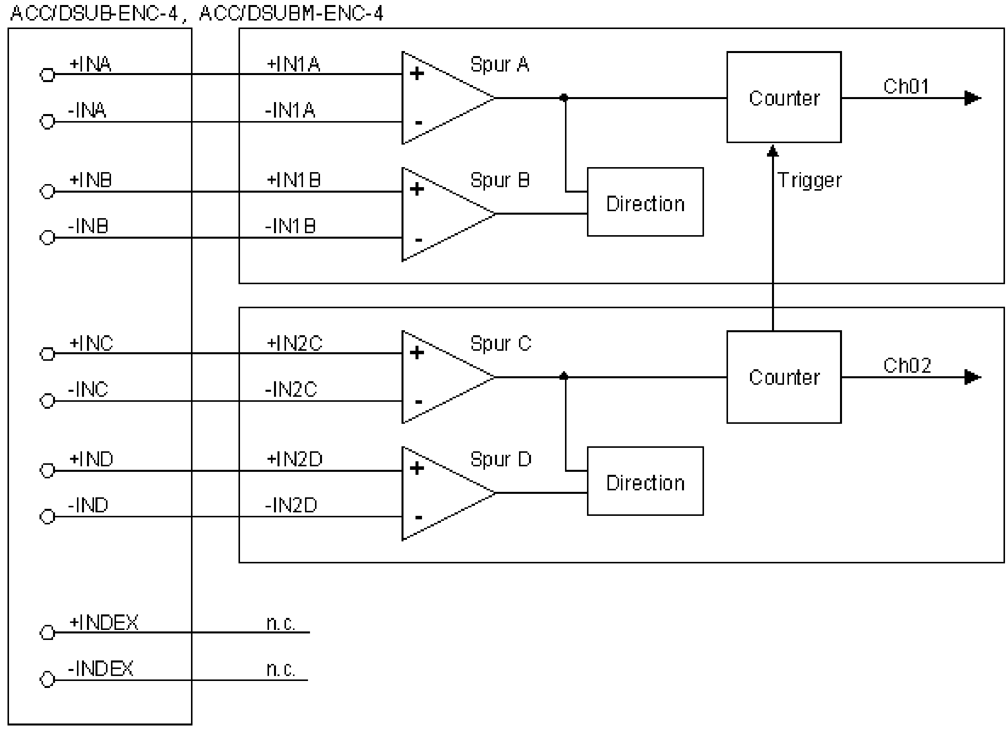


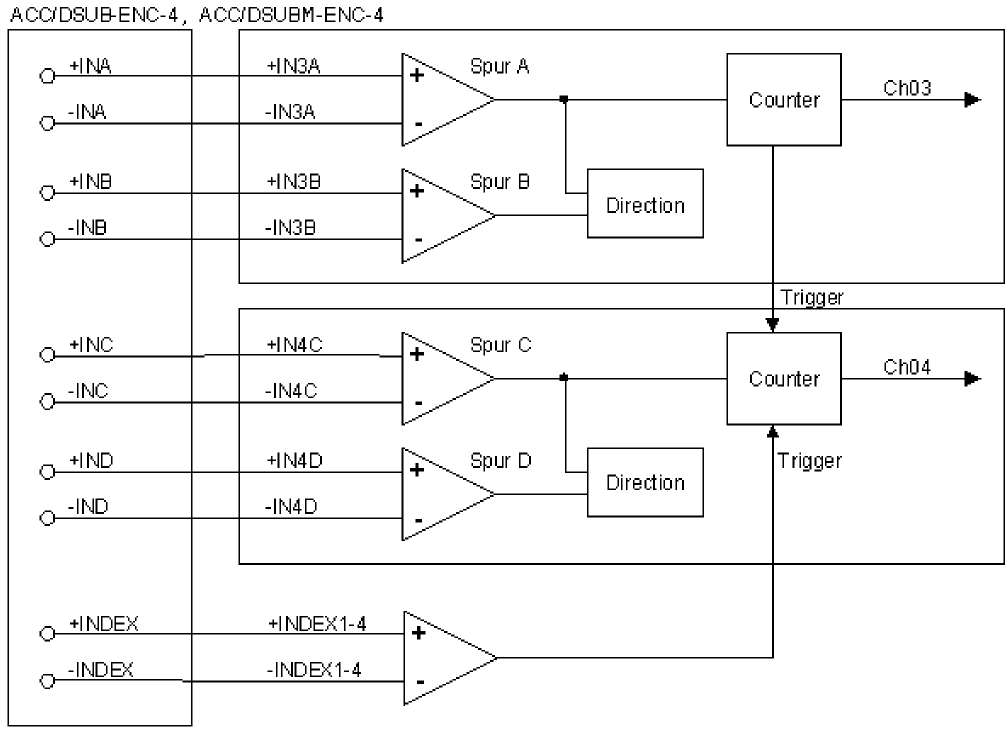


One differentiates between single-track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B. By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported. The actual time or frequency information, however, is derived exclusively from the A-track!

Like the other channels, the Index-channel is fully conditioned. If its function is activated, it can take effect on all four channels. The DSUB-15 terminal sockets are each occupied by 2 channels. In order to prevent accidental short-circuiting due to incorrect wiring, the index-channel occupies only the second DSUB-15 socket, together with Channels 3 and 4. The first socket, occupied by Channels 1 and 2, has no contact to the Index-channel at its corresponding pins! However, in the interest of uniformity, imc terminal plugs all are labeled ±INDEX!

8.11.10.3 Channel assignment





The condition for the input differential amplifier reaching the correct working point is that the sensor be ground referenced, meaning that is has low impedance towards ground (GND, CHASSIS, PE). This is not to be confused with the sensor's common mode potential, which may be as much as ±30 V (even for the –IN input!). This also applies if differential measurement is configured for the high-impedance differential input. If this galvanic contact to the system (CHASSIS) doesn't exist for an isolated sensor, such a connection must be created, for instance as a jumper between GND (device) and the sensor's POWER_GND!

The 5 V (max. 100 mA, 300 mA as option) supply voltage provided at the terminals "+5 V, GND" can be used to supply sensors. if a greater voltage or supply power is required, the sensor must be supplied externally, and you must make sure to provide a galvanic connection between this supply voltage and the system ground!

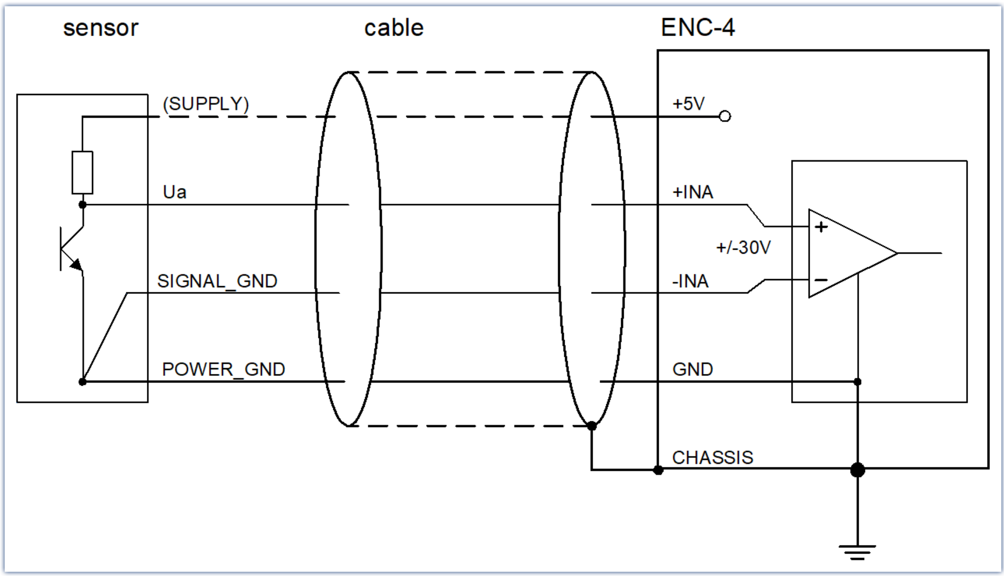
8.11.10.4 Connection

Each of the 4 incremental counter channels has an A and B-track (C and D) for connecting a dual-track encoders. If a single-track encoder is used, it must be connected to the A-track and the positive B-track must be shorted with the negative B-track. If the index-input is not used, the positive index channel must be shorted with the negative index-channel.

The pin configuration of the DSUB-15 plug 497.

8.11.10.4.1 Connection: Open-Collector Sensor

Simple rotary encoder sensors are often designed as an Open-Collector stage, which emit a Signal that moves between condition 0 V and SUPPLY. In this case the signal teshold should be adjusted to the half SUPPLY-voltage:

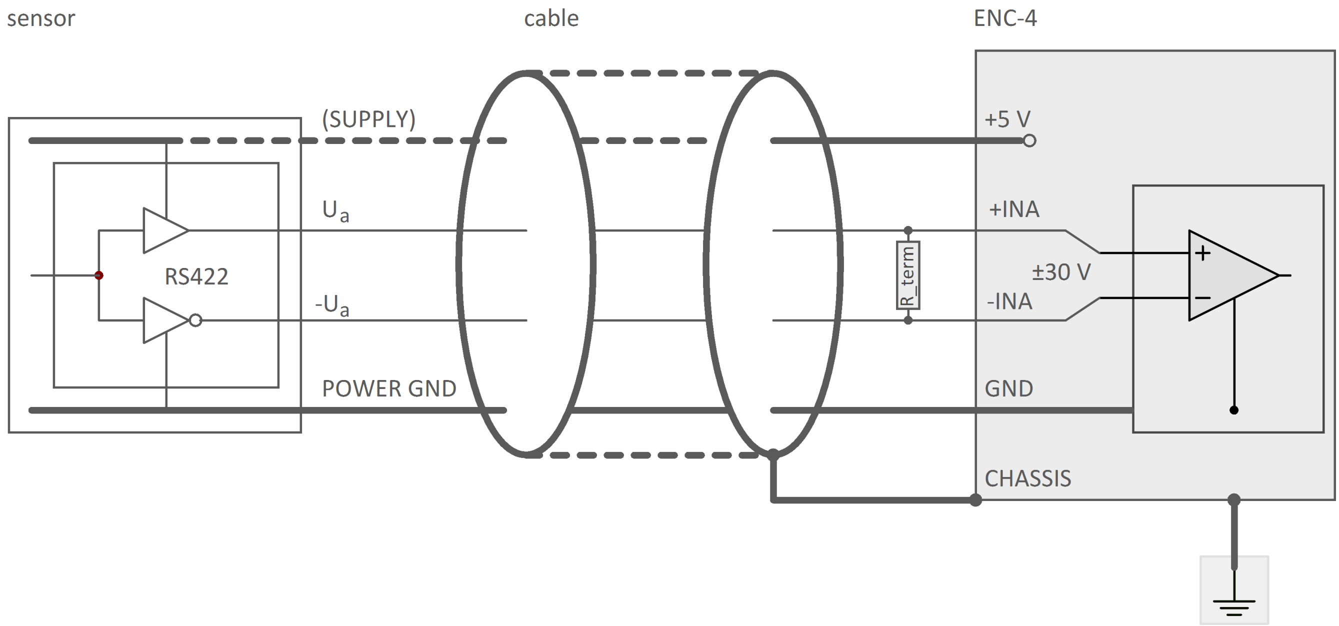


Sensor with Open-Collector output

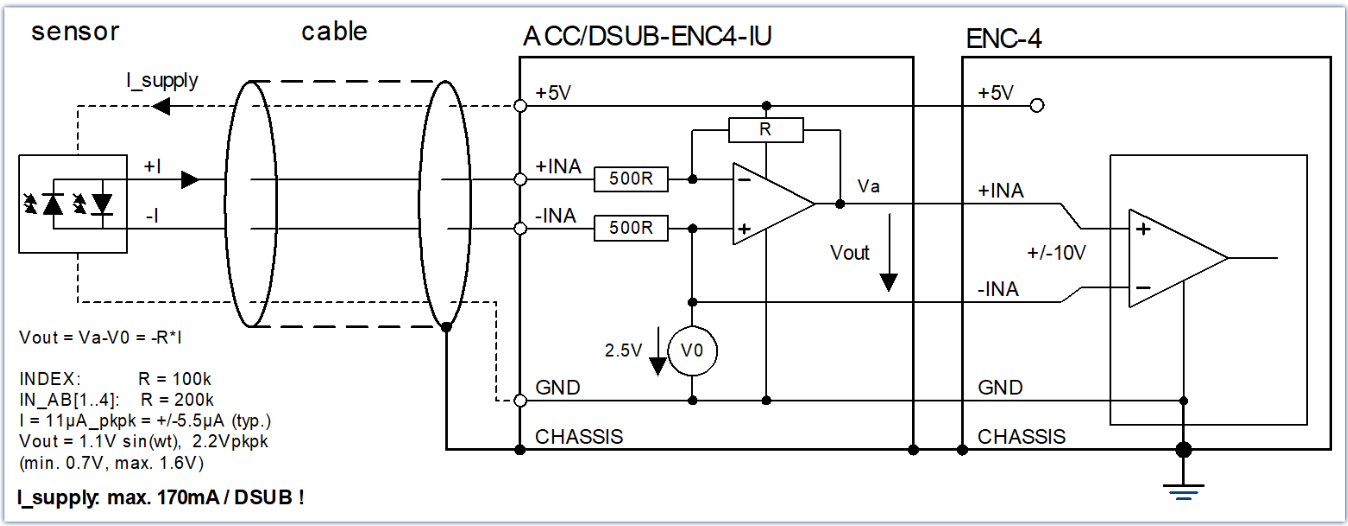
8.11.10.4.2 Connection: Sensors with RS422 differential line drivers

Commercially available rotary encoders are often equipped with differential line drivers, for instance as per the EIA-standard RS422. These deliver a complementary (inverse) TTL-level signal for each track. The sensor's data are evaluated differentially between the complementary outputs. The threshold to select is 0 V, since the differential evaluation results in a bipolar zero-symmetric signal: 3.8 to 5 V (HIGH) or –3.8 to -5 V (LOW). Ground loops as pure common mode interference are suppressed to the greatest possible extent.

The illustration below shows the circuiting. The reflection response and thus the signal quality can be further improved by using terminator resistor (R_term) approx. 90 Ω to 150 Ω, we recommend 126 Ω.



8.11.10.4.3 Connection: Sensors with current signals



For a rotational encoder working with current signals, the current/ voltage terminal ACC/DSUB(M)-ENC-4-IU 497 can be used. It is possible to power the sensor from the ENC-4 module. The pertinent specifications are:

max. supply current: 320 mA / module

> The resulting input voltage for the ENC-4 can not be measured at the terminals but directly at the pins of the DSUB plug.

8.11.11 FRQ2-4 Frequency modulated signals

This amplifier is especially designed for sensors that are able to convert electrical, physical dimensions in frequency. These sensors spent in a "state of rest" (input parameter = 0) a frequency not equal zero.

	FRQ-4	FRQ2-4
Measurement mode:	frequency (TTL-level)	frequency (TTL-level)
Sampling rate:	max. 50 kHz per channel	max. 50 kHz per channel
Input range:	1 kHz, 2.5 kHz, 5 kHz, 10 kHz, 20 kHz	measurement range ± / center frequency: 3 kHz, / 6 kHz, 5 kHz, / 10 kHz, 12 kHz, / 24 kHz, 30 kHz, / 60 kHz, 50 kHz, / 100 kHz, 120 kHz / 240 kHz
Furhter specs:		please see page 449

The center frequency will be provided by operating software after selection of the measurement range.

Corresponding to the noise in the input variable, the output frequency signal is also noisy. This can be reduced using the adjustable filter. This filter is not to be confused with the filter setting for an incremental counter input: there, the output variable is filtered to eliminate interfering signal pulses. By contrast, with the FRQ-4, the resulting physical quantity is filtered.

By taring, this rest state is defined as zero position (Setup page "*Channel balance*"). Frequencies below the defined rest state value are then interpreted as negative values of the physical variable.

8.11.11.1 Connection

Recommended plug

- for FRQ-4: ACC/DSUB(M)-ENC4 497 and
- for FRQ2-4: ACC/DSUBM-FRQ2 497.

8.11.12 HRENC-4: High Resolution Incremental Counter

The HRENC-4 module serves to measure signals whose time- or frequency information is to be captured. In contrast to the case with analog channels, to actual measurement does not consist of repeated sampling at a fixed time interval. Instead, digital counters are used to determine either the count of pulses occurring or the time intervals between defined signal slope events. For the time measurement/ maximum frequency, a resolution of approx. 3.9 ns (256 MHz) is achieved.

When using two-track sine/cosine signal encoders, conversion to digital values for determining the rotation direction and the absolute count of increments (full periods) is performed. Additionally, detailed information about the position can be gained by analog evaluation of the sine/ cosine signal, which results in yet further increased resolution.

Features:

- The HRENC-4 is both a digital comparator and serves the purpose of analog evaluation (sine / cosine signals).
- Fully conditioned (differential input and filter)
- 256 MHz measurement time resolution
- Feedback of revolution speed etc. to precise time measurement

For two-track sine signal generator

Besides including the technical equipment of an ENC-4 unit, the HRENC-4 also comes with analog analysis capability. Normally, incremental encoders emit simple square-wave signals, whose pulse sequence is evaluated according to certain criteria. In this case, it is adequate for the incremental counter's input amplifier to clearly detect the pulses on the basis of either a HIGH or LOW voltage level.

Two-track sine/cosine signal generators output the pulse sequence as a continuous sine/cosine plot 312.

Technical details HRENC-4 452.

8.11.12.1 Sensor types, synchronization

Index signal denotes the synchronization signal SYNC which is globally available to all four channels in common. If its function Encoder w/o zero impulse is not activated, the following conditions apply: After the start of a measurement the counters remain inactive until the first positive slope arrives from SYNC. This arrangement is independent of the release-status of the Start-trigger condition.

The zero impulse is set back before each measurement.

> If a **sensor without an index track** (Reset signal) is used, ***Encoder w/o zero impulse*** **must be selected**, otherwise the counters will remain in reset-state and will never be started because the enabling start-impulse will never occur!!
> The index signal has to be connected to **CON1** (channels **IN1** and **IN2**)! (first plug, female)!

Incremental encoder sensors often have an index track (index signal, zero marker pulse) which emits a synchronization-signal once per revolution. The **index signal** is differential and set by the comparator settings of the **first** incremental counter channel of the module. Its bandwidth is limited to 20 kHz by a permanently low-pass filter. The input is located on pins 6 and 13. If the input remains open, an (inactive) HIGH-state will set in.

The measurement types Linear Motion, Angle, RPM and Velocity are especially well adapted for direct connection to incremental encoder sensors. These consist of a rotating disk with fine gradation in conjunction with optical scanning and possibly also with electric signal conditioning.

One differentiates between single-track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B (C and D). By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported.

The actual time or frequency information, however, is derived exclusively from the A(C) -track!

The measurement types Event, Frequency, and Time always are measured by single-track encoders, since in these cases no evaluation of direction or sign would make any sense. The sensor must simply be connected to the terminal for Track A (C).

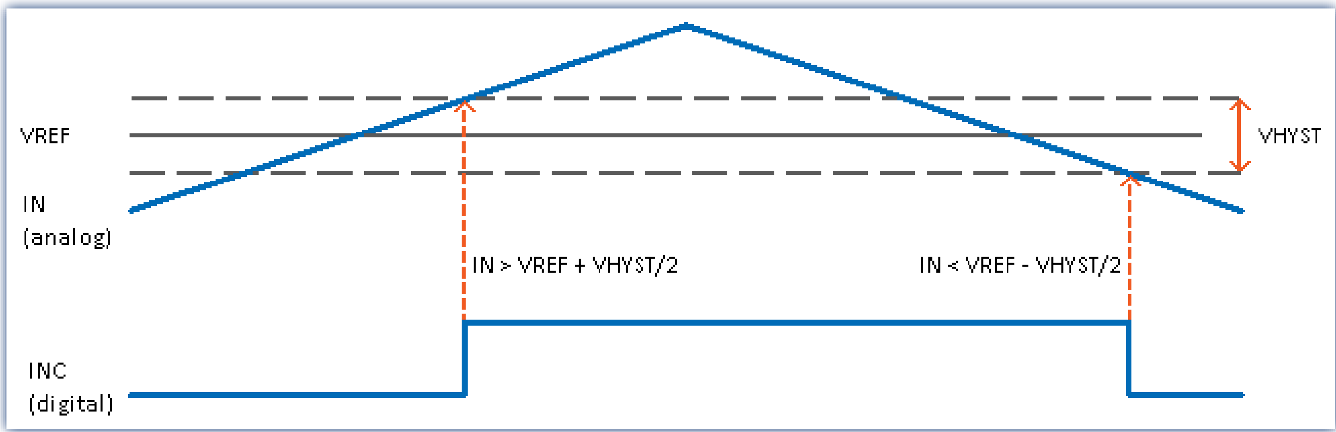
Since many signal encoders require a supply voltage, +5 V are provided at the plug for this purpose (max. 300 mA). The reference potential for this voltage, in other words the supply-ground connection for the sensor, is CHASSIS.

8.11.12.2 Comparator conditioning (threshold, hysteresis)

The incremental counter channels' **special properties make special demands** on the signal quality: The very high time-resolution of the detector or counter means that even extremely short impulses which sampling measurement procedures (as at the digital inputs) would miss are captured and evaluated. Therefore the digital signals must have clean edges in order not to result in distorted measurements. Missed pulses or bounces could otherwise lead to drop-outs in the time measurements, or enormous "peaks" in the rpm-measurements.

Simple sensors such as those based on induction or photosensitive relays often emit only unconditioned analog signals which must be evaluated in terms of a threshold value condition. Furthermore long cables, ground loops or interference, can make the processing of even conditioned encoder signals (such as TTL-levels) difficult. The imc CRONOS-measurement system, however, can counteract this using its special three-step conditioning unit.

To begin with, a high-impedance differential amplifier (±10 V range, 100 kΩ) enables reliable measurement from a sensor even along a long cable, as well as effective suppression of common mode interference and ground loops. A (configurable) filter (in preparation) at the next stage offers additional suppression of interference, adapted to the measurement set-up. Finally, a comparator with configurable threshold and hysteresis acts as a digital detector. The (configurable) hysteresis is an extra tool for suppressing noise:



If the analog signal exceeds the threshold VREF + VHYST/2. the digital signal changes its state (← : 0 ⇒ 1) and at the same time reduces the threshold which must be crossed in order to change the state back to 0 by the amount VHYST (new threshold: VREF - VHYST/2). The magnitude of the hysteresis therefore represents the maximum level of noise and interference that would not cause a spurious transition.

The threshold VREF is set to 1.5 V, the hysteresis VHYST is 0.5 V.
State transitions are therefore detected at the signal amplitudes:

1.75 V (↑ : 0 ⇒ 1) und ***1.25 V (↓ : 0 ⇒ 1)***.

In future device versions, the threshold and hysteresis will be globally adjustable for all four channels within the range:

Input (VREF) = ±10 V	**Threshold** (VREF) = ±10 V	**Hysteresis** (VHYST) = 100 mV .. 10 V	Requirement: (|VREF|+VHYST/2) < 10 V
Input (VREF) = ±1.5 V	**Threshold** (VREF) = ±1.5 V	**Hysteresis** (VHYST) = 100 mV .. 1.5 V	Requirement: (|VREF|+VHYST/2) < 10 V

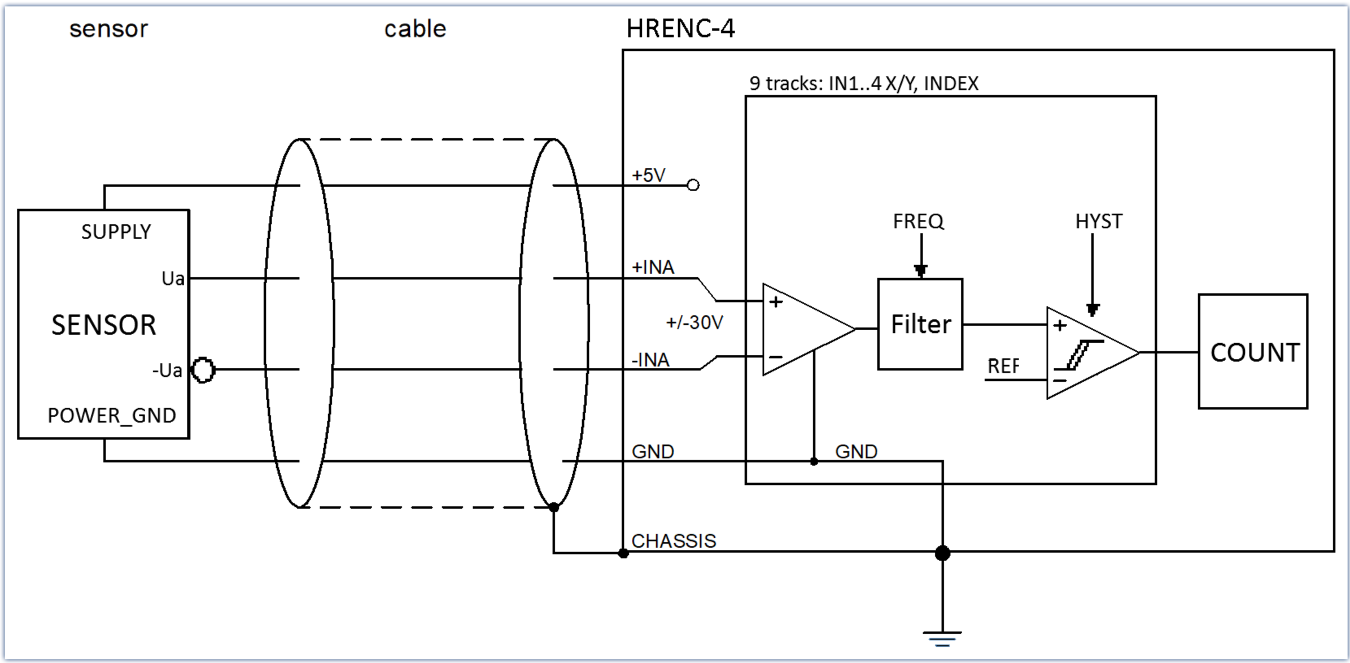
Corner frequencies of the (2-pole) low-pass filter will be jointly configurable for both of a channel's tracks to the values:

- Low-pass filter: 200 Hz, 2 kHz, 20 kHz or without (500 kHz bandwidth)

Structure

Complete conditioning is provided for all 8 tracks of the 4 channels: for each channel, the two tracks (A and B or C and D) of a **dual-track encoder** can be connected, in which case the differential inputs of each pair of tracks share a **common reference** (negative input).

Block schematic

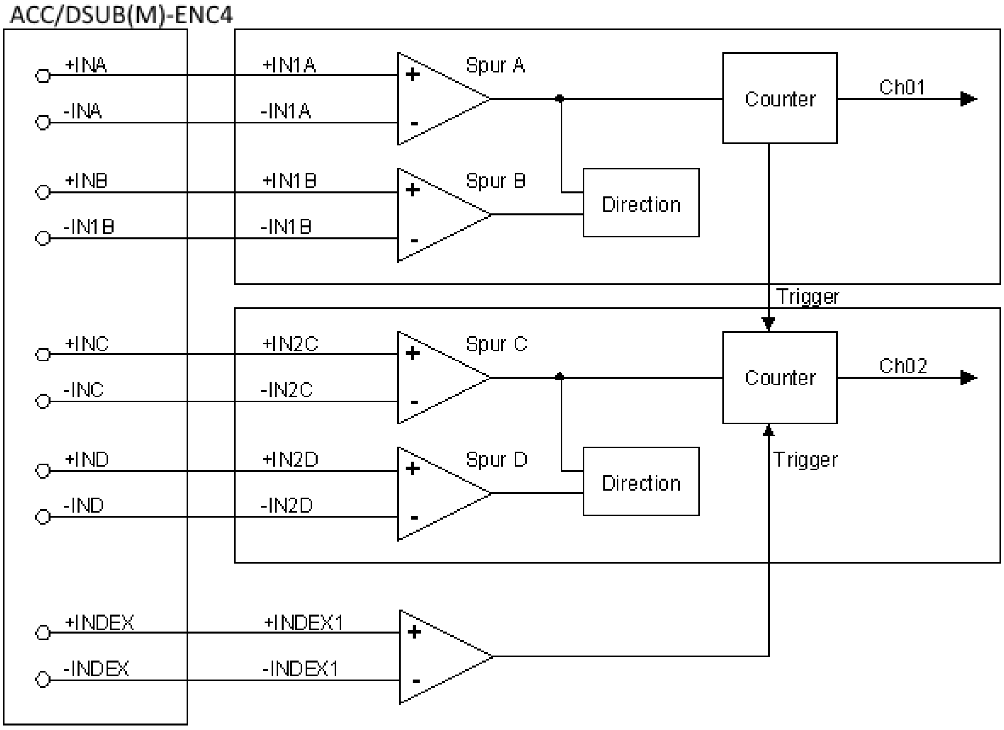


One differentiates between single track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B. By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported. The actual time or frequency information, however, is derived exclusively from the A-track!

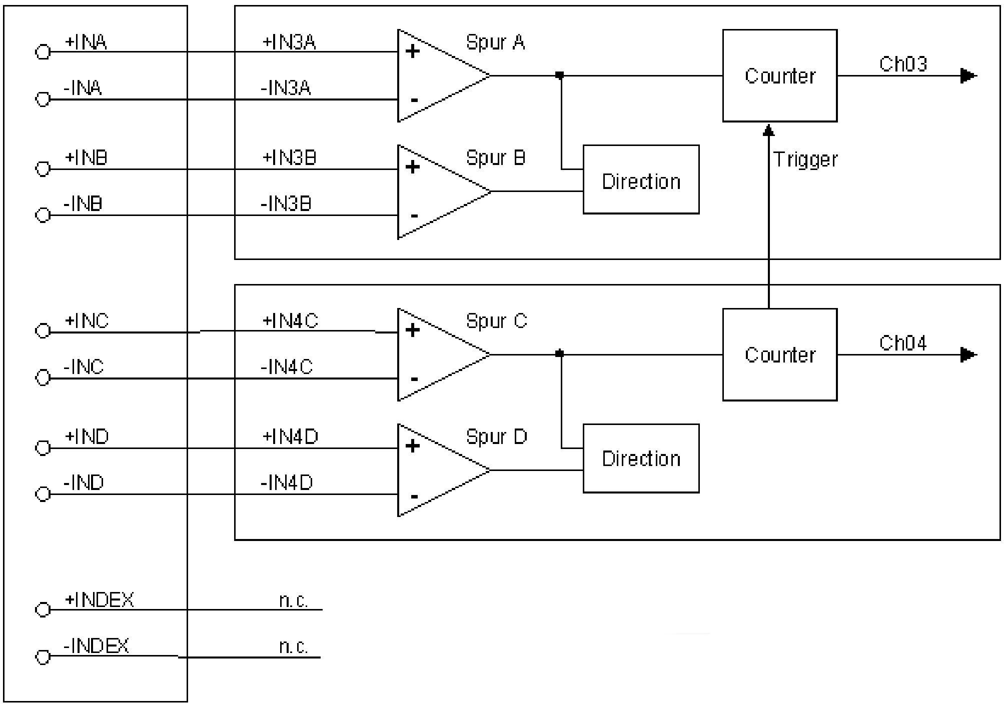
Like the other channels, the Index-channel is fully conditioned. If its function is activated, it can take effect on all four channels. The DSUB-15 terminal sockets are each occupied by 2 channels. In order to prevent accidental short-circuiting due to incorrect wiring, the **index-channel** occupies **only the first DSUB-15 socket**, together with Channels 1 and 2. The second socket, occupied by Channels 3 and 4, has no contact to the Index-channel at its corresponding pins! However, in the interest of uniformity, imc terminal plugs all are labeled ±INDEX!

8.11.12.3 Channel assignment

ACC/DSUB(M)-ENC4



ACC/DSUB(M)-ENC4



The condition for the input differential amplifier reaching the correct working point is that the sensor be ground referenced, meaning that is has low impedance towards ground (GND, CHASSIS, PE). This is not to be confused with the sensor's common mode potential, which may be as much as ±30 V (even for the –IN input!). This also applies if differential measurement is configured for the high-impedance differential input. If this galvanic contact to the system (CHASSIS) doesn't exist for an isolated sensor, such a connection must be created, for instance as a jumper between GND (device) and the sensor's POWER_GND!

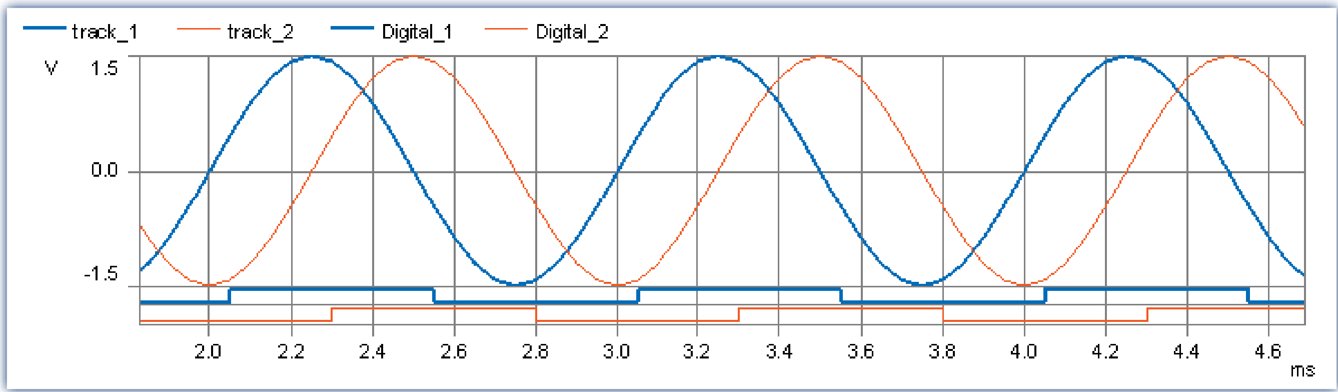
The 5 V (max. 300 mA) supply voltage provided at the terminals "+5 V, GND" can be used to supply sensors. if a greater voltage or supply power is required, the sensor must be supplied externally, and you must make sure to provide a galvanic connection between this supply voltage and the system ground!

8.11.12.4 Content of high resolution incremental counter measurement

Normally, incremental encoder emit simple square-wave signals, whose pulse sequence is evaluated according to certain criteria. In this case, it is adequate for the incremental counter's input amplifier to clearly detect the pulses on the basis of either a HIGH or LOW voltage level.

Two-track sine/cosine signal generators output the pulse sequence as a continuous sine/cosine plot. The HRENC is capable of converting the instantaneous sine/cosine tracks into the angle. This makes a substantially increased resolution possible, which depends on the input amplifier's resolution and on the saturation degree of the input range.

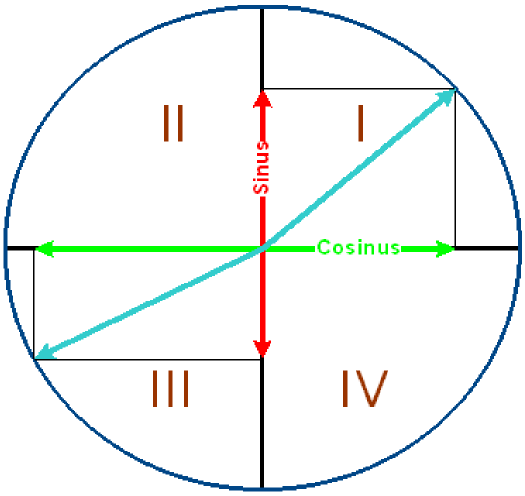
Additionally, the HRENC converts the analog signals to digital values, used for determining the direction of rotation and the discrete progress (complete periods).



Increased resolution by analysis of analog intermediate values

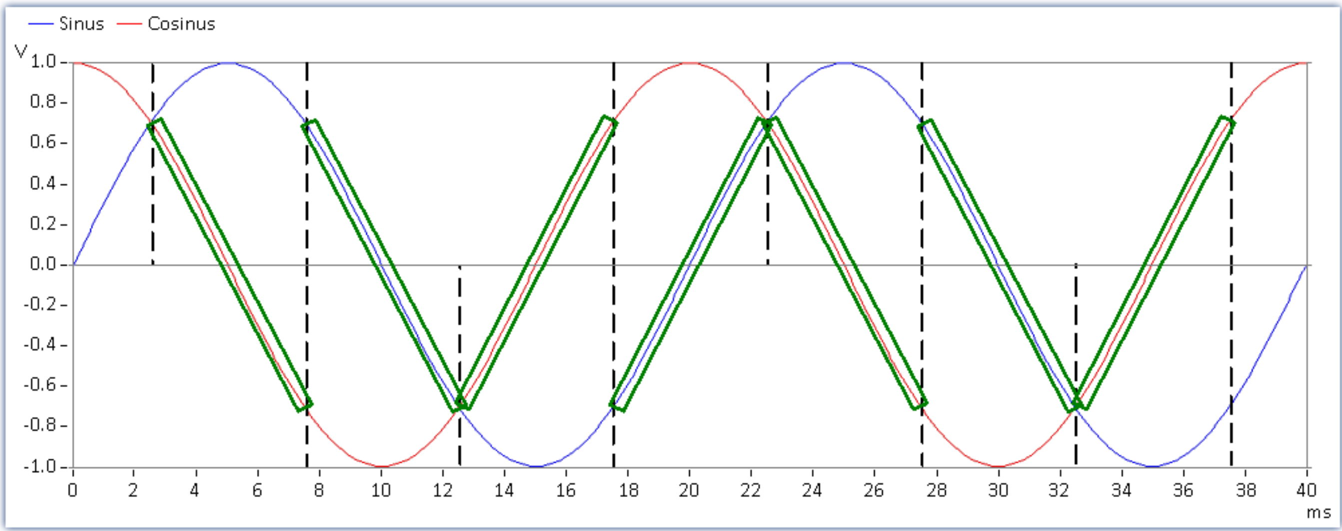
Increasing the resolution by analysis of analog intermediate values delivers better results and offers more possible applications than pulse multiplication by evaluation of all signal transitions. For this type of resolution improvement, incremental encoder sensors are used which generate two sinusoidal signals offset by 90°. Every sine wave's period is the result of the continually changing influence of the segmentation on the sensor's signal output during the rotational motion. These incremental encoder sensors are referred to as SinCos sensors. In explanation, consider an incremental rotation sensor whose angle increments consist of an evenly partitioned circular disc. Sampling both tracks yields the exact angular position of the rotating test object at every sampling point. In an orthogonal system featuring the sine and cosine functions, such as the SinCos sensor returns, every point on the circle can be represented.

The sin-/cos-shaped signals partition the respective angle increments into 4 quadrants (90°). Simultaneous capture of both signals enables certain determination of the respective quadrant.



Orthogonal system for determining position in a circle

For high resolution, the signal segments evaluated must be as linear as possible. For this reason, the regions of the SinCos sensor's signals marked in the figure below are sampled in order to increase the resolution, since those regions of the sinusoidal signal provide clear recognition of the direction, at high resolution. Thus, the resolution is increased by a factor of 256, and the precision by a factor of 10.



Signal segments used for evaluating analog intermediate values

Both signals are sampled at any given time. Just the information on the quadrant in which the signal currently resides provides much higher resolution for determining the position than the simple pulse counting performed by a single-track incremental encoder sensor. The tangent derived from the ratio of the sine and cosine values provides information independent on the amplitude. This is necessary in order to be able to use incremental sensors even with unknown amplitude and achieve high resolution, since the amplitude can change over time with attrition. Furthermore, there are many SinCos sensors whose signal plot depends on the frequency. With opto-electronic SinCos sensors, the signal suffers bandwidth limiting as the frequency increases, and a decreasing upper harmonic component causes its shape to change from triangular to sinusoidal. Asymmetry of the sensor signal due to tolerances in the manufacture of the sensors presents yet another problem. Both attrition and sensor production tolerances make calibration of the sensors necessary. For instance, the known winding-down pattern after shutoff of an axle having great mass inertia could be used to record a signal's exact course as it progresses through angles of rotation.

SinCos sensors have long been in use to improve resolution, but only for pulse multiplication purposes and not for evaluation of analog intermediate values. For this type of analysis, a weighted comparison of the two signals is performed. By means of appropriate weighting, pulses could be generated for every angle (q) given an ideal signal pattern. Furthermore, the reference position is independent of the signal amplitude.

8.11.12.5 Software settings

Besides the dialog elements familiar from ENC-4, the following settings options are available in the mode *Displacement*(diff) and *Angle*(diff):

8.11.12.5.1 Input

Selection of the input voltage range: 1.5 V and 10 V
To achieve higher resolution, the input range should be utilized to the greatest extent possible.

8.11.12.5.2 Signalshape

The default selection Rectangle (digital) corresponds to the conventional functioning of the ENC-4. Sine (analog) activates conversion of the discrete instantaneous values.

Note

In analog operation, too, an appropriate value must be set for the hysteresis. This is required for conversion to a digital signal. An appropriate setting of the switching level is also important, since this is considered the sine/cosine-signal's DC-component.

8.11.12.6 Functioning

A measurement of the sinusoidal (analog) counter signals is performed. These counter signals are, on the one hand, converted to binary signals (pulses) based on the threshold values set in the user interface (switching level with hysteresis), and on the other hand processed directly in order to achieve much higher counter resolution. For this purpose, the fact that the information content of an ideal sine/cosine-shaped incremental encoder signal theoretically has infinite resolution is exploited. The resolution of the analog counter signal is 12 bits, corresponding to a maximum possible pulse multiplication of 4096 (212).

Note

The 12-bit analog resolution applies to the (adjustable) analog input range. To achieve a counter signal resolution of 12 bits requires that the input range be fully utilized. Otherwise, the resolution of the Sin/Cos-signal is reduced accordingly.

Example Example 1

Using the software imcDevices, the input range is set as ± 10 V. The counter returns signals with 5 V peak value: 5 V sin(ω t) , 5 V cos(ω t)

The input range is only half utilized, i.e. ½ of the input range is lost (1/2^1). This means that the analog resolution is reduced by one bit to 11 bits (2-12 / 2-1 = 2-11).

If only ± 2.5 V of the input range is utilized, i.e. ¼ of the input range (1/2^2), two bits have already been lost (analog resolution: 10 bits).

The sign is determined from the logical pattern of the counter signals converted to squarewave pulses, and the pulses are counted with the respective correct sign.

At the moment of sampling (according to the sampling interval set in the user interface), the exact location is determined based on the analog signals (position in the sine-/cosine signal). The exact progress is then determined as the summation of the signed pulses plus the difference between the exact positions of the sine curve at the current sampling point and the and at the previous sampling point.

The resolution of the measurement results is then 2^{15} in relation to the maximum amount of pulses possible within a sampling interval (periods of the sinusoidal counter signals). This is because the maximum amount of pulses possible within a sampling interval determines the input range, which has a resolution of 2^{15} subdivisions. Any modification is made in terms of powers of two, and at least one pulse per sampling interval is captured (1, 2, 4, 8, 16 ...)

Example Example 2

max. pulses per sampling interval	Input range end value (pulses)
0.02	1
2.4	4
3.5	4
5	8
24.3	32

The actual input range and thus the actual resolution depend on how a pulse interpreted.

Example Example 3

A two-track rotation counter to be used to measure an angle returns 3600 Sin/Cos-periods per revolution, i.e. per Sin/Cos-period 0.1°. No RPM-values above 3000 min-1 are expected. The sampling interval is set to 500 µs From this, it follows that:

A maximum of 90 signal periods occur per sampling interval, because
3000 revs min-1/ 60 = 50 revs s-1
50 revs s-1 * 3600 signal periods / rev = 180000 signal periods / s
180000 signal periods / s * 0.5 ms = 90 signal periods within one sampling interval

The resulting input range end value (in signal periods) is then 128 signal periods (next power of two).
This resolution is 128 signal periods / 2^{15} = 0,004 signal periods (2^8 signal periods). The pulse multiplication achieved is 256.

The physical interpretation of a signal period, i.e. as an angle is
1rev / 3600 signal periods or 360°/ 3600 signal periods = 0.1° / signal period

The resulting physical input range for this application with the sampling interval set is thus 12.8° (approx. 0.036 U), because:
128 signal periods * 0.1° / signal period = 12.8°
The resolution is 0.0004° (approx. 1 µU), because:
0,004 signal periods * 0,1° / signal periods = 0.0004°

By comparison, regular counting of the counter pulses would yield a resolution of only 0.1° and the use of an evaluation algorithm with pulse multiplication only a resolution of 0.025°.

By increasing the sampling rate, the resolution could be improved further, e.g. to 0,0002° at 200 µs (pulse multiplication of 512) or to 0.0001° at a 100 µs sampling rate (pulse multiplication of 1024).

In addition to the ability to set the analog input range for capture of the Sin/Cos counter signal, it is also possible to configure input low-pass filters. The frequency specified then denotes the -3 dB-point, i.e. the frequency at which the level of the Sin/Cos counter is already attenuated by a factor of 0.71. Due to the filter properties, it is also possible that some of the analog resolution is lost.

Example Example 4

Using the software imc STUDIO, the input rant is set to ± 1.5 V and a 200 Hz low-pass filter is set. The counter returns signals with 1 V peak values. Signal frequencies of over 200 Hz can occur.

At 200 Hz the input level is attenuated to 0.707 V, i.e. the analog resolution is already reduced to about 11 bits. At even higher signal frequencies, the resolution drops further. If the attenuated input signal is already too low to ensure that the switching level (the specified hysteresis) is exceeded, no measurement is possible at all.

Note: Along with the signal levels, the signal phase shift also changes. This is not critical in many applications, however.

8.11.12.7 Connection

ENC-4 and HRENC-4 use the ACC/DSUB(M)-ENC4 497.

8.11.13 SYNTH-8: 8 channel signal generator, synthesizer and realtime PID controller

This expansion module provides 8 analog voltage outputs (DAC) to serve as programmable signal generator, synthesizer and for replay of arbitrary signal sequences. Such waveforms can either interactively defined or loaded as datasets for multiple segments.

Furthermore this module can act as programmable PID controller for realtime closed loop control applications. Its internal and exclusively dedicated processor can operate up to 16 independent and extensively configurable controllers. These operate independently and in parallel and can also be arbitrarily cascaded. Setpoints and inputs to the controllers can be selected from measurement channels, virtual channels and variables of the imc system. The controller outputs can be assigned to the 8 analog outputs in order to drive actuators.

Note

- Similar to the fieldbus interfaces, the SYNTH module is a configuration option: Devices can only be equipped ex-factory at time of order. Exchanging or retrofitting the module to existing systems in the field and by the user is not supported.
- The digital inputs and outputs are not implemented in the current software.

Reference

For details on operation, refer to the manual: "*Synthesizer_Manual.pdf*".

In the following sections you will find:

- Technical details of the SYNTH-8 457
- Pin configuration of the DSUB-15 497

9 Technical Specs

All devices described in this manual are intended at least for normal ambient conditions according to IEC 61010-1. In addition, the extended ambient conditions apply according to the explicitly stated technical data.

The data sheets in this chapter "Technical Specs" correspond to the separately managed data sheets. In addition to the tables, the separate data sheet contains module and device photos, drawings with dimensions, accessories and imc part numbers. This additional information would go beyond the scope of this manual. In individual cases it may happen that we publish a new data sheet before there is a new manual edition. The valid data sheets are always available on the imc website:
www.imc-tm.com/download-center/product-downloads

The specified technical data refer to the reference conditions, such as the specified preferred position of use (see respective technical data sheet) and an ambient temperature of 25 °C as well as compliance with the specifications for use (see Precautions for operation 15) and for grounding and shielding.

For device variants with BNC connection technology in particular (established for certain measurement tasks), gapless shielding is not initially guaranteed due to the design, as the negative pole of the measurement input is directly connected out as a coaxial outer conductor. Any interference coupled to the measuring lines thus has an asymmetrical effect on the measuring input. As a result, the accuracy specifications specified in the tables may be exceeded during the fault. Appropriate measures are taken to meet the EMC requirements for these devices as well. For the acceptance criterion A, a measuring accuracy of 2 % is assumed in the unshielded case for the reasons mentioned. If significant RF interference is to be expected in the measurement environment and if the limited accuracy is insufficient, the shielding measures shall be implemented in accordance with the above sections, i.e. the coaxial test lead shall be shielded.

Note HV amplifiers

HV amplifiers are a special case in the shielding concept. For these, the above-mentioned limitation relating to unshielded measurement connections does not apply.

9.1 Hardware Feature

Hardware features and their dependencies of imc software versions:

- **minimum low pass filter with imc CRONOS*flex* (CRFX)**

  In combination with the new software version the minimum low pass filter of the following amplifiers are improved:

CRFX Module	imc STUDIO 4.0	as of imc STUDIO 5.0 R1
CRFX/UNI-4 421	50 Hz to 20 kHz	10 Hz to 20 kHz
CRFX/UNI2-8 430	50 Hz to 20 kHz	10 Hz to 20 kHz
CRFX/LV3-8 409	50 Hz to 20 kHz	10 Hz to 20 kHz
CRFX/ICPU2-8 386	50 Hz to 20 kHz	10 Hz to 20 kHz
CRFX/ISO2-8 392	20 Hz to 5 kHz	2 Hz to 5 kHz
CRFX/DCB2-8 365	50 Hz to 5 k Hz	10 Hz to 5 kHz
CRFX/B-8 365	50 Hz to 20 kHz	10 Hz to 20 kHz

CRFX Module	imc STUDIO 5.0 R1	as of imc STUDIO 5.0 R3
CRFX/ISOF-8	50 Hz to 20 kHz	10 Hz to 20 kHz

Unless otherwise indicated, the technical specs given in the followings tables are valid.

- **Characteristic curve linearization - user defined**

Support of sensor characteristic curves is enabled for following devices:

Amplifier	Device			
	CRSL	CRC	CRFX	CRXT
ISO2-8	● as of 2.7 R3	● as of 2.7 R3	● as of 2.8 R5	● as of 2.13 R1
ISOF-8	---	---	● as of 2.9 R2	● as of 2.13 R1
UNI-4	● as of 2.8 R7	● as of 2.7 R3	● as of 2.8 R5	● as of 2.13 R1
SC2-32	● as of 2.7 R3	● as of 2.7 R3	---	---
ICPU2-8	Ø	● as of 2.8 R7	● as of 2.8 R5	● as of 2.13 R1
UNI2-8	Ø	● as of 2.8 R7	● as of 2.8 R5	● as of 2.13 R1
DCB2-8	Ø	● as of 2.8 R7	● as of 2.8 R5	● as of 2.13 R1
B-8	Ø	● as of 2.8 R7	● as of 2.8 R5	● as of 2.13 R1
LV3-8	Ø	● as of 2.8 R7	● as of 2.8 R5	● as of 2.13 R1

Device	Firmware
Cx-41xx-FD	● as of 2.9 R6
SPAR-N	● as of 2.8 R7

●: Feature supported

Ø: Feature currently not supported

---: Amplifier not available for this device series

imc STUDIO 4.0	included firmware 2.8 R3
imc STUDIO 5.0 R1	included firmware 2.8 R5
imc STUDIO 5.0 R3	included firmware 2.8 R7
imc STUDIO 5.0 R6	included firmware 2.9 R2
imc STUDIO 5.2 R10	included firmware 2.13 R1

9.2 Power consumption

Power consumption of imc CRONOS*flex* Modules

		Power supply / max. number of modules							
			direct click connection					PoE	
		n x CRFX	KFZ	AC/DC	AC/DC	CRFX/POWER	AC/DC	PoE, 48V	PoE, 50V
		V_DC	12,0 V	15,0 V	24,0 V	50,0 V	48,0 V	48,0 V	50,0 V
imc CRONOS*flex* Module	**P**	P_max	37,20 W	46,50 W	74,40 W	100 W	148,80 W	16,80 W	17,50 W
CRFX/LV3-8	6,4 W		5,8	7,3	11,6	15,6	23,3	2,6	2,7
CRFX/LV3-8 + ICP-Plug	8,8 W		4,2	5,3	8,5	11,4	17,0	1,9	2,0
CRFX/LV3-8 + SUPPLY	12,4 W		3,0	3,8	6,0	8,1	12,0	1,4	1,4
CRFX/UNI2-8	10,1 W		3,7	4,6	7,4	10,0	14,8	1,7	1,7
CRFX/DCB2-8 / B8	10,0 W		3,7	4,7	7,4	10,0	14,9	1,7	1,8
CRFX/ISO2-8	7,0 W		5,3	6,6	10,6	14,2	21,2	2,4	2,5
CRFX/ISO2-8 + ICP-Plug	9,2 W		4,1	5,1	8,1	10,9	16,2	1,8	1,9
CRFX/ISO2-8 + SUPPLY	12,4 W		3,0	3,8	6,0	8,1	12,0	1,4	1,4
CRFX/ISOF-8	8,8 W		4,3	5,3	8,5	11,4	17,0	1,9	2,0
CRFX/ISOF-8 + ICP-Plug	10,9 W		3,4	4,3	6,8	9,2	13,7	1,5	1,6
CRFX/UNI-4	7,0 W		5,3	6,6	10,6	14,3	21,3	2,4	2,5
CRFX/UNI4 + SUPPLY (120R)	8,5 W		4,4	5,5	8,8	11,8	17,5	2,0	2,1
CRFX/UNI4 + SUPPLY (0,5W)	10,8 W		3,4	4,3	6,9	9,3	13,8	1,6	1,6
CRFX/HV-4U	5,8 W		6,4	8,0	12,8	17,2	25,5	2,9	3,0
CRFX/HV-2U2I	5,8 W		6,4	8,0	12,8	17,2	25,5	2,9	3,0
CRFX/HISO-8	7,3 W		5,1	6,4	10,2	13,7	20,4	2,3	2,4
CRFX/BR2-4	9,3 W		4,0	5,0	8,0	10,8	16,0	1,8	1,9
CRFX/ICPU2-8	7,4 W		5,0	6,3	10,1	13,6	20,2	2,3	2,4
CRFX/AUDIO2-4	7,4 W		5,1	6,3	10,1	13,6	20,2	2,3	2,4
CRFX/HRENC-4	7,4 W		5,0	6,3	10,1	13,5	20,1	2,3	2,4
CRFX/DI2-16	3,9 W		9,6	12,0	19,2	25,9	38,5	4,3	4,5
CRFX/DI2-16 + SUPPLY	4,7 W		7,9	9,9	15,8	21,3	31,7	3,6	3,7
CRFX/DI2-16-DO-16-HC	4,3 W		8,7	10,9	17,4	23,4	34,9	3,9	4,1
CRFX/DI2-16-DO-16-HC + SUPPLY + LOAD	7,8 W		4,8	6,0	9,6	12,9	19,2	2,2	2,3
CRFX/DI2-32	4,4 W		8,5	10,6	16,9	22,7	33,8	3,8	4,0
CRFX/DI2-32 + SUPPLY	6,1 W		6,1	7,7	12,3	16,5	24,5	2,8	2,9
CRFX/DI-16-HV	3,9 W		9,6	12,0	19,2	25,9	38,5	4,3	4,5
CRFX/DO-16-HC	3,7 W		10,0	12,5	19,9	26,8	39,9	4,5	4,7
CRFX/DO-16-HC + LOAD	6,4 W		5,8	7,3	11,6	15,6	23,3	2,6	2,7
CRFX/DO-16-HC-DAC-8	7,1 W		5,3	6,6	10,5	14,2	21,1	2,4	2,5
CRFX/DO-16-HC-DAC-8 + LOAD	11,7 W		3,2	4,0	6,3	8,5	12,7	1,4	1,5
CRFX/DO-32-HC	4,1 W		9,0	11,3	18,0	24,2	36,0	4,1	4,2
CRFX/DO-32-HC + LOAD	9,5 W		3,9	4,9	7,9	10,6	15,7	1,8	1,8
CRFX/DAC-8	6,7 W		5,6	7,0	11,2	15,0	22,3	2,5	2,6
CRFX/DAC-8 + LOAD	8,7 W		4,3	5,4	8,6	11,5	17,2	1,9	2,0
		Min	**3**	**3**	**6**	**8**	**12**	**1**	**1**
		Max	**9**	**12**	**19**	**26**	**39**	**4**	**4**

Note

- Due to the flexible combinations, the number of supported modules is defined with one position after decimal point.
- A maximum length of 85 cm of attached (clicked) modules should not be passed! Mounting elements can be used for more stability.
- The power consumption of an imc CRONOS-XT module is the same as that of the corresponding imc CRONOS*flex* module.

9.3 Basic systems technical specs

9.3.1 imc CRONOSflex Base Unit (CRFX)

"✔" standard; "O" optional; "-" not available

Parameter	CRFX-400	CRFX-2000G(P)	Remarks
Max. aggregate sampling rate	400 kS/s	2000 kS/s	data rate of analog channels [1]
Terminal connections			
PC / network Ethernet TCP/IP	RJ45 100 MBit	RJ45 1 GBit	max. 100 m cable with 100 MBit (according to IEEE 802.3)
System bus for flex-modules (EtherCAT)	RJ45 alternatively: module connector		max. 100 m cable between 2 modules
Additional connections	<4 +3		with imc STUDIO Monitor or imc REMOTE Windows Explorer connections
Flash removable storage	CF-Card slot	CFast-Card slot	can also be read out via network
USB 2.0 (Host)	-	✔	for alternative storage media instead of CFast: such as ext. HDD, USB stick etc.
Internal hard drive (HDD)	O	O	option, only ex factory: SSD or magnetic; 400 kS/s data storage achievable with 16 bit / sample
Internal WiFi (WLAN) adaptor (optional)	1 antenna IEEE 802.11g max. 54 MBit/s 2.4 GHz	2 antennas IEEE 802.11n max. 300 MBit/s dual band (2.4 / 5 GHz)	
Sync	BNC		isolated (marked with yellow ring)
External display	DSUB-9		
External GPS module	DSUB-9		
Power supply	type LEMO.1B (2-pin)		compatible with LEMO.EGE.1B.302 multicoded 2 notches compatible with connectors FGG.1B.302 (standard) or FGE.1B.302 (E-coded, 48 V)
Remote control terminal	type LEMO.1B (6-pin)		connector LEMO FGG.1B.306
Module connector	2 x 20-pin		direct connection of modules (click) supply and system bus

1 2000 kS/s achievable with deactivated process vector, without trigger and in 16 Bit mode only.
When using the process vector a maximum of 128 active analog channels (monitor channels do count as well) at 2 kS/s per channel plus one fieldbus interface are possible. Each additional fieldbus interface might reduce the aggregate sampling rate of analog channels by a maximum of 200 kS/s.

Power supply	CRFX-xxx	CRFX-xxx-I	Remarks
DC supply input	-	✔	galvanically isolated of housing (CHASSIS)
Isolated system-electronics	-	✔	USB, display and GPS
Power supply	10 V to 50 V DC	20 V to 50 V DC	
Power-on threshold (typ.)	10.0 V	20.0 V	min. input voltage required for power-on (open circuit)
Shutdown threshold (typ.)	9.2 V	18.1 V	input voltage at which the automatic deactivation is triggered (data backup protected by internal UPS buffering)
Power consumption	CRFX-400: typ. 20 W CRFX-2000G(P): typ. 35 W		depending on model and equipment (e.g. fieldbus, HDD)
AC/DC power adaptor	48 V DC, 150 W 110-230 V AC 50-60 Hz		included in delivery
Pass through power	via module connector and onto RJ45 (EtherCAT): PoEC		min. 42 V required for PoEC

Pass through power limits	
Directly connected imc CRONOS*flex* modules via module connector	3.1 A (max.), equivalent power with chosen DC power input: • 149 W at 48 V DC (standard AC/DC power adaptor resp. DC/DC Power Handle) • 37 W at 12 V DC (typ. DC input voltage)
Power-over EtherCAT (PoEC) for remote imc CRONOS*flex* modules	350 mA (max., corresp. to IEEE 802.3), equivalent power with DC power input: • 17.5 W at 50 V DC (e.g. DC/DC Power Handle) • 16.8 W at 48 V DC (e.g. AC/DC power adaptor) • 14.7 W at 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

UPS and Data integrity	Value	Remarks
Autarkic operation without PC	✔	
Self start (Automatic data acquisition operation)	configurable	timer, absolute time, automatic start when power supply is available
Auto data-saving upon power outage	✔	buffering (UPS) with "auto-stop" auto-stop of measurement, data storage and automatic shutdown
UPS	integrated	Super-Caps, CRFX-xxx: delivery since Q2/2017 before: Lead gel batteries [2] CRFX-xxx-I: Super-Caps at all times
Charging time of the Super-Caps	6 min.	minimum required active operation for full UPS functionality
UPS coverage	CRFX base unit	no buffering of directly connected CRFX modules (to be covered by separate UPS module CRFX/HANDLE-xx)
UPS delay	0 s	"buffer-time constant": required duration of a continuous outage that will trigger auto shutdown procedure

2 see reference to lead batteries on device identification plate

Data acquisition, trigger	Value	Remarks
Channel individual sampling rates	selectable in 1–2–5 steps	
Number of sampling rates: analog channels, DI and counter	2	usable simultaneously in one configuration
Number of sampling rates: fieldbus channels	arbitrary	
Number of sampling rates: virtual channels	arbitrary	data rates generated via imc Online FAMOS (e.g. via reduction)
Monitor channels	✔ for all channels of the types: analog, DI and counter (incremental counter) and CAN	doubled channels with independent sampling and trigger settings
Intelligent trigger functions	✔	e.g. logical combination of multiple channel events (threshold, transition) to create triggers that start and stop acquisition of assigned channels
Multi.triggered data acquisition	✔	multiple trigger-machines and multi-shot
Max. Trigger events per CRFX module	8	each CRFX module
Multi-triggered data acquisition	✔	Multiple trigger-machines and multi-shot
Independent trigger-machines	48	start/stop, arbitrary channel assignment

<table>
<tr><th colspan="3">Maximum channel count per device</th></tr>
<tr><td>Active channels within a systems...</td><td>512</td><td>Active channels of the current configuration:
Total number of analog, digital, fieldbus and virtual channels, as well as monitor channels, if any.</td></tr>
<tr><td>...of which active analog channels</td><td>198 (1)</td><td>Active analog channels of the current configuration (sum of primary channels + monitor channels)</td></tr>
<tr><td>Fieldbus channels</td><td>1000</td><td>Number of defined channels (active and passive);
Currently activated channels are limited by the total number of activated channels (512).</td></tr>
<tr><td>Process vector variables</td><td>800</td><td>Single value variables, each containing the last measured values. A process vector variable is automatically created for each channel.</td></tr>
</table>

<table>
<tr><th colspan="2"></th><th colspan="4">without monitor channels</th><th colspan="4">with monitor channels</th></tr>
<tr><th>Channel type</th><th>determined by</th><th colspan="2">limit (aktive+passive)</th><th>activated</th><th>total activated</th><th colspan="2">limit (aktive+passive)</th><th>activated</th><th>total activated</th></tr>
<tr><td rowspan="2">Analog channels</td><td rowspan="2">system-expansion</td><td rowspan="2">Channel</td><td rowspan="2">240</td><td rowspan="2">198 (1)</td><td rowspan="9">512</td><td>Channel</td><td>240</td><td rowspan="2">198 (1)</td><td rowspan="9">512</td></tr>
<tr><td>Monitor</td><td>240</td></tr>
<tr><td rowspan="2">Incremental counter</td><td rowspan="2">system-expansion</td><td rowspan="2">Channel</td><td rowspan="2">16</td><td rowspan="2">16</td><td>Channel</td><td>16</td><td>16</td></tr>
<tr><td>Monitor</td><td>16</td><td>16</td></tr>
<tr><td rowspan="2">DIO/DAC-Ports</td><td rowspan="2">system-expansion</td><td rowspan="2">Port</td><td rowspan="2">16</td><td rowspan="2">16</td><td>Port</td><td>16</td><td>16</td></tr>
<tr><td>Monitor</td><td>16</td><td>16</td></tr>
<tr><td rowspan="2">Fieldbus channels</td><td rowspan="2">flexible</td><td rowspan="2">Channel</td><td rowspan="2">1000</td><td rowspan="2">512</td><td>Channel</td><td rowspan="2">1000</td><td rowspan="2">512</td></tr>
<tr><td>Monitor</td></tr>
<tr><td>Virtual channels (OFA)</td><td>flexible</td><td>-</td><td>-</td><td>512</td><td>-</td><td>-</td><td>512</td></tr>
</table>

Occupancy for ports (examples):

- one DO module (e.g. DO-16) occupies 1 port
- one DI8-DO8-ENC4-DAC4 module occupies 3 ports
- one DAC module (e.g. DAC-8 or DAC-4) occupies 1 port

Monitor-ports: DI-ports (respectively channels) have monitor-ports, DO/DAC-ports in contrary do not have monitor-ports

(1): 128 with imc CRONOS*flex* (CRFX) and imc CRONOS-XT (CRXT), incl. output channels of type DAC-8 and DIO-Ports of type DI / DO, incl. 18 channels per CRFX/WFT-2 input

Storage, signal processing		
Parameter	**Value**	**Remarks**
Removable flash storage	CF (CRFX-400) CFast, USB (CRFX-2000GP)	recommended media available at imc; the specified operating temperature range of the media is relevant
Storage on NAS (network storage)	✔	alternatively to onboard Flash storage SMBv2+3
Arbitrary memory depth with pre- and post trigger	✔	maximum pretrigger limited by size of Circular Buffer RAM; posttrigger only limited by available mass storage (Flash)
Circular buffer mode	✔	cyclic overwrite of circular buffer memory on mass storage media
Synchronization	DCF 77 GPS IRIG-B NTP PTP	Master / Slave via external GPS-receiver TTL via network for CRFX-2000GP devices
Extensive real-time analysis and control functions	✔ imc Online FAMOS included in standard delivery	device-option, licensed via activation code

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request

9.3.2 imc CRONOS-XT Base Unit (CRXT)

Parameter	Value	Remarks
Max. aggregate sampling rate	2000 kS/s	data rate of analog channels [1]
Terminal connections		
PC / network Ethernet TCP/IP	RJ45 1 GBit	sealed
Flash removable storage	CFast-Card Slot	can also be read out via network
Internal WiFi (WLAN) adaptor (optional)	2 antennas IEEE 802.11n max. 300 MBit/s dual band (2.4 / 5 GHz)	for antennas or cables wit RP-SMA
Sync	XT-Con (4-pin)	
Sync NTP / PTP	RJ45	PTP requires appropriate switch
External display	XT-Con (7-pin)	
External GPS module	XT-Con (7-pin)	
Power supply	XT-Con (2-pin)	is not located on the base unit itself, but on the power module option, which must always be explicitly combined
Remote	XT-Con (6-pin)	remote control main switch

Power supply		
Parameter	**Value**	**Remarks**
DC supply input	galvanically isolated	of housing (CHASSIS) remote control signals ("REMOTE") and forwarding the supply ("Power via CAN") on supply potential
Isolated system-electronics	galvanically block isolated	of housing and power supply input; applies to accessible interface connections such as Display, GPS (except Remote)
Power supply	10 V to 35 V DC	
Power-on threshold (typ.)	10.9 V	min. input voltage required for power-on (open circuit)
Shutdown threshold (typ.)	9.9 V	input voltage at which the automatic deactivation is triggered (data backup protected by internal UPS buffering)
Power consumption	typ. 23 W	depending on model and equipment e.g. with CAN FD-Interface
Max. current via internal power supply bus	5.5 A	Determines the minimum required supply voltage respectively the maximum system expansion. An Excel assistant is available for estimating the limits and boundary conditions.
AC/DC power adaptor	24 V DC, 150 W 110-230 V AC 50-60 Hz	connection: XT-Con (2-pin) included in delivery

1 2000 kS/s applies to a configuration without any trigger and a 16-bit resolution.
Due to the modules' sampling rate of 5 kHz, sampling rates < 5 kHz may result in a lower effective aggregate sampling rate. Please refer to the notes in the manual in the chapter *Sampling rate* under *Properties*.

"✔" standard; "O" optional; "-" not available

Data integrity	Value	Remarks
Autarkic operation without PC	✔	
Self start (Automatic data acquisition operation)	configurable	timer, absolute time, automatic start when power supply is available
Auto data-saving upon power outage	✔	buffering (UPS) with "auto-stop", data storage and automatic shutdown
UPS	integrated	Super-Caps
Charging time of the Super-Caps	6 min.	minimum required active operation for full UPS functionality
UPS coverage	CRXT base unit	no buffering of directly connected CRXT modules
UPS delay	0 s	"buffer-time constant": required duration of a continuous outage that will trigger auto shutdown procedure

Maximum channel count per device		
Active channels	512	including their monitor channels; active channels of the current configuration in total
Active analog inputs	128	including their monitor channels including also channels of DAC-8 and ports of DI-16, DO-16
Analog inputs (active + passive)	240 (+240 monitor channels)	
Fieldbus channels (active + passive)	1000	including their monitor channels
Incremental counter channels	16 (+16 monitor channels)	
DIO-Ports (digital IO) and DAC-Ports (analog outputs)	16	example: DI-16 module is equal to one DIO-Port
Process vector variables	800	

Data acquisition, trigger		
Channel individual sampling rates	selectable in 1-2-5 steps	
Number of sampling rates: analog channels, DI and counter	2	usable simultaneously in one configuration
Number of sampling rates: fieldbus channels	arbitrary	
Number of sampling rates: virtual channels	arbitrary	data rates generated via imc Online FAMOS (e.g. via reduction)
Monitor channels	✔ for all channels of the types: analog, DI and counter (incremental encoder)	doubled channels with independent sampling and trigger settings
Intelligent trigger functions	✔	e.g. logical combination of multiple channel events (threshold, edge) to create triggers that start and stop acquisition of assigned channels
Max. Trigger events per CRXT module	8	each CRXT module

Data acquisition, trigger		
Multi-triggered data acquisition	✔	Multiple trigger-machines and multi-shot
Independent trigger-machines	48	start/stop, arbitrary channel assignment

Storage, signal processing		
Parameter	**Value**	**Remarks**
Removable flash storage	CFast	recommended media available at imc; the specified operating temperature range of the media is relevant
Storage on NAS (network storage)	✔	alternatively to onboard Flash storage SMBv2+3
Arbitrary memory depth with pre- and post trigger	✔	maximum pretrigger limited by size of Circular Buffer RAM; posttrigger only limited by available mass storage (Flash)
Circular buffer mode	✔	cyclic overwrite of circular buffer memory on mass storage media
Synchronization	DCF 77 GPS IRIG-B NTP PTP	Master / Slave via external GPS-receiver TTL via network
Extensive real-time analysis and control functions	✔ imc Online FAMOS included in standard delivery	device-option, licensed via activation code

Operating conditions		
Parameter	**Value**	**Remarks**
Shock resistance	MIL-STD-810F IEC 60068-2-27, IEC 61373, Cat.1	
Vibration resistance	MIL-STD-810F Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure IEC 60068-2-64, IEC 61373, Cat.1	
Ingress Protection	IP67	The actual degree of protection depends on the connection technology (see CRXT module data sheets). The CRXT module with the lowest degree of protection determines the degree of protection of the entire system.
Operating temperature	-40°C to 85°C condensation allowed	
Pollution degree	2	
Dimensions (W x H x D) XT3	91.5 x 130 x 186.5 mm	CRXT housing: XT3 incl. optional CAN FD interface
Weight	2.1 kg	incl. optional CAN FD interface

Power via CAN - CRXT/CAN-POWER-1

Parameter	Value	Remarks
Output voltage	10 V to 35 V DC	according to supply voltage; the base unit can supply further CANSAS modules via the optional CAN connections "CAN 1" and "CAN 2"
Output current	1 A (max.)	both CAN nodes together permanently
Short circuit protection (4)	unlimited duration	to reference ground of the output voltage; automatic restart
Isolation	isolated	opposite housing (system ground, CHASSIS)

4 Depending on the performance of the power supply of the measuring system, a short circuit can cause repercussions on the measuring system (e.g. short interruption of the supply of clicked CRXT amplifiers). After removing the short-circuit, the operability of the system is automatically restored.

9.3.2.1 CRXT/POWER-X

General technical specs		
Parameter	**Value**	**Remarks**
Input supply voltage	7 V to 35 V DC 30 V to 35 V DC	e.g. via AC/DC adaptor or vehicle power supply via XT-CON supply socket "PoEC" via M8 EtherCAT socket no supply possible via M8 EtherCAT-OUT socket
Switch-on threshold (typ.)	8.5 V DC	min. input voltage required to switch on with CRXT base unit clicked on
Output voltage	34 V DC V_{in} - 0.3 V DC	internal device intermediate circuit (click connection and PoEC) 7 V to 31 V DC input 31 V DC to 35 V DC input
Output power	70 W 50 W	Supply of the connected device and further slaves via PoEC (M8) of which Supply via PoEC (M8)
Efficiency	>90 % (typ.)	10 V to 35 V DC input output power > 35 W
Overload / short circuit protection: output	unlimited duration (reversible)	to reference ground of the output voltage; automatic restart
Overload protection input	fuse 16 A	
Isolation	isolated from CHASSIS, no input-to-output isolation	to housing (CHASSIS). the connected and supplied CRXT modules, however, provide galvanic block isolation to the input supply circuit
Power supply socket (input)	XT-Con (2-pin)	
Remote control socket	XT-Con (6-pin)	remote control signals ("REMOTE") are referred to power supply input potential
EtherCAT-socket	2x M8 (4-pin)	
Power-over-EtherCAT (PoEC) Current limit	1.5 A	for imc CRONOS components in connection with imc CRONOS-XT (CRXT, M8) no PoEC functionality supported in conjunction with imc CRONOS*flex* (CRFX, RJ45)
Status-LED	POWER (Tri-Color) LIMIT (Tri-Color)	operating mode overload

9.3.3 imc CRONOScompact (CRC)

"✔" standard; "O" optional; "-" not available

Parameter	CRC-400	CRC-400GP	Remarks
Max. aggregate sampling rate	400 kS/s	400 kS/s	data rate of channels of the internal CRC modules
Max. aggregate sampling rate in conjunction with CRFX-Interface (device type "CRC-2000G(P)")		400 kS/s 2000 kS/s	via internal CRC modules data rate analog channels [1], total: internal CRC modules + external CRFX modules
Terminal connections			
PC / network Ethernet TCP/IP	RJ45 100 MBit	RJ45 1 GBit	max. 100 m cable with 100 MBit (according to IEEE 802.3)
Option CRFX-Interface: system bus for external *flex*-modules (CRFX, EtherCAT)	-	O RJ45	device type: "CRC-2000GP", max. 100 m cable between 2 modules
Flash removable storage	CF-Card slot	CFast-Card slot	can also be read out via network
USB 2.0 (Host)	-	✔	for alternative storage media instead of CFast: such as ext. HDD, USB stick etc.
Internal hard drive (HDD)	O	O	option, only ex factory: SSD or magnetic; 400 kS/s data storage achievable with 16 bit / sample
Internal WiFi (WLAN) adaptor (optional)	1 antenna IEEE 802.11g max. 54 MBit/s 2.4 GHz	2 antennas IEEE 802.11n max. 300 MBit/s dual band (2.4 / 5 GHz)	
Sync	BNC		isolated (marked with yellow ring)
External display	DSUB-9		
External GPS module	DSUB-9		
Power supply	type LEMO.2B (2-pin)		compatible with LEMO.FGG.2B.302
Remote (remote controlled main power switch)	DSUB-15		
Programmable status indicator	6 LED (green)		triggering via imc Online FAMOS
Measurement inputs	depending on actual system configuration		typically DSUB-15

1 2000 kS/s achievable with deactivated process vector, without trigger and in 16 Bit mode only.
When using the process vector a maximum of 128 active analog channels (monitor channels do count as well) at 2 kS/s per channel plus one fieldbus interface are possible. Each additional fieldbus interface might reduce the aggregate sampling rate of analog channels by a maximum of 200 kS/s.

Power supply	**CRC-xxx**	**CRC-AC-RACK**	**Remarks**
DC supply input	✔	✔	galvanically isolated of housing (CHASSIS)
AC/DC power adaptor	✔ 24 V DC, 150 W 110-230V AC 50-60 Hz	-	included in delivery
AC power supply	-	✔ 85-250 V AC 50-60 Hz	internal AC/DC power adaptor, standard AC mains inlet (Appliance coupler IEC-60320 C14)
UPS	✔	✔	
Optional Li-Ion UPS	O	-	extended battery capacity
DC supply voltage	10 V to 32 V DC		
Power-on threshold (typ.)	10.9 V		min. input voltage required for power-on (open circuit)
Shutdown threshold (typ.)	9.8 V		input voltage at which internal UPS buffering is activated respectively the delayed automatic deactivation is triggered
Power consumption	<130 W		depending on model and equipment

UPS and Data integrity	Value	Remarks
Autarkic operation without PC	✔	
Self start (Automatic data acquisition operation)	configurable	timer, absolute time, automatic start when power supply is available
Auto data-saving upon power outage	✔	buffering (UPS) with "auto-stop": auto-stop of measurement, data storage and automatic shutdown
UPS	integrated	with automatic charge control
UPS coverage	complete system including plug-in modules (amplifier)	
Shutdown delay with power outage	30 s (default), configurable	"buffer-time constant": required duration of a continuous outage that will trigger auto shutdown procedure
Minimum charging time for 1 min. buffer duration	≤53 min.	typ., 23°C, for empty battery
Additional power consumption during charging time	3.5 W (max.)	device activated
Charging power	2.5 W (typ.)	device activated
Charging time ratio: charging- and discharging duration	buffer time · 1.2 · (total power / 2.5 W)	worst case example: total power consumption of system 100 W, buffer duration 1 min., resulting charging time ≤ 48 min. (charging ratio 48:1)
Charging time for complete battery recovery	36 h	device activated
UPS batteries	**Value**	**Remarks**
Battery type	NiMH	
Effective buffer capacity	≥55 Wh	typ., 23°C, battery fully charged
Max. buffer duration	>30 min.	total buffer duration depending on device variant total power consumption ≤110 W
UPS-takeover threshold (typ.)	9.8 V 11.1 V	takeover internal buffer battery switch back to external supply

Data acquisition, trigger	Value	Remarks
Channel individual sampling rates	selectable in 1–2–5 steps	
Number of sampling rates: analog channels, DI and counter	2	usable simultaneously in one configuration
Number of sampling rates: fieldbus channels	arbitrary	
Number of sampling rates: virtual channels	arbitrary	data rates generated via imc Online FAMOS (e.g. via reduction)
Monitor channels	✔ for all channels of the types: analog, DI and counter (incremental counter) and CAN	doubled channels with independent sampling and trigger settings
Intelligent trigger functions	✔	e.g. logical combination of multiple channel events (threshold, transition) to create triggers that start and stop acquisition of assigned channels
Multi.triggered data acquisition	✔	multiple trigger-machines and multi-shot
Independent trigger-machines	48	start/stop, arbitrary channel assignment

Maximum channel count per device		
Active channels within a systems...	512	Active channels of the current configuration: Total number of analog, digital, fieldbus and virtual channels, as well as monitor channels, if any.
...of which active analog channels	198 (1)	Active analog channels of the current configuration (sum of primary channels + monitor channels)
Fieldbus channels	1000	Number of defined channels (active and passive); Currently activated channels are limited by the total number of activated channels (512).
Process vector variables	800	Single value variables, each containing the last measured values. A process vector variable is automatically created for each channel.

<table>
<tr><th colspan="2"></th><th colspan="4">without monitor channels</th><th colspan="4">with monitor channels</th></tr>
<tr><th>Channel type</th><th>determined by</th><th colspan="2">limit (aktive+passive)</th><th>activated</th><th>total activated</th><th colspan="2">limit (aktive+passive)</th><th>activated</th><th>total activated</th></tr>
<tr><td rowspan="2">Analog channels</td><td rowspan="2">system-expansion</td><td rowspan="2">Channel</td><td rowspan="2">240</td><td rowspan="2">198 (1)</td><td rowspan="10">512</td><td>Channel</td><td>240</td><td rowspan="2">198 (1)</td><td rowspan="10">512</td></tr>
<tr><td>Monitor</td><td>240</td></tr>
<tr><td rowspan="2">Incremental counter</td><td rowspan="2">system-expansion</td><td rowspan="2">Channel</td><td rowspan="2">16</td><td rowspan="2">16</td><td>Channel</td><td>16</td><td>16</td></tr>
<tr><td>Monitor</td><td>16</td><td>16</td></tr>
<tr><td rowspan="2">DIO/DAC-Ports</td><td rowspan="2">system-expansion</td><td rowspan="2">Port</td><td rowspan="2">16</td><td rowspan="2">16</td><td>Port</td><td>16</td><td>16</td></tr>
<tr><td>Monitor</td><td>16</td><td>16</td></tr>
<tr><td rowspan="2">Fieldbus channels</td><td rowspan="2">flexible</td><td rowspan="2">Channel</td><td rowspan="2">1000</td><td rowspan="2">512</td><td>Channel</td><td rowspan="2">1000</td><td rowspan="2">512</td></tr>
<tr><td>Monitor</td></tr>
<tr><td rowspan="2">Virtual channels (OFA)</td><td rowspan="2">flexible</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">512</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">512</td></tr>
<tr></tr>
</table>

Occupancy for ports (examples):

- one DO module (e.g. DO-16) occupies 1 port
- one DI8-DO8-ENC4-DAC4 module occupies 3 ports
- one DAC module (e.g. DAC-8 or DAC-4) occupies 1 port

Monitor-ports: DI-ports (respectively channels) have monitor-ports, DO/DAC-ports in contrary do not have monitor-ports

(1): 128 with imc CRONOS*flex* (CRFX) and imc CRONOS-XT (CRXT), incl. output channels of type DAC-8 and DIO-Ports of type DI / DO, incl. 18 channels per CRFX/WFT-2 input

Storage, signal processing		
Parameter	**Value**	**Remarks**
Removable flash storage	CF (CRC-xxx) CFast, USB (CRC-xxxGP)	recommended media available at imc; the specified operating temperature range of the media is relevant
Storage on NAS (network storage)	✔	alternatively to onboard Flash storage SMBv2+3
Arbitrary memory depth with pre- and post trigger	✔	maximum pretrigger limited by size of Circular Buffer RAM; posttrigger only limited by available mass storage (Flash)
Circular buffer mode	✔	cyclic overwrite of circular buffer memory on mass storage media
Synchronization	DCF 77 GPS IRIG-B NTP PTP	Master / Slave via external GPS-receiver TTL via network for CRC-xxxGP devices
Extensive real-time analysis and control functions	✔ imc Online FAMOS included in standard delivery	device-option, licensed via activation code

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to 50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (Standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request

9.3.3.1 Specs of Li-Ion UPS-module

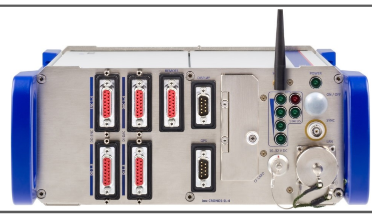
Li-Ion Smart Battery (included in CRC/B-Li-IO-1 and CRC/B-Li-IO-2)		
Parameter	**Value**	**Remarks**
Charging time for complete battery recovery	3 h	device must be switched on
Capacity of each Li-ion battery	98 Wh [4]	Nominal ratings at 21°C The available effective capacity depends on load and temperature. At temperatures below 0°C the usable capacity is reduced to a fraction of nominal values at 21°C. Example (at approx. 40 W load): approx. 85% at -10°C approx. 55% at -20°C
Operating temperature range		
Operation (discharge)	-20°C to +69°C	operational temperature range of UPS buffering functionality To protect the batteries at temperatures above 60°C the UPS buffer time constant is reduced to 15 seconds, regardless of configured setting
	-10°C to +50°C	specified temperature range as rated by Smart Battery manufacturer! Manufacturers of the individual Li-ion cells used in the Smart Battery, specify a discharging temperature range of -20°C to +60°C
	+75°C ± 5°C	battery disconnect: internal protection circuitry of the Smart Batteries prevent discharge
Charge	0°C to +45°C	above +45°C a charge of the batteries is inhibited (green charge level indicator LED stops flashing)
Storage	-20°C to +60°C	
Passive temperature fuse	+93°C (tolerance: +0°C, -5°C)	Once triggered, the passive temperature fuse cannot be reset thus irreversibly rendering the battery useless!
Relative Humidity	≤80%	

Note: Due to the inevitable leakage and self-discharge of the Smart Batteries we recommend a regular recharging cycle at least every 3 months that a device has not been in use (device must be switched on for charging).

(4) As of delivery date FEB-2019, before that 69 Wh

9.3.4 imc CRONOS-SL

General technical specs

Normal position		
Housing	**imc CRONOS-SL-2**	**imc CRONOS-SL-4**
Housing type	portable housing	portable housing
IP-degree of protection (#1)	IP65	IP65
Dimension (WxHxD in mm) with handles, feet and interconnections	286 x 80 x 352 (#2)	286 x 116 x 352 (#2)
Weight (kg)	6.5	8
Free module slots (#3)	2	4
Modular expansion	✔	✔
Max. number of channels (#4)	16	32

(#1) when used with IP65 plugs respectively with protective cover for not used sockets
the socket is IP65 certified even without protective cover (special fabrication)

(#2) without base and handholds (D in mm 280)

(#3) DI16-DO8-ENC4 needs no additional slot

(#4) The maximum number of channels depends on the amplifier configuration;
please contact us for detailed consultation.

Terminal connection	imc CRONOS-SL-2	imc CRONOS-SL-4
PC connector: Ethernet TCP/IP	10/100 MBit, approvable cable length for 100 MBit Ethernet max. 100 m according IEEE 802	
CF-card slot	1	
Synchronization of multiple devices	BNC	
GPS connection	DSUB-9	
Hand-held terminal connection	DSUB-9	
Remote connection	DSUB-15	
Measurement signal terminals	appropriately equipped with signal conditioning, typically DSUB connectors	

Current supply	imc CRONOS-SL-2	imc CRONOS-SL-4
Power supply	10 V to 32 V DC	
LEMO plug	FGG.1B.302 CLAD62ZN	
DC-input isolated	✔	
Power consumption (with UPS battery fully charged)	depending on amplifier (typ. 50 W)	depending on amplifier (typ. 60 W)

"✔" standard; "O" optional; "-" not available

Operating conditions	imc CRONOS-SL-2	imc CRONOS-SL-4
Operating temperature	-40°C to 85°C with condensation	
Storage temperature	-40°C to 85°C	
Shock resistance	MIL-STD-810F 60 g, 11 ms half sine IEC 60068-2-27, IEC 61373, Cat.2 300 m/s² (approx. 30 g), 18 ms half sine	MIL-STD-810F 60 g, 6 ms half sine IEC 60068-2-27, IEC 61373, Cat.2 300 m/s² (approx. 30 g), 18 ms half sine
Vibration resistance	MIL-STD-810F Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure IEC 60068-2-64, IEC 61373, Cat.2	
Condensation protection	✔	

UPS and Data integrity	Value	Remarks
Autarkic operation without PC	✔	
Self start (automatic data acquisition operation)	configurable	timer, absolute time, automatic start when power supply is available
Auto data-saving upon power outage	✔	buffering (UPS) with "auto-stop": auto-stop of measurement, data storage and automatic shutdown
Battery buffering / UPS	integrated	with automatic charge control
UPS coverage	complete system including plug-in modules (amplifier)	
UPS delay per power outage	30 s (Default), configurable	"buffer time constant": required duration of a continuous outage that will trigger auto shutdown procedure
Minimum charge duration for 1 min. buffer duration	≤53 min.	typ., 23°C, with discharged battery
Additional power consumption during charging time	3.5 W (max.)	device activated
Charging power (netto)	2.5 W (typ.)	device activated
Charging time ratio: charge / discharge	buffer time · 1.2 · (total power / 2.5 W)	worst case example: total power consumption of system 100 W, buffer duration 1 min., resulting charging time ≤ 48 min. (charging time ratio 48:1)
Charging time for complete battery recovery	36 h	device activated
UPS batteries	**Value**	**Remarks**
Battery type	NiMH	
Effective buffer capacity	≥55 Wh	typ., 23°C, battery fully charged
Max. buffer duration	>30 min.	total buffer duration depending on device variant, total power consumption ≤110 W
UPS takeover threshold (typ.)	9.8 V 11.1 V	takeover internal backup battery switch back to external supply

Data acquisition, trigger	**Value**	**Remarks**
Max. aggregate sampling rate	400 kS/s	
Channel individual rates	adjustable in 1-, 2-, 5 steps	
Number of sampling rates: analog channels, DI, counter	2	usable simultaneously in one configuration
Number of sampling rates: virtual channels	arbitrary	data rates generated via imc Online FAMOS (e.g. via reduction)
Monitor channels	✔ for all channels of type: analog, DI and counter (ENC)	doubled channels with independent sampling and trigger settings
Intelligent trigger functions	✔	e.g. logical combination of multiple channel events (threshold, transition) to create start and stop triggers
Multi.triggered data acquisition	✔	multiple trigger-machines and multi-shot
Independent trigger-machines	48	start/stop, arbitrary channel assignment

Maximum channel count per device		
Active channels	512	active channels of the current configuration: Total sum of analog, digital, fieldbus and virtual channels as well as possible monitor channels
Fieldbus channels	1000	Number of defined channels (active and passive); Currently activated channels are limited by the total number of activated channels (512).
Process vector variables	800	The process vector is a collection of single-value variables, each containing the latest current measured values. A process vector variable is automatically created for each channel.

<table>
<tr><th colspan="2"></th><th colspan="3">without monitor channels</th><th colspan="4">with monitor channels</th></tr>
<tr><th>Channel type</th><th>determined by</th><th>limit (aktive+passive)</th><th>activated</th><th>total activated</th><th colspan="2">limit (aktive+passive)</th><th>activated</th><th>total activated</th></tr>
<tr><td rowspan="2">Analog channels</td><td rowspan="2">depending device type</td><td rowspan="2">8..24</td><td rowspan="2">8..24</td><td rowspan="11">512</td><td>Channel</td><td>8..24</td><td rowspan="2">16..48</td><td rowspan="11">512</td></tr>
<tr><td>Monitor</td><td>8..24</td></tr>
<tr><td rowspan="2">Incremental counter</td><td rowspan="2">standard</td><td rowspan="2">4</td><td rowspan="2">4</td><td>Channel</td><td>4</td><td>4</td></tr>
<tr><td>Monitor</td><td>4</td><td>4</td></tr>
<tr><td rowspan="2">Digital DI-Ports</td><td rowspan="2">standard</td><td rowspan="2">1</td><td rowspan="2">1</td><td>Port</td><td>1</td><td>1</td></tr>
<tr><td>Monitor</td><td>1</td><td>1</td></tr>
<tr><td>Digital DO/DAC-Ports</td><td>standard</td><td>2</td><td>2</td><td>Port</td><td>2</td><td>2</td></tr>
<tr><td rowspan="2">Fieldbus-channels</td><td rowspan="2">definable (dbc)</td><td rowspan="2">1000</td><td rowspan="2">512</td><td>Channel</td><td rowspan="2">1000</td><td rowspan="2">512</td></tr>
<tr><td>Monitor</td></tr>
<tr><td>Virtual channels (OFA)</td><td>definable (OFA)</td><td>-</td><td>512</td><td>-</td><td>-</td><td>512</td></tr>
</table>

DI-ports (respectively channels) have monitor-ports, DO/DAC-ports in contrary do not have monitor-ports

9.4 Synchronization and time base

Time base of individual device without external synchronization			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Accuracy RTC		±50 ppm 1 µs (1 ppm)	not calibrated (standard devices), at 25°C calibrated devices (upon request), at 25°C
Drift	±20 ppm	±50 ppm	-40°C to +85°C operating temperature
Ageing		±10 ppm	at 25°C; 10 years

Time base of individual device with external synchronization					
Parameter	**GPS**	**DCF77**	**IRIG-B**	**NTP**	**PTP (4)**
Supported formats	NMEA / PPS (1)		B000, B001, B002, B003 (2)	Version ≤4	Version 2
Precision	±1 µs			<5 ms after ca. 12 h (3)	<1 µs under good conditions
Jitter (max.)	±8 µs			---	
Voltage level	TTL (PPS (1)) RS232 (NMEA)	5 V TTL Pegel		---	
Input impedance	1 kΩ (pull up)	20 kΩ (pull up)		---	
Input connection	DSUB-9 "GPS" not isolated	BNC "SYNC" (isolated) (test voltage 300 V, 1 min.)		RJ45 "LAN"	
Cable shield connection		BNC: isolated Signal-GND (marked with a yellow ring)		---	

Synchronization of multiple devices via DCF (Master/Slave)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Max. cable length		200 m	BNC cable type RG58 (propagation delay of cable needs to be considered)
Max. number of devices		20	only slaves
Common mode SYNC not-isolated	0 V		with non-isolated BNC connector: devices must have the same ground voltage level, otherwise signal integrity issues (signal artifacts and noise) may result. Available optional external isolation: see ISOSYNC
SYNC isolated		max. 50 V	with isolated BNC connector: SYNC-signal is already internally isolated, for reliable operation even with different ground voltage level (ground loops)
Voltage level	5 V		
DCF input/output	"SYNC" connection		BNC

ISOSYNC (optional external device for an isolated decoupling of the SYNC signal)			
Isolation strength	1000 V		1 minute (test voltage)
Delay	5 µs		@ 25°C
Temperature range		-35°C to +80°C	

(1) PPS (Pulse per second): signal with an impulse >5 ms is required; max. current = 220 mA
(2) Using BCD information only
(3) Max. value, concerning the following condition: first-synchronization
(4) Only available for devices with "**-GP**" suffix and in conjunction with imc STUDIO 5.0 R5 or higher. Please read the Software manual for detailed information of the PTP synchronization (chapter: "External clock: PTP").

Reference Synchronization and time base

Please find in the software manual a detailed description of **PTP** synchronization in the chapter: "*External Clocks: PTP*".

Note

Concerning all devices with a serial number less than 140000: The DCF77 signal can only be processed if it is configured as "active low". For devices with a serial number higher than 140000: both settings of the external synchronization signal "active low" or "active high" can be processed.

9.5 Audio and Vibration

9.5.1 CRFX/AUDIO2-4(-MIC): IEPE/ICP, Voltage

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	4	
Measurement modes	voltage measurement current fed sensors	 ICP™-, DELTATRON®-, PIEZOTRON®-Sensors
Terminal connection	4x BNC 4x LEMO	one channel per socket **microphone supply AUDIO2-4-MIC** 346

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Bandwidth	0 Hz to 49 kHz 0 Hz to 46 kHz	-3 dB -0.1 dB
Filter (digital) cut-off frequency characteristic order	 50 Hz to 20 kHz	 low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Bessel, Butterworth Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$
Resolution	 16 Bit 24 Bit	output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS - Transducer Electronic Data Sheet	conforming to IEEE 1451.4 Class 1 MMI	

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation		≤100 V	channel to case (chassis) and channel-to-channel [1], test voltage 500 V_{RMS}, 1 min.
Overvoltage protection		 ±150 V ±50 V	continuous, differential input (BNC) range >±2.5 V and device switched off range ≤±2.5 V
Input coupling	AC, DC, AC with current feed		
Input configuration	differential, isolated		galvanically isolated to System-GND (case, CHASSIS) and channels among each other
Input impedance	1 MΩ >10 MΩ	±1 %	range >±2.5 V and device switched off range ≤±2.5 V
Lower cut-off frequency	<0.2 Hz	±20 %	-3 dB; AC-coupling, voltage measurement

[1] no isolation with optional microphone supply (AUDIO2-4-MIC)

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Ranges	±100 V, ±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V to ±5 mV		
Gain error	0.002 %	≤0.05 %	of the measured value, at 25 °C
Gain drift	2 ppm/K·ΔT_a	13 ppm/K·ΔT_a	ΔT_a=|T_a-25°C|; with T_a = ambient temperature
Offset error	 0.002 %	 ≤0.05 % ≤0.1 %	of the range, DC coupling range >±10 mV range ≤±10 mV
Offset drift	±85 µV/K·ΔT_a ±2 µV/K·ΔT_a ±0.35 µV/K·ΔT_a	±200 µV/K·ΔT_a ±7 µV/K·ΔT_a ±0.9 µV/K·ΔT_a	ranges >±2.5 V ranges ±2.5 V to ±500 mV range ≤±250 mV ΔT_a=|T_a-25°C|; with T_a = ambient temperature
Non-linearity	10 ppm	≤20 ppm	
CMRR (common mode rejection ratio) range: ±50 V to ±2.5 V range: ±2.5 V to ±5 mV	 -100 dB -74 dB -146 dB -120 dB		Isolation test voltage, 70 V_{RMS} 50 Hz 1 kHz 50 Hz 1 kHz
Noise	 1.8 µV_{RMS} 0.3 µV_{RMS} 0.1 µV_{RMS}		DC-coupling; bandwidth: 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz
THD (Total Harmonic Distortion)	-100 dB		signal frequency ≤1 kHz
Signal-to noise ratio	 -105 dB -106 dB -97 dB -72 dB		(A-weighted), ≤100 ksps bandwidth 20 Hz to 20 kHz range ±100 V range ±1 V range ±100 mV range ±5 mV

Sensor supply			
Parameter	**typ.**	**min. / max.**	**Remarks**
Constant current	4.2 mA	±10 %	
Compliance voltage	25 V	>23 V	
Source impedance	280 kΩ	>100 kΩ	is parallel to input resistor

Power supply of the module		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Power consumption	 9 W 11 W	10 to 50 V DC AUDIO2-4 AUDIO2-4-MIC
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for expanded imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC) for remote *flex* modules	350 mA (maximum current according to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	62 x 118 x 186 mm	W x H x D
Weight	ca. 0.9 kg (CRFX/AUDIO2-4), 1.2 kg (CRFX/AUDIO2-4-MIC)	

Microphone supply

CRFX/AUDIO2-4-MIC with a supply module for microphones			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Low supply voltage max. supply current/channel	±14 V	±3 % ≥3 mA	 permanent short circuit proof
High supply voltage max. supply current/channel	±60 V	±3 % ≥3 mA	 permanent short circuit proof
Polarization voltage	+200 V	±0.2 %	permanent short circuit proof
Max current		<300 µA	**Attention!** Risk of electric shock

Block isolation of the CRFX microphone supply		
Parameter	**Value**	**Remarks**
Block isolation	60 V	entire microphone supply isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	-SUPPLY	
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Find here the description AUDIO2-4 148

9.5.2 CRFX/QI-4: charge and audio module

Inputs, measurement modes, terminal connections		
Parameter	**Value**	**Remarks**
Inputs	4+4	2 per channel
Measurement modes	voltage measurement charge measurement current fed sensors	 (ICP™-, DELTATRON®-, PIEZOTRON®-Sensors)
Terminal connection	8x BNC	4 for charge measurement (Q) and 4 for voltage measurement or IEPE (U), optionally charge or voltge

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Bandwidth	0 Hz to 49 kHz 0 Hz to 46 kHz	-3 dB -0.1 dB
Filter (digital) cut-off frequency characteristic order	 50 Hz to 20 kHz	 low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Bessel, Butterworth
Resolution	 16 Bit 24 Bit	output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS - Transducer Electronic Data Sheet	conforming to IEEE 1451.4 Class 1 MMI	

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation	≤100 V		channel to case (chassis) and channel-to-channel [2] test voltage 500 V_{RMS}, 1 min.
Overvoltage protection	<±1 V ±150 V ±50 V		charge measurement voltage measurement range >±2.5 V and device switched off range ≤±2.5 V
Input coupling	AC, DC, AC with current feed		
Input configuration	differential, isolated		to system ground (protection ground) and channel-to-channel
Input impedance	1 MΩ >10 MΩ		range >±2.5 V and device switched off range ≤±2.5 V
Lower cut-off frequency	0.2 Hz	±20 %	-3 dB; AC-coupling voltage measurement

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Ranges	±100 V, ±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V to ±5 mV		
Gain error	0.002 %	≤0.05 %	of reading
Gain drift	2 ppm/K·ΔT_a	13 ppm/K·ΔT_a	ΔT_a=|T_a-25°C|; with T_a = ambient temperature
Offset error	0.002 %	 ≤0.05 % ≤0.1 %	of the range, DC-coupling range >±10 mV range ≤±10 mV
Offset drift	±85 µV/K·ΔT_a ±2 µV/K·ΔT_a ±0.35 µV/K·ΔT_a	±200 µV/K·ΔT_a ±7 µV/K·ΔT_a ±0,9 µV/K·ΔT_a	ranges >±2.5 V ranges ±2.5 V to ±500 mV range ≤±250 mV ΔT_a=|T_a-25°C|; with T_a = ambient temperature
Non-linearity	10 ppm	≤20 ppm	
THD (Total Harmonic Distortion)	-100 dB		signal frequency ≤1 kHz
Isolation voltage rejection range: ±50 V to ±2.5 V range: ±2.5 V to ±5 mV	 -100 dB -74 dB -146 dB -120 dB		Isolation test voltage, 70 V_{RMS} 50 Hz 1 kHz 50 Hz 1 kHz
Signal-to noise ratio	 -105 dB -106 dB -97 dB -72 dB		(A-weighted), ≤100 ksps bandwidth 20 Hz to 20 kHz range ±100 V range ±1 V range ±100 mV range ±5 mV
Noise	 1.8 μV_{RMS} 0.3 μV_{RMS} 0.1 μV_{RMS}		DC-coupling; bandwidth: 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Charge measurement QI-4 (standard)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±100,000 pC; ±50,000 pC; ±25,000 pC; ... ±10 pC		
Overload resistance max. signal slope		±5,000,000 pC <±0.01 C/s	permanently
Gain error	 0.04 % 0.1 %	 0.2 % 0.5 %	of reading ranges 100 nC to 100 pC ranges 50 pC to 10 pC
Gain drift	0.01 ppm/K·ΔT_a		ΔT_a=|T_a-25°C|; with T_a = ambient temperature
Offset error DC-coupling Drift with DC-coupling	 0.02 % ±0.005 pC/s	 0.05 % 0.2 pC ±0.05 pC/s	the higher value applies of range after reset process, without incurring overload [1] ΔT_a=25°C
Duration of the reset process	500 ms		
Bandwidth, higher cut-off frequency	 48 kHz 30 kHz 10 kHz		Ck = Sensor- plus cable capacitance -3 dB ±0,1 dB; Ck <1 nF ±0,1 dB; Ck <10 nF
Bandwidth, lower cut-off frequency DC-coupling AC-coupling, ranges: ±100 nC to ±25 nC ±10 nC to ±2500 pC ±1000 pC to ±10 pC	 quasi static 0.2 Hz 0.3 Hz 1.4 Hz		
Noise, ranges: ±100 nC to ±25 nC ±10 nC to ±2500 pC ±1000 pC bis ±10 pC	 0.5 pC_{rms} 0.12 pC_{rms} 0.05 pC_{rms}		bandwidth: 0.1 Hz to 1 kHz

Charge measurement QI-4-1UC			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±1,000,000 pC; ±500,000 pC; ±250,000 pC; ... ±100 pC		

1 An overload of the measurement inputs is applied the moment the charge passes the measurement ranges before the reset process is initiated. If that happens the reset process has to be executed two times in a period of ca. 30 s.

Sensor supply			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Constant current	4.2 mA	±10 %	
Compliance voltage	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	is parallel to input resistor

Power supply of the module		
Input supply voltage	10 V to 50 V DC	
Power consumption	10 W	10 V to 50 V DC
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module		
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

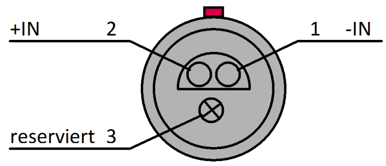
Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current corresponding IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature	-10°C to +55°C	without condensation
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	62 x 118 x 186 mm	W x H x D
Weight	1.2 kg	

Please find here the QI-4 description. 151

9.6 Strain Gauges and Bridges

9.6.1 ACI-8: Dynamic strain measurement

Inputs, Modes		
Parameter	**Value**	**Remarks**
Inputs	8	
Measurement Mode	voltage	AC voltage on current fed strain gauge
Suitable sensor type	strain gauge	single STRG-sensor, 2-wire connection dynamic strain measurement
Scaling	voltage [V]	primary scaling of measured data output (includes correction values for selected current feed)
Scaling for strain measurement	strain [µeps] = voltage / (I · R_STRG · k)	scaling factor to be entered in operating software imc STUDIO I: selected nominal value of supply current R_STRG: nominal strain gauge impedance k: k-factor of strain gauge sensor
Terminal connection	LEMO.ERN.1S.303.GLN	1 channel per plug  recommended plug: FFA.1S.303.CLA
Connection of cable shield	rotary switch on front panel: 1. case (CHASSIS) 2. +IN 3. -IN 4. not connected (float)	default setting of the switch = 1 cable shield will be internally connected accordingly (only for special applications)

Sampling rate, Bandwidth, Filter			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Sampling rate	≤100 kHz		per channel max system throughput of all module channels: 800 kHz including monitor channels
Bandwidth		0.5 Hz to 48 kHz	-3 dB
Filter frequency characteristic order Anti-Aliasing Filter	 10 Hz to 20 kHz Butterworth, Bessel 8th order low- and high pass each 4th order Cauer 8th order		 low pass or high pass band pass with $f_{cutoff} = 0.4\ f_a$
Resolution	16 Bit 24 Bit		output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation (measurement inputs)	galvanically isolated		only switch position 1 or 4 channel-to-channel and against system ground (housing, CHASSIS)
nominal rating	60 V		peak or DC
test voltage	±100 V (10 sec.)		
isolation impedance	10 MΩ, <1 nF		to system ground, to drain off electrostatic charge
	20 MΩ, 680 pF		channel-to-channel
	10 MΩ, 850 pF		against system ground
Input coupling	AC		
Input configuration	differential, isolated		internally connected current source

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±250 mV, ±100 mV, ±50 mV, ±25 mV, ±10 mV*, ±5 mV*, ±2,5 mV*		* deduced from ±25 mV input range
Gain error		±0.1 % ±0.15 %	of reading ±250 mV, ±100 mV, ±50 mV ±25 mV, ±10 mV*, ±5 mV*, ±2.5 mV* * gain error equivalent to ±25 mV input range
Gain drift		50 ppm/K·ΔT_a	$\Delta T_a = \lvert T_a - 25°C \rvert$; with T_a = ambient temperature
Isolation Mode Rejection Ratio IMRR	109 dB		50 Hz
Voltage noise		60 µVss	bandwidth: 50 kHz, ±250 mV range short-circuited input: without noise of current sources
Input capacity	330 pF		in parallel to internal impedance of the current source

Current supply			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Current feed	16 mA, 8 mA, 4 mA, 2 mA 0 mA		 current source can be deactivated for diagnosis
Max. compliance voltage	10 V		across total load / source impedance: (Strain gauge + cable)
Current feed error		±2 %	Does NOT affect accuracy of measurement! Actual current values will be assessed with individual correction values. These are accounted for by the firmware with voltage measurement already
Residual current with deactivated current feed	110 µA		
Temperature drift		50 ppm/°C	
Noise	300 µVss	400 µVss	2 mA, 100 Ω load
Current source bandwidth	50 kHz		load: 1 kΩ
Source impedance	1 MΩ		

Power supply of the module			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Power supply	10 V to 50 V DC		
Power consumption	8 W	12 W	

Terminal connections of the module		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current corresponding to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power-Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	82 x 118 x 186 mm	W x H x D
Weight	1.15 kg	

Find here the description of the ACI-8. 154

9.6.2 BR2-4 Strain gauges, LVDT, Voltage, IEPE/ICP

Parameter	Value	Remarks
Inputs	4	
Measurement modes DSUB-15	bridge sensor strain gauge LVDT voltage measurement current measurement current-fed sensors IEPE/ICP	ACC/DSUBM-B2 full-, half- and quarter bridge inductive transducers (CF) voltage or bridge mode globally selected for all four channels with current plug: ACC/DSUBM-I2 with IEPE/ICP extension plug (DSUB-15): ACC/DSUBM-ICP2I-BNC-S/-F, isolated, basic functionality (ICP-operation)
Measurement modes LEMO	full, half- and quarter bridge LVDT voltage measurement	
Terminal connection DSUB-15 LEMO	 2x DSUB-15 or 4x LEMO.1B.307(308)	 2 channels per plug 1 channel per plug

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	20 kHz (max) (CRC, CRSL) ≤100 kHz (CRFX)	per channel
Bandwidth	8.6 kHz (DC) 3.9 kHz (TF) (CRC, CRSL) 14 kHz (DC) (**CRFX**)	-3 dB -3 dB -3 dB -3 dB
Filter (digital) Frequency Characteristic Order	 2 Hz to 5 kHz (CRC, CRSL) 20 Hz to 5 kHz (**CRFX**)	 Butterworth, Bessel low pass and high pass: 8th order band pass: low and high pass 4th order anti aliasing filter: Cauer 8th order with $f_{cutoff} = 0.4\ f_s$
Resolution CRC, CRSL CRFX	 16 Bit 16 Bit 24 Bit	 internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor), see notes in chap. TEDS 104: only CRFX & CRXT support: DS2431
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed overview of supported device family 319

General	Value typ.	min. / max	Remarks
Overvoltage protection		±50 V ±80 V	long term (differential- and SENSE-inputs) short-term
Input impedance	10 MΩ 1 MΩ		range ±5 mV to ±2 V range ±5 V to ±50 V and for deactivated device
Input current		40 nA	
Input capacitance	300 pF		
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ±5 % >0.2 A <1.2 Ω	for IEPE (ICP)-expansion plug independent of integrated sensor supply, short circuit proof power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V ±500 mV / ±250 mV / ±100 mV ±50 mV / ±25 mV / ±10 mV / ±5 mV		
Gain error	0.02 %	≤0.05 %	of reading (measurement value)
Gain drift	60 ppm / K	<100 ppm / K	
Offset drift	 0.02 %	 ≤0.05 % ≤0.1 % ≤0.2 %	of measurement range range ≥±25 mV range = ±10 mV range = ±5 mV
Input offset-drift	0.05 µV / K	0.3 µV / K	DC voltage measurement
Non-linearity	<200 ppm		
Common mode voltage (max.)	±50 V ±2.8 V		ranges ±50 V to ±5 V ranges ±2 V to ±5 mV
Common mode rejection ratio (CMRR) range: ±5 mV to ±25 mV ±50 mV to ±100 mV ±250 mV to ±2 V ±5 V to ±50 V ±5 mV to ±2 V ±5 V to ±50 V all ranges	 >100 dB >68 dB 	 >120 dB >110 dB 95 dB >54 dB >90 dB >54 dB >50 dB	DC f ≤ 50 Hz f = 5 kHz
SNR (signal to noise ratio)	 >90 dB >88 dB >82 dB >75 dB >69 dB		full-scale / rms-noise full bandwidth ranges ±100 mV to ±50 V range ±50 mV range ±25 mV range ±10 mV range ±5 mV
Input noise, voltage (RTI)	 16 $nV/\sqrt{Hz}_{rms}$ 16 μV_{pk-pk} 2 μV_{rms}		DC-Mode (range ±5 mV) spectral noise density 1 kHz 0 Hz to 10 kHz 0 Hz to 10 kHz

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
	0.6 µV_{pk-pk}		0.1 Hz to 10 Hz

Current measurement with shunt plug		
Parameter	**Value**	**Remarks**
Input ranges	±40 mA / ±20 mA / ±10 mA ±5 mA / ±2 mA / ±1 mA ±400 µA / ±200 µA / ±100 µA	
Shunt impedance	50 Ω	shunt plug ACC/DSUBM-I2, not for LEMO version

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	DC, CF		
Sensors	LVDT, strain gauge: full-, half-, quarter bridge piezo-resistive bridge transducer potentiometer		directly connectable
Measurement mode	full-, half-, quarter bridge		
Input ranges	 ±1 mV/V to ±400 mV/V ±2 mV/V to ±800 mV/V ±5 mV/V to ±2000 mV/V		for bridge voltage: 5 V 2.5 V 1 V
Bridge supply DC CF (5 kHz)	 1 V; 2.5 V; 5 V (symmetric) 1 V; 2.5 V; 5 V (peak)		set globally for 4-channel groups corresponding to ±0.5 V, ±1.25 V, ±2.5 V corresponding to RMS: 0.7 V; 1.8 V; 3.5 V
Internal quarter-bridge completion	120 Ω, 350 Ω		selectable
Min. bridge impedance Bridge impedance (max.)	120 Ω, 10 mH full bridge 60 Ω, 5 mH half bridge 5 kΩ		bridge supply = 1 V to 5 V, I_{load} ≤ 42 mA
Gain error	<0.05 %		of measurement value
Offset after bridge balance	<0.02 %		of the range
Input offset-drift	0.01 µV/V / K	0.06 µV/V / K	DC full bridge (Bridge supply=5 V, 1 mV/V range) without ext. bridge offset
Drift of bridge balance Equivalent offset drift corresponding to balanced ext. bridge offset	50 ppm/K 0.05 µV/V/K	<90 ppm/K 0.09 µV/V/K	of compensated offset value full bridge (DC or CF), ext. bridge offset = 1 mV/V 1 mV/V input range
Half-bridge drift (int. half-bridge)	0.05 µV/V/K	1 µV/V/K	DC or CF
Bridge balancing range	≥measurement range not less than: ≥±5 mV/V ≥±10 mV/V ≥±25 mV/V		 for bridge supply = 5 V for bridge supply = 2.5 V for bridge supply = 1 V
Cable length (max.)	500 m (one-way length)		A = 0.14 mm², R = 130 mΩ/m, 65 Ω

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Cable-Compensation full bridge / half bridge quarter bridge	 4-wire-technique 3-wire-technique with shunt-calibration full compensation in 3-wire-technique		 any cable for symmetric (similar) cables one-time non-adaptive compensation including Gain-Correction!
Automatic shunt-calibration	0.5 mV/V		for 120 Ω and 350 Ω bridges
Input noise (bridge) DC full bridge	 3 µV/V_{pkpk}, 0.39 µV/V_{rms} 0.9 µV/V_{pkpk}, 0.12 µV/V_{rms} 0.3 µV/V_{pkpk}, 0.04 µV/V_{rms} 0.1 µV/V_{pkpk}		range: 1 µV/V (bridge voltage = 5 V) 0 Hz to 10 kHz 1 kHz, lowpass filter 100 Hz, lowpass filter 10 Hz, lowpass filter
DC half-/quarter bridge	3.3 µV/V_{pkpk}, 0.45 µV/V_{rms} 1.1 µV/V_{pkpk}, 0.15 µV/V_{rms} 0.35 µV/V_{pkpk}, 0.05 µV/V_{rms} 0.3 µV/V_{pkpk}		0 Hz to 10 kHz 1 kHz, lowpass filter 100 Hz, lowpass filter 10 Hz, lowpass filter
CF full bridge, half bridge	3.5 µV/V_{pkpk}, 0.47 µV/V_{rms} 1.7 µV/V_{pkpk}, 0.22 µV/V_{rms} 0.6 µV/V_{pkpk}, 0.07 µV/V_{rms} 0.3 µV/V_{pkpk}		0 Hz to 10 kHz 1 kHz, lowpass filter 100 Hz, lowpass filter 10 Hz, lowpass filter

The following technical statements only apply for this CRONOS*flex* module!

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	-VB, GND, TEDS_GND	all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of the imc CRONOS*flex* module			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Power supply	10 V to 50 V DC		
Power consumption	9.3 W		10 V to 50 V DC including bridge sensors (120 Ω 5 V all channels)
Isolation	60 V		nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC		supply via EtherCAT network cable

Terminal connections of the imc CRONOS*flex* module		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current corresponding IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	43.3 x 118 x 186 mm	W x H x D
Weight	ca. 820 g	

Find here the description of the BR2-4: Strain gauges, LVDT, Voltage, IEPE/ICP 169.

9.6.3 LVDT-8: LVDT Bridge mode, Voltage

Inputs, Measurement modes		
Parameter	**Value**	**Remarks**
Inputs	8	
Measurement modes	LVDT bridge mode voltage measurement	Carrier Frequency mode (CF) 5 kHz
Terminal connection LVDT-8	4x DSUB-15	2 channels per plug, recommended plug: ACC/DSUBM-B2
LVDTC-8	2x DSUB-26-HD	4 channels per plug, recommended plug: ACC/DSUBM-HD-B4

Sampling rate, Bandwidth, Filter		
Parameter	**Value**	**Remarks**
Sampling rate	max. 100 kHz	per channel
Bandwidth	0 Hz to 50 Hz	allowable bandwidth of mechanical signal
Filter (digital) Frequency Characteristic Order	1 Hz to 20 Hz	Butterworth, Bessel low pass 6th order
Resolution	16 Bit	internal processing 24 Bit

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation (nominal rating)	±60 V (nominal)		galvanically block isolated to System-GND (case, CHASSIS) no channel-to-channel isolation
Max. common mode voltage	±5 V		channel-to-channel
Overvoltage protection	ESD 2 kV transient protection		
Input current operating conditions on overvoltage condition power off	0.2 nA	25 nA 1 mA ≤5 mA	voltage mode, static
Non-linearity	<30 ppm		±2 V range, voltage mode
Auxiliary supply	+5 V (max. 160 mA / plug) non isolated		only with DSUB-15 variant

LVDT measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	CF		carrier frequency (5 kHz)
Bridge configuration	full bridge half bridge		LVDT transformer type transducers ("Schaevitz", transformator principle) inductive half bridge transducers
Input ranges	±800 mV/V,±400 mV/V, ±200 mV/V, … ±100 mV/V, ±40 mV/V, ±20 mV/V ±2000 mV/V,±1000 mV/V, ±500 mV/V,.. .. , ±250 mV/V, ±100 mV/V, ±50 mV/V		bridge supply = 2.5 V bridge supply = 1 V
Bridge excitation voltage (VB)	2.5 V, 1 V max. 28 mA		peak, sine wave, individually selectable per channel short circuit proof
Minimum transducer impedance	50 Ω, 10 mH 120 Ω, 10 mH		bridge supply = 1 V bridge supply = 2.5 V
Cable compensation	dual wire sense		adaptive compensation
Offset compensation range		≥±100% of range 9% 9%	of selected range ±2000 mV/V (bridge supply = 1 V) ±800 mV/V (bridge supply = 2.5 V)
Input impedance	6.7 MΩ	±1%	
Gain error	<0.025%	<0.05%	of the measured value
Gain drift		15 ppm/K·ΔT_a	$\Delta T_a = \|T_a - 25\ °C\|$; with T_a = ambient temperature
Offset error	<0.02%	<0.05%	of input range after automatic bridge balancing
Offset drift		1 µV/V /K·ΔT_a	full bridge, no ext. bridge offset $\Delta T_a = \|T_a - 25\ °C\|$; with T_a = ambient temperature
Half-bridge drift	0.5 µV/V /°C	1 µV/V /°C	internal half bridge completion
Max. lead wire resistance	<60 Ω <460 m		single cable with cable: 0.14 mm^2, 130 mΩ/m, AWG26
Input noise	5 µV/V_{rms}		bridge mode (bridge supply = 1 V) bandwidth 0.1 Hz to 50 Hz

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±5 V, ±2 V, ±1 V, ±500 mV		
Input coupling	DC		
Input configuration	differential		
Input impedance (differential)	6.7 MΩ 1 MΩ		ranges ≤±2 V range ±5 V
Gain error	<0.025%	<0.05%	of reading, 25°C
Gain drift		15 ppm/K·ΔT_a 50 ppm/K·ΔT_a	ranges ≤±2 V range ±5 V $\Delta T_a = \lvert T_a - 25\ °C \rvert$; with T_a = ambient temperature
Offset error	<0.02%	<0.05%	of range
Offset drift		0.6 µV/K·ΔT_a 30 µV/K·ΔT_a	ranges ≤±2 V range ±5 V $\Delta T_a = \lvert T_a - 25\ °C \rvert$; with T_a = ambient temperature
CMRR	>95 dB (50 Hz)		R_{source} = 0 Ω
Input noise	<2.6 μV_{rms} <15 μV_{pkpk}		bandwidth 0.1 to 50 Hz

9.6.4 DCB(C)2-8, B(C)-8 Strain gauges, Voltage, IEPE/ICP

Parameter	Value	Remarks
Inputs	8	
Measurement modes DSUB-15	voltage current bridge sensor strain gauges current-fed sensors (IEPE/ICP)	 shunt-plug ACC/DSUBM-I2(-IP65) or single end (internal shunt) full, half, quarter bridge with DSUB-15 extension plug: e.g. ACC/DSUBM-ICP2I-BNC-S/-F, isolated
Measurement modes DSUB-26-HD	voltage current bridge sensor strain gauges	 ACC/DSUBM-HD-I4 shunt-plug or Single-ended (internal shunt) full, half, quarter bridge
Measurement modes LEMO	voltage bridge sensor strain gauges current measurement	 full, half, quarter bridge Single-ended (internal shunt)
Terminal connection DSUB-15 DSUB-26-HD LEMO	 4x DSUB-15 2x DSUB-26-HD 8x LEMO.1B.307	 2 channels per plug 4 channels per plug 1 channel per plug

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels
Bandwidth	0 Hz to 5 kHz (DCB2-8) 0 Hz to 48 kHz (B-8)	-3 dB -3 dB
Filter (digital) cut-off frequency characteristic order	 1 Hz to 2 kHz (DCB2-8 in CRC, CRSL) 10 Hz to 5 kHz (DCB2-8 in CRFX) 10 Hz to 20 kHz (B-8)	 Butterworth, Bessel (digital) low pass or high pass filter 8th order band pass, LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$
Resolution CRC, CRSL CRFX, CRXT	 16 Bit 16 Bit 24 Bit	 internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS only with DSUB-15	conforming IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor), see notes in chap. TEDS 104: only CRFX & CRXT support: DS2431
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed overview of supported device family 319

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Overvoltage protection		±40 V	permanent
Input coupling	DC		
Input configuration	differential		
Input impedance	20 MΩ	±1%	
Auxiliary supply voltage available current internal resistance	 +5 V 0.26 A 1.0 Ω	 ±5% 0.2 A <1.2 Ω	only with DSUB-15 variant for IEPE/ICP expansion plug independent of integrated sensor supply, short-circuit protected power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	±10 V, ±5 V, ±2.5 V, ±1 V... ±5 mV		
Gain error	0.02%	0.05%	of the measured value, at 25°C
Gain drift	(10 ppm/K)·ΔT_a	(30 ppm/K)·ΔT_a	$\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature
Offset error	 0.02%	 ≤0.05% ≤0.06% ≤0.15%	of the input range at 25°C range >±50 mV range ≤±50 mV range ≤±10 mV
Offset drift	(±0.7 µV/K)·ΔT_a (±0.1 µV/K)·ΔT_a	(±6 µV/K)·ΔT_a (±1.1 µV/K)·ΔT_a	range ±10 V to ±0.25 V range ≤±0.1 V $\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature
Nonlinearity	10 ppm	50 ppm	
CMRR (common mode rejection ratio)	 110 dB 138 dB	 >90 dB >132 dB	DC and f≤60 Hz range ±10 V to ±50 mV range ±25 mV to ±5 mV
Noise (RTI)	0.6 μV_{RMS} 0.14 μV_{RMS}	1.0 μV_{RMS} 0.26 μV_{RMS}	bandwidth 0.1 Hz to 1 kHz bandwidth 0.1 Hz to 10 Hz

Current measurement with shunt plug			
Parameter	**Value typ.**	**min. / max**	**Remarks**
Input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		
Shunt impedance	50 Ω		external plug ACC/DSUBM-I2
Over load protection		±60 mA	permanent
Input configuration	differential		
Gain error	0.02%	0.06% 0.1%	of reading, at 25°C plus error of 50 Ω shunt
Gain drift	(15 ppm/K)·ΔT_a	(55 ppm/K)·ΔT_a	$\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature
Offset error	0.02%	0.05%	of range, at 25°C
Noise (current)	0.6 nA_{RMS} 0.15 nA_{RMS}	10 nA_{RMS} 0.25 nA_{RMS}	bandwidth 0.1 Hz to 1 kHz bandwidth 0.1 Hz to 10 Hz

Current measurement with internal shunt			
Parameter	**Value typ.**	**min. / max**	**Remarks**
Input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		
Shunt impedance	120 Ω		internal
Over load protection		±60 mA	permanent
Input configuration	Single-ended		internal current backflow to -VB
Gain error	0.02%	0.06%	of reading, at 25°C
Gain drift	(15 ppm/K)·ΔT_a	(55 ppm/K)·ΔT_a	$\Delta T_a = \lvert T_a - 25°C \rvert$; with T_a = ambient temperature
Offset error	0.02%	0.05%	of range, at 25°C
Noise (current)	0.6 nA_{RMS} 0.15 nA_{RMS}	10 nA_{RMS} 0.25 nA_{RMS}	bandwidth 0.1 Hz to 1 kHz bandwidth 0.1 Hz to 10 Hz

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	DC		
Measurement modes	full-, half-, quarter bridge		bridge supply ≤5 V with quarter bridge
Input ranges bridge supply: 10 V bridge supply: 5 V bridge supply: 2.5 V bridge supply: 1 V	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ... ... ±0.5 mV/V ... ±1 mV/V ... ±2 mV/V ... ±5 mV/V		 (as an option) (as an option)
Bridge excitation voltage (as an option)	10 V 5 V (2.5 V and 1 V)	±0.5% ±0.5%	The actual value will be dynamically captured and compensated for in bridge mode.
Min. bridge impedance Max. bridge impedance	120 Ω, 10 mH full bridge 60 Ω, 10 mH half bridge 5 kΩ		
Internal quarter bridge completion	120 Ω, 350 Ω		internal, switchable per software
Input impedance	20 MΩ	±1%	differential, full bridge
Gain error	0.02%	0.05%	of reading
Offset error	0.01%	0.02%	of input range after automatic bridge balancing
automatic shunt calibration	0.5 mV/V	±0.2%	for 120 Ω and 350 Ω
Cable resistance for bridges (without return line)	<6 Ω <12 Ω		10 V excitation 120 Ω 5 V excitation 120 Ω

Sensor supply			
Parameter	**Value typ.**	**max.**	**Remarks**
Configuration options	5 selectable settings		The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V
Output voltage	Voltage | Current | Power (+1 V) | 580 mA | 0.6 W (+2.5 V) | 580 mA | 1.5 W +5.0 V | 580 mA | 2.9 W +10 V | 300 mA | 3.0 W +12 V | 250 mA | 3.0 W +15 V | 200 mA | 3.0 W +24 V | 120 mA | 2.9 W (±15 V) | 190 mA | 3.0 W		set jointly for all eight channels upon request, also 2.5 V and 1 V settings are available, for example by replacing the +12 V or +15 V setting. An arbitrary set of 5 setting can be chosen preferred selections: +24 V, +12 V, +10 V, +5.0 V, +2.5 V +15 V, +10 V, +5.0 V, +2.5 V, +1 V upon request, special order: +15 V can be replaced by ±15 V. This eliminates the internal current- and quarter bridge measurement.
Isolation - applies for imc CRONOS*compact*, imc CRONOS-SL and PL systems			
Isolation	non isolated		output to case (CHASSIS)
Block isolation only applies for imc CRONOS*flex*			
Block isolation	60 V		Isolation of the entire global sensor supply (for all 8 channels, reference ground: "-VB") as well as the internal electronics
Short-circuit protection	unlimited duration		to output voltage reference ground: "-VB"
Accuracy of output voltage			at terminals, no load
	<0.25 %	0.5 %	at 25 °C
		0.9 %	over entire temperature range
		1.5 %	plus with optional bipolar output voltage
Compensation of cable resistances	3-line control: SENSE line as refeed (-VB: supply ground)		calculated compensation with bridges
Max. capacitive load	>4000 µF >1000 µF >300 µF		2.5 V to 10 V 12 V, 15 V 24 V

The following technical statements only apply for this CRONOS*flex* module!

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	-VB, GND, TEDS_GND	all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of this CRONOS*flex* module		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Power consumption	10 W	10 to 50 V DC incl. 120 Ω 5 V load to all channels
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for expanded imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current corresponding IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	62 x 118 x 186 mm (DSUB-26 variant: 43.3 mm width)	W x H x D
Weight	ca. 878 g (DSUB-26 variant: ca. 815 g)	

The description of the DCB(C)2-8: Strain gauges, Voltage, IEPE/ICP. 156

The description of the B(C)-8 amplifier 168.

9.7 Voltage, Current and Temperature

9.7.1 C-8: Voltage, temperature, current (20 mA)

Inputs, measurement nodes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	8	
Measurement modes DSUB-15	voltage measurement current measurement thermocouple measurement PT100 temperature measurement	ACC/DSUBM-I4
Measurement modes LEMO	voltage measurement current measurement PT100 temperature measurement	with external shunt
Measurement mode Thermocouple terminal socket (-2T)	thermocouple type-K	miniature thermocouple terminal
Terminal connection DSUB-15 LEMO -2T	 2x DSUB-15 or 8x LEMO.1B.307 or 8x miniature thermocouple terminal	 4 channels per plug 1 channel per plug 1 channel per plug

Sampling rate, bandwidth, filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate per channel	≤20 kHz	update rate max. 100 Hz
Bandwidth	0 Hz to 20 Hz	-3 dB
Filter (digital) cut-off frequency characteristic order	 1 Hz to 50 Hz	 Butterworth low pass: 6th order Anti-aliasing filter: Butterworth 6th order $f_{cutoff} = 0.5\ f_s$
TEDS - Transducer Electronic Data Sheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported DS2431 (typ. IEPE/ICP sensor)

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Overvoltage protection	 ±250 V	±80 V	long term to chassis <1 ms
Input coupling	DC		
Input configuration	differential		
Input impedance	1 MΩ 492 kΩ 79 kΩ	±1% >135 kΩ >75 kΩ	range ±50 V to ±2.5 V range ±1 V to ±50 mV range ±25 mV to ±2.5 mV

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V, ±500 mV, ±250 mV,..., ±2.5 mV		
Gain error	 0.01%	 ≤0.05% ≤0.02% ≤0.05%	of reading ±50 V to ±250 mV ±100 mV to ±25 mV ±10 mV to ±2.5 mV
Gain drift	5 ppm/K·ΔT_a	20 ppm/K·ΔT_a	ΔT_a=|T_a -25°C| T_a = ambient temperature
Offset error	 0.01% 0.005% 0.01% 0.02%	 ≤0.05% ≤0.01% ≤0.05% ≤0.1%	of measurement range ±50 V to ±250 mV ±100 mV to ±25 mV ±10 mV to ±5 mV ±2.5 mV
Offset drift	±4 µV/K ±0.07µV/K	<±12 µV/K <±0.16 µV/K	±50 V to ±2.5 V ±1V to ±2.5 mV
Signal-to noise ratio	 95 dB 90 dB 86 dB	 >90 dB >86 dB >82 dB	bandwidth 0.1 Hz to 10 Hz ±50 V to ±10 mV ±5 mV ±2.5 mV
Common mode voltage ±50 V to ±2.5 V ±1 V to ±2.5 mV	 50 V 2 V	 <30 V <1 V	with differential input voltage: ±50 V ±1 V
Common mode rejection ratio (CMRR) ±50 V to ±2.5 V ±1 V to ±2.5 mV	 70 dB 120 dB	 >54 dB >100 dB	 common mode test voltage: ±50 V ±1 V

Temperature measurement - Thermocouples			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement mode	J, T, K, E, N, S, R, B		
Measurement range	-270°C bis 1370°C -270°C bis 1100°C -270°C bis 500°C		type K
Resolution	0.063 K		J, T, K, E, N, S, R, B
Measurement error	 0.2 K	 <0.6 K <±1 K	type J, T, K, E, L (for all other types see specifications of voltage measurement) range -150°C to 1100°C otherwise
Drift	0.02 K/K·ΔT_a		ΔT_a=|T_a -25°C| T_a = ambient temperature
Cold junction compensation error drift of cold junction comp.	 ±0.001 K/K·ΔT_a	±0.15 K	DSUB (standard) ΔT_a=|T_a -25°C| with T_a = ambient temperature
Input impedance	100 kΩ		differential

Temperature measurement - PT100			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	-200°C to 850°C, -50°C to 150°C		
Resolution	0.063 K		
Error		<±0.1 K <±0.05%	-200°C to 850°C, four-wire connection plus of reading
Drift		±0.01 K/K·ΔT_a	ΔT_a=|T_a -25°C| with T_a = ambient temperature
Sensor supply	625 µA		
Input impedance	20 MΩ	±1%	differential
Signal-noise ratio		>85 dB	bandwidth 0.1 Hz to 10 Hz
Bandwidth	0 Hz to 10 Hz		-3 dB

Find here the description of the C-8. 179

9.7.2 HISO-8-L, HISO-8-T-8L and HISO-8-T-2L

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	8	
Measurement modes CRFX/HISO-8-L	 voltage measurement current measurement (20 mA) PT100, PT1000 measurement	all measurement modes isolated individually
Measurement modes CRFX/HISO-8-T-8L and CRFX/HISO-8-T-2L(-OR)	thermocouple measurement type K	
Terminal connection	8x LEMO.1P REDEL (5-pin) high-voltage proof plug 8x LEMO.2P REDEL (2-pin) high-voltage proof plug 2x LEMO.2P REDEL (8-pin) high-voltage proof plug	1 channel per plug / HISO-8-L 1 channel per plug / HISO-8-T-8L 4 channels per plug / HISO-8-T-2L(-OR)

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels
Bandwidth	0 Hz to 11 kHz 0 Hz to 8 kHz	-3 dB -0.2 dB
Filter type characteristic cut-off frequency order anti-aliasing filter (AAF)	 low-, high-, band pass, AAF Butterworth, Bessel 20 Hz to 5 kHz 8th order 4th + 4th order low pass Cauer 8th order with f_{cutoff} = 0.4 f_s	digital filter 1 - 2 - 5 steps low pass, high pass band pass: low- and high pass automatically adapted to selected sampling rate f_s
Resolution CRC CRFX	 16 Bit 16 Bit 24 Bit	 internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)

General				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Isolation strength (common mode)			per IEC (EN) 61010-1:2001	
Automotive operating voltage additional transient over voltage	 800 V 500 V		 impulse according ISO 7637-2	
Main power supply measurement categories assessment voltage	 CAT II 300 V			
General pollution degree test voltage against system ground	 2 3000 V		 1 min	
Overvoltage protection	 ±100 V ±600 V ESD 2 kV		differential measurement input permanent transient e.g.automotive load dump human body model	
CMRR (common mode rejection ratio) / IMR	>105 dB (50 Hz) >65 dB (5 kHz) >70 dB (50 Hz) >30 dB (5 kHz)		ranges ≤±2 V ranges ≥±5 V	R_{source} = 0 Ω
Input coupling	DC			
Input configuration	differential, isolated		galvanically isolated to System-GND (case, CHASSIS)	
Input impedance	6.7 MΩ 1 MΩ 50 Ω		ranges ≤±2 V ranges ≥±5 V and with device deactivated current input	
Input current normal operation in case of overvoltage		 1 nA 1 mA	bias for operating conditions $\lvert V_{in}\rvert$ >5 V for ranges <±5 V or deactivated	

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±60 V, ±50 V, ±25 V, ±10 V, ±5 V, ±2 V, ±1 V, ±500 mV, ±250 mV, ±100 mV, ±50 mV		
Gain error	<0.02%	<0.05%	of the measured value, at 25°C
Gain drift		15 ppm/K 50 ppm/K	ranges ≤±2 V ranges ≥±5 V over entire temperature range
Offset error	0.02%	≤0.05%	of the range, at 25°C
Offset drift	0.3 µV/K·ΔT_a 10 µV/K·ΔT_a	0.6 µV/K·ΔT_a 30 µV/K·ΔT_a	ranges ≤±2 V ranges ≥±5 V ΔT_a= |T_a -25°C| ambient temperature T_a
Linearity error	<120 ppm		±10 V input range
Noise voltage (RTI)	2.5 µV_{rms} 12 µV_{pkpk}		Bandwidth: 0.1 Hz to 1 kHz
Channel isolation	>1 GΩ, <40 pF >1 GΩ, <10 pF		to system ground channel-to-channel
Crosstalk	>165 dB (50 Hz) >92 dB (50 Hz)		ranges ≤±2 V ranges ≥±5 V R_{source} ≤100 Ω

Current measurement with internal shunt			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±10 mA, ±20 mA, ±40 mA		
Shunt resistor	50 Ω		internal
Gain error	<0.02%	<0.05%	of the measured value, at 25°C
Offset error	0.02%	≤0.05%	of range
Offset drift	6 nA/K·ΔT_a	12 nA/K·ΔT_a	ΔT_a=|T_a-25°C| ambient temperature T_a
Linearity error	<120 ppm		

Temperature measurement - Thermocouples			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement mode	type K		
Input ranges	-270°C to 1370°C -270°C to 1100°C		
Resolution	1/16 K (0.0625 K) 32 bit float (24 Bit mantissa)		with selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)
Bandwidth	0 Hz to 1 kHz		
Measurement error		<±0.6 K <±1.0 K	type K, range: -150°C to 1200°C otherwise
Temperature drift	±0.02 K/K·ΔT_a		ΔT_a= |T_a -25°C| ambient temperature T_a
Error of the cold junction temperature		<±0.5 K	
Drift of cold junction temperature	±0.001 K/K·ΔT_a		ΔT_a= |T_a -25°C| ambient temperature T_a

Temperature measurement – PT100, PT1000		
Parameter	**Value**	**Remarks**
Measurement mode	PT100, PT1000	4-wire configuration individual current sources, isolated
Input ranges	-200°C to +850°C -200°C to +250°C	
Bandwidth	0 Hz to 1 kHz	
Measurement error offset gain	 <±0.25 K <±0.05 %	-200°C to +850°C, four-wire measurement of measured value (corresponding resistance)
Temperature drift	±0.01 K/K· ΔT_a	$\Delta T_a = \lvert T_a - 25°C \rvert$ ambient temperature T_a
Excitation current (PT100)	250 µA	

The following technical statements only apply for the CRONOS*flex* module!

Power supply		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Power consumption	7.3 W	10 to 50 V DC
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connection		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for expanded imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current corresponding IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	82 x 118 x 186 mm	W x H x D
Weight	1.2 kg	

Find here the description of the HISO-8 182.

9.7.3 HVBOX-8-x

Input / Output		
Parameter	**Value**	**Remarks**
Inputs HVBOX-8-10M	terminals (Cu) for two sensors (PT100/1000) or voltage signals	
Inputs HVBOX-8-T-10M	terminals for 4 thermocouple type K	labelling in the box: CH = green wire = + AL = white wire = -
Output Connector plug	1x 8-pin LEMO.2P (Redel)	for CRFX/HISO-8-T-2L, CANFX/HISO8-T-2L, CANFX/HISO8-4L
Cable length	10 m	HV rated

Isolation		
Parameter	**Value**	**Remarks**
Isolation against accessible parts (case)	300 V CAT II 800 V CAT 0	reinforced isolation
Isolation of the measurement channels against each other (sensors)	300 V CAT II 800 V CAT 0	basic isolation
Isolation test voltage	AC 3000 V	1 min.
Operating temperature range	-20 °C to +80 °C	
Ingress protection class	IP65	only when the box is closed and when all gable glands properly sealed with cables

Dimensions, Weight		
Parameter	**Value**	**Remarks**
External dimensions, W x H x D	160 x 75 x 77 mm	w/o screwings, w/o cable
Weight	1.2 kg	

Reference HVBOX-8

Please find here the description of the connection box 185.

9.7.4 HV2-2U2I High isolated: Voltage, Current probe

General

Measurement modes and categories		
Parameter	**Value**	**Remarks**
Inputs	4	2 inputs for voltage 2 inputs for current measurement
Measurement modes	voltage measurement current measurement	 e.g. current probes, rogowski coil
Measurement categories	600 V_{RMS} (CAT III) / 1000 V_{RMS} (CAT II)	conformant to EN 61010-1, EN 61010-2-030
Pollution Degree	2	according to EN 60664
Terminal connection	2x safety banana jacks 2x 3-pin Phoenix terminals	 KGG-PC 4/3-F BK

Sampling rate, Bandwidth, Filter			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Sampling rate	≤100 kHz		per channel
Bandwidth	0 Hz to 48 kHz		-3 dB
Filter (digital)			
Anti-aliasing filter cut-off frequency characteristic order	 $f_{cutoff} = 0.4\ f_s$ Cauer 8		
Individual low pass filter cut-off frequency characteristic order	 10 Hz to 20 kHz Butterworth, Bessel 8		
Individual high pass filter cut-off frequency characteristic order	 10 Hz to 20 kHz Butterworth, Bessel 8		
Individual band pass filter cut-off frequency characteristic order	 10 Hz to 20 kHz Butterworth, Bessel 4		
Resolution CRC CRFX	 16 Bit 16 Bit 24 Bit		 internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
Isolation strength		5.4 kV_{RMS}	50 Hz, test voltage

Measurement modes

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±1000 V, ±500 V, ±250 V, ... , ±2.5 V		nominal
	$1000\ V_{RMS}$, $500\ V_{RMS}$, $250\ V_{RMS}$,..., $2.5\ V_{RMS}$		RMS continuous
	$\pm 1414\ V_{PK}$, $\pm 707\ V_{PK}$, $\pm 354\ V_{PK}$, ... , $\pm 3.4\ V_{PK}$		peak measurement range (valid measurements): ≥nominal range * √2
Max. Overvoltage protection		±1450 V	differential, continuous with operating temperature up to 70°C
Input impedance	2 MΩ		
Input coupling	DC		isolated
Gain error	0.02%	≤0.05%	of the reading, at 25°C
Gain drift	$\pm 25\ ppm/K \cdot \Delta T_a$	$\pm 60\ ppm/K \cdot \Delta T_a$	$\Delta T_a = \vert T_a - 25°C \vert$; with T_a = ambient temperature
Offset error			of range
	0.02%	≤0.05%	ranges >±5 V
		≤0.1%	range ±5 V
	0.04%	≤0.2%	range ±2.5 V
Offset drift	$\pm 20\ mV/K \cdot \Delta T_a$	$\pm 35\ mV/K \cdot \Delta T_a$	range >±100 V
	$\pm 2.0\ mV/K \cdot \Delta T_a$	$\pm 3.5\ mV/K \cdot \Delta T_a$	range ≤±100 V
	$\pm 0.1\ mV/K \cdot \Delta T_a$	$\pm 0.5\ mV/K \cdot \Delta T_a$	range ≤±10 V
			$\Delta T_a = \vert T_a - 25°C \vert$; with T_a = ambient temperature
IMRR (isolation mode rejection ratio)			
	160 dB	130 dB	DC
	80 dB	70 dB	50 Hz
	54 dB	44 dB	1 kHz
Bandwidth	0 Hz to 30 kHz		<±0.03 dB
		0 Hz to 48 kHz	-3 dB
Phase error		<±1°	0 Hz to 20 kHz
Signal noise			bandwidth: 0.2 Hz to 48 kHz
	$3.8\ mV_{RMS}$		range ±250 V
	$0.6\ mV_{RMS}$		range ±2.5 V

Channels for current measurement with current probes			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±5 V, ±2.5 V, ±1 V, ... , ±50 mV		modulation range ≥ range · √2
Overvoltage protection	±100 V		long-term
Input impedance	20 MΩ		isolated
Gain error	0.02%	≤0.05%	of the reading
Gain drift	±10 ppm/K·ΔT_a	±25 ppm/K·ΔT_a	ΔT_a=|T_a-25°C|; with T_a = ambient temperature
Offset error	0.02%	≤0.05%	of the measurement range
Offset drift	±10 µV /K·ΔT_a ±50 µV /K·ΔT_a	±100 µV /K·ΔT_a ±20 µV /K·ΔT_a	range >±0.5 V range ≤±0.5 V ΔT_a=|T_a-25°C|; with T_a = ambient temperature
IMRR (isolation mode rejection ratio)	160 dB 145 dB 125 dB	160 dB 126 dB 100 dB	DC 50 Hz 1 kHz
Bandwidth	0 Hz to 30 kHz	0 Hz to 48 kHz	<±0.03 dB -3 dB
Phase error		<±1°	0 Hz to 4 kHz
Signal noise	1 μV_{RMS}	LSB	bandwidth: 0.1 Hz to 48 kHz

Current measurement with AC current clamp			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	10 $A_{\approx}$, 5 $A_{\approx}$, ... , 2.5 $A_{\approx}$		RMS-values, crest factor up to √2
Measurement error	0.3%	≤0.8% ±1 mA	50 Hz, sine, line centered
Bandwidth	40 Hz to 2 kHz		<±0.1%
Phase error	±1°	<±3°	40 Hz to 1 kHz

Channels for current measurement with Rogowski coil (AC)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement principle	time-based integrating		Internal signal conditioning includes integrator stage
Usable sensors (Rogowski coil)	50 µV/A at 50 Hz		Current probes without active signal conditioning (no batteries required)
Input range	500 (A/s)/V, 1 (kA/s)/V, 2.5 (kA/s)/V, ... , 50 (kA/s)/V		the GUI display this value as an integrated value
Overload protection		±55 V	long-term
Gain error	0.02%	≤0.08%	of the reading at 50 Hz plus error of the sensor
Gain drift	±40 ppm/K·ΔT_a	±100 ppm/K·ΔT_a	ΔT_a=|T_a-25°C|; with T_a = ambient temperature plus error of the sensor
Bandwidth	0.5 Hz to 30 kHz 	 0.1 Hz to 48 kHz	<±0,1% -3 dB

Current measurement with Rogowski coil			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Sensor (accessory)	flexible current transducer		please finde in the price list a detailed list of available accessories
Input range	5 $kA_{\approx}$, 2,5 $A_{\approx}$, ..., 50 $A_{\approx}$		RMS-values, crest factor <1.5
Overload protection		 ≤60 $kA_{\approx}$ ≤1 $kA_{\approx}$	long-term, crest factor < 1.5 f ≤ 1 kHz f ≤ 50 kHz
Measurement error	0.3%	≤1% ±1 A	

Reference

Please find here the description of the HV2-2U2I module. 187

9.7.5 HV2-4U High isolated: Voltage

Measurement modes and categories		
Parameter	**Value**	**Remarks**
Inputs	4	
Measurement modes	voltage measurement	safety banana sockets
Measurement categories	600 V_{RMS} (CAT III) / 1000 V_{RMS} (CAT II)	
Pollution Degree	2	

Sampling rate, Bandwidth, Filter			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Sampling rate	≤100 kHz		per channel
Bandwidth	0 Hz to 48 kHz		-3 dB
Filter (digital)			
Anti-aliasing filter cut-off frequency characteristic order Individual low pass filter cut-off frequency characteristic order Individual high pass filter cut-off frequency characteristic order Individual band pass filter cut-off frequency characteristic order	 f_{cutoff} = 0.4 f_s Cauer 8 10 Hz to 20 kHz Butterworth, Bessel, Cauer 8 10 Hz to 20 kHz Butterworth, Bessel 8 10 Hz to 20 kHz Butterworth, Bessel 4		low pass filter depend on f_{cutoff} (f_s = sampling frequency, f_{cutoff} = cut-off frequency)
Resolution CRC CRFX	 16 Bit 16 Bit 24 Bit		 internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
Isolation strength		5.4 kV_{RMS}	50 Hz, test voltage

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±1000 V, ±500 V, ±250 V, ... , ±2.5 V 1000 V_{RMS}, 500 V_{RMS}, 250 V_{RMS} ,..., 2.5 V_{RMS} ±1414 V_{PK}, ±707 V_{PK}, ±354 V_{PK}, ... , ±3.4 V_{PK}		nominal RMS continuous peak measurement range (valid measurements): ≥nominal range * √2
Max. Overvoltage protection		±1450 V	differential, continuous with operating temperature up to 70 °C
Input impedance	2 MΩ		
Input coupling	DC		isolated
Gain error	0.02%	≤0.05%	of the reading, at 25°C
Gain drift	±25 ppm/K ·ΔT_a	±60 ppm/K ·ΔT_a	ΔT_a=|T_a-25°C|; ambient temperature T_a
Offset error 	 0.02% 0.04%	 ≤0.05% ≤0.2%	of range ranges >±5 V range ±2.5 V
Offset drift	±20 mV/K ·ΔT_a ±2.0 mV/K ·ΔT_a ±0.1 mV/K ·ΔT_a	±35 mV/K ·ΔT_a ±3.5 mV/K ·ΔT_a ±0.5 mV/K ·ΔT_a	range >±100 V range ≤±100 V range ≤±10 V ΔT_a=|T_a-25°C|; ambient temperature T_a
IMRR (isolation mode rejection ratio)	 160 dB 80 dB 54 dB	 130 dB 70 dB 44 dB	 DC 50 Hz 1 kHz
Bandwidth	0 Hz to 30 kHz	 0 Hz to 48 kHz	<±0.03 dB -3 dB
Phase error		<±1°	0 Hz to 20 kHz
Signal noise	 3.8 mV_{RMS} 0.6 mV_{RMS}		bandwidth: 0.2 Hz to 48 kHz range ±250 V range ±2.5 V

Reference

Please find here the description of the module. 187

9.7.6 ICPU2-8: Voltage, IEPE/ICP

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	8	
Measurement modes	voltage measurement IEPE-sensor with current-fed	

Sampling rate, Bandwidth, Filter, TEDS			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Sampling rate	≤100 kHz		per channel
Maximum system throughput	800 kHz (CRFX)		of all CRFX module channels including monitor channels
Bandwidth	0 Hz to 48 kHz 0 Hz to 30 kHz		-3 dB -0.1 dB
Filter (digital) cut-off frequency characteristic order	10 Hz to 20 kHz		Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$
Filter cut-off frequency (high pass, 3rd order,-3 dB)	0.43 Hz 1.06 Hz 0.07 Hz 0.13 Hz		CRFX/ICPU2-8 standard version ICP, ranges ≤±10 V ICP, ranges >±10 V special version CRFX/ICPU2-8(-D)-70mHz * ICP, ranges ≤±10 V ICP, ranges >±10 V
With CRC: Filter cut-off frequency (high pass, 3th order,-3 dB)	0.48 Hz		ICP, ranges ≤±10 V
Resolution CRC, CRSL CRFX, CRXT	16 Bit 16 Bit 24 Bit		internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS	conforming to IEEE 1451.4 Class I Mixed Mode Interface		TEDS-data and analog signal shared wire [2] supports TEDS type DS2433 not supported DS2431 (typ. IEPE sensor), only CRFX & CRXT support: DS2431
Characteristic curve linearization	user defined (max. 1023 supporting points) (only with CRFX modules) 318		

* The special versions are available on request. However, they should only be used when actually needed, as the settling times are correspondingly extended (up to the minute range).

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Overvoltage protection		±50 V	continuous channel to chassis
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS; input range ≤±10 V
Input coupling	AC, DC, AC with current feed (ICP)		
Input configuration	differential Single-ended		software-configurable
Input impedance range >±10 V range ≤±10 V	 333 kΩ 0.67 MΩ 1 MΩ 908 kΩ 1.82 MΩ 20 MΩ		at DC-voltage resp. 50 Hz ICP (Single-ended) AC (differential) DC (differential) ICP (Single-ended) AC (differential) DC (differential)

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V, ..., ±5 mV		
Gain error	0.02%	≤0.05%	of the reading, at 25°C
Gain drift	(+20 ppm/K)·ΔT_a	(+80 ppm/K)·ΔT_a	$\Delta T_a = \vert T_a - 25°C \vert$; with T_a = ambient temperature
Offset error	 0.02%	 ≤0.05% ≤0.06% ≤0.15%	of the input range, at 25°C >±50 mV ≤±50 mV ≤±10 mV
Offset drift	(±40 µV/K)·ΔT_a (±0.7 µV/K)·ΔT_a (±0.1 µV/K)·ΔT_a	(±200 µV/K)·ΔT_a (±6 µV/K)·ΔT_a (±1.1 µV/K)·ΔT_a	ranges >±10 V range ±10 V bis ±0.25 V ranges ≤±0.1 V
CMRR (common mode rejection ratio) Input ranges: ±50 V to ±10 V Input ranges: ±5 V to ±50 mV Input ranges: ±25 mV to ±5 mV	 62 dB 92 dB 120 dB	 >46 dB >84 dB >100 dB	common mode voltage (DC..60 Hz): ±50 V ±10 V ±10 V
Noise	 14 nV/√Hz 0.4 μV_{rms}		DC coupling 1 kHz bandwidth 0.1 Hz to 1 kHz

Constant current supply	Value typ.	min. / max.	Remarks
ICP current sources	4.2 mA/channel	±10%	
Compliance voltage	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	

The following technical statements only apply for this CRONOS*flex* module!

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal electronics isolated (incl. ICP current sources) from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	-IN	all channels with one common, galvanically connected reference ground: in ICP-mode: -IN as reference for current source, In voltage-mode not externally accessible
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply (CRFX)		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Power consumption	7.4 W	10 V to 50 V DC
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current, corresponding to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	62 x 118 x 186 mm	W x H x D
Weight	1 kg	

The description of the ICPU2-8 196.

[1] ICP is a registered trade mark of PCB Piezotronics Inc., Delta Tron is a registered trade mark of Bruel & Kjaer Sound and Vibration; PIEZOTRON, PIEZOBEAM is a registered trade mark of Kistler

[2] Only galvanically insulated sensors. For more detailed information, please refer to chapter "MMI-TEDS" in imc CRONOS manual.

9.7.7 ICPU-16: Voltage, IEPE/ICP

Parameter	Value	Remarks
Inputs	16	
Measurement modes	voltage measurement current fed sensors IEPE/ICP	 (e.g. ICP™-, DELTATRON®-Sensors)
Terminal connection	BNC	

Sampling rate, bandwidth, filter, TEDS			
Parameter	**Value**		**Remarks**
Sampling rate	≤20 kHz		per channel aggregate sampling rate 320 ksps
Bandwidth	0 kHz to 5 kHz 0 kHz to 6.6 kHz		-0.1 dB -3 dB (analog 5. order AAF)
Filter (digital) cut-off frequency characteristic, order	2 Hz to 5 kHz		Butterworth, Bessel (digital) low pass filter 8. order Anti-aliasing filter: Cauer 8. order with $f_{cutoff} = 0.4\ f_s$
Filter cut-off frequency (high-pass, 3rd order, -3 dB)	0.43 Hz	±5%	AC, differential AC, single end with current source
TEDS - Transducer Electronic Data Sheets	conforming to IEEE 1451.4 Class II MMI		

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Overvoltage protection		±40 V	permanently
Input coupling	DC AC, ICP		AC-coupling (or ICP) means a high pass filter at the input. To avoid drifting of the module, a high pass filter is always calculated, even if the user selects "without filter".
Input configuration	differential single-end		software-configurable
Input impedance	 908 kΩ 1.82 MΩ 20 MΩ		at DC-voltage resp. 50 Hz ICP (single-end) AC (differential) DC (differential)

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±10 V, ±5 V, ±2.5 V, ±1 V, ±500 mV, ±250 mV		
Gain error	0.02 %	≤0.05 %	of the reading
Gain drift	(±8 ppm/K)·ΔT_a	(±30 ppm/K)·ΔT_a	ΔT_a= |T_a -25°C|; with T_a= ambient temperature
Offset uncertainty	0.02 %	≤0.05 %	of range
Offset drift	(±18 µV/K)·ΔT_a (±2 µV/K)·ΔT_a	(±45 µV/K)·ΔT_a (±5 µV/K)·ΔT_a	±10 V to ±2.5 V ±1 V to ±250 mV ΔT_a= |T_a -25°C|; with T_a= ambient temperature
Max. common mode voltage		±12 V	
Common mode rejection ranges: ±10 V to ±2.5 V ±1 V to ±250 mV	-90 dB -108 dB	-80 dB -97 dB	common mode test voltage: ±10 $V_=$ and 7 V_{rms}, 50 Hz
Channel to channel crosstalk range ±10 V to ±2.5 V ±1 V to ±250 mV	-90 dB -116 dB		test voltage: ±10 $V_=$ and 7 V_{rms}, 0 Hz to 50Hz; range: ±10 V
Noise	12 µV_{rms}		bandwidth: 0.1 Hz to 1 kHz

Constant current supply			
ICP current sources	4.2 mA/channel	±10 %	
Compliance voltage	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	

Find here the description of the ICPU-16 199.

9.7.8 ISO2-8 Isolated: voltage, current (20 mA), temperature

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	8	
Measurement modes DSUB-15	voltage current thermocouple, RTD (PT100) current fed sensors	 shunt plug (ACC/DSUBM-I4) thermo plug (ACC/DSUBM-T4) with IEPE DSUB-15 extension plug: ACC/DSUB-ICP4, not isolated ACC/DSUBM-ICP2I-BNC-S/-F [1], isolated, basic functionality (ICP-operation)
Measurement modes LEMO	voltage current RTD (PT100)	differential (internal shunt)
Terminal connection Standard LEMO	 2x DSUB-15 or 8x LEMO.1B.307	 4 channels per plug 1 channel per plug

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz ≤10 kHz	per channel at temperature measurement
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels
Bandwidth	0 Hz to 11 kHz 0 Hz to 8 kHz 0 Hz to 1 kHz	-3 dB -0.2 dB -0,1 dB at temperature measurement
Filter (digital) cut-off frequency characteristic type and order	 2 Hz to 5 kHz	 Butterworth, Bessel low pass filter: 8th high pass filter: 4th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cut\text{-}off} = 0.4\ f_a$
Resolution CRC, CRSL CRFX, CRXT	 16 Bit 16 Bit 24 Bit	 internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor), only CRFX & CRXT support: DS2431
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed overview of supported device family 319

1 When using the two-channel IEPE plug in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used. Only the IEPE base functionality is supported by this module, see also TD ACC/DSUBM-ICP2I-BNC.

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation	galvanically isolated		channel-to-channel and against system ground (housing, CHASSIS, PE), as well as against common reference of all PT100 current sources and TEDS. not isolated when using ICP plug and PT100 mode
nominal rating	±60 V		
test voltage	±300 V (10 s)		
Overvoltage protection	±60 V ESD 2 kV transient protection: automotive load dump ISO 7637		differential input voltage, continuous human body model R_i=30 Ω, t_d=300 µs, t_r<60 µs
Input coupling	DC		
Input configuration	differential, isolated		
Input impedance	6.7 MΩ 1 MΩ 50 Ω		range ≤±2 V and temperature mode range ≥±5 V or device powered down with shunt plug ACC/DSUBM-I4
Input current			for operation
operating conditions		1 nA	$\|V_{in}\|$ > 5 V on ranges <±5 V
on overvoltage condition		1 mA	or device powered-down
Auxiliary supply			for IEPE/ICP plug
voltage	+5 V	±5 %	independent of optional
available current	>0.26 A	>0.2 A	sensor supply, short circuit proof
internal resistance	1.0 Ω	<1.2 Ω	power per DSUB-plug

Voltage measurement				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Voltage input ranges	±60 V / ±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V / ±500 mV ±250 mV / ±100 mV / ±50 mV			
Gain error	<0.02 %	<0.05 %	of the measured value, at 25 °C	
Gain drift		6 ppm/K·ΔT_a 50 ppm/K·ΔT_a	ranges ≤±2 V ranges ≥±5 V	over full temp. range
Offset error	0.02 %	<0.05 %	of the measurement range, at 25°C	
Offset drift		2.5 ppm/K·ΔT_a	over entire temperature range $\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature	
Non-linearity	<120 ppm		range ±10 V	
Signal noise	2.5 µV_{rms} 20 µV_{pkpk}		bandwidth 0.1 Hz to 1 kHz; in the range: ±50 mV	
IMR (isolation mode rejection)	140 dB 64 dB	>130 dB >60 dB	range ≤±2 V range ≥±5 V	R_{source}= 0 Ω, f=50 Hz
Channel isolation	>1 GΩ, < 40 pF		channel-to-ground / CHASSIS (case)	
	>1 GΩ, <10 pF		channel-to-channel	
Channel isolation (crosstalk)	>165 dB (50 Hz) >92 dB (50 Hz)		range ≤±2 V range ≥±5 V	R_{source} ≤100 Ω

Current measurement with shunt plug				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Input ranges	±40 mA / ±20 mA / ±10 mA ±5 mA / ±2 mA / ±1 mA			
Shunt impedance	50 Ω		external plug ACC/DSUBM-I4	
Input configuration	differential			
Gain error	<0.02 %	<0.05 % <0.1%	of the measured value, with 25 °C additional error of 50 Ω in plug	
Gain drift		6 ppm/K·ΔT_a 50 ppm/K·ΔT_a	ranges ≤±2 V ranges ≥±5 V	over entire temp. range
Offset error	0.02 %	<0.05 %	of the measurement range	
Offset drift		2.5 ppm/K·ΔT_a	over entire temperature range ΔT_a=|T_a -25°C|; with T_a = ambient temperature	

Current measurement with internal shunt (variant with round connector etc.)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±40 mA / ±20 mA / ±10 mA		
Shunt impedance	50 Ω		internal
Input configuration	differential		
Gain error	<0.02 %	<0.05 %	of the measured value, with 25 °C
Gain drift		30 ppm/K·ΔT_a	over entire temperature range
Offset error	0.02 %	<0.05 %	of the measurement range
Offset drift		2.5 ppm/K·ΔT_a	over entire temperature range ΔT_a=|T_a -25°C|; with T_a = ambient temperature

Temperature measurement - thermocouples			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement mode	R, S, B, J, T, E, K, L, N		
	C		special variant DSUB-15: additional type C (W5Re/W26Re)
Measurement range	-270°C to 1370°C -270°C to 1100°C -270°C to 500°C		type K
	0°C to 2320°C		type C (special variant, 24 bit mode)
Resolution	0.063 K (1/16 K)		16-Bit integer
Measurement error		<±0,6 K	type K, range -150°C to 1200°C type T, range -150°C to 400°C type N, range 380°C to 1200°C
		<±1.0 K	type K, range -200°C to -150°C type T, range -200°C to -150°C
		<±1.5 K	type N, range -200°C to 380°C
Temperature drift	±0.02 K/K·ΔT_a		ΔT_a=|T_a -25°C|; with T_a = ambient temperature
Error of cold junction compensation		<±0.15 K	with ACC/DSUBM-T4
Temperature drift	±0.001 K/K·ΔT_a		ΔT_a=|T_a -25°C|; with T_a = ambient temperature

Temperature measurement – PT100		
Parameter	**Value**	**Remarks**
Measurement range	-200°C to +850°C -200°C to +250°C	
Resolution	0.063 K (1/16 K)	
Gain error	<±0.05%	of measured value (corresponding resistance)
Offset error	<±0.2 K	with 4-wire configuration
Offset drift	±0.01 K/K ΔT_a	$\Delta T_a = \lvert T_a - 25°C \rvert$; with T_a = ambient temperature
Sensor feed	250 µA	non-isolated

Sensor supply (ISO2-8(-L)-SUPPLY)				
Parameter	**Value typ.**		**max.**	**Remarks**
Configuration options	5 selectable settings			The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V
Output voltage	Voltage (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	Current 580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	Netpower 1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	set jointly for all eight channels optional, special order: +12 V or 15 V can be replaced by +2.5 V preferred selection with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V, +24 V Special order: +15 V can be replaced by ±15 V. With the LEMO variant, TEDS support is omitted with this choice, see manual.
Isolation - applies for imc CRONOS*compact* and imc CRONOS-SL systems				
Isolation Standard: option, upon request:	 non isolated isolated			 output to case (CHASSIS) nominal rating: 50V, test voltage (10sec.): 300 V, not available with option ±15 V
Block isolation only applies for imc CRONOS*flex*				
Block isolation	60 V			Isolation of the entire global sensor supply (for all 8 channels, reference ground "-SUPPLY, GND") as well as the internal additional electronics from housing (CHASSIS, PE)
Short-circuit protection	unlimited duration			to output voltage reference ground
Accuracy of output voltage	 <0.25 %		 0.5 % 0.9 % 1.5 %	at terminals, no load at 25°C over entire temperature range plus with optional bipolar output voltage
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V to 10 V 12 V, 15 V 24 V

The following technical statements only apply for this CRONOS*flex* module!

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal additional-electronics (PT100-current sources, TEDS, sensor supply) isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	GND, TEDS_GND, -I4, -SUPPLY	PT100 current sources and TEDS for all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing	internal additional-electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of the imc CRONOS*flex* module		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Isolation	60 V	nominal isolation specification of the supply input
Power over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable
Power consumption		10 to 50 V DC
CRFX/ISO2-8	7.0 W	CRFX/ISO2-8
	9.2 W	CRFX/ISO2-8 with 2x ACC/DSUB-ICP4
	12.4 W	CRFX/ISO2-8(-L)-SUPPLY (Sensor-Supply 3 W netto)

Terminal connections of the imc CRONOS*flex* module		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current corresponding to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power-Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	43.3 x 118 x 186 mm (width of the LEMO variant is: 62 mm)	W x H x D
Weight	ca. 740 g (DSUB-15 variant)	

The description of the ISO2-8 200

9.7.9 ISO2-8(-16)-2T Isolated: Thermocouple

Channels, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Channels	8 16	ISO2-8-2T CRC variant as well as for CRFX ISO2-16-2T only for CRFX
Measurement mode	temperature measurement thermocouples type K	
Terminal connection Measurement input	miniature thermocouple terminal connector	2-pin, female
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply
Module connector	2x 20-pin	direct connection of modules (click) supply and system bus

Sampling rate, Bandwidth, Filter		
Parameter	**Value**	**Remarks**
Sampling rate	≤10 kHz	per channel
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels
Bandwidth	0 Hz to 1 kHz 0 Hz to 2 kHz	-0.1 dB ISO2-8-2T -0.1 dB ISO2-16-2T
Resolution CRC, CRSL	16 Bit	internal processing 24 Bit
CRFX	16 Bit 24 Bit	output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
Filter (digital) cut-off frequency	2 Hz to 500 Hz CRFX/ISO2-16-2T 2 Hz to 5 kHz CRC/CRFX/ISO2-8-2T	Butterworth, Bessel low pass filter: 8th order high pass filter: 4th order band pass: LP 8th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_a$

Temperature measurement - thermocouples			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement range	temperature range: -200°C to +1200°C type K		
Resolution	0.063 K (1/16 K) 32 bit float (24 Bit mantissa)		With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)
Measurement error		<±0.6 K <±1.0 K	type K, range -150°C to 1200°C type K, range -200°C to -150°C
Temperature drift	±0.02 K//K·ΔT_a		ΔT_a=|T_a -25°C|; with T_a = ambient temperature
Error of cold junction compensation[1]		<±0.15 K	
Temperature drift	±0.001 K//K·ΔT_j		ΔT_j=|T_j -25°C|; with T_j = cold junction temperature

General		
Parameter	**Value**	**Remarks**
Isolation nominal rating test voltage	galvanically isolated ±60 V ±300 V (10 sec.)	channel-to-channel and against system ground (housing, CHASSIS, PE) channel to case
Overvoltage protection	±60 V ESD 2 kV transient protection: automotive load dump ISO 7637	differential input voltage (continuous) human body model R_i=30 Ω, t_d=300 µs, t_r<60 µs
Input coupling	DC	
Input configuration	differential, isolated	galvanically isolated to System-GND (housing, CHASSIS)
Input impedance	6.7 MΩ	

Note Technical Specs for all imc CRONOS*flex* modules

The technical data regarding operating conditions, power supply and connections of the imc CRONOS*flex* (CRFX) modules are the same as for the ISO2-8 395 variant.

CRFX-ISO2-8(-16)-2T		
Parameter	**Value**	**Remarks**
Power consumption	10 W	10 V to 50 V DC
Dimensions	62 x 118 x 186 mm	W x H x D
Weight	approx. 1.1 kg	

Reference

Please find here the description of the ISO2-8 200

1 If the operating temperature exceeds 65 °C (typical), an additional deviation of the cold junction compensation of ±1 °C may occur.

9.7.10 ISOF-8 voltage, current (20 mA), temperature, IEPE/ICP

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	8	
Measurement modes DSUB-15	voltage measurement current measurement thermocouple, RTD (PT100) current fed sensors IEPE/ICP	 shunt plug (ACC/DSUBM-I4) thermo plug (ACC/DSUBM-T4) IEPE/ICP expansion plug (ACC/DSUB-ICP4, not isolated ACC/DSUBM-ICP2I-BNC-S/-F [1], isolated)
Measurement modes LEMO	voltage measurement current measurement RTD (PT100)	 differential (internal shunt)
Terminal connection Standard LEMO	 2x DSUB-15 or 8x LEMO.1B.307	 4 channels per plug 1 channel per plug

Sampling rate, bandwidth, filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels
Bandwidth	0 Hz to 48 kHz 0 Hz to 46 kHz	-3 dB -0.2 dB
Filter (digital) cut-off frequency characteristic order	 10 Hz to 20 kHz	 Butterworth, Bessel low pass filter: 8th order high pass filter: 4th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with f_{cutoff} = 0.4 f_a
Resolution CRC, CRSL CRFX, CRXT	 16 Bit 16 Bit 24 Bit	 internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS - Transducer Electronic Data Sheets	conforming to IEEE 1451 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported DS2431 (typ. IEPE/ICP sensor), only CRFX & CRXT support: DS2431
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed overview of supported device family 319

1 When using the two-channel IEPE plug in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used. Only the IEPE base functionality is supported by this module, see also TD ACC/DSUBM-ICP2I-BNC.

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation nominal rating test voltage	galvanically isolated ±60 V ±300 V (10 sec.)		channel-to-channel and against system ground (housing, CHASSIS), as well as against common reference of all PT100 current sources and TEDS. Isolation with IEPE/ICP connector: depends on plug type
Overvoltage protection	±100 V ESD 2 kV transient protection: automotive load dump ISO 7637		differential input voltage (continuous) human body model R_i=30 Ω, t_d=300 µs, t_r<60 µs
Input coupling	DC		
Input configuration	differential, isolated		
Input impedance	6,7 MΩ 1 MΩ 50 Ω		range ≤±2 V or temperature mode range ≥±5 V or device powered down current mode (shunt-plug) (ACC/DSUBM-I4)
Input current operating conditions on overvoltage condition	 1 mA	 2.4 nA	 for operation $\|V_{in}\|$ >5 V on ranges <±5 V or device powered-down
Auxiliary supply voltage available current internal impedance	 5 V >0.26 A 1.0 Ω	 ±5% >0.2 A <1.2 Ω	for IEPE/ICP plug independent of optional sensor supply, short circuit proof power per DSUB-plug

Voltage measurement				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Input ranges	±60 V / ±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V / ±500 mV ±250 mV / ±100 mV / ±50 mV / ±25 mV			
Gain error	<0.025%	<0.05%	of the measured value, at 25°C	
Gain drift		30 ppm/K·ΔT_a 60 ppm/K·ΔT_a	ranges ≤±2 V ranges ≥±5 V	over full temperature range
Offset error	0.02 %	<0.05 %	of the range	
Offset drift		2.5 ppm/K·ΔT_a	over entire temperature range ΔT_a=|T_a -25°C|; with T_a = ambient temperature	
Nonlinearity	<120 ppm			
Input voltage noise	 2.6 μV_{rms} / 22 μV_{pkpk} 0.5 μV_{rms} / 3.5 μV_{pkpk} 0.1 μV_{pkpk} 14 nV / √Hz		range ±25 mV bandwidth 0.1 Hz to 48 kHz bandwidth 0.1 Hz to 1 kHz bandwidth 0.1 Hz to 10 Hz spectral noise density	
CMRR (common mode rejection ratio) / IMR	>145 dB (50 Hz) >80 dB (50 Hz)		ranges ≤±2 V ranges ≥±5 V	R_{source} = 0 Ω
Channel isolation	>1 GΩ, < 40 pF		channel-to-ground / CHASSIS (case)	
	>1 GΩ, < 10 pF		channel-to-channel	
Channel isolation (crosstalk)	>155 dB (50 Hz) >92 dB (50 Hz)		ranges ≤±2 V ranges ≥±5 V	R_{source} ≤100 Ω

Current measurement with shunt plug				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Input ranges	±40 mA / ±20 mA / ±10 mA			
Shunt impedance	50 Ω		external plug ACC/DSUBM-I4	
Gain error	<0.07 %	<0.15 %	of the measured value, at 25 °C	
Gain drift		30 ppm/K·ΔT_a 60 ppm/K·ΔT_a	ranges ≤±2 V ranges ≥±5 V	over full temperature range
Offset error	10 µV		range ±25 mV	
Offset drift	0.7 µV/K·ΔT_a		range ±25 mV ΔT_a=|T_a -25°C|; with T_a = ambient temperature	

Current measurement with internal shunt (variant with round connector etc.)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±40 mA / ±20 mA / ±10 mA		
Shunt impedance	50 Ω		internal
Input configuration	differential		
Gain error	<0.02 %	<0.05 %	of the measured value, with 25°C
Gain drift		40 ppm/K·ΔT_a	over entire temperature range
Offset error	0.02 %	<0.05 %	of the measurement range
Offset drift		2.5 ppm/K ·ΔT_a	over entire temperature range $\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature

Temperature measurement - thermocouples			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement mode	R, S, B, J, T, E, K, L, N		
Measurement range	-270°C to 1370°C -270°C to 1100°C -270°C to 500°C		type K
Resolution	0.063 K (1/16 K)		With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)
Measurement error (gain + offset)		<±0.6 K <±1.0 K	type K, value -150°C to 1100°C else
Drift (gain + offset)		±0.02 K/K·ΔT_a ±0.05 K/K·ΔT_a	type K, range -270°C to 1100°C type K, range -270°C to 1370°C $\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature
Error of cold junction compensation		<±0.15 K	with ACC/DSUBM-T4
Cold junction drift	±0.001 K/K·ΔT_a		$\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature

Temperature measurement – PT100		
Parameter	**Value**	**Remarks**
Measurement range	-200°C to +850°C -200°C to +250°C	
Resolution	0.063 K (1/16 K)	16-Bit integer
Measurement error	<±0.05%	of the measured value
Offset error	<±0.2 K	4-wire connection
Offset drift	±0.01 K/K·ΔT_a ±0.02 K/K·ΔT_a	range -200°C to 250°C range -200°C to 850°C $\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature
Sensor feed (PT100)	250 µA	non-isolated

<table>
<tr><th colspan="5">Sensor supply (ISOF-8-SUPPLY, ISOF-8-L-SUPPLY)</th></tr>
<tr><th>Parameter</th><th colspan="2">Value typ.</th><th>max.</th><th>Remarks</th></tr>
<tr><td>Configuration options</td><td colspan="3">5 selectable settings</td><td>5 settings only
Default ranges: +5 V to +24 V</td></tr>
<tr><td>Output voltage</td><td>Voltage
(+2.5 V)
+5.0 V
+10 V
+12 V
+15 V
+24 V
(±15 V)</td><td>Current
580 mA
580 mA
300 mA
250 mA
200 mA
120 mA
190 mA</td><td>Netpower
1.5 W
2.9 W
3.0 W
3.0 W
3.0 W
2.9 W
3.0 W</td><td>set globally for all channels of a module
special order, +12 V or 15 V can be replaced by +2.5 V;
default selection with 2.5 V:
+2.5 V, +5.0 V, +10 V, +12 V, +24 V

Special order: +15 V can be replaced by ±15 V. With the LEMO variant, TEDS support is omitted with this choice, LEMO pin 5 (TEDS) is then GND, pin 3 is +15 V and pin 4 -15 V, see manual.</td></tr>
<tr><td colspan="5">Isolation - applies for imc CRONOScompact, imc CRONOS-SL and PL systems</td></tr>
<tr><td>Isolation
standard:
option, upon request:</td><td colspan="3">
non isolated
isolated</td><td>
output to case (CHASSIS, PE)
nominal rating: 50 V, test voltage (10 sec.): 300 V, not available with option ±15 V</td></tr>
<tr><td colspan="5">Block isolation only applies for imc CRONOSflex</td></tr>
<tr><td>Block isolation</td><td colspan="3">60 V</td><td>Isolation of the entire global sensor supply (for all 8 channels, reference ground "-SUPPLY, GND") as well as the internal additional electronics from housing (CHASSIS, PE)</td></tr>
<tr><td colspan="5">applies for imc CRONOScompact, imc CRONOS-SL and PL systems</td></tr>
<tr><td>Short-circuit protection</td><td colspan="3">unlimited duration</td><td>to output voltage reference ground</td></tr>
<tr><td>Accuracy of output voltage</td><td colspan="2">
<0.25 %

</td><td>
0.5 %
0.9 %
1.5 %</td><td>at terminals, no load
at 25 °C
over entire temperature range
plus with optional bipolar output voltage</td></tr>
<tr><td>Max. capacitive load</td><td colspan="3">>4000 µF
>1000 µF
>300 µF</td><td>2.5 V to 10 V
12 V, 15 V
24 V</td></tr>
</table>

The following technical statements only apply for this CRONOS*flex* module!

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal additional-electronics (PT100-current sources, TEDS, sensor supply) isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	GND, TEDS_GND, -I4, -SUPPLY	PT100 current sources and TEDS for all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing	internal additional-electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Power supply of the module		
Input supply voltage	10 V to 50 V DC	
Power consumption	10 W	10 V to 50 V DC
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module		
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC) for remote modules	350 mA (maximum current corresponding to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power-Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	43.3 x 118 x 186 mm	W x H x D
Weight	714 g	

Find here the description of the ISOF-8 205

9.7.11 LV-16 Voltage, Current (20 mA), IEPE/ICP

Parameter	Value	Remarks
Inputs	16	differential, analog, non isolated
Measurement modes (DSUB)	voltage measurement current measurement current fed sensors (IEPE/ICP)	 with shunt plug (ACC/DSUBM-I4) with DSUB-15 expansion plug ACC/DSUB-ICP4, not isolated ACC/DSUBM-ICP2I-BNC-S/-F [1], isolated
Measurement modes (LEMO)	voltage measurement current measurement	 with external shunt
Terminal connection Standard LEMO	 4x DSUB-15 socket 4 channels per plug 16x LEMO / 1 channel per socket	

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤20 kHz	per channel
Bandwidth	0 Hz to 6.6 kHz 0 Hz to 5 kHz	-3 dB (analog AAF 5th order) -0.2 dB
Filter (digital) cut-off frequency characteristic order	 2 Hz to 5 kHz	 Butterworth, Bessel (digital) low pass filter 8. order Anti-aliasing filter: Cauer 8. order with f_{cutoff} = 0.4 f_s
Resolution	16 Bit	internal processing 24 Bit
TEDS	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) see notes in chap. TEDS 104

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Overvoltage protection		±40 V	permanent channel to chassis
Input coupling	DC		
Input configuration	differential		
Input impedance	20 MΩ		differential, >10 kΩ off-state
Auxiliary supply voltage available current internal resistance	 +5 V 0.26 A 1.0 Ω	 ±5% 0.2 A <1.2 Ω	for IEPE/ICP-extension plug independent of integrated sensor supply, short-circuit protected power per DSUB-plug

1 When using the two-channel IEPE plug in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used.

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±10 V, ±5 V, ±2.5 V, ±1 V, ±500 mV, ±250 mV		
Gain: error drift	0.02 % ±8 ppm/K·ΔT_a	≤0.05 % ±30 ppm/K×DTa	of reading ΔT_a=|T_a -25°C|; with T_a= ambient temperature
Offset: error drift	0.02 % (±18 µV/K)·ΔT_a (±2 µV/K)·ΔT_a	≤0.05 % (±45 µV/K)·ΔT_a (±5 µV/K)·ΔT_a	of range ±10 V to ±2.5 V ±1 V to ±250 mV ΔT_a=|T_a -25°C|; with T_a= ambient temperature
Max. common mode voltage		±12 V	
Common mode rejection Ranges ±10 V to ±2.5 V ±1 V to ±250 mV	 -90 dB -108 dB	 -80 dB -97 dB	common mode test voltage: ±10 $V_=$ and 7 V_{rms}, 50 Hz
Channel to channel crosstalk Ranges 10 V to ±2.5 V ±1 V to ±250 mV	 -90 dB -116 dB		test voltage: ±10 $V_=$ and 7 V_{rms}, 0 Hz to 50 Hz; range: ±10 V
Noise	12 µV_{rms}		bandwidth: 0.1 Hz to 1 kHz

Current measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 mA, ±20 mA, ±10 mA, ±5 mA		50 Ω shunt in terminal plug
Max. over load	±60 mA		permanent
Input configuration	differential		50 Ω shunt plug (ACC/DSUBM-I4)
Gain: error drift	 0.02 % (±20 ppm/K)·ΔT_a	 ≤0.06 % ≤0.1 % (±55 ppm/K)·ΔT_a	of reading plus error of 50 Ω shunt ΔT_a=|T_a -25°C|; with T_a= ambient temperature
Offset: error drift	 0.02 % (±30 nA/K)·ΔT_a	 ≤0.05 % (±60 nA/K)·ΔT_a	 of range ΔT_a=|T_a -25°C|; with T_a= ambient temperature

Find here the description of the LV-16 Voltage, Current (20 mA), IEPE/ICP 209. Technical data of the sensor supply (option) 469.

9.7.12 LV3-8 Voltage, Current (20 mA), IEPE/ICP

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	8	
Measurement modes DSUB	voltage measurement current measurement current feed sensors	 shunt plug (ACC/DSUBM-I4) with DSUB-15 expansion plug: ACC/DSUB-ICP4, not isolated ACC/DSUBM-ICP2I-BNC-S/-F [1], isolated
Measurement modes LEMO	voltage measurement current measurement	 with external shunt
Terminal connection Standard LEMO	 2x DSUB-15 8x LEMO.1B.307	 4 channels per plug 1 channel per plug

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels
Bandwidth	0 Hz to 48 kHz 0 Hz to 30 kHz	-3 dB -0.1 dB
Filter (digital) cut-off frequency characteristic order	 10 Hz to 20 kHz	 Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$
Resolution CRC, CRSL CRFX, CRXT	 16 Bit 16 Bit 24 Bit	 internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor) see notes in chap. TEDS 104: only CRFX & CRXT support: DS2431
Characteristic curve linearization	user defined (max. 1023 supporting points) (only with CRFX modules) 318	see detailed overview of supported device family 319

1 When using the two-channel IEPE plug in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used.

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Overvoltage protection		 ±80 V ±50 V	permanent, differential input range >±10 V or device switched off input range ≤±10 V
Input coupling	DC		
Input configuration	differential		
Input impedance	1 MΩ 20 MΩ		range >±10 V range ≤±10 V
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ±5% >0.2 A <1.2 Ω	for IEPE/ICP expansion plug independent of optional sensor supply, short circuit proof power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 V, ±25 V, ±10 V, ±5V, ±2.5 V, ±1 V... ±5 mV		
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS; input range ≤±10 V
Gain error	0.02 %	0.05 %	of the reading
Gain drift	10 ppm/K·ΔT_a	30 ppm/K·ΔT_a	ΔT_a=|T_a-25 °C|; T_a = ambient temperature
Offset error	 0.02 %	 ≤0.05 % ≤0.06 % ≤0.15 %	of the range, at 25 °C >±50 mV ≤±50 mV ≤±10 mV
Offset drift	±40 µV/K·ΔT_a ±0.7 µV/K·ΔT_a ±0.1 µV/K·ΔT_a	±200 µV/K·ΔT_a ±6 µV/K·ΔT_a ±1.1 µV/K·ΔT_a	range >±10 V range ±10 V to ±0.25 V range ≤±0.1 V ΔT_a=|T_a-25 °C|; T_a = ambient temperature
Nonlinearity	30 ppm	≤90 ppm	
Common mode rejection ranges ±50 V to ±25 V ±10 V to ±50 mV ±20 mV to ±5 mV	 80 dB 110 dB 138 dB	 >70 dB >90 dB >132 dB	Common mode voltage (DC..60 Hz): ±50 V ±10 V ±10 V
Noise	 3.6 µV_{rms} 0.6 µV_{rms} 0.14 µV_{rms}	 5.5 µV_{rms} 1.0 µV_{rms} 0.26 µV_{rms}	bandwidth 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Current measurement with shunt plug			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±100 µA1 mA		50 Ω shunt in terminal plug
Shunt impedance	50 Ω		external plug ACC/DSUBM-I4
Over load protection		±60 mA	permanent
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS
Input configuration	differential		50 Ω shunt in terminal plug
Gain error	0.02 %	≤0.06 % ≤0.1 %	of reading plus error of 50 Ω shunt
Gain drift	+15 ppm/K·ΔT_a	+55 ppm/K·ΔT_a	$\Delta T_a = \lvert T_a - 25\ °C \rvert$; T_a = ambient temperature
Offset error	0.02 %	≤0.05 %	of the range
Current noise	 40 nA_{rms} 0.7 nA_{rms} 0.17 nA_{rms}	 70 nA_{rms} 12 nA_{rms} 0.3 nA_{rms}	Bandwidth: 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Sensor supply module (LV3-8-SUPPLY, LV3-8-L-SUPPLY)				
Parameter	**Value typ.**		**max.**	**Remarks**
Configuration options	5 selectable settings			The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V
Output voltage	Voltage (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	Current 580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	Netpower 1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	set jointly for all eight channels optional, special order, +12 V or 15 V can be replaced by +2.5 V preferred selection with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V, +24 V optional, special order: +15 V can be replaced by ±15 V
Isolation - only applies for imc CRONOS*compact*, imc CRONOS-SL and PL systems				
Isolation Standard: option, upon request:	non isolated isolated			output to case (CHASSIS) nominal rating: 50V, test voltage (10sec.): 300 V, not available with option ±15 V.
Block isolation only applies for imc CRONOS*flex*				
Block isolation	60 V			Isolation der gesamten globalen Sensorversorgung (für alle 8 Kanäle, Bezug "-SUPPLY, GND") sowie der internen Messelektronik gegenüber Gehäuse (CHASSIS, PE
Short-circuit protection	unlimited duration			to output voltage reference ground
Accuracy of output voltage	<0.25 %		 0.5 % 0.9 % 1.5 %	at terminals, no load at 25°C over entire temperature range plus with optional bipolar output voltage
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V to 10 V 12 V, 15 V 24 V

The following technical statements only apply for this CRONOS*flex* module!

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	GND, TEDS_GND, -SUPPLY	all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of the module		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Power consumption 	 6.4 W 8.8 W 12.4 W	10 to 50 V DC CRFX/LV3-8 CRFX/LV3-8 with 2x ACC/DSUB-ICP4 CRFX/LV3-8-SUPPLY, CRFX/LV3-8-L-SUPPLY (Sensor-Supply 3 W netto)
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for expanded imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current, corresponding to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions

Parameter	Value	Remarks
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	43.3 x 118 x 186 mm (width of the LEMO variant is: 62 mm)	W x H x D
Weight	640 g (DSUB-15 variant) 1000 g (LEMO variant)	

The description of the LV3-8: Voltage, Current (20 mA), IEPE/ICP 210.

9.7.13 OSC-16 Isolated: Voltage, current (20 mA), temperature

Parameter	Value	Remarks
Inputs	16	
Measurement mode DSUB-15	voltage measurement current measurement thermocouple measurement RTD (PT100)	standard plug (ACC/DSUBM-U4) current plug (ACC/DSUBM-I4) Thermo-plug (ACC/DSUBM-T4)
Measurement mode OSC-16-**T**	temperature measurement thermocouple type-K	two pin thermo-sockets
Terminal connection DSUB-15 OSC-16-T	 4x DSUB-15 or 16x thermo-sockets	 4 channels per plug one channel per plug

Sampling rate, Bandwidth, TEDS			
Parameter	**Value**		**Remarks**
Sampling rate	≤500 Hz / channel ≥10 Hz (100 ms)		internal sampling: 2 Hz with additional interpolation: 5Hz for higher rates:output of doubled values max. allowable input signal frequency: 1 Hz filter / bandwidth like at 2 Hz / 5 Hz, additional values are duplicated
Bandwidth	1 Hz		-0.01 dB
Resolution	16 bit		
Noise suppression @ 50 Hz (±2%) at sampling rate: 1 Hz > 1 Hz	49 Hz to 51 Hz 68 dB 34 dB		noise frequency recommended sampling rate 1 Hz other sampling rates > 1 Hz
Bandwidth / max. signal freq. vs. noise suppression @ 50 Hz at sampling rate: 0.5 Hz 1 Hz 2 Hz 5 Hz	Bandwidth and max. signal frequency 0.25 Hz 0.5 Hz 1 Hz 1 Hz	noise suppression ≥60 dB 48.5 Hz 48.5 Hz 50 Hz 50 Hz	suppression of ≥60 dB is achieved for: noise frequency ≥48.5 Hz noise frequency ≥50 Hz
Max. settling time	max. 1 s		sampling rate 5 Hz (200 ms) complete settling as a response to input step
Synchronicity (at sampling rate)	constant time offset between two equally configured channels: max. 500 ms		 sampling rate ≥2 Hz
TEDS	conforming to IEEE 1451.4 Class II MMI		esp. with ACC/DSUBM-TEDS-xx (DS2433) see notes in chap. TEDS 104
Characteristic curve linearization	user defined (max. 1023 supporting points)		see detailed overview of supported device family 319

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation nominal test voltage	±60 V 300 V (10 s)		channel to frame (housing, CHASSIS) and channel to channel
Overvoltage protection	±60 V ESD 2 kV transient protection: automotive load dump ISO 7636		diff. input voltage, (long term) human body model R_i=30 Ω, t_d=300 µs, t_r<60 µs
Input coupling	DC		
Input configuration	differential, isolated		electrical isolation to system-GND (housing, CHASSIS)
Input impedance	10 MΩ 1 MΩ 50 Ω		voltage mode (range ≤±2 V), temperature mode voltage mode (range ≥ ±5 V) current mode (shunt plug)
Static input current	1 nA	10 nA	
Dynamic input current	0.1 mA 30 nA	1.5 mA 600 nA	peak dynamic input current value (typ. @100 mV, max. @2 V) mean dynamic input current value (typ. @100 mV, max. @2 V)
Input current upon overvoltage		1.5 mA	$\|V_{in}\|$ > 7 V in the range ≤±2 V or device deactivated
Auxiliary supply voltage available current internal resistance	+5 V >0.26 A 1.0 Ω	± 5% >0.2 A <1.2 Ω	independent of integrated sensor supply, short circuit proof power per DSUB-plug

Voltage measurement				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Input range	±60 V / ±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V / ±500 mV ±250 mV / ±100 mV / ±50 mV			
Gain error	<0.025%	<0.05%	of the reading, at 25°C	
Gain drift		6 ppm/K 36 ppm/K	ranges ≤±2 V ranges ≥±5 V	over entire temp. range
Offset error		<0.05% <3 µV	of input range	
Offset drift		3 ppm/K	over entire temperature range	
Non-linearity	<30 ppm		range: ±10 V	
Noise voltage (RTI)	<0.5 μV_{rms} <3.0 μV_{pkk} (<1 LSB)		sampling rate 5 Hz (200 ms)	
CMRR/ IMR (isolation mode rejection)	all sampling rates >110 dB (50 Hz) >95 dB (50 Hz) >65 dB (50 Hz)		 range ≤±2 V range ≤±2 V range ≥±5 V	 R_{source} = 0 Ω R_{source} = 100 Ω R_{source} = 100 Ω
Channel isolation	<50 pF, <100 nA		Channel to protection ground (CHASSIS); Channel-to-channel	
Channel cross-talk damping	all sampling rates >116 dB (50 Hz) >101 dB (50 Hz)		 range ≤±2 V range ≤±2 V	 R_{source} = 0 Ω R_{source} = 100 Ω
Suppression of square wave on neighboring channels	>123 dB @ sampling rate 200 ms		range ≤±2 V	R_{source} = 100 Ω
Max. source impedance	5 kΩ			

Current measurement with shunt plug				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Input range	±1 mA / ±2 mA / ±5 mA ±10 mA / ±20 mA / ±40 mA			
Shunt resistor	50 Ω		external plug ACC/DSUBM-I4	
Gain error	<0.07%	<0.15%	of the reading, at 25°C	
Gain drift		6 ppm/K 36 ppm/K	ranges ≤±2 V ranges ≥±5 V	over entire temp. range
Offset error		<0.05%	of input range	
Offset drift		3 ppm/K	over entire temperature range	

Temperature measurement - Thermocouples			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input mode	R, S, B, J, T, E, K, L, N		
Input ranges	-270°C to 1370°C -270°C to 1100°C -270°C to 500°C		type K
Resolution	0.063 K (1/16 K)		
Measurement error (gain error + offset)		<±0.5 K ±0.05%	type K, range -150°C to 1200°C plus indicated value
Drift (gain error + offset)	±0.02 K/K·ΔT_a		ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Error of cold junction compensation		<±0.15 K <±0.5 K <±0.7 K <±1 K	DSUB (ACC/DSUBM-T4) thermo plug (green) type K thermo plug (white) with type K thermo plug (white) other types
Drift of cold junction temp.	±0.001 K/K·ΔT_a		ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Sensor breakage recognition	display: "-2000°C"		indicating unconnected input

Temperature measurement – PT100 (RTD)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	-200°C to 850°C -200°C to +250°C		
Resolution	0.063 K (1/16 K)		
Measurement error (gain error + offset)	<±0.1 K ±0.05%		-200°C to +850°C, 4-wire configuration plus indicated value
Drift (gain error + offset)	±0.01 K/K·ΔT_a		ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Reference current (PT100)	250 µA		non-isolated (CHASSIS is Ground)

Find here the description of the OSC-16 Isolated: Voltage, current (20 mA), temperature 213. Technical data of the sensor supply module SUPPLY (optional) 469.

9.7.14 SC2-32 Voltage, Current (20 mA), IEPE/ICP

Parameter	Value typ.	min. / max.	Remarks
Inputs	32		differential, analog, non isolated
Measurement modes DSUB	voltage measurement current measurement transducer with constant current supply		with ACC/DSUB-ICP4 (e.g. ICP™-, DELTATRON®-Sensors)
Measurement modes LEMO	voltage measurement current measurement		 with external shunt
Filter (digital) Frequency Characteristic Order	50 kHz, 20 kHz, 10 kHz to 20 Hz		Cauer, Butterworth, Bessel low pass filter 8. order Anti-aliasing filter: Cauer 8. order with $f_{cutoff} = 0.4\ f_s$
Sampling rate		≤100 kHz	per channel aggregate sampling rate 400 kHz
Bandwidth	0 Hz to 20 kHz 0 Hz to 28 kHz		-0.1 dB -3 dB (analogue 5th order Anti-aliasing filter)
Terminal connection DSUB LEMO	8x DSUB-15 2x DSUB-37 32x LEMO		4 channels per plug 16 channels per plug 1 channel per plug
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI		esp. with ACC/DSUBM-TEDS-xx (DS2433) see notes in chap. TEDS 104
Characteristic curve linearization	user defined (max. 1023 supporting points)		see detailed overview of supported device family 319

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±10 V, ±5 V, ±2.5 V, ±1 V, ±500 mV, ±250 mV		
Overvoltage protection		±40 V	permanent channel to chassis
Input impedance	20 MΩ	±1%	differential, >10 kΩ off-state
Gain: error drift	0.02% ±8 ppm/K·ΔT_a	≤0.05% ±30 ppm/K·ΔT_a	of reading ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Offset: error drift	0.02% ±20 µV/K·ΔT_a ±1.7 µV/K·ΔT_a	≤0.05% ±40 µV/K·ΔT_a ±3 µV/K·ΔT_a	of range ±10 V to ±2.5 mV ±1 V to ±250 mV ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Max. common mode voltage		±12 V	
Common mode rejection ranges ±10 V to ±2.5 V ±1 V to ±250 mV	 -87 dB -107 dB	 -72 dB -92 dB	common mode test voltage: ±10 $V_=$ and 7 V_{rms}, 50 Hz
Channel to channel crosstalk ranges ±10 V to ±2.5 V ±1 V to ±250 mV	 -98 dB -116 dB		test voltage: ±10 $V_=$ and 7 V_{rms}, 0 Hz to 1 kHz; range: ±10 V
Noise	23 µV_{rms}	30 µV_{rms}	bandwidth: 0.1 Hz to 10 kHz

Current measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 mA, ±20 mA, ±10 mA, ±5 mA		50 Ω shunt in terminal plug
Max. overload		±60 mA	permanent
Input configuration	differential		50 Ω shunt plug
Gain: error drift	0.02% ±20 ppm/K·ΔT_a	≤0.06% ≤0.1% ±55 ppm/K·ΔT_a	of reading plus error of 50 Ω shunt ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Offset: error drift	0.02% ±30 nA/K·ΔT_a	≤0.05% ±80 nA/K·ΔT_a	of range ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Auxiliary supply	+5 V (max. 160 mA / plug) not isolated		e.g. for ICP-expansion plug

Find here the description of the SC2-32 216.

9.8 Universal

9.8.1 UNI-4 isolated: Voltage, Current (20 mA), Temperature, Bridge, IEPE

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	4	
Measurement modes DSUB		ACC/DSUBM-UNI2 for all modes
isolated measurement modes:	voltage measurement (differential) current measurement thermocouple measurement	 with Shunt-plug (ACC/DSUBM-I2)
non-isolated measurement modes:	voltage measurement (single-end) current measurement bridge-sensor strain gauges PT100/PT1000 (3- and 4-wire connection) current fed sensors (IEPE/ICP)	 with internal Shunt with DSUB-15 extension plug ACC/DSUBM-ICP2I-BNC-S/-F, isolated
Measurement modes LEMO		
isolated measurement modes:	voltage measurement (differential) thermocouple measurement	 with ACC/TH-LEM-150
non-isolated measurement modes:	voltage measurement (single-end) current measurement bridge-sensor strain gauges PT100/PT1000 (3- and 4-wire connection)	 with internal shunt
Terminal connections Standard LEMO	 2x DSUB-15 4x LEMO.1B.307	 2 channels per plug 1 channel per plug

Individual Sensor- and Bridge supply		
Parameter	**Value**	**Remarks**
Output-Voltage	channel-wise individually configurable 15 V, 12 V, 10 V, 5 V, 2,5 V	5 possible settings standard version
	5 settings configurable out of: 24 V, 15 V, 12 V, 10 V, 5 V, 2.5 V, 1 V, 0.5 V, 0.25 V	special version, special order
Short circuit protection	unlimited duration	
Output power	0.5 W / channel 0.2 W / channel	≥5 V ≤2.5 V
Accuracy	±0.2%	At the amplifier terminals, no load. Does not affect the accuracy in bridge mode (live software compensation of actual value and of additional cable loss via SENSE)

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Bandwidth	0 Hz to 48 kHz 0 Hz to 46 kHz	-3 dB 0.2 dB
Filter cut-off frequency characteristic order	10 Hz to 20 kHz	Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$
Resolution	16 Bit	internal processing 24 Bit
Resolution CRC, CRSL CRFX	16 Bit 16 Bit 24 Bit	internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported DS2431 (typ. IEPE/ICP sensor) see notes in chap. TEDS 104: only CRFX & CRXT support: DS2431
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed overview of supported device family 319

General - the following statements only apply for CRC, CRSL		
Parameter	**Value**	**Remarks**
Isolation of voltage channels	channel-wise galvanically-isolated	voltage channels isolated against each other and against system ground (housing, CHASSIS), Isolation with IEPE/ICP plug: depending on connector type
Bridge excitation voltage isolation	not isolated	Isolated against additional electronics (all sensor power supplies, bridge and input wiring, TEDS, etc.) with common reference ground "-VB". galvanically connected with system ground (housing, CHASSIS)
Max common mode voltage isolated mode tested:	±60 V 300 V (10 s)	against system ground (housing, CHASSIS)
Max common mode voltage non-isolated mode	±10 V	against system ground (housing, CHASSIS)

General only with CRFX		
Parameter	**Value**	**Remarks**
Isolation of voltage channels	channel-wise galvanically-isolated	voltage channels isolated against each other and against system ground (housing, CHASSIS), as well as against common reference and all bridge excitation voltages "-VB" Isolation with IEPE/ICP plug: depends on plug type
Bridge excitation voltage isolation	not channel-wise isolated	isolated against additional electronics (all sensor power supplies, bridge and input wiring, TEDS, etc.) with common reference ground "-VB" Block-isolated against system ground (housing, CHASSIS)
Max common mode voltage isolated mode tested:	±60 V 300 V (10 s)	against internal reference ground "-VB", against system ground (housing, CHASSIS)
Max common mode voltage non-isolated mode	±10 V	against internal reference ground "-VB" Also for "non-isolated" mode, there is an additional global block-isolation of the entire internal measurement electronics from the housing (CHASSIS)

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Overvoltage protection (inputs +IN, -IN)	±100 V ESD 2 kV transient protection: automotive load dump ISO 7636		differential input voltage (continuous) human body model R_i=30 Ω, t_d=300 µs, t_r<60 µs
Input coupling	DC		
Input impedance	10 MΩ 1 MΩ		voltage mode (range ≤±2 V), temperature mode voltage mode (range ≥±5 V)
Input current operating conditions on overvoltage condition	 1 mA	 2.4 nA	 $\|V_{in}\|$ >5 V on ranges <±2 V
Input noise	 2.2 $µV_{rms}$ / 15 $µV_{pkpk}$ 0.3 $µV_{rms}$ / 2.1 $µV_{pkpk}$ 0.1 $µV_{pkpk}$ 10 nV / √Hz		range ≤±25 mV bandwidth 0.1 to 48 kHz bandwidth 0.1 to 1 kHz bandwidth 0.1 to 10 Hz spectral noise density (at 1 kHz)
CMRR (common mode rejection ratio) / IMR	>145 dB (50 Hz) >80 dB (50 Hz)		range ≤±2 V range ≥±5 V R_{source} = 0 Ω
Spurious free dynamic range (SFDR)	>80 dB (10 kHz) >95 dB (1 kHz) >84 dB (10 kHz) >100 dB (1 kHz)		range ≤±2 V range ≥±5 V
Auxiliary supply voltage available current internal resistance	 +5 V 0.26 A 1.0 Ω	 ±5% 0.2 A <1.2 Ω	for IEPE/ICP-extension plug independent of integrated sensor supply, short-circuit protected power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Voltage input range	±60 V, ±50 V, ±25 V, ±10 V, ±5 V, ±2 V, ±1 V, ±500 mV, ±250 mV, ±100 mV, ±50 mV, ±25 mV, ±10 mV, ±5 mV, ±2.5 mV		with single-end mode: max. ±10 V
Input configuration	differential / single-end		
Gain error	<0.02%	<0.05%	of the measured value, at 25°C
Gain drift		20 ppm/K·ΔT_a 60 ppm/K·ΔT_a	range ≤±2 V range ≥±5 V ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Offset error		 0.01% 10 µV	of the range range ≥±50 mV range ≤±25 mV
Offset drift	0.7 µV/K·ΔT_a		range ≤±25 mV ΔT_a= |T_a-25°C|; with T_a = ambient temperature

Current measurement with Shunt-Plug			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Current input range	±40 mA, ±20 mA, ±10 mA		
Shunt-Resistor	50 Ω		external plug ACC/DSUBM-I2
Input configuration	differential		isolated
Gain error	<0.02%	<0.05% <0.1%	of the measured value, at 25°C additional error of 50 Ω in plug
Gain drift	10 ppm/K·ΔT_a	30 ppm/K·ΔT_a	ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Offset error		<0.01%	of the range, at 25°C

Current measurement with internal shunt			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Current input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		
Shunt-Resistor	120 Ω		internal
Input configuration	single-end		not isolated
Gain error	<0.02%	<0.05%	of the measured value, at 25°C
Gain drift	10 ppm/K·ΔT_a	30 ppm/K·ΔT_a	ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Offset error		<0.01%	of the range, at 25°C

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	DC		
Measurement modes	full, half, quarter bridge		
Measurement range			
bridge supply: 10 V	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V, ±50 mV/V, ±25 mV/V, ... ±0.5 mV/V, ±0.25 mV/V		
bridge supply: 5 V	±1000 mV/V, ±400 mV/V, ±200 mV/V, ±100 mV/V, ±50 mV/V ... ±1 mV/V, ±0.5 mV/V		
bridge supply: 2.5 V	±800 mV/V, ±400 mV/V, ±200 mV/V, ±100 mV/V, ... ±2 mV/V, ±1 mV/V		
(bridge supply: 1 V)	±1000 mV/V, ... , ±2.5 mV/V		special order
(bridge supply: 0.5 V)	±1000 mV/V, ... , ±5 mV/V		special order
(bridge supply: 0.25 V)	±800 mV/V, ... , ±10 mV/V		special order
Bridge supply	0.25 V to 10 V		selectable for each channel possible options: see above
Minimum bridge impedance	200 Ω 50 Ω 32 Ω		bridge supply = 10 V bridge supply = 5 V bridge supply = 2.5 V
Cable-Compensation			
full bridge / half bridge	4-wire-technique 3-wire-technique with shunt-calibration		any cable for symmetric (similar) cables one-time non-adaptive compensation
quarter bridge	full compensation in 3-wire-technique		including Gain-Correction!
Quarter bridge completion	120 Ω, 350 Ω, 1 kΩ		switched per software / bridge supply ≤5 V
Automatic shunt-calibration (calibration step)	0.5 mV/V		with 120 Ω and 350 Ω
Input impedance	6.7 MΩ	±1%	differential, full bridge
Gain error	<0.02%	<0.05%	of the reading, at 25°C
Gain drift		20 ppm/K·ΔT_a	ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Offset error	within residual noise band		
Offset drift		0.14 µV/V /K·ΔT_a	ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Drift half bridge	0.5 µV/V / °C	1 µV/V / °C	additional drift of internal half bridge completion
Bridge offset balancing range	≥100% of measurement range ≥±4 mV / V		 valid for the entire meas. range
Cable resistance max cable length (simple)	<60 Ω <460 m		120 Ω bridge 0.14 mm^2, 130 mΩ / m

Temperature measurement			
Thermocouple	**Value typ.**	**min. / max.**	**Remarks**
Measurement mode	J, T, K, E, N, S, R, B L C		 available with CRC and CRFX variant only with CRFX variant available
Measurement range	-270°C to 1370°C -270°C to 1100°C -270°C to 500°C		type K
Resolution	0.063 K (1/16 K) 32 bit float (24 Bit mantissa)		With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)
Measurement error (gain + offset)		 <±0.6 K <±1.0 K	with type K range -150°C to 1100°C else
Drift (gain + offset)		±0.02 K/K·ΔT_a ±0.05 K/K·ΔT_a	type K, range -270°C to 1100°C type K, range -270°C to 1370°C $\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature
Error of cold junction compensation		<±0.15 K	with ACC/DSUBM-UNI2
Cold junction drift	±0.001 K/K·ΔT_a		$\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature

Temperature measurement			
PT100 / PT1000	**Value typ.**	**min. / max.**	**Remarks**
Measurement range	-200°C to 850°C -200°C to 250°C		
Resolution	0.063 K (1/16 K) 32 bit float (24 Bit mantissa)		With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)
Measurement error		<±0.05%	of the measured value
Offset error		<±0.1 K	4-wire connection
Offset drift		+0.01 K/K·ΔT_a	$\Delta T_a = \|T_a - 25°C\|$; with T_a = ambient temperature
Sensor feed	250 µA		

The following technical statements only apply for this CRONOS*flex* module!

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE) Exception: additional individual isolated voltage channels
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	-VB, GND, TEDS_GND	all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Power supply of this CRONOS*flex* module		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Power consumption	10 W	10 V to 50 V DC
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module		
Parameter	**Value**	**Remarks**
EtherCAT connection Input supply plug (female) Module connector	2x RJ45 LEMO.EGE.1B.302 2x 20 pin	system bus for distributed imc CRONOS*flex* components multicoded 2 notches for optional individually power supply direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current, corresponding to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	43.3 x 118 x 186 mm	W x H x D
Weight	850 g	

Find here the description of the UNI-4 240.

9.8.2 UNI2-8: Voltage, Current (20 mA), Temperature, Bridge, IEPE/ICP

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	8	
Measurement modes DSUB-15	voltage measurement current measurement bridge sensor strain gauge thermocouple measurement PT100 (3- and 4-wire configuration) current-fed sensors (IEPE/ICP)	ACC/DSUBM-UNI2 Single-ended (internal shunt) or shunt plug ACC/DSUBM-I2 full, half, quarter bridge with DSUB-15 expansion plug: (ACC/DSUB-ICP2, not isolated ACC/DSUBM-ICP2I-BNC-S/-F, isolated)
Measurement modes LEMO	voltage measurement current measurement thermocouple measurement bridge sensor strain gauge PT100 (3- and 4-wire configuration)	 LEMO plug with built-in cold-junction compensation (CJC) ACC/TH-LEM-150 full, half, quarter bridge
Terminal connection DSUB-15 LEMO	 4x DSUB-15 8x LEMO.1B.307	 2 channels per plug 1 channel per plug

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels
Bandwidth	0 Hz to 48 kHz 0 Hz to 30 kHz 0 Hz to 10 Hz	-3 dB -0.1 dB -3 dB for temperature measurement
Filter (digital) cut-off frequency characteristic type and order	 10 Hz to 20 kHz	 Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8th order with $f_{cutoff} = 0.4\ f_s$
Resolution CRC, CRSL CRFX	 16 Bit 16 Bit 24 Bit	 internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
TEDS Transducer Electronic Data Sheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor) see notes in chap. TEDS 104: only CRFX & CRXT support: DS2431
Characteristic curve linearization	user defined (max. 1023 supporting points) (CRFX) 318	see detailed overview of supported device family 319

General			
Parameter	**Value typ.**	**min. / max**	**Remarks**
Overvoltage protection		 ±80 V ±50 V	permanent, differential input range >±10 V or device off input range ≤±10 V
Input coupling	DC		
Input configuration	differential		
Input impedance	1 MΩ 20 MΩ		range >±10 V range ≤±10 V
Auxiliary supply voltage available current internal resistance	 +5 V 0.26 A 1.0 Ω	 ±5 % 0.2 A <1.2 Ω	for IEPE/ICP-expansion plug independent of integrated sensor supply, short-circuit protected power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V to ±5 mV		
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS; input range ≤±10 V
Gain error	0.02 %	0.05 %	of the measured value, at 25 °C
Gain drift	10 ppm/K·ΔT_a	30 ppm/K·ΔT_a	ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Offset error	 0.02 %	 ≤0.05 % ≤0.06 % ≤0.15 %	of the range, at 25 °C range >±50 mV range ≤±50 mV range ≤±10 mV
Offset drift	±40 µV/K·ΔT_a ±0.7 µV/K·ΔT_a ±0.1 µV/K·ΔT_a	±200 µV/K·ΔT_a ±6 µV/K·ΔT_a ±1.1 µV/K·ΔT_a	range >±10 V range ±10 V to ±0.25 V range ≤±0.1 V ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Non-linearity	30 ppm	90 ppm	
CMRR (common mode rejection ratio)	 80 dB 110 dB 138 dB	 >70 dB >90 dB >132 dB	DC and f≤60 Hz range ±50 V to ±25 V range ±10 V to ±50 mV range ±25 mV to ±5 mV
Noise	3.6 µV_{rms} 0.6 µV_{rms} 0.14 µV_{rms}	5.5 µV_{rms} 1.0 µV_{rms} 0.26 µV_{rms}	range 0.1 Hz to 50 kHz range 0.1 Hz to 1 kHz range 0.1 Hz to 10 Hz

Current measurement with shunt plug			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		
Shunt impedance	50 Ω		external plug ACC/DSUBM-I2
Over load protection		±60 mA	permanent
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS
Input configuration	differential		
Gain error	0.02 %	0.06 % 0.1 %	of the reading, at 25 °C additional error of 50 Ω in plug
Gain drift	15 ppm/K·ΔT_a	55 ppm/K·ΔT_a	$\Delta T_a = \lvert T_a - 25°C \rvert$; with T_a = ambient temperature
Offset error	0.02 %	0.05 %	of the range, at 25 °C
Noise	 40 nA_{rms} 0.7 nA_{rms} 0.17 nA_{rms}	 70 nA_{rms} 12 nA_{rms} 0.3 nA_{rms}	Bandwidth: 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Current measurement with internal shunt			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		
Shunt impedance	120 Ω		internal
Over load protection		±60 mA	permanent
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS
Input configuration	Single-ended		internal current sink to -VB
Gain error	0.02 %	0.06 %	of the reading, at 25 °C
Gain drift	15 ppm/K·ΔT_a	55 ppm/K·ΔT_a	$\Delta T_a = \lvert T_a - 25°C \rvert$; with T_a = ambient temperature
Offset error	0.02 %	0.05 %	of the range, at 25 °C
Noise	 40 nA_{rms} 0.7 nA_{rms} 0.17 nA_{rms}	 70 nA_{rms} 12 nA_{rms} 0.3 nA_{rms}	Bandwidth: 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	DC		
Measurement modes	full, half, quarter bridge		bridge supply ≤5 V with quarter bridge
Input range	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ...		
with bridge supply: 10 V	... ±0,5 mV/V		
with bridge supply: 5 V	... ±1 mV/V		
with bridge supply: 2.5 V	... ±2 mV/V		(as an option)
with bridge supply: 1 V	... ±5 mV/V		(as an option)
Bridge supply	10 V 5 V	±0.5 % ±0.5 %	The actual value will be dynamically captured and compensated for in bridge mode.
(as an option)	2.5 V and 1 V		
Minimum bridge impedance	120 Ω full bridge 60 Ω half bridge		
Maximum bridge impedance	5 kΩ		
Quarter bridge completion	120 Ω, 350 Ω		internal, switchable per software
Input impedance	20 MΩ	±1 %	differential, full bridge
Gain error	0.02 %	0.05 %	of the reading, at 25 °C
Gain drift	20 ppm/K·ΔT_a	50 ppm/K·ΔT_a	ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Offset error	0.01 %	0.02 %	of input range, at 25°C, after automatic bridge balancing
Automatic shunt-calibration (calibration jump)	0.5 mV/V	±0.2 %	for 120 Ω and 350 Ω

Temperature measurement - Thermocouples			
Parameter	**Value typ.**	**min./ max.**	**Remarks**
Measurement mode	J, T, K, E, N, S, R, B		
Measurement range	-270 °C to 1370 °C -270 °C to 1100 °C -270 °C to 500 °C		type K
Resolution	0.063 K (1/16 K)		16-Bit integer
Measurement error		 0.06 % 0.05 %	type K of measurement range, at 25 °C of reading (total uncertainty min. 0.85 K)
Drift	0.02 K/K·ΔT_a	0.05 K/K·ΔT_a	ΔT_a= |T_a-25°C|; with T_a = ambient temperature
Error of cold junction compensation		±0.15 K	with ACC/DSUBM-UNI2, at 25 °C
Cold junction drift	±0.001 K/K·ΔT_a		ΔT_a= |T_a-25°C|; with T_a = ambient temperature

RTD (PT100)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	-200 °C to 850 °C -200 °C to 250 °C		
Resolution	0.063 K		
Measurement error			
4-wire measurement		0.25 K +0.02 %	-200 °C to 850 °C of measured value of resistance
		0.1 K +0.02 %	-200 °C to 250 °C of measured value of resistance
3-wire measurement		0.42 K +0.03 %	-200 °C to 850 °C of measured value of resistance
		0.38 K +0.02%	-200 °C to 250 °C of measured value of resistance
			Precision for 3-wire mode: with individual adjustment, only (special version upon request)
Drift		0.01 K/K·ΔT_a	ΔT_a= $\lvert T_a$-25°C$\rvert$; with T_a = ambient temperature
Sensor feed (PT100)	1.25 mA		

Sensor supply					
Parameter	**Value typ.**		**max.**	**Remarks**	
Configuration options	5 selectable settings			always 5 selectable voltage settings default selection: +5 V to +24 V	
Output voltage	Voltage (+1 V) (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	Current 580 mA 580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	Power 0.6 W 1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	set jointly for all eight channels upon request, also 2.5 V and 1 V settings are available, for example by replacing the +12 V or +15 V setting. An arbitrary set of 5 setting can be chosen preferred selections: +24 V, +12 V, +10 V, +5.0 V, +2.5 V +15 V, +10 V, +5.0 V, +2.5 V, +1 V upon request, special order: +15 V can be replaced by ±15 V. This eliminates the internal current- and quarter bridge measurement.	
Isolation - applies for imc CRONOS*compact*, imc CRONOS-SL and PL systems					
Isolation	non isolated			output to case (CHASSIS)	
Block isolation only applies for imc CRONOS*flex*					
Block isolation	60 V			Isolation of the entire global sensor supply (for all 8 channels, reference ground: "-VB") as well as the internal electronics from housing (CHASSIS, PE)	
Short-circuit protection	unlimited duration			to output voltage reference ground: "-VB"	
Compensation of cable resistances	3-line control: SENSE line as refeed (-VB: supply ground)			calculated compensation with bridges	
Accuracy of output voltage	 <0.25 %		 0.5 % 0.9 % 1.5 %	at terminals, no load at 25°C over entire temperature range plus with optional bipolar output voltage	
Max. capacitive load			>4000 µF >1000 µF >300 µF	2.5 V to 10 V 12 V, 15 V 24 V	

The following technical statements only apply for this CRONOS*flex* module!

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	-VB, GND, TEDS_GND	all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of this CRONOS*flex* module		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Power consumption	10.1 W	10 to 50 V DC incl. 120 Ω 5 V load to all channels
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded, 2-notch connector for optional individual power supply
Module connector	2x 20 pin	Click-mechanism provides direct connection of modules (supply and system bus) without additional cabling

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current according to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	62 x 118 x 186 mm	W x H x D
Weight	approx. 878 g	

Find here the description of the UNI2-8. 218

9.9 DI, DO, Pulse Counter, SYNTH and DAC modules

9.9.1 DAC-8

Parameter	Value typ.	min. / max.	Remarks
Outputs	8		
Output level	±10 V		
Load current		max. ±10 mA	short circuit protection
Resolution	16 bit		
Linearity		max. 4 LSB	14-bit no missing codes
Max. output rate	50 kHz 5 kHz		with CRC, CRSL CRFX
Analog bandwidth	50 kHz		-3 dB, low pass 2nd order
Additional system delay	typ. 400 µs ±100 µs (CRFX)		delay from setting value (imc Online FAMOS) to analog output
Accuracy	±4 LSB (16 bit)		25°C
Offset error	<10 mV	<17 mV	25°C
Offset drift	0.06 mV / K		
Total offset error		<20 mV	over entire temperature range
Gain error	<0.29 %		25°C
Gain drift	25 ppm / K		
Total gain error		<0.8 %	over entire temperature range
Block isolation only applies for imc CRONOS*flex* systems			
Block isolation	60 V		DAC outputs and the driver units isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF		
Internal reference ground	AGND		all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing		DAC outputs as one unit (8 channels), galvanically isolated from housing
Terminal connection	DSUB-15 BNC		standard CRFX/DAC-8-BNC, CRSL/DAC-8-BNC

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Find here the description of the DAC-8 300.

General only concerning the imc CRONOS*flex* module (CRFX/DAC-8)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input supply voltage	10 V to 50 V DC		
Power consumption	6.5 W	9 W	10 V to 50 V DC
Isolation	60 V		nominal isolation specification of the supply input
Power-over EtherCAT (PoE)	minimal 42 V DC necessary		supply via EtherCAT network cable

9.9.2 DI2-16: Digital Inputs

Parameter	Value typ.	min. / max.	Remarks
Channels	16 (with CRFX also 32 available)		groups of 4 Bit with common ground reference, galvanic isolation between groups
Input voltage level	 TTL 24 V		configurable globally for 8 Bit at DSUB using the "LEVEL" pin: "LEVEL": Jumper to "LCOM" "LEVEL": unconnected
Max input voltage	5.5 V 30 V		TTL mode 24 V mode
Input configuration	differential		groups of 4 Bit galvanic isolation between groups of 4 Bit
Isolation strength	±150 V		to system ground (housing, CHASSIS, PE) and between groups of 4 Bit (tested ±200 V)
Switching time HIGH-LOW LOW-HIGH	 34 µs 3 µs	 130 µs 30 µs	edge detection; over entire temperature range
Additional system delay	typ. 400 µs ±100 µs (CRFX)		delay from input transition to changing state available in imc Online FAMOS
Input current		max. 500 µA	
Switching threshold TTL (5 V) 24 V	 V_{Lmax} = 0.8 V V_{Lmax} = 5.0 V	 V_{Hmin} = 2.0 V V_{Hmin} = 8.0 V	
Internal supply voltage, available at user pin "HCOM"	5 V max. 100 mA		isolated reference ground of both "HCOM" and "LEVEL" is "LCOM"
Terminal connection	DSUB-15 / 8 Bit		ACC/DSUBM-DI4-8

Find here the description of the digital inputs 279.

9.9.3 DI16-DO8-ENC4: Digital Multiboard

The Multi-IO-Module: **DI16-DO8-ENC4** comes with 16 digital inputs, 8 digital outputs and 4 inputs for capture of incremental encoder signals, RPM measurements, angle, frequencies etc.

Description of DI16-DO8-ENC4 283

9.9.3.1 Digital Inputs

Parameter	Value	Remarks
Channels	16	common ground reference for each 4-channel group, isolated from the other input group
Configuration options	TTL or 24 V input voltage range	configurable at the DSUB globally for 8 Bits: • jumper from LCOM to LEVEL: activates TTL-mode • LEVEL unconnected: activates 24 V-mode
Sampling rate	≤10 kHz	
Isolation strength	±50 V	tested ±200 V isolated to system ground, supply and channel-to-channel
Input configuration	differential	
Input current	max. 500 µA	
Switching threshold	1.5 V (±200 mV) 8 V (±300 mV)	5 V level 24 V level
Switching time	<20 µs	
Supply HCOM	5 V max. 100 mA	electrically isolated from system (case), Configuration signal "LEVEL" is referenced to HCOM, LCOM
Terminal connection	DSUB-15	ACC/DSUBM-DI4-8

Find here the description of digital inputs 283.

9.9.3.2 Digital outputs

Parameter	Value		Remarks
Channels / bits	8 bit		Group of 8 bits, galvanically isolated; common reference potential ("LCOM") for each group
Isolation strength	±50 V		to system ground (case, CHASSIS)
Output configuration	totem pole (push-pull) or open-drain		configurable at the DSUB globally for 8 Bits: • jumper from OPDRN to LCOM: totem pole • OPDRN unconnected: open-drain
Output level	TTL or max. U_{ext}-0.8 V		internal, galvanically isolated supply voltage by connecting an external supply voltage U_{ext} with "HCOM", U_{ext} = 5 V to 30 V
State upon system power up	high impedance (High-Z)		Independent of output configuration (OPDRN-pin)!
Activation of the output stage following system start	upon first preparation of measurement		with initial states which can be selected in the experiment (High / Low) in the selected output configuration (OPDRN-pin)
Max. output current (typ.)	HIGH	LOW	
TTL 24 V-logic open-drain	15 mA 22 mA ---	0.7 A 0.7 A 0.7 A	 external clamp diode needed for inductive load
open-drain with intern. 5 V supply		160 mA	for all outputs
Output voltage	HIGH	LOW	for load current:
TTL	>3.5 V	≤0.4 V	I_{high} = 15 mA, I_{low} ≤0.7 A
24 V-logic (U_{ext} = 24 V)	>23 V	≤0.4 V	I_{high} = 22 mA, I_{low} ≤0.7 A
Internal supply voltage	5 V, 160 mA (isolated)		available at terminals
Switching time	<100 µs		
Terminal connection	DSUB-15		ACC/DSUBM-DO8

The description of the digital outputs 285.

9.9.3.3 ENC4: Pulse counter for incremental encoder

Parameter	Value		Remarks
Channels	4 + 1 (5 tracks)		four single-tracks or two two-track channels one index track
Measurement modes	Displacement (abs), Displacement (diff), Angle (abs), Angle (diff), Event, Frequency, Speed, Velocity, Time and Puls Time Measurement		only if the sampling rate is ≤ 1 ms
Sampling rate	≤50 kHz		per channel
Time resolution of measurement	31.25 ns		counter frequency: 32 MHz
Data resolution	16 bits		
Input configuration	differential		
Input impedance	100 kΩ		
Input voltage range	±10 V		differential
Common mode input range	min. -11 V	max. +25 V	
Switching threshold	-10 V to +10 V		detection level selectable per channel
Hysteresis	min. 100 mV		selectable per channel
Analog bandwidth	500 kHz		-3 dB (full power)
Analog filter	Bypass (no Filter), 20 kHz, 2 kHz, 200 Hz		selectable (per-channel) 2nd order Butterworth
Switching delay	500 ns		signal: 100 mV squarewave
CMRR	70 dB 60 dB	50 dB 50 dB	DC, 50 Hz 10 kHz
Gain error	<1 %		of input voltage range @ 25 °C
Offset error	<1 %		of input voltage range @ 25 °C
Overvoltage strength	±50 V		to system ground
Sensor supply	+5 V, 300 mA		not isolated (reference: GND, CHASSIS)
Terminal connection	DSUB-15		ACC/DSUBM-ENC4

The description of the incremental counter channels 288.

9.9.4 DI8-DO8-ENC4-DAC4

The Multi-IO-Module: **DI8-DO8-ENC4-DAC4** comes with **8 digital inputs** and **4 analog outputs**, 8 digital outputs and 4 inputs to capture incremental encoder signals.

The technical details of the DI16-DO8-ENC4 Multi-IO-Module apply, but with the additional 4 analog outputs and only 8 digital inputs instead of 16.

Description of DI8-DO8-ENC4-DAC4 292

9.9.4.1 Analog outputs

Parameter	Value typ.	min. / max.	Remarks
Channels	4		
Output level	±10 V		
Load current	max. ±10 mA / channel		
Resolution	16-bit		15-bit, no missing codes
Non-linearity	±2 LSB	±3 LSB	
Max. output frequency	50 kHz		
Analog bandwidth	50 kHz		-3 dB, low pass 2nd order
Gain error	<±5 mV	<±10 mV	-40 °C to 85 °C
Offset error	<±2 mV	<±4 mV	-40 °C to 85 °C
Terminal connection	DSUB-15		ACC/DSUBM-DAC4

The description of the analog outputs 292.

9.9.5 DIO-HV-4: Digital inputs

4 digital inputs			
Parameter	**typ.**	**min. / max.**	**remarks**
channels / bits	4		each isolated
terminal connections	screw terminal 14 to 24 AWG 0.2mm² to 2.5mm²		American Wire Gauge for rigid or flexible line
isolation test voltage	3.6 kV_{RMS}		50 Hz, 10 s between channels and chassis
electrical safety rating measurement category degree of pollution	250V / CAT III 2		in accordance with EN 61010-1 in accordance with IEC 60664
max. input level ue		≤600 V	peak-to-peak or DC voltage
nom. input level ue	230 V_{RMS} / 350 VDC		
switching level Us unipolar low unipolar high	 <16 V >16.8 V	 <14 V >18 V	Schmitt-Trigger-characteristics Hysteresis 0.04 V typ.
current input	280 µA	<500 µA	u_e = -600 V to +600 V
circuit time low → high high → low	 70 µs 23 µs	 <180 µs <40 µs	

Description: digital inputs 281.

9.9.6 DIO-HV-4: Digital outputs

4 digital outputs			
Parameter	**typ.**	**min. / max.**	**remarks**
channel / bits	4		mechanical closer
terminal connection	screw terminal 14 to 24 AWG 0.2 mm² to 2.5mm²		American Wire Gauge for rigid and flexible lines
isolation test voltage	3.6 kV_{RMS}		50 Hz Sinus; 10 s
electrical safety rating / measurement category degree of pollution	 250 V / CAT III 2		 according EN 61010-1 according IEC 60664
switching time	5 ms	<8 ms	
max. switching power		<1000 VA	
switching voltage	>1 VDC	<250 V_{RMS}	min. switching voltage at 1 mA
max. switching current		<1 A <4 A	250 V~ cosφ=1.0 ... 0.4 250 V~ cosφ=1.0
contact impedance		<50 mΩ	

Description: digital outputs 282

9.9.7 DO-16: Digital Outputs

Parameter	Value typ.	min. / max.	Remarks
Channels	16		two 8-bit groups, isolated, common reference potential ("LCOM") for a group
Terminal connection	DSUB-15		ACC/DSUB-DO8
Isolation strength	±50 V		to system ground (protection ground)
Output configuration	totem pole (push pull) *or* open-drain		configurable with wire jumper ("ODRN" - "LCOM") in the connector pod
State following system start	High resistance (high-Z)		Independent of output configuration (OPDRN-pin)!
Activation of the output stage following system start	upon first preparation of measurement		with initial states which can be adjusted in the experiment (High / Low) in the selected output configuration (OPDRN-pin)
Output level	TTL *or* max. U_{ext} -0.8 V		internal isolated supply voltage by means of connecting an external supply voltage U_{ext} with "HCOM", U_{ext} = 5 V to 30 V
Max. output current (typ.) TTL 24 V-logic open-drain open-drain with intern. 5 V supply	*HIGH* 15 mA 22 mA ---	*LOW* 0.7 A 0.7 A 0.7 A 20 mA	 external inverse diode needed with inductive load
Output voltage TTL 24 V-logic (U_{ext} = 24 V)	*HIGH* >3.5 V >23 V	*LOW* 0.5 Ω · I_{low} 0.5 Ω · I_{low}	with load current: I_{high} = 15 mA, I_{low} ≤0.7 A I_{high} = 22 mA, I_{low} ≤0.7 A
Internal supply voltage available at contacts	5 V, 160 mA isolated		per 8-bit group; VCC_int = 5 V
Switching time	<165 µs		

Find here the description of the digital outputs 293.

9.9.8 DO-16-HC

Parameter	Value		Remarks
Channels	16 (with CRFX also 32 available)		groups of 8 Bit, isolated, common reference potential ("LCOM") for each group
Isolation strength	±50 V		to system ground (housing, CHASSIS, PE) and between groups of 8 Bit
Output configuration	Totem Pole (push-pull) Open Drain (LowSide) Open Source (HighSide)		configurable at DSUB with "OPDRN" - pin: "OPDRN": wire jumper to "LCOM" "OPDRN": open "OPDRN": 10 kΩ-resistor to “LCOM”
Output level	max. U_{ext} = 8 V to 28 V *or* TTL / CMOS 5 V *or* Open-Drain (max. 28 V)		connection of an external supply voltage U_{ext} to "HCOM", (Totem Pole or Open-Source) by means of internal isolated supply voltage and external pull-up-resistors (with 5 V, only Open-Drain configuration supported, no Totem-Pole / push-pull) external supply not required for Open-Drain operation
Max. output current (typ.) Totem Pole (8 V to 28 V) Open Source (8 V to 28 V) Open Drain (max. 28 V) open-drain with internal 5 V supply	HIGH 0.7 A 0.7 A ---	LOW 0.7 A --- 0.7 A 20 mA	no external clamping diode required for inductive load switching
Output impedance	0.5 Ω		sink and source
Output voltage	HIGH U_{ext} -0.5 Ω · I_{high}	LOW 0.5 Ω · I_{low}	with load current: I_{high} and I_{low} ≤0.7 A
Internal supply voltage, available at user pin "HCOM"	5 V, 160 mA isolated		per 8-bit group; VCC_int = 5 V, decoupled from U_{ext} by diodes on HCOM
Protection mechanisms	short circuit thermal overload capacitive load (surge) inductive load (load dump)		quick response current limiting: 1.4 A (typ.), 2 A (max.) unlimited duration current limiting voltage limiting
State upon system power-up Activation of the output stage Connection of internal 5 V supply to contacts	high impedance (High-Z) upon preparation of measurement upon preparation of measurement		Independent of output configuration with selectable initial states (High / Low) in the selected output configuration VCC_int = 5 V via diodes at HCOM
Switching time	<300 µs		
Additional system delay	typ. 400 µs ±100 µs (CRFX)		Delay, until the value (imc Online FAMOS) is available for output
Terminal connection	DSUB-15		ACC/DSUBM-DO-HC-8 with high current capacity wiring recommended (HCOM / LCOM!)

Find here the description of the DO-16-HC 296.

9.9.9 ENC-4

Parameter	Value	Remarks
Inputs	4 + 1 (9 tracks)	4 channels with 2 tracks each (A, B) 1 index-channel, all fully conditioned
Measurement modes	Displacement (abs), Displacement (diff), Angle (abs), Angle (diff), Event, Frequency, Speed, Velocity, Time and Puls Time Measurement	only if the sampling rate is ≤ 1 ms
Terminal connection	2x DSUB-15 / 2 channels or 4x LEMO/ 1 channel	ACC/DSUBM-ENC-4(-IP65) ACC/DSUBM-ENC-4-IU for each group of 2 channels per plug INDEX only occupied on second socket
Sampling rate	≤50 kHz	
Time resolution of measurement	33 ns	counter frequency 32 MHz (primary sampling rate)
Resolution of data	16 bit	
Frequency stability	<100 ppm deterioration <± 5ppm / year	
Input configuration	differential	
Input impedance	100 kΩ	
Input voltage range (differential)	±10 V ±30 V	linear range maximum, outside of the linear range: max. non-linearity error: 300 ns
Common mode input voltage	max. ±30 V	
Switching threshold	-10 V to +10 V	globally selectable in 0.1 V steps
Hysteresis	0 % to 40 % of |threshold|, min. 100 mV	globally selectable in 0.1 V steps
Analog bandwidth	500 kHz	-3 dB (full power)
Analog filter	bypass (without filter), 20 kHz, 2 kHz, 200 Hz	selectable per channel Butterworth, 2nd order per channel
CMRR	70 dB (typ.), 50 dB (min.) 60 dB (typ.), 50 dB (min.)	DC, 50 Hz 10 kHz
Switching delay	500 ns	level: 100 mV square wave
Gain uncertainty	<1 %	of the measured value, at 25 °C
Offset	<1 %	of the range, at 25 °C
Safe voltage (max.)	±50 V	long-term
Sensor supply	+5 V, 100 mA 300 mA (optional)	reference: GND

Find here the description of the ENC-4 301.

9.9.10 FRQ2-4 Frequency modulated signals

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	4	for frequency modulated signals
Measurement mode	frequency measurement	
Terminal connections	2x DSUB-15	

General			
Parameter	**Value**		**Remarks**
Input range	measurement range ±	center frequency	The center frequency will be provided by imc software after selection of the measurement range.
	3 kHz, 5 kHz, 12 kHz, 30 kHz, 50 kHz, 120 kHz	6 kHz, 10 kHz, 24 kHz, 60 kHz, 100 kHz, 240 kHz	
Sampling rate	≤50 kHz		per channel
Filter (digital) Frequency	50 Hz to 20 kHz		filtering of output data stream (frequency values)
Time resolution of the frequency measurement	3.9 ns		primary oszillator for frequency measurement: 256 MHz
Frequency stability of the primary oszillator	<100 ppm aging <±5 ppm / year		
Resolution	16 Bit integer 32-Bit float (24 bit mantissa)		With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)

Differential-inputs		
Parameter	**Value**	**Remarks**
Input configuration	differential	
Input voltage range	TTL	treshold respectively hysteresis: 0.8 .. 1.4 V
Input impedance	50 kΩ	
Common mode input voltage	max. ±30 V	
CMRR	70 dB (typ.), 50 dB (min.) 60 dB (typ.), 50 dB (min.)	DC, 50 Hz 10 kHz
Overvoltage protection	±50 V	long-term

Parameter	Value	Remarks
Sensor supply	+5 V, 300 mA / module	block isolated from housing (CHASSIS, PE), reference: GND

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	GND	all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Power supply of the imc CRONOS*flex* module		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Power consumption	9 W	10 to 50 V DC
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connection of the module		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply
Module connector	2x 20-pin	direct connection of modules (click) supply and system bus

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current, corresponding to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	43.3 x 118 x 186 mm	W x H x D
Weight	740 g	

9.9.11 Technical Specs - HRENC-4

Inputs, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	4 + 1 (9 tracks)	4 channels with 2 tracks (X, Y) each 1 index-channel, all fully conditioned
Measurement modes	Displacement (abs), Displacement (diff), Angle (abs), Angle (diff), Event, Frequency, Speed, Velocity, Time and Puls Time Measurement	only if the sampling rate is ≤ 1 ms
Terminal connection	2x DSUB-15 or 4x LEMO 1B.307	2 channels per DSUB (ACC/DSUBM-ENC4) 1 channel per LEMO

General		
Parameter	**Value**	**Remarks**
Sampling rate	≤50 kHz	per channel
Measurement time resolution	3.9 ns	Counter frequency 256 MHz (primary sampling rate) as of imc DEVICES 2.6 R2 SP1
Data resolution	16 bit	
Sensor supply	+5 V, 300 mA / module	block isolated from housing (CHASSIS, PE), reference: GND Block isolation only with CRFX, else: not isolated (reference: GND, CHASSIS)

Differential-inputs		
Input configuration	differential	
Input voltage range (differential)	±10 V ±30 V	linear range maximum range
Input impedance	50 kΩ	
Common mode input voltage	max. ±30 V	
CMRR	70 dB (typ.), 50 dB (min.) 60 dB (typ.), 50 dB (min.)	DC, 50 Hz 10 kHz
Overvoltage protection	±50 V	long-term
Gain error	<1 %	25°C
Offset error	<1 %	25°C
Analog bandwidth	500 kHz	-3 dB (full power)
Analog filter	Bypass (without filter), 20 kHz, 2 kHz, 200 Hz	adjustable (per channel) Butterworth, 2nd order

Digital Analysis (comparator)		
Switching threshold	-10 V to +10 V	adjustable individual for each channels
Hysteresis	0 % to 40 % off |threshold|, min. 100 mV	adjustable individual for each channels
Switching delay	500 ns	modulation: 100 mV square wave

Analog analysis (ADC)		
SIN/COS encoder analysis	8x12 Bit A/D-converter	8 channels of simultaneous sampling
Input voltage range	±1.5 V, ±10 V	(differential)

Sensor supply (HRENC-4-SUPPLY)				
Parameter	**Value typ.**		**max.**	**Remarks**
Configuration options	one voltage setting			must be selected out of 7 possible settings at the time of ordering
Output voltage	Voltage	Current	Netpower	must be selected at the time of ordering
possible settings	+2.5 V +5.0 V +10 V +12 V +15 V +24 V ±15 V	580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	
Block isolation	60 V			Isolation of the entire global sensor supply (reference ground "-SUPPLY, GND") as well as the internal electronics from housing (CHASSIS, PE)
Short-circuit protection	unlimited duration			to output voltage reference ground
Accuracy of output voltage				at terminals, no load
	<0.25 %		0.5 %	at 25°C
			0.9 %	over entire temperature range
			1.5 %	plus with optional bipolar output voltage
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V to 10 V 12 V, 15 V 24 V

Block isolation		
Parameter	**Value**	**Remarks**
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ || 1 nF	
Internal reference ground	GND	all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing

Note

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

The following technical statements only apply for the CRONOS*flex* module!

Terminal connection of the imc CRONOS*flex* module (CRFX)		
Parameter	**Value**	**Remarks**
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS*flex* components
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply
Module connector	2x 20-pin	direct connection of modules (click) supply and system bus

Power supply		
Parameter	**Value**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Power consumption	 7.4 W 13 W	10 to 50 V DC CRFX/HRENC-4 CRFX/HRENC-4-SUPPLY
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC) for remote imc CRONOS*flex* Modules	350 mA (maximum current, corresponding to IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	43.3 x 118 x 186 mm	W x H x D
Weight	approx. 730 g	

Reference

Find here the description of the HRENC-4 308.

9.9.12 DI-16-HV

Parameter	Value typ.	min. / max.	Remarks
Channels	16		groups of 4 Bit with common ground reference; galvanic isolation between groups
Configuration option	24 V or 110 V input voltage range		Selectable via switch at the front (separately for every input group 1..8 and 9..16)
Input configuration	differential		isolated from supply, groups of 4 Bit isolated from each other
Isolation strength	±150 V		to system ground (housing, CHASSIS) and between groups of 4 Bit (tested ±200 V)
Switching time HIGH-LOW LOW-HIGH	 50 µs 250 µs	 max. 150 µs max. 350 µs	edge detection; over entire temperature range
Additional system delay	typ. 400 µs ±100 µs		delay from input transition to changing state available in imc Online FAMOS
Input current		max. 500 µA	110 V-logic level
Switching treshold	12.6 V (±2.5 V)		24 V-logic level
	52.3 V (±4 V)		110 V-logic level
Terminal connection	4x plugable terminal block		FMC 1,5/ 6-ST-3,5-RF (Phoenix Contact)

Reference

Find here the description: CRFX/DI-16-HV 277

9.9.13 SYNTH-8 Signal generator, synthesizer, realtime PID controller

Outputs, measurement mode, Terminal connection		
Parameter	**Value**	**Remarks**
Outputs	8	
Measurement mode	analog signal output (Synthesizer), real time-controller (PID)	
Terminal connection	2x DSUB-15	4 channels per plug ACC/DSUB(M)-SYNTH-4

Output rate, bandwidth, resolution		
Parameter	**Value**	**Remarks**
Max. output rate (synthesizer mode)	80 kHz	aggregate output rate of all activated channels
Max. output rate with linear interpolation	200 kHz	aggregate output rate
Max. output rate with extended interpolation: Double / triple integral	10 kHz	per channel
Max. output rate (controller mode)	10 kHz	per channel
Analog bandwidth	50 kHz	-3 dB, 3rd order low pass bandwidth of analog driver stage
Resolution	16 Bit	
Total size of memory for all segments	1.000.000 time-stamped samples 4.000.000 equidistant samples	imc format (*.DAT or *.RAW)

Analog output			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Output voltage range	±10 V		
Isolation	no galvanic isolation		signal reference: AGND (system ground)
Load current / channel		±10 mA	25°C
Load current / plug		±30 mA	current for all four channels of a plug at 25°C
Gain uncertainty		<0.05%	25°C
Gain drift		5 ppm /K	over entire temperature range
Offset	<2 mV	<5 mV	25°C
Offset drift		0.05 mV /K	over entire temperature range
Sensor supply	+5 V (max. 200 mA / plug)		reference "LCOM"
Linearity		2 LSB	

Digital inputs		
Parameter	**Value**	**Remarks**
Channels	2	isolated, common reference potential (“LCOM“)
Input configuration	single-end	common reference: “LCOM“
Input level	TTL / CMOS or 24 V logic	configurable with wire jumper ("LEVEL" - "LCOM") in the connector

Controller functions		
Parameter	**Value / Function**	**Remarks**
Maximum number of controllers	16	independent and parallel
Set point variable	2 set point channels per controller	selection via control signal; dynamic switching, cross-fade with time constant
Measured process variable (actual value)	2 actual value channels per controller	selection via control signal; dynamic switching, cross-fade with time constant
Cascade control	any number of controllers arbitrarily cascadable: 2 to max. 16 cascade levels	dynamic set point channel switching: from channel to cascaded controller output
Assignment of controllers to analog outputs	2 controllers per analog output (DAC)	selection via control signal dynamic controller output switching, cross-fade with time constant
PID-controller parameter	dynamically alterable during continuous operation	changing PID variables individually or jointly (synchronously) as consistent parameter set
PID parameter sets	2 complete dynamic sets per controller	selection via control signal; dynamic switching, e.g. reference- and working parameter sets
Linearization of controller output variable	configurable characteristic curve	correction of actuator output non-linear characteristics by means of arbitrary loadable data set
Controller output correction	max. 8 per controller	by means of weighted state variables (e.g. measurement channels) or interactive editing
Response to limiting and saturation of controller output	limiting of the integral component	three optional strategies: 1. limit to current I-term 2. reduce by control value 3. limit, if output and I-term have same sign
Controller inhibit	individual controller activation (enable)	via control signal; fade in and out with time constant
Test points (probes)	assignment of internal controller variables to channels	for display and monitoring

Controller parameters	Functions	Remarks
Proportional (P-) component	proportional of current control error	weighting factor proportional gain K_p
Integral (I-) component	integral of control error	integral gain K_i resettable to zero by control signal, reset with time constant, can be limited in response to saturation of control value
Derivative (D-) component	derivative of current error	derivative gain K_d slope of the D-component can be limited by time constant (decay)
Feed forward control	weighted adding of the set point value to the control value	

Time constants		
Parameter	**Functions**	**Remarks**
Time constant for D-component	low pass filter for the derivative component	decay time
Time constant for resetting the I-component	linear decay of the integral component to zero	after activation of reset control signal
Time constant for activation of closed-loop controller	fade in and out of the resulting control value	after state change of the enable-control signal
Time constant for set point channel switching	smooth transition between alternative set point-channel	after switching of control signal
Time constant for actual value channel switching	smooth transition between alternative channels for measured process variable	after switching of control signal
Time constant for switching of the controller at the DAC	smooth transition between alternative changing controllers assigned to a DAC output	after switching of control signal
Value limits		
Limiting of the control output value	maximum control value minimum control value (independent, asymmetrical)	applies after calculation of all components and of the characteristic curve linearization
Slope limiting	maximum slope of control value	applies after calculation of all components and of the characteristic curve correction linearization
Limiting of the I-component	symmetric (max. / min.)	
Limiting of the D-component	symmetric (max. / min.)	

Find here the description of the SYNTH-8 317.

9.10 Fieldbus: Technical Details

9.10.1 CAN-Bus Interface

Parameter	Value	Remarks
Number of CAN-nodes	2	one galvanically isolated node per connector (each with CAN IN and CAN OUT)
Terminal connection	2x DSUB-9	
Topology	bus	
Transfer protocol	configurable per software: CAN High Speed (max. 1 MBaud) CAN Low Speed (max. 125 KBaud)	individually for each node according to ISO 11898 according to ISO 11519
Operating mode	Multi Master principle	
Direction of data flow	sending and receiving	
Baud rate	5 kbit/s to 1 Mbit/s	configurable via software; maximum is depending on selected protocol (High/Low Speed)
Max. cable length at data transfer rate	25 m at 1000 kBit/s 90 m at 500 kBit/s	CAN High Speed cable delay 5.7 ns/m
Termination	120 Ω	switchable by software for each node
Isolation strength	60 V	to system ground (case, CHASSIS)
Direct access for configuration of imc CANSAS modules	yes	via the CAN node of the device, with imc STUDIO

To the pin configuration 508 and the cabling 121 of the CAN-Bus interface.

Note Remote Frame

imc devices actually does not support Remote Frames (RTR) according to CAN specification.

9.10.2 CAN FD Bus Interface

Parameter	Value	Remarks
Number of CAN-nodes	2	one galvanically isolated node per connector
Terminal connection	2x DSUB-9	
Topology	bus	
Transfer protocol	configurable per software: CAN FD (ISO Standard) (max. 8 MBaud) non-ISO CAN FD (Draft) (max. 8 MBaud) CAN High Speed (max. 1 MBaud) CAN Low Speed (max. 125 KBaud)	individually for each node current standard according ISO 11898-1:2015 former draft (Bosch) according ISO 11898 according ISO 11519
Operating principle	Multi Master principle	
Direction of data flow	sending and receiving	
Baud rate	5 kbit/s to 8 Mbit/s	configurable via software; maximum is depending on selected protocol (FD/High/Low Speed)
Termination	120 Ω	switchable by software for each node
Isolation strength	±60 V	to system ground and case
Direct access for configuration of imc CANSAS modules	yes	via the CAN node of the device with imc STUDIO (CAN High Speed Mode only)

Note Remote Frame

imc devices actually does not support Remote Frames (RTR) according to CAN specification.

9.10.3 LIN-Bus Interface

Parameter	Value	Remarks
Nodes	2	for each node LIN_IN / LIN_OUT
Terminal connection	2x DSUB-9	one DSUB for each node
Topology	Bus	
Transfer protocol	LIN 2.1, LIN 2.0, LIN 1.3	LIN 1.3 and LIN 2.x specifications can run on a bus simultaneously
Operating mode	Master and/or Slave	Master: with fixed schedule table in the LDF file
Direction of data flow sending receiving	 Display variables, virtual bits LIN data in measurement channels	
Baud rate	1 to 20 kbit	
Data rate	30 kS/s	
Termination	Pull up resistor	selectable via software Master/Slave
Isolation strength	60 V	to system ground (case, CHASSIS)

To the pin configuration 508 and the cabling 122 of the LIN interface.

9.10.4 EtherCAT Slave Interface

Parameter	Value	Remarks
Nodes	1	
Terminal connection with CRXT all others	 2x M8 2x RJ45	 EtherCAT in / out
Transfer protocol	EtherCAT Specification – Part 4 Data Link Layer protocols specification EtherCAT Specification – Part 6 Application Layer protocol specification	Along with cyclical data transfer on the basis of EtherCAT, the interface is parameterized using CANopen® over EtherCAT (CoE)
Operating mode	slave	
Direction of data flow sending receiving	 process vector process vector	
Max. cable length	100 m	EtherCAT 100 Mbit/s
Max. bus transfer cycle	200 µs (5 kHz)	
Max. channel count for cyclic transfer	bus cycle / 4.5 µs - 10	max. 34 channels at 200 µs bus rate
Isolation strength	standard EtherCAT specification	

To the pin configuration 510 and the cabling 126 of the EtherCAT interface.

9.10.5 FlexRay Interface

Parameter	Value	Remarks
Number of FlexRay nodes	1 additional 1 cold start node	1x channel A+B for modules type FlexRay2
Terminal connection Standard	 1x DSUB-9 per module	 optionally 2x DSUB-9 (channel A+B separately)
Topology	Bus	
Transfer protocol	FlexRay protocol specification v3.0	
	XCP- specification Universal Measurement and Calibration Version 1.2.0; Date: 2013-06-20"	• ASAM_AE_MCD-1_XCP_BS_Protocol-Layer_V1-2-0.pdf "ASAM MCD-1 (XCP); Protocol; Protocol Layer Specification; • ASAM_AE_MCD-1_XCP_AS_Flexray-Transport-Layer_V1-2-0.pdf "ASAM MCD-1 (XCP on FlexRay); Protocol; FlexRay Transport Layer;
Operating mode	Sync nodes, cold start nodes or normal nodes	
Direction of data flow sending	 Display variables, Virtual bits, Process vector variables and Ethernet bits	 Cyclic and Single Shot Frames with imc Online FAMOS
Baud rate	2.5 / 5.0 or 10.0 Mbit/s	
Max. cable length at data transfer rate	see FlexRay protocol	
Data rate	 max 30 kSample/s max 60 kSample/s	per module current modules type FlexRay2
Isolation strength	60 V	to system ground (case, CHASSIS)

To the pin configuration 509 and the cabling 122 of the FlexRay interface.

9.10.6 PROFIBUS Interface

Parameter	Value	Remarks
Nodes	1	
Terminal connection	1x DSUB-9 per module	RS 485
Transfer protocol	DPV0, DPV1	
Operating mode	Sniffer (logging of existing bus communication)	no master, no slave
Baud rate	max. 12 Mbit/s	
Max. cable length at data transfer rate	PROFIBUS specification	
Isolation strength	60 V	to system ground (case, CHASSIS)

To the pin configuration 512 and the cabling 123 of the PROFIBUS interface.

9.10.7 PROFINET Interface

Profinet-Class	Value	Remarks
Node	1	
Device class	IO-DEVICE	
Functionality	CC-C	Conformance Class C
Profinet-Certification	Netload Class III certified according to PNIO-version V2.34	
Cyclic data exchange	RT, IRT	
Minimum supported bus cycle time	250 µs	Isochronous Real Time (IRT)

Network connection	Value	Remarks
Terminal connection	2x RJ45	internal network switch labeling: Port 1 and Port 2
Network	100 Mbit/s	full duplex with autonegotiation
Isolation	standard Ethernet specification	
Supported topologies	star/tree/line/circular	

Configuration options	Value	Remarks
Supported variable assignments	channels, pv-variables	assignment to Profinet variables
Max. number of pv-variables	800	general system limit for imc CRONOS devices
Endianess support	Big-Endian / Little-Endian	Byte order (Motorola/Intel), via wizard
internal data type converter	yes	
Save / Load configurations	yes	via wizard
Validation of configurations	yes	via wizard
Number of pluggable slots	40	Profinet: logical module structure "plugging" of slots = parameterization of logical units
max. pluggable output modules	20	
Size per output modules	64 Byte	
max. pluggable input modules	20	
Size per input module	64 Byte	
Maximum I/O process space	1280 Byte each	20 · 64 Byte

To the pin configuration 512 and the cabling 122 of the PROFINET interface.

9.10.8 XCPoE Master-Slave Interface

Parameter	Value	Remarks
Nodes	1	
Terminal connection	1x RJ45	
Transfer protocol	XCP -Part 1- Overview XCP -Part 2- Protocol Layer Specification	Ver. 1.0; ASAM e.V. Ver. 1.0; ASAM e.V.
	XCP -Part 3- Transport Layer Specification XCP on Ethernet (TCP_IP and UDP_IP)	Ver. 1.0; ASAM e.V.
	XCP -Part 4- Interface Specification XCPplus	Ver. 1.0; ASAM e.V.
Operating mode	Master or Slave	A2L file can be imported (XCPplus support included) A2L-file will be generated
Transmittable channel type when operating as slave	All meas. channels (analog, digital, fieldbus-, as well as virtual channels (OFA)	
Data rate per channel	 max. 50 kHz max. 10 kHz	depending on system configuration Slave Master
Max. cable length	100 m	
Hardware interface (Physical Layer)	Ethernet 100 Mbit/s	
Isolation strength	standard Ethernet specification	

To the pin configuration 509 and the cabling 122 of the XCPoE interface.

9.10.9 IPTCom Interface

Parameter	Value	Remarks
Node	1	
Terminal connection	1x RJ45	
Operating mode	Slave	
Data transfer direction receive	 SINT16/FLOAT-channels	
Data rate	max. 100 kS/s	total
Ethernet	100 Mbit/s	
Isolation strength	60 V	to system ground (case, CHASSIS)

9.10.10 MVB-Bus Interface

Property	**Characteristics**
Node	1
Transmission medium	Copper: twisted pair, RS485
Terminal connection	2x DSUB-9
Topology	Bus
Protocol standards	IEC 61375-3-1 Electronic Railway Equipment - Train Communication Network - Part 3-1: MVB - Multipurpose Vehicle Bus IEC 61375-3-2 Electronic railway equipment - Train communication Network - Part 3-2: MVB - Multipurpose Vehicle Bus Conformance Testing
Physical Layer	EMD Electrical Middle distance medium non-reactive tapping of data **or as an option** (alternatively): ESD+ Electrical short distance
Operation mode	logging of periodical process data
Max. cable length	200 m with up to 32 subscribers
Redundancy	duplication: messages sent on both lines
Gross data rate	1.5 Mbit/s
Address room	4095 physical devices, 4095 logical ports, 8-bit station addresses for messages
Frame size	16, 32, 64, 128 and 256 bit
Isolation strength	500 V_{RMS} (1 min.)

To the pin configuration 513 and the cabling 124 of the MVB-Bus interface.

9.10.11 ARINC-Bus Interface

Parameter	**Value typ.**	**min. / max.**	**Remarks**
Number of Rx-channels	8		
Number of Tx-channels	4		
Terminal connection	2x DSUB-15		
Transfer protocol	ARINC 429		
Baud rate	Low (12.5 kbit/s) High (100 kbit/s)		
Max. voltage for each Rx connection		±29 V	to System ground (protection ground)
Max. voltage for each Tx connection	5 V	4.5 V / 5.5 V	to GND "ZERO": min -0.25 V .. max 0.25 V
	10 V	9 V / 11 V	differential "ZERO": min -0.5 V .. max 0.5 V
Isolation strength	no galvanically isolation		

To the pin configuration 511 and the cabling 122 of the ARINC interface.

9.10.12 RoaDyn Interface

The RoaDyn® Interface provides the interface between the wheel force transducer system RoaDyn® 2000 by Kistler and an imc CRONOS measurement device. The compatible Kistler unit version is 4.01a, 4.01b and c with DSP-Type_ VC33.

Along with the RoaDyn® system's (3x force, 3x torque, angle, angular velocity, temperature, supply voltage) main channels, all additional service channels (single force components, errors etc.) are available.

Physical structure: The RoaDyn® Interface is a configuration option ("configuration module"), devices can only be equipped ex-factory with this Interface. An exchange or plug-in by the user is not allowed.

Parameter	Value	Remarks
Nodes	Interface for a Kistler 2000 system max. 4 wheels	
Terminal connection	2x BNC RJ45	Clock and Trigger for the data exchange
Channels	all channels of the RoaDyn® system available: 10 main channels (3x force, 3x torque, angle, angular velocity, temperature, supply voltage additionally all service and additional-channels (single force, error cases etc.)	
Transmission medium	Ethernet 100 Mbit/s	10/100 Mbit/s, approvable cable length for 100 Mbit/s Ethernet max. 100 m according IEEE 802.3
Delay of tested Kistler unit - Version: 4.01a - DSP-Type: SBC31	2 ms plus 16 Samples	complete delay is compensated in the data processing imc Online FAMOS calculates with measurement data
Sampling rate	max. 1 kHz synchronized to imc system	

9.11 Accessories

9.11.1 Sensor supply module: SEN-SUPPLY

Parameter	Value typ.		max.	Remarks
Configuration options	5 adjustable ranges			The sensor supply module always got 5 selectable voltage ranges. Default ranges: +5 V to +24 V
Output voltage	Voltage (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	Current 580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	Netpower 1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	set globally for all channels of an amplifier special order: +12 V can be replaced by +2,5 V. +15 V can be replaced by ±15 V
Isolation Standard: option, upon request:	 non isolated isolated			 output to case (CHASSIS) nominal rating: 50 V, Test voltage (10 sec.): 300 V, not available with option ±15 V.
Short-circuit protection	unlimited duration			to output voltage reference ground
Accuracy of output voltage	 <0.25 %		 0.5 % 0.9 % 1.5 %	at terminals, no load at 25°C over entire temperature range plus with optional bipolar output voltage
Efficiency	typ. 72% typ. 66% typ. 55% typ. 50%			10 V to 24 V none isolated 5 V 10 V to 24 V isolated 5 V
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V to 10 V 12 V, 15 V 24 V

The description of the sensor supply. 274

9.11.2 CRFX/SEN-SUPPLY-4

Sensor supply		
Parameter	**Value**	**Remarks**
Channels	4	
Terminal connection		
Sensor	DSUB-9	direct connection of current transducers (e.g. LEM Ultrastab, Danisense or current clamps)
Amplifier	LEMO.FGG.1B.307 (plug)	direct connection of any amplifier via LEMO patch cables
Power supply	LEMO.EGE.1B.302 (socket)	multicoded 2 notches (E-coded: 48 V) recommended plug: LEMO.FGE.1B.302
Module connector	2x 20 pin	CRFX system bus (EtherCAT) and power supply: passed through to further directly connected (clicked) amplifiers
Output voltage	±15 V	
Accuracy of output voltage Temperature coefficient	±2% typ. ±0.02%/K	at terminals, no load 25°C
Output power	max. 48 W	total continuous power, 4 channels
Current limiting	typ. 1080 mA [1]	for each channel pairs 1+2 or 3+4 (max. 2 transducer IN-1000 respectively DS600ID for each module)
Short-circuit protection	unlimited duration	automatic restart of all channels
Capacitive load	>470 µF	per channel
Efficiency	typ. 80%	full load, 25°C
Isolation	60 V	block isolation of entire global sensor supply (for all 4 channels, common reference"-SUPPLY, GND") to housing (CHASSIS, PE), as well as to power input
Status indication	channel individual LED	display of error status from sensor (signal or switching contact) or overload of power supply
TEDS	TEDS memory inside DSUB-9 connector (parameters and scaling information)	TEDS signals are passed to the connected (TEDS-capable) amplifiers

1 the pairs k1+k2 and k3+k4 are fused together with 1080 mA; typical operating examples:
4 x 540 mA (e.g. 4 x IT-405) with k1/k2/k3/k4
2 x 1080 mA (e.g. 2 x IN-1000 respectively DS600ID) with channel k1 and k3; k2/k4 thereby unused

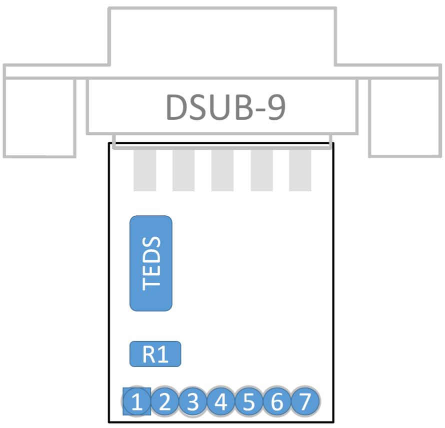
Power supply of the module		
Parameter	**Value**	**Remarks**
Input supply voltage	20 V to 50 V DC	only via LEMO.1B socket
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	not supported	DC power supply via EtherCAT network
Power consumption	max. 65 W	20 V to 50 V DC

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* modules via module connector	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W at 48 V DC (e.g. AC/DC line adaptor) • 37 W at 12 V DC (typical vehicle supplied DC input) Refers only to the supply power passed through (in/out). The module itself is always supplied individually from the LEMO socket

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	62 x 118 x 186 mm	W x H x D
Weight	860 g	

Plug for the sensor connection			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Plug	DSUB-9		solder connections in the plug housing
Internal load resistor Rm	1 Ω, 5 Ω, 10 Ω none		SEN/DSUB9-xR: for transducers with current output SEN/DSUB9-NR: for sensors with voltage output
Accuracy for Rm calibrated version 10 Ω 5 Ω 1 Ω not calibrated 10 Ω 5 Ω 1 Ω		 0.009 % 0.012 % 0.036 % 0.050 % 0.050 % 0.050 %	see separate data sheet "Calibration and TEDS"
Temperature drift	0.05 ppm/°C 0.2 ppm/°C		0 to +60 °C -55 to +125 °C
Drift due to self-heating	5 ppm / W		
Long-term stability		50 ppm (= 0.005 %)	10 000 h @ 1 W
Power rating		1 W 0.8 W	+70°C +85°C
Operating temperature range	-40 to +85°C		

Pinning of the plug for the sensor connection (SEN/DSUB9-xxR)



Pad	Signal	LEM (I_{out})	Sensor (V_{out})	Remarks
1	-SUPPLY	-SUPPLY	-SUPPLY	-15 V
2	+SUPPLY	+SUPPLY	+SUPPLY	+15 V
3	FAIL	STATUS	n.c.	open: error
4	GND	STATUS_GND	n.c.	contact with FAIL
5	GND	PWR_GND	PWR_GND	Power-GND
6	-IN	n.c.	+SIGNAL	$-V_{out}$
7	+IN	I_OUT	-SIGNAL	$+V_{out}$ / $+I_{out}$
R1	Bridge	n.c.	0 Ω	FAIL = 0 (OK)

Reference

Please find here a short module description: CRFX/SEN-SUPPLY-4 273

9.11.3 CRFX/WFT-2

Parameter	Value	Remarks
Inputs	2	for two WFT measuring wheels
Terminal connection LEMO Input supply plug (female) EtherCAT connection Module connector	 2x LEMO.ERA.1E.306 1x LEMO.EGE.1B.302 2x RJ45 2x 20 pin	 measuring wheel connection multicoded 2 notches, for optional individually power supply system bus for expanded imc CRONOS*flex* components direct connection of modules (click) supply and system bus

Parameter	Value	Remarks
Channels	36 F_x, F_y, F_z, M_x, M_y, M_z Umdr, Drehz, Temp rot_f_x, rot_f_z ,rot_m_x, rot_m_z Winkel, sin, cos Status, Aux	18 analog channels per measuring wheel: forces and moments revolutions, speed, temperature rotating coordinate system angle state, aux
Sampling rate	≤10 kHz	samplings rate and filter settings apply to all channels of a socket
Filter (digital) characteristic frequency order	low pass Butterworth, Bessel 5 Hz to 500 Hz 5 Hz to 1 kHz 8th order	 individual selectable with Bessel with Butterworth
Resolution	16 Bit	

Sensor supply for WFT-C^X or -C^{XS}		
Parameter	**Value (typ. / max.)**	**Remarks**
Input supply voltage	10 V to 50 V DC	
Output voltage	12.2 V DC	no load, 25 °C
Output power	10 W (max.)	for each channel
Efficiency	typ. 83 %	full load, 25 °C
Capacitive load	>800 µF	per channel
Isolation	isolated	channel individual to housing and input nominal 60 V
Short-circuit protection	unlimited duration	automatic restart
Accuracy of output voltage Temperature coefficient	±1 % typ. ±0.02 % / K	at terminals, no load 25 °C

Power supply	Value	Remarks
Input supply voltage	10 V to 50 V DC	
Power consumption	5 W plus 13 W per WFT	

Please find in the following chapter the LEMO pin configuration 505.
A separate documentation describes setup and operation of the WFT 6-component wheel.

9.11.4 Color Display

Parameter	Color Display
Display	5.7^2 TFT
Colors	65536
Resolution	320 x 240
Backlight	LED
Contrast (typ.)	600:1
Brightness (typ.)	450 cd/m^2
Connection cable	RS232, max. 2 m
Dimensions (W x H x D)	192 x 160 x 30 mm (w/o connectors)
Display area	approx. 11.5 x 8.6 cm
Weight	approx. 1 kg
Supply voltage	9 V to 32 V_{DC} 6 V to 50 V_{DC} upon request
Power consumption	approx. 3 W with 100% back light
Temperature range	-20°C to +60°C: operating temperature ≤+85°C: module interior temperature
Rel. humidity	80% up to 31°C, above 31°C: linear declining to 50%, according DIN EN61010-1
Terminal connections	DSUB-9 (female) for connection to measurement device 3-pin Binder (metal) ESTO RD03 series 712, 3-pin for external current supply
Miscellaneous	membrane touch panel with 15 buttons robust metal frame anti-reflection coated glass pane to protect display

Description the display 103 and the DSUB-9 pin configuration 507.

Included accessories article no.

- Modem cable in the extended temperature range
- ACC/POWER-SUPPLY AC/DC power supply unit 1350043
- ACC/POWER-PLUG4 power plug 1350052

9.11.5 Power Handle (CRFX/HANDLE-POWER)

Parameter	Value	Remarks
Input supply voltage	7 V to 50 V DC	
Shutdown-threshold (typ)	5.9 V	min. input voltage (no load)
Min. required input voltage for restart (typ.)	9.5 V	min. input voltage (no load)
Output voltage	50 V DC	constant, regulated over entire input range
Output power	100 W 70 W	10 V to 50 V DC input $V_{in} \cdot 10$ A
Output short circuit protection	continuous	
Isolation	isolated from CHASSIS, no input-to-output isolation	When connecting a CRFX base unit (with non-isolated supply input), the supply voltage is then grounded.
Power supply socket (input)	LEMO.EGE.1B.302 (female)	multicoded 2 keyways, compatible to plugs: LEMO.FGG.1B.302 (standard) LEMO.FGE.1B.302 (E-coded: 2 coding keys)
Remote control socket	LEMO.1B.306	
Auxiliary output power supply sockets	LEMO.1B.304	5 sockets for the supply of additional units and blocks that are not directly attached via module connector
UPS functionality	none	refer to NiMH or Li-Ion type UPS variant

Parameter	Value	Remarks
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to 50%	according to IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET")	-40°C to +85°C	condensation temporarily allowed

Reference Li-Ion type UPS variant

Technical Specs: Handle with Lead-gel batteries (CRFX/HANDLE-LI-IO-L) 477

9.11.6 USV-NiMH (CRFX/HANDLE-UPS-NIMH-L)

Parameter	Value	Remarks
Input supply voltage	10 V to 50 V DC	
Shutdown-threshold (typ)	9.6 V	min. input voltage (no load)
Min. required input voltage for restart (typ.)	10.9 V	min. input voltage (no load)
Output voltage	50 V DC	constant, regulated over entire input range
Output power	100 W	10 V to 50 V DC input
Output short circuit protection	continuous	
Isolation	isolated from CHASSIS, no input-to-output isolation	When connecting a CRFX base unit (with non-isolated supply input), the supply voltage is then grounded.
Input supply terminal	LEMO.EGE.1B.302	multicoded 2 notches, compatible to connectors: LEMO.FGG.1B.302 (standard) LEMO.FGE.1B (E-coded: 2 coding keys)
Remote control terminal	LEMO.1B.306	
On/Off push button	✔ [1]	especially for use with imc EOS
Auxiliary output supply	LEMO.1B.304	5 terminals for the supply of additional units and blocks that are not directly attached via module connector
Weight	2.06 kg	
UPS battery type	NiMH	
UPS battery capacity	≥55 Wh	typ. 25°C, battery fully charged
UPS total buffering time	>30 min	typ. 25°C, depending on system size and configuration (rated for total system consumption of ≤100 W, gross input power)
UPS buffer time constant Selectable via manual switch	16 positions (0..9, A..F): 0s, 1s, 2s, 5s, 10s, 30s, 1min, 2min, 5min, 10min, 30min, 1h, 2h, 5h, 10h, maximum	maximum duration of a continuous outage before triggering device shutdown
Charging power	2.5 W (typ.)	device must be switched on
Duty cycle: charge time / discharge time	discharge time · 1.2 · (system power / 2.5 W)	worst case example: system power consumption 100 W buffer time 1 min., resulting recharge time ≤48 min. (duty cycle 48:1)
Charging time for complete battery recovery	36 h	

(1) In connection with imc CRONOS*flex*, both the latching main switch on the CRFX base unit or the push button on the power handle can be used, both are "synchronized". In connection with imc EOS, the latching main switch is typically permanently pressed. The entire system is then switched on and off by the latching main switch on the power handle.

9.11.7 USV-Li-Ion (CRFX/HANDLE-LI-IO-L)

Parameter	Value	Remarks
Input supply voltage	10 V to 50 V DC	
Shutdown-threshold (typ)	9.6 V	min. input voltage (no load)
Min. required input voltage for restart (typ.)	10.9 V	min. input voltage (no load)
Output voltage	50 V DC	constant, regulated over entire input range
Output power	100 W	10 V to 50 V DC input
Output short circuit protection	continuous	
Isolation	isolated from CHASSIS, no input-to-output isolation	When connecting a CRFX base unit (with non-isolated supply input), the supply voltage is then grounded.
Power supply socket (input)	LEMO.EGE.1B.302 (female)	multicoded 2 keyways, compatible to plugs: LEMO.FGG.1B.302 (standard) LEMO.FGE.1B.302 (E-coded: 2 coding keys)
Remote control socket	LEMO.1B.306	
On/Off push button	✔ [2]	especially for use with imc EOS
Auxiliary output supply socket	LEMO.1B.304	5 sockets for the supply of additional units and blocks that are not directly attached via module connector
Weight	2.34 kg	
UPS battery type	2x Li-Ion Smart Battery	
UPS battery capacity	196 Wh [3]	typ. 25°C, battery fully charged
UPS total buffering time	>1 h	typ. 25°C, depending on system size and configuration (rated for total system consumption of ≤100 W, gross input power)
UPS buffer time constant Selectable via manual switch	16 positions (0..9, A..F): 0s, 1s, 2s, 5s, 10s, 30s, 1min, 2min, 5min, 10min, 30min, 1h, 2h, 5h, 10h, maximum	maximum duration of a continuous outage before triggering device shutdown
Charging power	37 W (typ.)	device must be switched on temporarily higher charging power possible
Duty cycle: charge time / discharge time	discharge time · (system power / 37 W)	worst case example: system power consumption 100 W buffer time 1 min., resulting recharge time ≤3 min (duty cycle 3:1)
Charging time for complete battery recovery	6 h	

(2) As of delivery date approx. 2023, before that handle w/o On/Off push button

(3) As of delivery date FEB-2019, before that 138 Wh

Li-Ion Smart Battery (included in CRC/B-Li-IO-1 and CRC/B-Li-IO-2)		
Parameter	**Value**	**Remarks**
Charging time for complete battery recovery	3 h	device must be switched on
Capacity of each Li-ion battery	98 Wh [4]	Nominal ratings at 21°C The available effective capacity depends on load and temperature. At temperatures below 0°C the usable capacity is reduced to a fraction of nominal values at 21°C. Example (at approx. 40 W load): approx. 85% at -10°C approx. 55% at -20°C
Operating temperature range		
Operation (discharge)	-20°C to +69°C	operational temperature range of UPS buffering functionality To protect the batteries at temperatures above 60°C the UPS buffer time constant is reduced to 15 seconds, regardless of configured setting
	-10°C to +50°C	specified temperature range as rated by Smart Battery manufacturer! Manufacturers of the individual Li-ion cells used in the Smart Battery, specify a discharging temperature range of -20°C to +60°C
	+75°C ± 5°C	battery disconnect: internal protection circuitry of the Smart Batteries prevent discharge
Charge	0°C to +45°C	above +45°C a charge of the batteries is inhibited (green charge level indicator LED stops flashing)
Storage	-20°C to +60°C	
Passive temperature fuse	+93°C (tolerance: +0°C, -5°C)	Once triggered, the passive temperature fuse cannot be reset thus irreversibly rendering the battery useless!
Relative Humidity	≤80%	

Note: Due to the inevitable leakage and self-discharge of the Smart Batteries we recommend a regular recharging cycle at least every 3 months that a device has not been in use (device must be switched on for charging).

(4) As of delivery date FEB-2019, before that 69 Wh

9.11.8 DSUB-15 adapter plug

Parameter	Value	Remarks
Terminal count Standard Special	 18 20 24 25	 e.g. ACC/DSUBM-B2, -U4, -UNI2, e.g. ACC/DSUBM-T4 ACC/DSUBM-TEDS-T4 ACC/DSUBM-HD-I4, HD-B4 (**DSUB-26**)
Housing material	metal	zinc die-cast (nickel-plated)
Connector type	DSUB-15 DSUB-HD-26	ACC/DSUBM-xx ACC/DSUBM-HD-xx
Protection level	IP20 IP65	ACC/DSUBM-xx ACC/DSUBM-xx-IP65
Usable wire cross section	max. 1.5 mm^2 corresponds to AWG 16	braided with wire end sleeve
Cable passage max. aperture at sealing gasket with ACC/DSUBM-xx with ACC/DSUBM-xx-IP65	 Ø 9 mm sealing gasket, black sealing gasket, yellow	 both black and yellow with bend relief sleeve without bend relief sleeve
Gasket bore length range	5 to 7.5 mm	other sizes[2] upon request
Locking screws	2x M2.5 X 58 mm 2x M2.5 X 65 mm	ACC/DSUBM-xx, suitable for corresponding latching to the imc device ACC/DSUBM-xx-IP65 suitable for the imc SL-Series devices (imc CRONOS-SL / imc CANSAS-SL) and imc XT-Series (imc CRONOS-XT)
Dimensions (L x B x H)	118 x 55.2 x 19 mm 77.5 x 55.2 x 19 mm	with bend relief sleeve without bend relief sleeve
Weight	typ. 140 g	metal connector

2 As of 2019-01-01, the previously used gasket bore: 4 to 6.5 mm is no longer available.

9.11.9 ACC/DSUB-ICP

Parameter	Value (min / max)		Remarks
option for	BR(2)-4, DCB(2)-8, ISO(2)-8, LV(2,3)-8, LV-16, SC(2)-32, UNI(2)-8		
Inputs 	 4 2		differential, not isolated ACC/DSUB-ICP4 ACC/DSUB-ICP2
Input coupling	DC ICP		 current source, 1st order high-pass
Current drain per connector		<0.2 A <0.1 A	ACC/DSUB-ICP4 ACC/DSUB-ICP2
Voltage measurement			
Input voltage max. voltage ICP		 ±60 V -3 V to 50 V ±3 V	permanent to chassis at +IN1, ..., +IN2 bzw. +IN4 at -IN1, ..., -IN2 bzw. +IN4
Input impedance voltage ICP	 1 MΩ 10 MΩ 20 MΩ 0.33 MΩ 0.91 MΩ		depending on the measurement ranges of the measurement inputs differential single end
ICP™-, DELTATRON®-, PIEZOTRON®-Sensors			
Highpass cutoff frequency	 3 Hz 1 Hz	 ±20 % ±20 %	-3 dB, AC, corresponding to input impedance of the used measurement input 1 MΩ 10 MΩ, 20 MΩ
ICP-current source	4.2 mA	±10%	
Voltage swing	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	

Find here the description of the IEPE (ICP)-expansion plug 260.

9.11.10 ACC/DSUBM-ICP2I-BNC(-S/-F)

Parameter	Value typ.	min./ max.	Remarks
Compatible channel types	imc measurement amplifier		with DSUB-15 sockets
Full support			only with CRFX, CRXT device family: software support with variant differentiation (-F/-S), full support of TEDS sensors including sensors of type DS2431 and a improved offset performance
	bridge amplifiers UNI2-8, UNI-4, DCB2-8, B-8 Cx-70xx, Cx-50xx		types with 2 channels per DSUB-15 imc CRONOS device series similar imc C-SERIES devices
	voltage amplifier LV3-8 Cx-12xx		types with 4 channels per DSUB-15: first and third channel used imc CRONOS device series similar imc C-SERIES devices
Basic support			basic ICP operation
	Bridge amplifiers BR2-4		types with 2 channels per DSUB-15 imc CRONOS device series
	Voltage amplifiers ISO2-8, ISOF-8, LV-16, SC2-32 Cx-10xx, Cx-41xx		types with 4 channels per DSUB-15: first and third channel used imc CRONOS device series similar imc C-SERIES devices
Inputs	2		BNC
Input coupling	ICP		current source, 1st order high-pass
Isolation	channel wise isolated ICP-conditioning (current source)		the isolation of each measurement channel depends on the amplifier used (e.g.: ISO2-8 is isolated)
Isolation voltage		≤±50 V	to system ground (CHASSIS) and channel-to channel
Max. input voltage		<±40 V	at BNC input
Constant current feed	4.2 mA	±10%	
Voltage swing	24 V	>22 V	
Current source impedance	340 kΩ	>100 kΩ	in parallel with input impedance of the amplifier
Error indication	LED		open sensor detection and short circuit detection
TEDS	conforming to IEEE 1451.4 Class I MMI supported for selected amplifier and only with CRFX / CRXT		sensor with current feed supported as of imc STUDIO 5.0R1

AC-coupling: High pass cut-off frequency (-3 dB) and typ. settling time - Note (1)			
Parameter	**Value typ.**		**Remarks**
	variant -S "slow"	**variant -F "fast"**	
AC-coupling	235 nF 10 MΩ	235 nF 1 MΩ	RC high pass in the plug The resulting high pass is formed with the additional input impedance of the amplifier (depending on type and measuring range).
Typ. settling time ts	approx. 10 s	approx. 1 s	when connecting and activating
For amplifier types **with software support**			detection, additional digital high pass
imc CRONOS*compact* (CRC), C-SERIES			
UNI2-8, DCB2-8, LV3-8	0.40 Hz	<1 Hz **ts approx. 5 s**	*long settling time for both variants; for the F variant: settling time: ts = 5 s*
imc CRONOS*flex* (CRFX)			
UNI2-8, DCB2-8, LV3-8	0.12 Hz	<1 Hz	time constant of the digital HP specifically matched for S- and F-variant
All other amplifier types **without software support**			no detection, without digital high pass
Depending on input impedance:			
10 MΩ	0.14 Hz	<1 Hz	e.g. ISO2-8, measurement ranges ≤2 V
1 MΩ	0.75 Hz	<1.5 Hz	e.g. ISO2-8, measurement ranges ≥5 V

(1) The cut-off frequency and settling time is determined by the combination of an analog AC coupling (depending also on the amplifier's input impedance) and a digital high-pass (if supported).
The digital highpass is intended to suppress residual offset that can be caused by the amplifiers bias currents in conjunction with the high impedance RC circuit.

Reference

Please find here the description. 264

9.11.11 ACC/DSUBM-ESD

Intermediate filter-plug for ESD suppression for any module with DSUB-15 connections.

Parameter	Value	Remarks
Suitable for modules	for any module type, e.g.: analog inputs analog outputs (DAC) counter modules (ENC) digital (DIO)	modules with DSUB-15 connectors
Inputs	15 uniformly filtered lines	usable independent of actual channel count and connected signal type
ESD-filter topology	T-filter: ferrite – capacitor - T-ferrite	uniform filter for 15 signal lines at the DSUB (inputs or outputs)
Filter components	ferrite: 500 Ω @ 100 MHz capacitor: 1 nF T-ferrite: 1 nF, 35 dB @ 100 MHz	
DC-resistance (ferrite)	65 mΩ 2 A	 max. DC current for serial components
Nominal voltage	33 V_{AC} 70 V_{DC}	common-mode voltage to CHASSIS suitable for operation in circuits with such specified voltages
Filter attenuation	no details (in MHz range)	depending on module type, source impedance, shielding etc. for practically relevant source impedance's: no significant impact of relevant signal bandwidth
Terminal connection	DSUB-15 intermediate connector (male / female)	

Find here the description of the ACC/DSUB-ESD expansion plug 114

9.11.12 ACC/DSUB-ENC4-IU

Accessory: connector for incremental sensors with currents signals for use with an incremental counter interface

Parameter	Value	Remarks
Inputs	4 + 1	differential, non isolated
Input coupling	DC	
Range 4 basic channels: 1 index channel:	 ±12 µA ±24 µA	
Sensitivity 4 basic channels: 1 index channel:	 -0.2 V/µA -0.1 V/µA	Vout
Input impedance 4 basic channels: 1 index channel:	 200 kΩ 100 kΩ	
Voltage output	differential	differential signal "+Vout" – "-Vout" analyzed by the INC-4 module
Output level	approx. 0 V to 5 V +Vout = 2.5 V/µA to 0.2 V/µA -Vout = 2.5 V	basic channels
Analog bandwidth 4 basic channels: 1 index channel:	 80 kHz 50 kHz	
Supply: auxiliary power external sensor	 5 V, 5 mA, 25 mW 5 V, max. 170 mA	supplied by the INC-4 module: DSUB-15 (14) VCC DSUB-15 (7) = GND
Connector plug	DSUB-15 with screw clamp in the connector housing	

Description for incremental sensors with current signals. 306

9.11.13 ACC/SYNC-FIBRE

Parameter	Value typ.	min./ max.	Remarks
Compatible with	GPS-connection imc measurement device		Modification of the GPS-connection is necessary (device preparation for SYNC-FIBRE). The simultaneous use of both SYNC-FIBRE and the device's SYNC plug (BNC) is not allowed. Only the SYNC-FIBRE or the SYNC plug (BNC) can be used.
Terminal connection	2x ST plug 1x DSUB-9		FOC connection with measurement device
Supply	5 V	±10%	out of device internal sensor supply
Power consumption	0.5 W	±10%	
Propagation Delay tPD	25 ns	75 ns	SYNC-In to Opto-Out or Opto-In to Sync-Out
Link length		500 m	Length of the fiber optic distance between two ACC/SYNC-FIBRE
Total delay		8 µs	SYNC-In first device to SYNC-Out last device
Fiber Optics plug type	ST		
Fiber Optics	50 / 125 µm 62.5 / 125 µm		
Wave length	820 nm		
General			
Extended environmental range	-40°C to + 85°C		condensation temporarily allowed

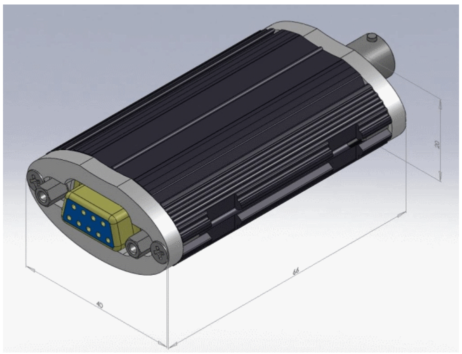
Find here the description of the ACC/SYNC-FIBRE 102.

9.11.14 IRIG-B

General			
Parameter	**typ.**	**min. / max.**	**Remarks**
Supported IRIG formats	B120..B127		Amplitude modulated (AM) signal evaluation of BCD-Time-Of-Year and BCD-Year
Input signal amplitude		max. 12 V_{SS} min. 0.8 V_{SS}	Level for mark-period (high) Level for space-period (low)
Input impedance	600 Ω		
Terminal connection	DSUB-9 (female) BNC		for connection with imc device IRIG input
IRIG-input shielding connection	System ground		
Output signal	RS232		Baud rate: 38400, no parity 8N1
Output data format	NMEA 0183		
Delay of the 1 pps-signal	<2 µs		dedicated signal for system clock synchronization of imc device
Jitter of the 1 pps-signal	±500 ns		Input signal: 12 V_{SS} without jitter
Supply power consumption	5 V, 70 mA		via DSUB connector
Operating temperature range (standard)	-40°C to +70°C		no condensation
Extended environmental range (optional)	-40°C to +85°C		condensation temporarily allowed
Storage temperature	-40°C to 85°C		
Dimensions	39 x 20 x 60		in mm, W x H x D
Weight	approx. 70 g		
imc article number	1270059		external IRIG-B module

Find here the description of IRIG-B 110.

Is only available for devices of group A5-A6 95



9.11.15 WLAN

Dual band	Value	Remarks
Standards	IEEE 802.11abgn	
Certification	WiFi certified (WMM)	
Data rate	300 Mbps 54 Mbps 11 Mbps	IEEE 802.11n IEEE 802.11a/g IEEE 802.11b
Operating frequency	2.412 GHz ... 2.4835 GHz channel 1...14, 5 MHz separation 5.180 GHz ... 5.825 GHz 5.15 GHz ... 5.85 GHz	IEEE 802.11 abgn ISM Band standard version version for Japan (xxx-JP)
Network type	Ad-Hoc, managed	
RF output power	+16 dBm +18 dBm +15 dBm	IEEE 802.11g IEEE 802.11n / 2.4 GHz, HT20 IEEE 802.11n / 5 GHz, HT20
Receiver sensitivity	-79 dBm -76 dBm -75 dBm	IEEE 802.11g IEEE 802.11n / 2.4 GHz, HT20 IEEE 802.11n / 5 GHz, HT20
Encryption	WEP to 104 Bit WPA-PSK TKIP/RC4 WPA2-PSK CCMP/AES	open system 8 to 63 characters [1] 8 to 63 characters [1]
Modulation	DSSS (DBPSK, DQPSK, CCK) OFDM (BPSK, QPSK, 16-QAM, 64-QAM)	IEEE 802.11b IEEE 802.11agn
Operating temperature range (standard)	-40°C to +80°C -50°C to +95°C	operating (ET version) storage temperature range
Operating temperature range (version for Japan xxx-JP)	-40°C bis +80°C -50°C bis +95°C	operating (ET not available) storage temperature range
Power consumption	1.5 W	

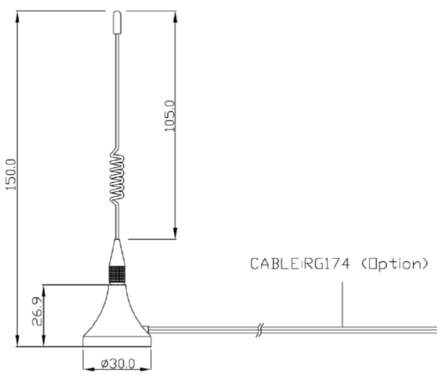
Single band	Value	Remarks
Standards	IEEE 802.11bgn	
Certification	WiFi certified (WMM)	
Data rate	150 Mbps 54 Mbps 11 Mbps	IEEE 802.11n IEEE 802.11g IEEE 802.11b
Operating frequency	2.412 GHz ... 2.462 GHz channel 1...11, 5 MHz separation	IEEE 802.11bgn ISM Band
Network type	Ad-Hoc, managed	
RF output power	+20 dBm +17 dBm	IEEE 802.11b (CCK) IEEE 802.11g (OFDM)
Receiver sensitivity	-73 dBm -86 dBm	IEEE 802.11g (54 Mbps) IEEE 802.11b (11 Mbps)
Encryption	WEP to 104 Bit WPA-PSK TKIP/RC4 WPA2-PSK CCMP/AES	open system (8 to 63 characters) [1] (8 to 63 characters) [1]
Modulation	DSSS (DBPSK, DQPSK, CCK) OFDM (BPSK, QPSK, 16-QAM, 64-QAM)	IEEE 802.11b IEEE 802.11gn

Single band	Value	Remarks
Operating temperature range	-30°C to +85°C	operating (ET version)
Power consumption	1.5 W	

Antenna - ACC/WLAN-ANT-RP-SMA		
Parameter	**Value**	**Remarks**
Type	clip on antenna	
Connector	RP-SMA (female)	reverse-SMA, antenna side: female
Flexibility	flexible joint bend and rotate	degrees of freedom for positioning
Operating frequency	single band / dual band 2.4 GHz / 5 GHz	
Antenna gain	1.5 dBi, 2.1 dBi	2.4 GHz / 5 GHz
Impedance	50 Ω	
Operating temperature range	-20°C to +65°C	
Mechanical dimensions	L: 108 mm / 82.5 mm diameter: 7.8 mm / 10 mm	with / without flexible joint diameter: antenna / SMA

Antenna - ACC/WLAN-MAG-ANT-RP-SMA		
Parameter	**Value**	**Remarks**
Type	magnetic base antenna	with 1.5 m cable
Connector	RP-SMA (female) with 1.5 m low loss cable	reverse-SMA, antenna side: female
Flexibility	magnetic attachment	
Operating frequency	single band 2.4 GHz	
Antenna gain	5 dBi	2.4 GHz
Voltage standing wave ratio	<1.6 : 1	characterizes cable transmission loss
Impedance	50 Ω	
Weight	50 g	

Mechanical dimensions - ACC/WLAN-MAG-ANT-RP-SMA:



Find here the description of WiFi 112 (WLAN) connection.

1 Access Point required

9.11.16 NET-SWITCH-5

Ports and operating modes		
Parameter	**Value**	**Remarks**
Number of ports	5	identical properties
Transfer rate	10 / 100 / 1000 Mbit/s	automatically
Modes	10BASE-Te	IEEE 802.3 Clause 14, requires Cat5 cabling
	100BASE-TX	IEEE 802.3 Clause 25 (ex 802.3u)
	1000BASE-T	IEEE 802.3 Clause 40 (ex 802.3ab)
Auto-Negotiation	active	priority 1: 1000BASE-T, full-duplex priority 2: 1000BASE-T, half-duplex priority 3: 100BASE-TX, full-duplex priority 4: 100BASE-TX, half-duplex priority 5: 10BASE-Te, full-duplex priority 6: 10BASE-Te, half-duplex
Auto MDI/MDI-X	active	
Address table	4 k entries	
Operating mode	store and forward	
MTU	1500 Byte	
Accepted frame size	64..1518(1522) Byte	smaller or larger packets are rejected
IEEE 1588v2 PTP clock configuration	E2E, TC, one-step	end-to-end transparent clock compatible with two-step no P2P (peer-to-peer) and no BC (boundary clock)
PTP Transport 1	UDP IPv4 and IPv6, Ethernet	
PTP Transport 2	multicast and unicast, Ports 319 and 320	multicast: messages are forwarded to all ports unicast: messages are only forwarded to the port to which the recipient is connected
PTP domain	is not checked	

General			
Parameter	**Value**		**Remarks**
Status LED	blue = on		
Port LED	yellow (left)	green (right)	
	off	off	no connection
	on	off	1000 Mbit/s connection, inaktive
	flashing	off	1000 Mbit/s connection, aktive
	off	on	100 Mbit/s connection, inaktive
	off	flashing	100 Mbit/s connection, aktive
	on	on	10 Mbit/s connection, inaktive
	flashing	flashing	10 Mbit/s connection, aktive

Power supply			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input supply voltage	10 V to 50 V DC		
Power consumption		4 W	
Module power supply options	power socket (LEMO) or adjacent module		imc CRONOS*flex* or imc BUSDAQ*flex* imc CANSAS*flex*

Terminal connection (front)	**Value**	**Remarks**
LAN interface	8P8C modular socket	RJ45
Interfaces for power supply	• LEMO.0B or LEMO.1B with CRFX • module connector/slider	suitable for setting up a redundant supply from 2 possible sources

Variant imc CRONOS*flex* (CRFX)

Terminal connections (rear side of the CRFX module)		
Parameter	**Value**	**Remarks**
Input supply plug (female)	LEMO.EGE.1B.302	multicoded, 2-notch connector for optional individual power supply
Module connector	2x 20 pin	system bus for distributed imc CRONOS*flex* components: EtherCAT not used by switch but fed through via module connector. Switch can be docked and inserted at arbitrary positions within the CRFX system (right hand side of base unit)

Pass through power limits	
Directly connected (clicked) imc CRONOS*flex* Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 74 W @ 24 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)

Operating conditions	**Value**	**Remarks**
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature	-40°C to +85°C	condensation temporarily allowed
Weight	550 g	

9.11.17 CRFX/ETHERCAT-GATEWAY

Parameter	Value	Remarks
Max. ECAT bus cycle	5 kHz (200 µs)	
Supported bus cycles	5 kHz, 1 kHz, 500 Hz, 100 Hz	
Typical channel configuration of the CRFX modules	sampling rate= ECAT bus cycle, AAF	however maximum 5 kHz only one global sampling rate is allowed
Max. sampling rate	34 channels up to 5 kHz 128 channels up to 1 kHz	170 kHz aggregate sampling rate
Terminal connections		
PC / network Ethernet TCP/IP	RJ45 100 MBit	max. 100 m cable with 100 MBit (according to IEEE 802.3)
System bus for *flex* modules (EtherCAT) "CRFX MODULE"	RJ45 alternatively: module connector	max. 100 m cable between 2 modules warning: here is PoEC power 492 available
ECAT Slave Interface	2x RJ45 (IN and OUT)	
Sync	BNC	IRIG-B (isolated, TTL) typically not necessary
Power supply	type LEMO.1B (2-pin)	compatible with LEMO.EGE.1B.302 multikodiert 2 Nuten kompatibel mit Steckern FGG.1B.302 (Standard) oder FGE.1B.302 (E-kodiert, 48 V)
Remote control terminal	type LEMO.1B (6-pin)	connector LEMO FGG.1B.306
Module connector	2 x 20-pin	direct connection of modules (click) supply and system bus

Power supply		
Parameter	**Value**	**Remarks**
Power supply	10 V to 50 V DC	
Power-on threshold (typ.)	10.0 V	min. input voltage required for power-on (open circuit)
Shutdown threshold (typ.)	9.2 V	input voltage at which the automatic deactivation is triggered (data backup protected by internal UPS buffering)
Power consumption	20 W	depending on model and equipment (e.g. fieldbus, HDD)
AC/DC power adaptor	48 V DC, 150 W 110-230 V AC 50-60 Hz	included in delivery
Pass through power	via module connector and onto RJ45 (EtherCAT): PoEC	min. 42 V required for PoEC

Pass through power limits	
Directly connected imc CRONOS*flex* modules via module connector	3.1 A (max.), equivalent power with chosen DC power input: • 149 W at 48 V DC (standard AC/DC power adaptor resp. DC/DC Power Handle) • 37 W at 12 V DC (typ. DC input voltage)
Power-over EtherCAT (PoEC) for remote imc CRONOS*flex* modules	350 mA (max., corresp. to IEEE 802.3), equivalent power with DC power input: • 17.5 W at 50 V DC (e.g. DC/DC Power Handle) • 16.8 W at 48 V DC (e.g. AC/DC power adaptor) • 14.7 W at 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions		
Parameter	**Value**	**Remarks**
Operating environment	dry, non corrosive environment within specified operating temperature range	
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature (standard)	-10°C to +55°C	without condensation
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60068-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure	
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request
Dimensions	90 x 118 x 186 mm	W x H x D
Weight	approximately 1.2 kg	

Reference

Please find here the description of the module 119.

9.11.18 imc APPMOD: Application module

Embedded Processor		
Parameter	**Value**	**Remarks**
Embedded processor	Freescale Power PC MPC5200B Core CLK 384 MHz	
RAM	64 MB 48 MB	total memory available for the application
Flash	16 MB	only for the operation system
Operating system	Linux	

General		
Parameter	**Value**	**Remarks**
Interfaces	1x Ethernet interface and 1x serial interface 3.5 mm jack plug	Specific applications can each use exactly one of the two interfaces. Simultaneous use of both interfaces requires a system with two interfaces. service-jack (RS232, 115 kBaud, Tx, Rx, GND) console for development, debugging
Module width	requires 1 slot	fixed installation, ex factory
Modularity	order option	upon request
Max. amount of interfaces in one system	3 8 1 2 3 5	totally in one CRFX base unit totally in one CRC system totally in one BUSFX-4 system totally in one BUSFX-6 system totally in one BUSFX-8 system totally in one BUSFX-12 system

Ethernet Variant		
Parameter	**Value**	**Remarks**
Terminals / Nodes	1	
Terminal connectors	1x RJ45	
Topology	bus	
Transfer protocol	TCP / IP	IEEE Norm 802.3
Transfer medium	Ethernet	
Data flow direction	sending/receiving	
Baud rate	100 MBit 10 MBit	100BaseT (Half- and Full-duplex) 10BaseT (Half- and Full-duplex) Auto-sensing
Isolation strength	60 V	to system ground (CHASSIS)

Serial interface variant		
Parameter	**Value**	**Remarks**
Terminals / Nodes	1	
Terminal connectors	1x DSUB-9	
Baud rate	300, 1200, 2400, 4800, 9600, *14400*, 19200, *28800*, 38400, 57600, 115200, 230400	special bit-rates: 14400 and 28800
Isolation Isolation strength	galvanically isolated 60 V	to system ground (CHASSIS) nominal working voltage
Operation modes	RS 232 RS 485 / RS 422	flexibly configurable: multi-protocol transceiver
RS232 mode		
Parameter	**Value**	**Remarks**
Topology	point-to-point	
Transfer protocol	RS232	
Signal type	Tx, Rx, GND CTS, RTS	Basis signals Handshake, flow control
Data flow direction	sending/receiving	
Byte format	7 or 8 data bits, 1 or 2 stop bits, none/odd/even parity	
Flow control	XON/XOFF, RTS/CTS	
RS485/422 mode		
Topology	Bus	
Transfer protocol	RS485	compatible to RS422
Operating mode	Half- and Full-duplex	activated via software
Signal type	2x Tx, 2x Rx, GND	basis signals, differential
Data flow direction	sending/receiving	
Termination	120 Ω	activated via software

10 Pin configuration

10.1 Connecting DSUB-15 adaptor plug

The **Standard plug** is a 1:1 DSUB-15 to screw terminal adapter. It can be used for all modules which come with the corresponding pin configuration.

The **Special plugs** do not offer direct adaption from the DSUB pins to the screw terminals, but instead come with extra functions:

- For current measurement (up to 50 mA) with voltage channels the **Shunt plug** (ACC/DSUBM-I2 and I4) have a built-in 50 Ω shunt. The scaling factor 0.02 A/V must be set in order to display the current value.
- For temperature measurements, a special, patented **Thermo plug** (ACC/DSUBM-T4) is available. This DSUB-15 plug is suited for measurement of voltages as well as temperatures with PT100 and thermocouples with integrated cold junction compensation (CJC). Any types of thermocouples can be connected at the differential inputs (+IN and -IN). It also has additional "auxiliary contacts" for connecting PT100 in 4-wire configurations, where the reference current loop is already pre-wired internally.The Thermo plug can also be used for normal voltage measurement.
- The **IEPE/ICP plug** (ACC/DSUB-ICP2 and ICP4) provide a current supply source as well as a capacitive coupling.
- The **TEDS plugs** store sensor information according to IEEE1451.4 for use with imc Plug & Measure 104 (integrated TEDS chips DS 2433).

Note The screw terminals of the plug

- To connect the measurement leads with the screw terminals, suitable leads should have a maximum cross section of 1.5 mm^2 incl. cable end-sleeve.
- The terminals' screw heads only have secure electrical contact once they are tightened to a connection wire. For this reason, a control measurement (for instance with multimeter probe tips) at "open" terminals can falsely mimic a missing contact!
- Cable shielding must be connected at CHASSIS (DSUB frame) as a rule. At some plugs, V_{CC} (5 V) is available, with a maximum load current of typically 135 mA per plug.

10.1.1 Device models overview

		Voltage	Current	Bridge	Thermocouple	PT100	Current feed sensors IEPE (ICP)	Universal
Analog amplifier	UNI2-8	UNI2 B2	UNI2 I2	UNI2 B2	UNI2	UNI2	ICP2	UNI2
	UNI-4	UNI2	UNI2 I2	UNI2 B2	UNI2	UNI2	ICP2	UNI2
	DCB2-8	B2 UNI2	I2	B2 UNI2			ICP2	
	BR2-4	B2	I2	B2			ICP2	
	LV-16	U4	I4					
	LV3-8	U4	I4				ICP4	
	SC2-32	U4	I4				ICP4	
	OSC-16	U4 T4	I4		T4	T4		
	C-8	U4 T4	I4		T4	T4		
	ISO2-8	U4 T4	I4		T4	T4	ICP4	
	ISOF-8	U4 T4	I4		T4	T4	ICP4	

		INC.-ENCODER	FREQUENCY	DIGITAL IN	DIGITAL OUT	DIGITAL OUT HIGH CURRENT	RELAIS	ANALOG OUT
Digital modules	ENC-4, HRENC-4	ENC4, ENC4-IU						
	FRQ2-4		FRQ2					
	DI-16			DI8				
	DIOINC	ENC4		DI2-8			REL4	
	DIO-PL2			DI8			REL4	
	DI2-16			DI4-8				
	DO-16				DO-8			
	DO-16-HC					DO8-HC		
	DAC-8							DAC4
	DI16-DO8-ENC4	ENC4		DI4-8	DO-8			
	DI8-DO8-ENC4-DAC4	ENC4		DI4-8	DO-8			DAC4

10.2 DSUB-15 pin configuration

In general: DSUB pin 1 is internally reserved.

10.2.1 Universal plug

Metal plug

ACC/DSUBM-		UNI2
DSUB Pin	Terminal	UNIVERSAL
9	1	+VB1
3	2	-VB1
2	3	+IN1
10	4	-IN1
11	5	I1_1/4B1 (1)
4	6	-SENSE1
5	7	+IN2
13	8	-IN2
14	9	I2_1/4B2 (1)
7	10	-SENSE2
12	11	+VB2
6	12	-VB2
15	15	(GND)
8	18	(+5V)
	13	
	14	
⏚	16	CHASSIS
⏚	17	CHASSIS

The abbreviation VB stands for the bridge sensor supply and can be equated with the sensor supply, abbreviation: SUPPLY.

(1) if the special version of the amplifier is equipped with the ±15 V option, then this pin = -15 V
+SENSE with UNI-4 and corresponding measurement configuration

10.2.2 Standard plug

ACC/DSUBM-		B2	U4
DSUB Pin	Terminal	BRIDGE	VOLTAGE
9	1	+VB1	(RES.)
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	-VB1	(+SUPPLY)
11	5	[+SENSE1_1/4B1]	+IN2
4	6	-SENSE1	-IN2
12	7	+VB2	(-SUPPLY)
5	8	+IN2	+IN3
13	9	-IN2	-IN3
6	10	-VB2	(GND) *
14	11	[+SENSE2_1/4B2]	+IN4
7	12	-SENSE2	-IN4
15	15	GND	(GND)
8	18	+5V	(+5V)
	13		
	14		
⏚	16	CHASSIS	CHASSIS
⏚	17	CHASSIS	CHASSIS

[ ] : 1/4 Bridge with UNI2-8 and DCB2-8
+SENSE with BR2-4 and UNI-4

* if special version with ±15 V option, then this pin 6 is the reference

ACC/DSUBM-		ENC4, ENC4-IU	FRQ2	DO-8	REL4	DAC4
DSUB Pin	Terminal	INC.-ENCODER	FREQUENCY	DIGITAL OUT	RELAIS	ANALOG OUT
9	1	+INA	+IN1	BIT1	IN1	
2	2	-INA	-IN1	BIT2	IN2	DAC1
10	3	+INB		BIT3	IN3	AGND
3	4	-INB		BIT4	IN4	
11	5	+INC	+IN2	BIT5	OFF1	DAC2
4	6	-INC	-IN2	BIT6	OFF2	AGND
12	7	+IND		BIT7	OFF3	
5	8	-IND		BIT8	OFF4	DAC3
13	9	+INDEX			ON1	AGND
6	10	-INDEX			ON2	
14	11	+5V	+5V	HCOM	ON3	DAC4
7	12	GND *	GND	LCOM	ON4	AGND
15	15	(-SUPPLY)		LCOM	(GND)	
8	18	(+SUPPLY)		OPDRN	(+5V)	
	13					
	14					
⏚	16	CHASSIS	CHASSIS	CHASSIS	CHASSIS	CHASSIS
⏚	17	CHASSIS	CHASSIS	CHASSIS	CHASSIS	CHASSIS

[ ] : 1/4 Bridge with UNI2-8 and DCB2-8
+SENSE with BR2-4 and UNI-4

* if special version with ±15 V option, then this pin 6 is the reference

ACC/DSUBM-		DI8	DI2-8	DI4-8	PWM
DSUB Pin	Terminal	DIGITAL IN	DIGITAL IN	DIGITAL IN	TTL PULSE
9	1	BIT1	+IN1	+IN1	PWM1_OPDRN
2	2	BIT2	+IN2	+IN2	PWM2_OPDRN
10	3	BIT3	-IN1/2	+IN3	PWM1_TTL
3	4	BIT4	+IN3	+IN4	PWM2_TTL
11	5	BIT5	+IN4	-IN1/2/3/4	PWM3_OPDRN
4	6	BIT6	-IN3/4	+IN5	PWM4_OPDRN
12	7	BIT7	+IN5	+IN6	PWM3_TTL
5	8	BIT8	+IN6	+IN7	PWM4_TTL
13	9	CLK	-IN5/6	+IN8	
6	10		+IN7	-IN5/6/7/8	
14	11	HCOM	+IN8	+HCOM	+5V
7	12	LCOM	-IN7/8	LCOM	GND
15	15	LCOM	LEVEL	LCOM	GND
8	18	LEVEL	LCOM	LEVEL	
	13				
	14				
	16	CHASSIS	CHASSIS	CHASSIS	CHASSIS
	17	CHASSIS	CHASSIS	CHASSIS	CHASSIS

[1] The DI4-8 plug is used by the latest digital input modules such as DI2-16 and the DI8-DO8-ENC4 multi-boards. In these cases, each 4-bit group has its own ground reference .

[2] The DI2-8 plug is used by the predecessor version DI-16. All of the plug's 8 bits share a common ground reference.

10.2.3 Special plug

Metal plug

ACC/DSUBM-		T4
DSUB Pin	Terminal	TH-COUPLE/RTD
9	1	+I1
3	2	(+SUPPLY)
2	3	+IN1
10	4	-IN1
11	5	+IN2
4	6	-IN2
5	7	+IN3
13	8	-IN3
14	9	+IN4
7	10	-IN4
12	11	(-SUPPLY)
6	12	-I4 (GND) *
	15	-I3
	18	+I2
15	13	GND
	14	+I3
	16	+I4
	17	-I1
	19	-I2
	20	CHASSIS

Metal plug

ACC/DSUBM-		I4	I2
DSUB Pin	Terminal	CURRENT	CURRENT
9	1	(RES.)	+SUPPLY1
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	(+SUPPLY)	-SUPPLY1
11	5	+IN2	
4	6	-IN2	
12	7	(-SUPPLY)	+SUPPLY2
5	8	+IN3	+IN2
13	9	-IN3	-IN2
6	10	(GND)	-SUPPLY2
14	11	+IN4	
7	12	-IN4	
15	15	(GND)	(GND)
8	18	(+5V)	(+5V)
	13		
	14		
⏚	16	CHASSIS	CHASSIS
⏚	17	CHASSIS	CHASSIS

DSUB-	ICP4	ICP2
Terminal	ICP	ICP
1	+ICP1	+ICP1
2	-ICP1	-ICP1
3	+ICP2	
4	-ICP2	
5	+ICP3	+ICP2
6	-ICP3	-ICP2
7	+ICP4	
8	-ICP4	
9		
10		
11		
12		
13		
14	CHASSIS	CHASSIS
15	CHASSIS	CHASSIS
16	CHASSIS	CHASSIS
17	+5V	+5V
18	AGND	AGND

* if the special version of the amplifier is equipped with the ±15 V option, then this pin 6 is the reference

Metal plug

ACC/DSUBM-		DO-HC-8
DSUB Pin	Terminal	DIGITAL OUT HIGH CURRENT
9	1	BIT1
2	2	BIT2
10	3	BIT3
3	4	BIT4
11	5	BIT5
4	6	BIT6
12	7	BIT7
5	8	BIT8
13	9	HCOM_1-4
6	10	LCOM_1-4
14	11	HCOM_5-8
7	12	LCOM_5-8
15	15	LCOM
8	18	OPDRN
	13	
	14	
⏚	16	CHASSIS
⏚	17	CHASSIS

Metal plug

ACC/DSUBM-		SYNTH4
DSUB Pin	Terminal	SYNTHESIZER
9	1	DOUT1
2	2	AOUT1
10	3	AGND
3	4	DOUT2
11	5	AOUT2
4	6	+5V
12	7	HCOM
5	8	AOUT3
13	9	AGND
6	10	DIN1
14	11	AOUT4
7	12	LCOM
15	15	LEVEL
8	18	OPDRN
	13	
	14	
⏚	16	CHASSIS
⏚	17	CHASSIS

10.2.4 TEDS plug

ACC/DSUBM-TEDS-		UNI2
DSUB Pin	Terminal	UNIVERSAL
9	1	+VB1
3	2	-VB1
2	3	+IN1
10	4	-IN1
11	5	I1_1/4B1 (1)
4	6	-SENSE1
5	7	+IN2
13	8	-IN2
14	9	I2_1/4B2 (1)
7	10	-SENSE2
12	11	+VB2
6	12	-VB2
15	15	TEDS_GND
8	18	(+5V)
	13	TEDS2
	14	TEDS1
⏚	16	CHASSIS
⏚	17	CHASSIS

ACC/DSUBM-TEDS-		B2	U4
DSUB Pin	Terminal	BRIDGE	VOLTAGE
9	1	+VB1	(RES.)
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	-VB1	(+SUPPLY)
11	5	[+SENSE1_1/4B1]	+IN2
4	6	-SENSE1	-IN2
12	7	+VB2	(-SUPPLY)
5	8	+IN2	+IN3
13	9	-IN2	-IN3
6	10	-VB2	GND
14	11	[+SENSE2_1/4B2]	+IN4
7	12	-SENSE2	-IN4
15	15	(GND), TEDS_GND	TEDS_GND
8	18	(+5V)	(+5V)
	13	TEDS1	TEDS1
	14	TEDS2	TEDS2
⏚	16	CHASSIS	CHASSIS
⏚	17	CHASSIS	CHASSIS
	19		TEDS3
	20		TEDS4

(1) if the special version of the amplifier is equipped with the ±15 V option, then this pin = -15 V
+SENSE with UNI-4 and corresponding measurement configuration

(2) if special version with ±15 V option, then this pin 6 is the reference

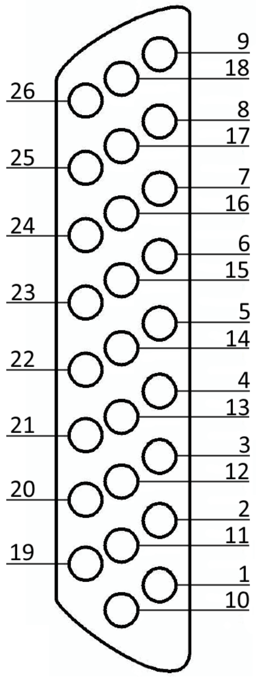
[ ] : 1/4 Bridge with UNI2-8 and DCB2-8

ACC/DSUBM-TEDS-		T4
DSUB	Terminal	TH-COUPLE/RTD
9	1	+I1
3	2	(+SUPPLY)
2	3	+IN1
10	4	-IN1
11	5	+IN2
4	6	-IN2
5	7	+IN3
13	8	-IN3
14	9	+IN4
7	10	-IN4
12	11	(-SUPPLY)
6	12	-I4
	15	-I3
	18	TEDS4
15	13	TEDS_GND
	14	+I3
	16	+I4
	17	TEDS3
	19	TEDS2
	20	TEDS1
	21	-I1
	22	+I2
	23	-I2
	24	CHASSIS

ACC/DSUBM-TEDS-		I4	I2
DSUB Pin	Terminal	CURRENT	CURRENT
9	1	(RES.)	+SUPPLY1
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	(+SUPPLY)	-SUPPLY1
11	5	+IN2	
4	6	-IN2	
12	7	(-SUPPLY)	+SUPPLY2
5	8	+IN3	+IN2
13	9	-IN3	-IN2
6	10	GND	-SUPPLY2
14	11	+IN4	
7	12	-IN4	
15	15	TEDS_GND	TEDS_GND
8	18	(+5V)	(+5V)
	13	TEDS1	TEDS1
	14	TEDS2	TEDS2
	16	CHASSIS	CHASSIS
	17	CHASSIS	CHASSIS
	19	TEDS3	
	20	TEDS4	

10.3 DSUB-26 pin configuration (high density)

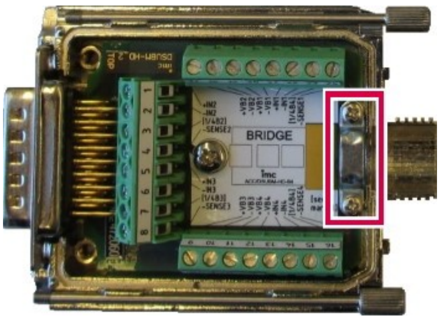
ACC/DSUBM-		HD-I4	HD-B4
DSUB	Klemme	CURRENT	BRIDGE
13	1	+IN2	+IN2
4	2	-IN2	-IN2
14	3		[+SENSE2_1/4B2]
5	4		-SENSE2
15	5	+IN3	+IN3
6	6	-IN3	-IN3
16	7		[+SENSE3_1/4B3]
7	8		-SENSE3
23	9	+SUPPLY3	+VB3
24	10	-SUPPLY3	-VB3
25	11	+SUPPLY4	+VB4
26	12	-SUPPLY4	-VB4
17	13	+IN4	+IN4
8	14	-IN4	-IN4
18	15		[+SENSE4_1/4B4]
9	16		-SENSE4
21	17	+SUPPLY2	+VB2
22	18	-SUPPLY2	-VB2
19	19	+SUPPLY1	+VB1
20	20	-SUPPLY1	-VB1
11	21	+IN1	+IN1
2	22	-IN1	-IN1
12	23		[+SENSE1_1/4B1]
3	24		-SENSE1



Please use the screw for a contact with Chassis.

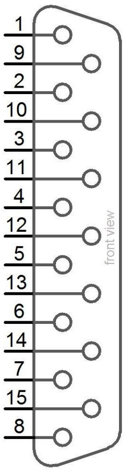
Example

The following picture shows the ACC/DSUBM-HD-B4 connector. To contact with Chassis please use marked screw displayed in the picture.



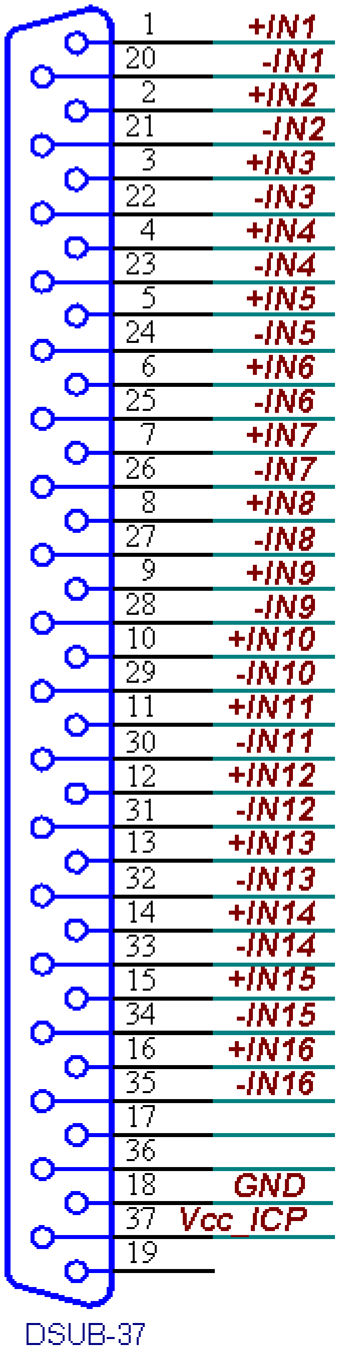
10.4 DSUB configuration of scanner SC2-32

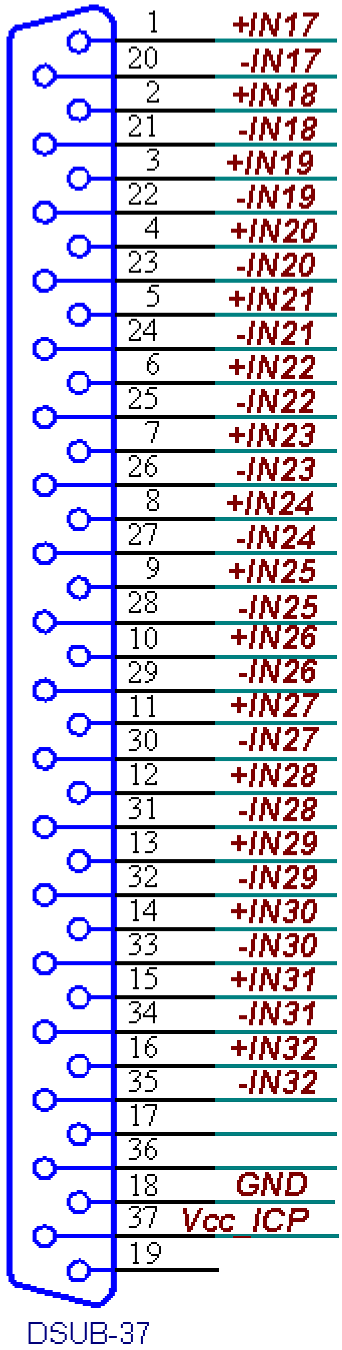
10.4.1 Variety 8 x DSUB 15



Pin	Signal	Plug 1	Plug 2	Plug 3	Plug 4	Plug 5	Plug 6	Plug 7	Plug 8
1	reserved								
9	reserved								
2	+IN A	+IN 17	+IN 21	+IN 25	+IN 29	+IN 1	+IN 5	+IN 9	+IN 13
10	-IN A	-IN 17	-IN 21	-IN 25	-IN 29	-IN 1	-IN 5	-IN 9	-IN 13
3	+V ext								
11	+IN B	+IN 18	+IN 22	+IN 26	+IN 30	+IN 2	+IN 6	+IN 10	+IN 14
4	-IN B	-IN 18	-IN 22	-IN 26	-IN 30	-IN 2	-IN 6	-IN 10	-IN 14
12	-V ext								
5	+IN C	+IN 19	+IN 23	+IN 27	+IN 31	+IN 3	+IN 7	+IN 11	+IN 15
13	-IN C	-IN 19	-IN 23	-IN 27	-IN 31	-IN 3	-IN 7	-IN 11	-IN 15
6	reserved								
14	+IN D	+IN 20	+IN 24	+IN 28	+IN 32	+IN 4	+IN 8	+IN 12	+IN 16
7	-IN D	-IN 20	-IN 24	-IN 28	-IN 32	-IN 4	-IN 8	-IN 12	-IN 16
15	GND								
8	Vcc ICP								

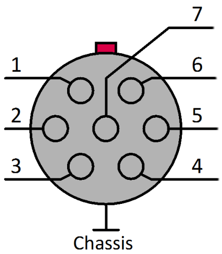
10.4.2 Variety 2 x DSUB 37





10.5 LEMO pin configuration

10.5.1 LEMO.1B (7-pin)



LEMO PIN	ISO2-8	ISOF-8(-SUPPLY, bipolar ±15 V)	C-8, OSC-16	LV3-8, LV-16, SC2-32	LV3-8-L-SUPPLY
1	+IN	+IN	+IN	+IN	+IN
2	-IN	-IN	-IN	-IN	-IN
3	+SUPPLY	+SUPPLY	+SUPPLY	+SUPPLY	+SUPPLY
4	GND (-SUPPLY*)	GND (-SUPPLY, -15 V)	GND (-SUPPLY*)	-SUPPLY (GND)	GND
5	TEDS OneWire	TEDS OneWire (SUPPLY GND) TEDS is omitted with ±15 V option	TEDS OneWire	TEDS OneWire	TEDS OneWire
6	PT100 current source	PT100 current source	PT100 current source	n.c.	-SUPPLY (-15 V)
7	+I (pos. signal input for current measurement)	+I (pos. signal input for current measurement)	n.c.	n.c.	n.c.

LEMO PIN	DCB2-8, B-8	UNI-8, UNI2-8	UNI-4	BR-4, BR2-4 **
1	+IN	+IN	+IN	+IN
2	-IN	-IN	-IN	-IN
3	+SUPPLY	+SUPPLY	+SUPPLY	+SUPPLY
4	-SUPPLY (GND)	-SUPPLY (GND)	-SUPPLY (GND)	-SUPPLY
5	TEDS (OneWire)	TEDS (OneWire)	TEDS (OneWire)	
6	-SENSE	-SENSE/PT100 current source	-SENSE	-SENSE
7	quarter bridge completion	quarter bridge completion / sense for PT100 3-wire configuration	+SENSE_1/4B	+SENSE

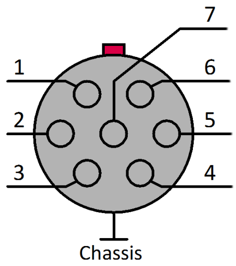
LEMO PIN	ENC-4, HRENC-4 ***
1	+IN X
2	-IN X
3	+SUPPLY
4	-SUPPLY (GND)
5	+INDEX
6	+IN Y
7	-IN Y

* sensor supply voltages available via the optional sensor supply module, see data sheet
Default ranges: +5 V to +24 V

** Upon request BR2-4 with TEDS - then with 8-pin LEMO (because -SUPPLY is not GND and is also not TEDS-GND)

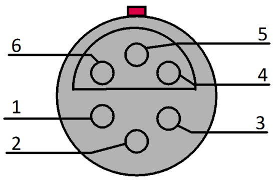
*** Reference of +INDEX is -SUPPLY (GND)
sensor supply voltage 5 VDC/ 100 mA (optional 300 mA)
other sensor supply voltages available via the optional sensor supply module

LEMO.1B (7-pin)



LEMO PIN	AUDIO2-4-MIC	SEN-SUPPLY-4	
1	reserved	+OUT	signal from the sensor, passed through to the amplifier
2	-IN / TEDS-Masse	-OUT	reference for the signal
3	polarization voltage	n.c.	pin 6 and 7 = n.c.
4	+IN	TEDS GND	reference for TEDS
5	TEDS	TEDS	scaling information, for analysis by TEDS-capable amplifiers
6	positive sensor supply		
7	negative sensor supply		
housing	device ground		

10.5.2 LEMO.1E (6-pin), WFT-2



view on the plug of the cable

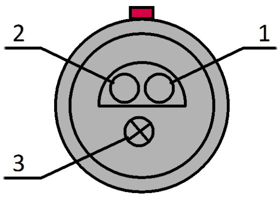
LEMO PIN	Signal
1	Command OUT
2	12 V POWER
3	Data OUT (normal)
4	Data OUT (invers)
5 and 6	GND

connection cable (H-CAB-LEM-WFT-*x*m: 6 m or 12 m cable length) between wheel force transducer and CRFX/WFT-2 module.

Reference WFT-documentation

A separate documentation describes setup and operation of the measurement wheel.

10.5.3 LEMO.1S (3-pin), ACI-8

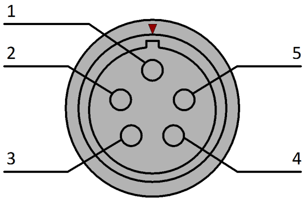


LEMO PIN	ACI-8
1	-IN X
2	+IN X
3	reserved

Reference

Please find here the ACI-8 description. 505

10.5.4 LEMO.1P (5-pin), HISO-8-L



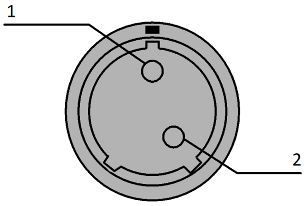
view on LEMO.1P socket

LEMO PIN	HISO-8-L
1	+IN
2	-IN
3	+I
4	+PT
5	-PT

Reference

Please find here the HISO-8 description. 182

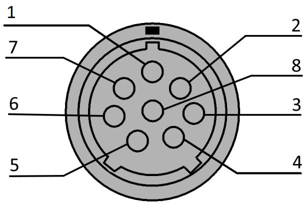
10.5.5 LEMO.2P (2-pin), HISO-8-T-8L



PIN	HISO-8-T-8L	Material
1	+IN	NiCr
2	-IN	Ni

Please find here the HISO-8 description. 182

10.5.6 LEMO.2P (8-pin), HISO-8-T-2L



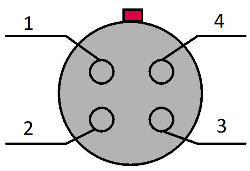
view on LEMO.2P socket

PIN	IN1..4 / Material	IN5..8 / material
1	+IN1 / NiCr	+IN5 / NiCr
2	-IN1 / Ni	-IN5 / Ni
3	+IN2 / NiCr	+IN6 / NiCr
4	-IN2 / Ni	-IN6 / Ni
5	+IN3 / NiCr	+IN7 / NiCr
6	-IN3 / Ni	-IN7 / Ni
7	+IN4 / NiCr	+IN8 / NiCr
8	-IN4 / Ni	-IN8 / Ni

Note **Manufacture of measuring cables**

To ensure that the working voltages specified for the channel isolation are reliably maintained, the cores must not be stripped too far during the manufacture of the measuring cables. The isolation of the cores must reach up to the solder cups. For a shielded cable, the exposed cable shield must be completely removed. As a rule, only suitable cables with sufficient isolation should be used.

10.5.7 LEMO.1B (4-pin), HANDLE



LEMO.1B.304 (additional output supply socket)

LEMO PIN	CRFX HANDLE POWER
1	50 V
2	GND
3 and 4	reserved

10.6 DSUB-9 pin configuration

10.6.1 Display

DSUB-PIN	Signal	Description	Use in device
1	DCD	Vcc 5V	connected
2	RXD	Receive Data	connected
3	TXD	Transmit Data	connected
4	DTR	5V	connected
5	GND	ground	connected
6	DSR	Data Set Ready	connected
7	RTS	Ready To Send	connected
8	CTS	Clear To Send	connected
9	R1	Pulldown to GND	connected

Supply for the graphical display

Connector	+9 V to 32 V	- (0V)	nc
Binder	1	2	3
Souriau	B	C	A

To the description 103 and the technical data of the displays 474.

10.6.2 GPS

DSUB-9		GPS 18 LVC	GPS 18 - 5Hz
Pin	Signal	Color	Color
1	Vin	Red	Red
2	RxD1*	White	White
3	TxD1	Green	Green
5	GND, PowerOff	2x Black	2x Black
7	PPS (1 Hz clock)	Yellow	Yellow
4,6,8 and 9	-	-	-

* Pin configuration at measurement device. At the GPS-mouse Rx and Tx are interchanged.

10.7 DSUB-9, CRFX/SEN-SUPPLY-4

Pin	Signal	Remarks
1	-IN	signal from the sensor
2	TEDS GND	reference for TEDS (no connection with GND)
3	n.c.	reserved
4	GND	reference for supply voltage ±SUPPLY
5	-SUPPLY	-15 V: supply line to sensor
6	+IN	signal from sensor
7	TEDS	TEDS-memory in the DSUB-9 plug
8	FAIL	sensor status: connection to GND = OK
9	+SUPPLY	+15 V: power supply to sensor

Find here the technical data 470 of the CRFX/SEN-SUPPLY-4 module.

10.8 APPMOD

RS 232

Signal	PIN
n.c.	1
RX	2
TX	3
n.c.	4
DG	5
n.c.	6
RTS	7
CTS	8
n.c.	9

RS 422 / RS 485 Full-Duplex

Signal	PIN
Rx+	2
Rx-	8
TX+	3
Tx-	7

RS 485 Half-Duplex

Signal	PIN
+D	3
-D	7

10.9 Pin configuration of the fieldbusses

10.9.1 CAN, CAN FD Interface

DSUB-PIN	Signal	Description	Use in device
1	+CAN_SUPPLY	optional supply for a CRXT Base Unit	output current I < 1 A (permanently) both CAN nodes together,see CRXT technical specs 329
2	**CAN_L**	**dominant low bus line**	connected
3	**CAN_GND**	**CAN Ground**	connected
4	nc	reserved	do not connect
5	-CAN_SUPPLY	optional supply for a CRXT Base Unit	unused as per standard* (supply I < 1 A)
6	**CAN_GND**	**optional CAN Ground**	connected
7	**CAN_H**	**dominant high bus line**	connected
8	nc	reserved (error line)	do not connect
9	nc	reserved	do not connect

Find here the technical data 460 and the cabling 121 of the CAN-Bus interface.

10.9.2 LIN-Bus (DSUB-9)

DSUB-PIN	Signal	Description
3	**LIN_GND**	LIN Ground
6	**LIN_GND**	Optional LIN Ground
7	**LIN_INPUT/OUTPUT**	LIN bus line
1, 2, 4, 5, 8 and 9	n.c.	

Find here the technical data 462 and the cabling 122 of the LIN-Bus interface.

10.9.3 FlexRay-Bus (DSUB-9)

imc standard: One DSUB-9 socket with two channels

DSUB-Pin	Signal	Description
1	nc	
2	BM channel A	negative bus line channel A
3	GND	FlexRay ground
4	BM channel B	negative bus line channel B
5	GND	FlexRay ground
6	nc	
7	BP channel A	positive bus line channel A
8	BP channel B	positive bus line channel B
9	nc	

Option: Two DSUB-9 sockets (CON1 and CON2) with one channel each

DSUB-Pin	CON1	CON2
1	nc	nc
2	BM channel A (negative bus line channel A)	BM channel B (negative bus line channel B)
3	GND	GND
4	nc	nc
5	GND	GND
6	nc	nc
7	BP channel A (positive bus line channel A)	BP channel B (positive bus line channel B)
8	nc	nc
9	nc	nc

Find here the technical data 463 and the cabling 122 of the FlexRay-Bus interface.

10.9.4 XCPoE (RJ45)

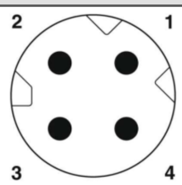
Standard Ethernet 1x RJ45. Find here the technical data 465 and the cabling 122 of the XCPoE interface.

10.9.5 EtherCAT (RJ45, M8)

CRFX modules are connected as load to be supplied to all 8 wires of the network cable, i.e. both the 4 data lines and the 4 additional free wires. In this sense (a redundant use of data and free lines) the concept is PoEC compliant – i.e. also to standard PoEC Power-Injectors 42.

M8 socket

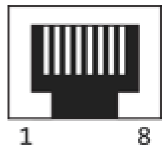
Pin	Signal
1	+TxD
2	+RxD
3	-TxD
4	-RxD



M8 socket, D-coded
(view on top of the stitches)
e.g. imc CRONOS-XT base (CRXT)

RJ45 socket

Pin	Signal
1	+TxD
2	-TxD
3	+RxD
6	-RxD
4, 5, 7, 8	unused



view on top of the RJ45 socket

Note imc CRONOS*flex* (CRFX) Base Unit

The CRFX base, as the power master, **feeds only on the free wires**.
We recommend a separate transmission of data and voltage, i.e. the use of all 8 pins.

FAQ

Are all 8 pins to be used?

No, not in every case: to supply the CRFX module the 4 data pins are sufficient, for example if a power injector is used.

Yes, if a CRFX base is used as power source.

How can I prevent the transmission of Power over EtherCAT?

Use a four-wire RJ45 cable with only pins 1,2,3 and 6 connected. This way the passive PoE is not transmitted.

Reference

Find here the technical data 462 and the cabling 126 of the EtherCAT-Bus interface.

Accessories

EtherCAT cable (CRXT system bus or ECAT Slave)		
CRXT/CABLE-ECAT-M8-2M	EtherCAT cable CRXT, on both sides M8-plug, 2 m	11100079
CRXT/CABLE-ECAT-M8-RJ45-2M	EtherCAT cable CRXT, on one side M8-plug to RJ-45, 2 m	11100080
CRXT/CABLE-ECAT-M8-10M	EtherCAT cable CRXT, on both sides M8-plug, 10 m	11100086
CRXT/CABLE-ECAT-M8-RJ45-10M	EtherCAT cable CRXT, on one side M8-plug to RJ-45, 10 m	11100087

10.9.6 ARINC-Bus (DSUB-15)

CON 1					
ARINC-Interface with 8 Rx channels			ARINC-Interface with 8 Rx and 4 Tx channels		
DSUB Pin	Signal	Description	DSUB Pin	Signal	Description
Standard 4x Rx			Standard 4x Rx; 2x Tx		
1	Rx1A	receiving channel 1A	1	Rx1A	receiving channel 1A
9	GND	GND	9	Tx1A	sending channel 1A
2	Rx1B	receiving channel 1B	2	Rx1B	receiving channel 1B
10	GND	GND	10	Tx1B	sending channel 1B
3	Rx2A	receiving channel 2A	3	Rx2A	receiving channel 2A
11	GND	GND	11	GND	GND
4	Rx2B	receiving channel 2B	4	Rx2B	receiving channel 2B
12	GND	GND	12	GND	GND
5	Rx3A	receiving channel 3A	5	Rx3A	receiving channel 3A
13	GND	GND	13	Tx2A	sending channel 2A
6	Rx3B	receiving channel 3B	6	Rx3B	receiving channel 3B
14	GND	GND	14	Tx2B	sending channel 2B
7	Rx4A	receiving channel 4A	7	Rx4A	receiving channel 4A
15	GND	GND	15	GND	GND
8	Rx4B	receiving channel 4B	8	Rx4B	receiving channel 4B

CON 2					
ARINC-Interface with 8 Rx channels			ARINC-Interface with 8 Rx and 4 Tx channels		
DSUB Pin	Signal	Description	DSUB Pin	Signal	Description
Standard 4x Rx			Standard 4x Rx; 2x Tx		
1	Rx5A	receiving channel 5A	1	Rx5A	receiving channel 5A
9	GND	GND	9	Tx3A	sending channel 3A
2	Rx5B	receiving channel 5B	2	Rx5B	receiving channel 5B
10	GND	GND	10	Tx3B	sending channel 3B
3	Rx6A	receiving channel 6A	3	Rx6A	receiving channel 6A
11	GND	GND	11	GND	GND
4	Rx6B	receiving channel 6B	4	Rx6B	receiving channel 6B
12	GND	GND	12	GND	GND
5	Rx7A	receiving channel 7A	5	Rx7A	receiving channel 7A
13	GND	GND	13	Tx4A	sending channel 4A
6	Rx7B	receiving channel 7B	6	Rx7B	receiving channel 7B
14	GND	GND	14	Tx4B	sending channel 4B
7	Rx8A	receiving channel 8A	7	Rx8A	receiving channel 8A
15	GND	GND	15	GND	GND
8	Rx8B	receiving channel 8B	8	Rx8B	receiving channel 8B

Find here the technical data 467 and the cabling 122 of the ARINC-Bus interface.

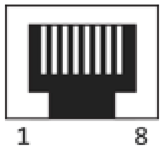
10.9.7 PROFIBUS (DSUB-9)

DSUB-PIN	Signal	Description
3	**DATA+**	**B-Line**
5	**GND**	**PROFIBUS Ground**
8	**DATA-**	**A-Line**
1, 2, 4, 6, 7 and 9	n.c.	

Find here the technical data 463 and the cabling 123 of the PROFIBUS interface.

10.9.8 PROFINET (RJ45)

Pin configuration of the network socket type modular 8P8C	Pin	Signal
	1	TX+
	2	TX-
	3	RX+
	6	RX-
	4, 5, 7, 8	via RC to ground



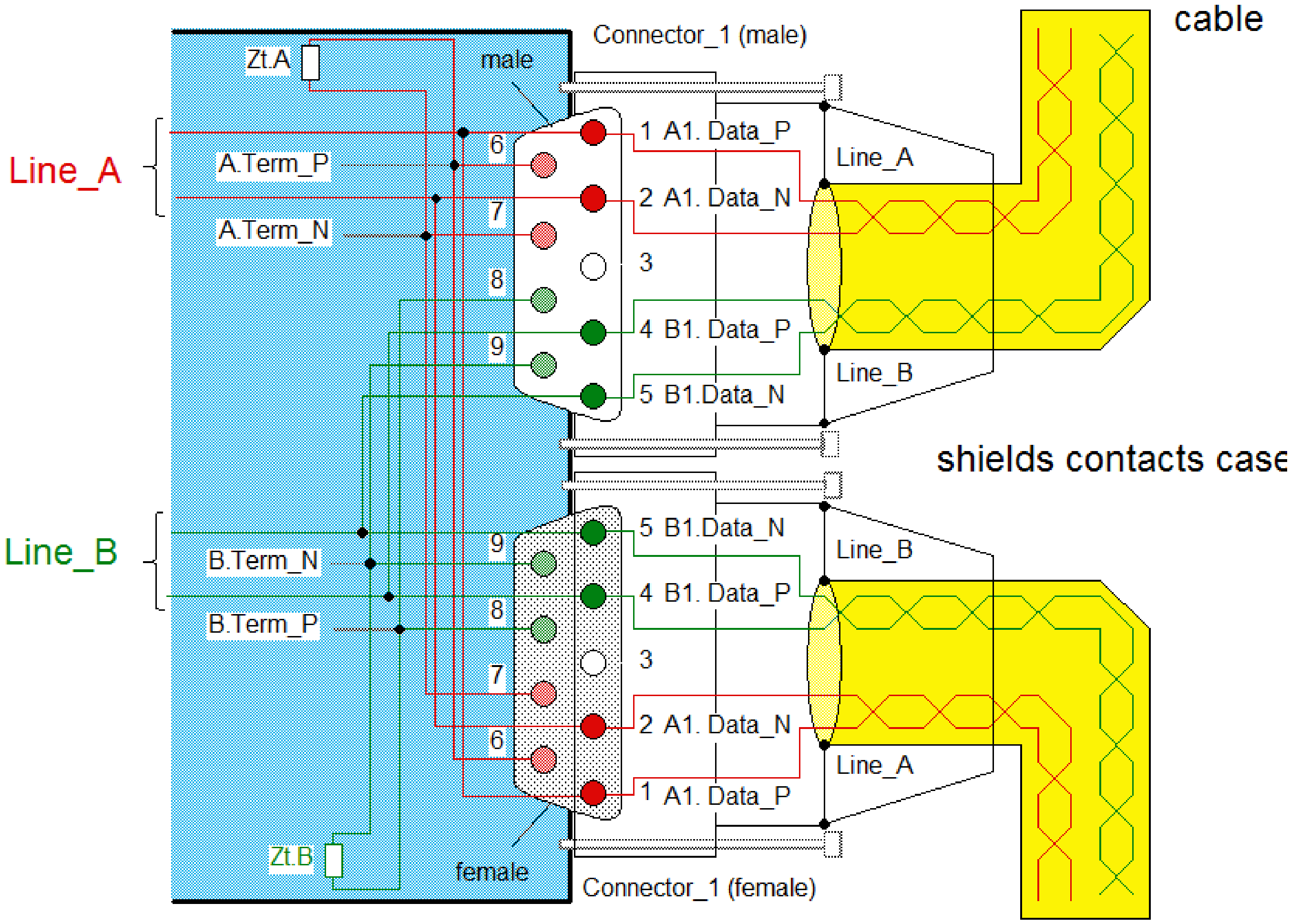
Find here the technical data 464 and the cabling 122 of the PROFINET interface.

10.9.9 MVB-Bus (DSUB-9)

10.9.9.1 EMD Pin configuration - DSUB-9

EMD connection with double-occupancy. Standard DSUB-9 terminals are used.

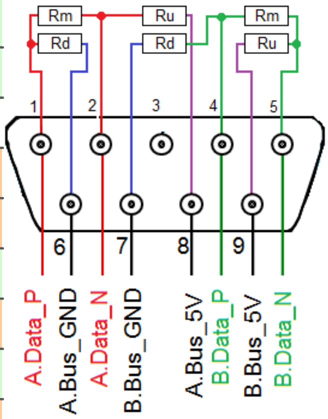
DSUB-PIN	Signal	Description	as termination terminal
1	A1. Data_P	data line A	jumper to 6
2	A1. Data_N	data line A	jumper to 7
3	NC	not connected	
4	B1. Data_P	data line B	jumper to 8
5	B1. Data_N	data line B	jumper to 9
6	Terminator A	internal	jumper to 1
7	Terminator A	interna	jumper to 2
8	Terminator B	interna	jumper to 4
9	Terminator B	interna	jumper to 5

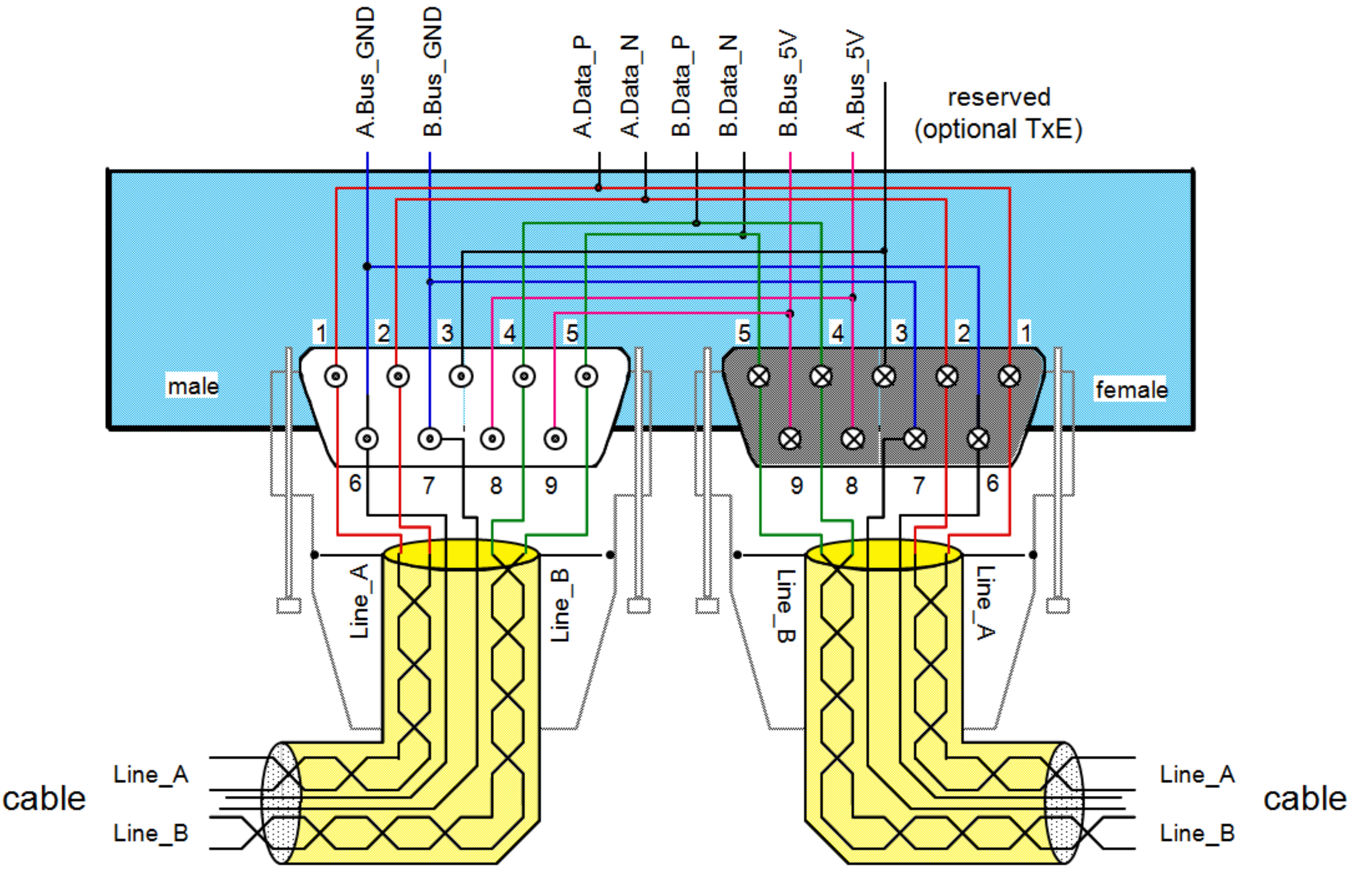


Internal wiring for EMD connection

10.9.9.2 ESD Pin configuration - DSUB-9

ESD Connection. Standard DSUB-9 terminals are used.

DSUB-PIN	Signal	Description	Termination
1	A. Data_P	Data lead A	
2	A. Data_N	Data lead A	
3	NC	not connected	
4	B. Data_P	Data lead B	
5	B. Data_N	Data lead B	
6	A.Bus_GND	Ground A	
7	B.Bus_GND	Ground B	
8	A.Bus_5V	5V Supply A	
9	B.Bus_5V	5V Supply B	



DSUB connection for ESD

Find here the technical data 466 and the cabling 124 of the MVB-Bus interface

10.10 Pin configuration of the REMOTE socket

Reference	Remote control

The assignment and the description of the modes can be found in the chapter "Start of operation 47".

10.11 XT-Con

Sealing and circular plugs/sockets (XT-Con)

The connection technology of the CRXT base units uses sealed DSUB-9 and circular plugs of type "XT-Con". This plug/socket family is available from imc as an accessory and has the following properties:

- XT-Con is mechanically compatible with sealed LEMO.1T series:
  However, the specified tightness is only guaranteed with the appropriate plugs (XT-Con) available from imc as accessories!
- XT-Con is not compatible with the LEMO.1B series:
  This LEMO plug family is not mechanically compatible and does not snap and latch!

The standard AC/DC power adaptor is not sealed. IP65 compatible adaptors are available as optional accessories, as well as sealed connector plugs for installation in vehicles, etc.

The same applies to network cables with RJ-45 plugs: The cable included in the standard scope of delivery is a non-sealed laboratory version for commissioning purposes. A cable is available as an accessory with the RJ-45 plug sealed on one side and suitable for connection to standard equipment such as computers or network switches on the other side.

The standard connection technology for amplifier modules is sealed DSUB-15 sockets. When equipped with other customer-specific plugs such as LEMO.1B, the respective IP ratings of the selected plugs apply to the complete device.

The sockets on the device side must be sealed either with the supplied sealed protective caps or with suitable sealing plugs.

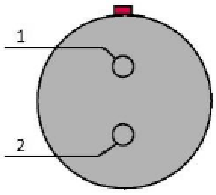
DSUB-15 Plug

For modules with DSUB-15 connection technology, the convenient imc terminal plugs for solderless screw terminal connection are available as optional accessories. These are to be used in the special IP65 version. This applies regardless of whether sealing properties are required: The simple standard terminal plugs have shorter locking screws and therefore cannot be fixed to CRXT devices. The two types are not mutually compatible, but long screws are available as accessories for retrofitting: long bolts: only for CRXT, short standard bolts: only for CRFX, CRC, C-SERIES, etc.

The DSUB plugs are made of robust metal and adapt the signals of the DSUB-15 sockets to solderless screw terminals.

Power supply

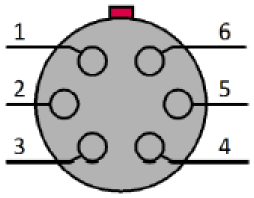
The Power Module is equipped with a XT-Con socket for an ultra-wide DC power input. The DC power input is not designed for a connection to a DC-grid according to EN 61326-1.



Supply, XT-Con
View on the socket at the slice

PIN	Signal
1	+Supply
2	-Supply

Remote



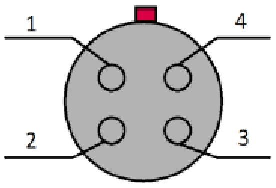
Remote, XT-Con
View on the socket at the slice

CRXT base unit	
PIN	**Signal**
1	GND
2	REMOTE switch
3	GND
4	REMOTE push button
5, 6	n.c.

CRXT/POWER-X	
PIN	**Signal**
1	GND
2	REMOTE switch
3	GND
4	REMOTE push button
5	GND
6	reserved

Optional accessory: CRXT/REMOTE-PLUG (11100036), XT-Con (6-pin)

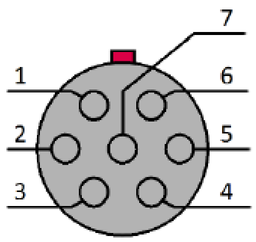
SYNC



SYNC, XT-Con

PIN	Signal
1	SYNC
2	GND
3	reserved
4	reserved

Display and GPS



Display, XT-Con
View on the socket

PIN	Signal
1	5V
2	RxD
3	TxD
4	CTS
5	GND
6	RTS
7	n.c.

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B

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imc ACADEMY - Training center

The safe handling of measurement devices requires a good knowledge of the system. At our training center, experienced specialists are here to share their knowledge.

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