



STEVAL-TCS003V1 based on the STMPE2403 24-bit port expander demonstration board

Introduction

This document explains the functioning of the port expander demonstration board which consists of the STMPE2403 port expander IC and the ST7263BK6 microcontroller, as the I²C master, along with a PC graphical user interface (GUI).

The objective of this demonstration board is to display the features and capabilities of the port expander chip (STMPE2403) using a Windows[®] based host software application and one of several USB low-speed microcontrollers (ST7263BK6) from STMicroelectronics, acting as a control device.

The host software and the ST7 source code provide a user friendly environment to use the demonstration board in the following modes:

- Standalone mode
- PC GUI mode.

In both modes, power to the board is provided from a USB mini B-type connector.

In this demonstration board, the ST7263BK6 microcontroller acts as the I²C master and controls one STMPE2403 device functioning as the I²C Slave. The STMPE2403 devices are used to interface a matrix keypad, dedicated keys, special function keys, rotator controller and PWM controllers. All these interfaces are controlled by using just I²C communication between the master and the slave device.

In run mode, events such as key press (matrix, special function or dedicated keys), rotator controller, power mode, etc, are captured and displayed on the LCD screen and in the scan window of the PC GUI. The capability of the rotator controller is demonstrated by using a 3-pin jumper connector.

For interfacing with the PC GUI, the application layer is built above the USB core library, which makes all the hardware control of the USB interface transparent.

The PC GUI supports various power saving modes of the port expander and wakeup feature to return to default operational mode.

In addition, the board has the provision for an alternate I²C path for external control.

The board also has an ICC connector to re-program the ST7 microcontroller Flash memory.

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1 Getting started

1.1 System requirements

In order to use the port expander demonstration board with the Windows operating system (OS), a recent version, such as Windows 2000 or Windows XP must be installed on the PC.

The version of the Windows OS installed on your PC may be determined by clicking on the System icon in the control panel.

1.2 Package contents

The port expander demonstration board includes the following items:

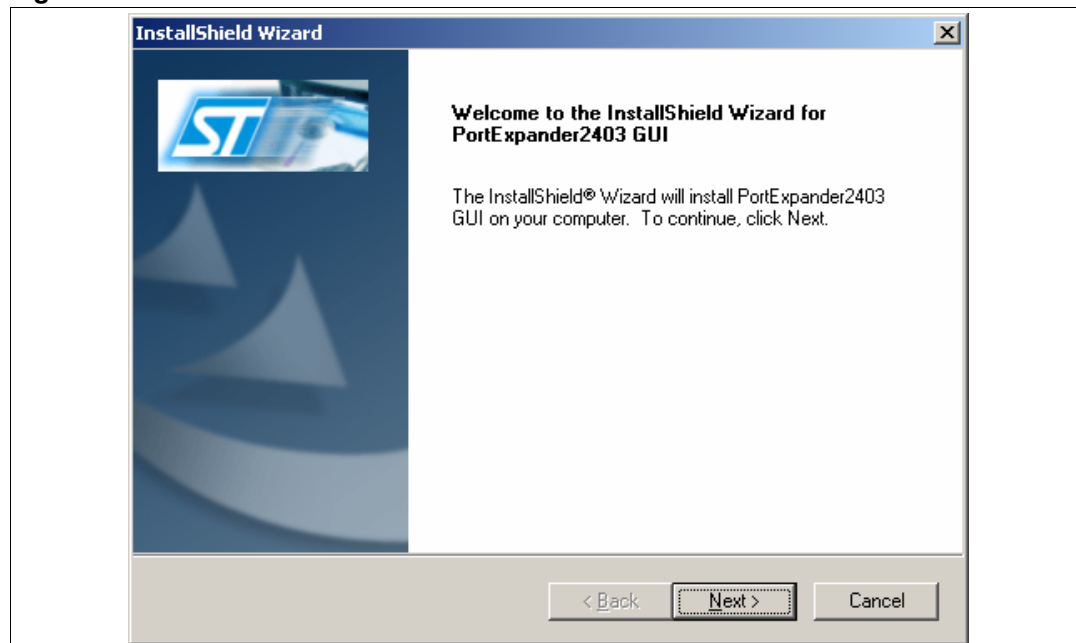
- Hardware content
 - One demonstration board.
- Software content
 - PC executable software to be used along with the demonstration board
- Documents
 - User manual

1.3 Software installation

To install the PC GUI software, follow these steps:

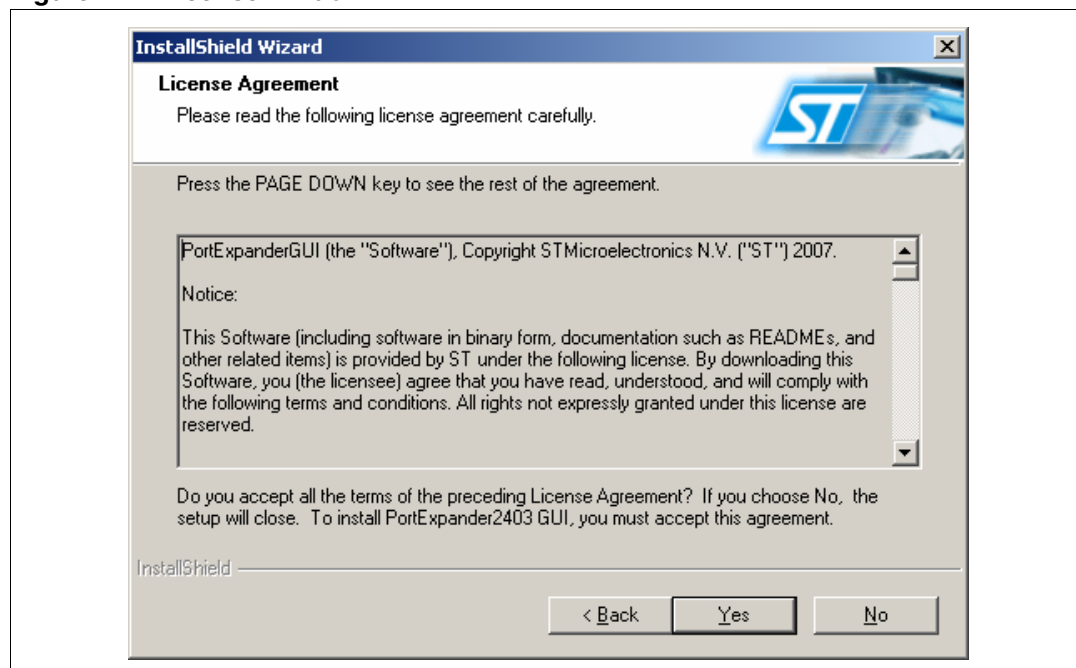
- Step1: As soon as the user clicks the PC GUI setup file (.exe) icon. The following window appears:

Figure 1. Installation window



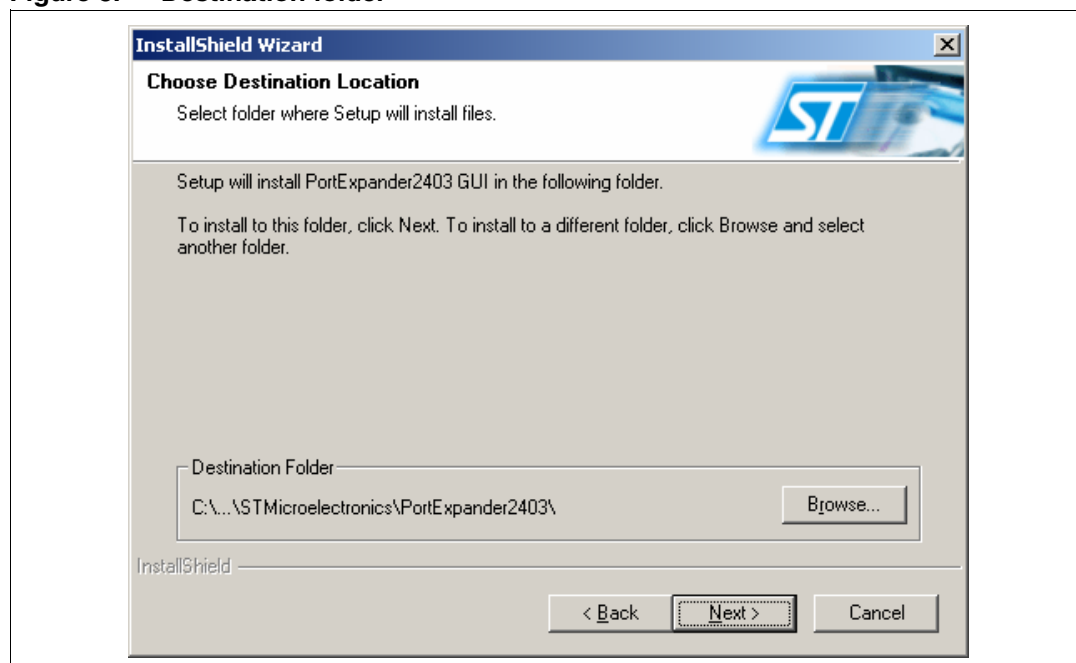
- Step 2: Read the license file and click the Yes button if you accept the license.

Figure 2. License window



- Step 3: Please select the folder in which you want to install the software. By default it installs the software in the following path - C:\Program Files\STMicroelectronics\PortExpanderSTMPE2403.

Figure 3. Destination folder



- Step 4: After you select the folder and click the Next button, it starts installing the software.

Figure 4. Installation ongoing

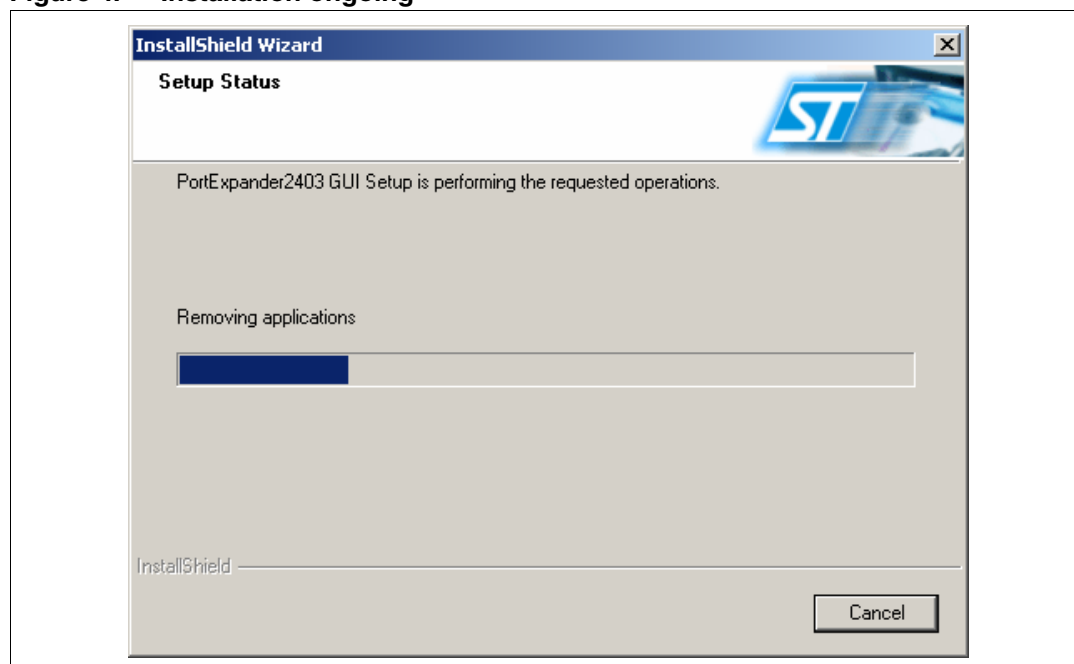
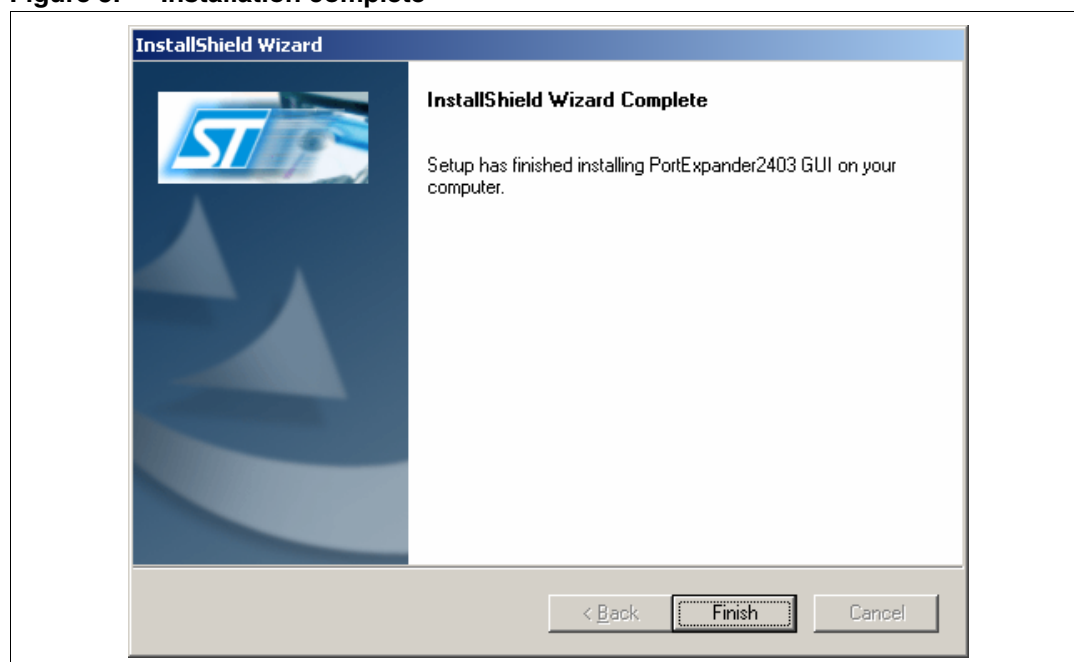


Figure 5. Installation complete

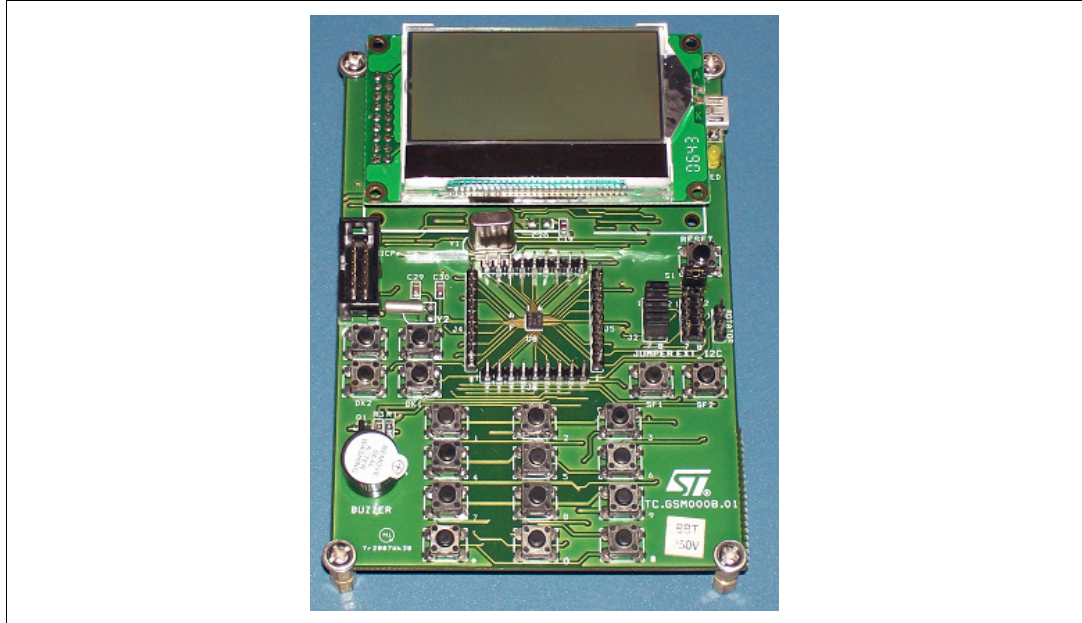


After clicking the Finish button, the software has been installed in the selected directory or in the default directory. A shortcut for this software is also available in the Start menu. This user manual is also available in the same directory.

1.4 Hardware installation

[Figure 6](#) shows a snapshot of the STMPE2403 demonstration board (STEVAL-TCS003V1).

Figure 6. STMPE2403 port expander demonstration board (STEVAL-TCS003V1)



1.4.1 Power supply

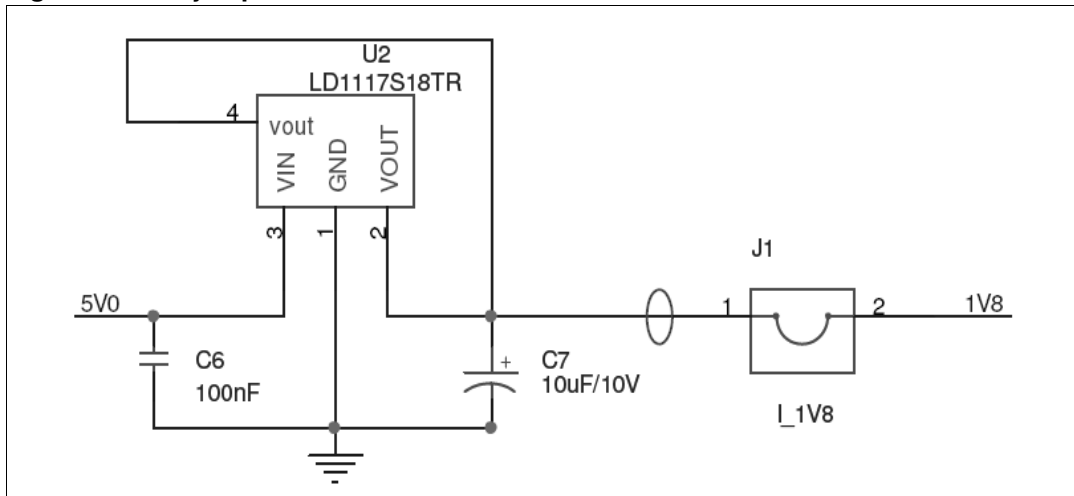
The demonstration board is directly powered by the USB mini B-type connector (bus powered).

1.4.2 Jumper settings

There are four jumpers, J1, J2 (Jumper) and EXT_I²C connectors are available on the board. The correct positioning of these connectors is necessary for the proper functioning of the demonstration board.

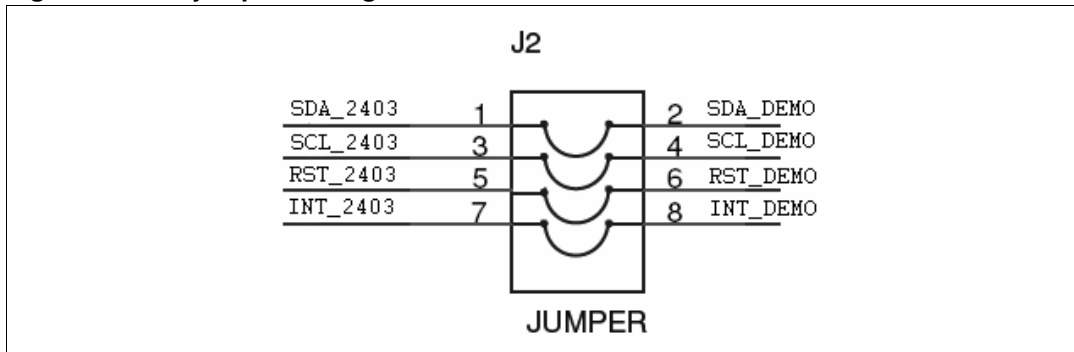
- J1: J1 is the jumper between the 1.8 V supply voltage and the supply pins of the STMPE2403 as shown in [Figure 7](#). It may be used for measuring the current consumed by the 1.8 V power supply or the STMPE2403 device.

Figure 7. J1 jumper for current measurement



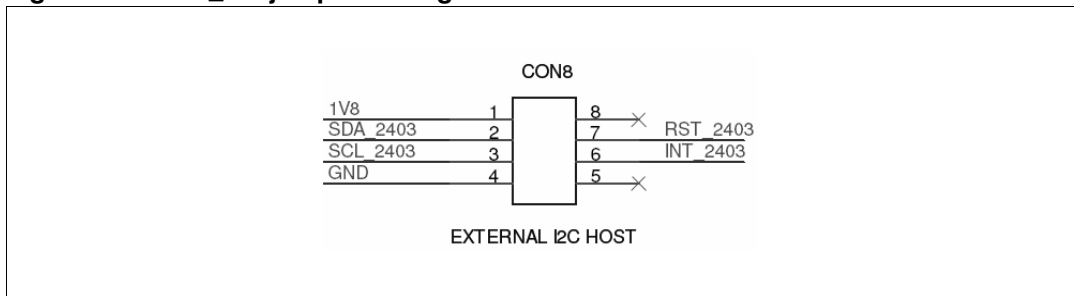
- J2: The J2 jumper structure is shown in [Figure 8](#). The control lines of the STMPE2403 device are connected to the ST7 controller device through these jumpers. By default, it is necessary to short these lines.

Figure 8. J2 jumper settings



The EXT_I²C: EXT_I2C jumper structure is shown in [Figure 8](#). The EXT_I²C jumper is an 8-pin connector used by the external I²C host to control the STMPE2403 device. See [Section 3](#) for more details.

Figure 9. EXT_I²C jumper settings



2 Running the STMPE2403 port expander demonstration board

This port expander demonstration board consists of two main parts:

- PC GUI
- Demonstration board.

In standalone mode, the demonstration board can be used without PC GUI.

Please connect the J1 and J2 jumpers before connecting the power supply to enable the demo mode.

2.1 Running in standalone mode

Within a few seconds of plugging in the power supply, a welcome message appears on the LCD screen which means that the demo has started correctly.

Then a series of messages appear on the LCD screen. At the end, a help manual explaining the features available in the standalone mode appears. For the first time user, it is advisable to go through the help manual in order to use the demo correctly by pressing key '1' available on the demonstration board. You can exit this help manual by pressing key '2'.

If you find that no message appears on the LCD screen after connecting the power supply, remove the power supply and plug it in again, and then observe. The message should now appear on the LCD screen. If this does not happen, even after removing and plugging in the power supply several times, it is necessary to contact technical support.

The following feature is available in standalone mode.

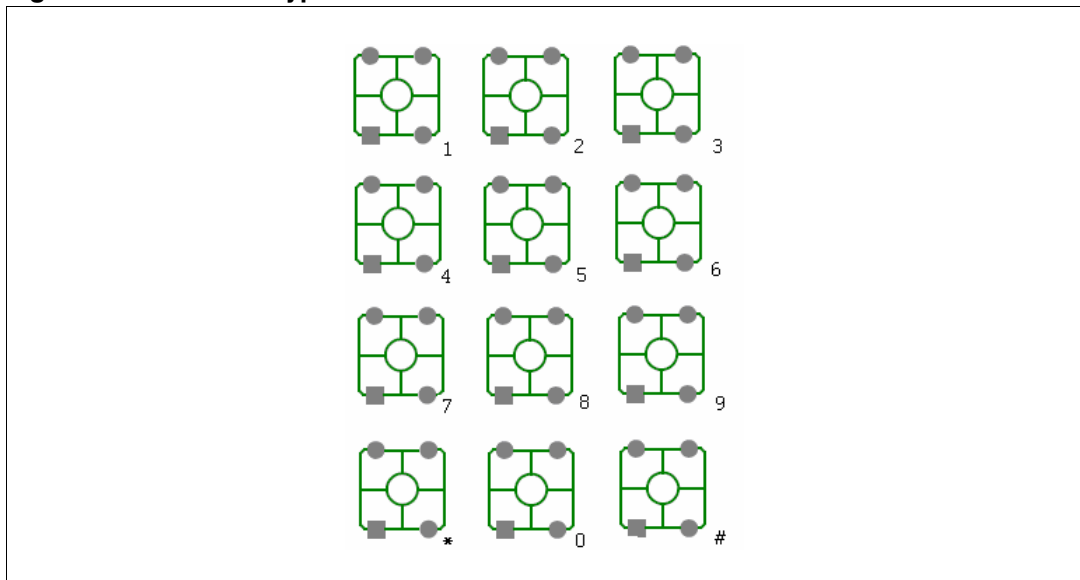
2.1.1 PWM signals in standalone mode

There are 3 PWM outputs available in the STMPE2403 device. PWM 1 is used to drive the buzzer available in the demonstration board, PWM 2 is used to drive the LCD backlight and PWM 3 is used to drive an LED available in the demonstration board.

2.1.2 Matrix keypad demo

There is a 6x2 normal keypad (Key 0-9, '*' and '#') available on the demonstration board as shown in [Figure 10](#).

Figure 10. Normal keypad

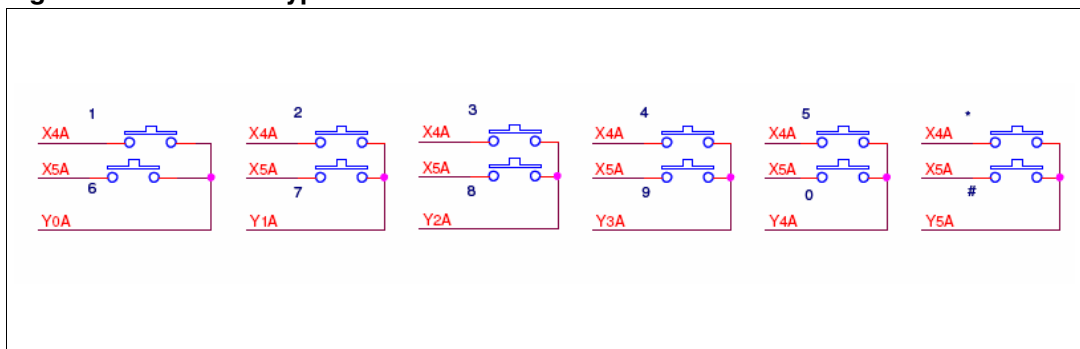


You can observe 3 simultaneous key press events at most. The key press events are recorded on a 128X64 monochrome LCD. Other than key press detection, this keypad is used for certain special purposes if the first key pressed is one of the following:

- Key '*' pressed event: If the first key pressed is '*' then the keypad goes into locked state and then no other key except the 'Reset' button is detected. The keypad is unlocked from the key press event detection when key '*' is pressed again.
- Key '#' pressed event: If the first key pressed is '#' then the keypad goes into PWM programming mode and then it is necessary to follow the instructions on the LCD screen to proceed further. The '*' key is unavailable to lock the keypad in this mode.
- Key '0' pressed event: If the first key pressed is '0' then the LCD displays the help menu. The '*' key is unavailable to lock the keypad in this mode.

Ghost key detection: The current version of the demonstration board does not deal with ghost key detection in order to keep the demo simple. To understand better please see [Figure 11](#):

Figure 11. Normal keypad schematic

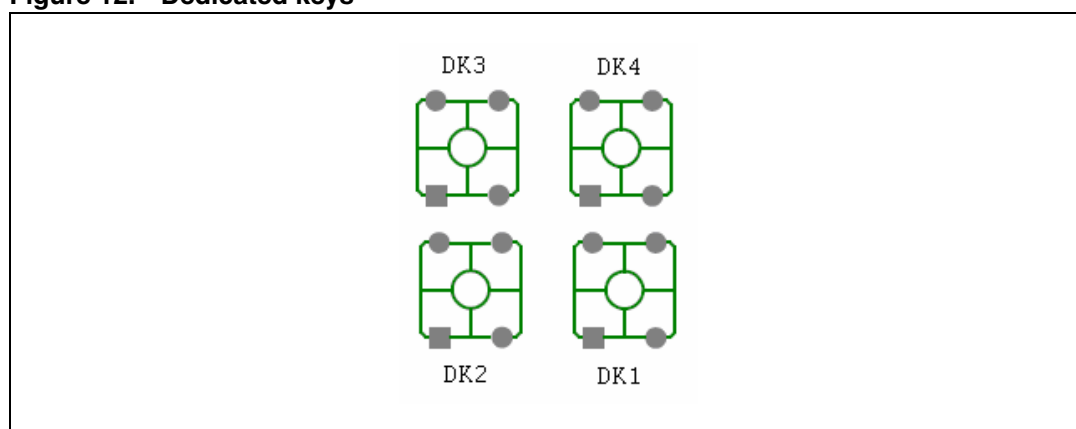


As shown in [Figure 11](#), if key '1' and key '2' are pressed, then you can observe that by pressing these keys, the input column lines X4 are shorted with output row lines y1 and y0. So now if you press key '7', the input column line X5 is also shorted with y0 (along with y1). Therefore, depending on the keypad controller scanning, either key 6 or key 7 may be reported instead of the correct key pressed. So in this case while the correct key pressed is key '7', key '6' may also be falsely reported.

2.1.3 Dedicated keypad demo

Similar to normal Key press, there are 4 dedicated keys available on the demonstration board as shown in [Figure 12](#). In comparison to the normal keypad where you can detect 4 keys simultaneously, here you can observe 4 dedicated keys simultaneously. All dedicated key press events are displayed on the LCD screen.

Figure 12. Dedicated keys



2.1.4 Special function key demo

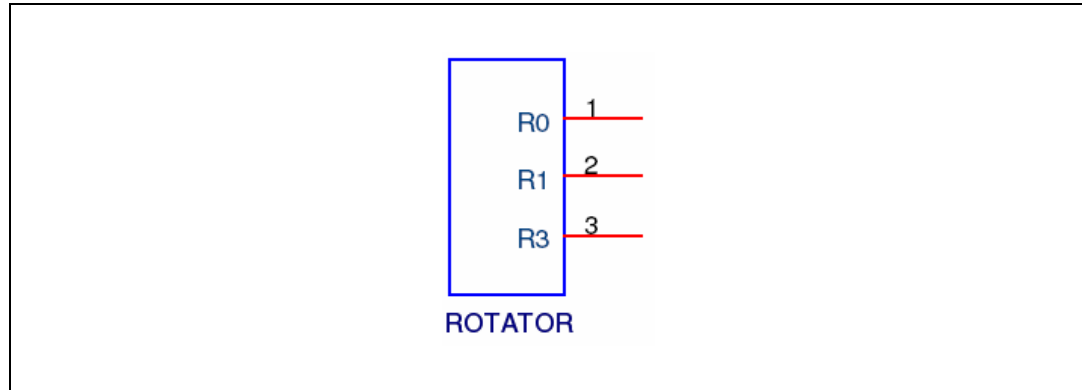
There are two special function keys, SF1 and SF2, available on the demonstration board. These lines are driven by input column lines X4 (for SF1) and X5 (for SF2). As mentioned in the STMPE2403 datasheet, if you have already pressed SF1 and then you try to press key 1 to 5 and '*', then these keys are not detected. Similarly if you have already pressed SF2 then if you try to press key 6 to 9, 0 and '#', then these keys are not observed.

SF1 and SF2 are also used to control enable/disable for the PWM output controlling the buzzer and the LCD backlight. If you press SF1, the LCD starts blinking, which is reset in case you press SF1 again. Similarly if you press SF2, then the buzzer sounds and is stopped by pressing SF2 again.

2.1.5 Rotator demo

The rotator is implemented using 3 pin connectors as shown in [Figure 13](#).

Figure 13. Rotator interface



To use the rotator, you need to use an external means to short these pins in cycle to observe the rotator events. These events are displayed on the LCD screen.

2.1.6 Screen-saver mode in standalone mode

The demo enters screen-saver mode if there is no key press event for quite some time and exits screen saver-mode once a key is pressed. Although the key press event is not observed on the LCD screen. Furthermore, any special function associated with a key is not performed when the demo is exiting screen-saver mode.

2.1.7 Programming PWM signals in standalone mode

There is an option in demo mode to program the PWM signal from the 4 PWM program available in the demo. The programming procedure on the demonstration board is as follows:

- Press key '#'
- Press 1 to enter PWM programming mode
- Select PWM by pressing key 1, 2, or 3
- Select the program by pressing key 1, 2, 3 or 4.

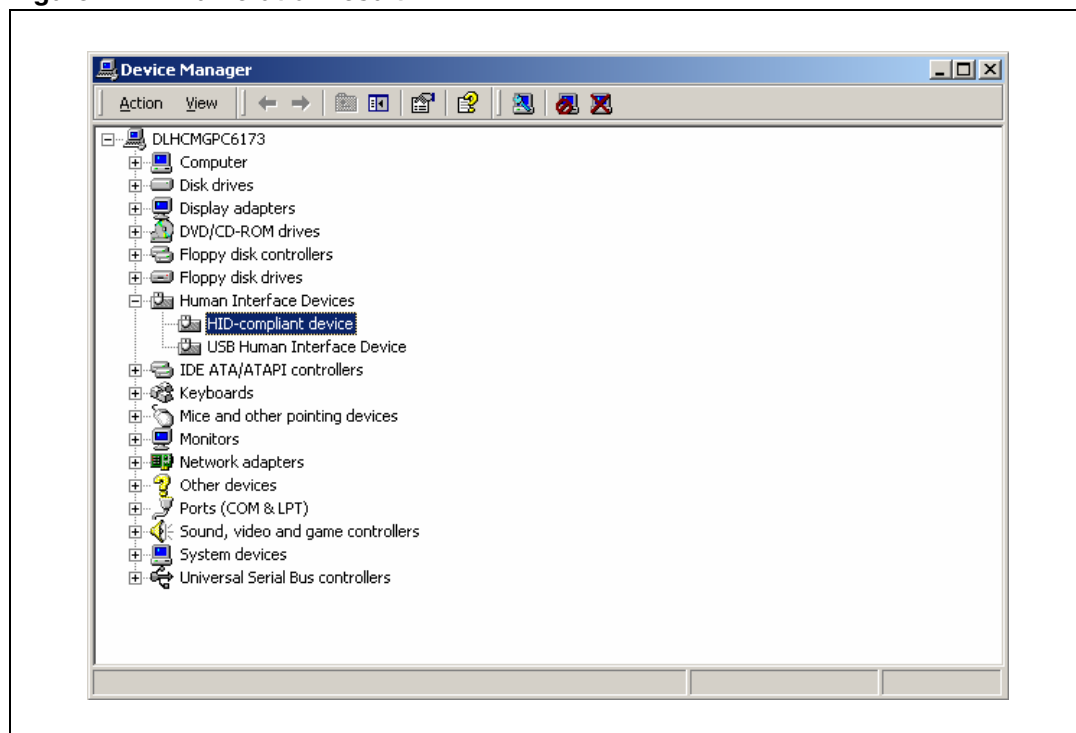
These instructions are also visible on the LCD screen which help to easily program the PWM.

2.2 Running in PC GUI mode

In GUI mode, in addition to the functions mentioned in the above section, PC GUI is also available. To run the GUI, the demonstration board must first be connected to the PC with the USB mini B-type cable, after positioning the jumper settings as described in [Section 1.4.2](#).

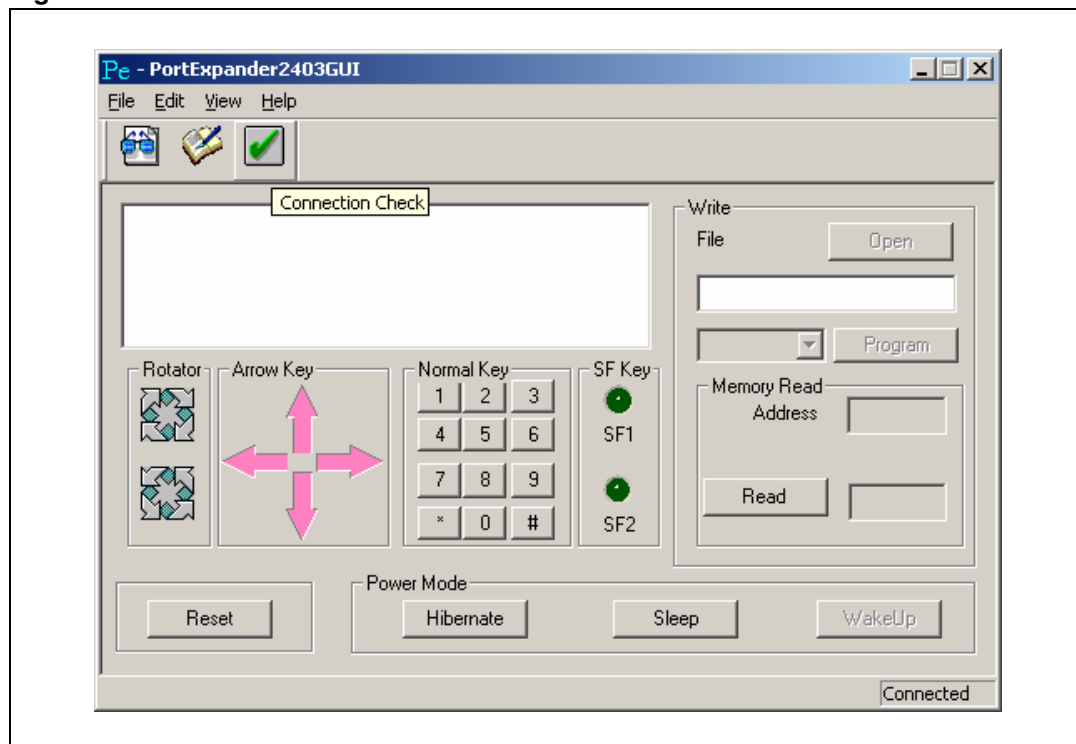
As a result, you should find the demonstration board enumerated as a HID device, as shown in [Figure 14](#), and the board is then ready for use, if this message does not appear contact technical support.

Figure 14. Enumeration result



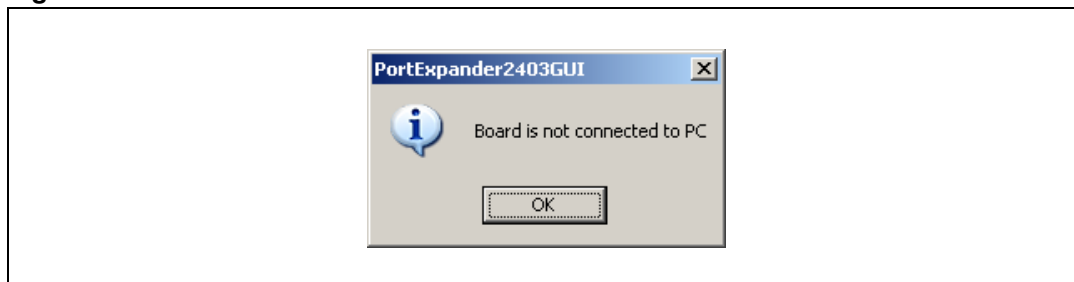
When starting the STMPE2403 GUI on the PC, a graphical interface appears ([Figure 15](#)) for controlling the demonstration board. This PC software is used to issue various commands and to control data transfer between the PC and the ST7 peripheral.

Figure 15. STMPE2403 PC GUI



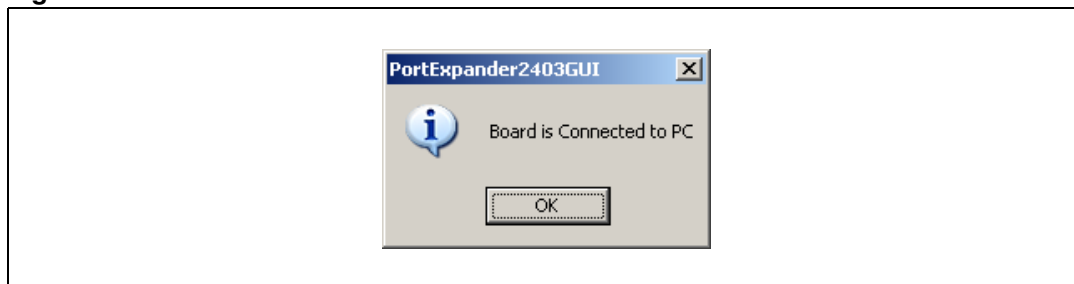
As seen in [Figure 15](#), you can check whether the board is connected or not by clicking the connection check button. If the board is not connected then the following message appears:

Figure 16. Board is not connected



And if the board is connected the following message appears:

Figure 17. Board is connected



Once this is done, the PC GUI is properly connected to the demonstration board and ready for use.

There are two operation modes in which the GUI operates:

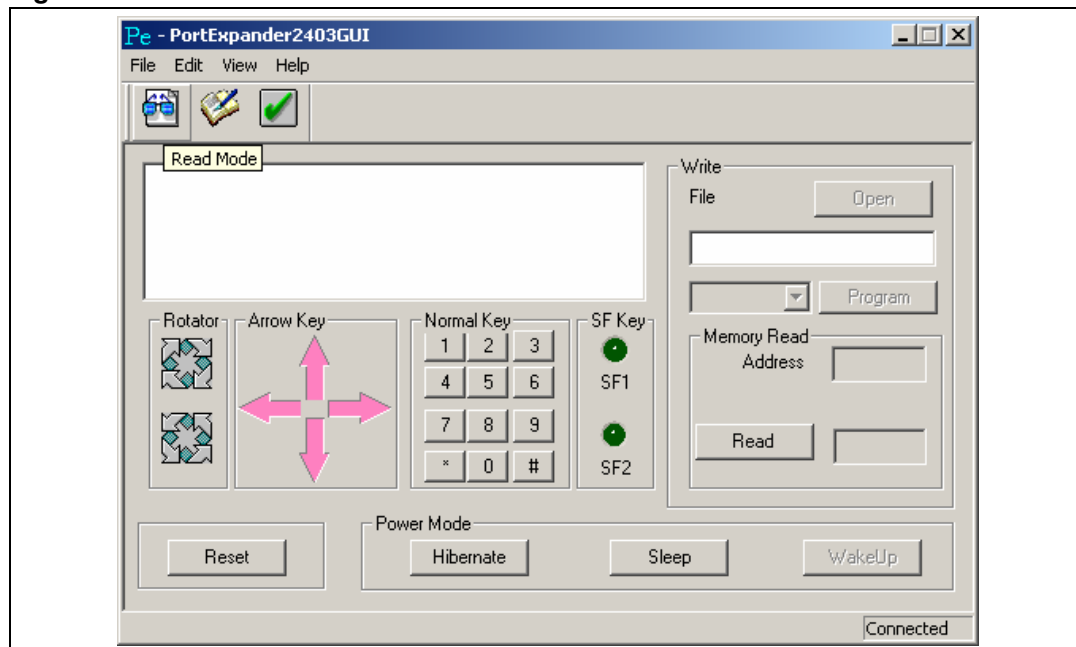
- Read/scan mode
- Write/program mode

In addition to these two modes, there are two power-down options available in the GUI to put the STMPE2403 into power-down mode. Again there is a Reset option available to return the demo to its default settings.

2.2.1 Read/Scan mode

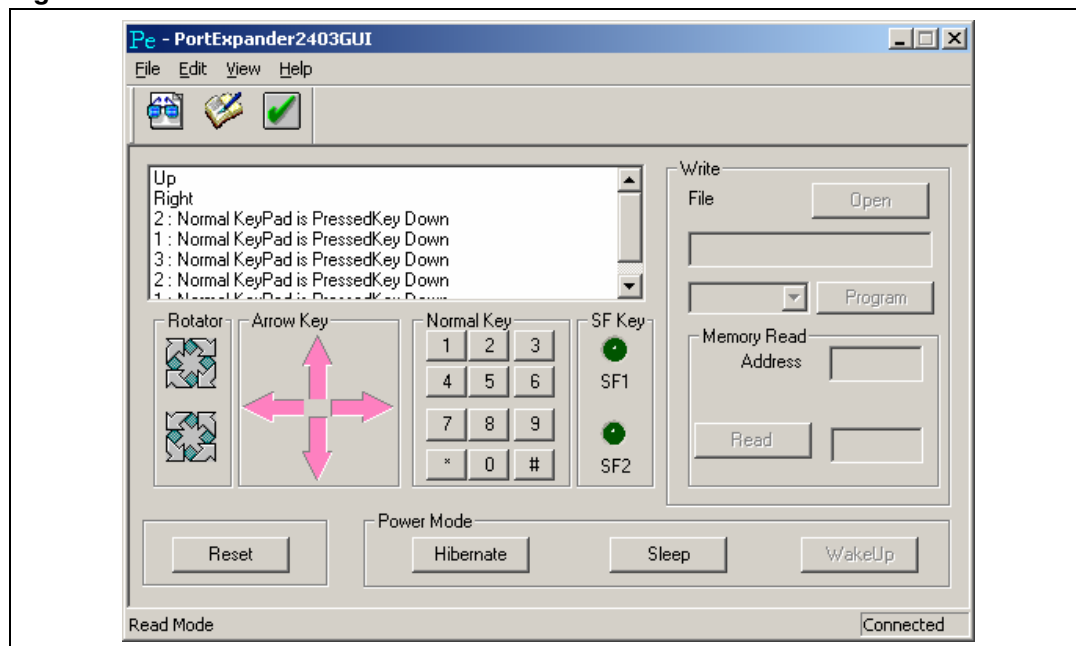
Enter the Read/Scan mode by clicking the Read/Scan button as highlighted in [Figure 18](#).

Figure 18. Read/Scan mode



In Read/Scan mode, you can observe the key press, dedicated key press, and rotator events. These events are also recorded in the scan window while the current session of scanning is ongoing so that you can observe or track the past activity, as shown in [Figure 19](#).

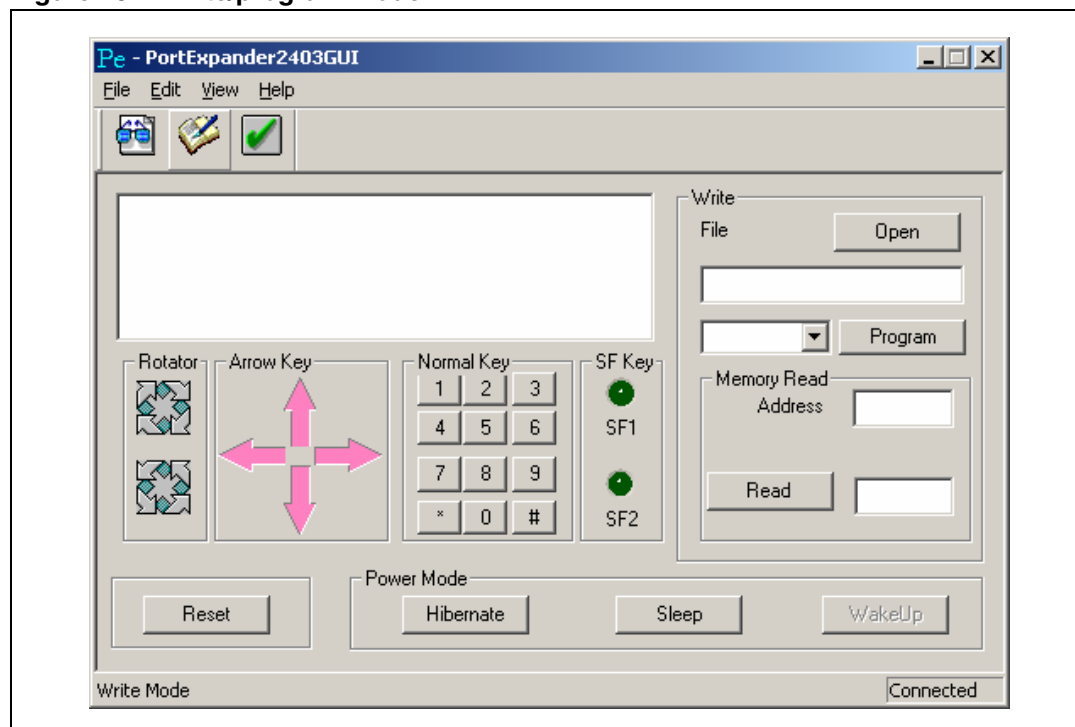
Figure 19. Events in scan window



2.2.2 Write/program mode

Enter this mode by clicking the Write/Program button, as highlighted in [Figure 20](#).

Figure 20. Write/program mode

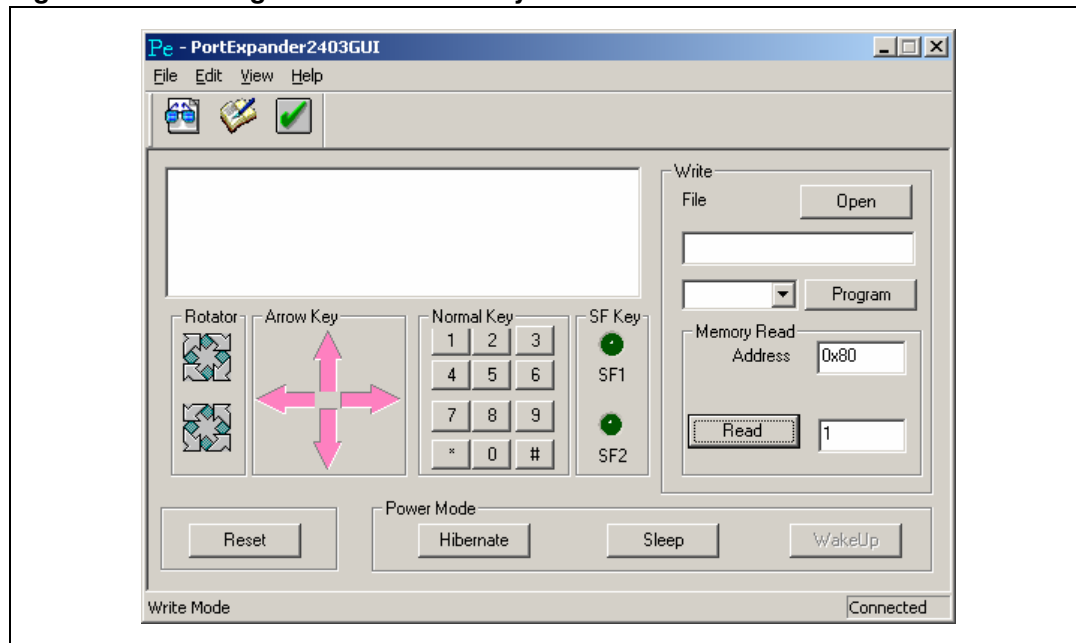


After clicking the Write/Program button, the Write mode becomes active if previous scanning being carried out has stopped. The Write mode provides the feature of reading the internal memory of either slaves, or to program any PWM output.

Reading the internal memory of the STMPE2403

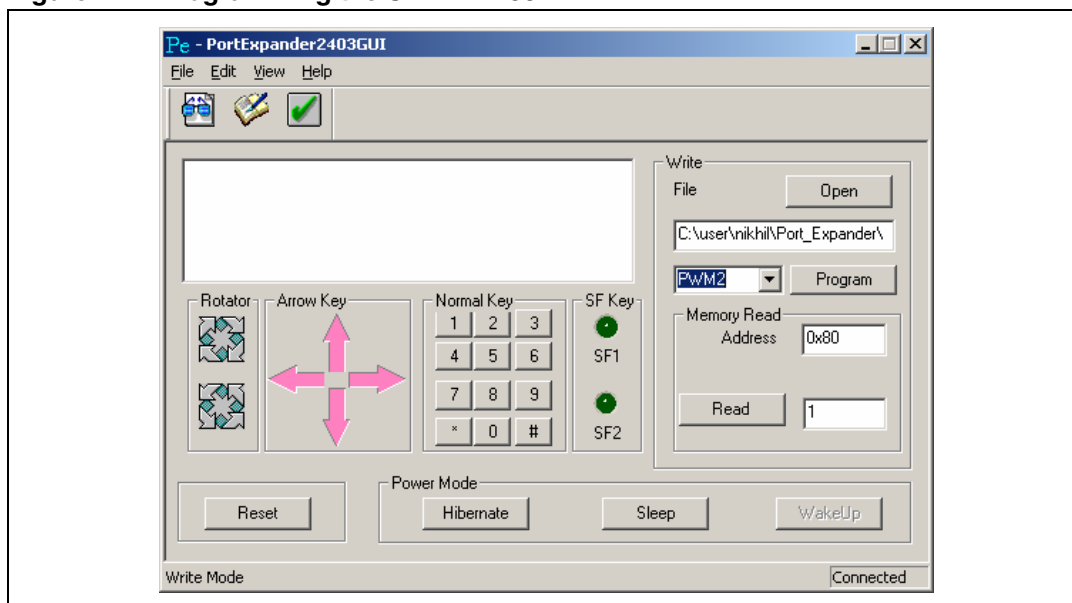
Read the internal memory of a particular STMPE2403 slave device by selecting the Memory Read section from the pop menu as shown in [Figure 21](#). Then you can read the memory by writing the 8-bit address in the Address box and then clicking Read. The return data is in HEX format.

Figure 21. Reading the internal memory of the STMPE2403



Programming PWM

To program either of the 3 PWM outputs coming from the STMPE2403 slave devices, firstly select the PWM to be programmed from the pop menu in the Write Mode section as shown in [Figure 22](#), and then load the correct PWM file (*.pex) by clicking the Open button. Now click the Program button to program the particular PWM. If the PWM file is correctly programmed then you should observe the correct PWM signal on the CRO by connecting the CRO probe at the programmed LED output. If there is any error, for e.g. a PWM programmed with a faulty program, then the particular PWM LED stops blinking.

Figure 22. Programming the STMPE2403 PWM

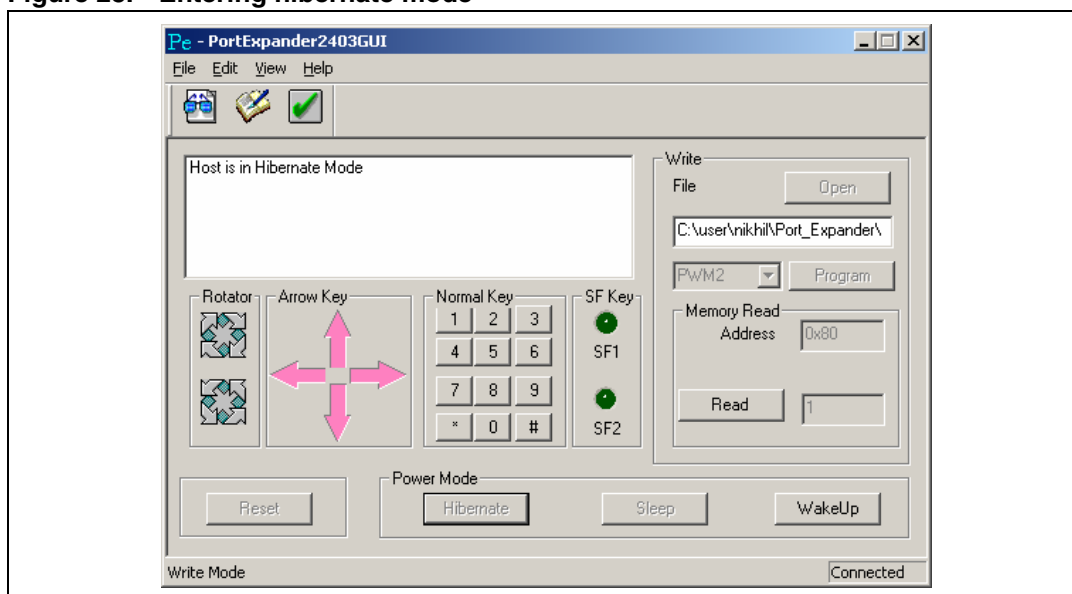
By clicking the Reset button the demo goes to default settings and all the PWMs start running with the default program loaded in their memory.

2.2.3 Power-down mode

There are 2 power-down modes as mentioned below-

- Hibernate mode
- Sleep mode

The STMPE2403 slave devices can be put into hibernate mode or sleep mode by clicking the corresponding button available on the GUI (see [Figure 23](#)).

Figure 23. Entering hibernate mode

Similarly, you can enter sleep mode. There is a corresponding message that also appears on the LCD screen.

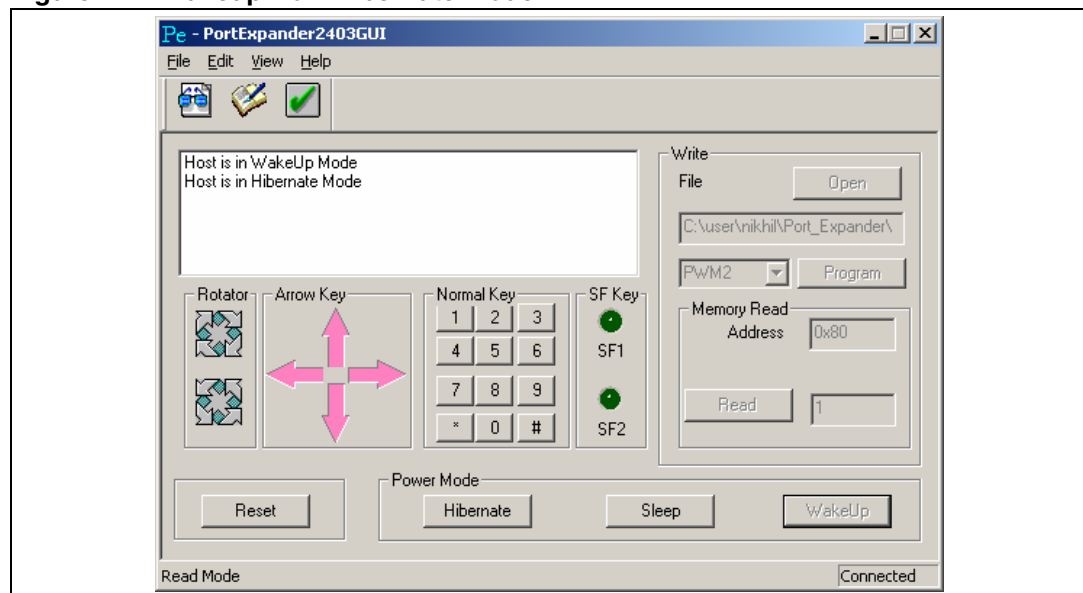
In Hibernate mode, you can observe that the clock to PWM is stopped and output LEDs stop blinking.

While in sleep mode, PWM keeps running as it is controlled by the 32 kHz clock.

To wake up the demo in the low power mode, click the wakeup button. A message appears in the Scan Window as soon as the demo comes out of the power-down mode, as shown in [Figure 24](#).

You can also exit sleep mode by clicking any normal key or dedicated key available in the demonstration board.

Figure 24. Wakeup from hibernate mode



3 Using the external I²C master

Use an external I²C master by using the 8-pin EXT_I²C connector explained in [Section 1.4.2](#).

To control the STMPE2403 device using the external masters follow these steps:

- First remove the jumper settings of the J2 jumper to free the demo from ST7 control.
- Now use the EXT_I²C connectors to connect the external I²C host to different control lines of the STMPE2403 device which are 1V8, Gnd, RST, INT, SCL and SDA.

Now the demonstration board is ready to control using the external I²C. In this mode, the PC GUI is not available to the external user. Again you must use the slave address as specified in the demo which is 0x84 for the STMPE2403 device.

After using the external I²C master, to return to the normal mode, do the following:

- After completing the required operations, remove the EXT_I²C connectors.
- Connect the J2 jumper.
- Click the Reset button on the demonstration board to put the demo back into action.

These I²C lines are working at 5 V power supply so the external I²C master should use 5 V power supply.

Appendix A Schematic and BOM list

3.1 Schematic

Figure 25. LCD interface section

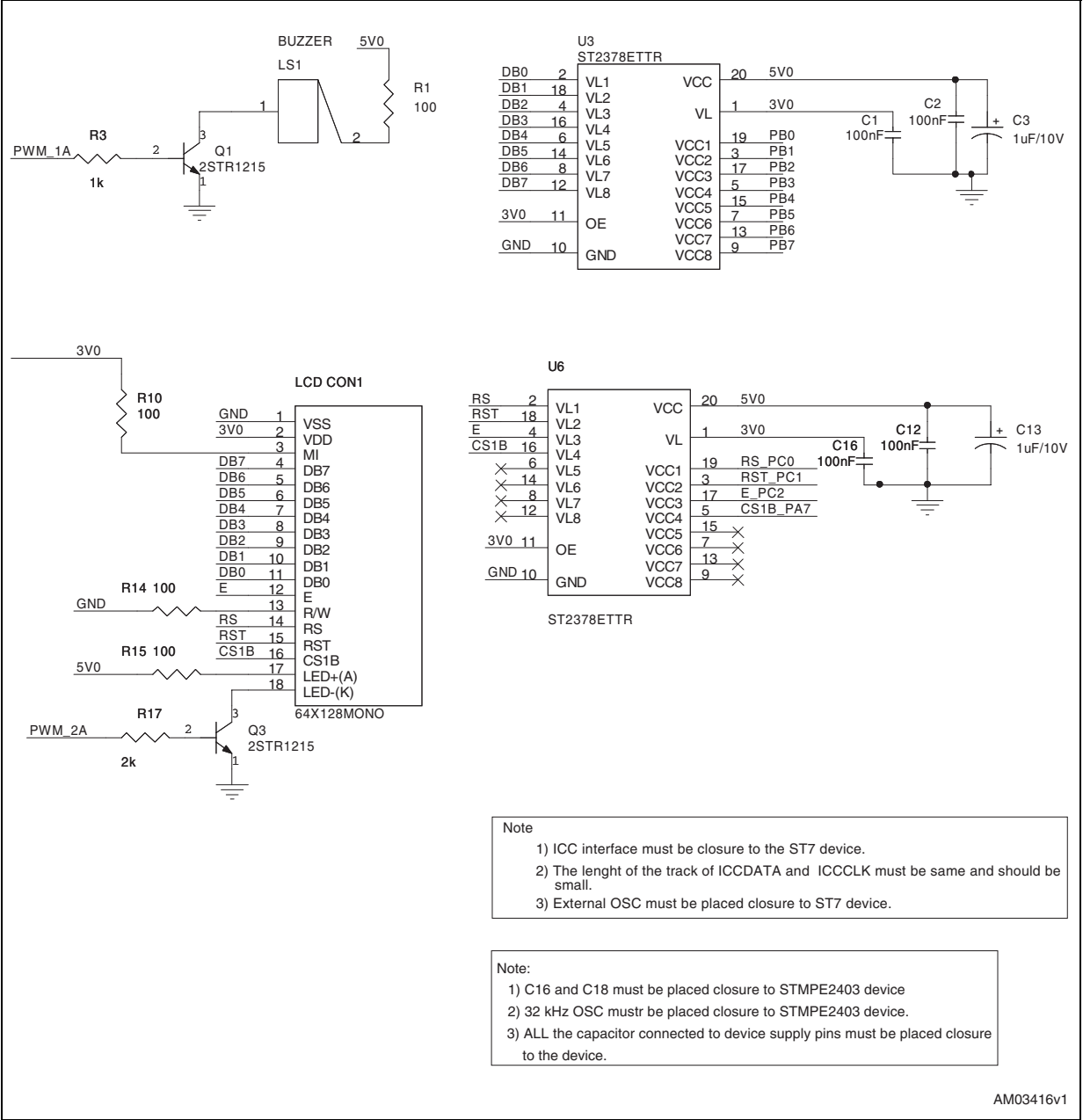
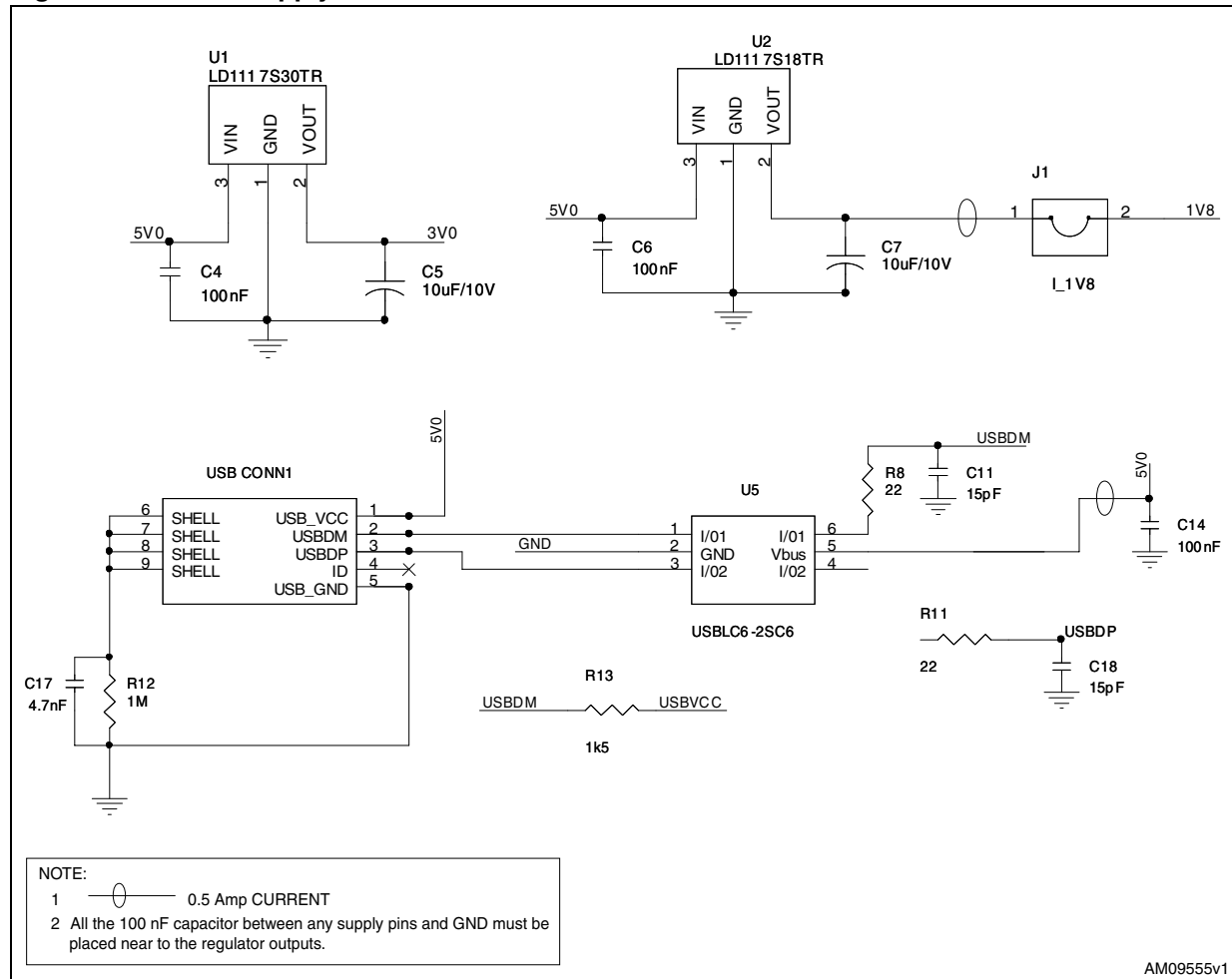


Figure 26. Power supply section



AM09555v1

Figure 27. ST7 microcontroller section

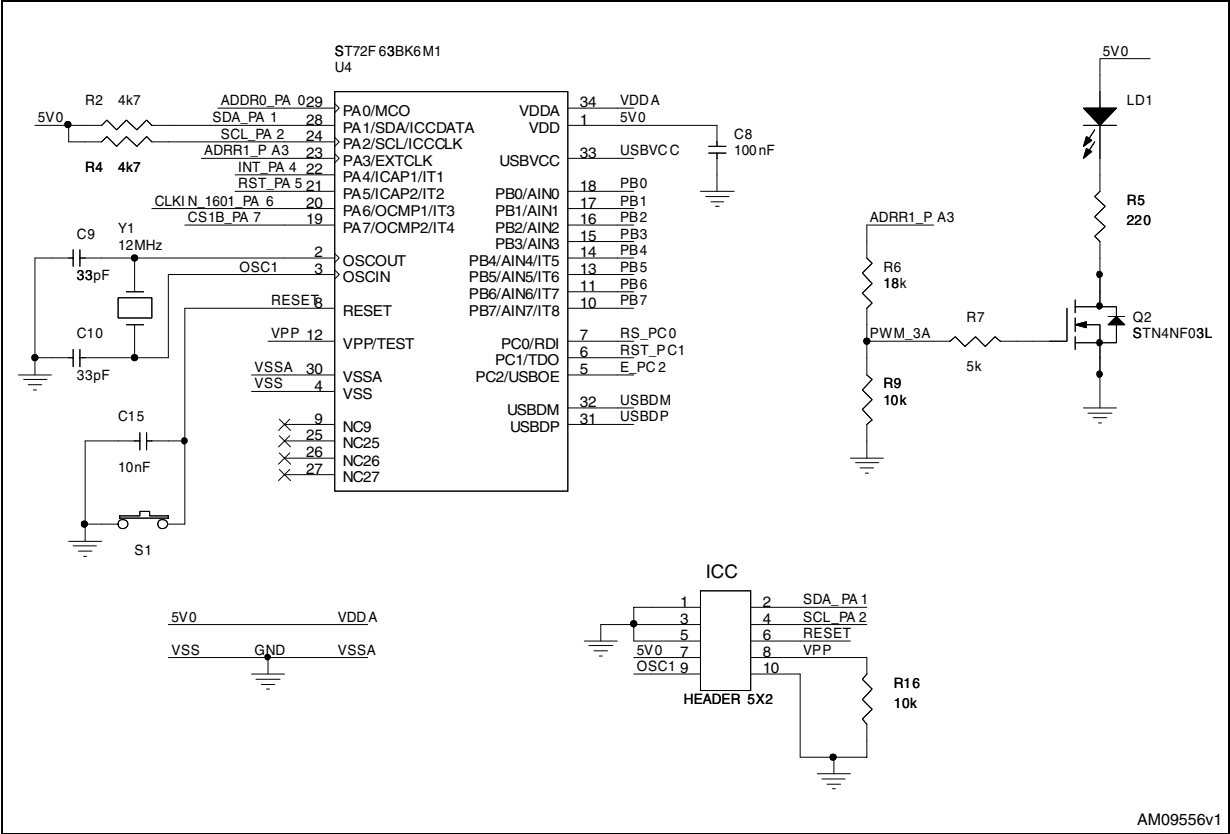


Figure 28. ST7 microcontroller section

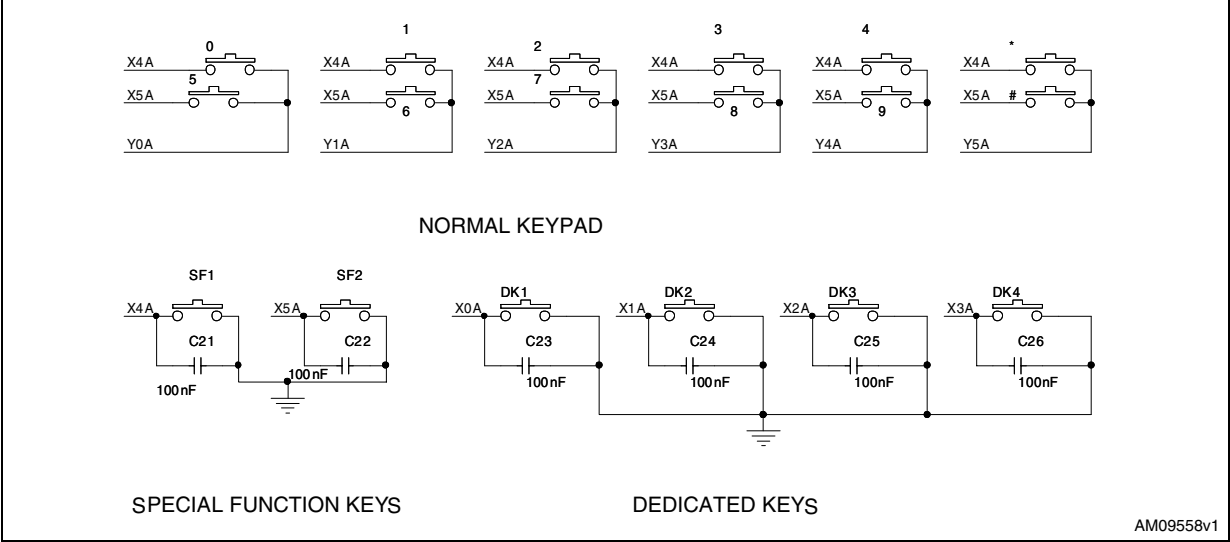


Figure 29. ST7 microcontroller section

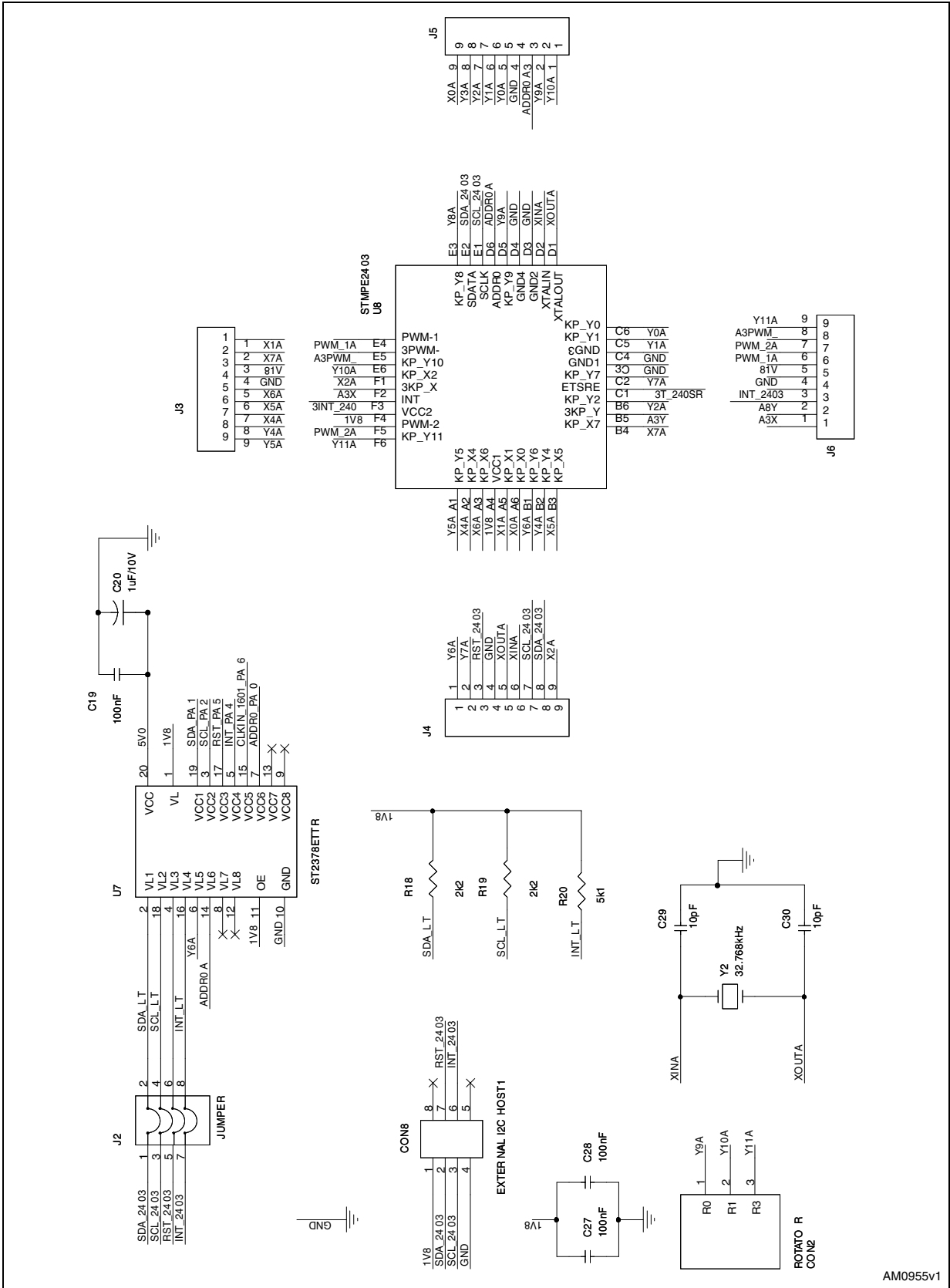


Table 1. STMPE2403 demonstration board BOM list

Reference	Value / generic part number	Package
SF1,DK1,1,SF2,DK2,2,DK3,3,DK4,4,5,6,7,8,9,0,*,#	SW pushbutton	Push button
CON1	HEADER 5X2	IDC-10B
CON2	ROTATOR	SIP3
C1,C2,C4,C6,C8,C12,C14,C16,C19,C21,C22,C23,C24,C25,C26,C27,C28	100 nF	805
C3,C13,C20	1 μ F/10 V	RB-5.5
C5,C7	10 μ F/10 V	RB-5.5
C9,C10	33 pF	USB-B
C11,C18	15 pF	805
C15	10 nF	805
C17	4.7 nF	805
C29,C30	22 pF	805
D1	LED	LED - 3 mm
EXTERNAL I ² C HOST1	CON8 BERG 2 way	2 x SIP4
J1	I_1V8	SIP2
J2	Jumper BERG 2 way	2 x SIP4
J3,J4,J5,J6	BUGSTICK single	SIP2
J7,J8,J9,J10	BUGSTICK single	SIP9
LCD CON1	64X128mono BERG 2 way	2 x SIP9
LS1	BUZZER	AXIAL
Q1,Q3	2STR1215	SOT-23
Q2	STN4NF03L	SOT-223
R1,R10,R14,R15	100 Ω	805
R2,R4	4.7 k Ω	805
R3	1 k Ω	805
R5	220 Ω	805
R6	18 k Ω	805
R7	5 k Ω	805
R8,R11	22 Ω	805
R9,R16	10 k Ω	805
R12	1 M Ω	805
R13	1.5 k Ω	805
R17	2 k Ω	805
R18,R19	2.2 k Ω	805

Table 1. STMPE2403 demonstration board BOM list (continued)

Reference	Value / generic part number	Package
R20	5.1 k Ω	805
S1	Reset	Push button
USB CONN1	USB-B	any
U1	LD1117S30TR	SOT-223
U2	LD1117S18TR	SOT-223
U3,U6,U7	ST2378ETTR	TSSOP20
U4	ST72F63BK6M1	SO-34
U5	USBLC6-2SC6	SOT-23-6L
U8	STMPE2403TBR	TFBGA36
Y1	12 MHz	CRYS
Y2	32.768 kHz	XTAL-3

4 Revision history

Table 2. Document revision history

Date	Revision	Changes
09-Mar-2011	1	Initial release

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