

# Why use isolated amplifiers



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## USER MANUAL

Why to use isolated amplifiers V21-1



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## 2. About this document

This is an explanation of the isolated amplifiers.

### 2.1 Legend

The following symbols and formats will be used throughout the document.



#### **Important**

It gives you important information about the subject.  
Please read carefully!



#### **Hint**

It gives you a hint or provides additional information about a subject.



#### **Example**

Gives you an example of a specific subject.

## 3. Introduction

This document explains why the usage of isolated amplifiers is highly recommended, in order to get reliable measurement results and save your instrument from eventual damage.

### 3.1. Amplifier technologies

#### 3.1.1 Single-ended amplifier

The architecture of the single-ended amplifier is very simple, and therefore cheap. It only makes sense in battery powered voltmeters (floating source), because there is no connection to the ground of any other equipment. The significance of this amplifier in the precision measurement segment is very small nowadays.

#### 3.1.2 Differential amplifier

The differential amplifier cancels out the noise, which is coupled in on both inputs with the same amount (due to long sensor cabling or environmental noise), it only amplifies the difference. With this concept it is possible to avoid ground loops, but only if the voltage on each line stays inside the common mode voltage.

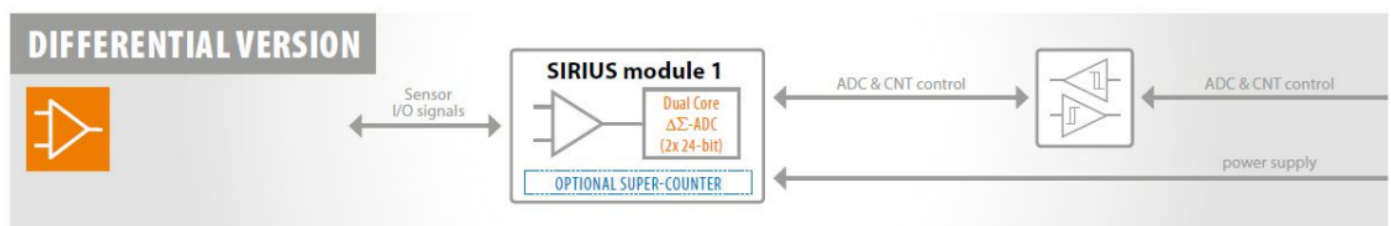


Image 1: Differential amplifier

#### 3.1.3 Isolated amplifier

The “worry-free solution” provides isolation and the differential input at the same time. With the isolated SIRIUSi devices of Dewesoft, both the sensor signal and the power supply (including sensor excitation) are isolated, so it's the perfect solution with channel-to-channel and channel-to-ground isolation. It copes with differences in ground voltage up to 1000 V, which covers all industrial applications.

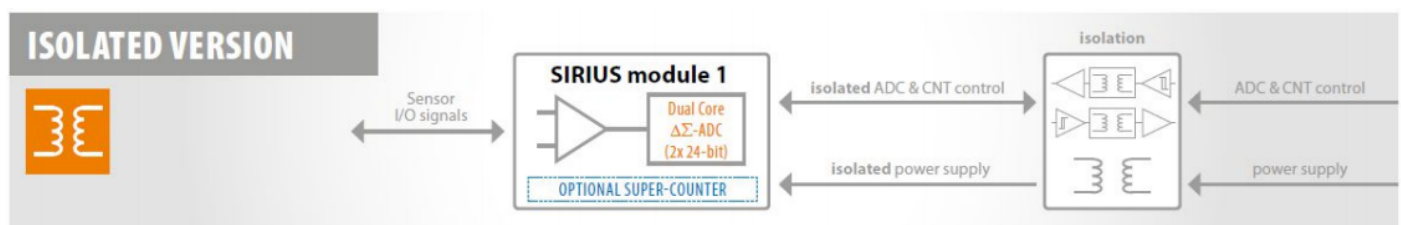


Image 2: Isolated amplifier

## 4. Measurement faults

### 4.1. Common mode voltage

Usually the differential amplifier cancels out the noise, which is coupled in on both inputs with the same amount, it only amplifies the difference. But in contrast to isolated amplifiers, the input common mode voltage range is very limited here. So there are certain situations, where differential technology reaches its limit:

- **Thermocouple measurement (AC common mode)**

When the common mode voltage amplitude exceeds the amplifier's common mode voltage input range, the amplifier starts "clipping", resulting in a distorted, unusable output signal.

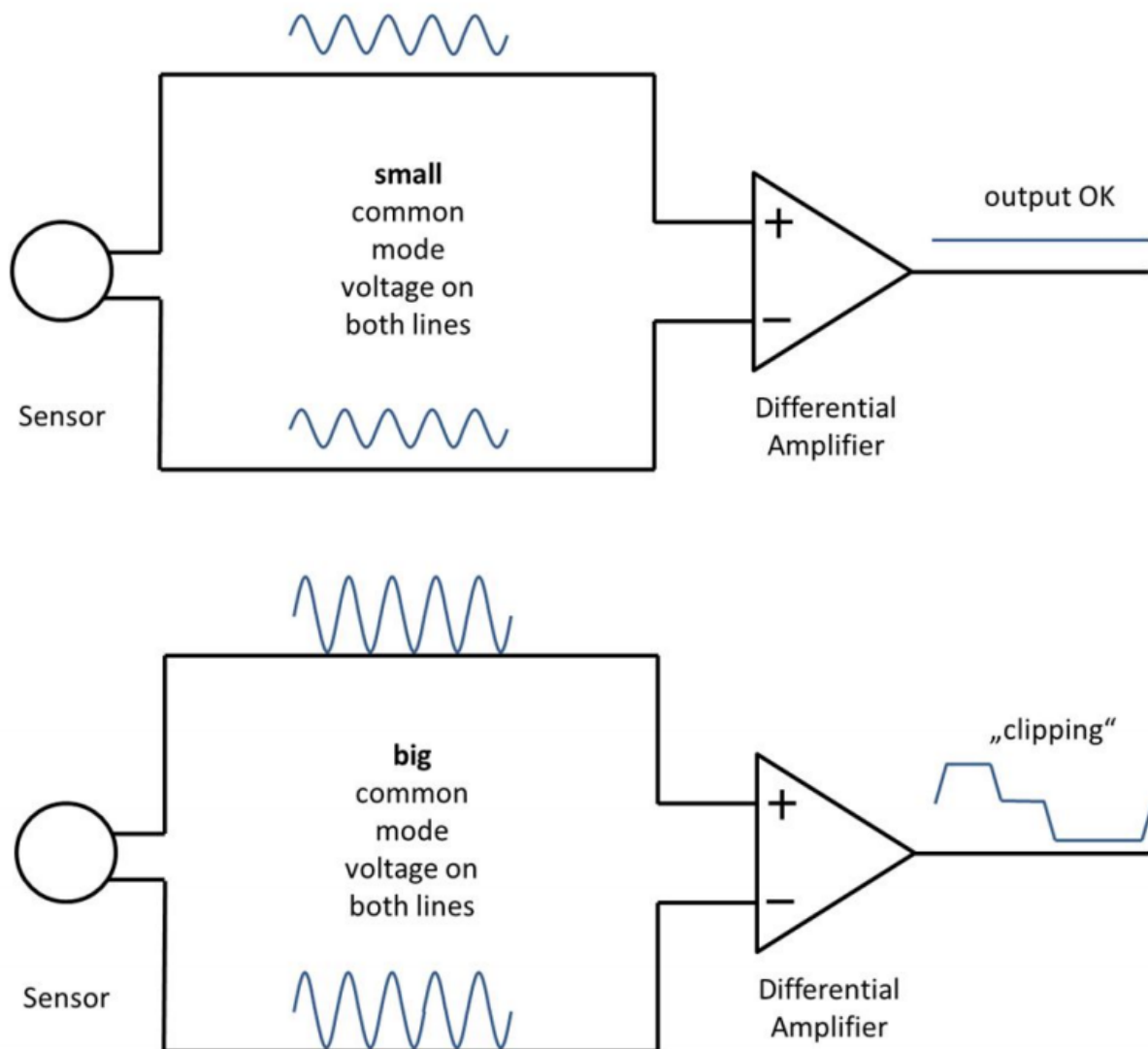


Image 3: Example of an "clipping" signal

With the use of an isolated amplifier, the measurement can be done, even if there is high common mode.

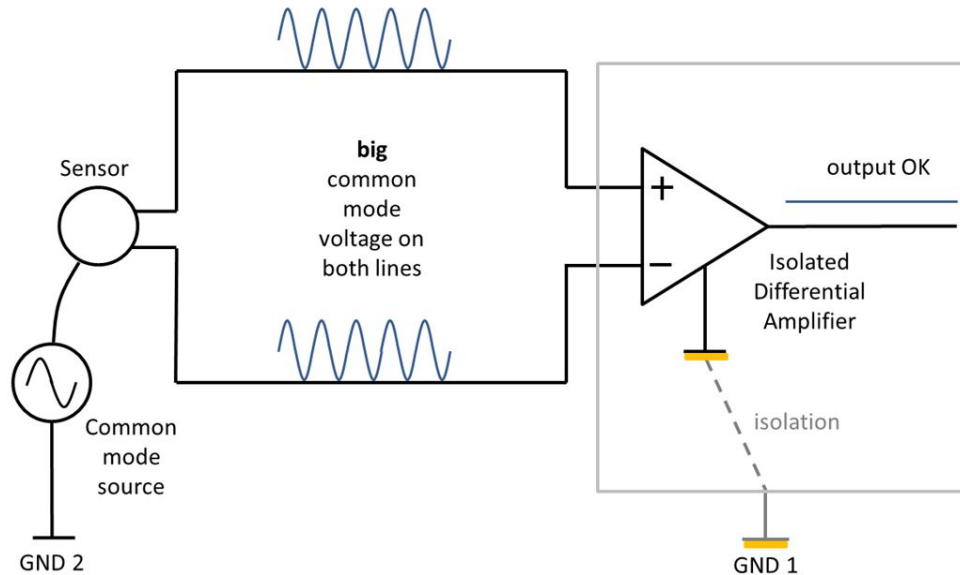


Image 4: Thermocouple connected to a isolated amplifier

- **Current measurement on shunt on positive line (DC common mode)**

The measurement configuration below shows the possibilities to measure the current of a 24 V supplied system. The optimum amplifier input range in this case is 500 mV. That will work fine for Ch 1 in the picture, but not for Ch 0. This channel will exceed the maximum common mode voltage and go to overflow.

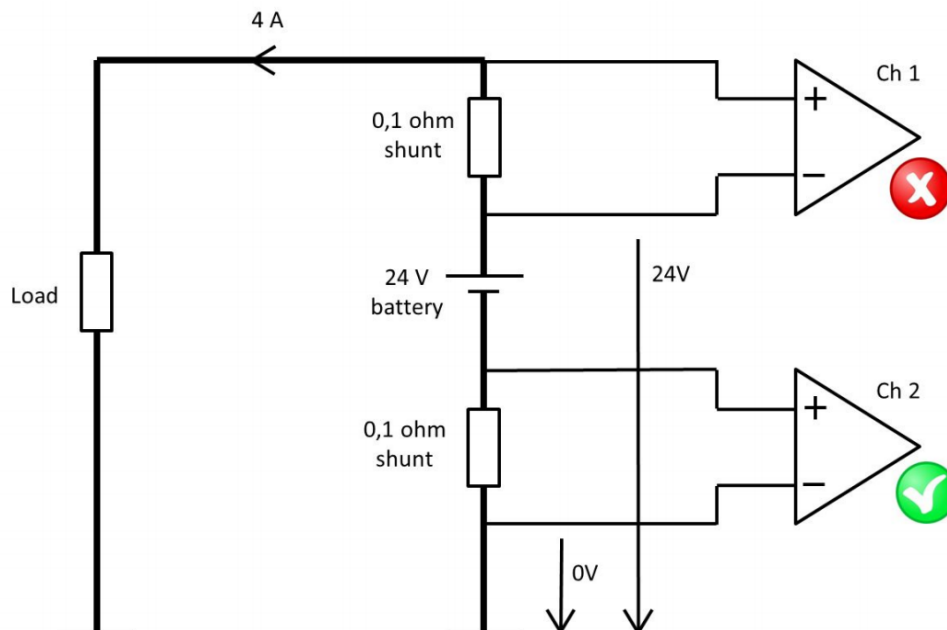


Image 5: Current measurement

The solution would be to measure in the low-line, or use an **isolated** amplifier.



## 4.2. Common mode rejection

The Common Mode Rejection Ratio (CMRR) is a parameter to specify how good an amplifier is able to suppress unwanted equal (non-differential) signals on the input. For example, if you measure a static signal, the DC common mode will affect the accuracy, while the AC common mode will result in noise.

## 4.3. Ground loops with sensor

In a lot of the cases the noise in the measurement data has its root cause by inducing through so-called “ground loops”.

There are various ways to create them, some of them can be very harmful to the measurement instrument!

In the picture below is a typical setup: the measurement amplifier is connected to the ground (GND 1) on one side, an asymmetrical shielded cable is used to connect the sensor, which metallic housing is placed on an electrically conducting on a ground (GND 2). Due to the long distance of the cable, there is already a difference in the ground levels, which acts like a voltage source, coupling in all electromagnetic noise e.g. in an industrial environment.

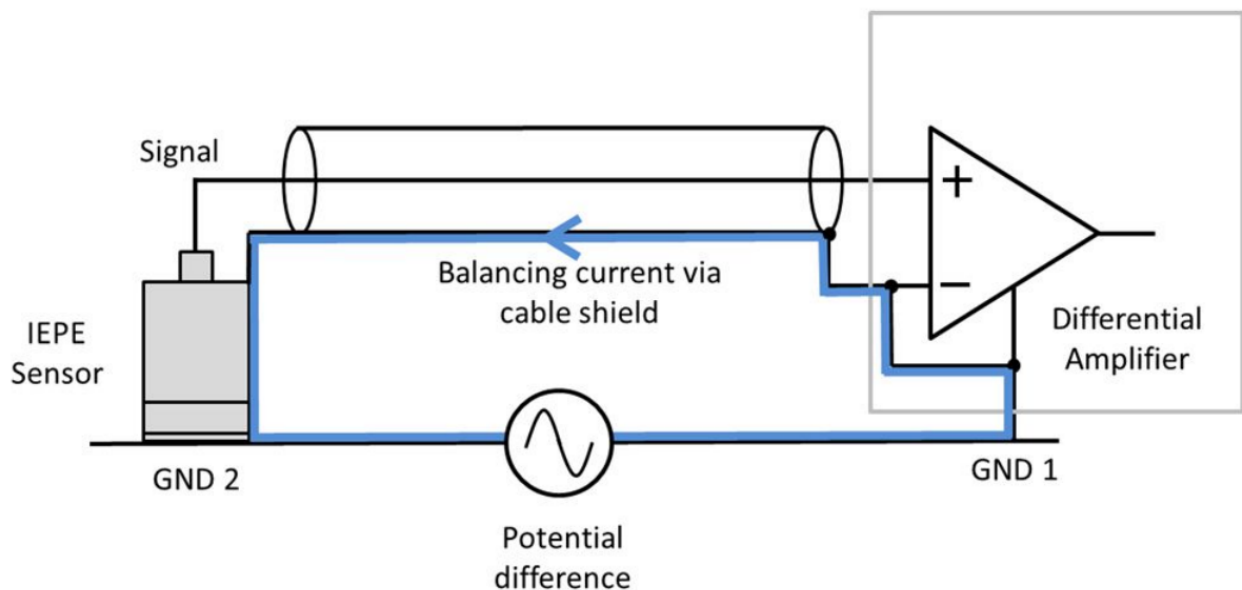


Image 6: Sensor connection done with an asymmetrical shielded cable



### Example

How big does the error have to be, to be significant?

That depends on the situation. For example, when connecting a Charge or IEPE sensor with a high dynamic output of 140 dB to the amplifier, which is set to 10 V input range, the allowed potential difference would be only 1  $\mu$ V!

So, the solution would be to **isolate the sensor or the amplifier.**

## Isolated amplifier

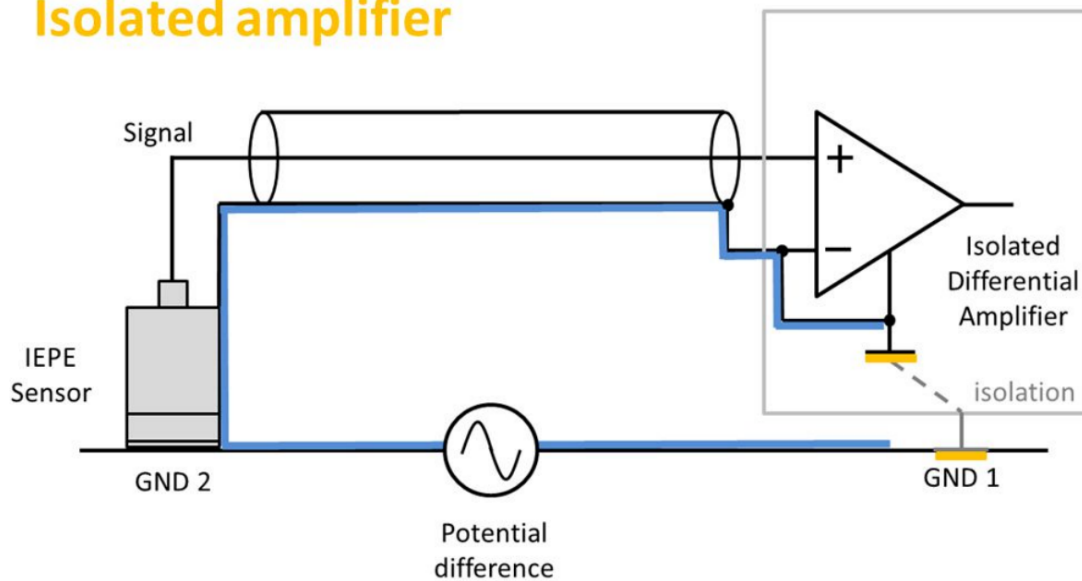


Image 7: An example of an isolated amplifier

## 4.4. Ground loops with power supply

Ground loops can also be created by non-isolated power supply concepts! Care must be taken when supplying multiple devices – even if each device itself has a correct over-voltage and reverse polarity protection like the complete DAQ System series from Dewesoft (like SIRIUS, DEWE-43...).

The picture below shows a typical configuration. A sensor and the DAQ-System are supplied out by the same DC power supply (e.g. the vehicle on board network). You can see the GND is connected from two points: The main current flows along the blue thick line (“high current path”), to the load and back. But the GND of both devices are also connected together, through the sensor output and DAQ input.

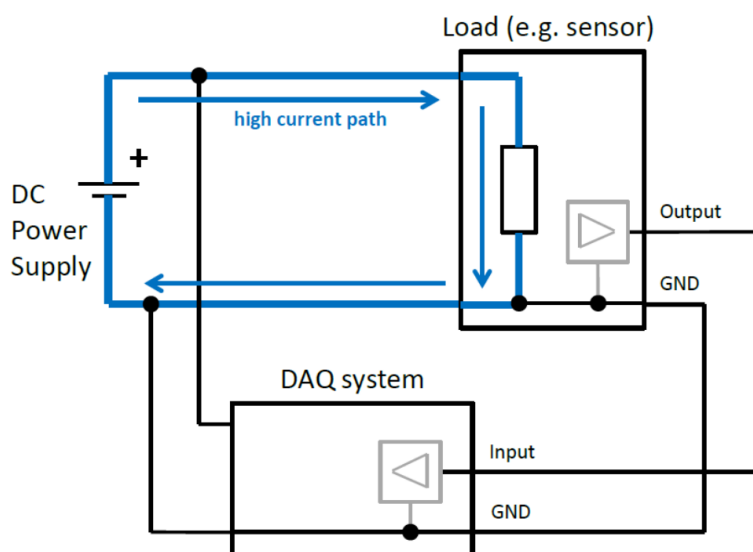


Image 8: A typical sensor connection



## Important



### Error case with broken GND cable:

You can imagine what will happen when the “high-current path” is open: the current will flow a different way. Now the return supply path of the sensor is routed through the GND of the sensor input from the DAQ device.

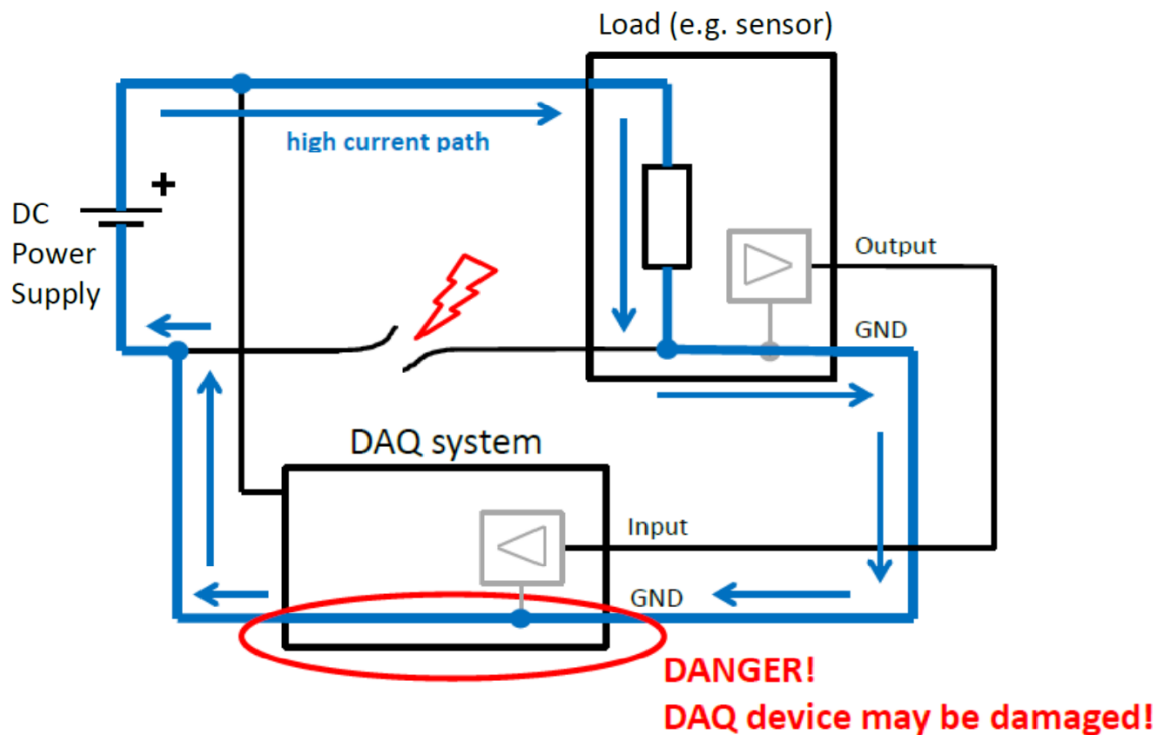


Image 9: Error case with broken GND cable

Usually the internal circuitry is not capable of driving this high current. So the DAQ device may be damaged! With an **isolated** power concept, no error current would have been possible through the supply line.

## 5. Conclusion

- **Isolated** (and at the same time: differential) signal conditioning: It is the more expensive, but “worry-free” solution, also an inexperienced person is able to make correct and accurate measurements.
- **Differential** signal conditioning: This technology is cheaper, and shows no disadvantages when using isolated sensors like strain gages, current clamps, acceleration and pressure sensors. It also delivers a high quality result, but the engineer needs to know the sensor behaviour (isolated, CM range..), and needs to take care of the correct setup/cabling, to guarantee correct measurements.

## 6. Warranty information

### Notice

The information contained in this document is subject to change without notice.

### Note:

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The copy of the specific warranty terms applicable to your Dewesoft product and replacement parts can be obtained from your local sales and service office. To find a local dealer for your country, please visit <https://dewesoft.com/support/distributors>.

### Calibration

Every instrument needs to be calibrated at regular intervals. The standard norm across nearly every industry is annual calibration. Before your Dewesoft data acquisition system is delivered, it is calibrated. Detailed calibration reports for your Dewesoft system can be requested. We retain them for at least one year, after system delivery.

### Support

Dewesoft has a team of people ready to assist you if you have any questions or any technical difficulties regarding the system. For any support please contact your local distributor first or Dewesoft directly.

Dewesoft d.o.o.  
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1420 Trbovlje Slovenia

Europe Tel.: +386 356 25 300  
Web: <http://www.dewesoft.com>  
Email: [Support@dewesoft.com](mailto:Support@dewesoft.com)  
The telephone hotline is available Monday to Friday from 07:00 to 16:00 CET (GMT +1:00)

### Service/repair

The team of Dewesoft also performs any kinds of repairs to your system to assure a safe and proper operation in the future. For information regarding service and repairs please contact your local distributor first or Dewesoft directly on <https://dewesoft.com/support/rma-service>.

### Restricted Rights

Use Slovenian law for duplication or disclosure. Dewesoft d.o.o. Gabrsko 11a, 1420 Trbovlje, Slovenia / Europe.

## Printing History

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## Safety instructions

Your safety is our primary concern! Please be safe!

### Safety symbols in the manual



#### **Warning**

Calls attention to a procedure, practice, or condition that could cause the body injury or death



#### **Caution**

Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

### General Safety Instructions



#### **Warning**

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. Dewesoft GmbH assumes no liability for the customer's failure to comply with these requirements.

All accessories shown in this document are available as an option and will not be shipped as standard parts.

## Environmental Considerations

Information about the environmental impact of the product.

## Product End-of-Life Handling

Observe the following guidelines when recycling a Dewesoft system:

## System and Components Recycling

Production of these components 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! Please recycle this product in an appropriate way to avoid 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 2002/96/EC on waste electrical and electronic equipment (WEEE). Please find further information about recycling on the Dewesoft web site [www.dewesoft.com](http://www.dewesoft.com)

**Restriction of Hazardous Substances**

This product has been classified as Monitoring and Control equipment and is outside the scope of the 2002/95/EC RoHS Directive. However, we take care of our environment and the product is lead-free.

## General safety and hazard warnings for all Dewesoft systems

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.
- Read your manual before operating the system.
- Observe local laws when using the instrument.
- DO NOT touch internal wiring!
- DO NOT use higher supply voltage than specified!
- Use only original plugs and cables for harnessing.
- You may not connect higher voltages than rated to any connectors.
- The power cable and connector serve as Power-Breaker. The cable must not exceed 3 meters, the disconnect function must be possible without tools.
- Maintenance must be executed by qualified staff only.
- During the use of the system, it might be possible to access other parts of a more comprehensive system. Please read and follow the safety instructions provided in the manuals of all other components regarding warning and security advice for using the system.
- With this product, only use the power cable delivered or defined for the host country.
- DO NOT connect or disconnect sensors, probes or test leads, as these parts are connected to a voltage supply unit.
- Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), a non-interruptible safety earth ground must be provided from the mains power source to the product input wiring terminals.
- Please note the characteristics and indicators on the system to avoid fire or electric shocks. Before connecting the system, please read the corresponding specifications in the product manual carefully.

- The inputs must not, unless otherwise noted (CATx identification), be connected to the main circuit of category II, III and IV.
- The power cord separates the system from the power supply. Do not block the power cord, since it has to be accessible for the users.
- DO NOT use the system if equipment covers or shields are removed.
- If you assume the system is damaged, get it examined by authorized personnel only.
- Adverse environmental conditions are Moisture or high humidity Dust, flammable gases, fumes or dissolver Thunderstorm or thunderstorm conditions (except assembly PNA) Electrostatic fields, etc.
- The measurement category can be adjusted depending on module configuration.
- Any other use than described above may damage your system and is attended with dangers like short-circuiting, fire or electric shocks.
- The whole system must not be changed, rebuilt or opened.
- 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 the safe operation can be verified by service-trained personnel. If necessary, return the product to Dewesoft sales and service office for service and repair to ensure that safety features are maintained.
- If you assume a more riskless use is not provided anymore, the system has to be rendered inoperative and should be protected against inadvertent operation. It is assumed that a more riskless operation is not possible anymore if the system is damaged obviously or causes strange noises. The system does not work anymore. The system has been exposed to long storage in adverse environments. The system has been exposed to heavy shipment strain.
- Warranty void if damages caused by disregarding this manual. For consequential damages, NO liability will be assumed!
- Warranty void if damage to property or persons caused by improper use or disregarding the safety instructions.
- Unauthorized changing or rebuilding the system is prohibited due to safety and permission reasons (CE).
- Be careful with voltages >25 VAC or >35 VDC! These voltages are already high enough in order to get a perilous electric shock by touching the wiring.
- The product heats during operation. Make sure there is adequate ventilation. Ventilation slots must not be covered!
- Only fuses of the specified type and nominal current may be used. The use of patched fuses is prohibited.
- Prevent using metal bare wires! Risk of short circuit and fire hazard!
- DO NOT use the system before, during or shortly after a thunderstorm (risk of lightning and high energy over-voltage). An advanced range of application under certain conditions is allowed with therefore designed products only. For details please refer to the specifications.
- Make sure that your hands, shoes, clothes, the floor, the system or measuring leads, integrated circuits and so on, are dry.
- DO NOT use the system in rooms with flammable gases, fumes or dust or in adverse environmental conditions.
- Avoid operation in the immediate vicinity of high magnetic or electromagnetic fields, transmitting antennas or high-frequency generators, for exact values please refer to enclosed specifications.
- Use measurement leads or measurement accessories aligned with the specification of the system only. Fire hazard in case of overload!

- 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 system unpowered to room temperature.
- Do not disassemble the system! There is a high risk of getting a perilous electric shock. Capacitors still might be charged, even if the system has been removed from the power supply.
- The electrical installations and equipment in industrial facilities must be observed by the security regulations and insurance institutions.
- The use of the measuring system in schools and other training facilities must be observed by skilled personnel.
- The measuring systems are not designed for use in humans and animals.
- Please contact a professional if you have doubts about the method of operation, safety or the connection of the system.
- Please be careful with the product. Shocks, hits and dropping it from already- lower level may damage your system.
- Please also consider the detailed technical reference manual as well as the security advice of the connected systems.
- This product has left the factory in safety-related flawlessness and in proper condition. In order to maintain this condition and guarantee safety use, the user has to consider the security advice 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 well-tried”, are excluded from the scope of IEC 61326-3-1.

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

## Documentation version history

Version	Date	Notes
V20-1	29-12-2020	New template