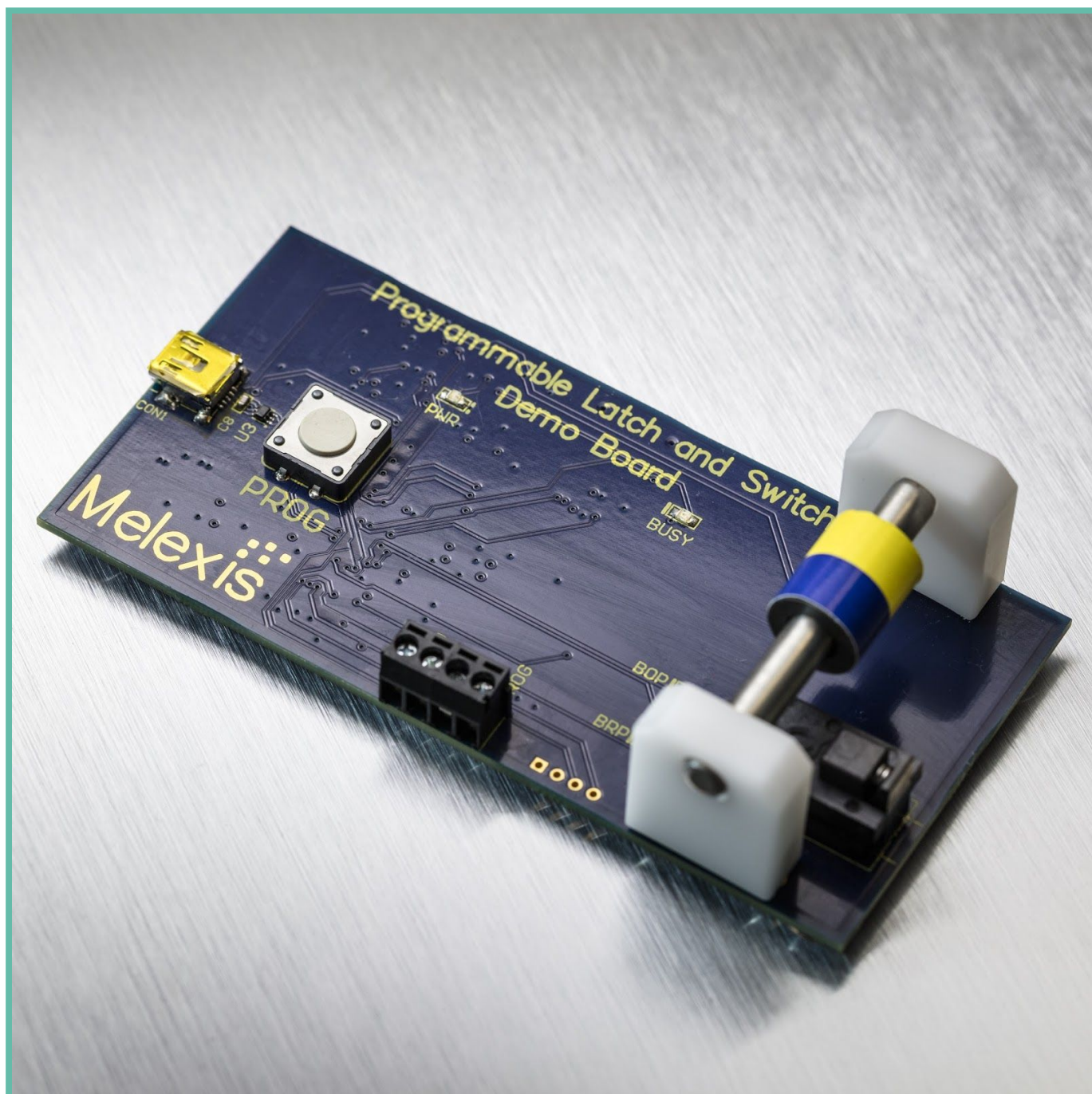# Application Note

Getting started with the Latch & Switch Evaluation Board/Demo Board

Melexis

Portable Latch & Switch (L&S) Evaluation / Demo and Programmer Board

Supporting MLX92292, MLX92232, MLX92242

www.melexis.com

Application Note

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Abbreviation and Definitions

Air gap	Distance between Magnet and the sensor surface, typically in mm
ASIL B	Automotive Safety Integrity Level B Grade
B	Magnetic field, expressed in mt
Bop	Magnetic field of operation point, expressed in mT
Brp	Magnetic field of release point, expressed in mT
DUT	Device under test
DB_922xx	Daughter board, used together with PTC04
EVB	Evaluation Board
Hysteresis	Bop-Brp
PTC-04	Programming Through Connector (Melexis universal programmer)
SMD	Surface Mounted Device
UI	User Interface
T_{op}	Programmable operating period
T_{tick}	Programmable "Output Ticking" repetition period
t_{tick}	Programmable "Output Ticking" duration
$T_{ACT\_D_{on}}$	Active phase duration, diagnostic On
$T_{ACT\_D_{off}}$	Active phase duration, diagnostic Off

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Recommended reading

The following documents are advised to consult throughout this text.

Melexis Programmable Latch & Switch Datasheets and usermanuals:

- MLX92292 Datasheet
- MLX92242 Datasheet   / software user manual
- MLX92232 Datasheet   / software user manual

General Application Note for Latch & Switch applications:

- Application note L/S

Scope

The scope of this application note concentrates around the ways in how to get started with this EVB by guiding customers in how to properly set up and get around with, both the hardware, and software related functionalities. Further this document will focus on the MLX92292 related key aspects and elaborate more on application related knowhow.

This purpose of this application note is to help the user to understand the functionality of this EVB / Demo Board. The EVB can be used for quick evaluation/demonstration of Melexis programmable L&S products, both for 2-wire and 3-wires products MLX92292, MLX92232 and MLX92242. It can also be used for small volume programming, when the costs for acquiring the Melexis Programmable Toolbox (PTC-04) + Daughterboard are too high for the project.

The EVB922xx is a compact and versatile board that the customer can use to have a first and fast investigation of MLX922xx behaviour and functionalities. The customer can even use this EVB to trim MLX922x2 parameters directly on module level. It also allows the customer to measure some parameters, such as supply current, output voltage and external magnetic field for a quick evaluation.

EVB922xx v.s. PTC-04 + DB922xx:

The table 1 below shows a comparison between this EVB and the tools used for mass programming (PTC-04 and 922xx DB).

Table 1 - Comparison between EVB922xx and mass production tools PTC-04 + DB

Comparison	EVB922xx	PTC04 + DB_922x2
Functionality	Evaluation, demonstration, measurements, low volume programming	Mass production tool
Cost	range <100€	range >100€
Robustness	low-volume programming, bench- test programming	Mass production

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Installation steps Evaluation Board/Demo Board

All software versions can be downloaded from the Melexis Softdist Server http://softdist.melexis.com. Please login and ask your local sales representable to grant you access to the Melexis PTC-04 folder. You can also apply for a softdist account by sending a mail to sales_europe@melexis.com if you don't have a softdist account.

Once downloaded, one can find In the PTC-04 folder the Evaluation Board (EVB) / Demo Board 922xx folder which contains a installation package (compressed zip-file). Unpack this package, and the following files will be available to you:
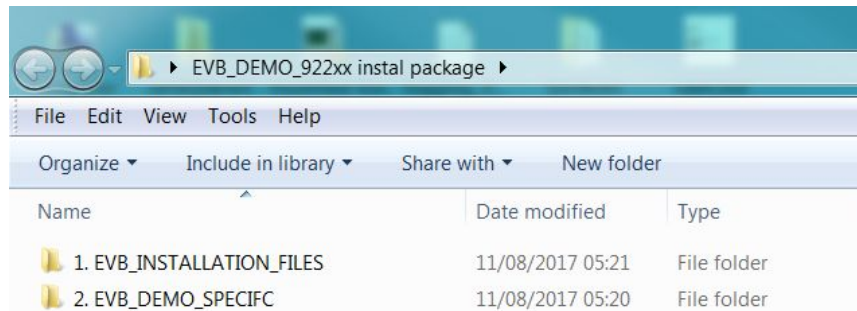

Figure 1 - content of the installation package

The software package contains two folder:

- **EVB_INSTALLATION_FILES: Contains general information regarding the EVB-platform**

    - First Install: PSF00EVBA AMLX (general library used by the EVB)
    - Location: EVB_DEMO_922xx instal package → 1. EVB_INSTALLATION_FILES → Soft → PSF

- **EVB_DEMO_SPECIFIC: Contains specific information that extends the EVB-platform w/ Demo functionality**

    - Second upload: LS_EVB_FIRMWARE (specific firmware developed firmware)
    - Third run: Either the Demo executable for MLX92292 or MLX922xx
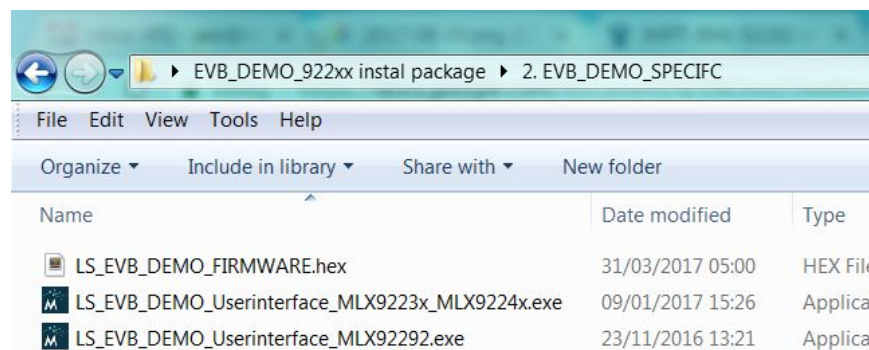

Figure 2 - content EVB_DEMO_SPECIFIC

*Note: that more information related to the EVB are to be consulted in the EVB_INSTALLATION_FILES. For example, the process how to upload the LS_EVB_DEMO_FIRMWARE can be found under EVB_DEMO_922xx instal package\1. EVB_INSTALLATION_FILES\Documentation\UI_00TEVAAMLX.pdf, you need first to select "Upload Firmware" shown as below figure 3, the other steps are described in above documentation.
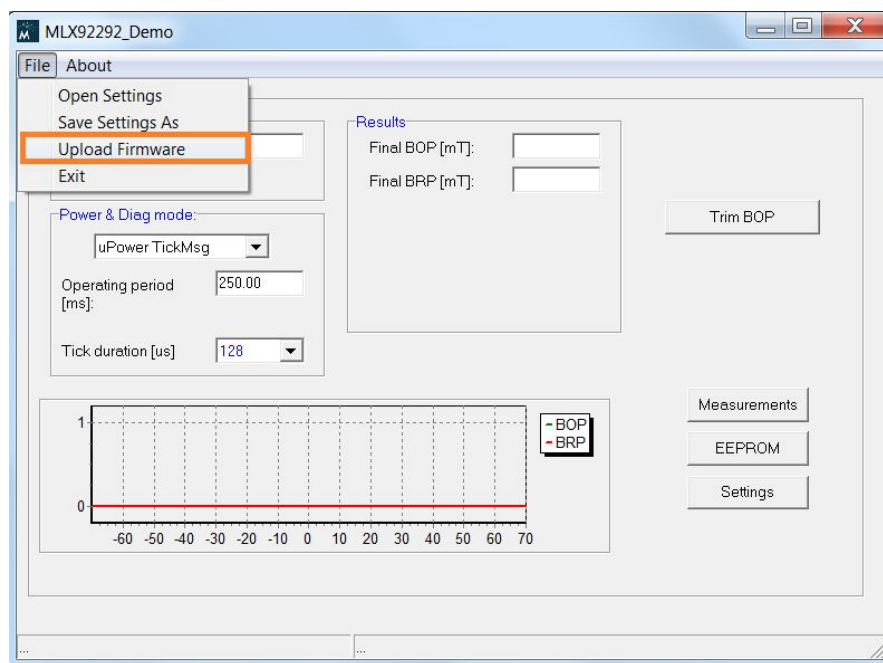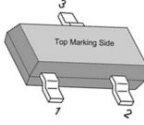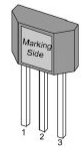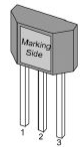
Figure 3 - Upload Firmware using EVB922xx

Supported products and pinouts

The EVB922xx supports both SE(TSOT-3L) package and Through-hole package devices (shown below in table 2).
Figure 4 indicates where to connect each type of device on the board.

Table 2 - 922x2 UA and SE package pinouts

Pin Number	SE Package (TSOT-3L)	UA Package (Through-hole)	UA Package (MLX92242 w/ cap integrated)
1	VDD (Supply Voltage)	VDD (Supply Voltage)	VDD (Supply Voltage)
2	**OUT (Output Voltage)**	GND (Ground)	**OUT (Output Voltage)**
3	GND (Ground)	**OUT (Output Voltage)**	GND (Ground)

Overview of supported devices:

- MLX9224xLSE / MLX9224xLUA
- MLX9223xLSE / MLX9223xLUA
- MLX9229xLSE / MLX9229xLUA

*Note: that for the products above, **different PC software is needed.**

Please refer to the datasheet for more information on the products differences.

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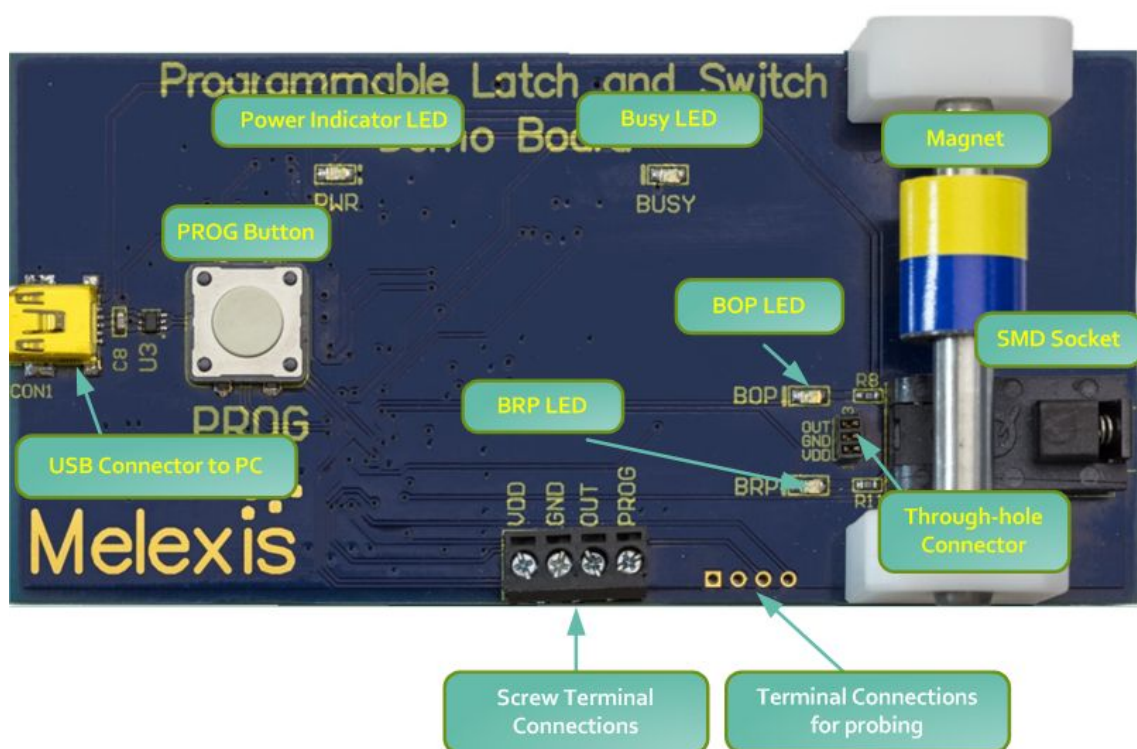## Getting started with the Evaluation Board

Overview

Figure 4 - EVB922xx top side

Figure 4 shows an overview of EVB922xx, and the indication of main components on the board, which are:

- **USB Connector to PC:** Allows connection to the PC through a USB cable for programming via PC software;
- **PROG Button:** Allows standalone programming (refer to standalone mode);
- **Power Indicator LED:** indicates if the EVB is being supplied;
- **BUSY LED:** LED that blinks while an operation is taking place on the EVB (such as BOP trimming or measurements);
- **BOP LED:** Indication programmed Bop-level is triggered;
- **BRP LED:** Indication programmed Brp-level is triggered;
- **Magnet:** Standard ferrite magnet;
- **SMD Socket:** Socket for devices with SE packages;
- **Through-hole Connector:** Connector for devices with UA packages;
- **Screw Terminal Connections:** Providing an external connection opportunity between programmer and DUT
  - Note: besides connections for VDD, GND and OUT a fourth terminal is available "PROG" (input). The EVB automatically programs the DUT when there is falling edge signal on "PROG" (5V).
- **Terminal Connections for Probing:** Both acts as a probing channel, and as back-up in case the terminal is broken.

Connection

When you first connect the EVB to the PC by USB-cable, the PWR LED will turn on indicating that the EVB is being supplied. Make sure that MLX92292 (MLX92232/MLX92242) is correctly mounted either inside of the SMD socket or on the through-hole connector.

The screw terminal connections allows you to connect your module directly to the EVB, instead of using SE or UA-socket on the board. Same principle applies to the probing terminal, and additionally provides the opportunity to solder on wires that go to directly to the DUT.

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*Note: that it's not allowed to program more than one version at the time. Therefore it's not possible to put for example a MLX92292 in the SMD socket and a MLX92232 in the Through-hole connector. These forbidden combinations will result in unexpected programming behavior and may damage the device.

Figure 5 shows the application diagram of MLX922x2 when connected to the EVB. (Notice that 2.5V is supplied from the regulator on EVB)
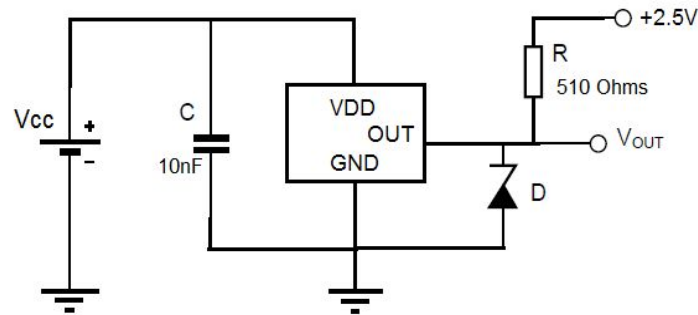

Figure 5 - MLX922x2 application diagram on EVB

Programming through software

- To program a part using the PC UI, first connect the EVB922xx to the PC via USB cable, then execute **MLX92292_Demo.exe**. If you are using MLX92242/MLX92232, execute MLX92232_Demo.exe instead;
- If the EVB922xx is connected successfully, the dialog box below should pop up.

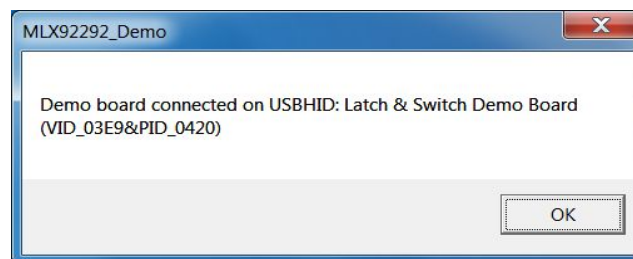

Figure 6 - EVB922xx successful PC connection dialog box

- Afterwards the MLX92292_Demo User Interface appears, see figure 7.

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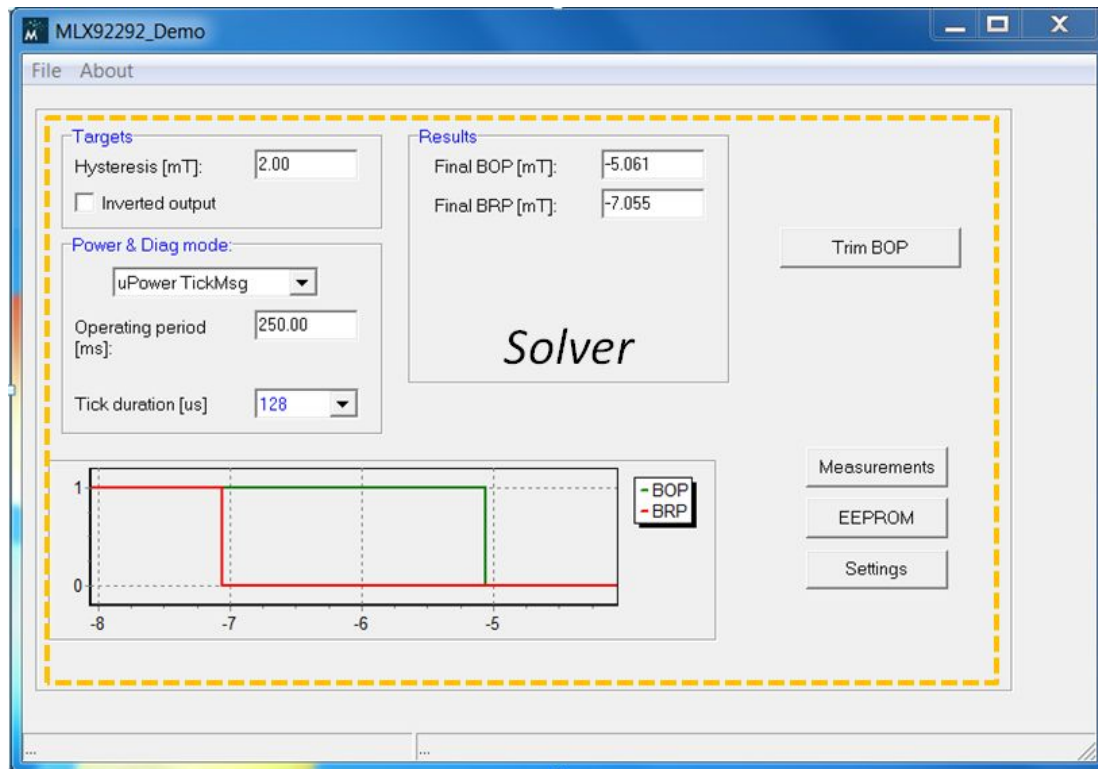## Programming through the User Interface

Figure 7 - MLX92292_Demo User Interface

The area inside of the orange dotted rectangle is referred to as the solver. Similar to PTC04 MLX92292 UI (UI for mass production tools - PTC04 + DB_922xx), MLX92292_Demo UI has a simplified solver to help you to trim the device based on below inputs:

- Program the desired Hysteresis in mT;
- Program the desired output behavior – Direct or Inverted Output;
- Program Power and Diagnostics mode;
- Trim BOP (BRP is then defined as BOP - hysteresis).

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Solver Flow

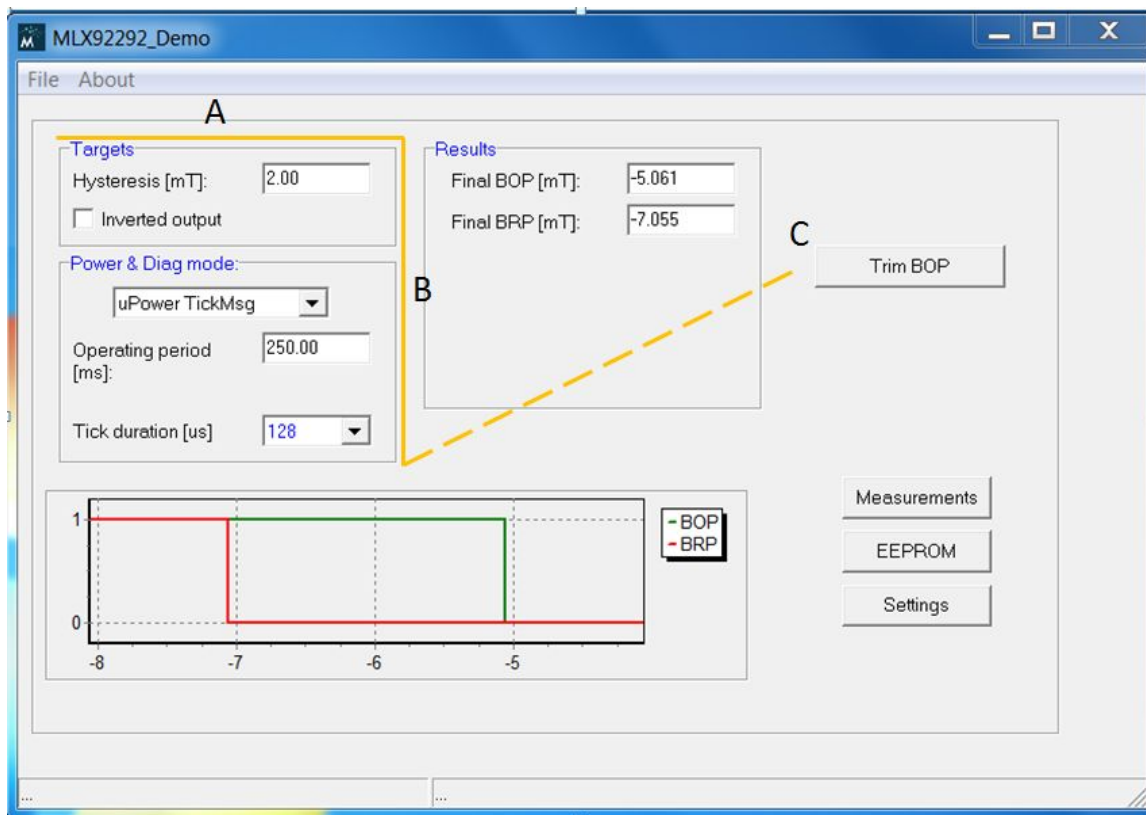- **Solver flow (A-->B-->C)**

Figure 8 - Solver flow overview

- **Setting the desired functionalities before trimming BOP (A --> B)**

  • Set the desired Hysteresis (for example: 2mT);
  • In case an inverted output is needed, 'Inverted output' checkbox must be checked;
  • Set the desired Power and Diagnostics mode. Detailed explanation of this setting is provided in paragraph diagnostic mode description

*Note: for more information configuring L&S products, tuned to different applications, consult: Application note L/S.

- **Trimming BOP (C)**

  • Apply the desired magnetic field by moving the magnet to the correct location above the sensor;
  • Press 'Trim Bop' button on the UI. The solvers measures BOP and calculates BRP based on the programmed hysteresis value. For example, in figure 8 the measured BOP was equal to -5.061mT. Therefore, BRP is determined as BOP - programmed hysteresis (2 mT in this case), resulting in -7.055mT.
  • The red and green graphs at the bottom of figure 8 indicate the output behavior.
  • BUSY LED on EVB indicates the "Trim Bop" process, when the programming is done, BUSY LED switch off.

Standalone mode

The EVB922xx has the ability to work in standalone-mode, for which there's no need to connect it to the PC, but only to be supplied by a power bank (min requirement 5V-1A output). Once the EVB is supplied, the PWR led will turn on. The aim of this mode is to allow customer to fine trim a part using the PC software and then next to program other parts with the same parameters used for the first part in a much faster way.

Here, the BOP is trimmed by pressing the "PROG" button on the EVB. Once the magnet is placed at the desired switching position, the user presses once the "PROG" button. As followed, the BOP and BRP LEDs will blink at same time and the programming process is complete. Afterwards BOP and BRP LEDs stop blinking and both turn ON.

Note: keep in mind that this method is not flexible as programming through the EVB922xx UI. Here, all the other solver configurations such as hysteresis, output behavior and power and diagnostics mode cannot be trimmed, which means that they are pre-defined according to the the latest UI settings.

Introduction to Micro Power functionality (MLX92292)

Operating period, output Tick and Tick-time duration selection

Operating period

The MLX92292 features micro-power capability, meaning that it can work in either active phase to sense the outside magnetic field, or in standby phase to reduce energy consumption. The active periods (Top) is programmable, allowing the customer to adjust the micro-power capability according to his needs.

Figure 9 illustrates the different periods involved in the active (Tact-Don) and standby phases (Top-Tac). Please note the difference in time between diagnostics activated and deactivated.
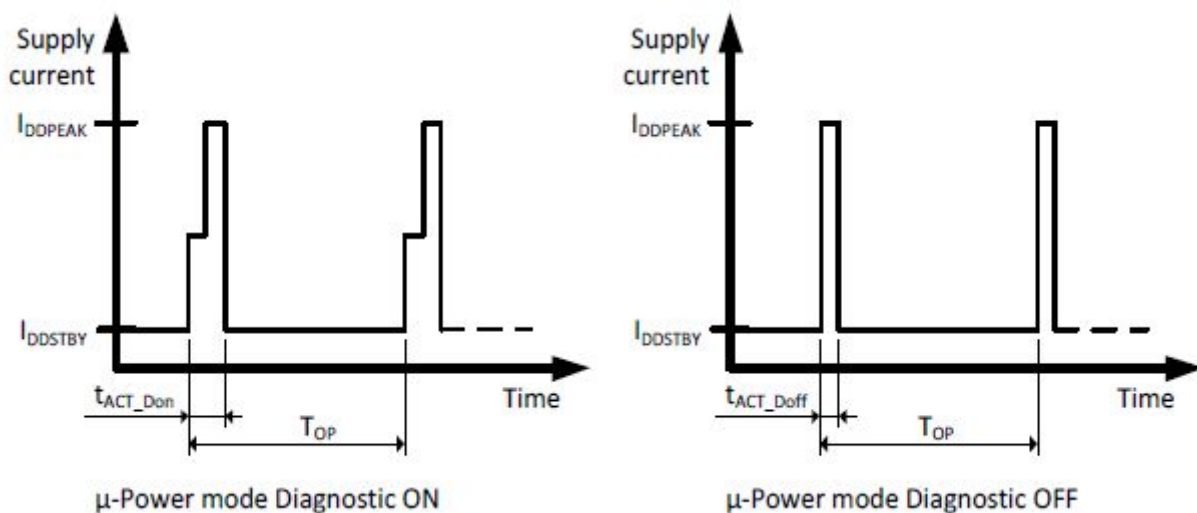

Figure 9 - Operating, tick and standby periods

- In the MLX92292_Demo UI, the Operating period (Top), can be set to any value between 2 and 260 ms.

Tick duration (tTICK**)**

The tick duration <u>on output</u> is customer programmable between 4, 8, 16, 32, 64 and 128 us, see figure 10 and 11
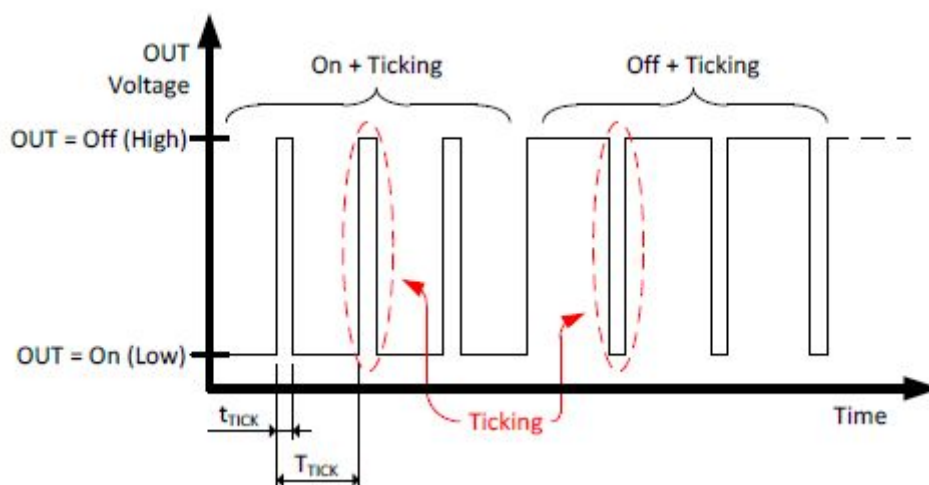

Figure 10 - Output ticking, indicating the tick duration (tTICK) and Operating time (Top)

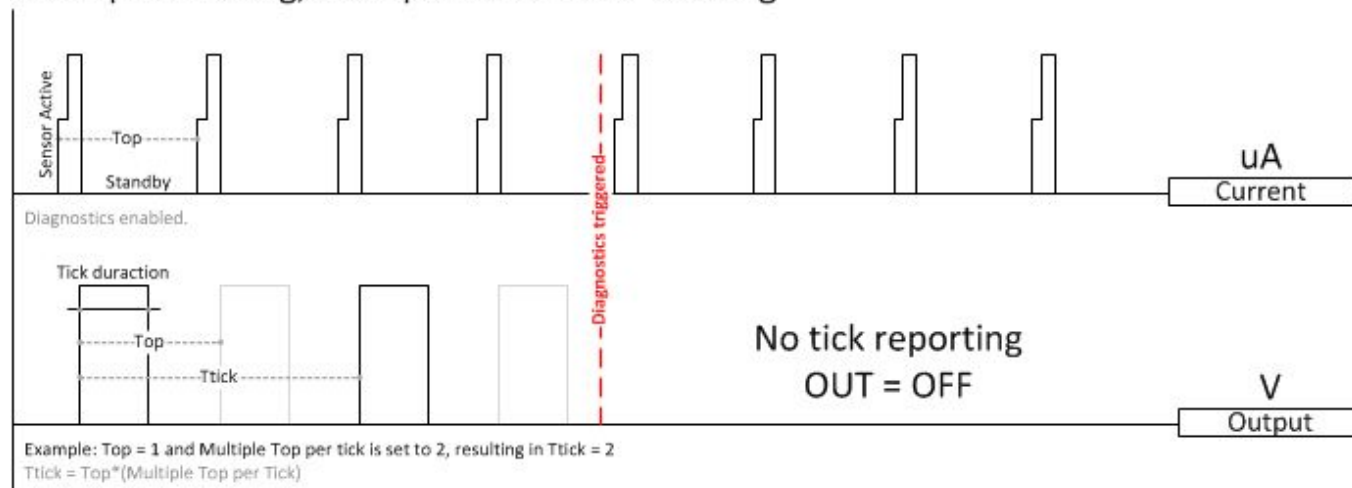**Multiple Top per tick (only available in software release V2):**

Figure 11 - Output ticking, indicating the tick duration (tTICK) and Operating time (Top)

With this option it can be programmed that the frequency of ticking will be different on the output. If the value is set to 1 the tick will always be visible after every active phase. If you select another value the tick will be skipped for that amount of number (for example 2: There will be a tick on the output every 2nd active phase).

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Diagnostics mode description (MLX92292)

MLX92292 features several diagnostic modes. Each of these modes can be selected in MLX92292_Demo UI -> Power & Diag mode -> Drop down list just above the **operating period** box (see figure 8).

Measurements function

The EVB922xx UI 'Measurements' option can be accessed by clicking on the "Measurements" button (figure 8).

In this example, the parameter to be measured was the applied field and it's selectable via the drop down list. With this, the customer can evaluate the magnetic field sensed by the chip at different air gaps. Vout (output voltage in Volts or %Vdd, IDD or directly the field in mT). In order to enable continuous measurements, one should check the "repeat" checkbox.

MLX92292 EEPROM overview and explanation

The EEPROM content of the the e.g. MLX92292 can be analyzed and re-programmed through the "EEPROM" window on the MLX92292_Demo UI (accessible by clicking on the EEPROM button shown in figure 8). The EEPROM window is shown in figure 12.

Figure 12 - MLX92292 EEPROM window

- Clicking **ReadBack**
  - will read back all the parameters stored inside the chip's EEPROM (black box = current EEPROM content).

- Clicking **CopyRomToRam**
  - will copy the chip's content to the temporary memory of the program itself, allowing the user to modify it directly (white box = PC's RAM).

- Clicking **Program**
  - will conduct a full programming cycle.

- Clicking **VerifyRomWithRam**
  - will check if the chip's memory corresponds to what has been read out.

Bop range - trimming value

Depending on the field sensed the sensor sets a range as indicated on table 3 . Therefore, BOP range can be seen as a rough trimming of the operating point (BOP).

Table 3 - BOP ranges

Bop Range: 0 to ... [mT]	Bop [9]	Sensitivity [mT/lsb]
4	512	0.0078125
8	512	0.015625
16	512	0.03125
32	512	0.0625
64	512	0.125
128	512	0.25

*Note: against what is demonstrated above, the datasheet guarantees in its spec until a range of +90mT / -90mT. Hence, in order to comply with that range (0...128mT) had to be generated – which does not mean that the sensor is not able to operate above +-90mT however, it's reflects to design to this +/- 90mT in order to guarantee the accuracy.

Bop, Brp - operational points

As the prior paragraph suggested, Bop range defines the rough trimming of the switch/latch point. In contrast, BOP and BRP define the fine trimming in order the reach the exact switching point (i.e operating point or release point). Below is an example of different Bop steps for a Bop range of 4 mT.
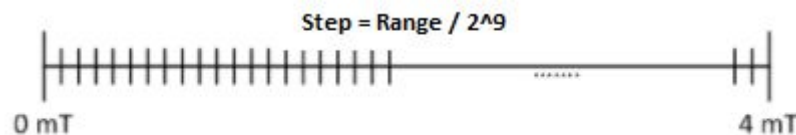

Figure 11 - BOP steps for a BOP range of 4 mT

TC - Magnet temperature coefficient

The parameter TC refers to the magnets temperature compensation slope implemented on the chip to compensate for magnetic field decreasing with increasing temperature and vice versa. This parameter must be set according to the thermal variation characteristics of the magnet used in the application, see table 4

Table 4 - TC code values

CODE	ppm/°C
10 (Ferrite)	-2000
23 (SmCo)	-400
17 (NdFeB)	-1100

Tick duration

The tick duration is given by Active phase duration (T) = Operating period (O) –Standby phase (SP). The period can be set according to the different values shown in figure 12.

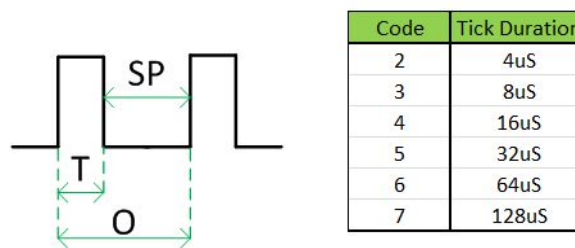| Code	Tick Duration
2	4uS
3	8uS
4	16uS
5	32uS
6	64uS
7	128uS

Figure 12 - Programmable Tick periods

Rev. OUT

If this bit is enabled, the output will be reversed.

Cust ID

Customer ID provides traceability. Any number between 0 and 255 can be stored.

Power and diagnostics mode

please refer to the datasheet for more information.

Document version overview

V1-9/3/2018:   Creation of document
V1-14/3/2018:   Correction

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