Operating instructions

Digital Transducer-
Electronics

AD105

HBM

Contents **Page**

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.
- When connecting lines implement measures against electrostatic discharges which may cause damage to the electronics.
- For power supply, a small voltage with safe disconnection from mains is required.
- When connecting additional units, the safety regulations according to EN61010[1)] must be complied with.
- Use shielded lines 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 units"

1 Application

The digital transducer electronic units AD105 belong to the family of AED components which digitally condition and network as bus-capable signals from measurement transducers with ohmic bridges. The objective of these components is the digitization and conditioning of the measuring signals directly at the transducer. The AD105 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.

AD105 type	Interface	Interface Electrical connection	Bus mode	Line length
1-AD105	asynchronous, serial	RS -485 2-wire, half-duplex	yes	$\leq$ 1000m

The transducer electronic units AD105 are also abbreviated with **AED** in the following text.

Characteristic features:

- Operating voltage 6V...15V DC
- 4 wire Inferface for a full bridge sensor, nominal input range : +/- 2mV/V, maximal input range: 2.4 mV/V
- Serial interface RS-485 2-wire, half-duplex, address range 00...31
- Separated calibration of transducer and application characteristic
- Digital filtering, choice of the output speed and scaling of the measured values
- Storage of the parameters with protection against power failure
- All settings are made through the serial interface
- Automatic zero tracking (1d/s, $\pm$2%), automatic initial zero setting ($\pm$2%...$\pm$20%)
- Limit value function with hysteresis (an open collector output)

2 Mechanical construction

The AD105 is a printed circuit board populated on both sides and having the dimensions
LxWxH = 45x22.5x7 [mm].

The connections for the bridge of the transducer as well as for the voltage supply and the interface provide for soldering pads (see photo on title page or Section 4).

The AD105 can be fitted into the load cell or it can be mounted on one side of the load cell. For mounting on one side a shield cap can be used (available from HBM).

If the AD105 is mounted outside of the transducer a shielded housing and cables should be used.

Warning: The AD105 board is not protected against electrostatic discharges. Appropriate safety precautions must be taken for handling during assembly into the transducer.

3 Electrical construction

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

- Transducer supply voltage (AC)
- Amplifier
- Analog-digital converter (A/D)
- Microprocessor unit (μP)
- Parameter memory (EEPROM) nonvolatile
- Serial interface RS485 2-wire
- internal voltage supply 5V
- digital output (open collector)

3.1 Function

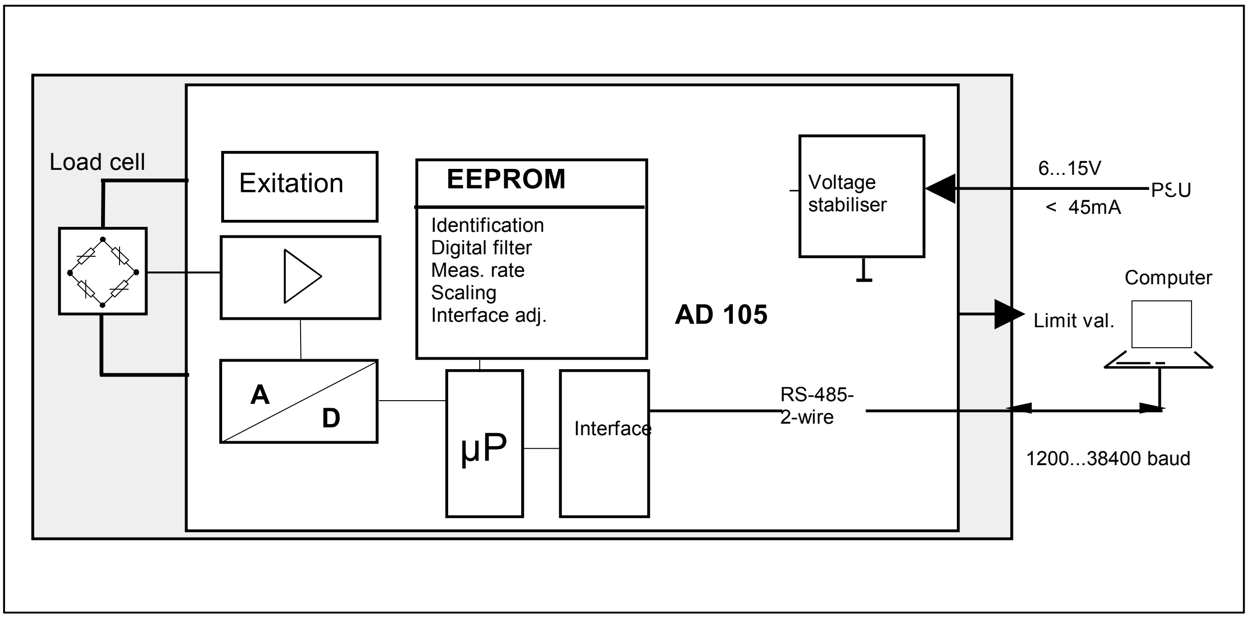


Fig. 3.1: Amplifier board AD105 block circuit diagram

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 via the serial interface. All parameters can be stored nonvolatile in the EEPROM.

The transducer electronic unit is adjusted in the factory to the nominal characteristic 0 ... 2mV/V. Following transducer calibration, the electronic unit determines a factory characteristic through the commands **SZA** and **SFA** and images the measured values following later by means of this characteristic. The following measured values are delivered according to the relevant 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 digits	0 ... NOV	
Binary 4 characters (Long Integer)	0 ... nominal load	0 ... 5,120,000 digits	0 ... NOV	
ASCII	0 ... nominal load	0 ... 1 000 000 digits	0 ... NOV	x

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

3.2 Signal processing

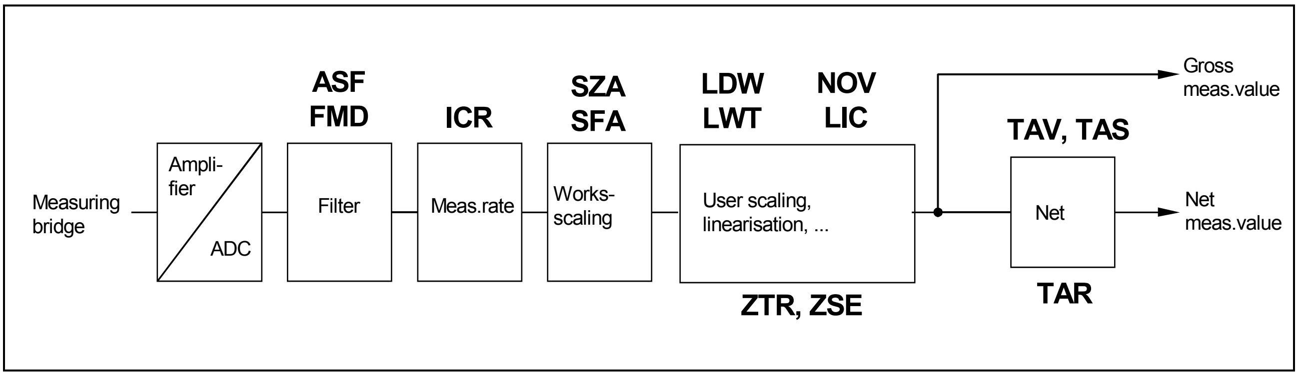


Fig. 3.2.1: Signal flow diagram

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 measured values per second) can be changed independently of the filter bandwidth with the command **ICR**.
The command **FMD** selects the filter types.
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**) as well as the taring command (**TAR**). 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 3rd oder polynomial). The polynomial parameters can be determined by means of a HBM PC program AED_Panel32 .

The current measured value is requested by the command MSV?. The format of the measured value (ASCII or binary) is set by the command COF.

In the AD105 a limit value function (**LIV**) is implemented. Here, the gross or net value can be monitored. The limit value information can be output in measured value status or as a hardware output (open collector). A hysteresis can be set via the separate input of input and output levels.

The light emitting diode (LED) can be used as an operating voltage display or as a status display of the limit value.

If the limit value function is deactivated, the control output OUT and the LED can be controlled via the command **POR** .

Control output OUT (open collector)

Limit value activated : Gross or net monitoring according to the **LIV** parameters

Gross/net measured value >= switch-on level: Voltage on the control output Low

Gross/net measured value < switch-off level: Voltage on the control output High

Limit value deactivated: Control via POR command

The control output is an open collector output. Thus, several control outputs can be connected as ‚wired OR', in order to indicate that the actual value has dropped below the limit value in a remote center.

Status display LED:

Limit value activated (command LIV, special mode of operation):

Gross/net measured value >= switch-on level: LED illuminates (ON)

Gross/net measured value < switch-off level: LED flashes

Limit value deactivated:

LED can be activated or deactivated via the port command POR

(default is On as operating voltage display)

4 Electrical connection

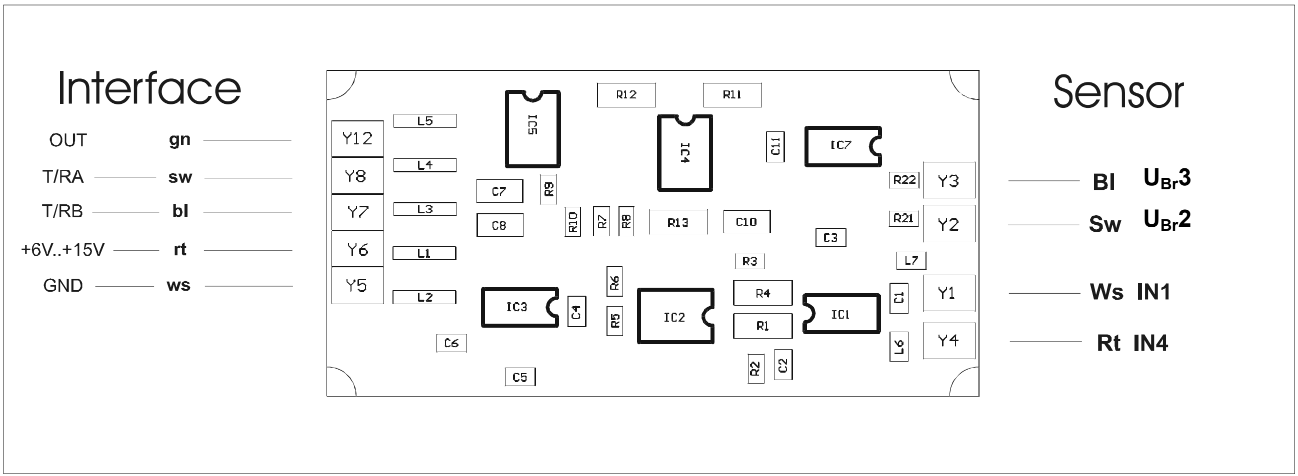


Figure 4.1 Connection layout (The specified colours are only used internally by HBM)

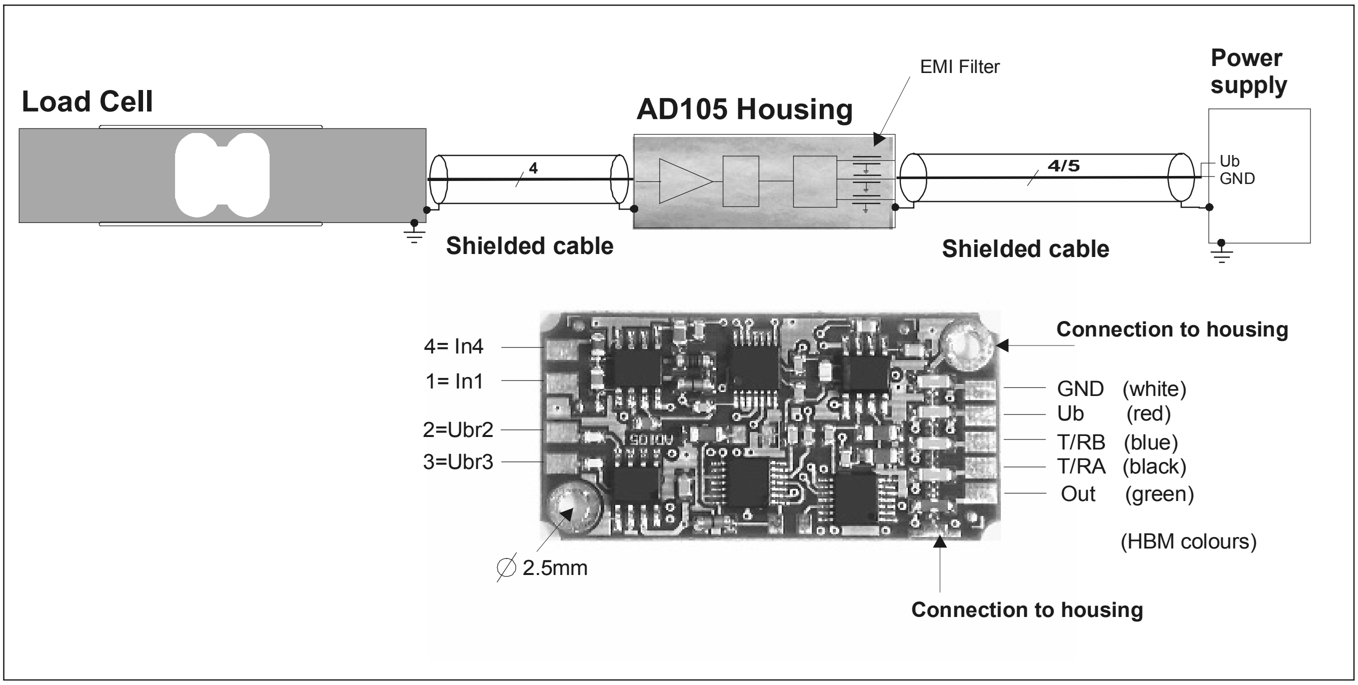


Fig. 4.2: Connection schema of the PCB an shielding concept of a measuring chain

Explanation:

UB.......Supply voltage (+6V...15V)
GND ground
T/RA 2-wire connection RS485, line A (=T/R-)
T/RB 2-wire connection RS485, line B (=T/R+)
OUT Control output Open Collector
$U_{Br}3$ Supply voltage bridge (alternating voltage 200Hz, 5V, rectangular)
$U_{Br}2$ Supply voltage bridge (alternating voltage 200Hz, 5V, rectangular inverted)
IN4 differential output bridge
IN1 differential output bridge

Important notes on EMC protection:

Mount the load cell onto a metallic carrier which is connected to the ground connection of the device, or shield AD105 with the load cell and load infeed components as a complete unit. A shielded cable is to be used. The cable shield needs to be connected with the measuring body in order to prevent any external line influences on the connection cable. The housing of the AED has to be connected to the solder pad ‘connection to housing’ (see Fig. 5). The AED unit itself is provided with a protective filter for all interfaces and supply lines. The connection of the line filters with the measuring body or for shielding is effected by means of the left-hand bottom mounting screw of the printed circuit board (see photo 4.1) or via an equivalent short circuit bridge)

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 AD105 uses a rectangular carrier frequency for bridge supply. Therefore, the cable length between AD105 and the transducer is limited to 100 cm max. For high precision applications(>= 3000d), the length should be reduced to 30cm (shielded cable, shield connection on the measuring body and on the shielded housing for AD105).

4.1 Bus connection

Up to 32 AEDs can be connected to a common bus line through the RS-485 interface. Furthermore, long line lengths (up to 1000m) can be achieved.

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 Chapter 7.

The interface signals T/RA and T/RB are connected in parallel for all AED and the master.

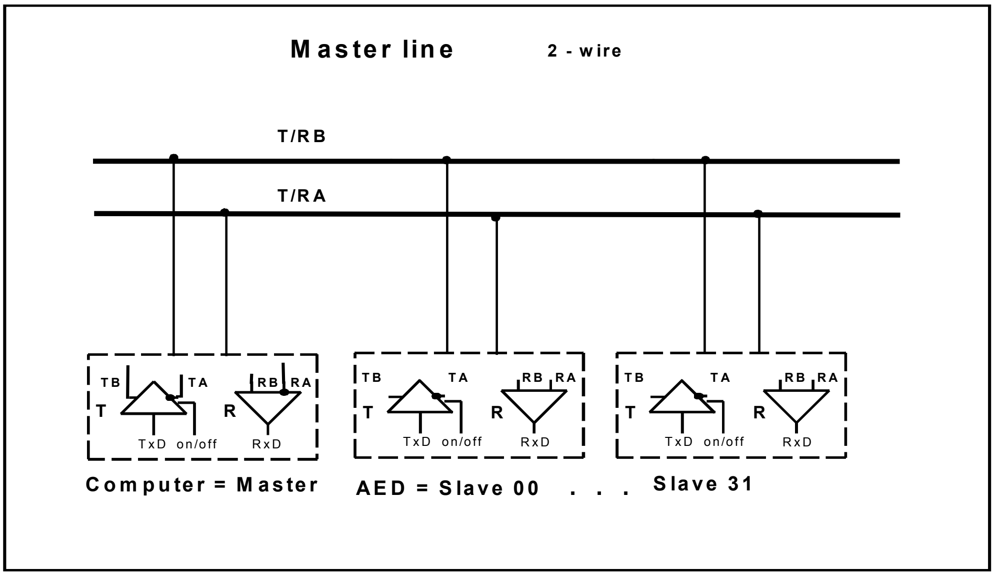


Fig. 4.1.1: Bus structure 2-wire bus (general)

Termination resistors are necessary for the electrical function of the bus system. These resistors protect the quiescent-signal levels for the receivers on the bus line. The termination resistors are already contained in the AED. The quiescent -signal level on the RS-485 master line results in the 2-wire mode at:

T/RB – T/RA $\geq$ 0.35 V

Since the RS-485 is a differential bus interface, the quiescent-signal levels are also stated as a differential voltage between the wires (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. A shielded cable is recommended for the master line for EMC reasons.

The connection of an AD105 to a PC-COM port is effected via an interface converter. This interface converter can be ordered from HBM (Part number: 1-SC232/ 422A). The interface converter is to be switched over to 2-wire mode (DIL switch in the converter). The HBM interface converter already contains bus termination resistors.

The interface cable length depends on the resistance, capacity of the cable, the number of AED connected in the bus system (total power supply current) and the baudrate.

4.2 Control output OUT

The control output can be used optionally as a limit value output or a general control output.

Limit value activated : Gross or net monitoring according to the LIV parameters:

Gross/net measured value >= switch-on level: Voltage on the control output Low

Gross/net measured value < switch-off level: Voltage on the control output High

Limit value deactivated (LIV1,0;) : Control via POR command:

POR0; Voltage on the control output Low (<=1V)

POR0; Voltage on the control output High (>=6V)

POR,0; LED is OFF

POR,1; LED illuminates (ON)

The voltage relates to the ground (GND) of the supply voltage.

The control output is an open collector output. Thus, several control outputs can be connected as ‚wired OR‘, in order to indicate that the actual value has dropped below the limit value in a remote center.

The control output OUT features an internal protective resistance of 20 Ohm (connected in series to the collector).

The maximum power dissipation loss of the transistor is 250 mW. This yields the maximum output current :

external voltage	max. current
6V	40 mA
15V	22 mA

5 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)
- Special commands (ZSE, ZTR, TDD, RES, DPW, SPW, IDN, LIV, POR, ENU, ESR)
- Commands for legal for trade applications (LFT,TCR,CRC)

5.1 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 exceed more than 10 characters in length.

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

	Command initials	**Parameter**	**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

5.2 Answers to commands

Answers to inputs (parameter adjustment) :

The AED does not answer to inputs (e.g. filter setting ASF3;). If the input is to be verified, then the relevant setting is to be read out again (ASF?; Response: 03crlf).

Answers to output commands (parameter query, measured value query) :

Correct command	Parameter1, ... Parameter n, or measured values **CRLF**
Faulty command	**no response**

5.3 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 one underneath the 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 response	Number of bytes
COF0; msv?;	yyyy CR LF (y- binary)	6
COF2; msv?;	yy CR LF (y- binary)	4
COF3; msv?;	xxxxxxxx CR LF (x- ASCII)	10
COF9; msv?;	xxxxxxxx,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**.

Command overview

Command	PW	TDD1	Function	Page
ADR		x	Address	16
ASF		x	Digital filter	37
BDR		x	Baud rate	17
COF		x	Output format in MSV?	18
CRC			external checksum	61
CSM		x	Check sum in MSV?	21
DPW			New password	44
ENU			Engeneering unit	47
ESR			Status	58
FMD		x	Filter mode	40
ICR		x	Measuring rate	40
IDN			Identification	47
LDW	x		Zero, user characteristic	29
LFT			Legal for trade switch	59
LIC	x		Linearization	54
LIV		x	Limit value	55
LWT	x		Nominal value, user characteristic	30
MSV			Current measured value	32
NOV	x	x	Nominal output value	31
POR		x	Port command	57
RES			Reset	46
S...			Select	23
SFA	x		Internal nominal value, factory characteristic	27
SPW			Password entry	**Fehler! Textmarke nicht definiert.**
SZA	x		Internal zero value, factory characteristic	26
TAR			Taring	40
TAS		x	Gross/net switch-over	43
TAV		x	Tare value	42
TDD1/2			Store setting in EEPROM, read EEPROM	48
TDD0	x		Factory setting	48
TEX		x	Data delimiter for measured value output	22
TCR			Trade Counter	60
ZSE		x	Initial zero setting	52
ZTR		x	Automatic zero tracking	51

Storing with TDD1, otherwise on entry
Password protection through commands DPW/SPW

6 Individual descriptions of the commands

6.1 Interface commands (asynchronous, serial)

Characteristic data of the interfaces:

Start bit:	1
Word length:	8 bits
Parity:	none / even
Stop bit:	1
Baud rate:	1200; 2400; 4800; 9600;19200; 38400 baud

Software handshake (XON / XOFF) is possible

The asynchronous interface of the AED is a serial interface, i.e. the data are transmitted bit by bit one after 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.

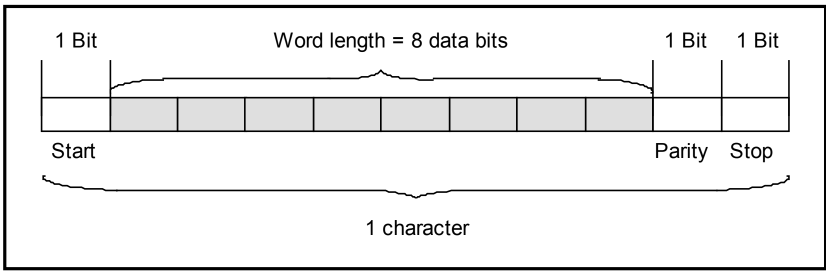


Fig. 7.1.1: Composition of a character

Since the data are transmitted one after 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 4 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:	<15 msec
Parameters:	2
Password protection:	no
Parameter protection:	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** (incl. space characters).

Example:

Input: **ADR25,“007“ CRLF**

Query: **ADR?;**

Response: **25CRLF**

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

BDR

Baud Rate
(Baud rate)

Baud rates:	1200,2400,4800,9600,19200,38400
Factory setting:	9600 baud and Even Parity
Response time:	<15 msec
Parameters:	1
Password protection:	no
Parameter protection:	with command **TDD1**

Input: **BDR<Baud Rate>,<Parity>**

Entry of the required baud rate as decimal number.

The following baud rates are possible: 1200, 2400, 4800, 9600, 19200, 38400 baud.

Entry of the parity required:
0 - without a parity bit
1 - with parity bit even

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?;**

Response: Output of the set baud rate and the identification for the parity bit

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

COF Configurate Output Format
(Ausgabeformat für die Messwertausgabe)

Range:	0...12
Factory setting:	9
Response time:	<15 msec
Parameters:	1
Password protection:	no
Parameter protection:	with command **TDD1**

Input: **COF(0...12);**

Entry 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 tables. The measured value output refers here to the set nominal value of the AED (see command **NOV**).

Output for nominal load	NOV > 0	NOV = 0
2 Bytes binary	NOV value	20000
4 Bytes binary	NOV value	5120000
ASCII	NOV value	1000000

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

Query: **COF?;**

Response: **008CRLF (Example)**

Effect: Output of the selected output format as three-digit decimal number from 0...12

COF formats:

Using the command COF, it is possible to adjust the output format as well as the output mode.

The combinations specified in the following tables result on entry of **COF0** to **COF12**:

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	4Bytes	MSB before LSB, LSB = 0 (no status)
COF2	Measured value	2Bytes	MSB/LSB
COF4	Measured value	4Bytes	LSB before MSB, LSB = 0 (no status)
COF6	Measured value	2Bytes	LSB/MSB
COF8	Measured value	4Bytes	MSB before LSB, LSB= status / CRC
COF12	Measured value	4Bytes	LSB before MSB, LSB= status / CRC

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

Here, length detail is without termination characters (Standard: cr lf).

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	Measured value(8)	T(1)	Address(2)		----	crlf or T
COF3	Measured value(8)		----		----	crlf or T
COF5	identical with COF1					
COF7	identical with COF3					
COF9	Measured value(8)	T(1)	Address(2)	T(1)	Status (3)	crlf or T
COF11	Measured value(8)	T(1)	-	-	Status (3)	crlf or T

Output speed of measured values:

The AD105 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 preset averaging (ICR).

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

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 MSV?0; (BDR)							
Binary format 2 characters for COF2/COF6	2400	1200	1200	1200	1200	1200	1200	1200
Binary format 4 characters for COF0/COF4	4800	2400	1200	1200	1200	1200	1200	1200
Binary format 6 characters MSV?1 for COF0/COF4	9600	4800	2400	1200	1200	1200	1200	1200
ASCII format measured value 10 characters for COF3	19200	9600	4800	2400	1200	1200	1200	1200
ASCII format measured value + address 13 characters for COF1	19200	9600	4800	2400	1200	1200	1200	1200
ASCII format measured value + address + status 17 characters for COF9	38400	19200	9600	4800	2400	1200	1200	1200

Table 1: Baud rate depending upon measuring rate and output format

Note for the evaluation of the binary measured values:

During measured value output in binary format, the binary codes for CR and LF can occur within the bytes representing the measured value. Therefore the contents of the measured value output must not be tested for the characters CR/LF in order to check for any end of the measured value transmission. Rather, for binary output, the number of characters which are received should be registered. Also for binary output, the control characters CR/LF are appended to the measured value.

CSM

Checksum
(Cheksum only in MSV binary status)

Range:	0/1
Factory setting:	0
Response time:	<15msec
Parameters:	1
Password protection:	no
Parameter protection:	with command **TDD1**

Input:	**CSM(0/1);**
Query:	**CSM?;**
Response:	**0CRLF (Example)**
Effect:	The preset function is output as a single digit decimal number (0/1)

The check sum formation can be used for identifying transmission faults in 4 byte binary output mode.

For CSM=0, check sum formation in measured value status is deactivated. The normal measured value status is output (see command MSV). For CSM=1, a check sum (EXOR) is formed from the three byte measured value and output instead of the measured value status. This check sum formation can only be utilized with the output formats COF8 and COF12.

TEX

Terminator Execution
(Data delimiter between measured values)

Range:	0...255
Factory setting:	172
Response time:	<15msec
Parameters:	1
Password protection:	no
Parameter protection:	with command **TDD1**

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

The required data delimiter is input in decimal form as an 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: -0123456, 12, 000, -0123457, 12, 000 etc. (for 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.*

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

Query: **TEX?;**

Response: **172CRLF (Example)**

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

S...

Select
(Selection of AEDs in bus mode)

Range:	0...31, 98
Factory setting:	-----
Response time:	<15msec
Parameters:	1
Password protection:	no
Parameter protection:	no data to be protected

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

The select command generates no answer. Several AEDs connected together to form a BUS can be addressed individually or jointly with this command. An AED is always active after reset or power On. In bus mode must therefore be addressed through the select command to prevent the other bus subscribers from responding. For just one AED the S command is not required. 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.

Example: *Select 00*
Command 1
Command 2 ...n
Select 01
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:

- S98; All AED selected,
- MSV?; Measured value query, all AED form the measured value and place this value after the integration time (ICR) in the output buffer, but no AED transmits.
- S01; AED with address 01 is selected and outputs the measured value,
- S02; AED with address 02 is selected and outputs the measured value etc.

6.2 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**

The command **NOV** is available for scaling the measured value.

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:

SZA: Transducer without load,

SFA: Transducer loaded with nominal load.

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

LDW: The scale is in a no load condition.

LWT: Scale loaded with nominal load.

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 is mapped to the following numerical ranges:

Output at nominal load (COF)	NOV = 0	NOV > 0
2 Bytes binary	20000	NOV value
4 Bytes binary	5120000	NOV value
ASCII	1000000	NOV value

For the 2-bytes binary output, the NOV value must be $\leq$ 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 seq.
Enter password	**SPW"AED";**
Load = Zero load scale	**LDW;**
Load = Nom. load scale	**LWT;**

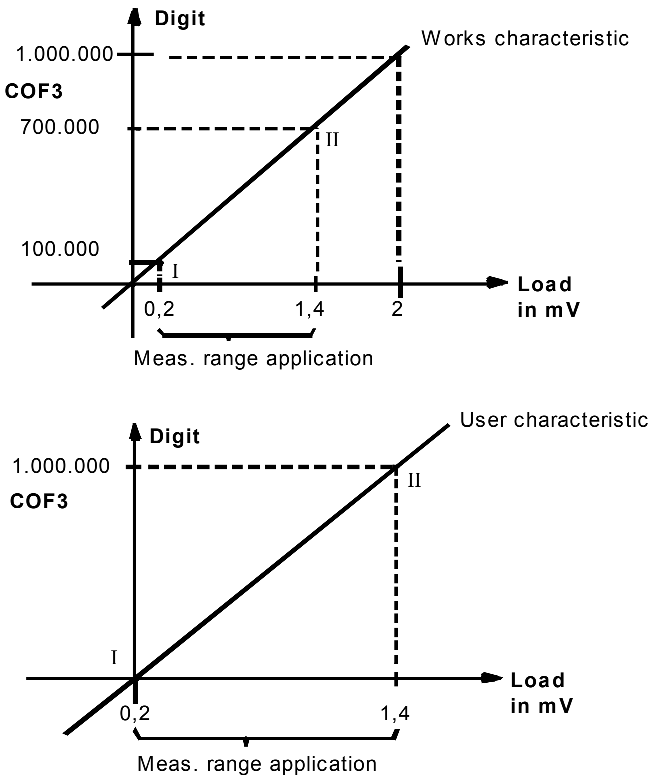


Fig. 7.7.1: Setting the user characteristic

SZA Sensor Zero Adjust
(Factory characteristic – zero point)

Range:	0...1.599999e6
Factory setting:	calibrated on unloaded load cell
Response time:	<15msec...4.2s
Parameters:	1
Password protection:	yes
Parameter protection:	after entry of **SFA**

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

Effect: Using this command, the transducer electronic system measures an input signal between ±2.4mV/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: <15msec)

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: <15msec)

Response: **0012345CRLF (Example)**

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

Important Note

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

SFA Sensor Fullscale Adjust
(Factory characteristic – fullscale value)

Range:	0...1.599999e6
Factory setting:	calibrated to nominal load of load cell
Response time:	<15msec... 4.2s
Parameters:	1 (0)
Password protection:	yes
Parameter protection:	on entry
Input:	**SFA;** (Response time <4.2sec)
Effect:	Using this command, the transducer electronic system measures an input signal between ±2.4mV/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 <1.5sec) 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 <15msec)
Effect:	output in ±7 digits (e.g. -0915345crlf) of the fullscale value. **The value is not converted via NOV.**

Important note

In an adjustment with **SZA** and **SFA**, the parameters for **LDW** and **LWT** are reset (default: **LDW=0** and **LWT=1000000)**

Procedure for entering the factory characteristic:

1. Enter password by means of command **SPW**
2. **NOV 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 0 = unloaded scale, 4000 at nominal load

Warning:

In an adjustment with **SZA** and **SFA**, the parameters for **LDW** and **LWT** are reset (default: L**DW=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 L**DW0,LWT1e6,** and **NOV0**.

LDW

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

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

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

Using this command, the transducer electronic system measures an input signal between ±2.4mV/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.

Input: **LDW<Zeropoint>;** (Response time: <15msec)

Instead of measuring the applied signal, the zeropoint value is entered here. The entered value is stored, but accounted for only after entry of the parameter for LWT.

Query: LDW?; (Response time: <15msec)

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:	<15msec...4.2s
Parameters:	1 (0)
Password protection:	yes
Parameter protection:	on entry

Input: LWT; (Response time <4.2sec)

Effect: Using this command, the transducer electronic system measures an input signal between ±2.4mV/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.

Input: **LWT<nominal value>;** (Response time <1.5sec)

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 LDW, used in calculating the user characteristic.

Query: **LWT?;** (Response time <15msec)

Effect: Output in ±7 digits (e.g. -0915345crlf) of the nominal value. 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. Deactivate user characteristic by means of **LDW0;** and **LWT1000000;**
4. Adjust the **ASF** filter such that a maximally quiescent display is effected
5. Scale at no load, wait for standstill
6. Determine measured value with **MSV?;** note value 1 for **LDW**
7. Load scale with nominal load; wait for standstill
8. Determine measured value with **MSV?;** note value 2 for **LWT**
9. Enter new characteristic with: **LDW** value 1; then **LWT** value 2;
10. Set **ASF** and **NOV** in accordance with the application, nonvolatile storage of the parameters **NOV, ASF** with the command **TDD1**

NOV

Nominal Value
(Resolution of the user characteristic)

Range:	0...1.599999e6
Factory setting:	0 (= deactivated)
Response time:	<15msec
Parameters:	1
Password protection:	yes
Parameter protection:	with command **TDD1**

Input: **NOV<value>;**

Query: NOV?; (Response time <15msec)

Effect: The value stored in the AED is output with 7 digits complete with sign (e.g. 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 Bytes binary	20000	NOV value
4 Bytes binary	5120000	NOV value
ASCII	1000000	NOV value

With the 2 byte binary type of output, the NOV value must be $\leq$ 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.

6.3 Measuring

Measuring includes all commands acting directly on a measured value; these are:

- **MSV** Measured value output
- **STP** Stop measured value output
- **FMD** Filter mode
- **ASF** Filter setting
- **ICR** Measuring rate setting
- **TAR** Taring
- **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:	no
Parameter protection:	no data to be protected

Query: **MSV?;**

Effect: Outputs a measured value.

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

Effect: Outputs the stated number of measured values.

Note: **MSV?0;** does not yield an output

The measured value will be output in ASCII or binary format (see command COF).

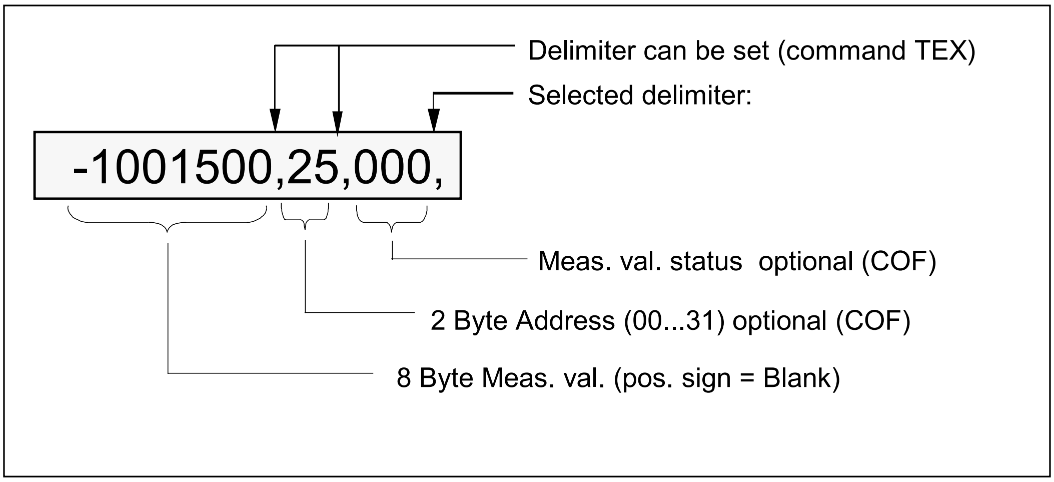
The output format for the measured value must be set **previously** via the command **COF**.

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 response	Number of characters
4 Bytes binary	yyyy CR LF (y- binary)	6
2 Bytes binary	yy CR LF (y- binary)	4
ASCII COF3;	xxxxxxxx CR LF (x- ASCII)	10
ASCII COF9;	xxxxxxxx,xx,xxx CR LF (x- ASCII)	17

CR: Carriage Return, LF: Line Feed



Example of ASCII output (**COF9**)

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

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

With the 2 byte binary type of output, the NOV value must be $\leq$ 30000. Otherwise the measured value will be output complete with overflow or underflow ($7fff_H$ or 8000_H ; H: Hexadecimal). With NOV30000, the remaining overload range is only 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 approx. [ms] for 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

Using the command **ICR**, the output rate is influenced via the interface. The internal scan rate of the ADU is maintained.

A predefined number P1 of measured values can be output via a command MSV?P1; . The total time for the acquisition of P1 (=1..65535) measured values is calculated as:

Measuring time [ms] = P1 x 2^{ICR} x 10 ms + 5 ms

In the 4-byte binary output mode or in the ASCII output mode the measured value status can be transmitted with the measured value (see command COF).

Error messages in measuring status

Contents of the status bytes at measuring output	**Possible cause**
0 = Net overflow	1 = Tare value too large
1 = Gross overflow	1 = Scaling too sensitive
2 = ADU overflow	1 = ADU overdrives (input > ±2.5mV/V)
3 = standstill	1 = standstill
4 = control output	1 = output active (voltage = Low)
5 = LED- status	1= LED on, 0=LED off or flashing
6	Reserve
7	Reserve

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: <15msec
Parameters: 1
Password protection: no
Parameter protection: with command **TDD1**
Input: **ASF(0...8);**

Entry of the filter stage as decimal number from 0...8

Query: **ASF?;**
Response: **00CRLF (Example)**
Effect: Output of the set filter stage (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 fast filter (FMD=1); cut off frequency selectable through ASF, fixed scan rate = 100Hz
- Averaging for output rate reduction (selectable through ICR, output rate <=100 Mv/s)

Thus the required filter effect and output rate can be set through the two commands (ASF, ICR). In addition to the standard filter characteristic, further new efficient digital filters have been implemented. The command FMD is used for switching over between the two filter types:
FMD 0; Standard filters
FMD 1; fast response filters

Filter characteristics of standard filters (**FMD0**):

ASF	Settling time in [ms] to 1%o	Cut-off frequency [Hz] at -3dB	Max. attenuation [dB] at 50 Hz
1	38	8	-20
2	95	3.5	-34
3	175	1.5	-48
4	350	0.7	-60
5	700	0.3	-72
6	1400	0.2	-82
7	2550	0.1	-90
8	5000	0.05	-96

At ASF0 the filter is deactivated. 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, with the measured value quiescence (standstill) being guaranteed if the weight does not change.

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

ASF	Filter length Taps	Cut-off frequency at -3 dB [Hz]	20 dB attenuation at frequency	40 dB attenuation at frequency	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	50...80	>15
6	20	4	9.5	12	45...85	>12.5
7	22	3.5	8	10	40...85	>10
8	24	3	7	8	40...80	>8

At ASF0 the filter is deactivated.

The filters ASF6...ASF8 are additionally limited in band width by average value calculation (ICR>4). The settling time of the filters is calculated from the filter length (12...24) multiplied by the filter scan rate of 10 ms

→ Settling time of the filter: 120ms ... 240ms

The average value calculation (ICR) does influence the total settling time of the AED. In addition, the total settling time is dependent on the mechanical structure of the transducer, the dead weight 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:	<15msec
Parameters:	1
Password protection:	no
Parameter protection:	with command **TDD1**

Input:	**FMD(0/1);**
	Entry of the filter type as a decimal number 0 or 1 (0= standard filter)
Query:	**FMD?;**
Response:	0crlf or 1crlf
Effect:	Output of the set filter type (0 or 1)
	The description of the filter type 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:	< 10msec
Parameters:	1
Password protection:	no
Parameter protection:	with command **TDD1**

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

Entry of the measuring rate as a 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 measured values with x = 0...7

The following settings are possible:

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 output rates to avoid measured data losses (see command COF).

Query: **ICR?;**

Response: 0crlf (Example)

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

The output rate does not influence the internal AD conversion rate. It is ensured that, for a smaller output rate, the mean value of the measured value is not falsified. This means:

The mean value across 8 measured values with an output rate of 100 measured values / seconds (ICR0;) equals the measured value which is output at ICR3 (no information loss)

Important note
At ICR>=1 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} x 10msec + 5msec
Parameters:	0
Password protection:	no
Parameter protection:	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 stored 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:	< 20msec
Parameters:	1
Password protection:	no
Parameter protection:	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 is 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 Bytes binary	+/- NOV value	+/- 150% NOV value	+/- 1000000	±8 388 607
4 Bytes binary	+/- NOV value	+/- 150% NOV value	+/- 1000000	±8 388 607
ASCII	+/- NOV value	+/- 150% NOV value	+/- 1000000	±1 599 999

Example:	***NOV3000;***		*(Output Scaling)*
	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;	*0rrlf*	*(Switching over to gross)*
	MSV?;	*3000crlf*	*(Measured value is at 100% = nominal load of scale)*
	TAV?;	*1500crlf*	*(Enquire tare value, without change)*

TAS

Tare Set
(Gross/net switch-over)

Range:	0...1
Factory setting:	1 (gross)
Response time:	< 10msec
Parameters:	1
Password protection:	no
Parameter protection:	with command **TDD1**

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

0 = net measured value, the value in tara memory is subtracted from the current measured value.

1 = gross measured value, the value in the tare memory is not offset.

The tare value remains unchanged during gross/net switchover.

Query: **TAS?;**

Response: 0crlf (Example)

Effect: Current setting is output.

6.4 Special functions

DPW

Define Password
(Defining a password)

Range:	1...7 letters or numbers (ASCII characters)
Factory setting:	AED
Response time:	< 80ms
Parameters:	1
Password protection:	no
Parameter protection:	on entry

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 quotation marks (‘‘...‘‘).

SPW

Set Password
(Write enable for all password-protected parameters)

Range:	the password defined with **DPW**
Factory setting:	AED
Response time:	<15msec
Parameters:	1
Password protection:	no

Parameter protection: **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:	no
Parameter protection:	no data to be protected

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: <15msec Input: < 40msec
Parameters:	1
Password protection:	no
Parameter protection:	on entry

Input: **ENU("mV/V");** (Example)

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?;**

Response: **mV/Vcrlf** (Example)

Effect: Output of the unit with 4 ASCII characters.

IDN Identification
(Identification of transducer type and serial number)

Range: 15 or 7 letters or numbers (ASCII characters)
Factory setting: according to transducer
Response time: Output: <15msec Input: <180msec
Parameters: 1
Password protection: no
Parameter protection: on entry

Input: **IDN<"Transducer type">,<"Serial number">;**

Entry of the transducer type and of the serial number.

The type and serial number of the transducer are stored in the EEPROM of the transducer electronic unit. The type designation must not exceed 15 characters in length; it must be entered as a string in quotation marks ("..."). If only the serial number is to be changed, then a comma is entered for the parameter Transducer Type, e.g. IDN,“4711“;

The serial number is entered at the factory and must not exceed 7 characters in length; it is entered in the same way as the type designation. The serial number must not be changed. If less than the maximum number of characters permitted are entered for the type designation or serial number, then the relevant entry is automatically filled with blanks until the maximum permitted number of characters is reached. It is not possible to enter the manufacturer and software version.

Query: IDN?;

Effect: An identification string is output. (33 characters).

Sequence: Manufacturer, transducer type, serial number, software version,

e.g. HBM, "AED105","1234", P50crlf

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** < 2.2sec
	TDD1 < 0.1sec
	TDD2 < 1.3sec
Parameters:	1
Password protection:	**TDD0** yes , **TDD1** no, **TDD2** no
Parameter protection:	no data to be protected

Input: **TDD(0);** Cold start, the parameters are reset to the following values

Copy of the default parameter setting from ROM - EEPROM - RAM

Query: TDD?

Effect: An output is not possible

Use this command to overwrite the parameters with default values from ROM (see table).

Factory setting	ROM default for TDD0	Remark
ADR31	No change	Address 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	Checksum off in measured value status
NOV0	NOV0	User scaling off
*DPW“AED“	*DPW“ „	Password
*ENUxxxx	*ENUxxxx	Unit
*FMD0	*FMD0	Filter mode
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	LFT0	Legal for trade OFF
*LDW0	*LDW0	User characteristic zeropoint
*LWT1000000	*LWT1000000	User characteristic fullscale value
*SFAxxx1)	No change	Sensor fullscale value
*SZAxxx1)	No change	Sensor Zero value
TAS1	TAS1	Gross measured value
TAV0	TAV0	Tare memory deleted
TEX172	TEX172	Data delimiter, output in columns with crlf
TCRxxx 1)	No change	Calibration counter
LIV	No change	Limit value function deactivated
ZSE0	ZSE0	Switch-on 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: **TDD1;**

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

You can change:

ADR	Address
ASF	Filter setting
BDR	Baud rate
COF	Configuration of the data output
CSM	Checksum in the measured value status
FMD	Filter mode
ICR	Measuring rate
TAS	Gross/net switch position
TAV	Contents of tare memory
TEX	Output data delimiter
ZSE	Switch-on zero setting
ZTR	Automatic zero tracking

Command: **TDD2;**

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.

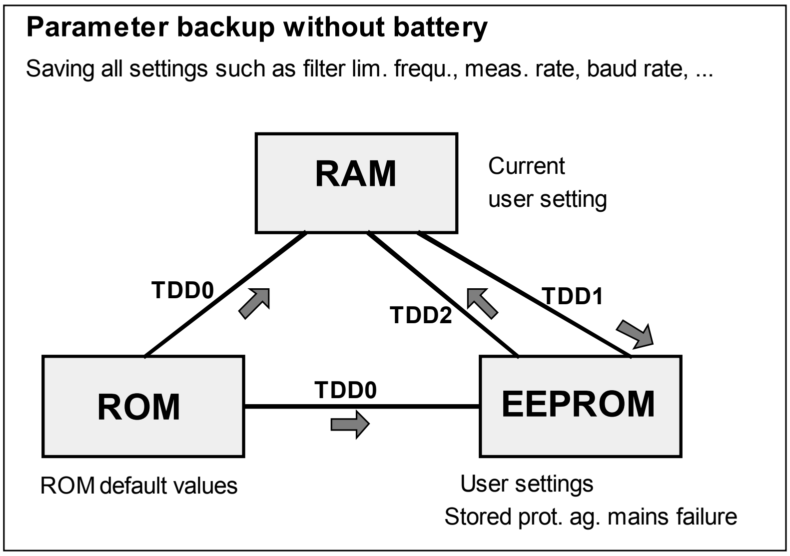


Fig. 7.3.1: Protecting the set parameters

ZTR

Zero Tracking
(Automatic zero tracking)

Range:	0/1
Factory setting:	0
Response time:	< 0,1sec
Parameters:	1
Password protection:	no
Parameter protection:	with TDD1

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

0- Zero tracking deactivated
1- Zero tracking activated

Query: **ZTR?;**

Response: 0/1 crlf

Function: Automatic zero tracking is effected at a gross value of < 1.0 d within a range of ± 2% from the nominal value (NOV) of the scale. The maximum adjustment velocity is 1.0 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.

ZSE Zero Setting
(Automatic zero setting)

Range:	0...4
Factory setting:	0
Response time:	< 0,1sec
Parameters:	1
Password protection:	no
Parameter protection:	with TDD1

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

0 - zero setting deactivated
1 - zero setting range +2% from NOV value
2 - zero setting range + 5% from NOV value
3 - zero setting range + 10% from NOV value
4 - zero setting range + 20% from 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.

LIC Linearization Coefficients
(Compensation of a linearity error)

Range:	±0...1999990	
Factory setting:	0,1000000,0,0	(= LIC deactivated)
Response time:	Output: <15msec	Input: < 35msec
Parameters:	4	
Password protection:	yes	
Parameter protection:	on entry	

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

Example for an entry:

LIC(0),(+10);	entry, coefficient 0
LIC(1),(+1000345);	entry, coefficient 1
LIC(2),(-345);	entry, coefficient 2
LIC(3),(+45);	entry, coefficient 3

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 AD105 comprises a 3 rd order polynomial for linearization:

Calculate: $mw := LIC0 + LIC1*x + LIC2 * x^2 + LIC3 * x^3$
x - input measured value

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

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

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* .

6.5 Limit value and LED

This group includes the following commands:

- **LIV** limit values
- **POR** Set outputs

The function description of LED and OUT is contained in Section 3.2.

LIV

Limit values
(Control output)

Range:	1, 0/1/2, 0/1, ±0...1599999 , ±0...1599999
Factory setting:	1,0,0,0,0
Response time:	< 10 msec
Parameters:	5
Password protection:	no
Parameter protection:	with TDD1

The AED contains a limit value switch with selectable hysteresis. These can monitor gross or net measured values.

Input: **LIV 1,<P2,P3,P4,P5>;**

P1 Number of the limit switch (fixed =1)

P2 limit value monitoring on/off
0=off
1=a limit value bit only in measured value status not set to OUT
2=a limit value bit in measured value status and set to OUT

P3 input value of the limit switch (0..1)
0=net measured value
1=gross measured value

P4 Switch-on level limit value bit is set to = 1 in measured value status
and the output OUT goes into the condition "high"=5V (if function is activated (P2))
P4=0...NOV switch-on level (at NOV>0)
P4=0...1599999 switch-on level (at NOV=0)

P5 Switch-off level limit value bit is set to =0 in measured value status
and the output OUT goes into the condition "low"=0V (if function is activated (P2))
P5=0...NOV switch-on level (at NOV>0)
P5=0...1599999 switch-on level (at NOV=0)

The measured value status can be a component part of the measured value (see command COF, MSV).

The described logic of the output is valid, if the following holds P4 > P5.
For P4 < P5 the inverse logic of the output holds.

Example: LIV **1,1,1,900000,100000;** **(P4>P5)**
The sample command sets the limit value.
The switching condition of the limit value is only shown in measured value status.
The limit value switches over to gross measured value.
The limit value switches on at a gross measured value > 900000
and off again at a gross measured value < 100000.

Query: **LIV?1;**
Response: 1,1,1, 0900000, 0100000crlf
Effect: Output of setting for limit switch in the sequence P1,P2,P3,P4,P5
(P4,P5 :) 7 digit output with sign)

Example: LIV **1,1,1,900000,100000;** **(P4<P5)**
The sample command sets the limit value.
The switching condition of the limit value is only shown in measured value status.
The limit value switches over to gross measured value.
The limit value switches on at a gross measured value > 900000
and off again at a gross measured value < 100000.

The speed of the limit value monitoring (response time) is determined by the parameter ICR :
ICR=0 → response time = 10ms, ICR=2 → response time = 40ms

POR

Port Set and Read
(Setting of OUT and LED)

Range:	0/1,
Factory setting:	0.0 (outputs to "LOW" = 0V)
Response time:	< 10 msec
Parameters:	2(4)
Password protection:	no
Parameter protection:	with TDD1

The AED offers two digital outputs which can be read or set via the command **POR** .
The outputs OUT and LED can be modified by means of the port command only if the limit value function is deactivated (LIV1,0,0,0,0;).

Input: **POR <P1>,<P2>;**

The parameters P1 and P2 can be 0 or 1; the following holds

P1= 1= OUT= inactive (open collector) and P1= 0= OUT=Low and

P2= 1 = LED illuminates, P2= 0= LED off.
Using this command, the outputs OUT and LED can be set to the required levels. If the outputs are used by the limit value function (LIV), there will be no change, the input value is without effect.

Query: **POR?;**

Effect: Output of the switching states of OUT and LED.
If limit values are activated (LIV), the limit value and LED states are output.

Example: Response to **por?** is 0,1
that is OUT=Low, LED=High
LIV is deactivated:

por 0,0; OUT and LED set to low

por ,1; LED is set to high, (LED illuminates), OUT remains unchanged

por 1; OUT is set to high, LED remains unchanged

After deactivating the limit value function, a port command is to be transmitted in order to set the port to the required state.

6.6 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 a 3-digit decimal. **The occurring errors are linked by "Or".**

Error message	Error
000	No error
004	not in use
008	Device Dependent Error (hardware error, e.g. EEPROM error)
016	Execution Error (parameter entry error)
032	Command Error (command error, command does not exist)

Example: 024 = Hardware and parameter error

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

6.7 Commands for legal for trade applications

LFT

Legal for Trade
(Legal for trade)

Range:	0/1
Factory setting:	0 (off)
Response time:	<50msec
Parameters:	1
Password protection:	no
Parameter protection:	on entry

Query: **LFT?**

Effect: **0/1 crlf**

Command: **LFT0/1;**

Effect: 0 = Legal for trade switched off,
1 = Legal for trade switched on

At each modification of the command LFT the calibration counter (TCR) is increased by 1. At LFT1 the calibration counter is increased by one for each parameter input of the following commands:

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

In this way, all modifications of these calibration-relevant parameters can be detected by means of the non-resettable TCR calibration counter.

TCR Trade Counter
(Trade Counter)

Range:	no parameter setting possible,
Response time:	<30msec
Parameters:	none
Password protection:	no
Parameter protection:	will no longer be needed

Query: **TCR?**

Effect: **xxxxxxxx crlf (8 characters + crlf)**

This non-resettable counter marks the parameter changes of the calibration-relevant commands (see command LFT). The maximum counter setting is 8388607 (7F FF FF hex). If this counter setting is reached, the counter comes to a standstill and at measured value output msv?; only overflow values are output. This condition can only be released at the factory.

CRC

Cyclic Redundancy Check
(Cyclic Redundancy Check)

Range:	+/- 8 388 607
Response time:	<50msec
Parameters:	1
Password protection:	no
Parameter protection:	on entry

Query: **CRC?**

Effect: **xxxxxxxx crlf (8 characters + crlf)**

Input: **CRCxxxxxxxx;**

Effect: **0crlf**

Using this command, users will be able to form a checksum externally across all parameters of the AED and to store the said checksum in the AED. How this checksum is arrived at, is to be decided by each user individually.

If the command LFT1 was used (lgal for trade applications) then the modification of the CRC results in an additional increase of the calibration counter (TCR).

In this way, any attempt to manipulate the AED parameters can be detected.

6.8 Further commands

The commands listed here are contained in the AD105 only for compatibility reasons. **They have no function in the AD105.**

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

The answers are output in a fixed fashion and independent of possible entries.

6.9 Examples of communication

Settings for the bus mode:

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.

The communication address can be entered in one of two ways:

1. Connect AED consecutively to the bus:

- Connect first AED to the bus line (The factory setting is ADR31, baud rate 9600)
- Initialize 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. enter addresses when all AEDs 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 with 9600 Bd, 8, e,1
- Output broadcast command ;S98;
- Set required address with the command ADR (e.g. ADR01,“xxxxx“;)
- Set required address with the command ADR (e.g. ADR02,“yyyyy“;), etc.
- Store addresses nonvolatile with the command TDD1;

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 send no answer)
2. Output command for the output format (e.g. COF3; for ASCII output)
3. Command TDD1; if this setting should be stored nonvolatile.

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 required baud rate on initialization (switching on) of the system (e.g. 9600), the following procedure can be helpful:

1. Set 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: ; (deletes the input buffer of the AED)
   S98; (selects all AED on the bus)
   BDR9600; (output of the required baud rate)
   (wait approx. 150ms)

3. Set 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: ; (deletes the input buffer of the AED)
   S98; (selects all AED on the bus)
   BDR9600; (output of the required baud rate)
   (wait approx. 150ms)

5. Set 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: ; (deletes the input buffer of the AED)
   S98; (selects all AED on the bus)
   BDR9600; (output of the required baud rate)
   (wait approx. 150ms)

7. Set 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: ; (deletes the input buffer of the AED)
   S98; (selects all AED on the bus)
   BDR9600; (output of the required baud rate)

9. Set 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: ; (deletes 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 driving the AED with different baud rates may cause undefined characters to occur in the input buffer of the AED which, however, are rejected by the reception of the semicolon.

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 required 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
38400	0.3 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 address)
   ADR?; The AED addressed with the address answers with the address 'xxCRLF'. If no answer comes after a time of approx. 100ms, then no AED is present at this address. If undefined characters are received by the master, then there can be a bus fault or a multiple occupancy of the address. The bus master must react accordingly.
3. 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 refer to these addresses only. 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 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 approximate query times result:

Master transmission:	**S00; MSV?;**		(9 characters + 1 character pause)
Response time AED:	**approx. 40ms**		(for ICR2)
AED Transmissions:		**xxCRLF**	(4 characters for COF2) (10 characters for COF3)

Baud rate	Output format	Measured value query time for one AED at 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 approximate query times result (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, 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 at 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)
2. Output parameter command (e.g. ICR3;)
3. Output command TDD1; if this setting should be stored protected against power failure
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).

7 Technical data

Type Precision at ≥1.0 µV/d	 d	AD 105 3000
Bridge resistance, load cell	Ohm	> 300
Bridge supply voltage	V	5 (AC)
Max. measurement range Nom. characteristic value (for works delivery) Measurement signal resolution Measured value (see ICR) Limit frequency of the digital filter, adjustable; for -3dB (see ASF)	mV/V mV/V Bit Hz Hz	+/- 2.4 2 20 (at 1Hz) 100; 50; 25; 12; 6; 3; 2; 1 8... 0.05
Cable lengths between AED and computer for RS-485	 m	 ≤ 1000
Linearity deviation relative to the characteristic value Temperature influence per 10K on the zero point, relative to the characteristic value of sensitivity, relative to the characteristic value	% % %	± 0.0025 ± 0.002 ± 0.005
serial interfaces electrical levels (RS485, differential) Baud rate, adjustable	 V Baud	 Low: B-A < 0.35 High: B-A > 0.35 1200; 2400; 4800; 9600; 19200; 38400;
max. voltage on the control output	V	15
max. current load, control output	mA	40 (at 6V), 22 (at 15V)
Operating voltage (DC) Current consumption (at 350 ohms load cell)	V mA	6...15 ≤ 45
Nominal temperature range Operating temperature range Storage temperature range	°C °C °C	-10...+40 -10...+50 -25...+75
Dimensions (l x w x h), printed circuit board	mm	45 x 22.5 x 7
Weight, approx.	g	50
Protection class EN 60529, printed circuit board		IP 00

Within the shielded structure (shield cap and shielded load cell cable), 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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