

QUANTUM^X MX411-P

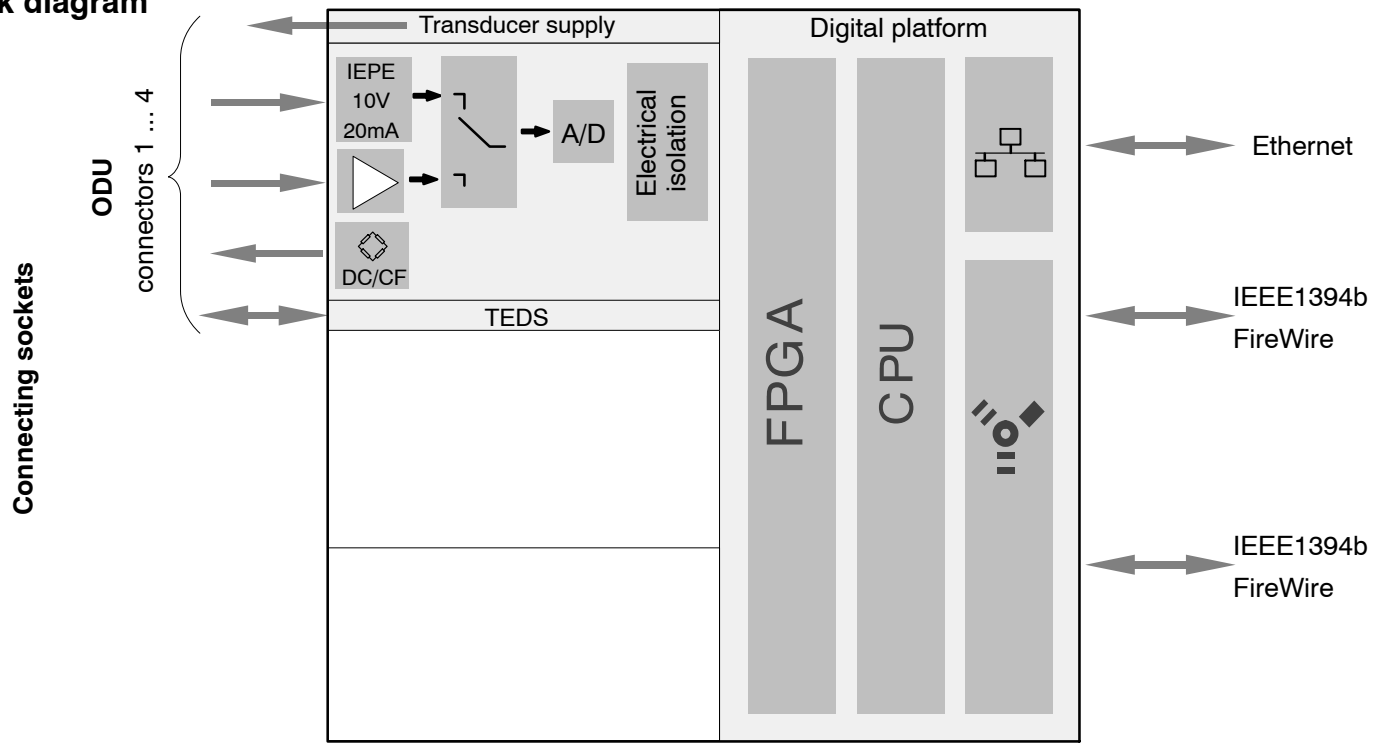
Rugged highly dynamic
universal amplifier

Special features

- 4 individually configurable inputs (electrically isolated)
- Connection of more than 5 transducer technologies
- Data rate: up to 96,000 Hz
19,2000 with 2 channels
- 24-bit A/D converter per channel for synchronous, parallel measurements
- Active low-pass filter
- 4 analog outputs
- Real-time computation (Peak, RMS)
- Supply voltage (DC) for active transducers: 5 V ... 24 V



Block diagram



Specifications MX411-P

General specifications		
Inputs	number	4, electrically isolated from each other and from supply ¹⁾
Transducer technologies per connector		Strain gage, half and full bridge (carrier frequency or DC), piezoelectric transducers (resistiv, current-fed) / IEPE, Inductive half and full bridge, voltage, (10 V) current (20 mA)
A/D conversion		24-bit delta-sigma converter
Data rate	Hz	0.1 ... 96,000 per channel, adjustable individually or 0.1 ... 192000 with 2 channels adjustable individually
Bandwidth	kHz	38 with 96,000 Hz data rate 78 with 192,000 Hz data rate
Active low pass filter (Bessel/Butterworth, adjustable)	Hz	0.1 ... 20,000
Transducer identification (TEDS, IEEE 1451.4) max. TEDS module distance	m	100
Transducer connection		ODU
Supply voltage range (DC)	V	10 ... 30 (nominal (rated) voltage 24 V)
Supply voltage interruption		max. for 5 ms at 24 V
Power consumption without adjustable transducer excitation with adjustable transducer excitation	W	< 12 < 15
Supply voltage (active transducers) Adjustable transducer excitation (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 (direct IP address or DHCP) ODU with twisted pair cable (CAT-5) 100
IEEE1394b FireWire (module synchronization, data link, optional supply voltage) 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 a IEEE1394b FireWire system (incl. hubs ²⁾ , backplane) Max. number of hops ³⁾	MBaud A m – – –	IEEE 1394b (HBM modules only) 400 (approx. 50 MBytes/s) 1.5 5 12 (= 11 hops) 24 14
Synchronization options EtherCAT NTP IRIG-B (B000 to B007; B120 to B127)		FireWire (automatically, recommended) via CX27 via Ethernet via MX440A- or MX840A input channel
Nominal (rated) temperature range	°C [°F]	–20[–4] ... +60 [–4 ... +140]
Operating temperature range	°C [°F]	–35 ... +80 [–31 ... +176]
Storage temperature range	°C [°F]	–40 ... +85 [–40 ... +185]
Relative humidity	%	5 ... 95 (non-condensing)
Protection class	–	III
Degree of protection		IP67 per EN60529
Mechanical tests⁴⁾ Vibration (30 min) Shock (6 ms)	m/s ² m/s ²	50 350
EMC requirements		per EN 61326
Maximum input voltage at transducer socket to ground (PIN 13 or PIN 4) PIN 1, 2, 5, 8, 11, 12, 14 (bridge and TEDS) PIN 3 (voltage) PIN 6 (current) PIN 5 (control circuits)	V V V V	± 5.5 ± 40 ± 1.5 + 3.3
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	2000

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

²⁾ Hub: IEEE1394b FireWire node point 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/s² 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/s² for 6 ms, half sine pulse shape, with 3 shocks in each of the 6 possible directions.

Specifications MX411-P (continued)

Strain gage full bridge and half bridge 4 mV/V CF with excitation 1 V or 2.5 V or 5 V (AC, effective)		
Accuracy class		0.05
Carrier frequency (sine)	Hz	4,800 + 2
Bridge excitation voltage (effective)	V	1 ; 2.5; 5 (± 5 %)
Transducers that can be connected		Strain gage and inductive full and half bridges
Permissible cable length between MX411-P and transducer	m	100
Measuring ranges at 5 V excitation at 2.5 V excitation at 1 V excitation	mV/V mV/V mV/V	± 4 ± 8 ± 20
Measurement frequency range (-3 dB)	Hz	0 ... 1,600
Transducer impedance at 5 V excitation at 2.5 V excitation at 1 V excitation	Ω Ω Ω	300 ... 1,000 110 ... 1,000 80 ... 1,000
Noise at 25 °C and 5 V excitation (peak to peak) at 1 Hz Bessel filter at 10 Hz Bessel filter at 100 Hz Bessel filter at 1 kHz Bessel filter	μV/V μV/V μV/V μV/V	< 0.1 < 0.2 < 0.5 < 1.5
Linearity error	%	< 0.02 of full scale value
Zero drift (full bridge with excitation 5 V)	% / 10 K	< 0.02 of full scale value
Full-scale drift (excitation 5 V)	% / 10 K	< 0.05 of measured value

Strain gage full bridge and half bridge 4 mV/V DC with excitation 1 V or 2.5 V or 5 V or 7.5 V (DC)		
Accuracy class		0.05
Bridge excitation voltage (DC)	V	1 ; 2.5; 5; 7.5 (± 8 %)
Transducers that can be connected		Strain gage full and half bridges
Permissible cable length between MX411-P and transducer	m	100 (at U _B =7.5 V: 50 m)
Measuring ranges at 7.5 V excitation at 5 V excitation at 2.5 V excitation at 1 V excitation	mV/V mV/V mV/V mV/V	± 4 ± 4 ± 10 ± 20
Measurement frequency range (-3 dB)	Hz	0 ... 39,300 with 96,000 Hz data rate 0 ... 78,600 with 192,000 Hz data rate
Transducer impedance at 7.5 V excitation at 5 V excitation at 2.5 V excitation at 1 V excitation	Ω Ω Ω Ω	300 ... 5,000 (max. 50 m cable) 110 ... 5,000 110 ... 5,000 80 ... 5,000
Noise at 25 °C and 5 V excitation (peak to peak) at 1 Hz Bessel filter at 10 Hz Bessel filter at 100 Hz Bessel filter at 1 kHz Bessel filter at 10 kHz Bessel filter at filter Off	μV/V μV/V μV/V μV/V μV/V μV/V	< 0.15 < 0.3 < 0.6 < 2 < 9 < 10
Linearity error	%	< 0.02 of full scale value
Zero drift (full bridge with excitation 5 V)	% / 10 K	< 0.05 of full scale value
Full-scale drift (excitation 5 V)	% / 10 K	< 0.05 of measured value

Specifications MX411-P (continued)

Strain gage full bridge and half bridge 100 mV/V CF with excitation 1 V or 2.5 V (AC, effective)		
Accuracy class		0.05
Carrier frequency (sine)	Hz	4,800 ± 2
Bridge excitation voltage (effective)	V	1 ; 2.5; (± 8 %)
Transducers that can be connected		Strain gage and inductive full and half bridges
Permissible cable length between MX411-P and transducer	m	100
Measuring ranges at 2.5 V excitation at 1 V excitation	mV/V mV/V	± 100 ± 250
Measurement frequency range (-3 dB)	Hz	0 ... 1,600
Transducer impedance at 2.5 V excitation at 1 V excitation	Ω Ω	110 ... 1,000 80 ... 1,000
Noise at 25 °C and 2.5 V excitation (peak to peak) at 1 Hz Bessel filter at 10 Hz Bessel filter at 100 Hz Bessel filter at 1 kHz Bessel filter	μV/V μV/V μV/V μV/V	< 2 < 4 < 12 < 40
Linearity error	%	< 0.02 of full scale value
Zero drift (full bridge with excitation 2.5 V)	% / 10 K	< 0.01 of full scale value
Full-scale drift (excitation 2.5 V)	% / 10 K	< 0.05 of measured value

Piezoresistive strain gage full bridge and half bridge 100 mV/V DC with excitation 2.5 V or 5 V (DC)		
Accuracy class		0.05
Bridge excitation voltage (DC)	V	2.5; 5 (± 5 %)
Transducers that can be connected		Strain gage full and half bridges
Permissible cable length between MX411-P and transducer	m	100
Measuring ranges at 5 V excitation at 2.5 V excitation	mV/V mV/V	± 50 ± 100
Measurement frequency range (-3 dB)	Hz	0 ... 39,300 with 96,000 Hz data rate 0 ... 78,600 with 192,000 Hz data rate
Transducer impedance at 5 V excitation at 2.5 V excitation	Ω Ω	110 ... 5,000 110 ... 5,000
Noise at 25 °C and 5 V excitation (peak to peak) at 1 Hz Bessel filter at 10 Hz Bessel filter at 100 Hz Bessel filter at 1 kHz Bessel filter at 10 kHz Bessel filter at filter Off	μV/V μV/V μV/V μV/V μV/V μV/V	< 2 < 3 < 8 < 25 < 130 < 150
Linearity error	%	< 0.02 of full scale value
Zero drift (full bridge with excitation 5 V)	% / 10 K	< 0.03 of full scale value
Full-scale drift (excitation 5 V)	% / 10 K	< 0.05 of measured value

Specifications MX411-P (continued)

Voltage 10 V (DC)		
Accuracy class		0.03
Transducers that can be connected		Voltage sensor ± 10 V
Permissible cable length between MX411-P and transducer	m	100
Measuring range	V	± 10
Measurement frequency range (-3 dB)	Hz	0 ... 39,300 with 96,000 Hz data rate 0 ... 78,600 with 192,000 Hz data rate
Internal resistance of the connected voltage source	k Ω	< 5
Input impedance	M Ω	> 10
Noise at 25 °C (peak to peak) at 1 Hz Bessel filter at 10 Hz Bessel filter at 100 Hz Bessel filter at 1 kHz Bessel filter at 10 kHz Bessel filter at filter Off / 96000 values/s	μ V μ V μ V μ V μ V μ V	< 150 < 300 < 600 < 3,000 < 13,000 < 15,000
Linearity error	%	< 0.02 of full scale value
Common-mode rejection at DC common-mode at 50 Hz common-mode	dB dB	> 100 typically 75
Max. common-mode voltage (to housing and supply ground)	V	± 60
Zero drift	% / 10 K	< 0.02 of full scale value
Full-scale drift	% / 10 K	< 0.03 of measured value

Current 20 mA (DC)		
Accuracy class		0.03
Transducers that can be connected		Transducer with 4 ... 20 mA current output
Permissible cable length between MX411-P and transducer	m	100
Measuring range	mA	± 20
Measurement frequency range (-3 dB)	Hz	0 ... 39,300 with 96,000 Hz data rate 0 ... 78,600 with 192,000 Hz data rate
Measuring resistance value	Ω	50
Noise at 25 °C (peak to peak) at 1 Hz Bessel filter at 10 Hz Bessel filter at 100 Hz Bessel filter at 1 kHz Bessel filter at 10 kHz Bessel filter at filter Off	μ A μ A μ A μ A μ A μ A	< 0.5 < 1.5 < 10 < 20 < 28 < 30
Linearity error	%	< 0.02 of full scale value
Common-mode rejection at DC common-mode at 50 Hz common-mode	dB dB	> 100 typically 75
Max. common-mode voltage (to housing and supply ground)	V	± 60
Zero drift	% / 10 K	< 0.02 of full scale value
Full-scale drift	% / 10 K	< 0.03 of measured value

Specifications MX411-P (continued)

Current-fed piezoelectric transducers (IEPE, Integrated electronics Piezo electric)		
Accuracy class		0.1
Transducer technology		Current-fed piezoelectric transducer
Permissible cable length between MX411-P and transducer	m	< 30
Transducer identification (TEDS, IEEE 1451.4)		only version 1.0
Transducer excitation	mA	5.5mA \pm 15%
Measuring ranges	V	\pm 2; \pm 10
Measurement frequency range (-3 dB)	Hz	0 ... 39,300 with 96,000 Hz data rate 0 ... 78,600 with 192,000 Hz data rate
Noise at 25 °C and measuring range \pm 10 V (peak to peak) at 1 Hz Bessel filter at 10 Hz Bessel filter at 100 Hz Bessel filter at 1 kHz Bessel filter at 10 kHz Bessel filter at filter Off	μ V μ V μ V μ V μ V μ V	< 100 < 300 < 600 < 3,000 < 13,000 < 15,000
Linearity error	%	< 0.1 of full scale value
Common-mode rejection at DC common-mode at 50 Hz common-mode, typically	dB dB	> 100 75
Max. common-mode voltage (to housing and supply ground)	V	\pm 60
Zero drift	% / 10 K	< 0.1 of full scale value

Real-time computation on the module		
Root-mean-square unit (RMS)		4
Peak-value unit Number of peak values Max. output rate	Hz	8 4800

Active low-pass filter data MX411-P

(4th order Bessel/Butterworth with data rate < 96,000 Hz; 6th order with data rate=96,000 Hz)

Type	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay*) (ms)	Rise time (ms)	Overshoot (%)	Data rate (Hz)
Bessel	20000	29250	43000	0.002	0.016	4.1	96000
	10000	16810	40260	0.008	0.023	1.5	96000
	5000	8510	19906	0.027	0.042	0.9	96000
	2000	3515	8275	0.094	0.1	0.6	96000
	1000	1715	4070	0.22	0.2	0.6	96000
	500	852	2008	0.47	0.41	0.6	96000
	200	341	803	1.22	1.01	0.8	96000
	100	171	402	2.5	2.01	0.8	96000
	50	84.2	215	4	4.08	1	19200
	20	33.7	86	10	10.2	1	9600
	10	16.9	43	20	20.6	1	9600
	5	8.41	21.5	40	41	1	4800
	2	3.37	8.6	98	102.8	1	1200
	1	1.68	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	1026	1	300
	0.1	0.17	0.43	1968	2052	1	150
Butterworth	20000	21700	27500	0.025	0.02	15.6	96000
	10000	11100	15500	0.06	0.04	15.6	96000
	5000	5585	8100	0.13	0.08	14.5	96000
	2000	2238	3280	0.3	0.2	14.5	96000
	1000	1119	1640	0.6	0.4	14.5	96000
	500	560	820	1.2	0.8	14.5	96000
	200	237	420	2.1	1.6	11	19200
	100	118	210	4	3.3	11	19200
	50	59	105	7.8	6.6	11	19200
	20	24	42	19.4	16.1	11	4800
	10	11.8	21	38.6	32.4	11	2400
	5	5.9	10.5	76.6	65	11	1200
	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	1900	1630	11	150
	0.1	0.12	0.21	3790	3260	11	150

*) The delay of the A/D converter is 293 µs for all data rates, it has not been accounted for in the "Phase delay" column!

Active low-pass filter data (High-speed mode) MX411-P

(4th order Bessel/Butterworth with data rate < 192,000 Hz; 6th order with data rate = 192,000 Hz)

Type	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay*) (ms)	Rise time (ms)	Overshoot (%)	Data rate (Hz)
Bessel	40000	58500	86000	0.001	0.008	1.6	192000
	20000	33620	80520	0.004	0.012	1.5	192000
	10000	17020	39812	0.0135	0.021	0.9	192000
	4000	7030	16550	0.047	0.05	0.6	192000
	2000	3430	8140	0.11	0.1	0.6	192000
	1000	1704	4016	0.235	0.21	0.6	192000
	400	682	1606	0.61	0.51	0.8	192000
	200	342	804	1.25	1.00	0.8	192000
	100	168.4	430	2	2.04	1	192 00
	40	67.4	172	5	5.1	1	19200
	20	33.8	86	10	10.3	1	19200
	10	16.82	43	20	20.5	1	9600
	4	6.74	17.2	49	51.4	1	2400
	2	3.36	8.6	98	103.2	1	1200
	1.0	1.68	4.3	196	205.6	1	1200
	0.4	0.68	1.72	491	513	1	600
	0.2	0.34	0.86	984	1026	1	300
Butterworth	40000	43400	55000	0.013	0.01	17.8	192000
	20000	22200	31000	0.03	0.02	15.6	192000
	10000	11170	16200	0.07	0.04	14.5	192000
	4000	4476	6560	0.15	0.1	14.5	192000
	2000	2238	3280	0.3	0.2	14.5	192000
	1000	1120	1640	0.6	0.4	14.5	192000
	400	474	840	1.05	0.8	14.5	19200
	200	236	420	2	1.65	11	19200
	100	118	210	3.9	3.3	11	19200
	40	48	84	9.7	8.05	11	9600
	20	23.6	42	19.3	16.2	11	4800
	10	11.8	21	38.3	32.5	11	2400
	4	4.8	8.4	95.5	81.5	11	1200
	2	2.4	4.2	191	162.5	11	600
	1	1.18	2.1	380	326.5	11	600
	0.4	0.48	0.84	950	815	11	300
	0.2	0.24	0.42	1895	1630	11	300

*) The delay of the A/D converter is 141 µs for all data rates, it has not been accounted for in the "Phase delay" column!

Accessories, to be ordered separately

MX460-P accessories		
Article	Description	Order no.
Power		
AC-DC power supply (24 V, ODU IP68)	Input: 90...264V~, 1.5 m cable + internat. plugs; 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; 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; 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. Lengths 0.2 m/2 m/5 m. 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 1-KAB272-2 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. 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. 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 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). 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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