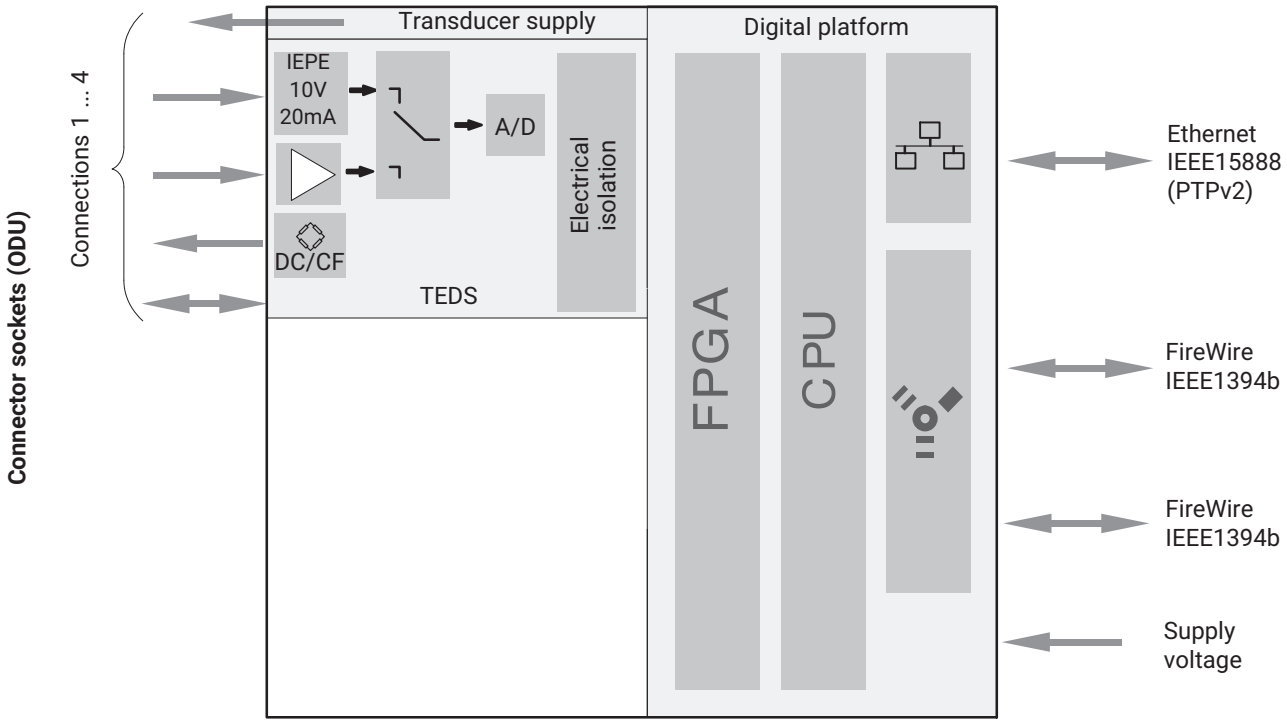
DATA SHEET

SOMAT XR MX411B-R
Ultra-rugged highly dynamic universal amplifier

SPECIAL FEATURES

- 4 individually configurable inputs (electrically isolated)
- Connection of more than 5 transducer technologies
- Sampling rate of up to 100 kS/s per channel, 200 kS/s in 2 channels, active low-pass filter
- TEDS support
- Use in harsh environments (shock, vibration, temperature, dewing, moisture)
- Supply voltage for active transducers

BLOCK DIAGRAM



SPECIFICATIONS MX411B-R

General specifications		
Inputs	number	4, electrically isolated from each other and from the supply[1)]
Transducer technologies per connector		SG full and half bridges, inductive full and half bridges, piezoresistive full bridges, Current-fed piezoelectric transducers (IEPE / ICP®), voltage (±10 V), current (20 mA)
A/D conversion		24 bit delta sigma converter
Sample rates	S/s	Decimal: 0.1 ... 100,000 / 200,000[2)] HBM Classic: 0.1 ... 96,000 / 192,000[2)]
Signal bandwidth, max. (-3 dB)	Hz	0 … 40,000 / 80,000[3)] (Filter off), 0 … 1,600 using carrier frequency
Active low-pass filter		Bessel, Butterworth, linear phase, filter off
Transducer identification (TEDS, IEEE 1451.4) max. TEDS module distance	 m	 100
Transducer connection		ODU MINI-SNAP, 14 pins
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	 < 12 < 15
Transducer excitation (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 (direct IP address or DHCP) ODU MINI-SNAP, 8 pins 100
Synchronization options FireWire IEEE1394b Ethernet PTPv2 IEEE1588 Ethernet NTP		 FireWire based synchronization Ethernet based Precision Time Protocol Ethernet based Network Time Protocol
IEEE1394b FireWire (optional voltage supply) Max. current from module to module Plug Max. cable length between nodes Max. number of modules connected in series (daisy chain) Max. number of modules in a IEEE1394b FireWire system (including hubs[6)]) Max. number of hops	 A - m - - -	IEEE 1394b (HBM modules only) 1.5 ODU MINI-SNAP, 8 pins 5 (optical: 100) 12 (= 11 hops[5)]) 24 14
Nominal (rated) temperature range Altitude de-rating maximum temperature a 0 m maximum temperature a 2500 m maximum temperature a 5000 m	°C [°F] - °C [°F] °C [°F] °C [°F]	-40... +80 [-40 … +176] dew point resistant - +80 [+176] +70 [+158] +55 [+131]
Storage temperature range	°C / °F	-40 ... +85 [-40 … +185]
Relative humidity	%	5 … 100
Protection class		III[7)]
Degree of protection		IP65/IP67 per EN 60529
EMC requirements		per EN 61326-1

Mechanical tests		
Vibration		as per MIL-STD202G, method 204D, test condition C
Acceleration	m/s^2	100
Duration	min	450
Frequency	Hz	5 to 2,000
Impact		as per MIL-STD202G, method 213B, test condition B
Acceleration	m/s^2	750
Pulse duration	ms	6
Number of impacts	-	18
Operational height, max.	m	5,000
Max. input voltage at transducer socket to ground (PIN 13 or PIN 4), without transients		
PIN 1, 2, 5, 8, 11, 12, 14 (bridge and TEDS)	V	±5.5
PIN 3 (voltage)	V	±40
PIN 6 (current)	V	±1.5
PIN 5 (control circuits)	V	+3.3
Dimensions, horizontal (H x W x D)	mm	80 x 205 x 140
Weight, approx.		1,900

1) By using the variable transducer excitation voltage, the electrical isolation to the supply is bridged.
2) Higher sample rate range only when using max. 2 channels
3) Higher bandwidth only when higher sample rates are used (max. 2 channels)
4) Uninterruptible Power Supply (UPS)) for prolonged interruption of power, available as an accessory.
5) Hops: transition from module to module or signal conditioning/distribution via IEEE1394b FireWire (hub, backplane)
6) Hub: IEEE1394b FireWire node or distributor
7) The DC voltage supply must meet the requirements of IEC 60950-1 on a SELV voltage supply.

Strain gauge full bridge and half bridge, bridge excitation: carrier frequency		
Accuracy class		0.05 [8]
Carrier frequency (sine)	Hz	4,800±2
Bridge excitation voltage	V	1 ; 2.5; 5 (±5 %)
Permissible cable length between module and transducer	m	100
Measuring ranges		
at 5 V excitation	mV/V	±4
at 2.5 V excitation	mV/V	±8
at 1 V excitation	mV/V	±20
Switchable shunt resistors (control signals)	kΩ	100 ±0.1%
Transducer impedances		
at 5 V excitation	Ω	300 ... 1,000
at 2.5 V excitation	Ω	110 ... 1,000
at 1 V excitation	Ω	80 ... 1,000
Noise (peak-to-peak) at 25 °C and 5 V excitation		
with 1 Hz Bessel filter	µV/V	< 0.1
with 10 Hz Bessel filter	µV/V	< 0.2
with 100 Hz Bessel filter	µV/V	< 0.5
with 1 kHz Bessel filter	µV/V	< 1.5
Non-linearity	%	< 0.02 of full scale value
Zero drift (full bridge with 5 V excitation)	%/10 K	< 0.02 of full scale value
Full-scale drift (5 V excitation)	%/10 K	< 0.05 of measured value

8) 0.1 with half bridge circuit

Strain gauge full bridge and half bridge, bridge excitation: DC voltage		
Accuracy class		0.05 [9]
Bridge excitation voltage (DC)	V	1 ; 2.5; 5; 7.5 (±8 %)
Permissible cable length between module and transducer	m	100 (at U_B=7.5 V: 50 m)
Measuring ranges		
at 7.5 V excitation	mV/V	±4
at 5 V excitation	mV/V	±4
at 2.5 V excitation	mV/V	±10
at 1 V excitation	mV/V	±20
Switchable shunt resistors (control signals)	kΩ	100 ±0.1%
Transducer impedance		
at 7.5 V excitation	Ω	300 ... 1,000 [10] (max. 50 m cable)
at 5 V excitation	Ω	300 ... 1,000 [10]
at 2.5 V excitation	Ω	110 ... 1,000 [10]
at 1 V excitation	Ω	80 ... 1,000 [10]
Noise (peak-to-peak) at 25 °C and 5 V excitation		
with 1 Hz Bessel filter	µV/V	< 0.15
with 10 Hz Bessel filter	µV/V	< 0.3
with 100 Hz Bessel filter	µV/V	< 0.6
with 1 kHz Bessel filter	µV/V	< 2
with 10 kHz Bessel filter	µV/V	< 9
with filter off	µV/V	< 10
Non-linearity	%	< 0.02 of full scale value
Zero drift (full bridge with 5 V excitation)	%/10 K	< 0.05 [9] of full scale value
Full-scale drift (5 V excitation)	%/10 K	< 0.05 of measured value

[9] 0.1 with half bridge circuit

[10] Range can be extended up to 5 kΩ. In this case: down to 1% absolute zero error.

Inductive full bridge and half bridge, bridge excitation: carrier frequency		
Accuracy class		0.05 [11]
Carrier frequency (sine)	Hz	4,800±2
Bridge excitation voltage	V	1; 2.5 (±8 %)
Permissible cable length between module and transducer	m	100
Measuring ranges		
at 2.5 V excitation	mV/V	±100
at 1 V excitation	mV/V	±250
Transducer impedances		
at 2.5 V excitation	Ω	110 ... 1,000
at 1 V excitation	Ω	80 ... 1,000
Noise (peak-to-peak) at 25 °C and 2.5 V excitation		
with 1 Hz Bessel filter	µV/V	< 2
with 10 Hz Bessel filter	µV/V	< 4
with 100 Hz Bessel filter	µV/V	< 12
with 1 kHz Bessel filter	µV/V	< 40
Non-linearity	%	< 0.02 of full scale value
Zero drift (full bridge with 2.5 V excitation)	%/10 K	< 0.01 [11] of full scale value
Full-scale drift (2.5 V excitation)	%/10 K	< 0.05 of measured value

[11] 0.1 with half bridge circuit

Piezoresistive full bridge, bridge excitation: DC voltage		
Accuracy class		0.05 [12)]
Bridge excitation voltage (DC)	V	2.5; 5 (±5 %)
Permissible cable length between module and transducer	m	100
Measuring ranges		
at 5 V excitation	mV/V	±50
at 2.5 V excitation	mV/V	±100
Transducer impedances		
at 5 V excitation	Ω	110 ... 5,000
at 2.5 V excitation	Ω	110 ... 5,000
Noise (peak-to-peak) at 25 °C and 5 V excitation		
with 1 Hz Bessel filter	µV/V	< 2
with 10 Hz Bessel filter	µV/V	< 3
with 100 Hz Bessel filter	µV/V	< 8
with 1 kHz Bessel filter	µV/V	< 25
with 10 kHz Bessel filter	µV/V	< 130
with filter off	µV/V	< 150
Non-linearity	%	< 0.02 of full scale value
Zero drift (5 V excitation)	%/10 K	< 0.03 [12)] of full scale value
Full-scale drift (5 V excitation)	%/10 K	< 0.05 of measured value

[12)] 0.1 with half bridge circuit

Voltage ±10 V		
Accuracy class		0.03
Permissible cable length between module and transducer	m	100
Measuring range	V	±10
Internal resistance of connected voltage source	kΩ	< 5
Input impedance	MΩ	> 10
Noise (peak-to-peak) at 25 °C		
with 1 Hz Bessel filter	µV	< 25
with 10 Hz Bessel filter	µV	< 50
with 100 Hz Bessel filter	µV	< 100
with 1 kHz Bessel filter	µV	< 300
with 10 kHz filter	µV	< 600
with filter off / 9600 values/s	µV	<1,000
Non-linearity	%	< 0.02 of full scale value
Common-mode rejections		
at DC common mode	dB	> 100
at 50 Hz common mode	dB	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		
Accuracy class		0.03
Permissible cable length between module and transducer	m	100
Measuring range	mA	±20
Measuring resistance value	Ω	50
Noise (peak-to-peak) at 25 °C		
with 1 Hz Bessel filter	µA	< 0.5
with 10 Hz Bessel filter	µA	< 1.5
with 100 Hz Bessel filter	µA	< 10
with 1 kHz Bessel filter	µA	< 20
with 10 kHz Bessel filter	µA	< 28
with filter off	µA	< 30
Non-linearity	%	< 0.02 of full scale value
Common-mode rejections		
at DC common mode	dB	> 100
at 50 Hz common mode	dB	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-fed piezoelectric transducers (IEPE, CCLD, ICP®)		
Accuracy class		0.1
Permissible cable length between module and transducer May be laid inside closed buildings only	m	< 30
Transducer excitation	mA	4 mA ±15%
Measuring ranges (AC)	V	±2; ±10
IEPE compliance voltage, typ.	V	21
Signal bandwidth (-3 dB)	Hz	0.34 ... 40,000 / 80,000 [13)]
Noise (peak-to-peak) at 25 °C and measuring range ±10 V		
for 1 Hz Bessel filter	µV	< 25
for 10 Hz Bessel filter	µV	< 50
for 100 Hz Bessel filter	µV	< 100
for 1 kHz Bessel filter	µV	< 300
for 10 kHz Bessel filter	µV	< 600
for filter off	µV	<1,000
Non-linearity	%	< 0.1 of full scale value
Common-mode rejections		
at DC common mode	dB	> 100
at 50 Hz common mode, typically	dB	75
Max. Common-mode voltage (to housing and supply ground)	V	±60
Zero drift	%/10 K	< 0.1 of full scale value
Full-scale drift	%/10 K	< 0.03 of measured value

13) Larger bandwidth only when using higher sampling rates (max. 2 channels)

Real-time calculation at the module		
Root mean square value (RMS)		4
Peak value		
Number of peak values		8
Output rate, max.	Hz	4,800

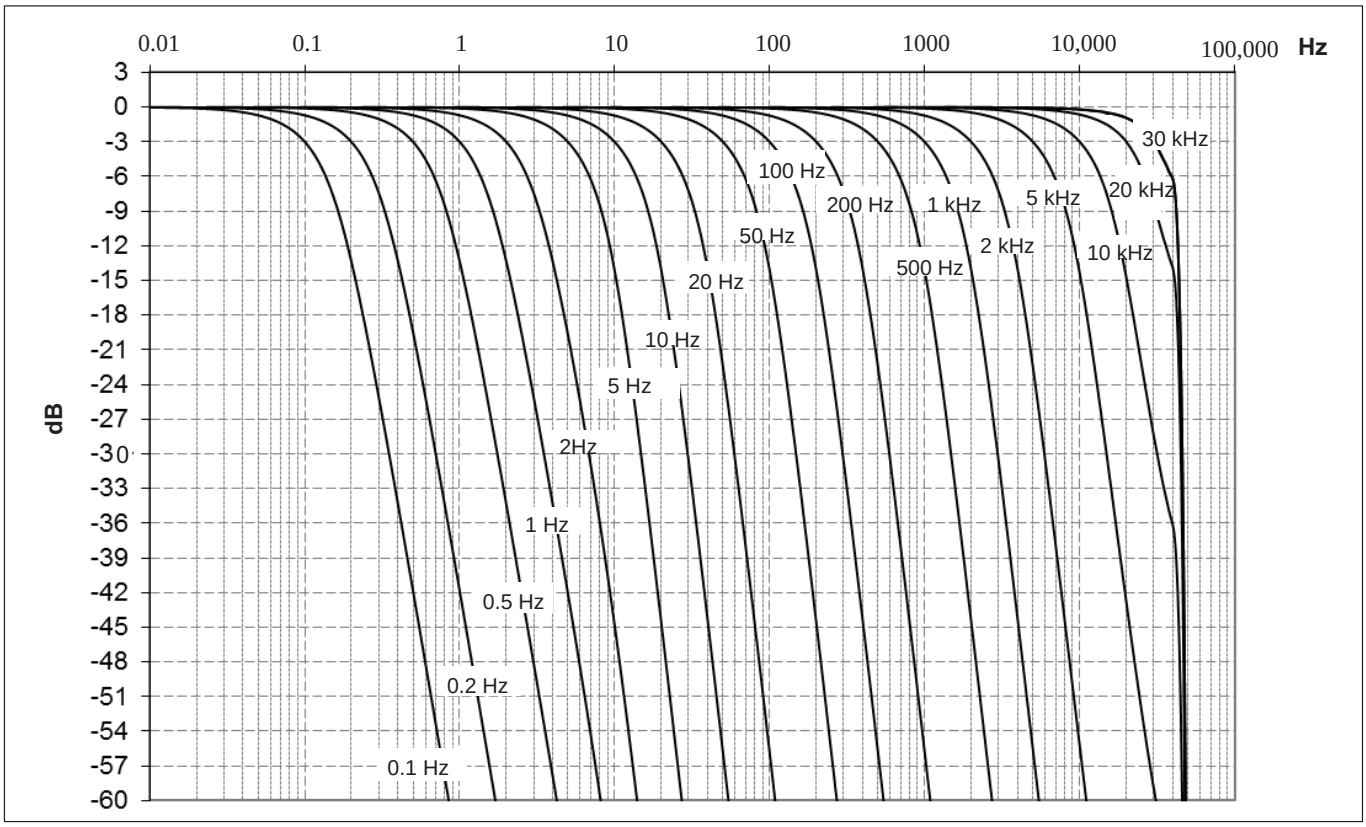
DECIMAL SAMPLE RATES AND BESSEL DIGITAL LOW-PASS FILTERS

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

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime[1)] (ms)	Rise time (ms)	Overshoot (%)	Sample 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	0.20	0.8	100,000
	584	1,000	2,350	0.40	0.30	0.6	100,000
	292	500	1,175	0.82	0.70	0.6	100,000
	117	200	470	2.10	1.70	0.6	100,000
	58.0	100	235	4.20	3.50	0.6	100,000
	29.2	50	117.5	8.50	7.0	0.6	100,000
	11.7	20	47	21.3	17.0	0.6	100,000
	5.80	10	23.5	42.7	35.0	0.6	100,000
	2.91	5	11.74	85.5	70.0	0.6	100,000
	1.19	2	5.04	187	175	0.9	1,000
	0.59	1	2.54	351	350	0.8	1,000
	0.30	0.5	1.27	680	700	0.8	1,000
	0.12	0.2	0.51	1,669	1,751	0.8	1,000
	0.06	0.1	0.25	3,315	3,499	0.8	1,000

1) The A/D converter's delay time for all sample rates is 277 µs and this is not taken into account in the "runtime" column!

DECIMAL SAMPLE RATES : BESSEL FILTER AMPLITUDE RESPONSE



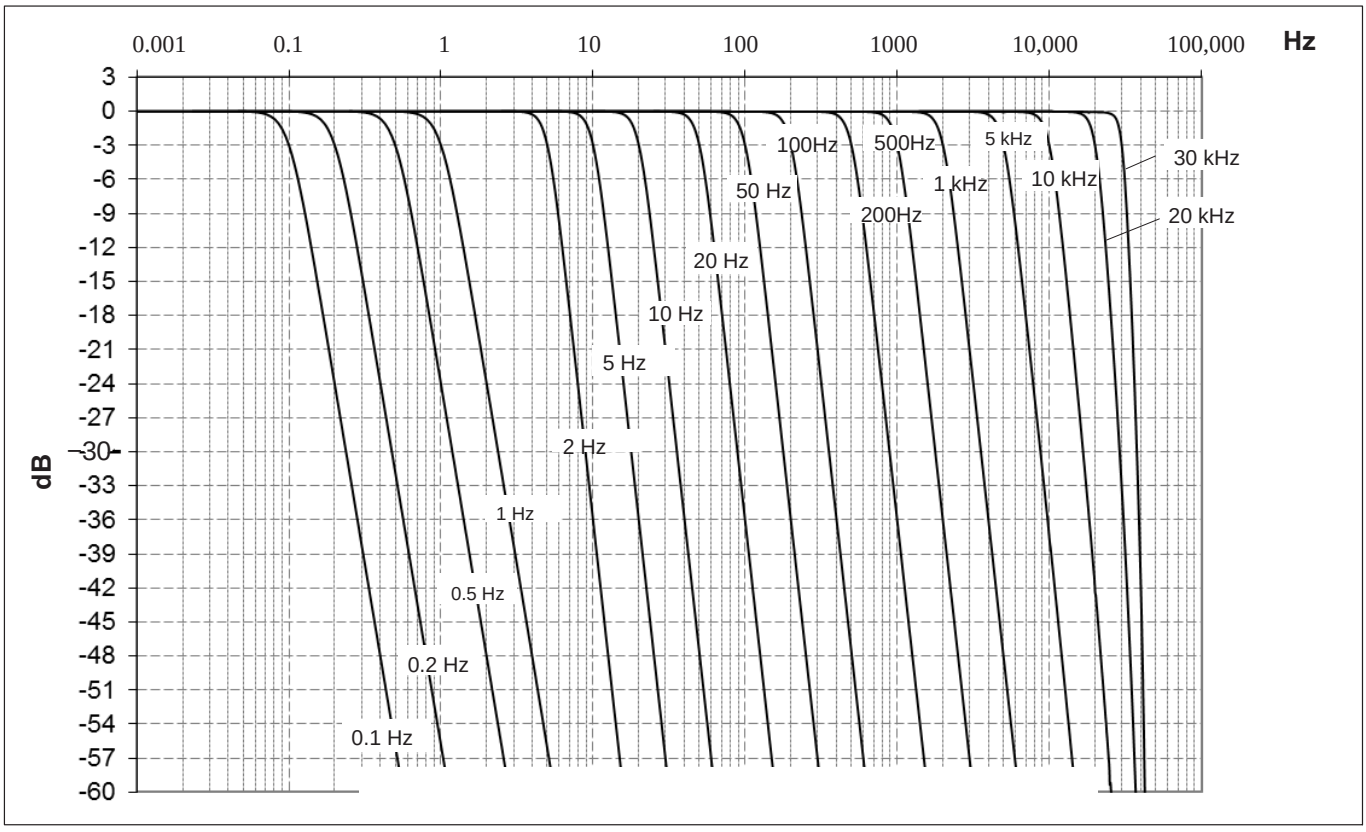
DECIMAL SAMPLE RATES AND BUTTERWORTH DIGITAL LOW-PASS FILTERS

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

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime[1)] (ms)	Rise time (ms)	Overshoot (%)	Sample 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	0.10	0.09	15	100,000
	1,787	2,000	2,929	0.30	0.20	14	100,000
	894	1,000	1,466	0.70	0.40	14	100,000
	447	500	733	1.30	0.80	14	100,000
	179	200	293	3.30	2.00	14	100,000
	89	100	147	6.60	4.00	14	100,000
	44.7	50	73.3	13.0	8.00	14	100,000
	17.9	20	29.3	33.0	21.0	14	100,000
	8.9	10	14.7	66.0	43.0	14	100,000
	4.47	5	7.33	132	85.0	14	100,000
	1.69	2	3.55	248	194	11	1,000
	0.84	1	1.78	471	387	11	1,000
	0.42	0.5	0.89	921	774	11	1,000
	0.17	0.2	0.35	2,266	1,934	11	1,000
	0.08	0.1	0.18	4,510	3,869	11	1,000

1) The A/D converter's delay time for all sample rates is 277 µs and this is not taken into account in the "runtime" column!

DECIMAL HBM SAMPLE RATES : BUTTERWORTH FILTER AMPLITUDE RESPONSE



DECIMAL SAMPLE RATES AND DIGITAL LOW-PASS FILTERS (TWO-CHANNEL MODE), BESSEL

4th order for sample rates < 200,000 Hz; 6th order for sample rate = 200,000 Hz

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime[1)] (ms)	Rise time (ms)	Overshoot (%)	Sample rate (Hz)
Bessel	41,232	60,000	89,200	0.001	0.005	2.8	200,000
	24,746	40,000	86,000	0.0025	0.01	1.0	200,000
	11,834	20,000	46,930	0.01	0.02	0.8	200,000
	5,858	10,000	23,430	0.03	0.035	0.8	200,000
	2,328	4,000	8,400	0.09	0.10	0.8	200,000
	1,168	2,000	4,700	0.40	0.15	0.6	200,000
	584	1,000	2,350	0.82	0.35	0.6	200,000
	234	400	940	2.10	0.85	0.6	200,000
	116	200	470	4.20	1.75	0.6	200,000
	58.4	100	235	8.50	3.50	0.6	200,000
	23.4	40	94	21.3	8.50	0.6	200,000
	11.6	20	47	42.7	17.50	0.6	200,000
	5.82	10	23.48	85.5	35.0	0.6	200,000
	2.38	4	10.08	187	87.5	0.9	1,000
	1.18	2	5.08	351	175	0.8	1,000
	0.60	1	2.54	680	350	0.8	1,000
	0.24	0.4	1.02	1,669	875	0.8	1,000
	0.12	0.2	0.50	3,315	1,750	0.8	1,000

1) The A/D converter's delay time for all sample rates is 140 µs and this is not taken into account in the "runtime" column!

DECIMAL SAMPLE RATES AND DIGITAL LOW-PASS FILTERS (TWO-CHANNEL MODE), BUTTERWORTH

4th order for sample rates < 200,000 Hz; 6th order for sample rate = 200,000 Hz

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime[1)] (ms)	Rise time (ms)	Overshoot (%)	Sample rate (Hz)
Butterworth	56,538	60,000	70,718	0.01	0.01	193	200,000
	36,656	40,000	52,018	0.015	0.015	17.6	200,000
	17,988	20,000	28,310	0.03	0.02	15.5	200,000
	8,950	10,000	14,530	0.05	0.045	15	200,000
	3,576	4,000	5,858	0.15	0.10	14	200,000
	1,788	2,000	2,932	0.35	0.20	14	200,000
	894	1,000	1,466	0.65	0.40	14	200,000
	358	400	586	1.65	1.00	14	200,000
	178	200	294	3.30	2.00	14	200,000
	89.4	100	147	6.50	4.00	14	200,000
	35.8	40	59	16.5	10.5	14	200,000
	17.8	20	29.4	33.0	21.5	14	200,000
	8.94	10	14.66	66.0	42.5	14	200,000
	3.38	4	7.1	124	97.0	11	1,000
	1.68	2	3.6	235	193	11	1,000
	0.84	1	1.78	460	387	11	1,000
	0.34	0.4	0.70	1,133	967	11	1,000
	0.16	0.2	0.36	2,255	1,934	11	1,000

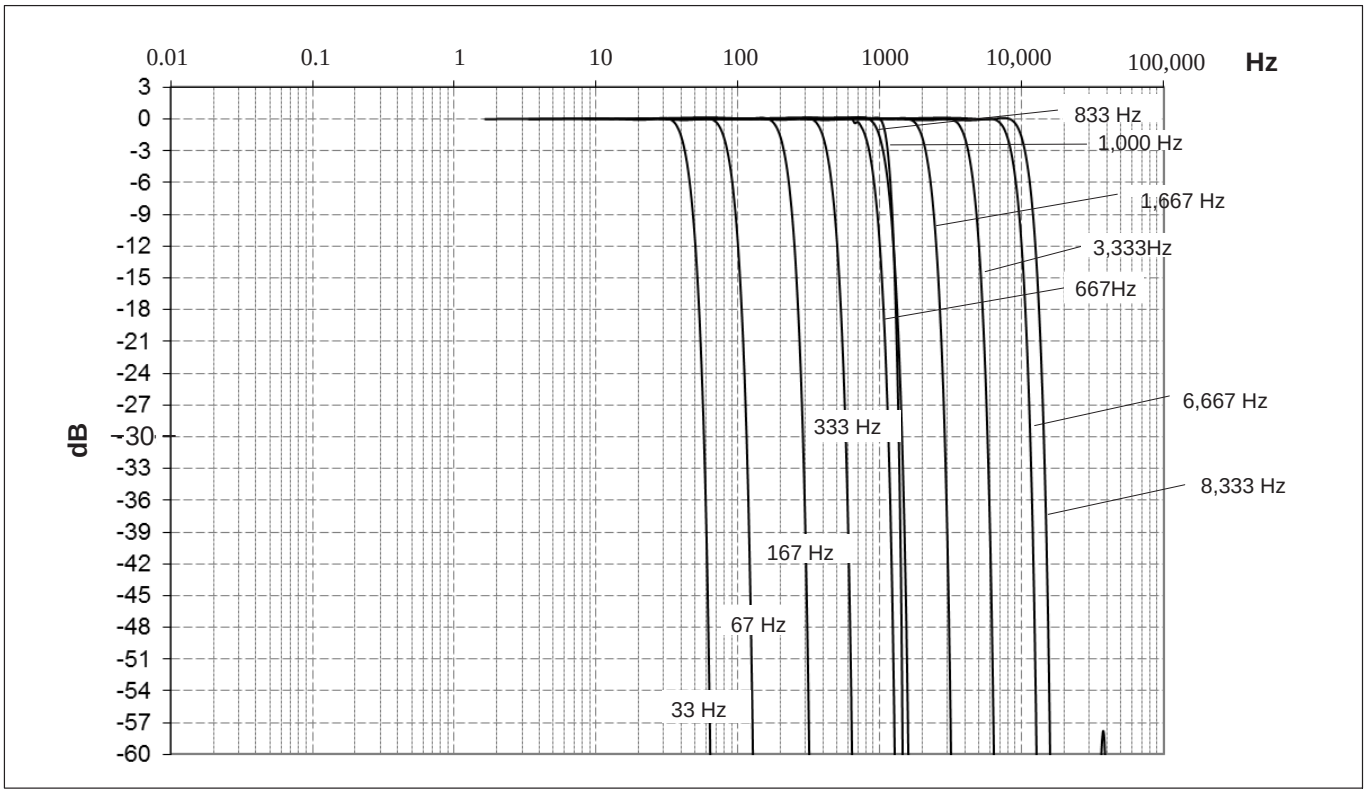
1) The A/D converter's delay time for all sample rates is 140 µs and this is not taken into account in the "runtime" column!

DECIMAL SAMPLE RATES AND DIGITAL LOW-PASS FILTERS, LINEAR PHASE (FIR)

Type	Start of level drop	-3 dB (Hz)	-20 dB (Hz)	Runtime[1)] (ms)	Rise time (ms)	Overshoot (%)	Sample rate (Hz)
Linear phase	8,333	10,530	13,460	1,130	0,055	8,6	25,000
	6,667	8,380	10,780	0.410	0,07	8,6	20,000
	3,333	3,900	4,580	0.802	0.117	8.6	20,000
	1,667	2,100	2,694	2.41	0.274	8.6	5,000
	1,000	1,130	1,308	6.21	0.544	8.6	2,500
	833	1,050	1,346	4.01	0.551	8.6	2,500
	667	838	1,078	4.80	0.694	8.6	1,000
	333	420	539	10.4	1.39	8.6	1,000
	167	210	269	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

1) The A/D converter's delay time for all sample rates is 277 µs and this is not taken into account in the "runtime" column!

DECIMAL SAMPLE RATES: AMPLITUDE RESPONSE, LINEAR PHASE (FIR)

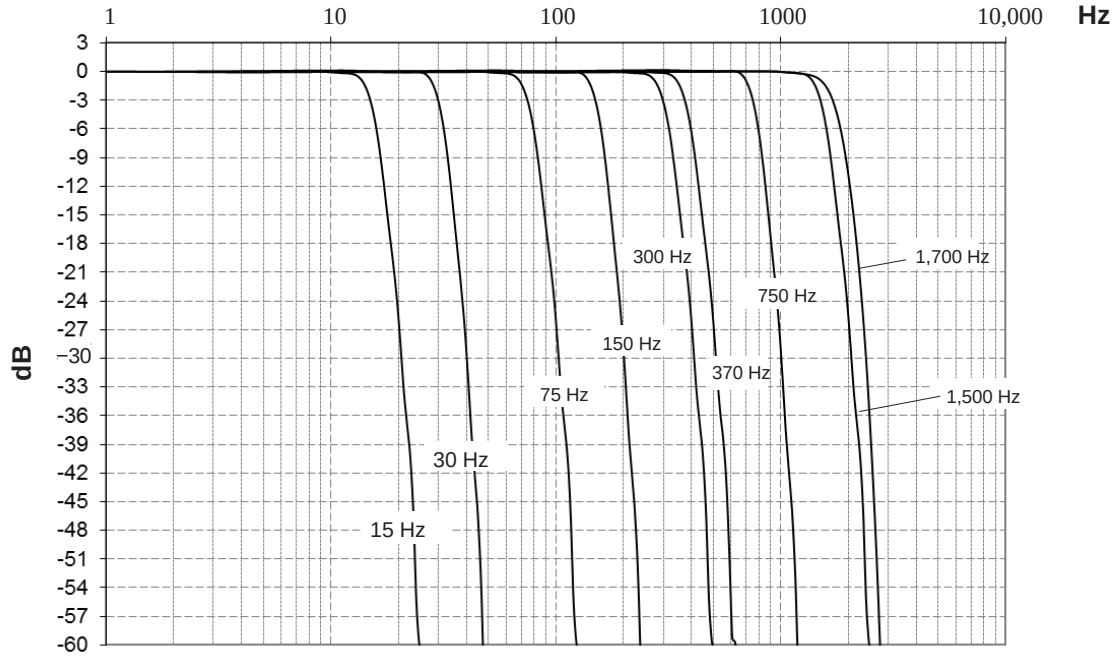


DECIMAL SAMPLE RATES AND DIGITAL LOW-PASS FILTERS, BUTTERWORTH (FIR)

Type	Start of level drop	-3 dB (Hz)	-20 dB (Hz)	Runtime[1)] (ms)	Rise time (ms)	Overshoot (%)	Sample 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	2,000
	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

1) The A/D converter's delay time for all sample rates is 277 µs and this is not taken into account in the "runtime" column!

DECIMAL SAMPLE RATES: BUTTERWORTH FILTER AMPLITUDE RESPONSE (FIR)



CLASSIC HBM SAMPLE RATES AND DIGITAL LOW-PASS FILTERS, BESSEL

4th order for sample rates < 96,000 Hz; 6th order for sample rate = 96,000 Hz

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime[1] (ms)	Rise time (ms)	Overshoot (%)	Sample 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

1) The A/D converter's delay time for all sample rates is 293 µs and this is not taken into account in the ”runtime” column!

CLASSIC HBM SAMPLE RATES AND BUTTERWORTH DIGITAL LOW-PASS FILTERS

4th order for sample rates < 96,000 Hz; 6th order for sample rate = 96,000 Hz

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime[1] (ms)	Rise time (ms)	Overshoot (%)	Sample 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

1) The A/D converter's delay time for all sample rates is 293 µs and this is not taken into account in the ”runtime” column!

CLASSIC HBM SAMPLE RATES AND DIGITAL LOW-PASS FILTERS (TWO-CHANNEL MODE), BESSEL

4th order for sample rates < 192,000 Hz; 6th order for sample rate = 192,000 Hz

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime[1)] (ms)	Rise time (ms)	Overshoot (%)	Sample rate (Hz)
Bessel	40,000	58,500	86,000	0.001	0.008	1.6	192,000
	20,000	33,620	80,520	0.004	0.012	1.5	192,000
	10,000	17,020	39,812	0.0135	0.021	0.9	192,000
	4,000	7,030	16,550	0.047	0.05	0.6	192,000
	2,000	3,430	8,140	0.11	0.1	0.6	192,000
	1,000	1,704	4,016	0.235	0.21	0.6	192,000
	400	682	1,606	0.61	0.51	0.8	192,000
	200	342	804	1.25	1.00	0.8	192,000
	100	168.4	430	2	2.04	1	192,000
	40	67.4	172	5	5.1	1	192,000
	20	33.8	86	10	10.3	1	192,000
	10	16.82	43	20	20.5	1	9,600
	4	6.74	17.2	49	51.4	1	2,400
	2	3.36	8.6	98	103.2	1	1,200
	1.0	1.68	4.3	196	205.6	1	1,200
	0.4	0.68	1.72	491	513	1	600
	0.2	0.34	0.86	984	1,026	1	300

1) The A/D converter's delay time for all sample rates is 141 µs and this is not taken into account in the "runtime" column!

CLASSIC HBM SAMPLE RATES AND DIGITAL LOW-PASS FILTERS (TWO-CHANNEL MODE), BUTTERWORTH

4th order for sample rates < 192,000 Hz; 6th order for sample rate = 192,000 Hz

Type	-1 dB (Hz)	-3 dB (Hz)	-20 dB (Hz)	Runtime[1)] (ms)	Rise time (ms)	Overshoot (%)	Sample rate (Hz)
Butterworth	40,000	43,400	55,000	0.013	0.01	17.8	192,000
	20,000	22,200	31,000	0.03	0.02	15.6	192,000
	10,000	11,170	16,200	0.07	0.04	14.5	192,000
	4,000	4,476	6,560	0.15	0.1	14.5	192,000
	2,000	2,238	3,280	0.3	0.2	14.5	192,000
	1,000	1,120	1,640	0.6	0.4	14.5	192,000
	400	474	840	1.05	0.8	14.5	192,000
	200	236	420	2	1.65	11	192,000
	100	118	210	3.9	3.3	11	192,000
	40	48	84	9.7	8.05	11	9,600
	20	23.6	42	19.3	16.2	11	4,800
	10	11.8	21	38.3	32.5	11	2,400
	4	4.8	8.4	95.5	81.5	11	1,200
	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	1,895	1,630	11	300

1) The A/D converter's delay time for all sample rates is 141 µs and this is not taken into account in the "runtime" column!

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