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ENX EASY INT

Product Information

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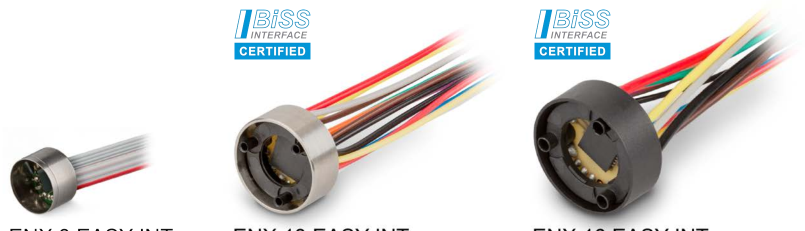
ENX EASY INT Encoders – Product Information



ENX 8 EASY INT | ENX 13 EASY INT | ENX 16 EASY INT

Figure 1 Overview (excerpt)

The ultra compact maxon EASY encoders use an interpolated Hall sensor angle measurement system to generate angle information of up to 4096 steps per turn. Electively or in combination available are incremental square wave signals, absolute angular values (SSI or BISS-C), and/or commutation signals.

The encoders are available for diameter-compliant mounting on motors of the ECX series with outside diameters of 8, 13, 16, 19, and 22 mm:

- ENX EASY INT – incremental encoder with differential output signals
- ENX EASY INT COMM – incremental encoder with commutation signals
- ENX EASY INT Absolute – absolute encoder
- ENX EASY INT Absolute COMM – absolute encoder with commutation signals
- ENX COMM – commutation signals, only

Depending on the design, flat ribbon cables or single strands are available as connecting cables. The designs with single strands are protected against reverse polarity.

Pin-out for all versions is compatible to most maxon controllers with encoder interface.

Note
The listed data are for informational purposes only. None of the stated values or information may be used as an indicator of guaranteed performance.

The following absolute encoders in the version with BiSS-C interface have the BiSS certification:

- ENX 13 EASY INT Absolute
- ENX 16 EASY INT Absolute
- ENX 19 EASY INT Absolute
- ENX 22 EASY INT Absolute

The corresponding certificate is available for download in the maxon web shop. Further information on the BiSS mode can be found in ➔ chapter “2.2 BiSS-C Mode” on page 11.

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1 TECHNICAL DATA

1.1 Absolute Maximum Rating

Parameter	Conditions		Min	Max	Unit
Supply voltage (V_{cc})			–0.3	+6.0	V
Voltage at signal output (V_{signal})			–0.3	+6.0	V
Supply current (I_{dd})			–30	+220	mA
Signal output current (I_{signal})	A,B,I; no supply voltage		–100	+100	mA
	DATA; no supply voltage		–10	+10	
ESD voltage (V_{esd}), all pins	HBM 100 pF, 1.5 kΩ	Ø 8		2	kV
	EN 61000-4-2	Ø 13…22		>2	
Operating temperature (T_{amb}) *1			–40	+100	°C
Storage temperature (T_{store}) *1			–40	+100	°C
Humidity (condensation not permitted)	Ø 8		20	80	%rH
	Ø 13…22 *1		20	100	

Annotation **1 The included connectors are designed for a temperature range of –40…+105 °C and a humidity of 20…80%rH.*

1.2 General Data

Parameter	Conditions		Min	Typ	Max	Unit
Supply voltage (V_{cc})			+4.5	5	+5.5	V
Supply current (I_{dd})	Output pulse frequency <100 kHz, load resistor ≥100 kΩ	Ø 8		19		mA
		Ø 13…22		22		

1.3 Incremental Interface

Parameter	Conditions		Min	Typ	Max	Unit
Number of channels	ChA, ChB, ChI			3		–
Counts per turn (N) (factory-configurable)	1…128, 256, 512, 1024	Ø 8	1	256	1024	cpt
	1…1024	Ø 13…22	1	256	1024	
Pulse frequency (f_{pulse})	Ø 8			0.5		MHz
	Ø 13…22			4		
Signal output current (I_{signal})	With Line Receiver EIA-422		–60	±20	+60	mA
Signal voltage high (V_{high})	I_{signal} <20 mA, relative to V_{cc}		V_{cc}–0.5 V			V
Signal voltage low (V_{low})	I_{signal} <20 mA				0.5	V
Transition time (t_{trans})	Rise time/fall time ChA/B/I @ load resistor 100 Ω, C_{load} ≤200 pF			10	25	ns

1.4 Absolute Interface

<table>
<tr><th>Parameter</th><th colspan="2">Conditions</th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td>Steps per turn (N)</td><td colspan="2">SSI/BiSS mode 12 bit</td><td></td><td>4096</td><td></td><td>steps</td></tr>
<tr><td>Signal output current (I_{signal})</td><td colspan="2">DATA output SSI/BiSS interface</td><td>–60</td><td>±20</td><td>+60</td><td>mA</td></tr>
<tr><td>Signal voltage high (V_{high})</td><td colspan="2">DATA output: I_{signal} <20 mA, relative to V_{cc}</td><td>V_{cc} –1 V</td><td></td><td></td><td>V</td></tr>
<tr><td>Signal voltage low (V_{low})</td><td colspan="2">DATA output: I_{signal} <20 mA</td><td></td><td></td><td>0.5</td><td>V</td></tr>
<tr><td>Transition time (t_{trans})</td><td colspan="2">DATA output: Rise time/fall time, C_{load} = 50 pF</td><td></td><td></td><td>60</td><td>ns</td></tr>
<tr><td>System Clock (f_{sys})</td><td colspan="2"></td><td>0.8</td><td>1.0</td><td>1.2</td><td>MHz</td></tr>
<tr><td rowspan="3">CLK Signal Frequency (f_{clk})</td><td colspan="2">SSI mode</td><td>0.04</td><td></td><td>4</td><td rowspan="3">MHz</td></tr>
<tr><td rowspan="2">BiSS mode</td><td>Ø 8</td><td>0.6</td><td></td><td>10</td></tr>
<tr><td>Ø13…22</td><td>0.05</td><td></td><td>10 [*a]</td></tr>
<tr><td rowspan="4">Timeout (t_{out})</td><td rowspan="2">SSI mode</td><td>Ø 8</td><td>16</td><td></td><td></td><td rowspan="4">µs</td></tr>
<tr><td>Ø13…22</td><td>20</td><td></td><td></td></tr>
<tr><td rowspan="2">BiSS mode</td><td>Ø 8</td><td>2</td><td></td><td></td></tr>
<tr><td>Ø13…22</td><td>1.5*(1/f_{clk})+ 3.75 µs</td><td></td><td></td></tr>
<tr><td>Minimum input level CLK HIGH (V_{high})</td><td colspan="2">SSI/BiSS mode</td><td>2</td><td></td><td></td><td>V</td></tr>
<tr><td>Maximum input level CLK LOW (V_{low})</td><td colspan="2">SSI/BiSS mode</td><td></td><td></td><td>0.8</td><td>V</td></tr>
<tr><td rowspan="2">Input resistance CLK (R_{input})</td><td colspan="2">Ø 8</td><td></td><td>6.7</td><td></td><td rowspan="2">kΩ</td></tr>
<tr><td colspan="2">Ø13…22</td><td></td><td>12</td><td></td></tr>
</table>

*Note [*a] ➔ A maximum CLK signal frequency of 5MHz applies to the certified BiSS mode.*

1.5 Commutation Interface

Parameter	Conditions	Min	Typ	Max	Unit
Number of channels	H1, H2, H3		3		–
Pulse frequency (f_{pulse})	Maximum output pulse frequency		53		kHz
Signal output current (I_{signal})		–20		+20	mA
Signal voltage high (V_{high})	I_{signal} <20 mA, relative to V_{cc}	V_{cc}–0.5 V			V
Signal voltage low (V_{low})	I_{signal} <20 mA			0.5	V
Transition time (t_{trans})	Rise time/fall time ChA/B/I without load		10	25	ns

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1.6 Angle Measurement

Conditions *All values at T = 25°C, n = 10000 rpm, V_{cc} = 5 V unless otherwise specified.*

Definitions *See ➔page 12.*

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		
Counting direction of absolute signals (Dir)	Motor shaft movement for increasing angle values as seen from the shaft end			CW		
State length (L_{state}) and index pulse width (L_{index} synchronized with ChA/B), incremental	N=1…128, 256, 512 cpt		45	90	135	°e
	N=1024 cpt		30	90	160	
	N=500, 1000 cpt and other non-binary number of impulses *2		30	90	250	
Minimum state duration (t_{state}), incremental	f_{pulse}≤0.5 MHz	Ø 8		500		ns
	f_{pulse}≤2.0 MHz	Ø 13…22		125		
	f_{pulse}>2.0 MHz	Ø 13…22		62.5		
Integral Nonlinearity (INL)	All number of impulses			<1	2	°m
Differential Nonlinearity (DNL)	N=1…128, 256, 512 cpt			0.3	0.5	LSB
	N=1024 cpt			0.6	0.9	
	N=500, 1000 cpt and other non-binary number of impulses *2				2	
Repeatability (Jitter), incremental	N=512 cpt	Ø 8		<2		LSB
		Ø 13…22		0.5		
	N=1024 cpt	Ø 8		<4		
		Ø 13…22		1		
Repeatability (Jitter)	All number of impulses	Ø 8		<0.35		°m
		Ø 13…22		0.1		
Repeatability (Jitter), absolute	SSI/BiSS mode 12 bit	Ø 8		<4 *3		LSB
		Ø 13…22		1 *3		
Phase delay A to B (Phase θ), incremental	N=1…512 cpt		45	90	135	°e
	N=513…1024 cpt		15	90	165	
Angle hysteresis (Hyst)	N=1…1024 cpt	Ø 8		0.35		°m
		Ø 13…22		0.17		
Bandwidth of analog signal path	Typical equivalent bandwidth of single pole low-pass filter			16		kHz
Delay of digital signal path	Typical latency of digital signal processing			2		µs
Maximum commutation angle error (maxCAE)	Variants with commutation signals (COMM)	Ø 8		4		°e
		Ø 13…22		2		

Annotations **2 With non-binary number of impulses (ENX 13…22 EASY INT only), individual states are systematically omitted from the maximum possible number of states per turn. Thereby, the associated initial impulses are being extended and thus deteriorate the resolution-dependent characteristics.*

**3 When reading the absolute angle at the same position, six standard deviations of the resulting sequence of values can approach 1, respectively 4 LSB.*

1.7 Angle Alignment

The angle value “zero” of the absolute encoder, the index of the incremental encoder, as well as the rising edge of the communication signal H1 are factory-programmed to the commutation angle “zero” of the used EC (BLCD) motor. The "zero" commutation angle is 30°e after the zero crossing of the back EMF (➔Figure 2).

- When assembled onto a motor with several pole pairs (n), the absolute encoders will show the angle value “zero” and the incremental encoders the index **once per mechanical turn**.
- Due to its multiple sets of pole pairs, the **motor** will show this commutation angle **n times per mechanical turn**.

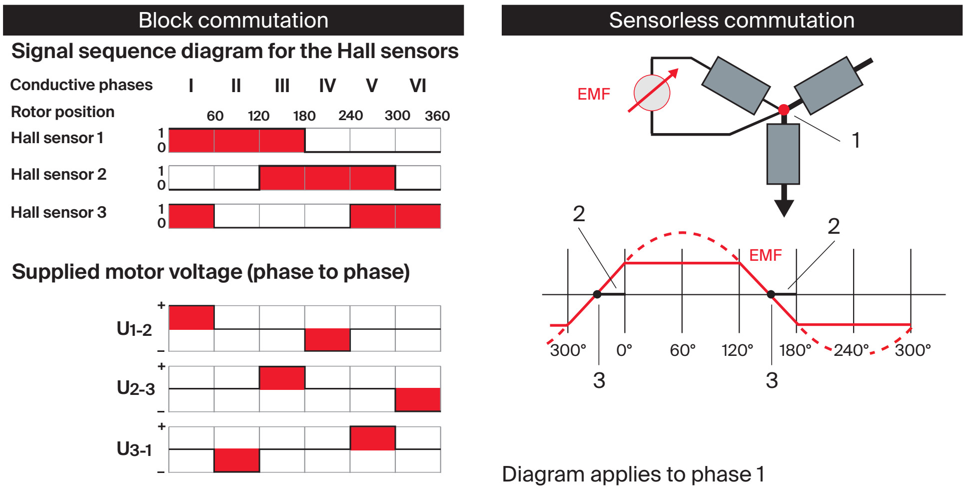

Diagram applies to phase 1

1	Star point
2	Time delay 30°e
3	Zero crossing of EMF

Figure 2 Block Commutation of EC (BLDC) Motors – Definition of Phases

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1.8 Mechanical Data

Parameter	Conditions	Value	Unit
Dimensions	ENX 8 EASY INT	Ø8	mm
	ENX 13 EASY INT ENX 13 COMM	Ø13	
	ENX 16 EASY INT ENX 16 COMM	Ø16	
	ENX 19 EASY INT ENX 19 COMM	Ø19	
	ENX 22 EASY INT ENX 22 COMM	Ø22	
Moment of inertia (Jt)	motor shaft Ø1…8 mm	0.01…0.7	g cm^2
Standard cable length (Lc)	ENX 8 EASY INT	300	mm
	ENX 13 EASY INT ENX 13 COMM ENX 16 EASY INT ENX 16 COMM ENX 19 EASY INT ENX 19 COMM ENX 22 EASY INT ENX 22 COMM	200	

Continued on next page.

ENX 8 EASY INT

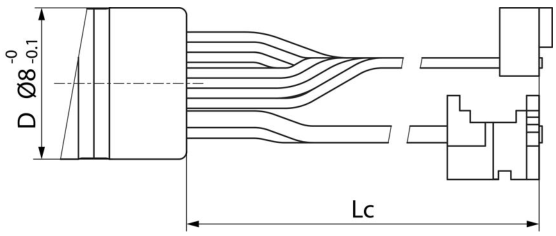


Figure 3 ENX 8 EASY INT – Dimensional Drawing [mm]

ENX 13 | 16 | 19 | 22 EASY INT COMM

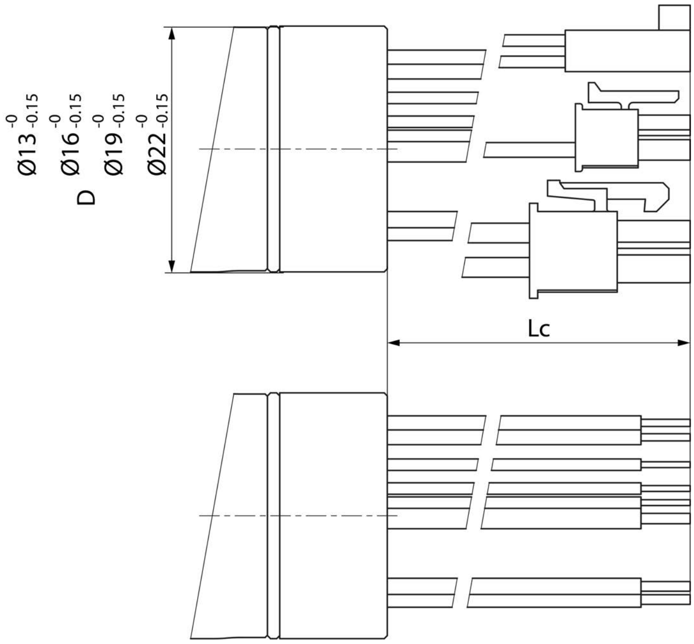


Figure 4 ENX 13 | 16 | 19 | 22 EASY INT COMM – Dimensional Drawing [mm]

ENX 13 | 16 | 19 | 22 EASY INT ABSOLUTE

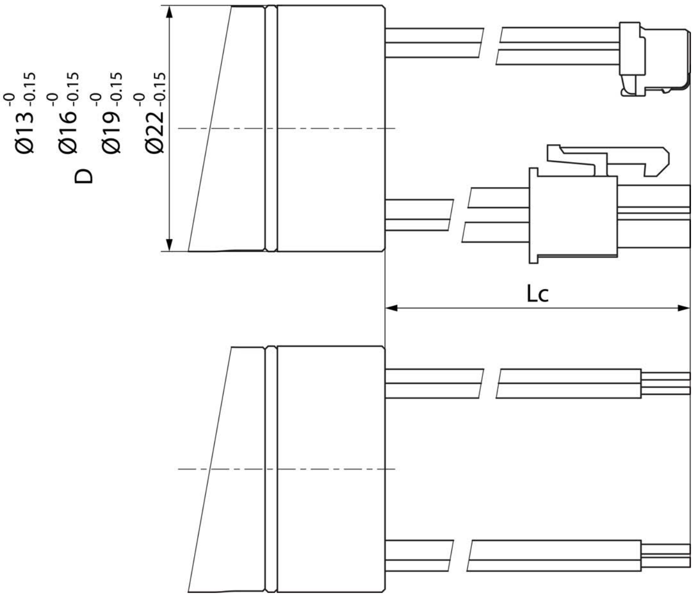


Figure 5 ENX 13 | 16 | 19 | 22 EASY INT Absolute – Dimensional Drawing [mm]

ENX 13 | 16 | 22 COMM

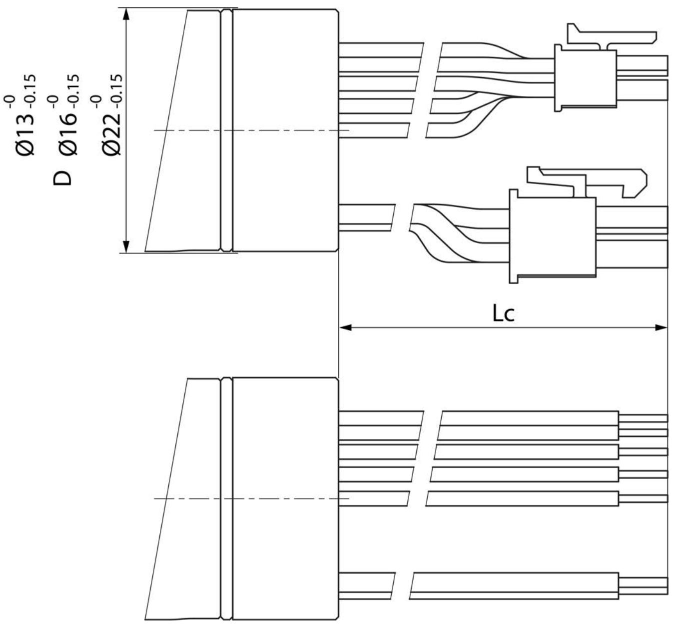


Figure 6 ENX 13 | 16 | 22 COMM – Dimensional Drawing [mm]

2 ABSOLUTE ENCODER

The «ENX EASY INT» absolute encoders provide the functionality of a single-turn absolute encoder. Two interface protocol variants are factory-configurable; SSI and BiSS-C.

2.1 SSI Mode

- The wait time after reading of last bit must be larger than Timeout (t_{out}).
- Protocol: 13 bit data, MSB first, last bit always zero, gray coded
- A complete reading cycle at maximum clock rate can be calculated using the following formula:

$$13 \cdot \frac{1}{4MHz} + t_{out} .$$

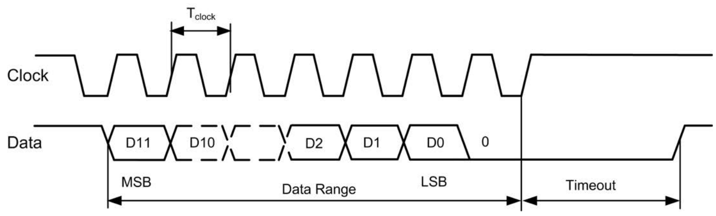


Figure 7 Timing of EASY INT Absolute in SSI Mode

2.2 BiSS-C Mode

- The wait time after reading of last bit must be larger than Timeout (t_{out}).
- Protocol: 3 bit start sequence {Ack, Start, CDS} fixed values, 12 bit data (MSB first), 2 bits Error/ Warning, 6 bit CRC (polynomial: 0b1000011, inverted mode, binary coded).
- A complete reading cycle at maximum clock rate takes at least as follows:

ENX 8 EASY INT

$$23 \cdot \frac{1}{10MHz} + t_{out}$$

ENX 13…22 EASY INT

$$23 \cdot \frac{1}{10MHz} + \left(1.5 \cdot \frac{1}{10MHz} + t_{out}\right) .$$

- The interface is BiSS-C compatible or certified (exception: ENX 8 EASY INT). A BiSS master (e.g. motion controller) can automatically configure its interface to the sensor by using the "Auto Profile Detection Concept" (number of bits ST, CRC, nE, nW). Encoder is pre-configured in this respect according to the BiSS Profile 1 (BP1) specification. For more details on the specification of the BiSS-C interface and BiSS Profile 1: ➔http://biss-interface.com/ (section “Downloads” ➔ "EDS and Profile Definitions").
- In the simplest configuration, the controller is the master and ENX 16 EASY Absolute the only slave.

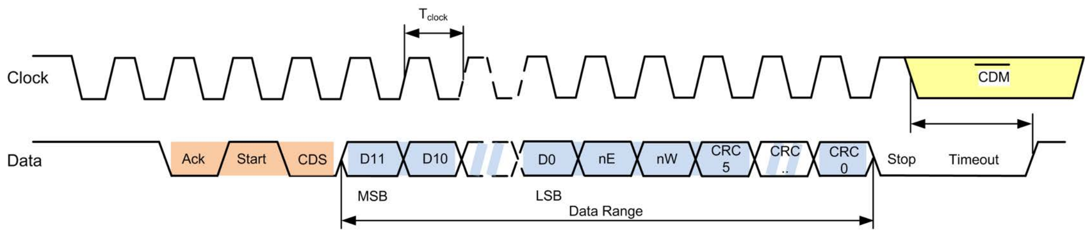
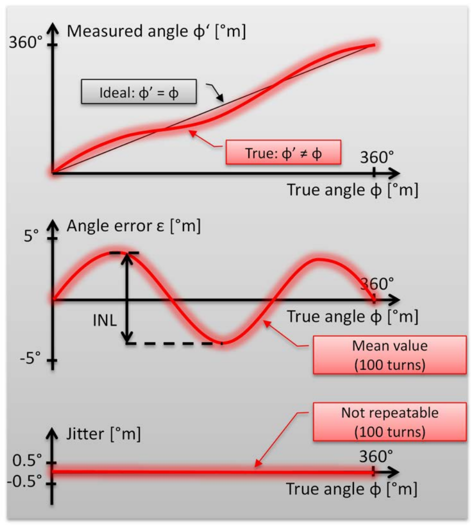
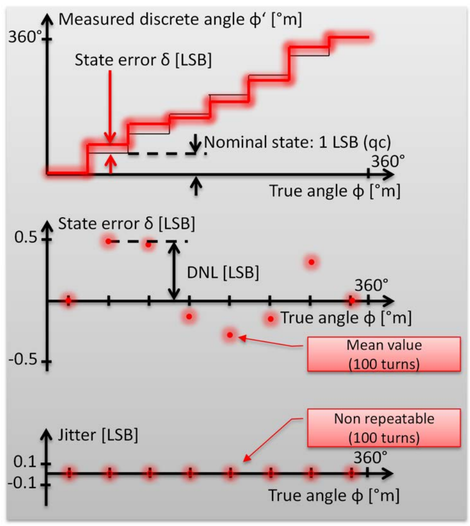
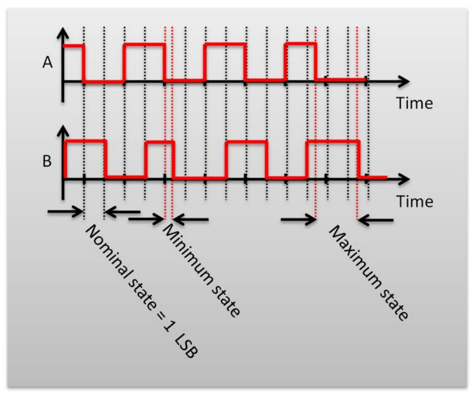


Figure 8 Timing of EASY INT Absolute in BiSS-C Mode

3 DEFINITIONS

Metric	Definition	Illustration
Angle Error [°m]	Difference of measured and true angular shaft position at each position.	
Average Angle Error [°m]	Average of Angle Error at each position, over a given number of turns.	
Integral Nonlinearity (INL) [°m]	Peak-to-peak value of Average Angle Error.	
Jitter (Repeatability) [°m] or [LSB]	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.	
Least Significant Bit (LSB)	Minimum measurable difference between two angle values at given resolution (= quadcount, = State).	
State Error [LSB]	Difference between actual state length and average state length.	
Average State Error [LSB]	Average of State Error over a number of turns for each state of a turn.	
Differential Nonlinearity [DNL]	Maximum positive or negative Average State Error.	
Minimum State Length [°e]	Minimum measured state length within a number of turns relative to pulse length.	
Maximum State Length [°e]	Maximum measured state length within a number of turns relative to pulse length.	
Minimum State Duration [ns]	By chip limited minimum time separation between two A/B transitions.	

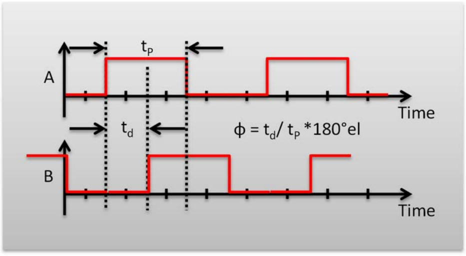
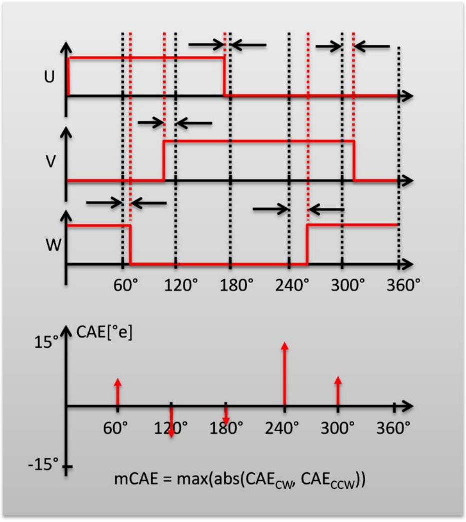
<table>
<tr><th>Metric</th><th>Definition</th><th>Illustration</th></tr>
<tr><td>Phase delay θ [°e]</td><td>Time difference of rising edge A to B relative to duration of positive level of A.</td><td>
</td></tr>
<tr><td>Maximum commutation angle error (maxCAE) [°e]</td><td>Minimum positive or negative deviation of the individual switching points of the commutation signals (reference signals), determined over a certain number of turns.</td><td>
</td></tr>
</table>

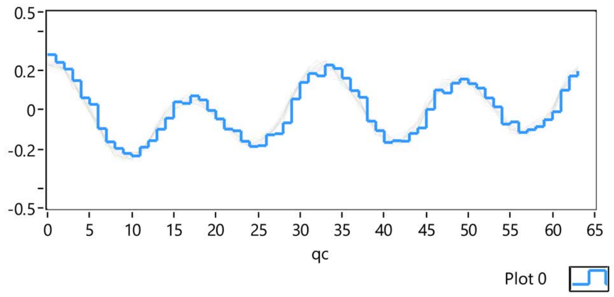
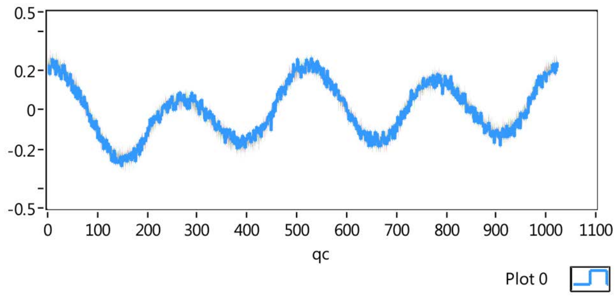
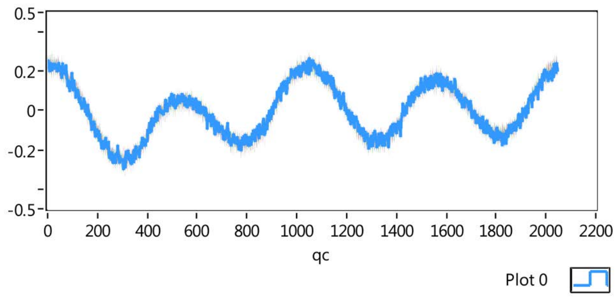
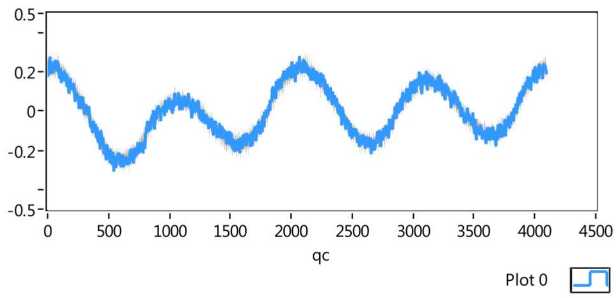
Table 1 Definitions

4 TYPICAL MEASUREMENT RESULTS

4.1 Angle Error per Turn, calibrated

The average angle error [°m] and the repeatability (Jitter) [°m] are independent of the chosen resolution. The metrics given in LSB are resolution-dependent.

Below graphs show angle error measurements of an ENX 13 EASY INT, configured as incremental encoder in various resolutions and as absolute encoder with maximum resolution under following conditions: Measurement of 25 turns at V_{CC}=5 V, n=10000 rpm, T=25°C.

<table>
<tr><th>Resolution</th><th>Graph</th><th colspan="2">Analysis</th></tr>
<tr><td>16 cpt</td><td>
</td><td>INL
Jitter
DNL
Min State
Max State</td><td>0.5°m
0.1°m = 0.02 LSB
0.03 LSB
0.97 LSB = 87°e
1.02 LSB = 92°e</td></tr>
<tr><td>256 cpt</td><td>
</td><td>INL
Jitter
DNL
Min State
Max State</td><td>0.5°m
0.1°m = 0.25 LSB
0.12 LSB
0.9 LSB = 81°e
1.1 LSB = 99°e</td></tr>
<tr><td>512 cpt</td><td>
</td><td>INL
Jitter
DNL
Min State
Max State</td><td>0.5°m
0.1°m = 0.5 LSB
0.3 LSB
0.85 LSB = 76°e
1.3 LSB = 117°e</td></tr>
<tr><td>1024 cpt</td><td>
</td><td>INL
Jitter
DNL
Min State
Max State</td><td>0.5°m
0.1°m = 1 LSB
0.5 LSB
0.8 LSB = 72°e
1.5 LSB = 135°e</td></tr>
</table>

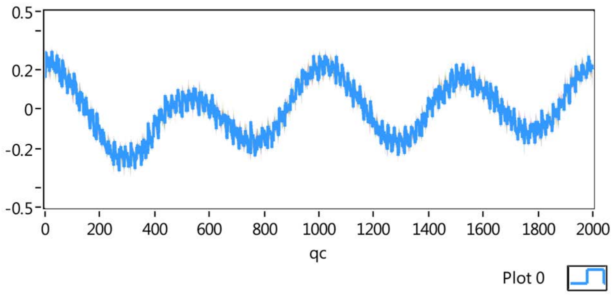
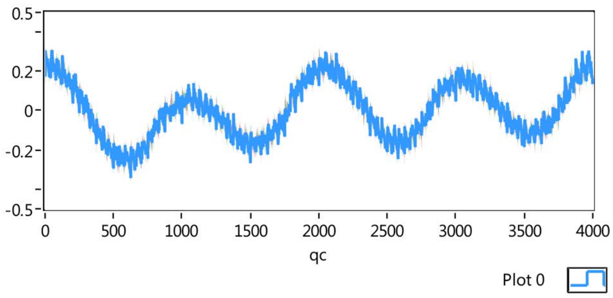
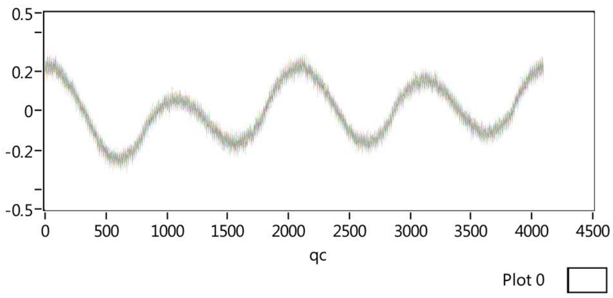
Resolution	Graph	Analysis	
500 cpt (non-binary)		INL Jitter DNL Min State Max State	0.5°m 0.1°m = 0.5 LSB 0.75 LSB 0.85 LSB = 76°e 1.75 LSB = 175°e
1000 cpt (non-binary)		INL Jitter DNL Min State Max State	0.5°m 0.1°m = 1 LSB 1.5 LSB 0.75 LSB = 67°e 2.5 LSB = 225°e
12 bit (Absolute)		INL Jitter	0.5°m 0.1°m = 1 LSB

Table 2 Typical Measurement Results

4.2 Temperature Dependence

Basically, INL, DNL, and State are temperature-independent. Due to thermal noise, Jitter increases, respectively repeatability decreases with rising temperature.

Figure 9 shows the temperature dependence of eight different ENX 13 EASY INT samples under the following conditions: V_{CC}=5 V, 10‘000 rpm, 1 kΩ load, 1024 cpt.

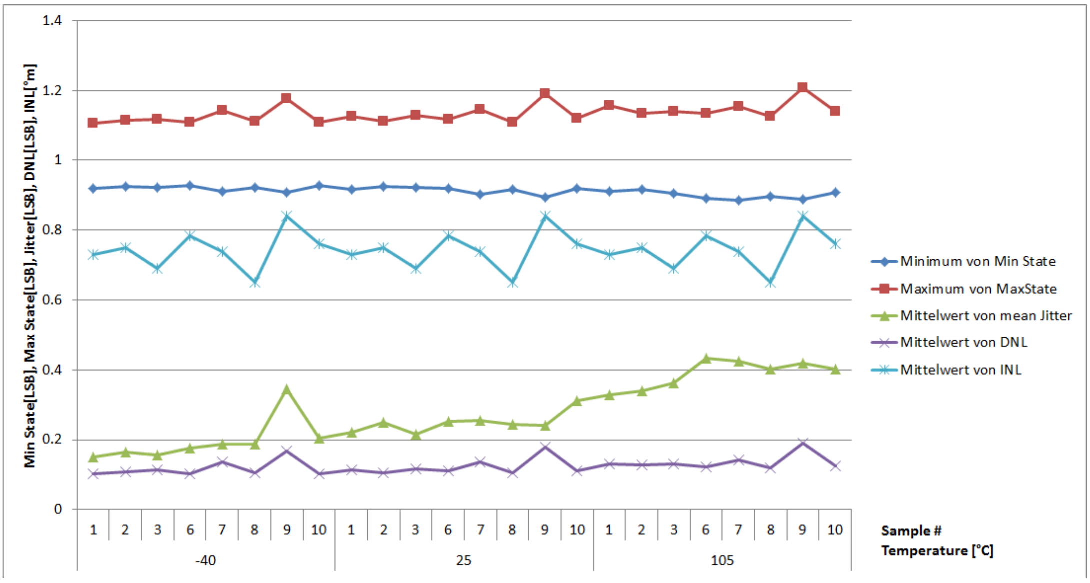


Figure 9 Temperature Dependence

4.3 Resolution Dependence

INL and Jitter [°m] are independent of resolution (➔Table 2). Resolution-dependent metrics deteriorate with increased resolution, particularly with non-binary resolutions (➔Figure 11)

Figure 10 shows the resolution dependence of eight different ENX 13 EASY INT samples under following conditions: V_{CC}=5 V, 10‘000 rpm, 1 kΩ load, 25°C, binary resolution

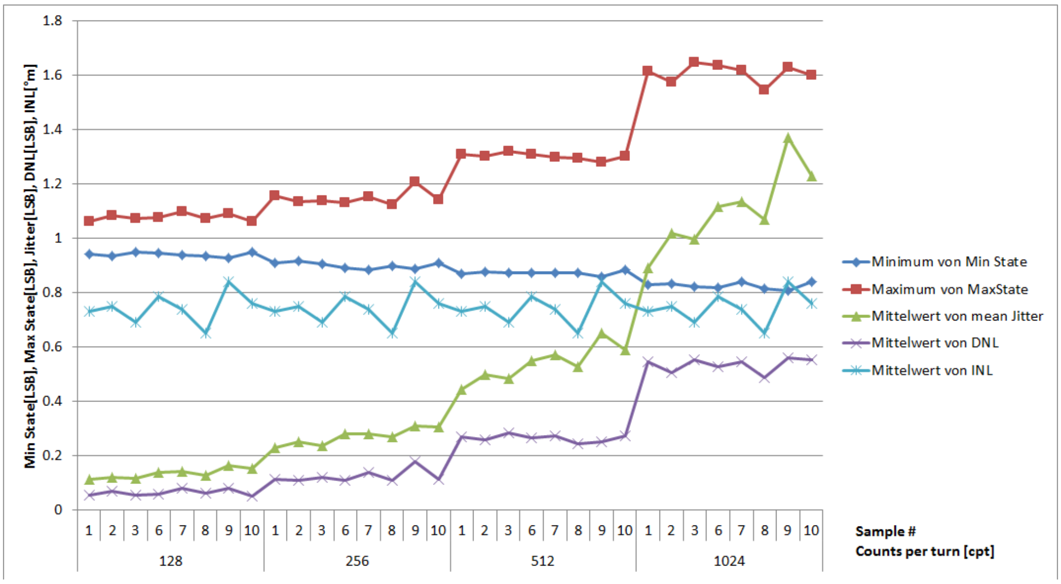


Figure 10 Resolution Dependence (binary Resolutions)

Figure 11 shows the resolution dependence of eight different ENX 13 EASY INT samples under following conditions: V_{CC}=5 V, 10‘000 rpm, 1 kΩ load, 25°C, non-binary resolution

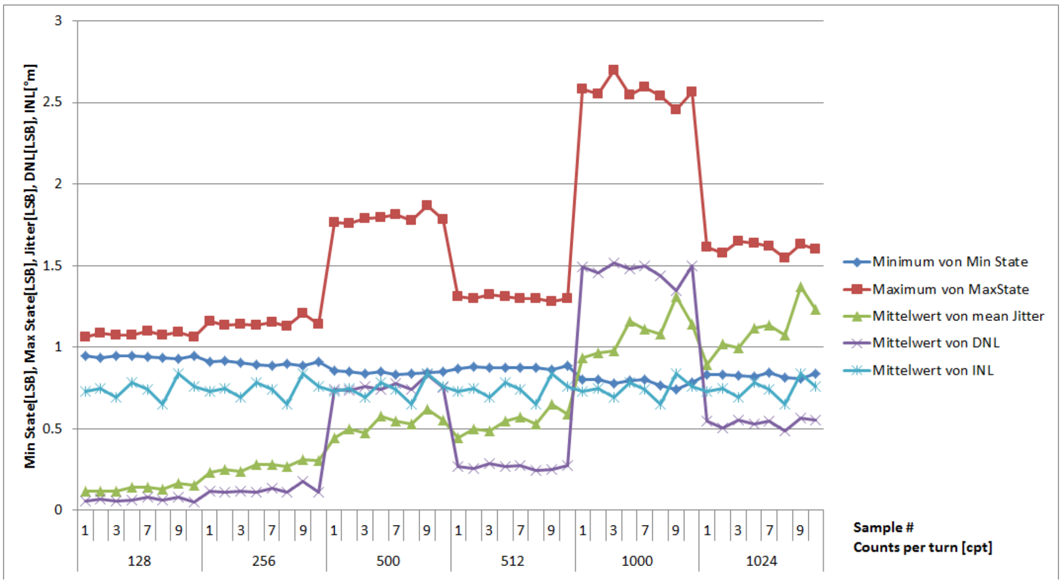


Figure 11 Resolution Dependence (Comparison binary/non-binary Resolutions)

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5 PIN ASSIGNMENT

Maximum permitted Supply Voltage

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

5.1 ENX 8 EASY INT & ENX 8 EASY INT COMM

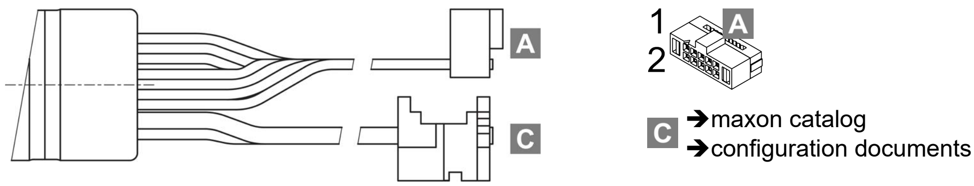

Figure 12 ENX 8 EASY INT (COMM) – Cable Plugs

Pin	Color	Signal		Description
		ENX 8 EASY INT	ENX 8 EASY INT COMM	
A1	marked	do not connect	do not connect	—
A2	gray	V_{CC}	V_{CC}	Power supply voltage
A3	gray	GND	GND	Ground
A4	gray	do not connect	do not connect	—
A5	gray	ChA/	H1	Channel A complement / Hall sensor 1
A6	gray	ChA	ChA	Channel A
A7	gray	ChB/	H2	Channel B complement / Hall sensor 2
A8	gray	ChB	ChB	Channel B
A9	gray	ChI/	H3	Channel I (Index) complement / Hall sensor 3
A10	gray	ChI	ChI	Channel I (Index)

Table 3 ENX 8 EASY INT (COMM) – Pin Assignment

Externally applied voltages at pins A1 and A4 can destroy the device.

Continued on next page.

Cable Plug ENX 8 EASY INT / ENX 8 EASY INT COMM		
A	Connector	IDC socket, pitch 1.27 mm, 5 x 2 poles
	Mating plug	Pin header, pitch 1.27 mm, 5 x 2 poles, pin length 3.05 mm/0.12 inch (e.g. Samtec FTSH series)
C	➔maxon catalog or configurations documents	

Table 4 ENX 8 EASY INT (COMM) – Specifications Cable Plugs

5.2 ENX 8 EASY INT Absolute & ENX 8 EASY INT Absolute COMM

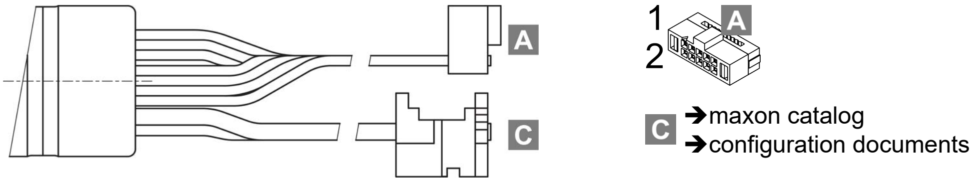

Figure 13 ENX 8 EASY INT Absolute (COMM) – Cable Plugs

Pin	Color	Signal		Description
		ENX 8 EASY INT Absolute	ENX 8 EASY INT Absolute COMM	
A1	marked	SSI/BiSS DATA	do not connect	Data output absolute encoder Data
A2	gray	V_{CC}	V_{CC}	Power supply voltage
A3	gray	GND	GND	Ground
A4	gray	SSI/BiSS CLK	do not connect	Data output absolute encoder Clock
A5	gray	do not connect	H1	Hall sensor 1
A6	gray	do not connect	ChA	—
A7	gray	do not connect	H2	Hall sensor 2
A8	gray	do not connect	ChB	—
A9	gray	do not connect	H3	Hall sensor 3
A10	gray	do not connect	ChI	—

Table 5 ENX 8 EASY INT Absolute (COMM) – Pin Assignment

Externally applied voltages at pins A1 and A4 can destroy the device.

Cable Plug ENX 8 EASY INT Absolute / ENX 8 EASY INT Absolute COMM		
A	Connector	IDC socket, pitch 1.27 mm, 5 x 2 poles
	Mating plug	Pin header, pitch 1.27 mm, 5 x 2 poles, pin length 3.05 mm/0.12 inch (e.g. Samtec FTSH series)
C	➔maxon catalog or configurations documents	

Table 6 ENX 8 EASY INT Absolute (COMM) – Specifications Cable Plugs

5.3 ENX 13 | 16 | 19 | 22 EASY INT COMM

Versions available:
- *Encoder with plug / Hall sensors without plug / Motor without plug*
- *Encoder with plug / Hall sensors with plug / Motor with plug (➔Figure 14)*

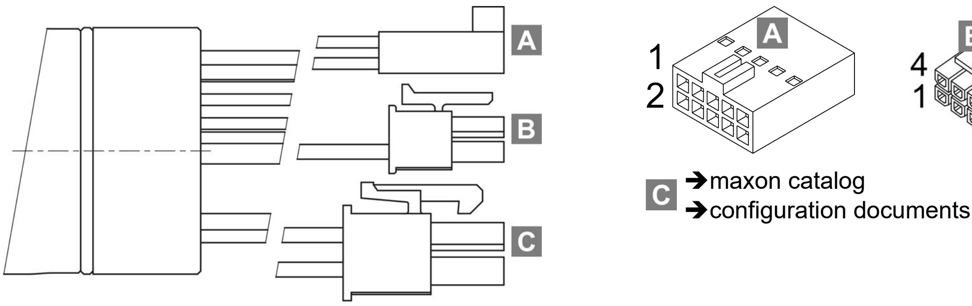

Figure 14 ENX 13 | 16 | 19 | 22 EASY INT COMM – Cable Plugs

Pin	Color	Signal	Description
A1	—	not connected	—
A2	black	V_{CC}	Power supply voltage
A3	brown	GND	Ground
A4	—	not connected	—
A5	red	ChA/	Channel A complement
A6	orange	ChA	Channel A
A7	yellow	ChB/	Channel B complement
A8	green	ChB	Channel B
A9	blue	ChI/	Channel I (index) complement
A10	violet	ChI	Channel I (Index)

Pin	Color	Signal	Description
B1	yellow	H1	Hall sensor 1
B2	brown	H2	Hall sensor 2
B3	gray	H3	Hall sensor 3
B4	—	not connected	—
B5	—	not connected	—
B6	—	not connected	—

Table 7 ENX 13 | 16 | 19 | 22 EASY INT COMM – Pin Assignment

Continued on next page.

Cable Plugs ENX 13…22 EASY INT COMM		
A	Connector	Crimp contact housing, pitch 2.54 mm, 5 x 2 poles
	Mating plug	Pin header, pitch 2.54 mm, 5 x 2 poles (EN 60603-13/DIN 41651)
B	Connector	Molex Micro-Fit 3.0, 6 poles (430-25-0600)
	Mating plug	Molex Micro-Fit 3.0, 6 poles (430-45-0612)
C	➔maxon catalog or configurations documents	

Table 8 ENX 13 | 16 | 19 | 22 EASY INT COMM – Specifications Cable Plugs

5.4 ENX 13 | 16 | 19 | 22 EASY INT Absolute

Versions available:
- *Absolute encoder without plug / Motor without plug*
- *Absolute encoder with plug / Motor with plug (➔Figure 15)*
- *Absolute encoder and motor with pins (➔Figure 16)*

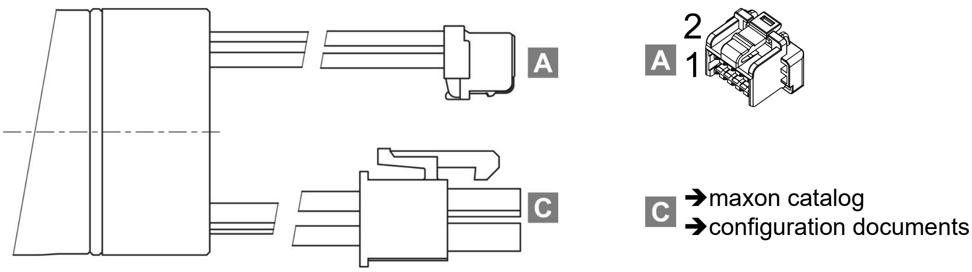

Figure 15 ENX 13 | 16 | 19 | 22 EASY INT Absolute – Cable Plugs

W1 / W2 / W3
Motor winding 1
Motor winding 2
Motor winding 3

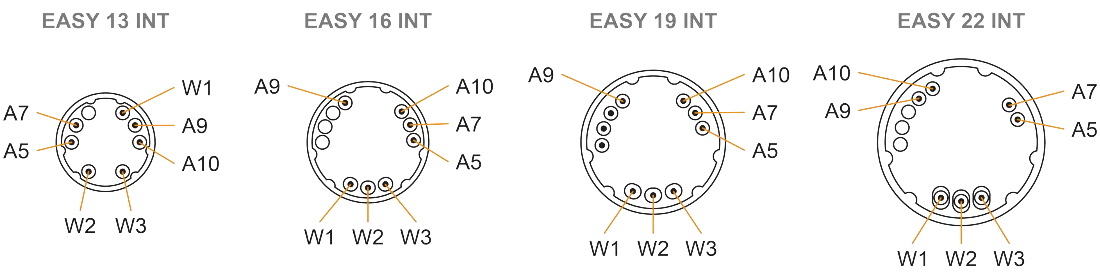

Figure 16 ENX 13 | 16 | 19 | 22 EASY INT Absolute – Pins

Pin	Color	Signal	Description
A1	—	not connected	—
A2	—	not connected	—
A3	—	not connected	—
A4	—	not connected	—
A5	yellow	SSI/BiSS CLK	Data output absolute encoder Clock
A6	—	not connected	—
A7	green	SSI/BiSS DATA	Data output absolute encoder Data

Pin	Color	Signal	Description
A8	—	not connected	—
A9	brown	GND	Ground
A10	black	V_{CC}	Power supply voltage

Table 9 ENX 13 | 16 | 19 | 22 EASY INT Absolute – Pin Assignment

Cable Plugs ENX 13…22 EASY INT Absolute		
A	Connector	Molex CLIK-Mate, pitch 1.5 mm, 5 x 2 poles (503149 series)
	Mating plug	Molex CLIK-Mate, pitch 1.5 mm, 5 x 2 poles (503154 series)
C	➔maxon catalog or configurations documents	

Table 10 ENX 13 | 16 | 19 | 22 EASY INT Absolute – Specifications Cable Plugs

5.5 ENX 16 | 19 | 22 EASY INT Absolute COMM

Versions available:
- *Absolute encoder, Hall sensors, and motor with pins (➔Figure 17)*

W1 / W2 / W3
Motor winding 1
Motor winding 2
Motor winding 3

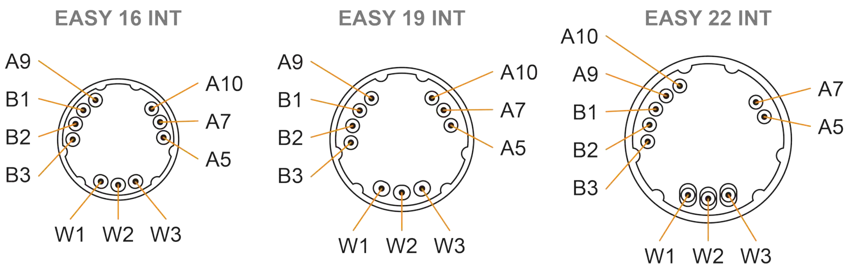

Figure 17 ENX 16 | 19 | 22 EASY INT Absolute COMM – Pins

Pin	Color	Signal	Description
A5	—	SSI/BiSS CLK	Data output absolute encoder Clock
A7	—	SSI/BiSS DATA	Data output absolute encoder Data
A9	—	GND	Ground
A10	—	V_{CC}	Power supply voltage
B1	—	H1	Hall sensor 1
B2	—	H2	Hall sensor 2
B3	—	H3	Hall sensor 3

Table 11 ENX 16 | 19 | 22 EASY INT Absolute COMM – Pin Assignment

5.6 ENX 13 | 16 | 22 COMM

Versions available:

- *Hall sensors without plug / Motor without plug*
- *Hall sensors without plug / Motor without plug / NTC without plug*
- *Hall sensors with plug / Motor with plug (➔Figure 18)*
- *Hall sensors with plug / Motor with plug / NTC with plug (➔Figure 19)*
- *Hall sensors, motor, and NTC with pins (➔Figure 20)*

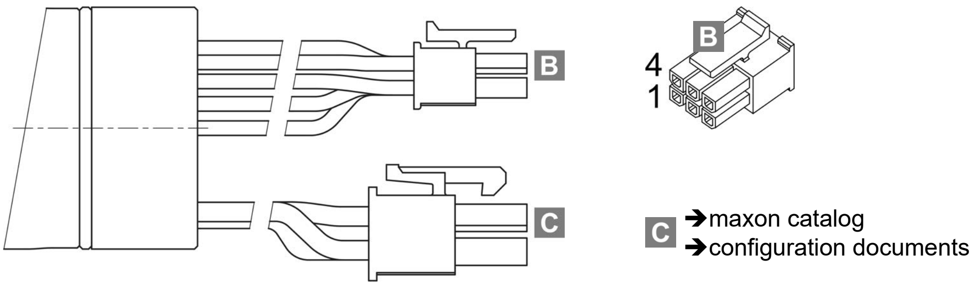

Figure 18 ENX 13 | 16 | 22 COMM – Cable Plugs

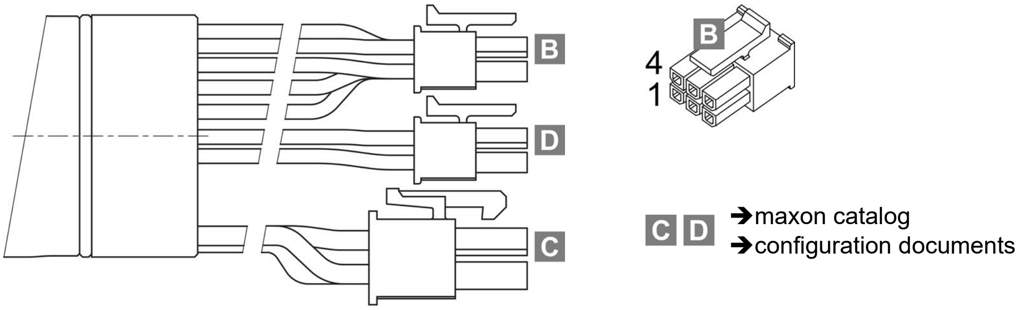

Figure 19 ENX 16 | 22 COMM (thermistor version) – Cable Plugs

W1 / W2 / W3
Motor winding 1
Motor winding 2
Motor winding 3

NTC1 / NTC2
Thermistor 1
Thermistor 2

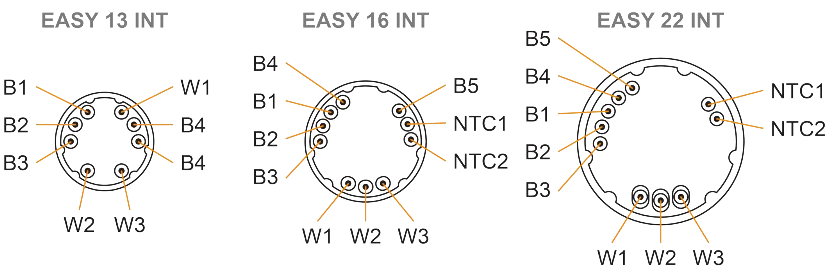

Figure 20 ENX 13 | 16 | 22 COMM – Pins

Continued on next page.

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Pin	Color	Signal	Description
B1	yellow	H1	Hall sensor 1
B2	brown	H2	Hall sensor 2
B3	gray	H3	Hall sensor 3
B4	blue	GND	Ground
B5	orange	V_{Hall}	Hall sensor supply voltage
B6	—	not connected	—

Table 12 ENX 13 | 16 | 22 COMM – Pin Assignment

Cable Plugs ENX 13…22 COMM		
B	Connector	Molex Micro-Fit 3.0, 6 poles (430-25-0600)
	Mating plug	Molex Micro-Fit 3.0, 6 poles (430-45-0612)
C	→maxon catalog or configurations documents	
D		

Table 13 ENX 13 | 16 | 22 COMM – Specifications Cable Plugs

6 OUTPUT CIRCUITRY

The following figures show the conceptual output schematics of the different encoders including ESD protection circuitry.

6.1 ENX 8 EASY INT

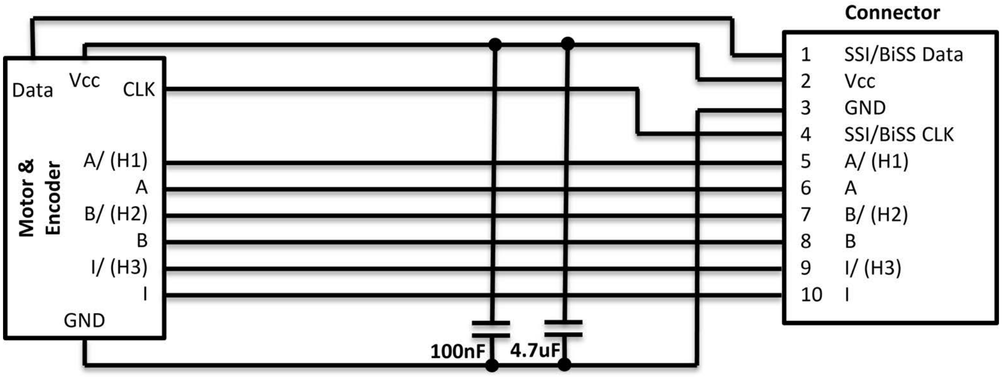

Figure 21 ENX 8 EASY INT – Output Circuitry

6.2 ENX 13 | 16 | 19 | 22 EASY INT COMM

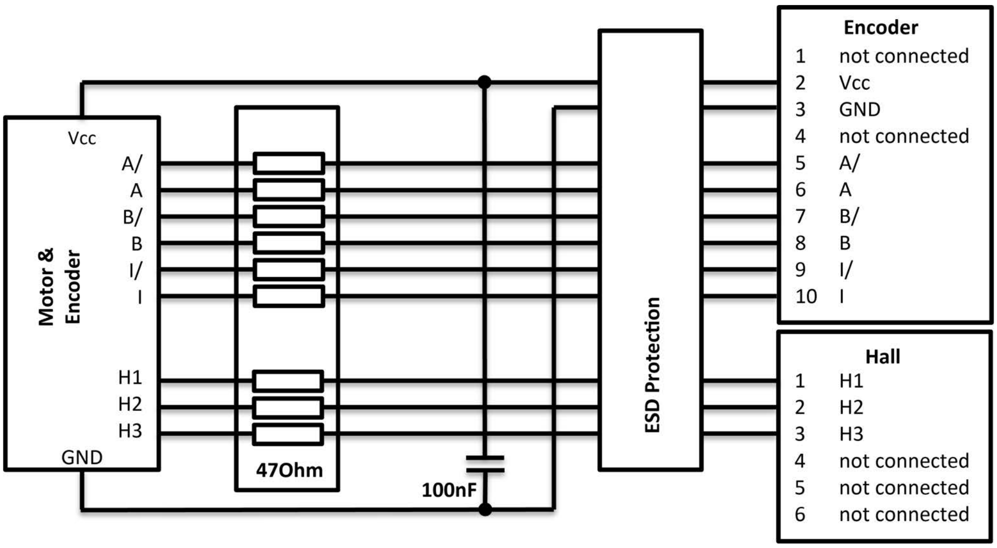

Figure 22 ENX 13 | 16 | 19 | 22 EASY INT COMM – Output Circuitry

6.3 ENX 13 | 16 | 19 | 22 EASY INT Absolute

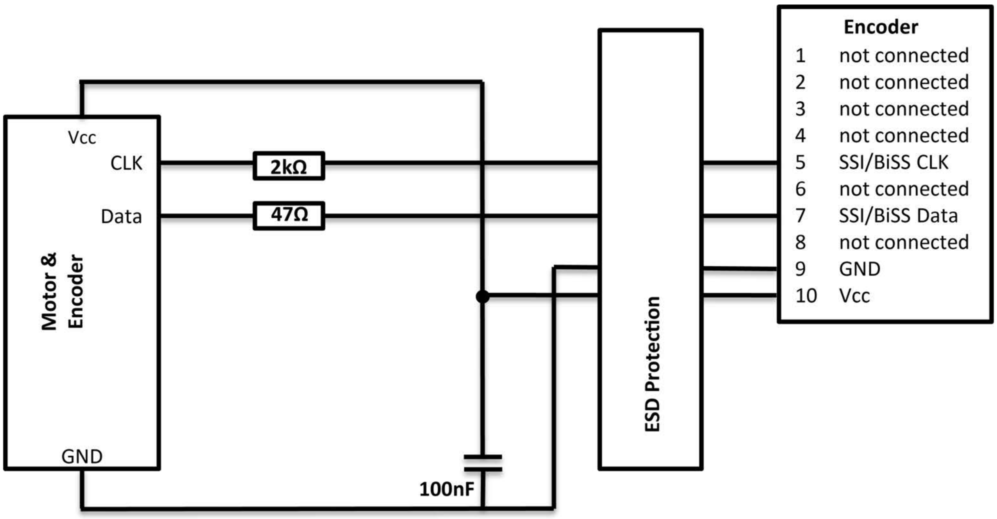

Figure 23 ENX 13 | 16 | 19 | 22 EASY INT Absolute – Output Circuitry

6.4 ENX 16 | 19 | 22 EASY INT Absolute COMM

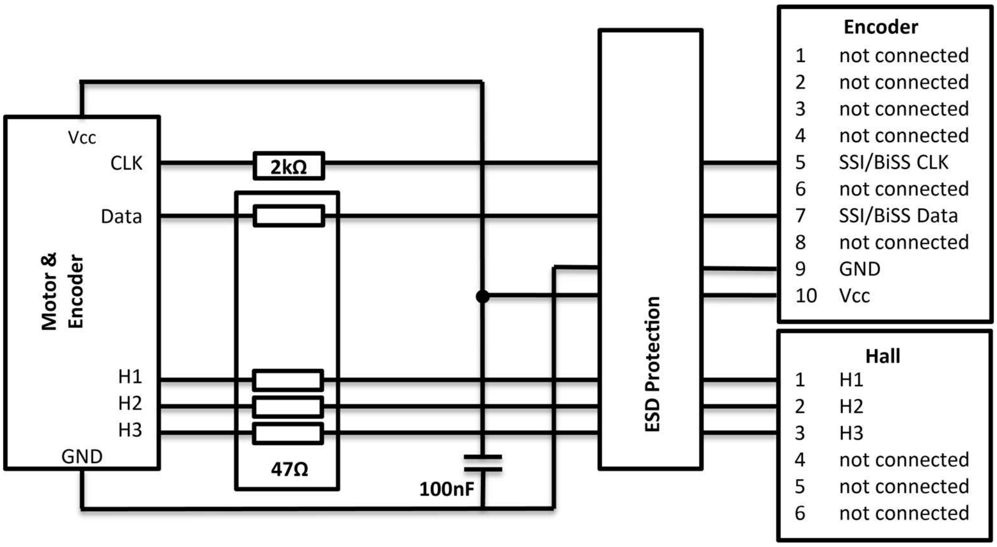

Figure 24 ENX 16 | 19 | 22 EASY INT Absolute COMM – Output Circuitry

6.5 ENX 13 | 16 | 22 COMM

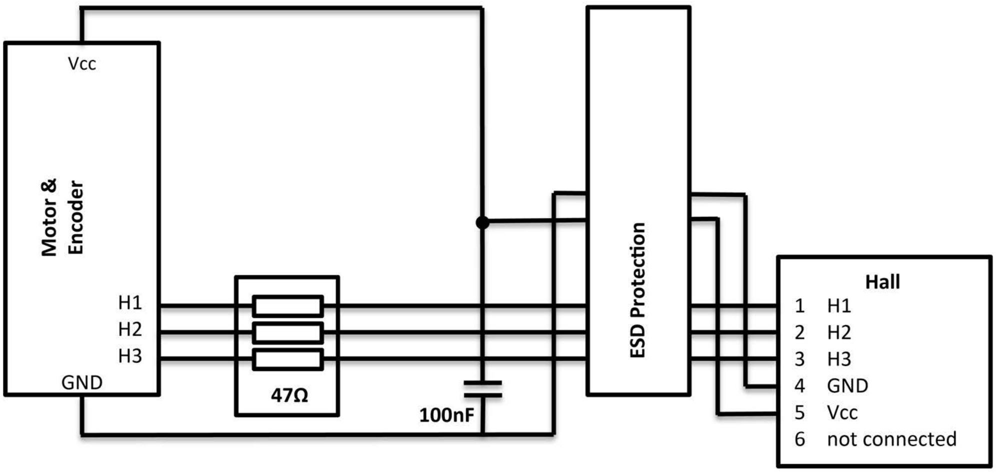

Figure 25 ENX 13 | 16 | 22 COMM – Output Circuitry

7 ACCESSORIES

Order number	Description	
498157	Adapter Micromotor	To connect the ENX 8 EASY INT to a maxon controller
For further details ➔maxon catalog		

Table 14 Suitable Accessories

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mmag | ENX EASY INT Encoders Product Information | Edition 2023-04 | DocID 4174182-04