AT6356E Rev. 01 - 11/2015

AVL microIFEM Piezo 4P4x
Product Guide

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Warnings and Safety Instructions

This manual contains important **warnings and safety instructions**, which must be observed by the user.

The device is intended only for an exactly defined use which is described in the manual. The manual also explains the essential prerequisites for the application and operation of the device as well as the safety measures to ensure smooth operation. AVL can offer no warranty nor accept any liability if the device is used in applications other than those described and if the necessary requirements are not met and the safety instructions not followed.

The device may only be used and operated by personnel, who, due to their qualifications, are capable of observing the necessary safety measures during use and operation.
Any accessories and equipment used with the device must be supplied or approved by AVL. The operating principle of this device is such that the accuracy of the measurement results depends not only on the correct operation and functioning of the device, but also on a variety of peripheral conditions beyond the control of the manufacturer. Therefore, the results obtained from this device must be examined by an expert (e.g. for plausibility) before any action is taken based on those results.

Any adjustment and maintenance work necessary on instruments when open and under voltage must be carried out by a professional technician who is aware of the dangers.

Repairs to the device may be carried out by the manufacturer or qualified service personnel only.

When the device is in use, an expert must ensure that neither the object under test nor the testing equipment is operated under conditions that may lead to damage or injury.

AVL List GmbH

Grouped Safety Messages

WARNING

Danger of explosion and injury

This device must not be used in any environment where there is a danger of explosion.

WARNING

Danger to life due to electrical voltage

Any connected equipment that uses voltages higher than 50 V AC or 75 V DC must satisfy the requirements of the 2006/95/EC.

To ensure that the risk of electric shock is minimized, the device may only be opened by qualified staff.

To prevent the risk of fire and electric shock, the devices of the system must not be exposed to rain or permanent humidity or moisture.

If a foreign body or liquid gets inside the device, disconnect the device from the power supply and have it checked by an expert before using it again.

Make sure that the device is supplied with the correct supply voltage.

Only use the supplied power supply cable with protective ground.

Only connect the power supply cable to a grounded socket.

Disconnect the device from the power supply system whenever you change a fuse.

NOTICE

In order to comply with the requirements of the 2004/108/EC Directive on Electromagnetic Compatibility, only shielded cables with adequately shielded plug connections may be used.

Power supply connections with standardized connectors and the exceptions mentioned do not need to be shielded.

Always place the device in a position that allows air to circulate freely through the device's venting apertures.

Information

When disposing of the product or of parts of it, make sure that the legal regulations in force in the country in which the device is operated are observed (e.g. regulations for the disposal of electronic scrap).

Table of Contents

1 What You Should Know

This documentation describes the functionality of the AVL microIFEM Piezo 4P4x, which is available in the following variants:

- 4P4A Piezo Amplifier suitable for TEDS with FISCHER triax connector
- 4P4B Piezo Amplifier Double Range suitable for TEDS with FISCHER triax connector
- 4P4C Piezo Amplifier suitable for TEDS with FISCHER triax connector and SID Sensor Identification
- 4P4D Piezo Amplifier Double Range suitable for TEDS with FISCHER triax connector and SID Sensor Identification
- 4P4E Piezo Amplifier suitable for TEDS with 4-pin FISCHER connector (AVL SDC)
- 4P4F Piezo Amplifier Double Range suitable for TEDS with 4-pin FISCHER connector (AVL SDC)
- 4P4G Piezo Amplifier suitable for TEDS with 4-pin FISCHER connector (AVL SDC) and SID Sensor Identification
- 4P4H Piezo Amplifier Double Range suitable for TEDS with 4-pin FISCHER connector (AVL SDC) and SID Sensor Identification

Double Range

If the expected sensor charges at the amplifier input are higher than 14400 pC, the permitted charge input range of the standard version is exceeded. In such cases, the **Double Range** version has to be used.
Permitted charge input range for double range amplifiers:
160 pC - 28800 pC

SID Sensor Identification

Using this function and the relevant sensors, the amplifier is capable of identifying the sensor's unique ID, which enables the sensor's type, serial number and sensitivity to be read from a sensor database.

1.1 Applicability

4P4 A/B/C/D/E/F/G/H, Rev. Level 00

1.2 Safety Instructions

This documentation contains a number of important **warnings and safety instructions**, which must be observed by the user. Smooth operation can only be ensured if the requirements are met and the safety instructions followed.

1.3 Warranty Seal

For safety reasons, the product is provided with a special seal which may only be broken by AVL personnel. Any unauthorized damage to the seal shall be considered an unauthorized change to the product, which will result in the termination of AVL´s warranty obligation.

1.4 Intended Use

The product is only intended for the area of application which is described in the documentation. If used contrary to its intended purpose or if the prerequisites and safety instructions mentioned are not observed, no guarantee and/or liability shall be assumed. The operating principle of this product is such that the accuracy of the measurement results depends not only on the correct operation and functioning of the product, but also on a variety of peripheral conditions beyond the control of the manufacturer. Therefore, the results obtained from this product must be examined by an expert (e.g. for plausibility) before any action is taken based on those results.

It is explicitly stated that use of this product alone will not ensure safety-related monitoring of the operating condition of the combustion engine under test.

1.5 About this Documentation

Target group

This documentation addresses test bed engineers/application engineers who set up and execute indicating measurements.

Information

This documentation is not intended to, and should not, replace adequate training!

It covers the following topics:

- Setup
- Parameterization
- Calibration and Maintenance

Secondary literature

For technical details about the handling of AVL indicating systems, please refer to the AVL IndiCom documentation and/or the relevant system manual.

1.5.1 Abbreviations and Glossary Terms

EMC	Electromagnetic Compatibility
SDB	Sensor Data Base
SCF	Signal Calibration Factor
SDC	Sensor Data Connector
SID	Sensor Identification
TEDS	Transducer Electronic Data Sheet

1.5.2 Typographic Conventions

Safety messages:

WARNING

WARNING indicates a hazardous situation which – if not avoided – could result in death or serious injury.

CAUTION

CAUTION indicates a hazardous situation which – if not avoided – could result in minor or moderate injury.

Additional safety symbols:

Voltage hazard warning

Additional messages:

NOTICE

This text indicates situations or operation errors which could result in property damage or data loss.

Information

This text indicates important information or operating instructions. Not observing these instructions could inhibit or impede you from successfully completing the tasks described in this documentation.

Standard text styles:

Bold	Parameters; control elements in windows and dialog boxes; important text
Italics	Cross-references; foreign-language or new terms; wildcards for elements that need to be entered by the user, i.e. characters or text. If you read, for example, *macro name*, you are required to type the name of a macro.
UPPERCASE LETTERS	Operating states
`Courier`	Programming examples; source code
Times New Roman	Formulas
Menu | Option	Description of how to select a menu or menu item

Lists:

1. **2.**	Step-by-step procedures with a given sequence
•	One-step instructions
▪ ▪	Listings in no particular order
– –	

1.5.3 Online Help

This printed manual is also available as online Help.

To access online Help:

- open the **Help** menu
- or press the **F1** key for context-sensitive Help.

1.5.4 We Want to Hear from You

Your comments and suggestions help us to improve the quality and practical relevance of our manuals.

If you have any suggestions for improvement, please send them to:

docu@avl.com

We appreciate your feedback!

2 General

2.1 Application

The AVL microIFEM Piezo 4P4x is designed as a compact 4-channel amplifier. Its small size makes it perfectly suitable for use in test cells close to the pressure transducers or in the vehicle.

The connections on the AVL microIFEM Piezo permit the control of the amplifiers as well as the transmission of the output signal.

Electrical isolation of each channel's power supply and use of a differential output amplifier ensure that the AVL microIFEM Piezo is also suitable for use in environments with severe interference. The high upper cut-off frequency on the other hand permits highly dynamic measurements.

The AVL microIFEM Piezo 4P4x is used to measure the electrostatic charges generated by piezo transducers in pressure, force and acceleration measurement chains. The extremely high input resistance makes it possible to carry out quasi-static measurements. The large sensitivity range means that the amplifier can be used in conjunction with most piezoelectric measurement transducers. An integrated drift compensation function ensures drift free measurement results where the isolation conditions are less than ideal.

2.2 Software Requirements

For parameterization of the AVL microIFEM Piezo 4P4x, AVL IndiSignal $\geq$v3.5a is required.

For use with AVL IndiCom, the following versions are required:

- AVL IndiCom v2.4 SP2 HF13
- AVL IndiCom v2.5 HF8
- AVL IndiCom v2.6
- AVL IndiCom v2.7

2.3 Basic Equipment

- 1 AVL microIFEM Piezo 4P4 A/B/C/D/E/F/G/H
- 1 serial interface cable, 10 m
- 1 power supply cable, 10 m
- 1 3-pin power connector
- 4 BNC connecting cables E109 - 1.5
- 4 clamp-on ferrites
- 1 CD-ROM with the AVL IndiSignal Software
- 1 Product Guide

2.4 Options

2.4.1 External Power Supply

EN0457 To supply the AVL microIFEM.

Type Model	IN	Maximum no. of connectable microIFEM	Maximum ambient temperature
TR70 (EN0457)	100 ... 240 V AC 50 ... 60 Hz 1.5 A	4	45 °C
		3	50 °C
		2	55 °C
		1	60 °C

2.4.2 Cascading Package

TI04FCCSA.01 The Cascading Package consists of the following components:

- 1 serial interface cable (30 cm)
- 1 power supply cable (30 cm)
- 1 Y-supply cable for 2 microIFEMs

3 System Overview and Connections

3.1 Block Diagram

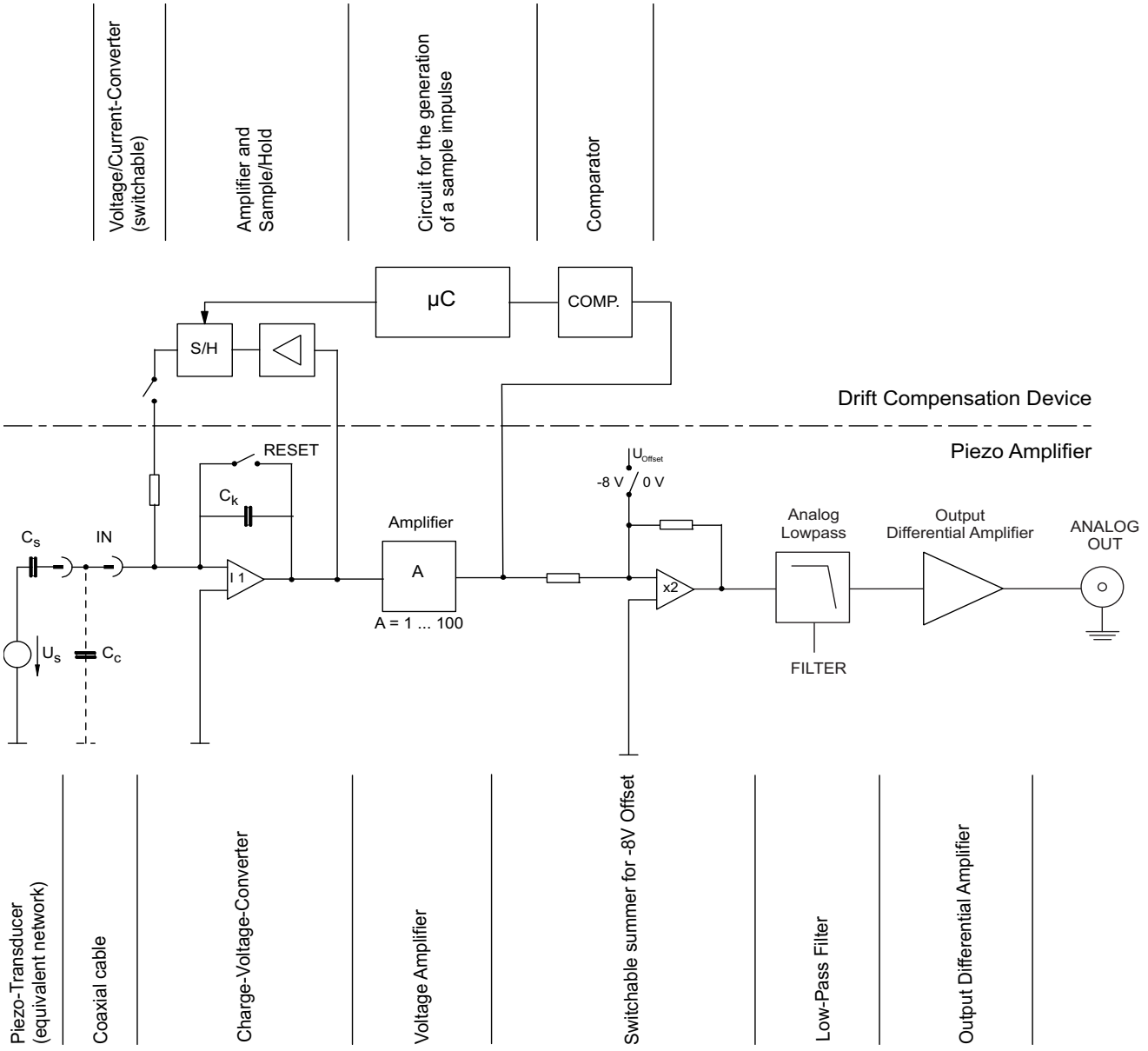

Fig. 1 Block diagram

3.2 Front View

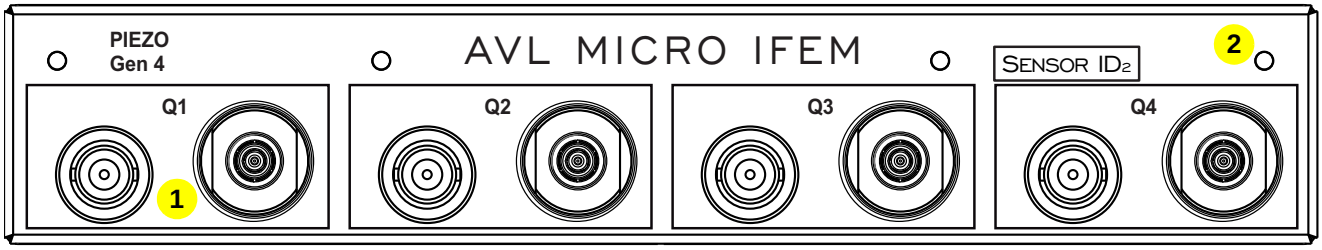

Fig. 2 AVL microIFEM Piezo 4P4 A/B/C/D, *front view*

1 **.... Q1 to Q4**
Pressure transducer connections:
– BNC sockets for pressure transducers with BNC connector
– FISCHER triax sockets for pressure transducers with sensor data connector (TEDS)

2 **.... LEDs**
Status indicators for the individual amplifier channels.
GREEN: regular operating state
ORANGE: acknowledgement of a control signal
RED flashes: amplifier channel is in saturation

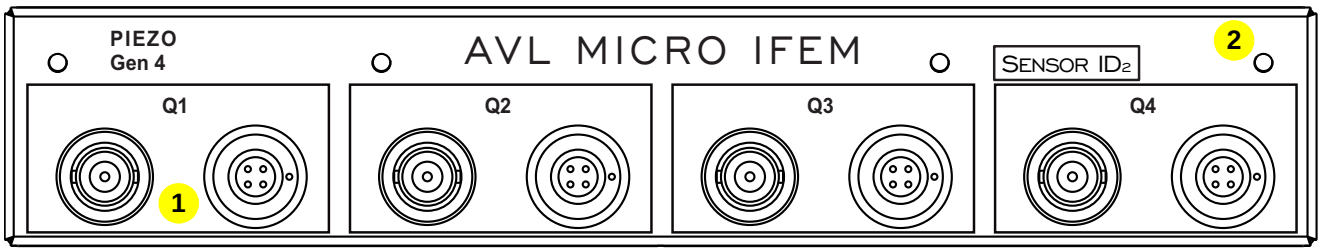

Fig. 3 AVL microIFEM Piezo 4P4 E/F/G/H, *front view*

1 **.... Q1 to Q4**
Pressure transducer connections:
– BNC sockets for pressure transducers with BNC connector
– 4-pin FISCHER sockets for pressure transducers with sensor data connector (AVL SDC)

2 **.... LEDs**
Status indicators for the individual amplifier channels.
GREEN: regular operating state
ORANGE: acknowledgement of a control signal
RED flashes: amplifier channel is in saturation

3.3 Rear View

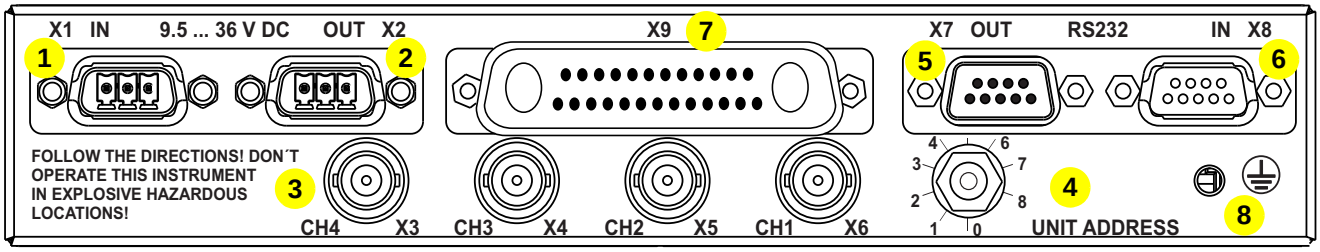

Fig. 4 AVL microIFEM Piezo 4P4x*, rear view*

1 **.....9.5 ... 36 V DC IN - X4**
Connection of power supply (9.5 ... 36 V DC)

2 **.....9.5 ... 36 V DC OUT - X2**
Voltage output.
If devices are cascaded, the next rack can be connected here.
Note: For restrictions, see *Cascading* on page 19 and *Technical Data* on page 41.

3 **.....CH4 to CH1 - X3 to X6**
BNC output sockets for the analog signal of the respective amplifier.

4 **.....UNIT ADDRESS**
Address switch for cascading.
Address must be set to **0** if only one device is used.
If devices are cascaded, the first rack must be set to address **0**. The address must be increased by **1** for each subsequent rack.

5 **.....RS232 OUT - X7**
Serial connection to another AVL microIFEM if devices are cascaded.

6 **.....RS232 IN - X8**
Connection to the PC serial port or to the **RS232 OUT** socket of the previous rack if devices are cascaded.

7 **.....X9**
Connection for Mounting Tray TI04F4MTA.02 for 4 devices.

8 .....Protective ground connection

3.4 Cascading

Up to 8 additional devices of the amplifier series can be cascaded.

1. Connect the PC's serial interface to the **RS232 IN** socket on the rear panel of the first amplifier.
2. Set the address switch **UNIT ADDRESS** on this rack to **0**.
3. Connect the **RS232 OUT** socket of the first AVL microIFEM to the **RS232 IN** socket of the second AVL microIFEM.
4. Connect the **9.5 ... 36 V DC OUT** socket of the first AVL microIFEM to the **9.5 ... 36 V DC OUT IN** socket of the second AVL microIFEM.
5. Set the address switch **UNIT ADDRESS** on the second AVL microIFEM to **1**.

Connect additional AVL microIFEM following the same principle, increasing the address by 1 for each rack added.

NOTICE

Make sure that the maximum continuous current of the supply connector does not exceed 8 A.

E.g.: 24 V DC power supply: 15 W/24 V = 0.625 A, i.e. 9 racks can be cascaded.
E.g.: 12 V DC power supply: 15 W/12 V = 1.25 A, i.e. 6 racks can be cascaded.

EnsureAlso ensure that the start-up power consumption (22 W for each unit) of all AVL microIFEM units does not exceed the maximum power output of the power supply!
The power supply unit TR70 can supply up to four AVL microIFEM units.

The RS232 and power supply connecting cables are 1:1 connecting cables. For the connector pin assignment and cable types, see *Pin Assignment - Rear Panel* on page 45.)

3.5 Temperature Range

NOTICE

Please note that the maximum ambient temperature range (see *Technical Data* on page 41) only applies if the device is used as a free-standing unit. If you stack several microIFEM units on top of each other at high ambient temperatures, this may lead to overheating and, consequently, failure, particular where the unit in the middle is concerned. We recommend leaving a gap of 0.5 to 1 rack units in between the devices.

4 AVL IndiSignal Operating Software

4.1 Installation

Information

Administrator privileges are required for installation.

The AVL microIFEM may be remote controlled via a serial line . Parameterization is done via the AVL IndiSignal operating software.

Depending on your indicating system, AVL IndiSignal is available in different versions. The basic operation is the same with all versions.

AVL IndiCom

AVL IndiSignal is an integral part of parameterization in AVL IndiCom. Not only the data acquisition hardware, but also the AVL microIFEM is visualized.

In this case, it is not necessary to do a separate AVL IndiSignal installation.

- Set the relevant COM port in the *IndiSignal* section within the *indicom.ini* file.

Stand-alone

AVL IndiSignal has to be installed as a separate program from the CD-ROM that comes with the AVL microIFEM.

1. Insert the CD-ROM into the CD drive.
   - The installation procedure will start automatically if the operating system's Autorun function is enabled.
   - If it does not start automatically after inserting the CD-ROM, double-click the file *Setup_IndiSignal.exe* in the folder **Install** on your CD-ROM.
2. Follow the instructions on the screen.

   COM1 to COM8 can be selected as communication interface. The selected interface is entered in the *indisignal.ini* file (under **ComPort=**) and may be changed using a text editor.
   If the amplifier is connected to a serial output of an AVL GigaBit indicating system, set **Ethernet** as interface type.

4.2 AVL IndiSignal View

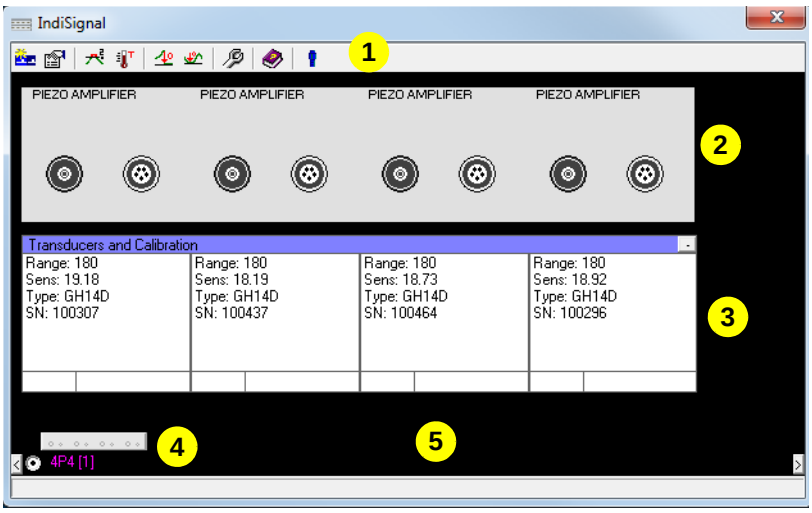

Fig. 5 AVL IndiSignal main window

1 .... Toolbar

2 .... Rack View

3 .... Transducers and Calibration

4 .... Status Bar

5 .... Black background:
You can right-click into this area to open a context menu, (e.g. amplifier properties dialog, etc.)

4.2.1 Toolbar

Check for new amplifiers
Has no function, because the amplifiers are permanently installed.

Properties
Shows the Properties dialog of the selected amplifier.

Temperature
Shows the amplifiers' current temperature in degrees Celsius.

Overrange Check On
When this button is clicked, the system continuously monitors the overrange state of all amplifiers and displays it via different colors of the LED symbol. The state is checked every 5 seconds. Click the button again to deactivate the mode. Calling up a properties menu and reloading amplifiers or sensors will also deactivate the function.

Reset Piezo Amplifiers
Resets all installed piezo amplifiers in all available racks, i.e. sets their output voltage to **0 V** or **-8 V**.

Reset Piezo Amplifiers at BDC
Resets all installed piezo amplifiers in all available racks in the correct pressure phase, i.e. sets their pressure signal to **0 V** or -**8 V**.
Phase-correct resetting means that the **RESET** function is activated in the low-pressure portion of the pressure signal. This prevents the pressure curve from being shifted downward in the high-pressure portion when the **RESET** button is pressed.

Overview
Displays the system settings (e.g. gain, drift compensation, correction factor, etc.) for the AVL microIFEM and the individual amplifiers.
Use the mouse to enlarge the window if you need to.
Firmware revision and SID identification hardware generation are also shown.

Help
Calls the online Help.

Refresh Sensor Data
Reloads the sensor data of all connected sensors (AVL SDC, SID, SDB) into the relevant amplifier.

4.2.2 Rack View

This section displays the selected AVL microIFEM. Devices can be selected in the status bar at the bottom of the window. Just click the required AVL microIFEM or the associated option button.

Information

With AVL IndiCom you also see here symbols for the connected acquisition units.The corresponding unit is shown when you click the symbol. These two views can be used to define the connections between data acquisition and AVL microIFEM.

4.2.3 Transducers and Calibration

This view shows a simplified version of calibration data. You see there sensitivity, type and serial number of the connected sensors and the range of corresponding amplifier.

- If you **double-click** into this view, an input dialog will be opened and you can edit these parameters for the individual amplifiers without having to open the Properties dialog.
  Modifications are submitted by pressing **RETURN**.
- If the TEDS (AVL SDC), SID or SDB functions are activated for a piezo transducer, the system will read in type, serial number and sensitivity from the data connector TEDS) or the database. These values are not editable.

4.2.4 Status Bar

The status bar shows all connected amplifiers. Here you can select amplifiers by mouse click and set parameters via the Properties dialog.

An amplifier's Properties dialog may be opened in the following ways:

- Double-click the relevant amplifier.
- When you click an amplifier, it will be marked with a red frame. Click this button to call up the Properties dialog:

- Right-click an amplifier area to show a context menu and select **Properties** from the menu.

For details about amplifier settings, see *Settings 4P4x* on page 24.

4.3 General Information About Calibration

Every amplifier is configured in the associated Properties dialog in AVL IndiSignal (for information on how to call this dialog, see *Rack View* on page 23).
In this dialog, the characteristic sensor data and measurement parameters are input, and the calibration factor is automatically calculated. It is also possible to input additional information about the sensor (i.e. type of sensor, serial number; etc.) and to set operating parameters of the amplifier. These parameters are stored in a non-volatile memory in the amplifier.
If the TEDS (AVL SDC), SID or SDB functions are activated for a piezo transducer, the system will read in type, serial number and sensitivity from the data connector or the database. These values are not editable.
If you work with AVL IndiCom, it is not necessary to manually transfer the calibration factor. When establishing a connection between an analog channel in the indicating system and an amplifier in the AVL microIFEM, the calibration factor is automatically transferred to AVL IndiCom.

4.4 Settings 4P4x

4.4.1 Piezo Amplifier Tab

This Properties dialog shows all amplifier settings, which can be changed if required.

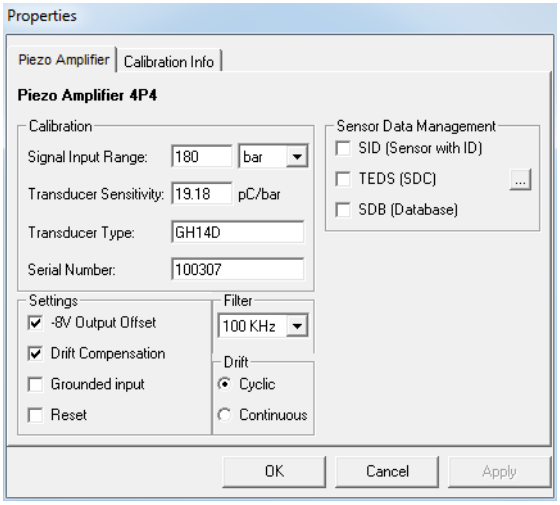

Fig. 6 Piezo Amplifier Properties

4.4.1.1 Calibration

- **Signal Input Range**

  Here enter the expected maximum peak pressure.
  Please note that any superimposed oscillations (knock) could increase it even further.

- **Transducer Sensitivity**

  Enter here the sensitivity of the used transducer in pC/bar. The correct gain is automatically calculated based on **signal input range** and **sensitivity**.

- **Transducer Type / Serial Number**

  For documentation of your measured data in conjunction with AVL IndiCom, enter transducer type and serial number.

Information

If this amplifier has already been calibrated with a dead weight tester, the calibration parameters are locked for input (see *Calibration with Dead-Weight Tester (IndiSignal Stand-alone Only)* on page 49).

4.4.1.2 Settings

- **-8 V Output Offset**

  If this check box is activated, the signal zero point is set to -8 V. This improves utilization of the -10/+10 V input range of connected indicating systems.

Information

This setting only concerns the analog device outputs (see *Fig. 4* on page 19).

- **Drift Compensation**

  If this check box is activated, a field will be displayed to the right containing the two options **Cyclic** and **Continuous**.

  – **Cyclic** mode: This mode attempts to keep the value that the curve has at approx. -180° at 0 V or -8 V. It therefore requires cyclic signals, such as e.g. cylinder pressures or line pressures. With signal periods T > 1.2 s Continuous mode is automatically selected.

  – **Continuous** mode: In this mode, the system attempts to keep the signal's linear mean value at 0 V or -8 V. This mode is suitable for piezoelectric transducers installed in the intake manifold or exhaust and for accelerometers. If used with cylinder pressure signals and at low speeds (< 1000 rpm), the accuracy of the indicated mean effective pressure is somewhat reduced.

NOTICE

Make sure to use the drift compensation appropriate for your signal type!
The minimum signal lift for the detection of cyclic signals is approx. 0.7 V above the signal's linear mean value (typ. at approx. 1.2 V). If this condition is not met (e.g. in idle), the amplifier will automatically switch to **Continuous** mode.
(Utilize the output offset of -8 V and set the gain in a way that, at full load, the output range is optimally used.)

- **Grounded Input**

  If this check box is activated, the sensor input ground is connected to protective ground.

NOTICE

With ground isolated sensors this function has to be activated for the potential to be defined.
With ground referenced sensors it depends on the ambient conditions at the test bed whether or not this function would be useful for reducing interference. It should generally be deactivated with ground referenced sensors.

- **Reset**
  - With this check box you can reset this piezo amplifier permanently.
  - If you want to reset the amplifier for a short time and then use it again, you have the following possibilities:

    Right-click the relevant amplifier to open the context menu and select **Reset**, or click the following toolbar button:

    

    All amplifiers of all cascaded IFEM racks will be reset.
  - If you want to reset the amplifier in the correct pressure phase ("grounding"), click the following button in the toolbar:

    

    All amplifiers of all cascaded IFEM racks will be reset in the correct pressure phase.
    Phase-correct resetting means that the **RESET** function is activated in the low-pressure portion of the pressure signal. This prevents the pressure curve from being shifted downward in the high-pressure portion when the **RESET** button is pressed.

4.4.1.3 Filter

An integrated second-order Bessel filter enables you to filter the output signal. The displayed frequency shows the upper cut-off frequency currently set (-3 dB).

The following options are available:
12, 20, 30, 50, 100 kHz

Information

The real filter frequencies may differ by around 10 %.
Please note that low filter frequencies will lead to a signal delay.

4.4.2 Sensor Data Management

Please see below a description of different ways to read out pressure transducer sensitivity from a database or a data medium (TEDS):

4.4.2.1 SID (Sensor with ID) for 4P4 C/D/G/H

If a sensor with SID is used, the sensor identity will be determined if this check box is activated and the **Apply** button is clicked. For this purpose, the unique ID stored in the sensor is read out and searched for in the database.
If a sensor with this ID is found in the database, the **Transducer Sensitivity**, **Transducer Type** and **Serial Number** fields are automatically filled with values. The system will use the optimal transducer sensitivity, depending on the set signal input range.

Information

A central sensor database is required to use this function.
For installation and operation of the sensor database, use the program **Sensor-Admin**, which is available under **Tools** on your AVL IndiSignal CD-ROM or in the IndiSignal installation folder.

The microIFEM 4P4 C/D/G/H is equipped with a third-generation SID identification hardware.

Information

When cascading different types of microIFEM units, care must be taken not to use amplifiers with 1st generation and 3rd generation SID identification hardware at the same time.

Which generation of the integrated SID identification hardware is installed, is shown under **SID** in the overview (see *AVL IndiSignal View* on page 22).

SID: 1, 2 -> 1st generation

SID: 3, 4 -> 2nd generation

SID: 5, 6 -> 3rd generation

4.4.2.2 TEDS (SDC)

Selecting the check box **TEDS (SDC)** activates the reading of the sensor data from a connected TEDS element (TEDS = Transducer Electronic Data Sheet). Depending on the type of AVL microIFEM, this can be a TEDS with FISCHER triax socket or with a 4-pin FISCHER socket (AVL SDC). The system will automatically use the optimal transducer sensitivity, depending on the set signal input range.

To call up the Properties dialog of the TEDS, click the following button:

For details, see *Electronic Sensor Data TEDS (SDC)* on page 31.

4.4.2.3 SDB (Database)

If you are using a sensor without SID, you can nevertheless utilize the benefits of a database. Activating this check box allows you to select the **transducer type** and **serial number**. The **Transducer Sensitivity** will be read automatically from the database and input in the relevant field. The system will use the optimal transducer sensitivity, depending on the set signal input range.

Information

A central sensor database is required to use this function. For installation and operation of the sensor database, use the program **SensorAdmin**, which is available under **Tools** on your AVL IndiSignal CD-ROM or in the IndiSignal installation folder.
To activate this database, use the program *ActivateSensorDataBase.exe*, which is available in the AVL IndiSignal installation folder.

4.5 Functions

4.5.1 Calculation of the Calibration Factor

Gain **A** is calculated based on transducer sensitivity **S** and signal input range $\mathbf{p_N}$. When you click the **Apply** button after entering the parameters, the amplifier is set to the following gain:

4P4 A/C/E/G:

$$A \leq \frac{8000(\text{for 0 V offset}) \text{ or } 14400(\text{for -8 V offset}) \text{ [pC]}]}{S\left[\frac{pC}{bar}\right] \cdot p_N \text{ [bar]}}$$

4P4 B/D/F/H:

$$A \leq \frac{16000(\text{for 0 V offset}) \text{ or } 28800(\text{for -8 V offset}) \text{ [pC]}}{S\left[\frac{pC}{bar}\right] \cdot p_N \text{ [bar]}}$$

This produces a signal calibration factor (SCF) of:

4P4 A/C/E/G:

$$SCF\left[\frac{bar}{V}\right] = \frac{800 \text{ [pF]}}{S\left[\frac{pC}{bar}\right] \cdot A}$$

4P4 B/D/F/H:

$$SCF\left[\frac{bar}{V}\right] = \frac{1600 \text{ [pF]}}{S\left[\frac{pC}{bar}\right] \cdot A}$$

Information

The formulas listed above should be considered merely as indicative, as the actual gain factor additionally requires the correction factor, which is determined when calibrating the AVL microIFEM. The correction factor is shown in the amplifier overview (see *AVL IndiSignal View* on page 22).

Regarding transfer of the signal calibration factor to the connected indicating system, see *Settings 4P4x* on page 24.
The resulting signal calibration factor can be used as a scaling factor for a connected data acquisition system. When connecting AVL IndiCom, no manual

input in AVL IndiCom is needed, because the software reads out the SCF automatically.
If the maximum pressure that occurs during operation is not known, we recommend starting with a high initial value and then reducing it until the piezo amplifier goes into saturation (check by means of LED or overrange check; red LED symbol). Then increase the value until the overrange check shows a green LED symbol.

4.5.2 Calibration Info Tab

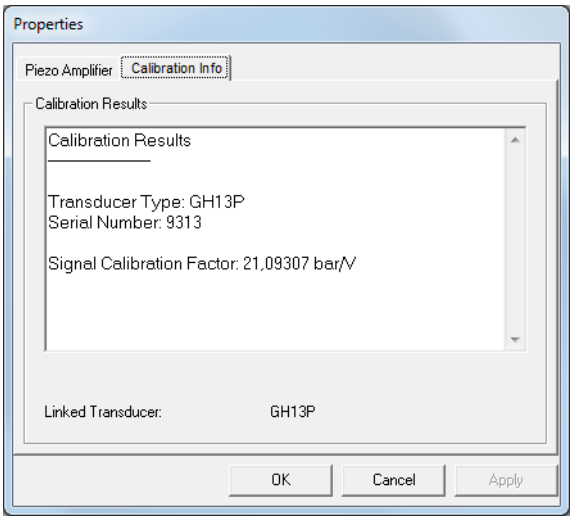

Fig. 7 Piezo Amplifier Calibration Info

This tab displays the calibration factor determined by the set measuring range and the transducer sensitivity.

4.6 Offline Mode

AVL IndiCom Offline also contains an offline version of AVL IndiSignal.

The Test Environment File (which may be copied from the test bed to an office PC) contains the AVL microIFEM.

Via context menu it is, however, also possible to add or remove an AVL microIFEM. This allows you to set the amplifiers to the required signal input range and input the transducer sensitivities in the office. The resulting picture can then be printed out and used as a guide for test setup on the test bed.

4.7 Presettings

By changing entries in the indicom.ini file it is possible to specify settings which cannot be defined via the user interface.

- With AVL IndiCom, you can find these settings in the [*IndiSignal*] section of the indicom.ini file.

Entry	Input Options	Description
Language=	GER ENG	Dialog language German Dialog language English (IndiSignal only)
ComPort=	1 ... 8, OFFLINE, OFF	Serial interface 1 ... 8 OFFLINE = Offline simulation OFF = Disconnected
CalPW=	AVL (factory setting) or any password	Password to unlock the calibration values after dead-weight tester calibration
PreLoad=	0 = NO 1 = YES	This defines whether or not the settings of the amplifiers come from the IndiCom parameter file. The system makes a configuration check of racks and amplifiers. (Only if used with AVL IndiCom.)
TEDSEditPW=	AVL (factory setting) or any password	Password which is requested if you want to change the settings of the AVL SDC.
ViewTime=	sec h cyc	Defines whether the operating time of the AVL SDC(s) is displayed in seconds, hours or cycles.
Database	OFF / ODBC	Defines whether or not the sensor database should be used (see also *Sensor Data Management* on page 27
Enable TEDS with SDB	0 = NO 1 = YES	Setting 1 means that a TEDS (SDC) is used together with a sensor database, i.e. only serial number and type are used.

Tab. 1

5 Sensor Data Management

The AVL microIFEM Piezo 4P4x enables you to read the characteristic transducer data from a sensor data connector or a database (either manually or automatically via SID). This includes both calibration values and sensor runtimes.

- **SID (Sensor Identification) for 4P4 C/D/G/H**

  If SID is activated, the amplifier identifies the unique sensor ID number which allows to read the sensor's type, serial number and sensitivity from the sensor database (requires amplifier with SID identification and piezo transducers provided with SID).

- **SDB (Sensor Data Base)**

  Here you can select a sensor type and a serial number via an input field. Sensitivity is then read out automatically from a sensor database according to the set input range.

- **AVL SDC (Sensor Data Connector) or non-AVL TEDS (Transducer Electronic Data Sheet)**

  This additional connector contains a memory in which the characteristic data are stored. Type, serial number and sensitivity according to the set input range are read out of this memory. The connected TEDS type is detected automatically.

5.1 Electronic Sensor Data TEDS (SDC)

Based on the AVL SDC-TEDS, the following sections show the dialogs with which the data stored in a connected TEDS can be displayed or changed.

The contents of these dialogs may differ, depending on TEDS type and sensor manufacturer.

Header

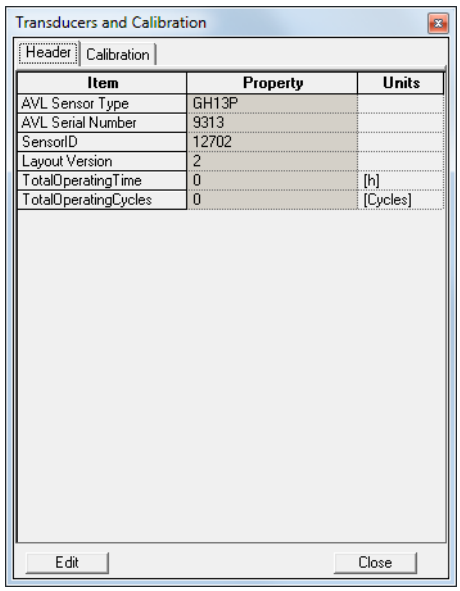

Fig. 8 AVL SDC, Header tab

- **AVL Sensor Type**
  Type of sensor.
- **AVL Serial Number**
  Serial number of sensor.
- **Sensor ID**
  Unique sensor ID number.

- **Layout Version**
  Version number of internal memory allocation.
- **Total Operating Time**
  Total operating time of the sensor.
  When you start AVL IndiCom, the operating time counter in the amplifier is set to **0**. As soon the amplifier gets a cylinder pressure signal, this internal counter recognizes the duration. When AVL IndiCom is stopped, the current counter content will be added to the field **Total Operating Time**. The time unit can be set in the indicom.ini file (sec, h or cyc).

```
; View SDC Operating Time in seconds or hours (sec/h/cyc)
ViewTime=h
```

- **Total Operating Cycles**
  Total number of engine cycles of the sensor.
- **Edit**
  By clicking **Edit** you can switch to the Edit mode, which enables you to edit the values in the **Property** column.
- At the same time, the button **Burn** is enabled which allows you to save the modifications in the AVL SDC.
- **Close**
  Closes the dialog.

Calibration

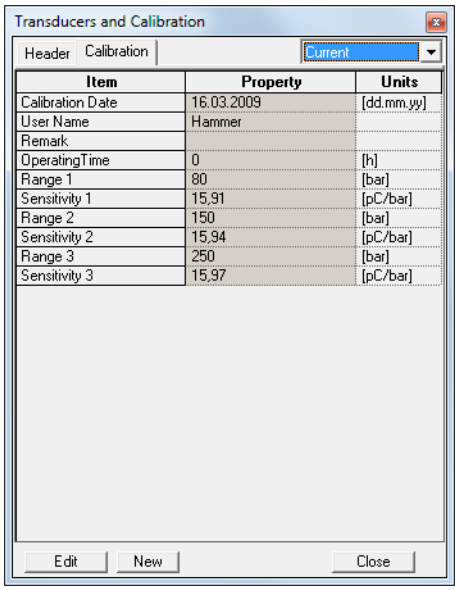

Fig. 9 AVL SDC, Calibration tab

This tab displays the calibration data.

- **Calibration Date**
  Date of the calibration.
- **User Name**
  Name of the person who does the calibration.
- **Remark**
  Comment.
- **Operating Time**
  In this field you see the operating time for the current calibration. If you recalibrate the sensor, the current data including the operating time will be moved to the **History 1** page and the operating time will be reset to **0**.

- **Range 1 to 3, Sensitivity 1 to 3 and Linearity 1 to 3**
  In these fields you can input the calibration values for up to 3 ranges. The transducer sensitivity factor is selected automatically according to the defined pressure range. The calibration values are taken from the **Current** page (see list box in upper right-hand section of window).

Example

Pressure Range (input signal range) = 80 bar
Range 1 to 15 bar
Range 2 to 50 bar
Range 3 to 100 bar
Selection of calibration factor from range 3

- **Sensor calibration**
  To calibrate a sensor, first click the button **New**. The calibration data of the **Current** page will be moved to the **History 1** page. History 1 will become History 2, etc. The pages History 1 to 5 allow you to compare the current calibration with the previous one and see whether there are any changes.
- **Edit**
  By clicking **Edit** you can switch to the Edit mode, which enables you to edit the values in the **Property** column.
  At the same time, the button **Burn** is enabled which allows you to save the modifications in the AVL SDC.
- **Close**
  Closes the dialog.

6 Optimizing the Signal Quality

6.1 Cable Length, Cable Installation

For best signal quality ensure that:

- The amplifier input cable is kept short.
- The amplifier input cable is installed as far away from other cables (especially ignition, injectors) as possible.
- Should you still notice superimposed interference signals, you could try to reduce them by adjusting the **Grounded Input** setting.
- The amplifier input cable is not exposed to mechanical stress and vibrations.
- The amplifier input cable connections are kept clean and dry.

NOTICE

The amplifier outputs are ground referenced. If you are using longer cables leading up to the indicating systems' inputs, these are required to have differential inputs.

6.2 Isolation

For quasi-static operation, the cable should have an isolation resistance of $\geq 10^{13}$ ohms, otherwise the output voltage of the charge amplifier will drift significantly.

6.3 Cable Noise

Normal coaxial cables generate electrical charges as a result of vibrations due to friction between the shield and dielectric. To prevent this effect, coaxial cables used for piezo electric measurements should have an additional coating of graphite or conductive plastic on the dielectric material.

6.4 Electromagnetic Compatibility

To comply with the **Electromagnetic Compatibility (EMC)** directive it is necessary to mount a clamp-on ferrite core onto the input signal cable (included in scope of supply):

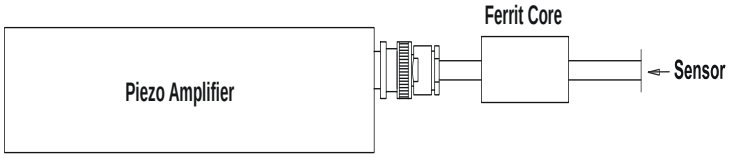

Fig. 10 Position of ferrite core (thick cable)

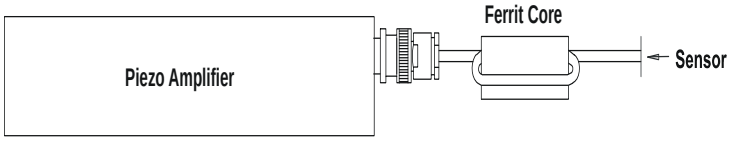

Fig. 11 Position of ferrite core (thin cable)

6.5 Piezo Signal Conditioning

Best quality of the measurement signal can be ensured by applying the following functions:

- Drift Compensation
- Extended Output Range
- Filter

6.5.1 Drift Compensation

You have a choice of the three modes no drift compensation, cyclic drift compensation or continuous drift compensation:

No drift compensation

For quasi-static measurements (e.g. dead weight calibration).

Advantage

Amplitude and phase of the measurement signal are not affected.

Disadvantage

Zero point drift; reset required prior to each measurement.

Continuous drift compensation

For signals with no distinctive pressure maximum (e.g. low pressure signals such as intake manifold pressure).
In this mode, the device attempts to keep the signal average value permanently at 0 V or -8 V, which also has an impact on the signal amplitude.

Information

This mode should not be used for accurate IMEP measurements at speeds < 1000 rpm.

Advantage

No zero point drift; no reset required prior to each measurement.

Disadvantage

IMEP error at speeds < 1000 rpm

Cylic drift compensation

For periodical signals (e.g. cylinder pressure).

Advantage

No zero point drift, no effect on amplitude and phase, no reset necessary prior to each measurement.
You can choose between **0 V** and **-8 V** offset voltage.

NOTICE

If the cylinder pressure signal is no longer detected (signal period > 1.2 s or amplitude < average value [V] +0.7 V), **Continuous** mode is automatically selected.

NOTICE

In the **Cyclic** mode, the maximum drift compensation current is no more than 10 % of the current available in the **Continuous** mode. This also applies if the signal is no longer detected and the operating mode internally switches to **Continuous**. This way, any interference from the drift control at the signal detection threshold is prevented.

6.5.2 Extended Output Range

0 V

To be used in case of:

- Positive input voltage range of the evaluation device
- Input signal with significant negative range (e.g. intake manifold pressure)

-8 V

To be used in case of:

- -10/+10 V input voltage range of the evaluation device
- Charge amplifier input signal with low negative signal range (e.g. cylinder pressure)

6.5.3 Filter

Basically, the 50 kHz or 100 kHz setting should be used to prevent phase shift errors even at very high speeds.

The other selectable cut-off frequencies serve to filter superimposed pipe oscillations if the sensor has been mounted unfavorably.

NOTICE

If the LED on the flashes red, this indicates a brief or longer saturation of the amplifier. Reset the amplifier. If necessary, reduce the gain by entering a higher value in the **Signal Input Range** input field. Also check cable connections.

7 Maintenance

7.1 Accuracy

On a regular basis (typically once a year):

Check of the amplifier's accuracy.
For this check, AVL provides the AVL Amplifier Calibration Unit.

Article:
TI04CALUA.01 Amplifier Calibration Unit

7.2 Drift

The high isolation resistance of piezo amplifiers at the time of delivery can only be maintained if the devices are always kept dry and clean.

If the piezo amplifier is in perfect condition, the typical drift is <0.03 pC/s (max. 0.2 pC/s in entire operating range), which corresponds to an input current of 0.03 pA.

Significant Drift

The drift is too large when a value of 36 mV/min at the amplifier output with Gain = 16 is exceeded. This gain is set internally when e.g. the following values are input:

- Transducer Sensitivity = 20 pC/bar
- Signal Input Range = 25 bar.

1. Check the drift on a regular basis.
2. Switch on the measurement chain.
3. Activate the check box **Reset** for 15 minutes.
4. Then terminate the **Reset** and observe the voltage at the respective output.
5. If there is too much drift in the measurement chain, disconnect the pressure transducer and the cable from the amplifier input.
   - If the drift is less than it was when the pressure transducer was connected, the drift is caused by the cable and/or the pressure transducer.
   - If there is still as much drift as there was before, perform the next steps.
6. Carefully clean the isolation element in the input socket.
   - For this purpose, use a clean, dry cloth.
   - If that does not reduce the drift, then clean it with pure diethyl ether or trichloroethylene and dry it with a clean cloth.

WARNING

Danger of chemical burns and injury

Always heed the relevant warnings and safety instructions when using caustic or highly flammable cleaning agents.

– If there is still too much drift, dry the amplifier for 6 hours at +70° C.

Information

If none of these measures solves the problem, the amplifier needs cleaning inside as well. This should only be done by the manufacturer.

8 Technical Data

8.1 General

Pollution degree
2

Power supply
Input voltage range 9.5 V ... 36 V DC

Max. continuous current load of supply connector
8 A

Power consumption
22 W start-up power, 15 W continuous power

Dimensions
218 x 42 x 230 mm (width x height x depth).
Depth including cable connections: 250 mm

Weight
1 AVL microIFEM = 1.5 kg19" tray incl. 2 pieces AVL microIFEM = 4 kg

Ambient temperature
-40 °C ... +60 °C
(See also *External Power Supply* on page 16.)

Storage temperature
0 °C ... +65 °C

Maximum relative humidity 80% for temperatures up to 31° C, with a linear decrease to 50% relative humidity at 40° C, non-condensing.

8.2 Signal Input

Charge

Type
Asymmetric, highly isolated for connecting piezoelectric measurement transducers.

Connection
BNC socket and 4-pin FISCHER or FISCHER triax socket **Q1 to Q4** on the front panel.

Isolation resistance
$\geq 10^{13}$ ohms

Overload capacity
Input protected against electrostatic voltages and charges occurring during operation and handling.

8.3 Signal Output

Type
Asymmetric, output ground connected to protective ground and can be decoupled from the input ground by means of a differential amplifier.

Connection
BNC socket on the rear panel of the AVL microIFEM.

Voltage
-11 V ... +11 V at load >333 ohms

Current
±30 mA max.

Output offset
0 V or -8 V selectable

Temperature drift
<0.5 mV/°C (DRCO, 50 pC/V)

8.4 Signal Conditioning

Polarity
Inverting, negative input charge produces positive output voltage.

Sensitivity
4P4 A/C/E/G: adjustable between 8 pC/V and 800 pC/V
4P4 B/D/F/H: adjustable between 16 pC/V and 1600 pC/V

Measuring range

- **Offset 0 V**
  - 4P4 A/C/E/G:
    For +10 V at output: 80 pC min., 8000 pC max.
  - 4P4 B/D/F/H:
    For +10 V at output: 160 pC min., 16000 pC max.
- **Offset -8 V**
  - 4P4 A/C/E/G:
    For 18 V at output: 144 pC min., 14400 pC max.
  - 4P4 B/D/F/H:
    For 18 V at output: 288 pC min., 28800 pC max.

Errors
Output voltage / input charge

- **Linearity error** <0.01% FSO
- **Gain error**
  - 4P4 A/C/E/G:
    25 pC/V... 800 pC/V: ≤0.3%
    8 pC/V ... 25 pC/V: ≤0.5%
  - 4P4 B/D/F/H:
    50 pC/V... 1600 pC/V: ≤0.3%
    16 pC/V ... 50 pC/V: ≤0.5%

Temperature sensitivity of gain
<40 ppm/°C

Gain resolution
12-bit

Frequency Response

Upper cut-off frequency (-3 dB)
Adjustable: approx. 12 kHz / 20 kHz / 30 kHz / 50 kHz / 100 kHz

Lower cut-off frequency

- **DRCO OFF**
  Quasi-static measurements possible. The time constant depends mainly on the degree of soiling and humidity of the highly isolating elements, the connected cable and the measurement transducer.
- **DRCO ON**
  Zero point drift-free, depending on the measurement signal period:
  - Measurement signal period T <1.2 s:
    Amplitude and phase not affected.
  - Measurement signal period T >1.2 s:
    Continuous drift compensation
    (i.e. amplitude and phase are affected)

Drift (due to leakage current)
typ. < 0.03 pC/sec
< 0.2 pC/sec in entire operating range

Drift (when applying a constant charge signal of 13500 pC)
typ. < 0.1 pC/sec

Hum and noise
<1 mV_{RMS} or <10 mV_{ss} (0 to 50 MHz)
(50 pC/V, DRCO)

8.5 Data of Other Functions

Overload Indication

When the control range is exceeded (approx. $\pm$11 V), the LED flashes red (or LED symbol lights up red) if the range monitoring function has been activated in AVL IndiSignal.

Drift Compensation DRCO

Signal period

- T <1.2 s (corresponds to 100 min^{-1} in 4-stroke engines):
  Drift-free measurement without any effect on amplitude and phase
- T >1.2 s:
  Continuous drift compensation

Output signal lift
$U_{out\ min}$ = 0.7 V_{ss}
Minimum output signal lift for drift compensation to function properly.

8.6 Pin Assignment - Front Panel

8.6.1 BNC Socket

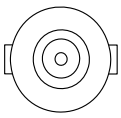

Fig. 12 BNC socket

8.6.2 4-Pin FISCHER Socket

Assignment	Signal
Pin 1	TEDS Data
Pin 2	Ground
Pin 3	Charge signal
Pin 4	Not used

Tab. 2

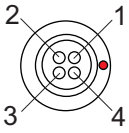

Fig. 13 4-pin FISCHER socket (only 4P4 E/F/G/H)

8.6.3 FISCHER Triax Socket

Assignment	Signal
Pin 1	Charge signal
Pin 2	TEDS Data
Pin 3	Ground
Pin 4	Not used

Tab. 3

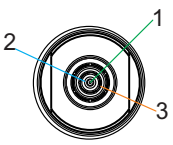

Fig. 14 FISCHER triax socket (only 4P4 A/B/C/D)

8.7 Pin Assignment - Rear Panel

8.7.1 Connector RS232 OUT (X7) / Socket RS232 IN (X8)

Assignment	Signal RS232 IN	Signal RS232 OUT
Pin 1	Not used	Not used
Pin 2	TXD	RXD
Pin 3	RXD	TXD
Pin 4	Not used	Not used
Pin 5	Ground	Ground
Pin 6	Not used	Not used
Pin 7	Not used	Not used
Pin 8	Not used	Not used
Pin 9	Not used	Not used
Socket housing	Cable shield (protective ground)	Cable shield (protective ground)

Tab. 4

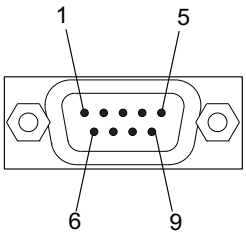

Fig. 15 9-pin Sub-D connector RS232 OUT (X7)

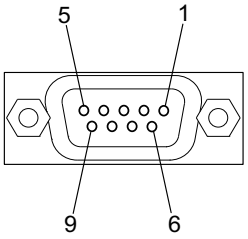

Fig. 16 9-pin Sub-D socket RS232 IN (X8)

8.7.2 Connectors 9.5 ... 36 V DC IN (X1) / 9.5 ... 36 V DC OUT (X2)

Assignment	Signal
Pin 1	Ground
Pin 2	Protective ground
Pin 3	+24V
Socket housing	Cable shield (protective ground)

Tab. 5

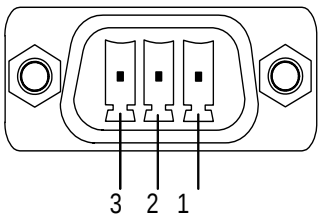

Fig. 17 3-pin Sub-D connector 9.5 ... 36 V DC IN (X1)/ 9.5 ... 36 V DC OUT (X2)

8.7.3 Connector X9

Assignment for 25-pin SUB-D connector	Signal
Pin 13	Ground
Pin 16	RESET CH1
Pin 17	RESET CH2
Pin 18	RESET CH3
Pin 19	RESET CH4
Socket housing	Cable shield (protective ground)

Tab. 6

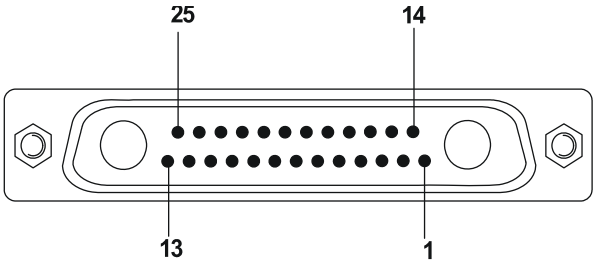

Fig. 18 25-pin Sub-D connector X9

8.7.4 Socket for Connector X9

Assignment for 37-pin SUB-D socket	Signal
Pin 16	Ground
Pin 25	RESET CH1
Pin 26	RESET CH2
Pin 27	RESET CH3
Pin 28	RESET CH4
Socket housing	Cable shield (protective ground)

Tab. 7

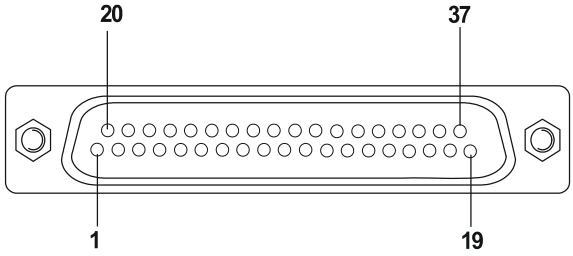

Fig. 19 37-pin Sub-D socket for connection to connector X9

8.8 CE Compliance

The AVL microIFEM Piezo 4P4x complies with the following directives and standards:

2004/108/EC Electromagnetic Compatibility Directive complied with by virtue of compliance with the following Standard:

- EN 61326-1:06 Electrical Equipment for Measurement, Control and Laboratory Use

  EMC Requirements

Area of application:

Class A equipment:
Equipment suitable for use in establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

AVL microIFEM Piezo 4P4x

The charge inputs Q1 to Q4 are not EMC-protected.

Because:

- The inputs must have high external impedance ($\geq 10^{13}$ ohms) so that no EMC filters can be used.
- The main sources of interference on the test bed are ground loop problems. To suppress such interference, the shields of input cables at the amplifier end must not be connected to protective ground because the sensors are connected to the engine ground at the engine end. In this way, no effective HF shielding can be achieved.

The CE test was therefore carried out with no measurement cables and pressure transducers connected.

9 Appendix

9.1 Calibration with Dead-Weight Tester (IndiSignal Stand-alone Only)

Individual pressure transducers or the entire measurement chain can be calibrated with a dead weight tester.

- Right-click the piezo amplifier and select the option **Dead-Weight Tester** from the context menu. The first dialog of the Calibration Wizard is then displayed where you can choose between three calibration methods:
  - Transducer Calibration
  - Calibration of the Entire Measurement Chain with Preselected Output Voltage
  - Calibration of the Entire Measurement Chain with Preselected Maximum Pressure

NOTICE

To avoid errors, make sure that the dead-weight tester is properly grounded when doing calibration measurements.

9.1.1 Transducer Calibration

The following example shows how to calibrate a sensor on a dead weight tester, i.e. how to determine the sensitivity in pC/bar.
The selected calibration pressure is 120 bar, the voltage at ambient pressure is set to -8 V.

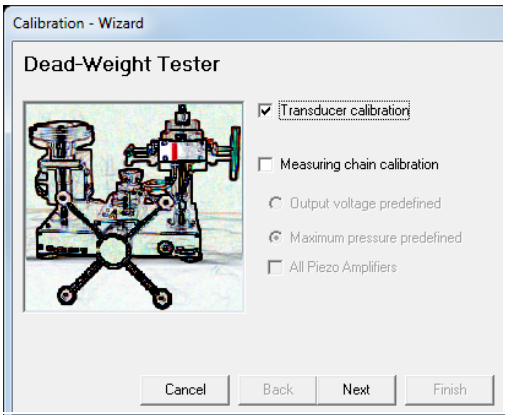

Fig. 20 Transducer Calibration

1. If you want to calibrate the transducer with a dead-weight tester, activate the **Transducer Calibration** check box.

2. Click **Next**.

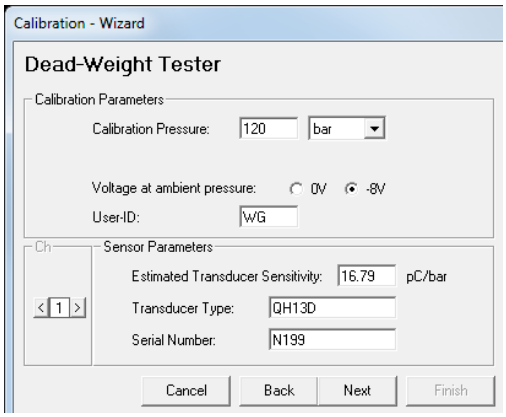

Fig. 21 Calibration parameters for transducer calibration

3. Mount the pressure transducer on the dead weight tester and input the calibration pressure (**Calibration Pressure** input field) as well as the approximate sensitivity (**Estimated Transducer Sensitivity** input field).
4. Enter the pressure transducer data.
5. Select **-8 V** offset voltage for optimum utilization of the measuring range.
6. Enter the user ID (**User-ID**).
7. Click **Next**.

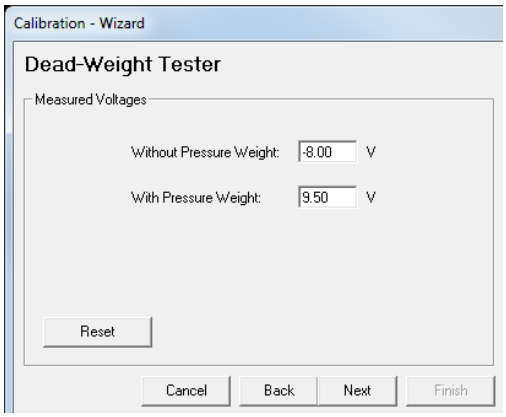

Fig. 22 Voltages measured during transducer calibration

8. Click **Reset** to reset the charge amplifier to its original status. When doing so, ensure that ambient pressure is applied to the transducer.
9. Read the output voltage without calibration pressure (e.g. with the DVM function of the indicating instrument) and enter this voltage value in the **Without Pressure Weight** input field.
10. Apply the calibration pressure.
11. Read the output voltage with calibration pressure and enter this voltage value in the **With Pressure Weight** field.

12. Click **Next**.

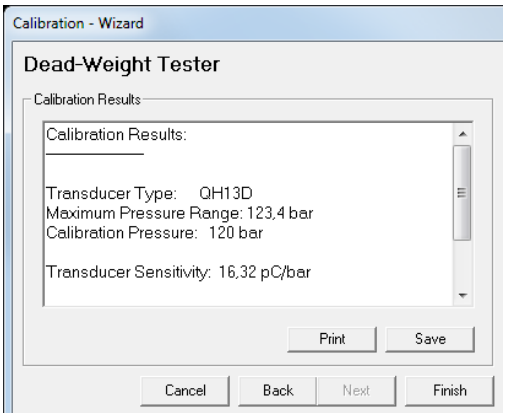

Fig. 23 Transducer calibration results

13. Read the automatically calculated pressure transducer sensitivity under **Transducer Sensitivity**.

    It is possible to print out the calibration results or save them to a text file.

14. Click **Finish** to close the Calibration Wizard.

    The transducer's calibration values are saved in the piezo amplifier. The amplifier, however, is not disabled for further calibration value modification.

9.1.2 Calibration of the Entire Measurement Chain with Preselected Output Voltage

The example given below shows the calibration of the entire measurement chain with preselected output voltage.
The selected calibration pressure is 120 bar, the required voltage difference between calibration pressure and ambient pressure is 16 V. The estimated sensitivity is 17 pC/bar.

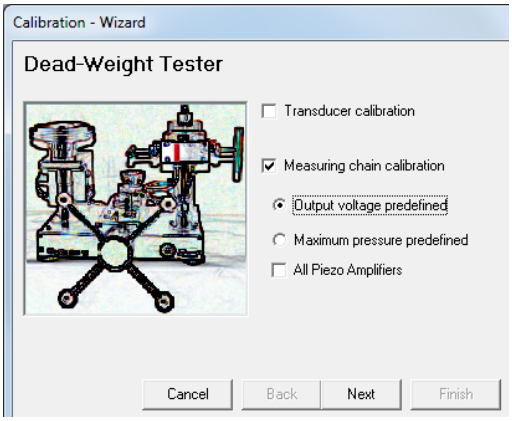

Fig. 24 Calibration of measurement chain with predefined output voltage

1. If you want to calibrate the entire measurement chain using a dead weight tester with preselected output voltage, activate the **Measuring chain calibration** check box and click the **Output voltage predefined** option button.

You can use this to obtain the required output voltage (maximum 10 V) for a specific calibration pressure.

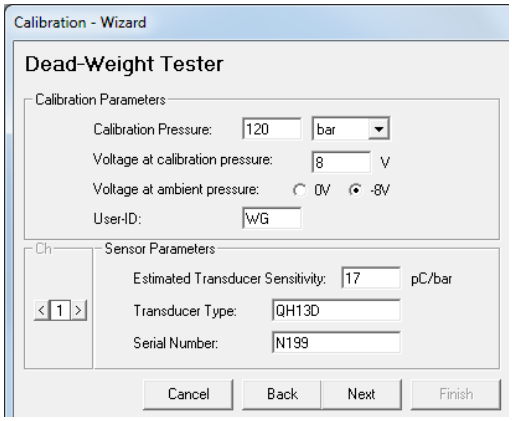

Fig. 25 Calibration parameters with predefined output voltage

2. Mount the pressure transducer on the dead-weight tester.
3. Input the calibration pressure (**Calibration Pressure** input field) and the approximate sensitivity (**Estimated Transducer Sensitivity** input field).
4. Enter the pressure transducer data.
5. In the **Voltage at calibration pressure** input field, enter the required output voltage at the applied calibration pressure (in the example 8 V).
6. Select **-8 V** offset voltage for optimum utilization of the measuring range.

   The internal gain will be calculated with the following values:

   – Calibration Pressure (in the example 120 bar)
   – Estimated Transducer Sensitivity (in the example 17 pC/bar)
   – Output voltage ~16 V = voltage difference between calibration pressure and ambient pressure
7. Enter the user ID (**User-ID**).
8. Click **Next**.

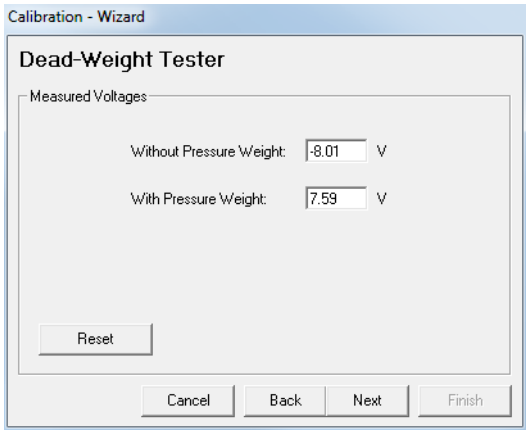

Fig. 26 Measured voltages with predefined output voltage

9. Click **Reset** to reset the charge amplifier to its original status. When doing so, ensure that ambient pressure is applied to the transducer.

10. Read the output voltage without calibration pressure (e.g. with the DVM function of the indicating instrument) and enter this voltage value in the **Without Pressure Weight** input field.
11. Apply the calibration pressure.
12. Read the output voltage with calibration pressure and enter this voltage value in the **With Pressure Weight** field.
13. Click **Next**.

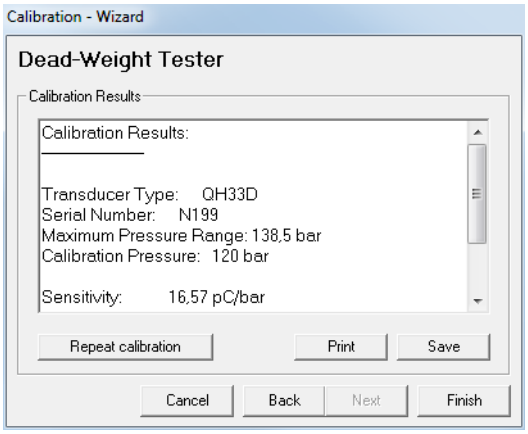

Fig. 27 Calibration results with predefined output voltage

It is possible to print out the calibration results or save them to a text file.

After this calibration, the system can calculate the exact sensitivity of this transducer (in our example 16.57 pC/bar instead of the estimated 17 pC/bar).

If you now repeat the calibration (click **Repeat calibration**), the calculated sensitivity (in the example 16.57 pC/V) will be transferred automatically into the field **Estimated Transducer Sensitivity** and the Calibration Wizard's **Measured Voltages** dialog will be displayed.

14. Carry out the calibration once again as described.

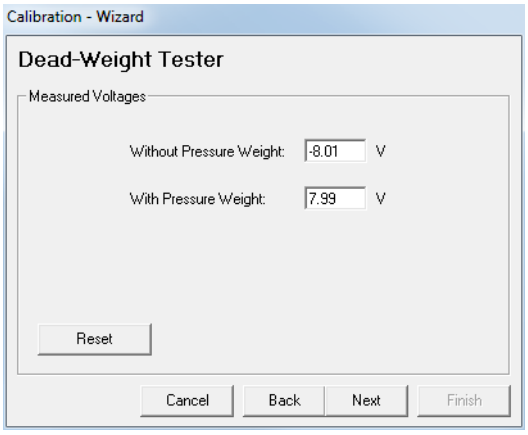

Fig. 28 Measured voltages (adjusted) with predefined output voltage

15. Enter the measurement values in the corresponding fields and click **Next**.

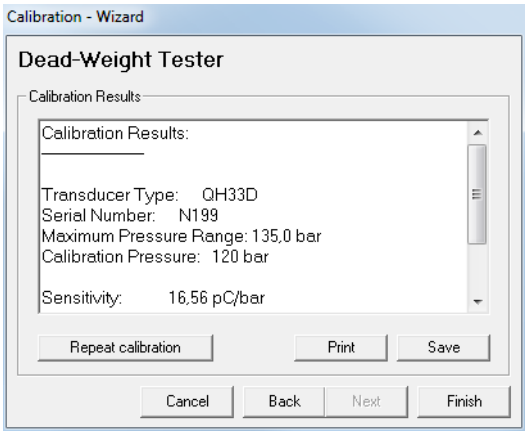

Fig. 29 Calibration results (adjusted) with predefined output voltage

Based on the correct transducer sensitivity you now get the expected voltage difference of 16 V for 120 bar.

It is possible to print out the calibration results or save them to a text file.

16. Click **Finish** to close the Calibration Wizard.

The calibration values of the entire measurement chain including the pressure transducer are stored in the piezo amplifier and can be checked on the **Calibration Info** tab in the Properties dialog.

These calibration values cannot be deleted until the link on the **Calibration Info** tab in the Properties dialog is canceled.

17. To do this, click **Cancel**.

The password to unlock the calibration values is defined in the indisignal.ini file (entry *CalPW* =).

9.1.3 Calibration of the Entire Measurement Chain with Preselected Maximum Pressure

The example given below shows the calibration of the entire measurement chain with preselected maximum pressure. A maximum pressure of 140 bar is assumed. However, calibration is performed using a pressure of 120 bar. The estimated sensitivity is again assumed to be 17 pC/bar.

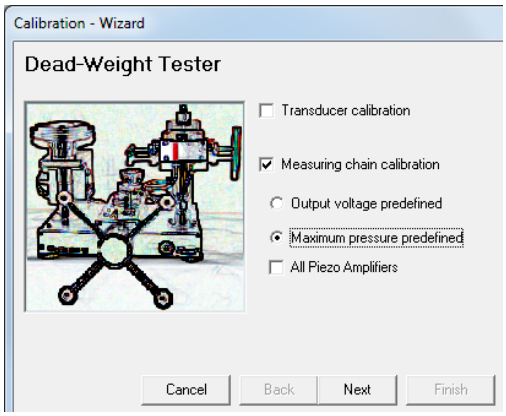

Fig. 30 Measurement chain calibration with predefined maximum pressure

1. If you want to calibrate the entire measurement chain using a dead weight tester with preselected maximum pressure, activate the **Measuring chain calibration** check box and click the **Maximum pressure predefined** option button.

You can use this if you want to carry out a measurement with a higher operating pressure than the one you use for calibration.

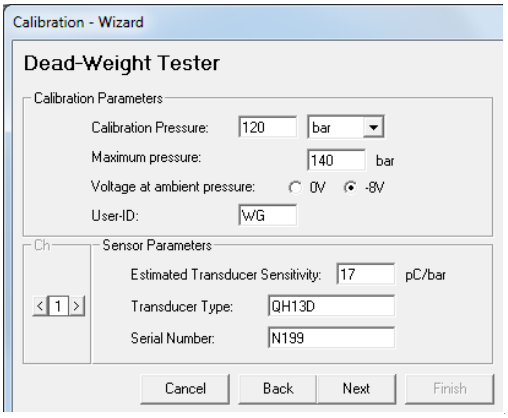

Fig. 31 Calibration parameters with predefined maximum pressure

2. Mount the pressure transducer on the dead-weight tester.
3. Input the calibration pressure (**Calibration Pressure** input field) and the approximate sensitivity (**Estimated Transducer Sensitivity** input field).
4. Enter the pressure transducer data.
5. Enter the required maximum operating pressure in the **Maximum Pressure** input field.
6. Select **–8 V** offset voltage for optimum utilization of the measuring range.

   The internal gain will be calculated with the following values:

   – Maximum Pressure
   – Estimated Transducer Sensitivity
7. Enter the user ID (**User-ID**).
8. Click **Next**.

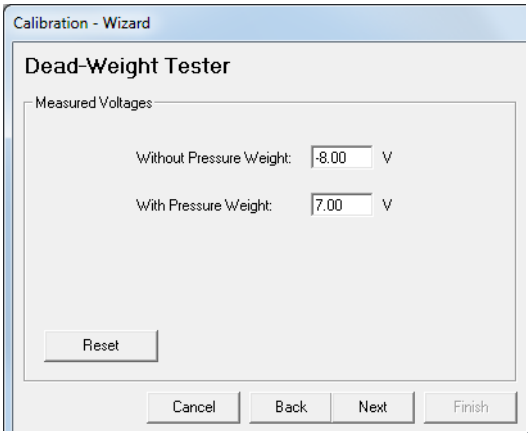

Fig. 32 Measured voltages with predefined maximum pressure

9. Click **Reset** to reset the charge amplifier to its original status. When doing so, ensure that ambient pressure is applied to the transducer.
10. Read the output voltage without calibration pressure (e.g. with the DVM function of the indicating instrument) and enter this voltage value in the **Without Pressure Weight** input field.
11. Apply the calibration pressure.
12. Read the output voltage with calibration pressure and enter this voltage value in the **With Pressure Weight** field.

13. Click **Next**.

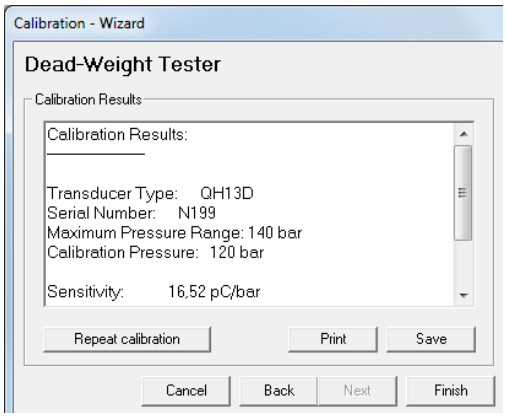

Fig. 33 Calibration results with predefined maximum pressure

It is possible to print out the calibration results or save them to a text file.

After this calibration, the system can calculate the exact sensitivity of this transducer (in our example 16.52 pC/bar instead of the estimated 17 pC/bar).

If you now repeat the calibration (click **Repeat calibration**), the calculated sensitivity (in the example 16.52 pC/V) will be transferred automatically into the field **Estimated Transducer Sensitivity** and the Calibration Wizard's **Measured Voltages** dialog will be displayed.

14. Carry out the calibration once again as described.

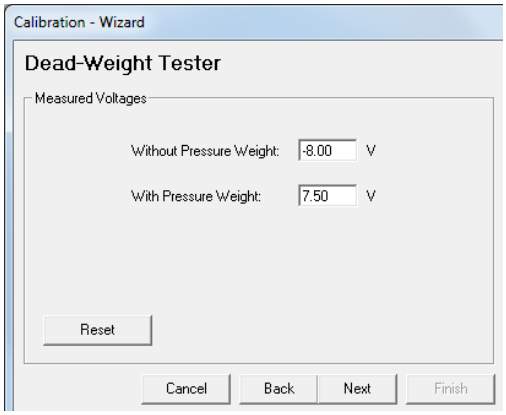

Fig. 34 Measured voltages (adjusted) with predefined maximum pressure

15. Enter the measurement values in **V** and click **Next**.

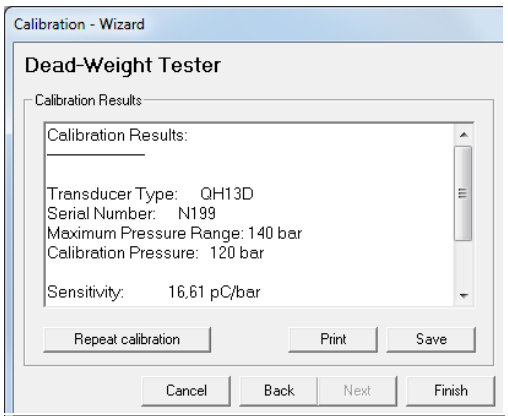

Fig. 35 Calibration results (adjusted) with predefined maximum pressure

Based on the correct transducer sensitivity you now get a maximum pressure range of 140 bar.

It is possible to print out the calibration results or save them to a text file.

16. Click **Finish** to close the Calibration Wizard.

    The calibration values of the entire measurement chain including the pressure transducer are stored in the amplifier of the AVL FlexIFEM and can be checked on the **Calibration Info** tab in the Properties dialog.

    The amplifier is disabled for further calibration value modification.

    The password to unlock the calibration values is defined in the indisignal.ini file (entry *CalPW* =).

9.1.3.1 Calibration of Entire Measurement Chain with Preselected Output Voltage for all Piezo Amplifiers

The example given below also demonstrates how to calibrate the entire measurement chain with preselected output voltage, but for multiple sensors.

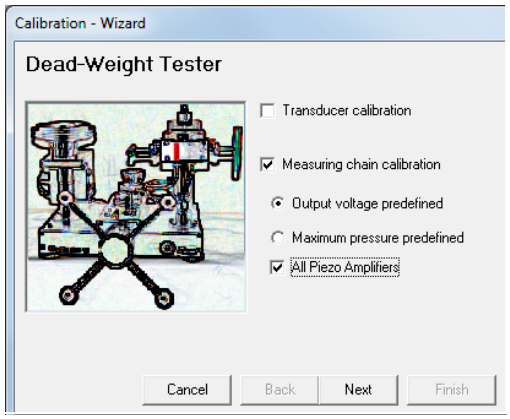

Fig. 36 Calibration of measurement chain with predefined output voltage for all piezo amplifiers

1. If you want to calibrate more sensors at the same time, activate the check box **All Piezo Amplifiers**.

   The calibrating parameters are valid for all sensors, the sensor parameters have to be defined individually.

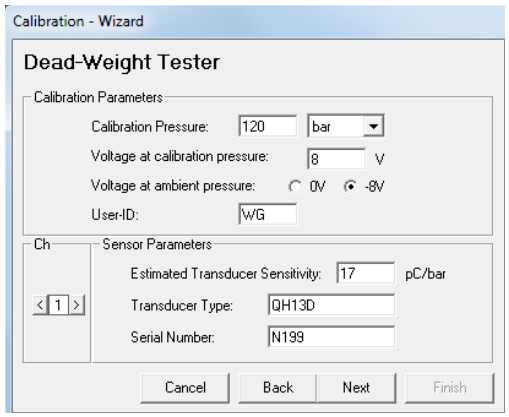

Fig. 37 Calibration parameters with predefined output voltage for all piezo amplifiers

2. After the pressure drop at the dead-weight tester, fill in the displayed voltage values for every amplifier.

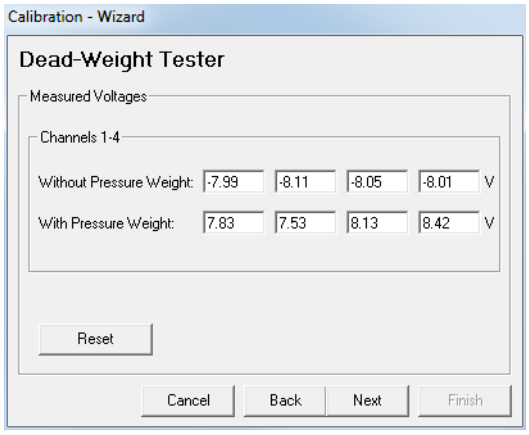

Fig. 38 Measured voltages with predefined output voltage for all piezo amplifiers

Finally, the system calculates the calibrating factors and writes them into each amplifier.

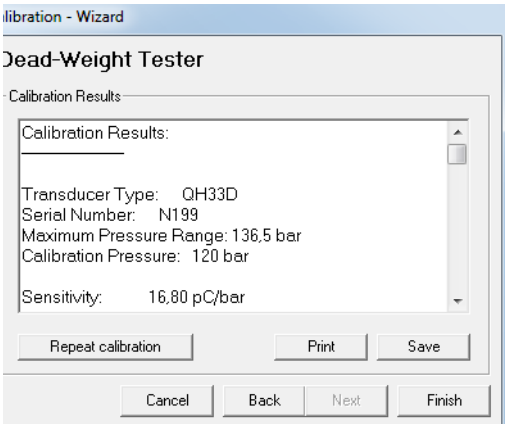

Fig. 39 Calibration results with predefined output voltage for all piezo amplifiers

3. Carry out the calibration once again as described.
4. Enter the measurement values in the corresponding fields and click **Next**.

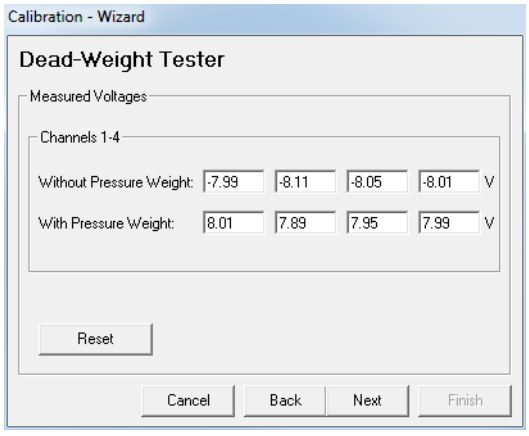

Fig. 40 Measured voltages (adjusted) with predefined output voltage for all piezo amplifiers

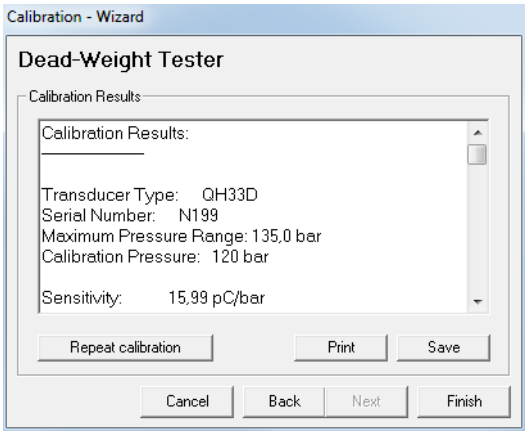

Fig. 41 Calibration results (adjusted) with predefined output voltage for all piezo amplifiers

Based on the correct transducer sensitivity you now get the expected voltage difference of 16 V for 120 bar.

It is possible to print out the calibration results or save them to a text file.

5. Click **Finish** to close the Calibration Wizard.

9.1.4 Deleting Saved Calibration Data

If you want to enter parameters directly or use a new calibration method, you first have to unlock the calibration data.

- Click the **Unlink** button on the **Calibration Info** tab within the Properties dialog.

  The password to unlock the calibration values is defined in the indisignal.ini file (entry *CalPW* =).

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