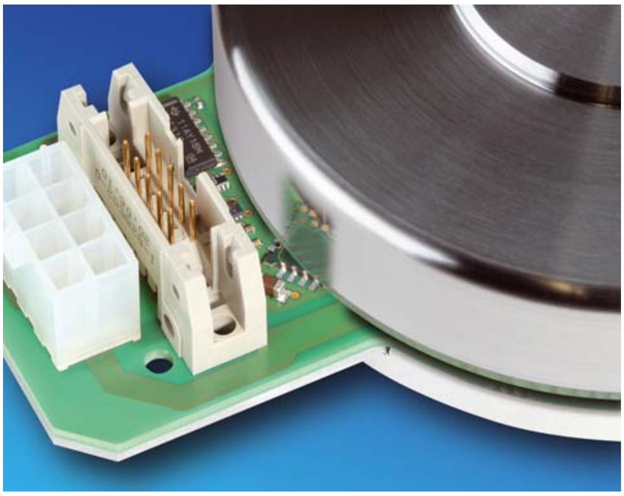
MILE Encoder for EC 90 flat

Encoders

Product Information



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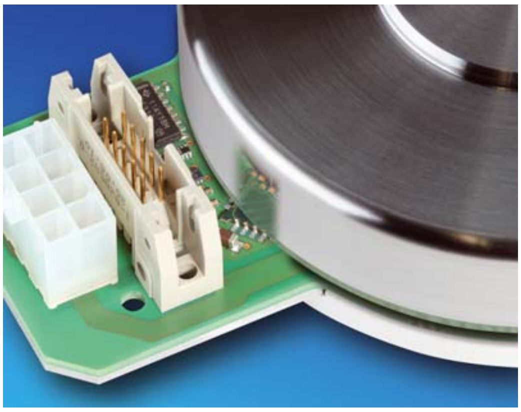


Figure 1 EC 90 flat with MILE-Encoder

The MILE encoder uses an inductive angle measurement system to generate incremental quadrature output signals. Two channels (A, B) with differential electrical signals according to EIA-422 (20 mA, maximum current) are available. Eight resolutions are available;

- a binary series of 512, 1024, 2048, and 4096 impulses per turn and
- a higher resolution series of 800, 1600, 3200, and 6400 impulses per turn.

The binary series uses a pole wheel of 128 lines per turn, the high resolution series a pole wheel of 200 lines per turn. For each pole wheel, the different resolutions stem from a factory-programmed setting of the interpolation factor (4x, 8x, 16x and 32x).

The encoder is designed for highest robustness in industrial applications. It can be operated in the open environment of an EC flat motor and is equipped with additional ESD protection circuitry. Due to the robustness of the MILE technology in terms of magnetic interference, integration of the encoder into the EC 90 flat was possible with minimal change of dimensions.

Pin-out is compatible to most maxon motor 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.

1 Technical Data

1.1 Absolute Maximum Rating

Parameter	Conditions	Min.	Max.	Unit
Supply voltage (V_{cc})	6.5 V for less than 5 minutes	–0.3	6.5	V
Voltage at signal output (V_{signal})		–0.3	V_{cc}+0.3	V
Signal output current (I_{signal})	Given by line driver	–100	+100	mA
ESD voltage (V_{esd}), all pins	EN 61000-4-2		>2	kV
Storage temperature (T_{store})		–40	+105	°C
Operation temperature (T_{amb})		–40	+100	°C
Humidity	Condensation not permitted	20	80	%rH

1.2 Electrical Data

Parameter	Conditions	Min.	Typ.	Max.	Unit
Supply voltage (V_{cc})		4.5	5.0	5.5	V
Supply current (I_{dd})	Output pulse frequency <100 kHz, load resistor ≥10 kΩ		15		mA
Signal output current (I_{signal})	With Line Receiver EIA-422	–20		+20	mA
Signal voltage high (V_{high})	I_{signal} –20 mA, V_{cc} =5 V	2.4	3.4		V
Signal voltage low (V_{low})	I_{signal} +20 mA		0.2	0.4	V
Transition time (t_{trans})	Rise time/fall time ChA/B @ load resistor 100 Ω, C_{load} 120 pF			20	ns

1.3 Angle Measurement

All values at T = 25°C, n = 1000 rpm, unless otherwise specified.
➔“Definitions” on page 6

Parameter	Conditions	Min.	Typ.	Max.	Unit
Number of channels	ChA, ChB		2		–
Pulse frequency (f_{pulse})	Max. output pulse frequency @ 6400 cpt without virtual backward states				
	@ 25°C	400	550	700	kHz
	@ –40°C	250	365	480	kHz
Resolution (N)	200 lines 128 lines	800 512	1600 1024	6400 4096	cpt
State length (L_{state})	N≤1600 cpt	45	90	135 *1	°el
	N=2048, 3200 cpt	36	90	—	°el
	N=4096, 6400 cpt	36	90	—	°el
Minimum state duration (t_{state}) *2	Depending on temperature, 4 x f_{pulse} < $1/t_{state}$	125	156	250	ns
Integral Nonlinearity (INL)	N≤6400 cpt		0.2	0.5	°m
Repeatability of angle error (Jitter)	N≤6400 cpt		0.015	0.045	°m
	N=512, 800 cpt		0.125	0.4	LSB
	N=1024, 1600 cpt		0.25	0.8	LSB
	N=2048, 3200 cpt		0.5	1.6	LSB
	N=4096, 6400 cpt		1.0	3.2	LSB

Parameter	Conditions	Min.	Typ.	Max.	Unit
Differential Nonlinearity (DNL)	N=512, 800 cpt		0.55	0.8	LSB
	N=1024, 1600 cpt		0.65	0.9	
	N=2048, 3200 cpt		0.75	1.0	
	N=4096, 6400 cpt		0.85	1.1	
Angle hysteresis (Hyst)	All resolutions		1		LSB

**1 Typical value for maximum state length*

**2 ➔Table 2*

1.4 Hall Sensor

Parameter	Conditions	Min.	Typ.	Max.	Unit
Supply voltage (V_{cc} Hall)	With ESD protection diode	4.5	5.0	18	V
Supply current (I_{Vcc})	Output "High", i.e. minimum current into output Q	0.5	3	6	mA
Signal output current (I_{signal})	Limits minimum external pull-up			12	mA
Signal output voltage (V_{signal})	Output Q = "High"		V_{cc}	V_{cc}+0.3	V
	Output Q = "Low"	0	0.2	0.4	V
ESD voltage (V_{esd}), all pins	EN 61000-4-2			>2	kV

1.5 Mechanical Data

Parameter	Conditions	Value	Unit
Dimensions (➔Figure 2)	D x H	Ø90.0 x 26.9	mm
	Lateral projection PCB (W x H)	40 x 31	
Moment of inertia of pole wheel		65	g cm^2

Table 1 Technical Data

2 Protection and Robustness

- Outputs for Hall sensor and encoder (line driver) are protected by ESD protection diodes designed for an ESD level of at least 2 kV according to EN 61000-4-2.
- In addition, outputs for Hall sensor and encoder (line driver) are protected by series resistances of 47 Ohm or 56 Ohm, respectively.
- Encoder outputs are provided through an EIA RS422 line driver circuit of type AM 26C31Q.
- The encoder by virtue of its inductive operating principle is immune to magnetic interference, dust, and dirt.

3 Definitions

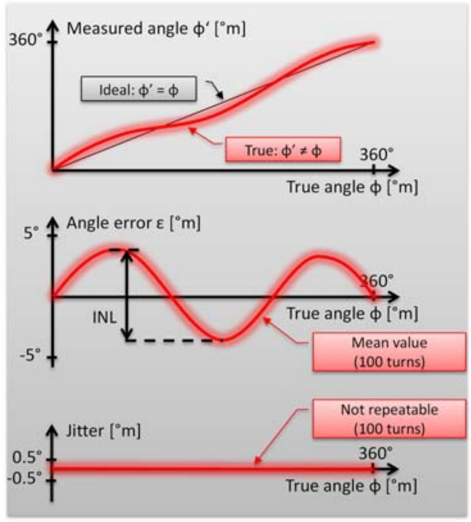
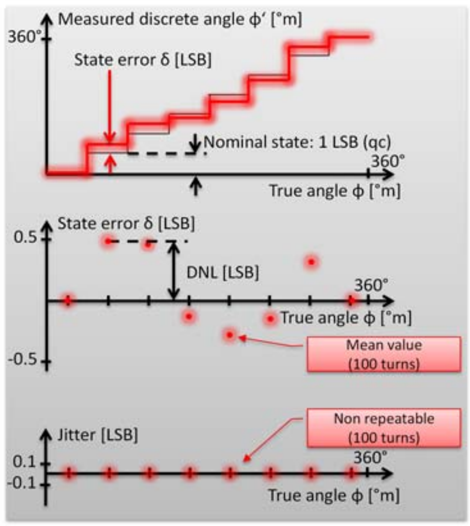
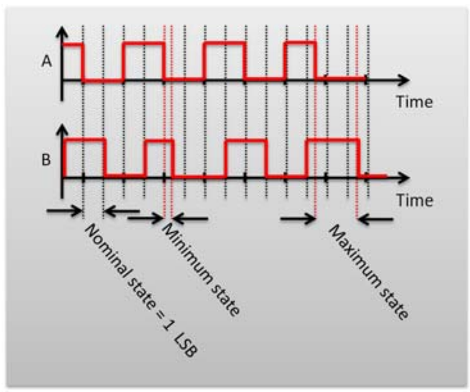
<table>
<tr><th>Metric</th><th>Definition</th><th>Illustration</th></tr>
<tr><td>Angle Error [°m]</td><td>Difference of measured and true angular shaft position at each position.</td><td rowspan="5">
</td></tr>
<tr><td>Average Angle Error [°m]</td><td>Average of Angle Error over a number of turns.</td></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 (over one turn, at a given number of turns).
Jitter [°m] is typically independent of 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 [°el]</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 [°el]</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>

Table 2 Definitions

4 Dimensional Drawing

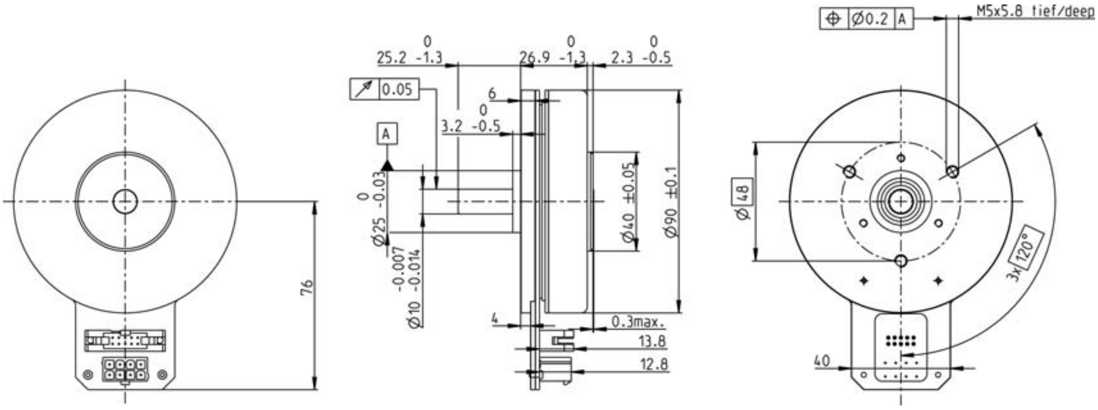


Figure 2 Dimensional Drawing [mm]

5 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).*

5.1 Encoder

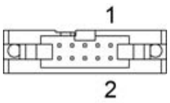


Figure 3 Encoder Connector

Pin	Signal	Description
1	–	not connected
2	V_{CC}	Power supply voltage
3	GND	Ground
4	–	not connected
5	ChA/	Channel A complement
6	ChA	Channel A
7	ChB/	Channel B complement
8	ChB	Channel B
9	internal signal	do not connect
10	internal signal	do not connect

Table 3 Encoder Connector – Pin Assignment

Specifications	
Connector	Wire-to-board connector, pitch 2.54 mm, 5 x 2 poles (EN 60603-13/DIN 41651)
Mating plug	Pin socket, pitch 2.54 mm, 5 x 2 poles

Table 4 Encoder Connector – Specifications

5.2 Motor/Hall Sensor

The MILE on EC 90 flat PCB comprises three digital Hall sensors for commutation. For specifications ➔chapter “1.4 Hall Sensor” on page 5, for output interface ➔Figure 5.

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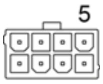

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Figure 4 Motor/Hall Sensor Connector

Pin	Signal	Description
1	Hall sensor 1	Hall sensor 1 output
2	Hall sensor 2	Hall sensor 2 output
3	V_{CC}, Hall	Hall sensor supply voltage
4	Motor winding 3	Winding 3
5	Hall sensor 3	Hall sensor 3 output
6	GND	Hall Sensor ground
7	Motor winding 1	Winding 1
8	Motor winding 2	Winding 3

Table 5 Motor/Hall Sensor Connector – Pin Assignment

Specifications	
Connector	Pin header, pitch 4.2 mm, 4 x 2 poles (MOLEX 39-28-1083)
Mating plug	Crimp housing, pitch 4.2 mm, 4 x 2 poles

Table 6 Motor/Hall Sensor Connector – Specifications

6 Output Circuitry

6.1 Hall Sensor

The Hall sensor output signals H1-H3 are equipped with ESD protection diodes.

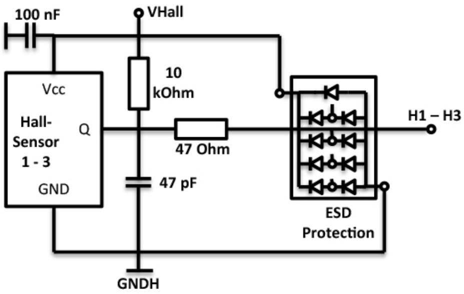

Figure 5 Hall Sensor – Output Circuitry

6.2 Encoder

The encoder output signals are equipped with ESD protection diodes.

Conceptual output circuitry of Encoder signals including ESD protection.

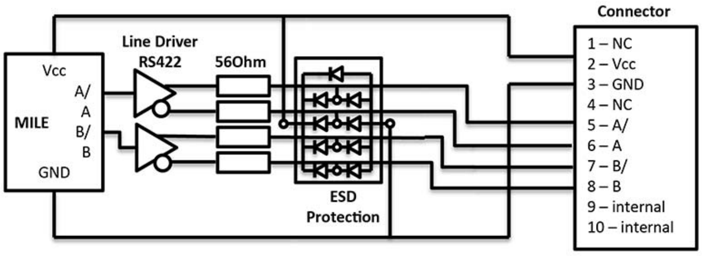

Figure 6 Encoder – Output Circuitry

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