HBM

QUANTUM^X

HBM

Content

1 Safety instructions

Appropriate use

The module and the connected transducers may be used for measurement and directly related control tasks only. Any other use is **not** appropriate.

To ensure safe operation, the module may only be used as specified in the operating manual. It is also essential to follow the respective legal and safety regulations for the application concerned during use. The same applies to the use of accessories.

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.

Additional safety precautions must be taken in plants where malfunctions could cause major damage, loss of data or even personal injury. In the event of a fault, these precautions establish safe operating conditions.

This can be done, for example, by mechanical interlocking, error signaling, limit value switches, etc.

Safety rules

A module must not be connected directly to a power supply network. The maximum permissible supply voltage is 10...30 V (DC).

The supply connection, as well as the signal and sense leads, must be installed in such a way that electromagnetic interference does not adversely affect device functionality (HBM recommendation: "Greenline shielding design", downloadable from the Internet at http://www.hbm.com/Greenline).

Automation equipment and devices must be covered over in such a way that adequate protection or locking against unintentional actuation is provided (such as access checks, password protection, etc.).

When devices are working in a network, these networks must be designed in such a way that malfunctions in individual nodes can be detected and shut down.

Safety precautions must be taken both in terms of hardware and software, so that a line break or other interruptions to signal transmission, such as via the bus interfaces, do not cause undefined states or loss of data in the automation device.

General dangers of failing to follow the safety instructions

The module is a state of the art device and as such is failsafe. The module may give rise to further dangers if it is inappropriately installed and operated by untrained personnel. Any person instructed to carry out installation, commissioning, maintenance or repair of the module must have read and understood the Operating Manuals and in particular the technical safety instructions.

Remaining dangers

The scope of supply and performance of the module covers only a small area of measurement technology. In addition, equipment planners, installers and operators should plan, implement and respond to the safety engineering considerations of measurement technology in such a way as to minimize remaining dangers. Prevailing regulations must be complied with at all times. There must be reference to the remaining dangers connected with measurement technology. After making settings and carrying out activities that are password–protected, you must make sure that any controls that may be connected remain in safe condition until the switching performance of the module has been tested.

Working safely

Error messages should only be acknowledged once the cause of the error is removed and no further danger exists.

Conversions and modifications

The module must not be modified from the design or safety engineering point of view except with our express agreement. Any modification shall exclude all liability on our part for any resultant damage.

In particular, any repair or soldering work on motherboards (replacement of components is prohibited. When exchanging complete modules, use only original parts from HBM.

The module is delivered from the factory with a fixed hardware and software configuration. Changes can only be made within the possibilities documented in the manuals.

Outputs

It is essential to take safety precautions when using a module's digital, analog or CANbus outputs. Make sure that status or control signals do not perform any actions that result in damage to human health or the environment.

Qualified personnel

Qualified persons means persons entrusted with the installation, fitting, commissioning and operation of the product who possess the appropriate qualifications for their function. This module is only to be installed and used by qualified personnel, strictly in accordance with the specifications and the safety rules and regulations.

This includes people who meet at least one of the three following requirements:

*   Knowledge of the safety concepts of automation technology is a requirement and as project personnel, you must be familiar with these concepts.

*   As automation plant operating personnel, you have been instructed how to handle the machinery and are familiar with the operation of the modules and technologies described in this documentation.

*   As commissioning engineers or service engineers, you have successfully completed the training to qualify you to repair the automation systems. You are also authorized to activate, to ground and label circuits and equipment in accordance with safety engineering standards.

It is also essential to comply with the legal and safety requirements for the application concerned during use. The same applies to the use of accessories.

NOTE

The safety instructions in this document also apply to the NTX001 power supply and the BPX001 active back plane.

In this manual, the following symbols are used to point out residual dangers:

Symbol: **DANGER**

Meaning: **Maximum danger level**

Warns of an **imminently** dangerous situation in which failure to comply with safety requirements **will** result in death or serious bodily injury.

Symbol: **WARNING**

Meaning: **Dangerous situation**

Warns of a **potentially** dangerous situation in which failure to comply with safety requirements **can** result in death or serious bodily injury.

Symbol: **CAUTION**

Meaning: **Potentially dangerous situation**

Warns of a **potentially** dangerous situation in which failure to comply with safety requirements **could** result in damage to property or some form of bodily injury.

Symbol:

Meaning: **Electrostatic Sensitive Devices**

Devices marked with this symbol can be destroyed by electrostatic discharge. Please observe the precautions for handling electrostatic sensitive devices.

Symbol: **On the equipment**

Meaning: **Observe information provided in the operating manual.**

Symbols pointing out notes on use and waste disposal as well as useful information:

Symbol: **NOTE**

Points out that important information about the product or its handling is being given.

Symbol:

Meaning: **CE mark**

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).

Symbol:

Meaning: **Statutory marking requirements for waste disposal**

National and local regulations regarding the protection of the environment and recycling of raw materials require old equipment to be separated from regular domestic waste for disposal.
For more detailed information on disposal, please contact the local authorities or the dealer from whom you purchased the product.

Conditions on site

For modules in housings with IP20 degree of protection:

– Protect the modules from moisture and dampness or weather such as rain, snow, etc.

– The permissible relative humidity at 31ºC is 80% (non condensing); linear reduction to 50% at 40 ºC.

– Make sure that you do not cover the ventilation openings at the side.

For all modules:

– Do not expose the modules to direct sunlight

– Comply with the maximum permissible ambient temperatures as stated in the specifications.

– Ensure sufficient ventilation during installation into the BPX001 backplane.

Maintenance and cleaning

The modules are maintenance–free. Please note the following points when cleaning the housing:

– Before cleaning, disconnect the device from all connections.

– Clean the housing with a soft, slightly damp (not wet!) cloth. **Never** use solvent as this could damage the labeling or the housing.

– When cleaning, ensure that no liquid gets into the module or connections.

2   Introduction

2.1   About the QuantumX documentation

The QuantumX family documentation consists of

- A printed Quick Start Guide for initial start-up

- The data sheets in PDF format

- This operating manual in PDF format

- The operating manual for the EtherCAT®[1] / Ethernet gateway CX27 in PDF format

- The operating manual for data recorder CX22–W

- The operating manual for the Signal Conditioning Modules (SCM)
    High-voltage signal conditioner SCM–HV (300 V CAT II)
    Quarter bridge adapter SCM–SG–120 / –350 for single strain gauges

- A comprehensive online help with index and easy search options which is available after the installation of a software package (e.g. QuantumX Assistant, catman®EASY). Information about module and channel configuration can also be found here.

These documents can be found

- On the QuantumX system CD supplied with the device

- After installation of the QuantumX Assistant on the hard drive of your PC, which can be reached through the Windows start menu

- Up-to-date versions are always available from our Internet site at http://www.hbm.com/hbmdoc

[1]   EtherCAT® is a registered brand and patented technology, licensed by Beckhoff Automation GmbH, Germany

2.2   The QuantumX family

The QuantumX family is a modular measurement system for universal applications. The modules can be individually combined and intelligently connected according to the measurement task. Distributed operation makes it possible to position individual modules close to the measuring points, resulting in short sensor lines.

The QuantumX family consists of the following modules:

- **MX840** Universal amplifier
  The module has 8 universal inputs and supports more than 10 transducer technologies.

- **MX840A** Universal amplifier
  Like the MX840, but half bridges and ohmic resistors can also be connected.

- **MX440A** Universal amplifier
  Like the MX840A, but with 4 inputs (connections 5-8 of MX840A, without CAN).

- **MX1615** SG bridge amplifier
  The module has 16 individually configurable inputs for SGs in quarter, half and full bridge circuits. Bridge excitation voltage DC or carrier frequency (1200 Hz).

- **MX1601** Analog amplifier (standardized voltage / current, IEPE)
  The module has 16 individually configurable inputs for standardized voltage or current measurement or for connecting current-fed piezoelectric transducers (IEPE / ICP(R)).

- **MX410** Highly dynamic universal amplifier
  The module has 4 universal inputs and supports commonly used transducer technologies (at a sampling rate of up to 96000 measured values per channel per second).

- **MX460** Digital input amplifier (rotation, torque, PWM)
  The module has 4 individually configurable inputs for connecting HBM torque measurement shafts (T10, T40), incremental rotary encoders, frequency signal source and pulse-width-modulated signals.

- **MX1609** Thermocouple amplifier
  The module has 16 inputs for type K thermocouples.

- **MX1609–T** Thermocouple amplifier
  The module has 16 inputs for type T thermocouples.

- **MX471** CAN module

  The module has 4 CAN bus nodes that can be configured for receiving and sending messages. The module support the CCP and xCP-on-CAN protocols on up to 2 channels.

- **MX878** Analog output module
  The module has 8 analog outputs to which a system or source signal can be assigned. Signals can also be calculated in real time.

- **MX879** Multi-I/O module
  The module has 8 scalable voltage outputs and 32 configurable digital inputs/outputs. Signals can also be calculated in real time.

- **CX27** EtherCAT®/Ethernet gateway
  The module is used to connect QuantumX modules to the EtherCAT® fieldbus or the Ethernet.

- **CX22–W** (WLAN) Data recorder
  The module is used for local recording of measurement data.

All modules have the following in common:

- 10 ⋯ 30 V DC supply voltage range (24 V DC nominal voltage)

- Configurable Ethernet interface for data communication with an operating PC

- 2 IEEE1394b FireWire interfaces
  - For optional voltage supply
  - For optional data communication with a PC
  - For automatic time synchronization of the modules
  - For real-time data transmission between modules

- Connector for installation on a backplane (not applicable for ultra-robust variants)

- Status LEDs for displaying general system and channel states

- A factory calibration certificate stored on each amplifier, which can be read out by the QuantumX Assistant.

- AutoBoot (module configurations are retained)

With amplifiers, the following applies for each measurement channel:

- Galvanic isolation (signal inputs/outputs, voltage supply, communication)

- Configurable supply voltage for active sensors

- Support for TEDS[*] (read, write)

- Configurable data rate

- Configurable active digital filter (Bessel, Butterworth)

- Configurable scaling

Sensors assigned using the sensor database can be calibrated via the channel and written back into the sensor database.

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[*]   TEDS = Transducer Electronic Data Sheet

2.3 Module overview/transducer technologies

QuantumX Modules

	MX840A	MX440A	MX1601	MX1615	MX410	MX460	MX1609 [2]	MX878	MX879	MX471	CX27
Number of channels (total)	8	4	16	16	4	4	16	-	-	-	-
Data rate (Samples/s)	19200	19200	19200	19200	96000	96000	300	-	-	-	-
Bandwidth (Hz)	3200	3200	3000	3000	38000	38000	14	-	-	-	-
Full-bridge strain gages	●	●		●	●						
Half-bridge strain gages	●	●		●	●						
Quarter-bridge strain gages	● [3]	● [3]		●	● [3]						
Inductive full-bridge	●	●			●						
Inductive half-bridge	●	●			●						
LVDT	●	●									
Voltage	●	●	●	●	●						
Current (± 20 mA)	●	●	●		●						
Current fed piezoelectric transducer (IEPE)	● [1]	● [1]	●		●						
Piezoresistive transducer	●	●			●						
Resistance	●	●		●							
Potentiometers	●	●									
PT100 resistance thermometer	●	●		●							
Thermocouples	●	●					●				
Indctive rotary encoder						●					
Incremental encoder	●	●				●					
SSI	●	●									
Frequency measurement, pulse counti	●	●				●					
PWM						●					
Torque / rotary speed	●	●				●					
CANbus	●									●	
Analog outputs						●		●	●		
Mathematics					●	●		●	●		
Digital IN (static)									●		●
Digital OUT (static)									●		●
CCP / xCP-on-CAN										●	
EtherCAT											●

¹) For connecting current-fed piezoelectric transducers, a Smart Module (1-EICP-B-2) is required.

²) MX1609 supports type K only; MX1609-T type T only.

³) Pluggable quarter bridge modules available, see Accessories SCM-SG120 and SCM-SG350.

See data sheets for precise technical specifications. The pin assignments can be found in the following chapters.

2.4   Digitalization and signal path

Input channel and the signals generated from it

Each QuantumX measurement channel generates two signals.

These signals can be individually parameterized with a different data rate and filter. Parameterization is easiest to implement with the "QuantumX Assistant" software (Signal tab).

If several modules are connected together via the IEEE1394b FireWire, signals can be sent in real time (isochronously), e.g. from signal source to an output (analog, CAN or EtherCAT$^{\circledR}$ bus) or for calculation (MX878/MX879). This isochronous real time operation is possible in parallel to the asynchronous operation. The maximum data rate here is 4.8 kHz.

The data on runtimes and the filter tables of the respective data sheets must be used to calculate runtimes from signal input to signal output.

Scaling

QuantumX supports the following types of scaling:

- Two point (2-point / y=mx+b)
- Table (multi-point)
- Polynomial

The 16-channel modules (MX1601 and MX1615) as well as modules MX410 and MX460 only support two point scaling.

2.5   QuantumX module synchronization

If measurement signals need to be referenced over time with each other for processing and analysis, they must be recorded synchronously.

All QuantumX modules can be synchronized among themselves. This ensures simultaneous measurement on all channels. All the analog-digital converter rates, measuring rates and bridge excitation voltages are therefore also synchronized.

Synchronization methods:

Synchronization via IEEE1394b FireWire

All the modules are synchronized automatically when they are connected via the IEEE1394b FireWire cable. This is the recommended method.

No CX27 module present in the system and no external synchronization source available:

The module with the highest serial number takes over the master function.

CX27 module present in the system and no external synchronization source available:

If a CX27 module is connected, it automatically becomes the synchronization master. When starting the system, the system time is set once to the actual time.

If QuantumX modules alone are being used, internal synchronization is sufficient. However, if synchronous measurements are to be performed by different measurement systems, an external master must be used for synchronization.

This is also a requirement if the QuantumX modules are a long distance away from one another and an IEEE1394b FireWire connection would be too complex.

Synchronization with external sources

In an external synchronization source is set, the module with the best synchronization quality automatically becomes the master and synchronizes all modules connected via IEEE1394b FireWire.

If several external sources are selected, the system decides according to the following priorities:

1. EtherCAT$^®$

2. IRIG–B

3. NTP

Synchronization via EtherCAT$^®$

The CX27 gateway supports the "Distributed Clocks" expansion of EtherCAT$^®$. In an EtherCAT$^®$ group the time is distributed to all EtherCAT$^®$ nodes.

The CX27 module can be synchronized to the EtherCAT$^®$ time. This will mean that all the QuantumX module clocks are synchronized to this time.

Synchronization via an NTP server

Each QuantumX module can synchronize its internal clock with an NTP server. The NTP time is distributed to the other modules via IEEE1394b FireWire.

It is possible to achieve accuracies in the 100 μs range, although this depends on the relevant Ethernet utilization.

Modules located close together should be synchronized via IEEE1394b FireWire.

If the synchronization source for a module is changed to NTP, the system must be restarted once. An NTP software package is included in the HBM software catman®EASY.

Parameters:

IP address of the NTP server

Threshold in μs, from which the time deviation to NTP time is tolerated

Further information about NTP can be found at http://www.ntp.org

Synchronization via IRIG-B

IRIG−B is a standardized time coding.

To time-synchronize the QuantumX system, the digital or analog modulated time signal is sent externally to any analog voltage input of the amplifier type MX840A (see Assignment, section 6.3.1).

The B127 format uses analog modulation. Connection is identical to that of a 10−V voltage sensor.

The other formats are BCD-coded and must be connected analog to the sensor "Frequencies single-pole, without directional signal", see section .

The amplifiers can record IRIG-B signals of type B000 to B007 and B120 to B127. All modules connected via IEEE1394b FireWire are also automatically synchronized. The coding includes the time, year and optionally the seconds of the day.

Comparison of synchronization mechanisms

Feature	IEEE1394b FireWire	Ethernet (NTP)	EtherCAT®	IRIG−B
Synchronization with other device types	QuantumX only	QuantumX, MGCplus other interrogators	All EtherCAT® nodes	All IRIG−B nodes
Max. distance between QuantumX modules	5 m (40 m with IEEE1394b FireWire extender, 500 m via optical fiber)	100 m (Ethernet)	100 m	−
Number of modules to be synchronized	24	Unlimited	CX27 required, Unlimited	Unlimited MX440A, MX840A required
Synchronization accuracy	< 1 µs	100 µs to 10 ms	< 1 µs	< 1 µs
Synchronization settling time	Immediate	Approx. 2 h during first start, approx. 10 min. during restart	Immediate	Immediate
Synchronization master	Auto 1 QuantumX module	External SyncMaster , e.g. PC	External SyncMaster	External IRIG−B master
Voltage supply	< 1.5 A, looped through	−	−	−

Synchronizing via IEEE1394b FireWire

Auto   Auto   Auto   Auto

Time base:
Automatic
(factory setting)

Synchronizing via CX27 (EtherCAT®)

Auto   Auto   Auto   **CX27**

EtherCAT®

Time base:
EtherCAT® master

Synchronizing via Ethernet / NTP and Gateway CX27 (IEEE1394b FireWire to the modules)

Auto   Auto   Auto   **NTP *)**

Ethernet

NTP

Time base:
NTP server

Synchronizing via Ethernet / NTP (without IEEE1394b FireWire)

NTP   NTP   NTP   NTP

Ethernet switch

Time base:
NTP server

Abb. 2.1:   Different methods of time synchronization

*)   CX27 or the module with the highest serial number

Successful synchronization:

To achieve a precise reference over time, the applicable channels must be parameterized with the same filter settings. No automatic runtime correction is carried out. The filter runtimes are shown in the data sheet. After booting and successful synchronization, the system LED is lit green. If synchronization is disturbed, or not yet established, the system LED is lit orange.
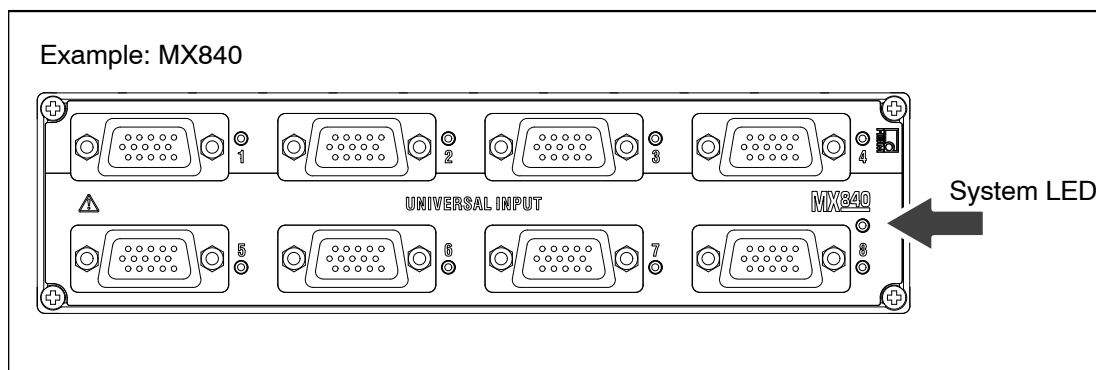
Time format used:

Basis: 1.1.2000

Time stamp: 64 bit

        32 bit seconds

        32 bit fractions of a second, resolution ($1/2^{32}$)

These time stamps are appended to the measured values.

There are several synchronization methods to choose from (also see Abb. 2.1 page 21):

- Synchronizing via IEEE1394b FireWire
- Synchronizing via EtherCAT® (CX27)
- Synchronizing via NTP *(Network Time Protocol)* with IEEE1394b FireWire
- Synchronizing via NTP without IEEE1394b FireWire

3   Software

The supplied QuantumX System CD contains a powerful software package consisting of the QuantumX Assistant, programming libraries for .NET, TEDS Editor, FireWire driver and a program for module firmware updating. catman®EASY and DIAdem driver are software products that can be obtained as separate product packages.

3.1   QuantumX Assistant

The HBM software "QuantumX Assistant" offers the following functions:

System:

- Create overview (modules, Host PC)

Modules:

- Search and configuration (e.g. TCP/IP communication), naming

- Reset to factory settings

- Read factory calibration certificate

- Analysis (information, status, log file)

- Save configuration to operating PC

Channels/sensors:

- Configuration (name, connection type, TEDS, semi-automatic assignment)

- Measurement (alphanumeric display)

- Open the TEDS editor and read/write to TEDS

- Activate/deactivate isochronous operation via IEEE1394b FireWire

Individual signals:

- Set sampling rates and filters (type, cut-off frequency)

Measured values (scope):

- Start/stop continuous graphic measurements (time frames, trigger, zoom)

- Basic signal analysis (X-Y cursor)

- Record measurements

Functions and outputs:

- Map inputs to outputs (scaled, filtered)

- Generate new signals through mathematic functions (peak value, RMS (root mean square) value, addition and multiplication, rotation)

Sensor database

- Write sensor data sheets to TEDS

- Add user-defined sensor data sheets, import or export CANdb (*.dbc)

3.2   catman®AP

The HBM "catman®AP" software is optimally suited for the following tasks:

- Setting the communication and measurement channels (integrated TEDS Editor and extendable sensor database)

- Configuration of measurement or test tasks (channels, sampling rates, triggers, comments, interactions)

- Setting up virtual online calculated channels (algebra, FFT, logic, SG rosette evaluation, differential, integral, etc.)

- Setting up limit value or event monitoring (digital output activation, acoustic alarm, logbook entry)

- Individual graphic representation options (strip chart, analog meter, digital or bar display, tables, status LEDs, etc.)

- Diverse storage options (all data, cyclic, ring buffer, long-term measurements, etc.)

- Export of measured data in current data format (catman®BIN, Excel, ASCII, DIADEM, MDF)

- Graphic analysis of acquired data

- Automation of measurement sequences (AutoSequence and EasyScript)

- Generating reports (with graphic displays, analyses, comments)

The software package consists of various modules:

- **catmanEASY – the basic package for recording measurement and virtual channels, visualization and storing measurement data with integrated sensor database**

- **EasyRoadload** Integration of KistlerRoaDyn® measuring wheels

- **EasyVideocam** Integration of up to 4 video cameras (generally Windows DirectShow, USB / Ethernet / FireWire)

- **EasyPlan** allows for preparatory parameterization and configuration without an amplifier connected using a wizard or tables with Microsoft EXCEL®

- **EasyScript** is based on the current VBA standard (Visual Basic for Applications) and allows users to write their own scripts for individual measurement tasks

3.3 LabVIEW® driver / library

LabVIEW is a graphical programming system from National Instruments. The acronym stands for "**Lab**oratory **V**irtual **I**nstrumentation **E**ngineering **W**orkbench".

The main application areas for LabVIEW are in measurement, control and automation technology.

LabVIEW modules are virtual instruments (VIs) or sub-programs that are used in LabVIEW programs for convenient device control. The library components are used to initialize, open and close interfaces, to initialize and configure the modules, to make settings, and to trigger and query measurements. The LabVIEW driver is based on QuantumX .NET API and therefore supports all module functions. The installation includes some examples and extensive help.

3.4 Programming interface (.NET API)

The abbreviation API stands for "Application Programming Interface" and designates programming interfaces. Programmers can directly access functions of other programs via APIs and use them in their own programs.

With the API, you have full access to all QuantumX functions through an individually programmed application, e.g. your own operator interface.

The API can be used in the form of programming libraries in .NET technologies. The libraries allow users to create their own applications in Microsoft Visual(R) Studio programming languages such as Visual Basic, C++ or C#. Functions such as communication connection, configuration of measurement channels, implementation of measurements and troubleshooting are components of the library.

The API can be easily installed from the QuantumX system CD. Application-based examples and practice-oriented documentation enable users to get started quickly.

3.5 Firmware update via Ethernet

You can easily check the firmware status of the modules and update them when necessary with the "QuantumX firmware update" software.

Before updating your firmware, check whether your PC software needs updating first.

We recommend checking the firmware and updating it as needed:

- If you want to use a new PC software package
- If you want to expand your system with new modules

You can also determine the firmware status of your modules using the QuantumX Assistant:

- Right-click on a module − > Details − > System parameters

3.6   TEDS Editor

The HBM TEDS Editor can read, edit and write TEDS data directly via a measurement channel or via the HBM TEDS dongle. If TEDS is retrofitted, the Editor will provide the corresponding templates for various transducer types. Some templates can be stored and loaded.

Section 6.1.3 describes TEDS in general. The QuantumX Assistant no longer requires the TEDS Editor. Sensor data sheets can be written directly from the sensor database to the TEDS chip.

3.7   DIAdem driver

DIAdem is a graphical programming system from National Instruments.
DIAdem offers suitable library modules for the complete data flow, from measurement data acquisition to evaluation and creating reports.

The DIAdem driver from HBM enables measurement data acquisition with QuantumX amplifiers **MX840, MX840A, MX440A, MX410, MX460** and **MX1609**.
The most recent information can be found in the relevant release notes under www.hbm.com.

3.8   DASY*Lab* driver

DASY*Lab* is a graphical programming system from National Instruments.
The acronym stands for "Data Acquisition System Laboratory". The main application areas for DASY*Lab* are in measurement, control and automation technology.
Graphical library modules are used to operate interfaces such as inputs and outputs, signal conditioning and analysis, control and regulation, visualization and data storage.

The partner company IMP markets a DASYLab driver for measurement data acquisition with QuantumX modules **MX840, MX840A, MX440A, MX1615, MX1601** and **MX1609**.
You can find the most recent information at www.impkoeln.de.

3.9 CANape driver

CANape is a software program from Vector Informatik GmbH, a company based in Stuttgart. This program is used mainly in the development of software for electronic control devices in automotive applications.

The QuantumX CANape driver requires version 10.0 SP2 of CANape. Further information can be found in the operating manual for the driver.

CANape can record, visualize and analyze data via the gateways connected on the PV. This includes signals from fieldbuses such as FlexRay, CAN, derivatives of CAN or LIN and also measuring instruments, for example QuantumX or cameras.

Using special protocols such as CCP or XCP, the software is able to read variables internal to the control system such as sensor data and parameter tables and if possible to parameterize them as well, for example to optimize algorithms at runtime.

The error memory of a control device can be read using protocols such as KWP2000 (used for sensor break, etc.).

4   Mechanical

The degree of protection given in the technical data indicates the suitability of the housings for various ambient conditions and also the protection of persons against potential risks when used. The letters **IP** (International Protection), which are always present in the designation, are followed by two digits. These indicate which degree of protection a housing offers against contact or foreign matter (first digit) and moisture (second digit). QuantumX modules are in a housing with IP20 as degree of protection.

IP   **2**   **0**

Code index	Degree of protection against contact and foreign matter	Code index	Degree of protection against water
2	Protection against contact with fingers, protection against foreign matter with ∅ >12 mm	0	No water protection

Both housing types can be connected together with the aid of two lateral housing clips (1−CASECLIP, not included in scope of delivery). To do this, the existing lateral covers must be removed and the housing clips screwed on.
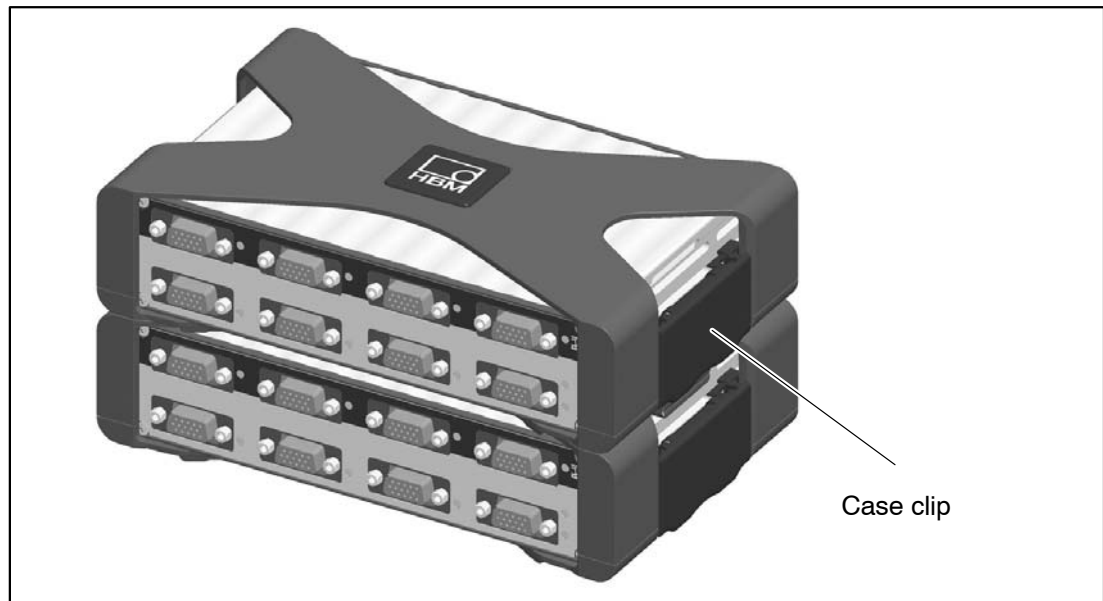
Case clip

Fig.4.1: Two connected IP20 housings

4.1   Mounting case clips on modules

The module electronics are integrated in a metal housing that is surrounded by a case protection (CASEPROT). This also serves for centering when several devices are stacked on top of each other and offers a certain degree of protection against mechanical damage.
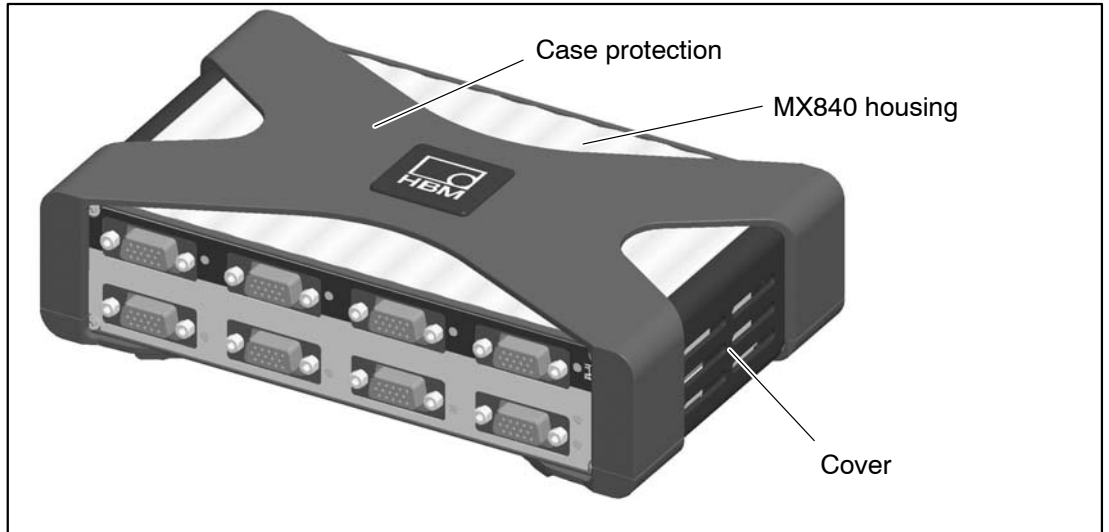
Fig.4.2: Amplifier MX840 with case protection

The mounting of the housing clips shown in the following pictures must be implemented on both sides of the housing.
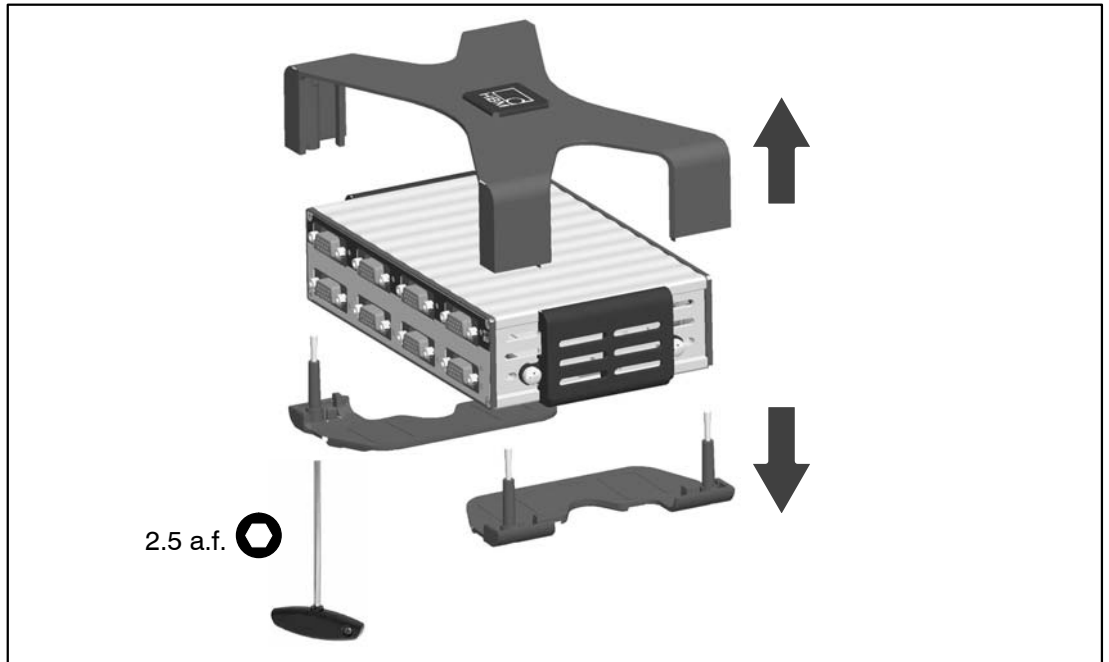
Fig.4.3: Removing the case protection
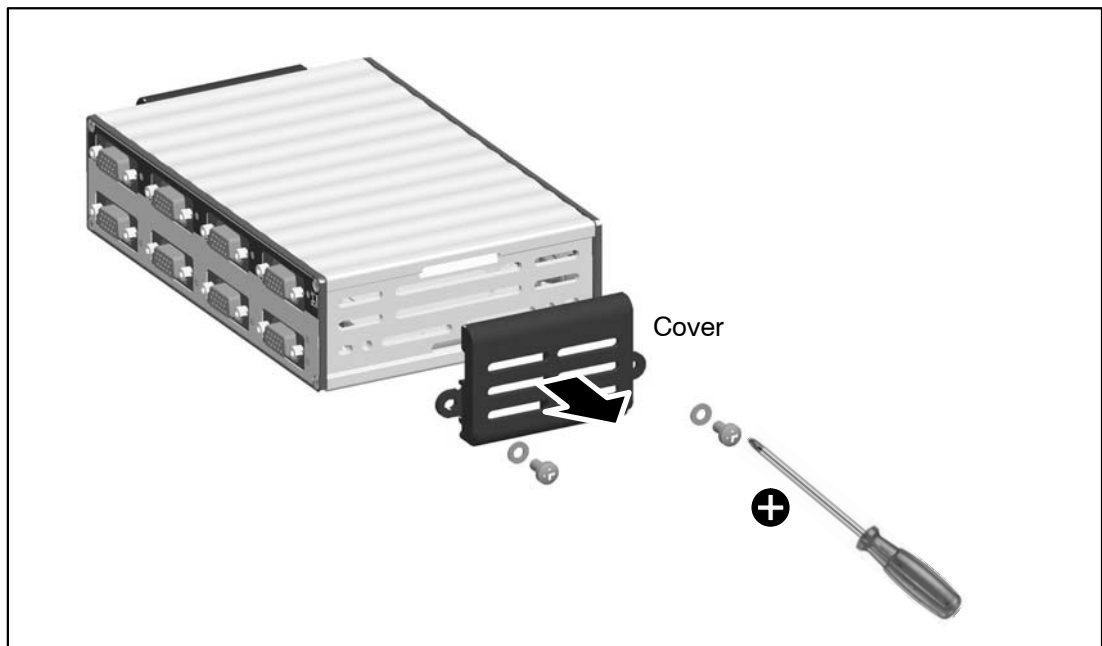
Fig.4.4: Removing the cover
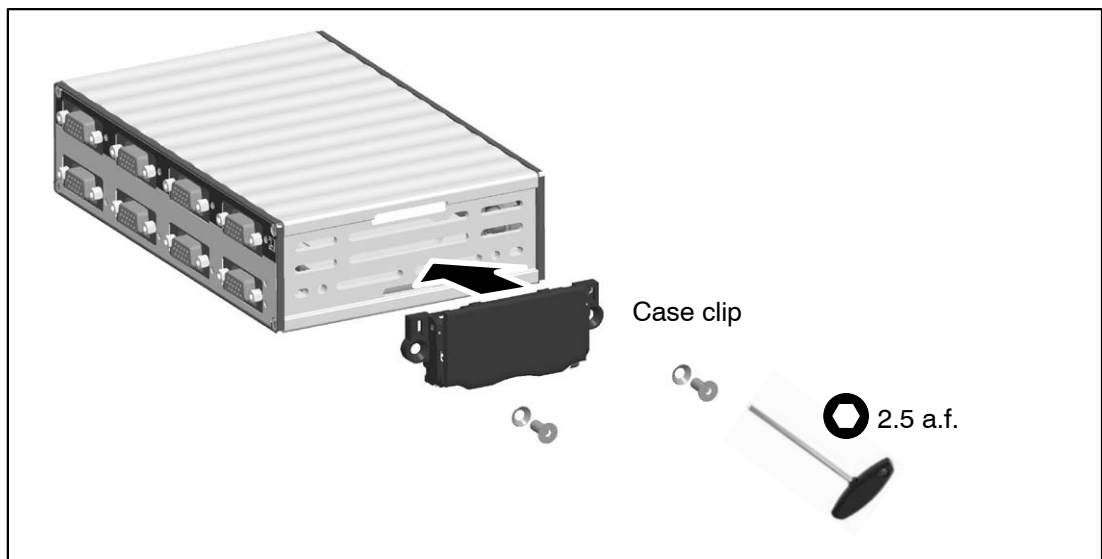
Fig.4.5: Mounting the case clip CASECLIP
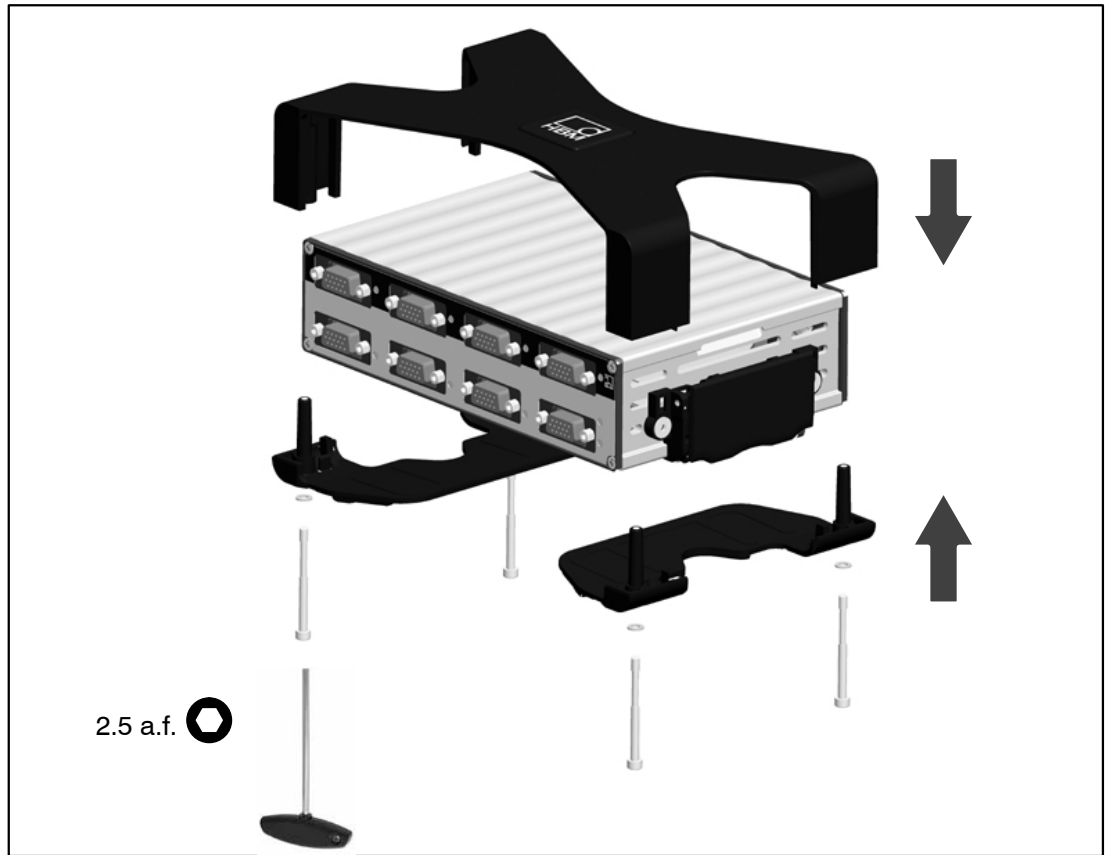
Fig.4.6: Mounting the case protection CASEPROT

4.2   Connecting housings

The following pictures show the connection of two housings.

Fig.4.7: Unclip the case clip CASECLIP
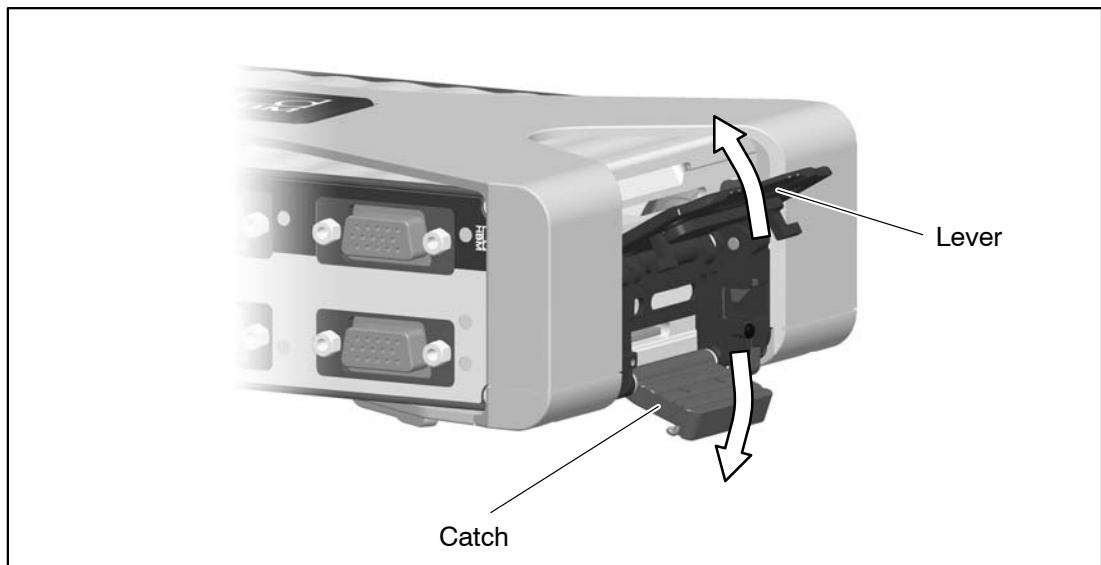
Fig.4.8: Unclip the lever and catch
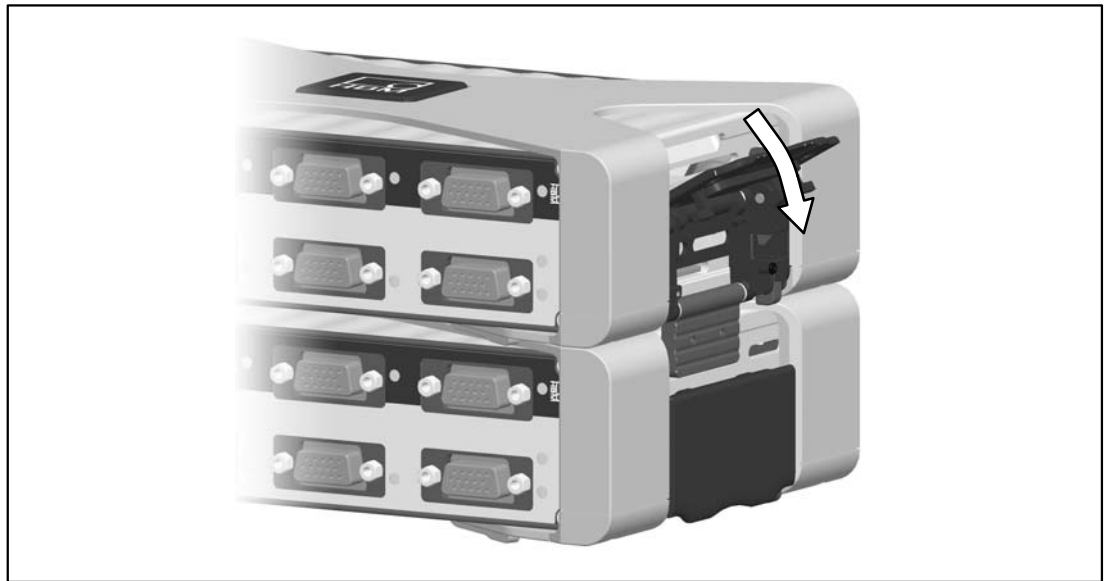
Fig.4.9: Close the lever

Fig.4.10:   Connected housings

4.3   Mounting a housing with CASEFIT

The fitting panel CASEFIT can be used for flexible mounting of QuantumX series modules.
The modules can be fastened in place with belt tensioners or case clips.

Lugs for additional fastening
with tension belts

Dimensions in mm
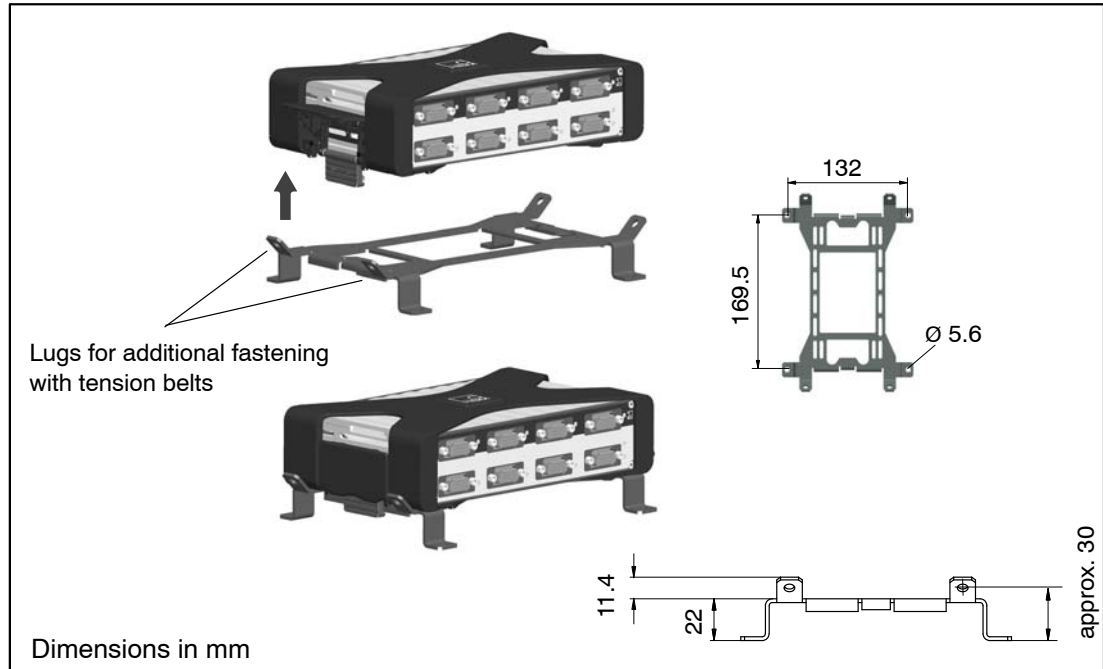
Fig.4.11:   Mounting with CASEFIT

4.4   BPX001 backplane

You can connect up to 9 modules with each other using the active BPX001 backplane without the need for complicated cabling and you can link these via the two IEEE1394b FireWire interfaces of the backplane with other modules or module groups. You can also set up a direct connection to a PC via one of the IEEE1394b FireWire interfaces of the backplane. The IEEE1394b FireWire interfaces of the individual modules are actively connected to each other.

The supply voltage (18 V ⋯ 30 V DC) for the modules must be supplied externally. The circuits of the IEEE1394b FireWire connections and the modules are protected with a total of four fuses with control displays (for arrangement see page 36).

The modules can be positioned anywhere in the backplane. The backplane is designed for wall or control cabinet installation and has drill holes for attachment.
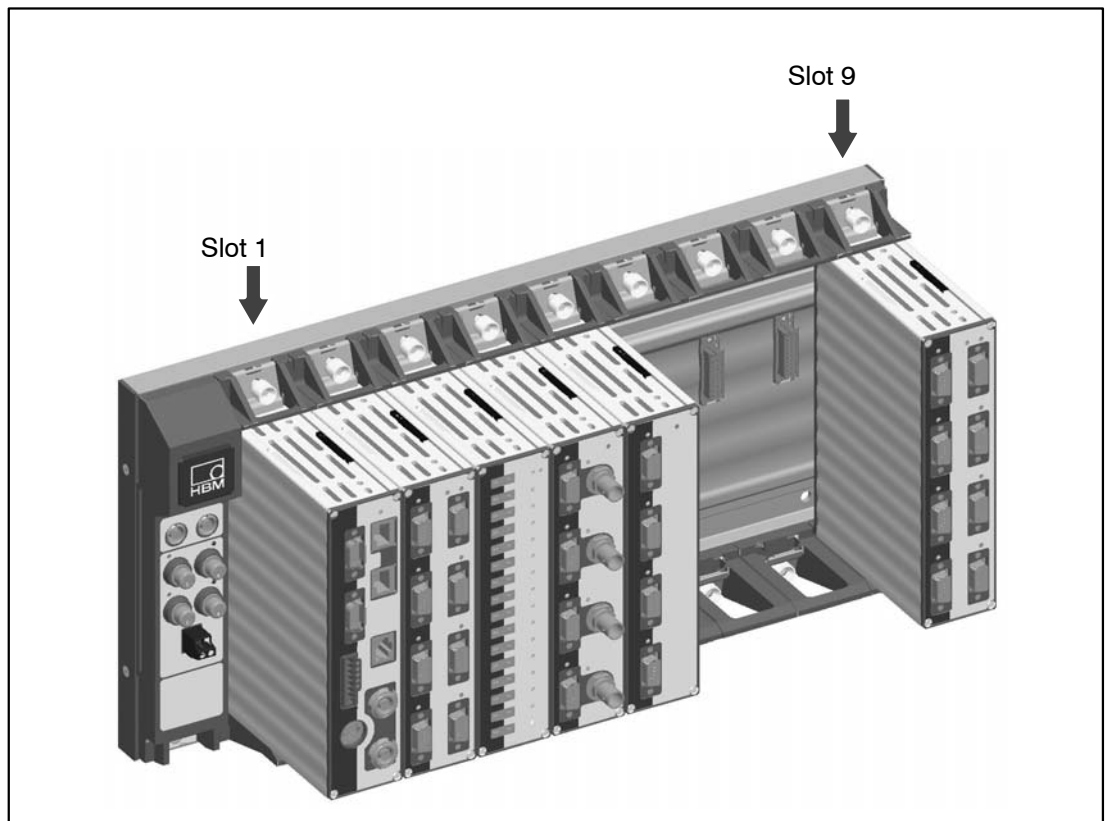
Fig.4.12: Example of QuantumX backplane fitting

4.4.1   Connection
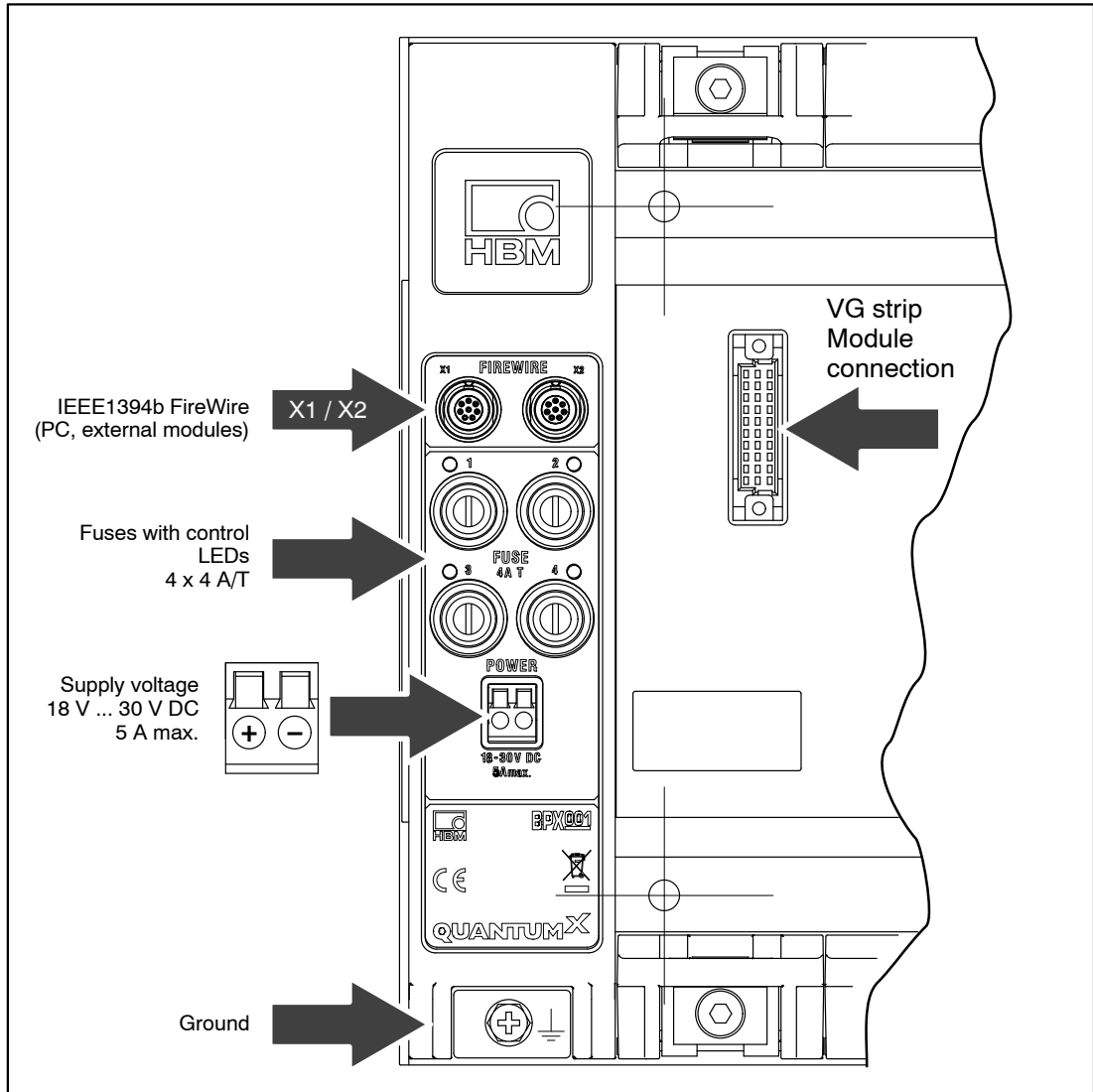
Fig.4.13:   BPX001 connections

Fuse	Protects
1	IEEE1394b FireWire X1 connection
2	IEEE1394b FireWire X2 connection
3	Slots 1 to 4
4	Slots 5 to 9

4.4.2   Wall mounting

A total of 10 drill holes are provided in the backplane for wall mounting ($\varnothing$ 6.5 mm). We recommend using the outer 4 drill holes for wall mounting.

NOTE

Only use countersunk screws for fastening, otherwise the modules cannot be mounted correctly.
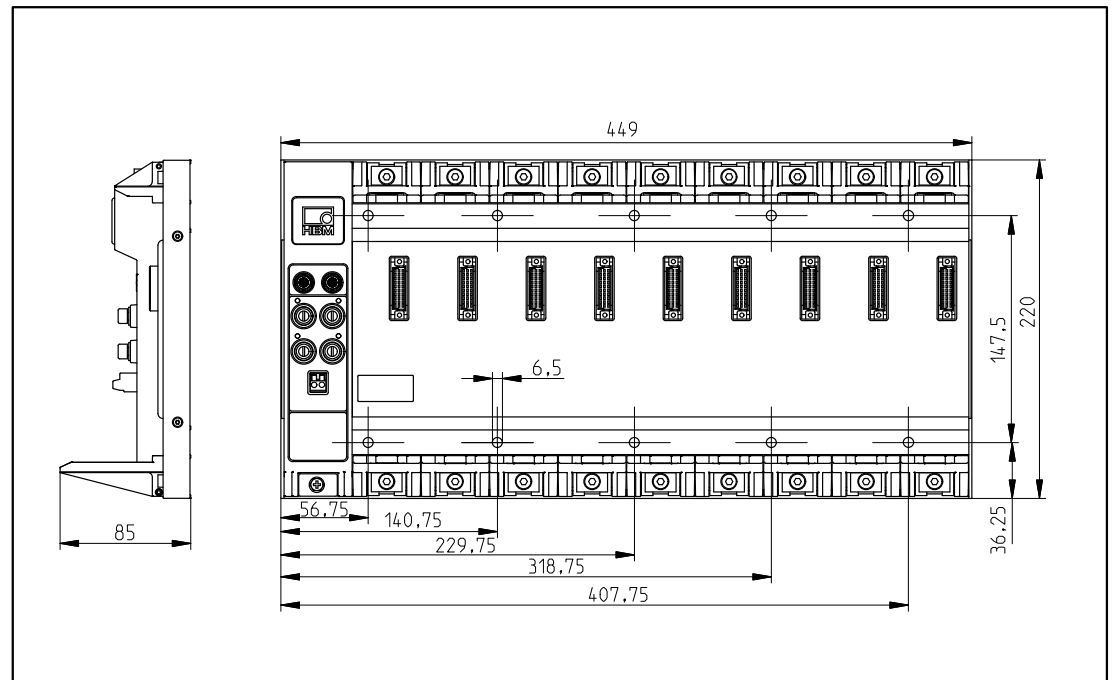
Fig.4.14:   BPX001 drilling pattern and dimensions

Note the following information when installing one or more backplanes in a control cabinet:

- When installing in a control cabinet, the temperature limits given in the technical data of the backplanes must be complied with

- Depending on the installation situation, sufficient ventilation (vertical air flow) or cooling must be provided (the maximum total output on a backplane is approx. 150 watts)

- The ventilation slots of the modules must not be covered (e.g. by cable ducts)

4.4.3   Mounting the modules

TOOLS

We recommend a T−handle Allen wrench 4x150 (4 mm across flats, length 150 mm).

NOTE

The modules can only be fastened in backplanes in housings with degree of protection IP20 without case protection, case clips or lateral covers. If these are present, remove as shown in section 4.

Mounting sequence:

1. Remove the cover of the connecting plug (rear of module).
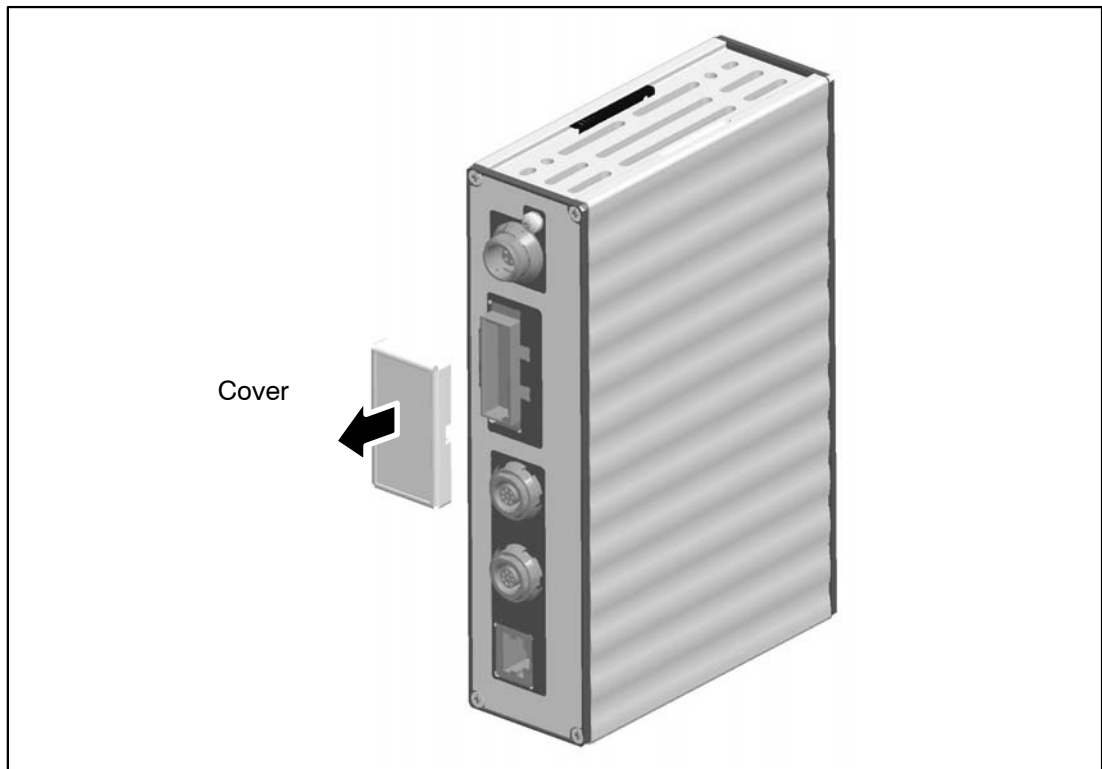
Cover

Fig.4.15:   Removing the cover

2. Unscrew the upper and lower screwed clamping glands of the backplane up to the stop (the screws are secured against falling out!).

3. Position the module vertically on the backplane and push it in carefully on the lower guide rail back up to the stop.
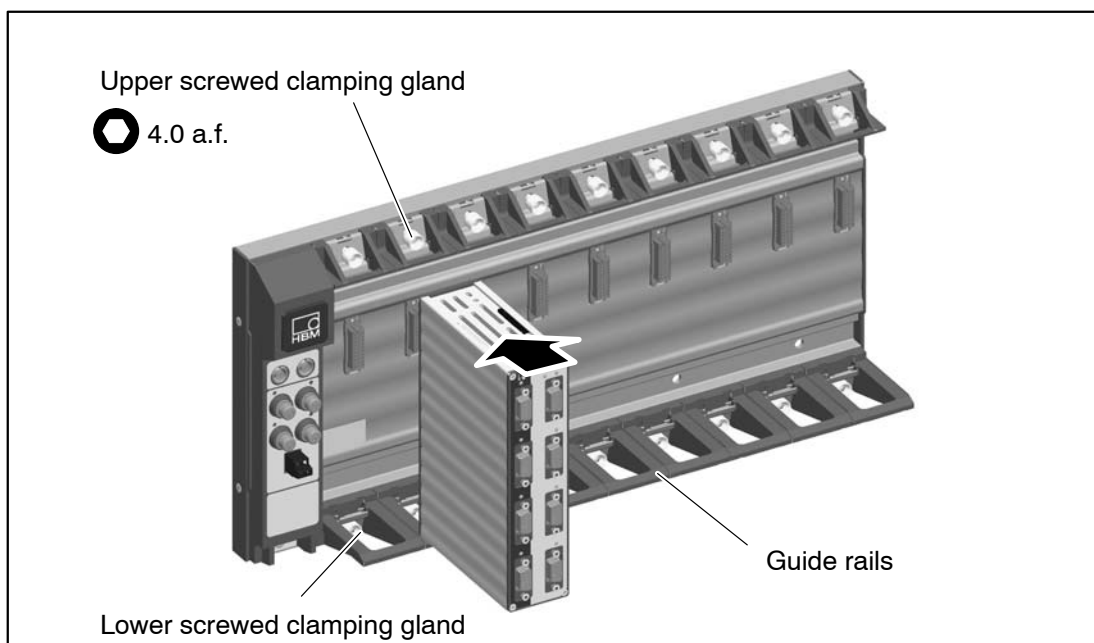
Fig.4.16:   Mounting the module
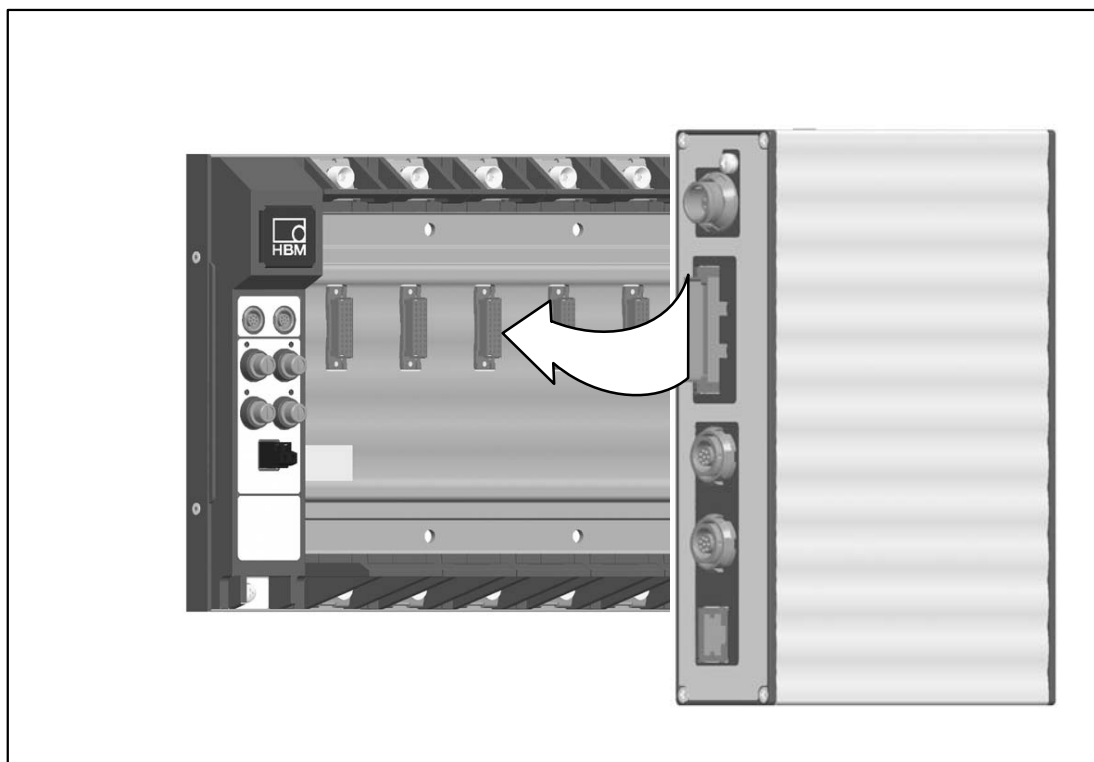
Fig.4.17:   Centering above the connection plug

4. Tighten the lower then the upper screwed clamping gland.
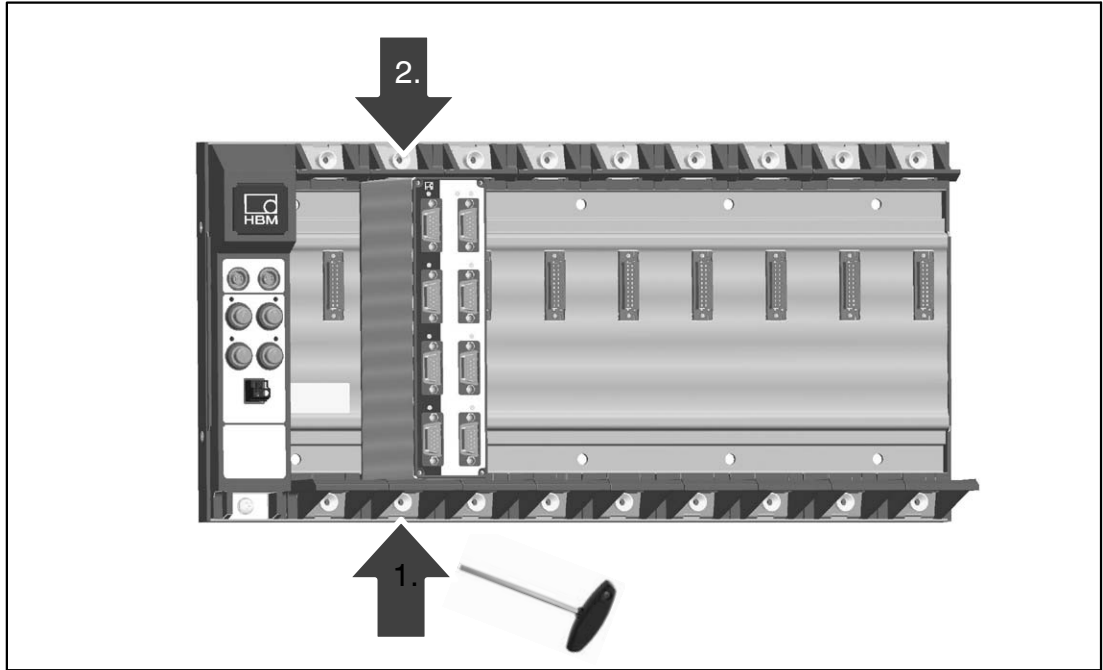
Fig.4.18:   Tightening the screwed clamping glands, sequence

4.4.4   Backplane with Ethernet connection

The CX27 gateway can be used to connect a BPX backplane via Ethernet. Maximum data throughput: 400 kS /sec.

The IEEE1394b FireWire sockets on the backplane make it possible to integrate distributed modules into the system.
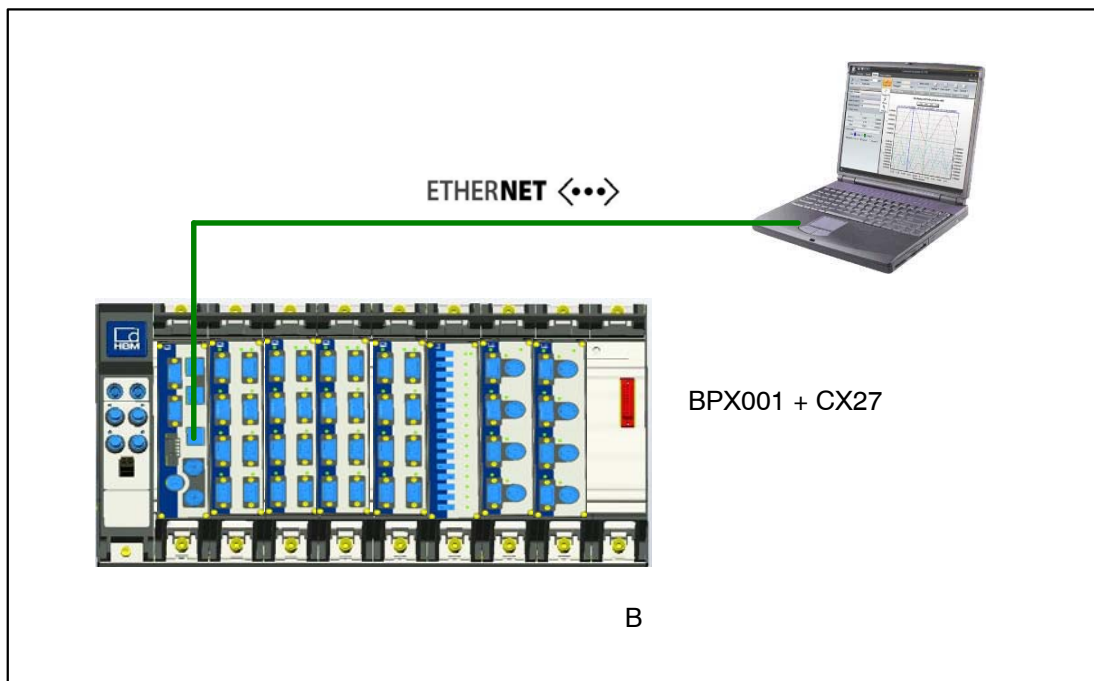
Fig.4.19:   Connecting a backplane via Ethernet

4.4.5   Backplane with IEEE1394b FireWire connection

The BPX backplane can be connected via IEEE1394b FireWire directly to a PC or data recorder.

The second IEEE1394b FireWire socket on the backplane can be used to integrate distributed modules into the system.
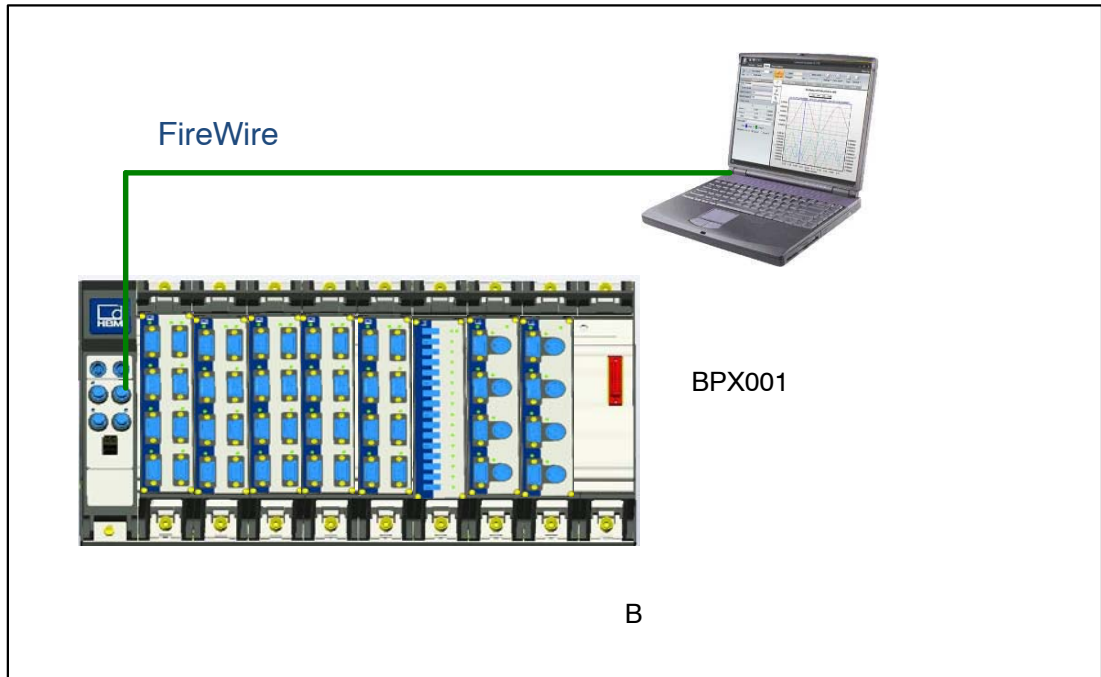
Fig.4.20:   Connecting a backplane via IEEE1394b FireWire

4.4.6   System layout with several backplanes

Multiple BPX backplanes can be synchronized via CX27 gateway modules. Connection of CX27 to CX27 via KAB272-2 or -5, via front IEEE1394b FireWire connection.
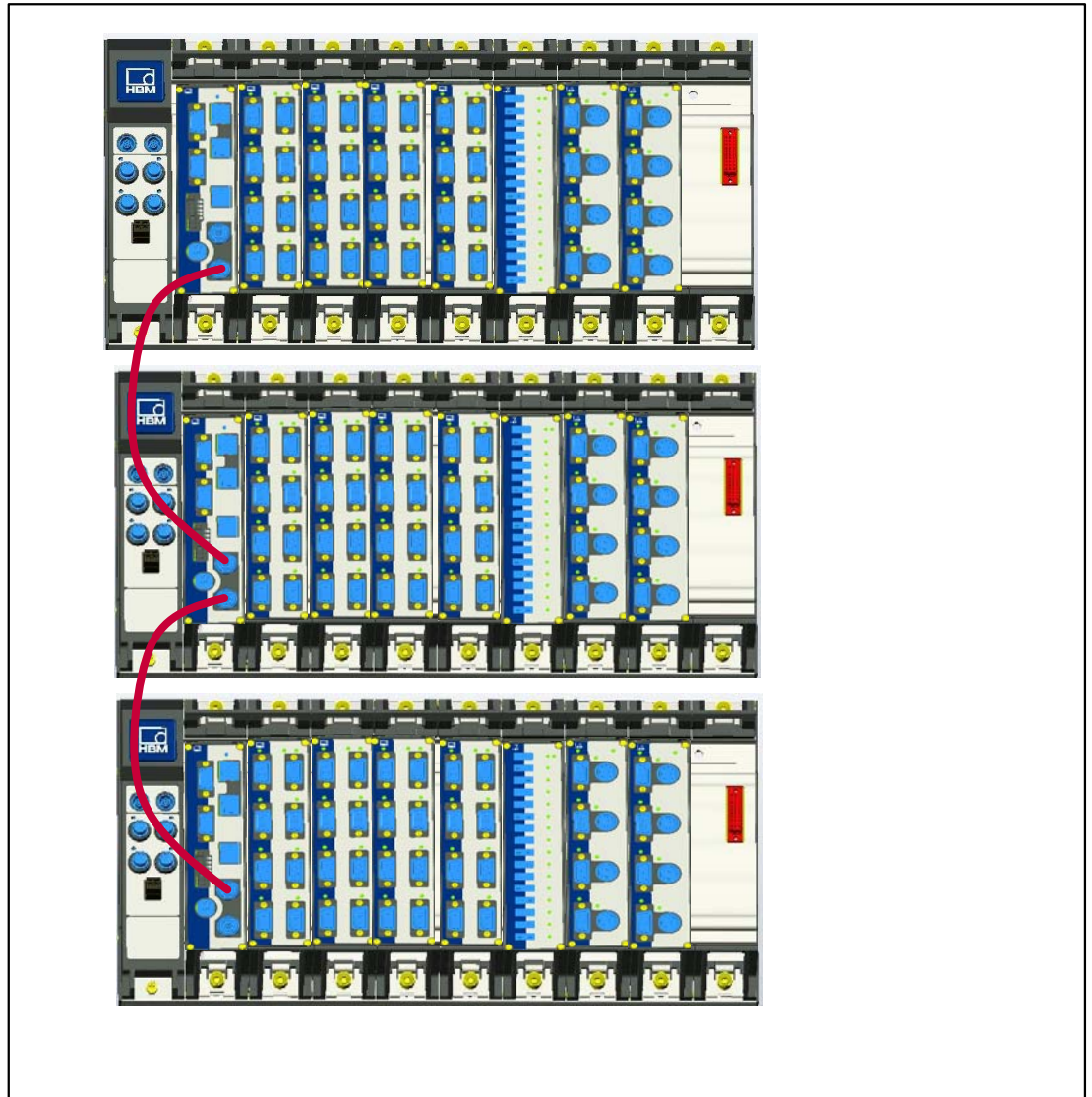
Fig.4.21:   Synchronizing multiple backplanes

5   Connecting individual QuantumX modules

5.1   Connecting the supply voltage

Connect the modules to a DC voltage of 10 V ... 30 V (24V recommended). The power consumption per device can be found in the following table.

⚠ CAUTION

The following rule of thumb applies to power distribution via FireWire:
"An external voltage supply with the <u>same voltage potential</u> is required on every 3rd module".

Defects in the module cannot be excluded if a supply voltage > 30 V is used. If the supply voltage drops below 10 V, the modules switch off.

We recommend installing an uninterruptible power supply (UPS) in vehicles with battery operation between battery and module to compensate for voltage drops during start procedures.

Module	Typical power consumption, including transducer excitation (watts)
MX840	13
MX840A	12
MX440A	10
MX1601	13
MX410	15
MX1615	12
MX879	7
MX460	9
MX1609	6
CX22	12
CX27	7
MX878	7
MX471	6

If several modules are connected to each other via **FireWire** for time-synchronous data acquisition (see Fig.5.4), the supply voltage can be looped through. The power pack used must be able to provide the appropriate output.
The maximum permissible current on the IEEE1394b FireWire connection cable is 1.5 A. If the chain is longer, **repeating the supply connection is mandatory**.
If several amplifiers are operated non-synchronously (see Fig.5.3), they must be supplied separately.
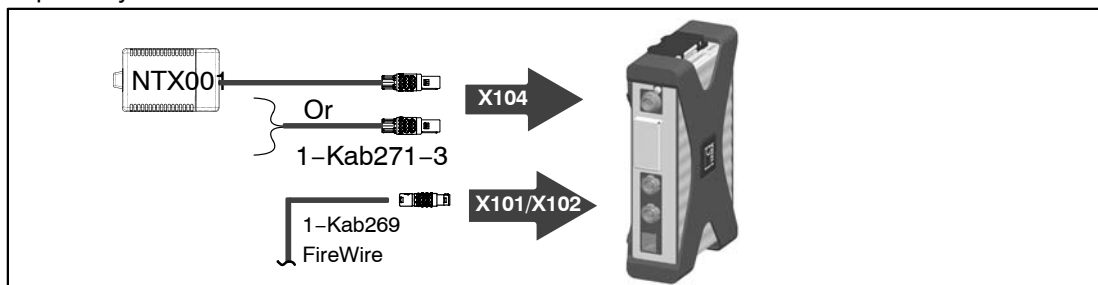
Fig.5.1: Connecting socket for supply voltage

5.2 Connection to host PC or data recorder

5.2.1 Single Ethernet connection
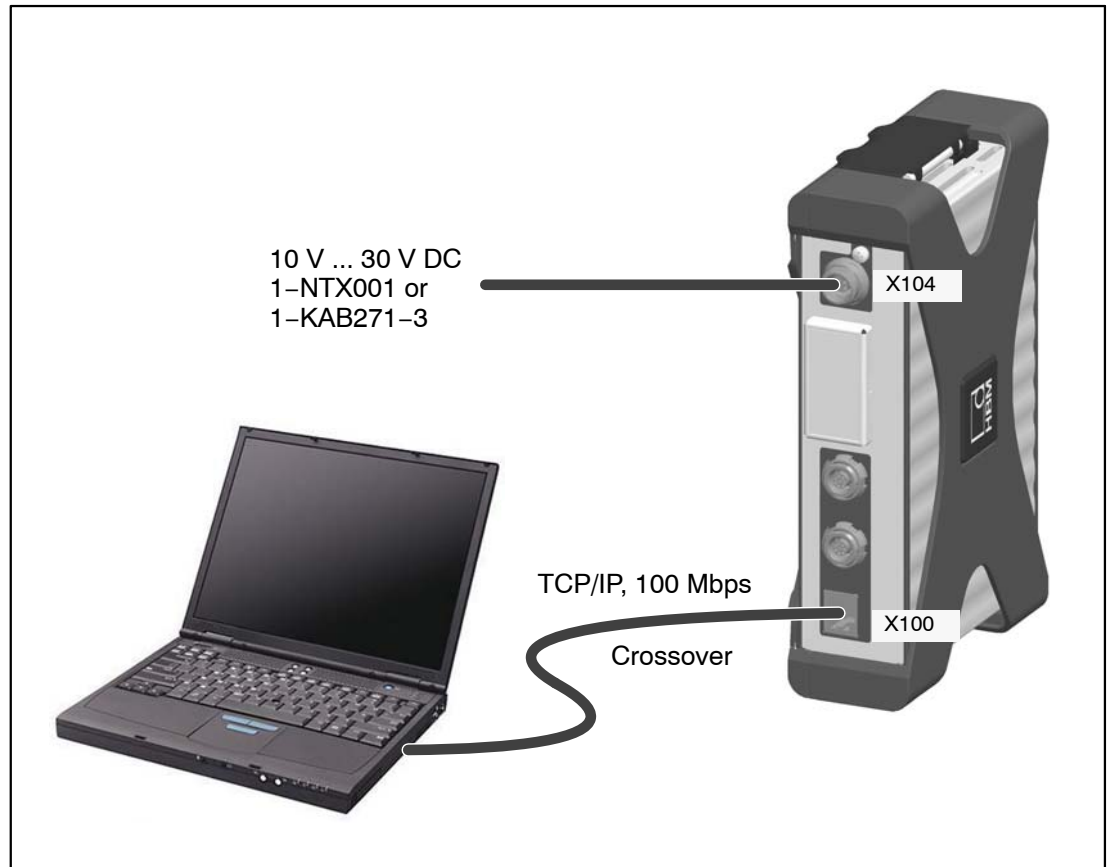
Fig.5.2: Single Ethernet connection

NOTE
You must use an Ethernet crossover cable with older computers. Newer PCs/laptops have Ethernet interfaces with autocrossing function. You can also use Ethernet patch cables here.

5.2.2   Multiple Ethernet connection with NTP synchronization
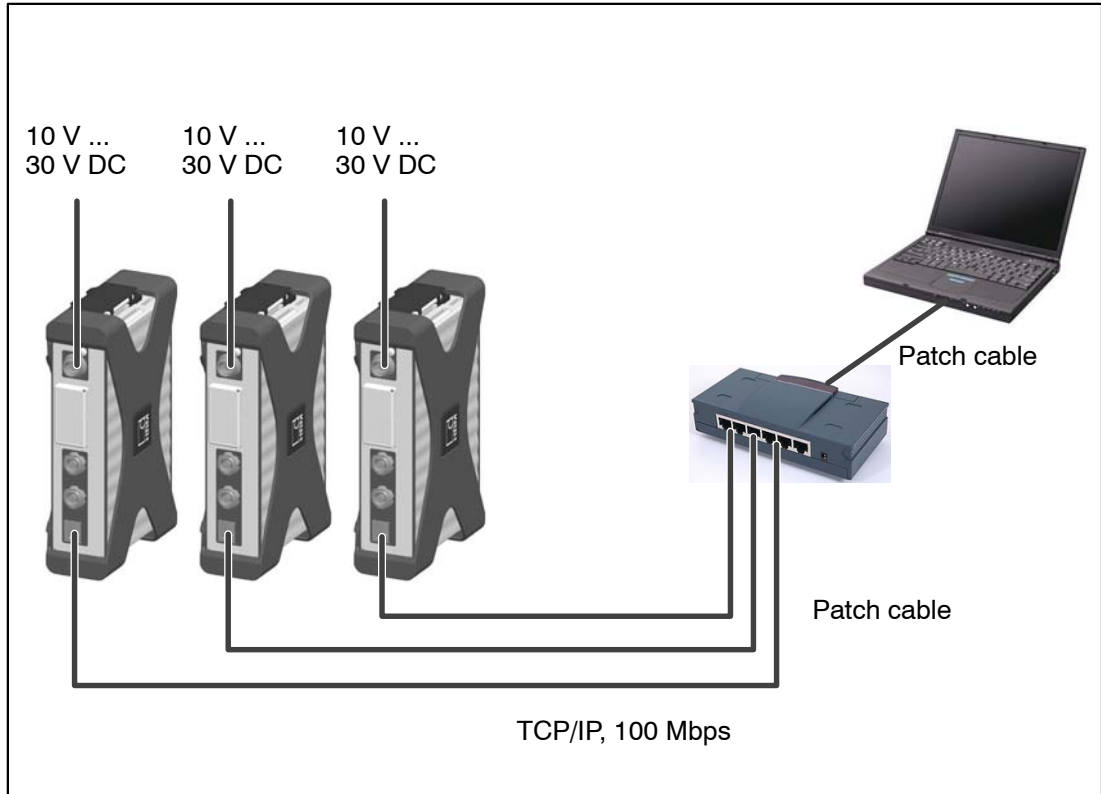
Fig.5.3: Multiple connection via Ethernet and synchronization via NTP

Modules can be connected to the PC with standard Ethernet switches. We recommend patch cables.

With the star structure displayed here, measurement data from other modules is not lost if the Ethernet cable is broken!

5.2.3 Multiple Ethernet connection and FireWire synchronization
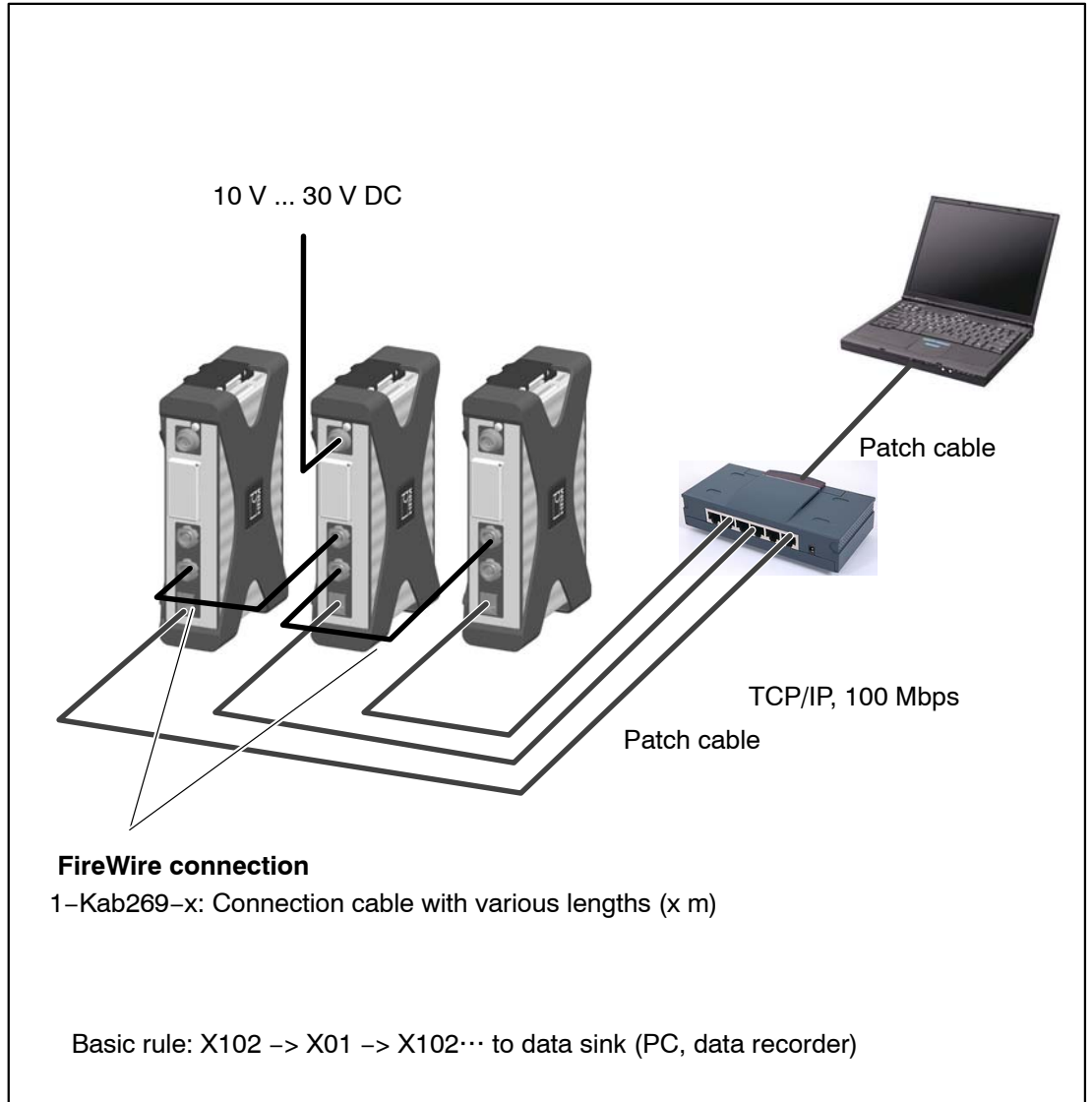
Fig.5.4: Example of multiple connection via Ethernet with synchronization

The supply voltage for the modules is looped through FireWire in the configuration shown above (max. 1.5 A through FireWire; for power consumption of 1 module see specifications in data sheet).

Advantage of this connection structure: The other modules remain active if the Ethernet cable is broken.

5.2.4 Module connection setup via Ethernet

Direct connection with a PC (peer-to-peer)

NOTE

Ensure that your PC has a valid IP address.

Install and start up the latest QuantumX Assistant version on your PC.

(All screenshots shown in this description display the menus in the Windows®XP operating system).

- Click on the icon (Find modules) or press the F4 function key.

The next dialog window offers you some options for network searching. For initial setup we recommend:

- Search the entire network and select from the result
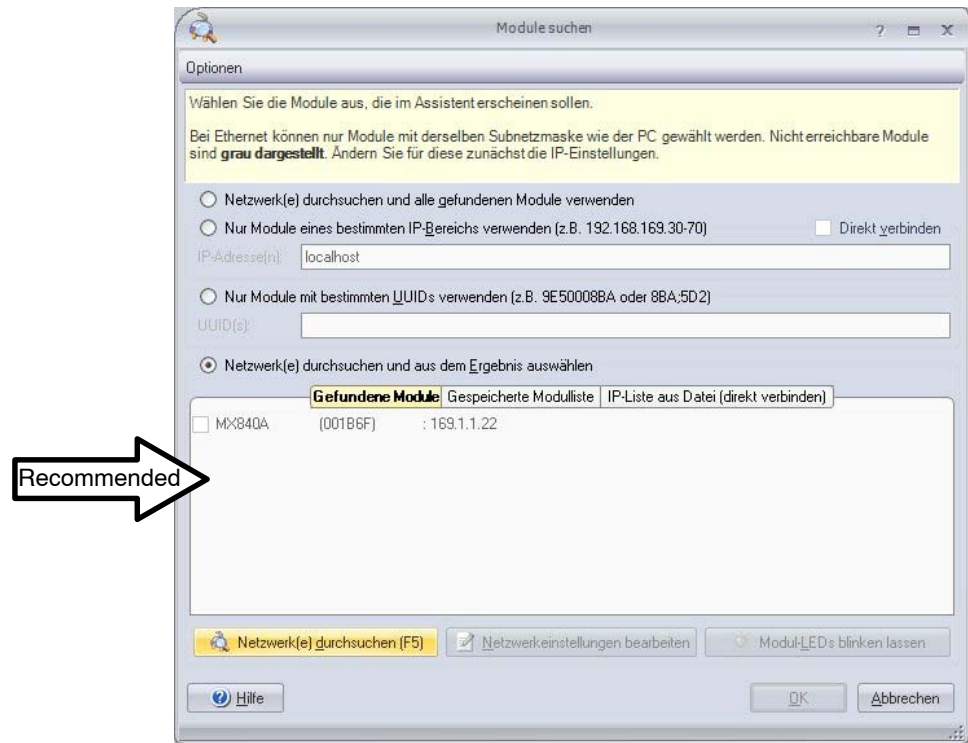
- If your modules are not displayed yet, click on the

 button.
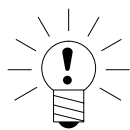
NOTE

The network connection can be influenced by:

- **An activated WiFi connection on your PC: Switch this connection off and start the network search again**

- **The use of a standard patch cable in a direct connection (peer-to-peer)**

If the module you have selected appears in black in the list, immediate operation is possible.

If the module appears in gray in the list, mark it and click on the "Edit network settings" button.
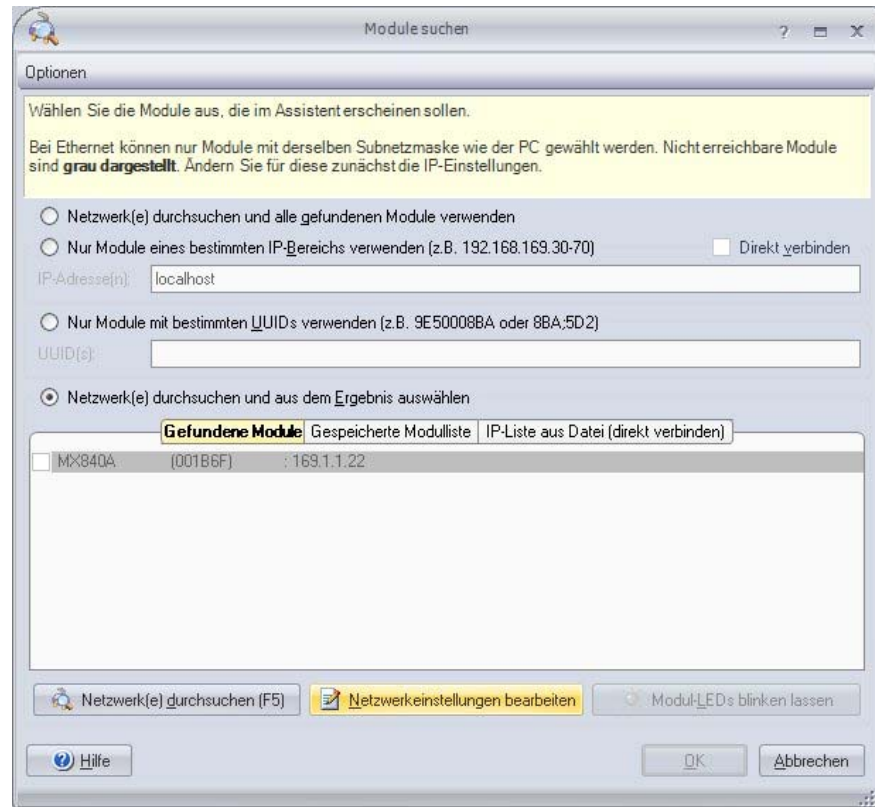
Check your settings and adjust if necessary as follows:
To configure the IP address of the module:

- Activate DHCP/APIPA for automatic configuration. Please set any PC directly connected to QuantumX to DHCP as well.

- Manual configuration: Deactivate DHCP and enter the same subnet mask address as used with your PC. Change the IP address of your module so that it permits communication (see example below)

Example: Setting the IP address manually – module side

Settings	IP address	Subnet mask
Module before	169.1.1.22	255.255.255.0
PC / notebook	172.21.108.51	255.255.248.0
Module after	**172.21.108.1**	**255.255.248.0**

The first **three** digit groups of the PC and module IP addresses should be the same.

The subnet mask address digit groups must be identical in the module and PC!
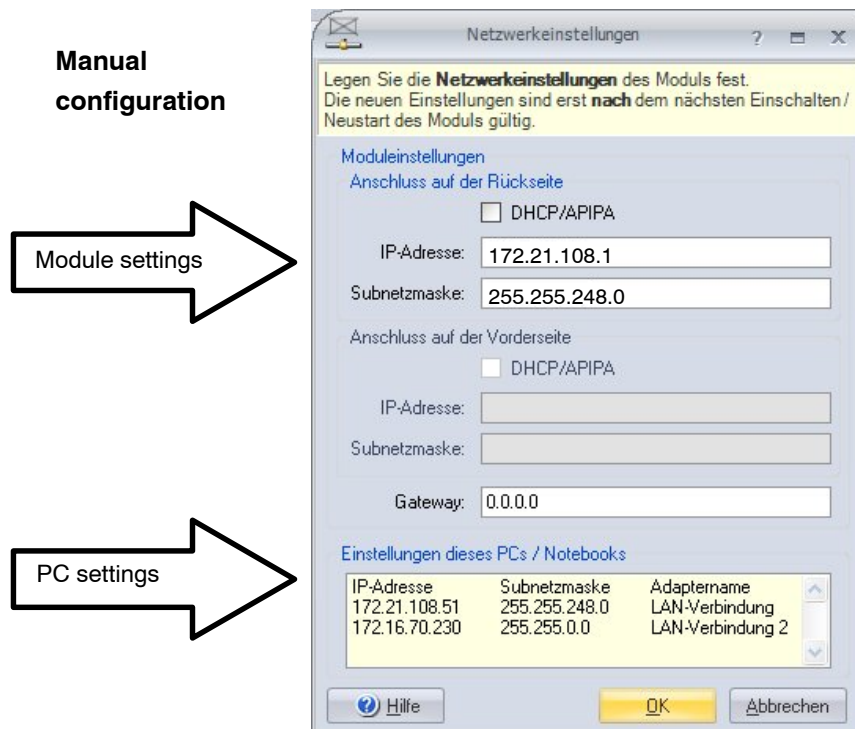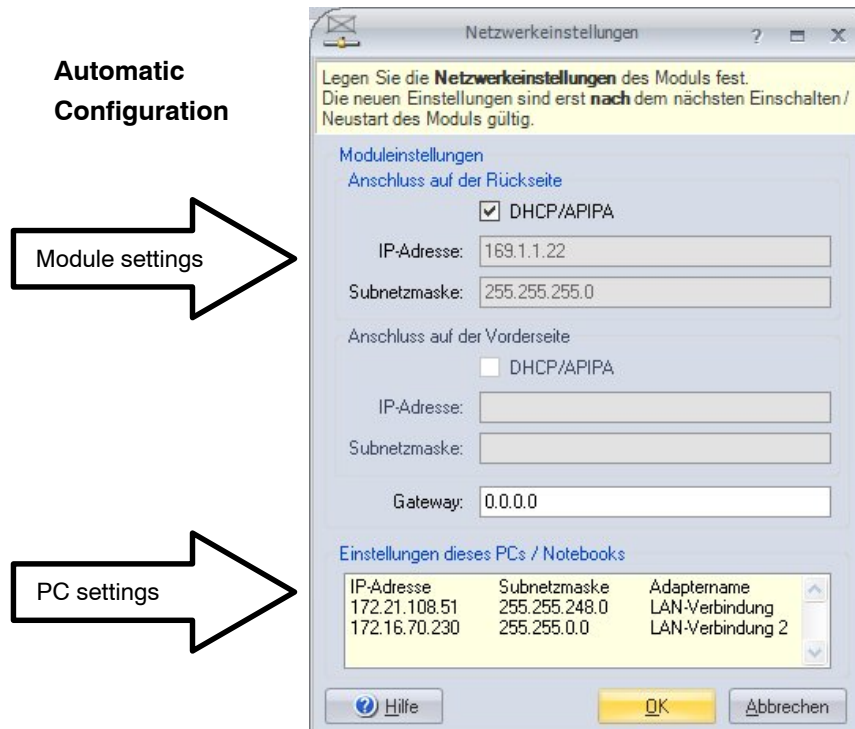
Fig.5.5: Example of settings for a direct connection

- Click on "OK"

- Confirm the settings with the "Yes" button. The module is then restarted with the current settings.

After approx. 45 seconds click on the [Netzwerk durchsuchen] button.

The system LED of the module should now light up green, if not please check your network settings again! If the network settings are OK, the module names are shown in black.

- Mark the appropriate modules by checking the relevant checkbox,

- Confirm with "OK." Now everything is ready for your first measurement.

Channel configuration can be found in the online help of your software.

Ethernet settings: adjust the IP address of your PC

If you use your computer in various networks (IP address changes), but your modules have a fixed IP address, you should use the "Alternative Configuration" in the TCP/IP properties (fixed IP address and subnet mask, user-defined)!

Edit the PCs settings as follows:

- Open the network connections (Start/Settings/Network connections).

- Right-click to mark your LAN connection and select "Properties" in the context menu.

- Select the "General" tab and mark Internet (TCP/IP) under "This connection uses the following items". Click on the "Properties" button.
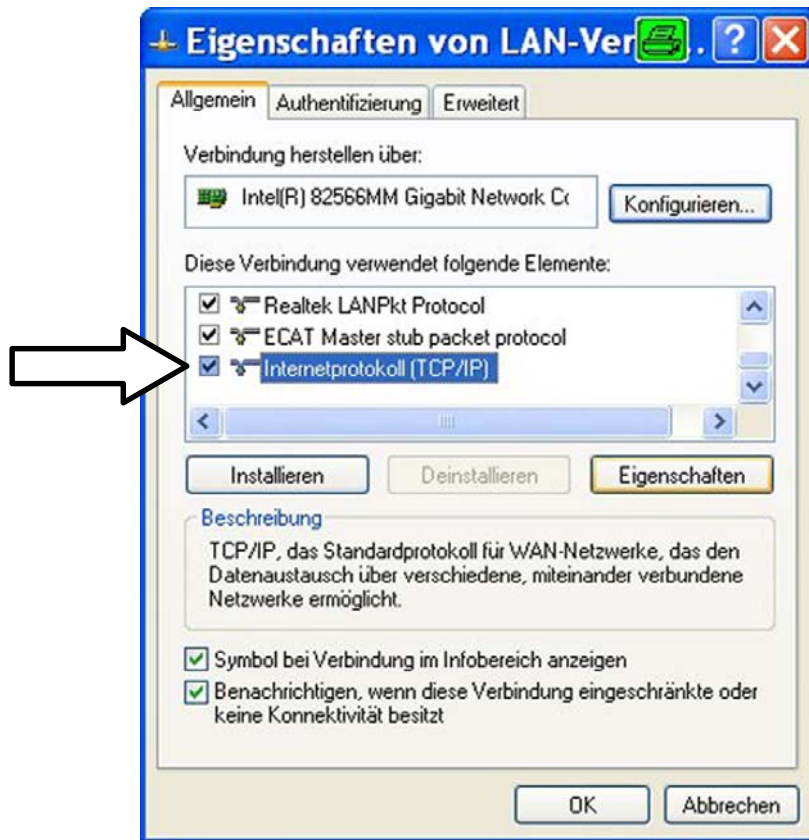
- On the "Alternate Configuration," select the "User-defined" option and enter your data in the "IP address" and "Subnet mask" lines.

Example: Setting the IP address manually – PC side

Settings	IP address	Subnet mask
Module before	169.1.1.22	255.255.255.0
PC / notebook before	172.21.108.51	255.255.248.0
PC / notebook after	**169.1.1.1**	**255.255.255.0**
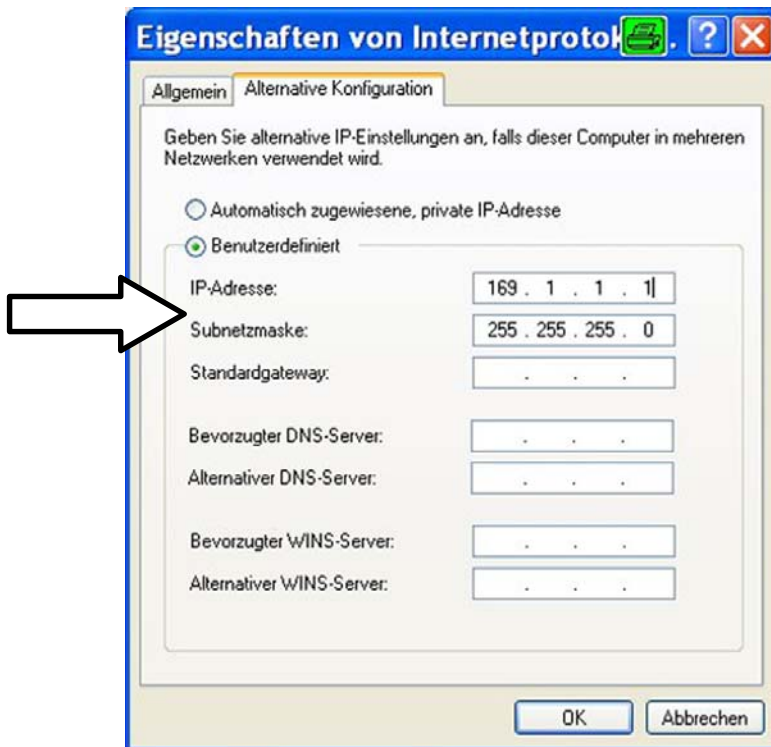
- Confirm twice with "OK."

In future your computer will use the "Alternate Configuration" for the direct connection.

Integrating modules in an Ethernet network

- Activate the DHCP checkbox and click on "OK." The following confirmation window then appears:
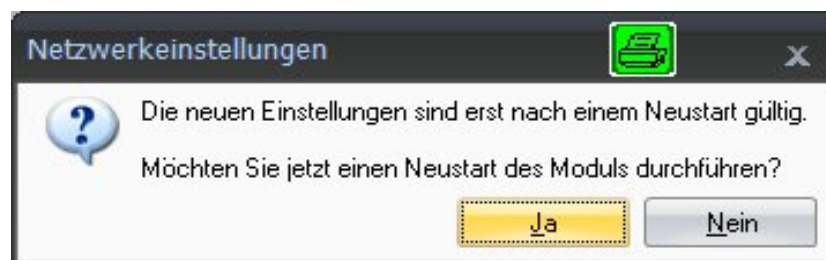
- Confirm the settings with the "Yes" button. The module is then restarted with the current settings.

- After approx. 45 seconds click on the button.

The system LED of the module should now light up green, if not please check your network settings again! If the network settings are OK, the module names are shown in black.

- Mark the appropriate modules by checking the relevant checkbox
- Confirm with "OK"

Channel configuration can be found in the online help of your software.

5.2.5   Firmware update via Ethernet

We recommend updating the module firmware:

*   if you want to use new HBM software

*   if you want to use a new module with a different firmware version

Your PC software must also be updated

*   if you want to update the firmware of your module to be able to use new functions

Use the QuantumX Assistant as follows to determine which firmware version your module is working with:

*   Right-click on Module –> Details –> System parameters
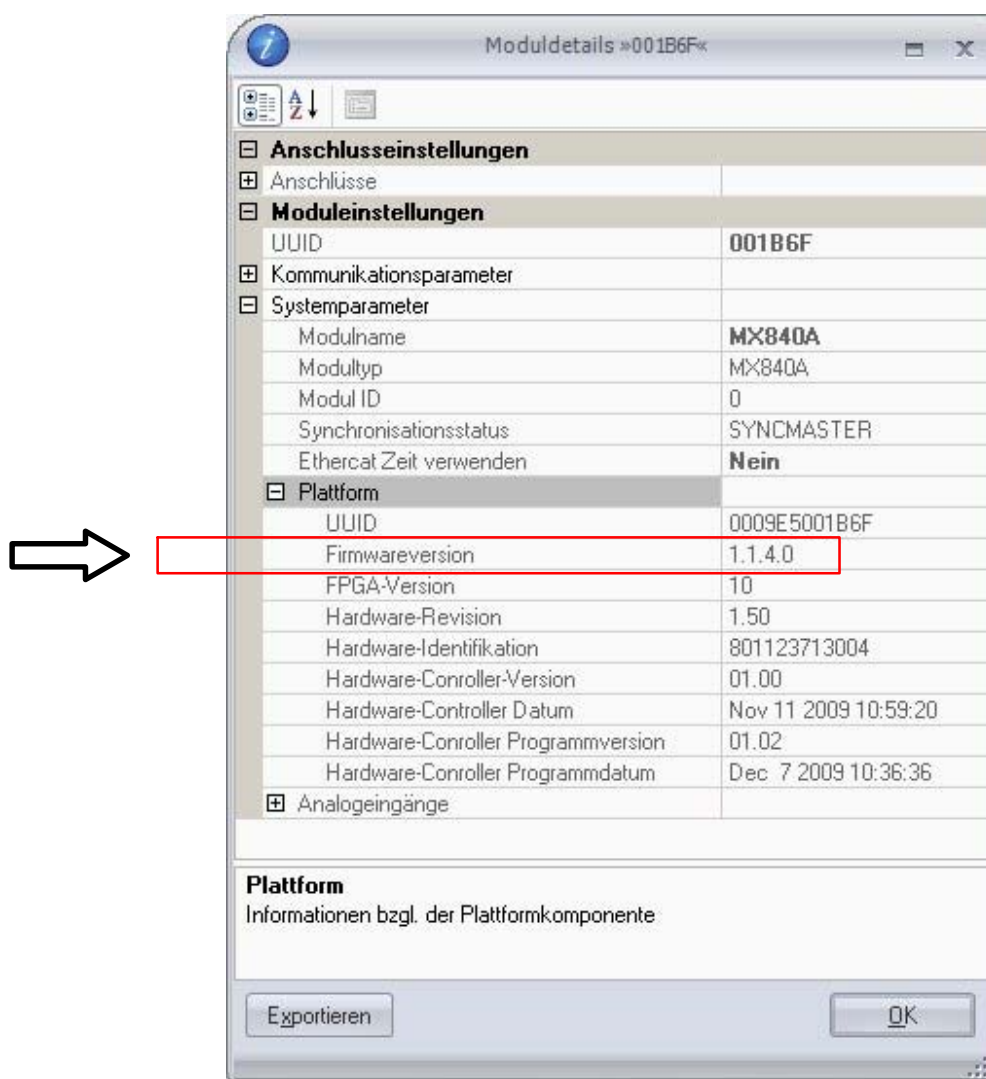
*   Compare your version with the current firmware version on the Internet under: www.hbm.comquantumX

If the firmware version number of your module is lower than the current number on the Internet, you can perform an update as follows:

- Download the current software package from the HBM website (QuantumX firmware downloader, QuantumX Assistant, etc.)

- Close all open HBM software, install the new software and start the QuantumX Firmware Updater

- Download the current firmware from the HBM website and save it in the download directory of the firmware updater (in most cases: C:Program FilesHBMQuantumX Firmware UpdateDownload)

- Click on the "Find modules" symbol or press the F4 function key
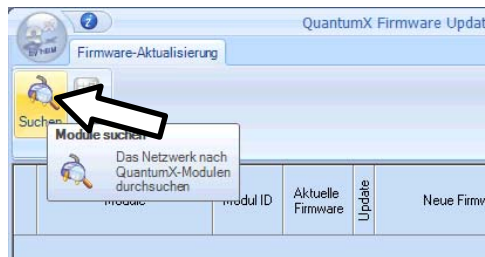
- Select the module

- Select the required version in the "New firmware" dropdown menu

- Activate the modules whose firmware you want to update by checking the boxes in the column "Update" and then click on the "OK" button
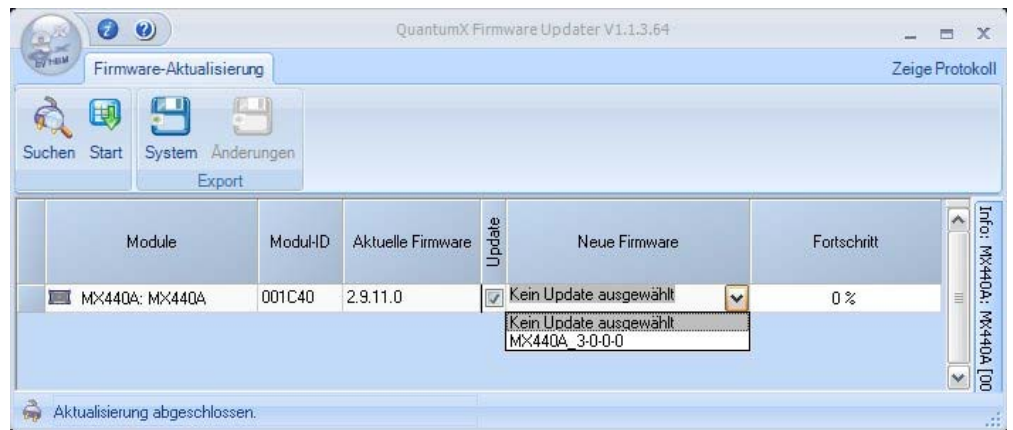
- Press the "Start" button and wait until the update is complete (do not interrupt the process/do not switch off the modules/do not interrupt the connection)

NOTE

You can update the firmware of the modules directly via FireWire and Ethernet or via the Ethernet connection of the CX27 gateway.

5.2.6   Connection via FireWire (IEEE 1394b)

General information

- Baud rate of 400 MBaud (approx. 50 MByte/s)

- Asynchronous (all nodes) or isochronous (in real time) data transmission

- Data synchronization

- Supply voltage via FireWire connection cable (max. 1.5 A)
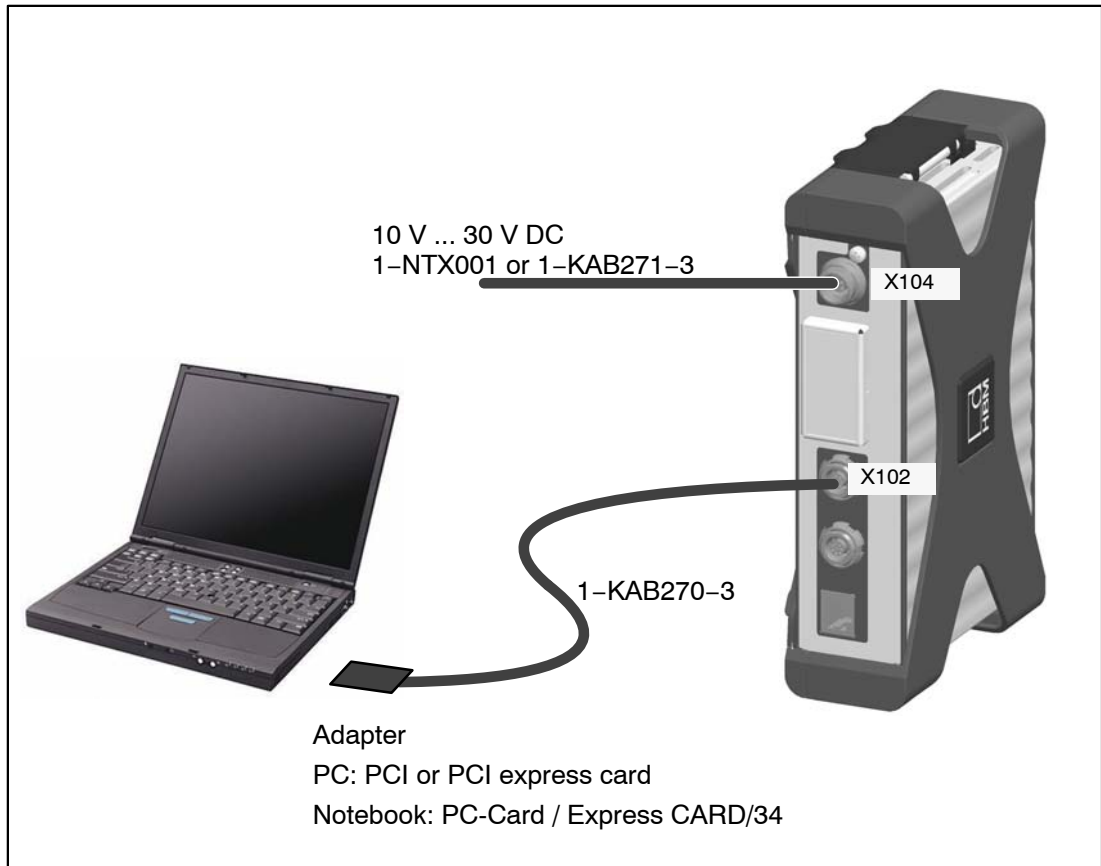
Fig.5.6: Single FireWire connection

NOTE

**Please check in advance whether a firmware or software update is required.
Software/firmware downloads can be found on the HBM website:**
www.hbm.comdownloads

5.2.7   Setting up FireWire

- Integrate the FireWire PC adapter into your computer.

- Install the "t1394bus_installwizard.exe" driver wizard, available from the QuantumX
  system CD or catman®AP CD (target directory C:Program FilesHBMFireWire or similar).
  Double click to start the program.

NOTE

**For troubleshooting you can switch to the original FireWire driver with
"t1394bus_installwizard.exe". After the driver is installed you will find it on your hard
disk.**

- After installation and configuration, connect the FireWire cable first to the PC adapter and
  then to the first module. Activation is confirmed acoustically by Windows.

Whenever you connect a new module to your computer via FireWire, you are prompted one
time by the operating system to register the module. When you do this, please refer to the
"hbm1394.sys" driver.

- Install and then start the current QuantumX Assistant on your PC.

- Click on the [icon] icon (Find modules) or press the F4 function key.

The "Modules found" field shows all modules found via FireWire.

- If your modules are not yet displayed, mark "Search the complete network" and click

  again on the [🔍 Netzwerk durchsuchen] button.

- Mark the appropriate modules by checking the relevant checkbox

- Confirm with "OK"

This completes the settings for your connection. Connect your transducer now. Connection
information can be found in the "QuantumX operating instructions".

Information about further channel configuration can be found in the online help of the HBM
software you are using.

NOTE

If no modules are found via FireWire this may be caused by one of the following reasons:

– **The modules have not been properly registered. Click on the FireWire driver in the systray, check the driver after the modules and reinstall it if necessary (hbm1394.sys).**

– **Check all connections between modules.**

5.2.8   Multiple FireWire connection
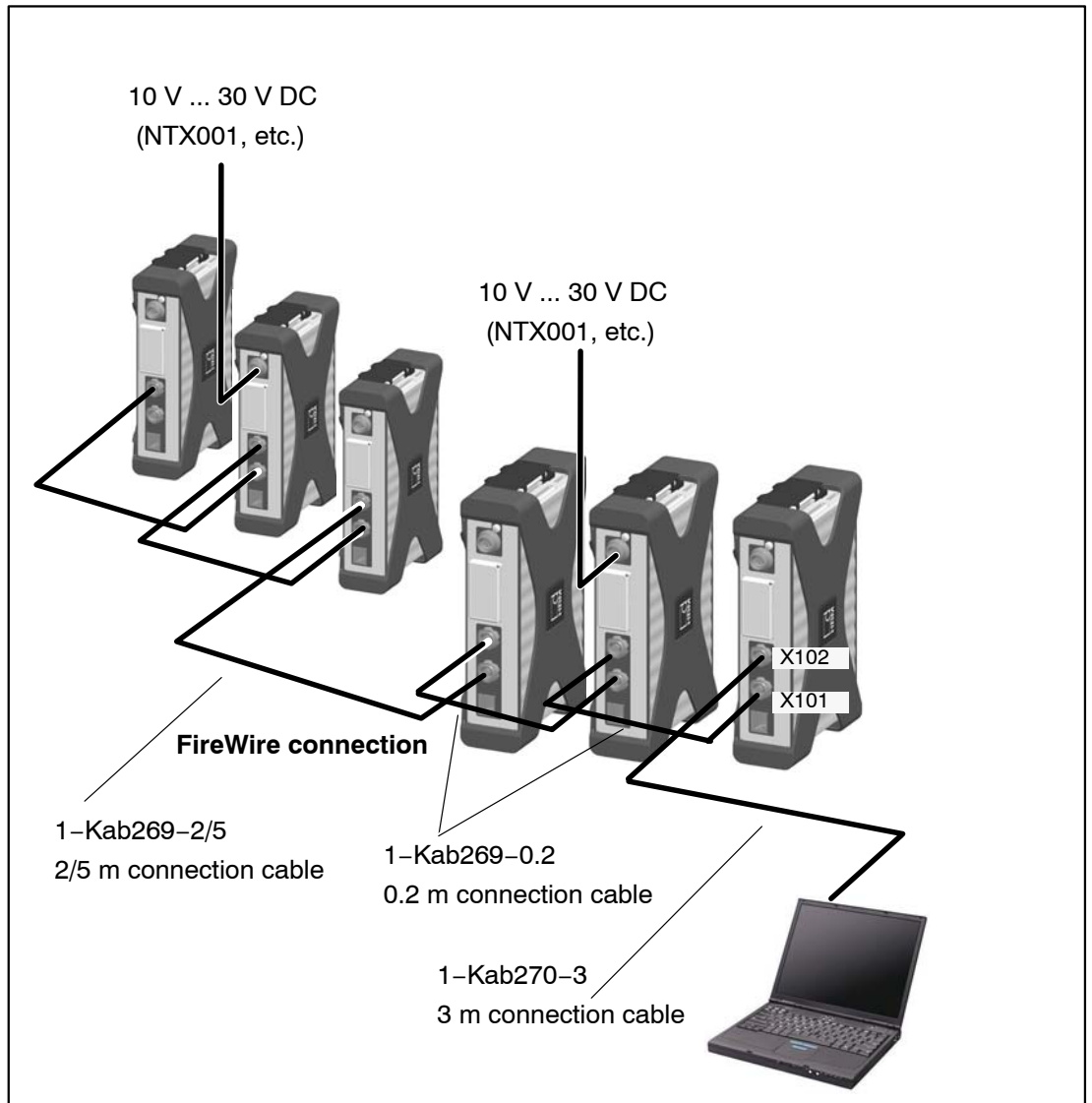
Fig.5.7: Example of multiple connection via FireWire with synchronization

Data is transferred, modules are synchronized in timing and voltage is supplied via the FireWire connections. You can connect a maximum of 12 modules in series with each other.

> **NOTE**
>
> **Different supply voltage sources need to have the same reference potential and should be in the same voltage range. Voltage drops occur as a result of cable resistance and internal protective circuits; therefore, a considerably lower supply voltage is applied to the last module in the chain.**
> **Make sure that at least 10 V is applied to the last module.**

5.2.9 Setup with data recorder CX22-W

10 V ... 30 V DC
(NTX001, etc.)

Connection via Ethernet cable
or wireless (WLAN)

CX22-W

FireWire connection
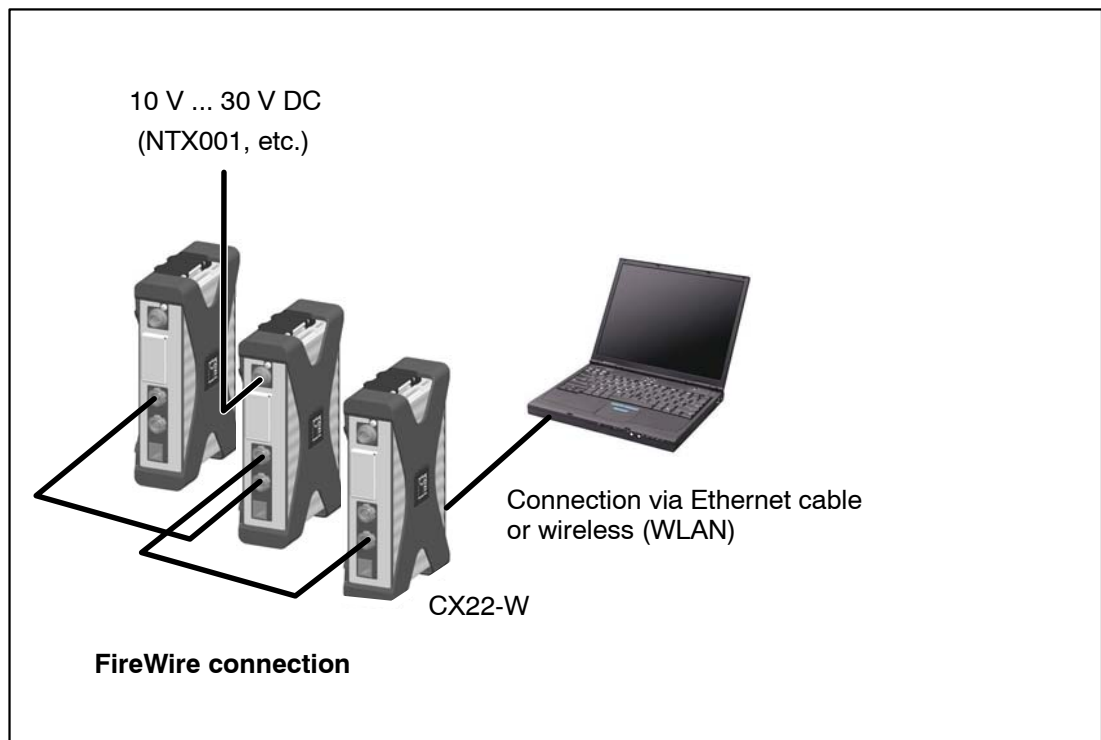
Fig.5.8: Layout with CX22-W

5.2.10   Output measurement signal to CAN bus (MX840A)

Measurement signals of connectors 2-8 are output to the CAN bus via connector.

Fig.5.9: Output to CAN bus (MX840A, connection 1)

5.2.11 Output measurement signals to CAN bus (MX471)

Isochronously parameterized signals can be output.

The parameterization is permanently stored in the modules (EEPROM). To simplify parameterization on the opposite side, a CAN db (*.dbc) can be generated using the QuantumX Assistant software.
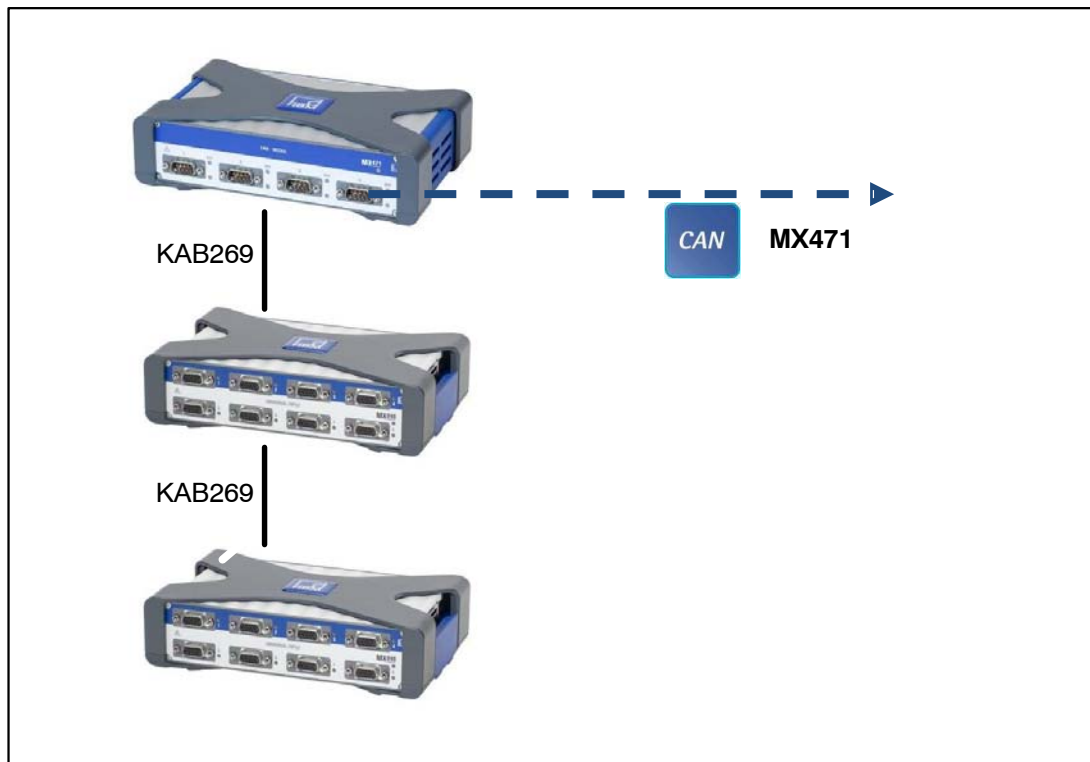
Fig.5.10: Output to CAN bus (MX471, every connection)

5.2.12   Output of signals with standardized voltage in real time

Isochronously parameterized signals can be output.

The parameterization is permanently stored in the modules (EEPROM).
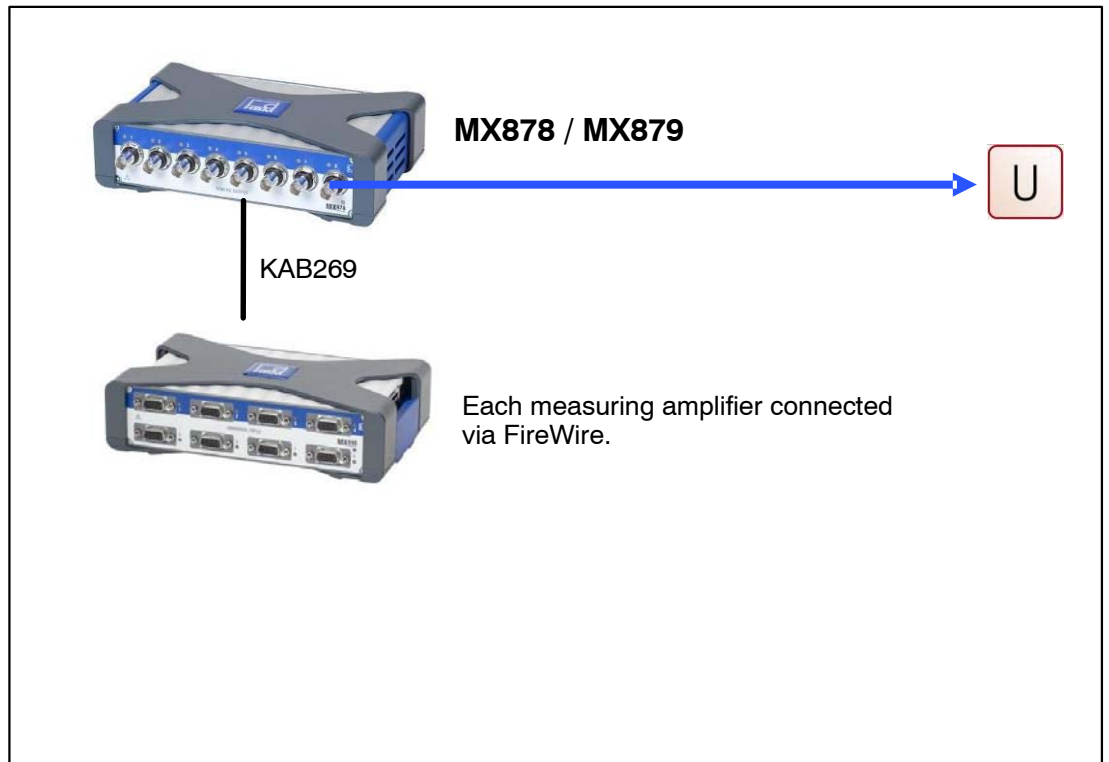
Fig.5.11:   Analog output in real time

5.2.13   Output signals in real time via EtherCAT® and in parallel via Ethernet

Each source in a QuantumX system is distributed into two signals, to which different data rate and filtering parameters can be assigned.

For example, the first signal of an input channel with a high data rate, e.g. acceleration sensor with 96,000 measured values per second and deactivated filter (38 kHz maximum bandwidth), can be output to PC software for analysis while the second signal with 4800 measured values per second and a 600 Hz filter can be output via CAN or EtherCAT®.
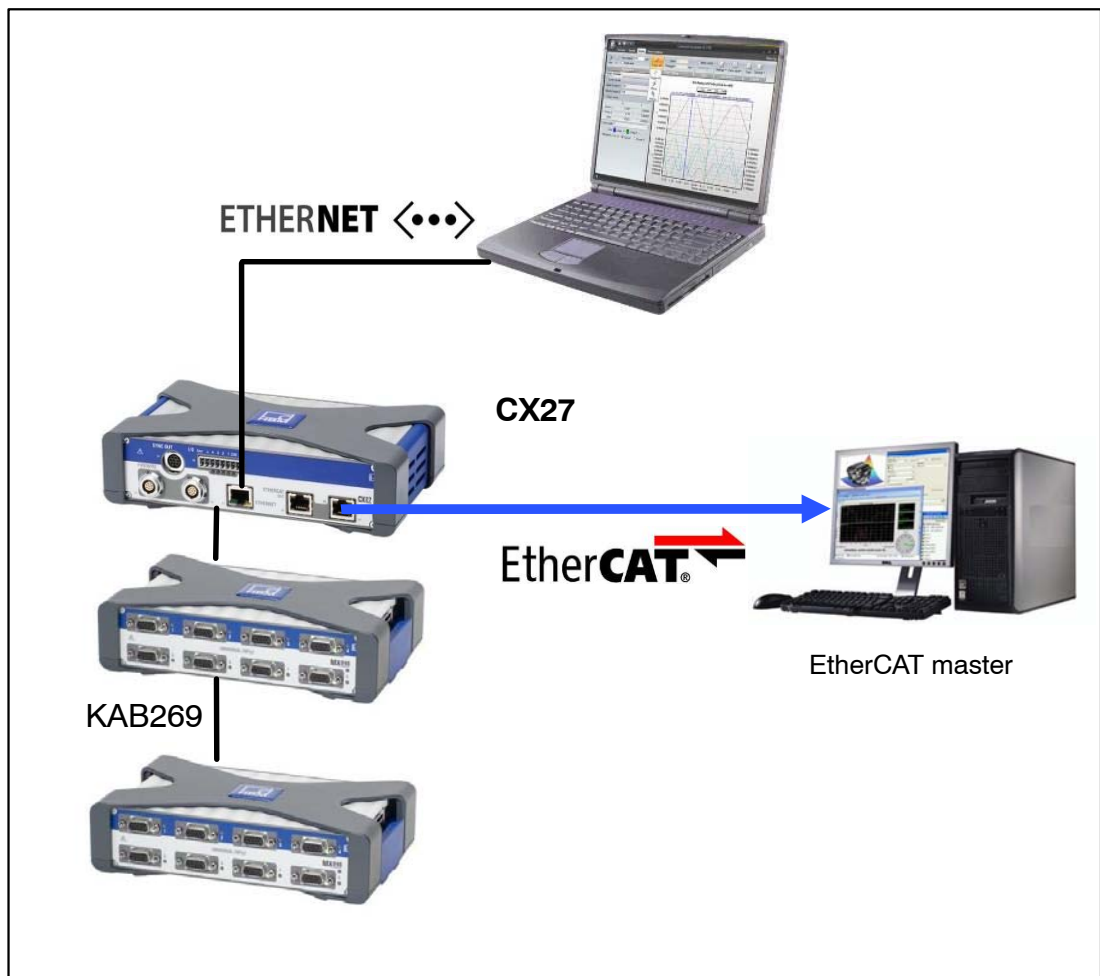
Fig.5.12:   Output in real time via EtherCAT® and in parallel via Ethernet

5.2.14 Connecting more than 12 modules
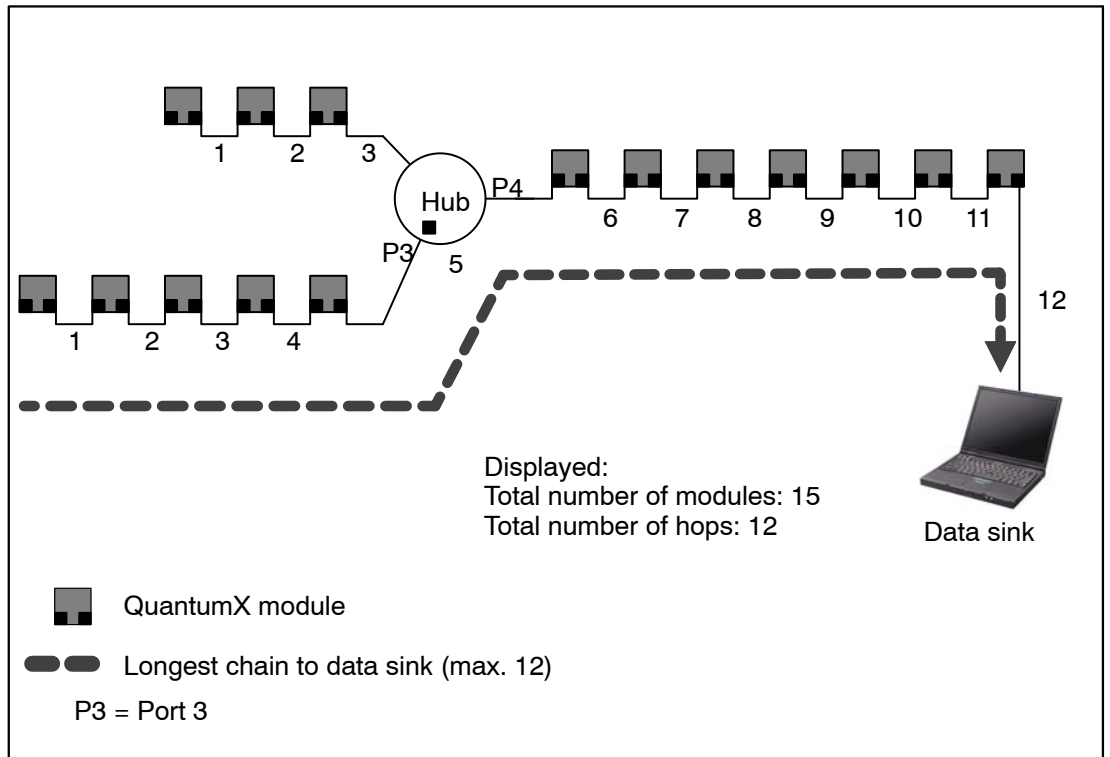
Fig.5.13: Example of a star topology with two chains and one hub

The number of modules connected in series (daisy chain) is limited to 12. If you want to connect more modules (maximum 24), you must use hubs. Hubs are devices that connect network chains together in star configurations. This connection mode is again limited to 14 hops.

A hop is the transition from one module to another (this means n−1 hops for n QuantumX modules in a chain).

Depending on the connection situation, 1 to 2 hops are counted in one hub (see Fig.5.14).

To count the total number of hops, the longest chain to the data sink must be counted (worst case).
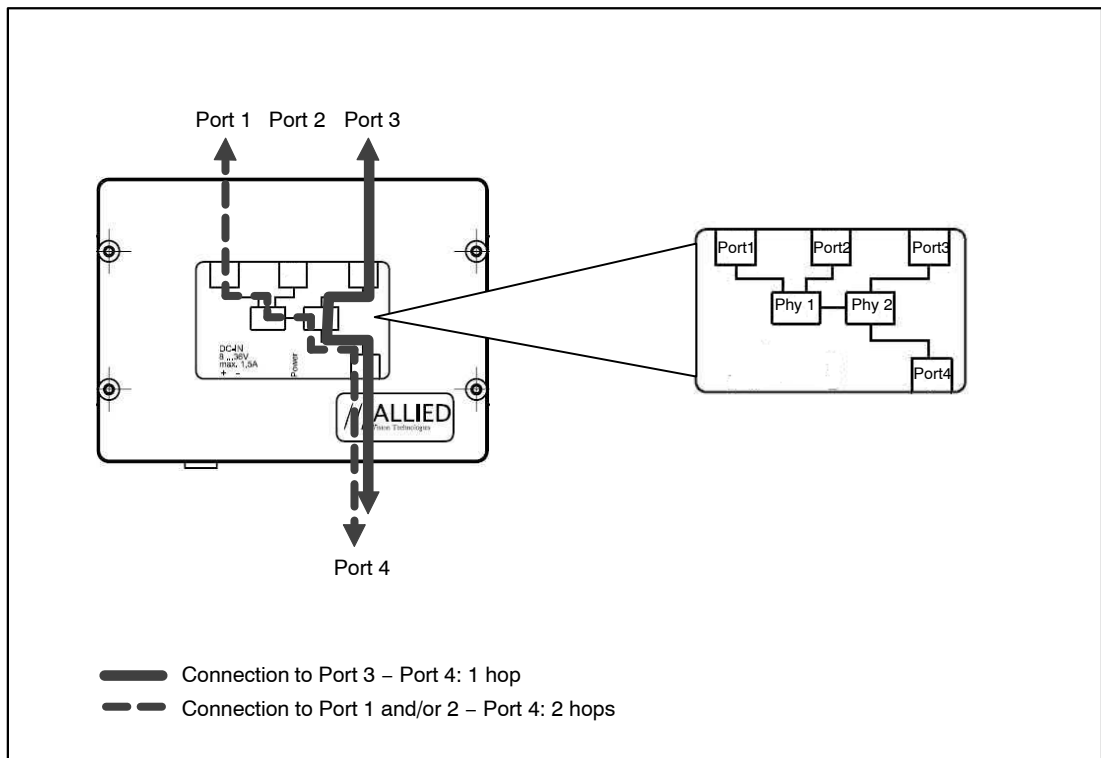
Fig.5.14:   Connection situation on the AVT 1394b hub

Note
Always connect the chain with the most modules to Port 3 or Port 4.

5.2.15   FireWire – optical connection up to 300 m

Greater distances in FireWire networks can be bridged with optohubs that enable distances of up to 300 m with the use of a fiber optical cable.
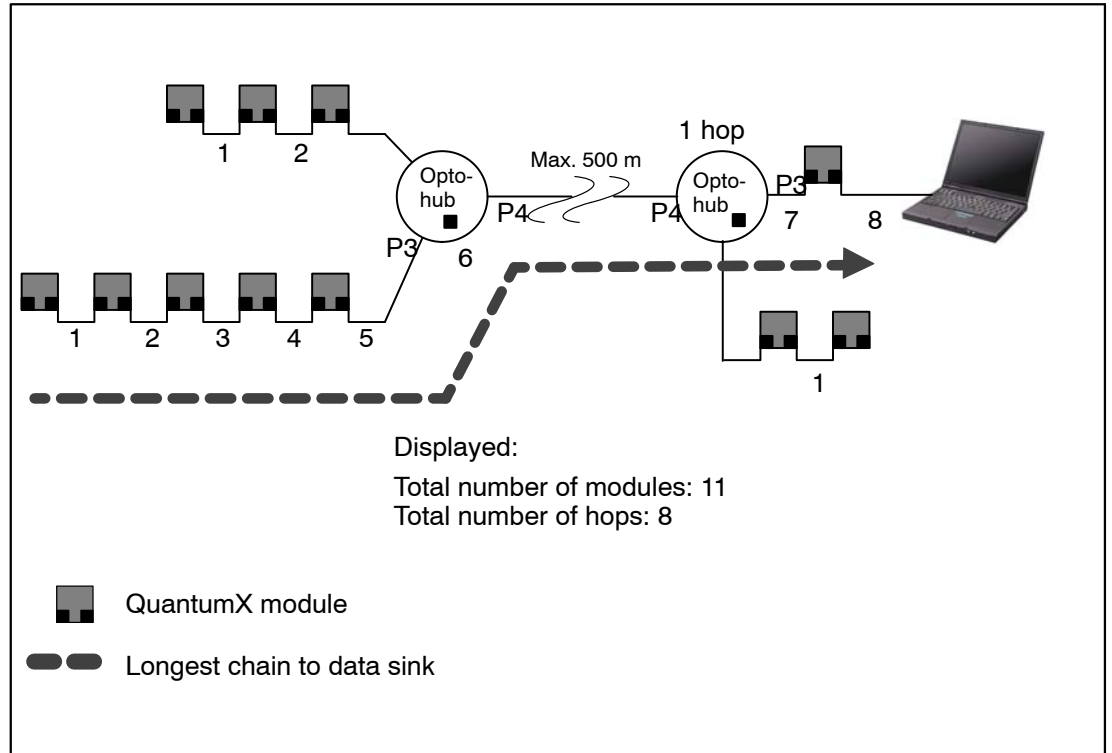
Fig.5.15:   Example of the use of optohubs

5.2.16   FireWire with optohub and fiber optical cable
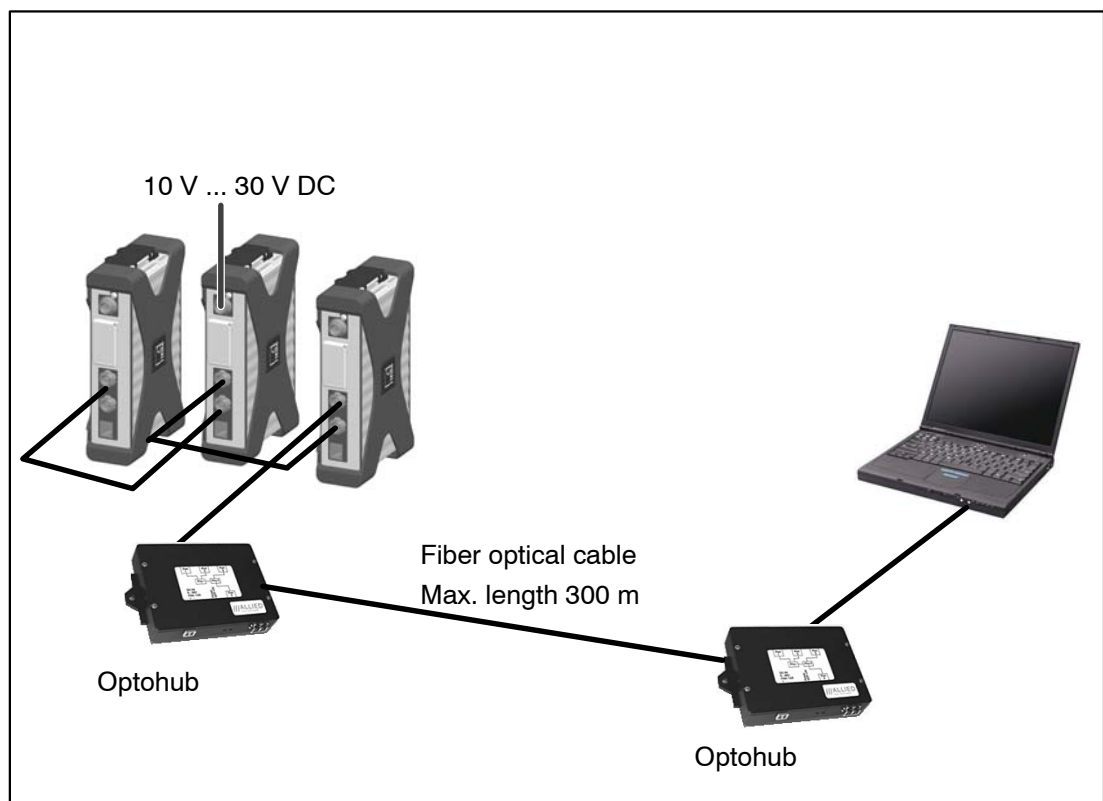
Fig.5.16:   FireWire 1394b optohubs and fiber optical cable from HBM partner Allied Vision
Technologies

6 Modules and transducers

6.1 General information

6.1.1 Shielding design

Sources of interference can cause electromagnetic fields which can induce interference voltages inductively or capacitively via the connection cable and device housing in the measurement circuit and therefore interfere with the device function. It must be ensured that the devices used in the system also do not transmit any electromagnetic interference. Electromagnetic compatibility (EMC), which encompasses both the required electromagnetic interference immunity (EMI) and the permissible electromagnetic interference emissions (EME), has become increasingly important over the years.

The HBM Greenline shielding design

The measuring chain is completely enclosed by a Faraday cage by appropriate routing of the cable shield. The cable shield is extensively connected with the transducer housing and is routed via the conductive plug to the amplifier housing. The effect of electromagnetic interference is significantly reduced by these measures.

The conductive housing ensures the connection to the plug or device housing

Signal-carrying contacts

The cable shield is connected with the conductive housing through strain relief
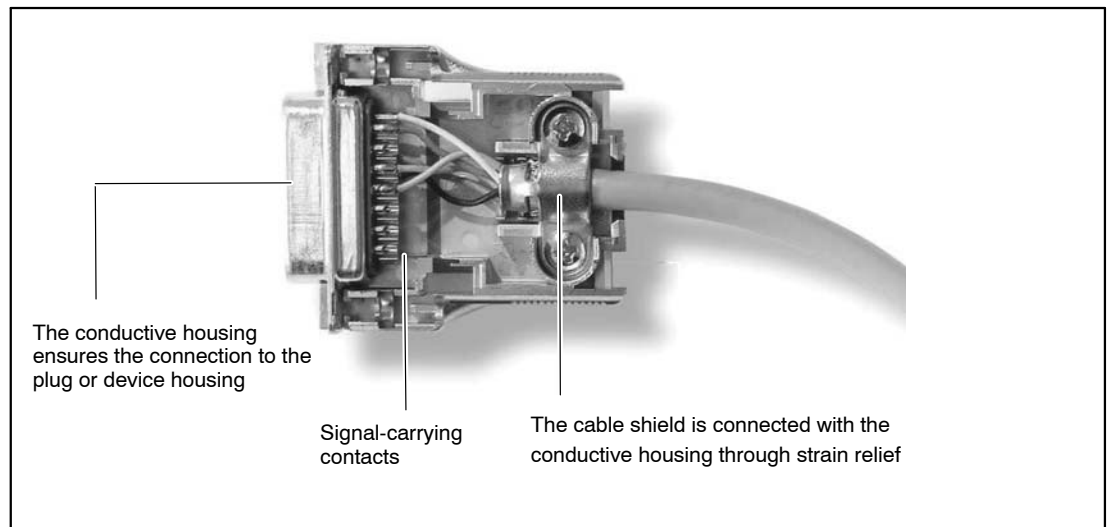
Fig.6.1: Routing of the cable shield on the plug

Note

All parts of the measurement chain (including all cable connection points such as plugs and couplings) must be surrounded by a closed EMC-proof shield. Shield junctions must represent a full contact, closed and low-impedance connection. This is the case for original HBM plug connections.

Ground connection and grounding

As the signal ground and shielding are separated in EMC-compliant cabling, the shielding can be connected at more than one point to the ground, i.e. via the transducer (metal housing) and the amplifier (housing is connected to the grounded conductor).

If there are differences in potential in the measuring system, a potential compensating line must be laid (reference value: highly flexible stranded wire, wire cross section $10mm^2$). Signal and data leads must be set up physically separated from current-carrying power lines. Ideally, cable ducts made of sheet metal with an internal partition should be used. Signal ground, ground and shielding must be laid out as separated as possible.

In order to minimize the effect of electromagnetic interference and differences in potential, the signal ground and ground (or shielding) are designed to be physically separate in the HBM devices. The grounded supply connector or a separate ground potential lead should serve as the ground connection, as is the case for potential compensation in buildings, for example. The ground cable should not be connected to a radiator body, water pipe or similar objects.

6.1.2   Active transducer connection

Some modules can supply active transducers with an excitation voltage of 5…24 V.

When using the adjustable transducer excitation, there is no electrical isolation from the amplifier's supply voltage.

The maximum permissible power consumption is 700 mW per channel, however, no more than 2 W in total. If the power consumption exceeds 700 mW on one channel, transducer excitation of this channel will be switched off. If the power consumption exceeds a total of 2 W, the device may be switched off.

Connection as per measurement principle

Sensor

Supply voltage 5V ... 24V[1]

Power supply 0V

Cable shield

4
9
12
11
Hsg.

[1]   Adjustable via software

Hsg. = Housing
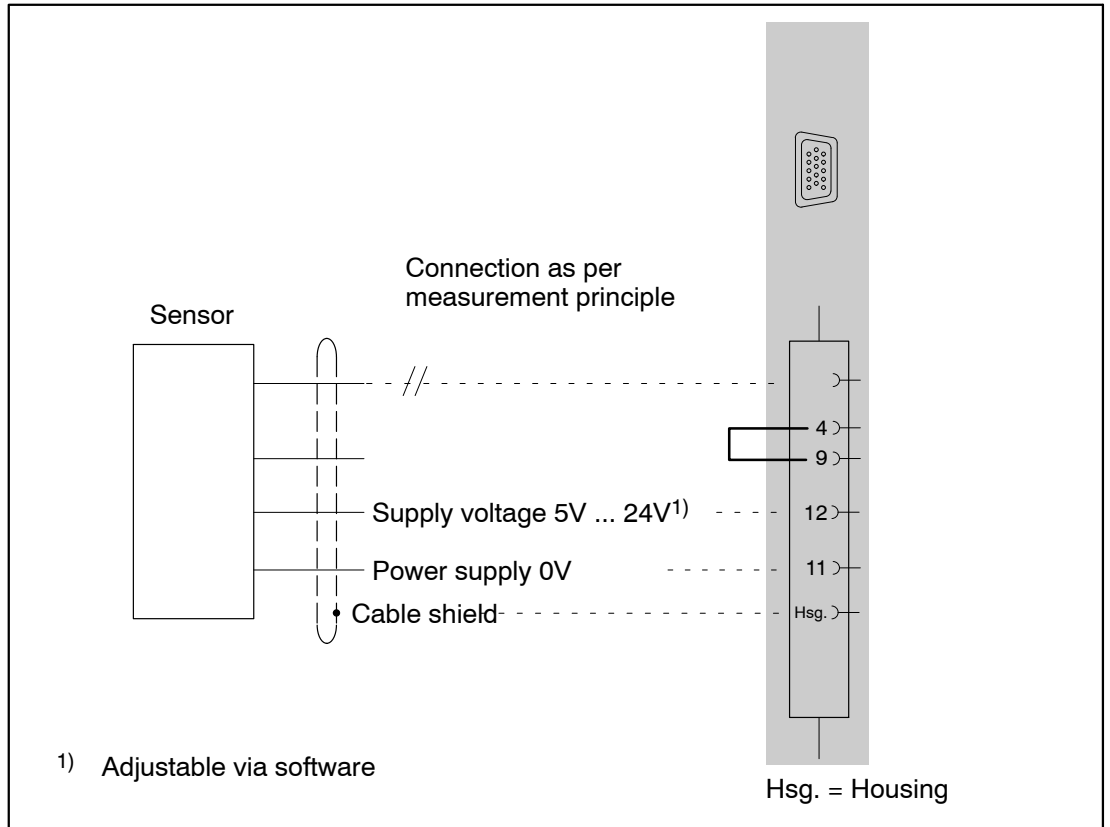
⚠ CAUTION

Check the correct voltage setting when connecting a sensor. Too high a voltage can destroy the sensor. The voltage value is a part of the MX840 parameterization and can only be changed with a new parameterization. The sensor supply is switched off in condition at the time of delivery.

6.1.3   TEDS

TEDS stands for "Transducer Electronic Data Sheet" and refers to the electronic data sheet of a transducer or sensor that is stored in a small electronic chip or appropriate module which is permanently connected to the device.

In addition, valuable metadata such as calibration data is provided, which gives important information for the traceability of measurements or tests. The electronic data sheet can be located in the transducer housing, in the inseparable cable or connector plug.

The function and working method of TEDS are defined in Standard IEEE1451.4.
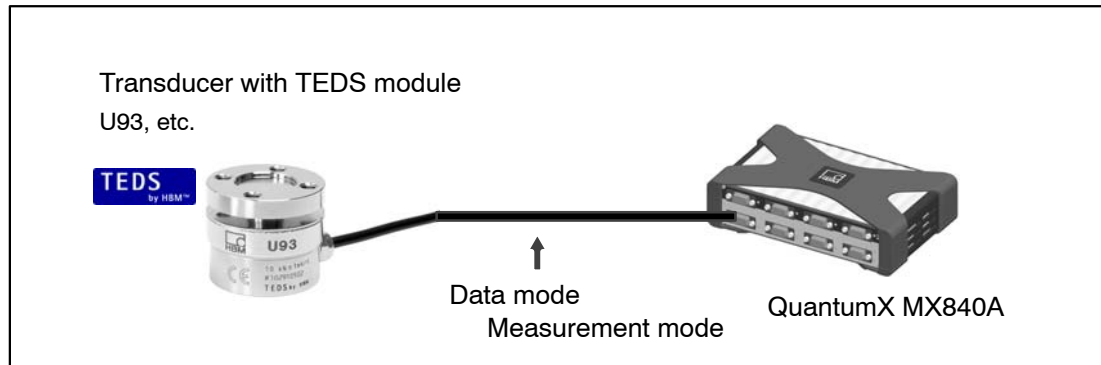
Transducer information stored in the TEDS data memory:

- The physical unit of the measured quantity (N for force, for example) and its measuring range

- The unit of the electrical output signal (mV/V for bridge transducers, for example)

- The linear characteristic curve as the relation between the measured quantity and the electrical signal

- If applicable, the requisite excitation and electrical power supply of the transducer

Additional information, that could be read using appropriate software, for example:

- Transducer manufacturer, type, serial number, etc.

- Calibration date, recalibration interval, calibrator's initials, etc.

The amplifiers in the QuantumX series are capable of reading the transducer information stored in the data sheet and automatically converting it into amplifier settings to enable rapid and safe measurement operation.

The electronic data sheet is read automatically as soon as the transducer is connected to the device. The electrical bridge between two pins in the plug serves as the "transducer identification". The amplifier switches automatically to the configured measurement mode after the digital identification mode.

TEDS data can also be read with a software command, for example with catman®AP.

All TEDS data can be read and edited with the TEDS Editor, see section 3.6.

QuantumX supports several options for reading and writing TEDS data:

- It is possible to access a TEDS module via two separate cable wires ("one-wire circuit") or retrofit TEDS in the transducer connector.

- Amplifiers with direct connection of IEPE transducers support TEDS Version 1.0.

- A special TEDS module is integrated in some HBM transducers. It can transmit TEDS data via the feedback line of a sensor (patented "zero-wire circuit").
  The amplifier switches to the measurement mode after the digital communication (data mode). These transducers include the force transducer U93 for example.

- Thermocouple amplifiers with RFID chips on the transducer connector support the TEDS technology, for example in order to connect the measuring point electronically with the transducer.

The data sheet of each amplifier includes further specifications with regards to TEDS, e.g. the maximum possible cable length to the transducer. If TEDS is not used, the possible cable length can be significantly longer.

Note

Further information about TEDS topics can be found on the HBM Internet pages:
http://www.hbm.com/teds

Retrofitting TEDS in transducer connectors

The IEEE standard 1451.4 defines a generally acknowledged process with which sensors can be identified. The sensor is identified by the respective data sheet which is stored in electronic format in the sensor, cable or plug on a 1-wire EEPROM (TEDS – Transducer Electronic Data Sheet). The amplifier communicates with this EEPROM via the serial 1-wire interface, reads the data sheet and makes the corresponding amplifier settings.

The following figure shows the retrofitting of TEDS in a plug. The bridge between Pin 4 and Pin 9 is used for plug identification of the transducer. It starts automatic reading of the TEDS.

HBM recommends the TEDS module (1-wire(R) EEPROM) DS24B33 from Dallas Maxim. HBM offers a package with 10 TEDS: order no.: 1–TEDS–PAK
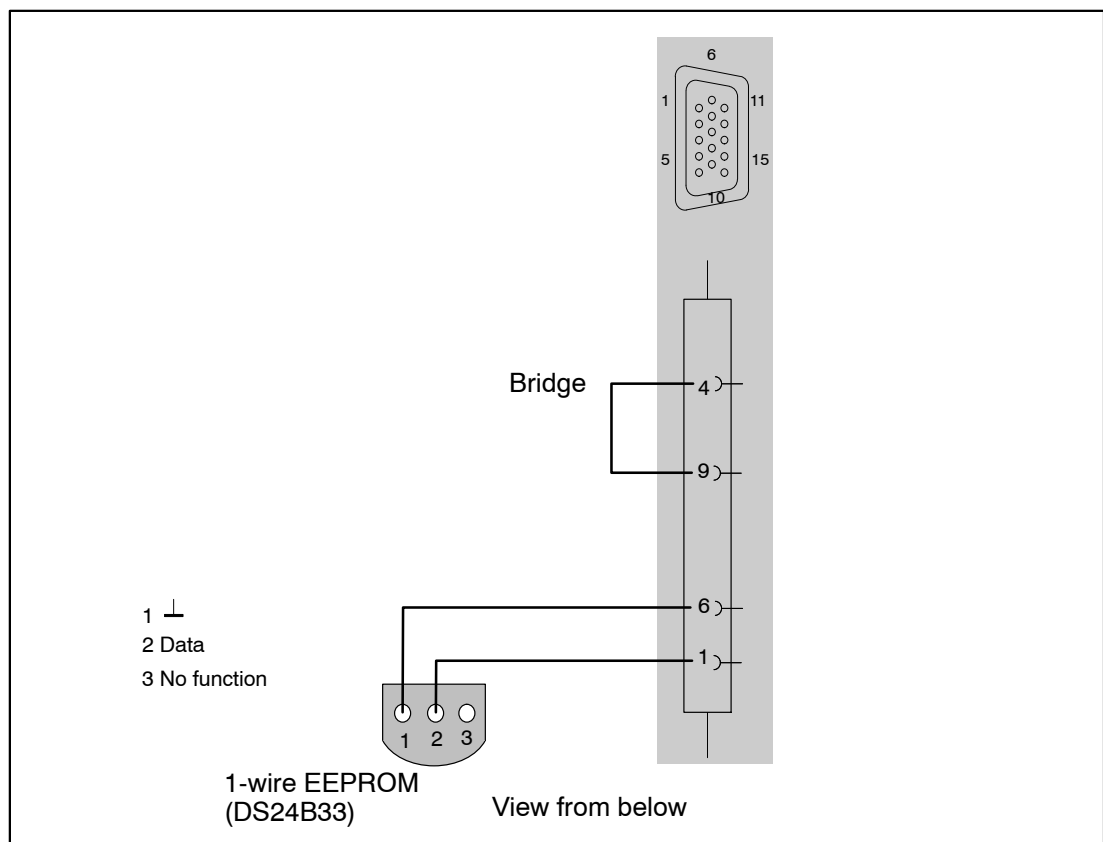
6.1.4   Autocalibration / autoadjustment

Measurement channels with full/half bridge mode are cyclically calibrated during the runtime following the start of the module. This mechanism improves long-term stability (aging) and also the short-term stability of an amplifier if there are temperature fluctuations at the site of the measuring device.

Autocalibration briefly interrupts measurement and – in place of the measured values from the transducer – sends signals from an internal calibration source to the AD converter (zero and reference signal).

Amplifiers MX840, MX840A and MX440A have **autoadjustment**.

These amplifiers have a second measurement circuit in the full/half bridge measurement mode, which measures in parallel to the input circuit and implements a calibration cycle in a 30 second rhythm. This ensures long-term and short-term stability in the circuit. The accuracy of the calibration channel is then transferred to the measurement channel with a patented process.

This allows the modules to achieve a high stability without having to cyclically freeze the measured value.

Autoadjustment can be parameterized with the QuantumX Assistant or using catmanEASY.

Autoadjustment is switched on the default settings. This cyclical calibration can be briefly deactivated with the QuantumX Assistant and via catmanEASY®.

6.2   MX840 universal amplifier

You can connect up to eight transducers to the universal amplifier MX840. The transducers are connected via 15-pin D–SUB–15HD device connectors. All measuring channels are electrically isolated from one another and from the power supply.

MX840 connectable transducers

	Transducer type	Connector sockets	See page
	SG full bridge	1 ... 8	107
	SG quarter bridge via external adapter	1 ... 8	112
	Inductive full bridge	1 ... 8	108
	Inductive half bridge	1 ... 8	111
	LVDT	1 ... 8	116
	Electrical voltage	1 ... 8	120, 121
	High-voltage via external adapter (300 V CAT II)	1 ... 8	122
	Electrical current	1 ... 8	123
	Piezoresistive transducer	1 ... 8	109
	Current-fed piezoelectric transducer (IEPE, ICP®) via an external adapter	1 ... 8	117
	Potentiometer	1 ... 8	115
	Resistance thermometer PT100, PT1000	1 ... 8	126
	Thermocouple	1 ... 8	127
	Incremental encoder	5 ... 8	129
	SSI protocol	5 ... 8	135

Connectable MX840 transducers (continued)

	Transducer type	Connector sockets	See page
	Torque/speed (HBM torque transducer)	5 ... 8	130, 131
	Frequency measurement, pulse counting	5 ... 8	129
	CAN bus	1	139

6.2.1   MX840 pin assignment

So that insertion or removal of a transducer connection can be unmistakably identified, Pin 4 and Pin 9 in the connector plug must be bridged! If this bridge is missing, no measurement values will be recorded at the connection!

Fig.6.2: Pin arrangement of connector plug, view from the solder side

Pin	Connector
1	TEDS (+)
2	Bridge excitation voltage (−), 0°-reference pulse (zeroing pulse) (−)
3	Bridge excitation voltage (+), 0°-reference pulse (zeroing pulse) (+)
4	Always connect with Pin 9! (Plug-in detection)
5	Measurement signal (+), potentiometer measurement signal (+), voltage input 100 mV (+), f_1(−) signal differential, SSI data (−)
6	TEDS (−), ground frequency measurement
7	Sense lead (−), f_2(−) signal differential, CAN−High, SSI clock (−)
8	Sense lead (+), f_2(+) signal differential, CAN−Low, SSI clock (+)
9	Signal ground
10	Measurement signal (−), f_1(+) signal differential, SSI data (+)
11	Active sensor supply 5 ... 24 V (0 V)
12	Active sensor supply 5 ... 24 V (+)
13	Current input ± 30 mA (+)
14	Voltage input 10 V (+), 60 V (+)
15	Unassigned

6.2.2   MX840 status display

The front panel of the universal amplifier has a system LED and 8 connection LEDs. The system LED indicates the status of the device, the connection LEDs the states of the individual connections.

Fig.6.3: MX840 front view

System LED	
Green	Error-free operation
Orange	System is not ready, boot procedure running
Flashing orange	Download active, system is not ready
Red	Error
Connection LEDs	
All LEDs are orange	Boot procedure running (system is not ready)
All LEDs are flashing orange	Firmware download active (system is not ready)
Orange	Connection newly assigned, transducer identification running (calibration)
Green	Error-free operation
Flashing green (5s), then green	TEDS data being read in
Flashing orange (5s), then green	Manual configuration ongoing (ignore TEDS)
Red	No sensor connected Channel error (incorrectly parameterized, connection error, invalid TEDS data)
CAN LEDs	
Green	CAN bus activated, CAN data can be received
Orange	CAN bus in "WARNING" state, CAN data received but bus is subject to occasional disruptions; buffer overflow, some data items lost
Red	CAN bus in "ERROR" or "BUS-OFF" state, CAN data cannot be received or processed

General rule: Brief flashing →TEDS identified (green: is used, orange: is not used).

6.3 MX840A universal amplifier

The MX840**A** universal amplifier corresponds to the MX840 amplifier, with the additional option of connecting SG half bridges and variable ohmic resistors.

MX840A connectable transducers

	Transducer type	Connector sockets	See page
	SG full bridge	1 ... 8	107
	SG half bridge	1 ... 8	110
	SG quarter bridge via adapter	1 ... 8	112
	Inductive full bridge	1 ... 8	108
	Inductive half bridge	1 ... 8	111
	LVDT	1 ... 8	116
	Electrical voltage	1 ... 8	120, 121
	High-voltage via adapter (300 V CAT II)	1 ... 8	122
	Electrical current	1 ... 8	123
	Current-fed piezoelectric transducer (IEPE, ICP®) via adapter	1 ... 8	117
	Piezoresistive transducer	1 ... 8	109
	Potentiometer	1 ... 8	115
	Resistance thermometer PT100, PT1000	1 ... 8	126
	Ohmic resistor	1 ... 8	125
	Thermocouple	1 ... 8	127

Connectable MX840A transducers (continued)

	Transducer type	Connector sockets	See page
min⁻¹	Incremental encoder, rotary encoder	5 ... 8	from 129
SSI	SSI protocol	5 ... 8	135
f	Frequency measurement, pulse counting	5 ... 8	from 129
	Torque/speed (HBM torque transducer)	5 ... 8	130, 131
CAN	CAN bus (receive/send)	1	139

6.3.1   MX840A pin assignment

So that insertion or removal of a transducer connection can be unmistakably identified, Pin 4 and Pin 9 in the connector plug must be bridged! If this bridge is missing, no measurement values will be recorded at the connection!
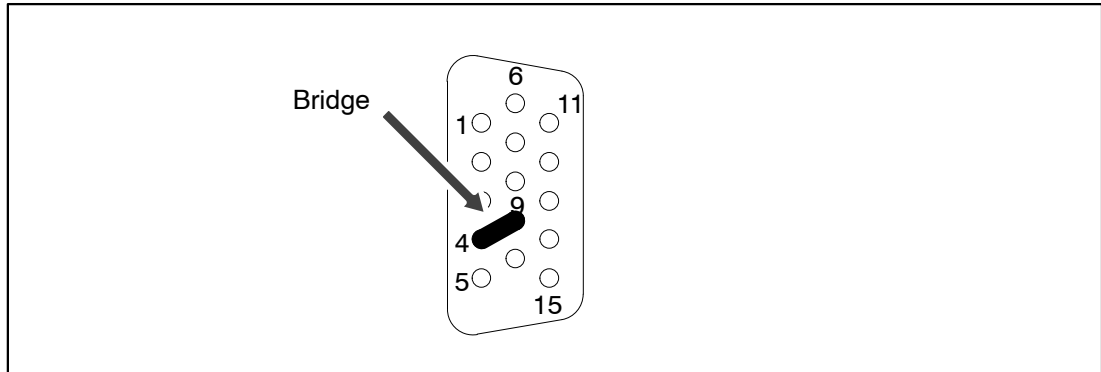

Fig.6.4: Pin arrangement of connector plug, view from the solder side

Pin	Connector
1	TEDS (+)
2	Bridge excitation voltage (−), 0°-reference pulse (zeroing pulse) (−)
3	Bridge excitation voltage (+), 0°-reference pulse (zeroing pulse) (+)
4	Always connect with Pin 9! (Plug-in detection)
5	Measurement signal (+), potentiometer measurement signal (+), voltage input 100 mV (+), f_1(−) signal differential, SSI data (−)
6	TEDS (−), ground frequency measurement
7	Sense lead (−), f_2(−) signal differential, CAN-High, SSI clock (−)
8	Sense lead (+), f_2(+) signal differential, CAN-Low, SSI clock (+)
9	Signal ground
10	Measurement signal (−), f_1(+) signal differential, SSI data (+)
11	Active sensor supply 5 ... 24 V (0 V)
12	Active sensor supply 5 ... 24 V (+)
13	Current input ±30 mA (+)
14	Voltage input 10 V (+), 60 V (+)
15	Digital output, for example to activate a calibration signal for T10F(S) and T40, 5 V/max. 10 mA

6.3.2   MX840A status display

The front panel of the universal amplifier has a system LED and 8 connection LEDs. The system LED indicates the status of the device, the connection LEDs the states of the individual connections.
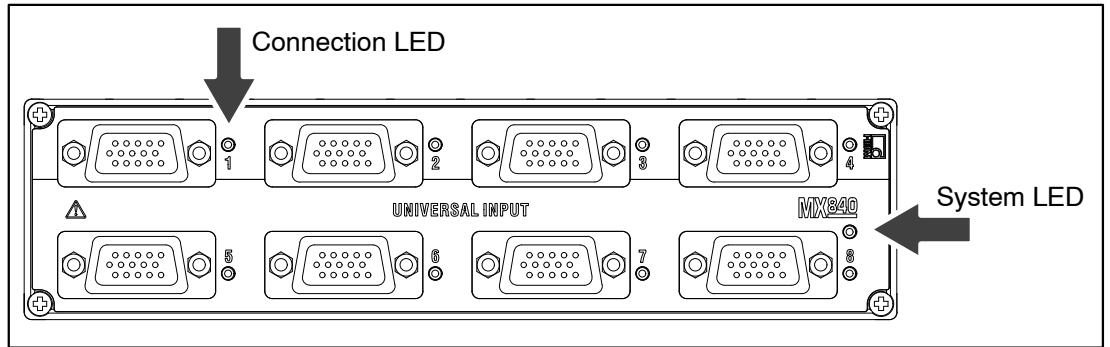

Fig.6.5: MX840 front view

System LED	
Green	Error-free operation
Orange	System is not ready, boot procedure running
Flashing orange	Download active, system is not ready
Red	Error
Connection LEDs	
All LEDs are orange	Boot procedure running (system is not ready)
All LEDs are flashing orange	Firmware download active (system is not ready)
Orange	Connection newly assigned, transducer identification running (calibration)
Green	Error-free operation
Flashing green (5s), then green	TEDS data being read in
Flashing orange (5s), then green	Manual configuration ongoing (ignore TEDS)
Red	No sensor connected Channel error (incorrectly parameterized, connection error, invalid TEDS data)
CAN LEDs	
Green	CAN bus activated, CAN data can be received
Orange	CAN bus in "WARNING" state, CAN data received but bus is subject to occasional disruptions; buffer overflow, some data items lost
Red	CAN bus in "ERROR" or "BUS-OFF" state, CAN data cannot be received or processed

General rule: Brief flashing →TEDS identified (green: is used, orange: is not used).

6.4   MX440A universal amplifier

You can connect up to four transducers to the universal amplifier MX440A. The transducers are connected via 15-pin D−SUB−15HD device connectors. All measuring channels are electrically isolated from one another and from the power supply.

Connectable transducer types and the status display are identical with the universal amplifier MX840A (without CAN) (see page 82).
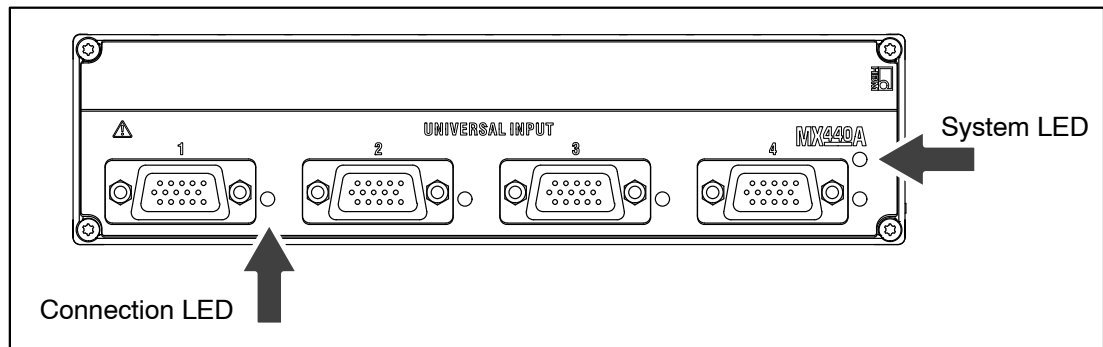

Fig.6.6: MX440A front view

System LED	
Green	Error-free operation
Orange	System is not ready, boot procedure running
Flashing orange	Download active, system is not ready
Red	Error
Connection LEDs	
All LEDs are orange	Boot procedure running (system is not ready)
All LEDs are flashing orange	Firmware download active (system is not ready)
Orange	Connection newly assigned, transducer identification running (calibration)
Green	Error-free operation
Flashing green (5s), then green	TEDS data being read in
Flashing orange (5s), then green	Manual configuration ongoing (ignore TEDS)
Red	No sensor connected Channel error (incorrectly parameterized, connection error, invalid TEDS data)

General rule: Brief flashing →TEDS identified (green: is used, orange: is not used).

6.5   MX410 highly dynamic universal amplifier

You can connect up to four transducers to the highly dynamic universal amplifier MX410. The transducers are connected via 15-pin D–SUB–15HD device connectors. You will need BNC adapters (accessory 1–IEPEMX410) to connect the IEPE transducers.

All measuring channels are electrically isolated from one another and from the power supply. When using the adjustable transducer excitation, electrical isolation from the supply voltage of the amplifier is not required.

MX410 connectable transducers

	Transducer type	Connection sockets	See page
	SG full bridge	1 ... 4	107
	SG half bridge	1 ... 4	110
	SG quarter bridge via adapter	1 ... 8	112
	Inductive full bridge	1 ... 4	108
	Inductive half bridge	1 ... 4	111
	Voltage	1 ... 4	120, 121
	High-voltage via adapter (300 V CAT II)	1 ... 8	122
	Current	1 ... 4	123
	Current-fed piezoelectric transducer (IEPE, ICP$^{\circledR}$)	1 ... 4	117
	Piezoresistive transducer	1 ... 4	109

6.5.1   MX410 pin assignment

So that insertion or removal of a transducer connection can be unmistakably identified, Pin 4 and Pin 9 in the connector plug must be bridged! If this bridge is missing, no measurement values will be recorded at the connection!
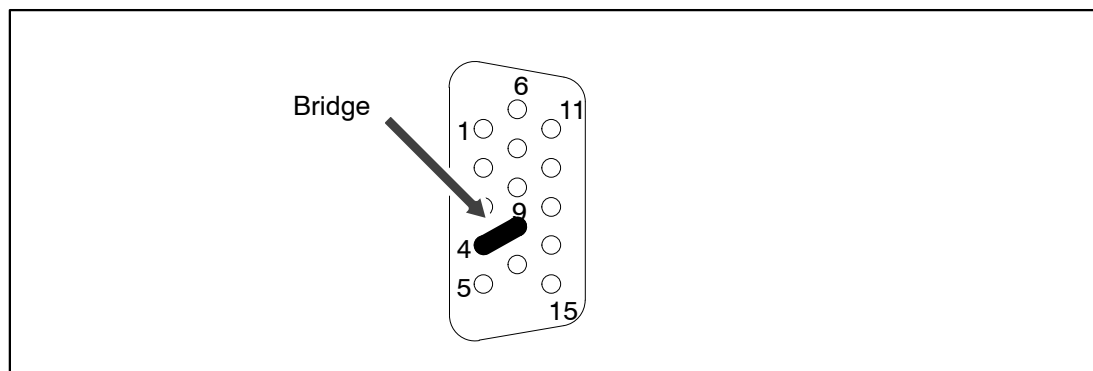
Fig.6.7: Pin arrangement of connector plug, view from the solder side

Pin	Connector
1	TEDS (+)
2	Bridge excitation voltage (−)
3	Bridge excitation voltage (+)
4	Always connect with Pin 9! (Plug-in detection)
5	Measurement signal (+)
6	TEDS (−)
7	Sense lead (−)
8	Sense lead (+)
9	Signal ground
10	Measurement signal (−)
11	Active sensor supply (−)
12	Active sensor supply (+)
13	Current input ±30 mA (+)
14	Voltage input 10 V, IEPE (+)
15	Digital output, for external charge amplifier e.g., 5 V/max. 10 mA

The analog output can be tapped via BNC. For configuration instructions see section 8 "Functions and outputs".

6.5.2   MX410 status display
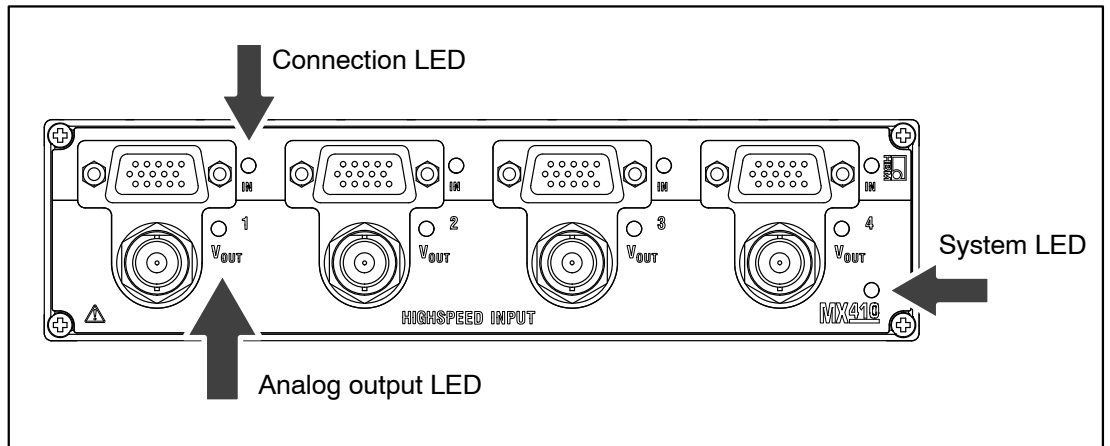
Fig.6.8: MX410 front view

System LED	
Green	Error-free operation
Orange	System is not ready, boot procedure running
Flashing orange	Download active, system is not ready
Red	Error
Connection LEDs	
All LEDs are orange	Boot procedure running (system is not ready)
All LEDs are flashing orange	Firmware download active (system is not ready)
Orange	Connection newly assigned, transducer identification running (calibration)
Green	Error-free operation
Flashing green (5s), then green	TEDS data being read in
Flashing orange (5s), then green	Manual configuration ongoing (ignore TEDS)
Red	No sensor connected Channel error (incorrectly parameterized, connection error, invalid TEDS data)
Red	Sensor supply overload
Analog output LEDs	
Green	Error-free operation
Orange	System is not ready, boot procedure running
Red	Overcurrent at the analog output
Orange	Input signal overflow
Red	Overflow due to invalid scaling of the analog outputs

General rule: Brief flashing →⬚TEDS identified (green: is used, orange: is not used).

6.6   MX460 frequency amplifier

You can connect up to four transducers to the frequency measuring amplifier MX460. The transducers are connected via 15-pin D–SUB–15HD device connectors. All measuring channels are electrically isolated from one another and from the power supply. When using the adjustable transducer excitation, electrical isolation from the supply voltage of the amplifier is not required.

MX460 connectable transducers

	Transducer type	Connection sockets	See page
	Torque/speed (HBM torque transducer)	1 ... 4	130, 131
	Frequency measurement, pulse counting	1 ... 4	from 129
	Pulse width, pulse duration, period duration (PWM)	1 ... 4	137
	Passive inductive encoder	1 ... 4	136
	Incremental encoder	1 ... 4	from 129

6.6.1   MX460 pin assignment

So that insertion or removal of a transducer connection can be unmistakably identified, Pin 4 and Pin 9 in the connector plug must be bridged! If this bridge is missing, no measurement values will be recorded at the connection!
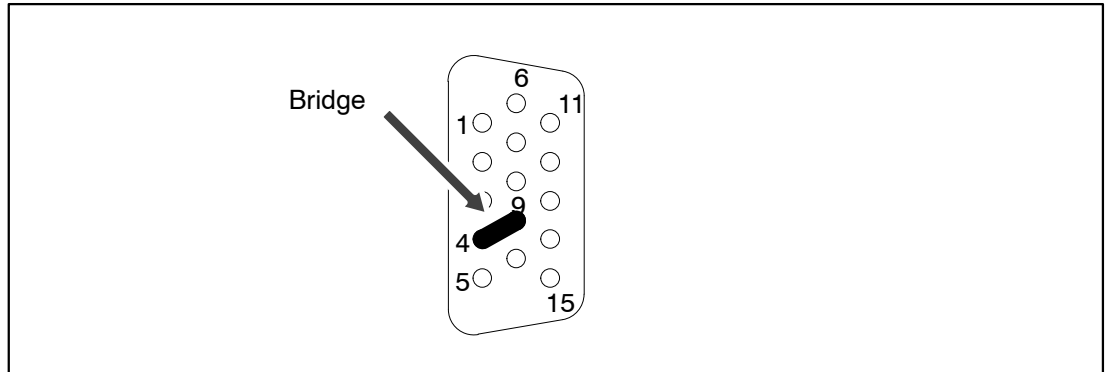
Fig.6.9: Pin arrangement of connector plug, view from the solder side

Pin	Connector
1	TEDS (+)
2	Reference pulse 0° (zeroing pulse) (−)
3	Reference pulse 0° (zeroing pulse) (+)
4	Always connect with Pin 9! (Plug-in detection)
5	Frequency input f_1 (−)
6	TEDS (−), signal ground
7	Frequency input f_2 (−)
8	Frequency input f_2 (+)
9	Reference voltage V_{ref} (2.5 V)
10	Frequency input f_1 (+)
11	Active sensor supply 5 ... 24 V (−)
12	Active sensor supply 5 ... 24 V (+)
13	Not in use
14	f_1 AC+ (for passive inductive transducers)
15	Digital output, for example to activate a calibration signal for T10F(S) and T40, 5 V/max. 10 mA

6.6.2   MX460 status display
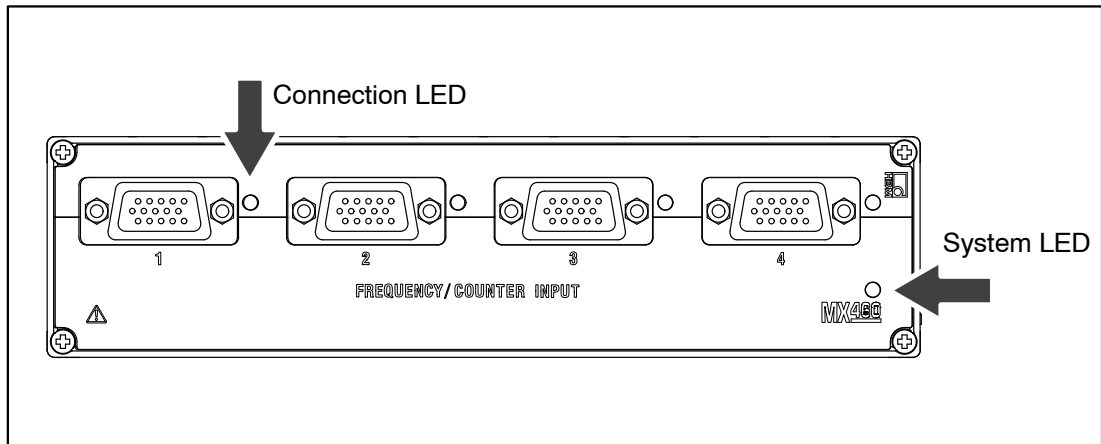
Fig.6.10:   MX460 front view

System LED	
Green	Error-free operation
Orange	System is not ready, boot procedure running
Flashing orange	Download active, system is not ready
Red	Error
Connection LEDs	
All LEDs are orange	Boot procedure running (system is not ready)
All LEDs are flashing orange	Firmware download active (system is not ready)
Orange	Connection newly assigned, transducer identification running (calibration)
Green	Error-free operation
Flashing green (5s), then green	TEDS data being read in
Flashing orange (5s), then green	Manual configuration ongoing (ignore TEDS)
Red	No sensor connected Channel error (incorrectly parameterized, connection error, invalid TEDS data)

General rule: Brief flashing →TEDS identified (green: is used, orange: is not used).

6.7 MX1609/MX1609T thermocouple amplifier

Up to 16 type K thermocouples (Ni–CrNi) can be connected to the module MX1609 for measuring temperatures.

Up to 16 type T thermocouples (Cu–CuNi) can be connected to the module MX1609T for measuring temperatures.

Connectable MX1609/MX1609T transducers

	Transducer type	Connection sockets	See page
	Thermocouple type K, type T	1 ... 16	127

Type	Thermocouple material 1 (+)	Thermocouple material 2 (−)
K	Nickel-chrome (color code green)	Nickel-aluminum (color code white)
T	Copper (wire color brown)	Copper-nickel (wire color white)
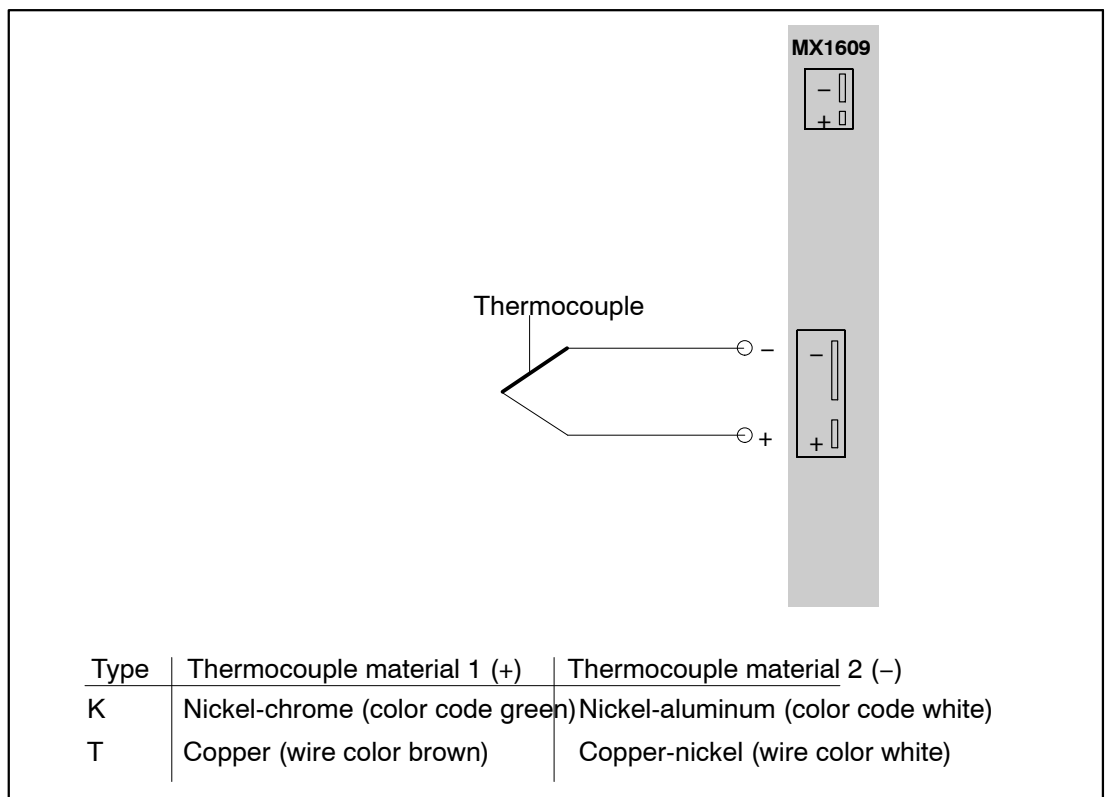
Connection of the thermocouple plug in the miniature design.
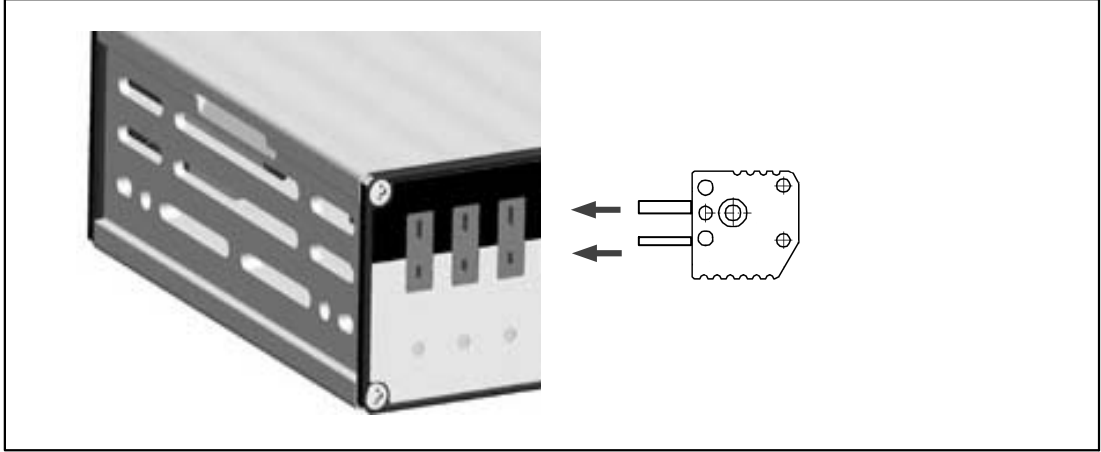
6.7.1   Thermocouple with TEDS functionality (RFID)

Measuring point identification

An RFID[1] chip in or on the thermocouple plug ensures wireless transducer identification through the amplifier. RFID technology enables contactless reading and writing of data such as the precise measuring point or the required physical unit (°C or °K). Data is entered with the TEDS Editor provided by HBM. It is then written to the RFID chip via a corresponding RFID transponder in the amplifier.

The chip is reusable and works without batteries.

Rescaling

The MX1609 has a rescaling function. Errors from thermocouples or installation situations can be minimized using a table that converts values from degree °C to degree °C.

The MX1609 can process maximum 64 value pairs. 14 value pairs can be stored in the TEDS template "Calibration Table" if no additional optional templates are used.

This function delivers the best results when the ambient temperature of the MX1609, and therefore the temperature of the cold junction, is kept constant.

Conditions for using RFID chips for measuring point identification:

– All channels can read/write via RFID

– The neighboring channel must not be occupied in the MX1609 during writing

– Maximum distance chip to housing: 1 mm

– For self-assembly: Check position of chip on plug

Thermocouple plug with integrated RFID chip from HBM

RFID chip
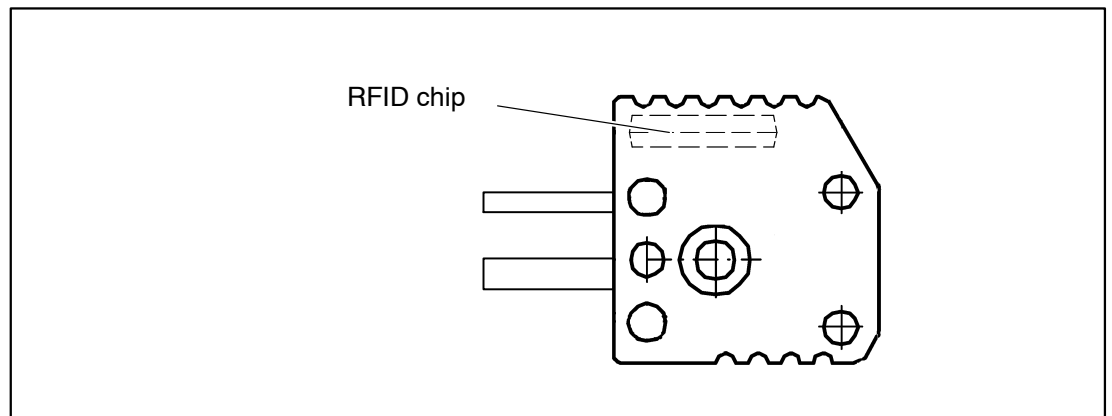
The chip for measuring point identification is already integrated in the HBM THERMO-MINI.

[1]   RFID = Radio Frequency Identification: Method for communication between transponder and read/write device with magnetic fields or electromagnetic waves.

6.7.2 MX1609/MX1609T status display
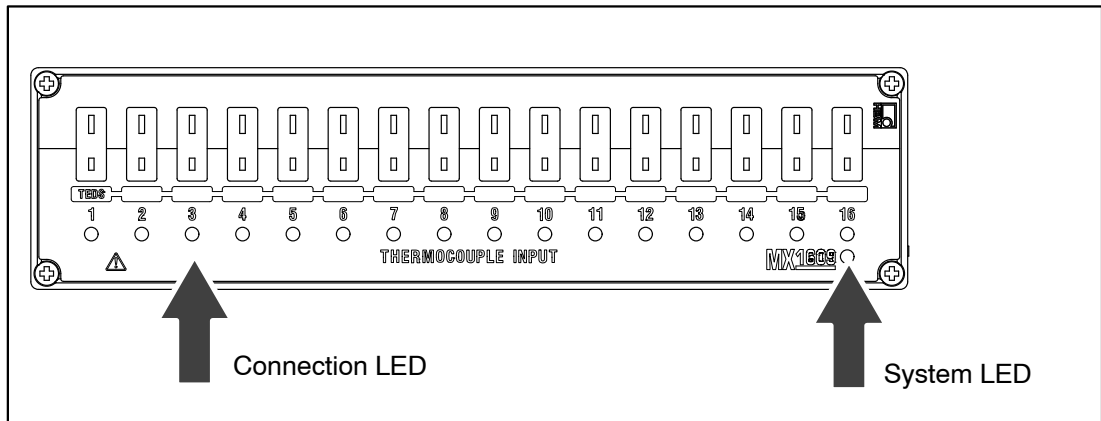
Fig.6.11: MX1609 front view

System LED	
Green	Error-free operation
Orange	System is not ready, boot procedure running
Flashing orange	Download active, system is not ready
Red	Error
Connection LEDs	
All LEDs are orange	Boot procedure running (system is not ready)
All LEDs are flashing orange	Firmware download active (system is not ready)
Orange	Connection newly assigned, transducer identification running (calibration)
Green	Error-free operation ("Ignore TEDS" or "if available" set, channel is manually configured)
Flashing green (5s), then green	Error-free operation ("Use TEDS" or "if available" set and TEDS data valid)
Red	No sensor connected Channel error (incorrectly parameterized, connection error, invalid TEDS data)
Red	Sensor supply overload

General rule: Brief flashing →TEDS identified (green: is used, orange: is not used).

6.8   MX471 CAN module

6.8.1   General information

The MX471 module provides four independent CAN bus nodes that are all electrically isolated from each other and power supply.

Connectable MX471 buses

	Type	Connector sockets / nodes	See page
CAN	CAN bus (high-speed CAN)	1 ... 4	139

Connected devices are not directly addressed during data transmission on a CAN bus. A unique identifier denotes the contents of a message (e.g. rotational speed or engine temperature).

The identifier also signifies the priority of the message.

Message = identifier + signal + additional information

Device connected to the bus = node

Each node on the MX471 can be parameterized either as a receiver or as transmitter (gateway). Parameterization as receiver is described in section 6.8.4. Parameterization as transmitter is described in section 7. The online help that comes with the respective software package provides detailed information about parameterization.

Note

To ensure normal operation, the CAN bus needs to be terminated at both ends, and only there, using appropriate termination resistors.
A 120-ohm termination resistor can be individually connected in the module by software. Termination is also required when short cables with low bit rates are used.

Please refer to the data sheet for the relation between bit rate and maximum bus line length.

The configuration of a node is retained after switching the modules off and on.

For decoding signals at a rate greater than 2000/s, please set up signal inputs 1 to 8 on the MX471. The signal buffers of these signal inputs have been expanded accordingly.

6.8.2   MX471 pin assignment
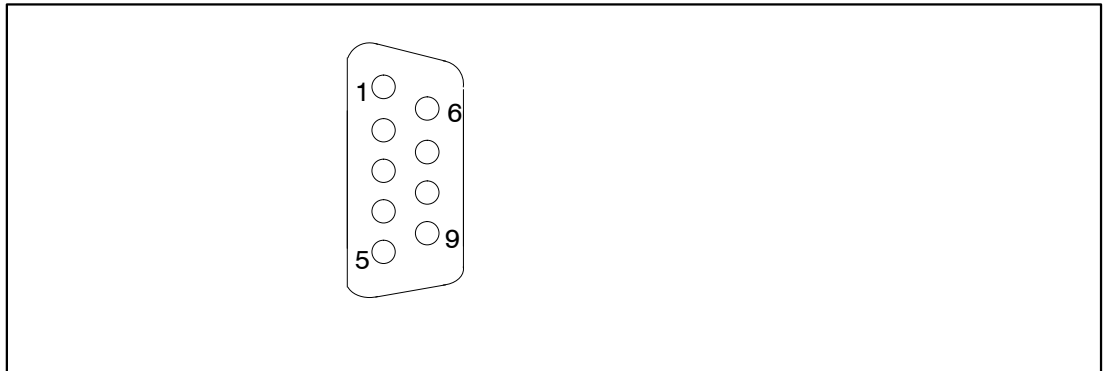
Fig.6.12:   Pin arrangement of connector plug, view from the solder side

Pin	Connector
1	No function
2	CAN Low
3	GND
4	No function
5	CAN Shield
6	GND
7	CAN High
8	No function
9	No function

6.8.3   LEDs status display
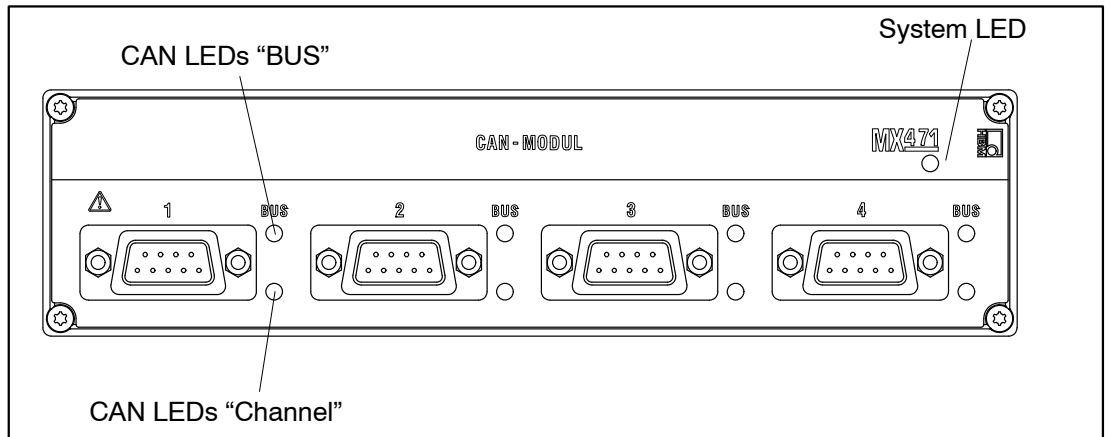
System LED:

Green	Error-free operation
Yellow	System is not ready, boot procedure running
Flashing yellow	Download active, system is not ready
Red	Error, faulty synchronization

CAN LEDs (BUS):

Green flickering	Bus is error-free and activity on CAN
Constant green	Bus is error-free and no activity on CAN
Yellow flickering	Intermittent bus errors (warning) and activity on CAN
Constant yellow	Intermittent bus errors (warning) and no activity on CAN
Red on	Bus error, CAN interface in "Bus-OFF" status

CAN LEDs (channel):

Constant green	Channel is ready for operation
Flashing yellow	Firmware1 download active
Yellow on	Boot process running
Red on	Channel has errors

Ethernet LED:

Green on	Ethernet link status is OK
Flashing yellow	Ethernet data transmission ongoing

6.8.4   Receiving CAN messages

To be able to receive CAN messages, the node must be able to identify the relevant messages. This can be done directly on the node or, in a reproducible way, by previously generated messages in the sensor database. Individual messages can be linked to the node by dragging from the sensor database and dropping them where required.

CAN databases type *.dbc can also be read into the sensor database. If no CAN database is available, it can also be created. Editors for this purpose are provided by different companies.

Received CAN messages are instantly "time-stamped" in measurement mode. This enables directly acquired measured quantities and CAN messages to be acquired and analyzed in parallel and synchronously in the entire system.

Note

The MX471 is not a traditional data logger that logs the complete CAN data stream on the bit level. The parameterized node "listens" on the CAN bus and extracts the signals from the relevant CAN messages to transmit them as measured values.

6.9   MX1601 amplifier

You connect up to 16 freely configurable inputs for voltage (10 V, 100mV) or current (20mA) or current-fed piezoelectric sensors (IEPE) to the MX1601.

The transducers are connected via 8-pin plug terminal connectors (Phoenix Contact FMC 1.5/8−ST−3.5−RF (order no. 1952089)).

All measuring channels are electrically isolated from one another and from the power supply. When using the adjustable transducer excitation, electrical isolation from the supply voltage of the amplifier is not required.

MX1601 connectable transducers

	Transducer type	Connection sockets	See page
	Electrical voltage	1 ... 16	120, 121
	Electrical current	1 ... 16	123
	Current-fed piezoelectric transducer (IEPE, ICP[®]) via an external adapter	1 ... 16	118

6.9.1   MX1601 pin assignment

So that insertion or removal of a transducer connection can be unmistakably identified, Pin 2 and Pin 5 in the connector plug must be bridged! If this bridge is missing, no measurement values will be recorded at the connection!

Bridge

1-wire EEPROM
(Maxim DS24B33+) view from below

1 ⊥
2 Data
3 No function
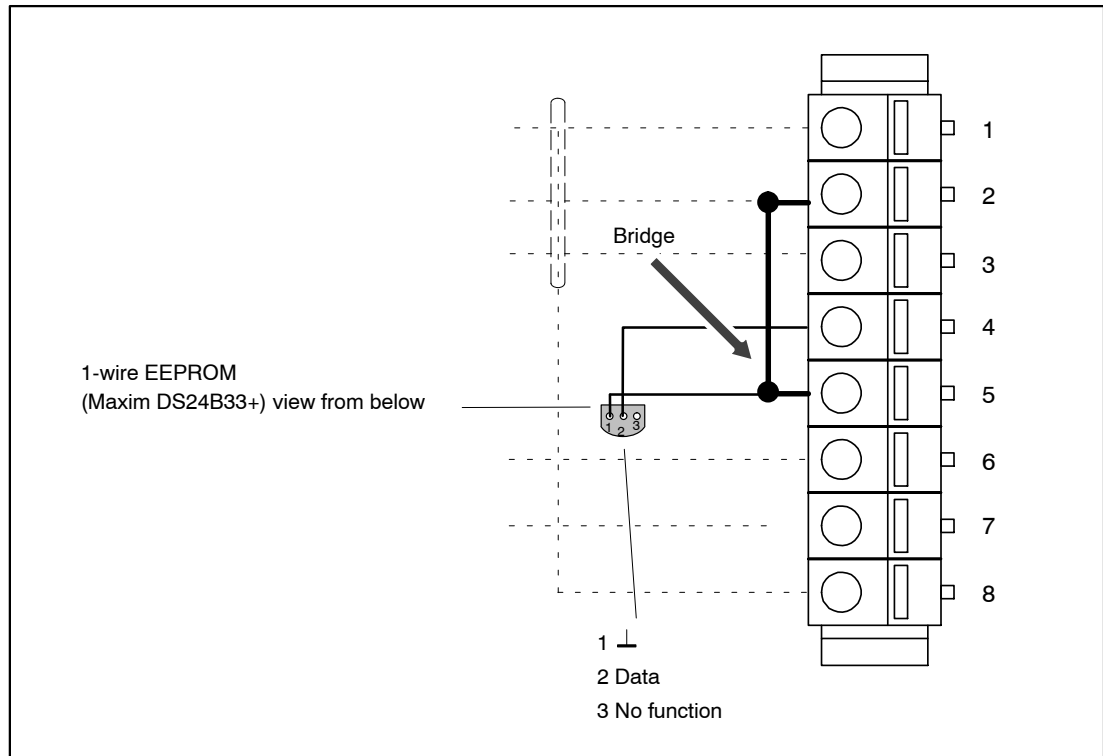
Fig.6.13:   Pin arrangement of connection plug, view from the connection side

Pin	Connector
1	Voltage output 10 V (+), 100 mV (+), IEPE (+)
2	Signal ground, TEDS (−)
3	Current input 20 mA (+)
4	TEDS (+)
5	Always connect with Pin 2! (Plug-in detection)
6	Active sensor supply (+)
7	Active sensor supply (−)
8	Housing (shield connection)

NOTE

The transducer excitation voltage can be set in the range of 5 ... 24 V (see 6.1.2) and is only available on channels 1 ... 8. On channels 9 ... 16 the supply voltage (10 ... 30 V) is output less approx. 1 V. With these channels, a current drain of max. 30mA can be consumed. Current limitation switches the transducer excitation off if current consumption is higher.

6.9.2   MX1601 status display

The front panel of the universal amplifier has a system LED and 16 connection LEDs. The system LED indicates the status of the device, the connection LEDs the states of the individual connections.
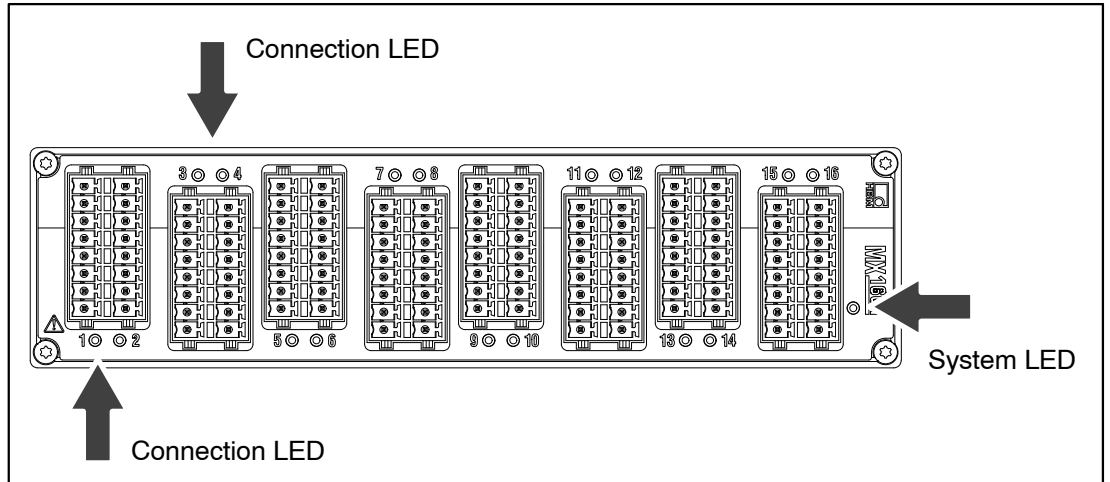
Fig.6.14:   MX1601 front view

System LED	
Green	Error-free operation
Orange	System is not ready, boot procedure running
Flashing orange	Download active, system is not ready
Red	Error
Connection LEDs	
All LEDs are orange	Boot procedure running (system is not ready)
All LEDs are flashing orange	Firmware download active (system is not ready)
Orange	Connection newly assigned, transducer identification running (calibration)
Green	Error-free operation
Flashing green (5s), then green	TEDS data being read in
Flashing orange (5s), then green	Manual configuration ongoing (ignore TEDS)
Red	Amplifier overload, no sensor connected Channel error (incorrectly parameterized, connection error, invalid TEDS data)
Flashing red	Sensor supply overload

General rule: Brief flashing →⬚TEDS identified (green: is used, orange: is not used).

6.10 MX1615 amplifier

Up to 16 freely configurable inputs can be connected to the MX1615 amplifier.

It supports:

Strain gauges (SG) or SG-based transducers in

- Full bridge circuit (six-wire configuration)
- Half bridge circuit (five-wire configuration)
- Quarter bridge circuit (two, three or four wires for 120 ohms or 350 ohms)

Normalized voltage ($\pm$10 V differential or 0. . . 30 V DC unipolar)

Resistor–based measurement (PT100 or resistor, implemented in a quarter bridge arm)

Bridge excitation voltage:
Constant DC voltage or 1200 Hz (AC) square wave carrier frequency with an amplitude of 0.5 V; 1 V, 2.5 V or 5 V

When TEDS or T-ID is used, the measurement channel is automatically parameterized after connection.

MX1615 connectable transducers

	Transducer type	Connection sockets	See page
	SG full bridge	1 … 16	107
	SG half bridge	1 ... 16	110
	SG quarter bridge	1 ... 16	110
	Electrical voltage	1 ... 16	120, 121
	Resistance thermometer Pt100	1 ... 16	126
	Ohmic resistor	1 ... 16	125

The transducers are connected via 8-pin plug terminal connectors (Phoenix Contact FMC 1.5/8–ST–3.5–RF (order no. 1952089)).

The measurement channels are only electrically isolated from the power supply of the MX1615, not from each other.

6.10.1   MX1615 pin assignment

So that insertion or removal of a transducer connection can be unmistakably identified, Pin 4 and Pin 5 in the connector plug must be bridged! This is automatically so for all bridge transducers. The bridge only needs to be completed for voltage measurements. If this bridge is missing, no measurement values will be recorded at the connection!
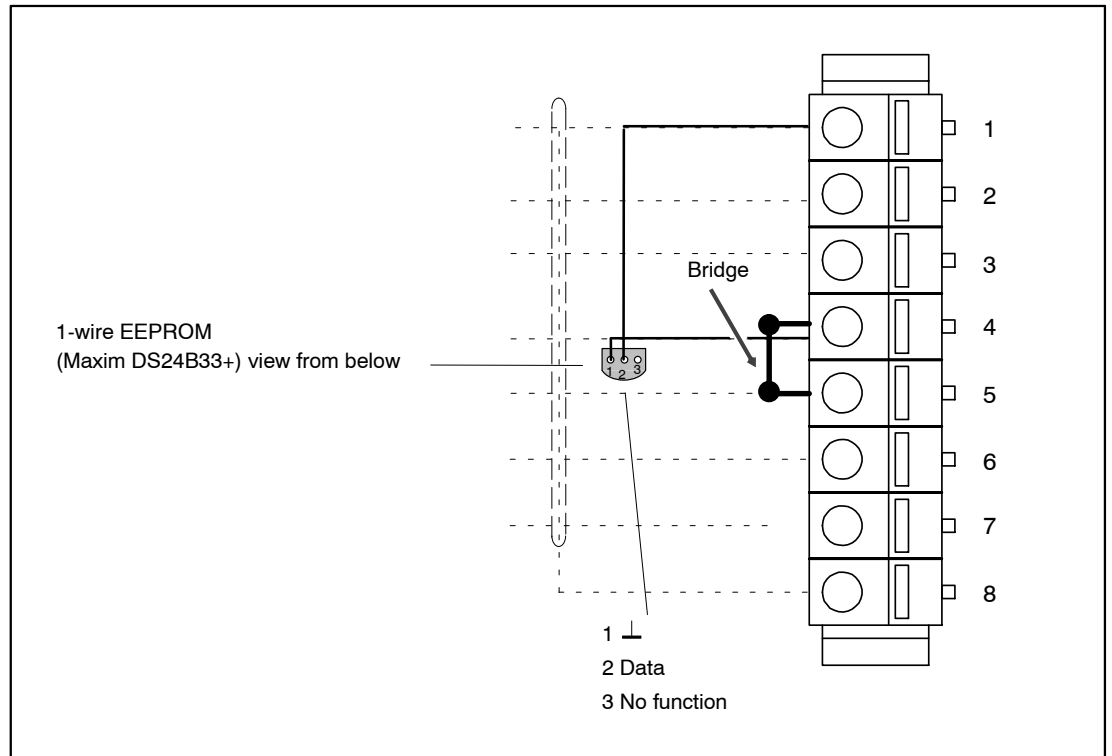
Fig.6.15:   Pin arrangement of connection plug, view from the connection side

Pin	Connector
1	TEDS (+)
2	Bridge excitation voltage (+)
3	Sense lead (+)
4	Bridge excitation voltage (−), TEDS (−)
5	Sense lead (−)
6	Measurement signal (+), voltage input 10 V / 30V (+)
7	Measurement signal (−), voltage input 0 V / 10 V (−), bridge excitation voltage (+) for strain gauge quarter bridge
8	Housing (shield connection)

6.10.2 MX1615 status display

The front panel of the universal amplifier has a system LED and 16 connection LEDs. The system LED indicates the status of the device, the connection LEDs the states of the individual connections.
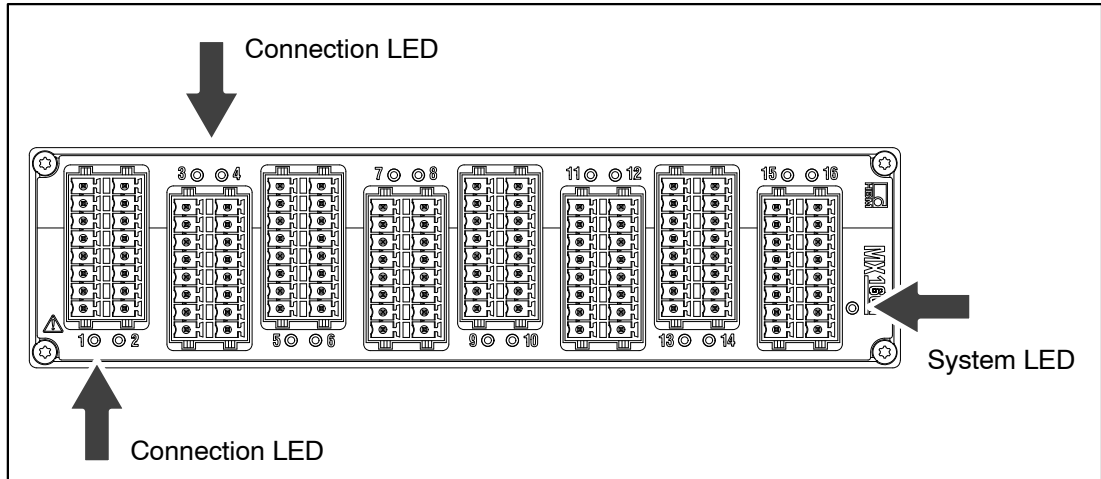
Fig.6.16: MX1615 front view

System LED	
Green	Error-free operation
Orange	System is not ready, boot procedure running
Flashing orange	Download active, system is not ready
Red	Error
Connection LEDs	
All LEDs are orange	Boot procedure running (system is not ready)
All LEDs are flashing orange	Firmware download active (system is not ready)
Orange	Connection newly assigned, transducer identification running (calibration)
Green	Error-free operation
Flashing green (5s), then green	TEDS data being read in
Flashing orange (5s), then green	Manual configuration ongoing (ignore TEDS)
Red	Amplifier overload, no sensor connected Channel error (incorrectly parameterized, connection error, invalid TEDS data)
Flashing red	Sensor supply overload

General rule: Brief flashing →TEDS identified (green: is used, orange: is not used).

7 Transducer connection

7.1 Full bridge, SG

Supported by the following modules: MX840, MX840A, MX440A, MX410, MX1615
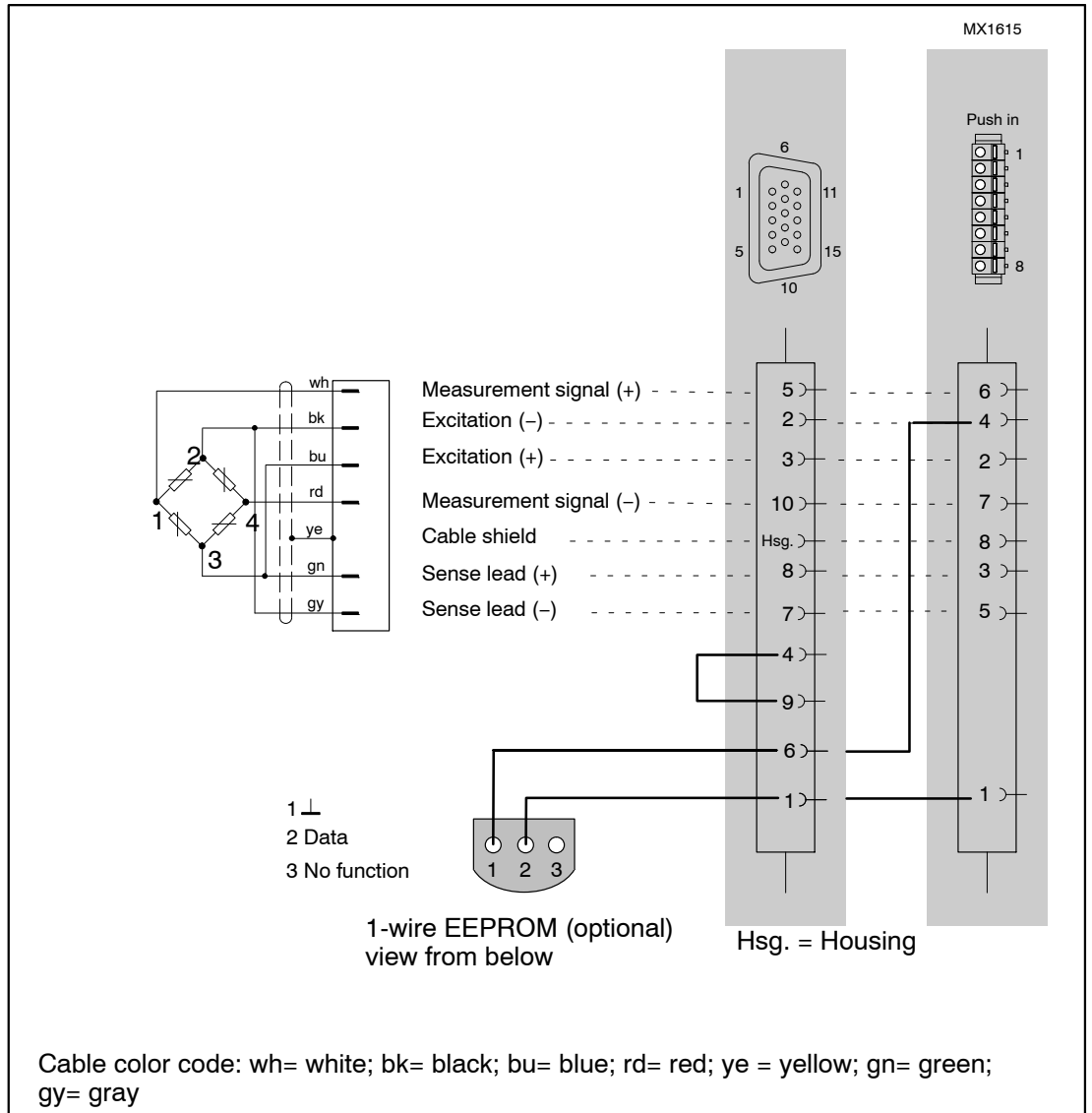
MX1615

Push in

6
1   11
5   15
10

1

8

wh		Measurement signal (+)	- - - - -	5	- - - - -	6
bk		Excitation (−)	- - - - - - - - -	2		4
bu		Excitation (+)	- - - - - - - - -	3	- - - - -	2
rd		Measurement signal (−)	- - - - -	10	- - - - -	7
ye		Cable shield	- - - - - - -	Hsg.	- - - - -	8
gn		Sense lead (+)	- - - - - -	8	- - - - -	3
gy		Sense lead (−)	- - - - - -	7	- - - - -	5

4
9
6
1   1

1 ⊥
2 Data
3 No function

1   2   3

1-wire EEPROM (optional)
view from below

Hsg. = Housing

Cable color code: wh= white; bk= black; bu= blue; rd= red; ye = yellow; gn= green;
gy= gray

7.2   Full bridge, inductive

Supported by the following modules: MX840, MX840A, MX440A, MX410

Cable color code: wh= white; bk= black; bu= blue; rd= red; ye = yellow; gn= green; gy= gray
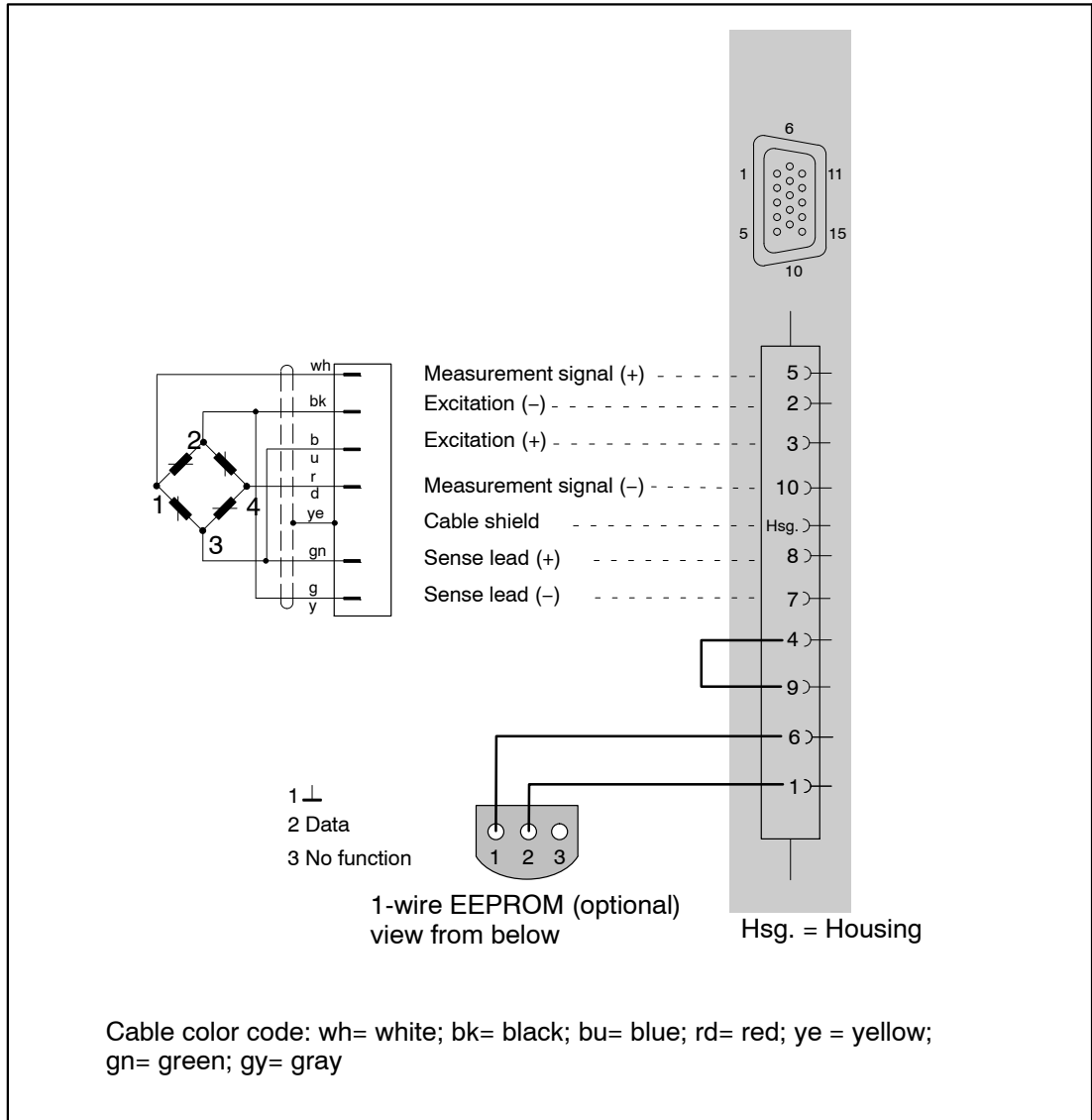
7.3 Full bridge, piezoresistive

Supported by the following modules: MX840, MX840A, MX440A, MX410, MX1615

MX1615

Measurement signal (+)	5	6
Excitation (−)	2	4
Excitation (+)	3	2
Measurement signal (−)	10	7
Cable shield	Hsg.	8
Sense lead (+)	8	3
Sense lead (−)	7	5

1 ⊥
2 Data
3 No function

1-wire EEPROM (optional)
view from below

Hsg. = Housing
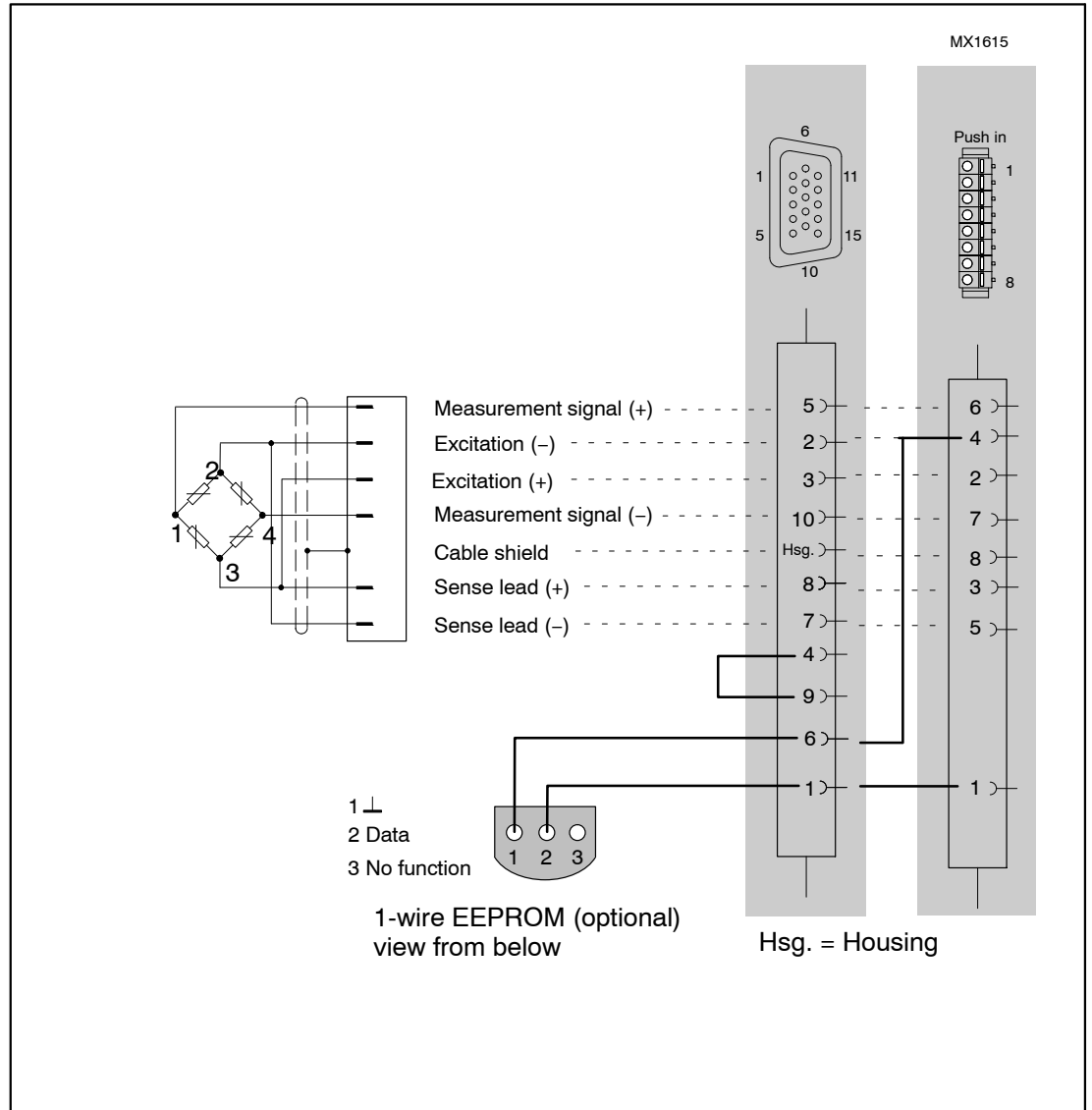
7.4   Half bridge, SG

Supported by the following modules: MX840A, MX440A, MX410, MX1615

Cable color code: wh= white; bk= black; bu= blue; rd= red; ye = yellow;
gn= green; gy= gray
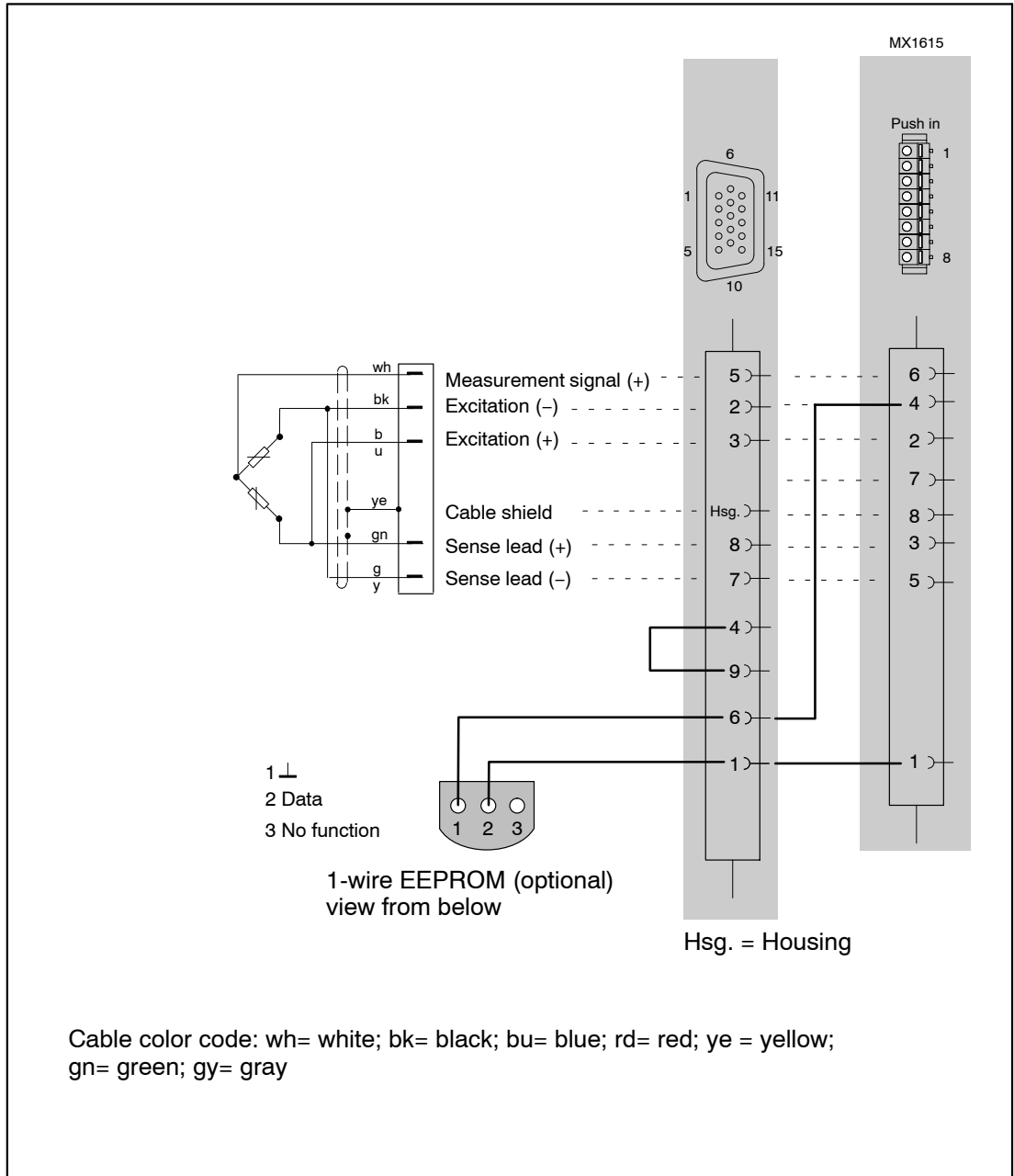
7.5   Half bridge, inductive

Supported by the following modules: MX840, MX840A, MX440A, MX410

Cable color code: wh= white; bk= black; bu= blue; rd= red; ye = yellow; gn= green; gy= gray
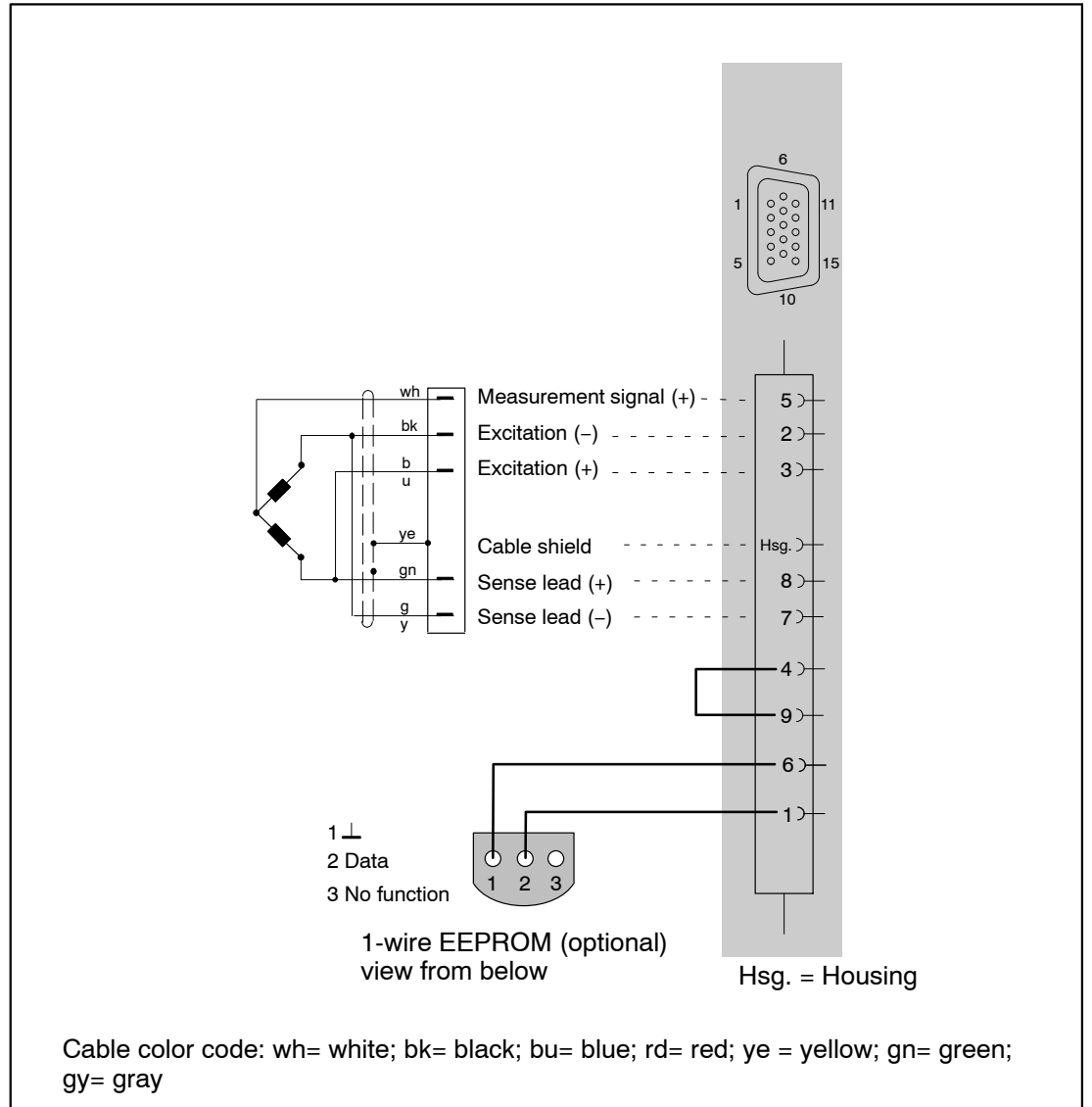
7.6   Quarter bridge, SG

Amplifier with directly supporting strain gauge quarter bridges: MX1615.

An adapter is required for connecting strain gauge quarter bridges to: MX840, MX840A, MX440A and MX410. Refer to the following page for instrictions on how to connect single strain gauges to this adapter.

Cable color code: wh= white; bk= black; bu= blue; rd= red; ye = yellow; gn= green; gy= gray
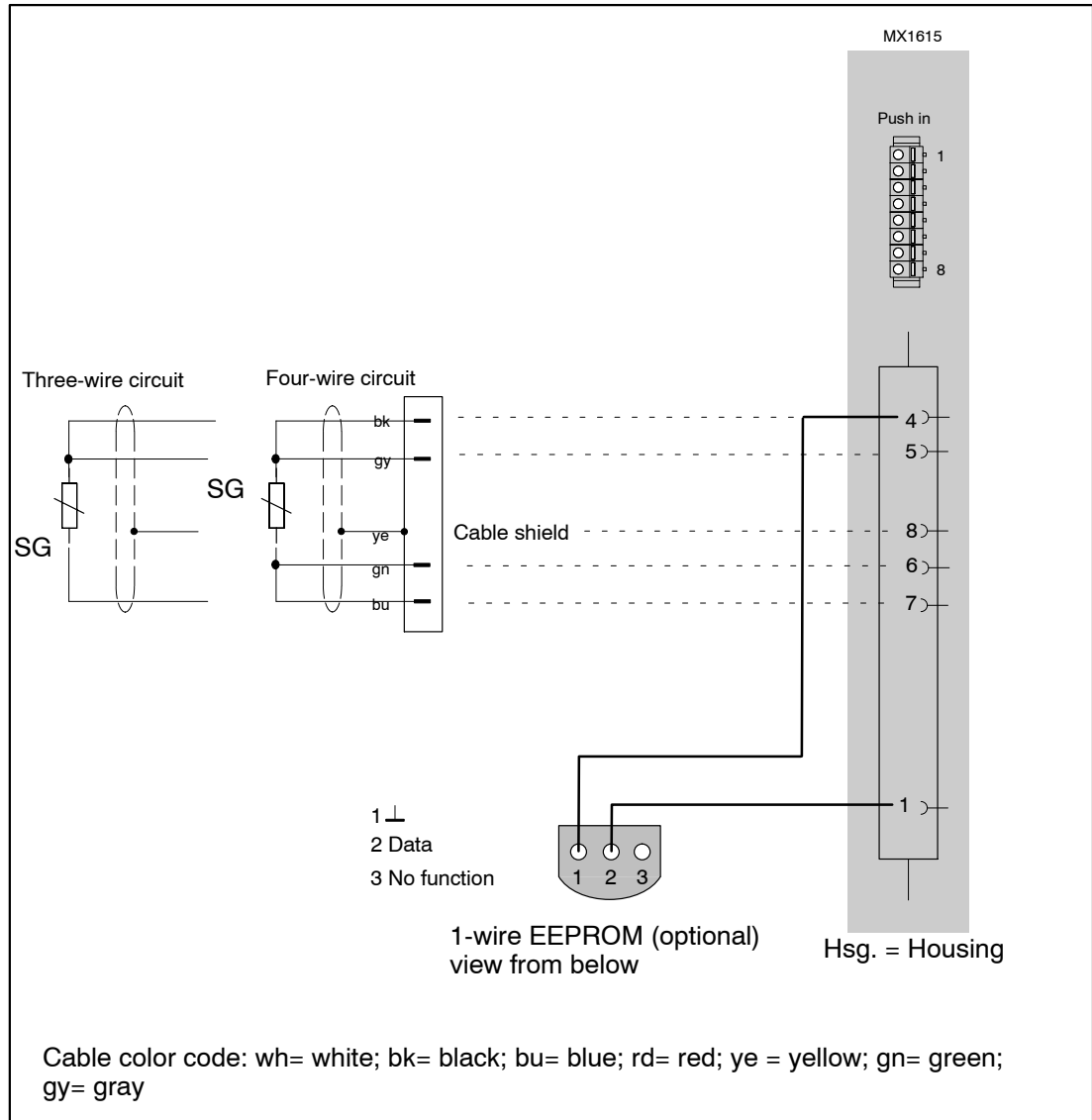
7.7 Adapter quarter bridge, SG

For connecting single quarter-bridge strain gauges in three-wire configuration, an adapter can be plugged onto the following modules:

MX840, MX840A, MX440A, MX410

Available adapters:

SG with 120 ohms: order number: SCM−SG120

SG with 350 ohms: order number: SCM−SG350
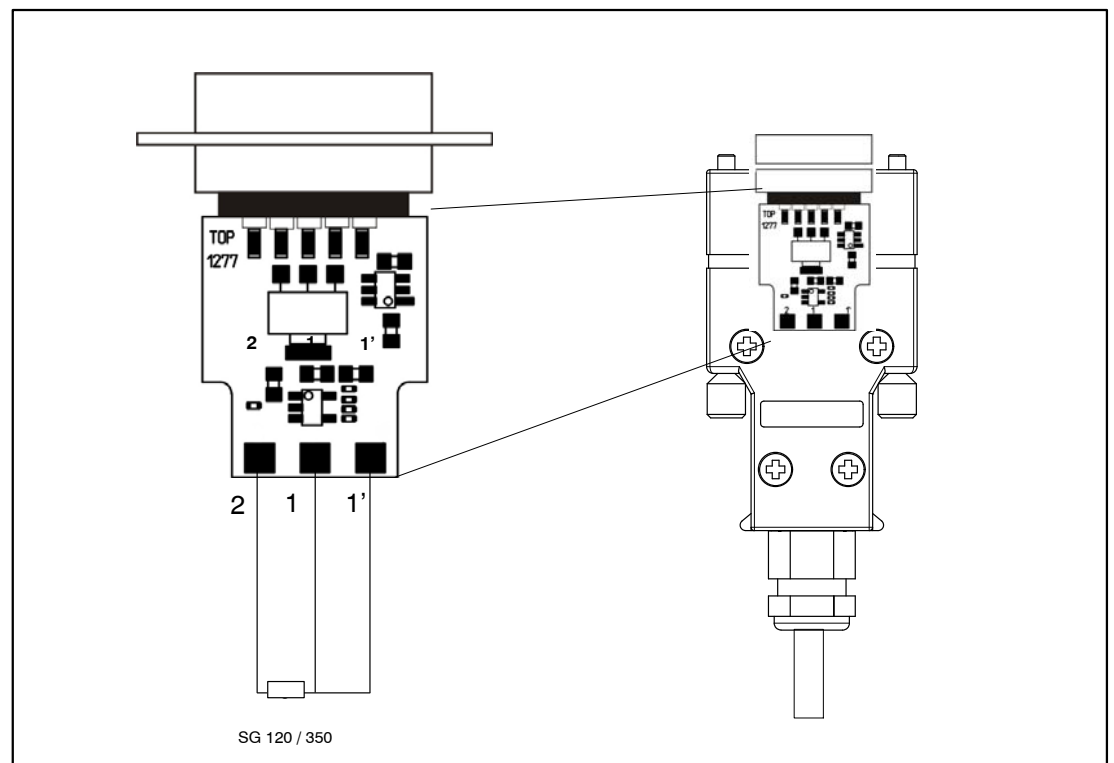
SG 120 / 350

For technical details see the leaflet entitled QuantumX / SCM−SG120/350.

7.8 Connecting transducers with double shield technique
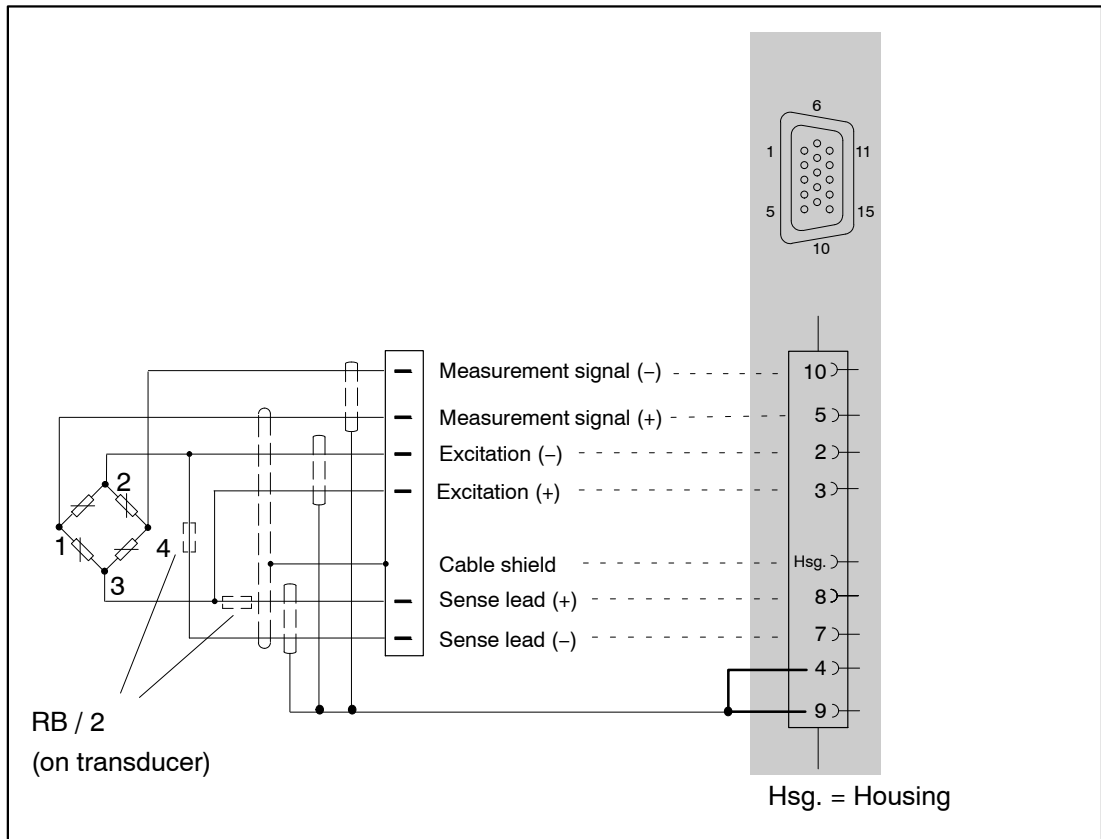
We recommend for the amplifiers MX840, MX840A, MX440A and MX410 this connection technique for very small measurement ranges, in particularly environments subject to interference and when using long cables.

This applies for all bridge connections.

With cable lengths >50 m, a resistor with half the value of the bridge resistance (RB/2) must be connected in each sense lead of the transducer.

7.9 Potentiometric transducers

Supported by the following modules: MX840, MX840A, MX440A
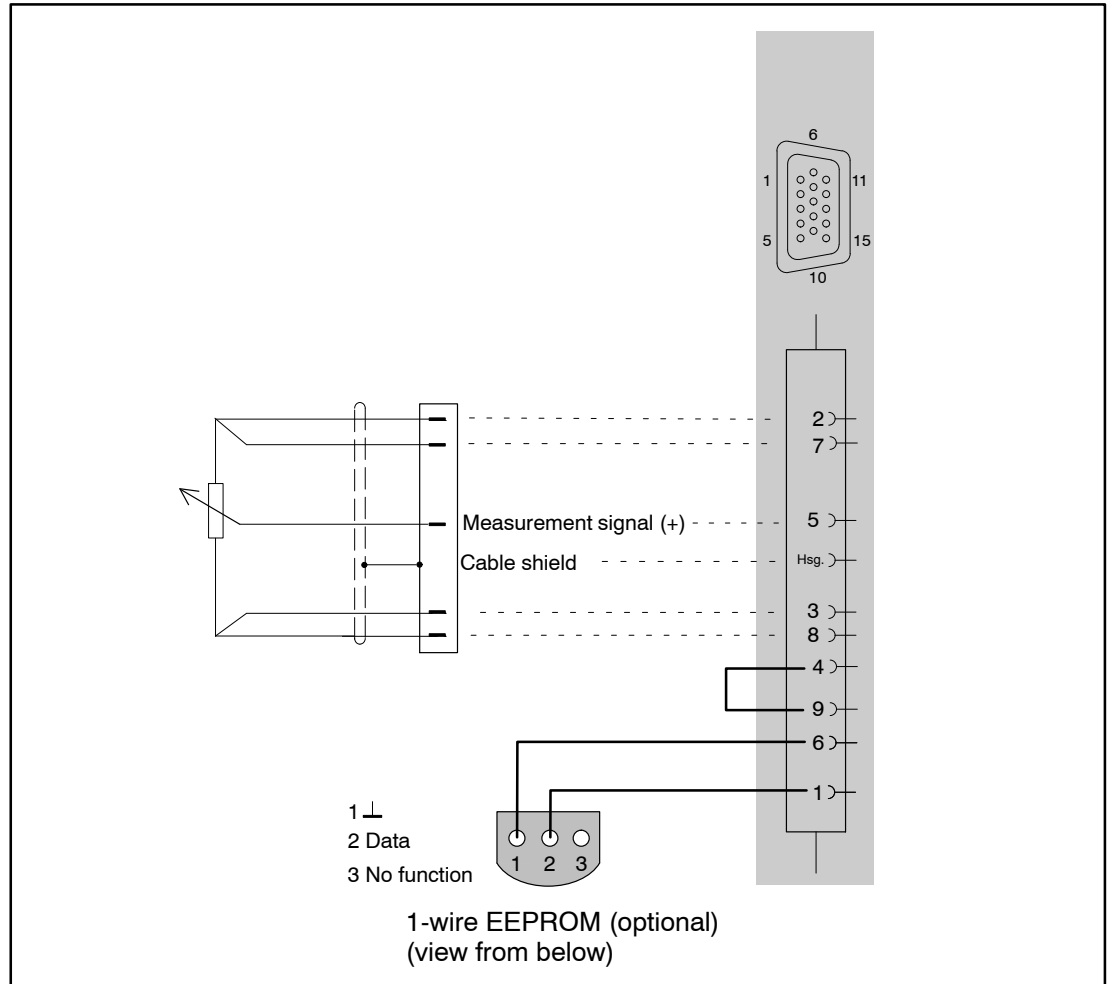
7.10 LVDT transducers

Supported by the following modules: MX840, MX840A, MX440A

LVDT transducers

Signal	Pin
Measurement signal (+)	5
Excitation (−)	2
Excitation (+)	3
Measurement signal (−)	10
Cable shield	Hsg.
Sense lead (+)	8
Sense lead (−)	7

1 ⊥
2 Data
3 No function

1-wire EEPROM
(optional)
view from below

Hsg. = Housing
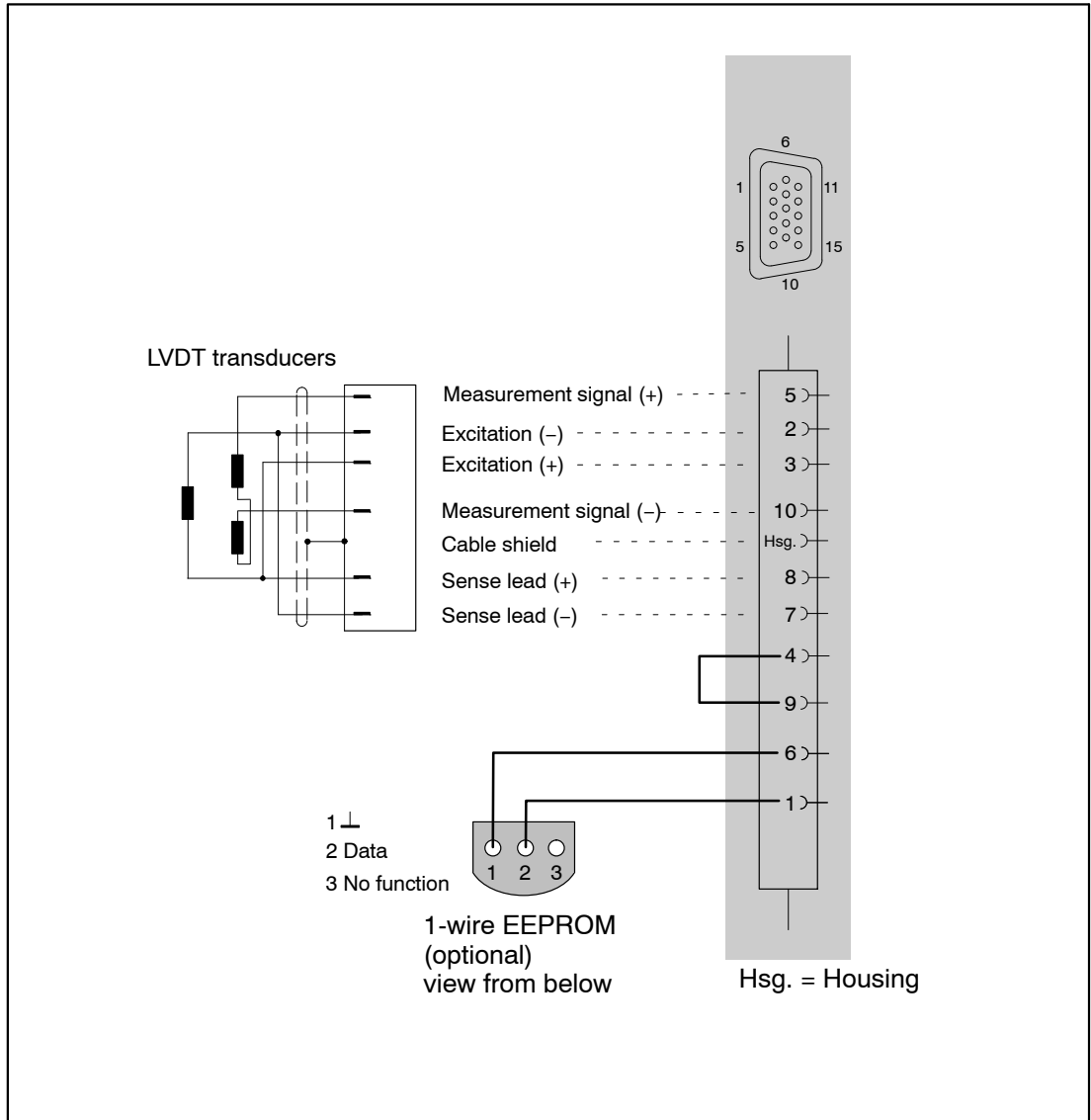
7.11 Current-fed piezoelectric transducer

Current-fed piezoelectric transducers are supplied with a constant current of e.g. 4 mA. They return a voltage signal to the amplifier. This type of transducer is also called an IEPE or ICP® transducer.

IEPE is short for "Integrated Electronics Piezo Electric"

ICP® is a registered trademark symbol of "PCB Piezotronics".

Supported by the following modules:
  MX410 (directly via BNC adapter), MX1601
  MX840, MX840A, MX440A via an external adapter (see following page)

Hsg. = housing
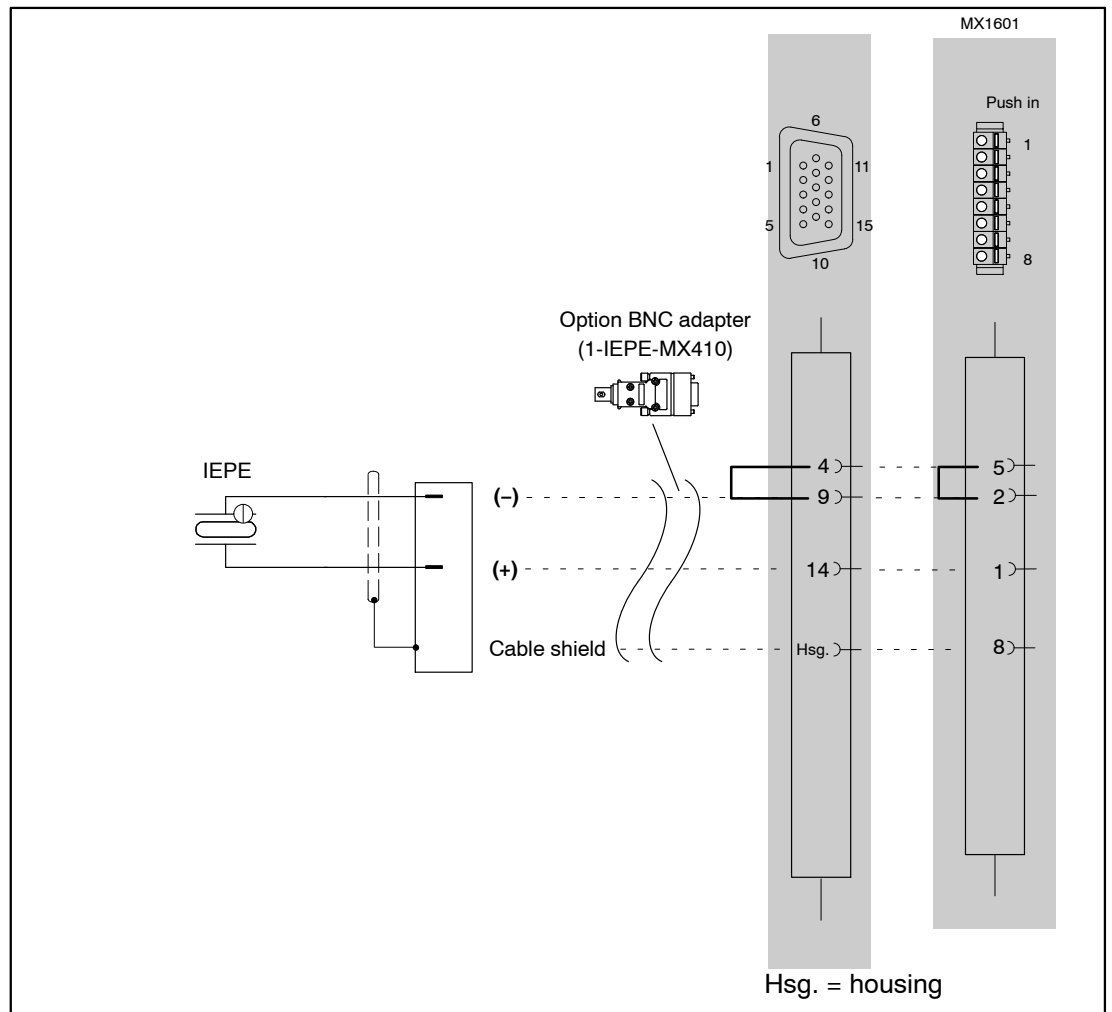
NOTE
IEPE transducers with TEDS version 1.0 are supported.

7.12   IEPE adapter

Wiring diagram for MX840, MX840A, MX440A with external IEPE adapter:
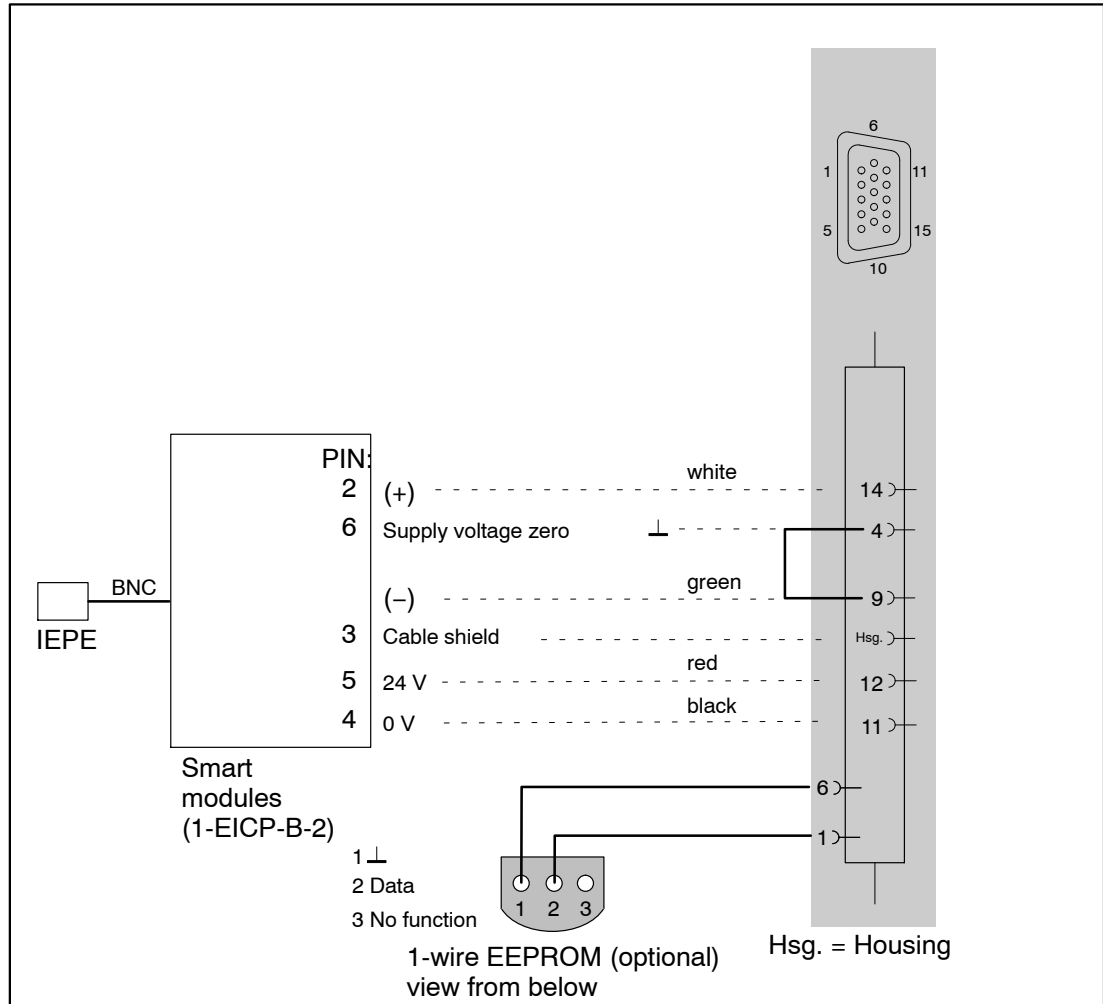
Accessories for connecting the Smart module:

Description	Description	Order no.
IEPE adapter	External signal conditioning module supplied with 24 V, supplies IEPE with constant current (BNC socket) and outputs a standardized voltage signal ± 10 V	1−EICP−B−2
Connection cable	Cable between Smart module and Sub−HD plug	1−SAC−EXT−MF−x−2 (x = length in meters)
Device plug	QuantumX connector	1−SubHD15−MALE

Retrofitting TEDS Chip in transducer connectors when using the Smart module:

TEDS data stored directly in the IEPE transducer cannot be read by the Smart module. TEDS can be retrofitted in the QuantumX plug so that the Smart module can be read in and the channel settings automated according to the IEPE transducer.

Settings can be implemented via the TEDS Editor

- TEDS-specific requirements:

  - "High Level Voltage Output Sensor"

  - Physical Measurand: Acceleration (m2/s or g)

  - Electrical range: standard +/− 10 V

  - Power requirements: required

- Complete the data sheet according to the transducer

- Excitation level: 24 V nominal

CAUTION

Changing the IEPE transducer on the Smart module can lead to incorrect device settings.

7.13   Electrical voltage 100 mV

Supported by the following modules: MX840, MX840A, MX440A, MX1601

Pin assignment for module MX1601, see section 6.9.1

Maximum input voltage to housing and signal ground :

   MX840, MX840A, MX440A: ±60 V

  MX1601: ±40 V

  MX1615: ±15 V

1 ⊥
2 Data
3 No function

1-wire EEPROM
(optional)
(view from below)

Hsg.=Housing

Adjustable sensor supply:	5 V … 24 V:	Pin 12	Pin 6
	0 V:	Pin 11	Pin 7
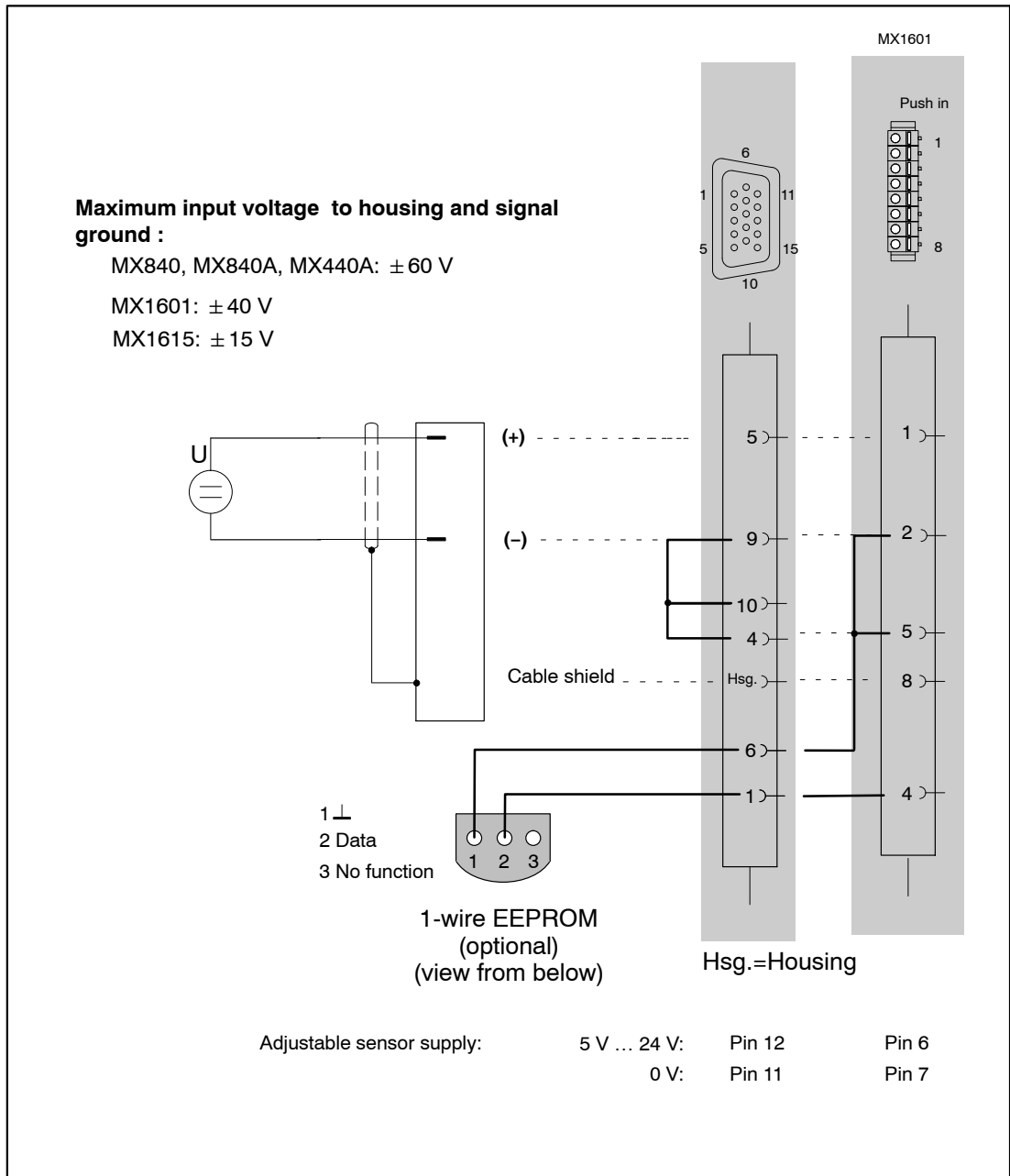
7.14   DC voltage sources 10 V or 60 V range

Voltage ranges supported by the measuring amplifiers:

10 V and 60 V: MX840, MX840A, MX440A
10 V: MX410, MX1601, MX1615

Pin assignment for MX1601, see section 6.9.1
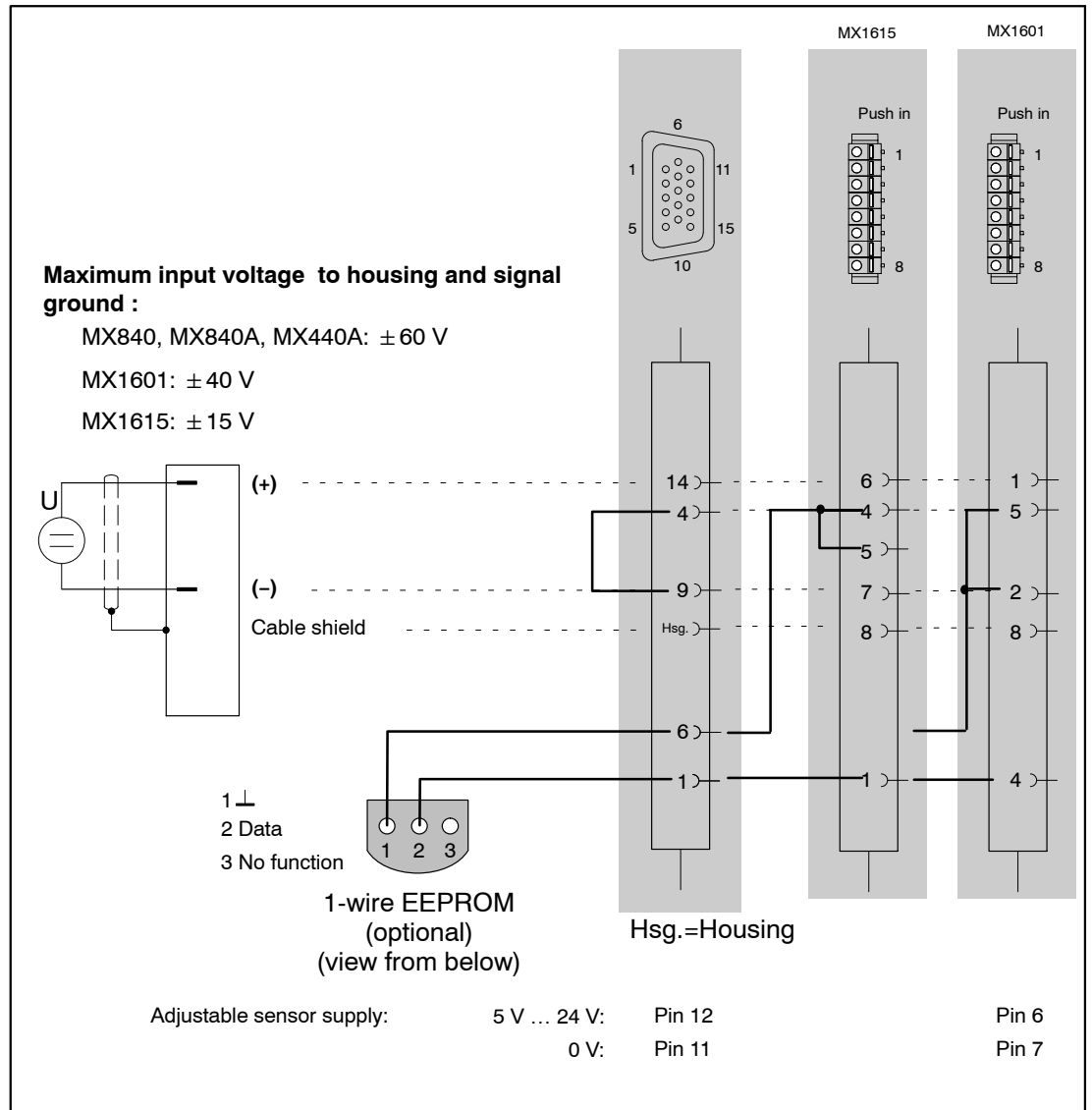
MX840, MX840A and MX440A:

You can select two measuring ranges (10 V or 60 V), depending on the parameterization.

Incorrect parameterization will not cause the destruction of the amplifier.

7.15   Voltage sources up to 300 V (CAT II)

The signal conditioning module (SCM-HV) enables high-voltage measurements up to 300 V CAT II and can be connected to a QuantumX device with bridge input and Sub–HD connector, for example MX840, MX840A, MX440A or MX410.

The SCM-HV is a voltage divider consisting of a protective circuit or isolating circuit. The voltage is measured by two permanently connected lab wires with completely isolated banana plug sockets.

Due to an integrated 1-wire-EEPROM (TEDS), the SCM-HV is equipped with a detection function for the connected components. After the connection is made the channel is configured automatically. The PC software is capable of linearizing the input and saving it to the adapter.

Separate operating instructions are included in the scope of delivery for the SCM-HV.

Measuring voltage 300 V DC / 300 V$_{eff.}$ AC
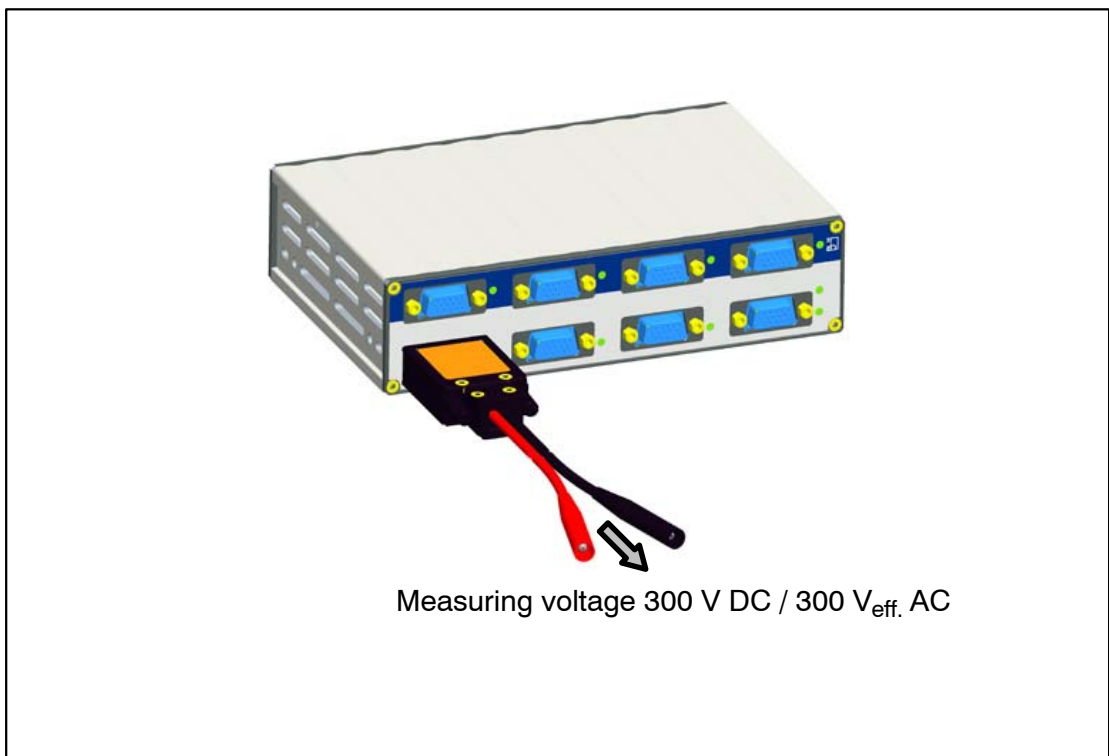
7.16 DC current sources 20 mA

Supported by the following modules: MX840, MX840A, MX440A, MX410, MX1601

Pin assignment for MX1601, see section 6.9.1
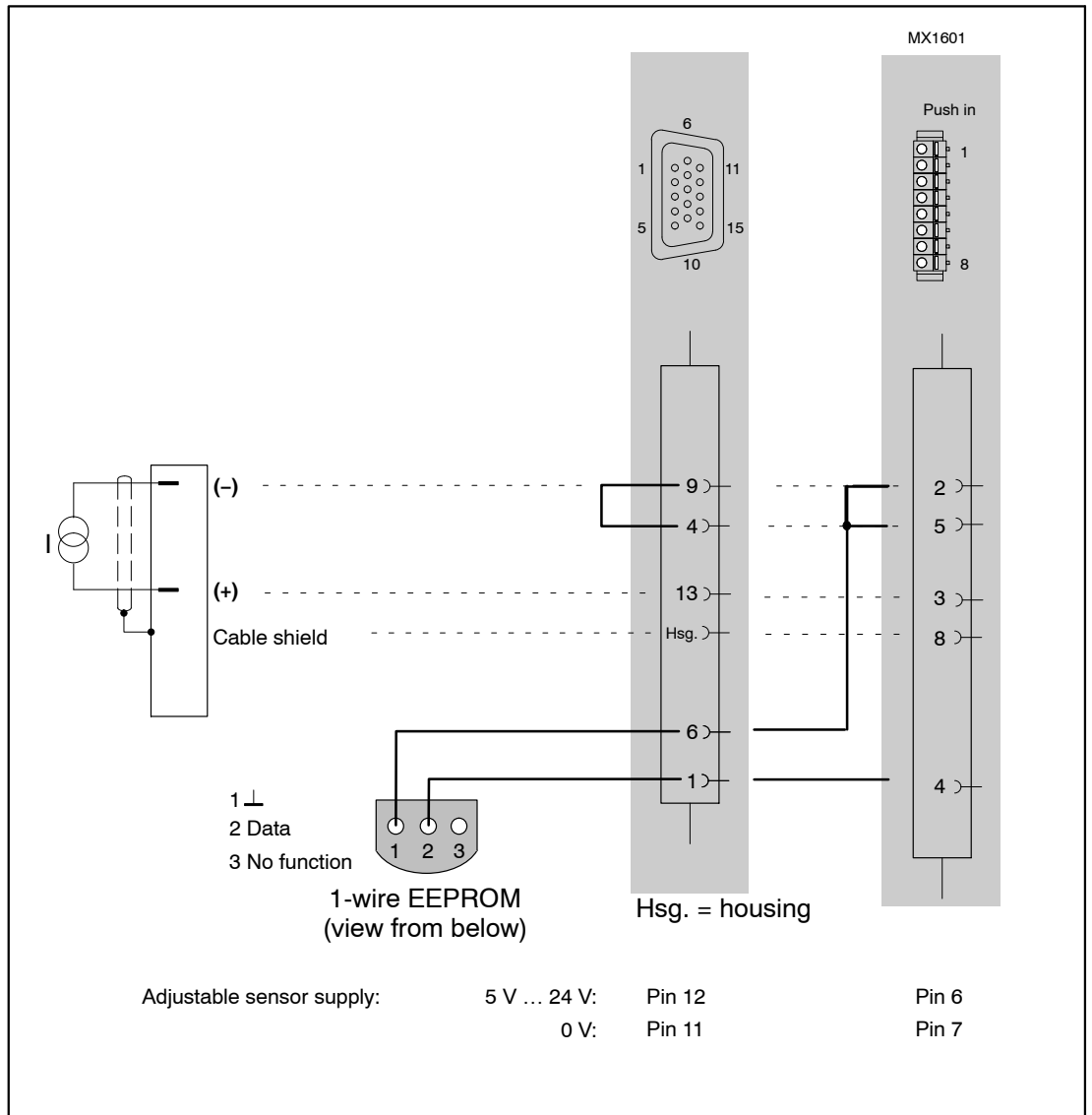
Maximum current ± 30 mA

7.17   DC current sources 20 mA – voltage-fed

Supported by the following modules: MX840, MX840A, MX440A, MX410, MX1601

Pin assignment for MX1601, see section 6.9.1
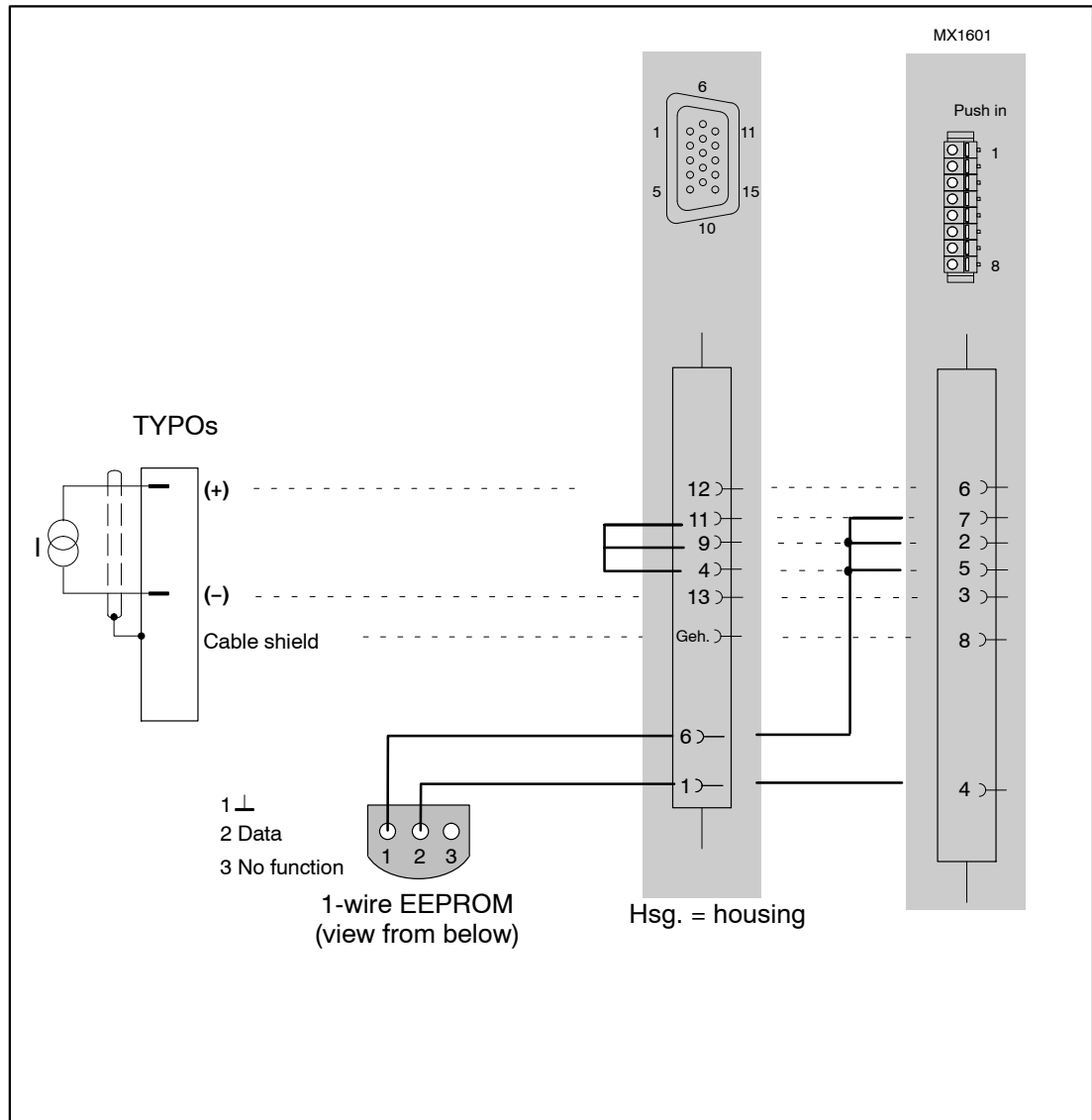
Maximum current ± 30 mA

The sensor supply must be connected in series. However, in this case, there is no electrical isolation from the module supply for the respective channel.

7.18 Resistance

Supported by the following modules: MX840A, MX440A, MX1615

1) When connecting a two-wire sensor, wire bridges must be soldered in the connector (between measurement line and supply)
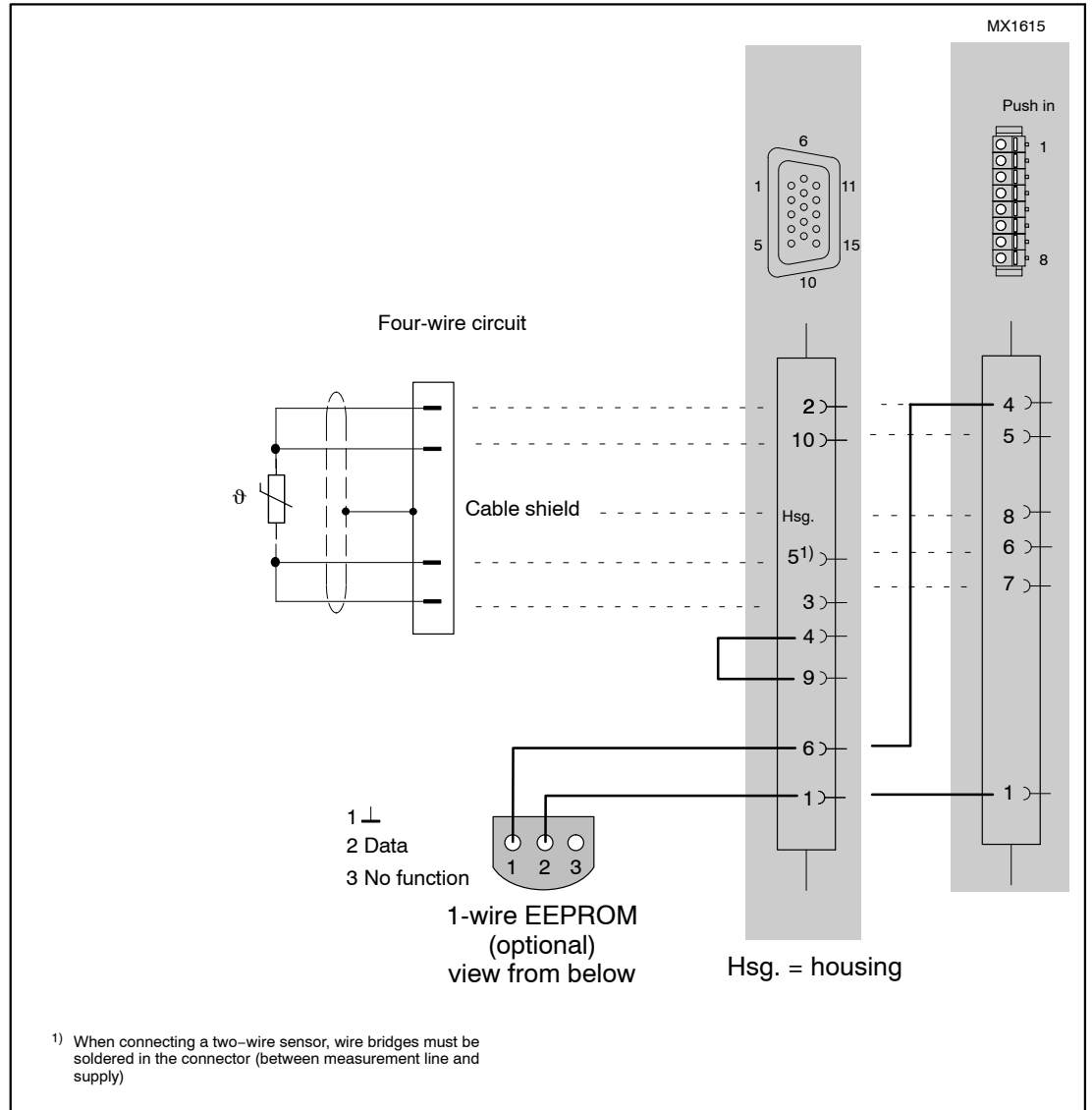
7.19   Resistance thermometer PT100, PT1000

Supported by the following modules:

PT100 / PT1000:   MX840, MX840A, MX440A

PT100:   MX1615
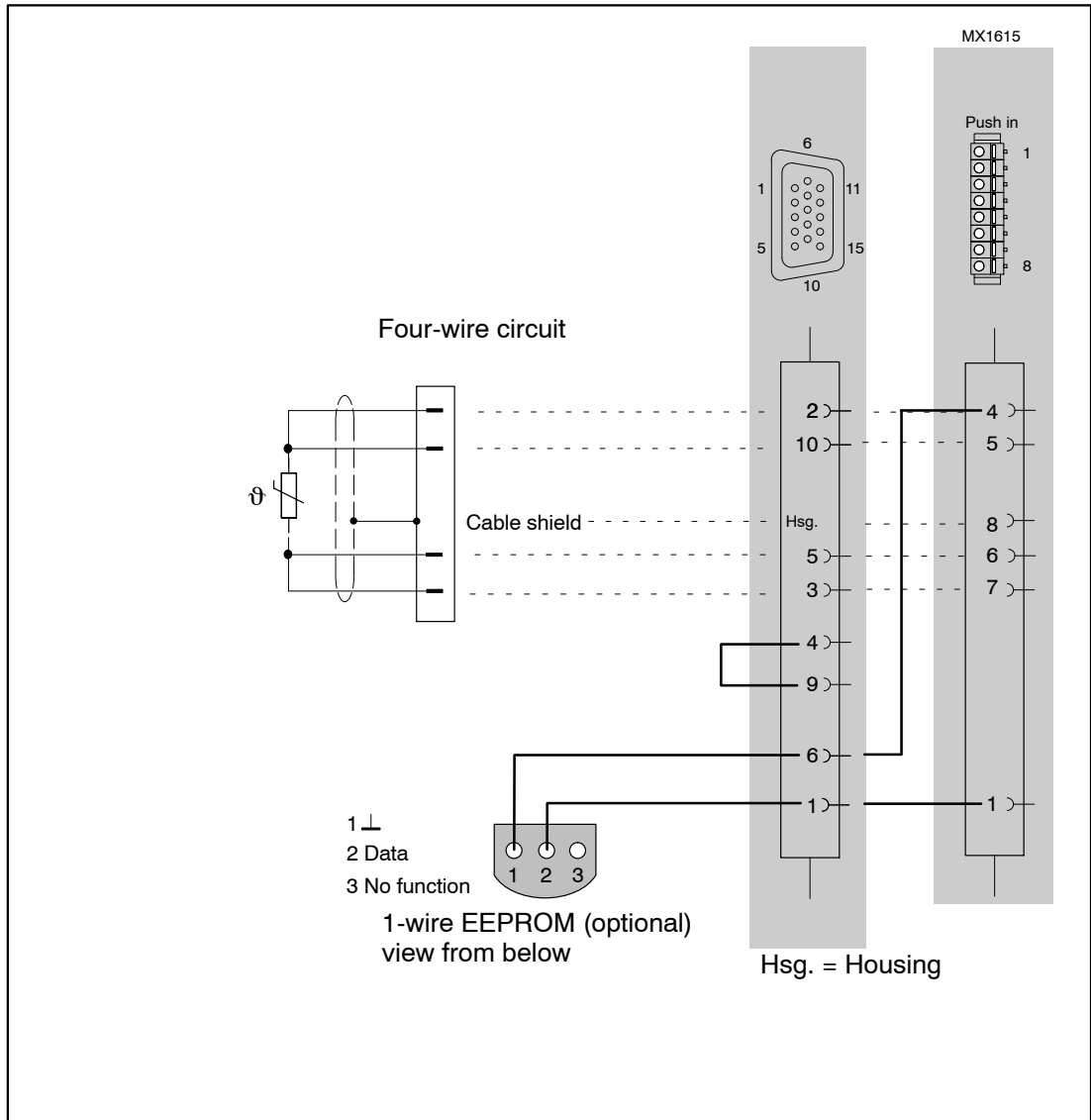
7.20   Thermocouples

Supported by the following modules: MX840, MX840A, MX440A, MX1609, MX1609−T

Modules MX1609/MX1609 support only thermocouples type K; module MX1609−T supports type T, with Mini thermo-connector (see page 93). Cold spot compensation is integrated in this case.

For MX840, MX840A and MX440A, accessory part 1−THERMO−MXBOARD must be integrated into the Sub−HD plug for cold spot compensation (see following page).

Connection for MX840, MX840A, MX440A

Maximum input voltage to housing and supply ground: ± 60 V

Thermocouple

1−THERMO−MX BOARD

(soldered into the Sub−HD connector plug and contains a cold spot compensation element and TEDS)

Type	Thermocouple material 1 (+)	Thermocouple material 2 (−)
J	Iron	Copper-nickel
K	Nickel-chrome (wire color green)	Nickel-aluminum (wire color white)
T	Copper	Copper-nickel
S	Rhodium-platinum (10%)	Platinum
E	Nickel-chrome	Copper-nickel
B	Rhodium-platinum (30%)	Rhodium-platinum (6%)
N	Nickel-chrome-silicone[1]	Nickel-silicone
R	Rhodium-platinum (13%)	Platinum

[1] Nicrosil

When recording temperatures with thermocouples with amplifiers MX840, MX840A or MX440A, you must solder the "1−THERMO−MX BOARD" board into the connector plug.

Position of board in plug

PINs to be soldered
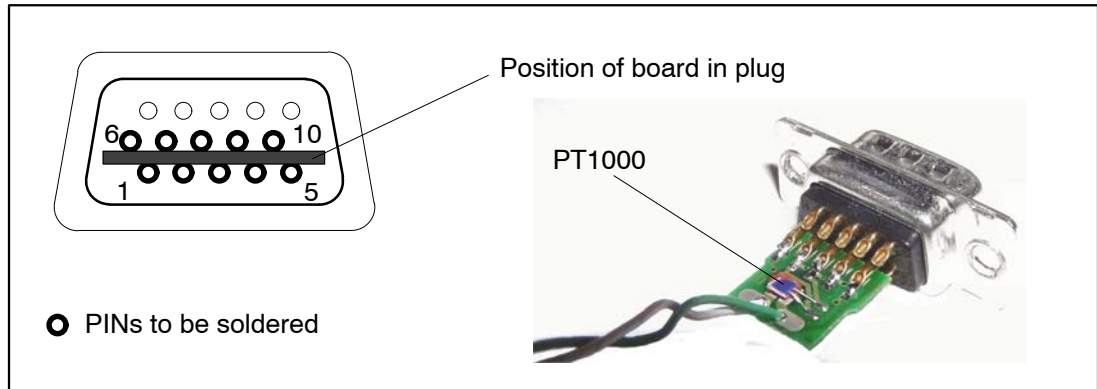
- Insert the 1−THERMO−MX BOARD in the correct position between the plug pins

Note

Check the position with the plug shape (see picture above).
In this position, the PT1000 of the cold spot compensation element is on top.
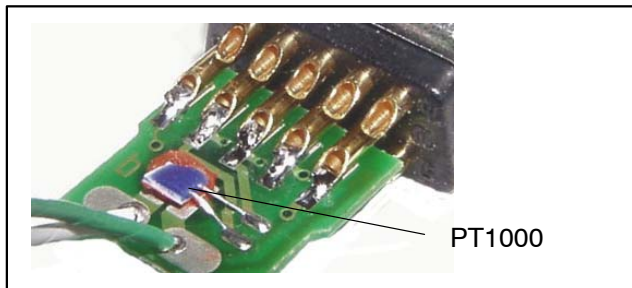
PT1000

- Solder the connector pins to the connections on the board

- PIN 1   TEDS

  PIN 6   TEDS

  PIN 5   Thermocouple (+)

  PIN 10   Thermocouple (−)

  PIN 9   Signal ground

  PIN 7   PT1000 cold junction

  PIN 8   PT1000 cold junction

  PIN 2   Supply (−)

  PIN 3   Supply (+)

7.21   Frequency, differential, without directional signal

Supported by the following modules: MX840, MX840A, MX440A, MX460

Differential signal (RS 485); schematic diagram

HBM torque transducer:
Signal level: TTL only
Voltage supply: separate

Plug 1
Md

200 mV

f$_1$ (−)
f$_1$ (+)
Cable shield
Shunt calibration
Ground

1 ⊥
2 Data
3 No function

1-wire EEPROM (optional)
view from below

Hsg. = Housing

Adjustable sensor supply:	Pin12:	5 V ... 24 V;	0.7 W per channel, in total 2 W.
	Pin 11:	0 V	Further information, see data sheet.

Cable color code: wh= white; bk= black; bu= blue; rd= red; ye = yellow; gn= green;
gy= gray
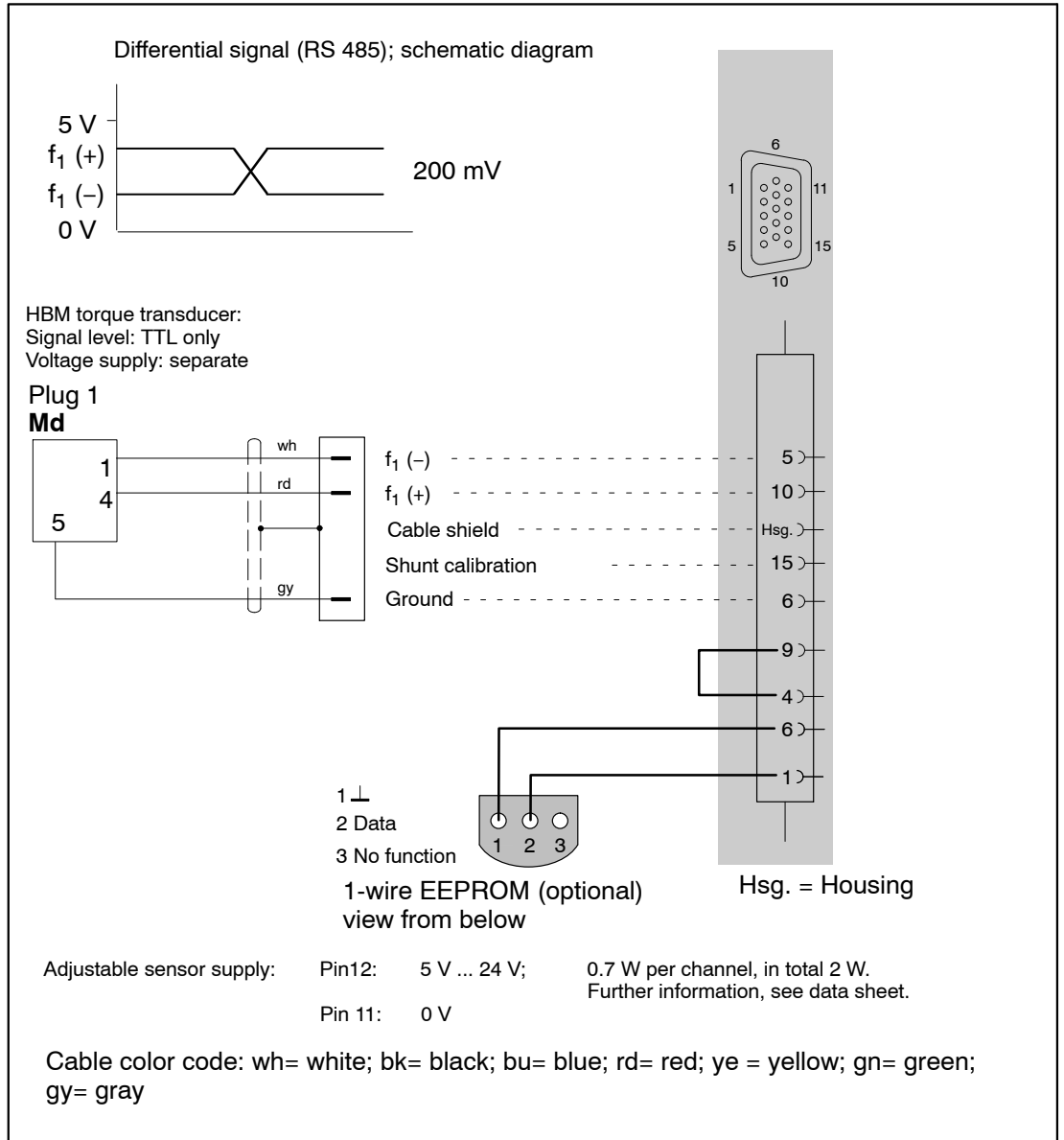
7.22   Frequency, differential, with directional signal

Supported by the following modules: MX840, MX840A, MX440A, MX460

Differential signal (RS 485); schematic diagram

5 V
f_1 (+)
f_1 (−)
0 V

200 mV

6
1   11
5   15
10

HBM torque transducer:
Signal level: TTL only
Voltage supply: separate

Plug 2
n

bk
and
bu

8   6
1
7
3

wh
rd
gn

gy

Ground - 6
f_1 (−) - 5
f_1 (+) - 10
f_2 (−) - 7
Cable shield - - - - - - - - - - - - - - - - Hsg.

f_2 (+) - 8

9
4

6

1

f_1 (−) = Measurement signal speed, 0° (−)
f_1 (+) = Measurement signal speed, 0° (+)
f_2 (−) = Measurement signal speed, 90° (−)
f_2 (+) = Measurement signal speed, 90° (+)

1 ⊥
2 Data
3 No function

1   2   3

1-wire EEPROM (optional)
view from below

Hsg. = Housing

Adjustable sensor supply: Pin12:   5 V ... 24 V;   0.7 W per channel, in total 2 W.
                                                                    Further information, see data sheet.
                               Pin 11:   0 V

Cable color code: wh= white; bk= black; bu= blue; rd= red; ye = yellow; gn= green;
gy= gray

7.23 Frequency, single-pole, without directional signal

Supported by the following modules: MX840, MX840A, MX440A, MX460

Signal single-pole, schematic diagram

HBM torque transducer

Plug 1
Md

1-wire EEPROM (optional)
view from below

Hsg. = Housing

Adjustable sensor supply: Pin12:   5 V ... 24 V
                              Pin 11:   0 V

Cable color code: wh= white; bk= black; bu= blue; rd= red; ye = yellow; gn= green;
gy= gray

7.24   Frequency, single-pole, with directional signal

Supported by the following modules: MX840, MX840A, MX440A, MX460

Signal single-pole, schematic diagram

5 V
3.5 V ———————————————— Thresholds

1.5 V ———————————————— Thresholds
0 V

f_1

Industrial pulse encoder

f_1 (+) - - - - - - -10

f_2 (+) - - - - - - 8
Cable shield   Hsg.
⊥ - - - - - - 6

9
4
5
7

6

1

1 ⊥
2 Data
3 No function

1   2   3

1-wire EEPROM (optional)
view from below

6
1   11
5   15
10

Hsg. = Housing

Adjustable sensor supply: Pin12:   5 V ... 24 V
                               Pin 11:   0 V
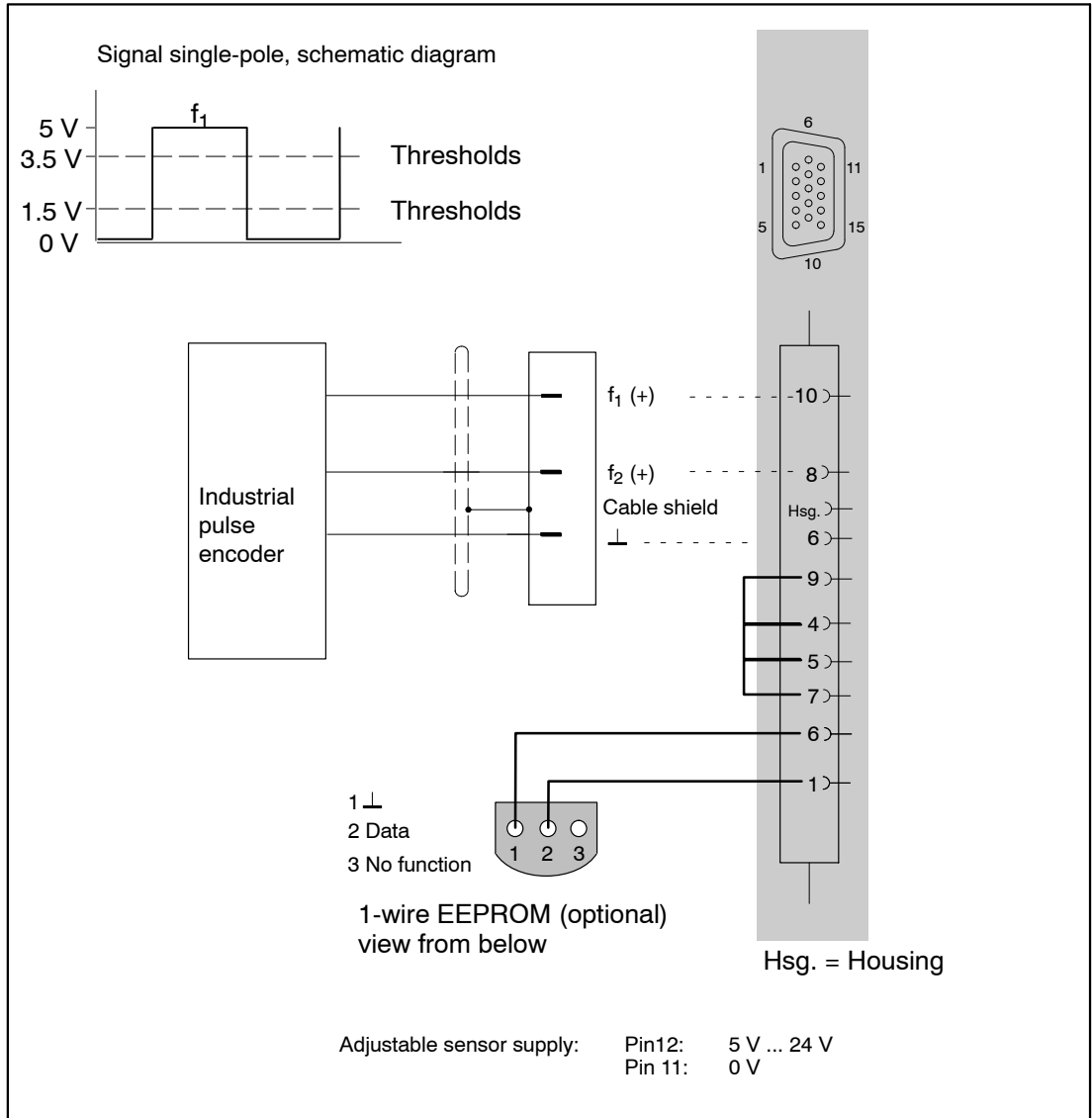
7.25   Encoder and pulse encoder, differential

Supported by the following modules: MX840, MX840A, MX440A, MX460

Differential signals (RS 485); schematic diagram

5 V
f_1 (+)
f_1 (−)
0 V

200 mV

6
1   11
5   15
10

Industrial
pulse
encoder

Zeroing pulse +   - - - -   3
Zeroing pulse −   - - - -   2
f_1 (+) - - - - - - - - - - -   10
f_1 (−) - - - - - - - - - - -   5
Cable shield   Hsg.
f_2 (−) - - - - - - - - - - -   7
f_2 (+) - - - - - - - - - - -   8
⊥ - - - - - - - - - - -   6
                                    9
                                    4
                                    6
                                    1

1 ⊥
2 Data
3 No function

1   2   3

1-wire EEPROM (optional)
view from below

Hsg. =
Housing

Adjustable sensor supply: Pin12:   5 V ... 24 V
                               Pin 11:   0 V
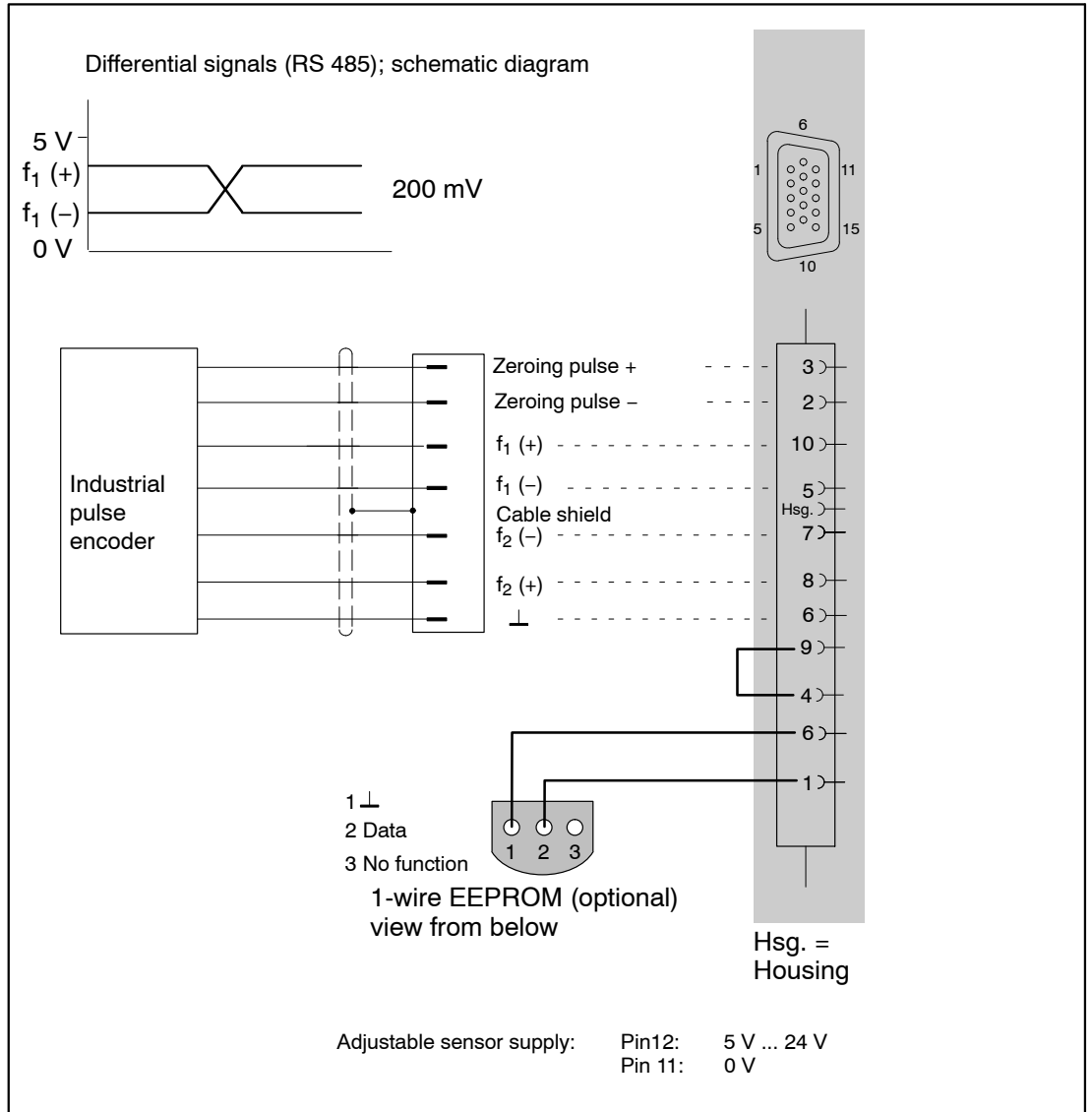
7.26 Encoder and pulse encoder, single-pole

Supported by the following modules: MX840, MX840A, MX440A, MX460

Signal single-pole, schematic diagram

f_1

5 V
3.5 V — — — — — — — Thresholds
1.5 V — — — — — — — Thresholds
0 V

Industrial pulse encoder

⊥ — — — — — — 6
f_2 (+) — — — — — — 8
f_1 (+) — — — — — — 10
Cable shield — Hsg.
Zeroing pulse + — — — — 3
9
4
7
5
2
6
1

1 ⊥
2 Data
3 No function

1 2 3

1-wire EEPROM (optional)
view from below

Hsg. = Housing

Adjustable sensor supply: Pin12: 5 V ... 24 V
                           Pin 11: 0 V
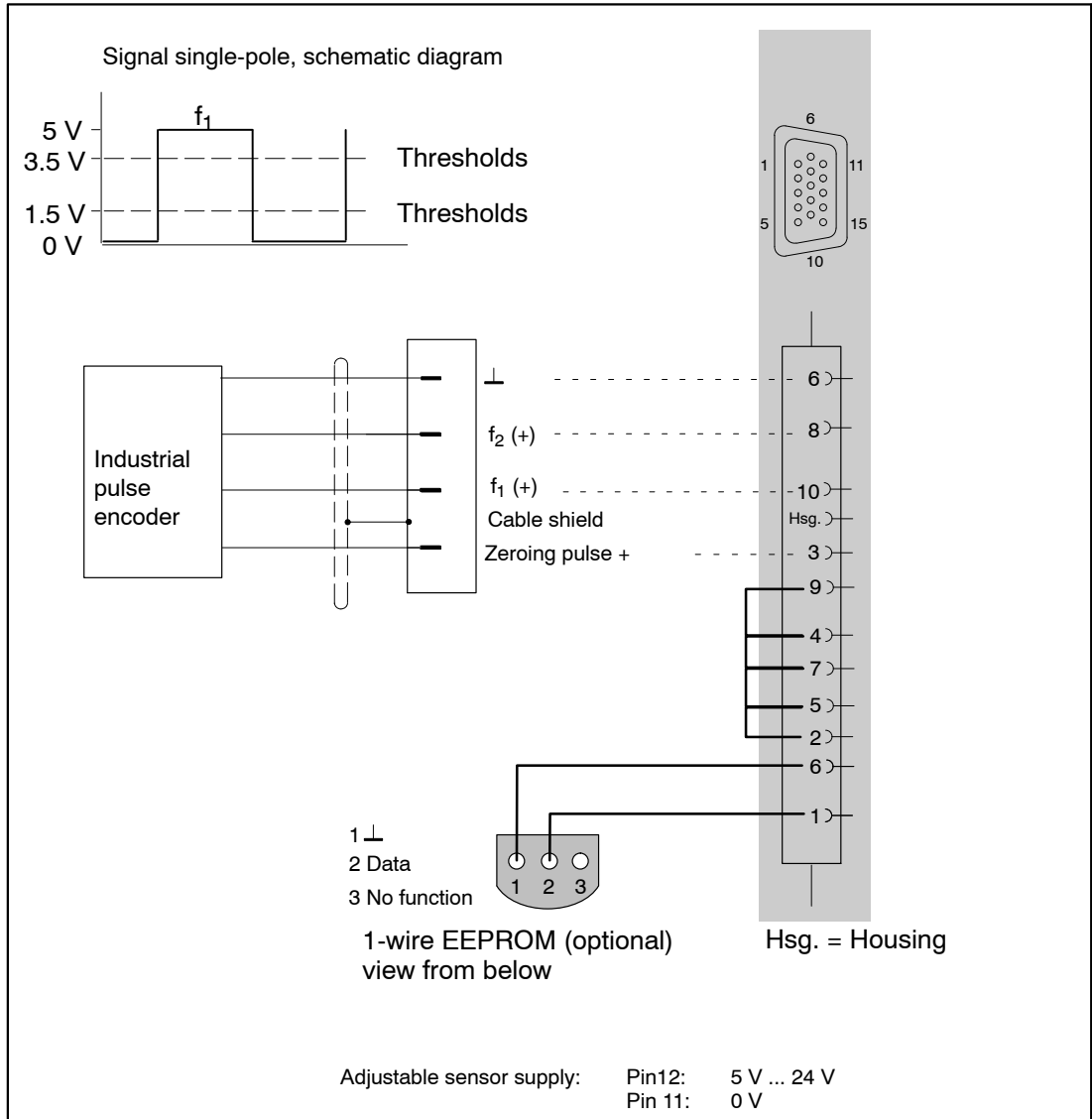
7.27 Absolute value encoder with SSI protocol

Absolute value encoders provide information about position in the form of a digital numeric value. Because the numeric value is unique over the entire resolution range of the absolute value encoder, no initial reference movement is needed is is the case for incremental rotary encoders. Absolute values can be transferred by the encoder using the international SSI, EnDat (Heidenhain) or Hiperface (Sick-Stegmann).

In addition to the current position value, other data items can also be transferred. They can include current temperature values of the encoder or the electrical data of the servo motor on which the encoder is mounted (the "electronic rating plate")

Supported by the following modules: MX840, MX840A, MX440A

$f_{1\ (-)}$ = Data (−)
$f_{1\ (+)}$ = Data (+)
$f_{2\ (-)}$ = Shift clock (−)
$f_{2\ (+)}$ = Shift clock (+)

Hsg. = Housing

| Adjustable sensor supply: | Pin12: | 5 V ... 24 V |
| | Pin 11: | 0 V |
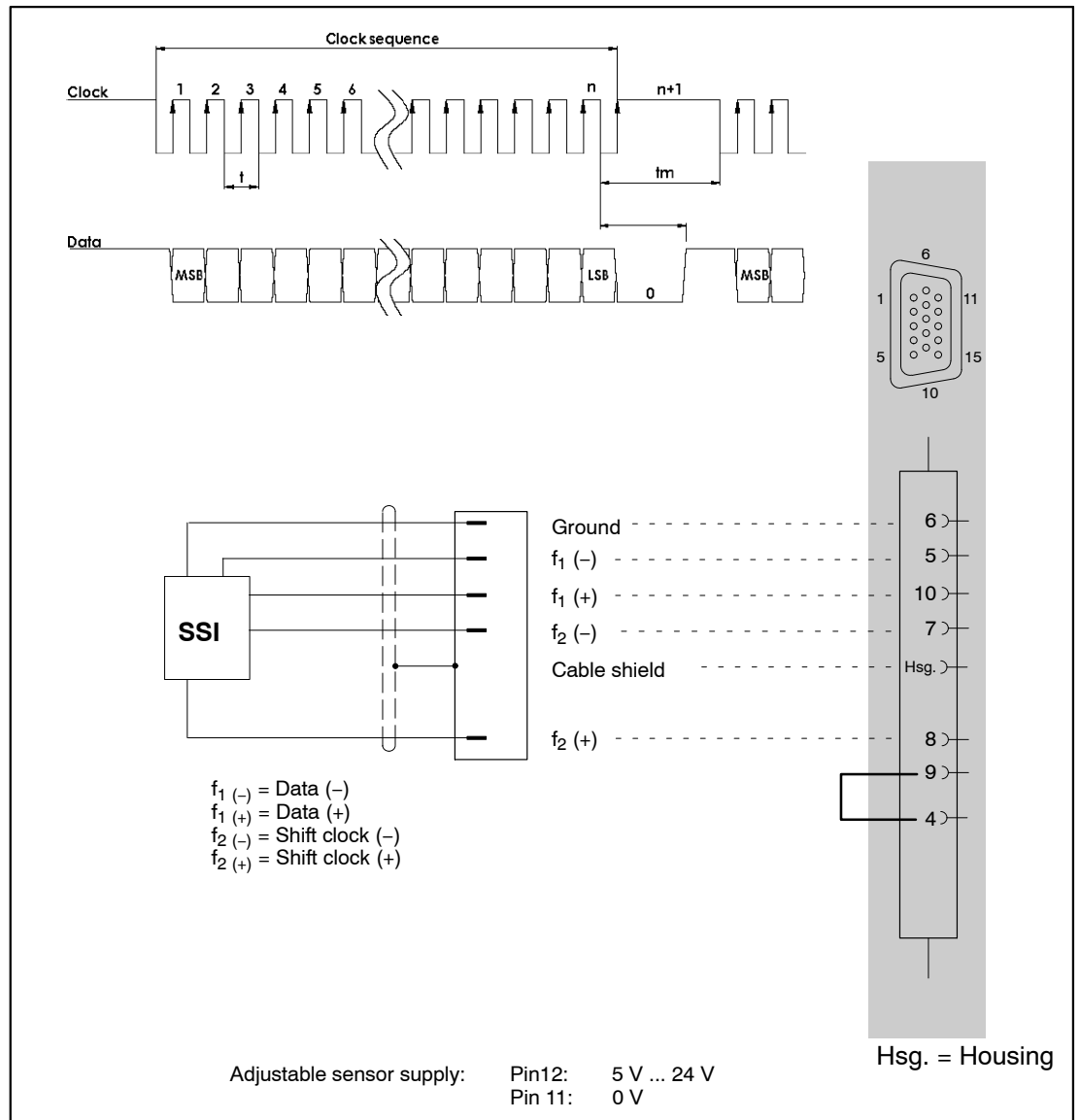
7.28   Passive inductive encoder

Supported by the MX460 module.

**Maximum input voltage to housing and supply
ground: ± 60 V**

f₁ AC+ — 14

Cable shield — Hsg.

Ground — 6

9

4

6

1

1 ⊥
2 Data
3 No function

1-wire EEPROM (optional)
view from below

Hsg. = Housing

7.29 PWM – Pulse width, pulse duration, period duration

Supported by the following modules: MX460
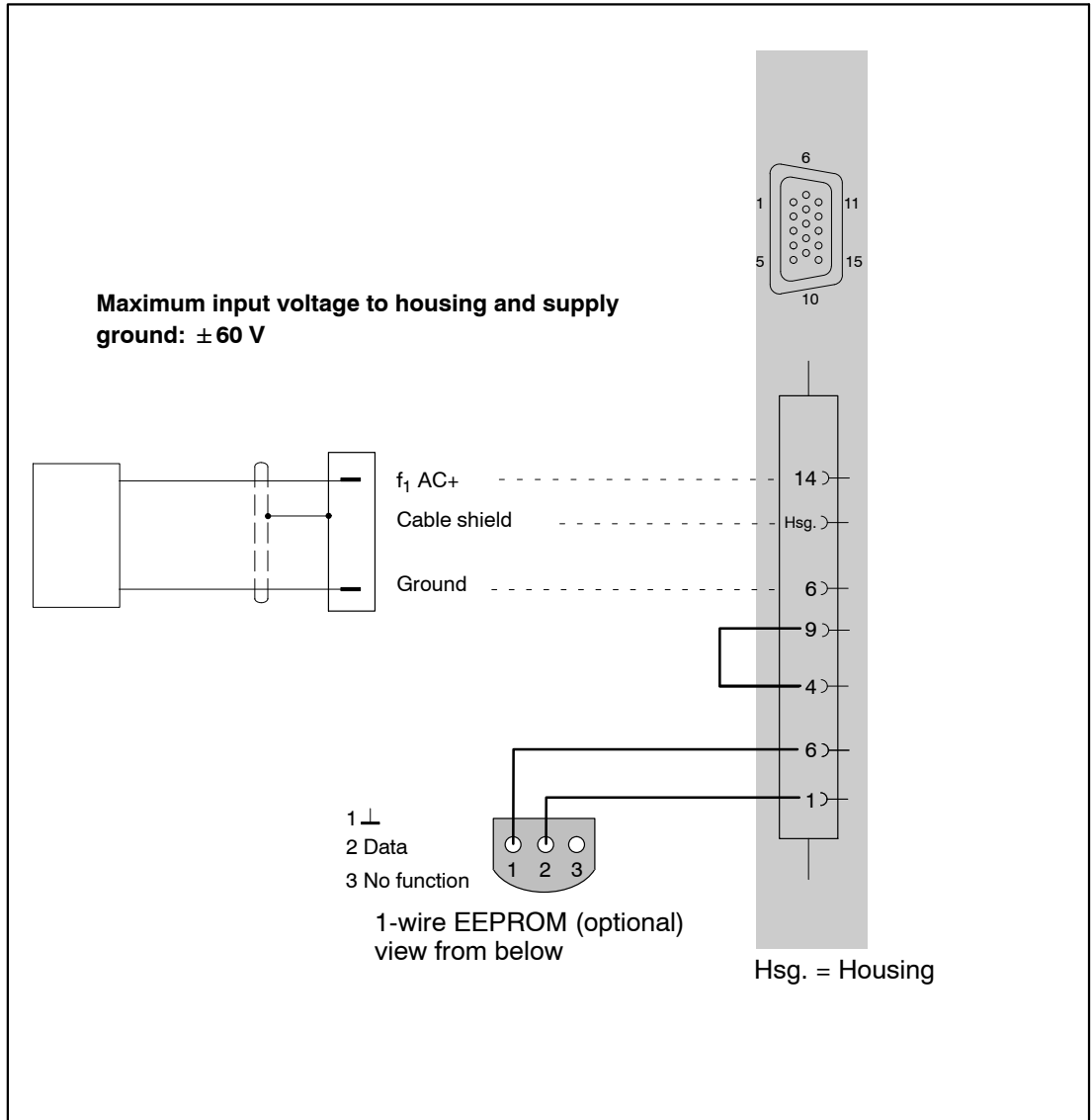
7.30 PWM – Pulse width, pulse duration, period duration, single-pole

Supported by the following modules: MX460

Transducer

⊥

f₁ (+)

Cable shield

6

10

Hsg.

9
4
7
5
2

6

1

1 ⊥
2 Data
3 No function

1 2 3

Hsg. = housing

Adjustable sensor supply: Pin12:   5 V ... 24 V
                             Pin 11:   0 V
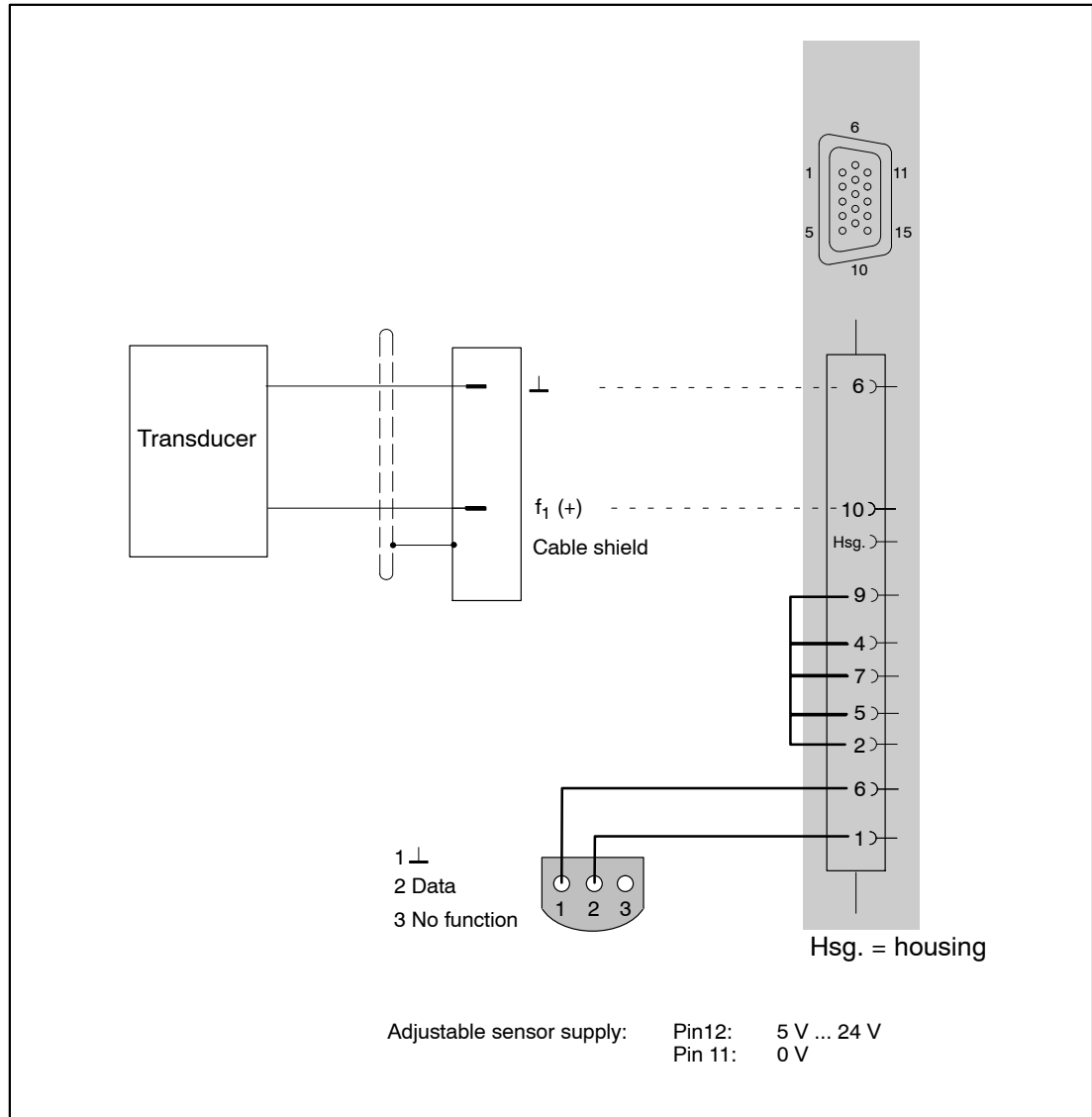
7.31   CAN bus

CAN messages can be acquired with the following modules: Channel 1 of MX840 or MX840A. CAN messages can be acquired and sent with the following modules: MX471, MX840A (only module-internal measured quantities). A dbc data file can be generated using the QuantumX assistant. Module MX471 supports protocols CAN, CCP and XCP-over-CAN on each channel.
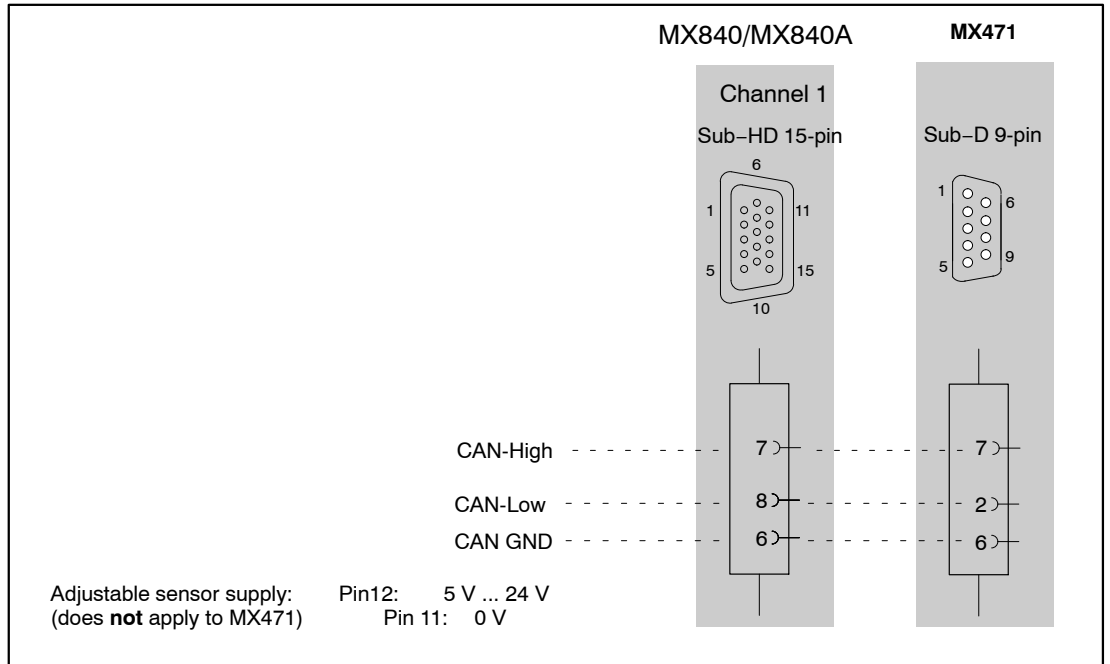
Note

Ensure correct termination with termination resistors is made, as shown in Fig. 7.1. The MX840/MX840A does not have any termination. The MX471 has internal termination that can be activated via software.
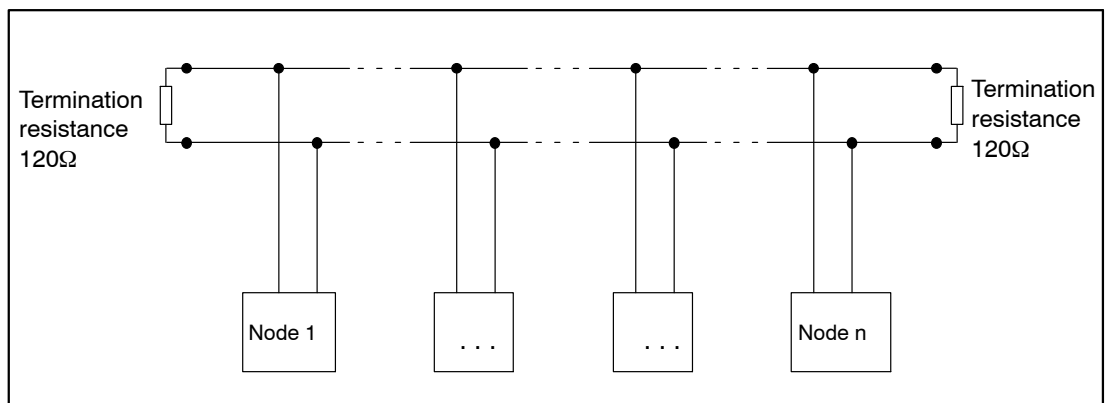
Fig. 7.1.:   Bus termination resistors

The adapter cable 1−KAB418 is used to connect the D−SUB−15HD device sockets of the MX840/MX840A to standard CAN plugs (D−SUB−9).

8   Functions and outputs:

Modules MX410, MX460 and MX878/MX879 can be used to perform **mathematics functions** in real time with the results available as **standard system signals**. These system signals can be used like actual measurement signals for subsequent tasks (analog output, EtherCAT® signal, source signal for mathematics function, data visualization and storage).

The MX878/MX879 and MX410 modules feature analog outputs that can be connected to a system or source signal, for example an actual measurement signal (additionally scaled, filtered) or the result of a mathematics function.

Measurement channels that are used in mathematics functions or directly for analog outputs need to be activated for **"isochronous data transfer"** (for example in the QuantumX Assistant software, "Signals" tab).

Note

The module configuration is immediately active after system reboot (Auto Startup). No operating PC is required for configured signal outputs to run standalone.

Mathematics functions at a glance:

-                         Peak values (Peak)

-                         (Add and Multiply)

-                         Root mean square value (RMS)

-                         Rotation (rotational analysis) and angle difference

-                         Matrix

Mathematics functions provided by the modules

MX878/MX879		MX410	MX460

8.1   MX410

The MX410 module is a module with four analog outputs that can be accessed on the front panel via BNC sockets.

The outputs are directly assigned to the inputs located above them.
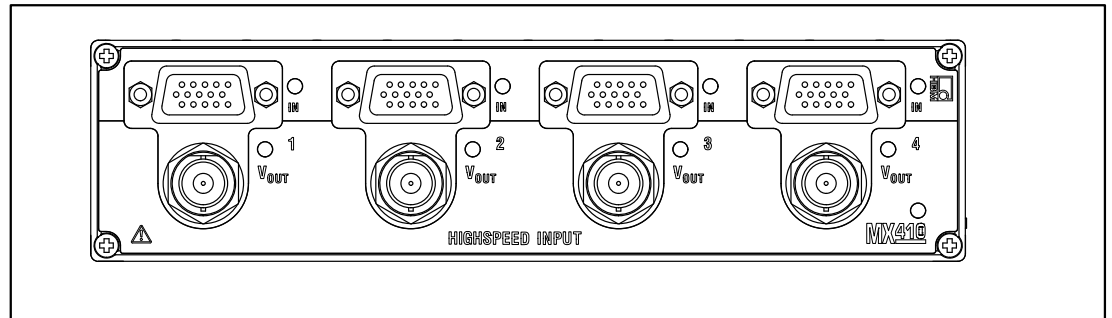
Fig. 7.1:MX410 front view

Note

After an analog output is configured its function (configuration, scaling) continues to be available even if the computer is disconnected. Therefore no connection to a PC is required.

The MX410 supports 8 peak value detection channels and 4 RMS channels.

These functions can be used to generate so-called virtual signals that can also be output at the analog output and made available to the QuantumX system. This also makes the signals visible to the software.

The device is parameterized by means of the software (e.g. QuantumX Assistant or catman®AP).

Keep in mind the following notes when working with peak value monitoring channels:

- The maximum output (sampling rate) is restricted to 4800 Hz

- PEAK values can only be reset via PC software (system signals will follow)

- The output rate of the peak value monitoring channel must not be higher than the sampling rate of the input channel.

- Filters set for the MX410 do not apply to peak value monitoring channels

- These channels are always unfiltered. However, the input signal is filtered.

- The peak value units do not accept other peak value units or RMS as input. Only the 4 analog inputs are allowed.

Peak value function

Each peak value detection unit can monitor either the Min peak or the Max peak of one of the module's 4 analog input channels. A peak value unit may operate in different modes:

- RUN: peak values will be continuously updated

- HOLD: last peak value will be "frozen"

- PEAK VALUE: peak value detection enabled

- FOLLOW: peak value detection disabled, i.e. the channel returns the original signal of the input channel

The following combinations are possible:

RUN MAX PEAK VALUE

HOLD MAX PEAK VALUE

FOLLOW HOLD MAX

This also applies to minima.

Graph for the peak value function

<table>
<tr><td>RMS</td></tr>
</table>

Function for Root Mean Square (RMS) calculation

RMS is computed from one of the module's 4 analog input channels according to the formula:

$$RMS = \sqrt{\frac{1}{T} * \int\limits_{0}^{T} f(x)^2 \, dx}$$

Where f(x) denotes the input channel signal and T the time window (in ms).

Keep in mind the following notes when working with RMS channels:

- The maximum sampling rate is 4800 (2400) Hz

- The output (sampling) rate of the RMS channel must not be higher than the sampling rate of the input channel.

- Filters set for the MX410 do not apply to RMS channels. These channels are always unfiltered. However, the input signal is filtered.

8.2   MX460

The MX460 supports 4 special math channels for analysis of rotational parts: Rotational vibration and angle difference.
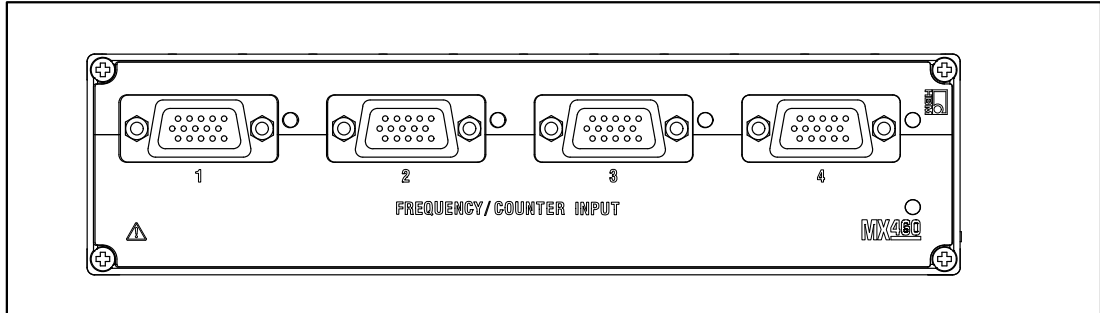
Fig. 7.2:MX460 front view

MX460 math channels

Keep in mind the following notes when working with these channels:

• The maximum sampling rate is 4800 (2400) Hz

• The sampling rate of the channel must not be higher than the sampling rate of the input channel.

• Filters set for the MX460 do not apply to math channels. These channels are always unfiltered.

However, the input signal is filtered.

8.3 MX878

The MX878 module is a module with eight analog outputs that can be accessed on the front panel via BNC sockets or plug terminals.
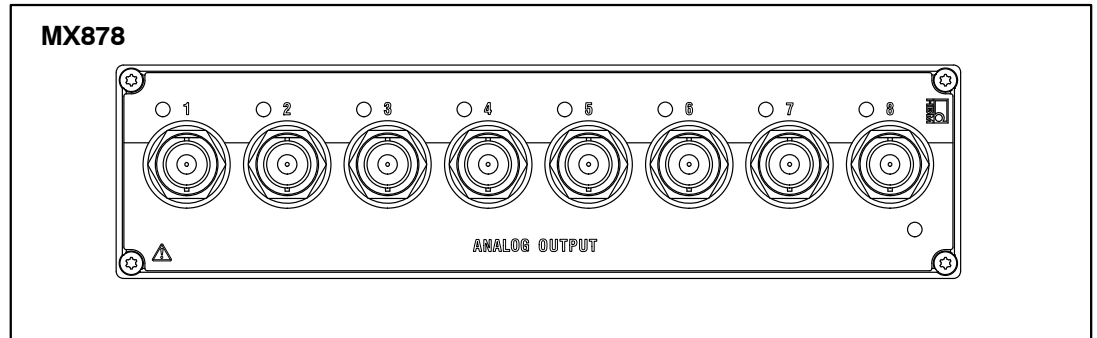
Fig. 7.3:MX878 front view

Two analog outputs each (1 and 2, 3 and 4, etc.) have the same ground potentials, for the others electrical isolation applies between them and the voltage supply ground.

The modules can receive all signals that are isochronously available on the IEEE1394b FireWire.

The settings for this are implemented with the QuantumX Assistant. Before output at the analog output, the signal passes through an output characteristic curve parameterized by the user (2-point scaling) and a filter also parameterized by the user. In addition, the rate for DAC is reduced to 96 kS/s through interpolation.

Math channels

The MX878 is a dedicated module designed for analog outputs and math channels.

The MX878 supports 4 math channels and 4 peak value detection channels.

In contrast to other modules, the MX878 has no analog sensor inputs. Instead it receives data from other modules via the "isochronous IEEE1394b FireWire transfer" from any source within the system configured for this data transfer mode. The module routes this data to an analog output or performs a math computation on this data (which may also be output on one of the analog outputs).

You need to connect all modules via IEEE1394b FireWire (or use a backplane) for the MX878 to become operational! You can configure several channels to "isochronous IEEE1394b FireWire transfer" using QuantumX Assistant software or catman®AP 3.1 or higher.

Please note:

Providing the data via isochronous transfer may use up significant computing power on the module (in particular on the MX410 module and the MX460 high-speed module). Do not activate the isochronous data transfer unless it is actually needed!
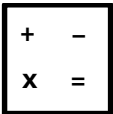
Add & Multiply functions

The MX878 currently provides the following type of computation:

Result = a0 + a1*InputSignal1 + a2*InputSignal2 +   a3*InputSignal1*InputSignal2

Where InputSignal1 and InputSignal2 denote the two input signals used for this computation.

These channels will reside on other modules and must have their isochronous IEEE1394b FireWire transfer enabled.

Keep in mind the following notes when working with math channels:

- The maximum sampling rate is restricted to 2400 Hz

- The sampling rate of the channel must not be higher than the sampling rate of the input channels.

- Filters do not apply to math channels. These channels are always unfiltered.
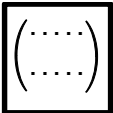
Matrix computation function

The MX878 The MX878 makes it possible to perform 4 parallel matrix computations each with a maximum of 6 input and output quantities and 36 constants.

Generic formula:

$F_x = a_1*U_{fx} + a_2*U_{fy} + a_3*U_{fz} + a_4*U_{mx} + a_5*U_{my} + a_6*U_{mz}$
etc. for Fy, Fz, Mx, My, Mz

The "Matrix computation" function can be used for mathematical compensation of interdependencies (crosstalk) of multi-component transducers for force and torque measurement.

The maximum data rate of the input and output quantities is 1200 Hz (< 1 ms of computation time). The computed output signals can be scaled and output as filtered analog voltages by the same module. The computed signals can also be distributed (isochronously) to the IEEE1394b FireWire bus in real time and output via CAN bus or EtherCAT® (MX471: CAN bus. MX878: EtherCAT® bus).

Scaling of the input and output quantities must always be e.

An EXCEL compensation matrix can be copied directly to the matrix parameterization (Ctrl + C, Ctrl + V).

RMS

Function for Root Mean Square (RMS) calculation

RMS is computed from one of the module's 4 analog input channels according to the formula:

$$RMS = \sqrt{\frac{1}{T} * \int_{0}^{T} f(x)^2 \, dx}$$

Where f(x) denotes the input channel signal and T the time window (in ms).

Keep in mind the following notes when working with RMS channels:

- The maximum sampling rate is 4800 (2400) Hz

- The output (sampling) rate of the RMS channel must not be higher than the sampling rate of the input channel.

- Filters set for the MX878/879 do not apply to RMS channels. These channels are always unfiltered. However, the input signal is filtered.

Peak value function

Keep in mind the following notes when working with peak value monitoring channels:

- The maximum sampling rate is 4800 Hz

- The sampling rate of the channel for peak value monitoring must not be higher than the sampling rate of the input channel.

- The peak value units do not allow for any other peak value units or RMS values as input

Each peak value detection unit can monitor either the Min peak or the Max peak of one of the four signals within the system identified as "isochronous".

A peak value unit may operate in different modes:

- RUN: peak values will be continuously updated

- HOLD: last peak value will be "frozen"

- PEAK VALUE: peak value detection enabled

- FOLLOW: peak value detection disabled, i.e. the channel returns the original signal of the input channel

The following combinations are possible:

RUN MAX PEAK VALUE

HOLD MAX PEAK VALUE

FOLLOW HOLD MAX

This also applies to minima.

Graph for the peak value function

Function	Run	Hold	Run
Operating mode	Peak value		Follow
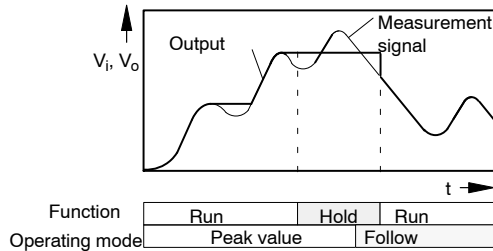
Analog outputs of the MX878

The MX878 is a dedicated module designed for analog outputs and math channels. In contrast to other modules, the MX878 has no analog sensor inputs. Instead it receives data from other modules via the "isochronous IEEE1394b FireWire transfer". The module then routes this data to an analog output.

You need to connect all modules via IEEE1394b FireWire (or use a backplane) for the MX878 to become operational! Please note the "ISO" column in the catman® channel configuration window. This column indicates if a channel provides its data via the isochronous link (indicated by a symbol). Click the column or use the column's context menu to enable or disable isochronous transfer for a channel.

Providing the data via isochronous transfer may use up significant computing power on the module (in particular on the MX410 module and the MX460 high-speed module). Do not activate the isochronous data transfer unless it is actually needed!

MX878 signal generator

The MX878 has 8 signal generators. The signals (e.g. set profiles for controlling uni- or multiaxial actuators) can be individually generated and assigned to analog outputs.

The following signal forms are available (to be defined in an ASCII file):

   constant, sine, rectangle, triangle

Depending on their type, the signal forms are described by the following parameters:

   level, frequency, duty ratio

The signals are buffered and described as follows:

   Repetition cycle (continuous, triggered)

   Point in time

A buffer that has been filled before can be output with a defined number of repetition cycles, continuously and triggered, starting at a specific point in time.

In addition, a second buffer is available. While one buffer is output the second buffer can be filled. Output of the second buffer can be activated immediately or when the first buffer has been output. At the end of the sequence, the last output value is held.

8.4   MX879 Multi-I/O module

The MX879 module is a multi-I/O module with eight analog outputs and 32 digital I/Os that can be accessed on the front panel via plug terminals.
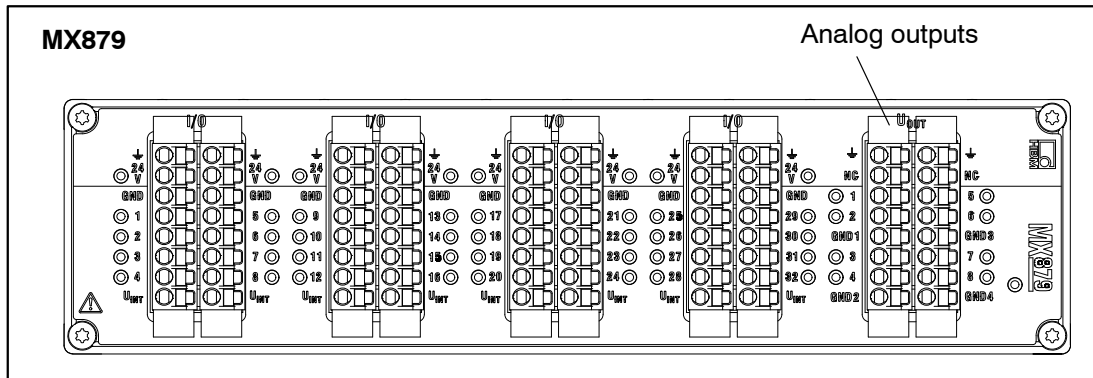
Fig. 7.4: MX879 front view

Two analog outputs each (1 and 2, 3 and 4, etc.) have the same ground potentials, for the others electrical isolation applies between them and the voltage supply ground.

The modules can receive all signals that are isochronously available on the IEEE1394b FireWire.

The settings for this are implemented with the QuantumX Assistant. Before output at the analog output, the signal passes through an output characteristic curve parameterized by the user (2-point scaling) and a filter also parameterized by the user. In addition, the rate for DAC is reduced to 96 kS/s through interpolation.

The MX879 functions are similar to those of the MX878.

In addition, the MX879 offers a **limit value monitoring function**.

Limit value monitoring

The limit value unit consists of eight limit value switches for monitoring of eight signals. Any signal that is available throughout the system can be used as the input signal.

The logic output can be assigned to a digital output. Parameterization includes the input signal and, in addition, the switching threshold, hysteresis, switching logic and output logic.

The update rate of limit values is 4800 Hz.
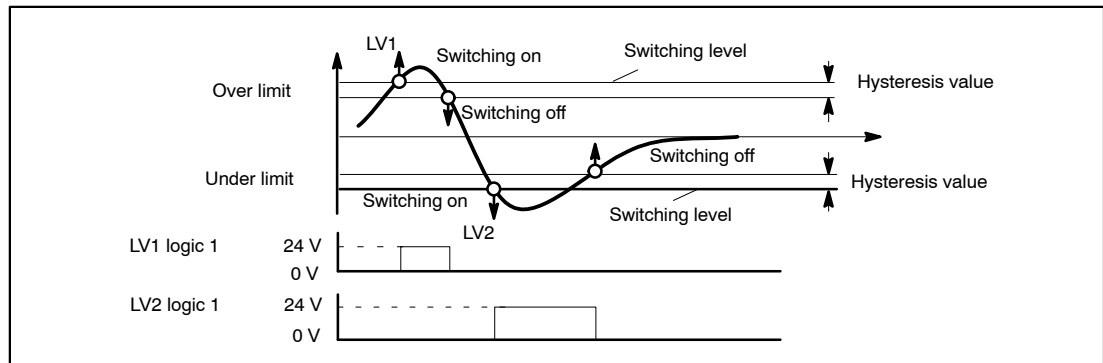
Fig. 7.5: Limit value functions and parameters

Examples of connections for MX879:

Digital output 24 V (1)

Digital output 5 V, internal (1)

Digital input 24 V (1)

Note:
Each twin unit comes with one power supply.

To supply all I/Os with power, bridging is required or each twin unit needs to be powered separately.

Analog output (1)

Note :
   GND 1: Terminals 1 and 2
   GND 2: Terminals 3 and 4
   GND 3: Terminals 5 and 6
   GND 4: Terminals 7 and 8
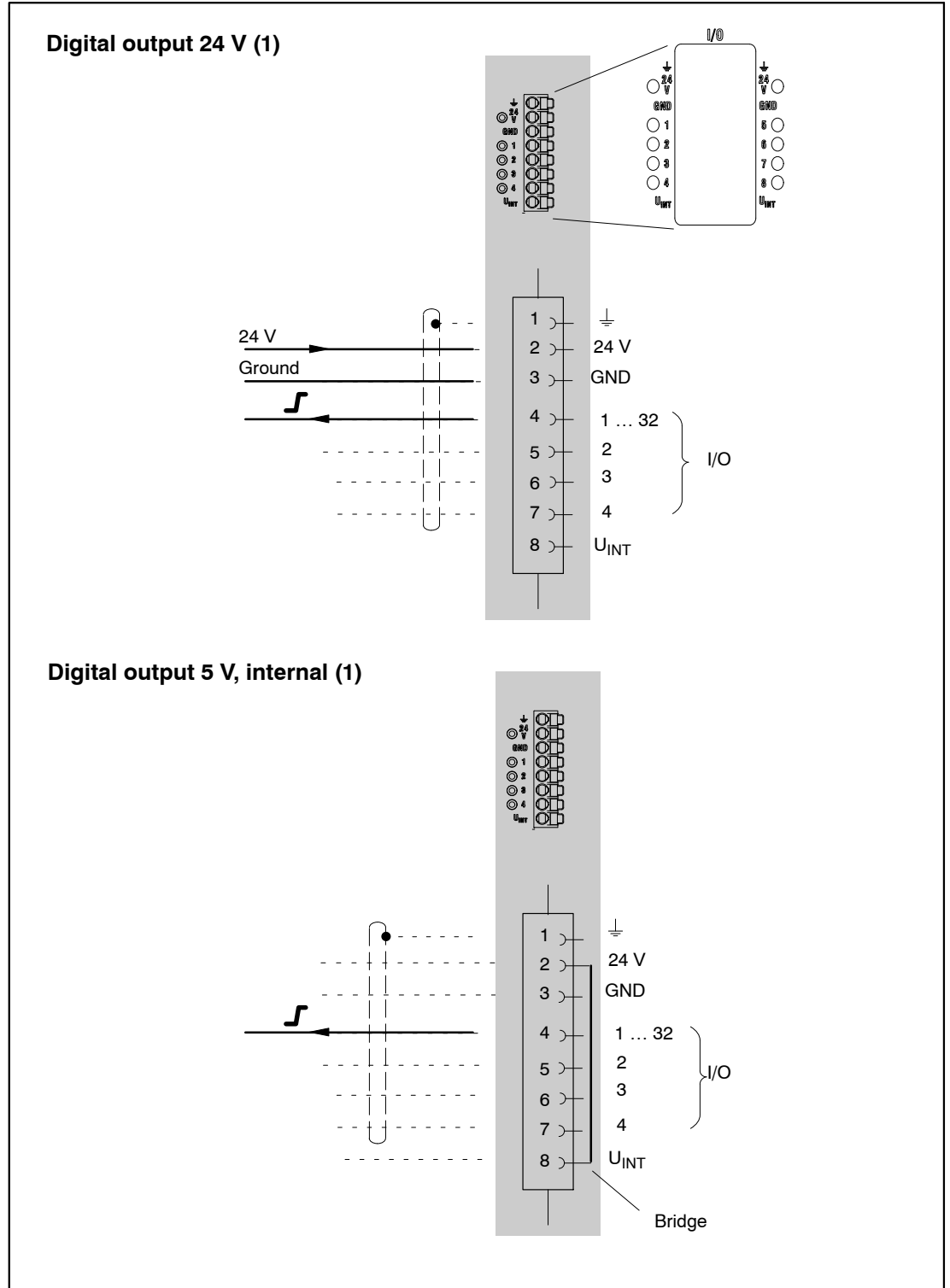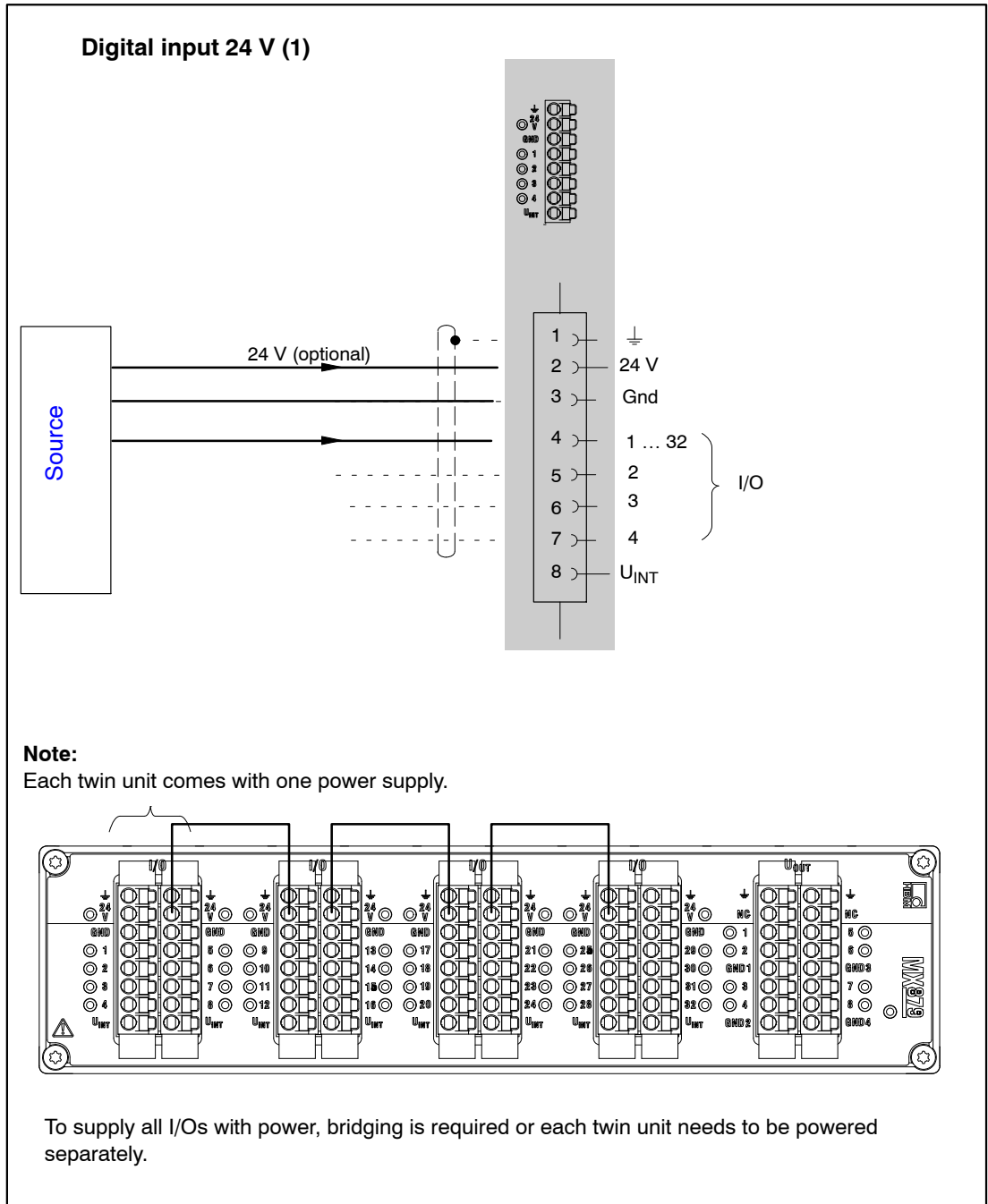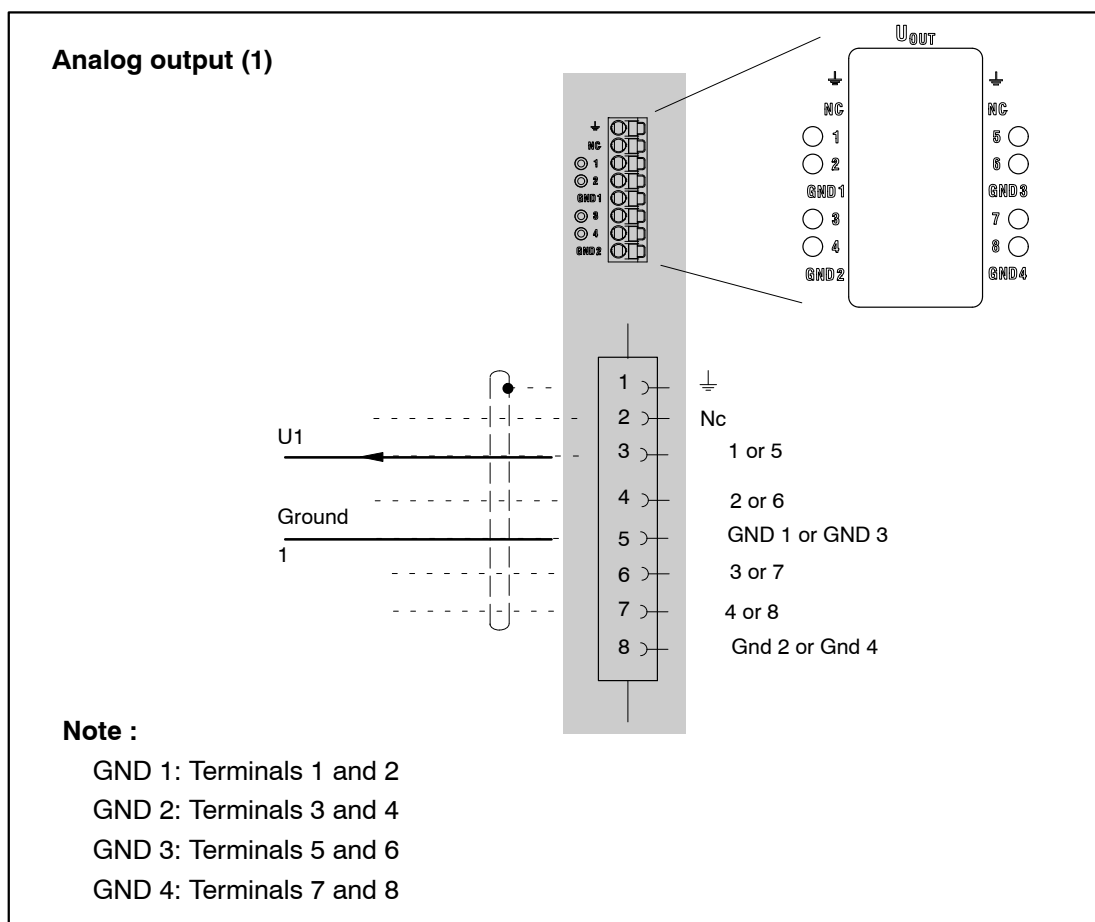
![Note bulb icon] **Note**

The analog output sockets are coded. The push-in plugs need to be prepared accordingly.

Coding of the **analog output sockets:**

Analog output sockets are coded for protection.

A tip needs to be cut off when preparing plug connections for analog outputs (coding).

8.5 MX471

The MX471 module ensures a high-performance connection between a CAN bus network and the QuantumX system.

Four CAN interfaces are available, all working independently of each other.

The CAN bus enables signals to be input to the measurement system and output as PDO (Process Data Object).

CAN output

The modular QuantumX data acquisition system can be individually assembled. IEEE1394b FireWire enables quantities measured using amplifiers or computed values to be transmitted to specific modules in real time (isochronous signals).

For example, to send a measured temperature as a "Process Data Object" (PDO) over the CAN bus via a specific node of the MX471, the temperature signal can simply be dragged and dropped onto the node. Parameterization is then performed automatically. The CAN message needs to be completed in the corresponding dialog.

A parameterized MX471 node is able to send any signals or measured quantities cyclically as CAN messages.

The CAN messages are sent to the CAN bus at the data rate set for the source signal. With a data rate > 4800 Hz, the transmission rate is limited. The transmission rate on the CAN bus can generally be reduced with a configurable divider.

For bus parameterization, the baud rate must be specified via software and it may be necessary to activate a termination resistor (bus termination).

Parameterizing the CAN message requires:
- Defining an identifier (decimal CAN-ID) and the corresponding format (11 or 29 bits)
- A divider to reduce the transmission rate, if required

Signals are sent using the 4-byte float format.

When parameterization of the node has been completed, a type *.dbc CAN database can be generated. This database makes configuring a receiver node easier.

Additional protocols

The MX471 module supports the following protocols on up to 2 channels:
- CAN Calibration Protocol (CCP)
- eXtended Calibration Protocol (xCP-on-CAN)

These protocols are commonly used in the automotive industry to communicate with parameter sets/signal lists from electronic control equipment.

The first step for parameterization of the individual MX471 channels requires the CANape software tool from Vector Informatik. Based on an available control device description file (*.a2l), CANape generates a signal description file (*.dbc) which is transferred to the channel using the QuantumX Assistant tool and parameterizes the respective CAN node. Seed&Key encryption technology is supported.

Note

Generally both message types (standard/extended) can be used in a CAN network.
There is no analysis of Sync or Remote-Frames messages.
The four CAN nodes are handled with equal priority.
A node parameterized as sender works as an autonomous gateway and no longer requires a connection to a PC.
SDOs are not supported, and therefore the MX471 cannot be considered as a CANopen slave.
The states of individual nodes are displayed directly at the relevant connection point.

CAUTION

If a CAN node uses an incorrect baud rate for transmission over the bus, all data transmission on the bus may fail.

9   FAQ

Subject:

QuantumX in an (Ethernet) network and device scanning with catman®Easy/AP

Question/Problem

I connected a QuantumX amplifier via a network cable and started the catman®EASY/AP software, but I am not getting a connection to the amplifier. Even though the network address of the QuantumX is entered in the scan options, the program says:

"The device scan cannot find any connected devices. …"

What might be causing this, how can I set up a connection to QuantumX?

Reply/Solution:

First of all, check carefully whether the network address of the QuantumX amplifier is in the same subnet as the PC and whether this IP address is correctly entered in the scan options of catman®Easy/AP. If this is the case, the following factors may also prevent the QuantumX from being located in the network:

- The Windows® firewall. This can block the connection during device scanning and should be switched off temporarily for the duration of the measurement. The settings for the firewall can be found under $-$> Control panel $-$> Security center $-$> "Windows Firewall".

- Wireless network adapters (WLAN). These can, depending on the configuration, take priority in operating the network and thereby disturb the wired network scan. If a WLAN adapter is present on the notebook or laptop, it must be deactivated.

- The firewall of an installed VPNClient. This can also disturb a network scan. For example, the setting "Stateful Firewall (Always On)" is activated by default in the CISCO VPN Client. This should be temporarily deactivated for the QuantumX device scan.

- A virus scanner can also possibly block the network scan due to its properties. It should therefore be temporarily deactivated.

- If the PC settings will not permit a scan via a network area at all (e.g. for security reasons), it is still possible to connect a device manually with a selected configuration (from catman®EASY/AP version 2.2). This setting can be found in the "Scan options" as the option "Add device manually".

Please note that administrator rights under Windows® may be necessary for some of these settings.
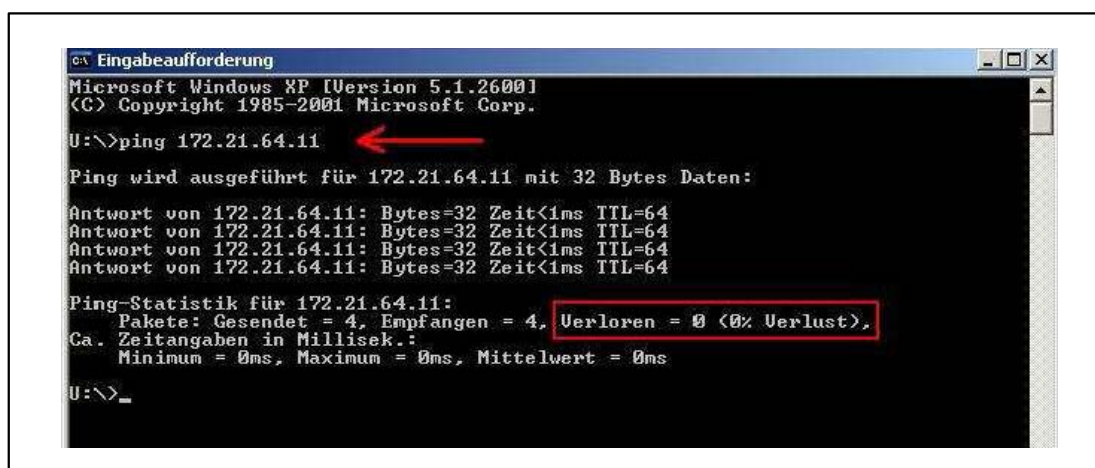
Question/Problem

How can I check whether the amplifier is physically connected correctly with the network cable and can actually be reached via my PC?

Reply/Solution:

This can be easily checked with the help of a Windows® function. Please open the Windows® entry prompt (Start − > Programs − > Accessories − > entry prompt) and enter the following at Prompt C:>:

`ping xxx.xxx.xxx.xxx` (ENTER)

The xxx.xxx.xxx.xxx represents the IP address of your QuantumX device. If correctly connected, the device will reply positively. An example is shown in the following screenshot:

If you connect a QuantumX directly 1:1 to the PC, a "crossover patch cable" must be used as the network cable.

If no module appears, there are several possible causes. Check the following points and then repeat the search.

General reasons

- Is the QuantumX module switched on and is the module LED lit up green?
- Is the interface cable connected?
- Have you activated the correct interface or correct interface adapter?
- Check the scan options in the dialog Find modules (Where do I find the scan options?).

If you are using the Ethernet interface

- Have you used the correct Ethernet cable (Ethernet Switch with standard cable or direct connection with crossed cable)?

- Is your Ethernet switch working correctly?

  If you are not operating any other devices on the switch with which you can check the function, try to set up a direct connection between the PC and the QuantumX module.

- Could your firewall be responsible for blocking the UDP scan?

  Try deactivating the firewall or enable the TCP ports via 1000 for your PC and 5001 for the IP address of the QuantumX. Also refer to Changing the Ethernet interface parameters of the QuantumX

- If a WLAN is also active in your PC, you must test whether the module can be found when you temporarily switch off the WLAN (just for the search period). With some WLAN configurations, problems can occur across all interfaces during a scan.

- If your PC has several Ethernet interfaces, limit the search to the interface which is connected to the module: Scan options in the dialog Find modules (Where do I find the scan options?).

- If you want to use the QuantumX module in a larger network, please contact your network administrator. There are a series of options in administrated networks to limit or completely prevent data transmission between individual subscribers. Administrative enabling may also be necessary here.

Possible examples and their effects with regards to the connection of PC and QuantumX via Ethernet

1. No server in the network, the PC has no address (DHCP) and the QuantumX module is set to DHCP/APIPA (factory setting)

   When using Windows XP or higher, temporary addresses are used by the PC and QuantumX module, connection can be made.

2. No server in the network, the PC has no setting or uses DHCP, the QuantumX module has a permanent address

   No connection can be set up with this combination.

3. DHCP server in the network, the PC has a permanent address or uses DHCP, the QuantumX module has a permanent address

   A connection can normally only be set up when the PC and QuantumX module addresses lie in the same subnet, i.e. the IP address may only have different digit groups where a 0 is present in the subnet mask. Also refer to Changing the Ethernet interface parameters of the QuantumX

4. DHCP server in the network, the PC and the QuantumX module use DHCP

   Connection can be made.

10 Accessories

System accessories

Article	Description	Order no.
Backplane QuantumX (standard)	Backplane for maximum 9 modules of the QuantumX family; General information: – Wall or control cabinet installation (19"); – External modules can be connected via IEEE1394b FireWire; – Power supply: 24 V DC; – Power consumption: Max 5 A (150 W); Note: Only modules with protection class IP20 can be inserted.	1–BPX001

Module accessories

Voltage supply		
	Description	Order no.
Power supply	AC/DC power supply unit; input: 100–240 V AC (± 10%); 1.5 m cable with international plug set Output: 24 V DC, Max. 1.25 A; 2 m cable with plug for IP20 modules	1–NTX001
Voltage supply, open line	3 m cable for voltage supply of a QuantumX module. Plug for IP20 modules on one side and exposed wires at the other end. Note when using multiple modules: The supply voltage can be looped through IEEE1394b FireWire connections (max. 1.5 A)	1–KAB271–3
Mechanical		
	Description	Order no.
Housing connection element for QuantumX modules, see page 28	Mechanical connection elements for QuantumX modules (IP20 / IP65). Set consisting of 2 case clips, including assembly material for fast connection of 2 modules.	1–CASECLIP
Fitting panel for QuantumX modules, see page 34	Fitting panel for mounting of QuantumX modules using case clips (1 CASECLIP), lashing strap or cable tie. Basic fastening by 4 screws.	1–CASEFIT
Case protection for QuantumX modules, see page 29	Case protection functioning as stacking aid for MX amplifiers, including material for fast mounting.	1–CASEPROT

IEEE1394b FireWire		
	Description	**Order no.**
IEEE1394b FireWire cable (module-to-module)	FireWire connection cable between QuantumX modules in **IP20** design (lengths: 0.2m/2 m/5 m). Fitted on both ends with appropriate plugs. Note: The cable can be used to optionally supply connected QuantumX modules with voltage (max. 1.5 A, from source to last acceptor).	1–KAB269–5 1–KAB269–0.2 1–KAB269–2
PC to module connection cable 3 m	FireWire connection cable between PC and QuantumX module (length: 3 m). Fitted on both ends with appropriate plugs. Note: The cable cannot be used to supply QuantumX modules with voltage.	1–KAB270–3
Hub to module connection cable 3 m	FireWire connection cable between hub and QuantumX modules in **IP20** design (length: 3 m). Fitted on both ends with appropriate plugs. Note: The cable can be used to optionally supply connected QuantumX modules with voltage via the hub (max. 1.5 A, from source to last acceptor).	1–KAB275–3
IEEE1394b FireWire expressCARD/34	FireWire IEEE 1394b ExpressCard (ExpressCard/34) for connecting QuantumX modules to a notebook or PC	1–IF–002
IEEE1394b FireWire PC-Card	FireWire PC-Card with FireWire 1394b interface for connecting QuantumX amplifiers to notebook or PC (via PCCARD adapter)	1–IF–001
IEEE1394b FireWire-Extender	SCM-FireWire-Extender, IP68 Package consisting of 2 elements for extending the FireWire connection up to 50 m. Also required: 2x1-KAB269-x and industrial Ethernet cable (M12, CAT5e/6, up to 50 m). Connection via KAB270-–3 not possible.	1-SCM-FW
Ethernet		
Ethernet	Ethernet crossover cable, 2 m	1–KAB239–2

Transducer side

General information

Article	Description	Order no.
D−Sub−HD 15-pin plug set with TEDS chip	Plug kit DSub HD 15-pin (male) with TEDS chip for storing a sensor data sheet. Housing: metallized plastic with knurled screws. Note: the TEDS chip is blank.	1−SUBHD15−MALE
D−Sub−HD 15-pin port saver	Four fully wired port savers protect D−Sub−HD 15-pin ports against wear and tear due to frequent plugging and unplugging of transducers. Extends durability by at least 500 contact cycles. Construction: plug-in socket with screw connection	1−SUBHD15−SAVE
High-voltage signal conditioner	SCM−HV high-voltage signal conditioner 300 V (CAT II), TEDS, D-SUB−HD device connection, insulated lab measuring lead (length 0.5 m)	1−SCM-HV
SCM−SG120/350	SCM−SG120/350 DMS quarter bridge module (120 ohms or 350 ohms) Signal conditioning SG quarter bridge on QuantumX input with full bridge. Integrated 120-ohm (350-ohm) completion resistor for quarter bridge, shunt calibration, TEDS, D−Sub−HD device connection, solder joints for transducer lead	1−SCM−SG120 1−SCM−SG350
Adapter D−Sub−HD 15-pin to D−Sub 15-pin	Adapter D−Sub−HD 15-pin to D−Sub 15-pin for connecting transducers with pre-assembled D−Sub plugs on MX840 (length approx. 0.3 m) Note: Ready-made for full-bridge (6-wire).	1−KAB416
Push-In connector (8 pins)	10 Push-In connectors, Phoenix Contact, 8 pins (modules: MX879, MX1601, MX1615)	1−CON−S1005
1-wire EEPROM DS24B33	Package consisting of 10 units 1-wire EEPROM DS24B33 (IEEE 1451.4 TEDS)	1−TEDS−PAK

MX840/MX840A/MX440A accessories

Article	Description	Order no.
Cold junction for thermocouple on MX840, MX840A, MX440A	Electronics for temperature compensation for measurements with thermocouples on MX840/MX840A/MX440, consisting of: – PT1000 cold junction – Including 1-wire TEDS chip for transducer identification Note: Mounting in D–Sub–HD 15-pin transducer plug.	1–THERMO–MXBOARD
Adapter D–Sub–HD15 to D–Sub 9 (CAN) for MX840, MX840A	Adapter for connecting CAN devices on MX840/MX840A/MX440 D–Sub–HD 15-pin (plug) to D–Sub 9-pin (socket); (length: approx. 30 cm).	1–KAB418
IEPE adapter	External signal conditioning module supplied with 24 V, supplies IEPE with constant current (BNC socket) and outputs a standardized voltage signal $\pm$ 10 V	1–EICP–B–2
Connection cable	Cable between Smart module and Sub–HD plug	1–SAC–EXT–MF–x–2 (x = length in meters)
Device plug	QuantumX connector	1–SubHD15–MALE

MX410 accessories

Article	Description	Order no.
BNC adapter	Adapter for connecting voltage signals (10 V) or IEPE sensors with BNC connection cable on MX410 (BNC socket to 15-pin D–Sub–HD, length: approx. 7 cm).	1–IEPE–MX410

MX1609, 1609P and 1609T accessories

| Article	Description	Order no.
Bag with 10 mini thermocouple plugs, incl. RFID for thermocouples type K	Package, consisting of 10 x mini thermocouple plugs with integrated RFID chip for measuring point detection for the MX1609 thermocouple measuring amplifier of the QuantumX family; type K: NiCr–NiAl, RFID integrated, green, male.	1–THERMO–MINI
Bag with 10 mini thermocouple plugs, incl. RFID for thermocouples type T	Package, consisting of 10 x mini thermocouple plugs with integrated RFID chip for measuring point detection for the MX1609 thermocouple measuring amplifier of the QuantumX family; type T: Cu–CuNi, RFID integrated, brown, male.	1–THERMO–MINI–T

MX879, MX1601 and 1615 accessories

Article	Description	Order no.
Push-In connector (8 pins)	10 Push-In connectors, Phoenix Contact, 8 pins (modules: MX879, MX1601, MX1615)	1−CON−S1005

Push-In connector
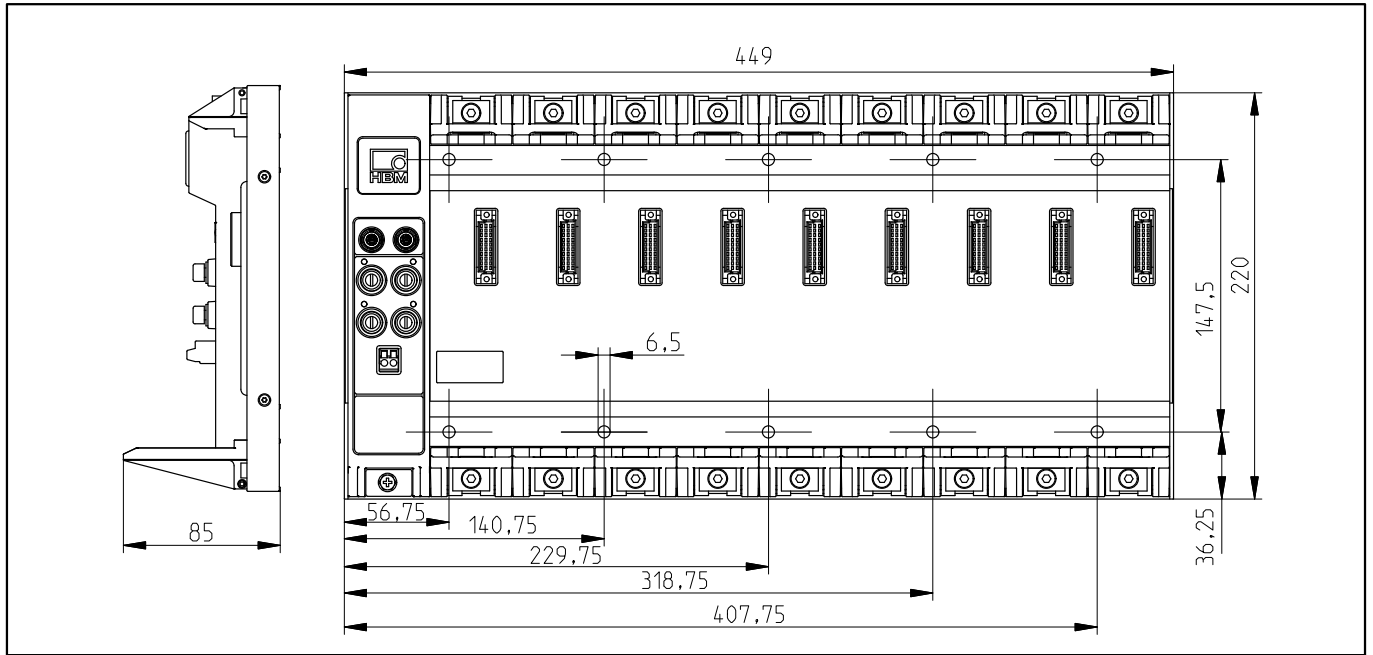

Package with 10 Push-In terminals
(8 pins) from HBM, 1−CON−S1005)
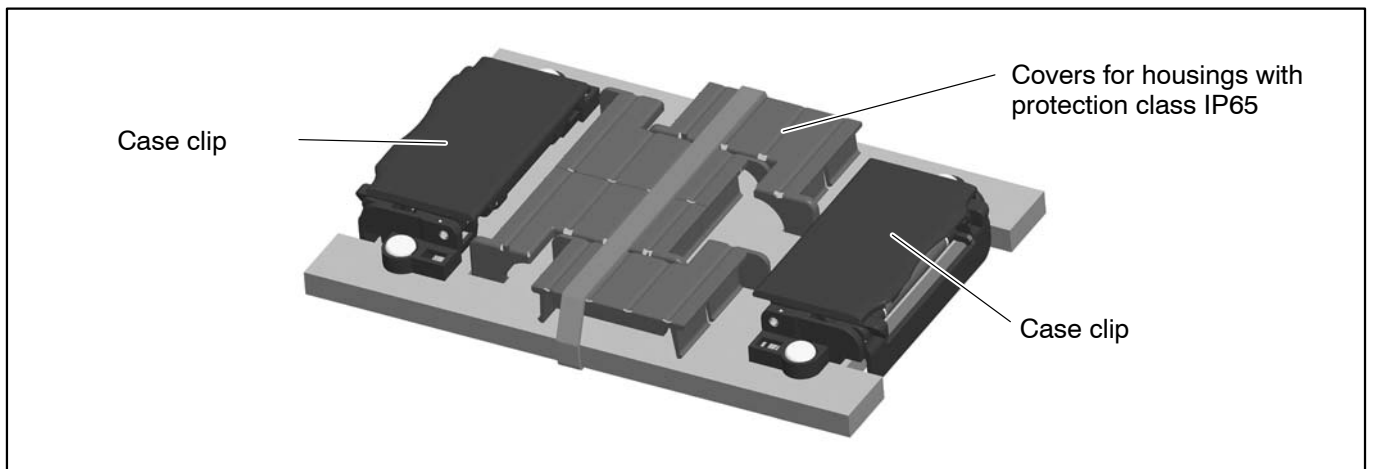
Phoenix Push-In connector **with** strain relief
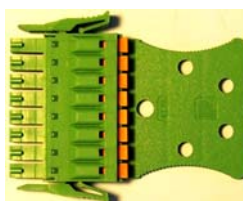
Available from Phoenix (http://www.phoenixcontact.com)
Article name: FMC 1.5/8-STZ3−3/5-RF
Article number : 1702246

10.1 System accessories

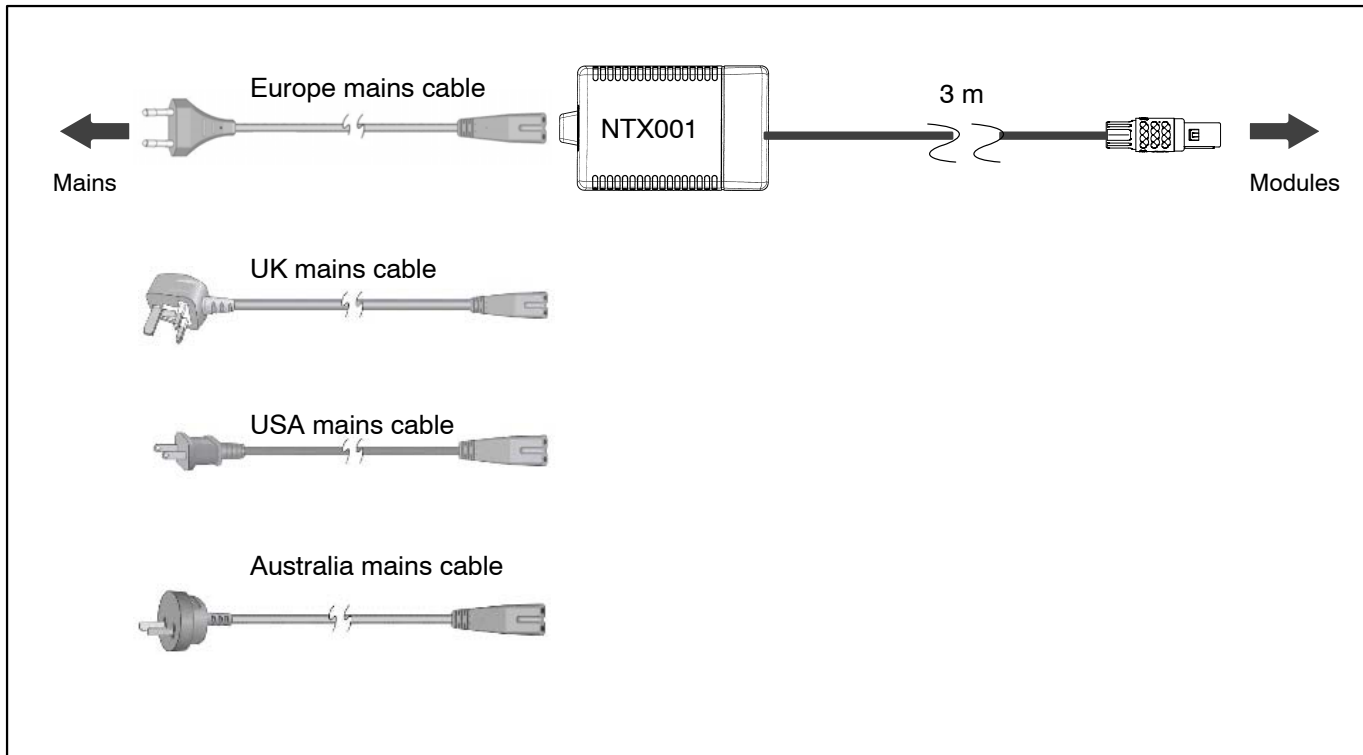## 10.1.1 BPX001 backplane
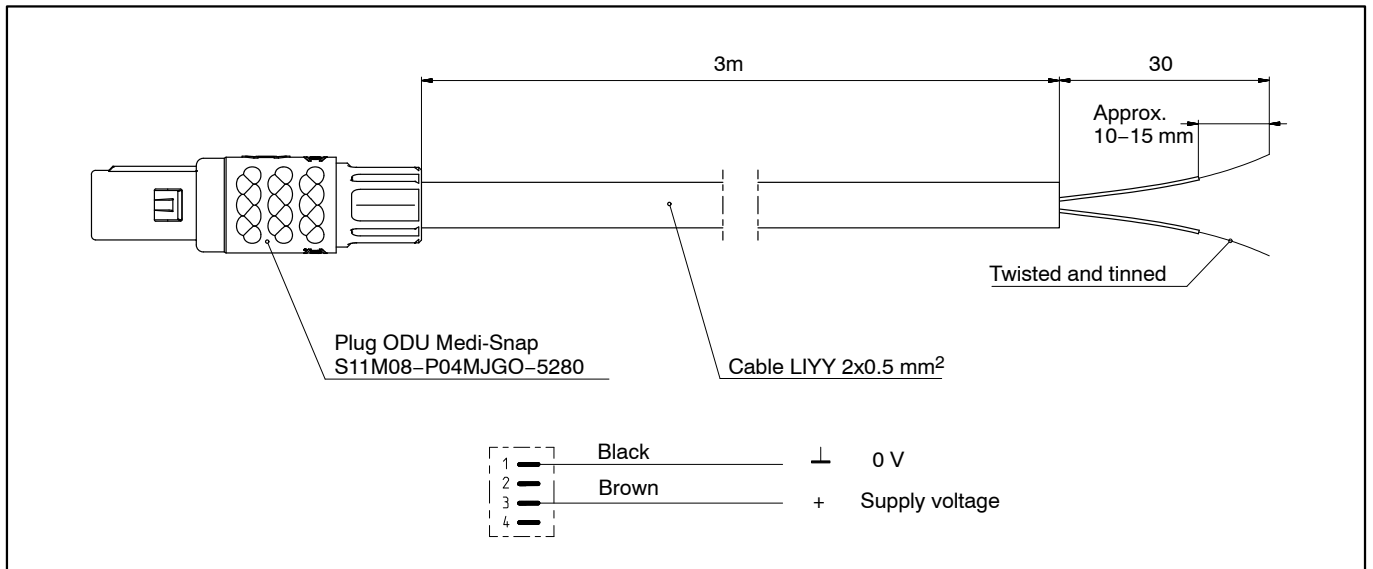

10.1.2 Housing connection elements

10.2   Voltage supply

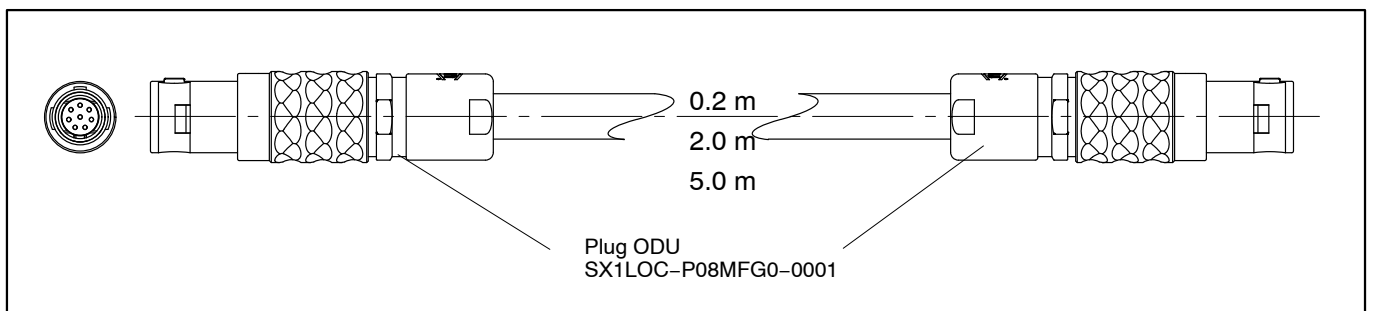## 10.2.1   Power pack NTX001

Order no.:   1−NTX001

10.2.2 Supply cable

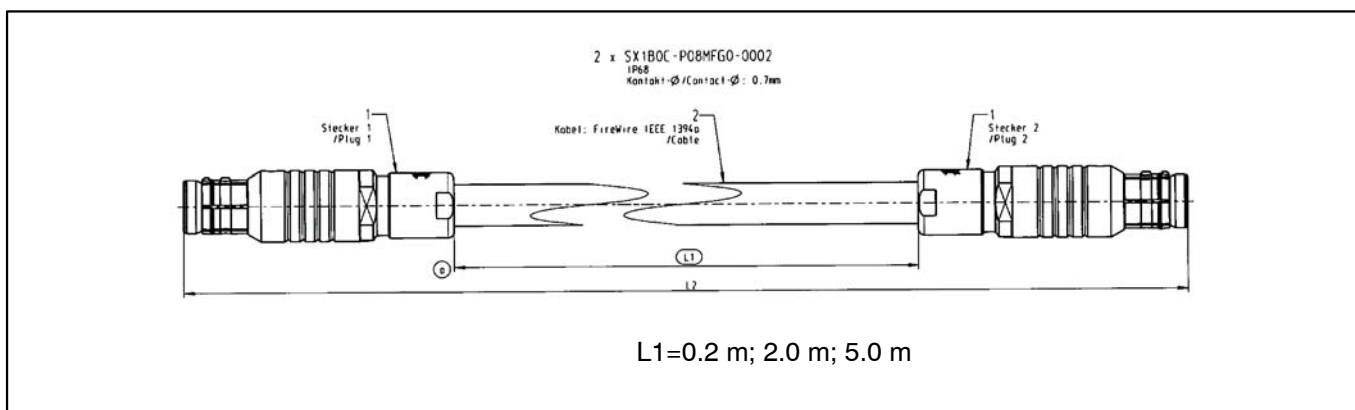**Order no.:** **1−KAB271−3** (length 3 m)

10.3 IEEE1394b FireWire

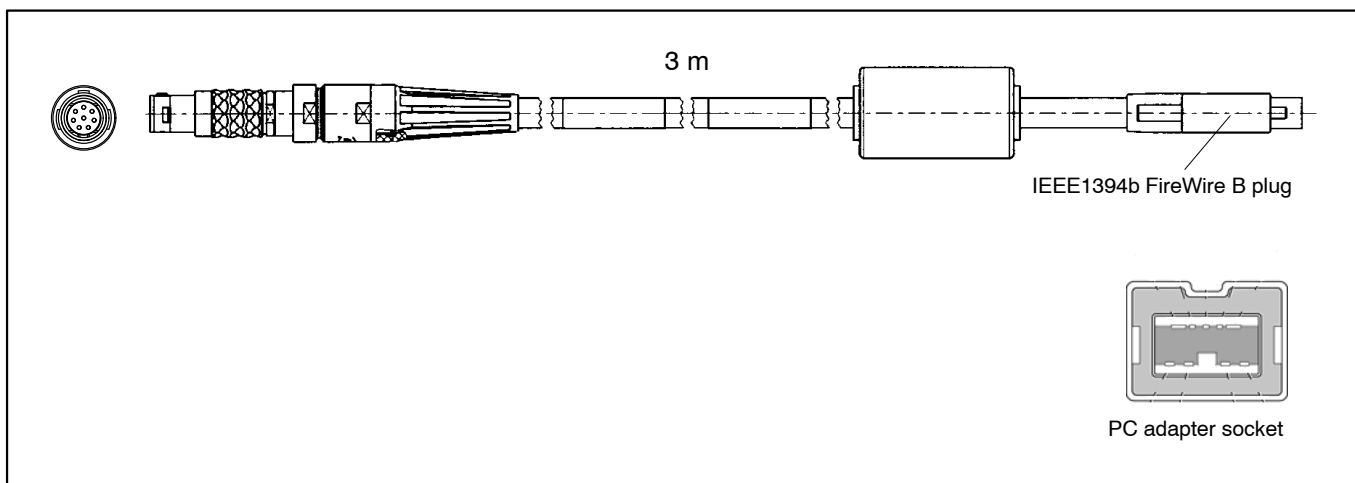## 10.3.1 IEEE1394b FireWire cable (module-to-module; IP20)

Order no.: **1−KAB269−2** (length 2 m)

1−KAB269−0.2 (length 0.2 m)

1−KAB269−5 (length 5 m)

10.3.2   IEEE1394b FireWire cable (module-to-module; IP65)

L1=0.2 m; 2.0 m; 5.0 m

Order no.:   **1−KAB272−2** (length 2 m)

1−KAB272−0.2 (length 0.2 m)

1−KAB272−5 (length 5 m)

10.3.3   Connection cable (PC to module)

3 m

IEEE1394b FireWire B plug

PC adapter socket

Order no.:   **1−KAB270−3** (length 3 m)

10.4 General information

10.4.1 Plug with TEDS chip

Plug kit D–Sub–HD 15-pin (male) with TEDS chip for storing a sensor data sheet.

Order No.: **1–SUBHD15–MALE**

10.4.2 Port saver Sub–HD 15-pin

Front

Rear

Order number: 1–SUBHD15–SAVE

When frequently connecting and disconnecting transducers we recommend that you use port savers for protecting the transducer sockets of the QuantumX module. The port saver is easy to screw into place and can be replaced after several hundred mating cycles. This eliminates that need for expensive module repairs.

10.4.3   Adapter D−Sub−HD 15-pin to D−Sub 15-pin

Wire bridge
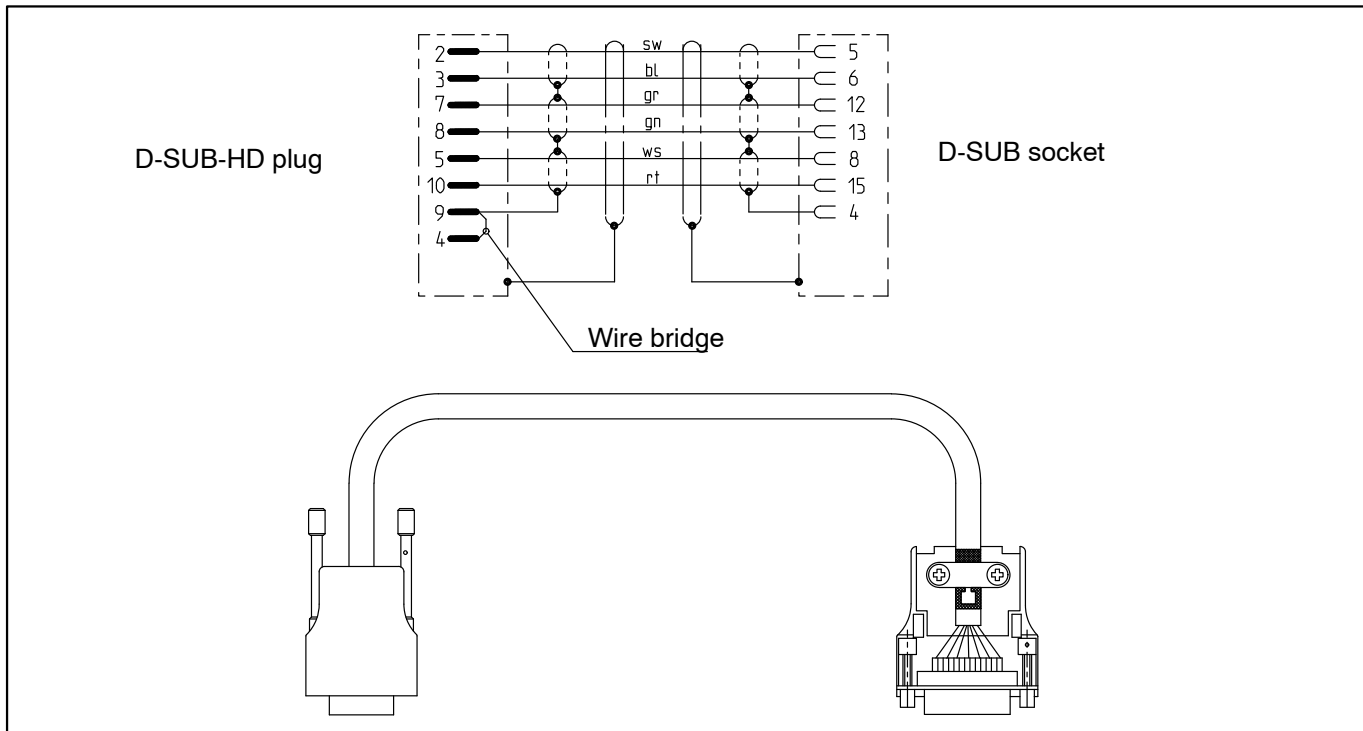
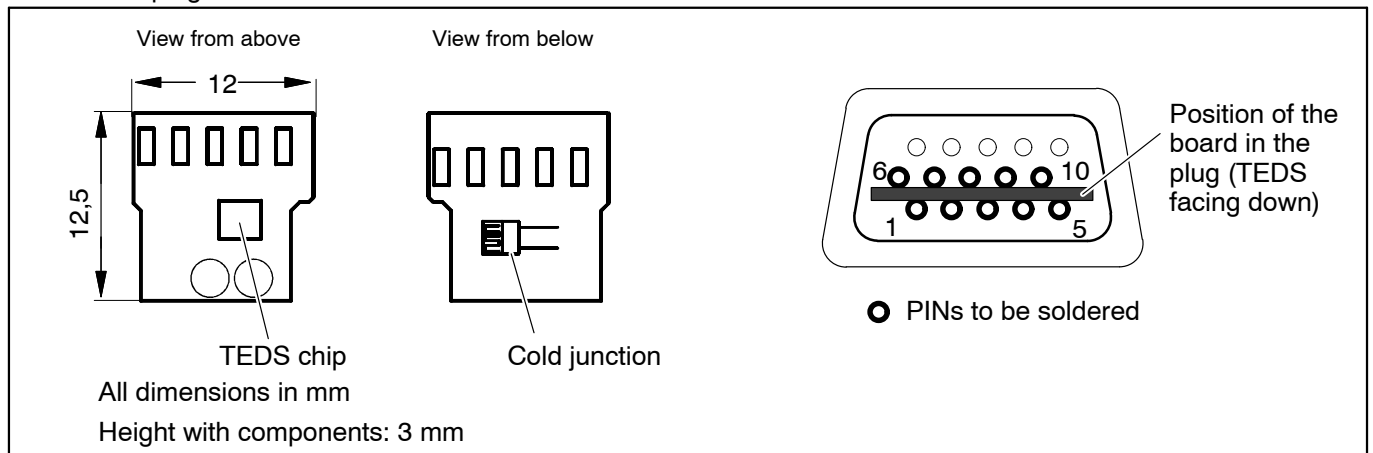**Order no.:   1−KAB416**

CAUTION

This cable is only for transducers with full bridge and 6-wire circuits! If other transducers are connected, the universal amplifier can be damaged or even destroyed.
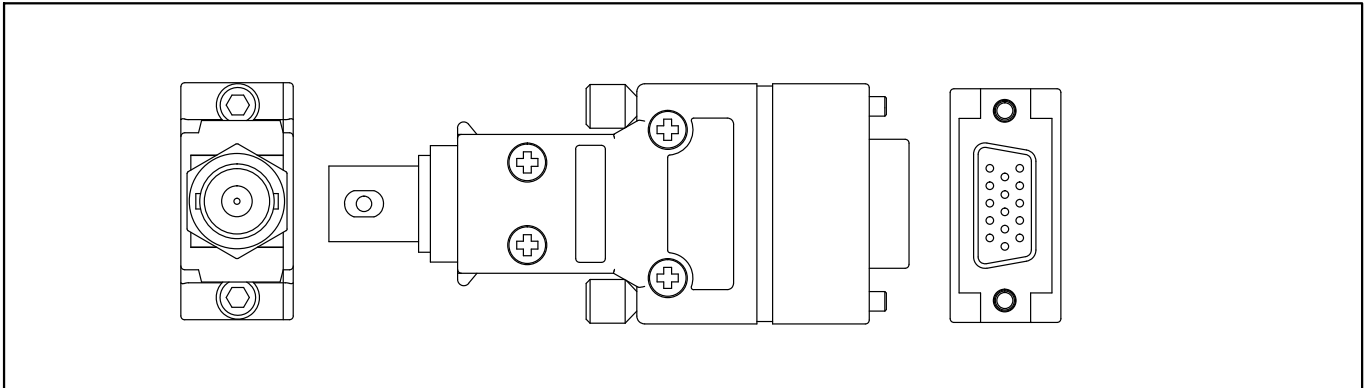
10.5 Accessories for MX840, MX840A, MX440A

10.5.1 Cold junction for thermocouples

Electronics for temperature compensation for measurements with thermocouples. Board for installation in a 15-pin D−Sub−HD plug.

View from above   View from below

12

12,5

TEDS chip

Cold junction

Position of the board in the plug (TEDS facing down)

6   10

1   5

○ PINs to be soldered

All dimensions in mm

Height with components: 3 mm

Order no.: **1-THERMO-MXBOARD**

10.6   MX410 accessories

Order no.:   1−IEPE−MX410

The adapter from D−Sub−HD plug male to BNC socket is used to connect current fed piezoelectric transducers (IEPE = Integrated Electronics Piezo Electric) or electrical voltages with BNC connector cable to universal amplifier MX410 as well as MX840, MX840A or MX440A.

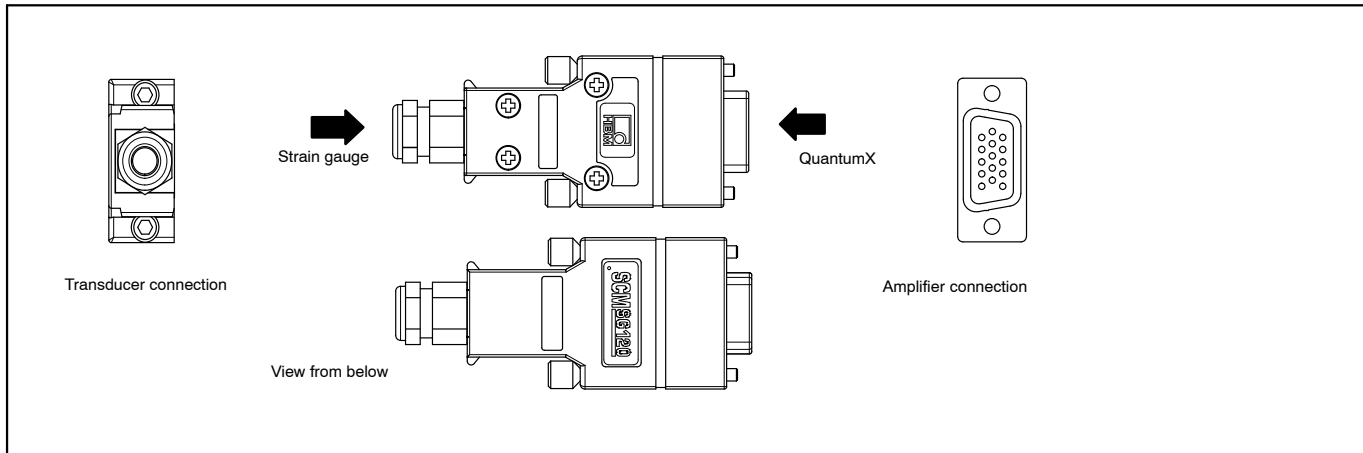Installation: connectors 1..4, screwed

10.7   SCM–HV accessories

Order no.:   1-SCM–HV

High-voltage signal conditioner for measuring differential voltages within the rated data indicated in the specifications together with a suitable QuantumX module.

Connection to 15-pin sockets of QuantumX modules MX840, MX840A, MX440A or MX410

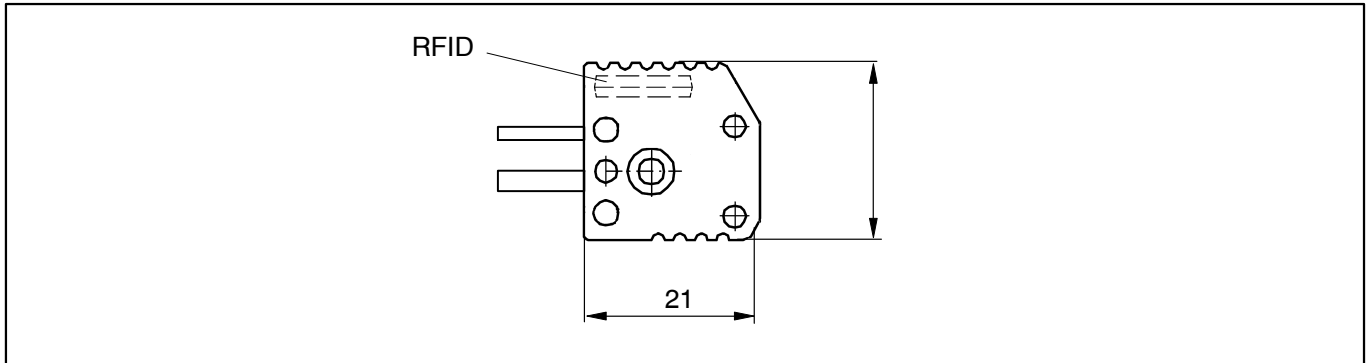# 10.8   SCM−SG120 / 350 accessories

Order no.:   **1-SCM−SG120/350**

Bridge adapter SCM−SG120/350 is inserted into QuantumX modules with SG full bridge input (D−Sub−HD15). This makes it possible to connect a SG in a quarter bridge circuit.

10.9   MX1609 accessories

10.9.1   Thermo-connector with integrated RFID chip

RFID

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Connectors for thermocouple amplifiers:

MX1609 / MX1609−P: Type K

Package unit: 10 mini connectors for thermocouples type K

Order no:**1-THERMO-MINI**

MX1609−T: Type T

Package unit: 10 mini connectors for thermocouples type T

Order no:**1-THERMO-MINI−T**

11   Support

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