

General description

Features & benefits

- Sensorless 1-coil No-Hall technology
- Open and closed loop speed control:
 - Up to 40k mRPM (for 2 pole-pair motors)
 - $\pm 1.5\%$ closed loop speed accuracy
 - Soft-switching, with boost mode
 - Lead angle control
- Configurable motor start & stop options:
 - Forward windmilling
 - Reverse windmilling
 - Universal windmilling
 - Brake & start
 - Bi-directional operation
- Integrated bridge driver
 - 135 mOhm (HS+LS)
 - Programmable current limit up to 4.0 A
 - 8.0 A braking current
 - Integrated supply clamp
- Operating range:
 - Supply voltage range from 6.7 V to 27.6 V
 - Junction temperature from -40 °C to 150 °C
- Extensive programmability (MTP)
 - Sleep mode option
 - PWM, I²C or FM mode input
 - 8-point configurable speed curves
 - Synthesized FG output for easy retrofitting of legacy 3-phase solutions
 - RD Alarm options
 - IO's for direction & brake input
- Protections & Diagnostics
 - LRP / UVP / OCP / TSD
 - Hot unplug handling
- Package RoHS compliant
 - DFN10 3.5x3 mm² with exposed pad

Applications examples

- 24 V Industrial fans
- 24 V Fans for home appliance & white goods
- General 24 V fans & pumps up to 60 W

Available support & tools

- www.melexis.com/technical-inquiry
- www.melexis.com/FanDriverEVB2
- www.melexis.com/FanDriverProgrammerB

Description

The MLX90416 is a member of the No-Hall sensorless 1-coil BLDC motor driver IC's for driving 24 V applications. It can be configured for a wide range of applications and supports replacing legacy sensorless 3-phase motors.

The device drives 12|24 V 1-coil motors, typically without the need for an external TVS for protection. It integrates an H-bridge with very low $R_{DS(on)}$, supporting 8 A braking current and a programmable operational current limit up to 4 A.

The MLX90416 is controlled via a PWM, I₂C or FM input, and can provide alarm or speed feedback through a programmable FG-pin. Extensive speed curve fitting up to 40k mRPM (for 2 pole-pair motors) is available with 8 configuration points, and different options for fail safe operation.

The non-volatile memory can be programmed through I2C and is “Multiple Times Programmable”

The IC features a wide range of protections, including: “Locked Rotor Protection”, “Under Voltage Protection” with hot unplug handling, “Thermal Shut Down” and “Over Current Protection”.

Plug-and-play prototyping for fast validation, using the Fan Driver EVB2 evaluation board and GUI, comprising a motor parameter extraction tool.

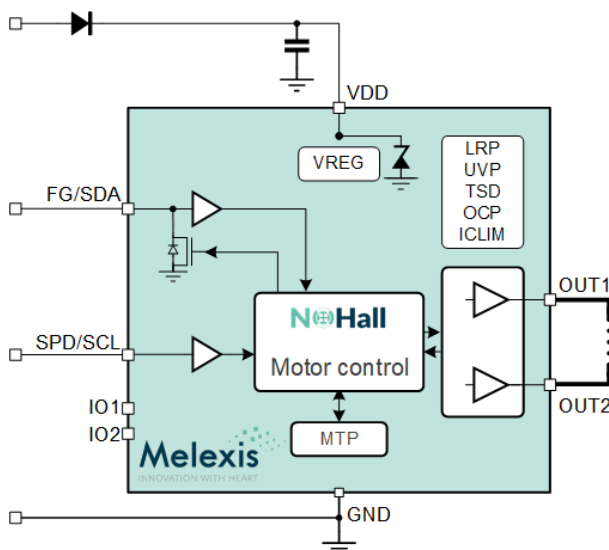


Figure 1 – Functional diagram

MLX90416

No-Hall 1-coil Code-Free Motor Driver for 24V-60W Fans & Pumps
Product Abstract



Ordering information

Product order code	Temperature	Package	IC version code	CLIM _{MAX}	Packing
MLX90416KLD-ABA-004-RE	-40 to 150 °C	DFN10	ABA-00	4.0 A	Reel
MLX90416KLD-ABA-002-RE	-40 to 150 °C	DFN10	ABA-00	2.8 A	Reel

Table 1 – Product codes

1 Conditions and specifications

1.1 Absolute Maximum Ratings (AMR)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply voltage	V _{DDcont}	-0.3		29	V	Externally applied
Peak motor braking current	I _{PHASE_brk}			I _{ocp_min}	A	During initial braking ¹ , <500 ms
FG, IO1 output voltage	V _{FG}	-0.3		29	V	
SPD, IO2 voltage	V _{PWM}	-0.3		V _{DD} + 0.3	V	
OUT1, OUT2 voltage	V _{OUT}	-1		V _{DD} + 1.0	V	During PWM switching dead time
OTP write temperature	T _{OTPWrite}			50	°C	3x OTP pages
Maximum ambient temperature	T _{AMB}	-40		125	°C	¹
Maximum junction temperature	T _J	-40		150	°C	¹
Storage temperature range	T _s	-55		165	°C	
ESD Sensitivity – HBM	V _{HBM}			4000	V	HBM according to JS-001
ESD Sensitivity – CDM	V _{CDM}			1000	V	CDM according to JS-001

Table 2 – Absolute Maximum Ratings

Exceeding the absolute maximum ratings may cause permanent damage.

Exposure to absolute maximum-rated conditions for extended periods may affect the device reliability.

1.2 Electrical operating conditions & specifications

Unless otherwise specified, the electrical specifications are valid at T_J 25 °C, and a supply voltage range from 6.7 to 24 V. All absolute timings, except for closed loop speed control are subject to RCO tolerances.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
VDD operating range	V _{DD}	6.7	12	27.6	V	
VDD degraded operating range	V _{DD_DEGR}	5.7		6.7	V	
VDD digital register preserved	V _{POR}		3.55	4.5	V	

Table 3 – Electrical operating conditions

¹ Maximum junction operating temperature should not be exceeded.

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1.2.1 Supply system

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply current	I _{DD}		7.3	8.5	mA	
Sleep current	I _{DD_SLP}			50	uA	V _{DD} = 12 V
Supply clamping voltage	V _{DD_CLAMP}	29		31	V	I _{CLAMP} = 50 mA
OTP write supply Voltage	V _{OTP}	12		18	V	

Table 4 – Electrical specifications

1.2.2 Driver stage

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Full bridge on resistance	R _{DSon-xx4}		135	170	mΩ	-xx4 version, T _J = 25 °C, I = 3.0 A
Full bridge on resistance	R _{DSon-xx4}		205	250	mΩ	-xx4 version, T _J = 150 °C, I = 3.0 A
Full bridge on resistance	R _{DSon-xx2}		180	225	mΩ	-xx2 version, T _J = 25 °C, I = 2.0 A
Full bridge on resistance	R _{DSon-xx2}		275	335	mΩ	-xx2 version, T _J = 150 °C, I = 2.0 A
Switching losses (*)	SL _{12V_2A} ²		3		%	V _{DD} = 12 V, I = 2.0 A, T _J = 150 °C
Switching losses (*)	SL _{12V_4A} ²		2		%	V _{DD} = 12 V, I = 4.0 A, T _J = 150 °C
Switching losses (*)	SL _{24V_2A} ²		8		%	V _{DD} = 24 V, I = 2.0 A, T _J = 150 °C
Switching losses (*)	SL _{24V_4A} ²		5		%	V _{DD} = 24 V, I = 4.0 A, T _J = 150 °C
Output PWM frequency	f _{DCOUT_25}		25		kHz	
Output PWM resolution	DC _{OUT_RES}		9		bit	
RCO tolerance	TOL _{RCO}	-5		5	%	T _J = [-40, 150] °C
Closed loop speed tolerance	TOL _{CLSP_1}	-1.5		1.5	%	T _J = [-20, 150] °C
Closed loop speed tolerance	TOL _{CLSP_2}	-2		2	%	T _J = [-40, 150] °C

Table 5 – Driver stage specification

1.2.3 Current limit

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Current limit tolerance	I _{CLIMTOL_1}	-10		10	%	I _{CLIM} > 2.0 A, [-40, 150] °C
Current limit tolerance	I _{CLIMTOL_2}	-15		15	%	I _{CLIM} > 1.5 A, [-40, 150] °C
Current limit tolerance	I _{CLIMTOL_3}	-20		20	%	I _{CLIM} > 1.0 A, [-40, 150] °C
Current limit blanking time	t _{CLIMblink}		2		μs	At PWM rising edge

Table 6 – Current limit specification

1.2.4 Protections

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Undervoltage threshold	V _{UV_LH}	6.1		6.7	V	Low-high transition
Undervoltage hysteresis	V _{UV_HYST}		0.5		V	
Undervoltage debounce time	t _{UV_DEB}		1.5		μs	
Thermal protection threshold	T _{TSD}	151	160	170	°C	Junction temperature
Thermal protection hysteresis	T _{TSD_HYST}		20		°C	Junction temperature
Over current protection	I _{OCP_2}	6	8	10	A	DC current, -xx2 version
Over current protection	I _{OCP_4}	8	10.5	13	A	DC current, -xx4 version
Over current blanking time	t _{OCP_BLNK}		2		μs	At PWM rising edge

Table 7 – Protections specification

² Total dissipated power in the driver can be calculated as $[I_{DD} \times V_{DD} + R_{DSon}(T_J) \times I_{PHASE_{RMS}}^2 \times (1 + SL)]$

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1.2.5 IO's

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Input: SPD(SCL)/IO1/IO2						
Input low voltage	V _{IL}			1	V	
Input high voltage	V _{IH}	2.3			V	
Internal pull-up voltage	V _{PU}	2.6	2.9	3.2	V	
Internal pull-up current source	I _{PU}	175	250	325	μA	
Input: SPD in sleep mode						
Input high voltage	V _{IH_SLP}	2.1			V	Wake up from sleep low
Internal pull-down resistor	R _{SPD_PD}	30	60	90	kOhm	
Sleep mode debounce time	t _{deb_SLP}	0.5		2	us	
Input: SPD in PWM input mode						
Input PWM frequency	f _{DCin}	1		100	kHz	PWM input frequency range
Input PWM resolution	DC _{IN_RES}		0.2		%	f _{DCIN} = 25 kHz
Input PWM Integration time	t _{INT}		82		ms	
Input: FG(SDA)						
Input Low Voltage	V _{IL}			1	V	in I ₂ C mode
Input High Voltage	V _{IH}	2.3			V	in I ₂ C mode
Open drain output: FG/IO1/IO2						
Output voltage low	V _{OD_OL}	-		0.4	V	Output low, I _{OD} = 8 mA
Output saturation current limit	I _{OD_CL}	8		13	mA	Output low, V _{FG} = 5 V
Output leakage current	I _{FG_LEAK}			1	μA	Output high, V _{FG} = 18 V

Table 8 – IO's specification

1.3 Package

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Thermal resistance	R _{J-A_2s2p}		64		°K/W	2s2p, 4 thermal via's, JESD51 standard test board, still air (LFPM=0)
Thermal resistance	R _{J-C}		12		°K/W	

Table 9 – Package specification

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2 Pins description for DFN10 package

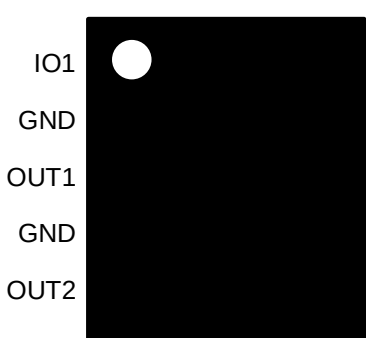
Pinout	Pin #	Name	I/O	Description
	1	IO1	I/O	Optional direction or brake input
	2	GND	Ground	Ground connection
	3	OUT1	Output	Motor coil connection 1
	4	GND	Ground	Ground connection
	5	OUT2	Output	Motor coil connection 2
	6	SPD	Input	<ul style="list-style-type: none"> PWM or FM input SCL input for the I²C interface
	7	FG	I/O	<ul style="list-style-type: none"> FG or RD output SDA input/output for the I²C interface
	8	IO2	I/O	Optional brake or Hall-sensor input
	9	VDD	Supply	Power supply input voltage
	10	VDD	Supply	Power supply input voltage
	EP	EP	Ground	Exposed pad to be connected to GND

Figure 2 - DFN10 package pinout

Table 10 – DFN10 package pins description

3 Recommended application diagram

A decoupling capacitor should be placed as close as possible to the MLX90418 VDD and GND pins.

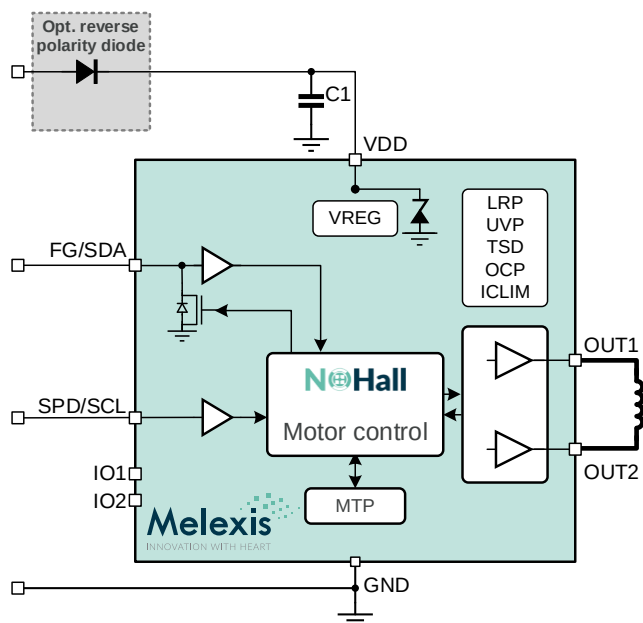


Figure 3 – Recommended application diagram

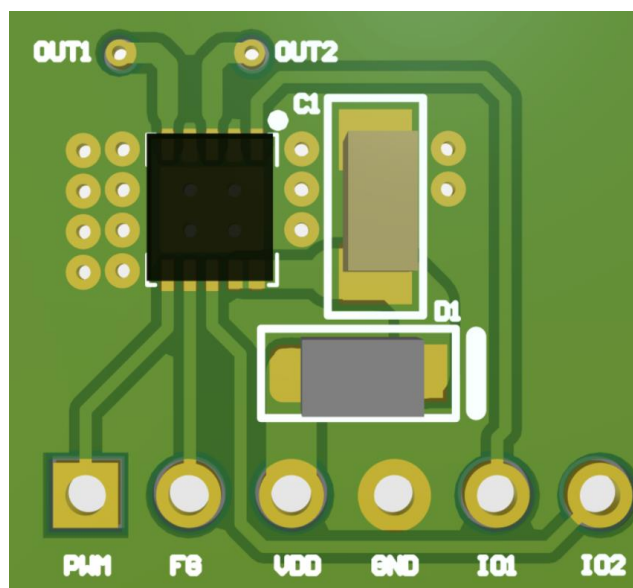


Figure 4 – Reference layout

Component	Symbol	Value	Condition
Decoupling capacitor	C1	10 μ F	
Optional reverse polarity diode	D1		<ul style="list-style-type: none"> Optional component, in case reverse polarity protection is not guaranteed by polarity of the connector Component to be selected acc. to application voltage and current requirements Prevents push-back to the supply

Table 11 – External components specifications for recommended application diagram

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4 Package, IC handling and assembly

4.1 Package information

4.1.1 Package DFN10 dimensions

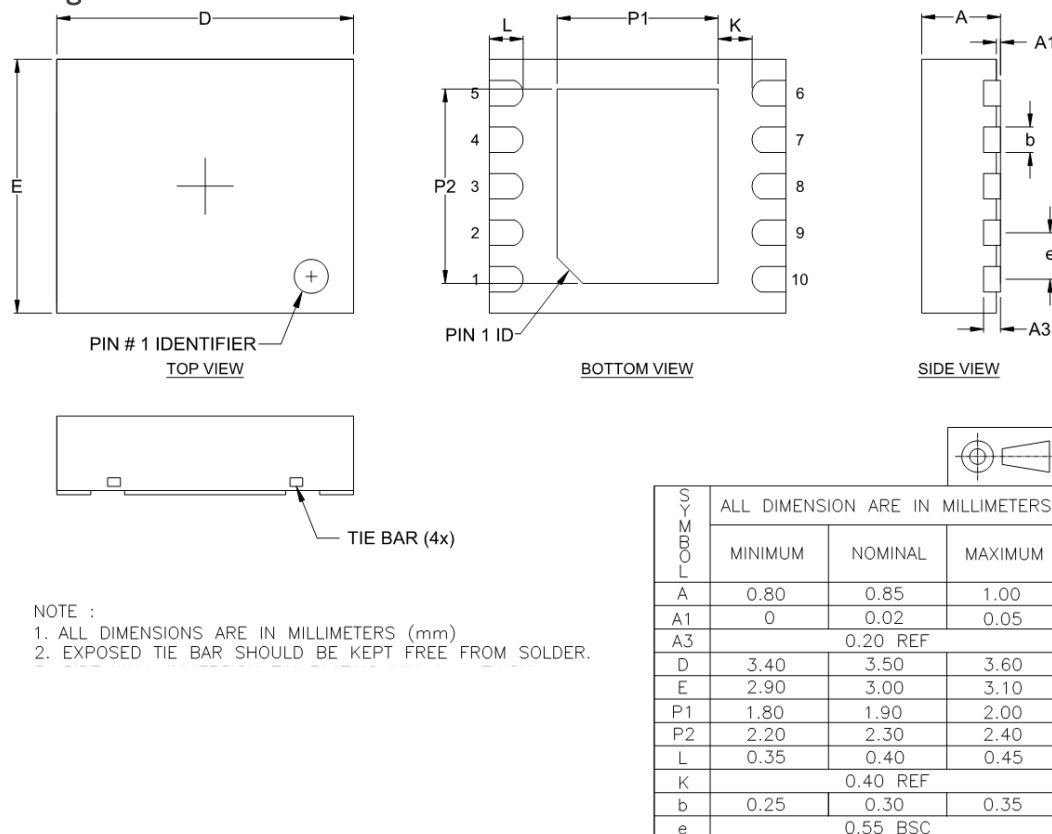
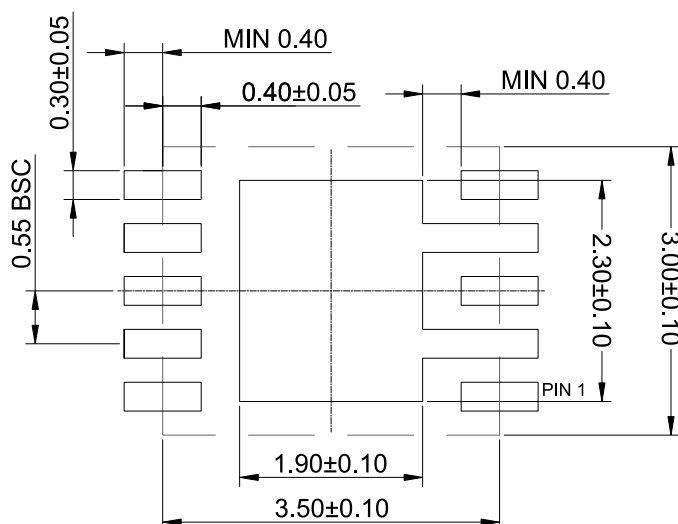


Figure 5 – Package outline dimensions



NOTE :
1. ALL DIMENSIONS IN MILLIMETERS (mm) UNLESS NOTED OTHERWISE
2. PIN 2 AND PIN 4 (ELECTRICAL GROUND) NEED TO BE CONNECTED TO EXPOSED PAD.

Figure 6 – Recommended land pattern

5 Revision history

Revision	Date	Change history
1.0	25-Jun-2024	▪ First release
2.0	1-Dec-2024	▪ Update for AB-version

Table 12 – Revision history

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