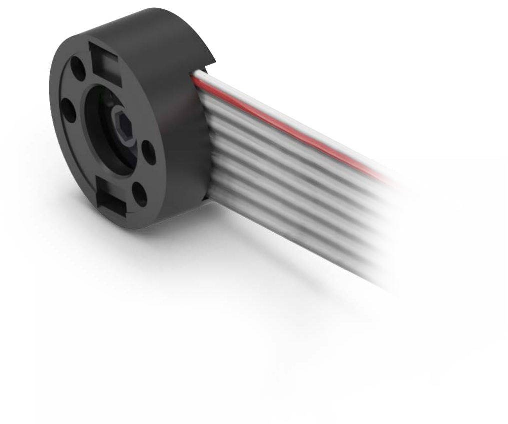
ENX IMR

Product Information



ENX IMR Encoders
Product Information
mmag | Edition 2025-03 | DocID 11923693 [rel12527]

maxon

TABLE OF CONTENTS

ENX IMR Encoders – Product Information

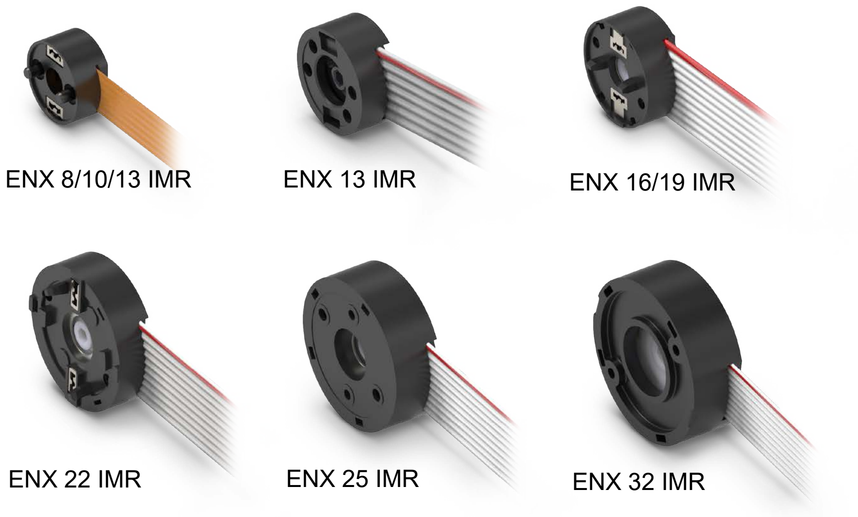


Figure 1 ENX IMR products

The flexible maxon ENX IMR Encoders are available with various maxon DC motors with a diameter of 8 mm or more. The encoder uses an interpolated angular measurement system with a magnetoresistiv sensor (AMR sensor) to generate incremental square wave signals.

The maxon ENX IMR Encoder family includes 2-channel and 3-channel versions with differential or single-ended outputs. The encoders provide up to 1024 pulses per revolution. Up to and including size 22, the motor wires are part of the encoder cable.

The IMR series replaces the MR encoders with models that are functionally and dimensionally identical. For more information, refer to Chapter 6 ➔ Appendix.

Note
The listed data are for informational purposes only. The values or specifications given are intended as an indicator and may differ from the effective performance.

1 TECHNICAL DATA

1.1 Preconditions for operation

Preconditions for trouble-free operation

- *The encoder already reacts to small and medium magnetic fields. For best performance, no magnetic fields must be present in the encoder's immediate vicinity.*
- *The supply voltage (V_{cc}) must be within the specified range.*
- *Voltage ripple (V_{pp}) on the supply voltage (V_{cc}) with an amplitude of ≥ 0.4 mV (≥ 800 mVpp) can affect the signal integrity of the encoder.*

1.2 Absolute maximum rating

Parameter	Conditions	Min	Max	Unit
Supply voltage (V_{cc})		–0.3	+5.5	V
Voltage at signal output (V_{signal})		–0.3	+5.5	V
ESD voltage (V_{ESD}), all pins	ENX 8, 10 IMR: HBM ENX 13 - 32 IMR: DIN EN 61000-4-2	–	2 8	kV
Operating temperature (T_{amb}) [a]		–20	+85	°C
Storage temperature (T_{store})		–20	+85	°C

[a] Extended temperature range available on request.

1.3 General data

Parameter	Conditions	Min	Typ	Max	Unit
Supply voltage (V_{cc})		+4.5	+5	+5.5	V
Supply current (I_{dd})	2-channel version	–	10	–	mA
Supply current (I_{dd})	3-channel version	–	13	–	mA
Startup time		–	–	10	ms

1.4 Incremental interface

Parameter	Conditions	Min	Typ	Max	Unit
Number of channels	ENX 8, 10, 13 IMR ENX 16, 19, 22 IMR ENX 25, 32 IMR	2	2 – 3	3	–
Counts per turn (N) [b]	ENX 8, 10, 13 IMR ENX 16, 19, 22 IMR ENX 25 IMR ENX 32 IMR	64 128 128 256	–	256 512 1000 1024	cpt
Pulse frequency (f_{pulse})	Maximum output pulse frequency	–	320	–	kHz
Signal output current (I_{signal})	with RS422 Line Driver	-20	–	20	mA
Signal voltage high (V_{high})	I_{signal} = 5 mA	2.4	–	–	V
Signal voltage low (V_{low})	I_{signal} = 5 mA	–	–	0.4	V
Transition time (t_{trans})	Rise time/fall time ChA/ChB without load, $R_{DIFF} = \infty$	–	0.1	–	µs

[b] Factory configurable

1.5 Angle measurement

Conditions: All values at T = 25°C, n = 5'000 rpm, V_{cc} = 5 V unless otherwise specified.

Definitions: see *➔Page 7.*

Parameter	Conditions	Min	Typ	Max	Unit
Counting direction of incremental signals (Dir)	Motor shaft movement for signal phase alignment “A leads B” as seen from the shaft end	–	CW	–	–
Integral Nonlinearity (INL)	ENX 8, 10, 13 IMR ENX 16, 19, 22, 25 IMR ENX 32 IMR	–	5 1.5 1.0	–	°m
Differential Nonlinearity (DNL)	ENX 8, 10, 13 IMR ENX 16, 19, 22, 25 IMR ENX 32 IMR	–	0.6 0.6 0.5	–	LSB
Repeatability (Jitter)	ENX 8, 10, 13 IMR ENX 16, 19, 22, 25 IMR ENX 32 IMR	–	0.8 0.4 1.0	–	LSB
Phase delay «A» to «B» (Phase θ)		45	90	135	°e
Angular hysteresis (Hyst)		–	0.045	–	°m
Delay of the digital signal path	Typical latency of digital signal processing	–	3.5	–	µs
Index position		–	A/ B/	–	
Index width		–	90	–	°e

1.6 Dimensional drawings

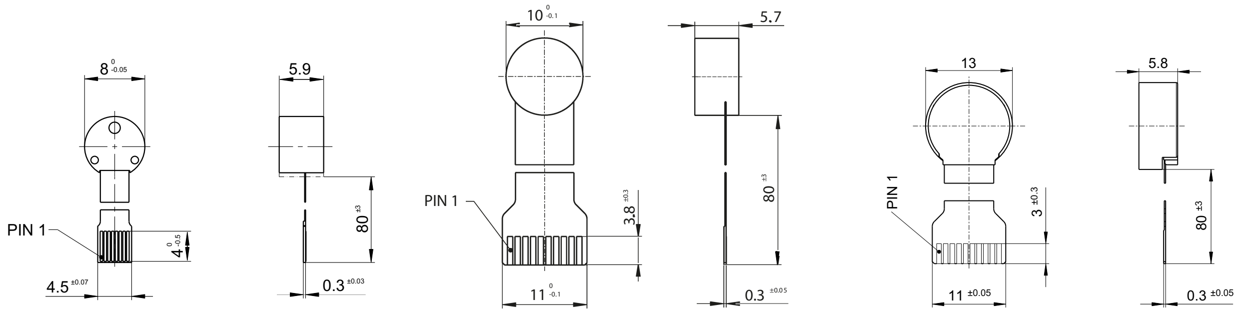


Figure 2 ENX 8/10/13 IMR Flexprint – Dimensional drawing [mm]

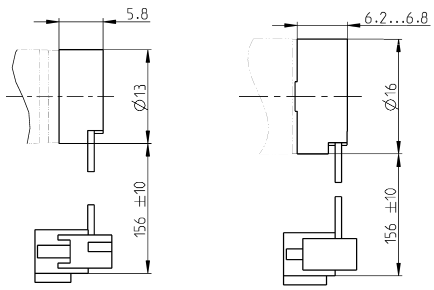


Figure 3 ENX 13/16 IMR – Dimensional drawing [mm]

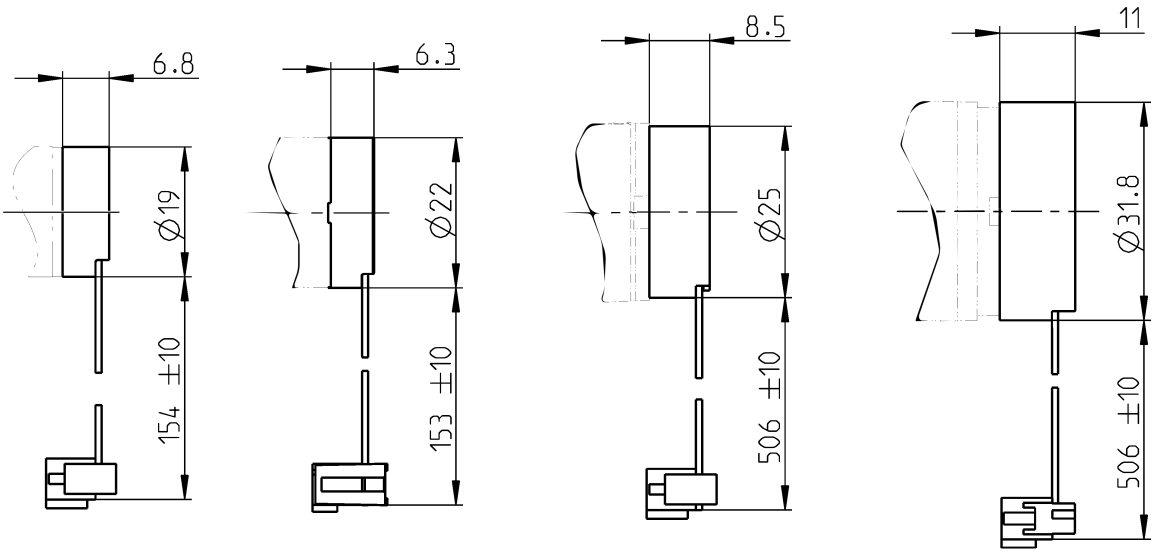
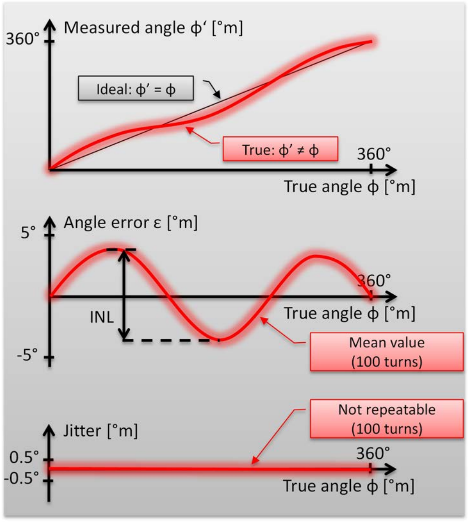
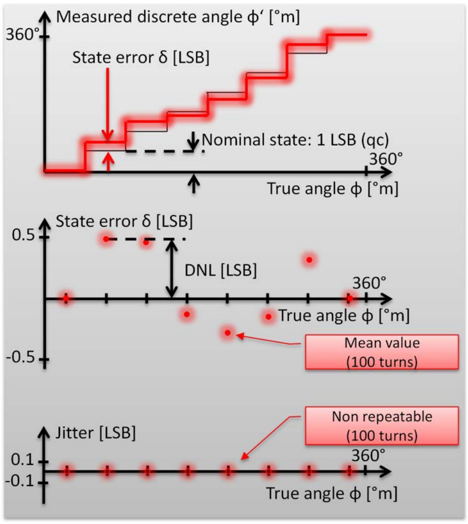
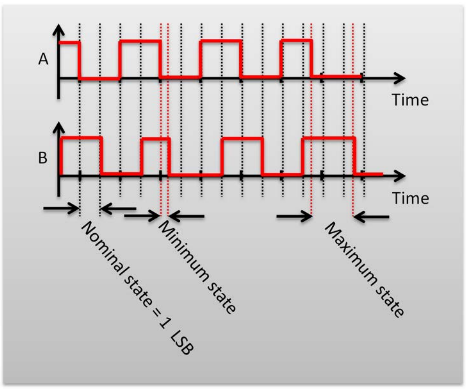


Figure 4 ENX 19/22/25/32 IMR – Dimensional drawing [mm]

2 DEFINITIONS

<table>
<tr><th>Metric</th><th>Definition</th><th>Illustration</th></tr>
<tr><td>Angle Error [°m]</td><td>Difference of measured and true angular shaft position at each position.</td><td rowspan="5">
</td></tr>
<tr><td>Average Angle Error [°m]</td><td>Average of Angle Error at each position, over a given number of turns.</td></tr>
<tr><td>Integral Nonlinearity (INL) [°m]</td><td>Peak-to-peak value of Average Angle Error.</td></tr>
<tr><td>Jitter (Repeatability) [°m] or [LSB]</td><td>Six standard deviations of Angle Error per turn (at each position, over a given number of turns).
Jitter [°m] is typically independent of the resolution and defines the maximum useful positioning repeatability.
Jitter [LSB] is resolution-dependent. At given Jitter [°m], the value is roughly proportional to resolution.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Least Significant Bit (LSB)</td><td>Minimum measurable difference between two angle values at given resolution (= quadcount, = State).</td><td rowspan="5">
</td></tr>
<tr><td>State Error [LSB]</td><td>Difference between actual state length and average state length.</td></tr>
<tr><td>Average State Error [LSB]</td><td>Average of State Error over a number of turns for each state of a turn.</td></tr>
<tr><td>Differential Nonlinearity [DNL]</td><td>Maximum positive or negative Average State Error.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Minimum State Length [°e]</td><td>Minimum measured state length within a number of turns relative to pulse length.</td><td rowspan="4">
</td></tr>
<tr><td>Maximum State Length [°e]</td><td>Maximum measured state length within a number of turns relative to pulse length.</td></tr>
<tr><td>Minimum State Duration [ns]</td><td>By chip limited minimum time separation between two A/B transitions.</td></tr>
<tr><td></td><td></td></tr>
</table>

maxon

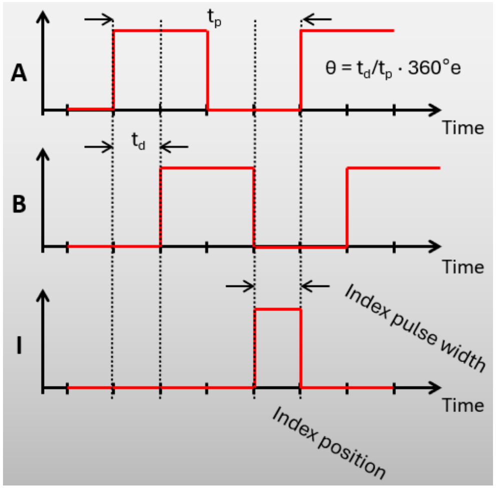
Metric	Definition	Illustration
Phase delay θ [°e]	Time difference of the rising edge A to B relative to the pulse duration.	
Index position resp. Index width [°e]	State of I relative to state of A and B, respective state length of I.	
Duty cycle [%]	Ratio of the state duration of the positive level to the pulse length.	

Table 1 Definitions

3 ADDITIONAL INFORMATION

3.1 Angle error per turn

The following diagrams show angular error measurements for four IMR encoders configured with different resolutions under the following conditions: measurement of 20 revolutions at V_{CC} = 5 V, n = 5000 rpm, T = 25°C.

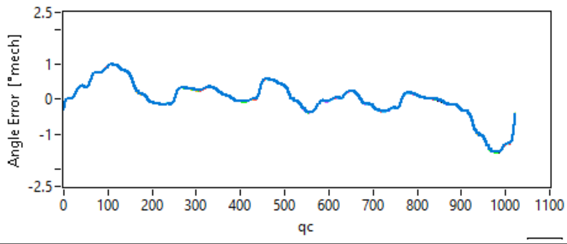
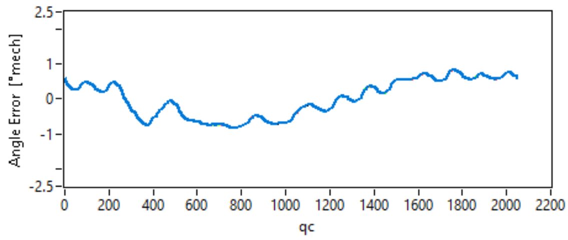
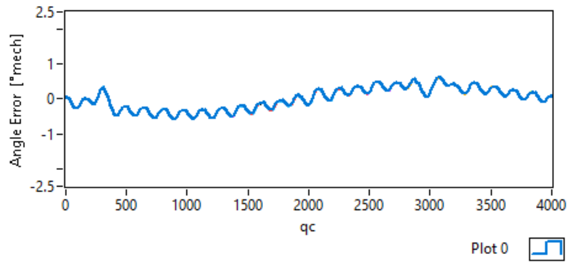
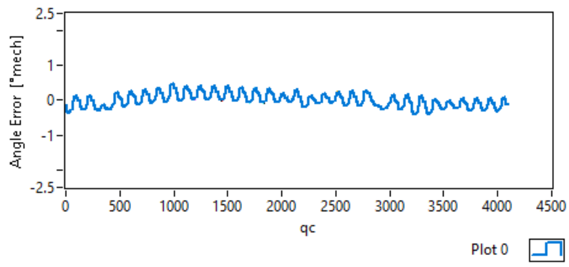
Resolution	Graph	Analysis	
256 (ENX 13 IMR)		INL Jitter DNL Min State Max State Min Phase Max Phase	2.6°m 0.05°m = 0.1 LSB 0.2 LSB 0.89 LSB 1.3 LSB 87°e 92°e
512 (ENX 16 IMR)		INL Jitter DNL Min State Max State Min Phase Max Phase	1.7°m 0.02°m = 0.1 LSB 0.12 LSB 0.87 LSB 1.1 LSB 88°e 91°e
1'000 (ENX 25 IMR)		INL Jitter DNL Min State Max State Min Phase Max Phase	1.2°m 0.072°m = 0.8 LSB 0.3 LSB 0.7 LSB 1.3 LSB 75°e 100°e
1'024 (ENX 32 IMR)		INL Jitter DNL Min State Max State Min Phase Max Phase	0.8°m 0.15°m = 1.7 LSB 0.35 LSB 0.65 LSB 1.54 LSB 75°e 1000°e

Table 2 Typical Measurement Results

3.2 Temperature dependence

INL [°m], DNL [LSB], and jitter [LSB] decrease slightly with increasing temperature. The phase delay is essentially independent of temperature.

Figure 5 shows the temperature dependence of eight ENX IMR on RE16 under the following conditions:

V_{CC} = 5 V, motor speed = 9000 rpm, resolution = 512 cpt, Belastung 1 kΩ // 4.7 kΩ

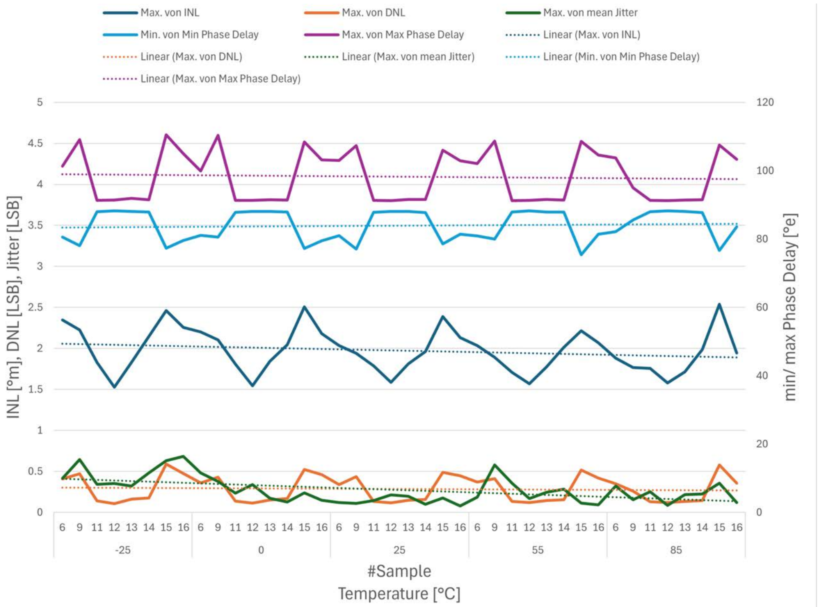


Figure 5 Temperature Dependence

3.3 Rotation rate dependence

INL [°m], DNL [LSB], and jitter [LSB] decrease slightly with increasing speed/pulse frequency, while the deviation in phase delay tends to increase.

Figure 6 shows the speed dependence of eight ENX IMR on RE16 under the following conditions:

V_{CC} = 5 V, temperature = 25 °C, resolution = 512 cpt, load 1 kΩ // 4.7 kΩ.

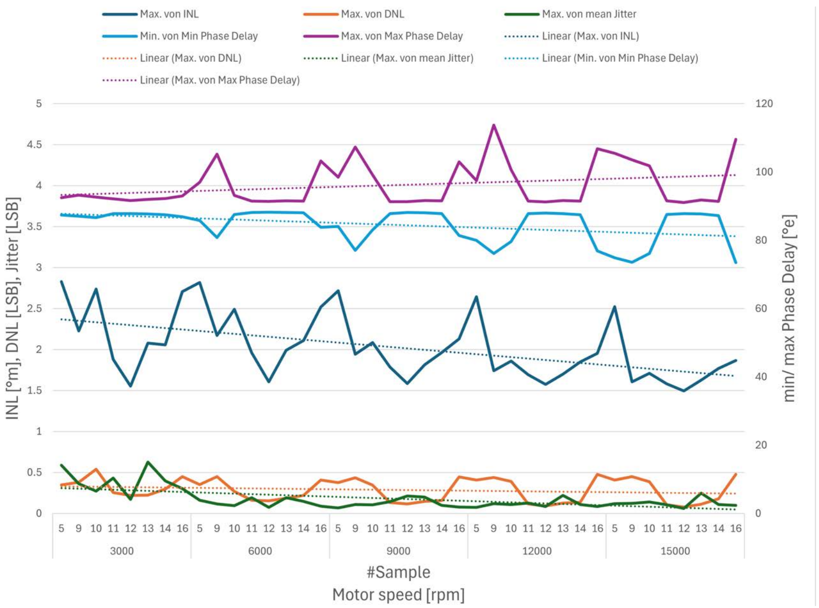


Figure 6 Rotation rate dependence

3.4 Compliance to regulations

Parameter	Description
ENX 13 - 32 IMR: Electrostatic discharge immunity (DIN EN 61000-4-2)	Contact discharge to conductive surfaces: ±8 kV
ENX 8, 10 IMR: Immunity to electrostatic discharge (HBM, 100 pF discharge at 1.5 kΩ)	Contact discharge to conductive surfaces: ±2 kV

Table 3 Compliance to regulations

maxon

4 PIN ASSIGNMENT

Maximum permitted supply voltage

- *Make sure that supply power is within stated range. Supply voltages exceeding the stated range – or wrong polarity – will destroy the unit.*
- *Connect the unit only when supply voltage is switched off (V_{cc}=0).*

Current capacity of connection cables

- *The maximum permissible continuous current of the cable and connector must be observed.*
- *The connection cable has no strain relief and must not be subjected to excessive pulling forces.*

4.1 Standard connector flexprint

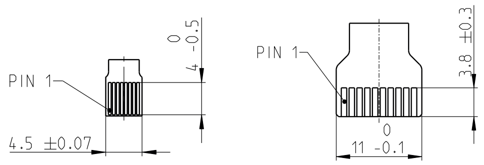


Figure 7 8-pole & 10-pole connector flexprint

Pin	ENX 8 IMR	ENX 10 IMR / ENX 13 IMR
1	Motor +	Motor +
2	V_{CC}	V_{CC}
3	GND	GND
4	Motor -	Motor -
5	Channel $\overline{A}$	Channel $\overline{A}$
6	Channel A	Channel A
7	Channel $\overline{B}$	Channel $\overline{B}$
8	Channel B	Channel B
9	–	N.C.
10	–	N.C.

Table 4 ENX 8 IMR / ENX 10 IMR / ENX 13 IMR – pin assignment

Specifications		
	ENX 8 IMR	**ENX 10 IMR / ENX 13 IMR**
Connector	Flexprint connection, 0.5 mm pitch, 8-pole, maximum permissible continuous current per line: 0.5 A	Flexprint connection, 1 mm pitch, 10-pole, maximum permissible continuous current per line: 1 A
Mating plug	Flexprint connector, 0.5 mm pitch, 8-pole (for example, Molex 52745-0896)	Flexprint connector, 1 mm pitch, 10-pole (for example, adapter board part no. 327086 or Molex 52207-1033)

Table 5 ENX 8 IMR / ENX 10 IMR / ENX 13 IMR – specifications

4.2 Standard cable plug 10-pole

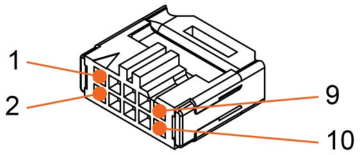


Figure 8 Cable plug 10-pole

Pin	ENX 13 IMR	ENX 16 - 22 IMR	ENX 25 IMR / ENX 32 IMR
1	Motor +	Motor +	N.C.
2	V_{CC}	V_{CC}	V_{CC}
3	Channel A	GND	GND
4	Channel B	Motor -	N.C.
5	GND	Channel $\overline{A}$	Channel $\overline{A}$
6	Motor –	Channel A	Channel A
7	N.C.	Channel $\overline{B}$	Channel $\overline{B}$
8	N.C.	Channel B	Channel B
9	N.C.	Channel $\overline{I}$ (Index) or N.C.	Channel $\overline{I}$ (Index)
10	N.C.	Channel I (Index) or N.C.	Channel I (Index)

Table 6 10-pole connector – Pin assignment

Specifications	
Connector	Pin header, pitch 2.54 mm, 5 x 2 pole, maximum permissible continuous current per line: 1.2 A
Mating plug	Pin header, pitch 2.54 mm, 5 x 2 pole (EN 60603-13/DIN 41651)

Table 7 10-pole connector – specifications

5 OUTPUT CIRCUITRY

Pull-up or pull-down resistors are allowed but not necessary. ESD protection is available only from size 13 mm. For single-ended variants, a high-impedance network is recommended.

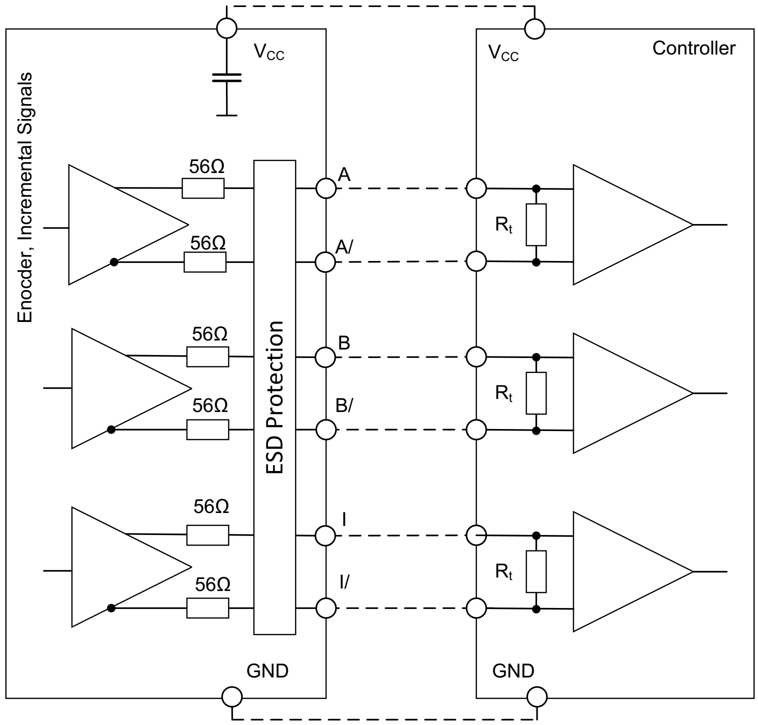


Figure 9 Output circuit: 3-channel differential configuration.

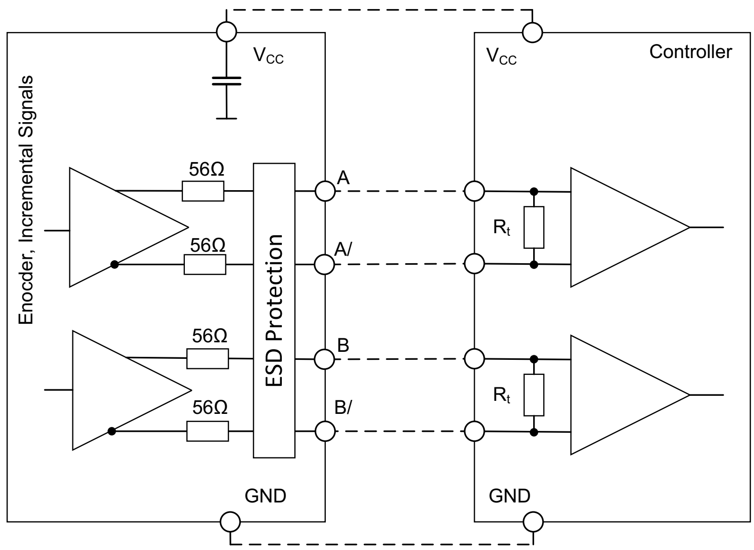


Figure 10 Output circuit: 2-channel differential configuration.

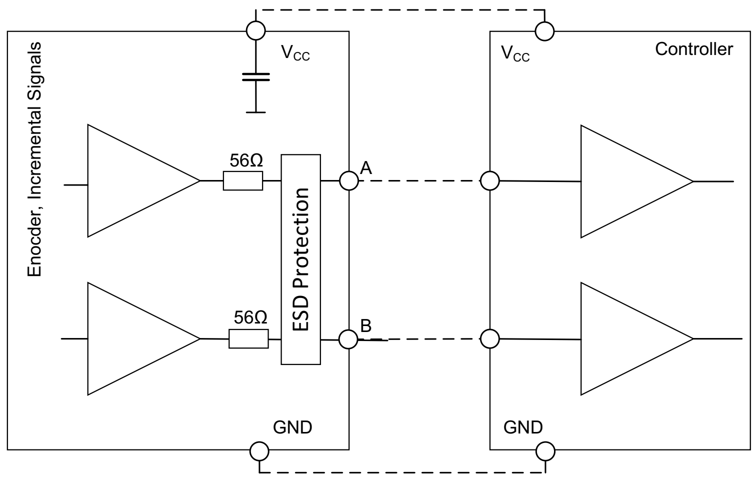


Figure 11 Output circuit: 2-channel single-ended configuration.

maxon

6 APPENDIX

6.1 Comparison table for MR type S

Encoder type		MR type S	ENX 8 IMR	MR type S	ENX 10 IMR ENX 13 IMR	MR type S	ENX 13 IMR
Housing diameter	[mm]	8		10 / 13		13	
Housing length	[mm]	5.9		5.7...5.8		5.8	
Number of channels		2		2		2	
Output configuration		Differential		Differential		Single-ended	
Output signal		TTL-compatible	EIA-Standard RS422	TTL-compatible	EIA-Standard RS422	TTL-compatible	CMOS-compatible
Cable type		Flexprint		Flexprint		Ribbon cable	
DC-motor wires integrated		Yes		Yes		Yes	
Resolution (incremental)	[cpt]	100		64...256		64...256	
Supply voltage	[V]	4.75...5.25	4.5...5.5	4.75...5.25	4.5...5.5	4.75...5.25	4.5...5.5
Typical current draw at 5 V	[mA]	11	10	11	10	11	10
Operating temperature range	[°C]	-20...+85		-20...+85		-20...+85	
Moment of inertia of the target	[gcm^2]	≤0.005		≤0.005		≤0.005	
Signal output current	[mA]	max. 5	max. 20	max. 5	max. 20	max. 5	
Counting direction, A to B		CW		CW		CW	
Transition time (rise / fall time)	[ns]	20 [a]	100 [a]	20 [a]	100 [a]	20 [a]	100 [a]
Integral Nonlinearity (INL)	[°m]	5 [a]		5 [a]		5 [a]	
Differential Nonlinearity (DNL)	[LSB]	undefined	0.4 [a]	undefined	0.6 [a]	undefined	0.6 [a]
Repeatability (Jitter)	[LSB]	undefined	0.2 [a]	undefined	0.8 [a]	undefined	0.8 [a]
Phase delay, A to B	[°e]	90 ±45		90 ±45		90 ±45	

[a] Typical value

Table 8 Comparison MR Type S – ENX8 / 10 / 13 IMR

6.2 Comparison table for MR type M, ML, L

Encoder type		MR type M	ENX 16 IMR ENX 19 IMR ENX 22 IMR	MR type ML	ENX 25 IMR	MR type L	ENX 32 IMR
Housing diameter	[mm]	16 / 19 / 22		25		32	
Housing length	[mm]	6.2...6.8		8.5		11.0	
Number of channels		2 / 3		3		3	
Output configuration		Differential		Differential		Differential	
Output signal		TTL-compatible	EIA-Standard RS422	TTL-compatible	EIA-Standard RS422	TTL-compatible	EIA-Standard RS422
Cable type		Ribbon cable		Ribbon cable		Ribbon cable	
DC-motor wires integrated		Yes		No		No	
Resolution (incremental)	[cpt]	128...512		128...1000		256...1024	
Supply voltage	[V]	4.75...5.25	4.5...5.5	4.75...5.25	4.5...5.5	4.75...5.25	4.5...5.5
Typical current draw at 5 V	[mA]	11 / 14	10 / 13	14	13	14	13
Operating temperature range	[°C]	-20...+85		-20...+85		-20...+85	
Moment of inertia of the target	[gcm^2]	≤0.09		≤0.7		≤1.7	
Signal output current	[mA]	max. 5	max. 20	max. 5	max. 20	max. 5	max. 20
Counting direction, A to B		CW		CW		CW	
Transition time (rise / fall time)	[ns]	20 [a]	100 [a]	20 [a]	100 [a]	20 [a]	100 [a]
Integral Nonlinearity (INL)	[°m]	1.5 [a]		1.0 [a]		1.0 [a]	
Differential Nonlinearity (DNL)	[LSB]	undefined	0.6 [a]	undefined	0.5 [a]	undefined	0.5 [a]
Repeatability (Jitter)	[LSB]	undefined	0.4 [a]	undefined	0.4 [a]	undefined	1.0 [a]
Phase delay, A to B	[°e]	90 ±45		90 ±45		90 ±45	

[a] Typical value

Table 9 Comparison MR Type M / ML / L – ENX16 / 19 / 22 / 25 / 32 IMR

mmag | ENX IMR Encoders Product Information | Edition 2025-03 | DocID 11923693 [rel12527]