Operating manual

Digital
Transducer-Electronics

AED 9101B

Part 1, Basic device

Part 1

Description of the hardware of the AED basic device AED9101B

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Part 2

Description of the hardware and the functions of the measurement amplifier board AD101B

Part 3

Description of the commands for the serial communication with the measurement amplifier board AD101B

Important notes

Without our express approval, the device must not be modified in terms of its design and/or technical safety aspects. Any modification excludes any and all liability on our part for any damage resulting therefrom.

In particular, it is prohibited to carry out any repairs, soldering work etc whatsoever on the boards and to exchange components. Repairs may only be carried out by HBM.

The complete factory settings are stored nonvolatile in the measurement board AD101B and cannot be deleted or overwritten; they can be reset at any time by means of the command **TDD0**.

You will find further information in the chapter ‘Individual descriptions of the commands’ *AD101B, AD103; Part 3*. The manufacturing number set in the factory should also not be changed.

The transducer must always be connected up (connect transducer or bridge model**).**

Safety notes

- Normally, the product does not represent any hazard if the notes and instructions for project planning, assembly, use within specifications and maintenance are complied with.
- The relevant accident prevention regulations, as applicable in each individual case, must be complied with.
- Assembly and commissioning may only be carried out exclusively by qualified personnel.
- Prevent dirt and humidity from ingressing into the inside of the equipment (AED9101B).
- When connecting cable implement measures against electrostatic discharges which may cause damage to the electronics.
- For power supply, a small voltage (6...30V) with safe disconnection from mains is required.
- When connecting additional devices, the safety regulations according to EN61010[1)] must be complied with.
- Use shielded cable for all connections. The screen is to be connected flush to ground on both sides.

1) "Safety regulations for electrical measurement, control, regulatory, and laboratory devices"

1 Introduction and Use

The digital transducer electronic devices AED9101B belong to the family of AED components which digitally condition and network as bus-capable signals from mechanical measured value transducers. This includes digital measurement amplifier boards, base devices with RS-485 interface, and intelligent sensors with integrated signal processing. The objective of these components is the digitization and conditioning of the measuring signals directly at the transducer location. Via the digital transducer electronics, SG transducers can be connected directly to a computer or PC within a full bridge circuit. This enables you to build up complete measurement chains – fast and at low cost.

The basic device AED9101B comprises the measurement amplifier AD 101B. The basic device provides mechanical protection, shields the measurement amplifier board (EMC protection), and offers the option to select additionally the serial interfaces RS422 (factory setting), RS 485, or RS232.

AED9101basic := basic device AED9101B + meas. amplifier AD101B

Part 2 of the operating instructions describes the measurement amplifier board, and Part 3 details the command set for serial communication.

The transducer electronic devices AED9101B are also abbreviated with **AED** in the following text.

1) Strain Gage

2 Mechanical construction

- Mechanical protection (IP65)
- Voltage supply for measurement amplifier board and transducer supply
- Total bridge resistance transducer > 40 Ω
- Selectable serial interfaces RS-422, RS-485 (4 wire / 2 wire)
- EMC tested

(The basic device AED9001A can be replaced by the basic device AED9101B.)

The measurement amplifier board is designed as a plug-in type board, which can be plugged into the carrier board of the basic device via a 25pin D connector. The basic device comprises the terminals for transducer, power supply device, and PC connection, the slide switches for interface selection, as well as the voltage stabilizer. The connection cables are fed out of the side of the housing, via PG boltings.

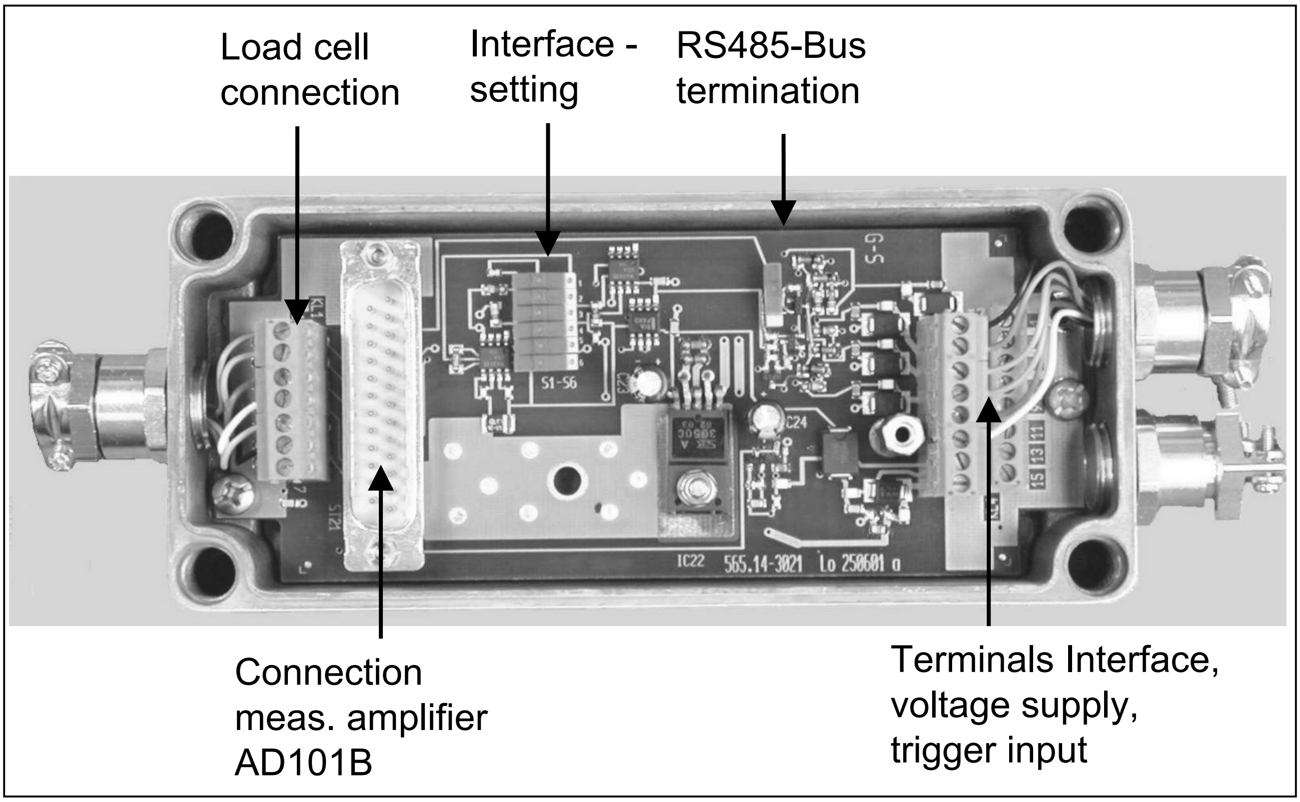


Fig. 2.1: Mechanical construction AED9101B

3 Electrical connection

A connection diagram is enclosed with the basic device AED 9101B. When making connections, please ensure that the cable wires do not protrude beyond the connection terminals (risk of loops forming). Please also ensure that the cable shield is correctly connected to the PG bolting (see Chapter 3.6).

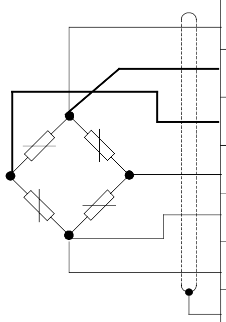
3.1 Transducer connection

Important Note

The transducer must always be connected up (connect transducer).

AED9101B with AD101B

It is possible to connect DMS transducers in a full bridge circuit with a total bridge resistance RB 40 ... 6000 Ω . The bridges are supplied by means of the basic device AED9101B (5VDC).



	Wire colour	Pin
Bridge supply voltage(+)	blue	3
Sense line (+)	green	3’
Meas. signal (-)	red	4
Meas. signal (+)	white	1
Sense line (-)	grey	2’
Bridge supply voltage (-)	black	2
Cable shield on housing		

Fig. 3.1.1: Transducer connection colour coding HBM for 6- wire technology

The 6 wire connection avoids a long cable influencing the measured value. When using several transducers and a distribution box, the 6-wire technology is routed through to the distribution box.

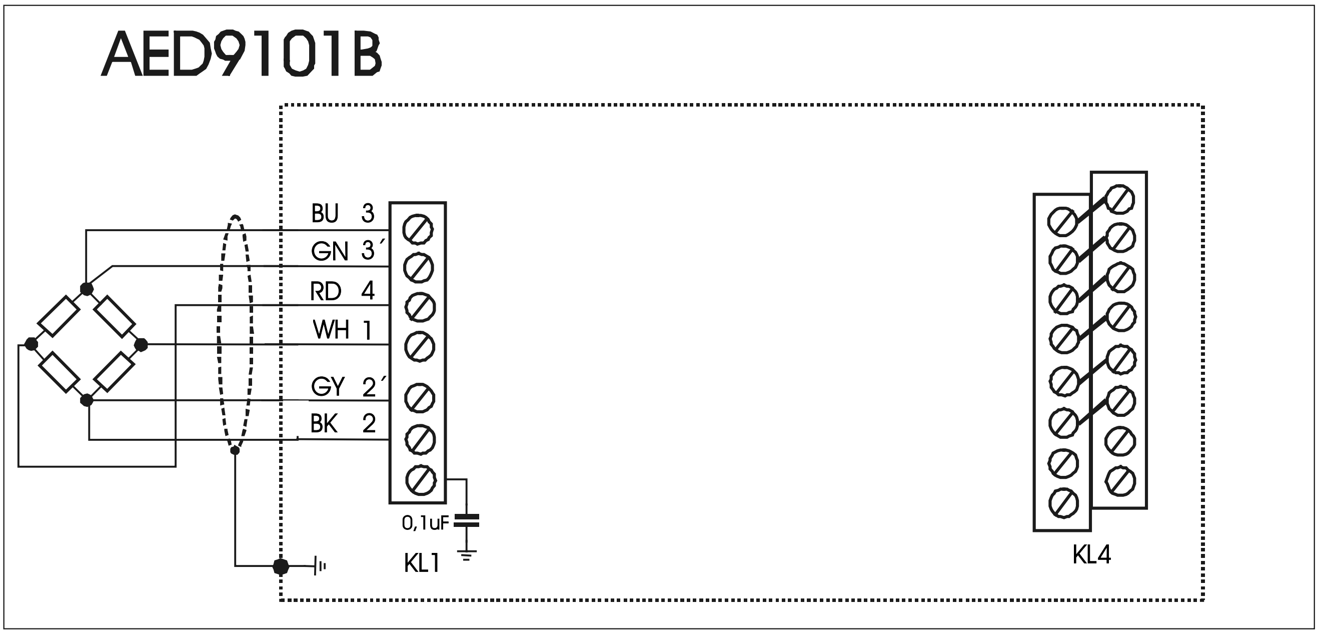


Fig. 3.1.2: Transducer connection in the basic device AED9101B with 6-wire connection (colours used by HBM: BU - blue, GN - green, RD - red, WH - white, GY - grey, BK – black)

For transducers calibrated in four-wire-technology, there are two types of connection:

- Connection via a six wire extension cable; sensor cable bridged in transducer connector.

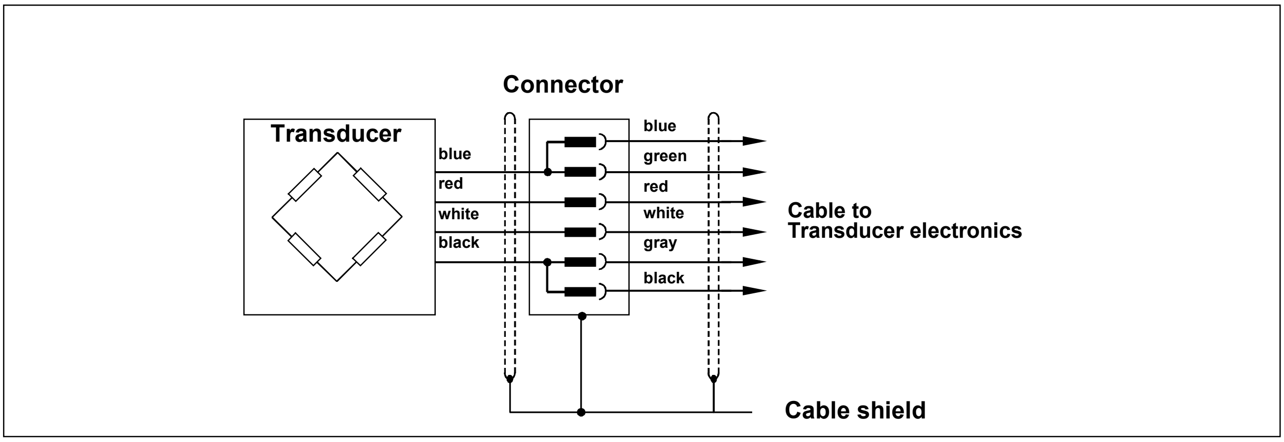


Fig. 3.1.3: Transducer connection in four - wire technology via six - wire cable extension (short circuit bridges 2 – 2‘ and 3 – 3‘,
Wire col. : BU - blue, GN - green, RD - red, WH - white, GY - grey, BK - black)

- Connection without an extension cable; sensor cable bridged on the transducer electronics (Fig. 3.1.4)

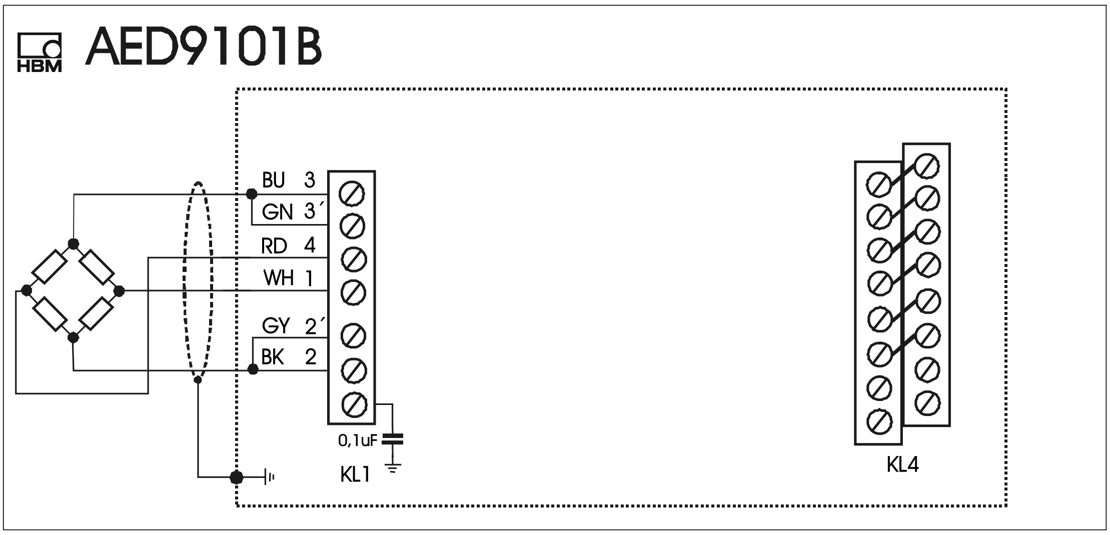


Fig. 3.1.4: Transducer connection in four-wire technology without cable extension (short circuit bridges 2 – 2‘ and 3 – 3‘),

(Wire colours : BU – blue, GN - green, RD – red, WH – white, GY – grey, BK – black)

When connecting several transducers, it is recommended to use a distribution box VKK4 or VKK6 by HBM. In general the supply cable to the AED should be implemented as shielded cable.

When connecting several transducers to the AED, note the number of connectable load cells (or the resulting bridge resistance) in relation to the external supply voltage, so as not to exceed the maximum dissipation loss in the basic device.

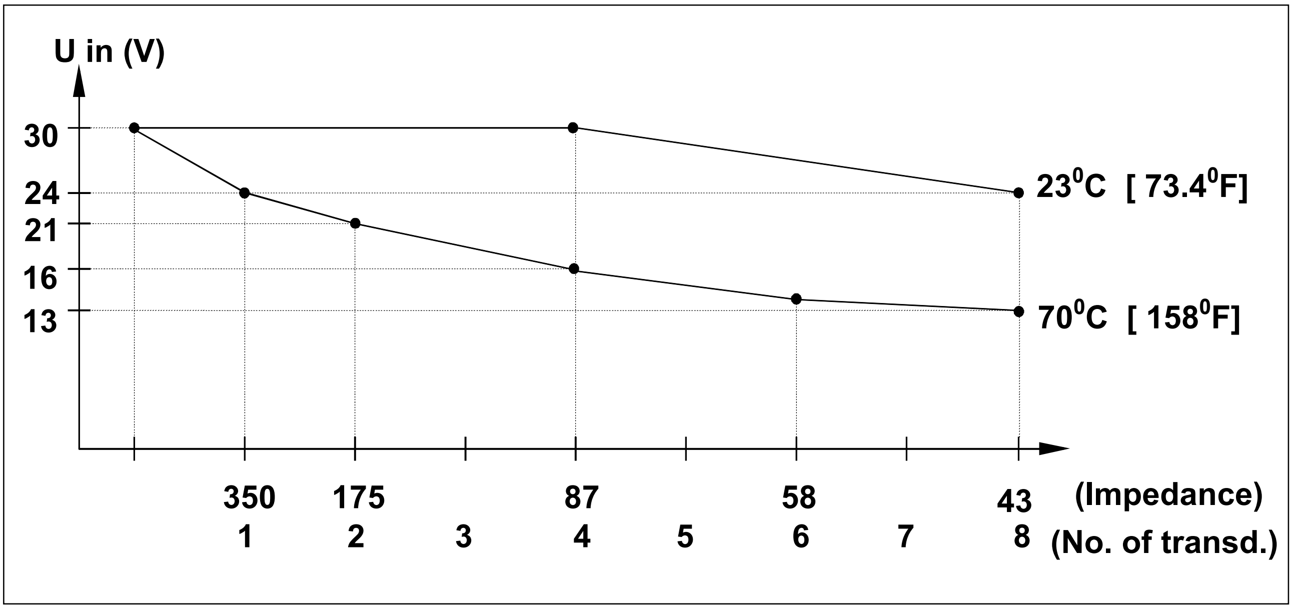


Fig. 3.1.5: Maximum operating voltage for the basic device AED9101B in relation to the number of transducers (resp. impedance in Ohm) and ambient temperature.

Notes on connection type, cable length and cable cross-section:

Depending on the bridge resistance of the transducer used, cable length, and cable cross-section of the load cell connection cable, voltage drops arise that lead to a reduction in the bridge supply voltage. Additionally, the voltage drop on the connection cable is also temperature-dependent (copper resistance). The load cell output signal also changes in proportion to the bridge supply voltage.

There is no effect with connection in 6-wire technology.

Effect on the measurement result with AUTOCAL (command ACL1) activated:

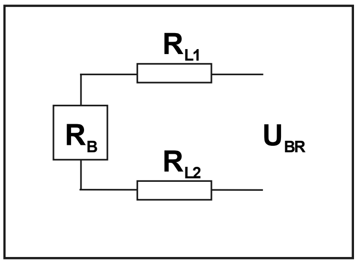
6-wire circuit (standard operation mode):

With the 6-wire-circuit the return cable 2´ and 3´ in the load cell (for load cells with 6-wire-connection) or directly on the load cell connection (for load cells with 4-wire circuit) with the supply cable 2 and 3 bridged (Fig.3.1.2). This corrects all influences. Even a change of cable length following a calibration does not lead to any deviations in the measurement results.

4-wire circuit:

With the 4-wire-circuit the return cable 2´ and 3´ on the connection terminals 2 and 3 are connected directly to the AED (Fig.3.1.3). As the correction by AUTOCAL can only be effected up to the return points 2´, 3´, all changes in cable resistance are reflected in the measurement result. That is, even if the 4-wire cable used for a calibration is no longer changed, there still result measurement errors in conditions with changing temperatures, caused by the temperature-dependent cable resistance and possibly also by transitory resistances in the connectors.

Replacement circuit for the bridge with bridge resistance RB and the supply cable with cable resistances R_{L1} and R_{L2}:



$R_{L1} = R_{L2}$: = $(4 x p_{cu}/\pi) x (l[m] / A [mm^2]$

p_{cu} = 0.0178 [Ωmm^2/m for copper]

π = 3.14 l = cable length A = cable cross section

$\rightarrow R_{L1} = R_{L2} = 1.6\Omega$ at l = 10m and A = 0.14mm^2

Fig. 3.1-2: Bridge replacement circuit

From the bridge resistance RB and the cable length l, cable cross-section A and the bridge supply voltage, the voltage across the supply cable of the bridge can be determined.

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

For R_B=80 ohms, $R_{L1}=R_{L2}$ = 1.6 ohms (l=10m) and U_{BR}=5V there results a a supply current $I_{BR} = U_{BR} / (R_{L1}+R_{L2}+R_B)$ = 60 mA and thus a voltage drop across the two cable resistors of a total 0.2V approx. (U_{bridge} = 4.8V).

For R_B=80 ohms, $R_{L1}=R_{L2}$ = 16 ohms (l=100m) and U_{BR}=5V there results a a supply current $I_{BR} = U_{BR} / (R_{L1}+R_{L2}+R_B)$ = 45 mA and thus a voltage drop across the two cable resistors of a total 1.4V approx. (U_{bridge} = 3.6V = 80 * 0.045).

For the 6-wire circuit, this is without significance as the voltage drop is taken into account via the sensor cable in the measurement signal.

However, for the 4-wire circuit, the dependence of the copper resistance of the cable directly influences the measurement result via the temperature, as the bridge supply voltage U_{bridge} changes:

$R_{L(t)}$:= R_{L20} x (1 + alpha x (t –20°C)),

with R_{L20} being the cable resistance at 20°C and alpha being the temperature coefficient of copper.

R_{L20} – calculation see above, $alpha_{CU}$:= 0,00392 [1/K]

For a cable length of l= 100m and a temperature difference of 10°C the following cable resistance results

$RL_{1(t)}$ = $R_{L2(t)}$:= 16 * (1 + 0,00392 x 10) = 16.6 Ohm

This changes the bridge supply voltage from U_{bridge} = 3.6 V (at 20°C) to U_{bridge} = 3.53V. This change in the bridge supply voltage directly at the transducer changes the measured signal of the bridge by 1.9 %
(= 100% x (1 – 3.53V/ 3.6 V)).

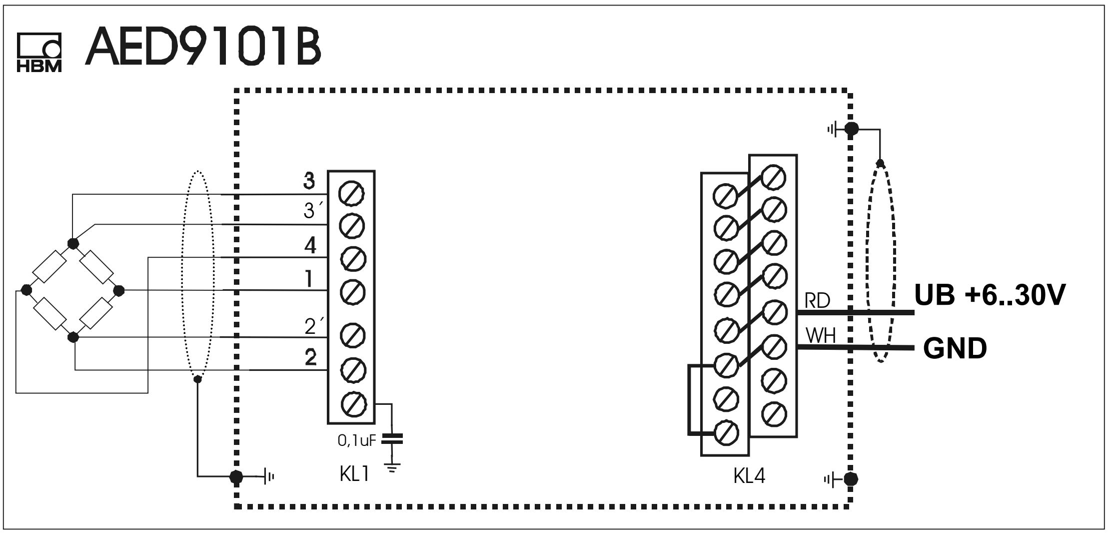
This exemplary calculation shows that for long cable lengths only 6-wire technology may be used.

3.2 Connection of the supply voltage

The voltage supply must meet the following requirements:

AED9101B with AD101B Direct voltage +6...+30V

Current consumption ≤200mA (for 40Ω bridge)



The voltage supply must be shielded. It can be fed in within the interface cable or designed as a separate cable.

When supplying several AED via a single cable, the voltage drop across the cable must be taken into account. The voltage drop depends on the necessary supply current and the cable resistance.

3.3 Connection to a PC

The basic device can be set to several interface variants.

No bus mode:

The interface **RS232** permits the direct connection of the AED to a PC. Therefore, the cable length is limited to 15m max., and no bus mode can be executed.

The interface **RS422** is a 4-wire- interface with a maximum cable length of 1000 m. In order to connect the AED to the COM-Port of a PC (RS232), an interface converter (interface converter by HBM 1-SC232/422A) is necessary. This interface is not designed for bus mode operation, as the transmitter is always active.

Bus mode

The interface **RS485** with a 4-wire- connection provides for the full functionality of the AED with a maximum cable length of 1000 m. In order to connect the AED to the COM-Port of a PC (RS232), an interface converter (by HBM 1-SC232/422A) is necessary.

The interface **RS485** with a 2-wire- interface also provides for cable lengths of <= 1000 m. In order to connect the AED to the COM-Port of a PC (RS232), an interface converter (by HBM 1-SC232/422A, switchover to two-wire mode) is necessary. However, here the AED must be operated in half-duplex mode (always set command COF 64 ... COF76). The command **MSV?0;** must not be used as an interruption of the measured value output with the command **STP;** is not possible.

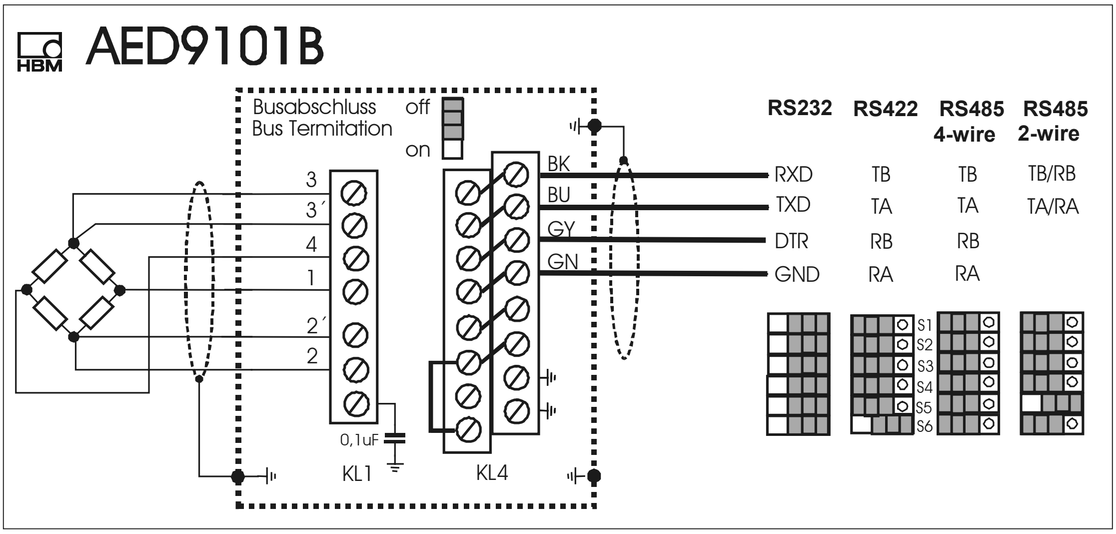


Fig. 3.3.1: Connection layout and interface setups (slide switches)
Wire colours : BU - blue, GN - green, RD - red, WH - white, GY - grey, BK - black GND=ground)

(equivalent designation of the interface TA=T-, TB=T+, RA=R- and RB=R+)

In principle, shielded cables should be used for interface wiring, with the cable shield being connected via the PG to the AED housing. (see Section 3.6) The voltage supply can now also be connected up via this cable, so that a 6-wire shielded cable is necessary.

If it is necessary, equipotential bonding should be established between the bus subscribers through a separate cable. The cable shield should not be used for this equipotential bonding. A double shielded cable is recommended for this cable for EMC reasons (available from HBM, e.g.: 3 x 2 x 0.14m² , 4-3301.0071).

The shield of the master cable is connected with the shield of the AED cable (not with the supply ground).

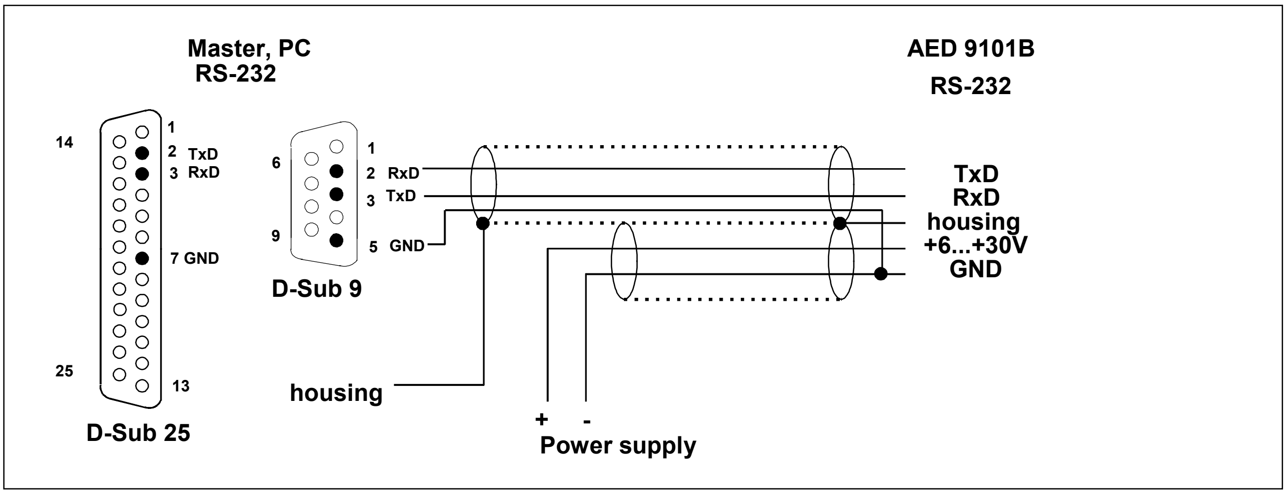


Fig. 3.3.2 Connection of an AED to a computer via the interface RS-232

During interface setup of the RS232 the switch bus termination must be set to OFF.

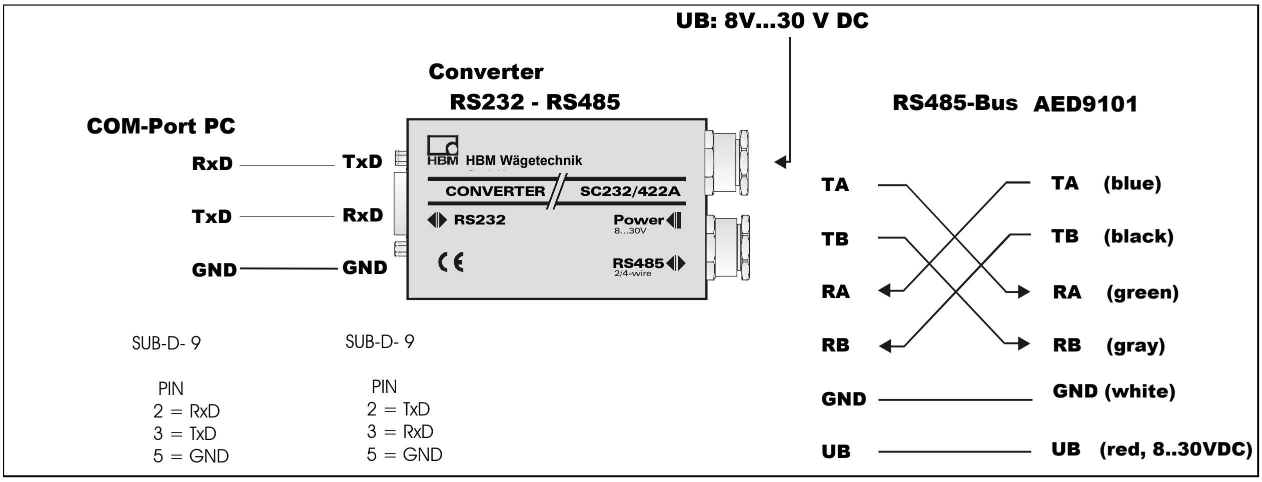


Fig. 3.3.3 Connection of an AED (RS422 or RS485 4 wire) to a computer via the HBM Converter.

3.4 Multi-channel measurements (bus mode, RS485)

Several AEDs can be connected to a common bus cable through the RS-485 interface. The principle of bus wiring for 4-wire operat. is illustrated in Fig. 3.4.1.

Up to 32 AEDs can be connected to a common bus cable through the RS-485 interface. Long cable lengths (up to 1000m) can be achieved with the aid of the RS485 bus drivers.

The bus mode of the AED is designed as master-slave configuration, whereby the AED implements a slave. Thus all activities of the AED are initiated by the control computer. Each AED receives its own communication address (00 ... 31) and can be activated through a select command Sii (ii= 00...31). A broadcast command (S98) is implemented for certain cases of communication. This means that after such a command, all AED execute the command of the master, but no AED answers. All commands of this communication as well as corresponding examples are described in the operating instructions, Part 3.

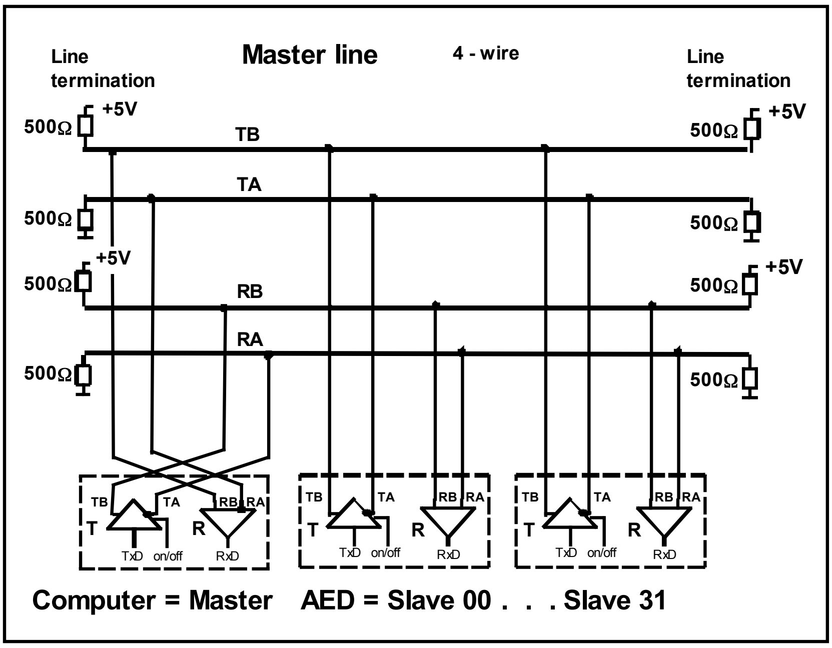


Fig. 3.4.1: Bus structure 4 - wire bus (general)

The terminating resistors of 500 ohms drawn in Figure 3.4.1 are important for the electrical functioning of the bus system. These resistors protect the quiescent-signal levels for the receivers on the bus cable. The master cable may be terminated with these resistors at the cable ends only.

The master and the AED with the address 31 should contain the terminating resistors for the local distribution of the bus connections shown in the Figure. Therefore, bus termination is activated in this AED by means of the switch ‚bus termination ON;**.** In addition, this bus termination in the AD101B must be activated via the commands **STR1**; and **TDD1** (see operation instructions, Part 3). If the switch ‚Bus termination' is set to OFF, then the command **STR** does not have any effect, that is, bus termination is deactivated.

The HBM interface converter also contains these bus termination resistors.

Important note

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

The quiescent -signal level on the RS-485 master cable results in the 4-wire mode at:

TB - TA $\geq$ 0.35 V (quiescent -signal level due to the AED term. resistors)

RB - RA $\geq$ 0.35 V (quiescent -signal level due to the master term. resistors)

Since the RS-485 is a differential bus interface, the quiescent-signal levels are also stated as a differential voltage between the cable (and not related to ground). It must further be noted that this interface tolerates a maximum common-mode range of ±7V.

RS485-2-wire-mode

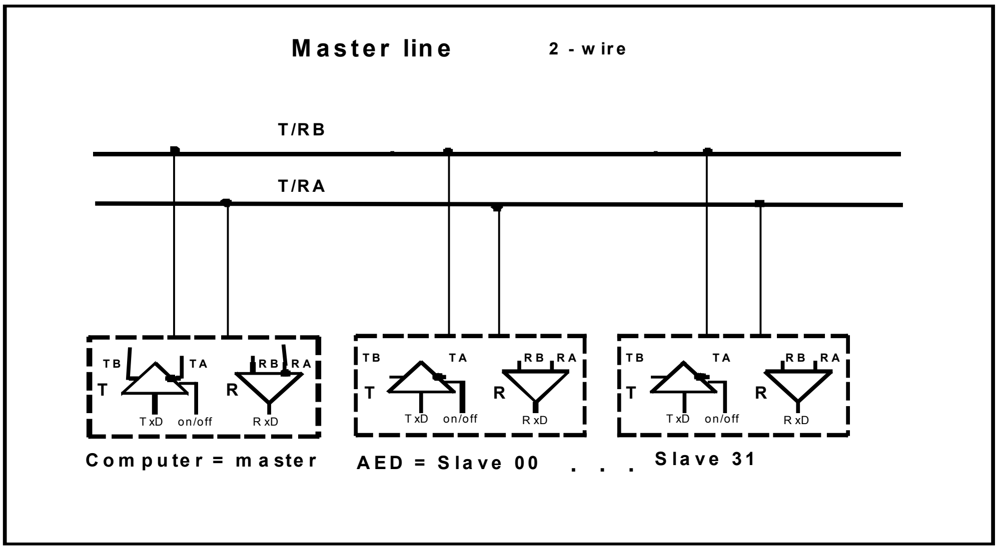


Fig. 3.4.2 : Bus structure 2 - wire bus RS485 (general, T/RB = T/R+, T/RA = T/R-)

Termination resistors are necessary for the electrical function of this bus system. These resistors protect the quiescent-signal levels for the receivers on the bus cable. These termination resistors are already contained in the AED and to be set via the switch ‚Bus termination’ (see 4-wire cable) . The quiescent -signal level on the RS-485 master cable results in the 2-wire mode at:

T/RB – T/RA ≥ 0,35V

The master and the AED with the address 31 should contain the terminating resistors for the local distribution of the bus connections shown in the Figure. Therefore, bus termination is activated in this AED by means of the switch ‚bus termination ON;**.** In addition, this bus termination in the AD101B must be activated via the commands STR1; and TDD1 (see operation instructions, Part 3). If the switch ‚Bus termination‘ is set to OFF, then the command STR does not have any effect, that is, bus termination is deactivated.

3.5 Trigger input

An external sensor (light barrier, contact a.o.) can be connected to the trigger input of the AD101B in order to drive the trigger measurement function (see operation instructions AD101B, Part 2).

The command is to be activated as an "external trigger" via the command TRC (see operating instructions Part 3)

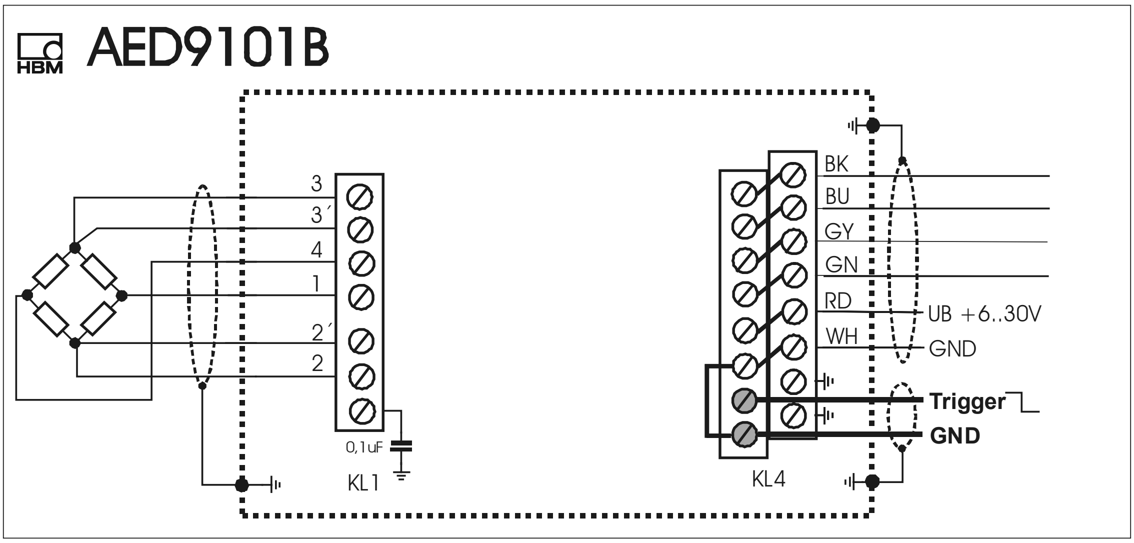


Fig. 3.5.1: Connection of the trigger input

The trigger input has the following properties:

Quiescent signal level:	High
Active flank:	High - Low
High level:	2....30 V
Low level:	0....1 V
Input current:	$\leq$ 3 mA (at 30V), 10k ohm input resistance

If the input is not required, the input remains open.

The GND of the trigger input is connected with the GND of the supply voltage.

3.6 Cable connection AED9101B via PG unions

As a connection cable between the AED 9101B and partner device, only a connection cable with a shield grounded on both sides (and metal connectors) may be used. The shield is to be full-surface applied to the PG union (and to the housing of the metal connector). If the partner device does not have any metal connector, the cable shield is to be full-surface connected to ground. If large ground potential differences exist between AED9101B and the partner device, an equipotential bonding conductor is to be provided additionally.

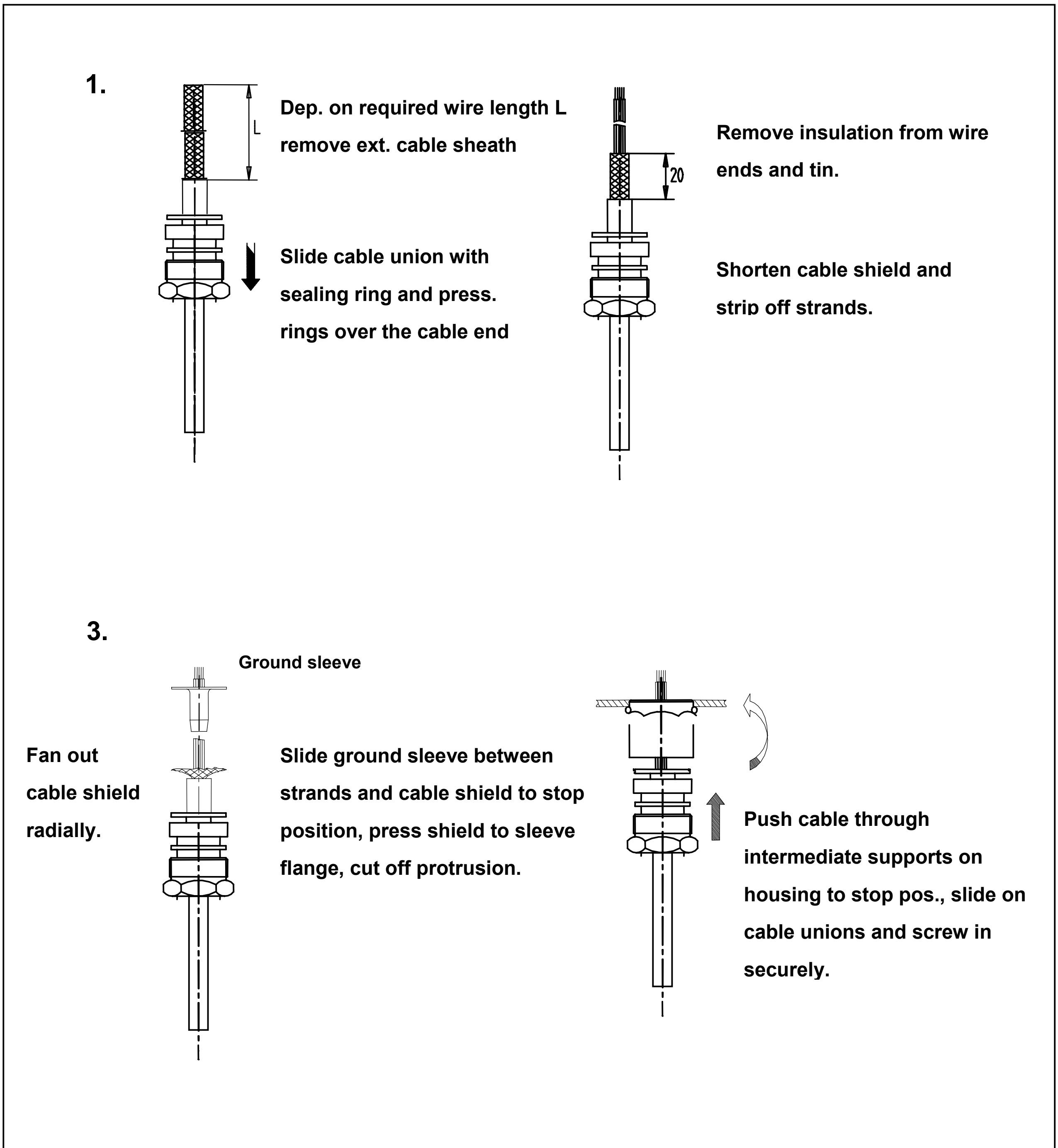


Fig. 3.5-2: Connection of transducer, supply voltage and computer to a PG union

4 Technical data of the AED9101B basic device

Type		**AED 9101B**
Measured signal input; DMS transducer (full bridge) Transducer connection Transducer – supply voltage	 Ohm VDC	 >40 * 6-wire circuit 5
Transducer cable length	m	≤100
Interfaces (selectable by slide switch)		RS422, RS485 or RS232
Cable length interface RS-232	m	≤15
Cable length interface RS-422 / RS-485	m	≤1000
Trigger input Low level High level Input current	 V V mA	 0...1 2...30 <3 mA
Operating voltage (DC)	V	6...30
Current consumption (without load cell)	mA	≤ 80 **
Nominal temperature range	°C	-10 ... +60
Operating temperature range	°C	-20 ... +70
Storage temperature range	°C	-40 ... +85
Dimensions (l x w x h)	mm	200 x 65 x 40
Weight	g	approx. 400
Type of protection according to DIN 40050 (IEC 529)		IP 65

*** Supply from operating voltage**

**** Current consum.** $= \leq 80\text{mA} + \frac{\text{Supply voltage UB} = 5\text{V}}{\text{Bridge resistance RB}}$

Within the shielded structure (see Sect. 3), the entire measuring chain including the AED is insensitive against HF interference and conducted interference in accordance with OIMLR76, EN45501 or EN55011B (interference emissions) and EN50082-2.

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