

Features and Benefits

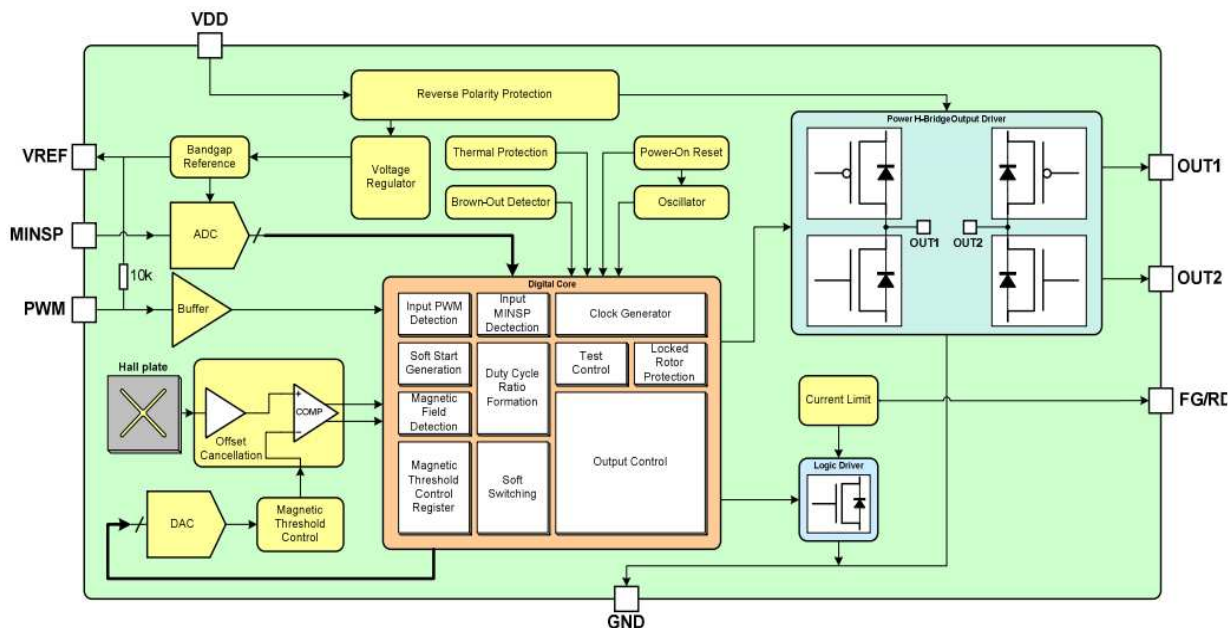
- Wide Operating Voltage range**
 Operates from 4.5V to 16V, allowing speed regulation through PWM or even DC voltage control
- PWM Input**
 Easy speed control via PWM input duty cycle with wide input frequency range from 100Hz to 100KHz
- Intelligent Soft Start**
 Suppress high peak start-up current while providing a reliable start-up even for low rotation speed
- Minimal Speed Setting**
 Allows setting a minimal output duty cycle to satisfy minimum cooling requirements
- Built-in PWM Input Resistor**
 Saving external components and providing fail/safe functionality in case of wire-break
- Active Soft Switching**
 Optimum low noise performance at different rotation speed with no external components
- Integrated Protection**
 Reverse Voltage, Locked Rotor, Brown-Out, Thermal Shutdown and High ESD rating provides a best-in-class device robustness
- Green Compliant**
 Reducing environmental impact with a Lead-Free and Halogen-Free SOIC 8-pin narrow body package

Application Examples

- 4-Wire BLDC Cooling Fans
- Single-Phase Water and Oil Auxiliary Pump (Automotive and non-Automotive)
- Temperature-Controlled Cooling Fans
- 2-Speed Cooling Fans

Ordering Information			
Part No.	Temperature Code	Package Code	Packing Form
MLX90287LDC-AAA-000-RE ⁽²⁾	L (-40°C to 150°C) ⁽¹⁾	DC (SOIC8 NB)	RE (Tape & Reel)
MLX90287KDC-AAA-000-RE ⁽²⁾	K (-40°C to 125°C)	DC (SOIC8 NB)	RE (Tape & Reel)
MLX90287LDC-AAA-000-RX ⁽²⁾	L (-40°C to 150°C) ⁽¹⁾	DC (SOIC8 NB)	RE (Tape & Reel)
MLX90287KDC-AAA-000-RX ⁽²⁾	K (-40°C to 125°C)	DC (SOIC8 NB)	RE (Tape & Reel)

1 Functional Diagram



¹ L version is Automotive Qualified
² RE = Live bug RX = dead bug

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2 Glossary of Terms

MilliTesla (mT), Gauss	Units of magnetic flux density: 1mT = 10 Gauss
RoHS	Restriction of Hazardous Substances
DC	Small Outline Integrated Circuit (SOIC package) – also referred with the Melexis package code “DC”
PWM	Pulse Width Modulation
ESD	Electro-Static Discharge

3 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Supply Voltage ^(1, 2)	V _{DD}	+18	V
Supply Current ^(1, 2, 3)	I _{DD}	+20	mA
Reverse Supply Voltage ^(1, 2)	V _{DDREV}	-18	V
Reverse Supply Current ^(1, 4, 2)	I _{DDREV}	-20	mA
FG Output Voltage ^(1, 2)	V _{FG}	+18	V
FG Output current ^(1, 2, 3)	I _{FG}	+30	mA
Reverse FG Output Current ^(1, 2, 3)	I _{FG}	-50	mA
PWM input voltage ^(1, 2)	V _{PWM}	+7	V
Reverse PWM input voltage ⁽¹⁾	V _{PWM}	-0.3	V
MINSPI input voltage ^(1, 2)	V _{MINSPI}	+3.6	V
Reverse MINSPI voltage ⁽¹⁾	V _{MINSPI}	-0.3	V
Reverse current on MINSPI or PWM ^(1, 2)	I _{MINSPI, IPWM}	-10	mA
Average Output Current ^(1, 2, 3)	I _{OUT}	+550	mA
Peak Output Current ^(1, 2)	I _{OUT}	+1000	mA
Operating Temperature Range	T _A	-40 to +150	$\frac{255}{273}$ C
Storage Temperature Range	T _S	-55 to +165	$\frac{255}{273}$ C
Maximum Junction Temperature ⁽⁵⁾	T _J	+165	$\frac{255}{273}$ C
ESD Sensitivity – HBM ⁽⁶⁾	-	6000	V
Magnetic Flux Density	B	Unlimited	mT

Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

¹ The maximum junction temperature should not be exceeded

² For maximum 1 hour

³ Including current through protection device

⁴ Through protection device

⁵ For 1000 hours.

⁶ Human Model according AEC-Q100-002 standard

4 General Electrical Specifications

DC Operating Parameters $T_A = -40^{\circ}\text{C}$ to 150°C , $V_{DD} = 4.5\text{V}$ to 16V (unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ ⁽⁷⁾	Max	Units
Supply Voltage	V_{DD}	Operating	4.5	12	16	V
Supply Current	I_{DD}			3	6	mA
Reverse Supply Current	I_{DDREV}	$V_{DD} = -16\text{V}$			1	mA
PWM Input Low Voltage	V_{IL}				0.8	V
PWM Input High Voltage	V_{IH}		2.1		5.5	V
PWM Input Frequency	F_{IN}	$-2\% < DC_{ERR} < 2\%$	0.1		100	kHz
PWM internal pull-up resistor ⁽⁸⁾	R_{IN}			10		k Ω
Full Bridge On Resistance	R_{DSON}	$T_J = 25^{\circ}\text{C}$		3.4	7.1	Ω
Full Bridge On Resistance	R_{DSON}	$T_J = 105^{\circ}\text{C}$		4.1	9.1	Ω
Output PWM frequency	F_{OUT}	$10\% < DC_{IN} < 100\%$	26	30		kHz
Output Duty Cycle Range	DC_{OUT}	$V_{MINSP} = 0\text{V}$	0		100	%
Output Duty Cycle Range	DC_{OUT}	Resistor R1 between MINSP to VREF, $DC_{IN} < 10\%$	10		100	%
Minimal Speed Setting Resistor	R_{MINSP}	$DC_{IN} < 10\%$, $10\% < DC_{OUT} < 100\%$, $R_{REF} = 68\text{k}$	40		100	k Ω
Output Duty Cycle Mismatch	DC_{ERR}	$DC_{OUT} - DC_{IN}$, $V_{DD} = 12\text{V}$, $T_A = 25^{\circ}\text{C}$	-2		2	%
Freewheel Period ⁽⁹⁾	T_{FW}			1		Ms
Soft Start Initial Overdrive ⁽¹⁰⁾	K_{SOFT}			40		%
Soft Start Rotation Detector	E_{SOFT}			4		Edges
Soft Start Duration	T_{SOFT}			1.3	2	S
FG Output Saturation Voltage	V_{OL}	$B > B_{OP}$, $I_{OUT} = 5\text{mA}$		0.2	0.5	V
FG Output Current Limit	I_{CL}	$B > B_{OP}$	20	23	26	mA
FG Output Leakage Current	I_{OFF}	$V_{OUT} = 16\text{V}$, $V_{DD} = 12\text{V}$, $B < Brp$		0.1	10	μA
Minimum recommended magnetic field	B_{HALL}	$B_{OP} = B_{HALL} $, $B_{RP} = - B_{HALL} $		± 3	± 6	mT
Output Slope Duration	T_{SLOPE}	Total Regulation Range	300		4000	Us
Slope to Torque Ratio	SL_{RATIO}			12.5		%
Reference Output Voltage	V_{REF}		2.9	3.1	3.4	V
Reference Output Current Capability	I_{REF}				2	mA
Brown-Out Detector Threshold	V_{BOD}		3.8	4.1	4.4	V
Brown-Out Detector Reaction Time	T_{BOD}			8		Ms
Locked Rotor Protection ON time	T_{ON}			0.5		S
Locked Rotor Protection OFF time	T_{OFF}			3		S
Thermal Protection Threshold	T_{PROT}	Junction temperature		170		$^{\circ}\text{C}$
Thermal Protection Release	T_{REL}	Junction temperature		155		$^{\circ}\text{C}$
DC Package Thermal Resistance	R_{thJA}	Single layer (1S) Jeduc board		150		$^{\circ}\text{C}/\text{W}$
Thermal Resistance junction-to-case	R_{thJC}			50		$^{\circ}\text{C}/\text{W}$

⁷ Typical values are defined at $T_A = +25^{\circ}\text{C}$ and $V_{DD} = 12\text{V}$, unless otherwise specified

⁸ Internally connected between PWM to VREF

⁹ Period when both output NMOST stay ON prior putting the H-bridge in tri-state for LRP, TSD and Brown-out

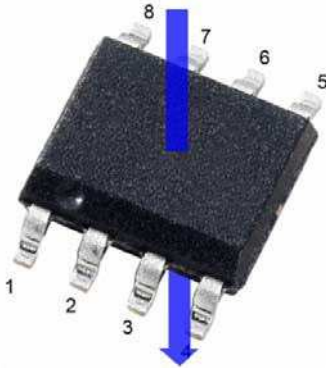
¹⁰ Initial Output Duty Cycle after power-on

5 Output Behaviour versus Magnetic Pole

DC Operating Parameters $T_A = -40^{\circ}\text{C}$ to 150°C , $V_{DD} = 4.5\text{V}$ to 16V (unless otherwise specified)

Parameter	Test Conditions	OUT 1	OUT2	FG
South pole	$B > B_{OP}$	Low	High	Low
North pole	$B < B_{RP}$	High	Low	High

Table 1: Output behaviour versus magnetic pole⁽¹¹⁾



¹¹ Magnetic pole facing the branded/top side of the package

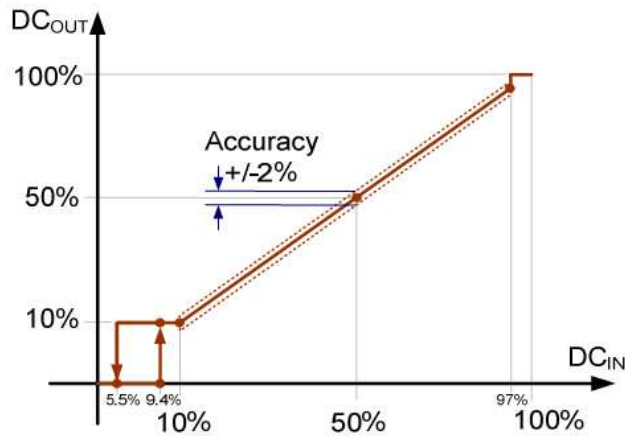
6 General Description

The Melexis MLX90287 is a one-chip solution designed in mixed signal CMOS technology for driving single-coil brushless DC motors like PWM cooling fans.

The device integrates a voltage regulator, Hall sensor with advanced offset cancellation system, a power output H-bridge all controlled by a sophisticated digital state machine, all in a single package.

The included voltage regulator operates from 4.5 to 16V, hence covering a wide range of applications. With the built-in reverse voltage protection, no diode on the supply line is required. In case of critical low voltage operation, the Brown-Out Detection will automatically stop the device operation until normal supply voltage in the operational range is applied.

The PWM input allows very wide input frequency range (100Hz to 100kHz) while the output PWM frequency is kept constant above the audible frequency range. The input duty cycle controls the driving of the output duty cycle applied to the motor coil, thus the rotation speed is directly proportional to the input duty cycle with very high accuracy of +/-2% ensuring very good linearity.



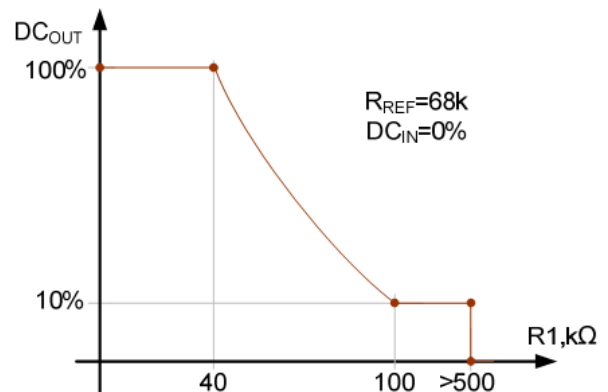
The PWM input features a built-in pull-up resistor of 10kohms tied to the Reference Output Voltage (V_{REF}). Since the interface providing the PWM signal is generally open-collector/drain type, an external resistor is not required. In addition, it provides a fail/safe functionality as it will drive the motor at full speed in case of PWM signal wire-break.

The Soft Switching is performed using the output duty cycle rather than analog voltage sweep, leading to less power dissipation. The device automatically adjusts its

slope duration targeting 12.5% from the torque period independent of the rotor magnet strength, producing an optimum balance between high efficiency and low noise performance. The possibility for very long slope duration guarantees extremely quiet operation even at very low rotation speed.

The Intelligent Soft Start prevents very high peak current during start-up. An additional system guarantees proper motor start-up even with low PWM input duty cycle, ensuring enough initial torque to the motor is generated to enable rotation. When motor rotation is detected the output duty cycle is adjusted linearly to the input duty cycle.

The Minimal Speed input allows setting of a minimum required rotation speed of the motor by using 2 inexpensive resistors. This is especially useful for applications where minimum cooling is a requirement to avoid system damage (example: computer CPU, graphics processor, etc).



The tachometer open drain output (FG) communicates motor rotation speed to the system and is fully protected against short-circuit.

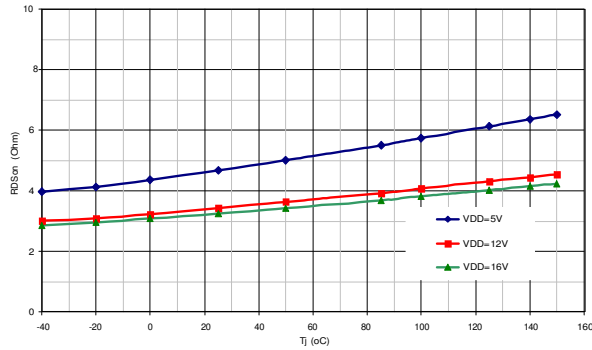
The device also features Locked Rotor Protection to avoid overheating issues in case of a mechanical blockage of the rotor or bearing failure.

The on-chip Thermal Protection switches off the outputs if the junction temperature increases above an abnormally high threshold. It will automatically recover once the temperature decreases below a safe value.

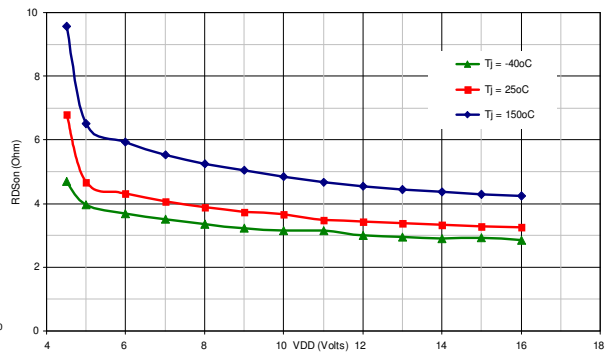
The MLX90287 is delivered in a Green compliant 8-pin Small-outline Integrated Circuit (SOIC) package for surface-mount process.

7 Performance Graphs

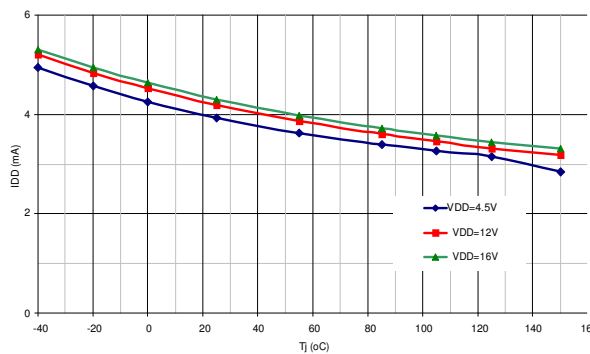
7.1 R_{DSon} vs. T_J



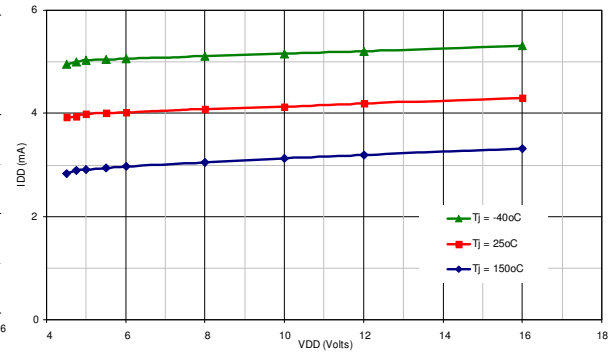
7.2 R_{DSon} vs. V_{DD}



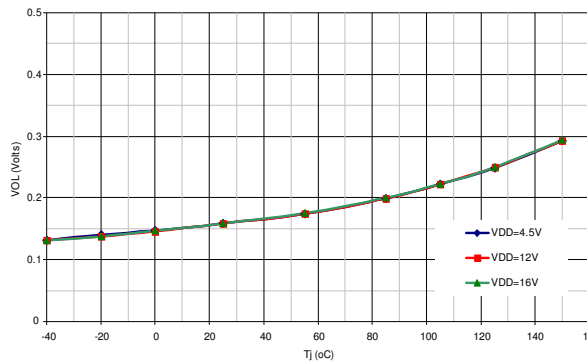
7.3 I_{DD} vs. T_J



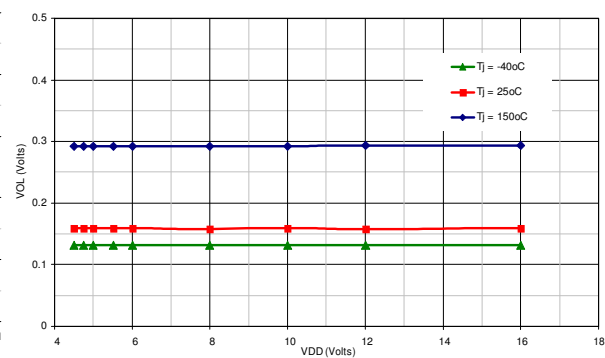
7.4 I_{DD} vs. V_{DD}



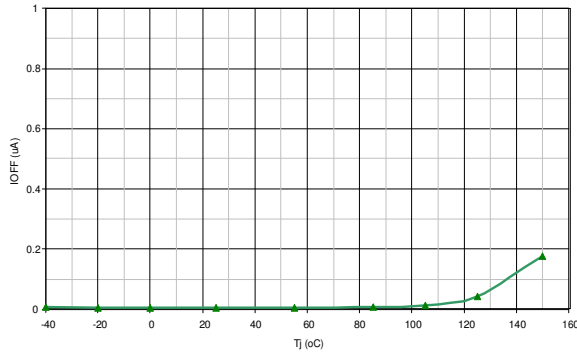
7.5 V_{OL} vs. T_J



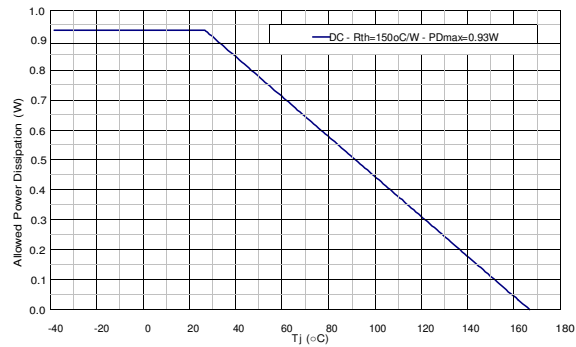
7.6 V_{OL} vs. V_{DD}



7.7 I_{OFF} vs. T_J

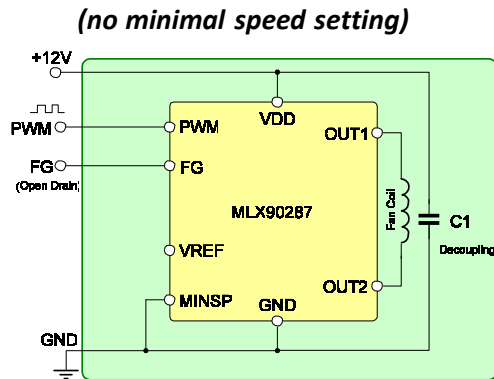


7.8 Power Derating vs. T_J

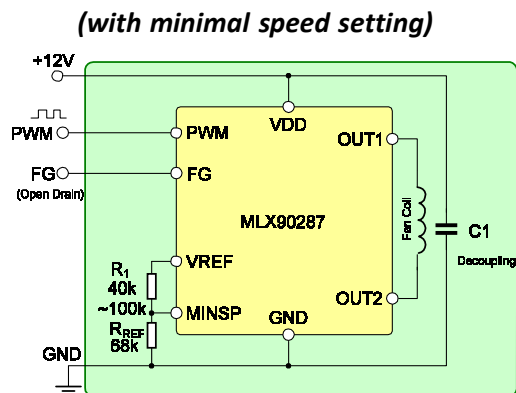


8 Application Information

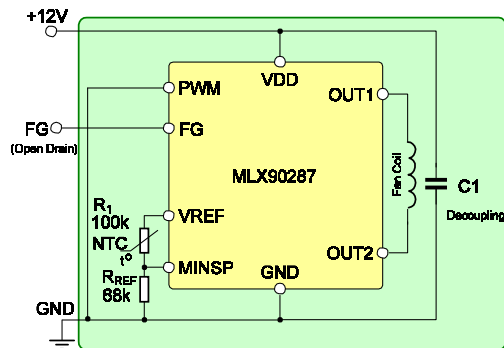
8.1 4-Wire PWM Cooling Fan (no minimal speed setting)



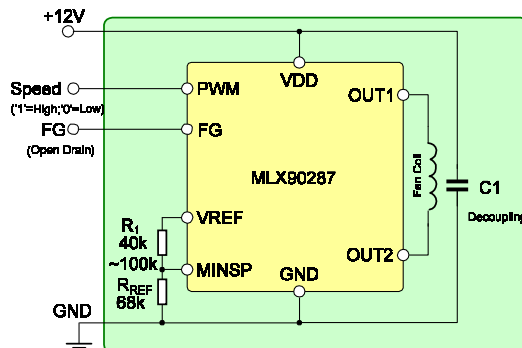
8.2 4-Wire PWM Cooling Fan (with minimal speed setting)



8.3 Temperature Controlled Cooling Fan



8.4 2-Speed Cooling Fan



8.5 Application Comments

A decoupling capacitor from 100nF or higher should be placed as close as possible to the MLX90287 VDD and GND pins to increase the stability and protect against external noise and power surge.

Every application using the FG output pin requires a pull-up resistor either to the fan supply voltage (+12V), or to a separate voltage source.

9 Standard information regarding manufacturability of Melexis products with different soldering processes

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

Reflow Soldering SMD's (Surface Mount Devices)

IPC/JEDEC J-STD-020

Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices
(classification reflow profiles according to table 5-2)

EIA/JEDEC JESD22-A113

Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing
(reflow profiles according to table 2)

Wave Soldering SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

EN60749-20

Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat

EIA/JEDEC JESD22-B106 and EN60749-15

Resistance to soldering temperature for through-hole mounted devices

Iron Soldering THD's (Through Hole Devices)

EN60749-15

Resistance to soldering temperature for through-hole mounted devices

Solderability SMD's (Surface Mount Devices) and THD's (Through Hole Devices)

EIA/JEDEC JESD22-B102 and EN60749-21

Solderability

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

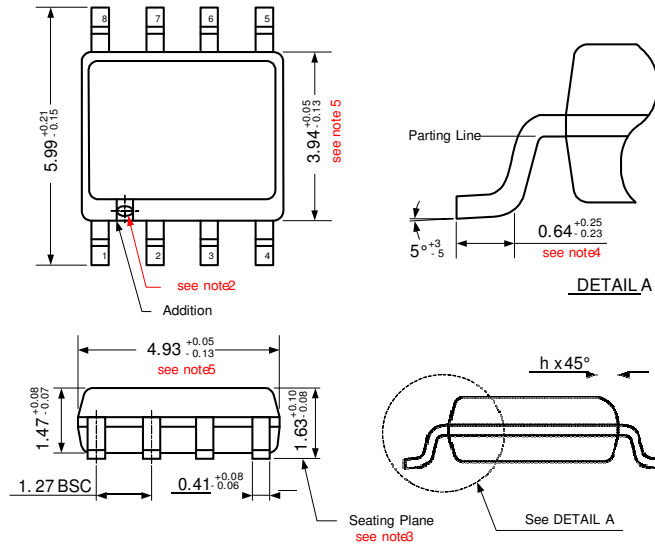
Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: <http://www.melexis.com/quality.aspx>

10 ESD Precautions

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD).
Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

11 Package Information

11.1 DC Package (SOIC8 NB)



Notes:

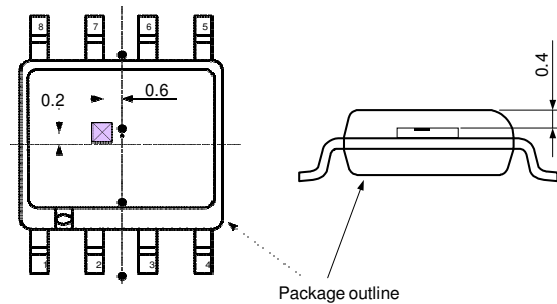
- Controlling dimensions in millimeters.
- The appearance of pin 1 is optional, round type on single leadframe and rectangular type on matrix leadframe.
- Formed leads shall be planar with respect to one another within 0.0792mm at seating plane.
- Length of terminal for soldering to a substrate.
- Package length and width are reference datums and do not include mold flash or protrusions, but does include mold mismatch and are measured at the mold parting line.
Mold flash or protrusions shall not exceed 0.1524mm at end and 0.254mm at window.
- This part is compliant with JEDEC standard MS-012.

Marking:

- Top side :
- Line 1: 90287 - Name of the Device (MLX90287)
 - Line 2: FGyyww - Date Code
FG = Identification code
yy = Year
ww = Calendar week
 - Line 3: xxxxxx - Assembly lot (6 digits)

Marking on top side is duplicated on bottom side

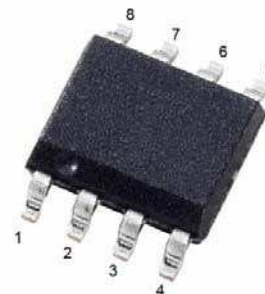
Hall plate location



11.2 Pin Definitions and Descriptions

DC Pin №	Name	Type	Function
1	PWM	Input	Input for digital speed control
2	FG	Output	Open Drain Tachometer Output
3	OUT1	Output	H-bridge Output1
4	VDD	Power	Supply Voltage pin
5	OUT2	Output	H-bridge Output2
6	GND	Ground	Ground pin
7	MINSPEED	Input	Minimum Speed Setting pin
8	VREF	Power	Reference voltage output pin

Table 2: Pin definitions and descriptions



12 Disclaimer

Devices sold by Melexis are covered by the warranty and patent indemnification provisions appearing in its Term of Sale. Melexis makes no warranty, express, statutory, implied, or by description regarding the information set forth herein or regarding the freedom of the described devices from patent infringement. Melexis reserves the right to change specifications and prices at any time and without notice. Therefore, prior to designing this product into a system, it is necessary to check with Melexis for current information. This product is intended for use in normal commercial applications. Applications requiring extended temperature range, unusual environmental requirements, or high reliability applications, such as military, medical life-support or life-sustaining equipment are specifically not recommended without additional processing by Melexis for each application.

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Or for additional information contact Melexis Direct:

Europe, Africa:	Americas:	Asia:
Phone: +32 1367 0495	Phone: +1 248-306-5400	Phone: +32 1367 0495
E-mail: sales_europe@melexis.com	E-mail: sales_usa@melexis.com	E-mail: sales_asia@melexis.com

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