1. Features and Benefits

- Triphibian™ technology
- 0.5%FS accuracy absolute pressure sensor
- Absolute pressure ranges from 2bar to 70bar in gas and/or liquid media (12bar and 36bar range default available)
- Factory calibrated or fully programmable through the connector for customized calibration curves at customer's side
- LIN output with available compensated NTC temperature information
- Option for LIN 2.x, ISO 17987, LIN 1.3 or SAE J2602
- LIN Auto-Addressing with Bus Shunt Method 2
- Deep sleep mode with max 50µA current consumption
- 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, LIN transceiver
- Large automotive temperature range (-40°C to 150°C)
- Robust in gas and liquid media, compliant with chemical refrigerants and coolants
- Automotive qualified and automotive diagnostic features (multiple programmable internal fault diagnostics)
- ASIL compliant developed as an ASIL B SEooC as per ISO 26262 for pressure signal

2. Application Examples

- Thermal Management of Electric Vehicles
  - Standalone sensors
  - Embedded sensors in expansion valves
  - Embedded sensors in e-compressors
  - Embedded sensors in pumps
- HVAC-R systems

Figure 1: MLX90833

3. Ordering information

Product Code	Temperature Code	Package Code	Option Code	Packing Form Code
MLX90833	L	XZ	BAE-003	RE
MLX90833	L	XZ	BAF-002	RE

Legend:
Temperature Code: L (-40°C to 150°C)
Package Code: XZ = SOIC16 WB cavity package
Option Code: BAE-003 = 0 to 12bar absolute pressure / 193 to 3896LSB LIN output / NTC / ISO 17987
BAF-002 = 0 to 36bar absolute pressure / 193 to 3896LSB LIN output / NTC / ISO 17987
Packing Form: RE = Reel
Ordering example: MLX90833LXZ-BAF-002-RE

MLX90833LXZ-BAE-003-RE

- Packing delivery form
- Option code for variant
- Silicon & firmware version
- Package code
- Temperature code
- Product name

4. Package Diagram

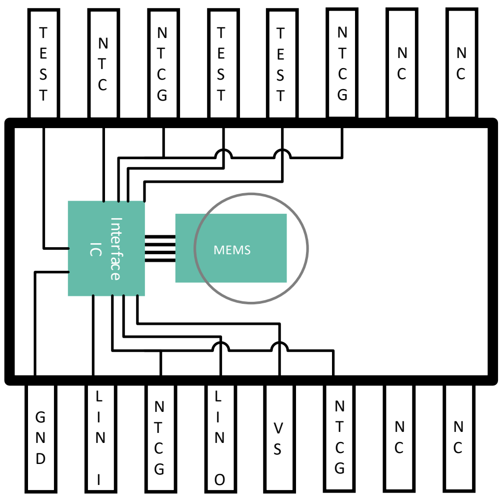


Figure 2: Internal wiring of the MLX90833. Top view. Pressure cavity is on the top side.

5. General Description

The MLX90833 is a packaged, factory calibrated, absolute pressure sensor measuring spans from 2 to 70 bar. It outputs the pressure and temperature information over a digital LIN protocol; supporting communications up to 20 kb/s.
The MLX90833 consists of a MEMS pressure sensor element and an interface chip (CMOS technology). An external NTC can be connected for a fast and highly accurate temperature reading of the medium.
This optimized solution integrated on a PCB exhibits excellent EMC performance. The DSP based signal interface provides outstanding accuracy over life. 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
ASIC	Application specific integrated circuit, the interface IC
ASIL	Automotive Safety Integrity Level
Bar	Pressure unit (1bar = 100kPa)
DSP	Digital Signal Processor
EEPROM	Electrically erasable programmable read-only memory
EMC	Electro Magnetic Compatibility
ESD	Electrostatic discharge
FS	Output Full Scale = O2 – O1
GND	Ground connection
LIN	Local Interconnect Network: a digital serial protocol
LSB	Least Significant Bit
MEMS	Micro-ElectroMechanical System, the die with the pressure sensitive element
NC	Not Connected
NTC	Negative Temperature Coefficient thermistor
NTCG	NTC_GND pin: should be connected to the ground pin of the external NTC
NVM	Non-volatile 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
SEooC	Safety Element out of Context
T_A	Ambient temperature
TEST	Test pin
T_{MEMS}	Temperature sensor measurement on the MEMS die. Also called TEMP_MEDIUM.
UV	Under Voltage
Vsup	Supply pin

Table 1: Glossary of terms

7. Absolute Maximum Ratings

Parameter	Value	Units	Max duration
Supply Voltage (overvoltage)	45	V	1s
Reverse Supply Voltage Protection	-0.5	V	2h
Output voltage (overvoltage)	45	V	1s
	27	V	2h
Reverse output voltage	-45	V	1s
Operating Temperature Range	-40 to 150	°C	
Storage Temperature Range	-40 to 150	°C	
Programming Temperature Range	-40 to 125	°C	
LIN auto-addressing temperature range	0 to 50	°C	
LIN Auto-addressing mode supply range	9 to 15	V	
Proof pressure	3x P2	Bar	
Burst pressure	5x P2	Bar	
Max voltage on NTC pin	-0.2 to 2	V	Max 1 minute at Ta = 25°C

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.

8. Pin Definitions and Descriptions

Pin number	Description	Pin number	Description
1	Not connected	9	GND
2	Not connected	10	LIN_IN
3	NTC_GND (connected to leadframe)	11	NTC_GND (connected to leadframe)
4	Test	12	LIN_OUT
5	Test	13	VS (external supply)
6	NTC_GND (connected to leadframe)	14	NTC_GND (connected to leadframe)
7	NTC_IN	15	Not connected
8	Test	16	Not connected

Table 3: Pinout definitions and descriptions

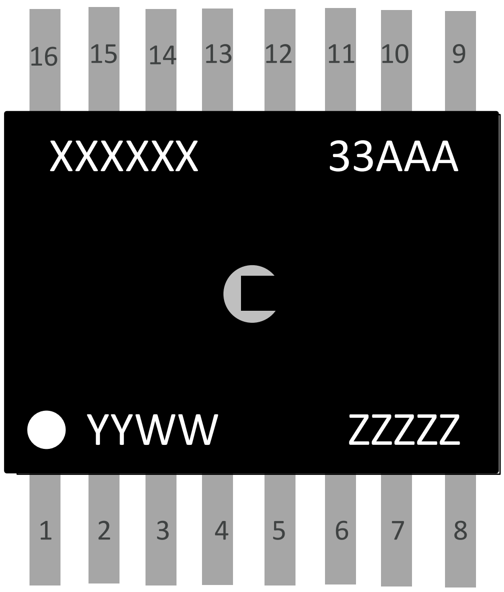


Figure 3: Package marking (Top view)

Symbol	Function / Description
XXXXXX	ASIC lot number
ZZZZZ	Assembly lot number
YY	Year of assembly
WW	Calendar week of assembly
AAA	MEMS and ASIC traceability letter (BAE/BAF)

Table 4:Package marking definition

9. General Electrical Specifications

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

Parameter	Remarks	Min	Typ.[1]	Max	Units
Nominal supply voltage		6	12	18	V
Nominal supply current	No output load, no NTC connected		9	15	mA
Current consumption in deep sleep mode	No output load, no NTC connected		10	50	µA
Start-up time	Time from power on until start of first frame with all status bits cleared and remain cleared (valid data)		22	30	ms
Wake-up time deep sleep mode	Time from end of wake-up pulse until start of first frame with all status bits cleared and remain cleared (valid data)		16	30	ms
Pressure response time (fast mode)[2]	With filtering disabled			5	ms
Pressure output update time	Internal update time of pressure			2.5	ms
Pressure output noise	With default filter settings			4	LSB pk-pk
On chip temperature accuracy	On chip PTAT temperature	-10		10	°C
On chip temperature update time				50	ms
MEMS temperature accuracy	Temperature sensor on MEMS die	-10		10	°C
MEMS temperature update time				50	ms
NTC temperature update time	External NTC temperature sensor			50	ms
NTC Temperature noise	For the default filter settings			4	LSB pk-pk
NTC Temperature response time[3]	For the default filter settings		0.1	0.25	s
NTC resistive range		20		1M	Ω
Under-voltage detection range	Programmable value. See also section 13.4.1. Disabled in the default configuration	4.1		9.1	V
Over-voltage detection range	Programmable value. See also section 13.4.1. Disabled in the default configuration	22		40	V

Table 5: Electrical specifications

[1] *Typical values are defined at TA = +25°C and VDD = 12V.*
[2] *Time between pressure step at pressure input pins until output is settled within spec.*
[3] *Time between temperature step at NTC input pins until output is settled within spec.*

10. Detailed General Description

The MLX90833 contains a pressure sensing element which 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. On the same die, there is a temperature sensor that senses the temperature of the medium it is exposed to (T_{MEMS}).

The electronics front-end amplifies the signal from the bridge, performs an offset compensation and an ADC conversion. The DSP performs the compensation over temperature and linearization. Furthermore, the digital circuit provides some filtering and implements the clamping function. This chip delivers a LIN output that can be configured in many formats. Next to the pressure information, it is possible to transmit linearized and calibrated temperature information measured by an external NTC thermistor, the T_{MEMS} and the on-chip temperature (the internal temperature). An analog interface is available for the temperature sensors and the 16-bit DSP performs the calibration and linearization of the measured temperature signals.
Extensive protection of the supply lines allows the MLX90833 to handle overvoltage conditions and is immune to severe external disturbances. Several diagnostic functions (over-voltage, under-voltage, pressure out of range, internal error etc.) have been implemented on the 90833 and can be enabled by programming EEPROM settings. Figure 4 describes the MLX90833 block diagram.

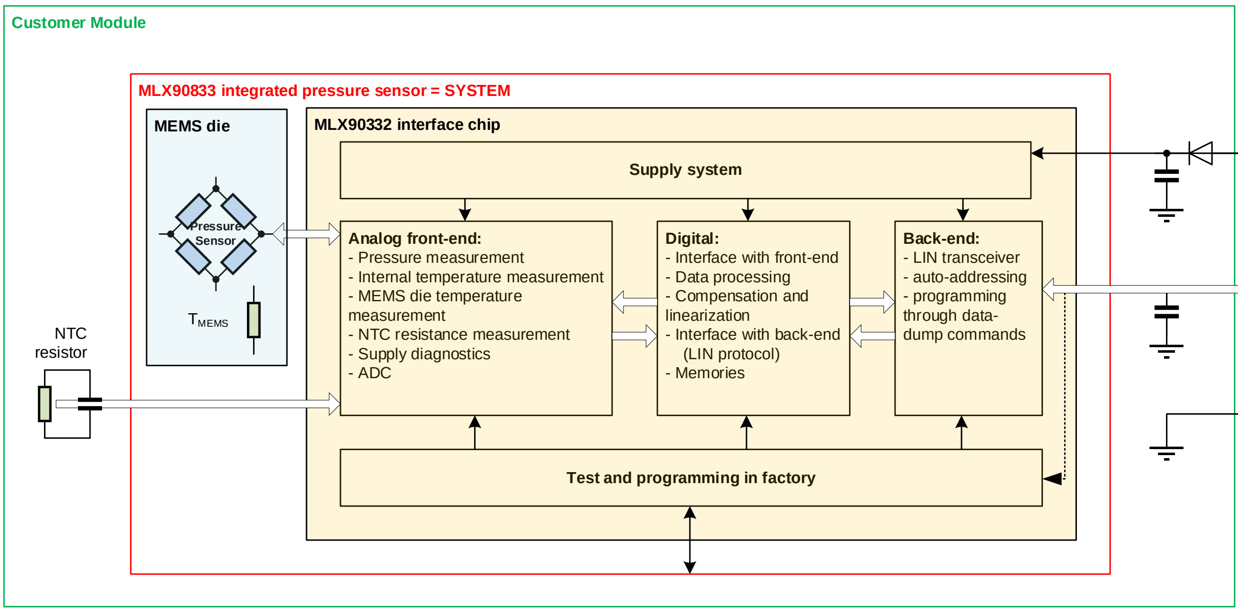


Figure 4: MLX90833 Block diagram

11. Default programmed settings

The MLX90833 is calibrated in the final step of manufacturing. During the calibration, settings are stored in the chip's EEPROM, defining the pressure transfer curve. Besides pressure, the internal temperature and optionally the NTC temperature calibrations are performed. The default temperature coding can be found in the graph of Figure 5. The LIN parameters and the digital filter values are also configured.

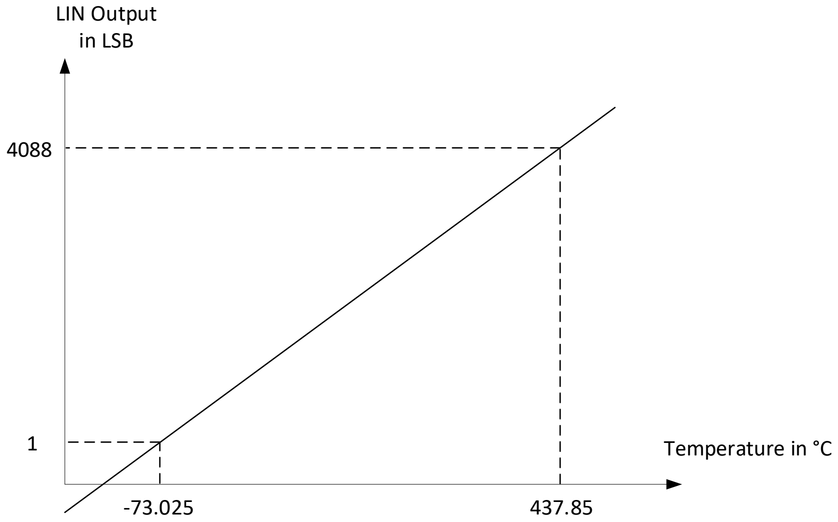


Figure 5: NTC, internal temperature and T_{MEMS} default transfer function. This curve is the default setting. It can be changed through settings in the non-volatile memory.

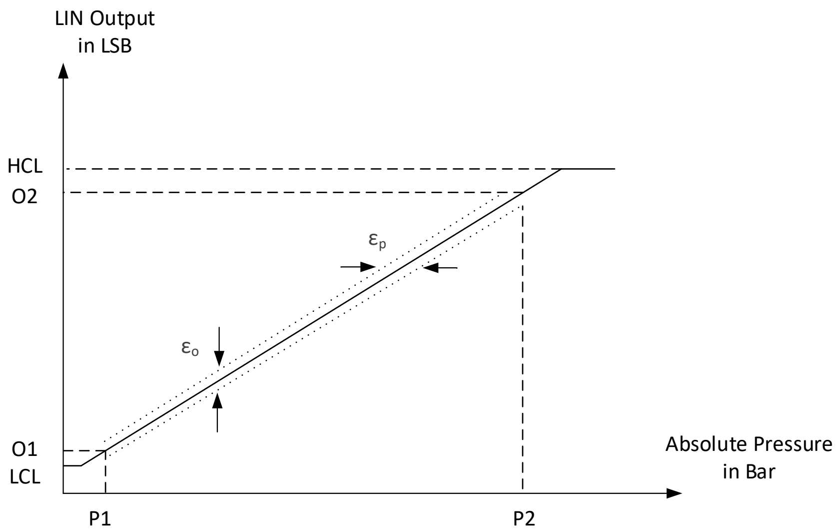


Figure 6: Pressure transfer function description at room temperature

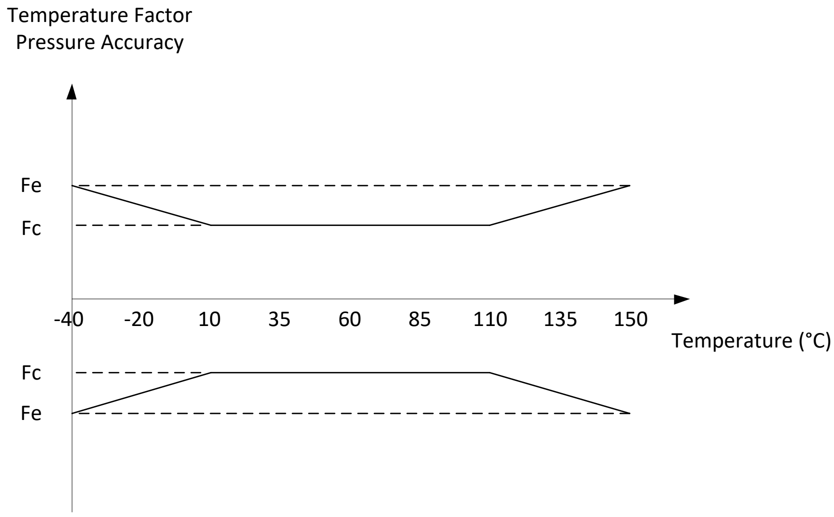


Figure 7: Pressure accuracy temperature factor

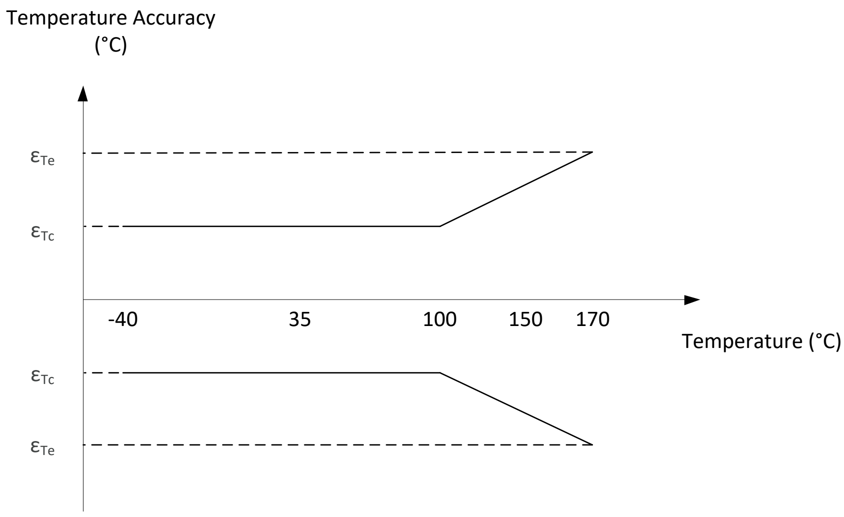


Figure 8: NTC temperature accuracy

11.1. MLX90833LXZ-BAE-003

Transfer Curve Parameter	Symbol	Remarks	Value			Unit
Pressure 1	P1		0			Bar
Pressure 2	P2		12			Bar
Output 1	O1		193			LSB
Output 2	O2		3896			LSB
Low clamping level	LCL		0			LSB
High clamping level	HCL		4095			LSB
Pressure Accuracy Parameter	**Symbol**	**Remarks**	**Min**	**Typ.**	**Max**	**Unit**
Output accuracy	ε_o	For center temperature region	-19 0.5		19 0.5	LSB %FS
Pressure accuracy	ε_p	For center temperature region	-60		60	mBar
Center temperature accuracy factor	Fc	See Figure 7: Pressure accuracy temperature factor			1	
Extended temperature accuracy factor	Fe				1.5	
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 16	-0.75		0.75	°C
Extended NTC temperature accuracy	ε_{Te}	See Figure 8: NTC temperature accuracy	-1		1	°C
LIN programmed settings	**Symbol**	**Remarks**	**Decimal**		**Hexadecimal**	
Node address	NAD		1		0x1	
Initial node address	iNAD		1		0x1	
Frame id 1 / Protected frame id 1	FID1		7		0x7	
	PID1		71		0x47	
Frame id 2 / Protected frame id 2	FID2		8		0x8	
	PID2		8		0x8	

Table 6: BAE-003 default configuration

Note:
Output accuracy: Overall accuracy expressed as output value (FS range from 193 to 3896). Pressure accuracy: Overall accuracy expressed as pressure value.

11.2. MLX90833LXZ-BAF-002

Transfer Curve Parameter	Symbol	Remarks	Value	Unit
Pressure 1	P1		0	Bar
Pressure 2	P2		36	Bar
Output 1	O1		193	LSB
Output 2	O2		3896	LSB
Low clamping level	LCL		0	LSB
High clamping level	HCL		4095	LSB

Pressure Accuracy Parameter	Symbol	Remarks	Min	Typ.	Max	Unit
Output accuracy	ε_o	For center temperature region	-19 -0.5		19 0.5	LSB %FS
Pressure accuracy	ε_p	For center temperature region	-180		180	mBar
Center temperature accuracy factor	Fc	See Figure 7: Pressure accuracy temperature factor			1	
Extended temperature accuracy factor	Fe				1.5	

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 16	-0.75		0.75	°C
Extended NTC temperature accuracy	ε_{Te}	See Figure 8: NTC temperature accuracy	-1		1	°C

LIN programmed settings	Symbol	Remarks	Decimal	Hexadecimal
Node address	NAD		1	0x1
Initial node address	iNAD		1	0x1
Frame id 1 / Protected frame id 1	FID1		7	0x7
	PID1		71	0x47
Frame id 2 / Protected frame id 2	FID2		8	0x8
	PID2		8	0x8

Table 7: BAF-002 default configuration

Note:
Output accuracy: Overall accuracy expressed as output value (FS range from 193 to 3896).
Pressure accuracy: Overall accuracy expressed as pressure value.

12. Digital

The digital is built around a 16-bit microcontroller. It contains, besides the processor, the 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.
Both for gain and offset of the pressure signal, there is a separate temperature dependency programmable ranging from a temperature independence to a first order, second order and finally 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 without a temperature dependency or with a first order temperature dependency through EEPROM parameters L0 and L1.
The higher order the compensation, the more accurate the sensor will be.
Linearization of the NTC temperature is also covered partially by the microcontroller. More information in this topic can be found in chapter 14.

13. LIN interface

This IC is a fully integrated LIN Slave for applications in the automotive environment. It can be configured to be suitable for bus systems according to:

- ISO 17987
- LIN 2.x
- SAE J2602
- LIN 1.3

13.1. Technical specs

The technical specs are according to the LIN standard. The baud rate and slew rate are configurable.

13.2. Functional description

Following features are available

- The checksum can be configured to be compliant with LIN 1.3 or 2.x (classic or enhanced checksum)
- Auto baud rate feature available
- Assign NAD and conditional change NAD
- Read by identifier
- Auto addressing: Slave Node Position Detection (SNPD) during LIN Auto-Addressing (AA) according to the Bus Shunt Method 2.
- Sleep mode and wake-up
- Byte echo mode
- SAE J2602 specific features
    - Targeted reset command
    - NAD and PID relationship

13.2.1. Checksum configuration

The device can be configured to use either the classical checksum (compliant with LIN 1.x) or the enhanced checksum (compliant with LIN 2.x).

13.2.2. Baud rate setting and automatic baud rate detection

The baud rate can be configured in NVM to be 1-20kbps with 2^{15} possible values.

Alternatively, the automatic baud rate detection can be enabled. In this case, the device will detect the used baud rate from the synchronization field of the master upon reset or when waking up. This baud rate will then be used to respond to the header.

13.2.3. Assign NAD

If the device receives a master request frame with following content:

NAD	PCI	SID	D1	D2	D3	D4	D5
Initial NAD	0x06	0xB2	Supplier ID LSB	Supplier ID MSB	Function ID LSB	Function ID MSB	New NAD

It will store the new NAD in temporary memory and use it as the new NAD. It will respond with a positive response. The initial NAD is configurable in NVM and can be programmed using LIN data dump commands.

When the device is configured to be in compliance with the SAE J2602, the NAD will not be changed when it is not conforming the requirements described in section 5.9 of SAE J2602.

13.2.4. Read by identifier

If the device receives a master request frame with following content:

NAD	PCI	SID	D1	D2	D3	D4	D5
NAD	0x06	0xB2	**Identifier**	Supplier ID LSB	Supplier ID MSB	Function ID LSB	Function ID MSB

The device will respond in a slave response frame. The response is dependent on the identifier of the master request according to Table 8. Next to the read by identifier commands that are mandatory in the LIN standard, there are also 5 fully configurable read by identifier messages. Contact Melexis if you have a specific requirement for these messages.
There can be other frames between the master request frame and the slave response frame (e.g. unconditional fames), but no other diagnostic frames.

Master request	Slave response							
Identifier field	NAD	PCI	RSID	D1	D2	D3	D4	D5
0	NAD	0x06	0xF2	Supplier ID LSB	Supplier ID MSB	Function ID LSB	Function ID MSB	configurable
1	NAD	0x05	0xF2	Serial number 7-0	Serial number 15-8	Serial number 23-16	Serial number 31-24	0xFF
Configurable range 32 tot 63	NAD	configurable	0xF2	Custom data of configurable length				

Table 8: Read by identifier positive response frames, dependent on the identifier field in the master request.

13.2.5. Conditional change NAD (LIN2.x)

If the device receives a master request frame with following content:

NAD	PCI	SID	D1	D2	D3	D4	D5
NAD/0x7F	0x06	0xB3	identifier	Byte selection	mask	invert	New NAD

It will retrieve the needed data to respond to a 'read by identifier'-command with D1 as identifier. It will select from the payload of this response the byte selected by D2. It will perform a bitwise XOR with D4 and a bitwise AND with D3. If the result is 0, the D5 is stored in temporary memory and used as new NAD. The device responds with a positive response.

When the device is configured to be in compliance with the SAE J2602, the NAD will not be changed when it is not conforming the requirements described in section 5.9 of SAE J2602.

13.2.6. LIN Auto-addressing

To assign to all devices on a bus a unique NAD without having to pre-program them, auto-addressing is used. Lin auto-addressing according to the Bus Shunt Method 2 is available in the MLX90833. This method requires the slave devices to be connected in a daisy chain type configuration as can be seen in Figure 9.

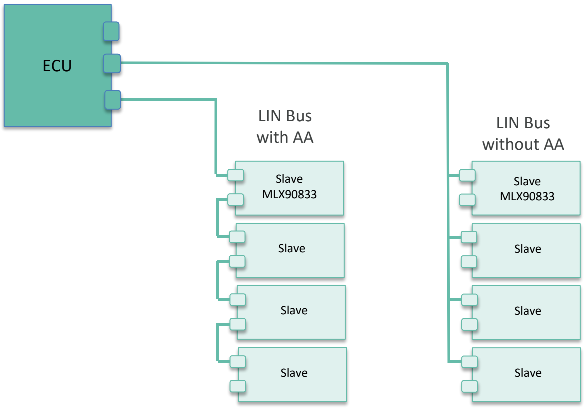


Figure 9: Schematic for the MLX90833 in a bus with and without auto-addressing

The LIN auto-addressing (LINAA) block allows to push a current to the LININ pin and to sense the voltage over a shunt resistor connected between the LININ and LINOUT pins, as shown in Figure 10.

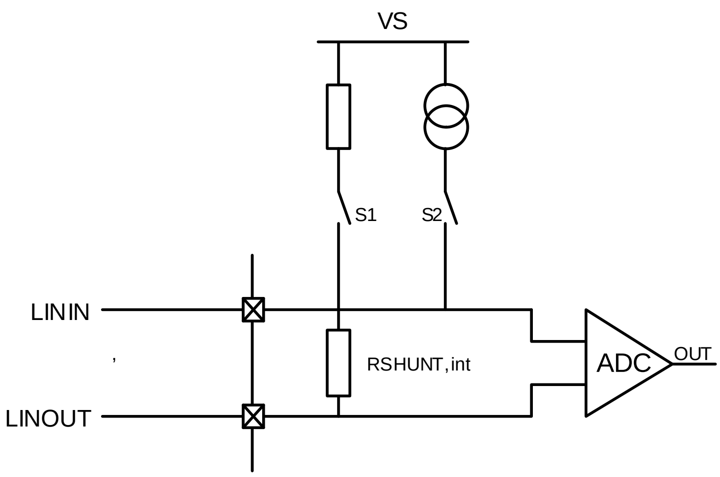


Figure 10: Internal schematic of LINAA block

The shunt resistor is an internal shunt resistor. The voltage over the shunt resistor is measured by the internal ADC. The ADC conversion results are used to assess the level of the auto-addressing current through the shunt resistor.

Slave Node Position Detection is done by measuring the current through the shunt resistor during the break field (when the master pulls the bus low). The unaddressed slave that is located farthest from the master (so with the least amount of current flowing to its shunt resistor) will get a new NAD first. The procedure is repeated multiple times until all slaves get a new NAD.

The device supports the necessary frames to allow auto-addressing using the Bus Shunt Method. The SID of the frames is either 0xB5 and 0xB8. For the SAE J2602 it should be 0xB8 and 0xB5 is explicitly not supported as auto-addressing.

When receiving below frame, the device enters auto-addressing mode. Note that the device needs 1 ms to enter the auto-addressing mode. The inter-frame space should be minimally 1 ms between below frame and the Next NAD (Sub 0x02) frame.

NAD	PCI	SID	D1	D2	D3	D4	D5
0x7F	0x06	0xB5/0xB8	0xFF	0x7F	**0x01**	0xF1	0xFF

When receiving below frame, the last AA-slave on the bus stores D5 in temporary memory and uses it as new NAD.

NAD	PCI	SID	D1	D2	D3	D4	D5
0x7F	0x06	0xB5/0xB8	0xFF	0x7F	**0x02**	0xF1	New NAD

When receiving below frame, the device writes the NAD in temporary memory to NVM.

NAD	PCI	SID	D1	D2	D3	D4	D5
0x7F	0x06	0xB5/0xB8	0xFF	0x7F	**0x03**	0xF1	0xFF

When receiving below frame, the device resets and disables the auto-addressing mode. The AA-BSM routine is finished. Upon receiving, the device resets and will not respond for 20 ms due to start-up.

NAD	PCI	SID	D1	D2	D3	D4	D5
0x7F	0x06	0xB5/0xB8	0xFF	0x7F	**0x04**	0xF1	0xFF

13.2.7. Sleep mode and wake-up

If the master sends a go-to sleep command, the device will go to sleep mode. The bus will be set to the recessive state.

PID	D1	D2	D3	D4	D5	D6	D7	D8
0x3C	0	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

The device will also enter sleep mode when the bus is inactive for more than 4 seconds. When the bus is forced high to the dominant state for 250 µs to 5 ms and returns to the recessive state, the device will wake up.

There are two different sleep modes that can be used. Which sleep mode is used, can be configured by writing the setting into the NVM of the device. Both behave the same from the master's perspective, but the activity in the device is different:

Parameter	Description	Current draw [mA]		Wake-up time [ms]	
		Typ.	Max	Typ.	Max
Deep sleep mode	Most parts of the IC are turned off, minimizing power and maximizing life-time	0.01	0.05		30
Active sleep mode	All parts of IC functional	9	15	10	20

13.2.8. Byte echo mode

For LIN compliance test purposes, the byte echo mode is available.

13.2.9. SAE J2602 specific features

13.2.9.1. Targeted reset command

In compliance with the SAE J2602 specification, the device will reset and set the reset flag upon receiving below message:

PID	D1	D2	D3	D4	D5	D6	D7	D8
0x3C	NAD	0x01	0xB5	0xFF	0xFF	0xFF	0xFF	0xFF

13.2.9.2. NAD and PID relationship

In the SAE J2602 variant of the device the NAD should be configured in the range 0x60 to 0x6D.

The PID is limited dependent on the NAD in compliance with the SAE J2602 standard. The MSNibble of NAD is fixed to 0x6.

The PID is limited to a certain range depending on its NAD. In each command that reassigns the NAD, it is checked to be sure it starts with 0x6. In each command that reassigns the PID, the change is rejected if it is not allowed by the NAD in memory. See the table below for allowed PID – NAD combinations.

Table 9: possible PIDs for every NAD when device is configured to SAE J2602 compliance. Note the MLX90833 has only 2 configurable PIDs.

Possibility 1		Possibility 2		Possibility 3	
NAD	PID	NAD	PID	NAD	PID
0x60	0x00	0x60	0x00	0x60	0x00
	0x01		0x01		0x01
	0x02		0x02		0x02
	0x03		0x03		0x03
0x61	0x04		0x04		0x04
	0x05		0x05		0x05
	0x06		0x06		0x06
	0x07		0x07		0x07
0x62	0x08	0x62	0x08		0x08
	0x09		0x09		0x09
	0x0A		0x0A		0x0A
	0x0B		0x0B		0x0B
0x63	0x0C		0x0C		0x0C
	0x0D		0x0D		0x0D
	0x0E		0x0E		0x0E

	0x0F		0x0F		0x0F
0x64	0x10	0x64	0x10	0x64	0x10
	0x11		0x11		0x11
	0x12		0x12		0x12
	0x13		0x13		0x13
0x65	0x14		0x14		0x14
	0x15		0x15		0x15
	0x16		0x16		0x16
	0x17		0x17		0x17
0x66	0x18	0x66	0x18		0x18
	0x19		0x19		0x19
	0x1A		0x1A		0x1A
	0x1B		0x1B		0x1B
0x67	0x1C		0x1C		0x1C
	0x1D		0x1D		0x1D
	0x1E		0x1E		0x1E
	0x1F		0x1F		0x1F
0x68	0x20	0x68	0x20	0x68	0x20
	0x21		0x21		0x21
	0x22		0x22		0x22
	0x23		0x23		0x23
0x69	0x24		0x24		0x24
	0x25		0x25		0x25
	0x26		0x26		0x26
	0x27		0x27		0x27
0x6A	0x28	0x6A	0x28		0x28
	0x29		0x29		0x29
	0x2A		0x2A		0x2A
	0x2B		0x2B		0x2B
0x6B	0x2C		0x2C		0x2C
	0x2D		0x2D		0x2D
	0x2E		0x2E		0x2E
	0x2F		0x2F		0x2F
0x6C	0x30	0x6C	0x30	0x6C	0x30
	0x31		0x31		0x31
	0x32		0x32		0x32
	0x33		0x33		0x33
0x6D	0x34		0x34	0x6D	0x34
	0x35		0x35		0x35
	0x36		0x36		0x36
	0x37		0x37		0x37
0x6E	No message IDs defined	0x6E	No message IDs defined	0x6E	No message IDs defined
0x6F	No message IDs defined	0x6F	No message IDs defined	0x6F	No message IDs defined

13.3. Available frame types and configuration

MLX90833 supports two types of frames: Unconditional frames and diagnostic frames. Other frame types are not supported.

13.3.1. Unconditional frames

Unconditional frames carry signals and their frame identifiers are in the range 0 to 59 (0x3B).
Two unconditional frames can be fully independently configured. Their configuration can be set in EEPROM parameters. They can be enabled or disabled separately and their length can be set to any number of bytes between 1 and 8 bytes.

Parameter	Min	Max
Frame 1 length	1	8
Frame 1 identifier	0	59
Frame 1 enable	0	1
Frame 2 length	1	8
Frame 2 identifier	0	59
Frame 2 enable	0	1

Table 10: configurable parameters for the unconditional frames

The number of data bytes can be set with a maximum of 8 data bytes. The displayed information in the data fields can be enabled or disabled separately. Possible information to be displayed in data fields (in order):

1.) 12-bit pressure output or 16-bit extended pressure output
2.) 12-bit temperature output 1 or 16-bit extended temperature output 1
3.) 12-bit temperature output 2 or 16-bit extended temperature output 2
4.) extra byte with diagnostic information
5.) extra bytes with data 0xFF to reach specified number of bytes

All data is displayed adjacent to each other, with the exception that the extra bytes (4-5) always start at as a new data byte. The optional four free bits in between the output fields (1-3) and the extra bytes are set to 1.
Four each temperature output there are three options:

- Interface die temperature
- MEMS die temperature
- NTC temperature

The extended versions of the output fields contain extra MSB's:

- 2 rolling counter bits + 2 parity bits (for even and odd bits of the data separately)
- 4 diagnostic bits to be selected from relevant diagnostic bits from section 13.4. Each bit can also be fixed to 0 or 1.

Examples of unconditional frame configurations:

PID	D1	D2	D3	D4	D5
0 -> 59 (configurable)	Pressure [0:11]	Press. diagn.	Internal temp. [0:11]	Temp. diagn.	0xFF

PID	D1	D2	D3	D4	D5
0 -> 59 (configurable)	Pressure [0:11]		Internal temp. [0:11]	Diagnostic byte	0xFF

PID	D1	D2		D3
0 -> 59 (configurable)	Pressure [0:11]	Counter [0:1]	Parity [0:1]	Diagnostic byte

In Table 11, all possibilities for the configuration of the payload sequence are given. The length is the total number of bytes that are transmitted (maximum of eight). The bit 'Diagnostic byte' enables or disables the diagnostic byte.
For the configuration of the T1, T2 (temperature) and P (pressure) channels following settings apply:

- 00: channel is disabled
- 01: enabled with 12 bits of output
- 10: enabled with 12 bits of output + 4 extra diagnostic bits
- 11: enabled with 12 bits of output + 2 bits counter + 2 bits parity

Length	Diagn byte	T2 config		T1 config		P config		Bits offset																
								64	60	56	52	48	44	40	36	32	28	24	20	16	12	8	4	0
1	0	0	0	0	0	0	0																	
2	0	0	0	0	0	0	1															P		
2	0	0	0	0	0	1	0														Pr	P		
2	0	0	0	0	0	1	1														Pr	P		
2	0	0	0	0	1	0	0															T1		
3	0	0	0	0	1	0	1												T1			P		
4	0	0	0	0	1	1	0											T1			Pr	P		
4	0	0	0	0	1	1	1											T1			Pr	P		
2	0	0	0	1	0	0	0														T1r	T1		
4	0	0	0	1	0	0	1											T1r	T1			P		
4	0	0	0	1	0	1	0										T1r	T1			Pr	P		
4	0	0	0	1	0	1	1										T1r	T1			Pr	P		
2	0	0	0	1	1	0	0														T1r	T1		
4	0	0	0	1	1	0	1											T1r	T1			P		
4	0	0	0	1	1	1	0										T1r	T1			Pr	P		
4	0	0	0	1	1	1	1										T1r	T1			Pr	P		
2	0	0	1	0	0	0	0															T2		
3	0	0	1	0	0	0	1												T2			P		
4	0	0	1	0	0	1	0											T2			Pr	P		
4	0	0	1	0	0	1	1											T2			Pr	P		
3	0	0	1	0	1	0	0												T2			T1		
5	0	0	1	0	1	0	1									T2			T1			P		
5	0	0	1	0	1	1	0								T2			T1			Pr	P		
5	0	0	1	0	1	1	1								T2			T1			Pr	P		
4	0	0	1	1	0	0	0											T2			T1r	T1		
5	0	0	1	1	0	0	1								T2			T1r	T1			P		
6	0	0	1	1	0	1	0							T2			T1r	T1			Pr	P		
6	0	0	1	1	0	1	1							T2			T1r	T1			Pr	P		

4	0	0	1	1	1	0	0											T2			T1r	T1		
5	0	0	1	1	1	0	1								T2			T1r	T1			P		
6	0	0	1	1	1	1	0							T2			T1r	T1			Pr	P		
6	0	0	1	1	1	1	1							T2			T1r	T1			Pr	P		
2	0	1	0	0	0	0	0														T2r	T2		
4	0	1	0	0	0	0	1											T2r	T2			P		
4	0	1	0	0	0	1	0										T2r	T2			Pr	P		
4	0	1	0	0	0	1	1										T2r	T2			Pr	P		
4	0	1	0	0	1	0	0											T2r	T2			T1		
5	0	1	0	0	1	0	1								T2r	T2			T1			P		
6	0	1	0	0	1	1	0							T2r	T2			T1			Pr	P		
6	0	1	0	0	1	1	1							T2r	T2			T1			Pr	P		
4	0	1	0	1	0	0	0										T2r	T2			T1r	T1		
6	0	1	0	1	0	0	1							T2r	T2			T1r	T1			P		
6	0	1	0	1	0	1	0						T2r	T2			T1r	T1			Pr	P		
6	0	1	0	1	0	1	1						T2r	T2			T1r	T1			Pr	P		
4	0	1	0	1	1	0	0										T2r	T2			T1r	T1		
6	0	1	0	1	1	0	1							T2r	T2			T1r	T1			P		
6	0	1	0	1	1	1	0						T2r	T2			T1r	T1			Pr	P		
6	0	1	0	1	1	1	1						T2r	T2			T1r	T1			Pr	P		
2	0	1	1	0	0	0	0														T2r	T2		
4	0	1	1	0	0	0	1											T2r	T2			P		
4	0	1	1	0	0	1	0										T2r	T2			Pr	P		
4	0	1	1	0	0	1	1										T2r	T2			Pr	P		
4	0	1	1	0	1	0	0											T2r	T2			T1		
5	0	1	1	0	1	0	1								T2r	T2			T1			P		
6	0	1	1	0	1	1	0							T2r	T2			T1			Pr	P		
6	0	1	1	0	1	1	1							T2r	T2			T1			Pr	P		
4	0	1	1	1	0	0	0										T2r	T2			T1r	T1		
6	0	1	1	1	0	0	1							T2r	T2			T1r	T1			P		
6	0	1	1	1	0	1	0						T2r	T2			T1r	T1			Pr	P		
6	0	1	1	1	0	1	1						T2r	T2			T1r	T1			Pr	P		
4	0	1	1	1	1	0	0										T2r	T2			T1r	T1		
6	0	1	1	1	1	0	1							T2r	T2			T1r	T1			P		
6	0	1	1	1	1	1	0						T2r	T2			T1r	T1			Pr	P		
6	0	1	1	1	1	1	1						T2r	T2			T1r	T1			Pr	P		
1	1	0	0	0	0	0	0																D	
3	1	0	0	0	0	0	1												D		f	P		
3	1	0	0	0	0	1	0												D		Pr	P		
3	1	0	0	0	0	1	1												D		Pr	P		
3	1	0	0	0	1	0	0												D		f	T1		
4	1	0	0	0	1	0	1										D		T1			P		
5	1	0	0	0	1	1	0								D		f	T1			Pr	P		
5	1	0	0	0	1	1	1								D		f	T1			Pr	P		
3	1	0	0	1	0	0	0												D		T1r	T1		
5	1	0	0	1	0	0	1								D		f	T1r	T1			P		
5	1	0	0	1	0	1	0								D		T1r	T1			Pr	P		
5	1	0	0	1	0	1	1								D		T1r	T1			Pr	P		
3	1	0	0	1	1	0	0												D		T1r	T1		
5	1	0	0	1	1	0	1								D		f	T1r	T1			P		
5	1	0	0	1	1	1	0								D		T1r	T1			Pr	P		
5	1	0	0	1	1	1	1								D		T1r	T1			Pr	P		
3	1	0	1	0	0	0	0												D		f	T2		
5	1	0	1	0	0	0	1										D		T2			P		

6	1	0	1	0	0	1	0								D		f	T2			Pr	P		
6	1	0	1	0	0	1	1								D		f	T2			Pr	P		
4	1	0	1	0	1	0	0										D		T2			T1		
6	1	0	1	0	1	0	1						D		f	T2			T1			P		
6	1	0	1	0	1	1	0						D		T2			T1			Pr	P		
6	1	0	1	0	1	1	1						D		T2			T1			Pr	P		
5	1	0	1	1	0	0	0								D		f	T2			T1r	T1		
6	1	0	1	1	0	0	1						D		T2			T1r	T1			P		
7	1	0	1	1	0	1	0				D		f	T2			T1r	T1			Pr	P		
7	1	0	1	1	0	1	1				D		f	T2			T1r	T1			Pr	P		
5	1	0	1	1	1	0	0								D		f	T2			T1r	T1		
6	1	0	1	1	1	0	1						D		T2			T1r	T1			P		
7	1	0	1	1	1	1	0				D		f	T2			T1r	T1			Pr	P		
7	1	0	1	1	1	1	1				D		f	T2			T1r	T1			Pr	P		
3	1	1	0	0	0	0	0												D		T2r	T2		
5	1	1	0	0	0	0	1								D		f	T2r	T2			P		
5	1	1	0	0	0	1	0								D		T2r	T2			Pr	P		
5	1	1	0	0	0	1	1								D		T2r	T2			Pr	P		
5	1	1	0	0	1	0	0								D		f	T2r	T2			T1		
6	1	1	0	0	1	0	1						D		T2r	T2			T1			P		
7	1	1	0	0	1	1	0				D		f	T2r	T2			T1			Pr	P		
7	1	1	0	0	1	1	1				D		f	T2r	T2			T1			Pr	P		
5	1	1	0	1	0	0	0								D		T2r	T2			T1r	T1		
7	1	1	0	1	0	0	1				D		f	T2r	T2			T1r	T1			P		
7	1	1	0	1	0	1	0				D		T2r	T2			T1r	T1			Pr	P		
7	1	1	0	1	0	1	1				D		T2r	T2			T1r	T1			Pr	P		
5	1	1	0	1	1	0	0								D		T2r	T2			T1r	T1		
7	1	1	0	1	1	0	1				D		f	T2r	T2			T1r	T1			P		
7	1	1	0	1	1	1	0				D		T2r	T2			T1r	T1			Pr	P		
7	1	1	0	1	1	1	1				D		T2r	T2			T1r	T1			Pr	P		
3	1	1	1	0	0	0	0												D		T2r	T2		
5	1	1	1	0	0	0	1								D		f	T2r	T2			P		
5	1	1	1	0	0	1	0								D		T2r	T2			Pr	P		
5	1	1	1	0	0	1	1								D		T2r	T2			Pr	P		
5	1	1	1	0	1	0	0								D		f	T2r	T2			T1		
6	1	1	1	0	1	0	1						D		T2r	T2			T1			P		
7	1	1	1	0	1	1	0				D		f	T2r	T2			T1			Pr	P		
7	1	1	1	0	1	1	1				D		f	T2r	T2			T1			Pr	P		
5	1	1	1	1	0	0	0								D		T2r	T2			T1r	T1		
7	1	1	1	1	0	0	1				D		f	T2r	T2			T1r	T1			P		
7	1	1	1	1	0	1	0				D		T2r	T2			T1r	T1			Pr	P		
7	1	1	1	1	0	1	1				D		T2r	T2			T1r	T1			Pr	P		
5	1	1	1	1	1	0	0								D		T2r	T2			T1r	T1		
7	1	1	1	1	1	0	1				D		f	T2r	T2			T1r	T1			P		
7	1	1	1	1	1	1	0				D		T2r	T2			T1r	T1			Pr	P		
7	1	1	1	1	1	1	1				D		T2r	T2			T1r	T1			Pr	P		

Table 11: possible configurations for an unconditional frame and the resulting transmission. Note that the length in bytes will be transmitted; some padding of 1s might be added. The bytes are transmitted from the right to the left (LSB to MSB).

13.3.1.1. SAE J2602 version

With the SAE J2602 version enabled, the status byte (as defined in the SAE J2602 standard) is always sent as first byte of the unconditional frame. It can be fully configured with the bits from section 13.4 (except LIN response error), but will be the same in both of the unconditional messages.

The rest of the frame is configured like in the normal mode. The data in Table 11 is then shifted by 8 bits.

Bit 7 (MSB)	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 (LSB)
Comm. Error	Reset flag	Configurable from Table 12					

13.3.2. Diagnostic frames

The diagnostic frames are limited to node-configuration services (diagnostic class I). They are defined in section 13.2 (read by identifier, change NAD, conditional change NAD).
The 90833 supports PDUs with PCI-type as Single Frame, meaning the slave response will be all in one frame with 5 bytes of data.

13.4. Diagnostics

There is a total of 14 internal diagnostic signals available, see Table 12 for the available signals. Each of these can be outputted

- on each bit of the two, configurable unconditional frames in:
  - The extended pressure output (4 diagnostic bits to be configured)
  - The extended temperature output (4 diagnostic bits to be configured)
  - The diagnostic byte (8 diagnostic bits to be configured)
- In a 'read by identifier' configurable diagnostic frame (see section 13.2.4).

In addition to a diagnostic signal, every diagnostic bit above can also be permanently be set to 0 or 1.

Error name	Description
LIN response error	Like defined in LIN 2.2. set whenever a frame contains an error in the frame response.
Global error	Can be any aggregation of below errors. Mask to be configured in EEPROM parameter.
Pressure error	Pressure related error.
Pressure out of range	Pressure output of predefined range.
Pressure output not refreshed	Only applicable as a response to a sampling command in sampling mode. The response with this error indicates that the pressure output is not up-to-date.
Temperature error (for each temperature separately)	Interface die temperature error
	MEMS die temperature error
	NTC read-out error
Temperature out of range (for each temperature separately)	Interface die temperature out of predefined range
	MEMS die temperature out of predefined range
	NTC read-out out of predefined range
Supply too low	Under-voltage detection
Supply too high	Over-voltage detection
Internal error	Other internal error

Table 12: Available internal diagnostics

13.4.1. Over- and undervoltage diagnostic settings

The over- and undervoltage detection diagnostic can be configured via settings in the non-volatile memory of the device. The detection level is different depending on if it is a rising or falling supply voltage. The undervoltage diagnostic is reported when the voltage falls below the fall level and is cleared when the supplied voltage rises again above the rise level. The overvoltage diagnostic is reported when the voltage rises above the rise level and is cleared when it falls below the fall level. There is some device dependence on the exact level; this is captured in the tolerance.

Undervoltage detection options			
Setting	Fall [V]	Rise [V]	Maximum tolerance [V]
0	4.10	4.60	±0.2
1	5.10	5.60	±0.2
2	6.10	6.60	±0.25
3	7.10	7.60	±0.3
4	8.10	8.60	±0.3
5	9.10	9.60	±0.35
6..7	disabled		/

Table 13: undervoltage detection options

Overvoltage detection options			
Setting	Rise [V]	Fall [V]	Maximum tolerance [V]
0	22	20	±1
1	24	22	±1
2	40	38	±1
3	disabled		

Table 14: overvoltage detection options

14. NTC Temperature Linearization

A thermistor can be optionally connected to the MLX90833. The read resistance is converted to a temperature reading in the MLX90833 and can be transmitted over LIN.
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 15. The corresponding default NTC characteristic can be found in Table 16. This table matches the thermistor TDK B57551G1103F000. To suit other NTCs, the device can be programmed with different Steinhart-Hart coefficients using the PTC04 software. The default Steinhart-Hart coefficients are programmed in BAE-003 and BAF-002.

Steinhart-Hart coefficients	Value
A	$\frac{3564}{2^{22}}$
B	$\frac{17506}{2^{26}}$
C	$\frac{2237}{2^{34}}$

Table 15: Default programmed Steinhart-Hart coefficients

T (°C)	R (Ω)	T (°C)	R (Ω)
-55	526524	75	1882
-50	384619	80	1629
-45	284035	85	1416
-40	211940	90	1235
-35	159712	95	1081
-30	121491	100	948.9
-25	93248	105	835.7
-20	72185	110	738.2
-15	56338	115	654.0
-10	44314	120	581.0
-5	35117	125	517.6
0	28028	130	462.3
5	22523	135	414.0
10	18218	140	371.7
15	14828	145	334.5
20	12142	150	301.7
25	10000	155	272.7
30	8281	160	247.0
35	6894	165	224.3
40	5769	170	204.0
45	4851	175	186.0
50	4098	180	169.8
55	3478	185	155.4
60	2965	190	142.4
65	2538	195	130.8
70	2181	200	120.3

Table 16: Default NTC characteristic

15. Application Information

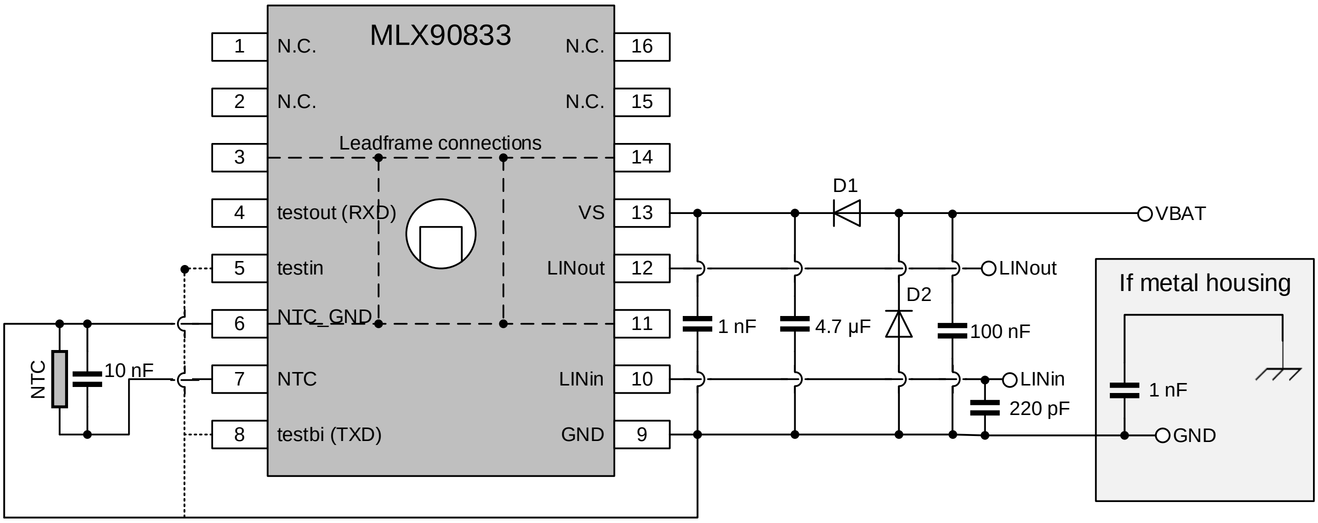


Figure 11: Application schematic with auto-addressing: both LIN IN and LIN OUT

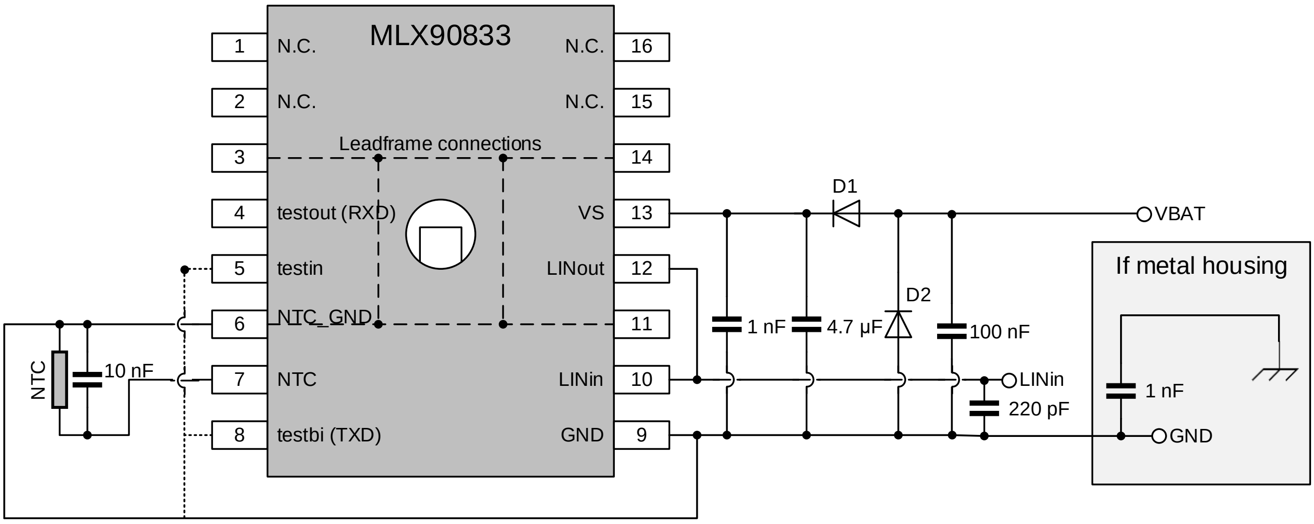


Figure 12: Application schematic with only one LIN pin. The LIN OUT pin should be shorted to the LIN IN pin close to the IC.

15.1. PCB guidelines

1.) Ground signal for NTC should be connected to GND close to chip side (pin 9). Looking from outside into the connector, the ground should first be connected to all capacitors to the connector pins, before it goes to the chip (pin 9) and the NTC. It should also go first to the NTC and its capacitor, before it is connected to pin 6 (NTC_GND).

2.) The NTC capacitor should be close to the NTC thermistor.

3.) The connections between the NTC thermistor and pin 6 & 7 of the chip should be not longer than needed.

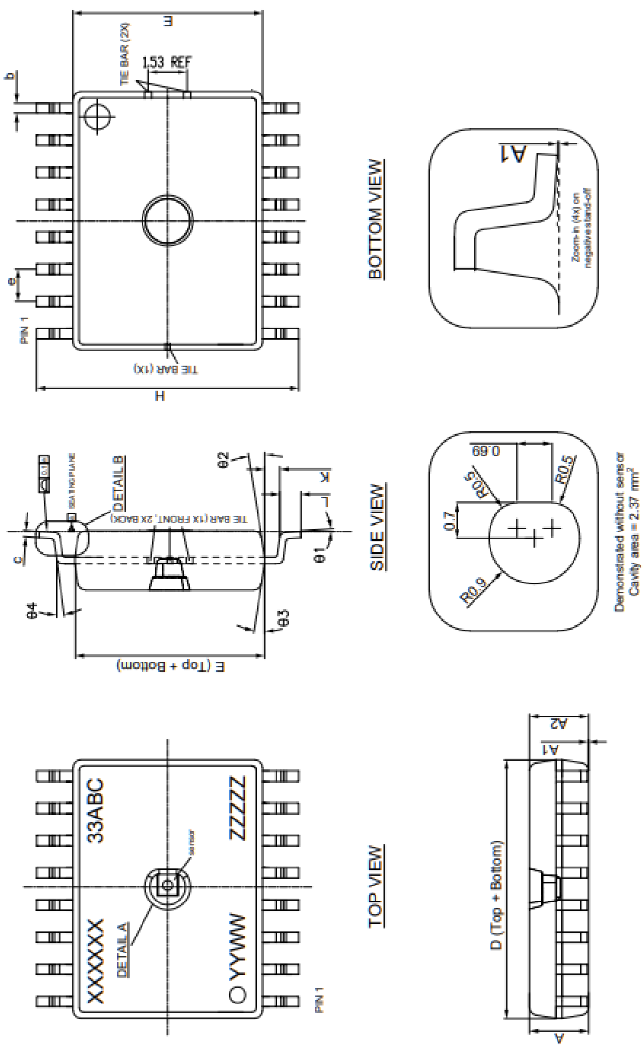
4.) Pins 1, 2, 5, 8, 15 and 16 should be shorted to ground for robustness. Test pin 4 should not be connected.

5.) If the NTC is not used, pin 7 and 6 should be shorted to ground.

16. Package, IC handling and assembly

16.1. Package information

SYMBOL	MINIMUM	NOMINAL	MAXIMUM	NOTES
	ALL DIMENSION ARE IN MILLIMETERS			
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°	



NOTES

1. Package outline and dimensions are based on JEDEC MS-013, variant AA.
2. Dimension does not include mold flash, protrusion or gate burrs. Mold flash, protrusions and gate burrs shall not exceed 0.15 mm per end.
3. Dimension does not include interlead flash or protrusion. Interlead flash or protrusion shall not exceed 0,25 mm per side.
4. The package top may be smaller than the package bottom. Both dimensions are determined at the outer most extremes of the plastic body, exclusive of mold flash, tie bar burrs, gate burrs and interlead flash, but including any mismatch between top and bottom of the plastic body
5. Plating of the leads:
   Ni: 0.25 - 1.27 um
   Pd: 0.005 - 0.02 um
   Au-Ag: 0.005 - 0.064 um

Figure 13: MLX90833 package drawing

16.2. 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* (4)

16.3. 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*[5]. 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* (4).

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 (4) 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*(4).

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 (4)

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

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

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

16.4. 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*

17. ESD Precautions

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

18. Appendix: LDF of sensor versions

Both sensor versions in the datasheet have the same LDF.

```
/* This LDF is generated automatically for development purposes only. Melexis does not take any responsibility
for its reliability. Adapt it to your needs before distributing.*/
LIN_description_file;
LIN_protocol_version = "2.2";
LIN_language_version = "2.2";
LIN_speed = 19.2 kbps;
Nodes
{
    Master: LIN_master, 5 ms, 1 ms;
    Slaves: MLX_slave;
}
Signals
{
    PRESS: 12, 4095, MLX_slave, LIN_master;
    PRESS_COUNTER: 2, 0, MLX_slave, LIN_master;
    PRESS_PARITY: 2, 0, MLX_slave, LIN_master;
    TEMP_MEDIUM: 12, 4095, MLX_slave, LIN_master;
    TEMP_MEDIUM_DIAG: 4, 0, MLX_slave, LIN_master;
    FR1_DIAG: 7, 0, MLX_slave, LIN_master;
    LIN_RESPONSE_ERROR: 1, 0, MLX_slave, LIN_master;
    TEMP_INTERFACE: 12, 4095, MLX_slave, LIN_master;
    TEMP_INTERFACE_COUNTER: 2, 0, MLX_slave, LIN_master;
    TEMP_INTERFACE_PARITY: 2, 0, MLX_slave, LIN_master;
    TEMP_NTC: 12, 4095, MLX_slave, LIN_master;
    TEMP_NTC_DIAG: 4, 0, MLX_slave, LIN_master;
}
Frames
{
    FR_1: 7, MLX_slave, 5
    {
        PRESS, 0;
        PRESS_COUNTER, 12;
        PRESS_PARITY, 14;
        TEMP_MEDIUM, 16;
        TEMP_MEDIUM_DIAG, 28;
        FR1_DIAG, 32;
        LIN_RESPONSE_ERROR, 39;
    }
    FR_2: 8, MLX_slave, 4
    {
        TEMP_INTERFACE, 0;
        TEMP_INTERFACE_COUNTER, 12;
        TEMP_INTERFACE_PARITY, 14;
        TEMP_NTC, 16;
        TEMP_NTC_DIAG, 28;
    }
}
```

```
Node_attributes
{
    MLX_slave
    {
        LIN_protocol = "2.2";
        configured_NAD = 1;
        initial_NAD = 1;
        product_id = 19, 1281;
        response_error = LIN_RESPONSE_ERROR;
        configurable_frames
        {
            FR_1;
            FR_2;
        }
    }
}
Schedule_tables {
    normal_mode
    {
        FR_1 delay 10.0 ms;
        FR_2 delay 10.0 ms;
    }
}
Signal_encoding_types
{
    EncTemperatureINT
    {
        physical_value, 0, 4095, 0.125, -73.15, "degC";
    }
    EncTemperatureNTC
    {
        physical_value, 0, 4095, 0.125, -73.125, "degC";
    }
    EncTemperatureMEDIUM
    {
        physical_value, 0, 4095, 0.125, -73.15, "degC";
    }
}
Signal_representation
{
    EncTemperatureINT: TEMP_INTERFACE;
    EncTemperatureNTC: TEMP_NTC;
    EncTemperatureMEDIUM: TEMP_MEDIUM;
}
```

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