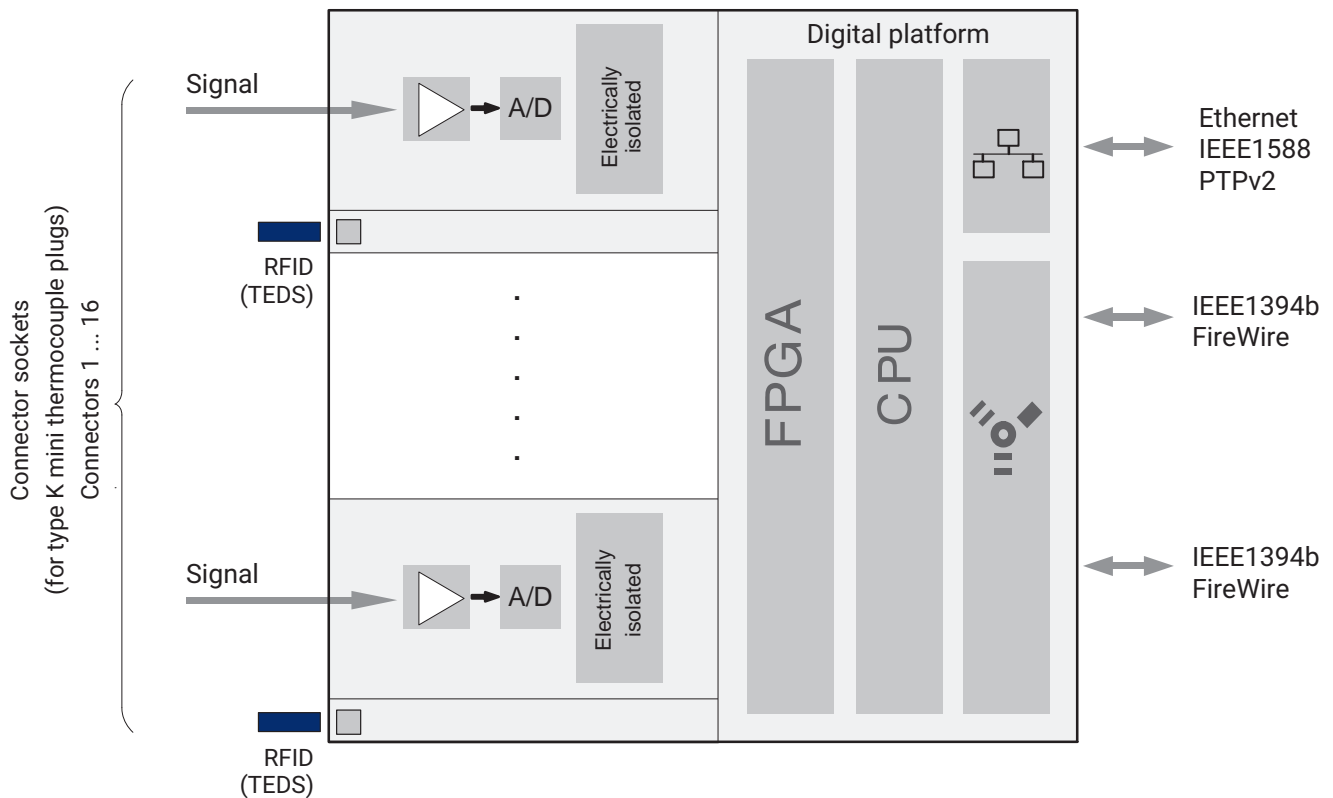# HBK
HOTTINGER BRÜEL & KJÆR

QUANTUM X

MX1609KB
Thermocouple amplifier Type K

SPECIAL FEATURES

- 16 individually configurable inputs (electrically isolated)
- Thermocouple mini type K
- Data rate up to 600 Hz per channel
- 8 internal cold junction
- Active low pass filter
- TEDS chip support thanks to RFID (automatic measuring point detection and thermal calibration data)

BLOCK DIAGRAM

General specifications		
Inputs	Number	16, electrically isolated from each other
Transducer		Thermocouples Type K (NiCr -NiAl)
Transducer connection		Mini thermocouple socket Type K
Transducer identification (TEDS chip, IEEE 1451.4)		HBM offers thermo-minis with an integrated RFID chip (wireless TEDS chip) as an option. 1-THERMO-MINI item code. The following information can be stored on the chip: Sensor type, measuring point name in plain text, such as "thermo-clamp-pos-4"; also thermal calibration points such as 0 and 100°.
Sample rates (Domaine adjustable by software, Factory setting is „HBM Classic)	S/s	Dezimal: 0,1 …200 (600) HBM Classic: 0,1 … 600
A/D converter		24 Bit Delta Sigma converter
Signal bandbwidth	Hz	20 (-3 dB)
Aktive low-pass filter	Hz	Bessel, Butterworth 0.01 ... 20 (-3 dB),
Permissible cable length between MX1609TB and transducer	m	<30
Supply voltage range (DC)	V	10 ... 30, 24 V nominal (rated) voltage
Supply voltage interruption		max. 5 ms at 24 V
Power consumption	W	< 6
Ethernet (data link)		10Base-T/100Base-TX
Protocol/Addressing	-	TCP/IP (static IP/DHCP, IPv4/IPv6)
Connection	-	8P8C plug (RJ-45) with twisted pair cable, Streaming (CAT-5)
Max. cable length to module	m	100
Synchronization options EtherCAT® [1] IRIG-B (B000 to B007; B120 to B127) IEEE 1588v2 (PTP), NTP PROFINET		IEEE 1394b FireWire (automatically, recommended) via CX27C via MX440A- or MX840A input channel via Ethernet
FireWire (module synchronization, data link, optional supply voltage)		IEEE 1394b (HBM modules only)
Baud rate	MBaud	400 (approx. 50 MByte/s)
Max. current from module to module	A	1.5
Max. cable length between the nodes	m	5
Max. number of modules connected in series (daisy chain)	-	12 (=11 Hops)
Max. number of modules in a FireWire system (including hubs[2], backplane)	-	24
Max. number of hops[3]	-	14
Nominal (rated) temperature range	°C [°F]	-20 ... +60 [-4 ... +140]
Operating temperature range	°C [°F]	-20 ... +65 [-4 ... +149]
Storage temperature range	°C [°F]	-40 ... +75 [-40 ... +167]
Rel. humidity	%	5 ... 95 (non condensing)
Protection class		III
Degree of protection		IP20 per EN 60529
EMC requirements		per EN 61326

Mechanical tests[4] (transport tests)		
Vibration (30 min)	m/s^2	50
Shock (6 ms)	m/s^2	350
Maximum input voltage at transducer (to housing and ground)	V	60 (no transients)
Dimensions, horizontal (H x W x D)	mm	52.5 x 200 x 122 (with case protection) 44 x 174 x 119 (without case protection)
Weight, approx.	g	900
Thermocouples		
Linearization range Type K	°C [°F]	-100 ... +1300 [-148 ... +2372]
Transducer impedance	Ω	<500
Measurement frequency range (-1 dB)	Hz	0 ... 10
Noise (peak to peak) with Filter 0.1 Hz Bessel	K	0.1
with Filter 1 Hz Bessel	K	0.2
with Filter 10 Hz Bessel	K	0.4
Total error limit at 22 °C ambient temperature	K	±0,7 (±0.2 °C: measurement accuracy at a constant ambient temperature in the module can be improved significantly if thermal calibration is used and the calibration data is saved to the sensor data sheet or TEDS chip/RFID)
Temperature drift	K/10K	±0.2
Optionel post-scaling of the temperature values Number of pairs of values in the MX1609KB, max.		64
Number of pairs of values from TEDS, max. (from Template Calibration Table)		14 [5]

[1] EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany
[2] Hub: FireWire node or distributor
[3] Hop: Transition from module to module/signal conditioning
[4] Mechanical stress is tested according to European Standard EN60068-2-6 for vibrations and EN60068-2-27 for shock. The equipment is subjected to an acceleration of 50 m/s^2 in a frequency range of 5...65 Hz in all 3 axes. Duration of this vibration test: 30min per axis. The shock test is performed with a nominal acceleration of 350 m/s^2 for 6 ms, half sine pulse shape, with 3 shocks in each of the 6 possible directions.
[5] Restrictions when using several templates; delete additional templates, such as the name template, if required.

DECIMAL SAMPLE RATES AND DIGITAL LOW PASS FILTER, TYPE BESSEL 4TH ORDER

Typ	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay (ms)[1]	Rise time (ms)	Overshoot (%)	Data rate (Hz)
Bessel	11.9	20	36.3	36.7	19.9	5.44	600
	5.9	10	25.3	52.3	35.2	0.98	600
	3.0	5	12.7	85	70	0.84	600
	1.2	2	5.1	184	175	0.85	600
	0.6	1	2.5	349	350	0.85	600
	0.30	0.5	1.27	680	700	0.85	600
	0.12	0.2	0.51	1673	1756	0.85	600
	0.06	0.1	0.25	3324	3518	0.85	600
	0.030	0.05	0.127	7278	6850	0.90	20
	0.012	0.02	0.051	18590	17219	0.90	20
	0.006	0.01	0.025	35098	34966	0.86	20

[1] The analog-to-digital converter's delay time is 128 µs for all data rates and has not been accounted for in the "Phase delay" column!

## DECIMAL SAMPLE RATES : AMPLITUDE RESPONSE BESSEL FILTER
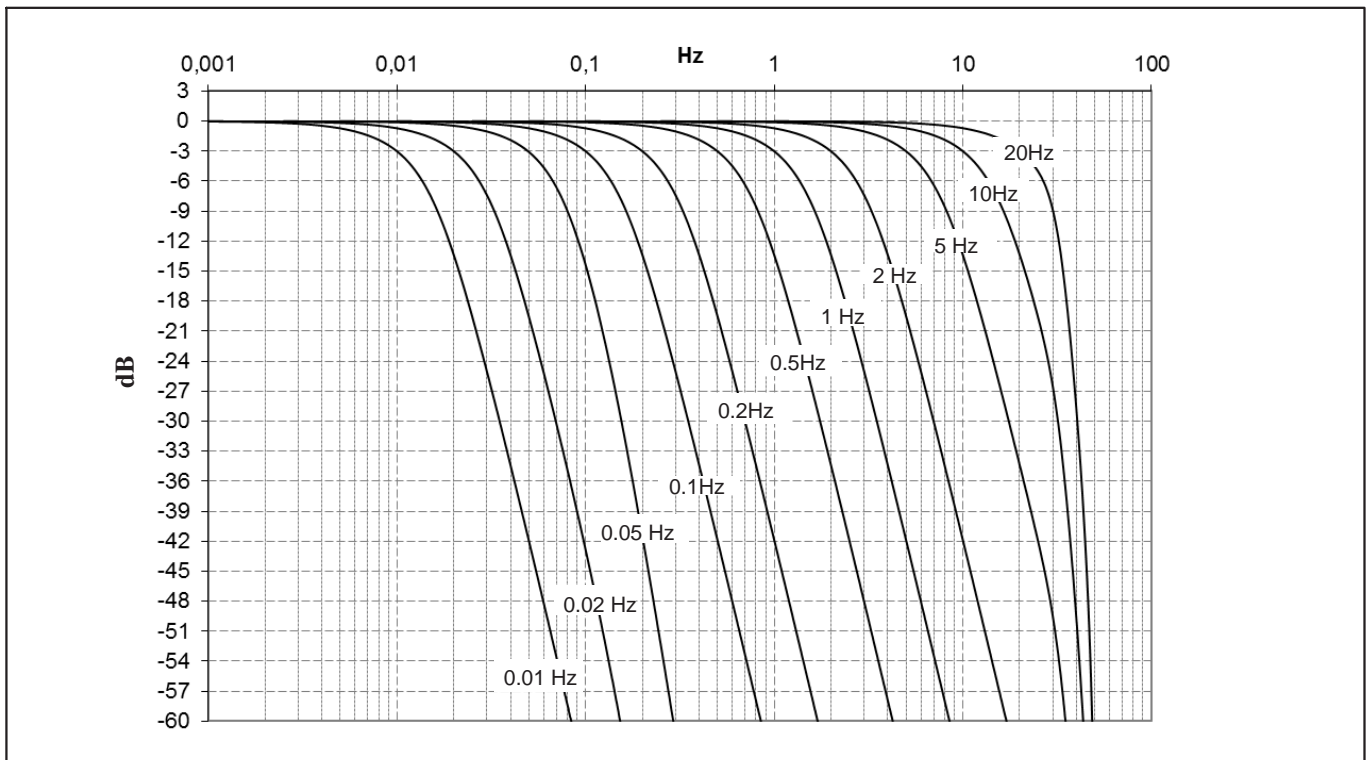
DECIMAL SAMPLE RATES AND DIGITAL LOW PASS FILTER, TYPE BUTTERWORTH 4TH ORDER

Typ	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay (ms)[1]	Rise time (ms)	Overshoot (%)	Data rate (Hz)
Butterworth	16.9	20	32.1	45.3	21.2	13	600
	8.4	10	17.7	67.3	39.0	11	600
	4.2	5	8.9	112	77.5	10.86	600
	1.7	2	3.6	247	193	10.86	600
	0.8	1	1.8	473	387	10.86	600
	0.42	0.5	0.89	924	774	10.89	600
	0.17	0.2	0.36	2274	1952	10.84	600
	0.08	0.08	0.1	4807	3858	11	600
	0.042	0.05	0.089	9323	7744	10.90	20
	0.017	0.02	0.036	22805	19439	10.82	20
	0.008	0.01	0.018	45275	38845	10.82	20

[1] The analog-to-digital converter's delay time is 128 µs for all data rates and has not been accounted for in the "Phase delay" column!
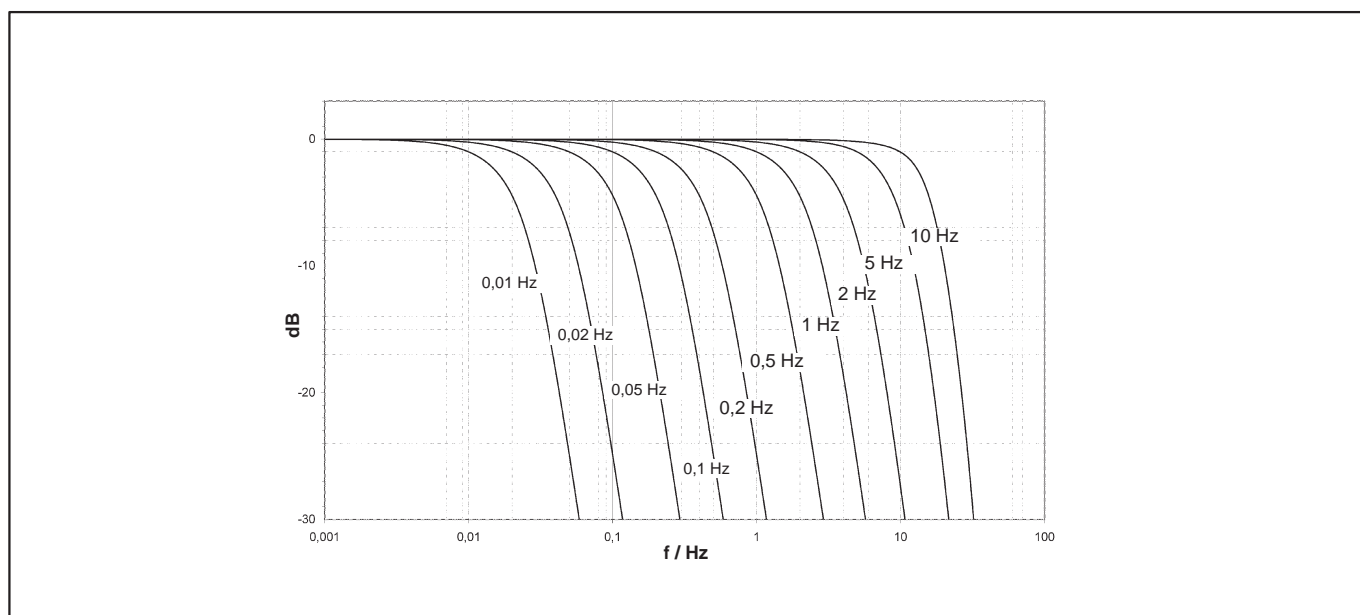
DECIMAL SAMPLE RATES : AMPLITUDE RESPONSE BUTTERWORTH FILTER
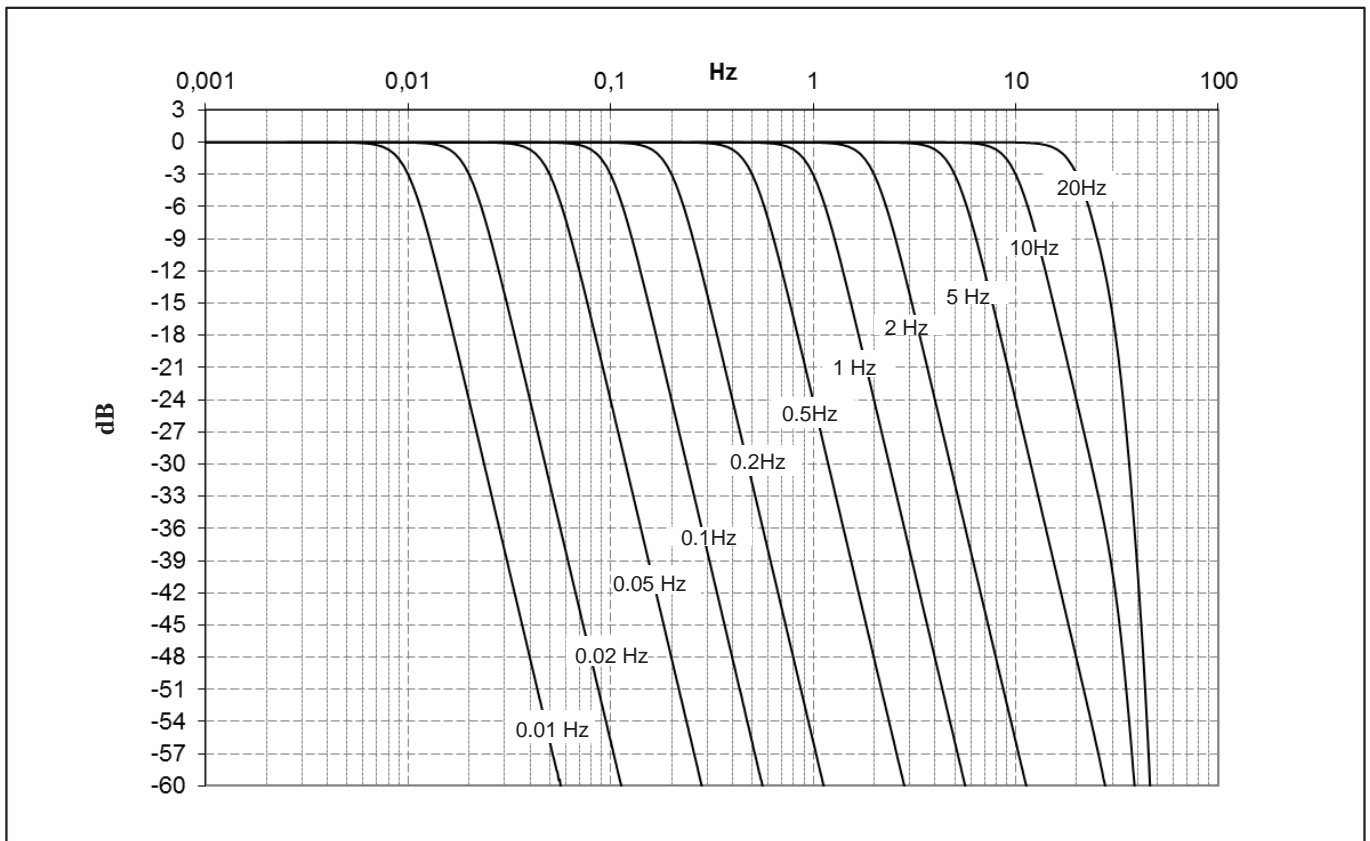
CLASSIC HBM SAMPLE RATES AND DIGITAL LOW PASS FILTER, TYPE BESSEL 4TH ORDER

Typ	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay (ms)	Rise time (ms)	Overshoot (%)	Data rate (Hz)
Bessel	10	14.1	26.7	44.6	27.4	6.7	600
	5	7.7	17.1	63.4	46.6	3.2	600
	2	3.3	8.1	122.3	107.1	1.3	600
	1	1.7	4.2	221.8	210.2	1.0	600
	0.5	0.84	2.12	418.8	418.4	0.9	300
	0.2	0.34	0.85	1020.9	1045.0	0.9	300
	0.1	0.17	0.43	2023.4	2090.1	0.9	300
	0.05	0.085	0.214	3938.8	4184.2	0.8	20
	0.02	0.034	0.086	9959.6	10420.4	0.9	20
	0.01	0.017	0.043	19995.0	20900.9	0.9	20

CLASSIC HBM SAMPLE RATES : AMPLITUDE RESPONSE BESSEL FILTER

CLASSIC HBM SAMPLE RATES AND DIGITAL LOW PASS FILTER, TYPE BUTTERWORTH 4TH ORD.

Typ	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay (ms)	Rise time (ms)	Overshoot (%)	Data rate (Hz)
Butterworth	10	11.3	18.4	76.6	35.4	15.7	600
	5	5.9	10.1	126.1	66.7	12.0	600
	2	2.4	4.2	283.3	164.6	11.0	600
	1	1.2	2.1	546.5	328.3	11.0	600
	0.5	0.60	1.05	1069.7	656.7	11.0	300
	0.2	0.24	0.42	2646.9	1631.6	11.0	300
	0.1	0.12	0.21	5278.4	3263.3	11.0	300
	0.05	0.059	0.106	10452.6	6566.6	11.0	20
	0.02	0.024	0.042	26253.9	16316.3	11.0	20
	0.01	0.012	0.021	52588.9	32632.6	11.0	20

CLASSIC HBM SAMPLE RATES : AMPLITUDE RESPONSE BUTTERWORTH FILTER
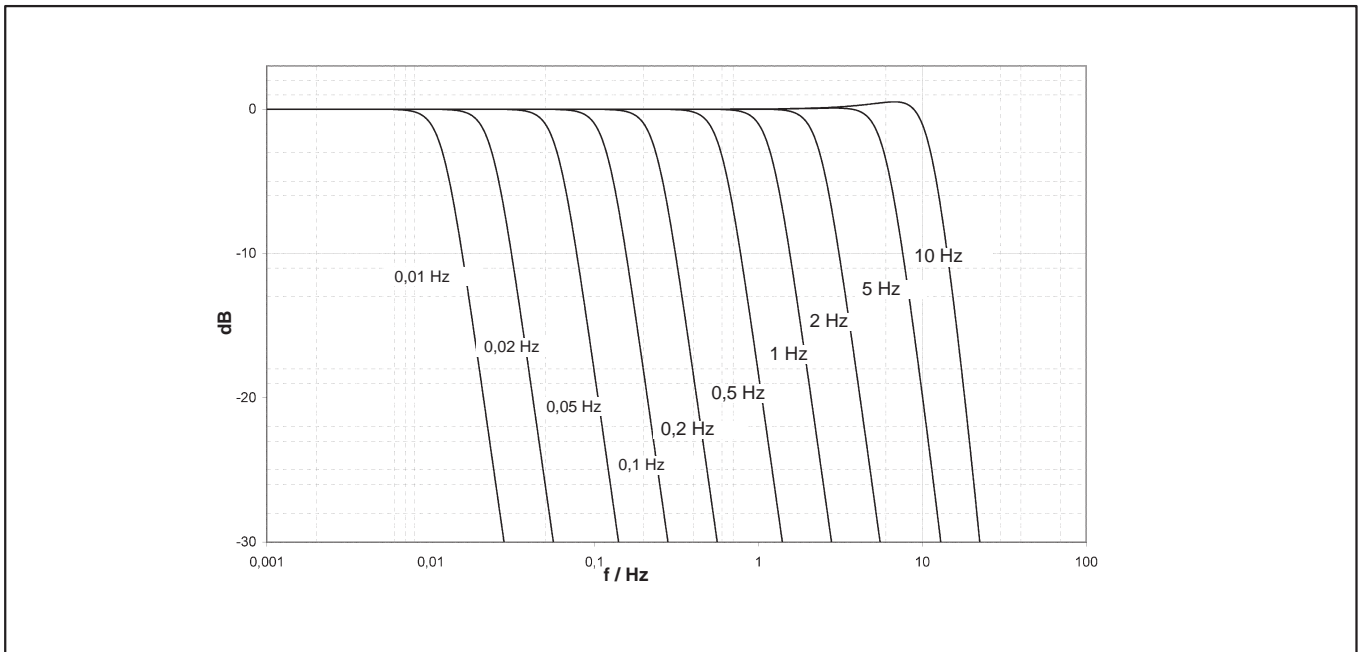
SPECIFICATIONS POWER PACK NTX001

|		
Nominal input voltage (AC)	V	100 ... 240 ($\pm$ 10%)
Stand-by power consumption at 230 V	W	0.5
Nominal load		
U_A	V	24
I_A	A	1.25
Static output characteristics		
U_A	V	24 $\pm$ 4%
I_A	A	0 - 1.25
U_{Br} (Output voltage ripple, peak to peak)	mV	$\leq$ 120
Current limiting, typically from	A	1.6
Primary - secondary isolation		galvanically, by optocoupler and converter
Creep distance and clearance	mm	$\geq$ 8
High-voltage test	kV	$\geq$ 4
Ambient temperature range	°C [°F]	0... +40 [+32 ... +104]
Storage temperature	°C [°F]	-40 ... +70 [-40 ... +158]

THERMAL CALIBRATION

Measurement chain accuracy largely depends on the thermocouples used. The MX1609 measurement module offers the option of improving accuracy by performing thermal calibration of two measurement points, for example.

climate / oven run
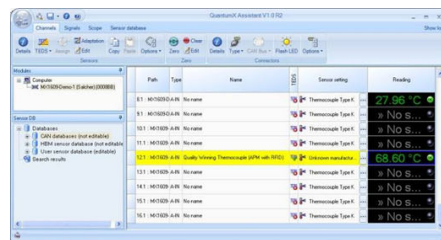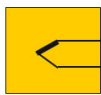
To do so, all thermocouples from a production lot are connected to the thermo-mini, for example. During this process, temperatures measured with a precise PT1000 are entered into a table on the sensor and a calibration data sheet for the thermocouple concerned in the software. This means that additional table-based thermocouple linearization is performed on the device in real time alongside the IEC-based polynomial linearization. In an ideal situation, calibration points are saved to the THERMO-MINI with an integrated RFID by HBM. This means a highly precise temperature measurement is possible with the MX1609 where the ambient temperature is constant for the device.

Polynomial linearization stored in the device
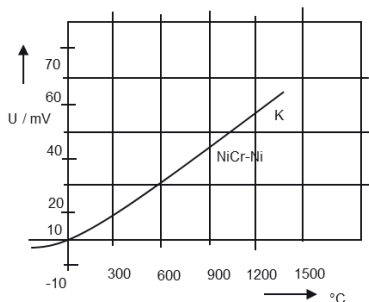
Second user specific x point thermal calibration
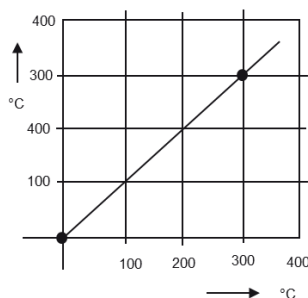
Open up TEDS editor

cal table

Result:
further improve accuracy in thermocouple measurement up to 14 cal pairs can stored in rfid

ACCESSORIES MX1609KB, TO BE ORDERED SEPARATELY

Article	Description	Order No.
Transducer side		
Pack comprising 5 mini thermocouple plugs for type K thermocouples, including integrated RFID chip	5 type-K thermocouple mini-connectors with an integrated RFID chip to detect measurement points for the MX1609/KB/TB/-R installation variants Type K thermocouple modules: NiCr-NiAl, green.	1-THERMO-MINI
Power		
AC-DC power supply / 24 V	Input : 100 ... 240 V AC ($\pm$ 10%), 1.5 m cable Output: 24 V DC, max. 1.25 A, 2 m cable with ODU connector	1-NTX001
3m cable - QuantumX supply	3 m cable for voltage supply of QuantumX modules; Suitable plug (ODU Medi-Snap S11M08-P04MJGO-5280) on one side and open strands on the other end.	1-KAB271-3
Communication		
Ethernet cable	Ethernet cable for direct operation between a PC or Notebook and a modul / device, length 2 m, type CAT5+	1-KAB239-2
Firewire cable (module-to-module)	Firewire connection cable for QuantumX modules; with matching plugs on both sides. Lengths 0.2 m/2 m/5 m. Note: The cable enables QuantumX modules to be supplied with voltage (max. 1.5 A, from the source to the last drain).	1-KAB272-W-0.2 1-KAB272-2 1-KAB272-5
Mechanic		
Connecting elements for QuantumX modules	Connecting elements (clips) for QuantumX modules; Set comprising 2 case clips including mounting material for fast connection of 2 modules.	1-CASECLIP
Connecting elements for QuantumX modules	Fitting panel for mounting of QuantumX modules using case clips (1-CASECLIP), lashing strap or cable tie. Basic fastening by 4 screws.	1-CASEFIT
QuantumX Backplane (big)	QuantumX Backplane for a maximum of 9 modules - Mounting on wall or control cabinet (19") - Connection of external modules by FireWire possible - Power supply: 18 ... 30 V DC / max. 5 A (150 W)	1-BPX001
QuantumX Backplane (Rack)	QuantumX Backplane – Rack for maximum 9 modules - 19" rack mounting with handles left and right - Connection of external modules via FireWire possible - Power supply: 18 ... 30 V DC / max. 5 A (150 W)	1-BPX002
QuantumX Backplane (small)	QuantumX Backplane for a maximum of 5 modules - Connection of external modules by FireWire possible - Power supply: 11 ... 30 V DC/ max. 5 A (90 W)	1-BPX003
Software and product packages		
catman®AP	Software package including catman®Easy functionality plus additional modules such as integration of video cameras (EasyVideoCam), complete post-process analysis (EasyMath), automation of recurring processes (EasyScript), offline preparation of measurement projects (EasyPlan) as well as additional functions such as calculating electrical power, special filters, frequency spectrum and more details at www.hbm.com\catman\	1-CATMAN-AP
catman®EASY	The basic software package for measurement data acquisition comprises convenient channel parameterization using TEDS or the sensor database, measurement job parameterization, individual visualization, data storage and reporting.	1-CATMAN-EASY

Article	Description	Order No.
catman®PostProcess	Post Process edition for visualization, preparation and analysis of measurement data, including many mathematical functions, data export and reporting.	1-CATEASY-PROCESS
LabVIEW™ driver[1]	Universal driver from HBM for LabVIEW™	1-LabVIEW-DRIVER
DIAdem® driver	QuantumX device driver for the DIAdem® software from National Instruments. German user interface.	1-DIADEM-DRIVER
CANape® driver	QuantumX driver for the software CANape® from Vector Informatik. CANape versions from 10.0 are supported.	1-CANAPE-DRIVER

[1] More drivers and partners at www.hbm.com\quantumX\

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