

# USER MANUAL CALIBRATION SOFTWARE PTC04 PROGRAMMER

# Introduction

In this document you'll find a description of:

- The Calibration Setup.
- How to proceed with the calibration check.
- What if the calibration check fails?
- How does the calibration work?
- What do we calibrate?

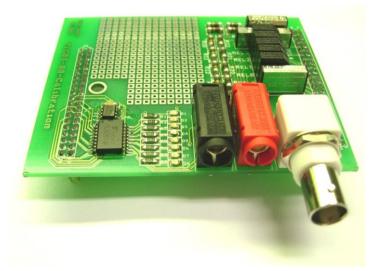


Figure 1: PTC04-DB-Calib.



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User Manual

# **Calibration Setup**

#### Requirements

For the calibration test you need:

- A high accuracy voltmeter;
- A PTC04 calibration board (PTC04-DB-Calib Supporting daughter board for calibration of PTC04 programmer).

The software has an automatic calibration feature. For this you need a Keithley 2000 or an Agilent (HP) 34401A multimeter. The Agilent 34401A multimeter is supported in the PTC04 User Interface revision 1.35 or higher. If you use the automatic calibration feature, all channels will be calibrated with the multimeter as reference meter.

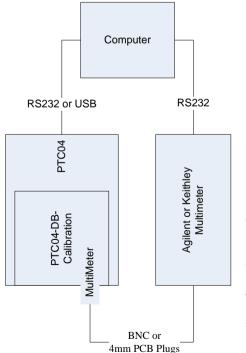
If a manual approach is used, only the first sensing line is calibrated with the external reference meter. For all the other channels the first sensing line will be used as reference.

#### IMPORTANT NOTE:

Although the firmware version of the PTC04 has no impact on the quality of the PTC04 calibration, it is advised to upload the ptc04\_mlx90251\_firmware.hex or ptc04\_mlx90316\_firmware.hex firmware to the PTC04 **before** replacing the daughter board of the PTC04 with the PTC04-DB-Calibration.



Figure 2: Connections



Because: some firmware versions have a pre-configuration of the relays on the daughter board that does not match with the relay configuration of the PTC04-DB-Calibration.

#### Connections

- 1. Replace the daughter board of the PTC04 with the calibration board:
  - Remove the cover of the PTC-04;
  - Remove the PTC04 Daughter Board of the MLX device;
  - Plug in the PTC04 Calibration Board;
- Connect the reference voltmeter to the BNC connector or 4mm PCB Plugs (Both connections are in parallel);
- 3. Connect the RS232 or USB cable to the PTC04 and the PC;
- 4. Connect the RS232 of the multimeter to the PC;
- 5. Connect the power supply of the PTC04.

Figure 3: PC Connections



#### RS232 settings

The RS232 communication of the multimeter has to be configured as follows:

Keithley 2000	multimeter	Agilent (HP) 34401A multimeter				
BAUD:	19.2 K	BAUD:	9600		BAUD:	4800
FLOW:	NONE	PARITY:	EVEN: 7BITS	OR	PARITY:	NONE: 8BITS
TX TERM:	CR	LANGUAGE:	SCPI		LANGUAGE:	SCPI

For configuration instructions, please consult the user's manual of your multimeter. All other settings are set by the software via RS232 commands.

# Check Calibration of the programmer

Now your PTC programmer is connected and you can start-up the MPT software. When the software is started, double click on PTC-04 in the UI modules list or select from the menu "Tools  $\rightarrow$  Search devices  $\rightarrow$  All"

%	Melexis P	rogrammable Toolb	ox	
E	jle <u>V</u> iew	<u>T</u> ools <u>H</u> elp		
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ø				
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	= 🔄 Syste	m Log 🗐 Data Log 🛛		
Scan	for all devi	ies		

Figure 4: Melexis Programmable Toolbox.



The software will search for all available devices. When a PTC programmer is found it will be initialized. Otherwise the software will display a notification that no PTC devices have been found and will enter the disconnected state.

就 User Interface PTC-04	Z
Test programmer	Calibrate
Configuration	Firmware commander
Upload firmware	

If the connection failed, check the serial cable and power connection or change the settings if you have connected the programmer to a different serial port.

To open the Calibration test module, press the button **Calibrate** on the PTC04 User Interface.

Figure 5: User Interface PTC-04.

#### **Calibration check**

This module of the PTC-04 User Interface is used to verify if the calibration parameters of the programmer are within tolerance. The software will check the power drivers (DAC) and the voltmeter (ADC), and compare its results with the calibration parameters. If the calibration parameters are out of tolerance, they **can** be corrected.

#### Before starting the calibration check

- It is advised to leave the programmer powered up for minimum 30 to 60 minutes before starting the calibration. For the accuracy of the calibration, it is important that the programmer is at operating temperature.
- Very important: do not connect any load on the connectors of the calibration board during the calibration check. Any additional load will corrupt the calibration parameters and lead to an unusable set-up. If this should happen, restart the calibrate check without a load connected to the programmer.
- If you have a Keithley 2000 or an Agilent (HP) 34401A Multimeter, select the correct multimeter from the selection box (1) before you start the calibration check. The multimeter has to be connected to the PC used for the calibration check. The default COM-port for the multimeter is COM2. One can change the selected COM-port in the "COM port #" Edit-box (2).



# User Manual

Microelectronic Integrated Systems

號 Calibration Check		
Measuremer 65,000 +	nt ADC or DAC Vs. reference Meter.	
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20,000		
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	o Reference Meter	
	Difference - Measured	
Manual input of measureme	ents 💽 COM port # 2 Verify Calibr	
1	ents COM port # 2 Verify Calibr	adon
1	4	

Figure 6: Calibration Check.

• Press Verify Calibration to start the calibration.

You are reminded to leave your PTC04 powered up for minimum 30 to 60 minutes before starting the calibration.

Calibrat	ion Check 🛛 🔀
♪	You are about to start the calibration check of your Melexis Programmer. For this calibration check, a high precision voltmeter is required. The accuracy of the calibration check depends on the precision of the voltmeter.
	For the automatic calibration check, a Keithley 2000 or Agilent 34401A Multimeter is required.
	Important note: It is advised to leave the programmer powered up for minimum 30 to 60 minutes before starting the calibration.
	Start Check?
	Yes No

Figure 7: Start Check?

• Press yes to continue.



If you **don't use** a Keithley 2000 or Agilent 34401A multi meter, you have to use a high accuracy voltmeter. The accuracy of the calibration depends on the precision of the voltmeter and the number of digits entered. With a manual voltmeter, the program will start with calibrating the internal voltmeter which will be used to check the PTC04 programmer.

Calibrat	ion Check 🛛 🔀
⚠	You chose a manual voltmeter. Remember, the accuracy of the calibration check depends on the precision of the voltmeter.
	Proceed Check?
	Yes <u>N</u> o

Figure 8: Proceed Check?

• Press **yes** to continue.

At this stage the software will check if the calibration board and, if selected, the Keithley 2000 or Agilent 34401A Multimeter are connected. If the calibration board is not detected, a message is shown.

Calibrat	tion Check 🛛 🛛 🔀
	Please check if the Calibration board for the PTC04 is inserted in the programmer and if the reference voltmerer is connected!
	Are they connected?
	Yes No

Figure 9: Check setup

• If the setup is not complete, press No, switch of the programmer, check your setup and restart the program.



#### Manual voltmeter

If the *Keithley 2000 or Agilent 34401A multimeter* feature is **not** selected the program will ask you to put in a few values from your voltmeter manually. These are used to calibrate the first sensing line of the PTC-04. This sensing line will be used as reference meter for the calibration check.

**Note:** the accuracy of the calibration depends on the precision of the voltmeter and the number of digits you enter.

Calibrat	ion Check 🛛 🔀
?	The calibration check will now start with measuring the internal reference channel. For this test, a few measurements will have to be inserted manually.
	OK Cancel

Figure 10: Manual calibration internal reference meter.

• Press **OK** to continue.

For the calibration of the internal reference meter, two series of 32 values are required. Once the internal reference meter is calibrated the software will continue with the calibration check.

**Note:** the decimal separator of the software is "." not ",". If one uses a "," as decimal separator, the calculated parameters will be incorrect.

Input Box Manual Voltmeter 🛛 🛛 🔀	
Give new value from voltmeter in VOLT	
OK Cancel	

Figure 11: Input Box Manual Voltmeter.

• Insert the value from the voltmeter in volt [V] and press **OK**.

Note: If you entered a wrong value, press Cancel. Two error messages are shown.

Calibrat	ion Check 🛛 🛛 🕅
$\bigotimes$	Check Measuring Line 1 failed
	ОК

Figure 12: Check Measuring line 1 Failed

Calibrat	tion Check 🛛 🔀
8	The calibration check has been cancelled! One of the ADC or DAC channels failed during the calibration check.
	<u>6</u>

Figure 13: The calibration check has been cancelled.

• Press **OK** on both messages to continue.

Now the calibration check is terminated, you can restart the calibration check.



#### The calibration check

Now the calibration software will perform a number of measurements on all the ADC and DAC channels of the programmer. This can take several minutes. At the end of the calibration check the program verifies if a correction of the calibration parameters is needed.

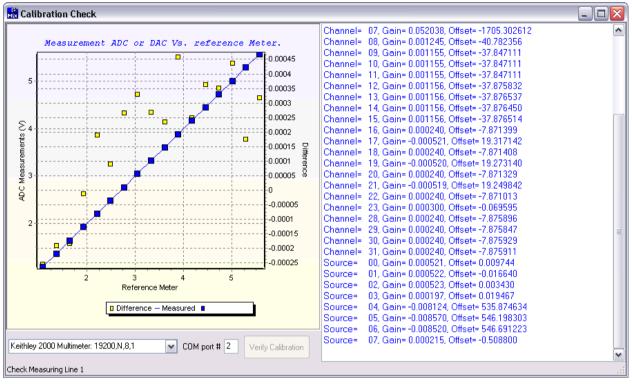


Figure 14: Calibration Check

#### There are three possible outcomes

1. The program notifies you that the current calibration is out of tolerance and ask you if you want to corrected the calibration parameters or not.

Calibrat	ion Check 🛛 🔯	
1	The current calibration of the Programmer is out of tolerance! If you would like to correct the calibration parameters (Calibrate), press YES. Calibrate?	
	Yes No	

Figure 15: Calibrate?

- If you press yes, the new calibration parameters are written into the PTC04.
- If you press **no**, there are no modifications done.



2. The program notifies you that the current calibration is within tolerance! No Correction of the calibration parameters (Calibration) is needed.

Calibration Check		
2	The current calibration of the Programmer is within tolerance! No correction of the calibration parameters (Calibration) is needed.	
	Would you like to correct the calibration parameters anyway?.	
	Yes No	

Figure 16: Calibrate Anyway?

If no calibration is needed you can still choose to calibrate or not.

- If you press **yes**, the new calibration parameters are written into the PTC04.
- If you press **no**, there are no modifications done.
- 3. At the end of the calibration, the software verifies if the programmer was at temperature when the calibration started. If the programmer was not at temperature, the following message is given.

Warning	
⚠	The current calibration of the programmer is out of tolerance! Important note: The programmer is not completely warmed up.
	It is advised to leave the programmer powered up for minimum 30 minutes before starting the calibration. If you would like to correct
	the calibration parameters (Calibrate), press YES. Calibrate?
	Yes No

Figure 17: Programmer is not at temperature.

It is advised not to calibrate (store the new calibration parameters in the programmer) when the programmer is not at operating temperature. This is important for the accuracy of the PTC04 programmer.

- If you press **yes**, the new calibration parameters are written into the PTC04.
- If you press **no**, there are no modifications done.



When you choose to calibrate (press **yes**), the new calibration parameters are written into the PTC04. Afterwards the software verifies if the writing of the calibration data in the PTC04 was done correctly.

Calibration Check	
	Verifying written calibration parameters to PTC:
Calibration Check  Measurement ADC or DAC Vs. reference Meter.  Me	Verifying written calibration parameters to PTC:           Channel=         00, Gain= 0.001155, Offset= -37.849731           Channel=         01, Gain= 0.077207, Offset= -37.849731           Channel=         01, Gain= 0.077207, Offset= -37.849266           Channel=         02, Gain= 0.001155, Offset= -2527.810547           Channel=         03, Gain= 0.077195, Offset= -37.849266           Channel=         03, Gain= 0.007155, Offset= -2527.424561           Channel=         05, Gain= 0.007156, Offset= -2526.145264           Channel=         06, Gain= 0.001155, Offset= -37.846298           Channel=         07, Gain= 0.052049, Offset= -407.85049           Channel=         08, Gain= 0.001155, Offset= -37.846298           Channel=         09, Gain= 0.001155, Offset= -37.849549           Channel=         09, Gain= 0.001155, Offset= -37.849731           Channel=         10, Gain= 0.001155, Offset= -37.879642           Channel=         11, Gain= 0.001156, Offset= -37.879642           Channel=         12, Gain= 0.001156, Offset= -37.879642           Channel=         13, Gain= 0.001156, Offset= -37.879642           Channel=         14, Gain= 0.001156, Offset= -37.879642           Channel=         14, Gain= 0.0001156, Offset= -37.879642           Channel=         14, Gain= 0.0001240, Offset= -7.875703           Channel=
0         Source=         00, Gain= 0.000521, Offset= 0.009803           Reference Meter         Source=         01, Gain= 0.000522, Offset= -0.014901           Source=         02, Gain= 0.000523, Offset= 0.002263         02, Gain= 0.000523, Offset= 0.002263           Difference – Measured         Source=         03, Gain= 0.000197, Offset= 0.019446	
eithley 2000 Multimeter: 19200,N,8,1 💌 COM port # 2 Verify Calibration	Source=         04, Gain=-0.008131, Offset= 536.057678           Source=         05, Gain=-0.008575, Offset= 546.299988           Source=         06, Gain=-0.008524, Offset= 546.902527           Source=         07, Gain= 0.000215, Offset=-0.508800
e Calibration check has been ended successfully. The Programmers calibration parameters	are Corrected.

Figure 18: The Calibration check has been ended successfully.

Now the calibration check is completed.

The END status of the calibration check is shown in the status bar of the calibration window.



#### What if the Calibration check failed

When the calibration fails, it is usually caused by a bad connection, measurement or incorrect input of measured data. If this occurs, check the setup and redo the calibration check.

#### Very important:

- If the calibration check is done with a manual voltmeter, you have to take extra care that the measurements are done correctly. These measurements are used to calibrate the first sensing line of the PTC-04. This sensing line will be used as reference meter for the calibration check.
- The accuracy of the calibration also depends on the precision of the voltmeter and the number of digits you enter for each measurement.
- The connection of the calibration board and the voltmeter are very imported. A bad connection or any additional load will corrupt the calibration parameters.
- The decimal separator of the software is "." Not ",". If one uses a "," as decimal separator, the calibration of the first sensing line will not be done correctly.

#### Measurement failed

The following error message is shown during the calibration procedure;

- If there is a bad connection in the setup. For example: between the PTC04 main board and the calibration board.
- When using a Keithley 2000 multimeter for the calibration, the failure can also be caused by a wrong measurement of the Keithley. For example: communication error.
- When you are using the manual calibration procedure. The software will perform a check on the data you enter. If there is a large deviation from the expected data. The check will fail and the calibration check is ended.

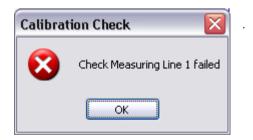


Figure 19: Check Measuring line 1 Failed

Calibrat	ion Check 🛛 🔀
8	The calibration check has been cancelled! One of the ADC or DAC channels failed during the calibration check.
	ОК

Figure 20: The calibration check has been cancelled.

To determine this:

- Press **OK** on both messages to cancel the calibration check.
- Remove the calibration board, place it back and check the connections with the voltmeter. The connection of the calibration board and the voltmeter are very imported. A bad connection or any additional load will corrupt the calibration parameters.
- After checking the setup, restart the calibration check. If the same channel fails again it is possible that there is hardware damaged on the PTC04.



#### Large deviation

When all the measurements are completed, the software calculates the new calibration parameter. After the calculation of the calibration parameters, the software verifies if there is a large deviation with the standard (expected) calibration parameters. If the deviation is too large the following warning message is shown.

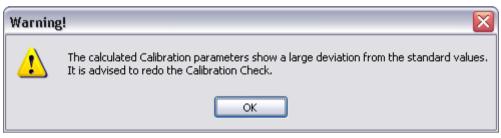


Figure 21: Large deviation of the calibration parameters.

In the main window you get a list of the channels that have a large deviation from the default values.

Calibration Check		
Calibration Check  Measurement ADC or DAC Vs. reference Meter.	Source= 01, Offset=-0.016640 should be-0.015470 : Fail Source= 01, Gain= 0.000522 should be 0.000522 : Pass Absolute Accuracy on CODE 1 for Source= 01 : Pass Source= 02, Offset= 0.003430 should be 0.002848 : Pass Source= 02, Gain= 0.000523 should be 0.000523 : Pass Absolute Accuracy on CODE 1 for Source= 02 : Pass Absolute Accuracy on CODE 2 for Source= 02 : Pass Source= 03, Offset= 0.019467 should be 0.00197 : Pass Source= 03, Gain= 0.000197 should be 0.000197 : Pass Absolute Accuracy on CODE 1 for Source= 03 : Pass Absolute Accuracy on CODE 2 for Source= 03 : Pass Source= 03, Gain= 0.000197 should be 0.000197 : Pass Absolute Accuracy on CODE 1 for Source= 03 : Pass Source= 04, Offset= 535.874634 should be 536.156982 : Pass Source= 04, Offset= 535.874634 should be 536.156982 : Pass Source= 04, Gain = -0.008124 should be -0.008131 : Pass Absolute Accuracy on CODE 1 for Source= 04 : Pass Source= 05, Gist= 546.198303 should be 546.264771 : Pass Source= 05, Gain = -0.008570 should be -0.008573 : Pass Absolute Accuracy on CODE 1 for Source= 05 : Pass Source= 06, Gist= 546.691223 should be 547.004089 : Pass Source= 06, Gist= 546.691223 should be 547.004089 : Pass Source= 07, Offset= 546.691223 should be 540.008573 : Pass Absolute Accuracy on CODE 1 for Source= 05 : Pass Source= 07, Offset= 546.691223 should be 540.008573 : Pass Absolute Accuracy on CODE 2 for Source= 06 : Pass Source= 07, Offset= 546.69123 should be 540.008525 : Pass Absolute Accuracy on CODE 1 for Source= 06 : Pass Source= 07, Offset= -0.008500 should be -0.008525 : Pass Absolute Accuracy on CODE 1 for Source= 06 : Pass Source= 07, Offset= -0.008500 should be 0.00215 : Pass Source= 07, Offset= -0.508800 should be 0.00215 : Pass Absolute Accuracy on CODE 1 for Source= 07 : Pass	
eithley 2000 Multimeter: 19200,N,8,1 COM port # 2 Verify Calibration	Absolute Accuracy on CODE 2 for Source= 07 : Pass There is a large deviation from the default values on ADC Channel 23	

Figure 22: List of channels that have a large deviation.

The large deviation could be a result of incorrect reference measurements. If it occurs:

- Remove the calibration board, place it back and check the connections with the voltmeter. The connection of the calibration board and the voltmeter are very imported. A bad connection or any additional load will corrupt the calibration parameters.
- After checking the setup, restart the calibration check. If the same channel(s) fail(s) again it is possible that there is hardware damaged on the PTC04.



#### Loggings

Each time a calibration check is performed and the new correction parameters are saved in the PTC-04 programmer, the old and the new parameters are logged in a file called "Calibration Log.txt". This file is for information purpose only and **is not used by the PTC-04 programmer.** 

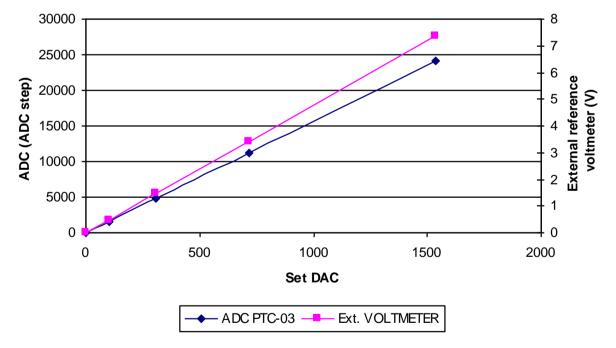
# Calibration details

#### How does the calibration work?

#### ADC

In the graph below, you have two curves: the measurements of the ADC (left Y-axis) and the reference measurements of the external voltmeter (the right Y-axis). The internal voltage source is used as supply (Set DAC X-axis). The purpose of the calibration check is to compare the ADC with the external high precision voltmeter.

For the check, a number of voltage values are measured to calculate the difference between the ADC of the PTC04 and the External Voltmeter which results in to correction parameters for offset and gain.



#### **Calibration check ADC**

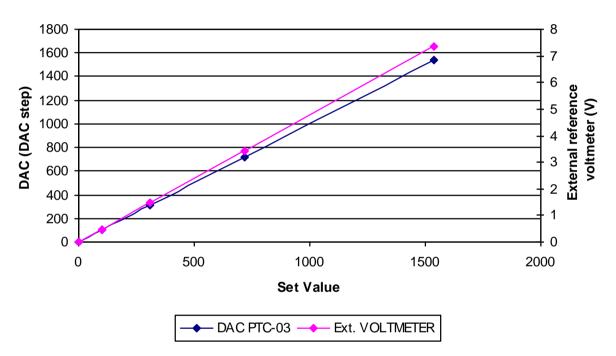
Graph 1



#### DAC

In the 2nd graph, you have agene two curves: the Set DAC (left Y-axis) and the reference measurements of the external voltmeter (the right Y-axis). The purpose of the calibration check is to compare the DAC with the external high precision voltmeter.

Also for this check, a number of values are measured to calculate the difference between the DAC of the PTC04 and the External Voltmeter which results in to correction parameters for offset and gain.



#### Calibration check DAC

Graph 2

At the end of the calibration check these values, of the ADC channels and the DAC, are compared with the values stored in the PTC. If the parameters for offset and gain, that are currently stored in the PTC04, are out of specifications in comparison with the new correction parameters, the software gives a warning and asks if the new correction parameter may be saved.



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#### What do we calibrate?

#### Sensing lines:

There are four sensing lines with independent ground connection. The source and reference that are used to calibrate the sensing lines are PPS 1 and the external voltmeter.

Sensing line 1	channel 12 and Channel 28 (High sensitivity) of the ADC;
Sensing line 2	channel 13 and Channel 29 (High sensitivity) of the ADC;
Sensing line 3	channel 14 and Channel 30 (High sensitivity) of the ADC;
Sensing line 4	channel 15 and Channel 31 (High sensitivity) of the ADC.

#### **PPS1:**

For each PPS, the software checks the ADC first then the DAC and then the additional channels that are connected to that source.

#### PPS2:

Voltmeter on the PPS2	channel 2 and Channel 18 (High sensitivity) of the ADC;
PPS2	channel 1 of the <i>DAC</i> ;
Current meter on the PPS2	channel 3 of the ADC;
PPS 6: IDD limiter PPS2	channel 5 of the <b>DAC</b> .

#### PPS3:

Voltmeter on the PPS3	channel 4 and Channel 20 (High sensitivity) of the ADC;
PPS3	channel 2 of the <b>DAC</b> ;
Current meter on the PPS3	channel 5 of the <b>ADC</b> ;
PPS7: IDD limiter PPS3	channel 6 of the <b>DAC</b> .

#### **PPS4:**

Voltmeter on the PPS4 PPS4	channel 6 and Channel 22 (High sensitivity) of the <b>ADC</b> ; channel 3 of the <b>DAC</b> ;
Current meter on the PPS4	channel 7 of the <b>ADC</b> ;
PPS8: IDD limiter PPS4	channel 7 of the <b>DAC</b> .



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Or for additional information contact Melexis Direct:

Europe, Africa, Asia: Phone: +32 13 670 495 E-mail: <u>sales\_europe@melexis.com</u> America: Phone: +1 603 204 2900 E-mail: <u>sales\_usa@melexis.com</u>

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