Operating Manual

AD103C

Digital Transducer Electronics

Amplifiers
Hardware and Functions

I1691-2.0 en

HBM

Content

Typographical conventions

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

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

CE Designation

Statutory marking requirements for waste disposal

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

Important information

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

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

All the factory defaults are stored at the factory where they are safe from power failure and cannot be deleted or overwritten. They can be reset at any time by using the command **TDD0**. Further information can be found in the aed_help_e, AD103C; “Description of the basic commands”.

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

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

The AD103C is designed for an operating voltage = bridge excitation voltage of **5 V_{DC}**.

The amplifier AD103C requires a warm up time of 15 min. after power on.

Safety instructions

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

1 Introduction and appropriate use

AD103C digital transducer electronics are part of the AED component family that digitally conditions signals from mechanical measurement sensors and networks them with bus capability.

These include digital amplifier motherboards, basic devices 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 AD103C amplifier motherboard can be operated independently of the AED basic devices. The basic devices provide mechanical protection, shield the amplifier boards (EMC protection) and also give you the opportunity to select the serial interfaces (RS232, RS485, Profibus, CAN bus, DeviceNet).

The AD103C amplifier is the successor of the AD103B amplifier. The default settings of both amplifiers are fully compatible.

The AED command set is described in the help file aed_help_e.chm (Document CD-ROM).

The signal processing functions of limit value monitoring, minima/maxima memory and the fast-settling digital filter open up additional areas of application. In addition to this, the AD103C gives you the opportunity to control the filling and dosing processes. The additional implemented diagnostic function enables the analysis of dynamic processes.

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

The abbreviation **AED** is also used for AD103C transducer electronics in the following text.

The calibration function (commands **CAL**, **ACL**) to ensure the accuracy of the AD103C is no longer needed. However, these commands are still implemented to ensure software-compatibility. The AD103C no longer needs measurement interruption to ensure measurement accuracy.

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

2 Special features

- Operating voltage 5 V_{DC} ±5 %
- Transducer excitation via external power supply.
- Measurement input ohmic full bridges
- Nominal sensitivity ±2 mV/V
- RS232 serial interfaces
- Digital filtering and scaling of the measurement signal
- Linearity error correction
- Power fail safe parameter storage, Hardware switch to protect parameters in legal for trade applications
- Indestructible storage of factory defaults
- Choice of output speed for the measured values (≤1200 val./s)
- All settings made via the serial interface
- Zero balancing (±2 %)
- Automatic zero tracking (0.5 d/s, ±2 %)
- Automatic initial zero setting (±2 %...±20 %)
- Trigger functions (level pre-/post - triggering, external pre-/post triggering)
- Four limit value switches
- Minima/maxima memory (MIN/MAX)
- Filling and dosing function
- Diagnostic bus

When installing AD amplifier motherboards, try to avoid touching the components. It is essential to take action to prevent electrostatic discharge, as this may damage the electronics.

The operating voltage range of 5 V_{DC} ±5 % must not be exceeded.

The AED's external supply voltage must have low residual ripple (<10 mV), as this operating voltage is used simultaneously as the bridge excitation voltage.

When using the AD103C amplifier motherboard outside the AED basic devices, the primary device must implement EMC shielding.

3 Mechanical construction

AD amplifier motherboards are designed as plug-in boards and plug into the carrier board via a 25-pin sub-D connector.

Using an AED basic device (not supplied with the AD103C) extends functionality by the following properties:

- Mechanical protection (IP65) via the AED basic devices
- Overall bridge resistance 40…4000 Ω via the power supply for the basic devices
- Additional interfaces RS422/RS485, Profibus, CANOpen, DeviceNet, Diagnosis
- Electrical isolation for digital inputs/outputs
- EMC protection (tested)
- Diagnostic bus

The basic device contains terminals for the transducer, power pack and PC connections, switches for interface selection and the voltage stabilizer. The connection cable exits the casing via PG glands (see the respective operating manuals, basic devices).

AED9101C basic device	Interface RS232 / RS485 - 2/4-wire
AED9201B basic device	Interface RS232 / RS485-4-wire
AED9301B basic device	Profibus interface
AED9401A basic device	CANOpen or DeviceNet / Diagnosis bus
AED9501A basic device	CANOpen or DeviceNet

There continues to be a distinction between the AED9201B and AED9301B basic devices in the following functionality

AED9101C basic device	Supports input IN1 (trigger)
AED9201B basic device	Supports inputs IN1, IN2 and OUT1...6
AED9301B basic device	Supports inputs IN1, IN2 and OUT1...4
AED9401A basic device	Supports inputs IN1, IN2 and OUT1...4
AED9501A basic device	Supports input IN1 (trigger)

The basic devices, AED9201B, AED9301B and AED9401A, implement the complete electrical isolation of the amplifier from the power supply, the serial interface and the digital inputs/outputs.

All basic devices support the diagnostic bus.

4 Electrical configuration of the amplifier motherboard

The digital electronics circuit basically comprises the following function groups:

- Amplifier
- Analog/digital converter (A/D)
- Evaluating unit (µP)
- Power fail safe parameter storage (EEPROM)
- RS232 serial interface
- Digital inputs/outputs (HCMOS)
- Power supply
- Hardware switch for write protection for legal for trade parameters
- Interface CAN bus or DeviceNet
- Diagnostic channel

The analog part is supplied with power via the 5 V_{DC} external supply voltage, which is used simultaneously as the bridge excitation voltage.

The operating voltage range of 5 V_{DC} ±5 % must not be exceeded.

The AED's external supply voltage must have low residual ripple (<10 mV), as this operating voltage is used simultaneously as the bridge excitation voltage.

4.1 Function

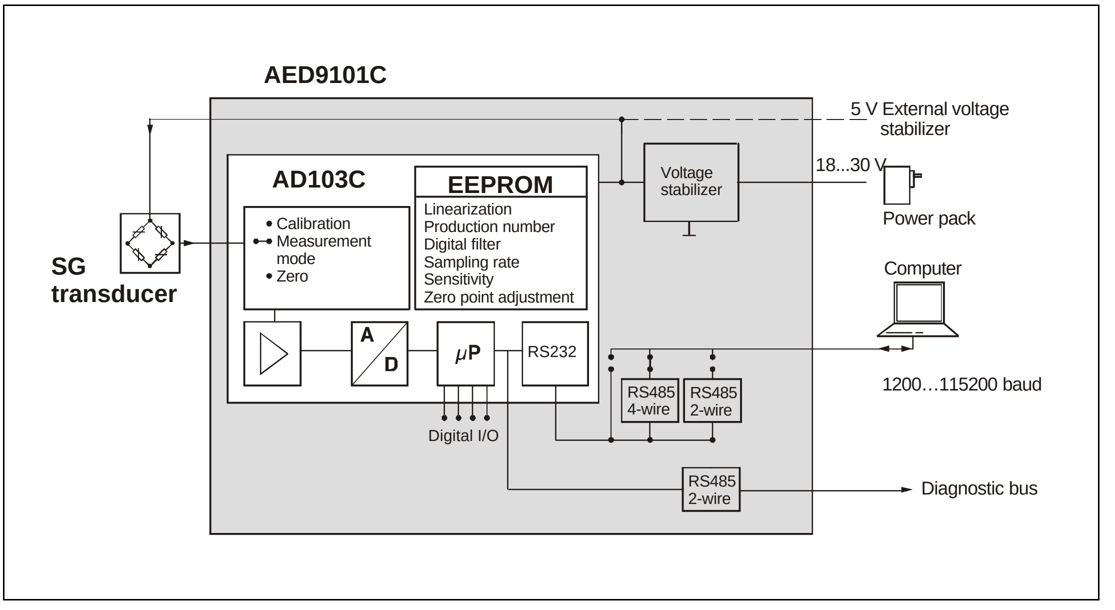


Fig. 4.1-1: Basic device with amplifier board

The analog transducer signal is first amplified, then filtered and converted to a digital value in the analog/digital converter. The digitized measurement signal is processed in the microprocessor. The conditioned signal is forwarded to a computer via the serial interface. All the parameters can be stored power fail safe in the EEPROM.

The transducer electronics are adjusted by a calibration instrument at the factory to the absolute values 0 mV/V and +2 mV/V. From these measured values, the electronics use the commands **SZA** and **SFA** to determine a factory characteristic curve and subsequent measurement data is mapped over this characteristic curve. Depending on the output format (**COF**), the following measured values are returned:

Output format	Input signal	Meas. values for NOV = 0	Meas. values for NOV > 0	Status on delivery NOV = 0
Binary 2 chars. (integer)	0...2 mV/V	0 - 20000 digits	0 - NOV	
Binary 4 chars. (long integer)	0...2 mV/V	0 - 5120000 digits	0 - NOV	
ASCII	0...2 mV/V	0 - 1000000 digits	0 - NOV	X

The unit of measurement mV/V reflects the ratio of the measurement voltage to the excitation voltage at the transducer bridge.

The factory default for the **SZA**/**SFA** characteristic curve should not be changed.

The two parameters **LDW** and **LWT** give you the opportunity to adapt the curve to meet your requirements (weighing machine curve) and you can use the **NOV** command to standardize the measured values to the required scaling value (e.g. 3000 d).

With the AD103C, you also have the opportunity to use the **RSN** command to set different increments (1, 2, 5, 10, 20, 50, 100 d).

4.2 Signal processing

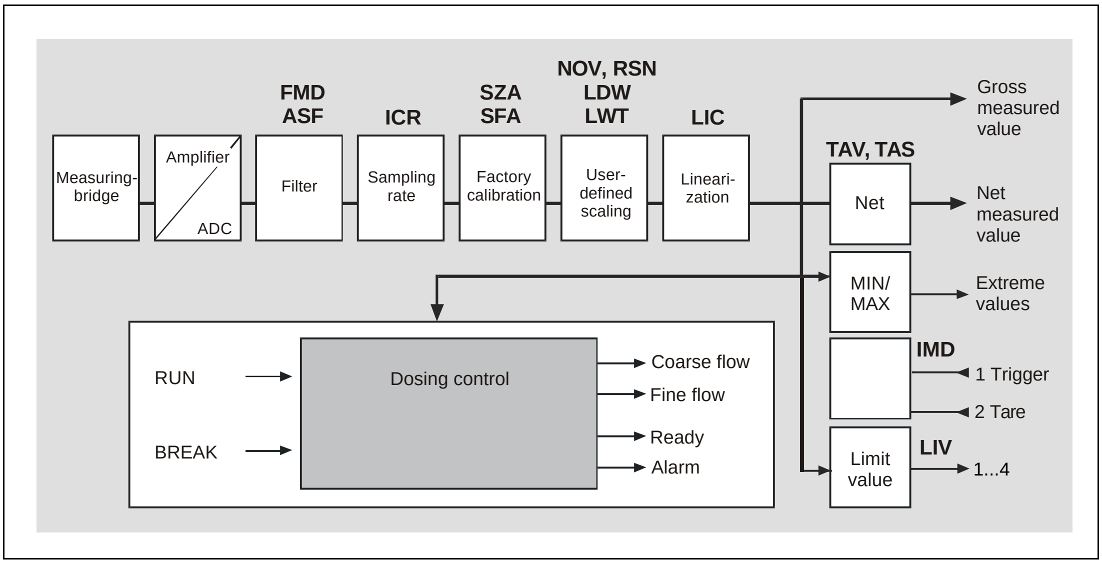


Fig. 4.2-1: Signal flow diagram for the AD103C measuring amplifier

After amplification and A/D conversion, the signal is filtered by adjustable digital filters (commands **FMD**, **ASF**). The commands **ASF** and **FMD** set the bandwidth for the measurement signal (digital filter). The command **ICR** can be used to modify the output rate (measured values per second) independently from the filter bandwidth.

The command **HSM** defines the ADC sample rate (600 or 1200 meas. val./s)

The signal processing functions described below are executed at the set output rate, even if there is no communication via the serial interface.

Commands **SZA** and **SFA** are used to specify the factory characteristic curve.

Command (**LIC**) is available for linearization of the weighing machine curve (with a third order polynomial). Polynomial parameters can be defined using the HBM PC software *AED_Panel32*.

As a user, you can set your own characteristic curve with the commands **LDW**, **LWT** and **NOV**, without modifying the default calibration (**SZA**/**SFA**). Gross/net selection is also available to you (**TAS**, **TAR** command). Command **ZSE** activates automatic initial zero setting. There is also an automatic zero tracking function (**ZTR**) and a set to zero function (**CDL**).

The current measured value is read out using the command **MSV**?. The format of the measured value (ASCII or binary) is set with the command **COF**. You can also use command **COF** to select automatic data output.

More detailed information on this topic can be found in the help file aed_help_e, part “Description of the basic commands”.

4.2.1 Triggering

The AD103C includes two trigger functions to support the functions in packing machines and checkweighers:

- Level triggering via an adjustable level
- External pre-triggering via a digital trigger input (IN1)
- Level post-triggering via an adjustable level
- External post-triggering via a digital trigger input (IN1)

More detailed information on this topic can be found in the help file aed_help_e, part “Description of the commands for signal processing”.

4.2.2 Limit value outputs

Four limit values are available in the AD103C which are set via the **LIV** command. Limit value outputs are available as hardware outputs on the 25-pin connector as well as logical outputs in the measurement status. You can choose between the gross value, the net value or the trigger result as the input signal for limit value monitoring.

(see also the Connecting limit values; digital inputs and outputs section)

More detailed information can be found in the help file aed_help_e, part “Description of the commands for signal processing” (**LIV**).

4.2.3 Control inputs

You can use the command **IMD1**; to activate 2 inputs (IN1/2) as control inputs.

A Low/High (0 V → 5V) edge at input IN1 initiates an external triggering procedure (**TRC**, external triggering). A Low level at input IN2 results in measured value taring. For the tare input, the Low level must be applied for at least 20 ms (debounce time).

IMD2 activates the dosing functions (digital inputs RUN, BREAK).

More detailed information can be found in the help file aed_help_e, part “Description of the commands for signal processing”.

4.2.4 Extreme values

The AED includes an extreme value function that can monitor either gross values, net values or trigger results (**MAV**) . Output of the two extreme values (MIN and MAX) is implemented by the **PVA** command. The **CPV** command can be used at any time to clear the extreme values . The command **PVS** is used for activation.

More detailed information can be found in the help file aed_help_e, part “Description of the commands for signal processing”.

4.2.5 Filling control

The filling and dosing function is activated via the command **IMD2**;.

In this situation, the limit value function settings and the trigger function for the digital inputs and outputs are meaningless.

The dosing function is described in the help file aed_help_e, Part “Description of the commands for filling and dosing control”.

4.2.6 Diagnostic channel

With the diagnostic function, it is possible to analyze dynamic processes in the AED / FIT®. Up to 512 values (measured value and status) can be stored in real time (**DGN**). Once the recording process is complete, the values can be read out (**DGR**). Different trigger conditions can be set at the start of the recording (**DGS**).

The advantage of this diagnostic function is that the measured values are stored in real time (without loss of data) and then read out slowly (OFF-line). This means that it is possible to access this real-time data even at low communication rates.

The diagnostic function can be accessed in two modes:

- Via the main communication channel of the AED / FIT® (UART with RS232/RS485, Profibus, CAN bus or DeviceNet)
- Via a second communication channel (2-wire Bus RS485),

The HBM display unit DWS2103 can be connected to the diagnostic channel. In this case the communication between both units will be an encrypted data exchange.

The diagnostic functions is described in the help file aed_help_e, part “Description of the commands for diagnosis”.

5 Electrical connections

5.1 Transducer connection

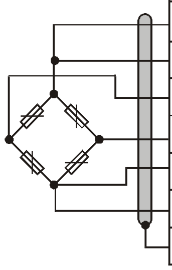
It is possible to connect SG transducers with a full bridge; bridge resistance R_B = 40...1000 Ω (external excitation voltage). SG transducers must operate at a bridge excitation voltage of 5 V_{DC}.

In principle, transducers with a bridge resistance > 1000 Ω can also be connected. But this will increase the noise of the measurement signal (increased measurement ripple).

$$\text{Current consumption} = \leq 90\text{ mA} + \frac{\text{Excitation voltage } U_B}{\text{Bridge resistance } R_B}$$

Make sure that a low-noise constant voltage source is used for the excitation voltage, as the quality of the power supply is directly adopted in the measurement result.

5.1.1 Connecting in 6-wire circuitry



	Color code HBM	Female pin contact
Bridge excitation voltage (+)	bu	9/21
Sense line (+)	gn	10
Measurement signal (+)	wh	24
Measurement signal (–)	rd	11
Bridge excitation voltage (–)	bk	12/13
Sense line (–)	gy	23
Cable shield	ye	Housing

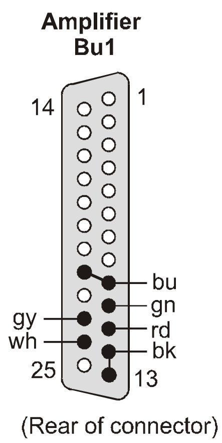
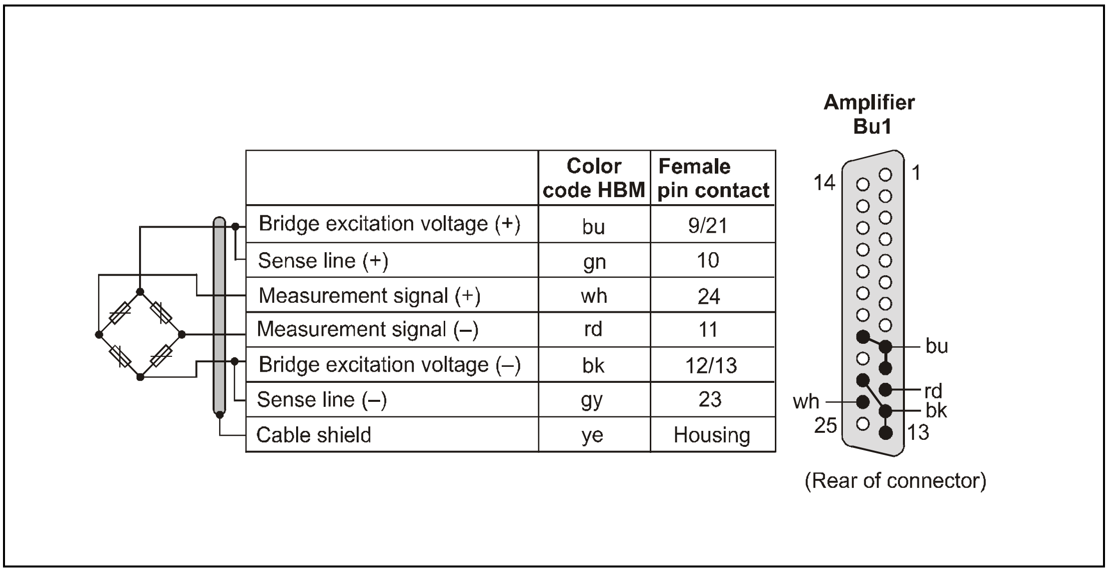


Fig. 5.1-1: Transducer connection (6-wire) to the AD103C amplifier motherboard

5.1.2 Connecting in 4-wire circuitry

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



	Color code HBM	Female pin contact
Bridge excitation voltage (+)	bu	9/21
Sense line (+)	gn	10
Measurement signal (+)	wh	24
Measurement signal (–)	rd	11
Bridge excitation voltage (–)	bk	12/13
Sense line (–)	gy	23
Cable shield	ye	Housing

Fig. 5.1-2: Transducer connection of supply lines and sensor lines in 4-wire circuitry without a cable extension

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

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

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

(see operating manuals AED Basic device; Part “Description of the hardware of the basic device”)

5.2 Connecting the supply voltage

The power supply must meet the following requirements:

Regulated DC voltage	+5 V ±5 %
Residual ripple	<10 mV (peak to peak)
Current consumption AD103C	<120 mA (without SG bridge)

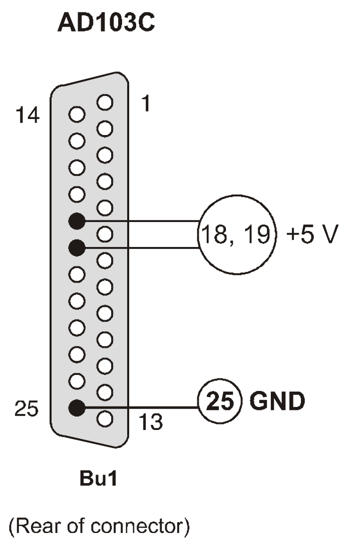


Fig. 5.2-1: Connecting the supply voltage to the amplifier motherboard

5.3 Connecting the serial interface RS232

An RS232 interface is fitted as standard to the amplifier motherboard. Baud rates of 1200…115200 bit/s are available for this serial interface. In addition to the RxD (Receive Data) and TxD (Transmit Data) interface lines, there is also a DTR (Data Terminal Ready) control line available for triggering bus driver modules (e.g. LTC485). When the amplifier motherboard is installed in a basic device, the RS422 (factory setting), RS485 and RS232 interfaces are directly available.

Interface pin assignment

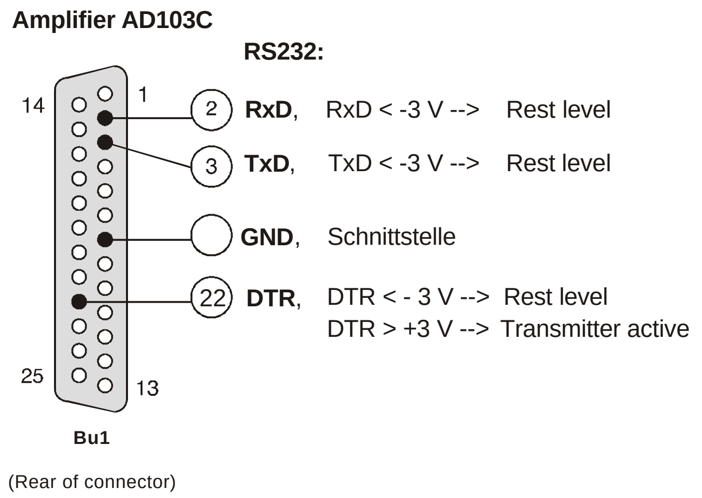


Fig. 5.3-1: Pin assignment for the RS232 interface at the amplifier motherboards

Connecting the AED to a computer via the RS232 interface

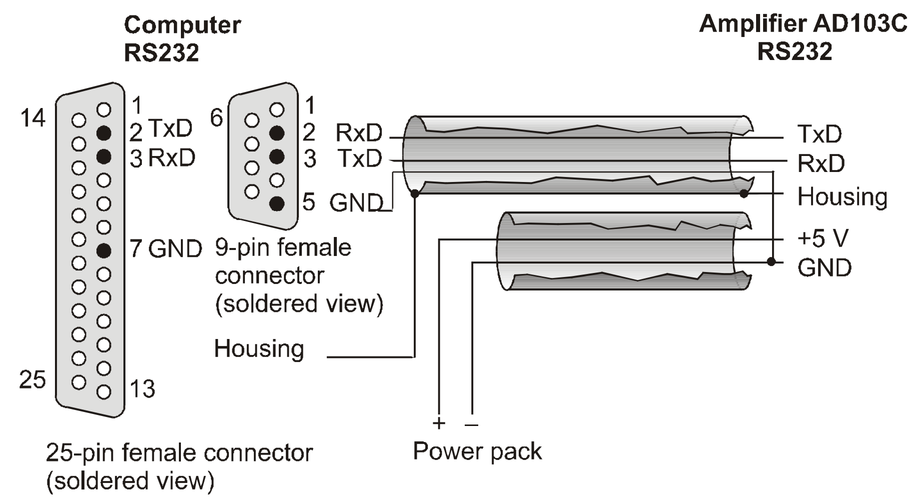


Fig. 5.3-2: Connecting an AED to a computer via RS232 and the supply voltage (only 5 V_{DC} !!)

Multi-channel measurements are only possible with appropriate bus drivers (RS485) (see operating manuals AED, Basic device; AED9101C, AED9201B, AED9301B, AED9401A or AED9501A.

5.4 Connection of CANOpen or DeviceNet

The AD103C amplifier has an additional 12-pin connector for implementing an additional connection to the AED basic device. The following signals are directed over this two-row connector:

PIN	I/O	Signal	PIN	I/O	Signal
1	-	GND	2	-	Nc
3	-	Nc	4	I	DRxD (diagnosis)
5	I	CRxD (CAN / DeviceNet)	6	O	CTxD (CAN / DeviceNet)
7	O	DDTR (diagnosis)	8	O	DTxD (diagnosis)
9	-	Nc	10	-	Nc
11	I	CDS (CAN / DeviceNet selection)	12	I	DIAG (digital outputs), for HBM only

Nc – not connected ; I/O – input / output

CDS: Low = CANOpen protocol, High = DeviceNet protocol

CAN bus connections: CRxD (receive), CTxD (transmit)

Pin 1 of the connector is marked on the amplifier PCB.

The communication is described in the help file aed_help_e, part CANOpen or DeviceNet.

The signals are connected directly with the microprocessor and do not include a protective element or a driver. These functions must be implemented outside the amplifier. The maximum electrical load is therefore limited to an HCMOS load in each case. The electrical HCMOS levels are relative to a supply voltage of 5 V.

5.5 Connecting the diagnostic interface

The AD103C amplifier has an additional 12-pin connector for implementing an additional connection to the AED basic device. The pin assignment is described in Section 5.4.

The diagnostic interface is a UART interface and can be implemented as a 2-wire bus via an RS485 driver connected externally. The following signals are available for this:

DRxD (receive), DTxD (transmit), DDTR (driver selection)

The diagnostic function is described in the help file aed_help_e, part “Description of the commands of diagnosis”.

The signals are connected directly with the microprocessor and do not include a protective element or a driver. These functions must be implemented outside the amplifier. The maximum electrical load is therefore limited to an HCMOS load in each case. The electrical HCMOS levels are relative to a supply voltage of 5 V.

5.6 Hardware switch Legal for trade

The AD103C board contains on the top layer a hardware switch to protect the legal for trade parameters:

Position 0: parameters protected

Position 1: parameters not protected

If the parameters are protected, a write command will be answered with ‘?crlf’.

In the basic devices AED9201B, AED9301B and AED9401A this switch can be covered and sealed with a mark. With the basic devices AED9101C and AED9501A the whole boxes have to be sealed with a mark.

Legal for trade commands are:

CRC, **CWT**, **LDW**, **LWT**, **LIC**, **NOV**, **SZA**, **SFA**, **ZSE**, **ZTR**, **RSN**, **DPT**, **MRA**, **TRF**, **ENU**

5.7 Connecting digital inputs/outputs

5.7.1 Hardware connection, signal level

The AD103C has two digital inputs (IN1, IN2) and 6 control outputs (OUT1…6) that are triggered by various functions, depending on the selected mode of operation.

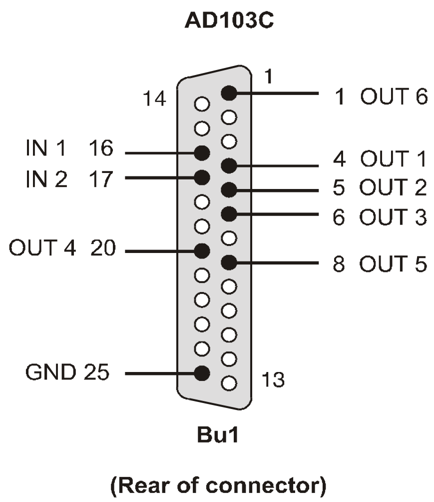


Fig. 5.7-1: Digital inputs and outputs of the amplifier motherboard

The signals at inputs IN1 and IN2 of the amplifier motherboard work at HCMOS level.

The levels at outputs OUT1…6 of the amplifier motherboard are HCMOS levels.

HCMOS level (electrical data)

High level	3.2...5 V
Low level	0…0.8 V related to GND
Output current	< 2 mA
Input current	< 10 µA

Logical assignment of inputs for IMD0

IN1 = POR?	IN1 = Low --> parameter 3 = 0 for query
IN2 = POR?	IN1 = Low --> parameter 4 = 0 for query

Logical assignment of inputs for IMD1

IN1 = trigger	Quiescent level = Low level Trigger start = Low/High edge
IN2 = taring	Quiescent level = High level Low = taring (20 ms debounce time)

Logical assignment of inputs for dosing (IMD2)

IN1 = BRK **IN2 = RUN**	Quiescent level = High level, Low = **RUN** or **BRK** (20 ms debounce time)

Logical assignment of outputs for IMD0

OUT1/2 Low level	POR,Parameter1/2 = 0
OUT1/2 High level	POR,Parameter1/2 = 1

Logical assignment of outputs for IMD1/2

Low level	Function/output = inactive
High level	Function/output = active

There is a distinction between the AED9201B and AED9301B basic devices in the following functionality

AED9101C basic device Supports input IN1

AED9201B basic device Supports inputs IN1, IN2 and OUT1...OUT6

AED9301B basic device Supports inputs IN1, IN2 and OUT1...OUT4

AED9401A basic device Supports inputs IN1, IN2 and OUT1...OUT4

AED9501A basic device Supports input IN1

The inputs/outputs of the AED9201B, AED9301B and AED9401A basic devices are electrically isolated.

5.7.2 Function of limit value outputs, control inputs

The two OUT1…4 outputs of the amplifier motherboard can be used either as limit value outputs (**LIV** command) or as digital outputs that can be set with the command **POR**. The amplifier motherboard outputs can drive a standard TTL load.

Modes of operation IMD0 and IMD1

Inputs	**IMD0;**	**IMD1;**
IN1	Query via **POR?**	External trigger input
IN2	Query via **POR?**	Tare and select net value output

Outputs	**Limit values (LIV) deactivated**	**Limit values (LIV) activated**
OUT1	Settings via **POR**	Settings via **LIV1**
OUT2	Settings via **POR**	Settings via **LIV2**
OUT3	-	Settings via **LIV3**
OUT4	-	Settings via **LIV4**

5.7.3 Function of the inputs and outputs for dosing control (IMD2)

Inputs	**IMD2; Dosing**
IN1	Stop (**BRK**)
IN2	Start (**RUN**)

The following output functions are available, subject to the output mode command (**OMD**, see help file aed_help_e, “Description of the commands for filling and dosing application”):

Outputs	**OMD0**	**OMD1**	**OMD2**
OUT1	Coarse flow	Coarse flow	Coarse flow
OUT2	Fine flow	Fine flow	Fine flow
OUT3	Ready signal/emptying [1)]	Ready signal/emptying [1)]	Ready signal/emptying [1)]
OUT4	Tolerance+ overrun	Outside tolerance ±	Alarm
OUT5	Tolerance– underrun	No function	No function
OUT6	Alarm	No function	No function

[1)] for emptying time = 0 (**EPT**) → OUT3 ready signal is after actual value determination,
for emptying time > 0 (**EPT**) → OUT3 emptying control is over set time

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