Operating Manual

AD101B

Digital Transducer Electronics

Communication Commands

I2048-1.0 en

HBM

Content

Important Information

All the Factory settings are stored safe from power failure at the factory, not in the measuring amplifier where they can be deleted or overwritten. They can be reset at any time by using the command **TDD**0. For more information, see Individual Command Descriptions.

The production number set at the factory must not be changed.

Safety Instructions

- There are not normally any hazards associated with the product, provided the notes and instructions for project planning, assembly, appropriate operation and maintenance are observed.
- It is essential to comply with the safety and accident prevention regulations applicable to each individual case.
- Installation and start-up must only be carried out by suitably qualified personnel.
- Do not allow the equipment to become dirty or damp.
- During installation and when connecting the cables, take action to prevent electrostatic discharge as this may damage the electronics.
- The required power supply is an extra-low voltage (6…30 V) with safe disconnection from the mains.
- When connecting additional devices, comply with the safety requirements according to EN61010[1)].
- All the interconnecting cables must be shielded cables. The screen must be connected extensively to ground on both sides.
  The power supply and digital I/O connection cables only need to be shielded if the cables are longer than 30 m (32.81 yd) or are routed outside closed buildings.

[1)] safety regulations for electrical devices

1 Introduction and appropriate Use

AD101B digital transducer electronics are part of the AED component family that digitally conditions signals from mechanical measurement sensors and networks them with bus capability.

These include digital amplifier motherboards, basic boxes and intelligent sensors with integrated signal processing. It is the task of these components to directly digitize and condition the measurement signals at the transducer location. Using digital transducer electronics, you can connect S.G.[1)] transducers in a full-bridge circuit directly to a computer or a P.C. This enables you to configure complete measurement chains quickly and with little extra work.

The AD101B amplifier motherboard can be operated independently of the AED9101B basic box. The basic box provides mechanical protection, shield the amplifier boards (EMC protection) and also give you the opportunity to select the serial interfaces (RS485).

The signal processing functions of limit value monitoring, minima/maxima memory and the fast-settling digital filter open up additional areas of application.

The abbreviation **AED** is also used for AD101B transducer electronics in the following text.

The AD101B has an internal calibration function to ensure measurement accuracy (command **ACL** and **CAL**, see section 3.10 Other commands).

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

2 AD101B Command Set

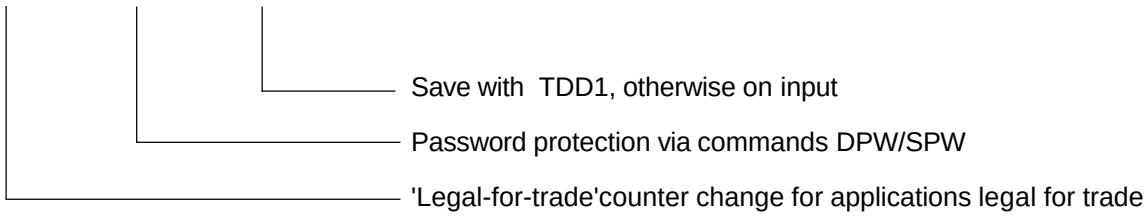
The AED commands can be divided into the following groups:

- Interface commands
  (**ADR**, **BDR**, **COF**, **CSM**, **GRU**, **S..**, **TEX**, **STR**)
- Factory characteristic curve
  (**SZA**, **SFA**, **LIC**)
- User characteristic curve and output scaling
  (**CWT**, **LDW**, **LWT**, **NOV**, **ENU**)
- Settings for measuring mode
  (**ASS**, **FMD**, **ASF**, **ICR**, **MTD**, **ZSE**, **ZTR**, **ACL)**
- Commands for measuring mode
  (**MSV**, **TAR**, **TAS**, **TAV**, **CAL)**
- Digital inputs, outputs and limit values
  (**IMD**, **LIV**, **POR**)
- Trigger function
  (**MAV**, **TRC**)
- Special commands
  (**TDD**, **RES**, **DPW**, **SPW**, **IDN**, **ESR**)
- Commands for legal for trade applications
  (**LFT**, **TCR**, **CRC**)

2.1 Command Overview

Command	TCR	PW	TDD1	Function	Page
ACL			X	Automatic Calibration	73
ADR			X	Device address	18
ASF			X	Filter selection limit frequencies	63
ASS			X	Select input signal	60
BDR			X	Baud rate	16
CAL;				One-off calibration	86
COF			X	Output format for data output (for **MSV**?)	22
CRC	X			Checksum	114
CSM			X	Checksum in measurement status for binary output (**MSV**?)	28
CWT	X	X	X	Calibration weight	54
DPW				Define password	100
ENU	X			Unit of measurement	58
ESR				Output of error messages	110
FMD			X	Filter mode	62
GRU			X	Group address	29
ICR			X	Sampling rate	66
IDN	X			Identification of transducer type and serial number	103
IMD			X	Set the function of the inputs	88
LDW	X	X		User characteristic curve zero point	49
LFT	X		X	Legal for Trade Application	112
LIC	X	X		Linearization	44
LIV			X	Limit value settings	90
LWT	X	X		User characteristic curve full scale (nominal value)	51
MAV?				Measured value trigger function	95
MSV?				Data output	75
MTD	X		X	Standstill monitoring	68
NOV	X	X	X	Resolution of the user characteristic curve	56
POR			X	Set and read digital inputs and outputs	92
RES;				Reset	102
S..				Selecting AED in bus mode (Select)	30
SFA	X	X		Default curve full scale (nominal value)	41

Command	TCR	PW	TDD1	Function	Page
SPW				Write enable for all password-protected parameters	101
STP				Stop data output	81
STR			X	Activate/deactivate bus termination resistors	35
SZA	X	X		Default curve zero point	39
TAR				Taring	82
TAS			X	Gross/net selection	85
TAV			X	Tare value	83
TCR				Legal-for-trade-counter	113
TDD1/2				Saving setting in EEPROM, Reading EEPROM	105
TDD0	X	X		Factory setting	105
TEX			X	Separator for data output	33
TRC			X	Trigger settings	96
ZSE	X		X	Initial zero setting	71
ZTR	X		X	Automatic zero tracking	70



The following commands do not change the AED settings:

COR (compatible with older AED versions)

2.2 Command Format

Commands are not case-sensitive, so either format can be used for input.

Each command entry must be concluded by a delimiter. This can either be a line feed (lf) or a semi-colon (;).

If a delimiter is all that is sent to the AED, the AED input buffer is cleared.

The data provided in round brackets () for the commands are mandatory and must be entered. Parameters in pointed brackets <> are optional and do not have to be provided. The brackets themselves are not part of the input.

Text must be enclosed in quotes.

With numeric input, preceding zeroes are suppressed. Numbers can either be entered directly or as an exponential representation, e.g. ±12000LF or ±1.2 e4LF.

The exponent e can have 1 or 2 digits, but must not be a number greater than 10 characters, including the sign and the exponent.

Responses consist of ASCII characters and close with crlf. An exception to this is binary character output (see **MSV** and **COF** commands).

Each command consists of the command shortform, one or more parameters and the delimiter.

	Command shortform	**Parameters**	**Delimiter**
Input	ABC	X, Y	lf or ;
Output	ABC?	X, Y	lf or ;

lf: line feed (lf = $0a_{Hex}$)

Example:

MSV?20;

On this command, 20 measured values will be output.

All ASCII characters ≤20_{Hex} (blank) are allowed between the command shortform, the parameters and the delimiter, apart from 11_{Hex} (Ctrl q) and 13_{Hex} (Ctrl s); Hex: Hexadecimal.

2.3 Responses to Commands

Note on the Response times of the AED:

The AED Response times indicated in the command description do not include the transmission time of the command to the AED and the transmission time of a response from the AED.

Responses to input (exception COF64...COF79)

	Response	Delimiter
correct input	0 (zero)	crlf
incorrect input	?	crlf

crlf: carriage return,
line feed (cr = $0d_{Hex}$, lf = $0a_{Hex}$)

Exceptions:

The commands **RES**, **STP** and **S**00...S99 do not return a response.
The command **BDR** returns the response in the new baud rate.

The command **ESR** will identify the error.

Responses to queries

correct command	Parameter 1...parameter n or meas. values, crlf
incorrect command	? crlf (error identification via **ESR** command)

crlf: carriage return,
line feed (cr = $0d_{Hex}$, lf = $0a_{Hex}$)

The response to measurement queries (**MSV**?) will depend on the separator that has been set (**TEX**) and on the output format (**COF**) (see the output types for measured values section).

2.4 Output Types for Measured Values

You can choose two output types and one separator (**TEX** command):

Output type 1: Measured values arranged one below the other

Output type 2: Measured values arranged next to one another

Output types 1

The measured values are arranged one below the other for output:

Example:

Measured value 1 crlf
Measured value 2 crlf
...
Measured value n crlf

Output type 2

The measured values are arranged next to one another for output:

Example:

Measured value 1 (separator) Measured value 2 (separator)...Measured value n crlf

Data output works with fixed output lengths (see **COF** command):

Format command		AED response		No. bytes
COF0;	**MSV**?	yyyy crlf	(y – binary)	6
COF2;	**MSV**?	yy crlf	(y – binary)	4
COF3;	**MSV**?	xxxxxxxx crlf	(x – ASCII)	10
COF9;	**MSV**?	xxxxxxxx,xx,xxx crlf	(x – ASCII)	17

crlf: carriage return,
line feed (cr = $0d_{Hex}$, lf = $0a_{Hex}$)

The delimiter for data output is always crlf or the separator defined using the **TEX** command. But these characters must not be filtered out as delimiters during binary output, as these characters can also be included in the binary code of the measured value.

So with binary output, the bytes have to be counted. In the subsequent syntax check, the relevant places after cr or lf or the separator can then be queried.

Password Protection

AED password protection includes important settings for the characteristic curve of the scale and its identification. Commands with password protection are only activated once the password is entered. Unless the password is entered using the **SPW** command, the response to these commands is "?".

3 Individual Command Descriptions

3.1 Interface Commands

The interface must be configured to establish communication between the AED and the computer. The AED makes the following commands available for setting up the interface and selecting the transmission formats:

- Communication address for bus mode **ADR**
- Baud rate setting **BDR**
- Measurement data output format (ASCII / binary) **COF**
- Checksum in the measurement status (binary output only) **CSM**
- Group address for bus mode **GRU**
- Bus node select command through the communication address (Select) **S**...
- Separator for ASCII data output **TEX**
- Bus termination resistors for the RS485 bus **STR**

Interface characteristics (RS232 / RS485 / RS422):

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

The asynchronous interface of the AED is a serial interface, that is to say, data is transferred bit by bit, one after the other and asynchronously. Asynchronous means that the transmission works without a clock signal.

A start bit is set before each data byte. Then come the word bits, a parity bit for the transmission check (optional) and a stop bit.

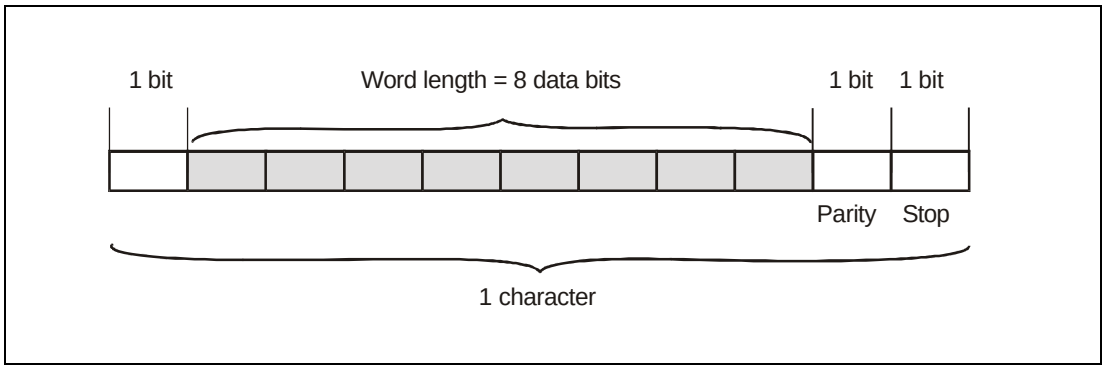


Fig. 3.1-1: Composition of a character

As the data is transferred serially, the speed of transmission must match the speed of reception. The number of bits per second is called the baud rate.

The exact baud rate of the receiver is synchronized with the start bit for each character transferred. Next come the data bits, that all have the same length. When the stop bit is reached, the receiver goes to the wait state, until it is reactivated by the next start bit.

The number of characters per measured value ranges between 2 and 17 and depends on the output format selected (**COF** command).

3.1.1 Interface Command - Address (ADR)

ADR

Address
(**device address**)

Property	Content	Comment
Command string	**ADR**	
No. of parameters	2	
Parameter range	P1 = 00...31, P2 = "7 characters"	P2= string
Factory setting	31	
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1;	
Master **input**	**ADR**(P1),<"P2">;	
AED response	0 crlf	On input OK
Master **query**	ADR?;	
AED response	P1 crlf	P1 = 2 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The command is used to prepare bus mode. Each AED connected on the bus must have a unique address (0...31).

The command **TDD**0; does not change the address.

Parameter description:

Input: ADR(new address), <"serial number">;

The serial number can also be entered as an optional second parameter. The new device address is then only entered for the AED with the serial number specified. This then means that if there are several AEDs with the same address (initializing bus mode), it is possible to change device addresses without addressing several AEDs.

The serial number must be given in quotes, as for the **IDN** command.

Example:

S98;	Broadcast command
ADR25,"007" crlf	on input with a serial number
	Only the AED with serial number 007
	Changes the address
S31;	Select the ’old’ address (example)
ADR25 crlf	on input without a serial number

3.1.2 Interface Command - Baud Rate (BDR)

BDR

Baud Rate

Property	Content	Comment
Command string	**BDR**	
No. of parameters	2	
Parameter range	P1 = 1200, 2400, 4800, 9600, 19200, 38400, P2 = 0 / 1 (parity bit = none / even)	P1 in Bd
Factory setting	9600	Bd
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1;	
Master **input**	**BDR**<P1>,<P2>;	
AED response	0 crlf (response given at the new baud rate)	On input OK
Master **query**	**BDR**?;	
AED response	P1,P2 crlf	P1 = 6 characters, P2 = 1 character

Explanation: ( ) required parameters, < > optional parameters on parameter input,
AED responds with ? crlf, if the input or the query is incorrect.

Function:

The command sets the baud rate and the parity for serial communication.

The response is given at the new setting (baud rate, parity). Once the baud rate is changed, communication is not possible initially. The computer also has to be changed over to the chosen new setting (baud rate). For the change in baud rate to become permanent, it has to be saved in the EEPROM with the **TDD**1 command. This procedure ensures that you do not set baud rates in the AED which are not supported by the remote station. If the new baud rate entry is not saved, the AED will go back to the previously valid baud rate after a "*reset*" or a "*power-up*".

The command **TDD**0; does not change the baud rate setting.

Example:

BDR?;	9600.1 crlf	corresponds to 9600 Bd, parity bit even
BDR38400;	0 crlf	AED responds at 38400 Bd
BDR19200,1;	0 crlf	AED responds at 19200 Bd, even parity
BDR,1;	0 crlf	AED responds at even parity Without changing the baud rate

3.1.3 Interface Command - Configurate Output Format (COF)

COF

Configurate Output Format
(Output format for data output)

Property	Content	Comment
Command string	**COF**	
No. of parameters	1	
Parameter range	P1 = 0...144	
Factory setting (**TDD**0)	9	ASCII
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1;	
Master **input**	**COF**(P1);	
AED response	0 crlf	On input OK
Master **query**	**COF**?;	
AED response	P1 crlf	P1 = 3 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function

The command is used to set the output formats for the **MSV**? and **MAV**? commands.

The available formats and the decimal number to be entered are listed in the following table. The following format groups are supported:

- **COF**000...012 standard formats
- **COF**016…028 formats for bus mode
- **COF**032…044 formats without a crlf end label
- **COF**064…072 formats for 2-wire bus mode
- **COF**128...144 formats for continuous output after "*Reset*"

The formats within a format group correspond to the standard format. The different data output communication responses are set by adding 16, 32, 64 or 128.

Data output is related to the nominal value set for the AED (see **NOV** command).

Output on max. capacity	NOV > 0	NOV = 0
2 byte binary	**NOV** value	20000
4 byte binary	**NOV** value	5120000
ASCII	**NOV** value	1000000

For 2-byte binary output, the **NOV** value must be <30000, otherwise the measured value will be output with overflow or underflow ($7FFF_{Hex}$ or 8000_{Hex}). With **NOV**30000, the overflow reserve is only about 2700 digits.

Description of the COF formats within a format group:

Standard formats COF0...**COF**12:

On input of **COF**0 to **COF**12, the following combinations result:

Binary measurement format:

- 2 or 3 byte measured value
- with or without measurement status
- Byte output sequence:
  MSB → LSB or LSB → MSB chosen

	Parameter	Length	Sequence for data 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/ check sum (CSM)
COF12	measured value	4 byte	LSB before MSB	LSB = status/ check sum (CSM)

MSB = most significant bit, LSB = least significant bit

Information for evaluating binary measured values

With data output in binary format, the binary codes for cr and lf may occur within the bytes that are representing the measured value. So the data output content must not be tested for the crlf characters, in the event of checking for an end to data transmission. With binary output, it is more a case of recording the number of characters received. Also with binary output, the control character crlf is appended to the measured value (sole exception: **MSV**?0;).

ASCII data format:

With ASCII output, the device address and/or measurement status information can be output as well as the measured value.

With ASCII output, the separator of your choice is placed between the parameters (see **TEX** command). crlf, or the chosen separator, follows the last parameter.

	1. Parameter	T	2. Parameter	T	3. Parameter	Delimiter
COF1	Measured value (8)	T(1)	Address(2)		—	crlf or T
COF3	Measured value (8)		—		—	crlf or T
COF5	Identical to **COF1**					
COF7	Identical to **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

T = separator, () = number of characters

With bus mode, the output format must not be set to **COF**9.

COF16 to COF28, bus mode:

If you add the decimal number 16 to the **COF**0...**COF**12 output formats specified above, the AED switches to bus output mode. A measured value is output. The AED changes over to partially active mode (each new measured value is stored in the output buffer, but is not output). With the Select command **S**.., the measured value is output to the bus. Data is output without crlf.

Example:

2 AEDs in bus mode

Command	Effect
S98;	All AEDs are partially active (listening, but not transmitting)
COF18;	Output as 2-byte binary output
ICR0;	Maximum sampling rate
MSV?0;	Continuous measurement in the AED
S01;	Read measured value of AED 1
S02;	Read measured value of AED 2, when response from first AED is received in full
S01;	Read measured value of AED 1, when response from second AED is received in full
S02;	Read measured value of AED 2, when response from first AED is received in full
...	...
STP;	End data output
S01;	Possible new AED 1 setting

COF32 to COF44, binary data output without crlf:

If you add the decimal number 32 to the **COF**0...**COF**12 binary output formats specified above, the AED switches to the following output mode for the measurement data. With *binary data output* the delimiter crlf is omitted, so that only 2 or 4 characters are output per measured value. This action increases the output speed of the measured values.

Format	Length	Sequence for data output	
COF32	4 byte	MSB before LSB	LSB = 0 (no status)
COF34	2 byte	MSB/LSB	
COF36	4 byte	LSB before MSB	LSB = 0 (no status)
COF38	2 byte	LSB/MSB	
COF40	4 byte	MSB before LSB	LSB = Status/ check sum (CSM)
COF44	4 byte	LSB before MSB	LSB = Status/ check sum (CSM)

COF64...COF76, 2-wire bus mode:

If you add the decimal number 64 to the **COF**0...**COF**12 output formats specified above, the AED switches to 2-wire bus mode. This means that when commands are entered, the AED no longer responds with "0" or "?". Only command queries such as **ASF**? obtain the response with the parameter, or in the case of **MSV**?, with the measured value. The command **MSV**?0; (continuous measured value transmission) must not be used in this mode, as otherwise it will no longer be possible to stop this output (unless you switch off the supply voltage).

COF128 to COF 140, continuous output of measured values after *"power-up"*(not valid for bus mode):

If you add the decimal number 128 to the **COF**0...**COF**12 output formats specified above, the AED switches to continuous output mode. After a "*power-up*" or **RES** command, the AED sends out the measured values without an **MSV**? prompt. Continuous output can be deactivated with the **STP** command. Make the setting with the following input (**COF** ≥ 128):

1. ... Make all the requisite settings.
2. **ICR**i; Set the AED sampling rate.
3. **COF**x+128; The AED sends data continuously, the time interval corresponds to the setting ICR, x = 0...12.
4. **STP**; Stop continuous transmission.
5. **TDD**1; Saving the settings safe from power failure
6. **COF**+128; The AED sends data continuously, the time interval corresponds to the setting **ICR**.

When you bring in the voltage, the AED also starts data output without a separate prompt. These output formats have another special feature (depending on the trigger setting, **TRC** command):

trigger deactivated:	continuous, automatic data output
trigger activated:	automatic data output only when a new measured value has been formed after triggering.

Speed of data output of measured values:

The maximum output rate of the AED is 600 measured values per second. This data transfer rate also depends on the baud rate (**BDR**), the data output format (**COF**), the set output rate (**ICR**) and the filter mode (**FMD**, **ASF**).

The following table shows this correlation for continuous data output (**MSV**?, **FMD** = 0):

Measured values / s	**600**	**300**	**150**	**75**	**37,5**	**18,75**	**9,375**	**4,688**
(ICR)	**(0)**	**(1)**	**(2)**	**(3)**	**(3)**	**(4)**	**(5)**	**(6)**
Time in ms	1.66	3.33	6.66	13.33	26.66	53.33	106.7	213.3
Output format (**COF**)	Requisite baud rates for **MSV**0; (**BDR**)							
Binary format 2 characters for **COF**2/**COF**6	19200	9600	4800	2400	1200	1200	1200	1200
Binary format 4 characters for **COF**0/**COF**4	38400	19200	9600	4800	2400	1200	1200	1200
ASCII format meas. value 10 chars. for **COF**3	—	38400	19200	9600	4800	2400	1200	1200
ASCII format meas. value + address 13 chars. for **COF**1	—	—	38400	19200	9600	4800	2400	1200
ASCII format meas. value + address + status	—	—	38400	19200	9600	4800	2400	1200
	Requisite baud rates for **MSV**?1; (**BDR**)							
Binary format 6 characters **MSV**?; for **COF**0/**COF**4	57600	38400	19200	9600	4800	2400	1200	1200

The command **MSV**?0; starts continuous data output for the selected AED. Output can be stopped with the **STP**; command.

The command **MSV**?1; (= **MSV**?;) requests a measured value.

3.1.4 Interface Command - Checksum (CSM)

CSM

Checksum
(Checksum in measurement status)

Property	Content	Comment
Command string	**CSM**	
No. of parameters	1	
Parameter range	P1 = 0/1	
Factory setting (**TDD**0)	0	deactivated
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1;	
Master **input**	**CSM**(P1);	
AED response	0 crlf	On input OK
Master **query**	**CSM**?;	
AED response	P1 crlf	P1 = 1 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect	

Function:

Checksum calculation can be used to find transmission errors during 4-byte binary output.

Parameter description:

When **CSM** = 0, checksum calculation in the measurement status is deactivated. The standard measurement status is output (see **MSV**).

With **CSM** = 1, a checksum (EXOR) is formed over the measured value covering three bytes and this is output instead of the measurement status. This checksum output can only be used for output formats **COF**8 and **COF**12 (+ i ∗16, i = 0, 1...7).

3.1.5 Interface Command - Group Address (GRU)

GRU

Group Address

Property	Content	Comment
Command string	**GRU**	
No. of parameters	1	
Parameter range	P1 = 0...32	
Factory setting (**TDD**0)	32	deactivated
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD1;**	
Master **input**	**GRU**(P1);	
AED response	0 crlf	On input OK
Master **query**	**GRU**?;	
AED response	P1 crlf	P1 = 2 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The device address must be entered as a decimal number.

By specifying a group address , several AEDs can be assigned to a group. This association with a group applies until it is overridden by the entry of a new group address.

Group address 32 has a special status. An AED with group address 32 does not belong to a group, as this address is cannot be assigned as a device address.

In bus mode, all the connected AEDs usually listen. An AED becomes active when its address matches the address sent from the master. It executes a subsequent command and sends its response to the Master. If the address sent from the Master matches the group address, the subsequent command is executed and the response placed in the output memory, but it is only transmitted to the Master on request (**S**..) (see **Select** command).

3.1.6 Interface Commands - Select (S..)

S..

Select
(Selection in bus mode)

Property	Content	Comment
Command string	**S**	
No. of parameters	1	
Parameter range	P1 = 00, 01,...31, 96, 97, 98, 99 always enter 2 digits for P1	98 = broadcast
Factory setting (**TDD**0)		
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	No data to protect	
Master **input**	**S**(P1);	Only with **;** Not with crlf
AED response		No response
Master **query**	Not permitted	
AED response		
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

When several AEDs are connected together to a bus, this can be used to address them individually or jointly. The command **ADR** is used to assign the maximum 32 addresses (00...31).

The Select command does not generate a response.

One AED is always active after reset or power-up (except when **COF** > 127) and in bus mode, this must be addressed by the Select command, so that the other bus nodes do not respond. If there is only one AED, the **S**.. command is not needed.

Parameter description:

Select	Effect for AED	Effect for PC
S00 to **S**31	Only the AED with the specified address executes all the commands and responds. All AEDs with the same group address execute all the commands and do not respond. All the other AEDs understand only Select commands **S**00 to **S**99 and do not respond.	1:1 communication with a selected AED.
S32 to **S**63	Only the AED with the specified address executes all the commands and responds. All the other AEDs execute all the commands but do not give a response.	1:1 communication with a selected AED deputizing for all AEDs.
S64 to **S**95	Only the AED with the specified address is accepted as the node that executes all commands but does not respond. All the other AEDs are unchanged. This applies until this AED is addressed with the command **S**00...**S**31. A permanent group can only be set up via the group address (**GRU** command).	a) When an AED is selected with **S**00 to **S**31, then 1:1 communication with this AED deputizing for the additionally selected AED. b) When no AED is selected with **S**00 to **S**31, the commands will be processed in all the additionally selected AEDs, but there is no response.
S96	All the AEDs only understand the Select command	No communication apart from the Select command
S97, **S**98	All AEDs execute all commands	
S99		Collision during bus mode

Example:

Select 00
Command 1
Command 2...n
Select 01
Command 1 etc.

Command **S**98; is intended for special functions (broadcast). All AEDs connected at the bus are addressed. All AEDs execute the subsequent commands. No AEDs respond. This continues until once again **S**00...**S**31 is used to address a single AED.

The **S**.. command alone does not generate a response. Only when it is used together with another command, does the selected AED respond. Exception in bus mode: **COF**16...**COF**28 (after **MSV**?0;).

To query a measured value on the bus, proceed as follows:

1. Use command **S**98; to select all the AEDs.
2. Use command **MSV**?; to query the measured values.
   All the AEDs form the measured value and after the integration time (**ICR**), store this value in the output buffer, but none of the AEDs transmits.
3. Use command **S0**1; to select the AED with address 1.
   The AED with address 01 outputs the measured value.
4. Use command **S0**2; to select the AED with address 2.
   The AED with address 02 outputs the measured value.

3.1.7 Interface Command - Terminator Execution (TEX)

TEX

Terminator Execution (**Separator for data output**)

Property	Content	Comment
Command string	**TEX**	
No. of parameters	1	
Parameter range	P1 = 0...255	
Factory setting (**TDD**0)	172	=comma
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1;	
Master **input**	**TEX**(P1);	
AED response	0 crlf	On input OK
Master **query**	**TEX**?;	
AED response	P1 crlf	P1 = 3 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The command sets the separator for ASCII data output.

Parameter description:

The required separator is entered in decimal as an ASCII character
(e. g. comma = 2CH = 44_D → input TEX44; Hex: Hexadecimal, D: Decimal). Any ASCII character from 0...127_D (0...$7F_{Hex}$) can be used as a separator. The separator is placed between the parameters for data output (also see **MSV** and **COF** commands).

Example:

TEX44;

Data output: -0123456, 12, 000, -0123457, 12, 000, etc. (for **COF9**)

If the chosen ASCII character is entered with an offset of 128 (above example: comma=44_D+128_D=172_D → input **TEX**172;), then the parameters of a measured value are separated as before by a comma, but crlf is output at the end of the data.

Example:

TEX172;

Data output: -123456, 12, 000 crlf
-123457, 12, 000 crlf etc.

3.1.8 Interface Command - Set Termination Resistor (STR)

STR

Set Termination Resistor (Bus termination resistors)

Property	Content	Comment
Command string	**STR**	
No. of parameters	1	
Parameter range	P1 = 0/1	
Factory setting (**TDD**0)	0	deactivated
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1;	
Master **input**	**STR**(P1);	
AED response	0 crlf	On input OK
Master **query**	**STR**?;	
AED response	P1crlf	P1 = 1 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The command activates or deactivates the bus termination resistors in the AED basic box.

Parameter description:

P1: 0 = Bus termination deactivated,
1 = Bus termination activated

The requisite steps for electrical bus termination (resistors) were described in Part 1 of the Operating Manual (RS485 bus). These resistors safeguard the quiescent level on the physical circuit when none of the connected modules are transmitting. You must make sure that this bus termination is only activated twice per bus system (physical circuit) and that this is usually at the line ends of the physical circuit. The Master interface usually includes a bus termination of this type and the termination is activated by the command **STR**1; in the AED furthest away.

(only relevant for the AED9101B basic box, see AED9101B Operating Manual Part 1)

3.2 Factory Characteristic Curve

The commands described in this section are used to set the factory characteristic curve:

- Adjustment of the factory characteristic curve: **SZA**, **SFA**
- Linearization: **LIC**

Characteristic curve setting

The AED works initially with a factory characteristic curve **SZA**, **SFA**. This factory setting is made with a calibration standard at 0mV/V and 2mV/V. This factory characteristic curve should not be modified.

A second characteristic curve (**LDW**, **LWT**) is available for the user characteristic curve.

The factory characteristic curve can be restored with **TDD**0. The factory characteristic curve is set to 2 mV/V. The characteristic curve set at the factory is read out from a second write-protected EEPROM and activated (not forgetting that a **TDD**0 resets the application parameters to the factory characteristic curve.).

Linearization **LIC** is only activated if required (deactivated as standard).

Setting the factory characteristic curve with SZA, SFA (absolute value calibration in mV/V)

Action	**Command sequence**
Enter the password, e.g.	**SPW"AED";**
Input at 0 mV/V	**SZA;**
Input at 2 mV/V	**SFA;**

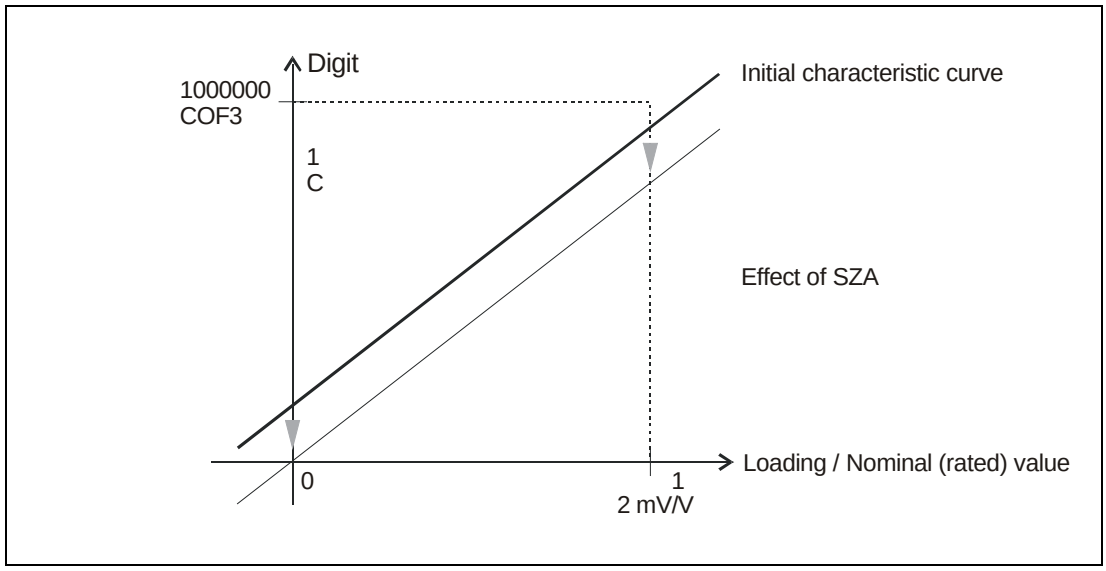


Fig. 3.2-1: Effect of the SZA command on the factory characteristic curve

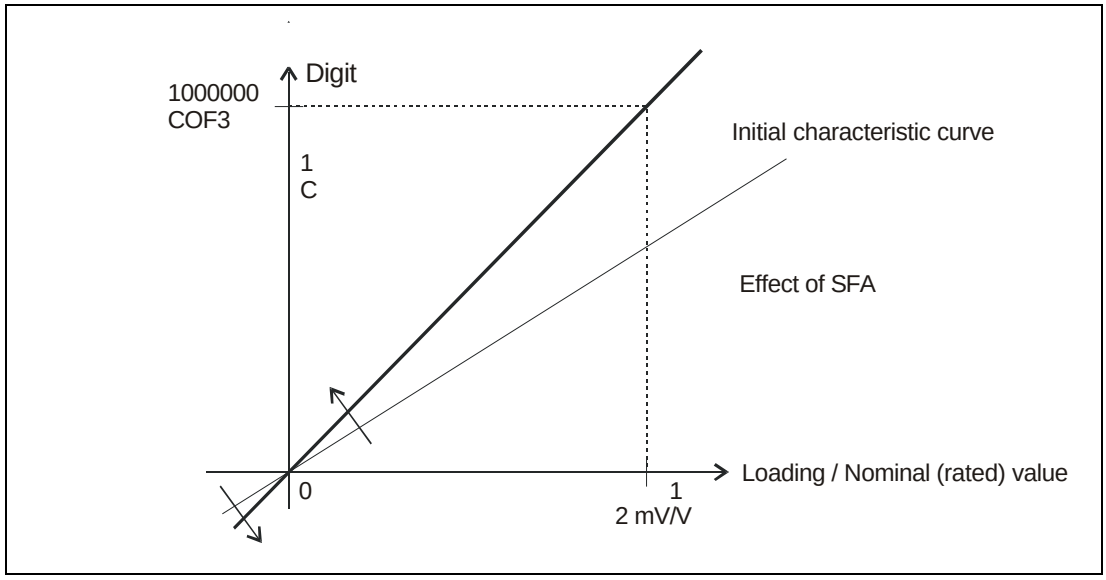


Fig. 3.2-2: Effect of the SFA command on the factory characteristic curve

3.2.1 Factory Characteristic Curve - Sensor Zero Adjust (SZA)

SZA

Sensor Zero Adjust
(factory characteristic curve zero point)

Property	Content	Comment
Command string	**SZA**	
No. of parameters	1	
Parameter range	P1 = 0...±1599999	
Factory setting (**TDD**0)	Adjustment to 0 mV/V	
Response time	<15 ms for input or query	
	<4.2 s for measurement (**SFA**;)	
Password protection	Yes	
Relevant to verification	Yes	
Parameter protection	after input of **SFA**	
Master **input**	**SZA**(P1);	For input
AED response	0 crlf	On input OK
Master **input**	**SZA**;	For measurement
AED response	0 crlf	After measurement
Master **query**	**SZA**?;	
AED response	P1crl (P1 = 7 digits with sign)	P1 = 8 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect or if the password has not been activated for input or measurement.	

Function:

For an input signal of 0 mV/V, the output value 0 digits is assigned to the internal measured value.

Parameter description:

With a query, the value is output with ±7 digits (e.g. -0950246 crlf).

The characteristic curve is deactivated at **SZA** = 0 and **SFA** = 1000000.

There are two options for zero adjustment:

1. option Manual input of the zero point via **SZA**

2. option Adopting an applied signal with **SZA**:

Manual input of nominal value via SFA (reaction time < 15 s):

Use the command **SZA <zero value>** to enter the zero point.
The value entered is stored, but only offset after measurement or input of the parameter for **SFA**.

Transferring an applied signal with SZA (reaction time < 4.2 s):

1. Connect the transducer electronics to a calibration standard.
2. Set the calibration standard to 0 mV/V misalignment.
3. Adopt the applied signal with the command **SZA**.
   The applied signal is measured and stored in memory,
   but only offset after measurement or input of the **SFA** value.

The characteristic curve commands **SZA** and **SFA** must be entered or executed in the sequence **SZA** followed by **SFA**. The input data is only offset when the two parameters have been entered or measured in pairs.

3.2.2 Factory Characteristic Curve - Sensor Full-scale Adjust (SFA)

SFA

Sensor Fullscale Adjust
(factory characteristic curve full scale)

Property	Content		Comment
Command string	**SFA**		
No. of parameters	1		
Parameter range	P1 = 0...±1599999		
Factory setting (**TDD**0)	Adjustment to 2 mV/V		
Response time	<15 ms	for query (SFA?;)	
	<1.5 s	for input (SFA P1;)	
	<4.2 s	for measurement (SFA;)	
Password protection	Yes		
Relevant to verification	Yes		
Parameter protection	For input/measurement		
Master **input**	**SFA**(P1);		For input
AED response	0 crlf		On input OK
Master **input**	**SFA**;		On measurement
AED response	0 crlf		After measurement
Master **query**	**SFA**?;		
AED response	P1 crlf (P1 = 7 digits with sign)		P1 = 8 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect or if the password has not been activated for input or measurement.		

Function:

For an input signal of 2 mV/V, the output value 1000000 digits is assigned to the internal measured value for ASCII output.

Parameter description:

With a query, the value is output with ±7 digits (e.g. -0950246 crlf).

The characteristic curve is deactivated at **SZA** = 0 and **SFA** = 1000000.

There are two options for nominal value adjustment:

1. **Manual input of nominal value via SFA (reaction time < 1.5 s):**

   - Enter the **SZA** value.
   - Use the command **SFA**<nominal value> to enter the measured value for 2 mV/V.
     The value entered is stored and offset with the previously measured or entered **SZA** value.

2. **Transferring an applied signal with SZA (reaction time < 4.2 s):**

   - Connect the transducer electronics to a calibration standard.
   - Set the calibration standard to 0 mV/V misalignment.
   - Adopt the applied signal with the command **SZA**;.
     The applied signal is measured and stored in the memory.
   - Set the calibration standard to 2 mV/V misalignment.
   - Adopt the applied signal with the command **SFA**;.
     The applied signal is measured and stored in the memory
     and offset with the previously measured or entered **SZA** value.

The characteristic curve commands **SZA** and **SFA** must be entered or executed in the sequence **SZA** followed by **SFA**. The input data is only offset when the two parameters have been entered or measured in pairs.

Entering or measuring the factory characteristic curve with **SZA**/**SFA** resets the user characteristic curve to the default values **LDW** = 0, **LWT** = 1000000 and **CWT** = 1000000.

Procedure for entering the factory characteristic curve (SZA, SFA):

1. Connect the AED to a calibration standard (e.g. K3608 or K3607).
2. Use the command **SPW** to enter your password
3. Set the **ASF** filter so that the display is as smooth as possible.
4. Set the value 0 mV/V at the calibration standard and wait for standstill.
5. Use the command **MSV**?; to determine the measured value (see the Individual command descriptions/Measurement/**MSV** command section). Note value1 for **SZA**.
6. Set the value 2 mV/V at the calibration standard and wait for standstill.
7. Use command **MSV**?; to determine the measured value (see above). Note value2 for **SFA**.
8. Use **SZA**<value1>; followed by **SFA**<value2>; to enter the new user characteristic curve.

Points 3...7 are not relevant if the factory characteristic curve can be re-entered using parameters that are already familiar.

3.2.3 Factory Characteristic Curve - Linearization Coefficients (LIC)

LIC — Linearization Coefficients

Property	Content	Comment
Command string	**LIC**	
No. of parameters	3	
Parameter range	P0, P1, P2, P3 = 0...±1599999	
Factory setting (**TDD**0)	0,1000000, 0, 0	deactivated
Response time	<15 ms for query <35 ms for input	
Password protection	Yes	
Relevant to verification	Yes	
Parameter protection	for input	
Master **input**	**LIC**(0),(P0); **LIC**(1),(P1); **LIC**(2),(P2); **LIC**(3),(P3);	
AED response	0 crlf	On each input OK
Master **query**	**LIC**?;	
AED response	P0,P1,P2,P3 crlf	P0,1,2,3 = 8 characters each
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect or if the password has not been activated for input.	

Function:

The characteristic curve specified with command pair **SZA** and **SFA** is first defined in two points. The AED can adjust for the linearity error of a transducer or of a scale. The AED has a third order polynomial for linearization:

measured value = **LIC0** + **LIC1** ∗ x + **LIC2** ∗ x^2 + **LIC3** ∗ x^3, where x = input value

With the aid of a third order polynomial, even a linearity error with an inflection point can be corrected. Increased measurement errors are to be expected outside the linearization interval.

Parameter description:

The coefficients **LIC**0...**LIC**3 are entered as ASCII numbers with the **LIC** command.

Example:

Coefficient 0 =	+10	enter:	*LIC(0),(+10);*
Coefficient 1 =	+1000345	enter:	*LIC(1),(+1000345);*
Coefficient 2 =	-345	enter:	*LIC(2),(-345);*
Coefficient 3 =	+45	enter:	*LIC(3),(+45);*

The coefficients are defined when the measurement chain is calibrated. The factors are not calculated in the AED, HBM's AED_Panel32 software must be used for this and they must then be loaded into the AED. The exact procedure is described in the *AED_Panel32* Operating Manual.

3.3 User Characteristic Curve and Output Scaling

- Adjustment of the user characteristic curve: **LDW/LWT**
- Partial load parameter for **LDW**, **LWT**: **CWT**
- Nominal output scaling: **NOV**
- Unit of measurement: **ENU**

You can adapt the AED characteristic curve to the particular requirements with the command pair **LDW/LWT**.

Using the command **CWT**, the user characteristic curve can also be set with partial load.

Before the user characteristic curve is adjusted, **CAL** should be run to safeguard measurement accuracy.

More detailed descriptions can be found in the application document

- **APPN004** (Static adjustment of a scale),

The characteristic curve commands **LDW** and **LWT** must be entered or executed in the sequence **LDW** followed by **LWT**. The input data is only offset when the two parameters have been entered or measured in pairs. When defining the characteristic curve, scaling must be deactivated (**NOV**0).

Once values for the zero point and nominal value of the user characteristic curve have been successfully entered or measured, the range **LDW** → **LWT** (for **NOV** = 0) is assigned to the following number ranges:

Output on max. capacity (COF)	**NOV = 0**	**NOV > 0**
2 byte binary	20000	**NOV** value
4 byte binary	5120000	**NOV** value
ASCII	1000000	**NOV** value

Setting the user characteristic curve with LDW and LWT (on max. capacity adjustment)

Action	Command sequence
Enter the password, e.g.	**SPW**"AED";
Loading with zero load, scale	**LDW**;
Loading with max. capacity scale	**LWT**;

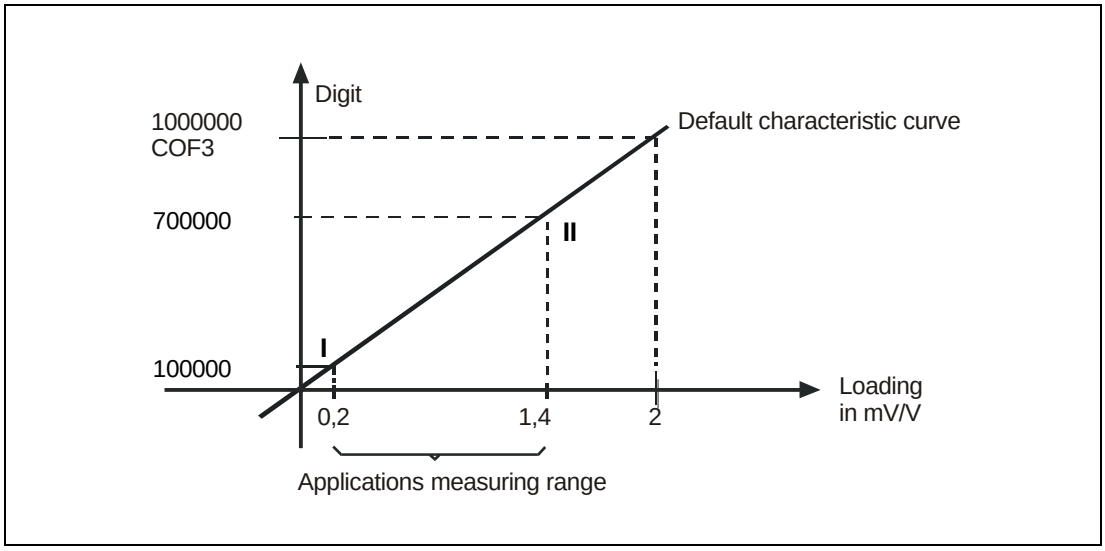


Fig. 3.3-1: Factory characteristic curve at zero load

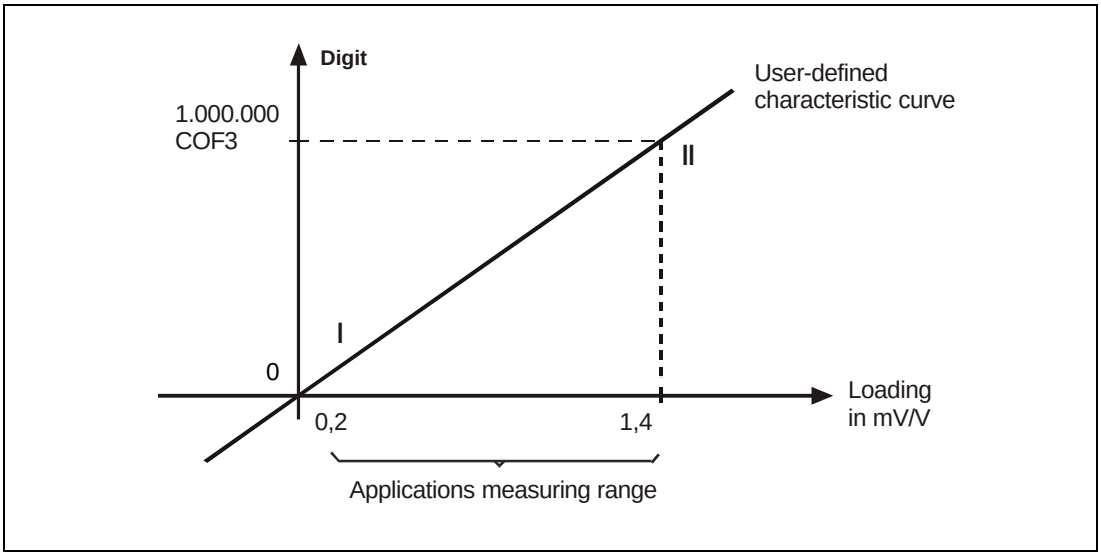


Fig. 3.3-2: User characteristic curve at max. capacity

3.3.1 User Characteristic Curve and Output Scaling - Load Cell Dead Weight (LDW)

LDW

Load Cell Dead Weight
(User characteristic curve zero point)

Property	Content		Comment
Command string	**LDW**		
No. of parameters	1		
Parameter range	P1 = 0...±1599999		
Factory setting (**TDD**0)	0		
Response time	<15 ms	for input or query	
	<4.2 s	for measurement (LDW;)	
Password protection	Yes		
Relevant to verification	Yes		
Parameter protection	after input of **LWT**		
Master **input**	**LDW**(P1);		For input
AED response	0 crlf		On input OK
Master **input**	**LDW**;		On measurement
AED response	0 crlf		After measurement
Master **query**	**LDW**?;		
AED response	P1 crlf (P1 = 7 digits with sign)		P1 = 8 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect or if the password has not been activated for input or measurement.		

Function:

When measuring, the current input signal (e.g. scale not loaded = previous load) is assigned to the internal measured value, the output value 0 digits.

Parameter description:

With a query, the value is output with ±7 digits (e.g. -0950246 crlf).

The user characteristic curve is deactivated at **LDW** = 0 and **LWT** = 1000000.

The **LDW** value is not converted via **NOV**.

There are two options for zero point adjustment:

1. **Adopting the zero point of the user characteristic curve with LDW (reaction time < 15 ms):**

   The scale is not loaded.
   Adopt the zero point with the command **LDW**;.
   The transducer electronics measure the input signal between ±3mV/V or the zero load of the scale, store the measured value and offset it, but only after the parameter for **LWT** is entered.

2. **Manual input of the user characteristic curve zero point via LWT (reaction time < 15 ms):**

   Use the command **LDW**<zero point> to enter the value for the zero point of the scale. The value entered is stored, but only offset after the parameter for **LWT** is entered.

If the **LDW**/**LWT** adjustment is not being executed with 100 % of the input signal, the **CWT** value (calibration weight) must be set first (see the Individual command description/Adjustment and calibration/**CWT** command section).

Before the user characteristic curve is adjusted, CAL should be run to safeguard measurement accuracy.

3.3.2 User Characteristic Curve and Output Scaling - Load Cell Weight (LWT)

LWT

Load Cell Weight
(User characteristic curve zero point)

Property	Content		Comment
Command string	**LWT**		
No. of parameters	1		
Parameter range	P1 = 0...±1599999		
Factory setting (**TDD**0)	1000000		
Response time	<15 ms	for query (LWT?;)	
	<1.5 s	for input (LWT P1;)	
	<4.2 s	for measurement (LWT;)	
Password protection	Yes		
Relevant to verification	Yes		
Parameter protection	for input		
Master **input**	**LWT**(P1);		For input
AED response	0 crlf		On input OK
Master **input**	**LWT**;		For measurement
AED response	0 crlf		After measurement
Master **query**	**LWT**?;		
AED response	P1 crlf (P1 = 7 digits with sign)		P1 = 8 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect or if the password has not been activated for input or measurement.		

Function:

When measuring, the current input signal (e.g. scale loaded = max. capacity) is assigned to the internal measured value, the output value 1000000 digits.

Parameter description:

With a query, the value is output with ±7 digits (e.g. -0950246 crlf).

The user characteristic curve is deactivated at **LDW** = 0 and **LWT** = 1000000.

The LWT value is not converted via **NOV**.

Adopting the nominal value of the user characteristic curve with LWT (reaction time < 4.2 s):

1. The scale is loaded at max. capacity.
2. Using the command **LWT**;, the AED measures an input signal between ±3.0 mV/V or at max. capacity and offsets this measured value with the previously entered value for **LDW** to a new characteristic curve.

Manual input of the user characteristic curve full scale via LWT (reaction time < 1.5 s):

1. Enter the **LDW** value.
2. Use the command **LWT**<nominal value> to enter the measured value for the max. capacity. The value entered is stored and offset with the previously measured or entered **LDW** value.

If the **LDW**/**LWT** adjustment is not being executed with 100 % of the input signal, the **CWT** value (calibration weight) must be set first (see the Individual command description/**CWT** command section).

Before the user characteristic curve is adjusted, CAL should be run to safeguard measurement accuracy.

Entering or measuring the factory characteristic curve with **SZA**/**SFA** resets the user characteristic curve to the default values **LDW** = 0, **LWT** = 1000000 and **CWT** = 1000000.

Procedure for entering the user characteristic curve (LDW, LWT, CWT):

1. Use the command **SPW** to enter your password.
2. Deactivate scaling by entering **NOV**0.
3. Deactivate partial load calibration with the command **CWT**1000000;.
4. Deactivate the user characteristic curve with commands **LDW**0; and **LWT**1000000;.
5. Set the **ASF** filter so that the display is as smooth as possible.
6. Switch the scale to the unloaded state and wait for standstill.
7. Use command **MSV**? to determine the measured value. (see the Individual command descriptions/Measurement/**MSV** command section). Note value1 for **LDW**.
8. Load the scale at max. capacity and wait for standstill.
9. Use command **MSV**?; to determine the measured value (see above). Note value2 for **LWT**.
10. Should the measured LWT value not correspond to 100 % of the max. capacity, enter **CWT**.
11. Use **LDW**<value1>; followed by **LWT**<value2>; to enter the new user characteristic curve.
12. Set **NOV**, **ENU** in accordance with the application and use command **TDD**1 to store the parameters safe from power failure.

Procedure for measuring the user characteristic curve (LDW, LWT, CWT):

1. Use the command **SPW** to enter your password.
2. Use the command **CWT**<partial load> to enter the partial load adjustment (see the Individual command descriptions/**CWT** command section.
3. Switch the scale to the unloaded state and wait for standstill.
4. Use the **LDW**; command to determine the measured value for the zero point of the user characteristic curve. The input signal for the unloaded scale is measured and stored.
5. Load the scale at max. capacity and wait for standstill.
6. Use the **LWT**; command to determine the measured value for the full scale of the user characteristic curve. The input signal for the loaded scale is measured and stored and the user characteristic curve is recalculated.
7. Set **NOV**, **ENU** in accordance with the application and use command **TDD**1 to store the parameter safe from power failure.

3.3.3 User Characteristic Curve and Output Scaling - Calibration Weight (CWT)

CWT — Calibration Weight

Property	Content	Comment
Command string	**CWT**	
No. of parameters	1	
Parameter range	P1 = 200000...1200000 (20 %...120 %)	1000000 = 100 %
Factory setting (**TDD**0)	1000000	= 100 %
Response time	<15 ms	
Password protection	Yes	
Relevant to verification	Yes	
Parameter protection	for input	
Master **input**	**CWT**(P1);	without P2
AED response	0 crlf	On input OK
Master **query**	**CWT**?;	
AED response	P1,P2 crlf	P1, P2 = 8 Characters

Explanation: ( ) required parameters, < > optional parameters on parameter input,
AED responds with ? crlf, if the input or the query is incorrect or if the password has not been activated for input.

Function:

If you cannot apply 100 % of the input signal when adjusting the user characteristic curve, then the **CWT** command also gives you the opportunity to adjust the AED with an input signal in the range 20 % to 120 % of the required nominal value (partial load calibration).

Parameter description:

P1 and P2 are two 7-digit decimal numbers in the range 200000 to 1200000 (= 20 %...120 %).

P1 is the percentage of the max. capacity, at which the next **LDW**/**LWT** adjustment is to be implemented.

P2 is the percentage of the max. capacity, at which the last **LDW**/**LWT** adjustment was implemented. P2 cannot be entered.

The **CWT** value used to implement the **LDW**/**LWT** adjustment is part of the **LDW**/**LWT** characteristic curve pair.

Example:

When the AED is delivered, the LDW value = 0, the LWT value = 1000000 and the CWT value = 1000000. The user characteristic curve LDW/LWT of a scale should be adjusted at 100 kg = 1 million. But only a 110.23 lb balancing weight is available for the adjustment. Please proceed as follows:

Set the CWT value to 500000 for the adjustment (corresponds to 50 %).

Perform an LDW/LWT adjustment.

After the adjustment, the measured values the AED outputs are 500000 digits for 110.23 lb and 1000000 digits for 220.46 lb. After a successful adjustment the response to CWT? would be 500000,500000 crlf.

Should the values for **LDW** and **LWT** be entered again later, the **CWT** value must be entered first, then the **LDW** value and finally the value for **LWT**.

Users of the previous AD101/102 can perform the **LDW**/**LWT** adjustment in the usual way, because the factory setting sets the **CWT** value to 1000000 = 100 %.

Entering or measuring the factory characteristic curve with **SZA**/**SFA** resets the user characteristic curve to the default values **LDW** = 0, **LWT** = 1000000 and **CWT** = 1000000.

3.3.4 User Characteristic Curve and Output Scaling - Nominal Output Value (NOV)

NOV

Nominal Value
(Resolution of user characteristic curve)

Property	Content	Comment
Command string	**NOV**	
No. of parameters	1	
Parameter range	P1 = 0...1599999	0 =deactivated
Factory setting (**TDD**0)	0	
Response time	<10 ms	
Password protection	Yes	
Relevant to verification	Yes	
Parameter protection	With command **TDD**1	
Master **input**	**NOV**(P1);	
AED response	0 crlf	On input OK
Master **query**	**NOV**?;	
AED response	P1 crlf	P1 = 8 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ?crlf, if the input or the query is incorrect or if the password has not been activated for input.	

Function:

The **NOV** value is used to scale the output value during data output. When **NOV** = 0, this output scaling is deactivated. ASCII data output is scaled at the factory to 1000000. If a data output of 2000 digits is required at max. capacity, for example, the nominal value **NOV**2000; must be set with this command. This scaling does not modify the input parameters or the tare value.

Output format measured value at max. capacity	NOV = 0	NOV > 0
2 byte binary	20000	**NOV** value
4 byte binary	5120000	**NOV** value
ASCII	1000000	**NOV** value

For 2-byte binary output, the **NOV** value must be < 30000. Otherwise the measured value will be output with overflow or underflow ($7FFF_{Hex}$ or 8000_{Hex}; Hex: hexadecimal). With **NOV**30000, the overflow reserve is only about 2700 digits.

If **NOV** > 0 is entered, the parameters for the limit values (**LIV**) and the level value of the trigger function (**TRC**) are changed. The output of peak values (**PVA**) and of the trigger result (**MAV**?) is also scaled by NOV.

Which is why, after an adjustment with **LDW/LWT**, first the output scaling with **NOV** should be entered and then the parameters for the other signal processing functions.

3.3.5 User Characteristic Curve and Output Scaling - Engineering Unit (ENU)

ENU

Engineering Unit
(unit of measurement)

Property	Content	Comment
Command string	**ENU**	
No. of parameters	1	
Parameter range	4 ASCII characters	Put in „ „
Factory setting (**TDD**0)	„ „	
Response time	<15 ms for query <40 ms for input	
Password protection	No	
Relevant to verification	No	
Parameter protection	For input	
Master **input**	**ENU"xxxx"**;	
AED response	0 crlf	On input OK
Master **query**	**ENU**?;	
AED response	xxxxcrlf	4 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect	

Function:

The command implements input of a unit of measurement with max. ASCII characters.

Any string of a maximum four characters can be entered. If less than four characters are entered, blanks are added to the input. The unit entered is not appended to the measured value. The characters must be entered in quotes.

3.4 Settings for Measuring Mode

These commands should be set before data is output.

- Select input signal **ASS**
- Filter mode **FMD**
- Filter selection limit frequencies **ASF**
- Output rate **ICR**
- Standstill monitoring **MTD**
- Automatic zero tracking **ZTR**
- Initial zero setting **ZSE**
- Auto calibration **ACL**

The commands for setting the trigger function **TRC** and the limit values **LIV** are described in separate sections (see the Special signal processing functions section).

3.4.1 Setting for Measuring Mode - Amplifier Signal Selection (ASS)

ASS

Amplifier Signal Selection
(Select input signal)

Property	Content	Comment
Command string	**ASS**	
No. of parameters	1	
Parameter range	P1 = 0...3	
Factory setting (**TDD**0)	2	Bridge signal
Response time	<10 ms for query	
	<220 ms for input	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	**ASS**(P1);	
AED response	0 crlf	On input OK
Master **query**	**ASS**?;	
AED response	P1 crlf	P1 = 2 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect	

Function:

The command changes over the input of the measuring amplifier input.

Parameter description:

Input	Input signal
0	Internal stable zero signal (0 mV/V)
1	Internal stable calibration signal (2 mV/V)
2	Measurement signal (SG bridge / transducer input)
3	Internal calibration signal (this switch position is available for reasons of AD101B compatibility)

3.4.2 Setting for Measuring Mode - Filter Mode (FMD)

FMD

Filter Mode

Property	Content	Comment
Command string	**FMD**	
No. of parameters	1	
Parameter range	P1 = 0/1	
Factory setting (**TDD**0)	0	
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	**FMD**(P1);	
AED response	0 crlf	On input OK
Master **query**	**FMD**?;	
AED response	P1 crlf	P1 = 1 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The command selects the filter mode of the digital filters. Which exerts an influence over the filter performance of the AED (see **ASF** command).

Parameter description:

FMD0: Standard filter

FMD1: Fast settling digital filters

The output rate of the AED (depending on **FMD**, **ASF** and **ICR**) is also the monitoring rate at which subsequent functions are executed (limit values, minima/maxima memory and trigger function).

3.4.3 Setting for Measuring Mode - Amplifier Signal Filter (ASF)

ASF

Amplifier Signal Filter
(filter selection cut-off frequency)

Property	Content	Comment
Command string	**ASF**	
No. of parameters	1	
Parameter range	P1 = 0…9(10)	10 is reserved for HBM
Factory setting (**TDD**0)	0	
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	**ASF**(P1);	
AED response	0 crlf	On input OK
Master **query**	**ASF**?;	
AED response	P1 crlf	P1 = 2 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The command selects a digital filter. This exerts an influence over the filter performance of the AED (measurement signal bandwidth).

The AED has a multi-level filter chain:

Standard filter (**FMD**0) or a fast filter (**FMD**1);
cut-off frequency selectable via **ASF**, fixed sampling rate = 600 Hz

Mean-value calculation to reduce the output rate (selectable via **ICR**, output rate ≤ 600 Hz)

The cut-off frequency of the filter determines the settling time. The higher the filter index, the better the filter effect, but also the longer the settling time when changing the weight. The filter setting should be chosen to be as low as possible, while still being able to ensure non-operation (standstill) at a weight that does not change.

Mean-value calculation (**ICR**) influences the overall settling time of the AED. The total settling time is also dependent on the mechanical construction of the transducer, on the dead load of the scale and on the weight to be weighed.

The output rate of the AED (depending on FMD, **ASF** and **ICR**) is also the monitoring rate at which subsequent functions are executed (limit values, minima/maxima memory and trigger function).

Parameter description:

So you can use the commands (**ASF**, **ICR**, **FMD**) to set the desired filter effect and output rate. As well as the standard filter properties, the AED has additional powerful digital filters available. The command **FMD**: is used to toggle between the two filter methods.

FMD0 (standard filter): selectable filter levels: 0...8

FMD1 (fast settling digital filter): selectable filter levels: 0...9(10)

With **ASF**0, the filter is deactivated.

Filter characteristics of standard filters with FMD0:

ASF	Settling time in ms to 0.1 %	Cut-off frequency in Hz at –3 dB	max. damping in dB at 100 Hz
1	22	40	-20
2	53	18	-34
3	115	8	-48
4	238	4	-60
5	485	2	-72
6	970	1	-82
7	1897	0.5	-90
8	3800	0.25	-96

Filter characteristics of FIR filters with FMD1:

ASF	Settling time in ms	Cut-off frequency in Hz at –3 dB	20 dB damping when frequency in Hz	40 dB damping when frequency in Hz	Damping in dB in the stop band	Stop band in Hz
1	62	18	47	63	>90	>90
2	90	11	32	45	>90	>70
3	119	9	24	31	>90	>60
4	147	7	18	24	>90	>60
5	208	5	12	17	>90	>40
6	240	4	10.5	13	>90	>34
7	295	3.5	8	10	>90	>34
8	330	3	7	9	>90	>30
9	365	2.5	6.2	8	>90	>30

FIR filters reduce the output rate in accordance with the filter setting (see **ICR** command).

3.4.4 Setting for Measuring Mode - Internal Conversion Rate (ICR)

ICR

Internal Conversion Rate
(output rate)

Property	Content	Comment
Command string	**ICR**	
No. of parameters	1	
Parameter range	P1 = 0...7	
Factory setting (**TDD**0)	2	
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	**ICR**(P1);	
AED response	0 crlf	On input OK
Master **query**	**ICR**?;	
AED response	P1 crlf	P1 = 2 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The command defines the output rate of the measured values for the measurement query (**MSV**?).

The output rate of the AED (depending on **FMD**, **ASF** and **ICR**) is also the monitoring rate at which subsequent functions are executed (limit values, minima/maxima memory and trigger function).

Parameter description:

ICRx = mean-value calculation via 2^x measured values, with x = 0...7 and **FMD** = 0

Which produces the following output rates:

1. Output rates for filter mode FMD0:

ICR	Output rate Mw/s (for MSV?x; with x = 0...65536)
0	600
1	300
2	150
3	75
4	37.5
5	18.75
6	9.38
7	4.69

2. Output rates for filter mode FMD1:

ICR	Output rate Mw/ s (for MSV?x; with x = 0...65536)									
	ASF0	ASF1	ASF2	ASF3	ASF4	ASF5	ASF6	ASF7	ASF8	ASF9
0	600	600	300	200	150	120	100	85.71	75	66.67
1	300	300	150	100	75	60	50	42.86	37.5	33.33
2	150	150	75	50	37.5	30	25	21.43	18.75	16.67
3	75	75	37.5	25	18.75	15	12.5	10.71	9.38	8.33
4	37.5	37.5	18.75	12.5	9.38	7.5	6.25	5.36	4.69	4.17
5	18.75	18.75	9.38	6.25	4.69	3.75	3.13	2.68	2.34	2.08
6	9.38	9.38	4.69	3.13	2.34	1.88	1.56	1.34	1.17	1.04
7	4.69	4.69	2.34	1.56	1.17	0.94	0.78	0.67	0.59	0.52

The baud rate setting must be taken into consideration when setting the measurement data rate. With high measurement data rates, the baud rate setting must also be high, to prevent loss of measurement data (see **COF** command).

3.4.5 Setting for Measuring Mode - Motion Detection (MTD)

MTD

Motion Detection
(Standstill monitoring)

Property	Content	Comment
Command string	**MTD**	
No. of parameters	1	
Parameter range	P1 = 0...5	
Factory setting (**TDD**0)	0	
Response time	<10 ms	
Password protection	No	
Relevant to verification	Yes	
Parameter protection	With command **TDD**1	
Master **input**	**MTD**(P1);	
AED response	0 crlf	On input OK
Master **query**	**MTD**?;	
AED response	P1 crlf	P1 = 2 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The command defines measured value standstill monitoring.

If standstill monitoring is deactivated (**MTD**;), standstill monitoring is not implemented in the AED and standstill is set in the measurement status (see **MSV**?). The standstill bit in the measurement status is then always set to 1.

If standstill monitoring is activated (**MTD**), it relates to the nominal value set with the **NOV** command. If user scaling is deactivated (**NOV** = 0) or if scaling >100000 is selected with **NOV**, standstill consideration is executed with 1 d/s for 100000 d scaling.

Information about whether the measured values during a second fall within the selected standstill range, is transferred in measurement status information (bit 3).

Parameter description:

MTD0:	Standstill monitoring deactivated	
MTD1:	Standstill monitoring ±0.25 d/s	of **NOV** value
MTD2:	Standstill monitoring ±0.5 d/s	of **NOV** value,
MTD3:	Standstill monitoring ±1 d/s	of **NOV** value,
MTD4:	Standstill monitoring ±2 d/s	of **NOV** value,
MTD5:	Standstill monitoring ±3 d/s	of **NOV** value,

The increment (**RSN**) also affects the standstill range:

Example:

MTD3, RSN = 5 d

The standstill step size is ±5 d of the NOV value

3.4.6 Setting for Measuring Mode - Zero Tracking (ZTR)

ZTR

Zero Tracking
(Automatic zero tracking)

Property	Content	Comment
Command string	**ZTR**	
No. of parameters	1	
Parameter range	P1 = 0/1 (0 = Off, 1 = On)	
Factory setting (**TDD**0)	0	deactivated
Response time	<10 ms	
Password protection	No	
Relevant to verification	Yes	
Parameter protection	With command **TDD**1	
Master **input**	**ZTR**(P1);	
AED response	0 crlf	On input OK
Master **query**	ZTR?;	
AED response	P1 crlf	P1 = 1 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

Automatic zero tracking occurs for a gross or net measured value <0.5 d in the range ±2 % of the nominal value of the scale (**NOV**). The maximum reset speed is 0.5 d/s at scale standstill. Standstill detection can be set using the **MTD** command. The unit d (digit) relates to the nominal value (**NOV**). If the **NOV** value is deactivated (**NOV** = 0) or the **NOV** value is > 100000 d (range: 0...4).

3.4.7 Setting for Measuring Mode - Initial Zero Setting (ZSE)

ZSE

Zero Setting
(Initial zero setting)

Property	Content	Comment
Command string	**ZSE**	
No. of parameters	1	
Parameter range	P1 = 0...4	
Factory setting (**TDD**0)	0	deactivated
Response time	<10 ms	
Password protection	No	
Relevant to verification	Yes	
Parameter protection	With command **TDD1**	
Master **input**	**ZSE**(P1);	
AED response	0 crlf	On input OK
Master **query**	**ZSE**?;	
AED response	P1 crlf	P1= 2 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

After the voltage cut-in, when there is a “RESET” or after the **RES** command, zero is set after about 2.5 s in the selected range at standstill. A change to the initial zero setting correction range only takes effect after the voltage cut-in or after the **RES** command.

If there is no standstill or if the gross value falls outside the selected limits, zero is not set. The internal zero memory is always cleared before automatic zeroing. If the gross value at standstill falls within the selected range, the gross value is accepted into the zero memory. Zero memory cannot be read out. Scale standstill is fixed at 1 d/s. The digit unit relates to the nominal value (**NOV**). When the **NOV** value is deactivated (**NOV** = 0) or the **NOV** value is >100000 d, standstill monitoring is related to a nominal value of 100000 d.

Parameter description:

ZSE0:	Zeroing deactivated	
ZSE1:	Zeroing range ±2 %	of **NOV** value
ZSE2:	Zeroing range ±5 %	of **NOV** value
ZSE3:	Zeroing range ±10 %	of **NOV** value
ZSE4:	Zeroing range ±20 %	of **NOV** value

3.4.8 Settings for Measuring Mode - Auto Calibration (ACL)

ACL

Auto Calibration
(Automatic calibration)

Property	Content	Comment
Command string	**ACL**	
No. of parameters	1	
Parameter range	P1= 0/1 (0 = off, 1= on)	
Factory setting (**TDD**0)	1	activated
Response time	<10 ms	
Password protection	No	
Relevant to verification	Yes	
Parameter protection	With command **TDD1**	
Master **input**	**ACL**(P1);	
AED response	0 crlf	On input OK
Master **query**	**ACL**?;	
AED response	P1 crlf	P1 = 1 characters
Explanation.	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The **CAL** command performs a one-tine calibration, to safeguard the measurement accuracy of the AED. Automatic calibration every 5 minutes can be activated using the **ACL**1; command. During the 1.5 second calibration time, the measurement signal is deactivated and switched to the internal, stable calibration scaler (0 and 2 mV/V).

When **ACL**1; is entered, calibration is performed immediately. The next command after **ACL**1; should only be entered 1.5 seconds later. After a reset, calibration is more frequent in the first five minutes (after 1, 2 mins.).

3.5 Commands for Measuring Mode

- Data output **MSV**
- Stop data output **STP**
- Tare mode **TAR**
- Tare value **TAV**
- Gross/net selection **TAS**
- One-time calibration **CAL**

The commands for output of the **MAV**? trigger result are described in separate sections (see the Special signal processing functions section).

More detailed descriptions can be found in the application documents:

- APPN005 (Measurement query with MSV?),
- APPN011 (Reading out trigger results).

3.5.1 Command for Measuring Mode - Measured Signal Value (MSV)

MSV

Measured Signal Value
(Data output)

Property	Content	Comment
Command string	**MSV**?	
No. of parameters	1	
Parameter range	P1 = 0...65535	
Factory setting (**TDD**0)	0	deactivated
Response time	for **FMD**0: < 2^{ICR} ∗ 1.67 ms + 1.67 ms	ICR = output rate
	for **FMD**1: < 2^{ICR} ∗ **ASF**(1...9) ∗ 1,67 ms + 1,67 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	No data to protect	
Master **input**	**MSV**?<P1>;	
AED response	See description	
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the query is incorrect.	

Function:

As previously defined (see **COF**, **TEX**, **NOV** commands), the measured value is output in ASCII format or in binary format. The maximum scope for the measured values is :

For 2-byte data output:	Integer	± 32767
For 4-byte data output:	Long Integer	±8388607
For ASCII data output:	ASCII	±1599999

The output length depends on the output format (**COF** command).

Output format		AED response		Character count
Binary	4 byte	yyyy crlf	(y – binary)	6
Binary	2 byte	yy crlf	(y – binary)	4
ASCII	(**COF**3;)	xxxxxxxx crlf	(x – ASCII)	10
ASCII	(**COF**9;)	xxxxxxxx,xx,xxx crlf	(x – ASCII)	17

cr: Carriage Return, lf: Line Feed

The output format for a measured value must be defined before measurement. The measured value is output in relation to the particular measuring range (**NOV**). The measured value can be net or gross (**TAS**).

Parameter description:

Parameter P1 controls the number of outputs:

Single query: MSV?; Parameter P1 = 1 is not needed

AED response: xxxx crlf

Block query: **MSV**?(1...65535);

AED response: xxxx yyyy...zzzz crlf

The command outputs the given number of measured values. The end label crlf is only output after the last measured value.

Continuous output: MSV?0;

With **MSV**?0; measured values are output continuously. This output can only be stopped with the **STP** or **RES** commands or by cutting off the voltage. During continuous output, no other parameters can be entered or queried.

MSV?0; must not be used for RS485 2-wire mode.

Preparing for data output

1. Use the **COF** command to define the **output format**.
2. Use the **TEX** command to define the **separator** for ASCII data output.

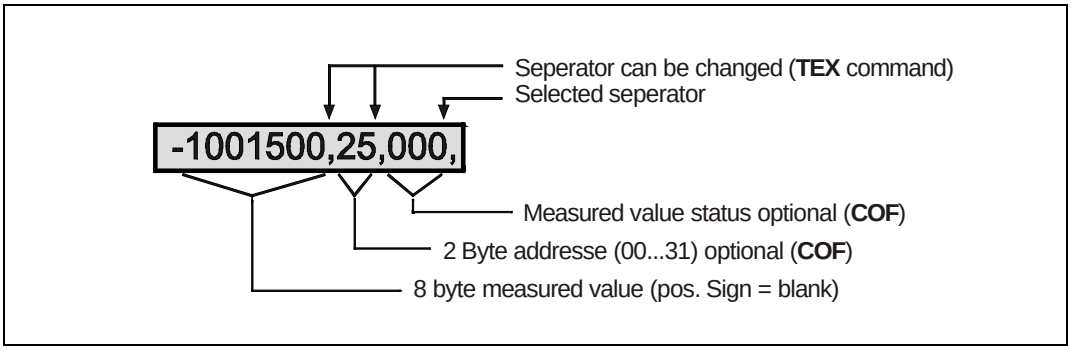


Fig. 3.5-1: ASCII - measurement data output format (COF9)

3. Use the **NOV** command to define **output scaling**.

   Output scaling is defined by the parameter of the **NOV** command:

Output format measured value at max. capacity	NOV = 0	NOV > 0
2 byte binary	20000	**NOV** value
4 byte binary	5120000	**NOV** value
ASCII	1000000	**NOV** value

   For 2-byte binary output, the **NOV** value must be < 30000, otherwise the measured value will be output with overflow or underflow ($7FFF_{Hex}$ or 8000_{Hex}; Hex: hexadecimal). With **NOV**30000, the overflow reserve is only about 2700 digits.

4. Use commands **FMD**, **ASF** and **ICR** to define the **output rate**.

   The response time for measurement query is defined by the integration time (**ICR** command) and the filter mode (**FMD**) and with **FMD** = 1, also by the filter level **ASF**:

Filter mode for FMD0 (single query MSV?;):

ICR	Max. meas. time [ms] for MSV?;
0	3.3
1	5.0
2	8.3
3	15.0
4	28.3
5	55.0
6	108.3
7	215.0

Filter mode for FMD0 (single query MSV?;):

ICR	Max. meas. time [ms] for MSV?;									
	ASF0	ASF1	ASF2	ASF3	ASF4	ASF5	ASF6	ASF7	ASF8	ASF9
0	3.3	3.3	5.0	6.7	8.3	10.0	11.7	13.3	15.0	16.7
1	5.0	5.0	8.3	11.7	15.0	16.3	21.7	25.0	28.3	31.7
2	8.3	8.3	15.0	21.7	28.3	35.0	41.7	48.3	55.0	61.7
3	15.0	15.0	28.3	41.7	55.0	68.3	81.7	95.0	108.3	121.7
4	28.3	28.3	55.0	81.7	108.3	135.0	161.7	188.3	215.0	241.7
5	55.0	55.0	108.3	135.0	188.3	241.7	321.7	375.0	428.3	481.7
6	108.3	108.3	188.3	321.7	428.3	535.0	641.7	748.3	855.0	961.7
7	215.0	215.0	428.3	641.7	855.0	1068.3	1281.7	1495.0	1708.0	1921.7

The output rates possible in conjunction with **FMD**, **ASF** and **ICR** are shown in the Individual command descriptions/Measurement/**ICR** command section.

5. Use the **MSV**? command to start data output

   If you use the command **MSV**?(number);, a predefined number of measured values can be output.

   The time between the output of two measured values is the measurement time. The total recording time for the selected number of measured values will depend on the filter mode set (**FMD**) and is calculated as follows:

   The following applies for **FMD** = 0 and **FMD** = 1 with **ASF** = 0:

Meas. Time [ms]	=	$2^{ICR} * 1.666$ ms	between the two measured values
Total meas. time [ms]	=	Number $* 2^{ICR} * 1.666$ ms + 1.666 ms	
with ICR	=	Sampling rate index	

   The following applies for **FMD** = 1 and **ASF** = 1…9:

Meas. Time [ms]	=	ASF $* 2^{ICR} * 1.666$ ms + 1.666 ms	between the two measured values
Total meas. time [ms]	=	Number $*$ ASF $2^{ICR} * 1.666$ ms + 1.666 ms	
with ICR	=	Sampling rate index, ASF = digital filter index	

Measurement status

In 4-byte binary output and in ASCII output, the measurement status can be transferred with the measured value (see **COF** command, subject to **IMD**).

Messages in the measurement status for IMD0

Content of the status byte for data output			Possible cause
Bits 0 1	=	Net overflow	Tare value too high
Bits 1 1	=	Gross overflow	Scaling too sensitive
Bits 2 1	=	ADU overflow	ADU overdriven (input > ±2.5 mV/V)
Bit 3 1	=	Standstill	Measured values fall within the standstill range selected by the **MTD** command in digits/s
Bits 4 1	=	Limit value 1 active	Status of limit value 1, when activated (see **LIV**)
Bits 5 1	=	Limit value 2 active	Status of limit value 2, when activated (see **LIV**)
Bits 7/6 1	=	Measured values not related	They do not match. Measured value output is not conclusive in the chosen configuration (**ICR**, **BDR** and **COF** do not match →COF)

Messages in the measurement status for IMD1

Content of the status byte for data output			Possible cause
Bits 0 1	=	Net overflow	Tare value too high
Bits 1 1	=	Gross overflow	Scaling too sensitive
Bits 2 1	=	ADU overflow	ADU overdriven (input > ± 2.5 mV/V)
Bit 3 1	=	Standstill	Measured values fall within the standstill range selected by the **MTD** command in digits/s
Bits 4 1	=	Limit value 1 active	Status of limit value 1, when activated (see **LIV**)
Bits 5 1	=	Limit value 2 active	Status of limit value 2, when activated (see **LIV**)
Bits 6 1	=	Trigger function active	Triggering occurs; remaining active until the trigger output value is determined (**MAV**)
Bits 7/6 1	=	Measured values not related (overwrites trigger![1)]	They do not match. Measured value output is not conclusive in the chosen configuration (**ICR**, **BDR**, **COF** do not match →COF)

1) Only occurs with **MSV**?; when the baud rate is too slow (see **BDR**).

3.5.2 Command for Measuring Mode - Stop (STP)

STP

Stop
(Data output stop)

Property	Content	Comment
Command string	**STP**	
No. of parameters	-	
Parameter range	-	
Factory setting (**TDD**0)	-	
Response time	Depending on data output measurement time	
Password protection	No	
Relevant to verification	No	
Parameter protection	No data to protect	
Master **input**	**STP**;	
AED response	No response	
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input is incorrect.	

Function:

This command ends data output.

STP; only works on the **MSV** command.

If a measured value has started, it is output in full.

3.5.3 Command for Measuring Mode - Tare (TAR)

TAR

Tare

Property	Content	Comment
Command string	**TAR**	
No. of parameters	-	
Parameter range	-	
Factory setting (**TDD**0)	-	
Response time	for **FMD0:** $<2^{ICR} * 1.67$ ms + 1.67 ms at **FMD**1 and **ASF**0 $<2^{ICR} * 1.67$ ms + 1.67 ms at **FMD**1: $<2^{ICR} *$ **ASF**(1...9) $* 1.67$ ms + 1.67 ms	**ICR** = output rate index
Password protection	No	
Relevant to verification	No	
Parameter protection	No data to protect	
Master **input**	**TAR**;	
AED response	0 crlf	On input OK
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The **TAR**; command tares the current measured value. After taring, the system changes back to the net measured value (**TAS**0;). The current value is stored in the tare memory (also see **TAV** command) and subtracted from the measured value and from all subsequent measured values.

With the AED, taring can also be triggered via an external contact (digital input IN2 when **IMD** = 1).

A **TAR**?; query is not permitted.

3.5.4 Command for Measuring Mode - Tare Value (TAV)

TAV

Tare Value

Property	Content	Comment
Command string	**TAV**	
No. of parameters	1	
Parameter range	P1 = 0...±8388607	
Factory setting (**TDD**0)	0	deactivated
Response time	<20 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	**TAV**(P1);	
AED response	0 crlf	On input OK
Master **query**	**TAV**?;	
AED response	X crlf (X = current tare value 7 digits with sign)	X = 8 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The tare value can be preset or a tare value saved by the tare function (**TAR**) is output.

The value is on the **LDW**/**LWT** characteristic curve scaled with the **NOV** parameter (0...**NOV**). After the commands **SZA**, **SFA** or **LDW**, **LWT** have been used for characteristic curve input, the tare memory is cleared (content = 0).

The changeover to net output is not forced by entering the tare value. The **TAS** command is used for this.

Query: TAV?;

The content of the tare memory is output. The tare value is converted to the **NOV** value.

Output format measured value at max. capacity	nominal tare range for NOV > 0	maximum tare range for NOV > 0	nominal tare range for NOV = 0	maximum tare range for NOV = 0
2 byte binary	±**NOV** value	±150 % **NOV** value	±1000000	±8388607
4 byte binary	±**NOV** value	±150 % **NOV** value	±1000000	±8388607
ASCII	±**NOV** value	±150 % **NOV** value	±1000000	±1599999

Example:

NOV3000;		(scale scaling)
TAS1;		(gross output activated)
MSV?;	1500 crlf	(measured value at 50 % = max. capacity of scale)
TAR;		(tare and select net output)
TAV?;	1500 crlf	(query tare value)
MSV?;	0 crlf	(net measured value)
TAS?;	0 crlf	(net is activated)
TAS1;	0 crlf	(select gross)
MSV?;	3000 crlf	(measured value at 100 % = max. capacity of scale)
TAV?;	1500 crlf	(query tare value, unchanged)

3.5.5 Command for Measuring Mode - Tare Set (TAS)

TAS

Tare Set
(Gross/net selection)

Property	Content	Comment
Command string	**TAS**	
No. of parameters	1	
Parameter range	P1 = 0/1 (0 = Netto, 1 = Brutto)	
Factory setting (**TDD**0)	1	
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	**TAS**(P1);	
AED response	0 crlf	On input OK
Master **query**	**TAS**?;	
AED response	P1 crlf	P1 = 1 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The command changes the data output (**MSV**?, **MAV**?).

TAS0: net measured value

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

TAS1: Gross measured value

The value in tare memory is not offset. The tare value remains unchanged when the gross/net switch is made.

3.5.6 Command for Measuring Mode - One-Time Calibration (CAL)

CAL

Calibration
(one-time calibration)

Property	Content	Comment
Command string	**CAL**	
No. of parameters	-	
Parameter range	-	
Factory setting (**TDD**0)	-	
Response time	<1.5 s	
Password protection	No	
Relevant to verification	No	
Parameter protection	No data to protect	
Master **input**	**CAL**;	
AED response	0 crlf	On input OK
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input is incorrect.	

Function:

The **CAL** command performs a one-time calibration, to safeguard the measurement accuracy of the AED. Automatic calibration every 5 minutes can be activated using the ACL command. During the 1.5 second calibration time, the measurement signal is deactivated and switched to the internal, stable calibration scaler (0 and 2 mV/V).

3.6 Special Signal Processing Functions

The commands for the digital input and output settings are described in this section.

Limit value functions

- Setting the functions for the inputs, **IMD**
- Setting the limit values, **LIV**
- Reading and setting inputs and outputs, **POR**

Trigger function

The AED has a trigger function that is implemented chiefly for the dynamic weighing of piece goods (checkweigher).

- Read out result trigger function, **MAV**
- Setting trigger function, **TRC**

The data transfer rate (speed) of the signal processing functions depends on the output rate that is set (**FMD**, **ASF**, **ICR)**.

3.6.1 Control Input Functions - Input Mode (IMD)

IMD

Input Mode
(control input function)

Property	Content	Comment
Command string	**IMD**	
No. of parameters	1	
Parameter range	P1 = 0, 1,2	
Factory setting (**TDD**0)	0	
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	**IMD**(P1);	
AED response	0 crlf	On input OK
Master **query**	**IMD**?;	
AED response	P1 crlf	P1 = 2 characters
Explanation:	( ) required paramete rs, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

This command selects the function of digital inputs IN1 (connector 1, PIN16) and IN2 (connector 1, PIN17) of the AED. The function of the digital outputs is also affected.

Parameter description:

IMD0;

The logic states at inputs IN1 and IN2 can be queried
with the **POR** command. A change in level at IN1 or IN2 does not affect the AED.

Digital outputs OUT1/2 can be general control outputs or limit value outputs (**LIV**, **POR**).

IMD1;

Input IN1 is an external trigger input for the trigger function (**TRC**). A low/high edge at input IN1 activates measurement (see AD101B Operating Manual; Part 2, Measuring amplifier/Trigger function).

Input IN2 is an input for an external tare command. A high signal applied to input IN2 for at least 25 ms, triggers taring.

The time to wait until the tare command is executed depends on the selected sampling rate and filter (also see the **TAR**, **ICR**, **ASF** and **FMD** command descriptions). The tare command via input IN2 has the same effect as the **TAR** command.

Digital outputs OUT1/2 can be general control outputs or limit value outputs (**LIV**, **POR**).

Command IMD affects the content of the measurement status (see **MSV**?)

3.6.2 Limit Value Function - Limit Values (LIV)

LIV

Limit Values

Property	Content	Comment
Command string	**LIV**	
No. of parameters	1	
Parameter range	P1 = 0/1, P2 = P3 = 0,1,2,	
	P4 = P5 = 0...±1599999	
Factory setting (**TDD**0)	1, 0, 0, 0, 0 for limit value 1	deactivated
	2, 0, 0, 0, 0 for limit value 2	
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	**LIV**(P1),<P2>,<P3>,<P4>,<P5>;	
AED response	0 crlf	On input OK
Master **query**	**LIV**?(P1);	
AED response	P1,P2,P3,P4,P5 crlf	P1,2,3 = 1 character each
		P4,5 = 8 characters each
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The AED contains 2 limit value switches with selectable hysteresis. These can monitor gross or net measured values. The monitoring speed depends on the filter setting (**FMD**, **ASF**) and the set output rate (**ICR**). Monitoring is always implemented, even when there is no communication via the serial interface.

Parameter description:

Input: LIV(P1),<P2, P3, P4, P5>;

P1: number of the limit value switch (1 or 2)

P2: limit value monitoring on/off

0 = OFF

1 = ON: limit value bit only in measurement status; not at OUT1 or OUT2

2 = ON: Limit value bit in measurement status; LV1 at OUT1, LV2 at OUT2

P3: number of the limit value switch (0,1 or 2)

0 = net measured value

1 = gross measured value

2 = trigger output value (**MAV**?)

P4: Activation level: The deactivation level limit value bit is set to 1 in the measurement status and output OUT1 or OUT2 goes to the state High = 5 V = GW off
(if function activated (P2))

P4 = 0...**NOV** Activation level when **NOV** > 0

P4 = 0...±1599999: Activation level when **NOV** = 0

P5: The deactivation level limit value bit is set to 0 in the measurement status and output OUT1 or OUT2 goes to the state Low =0 V = LV off (if function activated (P2))

P5 = 0...**NOV:** action level when **NOV** > 0

P5 = 0...±1599999: action level when **NOV** = 0

The measurement status can be part of the measured value (see **COF** command).

The limit value 1 output OUT1 is at connector 1/ Pin4 and the limit value 2 output OUT2 is at connector 1/Pin5. (see Measuring Amplifier AD101B Operating Manual; Part 2, or AED9101B, Part 1)

Example:

LIV(1),1,0,900000,100000;

The command in the example sets limit value 1 (P1 = 1).

The switching state of limit value 1 is only shown in the measurement status (P2 = 1).

Limit value 1 switches to the gross measured value (P3 = 0).

Limit value 1 activates at a gross measured value > 900000 (P4 = 900000) and deactivates at a gross measured value < 100000 (P5 = 100000).

3.6.3 Control Input / Control Output Functions - Port Set and Read (POR)

POR

Port Set and Read
(Set and Read of digital in- and outputs)

Property	Content	Comment
Command string	**POR**	
No. of parameters	2 on input	For outputs
	4 on output	+ status inputs
Parameter range	P1,2,3,4 = 0/1,	
Factory setting (**TDD**0)	0, 0	OUT1 = OUT2 = Low
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	POR<P1>,<P2>;	
AED response	0 crlf	On input OK
Master **query**	POR?;	
AED response	P1,P2,P3,P4 crlf	P1,2,3,4 = 1 characters each
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect	

Function:

The AED has two digital inputs and outputs, that can be set and read using the **POR** command.

Outputs OUT1 (connector 1, PIN4) and OUT2 (connector 1, PIN5) can only be changed when the limit value function is deactivated (**LIV**).

Parameter description:

Input: POR<P1>,<P2>;

Parameters P1 and P2 can be 0 or 1; where 0 = Low = 0 V and 1 = High = +5 V.

Using this command, outputs OUT1 and OUT2 at connector 1 can be set to the required level. If the outputs are being used by the limit value function (**LIV**), the AED responds with "?".

Query: POR?;

Outputs the switching states of two outputs and the signal levels at two inputs.

The outputs are OUT1 and OUT2 at connector 1, PIN4 and PIN5.

The inputs are IN1 and IN2 at connector 1, PIN16 and PIN17. The response contains four parameters.

If limit values are activated (**LIV**), the limit value states are output.

Examples:

Response to POR?; is 0, 1, 1, 0

OUT1(LV1)	OUT2(LV2)	IN1	IN2
Low	High	High	Low

Both limit values (LV) are deactivated:

POR0,0; OUT1 and OUT2 are set to Low

POR,1; OUT2 is set to High, OUT1 remains unchanged

POR1; OUT1 is set to High, OUT2 remains unchanged

LV1 activated, LV2 deactivated:

POR0,0; not allowed, response will be "?"

POR,1; OUT2 is set to High, OUT1 is LV1

LV2 activated, LV1 deactivated:

POR0,0; not allowed, response will be "?"

POR,1; OUT2 is set to High, OUT2 is GW2

Once the limit value function is deactivated, a port command should be sent to bring the port to the required state.

3.6.4 Trigger Function

The AED has a trigger function, that is implemented chiefly for the dynamic weighing of piece goods (checkweigher).

The general function is described in the AD101B Operating Manual; Part 1, Measuring amplifier.

The command (**TRC**) is used to set the trigger function. The result can be read out using the **MAV**? command.

The monitoring speed depends on the filter setting (**FMD**, **ASF**) and the set output rate (**ICR**).

The advantage of this function is that it reduces the data. The Master no longer has to use the **MSV**? command to read out every measured value.

More detailed descriptions can be found in the application documents

- APPN001 (Checkweigher),
- APPN002 (Trigger function),
- APPN011 (Reading out trigger results).

When using the trigger function , **IMD**1 must be set.

3.6.4.1 Trigger Function - Trigger Result (MAV)

MAV

Measured Alternative Data
(Measured value Trigger function)

Property	Content	Comment
Command string	**MAV**?	
No. of parameters	-	
Parameter range	-	
Factory setting (**TDD**0)	-	
Response time	<2 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	No data to protect	
Master **input**	**MAV**?;	
AED response	See description	
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the query is incorrect.	

Function:

The command is used to read out the trigger result. If a new trigger measured value is calculated, the result is read out once. If no new measured value has yet been calculated, the output value corresponds to the overflow value (binary = 800000_{Hex} or ASCII = -1638400). This value is also output after the measured value is read out and the query is repeated.

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

The monitoring speed depends on the filter setting (**FMD**, **ASF**) and the set output rate (**ICR**).

3.6.4.2 Trigger Function - Trigger Command (TRC)

TRC

Trigger Command
(trigger setting)

Property	Content	Comment
Command string	**TRC**	
No. of parameters	1	
Parameter range	P1 = P2 = 0/1, P3 = 0...±1599999 P4 = P5 = 0...99	
Factory setting (**TDD**0)	0, 0, 0, 0, 0	deactivated
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	With command **TDD**1	
Master **input**	**TRC**<P1>,<P2>,<P3>,<P4>,<P5>;	
AED response	0 crlf	On input OK
Master **query**	**TRC**?(P1);	
AED response	P1,P2,P3,P4,P5 crlf	P1,2,3 = 1 character each P4,5 = 8 characters each
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

The command is used to set the trigger function. The general function is described in the AD101B Operating Manual; Part 1, Measuring amplifier.

Parameter description:

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

P1: Trigger function ON/OFF

0 = OFF

1 = ON

P2: Trigger method

0 = level triggering

1 = external trigger input (IN1, condition: **IMD**1)

P3: Trigger level

0…NOV = trigger level (for P2 = 0 and **NOV** > 0)

0...1599999 = trigger level (for P2 = 0 and **NOV** = 0)

P4: Delay time

0...99: Delay time. 1.66 ms ∗ 2. **ICR** (for **FMD** = 0)
Delay time = P4 ∗ 1.66 ms ∗ 2 ∗ **ICR** ∗ **ASF**
(for **FMD** = 1 and **ASF** > 0)

P5: Measurement time

0...99: Delay time = P5 ∗ 1.66 ms ∗ 2 ∗ **ICR** (for **FMD** = 0)
Measurement time = P5 ∗ 1.66 ms ∗ 2 ∗ **ICR** ∗ **ASF**
(for **FMD** = 1 and **ASF** > 0)

The position of the trigger level depends on the output scaling (**NOV**). When **NOV** = 0 (scaling off), the trigger level is on the characteristic curve 0...1000000 and when **NOV** > 0, the trigger level is in the range 0...**NOV**.

The external trigger is only enabled again when the output value has been calculated (no re-trigger function).

The trigger status (ext. or level trigger) is output for **IMD**1; in the measurement status of **MSV**? or **MAV**? in bit 6. The bit becomes active when triggering occurs; it becomes inactive when a new trigger value (**MAV**) has been calculated. This allows the trigger function to be monitored over time.

If the **COF** command (128…140) has been used to select automatic output and the trigger function is activated, the AED outputs the trigger result once only, after triggering and subsequent measurement. This means that it is not necessary to use the **MAV**? command to query the measured value. The connected computer only has to receive this trigger result.

COF128 to **COF**140 continuous output after *"power-up"* (not for bus mode).

Example:

External triggering with automatic output:

1. Set the AED parameters (ASF, ICR, etc.)
2. Use the command TRC1,1,0,20,5; to activate the external trigger.
3. Use the command COF 128+i; to define the output format for the measured values. i is dependent on binary/ASCII output (see COF command)
   (no parameter setting possible, the result is automatically output after each trigger event (without the MAV?; command)
4. Use the STP; command to stop automatic data output.
5. Use the TDD1; command to store the output in the EEPROM where it is safe from power failure.
6. Use the RES; command to restart automatic data output. The result is automatically output after each trigger event (without the MAV?; command).
7. Use the STP; command to stop automatic data output.
   Parameter settings are possible again.
8. Use the COF 3; command to deactivate automatic data output.
9. If you wish, you can use the TDD1; command to store the change safe from power failure.
10. If you wish, you can use the command MSV?; or MAV?; (single data output or single trigger query) to query the measured values.

3.7 Special Functions

- Password commands **DPW**, **SPW**
- Measuring amplifier reset **RES**
- Measuring amplifier identification **IDN**
- Save / restore application settings **TDD**1, **TDD**2
- Restore factory settings **TDD**0

The AED has password protection for adjustment functions and output scaling.

If the password is not activated by **SPW**, although the parameter of a protected function can be read out, it cannot be modified (acknowledged with ? crlf). Use the **DPW** command to enter a new password.

3.7.1 Special Function - Define Password (DPW)

DPW

Define Password
(Define password)

Property	Content	Comment
Command string	**DPW**	
No. of parameters	1	
Parameter range	P1 = string with max. 7 ASCII characters (letters or numbers)	
Factory setting (**TDD**0)	„AED"	
Response time	<70 ms	
Password protection	No	
Relevant to verification	Yes	
Parameter protection	For input	
Master **input**	**DPW**("Password");	
AED response	0 crlf	On input OK
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input is incorrect.	

Function:

The command stores the new password. A query is not possible. The new password must be activated after it has been entered with the **SPW** command.

The password function is case-sensitive.

3.7.2 Special Function - Set Password (SPW)

SPW

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

Property	Content	Comment
Command string	**SPW**	
No. of parameters	1	
Parameter range	P1 = string with max. 7 ASCII characters	
Factory setting (**TDD**0)	„AED"	
Response time	<70 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	For input	
Master **input**	**SPW**("Password");	
AED response	0 crlf	On input OK
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input is incorrect.	

Function:

The command **SPW** with the correctly entered password (by the **DPW** command) authorizes data input with all commands. The command **SPW** with an incorrect password inhibits data input for protected commands. A password is not necessary for output. Password input is case sensitive.

The use of protected commands is also inhibited after **RES** or *"power-up"*.

The following commands are protected by a password:

CWT, **LDW**, **LWT**, **LIC**, **NOV**, **SFA**, **SZA**, **TDD**0

3.7.3 Special Function - Restart (RES)

RES

Restart
(Reset)

Property	Content	Comment
Command string	**RES**	
No. of parameters	-	
Parameter range	-	
Factory setting (**TDD**0)	-	
Response time	<3 s	
Password protection	No	
Relevant to verification	No	
Parameter protection	-	
Master **input**	**RES**;	
AED response	No response	

Function:

The **RES** command restarts the device (warm restart).

This command does not generate a response. All parameter settings are as saved by the last **TDD** command, that is to say, the EEPROM values are transferred to the RAM.

3.7.4 Special Function - Identification (IDN)

IDN

Identification
(Transducer type and serial number identification)

Property	Content	Comment
Command string	**IDN**	
No. of parameters	2	
Parameter range	P1 = 15 ASCII characters, P2 = 7 ASCII characters	
Factory setting (**TDD**0)	HBM,"AD101B „,"xxxxx ",P1x crlf	Response to?;
Response time	<15 ms for output <180 ms for input	
Password protection	No	
Relevant to verification	Yes	
Parameter protection	For input	
Master **input**	**IDN**<"P1">,<"P2">;	
AED response	0 crlf	On input OK
Master **query**	IDN?;	
AED response	HBM,"P1","P2",P1x crlf P1x is the program version number	P1 = 15 characters P2 = 7 characters P1x = 3 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

Input: IDN<"AED type">,<"serial number">;

Entering transducer type and serial number.

The transducer type and the serial number are stored in the EEPROM of the transducer electronics. The type name must have no more than 15 characters and must be entered as a string in quotes. If only the serial number is to be changed, enter a comma for the transducer type parameter (e.g. **IDN**,"4711";).

The serial number is entered at the factory and is no more than seven characters long; it is entered in the same way as the type name. The serial number must not be modified. If less than the permitted maximum number of characters is entered for the type name or the serial number , the input is automatically padded out with blanks up to the permitted maximum. The manufacturer and the software version cannot be entered.

Query: IDN?;

An identification string is output (33 characters).

Sequence: Manufacturer, transducer type, serial number, software version (P1x, with x = 0…9)

Example:

HBM,"AED101B ","1234 ",P14 crlf.

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

3.7.5 Special Function - Transmit Device Data (TDD)

TDD

Transmit Device Data
(Back up device parameters)

Property	Content	Comment
Command string	**TDD**	
No. of parameters	1	
Parameter range	P1 = 0, 1, 2 0 = establish factory settings 1 = saving current parameters to the EEPROM 2 = activating saved parameters from the EEPROM	
Factory setting (**TDD**0)	-	
Response time	**TDD0**; < 2,2 s **TDD1**; < 0,1 s **TDD2**; < 1,3 s	
Password protection	**TDD0**; Yes **TDD1**; No **TDD2**; No	
Relevant to verification	**TDD0**; Yes **TDD1**; No **TDD2**; No	
Parameter protection	No data to protect	
Master **input**	**TDD**(P1);	
AED response	0 crlf	On input OK
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input is incorrect.	

Function:

These commands are used to store and activate parameters. The AED has two EEPROMs. The customized parameters are stored safe from power failure in the first EEPROM. The second EEPROM contains the factory settings. These factory settings are write-protected.

The commands **MSV**, **MAV**, **STP**, **S**.., and **RES** cannot be stored. A **TDD**? query is not allowed.

TDD0; restoring the factory settings

→ After adjustments have been made, the settings are stored in a second, write-protected EEPROM. The **TDD**0 command copies the actual factory settings to the working EEPROM:

Write-protected EEPROM → working EEPROM → RAM

The settings for communication, such as address (**ADR**) and baud rate (**BDR**), as well as the legal-for-trade-counter (**TCR**) are not reset. The mV/V characteristic curve set at the factory is retained.

TDD0-settings:

Command	Factory setting	Comment
ACL	1	Autocalibration ON
ASF	5	Filter 1Hz
ASS	2	Amplifier input signal = measurement signal
COF	9	Data output decimal format, address, error status
CRC[2)]	0	External checksum
CSM	0	Checksum in measurement status OFF
DPW[2)]	"AED"	Password
ENU[2)]	XXXX	Unit of measurement
FMD	0	Filter mode: Standard filter
ICR	2	Sampling rate: 150 measurements/s
IDN[2)]	HBM, .., ..,...[1)]	Device type: 15 characters; production no.: 7 characters; program version
IMD	0	IN1 and IN2 are inputs only
LDW[2)]	0	User characteristic curve zero point
LWT[2)]	100000	User characteristic curve full scale
LFT[2)]	0	Obligation of verification deactivated
LIC[2)]	0,1000000,0,0	Linearization deactivated
LIV	0,0,0,0	Limit value 1 and limit value 2 deactivated
MTD	0	Standstill monitoring off
NOV	0	User scaling off
POR	0,0	Outputs = 0 (Low)
SFA[2)]	XXX[1)]	Full scale (for 2mV/V curve)
SZA[2)]	XXX[1)]	Full scale (for 2mV/V curve)
STR	0	Termination resistors deactivated
TAS	1	Gross measured value

TAV	0	Tare memory cleared
TCR	XXX[1)]	Legal-for-trade-counter(starts at >0)
TEX	172	Separators, output in columns with crlf
TRC	0,0,0,0,0	Trigger function off, all parameters = 0
ZSE	0	Setting initial zero setting deactivated
ZTR	0	Zero tracking deactivated

1) any value, factory setting
2) These parameters are stored immediately on input (EEPROM). For these parameters, **TDD**1; or **TDD**2; do not apply.

TDD1; Saving current parameters to the EEPROM

With the following parameters, changed settings are only saved in the RAM initially, so they are not safe from power failure. The command **TDD**1 stores the settings you have changed in the RAM in the EEPROM where they are safe from power failure.

ACL	Autocalibration
ADR	Address
ASF	Filter setting
ASS	Amplifier input signal
BDR	Baud rate
COF	Data output configuration
CSM	Checksum in measurement status
FMD	Filter mode
ICR	Sampling rate
IMD	Function of inputs IN1 and IN2
LIV	Settings for limit value 1 and limit value 2
MTD	Standstill monitoring
NOV	User scaling
POR	Setting digital outputs OUT1 and OUT2
STR	Bus termination resistors on/off
TAS	Switch setting “*Gross/net*”
TAV	The content of the tare memory
TEX	Output separator
TRC	Trigger function
ZSE	Initial zero setting
ZTR	Automatic zero tracking

The other commands that are not listed here store the parameters as they are input.**TDD**2;
Loading parameters from EEPROM to RAM

Transferring parameters from EEPROM to RAM.

The parameters listed under **TDD**1 are copied from the EEPROM to the RAM. This happens automatically after *“Reset”* and *“power-up”*.

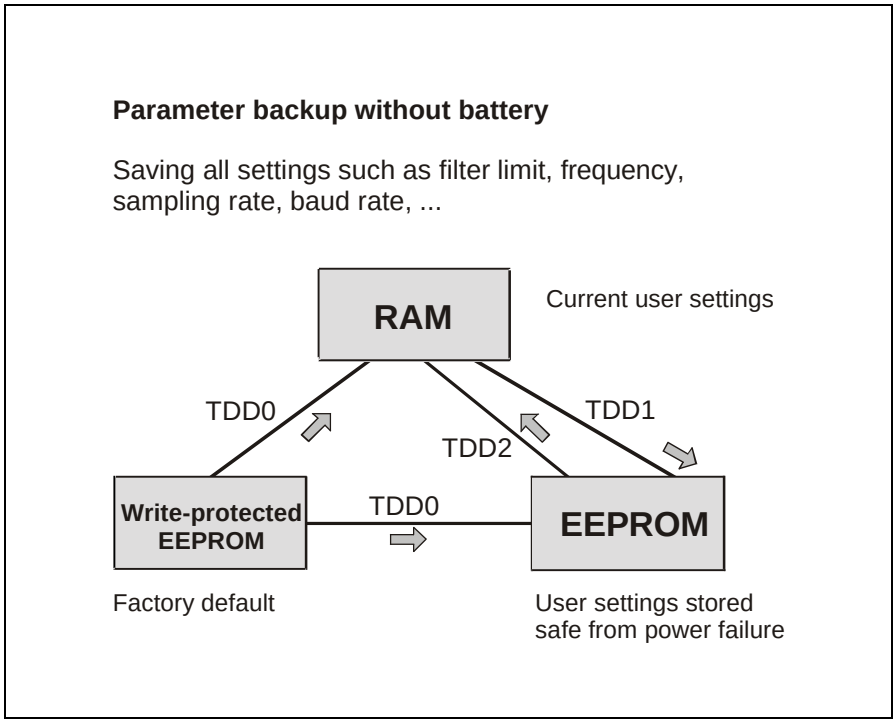


Fig. 3.7-1: Saving the setup parameters

3.8 Error Messages

The AED produces error messages for the following possibilities:

- AED responds with ? crlf, if the input or the query is incorrect.
  This response is given, if the command string has been received with errors, or if input is inhibited (password protection)
- AED conveys measurement errors in the measurement status (**MSV**?)
- Output of error messages via the **ESR** command

3.8.1 Error Message Output - Event Status Register (ESR)

ESR

Event Status Register
(Output error messages)

Property	Content	Comment
Command string	**ESR**?	
No. of parameters	-	
Parameter range	-	
Factory setting (**TDD**0)	-	
Response time	<10 ms	
Password protection	No	
Relevant to verification	No	
Parameter protection	No data to protect	
Master **input**	**ESR**?;	
AED response	See description	
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the query is incorrect.	

Function:

This function outputs error messages defined in accordance with the IEC Standard as a 3-digit decimal number. The errors are linked by “or“.

Fehlermeldung	Error
000	No error
004	Not in use
008	Device Dependent Error (hardware error, e.g. EEPROM error)
016	Execution Error (error on parameter input)
032	Command Error (command error, command not available)

Example:

024 → Hardware and parameter errors
After RES, power-up or error status readout, the contents of the register are cleared.

3.9 Commands for Legal for Trade Applications

The commands are used to monitor changes to parameters that are relevant to verification via the legal-for-trade-counter:

- Verification switch **LFT**
- Legal-for-trade-counter **TCR**
- Checksum **CRC**

The parameters relevant to verification are:

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

A customized checksum (**CRC**) can also be calculated to monitor the parameters and this can be stored in the AED.

More detailed descriptions can be found in the application document

- APPN010 (Legal for trade applications)

3.9.1 Command for Legal for Trade Application - Legal for Trade (LFT)

LFT

Legal for Trade
(Legal for trade application)

Property	Content	Comment
Command string	**LFT**	
No. of parameters	1	
Parameter range	P1 = 0/1 0 = legal for trade application calibration deactivated, 1 = legal for trade application calibration activated	
Factory setting (**TDD**0)	0	deactivated
Response time	<50 ms	
Password protection	Yes	
Relevant to verification	Yes	
Parameter protection	For input	
Master **input**	**LFT**(P1);	
AED response	0 crlf	On input OK
Master **query**	**LFT?**;	
AED response	P1 crlf	P1 = 1 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

Each time the **LFT** command is changed, the legal-for-trade-counter (**TCR**) is increased by 1. With **LFT**1 (legal for trade application calibration), the legal-for-trade-counter is increased by one for each parameter input of the following commands:

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

This means that every change to these calibration-relevant parameters can be detected by the legal-for-trade-counter **TCR**, which cannot be reset.

3.9.2 Command for Legal for Trade Application calibration - Trade Counter (TCR)

TCR

Trade Counter
(Legal-for-trade-counter)

Property	Content	Comment
Command string	**TCR**	
No. of parameters	-	
Parameter range	-	
Factory setting (**TDD**0)	unchanged	
Response time	<10 ms	
Password protection	No	
Relevant to verification	Yes	
Parameter protection	-	
Master **query**	**TCR**?;	
AED response	xxxxxxxx crlf	8 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the query is incorrect.	

Function:

This counter cannot be reset and it marks the parameter changes of the commands relevant to verification (see **LFT** command). The maximum count is 8388607 ($7FFFFF_{Hex}$). If this count is reached, the counter stops; then, at the next **MSV**?; data output, only overflow values are output. This situation can only be remedied at the factory.

3.9.3 Command for Legal for Trade Application calibration - Cyclic Redundancy Check (CRC)

CRC

Cyclic Redundancy Check
(checksum)

Property	Content	Comment
Command string	**CRC**	
No. of parameters	1	
Parameter range	P1 = ±8388607	
Factory setting (**TDD**0)	0	
Response time	<50 ms	
Password protection	No	
Relevant to verification	Yes	
Parameter protection	For input	
Master **input**	**CRC**(P1);	
AED response	0 crlf	On input OK
Master **query**	**CRC**?;	
AED response	P1 crlf	P1 = 8 characters
Explanation:	( ) required parameters, < > optional parameters on parameter input, AED responds with ? crlf, if the input or the query is incorrect.	

Function:

This command gives you the opportunity to externally calculate a checksum over all the AED parameters and store it in the AED. It is down to you how this checksum is calculated.

If the command **LFT**1 has activated the legal for trade application the change to the **CRC** also increases the legal-for-trade-counter (**TCR**).

This allows every attempted manipulation of the AED parameters to be detected.

3.10 Other Commands

The commands listed here are only included in the AD101B for reasons of compatibility. **They have no function in the AD101B**.

Query: **COR**?;

Response: 0/1 crlf
The response outputs are fixed, whatever the possible input.

4 Communication Examples

4.1 Making Settings for Bus Mode

The AED is able to work with up to 32 modules in one bus. This is on condition that each AED is connected to the bus via an RS485 interface driver. Each AED operates as a Slave, that is to say, unless prompted by the bus master (e.g. the PC or the PLC), the AED transmission line remains inactive. The Master selects an AED by using the Select command **S**.. (**S**00...31;). This is why it is essential to enter a communication address for each AED before connecting to the bus. Of course, each address on the bus can only be assigned once.

4.2 Connecting the AED to the Bus

There are two possible ways to connect the AEDs to the bus :

1. **Connect the AEDs to the bus one after the other**

   - Connect the first AED to the bus line (Factory setting: **ADR**31, baud rate = 9600 Bd, even)
   - Initialize the Master interface at 9600 Bd, 8, e, 1.
   - Use the command ;**S**31; to select the AED.
   - Use the **ADR** command to set the desired address (e.g. **ADR**01;)
   - Use ;**S**01; to select the AED with the new address.
   - Use the **TDD**1; command to store the address in the EEPROM where it is safe from power failure.
   - Connect the next AED to the bus , use ;**S**31; to call it, set **ADR**02;,
   - etc.

2. All AEDs are interfaced at the bus

- Read off the production numbers of the AEDs (7 digits)
  (1st AED: xxxxx, 2nd AED: yyyyy, etc.).
- Initialize the Master interface at 9600 Bd, 8, e, 1.
- Use the broadcast command ;**S**98; to select all the AEDs.
- Use the ADR command to set the desired addresses, one after the other (e.g. **ADR**01,"xxxxx"; **ADR**02,"yyyyy"; etc.).
- Use the **TDD**1; command to store the addresses in the EEPROM where they are safe from power failure.

With **S**98; none of the AEDs respond; but all the AEDs execute the command. If there is no communication, the address or the baud rate must be wrong.

Once all the addresses have been set correctly and there is a uniform baud rate, the bus is ready for action. You must now define how the measured values are to be read out.

4.3 Set Data Output

The output format must be set in all the modules before the **MSV**?; command can be used for data output. Please proceed as follows:

1. Enter the broadcast command ;**S**98;.
   All AEDs execute the command, but do not send a response.
2. Use the **COF** command to specify the output format
   (e.g. COF3; for ASCII output).
3. Use the **TDD**1; command to store the setting in the EEPROM where it is safe from power failure.

4.4 Set Baud Rate

The AED can work at different baud rates. The setting can only be modified via the serial interface, using the **BDR** command.

In bus mode of course, the baud rate of all the connected nodes must be the same. To make sure that the AEDs in a bus are set to the desired baud rate during initialization (activation) of the system (in this example 9600), please proceed as follows:

Example:

1. Set the baud rate of the Master interface to 1200Bd, 8 data bits, 1 parity bit (even) and 1 stop bit.
2. Output the following commands in the order given below:

   ; Clear the AED input buffer

   S98; Select all the AEDs on the bus

   BDR9600; Set the desired baud rate

   Then wait about 150ms.
3. Set the baud rate of the Master interface to 2400Bd, 8 data bits, 1 parity bit (even) and 1 stop bit.
4. Output the following commands in the order given below:

   ; Clear the AED input buffer

   S98; Select all the AEDs on the bus

   BDR9600; Set the desired baud rate

   Then wait about 150ms.
5. Set the baud rate of the Master interface to 4800Bd, 8 data bits, 1 parity bit (even) and 1 stop bit.
6. Output the following commands in the order given below:

   ; Clear the AED input buffer

   S98; Select all the AEDs on the bus

   BDR9600; Set the desired baud rate

   Then wait about 150ms.
7. Set the baud rate of the Master interface to 19200Bd, 8 data bits, 1 parity bit (even) and 1 stop bit.

8. Output the following commands in the order given below:

   ; Clear the AED input buffer

   S98; Select all the AEDs on the bus

   BDR9600; Set the desired baud rate

   Then wait about 150ms.

9. Set the baud rate of the Master interface to 38400Bd, 8 data bits, 1 parity bit (even) and 1 stop bit.
10. Output the following commands in the order given below:

    ; Clear the AED input buffer

    S98; Select all the AEDs on the bus

    BDR9600; Set the desired baud rate

    Then wait about 150ms.

11. Set the baud rate of the Master interface to 57600Bd, 8 data bits, 1 parity bit (even) and 1 stop bit.
12. Output the following commands in the order given below:

    ; Clear the AED input buffer

    S98; Select all AEDs at the bus

    BDR9600; Set the desired baud rate

    Then wait about 150ms.

13. Set the baud rate of the Master interface to 115200Bd, 8 data bits, 1 parity bit (even) and 1 stop bit.
14. Output the following commands in the order given below:

    ; Clear the AED input buffer

    S98; Select all the AEDs on the bus

    BDR9600; Set the desired baud rate

    Then wait about 150ms.

15. Set the baud rate of the Master interface to 9600Bd, 8 data bits, 1 parity bit (even) and 1 stop bit.
16. Enter the blank command to clear the input buffer:

    ; Clear the AED input buffer

17. Use the TDD1; command to store the settings in the EEPROM where they are safe from power failure.

It is absolutely essential to output the semicolon before command **S**98;, as because the AEDs have been triggered at different baud rates, there may be undefined characters in the AED input buffer. These characters are rejected when the semicolon is received.

With **S**98; none of the AEDs respond; but all the AEDs execute the command.

In the example given above, all the AEDs on this bus are set to the baud rate 9600 Bd, whatever their previous settings.

Of course, other baud rates can also be set. To do this, provide the required baud rate in the **BDR** command and modify the initialization of the Master interface accordingly.

Interface transmission time

The baud rate is the transmission speed of the interface. This does not alter the number of measured values that the AED determines every second.

A fast baud rate merely makes it possible for the AED to query a greater number per time unit in bus mode.

Baud rate	Transmission time for one ASCII character
2400	4.40 ms
4800	2.20 ms
9600	1.10 ms
19200	0.57 ms
38400	0.29 ms

With this information, it is possible to estimate the transmission time for a command sequence. To do this, determine the number of characters in the command and multiply by the transmission time. In addition to this, the AED has a processing time (response time) for each command. These times can be found in the individual command descriptions (total time = transmission time + processing time).

4.5 Determining Bus Occupancy (Bus Scan)

It is often useful, each time the bus is activated or when the AED fails to respond, to determine the bus configuration. The address occupancy of the bus can be determined with the aid of Bus Scan. This is on condition that all the modules are set to the same baud rate. Carry out the Bus Scan as follows:

1. Initialize the Master interface at the set AED baud rate
2. Scan an address with the following command sequence:

   ;**S**00; select address

   ADR?; Query address

   The AED sensed at the address responds with 00 crlf. If no response is received after about 100 ms, there is no AED at this address. If the Master receives undefined characters or no ? character, there may be a bus malfunction or multiple occupancy of the address. The bus master must react accordingly.
3. Repeat point 2 with subsequent addresses 01...31.

If there are only a few AEDs connected and their addresses are known, the bus scan can, of course, be related to just these addresses. Once all the AEDs are successfully established as bus nodes, the AED identification string can be read in (identification = measuring point identification and production number).

The time-out setting for the Master interface driver is crucial for the speed of the bus scan. The Select command needs max. 20...30 ms for output at 2400 Bd. The AED does not respond to this Select command.

4.6 Measurement Query in Bus Mode

In the previous sections of this example, all the AEDs have been prepared for bus mode and the Bus Scan has found all the connected AEDs. The output format for a simple measurement query with the command **MSV**?; has been set with the **COF** command. Now start the measurement query with the following command sequence:

S00; **MSV**?; the AED at address 00 responds with the measured value

S01; **MSV**?; the AED at address 01 responds with the measured value

Master command	Measurement time	AED response	Comment
S00; **MSV**?;			9 characters + 1 character pause
	approx. 6.7 ms		for **ICR**2, **FMD**0
		xx crlf	4 characters for **COF**2, or
		xxxx crlf	6 characters for **COF**8, or
		xxxxxxxxxx crlf	10 characters for **COF**3

Which gives the following approximate query times:

Baud rate	Output format	Measured value query time for an AED with ICR2, FMD0
9600	**COF**2	23 ms
19200	**COF**2	15 ms
9600	**COF**3	30 ms
19200	**COF**3	18 ms

These times should only be used as a guide.

More detailed descriptions can be found in the application document

- APPN005 (Measurement query with MSV?),

For faster measurement query with the **MSV**? command, use the command sequence:

S98; **MSV**?; All the AEDs calculate a measured value, but do not respond

S01; The AED at address 01 responds with the measured value

S02; The AED at address 02 responds with the measured value

S03; The AED at address 03 responds with the measured value, etc.

Which gives the approximate query times (**ICR**0, **FMD**0) for 9600 Bd:

Master transmission	AED measurement time (ICR0)	AED transmissions
S98; **MSV**?;		
	approx. 1.67 ms	
S01;		
		xx crlf
S02;		
		yy crlf
S03;		
		zz crlf

The Master can only send a new Select command once the measured value has been received.

Query time = total character count · time for one character + AED response time

Baud rate	Output format	Measured value query time for an AED with ICR2, FMD0
9600	**COF**2	42 ms
19200	**COF**2	22 ms
38400	**COF**2	12 ms
9600	**COF**4	49 ms
19200	**COF**4	25 ms
38400	**COF**4	13 ms

These times should only be used as a guide.

4.7 Setting a Parameter in all the connected AED

If measurement query is executed correctly, the parameters can be set in all the AEDs connected on the bus. Proceed as follows:

1. Use the broadcast command ;**S**98; to select all the AEDs
   All the AEDs execute the command but do not send a response.
2. Enter the required parameter (e.g. **ICR**3;).
3. Use the **TDD**1; command to store the parameter in the EEPROM where it is safe from power failure.
4. Use **S**ii; to select the next AED to read parameters for checking, for example.

This sequence can, for example, also be used when taring with the aid of the **TAR**; command, or when switching between gross and net output.

Index

2

A

B

C

D

E

F

G

I

L

M

N

O

P

R

S

T

U

W

Z

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