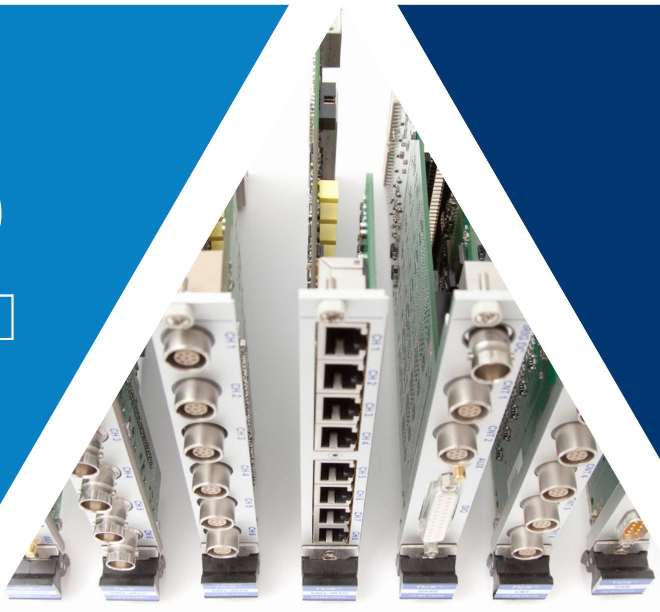
DEWETRON

# TRION/TRION3 MODULE SERIES

## TECHNICAL REFERENCE

EN ISO 14001

ISO 9001



# Preface

## Thank you!

Thank you very much for your investment in DEWETRON's unique data acquisition systems. These are top-quality instruments which are designed to provide you years of reliable service. This guide has been prepared to help you get the most from your investment, starting from the day you take it out of the box, and extending for years into the future.

This guide includes important startup notes, as well as safety notes and information about keeping your DEWETRON system in good working condition over time. However, this manual cannot and is not intended to replace adequate training.

This documentation contains operating as well as safety and care instructions that must be observed by the user. Faultless operation can only be guaranteed by observing these instructions.

## Intended use

TRION/TRION3 series data acquisition modules are used for measuring of various physical and/or electrical measured variables (depending on the model) and fit exclusively into DEWE2/DEWE3 all-in-one devices, mainframes and front-ends. Modules are available for binary/counter/timing inputs, for bus interfaces and for analog inputs.

Depending on the version or configuration, the connection can be done via safety banana plugs, BNC connectors, D-SUB connectors, SMB connectors, µdot connectors, LEMO® connectors or RJ-45 connectors.

This product is designed for use in indoor industrial conditions. Any unspecified use not described in these specifications is not considered as intended use.

## Labeling of TRION(3) series modules

TRION series modules do have different names and contain important information about the module itself. The labeling gives information about the kind of module, channels, resolution, sample rate and type of connector used.

The figure below illustrates how to decode your TRION(3) series module

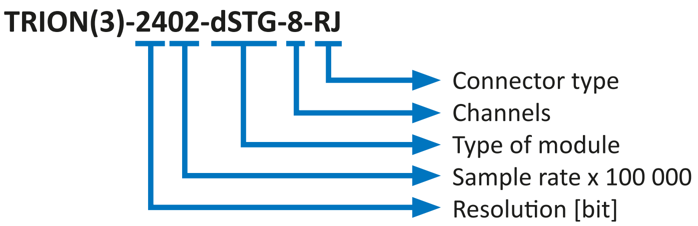



*Fig. 1: Decoding a TRION(3) series module*

# Table of contents

# Safety

## Safety instructions

The following section contains warning and safety instructions that must be observed by the user. Faultless operation can only be guaranteed if these instructions are observed.

### General safety instructions

- Read this manual before operating the module. Safety of the operator and the unit depend on following these rules.
- Use this system under the terms of the specifications only to avoid any possible danger. If the unit is used in a manner not specified by the manufacturer the protection can be impaired.
- The TRION(3) modules may only be installed by experts.
- DO NOT service or adjust a module. Maintenance is to be executed by qualified staff only.
- DO NOT substitute parts or modify equipment.
- Observe local laws when using the module.
- DO NOT use the system if equipment covers or shields are removed. If you assume the system is damaged, have it examined by authorized personnel only.
- DO NOT operate damaged equipment.

  Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, remove power and do not use the product until safe operation can be verified by service-trained personnel.

  If necessary, return the product to a DEWETRON sales and service office for service and repair to ensure that safety features are maintained.
- Disconnect power before opening the instrument or computer. Opening any device must only be carried out by experts.
- Any other use than described above may damage your system and is attended with dangers such as short-circuits, fire or electric shocks.
- Reinstall filler panels of unused TRION slots to guarantee proper cooling of the installed modules. The warranty is void if the modules overheat due to missing filler panels.
- The warranty is void if damages caused by disregarding this manual. For consequential damages NO liability will be assumed.
- The warranty is void if damages to property or persons caused by improper use or disregarding the safety instructions.
- Prevent using metal bare wires as there is a risk of short-circuit and fire hazard.
- Make sure that your hands, shoes, clothes and as well as the floor, the system or measuring leads, integrated circuits etc. are dry.
- Use measurement leads or measurement accessories aligned to the specification of the system only. Fire hazard in case of overload.
- Do not disassemble the system. There is a high risk of getting a perilous electric shock. Capacitors still might charged, even the system has been removed from the power supply.
- Contact a professional if you have doubts about the method of operation, safety or the connection of the system.
- Handle the product with care. Shocks, hits and dropping it even from an already lower level may damage your system.
- Use only original plugs and cables for harnessing.
- Using the board for medical applications only at the owner's risk.

### Electrical safety instructions

- Keep away from live circuits

Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for use by service-trained personnel only.

Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

- DO NOT touch any exposed connectors or components if they are live wired. The use of metal bare wires is not allowed. There is a risk of short-circuits and fire hazard.
- DO NOT touch internal wiring since electrostatic damage is possible.
- DO NOT use higher supply voltage than specified.
- The electrical installations and equipments in industrial facilities must be observed by the security regulations and insurance institutions.

### Ambient safety notices

- This product is intended for use in industrial locations. As a result, this product may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interferences to the reception of radio and television broadcasts.
- Do not switch on the system after transporting it from a cold into a warm room and vice versa. The thereby created condensation may damage your system. Acclimatise the product unpowered to room temperature.
- Any use in wet rooms, outdoors or in adverse environmental condition is not allowed. Adverse environmental conditions are:
  – Moisture or high humidity
  – Dust, flammable gases, fumes or dissolver
  – Thunderstorm or thunderstorm conditions (except assembly PNA)
  – Electrostatic fields etc.
- DO NOT use the system in rooms with flammable gases, fumes or dust or in adverse environmental conditions.
- Direct exposure of any DEWETRON product to strong sunlight or other heat radiation shall be prevented, as this could excessively heat up the product and lead to permanent damage of the product.

## Electromagnetic compatibility

**Class A – Federal communications commission**

This equipment has been tested and found to comply with the limits stated in EN55011 for Class A products. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Operation of this equipment in a residential area is likely to cause harmful interference in which case the user is required to correct the interference at their own expense.

## Standards and norms

This product has left the factory in safety-related flawless and proper condition.

In order to maintain this condition and guarantee safety use, the user has to consider the security advices and warnings in this manual.

**EN 61326-3-1:2008**

IEC 61326-1 applies to this part of IEC 61326 but is limited to systems and equipment for industrial applications intended to perform safety functions as defined in IEC 61508 with SIL 1-3.

The electromagnetic environments encompassed by this product family standard are industrial, both indoor and outdoor, as described for industrial locations in IEC 61000-6-2 or defined in 3.7 of IEC 61326-1.

Equipment and systems intended for use in other electromagnetic environments, for example, in the process industry or in environments with potentially explosive atmospheres, are excluded from the scope of this product family standard, IEC 61326-3-1.

Devices and systems according to IEC 61508 or IEC 61511 which are considered as “operationally welltried”, are excluded from the scope of IEC 61326-3-1.

Fire-alarm and safety-alarm systems, intended for protection of buildings, are excluded from the scope of IEC 61326-3-1.

# Typographic conventions

## Safety and warning notices

**WARNING**

**Indicates a hazardous situation that, if not avoided, could result in death or serious injury.**

**CAUTION**

**Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.**

## Notices

**NOTICE**

This text indicates situations or operation errors which could result in property damage or data loss.

**INFORMATION**

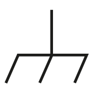
This text indicates important information or operating instructions. Not observing these instructions could inhibit or impede you from successfully completing the tasks described in this documentation.

## Symbols

Denotes a warning that alerts you to take precautions to avoid injury. When this symbol is shown on the product, refer to the technical reference manual (ISO 7000-4034; 2004-01).

Indicates hazardous voltages.

Observe precautions for handling electrostatic sensitive devices.



Indicates the chassis terminal (IEC 60417-5020; 2002-10).

Direct current (IEC 60417-5031; 2002-10)

Alternate current (IEC 60417-5032; 2002-10)

Both direct and alternating current (IEC 60417-5033; 2002-10)

3~ Three-phase alternating current (IEC 60417-5032-1; 2002-10)

Protective conductor terminal (IEC 60417-5019; 2006-08)

Equipment protected throughout by double insulation or reinforced insulation (IEC 60417-5172; 2003-02).

On (power) (IEC 60417-5007; 2002-10)

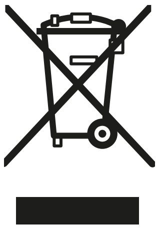
Off (power) (IEC 60417-5008; 2002-10)

# General information

## Environmental considerations

The following information refers to the environmental impact of the product and the product end-of-life handling. Observe the following guidelines when recycling a DEWETRON system:

- System and components recycling



The production of these components has required the extraction and use of natural resources. The substances contained in the system could be harmful to your health and to the environment if the system is improperly handled at its end of life. Recycle this product in an appropriate way to avoid an unnecessary pollution of the environment and to keep natural resources.

This symbol indicates that this system complies with the European Union's requirements according to Directive 2021/19/EU on Waste of Electrical and Electronic Equipment (WEEE). Further information about recycling can be found on the DEWETRON website (www.dewetron.com).

- Restriction of hazardous substances

This product has been classified as monitoring and control equipment, and is outside the scope of the 2011/65/EU RoHS Directive. This product is known to contain lead.

## Problematic network stacks

Often intrusive IT software or network processes can interfere with the primary function of the DEWETRON system: to record data. Therefore we recommend strongly against the installation of IT/MIS software and running their processes on any DEWETRON data acquisition system, and cannot guarantee the performance of our systems if they are so configured.

## Warranty information

A copy of the specific warranty terms applicable to your DEWETRON product and replacement parts can be obtained from your local sales and service office.

## Legal information

### Restricted rights legend

Use Austrian law for duplication or disclosure.

DEWETRON GmbH
Parkring 4
8074 Grambach
Austria

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## Printing history

Refer to the page bottom for printing version.

# System and modules overview

## Compatibility information

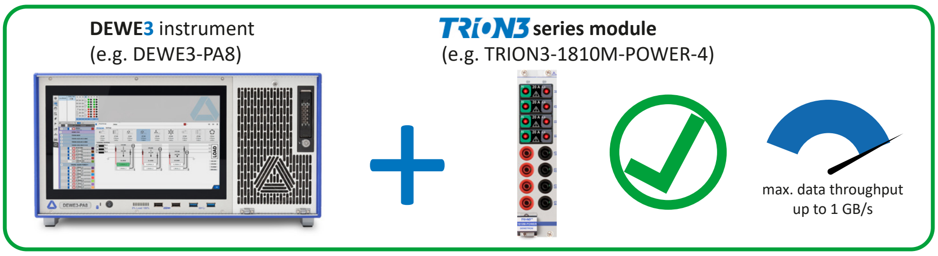
### TRION(3) modules/OXYGEN compatibility

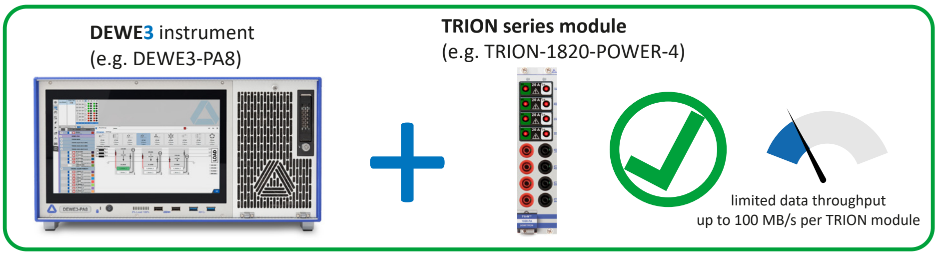
**INFORMATION**

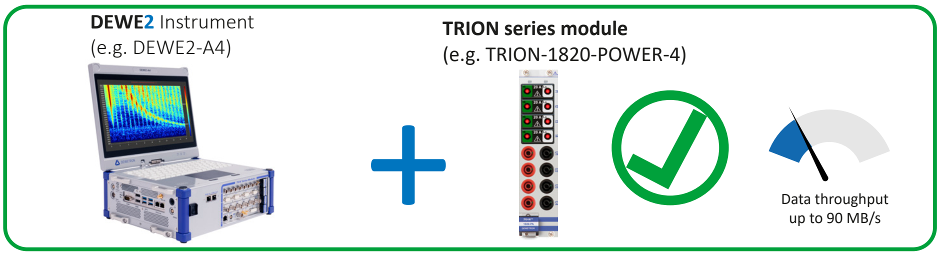
Since not all TRION modules are supported by previous OXYGEN versions, refer to the OXYGEN release notes and version history for TRION module compatibility.

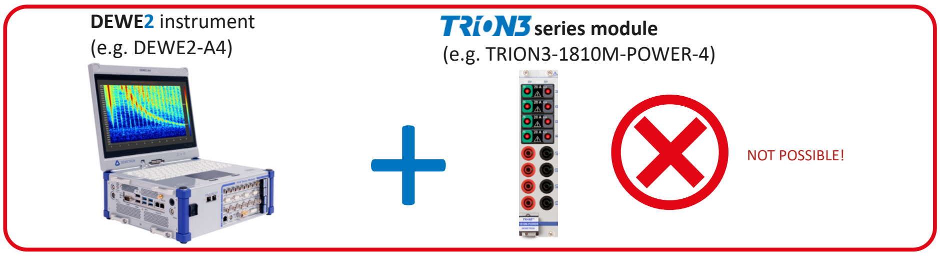
### DEWE2/3 – TRION(3) hardware compatibility

In 2019 DEWETRON introduced a new family of data acquisition systems, the DEWE3 and TRION3 express series. The DEWE3 chassis features a PXIe hybrid backplane and supports any TRION3 series modules. The DEWE3 chassis is also backward compatible and for simplification. The figures below provide an overview of the hardware compatibility.

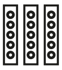


# DEWE2/DEWE3 systems overview


Signal conditioning amplifier

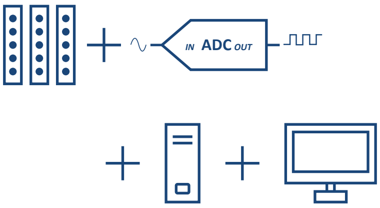
A/D conversion

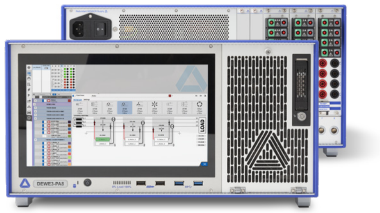

Computer inside


Display

### Power analyzer

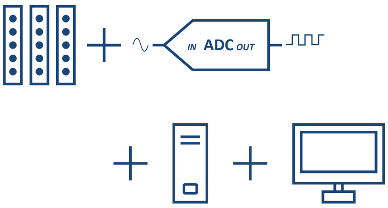
- Up to 16 power channels
- 0.04 % power accuracy from 0.5–1000 Hz
- Mixed signal analyzer
- Multi-touch screen





DEWE3-PA8

### All-in-one

- Built-in display
- Compact and flexible configuration
- Powerful PC inside for fast online displays and analysis
- Convenient for mobile applications

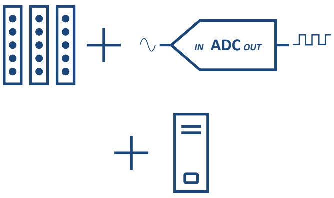




DEWE3-A4

### Mainframe

- Powerful PC inside for fast online displays and analysis
- Can be used with external display
- Very popular for applications where the instrument is installed in a poorly accessible place for the user

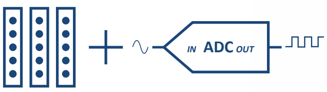


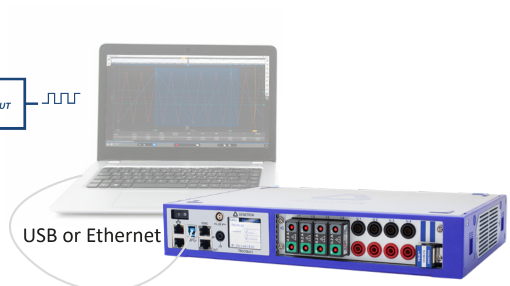


DEWE3-RM16

### Front-end

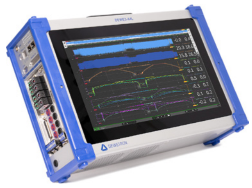
- Used with an external computer
- Expansion for all-in-one or mainframe instruments
- Multiple units can be daisy-chained
- Connected via USB 3.0 or GBit-Ethernet



TRIONet3

## DEWE2/DEWE3 all-in-one instruments


| | DEWE3-A4 | DEWE3-A4L | DEWE2-A13 |
|---|---|---|---|
| **Slots for TRION(3) acquisition modules** | 4 | 4 | 13 |

## DEWE2/DEWE3 mainframes


| | DEWE3-M4 | DEWE3-M8s |
|---|---|---|
| **Slots for TRION(3) acquisition modules** | 4 | 8 |

## DEWE3 front-end

| | TRIONet3 |
|---|---|
| **Slots for TRION acquisition modules** | 2 |

## DEWE3 power analyzer


| | DEWE3-PA8 | DEWE3-PA8-RM |
|---|---|---|
| **Slots for TRION(3) acquisition modules** | 8 | 8 |

### DEWE3 rack-mount

| | DEWE3-RM4 | DEWE3-RM8 | DEWE3-RM12 | DEWE3-RM16 |
|---|---|---|---|---|
| **Slots for TRION(3) acquisition modules** | 4 | 8 | 12 | 16 |

## Environmental module specifications

Unless not otherwise noted, the general environmental specifications for TRION(3) modules are:

- Operating temperature: 0 to +50 °C (with prewarmed unit down to -20 °C)
- Storage temperature: -20 to +70 °C
- Humidity (operating): 10 to 80 %, non condensing, 5 % to 95 % rel. humidity

# System setup

## Installing a TRION module

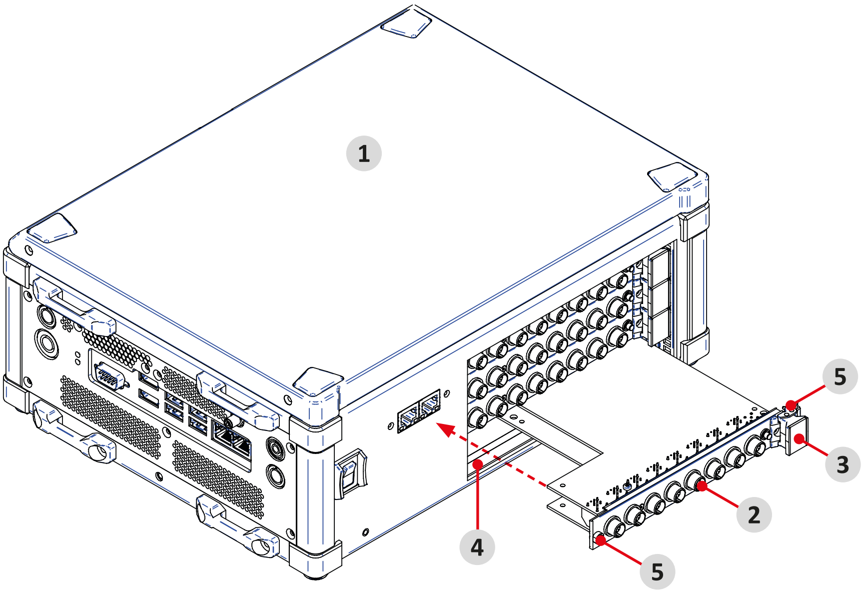



*Fig. 2: Installing a TRION module*

1. DEWE3 chassis
2. TRION series module
3. Injector/ejector module
4. Module guides
5. Mounting screws

In order to install a TRION module into a chassis proceed as follows:

1. Take proper ESD precautions to avoid any damage to the unit.
2. Power off and unplug all connected cables including sensors from the DEWE2/DEWE3 chassis and TRION(3) series modules.
3. Identify a supported TRION(3) peripheral slot.

   Some modules require a TRION STAR-slot, see on page 21.
4. Remove the filler panel of an unused TRION(3) peripheral or STAR-slot.
5. Place the module edges of the TRION(3) module into the module guide at the top and bottom of the chassis.
6. Insert the TRION(3) module to the rear of the chassis until a resistance appears.
7. Pull up on the injector/ejector handle to latch the device.
8. Secure the installed TRION front panel to the chassis by using the mounting screws.

The TRION(3) module is now installed into a DEWE2/DEWE3 chassis.

**NOTICE**

Unused TRION slots must always be covered. Make sure to reinstall the filler panels to unused TRION slots to guarantee proper cooling of the installed modules.

The warranty is void if the modules overheat due to missing filler panels.

## STAR-slot for TRION timing/sync modules

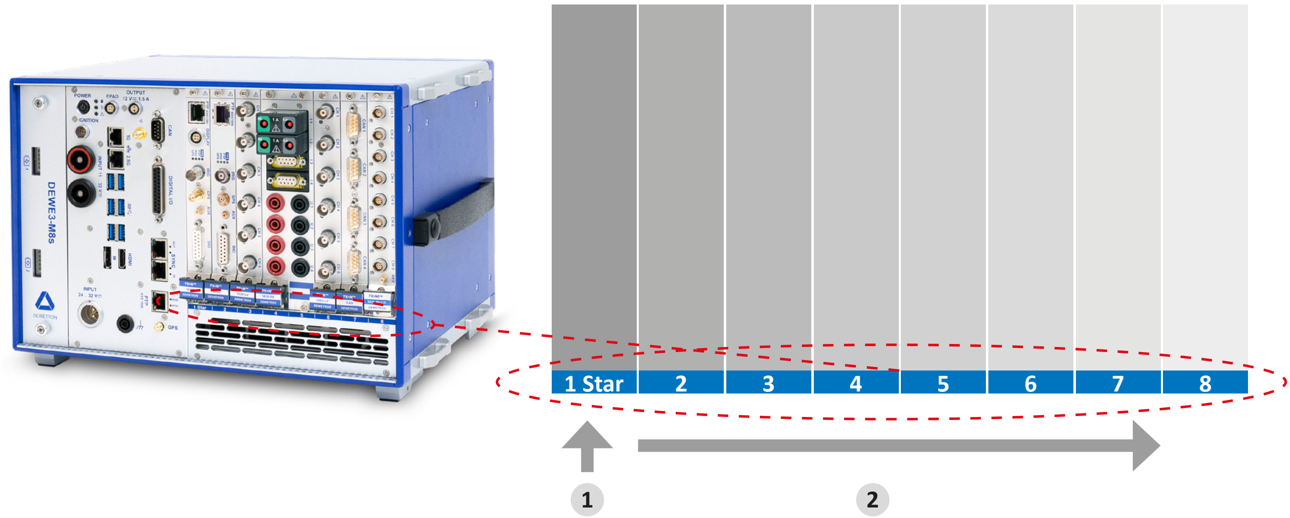



*Fig. 3: STAR-slot for TRION timing/sync modules*

1. TRION(3) system timing slot
2. TRION(3) peripheral slots

The TRION system timing slot is either slot "1" or labeled as "STAR". Timing/Sync/GPS modules have to be installed in this slot, but it also accepts any other TRION(3) modules.

**INFORMATION**

If the system is equipped with a TRION-BASE, TRION-TIMING or TRION-VGPS-20/-100 module, it has to be installed in the "star slot". This is the only slot a module is able to override the system 10 MHz clock with its PPS-synced 10 MHz, and thus providing the system with a timebase of higher accuracy.

## Slots for DEWE3-RMx devices

The slots for TRION series modules at the DEWE3-RMx are divided into four segments. The figure below shows the four different segments of the DEWE3-RMx devices:

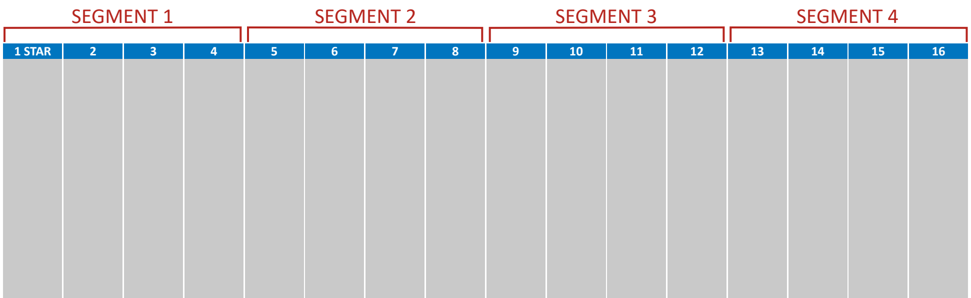



*Fig. 4: Slots for DEWE3-RMx devices*

**INFORMATION**

A TRION module has to be installed in the first segment (Slot 1 to 4) for the following ones to become activated

## Slots for DEWE2-M13/M13s/M18 devices

The slots for TRION series modules at the DEWE2-M13/M13s/M18 are divided into three segments. The reason for this is because of the internal bus system to connect and collect all the data from the installed TRION series modules. The figure below shows the three different segments of the DEWE2-M13/M13s/M18:

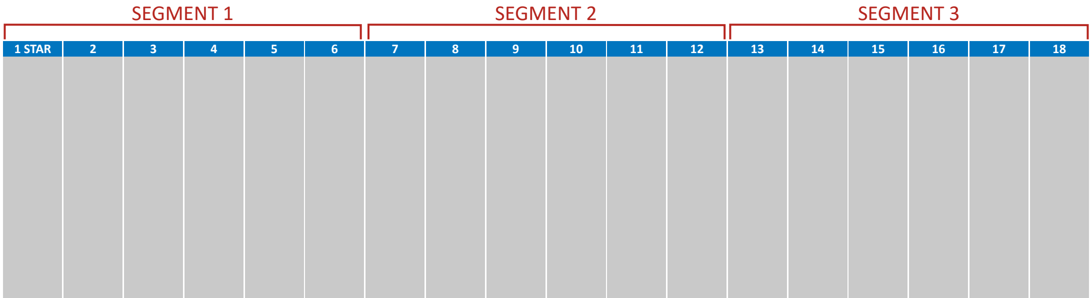



*Fig. 6: Slots for DEWE2-M13/M13s/M18 devices*

**INFORMATION**

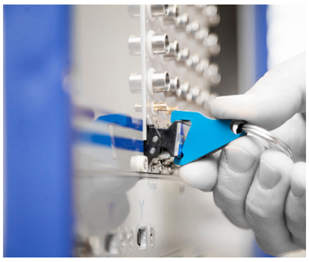
A TRION module has to be installed in the first segment (Slot 1 to 6) for the following ones to become activated

## Removing a TRION(3) module

To remove a TRION(3) module from any chassis proceed as follows:

1. Take proper ESD precautions to avoid any damage to the unit.
2. Power off and unplug all connected cables including sensors from the chassis and TRION(3) series modules.
3. Loosen the screws at the top and bottom of the TRION(3) module front panel.


4. Pull down the injector/ejector handle or use the TRION extraction tool to release the module.



5. Remove the TRION(3) module and reinstall the filler panel into the empty slot.

The TRION(3) module is now removed from the chassis. To remove another TRION(3) module repeat the procedure.

**NOTICE**

Unused TRION slots must always be covered. Make sure to reinstall the filler panels to unused TRION slots to guarantee proper cooling of the installed modules.

The warranty is void if the modules overheat due to missing filler panels.

# Analog to digital conversion

## A/D of TRION-2402 series

Any **TRION-2402 series** module uses up to 8 delta-sigma A/D converters. If you sample with a data rate of 102.4 kS/s, the ADC actually samples the input signal with 13.1072 MS/s (multiply the data rate with 128) and produces 1-bit samples which are applied to the digital filter. The filter expands the data to 24-bits and rejects signal parts greater than 51.2 kHz (Nyquist frequency). It also re-samples the data to the desired rate of 102.4 kS/s.

A 1-bit quantizer introduces many quantization errors to the signal. The 1-bit, 13.1072 MS/s from the ADC carry all information to produce 24-bit samples at 102.4 kS/s. The delta-sigma ADC converts from high speed to high resolution by adding random noise to the signal. In this way the resulting quantization noise is restricted to frequencies above 100 kHz. This noise is not correlated with the useful signal and is rejected by the digital filter.

### TRION-2402 sample system architecture

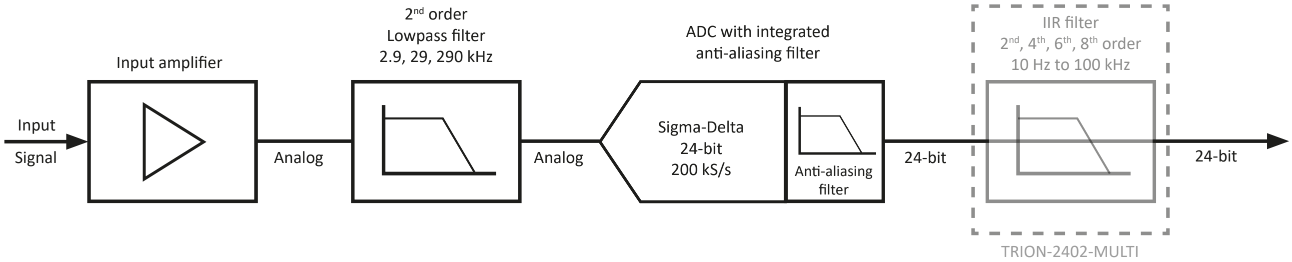



*Fig. 7: TRION-2402 sample system architecture*

## Anti-aliasing filter

ADCs can only represent signals of a limited bandwidth. The maximum frequency you can represent is the half of the sampling rate. This maximum frequency is also called Nyquist frequency. The bandwidth between 0 Hz and the Nyquist frequency is called Nyquist bandwidth. Signals exceeding this frequency range cannot be converted correctly.

For example, if the sample rate is 1000 S/s, the Nyquist frequency is 500 Hz. If the input signal is a 375 Hz sine wave, the resulting samples represent a 375 Hz sine wave. If a 625 Hz sine wave is sampled, the resulting samples represent a 375 Hz sine wave too. This happens because signals exceeds the Nyquist frequency (500 Hz). The represented frequency of the sine wave is the absolute value of the difference between the input frequency and the closest integer multiple of the sampling rate (in this case 1000 Hz).

**Some examples**

- Input sine wave 2280 Hz, sampling frequency 1000 Hz: |2280 - 2 * 1000| = 280 Hz
- Input sine wave 3890 Hz, sampling frequency 1000 Hz: |3890 - 4 * 1000| = 110 Hz

The effect that frequencies above the Nyquist frequency appear as low frequency inside the Nyquist bandwidth is called aliasing. Signals which are not a pure sine wave can have many components (harmonics) above the Nyquist frequency. These harmonics are erroneously aliased back to the baseband, added to parts of the accurately sampled signal and produces a distorted data set. To block frequencies outside the Nyquist bandwidth, a lowpass filter is applied to the signal before it reaches the ADC.

If aliasing is caused by a clipped or overranged waveform, (exceeding the voltage range of the ADC) it can not be rejected with any filter. The ADC assumes the closest value to the actual value of the signal in its digital range when the signal is clipping. The result of clipping is also a sudden change in the signal slope and results in corrupt digital data with high-frequency energy. This energy is spread over the complete frequency spectrum and is aliased back into the baseband. Do not allow the signal to exceed the input range to avoid this.

Each input channel has three analog 2nd order low pass filters in front of the ADC. Depending on the sample rate the TRION board automatically selects the best suitable filter. The analog sampling rate of a sigma delta converter is much higher than the data output rate. This is called oversampling. That is why in contrast to a traditional anti aliasing filter the cut-off frequency of this analog filter could be very high. So there is almost no attenuation or phase shift within the bandwidth of interest because of this filter.

| Sample rate | Max. analog filter bandwidth | Digital filter bandwidth | Oversampling |
|---|---|---|---|
| 100 S/s to 1 kS/S | 2.9 kHz | 0.494 *fs | 256 *fs |
| >1 k to 10 kS/S | 29 kHz | 0.494 *fs | 256 *fs |
| >10 to 51.210 kS/S | 290 kHz | 0.494 *fs | 256 *fs |
| >51.2 to 102.410 kS/S | 290 kHz | 0.5 *fs | 128 *fs |
| >102.4 to 200 10 kS/S | 290 kHz | 0.38 *fs | 64 *fs |

*Tab. 1: Anti-aliasing filter TRION-2402 series*

The programmable low pass filter allows aliasing free measurement also at low sample rates. For example at 100 S/s the oversampling frequency would be 25.6 kHz. That means that any noise signal around this frequency would be mapped into your measured data, but the 2.9 kHz filter attenuates most of this noise signal.

After conversion the 1-bit oversampled data is passed to a digital anti-aliasing filter. This filter has no phase error and an extremely flat frequency response. It also has an extremely sharp roll-off near the cut-off frequency (0.38 to 0.494 times the sample rate) and the rejection above 0.5465 times the sample rate is greater than 92 dB. The output stage of the digital filter finally resamples higher frequencies to 24-bit samples.

The digital filter passes only signal components within the Nyquist bandwidth or within the Nyquist bandwidth at 64, 128 or 256 times (depending on the sampling rate) the sample rate and multiples of it. The upstream analog lowpass filter rejects most noise near these multiples. The following diagrams show the frequency response of the input circuitry. In the following diagrams the y-axis shows the amplitude attenuation in dB whilst the x-axis shows the coefficient between signal frequency and sample rate.

### Sample rate 100 S/s to 51.2 kS/s

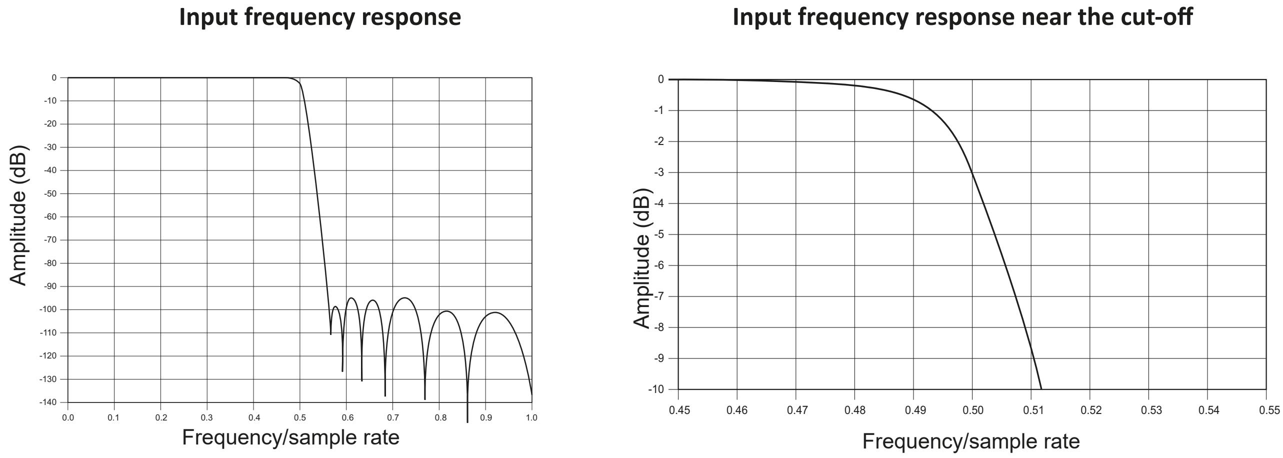



*Fig. 8: Sample rate 100 S/s to 51.2 kS/s*

### Sample rate 51.2 kS/s to 102.4 kS/s

**Input frequency response** | **Input frequency response near the cut-off**

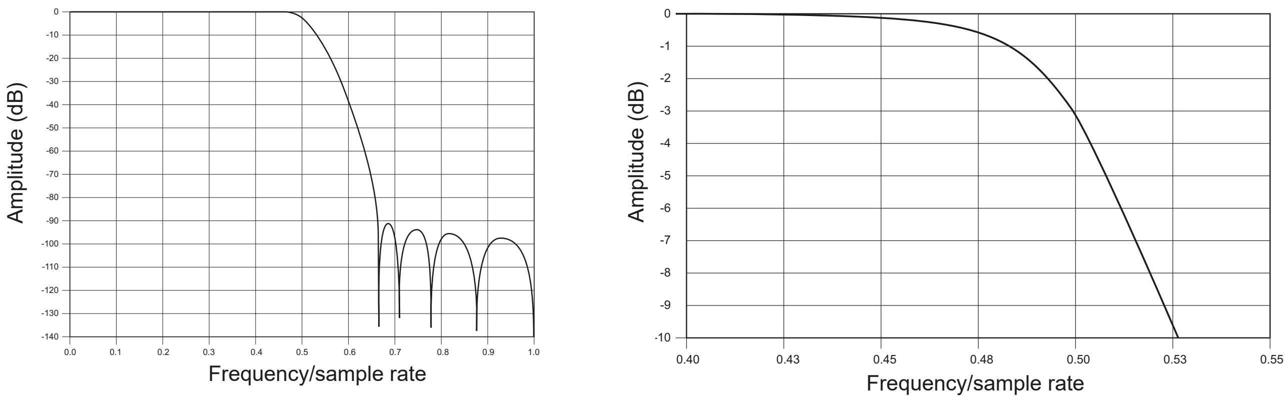



*Fig. 9: Sample rate 51.2 kS/s to 102.4 kS/s*

### Sample rate 102.4 kS/s to 200 kS/s

**Input frequency response** | **Input frequency response near the cut-off**

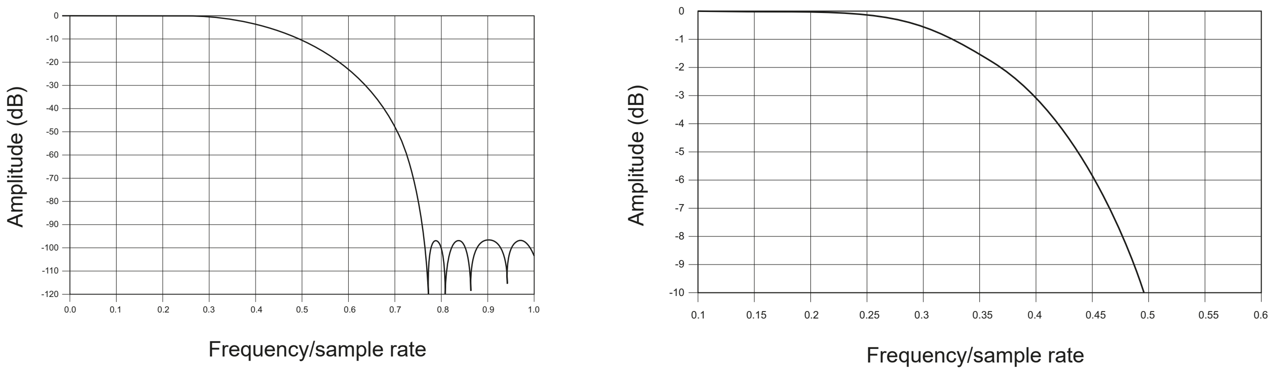



*Fig. 10: Sample rate 102.4 kS/s to 200 kS/s*

## IIR filtering

The TRION-2402-MULTI series use a combination of an analog and a digital filter. Whenever the user selects a filter, the TRION board configures both of them. The advantage of a digital IIR filter in comparison to an analog filter is, that they do not have any component related tolerances. So even for high filter orders, there is no signal delay or phase shift between the channels. The disadvantage is, they cannot distinguish between aliased signals and real signals. In order to block all aliased signal components, the cut-off frequency of the analog filter is set at least 3 times higher than the digital one.

| Selected filter frequency | Auto selected analog filter |
|---|---|
| 100 kHz to >10 kHz | 290 kHz |
| 10 kHz to >300 Hz | 29 kHz |
| <300 Hz | 2.9 kHz |

*Tab. 2: IIR filtering TRION-2402 series module*

## A/D conversion of TRION(3)-18xx-MULTI series

The TRION(3)-18xx-MULTI series utilizes one 18-bit 5 MS/s ultra-low noise successive approximation ADC per channel. This allows measuring a signal bandwidth of up to 2 MHz with very low noise and excellent accuracy. By using frequency compensated analog amplifiers, the TRION(3)-18xx-MULTI series can keep the phase shift between the channels very low. The channel-to-channel phase error within one board is typically below 5 ns. In other words, a 1 kHz sine wave signal can be measured with a maximum phase error of 0.002°.

### TRION3-1850 sample system architecture

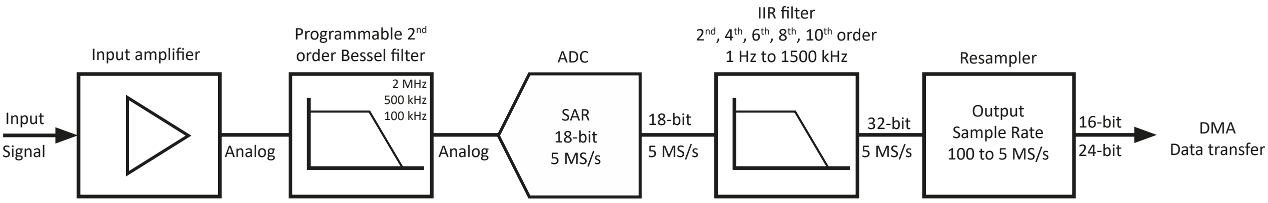



*Fig. 11: TRION3-1850 sample system architecture*

### TRION(3)-18xx-MULTI series overview

| Board | Max. sample rate [S/s] | Resolution [bit] | Oversampling | Channels | Data bus bandwidth |
|---|---|---|---|---|---|
| TRION3-1850-MULTI-4-D | 5 M | 18/24 | yes | 4 | 200 MB/s per card |
| TRION3-1850-MULTI-8-L0B | 5 M | 18/24 | yes | 8 | 200 MB/s per card |
| TRION3-1820-MULTI-4-D | 2 M | 18/24 | yes | 4 | 200 MB/s per card |
| TRION3-1820-MULTI-8-L0B | 2 M | 18/24 | yes | 8 | 200 MB/s per card |
| TRION-1820-MULTI-4-D | 2 M | 18/24 | yes | 4 | 80 MB/s per system |

*Tab. 3: TRION(3)-18xx-MULTI series overview*

### High-speed mode

The high-speed mode applies to TRION3-1850-MULTI series only. Between 2 and 5 MS/s the card is in the high-speed mode. The data transfer in that mode switches from 24 to 16-bit per channel per default. However, if it is needed, the user can still select a higher resolution. There is no need to do any rescaling in software. This is important to keep the CPU load on the host system as low as possible.

### Oversampling mode

Most physical measurement applications do not require a signal bandwidth of 2 MHz. Therefore, the needed sample rate is much lower. In that case, traditional signal conditioning systems simply decrease the ADC clock to reduce the amount of data. The TRION(3)-18xx-MULTI series automatically activates the oversampling mode at 2.5 MS/s and below. That means by using averaging and filtering techniques the resolution increases while the sample rate drops. In theory, the benefit of oversampling is 0.5 bit more per every half of the sample rate. The table on the next page shows the performance of the TRION3-1850-MULTI. To optimize the performance it is recommended, to use sample rates that can be divided from 5 MS/s without remainder. In that case, the ADC runs on the highest possible setting, 5 MS/s.

## Filtering

The TRION(3)-18xx-MULTI series uses a combination of an analog and a digital filter. Whenever the user selects a filter, the card sets up both of them. The advantage of an IIR filter in comparison to an analog filter is, that they do not have any component related tolerances. So even for high filter orders, there is no signal delay or phase shift between the channels. The disadvantage is, they cannot distinguish between aliased signals and real signals. Therefore they are normally not used as anti-aliasing filter. Consequently an analog filter in front of the ADC is needed to minimize the aliasing components in the measured signal.

However, in case of oversampling the aliased bandwidth of the ADC starts much higher than the output bandwidth. In that mode, the IIR filter works as an excellent aliasing filter. The cut-off frequency of the analog filter is around 3 times higher than the digital one. This keeps the influence of components tolerances very small and as a result attenuates the aliased signal bandwidth of the ADC. In the high-speed mode this does not work. For measuring a 2 MHz input bandwidth, in high-speed mode the IIR filter could be deactivated. Consequently there is a 2 MHz 2$^{nd}$ order Bessel filter left, which is purely analog. The user has to be aware of aliasing effects in that mode.

| Selected filter frequency | Auto selected analog filter |
|---|---|
| 1500 kHz to >167 kHz | 2 MHz |
| 600 kHz to >167 kHz | 2 MHz |
| 167 kHz to >30 kHz | 500 kHz |
| <30 kHz | 100 kHz |

*Tab. 4: Filtering TRION(3)-18xx-MULTI series*

## Step response

In comparison to delta-sigma converters, SAR converters have a perfect step response. Whenever a square signal has to be measured in the time domain, SAR or flash ADCs should be used.
In order to eliminate the overshoot of the measurement system a Bessel filter characteristic should be used.

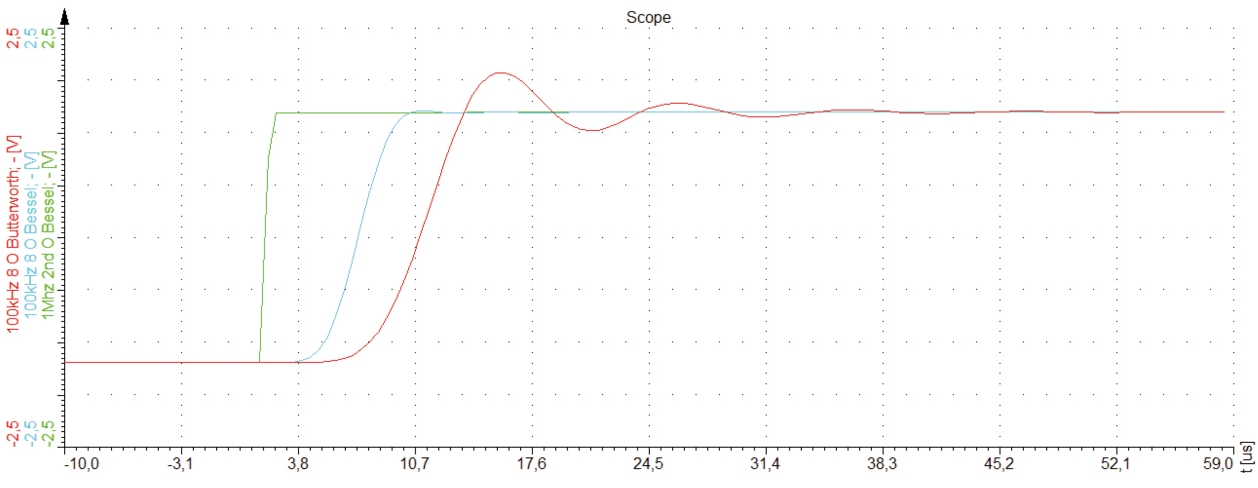
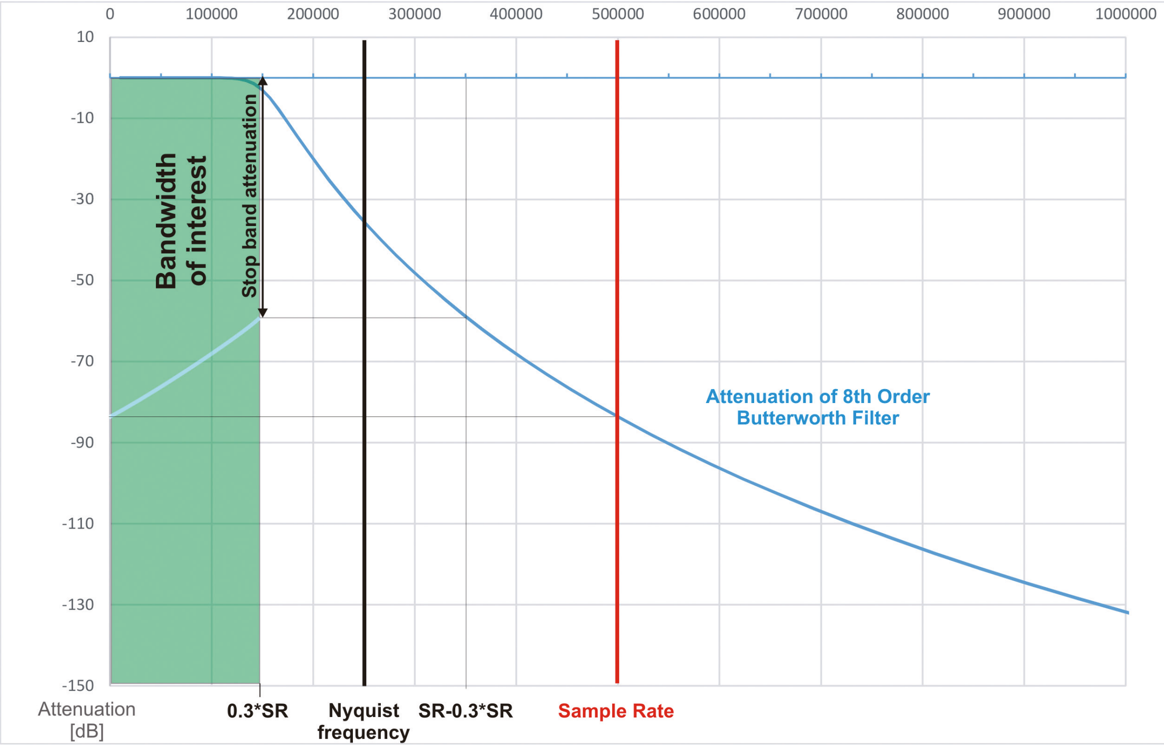



*Fig. 12: Step response TRION(3)-18xx-MULTI series*

## Aliasing protection

As mentioned in the filtering section, in the oversampling mode the IIR filter is used as an anti-aliasing filter. When using the TRION(3)-18xx-MUTLI series, DEWETRON recommends setting up the sample rate at least 3 times higher than the bandwidth of interest. Therefore the auto selected filter is usually 30 % of the sample rate. In case of 8$^{th}$ order Butterworth filter, this gives a stop-band attenuation of 60 dB (0.1 % of the input signal). If a higher stop-band attenuation is required they user may select a higher ratio between sample rate and filter frequency. For the highest aliasing protection, the user should also consider the TRION-2402 series.




*Tab. 5: Aliasing protection TRION(3)-18xx-MULTI series*

## A/D conversion of TRION(3)-18xx-POWER series

The TRION(3)-18xx-POWER series utilizes one 18-bit 10 MS/s ultra-low noise successive approximation ADC per channel. This allows measuring a signal bandwidth of up to 5 MHz with very low noise and excellent accuracy.

### TRION3-1810M-POWER-4 HV input system architecture

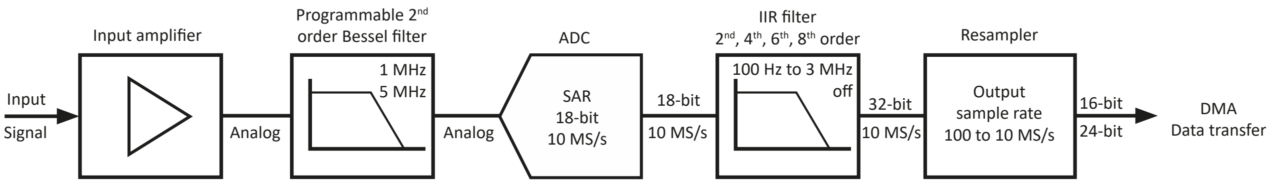



*Fig. 13: TRION3-1810M sample system architecture*

### TRION(3)-18xx-POWER series overview

| Board | Max. sample rate [S/s] | Resolution [bit] | Oversampling | Channels | Data bus bandwidth |
|---|---|---|---|---|---|
| TRION3-1810M-POWER-4 | 10 M | 16/24 | yes | 8 | 200 MB/s per card |
| TRION-1820-POWER-4 | 2 M | 16/24 | yes | 8 | 80 MB/s per system |
| TRION-1810-HV-8 | 1 M | 16/24 | yes | 8 | 80 MB/s per system |

*Tab. 6: TRION(3)-18xx-POWER series overview*

### High-speed mode

Between 5 and 10 MS/s the card is in the high-speed mode. The data transfer in that mode switches from 24 to 16-bit per channel per default. However, if it is needed, the user can still select a higher resolution. There is no need to do any rescaling in software. This is important to keep the CPU load on the host system as low as possible.

### Oversampling mode

If the maximum sample rate is not needed, the TRION(3)-18xx-POWER series automatically activates the oversampling mode at 5 MS/s and below. That means by using averaging and filtering techniques the resolution increases while the sample rate drops. In theory, the benefit of oversampling is 0.5 bit more per every half of the sample rate.

The analog filter is set at the HV input depending on the set filter frequency:

| Filter frequency | Analog filter |
|---|---|
| 1 Hz ... 666 kHz | 1 MHz |
| 667 kHz ... 3 MHz | 5 MHz (bandwidth) |
| OFF | 5 MHz (bandwidth) |

*Tab. 7: Filter frequency vs. analog filter*

## A/D conversion of TRION-16xx/18xx series

The TRION-1620 series utilizes one 16 bit 2 MS/s ultra-low noise successive approximation ADC per channel. This allows measuring a signal bandwidth of up to 1 MHz with very low noise and excellent accuracy. By using frequency compensated analog amplifiers, the TRION-1620 series can keep the phase shift between the channels very low.
The channel-to-channel phase error within one board is typically below 20 ns.
In other words, a 1 kHz sine wave signal can be measured with a maximum phase error of 0.007°.

### TRION-1620 sample system architecture

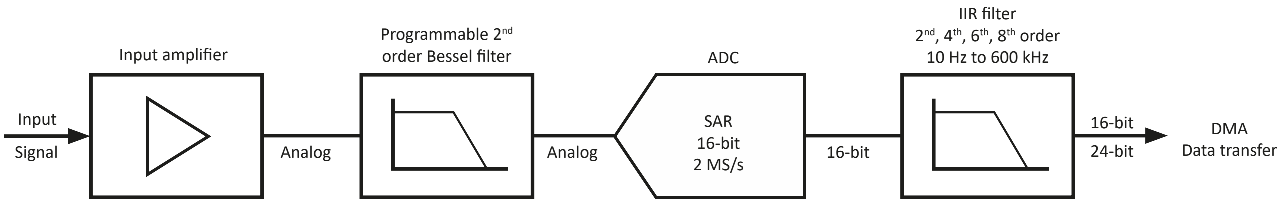



*Fig. 14: TRION-1620 sample system architecture*

### TRION-16xx series overview

| Board | Max. sample rate [S/s] | Resolution [bit] | Oversampling | IEPE | Counter | TEDS |
|---|---|---|---|---|---|---|
| TRION-1603-LV-6-BNC | 250 k | 16 | yes | - | - | - |
| TRION-1603-LV-6-L1B | 250 k | 16 | yes | - | - | yes |
| TRION-1620-LV-6-BNC | 2 M | 16/24 | yes | - | - | - |
| TRION-1620-LV-6-L1B | 2 M | 16/24 | yes | - | - | yes |
| TRION-1620-ACC-6-BNC | 2 M | 16/24 | yes | 4/8 mA | CH0 | - |
| TRION-1620-ACC-6-L1B | 2 M | 16/24 | yes | 4/8 mA | CH0 | yes |

*Tab. 8: TRION-16xx series overview*

### High-speed mode (TRION-1620 series only)

Between 1 and 2 MS/s the card is in the high-speed mode. The data transfer in that mode switches from 24 to 16-bit per channel. Since the gain and offset correction is done analog, not a single bit gets lost because of board calibration. There is also no need to do any rescaling in software. This is important to keep the CPU load on the host system as low as possible.

### Oversampling mode with TRION-1620 series

Most physical measurement applications do not require a signal bandwidth of 1 MHz. Therefore, the needed sample rate is much lower. In that case, traditional signal conditioning systems simply decrease the ADC clock to reduce the amount of data. The TRION-1620 series automatically activates the oversampling mode at 1 MS/s and below. That means by using averaging and filtering techniques the resolution increases while the sample rate drops. In theory, the benefit of oversampling is 0.5 bit more per every half of the sample rate. The table on the next page shows the performance of the TRION-1620-ACC in the 2 V range. To optimize the performance it is recommended, to use sample rates that can be divided from 2 MS/s without remainder. In that case, the ADC runs on the highest possible setting, 2 MS/s.

| Sample rate [kS/s] | 2000 | 1000 | 500 | 250 | 200 | 100 | 10 | 1 | 0.1 |
|---|---|---|---|---|---|---|---|---|---|
| Oversampling active | no | yes | yes | yes | yes | yes | yes | yes | yes |
| Filter | 1 MHz | 300 kHz | 150 kHz | 75 kHz | 65 kHz | 30 kHz | 3 kHz | 300 Hz | 30 Hz |
| Data word length [bit] | 16 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| SNR [dB] | 88 | 93.2 | 99.5 | 102.7 | 103.7 | 106 | 111 | 123 | 130 |
| Spurious free dynamic [dB] | 88 | 130 | 140 | 140 | 142 | 142 | 150 | 150 | 155 |
| ENOB [bit] | 14.3 | 15.2 | 16.2 | 16.8 | 16.9 | 17.3 | 18.1 | 20.1 | 21.3 |

*Tab. 9: Oversampling TRION-1620 series*

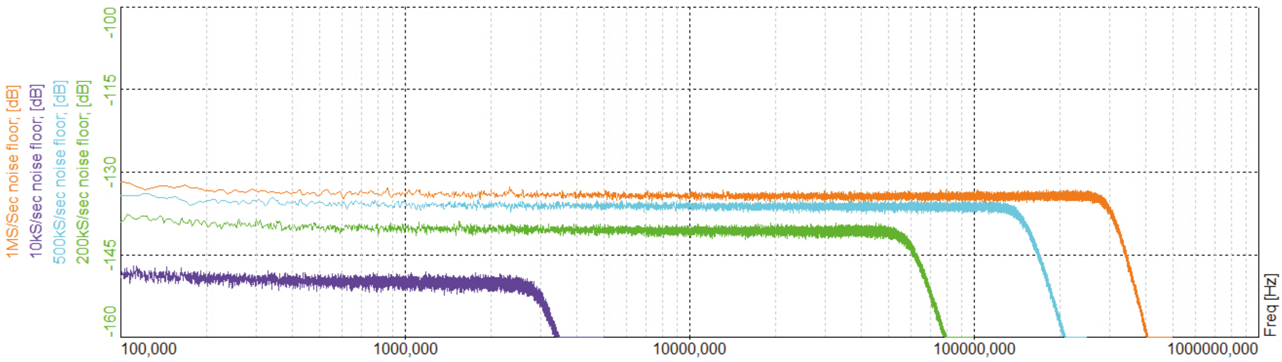



*Fig. 15: Noise floor of TRION-1620-ACC at different sample rates*

## Filtering

The TRION-16xx series uses a combination of an analog and a digital filter. Whenever the user selects a filter, the card sets up both of them. The advantage of an IIR filter in comparison to an analog filter is, that they do not have any component related tolerances. So even for high filter orders, there is no signal delay or phase shift between the channels. The disadvantage is, they cannot distinguish between aliased signals and real signals. Therefore, they are normally not used as anti-aliasing filter. Consequently an analog filter in front of the ADC is needed to minimize the aliasing components in the measured signal.

However, in case of oversampling the aliased bandwidth of the ADC starts much higher than the output bandwidth. In that mode, the IIR Filter works as an excellent aliasing filter. The cut-off frequency of the analog filter is around 3 times higher than the digital one. This keeps the influence of components tolerances very small and as a result attenuates the aliased signal bandwidth of the ADC. In the high-speed mode this does not work. For measuring a 1 MHz input bandwidth, in high-speed mode the IIR filter could be deactivated. Consequently there is a 1 MHz $2^{nd}$ order Bessel filter left, which is purely analog. The user has to be aware of aliasing in that mode.

| Selected filter frequency | Analog filter |
|---|---|
| 600 kHz to >100 kHz | 1 MHz |
| 100 kHz to >30 kHz | 333 kHz |
| 30 kHz to >10 kHz | 100 kHz |
| 10 kHz to >3 kHz | 33 kHz |
| <3 kHz | 10 kHz |

*Tab. 10: Filtering TRION-16xx series*

## Step response

In comparison to delta-sigma converters, SAR converters have a perfect step response. Whenever a square signal has to be measured in the time domain, SAR or flash ADCs should be used.
In order to eliminate the overshoot of the measurement system a Bessel filter characteristic should be used.

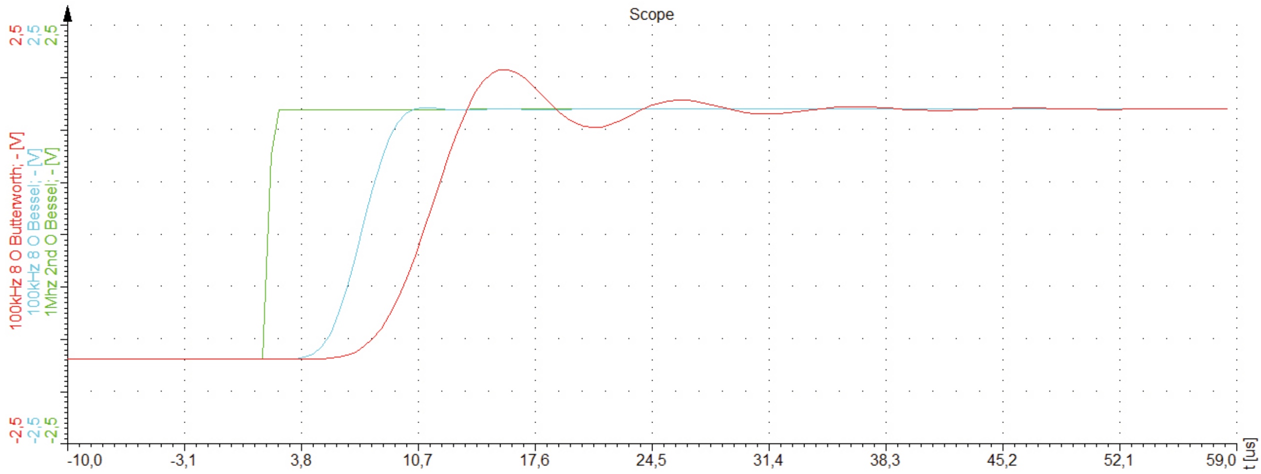



*Fig. 16: Step response TRION-16xx series*

## Aliasing protection

As mentioned in the filtering section, in the oversampling mode the IIR filter is used as an anti-aliasing filter. When using the TRION-16xx series, DEWETRON recommends setting up the sample rate at least 3 times higher than the bandwidth of interest. Therefore usually the auto selected filter is 30 % of the sample rate. In case of 8th order Butterworth filter, this gives a stop-band attenuation of 60 dB (0.1 % of the input signal). If a higher stop-band attenuation is required they user may select a higher ratio between sample rate and filter frequency. For the highest aliasing protection, the user should also consider the TRION-2402 series.

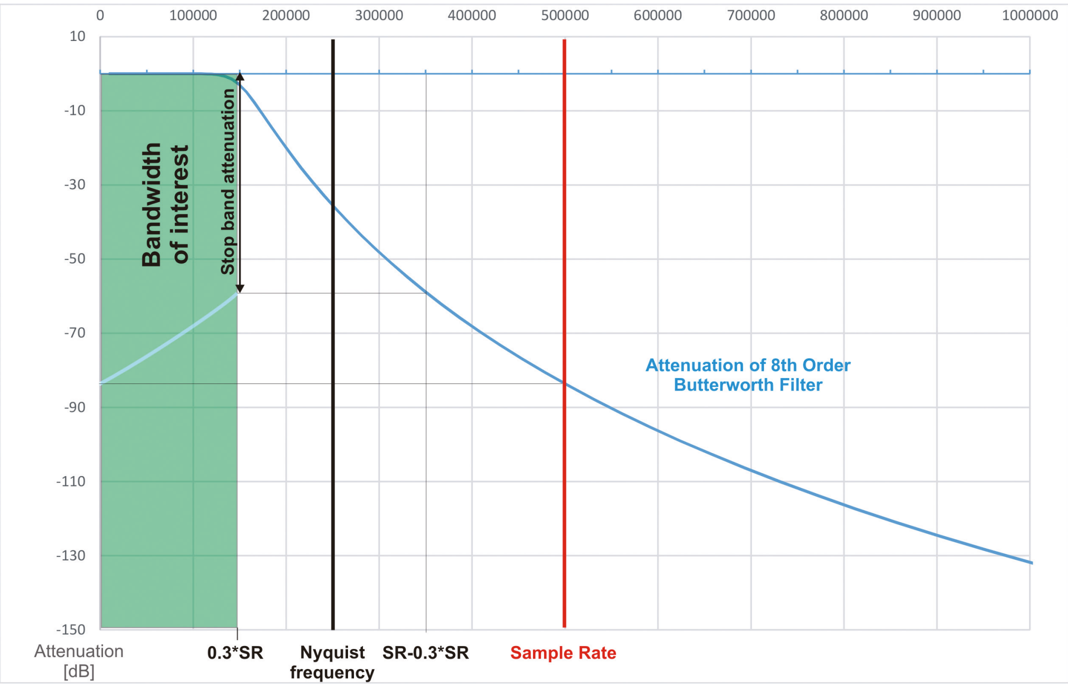



*Fig. 17: Stop-band attenuation TRION-16xx series for 30 % bandwidth (8th order Bessel/Butterworth)*

| Selected bandwidth | $8^{th}$ order Bessel | $8^{th}$ order Butterworth |
|---|---|---|
| [% of SR] | [dB] | [dB] |
| 30 | 20 | 60 |
| 20 | 52 | 90 |
| 10 | 107 | 150 |

*Tab. 11: Stop-band attenuation TRION-16xx series*

## CPU load

The TRION-1620 series computes all mathematic calculations on the board itself. Consequently no calculation for filtering or calibration is required from the host CPU. This frees the CPU for other purposes, and allows a very high data throughput.

# System clocking

## DEWE chassis functional overview

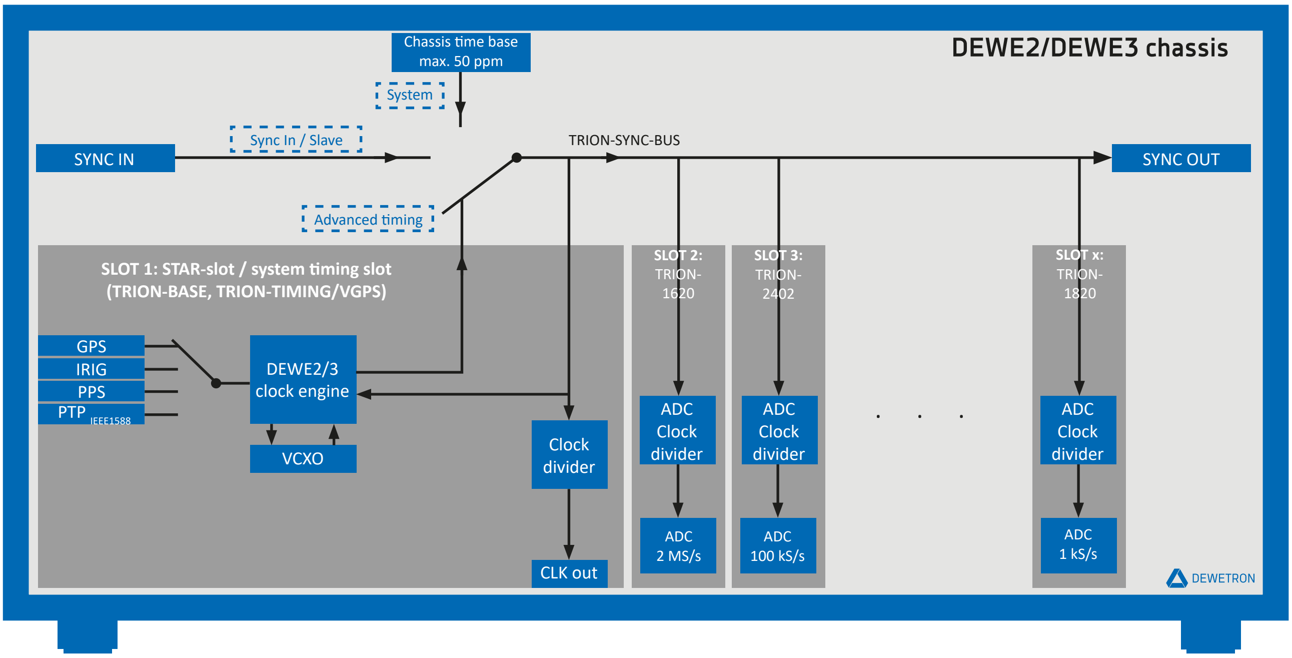



*Fig. 18: DEWE chassis functional overview*

## Clock routing

All DEWE2 and DEWE3 systems have internally the same clock structure, independent on the number of slots. The timing information is distributed via the TRION-SYNC-BUS to every slot of the chassis. All modules generate their AD clocks out of the TRION-SYNC-BUS signals separately. Hence, different sample rates at different modules are feasible while still being precisely synchronized.

The source of the internal sync bus can be either:

- Chassis time base
- Another DEWE2/DEWE3 system by using the “SYNC IN”
- An external source by using a TRION module with timing capabilities such as:
  - GPS or other global navigation satellite systems
  - PTP/IEEE1588
  - IRIG with various codes
  - PPS (pulse per second)

## Time base accuracy

The system time base affects everything that measures time, or is derived from a timing measurement in your system:

- Sample rate
- Frequency measurement; FFT frequency accuracy
- Period measurement
- Speed or rotation speed measurement

| Mode | Accuracy |
|---|---|
| DEWE3 system, no timing module | 10 ppm |
| DEWE2 system, no timing module | 50 ppm |
| GPS or other GNSS | <1 ppm |
| DEWE2 / DEWE3 sync-in | Depending on master system |
| PTP/IEEE1588, IRIG, PPS | Depending on source accuracy |

*Tab. 12: Synchronization type overview*

## Synchronization

The time base accuracy is relevant if standalone systems without synchronization are running for a longer period and you want to know if the timing error is acceptable.

EXAMPLE Two systems are measuring an external event

- System A with a timing error of +39 ppm
- System B with a timing error of +15 ppm

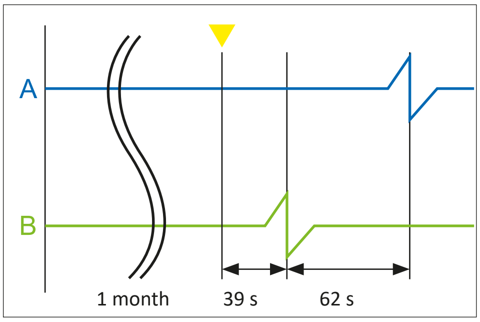



*Fig. 19: Not synchronized*

Both systems start with the same start trigger. After one month of measuring, the time stamp difference is approximately 62 seconds. That means that system B measures any event 62 seconds earlier than the other system.

30(days) * 24(hours) * 3600(seconds) * (0.000039-0.000015) = 62.2 s (see *Fig. 19*)

### System to system synchronization

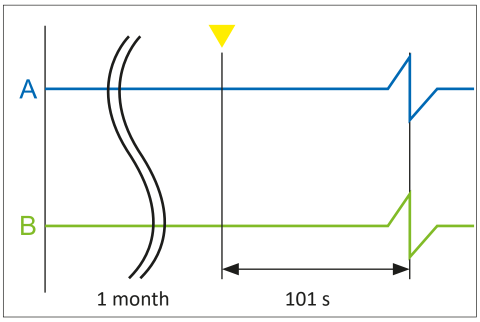



*Fig. 20: System to system synchronization*

Synchronization avoids this problem. If System A is Master and System B is synced as a Slave to it, both systems will run with +39 ppm time base error. However, the differential error is 0 ppm.

Also after one month, an event measured with both systems will be displayed at the same time. The best way to synchronize two DEWE2/DEWE3 systems is with TRION-SYNC-BUS via RJ45 cable (see *Fig. 20*).

## Absolute time synchronization

System-to-system synchronization might be sufficient for most cases but sometimes it is required to align measured events with an external one. Then an absolute time stamp for your data is needed. The easiest way to get this done is using GNSS based synchronization. In cases where you cannot get satellite communication, such as in tunnels or big structures, use IRIG or PTP.

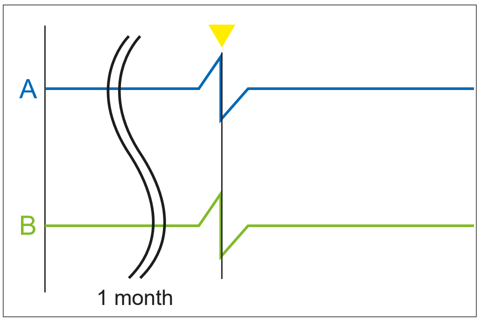



*Fig. 21: Absolute time synchronization*

## Synchronization type overview

| Synchronization type | Typical synchronization accuracy* | Absolute time | Distance** | Cable type | Recommended for |
|---|---|---|---|---|---|
| GPS | ±100 ns | ✓ | - | - | Highest distance; cable connection is impossible |
| PTP / IEEE1588 direct connection to master or via dedicated switch | ±50 ns | ✓ | RJ45: 100 m<br>Fibre: 1 km | RJ45 or fibre optic | Within buildings; medium distance; use with existing installation; cable length compensated |
| PTP / IEEE1588 connected via standard Ethernet switch | 25 µs | ✓ | RJ45: 100 m<br>Fibre: 1 km | RJ45 or fibre optic | Only for sample rates up to 10 kS/s |
| TRION Sync | ±60 ns<br>+5 ns/m | ✗ | 100 m | RJ45 CAT VI | Medium distance; low jitter; use between DEWE2/3 chassis |
| PPS | ±60 ns<br>+5 ns/m | ✗ | 10 m | RG58 | Low distance |
| PPS out | 500 ns | ✗ | 10 m | RG58 | Low distance; clocking 3rd party devices |
| IRIG-B TTL | 100 ns | ✓ | 50 m | RG58 | Medium distance; use with existing IRIG installation |
| IRIG-A/B DC; AC | Slave to slave ±2 µs<br>Master to slave ±20 µs | ✓ | 300 m | RG58 | Medium distance; use with existing IRIG installation |
| Frequency out (TTL) | 500 ns | ✗ | 10 m | RG58 | E.g. camera trigger |

*Tab. 13: Synchronization type overview*

*) For mixed sample rate or mixed TRION module configurations, the sample period of the slower sampling card must be added to the sync accuracy.

**) These values are recommended maximum distances and might vary due to used cables.

## Synchronization input

| Device | Synchronization input | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PTP IEEE1588 | IRIG A | IRIG B | IRIG with modulation | GPS | GLONASS | Galileo | BeiDou | PPS |
| TRION-BASE | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| TRION-VGPS-V3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ | ✗ | ✓ |
| TRION-TIMING-V3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

*Tab. 14: Synchronization input*

# TRION-1620-ACC/LV

- Sampling: 2 MS/s per channel at 16-bit; 24-bit in oversampling mode
- ADC: Low noise, SAR
- Input ranges
  - Voltage: ±5 mV to ±100 V
  - IEPE®: ±5 mV to ±50 V
- Isolated


## Module specifications

| TRION-1620-ACC/LV specifications | | | |
|---|---|---|---|
| Input channels | TRION-1620-LV-6-BNC | 6 channels BNC, voltage input | |
| | TRION-1620-ACC-6-BNC | 6 channels BNC, voltage input; IEPE®; 1 counter | |
| | TRION-1620-LV-6-L1B | 6 channels 1B LEMO, voltage or current input, 1 to 28 V sensor supply, TEDS | |
| | TRION-1620-ACC-6-L1B | 6 channels 1B LEMO, voltage or current input, IEPE®, 1 counter, sensor supply, TEDS | |
| Sampling rate / resolution | Highspeed mode | >1 to 2 MS/s | 16-bit |
| | Over sampling mode | 100 S/s to 1 MS/s | 24-bit |
| Data transfer | 16-bit / 24-bit | | |
| Data rate DMA transfer | 6 analog channels: max 24 MB/s; 1 x counter: max. 16 MB/s | | |
| ADC type | SAR (Successive Approximation Register) | | |
| Input ranges | | | |
| – Voltage | ±5 mV, ±10 mV, ±20 mV, ±50 mV, ±100 mV, ±200 mV, ±500 mV, ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, ±50 V, ±100 V, | | |
| – IEPE® | ±5 mV, ±10 mV, ±20 mV, ±50 mV, ±100 mV, ±200 mV, ±500 mV, ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, ±50 V | | |
| – Current[1)] | ±10 mA, ±20 mA, ±50 mA, ±100 mA | | |
| Accuracy[3)] | Voltage | DC to 1 kHz | ±0.02 % of reading ± 0.02 % of range ±20 µV |
| | | >1 kHz to 5 kHz | ±0.2 % of reading ± 0.02 % of range ±20 µV |
| | | >5 kHz to 10 kHz | ±0.5 % of reading ± 0.02 % of range ±20 µV |
| | | >10 kHz to 50 kHz | ±1.00 % of reading ± 0.02 % of range ±20 µV |
| | | >50 kHz to 100 kHz | ±3.00 % of reading ± 0.02 % of range ±20 µV |
| | Current[1)] | DC to 1 kHz | ±0.1 % of reading ± 0.02 % of range ±10 µA |
| | | >1 kHz to 5 kHz | ±0.2 % of reading ± 0.02 % of range ±10 µA |
| | | >5 kHz to 10 kHz | ±0.5 % of reading ± 0.02 % of range ±10 µA |
| | | >10 kHz to 50 kHz | ±1.00 % of reading ± 0.02 % of range ±10 µA |
| | | >50 kHz to 100 kHz | ±2.00 % of reading ± 0.02 % of range ±20 µA |
| MTBF[4)] | TRION-1620-LV-6-BNC: 230,318 h | | |
| Input noise (5 mV range) | | | |
| – 0 to 10 Hz | 1.5 $\mu V_{PP}$ | | |
| – Noise density | 6.4 nV/SQRT(Hz) | | |

*Tab. 15: Module specifications*

| **TRION-1620-ACC/LV specifications** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Input impedance | 1 MΩ shunted by 18 pF | | | | | | | | |
| Current input | Internal 10 Ω shunt; max. 100 mA protected with resettable fuse | | | | | | | | |
| Input bias current | <1 nA | | | | | | | | |
| Input coupling | DC; AC: 0.16Hz[2] | | | | | | | | |
| Gain drift | Typically 10 ppm/°C max. 20 ppm/°C | | | | | | | | |
| Offset drift | Typically 0.3 µV/°C + 10 ppm of range/°C, max 15 µV/°C + 20 ppm of range/°C | | | | | | | | |
| Linearity | Typically 0.01 % | | | | | | | | |
| Input configuration | Isolated | | | | | | | | |
| Isolation impedance | Isolation resistance >1 GΩ; Isolation capacitance typically 15 pF | | | | | | | | |
| Rated input voltage to earth according to EN 61010-2-30 | 33 $V_{RMS}$, 46.7 $V_{PEAK}$, 70 $V_{DC}$ | | | | | | | | |
| Isolation voltage (channel-to-channel and channel-to-chassis) | 1500 $V_{PEAK}$ | | | | | | | | |
| Overvoltage protection | ±300 $V_{DC}$ | | | | | | | | |
| IEPE® excitation[2] | 4 mA, 8 mA ±10 % @ 1 % ±1 mV accuracy @ 24 V compliance voltage | | | | | | | | |
| Voltage excitation[1] | 1 to 28 V @ 1 % ±1 mV accuracy freely programmable (max. 100 mA, max. 1 W) per channel | | | | | | | | |
| Typical signal-to-noise ratio, spurious | **20 mV range** | | | **2 V range** | | | **100 V range** | | |
| Free SNR, effective number of Bits[5] | SNR | SFDR[6] | ENOB[7] | SNR | SFDR[6] | ENOB[7] | SNR | SFDR[6] | ENOB[7] |
| Sample rate | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] |
| 0.1 kS/s | 104 | 125 | 17.0 | 130 | 155 | 21.3 | 130 | 155 | 21.3 |
| 1 kS/s | 97 | 125 | 15.8 | 123 | 150 | 20.1 | 122 | 145 | 20.0 |
| 10 kS/s | 91 | 122 | 14.8 | 111 | 150 | 18.1 | 112 | 135 | 18.3 |
| 100 kS/s | 82 | 116 | 13.3 | 106 | 142 | 17.3 | 105 | 130 | 17.1 |
| 200 kS/s | 78.7 | 116 | 12.8 | 103.7 | 142 | 16.9 | 102 | 125 | 16.7 |
| 500 kS/s | 74 | 114 | 12.0 | 99.5 | 140 | 16.2 | 98 | 121 | 16.0 |
| 1000 kS/s | 71 | 87 | 11.5 | 93.2 | 130 | 15.2 | 93 | 116 | 15.2 |
| 2000 kS/s | 56 | 56 | 9.0 | 88 | 88 | 14.3 | 88 | 88 | 14.3 |
| Typical THD | -97 dB | | | | | | | | |
| Typical CMR<br>– ≤2 V range<br>– >2 V range | <br>>140 dB @ 50 Hz >120 dB @ 1 kHz<br>>90 dB @ 50 Hz >60 dB @ 1 kHz | | | | | | | | |
| Low pass Filter (-3 dB, digital)<br>– Characteristic<br>– Filter order | 10 Hz, 30 Hz, 100 Hz, 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz, 100 kHz, 300 kHz, 600 kHz<br>Bessel or Butterworth<br>2nd , 4th, 6th, 8th | | | | | | | | |
| Analog anti-aliasing filter | 2nd order Bessel, automatically selected | | | | | | | | |
| Bandwidth (-3 dB, deactivated digital filter) | 1 MHz 2nd order Bessel filter | | | | | | | | |
| Crosstalk fin 1 kHz [10 kHz] | ≤2 V Range: 120 dB [105 dB] | | | | | | | | |
| Channel-to-channel phase mismatch | Typically <10 ns when using the same range; <60 ns for using different ranges | | | | | | | | |
| Board-to-board phase mismatch | <30 ns | | | | | | | | |

*Tab. 15: Module specifications*

| TRION-1620-ACC/LV specifications | |
|---|---|
| Counter | 1x counter channel linked to analog channel #1; trigger level 70 % of actual analog input range |
| Counter modes | Event counting, period, frequency, pulse width, duty cycle |
| Counter input bandwidth | 1 MHz to 10 kHz depending on analog filter of CH1 |
| Counter time base | 80 MHz |
| ESD protection | IEC61000-4-2: ±8 kV air discharge, ±4 kV contact discharge |
| Supported TEDS chips (LEMO only) | All common TEDS chips are supported. |
| Power consumption | Voltage mode: 6 W; IEPE® mode: 7.5 W |

*Tab. 15: Module specifications*

1) TRION-1620-LV-6-L1B only
2) TRION-1620-ACC only
3) 1 year accuracy 23 °C ±5 °C
4) Mean time between failure
5) LP Filter in auto mode
6) SFDR excluding harmonics
7) ENOB calculated from SNR

# Connection

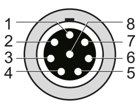
## TRION-1620-ACC/LV-6-BNC module


Hot: IN +
Shield: IN -

## TRION-1620-ACC/LV-6-L1B module


Mating connector

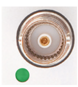
FGG.1B.308.CLAD52Z




8-pin LEMO connector female
EGG.1B.308.CLL

1: EXC
2: GND
3: IN+
4: IN-
5: Excitation Sense
6: RESERVED (GND)
7: Current+
8: TEDS
Housing GND

# LED function



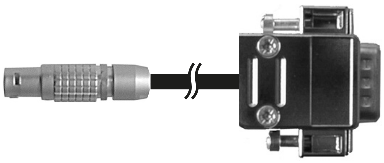
Green: Normal operation

*Fig. 22: LED function*

# Optional accessory

## TRION-CBL-L1B8-D9-0.5-01

High quality adapter cable from LEMO 1B.308 plug to D-SUB-9 socket, 0.5 m, no MSI support.



1: TEDS
2: IN+
3: n.c.
4: GND
5: EXT+
6: n.c.
7: IN-
8: n.c.
9: n.c.

*Fig. 23: TRION-CBL-L1B8-D9-0.5-01*

## TRION-CBL-L1B8-OE-05-00

High quality cable from Lemo 1B.308 plug to open end, 5 m.

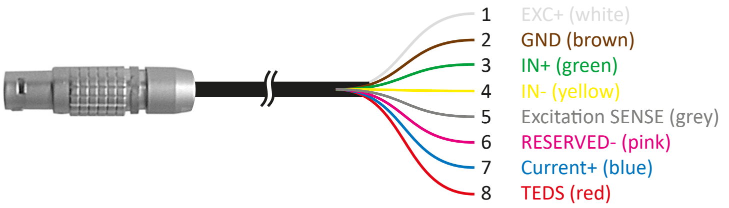
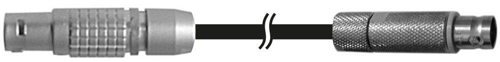



*Fig. 24: TRION-CBL-L1B8-OE-05-00*

## TRION-CBL-L1B8-BNC-0.5-00

High quality cable from Lemo 1B.308 plug to BNC connector, 0.5 m.



Hot: IN +
Shield: IN -

*Fig. 25: TRION-CBL-L1B8-BNC-0.5-00*

## Base block diagram

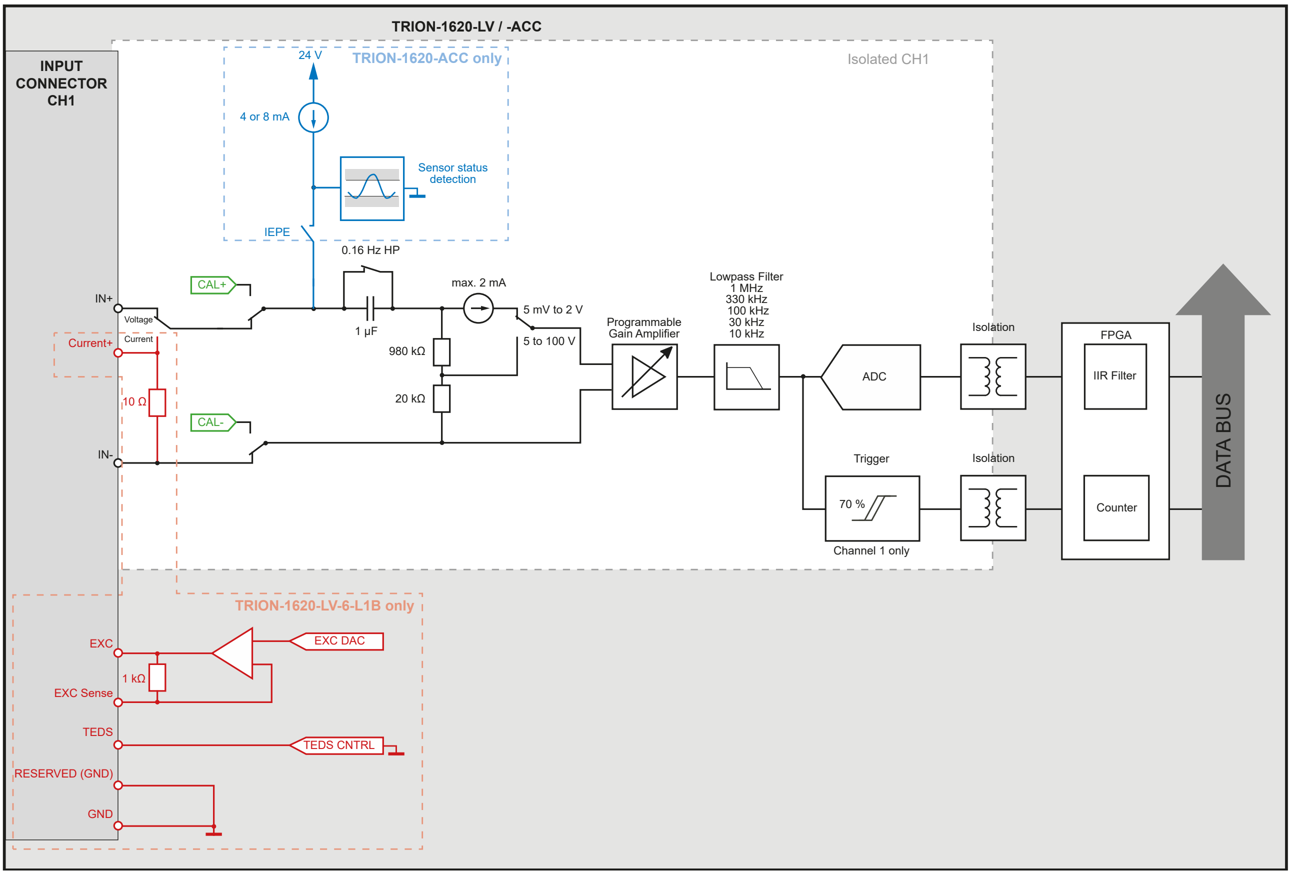



*Fig. 26: Base block diagram of the TRION-1620-ACC/LV module*

The TRION-16xx series is a highly accurate, isolated, 16-bit voltage digitizer. Each channel is separately isolated and has its own AD converter. For ranges above 2 V, a temperature compensated resistance divider attenuates the input signal. In lower ranges, the signal is directly routed to the programmable gain amplifier via a current limiting circuit. This architecture allows measuring voltages from a few µV to 100 V with an excellent signal-to-noise ratio and accuracy. The current limiting circuit can easily withstand 300 $V_{DC}$. So also the 5 mV range will not be damaged when 300 V are applied by accident. After the gain amplifier, the conditioned signal passes a programmable low pass filter before getting to the ADC.

For more details about bandwidth and filtering, refer to chapter *Analog to digital conversion* in the TRION(3) series modules technical reference manual.

# TRION-16xx series functions

## Short

The short function switches IN+ to IN- via the calibration circuit. It can be used to check the offset stability of the input amplifier.

## Self test

The TRION-16xx series has an integrated special self test circuit. It consist of a programmable high precision voltage source on the first isolated channel and a relay matrix. It is used to check the analog input path of the voltage amplifier by applying 0 V and 90 % of the input range to the input. This test can be performed in the channel setup for the actual range. During the board self test, which is available in the DEWETRON Explorer, this test is performed for all ranges and channels automatically.


By right clicking the board in the DEWETRON Explorer a self test can be carried out.

## IEPE® (TRION-1620-ACC only)

The TRION-1620-ACC also supports IEPE® sensors. This board is equipped with ultra-low noise constant current source. The excitation can be selected between 4 and 8 mA. The compliance voltage is 24 V.

**INFORMATION**

TEDS functionality is not available in that mode:

## Counter function (TRION-1620-ACC only)

The first channel of the TRION-1620-ACC module, can be used beside the normal functionality also as a counter input. It has a fixed trigger level at 75 % of the actual analog input range. This makes the input perfectly suitable for all kind of tacho probes. By activating the IEPE® supply it is even possible using probes without any additional sensor supply, just with a BNC cable. Supported counter functions are:*)

- Simple event counting
- Period measurement
- Pulse width measurement
- Frequency
- Duty cycle

*) The available counter functions depend on the application software used and may differ from this list.

For detailed information about this function refer to chapter *Functional description of advanced counter* in the TRI-ON(3) series modules technical reference manual.

**INFORMATION**

It is not possible to change the analog input settings out of the counter dialog. This has to be done in the channel setup of the analog input

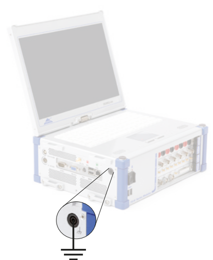
## Isolation

The isolation of the module has many advantages:

- It allows very high common mode voltages even in the 5 mV range. This is especially required for current measurement with shunt technology.
- High input protection.
- DC offset errors because of ground loops are eliminated.
- Eliminating current loops; noise reduction.

## Ground connection

The TRION-16xx series is fully isolated and has high impedance inputs, with very high sensitivity. For achieving the highest signal-to-noise ration it is strongly recommended to connect the DEWE2/3 system to a structural ground potential. This could be for example the chassis of the car or train, in case of vehicle measurements. With that simple method, you can avoid catching noise signals such as the 50/60 Hz interference. Sometimes the power supply cable already provides this connection. If the system runs on battery or with an isolated DC power supply, the operator should take care of the ground connection.



# Signal connection

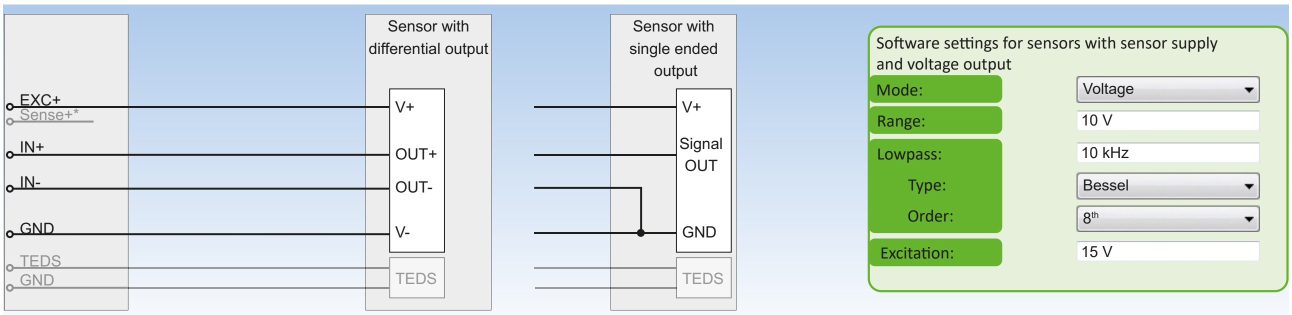
## Voltage

### Voltage measurement

- Isolated sensors
- Battery powered sensors
- Sensors with differential output


*Fig. 27: Voltage measurement*

### Sensors with sensor supply and voltage output




*) Sense as well as TEDS connection is optional.

*Fig. 28: Sensors with sensor supply and voltage output*

## Current

### Current measurement

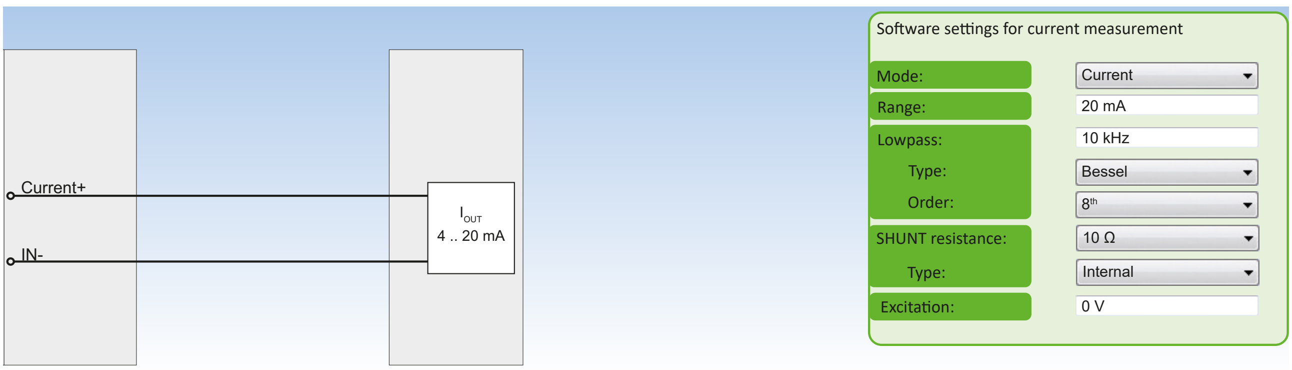
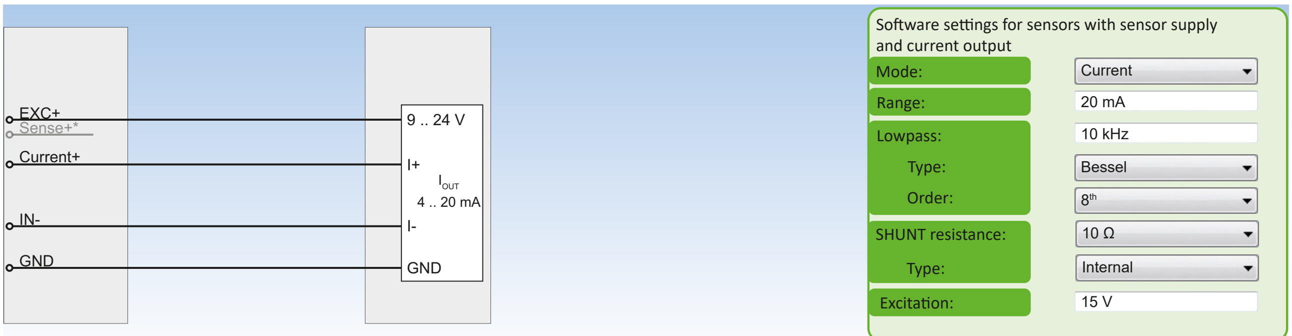



*Fig. 29: Current measurement*

### Sensors with sensor supply and current output




*) Sense connection is optional.

*Fig. 30: Sensors with sensor supply and current output*

### Loop-powered sensors with 4 to 20 mA output

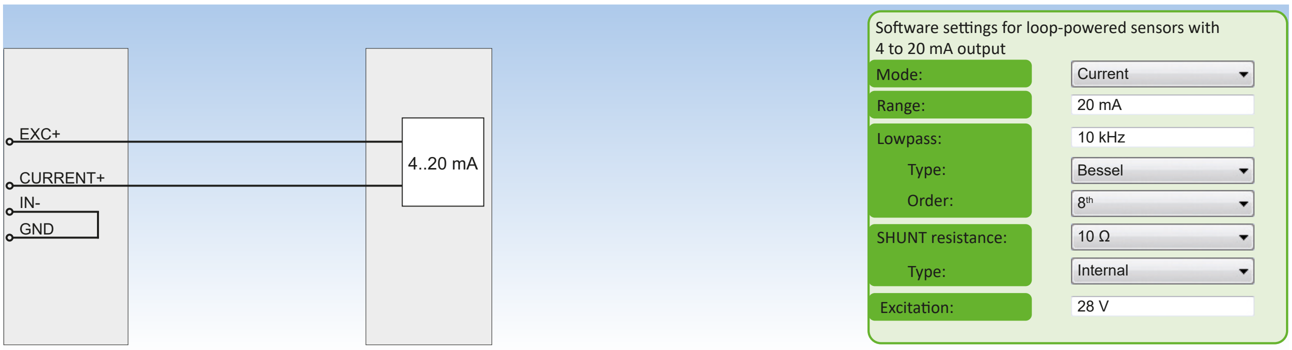
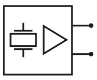



*Fig. 31: Loop-powered sensors with 4 to 20 mA output*



## IEPE®

### IEPE® sensor (TRION-1620-ACC only)

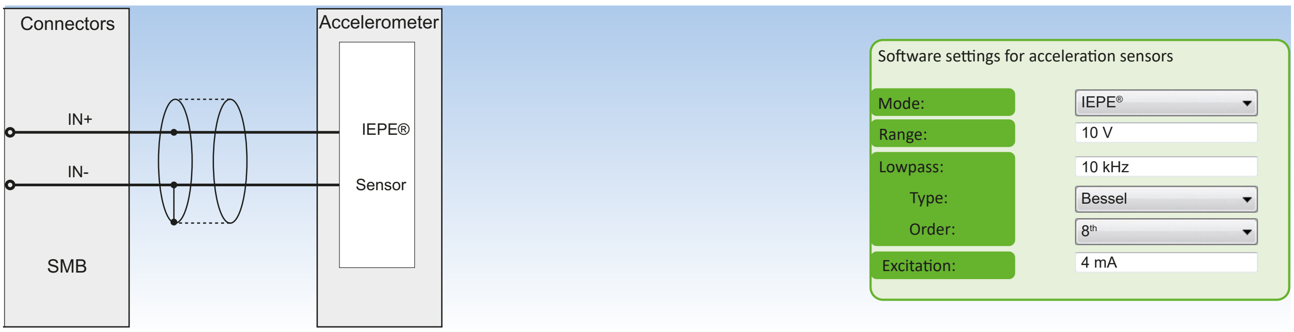
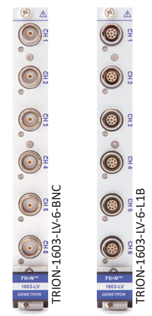



*Fig. 32: IEPE® sensor (TRION-1620-ACC only)*

# TRION-1603-LV

- Isolated input module
- Sampling: 250 kS/s per channel at 16-bit;
- ADC:  Low noise, SAR
- Voltage range: ±5 mV to ±100 V




## Module specifications

| TRION-1603-LV specifications | | | |
|---|---|---|---|
| Input channels | | TRION-1603-LV-6-BNC | 6 channels BNC; voltage input |
| | | TRION-1603-LV-6-L1B | 6 channels LEMO; voltage or current input; TEDS |
| Sampling rate / resolution | | 100 S/s to 250 kS/s | 16-bit |
| Data transfer | | 16-bit | |
| ADC type | | SAR (Successive Approximation Register) | |
| Data rate DMA transfer | | 6 analog channels: max. 3 MB/s | |
| Input ranges | | | |
| – Voltage | | ±5 mV, ±10 mV, ±20 mV, ±50 mV, ±100 mV, ±200 mV, ±500 mV, ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, ±50 V, ±100 V | |
| – Current[1] | | ±10 mA, ±20 mA, ±50 mA, ±100 mA | |
| Accuracy[2] | Voltage | DC to 1kHz | ±0.02 % of reading ± 0.02 % of range ±20 µV |
| | | >1 kHz to 5 kHz | ±0.2 % of reading ± 0.02 % of range ±20 µV |
| | | >5 kHz to 10 kHz | ±1 % of reading ± 0.02 % of range ±20 µV |
| | Current[1] | DC to 1kHz | ±0.1 % of reading ± 0.02 % of range ±10 µA |
| | | >1 kHz to 5 kHz | ±0.2 % of reading ± 0.02 % of range ±10 µA |
| | | >5 kHz to 10 kHz | ±0.5 % of reading ± 0.02 % of range ±10 µA |
| MTBF[3] | | TRION-1603-LV-6-BNC: 292,916 h | |
| Input noise (5 mV range) | | | |
| – 0 to 10 Hz | | 1.5 $\mu V_{PP}$ | |
| – Noise density | | 6.4 $nV/\sqrt{Hz}$ | |
| Input impedance | | 1 MΩ shunted by 18 pF | |
| Input bias current | | <1 nA | |
| Input coupling | | DC | |
| Gain drift | | Typical 10 ppm/°C max. 20 ppm/°C | |
| Offset drift | | Typical 0.3 µV/°C + 10 ppm of range/°C, max 15 µV/°C + 20 ppm of range/°C | |
| Linearity | | Typical 0.01 % | |
| Current input | | Internal 10 Ω shunt; max. 100 mA protected with resettable fuse | |

| Typical signal-to-noise ratio, spurious | 20 mV range | | | 2 V range | | | 100 V range | | |
|---|---|---|---|---|---|---|---|---|---|
| Free SNR, effective number of Bits[4] | SNR | SFDR[5] | ENOB[6] | SNR | SFDR[5] | ENOB[6] | SNR | SFDR[5] | ENOB[6] |
| Sample rate | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] |

*Tab. 16: Module specifications*

| **TRION-1603-LV specifications** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 kS/s | 93 | 120 | 15.2 | 93 | 120 | 15.2 | 93 | 120 | 15.2 |
| 10 kS/s | 90 | 120 | 14.7 | 93 | 120 | 15.2 | 93 | 120 | 15.2 |
| 100 kS/s | 80 | 116 | 13.0 | 93 | 120 | 15.2 | 93 | 120 | 15.2 |
| 250 kS/s | 74 | 100 | 12.0 | 93 | 120 | 15.2 | 93 | 120 | 15.2 |
| Typical THD | -97 dB | | | | | | | | |
| Typical CMR<br>– ≤2 V range<br>– >2 V range | <br>140 dB @ 50 Hz 120 dB @ 1 kHz<br>90 dB @ 50 Hz 60 dB @ 1 kHz | | | | | | | | |
| Low pass filter (-3 dB, digital)<br>– Characteristic<br>– Filter order | 10 Hz, 30 Hz, 100 Hz, 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz, 100 kHz<br>Bessel or Butterworth<br>$2^{nd}$ , $4^{th}$, $6^{th}$, $8^{th}$ | | | | | | | | |
| Analog antialiasing filter | $2^{nd}$ order Bessel, automatically selected | | | | | | | | |
| Bandwidth (-3 dB, deactivated digital filter) | 100 kHz $2^{nd}$ order Bessel filter | | | | | | | | |
| Crosstalk fin 1 kHz [10 kHz] | ≤2 V range: 120 dB [105 dB] | | | | | | | | |
| Channel-to-channel phase mismatch | Typically <10 ns when using the same range; <60 ns for using different ranges | | | | | | | | |
| Board-to-board phase mismatch | <30 ns | | | | | | | | |
| Rated input voltage to earth according to EN 61010-2-30 | 33 $V_{RMS}$, 46.7 $V_{PEAK}$, 70 $V_{DC}$ | | | | | | | | |
| Input configuration<br>– Isolation impedance<br>– Isolation voltage (channel-to-channel and channel-to-chassis) | Isolated<br>Isolation resistance >1 GΩ; Isolation capacitance typically 15 pF<br>1500 $V_{PEAK}$ with TRION-1603-LV-6-BNC<br>800 $V_{PEAK}$ with TRION-1603-LV-6-L1B | | | | | | | | |
| Overvoltage protection | ±300 $V_{DC}$ | | | | | | | | |
| Voltage excitation[1)] | 1 to 28 V @ 1 % ±1 mV accuracy freely programmable (max. 100 mA, max. 1 W) per channel | | | | | | | | |
| ESD protection | IEC61000-4-2: ±8 kV air discharge, ±4 kV contact discharge | | | | | | | | |
| Supported TEDS chips (LEMO only) | All common TEDS chips are supported. | | | | | | | | |
| Power consumption | 6 W w/o sensor supply[1)]; absolute maximum with sensor supply[1)]: 13 W | | | | | | | | |

*Tab. 16: Module specifications*

1) TRION-1603-LV-6-L1B only

2) 1 year accuracy 23 °C ±5 °C

3) Mean time between failure

4) LP Filter in auto mode

5) SFDR excluding harmonics

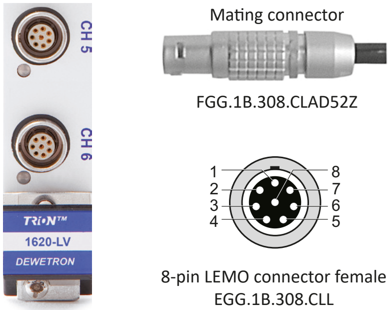
6) ENOB calculated from SNR

# Connection

## TRION-1603-LV-6-BNC module


Hot: IN +
Shield: IN -

## TRION-1603-LV-6-L1B module




1: EXC
2: GND
3: IN+
4: IN-
5: Excitation Sense
6: RESERVED (GND)
7: Current+
8: TEDS
Housing GND

# LED function

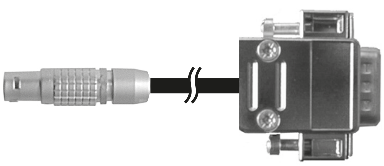
Green: Normal operation

*Tab. 17: LED function*

# Optional accessory

## TRION-CBL-L1B8-D9-0.5-01

High quality adapter cable from LEMO 1B.308 plug to D-SUB-9 socket, 0.5 m, no MSI support.



1: TEDS
2: IN+
3: n.c.
4: GND
5: EXT+
6: n.c.
7: IN-
8: n.c.
9: n.c.

*Fig. 33: TRION-CBL-L1B8-D9-0.5-01*

## TRION-CBL-L1B8-OE-05-00

High quality cable from Lemo 1B.308 plug to open end, 5 m.

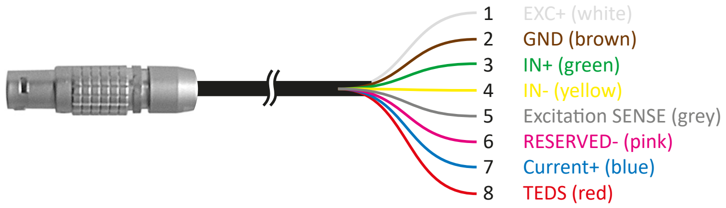



*Fig. 34: TRION-CBL-L1B8-OE-05-00*

## TRION-CBL-L1B8-BNC-0.5-00

High quality cable from Lemo 1B.308 plug to BNC connector, 0.5 m.


*Fig. 35: TRION-CBL-L1B8-BNC-0.5-00*

# Block diagram

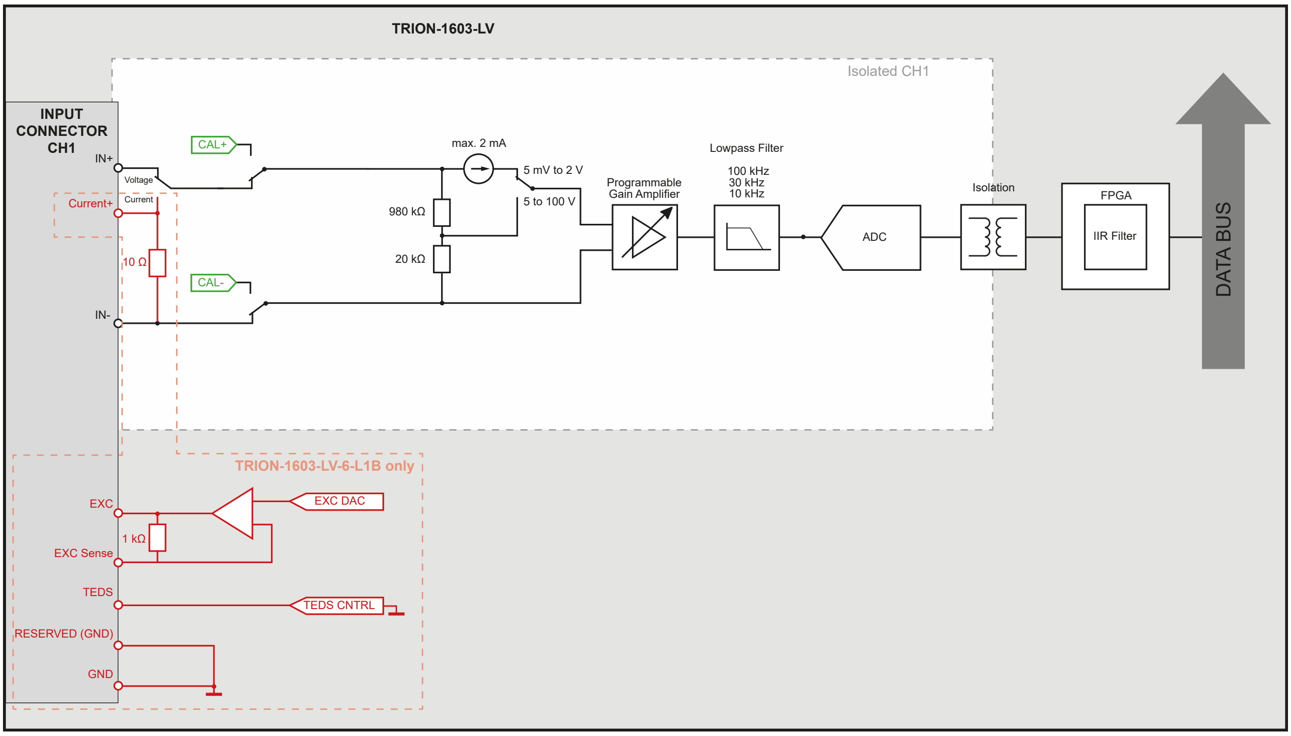



*Fig. 36: Base block diagram of the TRION-1603-LV module*

The TRION-16xx series is a highly accurate, isolated, 16-bit voltage digitizer. Each channel is separately isolated and has its own AD converter. For ranges above 2 V, a temperature compensated resistance divider attenuates the input signal. In lower ranges, the signal is directly routed to the programmable gain amplifier via a current limiting circuit.

This architecture allows measuring voltages from a few µV to 100 V with an excellent signal-to-noise ratio and accuracy. The current limiting circuit can easily withstand 300 $V_{DC}$. So also the 5 mV range will not be damaged when 300 V are applied by accident. After the gain amplifier, the conditioned signal passes a programmable low pass filter before getting to the ADC.

For more details about bandwidth and filtering, refer to chapter Analog to digital conversion..

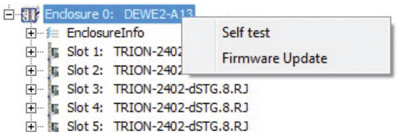
# TRION-16xx series functions

## Short

The short function switches IN+ to IN- via the calibration circuit. It can be used to check the offset stability of the input amplifier.

## Self test

The TRION-16xx series has an integrated special self test circuit. It consist of a programmable high precision voltage source on the first isolated channel and a relay matrix. It is used to check the analog input path of the voltage amplifier by applying 0 V and 90 % of the input range to the input. This test can be performed in the channel setup for the actual range. During the board self test, which is available in the DEWETRON Explorer, this test is performed for all ranges and channels automatically.




By right clicking the board in the DEWETRON Explorer a self test can be carried out.

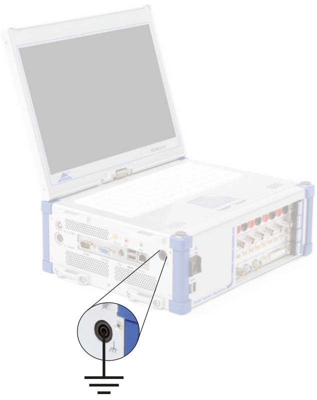
## Isolation

The isolation of the module has many advantages:

- It allows very high common mode voltages even in the 5 mV range. This is especially required for current measurement with shunt technology.
- High input protection.
- DC offset errors because of ground loops are eliminated.
- Eliminating current loops; noise reduction.

## Ground connection

The TRION-16xx series is fully isolated and has high impedance inputs, with very high sensitivity. For achieving the highest signal-to-noise ration it is strongly recommended to connect the DEWE2/3 system to a structural ground potential. This could be for example the chassis of the car or train, in case of vehicle measurements. With that simple method, you can avoid catching noise signals such as the 50/60 Hz interference. Sometimes the power supply cable already provides this connection. If the system runs on battery or with an isolated DC power supply, the operator should take care of the ground connection.



# Signal connection

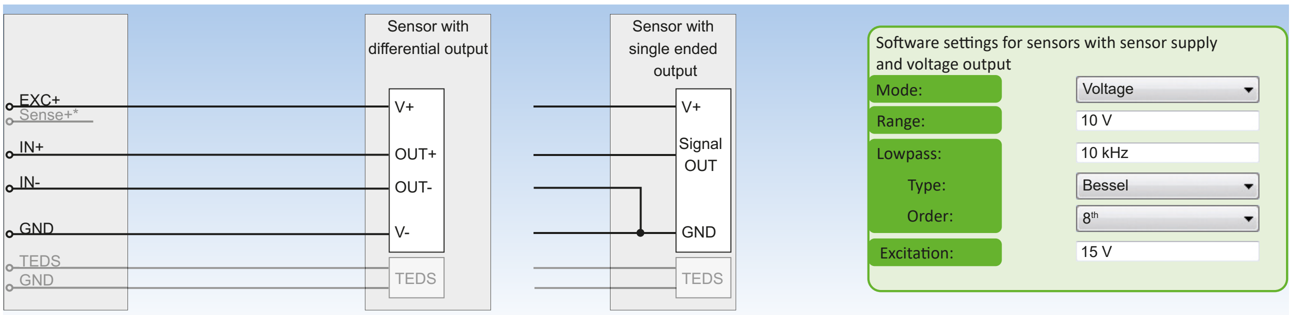
## Voltage

### Voltage measurement

- Isolated sensors
- Battery powered sensors
- Sensors with differential output


*Fig. 37: Voltage measurement*

### Sensors with sensor supply and voltage output




*) Sense as well as TEDS connection is optional.

*Fig. 38: Sensors with sensor supply and voltage output*

## Current

### Current measurement

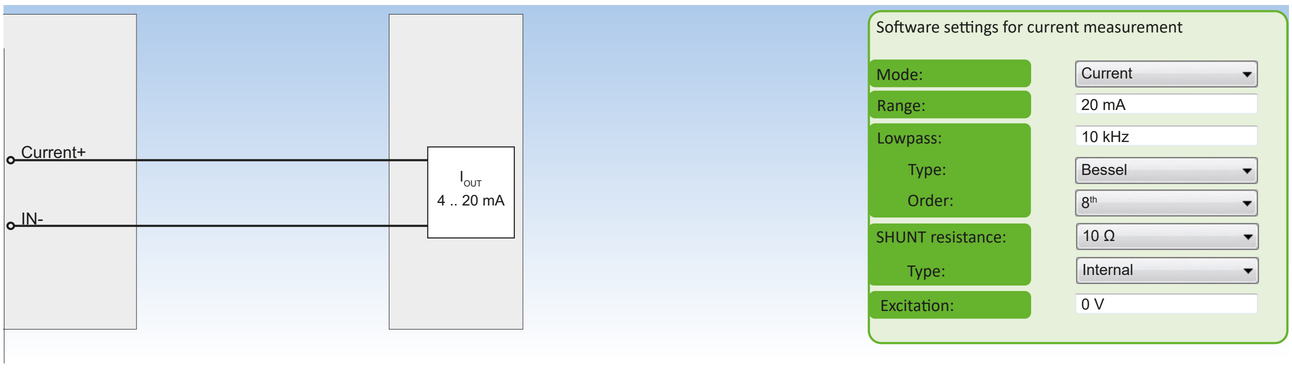



*Fig. 39: Current measurement*

## Sensors with sensor supply and current output


*) Sense connection is optional.

*Fig. 40: Sensors with sensor supply and current output*

## Loop-powered sensors with 4 to 20 mA output

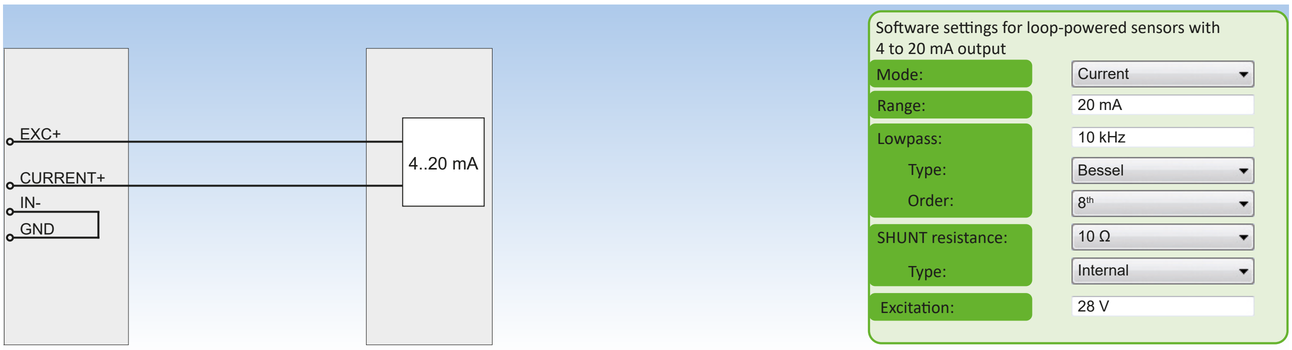
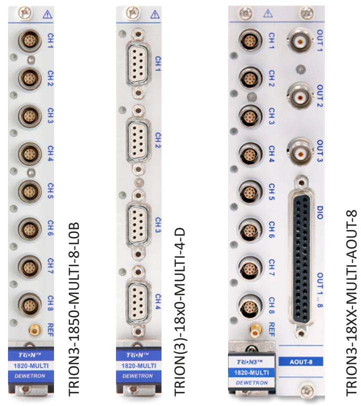



*Fig. 41: Loop-powered sensors with 4 to 20 mA output*

# TRION(3)-18xx-MULTI

- Universal input module
- Sampling: 5 MS/s per channel
- Input types: Voltage, bridge, resistance, RTD, IEPE® current and counter
- Isolated
- CAN: High-speed CAN2.0 port
- Bandwidth: 2 MHz
- TRION3-18xx-MULTI-AOUT-8: Isolated ±5 V, ±10 V or ±30 mA output




## Module specifications

### General specifications

| TRION(3)-18xx-MULTI specifications | | | |
|---|---|---|---|
| | | **Ranges** | **Supported sensors** |
| Input types | Voltage | ±2 mV to ±100 V freely programmable | - |
| | IEPE | ±100 mV to ±10 V freely programmable | IEPE® sensors |
| | Bridge | ±1 to 1000 mV/V | 4-, 5-, 6-wire full bridge<br>3-, 4-, 5-wire ½ bridge<br>2-, 3-, 4-wire ¼ bridge<br>120/350/1000 Ω internal ¼ bridge completion |
| | Resistance | 10 Ω to 30 kΩ | Potentiometer, resistance temperature detection:<br>Pt100, Pt200, Pt300, Pt500, Pt2000 (2-, 3-, 4-wire) |
| | Current | ±30 mA | 4 to 20 mA sensors;<br>loop-powered sensors |
| | MSI | MSI2-CH-x: 500 to 50000 pC<br>MSI2-TH-x: various TC ranges<br>MSI2-LVDT | LVDT, RVDT, charge output and thermocouple sensors |
| Input channels / connectors | TRION-1820-MULTI-4-D | 4 channels D-SUB | CH1 Analog/CAN, CH2 Analog, CH3 Analog/CNT, CH4 Analog/CNT |
| | TRION3-1820-MULTI-8-L0B | 8 channels 0B LEMO | CH1 Analog CAN, CH2 Analog, CH3 Analog, CH4 Analog, CH5 Analog, CH6 Analog, CH7 Analog CNT, CH8 Analog CNT |
| | TRION3-1820-MULTI-4-D | 4 channels D-SUB | CH1 Analog/CAN, CH2 Analog, CH3 Analog/CNT, CH4 Analog/CNT |
| | TRION3-18xx-MULTI-AOUT-8[1)] | 3 channels BNC, 1 D-SUB-37 | CH1 Analog OUT, CH2 Analog OUT, CH3 Analog OUT, Analog out CH1 to CH8 DI1 to 8, DI11 DO1 to 5 |
| | | 8 channels 0B LEMO | CH1 Analog CAN, CH2 Analog, CH3 Analog, CH4 Analog, CH5 Analog, CH6 Analog, CH7 Analog CNT, CH8 Analog CNT |
| | TRION3-1850-MULTI-8-L0B | 8 channels 0B LEMO | CH1 Analog CAN, CH2 Analog, CH3 Analog, CH4 Analog, CH5 Analog, CH6 Analog, CH7 Analog CNT, CH8 Analog CNT |
| | TRION3-1850-MULTI-4-D | 4 channels D-SUB | CH1 Analog/CAN, CH2 Analog, CH3 Analog/CNT, CH4 Analog/CNT |

*Tab. 18: General specifications*

| TRION(3)-18xx-MULTI specifications | | | |
|---|---|---|---|
| Sampling rate / resolution | TRION-1820-MULTI<br>TRION3-1820-MULTI | 100 S/s to 2 MS/s | 24-bit |
| | TRION3-1850-MULTI | 100 S/s to 2 MS/s<br>>2 MS/s to 5 MS/s | 24-bit<br>18-bit |
| Onboard data buffer | | 512 MB | |
| Rated input voltage to earth according to EN 61010-2-30 | | 33 $V_{RMS}$, 46.7 $V_{PEAK}$, 70 $V_{DC}$ | |
| Isolation voltage (channel-to-channel and channel-to-chassis) | | ±350 $V_{DC}$ | |
| REF connector | | SMB connector to apply external calibration signal (LEMO version only) | |
| Input connector | | 9-pin LEMO EPG.0B.309 (TRION3-18xx-MULTI-8-L0B)<br>9-pin D-SUB connector (TRION(3)-18xx-MULTI-4-D) | |
| Environmental specifications | Operating temperature | 0 to +45 °C (32 to 113 °F) | |
| | Storage temperature | -20 to +70 °C (-4 to 158 °F) | |
| | Humidity | 10 to 80 % non cond., 5 to 95 % rel. humidity | |
| MTBF[2] (MIL HDBK 217 F, GB) | TRION3-1820-MULTI-4-D | 196 187 hours | |
| | TRION3-1850-MULTI-8-L0B | 93 843 hours | |
| Power consumption | TRION(3)-1820-MULTI-4-D | Typ. 10 W, max. 14 W | |
| | TRION3-1850-MULTI-8-L0B | Typ. 18 W, max. 25 W | |
| | | Voltage mode, no excitation | 15 W |
| | | IEPE® mode (4 mA / 20 mA) | 15 W / 19 W |
| | | Loop powered sensor (24 V, 20 mA) | 20 W |
| | | 350 Ω full bridge (5 V / 10 V) | 18 W / 21 W |
| | | PT100, PT1000 | 15 W |
| | TRION3-18xx-MULTI-AOUT-8 | Typ. 32 W, max. 50 W | |

*Tab. 18: General specifications*

1) Occupies 2 module slots.

2) Mean time between failures

## Input amplifier

| Input amplifier | | | | |
|---|---|---|---|---|
| Voltage input accuracy [1) 2)] | ≤10 V | DC<br>0.1 Hz to 10 kHz<br>10 kHz to 100 kHz | ±0.02 % of reading ±0.02 % of range ±20 µV<br>±0.02 % of reading ±0.02 % of range ±20 µV<br>±(0.005 % * f) of reading ±0.02 % of range ±20 µV | f: frequency in kHz |
| | >10 V input divider on | DC<br>0.1 Hz to 5 kHz<br>5 kHz to 100 kHz | ±0.02 % of reading ±0.02 % of range<br>±0.02 % of reading ±0.02 % of range<br>±(0.015 % * f) of reading ±0.02 % of range | f: frequency in kHz |
| Amplifier drift | | Gain drift<br>Offset drift | Typical 10 ppm/°C max. 20 ppm/°C<br>Typical 0.3 µV/°C + 10 ppm of range/°C, max 2 µV/°C + 20 ppm of range/°C | |
| Linearity | | | Typical <25 ppm | |
| Current input accuracy[1) 2)] | | | Direct input | 0.1 % of reading ±10 µA |
| | | | Loop-powered sensor | 0.1 % of reading ±30 µA |
| Current input impedance | | | Direct input (IN- to GNDi) | 75 Ω ±25 Ω |
| | | | Loop-powered sensor | 120 Ω ±1 Ω |

*Tab. 19: Input amplifier*

| **Input amplifier** | | | |
|---|---|---|---|
| | | **Differential** | **Input (single-ended)** |
| Input impedance | ≤100 mV range | 20 MΩ or 1 MΩ (prog.) // 35 pF | 10 MΩ or 1 MΩ (prog.) // 130 pF |
| | >100 mV to 10 V range | 200 MΩ or 1 MΩ (prog.) // 35 pF | 100 MΩ or 1 MΩ (prog.) // 120 pF |
| | >10 V to 100 V | 2 MΩ // 20 pF | 1 MΩ // 90 pF |
| Input configuration | | Single-ended or differential (programmable) | |
| Input coupling | | 2nd order Bessel filter: | DC … 100 Hz freely programmable |
| | | 0.15 Hz: | Analog highpass filter |
| | | 0.16…100 Hz: | Digital highpass filter, freely programmable |
| Common mode voltage to $GND_{isolated}$ | 0 to 10 V range | ±10 $V_{DC}$ | |
| | >10 to 100 V range | ±100 $V_{DC}$ | |
| Overvoltage protection | 0 to 10 V range | ±50 $V_{DC}$, 100 $V_{PEAK}$ (1 min) | |
| | >10 to 100 V range | ±200 $V_{DC}$ | |
| Low pass filter (-3 dB, digital) | | 1 Hz to 1.5 MHz freely programmable or OFF | |
| – Characteristic | | Bessel or Butterworth | |
| – Filter order | | 2nd, 4th, 6th, 8th, 10th | |
| – Filter setting AUTO | | 30 % of sample rate with 10th order Bessel | |
| Analog anti-aliasing filter | | 2nd order Bessel, automatically selected | |
| | | 100 kHz, 500 kHz, 2 MHz, (≤1 V range bandwidth is limited to 1.8 MHz) | |
| Typ. channel-to-channel phase mismatch | | <10 ns between channels using the same range | |
| Typ. CMRR | | 135 dB @ 50 Hz; 110 dB @ 1 kHz; 90 dB @ 10 kHz; 90 dB @ 100 kHz | |
| Typical crosstalk | | -134 dB (10 V range; 0 to 100 kHz) | |
| Input noise (100 mV range) | 0 to 10 Hz | 0.3 $\mu V_{PP}$ | |
| | Noise density | 6.9 nV/SQRT(Hz) | |
| Typical THD | 10 V range | -108 dB | for 1 kHz fundamental frequency |
| | 1 V range | -102 dB | |

| Typ. signal to noise ratio; Spurious free SNR; Effective number of Bits[3]; noise $V_{PP}$ | **100 mV range** | | | | **1 V range** | | | | **10 V range** | | | | **100 V range** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SNR | SFDR[4] | ENOB[5] | Noise | SNR | SFDR[4] | ENOB[5] | Noise | SNR | SFDR[4] | ENOB[5] | Noise | SNR | SFDR[4] | ENOB[5] | Noise |
| Sample rate | [dB] | [dB] | [Bit] | [$mV_{PP}$] | [dB] | [dB] | [Bit] | [$mV_{PP}$] | [dB] | [dB] | [Bit] | [$mV_{PP}$] | [dB] | [dB] | [Bit] | [$mV_{PP}$] |
| 1 kS/s | 113.5 | 130 | 18.6 | 0.001 | 112.4 | 135 | 18.4 | 0.010 | 127.2 | 140 | 20.8 | 0.018 | 120.1 | 140 | 19.7 | 0.400 |
| 10 kS/s | 103.0 | 130 | 16.8 | 0.003 | 109.0 | 135 | 17.8 | 0.017 | 119.5 | 140 | 19.6 | 0.055 | 114.7 | 140 | 18.8 | 0.950 |
| 100 kS/s | 94.7 | 130 | 15.4 | 0.011 | 103.9 | 130 | 17.0 | 0.038 | 109.8 | 140 | 17.9 | 0.190 | 106.6 | 140 | 17.4 | 2.700 |
| 200 kS/s | 91.4 | 130 | 14.9 | 0.016 | 101.4 | 130 | 16.6 | 0.051 | 107.4 | 140 | 17.6 | 0.260 | 104.1 | 140 | 17.0 | 3.800 |
| 1000 kS/s | 84.7 | 125 | 13.8 | 0.038 | 95.0 | 130 | 15.5 | 0.116 | 99.8 | 139 | 16.3 | 0.650 | 97.7 | 135 | 15.9 | 8.300 |
| 2000 kS/s | 81.4 | 120 | 13.2 | 0.058 | 91.0 | 128 | 14.8 | 0.170 | 95.4 | 132 | 15.6 | 1.100 | 94.1 | 132 | 15.3 | 14.000 |
| 5000 kS/s | 78.7 | 110 | 12.8 | 0.080 | 88.7 | 125 | 14.4 | 0.270 | 93.1 | 130 | 15.2 | 1.600 | 91.4 | 130 | 14.9 | 19.000 |
| Filter = OFF | 76.2 | 105 | 12.4 | 0.110 | 86.5 | 120 | 14.1 | 0.330 | 90.5 | 130 | 14.7 | 2.000 | 89.0 | 130 | 14.5 | 23.000 |

*Tab. 19: Input amplifier*

1) 1 year accuracy 23 °C ±5 °C.

2) Add 0.02 % of reading with filter settings OFF.

3) LP Filter in auto mode.

4) SFDR excluding harmonics.

5) ENOB calculated from SNR.

## Excitation

| Excitation | | | |
|---|---|---|---|
| Excitation voltage | 0 to 24 $V_{DC}$; freely programmable separately for each channel, 1 mV resolution, balanced around GNDi, remote sense support | | |
| | 1 year accuracy (23 °C ±5 °C) | ±0.03 % ±1.5 mV | |
| | Drift | ±10 ppm/°C ±50 µV/°C | |
| | Current limit | 0.1 to 5 V: | 100 mA |
| | | >5 V to <24 V: | limited to 0.6 W |
| | | 24 V: | limited to 1 W; >0.6 W accuracy: ±5 % |
| | Protection | Continuous short | |
| | Load and line regulation error | ±0.002 % with sense line connected | |
| | Voltage regulation reserve | 0.1 to 10 V: | >2 V |
| | | >10 to 24 V: | >1 V |
| Excitation current | 0.1 to 60 mADC (programmable, 16-bit DAC) 1 µA; balanced around GNDi | | |
| | 1 year accuracy (23 °C ±5 °C) | 0.1 to 5 mA: | 0.05 % ±2 µA |
| | | >5 to 60 mA: | 0.5 % ±5 µA |
| | Drift | 15 ppm/°C | |
| | Compliance voltage | 0.1 to 20 mA | 24 V |
| | | >20 mA | 10 V |
| | Output impedance | >10 MΩ | |
| | Load regulation bandwidth | 100 kHz | |
| IEPE® excitation | | 2 to 20 mA; 10 %; >21 V compliance voltage | |

*Tab. 20: Excitation*

## Bridge functions

| Bridge functions | | | |
|---|---|---|---|
| Supported bridge types | Full bridge | 4-, 5- or 6-wire full bridge | |
| | | 4-wire full bridge with constant current excitation (piezoresistive bridge sensors), potentiometer | |
| | Half bridge | 3-, 4- or 5-wire ½ bridge with internal completion (software programm-able) | |
| | Quarter bridge | 2-, 3- or 4-wire ¼ bridge with internal completion resistor for 120 Ω, 350 Ω and 1000 Ω (software programmable) | |
| | | 2-wire ¼ with constant current excitation for dynamic measurement (AC coupled) | |
| Internal quarter bridge completion | | 120 Ω, 350 Ω, 1000 Ω | ±0.05 % |
| Bridge resistance | 80 Ω to 10 kΩ @ ≤ 5 $V_{DC}$ excitation | | the lower limit is caused by the maximum power supply |
| Bridge excitation volage | Max. 10 V | | |
| Shunt calibration | 4000 steps programmable shunt; shunt target can be programmed in mV/V or in Engineering Unit (programming in Engineering Unit requires OXYGEN R7.4 or higher) | | |
| Completion resistor accuracy | 0.05 % ±15 ppm/K | | |
| Automatic bridge balance | ±400 % of range | | |
| Bridge features | Bridge balance, line-resistance compensation | | |

*Tab. 21: Bridge functions*

## CAN functions

| CAN functions | |
|---|---|
| CAN specification | CAN 2.0 |
| CAN physical layer | High-speed |
| CAN termination | Programmable: high impedance or 120 Ω |
| Bus pin fault protection | ±36 $V_{DC}$ |

*Tab. 22: CAN functions*

## Counter functions

| Counter functions | |
|---|---|
| Counter | 2x counter channels linked to the last two analog channels; trigger level is adjustable within the input range |
| Counter modes*) | Simple event counting, period measurement, pulse width measurement, frequency, duty cycle |
| Timebase / resolution | 5 MHz (200 ns) |
| Filter | 0.1 µs to 100 µs |

*Tab. 23: Counter functions*

*) The available counter functions depend on the application software used and may differ from this list.

## AOUT functions

<table>
<tr><th colspan="4">AOUT functions[1]</th></tr>
<tr><td colspan="2">Analog outputs</td><td colspan="2">8 isolated channels, independently programmable</td></tr>
<tr><td colspan="2">Output range</td><td colspan="2">±5 V, 0 to 5 V, ±10 V, 0 to 10 V, ±30 mA; 0 to 30 mA</td></tr>
<tr><td colspan="2">Load current</td><td colspan="2">±30 mA max.</td></tr>
<tr><td rowspan="12">Modes[2]</td><td>Constant output</td><td colspan="2">-10 to +10 V or -30 to +30 mA</td></tr>
<tr><td rowspan="7">Function generator</td><td>Waveform</td><td>Sine, square, triangle, custom</td></tr>
<tr><td>Frequency</td><td>0.001 Hz to 1 MHz</td></tr>
<tr><td>Amplitude</td><td>0–10 $V_{PEAK}$ or 0–30 $mA_{PEAK}$</td></tr>
<tr><td>Offset</td><td>-10 to 10 V or -30 to 30 mA</td></tr>
<tr><td>Phase</td><td>-180 to 180°</td></tr>
<tr><td>Symmetry (triangle)/ dutycycle (square)</td><td>0.01 to 100 %</td></tr>
<tr><td>Custom waveforms</td><td>Up to 4 custom waveforms<br>Max. 16384 samples per waveform</td></tr>
<tr><td rowspan="2">Stream output</td><td>Output signal</td><td>-10 to +10 V or -30 to +30 mA</td></tr>
<tr><td colspan="2">Optional factor and offset</td></tr>
<tr><td>Math output</td><td colspan="2">A*B; A+B; A-B</td></tr>
<tr><td>Monitor output</td><td colspan="2">Direct conditioned signal output: -10 to +10 V or -30 to +30 mA</td></tr>
<tr><td colspan="2">Function generator</td><td colspan="2">Sine, triangular, square or custom waveforms</td></tr>
<tr><td colspan="2">Analog output accuracy</td><td colspan="2">See *Tab. 25*.</td></tr>
<tr><td colspan="2">Temperature drift</td><td colspan="2">±25 ppm/K</td></tr>
<tr><td colspan="2">Linearity</td><td colspan="2"><100 ppm</td></tr>
<tr><td colspan="2">Output impedance</td><td colspan="2"><1 Ω at D- SUB connector, 50 Ω at BNC</td></tr>
<tr><td colspan="2">Output protection</td><td colspan="2">Continuous short to ground</td></tr>
</table>

*Tab. 24: AOUT functions*

| **AOUT functions**[1] | | |
|---|---|---|
| DAC mode | **High-speed mode** | **High-resolution mode** |
| Update rate | 2.5 MS/s | 500 kS/s |
| DAC resolution | 16-bit | 32 bit |
| Bandwidth | 600 kHz, $4^{th}$ order Bessel characteristic | 70 kHz, $6^{th}$ order Bessel characteristic |
| Latency | <5µs | <100 µs |
| LSB | 305 µV | 1 µV |
| Linearity | 50 ppm | 10 ppm |
| THD | 90 dB | 100 dB |
| Noise floor | 100 dB | 115 dB |
| Output noise static | 2 mV$_{PP}$ / 0.3 mV$_{RMS}$ | 2 mV$_{PP}$ / 0.3 mV$_{RMS}$ |
| Output noise on 1 kHz signal | 11 mV$_{PP}$ / 0.7 mV$_{RMS}$ | 3 mV$_{PP}$ / 0.3 mV$_{RMS}$ |
| Rise/fall time | 400 ns | 4 µs |
| Latency (filter=off) | 4 µs | 15 µs |
| Input to output Jitter | 400 ns | 3.5 µs |
| Number of DIO | 6 DI + 3 DI (isolated) + 4 DO + 1 DO (isolated) | |
| Non isolated digital I/O | | |
| – Compatibility (input) | CMOS/TTL, 100 kΩ pullup | |
| – Compatibility (output) | TTL, 20 mA | |
| – Overvoltage protection | ±30 V$_{DC}$, 50 V$_{PEAK}$ (100 ms) | |
| Isolated digital input | | |
| – Compatibility (input) | CMOS Low: <1.5 V | High: >3.2 V |
| – Overvoltage protection | ±35 V$_{DC}$, 65 V$_{PEAK}$ (100 ms) | |
| – Bandwidth | 50 kHz | |
| – Pulse width distortion | 2.3 µs | |
| – Input high current @ 5V UIN | <3 mA | |
| – Input high current @ 35V UIN | <5 mA | |
| Isolated digital output | | |
| – Compatibility (output) | Open collector | |
| – Max. collector voltage | ±30 V$_{DC}$ | |
| – Collector current | 5 mA | |
| Connector | D-SUB-37 socket for all 8 channels, additionally 3x BNC sockets for CH1 to CH3 | |
| BNC connector | Analog out | AO1, AO2, AO3 |
| D-SUB-37 connector | Analog out | AO1 to AO8 |
| | Digital in | DI3 to DI8 |
| | Digital in (isolated) | DI1, DI2, DI11 |
| | Digital out | DO1 to DO4 |
| | Digital out (isolated) | DO5 |
| Auxiliary power supply | +5 V, 20 mA | |

*Tab. 24: AOUT functions*

1) TRION3-18x0-MULTI-AOUT-8 only

2) Analog output channels can be assigned variably (e.g. AO1 = CH4; AO2 = CH2 + CH7)

| Output 1 year accuracy (23 °C ±5 °C) | | | | | |
|---|---|---|---|---|---|
| | | High-speed mode | | High-resolution mode | |
| Voltage output (+10 V; 0 to 10 V; ±5 V; 0 to 5 V) | DC | ±0.02 % of reading | ±1 mV | ±0.02 % of reading | ±1 mV |
| | 0.1 to 1 kHz | ±0.02 % of reading | ±1 mV | ±0.02 % of reading | ±1 mV |
| | 0.1 to 10 kHz | ±0.02 % of reading | ±1 mV | - | |
| | 10 to 100 kHz | ±(0.015 % * f) of reading | ±1 mV | - | |
| Current output (±30 mA; 0 to 30 mA) | DC | ±0.03 % of reading | ±3 µA | ±0.02 % of reading | ±3 µA |
| | 0.1 to 1 kHz | ±0.3 % of reading | ±3 µA | ±0.3 % of reading | ±3 µA |
| | 0.1 to 10 kHz | ±0.3 % of reading | ±3 µA | - | |
| | 10 to 100 kHz | ±(0.03 % * f)[1] of reading | ±3 µA | - | |

*Tab. 25: Output accuracy*

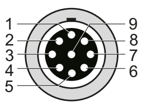
[1] f: frequency in kHz

# TRION3-18xx-MULTI-8-LOB module

## Connection


Mating connector

FGG.0B.309.CLADxx



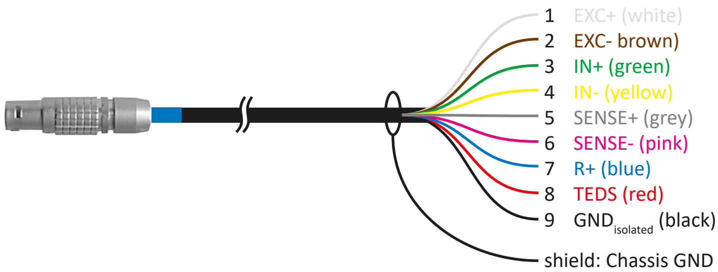

9-pin LEMO connector female
EPG.0B.309.HLN

1: EXC+ (CAN power supply 12 V, CH1 only)
2: EXC-
3: IN+
4: IN-
5: SENSE+ (CAN high, CH1 only)
6: SENSE- (CAN low, CH1 only)
7: R+
8: TEDS
9: $GND_{isolated}$ (CAN GND, CH1 only)
Housing connected to Chassis GND

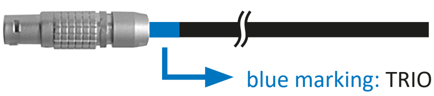
## Optional accessory

### TRION-CBL-L0B9-OE-xx-02

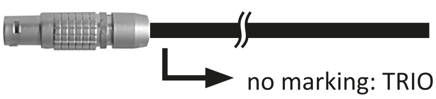
High quality cable from Lemo 0B.309 plug to open end, 1 or 5 m.




purple: not connected
blue/red: not connected
pink/grey: not connected



blue marking: TRION-CBL-L0B9-OE-xx-**02** -> **TRION(3)-18xx-MULTI and TRION-2402-MULTI series**
(Cable optimized for TRION(3)-18xx-MULTI series)



no marking: TRION-CBL-L0B9-OE-xx-**00** -> **TRION-2402-MULTI series only!**

**INFORMATION**

Using the preconfigured LEMO connector with cable is highly recommended because manually soldering the 0B LEMO connector is tricky. The wire colors are also mentioned in the signal connection section to simplify sensor connection.

**INFORMATION**

Note that the LEMO open end pinning and the D-SUB-9 pinning differ. See *Signal connection on page 68 and ff.* for the correct pinning.

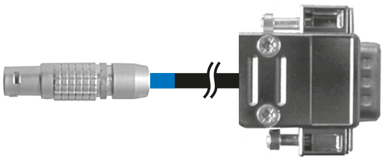
### TRION-CBL-L0B9-IEPE-0.5-01

IEPE Sensor adapter for TRION3-18xx-MULTI-8-L0B. It features TEDS sensors support and sensor status LED (lit green if IEPE sensor is connected). For connecting voltage signals and IEPE® sensors to TRION3-18xx-MULTI-8-L0B modules.

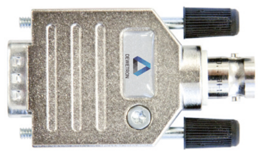
***INFORMATION*** It is not possible to measure voltage.

### TRION-CBL-L0B9-D9-0.5-02

High quality adapter cable from Lemo 0B.309 plug to D-SUB-9 socket, 0.5 m



1: EXC+
2: IN+
3: SENSE-
4: $GND_{isolated}$
5: R+
6: SENSE+
7: IN-
8: EXC-
9: TEDS
H: Housing connected to chassis GND



For connecting any MSI-BR and MSI2 series adapters

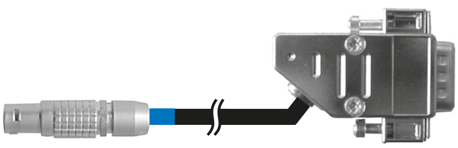
### TRION-CBL-L0B9-BNC-0.5-03

High quality adapter cable from LEMO 0B.309 plug to BNC cable jack, 0.5 m.

Hot: IN +
Shield: IN -

### TRION-CBL-L0B9-CAN-0.5

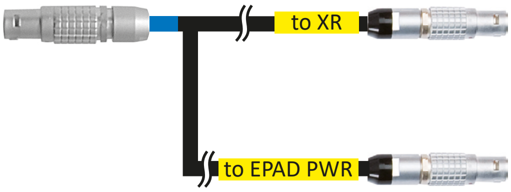
Adapter cable from LEMO 0B.309 plug to D-SUB-9 plug for CAN, 0.5 m. For TRION3-18xx-MULTI-8-L0B modules channel 1 only.



1: NC
2: CAN Low (isolated)
3: GND CAN (isolated)
4: NC
5: NC
6: GND Power
7: CAN High (isolated)
8: NC
9: CAN power supply +12 V

### TRION-CBL-L0B9-CPAD-01-01

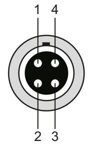
1 m adapter cable to supply several XR modules via an EPAD connector and to communicate via the TRION(3)-18xx-MULTI CAN interface




Pin assignment to XR series module
1: CAN high
2: CAN low
3: +12 V
4: GND

Additional power supply (e.g. to EPAD connector of instrument)
1: n.c.
2: n.c.
3: +12 V
4: GND

For connecting XR series module



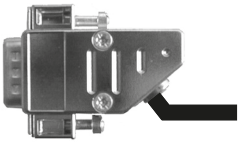

4-pin LEMO connector male
FGG.1B.304.CLL

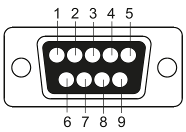
**INFORMATION**

XR modules require slightly more power than the preceding CPAD2 series as they support a higher sampling rate. Therefore, a module of the XR series can no longer be supplied directly via a single TRION(3)-18xx-MULTI channel.

## TRION(3)-18xx-MULTI-4-D module

### Connection



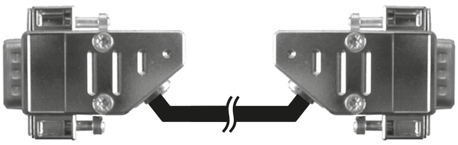

9-pin D-SUB connector male

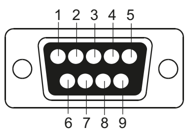
1: EXC+ (CAN power supply 12 V, CH1 only)
2: IN+
3: Sense- (CAN low, CH1 only)
4: $GND_{isolated}$ (CAN GND, CH1 only)
5: R+
6: Sense+ (CAN high, CH1 only)
7: IN-
8: EXC-
9: TEDS
Housing connected to chassis GND

### Optional accessory

#### TRION-CBL-D9-CAN-0.5

Adapter cable from D-SUB-9 plug to D-SUB-9 plug for CAN, 0.5 m. For TRION(3)-18xx-MULTI-4-D modules.





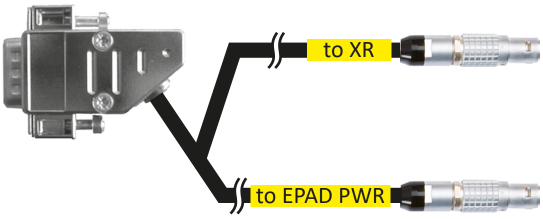

9-pin D-SUB connector male

1: NC
2: CAN Low (isolated)
3: GNDx CAN (isolated)
4: NC
5: NC
6: GND Power
7: CAN High (isolated)
8: NC
9: +12 V out

### TRION-CBL-D9-CPAD-01-01

Adapter cable from LEMO 0B.309 plug to XR series modules, 1 m. Additional LEMO FGG.1B.304 plug (EPAD) for XR module power supply.

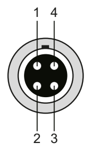
For connecting the first XR series module of a module-chain to a TRION3-18xx-MULTI-8-L0B.




Pin assignment to XR series module
1: CAN high
2: CAN low
3: +12 V
4: GND

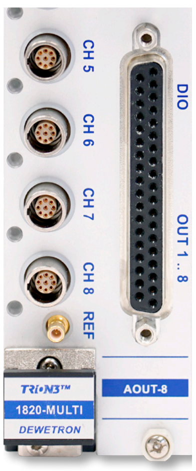
Additional power supply (e.g. to EPAD connector of instrument)
1: n.c.
2: n.c.
3: +12 V
4: GND

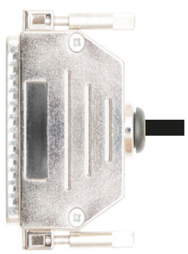
For connecting more than one XR series module




4-pin LEMO connector male
FGG.1B.304.CLL

## TRION3-18xx-MULTI-AOUT-8



| | |
|---|---|
| 1: + Digital Input DI11 (isolated) | 20: - Digital Input DI11 (isolated) |
| 2: GND | 21: +5 V, max. 20 mA |
| 3: + Analog Output AO1 (isolated) | 22: - Analog Output AO1 (isolated) |
| 4: + Analog Output AO2 (isolated) | 23: - Analog Output AO2 (isolated) |
| 5: + Analog Output AO3 (isolated) | 24: - Analog Output AO3 (isolated) |
| 6: + Analog Output AO4 (isolated) | 25: - Analog Output AO4 (isolated) |
| 7: + Analog Output AO5 (isolated) | 26: - Analog Output AO5 (isolated) |
| 8: + Analog Output AO6 (isolated) | 27: - Analog Output AO6 (isolated) |
| 9: + Analog Output AO7 (isolated) | 28: - Analog Output AO7 (isolated) |
| 10: + Analog Output AO8 (isolated) | 29: - Analog Output AO8 (isolated) |
| 11: + Digital Input DI1 (isolated) | 30: - Digital Input DI1 (isolated) |
| 12: + Digital Input DI2 (isolated) | 31: - Digital Input DI2 (isolated) |
| 13: Digital Input DI3 | 32: Digital Input DI4 |
| 14: Digital Input DI5 | 33: Digital Input DI6 |
| 15: Digital Input DI7 | 34: Digital Input DI8 |
| 16: GND | 35: Digital Output DO4 |
| 17: Digital output DO3 | 36: Digital Output DO2 |
| 18: Digital output DO1 | 37: + Digital Output DO5 (isolated) |
| 19: - Digital output DO5 (isolated) | |

## LED function

Green: Normal operation

Orange: Channel ID function. Typically active during channel setup or CAN mode active

Red: Error

*Fig. 42: LED function*

## Digital block diagram

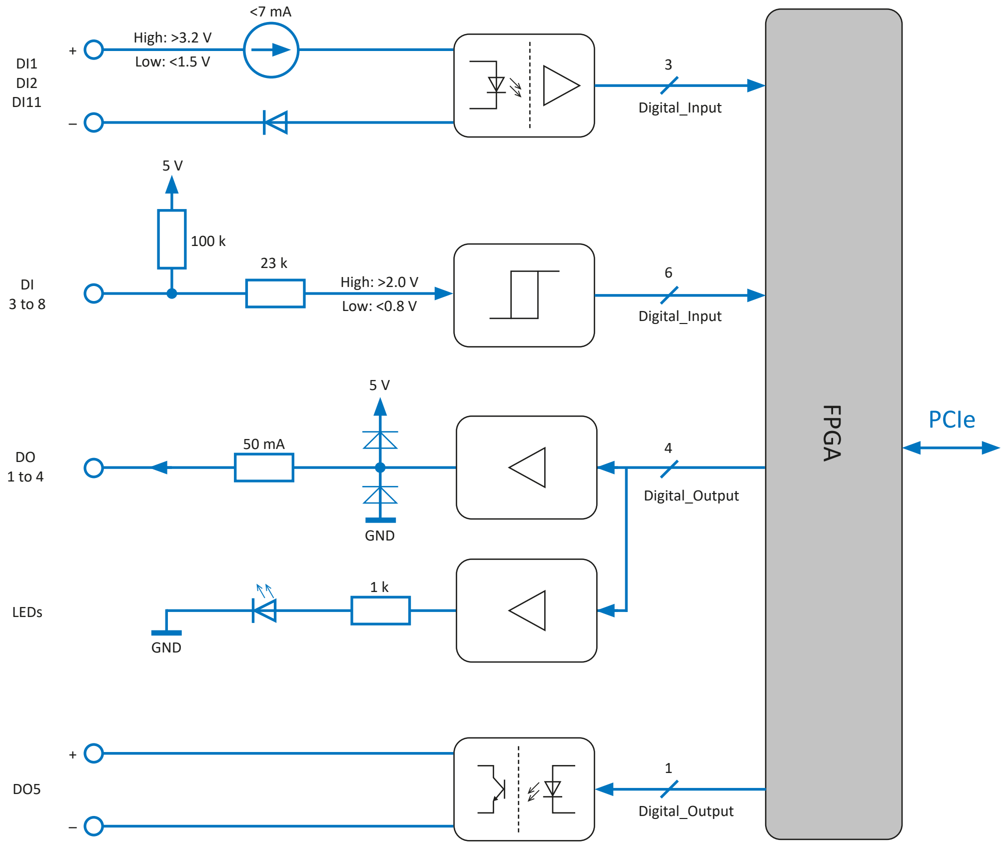



*Fig. 43: Digital block diagram*

# Block diagrams

## Analog block diagram

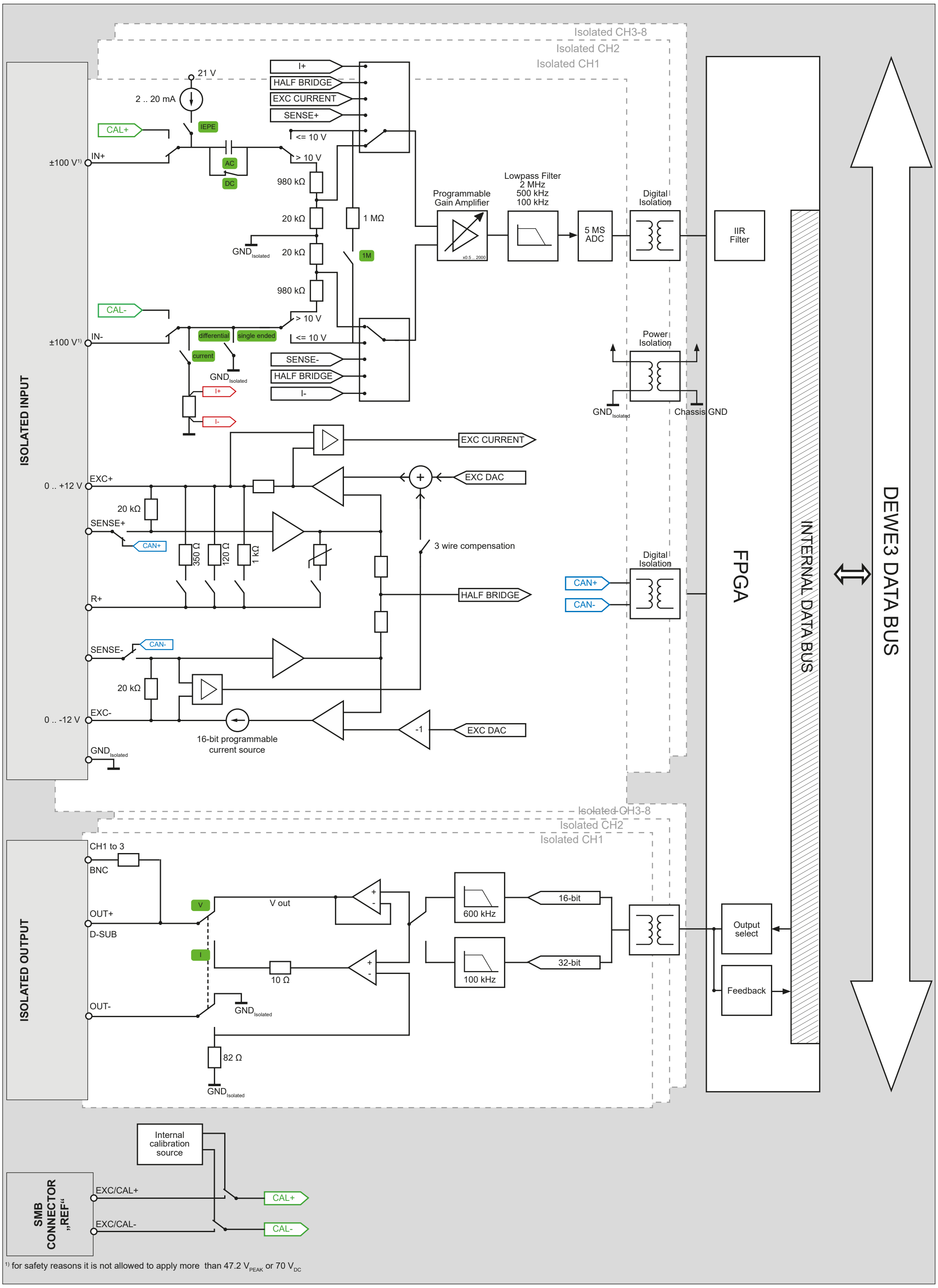



*Fig. 44: Analog block diagram*

# Signal path TRION3-18xx-MULTI-AOUT-8

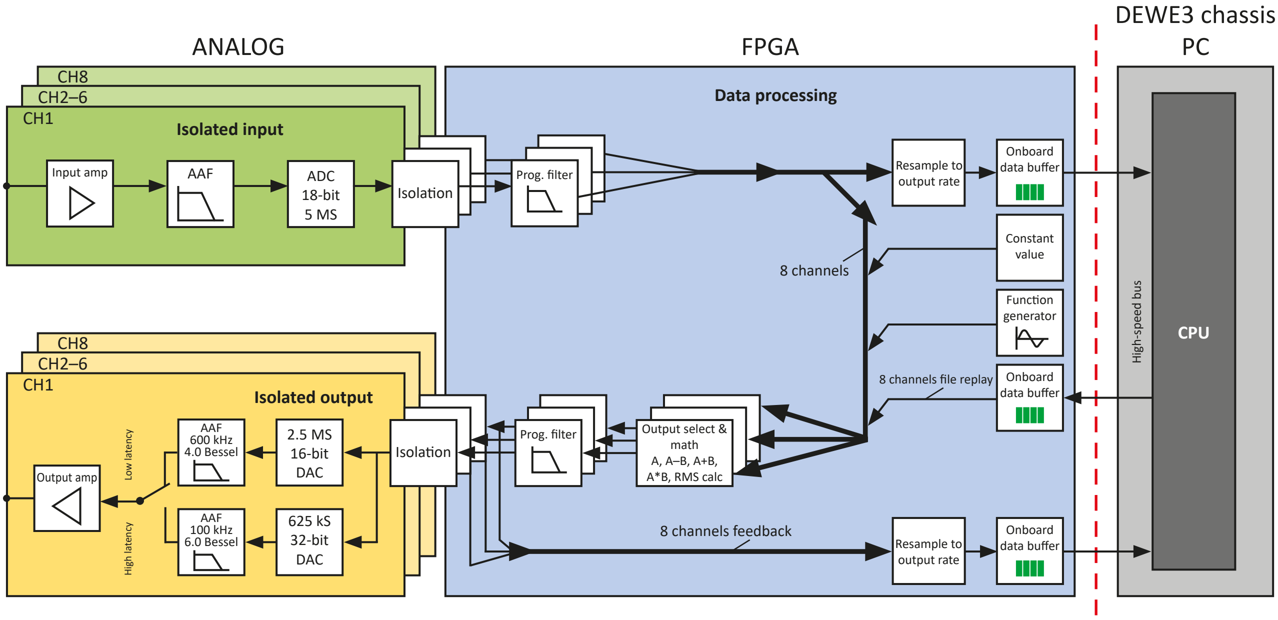



*Fig. 45: Simplified signal path*

# TRION(3)-18xx-MULTI function overview

## Isolated inputs

The TRION(3)-18xx-MULTI is fully isolated. That means every channel has a separate isolated excitation voltage and input amplifier. The main advantages of that configuration are:

- Very high common mode voltages of ±350 V
- Overcurrent protection e.g. if the isolation of a strain gauge on a 110 V power line fails
- Ground loops are eliminated
- Noise reduction
- Isolated outputs

## Freely variable gain and excitation

Amplifier parameters such as gain, excitation voltage, excitation current and sensor offset can be varied for every channel individually. This allows to perfectly match each input channel to the sensor/signal.

## Sensor balance

Normally every strain gauge sensor has a certain offset caused by manufacturer tolerances and sensor mounting. The *sensor balance* function removes that offset automatically up to 400 % of the selected input range.

## Internal shunt calibration

The purpose of this function is to check Quarter Bridge, Half Bridge or Full Bridge wiring and determining the sensitivity loss due to cable resistance. By applying a known resistor to the internal completion resistor, a known bridge unbalance can be simulated. In case of ideal wiring the measured unbalance will correlate exactly with the simulated unbalance. But in reality, cable resistance will decrease the measured value. By using the ratio between expected and measured unbalance this effect could be compensated.

The TRION(3)-18xx-MULTI supports a programmable shunt. The user can directly enter the "mV/V" within certain limits. The module calculates the appropriate resistor and applies it on demand. Sensor failures during test could easily be checked with this function. Simply compare the Shunt Cal result before and after the test run.

## Quarter bridge features

### Completion resistors

The TRION-18xx-MULTI supports 3 different quarter bridge completions: 120 Ω, 350 Ω and 1000 Ω.

### Compensate cable resistance

The TRION(3)-18xx-MULTI series uses an even more accurate way to determine the cable resistance than using the shunt. The internal routing matrix allows directly measuring the line resistance between R+ and the strain gauge. A gain correction factor is calculated afterwards and automatically applied. This function is only available when bridge scaling is active.

### 4-wire quarter bridge

To fully compensate any cable related effects the module also supports 4 wire technology.

**EXAMPLE** temperature drift
Copper has a temperature drift of 0.4 %/°C. This is especially a problem at quarter bridges, because also the offset changes with the wire resistance. The following table shows the difference between the 3 wiring methods for a 120 Ω strain gauge with a 50 m cable at 0.25 mm² diameter.

| | **Initial error** | | **Drift because of 10 °C warm-up** | |
|---|---|---|---|---|
| | Offset | Sensitivity | Offset | Sensitivity |
| 2-wire | 25 183 µm/m | -4.97 % | 956 µm/m | -0.18 % |
| 3-wire | 0 µm/m | -2.6 % | 0 µm/m | -0.01 % |
| 4-wire | 0 µm/m | -0.0 % | 0 µm/m | -0.00 % |

*Tab. 26: Temperature drift*

## External calibration (REF input)

The signal provided to the REF input can be routed to any input channel individually or in parallel using the TRION modules internal relay matrix. It provides the end-user with the capability to send a known calibrated reference signal to the analog inputs without having to disconnect any attached sensors; allowing for a seamless function check of the analog inputs prior to performing a measurement.
The REF input type is accessible in OXYGEN via the “ExtRef” setting in Voltage mode.

## Counter

The module supports two counter input channels. Both can be routed to the last two analog inputs. The trigger and retrigger level could be programmed within 0 to 100 % of the actual analog input range. Frequency measurement and event counting is supported. Supported counter functions are:*)

- Simple event counting
- Period measurement
- Pulse width measurement
- Frequency
- Duty cycle

*) The available counter functions depend on the application software used and may differ from this list.

**INFORMATION**

It is not possible to change the analog input settings out of the counter dialog. This has to be done in the channel setup of the analog input.

### CAN

The first channel of the TRION(3)-18xx-MULTI also has a CAN bus interface. Any CAN2.0B compatible device or bus can be connected. In CAN mode, the analog input function of the channel is deactivated. Sensor excitation is switched to ±12 V. For further information, refer to *Fig. 69* in the TRION(3) series modules technical reference manual.

One single CPAD series module can be directly connected to that channel. If more modules are required an additional power supply is needed.

### TEDS

Transducer Electronic Data sheet. The TEDS interface is used to identify MSI series adapters.

## DEWETRON Explorer SELF TEST functions

The self test function is designed to verify all features of the board. It also includes a complex analog accuracy check.

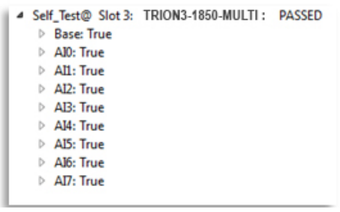



*Fig. 46: Accuracy check*

### Test results

#### Base section

Here, the test results of all I²C devices, the PLL, EE-Prom and the SDRAM are displayed. This test checks the infrastructure of the board. If it passes, also the PCI bus is working fine. If anything in this section fails, the board is defective and has to be repaired.

#### AI0 to AI7 Analog test section

- Input range

  These are the test results of the analog channels. For every channel and every range, an appropriate test voltage is applied by using the internal calibration source. If the measured voltage is within certain limits, this test passes. The detailed test results can be found by opening the tree structure in the result screen. By comparing the current measurement with the allowed limit, it can be categorized. If the measured result is slightly out of the limit a gain adjustment and auto zero will fix the problem. If the error is more than two or three times out of the limits, servicing the board should be considered.

- Excitation voltage

  At this test 1 V and 5 V is applied to the excitation terminals. By reading back the excitation with the input amplifier, it is checked if the excitation circuit is working correctly. It is recommened that the test is only performed when nothing is connected to the TRION(3)-18xx-MULTI measurement board.

**INFORMATION**

This test applies voltage to the sensor terminals. If the cabling or sensor short circuits the excitation for some reason, this test would fail even if the TRION(3)-18xx-MULTI is working correctly. Check if the connected sensors allow this test.

If the test fails, the sensors must always be disconnected and the test repeated. This is the only way to rule out the possibility of the error being caused by external influences.

### Auto zero

The "Auto Zero" or "Amplifier Balance" function eliminates automatically all internal amplifier offsets. It switches the differential amplifier inputs IN+ and IN- to the internal GND reference point. Consequently the offset of the module is adjusted to zero for all ranges. This function can take up to 4 seconds. It allows compensating the long term zero drift, as well as temperature drifts of the amplifier. The determined offset correction values are stored in the user memory section of the EE-Prom.

### Gain cal

The "Gain cal" function is an adjustment function. It applies the internal calibration source to all channels. The measured error is used as a calibration factor for correcting the measurements. These correction factors are stored in the user memory section of the EE-Prom.

### Three wire offset

This function is not supported by the TRION(3)-18xx-MULTI series.

### Reset default

All correction values stored in the user memory will be cleared.

### Save/save all

Stores the test result in an .XML File on the HDD.

## Signal connection

The following schematics will give you an overview on how to connect all the different sensors to the TRION(3)-18xx-MULTI module. To make things easier, the example below will introduce you on how to read the schematics.

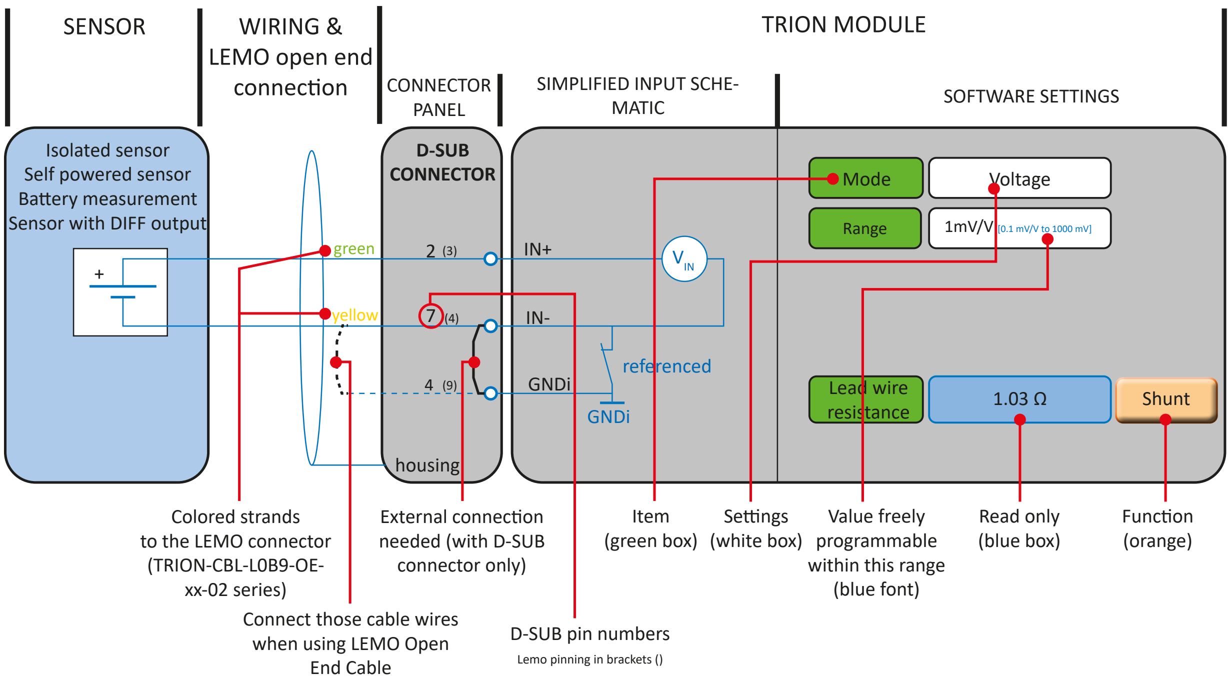
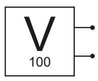



*Fig. 47: Reading schematics*




## Voltage

### Voltage measurement

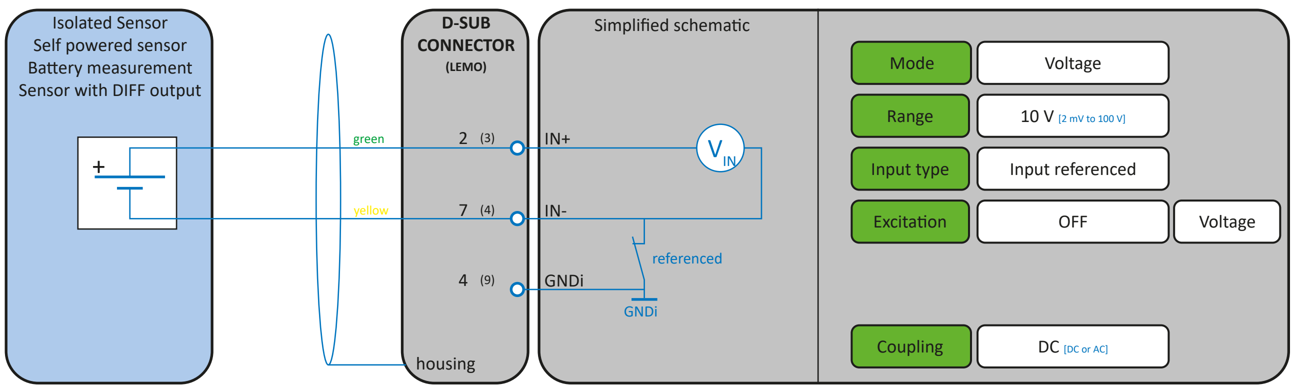



*Fig. 48: Voltage measurement*

### Differential output sensor powered by the TRION module

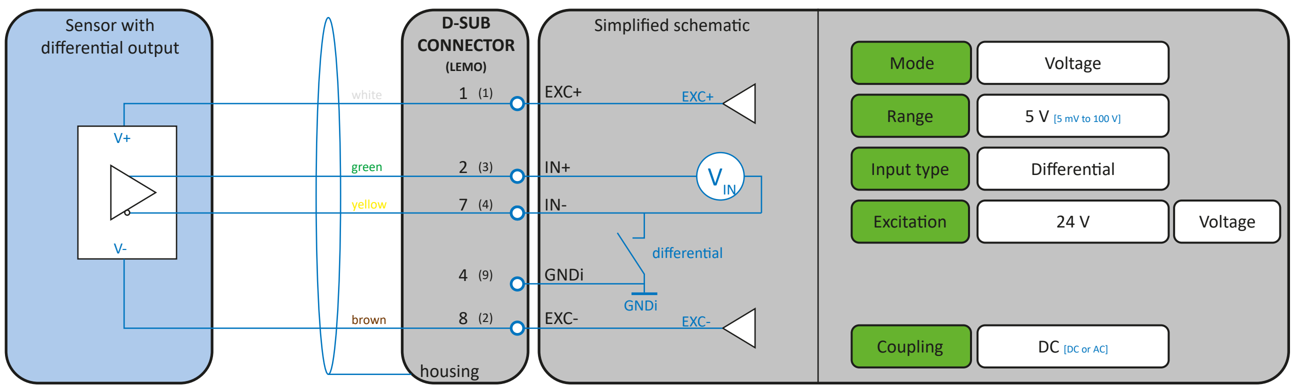



*Fig. 49: Differential output sensor powered by the TRION module*

### Single-ended sensor powered by the TRION module

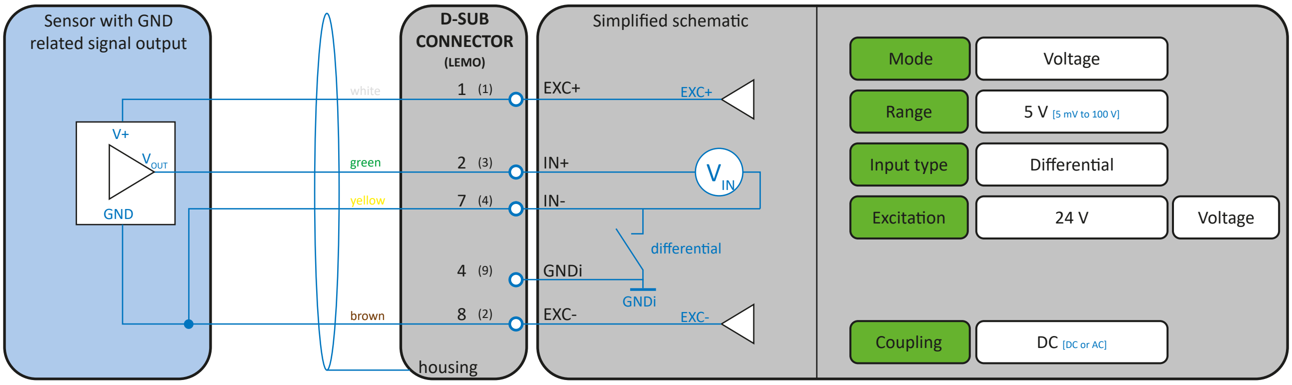



*Fig. 50: Single-ended sensor powered by the TRION module*

### Current transducer with voltage output

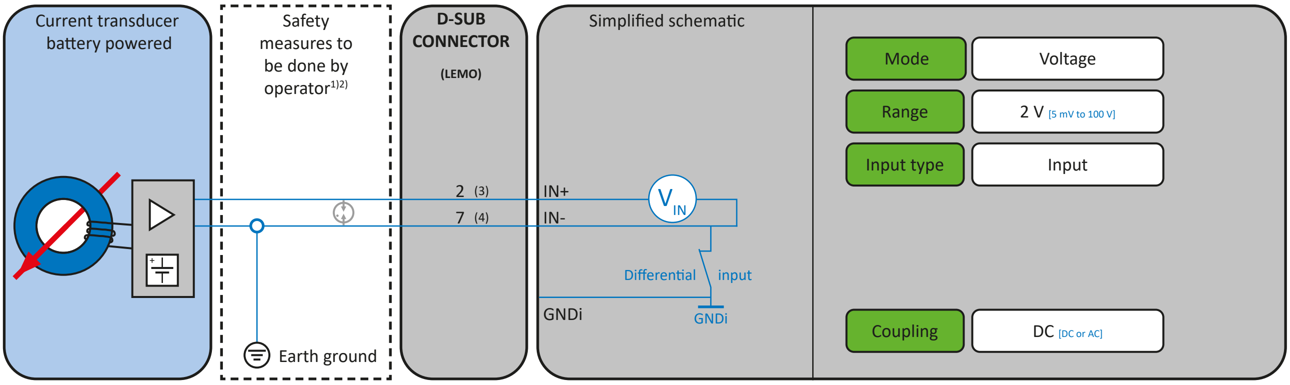



*Fig. 51: Current transducer with voltage output*

**[1] WARNING**

If a current transducer is connected to a TRION(3)-18xx-MULTI measurement board, it must be ensured that the transducer has the appropriate safety rating for the intended use.

The insulation of the TRION(3)-18xx-MULTI measurement board is only functional and does not fulfil any safety requirements.

**[2] WARNING**

When connecting a current transducer to the TRION(3)-18xx-MULTI measurement board, always connect one transducer output to an earth terminal. Transient switching voltages from the primnary circuit can easily destroy the input of the TRION(3)-18xx-MULTI measurement board via the capacitive coupling of the current transformer.

If the primary circuit voltage exceeds 500 V, it is recommended to install surge arresters between the inputs, e.g. TDK G31-A75X.

## Current

### Loop-powered 4 to 20 mA transmitter

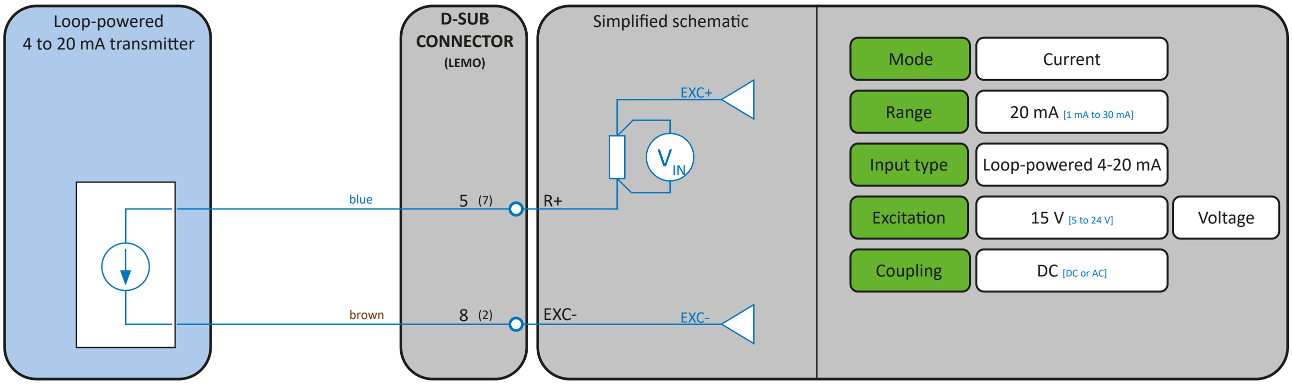



*Fig. 52: Loop-powered 4 to 20 mA transmitter*

### Externally powered transmitter

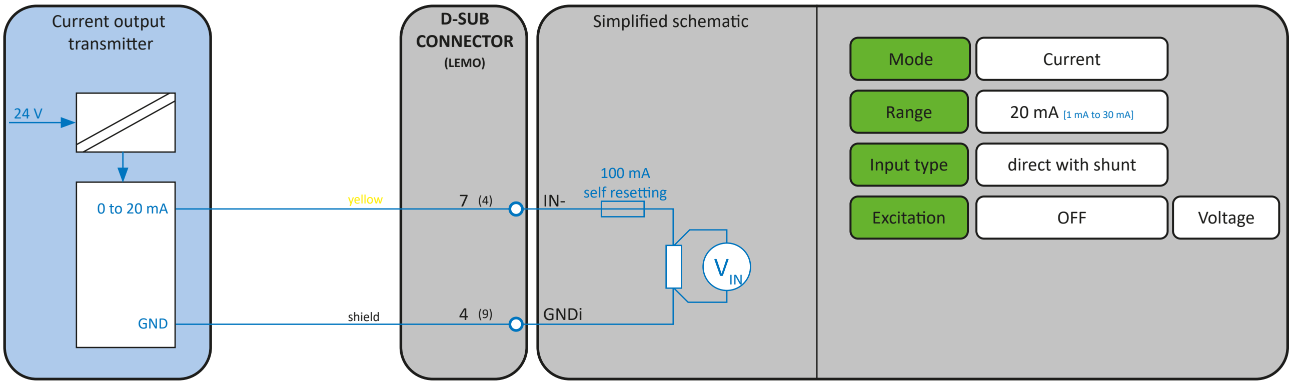



*Fig. 53: Current measurement (with externally powered transmitter)*

## Strain gauge measurement

### Full bridge 6-wire

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

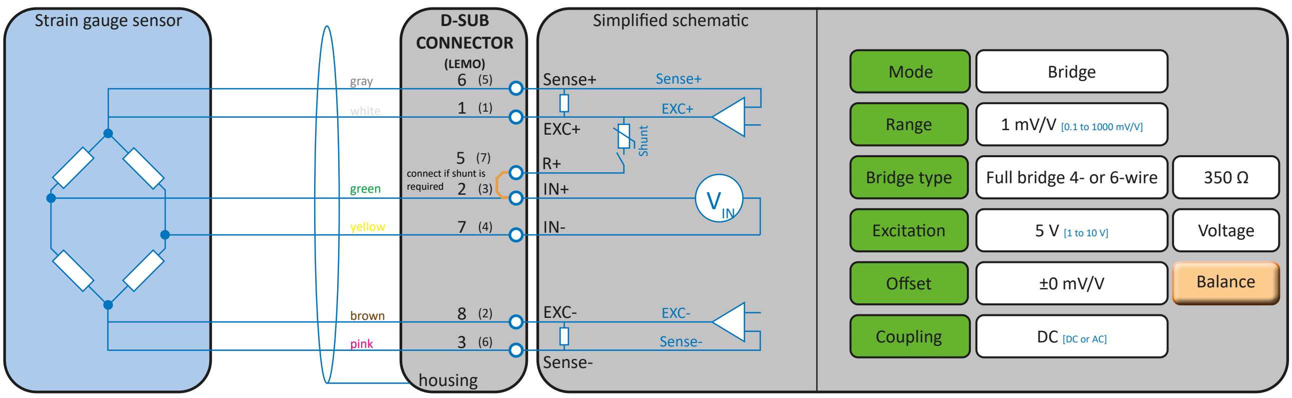



*Fig. 54: Full bridge 6-wire*

### High-speed strain gauge measurement (>50 kHz)

For high-speed applications (bandwidth >50 kHz) it is not recommended using the internal completion circuit, especially if you have long sensor cables. Usually it is better using external completion resistors nearby the strain gauge or use full bridge sensors. The advantage is you will get a differential signal out of the sensor. Disturbances and sensor cable included noise will be minimized. Also lower resistance values of the strain gauges reduce the noise because of lower thermal noise and lower signal source resistance. These resistors should have the same value as the strain gauge. They should also have a low temperature coefficient. A value below 25 ppm/°C is recommended.

### Full bridge 5-wire

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

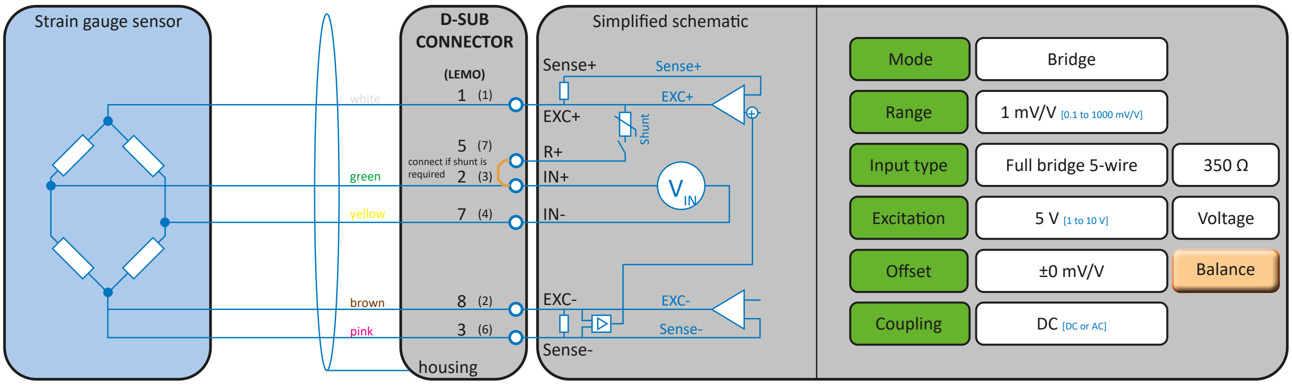
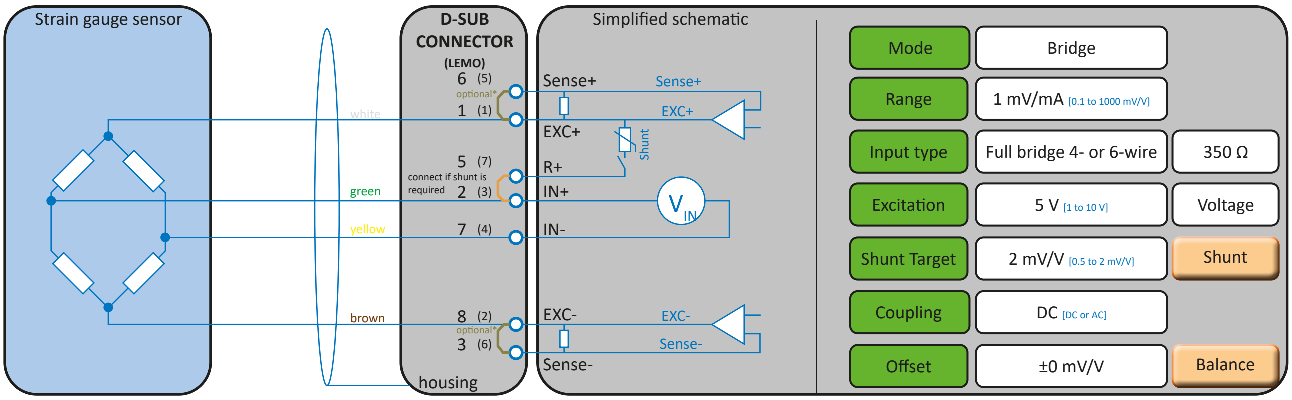



*Fig. 55: Full bridge 5-wire*

### Full bridge 4-wire

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.




*) Optional: might be installed on existing sensor cables from previous amplifier series.

*Fig. 56: Full bridge 4-wire*

### Full bridge 4-wire with constant current excitation

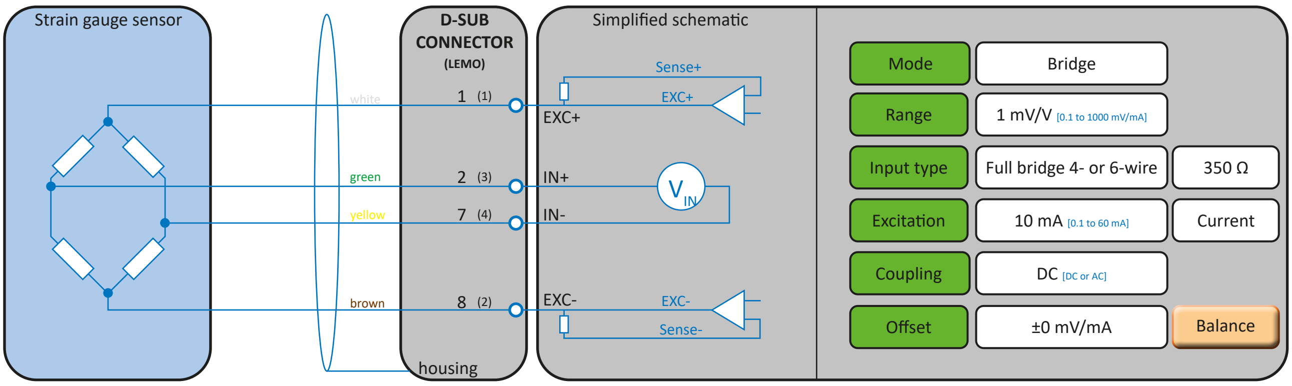



*Fig. 57: Full bridge 4-wire with constant current excitation*

### Half bridge 5-wire

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

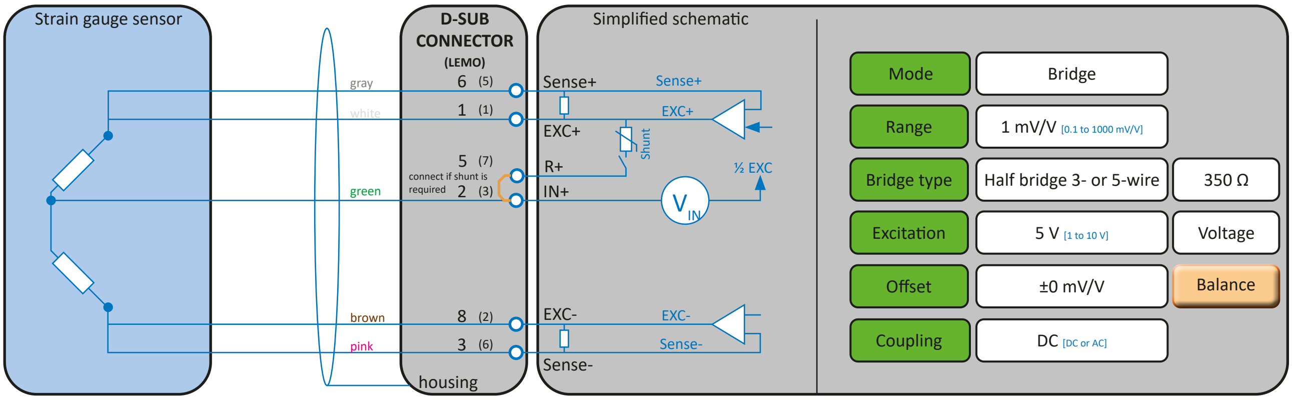



*Fig. 58: Half bridge 5-wire*

### Half bridge 4-wire

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

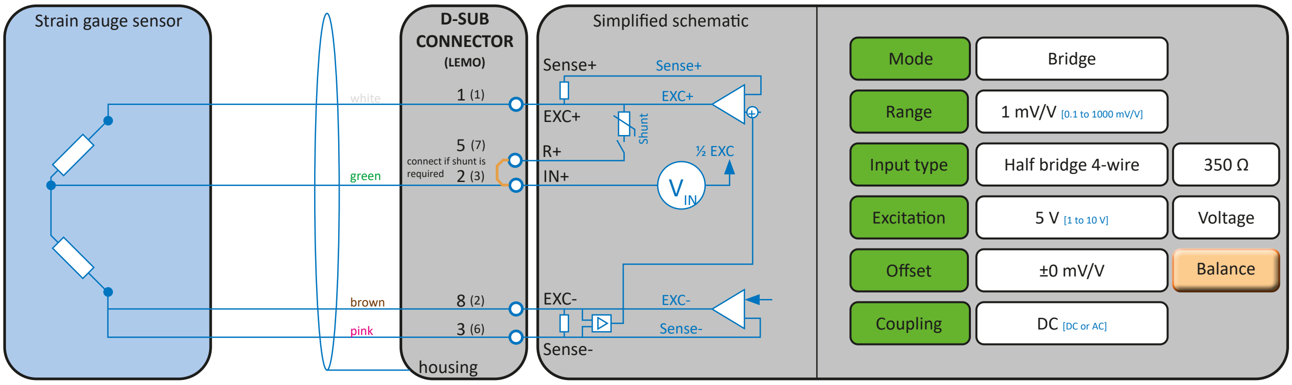



*Fig. 59: Half bridge 4-wire*

### Half bridge 3-wire

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

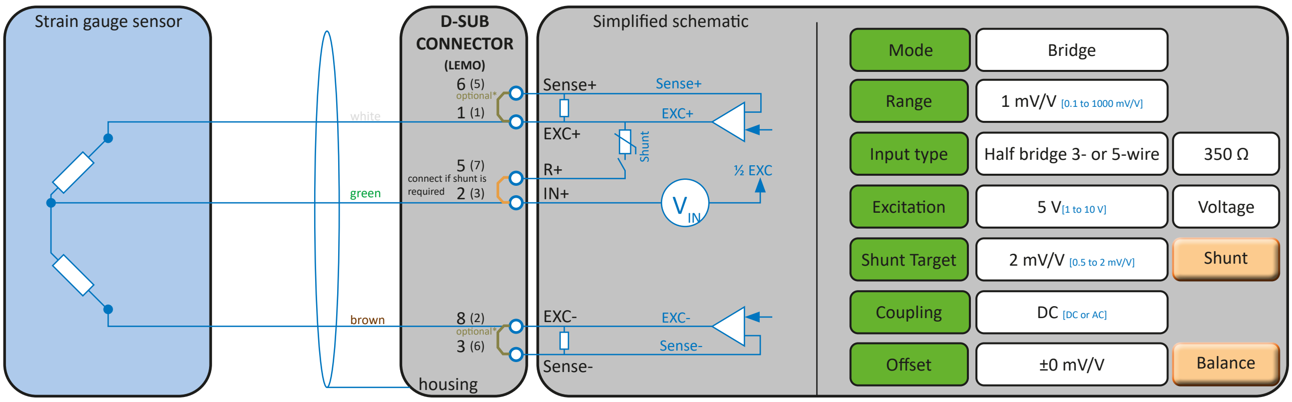



*Fig. 60: Half bridge 3-wire*

## Quarter bridge 4-wire

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

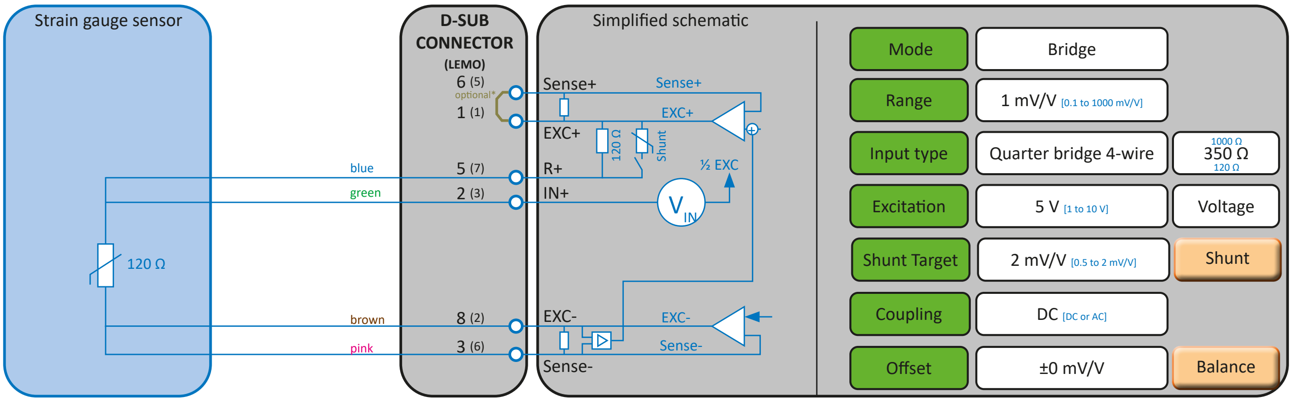



*Fig. 61: Quarter bridge 4-wire*

## Quarter bridge 3-wire

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

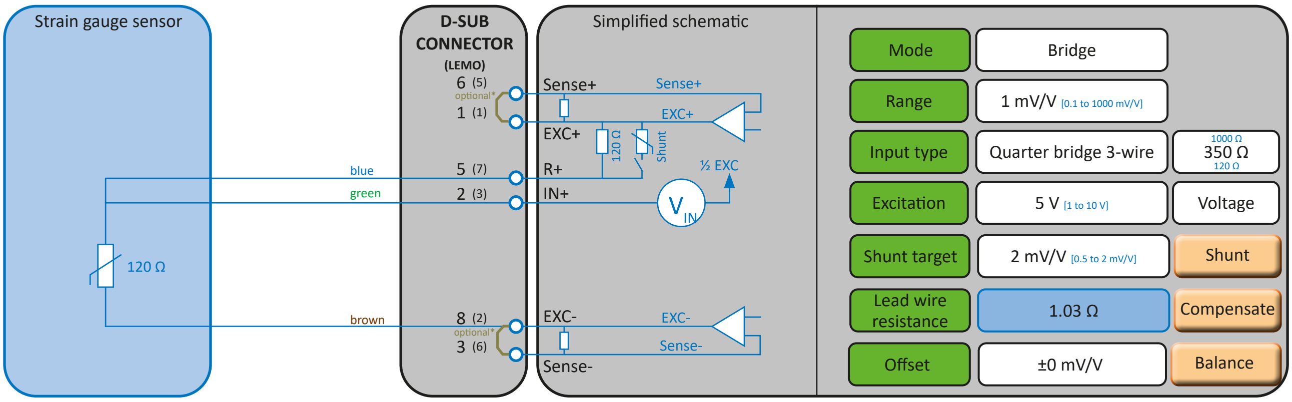



*Fig. 62: Quarter bridge 3-wire*

## Quarter bridge 2-wire

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

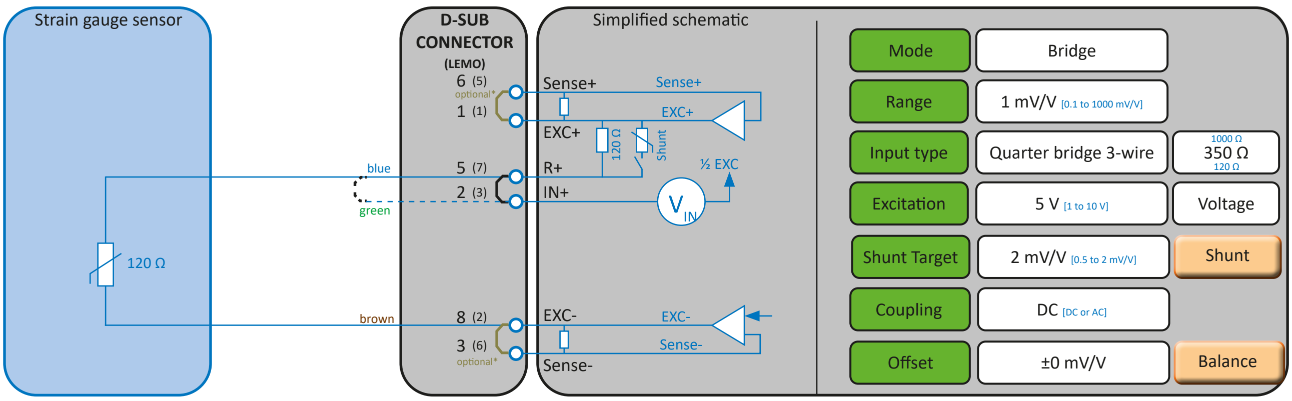



*Fig. 63: Quarter bridge 2-wire*

### Strain measurement with constant current supply and AC coupling

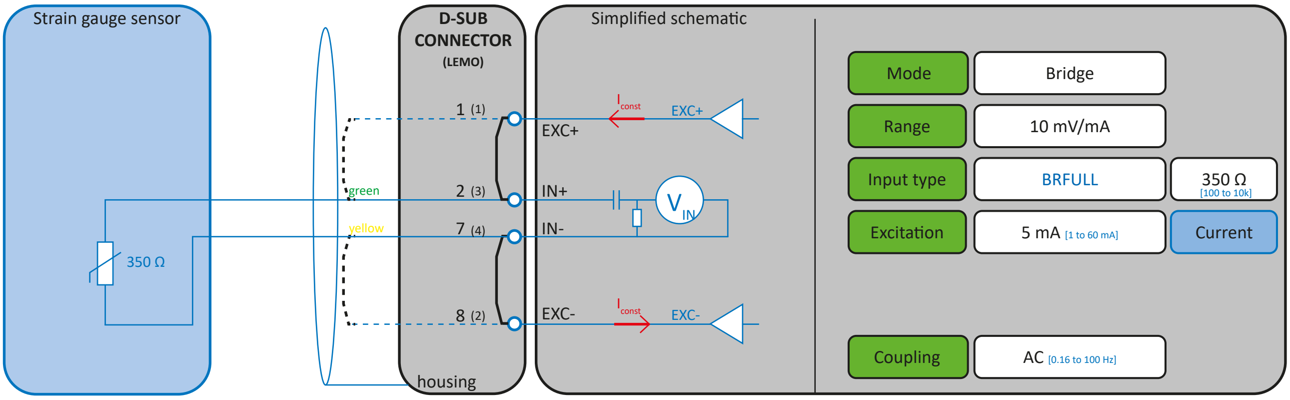



*Fig. 64: Strain measurement with constant-current supply and AC coupling”*

The measuring range changes to mV/mA as soon as the excitation is switched to current. Since the amplifier is AC coupled, the dynamic resistance change is measured in $\Delta R$ Ω.

**INFORMATION** Note that the Full Bridge mode is required for the single DMS measurement.

#### Formulas

- $R_0$: bridge resistance
- $\Delta R$: resistance change (measuring value mV/mA = Ω)
- E: Young‘s modulus (modulus of elasticity)
- k: k-factor (strain sensitivity)
- ε: relative length change
- $\sigma$: stress
- $k_{\text{SCALING}}$: scaling factor for OXYGEN

$$\varepsilon = \frac{\Delta l}{l} \quad \left[\frac{m}{m}\right]$$

$$\sigma = \frac{F}{A} \quad \left[\frac{N}{m^2}\right] \quad [Pa]$$

$$k = \frac{\Delta R/R_0}{\Delta l/l_0} = \frac{\Delta R/R_0}{\varepsilon} \quad \left[\frac{\Omega/\Omega}{m/m}\right]$$

$$E = \frac{\sigma}{\varepsilon} \quad \left[\frac{N/m^2}{m/m}\right]$$

**EXAMPLE**

- $R_0$: 350 $R$
- $\Delta R$ = 0.3 mV/mA (currently measured value)
- $k$ = 2.1
- $E$ = 196,000

$$\varepsilon = \frac{\Delta R/R_0}{k} \qquad \varepsilon = \frac{0.3/350}{2.1} = 0.000408$$

$$\sigma = \mathrm{E} * \varepsilon \qquad \sigma = 196{,}000 * 0.000408 = 80 \text{ MPa}$$

$$k_{\text{SCALING}} = \frac{E}{kR_0} \qquad k_{\text{SCALING}} = \frac{196{,}000}{350*2.1} = 266.66 \left[\frac{MPa}{\Omega}\right]$$

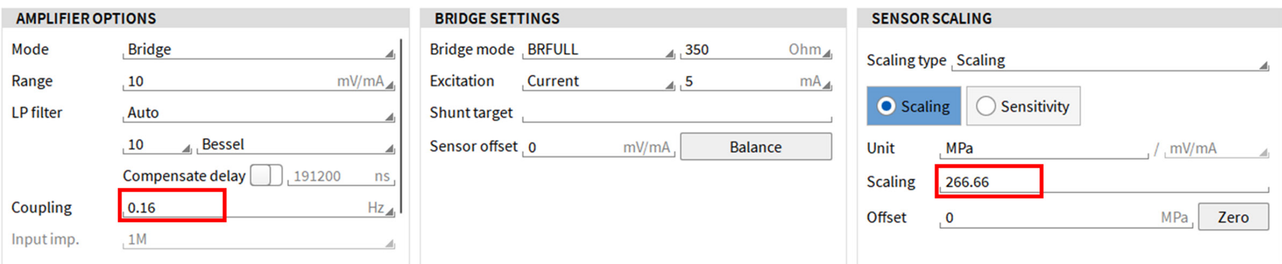



*Fig. 65: Scaling settings in OXYGEN*

# Resistance

## TRION(3)-18xx-MULTI resistance accuracy

| Range (Ω) | Excitation current (mA) | Accuracy |
|---|---|---|
| 30 k | 0.2 | 6 Ω ±1 % of reading |
| 10 k | 0.5 | 2 Ω ±0.45 % of reading |
| 3000 | 1 | 0.6 Ω ±0.25 % of reading |
| 1000 | 1 | 0.2 Ω ±0.25 % of reading |
| 300 | 1 | 80 mΩ ±0.25 % of reading |
| 100 | 1 | 40 mΩ ±0.25 % of reading |
| 30 | 5 | 8 mΩ ±2 % of reading |
| 10 | 5 | 4 mΩ ±2 % of reading |

*Tab. 27: TRION(3)-18xx-MULTI resistance accuracy*

## Resistance measurement

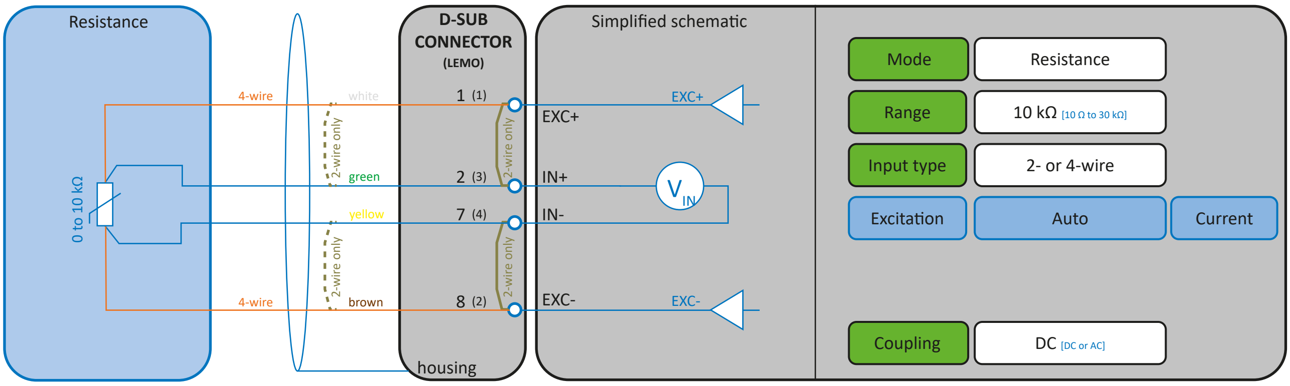



*Fig. 66: Resistance measurement*

# RTD (Pt100, Temperature)

| RTD (Type) | Temperature range (°C) | Excitation current (mA) | Range (Ω) | Accuracy |
|---|---|---|---|---|
| Pt100 | -200 to 850 | 1 | 1000 | 0.9 °C ±0.33 % of reading |
| Pt200 | -200 to 850 | 1 | 1000 | 0.7 °C ±0.33 % of reading |
| Pt500 | -200 to 850 | 1 | 2000 | 0.7 °C ±0.33 % of reading |
| Pt1000 | -200 to 850 | 0.5 | 10000 | 1.1 °C ±0.4 % of reading |
| Pt2000 | -200 to 850 | 0.5 | 10000 | 1.1 °C ±0.4 % of reading |

*Tab. 28: TRION(3)-18xx-MULTI RTD accuracy*

| Range (Ω) | Excitation current (mA) | Voltage range (V) | Accuracy | Temp drift (ppm /°C) | RTD sensor |
|---|---|---|---|---|---|
| 10 k | 0.5 | 10 | 2 Ω ±0.45 % | 100 | Pt2000, Pt1000 |
| 3 k | 1 | 10 | 0.6 Ω ±0.25 % | 100 | Pt500 |
| 1 k | 1 | 2 | 0.2 Ω ±0.25 % | 100 | Pt200, Pt100 |

*Tab. 29: RTD temperature drift specification for TRION(3)-18xx-MULTI*

### RTD 2- and 4-wire temperature measurement

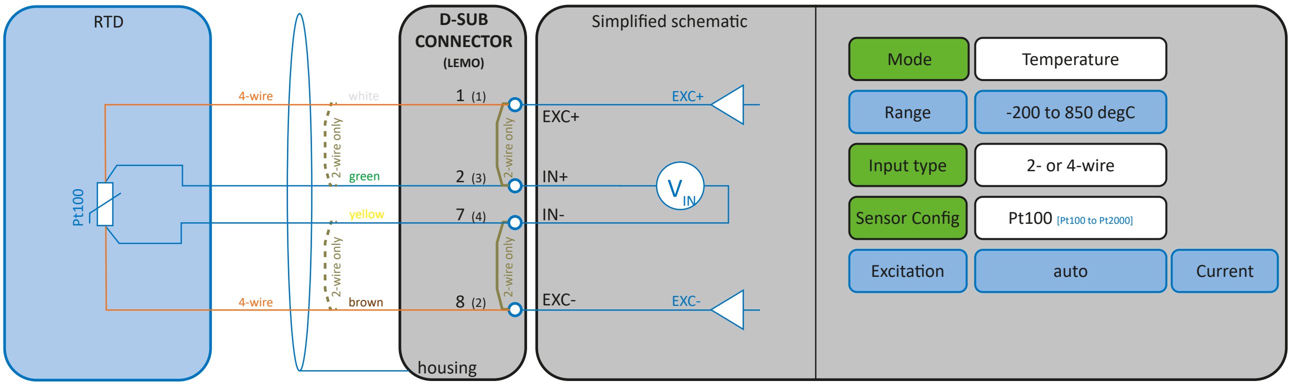



*Fig. 67: RTD 2- and 4-wire temperature measurement*

### RTD 3-wire temperature measurement

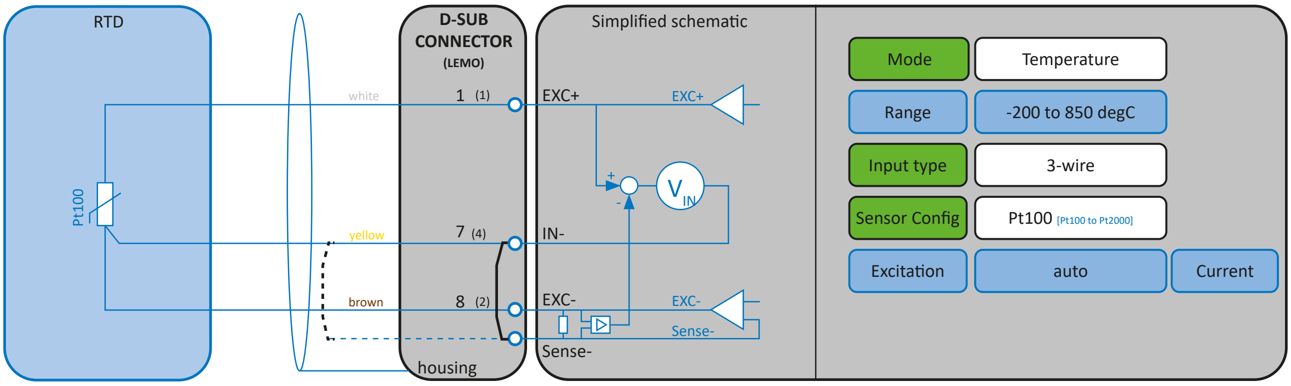



*Fig. 68: RTD 3-wire temperature measurement*

## Counter

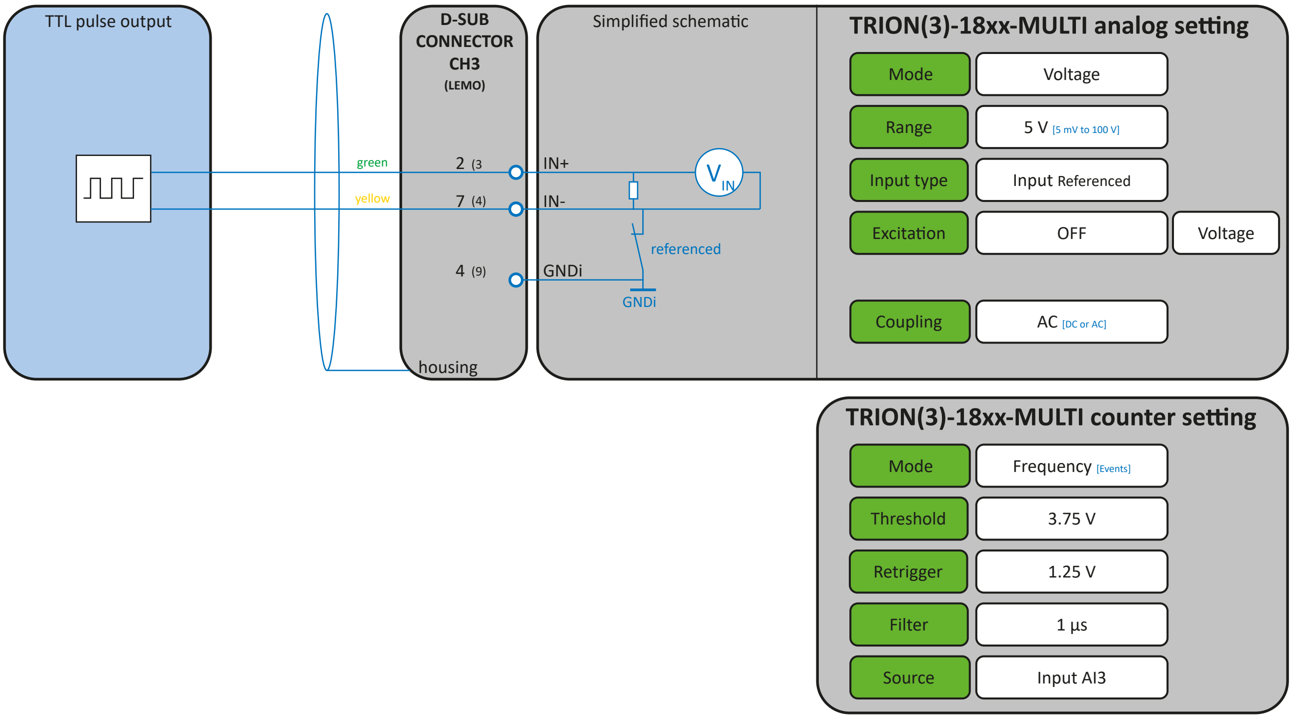



*Fig. 69: Counter measurement*

## IEPE®

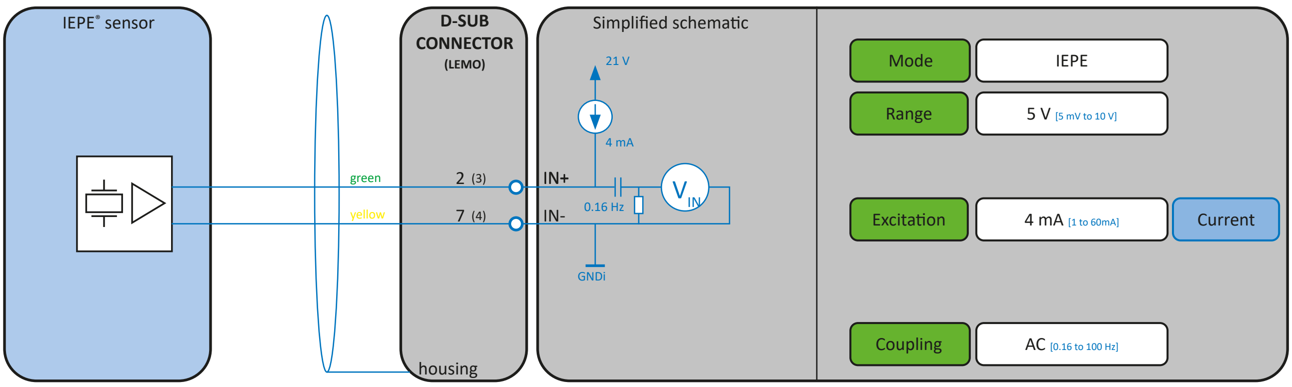



*Fig. 70: IEPE® sensor*

**INFORMATION**

Fig. 69 is an example, every analog input mode can be used with the counter function, not just voltage modes. Threshold and retrigger level can be set within the analog input range.

**INFORMATION**

When changing the input range, the threshold and retrigger level will also change in the same ratio. E.g. changing the input range from 1 V to 10 V will change the threshold from 0.7 V to 7 V.

## Potentiometer

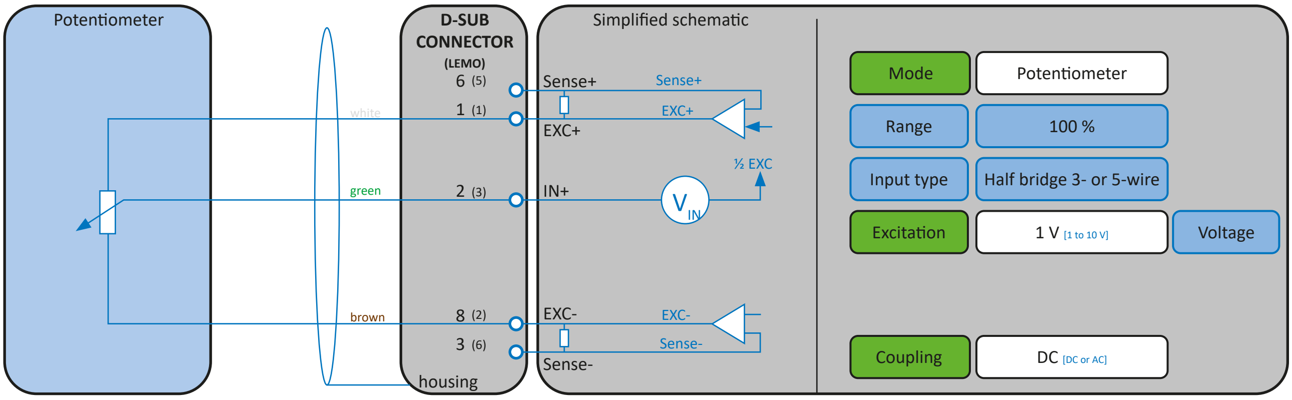



*Fig. 71: Potentiometer*

## CAN

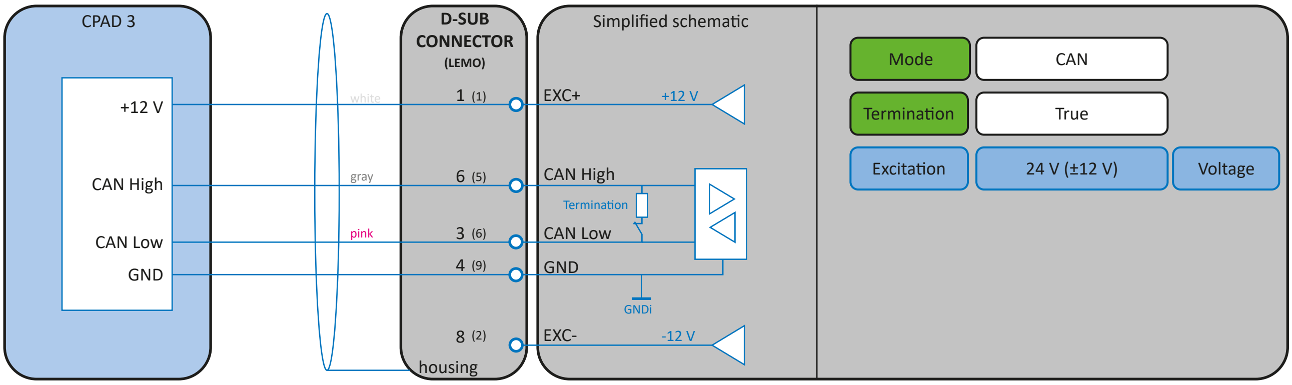



*Fig. 72: CAN*

## CAN bus connection

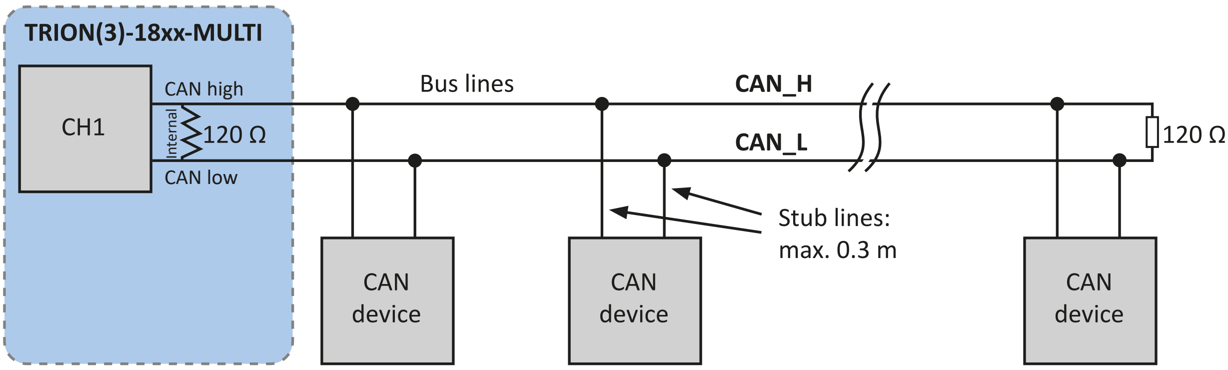



*Fig. 73: CAN bus connection*

## Cables and shielding

To suppress electromagnetic interference as much as possible, cables with shielded twisted pairs are recommended. Connect the shield to the connector housing or to the conductive mechanical structure.

The twisted pairs for **full bridge**, **half bridge**, **voltage** and **resistance** mode are:

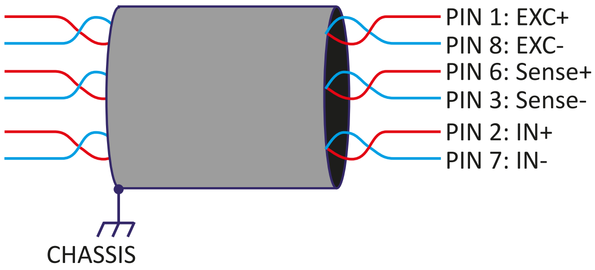



*Fig. 74: Cables and shielding*

## Shielding/noise reduction

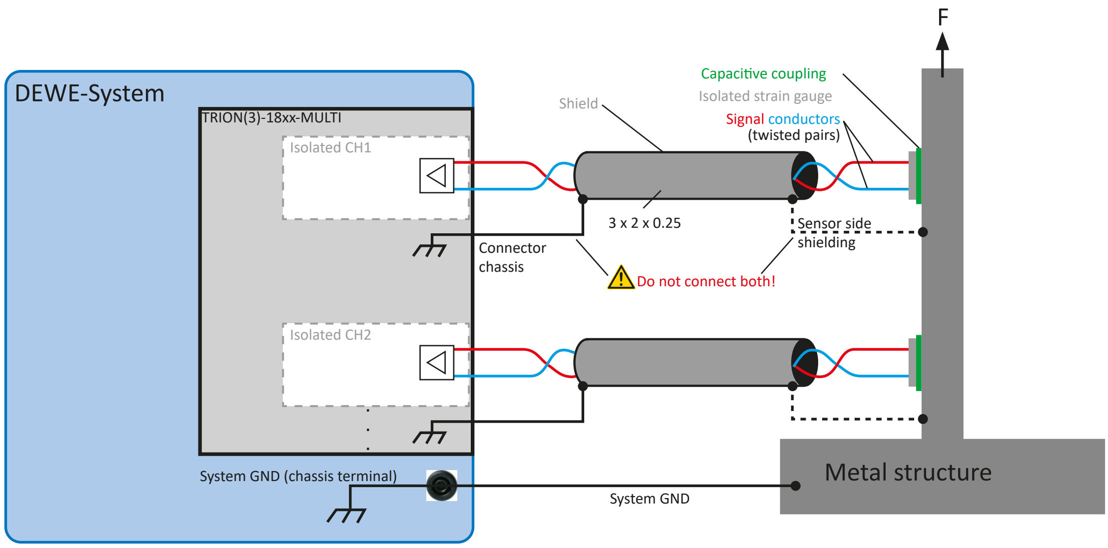



*Fig. 75: Strain gauge measurement on a metal structure*

**INFORMATION**

Connect cable shield either to the connector chassis on the TRION side, ***or*** to the structure on the sensor side. Do ***NOT*** connect on both sides.

It is always important that you connect your DEWETRON system ground (chassis terminal) to the ground potential of your measured object. This guarantees that the measurement system is not floating against the measured structure. It could simply be a connection to the metal structure of your proving ground. In case of an automotive application for example, it would be a connection to the cars chassis. Only if the DEWETRON system and the measured structure have an earth connection the system grounding line might not be needed.

**INFORMATION**

Grounding concept has changed from TRION-2402-MULTI series.

## Connecting XR modules to the TRION(3)-18xx-MULTI

The LED lights orange when in CAN mode.

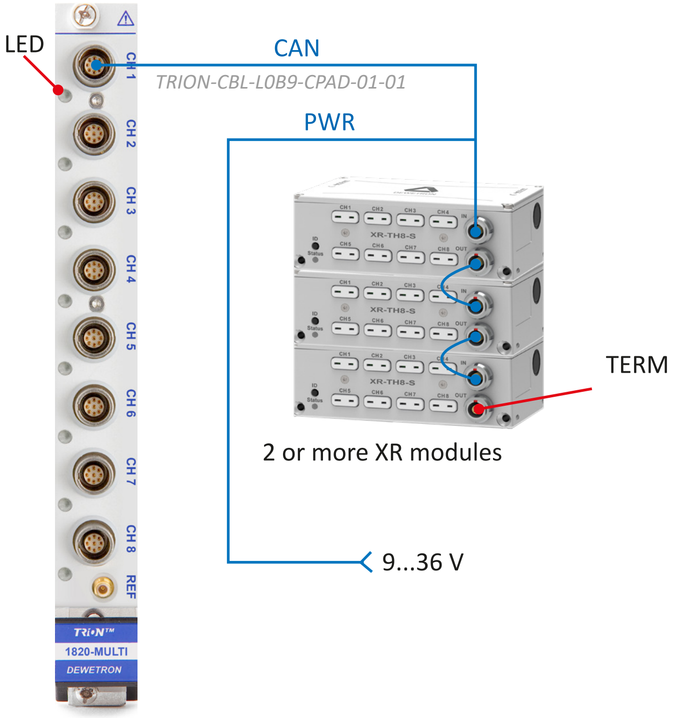
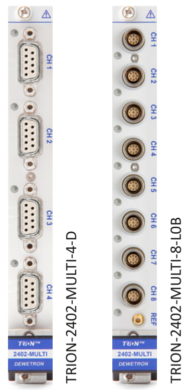



*Fig. 76: Connecting XR modules to the TRION(3)-18xx-MULTI*

# TRION-2402-MULTI

- Universal analog module
- Sampling: 24 bit, 200 kS/s per channel
- Input types: Voltage, bridge, resistance, RTD, IEPE®
- CAN: High-speed CAN2.0 port




## Module specifications

| TRION-2402-MULTI specifications | | |
|---|---|---|
| Input channels | TRION-2402-MULTI-4-D | 4 channels D-SUB connector<br>(CH1 can be used as CAN port) |
| | TRION-2402-MULTI-8-L0B | 8 channels 0B LEMO connector<br>(CH1 can be used as CAN port) |
| ADC | | |
| – Resolution | 24 bit | |
| – Sampling rate | 1 kS/s to 200 kS/s per channel | |
| Input ranges | | |
| – Voltage | ±2 mV to ±100 V freely programmable | |
| – IEPE® | ±100 mV to ±10 V freely programmable | |
| – Bridge | ±1 to 1000 mV/V | |
| – Resistance | 10 Ω, 30 Ω, 100 Ω, 300 Ω, 1 kΩ, 3 kΩ, 10 kΩ, 30 kΩ | |
| Accuracy[1)] | ±0.02 % of reading ± 0.02 % of range ±20 µV | |
| – Gain drift | Typical 10 ppm/°C max. 20 ppm/°C | |
| – Offset drift | Typical 0.3 µV/°C+ 10 ppm of range/°C, max 2 µV/°C + 20 ppm of range/°C | |
| – Linearity | Typical ±0.01 % | |
| Input impedance | 0 to 10 V range | 100 MΩ |
| | >10 to 100 V range | 2 MΩ |
| Input bias current | <5 nA | |
| Input configuration | Single-ended or differential (programmable) | |
| Input coupling | DC / AC (high pass filter 0.16 Hz) | |
| Rated input voltage to earth according to EN 61010-2-30 | 33 $V_{RMS}$, 46.7 $V_{PEAK}$, 70 $V_{DC}$ | |
| Isolation voltage (channel-to-channel and channel-to-chassis) | 350 $V_{DC}$ | |
| Common mode voltage to $GND_{isolated}$ | 0 to 10 V range | ±10 $V_{DC}$ |
| | >10 to 100 V range | ±100 $V_{DC}$ |
| Overvoltage protection | 0 to 10 V range | ±50 $V_{DC}$ continuous, 100 $V_{DC}$ (1 min) |
| | >10 to 100 V range | ±200 $V_{DC}$ |

*Tab. 30: Module specifications*

| **TRION-2402-MULTI specifications** | |
|---|---|
| Excitation voltage range | 0 to 24 $V_{DC}$ freely programmable; separately for each channel |
| – Resolution | 1 mV |
| – 1 year accuracy | ±0.03 % ±1.5 mV |
| – Drift | ±10 ppm/°C ±50 µV/°C |
| – Current limit | 0.1 to 5 V: 100 mA<br>>5 V to 24 V: limited to 0.5 W |
| – Protection | Continuous short |
| – Load and line regulation error | ±0.002 % with sense line connected |
| Excitation current | 0.1 to 60 mADC (programmable, 16-bit DAC) |
| – Resolution | 1 µA |
| – 1 year accuracy | 0.1 to 5 mA: 0.05 % ±2 µA<br>>5 to 60 mA: 2 % ±5 µA |
| – Drift | 15 ppm/°C |
| – Compliance voltage | 0.1 to 20 mA: 24 V<br>>20 mA: 10 V |
| – Output impedance | >10 MΩ |
| Supported sensors | ▶ 4-or 6-wire full bridge<br>▶ 3-or 5-wire ½ bridge with internal completion (software programmable)<br>▶ 3- or 4-wire ¼ bridge with internal resistor for 120 Ω and 350 Ω (software programmable)<br>▶ 4-wire full bridge with constant current excitation (piezoresistive bridge sensors)<br>▶ Potentiometer<br>▶ Resistance<br>▶ Resistance temperature detection: Pt100, Pt200, Pt300, Pt500, Pt1000, Pt2000 (2-, 3-, 4-wire)<br>▶ IEPE® |
| Bridge resistance | 80 Ω to 10 kΩ @ ≤5 $V_{DC}$ excitation |
| Shunt calibration | Two internal shunt resistors 50 kΩ and 100 kΩ |
| Shunt and completion resistor accuracy | 0.05 % ±15 ppm/K |
| Automatic bridge balance | ±400 % of range |
| Low pass filter (-3 dB, digital) | 1 Hz to 40 % of sample rate freely programmable or OFF |
| – Characteristic | Bessel or Butterworth |
| – Filter order | $2^{nd}$ , $4^{th}$, $6^{th}$, $8^{th}$ |
| – Filter setting AUTO | 30 % of sample rate with 8th order Bessel |
| Analog anti-aliasing filter<br>Sample rate > 10 kS/s | $2^{nd}$ order Bessel,<br>250 kHz (-3 dB), 150 kHz (-1 dB) |
| ADC anti-aliasing filter | -3 dB @ Filter = OFF |
| – 1 kS/s ≤ fs ≤ 51.2 kS/s | 0.494 fs |
| – 51.2 kS/s < fs ≤ 102.4 kS/s | 0.49 fs<br>fs = sample frequency |
| – 102.4 kS/s < fs ≤ 200 kS/s | 0.38 fs |

*Tab. 30: Module specifications*

| TRION-2402-MULTI specifications | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Typical signal-to-noise ratio, spurious | 10 mV range | | | | 100 mV range | | | | 1 V range | | | | 10 V range | | | |
| Free SNR, effective number of Bits[2] | SNR | SFDR[3] | ENOB[4] | Noise | SNR | SFDR[3] | ENOB[4] | Noise | SNR | SFDR[3] | ENOB[4] | Noise | SNR | SFDR[3] | ENOB[4] | Noise |
| Sample rate | [dB] | [dB] | [Bit] | [$mV_{pp}$] | [dB] | [dB] | [Bit] | [$mV_{pp}$] | [dB] | [dB] | [Bit] | [$mV_{pp}$] | [dB] | [dB] | [Bit] | [$mV_{pp}$] |
| 1 kS/s | 82 | 108 | 13.3 | 0.002 | 101 | 128 | 16.5 | 0.002 | 111 | 141 | 18.1 | 0.025 | 112 | 141 | 18.3 | 0.100 |
| 10 kS/s | 82 | 108 | 13.3 | 0.005 | 101 | 123 | 16.5 | 0.005 | 106 | 134 | 17.3 | 0.030 | 112 | 140 | 18.3 | 0.120 |
| 100 kS/s | 72 | 103 | 11.7 | 0.015 | 92 | 123 | 15.0 | 0.016 | 104 | 134 | 17.0 | 0.058 | 104 | 136 | 17.0 | 0.210 |
| 200 kS/s | 69 | 99 | 11.2 | 0.022 | 88 | 120 | 14.3 | 0.025 | 88 | 133 | 14.3 | 0.230 | 96 | 135 | 15.7 | 0.950 |
| 200 kS/s; Filter = OFF | 69 | 99 | 11.2 | 0.059 | 80 | 106 | 13.0 | 0.061 | 81 | 106 | 13.2 | 1.300 | 81 | 106 | 13.2 | 5.400 |
| Typical THD | -100 dB | | | | | | | | | | | | | | | |
| Typcial crosstalk | -125 dB (10 V range; 0 to 1 kHz) | | | | | | | | | | | | | | | |
| Typical CMRR | 110 dB @ 50 Hz, 90 dB @ 1 kHz, 80 dB @ 10 kHz | | | | | | | | | | | | | | | |
| Self test (self calibration) | Each channel is able to perform a complex self test by using internal high precision references | | | | | | | | | | | | | | | |
| Channel-to-channel phase mismatch | Typically <60 ns between channels using the same range | | | | | | | | | | | | | | | |
| CAN specification | CAN 2.0 | | | | | | | | | | | | | | | |
| CAN physical layer | High-speed | | | | | | | | | | | | | | | |
| CAN termination | Programmable: high impedance or 120 Ω | | | | | | | | | | | | | | | |
| Bus fault pin protection | ±36 $V_{DC}$ | | | | | | | | | | | | | | | |
| Input connector | 9-pin LEMO EPG.0B.309, 9-pin D-SUB connector | | | | | | | | | | | | | | | |
| REF connector | SMB | | | | | | | | | | | | | | | |
| Supported MSI | MSI-BR-TH-x, MSI-BR-CH-x, MSI2-TH-x, MSI2-CH-x, MSI2-LVDT | | | | | | | | | | | | | | | |
| Power consumption | TRION-2402-MULTI-4-D | | | | | | | | Typ. 8 W, max. 13 W | | | | | | | |
| | TRION-2402-MULTI-8-L0B | | | | | | | | Typ. 13 W, max. 23 W | | | | | | | |
| | – Voltage mode, no excitation | | | | | | | | 10.5 W | | | | | | | |
| | – IEPE® mode (4 mA / 8 mA) | | | | | | | | 13.5 W / 14.5 W | | | | | | | |
| | – Loop powered sensor (24 V, 20 mA) | | | | | | | | 18 W | | | | | | | |
| | – 350 Ω full bridge (5 V / 10 V) | | | | | | | | 13 W / 16 W | | | | | | | |
| | – PT100, PT1000 | | | | | | | | 13 W | | | | | | | |

*Tab. 30: Module specifications*

1) 1 year accuracy 23 °C ±5 °C

2) LP Filter in auto mode

3) SFDR excluding harmonics

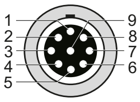
4) ENOB calculated from SNR

# TRION-2402-MULTI-8-LOB module

## Connection


Mating connector

FGG.0B.309.CLADxx




9-pin LEMO connector female
EPG.0B.309.HLN

1: EXC+ (CAN power supply 12 V, CH1 only)
2: EXC-
3: IN+
4: IN-
5: SENSE+ (CAN high, CH1 only)
6: SENSE- (CAN low, CH1 only)
7: R+
8: TEDS
9: $GND_{isolated}$ (CAN GND, CH1 only)
Housing connected to chassis GND

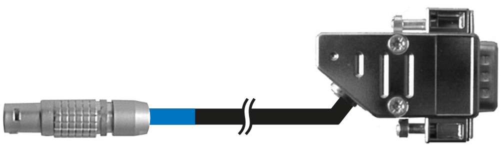
## Optional accessory

### TRION-CBL-LOB9-OE-xx-02

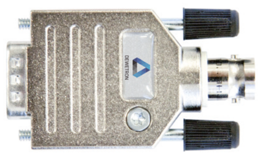
High quality cable from Lemo 0B.309 plug  to open end, 1 or 5 m.


### TRION-CBL-LOB9-D9-0.5-02

High quality adapter cable from Lemo 0B.309 plug to D-SUB-9 socket, 0.5 m



1: EXC+
2: IN+
3: SENSE-
4: $GND_{isolated}$
5: R+
6: SENSE+
7: IN-
8: EXC-
9: TEDS



For connecting any MSI-BR series adapters

### TRION-CBL-LOB9-BNC-0.5-01

High quality adapter cable from LEMO 0B.309 plug to BNC cable jack, 0.5 m. For connecting IEPE® sensors to TRION-2402-MULTI-8-LOB modules.


Hot: IN +
Shield: IN -

**NOTICE**

Do not use this cable for connecting voltage signals.

### TRION-CBL-L0B9-BNC-0.5-03

High quality adapter cable from LEMO 0B.309 plug to BNC cable jack, 0.5 m. For connecting voltage signals to TRION-2402-MULTI-8-L0B modules.

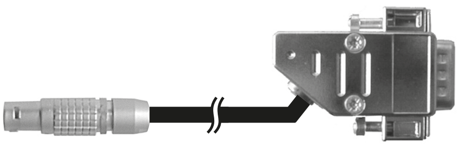

Hot: IN +
Shield: IN -

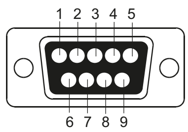
**NOTICE**

Do not use this cable for connecting IEPE® signals.

### TRION-CBL-L0B9-CAN-0.5

Adapter cable from LEMO 0B.309 plug to D-SUB-9 plug for CAN, 0.5 m. For TRION-2402-MULTI-8-L0B modules channel 1 only.



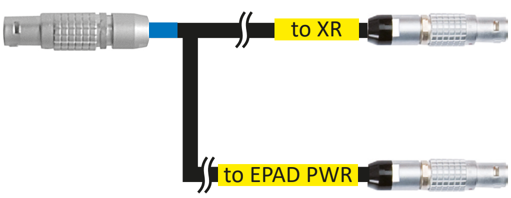



9-pin D-SUB connector male

1: NC
2: CAN low (isolated)
3: GNDx CAN (isolated)
4: NC
5: NC
6: GND Power
7: CAN High (isolated)
8: NC
9: CAN power supply +12 V

### TRION-CBL-L0B9-CPAD-01-01

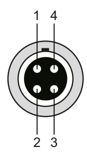
1 m adapter cable to supply several XR modules via an EPAD connector and to communicate via the TRION-2402-MULTI CAN interface




Pin assignment to XR series module
1: CAN high
2: CAN low
3: +12 V
4: GND

Additional power supply (e.g. to EPAD connector of instrument)
1: n.c.
2: n.c.
3: +12 V
4: GND

For connecting XR series module



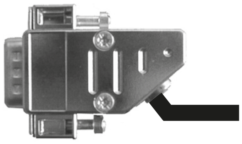

4-pin LEMO connector male
FGG.1B.304.CLL

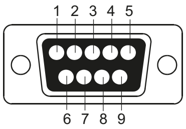
**INFORMATION**

XR modules require slightly more power than the preceding CPAD2 series as they support a higher sampling rate. Therefore, a module of the XR series can no longer be supplied directly via a single TRION-2402-MULTI channel.

# TRION-2402-MULTI-4-D module

## Connections



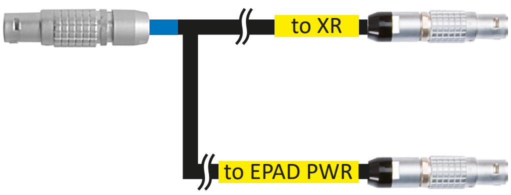

9-pin D-SUB connector male

1: EXC+ (CAN power supply 12 V, CH1 only)
2: IN+
3: Sense- (CAN low, CH1 only)
4: $GND_{isolated}$ (CAN GND, CH1 only)
5: R+
6: Sense+ (CAN high, CH1 only)
7: IN-
8: EXC-
9: TEDS

## Optional accessory

### TRION-CBL-L0B9-CPAD-01-01

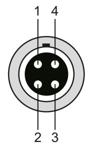
1 m adapter cable to supply several XR modules via an EPAD connector and to communicate via the TRION(3)-18xx-MULTI CAN interface




Pin assignment to XR series module
1: CAN high
2: CAN low
3: +12 V
4: GND

Additional power supply (e.g. to EPAD connector of instrument)
1: n.c.
2: n.c.
3: +12 V
4: GND

For connecting XR series module



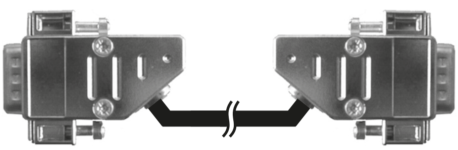

4-pin LEMO connector male FGG.1B.304.CLL

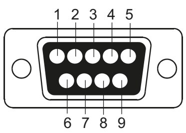
**INFORMATION**

XR modules require slightly more power than the preceding CPAD2 series as they support a higher sampling rate. Therefore, a module of the XR series can no longer be supplied directly via a single TRION(3)-18xx-MULTI channel.

### TRION-CBL-D9-CAN-0.5

Adapter cable from D-SUB-9 plug to D-SUB-9 plug for CAN, 0.5 m. For TRION-2402-MULTI-4-D modules.






9-pin D-SUB connector male

1: NC
2: CAN Low (isolated)
3: GND CAN (isolated)
4: NC
5: NC
6: GND Power
7: CAN High (isolated)
8: NC
9: CAN power supply +12 V

## LED function

Green: Normal operation

Orange: CAN mode active

Red: Error

*Fig. 77: LED function*

## TRION-2402-MULTI function overview

### Isolation

The TRION-2402-MULTI is fully isolated. That means every channel has a separate isolated excitation voltage and input amplifier. The main advantages of that configuration are:

- Very high common mode voltages of ±350 V.
- Overcurrent protection e.g. if the isolation of a strain gauge on a 110 V power line fails.
- Ground loops are eliminated.
- Noise reduction

### Free variable gain and excitation

Amplifier parameters such as gain, excitation voltage, excitation current and sensor offset can be varied for every channel individually. This allows a perfect match of each input channel to any sensor.

### Amplifier balance (amplifier zero)

The amplifier balance function eliminates automatically all internal amplifier offsets. It switches the differential amplifier inputs IN+ and IN- to the internal GND reference point. Consequently the offset of the module is adjusted to zero for all ranges. This function can take up to 4 seconds. It allows compensating the long term zero drift, as well as temperature drifts of the amplifier. It can be performed for one individual channel or for all channels at once.

### Sensor balance

Normally every strain gauge sensor has a certain offset caused by manufacturer tolerances and sensor mounting. The *sensor balance* function removes that offset automatically up to 400 % of the selected input range.

### Input short

This function switches both differential amplifier inputs IN+ and IN- from the input terminals to the internal half bridge reference of the module. With this function, the absolute sensor offset can be determined.

### Internal calibration voltage

The TRION-2402-MULTI has an internal, ultra-stable, programmable reference voltage generator. The voltage could be applied to every input channel via a relay matrix. Therefore the complete input signal path - from the analog input amplifier to the ADC can be checked. Eventually existing gain drifts can be discovered and compensated by utilizing this internal reference voltage.

## External calibration (REF input)

Instead of the internal calibration voltage, an external signal can be applied to every input channel by using the calibration relay matrix. This allows external calibration of the voltage input without disconnecting the input connector (TRION-2402-MULTI-8-L0B only).

## CAN

The first channel of the TRION-2402-MULTI also has a CAN bus interface. Any CAN2.0B compatible device or bus can be connected. In CAN mode, the analog input function of the channel is deactivated. Sensor excitation is switched to ±12 V. For further information, refer to chapter *TRION-CAN* of the TRION(3) series modules manual.

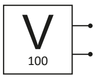
One single CPAD series module can be directly connected to that channel. If more modules are required an additional power supply is needed.

## TEDS

The maximum distance between module and TEDS chip: 20 m.

# Signal connection

The following schematics will give you an overview on how to connect all the different sensors to the TRION-2402-MULTI module.




## Voltage

### Voltage measurement

- Isolated sensors
- Battery powered sensors
- Sensors with differential output

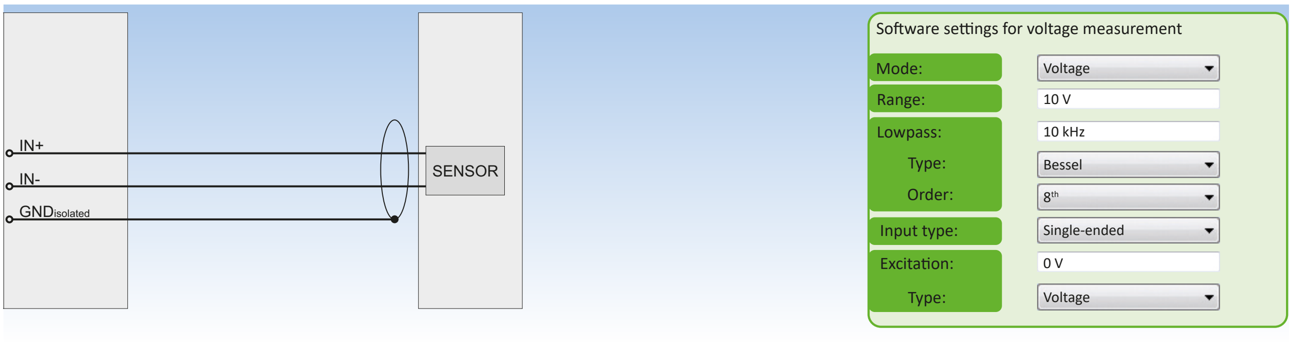
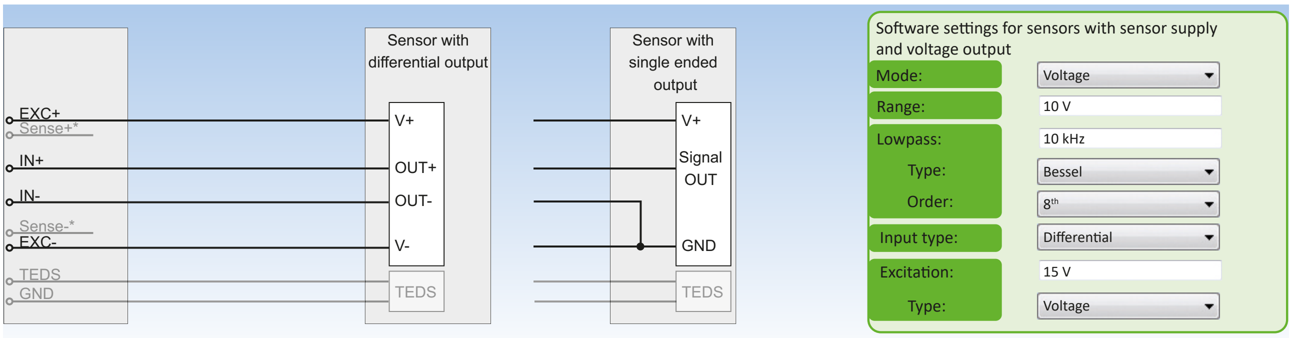



*Fig. 78: Voltage measurement*

### Sensors with sensor supply and voltage output




*) Sense as well as TEDS connection is optional.

*Fig. 79: Sensors with sensor supply and voltage output*

## IEPE®

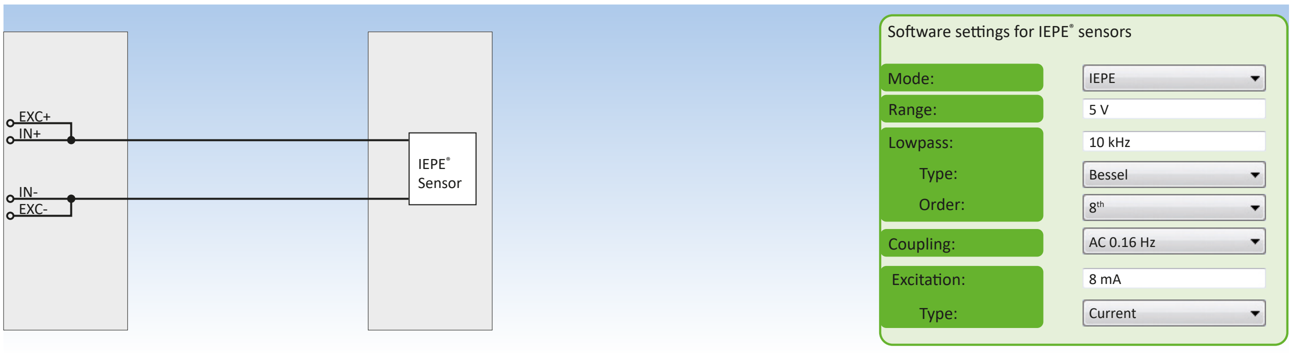



*Fig. 80: IEPE® sensor*

## Strain gauge and Potentiometer measurement

### Full bridge 6-wire sensor connection

Voltage or current excitation is allowed. TEDS connection is optional.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

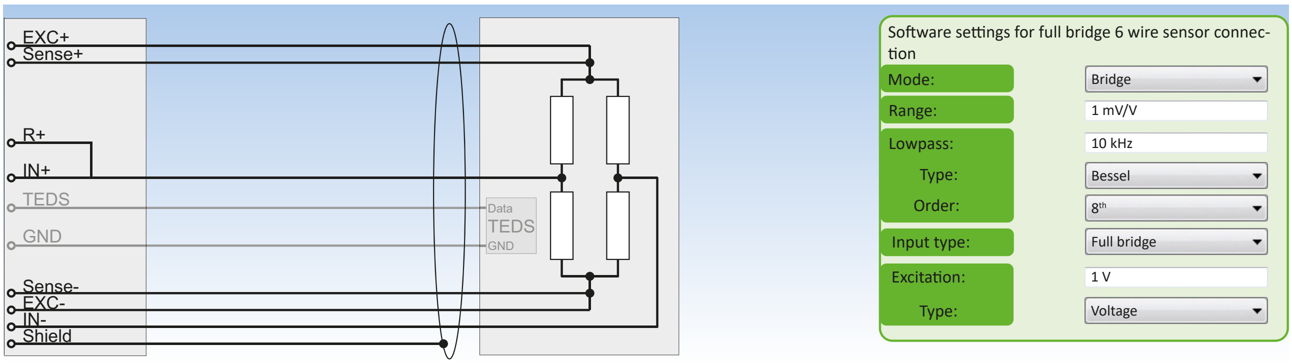



*Fig. 81: Full bridge 6-wire sensor connection*

### Full bridge 4-wire sensor connection

Voltage or current excitation is allowed. TEDS connection is optional.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

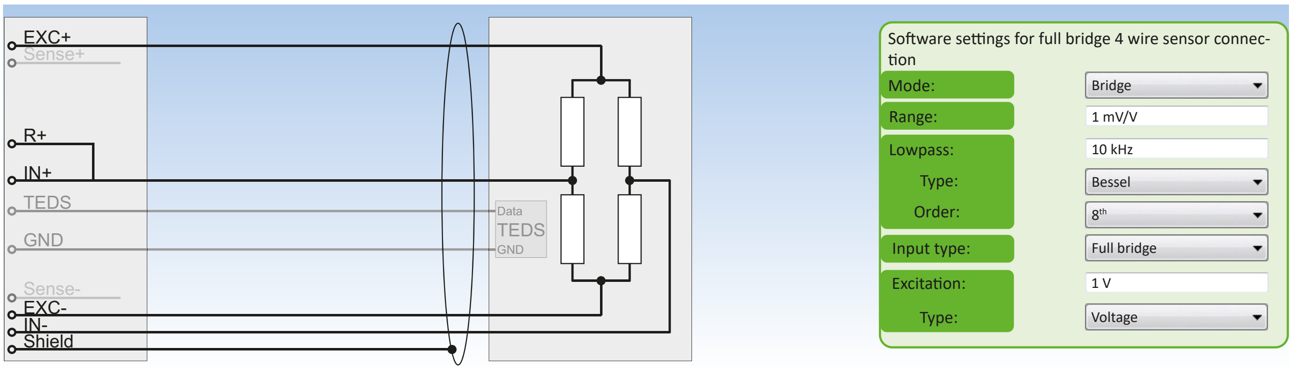



*Fig. 82: Full bridge 4-wire sensor connection*

### Half bridge or Potentiometer 5-wire sensor connection

Voltage and current excitation is allowed. A potentiometer can be seen similar to a half bridge sensor with ±500 mV/V sensitivity. TEDS connection is optional.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

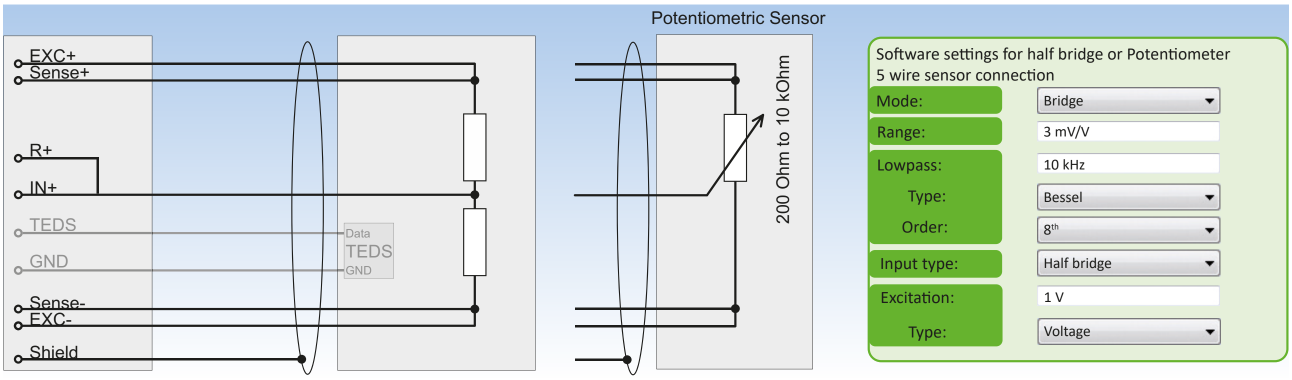



*Fig. 83: Half bridge or Potentiometer 5 wire sensor connection*

### Half bridge or Potentiometer 3-wire sensor connection

TEDS connection is optional.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

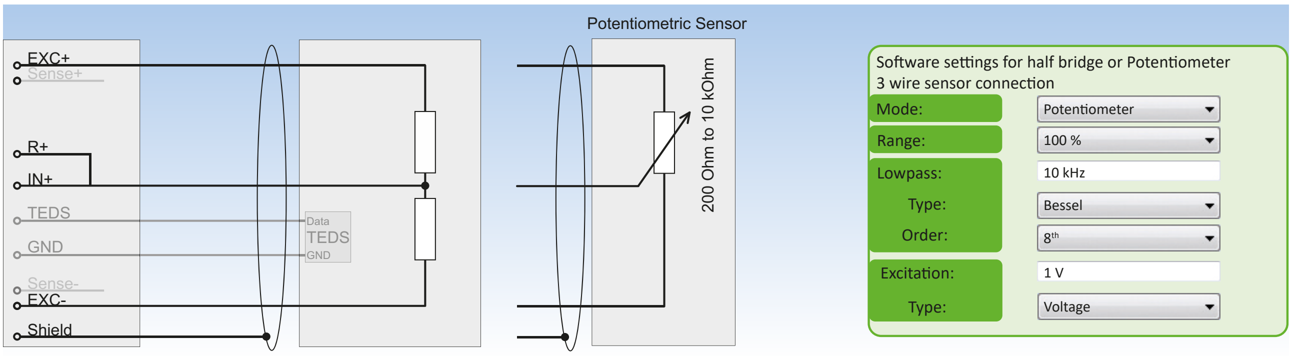



*Fig. 84: Half bridge or Potentiometer 3 wire sensor connection*

### Quarter bridge 3-wire sensor connection

The 3-wire quarter bridge is only able to compensate symmetric wire resistance. Sense connection is optional.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

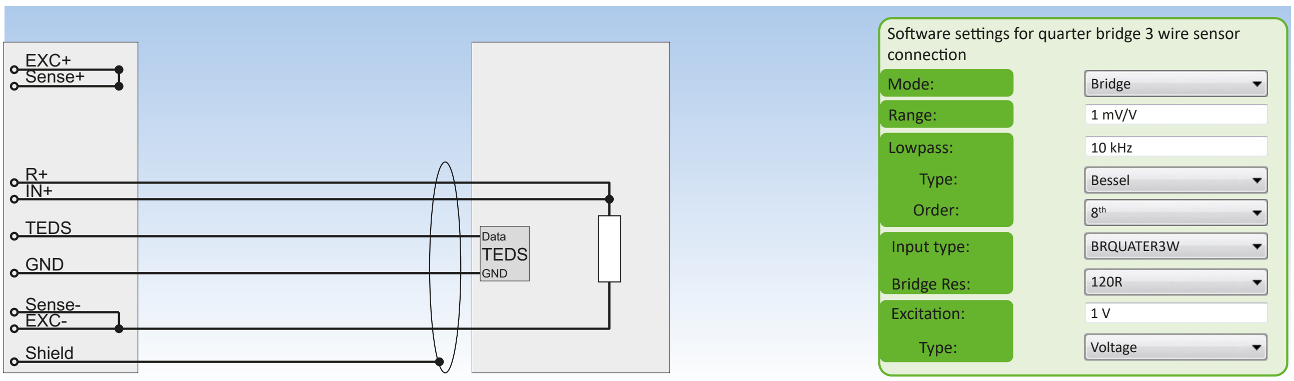



*Fig. 85: Quarter bridge 3 wire sensor connection*

### Quarter bridge 4-wire sensor connection

The 4 wire connection provides full lead wire resistance compensation. Sense connection is optional.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

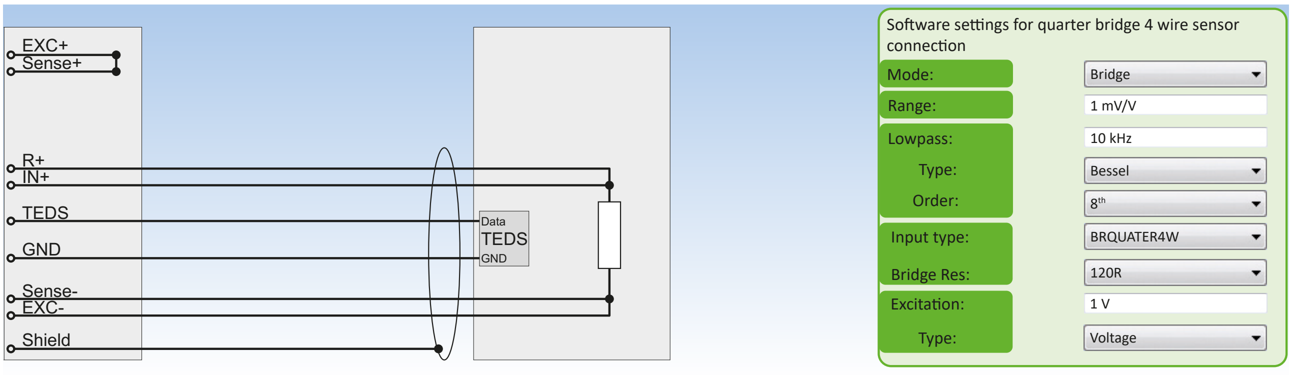
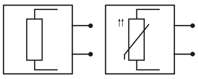



*Fig. 86: Quarter bridge 4 wire sensor connection*



## Resistance and RTD

### Resistance and RTD measurement 2 wire connection

The 2 wire technology does not compensate any lead wire resistance. For accurate temperature or resistance measurement the 4 wire technology is strongly recommended.


*Fig. 87: Resistance and RTD measurement 2 wire connection*

### Resistance and RTD measurement 3 wire connection

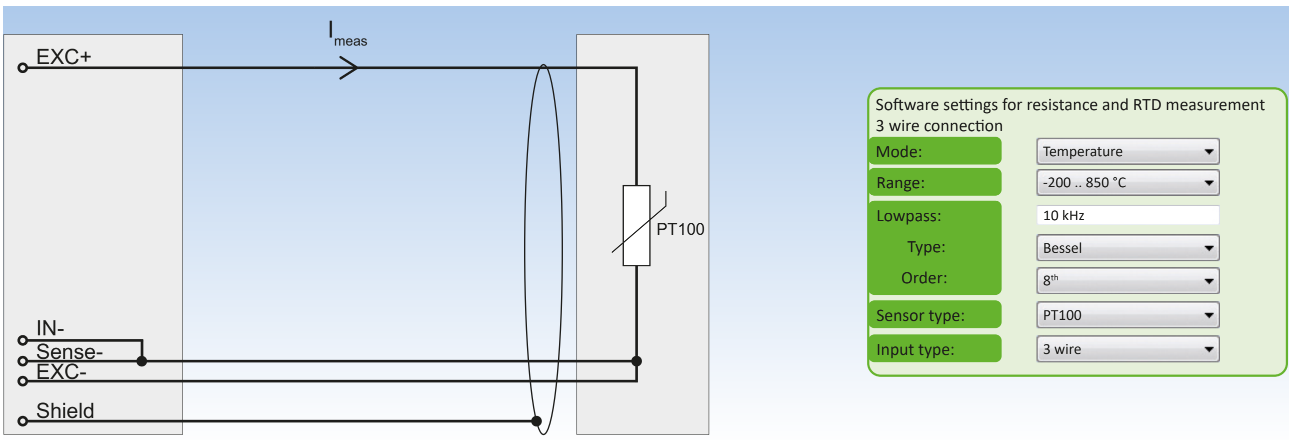



*Fig. 88: Resistance and RTD measurement 3 wire connection*

### Resistance and RTD measurement 4 wire connection

Sense connection is optional.

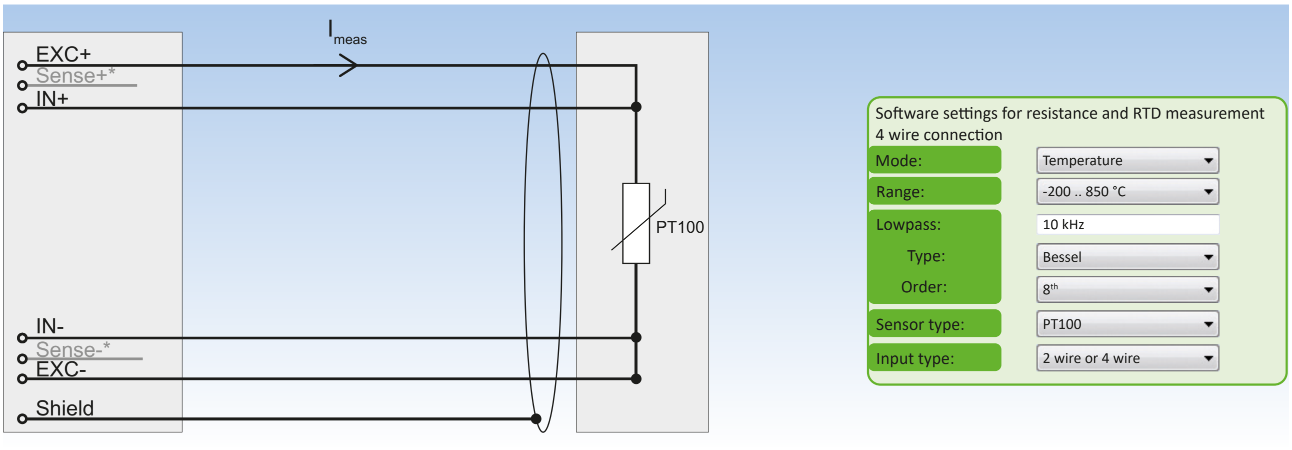



*Fig. 89: Resistance and RTD measurement 4 wire connection*

## CAN bus connection

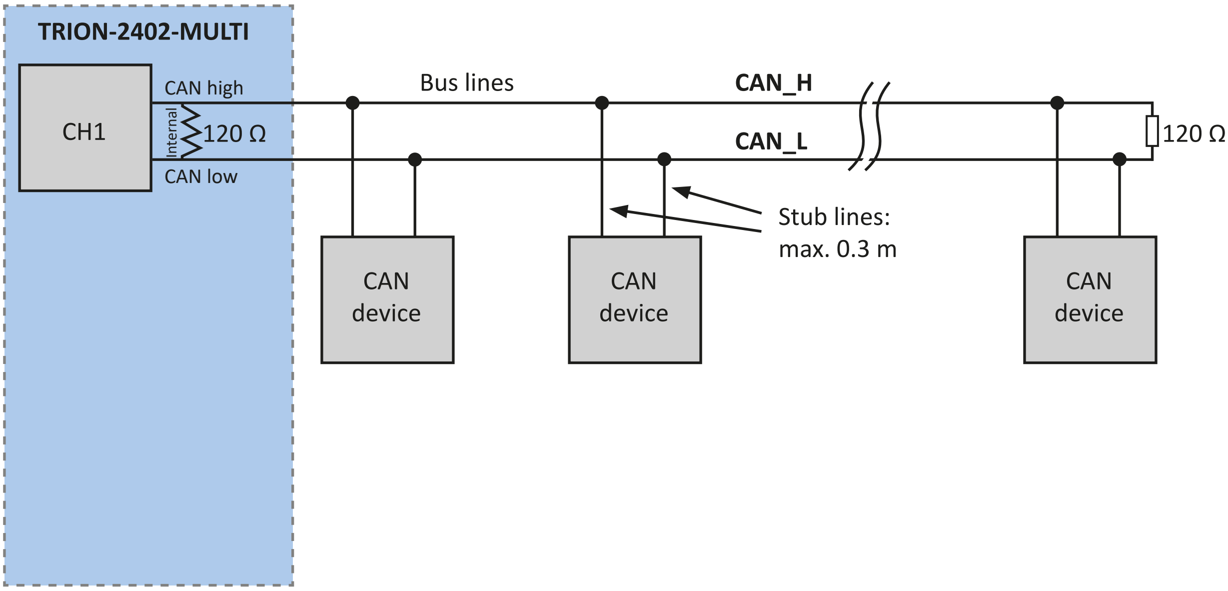



*Fig. 90: CAN bus connection*

## Connecting XR modules to the TRION-2402-MULTI

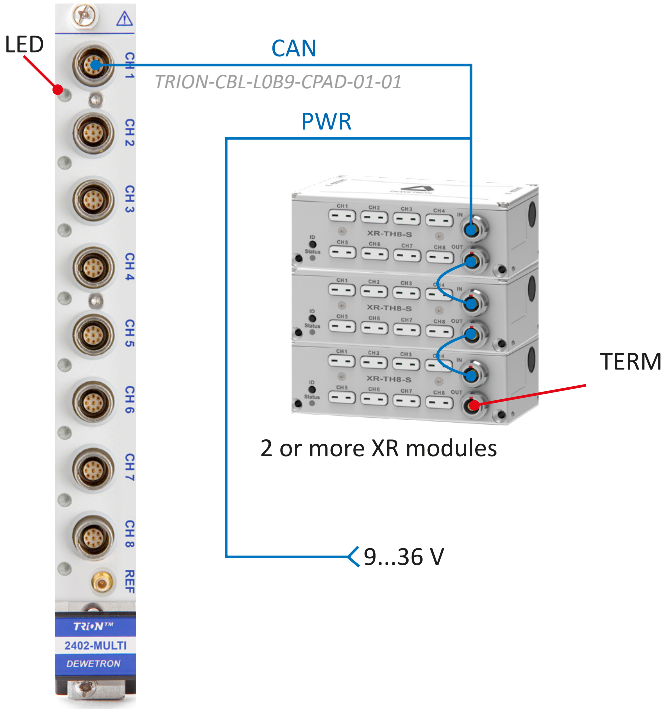



*Fig. 91: Connecting XR modules to the TRION-2402-MULTI module*

## TRION-2402-MULTI resistance accuracy

| Range (Ω) | Excitation current (mA) | Accuracy |
|---|---|---|
| 30 k | 0.2 | 6 Ω ±1 % of reading |
| 10 k | 0.5 | 2 Ω ±0.45 % of reading |
| 3000 | 1 | 0.6 Ω ±0.25 % of reading |
| 1000 | 1 | 0.2 Ω ±0.25 % of reading |
| 300 | 1 | 80 mΩ ±0.25 % of reading |
| 100 | 1 | 40 mΩ ±0.25 % of reading |
| 30 | 5 | 8 mΩ ±2 % of reading |
| 10 | 5 | 4 mΩ ±2 % of reading |

*Tab. 31: TRION-2402-MULTI resistance accuracy*

| RTD (Type) | Temperature range (°C) | Excitation current (mA) | Range (Ω) | Accuracy |
|---|---|---|---|---|
| PT100 | -200 to 850 | 1 | 1000 | 0.9 °C ±0.33 % of reading |
| PT200 | -200 to 850 | 1 | 1000 | 0.7 °C ±0.33 % of reading |
| PT500 | -200 to 850 | 1 | 2000 | 0.7 °C ±0.33 % of reading |
| PT1000 | -200 to 850 | 0.5 | 10000 | 1.1 °C ±0.4 % of reading |
| PT2000 | -200 to 850 | 0.5 | 10000 | 1.1 °C ±0.4 % of reading |

*Tab. 32: TRION-2402-MULTI resistance accuracy (temperature)*

| Range (Ω) | Excitation current (mA) | Voltage range (V) | Accuracy | Temp drift (ppm /°C) | RTD sensor |
|---|---|---|---|---|---|
| 10 k | 0.5 | 10 | 2 Ω ±0.45 % | 100 | Pt2000, Pt1000 |
| 3 k | 1 | 10 | 0.6 Ω ±0.25 % | 100 | Pt500 |
| 1 k | 1 | 2 | 0.2 Ω ±0.25 % | 100 | Pt200, Pt100 |

*Tab. 33: RTD temperature drift specification for TRION-2402-MULTI*

## Cables and shielding

To keep the influence of electromagnetic disturbances as small as possible, shielded twisted pair cables are recommended. Connect the shield to the connector housing or to the mechanical structure.

The twisted pairs for **full bridge**, **half bridge**, **voltage** and **resistance** mode are:

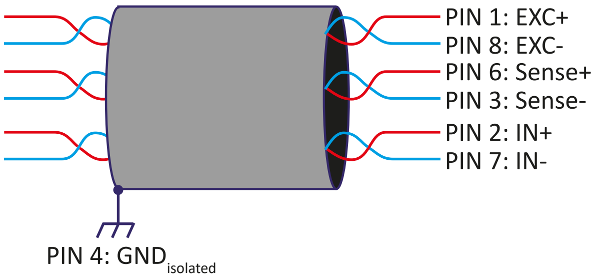



*Fig. 92: Cables and shielding*

## Shielding/noise reduction

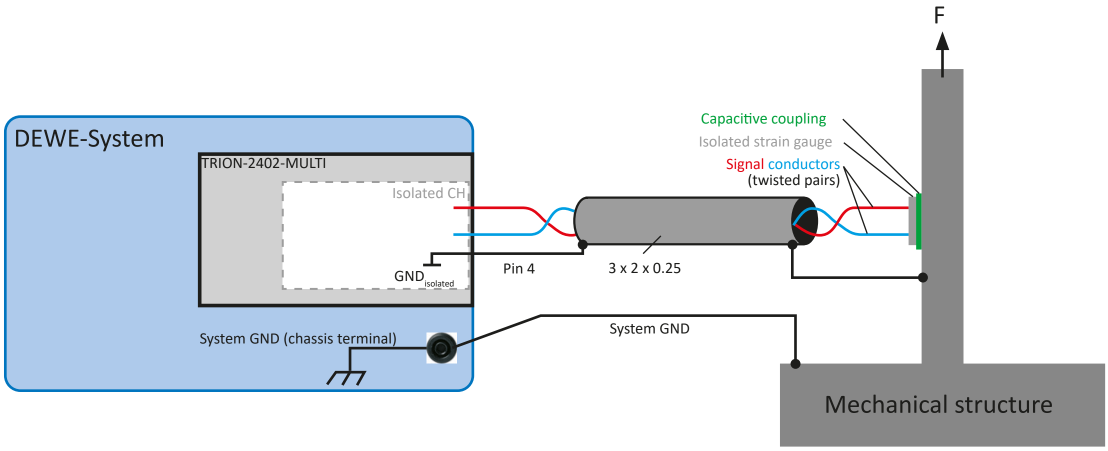



*Fig. 93: Strain gauge measurement on a metal structure*

It is always important that you connect your DEWETRON system ground (chassis terminal) to the ground potential of your measured object. This guarantees that the measurement system is not floating against the measured structure. It could simply be a connection to the metal structure of your proving ground. In case of an automotive application for example, it would be a connection to the cars chassis. Only if the DEWETRON system and the measured structure have an earth connection the system grounding line might not be needed.

# Block diagram

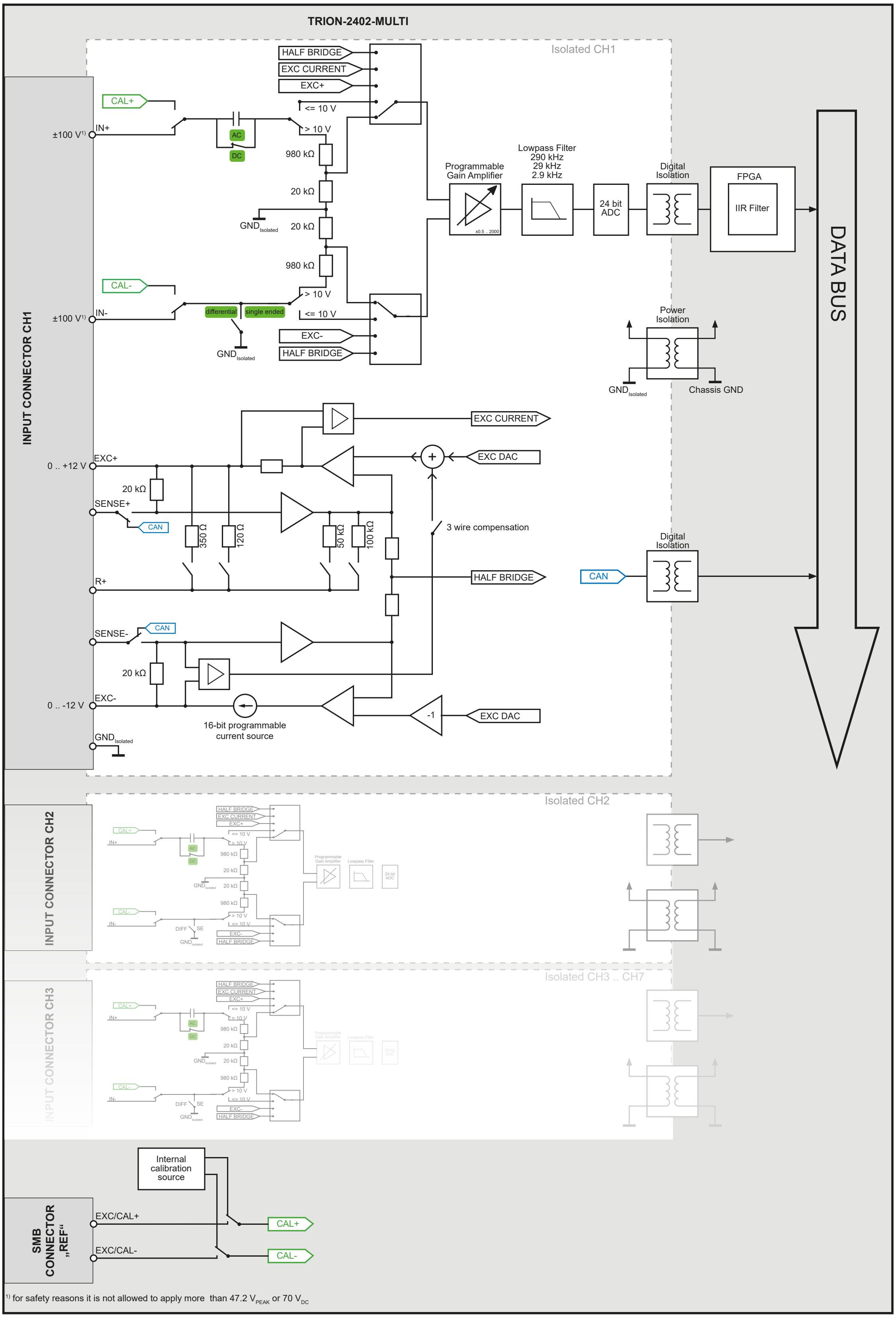



*Fig. 94: Block diagram*

# TRION3-1802/1600-dLV-32

- Multi-function module with voltage inputs, digital I/Os, counter and CAN
- Channels: 32 single-ended or 16 differential, synchronous channels
- Sampling
  - TRION3-1802-dLV-32: 18-bit; 200 kS/s per channel
  - TRION3-1600-dLV-32: 16-bit; 20 kS/s per channel
- Input type: 5 V/10 V
- Features: 2x counter; CAN bus; RS-485; 8x DI; 4x DO


## Module specifications

| TRION3-1802/1600-dLV-32 specifications | | |
|---|---|---|
| Input channels | TRION3-1802-dLV-32 | 32 channels single-ended or 16 channels fully differential |
| | TRION3-1802-dLV-32-CAN | 32 channels single-ended or 16 channels fully differential + CAN |
| | TRION3-1600-dLV-32 | 32 channels single-ended or 16 channels fully differential |
| | TRION3-1600-dLV-32-CAN | 32 channels single-ended or 16 channels fully differential + CAN |
| Sampling rate / resolution | TRION3-1802-dLV-32 | High-speed mode: >50 to 200 kS/s, 18-bit<br>Over-sampling mode: 100 S/s to 20 kS/s, 24-bit |
| | TRION3-1600-dLV-32 | 100 S/s to 20 kS/s 16-bit |
| Data transfer | TRION3-1802-dLV-32: 16-bit / 24-bit / 32-bit<br>TRION3-1600-dLV-32: 16-bit | |
| Onboard data buffer | 512 MB | |
| ADC type | 18-bit SAR[2)] (Successive Approximation Register) | |
| Data rate DMA transfer | 32 analog channels: max 28 MB/s; 2x counter: max. 6 MB/s | |
| Input ranges<br>– Voltage | <br>±5 V, ±10 V | |
| Input noise (5 mV range)<br>– 0 to 10 Hz<br>– Full bandwidth | <br>10 µ$V_{PP}$<br>1.35 m$V_{PP}$ | |
| Input impedance | 1 MΩ single-ended, 2 MΩ differential | |
| Input bias current | <25 pA | |
| Input coupling | DC | |
| Accuracy[1)] | Voltage | DC to 1 kHz ±0.02 % of reading ± 0.01 % of range ±20 µV<br>>1 kHz to 5 kHz ±0.5 % of reading ± 0.01 % of range ±20 µV<br>>5 kHz to 10 kHz[2)] ±1 % of reading ± 0.01 % of range ±20 µV |
| Gain drift | Typical 10 ppm/°C max. 20 ppm/°C | |
| Offset drift | Typical 0.3 µV/°C + 10 ppm of range/°C, max 15 µV/°C + 20 ppm of range/°C | |
| Linearity | <20 ppm | |
| Input configuration | Differential or single-ended with GND sense | |
| Typical THD | -95 dB | |
| Typical CMRR in differential mode | 100 dB @ 50 Hz; >70 dB @ 1 kHz | |

*Tab. 34: Module specifications*

| **TRION3-1802/1600-dLV-32 specifications** | | | | |
|---|---|---|---|---|
| Typical signal-to-noise ratio, spurious<br>Free SNR, effective number of Bits, $V_{PP}$[2] | **10 V range** | | | |
| | SNR | SFDR[3] | ENOB[4] | Noise peak to peak |
| Sample rate | [dB] | [dB] | [Bit] | [$mV_{PP}$] |
| 0.1 kS/s | 127 | 130 | 20.8 | 0.015 |
| 1 kS/s | 118 | 130 | 19.3 | 0.055 |
| 10 kS/s | 109 | 130 | 17.8 | 0.22 |
| 20 kS/s | 106 | 130 | 17.3 | 0.33 |
| 50 kS/s[2] | 102[2] | 130[2] | 16.7 | 0.52[5] |
| 100 kS/s[2] | 99[2] | 130[2] | 16.2 | 0.66[5] |
| 200 kS/s[2] | 96[2] | 125[2] | 15.7 | 1.00[5] |
| Low pass filter (-3 dB, dig.)<br>– Characteristic<br>– Filter order | 1 Hz to 40 % of sample rate freely programmable or OFF<br>Bessel or Butterworth<br>$2^{nd}$ , $4^{th}$, $6^{th}$, $8^{th}$ | | | |
| Analog antialiasing filter | $2^{nd}$ order Butterworth | | | |
| Bandwidth (-3 dB, deactivated digital filter) | 70 kHz $3^{rd}$ order Butterworth filter | | | |
| Crosstalk fin 1 kHz [10 kHz] | >108 dB | | | |
| Channel-to-channel phase mismatch | Typically <30 ns when using the same input range | | | |
| Board-to-board phase mismatch | <30 ns | | | |
| Common mode voltage | ±12.5 $V_{DC}$ | | | |
| Overvoltage protection | ±50 $V_{DC}$ | | | |
| Digital IN specification | Digital Input | 8 CMOS/TTL compatible digital inputs; weak pullup via 100 kΩ | | |
| | Overvoltage protection | ±30 $V_{DC}$, 50 $V_{PEAK}$ (for 100 ms) | | |
| | Counter<br>– Counter resolution<br>– Counter time base<br>– Max. input freq. | 2 counter channels; TTL input; shared with digital inputs<br>32-bit<br>80 MHz<br>10 MHz | | |
| | Counter modes<br>– Waveform timing<br>– Sensor modes<br>– Event counting | <br>Period, frequency, pulse width duty cycle and edge separation<br>Encoder (angle and linear)<br>Basic event counting, gated counting, up/down counting and encoder mode (X1, X2 and X4) | | |
| Digital OUT specification | Digital output | 4 DO; TTL | | |
| | Output indication | LED (green = high; off = low) | | |
| | Maximum current | 25 mA continuously | | |
| | Power-on default | Low | | |
| General specification | Sensor power supply (per module) | 5 V (600 mA) and 12 V (600 mA) | | |
| | ESD protection | IEC61000-4-2: ±8 kV air discharge, ±4 kV contact discharge | | |
| | Power consumption | Voltage mode: 6 W | | |

*Tab. 34: Module specifications*

| TRION3-1802/1600-dLV-32 specifications | | |
|---|---|---|
| Interfaces | CAN bus<br>– CAN specification<br>– CAN physical layer<br>– Bus pin fault protection<br>– Termination<br>– RS485 | 1 CAN Bus; not isolated; routed to D-SUB-25<br>CAN 2.0B<br>High-speed<br>±36 $V_{DC}$<br>Programmable: High impedance or 120 Ω<br>1 RS485 interface dedicated to DAQP series modules |

*Tab. 34: Module specifications*

1) 1 year accuracy 23 °C ±5 °C

2) LP Filter in auto mode

3) SFDR excluding harmonics

4) ENOB calculated from SNR

5) TRION3-1802-dLV-32 only

# TRION3-1802/1600-dLV-32 module

## Connection

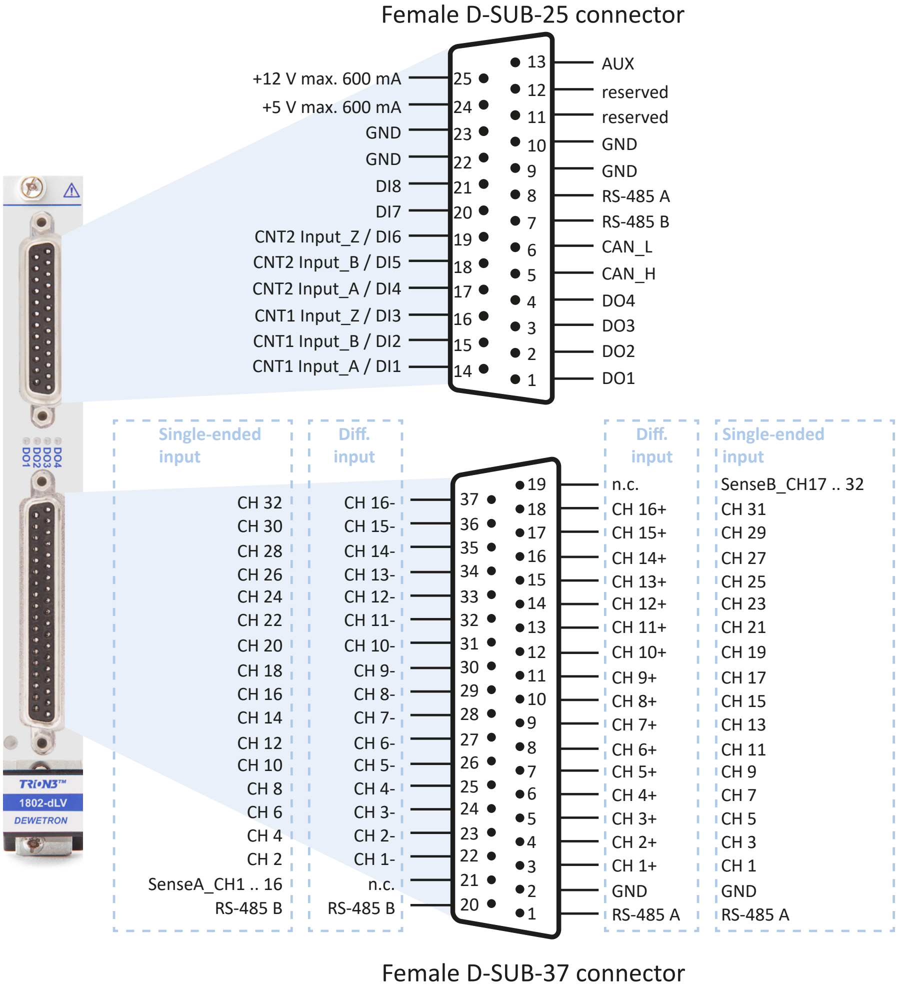



*Fig. 95: Connection*

## Optional accessory

### TRION-x-dLV-CB16-D9

- 16 channel sensor connection box
- Precision ±5 V excitation voltage with remote sense per channel
- MSI support (Modular Smart Interface)
- Auxiliary sensor supply

| Modular smart interfaces | | Input | Sensor excitation | Bandwidth[1)] | Accuracy | Sensor connection |
|---|---|---|---|---|---|---|
| MSI2-STG |  | Bridge-type sensors<br>full-bridge, half-bridge, quarter bridge 120 Ω and 350 Ω | 5 V and 10 V | 60 kHz | ±0.1 % | Miniature spring terminals |
| MSI2-LVDT |  | LVDT and RVDT sensors,<br>5- or 6-wire connection | 3 V at 2.5, 5 or 18 kHz | 1 kHz | ±0.1 % | Soldering pads |
| MSI-BR-ACC |  | IEPE® sensors, typ. accelerometer, microphone | 4 mA | 1.4 Hz to 70 kHz | ±0.2 % | BNC |
| MSI2-CH-x |  | Charge type sensors up to 100 000 pC | n/a | 0.08 Hz to 70 kHz | ±0.5 % | BNC |
| MSI2-TH-x |  | Thermocouple sensors<br>Standard models for type K, J, T, others on request | n/a | DC to 70 kHz | ±1 °C | Mini TC socket |
| MSI-BR-V-200 |  | Voltage up to 70 $V_{DC}$, 46.7 $V_{PEAK}$ | n/a | DC to 60 kHz | ±0.1 % | BNC |
| MSI2-V-600 |  | Voltage up to 600 V CAT II | n/a | DC to 60 kHz | ±0.1 % | Banana sockets |
| MSI-BR-RTD |  | RTD sensors<br>Pt100, Pt200, Pt500, PT1000, Pt2000; 2, 3 and 4 wire connection | 1.25 mA | DC to 10 kHz | ±0.1 % | Binder 712 series 5-pin socket |
| MSI2-250R-20mA |  | 4 to 20 mA sensors | n/a | DC to 70 kHz | ±0.1 % | Miniature spring terminals |

*Tab. 35: Input types for TRION-x-dLV-CB16-D9*

1) ***INFORMATION*** Max. value; consider limit of the used TRION module.

**INFORMATION**

For further information refer to the *TRION-x-dLV-CB16-D9 / MSI2 Series* technical reference manual.

### C15Axx

Cable for connecting 16 or 32 channels to a TRION3-1802-dLV module in single-ended configuration. Two C15Axx cables are required for 32 channels.

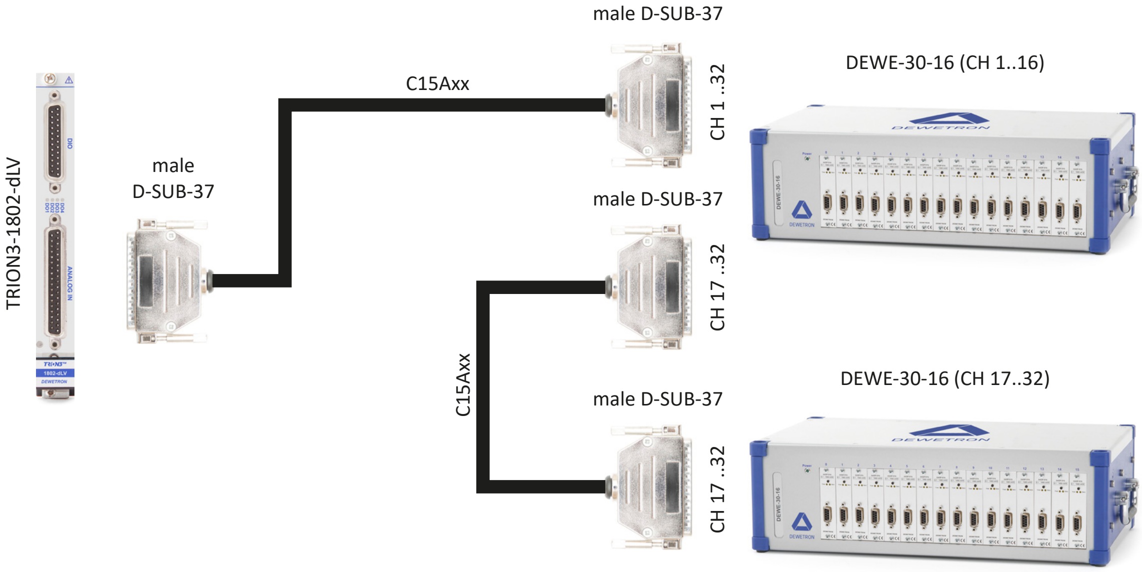



*Fig. 96: C15Axx*

# LED function

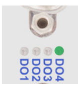
## Status LED

Green: Normal operation

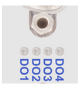
Off: Board not initailized

*Fig. 97: Status LED*

## Digital output LED



Green: DO is active (output is 5 V)



Off: DO is deactivated (output is 0 V)

*Fig. 98: Digital output LED*

## Block diagram

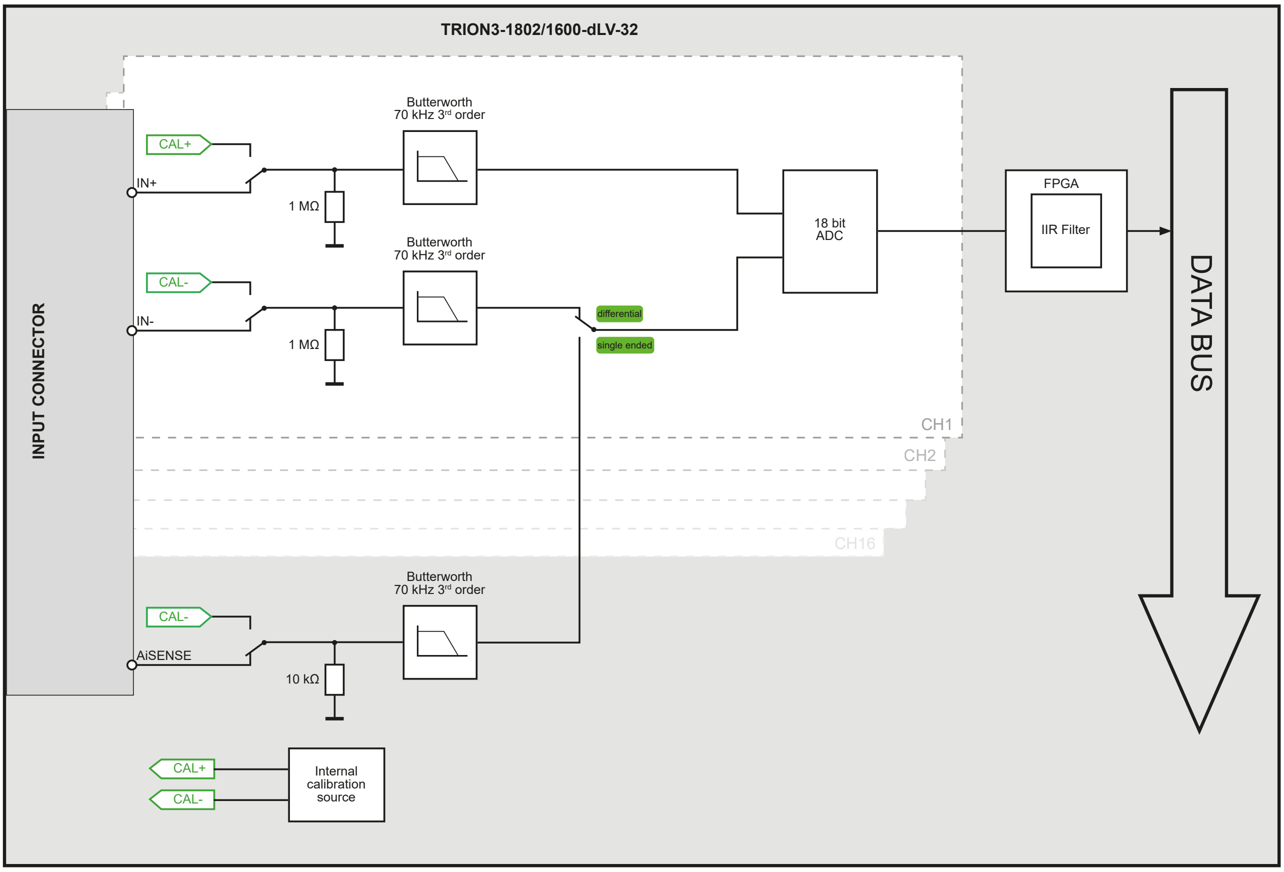



*Fig. 99: Block diagram*

The TRION3-1802/1600-dLV series is a highly accurate, 18-bit voltage digitizer. Each channel has its own AD converter. Refer to chapter *TRION-1620 sample system architecture* in the TRION(3) series modules technical reference manual for more details about bandwidth and filtering.

## TRION3-1802/1600-dLV-32 function overview

### Short

The short function switches IN+ to IN- via the calibration circuit. It can be used to check the offset of the input amplifier.

### Auto Zero

Uses the short function to compensate the input offset. This allows eliminating long-term offset drifts as well as compensating environmental temperature related offsets.

### Self Test

The TRION3-1802/1600-dLV series has an integrated special self test circuit. It consists of a programmable high precision voltage source on the first channel and a relay matrix. It is used to check the analog input path of the voltage amplifier by applying 0 V and 90 % of the input range to the input. During the board self test, which is available in the DEWETRON Explorer, this test is performed for all ranges and channels automatically. Disconnect all cables during self test to avoid ground loops.

### Single-ended / differential mode

Use the DEWETRON Explorer to setup the TRION3-1802/1600-dLV series board as 16 channel differential or 32 channel single-ended. The information is stored on the board.

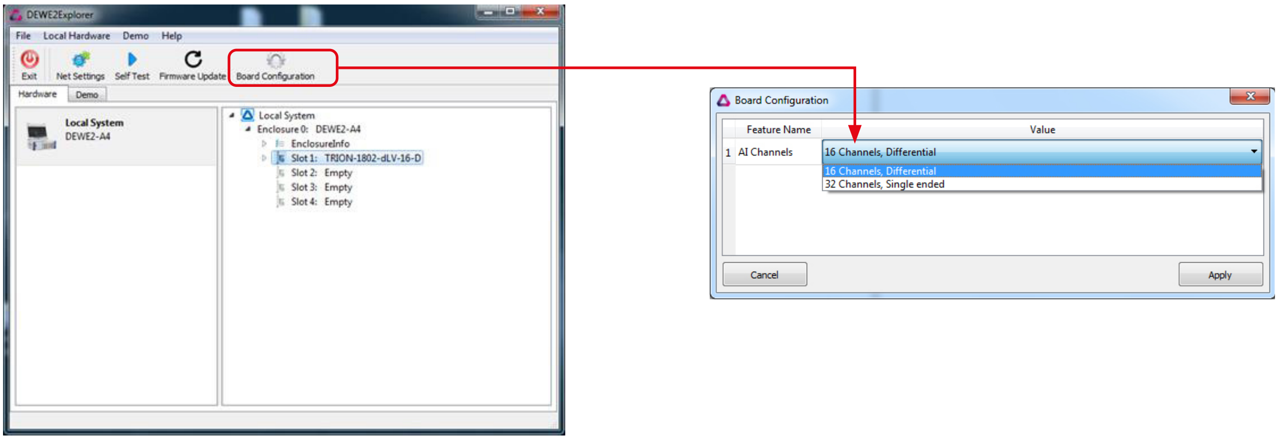



*Fig. 100: Single-ended / differential mode*

### Counter functions

Supported counter functions are:*)

- Simple event counting
- Period measurement
- Pulse width
- Frequency
- Duty cycle

*) The available counter functions depend on the application software used and may differ from this list.

For detailed information about this functions refer to chapter *Functional description of advanced counter* in the TRI-ON(3) series modules technical reference manual.

## Signal connection

### Single-ended

This is recommended to use with DEWE-30 series instruments or any other multi-channel output device with common ground.

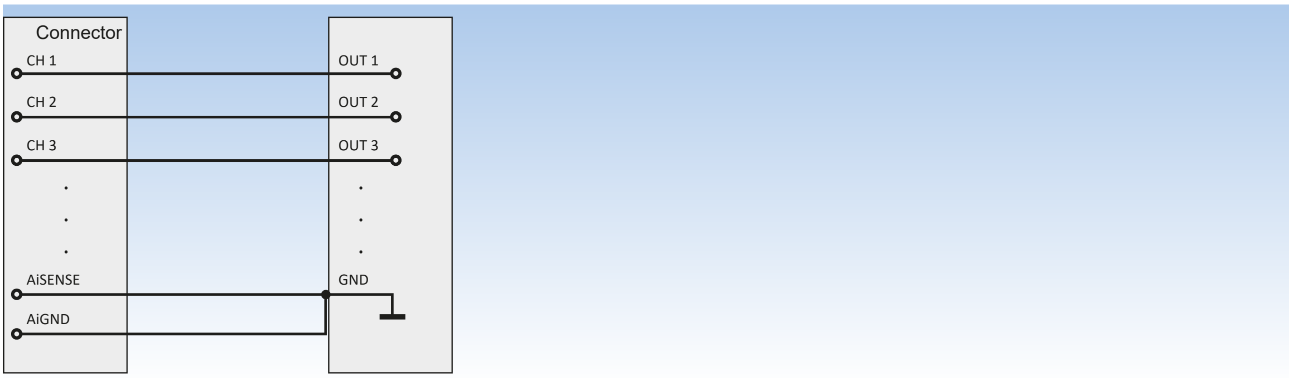



*Fig. 101: Single-ended*

## Differential input

This is recommended to use with multiple separated sensors without common ground or differential output.

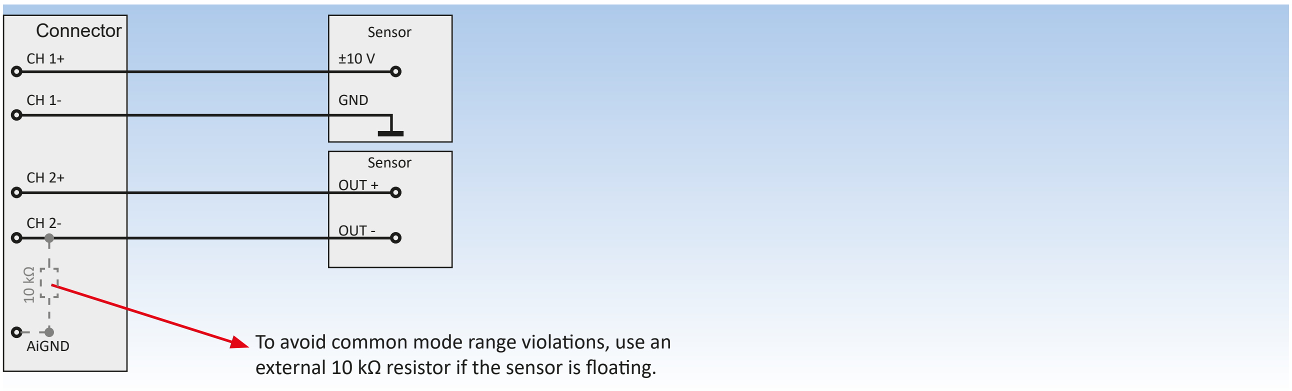
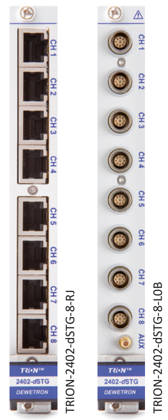



*Fig. 102: Differential input*

# TRION-2402-dSTG

- Differential universal input module
- Sampling: 24 bit, 200 kS/s per channel
- Input types
  - Voltage
  - Strain gauge, bridge sensor, piezo-resistive bridge
  - IEPE®
  - Resistance, potentiometer




## Module specifications

| TRION-2402-dSTG specifications | | |
|---|---|---|
| Input channels | TRION-2402-dSTG-8-RJ | 8 channels using RJ-45 sockets |
| | TRION-2402-dSTG-8-L0B | 8 channels using LEMO 0B sockets |
| Sampling rate | 200  kS/s channel | |
| Resolution | 24 bit | |
| Input ranges | | |
| – Voltage | ±10 mV, 30 mV, 100 mV, 300 mV, 1 V, 3 V, 10 V | |
| – Bridge | 1, 3, 10, 30, 100, 300, 1000 mV/V or mV/mA | |
| – IEPE® | ±100 mV, 300 mV, 1 V, 3 V, 10 V | |
| – Resistance | 10 Ω, 30 Ω, 100 Ω, 300 Ω, 1 kΩ, 3 kΩ, 10 kΩ, 30 kΩ | |
| – Current | Depending on external shunt | |
| Voltage input accuracy[1)] | ±0.02 % of reading ± 0.02 % of range ±20 µV | |
| – Gain drift | Typical 10 ppm/°C max. 20 ppm/°C | |
| – Offset drift | Typical 0.3 µV/°C+ 10 ppm of range/°C, max 2 µV/°C + 20 ppm of range/°C | |
| – Linearity | Typical ±0.01 % | |
| Input impedance | 100 MΩ | |
| Input bias current | <1 nA | |
| Input configuration | Single-ended or differential (programmable) | |
| Input coupling | DC, AC (0.16 Hz, 0.5 Hz, 3.4 Hz, 10 Hz); max. DC voltage when AC coupled: 50 V | |
| Excitation voltage | 0 to 13.5 $V_{DC}$ (programmable, 1 mV steps), 100 mA max. current, max. 8 W per module | |
| – Accuracy[1)] | ±0.03 % ±1 mV | |
| – Drift | ±10 ppm/K ±50 µV/K | |
| – Current limit | 100 mA | |
| – Protection | Continuous short to ground | |
| Excitation current | 0.002 to 20 mADC (pogrammable, 1 µA steps) | |
| – Accuracy[1)] | 0.05% ±2 µA | |
| – Drift | 15 ppm/°C | |
| – Compliance voltage | 10 V | |
| – Output impedance | >10 MΩ | |

*Tab. 36: Module specifications*

| **TRION-2402-dSTG specifications** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IEPE® excitation | 4 mA ±10 % | | | | | | | | | | | |
| – Compliance voltage | 22 V | | | | | | | | | | | |
| Supported sensors | 4- or 6-wire full bridge<br>3- or 5-wire ½ bridge with internal completion<br>3- or 4-wire ¼ bridge with internal resistor for 120 and 350 Ω<br>4-wire full bridge with constant current excitation (piezo-resistive bridge sensors)<br>Potentiometer; resistance<br>IEPE® (fixed 4 mA excitation) | | | | | | | | | | | |
| Bridge resistance | 80 Ω to 10 kΩ @ ≤ 5 $V_{DC}$ excitation | | | | | | | | | | | |
| Shunt calibration | Two internal shunt resistors 50 kΩ and 100 kΩ | | | | | | | | | | | |
| Shunt and completion resistor accuracy | 0.05 % ±15 ppm/K | | | | | | | | | | | |
| Automatic bridge balance | 250 % of range | | | | | | | | | | | |
| Typical signal-to-noise ratio, spurious | **10 mV range** | | | **100 mV range** | | | **1 V range** | | | **10 V range** | | |
| Free SNR, effective number of bits[2)] | SNR | SFDR[3)] | ENOB[4)] | SNR | SFDR[3)] | ENOB[4)] | SNR | SFDR[3)] | ENOB[4)] | SNR | SFDR[3)] | ENOB[4)] |
| Sample rate | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] |
| 1 kS/s | 82 | 108 | 13.3 | 101 | 128 | 16.5 | 111 | 141 | 18.1 | 112 | 141 | 18.3 |
| 10 kS/s | 78 | 106 | 12.7 | 98 | 126 | 16.0 | 108 | 136 | 17.6 | 109 | 138 | 17.8 |
| 100 kS/s | 72 | 103 | 11.7 | 92 | 123 | 15.0 | 104 | 134 | 17.0 | 107 | 136 | 17.5 |
| 200 kS/s | 69 | 99 | 11.2 | 80 | 120[5)]/106 | 13.0 | 81 | 133[5)]/106 | 13.2 | 81 | 135[5)]/106 | 13.2 |
| Typical THD | -97 dB | | | | | | | | | | | |
| Typical CMRR | 100 dB @ 50 Hz; 90 dB @ 1 kHz; 80 dB @ 10 kHz | | | | | | | | | | | |
| Analog anti-aliasing filter | | | | | | | | | | | | |
| – Sample rate ≤ 1k S/s | 2.5 kHz (-3 dB), 1.5 kHz (-1 dB) | | | | | | | | | | | |
| – Sample rate ≤ 10 kS/s | 25 kHz (-3 dB), 15 kHz (-1 dB) | | | | | | | | | | | |
| – Sample rate > 10 kS/s | 250 kHz (-3 dB), 150 kHz (-1 dB) | | | | | | | | | | | |
| Bandwidth (-3 dB digital filter) | 2.5 kHz (-3 dB), 1.5 kHz (-1 dB) | 0.494 fs | | | | | | | | | | |
| | 25 kHz (-3 dB), 15 kHz (-1 dB) | 0.49 fs | | | | | | | | | | |
| | 250 kHz (-3 dB), 150 kHz (-1 dB) | 0.38 fs | | | | | | | | | | |
| Crosstalk fin 1 kHz [10 kHz] | 120 dB [105 dB] | | | | | | | | | | | |
| Channel-to-channel phase mismatch | Typically <60 ns between channels using the same range | | | | | | | | | | | |
| Common mode voltage | ±10 $V_{DC}$ | | | | | | | | | | | |
| Overvoltage protection | ±50 $V_{DC}$ | | | | | | | | | | | |
| Supported TEDS chips | All common TEDS chips are supported. | | | | | | | | | | | |
| Supported MSI adapters | MSI adapters are not supported | | | | | | | | | | | |
| Typical power consumption | Voltage mode; no excitation | 7 W | | | | | | | | | | |
| | IEPE® mode | 7 W | | | | | | | | | | |
| | 350 Ω full bridge (5 V / 10 V) | 7 W / 9.5 W | | | | | | | | | | |
| | 120 Ω quarter bridge 5 V excitation | 8 W | | | | | | | | | | |
| | Bridge mode without connected sensor | 11.5 W[7)] | | | | | | | | | | |

*Tab. 36: Module specifications*

| TRION-2402-dSTG specifications | |
|---|---|
| Weight | Approx. 200 g (RJ45 version), appr. 250 g (LEMO version) |

*Tab. 36: Module specifications*

1) 1 year accuracy 23 °C ±5 °C

2) LP Filter in auto mode

3) SFDR excluding harmonics

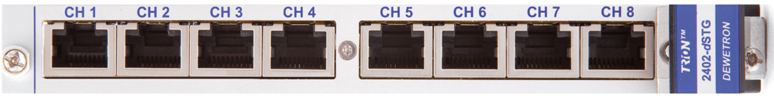
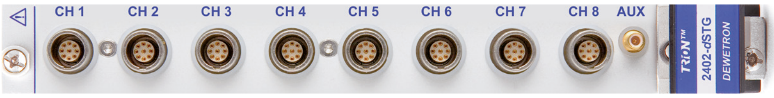
4) ENOB calculated from SNR

5) Below 0.22 fs

6) Consider maximum power supply of your DEWE2 chassis

7) Do not switch to bridge mode if the input is open.

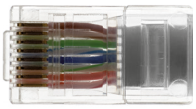
# TRION-2402-dSTG model overview

| | |
|---|---|
| **TRION-2402-dSTG-8-RJ** |  |
| **TRION-2402-dSTG-8-LOB** |  |

*Tab. 37: TRION-2402-dSTG model overview*

# TRION-2402-dSTG-8-RJ module

## Connection

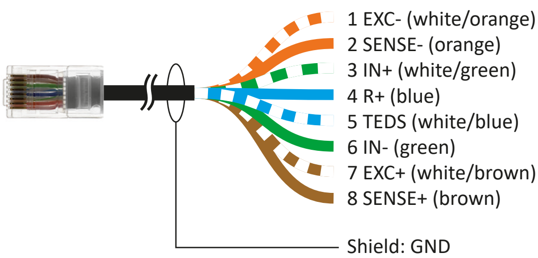



1 EXC-
2 SENSE-
3 IN+
4 R+
5 TEDS
6 IN-
7 EXC+
8 SENSE+
Housing GND

## Optional accessory

### TRION-CBL-RJ-OE-05-00

High quality cable from RJ45 plug to open end, 5 m.



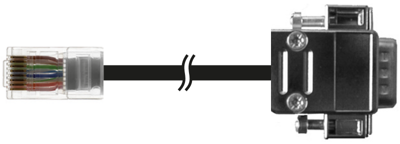

### TRION-CBL-RJ-BNC-01-00

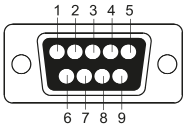
High quality cable from RJ45 plug to BNC socket, 1 m

Hot: IN +
Shield: IN -

### TRION-CBL-RJ-D9-01-00

High quality adapter cable from RJ45 plug to D-SUB-9 socket, 1 m





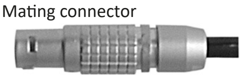

9-pin D-SUB connector
male

1 EXC+
2 IN+
3 Sense -
4 GND
5 R+
6 Sense +
7 IN-
8 EXC-
9 TEDS

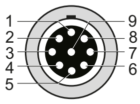
# TRION-2402-dSTG-8-LOB module

## Connection


Mating connector



FGG.0B.309.CLL




9-pin LEMO connector female
EPG.0B.309.HLN

1: EXC+
2: EXC-
3: IN+
4: IN-
5: SENSE+
6: SENSE-
7: R+
8: TEDS
9: GND
Housing: GND

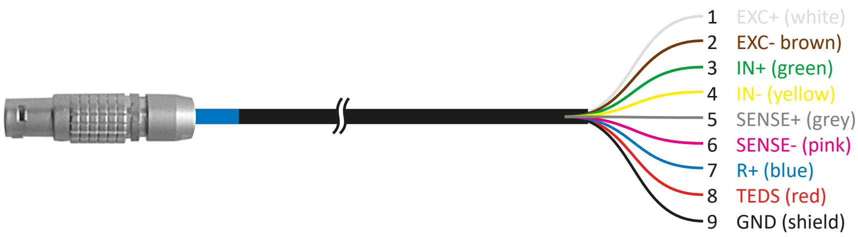
## Optional accessory

### TRION-CBL-L0B9-OE-05-02

High quality cable from Lemo 0B.309 plug to open end, 5 m.

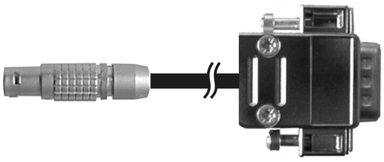

### TRION-CBL-L0B9-OE-01-02

High quality cable from Lemo 0B.309 plug to open end, 1 m.




### TRION-CBL-L0B9-D9-0.5-00

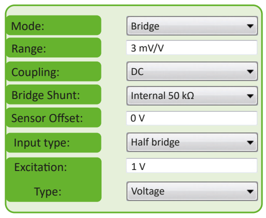
High quality adapter cable from Lemo 0B.309 plug to D-SUB-9 socket, 0.5 m.



1: EXC+
2: IN+
3: SENSE-
4: GNDi
5: R+
6: SENSE+
7: IN-
8: EXC-
9: TEDS

## TRION-2402-dSTG function overview

### Freely variable gain and excitation




Amplifier parameters such as gain, excitation voltage, excitation current and sensor offset are freely programmable for every channel individually. That allows to perfectly match each input channel to any sensor. Customized programming of the amplifier could be simply done by entering the desired value in the appropriate field.

### Excitation

The excitation circuit of the dSTG provides constant current and constant voltage excitation. The voltage mode also supports remote sense. The Sense wires have to be connected all the time, even if no remote sense is required. Beside the programmable excitation current there is also a fixed 4 mA excitation for IEPE® sensors available. This IEPE® current has a higher bias voltage of 22 V and is directly applied to the IN+ terminal.

### Amplifier balance (amplifier zero)

The amplifier balance allows eliminating automatically all internal amplifier offsets. It switches the differential amplifier inputs IN+ and IN- to the internal GND reference point. Then the offset of the module is automatically adjusted to zero for all ranges. This function takes up to 4 seconds.
It allows compensating the long term zero drift, as well as temperature drifts of the amplifier.
It could be performed for a single channel.

### Self test

The dSTG module has a special self test circuit integrated. The first part of it is a high precision voltage source and a temperature compensated divider. It is used to check the analog input path of the voltage amplifier by applying 0 V and ±98 % of the input range to the input. This test could be performed in the channel setup for the actual range. During the board self test which is available in the DEWETRON Explorer, this test is performed for all ranges and channels automatically. A self test can be carried out by right clicking the board in the DEWETRON Explorer.

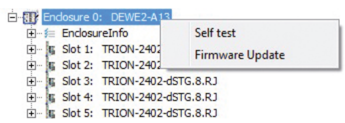



*Fig. 103: Self test*

The second part is a signal routing matrix that allows checking the sensor power supply of the acquisition channel. The driven current and the exact voltage are monitored. If the connected sensor exceeds the maximum power consummation or the nominal excitation value is wrong this test fails. That is an indication that either the sensor is damaged or the connection is wrong. Also a broken sensor cable could produce a negative result. This test could be performed in the channel setup.

### Sensor balance

Typically every strain gauge sensor has a certain offset. This offset is on the one hand caused by manufacturing tolerances and on the other influenced by the sensor mounting. By performing a “sensor balance” this sensor offset could be automatically removed up to 250 % of range.

### Internal completion resistors

The dSTG has an internal half bridge completion and two internal quarter bridge completions for 120 Ω and 350 Ω strain gauges. The used high precision resistors with low temperature drift allow a long-time stable measurement of almost every strain gauge type without using an external completion network.

### Internal shunt

With the Shunt function a 100 kΩ or a 50 kΩ shunt could be applied to the bridge sensor. That allows lead wire compensation for 3-wire quarter bridge sensors. It could also be used for checking the sensor connection of half bridge and full bridge sensors.

### Input short

It switches both differential amplifier inputs IN+ and IN- from the input terminals to the internal half bridge reference of the module. With this function the absolute sensor offset could be determined.

### Filter

Refer to chapter *A/D of TRION-2402 series* in the TRION(3) series modules technical reference manual.

### AC coupling

The TRION-2402-dSTG has four different input high pass filters available for AC coupling:

| Frequency | Time constant |
|---|---|
| 0.16 Hz | 1 s |
| 0.5 Hz | 320 ms |
| 3.4 Hz | 47 ms |
| 10 Hz | 16 ms |

*Fig. 104: AC coupling*

That allows removing DC components of the signal and using a much smaller input range. The maximum DC input voltage should not exceed ±50 $V_{DC}$.

## TEDS

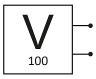
The dSTG uses a separate terminal for TEDS communication. All common TEDS chips are supported.

**NOTICE**

In IEPE® mode the TEDS function is not available because IEPE® sensors use IN+ for TEDS communication.

## Signal connection

The following schematics will give you an overview on how to connect all the different sensors to the TRION-2402-dSTG module.




### Voltage

#### Voltage measurement

- Isolated sensors
- Battery powered sensors
- Sensors with differential output

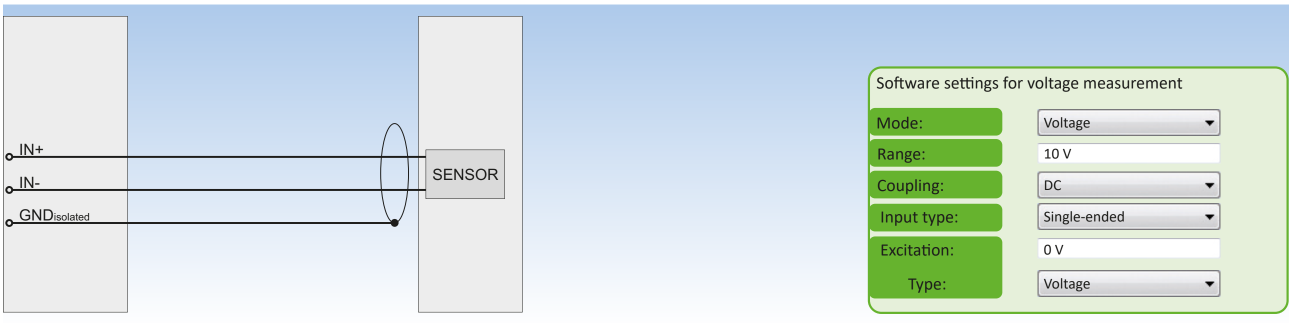



*Fig. 105: Voltage measurement*

#### Sensors with sensor supply and voltage output

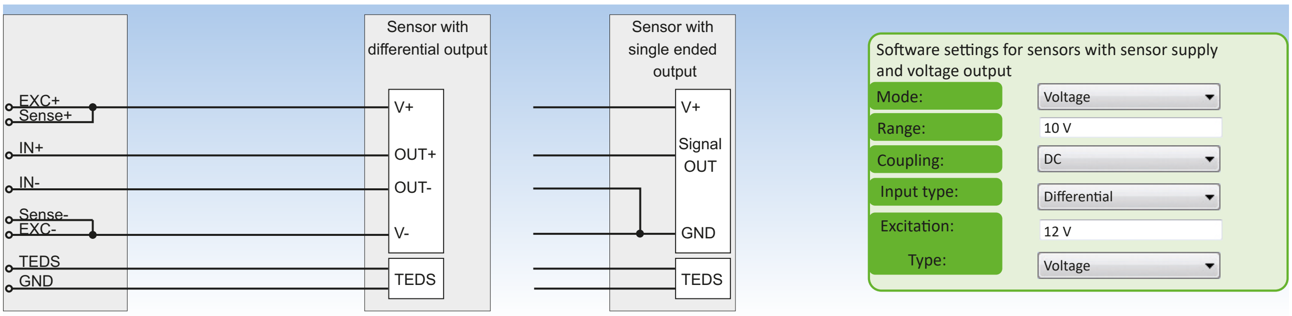
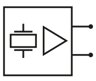



*Fig. 106: Sensors with sensor supply and voltage output*



### IEPE®

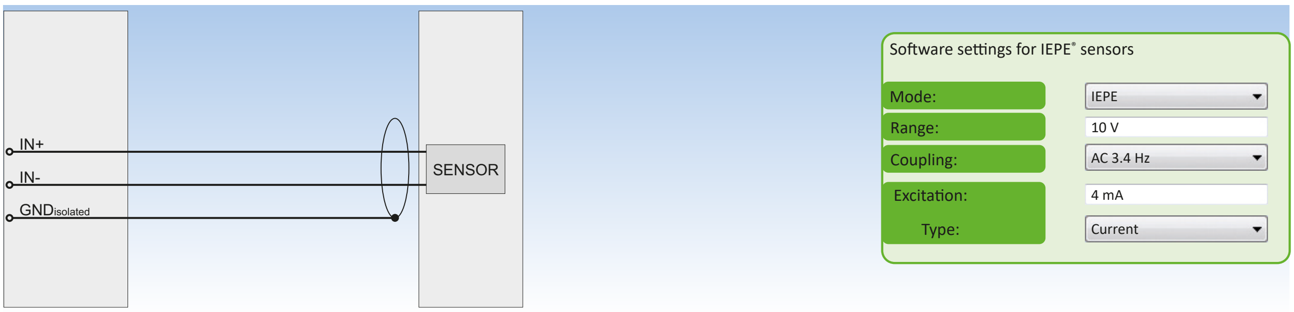
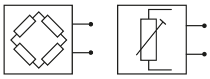



*Fig. 107: IEPE® sensor*



## Strain gauge and Potentiometer measurement

### Full bridge 6-wire sensor connection

Voltage or current excitation is allowed. TEDS connection is optional.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

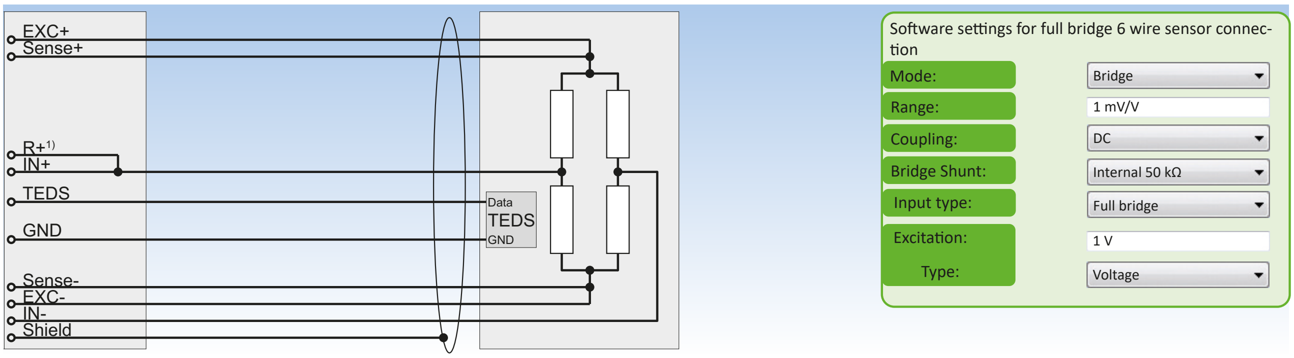



*Fig. 108: Full bridge 6-wire sensor connection*

### Full bridge 4-wire sensor connection

Voltage or current excitation is allowed. Senses terminals have to connected to the excitation also when 4-wire connection is used.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

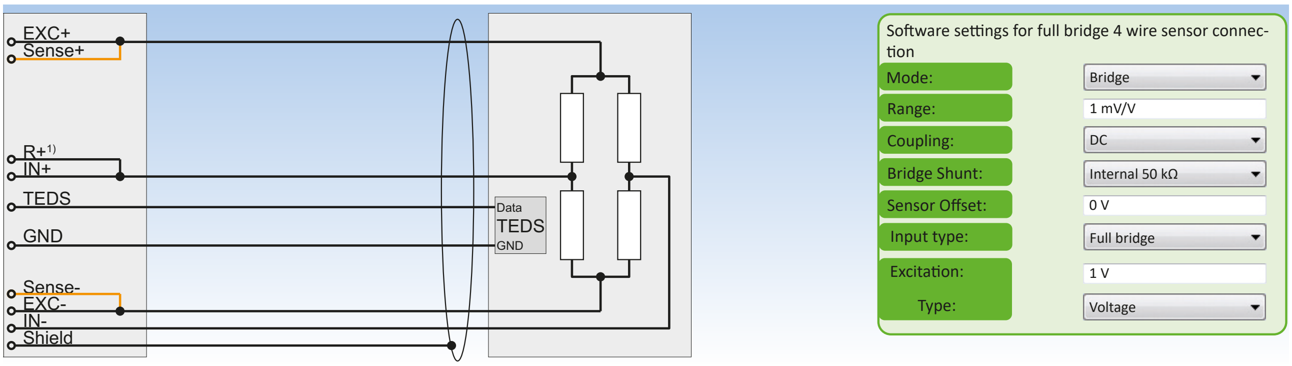



*Fig. 109: Full bridge 4-wire sensor connection*

### Half bridge or Potentiometer 5-wire sensor connection

Voltage and current excitation is allowed. A potentiometer can be seen similar to a half bridge sensor with ±500 mV/V sensitivity.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

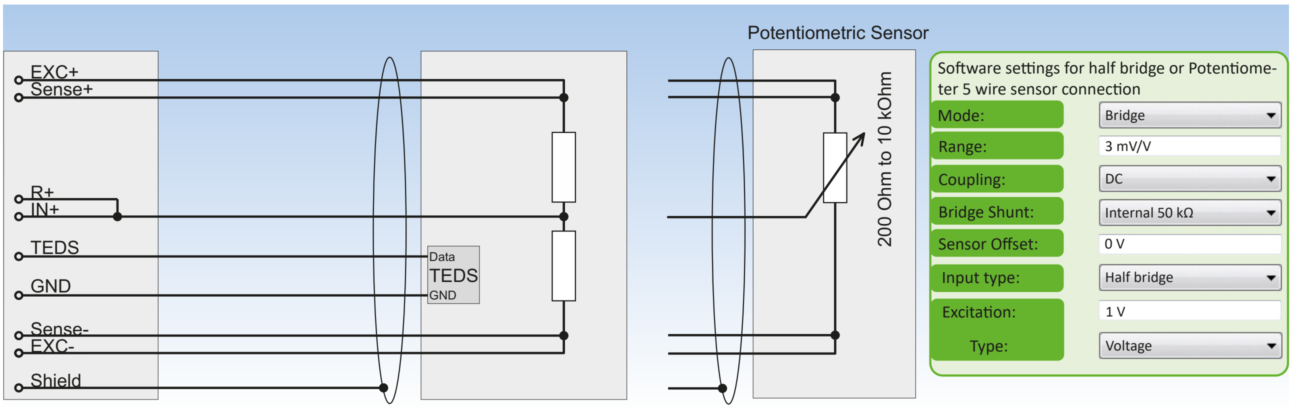



*Fig. 110: Half bridge or Potentiometer 5 wire sensor connection*

### Half bridge or Potentiometer 3 wire sensor connection

Senses terminals have to be connected to the excitation also when 4-wire connection is used.

**INFORMATION** R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

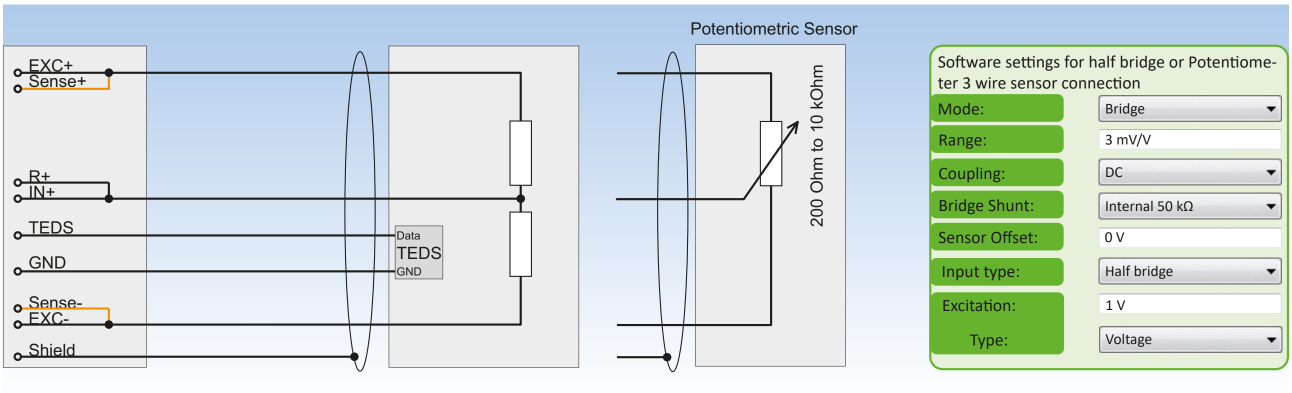



*Fig. 111: Half bridge or Potentiometer 3 wire sensor connection*

### Quarter bridge 3 wire sensor connection

The 3-wire quarter bridge is only able to compensate symmetric wire resistance.

**INFORMATION** Sense+ has to be connected to EXC+. R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

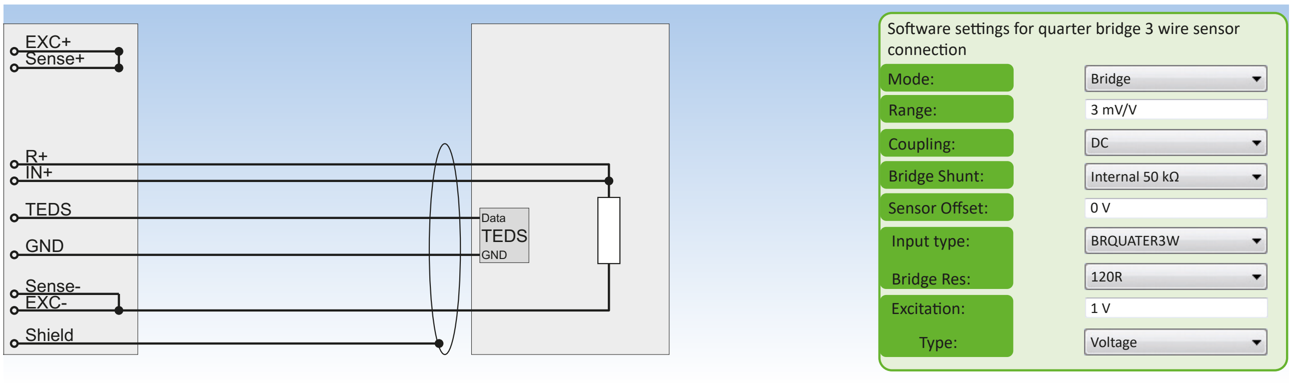



*Fig. 112: Quarter bridge 3 wire sensor connection*

### Quarter bridge 4 wire sensor connection

The 4 wire connection provides full lead wire resistance compensation.

**INFORMATION** Sense+ has to be connected to EXC+. R+ has to be connected only if shunt calibration is required, otherwise it can be left unconnected.

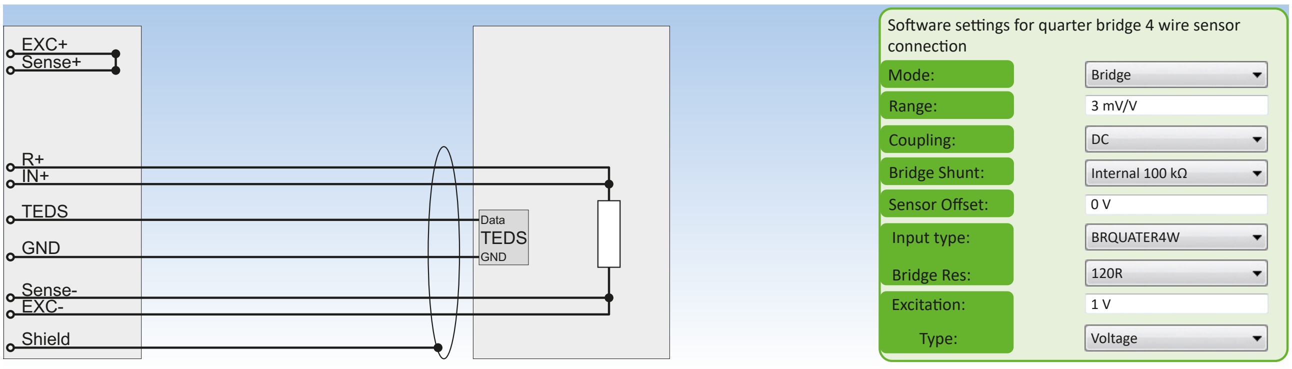
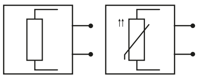



*Fig. 113: Quarter bridge 4 wire sensor connection*



## Resistance and RTD

### Resistance and RTD measurement 2 wire connection

The 2 wire technology does not compensate any lead wire resistance. For accurate temperature or resistance measurement the 4 wire technology is strongly recommended.

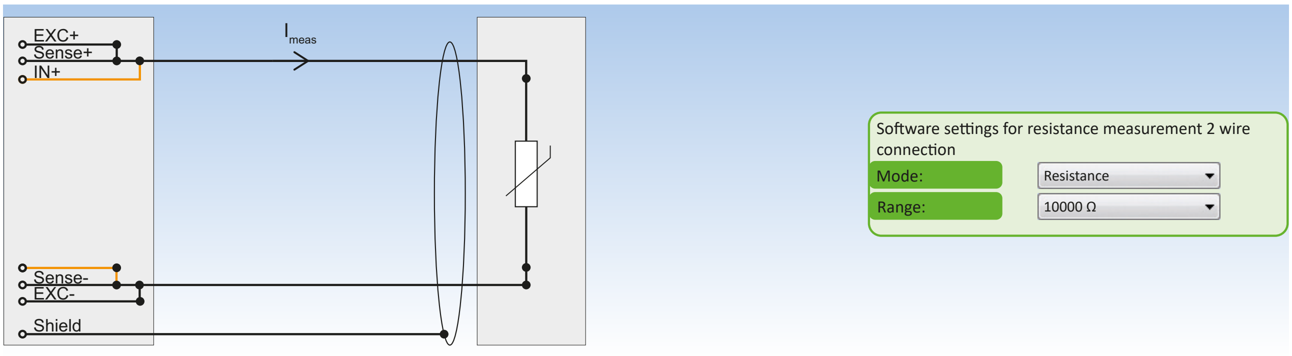



*Fig. 114: Resistance and RTD measurement 2 wire connection*

### Resistance and RTD measurement 4 wire connection

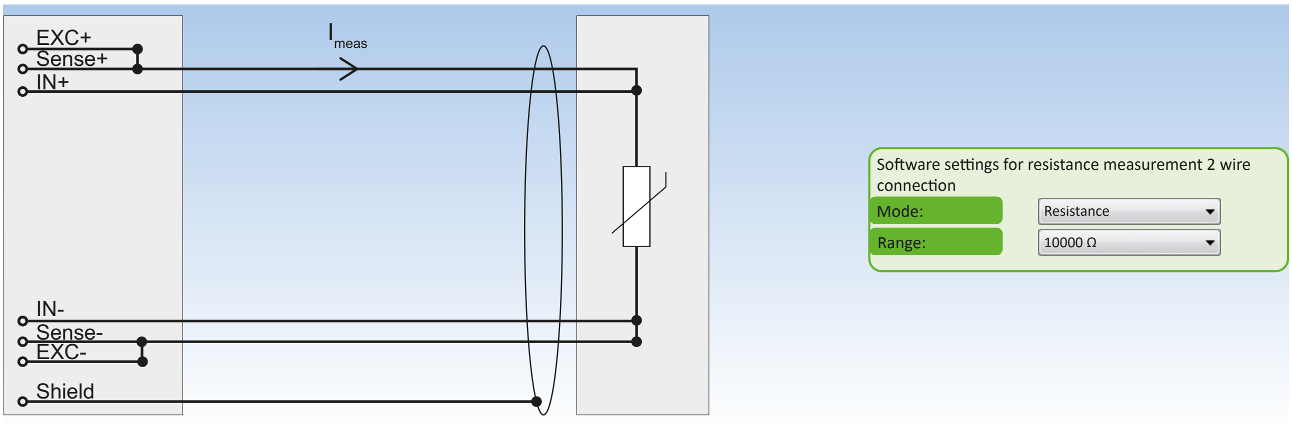



*Fig. 115: Resistance and RTD measurement 4 wire connection*

| Range (Ω) | Excitation current (mA) | Accuracy |
|---|---|---|
| 30 k | 0.2 | 6 Ω ±1 % of reading |
| 10 k | 0.5 | 2 Ω ±0.45 % of reading |
| 3000 | 1 | 0.6 Ω ±0.25 % of reading |
| 1000 | 1 | 0.2 Ω ±0.25 % of reading |
| 300 | 1 | 80 mΩ ±0.25 % of reading |
| 100 | 1 | 40 mΩ ±0.25 % of reading |
| 30 | 10 | 8 mΩ ±0.07 % of reading |
| 10 | 10 | 4 mΩ ±0.07 % of reading |

*Tab. 38: TRION-2402-dSTG resistance accuracy*

# Cables and shielding

## Cables

To keep the influence of electromagnetic disturbances as small as possible, shielded twisted pair cables are recommended. Connect the shield to the connector housing or to the mechanical structure.

The twisted pairs recommended for **full bridge**, **half bridge** and **voltage** mode are:

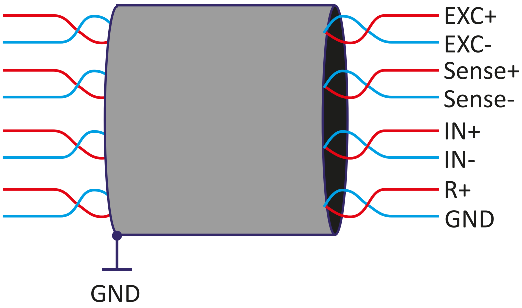



*Fig. 116: Cables and shielding for full bridge, half bridge and voltage modes*

The twisted pairs recommended for **quarter bridge** mode is:

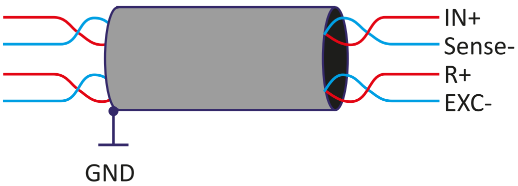



*Fig. 117: Cables and shielding for full bridge, half bridge and voltage modes*

## Multi-wire technology

**Sensitivity**: For sensor wiring typically copper cables are used. For example a 120 Ω full bridge connected with a 4x 0.14 mm$^2$ cable will have a sensitivity error of 2.1% just because of the 1.27 Ω wire resistance. By using the 6 wire technology that could be completely compensated.

**Temperature drift:** Copper has a temperature drift of 0.4 %/°C. This is especially a problem at quarter bridges, because there also the offset changes with the wire resistance. The following table shows the difference between the 3 wiring methods for a 120 Ω strain gauge with a 50 m cable 0.25 mm$^2$.

| | Initial error | | Drift because of 10 °C warm-up | |
|---|---|---|---|---|
| | Offset | Sensitivity | Offset | Sensitivity |
| 2-wire | 25183 µm/m | -4,97 % | 956 µm/m | -0.18 % |
| 3-wire | 0 µm/m | -2.6 % | 0µm/m | -0.01 % |
| 4-wire | 0 µm/m | 0.0 % | 0µm/m | 0.00 % |

*Tab. 39: Multi-wire technology*

## Shielding and grounding

### Strain gauge measurement on a metal structure

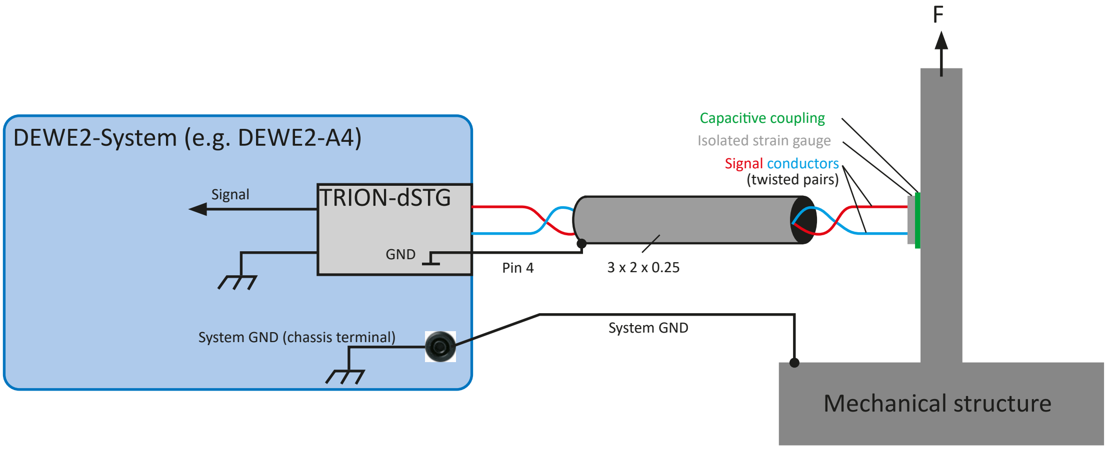



*Fig. 118: Strain gauge measurement*

It is important that you connect your DEWETRON system ground to the ground potential of your measured object. That is to guarantee that the measurement system is not floating against the measured structure. It could simply be a connection to the metal structure of your proving ground. In case of an automotive application for example it would be a connection to the cars chassis. Only if the DEWETRON system and the measured structure have an earth connection the system grounding line might not be needed.

## Single-ended / differential

At ranges below 10 V the input impedance of the TRION-dSTG is very high. The 100 MΩ resistors are usually not enough to balance the differential inputs automatically around the internal GND. As a result you might get wrong or disturbed measurement data if either the measurement instrument or the sensor is floating. To avoid this, you can either switch the input to SE or connect the sensor GND to the DEWE2 GND.

For further information regarding correct single-ended / differential measurement refer to chapter *Single-ended / differential* in the TRION(3) series modules technical reference manual.

## Block diagram

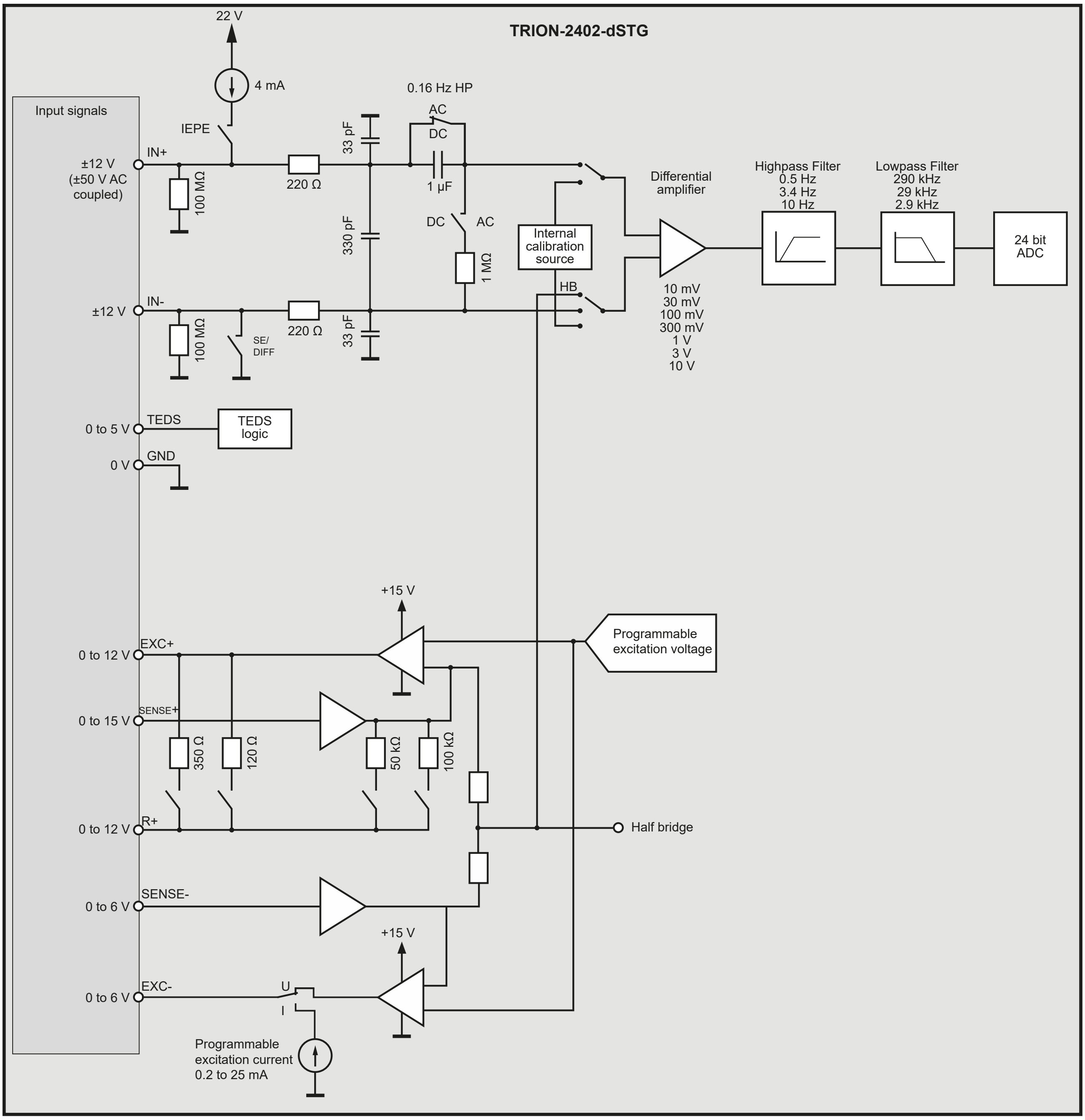
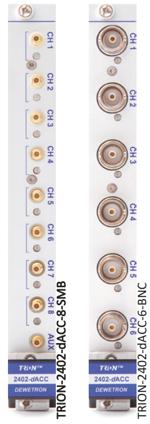



*Fig. 119: Block diagram*

# TRION-2402-dACC

- Differential multi-function input module
- Sampling: 24 bit; 200 kS/s per channel
- Input types
  - Voltage from ±30 mV to ±100 V
  - IEPE®
  - Resistance
  - Current (using external shunt)
- Additional feature: AUX socket




## Module specifications

| **Module specifications TRION-2402-dACC** | |
|---|---|
| Input channels | 8 using SMB sockets (TRION-2402-dACC-8-SMB) |
| | 6 using BNC sockets (TRION-2402-dACC-6-BNC) |
| AUX socket (SMB version) | Selectable: Camera trigger, external trigger, CAL-port |
| Sampling rate | 200 kS/s per channel |
| Resolution | 24 bit |
| Input ranges | |
| – Voltage | ±30 mV, ±100 mV, ±300 mV, ±1 V, ±3 V, ±10 V, ±30 V, ±100 V |
| – IEPE® | ±100 mV, 300 mV, 1 V, 3 V, 10 V |
| – Resistance | 10 Ω, 30 Ω, 100 Ω, 300 Ω, 1 kΩ, 3 kΩ, 10 kΩ, 30 kΩ, 100 kΩ, 300 kΩ, 1000 kΩ |
| – Current | Depending on external shunt |
| Voltage input accuracy[1)] | ±0.02 % of reading ± 0.02 % of range ±200 µV |
| – Gain drift | Typical 10 ppm/°C max. 20 ppm/°C |
| – Offset drift | Typical 0.3 µV/°C + 10 ppm of range/°C, max 15 µV/°C + 20 ppm of range/°C |
| – Linearity | Typical 0.01 % |
| Input impedance | |
| – Range ≤ 10 V | 10 MΩ |
| – Range > 10 V | 2 MΩ |
| Input bias current | <1 nA |
| Input configuration | Single-ended or differential (programmable) |
| Input coupling | DC, AC (0.16 Hz, 0.5 Hz, 3.4 Hz, 10 Hz) |
| Sensor fault detection for IEPE® | Short circuit and open sensor detection with LED indication |
| Excitation current | 0.1 to 24 mADC (programmable, 16 Bit DAC, 2 ranges) |
| – Accuracy[1)] | 0.05% ±2 µA; >20 mA: 10 % |
| – Drift | 15 ppm/°C |
| – Compliance voltage | 23 V |
| – Output impedance | >10 MΩ |
| Supported sensors | IEPE® (up to 24 mA excitation), resistance |

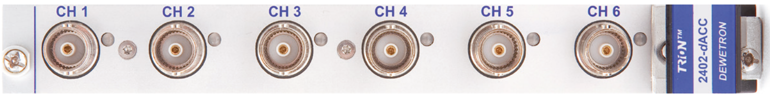
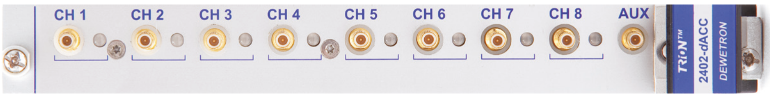
*Tab. 40: Module specifications*

| **Module specifications TRION-2402-dACC** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Counter Channels | 2 counter channels, linked to analog input channel 1 and channel 2 | | | | | | | | | | | |
| – Counter modes | Event counting; periode; frequency; pulsewidth; dutycycle | | | | | | | | | | | |
| – Trigger level | Trigger and retrigger level freely programmable within analog input range | | | | | | | | | | | |
| – Counter input bandwidth | 1 MHz | | | | | | | | | | | |
| Counter time base | 80 MHz | | | | | | | | | | | |
| Typical signal-to-noise ratio, Spurious Free SNR, Effective number of bits[2] | **100 mV range** | | | **1 V range** | | | **10 V range** | | | **100 V range** | | |
| | SNR | SFDR[3] | ENOB[4] | SNR | SFDR[3] | ENOB[4] | SNR | SFDR[3] | ENOB[4] | SNR | SFDR[3] | ENOB[4] |
| Sample rate | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] | [dB] | [dB] | [Bit] |
| 1 kS/s | 97 | 124 | 15.8 | 111 | 139 | 18.1 | 112 | 140 | 18.3 | 112 | 139 | 18.3 |
| 10 kS/s | 90 | 121 | 14.7 | 108 | 136 | 17.6 | 109 | 138 | 17.8 | 107 | 136 | 17.5 |
| 100 kS/s | 87 | 118 | 14.2 | 104 | 134 | 17.0 | 107 | 134 | 17.5 | 104 | 134 | 17.0 |
| 200 kS/s | 80 | 116[5]/110 | 13.0 | 81 | 131[5]/112 | 13.2 | 81 | 132[5]/110 | 13.2 | 81 | 131[5]/112 | 13.2 |
| Typical THD | -100 dB | | | | | | | | | | | |
| Typical CMRR | | | | | | | | | | | | |
| – ≤10V Range | 100 dB @ 50 Hz; 100 dB @ 1 kHz | | | | | | | | | | | |
| – >10 to 200 V Range | 90 dB @ 50 Hz; 70 dB @ 1 kHz | | | | | | | | | | | |
| Analog anti aliasing filter | 2nd order Bessel, automatically set by sample rate | | | | | | | | | | | |
| – Sample rate ≤ 1kS/s | 2.5 kHz (-3 dB), 1.5 kHz (-1 dB) | | | | | | | | | | | |
| – Sample rate ≤ 10kS/s | 25 kHz (-3 dB), 15 kHz (-1 dB) | | | | | | | | | | | |
| – Sample rate > 10kS/s | 250 kHz (-3 dB), 150 kHz (-1 dB) | | | | | | | | | | | |
| Bandwidth (-3 dB digital filter) | | | | | | | | | | | | |
| – 1 kS/s ≤ fs ≤ 51.2 kS/s | 0.494 fs | | | | | | | | | | | |
| – 51.2 kS/s < fs ≤ 102.4 kS/s | 0.49 fs | | | | | | | | | | | |
| – 102.4 kS/s < fs ≤ 200 kS/s | 0.38 fs | | | | | | | | | | | |
| Crosstalk fin 1 kHz [10 kHz] | 120 dB [105 dB] | | | | | | | | | | | |
| Channel-to-channel phase mismatch | Typically <60 ns between channels using the same range | | | | | | | | | | | |
| Rated input voltage according to EN 61010-2-30 | 33 $V_{RMS}$, 46.7 $V_{PEAK}$, 70 $V_{DC}$ | | | | | | | | | | | |
| Common mode voltage | Input range >10 V: ±100 $V_{DC}$ | | | | | | | | | | | |
| | Input range ≤10 V: ±12 $V_{DC}$ | | | | | | | | | | | |
| Overvoltage protection | 150 $V_{DC}$ (1 min) | | | | | | | | | | | |
| Supported TEDS chips | All common TEDS chips are supported. | | | | | | | | | | | |
| Power consumption[6] | | | | | | | | | | | | |
| – Voltage mode no excitation | 6 W | | | | | | | | | | | |
| – IEPE® mode 4 mA | 6.5 W | | | | | | | | | | | |
| – IEPE® mode 16 mA | 9.5 W | | | | | | | | | | | |
| – IEPE® mode 24 mA | 11.4 W | | | | | | | | | | | |
| Weight | Approx. 210 g (SMB version), approx. 270 g (BNC version) | | | | | | | | | | | |

*Tab. 40: Module specifications*

1) 1 year accuracy 23 °C ±5 °C
2) LP Filter in auto mode
3) SFDR excluding harmonics
4) ENOB calculated from SNR
5) Below 0.22 fs
6) Consider maximum power supply of your DEWE2 chassis

# TRION-2402-dACC model overview

| | |
|---|---|
| **TRION-2402-dACC-6-BNC** |  |
| **TRION-2402-dACC-8-SMB** |  |

*Tab. 41: TRION-2402-dACC model overview*

# TRION-2402-dACC-6-BNC module

## Connection


Hot: IN +
Shield: IN -

## Optional accessory

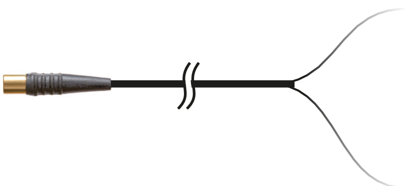
### TRION-CBL-SMB-BNC-01-00

High quality adapter cable from SMB plug to BNC cable-socket, 1 m

Hot: IN +
Shield: IN -

### TRION-CBL-SMB-OE-05-00

High quality cable from SMB plug to open end, 5 m



# TRION-2402-dACC-8-SMB module

## Connection


Hot: IN +
Shield: IN -

## Optional accessory

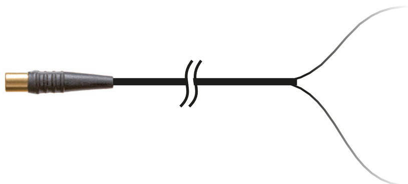
### TRION-CBL-SMB-BNC-01-00

High quality adapter cable from SMB plug to BNC cable-socket, 1 m

Hot: IN +
Shield: IN -

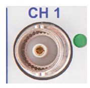
### TRION-CBL-SMB-OE-05-00

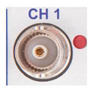
High quality cable from SMB plug to open end, 5 m



## LED function

The LED next to the input connector shows the input state for each channel. In IEPE® mode it becomes red if no sensor is connected or the sensor or the cable has a short circuit. In voltage mode the red color indicates a channel overload or if the channel is out of the common mode voltage range. A corrected channel state is shown when the LED is green.




| | | IN- | | IN+ | |
|---|---|---|---|---|---|
| | | min. | max. | min. | max. |
| | | [V] | [V] | [V] | [V] |
| Voltage Diff | Range ≤10 V | -12.5 | 12.5 | -12.5 | 12.5 |
| | Range >10 V | not available | not available | not available | not available |
| Voltage SE | Range ≤10 V | -12.5 | 12.5 | -12.5 | 12.5 |
| | Range >10 V | not available | not available | not available | not available |
| IEPE® | | -0.8 | 0.8 | 2 | 21 |
| Resistance | | not available | not available | not available | not available |

*Tab. 42: Sensor error detection limits*

## Block diagram

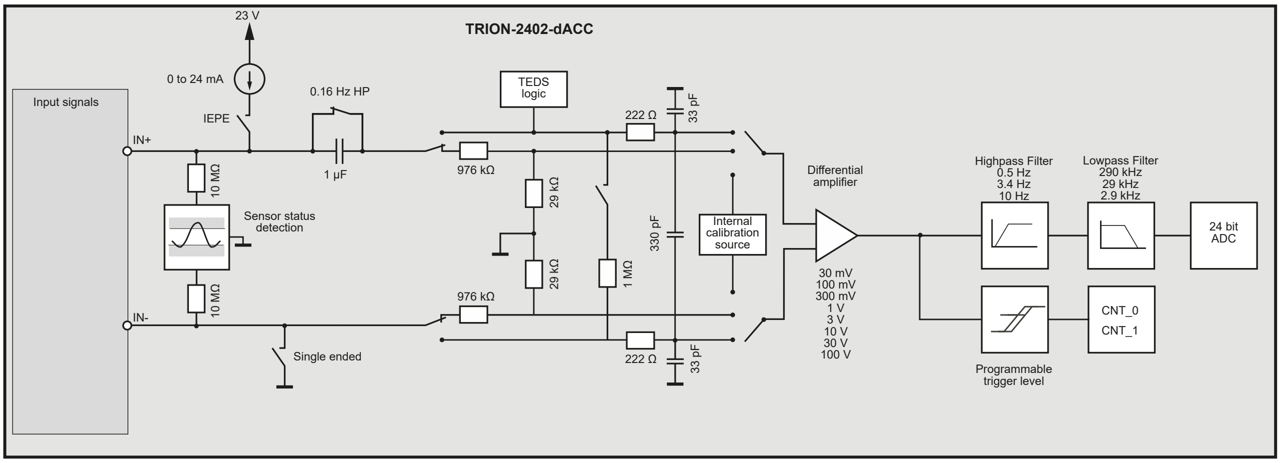



*Fig. 120:* Block diagram

## AUX terminal (only TRION-2402-dACC-8-SMB)


The auxiliary terminal of the TRION-2402-dACC module could be used either for input or output. The following functions are supported*):

- Video trigger output (to synchronize an external camera to the analog data.)
- Frequency output (programmable frequency output for synchronizing external hardware.)
- External trigger (to start the measurement with an TTL signal.)

*) The available functions provided by the AUX terminal depend on the application software used and may differ from this list.

## Function overview

### Counter functions

The first two channels of the TRION-2402-dACC module supports beside the normal functionality also counter inputs.

The trigger and retrigger level could be programmed within 0 to 100 % of the actual analog input range. This makes the input perfectly suitable for all kind of tacho probes. By activating the IEPE® supply it is even possible using probes without any additional sensor supply, just with a BNC cable.

Supported counter functions are:*)

- Simple event counting
- Period measurement
- Pulse width
- Frequency
- Duty cycle

*) The available counter functions depend on the application software used and may differ from this list.

For detailed information about this functions refer to *Functional description of advanced counter* in the TRION(3) series modules technical reference manual.

**INFORMATION**

It is not possible to change the analog input settings out of the counter dialog. This has to be done in the channel setup of the analog input.

## Freely variable gain and excitation

Amplifier parameters such as gain, excitation voltage, excitation current and sensor offset are freely programmable for every channel individually. That allows to perfectly match each input channel to any sensor. Customized programming of the amplifier could be simply done by entering the desired value in the appropriate field.

## High-pass filter

The TRION-2402-dACC module has four different input high pass filter available for AC coupling:

| Frequency | Time constant |
|---|---|
| 0.16 Hz | 1 s |
| 0.5 Hz | 320 ms |
| 3.4 Hz | 47 ms |
| 10 Hz | 16 ms |

*Tab. 43: High-pass filter*

## Self test

The TRION-2402-dACC module has an integrated special self test circuit. It is a high precision voltage source and a temperature compensated divider. It is used to check the analog input path of the voltage amplifier by applying 0 V and ±98 % of the input range to the input. This test could be performed in the channel setup for the actual range. During the board self test which is available in the DEWETRON Explorer, this test is performed for all ranges and channels automatically.

## Single-ended / differential

The TRION-2402-dACC module could be switched to differential or single-ended input. At ranges below 10 V the input impedance of the dACC is very high. The 10 MΩ resistors are usually not enough to balance the differential inputs automatically around the internal GND. As a result you might get wrong or disturbed measurement data if either the measurement instrument or the sensor is floating. To avoid this, you can either switch the input to SE or connect the sensor GND to the DEWE2 GND.

### Examples for correct single-ended / differential measurement

**Example 1: Battery/sensor**

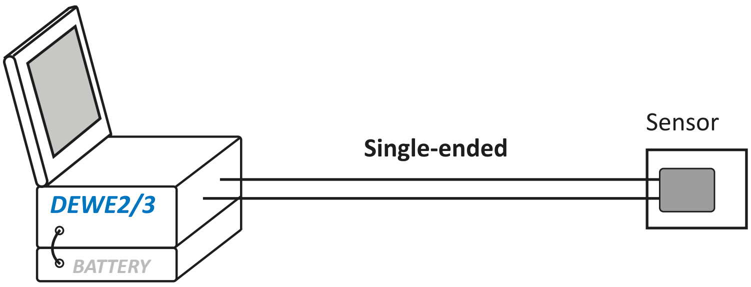



*Fig. 121: Battery/sensor*

**Example 2: Isolated power supply/sensor**

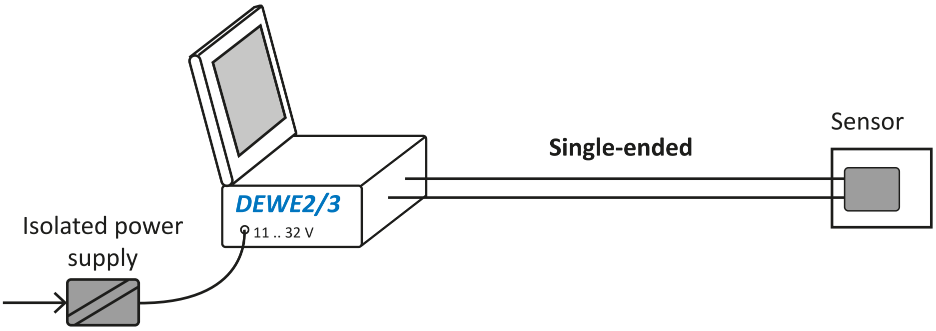



*Fig. 122: Isolated power supply/sensor*

**Example 3: Power supply / process calibrator or battery powered sensor**

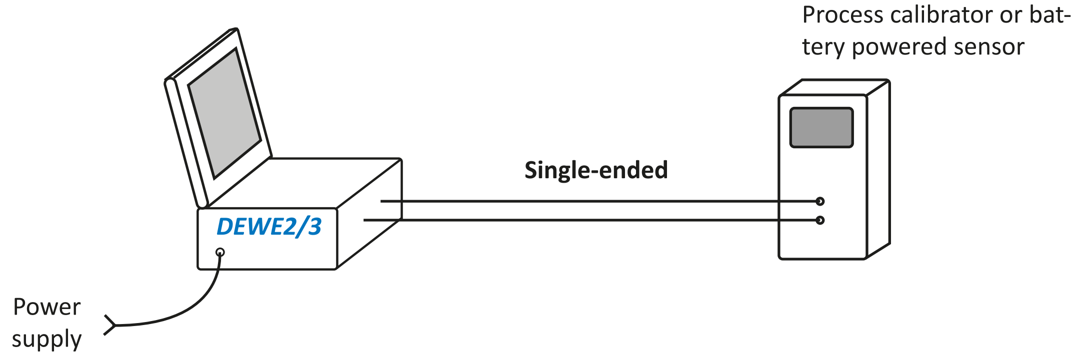



*Fig. 123: Power supply / process calibrator or battery powered sensor*

**Example 4: Sensor with differential output signal**

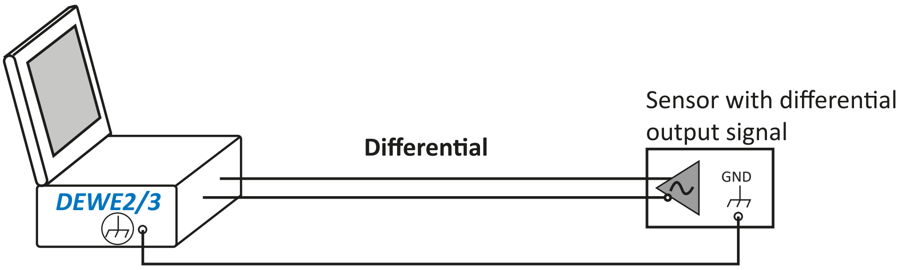



*Fig. 124: Sensor with differential output signal*

**Example 5: Voltage output of a grounded system**

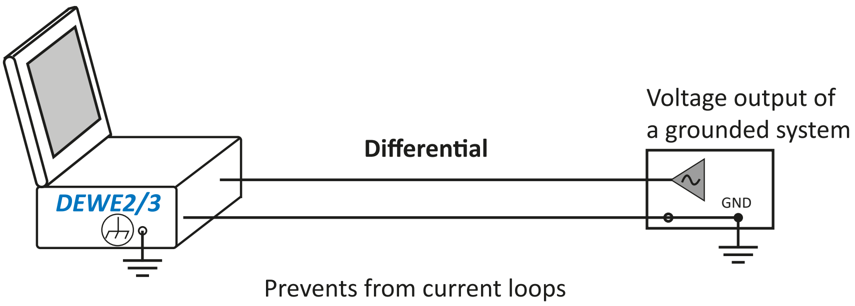
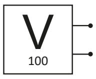



*Fig. 125: Voltage output of a grounded system*

## Signal connection

The following schematics will give you an overview on how to connect all the different sensors to the TRION-2402-dSTG module.




### Voltage

#### Voltage measurement

**INFORMATION** If having floating voltage sources such as batteries, select "Single-ended" as input type.

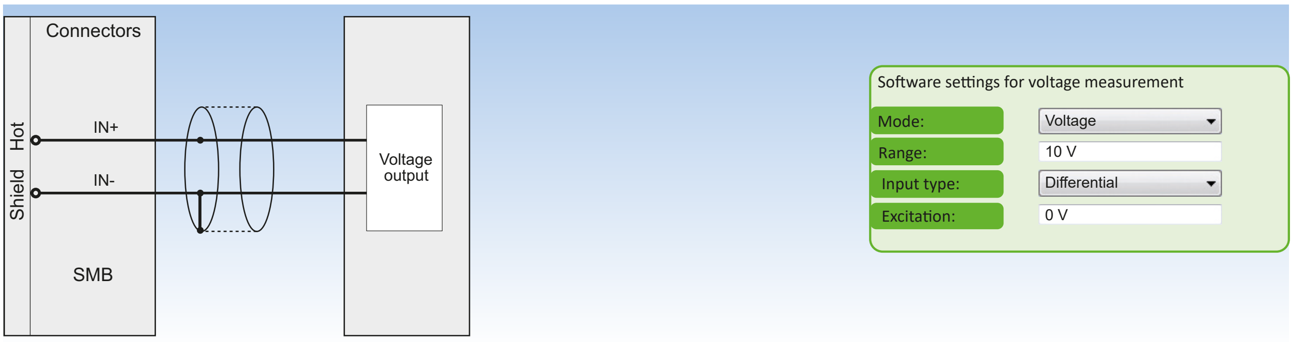
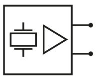



*Fig. 126: Voltage measurement*



### IEPE®

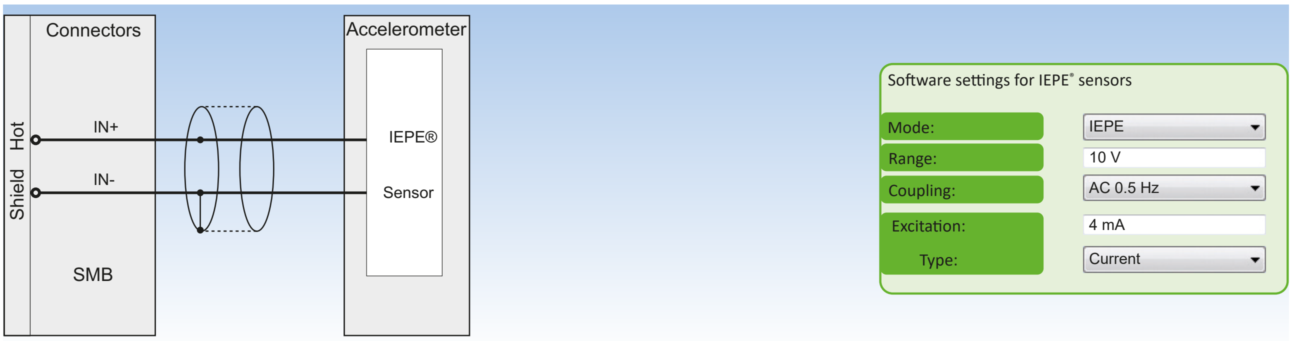
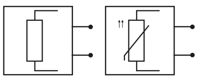



*Fig. 127: IEPE® sensor*



### Resistance

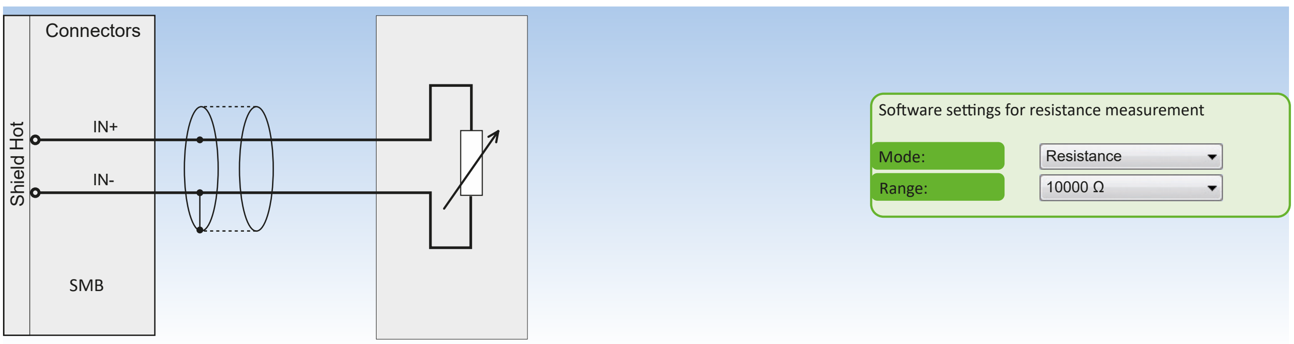


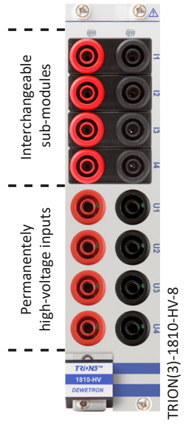

*Fig. 128: Resistance*

| Range (Ω) | Excitation current (mA) | Voltage range (V) | Accuracy | Temperature drift (ppm /°C) |
|---|---|---|---|---|
| 1 M | 0.01 | 10 | 300 Ω ±1 % | 100 |
| 300 k | 0.03 | 10 | 75 Ω ±1 % | 100 |
| 100 k | 0.1 | 10 | 30 Ω ±1 % | 100 |
| 30 k | 0.2 | 10 | 75 Ω ±1 % | 100 |
| 10 k | 0.5 | 10 | 3 Ω ±0.5 % | 100 |
| 3 k | 1 | 3 | 750 mΩ ±0.5 % | 100 |
| 1 k | 1 | 1 | 300 mΩ ±0.5 % | 100 |
| 300 | 1 | 0.3 | 100 mΩ ±0.5 % | 200 |
| 100 | 10 | 0.1 | 50 mΩ ±0.5 % | 200 |
| 30 | 10 | 0.3 | 10 mΩ ±0.5 % | 200 |

*Tab. 44: TRION-2402-dACC resistance accuracy*

# TRION(3)-1810-HV-8

- Isolated TRION(3) module for high-voltage inputs
- Channels: 4 to 8 voltage channels
  - 4 permanently installed high-voltage channels
  - 4 interchangeable sub-modules
- Sampling: Up to 1 MS/s
- Resolution: 24-bit
- Input types
  - Permanently installed channels: 1000 V
  - Interchangeable sub-modules: Different inputs for low-voltage, high-voltage or direct current measurement




## Basic module with fixed high-voltage inputs

The following section provides detailed information on the fixed high-voltage inputs. The values given below were determined in a standardized test setting[1].

### General specifications

| **Fixed high-voltage inputs** | |
|---|---|
| Input channels | Up to 8 (high) voltage channels with interchangeable inserts |
| Sampling rate | Up to 1 MS/s |
| Resolution | 24-bit |
| Input range | 1000 V (±2000 $V_{PEAK}$) CF = 2 |
| Accuracy[1,2,3] | |
| – DC | ±0.02 % of reading ±0.02 % of range |
| – 0.5 Hz to 1 kHz | ±0.03 % of reading |
| – 1 kHz to 5 kHz | ±0.15 % of reading |
| – 5 kHz to 10 kHz | ±0.35 % of reading |
| – 10 kHz to 50 kHz | ±0.6 % of reading |
| – 50 kHz to 300 kHz | ±(0.02 % * f) of reading f: frequency in kHz |
| Gain drift | 20 ppm/°C |
| Offset drift | 5 mV/°C |
| Typical THD | -95 dB |
| CMRR | >85 dB @ 50 Hz; >60 dB @ 1 kHz; >40 dB @ 100 kHz |
| Bandwidth | 5 MHz |
| Rated input voltage to earth according to EN 61010-2-30 | 600 V CAT IV / 1000 V CAT III |
| Common mode voltage | 1000 $V_{RMS}$ |
| Isolation voltage | 3750 $V_{RMS}$ (1 min), 35 kV/µs transient immunity |
| Overvoltage protection | 4250 $V_{PEAK}$ or 3000 $V_{RMS}$ (1 min) |
| Input resistance | 5 MΩ; 2.6 pF |
| Isolation (earth) resistance | 100 GΩ; 5.6 pF |
| Connector | Safety banana sockets |

*Tab. 45: Fixed high-voltage inputs*

| Fixed high-voltage inputs | | | | |
|---|---|---|---|---|
| | SNR | SFDR[4] | ENOB[5] | Noise$_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [mV] |
| 0.1 kS/s | 126 | 144 | 20.6 | 2.6 |
| 1 kS/s | 123 | 140 | 20.1 | 4.5 |
| 10 kS/s | 118 | 137 | 19.3 | 9.5 |
| 100 kS/s | 110 | 134 | 18.0 | 27.2 |
| 1000 kS/s | 100 | 134 | 16.3 | 92.5 |

*Tab. 45: Fixed high-voltage inputs*

1) The following accuracy conditions were applied: Temperature: 23 ±5 °C; humidity: 40 to 60 % rel. humidity; input waveform: sine wave; common mode voltage: 0 V; line filter: Auto (8$^{th}$ or Butterworth); sample rate: 1 MS/s; resolution: 24-bit; power factor: 1; after warm-up; after zero level, accuracy: Frequency (f) in [kHz] (12-month accuracy ± reading error and range error)

2) Add 0.02 % of reading with filter settings OFF

3) Below 1 % of range, add 10 ppm of range.

4) SFDR excluding harmonics

5) ENOB calculated from SNR

## Connection

High voltage input for line voltage measurement.

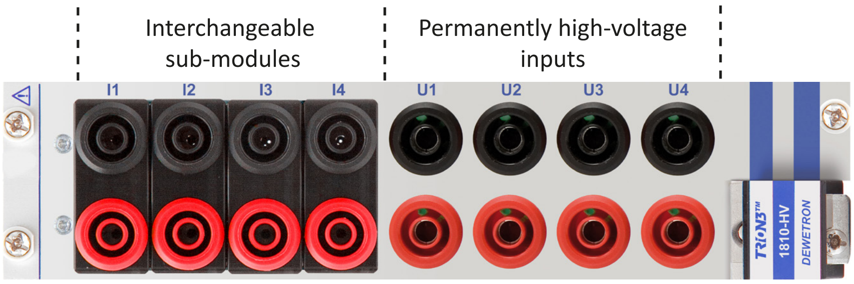
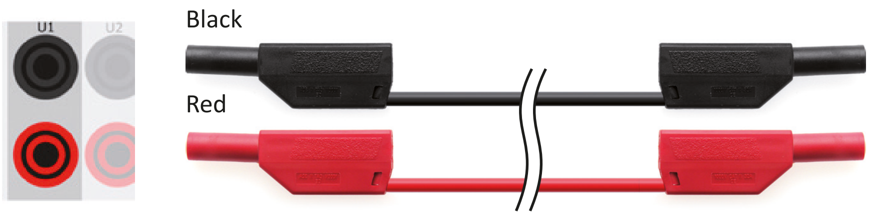



*Fig. 129: Connection ports*




**WARNING**

**Risk of injury due to electric shock**

Voltage measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$, 70 $V_{DC}$ is only permitted with rated safety test leads.

## Power specifications

| Power specifications | | |
|---|---|---|
| Active power accuracy with PF=1[1) 3)]<br>(f: frequency in kHz) | DC | ±0.03 % of reading ±0.03% of range[2)] |
| | 0.5 Hz–1 kHz | ±0.04 % of reading |
| | 1 kHz–5 kHz | ±0.2 % of reading |
| | 5 kHz–10 kHz | ±0.5 % of reading |
| | 10 kHz–50 kHz | ±(0.5 % + 0.05 % * f) of reading |
| Influence of power factor | Add 0.01 % * f/50 * √(1/PF²-1) | f: frequency in Hz |
| Typ. channel-to-channel phase mismatch<br>(Voltage-Voltage, Current-Current, Voltage-Current) | <250 ns (0.1° @ 1 kHz, 0.005° @ 50 Hz) | |
| Typical board-to-board phase mismatch | <250 ns (0.1° @ 1 kHz, 0.005° @ 50 Hz); same board type only | |
| Fundamental frequency | | |
| – Range | 0.1 Hz–200 kHz (>500 kS/s: >0.2 Hz) | |
| – Accuracy DEWE2 | ±0.01 % of reading ± 1 mHz | |
| – Accuracy DEWE3 | ±0.005 % of reading ± 1 mHz | |
| Low pass filter (-3 dB, digital and analog combined) | 100 Hz to 300 kHz freely programmable or OFF | |
| – Filter order and characteristics | $2^{nd}$, $4^{th}$, $6^{th}$, $8^{th}$ Bessel or Butterworth | |
| Filter delay compensation | Up to 15 µs the group delay of the selected filter will be automatically compensated. This works for:<br>– $2^{nd}$ order filter 15 kHz to 300 kHz<br>– $4^{th}$ order filter 30 kHz to 300 kHz<br>– $6^{th}$ order filter 60 kHz to 300 kHz | |
| Onboard data buffer | 512 MB | |
| Power consumption | Typ. 13 W, max. 15 W | |
| – With sensor supply | Max. 21 W | |

*Tab. 46: Power specifications*

1) Voltage and current channel have a minimum input of 1 % range, otherwise individual uncertainty has to be calculated.

2) Add 0.03 % of range with no zero level.

3) When using the TRION-POWER-SUB-CUR-20A-1B sub-module: For self-generated heat caused by current input, add $1.5 \times 10^{-4} \times I^2$ %/A² of reading and additionally for DC only add $10^{-4} \times I^2$ %/A² of range to the active power accuracy. I is the current reading [A]. The influence from self-generated heat continues until the temperature of the shunt resistor inside the chassis lowers, even if the current input changes to a small value.

## Interchangeable sub-modules

The following TRION-SUB-xV and TRION-POWER-SUB-xx modules can be used with the TRION(3)-1810-HV-8 module. For detailed information about the various sub-modules refer to chapter *TRION sub-modules* in the TRION(3) series modules technical reference manual.

*Fig. 130: Available TRION sub-modules*

| Type | Range | Bandwidth | Isolated |
|---|---|---|---|
| *TRION-SUB-600V* | 600 $V_{RMS}$ (±1500 $V_{PEAK}$) | 300 kHz | Yes |
| *TRION-SUB-5V* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 300 kHz | Yes |

*Tab. 47: TRION sub-modules overview*

| Type | Range | Bandwidth | Isolated |
|---|---|---|---|
| *TRION-SUB-XV* | 600 $V_{RMS}$ (±1000 V)[1)]<br>60 $V_{RMS}$ (±100 V)<br>6 $V_{RMS}$ (±10 V)<br>0.6 $V_{RMS}$ (±1 V) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-20A-1* | 20 $A_{RMS}$ (±40 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-2A-1* | 2 $A_{RMS}$ (±4 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-1A-1* | 1 $A_{RMS}$ (±2 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-02A-1* | 0.2 $A_{RMS}$ (±0.4 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-dLV-5V* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-dLV-1V* | 1 $V_{RMS}$ (±2 $V_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-CT* | 1 $A_{RMS}$ (±2 $A_{PEAK}$)<br>0.5 $A_{RMS}$ (±1 $A_{PEAK}$)<br>0.25 $A_{RMS}$ (±0.5 $A_{PEAK}$)<br>0.1 $A_{RMS}$ (±0.2 $A_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-dLV-1* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 100 kHz | No |

*Tab. 47: TRION sub-modules overview*

[1)] Max. allowed input: 600 V CAT II (850 $V_{PEAK}$).

## Connection

### Connection to voltage input module (TRION-SUB-xV)

This input is isolated and rated with CAT II 600 V. Modules with 5 V and 600 V are available.

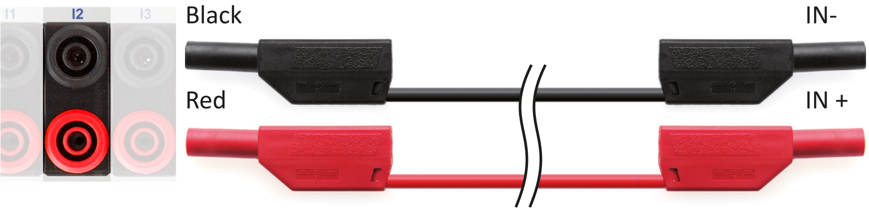



*Fig. 131: Voltage input module*

**WARNING**

**Risk of injury due to electric shock**

Voltage measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

### Connection to current input module (TRION-POWER-SUB-CUR-xA-1B)

Direct current input for measuring current directly. This input is isolated and rated with CAT II 600 V. Modules with 20 A, 2 A, 1 A and 0.2 A nominal current are available.

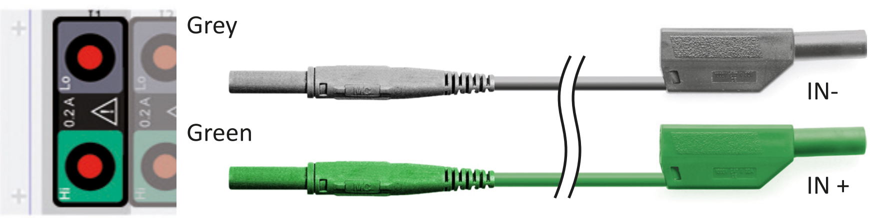


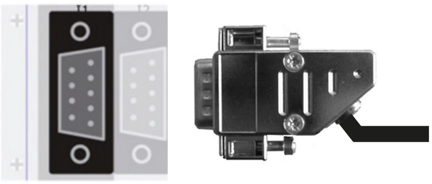

*Fig. 132: Current input module*

**WARNING**

**Risk of injury due to electric shock**

Current measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

#### Connection to clamp input module (TRION-POWER-SUB-dLV-xx)



| | | | |
|---|---|---|---|
| Pin 1: | TEDS | Pin 6: | n.c. |
| Pin 2: | IN+ | Pin 7: | IN- |
| Pin 3: | n.c. | Pin 8: | n.c. |
| Pin 4: | GND (not isolated) | Pin 9: | -9 V (40 mA max.) |
| Pin 5: | +9 V (40 mA max.) | | |

*Fig. 133: Clamp input module*

**WARNING**

**Risk of injury due to electric shock**

Those modules are not isolated. Do not connect any other appliances than isolated current transducers with voltage output.

## Exchanging SUB-modules

For the exchanging procedure refer to chapter *TRION sub-modules overview* in the TRION(3) series modules technical reference manual.

## Block diagram

The TRION(3)-1810-HV-8 can be equipped with interchangeable inserts (SUB-modules) and expanded up to 8 channels in total.

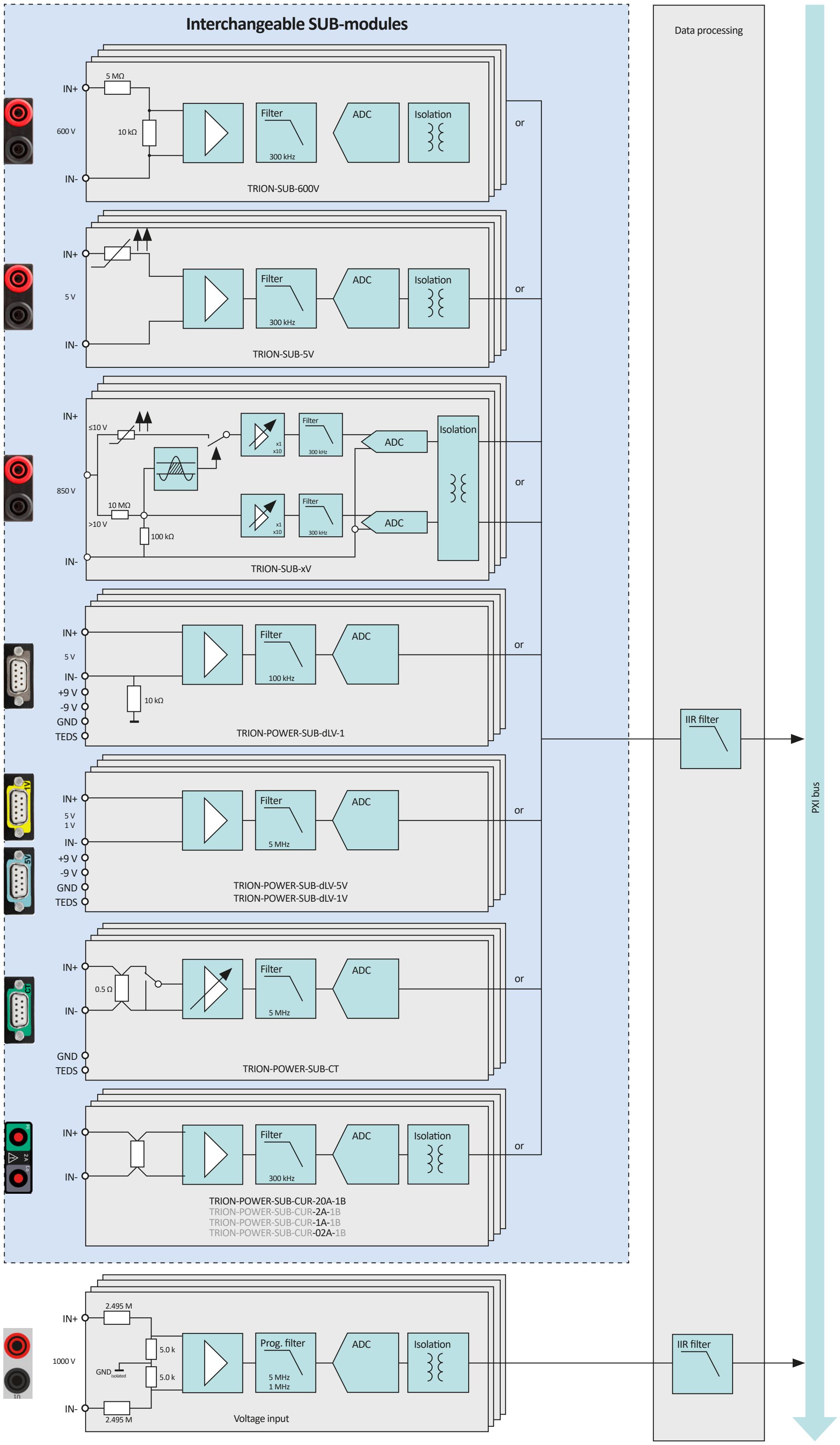
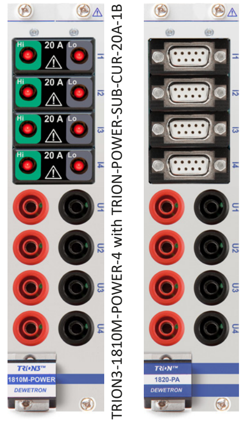



*Fig. 134: Block diagram*

# TRION(3)-18xx-POWER-4

- TRION(3) module for 4-phase power analysis
- Sampling
  - TRION3-1810M-POWER: up to 10 MS/s
  - TRION3-1820-POWER: up to 2 MS/s
  - TRION-1820-POWER: up to 2 MS/s
- Voltage input: 1000 $V_{RMS}$ / 2000 $V_{DC}$
- Modular current input



TRION3-1810M-POWER-4 with TRION-POWER-SUB-CUR-20A-1B

TRION-1820-POWER-4 with TRION-POWER-SUB-dLV-1

## Basic module with fixed high-voltage inputs

The following section provides detailed information on the fixed high-voltage inputs. The values given below were determined in a standardized test setting[1].

### General specifications

| Fixed high-voltage inputs | | | |
|---|---|---|---|
| Input channels | | | |
| Sampling rate / resolution | TRION3-1820-POWER | 100 S/s to 2 MS/s | 24-bit |
| | TRION-1820-POWER | | |
| | TRION3-1810M-POWER | 100 S/s to 2 MS/s | 24-bit |
| | | >2 MS/s to 10 MS/s | 18-bit |
| Input range | | 1000 $V_{RMS}$ (±2000 $V_{PEAK}$) CF = 2 | |
| Accuracy[1,2,3] | | | |
| – DC | | ±0.02 % of reading ±0.02 % of range | |
| – 0.5 Hz to 1 kHz | | ±0.03 % of reading | |
| – 1 kHz to 5 kHz | | ±0.15 % of reading | |
| – 5 kHz to 10 kHz | | ±0.35 % of reading | |
| – 10 kHz to 50 kHz | | ±0.6 % of reading | |
| – 50 kHz to 300 kHz | | ±(0.02 % * f) of reading | f: frequency in kHz |
| Gain drift | | 20 ppm/°C | |
| Offset drift | | 5 mV/°C | |
| Typical THD | | -95 dB | |
| CMRR | | >85 dB @ 50 Hz; >60 dB @ 1 kHz; >40 dB @ 100 kHz | |
| Bandwidth | | 5 MHz | |
| Rated input voltage to earth according to EN 61010-2-30 | | 600 V CAT IV / 1000 V CAT III | |
| Differential input (floating circuits) | | 600 V CAT IV / 1000 V CAT III / 2000 $V_{DC}$ (see Fig. 136) | |
| Common mode voltage | | 1000 $V_{RMS}$ | |
| Isolation voltage | | 3750 $V_{RMS}$ (1 min), 35 kV/µs transient immunity | |
| Overvoltage protection | | 4250 $V_{PEAK}$ or 3000 $V_{RMS}$ (1 min) | |
| Input resistance | | 5 MΩ; 2.6 pF | |
| Isolation (earth) resistance | | 100 GΩ; 5.6 pF | |

*Tab. 48: Fixed high-voltage inputs*

| Fixed high-voltage inputs | | | | |
|---|---|---|---|---|
| Connector | Safety banana sockets | | | |
| | SNR | SFDR[4)] | ENOB[5)] | $\text{Noise}_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [mV] |
| 0.1 kS/s | 126 | 144 | 20.6 | 2.6 |
| 1 kS/s | 123 | 140 | 20.1 | 4.5 |
| 10 kS/s | 118 | 137 | 19.3 | 9.5 |
| 100 kS/s | 110 | 134 | 18.0 | 27.2 |
| 1000 kS/s | 100 | 134 | 16.3 | 92.5 |
| 2000 kS/s | 82 | 132 | 13.3 | 134.0 |

*Tab. 48: Fixed high-voltage inputs*

1) The following accuracy conditions were applied: Temperature: 23 ±5 °C; humidity: 40 to 60 % rel. humidity; input waveform: sine wave; common mode voltage: 0 V; line filter: Auto (8th or Butterworth); sample rate: 2 MS/s (1 MS/s TRION-1810-HV); resolution: 24-bit; power factor: 1; after warm-up; after zero level, accuracy: Frequency (f) in [kHz] (12-month accuracy ± reading error and range error)

2) Add 0.02 % of reading with filter settings OFF

3) Below 1 % of range, add 10 ppm of range.

4) SFDR excluding harmonics

5) ENOB calculated from SNR

## Connection

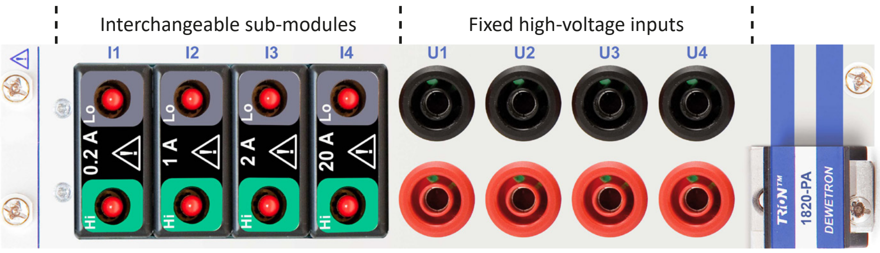
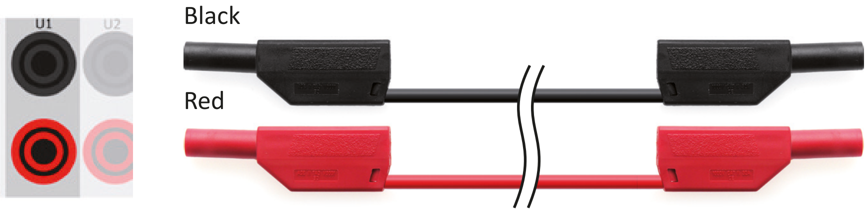



*Fig. 135: Connection ports*

Fast sampling, high bandwidth and minimum capacity to earth are just a few outstanding performance qualities of the high voltage inputs. The high input impedance allows high continuous voltage levels with a very low temperature drift. Although small outline, the safety category is on a very high level (CAT III 1000V).




**WARNING**

**Risk of injury due to electric shock**

Voltage measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

## Power specifications

| Power specifications | | |
|---|---|---|
| Active power accuracy with PF=1[1,3]<br>(f: frequency in kHz) | DC | ±0.03 % of reading ±0.03% of range[2] |
| | 0.5 Hz–1 kHz | ±0.04 % of reading |
| | 1 kHz–5 kHz | ±0.2 % of reading |
| | 5 kHz–10 kHz | ±0.5 % of reading |
| | 10 kHz–50 kHz | ±(0.5 % + 0.05 % * f) of reading |
| Influence of power factor | Add 0.01 % * f/50 * √(1/$PF^2$-1) | f: frequency in Hz |
| Typ. channel-to-channel phase mismatch<br>(Voltage-Voltage, Current-Current, Voltage-Current) | <250 ns (0.1° @ 1 kHz, 0.005° @ 50 Hz) | |
| Typical board-to-board phase mismatch | <250 ns (0.1° @ 1 kHz, 0.005° @ 50 Hz); same board type only | |
| Fundamental frequency | | |
| – Range | 0.1 Hz–200 kHz (>500 kS/s: >0.2 Hz; >1 MS/s: >0.5Hz; >2MS/s: >1 Hz) | |
| – Accuracy DEWE2 | ±0.01% of reading ± 1 mHz | |
| – Accuracy DEWE3 | ±0.005% of reading ± 1 mHz | |
| Low pass filter (-3 dB, digital and analog combined) | | |
| – TRION3-1810M-POWER | 100 Hz to 3 MHz freely programmable or OFF | |
| – TRION(3)-1820-POWER | 100 Hz to 600 kHz freely programmable or OFF | |
| – Filter order and characteristics | 2nd, 4th, 6th, 8th Bessel or Butterworth | |
| Filter delay compensation | Up to 15 µs the group delay of the selected filter will be automatically compensated. This works for:<br>– 2nd order filter 15 kHz to 1 MHz<br>– 4th order filter 30 kHz to 1 MHz<br>– 6th order filter 60 kHz to 1 MHz | |
| Onboard data buffer | 512 MB | |
| Power consumption | Typ. 13 W, max. 15 W | |
| – With sensor supply | Max. 21 W | |

*Tab. 49: Power specifications*

1) Voltage and current channel have a minimum input of 1 % range, otherwise individual uncertainty has to be calculated.

2) Add 0.03 % of range with no zero level.

3) When using the TRION-POWER-SUB-CUR-20A-1B sub-module: For self-generated heat caused by current input, add 1.5 × $10^{-4}$ × $I^2$ %/$A^2$ of reading and additionally for DC only add $10^{-4}$ × $I^2$ %/$A^2$ of range to the active power accuracy. I is the current reading [A]. The influence from self-generated heat continues until the temperature of the shunt resistor inside the chassis lowers, even if the current input changes to a small value.

## Maximum input voltage

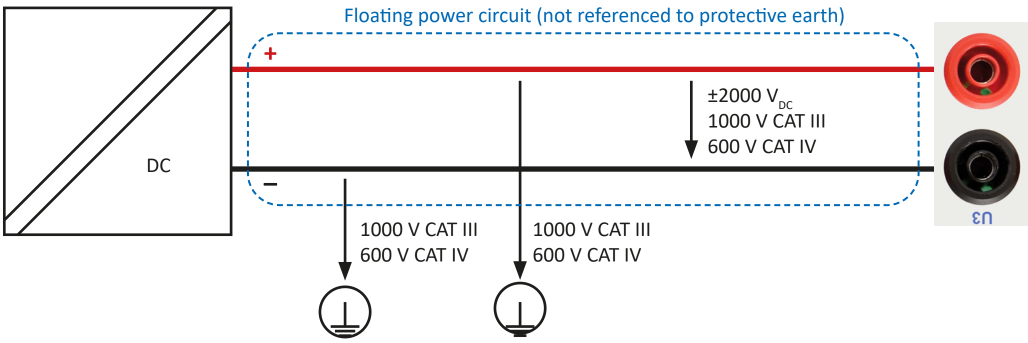



*Fig. 136: Maximum input voltages*

# Interchangeable sub-modules

## Available TRION-SUB modules

The TRION(3)-18xx-POWER-4 modules have 4 highly flexible voltage or current inputs. The 4 slots can be populated with four different direct current measurement modules or with three different D-SUB-9 modules to connect almost any kind of current transducer. Alternatively, this connector can also be used to measure any auxiliary ±10 V signal (e.g. such as windspeed or water flow).

If more than 4 voltage inputs are required, the 4 slots can be also populated with our latest interchangeable voltage input sub-modules. Choose from a low-voltage, isolated 5 V or an isolated, 600 V CATII rated sub-module.


*Fig. 137: Available TRION sub-modules*

The following TRION-SUB modules can be used with the TRION(3)-18xx-POWER-4 module. For detailed information about the various sub-modules refer to chapter *TRION sub-modules* in the TRION(3) series modules technical reference manual.

| Type | Range | Bandwidth | Isolated |
|---|---|---|---|
| *TRION-SUB-600V* | 600 $V_{RMS}$ (±1500 $V_{PEAK}$) | 300 kHz | Yes |
| *TRION-SUB-5V* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 300 kHz | Yes |
| *TRION-SUB-XV* | 600 $V_{RMS}$ (±1000 V)[1)]<br>60 $V_{RMS}$ (±100 V)<br>6 $V_{RMS}$ (±10 V)<br>0.6 $V_{RMS}$ (±1 V) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-20A-1* | 20 $A_{RMS}$ (±40 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-2A-1* | 2 $A_{RMS}$ (±4 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-1A-1* | 1 $A_{RMS}$ (±2 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-02A-1* | 0.2 $A_{RMS}$ (±0.4 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-dLV-5V* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-dLV-1V* | 1 $V_{RMS}$ (±2 $V_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-CT* | 1 $A_{RMS}$ (±2 $A_{PEAK}$)<br>0.5 $A_{RMS}$ (±1 $A_{PEAK}$)<br>0.25 $A_{RMS}$ (±0.5 $A_{PEAK}$)<br>0.1 $A_{RMS}$ (±0.2 $A_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-dLV-1* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 100 kHz | No |

*Tab. 50: TRION sub-modules overview*

[1)] Max. allowed input: 600 V CAT II (850 $V_{PEAK}$).

## Connection

### Connection to voltage input module (TRION-SUB-xV)

This input is isolated and rated with CAT II 600 V. Modules with 5 V and 600 V are available.

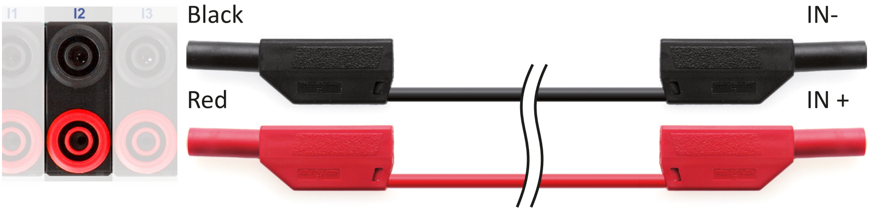



*Fig. 138: Voltage input module*

**WARNING**

**Risk of injury due to electric shock**

Voltage measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

### Connection to current input module (TRION-POWER-SUB-CUR-xA-1B)

Direct current input for measuring current directly. This input is isolated and rated with CAT II 600 V. Modules with 20 A, 2 A, 1 A and 0.2 A nominal current are available.

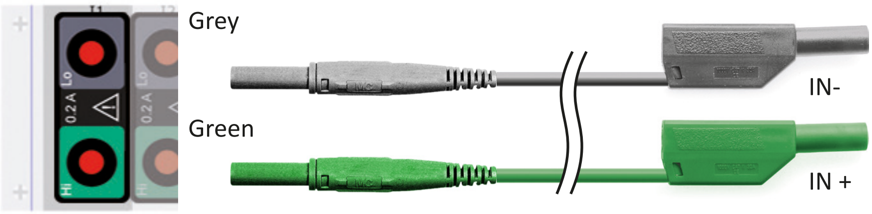


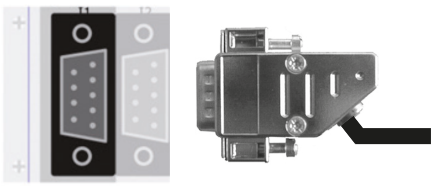

*Fig. 139: Current input module*

**WARNING**

**Risk of injury due to electric shock**

Current measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

### Connection to clamp input module (TRION-POWER-SUB-dLV-xx)



| | | | |
|---|---|---|---|
| Pin 1: | TEDS | Pin 6: | n.c. |
| Pin 2: | IN+ | Pin 7: | IN- |
| Pin 3: | n.c. | Pin 8: | n.c. |
| Pin 4: | GND (not isolated) | Pin 9: | -9 V (40 mA max.) |
| Pin 5: | +9 V (40 mA max.) | | |

*Fig. 140: Clamp input module*

**WARNING**

**Risk of injury due to electric shock**

Those modules are not isolated. Do not connect any other appliances than isolated current transducers with voltage output.

## Exchanging SUB-modules

Refer to chapter *Exchanging TRION sub-modules on page 225* in the TRION(3) series modules technical reference manual for the instructions on how to exchange TRION sub-modules.

# Bessel/Butterworth filter characteristics for power analysis

The TRION family is equipped with DSP lowpass filters from 2$^{nd}$ to 8$^{th}$ order in Bessel or Butterworth configuration. The difference between these two filter types can be seen in the following figures.

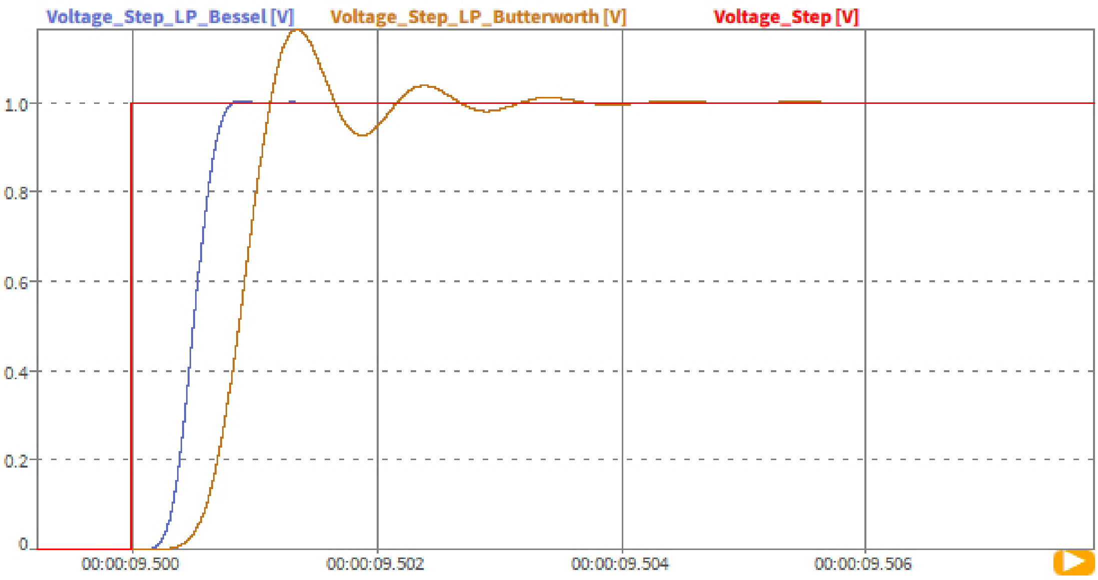



*Fig. 141: Step response of filter with 1000 Hz cutoff frequency and 8th order.*

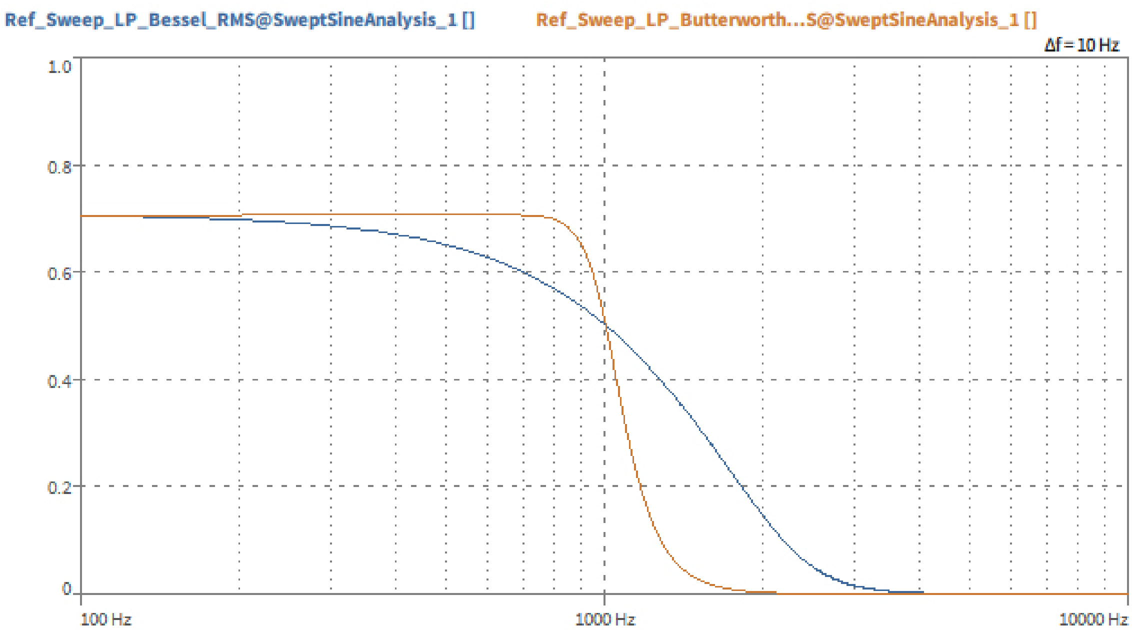



*Fig. 142: Frequency response of filter with 1000 Hz cutoff frequency and 8th order*

For magnitude accuracy (e.g. RMS accuracy), the Butterworth filter is more suitable than the Bessel filter. For step response (e.g. PWM signal monitoring), the Bessel filter is more suitable than the Butterworth filter.

## Block diagram

The TRION(3)-18xx-POWER-4 modules can be equipped with interchangeable inserts (SUB-modules) and expanded up to 8 channels in total.

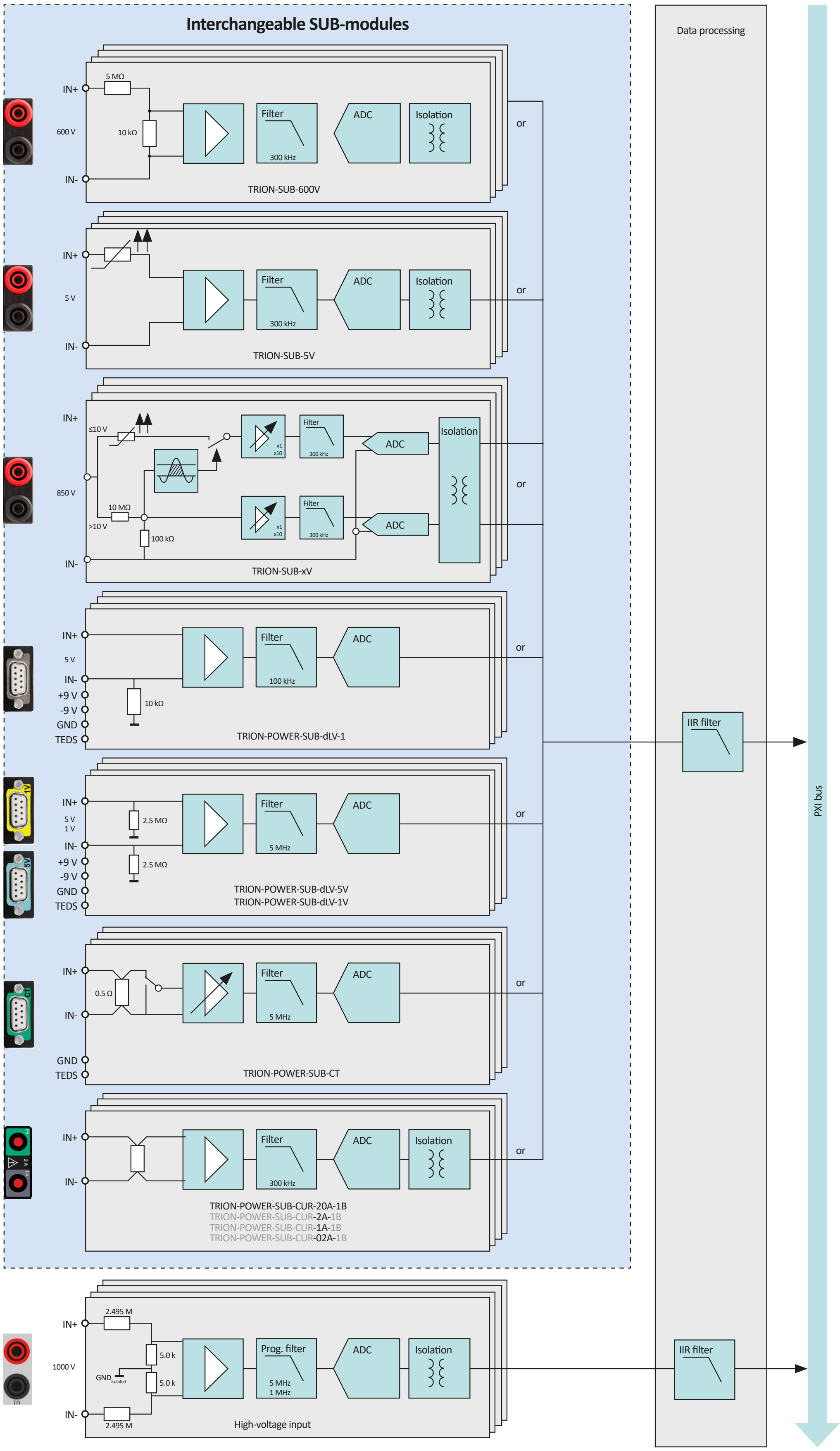
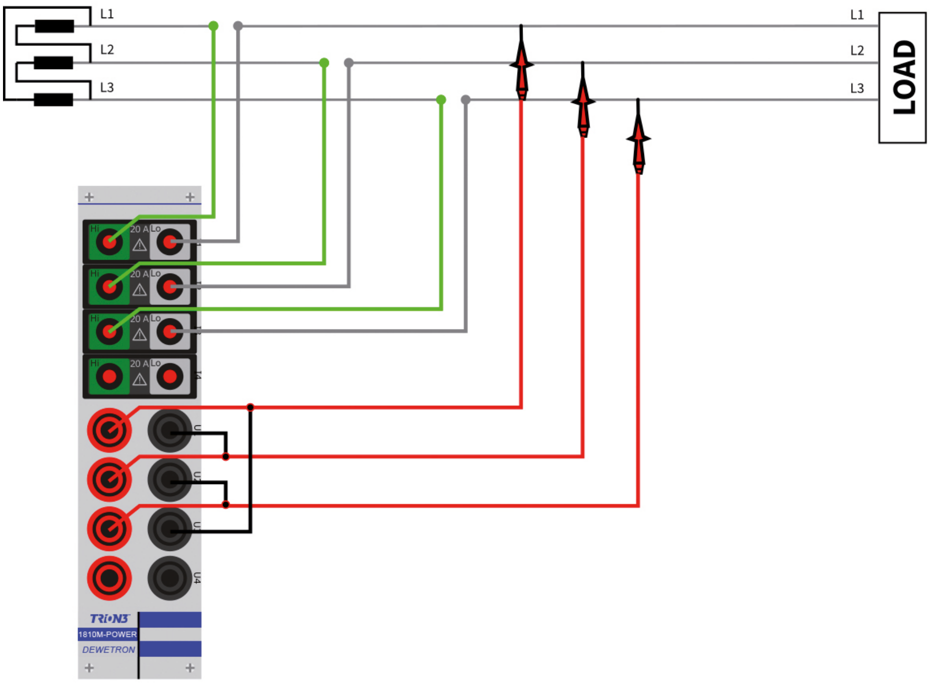



*Fig. 143: Block diagram*

# Connection examples

## Three phase (3P3W) without neutral line




Group selection in OXYGEN Power:

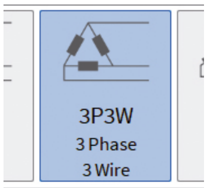
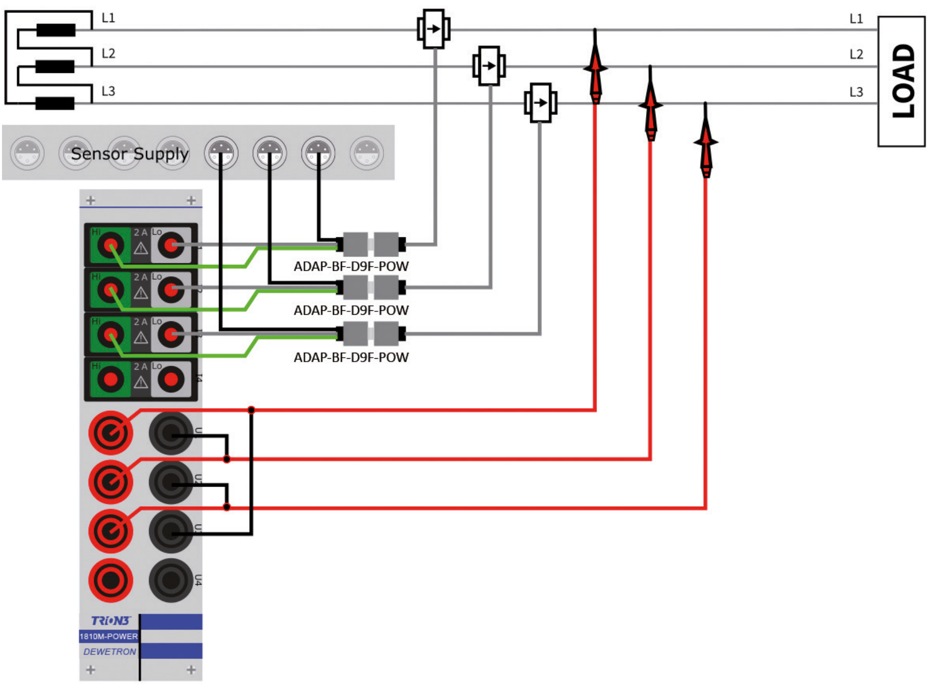



*Fig. 144: Three phase (3P3W) without neutral line*

## Three phase (3P3W) without neutral line, using current output transducers




Group selection in OXYGEN Power:

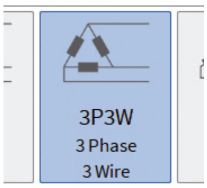
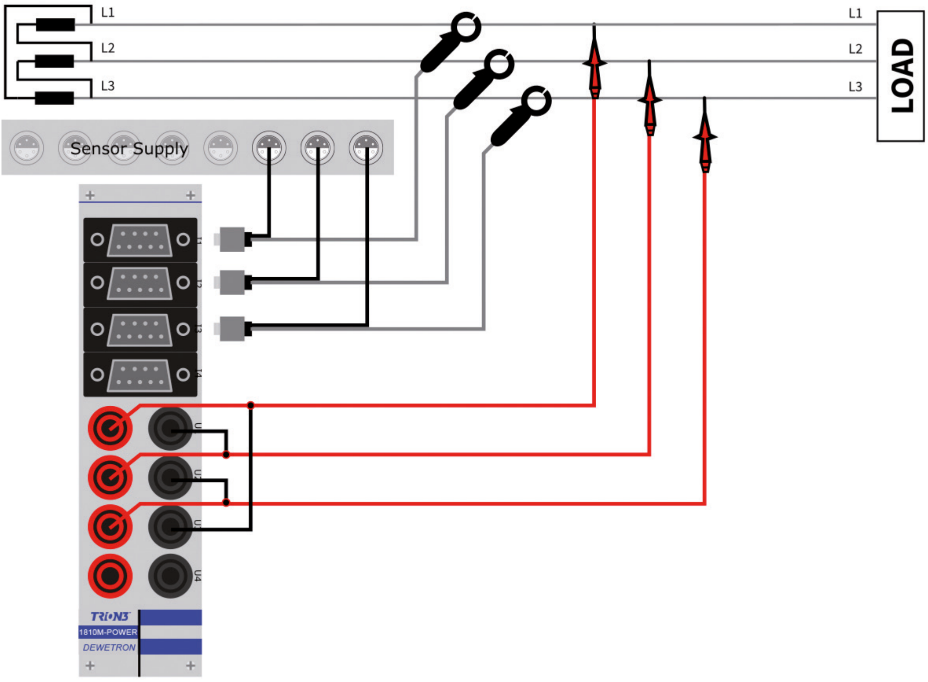



*Fig. 145: Three phase (3P3W) without neutral line, using current output transducer*

## Three phase (3P3W) without neutral line, using voltage output transducers



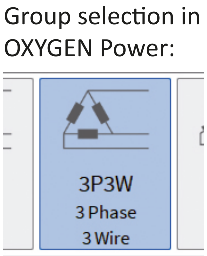
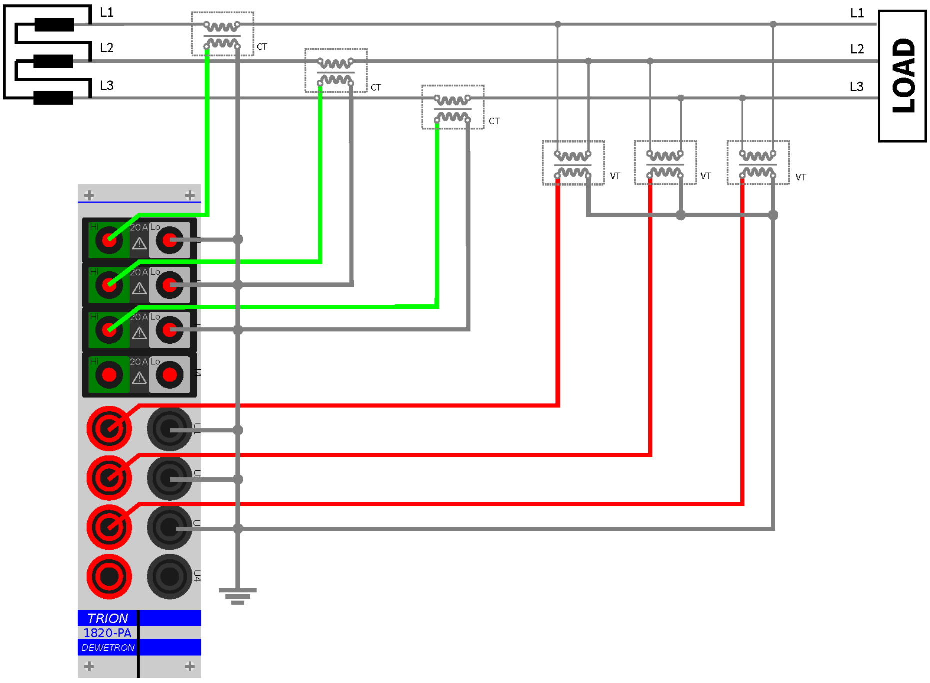




*Fig. 146: Three phase (3P3W) without neutral line, using voltage output transducers*

## Three phase (3P3W) with CT and VT



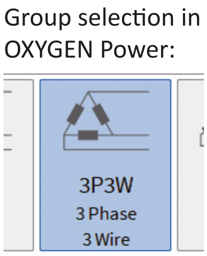
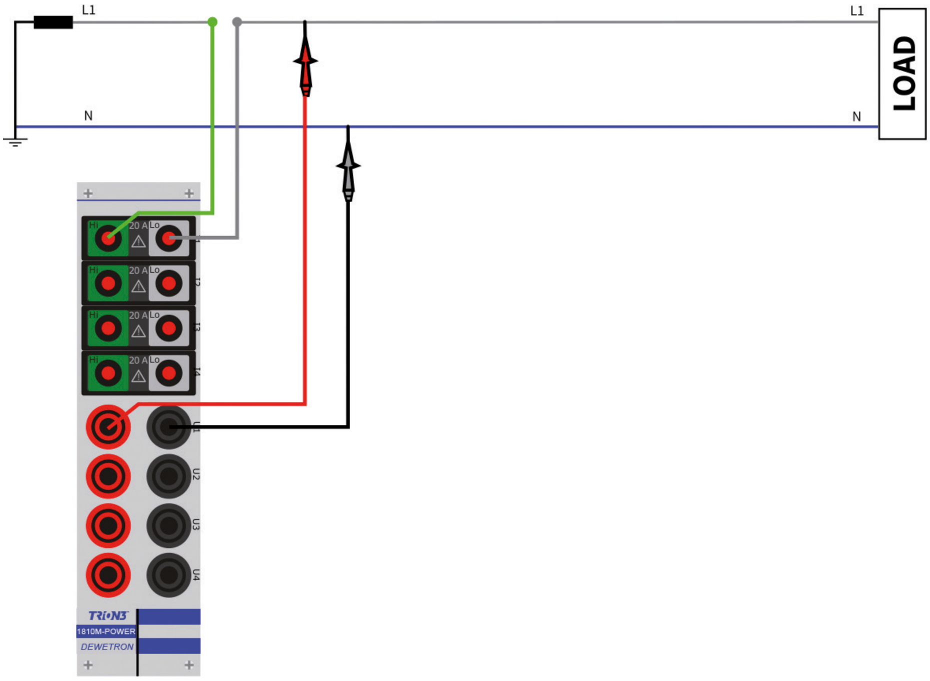




*Fig. 147: Three phase (3P3W) with CT and VT*

## One phase (1P2W)




Group selection in OXYGEN Power:

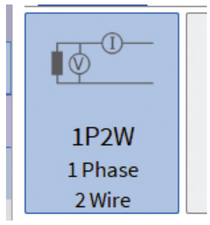
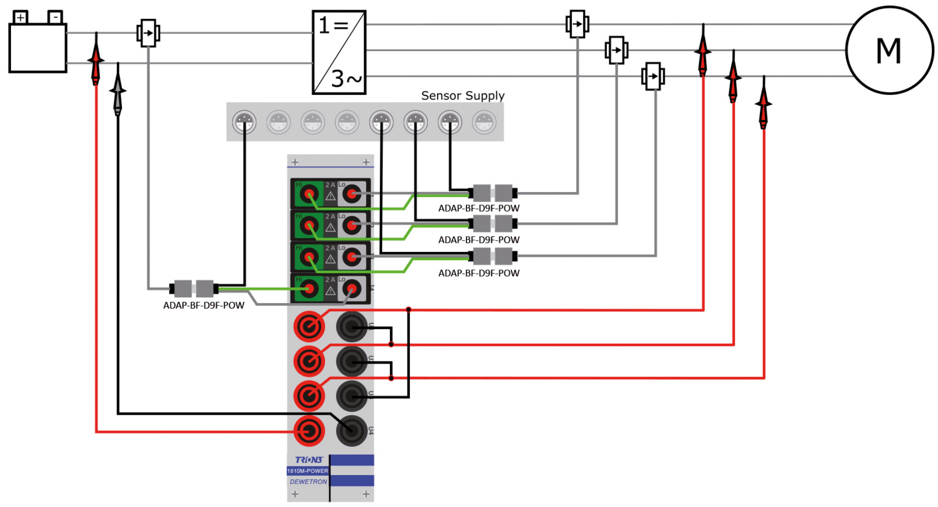



*Fig. 148: One phase (1P2W)*

## Three phase and one phase (3P3W and 1P2W)




Group selection in OXYGEN Power:

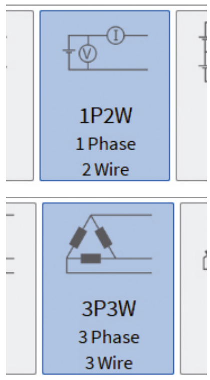



*Fig. 149: Three phase and one phase (3P3W and 1P2W)*

# Connection schemes for current sensors

## Solution 1

| | |
|---|---|
| Module | TRION-18xx-POWER-4 with TRION-POWER-SUB-CUR-x-1[1)] |
| Clamp supply required | Yes |
| Sensor | Zero flux transducer with current output signal (PA-IT-xxx-S or PA-IN-xxx-S series) |

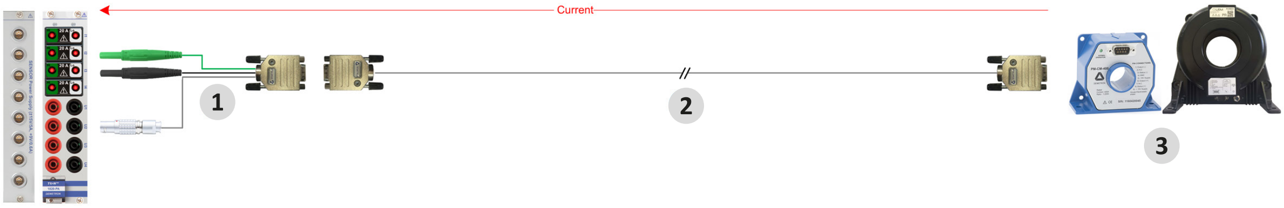



*Fig. 150: Solution 1*

| No. | Article | Description |
|---|---|---|
| **1.** | ADAP-BF-D9F-POW | 0.7 m cable length each |
| **2.** | PA-CBL-D9M-D9F-x | 5, 10 or 15 m cable length; other cable lengths on request |
| **3.** | PA-IT-xxx-S or PA-IN-xxx-S series | Zero flux transducers |

*Tab. 51: Articles for solution 1*

1) The connection scheme shown above also works with TRION-SUB-dLV-1V and TRION-SUB-dLV-5V sub modules.

## Solution 2

| | |
|---|---|
| Module | TRION-18xx-POWER-4 with TRION-POWER-SUB-dLV-1[1)] |
| Clamp supply required | Yes |
| Sensor | Zero flux transducer with current output signal (PA-IT-xxx-S or PA-IN-xxx-S series) |

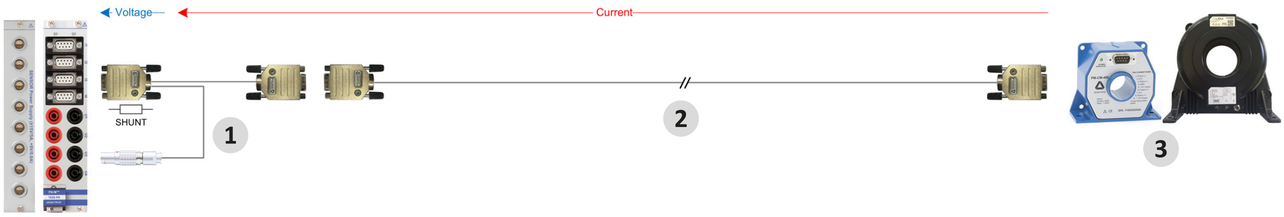



*Fig. 151: Solution 2*

| No. | Article | Description |
|---|---|---|
| **1.** | ADAP-BR1-D9M-D9F-POW | 0.7 m cable length each |
| **2.** | PA-CBL-D9M-D9F-x | 5, 10 or 15 m cable length; other cable lengths on request |
| **3.** | PA-IT-xxx-S or PA-IN-xxx-S series | Zero flux transducers |

*Tab. 52: Articles for solution 2*

1) The connection scheme shown above also works with TRION-SUB-dLV-1V and TRION-SUB-dLV-5V sub modules.

## Solution 3

| | |
|---|---|
| Module | TRION-18xx-POWER-4 with TRION-POWER-SUB-dLV-1[1)] |
| Clamp supply required | Yes |
| Sensor | CT6841A, CT6843A, CT6845A, CT6846A |

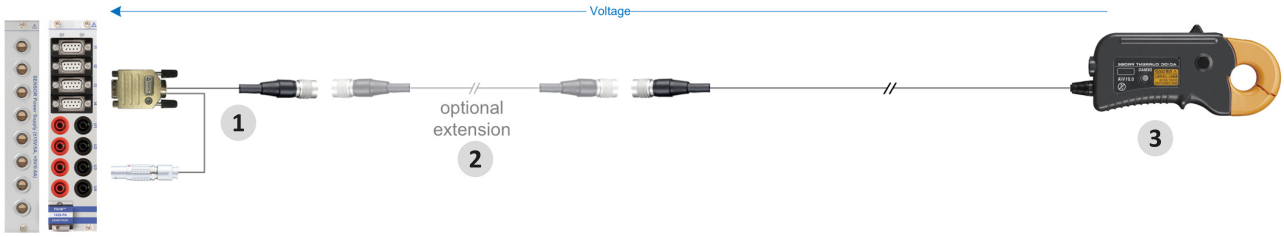



*Fig. 152: Solution 3*

| No. | Article | Description |
|---|---|---|
| **1.** | Adapter | Included with current clamp<br>▶ 0.2 m cable length between DB9 and H12F<br>▶ 0.7 m cable length between DB9 and LEMO |
| **2.** | CBL-H12M-H12F-5 | 5 m cable length |
| **3.** | High precision current clamp series | 3 m integrated cable (CT684xA models) |

*Tab. 53: Articles for solution 3*

1) The connection scheme shown above also works with TRION-SUB-dLV-1V and TRION-SUB-dLV-5V sub modules.

## Solution 4

| | |
|---|---|
| Module | TRION-18xx-POWER-4 with TRION-POWER-SUB-dLV-1[1)] |
| Clamp supply required | No |
| Sensor | Current probe with voltage output signal |

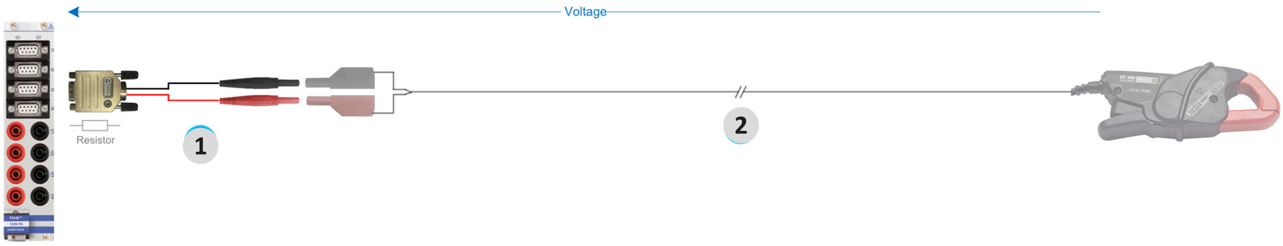



*Fig. 153: Solution 4*

| No. | Article | Description |
|---|---|---|
| **1.** | Adapter DB9 to banana sockets | On request; an internal resistor could be required depending on sensor) |
| **2.** | SE-CUR-CLAMP-x-B e.g. | Current probe or clamp with voltage output |

*Tab. 54: Articles for solution*

1) The connection scheme shown above also works with TRION-SUB-dLV-1V and TRION-SUB-dLV-5V sub modules.

## Solution 5

| | |
|---|---|
| Module | TRION-18xx-POWER-4 with TRION-POWER-SUB-dLV-1[1)] |
| Clamp supply required | Yes |
| Sensor | High precision flexible current transducers, (SE-CUR-LFR series) |

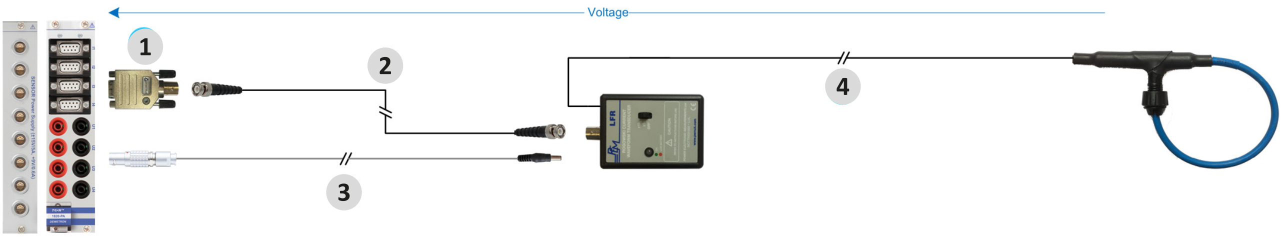



*Fig. 154: Solution 5*

| No. | Article | Description |
|---|---|---|
| **1.** | ADAP-DIFF-D9M-BNCF | - |
| **2.** | BNC to BNC measuring lead | 2 m cable length (included with SE-CUR-LFR series current probe) |
| **3.** | LEMO to barrel plug | 2 m cable length (included with SE-CUR-LFR series current probe) |
| **4.** | High precision flexible current transducers | 2.5 m cable length between box and coil (SE-CUR-LFR series) |

*Tab. 55: Articles for solution 5*

1) The connection scheme shown above also works with TRION-SUB-dLV-1V and TRION-SUB-dLV-5V sub modules.

## Solution 6

| | |
|---|---|
| Module | TRION-18xx-POWER-4 with TRION-SUB-5V |
| Clamp supply required | Yes |
| Sensor | CT6841A, CT6843A, CT6845A, CT6846A |

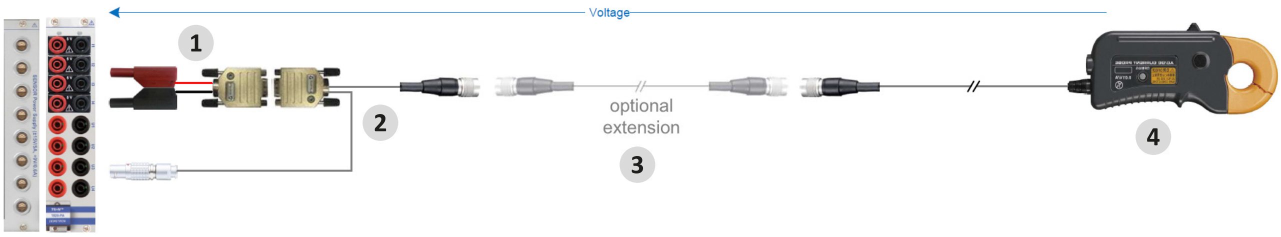



*Fig. 155: Solution 6*

| No. | Article | Description |
|---|---|---|
| **1.** | ADAP-BM-D9F | 0.3 m cable length |
| **2.** | Adapter | Adapter (included with current clamp)<br>▸ 0.2 m cable length between DB9 and H12F<br>▸ 0.7 m cable length between DB9 and LEMO |
| **3.** | CBL-H12M-H12F-5 | 5 m cable length |
| **4.** | High precision flexible current transducers | 3 m integrated cable (CT684xA models) |

*Tab. 56: Articles for solution 6*

# TRION3-1810x-SUB-8

- Carrier board for up to 8 TRION sub-modules
- Sampling:
  - TRION3-1810-SUB-8: up to 1 MS/s
  - TRION3-1810M-SUB-8: up to 10 MS/s


TRION3-1810-SUB-8 with TRION-POWER-SUB-dLV-xV, TRION-SUB-dLV-xV and TRION-POWER-SUB-CUR-xA-1B

## Module specifications

| **TRION3-1810x-SUB-8 specifications** | |
|---|---|
| Input channels | Carrier board for up to 8 TRION sub-modules for measuring voltage and current |
| Sampling rate | TRION3-1810-SUB-8: up to 1 MS/s<br>TRION3-1810M-SUB-8: up to 10 MS/s |
| Input specifications | For detailed information about the input specifications refer to *TRION sub-modules* in the TRION(3) series modules technical reference manual. |
| Typical channel to channel phase mismatch<br>(Voltage-Voltage, Current-Current, Voltage-Current) | <250 ns (0.1° @ 1 kHz, 0.005° @ 50 Hz) |
| Typical board-to-board phase mismatch | <250 ns (0.1° @ 1 kHz, 0.005° @ 50 Hz), same board type only |
| Low pass filter (-3 dB, digital and analog combined) | TRION3-1810-SUB-8: 1 Hz to 300 kHz freely programmable or OFF<br>TRION3-1810M-SUB-8: 1 Hz to 3 MHz freely programmable or OFF |
| – Filter order and characteristics | 2nd, 4th, 6th, 8th Bessel or Butterworth |
| Filter delay compensation | Up to 15 µs the group delay of the selected filter will be automatically compensated. This works for:<br>– 2nd order filter 15 kHz to 1 MHz<br>– 4th order filter 30 kHz to 1 MHz<br>– 6th order filter 60 kHz to 1 MHz |
| Onboard data buffer | 512 MB |
| Power consumption | Typ. 8 W, max. 10 W |
| – with sensor supply | Max. 15 W |
| Total sensor supply<br>– with TRION-POWER-SUB-dLV-xV modules | +9 V: 200 mA / -9 V: 200 mA |

*Tab. 57: General specifications*

# Connection

## Connection ports

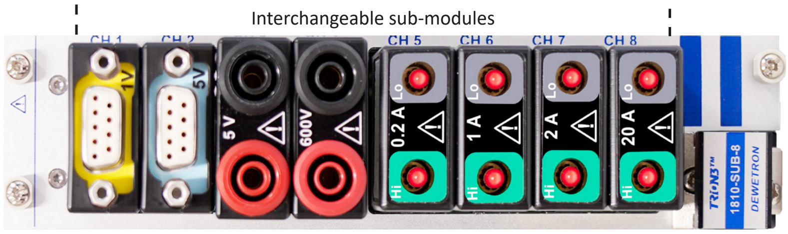



*Fig. 156: Connection ports*

## Interchangeable sub-modules

The TRION3-**1810x**-SUB-8 module provides 8 slots for TRION sub modules, thus allowing a very modular configuration of various voltage and current inputs.

*Fig. 157: Available TRION sub-modules*

The following TRION-SUB-modules can be combined as desired. For detailed information about the various TRION sub-modules refer to *TRION sub-modules* of the TRION(3) series modules technical reference manual.

| Type | Range | Bandwidth | Isolated |
|---|---|---|---|
| *TRION-SUB-600V* | 600 $V_{RMS}$ (±1500 $V_{PEAK}$) | 300 kHz | Yes |
| *TRION-SUB-5V* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 300 kHz | Yes |
| *TRION-SUB-XV* | 600 $V_{RMS}$ (±1000 V)[1)]<br>60 $V_{RMS}$ (±100 V)<br>6 $V_{RMS}$ (±10 V)<br>0.6 $V_{RMS}$ (±1 V) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-20A-1* | 20 $A_{RMS}$ (±40 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-2A-1* | 2 $A_{RMS}$ (±4 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-1A-1* | 1 $A_{RMS}$ (±2 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-02A-1* | 0.2 $A_{RMS}$ (±0.4 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-dLV-5V* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-dLV-1V* | 1 $V_{RMS}$ (±2 $V_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-CT* | 1 $A_{RMS}$ (±2 $A_{PEAK}$)<br>0.5 $A_{RMS}$ (±1 $A_{PEAK}$)<br>0.25 $A_{RMS}$ (±0.5 $A_{PEAK}$)<br>0.1 $A_{RMS}$ (±0.2 $A_{PEAK}$) | 5 MHz | No |

*Tab. 58: Supported TRION sub-modules*

[6)] Max. allowed input: 600 V CAT II (850 $V_{PEAK}$).

**INFORMATION**

The *TRION-POWER-SUB-dLV-1* sub-module is not supported.

**INFORMATION**

The TRION3-1810M-SUB-8 is mainly recommended for the use with TRION-SUB-CT, TRION-POWER-SUB-dLV-1V and TRION-POWER-SUB-dLV-5V to benefit from the full bandwidth of these sub-modules.

### Connection to voltage input module (TRION-SUB-xx)

Isolated inputs with 600 V CAT II rated input voltage to earth. Modules with 5 V and 600 V input are available.

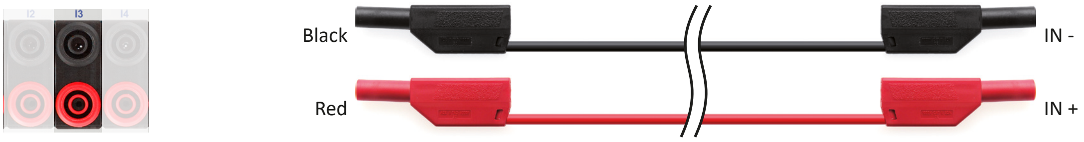



*Fig. 158: Voltage input module*

**WARNING**

**Risk of injury due to electric shock**

Voltage measurement above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

### Connection to current input module (TRION-POWER-SUB-CUR-xA-1B)

Current input for measuring current directly. Current inputs are isolated with 600 V CAT II rated input voltage to earth. Modules with 20 A, 2 A, 1 A and 0.2 A nominal current are available.

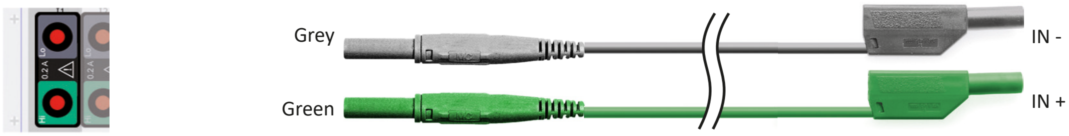


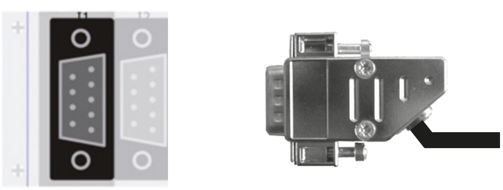

*Fig. 160: Current input module*

**WARNING**

**Risk of injury due to electric shock**

Current measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

### Connection to clamp input module (TRION-POWER-SUB-dLV-xV)



| | | | |
|---|---|---|---|
| Pin 1: | TEDS | Pin 6: | n.c. |
| Pin 2: | IN+ | Pin 7: | IN- |
| Pin 3: | n.c. | Pin 8: | n.c. |
| Pin 4: | GND (not isolated) | Pin 9: | -9 V (40 mA max.) |
| Pin 5: | +9 V (40 mA max.) | | |

*Fig. 161: Clamp input module*

**WARNING**

**Risk of injury due to electric shock**

TRION-POWER-SUB-dLV-xV modules are not isolated.

## Exchanging SUB-modules

Refer to *Exchanging TRION sub-modules on page 225* for the instructions on how to exchange TRION sub-modules.

## Block diagram

The TRION3-1810M-SUB-8 measurement boards can be equipped with interchangeable inserts (SUB-modules) and expanded up to 8 channels in total.

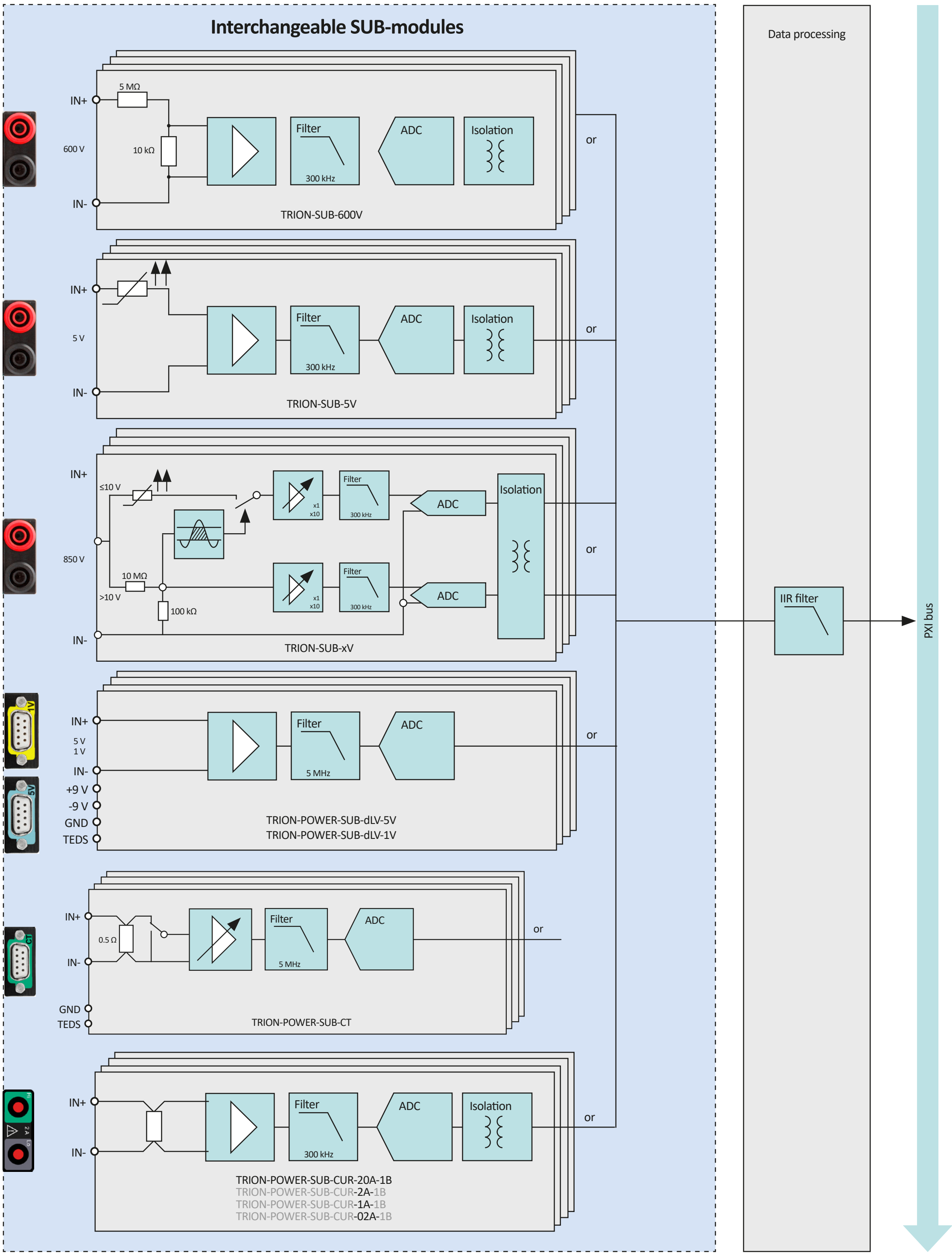
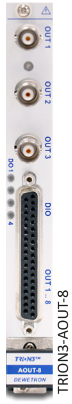



*Fig. 163: Block diagram*

# TRION3-AOUT-8

- 8 isolated output channels
- Programmable voltage or current output
  - ±5 V
  - ±10 V
  - ±30 mA
- FPGA based arbitrary signal generator
- Data replay




## Module specifications

| TRION3-AOUT-8 specifications | | | |
|---|---|---|---|
| Input channels / connectors | | CH1 Analog OUT; CH2 Analog OUT; CH3 Analog OUT; Analog out CH1 to CH8 DI1 to 8, DI11 DO1 to 5 | |
| Onboard data buffer | | 512 MB | |
| Isolation voltage (channel-to-channel and channel-to-chassis) | | ±350 $V_{DC}$ | |
| Environmental specifications | Operating temperature | 0 to +45 °C (32 to 113 °F) | |
| | Storage temperature | -20 to +70 °C (-4 to 158 °F) | |
| | Humidity | 10 to 80 % non cond., 5 to 95 % rel. humidity | |
| Power consumption | | Typ. 15 W, max. 24 W | |
| Modes[1] | Constant output | -10 to +10 V or -30 to +30 mA | |
| | Function generator | Waveform | Sine, square, triangle, custom |
| | | Frequency | 0.001 Hz to 1 MHz |
| | | Amplitude | 0–10 $V_{PEAK}$ or 0–30 $mA_{PEAK}$ |
| | | Offset | -10 to 10 V or -30 to 30 mA |
| | | Phase | -180 to 180° |
| | | Symmetry (triangle)/ dutycycle (square) | 0.01 to 100 % |
| | | Custom waveforms | Up to 4 custom waveforms<br>Max. 16384 samples per waveform |
| | Stream output[2] | Output signal | -10 to +10 V or -30 to +30 mA |
| | | Optional factor and offset | |
| | *Math output[3]* | *A*B; A+B; A-B* | |
| | *Monitor output[3]* | *Direct conditioned signal output: -10 to +10 V or -30 to +30 mA* | |
| Analog outputs | | 8 isolated channels, independently programmable | |
| Output range | | ±5 V, 0 to 5 V, ±10 V, 0 to 10 V, ±30 mA; 0 to 30 mA | |
| Load current | | ±30 mA max. | |

*Tab. 59: Module specifications*

| **TRION3-AOUT-8 specifications** | | |
|---|---|---|
| Temperature drift | ±25 ppm/K | |
| Linearity | <100 ppm | |
| Output impedance | <1 Ω at D-SUB connector, 50 Ω at BNC | |
| Output protection | Continuous short to ground | |
| Analog output accuracy | See *Tab. 60 below*. | |
| DAC mode | **High-speed mode** | **High-resolution mode** |
| Update rate | 2.5 MS/s | 500 kS/s |
| DAC resolution | 16-bit | 32 bit |
| Bandwidth | 600 kHz, $4^{th}$ ord. Bessel characteristic | 70 kHz, $6^{th}$ ord. Bessel characteristic |
| Latency | <5µs | <100 µs |
| LSB | 305 µV | 1 µV |
| Linearity | 50 ppm | 10 ppm |
| THD | 90 dB | 100 dB |
| Noise floor | 100 dB | 115 dB |
| Output noise static | 2 $mV_{PP}$ / 0.3 $mV_{RMS}$ | 2 $mV_{PP}$ / 0.3 $mV_{RMS}$ |
| Output noise on 1 kHz signal | 11 $mV_{PP}$ / 0.7 $mV_{RMS}$ | 3 $mV_{PP}$ / 0.3 $mV_{RMS}$ |
| Rise/fall time | 400 ns | 4 µs |
| Latency (filter=off) | 4 µs | 15 µs |
| Input to output Jitter | 400 ns | 3.5 µs |
| Auxiliary power supply | +5 V, 20 mA | |
| Isolated digital input | | |
| – Compatibility (input) | CMOS Low: <1.5 V High: >3.2 V | |
| – Overvoltage protection | ±35 $V_{DC}$, 65 $V_{PEAK}$ (100 ms) | |
| – Bandwidth | 50 kHz | |
| – Pulse width distortion | 2.3 µs | |
| – Input high current @ 5V UIN | <3 mA | |
| – Input high current @ 35V UIN | <5 mA | |
| Isolated digital output | | |
| – Compatibility (output) | Open collector | |
| – Max. collector voltage | +30 $V_{DC}$ | |
| – Max. collector current | 5 mA | |
| Non isolated digital I/O | | |
| – Compatibility (input) | CMOS/TTL, 100 kΩ pullup | |
| – Compatibility (output) | TTL, 20 mA | |
| – Overvoltage protection | ±30 $V_{DC}$, 50 $V_{PEAK}$ (100 ms) | |
| Number of DIO | 6 DI + 3 DI (isolated) + 4 DO + 1 DO (isolated) + 2 (reserved internally) | |
| Connector | D-SUB-37 socket for all 8 channels, additionally 3x BNC sockets for CH1 to CH3 | |
| BNC connector | Analog out | AO1, AO2, AO3 |

*Tab. 59: Module specifications*

| TRION3-AOUT-8 specifications | | |
|---|---|---|
| D-SUB-37 connector | Analog out | AO1 to AO8 |
| | Digital in | DI3 to DI8 |
| | Digital in (isolated) | DI1, DI2, DI11 |
| | Digital out | DO1 to DO4 |
| | Digital out (isolated) | DO5 |

*Tab. 59: Module specifications*

[1] Analog output channels can be assigned variably (e.g. AO1 = CH4; AO2 = CH2 + CH7).

[2] The smallest possible delay is 500 ms.

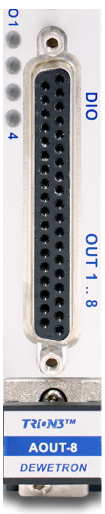
[3] Only supported by TRION3-18xx-MULTI-AOUT-8, not by TRION3-AOUT-8. Does not support CAN or Counter channels.

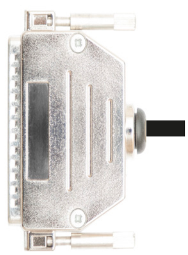
| Output 1 year accuracy (23 °C ±5 °C) | | | | | |
|---|---|---|---|---|---|
| | | **High-speed mode** | | **High-resolution mode** | |
| Voltage output (+10 V; 0 to 10 V; ±5 V; 0 to 5 V) | DC | ±0.02 % of reading | ±1 mV | ±0.02 % of reading | ±1 mV |
| | 0.1 to 1 kHz | ±0.02 % of reading | ±1 mV | ±0.02 % of reading | ±1 mV |
| | 0.1 to 10 kHz | ±0.02 % of reading | ±1 mV | - | |
| | 10 to 100 kHz | ±(0.015 % * f)[1] of reading | ±1 mV | - | |
| Current output (±30 mA; 0 to 30 mA) | DC | ±0.03 % of reading | ±3 µA | ±0.02 % of reading | ±3 µA |
| | 0.1 to 1 kHz | ±0.3 % of reading | ±3 µA | ±0.3 % of reading | ±3 µA |
| | 0.1 to 10 kHz | ±0.3 % of reading | ±3 µA | - | |
| | 10 to 100 kHz | ±(0.03 % * f)[1] of reading | ±3 µA | - | |

*Tab. 60: Output accuracy*

[1] f: frequency in kHz

## Connection



1: +Digital Input DI11 (isolated)
2: GND
3: +Analog Output AO1 (isolated)
4: +Analog Output AO2 (isolated)
5: +Analog Output AO3 (isolated)
6: +Analog Output AO4 (isolated)
7: +Analog Output AO5 (isolated)
8: +Analog Output AO6 (isolated)
9: +Analog Output AO7 (isolated)
10: +Analog Output AO8 (isolated)
11: +Digital Input DI1 (isolated)
12: +Digital Input DI2 (isolated)
13: Digital Input DI3
14: Digital Input DI5
15: Digital Input DI7
16: GND
17: Digital output DO3
18: Digital output DO1
19: -Digital output DO5 (isolated)

20: -Digital Input DI11 (isolated)
21: +5 V, max. 20 mA
22: -Analog Output AO1 (isolated)
23: -Analog Output AO2 (isolated)
24: -Analog Output AO3 (isolated)
25: -Analog Output AO4 (isolated)
26: -Analog Output AO5 (isolated)
27: -Analog Output AO6 (isolated)
28: -Analog Output AO7 (isolated)
29: -Analog Output AO8 (isolated)
30: -Digital Input DI1 (isolated)
31: -Digital Input DI2 (isolated)
32: Digital Input DI4
33: Digital Input DI6
34: Digital Input DI8
35: Digital Output DO4
36: Digital Output DO2
37: +Digital Output DO5 (isolated)
Housing connected to chassis GND

# Block diagrams

## Analog block diagram

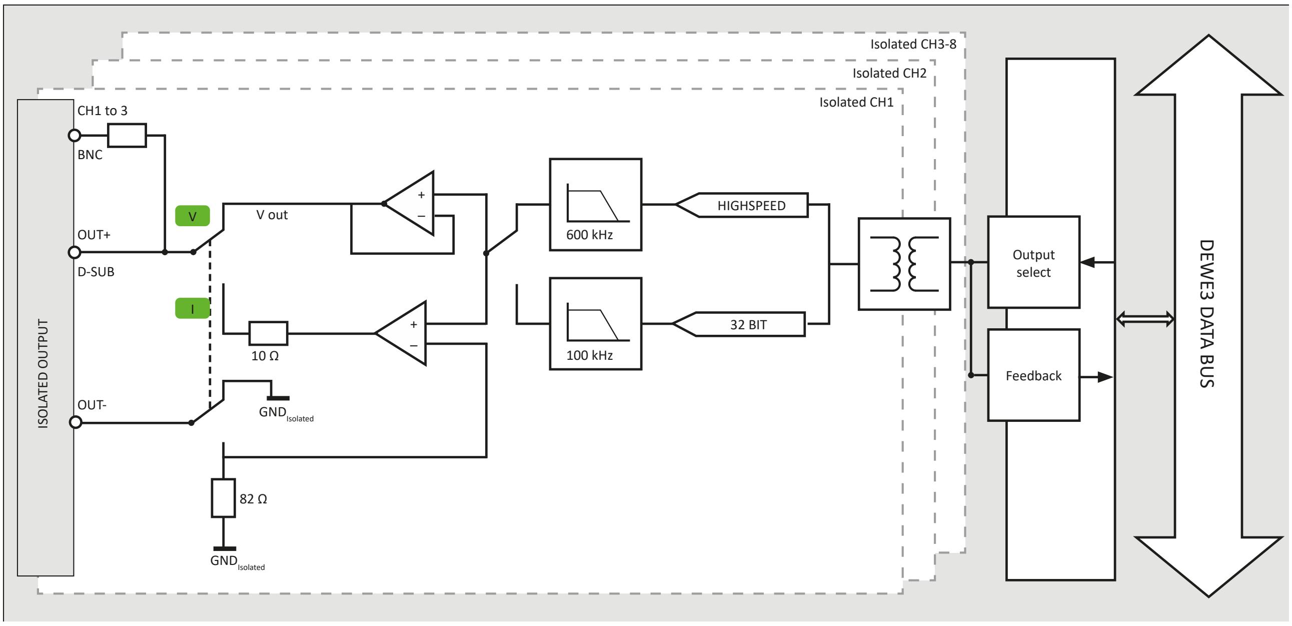



*Fig. 164: Analog block diagram*

## Digital block diagram

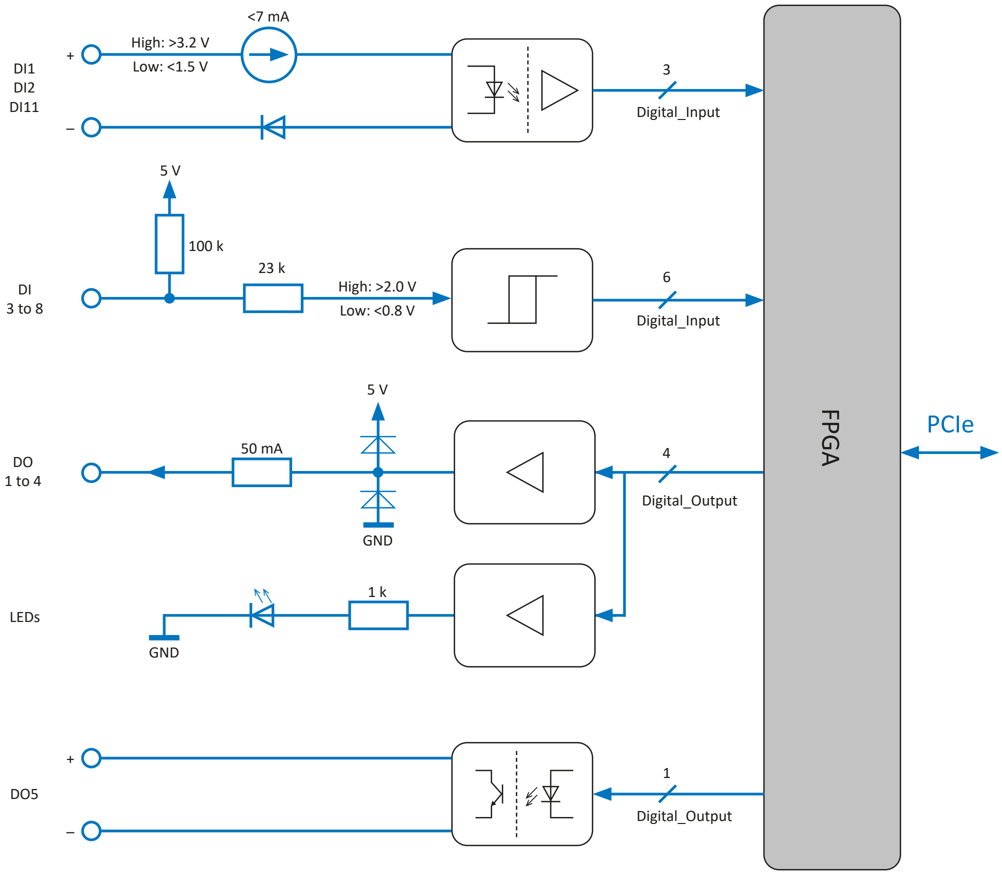



*Fig. 165: Digital block diagram*

## Signal path

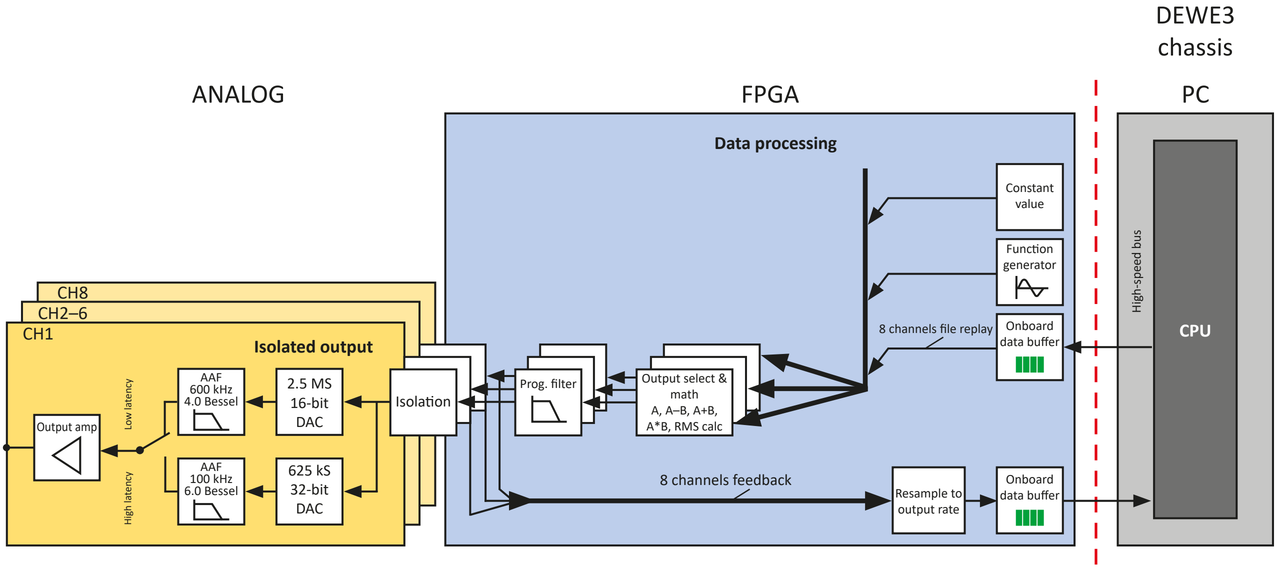



*Fig. 166: Signal path*

# TRION-BASE

- Counter, DIO and synchronization module
- Counter channels: 2 advanced counter
- Digital I/O: 8 DIO and 8 DI
- Synchronization
  - IRIG code B
  - DC I/O
- Additional features: 1 AUX socket (by default set to camera trigger)

TRION-BASE

## Module specifications

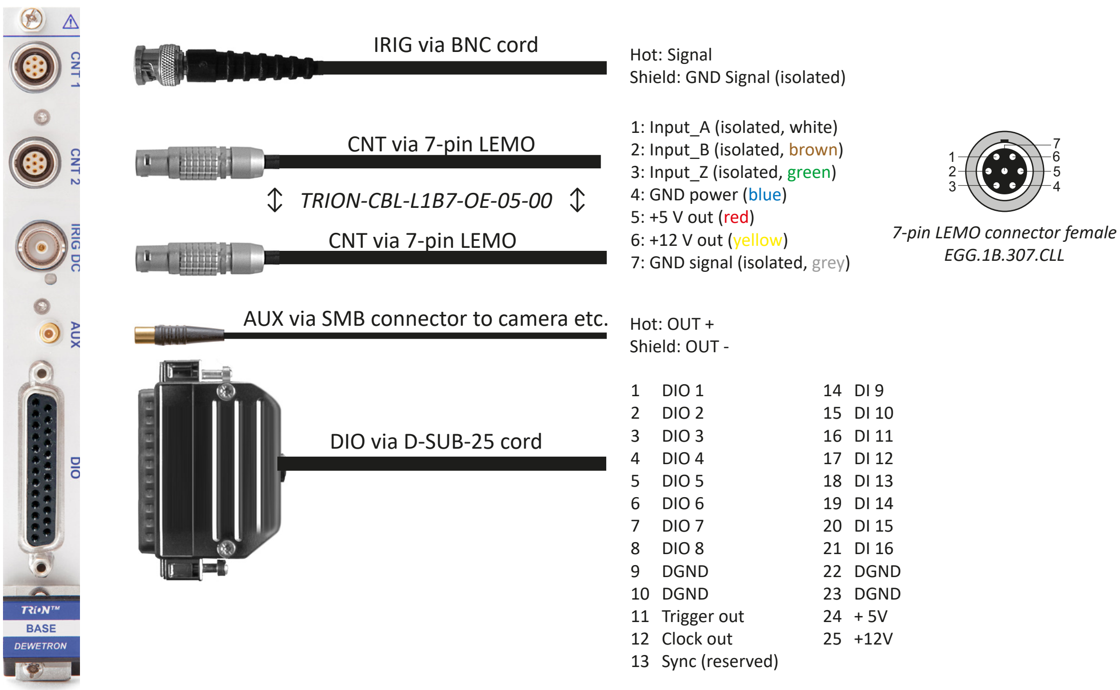
| **TRION-BASE specifications** | | |
|---|---|---|
| **Digital I/O specifications** | | |
| Number of channels | 8 DIO + 8 DI | |
| Compatibility (input) | CMOS/TTL; 100 kΩ pull up | |
| Compatibility (output) | TTL, 20 mA | |
| Overvoltage protection | ±30 $V_{DC}$, 50 $V_{PEAK}$ (100 ms) | |
| Sensor power supply (module total) | 5 V (600 mA) and 12 V (600 mA) | |
| Connector | D-SUB-25 socket | |
| **D-SUB-25 Sync OUT specifications** | | |
| Functionality | Acquisition clock and trigger output<br>(can be used to sync two systems/enclosures) | |
| Compatibility (input) | LVTTL | |
| Compatibility (output) | LVTTL, 10 mA | |
| Overvoltage protection | ±20 $V_{DC}$ | |
| **Counter specifications** | | |
| Number of channels | 2 advanced counter or 6 digital inputs | |
| Counter modes | | |
| – Waveform timing | Period, frequency, pulse width duty cycle and edge separation | |
| – Sensor modes | Encoder (angle and linear) | |
| – Event counting | Basic event counting, gated counting, up/down counting and encoder mode (X1, X2 and X4) | |
| Compatibility (input) | CMOS/TTL | |
| Counter resolution | 32-bit | |
| Counter time base | 80 MHz | |
| Time base accuracy | Within DEWE2 system | Typ. 10 ppm; max. 50 ppm |
| | Within DEWE3 system | Typ. 2 ppm; max. 10 ppm |
| Maximum input frequency | 10 MHz | |
| Overvoltage protection | ±30 $V_{DC}$, 50 $V_{PEAK}$ (100 ms) | |
| Sensor power supply (module total) | 5 V (600 mA) and 12 V (600 mA) | |

*Tab. 61: TRION-BASE specifications*

| TRION-BASE specifications | |
|---|---|
| Connector | LEMO 1B.307 |
| **AUX specifications** | |
| Functionality | Camera trigger, trigger input/output, acquisition clock and programmable clock output |
| Compatibility (input) | LVTTL |
| Compatibility (output) | LVTTL, 10 mA |
| Overvoltage protection | ±20 V |
| Connector | SMB socket |
| **Timing specifications** | |
| Input sources | IRIG code B, DC (B007) |
| Input specification<br>– Compatibility (DC code)<br>– Impedance | <br>DC level shift TTL / CMOS compatible<br>20 kΩ |
| Output specification<br>– Compatibility (DC code) | <br>TTL, 20 mA |
| Adjustment range | ±150 ppm |
| Clock acc. IRIG locked | Without drift |
| Clock acc. IRIG unlocked | <1 ppm |
| Isolation voltage | 350 $V_{DC}$ |
| Connector | BNC socket |
| **General specifications** | |
| Typical power consumption | 5 W |
| Temperature range | 0–50 °C |
| Weight | Approx. 240 g |

*Tab. 61: TRION-BASE specifications*

## Connection



# Encoder connection

## Supplied sensor connection

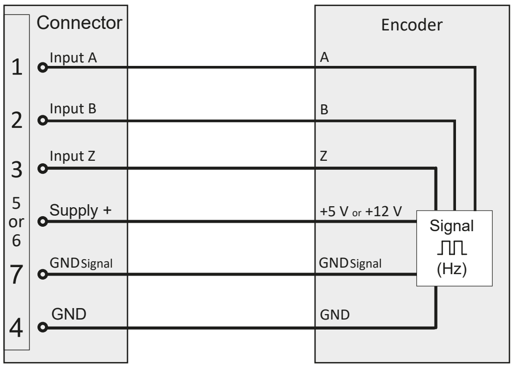



*Fig. 167: Supplied sensor connection*

## Non-supplied sensor connection

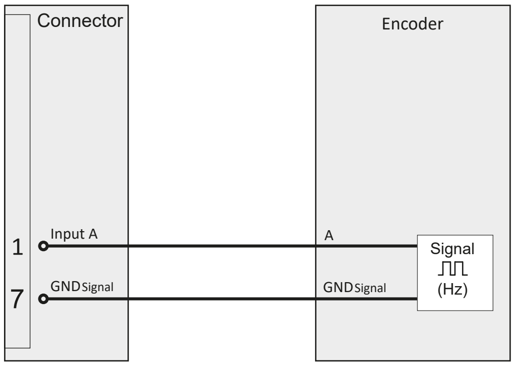



*Fig. 168: Non-supplied sensor connection*

# LED function

The IRIG connector has an indication LED flashing either green or red:


| | OFF | ON | Description |
|---|---|---|---|
| GREEN (flashing) | 20 % | 80 % | SYNC IN not available |
| RED (flashing) | 80 % | 20 % | SYNC detected, not locked |
| GREEN (flashing) | 80 % | 20 % | SYNC detected and locked |

*Tab. 62: LED indication*

# AUX terminal

| | |
|---|---|
|  | The auxiliary terminal of the TRION-BASE module could be used as programmable frequency output for synchronizing external hardware. |
| The output can be set in the Sync Out AUX settings via *System Settings → Sync Setup → Sync Out Aux*: | |

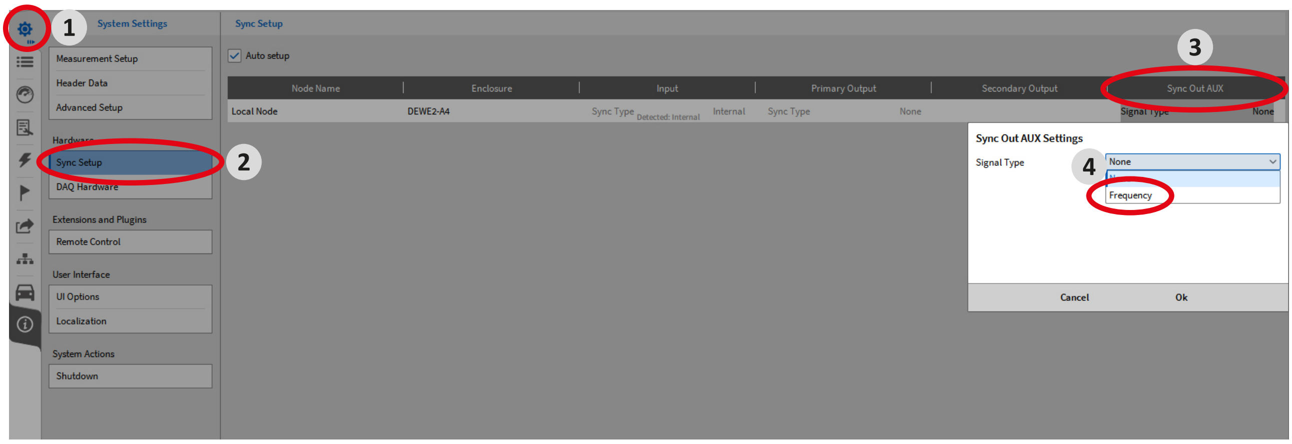



*Fig. 169: Output settings*

## Synchronization options with TRION-BASE

To create high channel count systems or for distributed measurements, DEWE2/3 instruments support multiple synchronization options. The kind of synchronization is depending on how far apart the instruments are from each other.

- Synchronization via TRION-SYNC-BUS (CAT IV ethernet cable) is limited to max. 100 m.
- Synchronization via IRIG time-code is limited to max. 300 m.
- Synchronization via GPS is not limited.

**INFORMATION**

Further information regarding different synchronization options refer to chapter *Synchronization of* DEWE2/3 in your DEWE2 or DEWE3 technical reference manual.

**INFORMATION**

If the system is equipped with a TRION-BASE, TRION-TIMING or TRION-VGPS-20/-100 module, it must be installed in the “star slot”. This is the only slot a module is able to override the system 10 MHz clock with its PPS-synced 10 MHz, and thus providing the system with a timebase of higher accuracy.

## Advanced counter

The TRION-BASE module supports 2 advanced counter or 6 digital inputs as shown in the module specifications. For information regarding advanced counters refer to chapter *Functional description of advanced counter* in the TRION(3) series modules technical reference manual.

# TRION-TIMING-V3

- System timing and synchronization module
- PTP / IEEE 1588
- GPS, GLONASS
- IRIG
- PPS
- 8x DIO, 1x counter, 1x AUX


TRION-TIMING-V3

## Module specifications

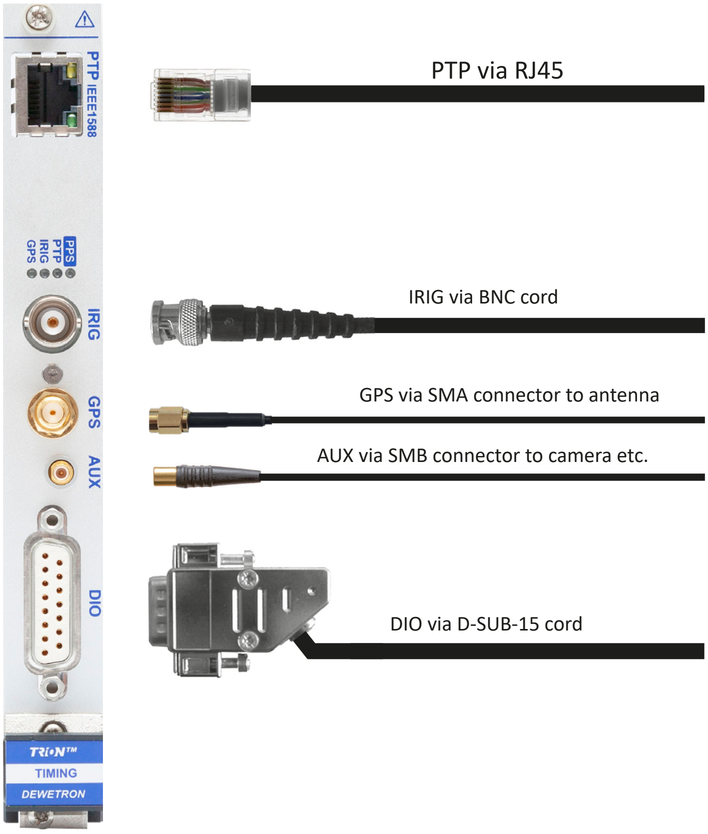
| TRION-TIMING-V3 specifications | | |
|---|---|---|
| Synchronization input modes | PTP / IEEE 1588, GPS, IRIG, PPS (pulse per second) | |
| Features | 1 programable frequency output (10 to 1 000 000 Hz) | |
| | 1 advanced counter input | |
| | 8 digital I/O | |
| **PTP / IEEE 1588** | | |
| IP mode | Multicast | |
| Protocol | UDP / IPv4 | |
| Delay mechanism | End to End | |
| IP address method | DHCP | |
| RJ-45 Ethernet | 10 / 100 Mbit Ethernet connection; only for synchronization, no data transfer possible. | |
| Programmable correction limit | 10 ns to 500 ms | |
| **GPS specifications** | | |
| Supported GNSS signals | GPS / SBAS L1, GLONASS | |
| Number of channels | 35 | |
| PPS accuracy | 100 ns | |
| Refresh rate | 1 Hz, 5 Hz, 10 Hz | |
| Position accuracy (horizontal CEP) | | |
| – Autonomous | 1.5 m | |
| – Differential | 1.0 m | |
| – Velocity | 0.1 m/s | |
| Velocity limit | 500 m/s | |
| Input connector GPS | SMA for GPS antenna | |
| **IRIG input specifications** | | |
| Supported codes | IRIG code A or B; AM or DC (A007, A127, B007, B127) | |
| Compatibility (AM code) | 0.5 Vp-p to 10 Vp-p | |
| Ratio (AM) | 3:1 ±10 % | |
| Compatibility (DC code) | DC level shift (edge detection); TTL / CMOS compatible | |
| | Low: <1.5 V | High: >3.5 V |
| Impedance | 20 kΩ | |
| Isolation voltage | 350 $V_{DC}$ | |

*Tab. 63: Module specifications*

<table>
<tr><th colspan="4">TRION-TIMING-V3 specifications</th></tr>
<tr><td colspan="2">Connector</td><td colspan="2">BNC</td></tr>
<tr><th colspan="4">IRIG output specifications</th></tr>
<tr><td colspan="2">Supported codes</td><td colspan="2">IRIG code B, DC (B007)</td></tr>
<tr><th colspan="4">Digital I/O specifications</th></tr>
<tr><td colspan="2">Number of channels</td><td colspan="2">8</td></tr>
<tr><td colspan="2" rowspan="2">Compatibility (input)</td><td colspan="2">CMOS/TTL</td></tr>
<tr><td>Low: <0.8 V</td><td>High: >2.0 V</td></tr>
<tr><td colspan="2">Compatibility (output)</td><td colspan="2">TTL, 20 mA</td></tr>
<tr><td colspan="2">Overvoltage protection<br>– Input mode<br>– Output mode</td><td colspan="2"><br>±30 $V_{DC}$<br>-0.5 to +5.5 V; short circuit protected</td></tr>
<tr><td colspan="2">Connector</td><td colspan="2">D-SUB-15 socket</td></tr>
<tr><th colspan="4">Counter specifications</th></tr>
<tr><td colspan="2">Number of channels</td><td colspan="2">1 advanced counter or 3 digital inputs</td></tr>
<tr><td rowspan="3">Counter modes</td><td>Event counting</td><td colspan="2">Basic event counting, gated counting, up/down counting and encoder mode (X1, X2 and X4)</td></tr>
<tr><td>Waveform timing</td><td colspan="2">Period, frequency, pulse width, duty cycle and edge separation</td></tr>
<tr><td>Sensor modes</td><td colspan="2">Encoder (angle and linear), gear tooth with/without zero, gear tooth with missing/double teeth</td></tr>
<tr><td colspan="2">Input signal compatibility</td><td colspan="2">CMOS/TTL</td></tr>
<tr><td colspan="2">Counter resolution</td><td colspan="2">32-bit</td></tr>
<tr><td colspan="2">Counter time base</td><td colspan="2">80 MHz</td></tr>
<tr><td colspan="2" rowspan="2">Time base accuracy</td><td>Within DEWE2 system</td><td>Typ. 10 ppm; max. 50 ppm</td></tr>
<tr><td>Within DEWE3 system</td><td>Typ. 2 ppm; max. 10 ppm</td></tr>
<tr><td colspan="2">Maximum input frequency</td><td colspan="2">10 MHz</td></tr>
<tr><td colspan="2">Overvoltage protection</td><td colspan="2">±30 $V_{DC}$, 50 $V_{PEAK}$ (for 100 ms)</td></tr>
<tr><td colspan="2">Sensor power supply</td><td colspan="2">5 V (600 mA) and 12 V (600 mA)</td></tr>
<tr><td colspan="2">Connector</td><td colspan="2">On same D-SUB-15 socket as Digital I/O</td></tr>
<tr><th colspan="4">AUX specifications</th></tr>
<tr><td colspan="2">Functionality</td><td colspan="2">Camera trigger, trigger input/output, acquisition clock and programmable clock output</td></tr>
<tr><td colspan="2">Compatibility (input)</td><td colspan="2">LVTTL</td></tr>
<tr><td colspan="2">Compatibility (output)</td><td colspan="2">LVTTL, 10 mA</td></tr>
<tr><td colspan="2">Overvoltage protection</td><td colspan="2">±20 $V_{DC}$</td></tr>
<tr><td colspan="2">Connector</td><td colspan="2">SMB socket</td></tr>
<tr><th colspan="4">General specifications</th></tr>
<tr><td colspan="2">Typical power consumption</td><td colspan="2">5 W</td></tr>
<tr><td colspan="2">Temperature range</td><td colspan="2">0–50 °C</td></tr>
<tr><td colspan="2">Weight</td><td colspan="2">Approx. 240 g</td></tr>
</table>

*Tab. 63: Module specifications*

## Connection




IRIG: Hot: IN +
Shield: IN -

GPS: Hot: IN +
Shield: IN -

AUX: Hot: OUT +
Shield: OUT -

| | | | |
|---|---|---|---|
| 1 | DIO 1 | 9 | Input A |
| 2 | DIO 2 | 10 | Input B |
| 3 | DIO 3 | 11 | Input Z |
| 4 | DIO 4 | 12 | DGND |
| 5 | DIO 5 | 13 | DGND |
| 6 | DIO 6 | 14 | +5 V |
| 7 | DIO 7 | 15 | +12 V |
| 8 | DIO 8 | | |

## Optional accessory

### TRION-CBL-CAMTRG-03-00

Camera trigger cable to synchronize a DEWE-CAM-GIGE via an AUX socket of TRION modules, 3 m.

### GPS-ANT-FIXED

GNSS/GPS antenna for TRION-TIMING, for fixed installation. Only supports GPS L1.

**NOTICE** When installing the GPS antenna outdoors, ensure that it is protected against lightning strikes.

### GPS-ANT-MOB

IP67 compliant, magnetic GNSS/GPS antenna for TRION-TIMING for mobile applications. Support of GPS L1, GLONASS G1, SBAS (WAAS, EGNOS & MSAS).

5 m cable, SMA plug

## LED function


The 4 LEDs indicate the active synchronization source and current sync status.

| Color | Description |
|---|---|
| GREEN (permanently) | Source is selected and working stable. |
| GREEN (flashing, PPS only) | The PPS LED flashes with the internal generated PPS, immediately when a working source is connected. |
| RED (permanently) | Source is selected bot not yet synced. |

*Tab. 64: LED indication*

**INFORMATION** A red glowing LED can be caused by several reasons depending on the selected input:

- Source might not be connected, or is deactivated. (E.g. IRIG generator is turned off)
- IRIG: wrong IRIG code is selected.
- GPS: not enough satellites found because of antenna position.
- GPS: GPS fix takes up to 1 minute and is not yet established.

## Signal routing

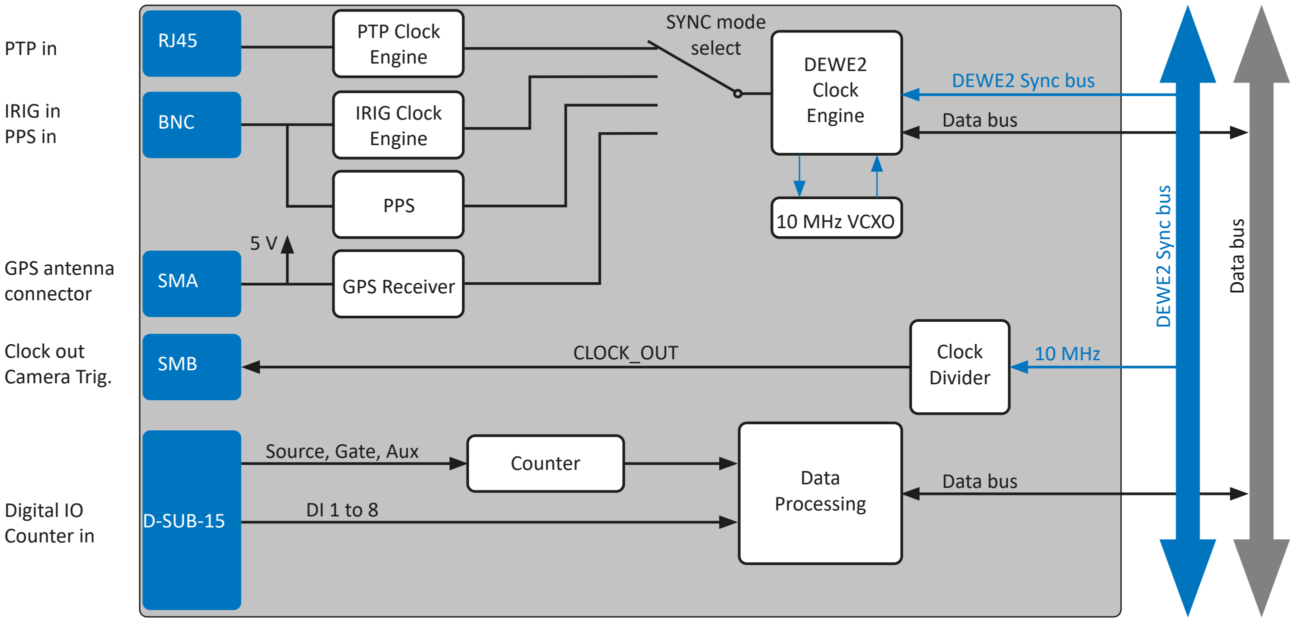



*Fig. 170: Signal routing*

## Simplified input schematics

### BNC (IRIG) input

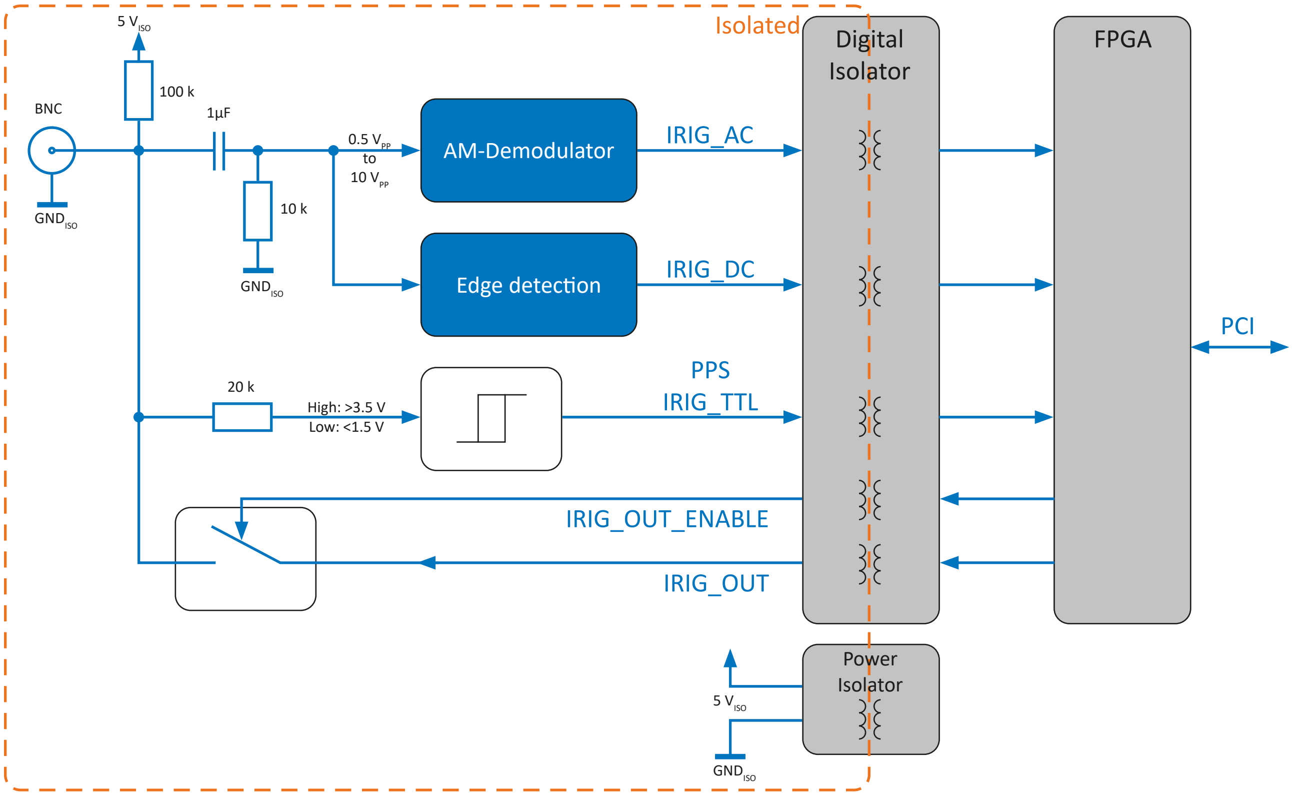



*Fig. 171: BNC (IRIG) input*

### Counter and digital I/O

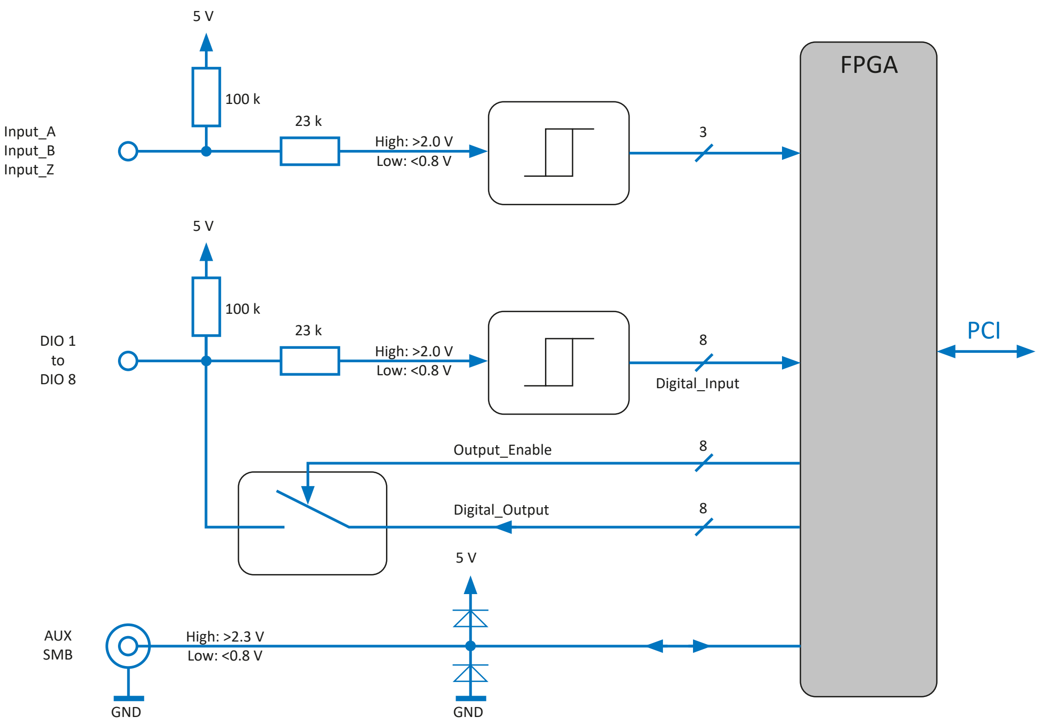



*Fig. 172: Counter and digital I/O*

# PTP/IEEE 1588

## Typical topology

**EXAMPLE** Two or more instruments from DEWETRON or 3rd party instruments synchronized via PTP, data transmission via Ethernet and local data storage are possible.

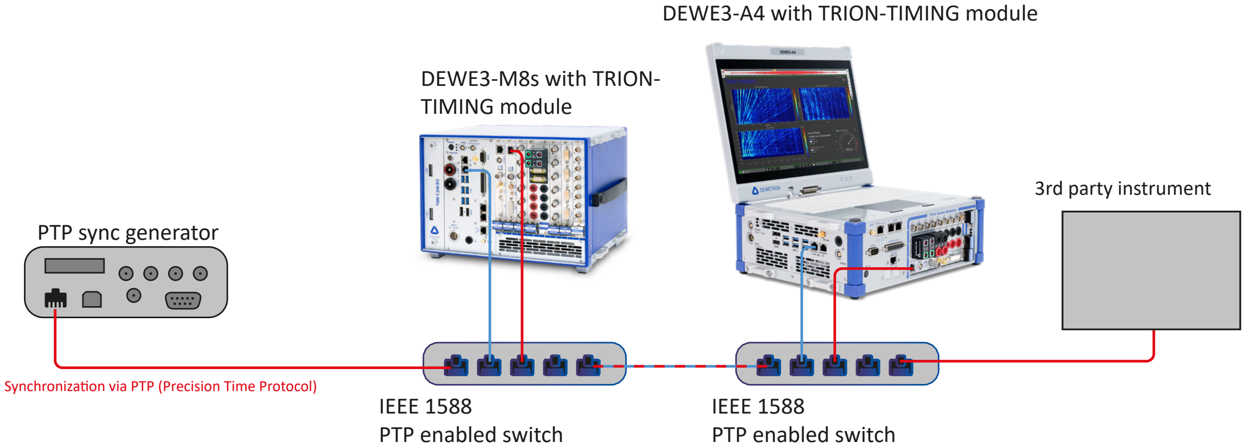



*Fig. 173: Typical topology*

## Settings

| **PTP / IEEE 1588 settings** | | |
|---|---|---|
| Protocol | UDP/IPv4 | (default) |
| | TCP/IPv4 | Coming soon |
| | ETH-IEEE 802.3 | Coming soon |
| Delay mechanism | End-to-end | - |
| | Peer-to-peer | Coming soon |
| IP address method | DHCP | - |
| | Auto IP | Coming soon |
| | Fix IP adress | Coming soon |
| RJ-45 Ethernet | 10/100 Mbit Ethernet connection<br>**INFORMATION** Only for synchronization, no data transfer possible. | |
| Programmable correction limit | 10 ns to 500 ms | - |

*Tab. 65: PTP / IEEE 1588 settings*

# DEWE2/3 clock engine

The TRION-TIMING-V3 is designed for continuously measuring data, even if the external time base source is temporarily not available. Especially in GPS mode that could easily happen. Reason for that is the weather sensitive GPS reception. One cloud might be enough to interrupt the synchronization for a while. In that case the TRION-TIMING-V3 generates a notifying event and continues measuring on its internal time base. This internal time base has been adjusted to the external reference while the sync was stable.

That minimizes the drift in free-run mode. Typically it is far below 1 ppm. Only when the environmental conditions change dramatically during a longer non-synced period of time, it might go up to a maximum of 10 ppm.

When the synchronization has established again the TRION-TIMING checks if the internal time base error is still below the pre-programmed restart limit. If yes, it starts resyncing by slightly changing the time-base until the time stamps matches again exactly. That prevents from gaps in the data file due to resync. That might take a while because the maximum readjusting speed is 100 ppm. If for some reason a hard resync is needed the restart limit could be set to a low value. In that case the datafile will be interrupted.

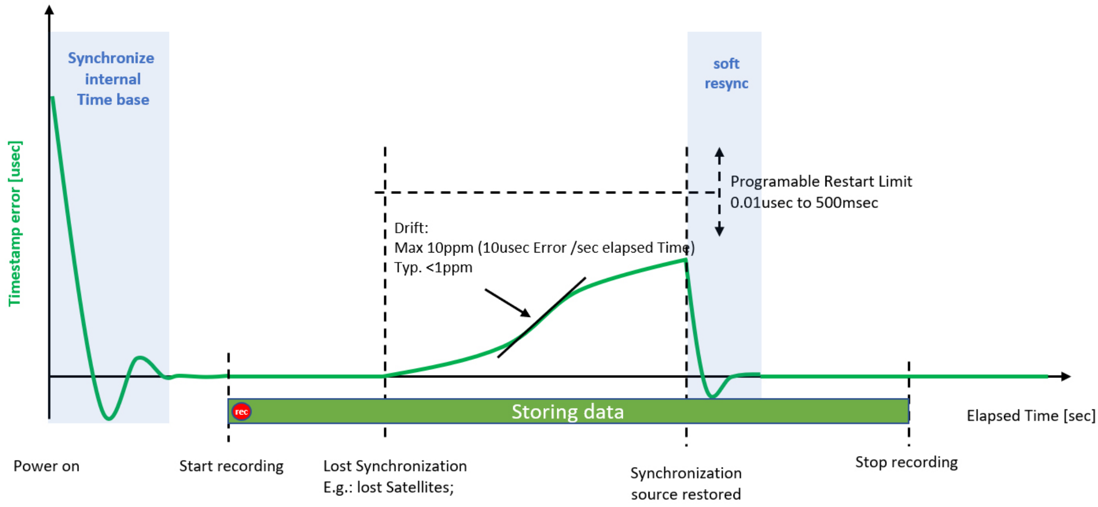



*Fig. 174: Gapless recording*

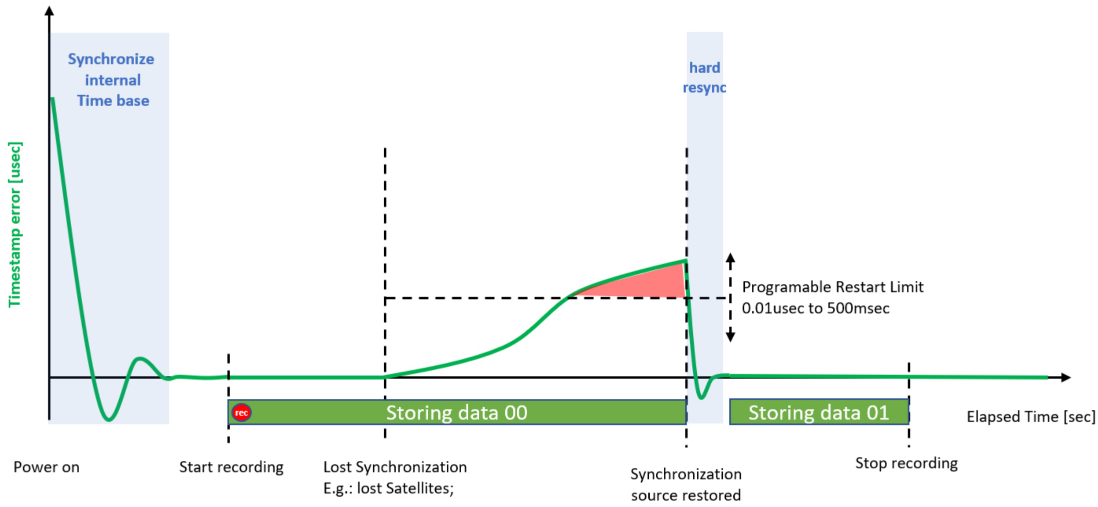



*Fig. 175: Forced restart after restored synchronization*

**INFORMATION**

If the system is equipped with a TRION-BASE, TRION-TIMING or TRION-VGPS-20/-100 module, it must be installed in the “star slot”. This is the only slot a module is able to override the system 10 MHz clock with its PPS-synced 10 MHz, and thus providing the system with a timebase of higher accuracy.

## AUX terminal


The auxiliary terminal of the TRION-TIMING-V3 module could be used as programmable frequency output for synchronizing external hardware.

The output can be set in the Sync Out AUX settings via *System Settings → Sync Setup → Sync Out Aux*:

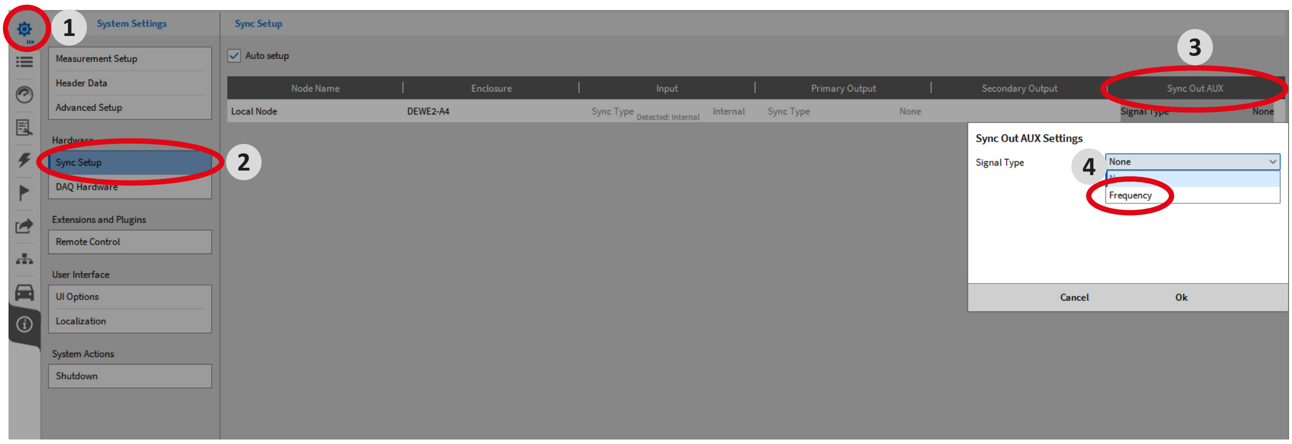



*Fig. 177: Output settings*

## Advanced counter

The TRION-TIMING-V3 module supports an advanced counter or 3 digital via the 15-pin D-SUB connector shown in the module specifications. For information regarding advanced counters refer to *Functional description of advanced counter on page 179*.

# TRION-VGPS-20/100-V3

- Position, speed and displacement module
- 20/100 Hz GPS receiver
- Supports differential GPS (SBAS) and GLONASS as a standard
- GPS or IRIG timing, 8x DIO, 1x counter, 1x AUX
- PTP / IEEE 1588
- Isolation: 350 $V_{DC}$

GPS antenna TRION-TIMING-ANT-2

TRION-VGPS-20/100-V3

## Module specifications

| **TRION-VGPS-20/100-V3 specifications** | |
|---|---|
| **GPS specifications** | |
| Supported GNSS signals | |
| – GPS | L1 C/A, L1C |
| – SBAS | L1, L5 |
| – GLONASS[2)] | L1 C/A |
| Number of channels | 555 |
| Horizontal position accuracy | |
| – Single point L1 | 1.5 m |
| – Single point L1/L2 | 1.2 m |
| – SBAS | 60 cm |
| Refresh rate | |
| – TRION-VGPS-20-V3 | 20 Hz |
| – TRION-VGPS-100-V3 | 100 Hz |
| Time to first fix | |
| – Cold start[3)] | <40 s (typical) |
| – Hot start[4)] | <19 s (typical) |
| Signal lost recovery | |
| – L1 | <0.5 s (typical) |
| – L2 | <1.0 s (typical) |
| Time accuracy[5)] | 240 ns |
| Heading accuracy | 0.1° (typical) |
| Velocity accuracy | <0.03 m/s RMS |
| Velocity limit[6)] | 515 m/s |
| GPS antenna | Incl. (5 m cable); supports GPS L1, GLONASS G1, SBAS (WAAS, EGNOS, MSAS) |
| Input connector GPS | SMA for GPS antenna |
| **PTP / IEEE 1588** | |
| IP Mode | Multicast |
| Protocol | UDP / IPv4; ETH |
| Delay mechanism | End-to-end, peer-to-peer |
| IP address method | DHCP |

*Tab. 66: Module specifications*

<table>
<tr><th colspan="4">TRION-VGPS-20/100-V3 specifications</th></tr>
<tr><td colspan="2">RJ-45 Ethernet</td><td colspan="2">10/100 Mbit Ethernet connection; only for synchronization, no data transfer possible.</td></tr>
<tr><td colspan="2">Programmable correction limit</td><td colspan="2">10 ns to 500 ms</td></tr>
<tr><td colspan="4">IRIG input specifications</td></tr>
<tr><td colspan="2">Supported codes</td><td colspan="2">IRIG code A or B; AM or DC (A007, A127, B007, B127)</td></tr>
<tr><td colspan="2">Compatibility (AM code)</td><td colspan="2">0.5 Vp-p to 10 Vp-p</td></tr>
<tr><td colspan="2" rowspan="2">Compatibility (DC code)</td><td colspan="2">DC level shift (edge detection); TTL / CMOS compatible</td></tr>
<tr><td>Low: <1.5 V</td><td>High: >3.5 V</td></tr>
<tr><td colspan="2">Impedance</td><td colspan="2">20 kΩ</td></tr>
<tr><td colspan="2">Isolation voltage</td><td colspan="2">350 $V_{DC}$</td></tr>
<tr><td colspan="2">Connector</td><td colspan="2">BNC</td></tr>
<tr><td colspan="4">IRIG output specifications</td></tr>
<tr><td colspan="2">Supported codes</td><td colspan="2">IRIG code B, DC (B007)</td></tr>
<tr><td colspan="4">Digital I/O specifications</td></tr>
<tr><td colspan="2">Number of channels</td><td colspan="2">8</td></tr>
<tr><td colspan="2" rowspan="2">Compatibility (input)</td><td colspan="2">CMOS/TTL, weak pull-up 100 kΩ to +5 V</td></tr>
<tr><td>Low: <0.8 V</td><td>High: >2.0 V</td></tr>
<tr><td colspan="2">Compatibility (output)</td><td colspan="2">TTL, 20 mA</td></tr>
<tr><td colspan="2">Overvoltage protection<br>– Input mode<br>– Output mode</td><td colspan="2"><br>±30 $V_{DC}$<br>-0.5 to +5.5 V; short circuit protected</td></tr>
<tr><td colspan="2">Connector</td><td colspan="2">D-SUB-15 socket</td></tr>
<tr><td colspan="4">Counter specifications</td></tr>
<tr><td colspan="2">Number of channels</td><td colspan="2">1 advanced counter or 3 digital inputs</td></tr>
<tr><td rowspan="3">Counter modes</td><td>Event counting</td><td colspan="2">Basic event counting, gated counting, up/down counting and encoder mode (X1, X2 and X4)</td></tr>
<tr><td>Waveform timing</td><td colspan="2">Period, frequency, pulse width, duty cycle and edge separation</td></tr>
<tr><td>Sensor modes</td><td colspan="2">Encoder (angle and linear), gear tooth with/without zero, gear tooth with missing/double teeth</td></tr>
<tr><td colspan="2">Input signal compatibility</td><td colspan="2">CMOS/TTL</td></tr>
<tr><td colspan="2">Counter resolution</td><td colspan="2">32-bit</td></tr>
<tr><td colspan="2">Counter time base</td><td colspan="2">80 MHz</td></tr>
<tr><td colspan="2">Time base accuracy</td><td colspan="2">Typical 10 ppm (DEWE2); 2 ppm (DEWE3); (defined by the backplane)</td></tr>
<tr><td colspan="2">Maximum input frequency</td><td colspan="2">10 MHz</td></tr>
<tr><td colspan="2">Overvoltage protection</td><td colspan="2">±30 $V_{DC}$, 50 $V_{PEAK}$ (for 100 ms)</td></tr>
<tr><td colspan="2">Sensor power supply</td><td colspan="2">5 V (600 mA) and 12 V (600 mA)</td></tr>
<tr><td colspan="2">Connector</td><td colspan="2">On same D-SUB-15 socket as Digital I/O</td></tr>
<tr><td colspan="4">AUX specifications</td></tr>
<tr><td colspan="2">Functionality</td><td colspan="2">Camera trigger, trigger input/output, acquisition clock and programmable clock output</td></tr>
<tr><td colspan="2">Compatibility (input)</td><td colspan="2">LVTTL</td></tr>
<tr><td colspan="2">Compatibility (output)</td><td colspan="2">LVTTL, 10 mA</td></tr>
<tr><td colspan="2">Overvoltage protection</td><td colspan="2">±20 $V_{DC}$</td></tr>
</table>

*Tab. 66: Module specifications*

| **TRION-VGPS-20/100-V3 specifications** | |
|---|---|
| Connector | SMB socket |
| **General specifications** | |
| Typical power consumption | 5 W |
| Temperature Range | 0–50 °C |
| Weight | Approx. 240 g |

*Tab. 66: Module specifications*

1) Typical values. Performance specifications subject to GNSS system characteristics, Signal-In-Space (SIS) operational degradation, ionospheric and tropospheric conditions, satellite geometry, baseline length, multipath effects and the presence of intentional or unintentional interference sources.

2) Hardware ready for L3 and L5.

3) Typical value. No almanac or ephemerides and no approximate position or time.

4) Typical value. Almanac and recent ephemerides saved and approximate position and time entered.

5) Time accuracy does not include biases due to RF or antenna delay.

6) Export licensing restricts operation to a maximum of 515 m/s, message output impacted above 500 m/s.

## LED function


The 4 LEDs indicate the active synchronization source and current sync status.

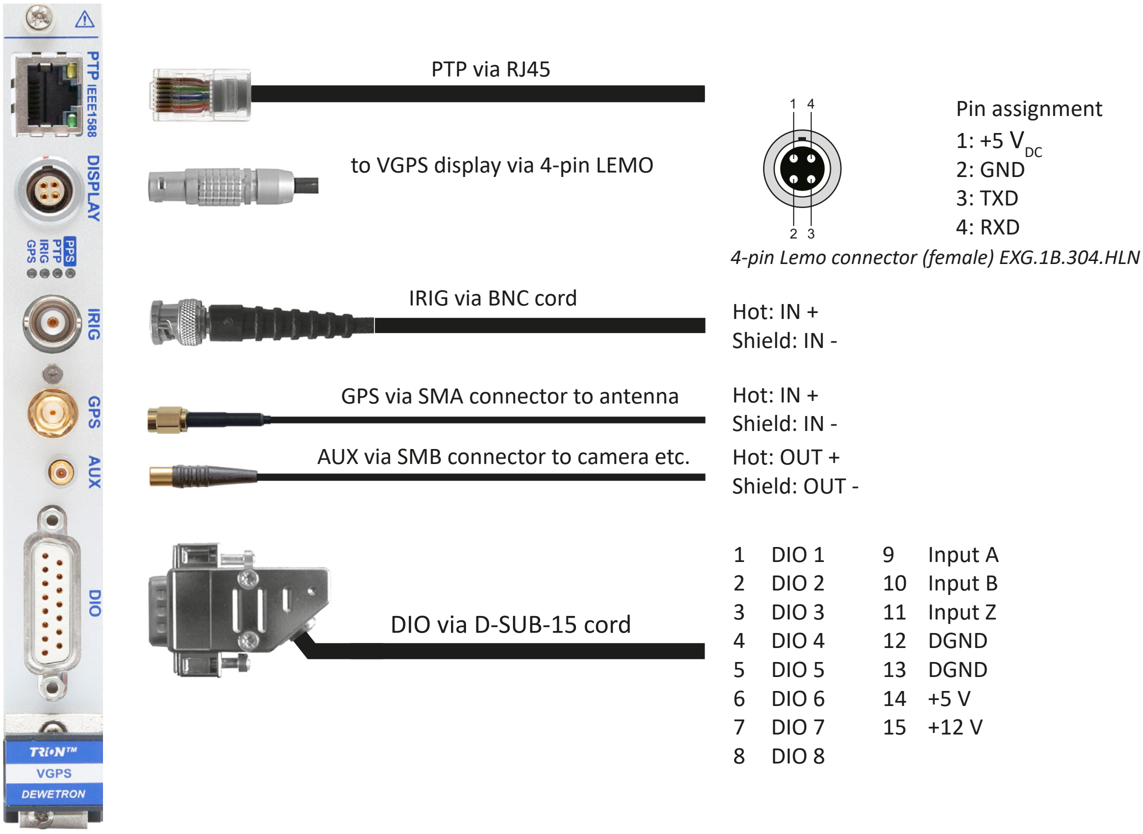
| Color | Description |
|---|---|
| GREEN (permanently) | Source is selected and working stable. |
| GREEN (flashing, PPS only) | The PPS LED flashes with the internal generated PPS, immediately when a working source is connected. |
| RED (permanently) | Source is selected bot not yet synced. |

*Tab. 67: LED indication*

**INFORMATION** A red glowing LED can be caused by several reasons depending on the selected input:

- Source might not be connected, or is deactivated. (E.g. IRIG generator is turned off)
- IRIG: wrong IRIG code is selected.
- GPS: not enough satellites found because of antenna position.
- GPS: GPS fix takes up to 1 minute and is not yet established.

## Connection




## Optional accessory

### TRION-CBL-CAMTRG-03-00

Camera trigger cable to synchronize a DEWE-CAM-GIGE via an AUX socket of TRION modules, 3 m.

## Software settings for TRION-VGPS-20/100-V3

### GPS receiver settings

The following parameters are selectable:

- **Receiver dynamic**

  is used to adjust the receiver dynamics to that of an application. It is used to optimally tune receiver parameters.

| Software setting | Description |
|---|---|
| Normal (default) | Receiver is being carried by a person with velocity less than 11 km/h (3 m/s) |
| High | Receiver is in a stable land vehicle with velocity less than 110 km/h (30 m/s) |
| Highest | Receiver is in an aircraft or a land vehicle, for example a high-speed train, with velocity greater than 110 km/h (30 m/s). This is also the most suitable dynamic for a jittery vehicle at any speed |
| Automatic | Receiver monitors dynamics and adapts behavior accordingly |

*Tab. 68: Receiver dynamic*

- **Position smoothing**

  is used to enable, disable or reset the Pseudorange/Delta-Phase (PDP) filter. The main advantages of the PDP implementation are:

  – Smooths a jumpy position

– Bridges outages in satellite coverage (the solution is degraded from normal but there is at least a reasonable solution without gaps)

| Software setting | Description |
|---|---|
| Disabled | Disable the PDP filter |
| Normal (default) | Enable the PDP filter. Auto detect dynamics mode. |
| Glide | Receiver is in an aircraft or a land vehicle, for example a high-speed train, with velocity greater than 110 km/h (30 m/s). This is also the most suitable dynamic for a jittery vehicle at any speed. GLIDE is a mode of the PDP filter that optimizes the position for consistency over time rather than absolute accuracy. |

*Tab. 69: Position smoothing*

- **Satellite Based Augmentation System**

is used to dictate how the receiver tracks and uses correction data from Satellite Based Augmentation Systems (SBAS). SBAS improves the accuracy and reliability of GNSS information by correcting signal measurement errors and by providing information about the accuracy, integrity, continuity and availability of its signals.

| Software setting | Description |
|---|---|
| Disabled | GPS and GLONASS satellites used, but no SBAS satellites<br>attention: GLONASS satellites are disabled for any other SBAS setting! |
| Auto (default) | Automatically determines satellite system to use and prevents the receiver from using satellites outside of the service area |
| Any | Uses any and all SBAS satellites found |
| WAAS | Uses only "Wide Area Augmentation System" satellites available in the United States |
| EGNOS | Uses only "European Geostationary Navigation Overlay Service" satellites available in Europe |
| MSAS | Uses only "Multi-functional Satellite Augmentation System" satellites available in Japan |
| GAGAN | Uses only "GPS Aided Geo Augmented Navigation" satellites available<br>in India |
| QZSS | Uses only Quasi-Zenit-Satellite-System signals available in Japan |

*Tab. 70: Satellite based augmentation system*

- **Velocity type**

configures the source of the velocity that is used.

| Software setting | Description |
|---|---|
| Position | Use the velocity from the same positioning filter that is being used |
| Doppler (default) | using Doppler-derived velocities. It is the highest-availability, lowest-latency velocity available from the receiver. Due to its low latency, it is also the noisiest velocity. |

*Tab. 71: Velocity type*

# PTP/IEEE 1588

The TRION-VGPS-20/100-V3 module supports synchronization via PTP (Precision Time Protocol)

## Typical topology

EXAMPLE Two or more instruments from DEWETRON or 3rd party instruments synchronized via PTP, data transmission via Ethernet and local data storage are possible.

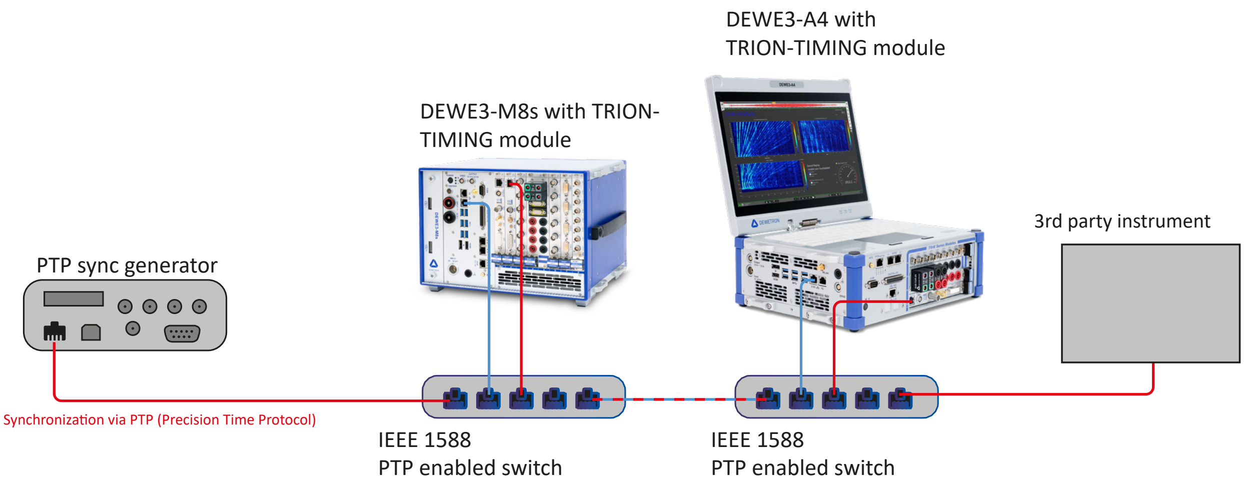



*Fig. 178: Typical topology*

## Settings

| PTP / IEEE 1588 settings | | |
|---|---|---|
| Protocol | UDP/IPv4 | (default) |
| | TCP/IPv4 | Coming soon |
| | ETH-IEEE 802.3 | Coming soon |
| Delay mechanism | End-to-end | - |
| | Peer-to-peer | Coming soon |
| IP address method | DHCP | - |
| | Auto IP | Coming soon |
| | Fix IP adress | Coming soon |
| RJ-45 Ethernet | 10/100 Mbit Ethernet connection<br>INFORMATION Only for synchronization, no data transfer possible. | |
| Programmable correction limit | 10 ns to 500 ms | - |

*Tab. 72: PTP / IEEE 1588 settings*

# AUX terminal


The auxiliary terminal of the TRION-TIMING-V3 module could be used as programmable frequency output for synchronizing external hardware.

The output can be set in the Sync Out AUX settings via *System Settings → Sync Setup → Sync Out Aux*:

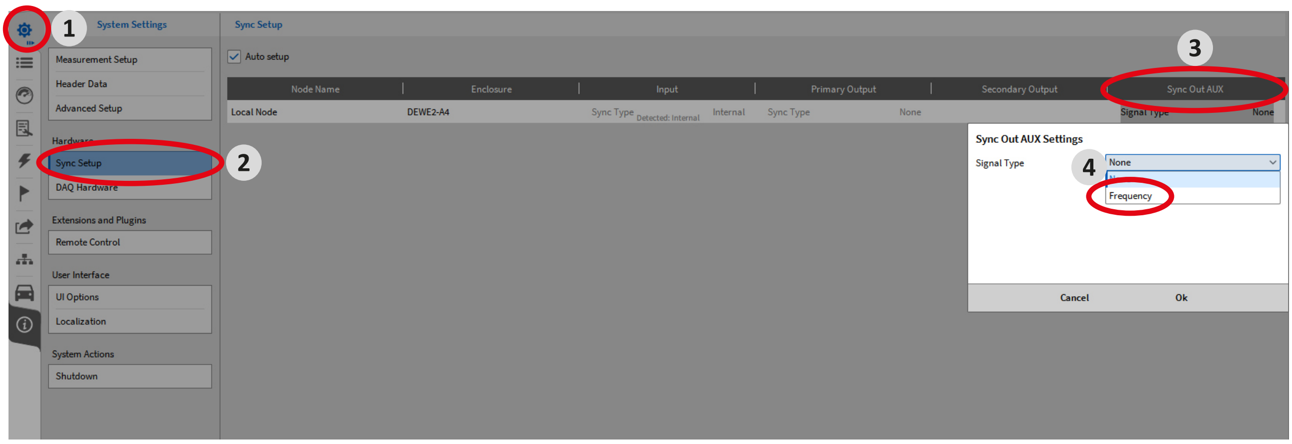



*Fig. 179: Output settings*

## Synchronization options

To create high channel count systems or for distributed measurements, DEWE2 instruments support multiple synchronization options. The kind of synchronization is depending on how far apart the instruments are from each other.

- Synchronization via IRIG time-code is limited to max. 300 m.
- Synchronization via GPS is not limited.

**INFORMATION**

If the system is equipped with a TRION-BASE, TRION-TIMING or TRION-VGPS-20/-100 module, it must be installed in the “star slot”. This is the only slot a module is able to override the system 10 MHz clock with its PPS-synced 10 MHz, and thus providing the system with a timebase of higher accuracy.

## Advanced counter

The TRION-VGPS module supports an advanced counter or 3 digital inputs via the D-SUB-15 connector as shown in the module specifications. For information regarding advanced counters refer to Functional description of advanced counter on page 179.

# TRION-CNT

- Isolated advanced counter module
- 80 MHz time base
- 2 MS/s per channel
- Event, waveform timing and sensor mode
- Programmable threshold and AC/DC coupling

TRION-CNT

## Module specifications

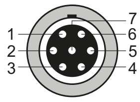
| **TRION-CNT specifications** | | |
|---|---|---|
| Input channels | 6 advanced counter | |
| Counter modes | | |
| – Events | Basic event counting | |
| – Frequency | 0.3 Hz to 4 MHz | |
| – Pulsewidth | 12.5 ns to 53.687 s | |
| – Two pulse edge separation | 12.5 ns to 53.687 s | |
| – Encoder | Encoder mode (X1, X2 and X4, up/down counting) | |
| Rated input voltage to earth according to EN 61010-2-30 | 33 $V_{RMS}$, 70 $V_{DC}$, 46,7 $V_{PEAK}$ | |
| Compatibility | Single ended input with adjustable trigger level (TTL, LVTTL, CMOS, analog)<br>For differential input use DIFF-CNT-LEMO-DB9F-01. | |
| Isolation voltage (channel-to-channel and channel-to-chassis) | 500 $V_{DC}$ | |
| Input coupling | DC and AC (1Hz) AC for input A only | |
| Input impedance (ground referenced) | 1 MΩ / 5 pF | |
| Sampling rate | 2 MS/s per channel | |
| Bandwidth (-3dB) | 5 MHz | |
| Trigger adjustment range | 0 to 50 V | |
| Trigger resolution | 12 mV | |
| Trigger level accuracy | ±20 mV ±1% of threshold/retrigger level | |
| Overvoltage protection | ±100 $V_{DC}$ | |
| Max. DC voltage @ AC coupling | ±50 $V_{DC}$ | |
| Counter resolution | 32-bit, 12.5 ns | |
| Counter time base | 80 MHz | |
| Time base accuracy | Within DEWE2 system | Typ. 10 ppm; max. 50 ppm |
| | Within DEWE3 system | Typ. 2 ppm; max. 10 ppm |
| Sensor power supply (not isolated) | 5 V, max. 600 mA combined for all channels, not isolated<br>12 V, max. 600 mA combined for all channels, not isolated | |
| Typcial power consumption without sensor supply | 5 W | |
| Weight | Approx. 240 g | |

*Tab. 73: TRION-CNT specifications*

## Connection

Measurement is carried out via LEMO cord (TRION-CBL-L1B7-OE-05-00).


1: Input_A (isolated, white)
2: Input_B (isolated, brown)
3: Input_Z (isolated, green)
4: GND power (blue)
5: +5 V out (red)
6: +12 V out (yellow)
7: GND signal (isolated, grey)




*7-pin LEMO connector female*
*EGG.1B.307.CLL*

*Fig. 180: Signal connection*

## Sensor connections

### Sensors with digital output

Supported functions:

- Event counting (for angle and speed measurement)
- Frequency measurement
- Two pulse edge separation

#### Event counting

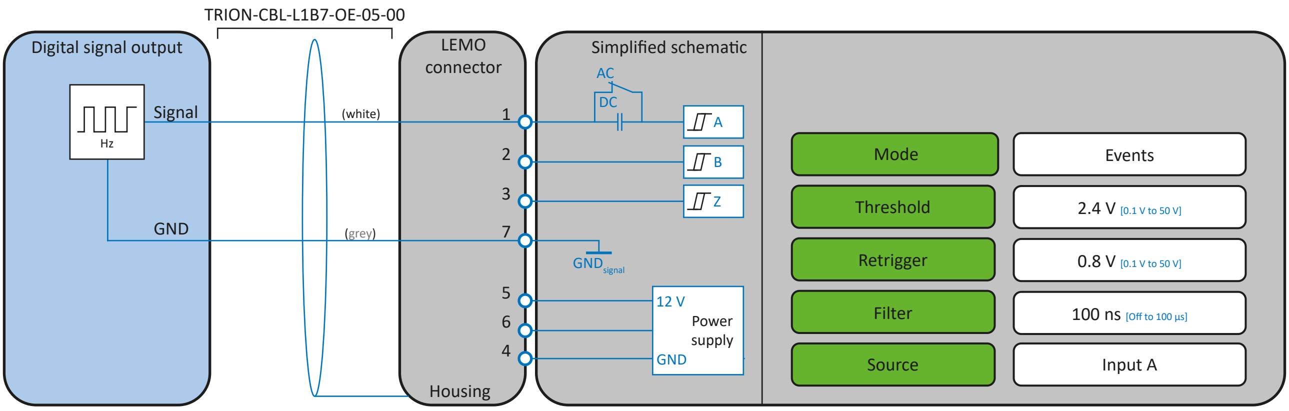



*Fig. 181: Event counting (digital output)*

#### Frequency measurement

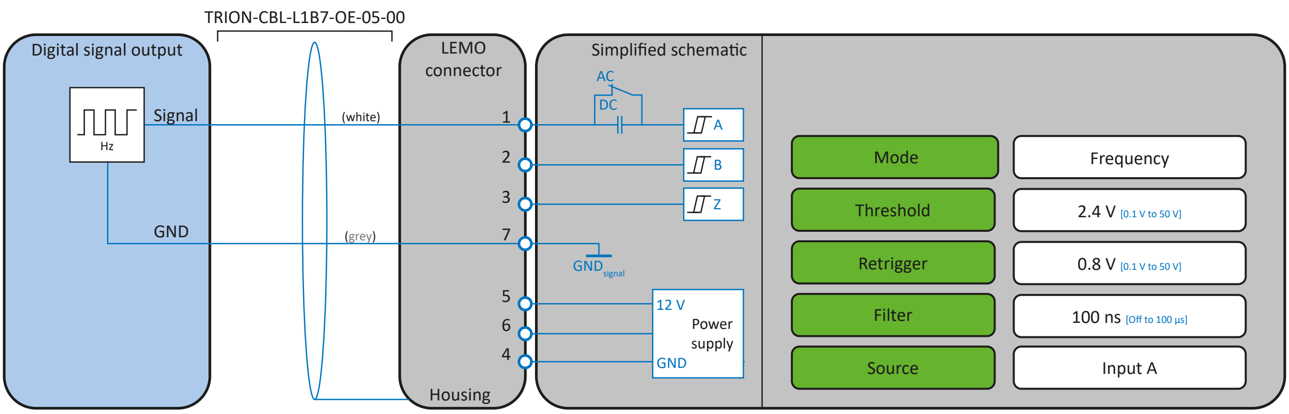



*Fig. 182: Frequency (digital output)*

### Two pulse edge separation

The two pulse edge separation measures the time between two edges of two input channels. It can be used for precise delay measurement.

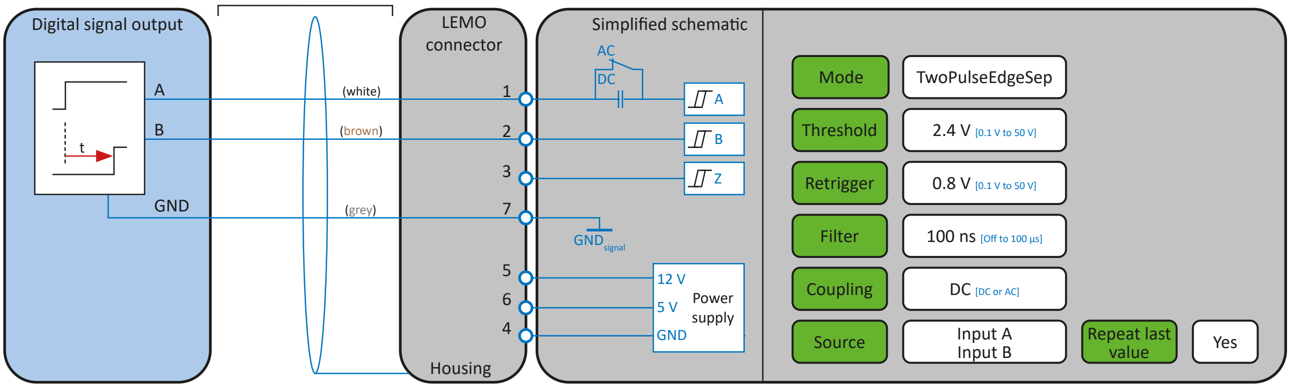



*Fig. 183: Two pulse edge separation*

## Sensor with analog output

e.g. inductive pick-up sensor, optical tachometer

Supported functions

- Event counting (for angle and speed measurement)
- Frequency measurement

**Coupling:** For magnetic pickup sensors, AC coupling is recommended.

**Trigger level:** Since the analogue output signal of the sensor becomes smaller the slower the movement is, the switching threshold should be set relatively low. Before measuring, you should test whether the sensor responds at the desired minimum speed. At the same time, selecting a threshold that is too low can lead to interference such as the mains frequency.

### Event counting

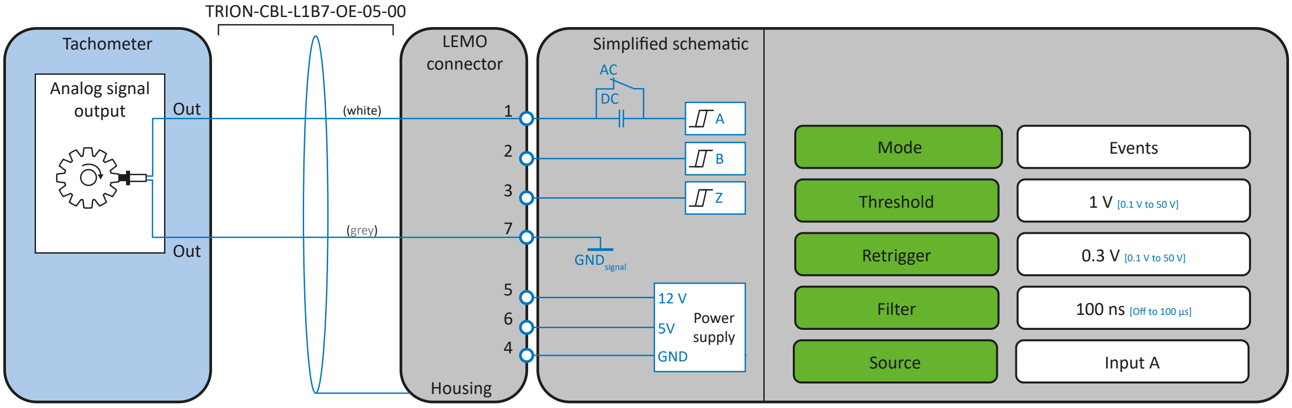



*Fig. 184: Event counting (analog output)*

### Frequency measurement

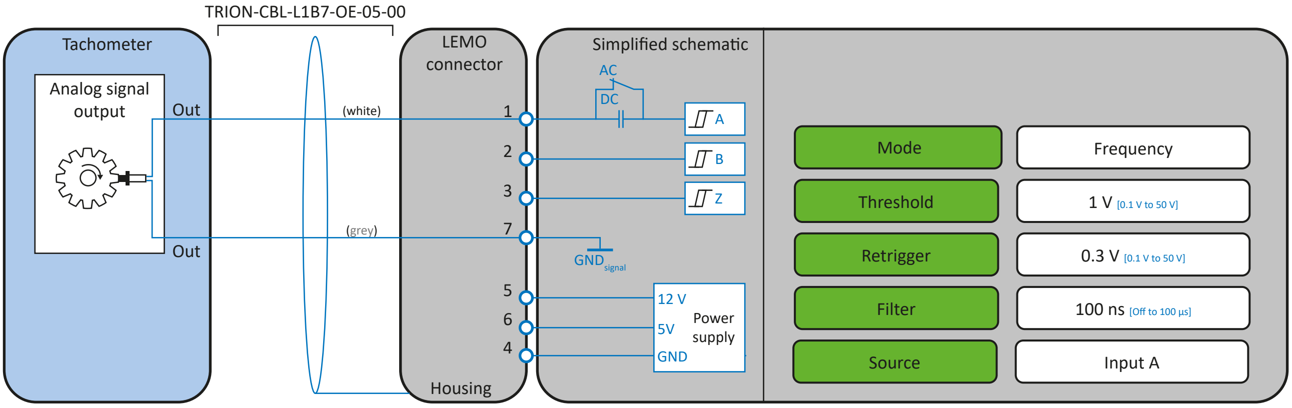



*Fig. 185: Frequency measurement (analog output)*

## Encoder

### Encoder with single ended output powered by the TRION-CNT

e.g. rotational encoder with or without zero pulse; linear encoder

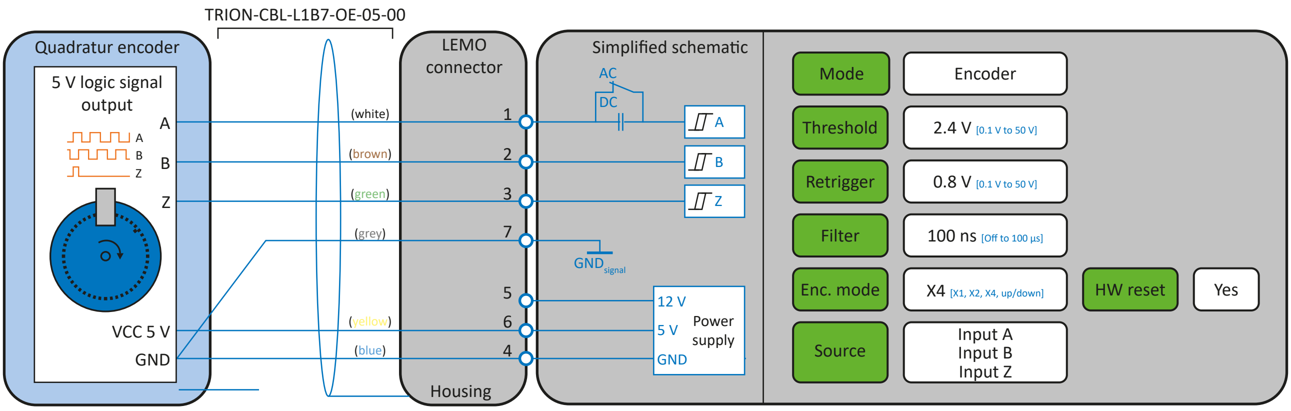



*Fig. 186: Quadratur encoder*

**INFORMATION**

Input channels and power supply are isolated in the TRION-CNT measurement board. Therefore, $GND_{signal}$ and GND must be connected at the sensor side.

### Encoder with differential output powered by the TRION-CNT

e.g. rotational encoder with or without zero pulse; linear encoder

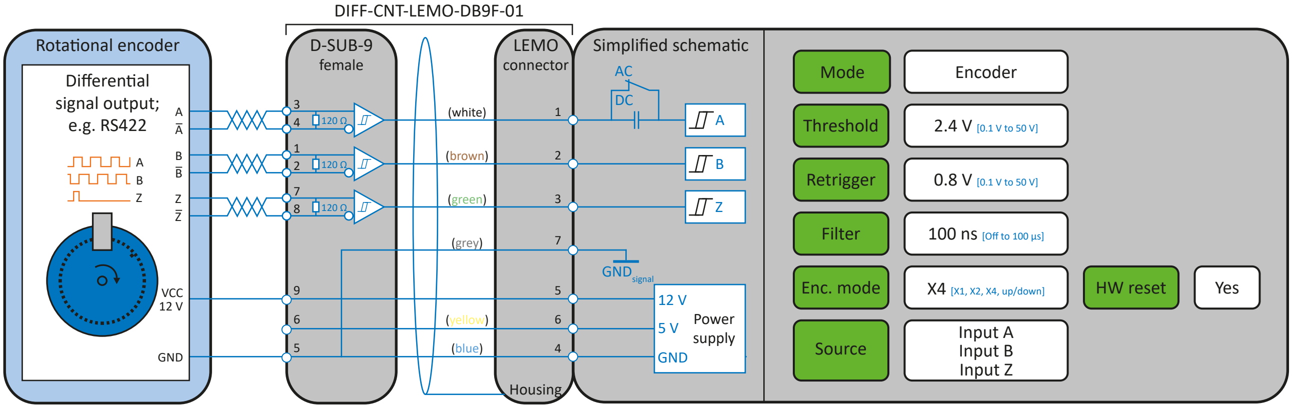



*Fig. 187: Rotational encoder*

**INFORMATION**

Using twisted pair cables for differential signals is highly recommended to avoid jitter.

### Encoder with differential output, externally powered

e.g. rotational encoder or torque sensor with 18 to 30 V power supply

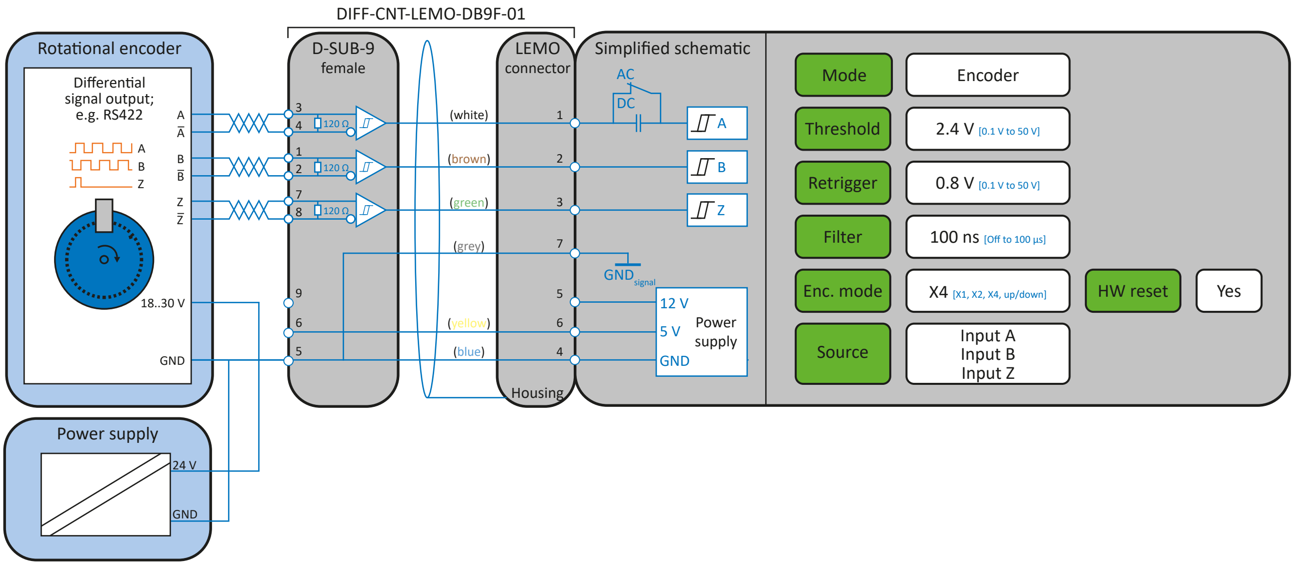



*Fig. 188: Rotational encoder externally powered*

**NOTICE**

The power supply GND must be connected to the D-SUB-9 pin 5. Otherwise, high common mode voltages can destroy the differential input.

## Optional accessory

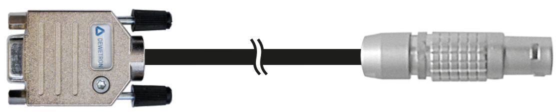
### TRION-CBL-L1B7-0E-05-00

High quality cable from LEMO 1B.307 plug to open end, 5 m for TRION-CNT-6-LEMO modules.

## DIFF-CNT-LEMO-DB9F-01

High quality adapter cable from Lemo 0B.309 plug to D-SUB-9 socket.

1 B-
2 B+
3 A+
4 A-
5 GND
6 +5 V
7 Z+
8 Z-
9 +12 V



| DIFF-CNT-LEMO-DB9F-01 specifications | |
|---|---|
| Supply | 12 V |
| Supply current | <55 mA |
| Common mode input range | ±12 V |
| Differential input voltage | ±12 V |
| Input sensitivity | ±200 mV |
| Input hysteresis | Typ. 50 mV |
| Input termination | 120 Ω |
| Max. input frequency | ≤10 MHz |
| Operating (free air temperture) | 0…+70 °C |

*Tab. 74: DIFF-CNT-LEMO-DB9F-01 specifications*

# Functional description of advanced counter

## Block diagram

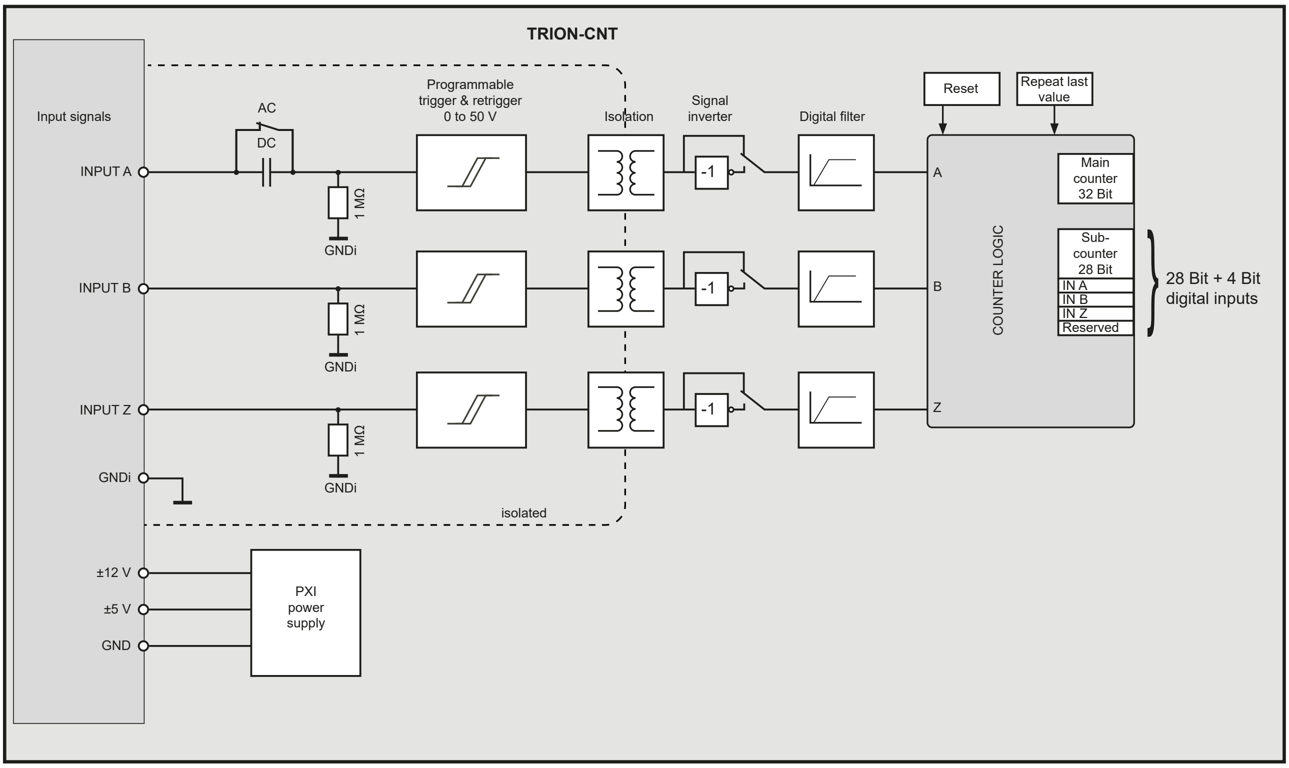



*Fig. 190: Block diagram*

## AC/DC coupling

Input A can be switched either to DC or AC coupling. The AC coupling removes the DC offset and is typically used for inductive pic-up sensors.

## Programmable trigger level

The TRION-CNT has free programmable trigger and retrigger levels for every input channel. The trigger voltage could be programmed between 0 and 50 V.

The diagram below illustrates the functionality of the settable trigger levels.

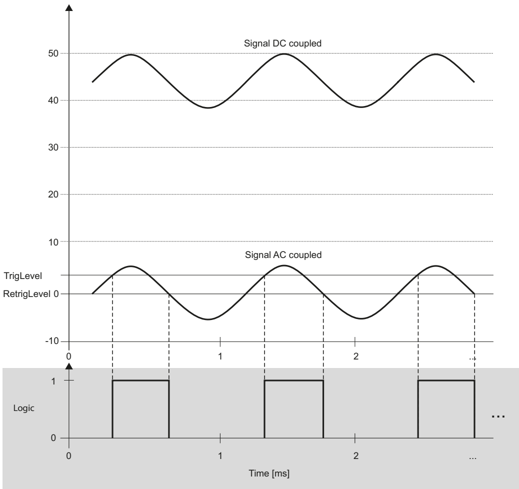



*Fig. 191: Programmable trigger level*

Threshold and retrigger must be set manually according to your input signal. The threshold should be selected so that it triggers reliably, even if the signal is slightly attenuated. However, it should also not be too low to prevent interference from being recognized as a pulse. The retrigger should be between 25 and 50 % of the trigger value.

With 5 V logic, the values 2.4 V as trigger and 0.8 V as retrigger have proved to be effective.

## Isolation power supply

The digital inputs of the TRION-CNT and the GNDi are isolated up to 500 $V_{DC}$ .The 500 V are for channel to channel and channel to chassis isolation. The 5 V and 12 V power supply are not isolated and directly connected to the system power supply. The current consumption is limited to 600 mA for the 12 V and the 5 V supply for the complete TRION-CNT and not for a single channel.

**NOTICE**

Do not short circuit the power supply pins. This might cause a system power down!

## Signal inversion

Each input signal could be digitally inverted before applying it to the counter logic.

## Digital filter

Each counter and digital input has a digital filter, which can be set to various gate times. If the gate time is set to “Off”, no filter is on the input signal.

The filter circuit samples the input signal on each rising edge of the internal time base. If the input signal maintains his state for at least the gate time, the new state is propagated. As an effect the signal transition is shifted by the gate time.

*Fig. 192* demonstrates the function of the filter.

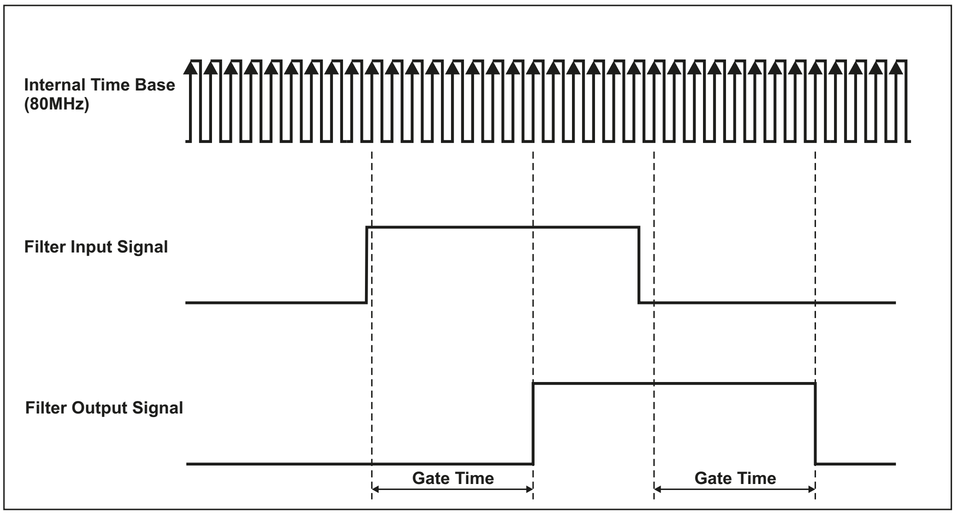



*Fig. 192: Filters*

The intent of the filter is to eliminate unstable states, e.g. glitches, jitter etc. which may appear on the input signal, as shown in *Fig. 193*.

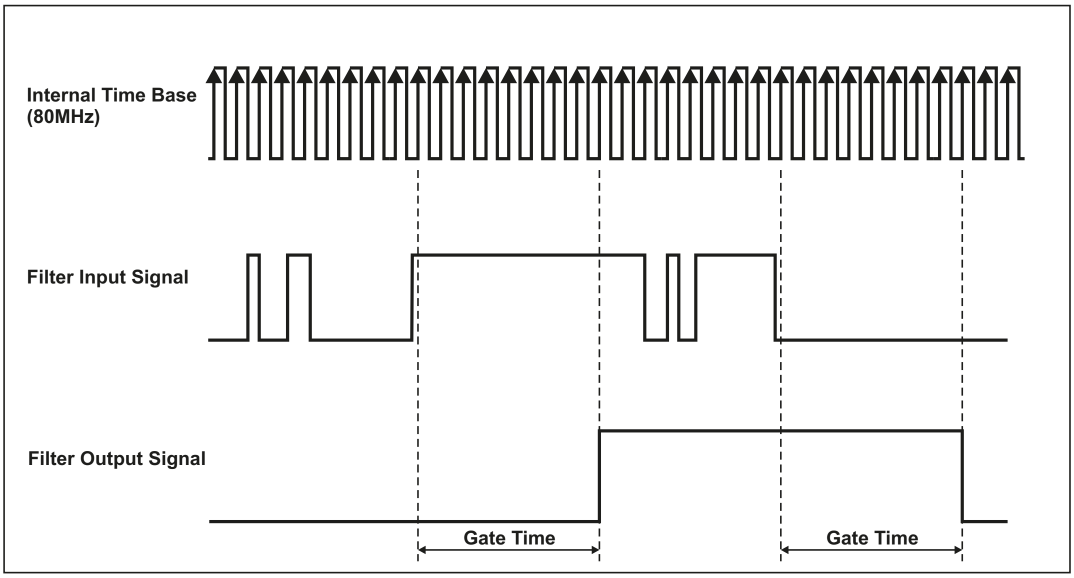



*Fig. 193: Input signal with jitter*

It can be chosen between eight filter settings: Off, 100 ns, 200 ns, 500 ns, 1 µs, 2 µs, 4 µs and 5 µs. Two examples of filter settings are described.

The 100 ns filter will pass all pulse widths (high and low) that are 100 ns or longer. It will block all pulse widths that are 75 ns or shorter. The 5 µs filter will pass all pulse widths (high and low) that are 5 µs or longer and will block all pulse widths that are 4.975 µs or shorter.

The internal sampling clock (time base) is 80 MHz, so the period time amounts 12.5 ns. Pulse widths between gate time minus two internal time base period times may or may not pass, depending on the phase of the input signal with respect to the internal time base.

Properties of all filter settings:

| Filter settings | Pulse width to pass | Pulse width to be blocked |
|---|---|---|
| 100 ns | 100 ns | 75 ns |
| 200 ns | 200 ns | 175 ns |
| 500 ns | 500 ns | 475 ns |
| 1 µs | 1 µs | 975 ns |
| 2 µs | 2 µs | 1975 ns |

*Tab. 75: Filter gate times*

| Filter settings | Pulse width to pass | Pulse width to be blocked |
|---|---|---|
| 4 µs | 4 µs | 3975 ns |
| 5 µs | 5 µs | 4975 ns |
| Off | - | - |

*Tab. 75: Filter gate times*

## Reset

Usually all counters are reset at the start of data acquisition, i.e. the counter value is set to zero at the start of data acquisition. In some applications this is not required. An angle encoder for example is adjusted to the physical zero position at the beginning of a test procedure. By resetting the counter at every start of the measurement this adjustment get lost. Without this reset the counter is also active if the acquisition is interrupted between the test cycles. As a result the counter types out the absolute angle position at the measurement output all the time.

## Repeat last value

Especially in every kind of input period time measurement mode (also pulse width or two pulse edge separation measurement) there may be new information between two samples. Also measuring the line frequency of about 50 Hz with a sample rate of 10 kS/s means, that only after every 200th measurement new input frequency information is available. Another example is the measurement on rotating machines if the sensor output frequency is lower than the sample rate. Depending on the application the TRION-CNT module can choose between two different output data settings:

- Repeat last value: last measured cycle time is taken until a new measured cycle time is available.
- Make zero value: as soon as no input information is available the output is set to Zero.

## Counter logic

As shown in the block diagram in *Fig. 190* each counter block is equipped with three inputs. With this three inputs the following applications can be done:*)

- Event Counting
- Gated Event Counting
- Period Time Measurement
- Pulse Width Measurement
- Two Pulse Edge Separation
- Quadrature Encoder (X1, X2, X4, A-Up/B-Down)
- Up/Down Counter

*) The available counter functions depend on the application software used and may differ from this list.

### Event counting

In Event Counting the counter counts the number of pulses that occur on input A/B. At every acquisition clock the counter value is read without disturbing the counting process.

*Fig. 194* shows an example of event counting where the counter counts eight events on Input A or B. Synchronized Value is the value read by the TRION-CNT module at Acquisition Clock (encircled numbers in the figure, e.g. 1, 2).

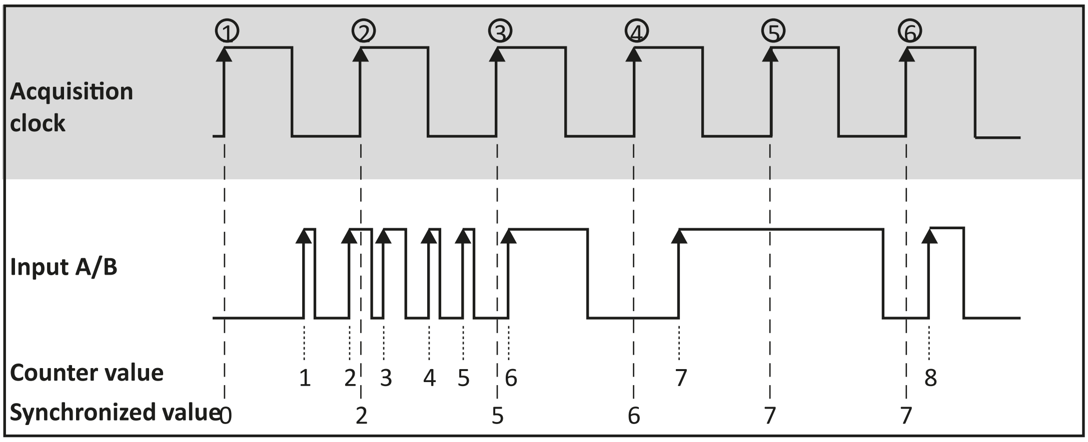



*Fig. 194: Event counting*

**INFORMATION**

If counting at falling edges is necessary, the input signal has to be inverted. This can be done directly in the software by selecting inverted input.

### Period time measurement

In Period Time Measurement the counter uses the internal time base to measure the period time of the signal present on Input A. The counter counts the rising edges of the internal time base which occurs between two rising edges on Input A. At the completion of the period interval the counter value is stored in a register and the counter starts counting from zero. At every Acquisition Clock (1, 2...6) the register value is read out. Fig. 195 shows a Period Time Measurement.

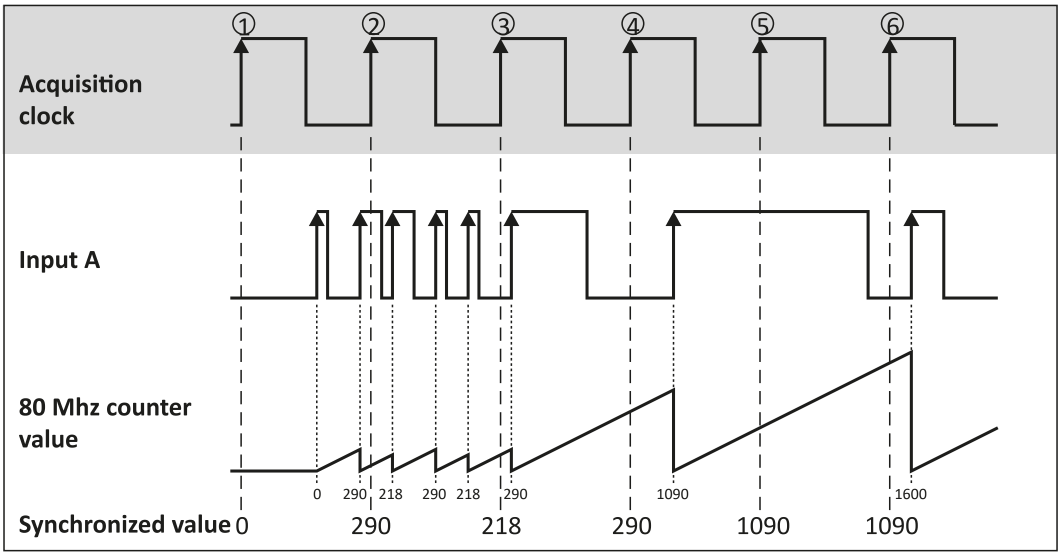



*Fig. 195: Period time measurement*

### Pulse width measurement

In Pulse Width Measurement the counter uses the internal time base to measure the pulse width of the signal present on Input A. The counter counts the rising edges of the internal time base after a rising edge occurs on Input A. At the falling edge on Input A the counter value is stored in a register and the counter is set to zero. With the next rising edge on Input A the counter starts counting again. At every Acquisition Clock (1, 2...6) the register value is read out. Fig. 196 shows a pulse width measurement.

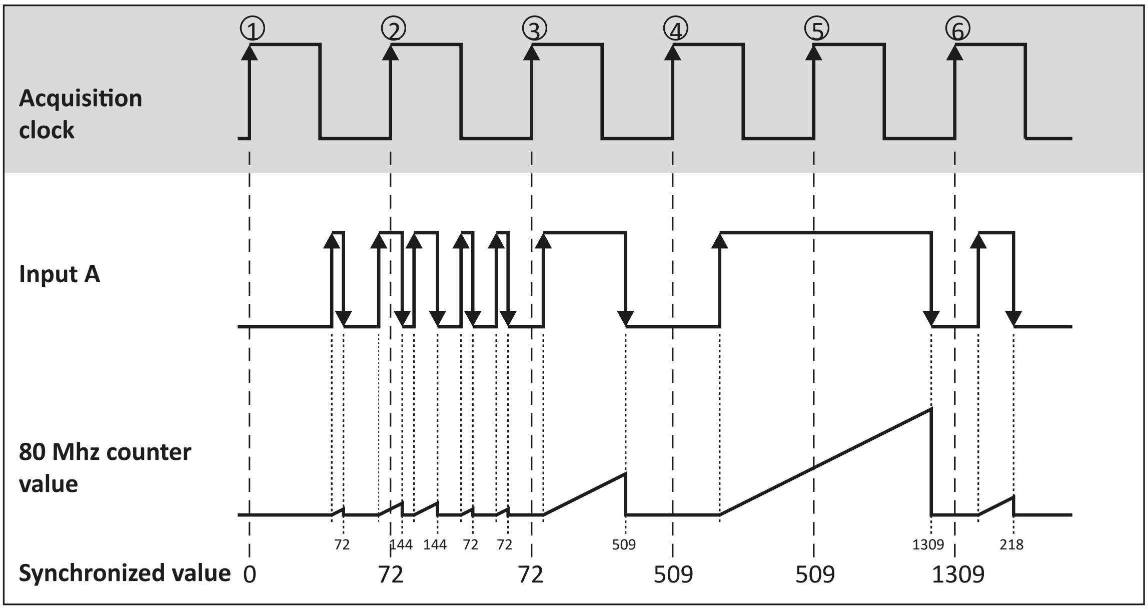



*Fig. 196: Pulse width measurement*

**INFORMATION**

For measuring the low time of the signal, the input signal has to be inverted on the TRION-CNT module.

### Two pulse edge separation measurement

The two pulse edge separation measurement is similar to the pulse width measurement, except that there are two input signals: Input A and Input B. After a rising edge has occurred on Input A the counter counts rising edges of the internal time base. Additional edges on input A are ignored. After a rising edge has occurred on Input B the counter stops counting and the value is stored in a register. At the next rising edge on Input A the counter starts counting from zero again. At every Acquisition Clock (1, 2...6)) the register value is read out.

*Fig. 197* shows an example of Two Pulse Edge Separation Measurement.

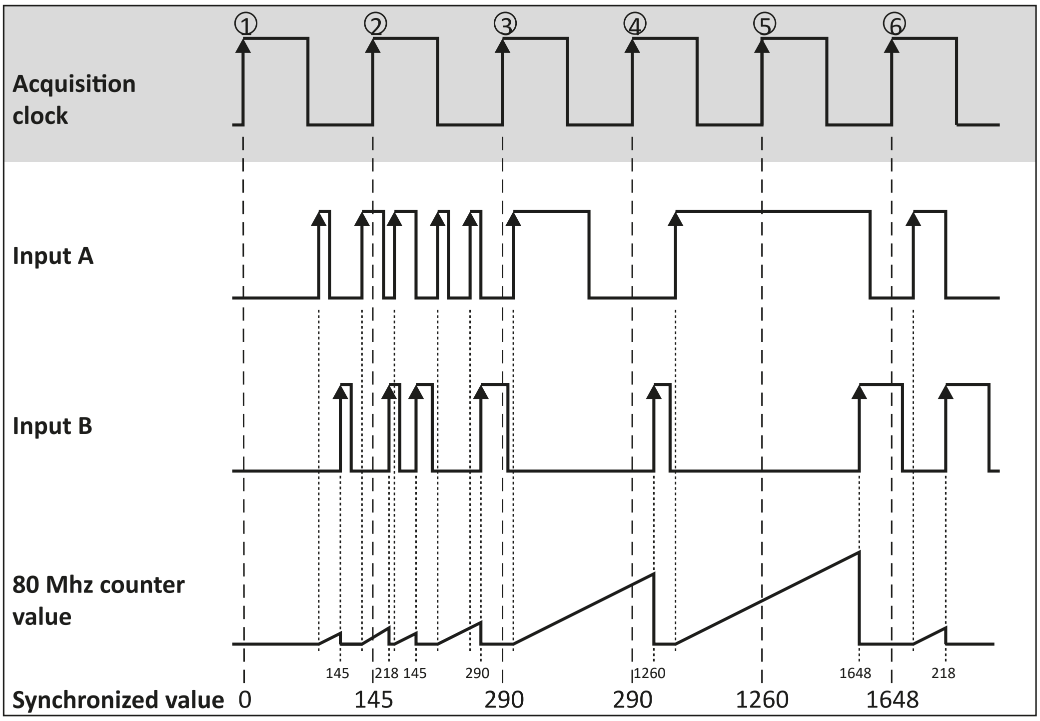



*Fig. 197: Two Pulse Edge Separation Measurement*

**INFORMATION**

If the input signals are inverted the counter takes the falling edges for counting.

### Encoder

Motion encoders have usually three channels: channel A, B and Z. Channel A and channel B are providing the square signals for the counter, and have a phase shift of 90°. With this phase shift the decoder is able to recognize the rotation direction of the motion encoder. The third channel types out one pulse at a certain position at each revolution. This pulse is used to set the counter to zero. The amount of counts per cycle at a given motion encoder depends on the type of decoding: X1, X2, X4. All three types are provided by the TRION-CNT module. Some motion encoders have two outputs, which are working in a different way. Either channel A or channel B providing the square signal, depending on the direction of the rotation. Also this type is supplied by the TRION-CNT module.

In the first case X1 decoding is explained. When Input A leads Input B in a quadrature cycle, the counter increments on rising edges of Input A. When Input B leads Input A in a quadrature cycle, the counter decrements on the falling edges of Input A. At every Acquisition Clock (1, 2...9) the counter value is read out.

*Fig. 198* shows the resulting increments and decrements for X1 encoding.

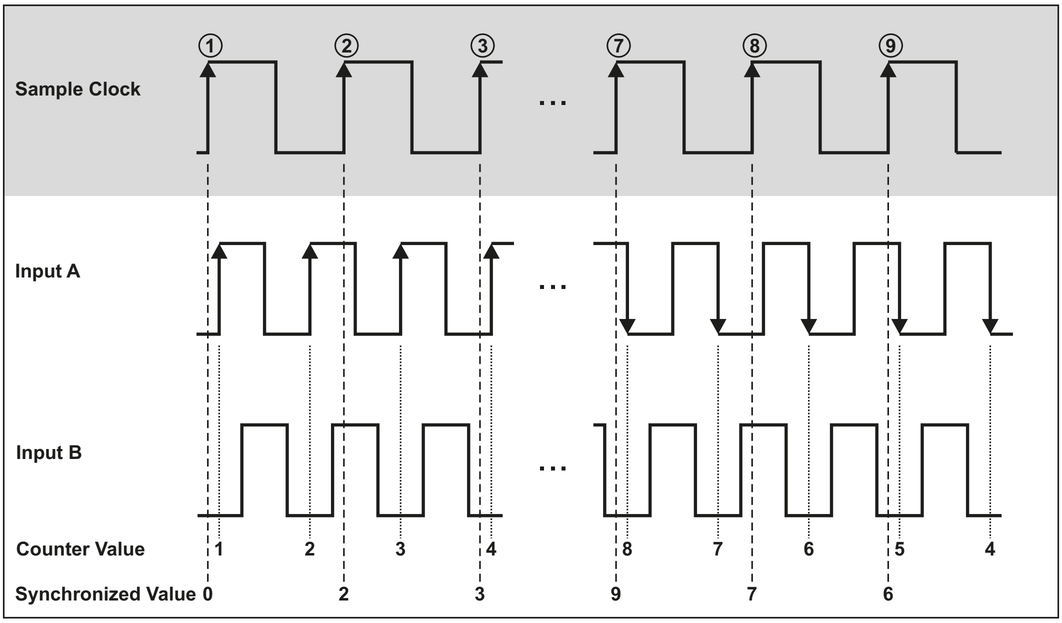



*Fig. 198: Quadrature Encoder X1 Mode*

For X2 encoding the rising edges and the falling edges of Input A are used to increment or decrement. The counter increments if Input A leads Input B and decrements if Input B leads Input A. This is shown in *Fig. 199*:

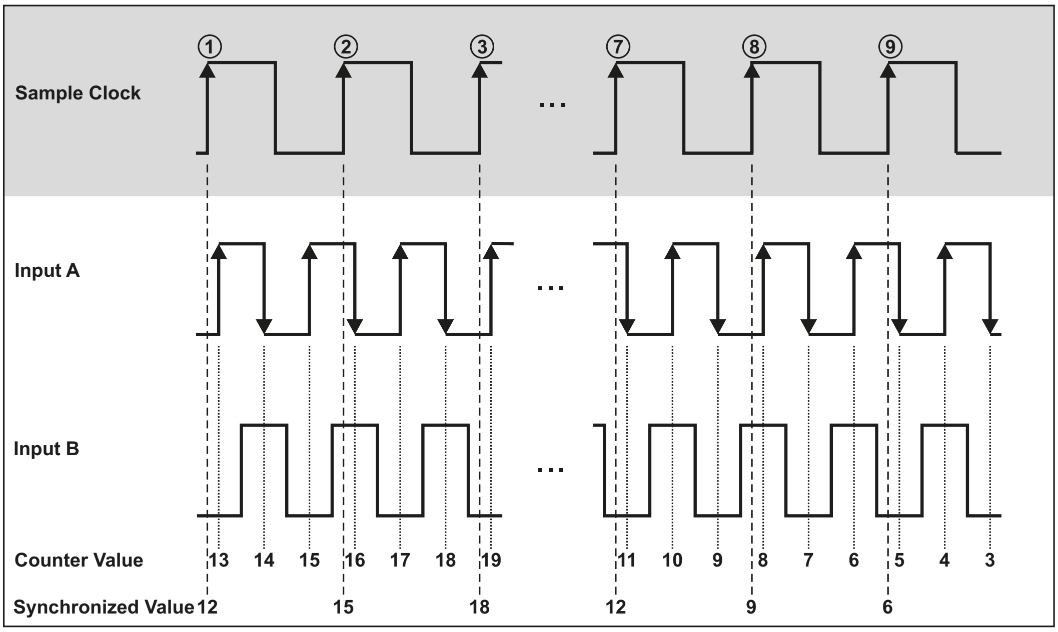



*Fig. 199: Quadrature Encoder X2 Mode*

Similarly, the counter increments or decrements on each edge of Input A and Input B for X4 decoding. The condition for increment and decrement is the same as for X1 and X2. *Fig. 200* shows the results for X4 encoding.

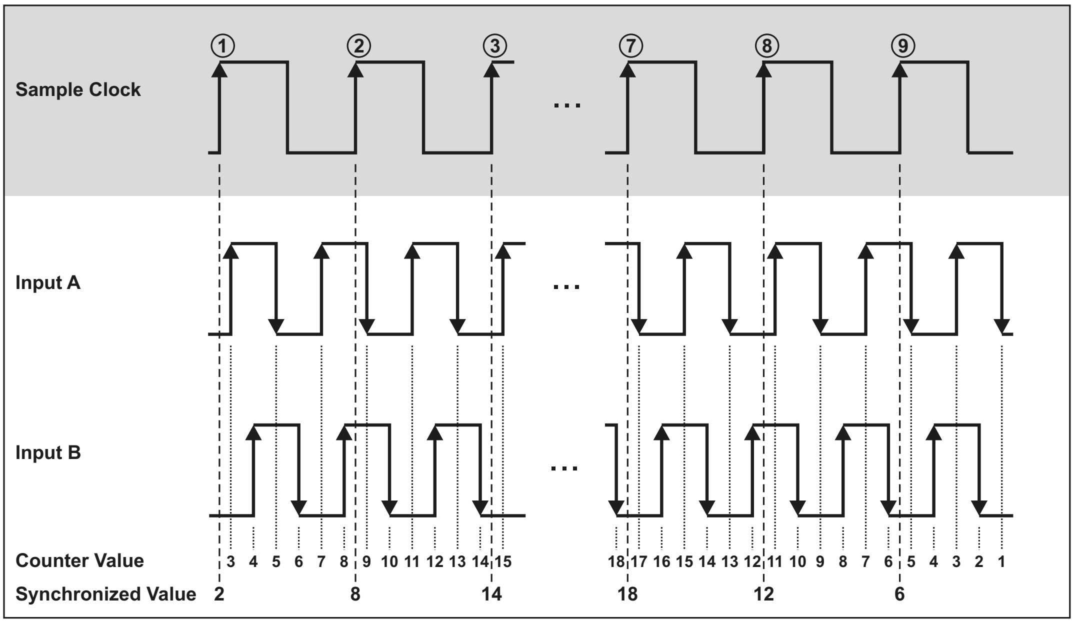



*Fig. 200: Quadrature Encoder X4 Mode*

The third channel Input Z, which is also referred as the index channel, causes the counter to be reloaded with zero in a specific phase of the quadrature cycle.

*Fig. 201* shows the results for X1 encoding with input Z.

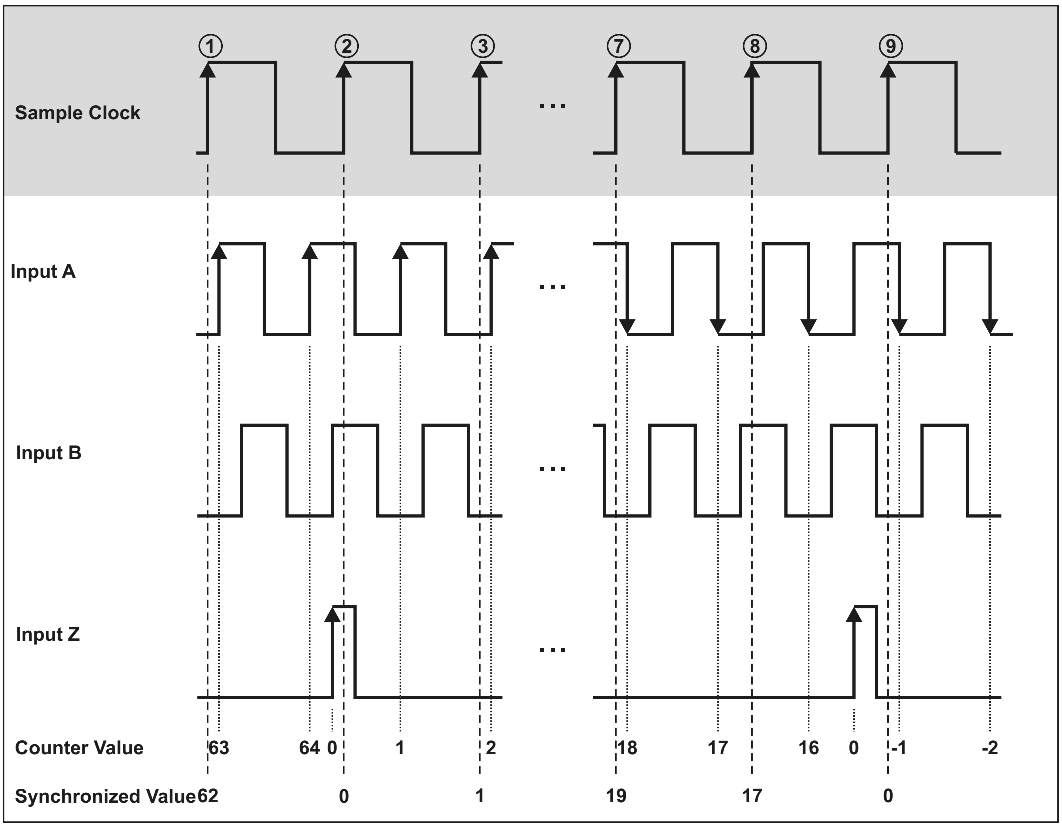



*Fig. 201: Quadrature Encoder with channel Z*

### Up/Down

The A-Up/B-Down Encoder supports two inputs, A and B. A pulse on Input A increments the counter on its rising edges. A pulse on Input B decrements the counter on its rising edges. At every Acquisition Clock (1, 2...9) the counter value is read out.

This situation is shown in *Fig. 202*.

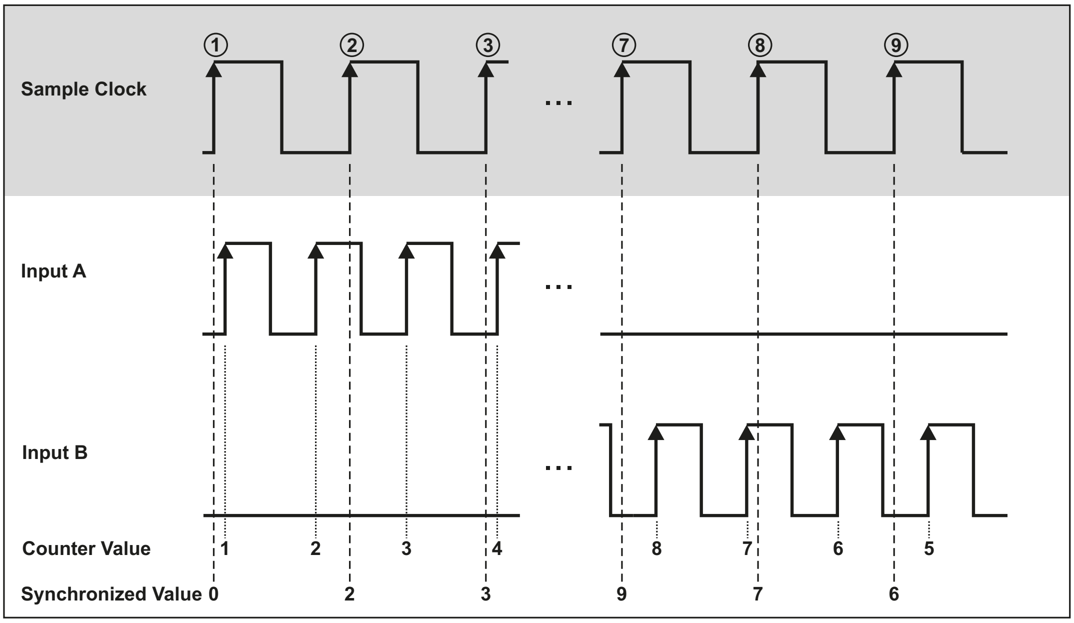



*Fig. 202: A-Up/B-down encoder*

# TRION3-CAN-FD

- 4-channel CAN interface module
- Isolated high-speed CAN 2.0B; CAN FD, CAN SIC
- Up to 8 Mbit/s
- Supports OBDII, J1939, CAN output
- Advanced bus fault detection

TRION3-CAN-FD

## Module specifications

| TRION3-CAN-FD specifications | |
|---|---|
| Input channels | 4 with D-SUB-9 connector |
| Specification | CAN 2.0B, CAN FD, CAN SIC |
| Physical layer | High-speed CAN, standard: ISO 11898-2:2024 Annex A<br>Signal improvement SIC, standard: CiA 601-4 |
| CAN baud rate | 5 kbps to 1 Mbps |
| CAN FD baud rate | 1 Mbps to 8 Mbps |
| Internal clock rate / bit timing tq | 120 MHz / 8.33 ns |
| Receive data rate | Full CAN bus bandwidth<br>DMA data transfer: low system CPU load |
| Timestamp accuracy | 0.1 µs; timestamp is set at the beginning of the CAN frame |
| Send data rate | Typ. 1000 data frames/s<br>Interrupt data transfer: CPU load is proportional to CAN traffic |
| Listen only mode | Supported |
| Bus diagnostics | Short-circuit, open circuit detection and BUS status |
| Termination | Programmable: high impedance or 120 Ω |
| Isolation voltage | 500 $V_{DC}$ (CANH, CANL and CAN_GND) |
| Bus pin fault protection | ±50 $V_{DC}$ |
| Common mode | ±12 V referred to isolated GND |
| ESD protection | 8 kV (HBM) |
| CAN transceiver | TCAN1576 |
| Sensor power supply (per module) | 5 V, max. 1 A cumulated for all 4 channels<br>12 V, max. 1 A cumulated for all 4 channels |
| Typical power consumption without sensor supply | 5 W |

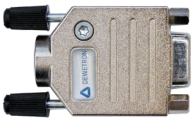
*Tab. 76: Module specifications*

The TRION-CAN module is equipped with four CAN-FD SIC interfaces. All ports are compatible with the CAN 2.0B specification. The CAN transceiver has a bus-pin fault protection of up to ±50 V.

The main application for these CAN-ports is acquiring CAN data alongside with analog data. Although the CAN data is asynchronous to the analog data, the TRION-CAN module guarantees perfect synchronization. Each incoming CAN message is directly time-stamped to the analog sample count number before the data is transferred to the application software.

# Connection

Measurement via D-SUB cord.

Pin 1: +5 V out (max. 1 A, cumulated for all 4 channels)
Pin 2: CANL (CAN Low isolated)
Pin 3: CAN_GND (isolated)
Pin 4: n.c.
Pin 5: n.c.
Pin 6: GND Power
Pin 7: CANH (CAN High isolated)
Pin 8: n.c.
Pin 9: +12 V out (max. 1 A, cumulated for all 4 channels)
Housing: Chassis GND

# LED indication


| | |
|---|---|
| ● Off | Channel is deactivated |
| ● Green | Channel is active |
| ● Green & orange flashing | Channel is active, and data is transmitted |
| ● Red | Bus fault has been detected (clears after 0.5s ) |

# Function overview

## High-speed CAN

The high-speed CAN is a differential bus where complementary signals are sent over two wires. The voltage difference between the two wires defines the logical state of the bus. The differential CAN receiver monitors this voltage difference and outputs the bus state with a single-ended output signal.

The high-speed CAN bus topology as well as the possible cable lengths and the recommended termination resistors are specified in the standards ISO-11898 and CiA 102. The high-speed CAN bus supports bitrates of up to 1 Mbit/s (or >125 kbit/s).

## Cable lengths for high-speed CAN bus

The cabling characteristics and the desired bit transmission rate affect the allowable cable length. ISO-11898 standard specifies a maximum bus length of 40 m and a maximum stub length of 0.3 m with a maximum of 30 nodes for a bitrate of 1 Mbit/s. However, with careful design, users can have longer cables, longer stub lengths, and many more nodes to a bus. A large number of nodes requires a transceiver with high input impedance and each node should be analyzed for signal integrity problems.

Characteristics of two-wire differential bus:

- Impedance: 108 Ω min., 120 Ω nominal, 132 Ω max.
- Length-related resistance: 70 mΩ/m nominal
- Nominal specific propagation delay: 5 ns/m nominal

For further information see ISO-11898 and CiA 102 specifications

## CAN-FD

CAN-FD stands for CAN with flexible data rate. With CAN-FD, the payload can be 64 bytes instead of 8 bytes as with classic CAN. In addition, the payload can be transmitted at a higher speed of up to 8 Mbit/s.

## SIC

The signal improvement capability is an additional feature added to CAN FD transceiver that enhances the maximum data rate achievable in complex star topologies by minimizing signal ringing.

## Termination

CANH and CANL are transmission lines. If the transmission line is not terminated, each signal line causes reflections which can cause communication failures therefore both ends of the cable have to be terminated. If multiple devices are connected only the devices at the ends of the cable need to be terminated. Recommended termination resistors in a high-speed CAN bus topology (according to ISO-11898): 120 Ω.

The TRION3-CAN-FD module offers a programmable termination resistance, either high impedance or 120 Ω

## Listen-only mode

This mode can be used if the TRION3-CAN card is to be used to monitor a CAN bus network traffic without influencing it. In this mode the transmitter is deactivated, only the receiver is active.

A typical application would be to find out an unknown baud rate of a CAN bus. With the listen-only mode activated, all baud rates can be tested one after the other without affecting the bus. As soon a plausible data is received, the unknown bus baud rate is found.

This mode is not suitable for point-to-point connections or XR modules. By default, this setting is off.

## Automatic retransmission (inverted one-shot mode)

Normally, if a CAN message loses arbitration, or is destroyed by an error frame, the message is retransmitted. With automatic retransmission disabled, a message will only attempt to be retransmitted one time, regardless of arbitration loss or error frame. This can increase the transmission speed in some cases. By default, Automatic retransmission is active.

## Bus fault detection

The TRION3-CAN-FD bus transceiver supports advanced bus fault detection, in mode transmit various faults can be recognized:

| Bus fault description | Channel name |
|---|---|
| CANL Shorted to VBAT or Both CANH & CANL Shorted to VBAT | BUS_SHORT_VCC |
| CANH Shorted to GND or Both CANH & CANL Shorted to GND | BUS_SHORT_GND |
| CAN Bus Open / Bus termination missing | BUS_OPEN |
| CANL Shorted to GND | CANL_SHORT_GND |
| CANH Shorted to VBAT | CANH_SHORT_VCC |
| CANH and CANL Shorted Together | CANH_SHORT_CANL |
| Bus fault detected (red LED active) | BUS_FAULT_DETECT |
| Data transmit/receive active (LEDs orange flashing) | CAN_RTX_ACTIVE |

*Tab. 77: Bus fault detection*

For schematics of the bus faults refer to TCAN1469 Datasheet 8.4.8.

| CAN status description | Channel Name |
|---|---|
| CAN RX error detected | CAN_RX_ERROR |
| CAN TX error detected | CAN_TX_ERROR |
| CAN State: Error-active | CAN_ERROR_ACTIVE |
| CAN State: Error-passive | CAN_ERROR_PASSIVE |
| CAN State: Bus-off | CAN_BUS_OFF |
| CAN Error Frame is being transmitted | CAN_ERR_FRAME_TX |
| CAN RX Signal input to CAN core | CAN_RX |
| CAN TX Signal output from CAN core | CAN_TX |

*Tab. 78: CAN core status channels*

All BUS faults and CAN status channels can be displayed and recorded as digital input channels. The CANH and CANL bus lines can also be displayed and recorded as CAN_RX and CAN_TX to support troubleshooting.

### Baud rate

Standard Baud rate of the TRION3-CAN-FD channel.

### Baud rate high

Baud rate of the CAN-FD payload. This can be a multiple of the standard baud rate. Depending on the bitrate switch bit (BTR) in the CAN Frame the TRION3-CAN-FD will switch to the higher baud rate for the payload.

E.g. Baud rate/baud rate high: 500 kBps/2 MBps, 1 Mbps/4 MBps, 1 MBps/8 MBps

### Bit timing

Bit timing can be used to define the sampling point within a single bit. The CAN controller can use the granularity of the internal clock to sample the bit at any time. Normally, this sample point is set to around 70 % of the total bit time. In some cases, it is necessary to adjust this value. A list of different settings for sample points from 50 % to 97 % is available for this purpose

## Block diagramm

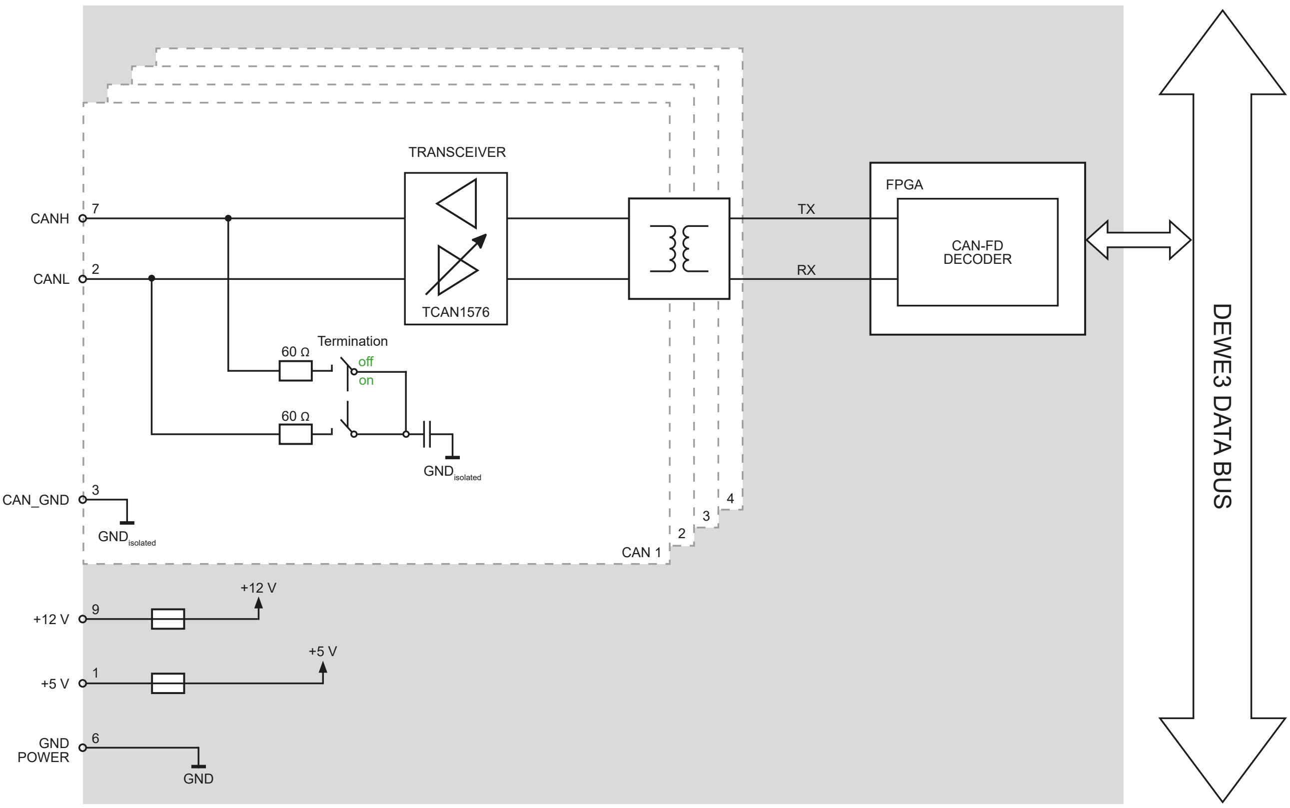



*Fig. 203: Block diagram*

### Isolation

Each of the four TRION3-CAN-FD channels is isolated. This serves to protect the module and allows high common mode voltages between the measured object and the TRION measuring system.

To ensure a stable connection, the CAN_GND (isolated) must be connected to the CAN bus GND. In addition, CAN_GND should be connected to the earth potential at exactly one point.

## CAN signal

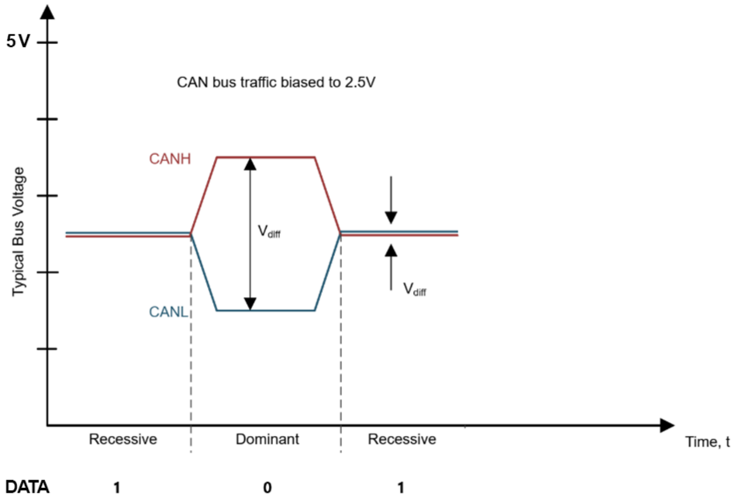



*Fig. 204: CAN signal*

## Connection examples

### Analyzing or monitoring a CAN bus

- E.g. OBD2, automotive CAN bus

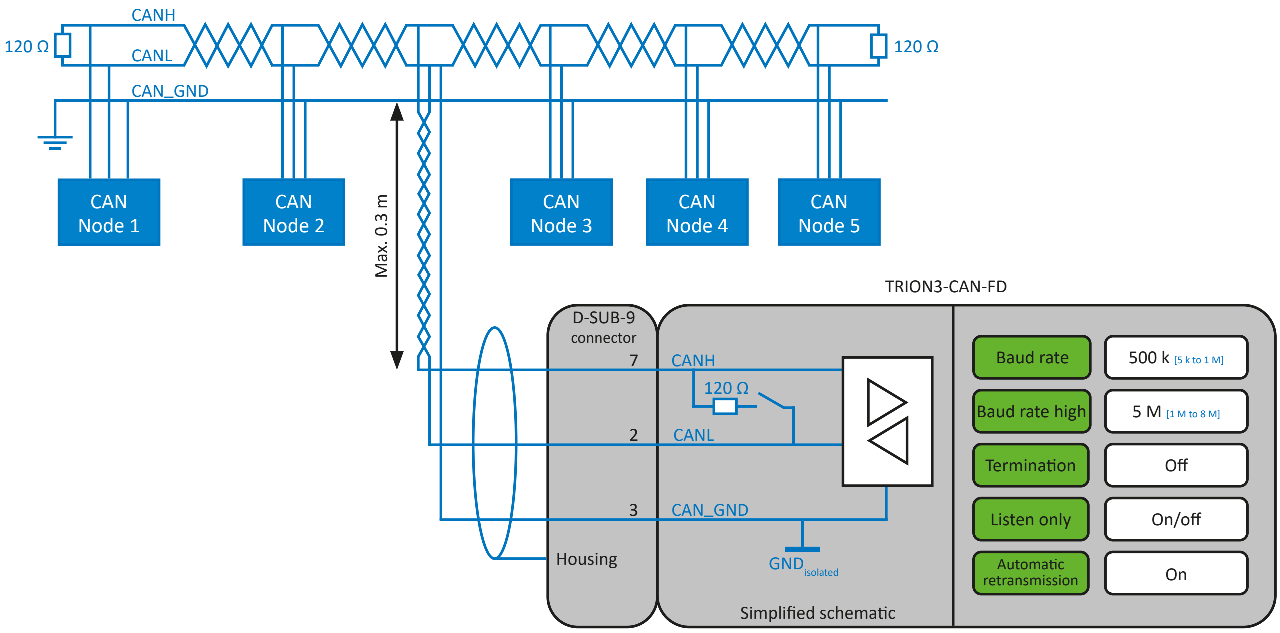



*Fig. 205: Analyzing or monitoring a CAN bus*

In "listen only" mode the TRION3-CAN-FD can monitor a CAN bus network traffic without influencing it. To also transmit messages the "listen Only" mode must be switched off.

## Connecting sensors via CAN Bus

- E.g. Environmental Sensors with CAN interface

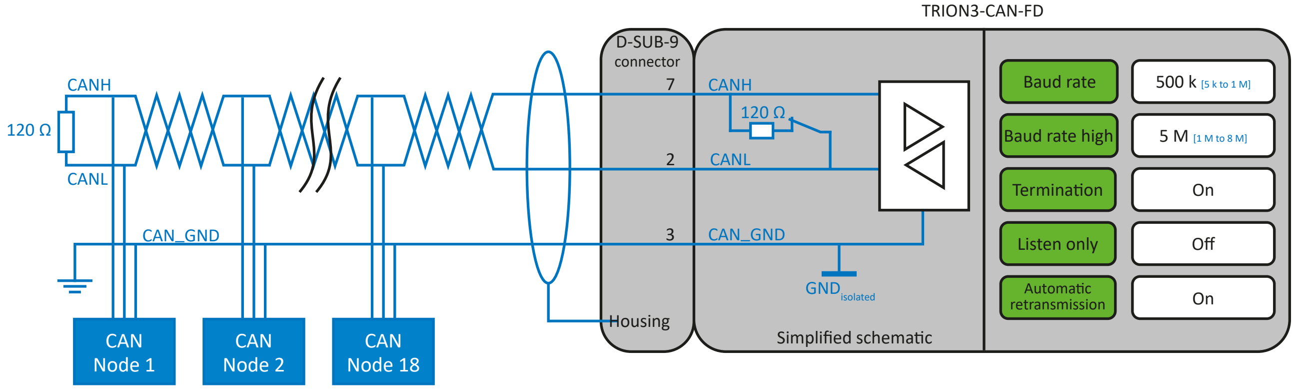



*Fig. 206: Connecting sensors via CAN Bus*

## Connecting sensors directly supplied by TRION3-CAN-FD

- E.g. XR-Series modules, Sensors with CAN interface

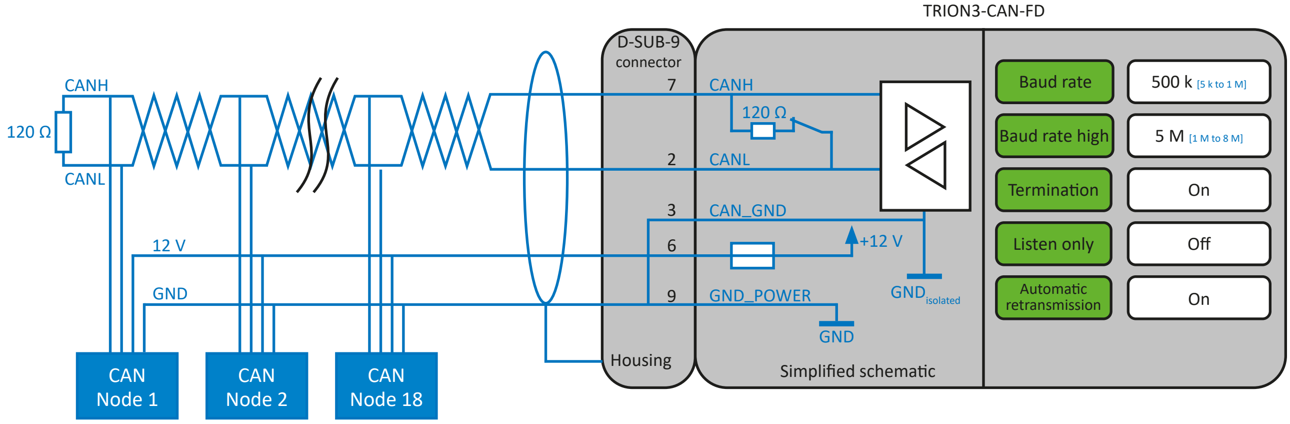



*Fig. 207: Connecting sensors directly supplied by TRION3-CAN-FD*

## Peer to peer

- E.g. sending OXYGEN data to a test stand

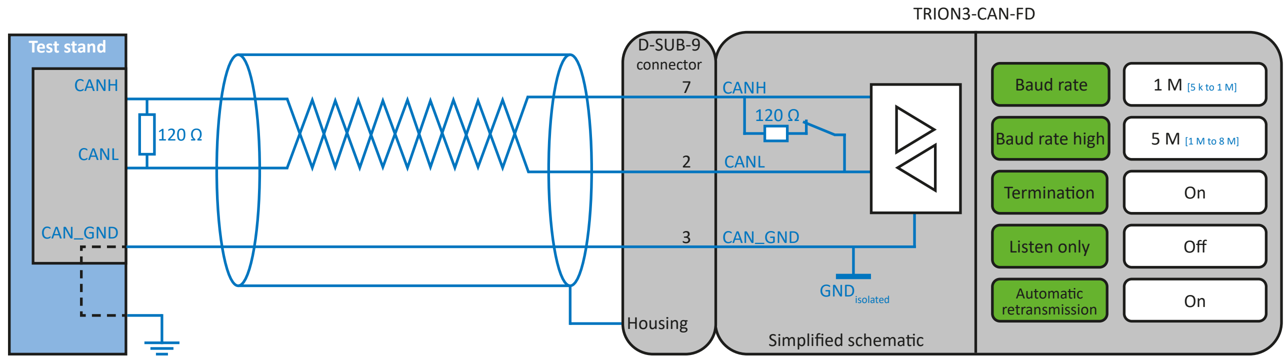



*Fig. 208: Peer to peer*

## Cabling

### Light industrial environment

- Cable: shielded, single twisted pair cable 1x 2x 0.25 mm²

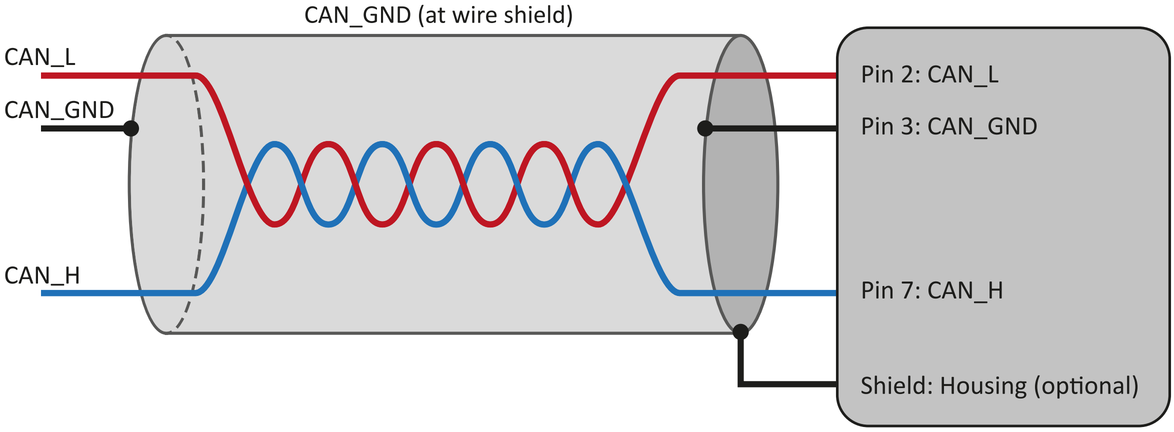



*Fig. 209: Cabling for light industrial environment*

### Heavy industrial environment

- Cable: shielded, double twisted pair cable 2x 2x 0.25 mm²

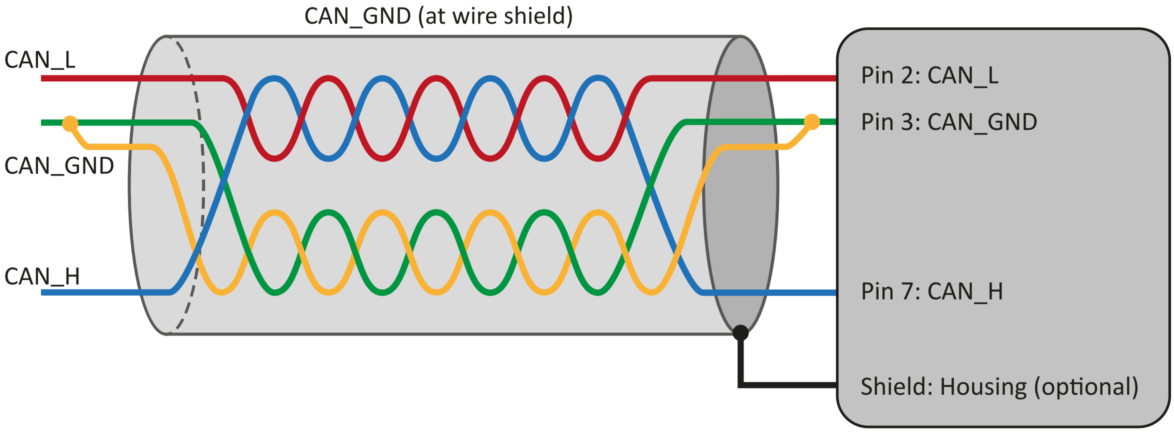



*Fig. 210: Cabling for heavy industrial environment*

### Connecting sensors with Power supply

- Cable: shielded twisted pair cable 2x 2x 0.25mm²

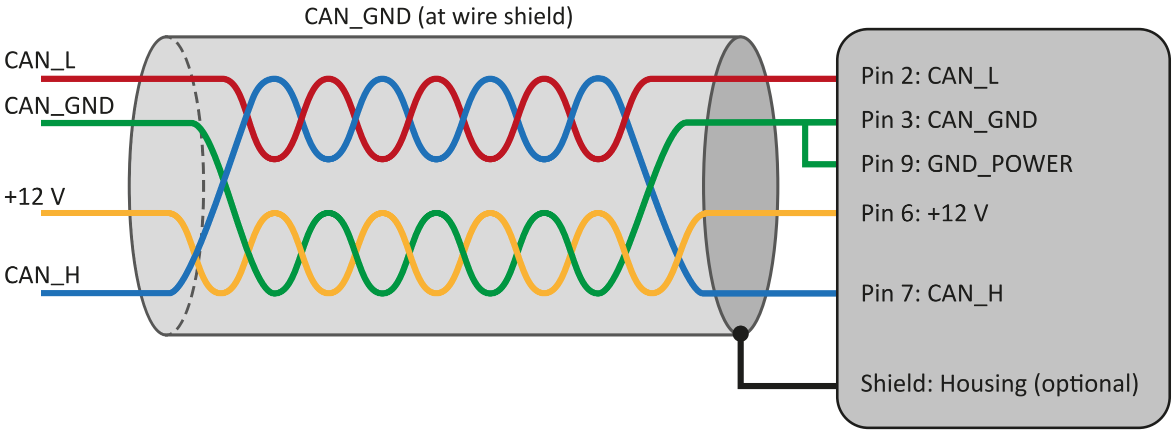



*Fig. 211: Cabling for sensors with power supply*

# Optional accessories

### TRION-CBL-D9-OE-05-00

High quality cable from D-SUB-9 socket to open end, 5 m.

### TRION-CBL-D9-CPAD-01-00

High quality cable from D-SUB-9 socket to CPAD, 1 m.

# TRION-CAN

- CAN interface module
- Isolated high-speed CAN 2.0B
- Up to 1 Mbit/s with programmable termination
- Supports OBDII, J1939, CAN output

TRION-CAN-4-D

## Module specifications

| **TRION-CAN specifications** | |
|---|---|
| Input channels | 4 with D-SUB-9 connector (TRION-CAN-4-D) |
| Specification | CAN 2.0B |
| Physical layer | High-speed, (low speed and single wire with optional converter) |
| Listen only mode | Supported |
| Termination | Programmable: High Impedance or 120 Ω |
| Isolation voltage | 500 $V_{DC}$ |
| Bus pin fault protection | ±36 $V_{DC}$ |
| ESD protection | 12 kV (HBM) |
| CAN transceiver | SNHVD235 |
| Sensor power supply (per module) | 5 V (600 mA) and 12 V (600 mA) |
| Typical power consumption without sensor/CPAD supply | 5 W |

*Tab. 79: Module specifications*

The TRION-CAN module is suited with four high-speed CAN interfaces. All ports are compatible with the CAN 2.0B specification. The CAN transceiver has a bus-pin fault protection of up to ±36 V.

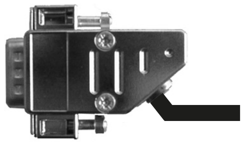
The main application for these CAN-ports is acquiring CAN data alongside with analog data. Although the CAN data is asynchronous to the analog data, the TRION-CAN module guarantees perfect synchronization. Each incoming CAN message is directly time stamped to the analog sample count number before the data is transferred to the application software.

When only CAN data should be acquired the “Listen Only-mode” can be used. In this mode the TRION-CAN module generates no data on CAN even if the CAN-baud-rate is not correctly selected.

This mode is not working when a direct connection to a sensor is used. In a point-to-point connection the “Listen Only” mode has to be deactivated at the CAN-Interface (see chapter “Listen Only-mode” & “point to point connection” for further information).

## Connection

Measurement via D-SUB cord.

| | |
|---|---|
| Pin 1: | +5 V out |
| Pin 2: | CANx Low (isolated) |
| Pin 3: | GNDx CAN (isolated) |
| Pin 4: | NC |
| Pin 5: | NC |
| Pin 6: | GND Power |
| Pin 7: | CANx High (isolated) |
| Pin 8: | NC |
| Pin 9: | +12 V out |

## Optional accessory

### TRION-CBL-D9-OE-05-00

High quality cable from D-SUB-9 socket to open end, 5 m for TRION-CAN-4-D modules.

**Color assignment**

| | | | | | |
|---|---|---|---|---|---|
| Pin 1: | Green | Pin 4: | NC | Pin 7: | Brown |
| Pin 2: | White | Pin 5: | NC | Pin 8: | NC |
| Pin 3: | Yellow | Pin 6: | Pink | Pin 9: | Gray |

## High-speed CAN

The high-speed CAN is a differential bus where complementary signals are sent over two wires. The voltage difference between the two wires defines the logical state of the bus. The differential CAN receiver monitors this voltage difference and outputs the bus state with a single-ended output signal.

The high-speed CAN bus topology as well as the possible cable lengths and the recommended termination resistors are specified in the standards ISO-11898 and CiA 102.

The high-speed CAN bus supports bitrates of up to 1 Mbit/s (or >125 kbit/s).

The schematic below will give you an overview of the high-speed CAN bus topology and the termination resistor placement.

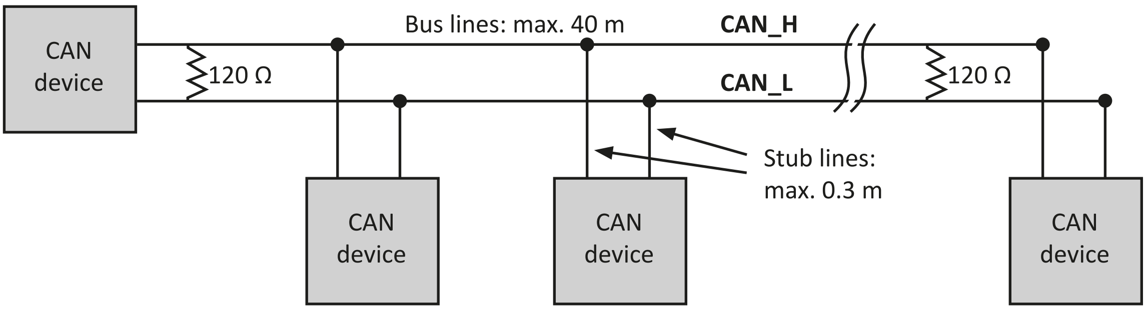



*Fig. 212: High-speed CAN*

### Cable lengths for high-speed CAN bus

The cabling characteristics and the desired bit transmission rate affect the allowable cable length.
ISO-11898 standard specifies a maximum bus length of 40 m and a maximum stub length of 0.3 m with a maximum of 30 nodes for a bitrate of 1 Mbit/s. However, with careful design, users can have longer cables, longer stub lengths, and many more nodes to a bus. A large number of nodes requires a transceiver with high input impedance and each node should be analyzed for signal integrity problems.

Characteristics of two-wire differential bus:

- Impedance: 108 Ω min., 120 Ω nominal, 132 Ω max.
- Length-related resistance: 70 mΩ/m nominal
- Nominal specific propagation delay: 5 ns/m nominal

For further information see ISO-11898 and CiA 102 specifications.

### Termination

CAN_H and CAN_L are transmission lines. If the transmission line is not terminated, each signal line causes reflections which can cause communication failures therefore both ends of the cable have to be terminated. If multiple devices are connected only the devices at the ends of the cable need to be terminated. Recommended termination resistors in a high-speed CAN bus topology (according to ISO-11898): 120 Ω.

The TRION-CAN module offers a programmable termination resistance, either high impedance or 120 Ω.

## Lowspeed CAN / fault-tolerant

With an optional additional adapter (ADAP-CAN-LS-HS) it is also possible to run the TRION-CAN module in a low-speed CAN bus. The low-speed CAN is also a differential bus, but the transmission lines (CAN_H and CAN_L) are not connected via a termination resistor. Low-speed CAN is not interference-prone and keeps working even if a transmission line is corrupt (switches to single-wire mode).

The schematic below will give you an overview of a low-speed / fault-tolerant CAN bus topology and termination resistor placement.

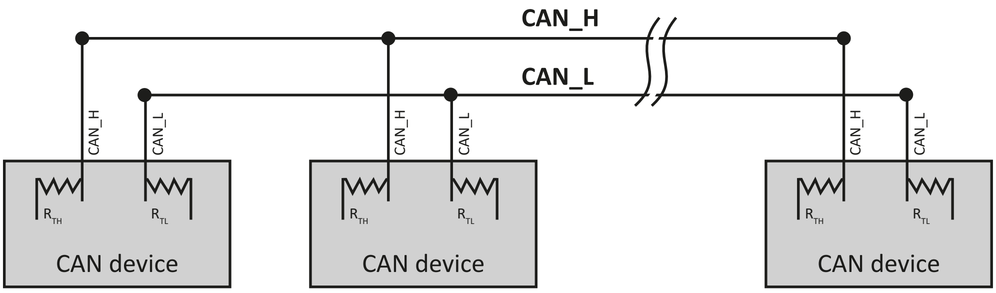



*Fig. 213: Low-speed / fault-tolerant CAN*

The low-speed / fault-tolerant CAN is specified in ISO 11898-3 (fault-tolerant CAN). The influence of signal reflections in this topology is not as big, but when long bus lines are used, the influence increases. This makes the use of an open bus line possible, which means low-speed CAN transceiver can be used for networks with very low power consumption and the bus topology is no longer limited to a linear structure.

### Cable requirements for low-speed / fault-tolerant CAN bus

Low-speed CAN bus supports bitrates of up to 125 kbit/s.

Cable characteristics for low-speed / fault-tolerant CAN devices **according to ISO-11898-3**:

- Length-related resistance: 90 mΩ/m nominal
- Length-related capacitance: 30 pF/m nominal
  (CAN_L and ground, CAN_H and ground, CAN_L, CAN_H)

The maximum number of devices depends on the electrical characteristics of the devices on the network. According to ISO-11898-3 it is possible to connect up to 32 devices to the bus. It is possible to connect a higher number of devices if the electrical characteristics of the devices do not degrade signal quality below low-speed / fault-tolerant signal level specifications.

### Termination

Each device on the low-speed CAN network needs a termination for each transmission line:
RTH for CAN_H and RTL for CAN_L. This configuration allows the SNHVD235 transceiver to recover from bus faults. Before connecting the TRION-CAN module to a low-speed / fault-tolerant network it is important to determine the overall

termination.

In general, if just small CAN networks are required or individual components are tested you should select the 560 Ω option at the low-speed adapter to gain an overall impedance of ~120 Ω (parallel connection of the resistors). If the existing low-speed CAN network already has the desired overall impedance of ~120 Ω select the 5.66 kΩ option on the adapter. This won't influence the overall impedance that much.

### LED indication

The ADAP-CAN-LS-HS has two LEDs indicating the following states:

- Green: Power (power supply +5 V)
- Red: Error (error in low-speed CAN network)

The error LED indicates one of the following low-speed CAN errors:

- CAN_H transmission line interrupted
- CAN_L transmission line interrupted
- Short-circuit between CAN_H & GND
- Short-circuit between CAN_H & VCC
- Short-circuit between CAN_L & GND
- Short-circuit between CAN_L & VCC
- Short-circuit between CAN_H & CAN_L

## Single-wire CAN

In single-wire CAN mode, the communication takes place via just one bus line with a nominal data rate of up to 33.3 kbit/s (83.3 kbit/s in high-speed mode for diagnostics) according to the standard SAE J2411. This standard defines up to 32 devices per network. An unshielded single wire is defined as the bus medium. A linear bus topology is not necessary.

In single-wire mode each CAN port has a high impedance local bus load between the CAN_H and RTH pins of the transceiver to provide protection against loss of ground (see Figure 2: Low-speed / fault-tolerated CAN).

**Cable lengths / requirements for single-wire CAN bus according to SAE J2411**

The cable length between two ECU nodes should not exceed 60 m.

Due to the fact that the total system cable length, bus loading of each node and clock tolerance are all interrelated it is the users responsibility to factor in all the above mentioned parameters when designing a single-wire CAN network. The SAE J2411 specification includes some recommendations that will help building up a single-wire CAN network.

### Termination

The ADAP-CAN-SW-HS adapter is internally terminated with a high impedance load resistor of 5.1 kΩ as specified by SAE J2411.

### LED indication

The ADAP-CAN-SW-HS has two LEDs indicating the following states:

- Red: power supply (+5 V)
- Orange: reception / transmission of wake-up signals on the single-wire CAN bus

### Single-wire CAN operation modes

With the optional adapter "ADAP-CAN-SW-HS" it is possible to operate in three different single-wire CAN modes. A slide switch on the side of the adapter determines the different modes of operation:

| Switch position | Mode | Description |
|---|---|---|
|  | Normal | Up to 33.3 kbit/s, with waveshaping |
|  | High-speed | Up to 83.3 kbit/s, without waveshaping |
|  | Wake-up | As normal mode, but with increased signal levels |

*Tab. 80: Switch position*

#### Normal mode

This mode is used for normal operation. Bit rates up to 33.3 kbit/s are supported. The output of signals on the Single-wire CAN bus is done with wave-shaping. The voltage slew rate and the shape of the rising edge as well as the beginning of the falling edge are controlled. This behavior contributes to the minimization of EM emissions.

#### High-speed single wire CAN mode

The adapter provides a high-speed mode for the transfer of software or diagnostic data, for example. Bit rates up to 83.3 kbit/s can be used. In contrast to the normal mode, the wave-shaping function is deactivated, i.e. the bus driver is switched on and off as fast as possible, in order to be able to reach higher bit rates. However, the electromagnetic compatibility (EMC) consequently is reduced in comparison to the normal mode. The high-speed mode is only used in special cases and shouldn't be used for regular operation of a single-wire CAN bus.

#### Wake-up mode

In this mode transmission is done with an increased voltage level in comparison to the normal mode. An activation of all "sleeping" bus nodes in the network results from it. Sleeping bus nodes ignore normal 4 V levels and only react to levels with higher voltage (12 V). Because the adapter itself does not have a sleep mode, incoming signals are all interpreted in the same manner independently of their level (normal or wake-up). The red/orange LED indicates a received or transmitted signal with wake-up level. After detection the LED switches off with some delay. Thus signals of short duration are also signaled.

## Point-to-point connection

An additional approach to using CAN low-speed networks with fault-tolerant functionality is specified in the ISO 11992 standard. It defines a point-to-point connection for use in e.g. towing vehicles and their trailers. For one vehicle with one trailer, a point-to-point connection is defined (transceiver - receiver).

The nominal data rate is 125 kbit/s with a maximum bus line length of 40 m. The standard defines the bus error management and the supply voltage of 12 V or 24 V. An unshielded twisted pair of wires is defined as the bus medium.

The TRION-CAN module supports 12 V sensor supply voltage.

**Cabling example: CAN with sensor supply (point-to-point connection)**

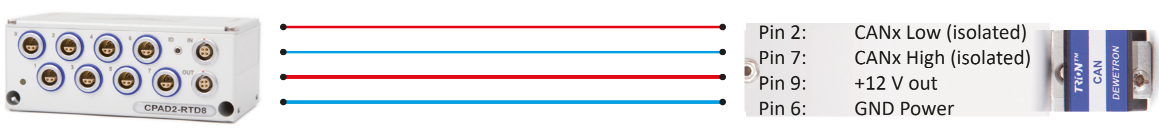



*Fig. 214: Cabling example CAN with sensor supply*

| INFORMATION |
|---|
| Return path of the power supply (GND) is Pin 6 (GND Power). Do not use Pin 3 (GNDx CAN). |

## Listen-only mode

The SNHVD235 (transceiver of the TRION-CAN module) supports a listen-only-loopback feature which allows the local node controller to synchronize its baud rate with the CAN bus baud rate. In auto-baud / listen-only mode, the transceiver output is placed in a high-impedance state while the receivers bus input remains active.

With the listen-only mode activated, normal bus activity can be monitored by the device. However, if an error frame is generated by the local CAN controller, it is not transmitted to the bus.
Since in listen-only mode the module has no transmit function this feature must not be used in a point-to-point connection.

This mode is designed to evaluate the correct baud rates of existing networks. Once this mode has been selected, assume a desired baud rate, then wait for a message to be transmitted by another node on the bus. If the wrong baud rate has been selected, an error message is generated by the host CAN controller. However, since the transmit function of the device has been disabled, no other devices receive the error message. If an error is generated, reset the CAN device with another baud rate and wait to receive another message. When an error free message has been received, the correct baud rate has been detected.

**Cabling example: CAN monitoring (listen-only / auto-baud mode)**

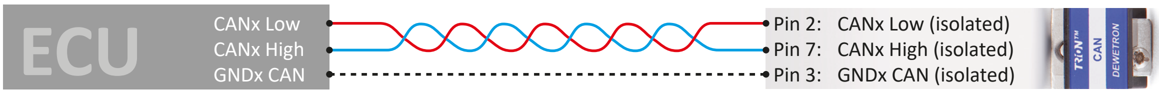



*Fig. 215: Cabling example CAN monitoring*

**INFORMATION**

GNDx CAN is an optional connection when measuring under harsh environment.

# TRION-DI-48

- Isolated digital input module
- 48 isolated digital inputs (TRION-DI-48)
- 3 MS/s sampling rate

TRION-DI-48

## Module specifications

| TRION-DI-48 specifications | |
|---|---|
| Input channels | 48 isolated digital inputs (TRION-DI-48) |
| Input modes | Digital input (discrete) |
| Sampling rate | 3 MS/s |
| Input signal characteristic | |
| – Compatibility | CMOS |
| – Configuration | Isolated input |
| – Input low level | UIN <1.8 V |
| – Input high level | UIN >3.2 V |
| – Input high current @ 5 V UIN | <3.5 mA |
| – Input high current @ 30 V UIN | <7 mA |
| – Propagation delay | <160 ns |
| – Bandwidth | 3 MHz |
| – Overvoltage protection | 35 $V_{DC}$ (65 $V_{PEAK}$) |
| – Isolation voltage (channel-to-channel) | 100 $V_{PEAK}$ |
| – Isolation voltage (input-to-chassis) | 250 $V_{PEAK}$ |
| Input connector | 2 x 50 pin mini centronics |
| Sensor power supply (per module) | 5 V (600 mA), not isolated |
| Typical power consumption | 5 W |
| Weight | Approx. 190 g |

*Tab. 81: Module specifications*

# Connection

**Measurement via mini-centronics cord**

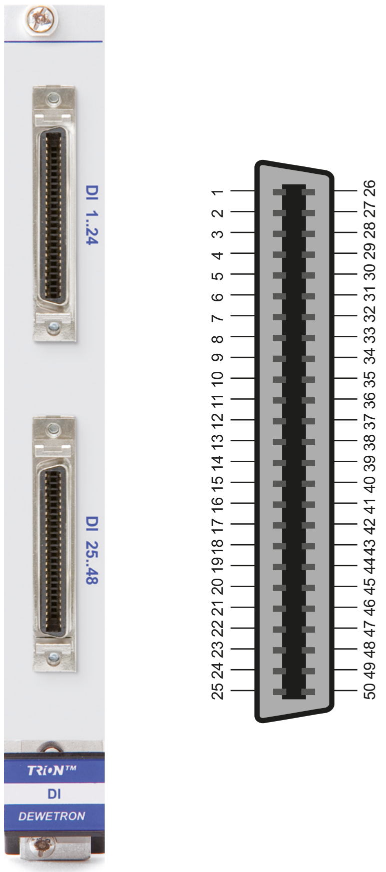



*Fig. 216: 50-pin mini-centronics socket*

**Digital inputs (DI 1...24)**

| | |
|---|---|
| 1: DI1+ | 26: DI1- |
| 2: DI2+ | 27: DI2- |
| 3: DI3+ | 28: DI3- |
| 4: DI4+ | 29: DI4- |
| 5: DI5+ | 30: DI5- |
| 6: DI6+ | 31: DI6- |
| 7: DI7+ | 32: DI7- |
| 8: DI8+ | 33: DI8- |
| 9: DI9+ | 34: DI9- |
| 10: DI10+ | 35: DI10- |
| 11: DI11+ | 36: DI11- |
| 12: DI12+ | 37: DI12- |
| 13: DI13+ | 38: DI13- |
| 14: DI14+ | 39: DI14- |
| 15: DI15+ | 40: DI15- |
| 16: DI16+ | 41: DI16- |
| 17: DI17+ | 42: DI17- |
| 18: DI18+ | 43: DI18- |
| 19: DI19+ | 44: DI19- |
| 20: DI20+ | 45: DI20- |
| 21: DI21+ | 46: DI21- |
| 22: DI22+ | 47: DI22- |
| 23: DI23+ | 48: DI23- |
| 24: DI24+ | 49: DI24- |
| 25: +5 V | 50: GND |

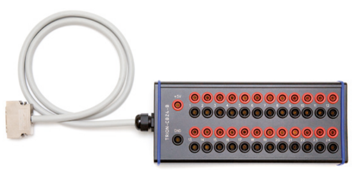
**Digital inputs (DI25...48)**

| | |
|---|---|
| 1: DI25+ | 26: DI25- |
| 2: DI26+ | 27: DI26- |
| 3: DI27+ | 28: DI27- |
| 4: DI28+ | 29: DI28- |
| 5: DI29+ | 30: DI29- |
| 6: DI30+ | 31: DI30- |
| 7: DI31+ | 32: DI31- |
| 8: DI32+ | 33: DI32- |
| 9: DI33+ | 34: DI33- |
| 10: DI34+ | 35: DI34- |
| 11: DI35+ | 36: DI35- |
| 12: DI36+ | 37: DI36- |
| 13: DI37+ | 38: DI37- |
| 14: DI38+ | 39: DI38- |
| 15: DI39+ | 40: DI39- |
| 16: DI40+ | 41: DI40- |
| 17: DI41+ | 42: DI41- |
| 18: DI42+ | 43: DI42- |
| 19: DI43+ | 44: DI43- |
| 20: DI44+ | 45: DI44- |
| 21: DI45+ | 46: DI45- |
| 22: DI46+ | 47: DI46- |
| 23: DI47+ | 48: DI47- |
| 24: DI48+ | 49: DI48- |
| 25: +5 V | 50: GND |

# Optional accessory

## TRION-CB24-B

High quality cable from Lemo 1B.308 plug to open end, 5 m

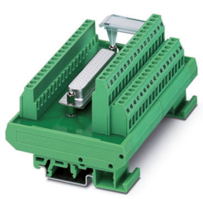


24 channel break-out box with 4 mm banana jacks. 1 m cable, terminated with 50-pin mini-centronics plug.

INFORMATION Two boxes are required for all 48 channel.

## TRION-CB24-B

High quality cable from Lemo 1B.308 plug to open end, 5 m



24 channel screw-terminal block, unshielded 1 m cable, terminated with 50-pin mini-centronics plug.

INFORMATION Two blocks are required for all 48 channels.

## Block diagram

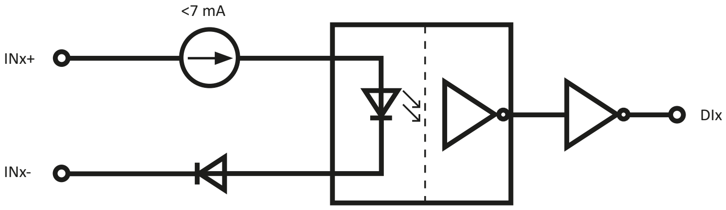



*Fig. 217: Block diagram*

# TRION-ARINC429/MIL1553

- ARINC 429 module with up to 16 channels
- MIL 1553 module with up to 4 channels

TRION-ARINC429 / TRION-MIL1553

## Module specifications

| | TRION-ARINC429 | TRION-MIL1553 |
|---|---|---|
| Input channels | 4 channels with 4 shared RX/TX channels<br>16 channels with 8 shared RX/TX channels and 8 RX channels | 1 channel with dual function<br>4 channels with dual function |
| Connector | SCSI 3 cable assembly with flying leads 36” | SCSI 3 cable assembly with 1553 3-plug stub cables |
| Baud rate | 12.5 k, 50 k and 100 k | - |
| Power consumption | 4 CH @ 4.5 W<br>16 CH @ 6.0 W | 1 CH @ 5.5 W<br>4 CH @ 8.5 W |
| Operating temperature | 0 to +70 °C | |
| Additional features | - | 1553A and 1553B support |
| Parts number[1)] | CPCIC3-A429-4-T<br>CPCIC3-A429-16-T | CPCIC3-1553-1D-T<br>CPCIC3-1553-4D-T |
| OXYGEN software support | ▸ Decoding of ARINC 429 / MIL 1553 signals<br>▸ Visualization of binary data<br>▸ Export of decoded signals | |
| | ▸ Integrated internal database (equipment IDs and labels from the ARINC standard[2)])<br>▸ Support of different baud rates for ARINC 429<br>▸ Check of parity bit<br>▸ Settings for equipment IDs and labels | ▸ Decoding of MIL 1553 signals<br>▸ Visualization of binary data<br>▸ Export of decoded signals<br>▸ Custom message decoder for signal visualization in OXYGEN |

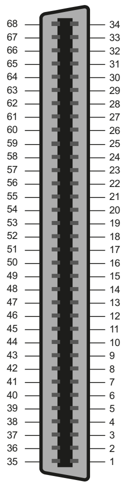
*Tab. 82: Module specifications*

1) For additional hardware specifications refer to the manufacturer’s ARINC429 datasheet or MIL1553 datasheet.

2) ARINC specification 429P1-19 (Digital Information Transfer System Set)

# Connection

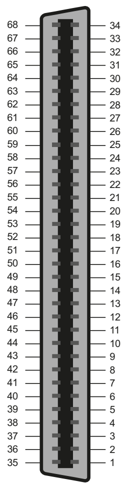
## Pin assignment for TRION-ARINC429

68-pin SCSI 3 connector

| | | | |
|---|---|---|---|
| 1 | RX1+/TX + | 35 | RX1-/TX1- |
| 2 | RX2+/TX + | 36 | RX2-/TX2- |
| 3 | RX3+/TX + | 37 | RX3-/TX3- |
| 4 | RX4+/TX + | 38 | RX4-/TX4- |
| 5 | RX5+/TX + | 39 | RX5-/TX5- |
| 6 | RX6+/TX + | 40 | RX6-/TX6- |
| 7 | RX7+/TX + | 41 | RX7-/TX7- |
| 8 | RX8+/TX + | 42 | RX8-/TX8- |
| 9 | RX9+ | 43 | RX9- |
| 10 | RX10+ | 44 | RX10- |
| 11 | RX11+ | 45 | RX11- |
| 12 | RX12+ | 46 | RX12- |
| 13 | RX13+ | 47 | RX13- |
| 14 | RX14+ | 48 | RX14- |
| 15 | RX15+ | 49 | RX15- |
| 16 | RX16+ | 50 | RX16- |
| 17 | RX17+/TX 7+ | 51 | RX17-/TX17- |
| 18 | RX18+/TX 8+ | 52 | RX18-/TX18- |
| 19 | RX19+/TX 9+ | 53 | RX19-/TX19- |
| 20 | RX20+/TX 0+ | 54 | RX20-/TX20- |
| 21 | RX21+/TX 1+ | 55 | RX21-/TX21- |
| 22 | RX22+/TX 2+ | 56 | RX22-/TX22- |
| 23 | RX23+/TX 3+ | 57 | RX23-/TX23- |
| 24 | RX24+/TX 4+ | 58 | RX24-/TX24- |
| 25 | RX25+ | 59 | RX25- |
| 26 | RX26+ | 60 | RX26- |
| 27 | RX27+ | 61 | RX27- |
| 28 | RX28+ | 62 | RX28- |
| 29 | RX29+ | 63 | RX29- |
| 30 | RX30+ | 64 | RX30- |
| 31 | AV Trig In1 | 65 | AV Trig Out1 |
| 32 | RS-485 | 66 | RS-485- |
| 33 | IRIG In | 67 | IRIG GND |
| 34 | TTL I/O | 68 | GND |

## Pin assignment for TRION-MIL1553

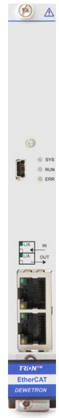
68-pin SCSI 3 connector

| | | | |
|---|---|---|---|
| 1* | 1553 SHIELD | 35 | GND – Connected to SCSI Hood |
| 2* | 1553 CH 4B- | 36 | TRIG_OUT4 |
| 3* | 1553 CH 4B+ | 37 | TRIG_IN4 |
| 4 | GND | 38 | SDISC6 / RTADDR1_P |
| 5* | 1553 SHIELD | 39 | SDISC5 / RTADDR1_4 |
| 6* | 1553 CH 4A- | 40 | DDISC2- |
| 7* | 1553 CH 4A+ | 41 | DDISC2+ |
| 8 | GND | 42 | GND |
| 9 | ~RTADDR_EN | 43 | TRIG_OUT3 |
| 10* | 1553 SHIELD | 44 | TRIG_IN3 |
| 11* | 1553 CH 3B- | 45 | DDISC1- (RS-485 CLK In/Out) |
| 12* | 1553 CH 3B+ | 46 | DDISC1+ (RS-485 CLK In/Out) |
| 13 | GND | 47 | SDISC14 / RTADDR2_P |
| 14* | 1553 SHIELD | 48 | SDISC13 / RTADDR2_4 |
| 15* | 1553 CH 3A- | 49 | GND |
| 16* | 1553 CH 3A+ | 50 | IRIGB IN GND |
| 17 | SDISC4 / RTADDR1_3 | 51 | ~AUTO_TEST |
| 18 | SDISC3 / RTADDR1_2 | 52 | IRIGB IN |
| 19* | 1553 SHIELD | 53 | GND |
| 20* | 1553 CH 2B- | 54 | TRIG_OUT2 |
| 21* | 1553 CH 2B+ | 55 | TRIG_IN2 |
| 22 | GND | 56 | N/C |
| 23* | 1553 SHIELD | 57 | GND |
| 24* | 1553 CH 2A- | 58 | SDISC12 / RTADDR2_3 |
| 25* | 1553 CH 2A+ | 59 | SDISC11 / RTADDR2_2 |
| 26 | SDISC2 / RTADDR1_1 | 60 | GND |
| 27 | SDISC1 / RTADDR1_0 | 61 | EXT_CLOCK_IN (TTL) |
| 28 | 1553 SHIELD | 62 | GND |
| 29 | 1553 CH 1B- | 63 | TRIG_OUT1 |
| 30 | 1553 CH 1B+ | 64 | TRIG_IN1 |
| 31 | GND | 65 | SDISC10 / RTADDR2_1 |
| 32 | 1553 SHIELD | 66 | SDISC9 / RTADDR2_0 |
| 33 | 1553 CH 1A- | 67 | SDISC8 |
| 34 | 1553 CH1A+ | 68 | SDISC7 |

*) Channel/model dependent

# TRION-EtherCAT-1-SLAVE

- EtherCAT slave interface module
- Measurement data output
- Up to 500 samples/s
- Up to 100 channels simultaneous



TRION-EtheCAT-1-SLAVE

## Module specifications

| **TRION-EtherCAT-1-SLAVE specifications** | |
|---|---|
| I/O connector | 1 EtherCAT Slave IN, RJ45<br>1 EtherCAT Slave OUT, RJ45 |
| Communication standard | Ethernet, 10BASE-T/100BASE-TX |
| Isolation voltage | 1000 $V_{DC}$ |
| Compatible chassis | DEWE2-A4/A4L/A7/A13<br>DEWE2-PA7<br>DEWE2-M4/M7/M13(s)<br>DEWE3-PA8<br>DEWE3-A4/A4L/M4<br>DEWE3-RMx |
| Required operating system | Windows 10 x64 |
| Measurement data update rate | 500 S/s (typ.), for higher rates refer to the *OXYGEN EtherCAT-Slave manual* |
| I/O delay | 200 ms (typ.), 500 ms (typ.) in versions prior to OXYGEN 7.0 |
| Manufacturer part number | Hilscher CFIX 80-RE |

*Tab. 83: Module specifications*

**INFORMATION**

This module is designed to be used in DEWE2/DEWE3 series instruments but is not compatible with TRIONet.

The TRION-EtherCAT-1-SLAVE is a communication interface module for the DEWE2/DEWE3 series. It can be used in combination with DEWETRON OXYGEN software to provide measurement data in an EtherCAT network via PDO mechanism.

Up to 100 user selectable measurement channels can be provided, combined with a high accurate timestamp. The measurement data is provided via IEEE 754 Floating-Point Number. The configuration is available via a separate ESI-File for use on the EtherCAT master.

Additionally, the input SDOs allow a selection of a measurement setup, the measurement (recording) can be triggered by a PDO control word.

# TRION sub-modules

In combination with the *TRION(3)-18xx-POWER-4*, *TRION(3)-1810-HV-8* and *TRION3-1810x-SUB-8* boards, the interchangable TRION sub-modules can be used to create individual input configurations.

## TRION sub-modules overview

The following sections provide an overview and detailed information on the TRION sub-modules. The values given below were determined in a standardized test setting[1)].

| Type | Range | Bandwidth | Isolated |
|---|---|---|---|
| *TRION-SUB-600V* | 600 $V_{RMS}$ (±1500 $V_{PEAK}$) | 300 kHz | Yes |
| *TRION-SUB-5V* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 300 kHz | Yes |
| *TRION-SUB-XV* | 600 $V_{RMS}$ (±1000 V)[2)]<br>60 $V_{RMS}$ (±100 V)<br>6 $V_{RMS}$ (±10 V)<br>0.6 $V_{RMS}$ (±1 V) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-20A-1* | 20 $A_{RMS}$ (±40 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-2A-1* | 2 $A_{RMS}$ (±4 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-1A-1* | 1 $A_{RMS}$ (±2 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-CUR-02A-1* | 0.2 $A_{RMS}$ (±0.4 $A_{PEAK}$) | 300 kHz | Yes |
| *TRION-POWER-SUB-dLV-5V* | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-dLV-1V* | 1 $V_{RMS}$ (±2 $V_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-CT* | 1 $A_{RMS}$ (±2 $A_{PEAK}$)<br>0.5 $A_{RMS}$ (±1 $A_{PEAK}$)<br>0.25 $A_{RMS}$ (±0.5 $A_{PEAK}$)<br>0.1 $A_{RMS}$ (±0.2 $A_{PEAK}$) | 5 MHz | No |
| *TRION-POWER-SUB-dLV-1*[3)] | 5 $V_{RMS}$ (±10 $V_{PEAK}$) | 100 kHz | No |

*Tab. 84: TRION sub-modules overview*

1) The following accuracy conditions were applied: Temperature: 23 ±5 °C; humidity: 40 to 60 % rel. humidity; input waveform: sine wave; common mode voltage: 0 V; line filter: Auto; sample rate: 1 MS/s; resolution: 24 bit; power factor: 1; after warm-up; after zero level, accuracy: Frequency (f) in [kHz] (12-month accuracy ± reading error and range error)

2) Max. allowed input: 600 V CAT II (850 $V_{PEAK}$).

3) Not supported by TRION3-18xx-SUB-8 module.

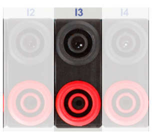
# TRION-SUB-600V

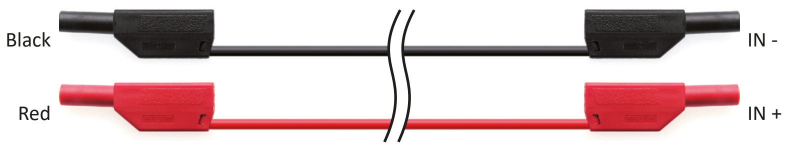
| **TRION-SUB-600V** | | | | |
|---|---|---|---|---|
| Input range | 600 $V_{RMS}$ (±1500 $V_{PEAK}$) CF=2.5 | | | |
| Resolution | 20 bit | | | |
| 1 year accuracy (23 °C ±5 °C) | DC | ±0.02 % of reading ±0.005 % of range | | |
| | 0.5 Hz to 10 kHz | ±0.03 % of reading | | |
| | 10 kHz to 100 kHz | ±(0.015 % * f) of reading | | f: frequency in kHz |
| | 100 kHz to 200 kHz | ±(0.04 % * f) of reading | | f: frequency in kHz |
| Gain drift | 20 ppm / °C | | | |
| Offset drift | 1 mV / °C | | | |
| Typical THD | -105 dB | | | |
| Typical CMRR | >100 dB @ 50 Hz; >90 dB @ 1 kHz; >70 dB @ 10 kHz; >50 dB @ 100 kHz | | | |
| Bandwidth (-3 dB) | 300 kHz | | | |
| Rated input voltage to earth according to EN 61010-2-30 | 300 V CAT III / 600 V CAT II | | | |
| Isolation voltage | 3750 $V_{RMS}$ (1 min); 35 kV/µs transient immunity | | | |
| Common mode voltage | 600 $V_{RMS}$ | | | |
| Overvoltage protection | 1500 $V_{PEAK}$ or 1000 $V_{RMS}$ (1 min) | | | |
| Input impedance | 5 MΩ; 3.5 pF | | | |
| Isolation (earth) resistance | 100 GΩ; 4 pF (IN- to GND) | | | |
| Connector | Safety banana sockets | | | |
| | SNR | SFDR[1)] | ENOB[2)] | $Noise_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [mV] |
| 0.1 kS/s | 125 | 140 | 20.4 | 2.0 |
| 1 kS/s | 120 | 140 | 19.6 | 3.2 |
| 10 kS/s | 111 | 140 | 18.2 | 5.4 |
| 100 kS/s | 104 | 140 | 16.9 | 35.0 |
| 1000 kS/s | 93 | 128 | 15.1 | 150.0 |
| 2000 kS/s | 93 | 126 | 15.1 | 151.0 |

*Tab. 85: TRION-SUB-600V*

1) SFDR excluding harmonics

2) ENOB calculated from SNR




**WARNING**

**Risk of injury due to electric shock**

Voltage measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

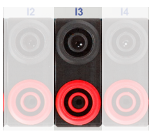
## TRION-SUB-5V

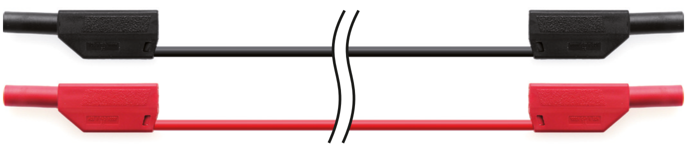
| TRION-SUB-5V | | | | |
|---|---|---|---|---|
| Input range | 5 $V_{RMS}$ (±10 $V_{PEAK}$) CF=2 | | | |
| Resolution | 20 bit | | | |
| 1 year accuracy (23 °C ±5 °C) | DC | ±0.02 % of reading ±0.005 % of range | | |
| | 0.5 Hz to 10 kHz | ±0.03 % of reading | | |
| | 10 kHz to 100 kHz | ±(0.015 % * f) of reading | | f: frequency in kHz |
| | 100 kHz to 200 kHz | ±(0.04 % * f) of reading | | f: frequency in kHz |
| Gain drift | 20 ppm / °C | | | |
| Offset drift | 1 µV / °C | | | |
| Typical THD | -102 dB | | | |
| Typical CMRR | >140 dB @ 50 Hz; >106 dB @ 10 kHz; >102 dB @ 100 kHz | | | |
| Bandwidth (-3 dB) | 300 kHz | | | |
| Rated input voltage to earth according to EN 61010-2-30 | 300 V CAT III / 600 V CAT II | | | |
| Isolation voltage | 3750 $V_{RMS}$ (1 min); 35 kV/µs transient immunity | | | |
| Common mode voltage | 600 $V_{RMS}$ | | | |
| Overvoltage protection | 1000 $V_{PEAK}$ or 600 $V_{RMS}$ (1 min) | | | |
| Input impedance | 5 MΩ; 22 pF | | | |
| Isolation (earth) resistance | 100 GΩ; 4 pF (IN- to GND) | | | |
| Connector | Safety banana sockets | | | |
| | SNR | SFDR[1)] | ENOB[2)] | $Noise_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [µV] |
| 0.1 kS/s | 134 | 145 | 22.0 | 5 |
| 1 kS/s | 126 | 148 | 20.6 | 14 |
| 10 kS/s | 118 | 145 | 19.4 | 44 |
| 100 kS/s | 109 | 138 | 17.8 | 155 |
| 1000 kS/s | 98 | 135 | 16.1 | 596 |
| 2000 kS/s | 98 | 132 | 16.1 | 598 |

*Tab. 86: TRION-SUB-5V*

1) SFDR excluding harmonics

2) ENOB calculated from SNR






**WARNING**

**Risk of injury due to electric shock**

Voltage measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

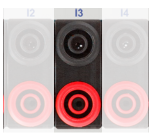
## TRION-SUB-XV

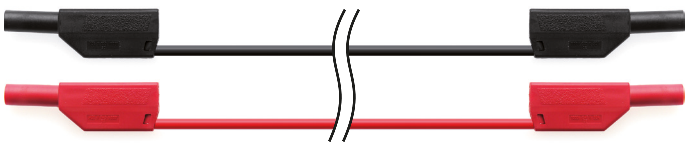
| TRION-SUB-XV | | | | |
|---|---|---|---|---|
| Input range | 600 $V_{RMS}$ (±1000 V)[1] | 60 $V_{RMS}$ (±100 V) | 6 $V_{RMS}$ (±10 V) | 0.6 $V_{RMS}$ (±1 V) |
| Resolution | 16-bit | | | |
| 1 year accuracy (23 °C ±5 °C) | DC (600 V, 60 V range) | ±0.03 % of reading ±0.01 % of range | | |
| | DC (6 V range) | ±0.02 % of reading ±0.01 % of range | | |
| | DC (0.6 V range) | ±0.02 % of reading ±150 µV | | |
| | 0.5 Hz to 500 Hz | ±0.03 % of reading | | |
| | >500 Hz to 100 kHz | ±(0.06 % * f) of reading | | f: frequency in kHz |
| Gain drift | 25 ppm / °C | | | |
| Offset drift | 2 µV / °C | | | |
| Typical THD | -90 dB | | | |
| Typical CMRR | ≤6 V range: >140 dB @ 50 Hz; >125 dB @1 kHz; >115 dB @ 10 kHz; >94 dB @ 100 kHz | | | |
| | >6 V range: >100 dB @ 50 Hz; >90 dB @ 1 kHz; >70 dB @ 10 kHz; >50 dB @ 100 kHz | | | |
| Bandwidth (-3 dB) | 300 kHz | | | |
| Rated input voltage to earth acc. to EN 61010-2-30 | 300 V CAT III / 600 V CAT II | | | |
| Isolation voltage | 3750 $V_{RMS}$ (1 min); 35 kV/µs transient immunity | | | |
| Common mode voltage | 600 $V_{RMS}$ | | | |
| Overvoltage protection | 1000 $V_{PEAK}$ or 600 $V_{RMS}$ | | | |
| Input impedance | 10 MΩ; t.b.d. pF | | | |
| Isolation (earth) resistance | 100 GΩ; 4 pF (IN- to GND) | | | |
| Connector | Safety banana sockets | | | |

| | 0.6 V | | | | 6 V | | | | 60 V | | | | 600 V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SNR | SFDR[1] | ENOB[2] | Noise | SNR | SFDR[1] | ENOB[2] | Noise | SNR | SFDR[1] | ENOB[2] | Noise | SNR | SFDR[1] | ENOB[2] | Noise |
| Sample rate | [dB] | [dB] | [Bit] | [$mV_{pp}$] | [dB] | [dB] | [Bit] | [$mV_{pp}$] | [dB] | [dB] | [Bit] | [$mV_{pp}$] | [dB] | [dB] | [Bit] | [$mV_{pp}$] |
| 0.1 kS/s | 111.0 | t.b.d | 18.1 | 0.0 | 120.1 | t.b.d | 19.7 | 0.0 | 120.1 | t.b.d | 19.7 | 0.0 | 100.1 | t.b.d | 16.3 | 3.5 |
| 1 kS/s | 109.4 | t.b.d | 17.9 | 0.1 | 111.0 | t.b.d | 18.1 | 0.1 | 111.0 | t.b.d | 18.1 | 0.1 | 113.5 | t.b.d | 18.6 | 9.0 |
| 10 kS/s | 101.4 | t.b.d | 16.6 | 0.1 | 84.3 | t.b.d | 13.7 | 0.4 | 84.3 | t.b.d | 13.7 | 0.4 | 104.9 | t.b.d | 17.1 | 34.0 |
| 100 kS/s | 92.9 | t.b.d | 15.1 | 0.3 | 94.7 | t.b.d | 15.4 | 1.1 | 94.7 | t.b.d | 15.4 | 1.1 | 95.2 | t.b.d | 15.5 | 110.0 |
| 300 kS/s | 87.7 | 122.0 | 14.3 | 0.5 | 89.4 | 122.0 | 14.6 | 2.4 | 89.4 | 122.0 | 14.6 | 2.4 | 89.9 | 122.0 | 14.6 | 220.0 |
| 1 MS/s | 83.4 | 122.0 | 13.6 | 1.3 | 82.3 | t.b.d | 13.4 | 4.7 | 82.3 | t.b.d | 13.4 | 4.7 | 83.0 | 122.0 | 13.5 | 470.0 |

*Tab. 87: TRION-SUB-XV*

1) Max. allowed input 600 V CAT II (850 $V_{PEAK}$) 2) SFDR excluding harmonics 3) ENOB calculated from SNR




**WARNING**

**Risk of injury due to electric shock**

Voltage measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

### Block diagram

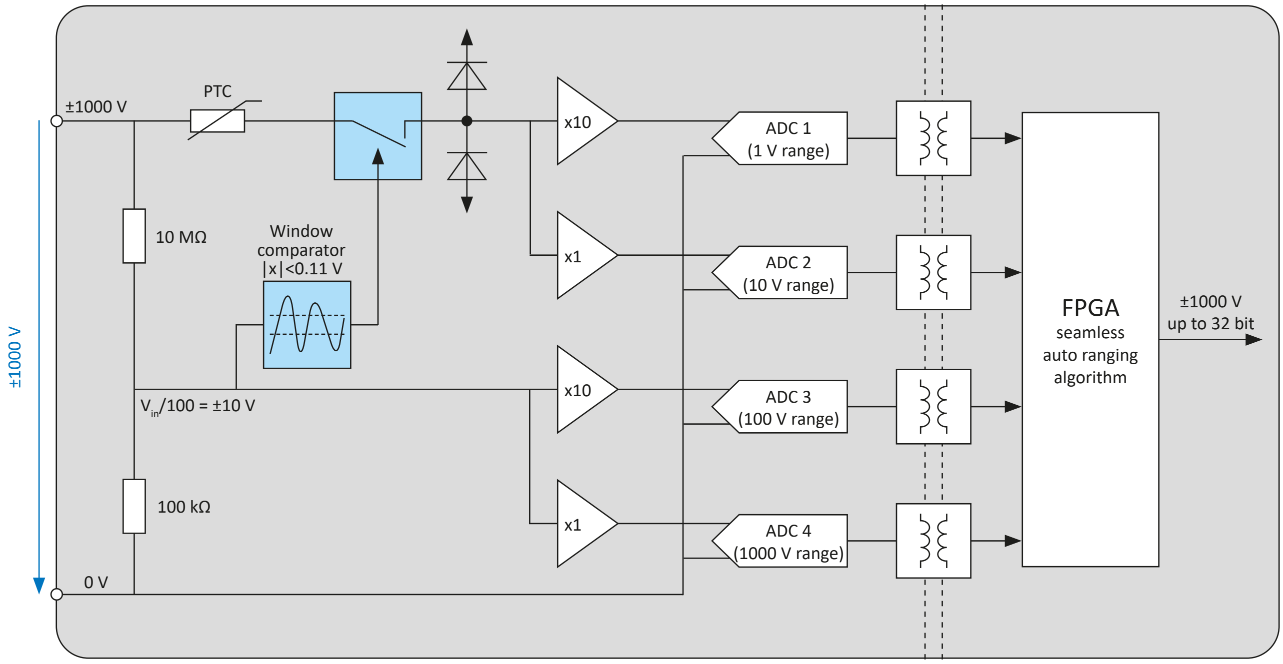



*Fig. 218: Block diagram TRION-SUB-XV*

### Seamless auto ranging function

The TRION-SUB-XV has four measuring ranges and therefore three measuring range switchovers.

The changes from 1 to 10 V and 100 to 1000 V are similar. These ranges are always operated in parallel. As soon as the input signal exceeds the lower measuring range, a transition phase begins. Here, the signal from the higher measuring range is mixed in with increasing weighting until finally only the signal from the higher measuring range is present on the output.

In the time domain, you can observe how the noise of the signal increases slightly. This works in exactly the same way in the other direction; there is no hysteresis here, only the transition range.

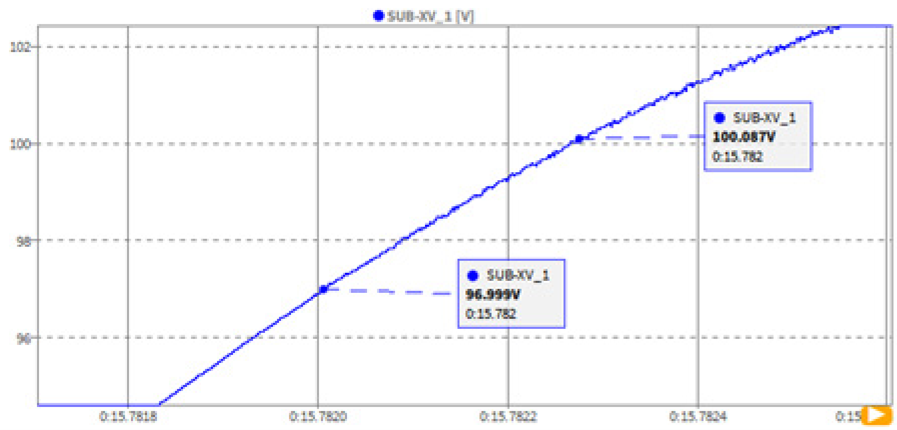



*Fig. 219: TRION-SUB-XV auto ranging 100 V ↔ 1000 V switch over*

At around 97 V the transition from the 100 V to the 1000 V range starts.

An additional functionality is required for switching from the 10 to the 100 V measuring range. If the voltage rises above 10 V, the signal first enters a small transition range and the module switches over to the 100 V range. If the input voltage continues to rise above 11 V, this is detected analogue and the 10 V measuring range is switched off electrically. The reason for this is that the input amplifiers would be overdriven in the direct path at higher voltages and thus a higher current would flow into the module.

This current is limited to protect the module from destruction. Nevertheless, it would lead to a higher load on the object to be measured.

Switching off the smaller measuring ranges takes about 200 µs. Once this process is triggered, the signal must fall below ±10 V again for at least 10 ms for the direct input path to be reactivated.

This prevents constant switching on and off at normal mains frequency.

**Advantages of seamless auto ranging**

- No gaps when changing the measurement range
- Smooth signal transition between ranges
- Smart logic prevents unnecessary switching
- No signal overload because the range is too small
- No accuracy problem because the measuring range is too high
- Worry free setup: It is automatically always in the right range

**Manual range selection (Autorange deactivated)**

If the range is selected manually, only the data from the appropriate ADC is used. For the 100 V and 1000 V range the direct input is deactivated. In the dedicated 1 V and 10 V range the direct input path is active. However, if an overload is detected on the input, it is deactivated automatically. Once the signal drops below 10 V it takes 10 ms to recover before valid data is measured again.


## TRION-POWER-SUB-CUR-20A-1

| **TRION-POWER-SUB-CUR-20A-1** | | | |
|---|---|---|---|
| Range | 20 $A_{RMS}$ (±40 $A_{PEAK}$) | | |
| Resolution | 20 bit | | |
| 1 year accuracy (23 °C ±5 °C)1)2) | DC | ±0.02 % of reading ±0.02 % of range3) | |
| | 0.5 Hz to 1 kHz | ±0.03 % of reading | |
| | 1 kHz to 5 kHz | ±0.15 % of reading | |
| | 5 kHz to 10 kHz | ±0.35 % of reading | |
| | 10 kHz to 50 kHz | ±(0.3 % + 0.05 % * f) of reading | f: frequency in kHz |
| | 50 kHz to 300 kHz | ±(0.10 % * f) of reading | f: frequency in kHz |
| Gain drift | 20 ppm/°C | | |
| Offset drift | 0.35 mA/°C | | |
| Rated input voltage to earth according to EN 61010-2-30 | 600 V CAT II | | |
| Isolation voltage | 3750 $V_{RMS}$ (1 min), 35 kV/µs transient immunity | | |
| Bandwidth | 300 kHz | | |
| Connector | Safety banana plugs | | |
| Overcurrent protection | 50 $A_{PEAK}$ or 40 $A_{RMS}$ (1 s) | | |
| Thermal current limit | 20 $A_{RMS}$ | | |
| Input resistance | 2 mΩ | | |

| **Typical signal to noise ratio, spurious free SNR, effective number of bits4)** | | | | |
|---|---|---|---|---|
| | SNR | SFDR5) | ENOB6) | $Noise_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [mA] |
| 0.1 kS/s | 101 | 117 | 16.5 | 0.8 |
| 1 kS/s | 100 | 119 | 16.3 | 1.4 |
| 10 kS/s | 98 | 113 | 16.0 | 2.1 |
| 100 kS/s | 93 | 110 | 15.2 | 3.9 |
| 1000 kS/s | 85 | 110 | 13.8 | 10.3 |
| 2000 kS/s | 84 | 107 | 13.7 | 10.9 |

*Tab. 88: TRION-POWER-SUB-CUR-20A-1*

1) For self-generated heat caused by current input, add 0.00015 × $I^2$ % of reading + 20 × $I^2$ µA to the current accuracy. 'I' is the current reading [A]. The influence from self-generated heat continues until the temperature of the shunt resistor inside the DEWE2-Chassis lowers even if the current input changes to a small value.

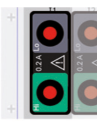
2) Below 1 % of range, add 10 ppm of range

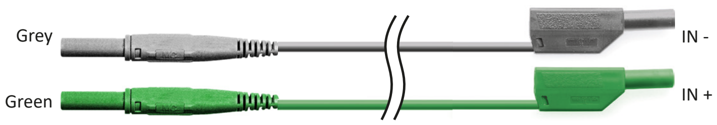
3) Add 0.03 % of range with no zero level.

4) LP filter in auto mode

5) SFDR excluding harmonics

6) ENOB calculated from SNR






**WARNING**

**Risk of injury due to electric shock**

Current measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

**WARNING**

**Risk of injury due to heat or fire**

Always use the dedicated measurement leads which come with your module, or appropriate measurement leads, which are rated for at least 20 A continuous current.

## TRION-POWER-SUB-CUR-2A-1

| TRION-POWER-SUB-CUR-2A-1 | | | |
|---|---|---|---|
| Range | 2 $A_{RMS}$ (±4 $A_{PEAK}$) | | |
| Resolution | 20 bit | | |
| 1 year accuracy (23 °C ±5 °C)[1)] | DC | ±0.02 % of reading ±0.02 % of range[2)] | |
| | 0.5 Hz to 10 kHz | ±0.03 % of reading | |
| | 10 kHz to 30 kHz | ±0.1 % of reading | |
| | 30 kHz to 200 kHz | ±(0.015 % * f) of reading | f: frequency in kHz |
| | 200 kHz to 300 kHz | ±(0.1 % * f) of reading | f: frequency in kHz |
| Gain drift | 20 ppm/°C | | |
| Offset drift | 15 µA/°C | | |
| Rated input voltage to earth according to EN 61010-2-30 | 600 V CAT II | | |
| Isolation voltage | 3750 $V_{RMS}$ (1 min), 35 kV/µs transient immunity | | |
| Bandwidth | 300 kHz | | |
| Connector | Safety banana plugs | | |
| Overcurrent protection | 10 $A_{PEAK}$ or 5 $A_{RMS}$ (1 s) | | |
| Thermal current limit | 3 $A_{RMS}$ | | |
| Input resistance | 50 mΩ | | |

**Typical signal to noise ratio, spurious free SNR, effective number of bits[3)]**

| | SNR | SFDR[4)] | ENOB[5)] | $Noise_{PP}$ |
|---|---|---|---|---|
| Sample rate | [dB] | [dB] | [Bit] | [µA] |
| 0.1 kS/s | 110 | 125 | 18.0 | 34.8 |
| 1 kS/s | 107 | 126 | 17.5 | 47.2 |
| 10 kS/s | 105 | 122 | 17.1 | 78.2 |
| 100 kS/s | 100 | 120 | 16.3 | 172.6 |
| 1000 kS/s | 91 | 114 | 14.8 | 541.2 |
| 2000 kS/s | 90 | 114 | 14.7 | 553.1 |

*Tab. 89: TRION-POWER-SUB-CUR-2A-1*

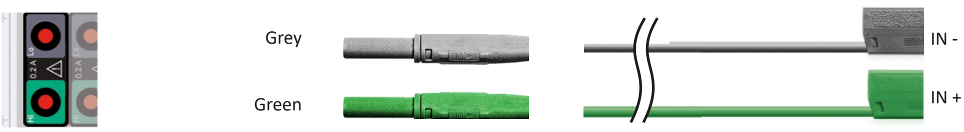
1) Below 1 % of range, add 25 ppm of range

2) Add 0.03 % of range with no zero level.

3) LP filter in auto mode

4) SFDR excluding harmonics

5) ENOB calculated from SNR




**WARNING**

**Risk of injury due to electric shock**

Current measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.


## TRION-POWER-SUB-CUR-1A-1

| TRION-POWER-SUB-CUR-1A-1 | | | | |
|---|---|---|---|---|
| Range | 1 $A_{RMS}$ (±2 $A_{PEAK}$) | | | |
| Resolution | 20 bit | | | |
| 1 year accuracy (23 °C ±5 °C)[1] | DC | ±0.02 % of reading ±80 µA[2] | | |
| | 0.5 Hz to 10 kHz | ±0.03 % of reading | | |
| | 10 kHz to 30 kHz | ±0.1 % of reading | | |
| | 30 kHz to 200 kHz | ±(0.015 % * f) of reading | | f: frequency in kHz |
| | 200 kHz to 300 kHz | ±(0.1 % * f) of reading | | f: frequency in kHz |
| Gain drift | 20 ppm/°C | | | |
| Offset drift | 4 µA/°C | | | |
| Rated input voltage to earth according to EN 61010-2-30 | 600 V CAT II | | | |
| Isolation voltage | 3750 $V_{RMS}$ (1 min), 35 kV/µs transient immunity | | | |
| Bandwidth | 300 kHz | | | |
| Connector | Safety banana plugs | | | |
| Overcurrent protection | 4 $A_{PEAK}$ or 2 $A_{RMS}$ (1 s) | | | |
| Thermal current limit | 1 $A_{RMS}$ | | | |
| Input resistance | 500 mΩ | | | |
| **Typical signal to noise ratio, spurious free SNR, effective number of bits[3]** | | | | |
| | SNR | SFDR[4] | ENOB[5] | $Noise_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [µA] |
| 0.1 kS/s | 131 | 149 | 21.5 | 1.4 |
| 1 kS/s | 125 | 149 | 20.5 | 3.9 |
| 10 kS/s | 116 | 144 | 19.0 | 12.6 |
| 100 kS/s | 106 | 137 | 17.3 | 47.0 |
| 1000 kS/s | 96 | 134 | 15.7 | 161.0 |
| 2000 kS/s | 95 | 130 | 15.5 | 162.0 |

*Tab. 90: TRION-POWER-SUB-CUR-1A-1*

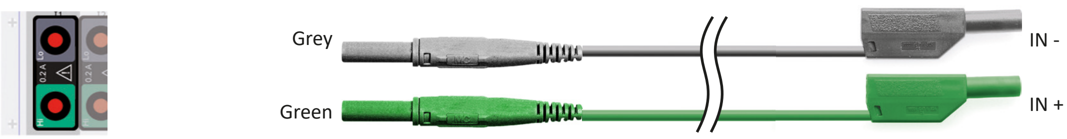
1) Below 1 % of range, add 25 ppm of range

2) Add 0.03 % of range with no zero level.

3) LP filter in auto mode

4) SFDR excluding harmonics

5) ENOB calculated from SNR




**WARNING**

**Risk of injury due to electric shock**

Current measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.


## TRION-POWER-SUB-CUR-02A-1

| TRION-POWER-SUB-CUR-02A-1 | | | | |
|---|---|---|---|---|
| Range | 0.2 $A_{RMS}$ (±0.4 $A_{PEAK}$) | | | |
| Resolution | 20 bit | | | |
| 1 year accuracy (23 °C ±5 °C)[1] | DC | ±0.02 % of reading ±0.02 % of range[2] | | |
| | 0.5 Hz to 10 kHz | ±0.03 % of reading | | |
| | 10 kHz to 30 kHz | ±0.1 % of reading | | |
| | 30 kHz to 200 kHz | ±(0.015 % * f) of reading | f: frequency in kHz | |
| | 200 kHz to 300 kHz | ±(0.1 % * f) of reading | f: frequency in kHz | |
| Gain drift | 20 ppm/°C | | | |
| Offset drift | 4 µA/°C | | | |
| Rated input voltage to earth according to EN 61010-2-30 | 600 V CAT II | | | |
| Isolation voltage | 3750 $V_{RMS}$ (1 min), 35 kV/µs transient immunity | | | |
| Bandwidth | 300 kHz | | | |
| Connector | Safety banana plugs | | | |
| Overcurrent protection | 2 $A_{PEAK}$ or 1 $A_{RMS}$ (1 s) | | | |
| Thermal current limit | 0.5 $A_{RMS}$ | | | |
| Input resistance | 500 mΩ | | | |
| **Typical signal to noise ratio, spurious free SNR, effective number of bits[3]** | | | | |
| | SNR | SFDR[4] | ENOB[5] | $Noise_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [µA] |
| 0.1 kS/s | 108 | 128 | 17.6 | 3.6 |
| 1 kS/s | 107 | 123 | 17.5 | 5.6 |
| 10 kS/s | 104 | 121 | 17.0 | 9.2 |
| 100 kS/s | 99 | 114 | 16.2 | 17.3 |
| 1000 kS/s | 91 | 114 | 14.8 | 51.3 |
| 2000 kS/s | 90 | 114 | 14.7 | 54.9 |

*Tab. 91: TRION-POWER-SUB-CUR-02A-1*

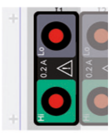
1) Below 1 % of range, add 25 ppm of range

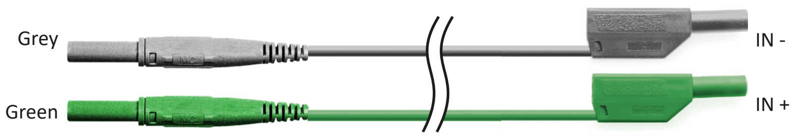
2) Add 0.03 % of range with no zero level.

3) LP filter in auto mode

4) SFDR excluding harmonics

5) ENOB calculated from SNR






**WARNING**

**Risk of injury due to electric shock**

Current measurement on lines above 33 $V_{RMS}$, 46.7 $V_{PEAK}$ or 70 $V_{DC}$ is only permitted with rated safety test leads.

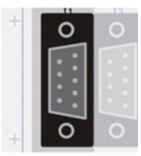

## TRION-POWER-SUB-dLV-1V

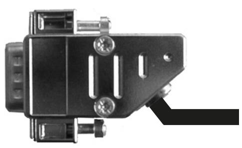
| TRION-POWER-SUB-dLV-1V | | | | |
|---|---|---|---|---|
| Range | 1 $V_{RMS}$ (±2 $V_{PEAK}$) **NOT ISOLATED** ⚠ | | | |
| Sampling rate / resolution | TRION(3)-1810-HV | 100 S/s to 1 MS/s | 24-bit | |
| | TRION3-1810-SUB-8 | 100 S/s to 1 MS/s | 24-bit | |
| | TRION(3)-1820-POWER | 100 S/s to 2 MS/s | 24-bit | |
| | TRION3-1810M-POWER | 100 S/s to 2 MS/s | 24-bit | |
| | | >2 MS/s to 10 MS/s | 18-bit | |
| 1 year accuracy (23 °C ±5 °C) | DC | ±0.015 % of reading ±200 µV | | |
| | 0.5 Hz to 10 kHz | ±0.03 % of reading | | |
| | 10 kHz to 500 kHz | ±(0.006 % * f) of reading | f: frequency in kHz | |
| | 500 kHz to 3000 kHz | ±(0.006 % * f) of reading | f: frequency in kHz | |
| Gain drift | 10 ppm / °C | | | |
| Offset drift | 10 µV / °C | | | |
| Typical THD | -100 dB | | | |
| Typical CMRR | >70 dB @ 50 Hz; >65 dB @ 10 kHz; >45 dB @ 100 kHz | | | |
| Bandwidth (-3 dB) | 5 MHz | | | |
| Isolation voltage | None. Use with isolated current transducer. | | | |
| Common mode voltage | ±10 $V_{DC}$ | | | |
| Overvoltage protection | ±300 $V_{DC}$ | | | |
| Connector | D-SUB-9 | | | |
| Input impedance | 5 MΩ, differential 5 MΩ, 15 pF | | | |
| Sensor supply (±9 V) | Max. 40 mA | | | |
| | SNR | SFDR[1] | ENOB[2] | $Noise_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [µV] |
| 0.1 kS/s | 120 | 133 | 19.6 | 4.8 |
| 1 kS/s | 117 | 130 | 19.2 | 6.3 |
| 10 kS/s | 111 | 129 | 18.2 | 16.0 |
| 100 kS/s | 104 | 129 | 17.1 | 49.0 |
| 1000 kS/s | 95 | 129 | 15.5 | 162.0 |
| 2000 kS/s | 92 | 129 | 15.0 | 243.0 |

*Tab. 93: TRION-POWER-SUB-dLV-1V*

1) SFDR excluding harmonics

2) ENOB calculated from SNR





| | | | |
|---|---|---|---|
| Pin 1: | TEDS | Pin 6: | n.c. |
| Pin 2: | IN+ | Pin 7: | IN- |
| Pin 3: | n.c. | Pin 8: | n.c. |
| Pin 4: | GND (not isolated) | Pin 9: | -9 V (40 mA max.) |
| Pin 5: | +9 V (40 mA max.) | | |

**WARNING**

**Risk of injury due to electric shock**

TRION-POWER-SUB-dLV-xV modules are not isolated.

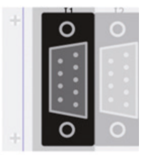

## TRION-POWER-SUB-dLV-5V

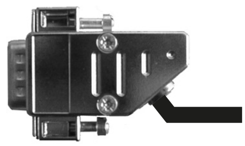
| TRION-POWER-SUB-dLV-5V | | | | |
|---|---|---|---|---|
| Range | 5 $V_{RMS}$ (±10 $V_{PEAK}$) **NOT ISOLATED** ⚠ | | | |
| Sampling rate / resolution | TRION(3)-1810-HV | | 100 S/s to 1 MS/s | 24-bit |
| | TRION3-1810-SUB-8 | | 100 S/s to 1 MS/s | 24-bit |
| | TRION(3)-1820-POWER | | 100 S/s to 2 MS/s | 24-bit |
| | TRION3-1810M-POWER | | 100 S/s to 2 MS/s | 24-bit |
| | | | >2 MS/s to 10 MS/s | 18-bit |
| 1 year accuracy (23 °C ±5 °C) | DC | ±0.015 % of reading ±200 µV | | |
| | 0.5 Hz to 10 kHz | ±0.03 % of reading | | |
| | 10 kHz to 500 kHz | ±(0.006 % * f) of reading | | f: frequency in kHz |
| | 500 kHz to 3000 kHz | ±(0.006 % * f) of reading | | f: frequency in kHz |
| Gain drift | 10 ppm / °C | | | |
| Offset drift | 10 µV / °C | | | |
| Typical THD | -100 dB | | | |
| Typical CMRR | >70 dB @ 50 Hz; >65 dB @ 10 kHz; >45 dB @ 100 kHz | | | |
| Bandwidth (-3 dB) | 5 MHz | | | |
| Isolation voltage | None. Use with isolated current transducer. | | | |
| Common mode voltage | ±10 $V_{DC}$ | | | |
| Overvoltage protection | ±300 $V_{DC}$ | | | |
| Connector | D-SUB-9 | | | |
| Input impedance | 5 MΩ, differential 5 MΩ, 15 pF | | | |
| Sensor supply (±9 V) | Max. 40 mA | | | |
| | SNR | SFDR[1)] | ENOB[2)] | $Noise_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [µV] |
| 0.1 kS/s | 125 | 138 | 20.5 | 13 |
| 1 kS/s | 122 | 135 | 20.0 | 21 |
| 10 kS/s | 116 | 134 | 19.0 | 54 |
| 100 kS/s | 108 | 134 | 17.7 | 152 |
| 1000 kS/s | 99 | 134 | 16.2 | 489 |
| 2000 kS/s | 96 | 134 | 15.7 | 712 |

*Tab. 92: TRION-POWER-SUB-dLV-5V*

1) SFDR excluding harmonics

2) ENOB calculated from SNR





| | | | |
|---|---|---|---|
| Pin 1: | TEDS | Pin 6: | n.c. |
| Pin 2: | IN+ | Pin 7: | IN- |
| Pin 3: | n.c. | Pin 8: | n.c. |
| Pin 4: | GND (not isolated) | Pin 9: | -9 V (40 mA max.) |
| Pin 5: | +9 V (40 mA max.) | | |

**WARNING**

**Risk of injury due to electric shock**

TRION-POWER-SUB-dLV-xV modules are not isolated.

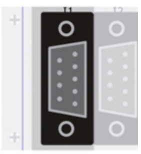
## TRION-POWER-SUB-dLV-1

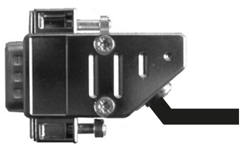
| TRION-POWER-SUB-dLV-1 | | | | |
|---|---|---|---|---|
| Range | 5 $V_{RMS}$ (±10 $V_{PEAK}$) **NOT ISOLATED** ⚠ | | | |
| Resolution | 18-bit | | | |
| 1 year accuracy (23 °C ±5 °C)[1)] | DC | ±0.02 % of reading ±0.02 % of range | | |
| | 0.5 Hz to 5 kHz | ±0.03 % of reading | | |
| | 5 kHz to 30 kHz | ±(0.01 % * f) of reading | | f: frequency in kHz |
| | 30 kHz to 50 kHz | ±(0.02 % * f) of reading | | f: frequency in kHz |
| | 50 kHz to 100 kHz | ±(0.1 % * f) of reading | | f: frequency in kHz |
| Typical THD | -100 dB | | | |
| Typical CMRR | >70 dB @ 50 Hz; >65 dB @ 10 kHz; >45 dB @ 100 kHz | | | |
| Isolation voltage | None. Use with isolated current transducer. | | | |
| Overvoltage protection | ±30 $V_{DC}$ | | | |
| Bandwidth | 100 kHz | | | |
| Connector | D-SUB-9 | | | |
| Input resistance | 1 MΩ | | | |
| Sensor supply (±9 V) | Max. 40 mA | | | |
| | SNR | SFDR[4)] | ENOB[5)] | $Noise_{PP}$ |
| Sample rate | [dB] | [dB] | [Bit] | [µV] |
| 0.1 kS/s | 129 | 150 | 21.1 | 14.3 |
| 1 kS/s | 119 | 142 | 19.5 | 45.3 |
| 10 kS/s | 109 | 139 | 17.8 | 163.3 |
| 100 kS/s | 99 | 131 | 16.2 | 590.1 |
| 1000 kS/s | 94 | 124 | 15.3 | 1337.5 |
| 2000 kS/s | 92 | 123 | 15.0 | 1375.7 |

*Tab. 94: TRION-POWER-SUB-dLV-1*

1) Below 1 % of range, add 25 ppm of range

2) Add 0.03 % of range with no zero level.





Pin 1: TEDS
Pin 2: IN+
Pin 3: n.c.
Pin 4: GND (not isolated)
Pin 5: +9 V (40 mA max.)
Pin 6: n.c.
Pin 7: IN-
Pin 8: n.c.
Pin 9: -9 V (40 mA max.)

**WARNING**

**Risk of injury due to electric shock**

TRION-POWER-SUB-dLV-1 modules are not isolated.

## TRION-POWER-SUB-CT

| **TRION-POWER-SUB-CT** | | | |
|---|---|---|---|
| Range **NOT ISOLATED** ⚠ | 1 $A_{RMS}$ (±2 $A_{PEAK}$) | 0.25 $A_{RMS}$ (±0.5 $A_{PEAK}$) | |
| | 0.5 $A_{RMS}$ (±1 $A_{PEAK}$) | 0.1 $A_{RMS}$ (±0.2 $A_{PEAK}$) | |
| Sampling rate/resolution | TRION(3)-1810-HV | 100 S/s to 1 MS/s | 24-bit |
| | TRION3-1810-SUB-8 | 100 S/s to 1 MS/s | 24-bit |
| | TRION(3)-1820-POWER | 100 S/s to 2 MS/s | 24-bit |
| | TRION3-1810M-POWER | 100 S/s to 2 MS/s | 24-bit |
| | | >2 MS/s to 10 MS/s | 18-bit |
| 1 year accuracy (23 °C ±5 °C)[1] | DC | ±0.02 % of reading ±0.02 % of range (±50 µA without zero) | |
| | 0.5 Hz to 10 kHz | ±0.03 % of reading | |
| | 10 kHz to 500 kHz | ±(0.006 % * f) of reading | f: frequency in kHz |
| | 500 kHz to 3000 kHz | ±(0.006 % * f) of reading | f: frequency in kHz |
| Gain drift | Typ. 10 ppm/°C; max: 20 ppm/°C | | |
| Offset drift | Typ. 0.5 µA/°C; max: 2.5 µA/°C | | |
| Typical THD | -95 dB | | |
| Typical CMRR | >100 dB @ 50 Hz; 100 dB @1 kHz; 95 dB @ 10 kHz; 70 dB @ 100 kHz | | |
| Bandwidth (-3 dB) | 5 MHz | | |
| Isolation voltage | None. Only use with isolated current sensors complying with the required safety category. | | |
| Common mode voltage | ±10 V | | |
| Overcurrent protection | ±1.3 $A_{RMS}$ continuously; 4 $A_{PEAK}$ or 2 $A_{RMS}$ (1 s) | | |
| Input resistance | 500 mΩ | | |
| Connector | D-SUB-9 | | |
| Mating cable | ADAP-DB9M-DB9F-POW | | |
| Supported current transducer | PA-IT-xxx-S or PA-IN-xxx-S series | | |
| Transducer supply | Requires clamp supply: DEWE3-PA8 series; DW2-CLAMP-DC-POWER-8 (Clamp Supply Box) | | |

**Typical signal to noise ratio, spurious free SNR, effective number of bits[2]**

| | 0.1 A | | | | 0.25 A | | | | 0.5 A | | | | 1 A | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SNR | SFDR[3] | ENOB[4] | Noise | SNR | SFDR[3] | ENOB[4] | Noise | SNR | SFDR[3] | ENOB[4] | Noise | SNR | SFDR[3] | ENOB[4] | Noise |
| Sample rate | [dB] | [dB] | [Bit] | [µ$A_{PP}$] | [dB] | [dB] | [Bit] | [µ$A_{PP}$] | [dB] | [dB] | [Bit] | [µ$A_{PP}$] | [dB] | [dB] | [Bit] | [µ$A_{PP}$] |
| 0.1 kS/s | 114 | 129 | 18.6 | 1.0 | 122 | 137 | 20.0 | 1.0 | 118 | 136 | 19.3 | 2 | 124 | 142 | 20.4 | 2.4 |
| 1 kS/s | 107 | 132 | 17.5 | 2.7 | 115 | 140 | 18.8 | 2.7 | 114 | 139 | 18.6 | 6 | 120 | 145 | 19.6 | 6.4 |
| 10 kS/s | 98 | 127 | 16.0 | 9.1 | 106 | 135 | 17.4 | 9.1 | 106 | 131 | 17.3 | 19 | 112 | 137 | 18.3 | 19 |
| 100 kS/s | 89 | 119 | 14.5 | 33 | 97 | 127 | 15.8 | 33 | 96 | 127 | 15.7 | 68 | 102 | 133 | 16.7 | 68 |
| 1 MS/s | 79 | 114 | 12.8 | 115 | 87 | 122 | 14.1 | 115 | 86 | 122 | 14.0 | 248 | 92 | 128 | 15.0 | 248 |
| 2 MS/s | 76 | 111 | 12.3 | 166 | 83 | 119 | 13.6 | 382 | 83 | 119 | 13.5 | 824 | 82 | 125 | 14.5 | 824 |
| 5 MS/s | 72 | 108 | 11.7 | 274 | 80 | 116 | 12.9 | 274 | 79 | 116 | 12.8 | 558 | 85 | 122 | 13.9 | 558 |
| 10 MS/s | 69 | 105 | 11.2 | 382 | 77 | 113 | 12.5 | 382 | 76 | 112 | 12.3 | 824 | 82 | 118 | 13.4 | 824 |

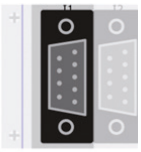
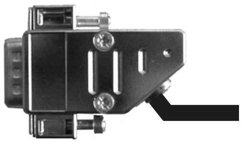
*Tab. 95: TRION-POWER-SUB-CT*

1) Below 1 % of range, add 25 ppm of range

2) LP Filter in auto mode

3) SFDR excluding harmonics

4) ENOB calculated from SNR

| | | | |
|---|---|---|---|
| Pin 1: | TEDS | Pin 6: | n.c. |
| Pin 2: | IN+ | Pin 7: | IN- |
| Pin 3: | n.c. | Pin 8: | n.c. |
| Pin 4: | GND (not isolated) | Pin 9: | n.c. |
| Pin 5: | n.c. | | |

**WARNING**

**Risk of injury due to electric shock**

TRION-POWER-SUB-CT modules are not isolated. Use with isolated current transducer only.

**INFORMATION**

The TRION3-1810M-SUB-8 is mainly recommended for the use with TRION-SUB-CT, TRION-POWER-SUB-dLV-1V and TRION-POWER-SUB-dLV-5V to benefit from the full bandwidth of these sub-modules.

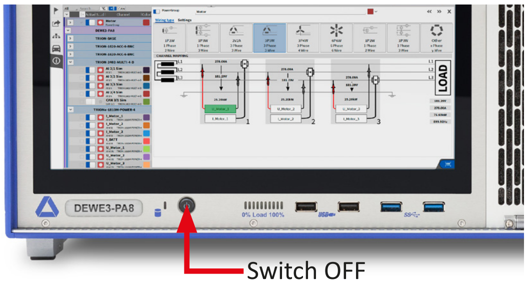
# Exchanging TRION sub-modules

**NOTICE**

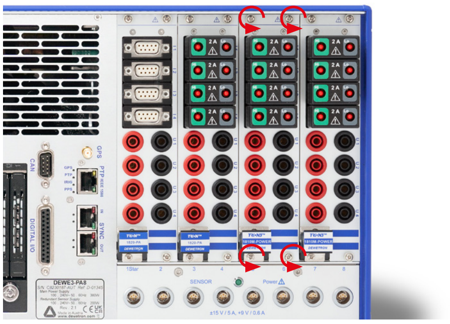
Proper ESD precautions must be taken to avoid any damage to the unit.

Proceed as follows to exchange a TRION sub-module:

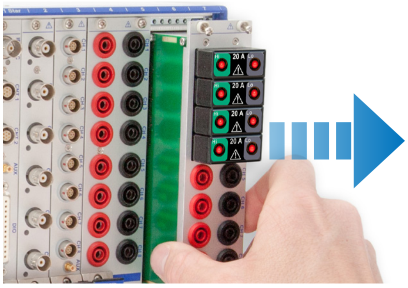
1. Switch off the instrument and unplug all connected cables including sensors from the TRION series modules.



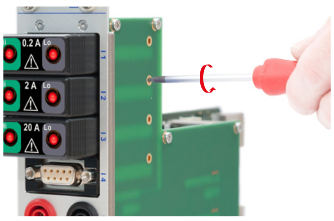

2. Loosen the screws at the top and bottom of the TRION(3) module front panel (4x) and pull down the injector/ejector handle to release the module.



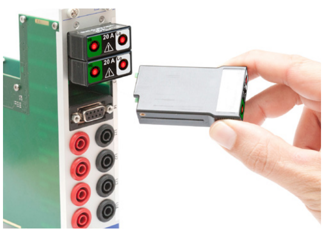
3. Remove the TRION(3) module from the housing.



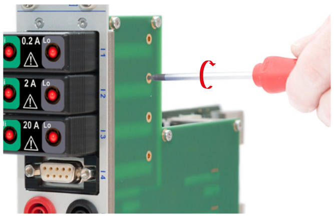
4. Loosen the torx screw (M2x4, TX6) which secures the sub-module of the channel you want to replace.



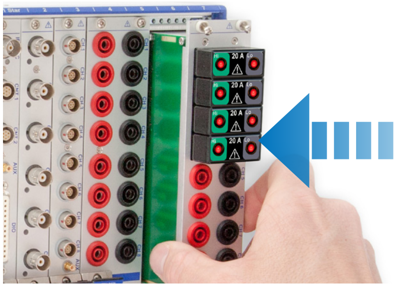
5. Insert the new sub-module.



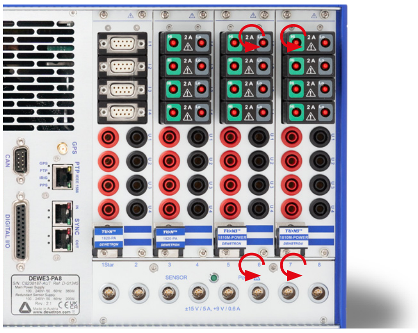
6. Secure the replaced sub-module with the torx screw (M2x4, TX6). Max. torque: 0.2 Nm.




7. Insert the TRION(3) module into the housing until a resistance appears.



8. Pull up the injector/ejector handle to latch the module. Tighten the screws at the top and bottom of the TRION(3) module front panel (4x) to secure the module.



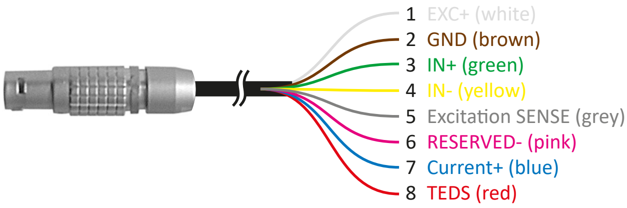
The TRION sub-module is now exchanged.

# Accessory and options

## TRION-x-LV-6-L1B & TRION-1620-ACC-6-L1B module

### TRION-CBL-L1B8-OE-05-00

High quality cable from Lemo 1B.308 plug to open end, 5 m.

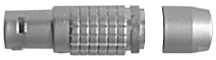



### TRION-CBL-L1B8-BNC-0.5-00

High quality cable from Lemo 1B.308 plug to BNC connector, 0.5 m


### LEMO-FGG.1B.308.CLAD52Z

LEMO FGG.1B.308 mating connector, for cable diameter 4.2 to 5.2 mm

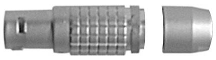


### LEMO-FGG.1B.308.CLAD62Z

LEMO FGG.1B.308 mating connector, for cable diameter 5.2 to 6.2 mm

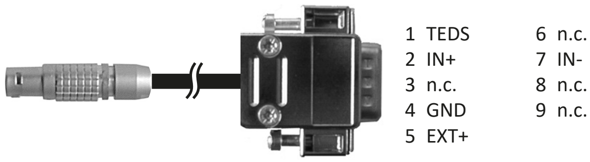
### LEMO-FGG.1B.308.CLAD72Z

LEMO FGG.1B.308 mating connector, for cable diameter 6.2 to 7.2 mm



### TRION-CBL-L1B8-D9-0.5-01

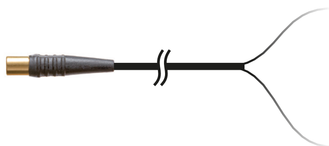
High quality adapter cable from LEMO 1B.308 plug to D-SUB-9 socket, 0.5 m, no MSI support..




## TRION-2402-dACC-x module

### TRION-CBL-SMB-OE-05-00

High quality cable from SMB plug to open end, 5 m



### TRION-CBL-SMB-BNC-01-00

High quality adapter cable from SMB plug to BNC cable-socket, 1 m


## TRION-CAN module

### TRION-CBL-D9-OE-05-00

High quality cable from D-SUB-9 socket to open end, 5 m for TRION-CAN-x-D modules.

**Color assignment**

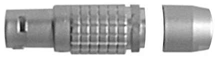
| | | | | | |
|---|---|---|---|---|---|
| Pin 1: | Green | Pin 4: | NC | Pin 7: | Brown |
| Pin 2: | White | Pin 5: | NC | Pin 8: | NC |
| Pin 3: | Yellow | Pin 6: | Pink | Pin 9: | Gray |

## TRION-CNT / TRION-BASE module

### TRION-CBL-L1B7-OE-05-00

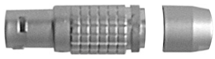
High quality cable from LEMO 1B.307 plug to open end, 5 m for TRION-CNT-6-LEMO and TRION-BASE modules.

### LEMO-FGG.1B.308.CLAD52Z



LEMO FGG.1B.308 mating connector, for cable diameter 4.2 to 5.2 mm

### LEMO-FGG.1B.308.CLAD62Z



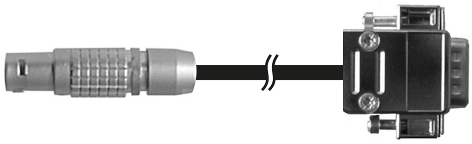
LEMO FGG.1B.308 mating connector, for cable diameter 5.2 to 6.2 mm

### LEMO-FGG.1B.308.CLAD72Z

LEMO FGG.1B.308 mating connector, for cable diameter 6.2 to 7.2 mm

### DIFF-CNT-LEMO-DB9F-01

High quality adapter cable from Lemo 0B.309 plug to D-SUB-9 socket.



1 B-
2 B+
3 A+
4 A-
5 GND
6 +5 V
7 Z+
8 Z-
9 +12 V

## TRION-DI-48 module

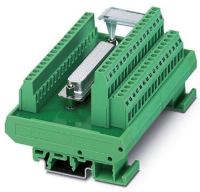
### TRION-CB24-B

24 channel break-out box with 4 mm banana jacks. 1 m cable, terminated with 50-pin mini-centronics plug.

**INFORMATION** Two boxes are required for all 48 channels!

### TRION-CB24- C

24 channel screw-terminal block, unshielded 1 m cable, terminated with 50-pin mini-centronics plug.



**INFORMATION** Two blocks are required for all 48 channels.

## TRION-2402-dSTG-8-RJ module

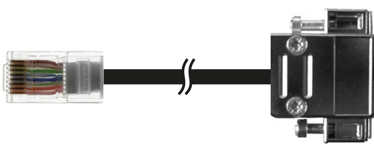
### TRION-CBL-RJ-BNC-01-00

High quality cable from RJ45 plug to BNC socket, 1 m

Hot: IN +
Shield: IN -

### TRION-CBL-RJ-D9-01-00

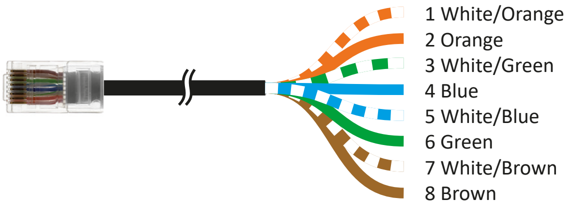
High quality adapter cable from RJ45 plug to D-SUB-9 socket, 1 m



1 EXC+
2 IN+
3 Sense -
4 GND
5 R+
6 Sense +
7 IN-
8 EXC-
9 TEDS

### TRION-CBL-RJ-OE-05-00

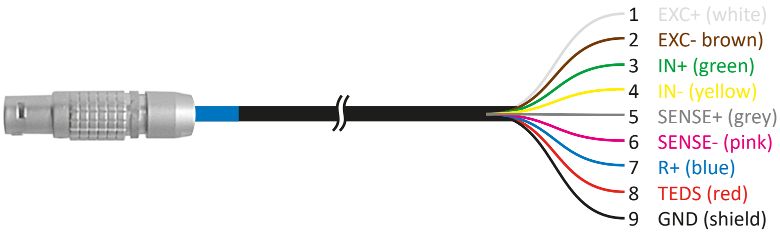
High quality cable from RJ45 plug to open end, 5 m




## TRION-2402-dSTG-8-LOB module

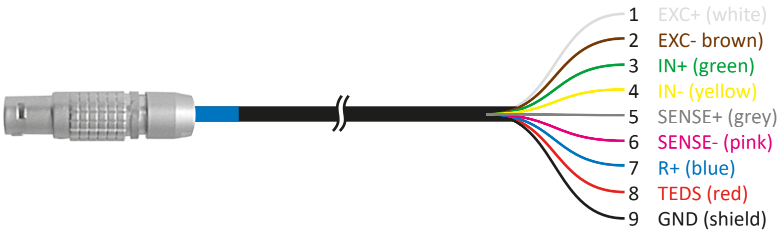
### TRION-CBL-LOB9-OE-05-02

High quality cable from Lemo 0B.309 plug to open end, 5 m



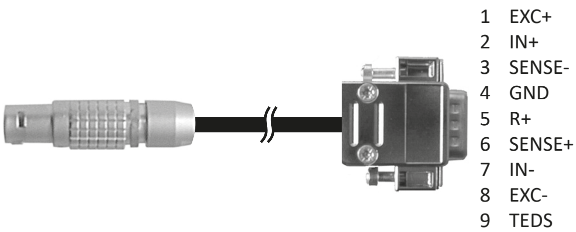

### TRION-CBL-LOB9-OE-01-02

High quality cable from Lemo 0B.309 plug to open end, 1 m




### TRION-CBL-LOB9-D9-0.5-00

High quality adapter cable from Lemo 0B.309 plug to D-SUB-9 socket, 0.5 m.




## TRION-TIMING-V3 module

### GPS-ANT-FIXED

GNSS/GPS antenna for TRION-TIMING, for fixed installation. Only supports GPS L1.

**NOTICE** When installing the GPS antenna outdoors, ensure that it is protected against lightning strikes.

### GPS-ANT-MOB

IP67 compliant, magnetic GNSS/GPS antenna for TRION-TIMING for mobile applications. Support of GPS L1, GLONASS G1, BeiDou B1, Galileo E1, SBAS (WAAS, EGNOS & MSAS).

5 m cable, SMA plug.

# TRION-VGPS-20/100-V3 module

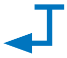
## GPS-ANT-FIXED

GNSS/GPS antenna for TRION-TIMING, for fixed installation. Only supports GPS L1.

**NOTICE** When installing the GPS antenna outdoors, ensure that it is protected against lightning strikes.

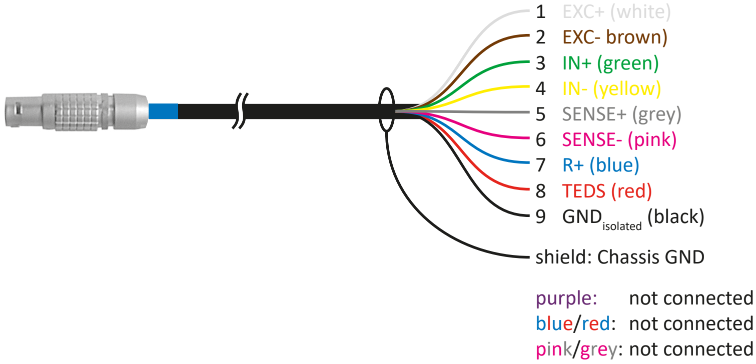
# TRION3-18xx-MULTI-8-L0B module

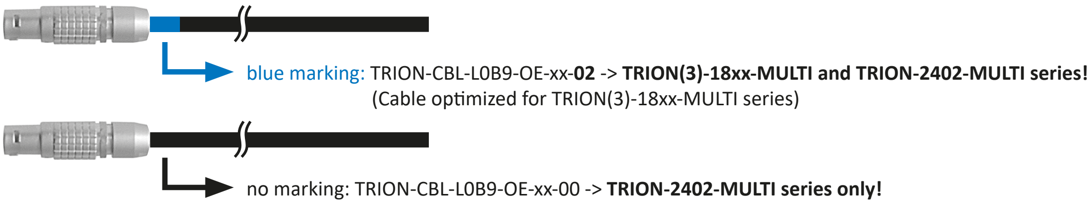
## TRION-CBL-L0B9-OE-xx-02



01 = 1 m
05 = 5 m

High quality cable from Lemo 0B.309 plug to open end, 1 or 5 m.

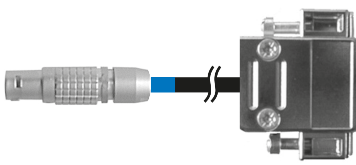



**INFORMATION** Using the pre-configured LEMO connector with cable is highly recommended because manually soldering the 0B LEMO connector is tricky. The wire colors are also mentioned in the signal connection section to amplify sensor connection.

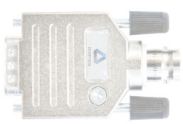
## TRION-CBL-L0B9-D9-0.5-02

High quality adapter cable from Lemo 0B.309 plug to D-SUB-9 socket, 0.5 m



1 EXC+
2 IN+
3 SENSE-
4 GNDi
5 R+
6 SENSE+
7 IN-
8 EXC-
9 TEDS
H: Shield

For connecting any MSI-BR series adapters



## TRION-CBL-L0B9-BNC-0.5-03

High quality adapter cable from LEMO 0B.309 plug to BNC cable jack, 0.5 m

Hot: IN +
Shield: IN -

### TRION-CBL-L0B9-IEPE-0.5-01

IEPE Sensor adapter for TRION3-18xx-MULTI-8-L0B. It features TEDS sensors support and sensor status LED (lit green if IEPE sensor is connected).

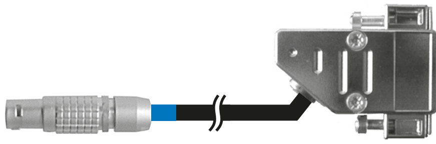
For connecting voltage signals and IEPE® sensors to TRION3-18xx-MULTI-8-L0B modules.


***INFORMATION*** It is not possible to measure voltage.

### TRION-CBL-L0B9-CAN-0.5

Adapter cable from LEMO 0B.309 plug to D-SUB-9 plug for CAN, 0.5 m

For TRION3-18xx-MULTI-8-L0B modules channel 1 only!



1: NC
2: CAN Low (isolated)
3: GNDx CAN (isolated)
4: NC
5: NC
6: GND Power
7: CAN High (isolated)
8: NC
9: +12 V out

### TRION-CBL-L0B9-CPAD-01-01

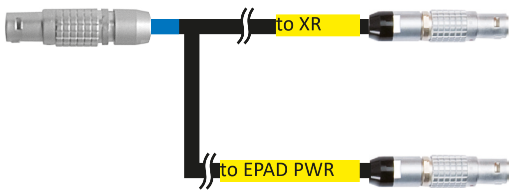
Adapter cable from LEMO 0B.309 plug to XR-series modules, 1 m.

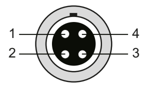
Additional LEMO FGG.1B.304 plug (EPAD) for XR-module power supply.

For connecting the first XR-series module of a module-chain to a TRION3-18xx-MULTI-8-L0B.

Pin assignment to XR series module
1: CAN high
2: CAN low
3: +12 V
4: GND

For connecting more than one XR series module




*4-pin LEMO connector male FGG.1B.304.CLL*

Additional power supply (e.g. to EPAD connector of instrument)
1: n.c.
2: n.c.
3: +12 V
4: GND

## TRION(3)-18xx-MULTI-4-D module

### TRION-CBL-D9-CPAD-01-01

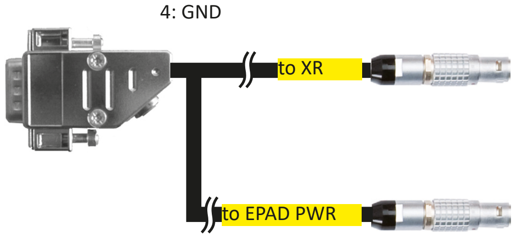
Adapter cable from LEMO 0B.309 plug to XR-series modules, 1 m.

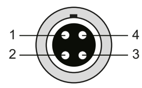
Additional LEMO FGG.1B.304 plug (EPAD) for XR-module power supply.

For connecting the first XR-series module of a module-chain to a TRION(3)-x-MULTI-4-D.

Pin assignment to XR series module
1: CAN high
2: CAN low
3: +12 V
4: GND

For connecting more than one XR series module



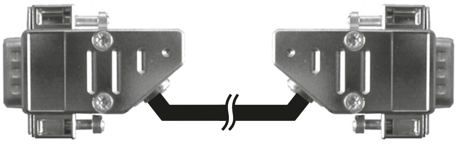

*4-pin LEMO connector male FGG.1B.304.CLL*

Additional power supply (e.g. to EPAD connector of instrument)
1: n.c.
2: n.c.
3: +12 V
4: GND

### TRION-CBL-D9-CAN-0.5

Adapter cable from D-SUB-9 plug to D-SUB-9 plug for CAN, 0.5 m.

For TRION(3)-18xx-MULTI-4-D modules.



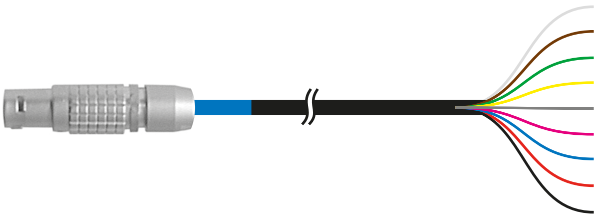
1: NC
2: CAN Low (isolated)
3: GNDx CAN (isolated)
4: NC
5: NC
6: GND Power
7: CAN High (isolated)
8: NC
9: +12 V out

## TRION-2402-MULTI-8-LOB module

### TRION-CBL-LOB9-OE-xx-02

01 = 1 m
05 = 5 m

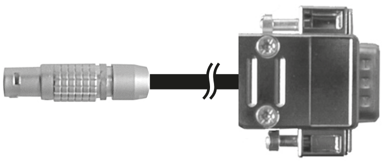
High quality cable from Lemo 0B.309 plug to open end, 1 or 5 m.



1 EXC+ (white)
2 EXC- brown)
3 IN+ (green)
4 IN- (yellow)
5 SENSE+ (grey)
6 SENSE- (pink)
7 R+ (blue)
8 TEDS (red)
9 GND (shield)

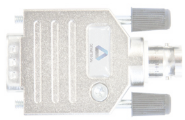
### TRION-CBL-LOB9-D9-0.5-02

High quality adapter cable from Lemo 0B.309 plug to D-SUB-9 socket, 0.5 m.



1 EXC+
2 IN+
3 SENSE-
4 GNDi
5 R+
6 SENSE+
7 IN-
8 EXC-
9 TEDS

For connecting any MSI-BR series adapters



### TRION-CBL-LOB9-BNC-0.5-01

High quality adapter cable from LEMO 0B.309 plug to BNC cable jack, 0.5 m

For connecting IEPE® sensors to TRION-2402-MULTI-8-LOB modules.


Hot: IN +
Shield: IN -

**NOTICE** Do not use this cable for connecting voltage signals.

### TRION-CBL-LOB9-BNC-0.5-03

High quality adapter cable from LEMO 0B.309 plug to BNC cable jack, 0.5 m

For connecting voltage signals to TRION-2402-MULTI-8-LOB modules.

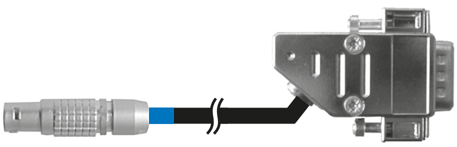

Hot: IN +
Shield: IN -

**NOTICE** Do not use this cable for connecting IEPE® sensors.

### TRION-CBL-LOB9-CAN-0.5

Adapter cable from LEMO 0B.309 plug to D-SUB-9 plug for CAN, 0.5 m

For TRION3-18xx-MULTI-8-LOB modules channel 1 only!



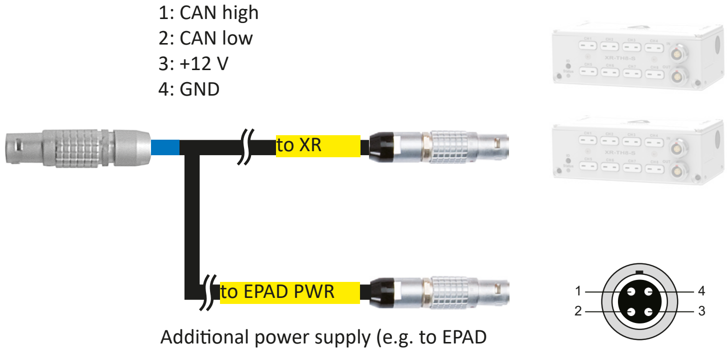
1: NC
2: CAN Low (isolated)
3: GNDx CAN (isolated)
4: NC
5: NC
6: GND Power
7: CAN High (isolated)
8: NC
9: +12 V out

### TRION-CBL-L0B9-CPAD-01-01

Adapter cable from LEMO 0B.309 plug to XR-series modules, 1 m.

Additional LEMO FGG.1B.304 plug (EPAD) for XR-module power supply.

For connecting the first XR-series module of a module-chain to a TRION3-18xx-MULTI-8-L0B.



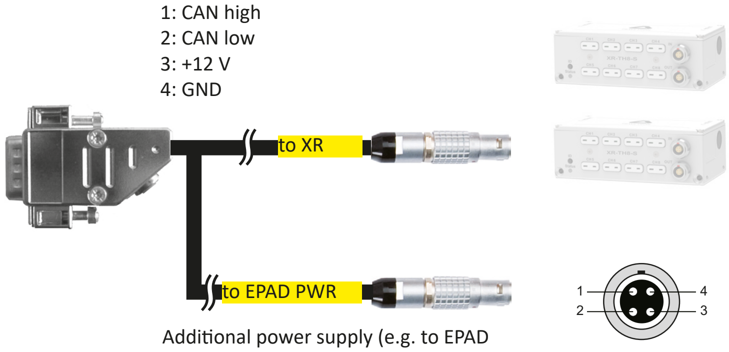

## TRION-2402-MULTI-4-D module

### TRION-CBL-L0B9-01-01

Adapter cable from LEMO 0B.309 plug to XR-series modules, 1 m.

Additional LEMO FGG.1B.304 plug (EPAD) for XR-module power supply.

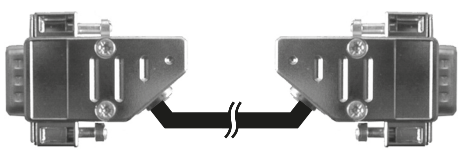
For connecting the first XR-series module of a module-chain to a TRION3-18xx-MULTI-8-L0B.




### TRION-CBL-D9-CAN-0.5

Adapter cable from D-SUB-9 plug to D-SUB-9 plug for CAN, 0.5 m.

For TRION(3)-18xx-MULTI-4-D modules.

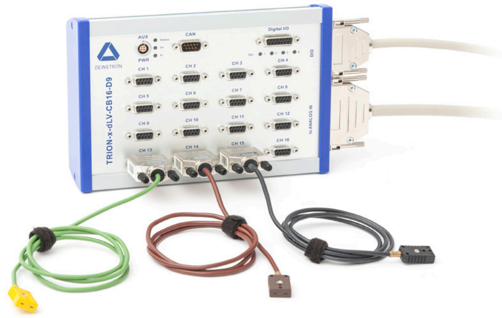


1: NC
2: CAN Low (isolated)
3: GNDx CAN (isolated)
4: NC
5: NC
6: GND Power
7: CAN High (isolated)
8: NC
9: +12 V out

# TRION3-1600/1802-dLV module

### TRION-x-dLV-CB16-D9

- 16 channel sensor connection box
- Precision ±5 V excitation voltage with remote sense per channel
- MSI support (Modular Smart Interface)
- Auxiliary sensor supply



| Input types | | Input | Sensor excitation | Bandwidth[1] | Accuracy | Sensor connection |
|---|---|---|---|---|---|---|
| MSI2-STG |  | Bridge-type sensors full-bridge, half-bridge, quarter bridge 120 Ω and 350 Ω | 5 V and 10 V | 60 kHz | ±0.1 % | Miniature spring terminals |
| MSI2-LVDT |  | LVDT and RVDT sensors, 5- or 6-wire connection | 3 V at 2.5, 5 or 18 kHz | 1 kHz | ±0.1 % | Soldering pads |
| MSI-BR-ACC |  | IEPE® sensors, typ. accelerometer, microphone | 4 mA | 1.4 Hz to 70 kHz | ±0.2 % | BNC |
| MSI2-CH-x |  | Charge type sensors up to 100 000 pC | n/a | 0.08 Hz to 70 kHz | ±0.5 % | BNC |
| MSI2-TH-x |  | Thermocouple sensors Standard models for type K, J, T, others on request | n/a | DC to 70 kHz | ±1 °C | Mini TC socket |
| MSI-BR-V-200 |  | Voltage up to 70 $V_{DC}$, 46.7 $V_{PEAK}$ | n/a | DC to 60 kHz | ±0.1 % | BNC |
| MSI2-V-600 |  | Voltage up to 600 $V_{DC}$ | n/a | DC to 60 kHz | ±0.1 % | Banana sockets |
| MSI-BR-RTD |  | RTD sensors Pt100, Pt200, Pt500, PT1000, Pt2000; 2, 3 and 4 wire connection | 1.25 mA | DC to 10 kHz | ±0.1 % | Binder 712 series 5-pin socket |
| MSI2-250R-20mA[2] |  | 4 to 20 mA sensors | n/a | DC to 70 kHz | ±0.1 % | Miniature spring terminals |

*Tab. 96: MSI types*

1) ***INFORMATION*** Max. value; consider limit of the used TRION module.

**INFORMATION**

For further information refer to the *TRION-x-dLV-CB16-D9 / MSI2 Series* technical reference manual.

### C15Axx

Cable for connecting 16 or 32 channels to a TRION(3)-1802-dLV module in **single-ended** configuration. Two C15Axx cables are required for 32 channels.

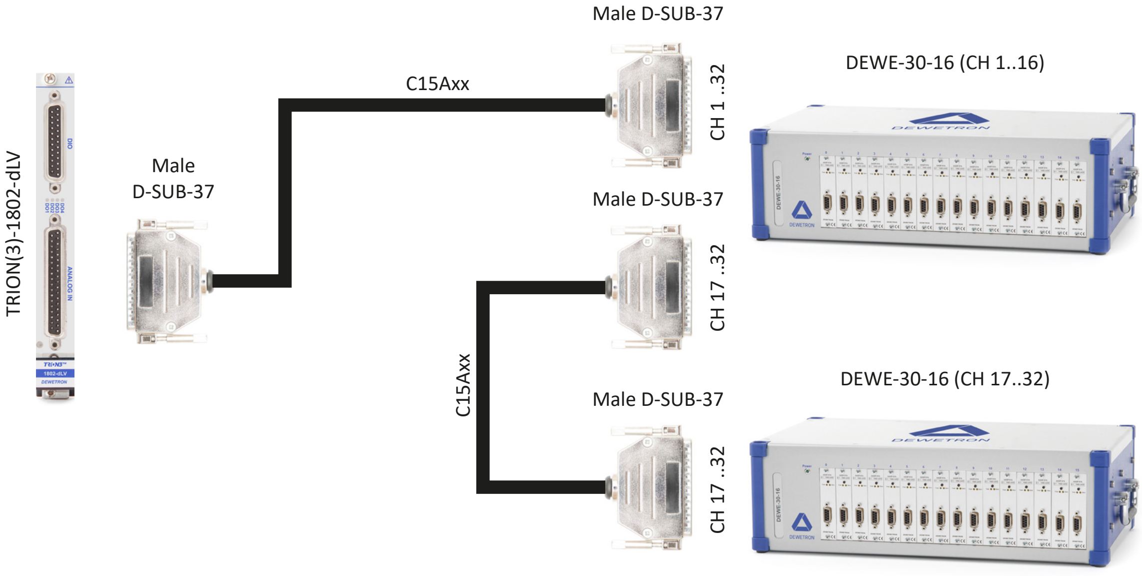
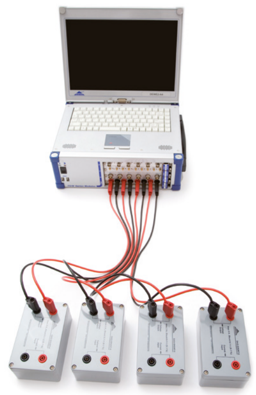



*Fig. 220: C15Axx overview*

## TRION-2402-V module



### SE-CUR-SHUNT-05

- 5 A shunt box (100 mΩ, ±0.1 %, <30 ppm/K)
- Fitting into 4 mm banana jacks with 19 mm distance
- Current input via 2 safety banana jacks, output via 2 safety banana jacks.


### SE-CUR-SHUNT-06

20 A shunt box (5 mΩ, ±0.1 %, 500 V CAT III, <30 ppm/K)

Current input via 2 safety banana jacks, voltage output via 2 safety banana jacks.


### SE-CUR-SHUNT-07

7.5 A socket shunt (20 mΩ, ±0.1%)

Current input and output via 2 safety banana jacks, for 4 mm banana jacks with 19 mm distance

# Maintenance and service

The information in this section is designed for use by qualified service personal.

## Service interval

Clean dust from the chassis exterior/interior and exchange filter foam based on the operating environment.

## Cleaning

- Clean surface of the chassis with dry lint-free cloth.
- Use a dry velocity stream of air to clean the chassis interior.

  Do not use harsh chemical cleaning agents.

**NOTICE**

Many components within the chassis are sensitive to static discharge damage. Always wear a ground wrist strap and service the unit only in static-free environment.

**WARNING**

**Risk of injury**

Disconnect all cables before servicing the unit.

## Updates

### Windows and antivirus/security software

Before installing Windows software updates consult with DEWETRON for compatibility guidance. Also keep in mind that the use of any antivirus or other security software may slow down your system and may cause data loss.

### Software updates

**NOTICE**

The system BIOS is protected by password. Any change in the BIOS may cause a system crash. When the system is booting, do not press ESC-button on keyboard. This may clear the BIOS settings and cause system faults.

Any change in the file structure as deleting or adding files or directories might cause a system crash.

Before installing software updates contact DEWETRON or your local distributor. Use only software packages which are released by DEWETRON. Further information is also available in the Internet (http://www.dewetron.com).

After power off the system wait at least 10 seconds before switching the system on again. Otherwise the system may not boot correct. This prolongs also the life of all system components.

## Training

DEWETRON offers training at various offices around the world several times each year. DEWETRON headquarters in Austria have a very large and professional conference and seminar center, where training classes are conducted on a regular basis starting with sensors and signal conditioning, A/D technology and software operation.

Dewetron Inc. in the USA also has a dedicated training facility connected to its headquarters, located in Rhode Island.

For more information about training services visit https://www.dewetron.com/academy.

## Calibration

Every instrument needs to be calibrated at regular intervals. The standard norm across nearly every industry is annual calibration. Before your DEWETRON data acquisition system is delivered, it is calibrated at our DEWETRON headquarter. Each of this system is delivered with a certificate of compliance with our published specifications. Detailed calibration reports from our calibration system are available for purchase with each order. We retain them for at least one year, so calibration reports can be purchased for up to one year after your system was delivered.

## Support

DEWETRON has a team of people ready to assist you if you have any questions or any technical difficulties regarding the system. For any support contact your local distributor first or DEWETRON directly.

For Asia and Europe contact:

DEWETRON GmbH
Parkring 4
8074 Grambach
AUSTRIA

| | |
|---|---|
| Tel.: | +43 316 3070 |
| Fax: | +43 316 3070-90 |
| E-Mail: | support@dewetron.com |
| Web: | http://www.dewetron.com |

The telephone hotline is available
Monday to Friday between
08:00 and 17:00 CET (GMT +1:00).

For the Americas contact:

DEWETRON Inc. (HQ USA)
2850 South County Trail, Unit 1
East Greenwich, RI 02818
USA

| | |
|---|---|
| Tel.: | +1 401 284 3750 |
| Toll-free: | +1 866 598 3393 |
| Fax: | +1 401 284 3750 |
| Email: | support@dewetron.com |
| Web: | http://www.dewetron.com |

The telephone hotline is available
Monday to Friday between
08:00 a.m. and 04:30 p.m. EST

## Service and repairs

We are very sorry that your DEWETRON system is not operating properly. Our team is here to ensure that your DEWETRON product is returned to peak performance as quickly as possible.

Help us to provide you with the best support by following the RMA policy.

Some problems can be solved remotely by our support team. To facilitate a quicker resolution to the problem and save unnecessary shipping costs, we ask you to first have your problem investigated by our technical support before sending your product. Contact details for our support can be found on our website. Describe the error accurately and with as much detail as possible. This helps expedite the repair process.

If a repair is necessary, complete our online RMA form. You will then receive an RMA (Return Material Authorization) number and detailed instructions that identify where to ship the damaged product.

**INFORMATION**

Products arriving at our repair department without RMA require follow-up calls and investigation, which lead to a longer turnaround. Only the team of DEWETRON is allowed to perform any kinds of repairs to your system to assure a safe and proper operation in future.

**INFORMATION**

Any spare parts (screws, backplanes, cables etc.) must be obtained from DEWETRON only.

# Certificates

## CE certificate of conformity

| | |
|---|---|
| Manufacturer | DEWETRON GmbH |
| Address | Parkring 4<br>8074 Grambach, Austria<br>Tel.: +43 316 3070-0<br>Fax: +43 316 3070-90<br>Email: sales@dewetron.com<br>http://www.dewetron.com |
| Name of product | **TRION/TRION3 module series** |
| Kind of product | *Data acquisition instrument* |

The product meets the regulations of the following EC-directives:

**2014/35/EU**

**Directive of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits**

**2014/30/EU**

**Directive of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (recast)**

The accordance is proved by the observance of the following standards:

| | | | |
|---|---|---|---|
| LV | **Safety** | IEC 61010-1:2010, Pol. deg. 2 | |
| EMC | **Emissions** | EN 61000-6-4 | EN 55011 Class B |
| | **Immunity** | EN 61000-6-2 | Group standard |

**Graz, December 05, 2016**

Place / Date of the CE-marking

Ing. Thomas Propst / Manager Total Quality

# Conformity to IEC 61000-4-30

| | |
|---|---|
| Manufacturer | DEWETRON GmbH |
| Address | Parkring 4<br>8074 Grambach, Austria<br>Tel.: +43 316 3070-0<br>Fax: +43 316 3070-90<br>Email: sales@dewetron.com<br>http://www.dewetron.com |

This certificate has been issued as a result of an assessment of the performance of the models listed below as to their conformity with the requirements of IEC 61000-4-30:2008 Class A, Electromagnetic compatibility (EMC) Part 4-30: Testing and measurement techniques – Power quality measurement methods.

Instruments

**DEWE2 series (all devices)**
**DEWE3 series (all devices)**
**LITE[PA]**
**TRIONet**
**TRIONet3**

*in combination with*

Amplifiers

**TRION(3)-1820-POWER-4**
**TRION3-1810M-POWER-4**
**LITE[PA] module**
**TRION(3)-1810-HV-8**
**TRION3-SUB-8 with SUB-600V**

*and*

Software **OXYGEN with OPT-POWER-BASIC and OPT-POWER-ADV since version 2.3**

| Standard | Parameter | IEC section | Referring to | Class | Comment |
|---|---|---|---|---|---|
| **IEC 61000-4-30** | Power frequency | 5.1 | - | A | a) |
| | Magnitude of supply voltage | 5.2 | - | A | a) |
| | Flicker | 5.3 | 61000-4-15 | A | b) |
| | Supply voltage unbalance | 5.7 | - | A | a) |
| | Voltage harmonics | 5.8 | 61000-4-7 | A | c), d) |
| | Voltage interharmonics | 5.9 | 61000-4-7 | A | d) |

General notice: no synchronisation to UTC 10 minute tick

a) 10/12 period values only with setting “Max. update rate” = 190 ms

b) For U_din in range of 60 V to 690 V

c) Only with grouping setting = “Type 1”; no smoothing with LP filter

d) For nominal value of 5 A, use SUB-CUR-20A; for currents above use external current sensor

On the basis of the evidence presented, the above products conform to the requirements of IEC 61000-4-30:2008 (Edition 2) Class A, Electromagnetic compatibility (EMC) Part 4-30: Testing and measurement techniques – Power quality measurement methods:

**Graz, August 10, 2023**

Place / date of issue

Ing. Thomas Propst / Manager Total Quality

# Appendix

## General

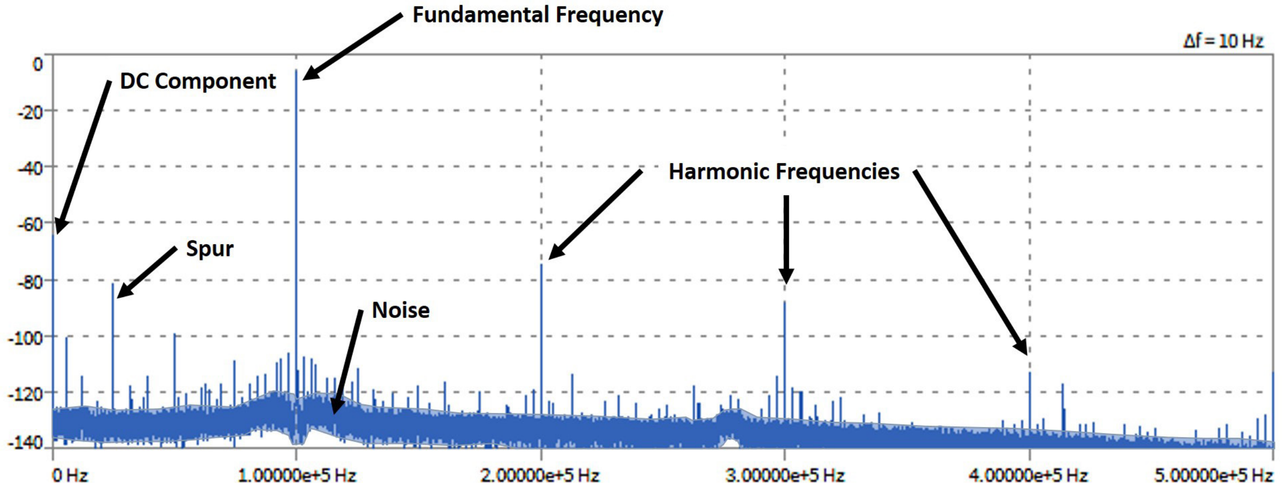



*Fig. 221: FFT chart of TRION-1620-ACC*

### Fundamental frequency

The fundamental frequency is the component with the lowest frequency of a periodic test-signal. In the case of an ideal sine wave, the only frequency which would appear is the fundamental frequency.

### Harmonic frequencies

Harmonic frequencies or Harmonics, as they are sometimes called, are frequencies that are multiples of the fundamental frequency. These disturbances are most likely caused by amplifier components and the function generator itself, which is used for testing. This is the reason why only special ultra-low noise function generators should be used for measurements.

### Spurs

These are frequency components that appear in signals due to the electrical components of the instrument, but which are not harmonics.

### Noise

Noise includes all voltage and frequency components in the signal which are present during measurement or generation but not present in the ideal or present signal, except for spurs and harmonics.

### DC component

The DC component is a spur with a frequency of 0 Hz.

## Testing

### General information about testing

For the measurement of the SNR, SFDR, THD and CMRR the eighth-order Bessel low-pass filter is set in Auto-mode, if a filter is available and if not stated otherwise. While measuring the SNR and SFDR a short circuit is placed at the channel of testing. For the measurement of THD a sine wave is used as the input signal for testing. At a sample rate higher than 100 kS/s, a frequency of 1 kHz and an amplitude of 70 % of the maximum input range is used. To measure the CMRR, both inputs are provided with the same sinusoidal signal which amplitude should be adjusted to a value that utilizes the range used for measurement. The CMRR is then directly measured from the FFT chart. As a function generator only ultra-low distortion function generators should be used. In our case we use the Model D360 Ultra Low Distortion Function Generator from Stanford Research Systems.

## SNR

The SNR, or Signal-to-noise ratio, is the ratio of the input power value to the root-mean-square value of the noise power value. The RMS of the noise power excludes the fundamental frequency, all harmonics and spurs and the DC component.

To calculate the SNR, the $AC_{RMS}$ is measured with a short circuit on the input channel. Afterwards the SNR is calculated depending on the range, used during measurement, with the equation below. Every $AC_{RMS}$ measurement, which is taken over the period of 1 second, is done five times and the mean of these measurements is used in the equation.

**Formula**

$$SNR\ [dB] = \left| 20\ x\ log_{10} \left( \frac{AC_{\mathrm{RMS}}\ [V]\ x\ \sqrt{2}}{range\ [V]} \right) \right|$$

*Equ. 1: Calculating the SNR from $AC_{RMS}$ depending on the range*

**Example for TRION-1802/1600-dLV-32 at 10 V range and a sample rate of 50 kS/s**

$$SNR\ [dB] = \left| 20\ x\ log_{10} \left( \frac{5.6068\ V\ x\ 10\text{-}5\ x\ \sqrt{2}}{10\ V} \right) \right| = 102\ dB$$

*Equ. 2: Calculating the SNR*

If the range is specified as AC value then SNR is calculated from:

**Formula**

$$SNR\ [dB] = \left| 20\ x\ log_{10} \left( \frac{AC_{\mathrm{RMS}}\ [V]}{range_{\mathrm{AC}}\ [V]} \right) \right|$$

*Equ. 3: Calculating the SNR with range as AC value*

**Example for TRION-1820-POWER at 1000 V range and a sample rate of 1000 kS/s:**

$$SNR\ [dB] = \left| 20\ x\ log_{10} \left( \frac{0.00954\ V}{1000\ V} \right) \right| = 100\ dB$$

*Equ. 4: Calculating the SNR*

## SFDR

The SFDR, or spurious free SNR or spurious free dynamic range can be defined as the free range between the signal amplitude of the fundamental frequency and the spur with the heights power value, excluding all harmonics and the DC component as shown in *Fig. 222*.

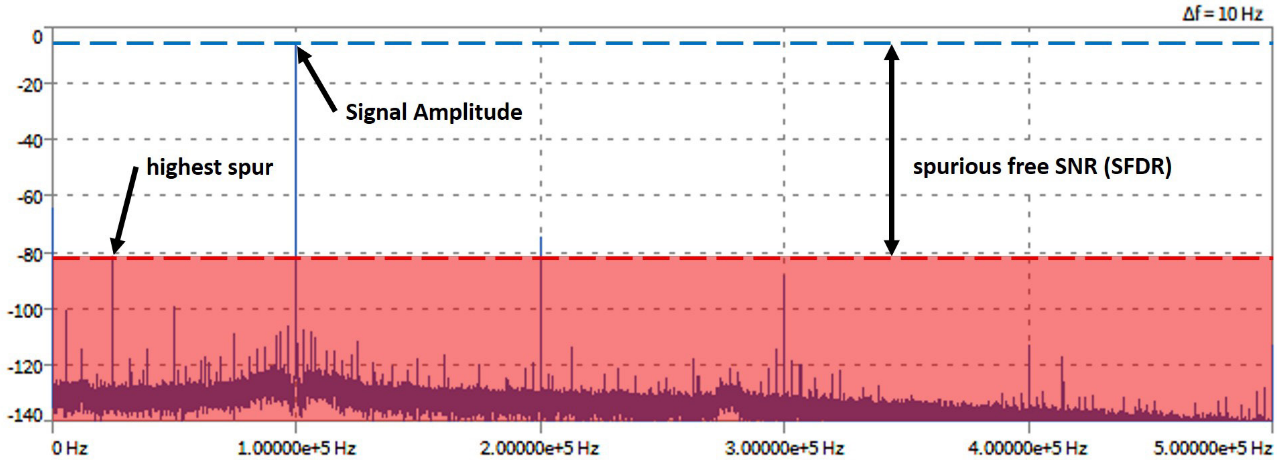



*Fig. 222: SFDR in a FFT chart with input signal (alternative method)*

The SFDR can also be measured as the highest spur with a short circuit on the input channel. This method, as used by DEWETRON, automatically excludes all harmonics and defines the SFDR as the highest spur seen in the FFT chart, excluding the DC component, as shown in *Fig. 223*.

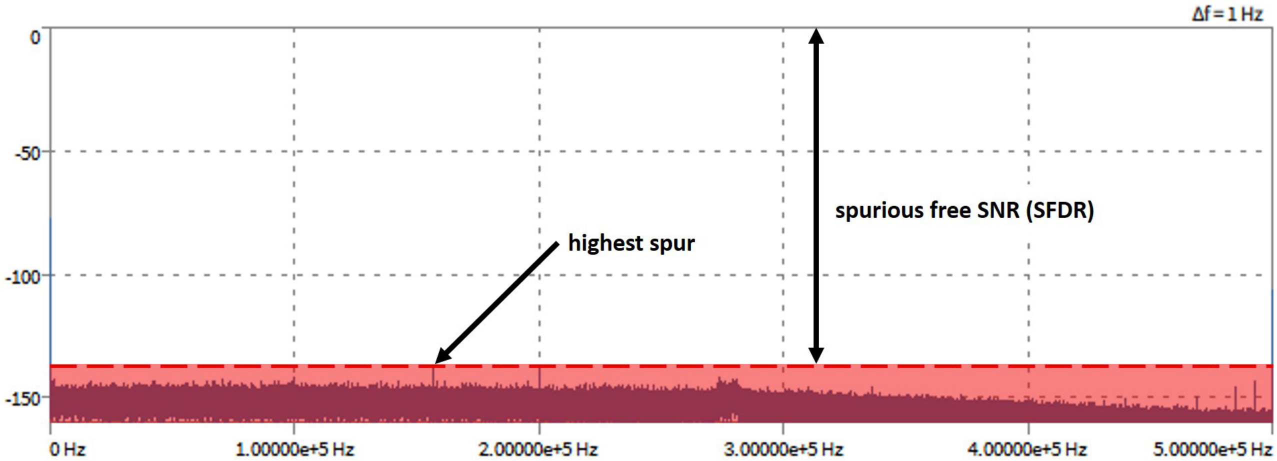



*Fig. 223: SFDR in a FFT chart without input signal (DEWETRON)*

## ENOB

The ENOB, or Effective Number of Bits, is a characteristic value that relates the SNR with bits of resolution, a common specification of data converters. The ENOB is directly calculated from the SNR.

**Formula**

$$ENOB\ [Bit] = \frac{\mathrm{SNR\ [dB]} - 1.76\ \mathrm{dB}}{6.02\ \mathrm{dB}}$$

*Equ. 5: Calculating the ENOB from SNR*

**Example for TRION-1802/1600-dLV-32 at 10 V range and a sample rate of 50 kS/s**

$$ENOB\ [Bit] = \frac{102\ \mathrm{dB} - 1.76\ \mathrm{dB}}{6.02\ \mathrm{dB}} = 16.65\ Bit \approx 16.7\ Bit$$

*Equ. 6: Calculating the ENOB*

## THD

The THD, or total harmonic distortion, is defined as the root-mean-square value of the first five harmonics of the fundamental frequency compared to the fundamental frequency. It is possible to calculate the THD as it is shown in equation 3 (with harmonics stated in [dB]) and equation 4 (with harmonics stated in [V]), if the amplitudes of the harmonics are expressed with respect to the input frequency. *Fig. 225* shows how the harmonics are measured from the FFT, when the maximum peak in the FFT is equal to 0 dB.

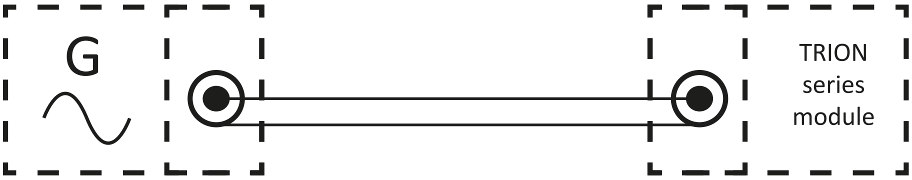



*Fig. 224: Schematic circuit diagram of THD measurement*

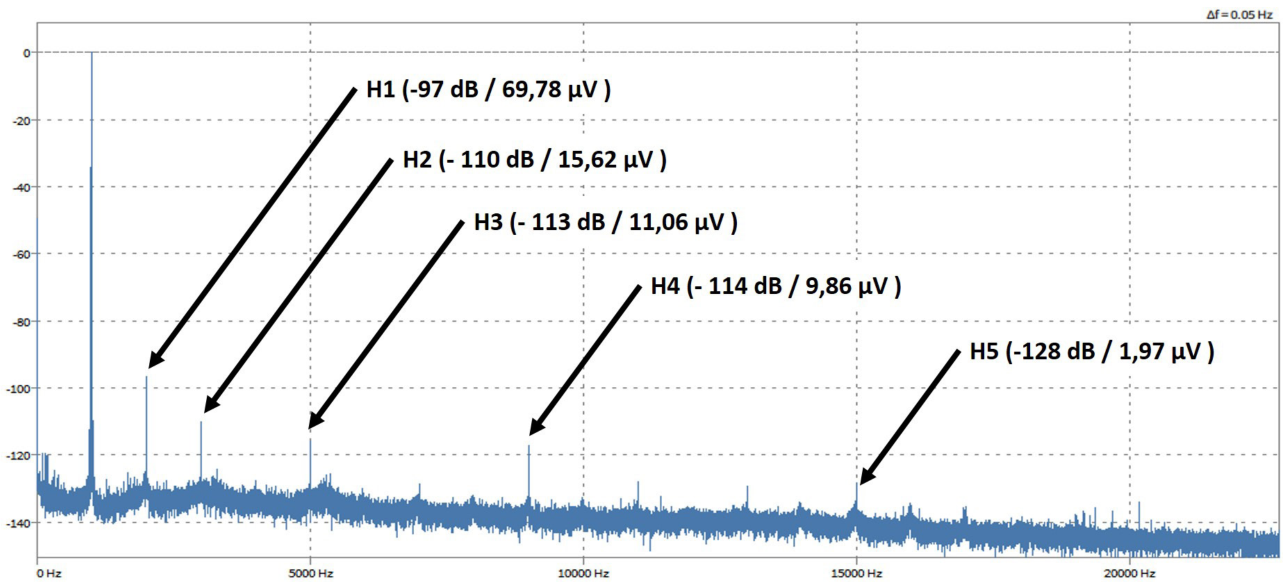



*Fig. 225: THD measurement of TRION-1802/1600-dLV-32 (@50 kS/s) where Uf = 4.94 V equals 0 dB*

**Formula**

$$THD\ [dB] = 10\ x\ \log_{10}\left( 10\,\frac{H_1\,[dB]}{10\ dB} + 10\,\frac{H_2\,[dB]}{10\ dB} + 10\,\frac{H_3\,[dB]}{10\ dB} + 10\,\frac{H_4\,[dB]}{10\ dB} + 10\,\frac{H_5\,[dB]}{10\ dB} \right)$$

*Equ. 7: Calculating the THD from harmonics [dB] - H: Harmonics [dB]*

$$THD\ [dB] = 20\ x\ \log_{10}\left( \frac{\sqrt{U_{H1}^2\,[V] + U_{H2}^2\,[V] + U_{H3}^2\,[V] + U_{H4}^2\,[V] + U_{H5}^2\,[V]}}{U_f\,[V]} \right)$$

*Equ. 8: Calculating the THD from harmonics [V] - UH: Harmonics [V], Uf: Fundamental (amplitude of test signal) [V]*

**Example for TRION-1802/1600-dLV-32 at 10 V range and a sample rate of 50 kS/s with $U_f$ = 4.94 V; (data from** *Fig. 225***):**

$$THD = 10\ x\ \log_{10}\left( 10\,\frac{-97\ dB}{10\ dB} + 10\,\frac{-110\ dB}{10\ dB} + 10\,\frac{-113\ dB}{10\ dB} + 10\,\frac{-114\ dB}{10\ dB} + 10\,\frac{-128\ dB}{10\ dB} \right) = -96.6\ dB$$

*Equ. 9: Calculation of THD from harmonics [dB]*

$$THD = 20 \times \log_{10}\left(\frac{\sqrt{(69.78\ V \times 10^{-6})^2 + (15.62\ V \times 10^{-6})^2 + (11.06\ V \times 10^{-6})^2 + (9.86\ V \times 10^{-6})^2 + (1.97\ V \times 10^{-6})^2}}{4.94\ V}\right) = -96.6\ dB$$

*Equ. 10: Calculation of THD from harmonics [V]*

## CMRR

The CMRR or common-mode rejection ratio of an ADC in differential mode (ADC input voltage is the difference between the two inputs) is the capability to filter out the input signal which is common to both inputs. It is often the case that noise is common to both terminals while the relevant information is contained in the voltage difference between the two inputs. A high CMRR results in a good noise rejection common to both terminals while the relevant signal information is preserved. To measure the CMRR the same input signal is applied to both inputs, as seen in *Fig. 226* and afterward directly measured from the FFT chart as seen in *Fig. 227*.

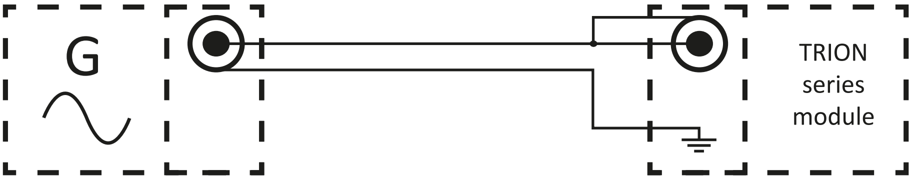



*Fig. 226: Schematic circuit diagram of CMRR measurement*

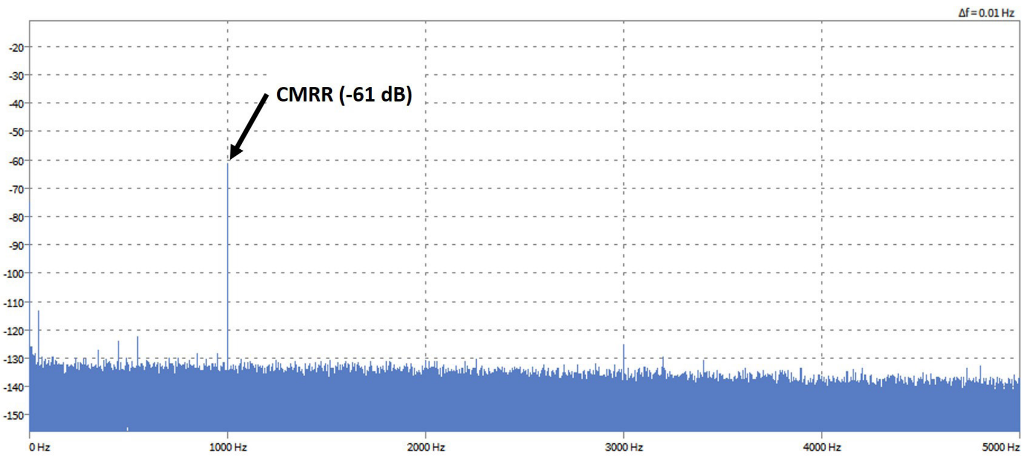



*Fig. 227: Measurement of CMRR in FFT chart of TRION-1620-ACC (>2 V range @ 1 kHz)*

*Fig. 228* shows the CMRR response, depending on the input frequency, of all four voltage channels of the TRION-1820-POWER-4.

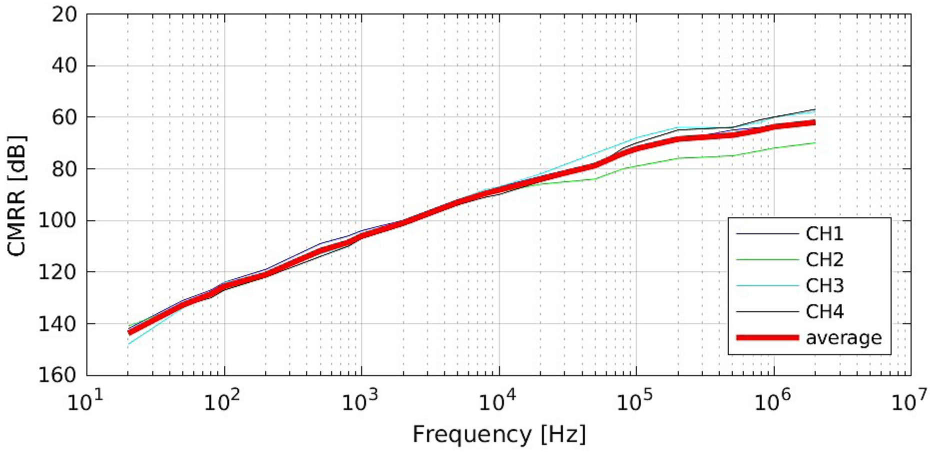



*Fig. 228: CMRR over frequency response of a TRION-1820-POWER-4 (V inputs) (not a directly measured FFT chart)*

### Phase mismatch

We state all our phase mismatch values Δt in the unit nanoseconds [ns]. To convert the phase mismatch in the unit degree [deg] *Equ. 11* is needed, as shown below. As the test-frequency f, we typically use 1 kHz.

**Formula**

$$\varphi\ [deg] = \frac{\Delta t\ [ns]\ x\ 360\ deg\ x\ f\ [Hz]}{10^9} \quad \leftrightarrow \quad \Delta t\ [ns] = \frac{\varphi\ [deg]}{360\ deg\ x\ f\ [Hz]}\ x\ 10^9$$

*Equ. 11: Calculating phase mismatch from [ns] in [deg] and conversely*

**Example for TRION-1802/1600-dLV-32 at 10 V range at 1 kHz test signal measured between CH1 and CH2:**

$$\varphi\ [deg] = \frac{18.33\ ns\ x\ 360\ deg\ x\ 1000\ Hz}{10^9} \approx 0.0066\ deg \quad \leftrightarrow \quad \Delta t\ [ns] = \frac{0.0066\ deg}{360\ deg\ x\ 1000\ [Hz]}\ x\ 10^9$$

*Equ. 12: Calculating phase mismatch from [ns] in [deg] and conversely*

### Accuracy

The accuracy specification is very common for most high precision multimeters on the market.

- % of reading

  This refers to the gain error of the XX. This error is relevant to gain errors of the amplifier stages, but also to the internal voltage reference.

- % of range

  This relates to the offset error and is mainly caused by amplifier offset drifts of the different gain stages.

- ±x µV

  This is about the input offset error which is mainly relevant for the small input ranges, but almost irrelevant for higher input ranges. It is typically caused by thermoelectric voltages, but also by the low frequency drift of the input amplifier.

As mentioned in the manual, the accuracy covers the drift and the aging of the data measurement board for at least one year. But also, a temperature drift of at least 5 °C from the calibration temperature.

All accuracy values must be summed normally, to get the actual accuracy for the actual signal.

The accuracy is for DC (average) and for $AC_{RMS}$ values for at least a 100 ms window.

It is not a single point accuracy, since the noise is not included. Therefore, refer to our detailed Input Amplifier “Signal to noise ratio” tables in or TRION manual. For more information, refer to our detailed input amplifier tables in the “signal-to-noise ratio” section of each TRION(3) measurement board in this manual.

## Glossary

### Isolation voltage

**WARNING**

**Danger to life due to electric shock**

Exceeding the isolation voltage may cause danger to life and physical condition (electric shocks, burn).

**NOTICE**

Exceeding the isolation voltage causes the damage of the measurement input in most every case, also other components inside the measurement unit could be affected.

This value indicates the highest voltage that can be applied between an input pin and the reference potential without causing an isolation breakdown (uncontrolled current flow).

The isolation voltage is basically limited by creepage and clearance distances, the insulation material, and the used components. The given specification has been proven by high voltage tests on a systematical basis and by sample testing on the released product.

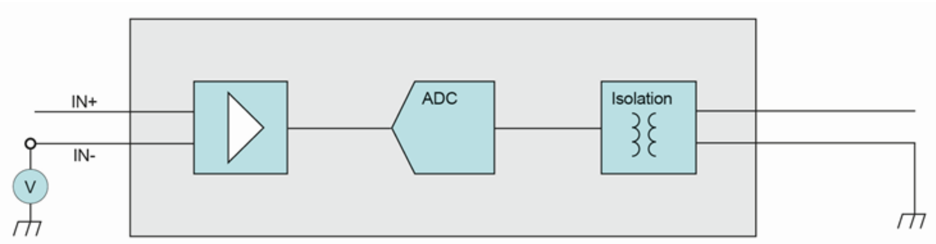



*Fig. 229: Isolation voltage*

## Input ranges

DEWETRON measurement equipment provides one or more input range(s). An input range indicates the highest possible value which can be displayed, similar to the limit position of a dial instrument.

Voltage and current values (V and A) are generally to be read as $V_{RMS}$ and $A_{RMS}$ values, especially if they are followed by a peak value (e.g. 5 $V_{RMS}$ (10 $V_{PEAK}$)). If a V value is prefixed by a plus-minus sign, the following value is to be interpreted as $V_{DC}$ value, unless otherwise stated.

**INFORMATION**

The value of the input range does not give any information concerning the allowable scope of application refer to *Rated input voltage to earth on page 246*.

## Rated input voltage to earth

Rated input indicates the allowable scope of application of a measurement input according to the IEC/EN 61010-2-30 (Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 2-030: Particular Requirements for Equipment Having Testing or Measuring Circuits) standard. DEWETRON equipment and measurement inputs are always specified according to this stated standard. Furthermore, the compliance tests are carried out by a 3rd party laboratory.

The rated input value specifies the highest possible voltage which can be applied to the measurement input. The IEC/EN 61010-2-30 additionally describes certain measurement categories within a public power grid (see also overvoltage categories IEC/EN 60664-1). Thus, measurement circuits can be applied according to their specification to the power grid categories as stated below:

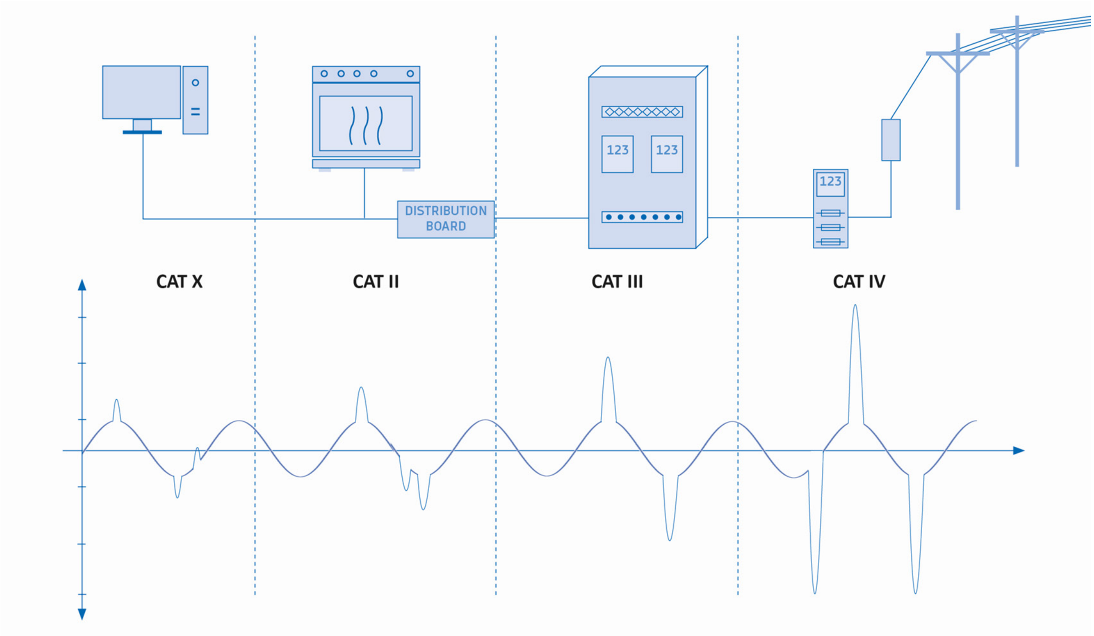



*Fig. 230: Rated input voltage*

The isolation is tested according to the IEC/EN 61010-2-30. The level of the isolation voltage depends on the rated input voltage and on the measurement category. Since potential overvoltage phenomena are higher within higher power grid categories, the isolation voltage needs to be higher too.

If there is no measurement category specified, the measurement input is not appropriate to be applied to a public power grid.

**EXAMPLES**

- Rated input 600 V CAT II

  The measurement input can be connected to a public power grid within the category II as long as the voltage of the grid does not exceed 600 $V_{RMS}$ or 600 $V_{DC}$. If there is a measurement category specified, the voltage value stated is always considered to be RMS or DC.

- Rated Input 600 $V_{RMS}$

  This measurement input is not intended to be connected within an on-board power system of a train for instance.

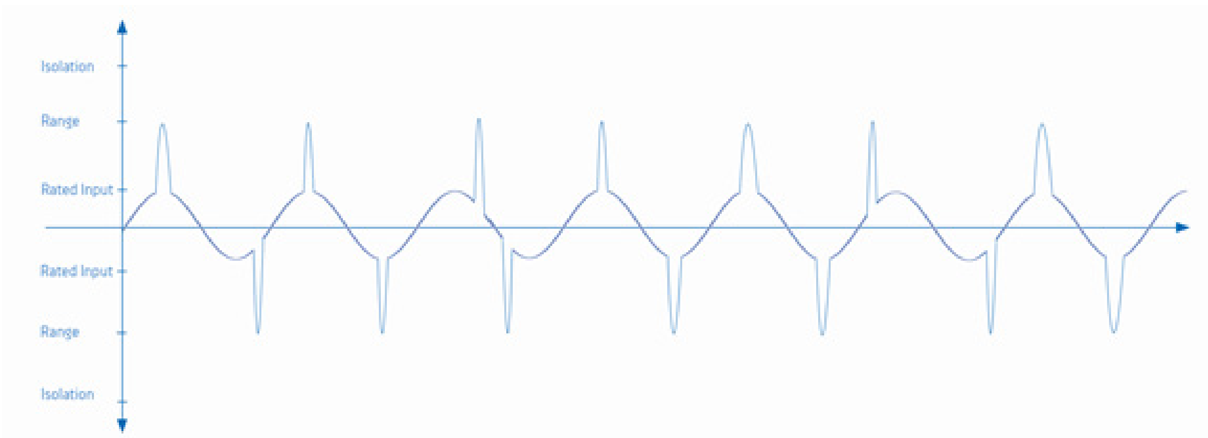



*Fig. 231: Relation between rated input, input ranges and isolation voltage*

## Common mode voltage

Common mode voltage indicates the highest possible voltage between the two input pins of a channel (e.g. IN+ and IN-) and the reference potential (GND) without clipping the wanted signal.

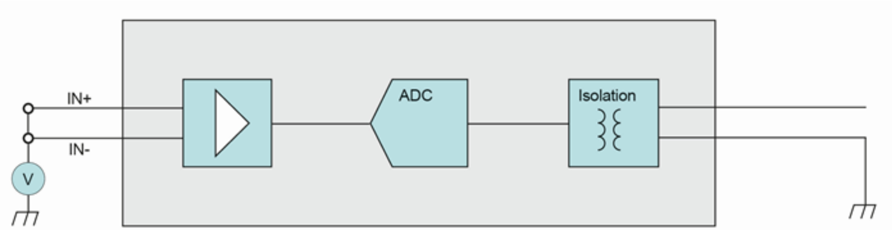



*Fig. 232: Common mode voltage*

In the very most cases the value of the common mode voltage corresponds to the value of the isolation voltage.

## Overvoltage protection

This value indicates the highest possible voltage which will not overload the input protection circuit when applied between two pins of one channel.

Exceeding this value causes the damage of the measurement input in most every case, also other components inside the measurement unit could be affected and it is furthermore a threat to life and physical condition (electric shocks, burn).

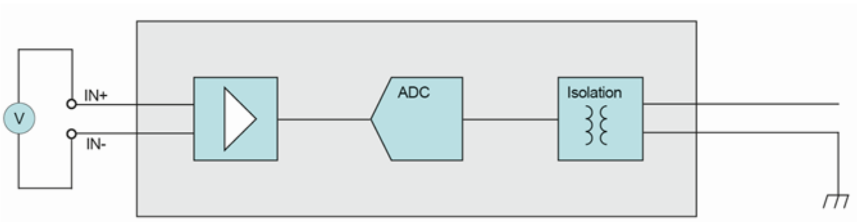



*Fig. 233: Overvoltage protection*

## Max. DC voltage @ AC coupling

The given value refers to input AC coupled inputs only. Max. DC voltage @AC coupling specifies the highest allowed direct voltage component on the measurement input, when the coupling mode is switched to “Coupling AC”.

## Bus pin fault protection

The specification of bus pin fault protection refers to the wiring of bus systems (e.g. CAN, RS-485, etc.) only. The value indicates the highest voltage which will not destroy the bus input or output when applied between the bus wiring and ground by accident.

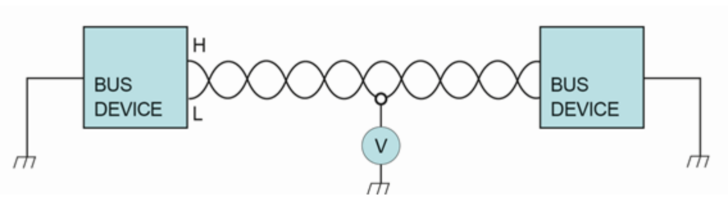



*Fig. 234: Bus pin fault protection*