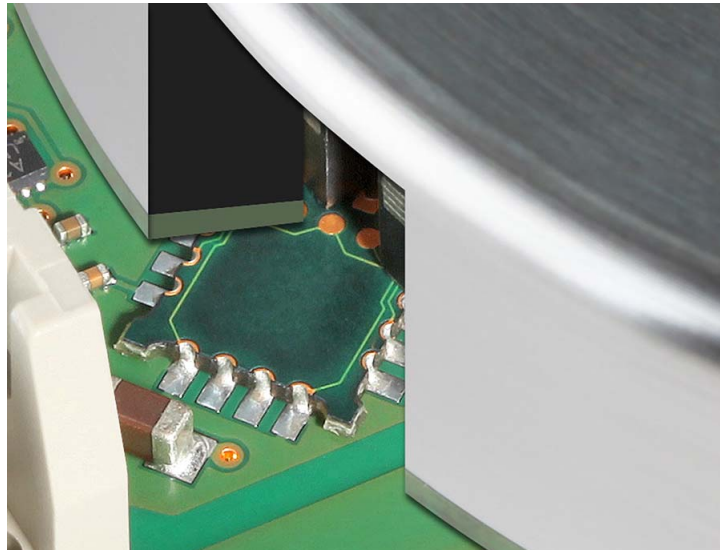


# MILE Encoder for EC 90 flat

Product Information



**TABLE OF CONTENTS**

<b>1</b>	<b>TECHNICAL DATA</b>	<b>4</b>
	1.1 Absolute Maximum Rating . . . . .	4
	1.2 Electrical Data . . . . .	4
	1.3 Angle Measurement . . . . .	4
	1.4 Hall Sensor . . . . .	5
	1.5 Mechanical Data . . . . .	5
	1.6 Dimensional Drawing . . . . .	5
<b>2</b>	<b>PROTECTION AND ROBUSTNESS</b>	<b>6</b>
<b>3</b>	<b>DEFINITIONS</b>	<b>7</b>
<b>4</b>	<b>PIN ASSIGNMENT</b>	<b>8</b>
	4.1 Encoder . . . . .	8
	4.2 Motor/Hall Sensor . . . . .	9
<b>5</b>	<b>OUTPUT CIRCUITRY</b>	<b>10</b>
	5.1 Hall Sensor . . . . .	10
	5.2 Encoder . . . . .	10

**TRADEMARKS AND BRAND NAMES**

In the present document, registered brand names will not be tagged with their respective trademark. It must be understood that the brands (below list is not necessarily concluding) are protected by copyright and/or other intellectual property rights even if their legal trademarks are omitted.

Micro-Fit™ and      © Molex, USA-Lisle, IL  
Mini-Fit Jr.™

## MILE Encoder for EC 90 flat – Product Information



Figure 1 EC 90 flat with MILE-Encoder

The MILE encoder uses an inductive angle measurement system to generate incremental quadrature output signals. It features two channels (A, B) with differential electrical signals and is available in eight resolutions;

- 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 ( $V_{CC}$ )		-0.3	6	V
Voltage at signal output ( $V_{signal}$ )		-0.3	$V_{CC}+0.3$	V
Signal output current ( $I_{signal}$ )		-4	+4	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 $\geq 10$ k $\Omega$		15		mA
Signal output current ( $I_{signal}$ )		-4		+4	mA
Signal voltage high ( $V_{high}$ )	$I_{signal} \leq 4$ mA, $V_{CC} = 5$ V	4.5	5		V
Signal voltage low ( $V_{low}$ )	$I_{signal} \leq 4$ mA, $V_{CC} = 5$ V		0.2	0.5	V
Transition time ( $t_{trans}$ )	Rise time/fall time ChA/B @ load resistor 1 k $\Omega$ , $C_{load}$ 25 pF			20	ns

## 1.3 Angle Measurement

All values at  $T = 25^\circ\text{C}$ ,  $n = 1000$  rpm, unless otherwise specified / → "Definitions" on page 7

Parameter	Conditions	Min.	Typ.	Max.	Unit
Number of channels	ChA, ChB	2			-
Pulse frequency ( $f_{pulse}$ )				1000	kHz
Resolution (N)	200 lines 128 lines	800 512	1600 1024	6400 4096	cpt
State length ( $L_{state}$ )	$N \leq 1600$ cpt	45	90	135 *1)	°el
	$N=2048, 3200$ cpt	36	90	—	
	$N=4096, 6400$ cpt	36	90	—	
Integral Nonlinearity (INL)	200 lines, $N \leq 6400$ cpt		0.2	0.6	°m
	128 lines, $N \leq 4096$ cpt		0.3	0.9	
Repeatability of angle error (Jitter)	$N \leq 6400$ cpt		0.015	0.045	°m
	$N=512, 800$ cpt		0.125	0.4	
	$N=1024, 1600$ cpt		0.17	0.8	
	$N=2048, 3200$ cpt		0.37	1.6	
	$N=4096, 6400$ cpt		0.64	3.2	

Parameter	Conditions	Min.	Typ.	Max.	Unit
Differential Nonlinearity (DNL)	N=512, 800 cpt		0.35	0.8	LSB
	N=1024, 1600 cpt		0.35	0.9	
	N=2048, 3200 cpt		0.4	1.0	
	N=4096, 6400 cpt		0.4	1.1	
Angle hysteresis (Hyst)	All resolutions		1		LSB

\*1 Typical value for maximum state length

## 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 L1	160 W / 220 W: $\varnothing 90 \times 28$ 260 W / 400 W: $\varnothing 90 \times 40.5$	mm
	Lateral projection PCB	47.2 x 8.5	
Moment of inertia of pole wheel		65	g cm <sup>2</sup>

## 1.6 Dimensional Drawing

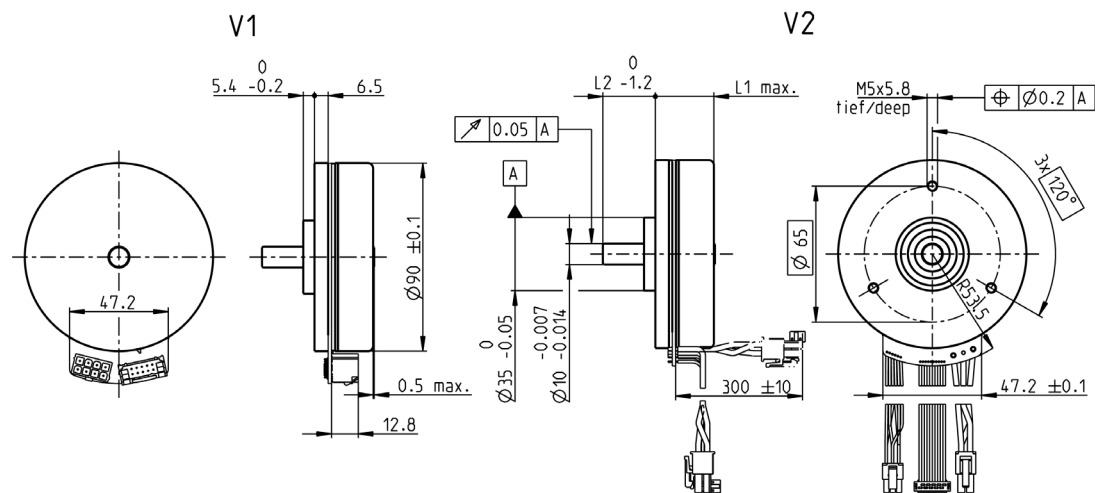


Figure 2 Dimensional Drawing [mm]

## **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.
- The encoder by virtue of its inductive operating principle is immune to magnetic interference, dust, and dirt.

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 over a 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 (over one turn, at a given number of turns). <b>Jitter [°m]</b> is typically independent of resolution and defines the maximum useful positioning repeatability. <b>Jitter [LSB]</b> 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 [°el]	Minimum measured state length within a number of turns relative to pulse length.	
Maximum State Length [°el]	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 1 Definitions

## 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 ( $V_{cc}=0$ ).

### 4.1 Encoder



Figure 3 Encoder Connector

V1	V2	Signal	Description
A1	A1	–	not connected
A2	A2	$V_{cc}$	Power supply voltage
A3	A3	GND	Ground
A4	A4	–	not connected
A5	A5	ChA/	Channel A complement
A6	A6	ChA	Channel A
A7	A7	ChB/	Channel B complement
A8	A8	ChB	Channel B
A9	A9	internal signal	do not connect
A10	A10	internal signal	do not connect

Table 2 Encoder Connector – Pin Assignment

Specifications			
V1	A	Connector	Pin header, pitch 2.54 mm, 5 x 2 poles (DIN 41651/EN 60603-13)
		Mating plug	IDC socket, pitch 2.54 mm, 5 x 2 poles
V2	A	Connector	IDC socket, pitch 2.54 mm, 5 x 2 poles (DIN 41651/EN 60603-13)
		Mating plug	Pin header, pitch 2.54 mm, 5 x 2 poles

Table 3 Encoder Connector – Specifications



## 4.2 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.



Figure 4 Motor/Hall Sensor Connector

V1	V2	Signal	Description
B1	B1	Hall sensor 1	Hall sensor 1 output
B2	B2	Hall sensor 2	Hall sensor 2 output
B3	B5	V <sub>CC</sub> , Hall	Hall sensor supply voltage
B4	C3	Motor winding 3	Winding 3
B5	B3	Hall sensor 3	Hall sensor 3 output
B6	B4	GND	Hall Sensor ground
B7	C1	Motor winding 1	Winding 1
B8	C2	Motor winding 2	Winding 3
—	B6	NTC	Thermistor

Table 4 Motor/Hall Sensor Connector – Pin Assignment

Specifications			
V1	B	Connector	Molex Mini-Fit Plus, pitch 4.2 mm, 8 poles (46015-0806)
		Mating plug	Crimp housing, pitch 4.2 mm, 8 poles
V2	B	Connector	Molex Micro-Fit 3.0, pitch 3 mm, 6 poles (43025-0600)
		Mating plug	Crimp housing, pitch 3 mm, 6 poles
	C	Connector	Molex Micro-Fit Jr., pitch 4.2 mm, 4 poles (39-01-2040)
		Mating plug	Crimp housing, pitch 4.2 mm, 4 poles

Table 5 Motor/Hall Sensor Connector – Specifications

## 5 OUTPUT CIRCUITRY

### 5.1 Hall Sensor

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

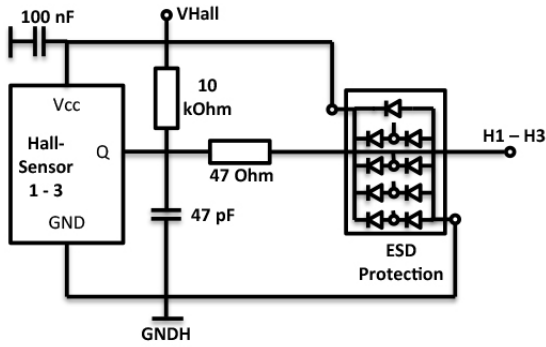


Figure 5 Hall Sensor – Output Circuitry

### 5.2 Encoder

The encoder output signals are equipped with ESD protection diodes.

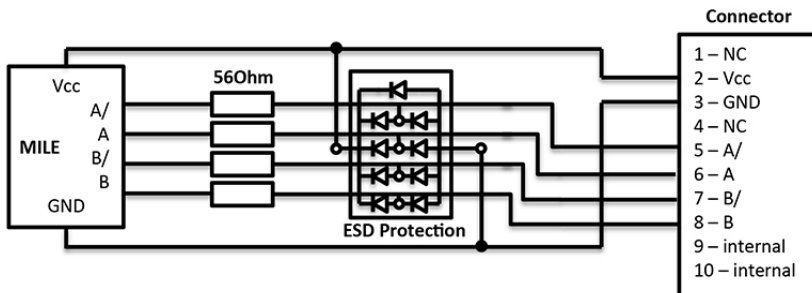


Figure 6 Encoder – Output Circuitry

••page intentionally left blank••

This document is protected by copyright. Any further use (including reproduction, translation, microfilming, and other means of electronic data processing) without prior written approval is not permitted. The mentioned trademarks belong to their respective owners and are protected under intellectual property rights.

© 2019 maxon. All rights reserved. Subject to change without prior notice.

mmag | MILE Encoder for EC 90 flat Product Information | Edition 2019-12 | DocID 4905089-03

maxon motor ag  
Brünigstrasse 220  
CH-6072 Sachseln

+41 41 666 15 00  
[www.maxongroup.com](http://www.maxongroup.com)