QUANTUMX

MX460B

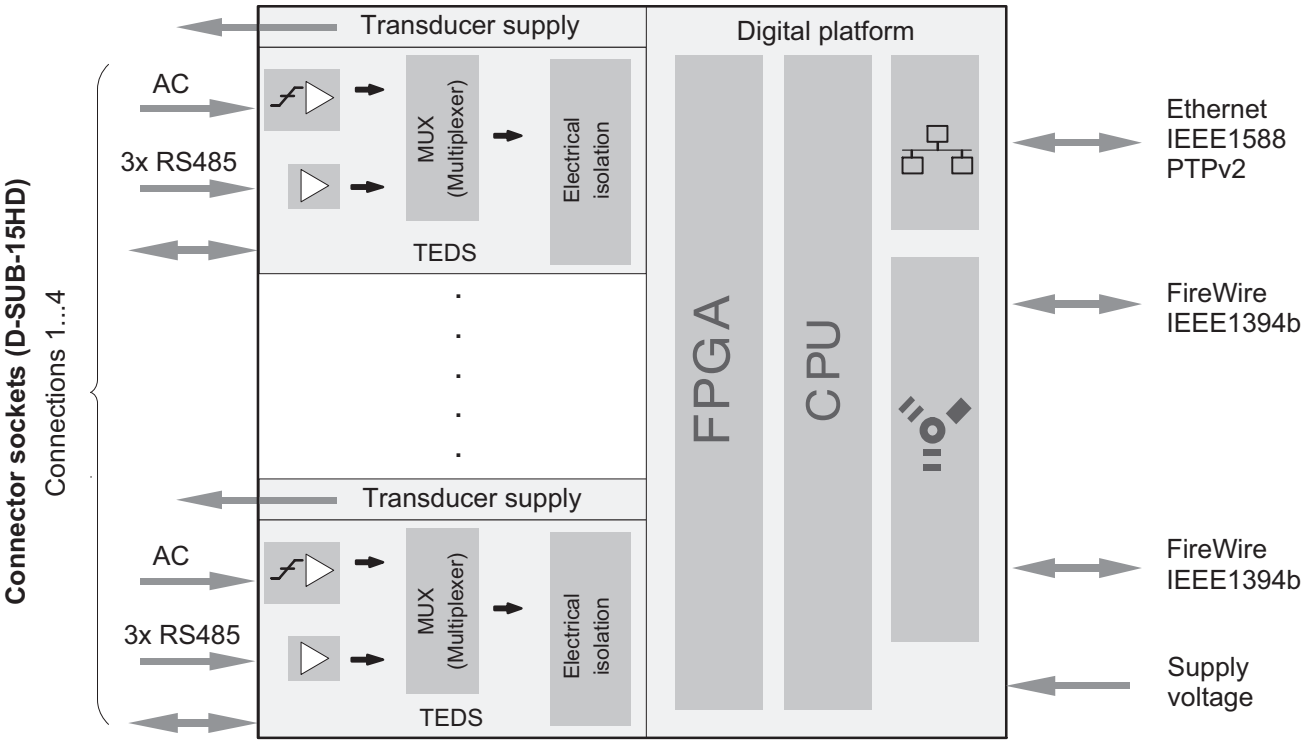
Pulse and frequency measurement module

Data sheet

Special features

- **4 individually configurable inputs (electrically isolated)**
- **Connection of digital pulse and frequency signals up to 1 MHz to record speed, torque (HBM), angle, position, displacement and PWM**
- **Sample rates up to 100 kS/s per channel, active low-pass filter**
- **High resolution and dynamics thanks to pulse interpolation and extrapolation**
- **TEDS support**
- **Real-time torsional vibration analysis (TVA) and difference angle calculation**
- **Supply voltage (DC) for active transducers : 5 V … 24 V**

Block diagram



Specifications

General data		
Inputs	Number	4,electrically isolated from each other and from the supply[1)]
Transducer technologies		General digital pulse measurement: Pulse counters, torque transducers from HBM, inductive rotary encoders (AC coupled) or digital incremental encoders (unipolar, two-track, with/without index) for speed recording (rpm), crankshaft encoder signals with gap detection (e.g. 50:2) for speed measurement or position detection, general digital frequency measurement, pulse width modulated signals PWM (pulse width/ duty ratio, pulse duration).
Sample rates (domain can be set via the software, factory setting is “HBM Classic”)	S/s	Individually programmable per channel: Decimal: 0.1…100,000 or HBM Classic: 0.1…96,000
Signal bandwidth, max. (-3dB)[2)]	Hz	0 … 40,000 (filter off)
Active low-pass filter		Bessel, Butterworth, linear phase, filter off[3)]
Transducer identification (TEDS chip, IEEE 1451.4) max. TEDS module distance	 m	 100
Transducer connection		D-SUB-15HD
Supply voltage range (DC)	V	10 … 30, nominal (rated) voltage 24 V
Supply voltage interruption, max. (at 24 V)	ms	5[4)]
Power consumption without adjustable transducer excitation with adjustable transducer excitation	 W W	 < 6 < 9
Transducer excitation voltage (active transducers) Adjustable supply voltage (DC) Maximum output power	 V W	 5 ... 24; adjustable channel by channel 0.7 per channel/2 in total
Ethernet (data link) Protocol (addressing) Plug connection Max. cable length to module	 - - m	10Base-T/100Base-TX TCP/IP (static IP/DHCP, IPv4/IPv6) 8P8C plug (RJ-45) with twisted-pair cable (CAT-5) 100
Synchronization options EtherCAT®[5)] PROFINET IRIG-B (B000 to B007; B120 to B127) IEEE1588 (PTPv2), NTP		IEEE1394b FireWire (QuantumX only, automatic, recommended) via CX27C via MX440A or MX840A input channel Ethernet-based Network Time Protocol
IEEE1394b FireWire (module synchronization, data link, optional power supply) Baud rate Max. current from module to module Max. cable length between nodes Max. number of modules connected in series (daisy chain) Max. number of modules in one IEEE1394b FireWire system (including hubs[7)], backplane) Max. hops in a chain	 MBaud A m - - -	IEEE 1394b 400 (approx. 50 MBytes/s) 1.5 5 (optical 100) 12 (=11 hops[6)]) 24 14
Nominal (rated) temperature range	°C	-20 ... +65
Storage temperature range	°C	-40 ... +75
Relative humidity	%	5 ... 95 (non-condensing)
Protection class		III[8)]
Equipment protection level		IP20 as per EN 60529
EMC requirements		EN 61326
Mechanical tests[9)] Vibration (30 min)	 m/s^2	 50

Impact (6 ms)	m/s^2	350
Dimensions, horizontal (H x W x D)	mm mm	52.5 x 200 x 122 (with case protection) 44 x 174 x 119 (without case protection)
Weight, approx.	g	850
Transducer technology		
Accuracy class (frequency measurement and counting)		0.01
Transducers that can be connected RS485 inputs		Torque transducer, incremental encoder, frequency signal source (square), crankshaft sensor with gap detection, internal mapping of channels e.g. from 1 to 2 for calculation of angle and speed signals with one sensor type
AC input		Passive inductive rotational speed sensors, frequency signal sources (any signal shape)
Input frequency range RS485 inputs AC inputs	 Hz Hz	 0.1 ... 1,000,000 10 ... 50,000
Frequency measurement ranges	kHz	20; 200; 1000
Frequency measurement resolution, min. Measurement range 20 kHz	mHz	 1 (signal range: 0.1 ... 8,192 Hz) 2 (signal range: 8,193 ... 16,384 Hz) 4 (signal range: 16,385 ... 32,768 Hz)
Measurement range 200 kHz		10 (signal range: 0.1 ... 65,536 Hz) 16 (signal range: 65,537 ... 131,072 Hz) 32 (signal range: 131,073 ... 262,144 Hz)
Measurement range 1000 kHz		125 (signal range: 0.1 ... 1048.576 Hz)
Square-wave signal measurement (RS485 inputs) F1 (+/-) F2 (+/-) Zero index (+/-)		Quadrature signals with index Frequency or pulse signal Directional signal offset by 90° to F1 Zero position signal
Input level (RS485 inputs) for single-pole mode Low level High level	 V V	 < 2.3 > 2.7
Input level (RS485 inputs) for differential signal mode **Push-pull signal at signal (+) and signal (-)** Low level High level	 mV mV	 Signal (+) < signal (-) -200 Signal (+) < signal (-) -50
Input voltage range (RS485 inputs) Common-mode voltage range (to ground) max. permissible voltages (to ground)	 V V	 -7 ... +12 ±40
Input level for AC input (F1) Minimum level (sinusoidal, peak-to-peak) Maximum level (peak-to-peak)	 V V V V	 0.1 (to 1 kHz) 1 (at 10 kHz) 5 (at 50 kHz) 40
Input impedances RS485 inputs Selectable termination resistor RS485 inputs AC input	 kΩ Ω kΩ	 > 45 125 > 100
Calibration signal output CAL (pin 15 DSUB) **Level (at 10 mA)** CAL active	 V	 4.5 min.

Frequency measurement		
Frequency (RS485 inputs)	Hz	10 ... 1,000,000
Frequency (AC inputs)	Hz	10 ... 50,000
Counter (RS485 inputs)		
Frequency	Hz	0 ... 1,000,000
Increments		±2,000,000
Pulse-width modulated signals (PWM)		
Frequency	Hz	0.1 ... 100,000
Pulse width/duty ratio	%	5 ... 95
Pulse duration/High level or Low level duration	ms	0 ... 5,000
Period duration	ms	0 ... 5,000
Internal sample rate	MHz	98.3
Glitch filter time constant (adjustable)	µs	0.1; 1; 10; 100
Permissible cable length between MX460B and transducer	m	< 100
Active low-pass filter (Bessel/Butterworth, can be disabled)	Hz	0.01 ... 10,000, filter off
Frequency measurement deviation	%	< 0.01 of measured value
PWM deviation	%/kHz	0.3
Pulse duration deviation	ns	500
Period duration deviation	ns	200
Zero drift	%/10 K	0
Full-scale drift	%/10 K	< 0.01 of measured value
Real-time calculations on module		
Peak value		
Number of peak values		8
Update rate max.	Hz	96,000
Output rate max.	Hz	96,000
Analysis functions		
Difference angle		
Update rate, max.	Hz	96,000
Output rate, max.	Hz	96,000
Torsional vibration analysis		
(formation of difference angle from uniform angular velocity)		
Update rate max.	Hz	96,000
Output rate, max.	Hz	96,000

1) When using variable transducer excitation voltage, clear the electrical isolation from the supply.
2) Conditions: FM with F0= 500 kHz and ΔF = 100 kHz
3) Filter OFF is only recommended for real-time applications, e.g. to realize low latency.
4) UPS available as accessory for longer interruptions
5) EtherCAT® is a registered brand and patented technology, licensed by Beckhoff Automation GmbH, Germany.
6) Hop: Transition from module to module/signal conditioning
7) Hub: IEEE1394b FireWire node or distributor
8) The DC voltage supply must meet the requirements of IEC 60950-1 on a SELV voltage supply.
9) Mechanical stress is tested in accordance with European standards EN60068-2-6 for vibration and EN60068-2-27 for shock. The devices are exposed to an acceleration of 50 m/s^2 within the frequency range 5...65 Hz in all 3 axes. Duration of this vibration test: 30 minutes per axis. The shock test is implemented at a nominal acceleration of 350 m/s^2 for a duration of 6 ms, half sine and with shocks in each of the six possible directions.

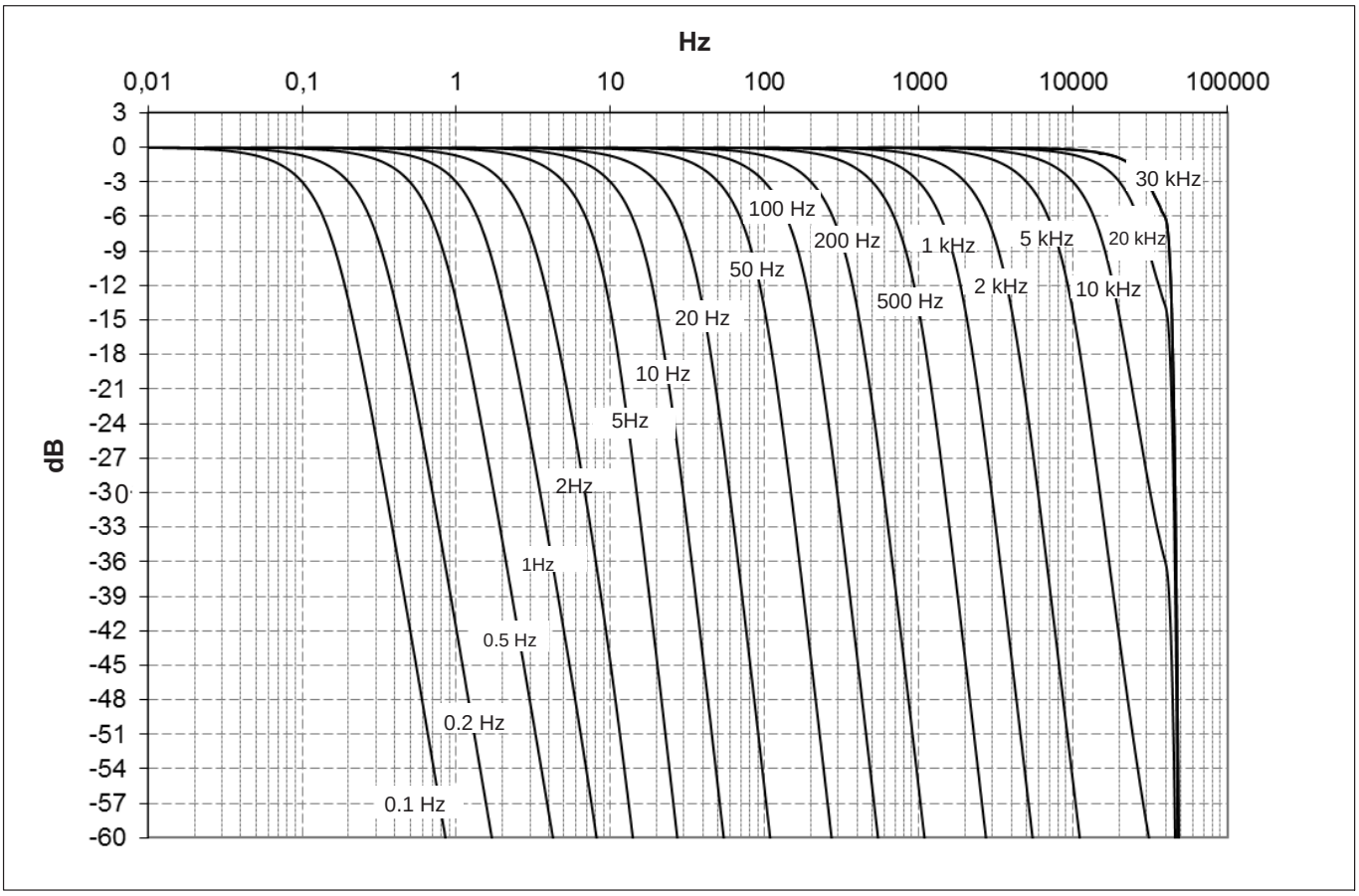
Decimal sample rates and Bessel digital low-pass filters

(4th order Bessel at sample rates < 100,000 Hz; 6th order at sample rate = 100,000 Hz)

The data apply to the modulation frequency Fm under the following conditions: sinusoidal FM with carrier frequency F0 = 500 kHz and deviation ∆F = 100 kHz.

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime (ms)	Rise time (ms)	Overshoot (%)	Sampling rate (Hz)
Bessel	20,616	30,000	44,600	0.002	0.01	2.8	100,000
	12,373	20,000	43,000	0.005	0.02	1.0	100,000
	5,917	10,000	23,465	0.021	0.04	0.8	100,000
	2,929	5,000	11,715	0.06	0.07	0.8	100,000
	1,164	2,000	4,700	0.19	0.2	0.8	100,000
	584	1,000	2,350	0.40	0.3	0.6	100,000
	292	500	1,175	0.82	0.7	0.6	100,000
	117	200	470	2.1	1.7	0.6	100,000
	58	100	235	4.2	3.5	0.6	100,000
	29.2	50	117.5	8.5	7	0.6	100,000
	11.7	20	47	21.3	17	0.6	100,000
	5.8	10	23.5	42.7	35	0.6	100,000
	2.91	5	11.74	85.5	70	0.6	100,000
	1.19	2	5.04	187	175	0.9	2,000
	0.59	1	2.54	351	350	0.8	2,000
	0.30	0.5	1.27	680	700	0.8	2,000
	0.12	0.2	0.51	1,669	1,751	0.8	2,000
	0.06	0.1	0.25	3,315	3,499	0..8	2,000

Decimal sample rates: Bessel filter amplitude response



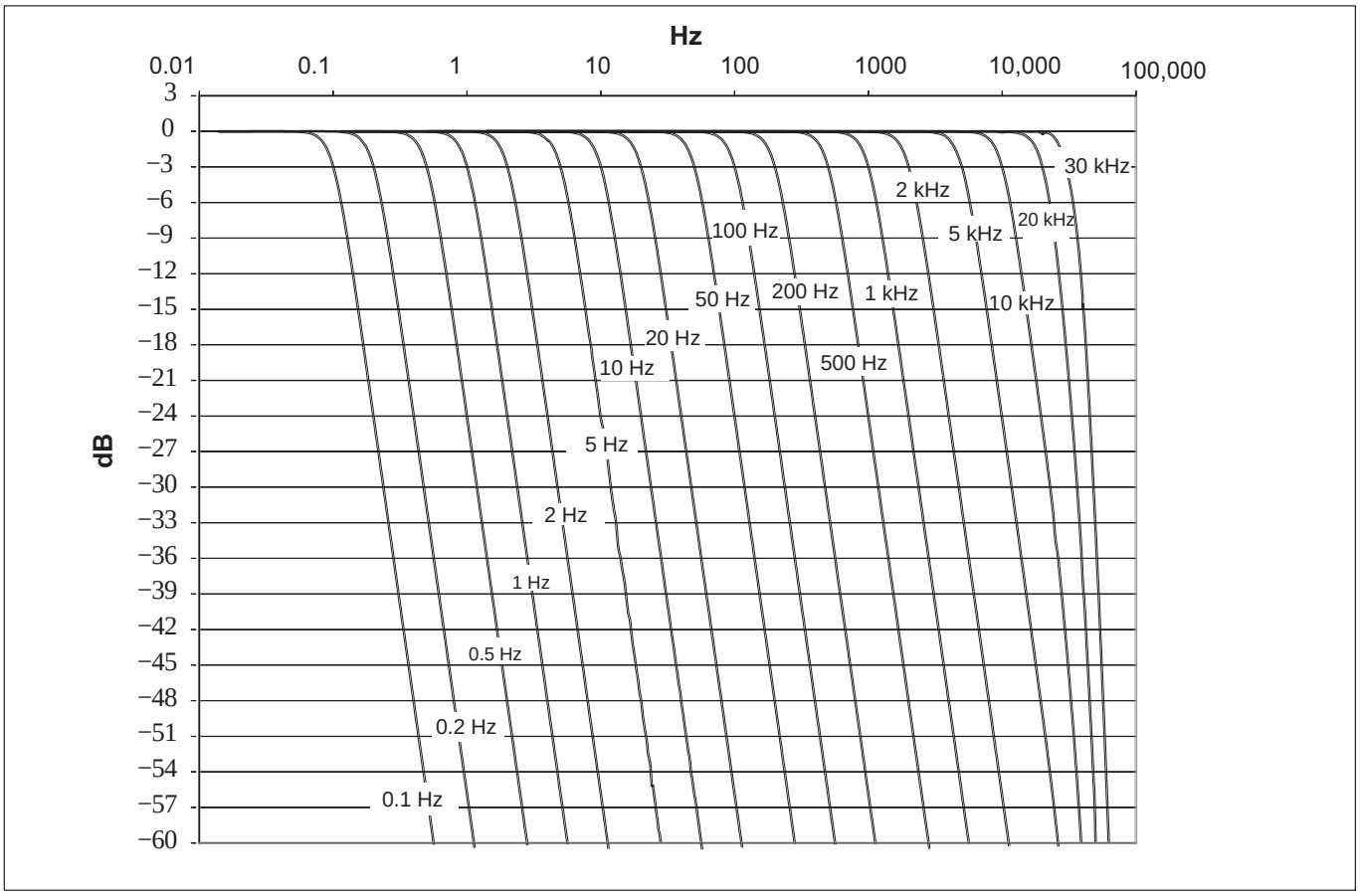
Decimal sample rates and Butterworth digital low-pass filters

(4th order Butterworth at sample rates < 100,000 Hz; 6th order at sample rate = 100,000 Hz)

The data apply to the modulation frequency Fm under the following conditions: sinusoidal FM with carrier frequency F0 = 500 kHz and deviation ΔF = 100 kHz.

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime (ms)	Rise time (ms)	Overshoot (%)	Sampling rate (Hz)
Butterworth	28,269	30,000	35,359	0.02	0.02	193	100,000
	18,328	20,000	26,009	0.03	0.03	17.6	100,000
	8,994	10,000	14,155	0.06	0.04	15.5	100,000
	4,475	5,000	7,265	0.1	0.09	15	100,000
	1,787	2,000	2,929	0.3	0.2	14	100,000
	894	1,000	1,466	0.7	0.4	14	100,000
	447	500	733	1.3	0.8	14	100,000
	179	200	293	3.3	2	14	100,000
	89	100	147	6.6	4	14	100,000
	44.7	50	73.3	13	8	14	100,000
	17.9	20	29.3	33	21	14	100,000
	8.9	10	14.7	66	43	14	100,000
	4.47	5	7.33	132	85	14	100,000
	1.69	2	3.55	248	194	11	2,000
	0.84	1	1.78	471	387	11	2,000
	0.42	0.5	0.89	921	774	11	2,000
	0.17	0.2	0.35	2,266	1,934	11	2,000
	0.08	0.1	0.18	4,510	3,869	11	2,000

Decimal HBM sampling rates: Butterworth filter amplitude response

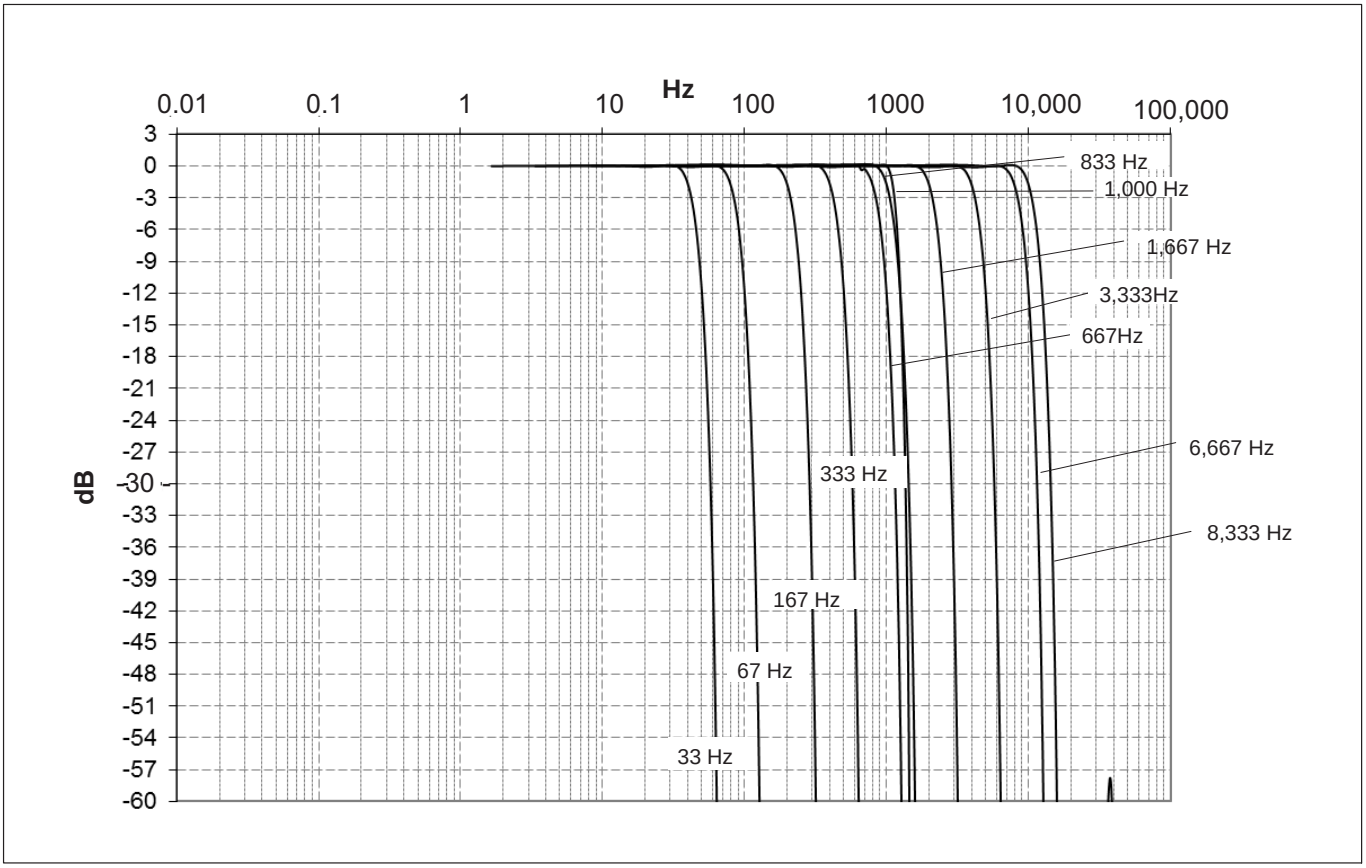


Decimal sampling rates and digital low-pass filters, linear phase (FIR)

The data apply to the modulation frequency Fm under the following conditions: sinusoidal FM with carrier frequency F0 = 500 kHz and deviation ΔF = 100 kHz.

Type	Start of level drop (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime (ms)	Rise time (ms)	Overshoot (%)	Sampling rate (Hz)
Linear phase	8,333	10,530	13,460	0.36	0.055	8.6	25,000
	6,667	8,380	10,780	0.41	0.07	8.6	20,000
	3,333	4,190	5,400	0.78	0.12	8.6	10,000
	1,667	2,120	2,700	2.41	0.28	8.6	5,000
	1,000	1,130	1,300	6.21	0.544	8.6	2,500
	833	1,050	1,345	4.01	0.551	8.6	2,500
	667	838	1,080	4.8	0.694	8.6	1,000
	333	420	540	10.4	1.39	8.6	1,000
	167	210	270	26.9	2.73	8.6	500
	67	84	108	50.2	6.88	8.6	200
	33	42	54	108	13.8	8.6	100

Decimal sample rates: Amplitude response, linear phase (FIR)

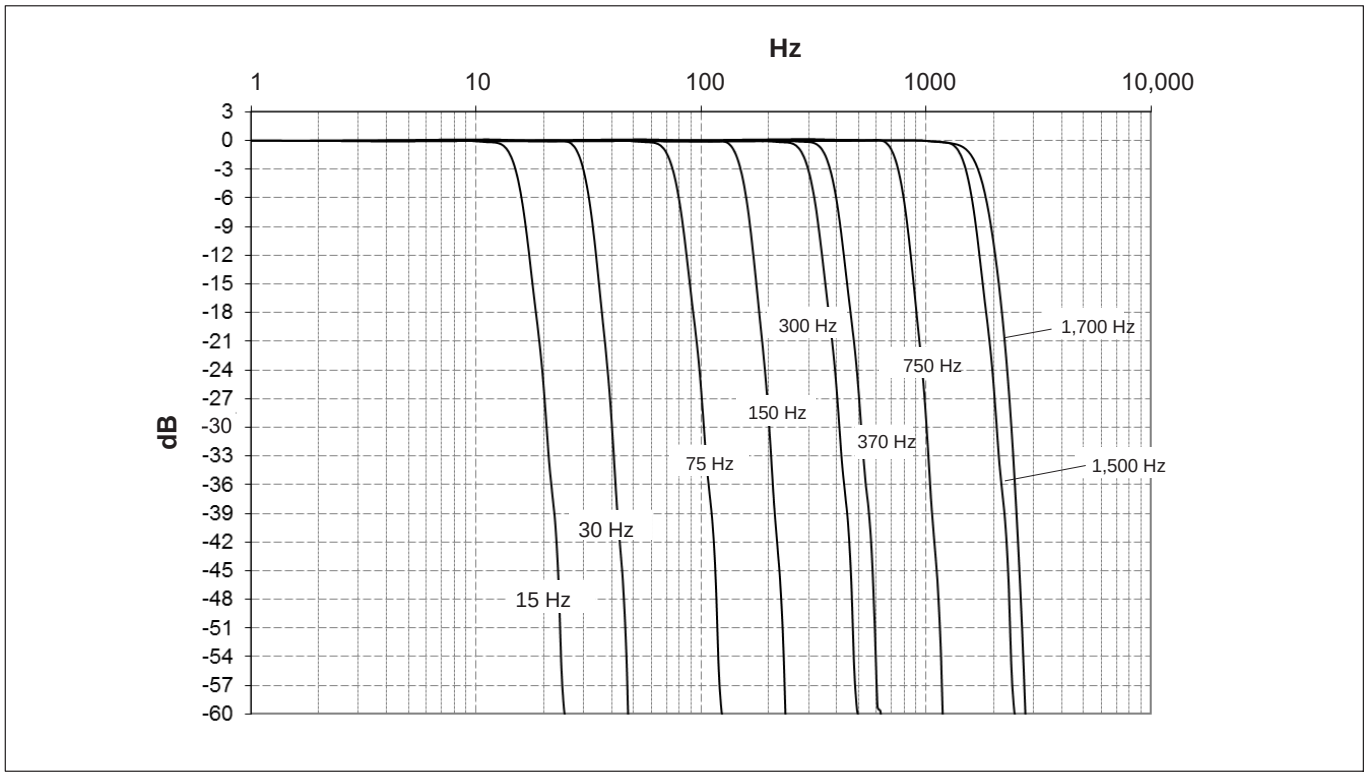


Decimal sample rates and digital low-pass filters, Butterworth (FIR)

The data apply to the modulation frequency Fm under the following conditions: sinusoidal FM with carrier frequency F0 = 500 kHz and deviation ΔF = 100 kHz.

Type	Start of level drop (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime (ms)	Rise time (ms)	Overshoot (%)	Sampling rate (Hz)
Butterworth	1,498	1,700	2,220	3.2	0.285	15.6	10,000
	1,384	1,500	1,887	3.48	0.346	18.7	10,000
	698	750	924	5.56	0.682	18.7	5,000
	344	370	471	14.1	1.40	18.7	2,500
	275	300	377	17.3	1.75	18.7	1,000
	140	150	185	27.6	3.41	18.7	1,000
	69	75	94	71.8	6.97	18.7	500
	28	30	37	139	17.0	18.7	200
	14	15	19	358	34.9	18.7	100

Decimal sample rates: Butterworth filter amplitude response (FIR)



Classic HBM sample rates and digital low-pass filters, Bessel

(4th order for sample rates < 96000 Hz; 6th order for sample rate = 96000 Hz)

The data apply to the modulation frequency Fm under the following conditions: sinusoidal FM with carrier frequency F0 = 500 kHz and deviation ΔF = 100 kHz.

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime (ms)	Rise time (ms)	Overshoot (%)	Sampling rate (Hz)
Bessel	20,000	29,250	43,000	0.002	0.016	4.1	96,000
	10,000	16,810	40,260	0.008	0.023	1.5	96,000
	5,000	8,510	19,906	0.027	0.042	0.9	96,000
	2,000	3,515	8,275	0.094	0.1	0.6	96,000
	1,000	1,715	4,070	0.22	0.2	0.6	96,000
	500	852	2,008	0.47	0.41	0.6	96,000
	200	341	803	1.22	1.01	0.8	96,000
	100	171	402	2.5	2.01	0.8	96,000
	50	84.2	215	4	4.08	1	19,200
	20	33.7	86	10	10.2	1	9,600
	10	16.9	43	20	20.6	1	9,600
	5	8.41	21.5	40	41	1	4,800
	2	3.37	8.6	98	102.8	1	1,200
	1	1.58	4.3	196	206.4	1	600
	0.5	0.84	2.15	392	411.2	1	600
	0.2	0.34	0.86	982	1,026	1	300
	0.1	0.17	0.43	1,968	2,052	1	150

Classic HBM sample rates and Butterworth digital low-pass filters

(4th order for sample rates < 96000 Hz; 6th order for sample rate = 96000 Hz)

The data apply to the modulation frequency Fm under the following conditions: sinusoidal FM with carrier frequency F0 = 500 kHz and deviation ΔF = 100 kHz.

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime (ms)	Rise time (ms)	Overshoot (%)	Sampling rate (Hz)
Butterworth	20,000	21,700	27,500	0.025	0.02	15.6	96,000
	10,000	11,100	15,500	0.06	0.04	15.6	96,000
	5,000	5,585	8,100	0.13	0.08	14.5	96,000
	2,000	2,238	3,280	0.3	0.2	14.5	96,000
	1,000	1,119	1,640	0.6	0.4	14.5	96,000
	500	560	820	1.2	0.8	14.5	96,000
	200	237	420	2.1	1.6	11	19,200
	100	118	210	4	3.3	11	19,200
	50	59	105	7.8	6.6	11	19,200
	20	24	42	19.4	16.1	11	4,800
	10	11.8	21	38.6	32.4	11	2,400
	5	5.9	10.5	76.5	65	11	1,200
	2	2.4	4.2	191	163	11	600
	1	1.2	2.1	382	325	11	300
	0.5	0.59	1.05	760	653	11	300
	0.2	0.24	0.42	1,900	1,630	11	150
	0.1	0.12	0.21	3,790	3,260	11	150

Specifications - NTX001 power supply

NTX001		
Nominal (rated) input voltage (AC)	V	100 ... 240 (± 10 %)
No-load power consumption at 230 V	W	0.5
Nominal load		
U_A	V	24
I_A	A	1.25
Static output data		
U_A	V	24 ± 4%
I_A	A	0 / 1.25
U_{Br} (output ripple voltage; peak-to-peak)	mV	≤ 120
Current limiter, typically from	A	1.6
Galvanic isolation primary - secondary		electrical, by optocoupler and transducer
SG creep and clearances	mm	≥ 8
High-voltage test	kV	≥ 4
Ambient temperature	°C	0 ... +40
Storage temperature	°C	-40 ... +70

MX460B accessories, to be ordered separately

Article	Description	Ordering number
Power supply		
AC/DC power supply / 30 W	Input: 100 ... 240 V AC (±10%), 1.5 m cable Output: 24 V DC, max. 1.25 A, 2 m cable with ODU male connector	1-NTX001
QuantumX supply cable	3 m cable to supply power to QuantumX modules; suitable plug (ODU Medi-Snap S11M08-P04MJGO-5280) at one end and exposed wires at the other.	1-KAB271-3
Communication		
Ethernet cable	Ethernet cable for direct operation of devices on a PC or notebook, length 2 m, type CAT5+	1-KAB239-2
IEEE1394b FireWire cable (module to module)	FireWire connection cable between QuantumX or SomatXR modules, fitted with matching plugs on both ends; lengths 0.2 m/2 m/5 m. Note: voltage can also be supplied to the modules via the cable (max. 1.5 A, from source to last acceptor).	1-KAB272-W-0.2 1-KAB272-2 1-KAB272-5
Mechanical		
Connecting elements for QuantumX modules	Connecting elements (clips) for QuantumX modules; set comprising 2 connecting elements and including assembly material for fast connection of 2 modules.	1-CASECLIP
Connecting elements for QuantumX modules	Mounting plate for installing QuantumX modules using connecting elements (1-CASECLIP), lashing strap or cable ties. Basic fastening by 4 screws	1-CASEFIT
QuantumX backplane (large)	QuantumX backplane for a maximum of 9 modules - Wall or control cabinet installation (19”) - External modules can be connected via FireWire - Power supply 18 … 30 V DC / max. 5 A (150 W)	1-BPX001
QuantumX backplane (rack)	QuantumX backplane – rack for a maximum of 9 modules; - 19" control cabinet installation with left and right handles - External modules can be connected via FireWire - Power supply: 18 … 30 V DC/max. 5 A (150 W)	1-BPX002
QuantumX backplane (small)	QuantumX backplane for a maximum of 5 modules: - External modules can be connected via FireWire - Power supply: 11 … 30 V DC/ max. 5 A (90 W)	1-BPX003
Transducer-side		
DSub-HD 15-pin plug kit with TEDS chip	DSub-HD 15-pin (male) plug kit with TEDS chip for storing a sensor data sheet; housing: metallized plastic with knurled screws. Note: The TEDS chip is blank.	1-SUBHD15-MALE
DSubHD 15-pole connector kit	DSubHD 15-pole connector kit (male); Housing: Metallized plastic with knurled screws.	1-CON-P1025
TEDS package (x5)	Package of TEDS chips, package consisting of 5 units 1-wire EEPROM DS24B33 (IEEE 1451.4 TEDS)	1-TEDS-PAK
Port saver, SubHD 15-pin	4 x Sub-HD 15-pin port saver to increase the mating cycles by at least 500. Construction: Plug in socket with screw connection 4-40 UNC.	1-SUBHD15-SAVE

Article	Description	Ordering number
Software and product packages		
catman®AP 	All-inclusive package, comprising catman®Easy Functionality plus add-on modules such as video camera integration (EasyVideoCam), full post-process analysis (EasyMath), recurrent activity automation (EasyScript), measurement project preparation offline (EasyPlan), and additional functions such as electrical power calculation, special filters, frequency spectrum, etc. Details at www.hbm.com\catman\	1-CATMAN-AP
catman®EASY 	This basic software package for data acquisition includes simple channel parameterization using TEDS or the sensor database, measurement job parameterization, individual visualization, data storage and reporting.	1-CATMAN-EASY
catman®PostProcess 	Post Process edition for visualization, analysis and processing of measurement data with 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 device driver for CANape® software from Vector Informatik. CANape® versions 10.0 and higher are supported.	1-CANAPE-DRIVER

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

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