1. Features and Benefits

- Triphibian™ technology
- 0.5%FS accuracy over life
- Digital SENT output
- Option to output linear temperature measured by external NTC thermistor
- Flexible NTC input supports wide range of different NTC characteristics without calibration
- System in a package: MEMS, analog front-end circuitry, 16-bit microcontroller, voltage regulators and digital back-end SENT driver
- Large automotive temperature range (-40°C to 150°C)
- Qualified according to AEC-Q100 and AEC-Q103-002
- Configurable diagnostic features like internal broken connection, over voltage, under voltage etc.
- Factory calibrated and fully programmable through the connector with the PTC04 programming tool for customized calibration curves
- Extended over (+40V) and reverse (-40V) voltage capabilities (supply & output)
- Harsh media and liquid media compliant
- ASIL compliant developed as an ASIL B SEooC as per ISO 26262

2. Application Examples

- Absolute pressures from 2bar to 70bar with gas and/or liquid media
- Thermal Management of Electric Vehicles
  - Standalone sensor
  - Embedded sensors in expansion valves
  - Embedded sensors in e-compressors
  - Embedded sensors in pumps
- HVAC-R systems
- Transmission oil monitoring
- Engine oil monitoring

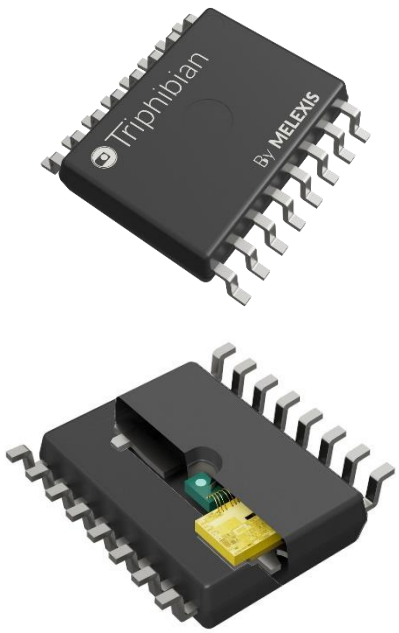


Figure 1: MLX90834

3. Ordering information

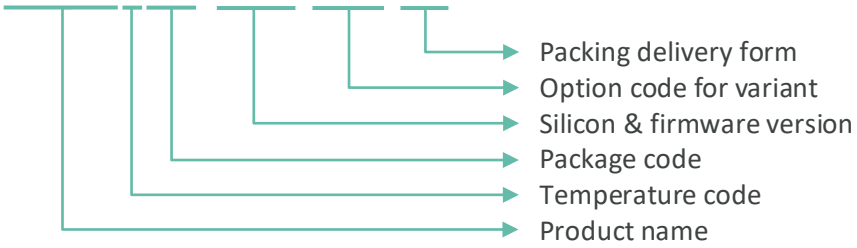
Product Code	Temperature Code	Package Code	Option Code	Packing Form Code
MLX90834	L	XG	DAH-003	RE
MLX90834	L	XG	DAF-004	RE

Legend:
Temperature Code: L (-40°C to 150°C)
Package Code: XG = SOIC16 WB cavity package
Option Code:

Option	Pressure range	SENT output
DAH-003	0 to 12bar	193 to 3896LSB
DAF-004	0 to 36bar	193 to 3896LSB

Packing Form: RE = Reel
Ordering example: MLX90834LXG-DAH-003-RE

MLX90834LXG-DAH-003-RE



4. Package Diagram

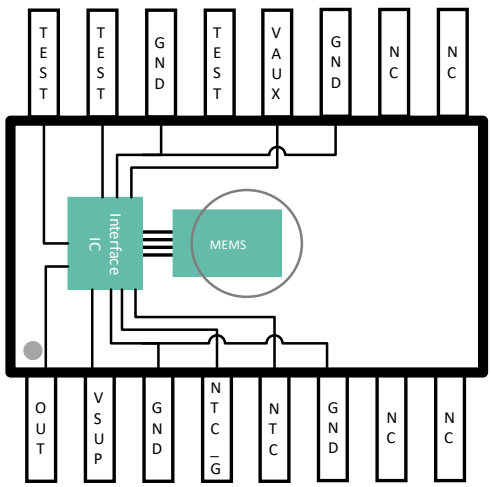


Figure 2: Internal wiring of MLX90834. Top view. Pressure cavity with access to the MEMS is on the bottom side.

5. General Description

The MLX90834 is a packaged, factory calibrated, absolute pressure sensor to be used for spans between 2bar and 70bar. It delivers a digital output signal using the SENT protocol.
The MLX90834 consists of a MEMS pressure sensor element and an interface chip (CMOS technology) in a SOIC16 WB package. An NTC can be connected for a fast and highly accurate temperature reading of the medium. The solution, integrated on a pcb with external components, exhibits excellent EMC performance. The DSP based signal interface provides outstanding initial accuracy and over life accuracy. A smart package and die assembly concept enable high output stability over life, even in stringent automotive temperature and stress conditions.
The MEMS pressure sensor element uses the Triphibian™ technology; a suspended cantilever design that is inherently more robust than rear-side exposed solutions, which still experience a pressure differential between the glass pedestal side and the wire bonding side. The pressure equalization principle is also valid for frozen media.

Contents

6. Glossary of terms

Term	Description
ADC	Analog to Digital Converter
ASIL	Automotive Safety Integrity Level
Bar	Pressure unit (1bar = 100kPa)
DSP	Digital Signal Processor
EMC	Electro Magnetic Compatibility
ESD	Electrostatic discharge
FS	Output Full Scale = O2 – O1
GND	Ground connection
LSB	Least Significant Bit
NTC	Negative Temperature Coefficient thermistor
NC	Not Connected
NTC	Negative Temperature Coefficient thermistor
NVM	Nonvolatile memory
OV	Over Voltage
PCB	Printed Circuit Board
Pk-Pk	Peak to peak
POR	Power-on Reset
PTC04	Melexis Programming Tool, hardware to program the device in lab or production
RV	Reverse Voltage
SENT	Single Edge Nibble Transmission
SEooC	Safety Element out of Context
T_A	Ambient temperature
TEST	Test pin
UV	Under Voltage
Vaux	Pin to connect an auxiliary capacitor
Vsup	Supply pin

Table 1: Glossary of terms

7. Absolute Maximum Ratings

Parameter	Value	Units	Comment
Supply Voltage (overvoltage)	40	V	Max 2 hours
Reverse Voltage Protection	-40	V	
Positive output voltage	40	V	
Reverse output voltage[1]	-40	V	
Max voltage on NTC pin	-0.2 to 2	V	Max 1 minute at Ta = 25°C
Operating Ambient Temperature Range	-40 to 150	°C	
Storage Ambient Temperature Range	-40 to 150	°C	
Programming Ambient Temperature Range	-40 to 125	°C	
Proof pressure	3x P2	BarA	
Burst pressure	5x P2	BarA	

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 device reliability.

1 *Absolute maximum DC negative output at floating supply or supply shorted to output. Maximum DC negative output at operating supply: -5.5V.*

8. Pin Definitions and Descriptions

Pin number	Description	Pin number	Description
1	SENT output	16	Test pin
2	Supply input	15	Test pin
3	Ground	14	Ground
4	NTC ground	13	Test pin
5	NTC input	12	Vaux
6	Ground	11	Ground
7	Not connected	10	Not connected
8	Not connected	9	Not connected

Table 3: Pin out definitions and descriptions

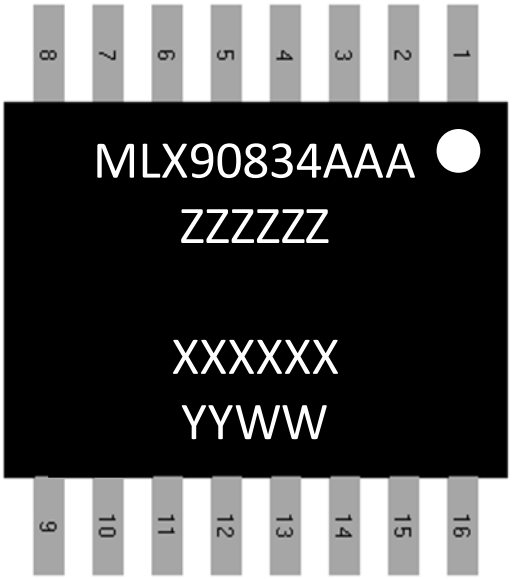


Figure 3: Package marking (top view)

Symbol	Function / Description
XXXXXX	Sub-lot number
ZZZZZZ	ASIC lot number
YY	Year of assembly
WW	Calendar week of assembly
AAA	MEMS and ASIC traceability letter (DAH/DAF)

Table 4: Package marking definition

9. General Electrical Specifications

DC Operating Parameters T_A = -40°C to 150°C

Parameter	Symbol	Remarks	Min	Typ[2]	Max	Units
Nominal supply voltage	Vdd		4.5	5	5.5	V
Nominal supply current	Idd	No output load		10.5	12	mA
Current consumption at overvoltage	IDD_OV				20	mA
Current consumption at reverse voltage	IDD_RV				20	mA
Output short-circuit current	IOUT_SH		-20		20	mA
Resistive load on output	$R_{pull-up}$	Pull-up to Vdd at receiver[3]	10		55	kOhm
Under voltage detection tolerance			-50		50	mV
Over voltage detection tolerance			-50		50	mV
Power up time		Time from reaching minimum allowed supply voltage of 4.5V till the first falling edge of the first SENT frame			5	ms
Pressure Response time[4]		Using default filter settings. Tick time = 3us and Pause Pulse enabled.			3	SENT frames
Pressure output noise		Default configuration in DAH-003 and DAF-004		2	3	LSB pk-pk
Pressure output update time		SENT frame of at least 0.528ms.			1	SENT frame
Internal temperature start up time				5 +1	9 +1	ms temperature output period[5]
Internal temperature update time				10	20	ms
On-chip temperature accuracy		On chip PTAT temperature, used in SC message. Compared to ambient temperature.	-7.5		7.5	°C

[2] Typical values are defined at T_A = +25°C and V_{DD} = 5V.

[3] As specified in the SENT standard

[4] Number of SENT frames between pressure step and settled output (last frame containing stable pressure data)

[5] The temperature output period is the time interval between two moments where temperature information is transmitted. If the internal temperature is transmitted in fast channel 2 this duration is one SENT frame. If the internal temperature is only transmitted in the slow channel this is the time between two slow channel messages with ID 23.

Parameter	Symbol	Remarks	Min	Typ[6]	Max	Units
Input voltage range on NTC pin			-0.2		2	V
NTC Temperature Output noise		Default configuration in DAH-003 and DAF-004			4	LSB pk-pk
NTC temperature update time				18	22	ms
NTC Temperature response time		From temperature change to end of frame with output >= 90% of step size			100 +1	ms temperature output period
NTC start up time				10 +1	12 +1	ms temperature output period[7]
NTC resistance range	R_NTC		20		1M	ohm

Table 5: Electrical specifications

10. Functional diagram

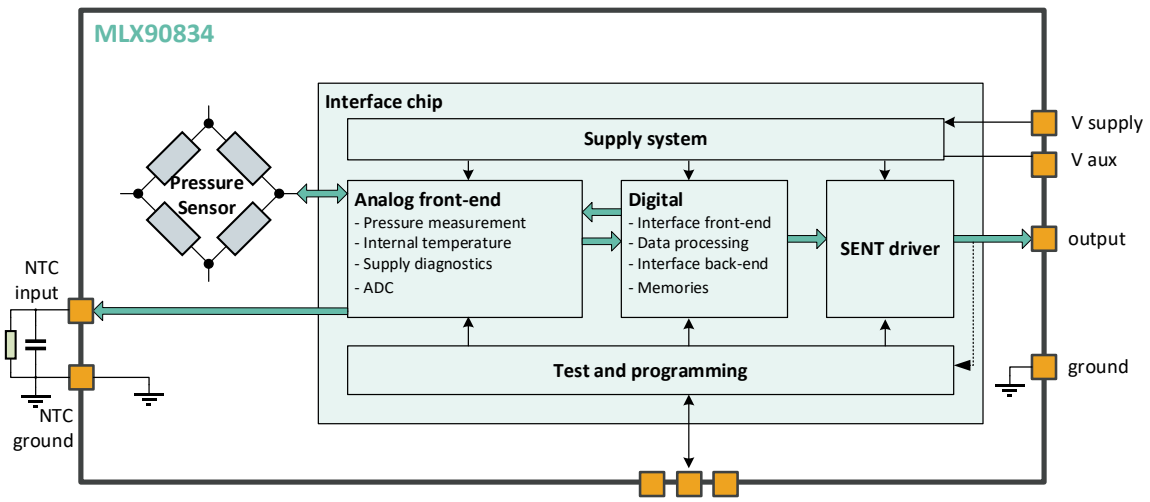


Figure 4: Functional diagram of the MLX90834

[6] *Typical values are defined at T_A = +25°C and V_{DD} = 5V.*

[7] *The temperature output period is the time interval between two moments where temperature information is transmitted. If the NTC temperature is transmitted in fast channel 2 this duration is one SENT frame. If the NTC temperature is only transmitted in the slow channel this is the time between two slow channel messages with ID 10.*

11. Detailed General Description

The MLX90834 consists of a pressure sensor element and a DSP-based interface chip.

The pressure sensor element consists of a diaphragm realized in the silicon chip by wafer bonding on an etched cavity with built in reference vacuum. The diaphragm reacts to a change in absolute pressure. The internal strain increases, in particular at the border of the diaphragm. Here, the piezo-resistive elements have been implanted into the silicon diaphragm forming a Wheatstone bridge, which act as a transducer.

The analog front-end of the interface chip applies filtering and converts the analog signal to a digital value. The DSP performs the compensations over temperature. Furthermore, the digital circuit provides some filtering, the possibility to linearize the pressure signal and also implements the clamping function. See chapter 13 for the default output characteristics. This chip transmits a SENT output compliant with SAE J2716 spec dated April 2016. See chapter 14 for detailed information on the SENT configuration. On one of the fast channels of the SENT message it is possible to transmit linearized and calibrated temperature information measured by an external NTC thermistor. An analog interface is available for the external thermistor and the 16bits DSP performs the calibration and linearization of the measured thermistor temperature.

Extensive protection of the supply lines and output allows the MLX90834 to handle extreme overvoltage conditions and is resistant to severe external disturbances. Several diagnostic functions (over-voltage, under-voltage, overpressure, under pressure detections) have been implemented on the MLX90834 and can be enabled by programming EEPROM settings. Figure 4 shows the MLX90834 block diagram. The product should be integrated together with external components on an PCB. See chapter 16 for the application schematic.

12. Digital

The digital is built around a 16-bit microcontroller. It contains besides the processor also ROM, RAM and EEPROM and a set of user and system IO registers. Temperature compensation of the pressure signal and pressure linearization is handled by the microcontroller. For the pressure compensation there are EEPROM parameters allocated to be able to cover a large variety of calibration approaches.
Both for gain and offset of the pressure signal, there is a separate temperature dependency which is programmable up to a third order compensation. This is reflected in EEPROM parameters for the offset (O0, O1, O2 and O3) and for the gain (G0, G1, G2 and G3).
If required, the linearity of the pressure signal can also be compensated with a first order temperature dependency through EEPROM parameters L0 and L1.
Linearization of the NTC temperature is also covered partially by the microcontroller. More information in this topic can be found in chapter 15.

13. Default programmed output transfer curve

The MLX90834 is calibrated at the final manufacturing test steps. During the calibration, settings are stored in the on chip EEPROM to define the pressure transfer curve. Besides pressure, the internal temperature calibrations are performed. The default temperature characteristic can be found in the graph of Figure 5. The SENT parameters and the IC filter values are also configured.

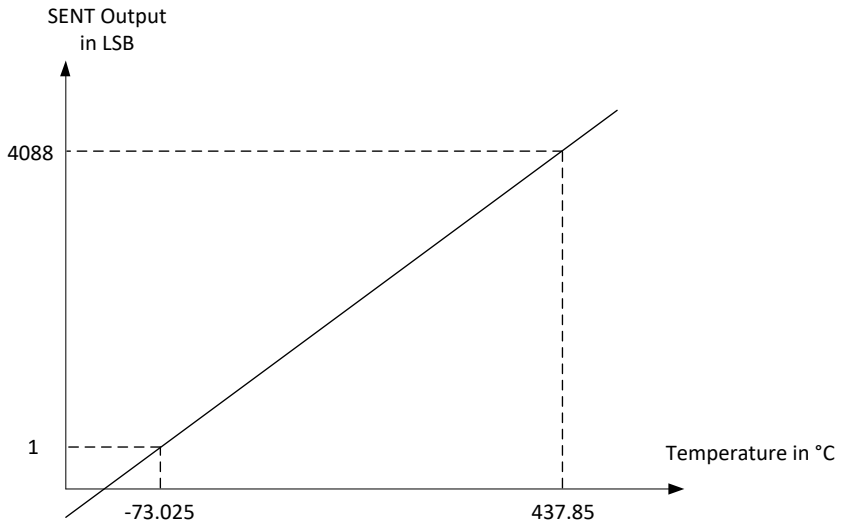


Figure 5: Internal temperature transfer function, used in SC message

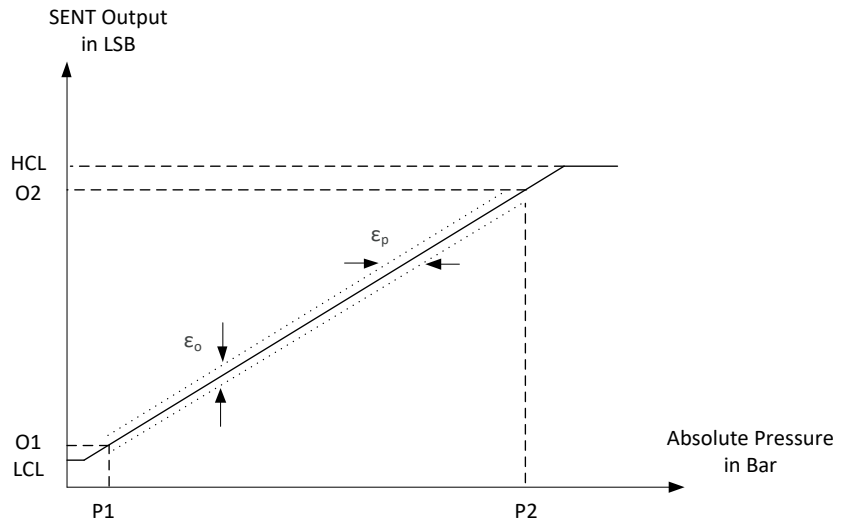


Figure 6: Pressure transfer function description at room temperature

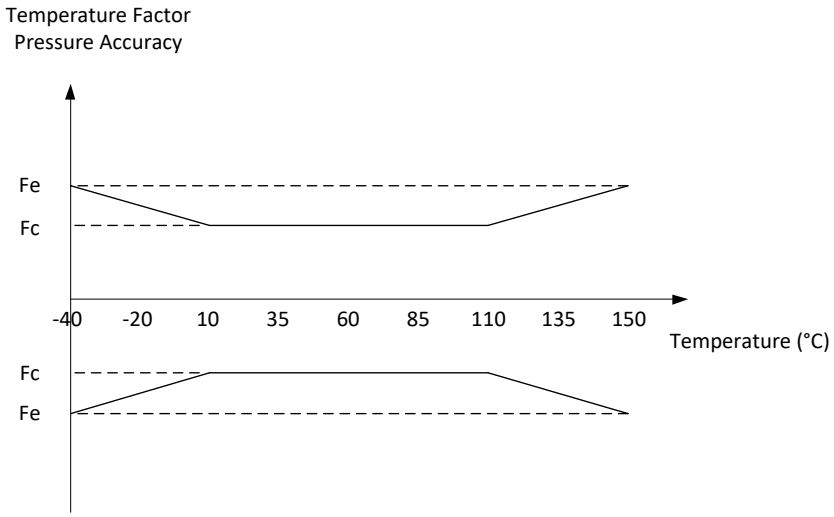


Figure 7: Pressure accuracy temperature factor

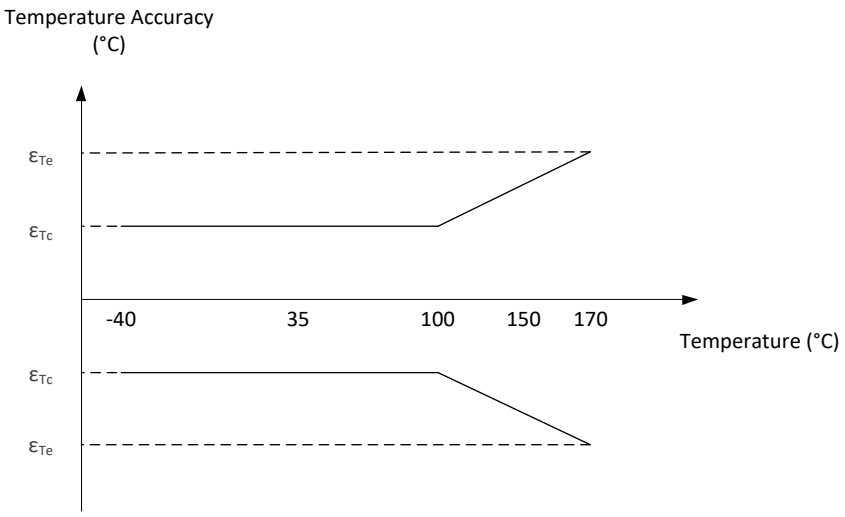


Figure 8: NTC temperature accuracy

13.1. MLX90834LXG-DAH-003

Transfer Curve Parameter	Symbol	Remarks	Value	Unit
Pressure 1	P1	See Figure 6: Pressure transfer function description at room temperature	0	Bar
Pressure 2	P2		12	Bar
Output 1	O1		193	LSB
Output 2	O2		3896	LSB
Low clamping level	LCL		1	LSB
High clamping level	HCL		4088	LSB

Pressure Accuracy Parameter	Symbol	Remarks	Min	Typ.	Max	Unit
Output accuracy	ε_o	Overall accuracy expressed as output value (FS range from 193 to 3896)	-19 -0.5%		19 0.5%	LSB %FS
Pressure accuracy	ε_p	Overall accuracy expressed as pressure value	-60		60	mBar
Center temperature accuracy factor	Fc	See Figure 7: Pressure accuracy temperature factor			1	
Extended temperature accuracy factor	Fe				1.25	

NTC Accuracy Parameter	Symbol	Remarks	Min	Typ	Max	Unit
Center NTC temperature accuracy	ε_{Tc}	Overall accuracy using the default NTC as described in Table 13. See Figure 9.	-0.75		0.75	°C
Extended NTC temperature accuracy	ε_{Te}		-1		1	°C

Table 6: DAH-003 Default configuration

13.2. MLX90834LXG-DAF-004

Transfer Curve Parameter	Symbol	Remarks	Value	Unit
Pressure 1	P1	See Figure 6: Pressure transfer function description at room temperature	0	Bar
Pressure 2	P2		36	Bar
Output 1	O1		193	LSB
Output 2	O2		3896	LSB
Low clamping level	LCL		1	LSB
High clamping level	HCL		4088	LSB

Pressure Accuracy Parameter	Symbol	Remarks	Min	Typ.	Max	Unit
Output accuracy	ε_o	Overall accuracy expressed as output value (FS range from 193 to 3896)	-19 -0.5%		19 0.5%	LSB %FS
Pressure accuracy	ε_p	Overall accuracy expressed as pressure value	-180		180	mBar
Center temperature accuracy factor	Fc	See Figure 7: Pressure accuracy temperature factor			1	
Extended temperature accuracy factor	Fe				1.25	

NTC Accuracy Parameter	Symbol	Remarks	Min	Typ	Max	Unit
Center NTC temperature accuracy	ε_{Tc}	Overall accuracy using the default NTC as described in Table 13. See Figure 9.	-0.75		0.75	°C
Extended NTC temperature accuracy	ε_{Te}		-1		1	°C

Table 7: DAF-004 Default configuration

14. SENT Configuration

The SENT output is designed to be compliant with the SAE J2716 rev. Apr 2016 SENT standard. The tick time can be configured between 2.667us and 20us. 3 us tick time is configured as default for the option codes listed in this datasheet. An optional pause pulse can also be enabled to have a fixed frame length. This frame length is configurable and has a maximum of 420 ticks/SENT frame. The default configuration is 282 ticks.

14.1. Shorthand definitions of default configurations

The SENT standard SAE J2716 defines a shorthand format that specifies the most important characteristics of the implemented SENT protocol. They are specified in Table 8.

Option code	Shorthand definition of programmed configuration
DAH-003, DAF-004	SENT2016-03.0us-6dn-ppc(282.0)-esp-ns

Table 8: Shorthand definitions for product options.

14.2. Fast Channel Configuration

On the fast channel 7 different options are available to configure channel 1 and channel 2. An overview of these different options and how to configure them can be found in Table 9.

FC_CFG setting	Fast Channel 1	Fast Channel 2	Remark	Default Configuration[8]
0	Pressure (3x 4 bit)	NTC temperature (3x 4 bit)		DAH-003, DAF-004
1	Pressure (3x 4 bit)	Internal temperature (3x 4 bit)	PTAT temperature	
2	Pressure (3x 4 bit)	Reverse pressure (3x 4 bit)		
3	Pressure (3x 4 bit)	0 (3x 4 bit)		
4	Pressure (3x 4 bit)	Rolling counter (2x 4bit) and Inverted MSN of pressure (1x 4bit)	Secure sensor	
5	Pressure only (3x 4 bit)	/		
6	Pressure high speed (4x 3 bit)	/		

Table 9: Fast channel configuration options

[8] *MLX90834 Option Code default configuration*

14.3. Slow Channel Configuration

The Slow Serial Channel is implemented according to the Enhanced Serial Message Format using 12 bit data and 8 bit message ID as described in the reference SENT protocol standard SAE J2716 rev. Apr 2016.

The MLX90834 offers a large number of available slow channel messages. Some of these messages have a pre-defined ID as they are advised by the SENT standard, for example MID29-2C, MID01, MID03, MID10, MID23, … On top of these messages which are already partially pre-defined, another 24 full configurable messages are available.

Following SENT messages are transmitted as default setting in the option codes listed in this datasheet.

MID	Description	Data in message		
		DAH-003	DAF-004	
0x01	Diagnostic codes	Diagnostic code (See 14.4 Diagnostics)		
0x03	Sensor Type	Data = 7		
0x06	SENT revision	Data = 4		
0x07	Fast channel 1 Characteristic X1	0x0		
0x08	Fast channel 1 Characteristic X2	0x643	0x3C4	0x125
0x09	Fast channel 1 Characteristic Y1	0xC1		
0x0A	Fast channel 1 Characteristic Y2	0xF38		
0x23	Internal Temperature	According to default linear temperature transfer characteristic in SAE J2716 standard		
0x29	Sensor ID #1	Melexis ID#1		
0x2A	Sensor ID #2	Melexis ID#2		
0x2B	Sensor ID #3	Melexis ID#3		
0x2C	Sensor ID #4	Melexis ID#4		

Table 10: Slow Channel messages

The order of transmission of these messages is like in the table above. After transmission of the list, the sequence is repeated.

14.4. Diagnostics

he MLX90834 product has several internal checks which monitor the status of device. For each of the 16 errors the Fast and Slow channel diagnostic message can be specified. The default settings for DAF-003 and DAH-004 are given in Table 11.

Error category	Slow Channel Diagnostic code	Default			
		Status FC1	Status FC2	FC1	FC2
Pressure related internal error	3	1	0	4090	U
NTC temperature related internal error	6	0	0	U	U
Internal temperature related internal error	1036	1	0	U	U
Other internal error	2565	1	0	U	U
Supply too low error	32	1	0	U	U
Supply too high error	33	1	0	U	U
Medium temperature out of range high error	4	0	0	U	U
Medium temperature out of range low error	5	0	0	U	U
SENT fast channel 1 clamp high error	1	1	0	N/A	
SENT fast channel 1 out of range high error		0	0		
SENT fast channel 1 clamp low error	2	1	0		
SENT fast channel 1 out of range low error		0	0		
SENT fast channel 2 clamp high error	4	0	0		
SENT fast channel 2 out of range high error		0	0		
SENT fast channel 2 clamp low error	5	0	0		
SENT fast channel 2 out of range low error		0	0		

Table 11: Fast and slow channel mapping for diagnostics. U = Unchanged, the value in the Fast Channel is not overwritten by an error code.

15. NTC Temperature Linearization

A thermistor can be optionally connected to the MLX90834. The read resistance is converted to a temperature reading in the MLX90834 and can be transmitted over SENT.
The NTC readout circuit measures the resistance between the NTC_input and NTC_Ground pins. It converts this resistance to a temperature value using the default programmed Steinhart-Hart coefficients in Table 12. The corresponding default NTC characteristic can be found in Table 13. This table matches the 20k NTC from the TDK G1551 series (B57551G1203+000). To suit other NTCs, the device can be programmed with different Steinhart-Hart coefficients using the PTC04 software.

Steinhart-Hart coefficients	Value
A	$\frac{4090}{2^{22}}$
B	$\frac{15600}{2^{26}}$
C	$\frac{1357}{2^{34}}$

Table 12: Default programmed Steinhart-Hart coefficients

T (°C)	R (Ω)	T (°C)	R (Ω)
-55	1953500	75	2935.8
-50	1358600	80	2490.2
-45	956760	85	2121.4
-40	681860	90	1814.62
-35	491520	95	1558.32
-30	358180	100	1343.36
-25	263720	105	1162.32
-20	196124	110	1009.24
-15	147242	115	879.34
-10	111552	120	768.7
-5	85250	125	674.14
0	65696	130	593.02
5	51034	135	523.24
10	39948	140	463.02
15	31500	145	410.86
20	25016	150	365.58
25	20000	155	326.14
30	16094.4	160	291.7
35	13032.6	165	261.54
40	10616.8	170	235.06
45	8698.8	175	211.76
50	7166.8	180	191.2
55	5936.2	185	173
60	4942.2	190	156.872
65	4135.2	195	142.538
70	3476.2	200	129.774

Table 13: Default NTC characteristic

16. Application Information

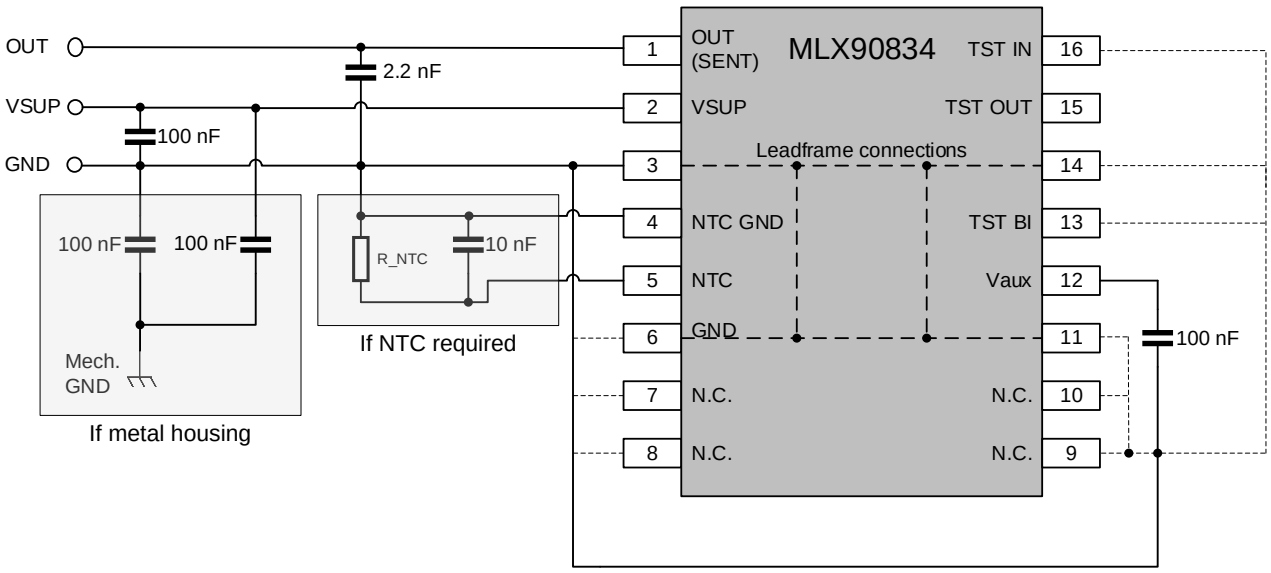


Figure 9: Basic application schematic. The black lines are absolutely needed connections, the grey lines are recommended connections for better EMC performance.

These recommendations for external components are only providing a basic protection. Depending on the module design and the EMC speciation requirements different configurations can be needed.

The NTC is optional. In case an external NTC is required: keep the NTC_GND line separate from the ground plane, except close to the NTC itself. If no NTC is required: both NTC_GND and NTC should be shorted to ground.

17. Package, IC handling and assembly

17.1. Package information

SYMBOL	ALL DIMENSION ARE IN MILLIMETERS MINIMUM	NOMINAL	MAXIMUM	NOTES
A	2.23	2.33	2.43	
A1	−0.15	−0.1	−0.05	
A2	2.23	2.33	2.43	
b	0.31	0.41	0.51	
c	0.234	0.254	0.274	
D	10.13	10.2	10.27	2,4
E	7.4	7.5	7.6	3,4
H	10	10.3	10.6	3,4
e		1.27 BSC		
L	0.74	0.84	0.94	
K		0.6 REF		
θ1	0°	–	8°	
θ2	9°	14°	19°	
θ3	9°	14°	19°	
θ4	0°	–	10°	

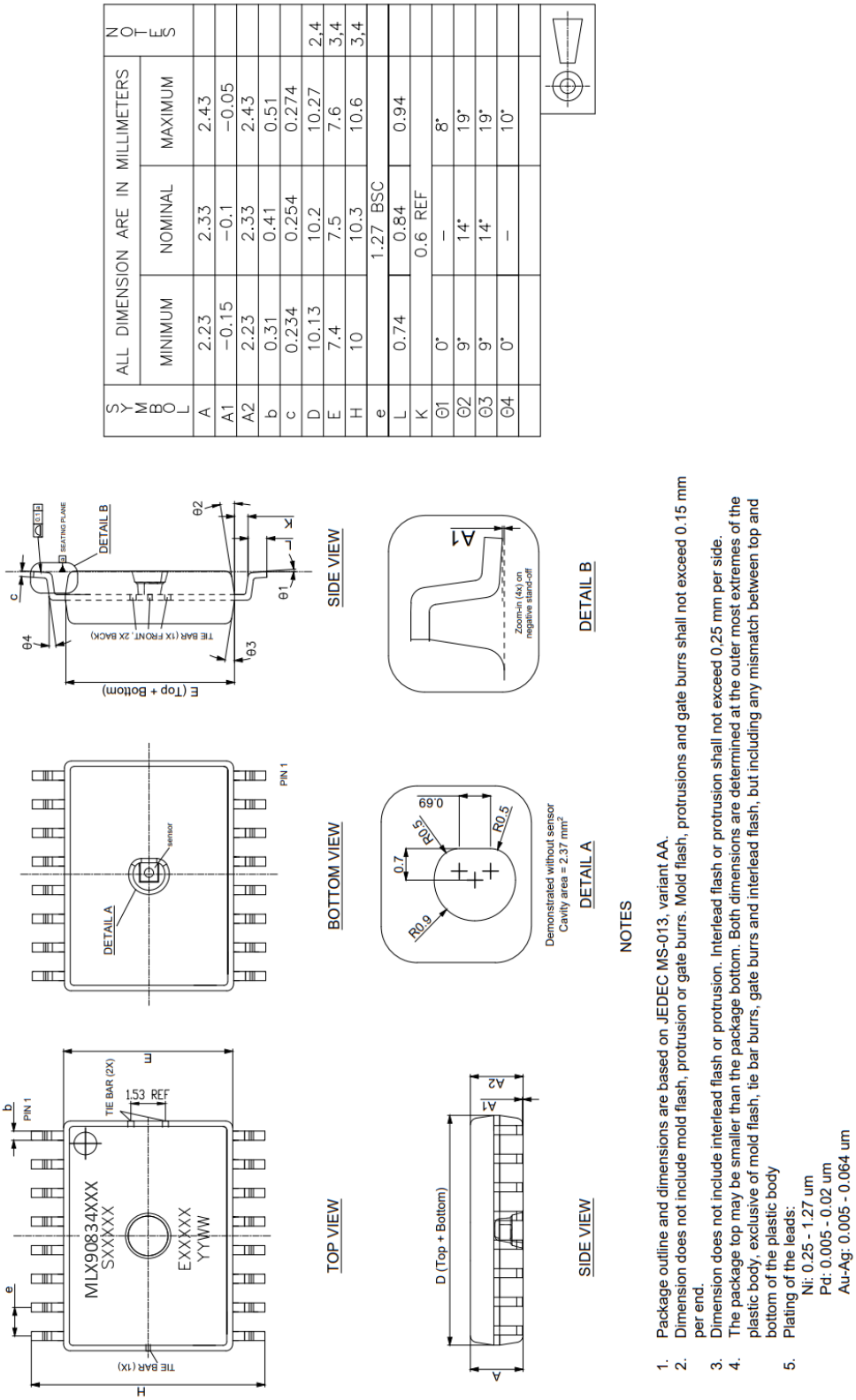


Figure 10: MLX90834 package drawing

17.2. Storage and handling of plastic encapsulated ICs

Plastic encapsulated ICs shall be stored and handled according to their MSL categorization level (specified in the packing label) as per J-STD-033.

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD). The component assembly shall be handled in EPA (Electrostatic Protected Area) as per ANSI S20.20.

For more information refer to Melexis *Guidelines for storage and handling of plastic encapsulated ICs* [9]

17.3. Assembly of encapsulated ICs

It is highly recommended to avoid the use of any flux cleaner with this open-cavity product. We recommend utilizing a No-Clean soldering process to ensure optimal performance and reliability. Please refer to Soldering and Welding[10]. For further guidance in case any other solder is needed, please consult Melexis directly for additional recommendations.

For Surface Mounted Devices (SMD, as defined according to JEDEC norms), the only applicable soldering method is reflow.

For Through Hole Devices (THD), the applicable soldering methods are reflow, wave, selective wave and robot point-to-point. THD lead pre-forming (cutting and/or bending) is applicable under strict compliance with Melexis *Guidelines for lead forming of SIP Hall Sensors* [9].

Melexis products soldering on PCB should be conducted according to the requirements of IPC/JEDEC and J-STD-001. Solder quality acceptance should follow the requirements of IPC-A-610.

For PCB-less assembly refer to the relevant application notes [9] or contact Melexis.

Electrical resistance welding or laser welding can be applied to Melexis products in THD and specific PCB-less packages following the *Guidelines for welding of PCB-less devices*[9].

Environmental protection of customer assembly with Melexis products for harsh media application, is applicable by means of coating, potting or overmolding considering restrictions listed in the relevant application notes [9]

For other specific process, contact Melexis via www.melexis.com/technical-inquiry

[9] www.melexis.com/ic-handling-and-assembly

[10] *https://www.melexis.com/en/tech-info/ic-handling-and-assembly/soldering-and-welding*

17.4. Environment and sustainability

Melexis is contributing to global environmental conservation by promoting non-hazardous solutions. For more information on our environmental policy and declarations (RoHS, REACH…) visit www.melexis.com/environmental-forms-and-declarations

18. ESD Precautions

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

19. Disclaimer

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