MLX90251

Programmable Linear Hall Effect Sensor

Features and Benefits

- Analog Signal Processing
- Quad Switched Hall Plate
- Chopper Stabilized Amplifier
- Linear Analog Ratiometric Output Voltage
- Programmable Output Quiescent Voltage (V_{OQ}) -100%V_{DD}…200%V_{DD} Range
- Programmable Magnetic Sensitivity
- Programmable Low Pass Filter
- Programmable Clamp Voltage
- Programmable Temperature Compensation
- Melexis ID Number
- Customer ID Number

Application Examples

- Linear Position Sensing
- Rotary Position Sensing
- Current Sensing
- Magnetic Field Measurement

Ordering Information

Part No.	Temperature Code	Package Code	Option code[†]
MLX90251EVA-0	E (-40°C to 85°C)	VA	0
MLX90251EVA-1	E (-40°C to 85°C)	VA	1
MLX90251EVA-2	E (-40°C to 85°C)	VA	2
MLX90251EVA-3	E (-40°C to 85°C)	VA	3
MLX90251LVA-0	L (-40°C to 150°C)	VA	0
MLX90251LVA-1	L (-40°C to 150°C)	VA	1
MLX90251LVA-2	L (-40°C to 150°C)	VA	2
MLX90251LVA-3	L (-40°C to 150°C)	VA	3

[†] Please see section 10.4 for detailed information on the option code.

1 Functional Diagram

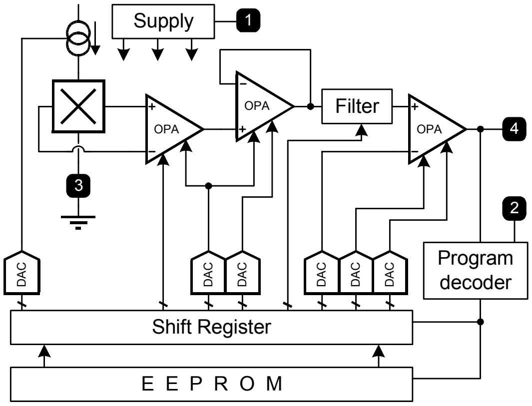

Figure 1-1 Functional Diagram

2 General Description

The MLX90251 is a CMOS programmable, ratiometric, linear Hall effect sensor IC. The linear output voltage is proportional to the magnetic flux density. The ratiometric output voltage is proportional to the supply voltage. The MLX90251 possesses active error correction circuitry, which virtually eliminates the offset errors normally associated with analog Hall effect devices. All the parameters of the MLX90251 transfer characteristic are fully programmable. The V_{OQ} (V_{OUT} @ B = 0 Gauss), the Sensitivity, the slope polarity, the clamping levels, the thermal Sensitivity drift, the internal bias point and a low-pass filter are all programmable in end-user applications. The MLX90251 has a very stable thermal compensation for both the Sensitivity and the V_{OQ} over a broad temperature range. For traceability purpose the MLX90251 will carry a unique ID number programmed by Melexis and 24 bits of EEPROM memory are allocated for a user programmed serial number.

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3 Glossary of Terms

mT (milli-Tesla) = Unit of measurement for magnetic flux density. 1mT is equal to 10 Gauss
V_{OQ} (Output Quiescent Voltage) = Output voltage at zero magnetic field, V_{OUT} for B = 0 mT
Sensitivity = Change in output voltage versus change in magnetic field. $\Delta V_{OUT} / \Delta B$
TempCo (Sensitivity Temperature Compensation) = Change in Sensitivity over temperature. Listed in units of ppm / °C (100ppm / °C. = 0.01 % / °C.)
PTC (Programming Through the Connector) = Melexis in circuit programming protocol.
MSB = Most Significant Bit
LSB = Least Significant Bit

4 Maximum Ratings

Parameter.	Units
Maximum Supply Voltage, V_{DD_MAX} (over Voltage, dV/dt < 1V/µs)	30 V
Over Voltage Slew Rate, V_{DD_SLEW} (30V > V_{DD} > 5.5V)	1 V/µs
Maximum Supply Current, I_{DD_MAX} (Over Voltage)	50 mA
Reverse Voltage, V_{DD_REV}	- 14.5 V
Reverse Supply Current, I_{DD_REV}	- 50 mA
Positive Output Voltage, V_{OUT_MAX}	24 V
Positive Output Current, $I_{OUT\_POS\_FAULT}$	20 mA
Reverse Output Voltage, V_{OUT_REV}	- 0.7 V
Reverse Output Current, $I_{OUT\_REV\_FAULT}$	-50 mA
Operating Ambient Temperature Range, T_A	-40°C to 150°C
Storage Temperature Range, T_S	-55°C to 165°C
Magnetic Flux Density	Infinite

Table 1: Absolute Maximum Ratings

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

5 Detailed Block Diagram

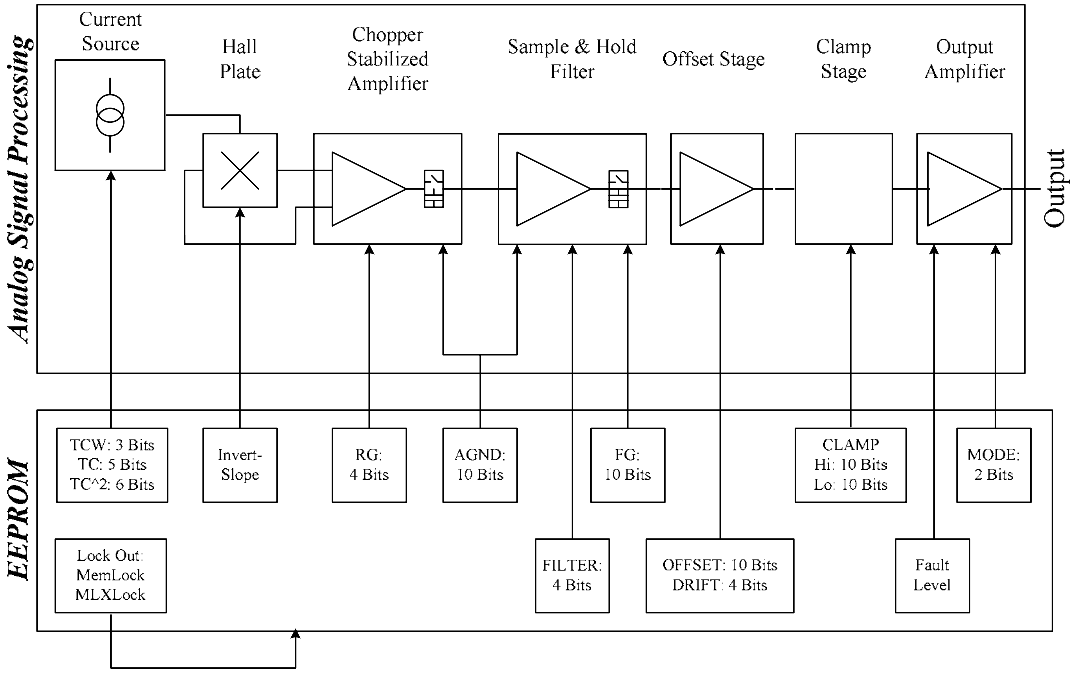


Figure 5-1 Detailed Block Diagram

5.1 Detailed Description

Integrated on the MLX90251 is a temperature-compensated chopper-stabilized Hall plate, chopper stabilized amplifiers, adjustable output filter, output driver, voltage protection circuitry, and a programmable EEPROM with security and redundancy. Programming the EEPROM allows each device to be calibrated in the application.

In normal operation data stored in the EEPROM feeds a register, RAM, that updates internal DACs and switches that effect the operation of the device. In programming mode the RAM can be directly accessed to allow faster calibration of the parameters. Communication to the device is done using Melexis' PTC serial interface.

6 General Electrical Specifications

DC operating parameters at V_{DD} = 5V (unless otherwise specified) and for T_A as specified by the temperature range (E or L).

Parameter.	Symbol	Test Conditions	Min	Typical	Max	Units
Nominal Supply Voltage	V_{DDNOM}		-	5	-	V
Operating Supply Voltage	V_{DD}[†]		4.5	-	5.5	V
Nominal Supply Current	I_{DDNOM}	$V_{DD} = V_{DDNOM}$	4.0	7.0	8.0	mA
Supply Current	I_{DD}	V_{DD} = 4.5 ... 5.5 V	3.0	-	9.0	mA
Output Voltage Swing	V_{OUTPD}	Pull Down Load 10 kΩ no clamping, MODE = 1	2		96	$\%V_{DD}$
	V_{OUTPU}	Pull Up Load 10 kΩ no clamping, MODE = 1	5		97	$\%V_{DD}$
Output Current	I_{OUT}	$V_{DD} = V_{DDNOM}$, MODE = 1	-1.25		1.25	mA
Output Short-Circuit Current	I_{OUTSC+} I_{OUTSC-}	$V_{DD} = V_{DDNOM}$ Output shorted to supply-permanent Output shorted to ground-permanent	-25 15		-15 25	mA mA
Diagnostic Output Voltage	V_{OUT1}	Broken supply, Pull-down load > 10 kΩ	0		0.5	$\%V_{DD}$
	V_{OUT2}	Broken ground, Pull-down load > 10 kΩ	94	96	100	$\%V_{DD}$
	V_{OUT3}	Broken supply, Pull-up load > 10 kΩ	0	3	5	$\%V_{DD}$
	V_{OUT4}	Broken ground, Pull-up load > 10 kΩ	99.5		100	$\%V_{DD}$
Power on Reset	V_{DD_POR}	Voltage on V_{DD}	1.5		3.5	V
Over Voltage Detection	V_{DD_OVD}	Voltage on V_{DD}	7.0		8.5	V

Table 2: Electrical Specifications

[†] The ratiometric output voltage is proportional to the supply voltage. When using the supply voltage as a reference for an A/D converter, fluctuations of ±10% in supply voltage are compensated.

7 Programming Range

T_A programming 20°C to 30°C.

Parameter.	Symbol	Test Conditions	Min	Typical	Max	Units
Output Quiescent Voltage	V_{OQ}	AGND = Default AGND = 0…1023	-10 -100		110 200	%V_{DD} %V_{DD}
Sensitivity	S		2.6		210	mV/mT
Output Clamping Voltage Low	ClampLo		0		100	%V_{DD}
Output Clamping Voltage High	ClampHi		0		100	%V_{DD}
Temperature Compensation	TempCo	1st order	0		2300	ppm / °C

Table 3: Programming Range Specifications

8 Timing Specifications

DC operating parameters at V_{DD} = 5V (unless otherwise specified) and for T_A as specified by the temperature range (E or L).

Parameter.	Symbol	Test Conditions	Min	Typical	Max	Units
Power On Delay	T_{PO}				5	ms
Step Response Time		RG = 0 to 3, FILTER = 0 RG = 4 to 7, FILTER = 0 RG = 8 to 11, FILTER = 0 RG = 12 to 15, FILTER = 0	24 48 100 200		32 64 132 264	µs µs µs µs

Table 4: Timing Specifications

9 Accuracy

DC operating parameters at V_{DD} = 5V (unless otherwise specified) and for T_A as specified by the temperature range (E or L).

Parameter.	Symbol	Test Conditions	Min	Typical	Max	Units
Thermal Voq Drift	$\Delta^T V_{OQ}$	25°C / 150°C 25°C / -40°C	- 0.2 - 0.4		+ 0.2 + 0.4	%V_{DD} %V_{DD}
Life Time Drift of the Thermal Voq Drift	$\Delta^L \Delta^T V_{OQ}$		- 0.2		+ 0.2	%V_{DD}
Life Time Voq Drift	$\Delta^L \Delta V_{OQ}$		- 0.3		+ 0.3	%V_{DD}
Life Time Sensitivity Drift	$\Delta^L \Delta S$		- 0.5		+ 0.5	%
Sensitivity Temperature Coefficient†	TCs	0 to 500 ppm / °C 500 to 1200 ppm / °C 1200 to 2300 ppm / °C	± 100 ± 150 ± 200			ppm / °C ppm / °C ppm / °C
Thermal Drift of Sensitivity Temperature Compensation	$\Delta^T TC$				150	ppm / °C
Thermal Drift Output Clamping Levels	$\Delta^T V_{OUTCLAMP}$		- 0.4		+ 0.4	%V_{DD}
Life Time Drift Output Clamping Levels	$\Delta^L V_{OUTCLAMP}$		- 0.2		+ 0.2	%V_{DD}
Linearity error	Le				0.2	%

Table 5: Accuracy Specifications

† Valid for Rough Gain within the specified option code.

10 Programmable Features

The MLX90251 has many programmable features for adjusting the output characteristics. The features are utilized by writing data into the redundant non-volatile EEPROM. Below is a quick list and description of all the programmable parameters. Many of the parameters are set by Melexis and they are not used by the end customer. Later sections of the data sheet give details on how the parameters are used.

Parameter.	Symbol	Description	Number of Bits
Internal Bias Point	AGND	Coarse adjustment of V_{OQ}. Default set by Melexis.	10
Analog Clock Choice[†]	CKANACH	Adjustment for amplifier clock generator. Default set by Melexis.	2
DAC Clock Choice[†]	CKDACCH	Adjustment for DAC clock generator frequency. Default set by Melexis.	2
Clamping High	CLAMPHIGH	Adjustment of upper output clamping voltage. Default value of 512.	10
Clamping Low	CLAMPLOW	Adjustment of lower output clamping voltage. Default value of 512.	10
Customer ID[††]	CUSTID	Open bits for customer programming.	24
Offset Drift[*]	DRIFT	V_{OQ} temperature drift compensation. Factory set by Melexis.	4
EEPROM Fault Level	FAULTLEV	Output state for EEPROM parity error.	1
Oscillator Adjust[†]	OSCADJ	Chip oscillator frequency adjustment. Default set by Melexis.	4
Fine Gain	FG	Fine adjustment for Sensitivity.	10
Filter	FILTER	Adjustment for low pass output filter.	4
Invert Slope	INVERT	Sensitivity polarity selection.	1
Memory Lock	MEM_LOCK	Used to lock the entire EEPROM.	1
Melexis ID[†]	MLX_ID	Melexis IC identification number. Set by Melexis.	
Melexis Lock[†]	MLX_LOCK	Used to lock Melexis area of the EEPROM.	1
Output Driver[†]	MODE	Adjustment for output stage amplifier. Default of 1 set by Melexis.	2
Offset DAC	OFFSET	Fine adjustment of V_{OQ}.	10
EEPROM Parity	PARITY	Ensures the integrity of the EEPROM data	3
Rough Gain	RG	Rough adjustment for Sensitivity.	4
Slow[†]	SLOW	Amplifier speed adjustment. Default set by Melexis.	1
Temperature Compensation Window	TCW	Range adjustment for Sensitivity Temperature Compensation.	3
Temperature Compensation	TC	Fine adjustment of Sensitivity Temperature Compensation.	5
2nd Order Temperature Compensations	TC^2	Linearization adjustment of the Sensitivity Temperature Compensation.	6

Table 6: Programmable Parameters

[†] Melexis parameter adjusted at final test.

[††] Not included in redundant area of the EEPROM.

10.1 Output Quiescent Voltage (V_{OQ})

Two parameters are used for adjustment of the V_{OQ}, AGND and OFFSET. The AGND is a 10 bit parameter for coarse adjustment of V_{OQ}. It has a resolution of approximately 0.014V and a range of -100%V_{DD} to 200%V_{DD}. The OFFSET is a 10 bit parameter with a resolution of approximately -0.005V. The OFFSET parameter is used for fine adjustment of the V_{OQ}, while the AGND parameter is used to set the range. The large adjustable range allows the MLX90251 to be used in a unipolar magnetic system without limiting the output voltage span. The formula below shows how the AGND and OFFSET parameters combine to set the V_{OQ}.

$$V_{OQ} = -0.75 + 0.014 * AGND + -4.88 * 10^{-3} * OFFSET(Volts), \qquad V_{DD} = 5.000V$$

This formula approximates the typical V_{OQ} of the MLX90251. The actual V_{OQ} formula varies slightly from chip to chip. Melexis calibrates the AGND setting during final test so the V_{oq} is approximately 50%V_{DD} with OFFSET set to 512. This gives the V_{OQ} a range of 0%V_{DD} to 100%V_{DD} without adjusting the AGND value. The OFFSET parameter is often used to set the application's offset output transfer characteristic.

10.2 Thermal V_{OQ} Drift (DRIFT)

The Thermal V_{OQ} Drift is tuned using 4 bits. This parameter, DRIFT, is calibrated for each unit by Melexis during final test. The value is set to achieve a V_{OQ} accuracy below 10 mV over a temperature span of 25°C to 150°C. This parameter is not used by the end customer.

10.3 Sensitivity, Rough Gain and Fine Gain

The Sensitivity of the MLX90251 is controlled through parameters linked to dedicated internal amplification stages. The parameter Rough Gain (RG), or pre-amplifier, has 4 bits for adjustment of two stages. The two MSB affect the Differential Input Differential Output (DIDO) stage. The two LSB effect the Differential to Single output (DTS) stage. The gain of both the DIDO and DTS are multiplied to get the total RG. The table below shows the small signal amplifier gain Vs. the parameter RG. The pre-amplifier is chopper stabilized and the refresh frequency is adapted automatically to the RG setting to match the chopper gain-bandwidth product.

Rough Gain (MSB LSB)	DIDO	DTS	Gain
00 (00 00)	16	1.0	16
01 (00 01)	16	1.5	24
02 (00 10)	16	2.33	37
03 (00 11)	16	4.0	64
04 (01 00)	39	1.0	39
05 (01 01)	39	1.5	59
06 (01 10)	39	2.33	91
07 (01 11)	39	4.0	156
08 (10 00)	82	1.0	82
09 (10 01)	82	1.5	123
10 (10 10)	82	2.33	191
11 (10 11)	82	4.0	328
12 (11 00)	205	1.0	205
13 (11 01)	205	1.5	308
14 (11 10)	205	2.33	477
15 (11 11)	205	4.0	820

Table 7: MLX90251 Rough Gain Small Signal Amplifier Gain

The MLX90251 also has an additional stage, Fine Gain, for fine tuning the Sensitivity. The stage (parameter FG) follows the RG and provides a 10 bit adjustment. The small signal gain of the FG is within 1.0 and 2.5. The RG and FG parameters are adjusted in the application to calibrate the sensitivity (gain) and output slope transfer characteristic of the device. The function for the fine gain is given in the following equation:

$$Fine\quad Gain = \frac{1}{1 - 0.6 * \frac{FG}{1023}}$$

Note. The one bit parameter INVERT is used to fix the "sign" of the sensitivity. A value of 0 makes the gain positive and the output voltage increase in response to a South magnetic field. A value of 1 makes the gain negative and the output voltage decrease in response to a South magnetic field. Refer to section 10.5, Sensitivity Polarity for more information on INVERT.

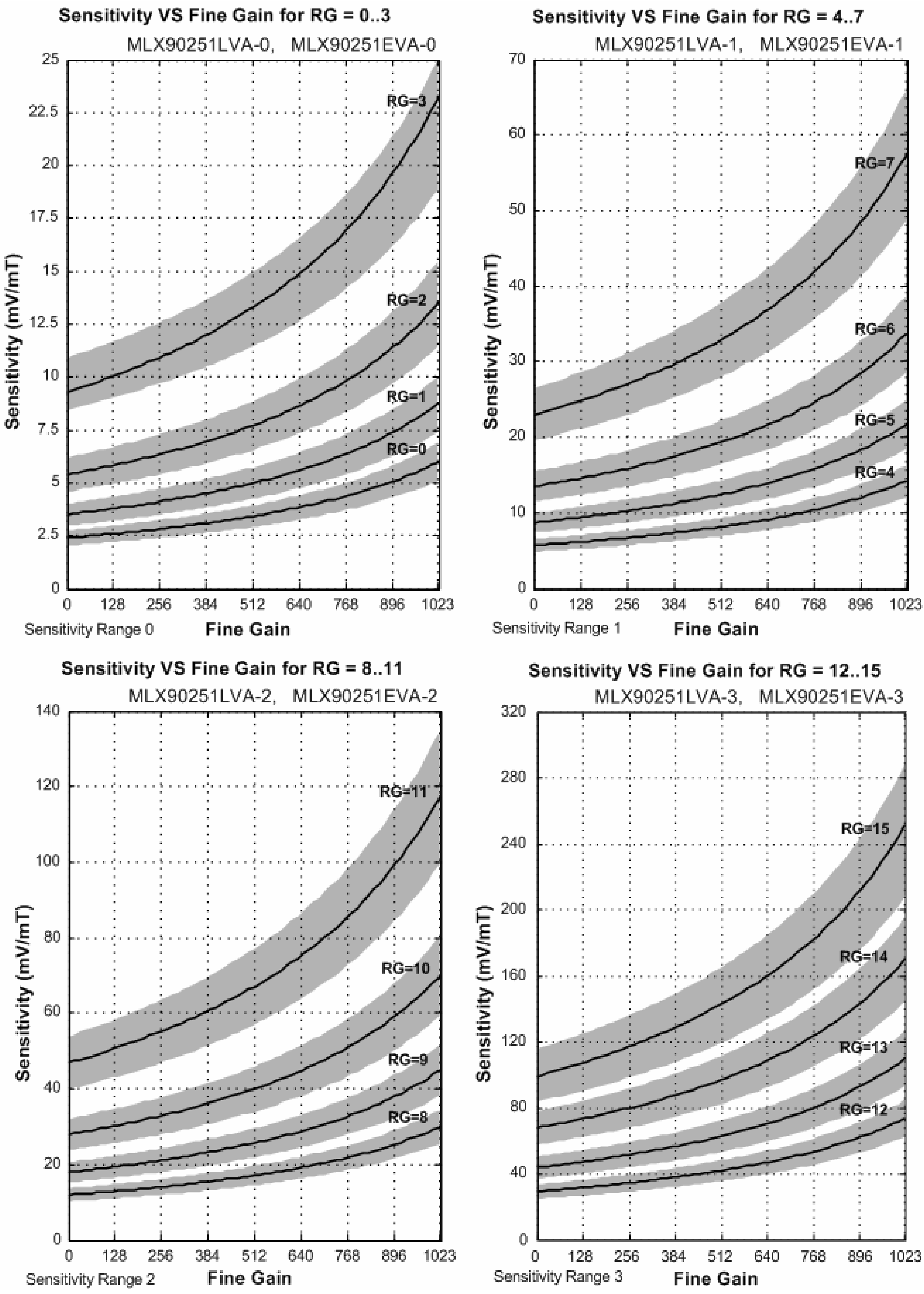
10.4 Sensitivity Range Selection

Each unit is characterized over temperature during final test to optimize its performance and accuracy. To achieve the best possible Sensitivity Temperature Compensation, TempCo, each unit is optimized for use within a specific Sensitivity range. This is represented in the ordering information by the option code. There are four available ranges, option codes 0,1,2, and 3. The option code corresponds with the two MSB of the RG parameter. Each device is tested to meet the TempCo specification in the Sensitivity range determined by the RG parameter (RG = 0..3, RG = 4..7, RG = 8..11 or RG = 12..15), regardless of the FG parameter.

Option Code	Rough Gain	Sensitivity Range (mV/mT)	Magnetic Field Range (mT, B_{MAX} - B_{MIN})
0	0-3 (00 xx)	2.6 < S < 15	333 < B < 800
1	4-7 (01 xx)	10 < S < 35	156 < B < 333
2	8-11 (10 xx)	18 < S < 90	62 < B < 156
3	12-15 (11 xx)	50 < S < 210	6 < B < 62

Table 8: Optimized Sensitivity Range

The next figures show the typical Sensitivity versus the FG and RG parameters. The gray areas are representative of the chip to chip dispersion (ie: for the same RG and FG parameters, the Sensitivity can vary from chip to chip). There is large overlap between the different ranges for use of one range for applications with large magnetic and/or mechanical dispersions. The Sensitivity graphs and tables can be used to select the right device type for the application. If one is unsure of the applications magnetic design and the desired Sensitivity range Melexis recommends option code 2.



Figures 10.4-1…10.4-4 Sensitivity Versus RG and FG

10.5 Sensitivity Polarity (INVERT)

The slope transfer characteristic defines the Sensitivity. The INVERT parameter changes the Sensitivity's polarity, or the slope's direction. This allows the device to accommodate the application requirements and the magnet's polarity. The slope is inverted in the first stage of the IC, at the Hall Plate. With INVERT set to 0, the output voltage increases as a South magnetic field is applied and decreases in the presence of a North magnetic field. An INVERT value of 1 causes the output voltage to increase in the presence of a North magnetic field and decrease in the presence of a South magnetic field. The magnetic field polarity is referenced to the field component perpendicular to the top-face of the MLX90251.

10.6 Clamping Levels (CLAMPLOW, CLAMPHIGH)

Two independent values called the clamping levels, can limit the output voltage range, or swing. The CLAMPLOW parameter adjusts the minimum output voltage level, ClampLo. The CLAMPHIGH sets the maximum output voltage level, ClampHi. Both parameters have 10 bits of adjustment with a resolution of approximately 0.005V. The formulas below give a close approximation of the output clamp voltage. The actual clamping level formulas vary slightly from chip to chip. If CLAMPLOW exceeds CLAMPHIGH the output voltage is fixed at the high clamp voltage level. The CLAMPHIGH and CLAMPLOW have an initial value of 512, set by Melexis. This results in a fixed output voltage of approximately 50% V_{DD}.

$$ClampLo = 5.0 * 10^{-3} * CLAMPLOW(Volts), \qquad V_{DD} = 5.000V$$

$$ClampHi = 5.0 * 10^{-3} * CLAMPHIGH(Volts), \qquad V_{DD} = 5.000V$$

10.7 Filter (FILTER)

The MLX90251 includes two programmable low-pass filters located within the chopper amplifier stages. The two low-pass filters are controlled through a 4 bit parameter, FILTER. The FILTER value 0 corresponds to minimum filtering, maximum speed (impulse response time), and maximum output noise. The value 15 provides the maximum filtering, minimum speed, and minimum output noise. It is important to note the noise is also linked to the gain settings. The FILTER parameter needs to be adjusted to achieve optimal performance. The next table shows the cut-off frequency at -3 dB versus FILTER and RG parameters. FILTER values from 8 to 11 are not used. For most applications FILTER values 7 or 15 are recommended.

Cut-off frequency at -3 dB (Hz) – Typical

Filter	MLX90251-0 Rough Gain 0…3	MLX90251-1 Rough Gain 4…7	MLX90251-2 Rough Gain 8…11	MLX90251-3 Rough Gain 12…15
0	22900	14300	7000	3850
1	19500	11450	5550	2950
2	12300	10000	3000	2300
3	10400	6750	2100	1100
4	7450	3900	1500	850
5	5850	2900	1125	860
6	5700	2700	1350	715
7	5050	2550	1380	650
8	Not used			
9	Not used			
10	Not used			
11	Not used			
12	2200	840	565	250
13	1000	480	470	190
14	920	380	290	155
15	800	330	250	135

Table 9: Cut-off Frequency Versus FILTER and RG Parameters

10.8 Sensitivity Temperature Compensation (TC, TCW, TC^2)

The change in the device's Sensitivity versus temperature is defined as the Sensitivity Temperature Compensation, TempCo. In an application the slope output transfer characteristic is often affected by temperature. Fluctuations in temperature can cause variations in the air gap, mechanical alignment, and magnetic field. The Sensitivity Temperature Compensation feature, compensates for these effects.

Three parameters, TC, TCW, TC^2 are used for adjustment of the TempCo. The TCW is used to adjust the TempCo range, TC is for fine adjustment of the TempCo value, and TC^2 effects the TempCo linear response. To simplify use of these parameters Melexis stores a look up table within the EEPROM of each device. The look up table is optimized for each device by characterizing the unit over temperature at final test.

The value of TempCo is often determined by the magnet. In the application the TempCo is adjusted to compensate for the temperature coefficient of the magnet. To adjust the value the look up table is read from the device. The parameters are then calculated to match the desired value. The Melexis PTC hardware and software tools contain built in functions for programming the TempCo.

TempCo Range (ppm / °C)	Accuracy (ppm / °C)
0 to 500	± 100
500 to 1200	± 150
1200 to 2000	± 200

Table 10: TempCo Accuracy

Note: The budget error of the whole system, the compensation mismatch (system Vs. IC) tolerance should be taken into consideration during the design. Table 10 is valid for Rough Gain within the specified option code. See section 10.4 for information on selecting the option code.

10.9 Diagnostic Output Level (FAULTLEV)

The MLX90251 EEPROM memory content is secured through a parity check. This self-diagnostic feature brings the output to a defined range in case of a parity error. The parameter, FAULTLEV, is used to define the parity error diagnostic state. With the FAULTLEV set to 0 a parity error event will result in an output diagnostic voltage low. With the FAULTLEV set to 1 a parity error event will result in an output diagnostic voltage high. To get rid of the output load influence the output diagnostic voltage level can be fixed to either Ground (to be used with pull-down load) or V_{DD} (to be used with pull-up load). Melexis PTC software and hardware tools have built in functions for calculating and programming the parity.

Note: The MLX90251 EEPROM is also redundant. Each parameter bit is written in three separate cells and a “majority voting” is applied to determine its status. A parity error is detected only if two out of the three cells unexpectedly change state. The bits available for the customer ID are not redundant.

10.10 The EEPROM, Parity, and Melexis CRC

The memory cells of the EEPROM are arranged in a table of four columns and one hundred twenty eight rows. This configuration gives redundancy to the parameters stored in the EEPROM. Each parameter bit is written in three separate cells in an individual row. A majority voting applied to the three cells determines the logic status of the bit.

A parameter bit only toggles state in error if two out of three memory cells, within a row, unexpectedly change. If this happens the feature, PARITY, forces the output voltage to the FAULTLEV diagnostic level. This ensures the device does not operate with a critical memory fault.

The remaining memory cells are used for data storage. The status of these cells does not effect the device operation. For example the Customer ID, CUSTID, is stored in this area. Melexis stores the device ID information, TempCo look-up table and CRC bits in the extra cells. The CRC bits ensure the integrity of the Melexis data.

Note: To avoid parity and CRC errors, the entire contents of the EEPROM must be read before programming. Melexis PTC software and hardware tools have built in functions for reading the EEPROM and handling parity.

10.11 Output Amplifier Configuration (MODE)

The output buffer can be configured to accommodate capacitive loads and improve the saturation voltage (output swing). The two bit parameter, MODE, sets the current capacity of the output amplifier. Melexis sets this parameter to 1 at final test. This parameter is not used by the end customer.

10.12 Memory Lock (MEMLOCK)

The Memory Lock feature prevents the device from entering programming mode and from any changes to the EEPROM. The entire EEPROM is locked by setting the MEMLOCK parameter to 1. This should be the last parameter set in the application.

10.13 IC traceability

A unique ID number is programmed into the EEPROM of every IC. The ID number gives Melexis additional traceability to better service its customers. The ID number is composed of the lot number, wafer number, and wafer coordinates (X and Y). Memory is also available for the customer to add a serial number of the product or any other data.

11 Performance Graphs

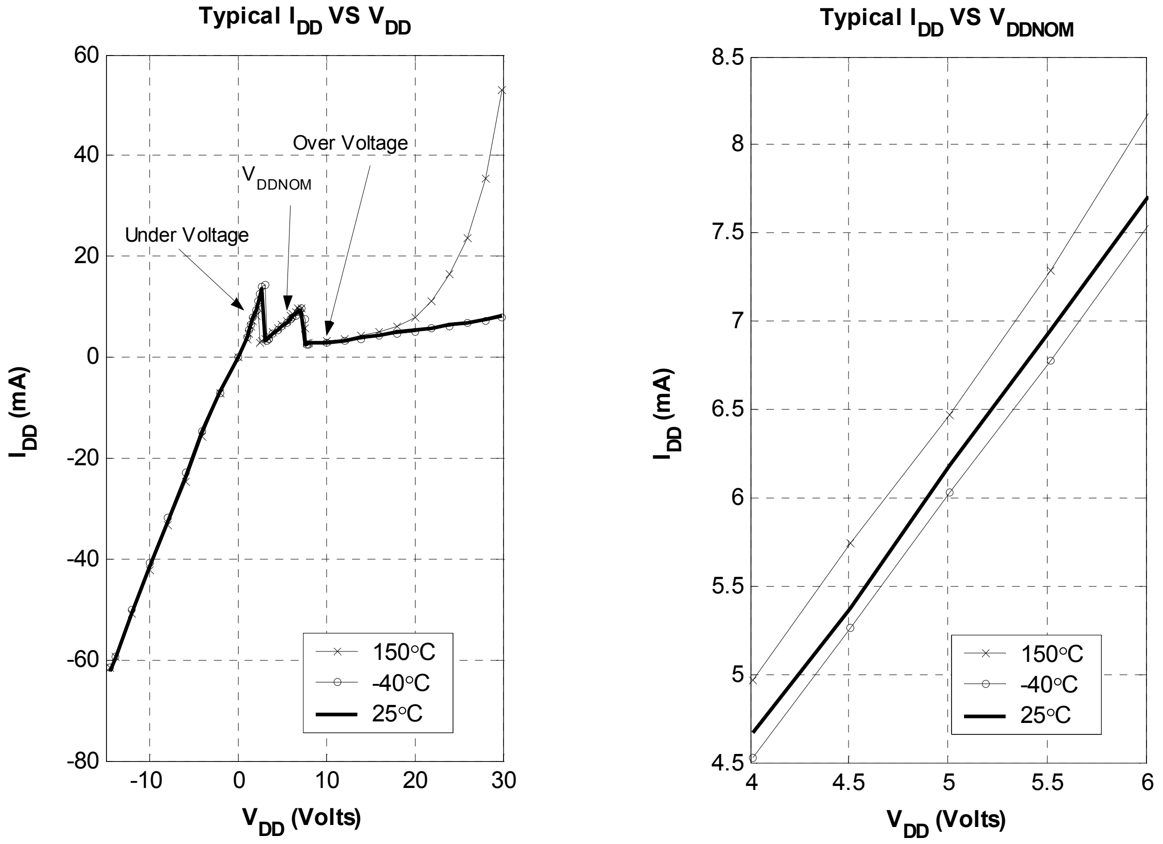
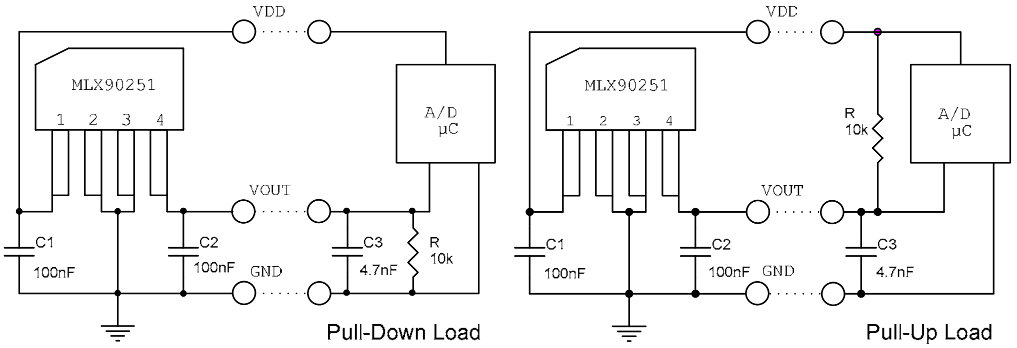


Figure 11-1…11-2 I_{DD} Versus V_{DD}

12 Applications Information

12.1 Application Circuits

Pin 2, TEST, is not used in applications. For EMC protection it is recommended to connect pin 2 to pin 3, Ground, as close as possible to the device pins. The values for capacitors, C1 and C2, can be adjusted to satisfy ESD and EMC requirements according to the environment. Ceramic capacitors are recommended for use in the application. The MLX90251 can operate with a high impedance load and C2, a load resistor is not required.



Pull-Down Load

Pull-Up Load

Figures 12.1-1…12.1-2 Application Circuits

A voltage of 9V is required on V_{DD} for programming. All additional components connected to V_{DD} must be able to withstand the voltage.

The MLX90251 is designed for operation with a stable 5V supply. If voltage transients exceed the absolute maximum rating for V_{DD_SLEW} additional filtering may be required.

12.2 Programming the Sensor

To program the MLX90251 connection to V_{DD}, GND, and V_{OUT} is required. The device is placed into program mode by increasing the supply voltage to the V_{DD} program level. In program mode data is clocked into the device through the output pin using the Melexis tri-level PTC protocol. The clock and data are integrated into one serial data stream, eliminating the need for a dedicated clock signal. The data is clocked at the leading edge of each bit.

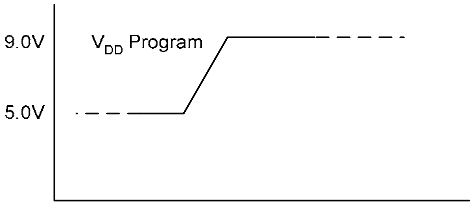


Figure 12.2-1 V_{DD} Programming Level

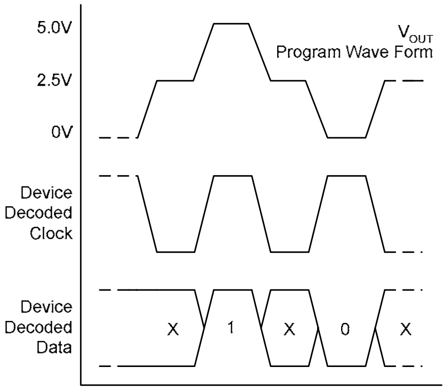


Figure 12.2-2 Tri-Level PTC

Note: External capacitors and resistors will effect the rise and fall times for the programming waveforms. Program pulse timings may require adjustment for the application. The device can not be programmed if MEMLOCK equals 1.

The EEPROM contents can be read from the device. This procedure, known as a read back, is done by sending a read command and then measuring the supply current. To successfully read the EEPROM it must be possible to measure the supply current to the device. The Melexis PTC hardware and software tools contain built in functions for reading the EEPROM.

The MLX90251 can be programmed by using the PTC-03 programmer and the dedicated software tools. The timing and voltage levels are controlled through the programming hardware and software. Further details can be found in the MLX90251 software documentation.

12.3 Calibration Procedure

The programmable features of the device allow it to be calibrated within the application. This section gives general information for a two point calibration procedure. The two point calibration is the most common however, it is possible to adapt other procedures.

1.) The first step in the calibration procedure is to initialize the device. This is done by establishing communication and reading the contents of the EEPROM.

2.)The second step is to set the TempCo and FILTER settings.

3.) Step three is the evaluation of position one. During this step the output voltage is measured with initial values for RG, FG and OFFSET.

4.) Step four is the evaluation of position two. During this step, the output voltage is measured with the same values from step 3. From the measurements it is possible to calculate the slope and offset error. Next the output slope transfer characteristic versus FG and RG is interpolated. With this information the initial settings are adjusted and the output voltage is measured again.

5.) Step five is the final check and adjustment. At this stage small corrections are made to the OFFSET and FG parameters. Next, the output clamping parameters, CLAMPHIGH and CLAMPLOW, are determined.

6.) The sixth step is the program phase. Now that all the parameters are determined and the application requirements are satisfied, the settings are programmed into the EEPROM.

7.) The final step, seven, is the lock and verify step. Here the customer can perform any number of additional measurements and verify the EEPROM contents. After this is complete the MEMLOCK is set and the EEPROM is locked, preventing any further programming.

Note: EEPROM verification is done by reading the contents of the EEPROM and comparing it to the data written. It is possible to read the EEPROM contents regardless of the status of MEMLOCK.

The Melexis PTC software tools contain built in functions and procedures for calibrating the MLX90251. Please refer to the software documentation for more information on how to use the calibration tools.

The output of the MLX90251 is ratiometric. To avoid calibration errors from fluctuations in the supply voltage, the output voltage should be measured as a percentage of the supply voltage.

13 Reliability Information

This Melexis device is classified and qualified regarding soldering technology, solderability and moisture sensitivity level, as defined in this specification, according to following test methods:

- 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)
- CECC00802
  Standard Method For The Specification of Surface Mounting Components (SMDs) of Assessed Quality
- EIA/JEDEC JESD22-B106
  Resistance to soldering temperature for through-hole mounted devices
- EN60749-15
  Resistance to soldering temperature for through-hole mounted devices
- MIL 883 Method 2003 / EIA/JEDEC JESD22-B102
  Solderability

For all soldering technologies deviating from the 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.

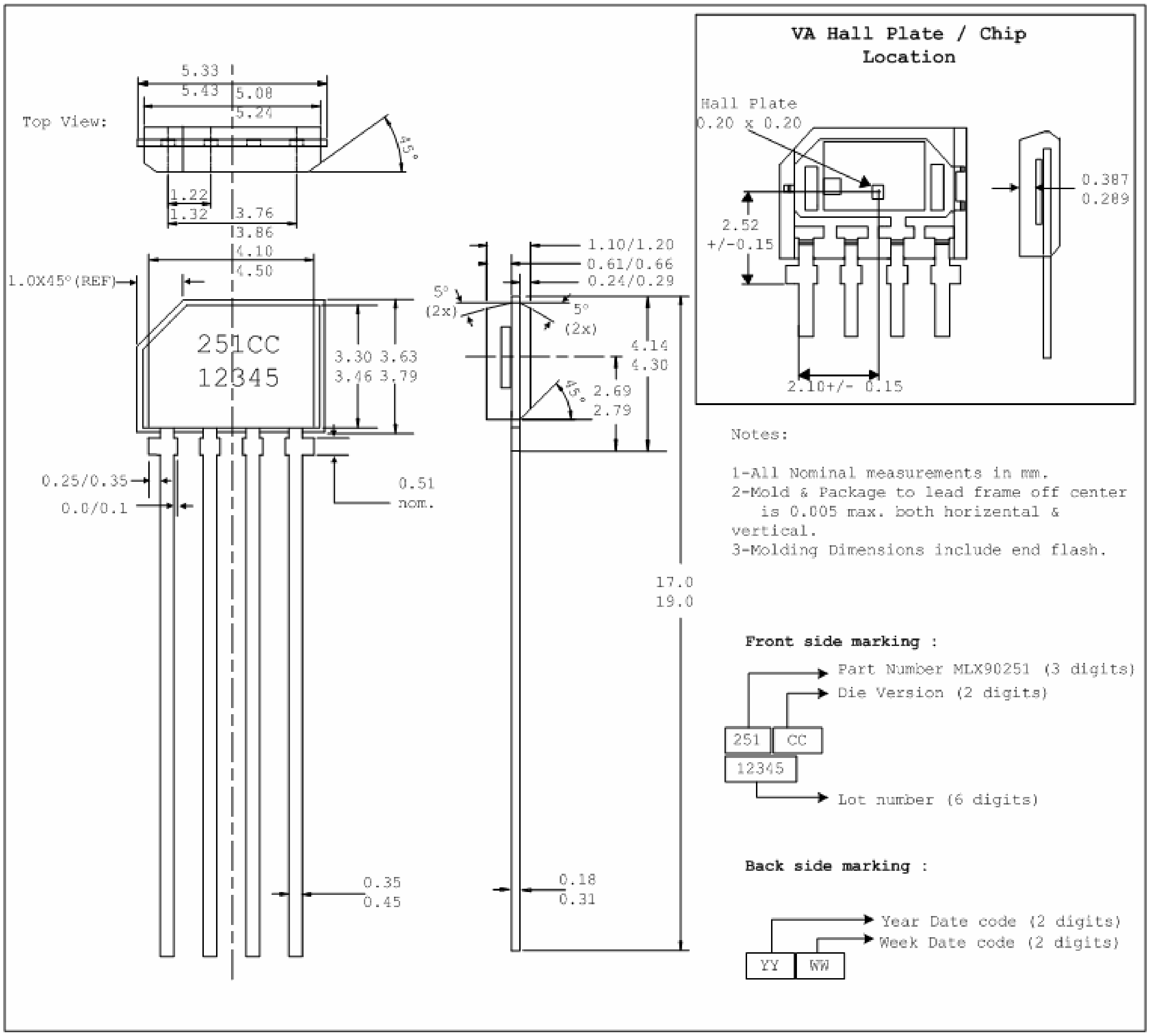
Based on Melexis' commitment to environmental responsibility, European legislation (Directive on the Restriction of the Use of Certain Hazardous substances, RoHS) and customer requests, Melexis has installed a Roadmap to qualify their package families for lead free processes also.
Various lead free generic qualifications are on going, current results are available on request.

For more information on manufacturability/solderability see the quality page at our website:
http://www.melexis.com/html/pdf/MLXleadfree-statement.pdf

14 ESD Precautions

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

15 Package Information



Notes:

1-All Nominal measurements in mm.
2-Mold & Package to lead frame off center is 0.005 max. both horizontal & vertical.
3-Molding Dimensions include end flash.

Front side marking :

Part Number MLX90251 (3 digits)
Die Version (2 digits)
Lot number (6 digits)

Back side marking :

Year Date code (2 digits)
Week Date code (2 digits)

16 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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