

## User manual for the USB to PMBus bridge demonstration board

### Introduction

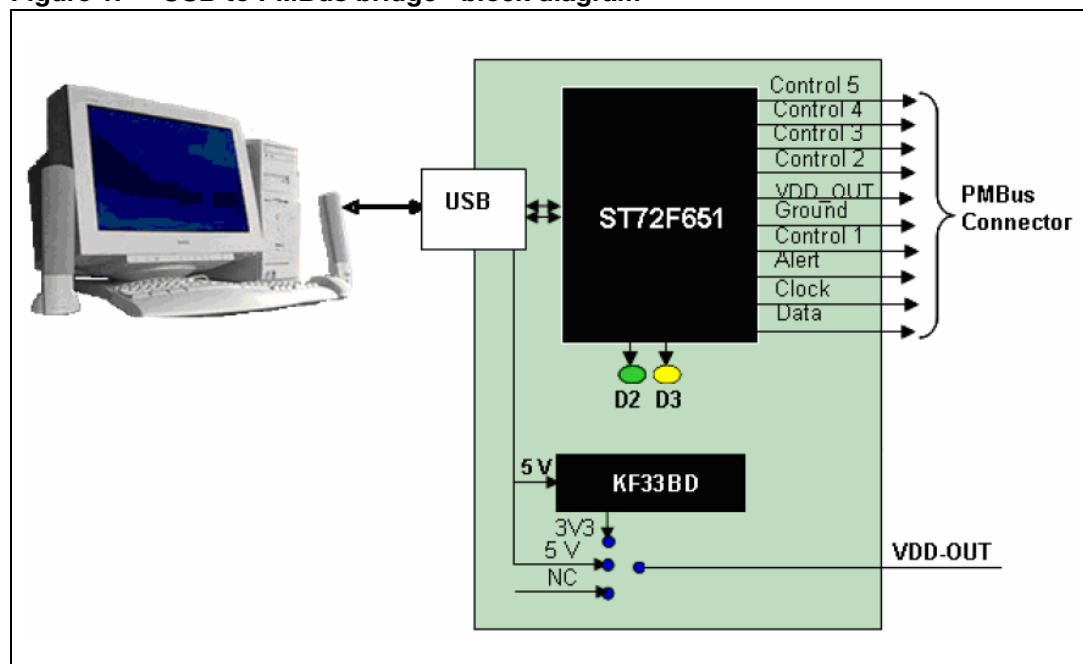
The power management bus (PMBus) is a variant of the system management bus (SMBus) which is targeted at digital management of power supplies. Like the SMBus, it is a relatively slow speed two-wire communications protocol based on I<sup>2</sup>C. The PMBus protocol helps to establish the first truly open communications standard for the digital control of power systems facilitating the programming, control, and real-time monitoring of compliant power conversion products.

This document describes how to set up and use the USB to PMBus bridge board for PMBus communication. The objective of this demonstration board is to show the features and capabilities of the PMBus using the ST7 I<sup>2</sup>C peripheral, to support the standard PMBus commands. This demonstration board has an ST72651AR6 microcontroller (MCU) which has an I<sup>2</sup>C peripheral. This microcontroller acts as the PMBus master. The demonstration board works with a PC GUI and controls one or more PMBus compatible slaves connected on the shared bus. The main purpose of this board is to interface with any compatible PMBus devices making use of the supported set of commands.

The firmware of this application performs the PMBus bus protocols mentioned in PMBus power system management protocol specification v1.1. The firmware is in C language.

*Figure 1* shows the block diagram of this demonstration board.

**Figure 1. USB to PMBus bridge - block diagram**



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# 1 Getting started

## 1.1 Package contents

The USB to PMBus bridge package includes the following items:

- Packaged hardware board (mechanical size: 79 mm x 39 mm x 20 mm) with a USB connector
- User friendly graphical user interface (GUI) to:
  - identify the connected PMBus slaves (up to four)
  - configure, control, and monitor the connected slaves
  - write/read different PMBus commands
  - poll the alert response

## 1.2 Hardware setup

*Figure 2* shows an image of the demonstration board.

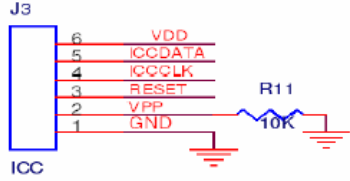
**Figure 2. Packaged board image, STEVAL-ISQ006V1**



### 1.2.1 Configuring the hardware

The connectors must be configured correctly, as described in [Table 1](#).

**Table 1. Connectors**

Connector name	Description
USB Connector	USB type B connector to communicate with the PC GUI
J3	<p>ICC connector pins to re-program the MCU if needed. The connection is shown in the following diagram:</p>  <p><i>Note: This 6-pin connection is a customized ICC connector from the normal connector. This modification is performed to achieve the low-form factor of the board.</i></p>
J8 (PMBus)	<p>The following is the 10-pin PMBus interface connector description:</p> <ul style="list-style-type: none"> <li>– Pin 1: Control signal 5</li> <li>– Pin 2: Control signal 4</li> <li>– Pin 3: Control signal 3</li> <li>– Pin 4: Control signal 2</li> <li>– Pin 5: VDD_OUT. Refers to slide switch position.</li> <li>– Pin 6: Ground</li> <li>– Pin 7: Control signal 1</li> <li>– Pin 8: PMBus alert signal coming from the slave device.</li> <li>– Pin 9: PMBus clock signal. This signal is always driven by the MCU in this demonstration board.</li> <li>– Pin 10: PMBus data signal. This signal is bi-directional.</li> </ul> <p><i>Note: The voltage on the control lines is either 5 V or 0 V depending on the selection made through the GUI.</i></p>

The user must connect the USB port of the PC or notebook to connect the demonstration board. The demonstration board should also be connected with the compatible slave module using the PMBus connector pins.

**Table 2. Switches**

Switch name	Description
SW1(Reset)	The reset switch restarts the application
J9(EG1313)	The voltage on VDD_OUT can be varied (5 V/ 3.3 V/NC) by varying the slide switch positions.

## 1.2.2 LED status indication

This demonstration board has 2 LEDs. Their operations are described in [Table 3](#).

**Table 3. LED indication**

LED	Description
D2	ON: PMBus communication is ongoing.
	OFF: no PMBus communication.
D3	ON: board is powered and MCU is running
	OFF: no power to board

*Note:* The connector (J3), switch (SW1), and LEDs (D2 and D3) are visible only when the casing is removed. For normal operation the user need not worry about these. These are needed only when the board is used for debugging purpose.

## 1.3 Software setup

This section explains how to install and set up the PC GUI for PMBus communication.

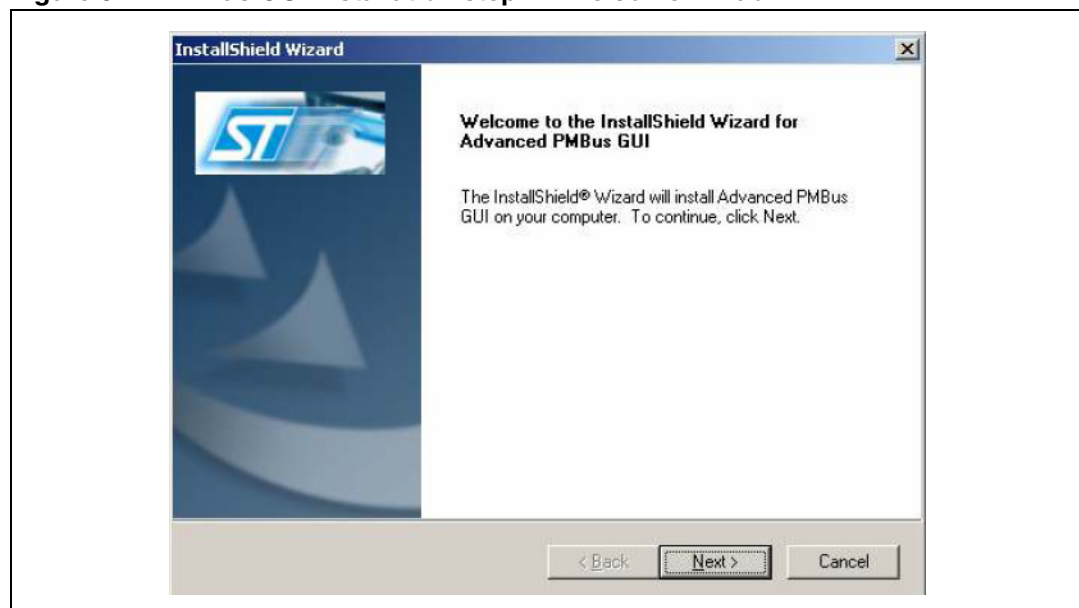
### 1.3.1 PC GUI installation

To install the PC GUI software, follow the steps as mentioned below:

#### Step 1:

As soon as the user clicks the PC GUI setup icon, the following window appears. Please click on the "Next" button.

**Figure 3. PMBus GUI installation step 1 – welcome window**

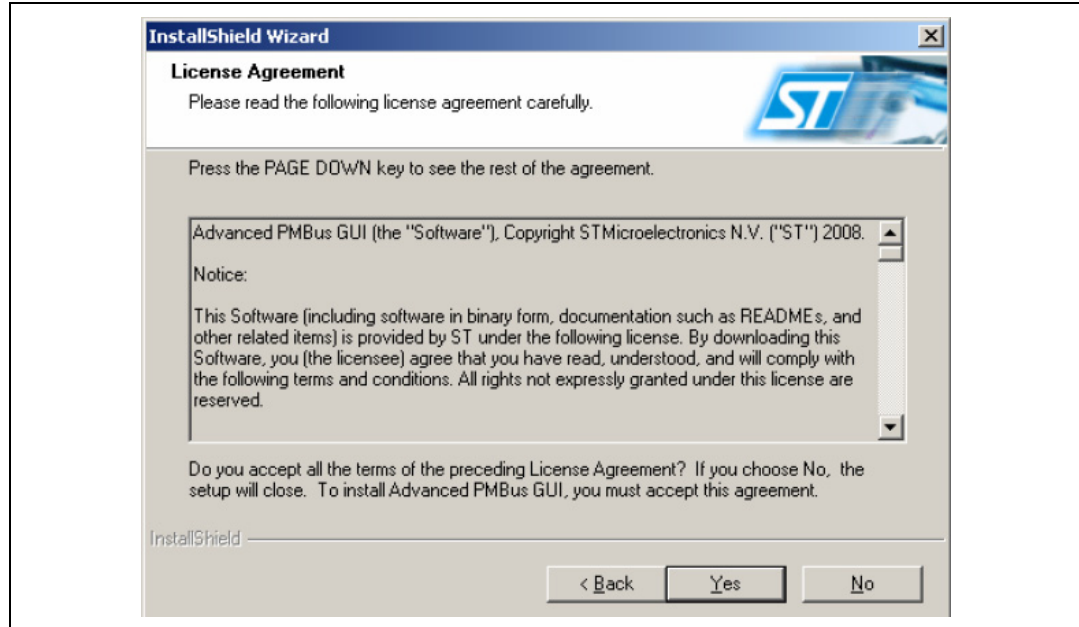




**Step 2:**

Read the license file and click the “Yes” button to accept.

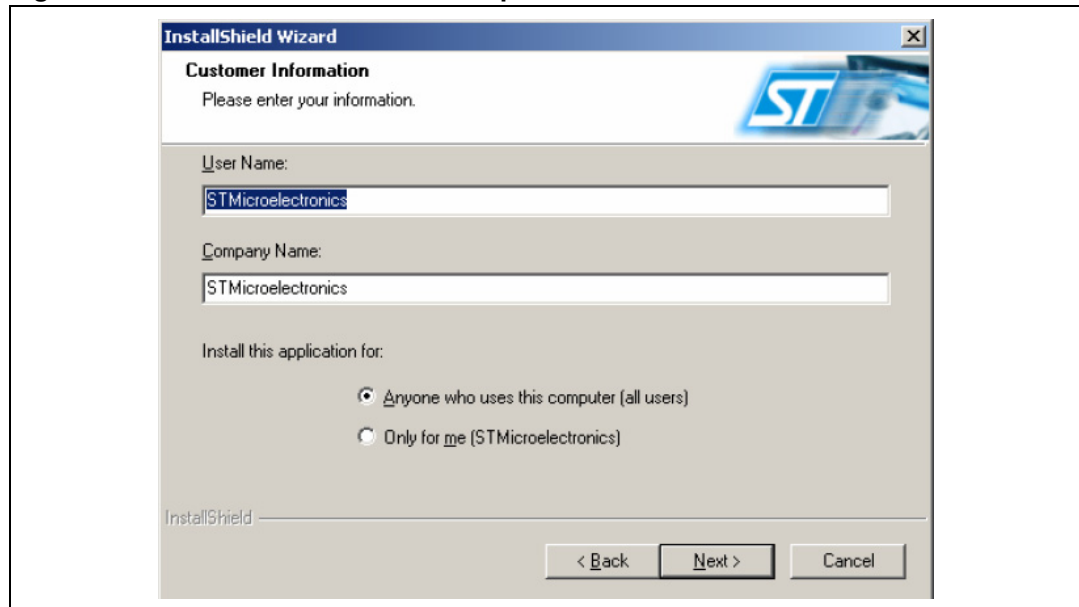
**Figure 4. GUI installation step 2 – license agreement window**



**Step 3:**

Select one of the following options in *Figure 5*:

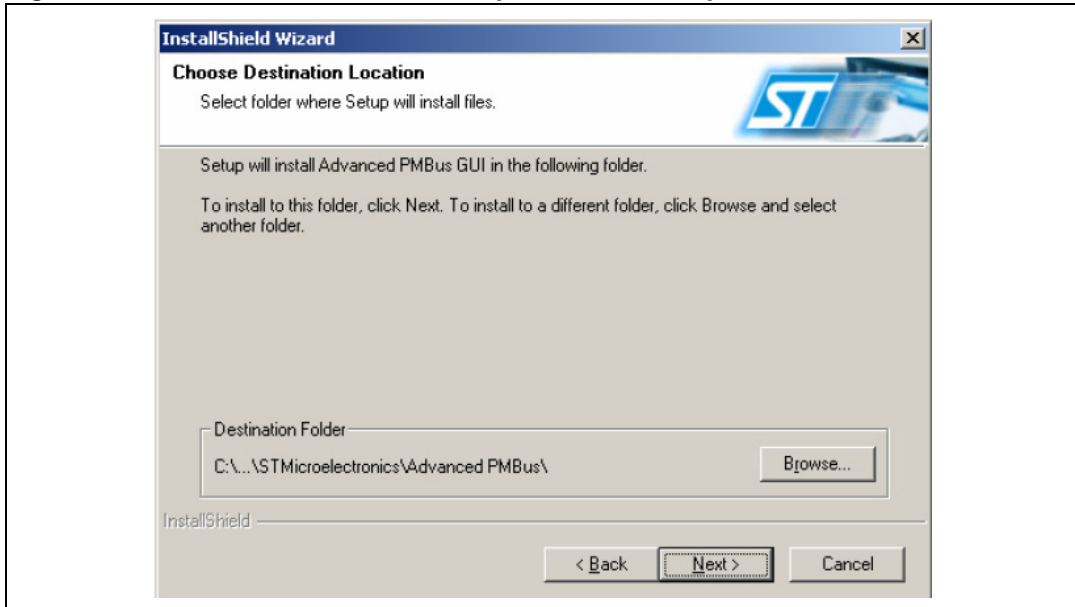
**Figure 5. PMBus GUI installation step 3 - customer information window**



**Step 4:**

Please select the folder in which to install the software. By default it installs the software in the following path: C:\Program Files\STMicroelectronics\.

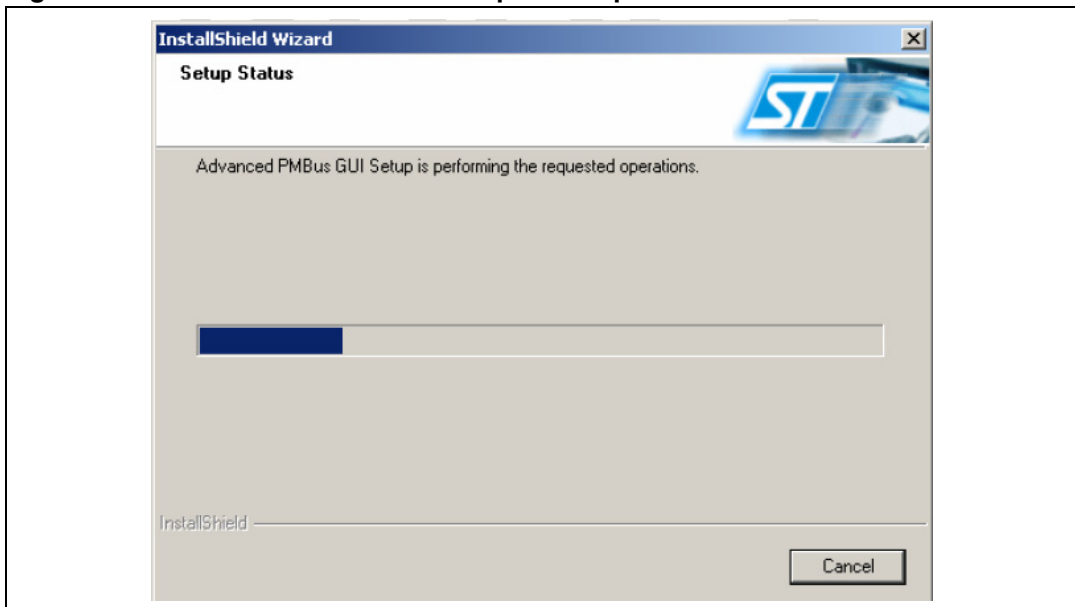
**Figure 6. PMBus GUI installation step 4 - installation path window**



**Step 5:**

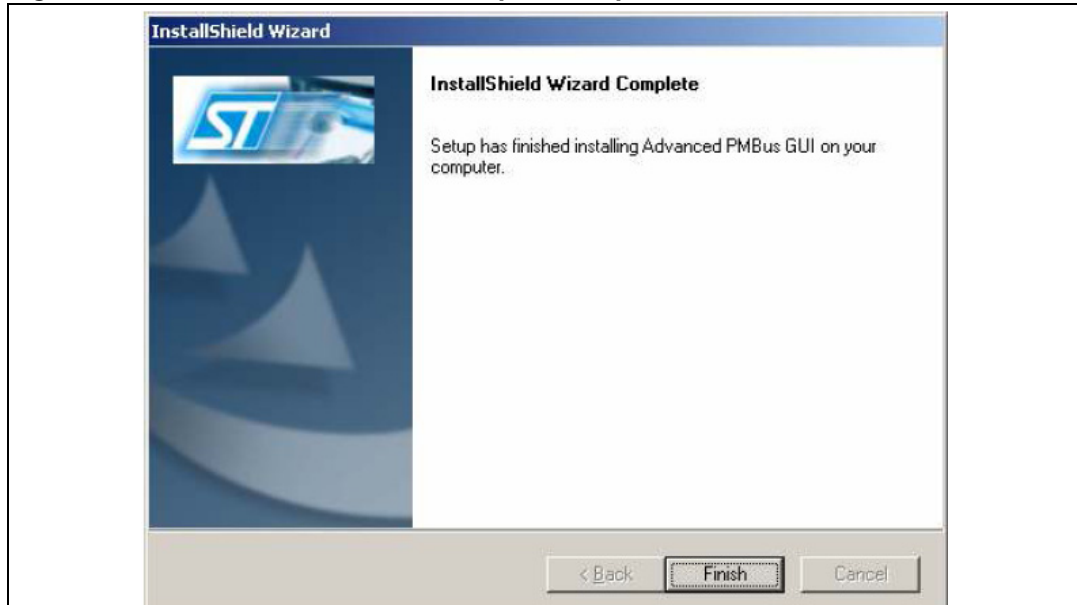
After selecting the folder and clicking the “Next” button, the software starts installing.

**Figure 7. PMBus GUI installation step 5 - setup status window**



**Step 6:**

After installation is complete, the following window appears to indicate that the installation has successfully completed.

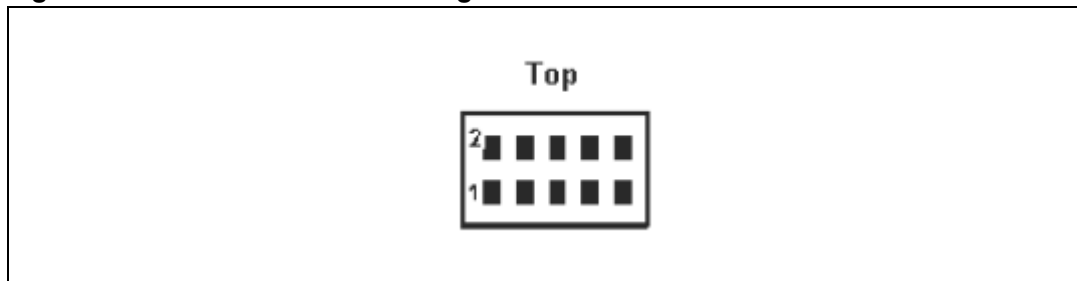
**Figure 8. PMBus GUI installation step 6 - setup finish window**

After clicking the “Finish” button, the software has installed in the directory selected or in the default directory. A shortcut of this software is also available in the START menu as well as on the desktop.

## 1.4 Quick start

### 1.4.1 Hardware configuration

- Connect the demonstration board to the PC through a USB type B connector
- Select the supply voltage for the slave, using the EG1313 switch (5 V/3.3 V/ NC)
- Connect the PMBus slave, (See [Figure 4](#) below).

**Figure 9. PMBus connector configuration**

**Table 4. PMBus connector**

Pin	Description
1	Control 5
2	Control 4
3	Control 3
4	Control 2
5	VDD_OUT
6	GND
7	Control 1
8	PMBus Alert
9	PMBus Clock
10	PMBus Data

### 1.4.2 Software configuration

- Install the GUI provided with the package
- Open the GUI (by clicking on Start -> Programs -> STMicroelectronics -> Advanced PMBus -> Advanced PMBus Software Application) or simply click on the shortcut of Advanced PMBus Software Application available on the desktop
- Click on File -> Connect option or on Connect icon
- Press the polling button to identify the connected slaves
- The user can now control/monitor the desired slave by clicking on the slave address.

## 2 How to connect the demonstration board with the GUI

The hardware and software must be set up as mentioned in [Section 1.2](#) and [Section 1.3](#). Any PMBus compatible module that acts as the slave must be connected. Refer to the relevant datasheets and development kit documents of the slave device.

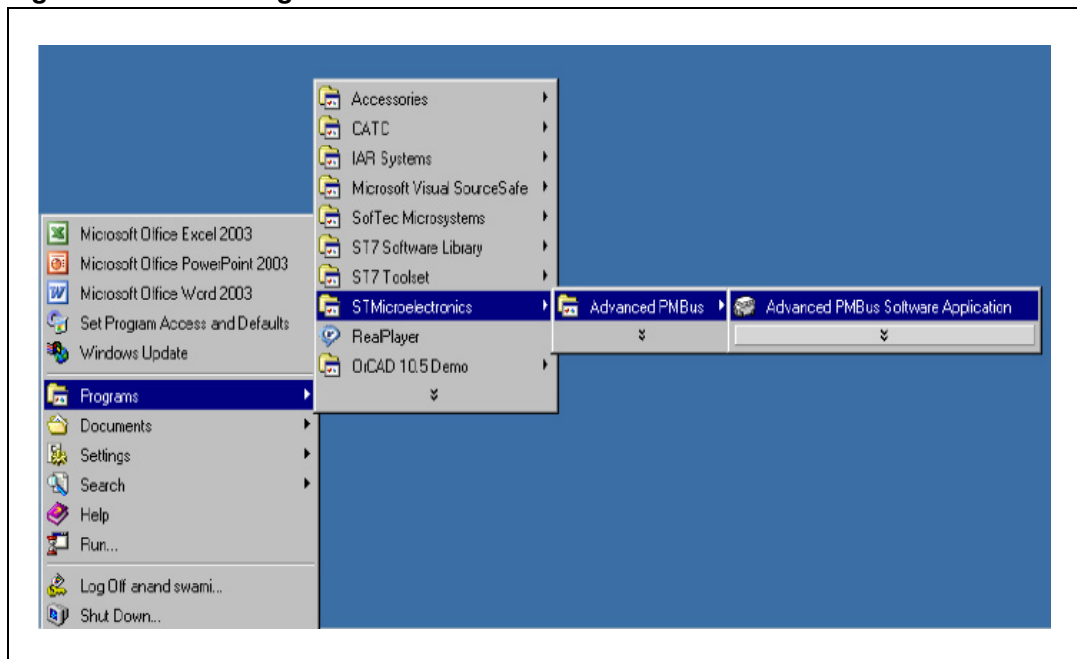
Once the hardware board is connected to the PC, LED D3 lights up to indicate the MCU is in USB powered state. If there is any problem in getting the LED to light up, press the reset switch provided in the demonstration board. This switch restarts the application.

### 2.1 Connecting the PC GUI with the demonstration board

To connect the PC GUI with the demonstration board, the following steps, as mentioned below, should be followed:

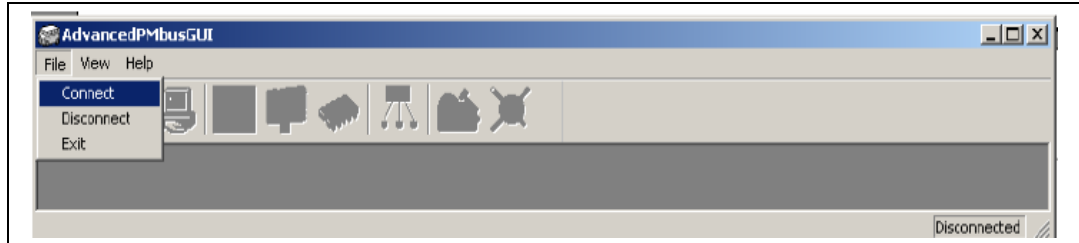
- Step 1: Click on Start -> Programs -> STMicroelectronics -> Advanced PMBus -> Advanced PMBus Software Application, as shown below, or simply click on the shortcut of Advanced PMBus Software Application available on the desktop

**Figure 10. Launching the GUI**



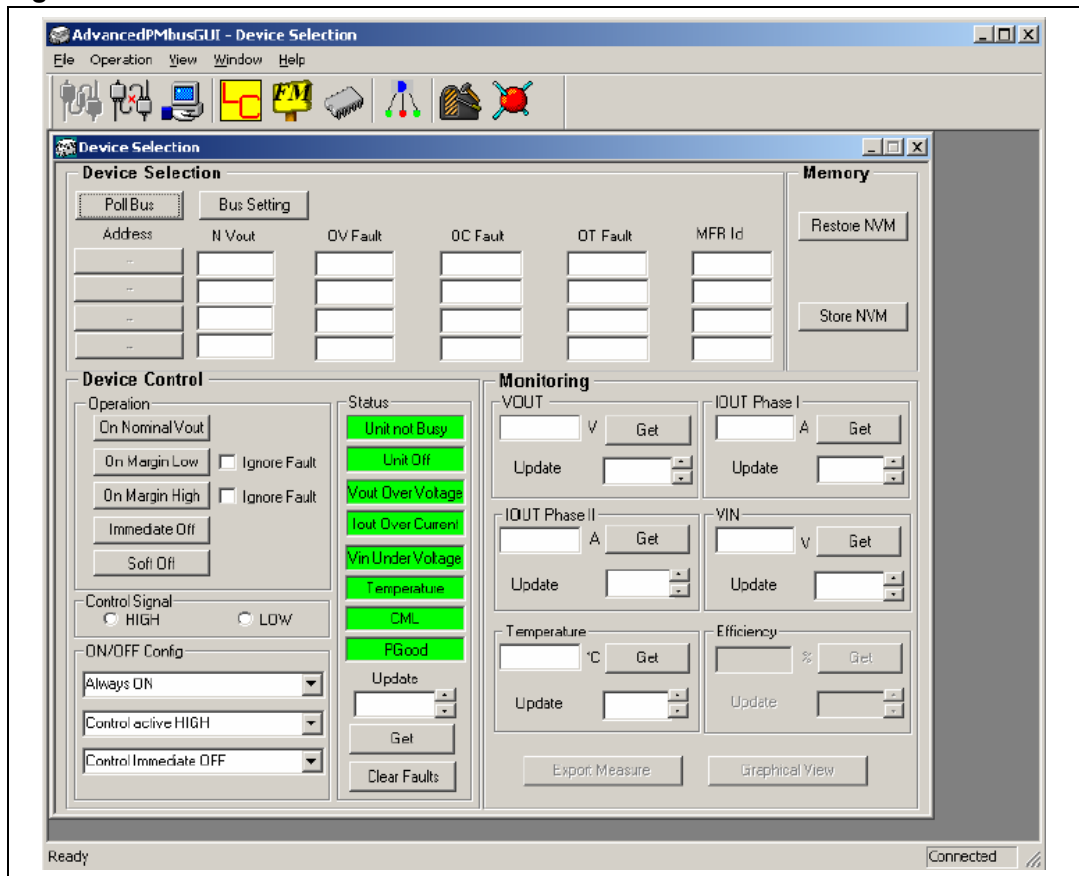
- Step 2: Click on the File -> Connect option or click on the “Open Connection” button on the tool bar

Figure 11. Connecting the board



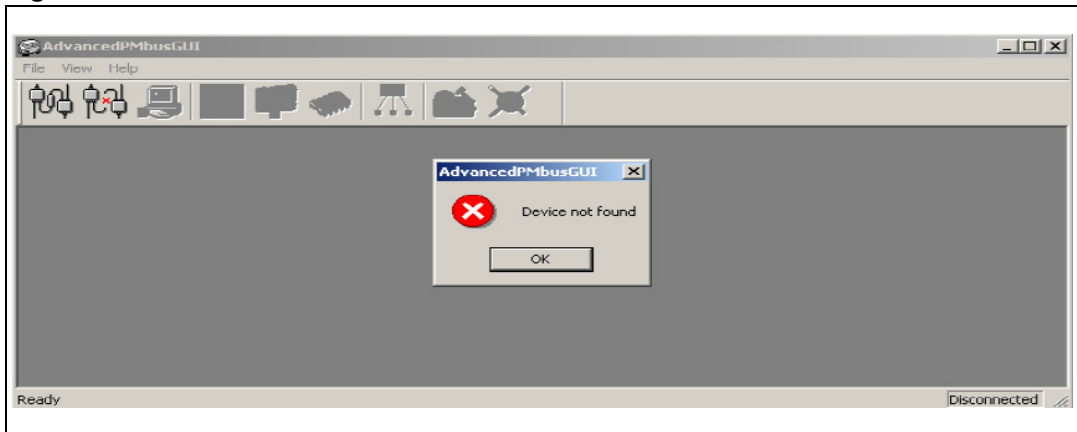
If the demonstration board is connected to the PC GUI, it shows 'Connected' in the status bar (on the bottom right-hand of the GUI screen) and the device selection window appears.

Figure 12. GUI connected to board



If there is any problem in the connection, the status bar shows 'Not connected' and the following error message appears (Figure 13).

Figure 13. Error in connection



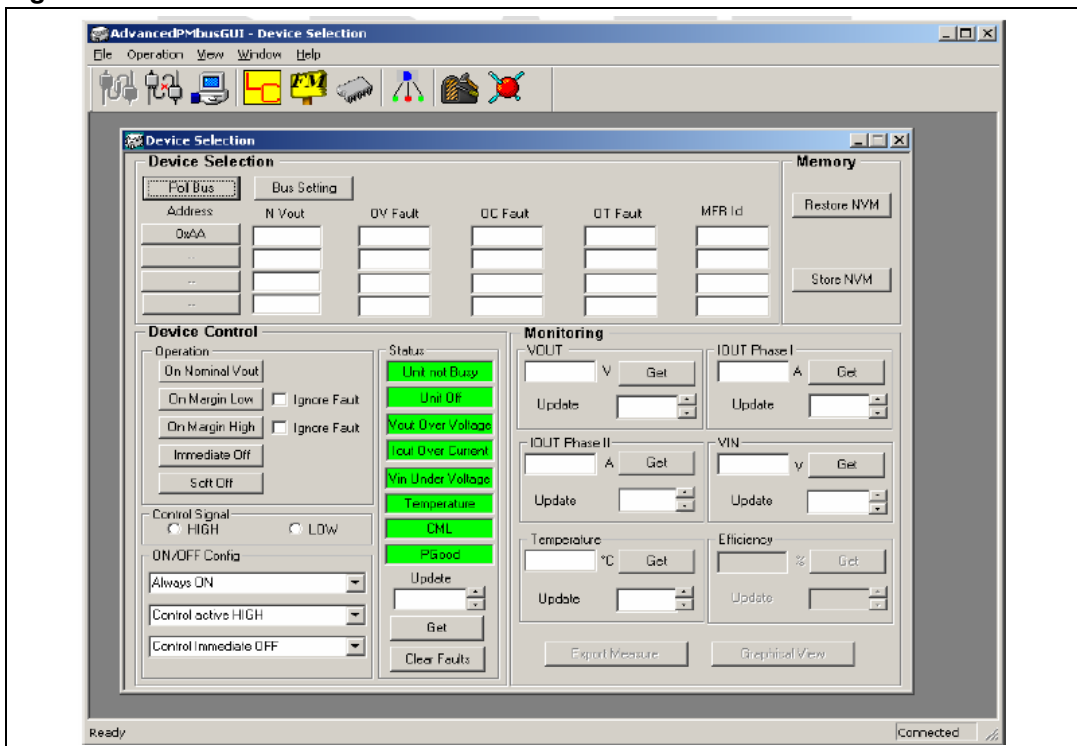
## 2.2 Identification of PMBus slaves and options configuration

### 2.2.1 Polling the connected slaves

After connecting the interface board, the GUI should poll the bus to identify the connected slaves.

In the polling procedure the GUI scans the entire slave address range except 0x18 which is the alert response address. As soon as the polling completes, the GUI lists the connected slave addresses in the device selection window. The GUI can support four simultaneous PMBus slaves.

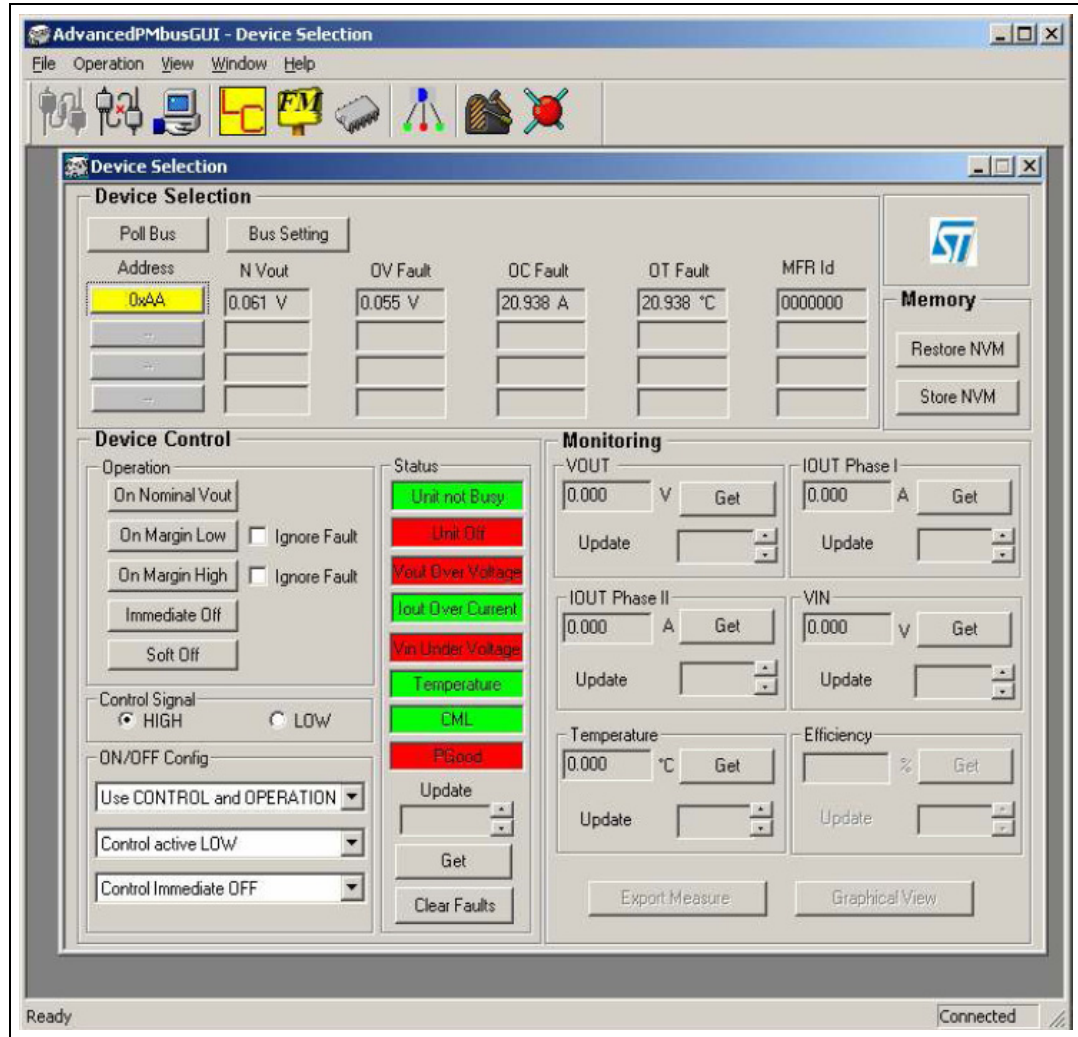
Figure 14. List of connected slaves



As soon as the polling procedure completes, a slave must be selected, as shown in [Figure 15](#). The selected slave is highlighted in the device selection window and the parameters corresponding to the selected slave are read from the slave device.

### 2.2.2 Enabling the slave

Figure 15. Selection of connected slave

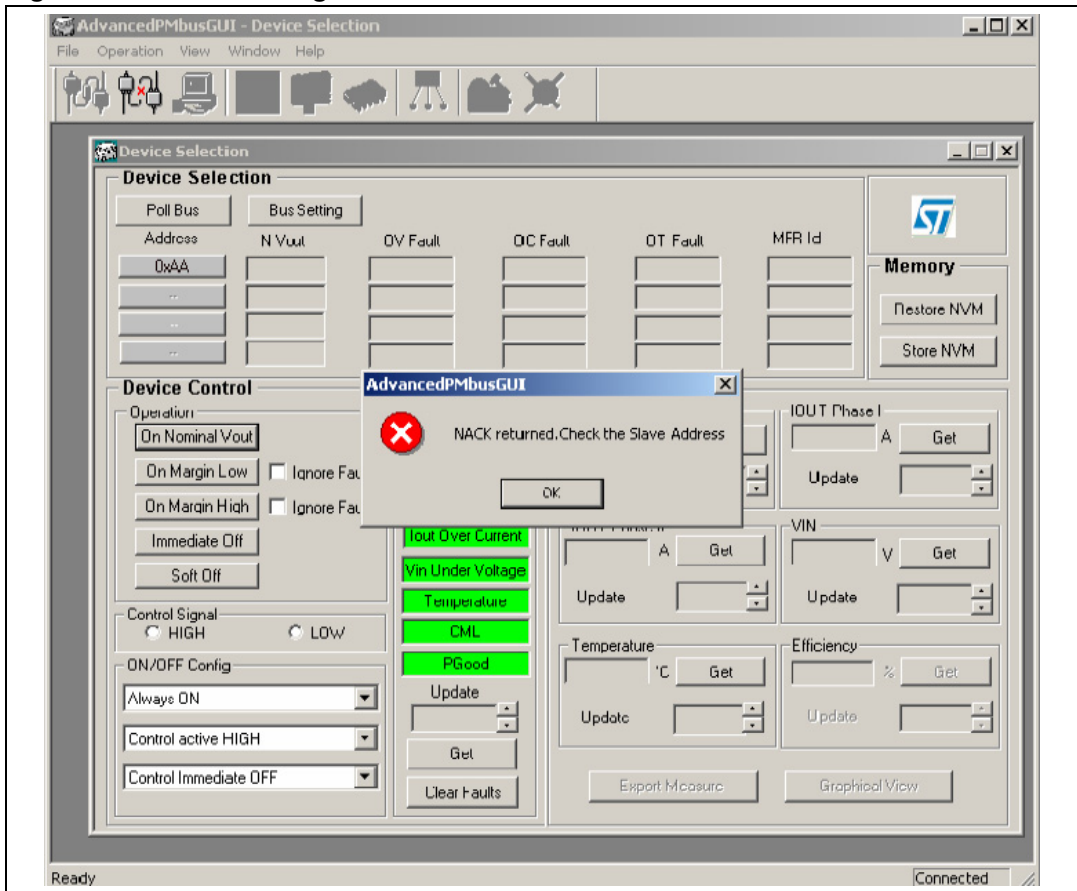


If the user clicks on the parameters without selecting the slave, an error message appears on the screen and it may cause undesired behavior.

- Note:
- 1 Ensure that there is no faulty slave connected. If a faulty slave is selected through the GUI, it may cause damage.
  - 2 After polling, the connected slaves appear below the address block. Then, select the slave address and start PMBus operation. Otherwise the GUI displays an error message.



Figure 16. Error message returned from the slave device



After selecting the slave, the bus setting and memory buttons are available. Now, any of the windows can be selected to configure the PMBus slave device.

## 3 Advanced PMBus GUI description

The PMBus GUI consists of 8 different windows where the device selection is the parent window:

1. Device selection window
2. Device setup window
3. Loop comp. window
4. Fault management window
5. Device information window
6. Device status window
7. Manual command window
8. Advanced setup window

### 3.1 Device selection window

The device selection window is the parent window of the GUI and opens automatically as soon as the demonstration board is connected, irrespective of whether the slave is connected or not. This window has the following options:

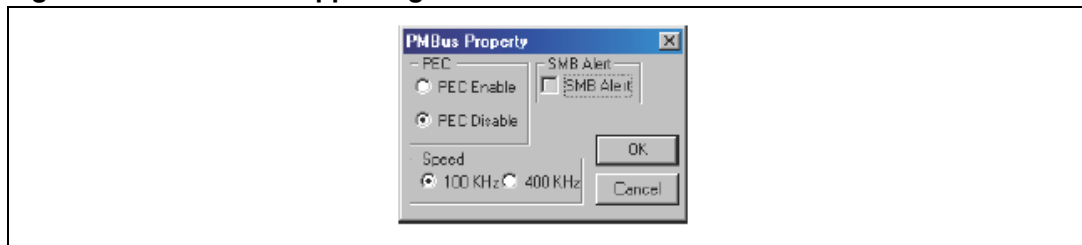
1. Device selection
2. Memory
3. Device control
4. Device monitoring

#### 3.1.1 Device selection window

As soon as the demonstration board is connected, the user must perform polling to identify the connected PMBus slave devices. After polling the bus, the GUI shows the list of connected slaves which can be selected, one at a time, for configuration or monitoring. As soon as the slave is selected, and the bus setting window is clicked, the CAPABILITY command is sent. The CAPABILITY command reads the supported features of the slave device.

Based on the data received from the slave, the buttons on the GUI are enabled or disabled. For example, if the slave does not support the PEC, the PEC enable button is disabled. Similarly, the alert and 400 kHz buttons are disabled if not supported by the slave.

**Figure 17. Slave not supporting alert feature**



Once PEC is enabled, this interface board communicates the PEC value after the last byte, in case it is a transmitter. The receiver returns a NACK for the PEC value, if the PEC value of

the transmitter is different to that of the receiver. In this case, the GUI displays the error message 'PEC failure'. In the case of the receiver, the PEC value is received after the last byte by this board and compared with a calculated PEC value. The GUI displays the error message 'PEC failure', if the PEC value of the transmitter is different to the calculated value.

The speed of the PMBus communication can be configured by checking the corresponding box against 100 kHz or 400 kHz.

### 3.1.2 Memory selection

This section has two buttons to move the PMBus related data from operating memory to non-volatile memory or vice-versa. At the conceptual level, the PMBus slave operates from the values stored in the volatile memory while a non-volatile memory (if supported by the PMBus slave) is called default store. The restore button instructs the PMBus slave device to copy the entire contents of the non-volatile user store memory to the matching locations in the operating memory. The values of the operating memory are overwritten by the values read from the non-volatile memory. Any item in the user store, not having a matching location in the operating memory, is simply ignored.

*Note: The user must confirm the behavior of store and restore commands with the manufacturer. Sometimes, use of the above commands while the device is operating, may lead to undesirable or damaging behavior.*

**Figure 18. Memory section**



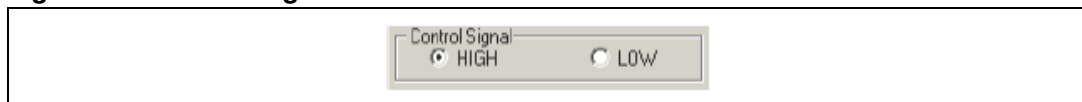
### 3.1.3 Device control section

This section can be subdivided into four blocks:

1. Operation
2. Control signal
3. ON/OFF configuration
4. Status

As soon as the PMBus slave is selected, all the parameters are read automatically from the device. They can then be modified by the user. In the control signal section, the checked box indicates the signal value to turn ON the selected slave. This may be low (if the slave is active low enabled) or high (if the slave is active high enabled). The user can switch off the device by reversing this signal. It must be switched on with the correct control signal value (high or low) to restart the operation.

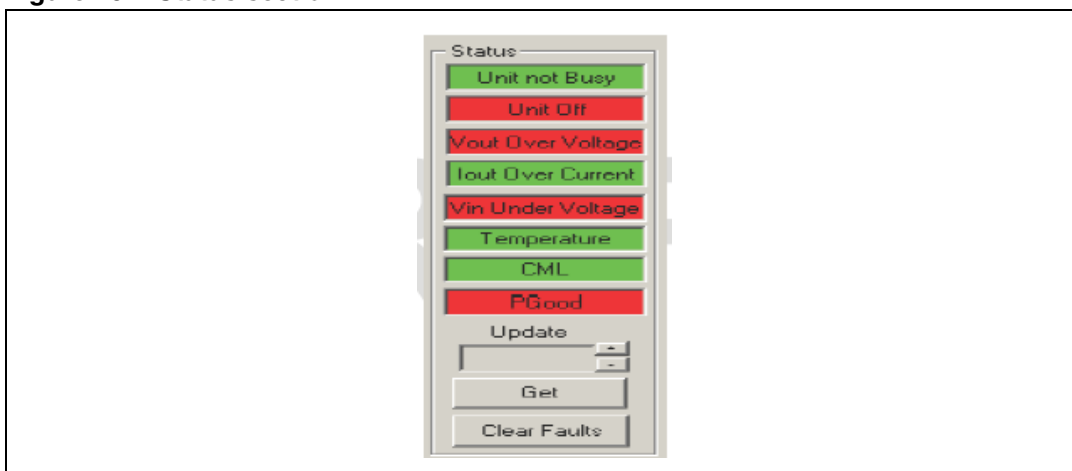
**Figure 19. Control signal section**



The status section indicates the PMBus status of the selected slave and can be periodically monitored by putting the update interval value. When the clear faults button is pressed, all

the faults are cleared and the GUI updates the values of the flags by reading the status. If there is still a fault present, shown in the GUI, the user must resolve the problem.

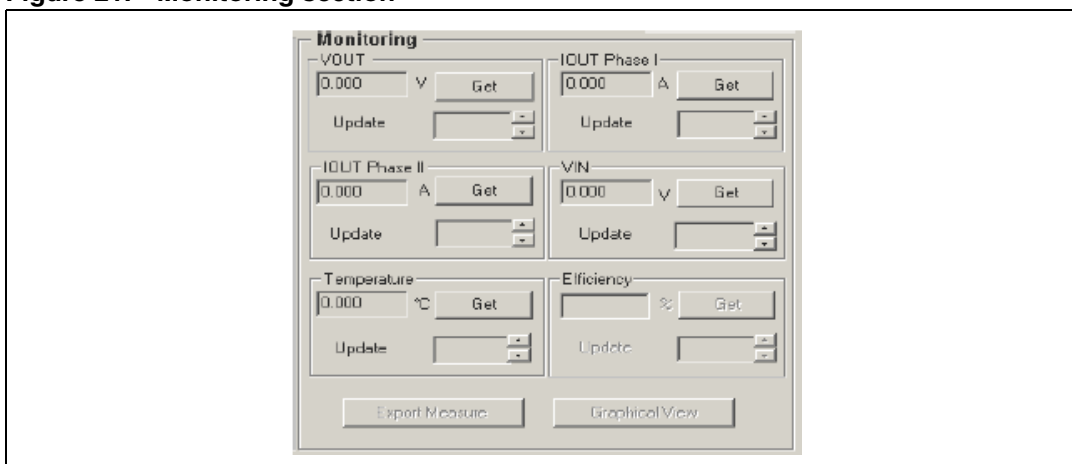
Figure 20. Status section



### 3.1.4 Monitoring section

In this section the current and voltage related parameters are read at the time of slave selection and can be periodically updated by changing the update interval value.

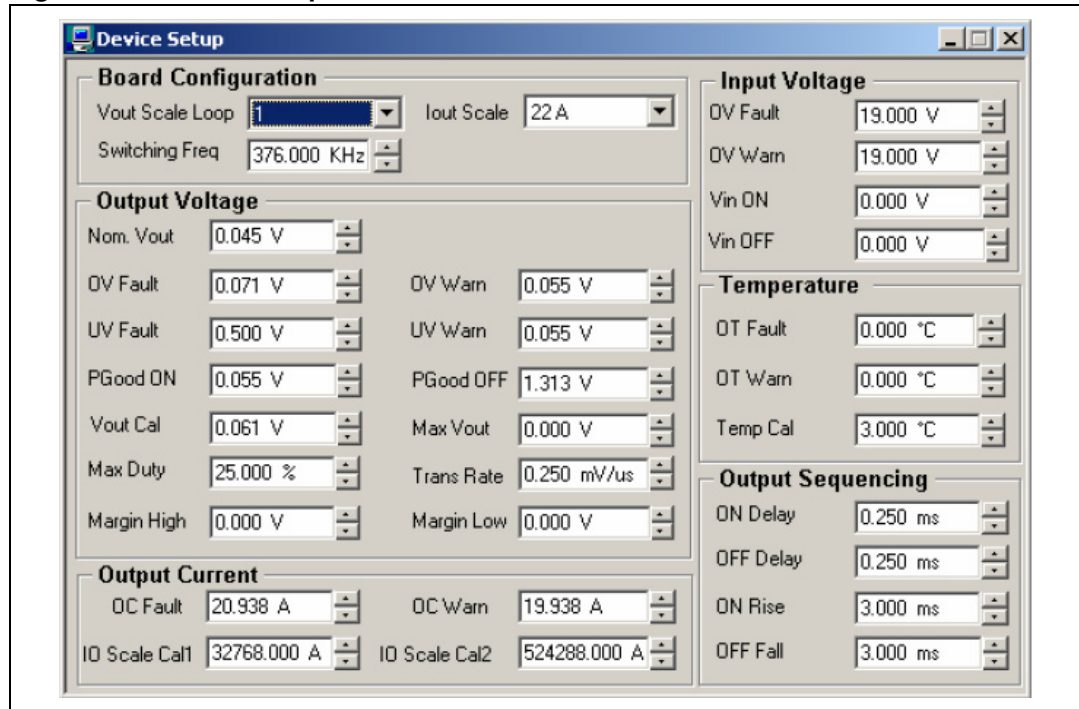
Figure 21. Monitoring section



### 3.2 Device setup window

The device setup window can be opened by either clicking on the device setup icon or by following Operation ->Device Setup Window.

Figure 22. Device setup window



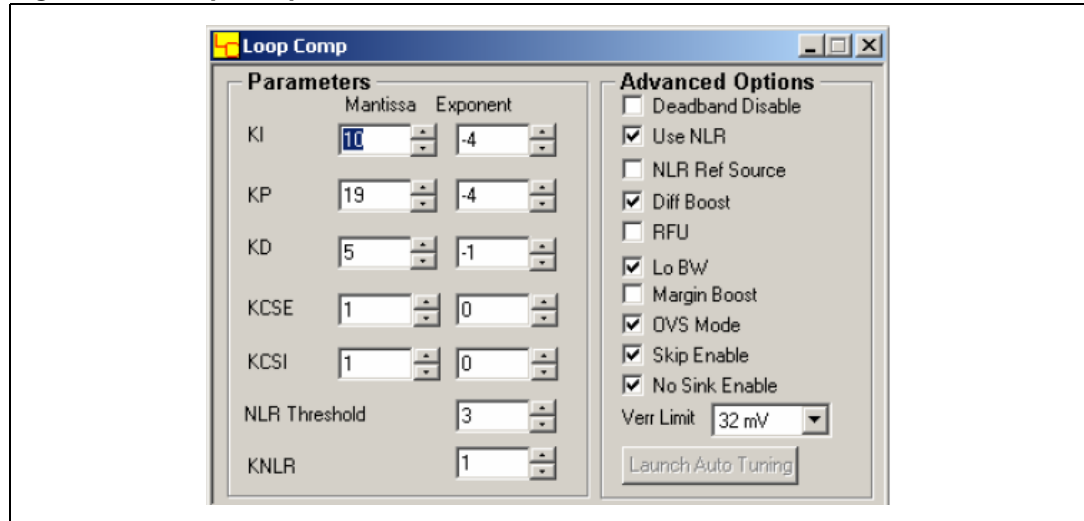
At the time of opening the window, all the parameters are read from the device, and they can then be increased or decreased by the user. Here, the resolution for voltage related commands is equal to  $15.625 \text{ mV} * \text{VOUT\_SCALE\_LOOP}$ , while for output current fault and warn limits the resolution equals  $\text{IOUT\_SCALE\_MFR} / 64$ . For input voltage related commands the resolution is 62.5 mV.

### 3.3 Loop comp. window

The loop comp. window can be opened by either clicking on the loop comp. icon or by following Operation-> Loop Comp. Window.

At the time of opening the window all the parameters are read from the device and they can then be modified by increasing/decreasing or by checking/un-checking the boxes.

Figure 23. Loop comp. window

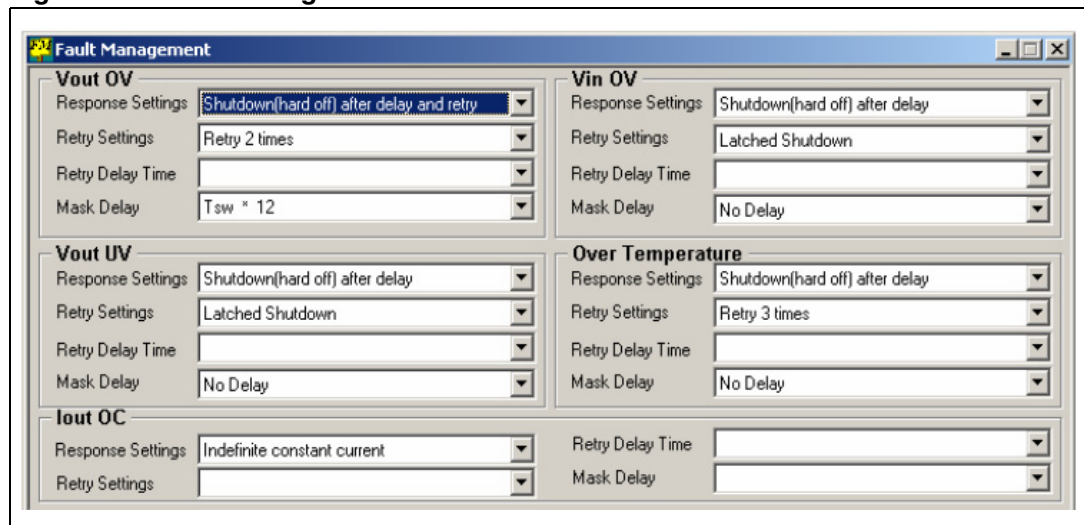


### 3.4 Fault management window

The fault management window can be opened by either clicking on the fault management window icon or by following Operation->Fault Management Window.

As soon as the fault management window is opened, the parameters are read from the PMBus slave and updated in the corresponding fields. These parameters can then be configured by the user.

Figure 24. Fault management window



### 3.5 Device information window

The device information window can be opened by either clicking on the device information window icon or by following Operation-> Device Information Window.

This window consists of three sections:

1. ST data
2. MFR data
3. PMBus revision

The MFR data section is also manufacturer specific. For details, please refer to the relevant datasheets for PMBus products (e.g. Point-of-load (POL) converters) which act as PMBus slaves.

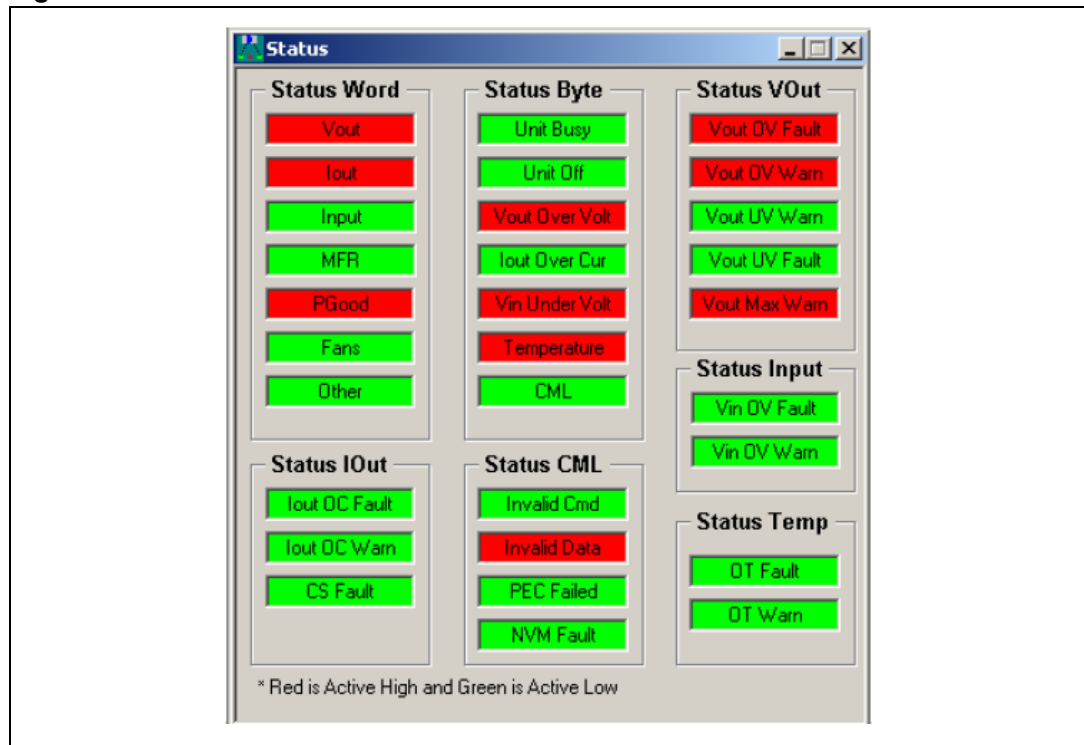
The PMBus section shows the PMBus spec revision supported by the slave.

### 3.6 Device status window

The device status window can be opened by either clicking on the device status window icon or by following Operation-> Device Status Window.

This window shows the status information retrieved from the PMBus slave. The status Byte shows the most critical fault conditions. The red colored box indicates that a fault has occurred.

Figure 25. Device status window



## 3.7 Manual command window

The manual command window can be opened by either clicking on the manual command window icon or by following Operation-> Manual Command Window.

Manual commands can be classified in two types:

1. Single command (Receive/Send Byte, Read/ Write Byte, Read/ Write Word, Read/ Write Block)
2. Group command

The Device address allows the user to enter the slave address. This field must be filled with the address of the selected slave.

The command ID field allows the user to write any PMBus command. To know the PMBus command code, please refer to the relevant datasheets for PMBus specifications or PMBus compatible products. As soon as the command ID is entered, the command type field and command description are automatically selected by the GUI.

The data field allows the user to enter the data in the case of write commands and shows the data received from the board in the case of read commands. This field automatically selects the length in accordance to the command ID entered and doesn't allow the user to enter data beyond the data length mentioned in the PMBus specification.

The read/write button allows the user to read/write the command accordingly.

The command description field describes the command and is read only. In the case of an unsupported command, it shows the unknown command in the box and is read only.

### 3.7.1 Single command

In the case of a single command, the user is able to read and write PMBus commands. The command is sent to the PMBus slave as soon as the user selects the read/write button. If the command is read only, the write button is disabled.

### 3.7.2 Group command

In the case of a group command, the user is only allowed to write the PMBus commands. The send group command button allows the group command to be sent, as mentioned in the PMBus specification. The group command protocol is used to send commands to more than one PMBus device. The commands are sent in one transmission. To terminate the group command, it is necessary to check the box against the last group command and press the send group command with the last command and data filled. If this box is not checked, the data is treated as either single command or group command. During group command, the received slave addresses, command codes, and data from the GUI are buffered by the MCU firmware. After the last command of the group command is sent from the GUI, all buffered data are transmitted from master to slave.



Figure 26. Manual command window

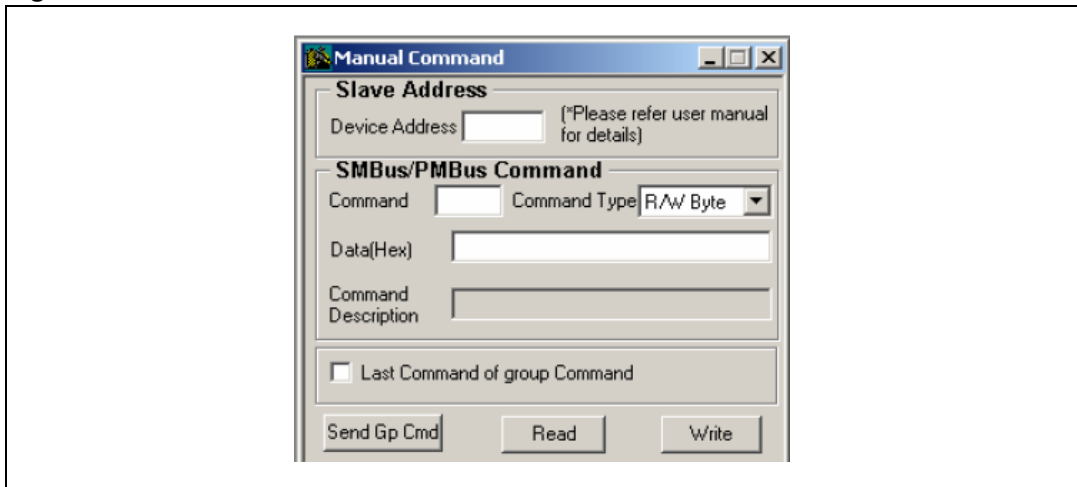


Figure 27. Error in case of no slave address

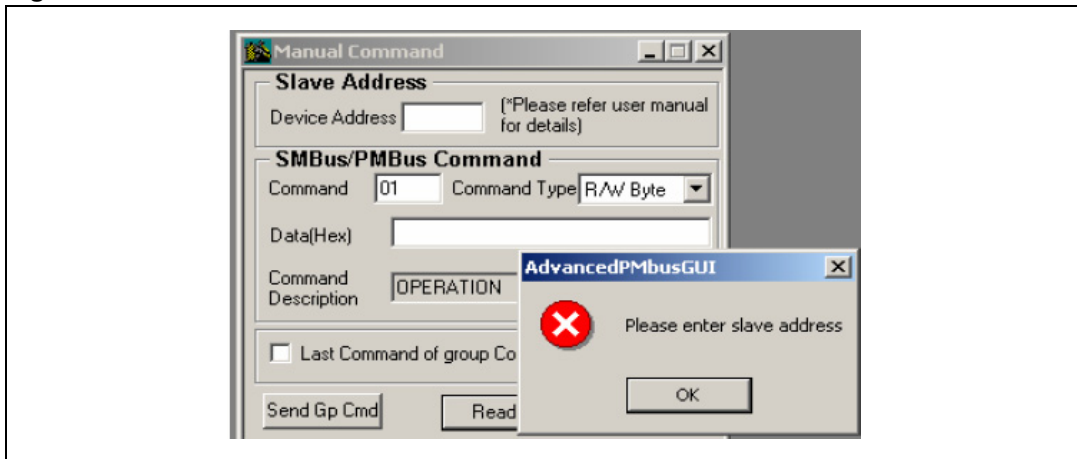
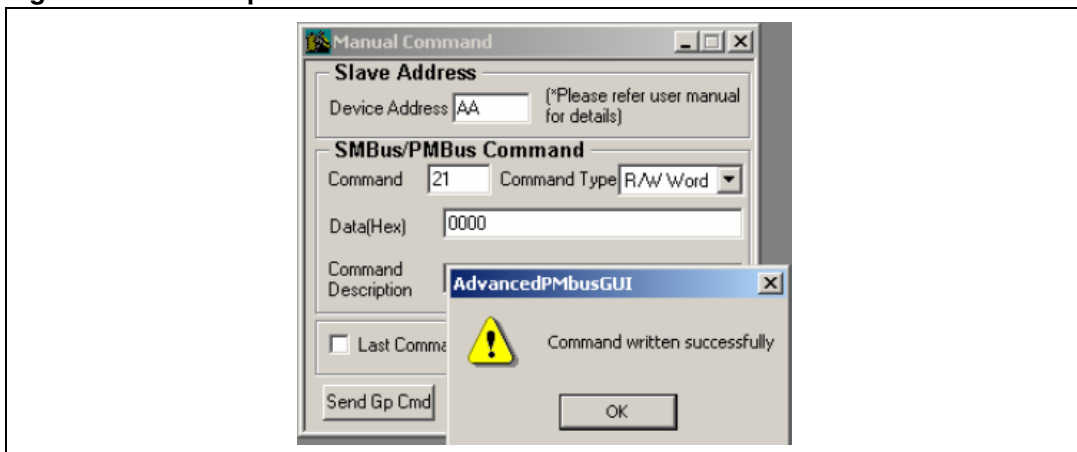


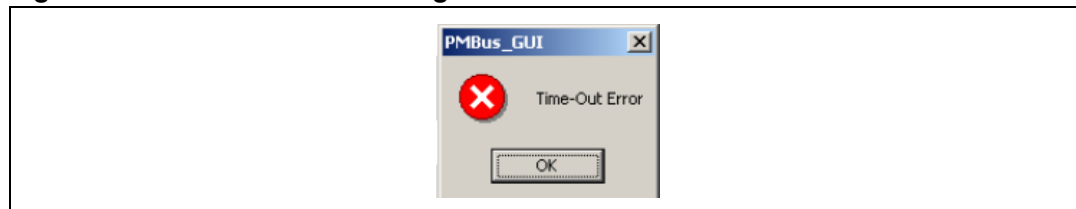
Figure 28 shows an example of the data writing process through the PMBus.

Figure 28. Write operation



In the case of an error occurring in PMBus communication, such as the slave device is busy or doesn't respond within the time limit mentioned in PMBus 1.1 specs, the GUI then shows the error message 'Time-Out Error'.

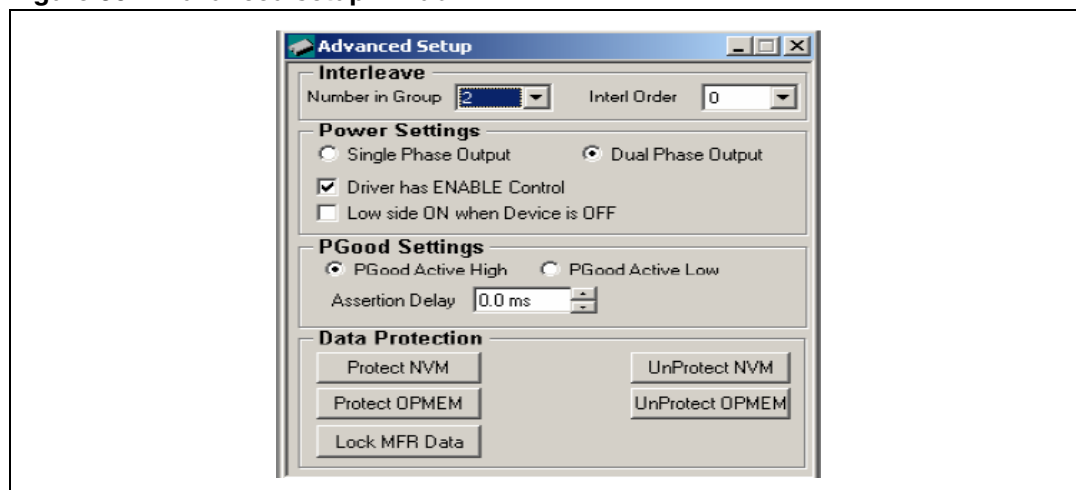
Figure 29. Time-out error message



### 3.8 Advanced setup window

The advanced setup window can be opened by either clicking on the advanced setup window icon or by following Operation-> Advanced Setup Window.

Figure 30. Advanced setup window





*Note:* This version of the board supports 5 V on the control and alert line and 3.3 to 5 V operation on the clock and data lines, so the level translator (U4) and diodes (D4 and D5), are not mounted.

## 4.2 BOM list

Table 5. BOM list

Reference	Value/generic part number	Package	Manufacturer	Manufacturer ordering code	Supplier
C1,C2	33 pF	SMD 805	Any		
C3,C5,C7,C9, C10, C12, C13, C14	100 n	SMD 805	Any		
C4	10 $\mu$ F	SMD 1210	Any		
C6	10 n	SMD 805	Any		
C8	4.7 $\mu$ F	SMD 1210	Any		
C11	2.2 $\mu$ F	SMD 1206	Any		
C15	1 $\mu$ F	SMD 1206	Any		
D2	LED1	Green LED 3 mm	Any		
D3	LED2	Yellow LED 3 mm	Any		
D4, D5	STPS1L30A	DO-214AC	STMicroelectronics	STPS1L30A	
D6	1N4148	DO-35	Fairchild		
J3	ICC	SIP-6	Any		
J8	PMBus Con	Header 5X2	Any		
J9	EG 1313		E-Switch	EG2485-ND	Digi-Key
R1, R2, R4, R7	4.7 k $\Omega$	SMD 805	Any		
R3, R5	100	SMD 805	Any		
R6	1.5 k $\Omega$	SMD 805	Any		
R8, R9	470 E	SMD 805	Any		
R11	10 k $\Omega$	SMD 805	Any		
SW1	SW-PB		Any		
TP1	Test point1	SIP-1	Any		
U1	ST72F651AR6T1	TQFP 64-N	STMicroelectronics	ST72F651AR6T1	
U2	KF33BD	SO-8	STMicroelectronics	KF33BD	
U4	ST2378ETTR	TSSOP20	STMicroelectronics	ST2378ETTR	
U5	USB CONN	USB-B	Any		
XT1	12 MHz	HC49U	Any		
Casing	Casing	HM380-ND	Hammond	HM380-ND	Digi-Key

### 4.3 Physical dimensions

Figure 32. Top layer

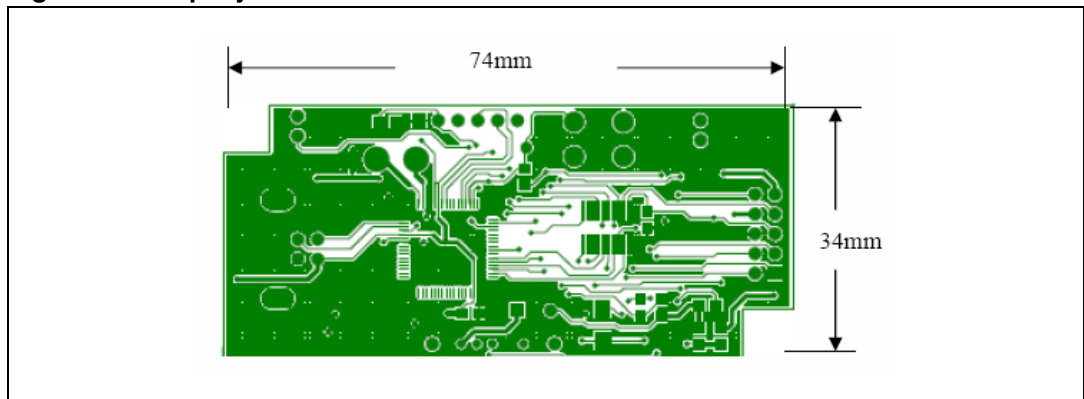
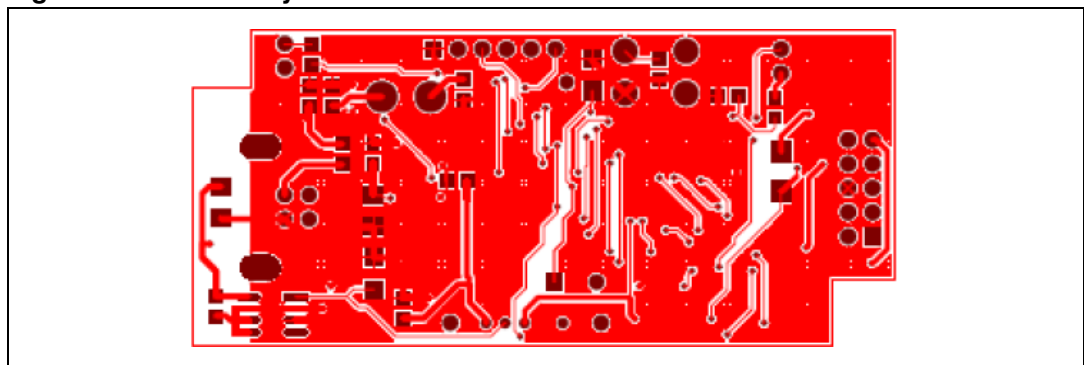


Figure 33. Bottom layer



## 5 Revision history

**Table 6. Document revision history**

Date	Revision	Changes
17-Nov-2010	1	First issue

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