An Axiometrix Solutions Brand

imc SPARTAN

Manual

Edition 15 - 2025-02-28

imc SPARTAN-4-N

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 Welcome to imc SPARTAN

imc SPARTAN Manual | Edition 15 - 2025-02-28

An Axiometrix Solutions Brand

imc SPARTAN

Manual

Thank you for deciding to purchase our product. We wish you total success in accomplishing your measurement assignments with the help of your imc measurement instruments and the imc measurement software.

In this manual, you will find a detailed description of how to operate your imc instrument.

Tech support

If you have any open questions about our products, please contact our tech support.

Questions or problems? Contact our Tech support 8.

Copyright

2 General introduction

2.1 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 8 will be happy to receive your feedback.

2.2 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.

2.3 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.

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.

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 8.

Notes on radio interference suppression

imc SPARTAN devices 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 imc SPARTAN devices 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 imc SPARTAN devices 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.

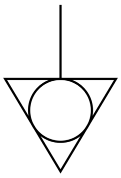
2.4 Explanation of symbols

CE Conformity

see CE chapter 1.2 8

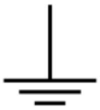
No household waste

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 8.



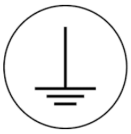
Potential compensation

Connection for potential compensation



Grounding

Connection for grounding (general, without protective function)



Protective connection

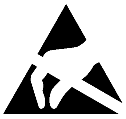
Connection for the protective conductor or grounding with protective function

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

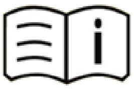
Supply of the device via a DC voltage source (in the specified voltage range)

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 8). 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).

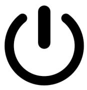
Labeling integrated energy sources

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)

2.5 History

Amendments and bug-fix in Edition 15

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 Edition 14

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

Amendments and bug-fix in Edition 13

Section	Amendments
Batteries	new battery labeling on the name plate

Amendments and bug-fix in Edition 12

Section	Amendments
Device overview	updated overview

3 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.

Responsibility of the operator

imc SPARTAN is 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 imc SPARTAN device 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.

Industrial safety

We certify that imc SPARTAN 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 SPARTAN series, 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).

* 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.

4 Assembly and connection

4.1 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 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.

4.2 Before commissioning

Condensation may form on the circuit boards when the device is moved from a cold environment to a warm one. In these situations, always wait until the device warms up to room temperature and is completely dry before turning it on. The acclimatization period should take about 2 hours. This is especially recommended for devices without ET (extended environmental temperature range).

We recommend a warm-up phase of at least 30 min prior to measure.

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.

4.3 Notes on connecting

4.3.1 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:

I. the device is visibly damaged,
II. loose parts can be heard within the device,
III. the device does not work
IV. 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 data in the chapter "Technical Specifications", 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 protection 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. If you are using a removable storage media, observe the notes in the imc software manual.
   Particular care should be taken to comply with the storage device's max. ambient temperature limitation.
5. Avoid prolonged exposure of the device to sunlight.

4.3.2 Power supply

The device is powered by a DC-supply voltage which is supplied via a 2-pole LEMO-plug.

Device	LEMO plug type designation	Size
imc SPARTAN	FGG.**1B**.302.CLAD.52ZN	middle
imc SPARTAN-N, imc SPARTAN-R	FGG.**2B**.302.CLAD.82ZN	big

The permissible supply voltage range is 10 to 32 V (DC) at 130 W max. consumption. The product package includes either a corresponding desktop supply unit with 24 V , DC and a max. power consumption of 150 W or a desktop supply unit with 15 V, DC and a max. power consumption of 60 W. The mains voltage is 110 V to 240 V 50/60 Hz. 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.

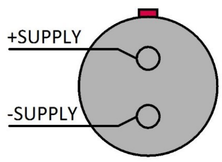
Note

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!

If the LEMO-plug is assembled with an appropriate cable it 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 provided. If the supply voltage source has a ground reference (ground connected to the (–) terminal), then the device is automatically grounded via the (–) terminal. The table-top power supply unit is configured in this manner.
- 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:

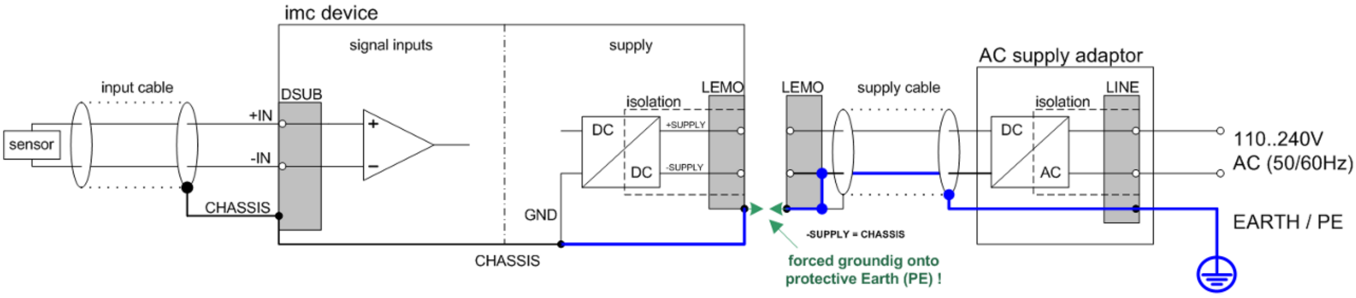


The +pin is marked with a red dot.

4.3.3 Grounding, shielding

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.

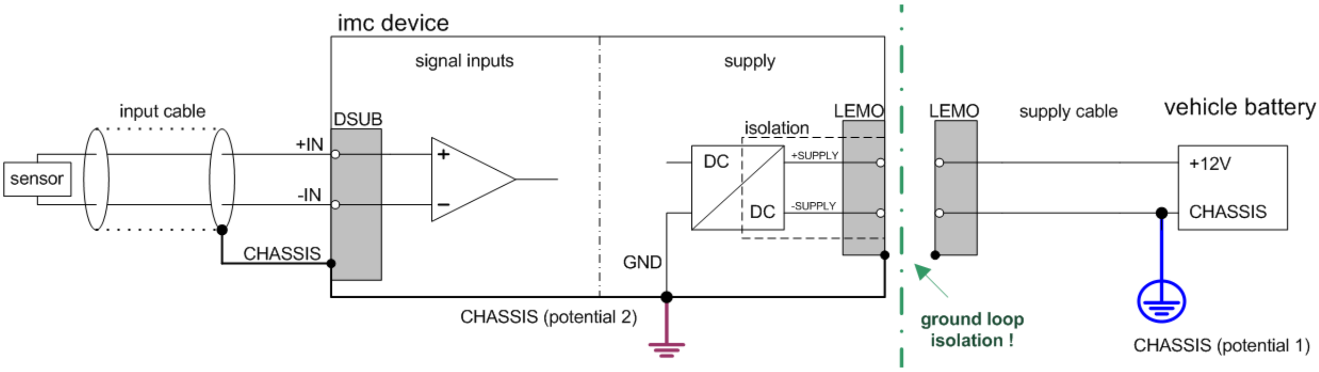
4.3.3.1 Grounding with the use of the included power adaptor



imc SPARTAN system with AC/DC power adapter

Use of the included table-top power adapter is protected by the power plug's protection ground connection: at the adapter's LEMO terminal, both the (-) pole of the supply voltage as well as the shielding and connector pod are connected with the power cable's protection ground.

4.3.3.2 Grounding with power supplied by a car battery



imc SPARTAN system with isolated from the housing (CHASSIS)) input with isolated DC-supply (e.g. 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.

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 connector'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.

4.3.3.3 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 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.

4.3.4 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. Any potential differences among devices may have to be evened out using an additional line having adequate cross section.

If the synchronized devices are at different voltage levels, they should be compensated by means of a lead having the appropriate cross-section. If the SYNC plug at your device is equipped with a yellow ring it is already isolated and it is protected against potential differences.

Note

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

4.3.5 Fuses (polarity-inversion protection)

The device supply input is equipped with maintenance-free polarity-inversion protection. No fuses or surge protection is provided here. Particularly upon activation of the device, high current peaks are to be expected. When using the device with a DC-voltage supply and custom-designed supply cable, be sure to take this into account by providing adequate cable cross-section.

4.3.6 Powering on

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

4.3.7 Powering off

In order to shut down the device the button must be pressed down again for approx. 1 s. During the deactivation the "POWER"-LED is blinking constantly. The measured files on the internal hard drive involved are closed before the device switches off by itself. This process takes up to 10 s. Holding the power-on button down is not necessary.

If no measurement is currently running, it takes only approx. one second for the device to be deactivated.

4.3.8 Remote control

imc SPARTAN measurement devices can be switched on and off remotely, by control signals that are accessible at the device's "REMOTE" terminal. These can be operated by externally installed manual switches, relay contacts or electronic switching elements.

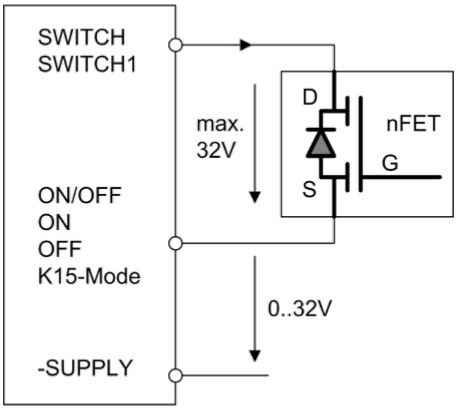
Depending on the different supply unit variants, used by the various imc SPARTAN types, several distinct switching functions and operating modes are available as described in the tables below. The main operating mode, available for all types, is the basic ON/OFF push button action performed with one single temporarily closing contact: Connecting the signals "ON/OFF" (Pin13) and "SWITCH" (Pin2) for at least a short time, activates the device as with the green main switch . Once powered up, the device can be switched off by connecting the two signals once again, that means at least releasing the connection and connecting again.

Reference

Pinbelegung der REMOTE Buchse 193

Note

- If pins 2 and 13 are connected via a closed two-way switch, the device remains activated throughout. The devices' green push-button has no effect in such a case!
- In order to turn the device off, the switch must be opened and then closed again (behavior of a push button switch)
- When using electronic switching elements (like FET or bipolar transistors), voltage levels and direction of current flow has to be considered:



4.3.9 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).

4.3.9.1 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 in the software manual under "*Device properties*" > "*Property: UPS*".

4.3.9.2 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.

4.3.9.3 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 (8.1 V for SPARTAN with not isolated supply 19). 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 (8.1 V for SPARTAN with not isolated supply 19), 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!

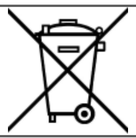
Note

- 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).

4.3.10 Rechargeable accumulators and batteries

imc SPARTAN devices contain maintenance-free lead-gel batteries. Charging these 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 rechargeable batteries contained in the device must not be thrown into household waste. Used batteries must be sent to the public collection points.

References

- The technical data of the batteries contained in the device can be found in the manual or data sheet.
- imc SPARTAN devices delivered by imc after November 2022 will have a "battery label" 12 on the nameplate for integrated energy sources.

4.3.11 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.

4.3.11.1 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.

4.3.11.1.1 Storage media

Storage media	Description
CF Cards (Compact Flash)	For devices of group A4 and A5 43: The device group exclusively uses CF cards for storage medium.

Storage media	Description
SSD	Applicable to devices having a hard drive (see "*Device overview* 43"). • With SSD hard drives, **Hot-Plug** 24 **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 25. • 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 29. • **In addition to** the SSD, a CF/CFAST-card can be inserted in the measurement device and used **alternatively**.

4.3.11.1.2 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

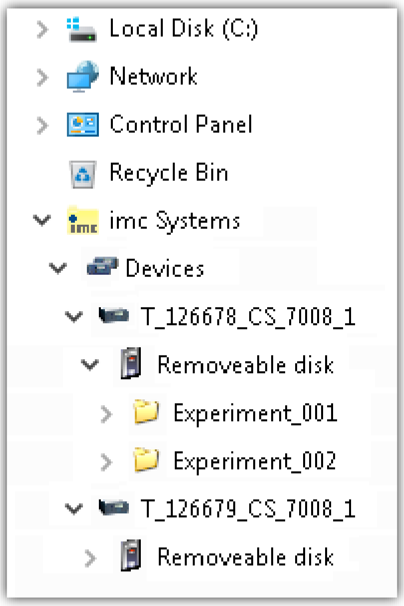
A tip on **interval saving**: Supposing the system's power supply suffers an outage during a measurement, it would not be possible to guarantee that the data file on the storage medium is terminated properly. This may lead to a failure to record the last measurement taken. Saving at intervals is a way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

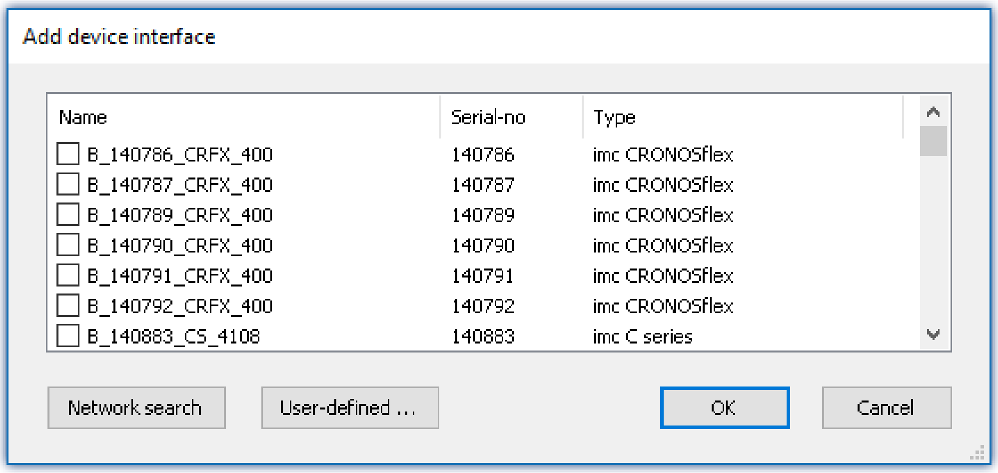
In order to get access to your device's storage medium, you must first add it to the tree diagram (see "*imc Systems - Adding a device* 27"). Subsequently, you are able to navigate to the desired data in the storage medium and thus to work with them.

4.3.11.1.2.1 imc Systems - Adding a device (Add)

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

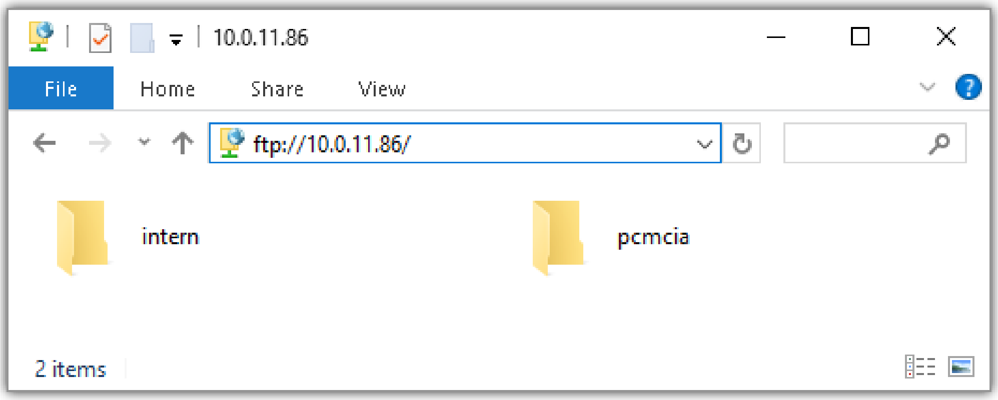
More information is presented in the imc STUDIO manual in the section: "*Setting Up - Connect the device*"

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

4.3.11.1.2.2 FTP access

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).

4.3.11.1.3 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 29 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* 29".
- 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.

4.3.11.1.3.1 Formatting

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.

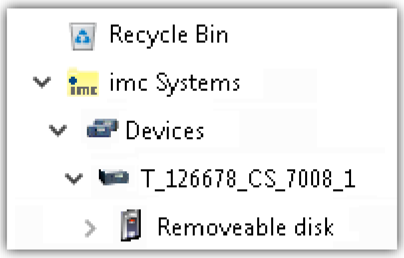
Note Cluster size - Avoidance of Data Overflow

The size and number of assignment units (clusters) and thus also the file system 29 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* 25 " 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!*".

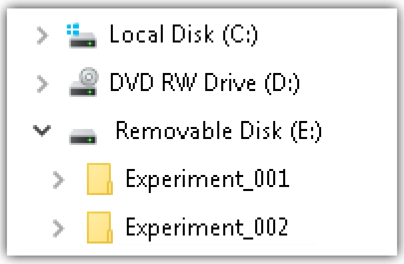
The device performs the formatting according to the following rule:

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** 28, 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 29.

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.

4.3.11.1.4 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 8.
The system won't recognize the data storage drive	• Answer 1: Check the file system: The device supports FAT32/FAT16 29. • 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 29, 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 29, data overflow can occur if a high aggregate sampling rate is generated by very many low-speed channels.

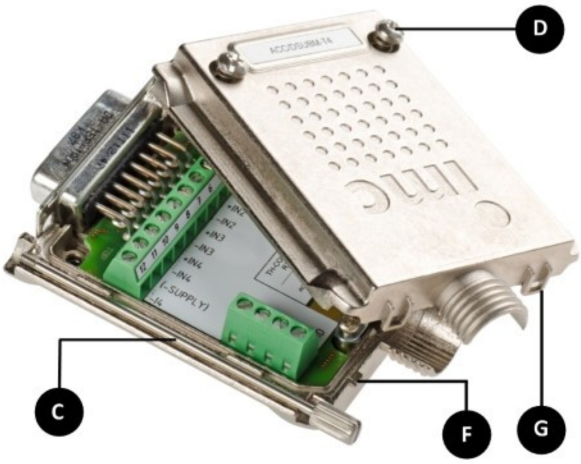
4.3.12 Signal connection

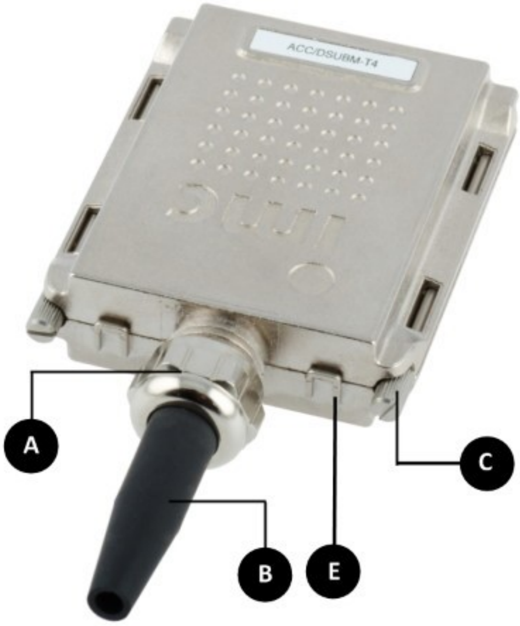
For devices with DSUB-15 connection technology, the convenient imc terminal plugs for solderless screw terminal connection are available as optional accessories.

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

Open the Metal connector:

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 connector:

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 180.

5 Maintenance and servicing

5.1 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.

5.2 Cleaning

- Always unplug the power supply before cleaning the device. Only qualified personnel 13 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.
- Be certain that the ventilation slits remain unobstructed.

5.3 Storage

As a rule, the measurement device must be stored in a temperature range of -40°C to +85°C.

5.4 Transport

When transporting, always use the original packaging or a appropriate packaging which protects the device against knocks and impacts. 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.

6 Start of operation Software / Firmware

6.1 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.

6.1.1 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.

6.2 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* 36" 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.

6.3 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.

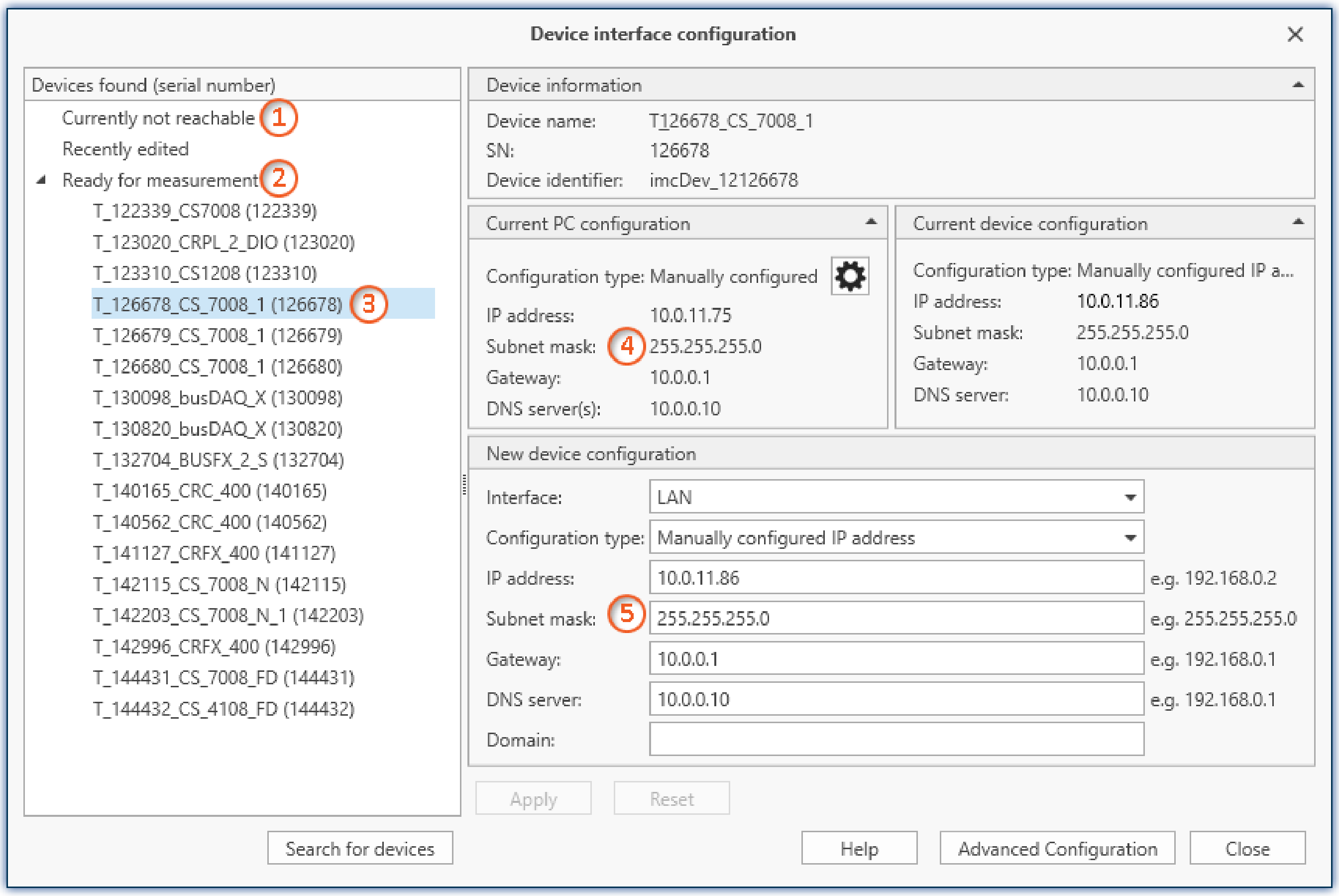
Ribbon	View
Setup-Configuration > Device interfaces ()	Complete

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

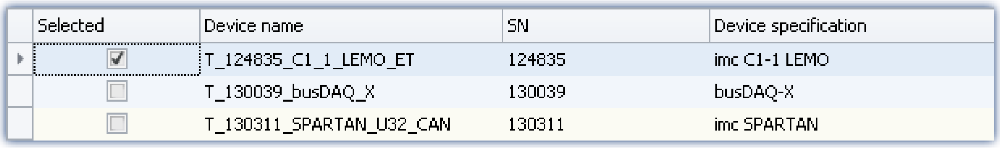
If the connection to the device is established via a modem or WLAN, start the program "*imc DEVICES Interface Configuration*" by clicking on the button: "*Advanced Configuration*" (see previous figure). An exact description is found in the software manual chapter: "*Setting Up - Connect the device*"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

6.4 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.

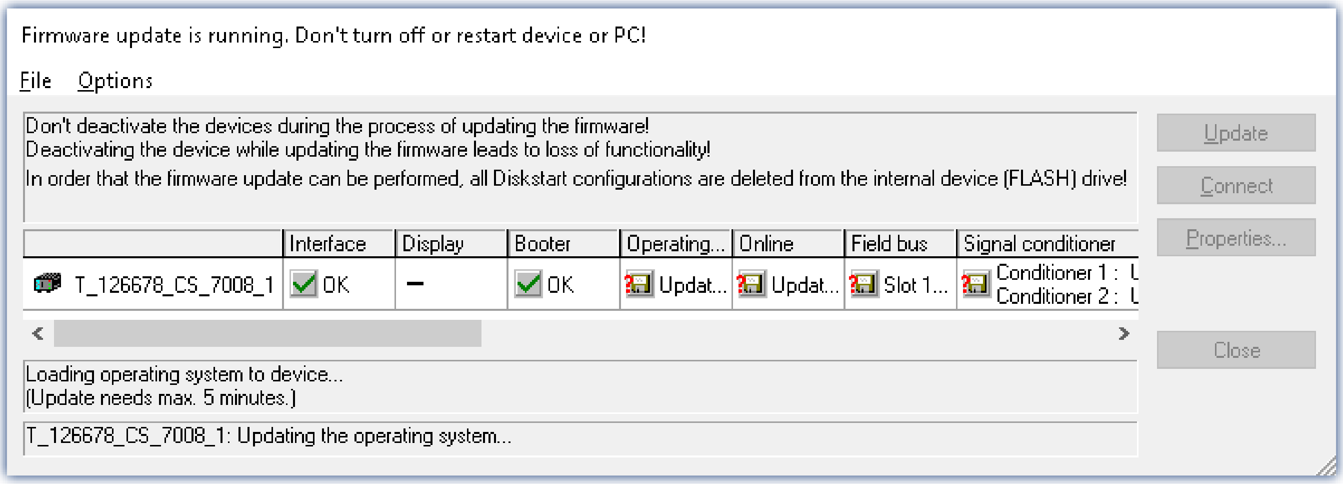
Warning Do not interrupt the firmware update!

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

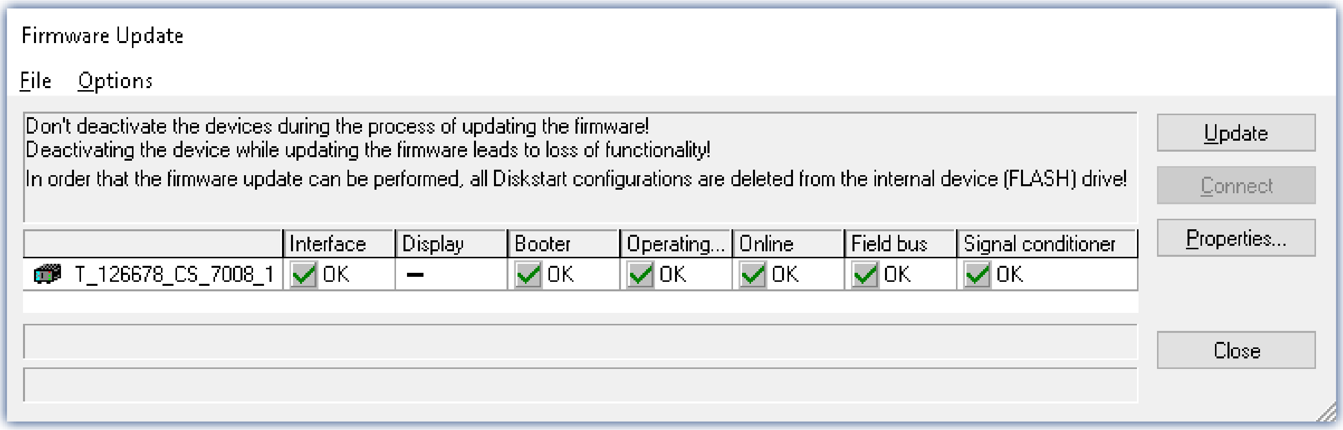
The following symbols for the individual firmware components appear in the list:

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 8. 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.

7 Properties of the imc SPARTAN

imc SPARTAN-N is a family of compact measurement instruments with 21 to 128 channels. Depending on the actual system configuration, that needs to be selected upon order, the devices will be equipped ex-factory with certain modules (T16, U16, B16, BCF16, LVDT16) that enable precise measurements of voltage, current (20 mA), temperature (thermocouples and PT100 and bridge (DC and CF mode) as well as LVDT.

The basic standard configuration of all imc SPARTAN instruments always includes 16 digital inputs, 8 digital outputs, 4 incremental counter inputs for the measurement of RPM, velocity or displacement, or for direct counting of pulses.

Furthermore individual expansions are interfaces for fieldbus systems from the automotive, avionics, railway engineering, industrial automation sector (e.g. CAN FD, FlexRay, XCPoE, ARINC, MVB, EtherCAT).

7.1 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

7.2 SPARTAN device properties

Independent of the particular housing model, all devices have the following properties:

- Up to 512 channels can be recorded, including Fieldbus channels.
- The connection is made via TCP/IP at data rates of up to 100 Mbit.
- A **UPS** buffers against power outages and closes the measurement properly in case the outage continues for a long time.
- The devices can be operated using a **hand-held terminal.**
- Extensive, intelligent **trigger functions**
- **Auto-start capability** independent of the PC.

7.2.1 Operating software

- imc BUSDAQ*flex*, imc BUSDAQ, imc SPARTAN, imc C-SERIES and measurement devices from the imc CRONOS-series is operated using the operating software **imc STUDIO**. The operating software enables complete manual and automatic setting of the measurement parameters, real-time functions, trigger machines and data saving modes. Display of measurement plots in the curve window and, as well as experiment documentation in the Report Generator, are integral elements of the software. There are extensive triggering options and data storage options adapted to particular applications. Together with the supplementary software imc Online FAMOS, the raw data can be processed in real time to yield the result data in the desired format, and can be displayed.
- imc CANSAS modules can be configured directly from the operating software if the imc CANSAS software is on the same computer. A separate connection from the imc CANSAS module to the PC, e.g. via a USB-CAN adapter, is not necessary. This is also the case for SPARTAN devices with CAN.
- For special tasks such as system integration in test rigs, there are comfortable interfaces for all common programming languages like Visual Basic ™, Delphi ™ or LabVIEW.

7.2.2 Sampling interval

Among the system's physical measurement channels, up to two different sampling times can be in use. For the possible sampling time see the technical specification in this manual.

The sampling rates of the **virtual channels** computed by imc Online 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).

There is one constraint when selecting two different sampling rates: **Two sampling rates** having the ratio 2:5 and lower than 1ms are not permitted (e.g. 200 µs and 500 µs).The sampling rates of **Fieldbus channels** are not subject to any particular rule and may be as diverse as desired. The **aggregate sampling** rate of the system is the **sum of the sampling rates** of all active channels.

7.3 Measurement types

7.3.1 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 IPTS-68.

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.

7.3.1.1 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**.

7.3.1.2 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).

7.3.1.3 imc Thermo plug (T4)

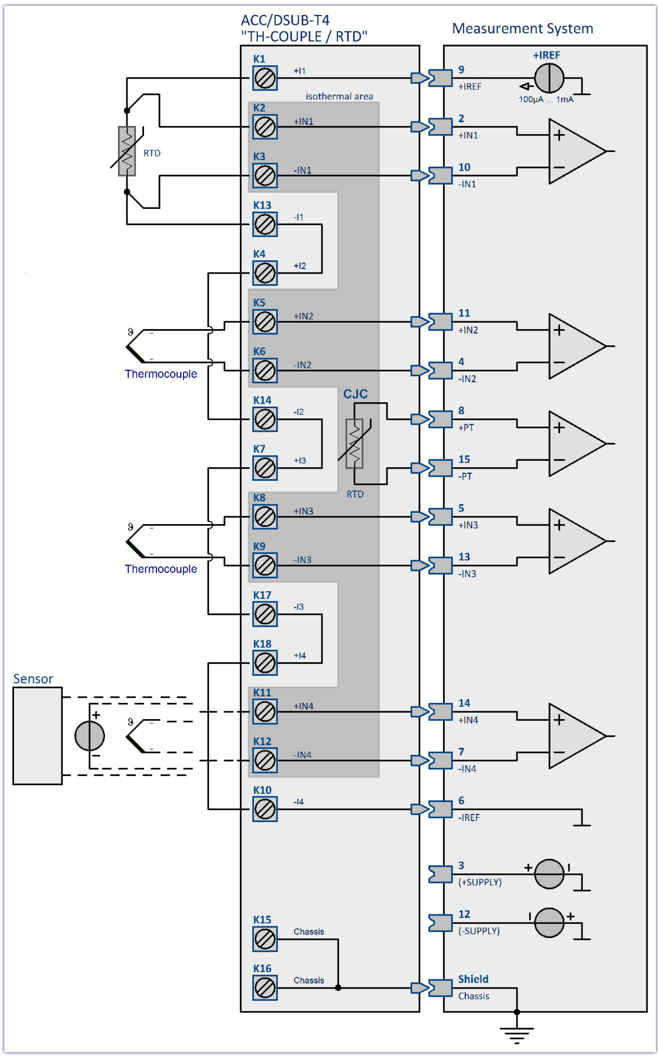
The imc Thermo plug contains a screw terminal block in a DSUB-15 plug housing with a built-in temperature sensor (PT1000) for **cold junction compensation**. This provides for direct connection of thermocouples of any type, directly to the differential inputs (+IN and -IN) without external compensation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

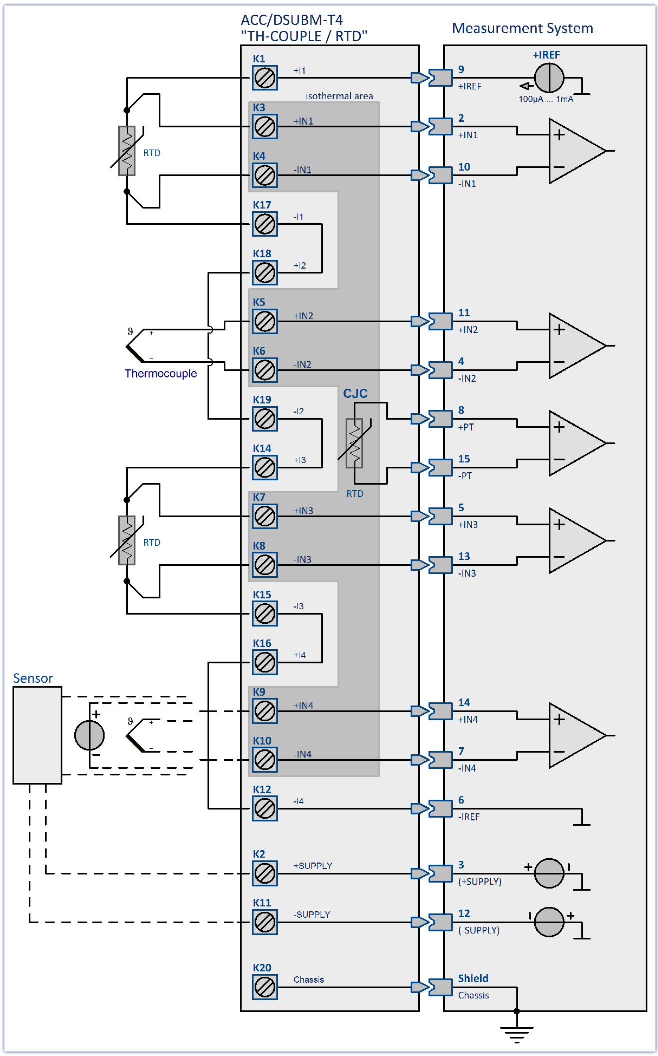
imc's system avoids the problem through the use of individual compensation sensors directly inside the plug, thus offering an especially simple, flexible and cost-effective connection solution.

7.3.1.3.1 Schematic: T4 plug

Plastic plug (ACC/DSUB-T4, discontinued)



Metal plug (ACC/DSUBM-T4)



7.3.2 Bridge measurement

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

7.3.2.1 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.

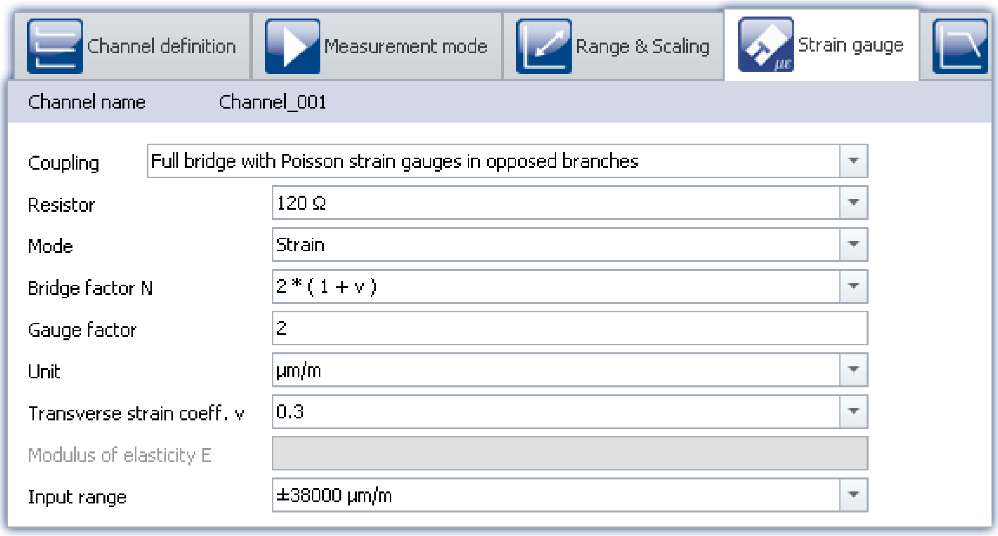
Note

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.

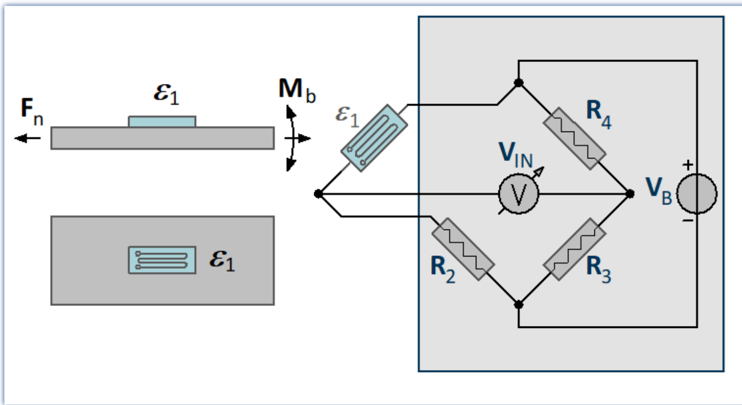
Elastic modulus

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.

7.3.2.2 Quarter bridge

7.3.2.2.1 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

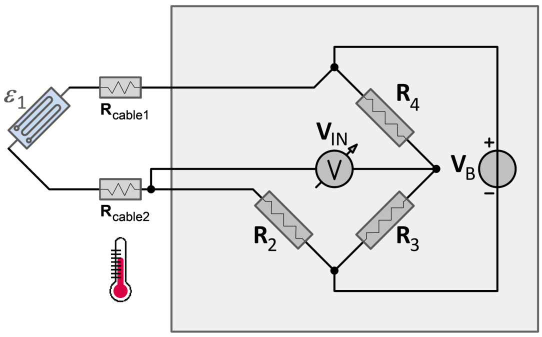
$$\varepsilon = \varepsilon_n + \varepsilon_b + \varepsilon_s$$

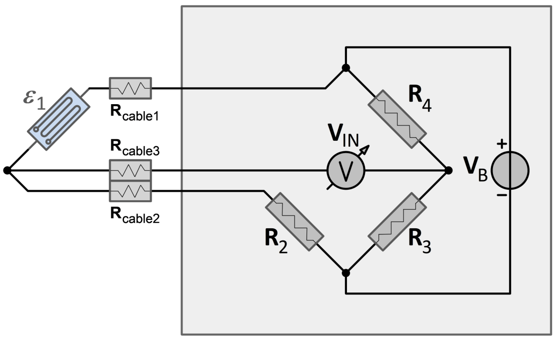
$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

$$\varepsilon_s = f(\vartheta)$$

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.



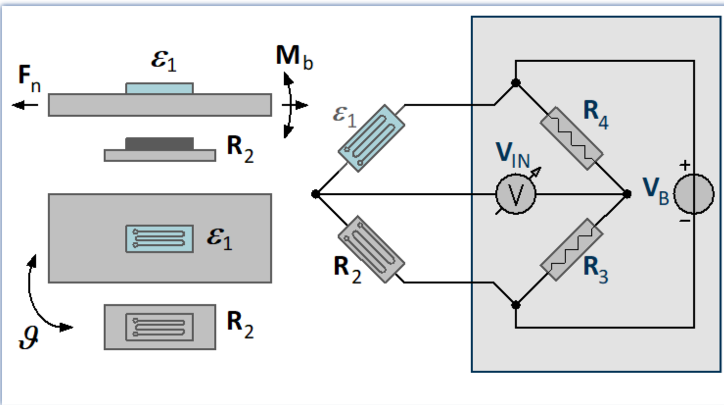


With the two-wire circuit, the temperature-related changes in the cable resistances R_{cable1} and R_{cable2} do not cancel each other out, which leads to a temperature drift in the measurement. In addition, it is not possible to take into account the signal reduction caused by the cable resistances. 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.

7.3.2.2.2 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

$$\varepsilon = \varepsilon_n + \varepsilon_b$$

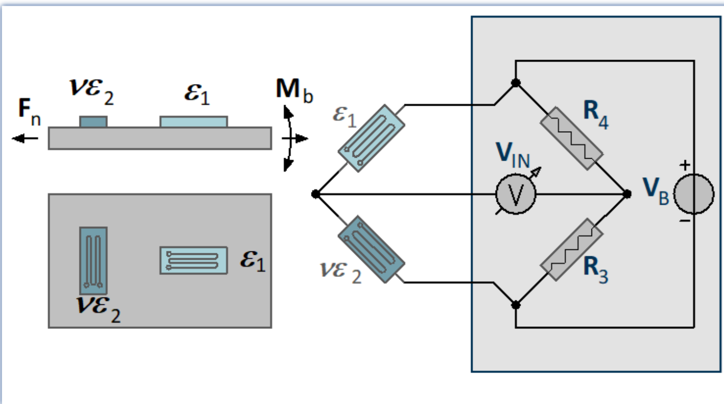
$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

The configuration does compensate the thermal influence (*insensitive to temperature changes*).

7.3.2.3 Half bridge

7.3.2.3.1 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

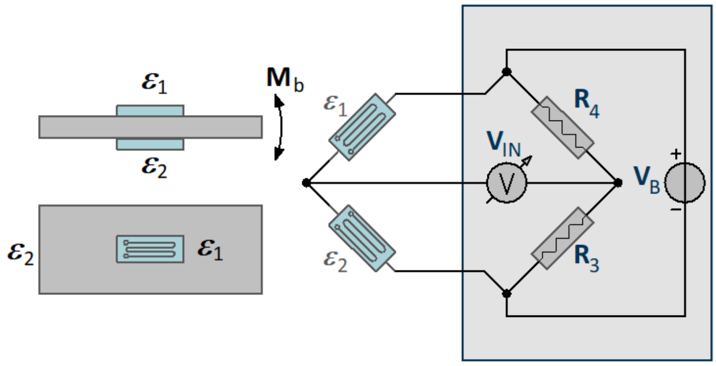
$$\varepsilon = \varepsilon_n + \varepsilon_b$$

$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

This configuration offers good temperature compensation.

7.3.2.3.2 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.



	F_n	M_b	M_t
N	0	2	0

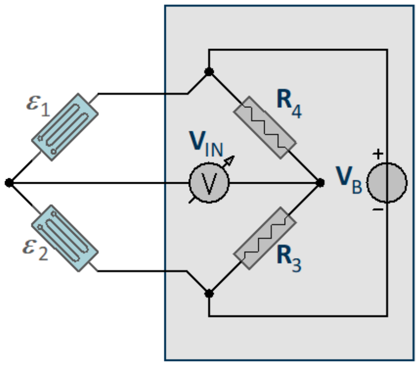
$$\varepsilon = \varepsilon_b$$

$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

Longitudinal forces, torsion and temperature changes are compensated.

7.3.2.3.3 Half bridge - general strain gauge

Freely configurable half-bridge circuit with bridge completion in the measuring device. N must be selected from a list.



$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

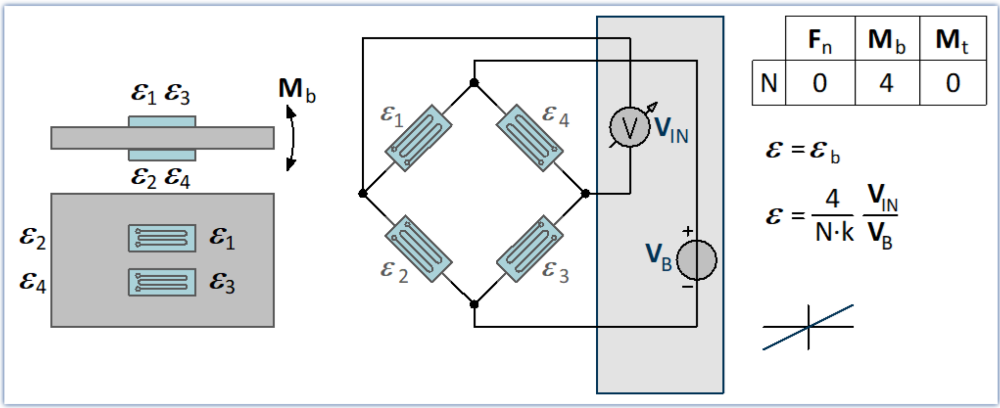
$$N = \begin{cases} 1 \\ 1 - \nu \\ 1 + \nu \\ 2 \end{cases}$$

7.3.2.4 Full bridge

7.3.2.4.1 Full bridge with four strain gauges - bending beam

General full bridge circuit for the bending moment

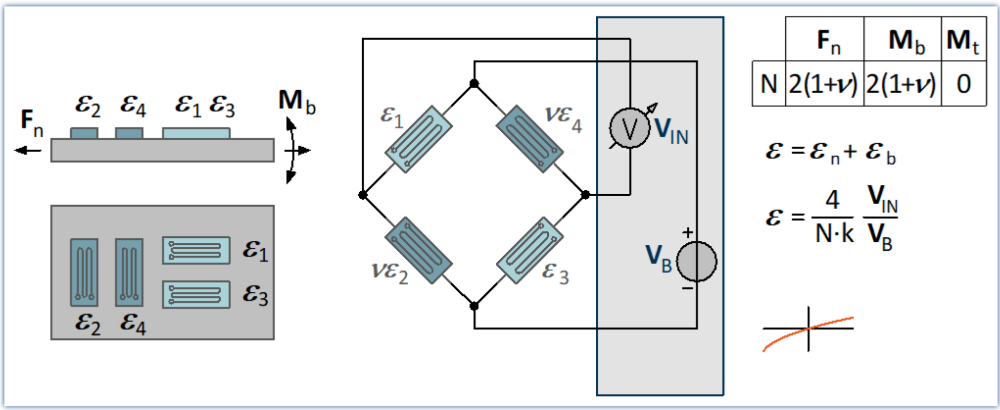
This bridge circuit uses four active strain gauges. Two of them are under compression and two are under equal tension, located on opposite sides of the structure.



The sensitivity of the bending moment is increased. At the same time, longitudinal force, torque and temperature are compensated for.

7.3.2.4.2 Full bridge consisting of two Poisson half bridges - installed on one side of the structure

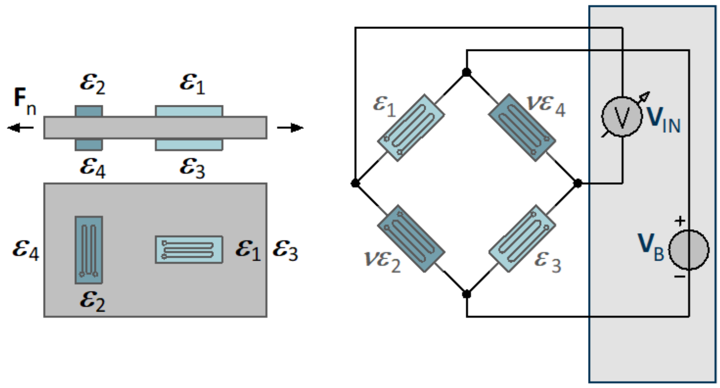
This bridge circuit uses a full bridge with four active strain gauges. Two active strain gauges are supplemented by two transversely arranged strain gauges to form Poisson half bridges, which are located in the diagonally opposite bridge branches (*tension rod arrangement*). This circuit results in a 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**.



In this circuit, the specification of the transverse strain coefficient of the material is important. The arrangement is **insensitive** to temperature changes.

7.3.2.4.3 Full bridge consisting of two Poisson half bridges - installed on opposite sides of the structure

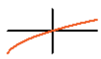
This bridge circuit uses a full bridge with four active strain gauges. Two active strain gauges are supplemented by two transversely arranged strain gauges to form Poisson half bridges, which are located in the diagonally opposite bridge branches. This circuit results in a high sensitivity by utilizing 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

$$\varepsilon = \varepsilon_n$$

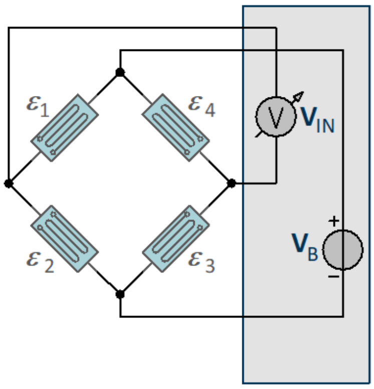
$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$



This circuit offers **good** compensation for temperature influences.

7.3.2.4.4 Full bridge - general strain gauge

Freely configurable full bridge circuit. The bridge factor N must be specified via list selection.



$$\varepsilon = \frac{4}{N \cdot k} \frac{V_{IN}}{V_B}$$

$$N = \begin{cases} 1 \\ 1-\nu \\ 1+\nu \\ 2 \\ 2(1-\nu) \\ 2(1+\nu) \\ 4 \end{cases}$$

7.3.3 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. The description of the SPAR/DI16-DO8-ENC4 digital multiboard. 85

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.	

7.3.3.1 Signals and conditioning

7.3.3.1.1 Mode

The various modes comprise the following measurement types:

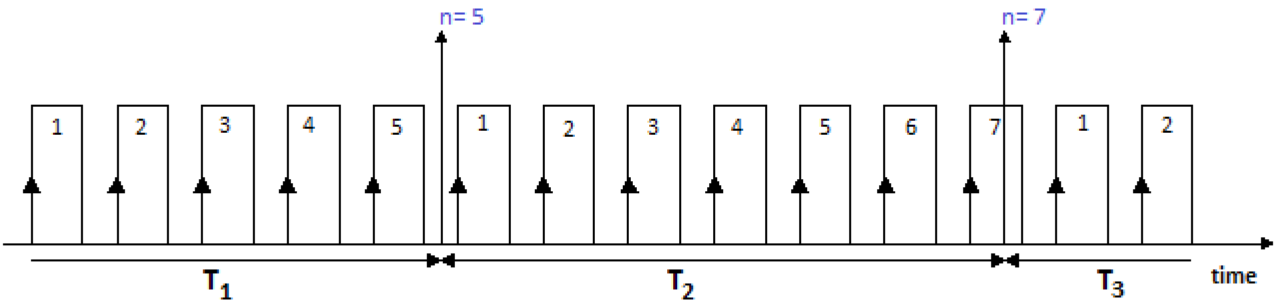
Event-counting	Time	Combined measurements
• events • distance(differential) • angle (differential) • angle (sum) • angle (abs 0-360°) • distance (sum)	• time • pulse time	• frequency • speed • RPM

Event-Counting

The following variables are derived from **Event counting**:

- events 60
- distance(differential) 60
- angle (differential) 61
- distance (abs.) 61
- angle (abs.) 61

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**.

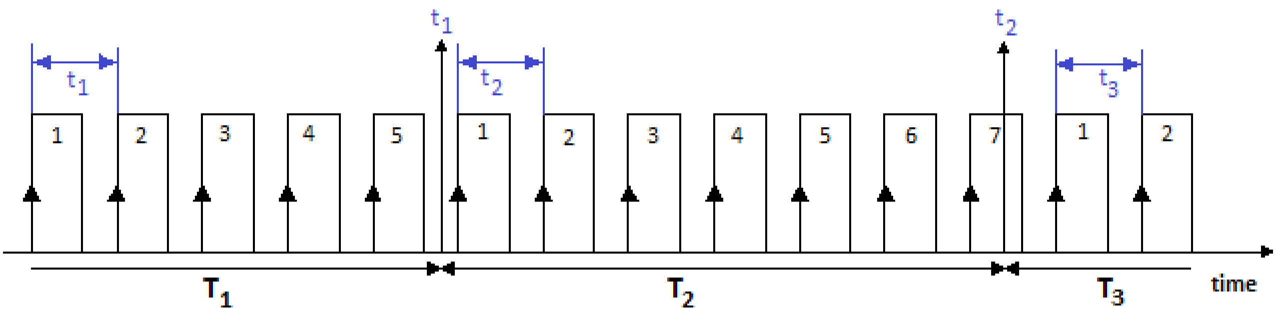


Time Measurements

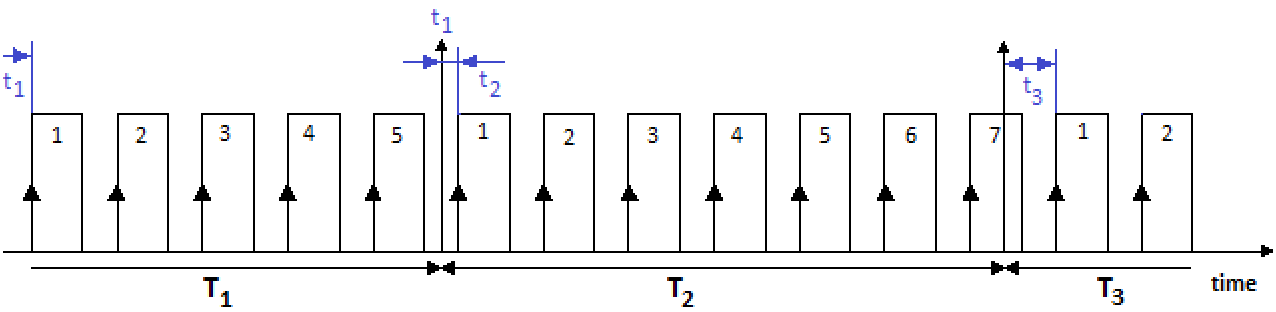
Exclusive measurement of **time** is performed as:

- time 61 (of two successive signal edges)
- pulse time 62 (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

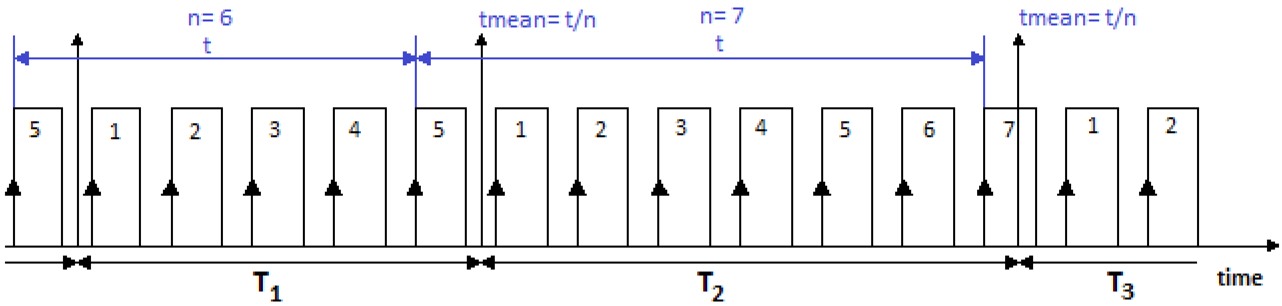


pulse time

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 63
- speed 63
- RPM 63



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 59
- Start of measurement with or without "Zero impulse" 60
- Number of pulses (per unit)

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.

7.3.3.1.2 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.

7.3.3.1.3 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:

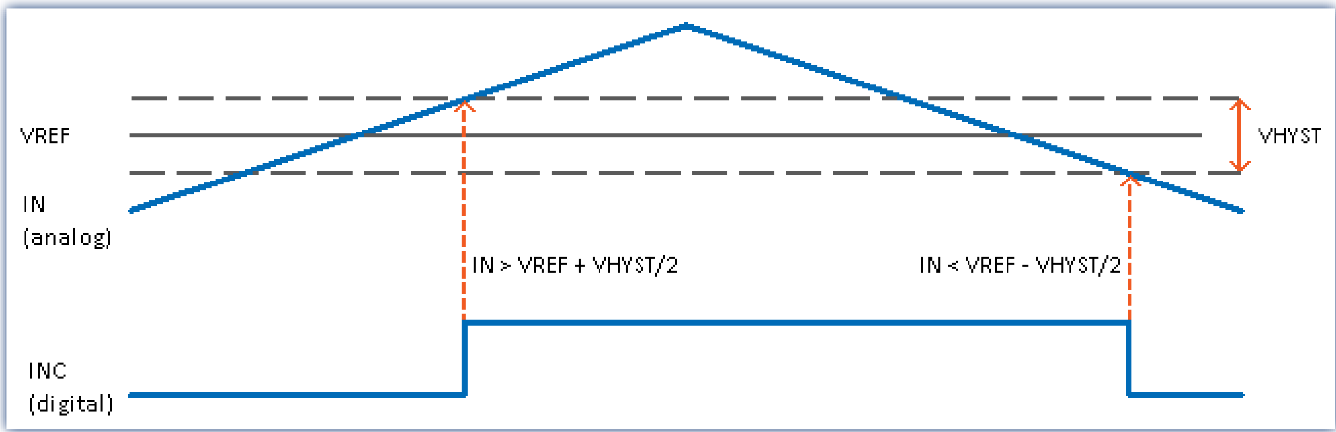
Measurement quantity	(Sensor-) scaling	Range	Maximum
Linear motion	**pulse**/*m*	m	m/s
Angle	**pulse**/*U*	U	U/min
Velocity	**pulse**/*m*	m/s	m/s
RPM	**pulse**/*U*	U/min	U/min
Event	**pulse**/*pulse*	1 pulse	Hz
Frequency	**Hz**/*Hz*	Hz	Hz
Time	**s**/*s*	s	s
Pulse time	**Hz**/*code*	Hz	Hz

7.3.3.1.4 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

7.3.3.1.5 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.

7.3.3.1.6 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.

7.3.3.2 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 59 • Start of measurement with or without "Zero impulse" 60 • 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.

7.3.3.3 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

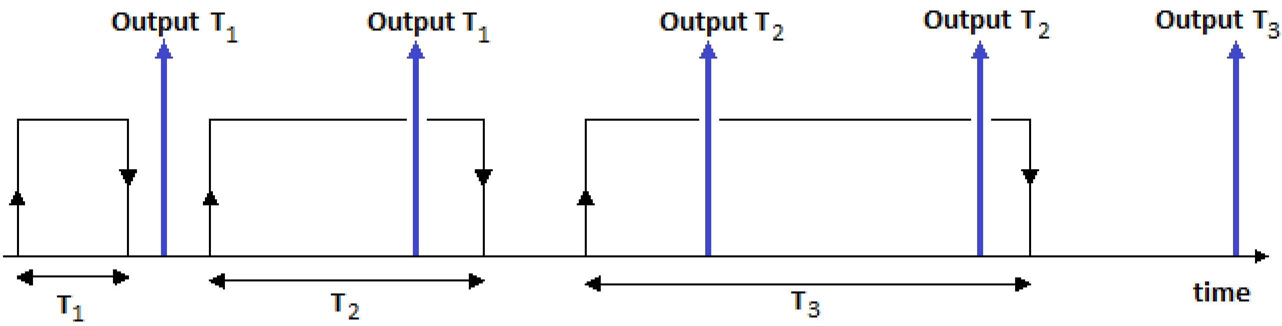
To ensure a high time resolution for the measurement results, suitable scaling must be set for the measurement. An **input range (INC4)** or **Max. time (s) (ENC-6)** specifies the maximum time interval which can be measured between the selected starting and stopping edge. **The time between the signal 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 $t_{pulse} * f * 100\%$

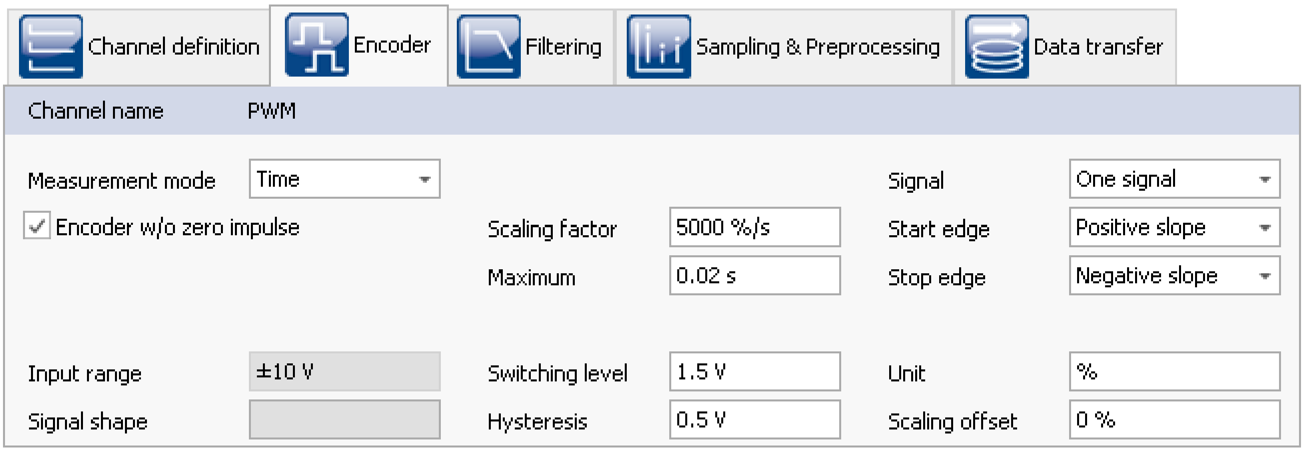
Example:

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

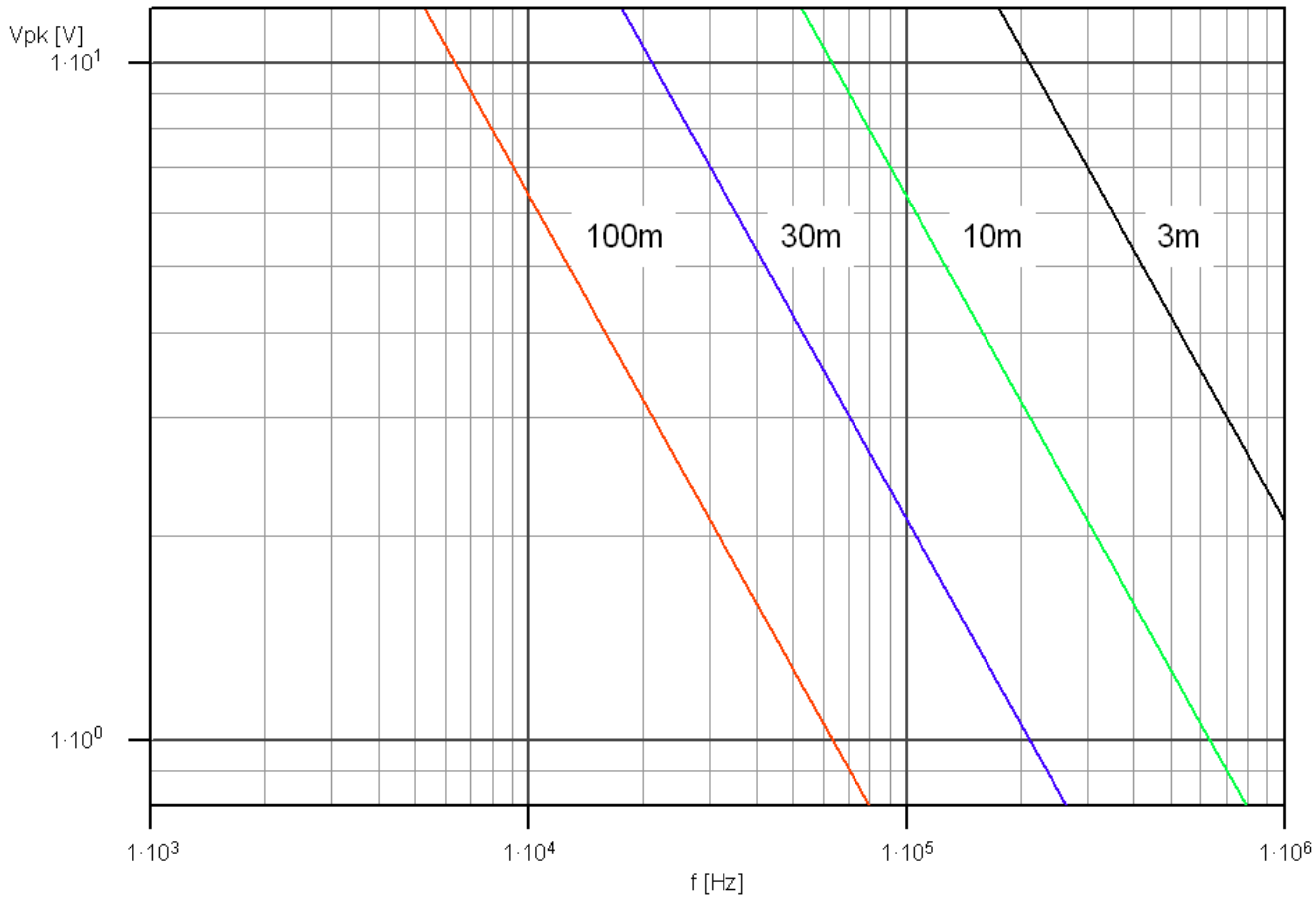
7.3.3.4 Mode (combined measurement)

Mode	Beschreibung
Frequency	Frequency is determined by means of a combination measurement 57. 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 57. 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 57. Toward this end, the number of pulses per revolution must be entered.

7.4 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.

7.4.1 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 65 and here technical specs: ACC/DSUB-ICP. 175

7.5 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.

7.5.1 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.

7.5.2 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 183.

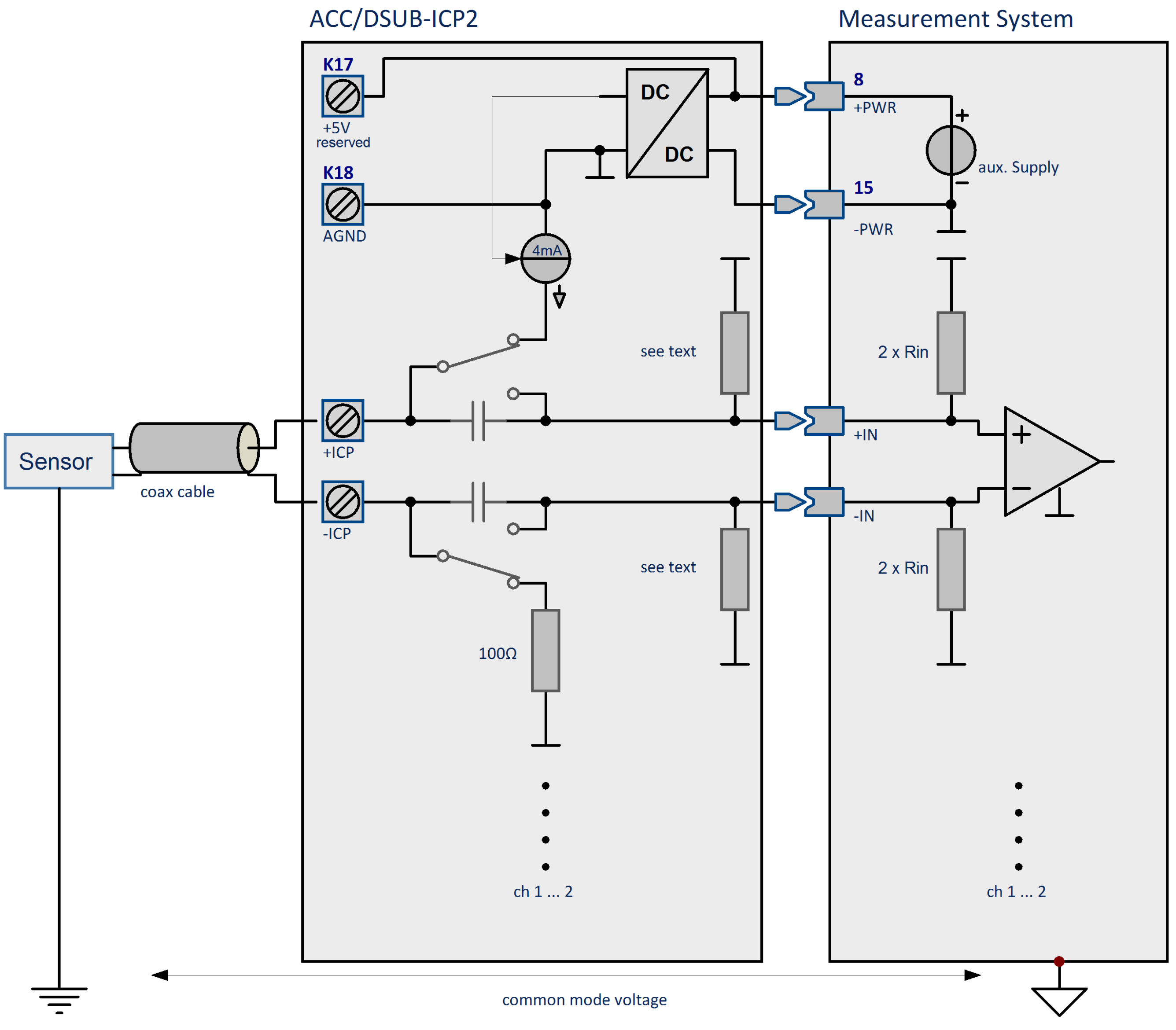
This (active) expansion plug having the same dimensions as the imc DSUB-plug, comes with additional conditioning equipment built into its housing and having the following **features**:

- 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 175
- 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 107. 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.

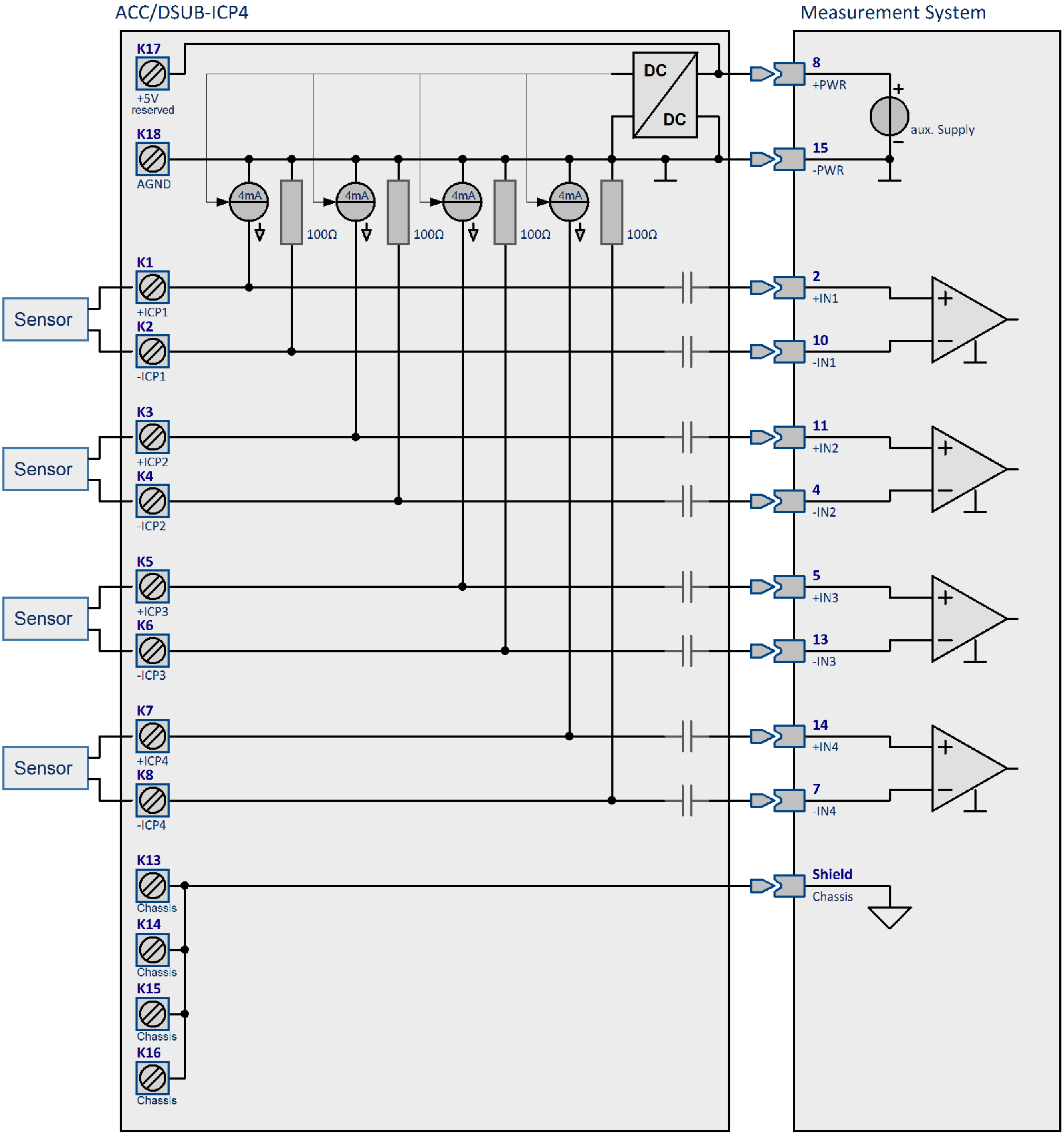
The voltage amplifiers' different input impedance values (with / without input divider) depend on the voltage range selected. The resulting high-pass cutoff frequencies and the time necessary for the 12 V-offset to decay to 10 µV are shown.

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.



7.5.3 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.

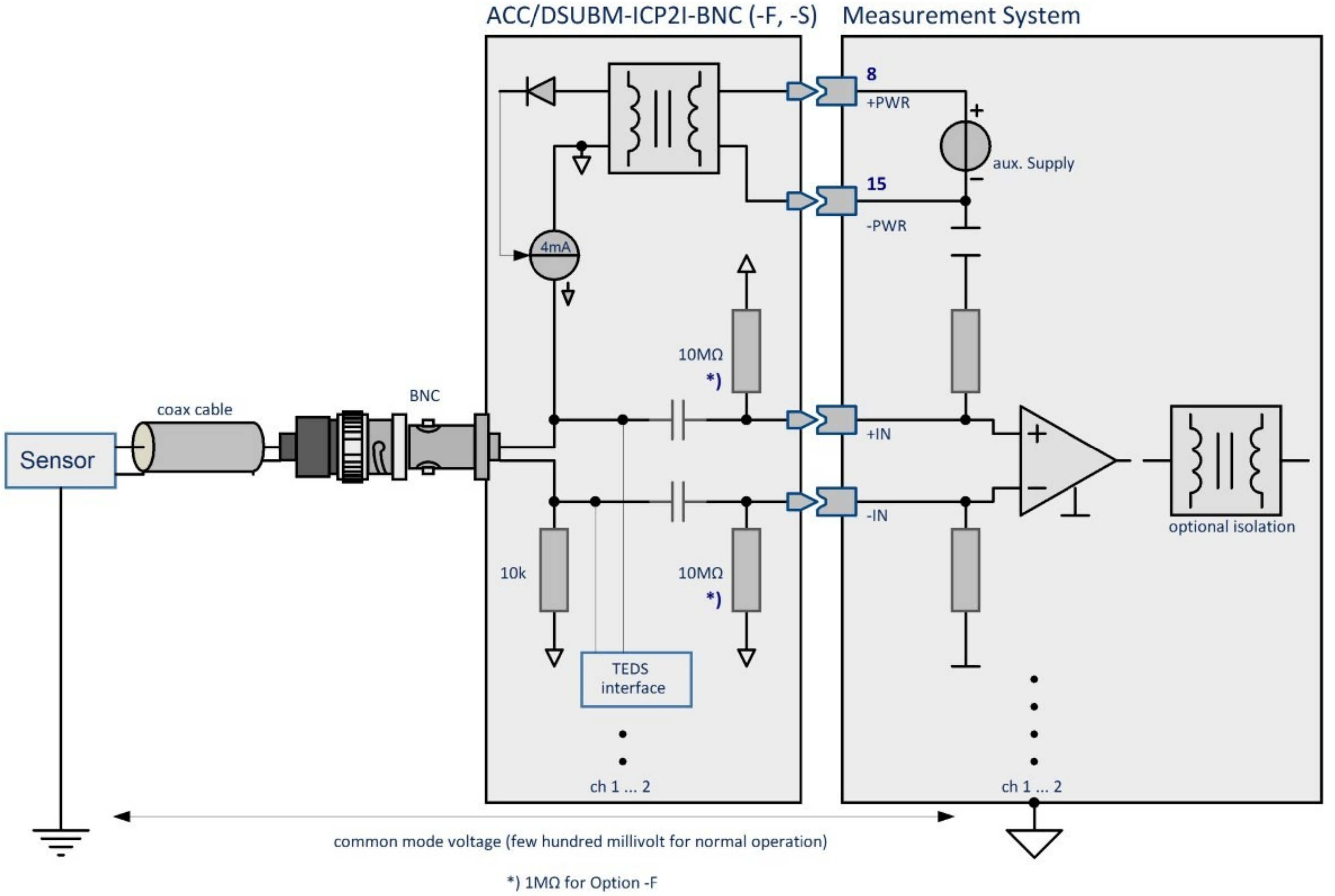
The expansion plug can be operated in conjunction with isolated and non-isolated voltage and bridge amplifier modules.

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

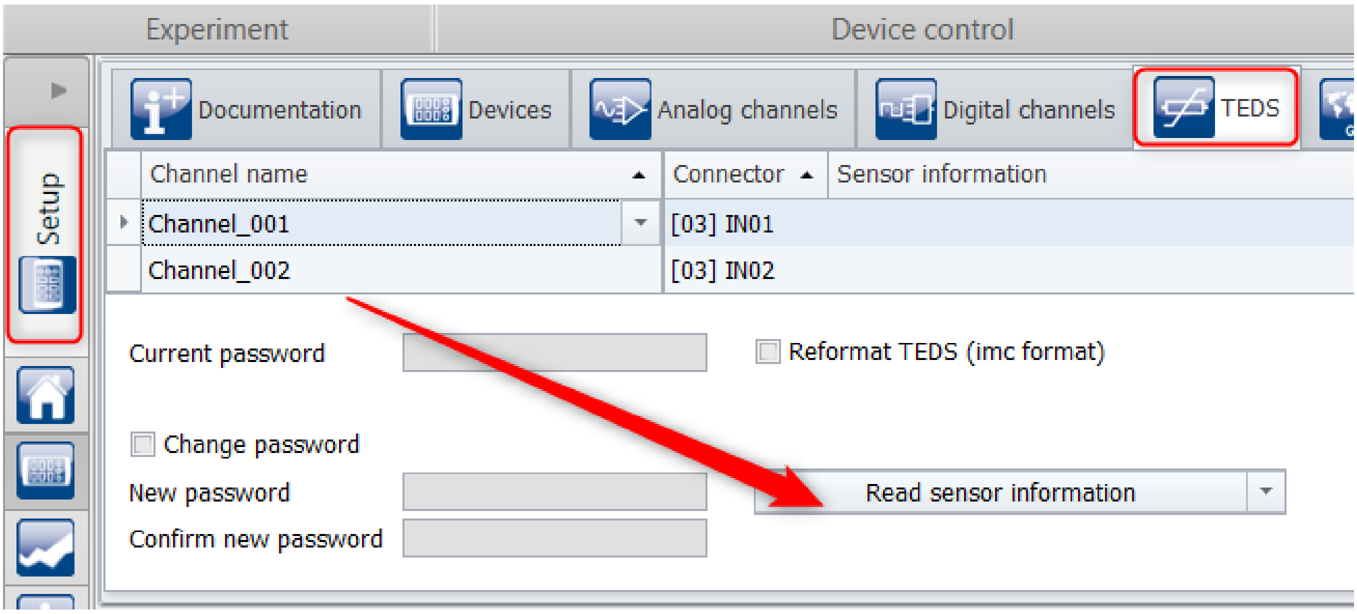
The variant differentiation (-S/-F) function is only supported in the CRFX and CRXT device platform:

- 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) 176

7.5.3.1 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.

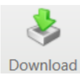
Typical **expected and normal "error"-messages** occurring in conjunction with valid recognition of the ICP-expansion plug:

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 72 are omitted.

Therefor the measurement mode must be set to the compatible setting "*Voltage, DC-coupling*", otherwise an incompatible coupling is reported.

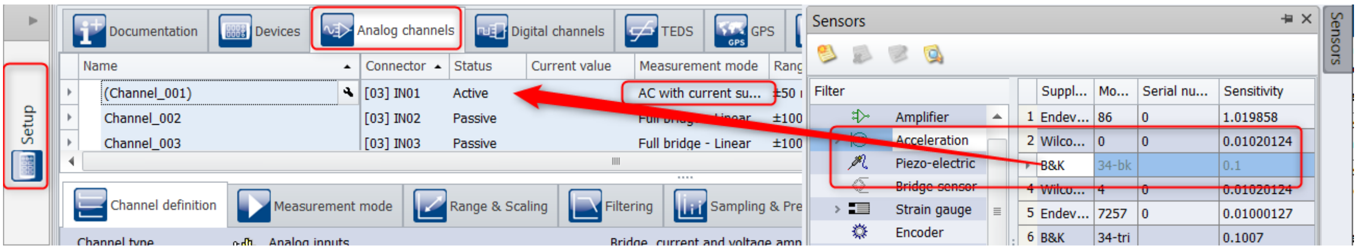
Note

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*".

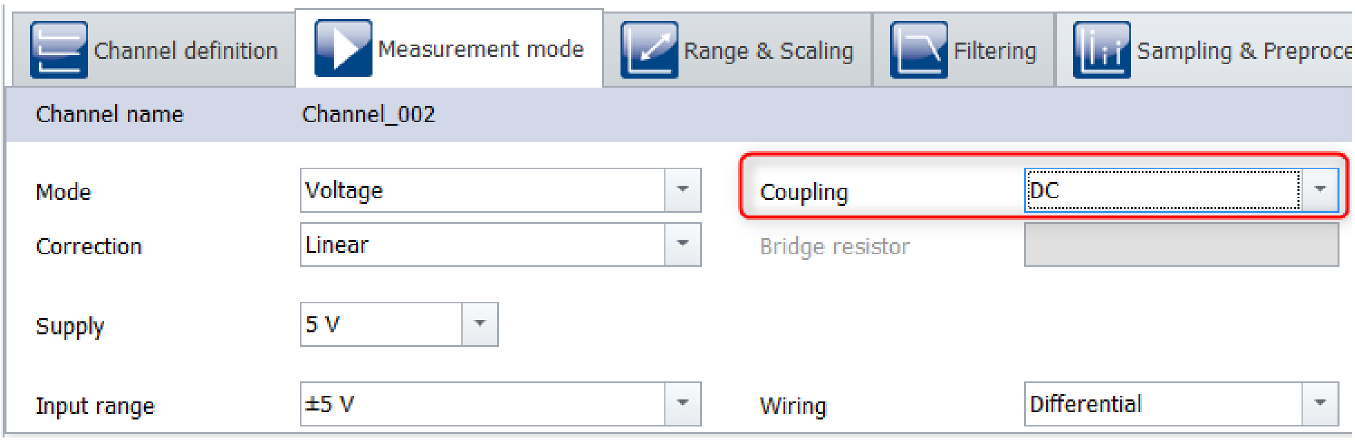
This AC coupling is also displayed if the sensor information is not read via TEDS, but when an ICP sensor is linked to the channel via the imc SENSORS database (drag&drop):



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

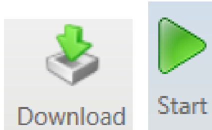
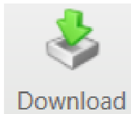
Note ICP-sensor without TEDS

When using a simple **sensor without TEDS memory**, the recognition procedure will displayed with the messages above (#6305, #6318) 72, 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!

7.5.3.2 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.***

7.5.3.3 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

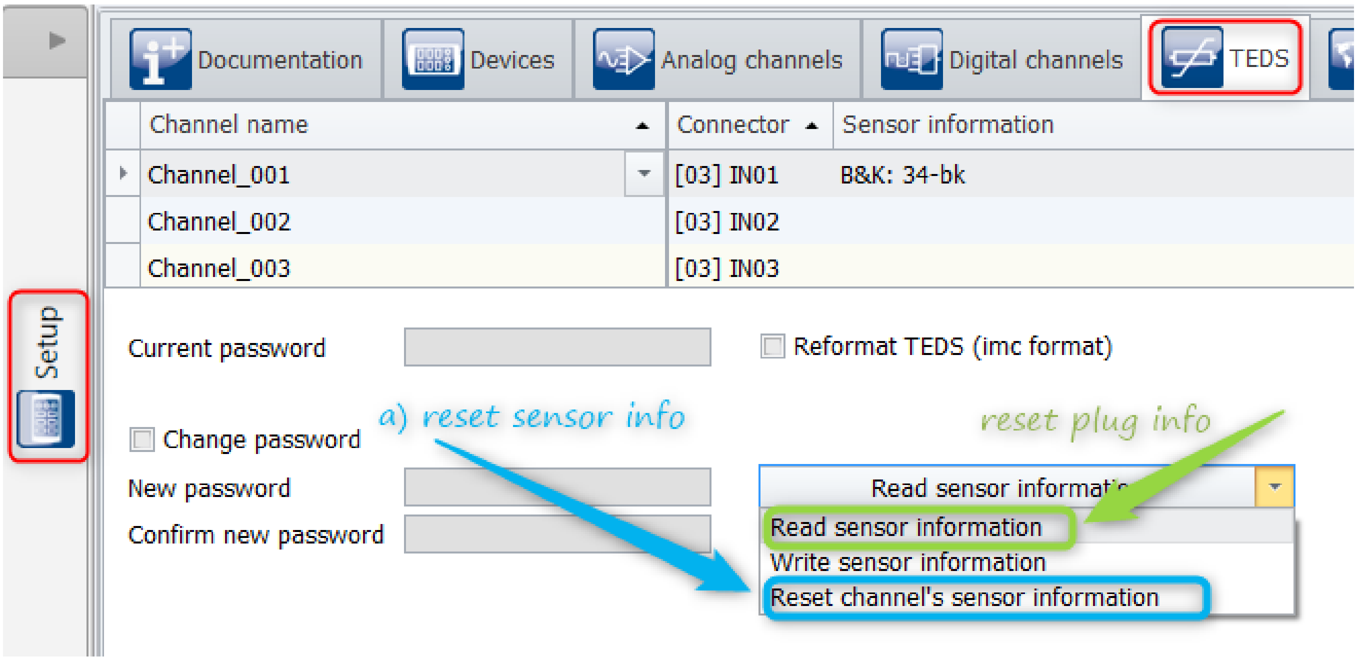
When resetting the recognition, there is a distinction between two stages:

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.

7.5.3.4 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 75:
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: 75
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:* 75

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 Hardware configuration of all devices

imc SPARTAN-8

All devices belonging to the SPARTAN come with the following equipment:

- SPAR/DI16-DO8-ENC4 with:
  - 4 incremental counter inputs
  - 16 digital inputs
  - 8 digital outputs
- Connection for Display
- Connection for GPS
- SYNC connection
- CF-Card slot

You can equip your SPARTAN device with maximally four SPAR/DI16-DO8-ENC4 modules.

8.1 SPAR/DI16-DO8-ENC4 digital multiboard

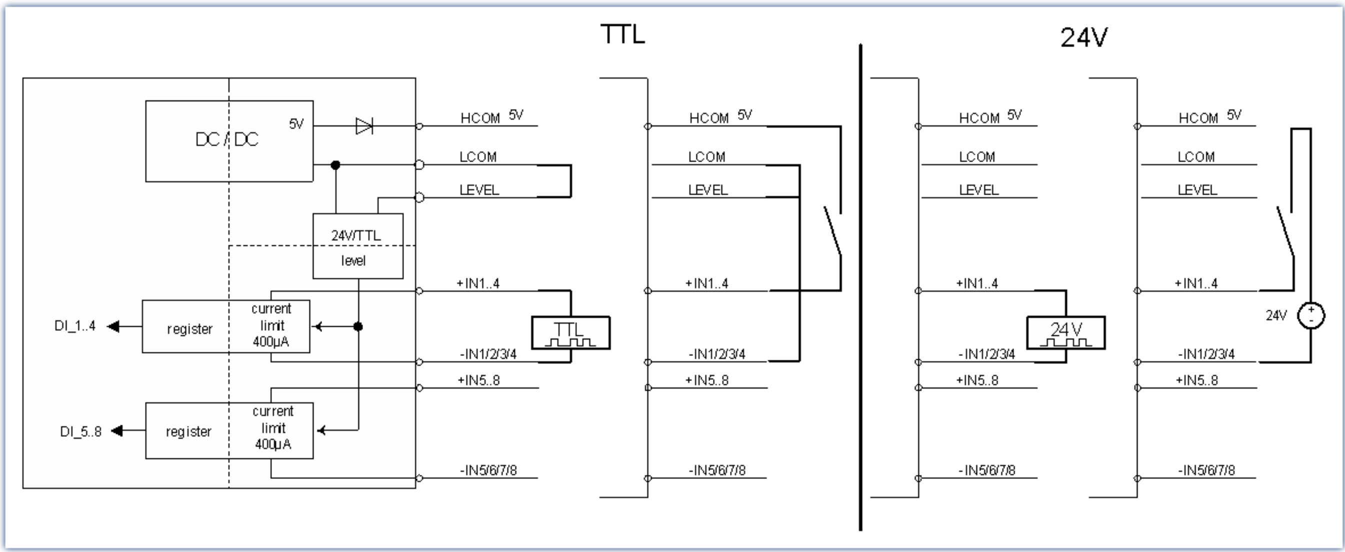
There are 16 binary inputs, 8 binary outputs and 4 incremental counter inputs available.

8.1.1 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 165.

The pin configuration of the ACC/DSUB(M)-DI4-8 182.



Open inputs are set to have LOW voltage by means of pull-down resistors

8.1.1.1 Input voltage

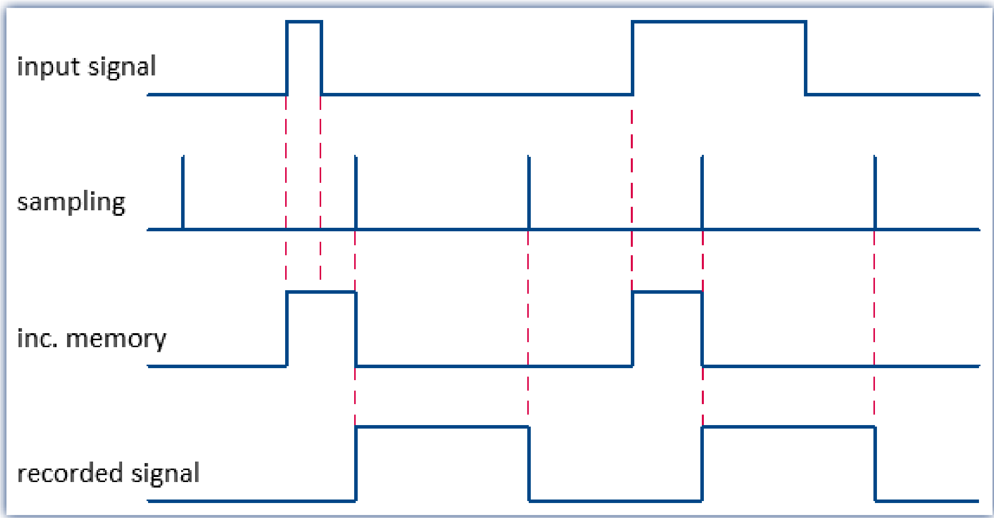
The input voltage range for a group of eight digital inputs can be set for either 5 V (TTL-range) or 24 V. The switching is accomplished by means of a jumper at the ACC/DSUBM-DI4-8 plug:

- 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.

8.1.1.2 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.



8.1.2 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 166.
The pin configuration of the ACC/DSUB(M)-DO8 182.

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".

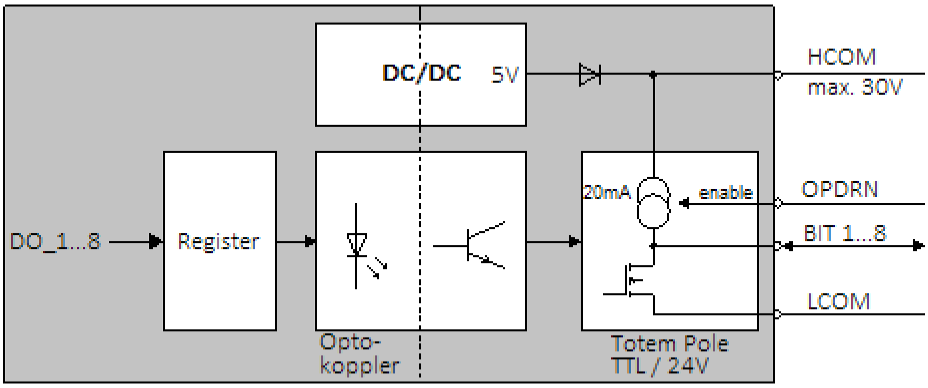
If a different state is desired, there are several options:

- 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*"

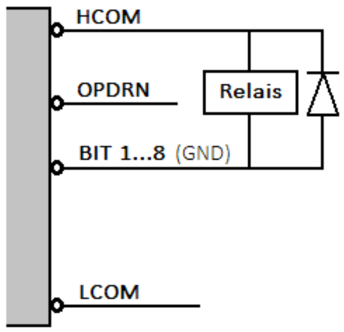
8.1.2.1 Block schematic



8.1.2.2 Possible configurations

5 V (internal)

Open Drain

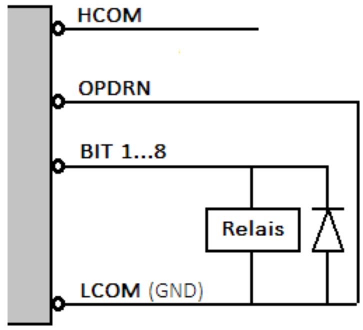


Device off: no continuity/high impedance (138 kΩ), 0 V at output

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



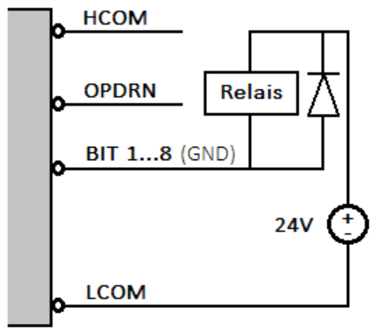
Device off: no continuity/high impedance

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

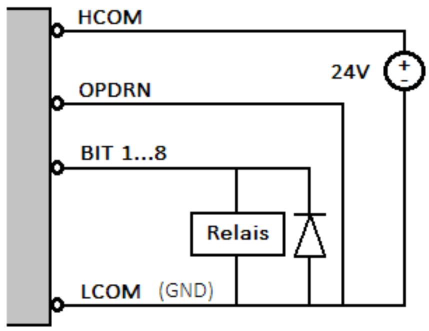


Device off: no continuity/high impedance (1.5 MΩ), 0 V at output

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.

8.1.3 Incremental counter channels

You can find a general description in the chapter of the "*Incremental Counters Channels* 55".

Reference

The technical specification of the incremental counter channels 167.
The pin configuration of the ACC/DSUBM-ENC-4 182.

8.1.3.1 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).

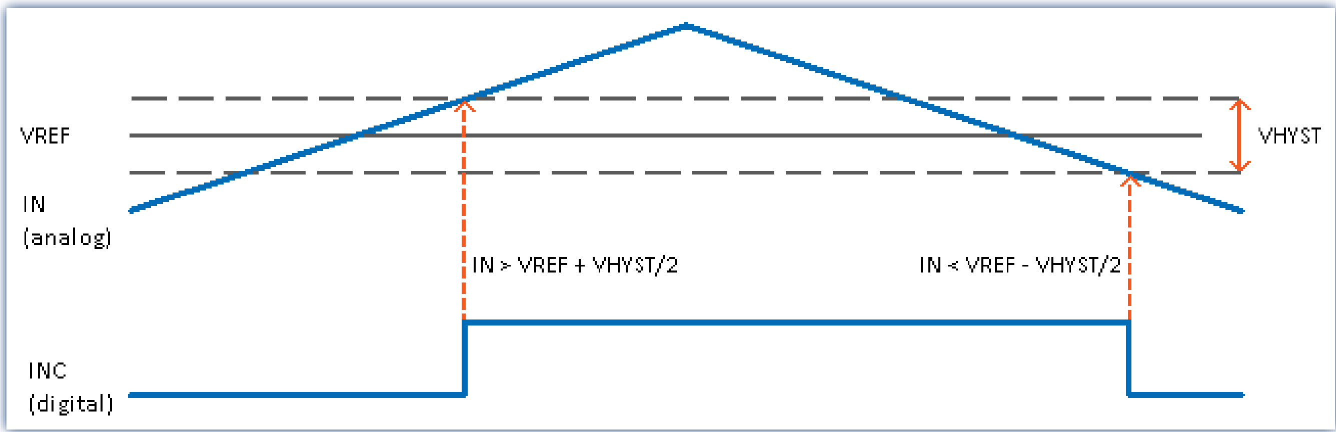
Since many signal encoders require a supply voltage, +5 V are provided at the connector socket for this purpose (max. 300 mA). The reference potential for this voltage, in other words the supply-ground connection for the sensor, is CHASSIS.

8.1.3.2 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:

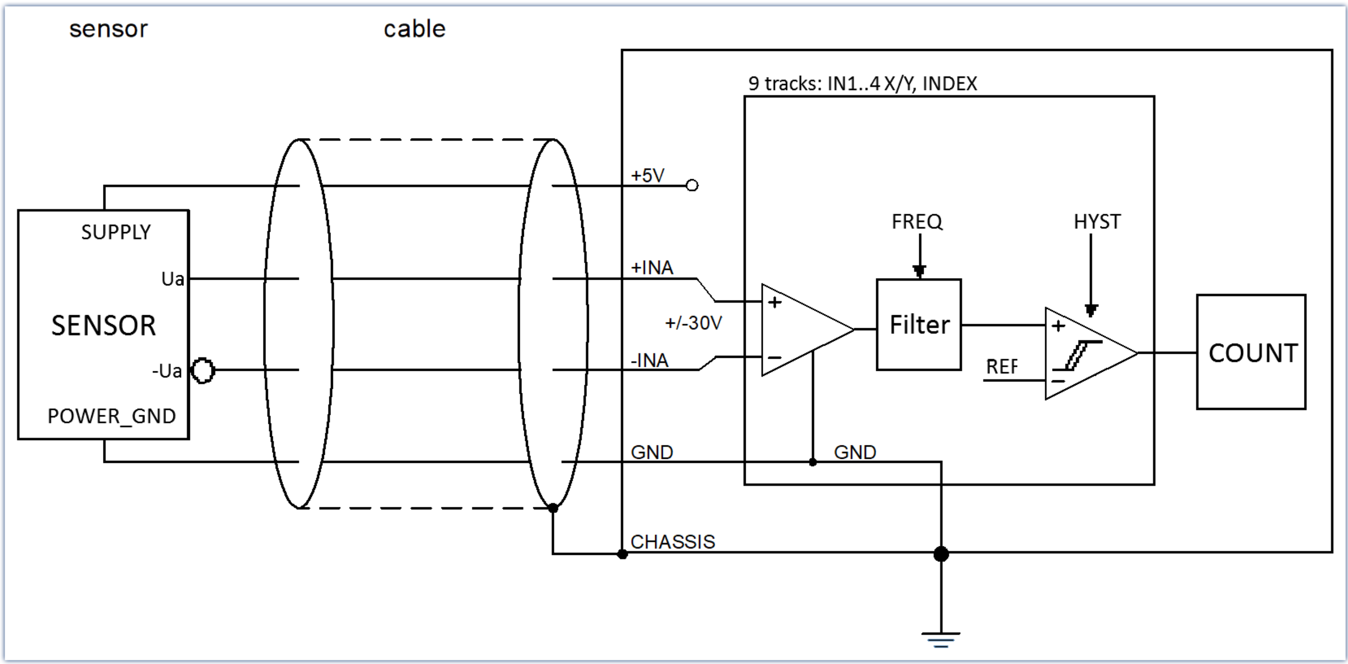
- VREF = ±10 V VHYST = +100 mV .. +4 V

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

8.1.3.3 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.

8.1.3.4 Channel assignment

The plug used is the ACC/DSUBM-ENC-4 88. 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!

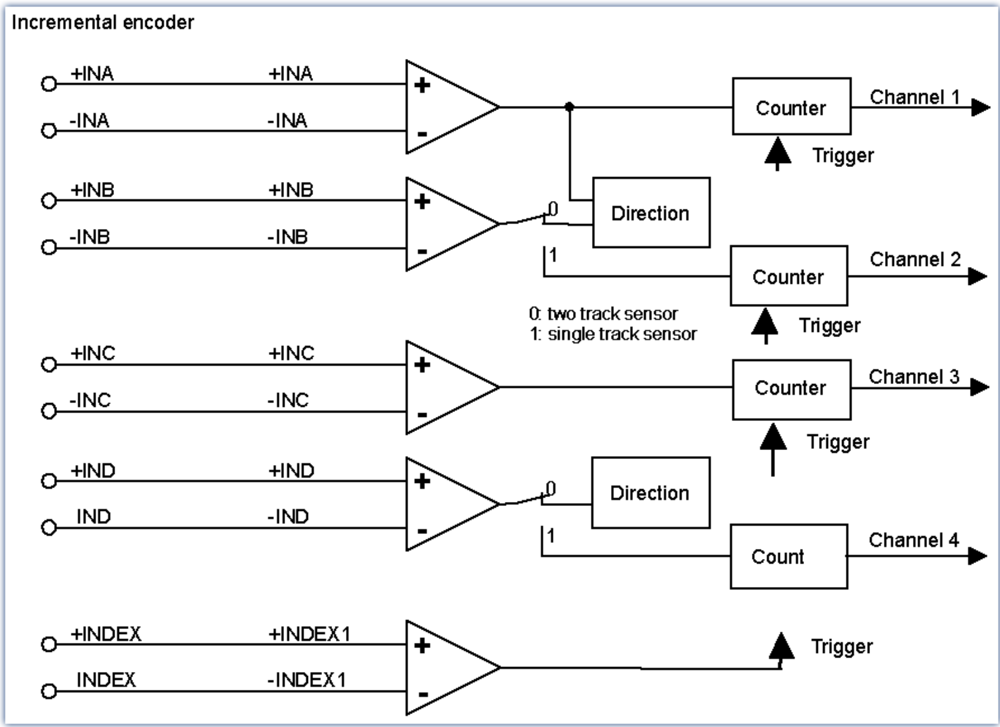
8.1.3.5 Incremental counter track configuration options

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* 59".
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.

8.1.3.6 Block schematic

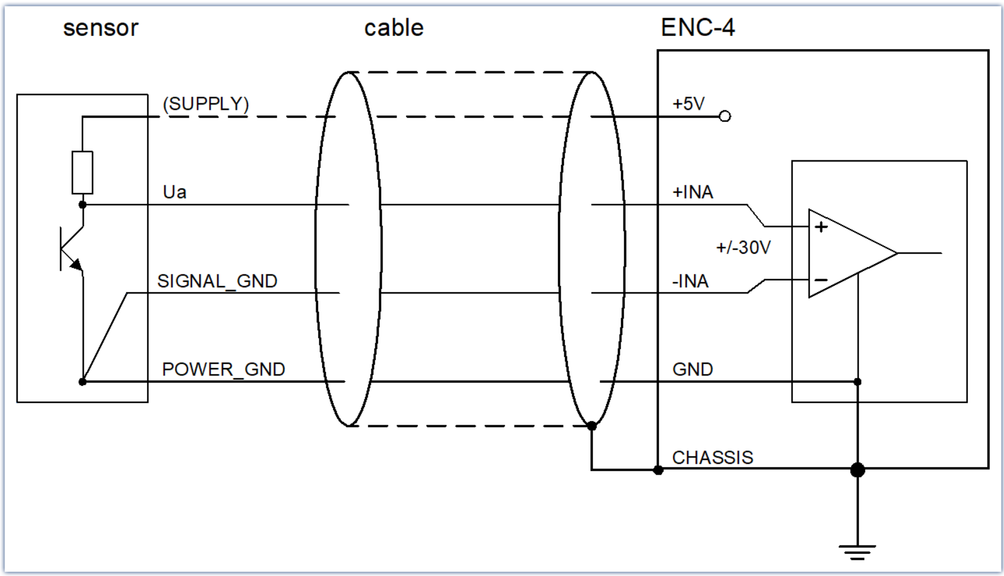


8.1.3.7 Connection

The pin configuration of the ACC/DSUBM-ENC-4 182.

8.1.3.7.1 Connection: Open-Collector Sensor

Simple rotary encoder sensors are often designed as an Open-Collector stage which outputs a signal which ranges between the states 0 V and SUPPLY. In this case, the switching threshold should be set to half the SUPPLY voltage:

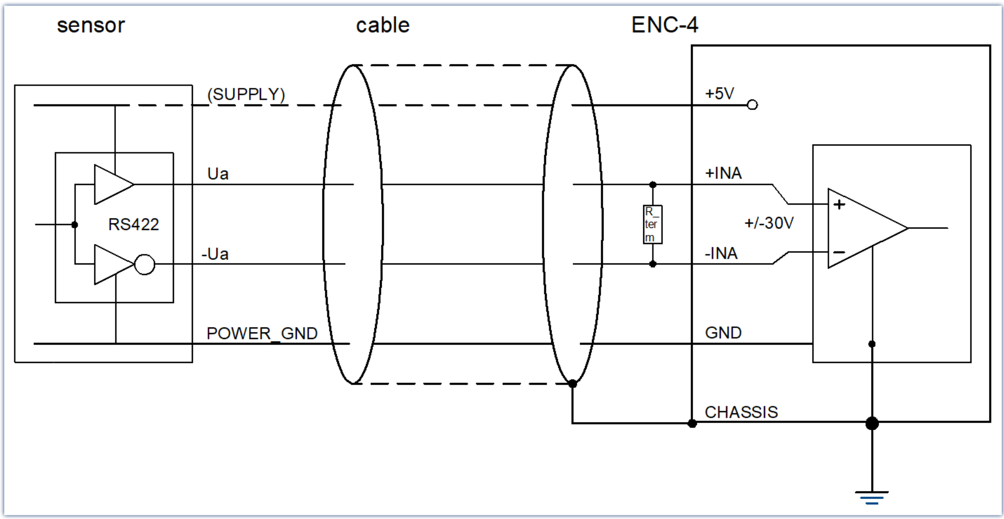


sensor with open-collector output

8.1.3.7.2 Connection: Sensors with RS422 differential line drivers

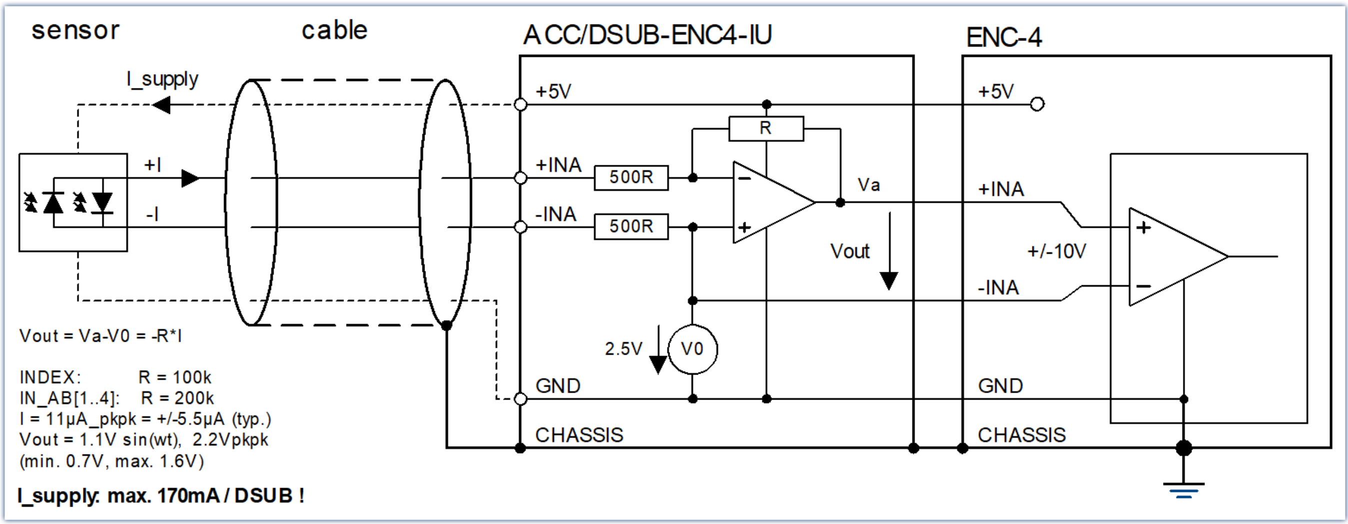
Commercially available rotary encoders are often equipped with differential line drivers, for instance as per the EIA-standard RS422. These deliver a complementary (inverse) TTL-level signal for each track. The sensor's data are evaluated differentially between the complementary outputs. The threshold to select is 0 V, since the differential evaluation results in a bipolar zero-symmetric signal: 3.8 V to 5 V (HIGH) or – 3.8 V 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 resistors.



sensor with RS422 differential output

8.1.3.7.3 Connection: Sensors with current signals



For a rotational encoder working with current signals, the current/ voltage terminal ACC/DSUB-ENC-4-IU 182 can be used.

It is possible to power the sensor from the ENC-4 module. The pertinent specifications are:

max. supply current: 320 mA

typ. encoder with 11 μA_{ss} signals:

Heidenhain ROD 456, current: max. 85 mA per (2-signal) encoder

8.2 Analog modules

For the capture of analog data, a variety of 16-channel modules are available.

8.2.1 SPAR/T16 voltage and temperature

Parameter	Value	Remarks
Inputs	16	
Measurement modes T16	 voltage measurement current measurement thermocouples, RTD (PT100)	recommended plug: ACC/DSUBM-U4 ACC/DSUBM-I4 ACC/DSUBM-T4

SPAR/T16 has 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:

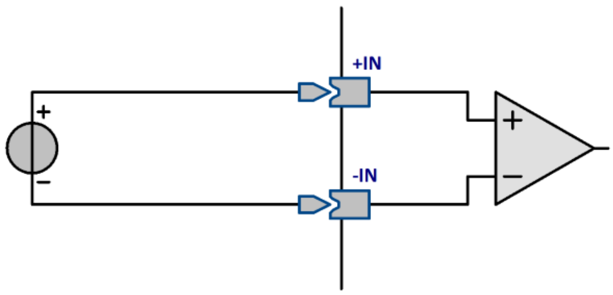
- Ideally for measurement with passiv sensors
- Optimal aliasing-free noise suppression of even 50 Hz interference
- Supports imc Plug & Measure

SPAR/T16 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 SPAR/T16 144

8.2.1.1 Voltage measurement



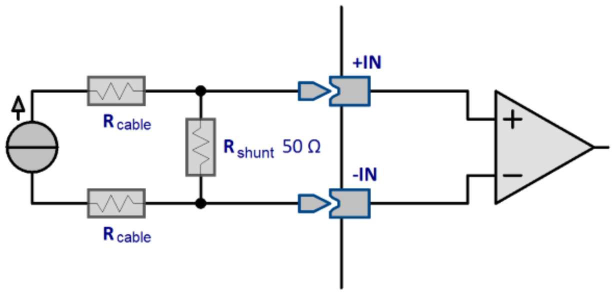
- ±60 V to ±50 mV in eleven ranges

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.

8.2.1.2 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).

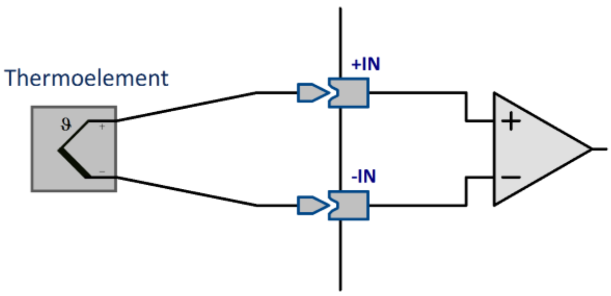
8.2.1.3 Temperature measurement

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. 45
- PT100 or thermocouples can be measured with the imc plug ACC/DSUBM-T4 47. Alternatively thermocouples can be recorded with two pin thermo plugs.

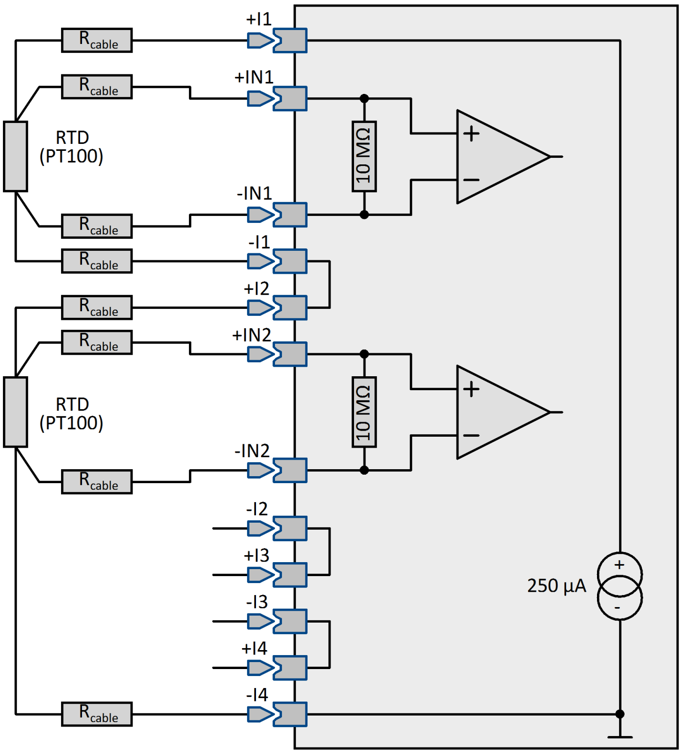
8.2.1.3.1 Thermocouple measurement



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 46).

8.2.1.3.2 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 47.

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.

8.2.1.4 Connection

The interconnections used are DSUB-15 terminals (SPAR/T16) or thermocouple plugs type-K (SPAR/T16-TC-K).

The pin configuration of the DSUB-plugs 182.

8.2.2 SPAR/U16 voltage and temperature

The isolated voltage channels of the SPAR/U16 module 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 65 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

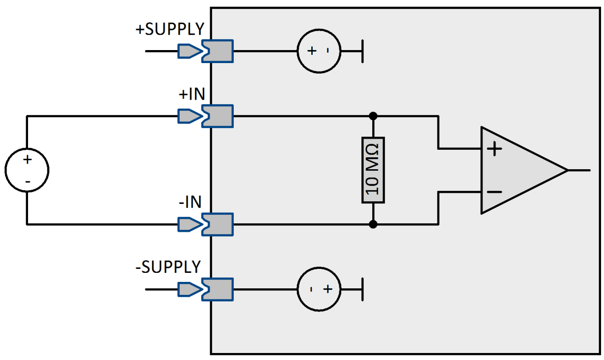
The technical data sheet of the SPAR/U16. 149

8.2.2.1 Voltage measurement

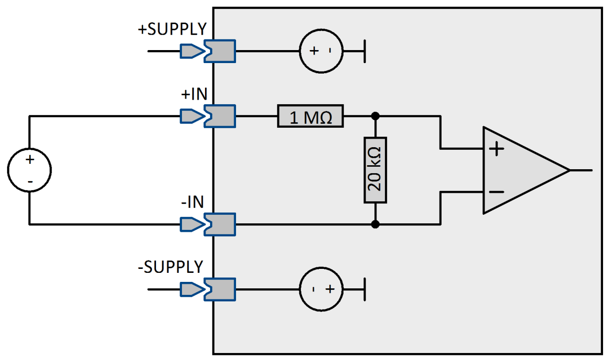
- Voltage: ±60 V to ±5 V with divider
- Voltage: ±2 V to ±50 mV without divider

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



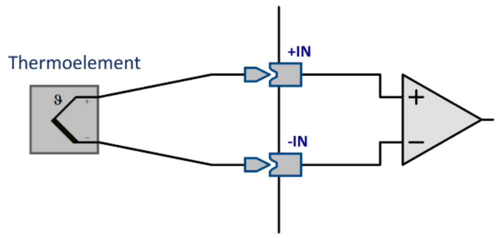
configuration for voltages >2 V with internal divider

8.2.2.2 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 45.

Temperature measurement is performed with the imc plug ACC/DSUBM-T4 47. Thermocouples can alternatively be captured using two-pin thermo-plugs.

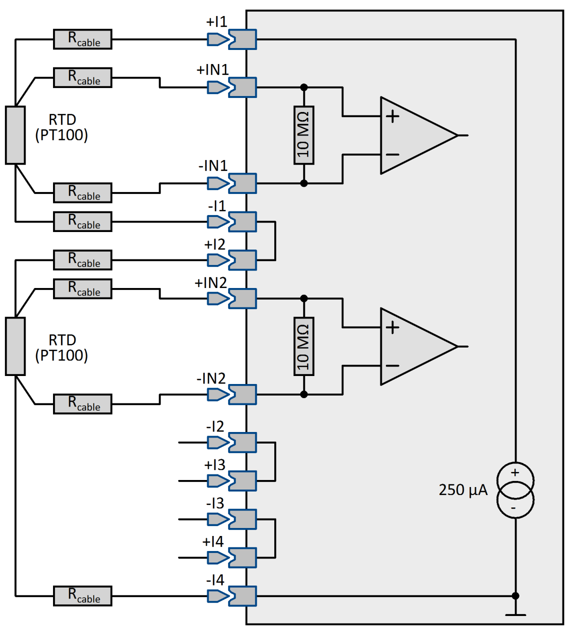
8.2.2.2.1 Thermocouple measurement



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 47).

8.2.2.2.2 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) 183 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 47). 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.

8.2.2.3 Current fed sensors

At the DSUB-15 sockets, a permanent 5 V supply voltage for external sensors 135 is available. This voltage source is grounded to the measurement device's frame. The description of measurement with ICP sensors is presented here. 65 For the measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) 65.

Note	DSUB-15 sockets

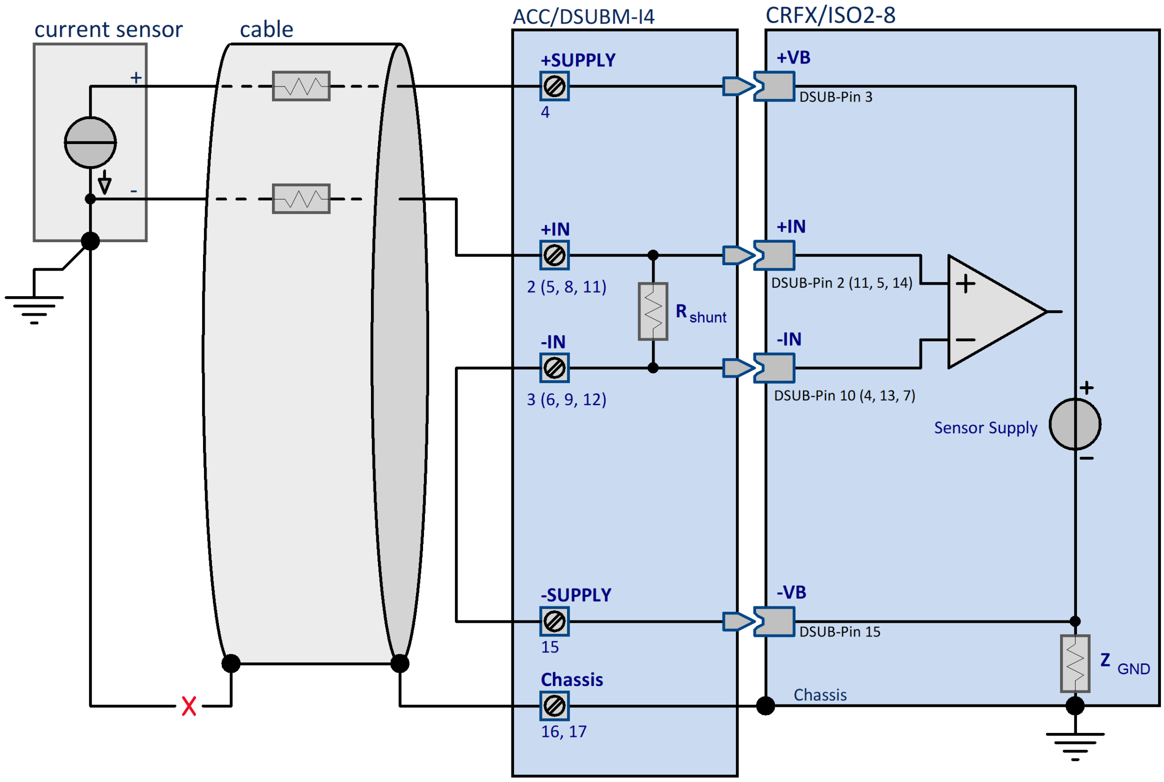
Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

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.

8.2.2.4 Current measurement

- Current: ±40 mA, ±20 mA, ±10 mA ... ±1 mA in 6 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/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).

8.2.2.5 Bandwidth

The channels' **max. sampling rate** is 500 Hz (2 ms). The **analog bandwidth** (without digital low-pass filtering) is 200 Hz (-3 dB).

8.2.2.6 Connection

The **interconnections** used are **DSUB-15** terminals or alternatively thermocouple plugs.

Reference

Please find here DSUB-15 plugs, on page 182.

8.2.3 SPAR/B(C)16 bridge and voltage

SPAR/B16 and SPAR/BC16 are 16-channel modules for precise measurement of bridges and voltages.

The difference between SPAR/B and SPAR/BC16 is the connections. SPAR/B uses the DSUB-15 sockets usually used in imc devices. The SPAR/BC16 measurement inputs have DSUB-26-HD connector plugs. For this reason, there are certain limitations on the measurement modes possible.

All signal inputs are **differential**, **not isolated** and support **TEDS**.

8.2.3.1 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!)

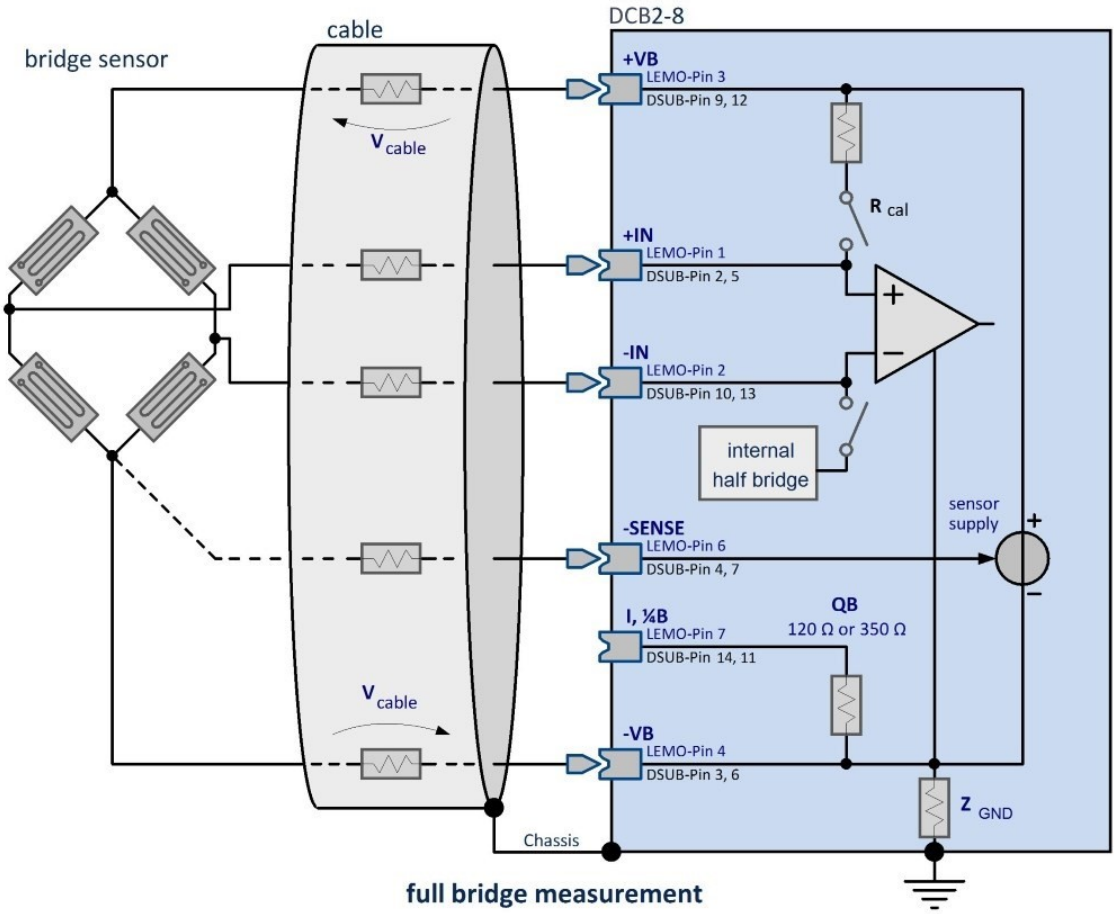
- For typical measurements with **strain gauges**, the ranges 5 mV/V to 0.5 mV/V are particularly relevant.
- There is a maximum voltage which the **potentiometer sensors** are able to return, in other words max. 1 V/V; a typical range is then 1000 mV/V.

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.

8.2.3.1.1 Full bridge

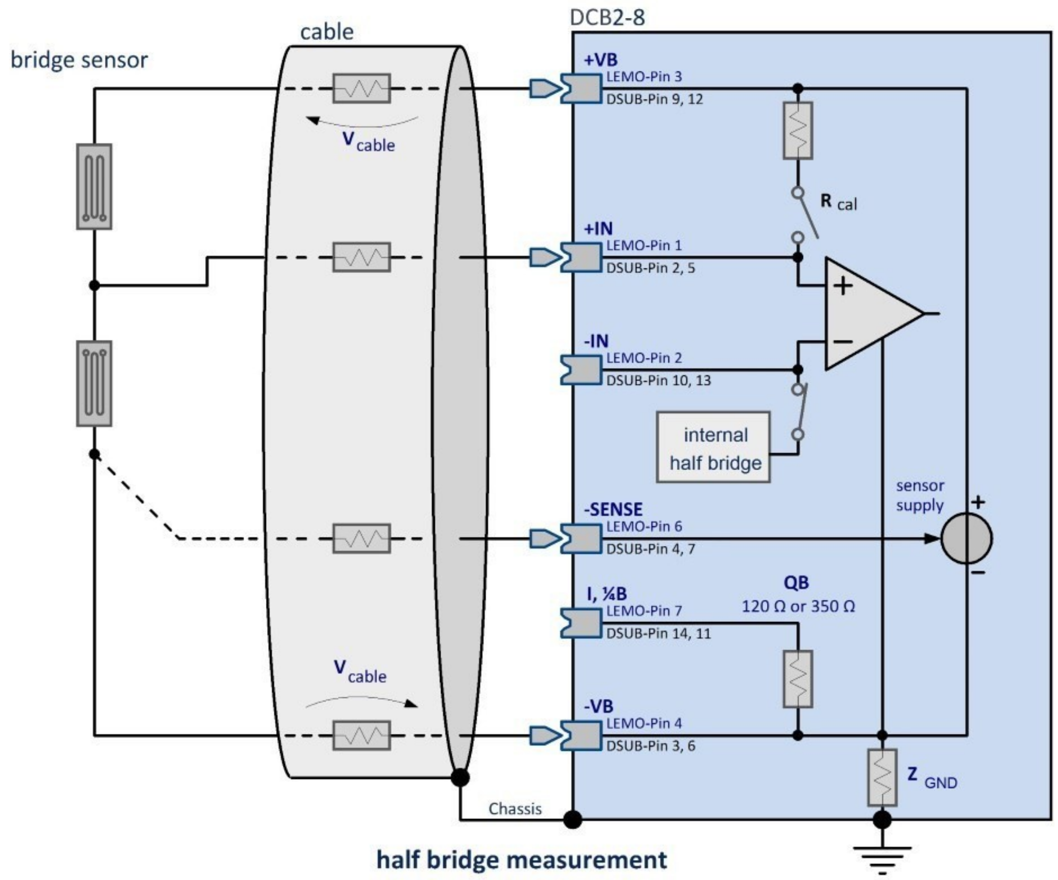


LEMO	is the 7-pin LEMO
DSUB	15-pin DSUB
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

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.

8.2.3.1.2 Half bridge



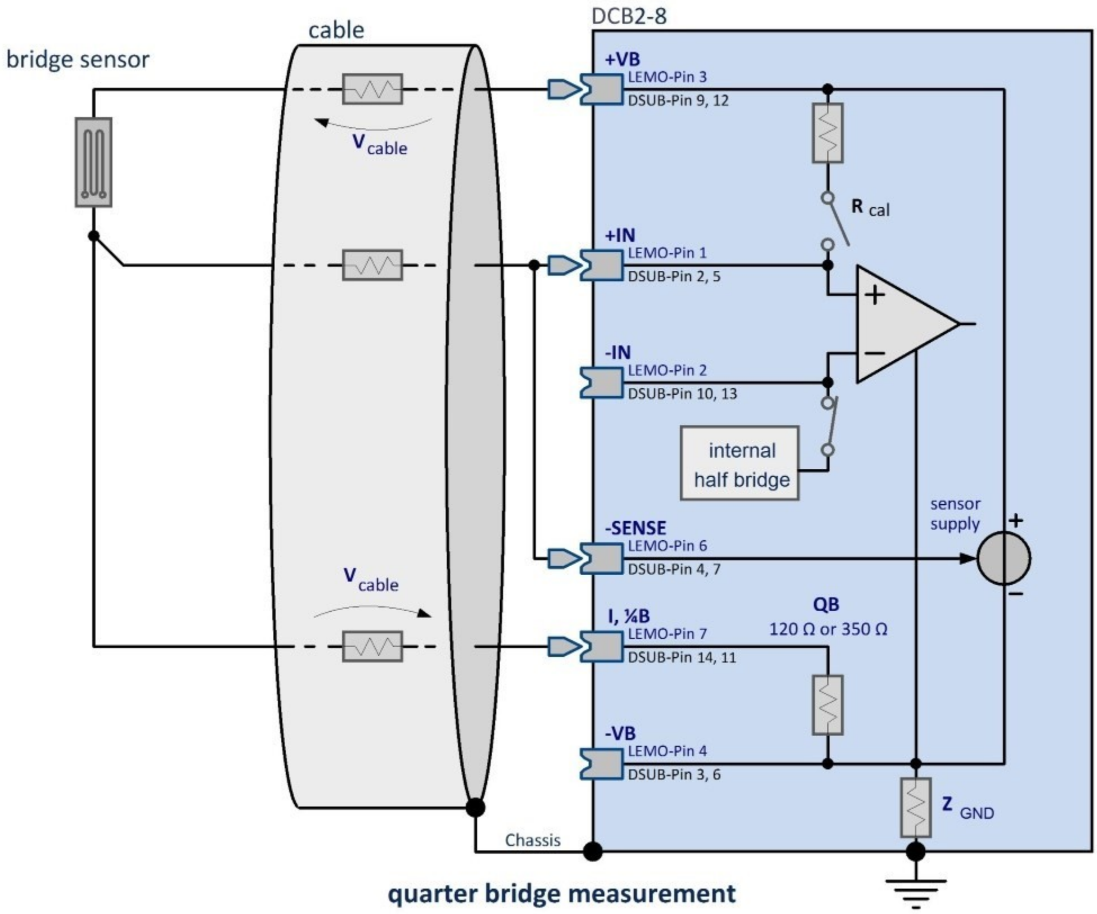
LEMO	is the 7-pin LEMO
DSUB	15-pin DSUB
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

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 99.

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.

8.2.3.1.3 Quarter bridge



LEMO	is the 7-pin LEMO
DSUB	15-pin DSUB
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.

8.2.3.1.4 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

8.2.3.1.5 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

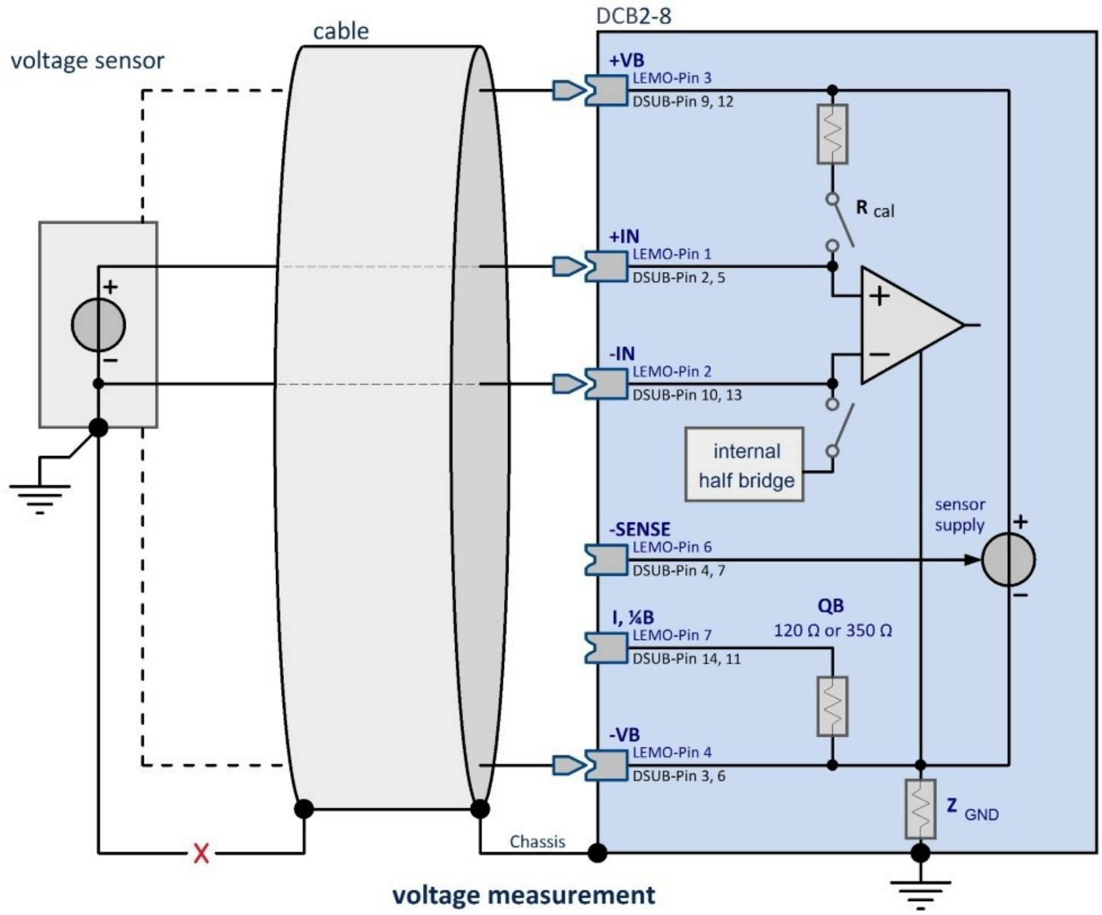
- We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

8.2.3.2 Voltage measurement

- Voltage: ±10 V to ±5 mV in 9 different ranges

The input impedance is 20MΩ. (1MΩ when switched off)

8.2.3.2.1 Voltage source with ground reference



LEMO	is the 7-pin LEMO
DSUB	15-pin DSUB
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

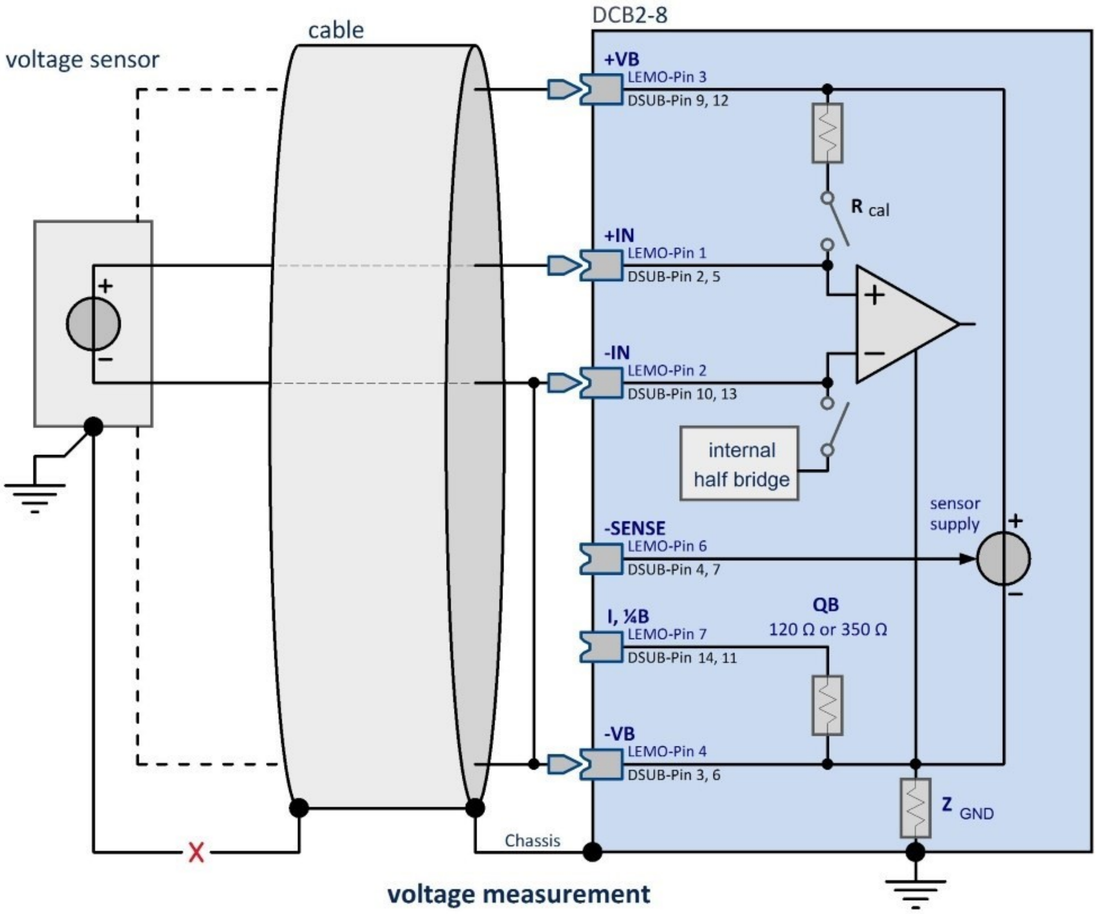
The voltage source itself already has a connection to the device's ground. The potential difference between the voltage source and the device ground must be fixed.

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.

8.2.3.2.2 Voltage source without ground reference



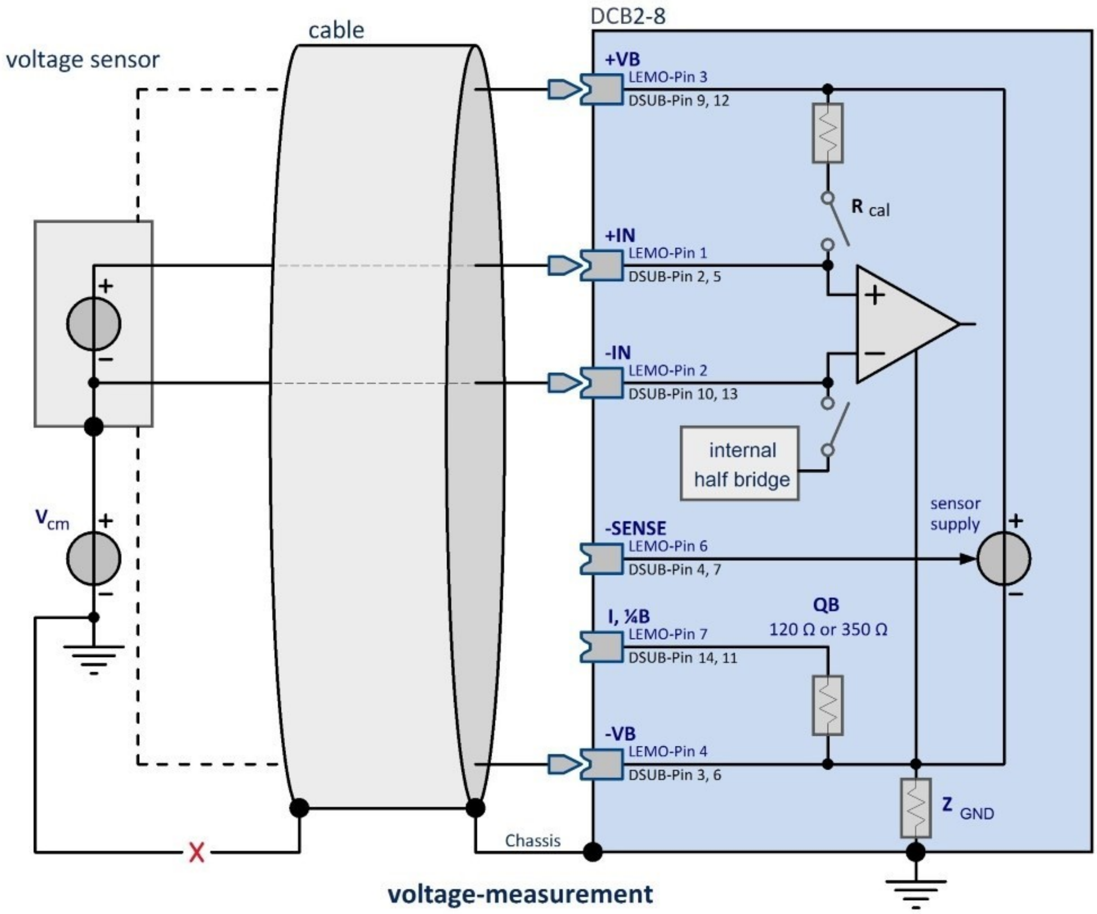
LEMO	is the 7-pin LEMO
DSUB	15-pin DSUB
Z_{GND}	is ca. 500 kΩ for CRFX, else 0 Ω

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.

8.2.3.2.3 Voltage source at a different fixed potential



LEMO	is the 7-pin LEMO
DSUB	15-pin DSUB
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.

8.2.3.3 Current measurement

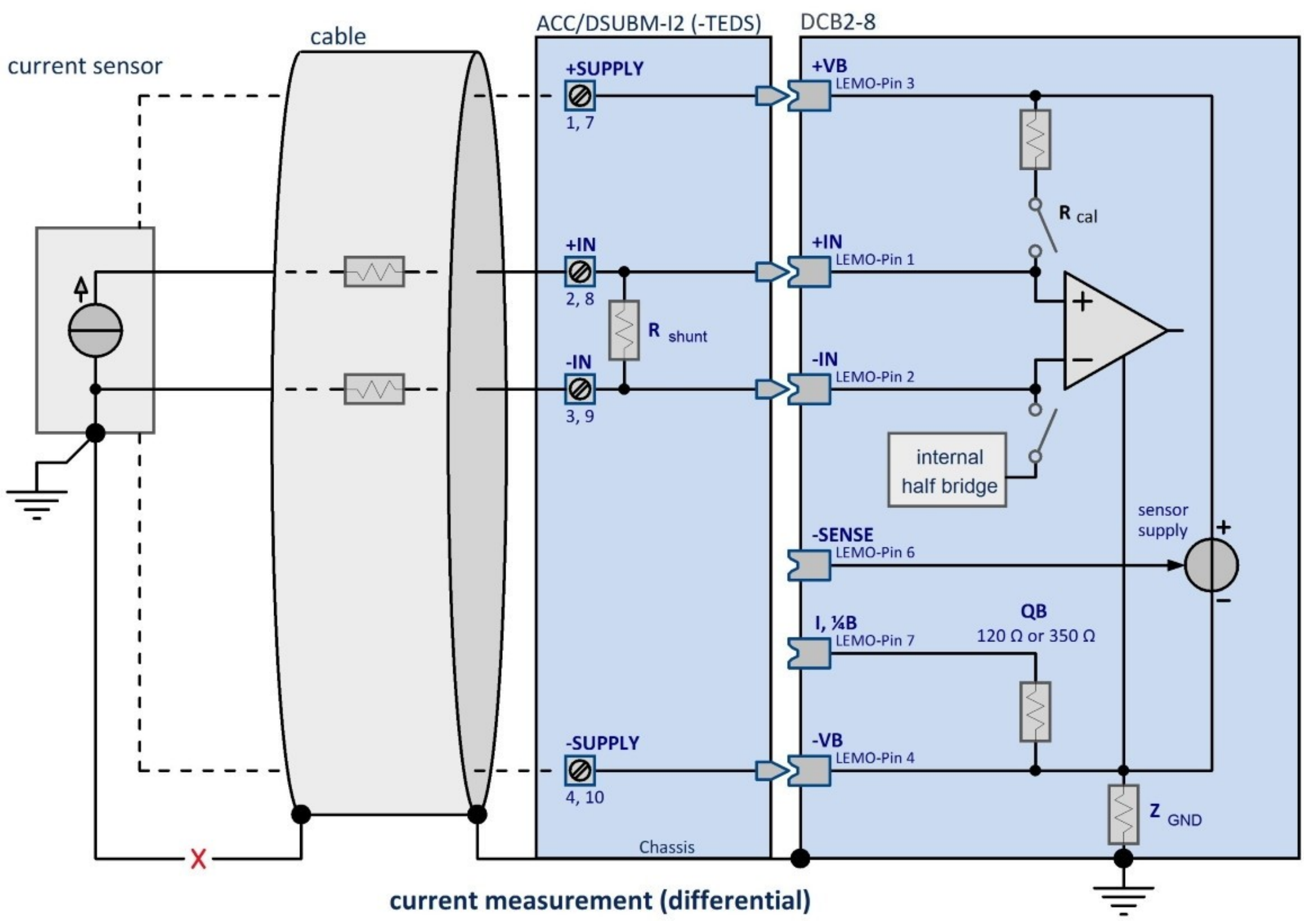
The current measurement is realized with shunt plug:

- ACC/DSUBM-I2 (DSUB-15)
- ACC/DSUBM-HD-I4 (DSUB-26-HD)

8.2.3.3.1 Differential current measurement

Note	Requirement
The following statements only apply for modules with DSUB sockets.	

- Current ±50 mA to ±1 mA



LEMO	is the 7-pin LEMO
DSUB	15-pin DSUB
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).

8.2.3.4 Current fed sensors

For the measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) 65.

Note 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.

8.2.3.5 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 a group of eight channels.

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!

8.2.3.6 Bandwidth

The channels' **maximum sampling rate** is 500 Hz (2 ms). The analog bandwidth (without digital low-pass filtering) is 200 Hz (-3 dB).

8.2.3.7 Connections

The various *SPAR/B16* and *SPAR/BC16* models differ in their connection terminals.

SPAR/B16 has the 15-pin DSUB connectors usual for imc amplifiers. *SPAR/BC16* enables connection of four channels per connector with 26-pin High Density DSUB connectors.

8.2.3.7.1 SPAR/B16 Connections

SPAR/B16 uses DSUB-15 sockets. This means that two bridge measurement channels per terminal can be connected. Additionally, the imc special connectors can be used for measuring current and current-fed sensors (ICP).

Under SPAR/B16 (ACC/DSUBM-XX) 182 the pin configuration of the DSUB-15 terminals is presented.

8.2.3.7.2 SPAR/BC16 Connections

SPAR/BC16 uses 26-pin HD (High Density) DSUB sockets, which enable connection of four bridge measurement channels per terminal. There are no imc special connectors for measurement of current-fed sensors. Current measurement must be performed in voltage mode via an external shunt resistor, the scaling of whose resulting voltage must be entered in the channel configuration.

Under SPAR/BC16 (DSUB-26 184), the configuration of the HD DSUB-26 pins is presented.

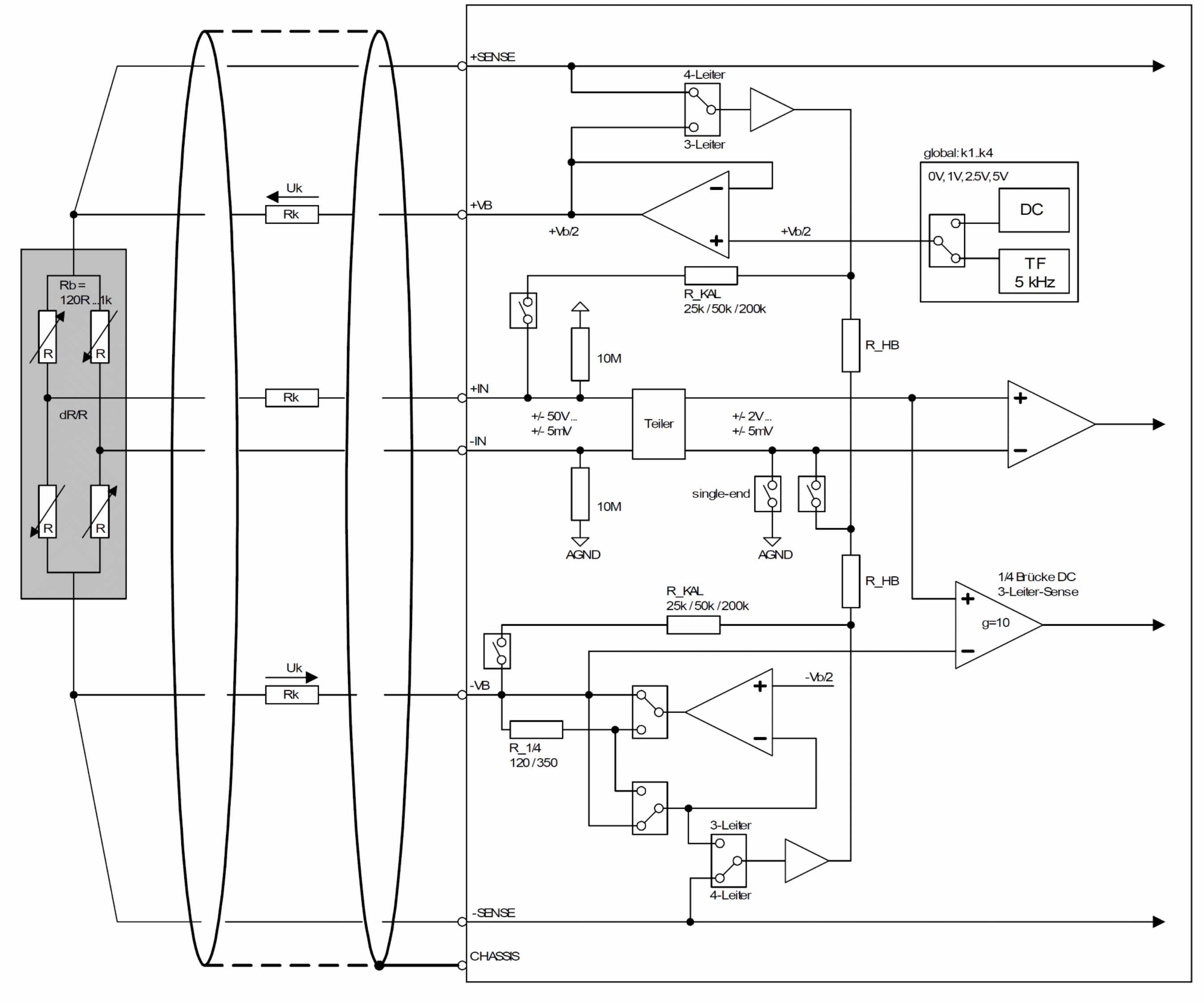
8.2.4 SPAR/BCF16 bridge, LVDT and voltage

The SPAR/BCF16 optionally enable, beside the DC mode, the carrier frequency (CF) and allow measurements of bridges and strain gauge and also LVDT mode and inductive transducers, technical details 157

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



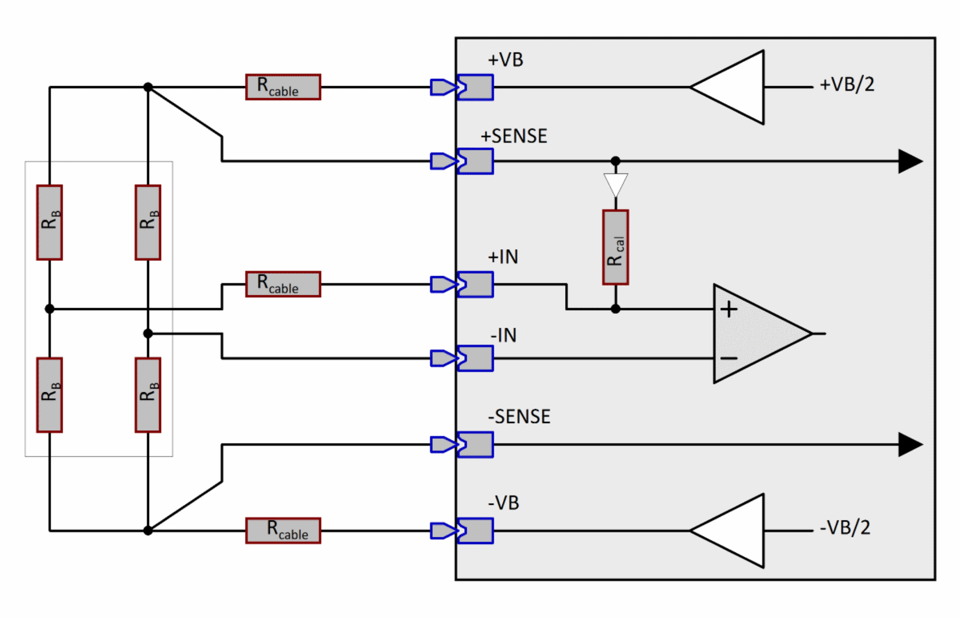
Block schematic

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



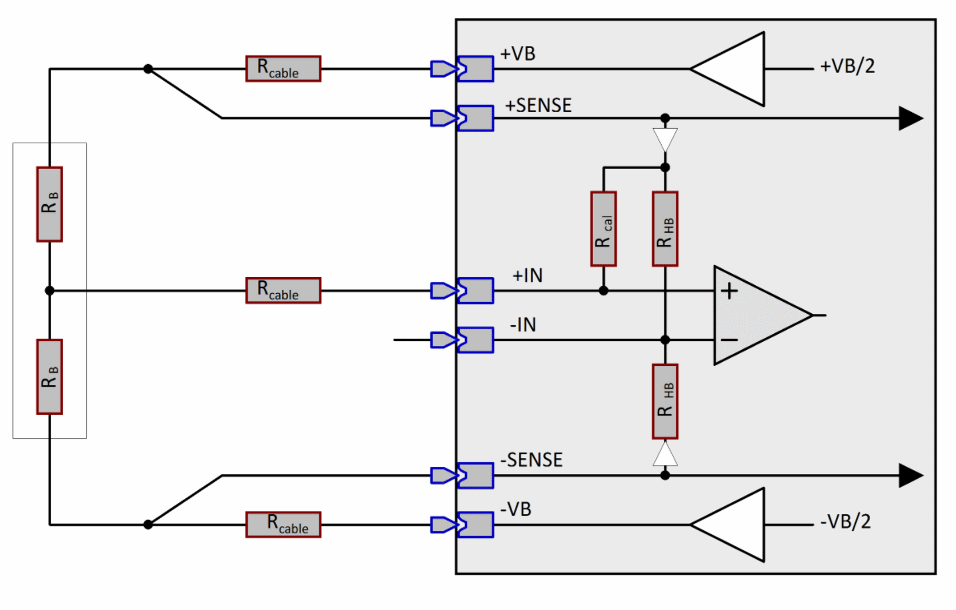
- 6-wire connection
- Both SENSE-lines, ±SENSE, used ("double sense").
  Compensation of the influence even of asymmetric cable resistances.
- Calibration resistor for shunt calibration;
  for long cables in CF mode, reduced precision due to phase errors

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

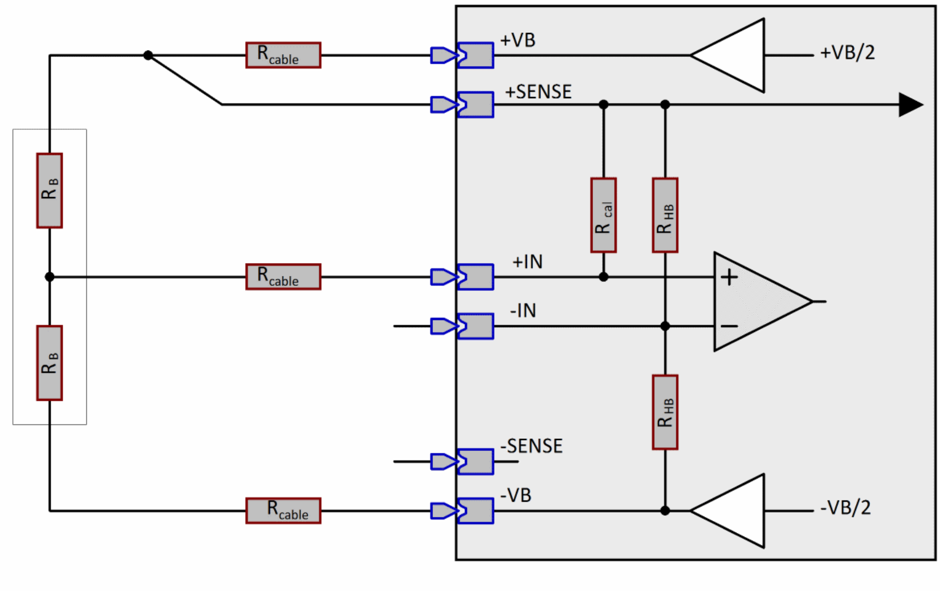
Connection scheme: Half-bridge, double Sense



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!

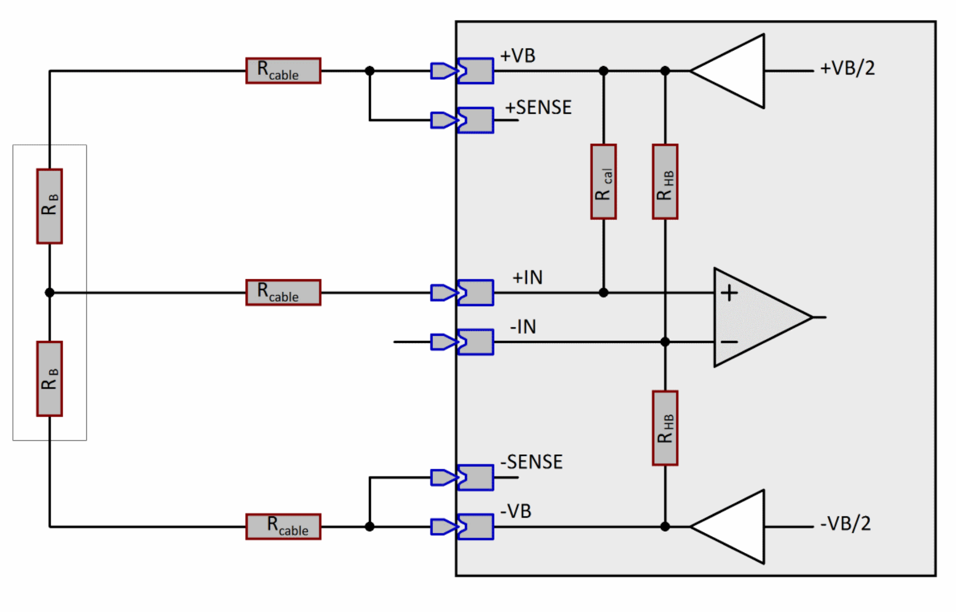
Connection scheme: Half-bridge, single line-Sense, only DC mode



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

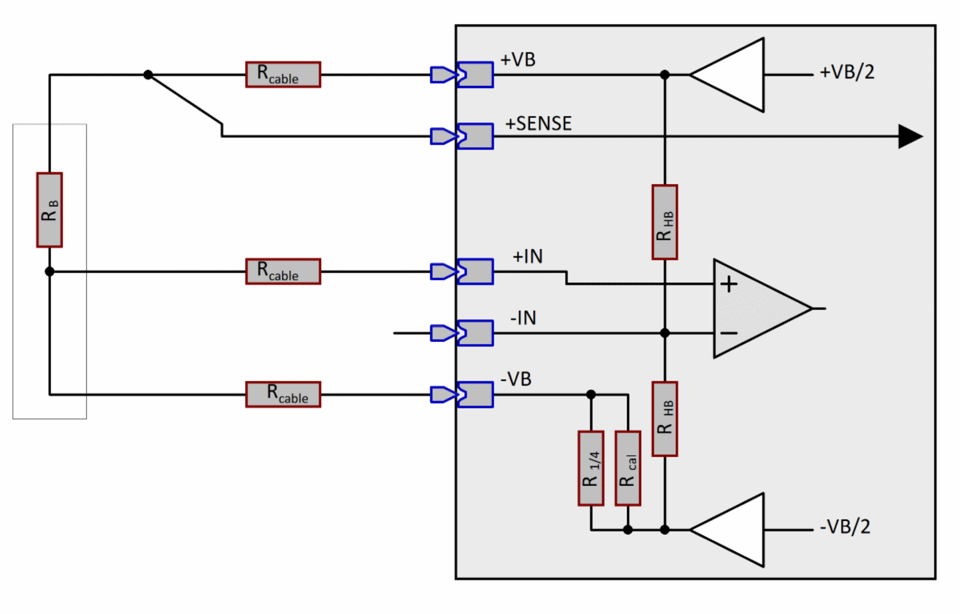


Half-bridge without single line-Sense

- 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

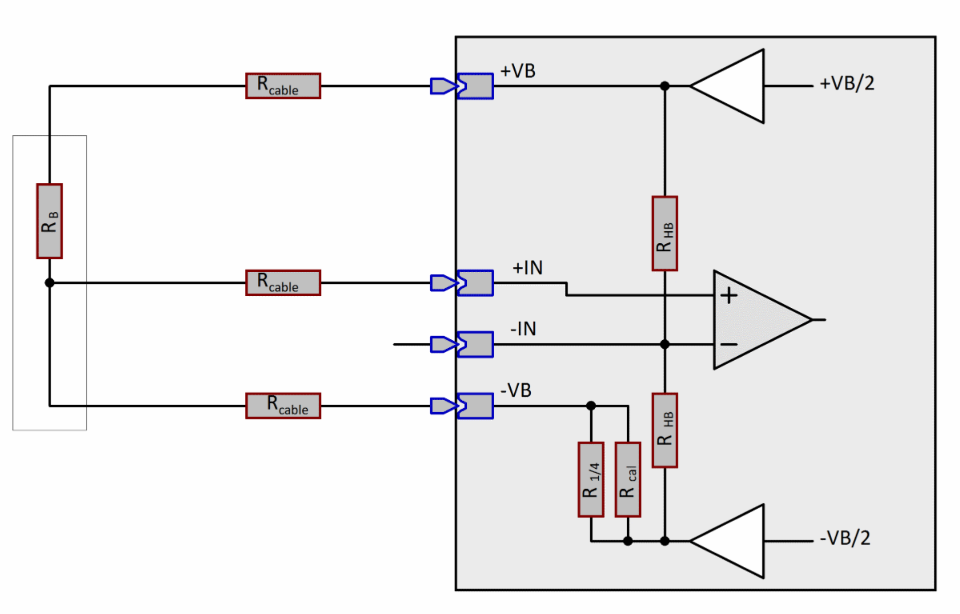
Connection scheme, quarter bridge, with Sense



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

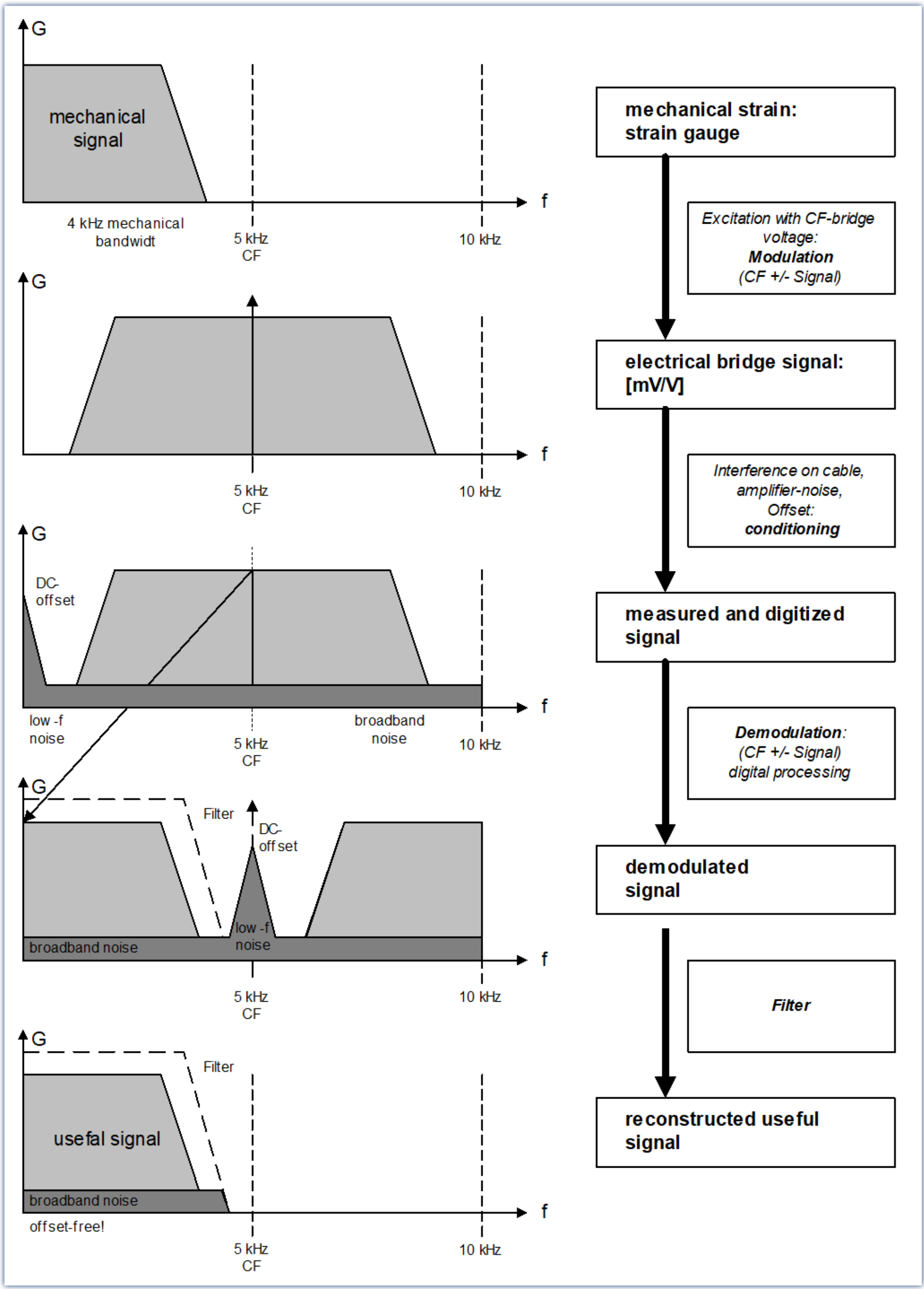
There are three different procedures for cable compensation:

- 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 Bandwidth

The channels' max. sampling rate is 500 Hz (2 ms). The analog bandwidth (without digital low-pass filtering) is 200 Hz (-3 dB).

8.2.4.4 Connection

For the signal connection, it is possible to use DSUB-15

Pin configuration of the DSUB-15 182

8.2.5 SPAR/LVDT(C)16

The SPAR/LVDT16 module is specially designed for LVDT measurements (Schaevitz coils according to the transformer principle and inductive half bridges). The module is also available in compact DSUB-26-HD version (LVDTC16).

Technical details: SPAR/LVDT(C)16 161

Pin configuration of the DSUB-15 182

8.3 Other inputs and outputs

8.3.1 SPAR/DI8-DO8-ENC4-DAC4 digital multiboard

Digital multiboard with 8 dig. inputs, 8 dig. outputs, 4 inputs for incremental encoder sensors and 4 analog outputs.

The digital inputs and outputs and the incremental counter part conform to the description of the standard included components 79. The only difference is that the number of digital inputs is limited to 8.

8.3.1.1 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 182.

The technical specification of the module DAC-4 168.

Highlights

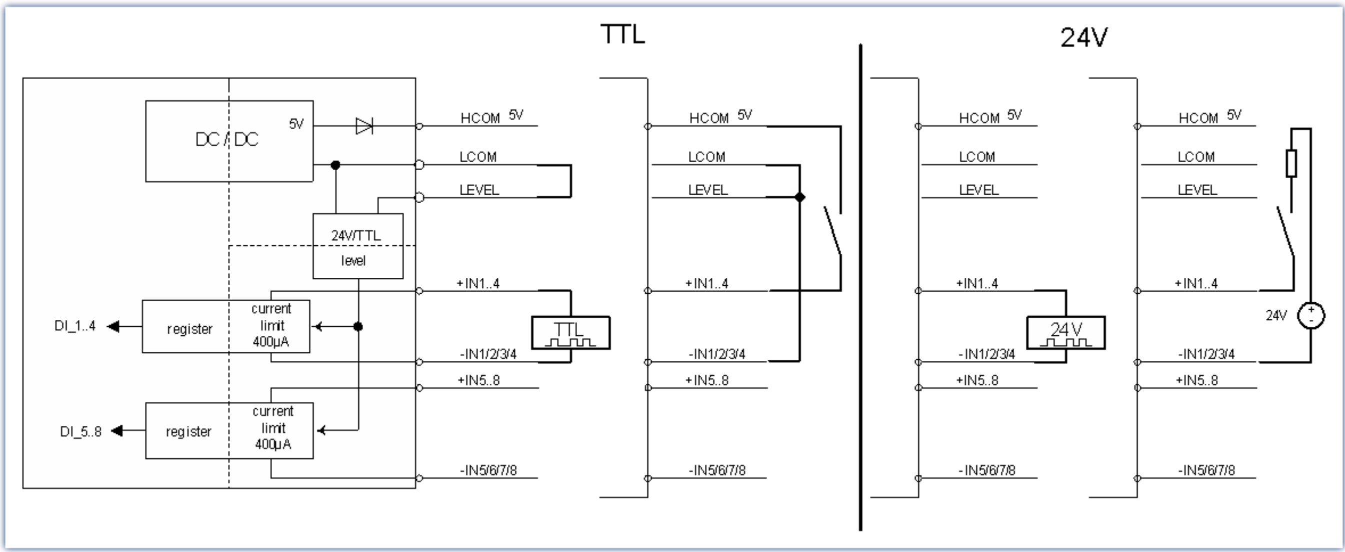
- ±10 V level at max. ±10 mA driver capability and 250 Ω load
- ensured startup level 0 V without undefined transient states
- short-circuit protected against ground.

8.3.2 SPAR/DI16 digital inputs

The DI16 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 SPAR/DI16 165.

The pin configuration of the DSUB-15 plug: ACC/DSUBM-DI4-8 182.



8.3.2.1 Input voltage

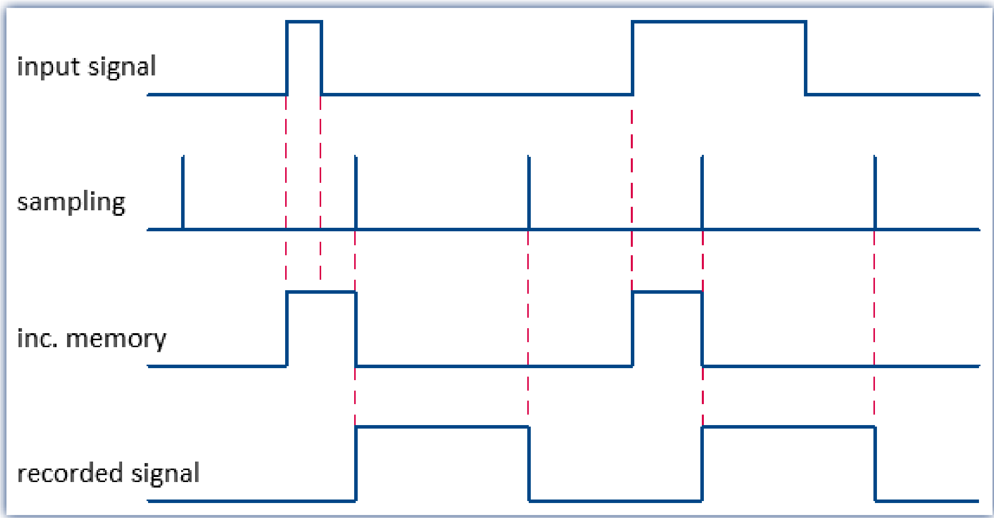
The input voltage range can be set for a group of 8 channels to either 5 V (TTL-range) or 24 V. The switching is accomplished by means of a jumper at the ACC/DSUB(M)-DI4-8 connector:

- 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.

8.3.2.2 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.



8.3.3 SPAR/DO16 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 SPAR/DO16 digital outputs 166.
Find here the pin configuration of the DSUB-15: ACC/DSUBM-DO8 166.

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".

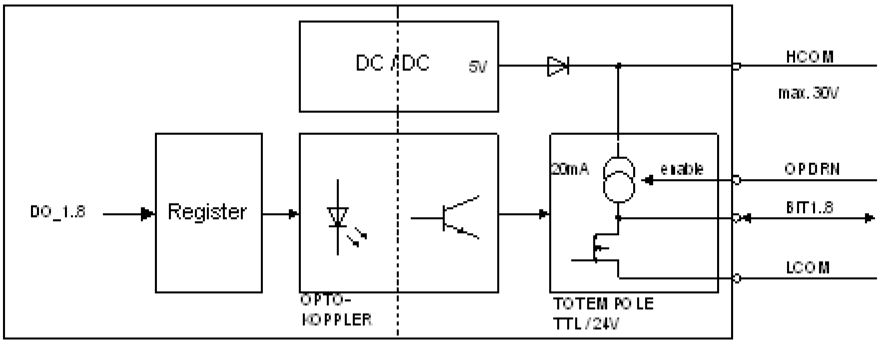
If a different state is desired, there are several options:

- 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*"**.

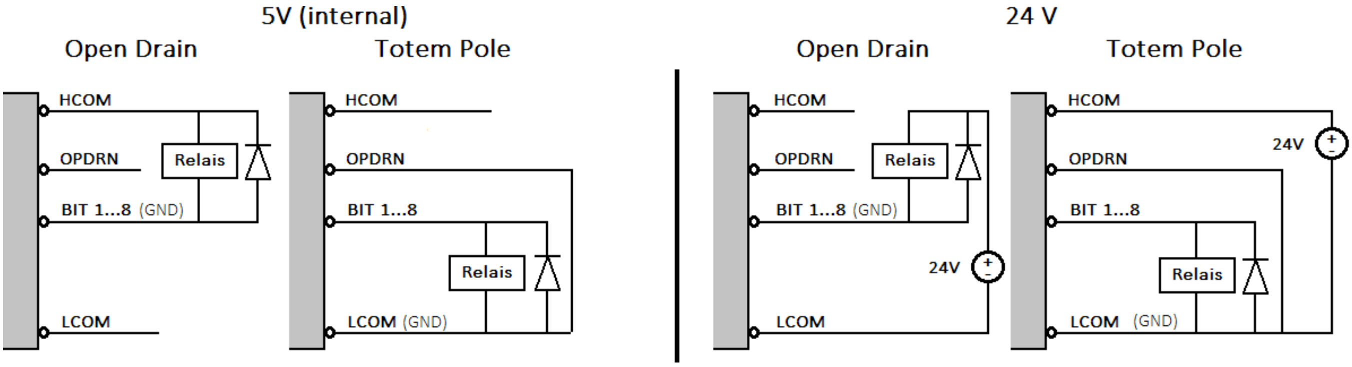
When "*preparing*" (reconfiguring) **imc Online FAMOS wins** and the value in the imc STUDIO variable is overwritten.

See: Manual imc STUDIO > "*Setup pages - Configuring device*" > "*Information and tips*" > "*Initial value for variables - Beginning the measurement - Jumps at the output*"

8.3.3.1 Block schematic



8.3.3.2 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**.

8.3.3.3 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.

8.3.4 SPAR/DAC8 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.

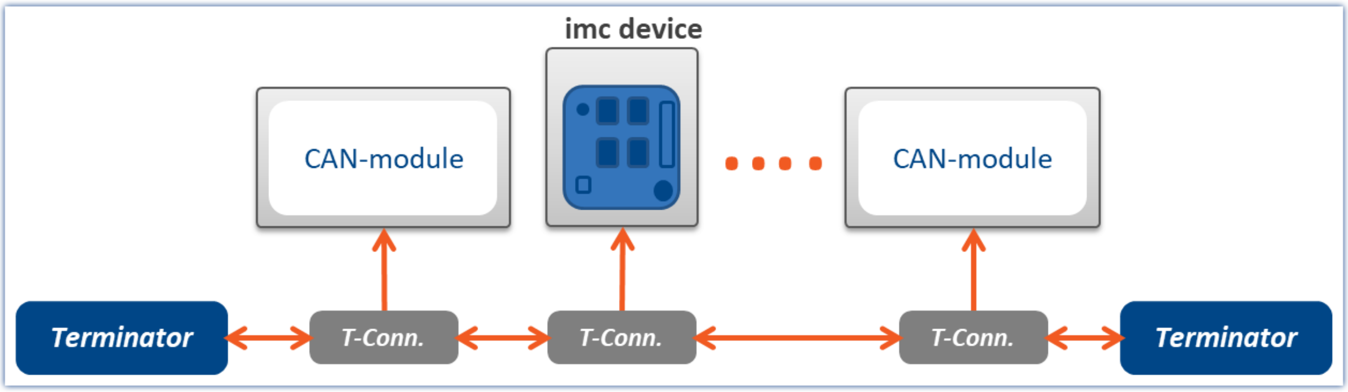
Technical details of the SPAR/DAC8 analog outputs 168.

Pin configuration: Standard plug 182

8.3.5 Fieldbus interfaces

8.3.5.1 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 SPARTAN 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 SPARTAN 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 168 and the pin configuration 186 of the CAN-Bus interface.

Find here the technical details 169 and the pin configuration 186 of the CAN FD interface.

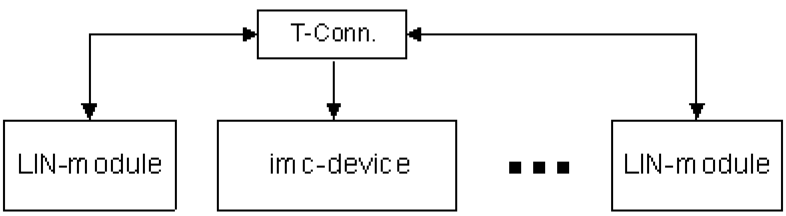
Connecting the terminators

- 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.

8.3.5.2 LIN



LIN-cabling

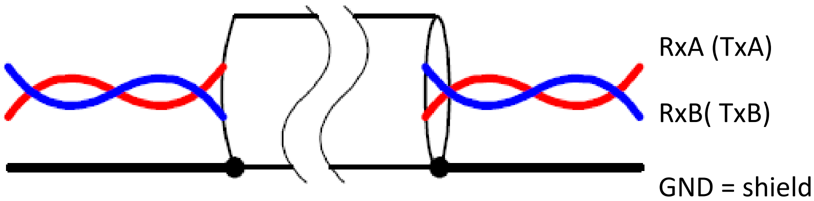
To the technical data 170 and the pin configuration 188 of the LIN-BUS interface.

8.3.5.3 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 173 and the pin configuration 189 of the ARINC-Bus interface.

8.3.5.4 FlexRay

Standard 1x DSUB-9

Reference

To the technical data 170 and the pin configuration (optional 2x DSUB-9) 188 of the FlexRay interface.

8.3.5.5 XCPoE

Standard 1x RJ45

Reference

To the technical data 171 and the pin configuration 188 of the XCPoE interface.

8.3.5.6 PROFIBUS

Reference

To the technical data 171 and the pin configuration 190 of the PROFIBUS interface.

8.3.5.7 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.

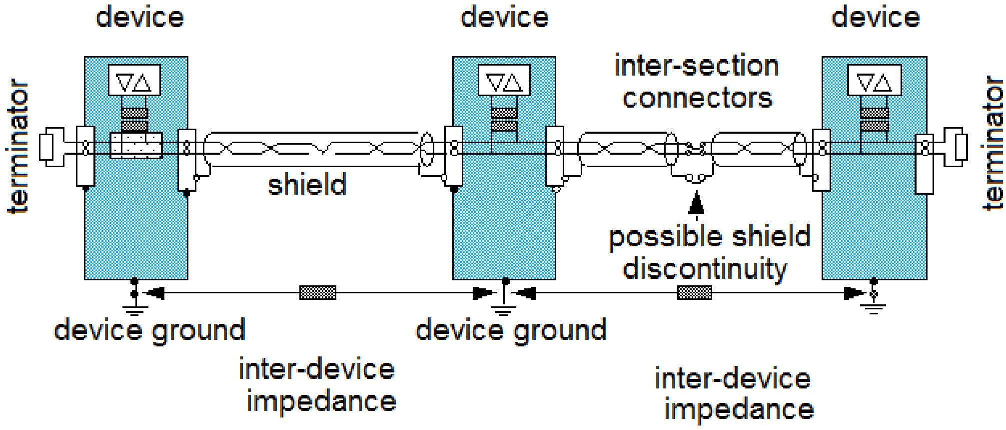
Reference

To the technical data 172 and the pin configuration 190 of the MVB-Bus interface.

8.3.5.7.1 EMD

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

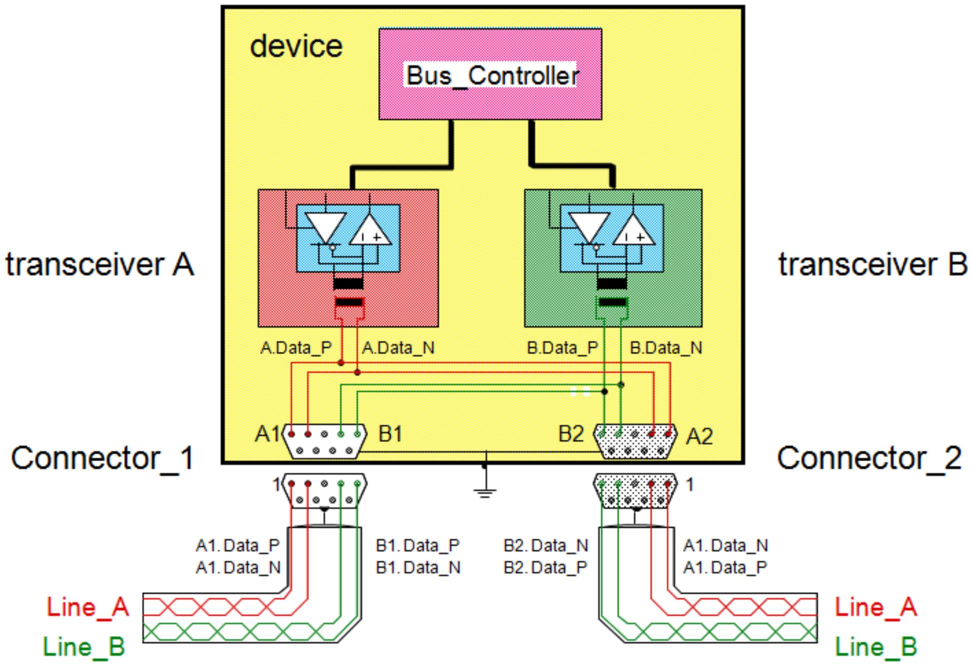
- Up to 32 devices can be connected across a distance of max. 200 m.
- The cables used are standard 120 Ω lines.
- The signals are connected by means of two DSUB-9 terminals.



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.

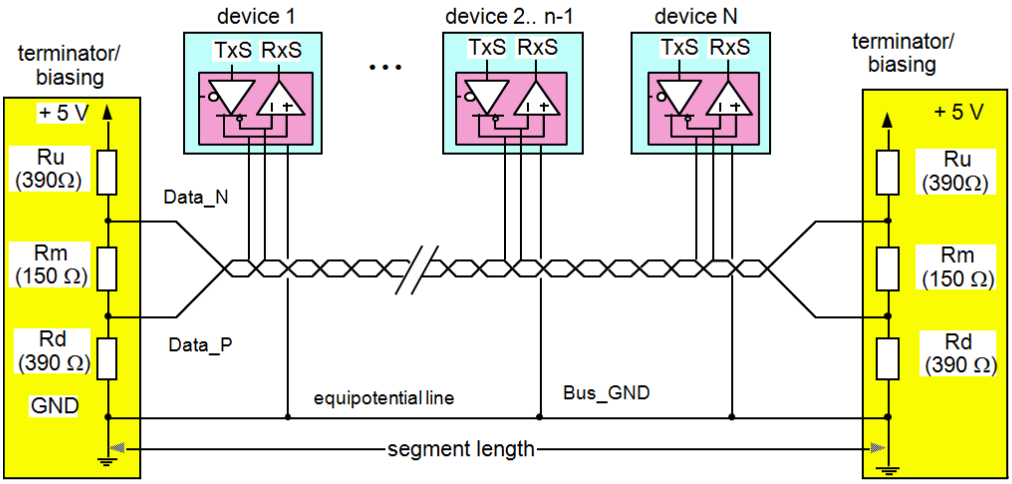


Internal wiring for EMD connection

8.3.5.7.2 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.

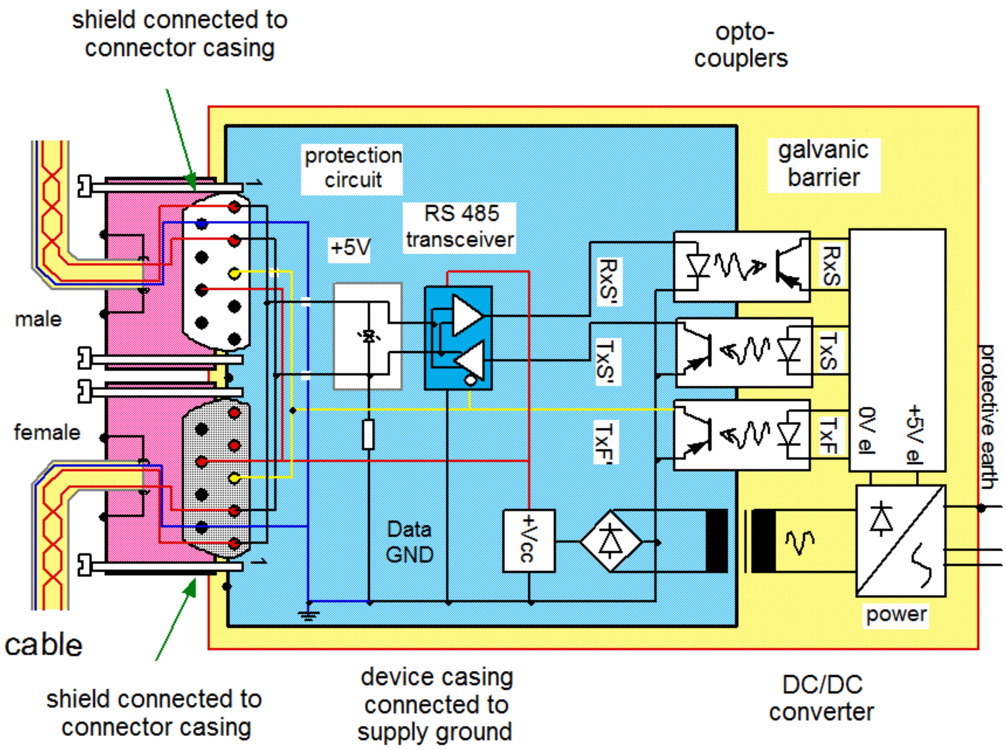
- Up to 32 devices can be connected across a max. distance of 20 m.
- Standard 120 Ω cable leads are used.
- Lines are connected via DSUB9 terminals.



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

8.4 Miscellaneous

8.4.1 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)

Devices of the imc SPARTAN series:
- support imc TEDS DSUB plugs (DS 2433)
- do not support sensor type DS 2431, e.g. imc Triaxial Accelerometers (SEN/ACC-ADxx).

8.4.2 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 130 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 143

8.4.2.1 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.

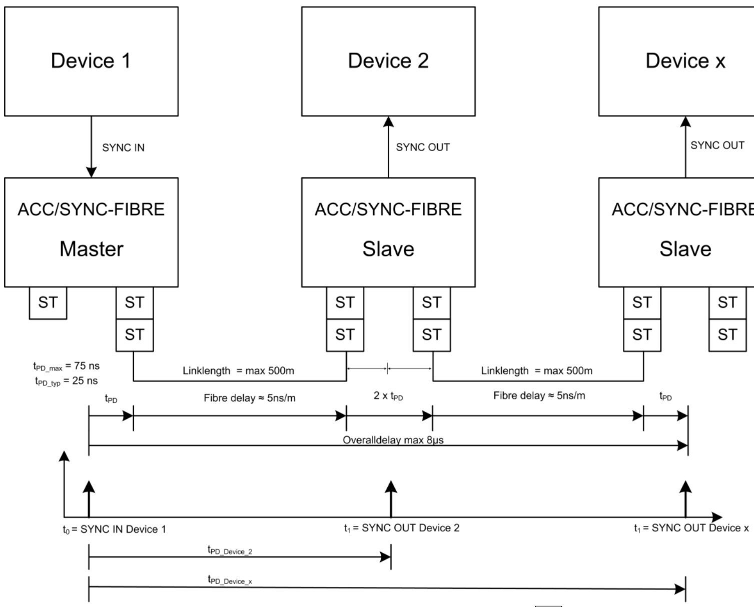
In areas of high electrical interference, or where long-distance signal transmission is needed, the signal can be conducted via fiber optic cabling with total isolation and no interference. For this purpose, the externally connectable optical SYNC adapter ACC/SYNC-FIBRE is available.

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 178

8.4.3 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 °

GPS information	Description
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:

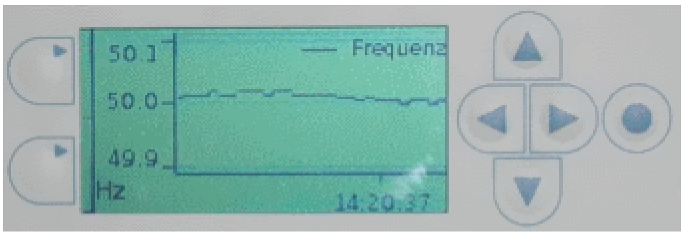
- GA: Galileo Positioning System
- GB: BeiDou (BDS) (China)
- GI: NavIC (IRNSS) (India)
- GL: GLONASS, according to IEIC 61162-1
- GN: Combination of multiple satellite systems (GNSS) (NMEA 1083)
- GP: Global Positioning System (GPS)
- GQ: QZSS regional GPS augmentation system (Japan)

DSUB-9 pin configuration 185

8.4.4 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.



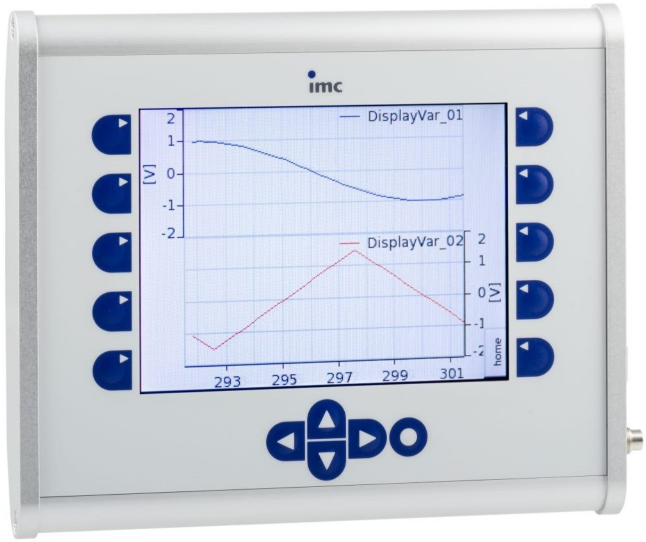
integrated display, only with CL and PL devices

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.

8.4.4.1 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 174".

- 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.

8.4.5 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":

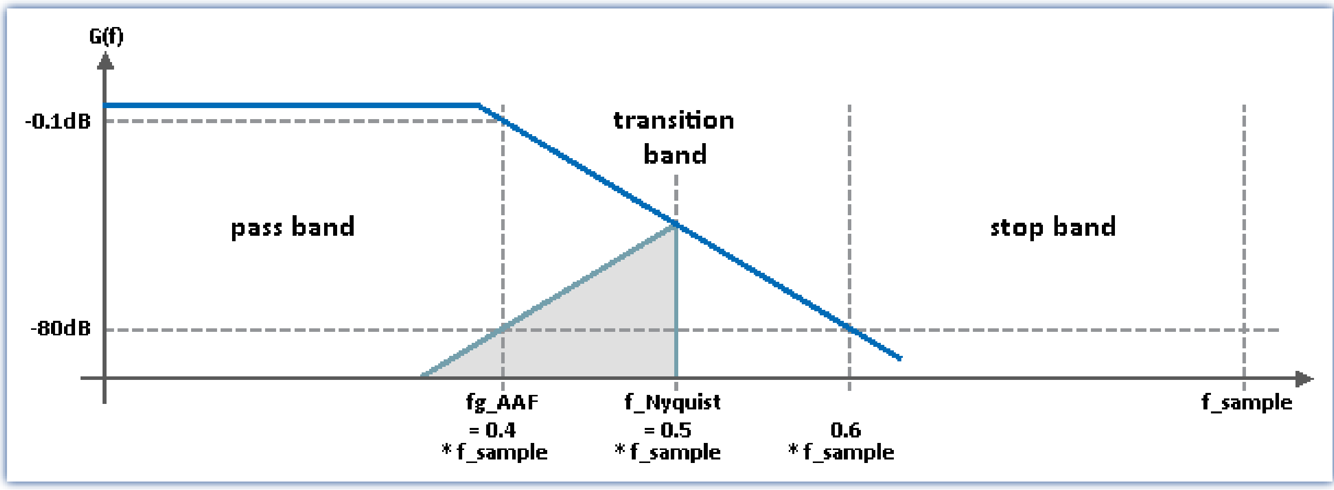
The (digital) anti-aliasing filters are elliptical Cauer filters. Their "tight" characteristic curve in the frequency range makes it possible to have the cutoff frequencies approach the sampling and Nyquist frequencies much closer without having to make a compromise between the bandwidth and freedom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

8.4.6 External sensor supply

8.4.6.1 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.

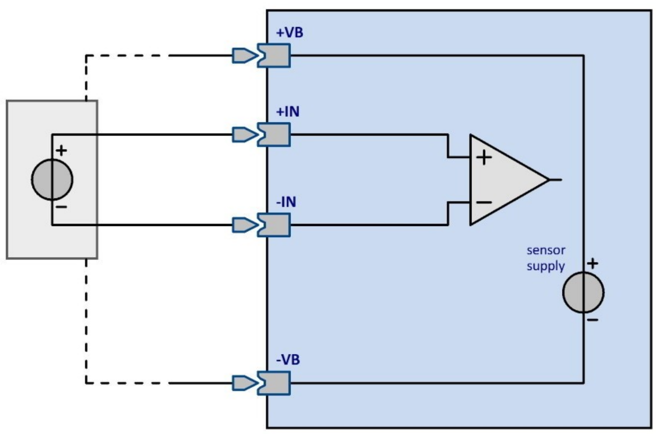
The +5 V supply outputs are electronically protected internally against short-circuiting and can each be loaded up to max. 160 mA (short-circuit limiting: 200 mA, refer to the data sheet of the used module). The sensor's reference potential, in other words its supply-ground connection is the terminal "GND". The 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 47). In this case, the 5 V supply can not be used for external sensors.

8.4.6.2 Sensor supply module

The modules SPAR/T16 and SPAR/U16 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.

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 182.

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 device.

Reference

Technical Specs "..-SUPPLY": T16-SUPPLY 148, U16-SUPPLY 152

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 chapter "Precautions for operation") 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.

9.1 Technical Specs for all devices

Terminal connections		
Parameter	**Value**	**Remarks**
PC / network Ethernet TCP/IP	RJ45 100 MBit	max. 100 m cable with 100 MBit (according to IEEE 802.3)
Removable flash storage	CF-Card Slot	can also be read out via network
Internal hard drive (HDD)	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	
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)	operation via imc Online FAMOS
Measurement inputs	depending on actual system configuration	typically DSUB-15

Power supply	Value	Remarks
DC supply input	10 V to 32 V DC	galvanically isolated of housing (CHASSIS)
DC-input LEMO type	FGG.2B.302.CLAD 82ZN	
AC/DC power adaptor	24 VDC, 150 W 110-230V AC 50-60 Hz	included in delivery
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		
Autarkic operation without PC	✔	
Self start (Automatic data acquisition operation)	configurable	timer, absolute time, automatic start when power supply is applied
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
USV coverage	complete system	
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 charging for 1 min. buffer duration	≤53 min.	typ. 23°C, with empty battery depending on device variant
Additional power consumption during charging time	3.5 W (max.)	device activated
Charging power	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 ratio 48:1)
UPS batteries		**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
Charging time for complete battery recovery	36 h	device activated
UPS-takeover threshold (typ.)	9.8 V 11.1 V	takeover internal buffer battery switch back to external supply

Data acquisition, trigger		
Parameter	**Value**	**Remarks**
Max. aggregate sampling rate	400 kS/s	
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	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.

		without monitor channels				**with monitor channels**			
Channel type	**determined by**	**limit (aktive+passive)**		**activated**	**total activated**	**limit (aktive+passive)**		**activated**	**total activated**
Analog channels	system-expansion	Channel	240	198	512	Channel	240	198	512
						Monitor	240		
Incremental counter	system-expansion	Channel	16	16		Channel	16	16	
						Monitor	16	16	
DIO/DAC-Ports	system-expansion	Port	16	16		Port	16	16	
						Monitor	16	16	
Fieldbus channels	flexible	Channel	1000	512		Channel	1000	512	
						Monitor			
Virtual channels (OFA)	flexible	-	-	512		-	-	512	

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

Storage, signal processing		
Parameter	**Value**	**Remarks**
Internal flash storage	CF-card	removable cover for the CF slot
Removable flash storage media	CF	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
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	Master / Slave via external GPS-receiver TTL via network

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

9.1.1 Synchronisation 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 signal				
Parameter	**GPS**	**DCF77**	**IRIG-B**	**NTP**
Supported formats	NMEA / PPS(1)		B000, B001 B002, B003(2)	Version ≤4
Precision	±1 µs			<5 ms after ca. 12 h(3)
Jitter (max.)	±8 µs			
Voltage level	TTL (PPS (1)) RS232 (NMEA)	5 V TTL level		---
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 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
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

(1) PPS (Pulse per second): signal with an impulse >5 ms is necessary
(2) using BCD information only
(3) Max. value, concerning the following condition: first-synchronization

9.2 Analog modules

9.2.1 SPAR/T16 analog inputs

Inputs, measurement modes		
Parameter	**Value**	**Remarks**
Inputs	16	
Measurement mode T16 (DSUB-15)	voltage measurement current measurement thermocouples, RTD (PT100)	standard plug (ACC/DSUBM-U4) current plug (ACC/DSUBM-I4) thermo-plug (ACC/DSUBM-T4)
Measurement mode T16-TC-K T16-TC-N T16-TC-UNI	thermocouple type-K thermocouple type-N thermocouple universal types R, S, B, J, T, E, K, L, N	miniature thermocouple terminal connector 2-pin, green connector 2-pin, pink connector 2-pin UNI (Cu), white
Width	2 slots	

Sampling rate, Bandwidth, TEDS			
Parameter	**Value**		**Remarks**
Sampling rate	max. 5 Hz (200 ms) / channel		internal sampling: 2 Hz with additional interpolation: 5Hz for higher rates:output of doubled values max. allowable input signal frequency: 1 Hz
Bandwidth	1 Hz		-3 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) not supported: DS2431 (typ. IEPE/ICP sensor)
Characteristic curve linearization	user defined (max. 1023 supporting points)		

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 Suppression of square wave on neighboring channels	all sampling rates >116 dB (50 Hz) >101 dB (50 Hz) >123 dB @ sampling rate 200 ms		 range ≤±2 V range ≤±2 V range ≤±2 V	 R_{source} = 0 Ω R_{source} = 100 Ω 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= $\lvert T_a$-25°C$\rvert$; 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= $\lvert T_a$-25°C$\rvert$; 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= $\lvert T_a$-25°C$\rvert$; with T_a = ambient temperature
Reference current (PT100)	250 µA		non-isolated (CHASSIS is Ground)

Sensor supply (T16-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
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

Find here the description of the SPAR/T16 voltage and temperature 91.

9.2.2 SPAR/U16 analog inputs

Parameter	Value	Remarks
Inputs	16	
Measurement modes U16 (DSUB-15)	voltage measurement current measurement thermocouple, RTD (PT100) current fed sensors (IEPE/ICP)	standard plug (ACC/DSUBM-U4) 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 mode U16-TC-K U16-TC-N U16-TC-UNI	thermocouple type-K thermocouple type-N thermocouple universal types R, S, B, J, T, E, K, L, N	miniature thermocouple terminal connector 2-pin, green connector 2-pin, pink connector 2-pin UNI (Cu), white
Width	2 slots	

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤500 Hz	per channel
Bandwidth	0 Hz to 200 Hz	-3 dB
Filter (digital) cut-off frequency characteristic type and order	1 Hz to 200 Hz	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 $f_{cut-off} = 0.4\ f_a$
Resolution	16 Bit	internal processing 24 Bit
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)	

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 on overvoltage condition		1 nA 1 mA	$\|V_{in}\|$ > 5 V on ranges <±5 V or device powered-down
Auxiliary supply			for IEPE/ICP plug
voltage available current internal resistance	+5 V >0.26 A 1.0 Ω	±5 % >0.2 A <1.2 Ω	independent of optional sensor supply, short circuit proof 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

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)		16-Bit integer
Measurement error		<±0,6 K <±1.0 K <±1.5 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 type K, range -200°C to -150°C type T, range -200°C to -150°C 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	ΔT_a=|T_a -25°C|; with T_a = ambient temperature
Sensor feed	250 µA	non-isolated

Sensor supply (U16-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 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
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

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9.2.3 SPAR/B(C)16 analog inputs

Parameter	Value	Remarks
Inputs	16	
Measurement modes B16 (DSUB-15)	Bridge sensors Strain gauges Voltage Current Current-fed sensors IEPE (ICP)	Bridge plug ACC/DSUBM-B2 full, half, quarter bridge Shunt-plug ACC/DSUBM-I2 with DSUB-15 extension plug: ACC/DSUBM-ICP2I-BNC-S/-F, isolated
Measurement modes BC16 (DSUB-26-HD)	Bridge sensors Strain gauges Voltage Current	ACC/DSUBM-HD-B4 Shunt-plug ACC/DSUBM-HD-I4
Width	2 slots 4 slots	BC16 (4x DSUB-26-HD) B16 (8x DSUB-15)

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤500 Hz	per channel
Bandwidth	0 Hz to 200 Hz	-3 dB
Filter (digital) cut-off frequency characteristic order	 1 Hz to 200 Hz	 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	16 Bit	internal processing 24 Bit
TEDS only SPAR/B16	conforming IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor)
Characteristic curve linearization	user defined (max. 1023 supporting points)	

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	ΔT_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 ΔT_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	ΔT_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

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	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ...		
bridge supply: 10 V	... ±0.5 mV/V		
bridge supply: 5 V	... ±1 mV/V		
bridge supply: 2.5 V	... ±2 mV/V		(as an option)
bridge supply: 1 V	... ±5 mV/V		(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	120 Ω, 10 mH full bridge 60 Ω, 10 mH half bridge		
Max. bridge impedance	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

<table>
<tr><th colspan="5">Sensor 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>The sensor supply module always has 5 selectable voltage settings.
default selection: +5 V to +24 V</td></tr>
<tr><td>Output voltage</td><td>Voltage
(+1 V)
(+2.5 V)
+5.0 V
+10 V
+12 V
+15 V
+24 V
(±15 V)</td><td>Current
580 mA
580 mA
580 mA
300 mA
250 mA
200 mA
120 mA
190 mA</td><td>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</td><td>set jointly for eight channels of a module
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.</td></tr>
<tr><td>Isolation</td><td colspan="3">non isolated</td><td>output to case (CHASSIS)</td></tr>
<tr><td>Short-circuit protection</td><td colspan="3">unlimited duration</td><td>to output voltage reference ground: "-VB"</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>Compensation of cable resistances</td><td colspan="3">3-line control:
SENSE line as refeed
(-VB: supply ground)</td><td>calculated compensation with bridges</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 description of the SPAR/B(C)16 bridge and voltage. 98

9.2.4 SPAR/BCF16 analog inputs

Parameter	Value	Remarks
Inputs	16	
Measurement modes	bridge sensors strain gauge LVDT voltage measurement current measurement current-fed sensors IEPE/ICP	bridge plug ACC/DSUBM-B2 full-, half-, quarter bridge inductive transducers (CF) voltage or bridge mode global for all four channels Shunt-plug ACC/DSUBM-I2 with IEPE/ICP expansion plug (DSUB-15): ACC/DSUBM-ICP2I-BNC-S/-F, isolated, basic functionality (ICP-operation)
Width	4 Slots	8x DSUB-15

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤500 Hz	per channel
Bandwidth	0 Hz to 200 Hz	-3 dB -3 dB
Filter (digital) Frequency Characteristic Order	 1 Hz to 200 Hz	 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	16 Bit	internal processing 24 Bit
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)
Characteristic curve linearization	user defined (max. 1023 supporting points)	

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:			DC
±5 mV to ±25 mV		>120 dB	
±50 mV to ±100 mV		>110 dB	
±250 mV to ±2 V		95 dB	
±5 V to ±50 V		>54 dB	
±5 mV to ±2 V	>100 dB	>90 dB	f ≤ 50 Hz
±5 V to ±50 V	>68 dB	>54 dB	
all ranges		>50 dB	f = 5 kHz
SNR (signal to noise ratio)			full-scale / rms-noise full bandwidth
	>90 dB		ranges ±100 mV to ±50 V
	>88 dB		range ±50 mV
	>82 dB		range ±25 mV
	>75 dB		range ±10 mV
	>69 dB		range ±5 mV
Input noise, voltage (RTI)			DC-Mode (range ±5 mV)
	16 $nV/\sqrt{Hz}_{rms}$		spectral noise density 1 kHz
	16 μV_{pk-pk}		0 Hz to 10 kHz
	2 μV_{rms}		0 Hz to 10 kHz
	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

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	DC, CF		

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
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, $I_{load} \leq 42$ 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
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	 $3\ \mu V/V_{pkpk}$, $0.39\ \mu V/V_{rms}$ $0.9\ \mu V/V_{pkpk}$, $0.12\ \mu V/V_{rms}$ $0.3\ \mu V/V_{pkpk}$, $0.04\ \mu V/V_{rms}$ $0.1\ \mu V/V_{pkpk}$		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

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
DC half-/quarter bridge	3.3 µV/V_{pkpk}, 0.45 µV/V_{rms}		0 Hz to 10 kHz
	1.1 µV/V_{pkpk}, 0.15 µV/V_{rms}		1 kHz, lowpass filter
	0.35 µV/V_{pkpk}, 0.05 µV/V_{rms}		100 Hz, lowpass filter
	0.3 µV/V_{pkpk}		10 Hz, lowpass filter
CF full bridge, half bridge	3.5 µV/V_{pkpk}, 0.47 µV/V_{rms}		0 Hz to 10 kHz
	1.7 µV/V_{pkpk}, 0.22 µV/V_{rms}		1 kHz, lowpass filter
	0.6 µV/V_{pkpk}, 0.07 µV/V_{rms}		100 Hz, lowpass filter
	0.3 µV/V_{pkpk}		10 Hz, lowpass filter

Find here the description of the SPAR/BCF16 bridge, LVDT and voltage 108.

9.2.5 SPAR/LVDT(C)16 analog inputs

Inputs, Measurement modes		
Parameter	**Value**	**Remarks**
Inputs	16	
Measurement modes	LVDT bridge mode voltage measurement	Carrier Frequency mode (CF) 5 kHz
Terminal connection LVDT16	8x DSUB-15	2 channels per plug, recommended plug: ACC/DSUBM-B2
LVDTC16	4x DSUB-26-HD	4 channels per plug, recommended plug: ACC/DSUBM-HD-B4
Width	2 slots 4 slots	LVDTC16 (4x DSUB-26-HD) LVDT16 (8x DSUB-15)

Sampling rate, Bandwidth, Filter		
Parameter	**Value**	**Remarks**
Sampling rate	≤500 Hz	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
Characteristic curve linearization	user defined (max. 1023 supporting points)	

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	$\Delta T_a = \lvert T_a - 25\,°C \rvert$; 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 $\Delta T_a = \lvert T_a - 25\,°C \rvert$; 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 $\Delta T_a = \|T_a - 25\ °C\|$; 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 $\Delta T_a = \|T_a - 25\ °C\|$; 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

9.3 Digital modules

imc SPARTAN devices are already equipped as standard with 16 digital inputs, 8 digital outputs and 4 pulse counter inputs for incremental encoders.

For the module (DI16-DO8-ENC4) one socket (2 slots) has already been reserved, it is not included in the number of freely assignable slots. Additional units of this module can also be configured in free slots, as well as additional modules with digital inputs (DI), digital outputs (DO) and analog outputs (DAC).

The technical specs listed below apply in general, the respective number of bits or channels depends on the specific module type.

9.3.1 Digital Inputs

Parameter	Value	Remarks
Channels	16 or 8 depending on module variant 165	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 80.

9.3.2 Digital outputs

Parameter	Value		Remarks
Channels / bits	16 or 8 depending on module variant 165		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 82.

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 85.

9.3.4 Analog outputs

Parameter	Value typ.	min. / max.	Remarks
Channels	4 or 8 depending on module variant 165		
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 119.

9.4 Fieldbus: Technical Details

9.4.1 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 186 and the cabling 125 of the CAN-Bus interface.

Note Remote Frame

imc devices actually does not support Remote Frames (RTR) according to CAN specification.

9.4.2 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.

9.4.3 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 188 and the cabling 125 of the LIN interface.

9.4.4 FlexRay Interface

Parameter	Value	Remarks
Number of FlexRay nodes	1 additional 1 cold start node	1x channel A+B
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 60 kSample/s	per module
Isolation strength	60 V	to system ground (case, CHASSIS)

To the pin configuration 188 and the cabling 126 of the FlexRay interface.

9.4.5 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 190 and the cabling 126 of the PROFIBUS interface.

9.4.6 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 188 and the cabling 126 of the XCPoE interface.

9.4.7 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)

9.4.8 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 190 and the cabling 126 of the MVB-Bus interface.

9.4.9 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 189 and the cabling 126 of the ARINC interface.

9.5 Miscellaneous

9.5.1 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 133 and the DSUB-9 pin configuration 185.

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

9.5.2 ACC/DSUB-ICP

Parameter	Value (min / max)		Remarks
option for	SPAR/U16		
Inputs	4		differential, not isolated ACC/DSUB-ICP4
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 65.

9.5.3 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. 69

9.5.4 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 130.

9.5.5 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	

10 Pin configuration

DSUB Connector plugs overview

Type / Description	Article #	Order Code	TEDS	T16	U16	B16	● BC16	BCF16	LVDT16	● LVDTC16
		Module Types Module Types								
				Module types: compatible (●)						
Screw terminal plugs for signals										
DIO-ENC-DAC DSUB-15 (all device types)										
Plug with screw terminals for 8 digital inputs: DI4-8	**13500174**	ACC/DSUBM-DI4-8								
Plug with screw terminals for 8 digital outputs: DO-8	**13500173**	ACC/DSUBM-DO8								
Plug with screw terminals for 4 pulse counter input: ENC4	**13500171**	ACC/DSUBM-ENC4								
Plug with screw terminals for 4 analog outputs: DAC4	**13500177**	ACC/DSUBM-DAC4								
Analog Inputs DSUB-15 (depending on device type)										
Plug with screw terminals for 4 temperatures (incl. CJC) or volt.: T4	**13500167**	ACC/DSUBM-T4		●	●					
Plug with screw terminals for 4 voltages: U4	**13500166**	ACC/DSUBM-U4		●	●					
Plug with screw terminals for 2 bridges/strain gauge: B2	**13500170**	ACC/DSUBM-B2				●		●	●	
Plug with screw terminals and shunts for 4 currents (20 mA): I4	**13500168**	ACC/DSUBM-I4		●	●					
Plug with screw terminals and shunts for 2 currents (20 mA): I2	**13500180**	ACC/DSUBM-I2				●		●		
Analog Inputs DSUB-26-HD (for compact versions "C")										
Plug HD with screw terminals and shunts for 4 currnets (20mA): I4	**13500195**	ACC/DSUBM-HD-I4					●			
Plug HD with screw terminals for 4 bridges/strain gauge: B4	**13500197**	ACC/DSUBM-HD-B4					●			●
DSUB-HD-26 plug male (for soldering, no screw terminals)	**13500132**	ACC/DSUB-HD26M					●			●
Screw terminal plugs for signals (with TEDS)										
Analog inputs with TEDS (plug & measure) DSUB-15										
Plug with screw terminals for 4 temp. (incl. CJC) or volt.: T4 (TEDS)	**13500190**	ACC/DSUBM-TEDS-T4	✓	●	●					
Plug with screw terminals for 4 voltages: U4 (TEDS)	**13500189**	ACC/DSUBM-TEDS-U4	✓	●	●					
Plug with screw terminals for 2 bridges/strain gauge: B2 (TEDS)	**13500191**	ACC/DSUBM-TEDS-B2	✓			●		●	●	
Plug with screw terminals, shunts for 4 currents (20 mA): I4 (TEDS)	**13500192**	ACC/DSUBM-TEDS-I4	✓	●	●					
Plug with screw terminals, shunts for 2 currents (20 mA): I2 (TEDS)	**13500193**	ACC/DSUBM-TEDS-I2	✓			●		●		
Extension plugs										
DSUB-Extension plugs for IEPE/ICP DSUB-15										
Extension plug for 4 IEPE/ICP transducers: ICP4 (screw terminals)	**13500032**	ACC/DSUB-ICP4			●					
Extension plug for 2 IEPE/ICP transducers: ICP2I (isolated, 2 x BNC), slow	**13500293**	ACC/DSUBM-ICP2I-BNC-S	✓			●		●		
Extension plug for 2 IEPE/ICP transducers: ICP2I (isolated, 2 x BNC), fast	**13500294**	ACC/DSUBM-ICP2I-BNC-F	✓			●		●		
Push-In clamp plugs (for strain gauge quarter bridge)										
DSUB-15 plug with Push-In clamps for quarter bridge (3 wire strain gauge) with SPAR/B-16	**13500268**	ACC/DSUBM-QB2-PH				●				
Filter-Plug for ESD suppression DSUB-15										
In-line filter plug ESD (compatible with all amplifier types)	**13500211**	ACC/DSUBM-ESD		●	●	●		●	●	

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 129 (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.

10.2 DSUB-15 pin configuration

In general: DSUB pin 1 is internally reserved.

10.2.1 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 B16 and +SENSE with BCF16

* if special version with ±15 V option, then this pin 6 is the reference

Metal plug

ACC/DSUBM-		ENC4, ENC4-IU	DI4-8	DO-8	DAC4
DSUB Pin	Terminal	INC.-ENCODER	DIGITAL IN	DIGITAL OUT	ANALOG OUT
9	1	+INA	+IN1	BIT1	
2	2	-INA	+IN2	BIT2	DAC1
10	3	+INB	+IN3	BIT3	AGND
3	4	-INB	+IN4	BIT4	
11	5	+INC	-IN1/2/3/4	BIT5	DAC2
4	6	-INC	+IN5	BIT6	AGND
12	7	+IND	+IN6	BIT7	
5	8	-IND	+IN7	BIT8	DAC3
13	9	+INDEX	+IN8		AGND
6	10	-INDEX	-IN5/6/7/8		
14	11	+5V	+HCOM	HCOM	DAC4
7	12	GND *	LCOM	LCOM	AGND
15	15	(-SUPPLY)	LCOM	LCOM	
8	18	(+SUPPLY)	LEVEL	OPDRN	
	13				
	14				
⏚	16	CHASSIS	CHASSIS	CHASSIS	CHASSIS
⏚	17	CHASSIS	CHASSIS	CHASSIS	CHASSIS

* if special version with ±15 V option, then this pin is reference

10.2.2 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

10.2.3 TEDS plug

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

(2) if special version with ±15 V option, then this pin 6 is the reference

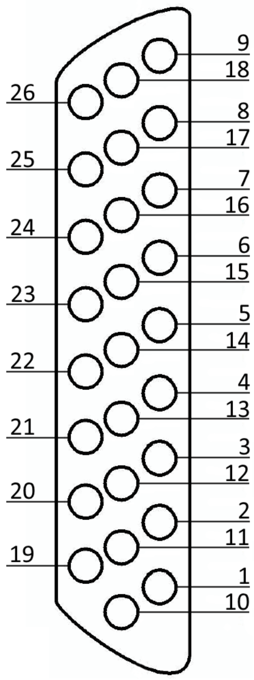
[ ] : 1/4 Bridge with B16 and +SENSE with BCF16

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	Terminal	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



For contact with the chassis use
the screw of the strain relief.

10.4 DSUB-9 pin configuration

10.4.1 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 133 and the technical data of the displays 174.

10.4.2 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.

10.5 Pin configuration of the fieldbusses

10.5.1 CAN, CAN FD Interface

DSUB-PIN	Signal	Description	Use in device
1	+CAN_SUPPLY	optional supply	unused as per standard* (supply I < 1 A)
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	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 168 and the cabling 125 of the CAN-Bus interface.

* The CAN and the CAN FD Interface can be equipped ex-factory with the option "**Power via CAN**".

The DSUB-9 sockets are labled.

CAN, CAN FD Interface with Power via CAN

The special option Power via CAN includes the internal connection of the unbuffered supply voltage of the device to the first two nodes "CAN1" and "CAN2" of the CAN interface of a device. This makes it possible to supply connected CANSAS modules (or CAN-based sensors) via the CAN cable. A cable with sufficient cross-section is required. The load current is a maximum of 1 A per node and is limited by a current limiter, which does not provide safe short-circuit protection.

Direction of electric current and fuse

- The direction of current flow is unidirectional, protected by diodes: the device supplies CAN bus participants. Current flow into the device is blocked.
- The diodes also decouple the supply lines of the two CAN nodes from each other.
- Overload protection is provided by an over current protection in the form of inert PTC components ("PolySwitch"). These will be reset in case and the operational again.
- The **fuse does not provide complete protection against destruction in the event of a short circuit**! Rather, it serves to limit the current at a slowly increasing load, such as the successive connection of a large number of imc CANSAS modules. On the other hand, it is not always possible to protect against very fast increasing currents, such as a hard short-circuit on the cable, safely and quickly enough!

- The current limit depends on the operating temperature (internal temperature of the unit):

  2.2 A (0°C)

  1 A (+70°C)

  0.74 A (+85°C)

  The corresponding maximum power in the event of a fault (short circuit) then depends on the supply voltage used.

  Guaranteed power available via CAN (Spec: 1 A) up to 70°C indoor temperature

Power consumption reserves:

- This design guarantees a current of 1 A per node (up to 70°C). In addition, the PTC fuse then slowly starts limiting the current and "disconnecting" the loads. The generally low consumption of the CANSAS modules should not be underestimated, since the power is achieved by the current at a low supply voltage. Even a UNI8 with a power consumption of max. 15 W (with connected sensors) achieves this limit with a current of 1 A at 15 V. In addition, there is the voltage drop for long cables and small cross-sections. It is always necessary to first calculate the power consumption and the expected currents.
- Due to its technology, the CAN bus is ideally suited for retrofitting a system. It can easily happen that the current load and the cross-section have been designed correctly at first, but then modules are added which do not comply with the specification.

USV-buffering:

- The CAN-supply is not buffered. It is not tapped at the output of the device UPS but directly at the LEMO power supply. For this reason, this power is not included in any limits for the total device power, as long as these are decisively determined by the UPS. Since a current and no power limitation is provided, a UPS buffering would also not be possible without further ado, because with 2 nodes with 1 A current limit (typically!) and a maximum input voltage of 30 V or even 50 V, considerable power results.
- Since Power-via-CAN is not coupled to UPS or startup logic, this CAN supply is not deactivated when the device is switched off, but is always active as soon as the main supply (LEMO) is powered.

Reference:

- The CAN supply voltage is identical to the main power supply (wide range, LEMO) and has corresponding potential reference. The pins on the DSUB-9 are marked with ±CAN_SUPPLY.
- In contrast, the pin "CAN-GND" has nothing to do with this: This is rather the electrical and logical completely independent reference of the CAN bus signals. It is electrically isolated from the rest of the system (housing, power supply, system electronics). CAN_GND should always be used independently of the power supply so that the CAN_H and CAN_L levels are reliably detected.

10.5.2 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 170 and the cabling 125 of the LIN-Bus interface.

10.5.3 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 170 and the cabling 126 of the FlexRay-Bus interface.

10.5.4 XCPoE (RJ45)

Standard Ethernet 1x RJ45. Find here the technical data 171 and the cabling 126 of the XCPoE interface.

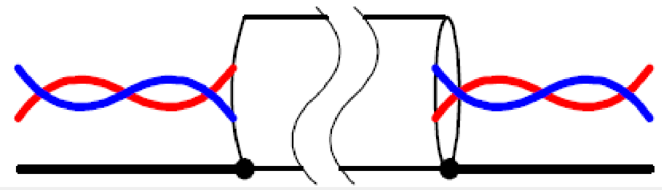
10.5.5 ARINC-Bus (DSUB-15)

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

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:



Find here the technical data 173 and the cabling 126 of the ARINC-Bus interface.

10.5.6 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.	

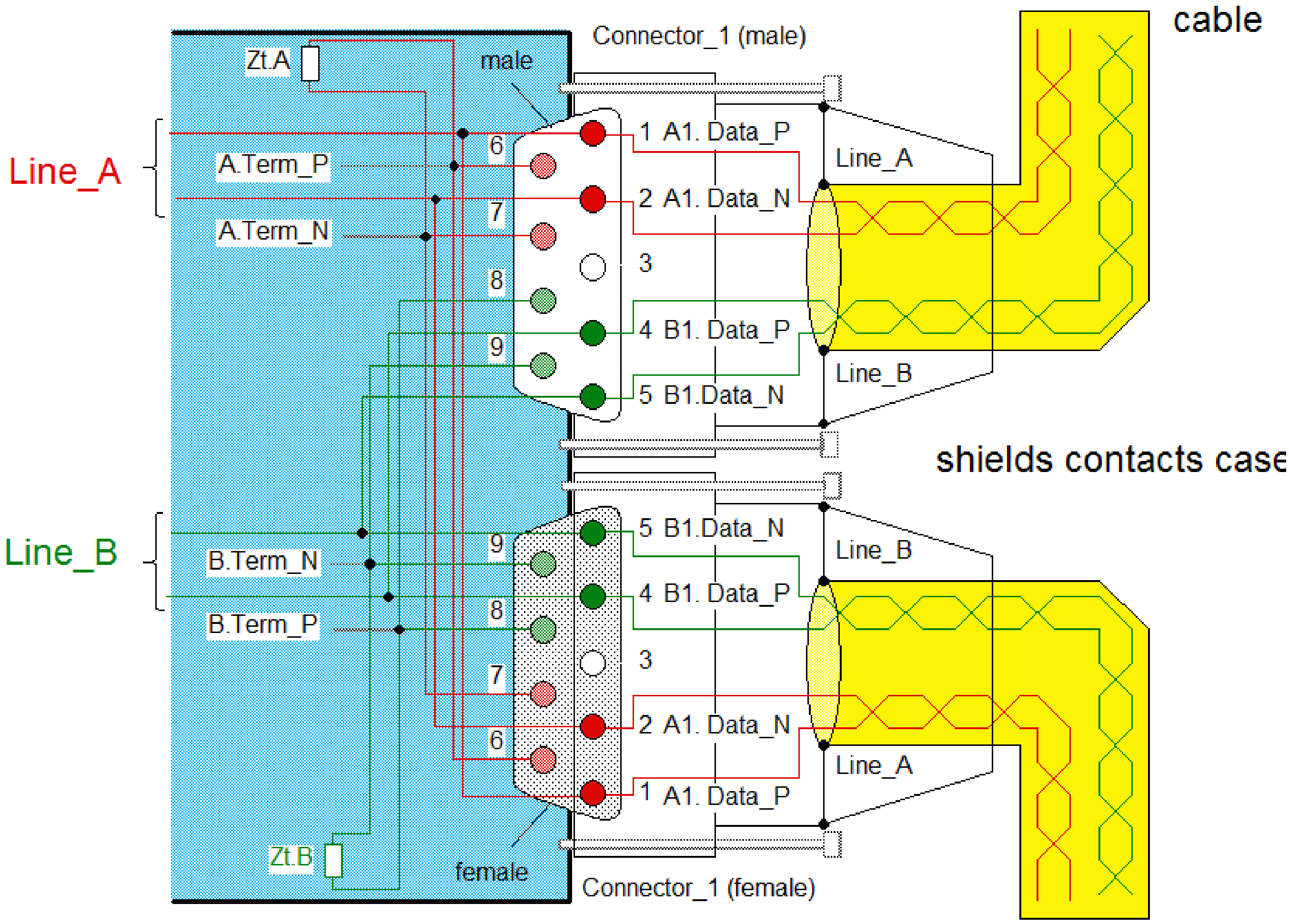
Find here the technical data 171 and the cabling 126 of the PROFIBUS interface.

10.5.7 MVB-Bus (DSUB-9)

10.5.7.1 EMD Pin configuration - DSUB-9

EMD connection with double-occupancy. Standard DSUB-9 terminals are used.

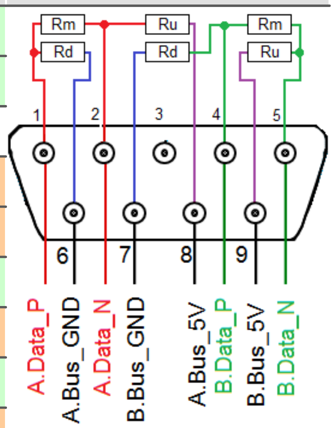
DSUB-PIN	Signal	Description	as termination terminal
1	A1. Data_P	data line A	jumper to 6
2	A1. Data_N	data line A	jumper to 7
3	NC	not connected	
4	B1. Data_P	data line B	jumper to 8
5	B1. Data_N	data line B	jumper to 9
6	Terminator A	internal	jumper to 1
7	Terminator A	interna	jumper to 2
8	Terminator B	interna	jumper to 4
9	Terminator B	interna	jumper to 5

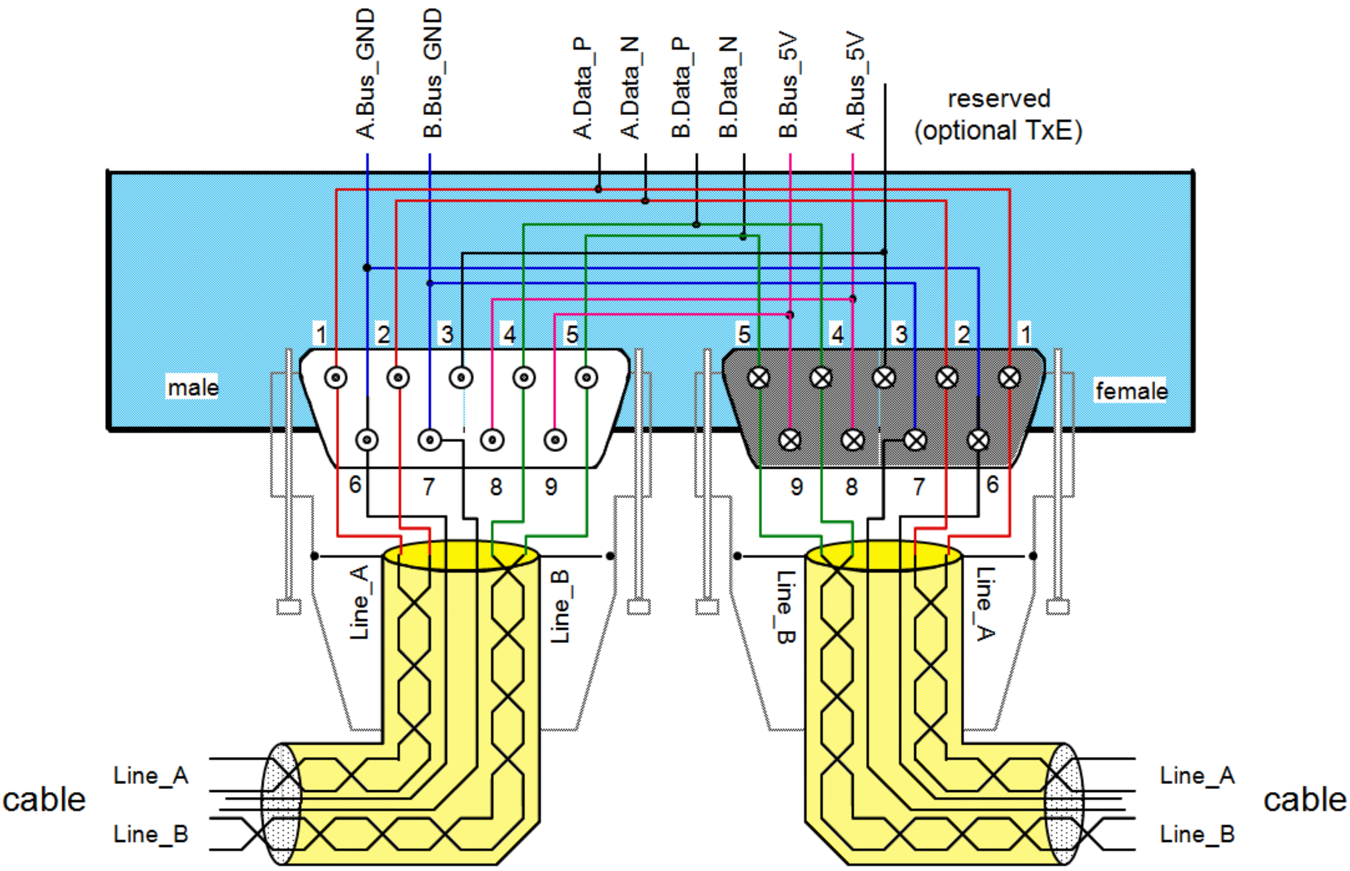


Internal wiring for EMD connection

10.5.7.2 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	*Rm = 143 Ω; Ru = Rd = 383 Ω*



DSUB connection for ESD

Find here the technical data 172 and the cabling 126 of the MVB-Bus interface

10.6 REMOTE plug

Signal	Function	Connection	Remarks	DSUB
ON	activation	connect pin 10 with SWITCH or SWITCH1	permanently jumpered to SWITCH1: automatic start with external power supply e.g. in vehicle	10
OFF	deactivation	connect pin 9 with SWITCH	brief connection will deactivate the device	9
ON/OFF	push button for start / shutdown	connect pin 13 with SWITCH	brief connection will initiate activation/deactivation as with the green main switch	13
SWITCH	switch signal / reference	connect pin 2 with ON/OFF, ON or OFF	Brief connection via a push button will initiate activation/deactivation. Note: power up from internal battery is supported!	2
SWITCH1	activation only from external power supply	connect pin 3 with ON	static, permanently jumpered: for automatic activation upon application of an external supply	3
K15-mode	controlling activation with an external low power control signal	jumper pin 12 to SWITCH	K15-mode=SWITCH provides K15 control mode: control voltage to be applied to "ON": · startup: >9 V · shutdown: <2 V (do not leave floating!) (no significant current drawn)	12
MUTE	muting the UPS buzzer	connect pin 5 with CHASSIS	e.g. for acoustic applications	5
RESET	immediate shutdown without saving	connect pin 1 with CHASSIS	**Will cause a lost of measurement data!** in case of malfunction, only	1
RESET_ GND			reference for MUTE and RESET	CHASSIS

Reference

Please find here the description of the REMOTE control 21.

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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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