DATA SHEET

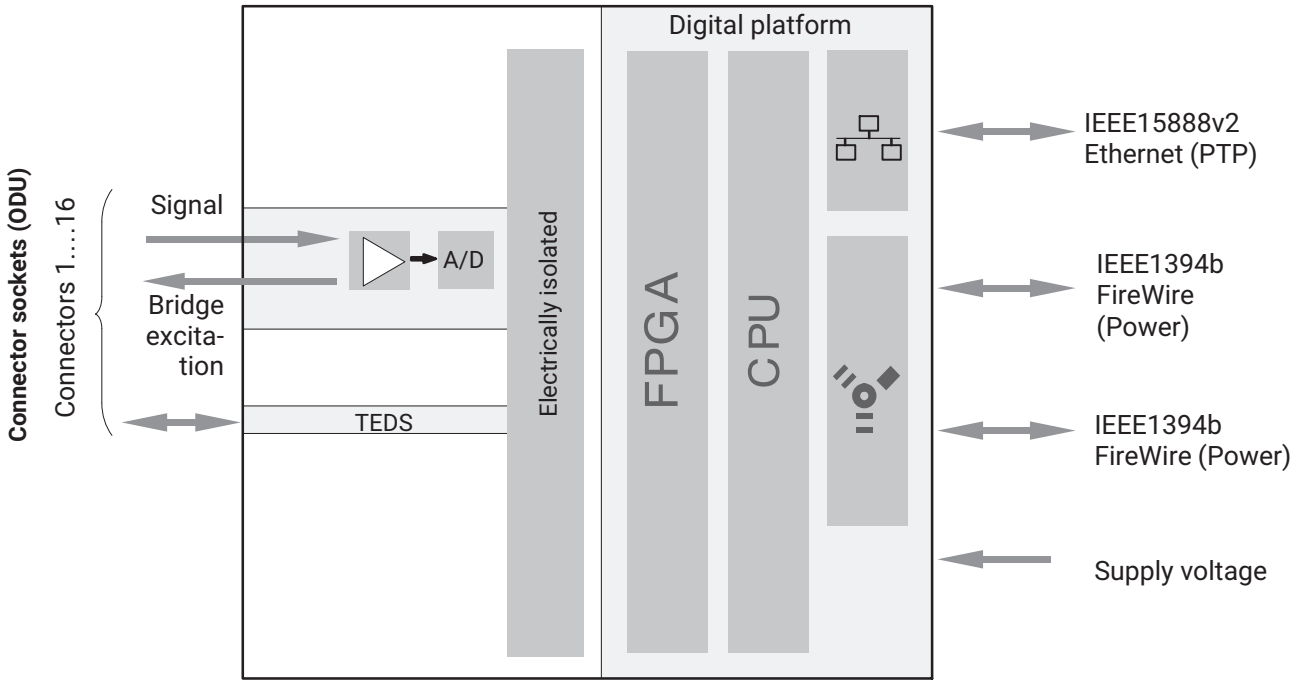
SOMAT XR

MX1615B-R
Ultra-rugged Bridge Amplifier

SPECIAL FEATURES

- 16 individually configurable inputs
- Connection of strain gages in half-, full- or quarter-bridge (120 Ohm or 350 Ohm)
- Bridge excitation: DC or carrier frequency (CF)
- Internal shunt calibration resistors, software controlled
- Connection of electrical voltage (60 V), Resistance thermometer, Resistor, Potentiometric transducer
- Sample rate up to 20 kS/s per channel, active low-pass filter
- TEDS support
- Use in harsh environments (shock, vibration, temperature, dewing, moisture)

BLOCK DIAGRAM



SPECIFICATIONS MX1615B-R

General specifications			
Inputs	Number	16, electrically isolated to supply voltage	
Supported transducer technologies		Strain gauges in full- , half- or quarter-bridge configuration (selectable internal 120 or 350 ohm completion resistor) Selectable bridge excitation voltage : voltage or carrier frequency with 1,200/1,250 Hz	
		SG-quarter bridges SG-half bridges SG-full bridges	Three wire and four wire five wire six wire
		Resistor, Resistance thermometer (Pt100, Pt500, Pt1000 - just one type per module)	
		Potentiometric transducers	
		Voltage (± 60 V) without transducer supply	
A/D converter		24 Bit Delta Sigma Converter	
Sample rates	S/s	Decimal: 0.1 … 20,000 HBM Classic: 0.1 … 19,200	
Signal bandwidth, max. (-3 dB)	Hz	0 … 3,900 (Linear Phase FIR filter), 0 … 400 using carrier frequency	
Active low-pass filter		Bessel, Butterworth, Linear Phase, Filter off[1)]	
Transducer identification (TEDS, IEEE 1451.4) Max. distance of the TEDS module	 m	 100	
Transducer connection		ODU MINI-SNAP, 14 pins	
Supply voltage range (DC)	V	10 ... 30 (24 V nominal (rated) voltage)	
Supply voltage interruption, max. (at 24 V)	ms	5[2)]	
Power consumption	W	< 12	
Ethernet (data link) Protocol (Addressing) Connector Max. cable length to module	 - - m	10Base-T / 100Base-TX TCP/IP (static IP, APIPA or DHCP / IPv4 or IPv6) 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 supply voltage) Max. current from module to module Connector Max. cable length between the nodes Max. number of modules connected in series (daisy chain) Max. number of modules in a IEEE1394b FireWire system (including hubs[4)]) Max. number of hops	 A m - - -	IEEE 1394b (HBM modules only) 1.5 ODU MINI-SNAP, 8 pins 5 (optical: 100) 12 (=11 Hops[3)]) 24 14	
Nominal (rated) temperature range Altitude de-rating maximum temperature at 0 m maximum temperature at 2500 m maximum temperature at 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[5)]	

Degree of protection (dust, humidity/water)		IP65/IP67 per EN 60529
EMC requirements		CE conformity test per EN 61326-1
Mechanical test		
Vibration		accord. MIL-STD202G, Method 204D, Test condition C
Acceleration	m/s^2	100
Duration	min	450
Frequency	Hz	5 bis 2,000
Shock		accord. MIL-STD202G, Method 213B, Test condition B
Acceleration	m/s^2	750
Pulse duration	ms	6
Number of impacts	-	18
Operating altidude, max.	m	5,000
Max. input voltage at transducer socket, transient free		
Pin 3 to Pin 4	V	±60
Pin 1, 2, 7, 8, 11, 12 or 14 to Pin 13	V	+ 5.5
Dimensions, horizontal (H x W x D)	mm	80 x 205 x 140
Weight, approx.	g [pound]	2,300 [5.07]

1) „Filter OFF" is recommended only for real-time applications to achieve short latencies.
2) Uninterruptible Power Supply (UPS) for prolonged interruption of power, available as an accessory.
3) Hops: Transition from module to module or signal conditioning / distribution via IEEE1394b FireWire (hub, backplane).
4) Hub: IEEE1394b FireWire node or distributor
5) The DC voltage supply must meet the requirements of IEC 60950-1 on a SELV voltage supply.

Strain gauge full or half bridge, bridge excitation: carrier frequency		
Accuracy class		0.05 6)
Carrier frequency (square)	Hz	Decimal: 1,250 ±2 HBM Classic: 1,200 ±2
Bridge excitation voltage (effective)	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
Control signals (Shunt)		
Shunt resistance (for pos. signal)	kΩ	100 ± 0.1 %, to positive excitation
Shunt resistance (for neg. signal)	kΩ	100 ± 0.1 %, to negative excitation
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 filter 1 Hz Bessel	µV/V	< 0.2
with filter 10 Hz Bessel	µV/V	< 0.5
with filter 100 Hz Bessel	µV/V	< 1.5
Linearity error	%	< 0.02 of full scale
Zero drift (Full bridge with 5 V excitation)	%/10 K	< 0.01 of full scale
Full-scale drift (5 V excitation)	%/10 K	< 0.05 of measurement value

6) Due to the higher zero error, the accuracy class of half bridge strain gages is 0.5. The more important linearity deviation remains < 0.02%.

Strain gauge full or half bridge, bridge excitation: DC voltage		
Accuracy class		0.1 7)
Bridge excitation voltage (DC)	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
Control signals (Shunt)		
Shunt resistance (for pos. signal)	kΩ	100 ± 0.1 %, to positive excitation
Shunt resistance (for neg. signal)	kΩ	100 ± 0.1 %, to negative excitation
Transducer impedances		
at 5 V excitation	Ω	300 … 1,000 [8)]
at 2.5 V excitation	Ω	110 … 1,000 [8)]
at 1 V excitation	Ω	80 … 1,000 [8)]
Noise (peak to peak) at 25 °C and 5 V excitation		
with filter 1 Hz Bessel	µV/V	< 0.2
with filter 10 Hz Bessel	µV/V	< 0.4
with filter 100 Hz Bessel	µV/V	< 1
with filter 1 kHz Bessel	µV/V	< 3
Linearity error	%	< 0.02 of full scale
Zero drift (Full bridge with 5 V excitation)	% / 10 K	< 0.1 of full scale
Full-scale drift (5 V excitation)	% / 10 K	< 0.05 of measurement value

7) Due to the higher zero error, the accuracy class of half bridge strain gages is 0.2. The more important linearity deviation remains < 0.02%.
8) A higher transducer impedance is possible (< 5 kΩ). This merely results in a higher zero error and thus an accuracy class of 0.3.

Strain gauges quarter bridge, bridge excitation: carrier frequency[9)]		
Accuracy class		0.1 [10)]
Carrier frequency (square)	Hz	Decimal: 1,250 ±2 HBM Classic: 1,200 ±2
Bridge excitation voltage (effective)	V	0.5; 1; 2.5; 5 (± 5 %)
Permissible cable length between module and transducer	m	< 100
Measuring ranges		
at 5 V excitation (only at 350 Ohm strain gage)	mV/V	±4
at 2.5 V excitation	mV/V	±8
at 1 V excitation	mV/V	±20
at 0.5 V excitation	mV/V	±40
Control signals (Shunt)		
Shunt resistance (via completion resistor, for pos. signal)	kΩ	100 ± 0.1 %
Shunt resistance (via external strain gage, for neg. signal)	kΩ	100 ± 0.1 %
Internal completion resistors	Ω	120 and 350
Noise[11)] (peak to peak) at 25 °C and 5 V excitation		
with filter 1 Hz Bessel	µV/V	< 0.3
with filter 10 Hz Bessel	µV/V	< 0.6
with filter 100 Hz Bessel	µV/V	< 1.5
Linearity error[11)]	%	< 0.05 of full scale
Zero drift[11)] (5 V excitation)	%/10 K	< 0.1 of full scale
Full-scale[11)] drift (5 V excitation)	%/10 K	< 0.05 of measurement value

9) 3-wire circuit with carrier frequency-based bridge excitation voltage is supported for modules as of February 2017.
10) Accuracy class focusses on linearity. Zero point deviation is 0.5% of range.
11) With 350 ohm resistor and connection in four-wire circuit.

Strain gauges quarter bridge, bridge excitation: DC voltage		
Accuracy class		0.1 [12)]
Bridge excitation voltage (DC)	V	0.5; 1; 2.5; 5 (± 5 %)
Permissible cable length between module and transducer	m	< 100

Measuring ranges		
at 5 V excitation (only at 350 Ohm strain gage) at 2.5 V excitation at 1 V excitation at 0.5 V excitation	mV/V mV/V mV/V mV/V	±4 ±8 ±20 ±40
Control signals (Shunt)		
Shunt resistance (via completion resistor, for pos. signal) Shunt resistance (via external strain gage, for neg. signal)	kΩ kΩ	100 ± 0.1 % 100 ± 0.1 %
Internal completion resistors	Ω	120 and 350
Noise[13] (peak to peak) at 25 °C and 5 V excitation		
with filter 1 Hz Bessel with filter 10 Hz Bessel with filter 100 Hz Bessel with filter 1 kHz Bessel	µV/V µV/V µV/V µV/V	< 0.4 < 0.6 < 1.5 < 3
Linearity error[13]	%	< 0.05 of full scale
Zero drift[13] (5 V excitation)	% / 10 K	<0.1 of full scale
Full-scale[13] drift (5 V excitation)	% / 10 K	< 0.05 of measurement value

[12] Accuracy class focusses on linearity. Zero point deviation is 0.5% of range.
[13] With 350 ohm resistor and connection using a four-wire circuit.

Potentiometric transducer		
Accuracy class		0.1
Excitation voltage (DC)	V	1 (± 5 %)
Permissible cable length between module and transducer	m	< 100
Measuring range	mV/V	± 500
Transducer impedance	Ω	100 ... 50,000
Noise (peak to peak) at 25 °C		
with filter 1 Hz Bessel with filter 10 Hz Bessel with filter 100 Hz Bessel with filter 1 kHz Bessel	µV/V µV/V µV/V µV/V	< 2 < 4 < 10 < 30
Linearity error	%	< 0.05 of full scale
Zero drift	%/10 K	< 0.1 of full scale
Full-scale drift	%/10 K	< 0.1 of measurement value

Voltage ±60 V		
Accuracy class		0.05
Permissible cable length between module and transducer	m	< 100
Measuring range	V	±60
Internal resistance of the connected voltage source	Ω	< 500
Input impedance	MΩ	> 2
Noise (peak to peak) at 25 °C		
at 1 Hz Bessel filter at 10 Hz Bessel filter at 100 Hz Bessel filter at 1 kHz Bessel filter	µV µV µV µV	150 300 600 2,000
Linearity error	%	< 0.02 of full scale
Common-mode rejection		
at DC common-mode at 50 Hz common-mode, typically	dB dB	> 90 75
Max. common-mode voltage		
to housing and supply ground	V	± 60

Zero drift	% / 10 K	< 0.03 of full scale
Full-scale drift	% / 10 K	< 0.03 of measurement value

Resistance		
Accuracy class		0.1
Transducers that can be connected		PTC, NTC, KTY, TT-3, resistances in general
Permissible cable length between module and transducer	m	< 100
Measuring range	Ω	0 ... 1,000[14)]
Excitation current	mA	0.37 ... 1.43
Noise (peak to peak) at 25 °C		
with filter 1 Hz Bessel	Ω	< 0.1
with filter 10 Hz Bessel	Ω	< 0.2
with filter 100 Hz Bessel	Ω	< 0.5
with filter 1 kHz Bessel	Ω	< 1.5
Linearity error	%	< 0.05 of full scale
Zero drift	%/10 K	< 0.02 of full scale
Full-scale drift	%/10 K	< 0.1 of measurement value

14) Measuring range can be extended up to 5 kΩ, in this case: accuracy class 2

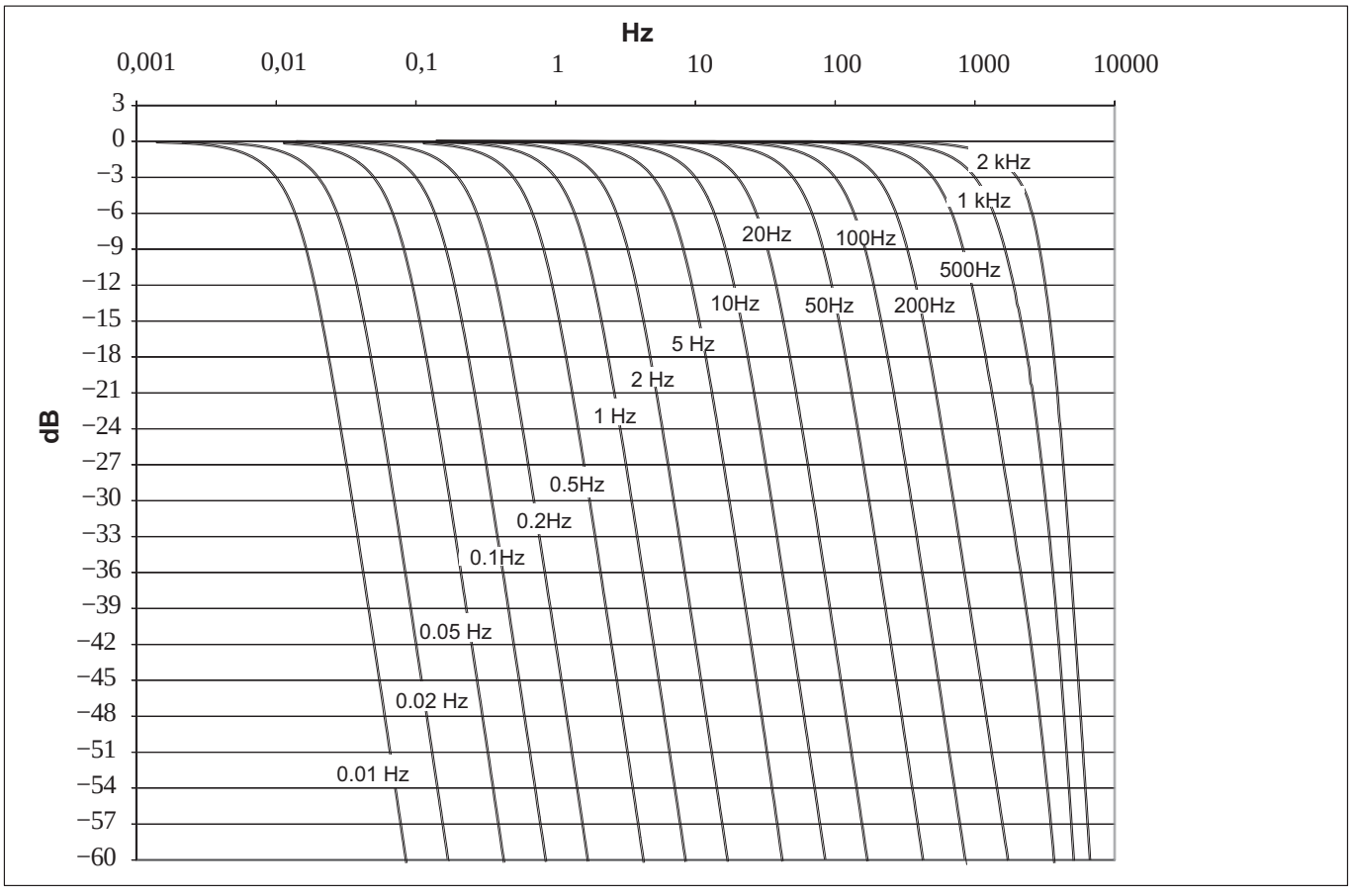
Resistance thermometer (Pt100, Pt500, Pt1000 - just one type per module)		
Accuracy class		0.1
Permissible cable length between module and transducer	m	< 100
Linearization range	°C [°F]	-200 ... +848 [-328 ... +1,558.4]
Excitation voltage (DC)	V	0.5 (±5 %)
Noise (peak to peak) at 25 °C		
with filter 1 Hz Bessel	K	< 0.02
with filter 10 Hz Bessel	K	< 0.04
with filter 100 Hz Bessel	K	< 0.1
with filter 1 kHz Bessel	K	< 0.3
Linearity error	K	< ± 0.3
Zero drift	K/10 K	< 0.2
Full-scale drift	K/10 K	< 0.5

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

Type	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay*) (ms)	Rise time (ms)	Overshoot (%)	Rate (Hz)
Bessel	1,203	2,000	3,830	0.113	0.189	2.1	20,000
	596	1,000	2,494	0.256	0.355	1.0	20,000
	298	500	1,278	0.581	0.701	0.9	20,000
	119	200	509	1.56	1.76	0.9	20,000
	59	100	254	3.21	3.51	0.9	20,000
	29.6	500	127.1	6.50	7.01	0.9	20,000
	11.8	20	50.8	16.4	17.6	0.9	20,000
	5.9	10	25.4	32.9	35.1	0.9	20,000
	2.96	5	12.70	69.0	70.1	0.9	10,000
	1.18	2	5.08	168	176	0.9	10,000
	0.59	1	2.54	333	351	0.9	5,000
	0.295	0.5	1.271	663	701	0.9	1,000
	0.118	0.2	0.508	1,660	1,760	0.9	1,000
	0.059	0.1	0.254	3,300	3,510	0.9	500
	0.0295	0.05	0.1271	6,620	7,010	0.9	100
	0.0118	0.02	0.0508	16,500	17,600	0.9	100
	0.0059	0.01	0.0254	33,000	35,100	0.9	50

*) 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".

DECIMAL SAMPLE RATES : AMPLITUDE RESPONSE BESSEL FILTER

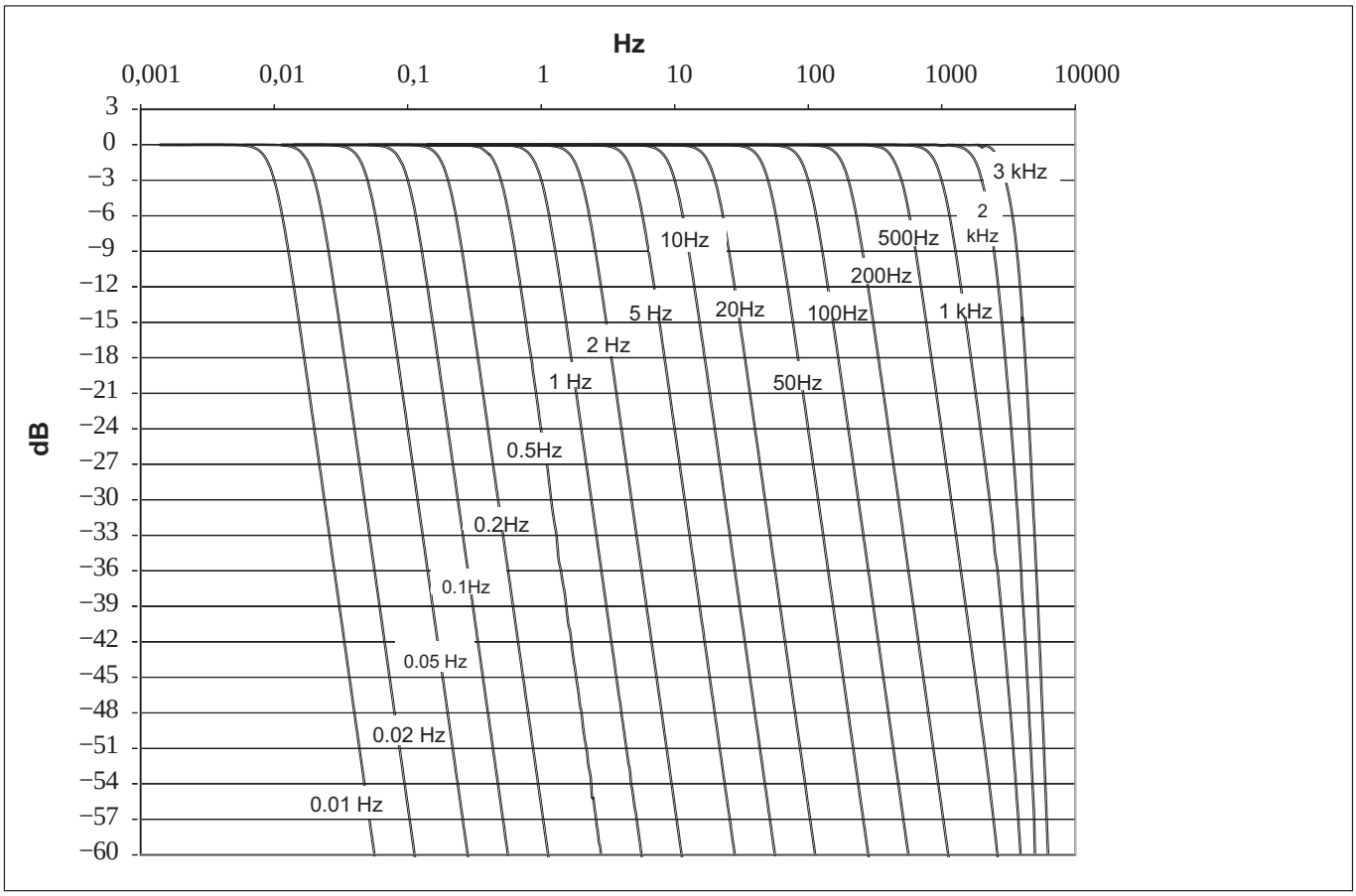


DECIMAL SAMPLE RATES AND DIGITAL LOW PASS FILTER, TYPE BUTTERWORTH 4TH ORDER

Typ	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay*) (ms)	Rise time (ms)	Overshoot (%)	Rate (Hz)
Butterworth	2,612	3,000	4,316	0.162	0.161	16.1	20,000
	1,703	2,000	3,600	0.234	0.211	12.7	20,000
	838	1,000	1,746	0.465	0.394	11.2	20,000
	430	500	890	0.914	0.778	11.0	20,000
	169	200	355	2.27	1.94	11.0	20,000
	84	100	178	4.51	3.88	11.0	20,000
	42.2	50	88.8	9.00	7.75	11.0	20,000
	16.9	20	35.5	22.5	19.4	11.0	20,000
	8.4	10	17.8	45.0	38.8	11.0	20,000
	4.22	5	8.88	89.9	77.5	11.0	20,000
	1.68	2	3.55	225	194	11.0	20,000
	0.84	1	1.78	449	387	11.0	20,000
	0.423	0.5	0.888	898	774	11.0	10,000
	0.169	0.2	0.356	2,250	1,940	11.0	10,000
	0.084	0.1	0.178	4,490	3,870	11.0	5,000
	0.0422	0.05	0.0888	8,980	7,740	11.0	1,000
	0.0168	0.02	0.0356	22,500	19,400	11.0	1,000
	0.0085	0.01	0.0178	44,900	38,700	11.0	500

*) 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”.

DECIMAL SAMPLE RATES : AMPLITUDE RESPONSE BUTTERWORTH FILTER

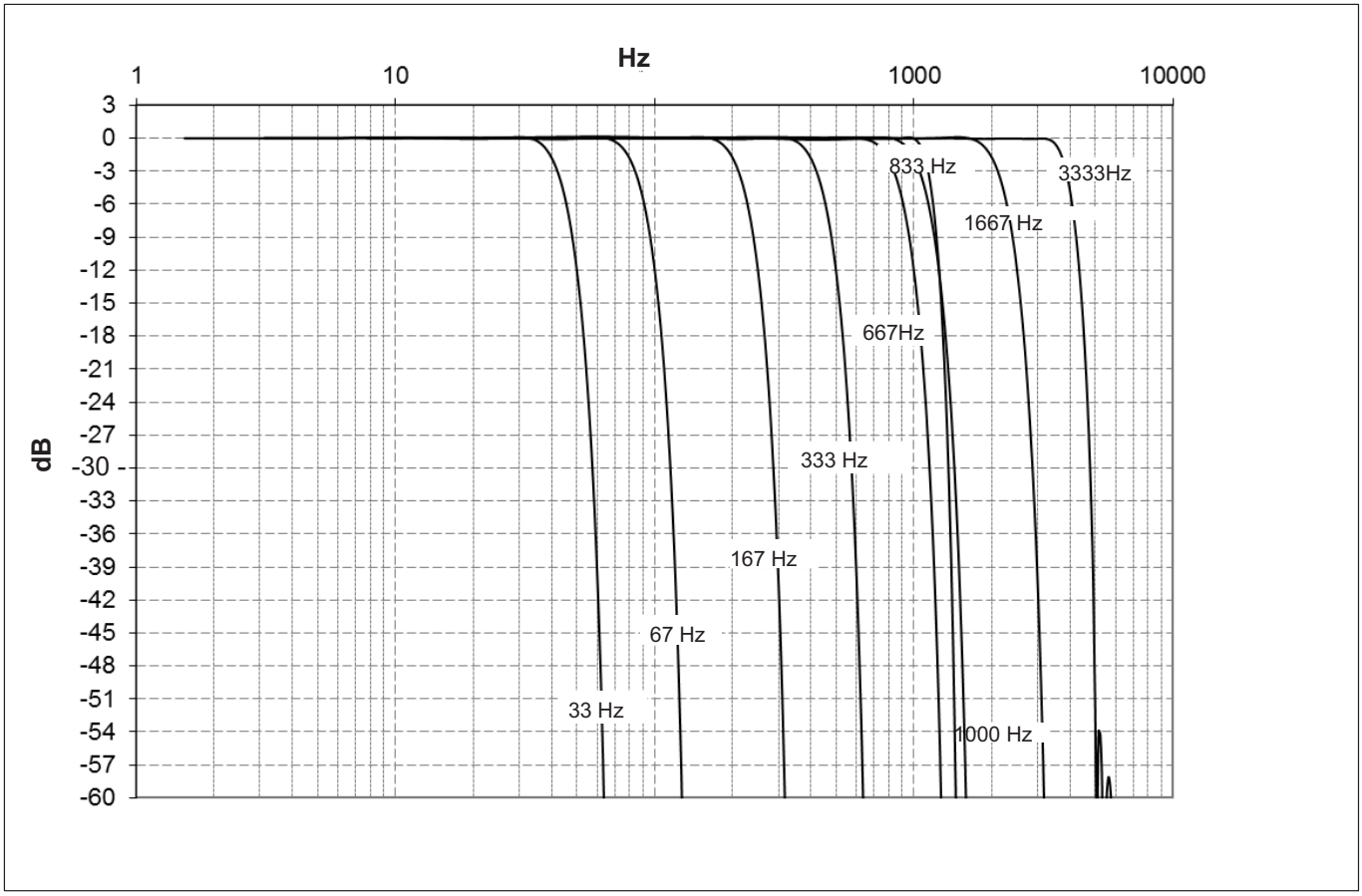


DECIMAL SAMPLE RATES : ACTIVE LOW PASS FILTER MX1615B-R, LINEAR PHASE (FIR)

Type	Start of Roll-off (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay*) (ms)	Rise time (ms)	Overshoot (%)	Rate (Hz)
Linear Phase	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

*) 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”.

DECIMAL SAMPLE RATES : AMPLITUDE RESPONSE OF MX1615B-R, LINEAR PHASE (FIR)

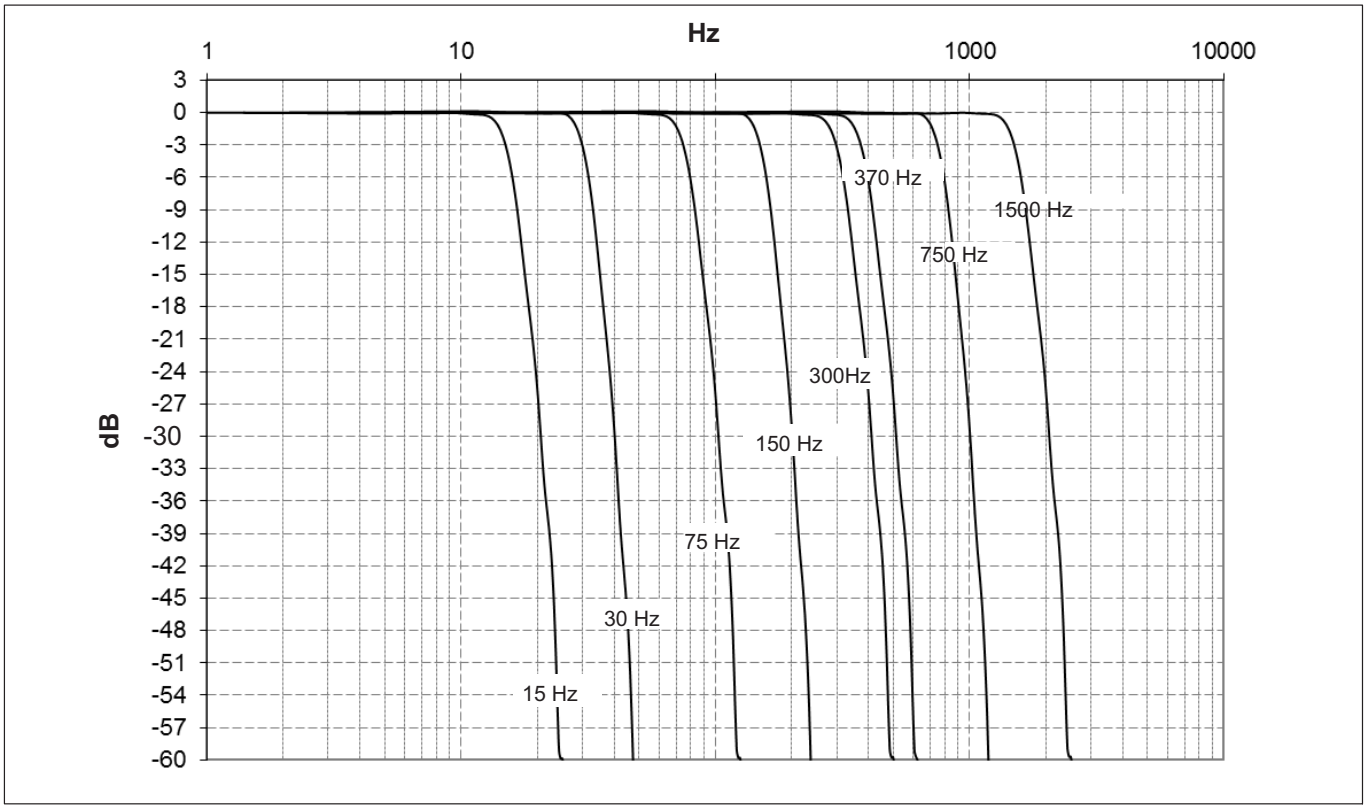


DECIMAL SAMPLE RATES : ACTIVE LOW PASS FILTER MX1615B-R, BUTTERWORTH FILTER (FIR)

Type	-1 dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay*) (ms)	Rise time (ms)	Overshoot (%)	Rate (Hz)
Butterworth	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

*) 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”.

DECIMAL SAMPLE RATES : AMPLITUDE RESPONSE OF MX1615B-R, BUTTERWORTH FILTER (FIR)



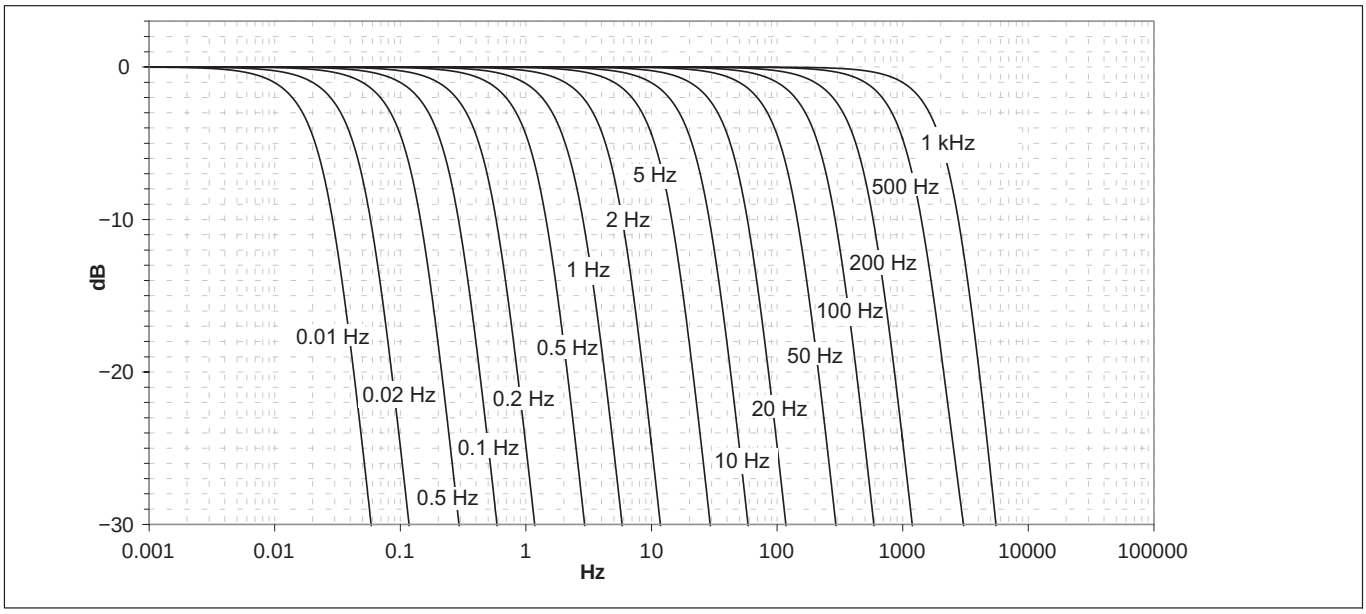
CLASSIC HBM SAMPLE RATES AND DIGITAL LOW PASS FILTER, TYPE BESSEL*) 4TH ORDER

Type	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay (ms)**)	Rise time (ms)	Overshoot (%)	Rate (Hz)
Bessel	1,000	1,575	3,611	0.11	0.2	1.4	19,200
	500	812	2,079	0.3	0.38	1.3	9,600
	200	335	860	0.9	1.05	0.8	9,600
	100	168	427	1.8	2.11	0.8	9,600
	50	84	213	3.9	4.18	0.8	9,600
	20	33.7	85	9.5	10.4	0.8	9,600
	10	16.6	43	19.5	21.0	0.8	9,600
	5	8.4	21	39	41.4	0.8	2,400
	2	3.4	8.6	97	102	0.8	2,400
	1	1.6	4.2	197	215	0.8	2,400
	0.5	0.84	2.1	390	418	0.8	300
	0.2	0.34	0.85	980	1,033	0.8	300
	0.1	0.17	0.43	1,950	2,090	0.8	300
	0.05	0.085	0.21	3,860	4,170	0.8	20
	0.02	0.036	0.088	9,800	10,560	0.8	20
	0.01	0.017	0.044	19,500	21,200	0.8	20

*) Bessel (-1 dB, with CF supply only valid for $f_g \leq 100$ Hz)

**) 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”.

CLASSIC HBM SAMPLE RATES : AMPLITUDE RESPONSE BESSEL FILTER



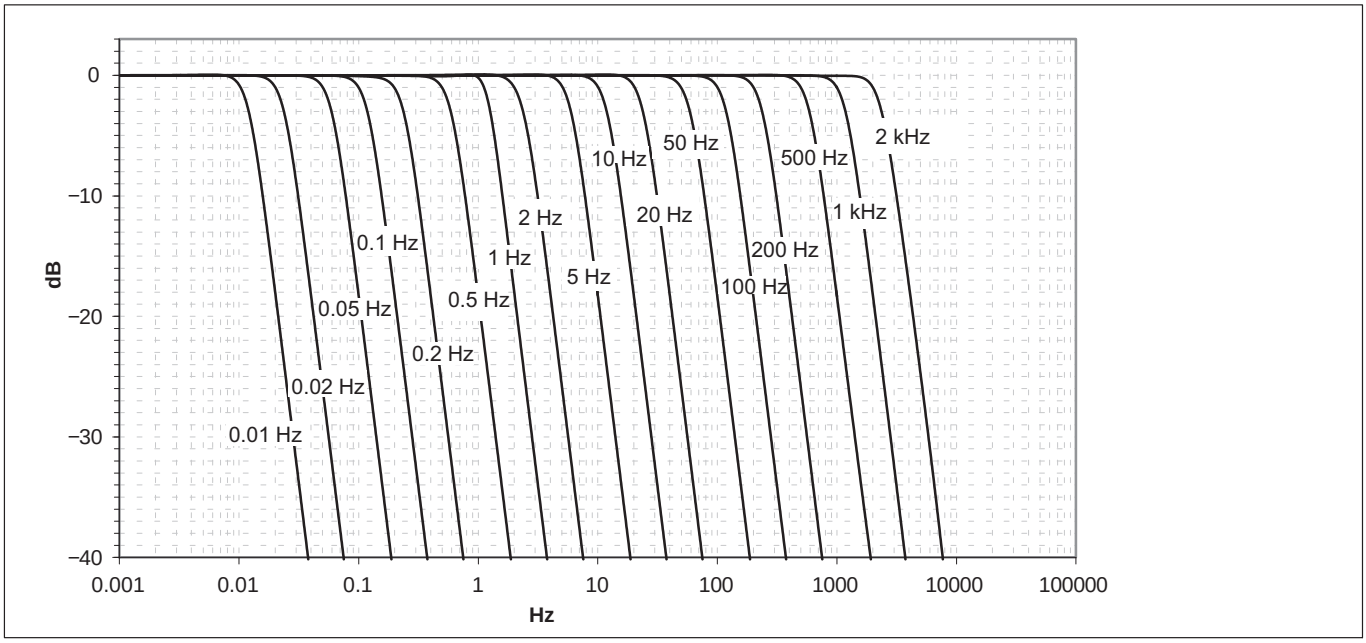
CLASSIC HBM SAMPLE RATES AND DIGITAL LOW PASS FILTER, TYPE BUTTERWORTH*) 4TH ORDER

Type	-1dB (Hz)	-3dB (Hz)	-20dB (Hz)	Phase delay (ms)**)	Rise time (ms)	Overshoot (%)	Rate (Hz)
Butterworth	2,000	3,053	5,083	0	0.144	8.5	19,200
	1,000	1,170	2,077	0.27	0.344	11	19,200
	500	587	1,048	0.64	0.652	11	9,600
	200	237	420	1.76	1.64	11	9,600
	100	118	210	3.65	3.28	11	9,600
	50	59	105	7.49	6.29	11	9,600
	20	24	42	18.8	16.15	11	9,600
	10	12	21	37.7	32.29	11	9,600
	5	5.95	10.5	74.9	65.92	11	2,400
	2	2.37	4.24	188	163.6	11	2,400
	1	1.26	2.12	370	315	11	2,400
	0.5	0.59	1.05	756	656	11	300
	0.2	0.241	0.419	1,900	1,640	11	300
	0.1	0.122	0.210	3,770	3,280	11	300
	0.05	0.060	0.106	7,490	6,596	11	20
	0.02	0.0245	0.042	18,900	16,200	11	20
	0.01	0.012	0.021	37,700	32,383	11	20

*) Butterworth (-1 dB, with CF supply only valid for $f_g \leq 100$ Hz)

*) 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”.

CLASSIC HBM SAMPLE RATES : AMPLITUDE RESPONSE BUTTERWORTH FILTER



B03759 08 E00 04 14.11.2023

Hottinger Brüel & Kjaer GmbH
Im Tiefen See 45 · 64293 Darmstadt · Germany
Tel. +49 6151 803-0 · Fax +49 6151 803-9100
www.hbkworld.com · info@hbkworld.com