Data Sheet

QUANTUMX

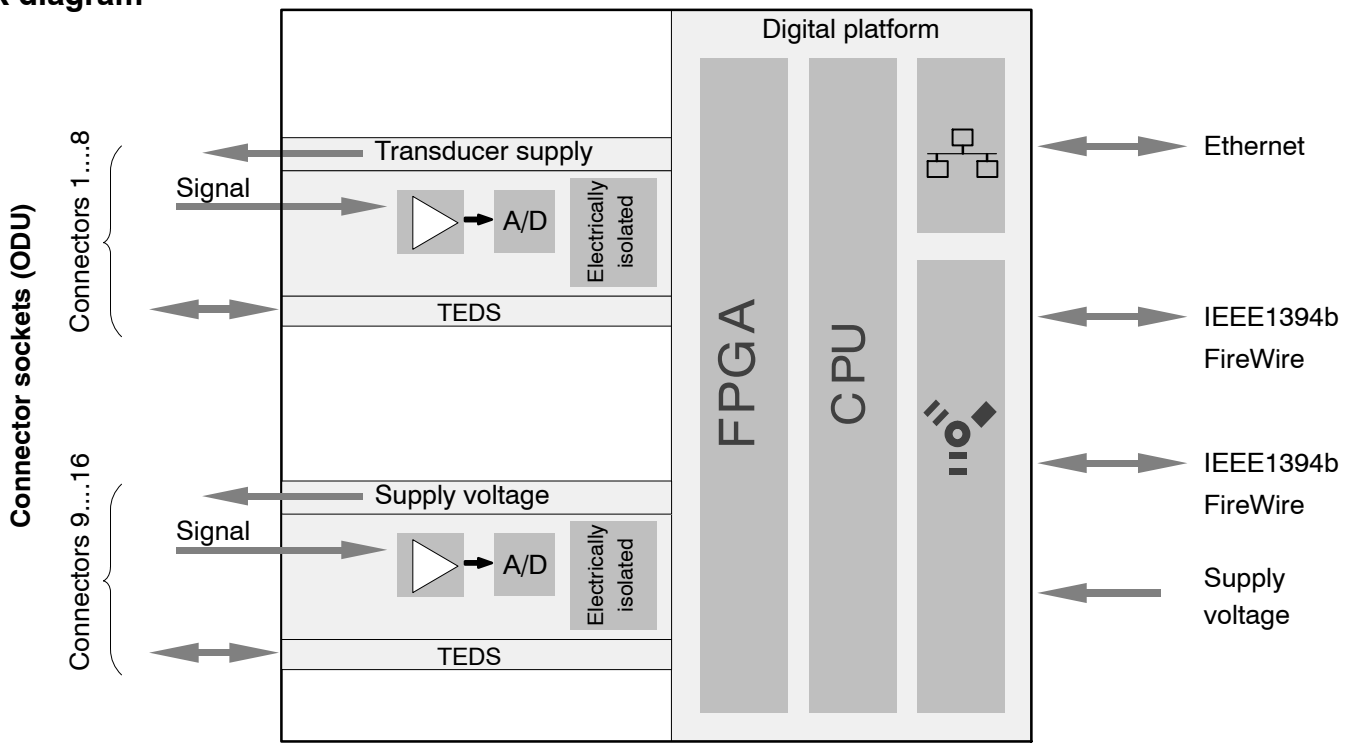
# MX1601–P

## Rugged universal amplifier

### Special features

- **16 individually configurable inputs (electrically isolated)**
- **Connection of of standard signals (10 V, 100 mV, 20 mA, IEPE)**
- **Data rate: up to 19,200 Hz**
- **24–bit A/D converter per channel for synchronous, parallel measurements**
- **Active low pass filter**
- **TEDS support**
- **Supply voltage for active transducers (DC)**

### Block diagram






HBM

## Specifications MX1601–P

| General specifications | | |
|---|---|---|
| **Inputs** | Number | 16, electrically isolated from each other and from the supply voltage[1)] |
| **Transducer technologies** | | Voltage, current, current–fed piezoelectric sensors (IEPE) |
| **A/D converter** | | 24 Bit Delta Sigma converter |
| **Data rate** | Hz | 0.1 ... 19200, adjustable for each channel |
| **Active low-pass filter** (Bessel/Butterworth, can be switched off) | Hz | 0.01 ... 3,000 (–3 dB) |
| **Transducer identification (TEDS, IEEE 1451.4)**<br>max. distance of the TEDS module | <br>m | <br>100 |
| **Transducer connection** | | Phönix Contact FMC–1,5/8–ST–3,5–RF plug terminal |
| **Supply voltage range (DC)** | V | 10 ... 30 (24 V nominal (rated) voltage) |
| **Supply voltage interruption** | | max. 5 ms at 24 V |
| **Power consumption**<br>without adjustable transducer supply<br>with adjustable transducer supply | <br>W<br>W | <br>< 10<br>< 13 |
| **Transducer Excitation** (active transducers)<br>Only channel 1... 8:<br>Adjustable supply voltage (DC)<br>Maximum output power<br>Only channel 9 ... 16:<br>Supply voltage (DC)<br>Maximum output current | <br><br>V<br>W<br><br>V<br>mA | <br><br>5 ... 24; adjustable for each channel<br>0.7 each channel / a total of 2<br><br>9 ... 29; Supply voltage of the module –1 V<br>30 each channel / a total of 75 |
| **Ethernet** (data link)<br>Protocol/addressing<br>Connection<br>Max. cable length to module | <br>–<br>–<br>m | 10Base-T / 100Base-TX<br>TCP/IP (direct IP address or DHCP)<br>8P8C plug (RJ-45) with twisted pair cable (CAT-5)<br>100 |
| **Synchronization options**<br>EtherCAT<br>NTP<br>IRIG–B (B000 to B007; B120 to B127) | | IEEE1394b FireWire (automatically, recommended)<br>via CX27<br>via Ethernet<br>via MX440A- or MX840A input channel |
| **IEEE1394b FireWire** (module synchronization, data link, optional supply voltage)<br>Baud rate<br>Max. current from module to module<br>Max. cable length between the nodes<br>Max. number of modules connected in series (daisy chain)<br>Max. number of modules in a IEEE1394b FireWire system (including hubs[2)], backplane)<br>Max. number of hops[3)] | <br>MBaud<br>A<br>m<br>–<br><br>–<br>– | IEEE 1394b (HBM modules only)<br>400 (approx. 50 MByte/s)<br>1.5<br>5<br>12 (=11 Hops)<br><br>24<br>14 |
| **Nominal (rated) temperature range** | °C [°F] | –20 .. +60 [–4 ... +140] |
| **Operating temperature range** | °C [°F] | –35 ... +80 [–31 ... +176] |
| **Storage temperature range** | °C [°F] | –40 ... +85 [–40 ... +185] |
| **Rel. humidity** | % | 5 ... 95 |
| **Protection class** | | III |
| **Degree of protection** | | IP67 per EN 60529 |
| **Mechanical tests[4)]**<br>Vibration (30 min)<br>Shock (6 ms) | <br>$m/s^2$<br>$m/s^2$ | <br>50<br>350 |
| **EMC requirements** | | per EN 61326–1 |
| **Max. input voltage at transducer socket to ground**<br>Pin 8 (TEDS)<br>Pin 3 (voltage)<br>Pin 4 (current)<br>Pin 1 (control lead) | <br>V<br>V<br>V<br>V | transient free<br>+ 5<br>± 15 (max. ± 40)<br>± 1,5<br>+ 3,3 |
| **Dimensions, horizontal (W x H x D)** | mm | 80 x 205 x 131.5 |
| **Weight, approx.** | g | 980 |

1) When the variable transducer supply is used, there is no electrical isolation from the supply voltage.

2) Hub: IEEE1394b FireWire node or distributor

3) Hop: Transition from module to module or signal conditioning / distribution via IEEE1394b FireWire (hub, backplane)

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.

## Specifications MX1601–P (Continued)

| Voltage 10 V (DC) | | |
|---|---|---|
| **Accuracy class** | | 0.03 |
| **Transducers that can be connected** | | Voltage sources |
| **Permissible cable length between MX1601 and transducer** | m | 100 |
| **Measuring range** | V | ±10 |
| **Measurement frequency range (–3 dB)** | Hz | 0 ... 3,000 |
| **Internal resistance of the connected voltage source** | kΩ | < 5 |
| **Input impedance** | MΩ | > 10 |
| **Noise at 25 °C (peak to peak)** | | |
| at 1 Hz Bessel filter | µV | 300 |
| at 10 Hz Bessel filter | µV | 300 |
| at 100 Hz Bessel filter | µV | 500 |
| at 1 kHz Bessel filter | µV | 800 |
| at filter Off, 19200 values/s | µV | 1,000 |
| **Linearity error** | % | < 0.02 of full scale |
| **Common-mode rejection** | | |
| at DC common-mode | dB | > 100 |
| at 50 Hz common-mode, typically | dB | 95 |
| **Max. common-mode voltage** (to housing and supply ground) | V | ±60 |
| **Zero drift** | % / 10 K | < 0.02 of full scale |
| **Full-scale drift** | % / 10 K | < 0.03 of measurement value |

| 100 mV DC voltage | | |
|---|---|---|
| **Accuracy class** | | 0.1 |
| **Transducers that can be connected** | | voltage generator |
| **Permissible cable length between MX1601 and transducer** | m | 100 |
| **Measuring range** | mV | ±100 |
| **Measurement frequency range (–3 dB)** | Hz | 0 ... 3,000 |
| **Internal resistance of the connected voltage source** | Ω | < 250 |
| **Input impedance** | MΩ | > 10 |
| **Noise at 25 °C (peak to peak)** | | |
| with filter 1 Hz Bessel | µV | 5 |
| with filter 10 Hz Bessel | µV | 10 |
| with filter 100 Hz Bessel | µV | 50 |
| with filter 1 kHz Bessel | µV | 300 |
| at filter Off, 19200 values/s | µV | 400 |
| **Linearity error** | % | < 0.02 of full scale |
| **Common-mode rejection** | | |
| with DC common mode | dB | > 100 |
| with 50 Hz common mode, typically | dB | 95 |
| **Maximum common-mode voltage** (to housing and supply ground) | V | ±60 |
| **Zero drift** | % / 10 K | < 0.05 of full scale |
| **Full-scale drift** | % / 10 K | < 0.03 of measurement value |

## Specifications MX1601–P (Continued)

| Current 20 mA (DC) | | |
|---|---|---|
| **Accuracy class** | | 0.05 |
| **Transducers that can be connected** | | Transducer with current output (0 ... 20 mA or 4 ... 20 mA) |
| **Permissible cable length between MX1601 and transducer** | m | 100 |
| **Measuring range** | mA | ±20 |
| **Measurement frequency range (–3 dB)** | Hz | 0 ... 3,000 |
| **Measuring resistance value** | Ω | 5 |
| **Noise at 25 °C (peak to peak)**<br>at 1 Hz Bessel filter<br>at 10 Hz Bessel filter<br>at 100 Hz Bessel filter<br>at 1 kHz Bessel filter<br>at filter Off, 19200 values/s | <br>µA<br>µA<br>µA<br>µA<br>µA | <br>1<br>2<br>10<br>40<br>50 |
| **Linearity error** | % | < 0.02 of full scale |
| **Common-mode rejection**<br>at DC common-mode<br>at 50 Hz common-mode, typically | <br>dB<br>dB | <br>> 100<br>95 |
| **Max. common-mode voltage**<br>(to housing and supply ground) | V | ±60 |
| **Zero drift** | % / 10 K | < 0.05 of full scale |
| **Full-scale drift** | % / 10 K | < 0.05 of measurement value |

| Current–fed piezoelectric transducers (IEPE, Integrated electronics Piezo electric) | | |
|---|---|---|
| **Accuracy class** | | 0.1 |
| **Transducer technology** | | Current-fed piezoelectric transducer |
| **Permissible cable length between MX1601 and transducer**<br>May be laid inside closed buildings only | m | < 30 |
| **Transducer excitation** | mA | 4.0 mA ±15% |
| **Measuring range** | V | ±8 |
| **Measurement frequency range (–3 dB)** | Hz | 0.34 ... 3,000 |
| **Internal resistance of the connected voltage source** | kΩ | < 2.5 |
| **Input impedance** | MΩ | > 1 |
| **Noise at 25 °C and measuring range ±10 V (peak to peak)**<br>at 1 Hz Bessel filter<br>at 10 Hz Bessel filter<br>at 100 Hz Bessel filter<br>at 1 kHz Bessel filter<br>at filter Off, 19200 values/s | <br>µV<br>µV<br>µV<br>µV<br>µV | <br>500<br>500<br>500<br>1,000<br>1,500 |
| **Linearity error** | % | < 0.01 of full scale |
| **Common-mode rejection**<br>at DC common-mode<br>at 50 Hz common-mode, typically | <br>dB<br>dB | <br>> 100<br>95 |
| **Max. common-mode voltage**<br>(to housing and supply ground) | V | ±60 |
| **Zero drift** | % / 10 K | < 0.1 of full scale |
| **Full-scale drift** | % / 10 K | < 0.1of measurement value |

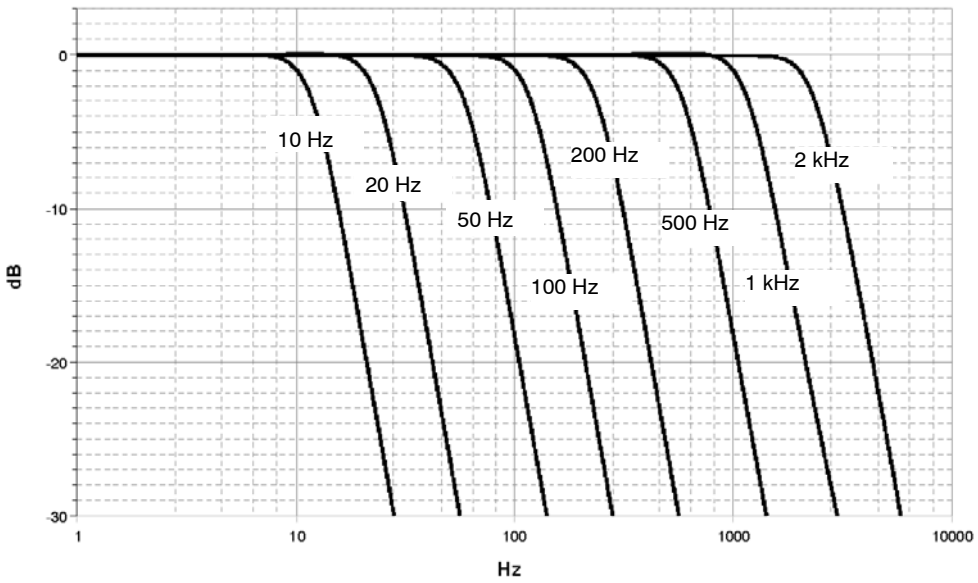
## Active low pass filter data

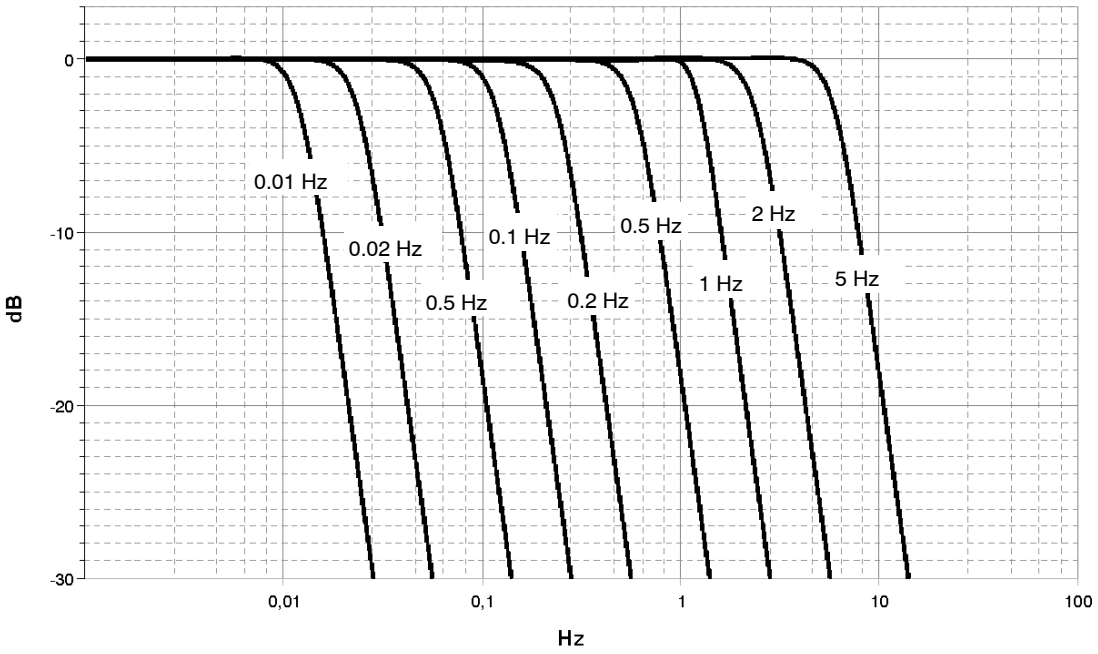
### (4th order Bessel/Butterworth)

| Type | –1dB (Hz) | –3dB (Hz) | –20dB (Hz) | Phase delay (ms) | Rise time (ms) | Overshoot (%) | Data rate (Hz) |
|---|---|---|---|---|---|---|---|
| Bessel | 1000 | 1575 | 3611 | 0.11 | 0.2 | 1.4 | 19200 |
| | 1000 | 1575 | 3612 | 0.11 | 0.2 | 1.4 | 9600 |
| | 500 | 812 | 2079 | 0.3 | 0.38 | 1.3 | 9600 |
| | 200 | 335 | 860 | 0.9 | 1.05 | 0.8 | 9600 |
| | 100 | 168 | 427 | 1.8 | 2.11 | 0.8 | 9600 |
| | 50 | 84 | 213 | 3.8 | 4.18 | 0.8 | 9600 |
| | 20 | 33.7 | 85 | 9.6 | 10.4 | 0.8 | 9600 |
| | 10 | 16.6 | 43 | 19.5 | 21.0 | 0.8 | 9600 |
| | 5 | 8.4 | 21 | 39 | 41.4 | 0.8 | 2400 |
| | 2 | 3.4 | 8,6 | 97 | 102 | 0.8 | 2400 |
| | 1 | 1.6 | 4,2 | 197 | 215 | 0.8 | 2400 |
| | 0.5 | 0.84 | 2,1 | 390 | 418 | 0.8 | 300 |
| | 0.2 | 0.34 | 0,85 | 980 | 1033 | 0.8 | 300 |
| | 0.1 | 0.17 | 0,43 | 1950 | 2090 | 0.8 | 300 |
| | 0.05 | 0.085 | 0,21 | 3860 | 4170 | 0.8 | 20 |
| | 0.02 | 0.036 | 0,088 | 9800 | 10560 | 0.8 | 20 |
| | 0.01 | 0.017 | 0,044 | 19500 | 21200 | 0.8 | 20 |
| Butterworth | 2000 | 3053 | 5083 | 0 | 0.144 | 8.5 | 19200 |
| | 1000 | 1170 | 2077 | 0.27 | 0.344 | 11 | 19200 |
| | 1000 | 1171 | 2078 | 0.27 | 0.378 | 11 | 9600 |
| | 500 | 587 | 1048 | 0.64 | 0.652 | 11 | 9600 |
| | 200 | 237 | 420 | 1.76 | 1.64 | 11 | 9600 |
| | 100 | 118 | 210 | 3.65 | 3.28 | 11 | 9600 |
| | 50 | 59 | 105 | 7.49 | 6.29 | 11 | 9600 |
| | 20 | 24 | 42 | 18.8 | 16.15 | 11 | 9600 |
| | 10 | 12 | 21 | 37.7 | 32.29 | 11 | 9600 |
| | 5 | 5.95 | 10.5 | 74.9 | 65.92 | 11 | 2400 |
| | 2 | 2.37 | 4.24 | 188 | 163.6 | 11 | 2400 |
| | 1 | 1.26 | 2.12 | 370 | 315 | 11 | 2400 |
| | 0.5 | 0.59 | 1.05 | 756 | 656 | 11 | 300 |
| | 0.2 | 0.241 | 0.419 | 1900 | 1640 | 11 | 300 |
| | 0.1 | 0.122 | 0.210 | 3770 | 3280 | 11 | 300 |
| | 0.05 | 0.060 | 0.106 | 7490 | 6596 | 11 | 20 |
| | 0.02 | 0.0245 | 0.042 | 18900 | 16200 | 11 | 20 |
| | 0.01 | 0.012 | 0.021 | 37700 | 32383 | 11 | 20 |

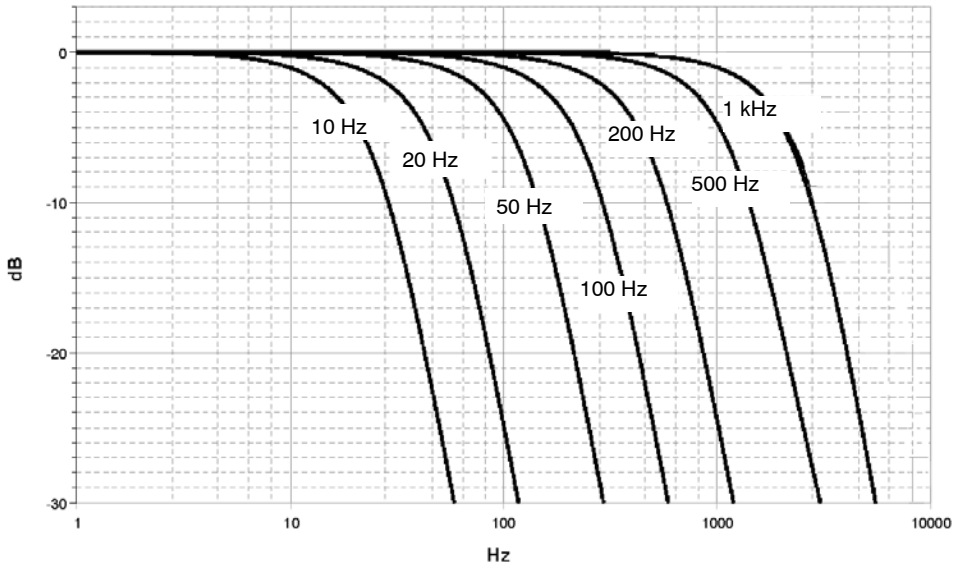
*) The analog-to-digital converter's delay time is 128 µs for all data rates and has not been accounted for in the "Phase delay" column! The anti-aliasing filter's delay time (160 µs) is not accounted for as well. Hence, 288 µs need to be added to the "Phase delay".

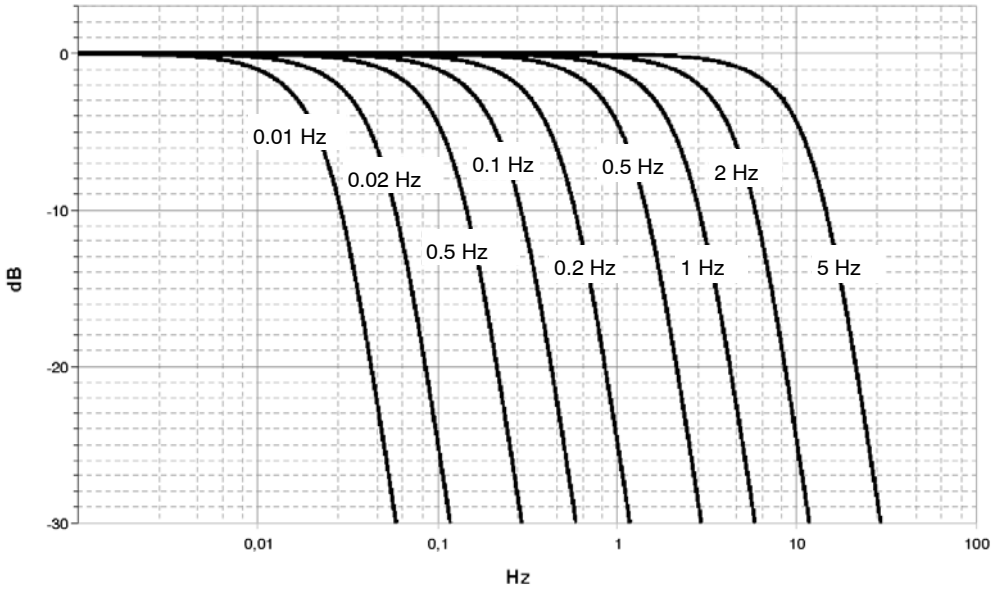
## Amplitude response of MX1601 Butterworth filter



## Amplitude response of MX1601 Bessel filter



## **Accessories,** to be ordered separately

| MX1601–P accessories | | |
|---|---|---|
| **Article** | **Description** | **Order no.** |
| **Power** | | |
| AC–DC power supply (24 V, ODU IP68) | Input: 90...264V~, 1.5 m cable + internat. plugs;<br>Output: 24V=, max. 1.25 A, 2 m cable with ODU–IP68. | 1–NTX002 |
| Cable power supply (ODU–IP68, 5 m) | Power supply cable for P modules; length 5 m. Suitable plug (ODU, IP68) at one end, open stranded wires at the other end. | 1–KAB294–5 |
| Connector power supply (ODU–IP68, 4 pin) | Push–in connector, ODU, IP68. For voltage supply of QuantumX modules with IP67 protection. | 1–CON–P1001 |
| **Ethernet** | | |
| Ethernet (modul to PC, ODU–IP68, RJ45, 5 m) | Ethernet patch cable from PC to QuantumX module, IP68, length: 5 m;<br>with matching plugs on both sides (RJ45 at PC end, ODU at module end). | 1–KAB273–5 |
| Ethernet (ODU–IP68, M12, 5 m) | Ethernet patch cable from PC to QuantumX module, IP68, length: 5 m;<br>with matching plugs on both sides (M12 at PC end, ODU at module end). | 1–KAB295–5 |
| **IEEE1394b FireWire** | | |
| IEEE1394b FireWire (modul to modul, IP68) | FireWire cable connector between QuantumX modules, fitted with suitable plugs at both ends.<br>Lengts 0.2 m/2 m/5 m.<br>Note: modules can be supplied with power over this cable (max. 1.5 A, from the source to the last drain). | 1–KAB272–0.2<br>1–KAB272–2<br>1–KAB272–5 |
| IEEE1394b FireWire IEEE PC–Card | FireWire IEEE 1394b PC–Card (PCMCIA adapter) to connect QuantumX modules to a Notebook or a PC. | 1–IF001 |
| IEEE1394b FireWire IEEE1394b ExpressCard | FireWire IEEE 1394b ExpressCard (ExpressCard/34) to connect QuantumX modules to a notebook or a PC. | 1–IF002 |
| IEEE1394b FireWire (modul to PC, IP68, 5 m) | FireWire cable connector from PC to first module. For data transmission from QuantumX modules to PC. Fitted with suitable plugs at both ends. Length: 5 m.<br>Note: modules can **not** be supplied with power over this cable. | 1–KAB293–5 |
| IEEE1394b FireWire (modul to Hub, ODU–IP68, 3 m) | FireWire connection cable from hub to first module with IP68 protection For data transfer from QuantumX modules to the PC. Fitted with suitable plugs at both ends. Length: 3 m.<br>Note: modules can be powered over this cable (max. 1.5 A, from source to the last drain). | 1–KAB276–3 |
| IEEE1394b FireWire-Extender | SCM-FireWire-Extender, IP68<br>Package consists of 2 In–line elements to extend the FireWire connection up to 50 m; Necessary parts: 2 x 1–KAB269–x and Industrial Ethernet cable (M12, CAT5e/6, max. 50 m).<br>KAB270–3 connection is not possible! | 1–SCM–FW |
| **Sensor** | | |
| Connector sensor (ODU–IP68, 14 Pin) | 10 push–pull connectors, ODU, IP68. For sensor connection. | 1–CON–P1007 |
| **Mechanik** | | |
| Connecting elements | 4 elements for mechanically connecting ultra-rugged modules | 1–CASELINK |
| Carrying handle | Foldable carrying handle and 4 screw feet for ultra-rugged modules | 1–CASECARRY |



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