User Manual

AED9101C

Digital Transducer Electronics

Basic Device for AD103C with RS232, RS422, RS485

I1692-2.0 en

HBM

Content

Typographical conventions

For clear identification and improved legibility, the following conventions have been used in this documentation:

Important paragraphs are marked with a symbol to draw attention to them.

CE Designation

Statutory marking requirements for waste disposal

Italics	Points out external documents and files
"File → Open"	All menus and menu commands appear in quotes, here the "File" menu and the "Open" sub-menu.
"Start"	Quotes and italics are used for buttons, input fields and user input.
MSV	All commands are set out in a bold font style or as a link to the command description.

Important information

Neither the design of the device nor any technical safety aspects may be modified without the express permission of Hottinger Baldwin Messtechnik GmbH. Any modification excludes Hottinger Baldwin Messtechnik GmbH from any and all liability for any damage resulting therefrom.

It is strictly forbidden to carry out any repairs and soldering work on the motherboards or to replace any components. Repairs may only be carried out by persons authorized thereto by Hottinger Baldwin Messtechnik GmbH.

All the factory defaults are stored safe from power failure at the factory, not in the measuring amplifier where they can be deleted or overwritten. They can be reset at any time by using the command **TDD**0. For more information, see aed_help_e, AD103C; “Description of the basic commands”.

The production number is set at the factory and cannot be changed.

The transducer connection must always be assigned.
It is essential for a transducer or a bridge model to be connected up for operation.

Safety instructions

- There are not normally any hazards associated with the product, provided the notes and instructions for project planning, assembly, appropriate operation and maintenance are observed.
- Each time, before starting up the modules, you must first run a project planning and risk analysis that takes into account all the safety aspects of automation technology. This particularly concerns personal and machine protection.
- It is essential to comply with the safety and accident prevention regulations applicable to each individual case.
- Installation and start-up must only be carried out by suitably qualified personnel.
- Do not allow the equipment to become dirty or damp.
- During installation and when connecting the cables, take action to prevent electrostatic discharge as this may damage the electronics.
- The required power supply is an extra-low voltage with safe disconnection from the mains.
- When connecting additional devices, comply with the local safety requirements.
- All the interconnecting cables must be shielded cables. The screen must be connected extensively to ground on both sides.
  The power supply and digital I/O connection cables only need to be shielded if the cables are longer than 30 m (32.81 yd) or are routed outside closed buildings (EN 61326-1).
- The CE mark enables the manufacturer to guarantee that the product complies with the requirements of the relevant EC directives (the declaration of conformity is available at http://www.hbm.com/HBMdoc).
- In accordance with national and local environmental protection and material recovery and recycling regulations, old devices that can no longer be used must be disposed of separately and not with normal household garbage.
  If you need more information about waste disposal, please contact your local authorities or the dealer from whom you purchased the product.

1 Introduction and appropriate use

AED9101C digital transducer electronics are part of the AED component family that digitally conditions signals from mechanical measurement sensors and networks them with bus capability. These include digital amplifier motherboards, basic devices with serial interfaces and intelligent sensors with integrated signal processing. The purpose of these components is to directly digitize and condition the measurement signals at the transducer location. Using digital transducer electronics, you can connect SG[1)] transducers in a full-bridge circuit directly to a computer or a PC. This enables you to configure complete measurement chains quickly and with little extra work.

Basic device AED9101C can contain the AD103C amplifier board. It provides mechanical protection, shields the amplifier board (EMC protection) and allows you to select the serial interfaces RS422 (factory default), RS485 or RS232.

The AD103C amplifier mother board is not included in the scope of supply of the basic device and must be ordered separately.

The AD101B amplifier is only required for replacement and will not be considered when new AED basic devices are ordered.

The PC software *AED PANEL 32* is available to facilitate parameter settings, to display dynamic measurement signals and for comprehensive analysis of the dynamic system.
The HBM display unit DWS2103 can be connected to all AED basic devices.

All basic devices of the AED family can be connected with the digital display unit DWS2103. This unit supports all implemented functions of the AED.

All commands are described in the help file aed_help_e.

The abbreviation **AED** is also used for transducer electronics in the following text.

1) **S**train **G**age

2 Mechanical construction

The basic device extends the functionality of the AD amplifier boards and provides:

- mechanical protection (IP65)
- the power supply for the amplifier motherboard and transducer excitation
- total transducer bridge resistance 40…4000 Ω
- a choice of serial interfaces RS422, RS485, RS232
- EMC-tested
- Diagnostic bus

(The AED9101A basic device can be replaced by the AED9101C basic device)

The amplifier motherboard is designed as a plug-in board that can be plugged into the carrier board of the basic device via a 25-pin D-connector. The basic device contains terminals for the transducer, power pack and interface connections, slide switches for interface selection and the voltage stabilizer. The connection cables exit the casing via PG glands on the side.

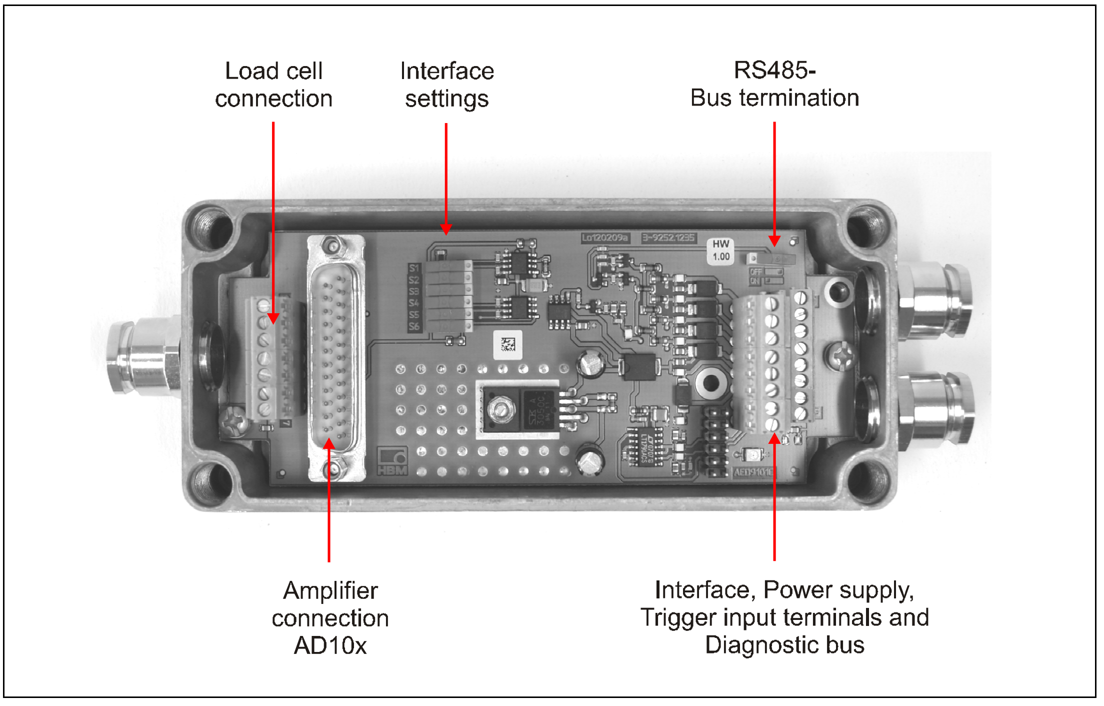


Fig. 2-1: Mechanical construction

3 Electrical connections

A connection diagram is attached inside the lid of the AED9101C basic device.

When making the connections, please ensure that the wires of the cable do not protrude beyond the connection terminals (risk that loops may form). Please make sure that the cable shielding is properly connected to the PG gland.

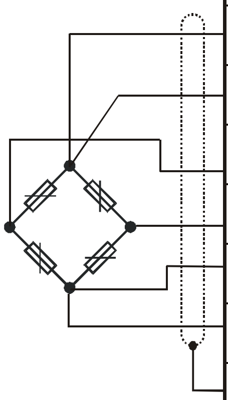
If it should be necessary, a separate cable can be used to establish potential equalization between the transducer and the AED and between the AED and the Master control unit (grounding concept). The cable shielding must not be used for this potential equalization.

3.1 Transducer connection

The transducer connection must always be assigned (connect the transducer).

AED9101C with AD103C

You can connect SG transducers in a full-bridge circuit with a total bridge resistance of R_B = 40...4000 Ω. With a transducer resistance of > 1000 Ω, increased noise (measurement ripple) must be taken into account. The bridges are supplied with power in the AED9101C basic device (5 V_{DC}).



	Color code HBM	Pin
Bridge excitation voltage (+)	blue	3
Sense line (+)	green	3'
Measuring signal (-)	red	4
Measuring signal (+)	white	1
Sense line (-)	grey	2'
Bridge excitation voltage (-)	black	2
Cable shield	Cable braid	Housing

Fig. 3.1-1: Transducer connection in 6-wire circuitry (HBM color-coding)

The 6-wire connection avoids the effect of a long cable on the measured value. When several transducers and a junction box are used, the 6-wire circuitry is routed to the junction box.

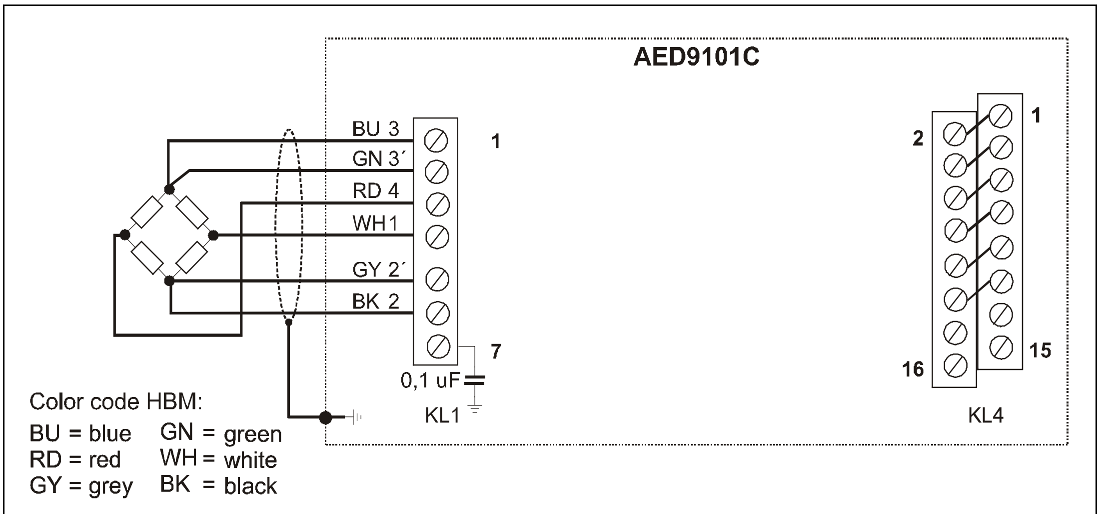


Fig. 3.1-2: Transducer connection in the AED9101C basic device for a 6-wire connection

There are two methods of connection for transducers implemented in four-wire circuitry:

- Connection via a 6-core extension cable; bridged sensor circuit in the transducer connector.

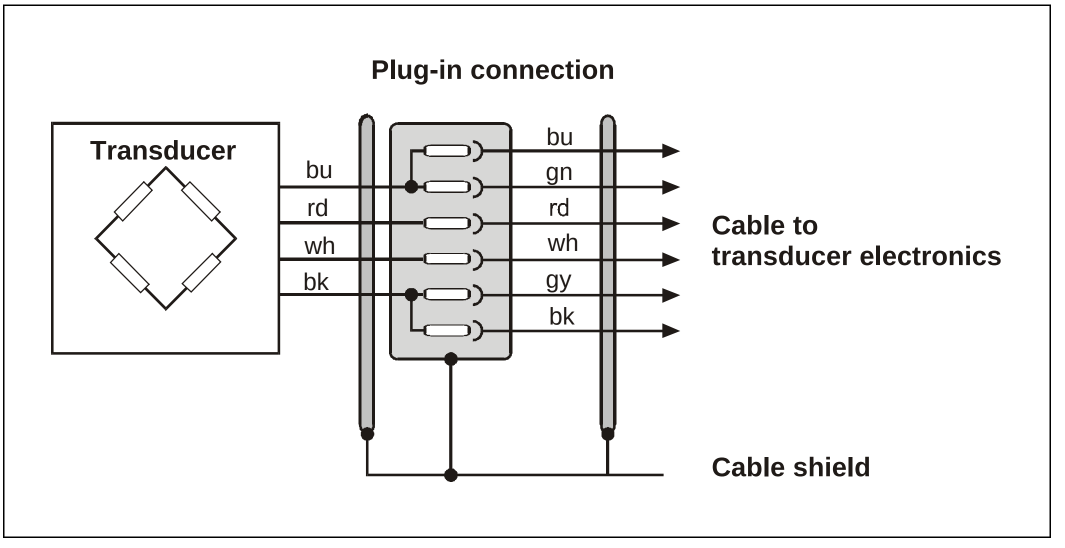


Fig. 3.1-3: Transducer connection in 6-wire circuitry via a 6-core cable extension

- Connection without an extension cable; sensor circuit bridged at the transducer electronics.

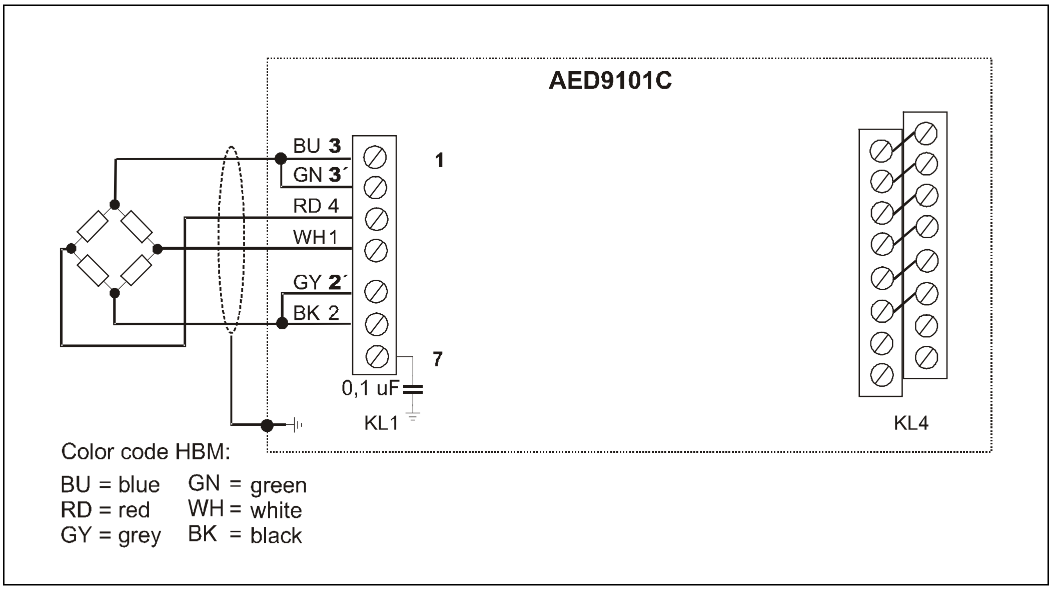


Fig. 3.1-4: Transducer connection in 4-wire circuitry without a cable extension (jumpers 2 – 2‘ and 3 – 3‘)

Connection without an extension cable; sensor circuit at transducer electronics. When connecting several transducers, it is advisable to use an HBM junction box VKKx. In general, the feed lines running to the AED should be shielded cables.

When connecting several transducers to the AED, the number of load cells that can be connected (and the resultant bridge resistance) must be taken into consideration with regard to the external supply voltage, so that the maximum power loss in the basic device is not exceeded.

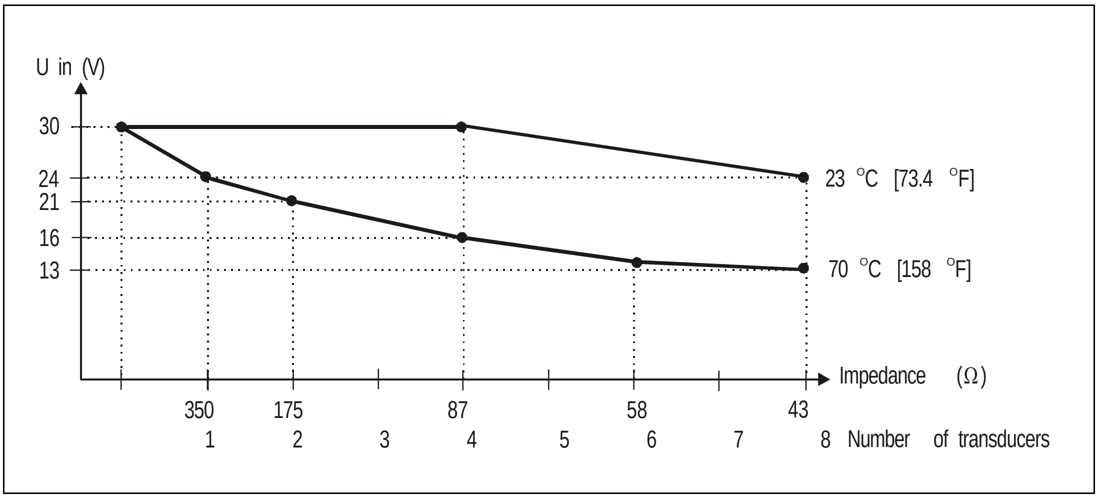


Fig. 3.1-5: Maximum operating voltage for the AED9101C basic device, with regard to the number of transducers and the ambient temperature

Notes on type of connection, length and cross-section of cables:

Depending on the bridge resistance of the load cell being used and the length and cross-section of the load cell connection cable, there may be voltage drops that can reduce the bridge excitation voltage. The voltage drop at the connection cable is also dependent on temperature (copper resistance). Likewise, the output signal of the load cell changes in proportion to the bridge excitation voltage.

This is balanced out when connecting in 6-wire circuitry.

6-wire circuit (standard mode of operation):

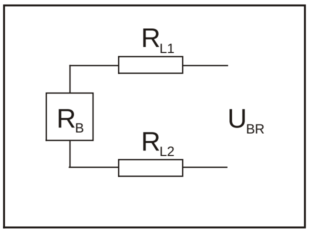
This will correct all the effects of the load cell cabling up to the feedback points. Even changing the length of a cable after calibration will not make any difference to the measurement results.

For load cells with a 6-wire connection, feedback lines 2´ and 3´ are bridged in the load cell with excitation 2 and 3 (Fig. 3.1-2). For load cells with a 4-wire connection, the feedback bridges must be implemented directly at the load cell connection (Fig 3.1-3 or 3.1-4).

4-wire circuit:

As correction through AUTOCAL can only ever take place up to feedback points 2´, 3´, all the changes of cable resistances affect the measurement result. This means that even if no further changes are made to the 4-wire cable used for calibration, there will still be measurement errors when there are temperature changes, because the cable resistance and possibly the contact resistances at the connectors are temperature-dependent. With the 4-wire circuit, feedback lines 2´ and 3´ are directly connected at connection terminals 2 and 3 in the AED (see Fig. 3.1-4).

Equivalent circuit of the bridge with bridge resistance R_B and supply lines with line resistances R_{L1} and R_{L2}:



$R_{L1} = R_{L2} = (4 * p_{CU} / \pi) * (l\,[m] / A\,[mm^2])$

$p_{CU} = 0{,}0178\ [\Omega\ mm^2/m]$ for copper

$\pi = 3{,}14$ l = Length of cable, A = Cross-section of cable

$\rightarrow R_{L1} = R_{L2} = 1{,}6\ \Omega$ at l = 10 m and A = 0,14 mm^2

Fig. 3.1-6: Bridge equivalent circuit diagram

The voltage drop over the bridge feeder cables can be determined from bridge resistance R_B, cable length l, cable cross-section A and the bridge excitation voltage:

$U_B + U_{RL1} + U_{RL2} = U_{BR}$

For
$R_B = 80\ \Omega$, $R_{L1} = R_{L2} = 1{,}6\ \Omega$ (l = 10 m) and $U_{BR} = 5$ V

there is an excitation current of
$I_{BR} = U_{BR}/(R_{L1} + R_{L2} + R_B) = 60$ mA

and thus a voltage drop over the two line resistances totaling approx. 0.2V ($U_{Bridge} = 4.8$ V).

For
$R_B = 80\ \Omega$, $R_{L1} = R_{L2} = 16\ \Omega$ (l = 100 m) and $U_{BR} = 5$ V

there is an excitation current of
$I_{BR} = U_{BR}/(R_{L1} + R_{L2} + R_B) = 45$ mA

and thus a voltage drop over the two line resistances totaling approx. 1.4 V
($U_{Bridge} = 3.6\ V = 80 * 0.045$).

This is irrelevant for the 6-wire circuit, as the voltage drop over the sensor lines is taken into account in the measurement signal.

But with a 4-wire circuit, the dependency of the copper resistance of the cables on temperature goes directly into the measurement result, as the bridge excitation voltage U_{Bridge} changes:

$R_L(t) = R_L20 * (1 + \alpha * (t - 20\ °C))$,

where R_{L20} is the line resistance at 20 °C and α is the temperature coefficient of the copper.

R_{L20} – for calculation, see page 23, α_{CU}: = 0.00392 [1/K]

With a cable length of l = 100m and a temperature differential of 10 °C, there is a line resistance of

$R_{L1}(t) = R_{L2}(t) = 16 * (1 + 0.00392 * 10) = 16.6\ \Omega$

This changes the bridge excitation voltage of

$U_{Bridge} = 3.6$ V (at 20 °C) to $U_{Bridge} = 3.53$ V.

This change in bridge excitation voltage directly at the transducer changes the measurement signal of the bridge by 1.9 % (= 100 % $*$ (1 – 3.53 V / 3.6 V)).

This typical calculation shows that if long cables are involved, only 6-wire circuitry should be used.

3.2 Connecting the supply voltage

The power supply must meet the following requirements:

AED9101C with AD103C	DC voltage	+6...+30 V
	current consumption	< 250 mA (for a 40 Ω bridge)

Calculation the total current consumption:

$$\text{Current consumption} = \leq 120\ \text{mA} + \frac{\text{Excitation voltage } U_B = 5\ \text{V}}{\text{Bridge resistance } R_B}$$

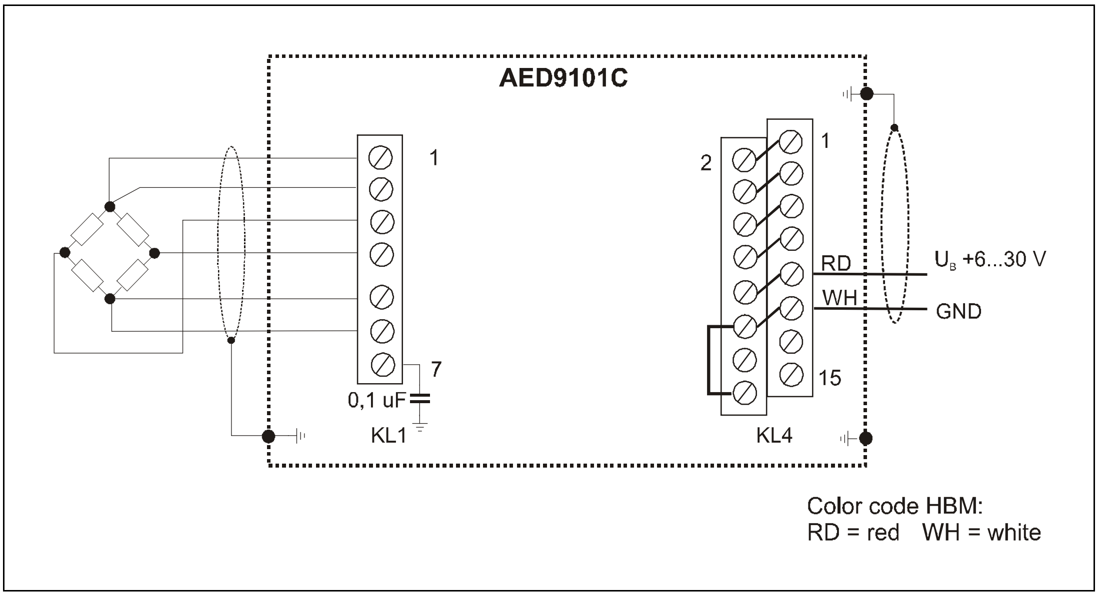


Fig. 3.2-1: Power supply connection

The voltage feed must be shielded. It can be applied within the interface cable or be implemented as a separate cable.

When supplying several AEDs via one cable, the voltage drop over the cable must be taken into consideration. The voltage drop depends on the supply current required and on the line resistance.

3.3 Connection to a computer

The basic device can be set up for several interface variants:

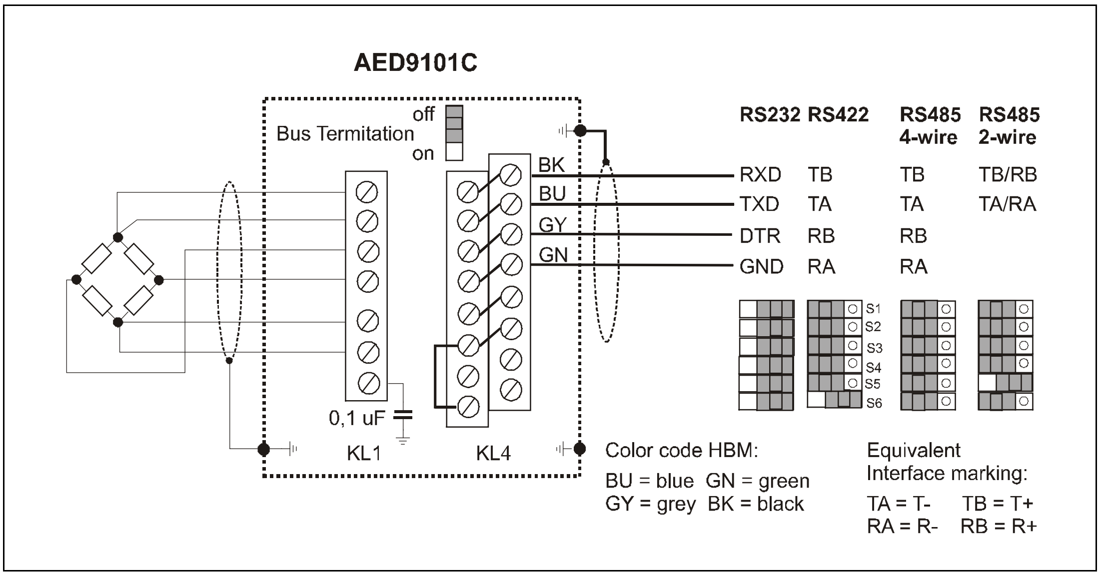


Fig. 3.3-1: Pin assignment and settings for the interfaces

No bus mode

The **RS232** interface allows the AED to be connected directly to a PC. The cable length is limited to 15 m and bus mode is not possible.

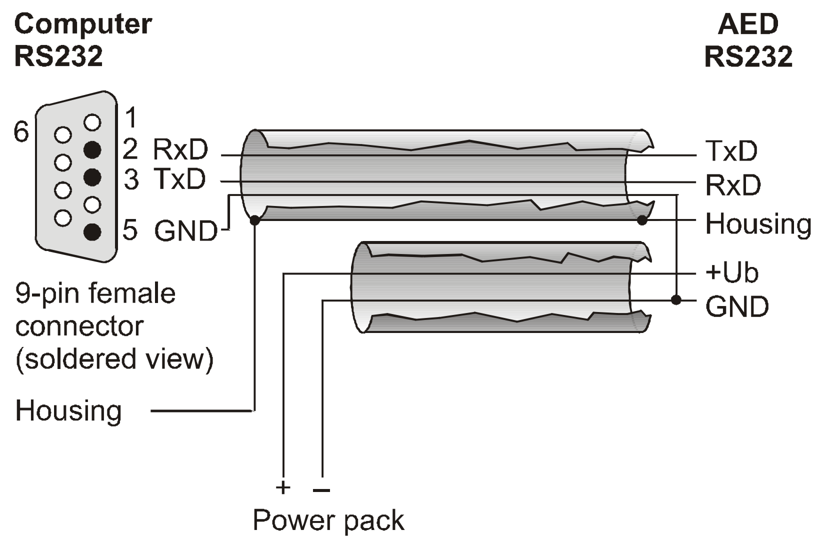


Fig. 3.3-2: Connecting an AED to a computer via the RS232 interface

For the RS232 interface setting, the "*bus termination switch must be set to OFF*".

The **RS422** interface is a 4-wire interface also with a maximum cable length of 1000 m. To connect the AED to the COM port of a PC (RS232), you need an interface converter. This interface is not designed for bus mode, as the transmitter is always active.

Bus mode

The **RS485** interface **with a 4-wire** connection allows the full range of AED functions with a maximum cable length of 1000 m. To connect the AED to the COM port of a PC (RS232), you need an interface converter.The **RS485** interface **with a 2-wire** connection also allows cable lengths of ≤1000 m. To connect the AED to the COM port of a PC (RS232), you need an interface converter
(1-SC232/422B from HBM, with 2-wire mode selected). However, the AED must be operated in half-duplex mode (command **COF**xxx must be set). The command **MSV**?0; must not be used, as it is not possible to interrupt data output with the **STP**; command.

Basically, shielded cables should be used for the interface wiring, with the cable shielding being connected to the AED housing via the PG (see AED9101C cable connection via the PG gland). The power supply can also be connected via this cable, with a 6-core, shielded cable being necessary.

If it should be necessary, a separate cable can be used to establish potential equalization between the bus nodes. The cable shielding must not be used for this potential equalization. For reasons of electromagnetic compatibility, it is advisable to use a double-shielded cable (from the HBM program, for example: 3 ∗ 2 ∗ 0.14 m², 4-3301.0071).

The shielding of the physical circuit is connected to the AED line (not to the power supply ground).

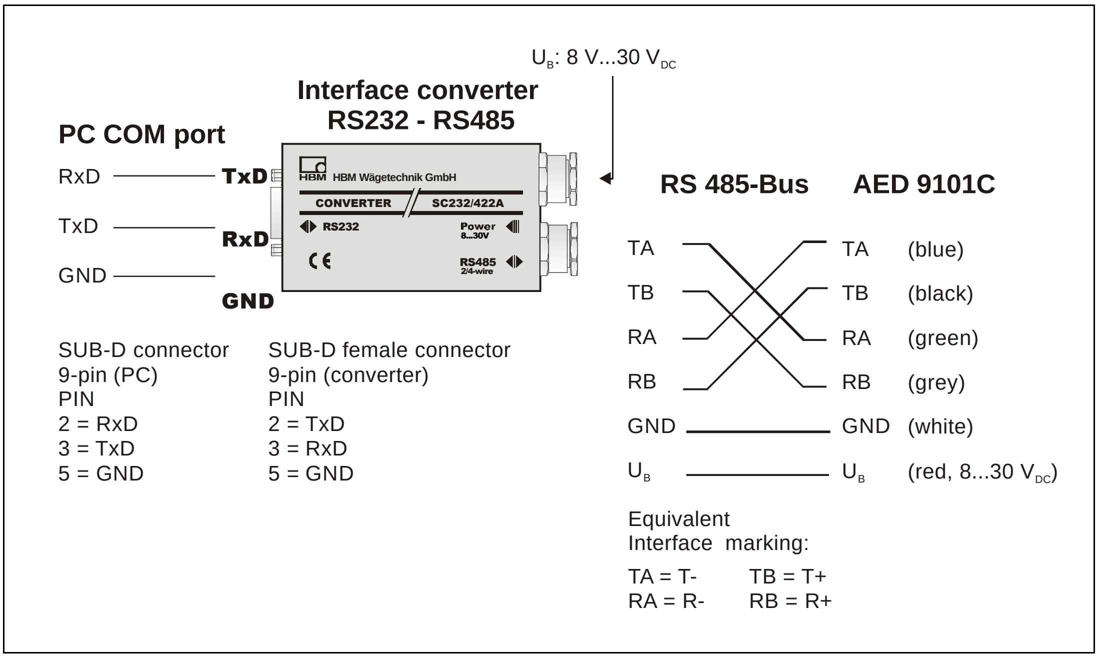


Fig. 3.3-3: Connecting an AED (RS422 or RS485 4-wire) to a computer via the interface converter

3.4 Multi-channel measurements (bus mode, RS485)

With the RS485 interface, several AEDs can be connected to a common bus line. The bus cabling for 4-wire mode is shown in Fig. 3.4-1.

With the RS485 interface, up to 32 AEDs can be connected to a common bus line. With the aid of the RS485 bus driver, it is possible to implement long cables (up to 1000 m (1,093.61 yd) in length).

AED bus mode is set out as a Master-Slave configuration, with the AED implementing a slave.

This means that all the AED activities are initiated from the control computer. Each AED is given a separate communication address (00...89) and can then be activated by an **S**ii (ii = 00...89) Select command.

A broadcast command (**S**98) is implemented for specific communication situations. This means that after a command of this type, all the AEDs execute the command of the Master, but none of the AEDs respond. All these communication commands are described with relevant examples in file aed_help_e, AD103C; “Description of the basic commands”.

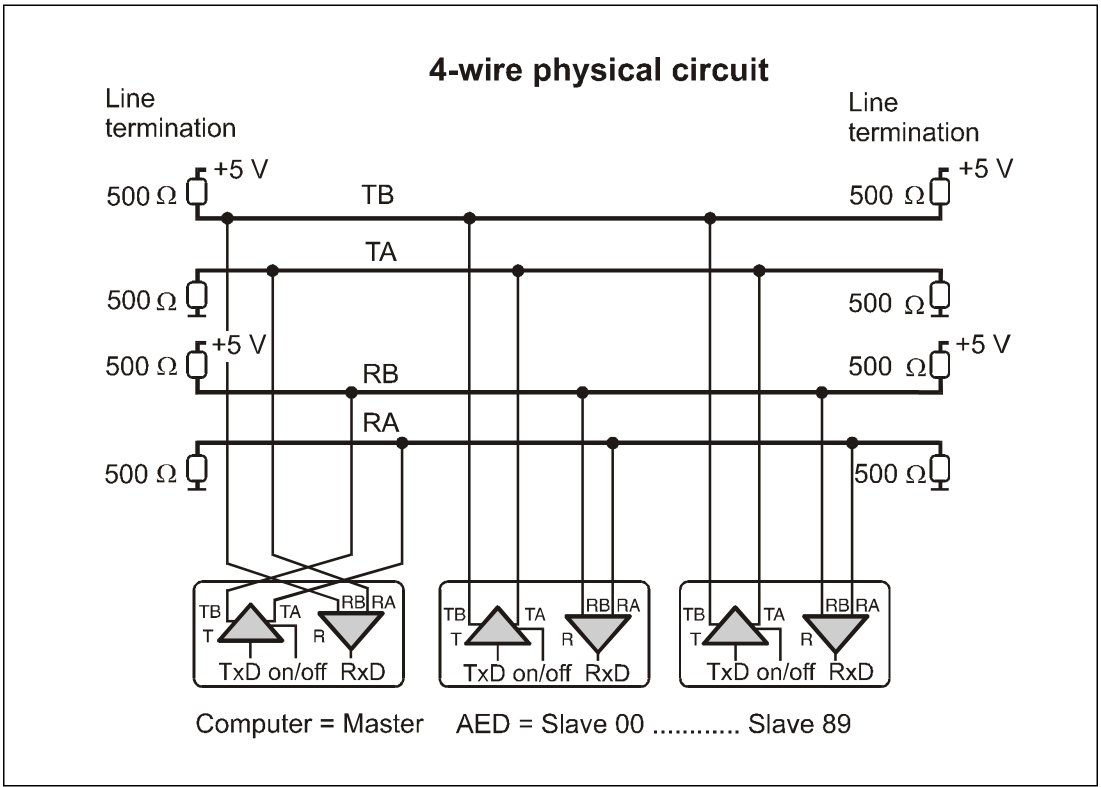


Fig. 3.4-1: Bus structure 4-wire bus (general)

The termination resistances of 500 Ω marked in the above diagram are important for the electrical function of the bus system. These resistances safeguard the quiescent level for the receiver on the bus line. The physical circuit must only be connected with these resistances at the line ends.

For the local bus termination distribution shown in the diagram, the Master and the AED with address 89 should include the termination resistances. Which is why in this AED, the bus termination is activated using the "*bus termination ON*" switch. This bus termination in the AD103C must also be activated using the commands **STR**1; and **TDD**1 (see file aed_help_e, AD103C; "Description of the basic commands"). If the "*bus termination switch is set to OFF*", the command **STR** will have no effect, which means that bus termination is deactivated.

The HBM interface converter also includes these bus termination resistances (do not deactivate them).

These terminations must not be activated more than twice in one bus.

The ground of the interface driver is related to the GND terminal. The interface driver of the master should be also connected to this GND.

The quiescent level on the RS485 physical circuit is produced in 4-wire mode at:

TB - TA > 0.35 V	(quiescent level though AED termination resistances)
RB - RA > 0.35 V	(quiescent level though Master termination resistances)

As the RS485 is a differential bus interface, the quiescent level is also specified as a differential voltage between the lines (and not ground-related). Furthermore, please note that this interface tolerates a maximum common-mode range of ±7 V. If it should be necessary, a separate cable can be used to establish potential equalization between the bus nodes. The cable shielding must not be used for this potential equalization.

RS485 2-wire mode

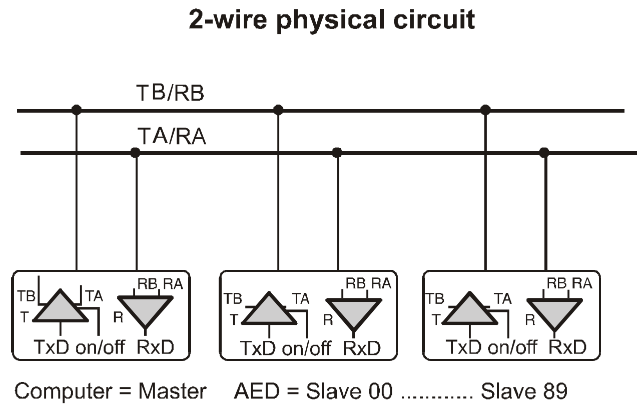


Fig. 3.4-2: Bus structure RS485 2-wire bus (general, TB/RB = T/R+, TA/RA = T/R-)

Termination resistances are also necessary for the electrical function of this bus system. These resistances safeguard the quiescent level for the receiver on the bus line. These termination resistances are already included in the AED and should be set with the “*bus termination switch*” (see 4-wire circuit). The quiescent level on the RS485 physical circuit is produced in 2-wire mode at:

TB/RB - TA/RA ≥ 0.35 V

For the local bus termination distribution shown in the diagram, the Master and the AED with address 89 should include the termination resistances. Which is why in this AED, the bus termination is activated using the “*bus termination ON*” switch. This bus termination in the AD103C must also be activated using the commands **STR**1; and **TDD**1 (see file aed_help_e, AD103C; “Description of the basic commands”). If the “*bus termination switch is set to OFF*”, the command **STR** will have no effect, which means that bus termination is deactivated.

3.5 Connecting the diagnostic bus

The diagnostic bus is used to analyze dynamic processes. The bus is set out as an RS485 2-wire bus (lines: TB/RB and TA/RA, GND).

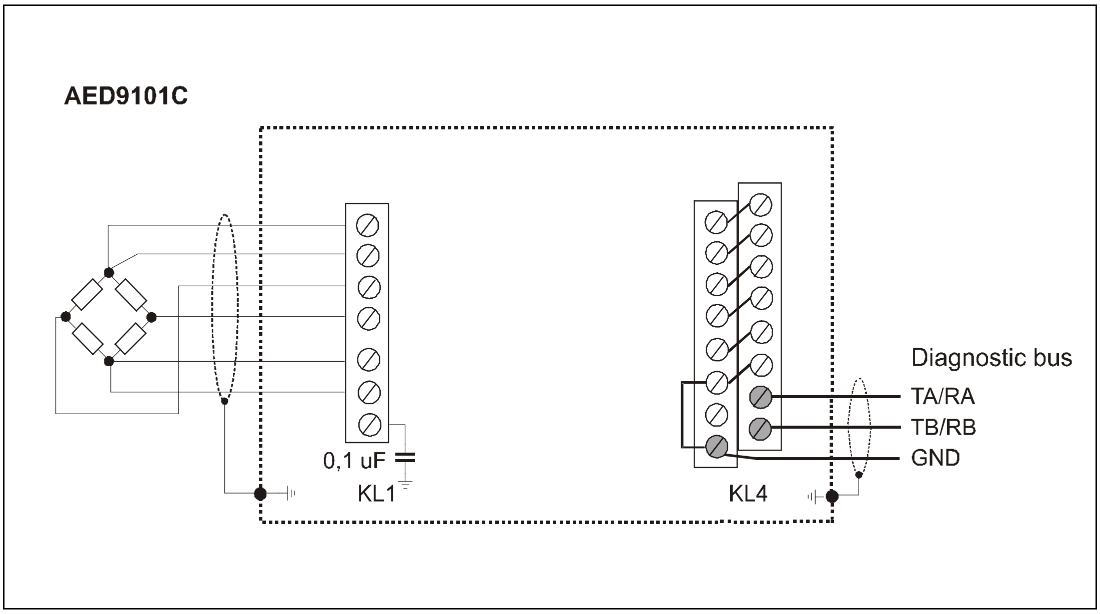


Fig. 3.5-1: Connecting the diagnostic bus via terminal KL4

The interfaces setting of the bus is defined and cannot be changed (38400 bit/s, 8E1).

External bus termination resistances are not necessary for this bus.

The HBM interface converter (1-SC232/485B) can be used to connect the RS485 bus to an (RS232) COM port of the PC.

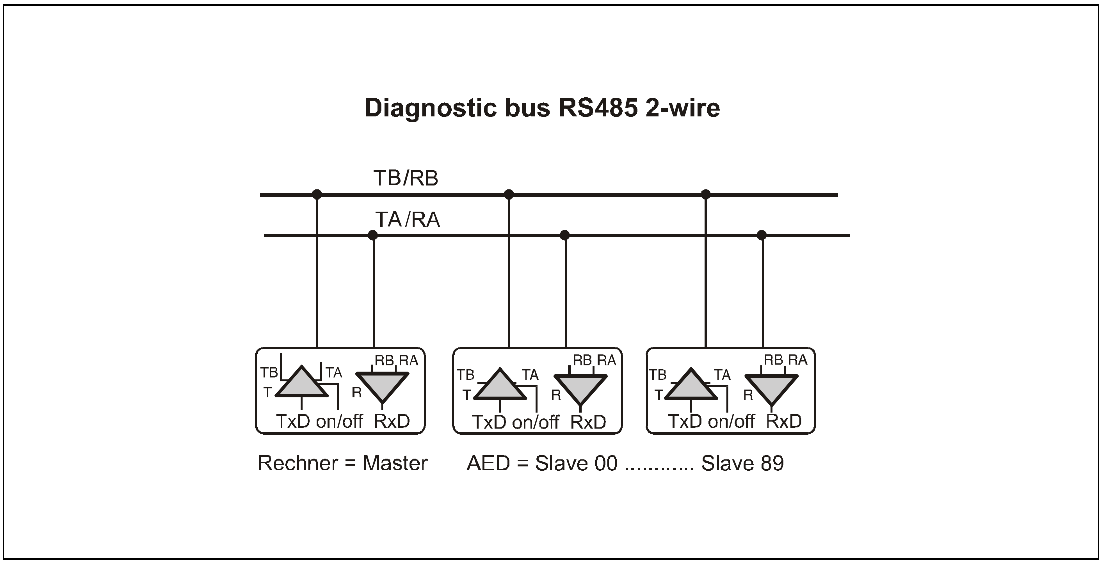


Fig. 3.5-2: Diagnostic RS485 bus

The ground of the interface driver is related to the GNDext terminal. The interface driver of the master should be also connected to this GNDext.

Only a connecting cable with a screen grounded on two sides should be used as the interconnecting cable between the AED 9101C and the bus and the master (see also: AED9101C cable connection via a PG gland)

The functions and commands of the diagnostic channel are described in the help file aed_help_e Diagnosis. The address corresponds to the address of the AD103C amplifier, command **ADR** (00...89, factory setting: 31), see aed_help_e, Basic Commands). This address is independently from the CANOpen address.

The following functions can also be executed via this bus:

Parameters	Read only (changes are not possible)
Measured values	Reading individual measured values **MSV**?; (MSV?i not possible)
Results	Trigger results and dosing results can be read

The diagnostic functions can be executed using the HBM *AED_Panel32* program (as from Version V3.0.0).

The HBM display unit DWS2103 can be connected with this interface. Than all implemented functions and parameters are accessible. This is independent from the main communication channel.

3.6 Trigger input

An external sensor (light barrier, contact, etc.), can be connected to the trigger input of the AD103C, to drive the trigger measurement function (see file aed_help_e, AD103C; “Description of the signal processing”).

The input is activated as an external trigger by the **TRC** command.

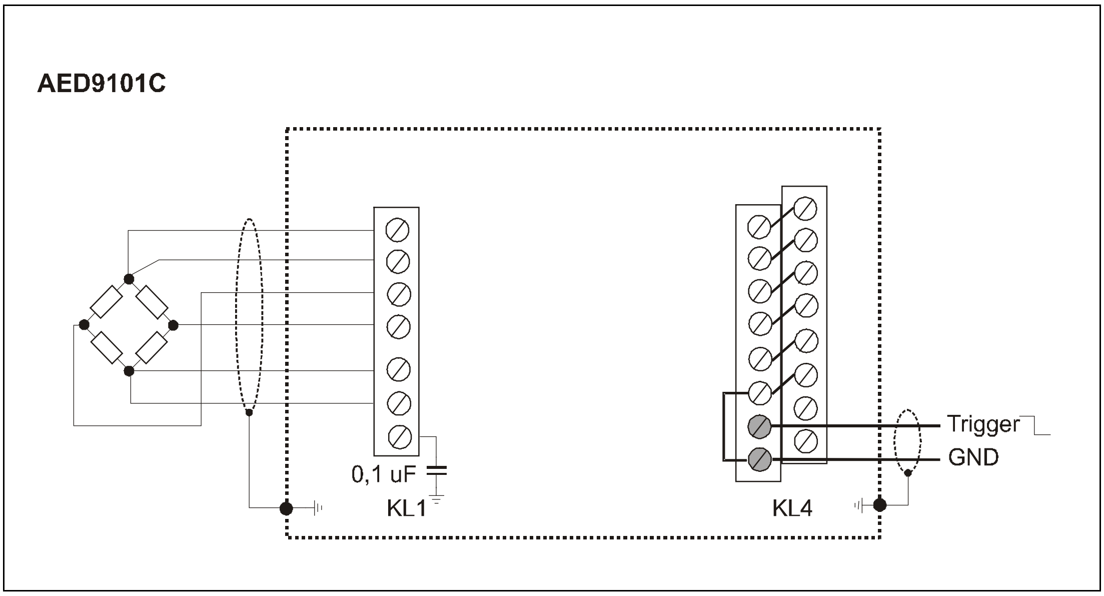


Fig. 3.6-1: Trigger input

The trigger input has the following properties:

Quiescent level:	Low
Active edge:	High – Low
High level:	2...30 V
Low level:	0...1 V
Input current:	≤3 mA (for 30 V), 10 kΩ input resistance

If the input is not required, the input remains unassigned. The GND of the trigger input is connected to the GND of the supply voltage.

3.7 AED9101C cable connection via a PG gland

Only a connecting cable with a screen grounded on both sides (and metal connectors) should be used as the connecting cable between the AED9101C and its partner device. Bring the screen extensively into contact on both sides at the PG gland (and at the metal shell of the connector). If the partner device does not have a metal connector, connect the cable shielding extensively to ground. If there are vast differences between the ground potential of the AED9101C and its partner device, a potential equalization line must be provided in addition.

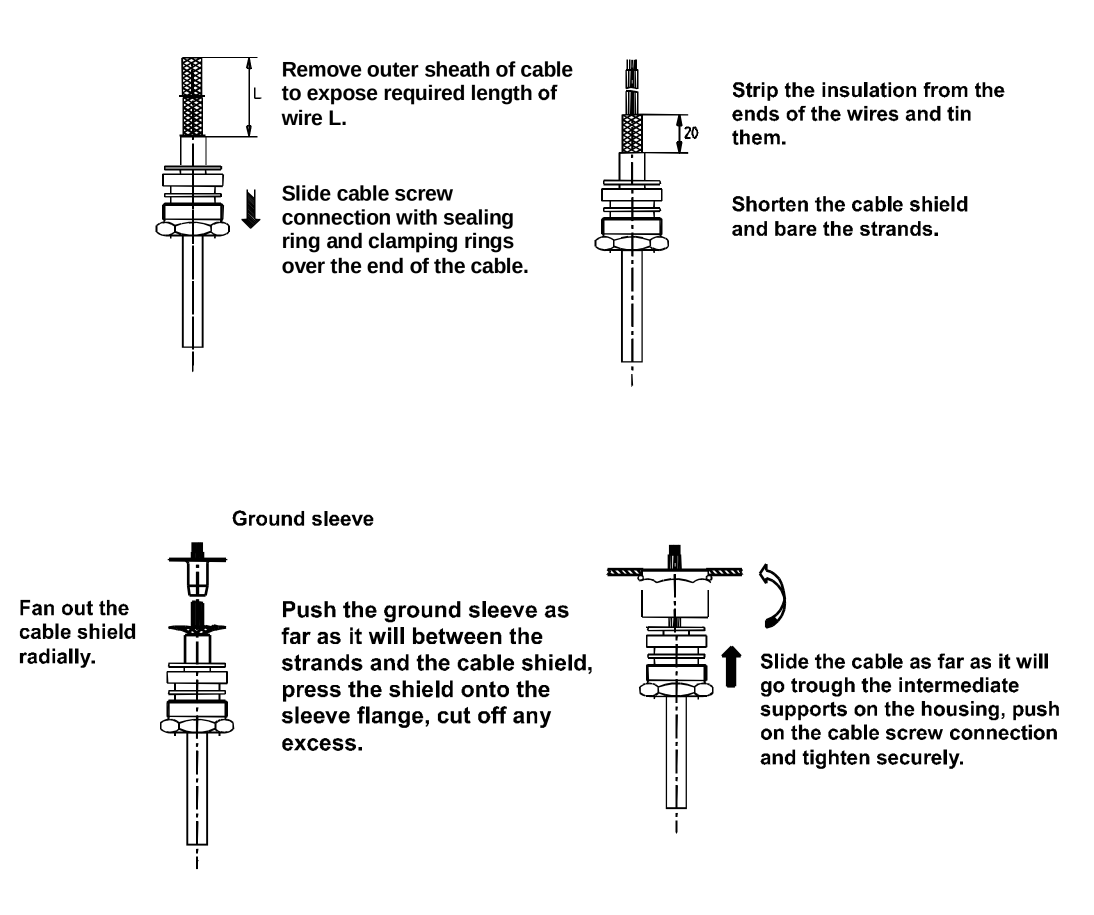


Fig. 3.7-1: Connecting the transducer, supply voltage and computer to the PG gland

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