MLX90418

No-Hall 1-coil motor driver for 12V high speed fans

Product Abstract

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)
  - ±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 5.7 V to 18 V
  - Junction temperature from -40 °C to 150 °C
- Extensive programmability (MTP)
  - Sleep mode option
  - PWM, I_2C 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 with power loss brake
  - AC-power loss management
- Package RoHS compliant
  - DFN10 3.5x3 mm2 with exposed pad

Applications examples

- High speed server cooling fans
- General 12V fans & pumps up to 30W

Available support & tools

- www.melexis.com/technical-inquiry
- www.melexis.com/FandriverEVB2
- www.melexis.com/FanDriverProgrammerB

Description

The MLX90418 is a member of the No-Hall sensorless 1-coil BLDC motor driver IC's. It can be configured for a wide range of applications and supports replacing legacy sensorless 3-phase motors. Furthermore, it includes dedicated features for high speed server fan applications.

The device drives 12 V 1-coil motors, typically without the need for an external TVS for protection. It integrates an H-bridge with very low RDSon, supporting 8 A braking current and a programmable operational current limit up to 4 A.

The MLX90418 is controlled via a PWM, I_2C 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 I_2C 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.

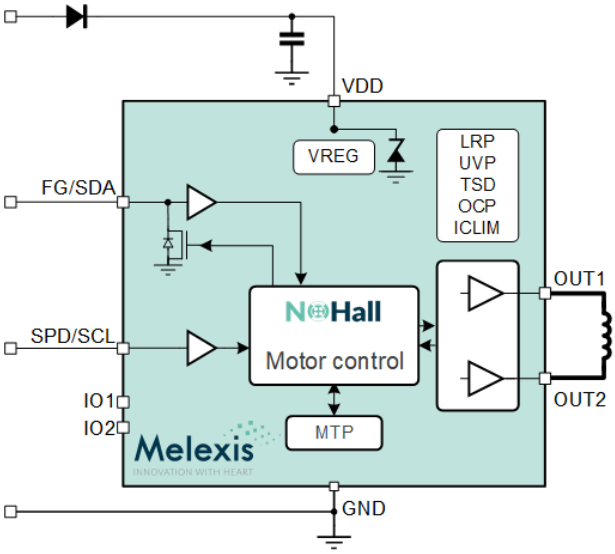


Figure 1 – Functional diagram

Ordering information

Product order code	Temperature	Package	IC version code	$CLIM_{MAX}$	Packing
MLX90418KLD-ABA-004-RE	-40 to 150 °C	DFN10	ABA-00	4.0 A	Reel
MLX90418KLD-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		20	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		20	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 12 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}	5.7	12	18	V	
VDD degraded operating range	V_{DD_DEGR}	4.6		5.7	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.

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}	20		24	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
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	$t_{CLIMblnk}$		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, for AA-version
Undervoltage threshold	V_{UV_LH}	5.1		5.7	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 $[I_{DD} \times V_{DD} + R_{DSon}(T_J) \times I^2_{PHASE_{RMS}} \times (1 + SL)]$

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_2C mode
Input High Voltage	V_{IH}	2.3			V	in I_2C 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	$R_{J\text{-}A\_2s2p}$		64		°K/W	2s2p, 4 thermal via's, JESD51 standard test board, still air (LFPM=0)
Thermal resistance	$R_{J\text{-}C}$		12		°K/W	

Table 9 – Package specification

2 Pins description for DFN10 package

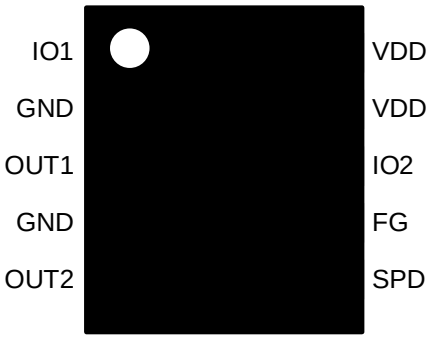
Pinout	Pin #	Name	I/O	Description
 *Figure 2 - DFN10 package pinout*	1	IO1	I/O	Optional direction or brake input
	2	GND	Ground	Ground connection
	3	OUT1	Output	Motor coil connection 1
	4	GND	Ground	Ground connection
	5	OUT2	Output	Motor coil connection 2
	6	SPD	Input	▪ PWM or FM input ▪ SCL input for the I_2C interface
	7	FG	I/O	▪ FG or RD output ▪ SDA input/output for the I_2C 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

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.

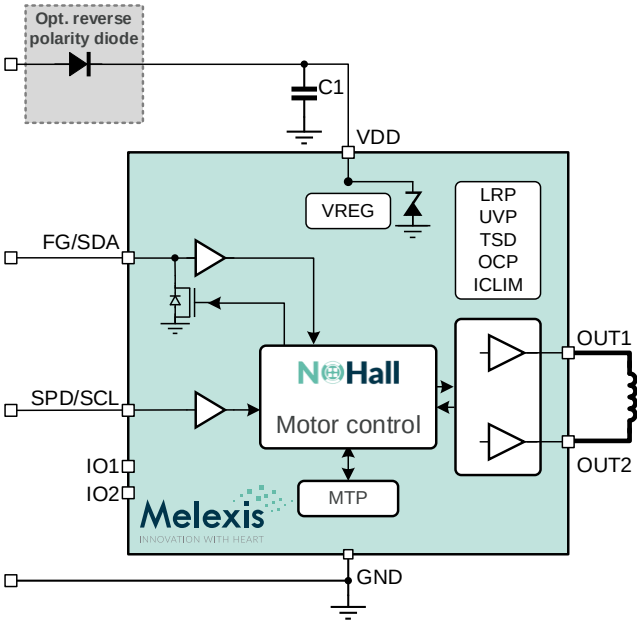


Figure 3 – Recommended application diagram

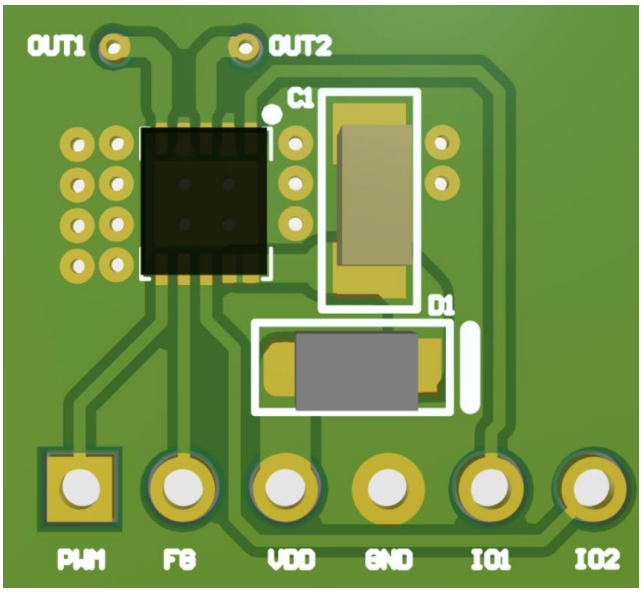


Figure 4 – Reference layout

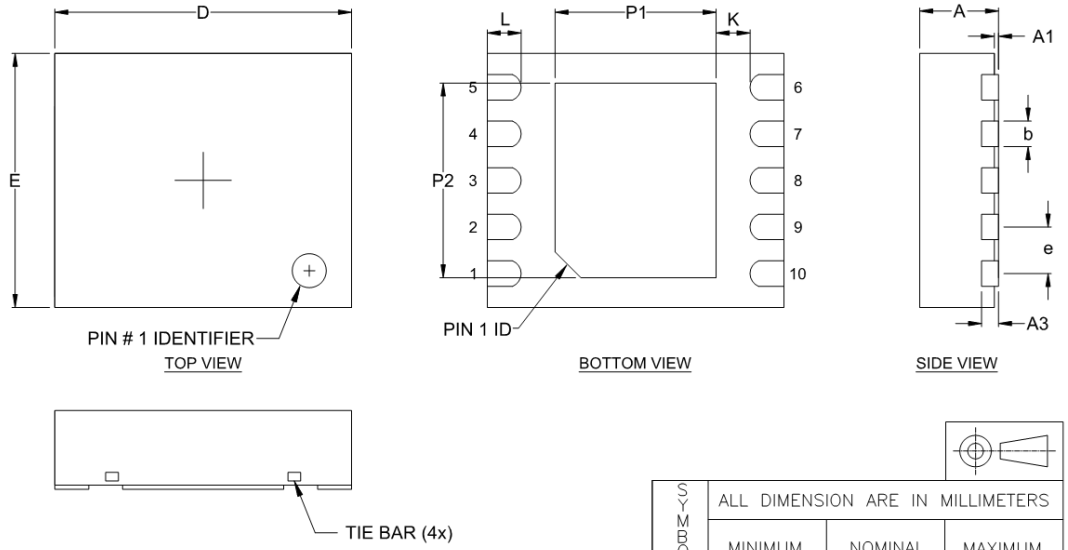
Component	Symbol	Value	Condition
Decoupling capacitor	C1	10 µF	
Optional reverse polarity diode	D1		• Optional component, in case reverse polarity protection is not guaranteed by polarity of the connector • Component to be selected acc. to application voltage and current requirements • Prevents push-back to the supply • Required for power loss braking

Table 11 – External components specifications for recommended application diagram

4 Package, IC handling and assembly

4.1 Package information

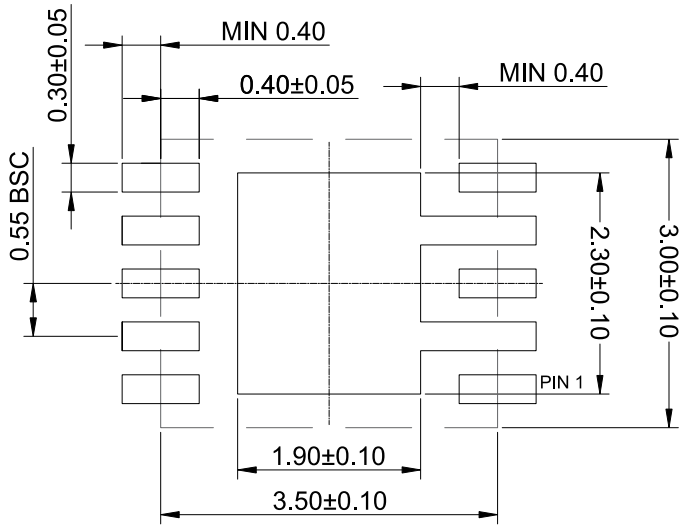
4.1.1 Package DFN10 dimensions



NOTE :
1. ALL DIMENSIONS ARE IN MILLIMETERS (mm)
2. EXPOSED TIE BAR SHOULD BE KEPT FREE FROM SOLDER.

SYMBOL	ALL DIMENSION ARE IN MILLIMETERS		
	MINIMUM	NOMINAL	MAXIMUM
A	0.80	0.85	1.00
A1	0	0.02	0.05
A3		0.20 REF	
D	3.40	3.50	3.60
E	2.90	3.00	3.10
P1	1.80	1.90	2.00
P2	2.20	2.30	2.40
L	0.35	0.40	0.45
K		0.40 REF	
b	0.25	0.30	0.35
e		0.55 BSC	

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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