

Digital Transducer-
Electronics

**AD104-R2,
AD104-R5**



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Safety notes

- In the normal case the product causes no dangers, provided the notes and instructions for configuring, installation, operation as intended and maintenance are complied with.
- The safety and accident prevention regulations applicable corresponding to the application must be observed without fail.
- Installation and commissioning may be performed exclusively by qualified personell.
- Avoid the penetration of dirt and moisture into the interior of the unit when connecting the cables.
- When connecting the cables take measures against electrostatic discharges which can damage the electronic unit.
- An extra low voltage with safe isolation from the mains is required for the power supply of the unit.
- When connecting additional devices, the safety regulations according to EN610101) must be complied with.
- Shielded cables are required for all connections. The shield must be connected flatly with ground at both ends.

1) "Safety regulations for electrical measuring, control and laboratory equipment"

1 Intended use

The digital sensor electronic units AD104 belong to the family of AED components which digitally condition and network as bus-capable signals of mechanical measured value transducers. The objective of these components is the digitization and conditioning of the measuring signals directly at the transducer. The AD104 and the transducer (load cell) form a unit and cannot be replaced separately (transducer calibration of the measurement chain with SZA/SFA is necessary).

As transducers, calibrated load cells or force transducers (adjusted in TCZ,TCS, and zero point) can be used.

The measuring amplifier boards AD104 have different interface connections which are produced in the factory by corresponding assembly:

AD104-Type	Interface	Interface Connect.	Bus mode	Cable length	external Trigger
AD104-R2	Asynchronous, serial	RS-232 duplex	no	≤ 15m	yes
AD104-R5	Asynchronous, serial	RS-485 -4-wire, full duplex	yes	≤ 500m	yes

The transducer electronic units AD104 are also abbreviated with AED in the following text.

Old type: AD104-R4 → **new type: is AD104-R5 with external trigger**

New type: AD104-R2 with external trigger and RS232 interface.

2 Characteristic features

- Operating voltage 5.6V...15V DC
- 4 wire Interface for a full bridge sensor, nominal input range ± 2 mV/V, maximal input range ± 2.6 mV/V
- Serial interface RS-485 (bus mode) or through RS-232 interface (point - to - point mode)
- Digital filtering, choice of the output speed and scaling of the measured signal
- Separated calibration of transducer and application characteristic
- Storage of the parameters nonvolatile
- All settings are made through the serial interface
- Automatic zero tracking (1d/s, $\pm 2\%$)
- Automatic initial zero setting ($\pm 2\%$... $\pm 20\%$)
- Trigger functions (level or external trigger)

3 Mechanical construction

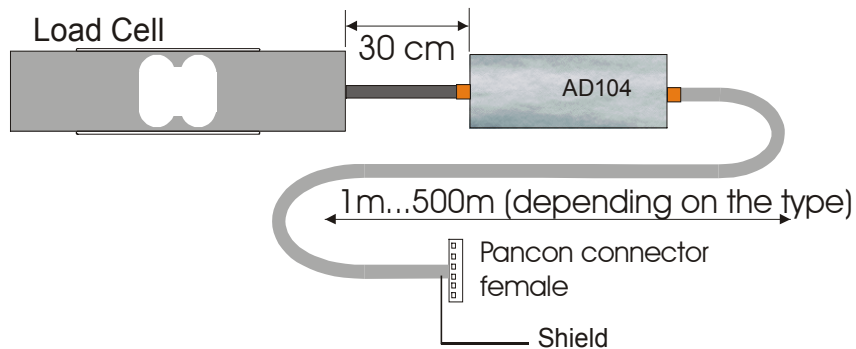


Fig. 3.1: Example of a mechanical construction of a measuring chain (HBM)

The amplifier circuit board has to be placed in a shielded housing (EMC protection). The cable connections has to be shielded leads.

With digital transducers (FIT, C16,...) the AD104 is build in the housing of the load cell. For digital measuring chains the AD104 is included in a separate housing in the cable (degree of protection IP 40).

Warning: The AD104 board is not protected against electrostatic discharges. Appropriate safety precautions must be taken for handling during assembly into the transducer.

4 Electrical construction

The circuit of the digital transducer electronic unit consists essentially of the following functional groups:

- Transducer supply
- Amplifier
- Analog-digital converter (A/D)
- Microprocessor unit (μ P)
- Parameter memory (EEPROM) protected against power failure
- Serial interface (RS232- 2 wire or RS485)
- Power supply
- Trigger input

4.1 Function

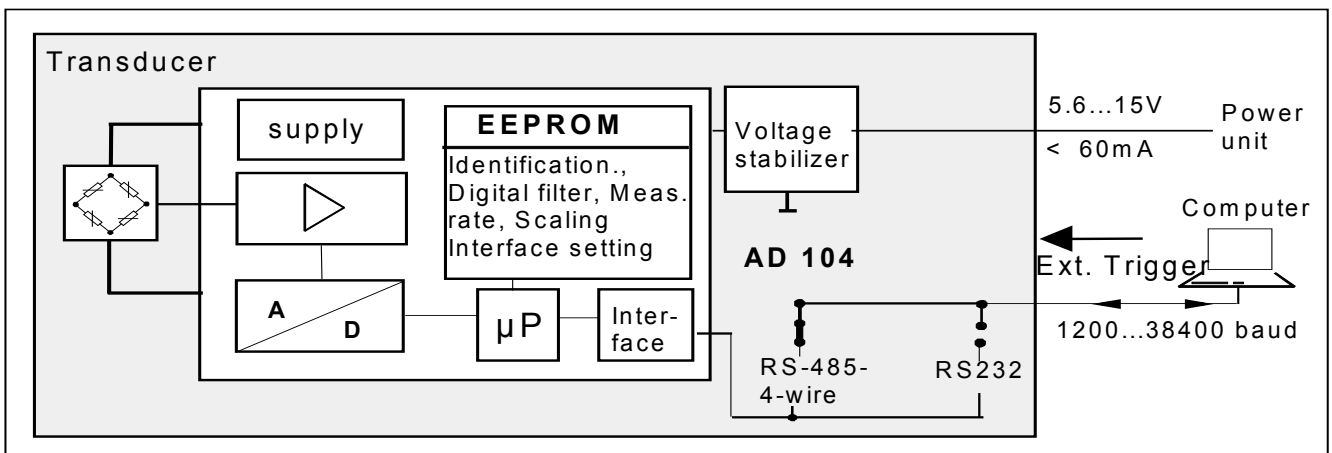


Fig. 4.1: Measuring amplifier board AD104 block circuit diagram

The analog transducer signal is initially amplified, filtered and then converted into a digital value in the analog-digital converter. The digitized measuring signal is processed in the microprocessor. The conditioned signal is then transmitted to a computer through the serial interface. All parameters can be stored in the EEPROM, protected against power failures.

The transducer electronic unit is adjusted in the factory to the no-load and the nominal load of the transducer. The electronic unit determines a factory characteristic through the commands **SZA** and **SFA** from these measured values and images the measured values following later by means of this characteristic.

The following measured values are delivered according to output format (COF):

Output format	Input signal	Measured values at NOV = 0	Measured values at NOV > 0	Delivery status NOV=0
Binary 2 characters (Integer)	0...Nominal load	0 ... 20 000 Digit	0 ... NOV	
Binary 4 characters (Long Integer)	0...Nominal load	0 ... 5 120 000 Digit	0 ... NOV	
ASCII	0...Nominal load	0 ... 1 000 000 Digit	0 ... NOV	x

You have the possibility of adapting the characteristic to your requirements (i.e. scale characteristic) correspondingly with the parameter pair **LDW** and **LWT** and to standardize the measured values to the required scaling value (e.g. 3000d) via the command **NOV**.

4.2 Signal processing

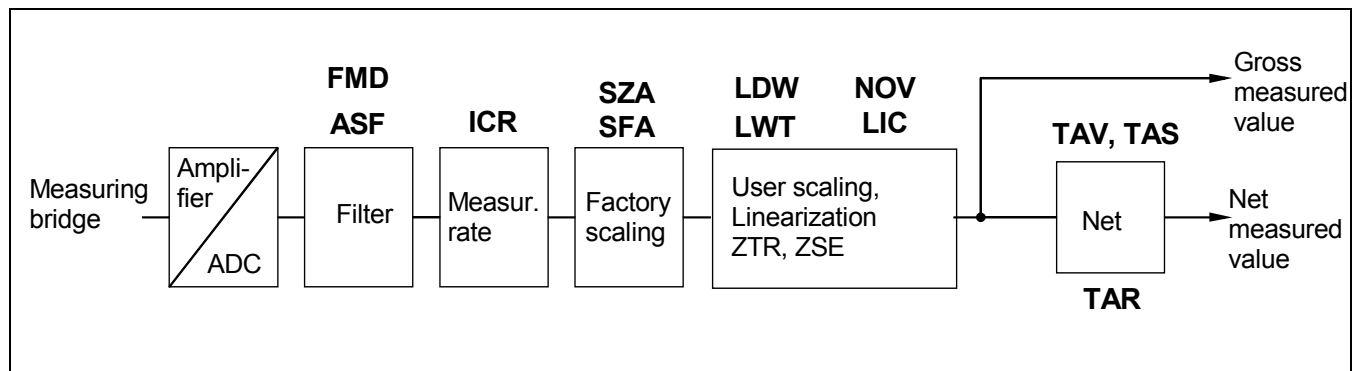


Fig. 4.2.1: Signal flow diagram

After amplification and AD conversion, the signal is filtered by adjustable digital filters (command **ASF**). The factory characteristic is determined with the aid of the commands **SZA** and **SFA**.

The measuring signal bandwidth (digital filter) is set with the command **ASF**. The measuring rate (number of measurements per time unit) can be changed depending upon the filter bandwidth with the command **ICR**.

The user can set his own characteristic (commands **LDW**, **LWT**, **NOV**) without changing the factory calibration (**SZA/SFA**). Furthermore, gross/net switch-over is available (command **TAS**). Using the command **ZSE** an automatic switch-on zero setting can be activated. An automatic zero tracking function (**ZTR**) is also available.

For a linearization of the scale characteristic, the command (**LIC**) is available (with a polynomial of the 3rd order). The polynomial parameters can be determined by means of a HBM PC program **AED_LIC**.

The current measured value is retrieved by the command **MSV?**. The format of the measured value (ASCII or binary) is set by the command **COF**. An automatic measured value output can also be selected via the command **COF**.

Two types of digital filters, which are switched over using the command **FMD**, are implemented in the AED. At **FMD0** filters lower than 1 Hz bandwidth are also available. In the filter mode **FMD1**, filters with fast transient recovery are activated with high damping in the stop band. You will find detailed information in the chapter 'Individual descriptions of the commands'.

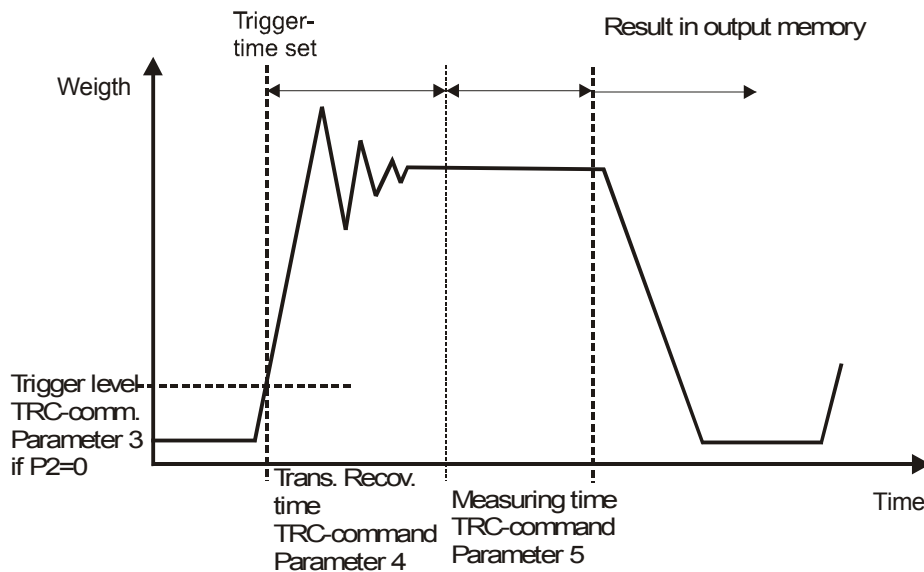
The AD104 comprises **two trigger functions** in order to support functions in packaging machines and checkweigher:

- triggering by means of an adjustable level (gross and net measured value, for both types)
- external triggering by means of a trigger input

This special measuring mode is activated by means of the command **TRC**. The measured value determined is output by means of the command **MAV?**. For this measuring mode, filter mode **FMD1** should be set (fast settling time).

The measuring speed depends on the preset stop time and the measuring period. The stop time should match the fast transient recovery of the filter used (**ASF**).

Triggering (TRC-Command: Parameter 1=1)



Level triggering:

This measuring mode is suitable for weighing processes where the scale is relieved in between weighing events.

The scale is in a no load condition. The material to be weighed will be placed on the scale, the trigger level is exceeded, and stop time measurement starts. On expiry of this transient period, the actual weight will be determined; and on expiry of this measuring period, the actual weight value will be stored in memory. The weighing process can be restarted only once the weight value is again lower than the trigger level (place scale in no load condition). In this measurement mode, weight determination does not need to be monitored by an external computer at high speed. The output memory will contain an invalid value until a new measured value has been created. After retrieving the contents of the measured value memory by means of the **MAV?** command, this memory is reset to an invalid condition (invalid value < - 1600 000).

The periods (stop time and measurement period x 10ms at **ICR0**) and the trigger level can be freely set by means of the command **TRC**. The trigger level will be on the user characteristic (**NOV**).

External trigger:

Both types support an external trigger instead of the limit value trigger. This trigger has a quiescent signal level at 0V (=low) and uses the low/high edge to activate the measurement process.

The trigger flank starts the stop time measurement. On expiry of this transient period, the actual weight will be determined over the measurement period, and the averaged actual weight value will be stored in memory. The output memory will contain an invalid value until a new measured value has been created. After retrieving the contents of the measured value memory by means of the **MAV?** command, this memory is reset to an invalid condition. The periods (stop time and measurement period x 10ms at **ICR0**) and the trigger level can be freely set by means of the command **TRC**. A renewed trigger flank will restart the measurement process. The scale does not need to be placed into a no load condition.

During a measuring (waiting time + measuring time) a trigger signal is invalid (no re-triggering). Within this mode the parameter trigger level (P3) has no function.

5 Electrical connection

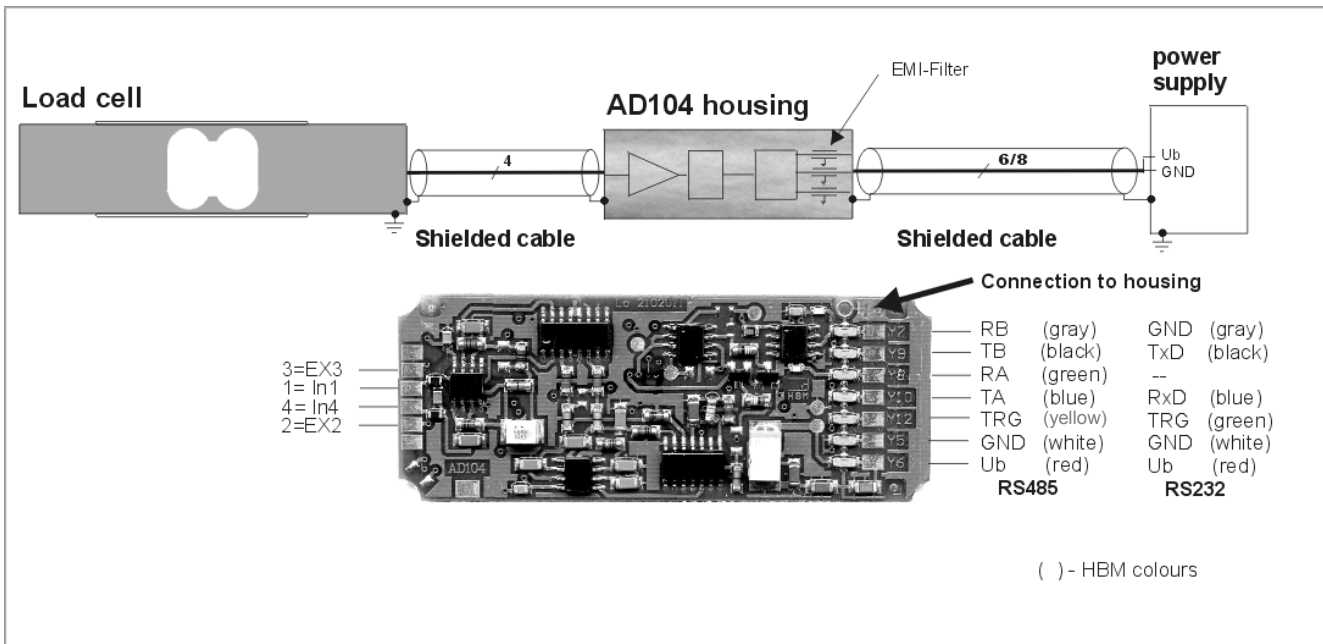


Fig. 5: Connection schema of the PCB and shielding concept of a measuring chain

The connection to the PC is effected by means of a 6 / 8 pin Pancon connector. The following pin wirings result at the connector according to the set interface (i.e. measuring chains of HBM):

AD104 type	AD104-R5	AD104-R2
Pancon Connector	Signals RS-485	Signals RS-232
1. red	UB	UB
2. white	GND	GND
3. blue	TA	RxD
4. green	RA	TRG
5. black	TB	TxD
6. grey	RB	GND
7. yellow	TRG	-
8.	-	-

- **do not connect!**

The measuring chain of HBM with AD104-R5 has a 8 wire shielded cable.

The measuring chain of HBM with AD104-R2 has a 6 wire shielded cable.

Explanation:	UB	Supply voltage (+ 5.6V...15V)
	GND	Ground
	RA	4-wire connection AED receiver, line A (=RX-)
	RB	4-wire connection AED receiver, line B (=RX+)
	TA	4-wire connection AED transmitter, line A (=TX-)
	TB	4-wire connection AED transmitter, line B (=TX+)
	RxD	Receiver data (UART, RS-232)
	TxD	Transmit data (UART, RS-232)
	TRG	External trigger signal

Trigger input (electrical data):

High:	3.2V ... 5V
Low:	0V ... 0.8V
Input current:	<2.5 mA

Important notes on EMC protection:

The PCB AD104 alone has no EMC protection. The EMC protection can be achieved in addition with a shielded housing for the electronic and the use of shielded cable.

Mount the load cell onto a metallic carrier which is connected to the ground connection of the device, or shield AD104 with the load cell and load introduction parts as a complete unit. The cable shield needs to be connected with the measuring body of the loadcell and the housing of the AED.

The housing of the AED or the load cell has to be connected via the solder pad to the PCB (see Fig. 5, 'connection to housing'). The AED unit itself is provided with a protective filter for all interfaces and supply lines.

The connection between load cell and electronics should be as short as possible. Depending on the bridge resistance of the transducer used, line length, and line cross-section of the transducer 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 transducer output signal also changes in proportion to the bridge supply voltage.

With the 4-wire circuit used, 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.

When setting up a measurement chain (electronics outside the transducer) it should also be noted that the AD104 uses a rectangular carrier frequency for bridge supply. Therefore, the cable length between AD104 and the transducer is limited to 100 cm max. For high precision applications ($\geq 3000d$), the length should be reduced to 30cm (shielded cable, shield connection on the measuring body and on the shielded housing for AD104).

5.1 Transducer Connection

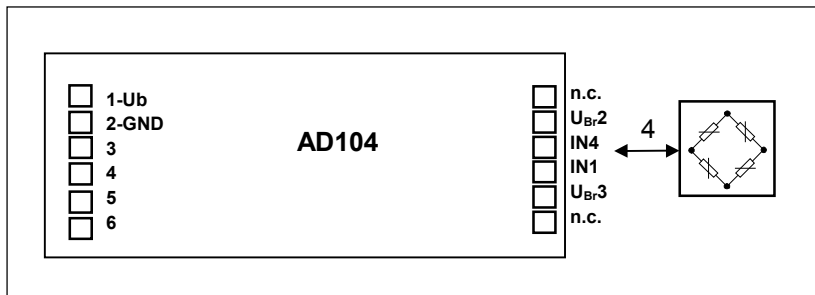


Fig. 5.1: Transducer connection with the PCB (n.c. - not connected)

The AED amplifier is already mounted with the transducer. A changing of the modules (AED or transducer) is only allowed in HBM factory.

For the transducer connection a 4 core **shielded** cable has to be used.

Connection Pads for a full bridge:

Pad	Description
U_{Br2}	bridge excitation 2
IN4	amplifier input 4
IN1	amplifier input 1
U_{Br3}	bridge excitation 3

Notes on cable length:

The connection between load cell and electronics should be as short as possible. Depending on the bridge resistance of the transducer used, line length, and line cross-section of the transducer 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 transducer output signal also changes in proportion to the bridge supply voltage.

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5.2 Serial Interface RS-232 (only AD104-R2)

The **AD104-R2** is a version of the AD104 with an asynchronous, serial interface (UART interface with RS-232 line driver). This interface provides a point-to-point communication (no bus mode).

The baud rate of 1200...38400 baud can be selected for this interface. The following specifications result for the transmission of one character:

Start bit:	1
Number of data bits:	8
Parity bit:	none / even
Stop bit:	1

The connection is made through a six-core cable. The maximum cable length is 15 m. **No bus mode** is possible in this type of communications (no bus driver).

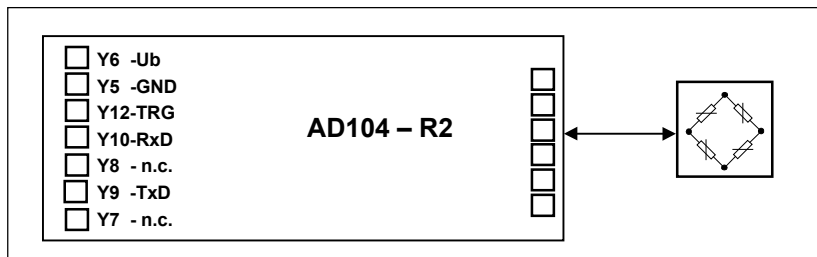


Fig.5.2: Connections on the PCB (AD104-R2)

The connection scheme for the asynchronous interface results as follows:

AD104-R2			Master	
Receiving line	RxD	←	TxD	transmission line
Transmission line	TxD	→	RxD	receiver line
Operating voltage	U _B	—		supply voltage (5.6V..15V _{DC})
Ground	GND	—	GND	Ground
Ext. trigger	TRG	←		external trigger signal

The levels on the RxD and TxD lines are RS-232 levels, whereby the quiescent-signal level is <-3V (Low).

External trigger signal:

Quiescent-signal level: TRG= 0V (Low)

Active measuring: TRG= Low-High edge (0V...5V)

If the external trigger is not used, the input remains open.

5.3 Serial Interface RS485 (Bus mode with AD104-R5)

Up to 32 AEDs can be connected to a common bus line through the RS-485 interface. The baud rate can be selected between 1200 and 38400 baud in this version.

The following specification applies for the transmission of one character:

Start bit:	1
Number of data bits:	8
Parity bit:	none / even

Stop bit: ^

1

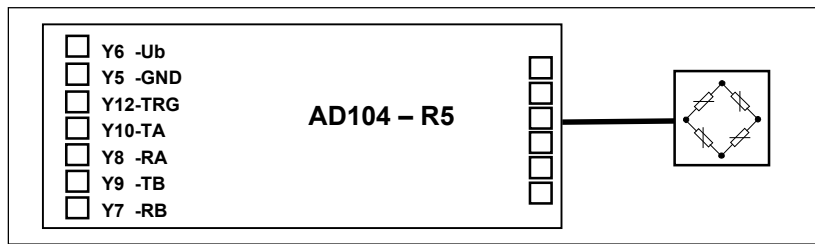


Fig. 5.3.1: AD104-R5 for 4-wire bus mode (PCB connections)

1. Long cable lengths (up to 500m) can be achieved with the aid of the RS485 bus drivers.
2. 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 S_{ii} ($ii= 00...31$). 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 Chapter 7.

Figure 5.3.2 shows the connection of the bus to the RS232/RS485 Converter (HBM Ordering-No. 1-SC232/422A).

Figure 5.3.3 shows the RS485 bus connection.

The terminating resistors of 500 ohms drawn in Figure 5.3.3 for the electrical function of the bus system are important. These resistors protect the quiescent-signal levels for the receivers on the bus line. The master line may be terminated with these resistors in this case only at the line ends. 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. The AED contains these resistors already. These can be activated by the command STR1 (these terminating resistors are switched off on factory delivery). These terminations may not be activated more than twice in one bus.

The HBM interface converter also includes these terminators.

External trigger signal:

Quiescent-signal level:	TRG= 0V (Low)
Active measuring:	TRG= Low-High edge (0V...5V)

If the external trigger is not used, the input remains open.

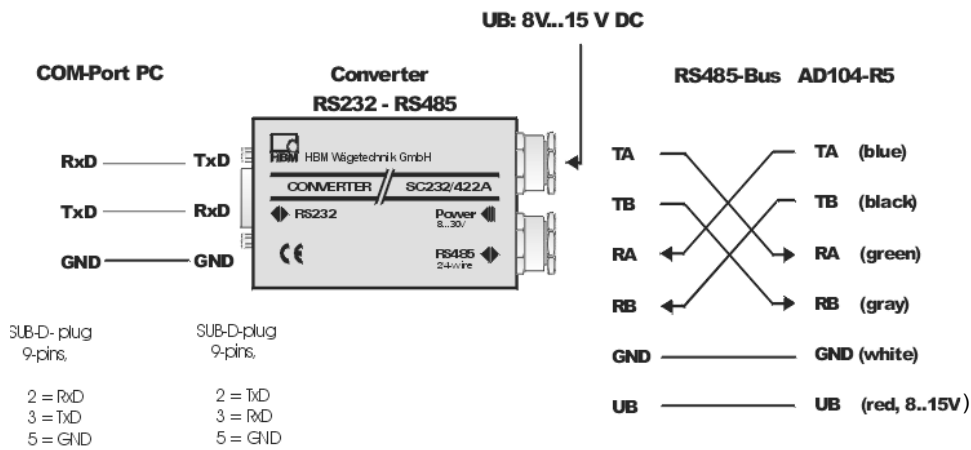


Fig: 5.3.2: Wiring of an AD104-R5 with an interface converter RS232/RS485

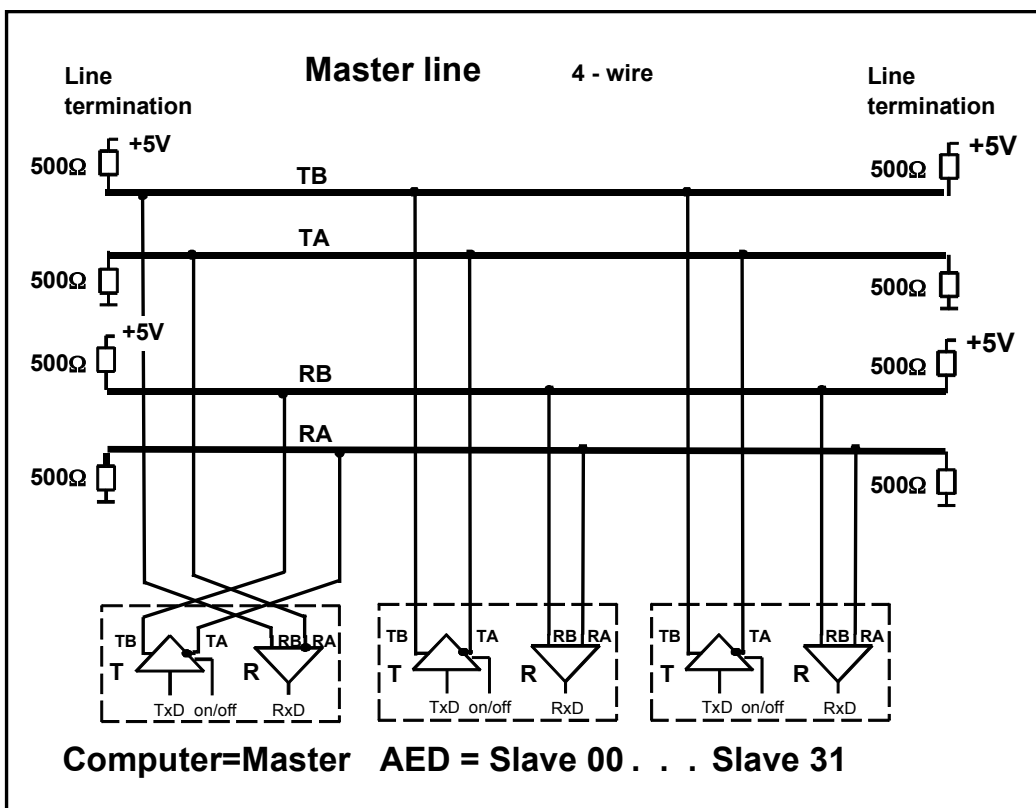


Fig: 5.3.3: Bus structure 4-wire bus (RS485)

The bus wiring is not to be allowed in star configuration. The leads of the slaves are not to be increased of 3m. The best solution here: chain the main leads directly to the slaves.

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

TB - TA ≥ 0.35 V (quiescent -signal level due to the AED terminating resistors)

RB - RA ≥ 0.35 V (quiescent -signal level due to the master terminating resistors)

Since the RS-485 is a differential bus interface, the quiescent-signal levels are also stated as a differential voltage between the lines (and not related to ground). It must further be noted that this interface tolerates a maximum common-mode range of +/-7V. If it is necessary, equipotential bonding should be established between the bus subscribers through a separate line. The cable shield should not be used for this equipotential bonding.

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

6 Command set

The commands can be classified roughly into:

- Interface commands (ADR, BDR, Sxx, TEX, COF, CSM)
- Commands for adjusting and scaling (SZA, SFA, LDW, LWT, NOV, LIC)
- Commands for the measuring mode (MSV, ASF, ICR, TAR, TAS, TAV, FMD, STP)
- Special commands (ZSE, ZTR, TDD, RES, DPW, SPW, IDN, STR, TRC, MAV)
- Command for legal for trade applications (LFT, TCR, CRC)

6.1 Command format

General notes:

The commands can be input in uppercase or lowercase type.

Each command has to be terminated by a termination character. This can be optionally a line feed (**LF**) or a semicolon (;). If only a termination character is sent to the AED, then the input buffer of the AED is cleared.

The statements made in round brackets () in the commands are urgently necessary and must be entered. Parameters in pointed brackets <> are optional and can also be dispensed with. The brackets themselves are not entered. Text must be included in “ ”.

With numerical entries, leading zeros are suppressed. Numbers can be entered either directly or in exponent format, e.g. $\pm 12000lf$ or $\pm 1,2e4lf$. The exponent **e** can be one- or two-digit, but a number including sign and exponent must not be more than 10 characters in length.

Answers consist of ASCII characters and are terminated with **CRLF**. The binary character output is an exception (see command MSV).

Each command consists of the command initials, the parameter(s) and the termination character.

	Command initials	Parameters	End character
Input	ABC	X,Y	LF or ;
Output	ABC?	X,Y	LF or ;

Example: *MSV?20*

20 measured values are output after this command.

All ASCII characters <= 20_H (blank) may stand between command initials, parameters and end character, except for 11_H (ctrl q) and 13_H (ctrl s).

H: Hexadecimal.

6.2 Answers to commands

Answers to inputs (exception COF64...COF79):

	Answer	End character
Correct input	0 (zero)	CRLF
Faulty input	?	CRLF

Exceptions: The commands **RES**, **STP**, **S00 ... S99** deliver no answer.

The command **BDR** delivers the answer in the new baud rate.

An error flag is received through the command **ESR**.

Answers to output commands:

Correct command	Parameter1, ... Parameter n, or measured values CRLF
Faulty command	? CRLF (error flag via command ESR)

6.3 Output types for the measured values

You can select two types of output and a data delimiter (command **TEX**).

Output type 1:

The measured values are output arranged beneath one another.

```

Measured value1 CRLF
Measured value2 CRLF
.....
Measured value n CRLF

```

Output type 2:

The measured values are output arranged next to one another.

Measured value1 (data delimiter) Measured value2 (data delimiter) ... Measured value n CRLF

The measured value query works with fixed output lengths
(see command COF):

Format command	AED answer	Number of bytes
COF0; msv?;	yyyy CR LF (y- binary)	6
COF2; msv?;	yy CR LF (y- binary)	4
COF3; msv?;	xxxxxxx CR LF (x- ASCII)	10
COF9; msv?;	xxxxxxx,xx,xxx CR LF (x- ASCII)	17

There is always a CRLF or the data delimiter defined by the command **TEX** as end identification of the measured value output. However these characters must not be filtered out as end identification in the binary output, since these characters can also be contained in the binary code of the measured value. Therefore only counting the bytes helps in the binary output. The corresponding places after CR or LF or the data delimiter can then be enquired for subsequent syntax testing.

Password protection:

The password protection of the AED comprises important settings for the characteristic of the scale and its identification. Commands with password protection are activated only after the password is entered. These commands are answered with “?” without entry of the password through the command **SPW**.

6.4 Command overview

Command	PW	TDD 1	Function	Page
ADR		x	Adress	18
ASF		x	Digital filter	40
BDR		x	Baud rate	19
COF		x	Output format in MSV?	20
CRC			external checksum for legal for trade applic.	66
CSM		x	checksum in MSV status	24
DPW			Define password	47
ENU			Dimensional unit	50
ESR			Status	62
FMD		x	Filter mode	42
ICR		x	Measuring rate	43
IDN			Identification of transducer type and serial number	51
LDW	x		Zero point, user characteristic	32
LFT		x	Legal for trade applications	64
LIC	x		Linearization	57
LWT	x		Nominal value, user characteristic	33
MAV			Measured value, trigger function	58
MSV			Measured value output	36
NOV	x	x	Nominal value scaling	34
RES			Reset	49
S...			Select of AED in bus operation	26
SFA	x		Internal nominal value, factory characteristic	30
SPW			Password entry	48
STP			Messwertausgabe stoppen	39
STR		x	Switch bus termination resistors on/off	63
SZA	x		Stop measured value output	29
TAR			Tare mode	44
TAS		x	Gross/net switch-over	46
TAV		x	Tare value	45
TDD1/2			Store setting in EEPROM, read EEPROM	52
TDD0	x		Factory setting	52
TEX		x	Data delimiter for measured value output	25
TCR			Trade counter	65
TRC		x	Trigger setting	59
ZSE		x	Initial zero setting	55
ZTR		x	Automatic zero tracking	56

TDD1 – stored with TDD1 command

PW – protected by password with commands **DPW/SPW**

The following commands result in no change to the AED setting:

ACL, ASS, CAL, COR, GRU (compatibility with other AED versions).

7 Individual descriptions of the commands

7.1 Interface commands (asynchronous, serial)

Characteristic data of the interfaces

Start bit:	1
Word length:	8 bits
Parity:	none / even
Stop bit:	1
Software handshake	(XON / XOFF) is possible
Baud rate:	1200; 2400; 4800; 9600; 19200; 38400 baud

The asynchronous interface of the AED is a serial interface, i.e. the data are transmitted bit for bit after one another and asynchronously. Asynchronous means that the transmission works without a clock signal.

A start bit is set before each data byte. The bits of the word, a parity bit for the transmission protocol (optional) and a stop bit then follow.

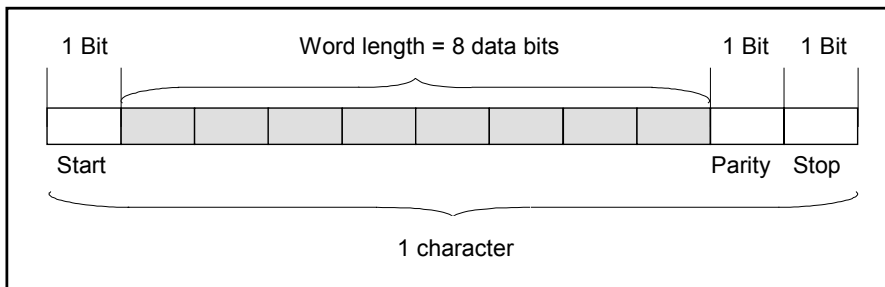


Fig. 7.1.1: Composition of a character

Since the data are transmitted after one another, the transmission speed must agree with the reception speed. The number of bits per second is called baud rate.

The exact baud rate of the receiver is synchronized with the start bit for each transmitted character. The data bits which all have the same length then follow. After the stop bit is reached, the receiver goes into a 'waiting position' until it is reactivated by the next start bit.

The number of characters per measured value depends upon the selected output format (**COF** command) and can be 2 to 17 characters (see also **COF** command).

The interface must be configured to build up the communication between AED and computer. The following commands are provided in the AED for this : **ADR**; **BDR**; **COF**; **TEX**; **S..**;

ADR**Address**
(device address)

Range:	0...31
Factory setting:	31
Response time:	<15ms
Parameters:	2
Password protection:	none
Parameter protect.:	with command TDD1

Input: **ADR(new address),<"Serial No.">;**
Entry of the device address as decimal number 0...31.

The serial number can also be stated optionally as 2nd parameter. The new address is then entered only for the AED with the stated serial number. This makes it possible to change device addresses in the case of several AEDs with the same address (initialization of the bus mode).

The serial number must be stated in “ “ as in the command **IDN**.

Example: **ADR25,"007" CRLF**

Query: **ADR?; 25CRLF (Example)**

Effect: Output of the device address as decimal number 0...31

BDR**Baud Rate**
(Baud rate)

Baud rates: 1200, 2400, 4800, 9600, 19200, 38400 Baud
Factory setting: 9600 Baud and even parity
Response time: <15ms
Parameters: 1
Password protection: none
Parameter protect.: with command **TDD1**

Input: **BDR <Baudrate>,<Parity>**

Entry of the required baud rate as decimal number.

Possible baud rates are:

1200, 2400, 4800, 9600, 19200, 38400 Baud

Input or the requested parity:

0= without parity bit

1= with even parity bit

Important Note

The answer is given in the new setting (baud rate, parity). Communication is no longer possible initially after a changed baud rate. The computer must also be changed over to the newly selected baud rate setting. So that the baud rate remains changed permanently, it must be stored in the EEPROM with the command **TDD1**. This procedure serves also as safeguard that no baud rates can be set in the AED which the remote station does not support. If the newly entered baud rate is not stored, the AED reports after a reset or power On again in the previously valid baud rate.

Query: **BDR?;**

Effect: Output of the set baud rate, Identification for parity bit

Example: ***BDR?; 9600,1 CRLF*** corresponds to 9600 baud, even parity

COF

Configure Output Format (Ausgabeformat für die Messwertausgabe)

Range: 0...255
 Factory setting: 9
 Response time: <15ms
 Parameters: 1
 Password protection: none
 Parameter protect.: with command **TDD1**

Input: **COF(0...255);**

Input of the output format for measured value command **MSV**

The possible formats and the decimal number to be entered for them are listed in the following Table. The measured value output refers here to the set nominal value of the **AED** (see command **NOV**).

Output at max. capacity	NOV > 0	NOV = 0
2 Byte binary	NOV value	20000
4 Byte binary	NOV value	5120000
ASCII	NOV value	1000000

For the 2-bytes binary output, the NOV value must be ≤ 30000 , otherwise the measured value is output with overflow or underflow ($7fff_H$ or 8000_H). With NOV30000, the overload range is only still approx. 2700 digits.

Query: **COF?;**

Effect: Output of the selected output format as three-digit decimal number from 0...255

COF formats:

The following combinations result on entry of **COF0** to **COF12**:

- MSB = most significant byte
- LSB = least significant byte

In binary output, the sequence of the bytes MSB → LSB or LSB → MSB can be selected. In ASCII output, the device address and/or measured value status information can be output in addition to the measured value.

Binary format:

	Parameter	Length	Sequence of the measured value output	
COF0	Measured value	4 Byte	MSB before LSB	LSB=0 (no Status)
COF2	Measured value	2 Byte	MSB/LSB	
COF4	Measured value	4 Byte	LSB before MSB	LSB=0 (no Status)
COF6	Measured value	2 Byte	LSB/MSB	
COF8	Measured value	4 Byte	MSB before LSB	LSB=Status/CRC
COF12	Measured value	4 Byte	LSB before MSB	LSB=Status/CRC

ASCII format:

In ASCII output, a freely selectable data delimiter is set between the parameters (see command **TEX**). crlf or the selected data delimiter follows after the last parameter.

T = Data delimiter () = Number of characters

	1st Parameter	T	2nd Parameter	T	3rd Parameter	End character
COF1	Meas. value (8)	T(1)	Adress (2)		—	CRLF or T
COF3	Meas. value (8)		—		—	CRLF or T
COF5	identical with COF1					
COF7	identical with COF3					
COF9	Meas. value (8)	T(1)	Adress (2)	T(1)	Status(3)	CRLF or T
COF11	Meas. value (8)	T(1)	—	—	Status(3)	CRLF or T

Important Note

In bus mode, the output format must not be set to **COF9**.

Bus mode: COF16 to COF 28

If the decimal number 16 is added to the above stated output formats COF0...COF12, then the AED is switched into the bus output mode. A measured value is output. The AED switches over to the partially active mode (each new measured value is stored in the output buffer but not output). The measured value is output on the bus with the select command S..;

Example: 2 AED's in bus operation

Command	Effect
S98;	All AED are partially active (listening but not transmission)
COF18;	Output in 2 byte binary output
ICR0;	Maximum measuring rate
MSV?0;	Continuous measurement in AED
S01;	Read measured value from 1st AED, immediate output of current measured value, without measuring time
S02;	Read measured value from 2nd AED, when response from first AED has been received completely. Immediate output of current measured value, without measuring time
S01;	Read measured value from 1st AED, when response from second AED has been received completely
S02;	Read measured value from 1st AED, when response from second AED has been received completely
...	...
STP;	Stop measured value output
S01;	Poss. new setting for 1st AED

Binary measured value output without CRLF: COF32 to COF44

If the decimal number 32 is added to the above stated binary output formats **COF0...COF12**, the AED is switched into the following output mode for the measured values.

In the **binary measured value output**, the end character CR LF is left out, so that only 2 or 4 characters per measured value are output. This measure increases the output speed of the measured values.

Format	Length	Sequence of the measured value output
COF32	4 Byte	MSB before LSB LSB=0 (no status)
COF34	2 Byte	MSB before LSB
COF36	4 Byte	LSB before MSB LSB=0 (no status)
COF38	2 Byte	LSB before MSB
COF40	4 Byte	MSB before LSB LSB=status/CRC
COF44	4 Byte	LSB before MSB LSB=status/CRC

2-wire bus mode: COF64 ... COF76 (do not use for variants AD104-R2 and AD104-R5)

If the decimal number 64 is added to the above stated output formats **COF0...COF12**, then the AED is switched into the 2-wire bus mode. This means that the AED answers no longer with "0" or "?" on command inputs. The answer with the parameter or in the case of **MSV?** with the measured value occurs only for command enquiries (e.g. **ASF?**). The command **MSV?0;** (continuous measured value transmission) may no longer be used in this case since otherwise it is no longer possible to stop this output (apart from supply voltage off).

Continuous output after power On: COF128 to COF 140

If the decimal number 128 is added to the above stated output formats **COF0...COF12**, then the AED is switched into the continuous output mode. After the power On or **RES** command, the AED outputs the measured values **without MSV?** request. The continuous output can be switched off with the command **STP**.

The setting is made with the following entries (**COF**≥128):

1. ... make necessary settings
2. **ICRi**; set measuring rate of the AED
3. **COFx+128**; the AED transmits measured values continuously, time interval corresponding to ICR, x=0...12
4. **STP**; stop continuous transmission
5. **TDD1**; store protected against power failure
6. **COFx+128**; the AED transmits measured values continuously, time interval corresponding to **ICR**.

The AED starts with the measured value output without separate request also after switching on the voltage.

These output formats have another special feature (depending on how triggering is set, command **TRC**):

Trigger deactivated: continuous automatic measured value output

Trigger activated: automatic measured value output only if a new measured value has been created after triggering (MAV? output value).

Output speed of measured values:

The AD104 can output a maximum of 100 measured values per second. This data rate also depends upon the baud rate (BDR), the data format of the measured value output and the set averaging (**ICR**).

Table 1 shows this relationship in the continuous measured value output (**MSV?0**):

Measured values/s (ICR)	100	50	25	12	6	3	2	1
Time in ms	10	20	40	80	160	330	500	1000
Output format (COF)	necessary baud rates for MSV0 ; (BDR)							
Binary format 2 characters at COF2/COF6	2400	1200	1200	1200	1200	1200	1200	1200
Binary format 4 characters at COF0/COF4	4800	2400	1200	1200	1200	1200	1200	1200
ASCII format Meas. value 10 characters at COF3	19200	9600	4800	2400	1200	1200	1200	1200
ASCII format Meas. value + Adress 13 characters at COF1	19200	9600	4800	2400	1200	1200	1200	1200
ASCII format Meas. value + Adress + status 17 characters at COF9	38400	19200	9600	4800	2400	1200	1200	1200

Note for the evaluation of the binary measured values:

The binary codes for CR and LF can occur inside the bytes representing the measured value in the measured value output in binary format. Therefore the contents of the measured value output must not be tested for the characters CR/LF in order possibly to check the end of the measured value transmission. Rather the number of characters which are received should be registered for the binary output. The control characters CR/LF are also appended to the measured value in the binary output (sole exception: **MSV?0**).

CSM

Checksum

(Checksum only in MSV binary status)

Range: 0/1
Factory setting: 0
Response time: <15ms
Parameters: 1
Password protection: none
Parameter protect.: with command **TDD1**

Input: **CSM(0/1);**

Query: **CSM?;**

Effect: The adjusted function is given out as: (0/1).

The command checksum can be used to find out transmitting errors within 4 Byte binary output.

If **CSM=0** the normal status will be transmitted (see **MSV**).

If **CSM=1** instead of the status a checksum will be transmitted in the binary output format **COF8** and **COF12** (+i*16, i=0,1...7). The checksum is a EXOR over the 3 bytes of the measured value.

TEX

Terminator Execution

(Data delimiter between measured values)

Range: 0...255
 Factory setting: 172
 Response time: <15ms
 Parameters: 1
 Password protection: none
 Parameter protect.: with command **TDD1**

Input: **TEX(0...255);**

The wanted data delimiter is input in decimal form as ASCII character (e.g. comma = 2C_H = 44_D → input **TEX44**; H: Hexadecimal, D: Decimal). Any ASCII character from 0...127_D (0...7F_H) can be taken as data delimiter. The data delimiter is set between the parameters in the measured value output (see also commands **MSV** and **COF**).

Example: **TEX44;**

Measuring value output: -0123456, 12, 000, -0123457, 12, 000, etc. (at **COF9**)

If the selected ASCII character is entered with an offset of 128

(above example: comma = 44_D + 128_D = 172_D → entry **TEX172**);

then the parameters of a measured value are separated by comma as before, but crlf is output at the end of the measured value.

Example: **TEX172;**

This results in: -123456,12,000
 -123457,12,000 etc.

Query: **TEX?;**

Effect: The set data delimiter is output as 3-digit decimal number (0...255).



Select (Selection of AEDs in bus mode)

Range:	0...31, 98
Factory setting:	—
Response time:	<15ms
Parameters:	1
Password protection:	none
Parameter protect.:	no data to be protected

Input: **S(00...31, 98);** (only with semicolon, *not with CRLF!*)

The select command generates no answer. Several AEDs connected together to form a BUS can be addressed individually or jointly with it. An AED is always active after reset or power On (except for **COF**>127) and must therefore be addressed through the select command. A maximum of 32 addresses (00...31) can be allocated through the command **ADR**.

Important Note

The command S.. alone generates no answer. The selected AED answers only together with a further command. Except in the bus mode: **COF16...COF28** (after **MSV?0;**).

Example: S00;
Command 1
Command 2...n
S01;
Command 1 etc.

The command **S98;** is provided for special functions (broadcast). In this case all AEDs connected to the bus are addressed. All AEDs execute the following commands. No AED answers. This occurs as long as only one AED is addressed through **S00 ... S31** again.

A measured value query in the bus can be performed as follows:

1. All AED selected via command **S98;**
2. Measured value query **MSV?;**, all AED form the measured value and places value after the integration time (**ICR**) in the output buffer, but no AED transmits
3. Select AED with address 1 with command **S01;**. The AED with adress 01 outputs the measured value
4. Select AED with address 1 with command **S02;**. The AED with adress 02 outputs the measured value etc.

7.2 Adjustment and scaling

The commands described below serve for setting the factory characteristic as well as the user characteristic:

- Commands for adjusting the transducer characteristic: **SZA, SFA**
- Commands for adjusting the user characteristic: **LDW, LWT**
- Scaling of the measured values: **NOV**

Setting the characteristic

As delivered, the AED works initially with a factory characteristic **SZA / SFA** (range 0...2 mV/V). This characteristic can be used for calibrating the the transducer characteristic. This characteristic should not be changed. It has to be print ore stored to keep the data.

The user can adapt the AED characteristic to his requirements with the command pair LDW, LWT (application or scale characteristic).

In the following, the balance of a measuring chain will be described with the balancing of a scale. This example can also be used for other kinds of transducers.

Important Note

The characteristic commands **LDW, LWT** must be entered or executed in the sequence LDW , then LWT... The input data are not computed until both parameters have been entered or measured in pairs The scaling must be switched off when determining the characteristic (**NOV0**).

After the values for zeropoint and nominal value of the user characteristic have been measured or entered, the range **LDW → LWT** (at **NOV=0**) is mapped to the following numerical ranges:

Output at nom. load (COF)	NOV=0	NOV>0
2 Byte binary	20000	NOV value
4 Byte binary	5120000	NOV value
ASCII	1000000	NOV value

For the 2-bytes binary output, the NOV value must be ≤ 30000 , otherwise the measured value is output with overflow or underflow ($7fff_H$ or 8000_H ; H: Hexadecimal). With $NOV30000$, the overload range is only approx. 2700 digits.

Set user characteristic with LDW, LWT

Action	Command string
Enter password	SPW"AED";
Load = 0, scale	LDW;
Load = Nominal value, scale	LWT;

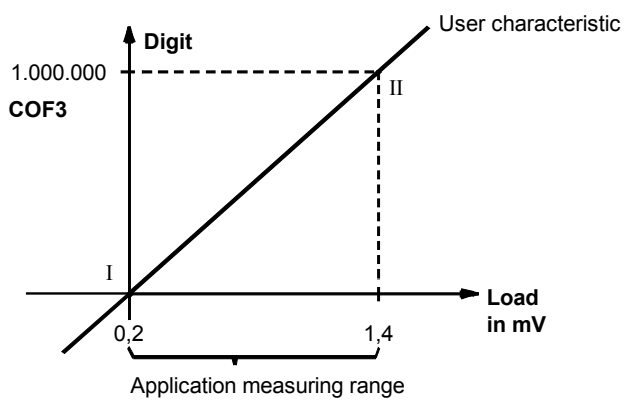
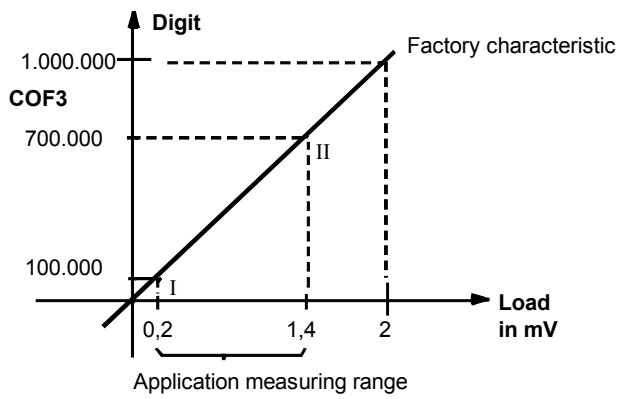


Fig. 7.7-1: Setting the user characteristic

SZA

Sensor Zero Adjust

(Factory characteristic – zero point)

Range: 0...1,599999e6
 Factory setting: adjusted on unloaded transducer
 Response time: <15ms...4.2s
 Parameters: 1
 Password protection: yes
 Parameter protect.: after input of **SFA**

Input: **SZA**; (Response time: <4.2s)

Effect: Using this command, the transducer electronic system measures an input signal between $\pm 2.5\text{mV/V}$, stores the measured value as the zero point of the factory characteristic, but only starts the calculation of the new characteristic after entering the parameter for **SFA**.

Input: **SZA<zero value>**; (Response time: <15ms)

Effect: Instead of causing the AED to measure the applied signal, the value is entered here. The entered value is stored, but accounted for only after entry of the parameter for **SFA** as the zero point of the factory characteristic.

Query: **SZA?**; (Response time <15ms)

Effect: The value used in the AED for calculating the factory characteristic for the zero point is output in ± 7 digits (e.g. -0000345cr1f).

Important Note

Enter the command SZA and SFA ore execute. The data will be calculated if both parameters were given in pairs ore been measured.

SFA

Sensor Fullscale Adjust (Factory characteristic – fullscale value)

Range: 0...1,599999e6
 Factory setting: adjusted to nominal load of transducer
 Response time: <15ms...4.2s
 Parameters: 1 (0)
 Password protection: yes
 Data protect.: with input

Input: **SFA;** (Response time: <4,2s)

Effect: Using this command, the transducer electronic system measures an input signal between $\pm 2.5\text{mV/V}$, stores the measured value as the fullscale value of the factory characteristic and calculates the new characteristic together with the previously entered value for **SZA**.

Input: **SFA <fullscale value>;** (Response time: <15ms)

Effect: Instead of causing the AED to measure the applied signal, here the value is entered directly as the fullscale value of the factory characteristic, stored and used together with the previously entered value for **SZA**.

Query: **SFA?;** (Response time <15ms)

Effect: The value used in the AED for calculating the factory characteristic for the zero point is output in ± 7 digits (e.g. -0915345CRLF).

Important Note

Entry the command SZA and SFA ore execute. The data will be calculated if both parameters were given in pairs ore been measured.

Procedure for *entering the factory characteristic*:

1. Enter password by means of command SPW
2. Switch off the scaling withNOV 0; output (scaling off)
3. Deactivate user characteristic by means of **LDW0;** and **LWT1000000;**
4. Adjust the **ASF** filter such that a maximally quiescent display is effected
5. Transducer (not scale) without load, wait until standstill
6. Determine measured value with **MSV?;** , note value1 for **SZA**
7. Load transducer (not scale) with nominal load, wait until standstill
8. Determine measured value with **MSV?;** , note value2 for **SFA**
9. Enter new characteristic with : SZA value1; subsequently SFA value2
10. Redetermine the user characteristic LDW/LWT

The points 3...8 are not applicable if the factory characteristic is entered anew using already known parameters.

User settings:

The commands **LDW** and **LWT** work like the commands **SZA** and **SFA** . It is possible with these commands to make a system-specific calibration (e.g. of a scale), without changing the transducer settings performed with **SZA** and **SFA**.

The user-specific settings LDW/LWT result as an ASCII output within the range 0... 1000000. This characteristic is converted into the **NOV** by means of the parameters

Example: NOV 0; User setting 0...1000000 (ASCII signal
 with 0 = unloaded scale, 1000000 at nominal load

 NOV 4000; User setting 0...4000
 With output 0 at load =0 or 4000 at nominal load

Attention:

In an adjustment with SZA and SFA, the parameters for LDW and LWT are reset (default: LDW=0 and LWT=1000000) .There is the option to determine the characteristic with SZA and SFA at any time by entering LDW0 and LWT1000000. Before setting your new characteristic, enter LDW0,LWT1e6, and NOV0.

LDW

Load Cell Dead Weight (Zero point of the user characteristic)

Range: 0...1.599999e6
Factory setting: 0
Response time: <15ms...4.2s
Parameters: 1
Password protection: yes
Parameter protect.: after input of **LWT**

Take the zero point of user characteristic with LDW

Input: **LDW;** (Response time: <4.2s)

1. The scale is unloaded.
Take the zero point with **LDW;** command.
Using this command, the transducer electronic system measures an input signal between $\pm 2.5\text{mV/V}$ (i.e. =measured value for scale in no load condition), stores the measured value, but only starts the calculation of the new user characteristic after entering the parameter for **LWT**.

Individual input of the zero point of the user characteristic via LDW

Input: **LDW<Zero point>** (Response time: <15ms)

1. Insert the value for the zero point of the scale via **LDW<Zero point>** command. The entered value is stored, but accounted for only after entry of the parameter for **LWT**.

Query: **LDW?;** (Response time<15ms)

Effect: Output in ± 7 digits (e.g. -0915345crLf) of the zero point value. The value is not converted via **NOV**.

LWT

Load Cell Weight (nominal value of the user characteristic)

Range: 0...1,599999e6
 Factory setting: 1000000
 Response time: <15ms...4.2s
 Parameters: 1 (0)
 Password protection: yes
 Parameter protect.: with input

Take the full scale value of user characteristic with LWT command

Input: LWT; (Response time <4,2s):

Using this command, the transducer electronic system measures an input signal between $\pm 2.5\text{mV/V}$ (i.e.= measured value at scale nominal load), stores this measured value as the nominal value and calculates the new user characteristic together with the previously entered value for **LDW**. The values for **SZA** and **SFA** are not changed.

Individual input of the full scale value of the user characteristic via LWT:

Input: LWT<Nominal value>; (Reaktionszeit<1,5s):

Instead of causing the AED to measure the applied signal, the value for the end value of the user characteristic is entered here directly and, in combination with the previously entered value for **LWT**, used in calculating the user characteristic.

Query: LWT?; (Response time <15ms)

Effect: Output the the value for the user characteristic in ± 7 digits (e.g. -0000345CRLF) of the nominal value or the loaded transducer (nominal load). The value is not converted via **NOV**.

Important Note

An input or measurement of the factory characteristic with **SZA/SFA** resets the user characteristic to the default values **LDW=0**, **LWT=1000000**.

Procedure for entering the user characteristic:

1. Enter password by means of command SPW.
2. **NOV 0**; output (scaling off).
3. Adjust the ASF filter such that a maximally quiescent display is effected
4. Scale at no load , wait for standstill

5.



Nominal Value (Resolution of the user characteristic)

Range: 0...1,599999e6
 Factory setting: 0 (=deactivated)
 Response time: <15ms
 Parameters: 1
 Password protection: yes
 Parameter protect.: with command **TDD1**

Input: **NOV<Wert>;**

Query: **NOV?;** (Response time <15ms)

Effect: The value stored in the AED is output with 7 digits complete with sign (e.g. 0001000CRLF 0000345crLf).

The **NOV** value is used for scaling the measured value. At **NOV=0** this output scaling is deactivated. The ASCII measured value output is scaled to 1000000 at the factory. If a measured value output of 2000 digit at nominal load is required, then use this command to set the nominal value **NOV2000**. The input parameters or tara values are not changed by this scaling.

Measured value output format at nominal load	NOV=0	NOV>0
2 Byte binary	20000	NOV value
4 Byte binary	5120000	NOV value
ASCII	1000000	NOV value

With the 2 byte binary type of output, the **NOV** value must be ≤ 30000 . Otherwise the measured value will be output complete with overflow or underflow (7fff_H or 8000_H ; H: Hexadecimal). With **NOV30000**, the overload range is only approx. 2700 digits.

7.3 Measuring

All commands acting directly on a measured value belong to measuring, these are:

- **MSV** Measured value output
- **STP** Stop measured value output
- **ASF** Filter setting
- **FMD** Filter mode
- **ICR** Measuring rate
- **TAR** Tare mode
- **TAV** Set tare memory
- **TAS** Gross/net switch-over

MSV**Measured Signal Value**
(Output measured values)

Range:	Integer	±32767
	Long Integer	±8388607
	ASCII	±1000000
Factory setting:	ASCII	
Response time:	< 2 ^{ICR} * 10ms + 5ms with ICR = Measuring rate	
Parameters:	1	
Password protection:	none	
Parameter protect.:	Output measured values	

Query: **MSV?(0); (not to be used in 2-wire connection)**

Effect: Outputs measured values constantly until the output is stopped with the command STP

Query: **MSV?(1...65535);**

Effect: Outputs the stated number of measured values.

(The measured values are output without the control character CR/LF, CR/LF is appended only to the last output measured value).

The measured value is output in ASCII or binary format (see command **COF**).

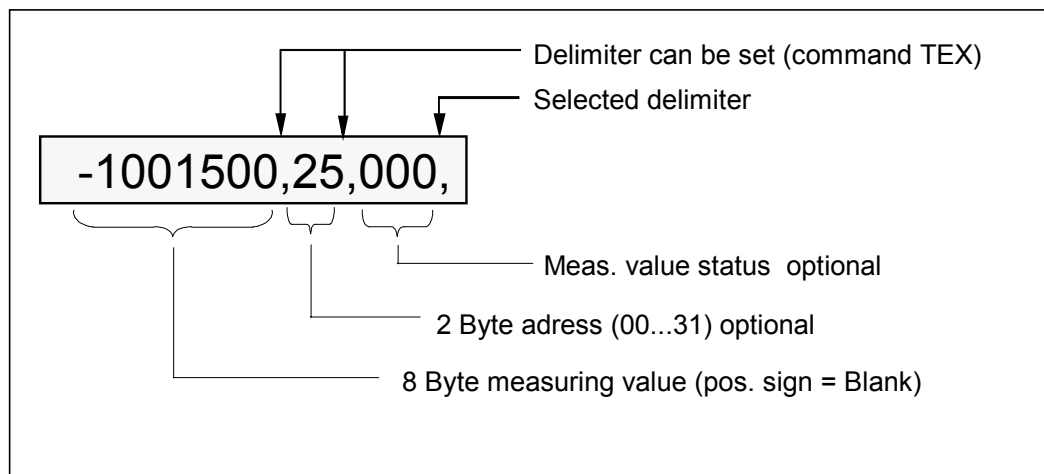
The output format for the measured value must be set **previously** via the command **COF**.

The measured value is output related to the relevant measuring range. The measured value can be a gross or net measured value (command TAS). This **COF** command generates answers of constant length.

The **output length** for the command **MSV?**; depends in this case upon the output format (see COF command):

Output format	AED answer	No. of characters
Binary 4 Byte	yyyy CRLF (y – binär)	6
Binary 2 Byte	yy CRLF (y – binär)	4
ASCII (COF3 ;))	xxxxxxx CRLF (x - ASCII)	10
ASCII (COF9 ;))	xxxxxxx,xx,xxx CR LF (x - ASCII)	17

CR: Carriage Return, LF: Line Feed



Example: Definition of a measuring value in ASCII format (**COF9**)

The **output scaling** depends upon the parameter of the command **NOV**.

Output format of the measuring value at nominal load	NOV=0	NOV>0
2 Byte binary	20000	NOV value
4 Byte binary	5120000	NOV value
ASCII	1000000	NOV value

With the 2-byte binary output, the NOV value must be ≤ 30000 , otherwise the measured value is output with overflow or underflow ($7fff_H$ or 8000_H ; H: Hexadecimal). With NOV30000, the overdriving reserve is only still approx. 2700 digits.

The **response time** for the measured value query is determined by the integration time (command **ICR**):

Filter settings with FMD0 (Query: MSV?;)

ICR	Output rate Mv/s	Response time [ms], approx. with MSV?;
0	100	10
1	50	20
2	25	40
3	12	80
4	6	165
5	3	333
6	2	500
7	1	1000

A predefined number P1 of measured values can be output via a command MSV?P1;. The reaction time lies between the output of two measured values. The end identification (CR LF) is output only for the *last measured value*. The total time for the acquisition of P1 measured values is calculated as:

$$\text{Measuring time [ms]} = P1 * 2^{ICR} * 10\text{ms} + 5\text{ms},$$

with ICR = Measuring rate

There is a continuous output of measured values with **MSV?0;**. This output can be stopped only through the commands STP, RES or voltage switch-off. No other parameters can be changed during the continuous output. In the 4-byte binary output or in the ASCII output, the measured value status can be transmitted with the measured value (see commands **COF**).

Error messages in the measured value status

Contents of the status byte in the measured value output	Possible cause
Bit 0 = 1, Nett-Overflow	Tare value too large
Bit 1 = 1, Gross-Overflow	Scaling too sensitive
Bit 2 = 1, ADU-Overflow	ADU overdrives (input $\geq \pm 2.5\text{mV/V}$)
Bit 3 = 1= Standstill	Measuring values are in the range of still standing ($\pm 1\text{d/s}$).
Bit 7, 6 = Measured values not coherent	Do not fit together. Measured values cannot be output justified in the selected configuration

A dark gray square containing the white text "STP".

Stop
(Stop of the measured value output)

The measured value output is ended with this command. **STP** acts only on the command **MSV**. A started measured value is output completely.

ASF**Amplifier Signal Filter**
(Digital filter setting)

Range: 0...8
 Factory setting: 5
 Response time: <15ms
 Parameters: 1
 Password protection: none
 Parameter protect.: with command **TDD1**

Input: **ASF(0...8);**

Query: **ASF?;**

Effect: Entry of the filter stage as decimal number from (0...8)

The AED has a multi-stage filter chain:

- An analog 3rd order filter (cut-off frequency approx. 50 Hz)
- Averaging over 2 measured values (at 200 Hz scan rate, fixed setting)
- Standard filter (FMD0) or a FIR filter (FMD=1); cut-off frequency selectable through ASF, fixed scan rate = 100 Hz
- Averaging for output rate reduction (selectable through ICR, scan rate <=100 Hz)

Thus the wanted filter effect and output rate can be set through the two commands (ASF, ICR). Further new efficient digital filters have been implemented apart from the standard filter properties. The command FMD is used for switching over between the two filter modes:

FMD 0; Standard filter
 FMD 1; FIR filter (with fast settling time)

Filter characteristics of standard filters (FMD0):

ASF	Settling time in ms to 0.1%	Cut-off frequency [Hz] at -3dB	max. attenuation [dB] at 300Hz
1	130	8	-20
2	320	3,5	-34
3	700	1,5	-48
4	1400	0,7	-60
5	2900	0,3	-72
6	5800	0,2	-82
7	11800	0,1	-90
8	23800	0,05	-96

The filter is switched off at **ASF0**. The cut-off frequency of the filter determines the settling time. The higher the filter index, the better is the filter effect but the longer is the settling time on changing the weight. The filter setting should be chosen as small as possible, whereby the measured value quiescence (standstill) must be guaranteed at unchanging weight.

The FIR-Filter (FMD1) can be described with the following Table:

ASF	Filter length (Tabs)	Cut-off frequency [Hz] at -3dB	20dB attenuation at frequency in Hz	40dB attenuation at frequency in Hz	Attenuation in the Stop band [dB]	Stop band [Hz]
1	12	7.6	17	23	50...100	>25
2	14	6.6	15	19	50...80	>20
3	16	6.2	14	17	50...90	>19
4	16	5.5	12.5	16	50...80	>17.5
5	18	4.7	11	14	45...80	>15
6	20	4	9.5	12	45...85	>12.5
7	22	3.5	8	10	40...85	>10
8	22	3	7	8	40...80	>8

The filter is switched off with **ASF0**.

The filters ASF6...ASF8 are limited additionally in bandwidth by averaging (ICR>4).

The transient recovery time of the filters is calculated from filter length (12...24) multiplied by the filter scan rate of 10ms.

Settling time filter : 120ms ... 240ms

Mean value formation (ICR) does affect the total settling time of the measuring chain. The total settling time depends additionally upon the mechanical construction of the transducer, the dead load of the scale and the weight to be weighed.

FMD**Filter Mode**
(Filter selection for the command ASF)

Range: 0/1
Factory setting: 0
Response time: <15ms
Parameters: 1
Password protection: none
Parameter protect.: with command **TDD1**

Input: **FMD(0/1);**

Entry of the filter stage as decimal number of 0 or 1:

Query: **FMD?;**

Effect: Output of the set filter stage (0 or 1)

The description of the filter selection can be found in the **ASF** command description.

ICR**Internal Conversion Rate**
(Output rate of measured values)

Range: 0...7
 Factory setting: 0
 Response time: <10ms
 Parameters: 1
 Password protection: none
 Parameter protect.: with command **TDD1**

Input: **ICR(0...7);**

Entry of the measuring rate as decimal number from 0...7

The integration time determines the output data rate of the measured values and thus also the response time to the measured value query with the command **MSV?**;

ICRx = Averaging over 2^x measuring values, with $x = 0...7$

The following setting possibilities result from this:

ICR	Output rate Mv/s
0	100
1	50
2	25
3	12
4	6
5	3
6	2
7	1

Observe the baud rate setting when setting the measured value rate. A high baud rate must be set at high measured value rates to avoid measured data losses (see command **COF**).

Query: **ICR?;**

Effect: Output of the set measuring rate (0...7)

Important Note

At ICR1 there is an especially good suppression of a 50 Hz mains frequency which may possibly cause interference.

TAR**Tare**
(Tare modus)

Range: —
Factory setting: —
Response time: $< 2^{ICR} * 10\text{ms} + 5\text{ ms}$
Parameters: 0
Password protection: none
Parameter protect.: no data to be protected

The current measured value is tared with the command **TAR**. After taring, the system switches over to "Net measured value" (**TAS0**). The current value is filed in the tare memory (see also command **TAV**) and subtracted from the measured value and all following measured values.

TAV

Tare Value

(Set / read tare memory)

Range: 0...±8388607
 Factory setting: 0
 Response time: <20ms
 Parameters: 1
 Password protection: none
 Parameter protect.: with command **TDD1**

Input: **TAV(±Tare value);**

Enter tare value 7digit with sign (max. ±8 388 607).
 This value is set off with the **LDW/LWT** characteristic scaled with the parameter **NOV** (0...**NOV**). The tare memory is cleared (contents = 0) after characteristic entries with the commands **SZA**, **SFA** or **LDW**, **LWT**.

Query: **TAV?;**

Effect: The contents of the tare memory are output.
 The tare value is converted to the **NOV** value.

Output format measured value at nominal load	Nominal taring range at NOV>0	Maximum taring range at NOV>0	Nominal taring range at NOV=0	Maximum taring range at NOV=0
2 Byte binary	± NOV value	±150% NOV value	±1000000	±8 388 607
4 Byte binary	± NOV value	±150% NOV value	±1000000	±8 388 607
ASCII	± NOV value	±150% NOV value	±1000000	±1 599 999

Example:

NOV3000;		(Scaling the scale)
TAS1;		(Gross output switched on)
MSV?;	1500CRLF	(Measured value lies at 50% = nominal load of the scale)
TAR;		(Taring and switching over to net output)
TAV?;	1500CRLF	(Enquire tare value)
MSV?;	0CRLF	(Net measured value)
TAS?;	0CRLF	(Net is switched on)
TAS1;	0CRLF	(Switching over to gross)
MSV?;	3000CRLF	(Measured value is at 100% = nominal load of the scale)
TAV?;	1500CRLF	(Enquire tare value, unchanged)

TAS**Tare Set**
(Gross/net switch-over)

Range: 0...1
Factory setting: 1 (Gross)
Response time: <10ms
Parameters: 1
Password protection: none
Parameter protect.: with command **TDD1**

Input: **TAS(0...1);**

TAS0: Net measured value

The value in the tare memory is subtracted from the current measured value.

TAS1: Gross measured value

The value in the tare memory is not offset.

Query: **TAS?;**

Effect: Current setting is output.

7.4 Special functions

DPW

Define Password (Defining a password)

Range:	1...7 Letters or numbers (ASCII-characteristics)
Factory setting:	AED
Response time:	<80ms
Parameters:	1
Password protection:	none
Parameter protect.:	with input

Input: **DPW("Password");**

The user can enter an arbitrary max. 7digit password with this command. All ASCII characters are permissible. The entry must be in inverted commas ("...").

SPW**Set Password**

(Write enable for all password-protected parameters)

Range:	The password defined with DPW
Factory setting:	AED
Response time:	<15ms
Parameters:	1
Password protection:	none
Parameter protect.:	no data to be protected

Input:**SPW("Passwd");**

The command **SPW** with the correctly entered password authorizes data entry with all commands. The command **SPW** with a wrong password disables the data entry for protected commands. No password is required for outputs. A distinction is made between uppercase and lowercase letters in the password entry.

Use of the protected commands is also disabled after **RES** or power On.

The following commands are protected by a password:

LDW, LWT, NOV, TDD0, SFA, SZA, LIC

RES**Restart**
(Device start)

Range: —
Factory setting: —
Response time: <3s
Parameters: —
Password protection: none
Parameter protect.: no data to be stored

The command **RES** produces a warm start. This command generates no answer. All parameters are set as they were stored with the last **TDD** command, i.e. EEPROM values are taken over into the RAM.

ENU**Engineering Unit**
(User engineering unit)

Range: 4 letters or numbers (ASCII characters)
Factory setting: none
Response time: Output: <15ms
Input: <40ms
Parameters: 1
Password protection: none
Parameter protect.: with input

Input: **ENU("abcd");**
Entry of a unit. An arbitrary unit with max. 4 characters can be entered. If less than 4 characters are input, the entry is supplemented with blanks. The entered unit is not appended to the measured value. The characters must be entered in quotation marks ("...").

Query: **ENU?;**

Effect: Output of the unit with 4 characters.

IDN**Identification**

(Identification of transducer type and serial number)

Range:	Transducer type: 15 ASCII characters
Factory setting:	Serial number: 7 ASCII characters
Response time:	depending on transducer
Parameters:	Output: <15ms
Password protection:	Input: <180ms
Parameter protect.:	1
	none
	with input

Input: **IDN<"Transducertype">,<"Serial number">;**

Entry of the transducer type and of the serial number.

The type and serial number of the transducer are filed in the EEPROM of the transducer electronic unit. The type designation may have maximum 15 characters and it must be entered as string in quotation marks ("..."). If only the serial number has to be changed, a comma is entered for the transducer type parameter, e.g. **IDN,"0815"**;

The serial number is entered by the factory and may have maximum 7 characters, it is entered like the type designation. The serial number must not be changed. If less than the maximum allowed number of characters is entered for the type designation or serial number, the entry is automatically filled up with blanks up to the maximum allowed number. The manufacturer and the software version cannot be entered.

Query: **IDN?;**

Effect: An identification string is output (33 characters).
Sequence: Manufacturer, transducer type, serial number, software version, e.g. HBM, "AED104", "1234", P20crLf

The number of the output characters is fixed. The transducer type is always output with 15 characters, the serial number always with 7 characters.

TDD**Transmit Device Data**
(Protect device parameters)

Range:	0...2
Factory setting:	—
Response time:	TDD0: <2.2s TDD1: <0.1s TDD2: <1.3s
Parameters:	1
Password protection:	TDD0: yes TDD1: none TDD2: none
Parameter protect.:	no data to be protected

Input: **TDD(0);**
Cold start, the parameters are reset to the factory settings (see table next page)

After balancing, the adjustments will be stored in the second writing protected EEPROM. TDD0 command copies the actual factory settings into the working EEPROM memory.

Write protected EEPROM → actual working EEPROM → RAM

Query: **TDD?**
Effect: An output is not possible.

Factory setting	ROM-Default at TDD0	Remark
ADR31	no change	Adress 31
ASF5	ASF5	Filter 1 Hz
BDR9600,1	no change	9600 Baud, even parity
COF9	COF9	Measured value output decimal format, address, error status
*CRC0	no change	external checksum
CSM0	CSM0	Measured value status output (no checksum)
NOV0	NOV0	User scaling off
*DPW"AED"	*DPW" „	Password
*ENUxxxx	*ENUxxxx	Unit
FMD0	FMD0	Filter setting, standardfilter
ICR2	ICR2	Measuring rate 25 measurements/s
*IDN HBM, ..., ..., ...	no change	Device type 15 characters, manufacturing -no. 7 characters, program version
LIC	no change	Linearization switched off, all par.=0
*LFT0	LFT	Legal for trade switched off
*LDW0	*LDW0	User characteristic zero point
*LWT1000000	*LWT1000000	User characteristic fullscale value
*SFAxxx ¹⁾	no change	Transducer fullscale value
*SZAxxx ¹⁾	no change	Transducer zero point
TAS1	TAS1	Gross measuring value
TAV0	TAV0	Delete tare memory
TEX172	TEX172	Data delimiter, output in columns with crlf
TCRxxx 1)	no change	Trade scale counter
TRC	TRC	Trigger function off, all parameters =0
STR0	STR0	Bus terminating resistor switched off
ZSE0	ZSE0	Initial zero setting deactivated
ZTR0	ZTR0	Zero tracking deactivated

1) Arbitrary value

The parameters marked with * are stored immediately on entry (EEPROM). **TDD1**; or **TDD2**; does not apply for these parameters.

Command: TDD(1);

Effect: The settings you have changed in the working memory are stored in the EEPROM nonvolatile.

ADR	Adress
ASF	Filter settings
BDR	Baud rate
COF	Configuration of the data output
CSM	Checksum of the data output
FMD	Filter mode
ICR	Measuring rate
STR	Terminator resistances on/off
TAS	Switch Gross/Net
TAV	Content of the tare memory
TEX	Output data delimiter
TRC	Trigger function
ZSE	Initial zero setting
ZTR	Automatic zero tracking

Command: TDD(2);

Effect: Transfer of the parameters from the EEPROM into the RAM. The parameters listed under TDD1 are copied from the EEPROM into the RAM. This occurs automatically after reset and power On.

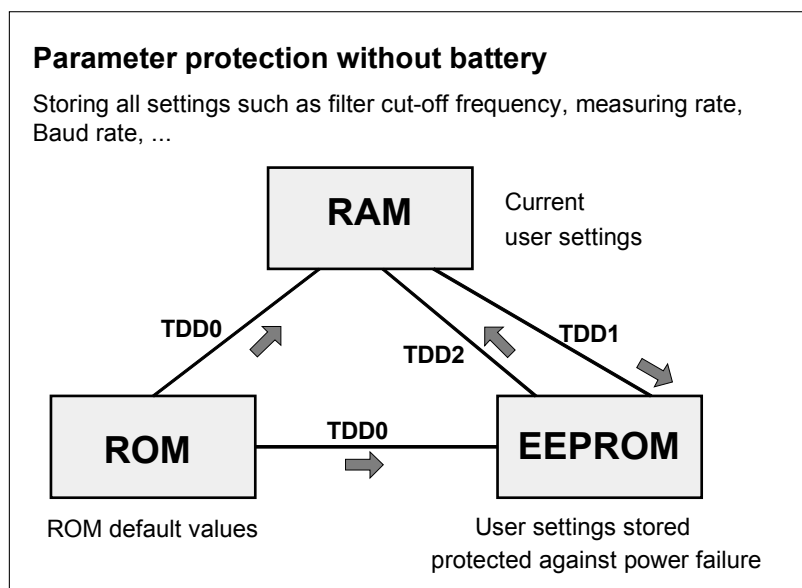


Fig. 3.4-1: Protecting the set parameters

ZSE**Zero Setting**
(Automatic zero setting)

Range: 0...4
 Factory setting: 0
 Response time: <0.1s
 Parameters: 1
 Password protection: none
 Parameter protect.: with command **TDD1**

Input: **ZSE(0...4);**

0 - Zero setting deactivated,
 1 - Zero setting range $\pm 2\%$ of NOV value
 2 - Zero setting range $\pm 5\%$ of NOV value
 3 - Zero setting range $\pm 10\%$ of NOV value
 4 - Zero setting range $\pm 20\%$ of NOV value

Query: **ZSE?;**

Response: **0...4**

Function:

After voltage switch-on, or following a RESET, or after the RES command, and on expiry of a 2.5s delay period, initial zero setting will be executed within the selected range at a standstill. If there is no standstill, or if the gross value is outside the selected limits, there will be no zero setting. The internal zero memory is always deleted before any automatic zero setting. If the gross value at standstill is within the selected range, this gross value will be stored in the zero memory. The zero memory cannot be read out. Scale standstill is fixed at 1d/second. The unit 'd' (digit) refers to the nominal value (NOV). If the nominal value is deactivated (NOV=0) or NOV value > 10000d, then there will be a standstill monitoring relative to a nominal value of 10000d.

If the NOV value is set to <100d, then there will be a standstill monitoring in accordance with a nominal value of 100d.

ZTR

Zero Tracking (Automatic zero tracking)

Range: 0/1
Factory setting: 0
Response time: <0.1s
Parameters: 1
Password protection: none
Parameter protect.: with command **TDD1**

Input: ZTR(0/1);

ZTR0: Zero tracking deactivated

ZTR1: Zero tracking activated

Query: ZTR?;

Response: 0/1

Function: Automatic zero tracking is effected at a gross value of <1d within a range of $\pm 2\%$ from the nominal value (**NOV**) of the scale. The maximum adjustment velocity is 1 d/second when the scale is at a standstill. Scale standstill is fixed at 1d/second. The unit 'd' (digit) refers to the nominal value (**NOV**). If the nominal value is deactivated (**NOV=0**) or **NOV** value > 10000d, then there will be a standstill monitoring relative to a nominal value of 10000d. If the **NOV** value is set to <100d, then there will be a standstill monitoring in accordance with a nominal value of 100d.

LIC

Linearization Coefficients (Compensation of a linearity error)

Range:	±0...1999990	
Factory setting:	0, 1000000, 0, 0 (=LIC off)	
Response time:	with output:	<15ms
	with input:	<35ms
Parameters:	4	
Password protection:	yes	
Data protect.:	with input	

Input: LIC(0...3),(coefficient);

Example for an entry of coefficients:

Coeffizient 0 = +10 entry:	LIC0,+10;
Coeffizient 1 = +1000345 entry:	LIC1,+1000345;
Coeffizient 2 = -345 entry:	LIC2,-345;
Coeffizient 3 = +45 entry:	LIC3,+45;

Query: LIC?;

Response: LIC0,1000000,0,0;

Effect: Output of the linearity coefficient in the sequence:
coefficient 0, coefficient 1, coefficient 2, coefficient 3 CRLF

The characteristic determined by the command pair **SZA, SFA** is initially determined in 2 points. Using the AED, the linearity fault of a scale can be compensated. The AD104 comprises a 3rd order polynomial for linearization:

*Meas. value = LIC0 + LIC1 * x + LIC2 * x² + LIC3 * x³, with x = input value*

Using a polynomial of the 3rd order, it is also possible to correct a linearity fault with a turning point. Outside the linearity interval, an increased occurrence of measurement faults is to be expected.

The coefficients **LIC0,....,LIC3** are entered as ASCII numbers with the command **LIC**.

Important Note

The coefficients are determined when the measuring chain is calibrated, the factors are not computed in the AED; computation of the same must be effected by means of the HBM program *AED_Panel32* and loaded into the AED. The precise procedure is described in the program *AED_Panel32*.

MAV**Measured Alternative Data**

(output alternative measured value, see trigger function)

Range:	Integer	±32767
	Long Integer	±8388607
	ASCII	±1638399
Factory setting:	ASCII	
Response time:	<25ms	
Parameters:	—	
Password protection:	none	
Parameter protect.:	no data to be protected	

Query: **MAV?;****Effect:** If a new trigger measured value has been formed, this measured value will be output once. If no new measured value has been formed, the output value is the overflow value (binary = 80000h or ASCII < -8388608). This value will be output also after the measured value has been read out and a new query is received.

The measured value will be output in ASCII or binary format (see command **COF**). This command can be used only when the trigger function is activated (see command **TRC**).

TRC**Trigger Command**
(Trigger setting)

Range: 0/1, 0/1, 0...1599999, 0..99, 0...99
 Factory setting: 0, 0, 0, 0, 0
 Response time: <0,1s
 Parameters: 5
 Password protection: none
 Parameter protect.: with command **TDD1**

Input: **TRC P1,P2, P3,P4, P5;**

P1: Trigger function On/Off
 0=Off
 1=On

P2: Trigger typeart
 0=Level triggering
 1=External trigger input (IN1)

P3: Trigger level
 0...NOV=Trigger level (at P2=0 and **NOV**>0)
 0...1599999=Trigger level (at P2=0 and **NOV**=0)

P4: Settling time
 0...99: Settling time = $P4 * 10ms * 2^{ICR}$

P5: Measuring time
 0...99: Measuring time = $P5 * 10ms * 2^{ICR}$

Query: **TRC?;**

Response: P1, P2, P3, P4, P5 CRLF

Function:

The general function is described in Section 4.2.

The position of the trigger level P3 depends on the output scaling (**NOV**). At **NOV=0** (scaling off) the trigger level will be on the characteristic 0...1000000. At **NOV>0** the trigger level will be in the range 0...**NOV**.

The response time P4 has to be adjusted, thus the settling time is not lower as of the used filter.

Example 1 : ICR0, ASF3 → total settling time \geq 160 ms → P4 = 16 (= 16 * 10 ms, if ICR=0)

Example 2 : ICR1, ASF3 → total settling time \geq 160 ms → P4 = 8 (= 8 * 20 ms, if ICR=1)

The measuring time P5 provide an additional averaging. (P5=6 → averaging over 6 values).

The external trigger will only be released again when the output value has been formed (no re-trigger function).

Important Note

If the command COF (128..140) was used to select automatic output and the trigger function is activated, then the AD104 will output the measured value once after triggering and subsequent measurement. Thus a measured value query by means of the command MAV? will not be necessary. The connected computer only needs to receive this measured value.

For details on how to set this mode, see command **COF**:

COF128 to **COF 140** continuous output foll. power On (not for bus operation).

Example: external triggering with automatical output

1. set parameter of the AED (**ASF,ICR,...**)
2. activate external Trigger with command **TRC1,1,0,20,5;**
3. Define the outputformat of the meas. values with command **COF128+j;** . "i" depending on binary output/ ASCII-output, see command **COF**, no parameter setting possible,i after each Trigger event the result is given out automatically (without **MAV?;** command)
4. Stop the automatical measuring value output with **STP;** command
5. nonvolatile storage of automatic output in the EEPROM with **TDD1;** command
6. starts again the automatical output with **RES** command. After each Trigger event the result is given out automatically (without **MAV?;** command)
7. Stop the automatical output with **STP;** command. Parameter setting is possible
8. Deactivate automatical output with **COF3;** command
9. Nonvolatile storage of none automatic output (if wanted) with **TDD1;**
10. Single measuring value output or single trigger output (if wanted) with **MSV?;** or **MAV?;**

7.5 Error messages

ESR

Event Status Register (Output of error messages)

Query: ESR?;

Effect: This function outputs the error messages defined according to the IEC standard as 3-digit decimal number. The occurring errors are linked by "Or".

Error message	Error
000	No error
004	Not used
008	Device Dependent Error (Hardware error, e.g. EEPROM error)
016	Execution Error (error at parameter input)
032	Comand Error (command not allowed)

Example:

024 → Device Dependent Error and Execution Error

After **RES**, power On or reading the error status, the register contents are cleared.

7.6 Bus termination for RS-485 version**STR****Set Termination Resistor**
(Bus termination resistors)

Range: 0/1
Factory setting: 0 (off)
Response time: <15ms
Parameters: 1
Password protection: none
Parameter protect.: with command **TDD1**

Query: **STR?**
Effect: **0/1 crlf**
Befehl: **STR0/1;**

Effect: 0 = Bus termination switched off
1 = Bus termination switched on

The necessary measures for the electrical bus termination (resistors) were described in Section 5.3. These resistors protect the zero-signal level on the master line if none of the connected modules is transmitting. Observe here that this bus termination must be switched on only twice per bus system (master line), and is generally located at the line ends of the master line.

Normally the interface of the master contains such a bus termination and the termination is switched on at the most remote AED via the command **STR1;**.

7.7 Commands for Legal for trade Applications

LFT

Legal for Trade (Legal for trade)

Range:	0/1
Factory setting:	0 (off)
Response time:	<50ms
Parameters:	1
Password protection:	none
Parameter protect.:	with input

Query: LFT?

Effect: 0/1 CRLF

Befehl: LFT0/1;

Effect: 0= legal for trade off (default)
1= legal for trade on

If **LFT** is changed, each change of the following parameters will increase the trade counter (**TCR**). With **LFT1** (legal for trade application) every input of parameters of following commands the trade counter will increase:

CRC, DPW, IDN, LDW, LWT, LIC, NOV, SZA, SFA, ZSE, ZTR,

Every change of parameters for legal for trade applications can be documented with this none resetable counter.

The logo consists of the letters 'TCR' in a bold, white, sans-serif font, centered within a dark gray square.

Trade Counter (Trade Counter)

Range:	no input
Response time:	<30ms
Parameters:	none
Password protection:	none
Parameter protect.:	—

Query: TCR?;

Effect: xxxxxxxx CRLF (8 characters+CRLF)

This is a none resetable counter for legal for trade applications. If LFT is switched on, each change of the parameters will increment the trade counter (see LFT). The maximum count is 8388607 (7F FF FF hex). Then the counter is fixed. If this occurs you get only overflow values with the command **MSV?**. The AED has to be send to HBM.

CRC**Cyclic Redundancy Check**
(Cyclic Redundancy Check)

Range: ± 8388607
Response time: <50ms
Parameters: 1
Password protection: none
Parameter protect.: with input

Query: **CRC?;**

Effect: xxxxxxxx CRLF (8 characters+CRLF)

Input: **CRCxxxxxx;**

Effect: 0 CRLF

This command can be used to calculate (external, in the master) a checksum over all parameters of the AED. So it is easy to check if one or more parameters has been changed. Which calculation is used is up to the software of the master. If **LFT1** is switched on, a change of this **CRC** will be also detected with the trade counter (**TCR**).

This **CRC** is an additional check for changed parameters in the AED.

7.8 Further commands

The commands listed here are contained in the AD104 only for compatibility reasons. **They have no function in the AD104.**

ACL?	Query ACL,	Answer AED: 0
GRU?	Query GRU,	Answer AED: 32
COR?	Query COR,	Answer AED: 0/1
ASS?	Query ASS,	Answer AED: 2
CAL	Query CAL,	Answer AED: 0

The answers are output fixed independent of possible entries.

7.9 Examples of communication

Settings for the bus mode (only AD104-R5):

The AED is able to work in a bus with up to 32 modules. A prerequisite for this is that each AED is connected to the bus through a RS-485 interface driver. In this case each AED works as slave, i.e. without request by the bus master (e.g. PC or PLC), the AED remains inactive on its transmission line. An AED is selected by the master via the command SELECT (S00...31). Therefore it is absolutely necessary to enter a communication address for each AED before the bus coupling. Naturally each address in the bus may be allocated only once.

There are two ways to entry the address for communication:

1. Connect AED consecutively to the bus:

- Connect first AED to the bus line (The factory setting is ADR31, baud rate 9600)
- Initialize the interface of the master with 9600 Bd, 8, e, 1
- Output command ;S31;
- Set wanted address with the command ADR (e.g. ADR01;)
- Select AED with the new address: ;S01;
- Store address nonvolatile with the command TDD1;
- Connect next AED to the bus, output ;S31;, set ADR02, etc.

or

2. All AED are interfaced to the bus:

- Read off manufacturing number of the AED (5-digit) (1st AED: xxxxx, 2nd AED: yyyyy, ...)
- Initialize interface of the master 9600 Bd, 8, e, 1
- Output broadcast command ;S98;
- Set wanted address with the command ADR (e.g. ADR01,"xxxxx";)
- Set wanted address with the command ADR (e.g. ADR02,"yyyyy";), etc.
- Store addresses nonvolatile with the command TDD1;

Important Note

With S98; no AED answers, but each AED executes the command.

If there is no communication, then the address or the baud rate can be incorrect.

After successful setting of all addresses and with uniform baud rates, the bus is ready. Now it must be determined how the measured values are read out.

With the measured value output via the command MSV?;, the output format must be set previously in all modules:

1. Output broadcast command S98; (all AED execute the command, but transmit no answer)
2. Output command for the output format (e.g. COF3; for ASCII output)
3. Command TDD1; if this setting should be stored protected against power failure.

Changing the baud rate:

The AED can work with different baud rates. The setting can be changed only through the serial interface with the aid of the command BDR.

Naturally the baud rate of all connected subscribers should be the same in the bus mode. The following procedure can be helpful to always certainly set the AEDs in a bus to the wanted baud rate on initialization (switching on) of the system:

1. Set the baud rate of the master interface to 2400 Bd, 8 data bits, 1 parity bit even, 1 stop bit
2. Output of the command string: ; (clears the input buffer of the AED)
 S98; (selects all AED on the bus)
 BDR9600; (output of the wanted baud rate)
 (wait approx. 150ms)
3. Set the baud rate of the master interface to 4800 Bd, 8 data bits, 1 parity bit even, 1 stop bit
4. Output of the command string: ; (clears the input buffer of the AED)
 S98; (selects all AED on the bus)
 BDR9600; (output of the wanted baud rate)
 (wait approx. 150ms)
5. Set the baud rate of the master interface to 19200 Bd, 8 data bits, 1 parity bit even, 1 stop bit
6. Output of the command string: ; (clears the input buffer of the AED)
 S98; (selects all AED on the bus)
 BDR9600; (output of the wanted baud rate)
 (wait approx. 150ms)
7. Set the baud rate of the master interface to 38400 Bd, 8 data bits, 1 parity bit even, 1 stop bit
8. Output of the command string: ; (clears the input buffer of the AED)
 S98; (selects all AED on the bus)
 BDR9600; (output of the wanted baud rate)
9. Set the baud rate of the master interface to 9600 Bd, 8 data bits, 1 parity bit even, 1 stop bit
10. Output of the empty command: ; (clears the input buffer of the AED)
11. Command TDD1; if this setting should be stored nonvolatile.

The output of the semicolon before the S98; command is absolutely necessary, since there can be undefined characters in the input buffer of the AED which, however, are rejected by the reception of the semicolon, due to driving the AED with different baud rates.

Important Note

With S98; no AED answers but executes the command.

With the example listed above, all AED on this bus are set to the baud rate of 9600, independent of their previous setting.

Naturally another baud rate can also be set. Then the wanted baud rates must be provided in the command BDR and the initialization of the master interface must be changed accordingly.

The baud rate is the transmission speed of the interface. This has no effect on the number of measured values which the AED determines per second.

A high baud rate simply enables a larger number of AED to be inquired per time unit in the bus mode.

Baud rate	Transmission time for one ASCII character
2400	4.4 ms
4800	2.2 ms
9600	1.1 ms
19200	0.6 ms

The transmission time for a command string can be calculated approximately with this information. Determine the number of characters in the command and multiply it with the transmission time. Moreover, the AED has a processing time for each command. Refer to the command description for these times (times = transmission plus processing times).

Determining the bus occupancy (Bus Scan):

Frequently it is expedient to determine the bus configuration each time the bus is switched on or if answers of the AED are not received. The address occupancy of the bus can thus be determined with the aid of the Bus Scan. A prerequisite for this is that all modules are set to the same baud rate.

1. Initialization of the master interface with the set baud rate of the AEDs
2. Scanning an address with the command string:

;S00;	(Select Adress)
X;	(output of an invalid command)
3. The AED addressed with the address answers with a '?CRLF', since it does not know the command. If no answer comes after a time of approx. 100ms, then no AED is present at this address. If undefined characters or no ? characters are received by the master, then there can be a bus fault or multiple occupancy of the address. The bus master must react accordingly.
4. Repetition of item 2 with the following addresses 01...31.

If only a few AED are connected and the addresses are known, then the BusScan can naturally only refer to these addresses. If all AED are determined successfully as bus subscribers, then the identification string of the AED can possibly be read (measuring point identification and manufacturing number).

The time-out setting for the interface driver of the master is decisive for the speed of the Bus Scan. The select command requires max. 20...30ms for the output (for 2400 Bd). The AED does not answer to this select command.

Measured value query in the bus mode:

All AED have been prepared for bus operation with the aid of the preceding chapter and the BusScan has found all connected AED.

The output format is set with the command COF for the **single measured value query** with the command **MSV?**. The command string is now:

S00; MSV?;	The AED with the address 00 answers with the measured value
S01; MSV?;	The AED with the address 01 answers with the measured value etc.

The following query times result approximately:

Master transmission:	S00; MSV?;	
Response time AED:	approx. 40ms	(9 charact. + 1 charact. pause) (at ICR2)
AED transmissions:	xxCRLF	(4 characters at COF2) (10 characters at COF3)

Baud rate	Output format	Measured value query time for one AED for ICR2
9600	COF2	54 ms
19200	COF2	47 ms
9600	COF3	61 ms
19200	COF3	51 ms

Use these times only as orientation values.

For the faster **measured value query** with the command **MSV?**, the command string is:

- S98; MSV?; All AED form a measured value but do not answer
- S01; The AED with the address 01 answers with the measured value
- S02; The AED with the address 02 answers with the measured value
- S03; The AED with the address 03 answers with the measured value etc.

The following query times result approximately (COF2, ICR0):

Master transmission:	;S98; MSV?; S01;			S02;		S03;	
Response time AED (ICR0):		approx. 10ms					
AED transmissions:			xxCRLF		yyCRLF		zzCRLF

The master may then transmit a new select command in this case if the measured value has been received.

Query time = Number of all characters x Time for one character + Response time AED

Baud rate	Output format	Measured value query time for three AED for ICR0
9600	COF2	48 ms
19200	COF2	29 ms
38400	COF2	20 ms
9600	COF4	54 ms
19200	COF4	32 ms
38400	COF4	21 ms

Use these times only as orientation values.

Setting a parameter in all connected AEDs:

Now that the measured value query no longer represents a problem, setting a parameter in all AEDs connected to the bus is also no longer a problem:

1. Output broadcast command S98; (all AED execute the command, but send no answer)
2. Output parameter command (e.g. ICR3;)
3. Output command TDD1; if this setting should be stored nonvolatile
4. (Sii; select next AED to read parameters as a check, for instance)

This string can also be used for taring with the aid of the command TAR or for switching over between gross and net output (TAS).

8 Technical data

Type		AD 104
Accuracy with $\geq 1.0 \mu\text{V/d}$	d	3000
Bridge resistance, transducer	Ohm	> 300
Bridge excitation voltage	V	5
Max. Measuring range		+/- 2.6 mV/V
Sensitivity	mV/V	2
Measuring signal resolution	Bit	20 (at 1Hz)
Measuring rate (depending on output format and baud rate)	Hz	100; 50; 25; 12; 6; 3; 2; 1
Cut-off frequency of digital filters, adjustable; at -3dB		
Filter mode 0 (s. ASF)	Hz	8... 0.05
Filter mode 1 (settling time $\leq 240\text{ms}$), (s. ASF)	Hz	8 ... 3
Cable length between AED and computer with RS232	m	≤ 15
RS-485	m	≤ 500
Linearity deviation, related to the nominal value	%	± 0.005
Temperature effect per 10K on the zeropoint, related to the nominal value	%	± 0.002
on the measuring sensitivity, related to the nominal value	%	± 0.005
Serial Interfaces		
electrical level AD104-R2 (RS232)	V	Low: -3.. -12V High: +3.. 12V
electrical level AD104-R5, (RS485,differential)	V	Low : B-A < 0.35 High: B-A > 0.35
Baud rate, adjustable	Baud	1200; 2400; 4800; 9600; 19200; 38400;
Operating voltage (DC)	V	5.6...15
Current consumption (without transducer)	mA	≤ 30 (typ). ≤ 40 (max.)
Nominal temperature range	$^{\circ}\text{C}[^{\circ}\text{F}]$	-10...+40 [+14...+104]
Service temperature range	$^{\circ}\text{C}[^{\circ}\text{F}]$	-10...+50 [+14...122]
Storage temperature range	$^{\circ}\text{C}[^{\circ}\text{F}]$	-25...+75 [-13...167]
Dimensions (l x w x h), pcb	mm	75 x 29 x 7
Dimensions (l x w x h), with housing	mm	102 x 31 x 15
Weight PCB, approx.	g	50
Degree of protection EN 60529 in the housing		IP 40

In its shielded setup (see Sect. 3), the entire measuring chain including the AED is insensitive against HF interference and conducted interference in accordance with OIMLR76, EN45501 and EN61326.

Modifications reserved. All details describe our products in general form. They are not to be understood as express warranty and do not constitute any liability whatsoever.

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