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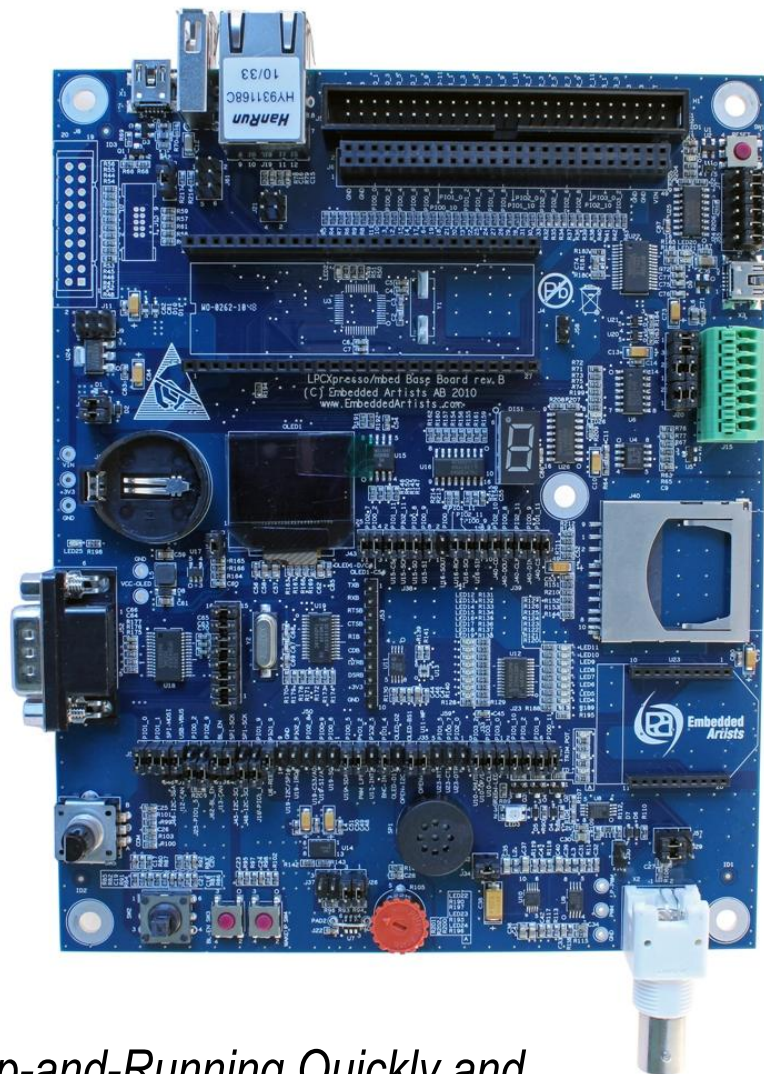
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# LPCXpresso Base Board rev B - User's Guide

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## LPCXpresso Base Board Rev B User's Guide



*Get Up-and-Running Quickly and  
Start Developing Your Applications On Day 1!*

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# 1 Document Revision History

<i>Revision</i>	<i>Date</i>	<i>Description</i>
PA1-PA2	2010-01-20	First incomplete version.
PA3	2010-01-24	Second, still incomplete version.
PA4	2010-01-25	Added more information about jumper settings.
PA5	2010-01-26	Added information to the Getting Started Chapter.
PA6	2010-01-26	Completed chapter 5 and 6.
PA7	2010-01-28	Completed chapter 4 and updated chapter 6.
PA8	2010-01-29	Updated chapter 3 and added Troubleshooting chapter (8).
PA9	2010-01-30	First complete version.
PA10	2010-02-10	Added information about PIO0_11 analog input.
PA11	2010-02-11	Added information about J54 in section 8.1.
PA12	2010-02-17	Corrected errors in Figure 23 and Figure 35.
PA13	2010-02-20	Added information about SW4 and updated powering instructions.
PA14	2010-02-22	Updated section 3.3: Added a recommendation to use the USB interfaces on the Base Board to power the board.
PA15	2010-03-28	Corrected default jumper settings picture (fig 10). Clarified the board powering information.
PA16	2010-10-21	Added information about rev A and rev B differences. Added information about mbed and LPC176x specific jumper settings.
PA17	2010-11-24	Updated section 3.9 and 3.10.3 regarding LPC176x ISP UART mode. Added section 3.10.4.
PA18	2011-01-19	Made this a separate document for rev B of the LPCXpresso Base Board. There is a separate document for rev A of the board. Clarified that LPC176x ISP mode is not directly supported by the board.
PA19	2011-06-15	Updated to generic pin names on the schematic. Added some LPC176x specific differences.
PA20	2011-06-21	Jumper setting for Fig 37 corrected. Also clarified that J41 (pin1-2) and J58 must not be inserted when using SD/MMC interface.
PA21	2011-08-18	Corrected Fig 35 to be for rev B of the board.
A	2011-08-24	Added section about LPCXpresso LPC11C24 differences.
B	2011-12-19	Added note about CE mark.
PC1	2013-01-25	Added clarifications around LPCXpresso LPC1768/1769 boards.

## 2 Introduction

Thank you for buying Embedded Artists' *LPCXpresso Base Board*, designed for the *LPCXpresso Board* (with multiple targets LPC176x, LPC134x, LPC1227, LPC11C24, LPC11U14, LPC111x, and more to come) and the *mbed* module from NXP.

This document is a User's Guide that describes the *LPCXpresso Base Board* hardware design. The general focus will be for the *LPCXpresso* boards but differences for the *mbed* module will be noted. All differences between different *LPCXpresso* target boards as well as *mbed* are gathered in a separate chapter; 6 *mbed and LPC1xxx Differences*.

### 2.1 Features

The *LPCXpresso Base Board* makes it possible for you to get started with experiments and prototyping immediately with the *LPCXpresso Board*. The *LPCXpresso Base Board* can also be used together with the *mbed* module.

The board has been design in cooperation with several Universities in order to also be suitable for training and education situations. The many on-board peripherals easy your learning curve and speed up your program development. The features of the *LPCXpresso Base Board* are:

- |                                    |  |
|------------------------------------|--|
| <i>Common features</i>             | <ul style="list-style-type: none"> <li>• Socket for <i>LPCXpresso</i> and <i>mbed</i> module</li> <li>• 50 pin expansion dual row pin list connector (male, 100mil pitch) for simple connection external designs and to a logic analyzer</li> <li>• 50 pin expansion dual row header connector (female, 100mil pitch) for simple connection to breadboard</li> <li>• Battery powering (small coin battery)</li> <li>• USB interface</li> <li>• Reset pushbutton</li> </ul> |
| <i>Digital IO</i>                  | <ul style="list-style-type: none"> <li>• RGB-LED (can be PWM controlled)</li> <li>• 5-key joystick switch</li> <li>• 2 pushbuttons, one for activating target mcu on-chip bootloader</li> <li>• Rotary switch with quadrature encoding (timer capture)</li> <li>• Temperature sensor with PWM output (timer capture)</li> </ul>  |
| <i>Analog IO</i>                   | <ul style="list-style-type: none"> <li>• Trimming potentiometer input (analog input)</li> <li>• PWM to analog LP-filtering (PWM output and analog input)</li> <li>• Speaker output (PWM output)</li> <li>• Oscilloscope probe inout stage</li> </ul>   |
| <i>Serial bus - SPI</i>            | <ul style="list-style-type: none"> <li>• Shift register driving 7-segment LED</li> <li>• SD/MMC memory card interface</li> <li>• Dataflash SPI-NOR flash</li> </ul>  |
| <i>Serial bus - I2C</i>            | <ul style="list-style-type: none"> <li>• PCA9532 port expander connected to 16 LEDs</li> <li>• 8kbit E2PROM</li> <li>• MMA7455L accelerometer with I2C interface</li> <li>• Light sensor</li> </ul>  |
| <i>Serial bus - I2C/SPI shared</i> | <ul style="list-style-type: none"> <li>• SC16IS752 - I2C/SPI to 2xUART bridge; connected to RS232 full-modem interface and one expansion UART</li> <li>• 96x64 pixel white <b>OLED</b> (alternative I2C/SPI interface)</li> </ul>  |
| <i>Serial bus - UART</i>           | <ul style="list-style-type: none"> <li>• USB-to-serial bridge, with functionality for automatic ISP activation (note: no such support for LPC176x and <i>mbed</i>)</li> </ul>  |

	<ul style="list-style-type: none"> <li>• RS422/485 interface</li> <li>• Interface socket for XBee RF-module</li> </ul>
<i>Specific mbed module support</i>	<ul style="list-style-type: none"> <li>• CAN bus interface (can be simulated with LPCXpresso)</li> <li>• Ethernet RJ45 connector with integrated magnetic</li> </ul>
<i>Dimensions</i>	<ul style="list-style-type: none"> <li>• 150 x 180 mm</li> </ul>
<i>Power</i>	<ul style="list-style-type: none"> <li>• Powered via USB (+5V)</li> </ul>

## 2.2 ESD and Handling Precaution

Please note that the *LPCXpresso Base Board* come without any case/box and all components are exposed for finger touches – and therefore extra attention must be paid to ESD (Electro-Static Discharge) precaution.

***Make it a habit to always first touch the metal surface of one of the USB or SC/MMC connectors for a few seconds with both hands before touching any other parts of the boards.*** That way, you will have the same electrical potential as the board and therefore minimize the risk for ESD.

***Note that Embedded Artists does not replace boards that have been damaged by ESD.***

Do not exercise pressure on the OLED display glass area. That will surely damage the display. Also, do not apply pressure on the flex cable connecting the OLED to the pcb. This cable is relatively sensitive and can be damaged if too much pressure is applied to it.

***Note that Embedded Artists do not replace OLED displays where it has been improperly handled.***

## 2.3 CE Assessment

The *LPCXpresso Base Board* (in combination with an LPCXpresso target board) is CE marked. See separate *CE Declaration of Conformity* document.

The *LPCXpresso Base Board* is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

EMC emission test has been performed on the *LPCXpresso Base Board* with the *LPCXpresso LPC1769 Board*. Standard interfaces like Ethernet, USB, serial have been in use. General expansion connectors where internal signals are made available (for example processor pins) have been left unconnected. Connecting other devices to the product via the general expansion connectors may alter EMC emission. It is the user's responsibility to make sure EMC emission limits are not exceeded when connecting other devices to the general expansion connectors of the *LPCXpresso Base Board*.

Due to the nature of the *LPCXpresso Base Board* – an evaluation board not for integration into an end-product – fast transient immunity tests and conducted radio-frequency immunity tests have not been executed. Externally connected cables are assumed to be less than 3 meters. The general expansion connectors where internal signals are made available do not have any other ESD protection than from the chip themselves. Observe ESD precaution.

## 2.4 Other Products from Embedded Artists

Embedded Artists have a broad range of low cost LPC1000/LPC2000/LPC3000/LPC4000 based boards developed for prototyping / development as well as for OEM applications. Modifications for OEM applications can be done easily, even for modest production volumes. Contact Embedded Artists for further information about design and production services.



#### 2.4.1 Design and Production Services

Embedded Artists provide design services for custom designs, either completely new or modification to existing boards. Specific peripherals and I/O can be added easily to different designs, for example, communication interfaces, specific analog or digital I/O, and power supplies. Embedded Artists has a broad, and long, experience in designing industrial electronics in general and with NXP's LPC1xxx/LPC2xxx/LPC3xxx microcontroller families in specific. Our competence also includes wireless and wired communication for embedded systems. For example IEEE802.11b/g (WLAN), Bluetooth™, ZigBee™, ISM RF, Ethernet, CAN, RS485, and Fieldbuses.

#### 2.4.2 OEM / Education / QuickStart Boards and Developer's Kits

Visit Embedded Artists' home page, [www.EmbeddedArtists.com](http://www.EmbeddedArtists.com), for information about other *OEM / Education / QuickStart* boards / Developer's kits or contact your local distributor.

## 3 Getting Started

This chapter contains information about how to get acquainted with the *LPCXpresso Base Board*. **Please read this section first before you start using the board - it will be worthwhile!**

### 3.1 LPCXpresso

The main source of information about the many different LPCXpresso target boards as well as the LPCXpresso Debugger/IDE is <http://www.nxp.com/lpcxpresso>.

On this site you will find introduction videos, getting started manual, a forum, link to where you can download the IDE and more information that is related to LPCXpresso.

### 3.2 Initial Preparation

The *LPCXpresso Base Board* is delivered with two pin lists. These pin lists must be soldered onto your LPCXpresso target board before it can be used with the *LPCXpresso Base Board*. Figure 1 and Figure 2 shows how the pin lists are soldered onto an LPCXpresso LPC1343 board. All different LPCXpresso target boards looks very similar and have two (27 pos) edge connectors where the pin lists shall be soldered.

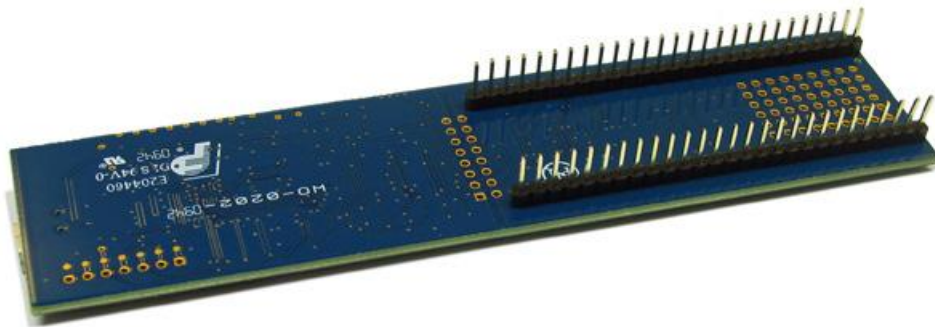


Figure 1 – LPCXpresso LPC1343 target board with pin list, bottom view

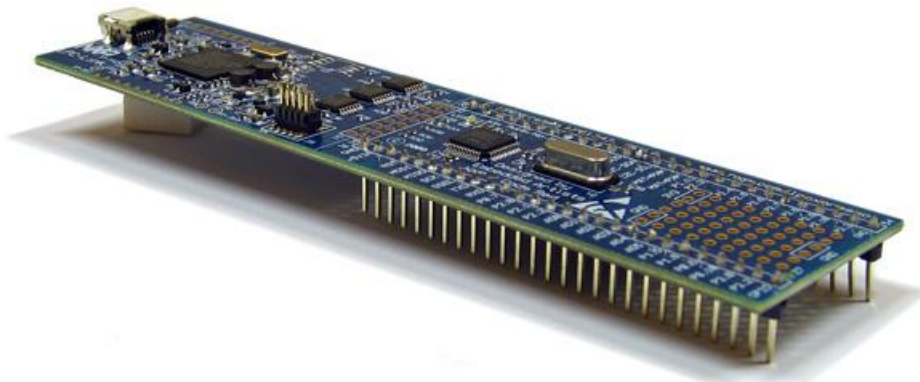


Figure 2 – LPCXpresso LPC1343 target board with pin list, top view

The mbed module already has pin lists, so no special preparation is needed for this module.

### 3.3 Board Powering

The *LPCXpresso Base Board* shall be powered from a PC via the included USB cable (mini-B to A cable). Up to 500mA can be drawn from the USB port. Note that not all PC USB ports supply the specified top current (500 mA). This is especially true for laptops, but affects many desktop PCs too. If in doubt, use a powered USB hub to power the *LPCXpresso Base Board*.

Symptoms when insufficient power is supplied can exhibit itself in a number of ways:

- the *board is always in reset*; in this case also check section 8.1 for more information. J54 jumpers (see Figure 21) might need to be removed,
- the *board may appear to work*, but:
  - you may fail to program the Flash on the device (as more power is drawn), or
  - the debugger may not be able to find the target, or
  - the debugger may disconnect unexpectedly, or
  - a variety of other inexplicable errors!

There are three USB interfaces in total when the *LPCXpresso target board* is mounted on the *LPCXpresso Base Board*. Technically any of all three can be used to power the system, but the main power source is however the USB-to-UART bridge. See Figure 3. Section 3.4 describes how to install necessary drivers for the USB-to-UART bridge.

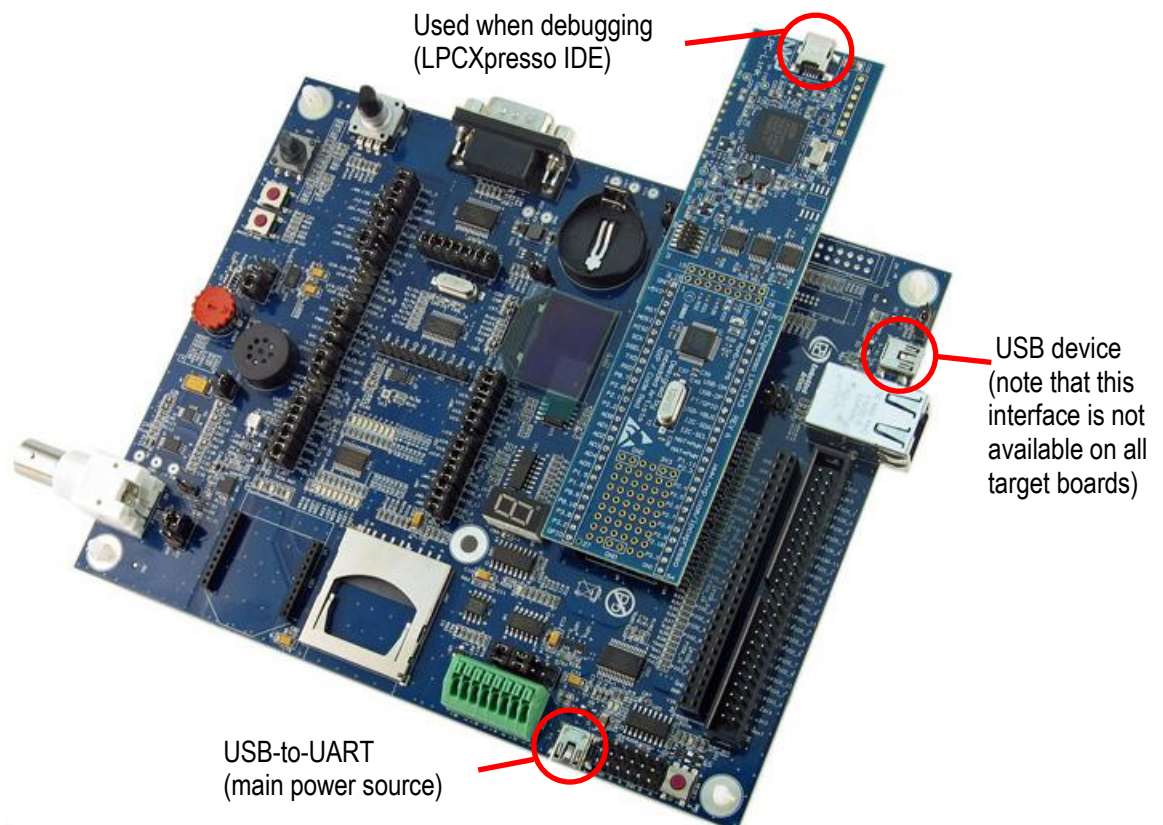


Figure 3 – Base Board with a mounted LPCXpresso LPC1343 board

The *LPCXpresso Base Board* can also be powered via signal VIN (available on expansion connectors). It shall be a regulated +5V DC supply.

### 3.4 Console Interface via USB-to-UART Bridge

The *LPCXpresso Base Board* contains a USB-to-Serial bridge chip (FT232R from FTDI) that connects one of the UART channels on the *LPCXpresso* target cpu to a virtual COM port on the PC (via USB). It is this serial channel that is the console interface to the system.

Special USB drivers must be installed on the PC in order for the virtual COM port to be created. See subsection below for a description of how to install the FTDI USB driver.

#### 3.4.1 FTDI USB Driver

A USB driver must be installed on your PC computer in order to get the USB-to-UART chip (FT232R) to function. Make sure to download the latest version of the driver, which can be found at the following URL: <http://www.ftdichip.com/Drivers/VCP.htm> (search for a FT232R driver for your operating system).

When the *LPCXpresso Base Board* is connected to the PC (via an USB cable) the PC will ask for a driver. Unpack/unzip the downloaded driver file and browse to the position of the driver files. After successful driver installation, a COM port will be created. Before any communication with the Board can take place the UART settings must be correctly set. The following description is valid for Windows™ XP, but other operating systems have similar dialog windows. See the USB driver documentation for details, if needed.

To change the UART settings, first open the System Properties dialog, as illustrated in the figure below.

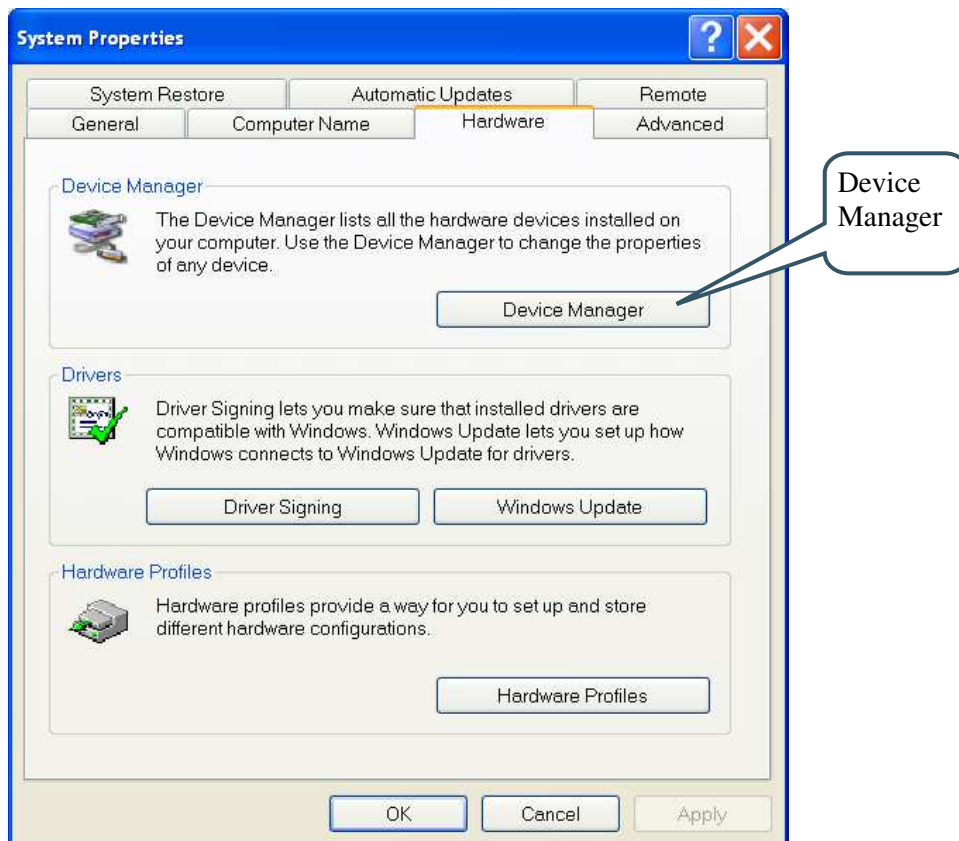


Figure 4 – System Settings Dialog

Then select the *Device Manager* and open the *Ports* list, as illustrated in Figure 5 below.

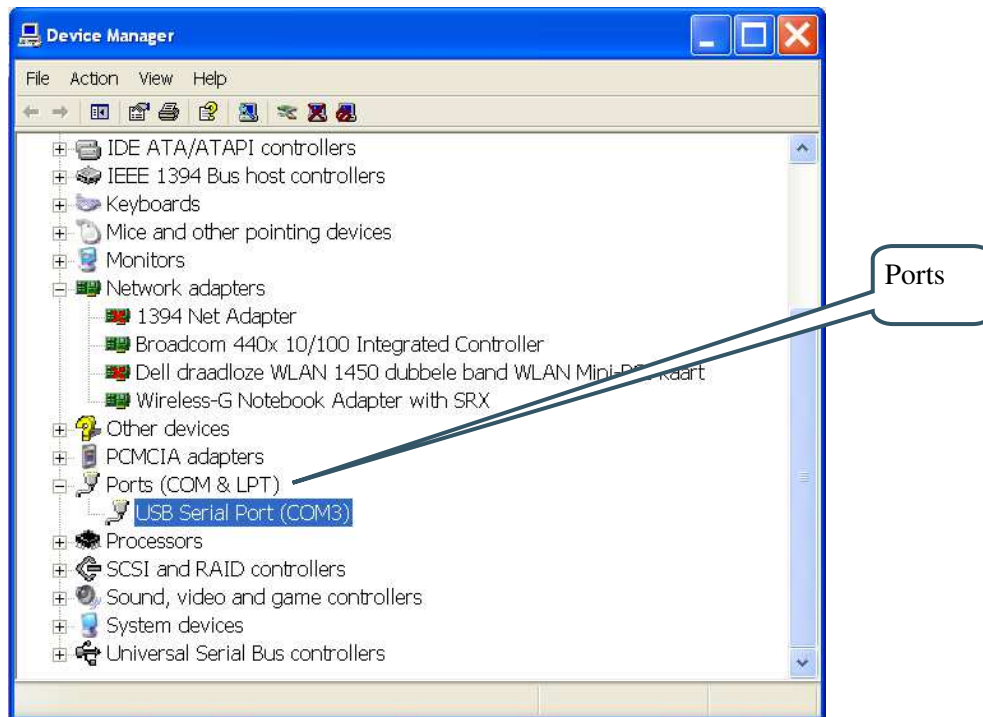


Figure 5 – Device Manager Dialog

The new COM port (USB Serial Port) will be listed under the *Ports* list. Right-click on the new USB Serial Port and select *Properties*, as illustrated in Figure 6 below.

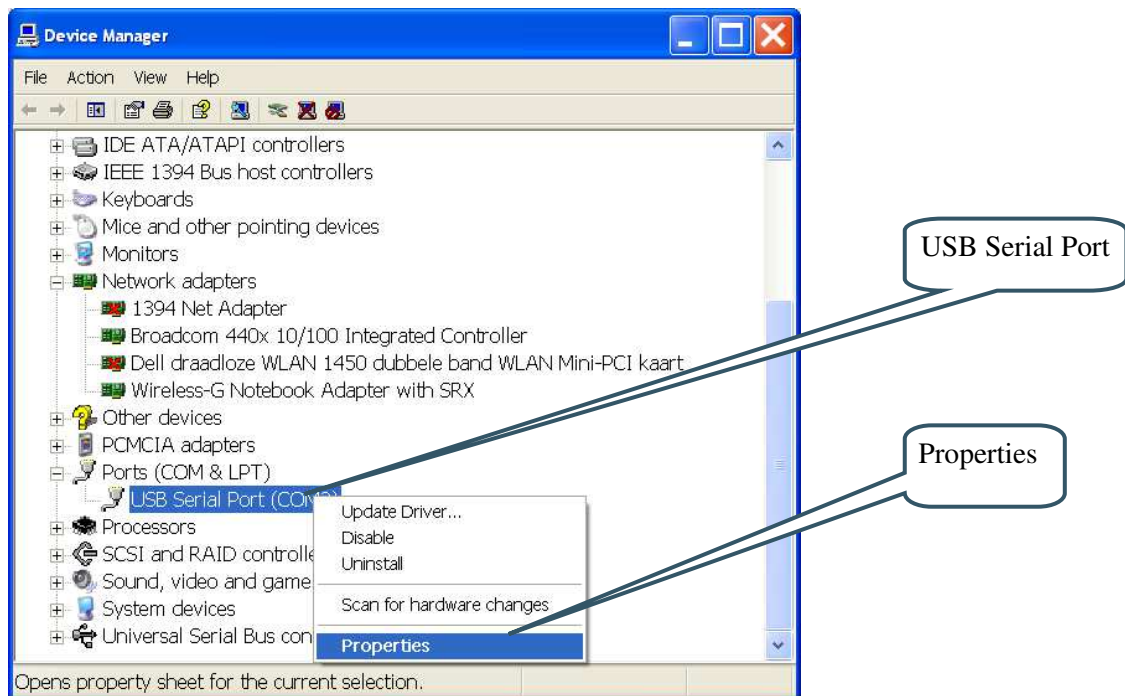


Figure 6 – Device Manager Port Dialog

Select 115200 bits per second, 8 data bits, none parity, 1 stop bit, and none flow control, as illustrated in Figure 7 below. Then select *Advanced* settings. Please note that different application programs can use different baudrate settings for the serial channel. Other baudrates can also be used, depending on your specific application.

Also note that it is normally not needed to set the used baudrate at all. The driver and FT232R chip will automatically handle different baudrates. The setting is only shown here for completeness.

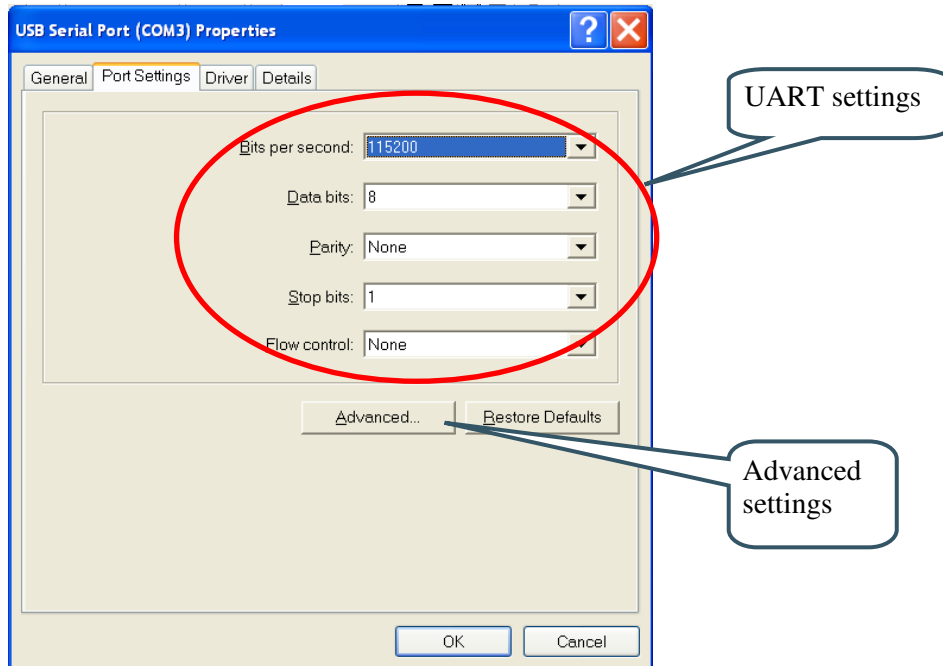


Figure 7 – USB Serial Port Properties Dialog

Select the desired COM port number under the *Advanced* settings dialog. Some terminal programs need low COM port number, for example between 1 and 5. Very often the COM port number for the USB Serial Port is higher than this, therefore this needs to be changed manually.

It is common that all COM ports with low numbers are listed as occupied, but test to change to a low number anyway. Very often it is no problem at all to do so.

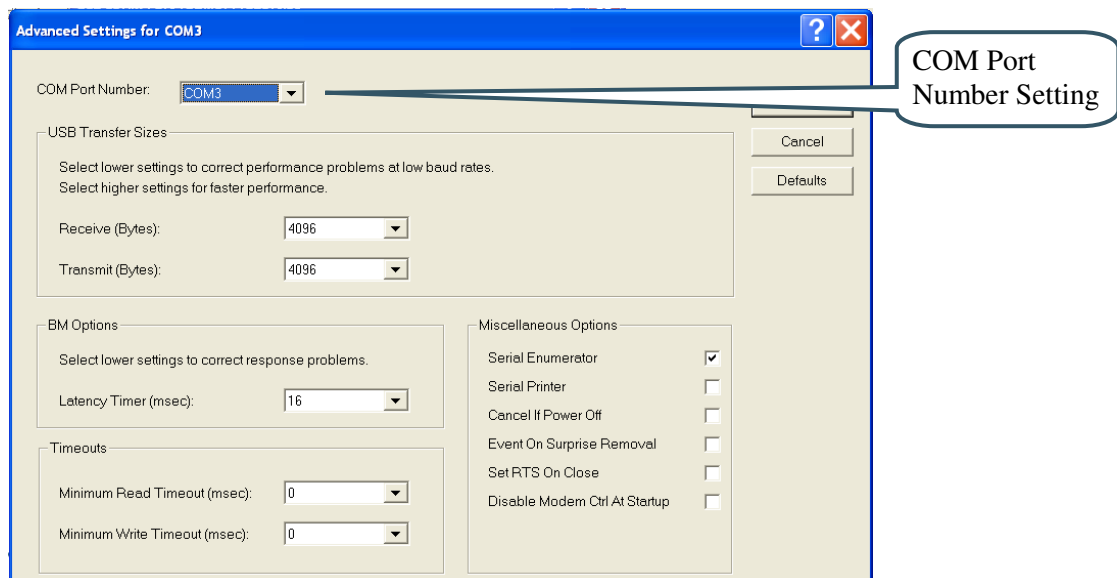


Figure 8 – Advanced USB Serial Port Properties Dialog

Finally it is time to test if you have successfully installed and configured the USB Serial Port. Start a terminal program. Connect to the correct COM port, with 115200 bits per second, 8N1, no flow control.

### 3.4.2 USB Driver Behavior

Sometimes the USB COM port does not enumerate properly when the board is connected to the PC. This is a known "feature" of the USB driver. If you experience this problem, just unplug the board shortly and then plug it in again. A new COM port that can be accessed properly should be created the second time.

This problem may occur after every time you start (i.e., power cycle) your PC.

### 3.5 Main Components

Figure 9 below illustrates the main component of the *LPCXpresso Base Board*. The number inside parenthesis (pX) indicate on which schematic page (X) the components can be found.

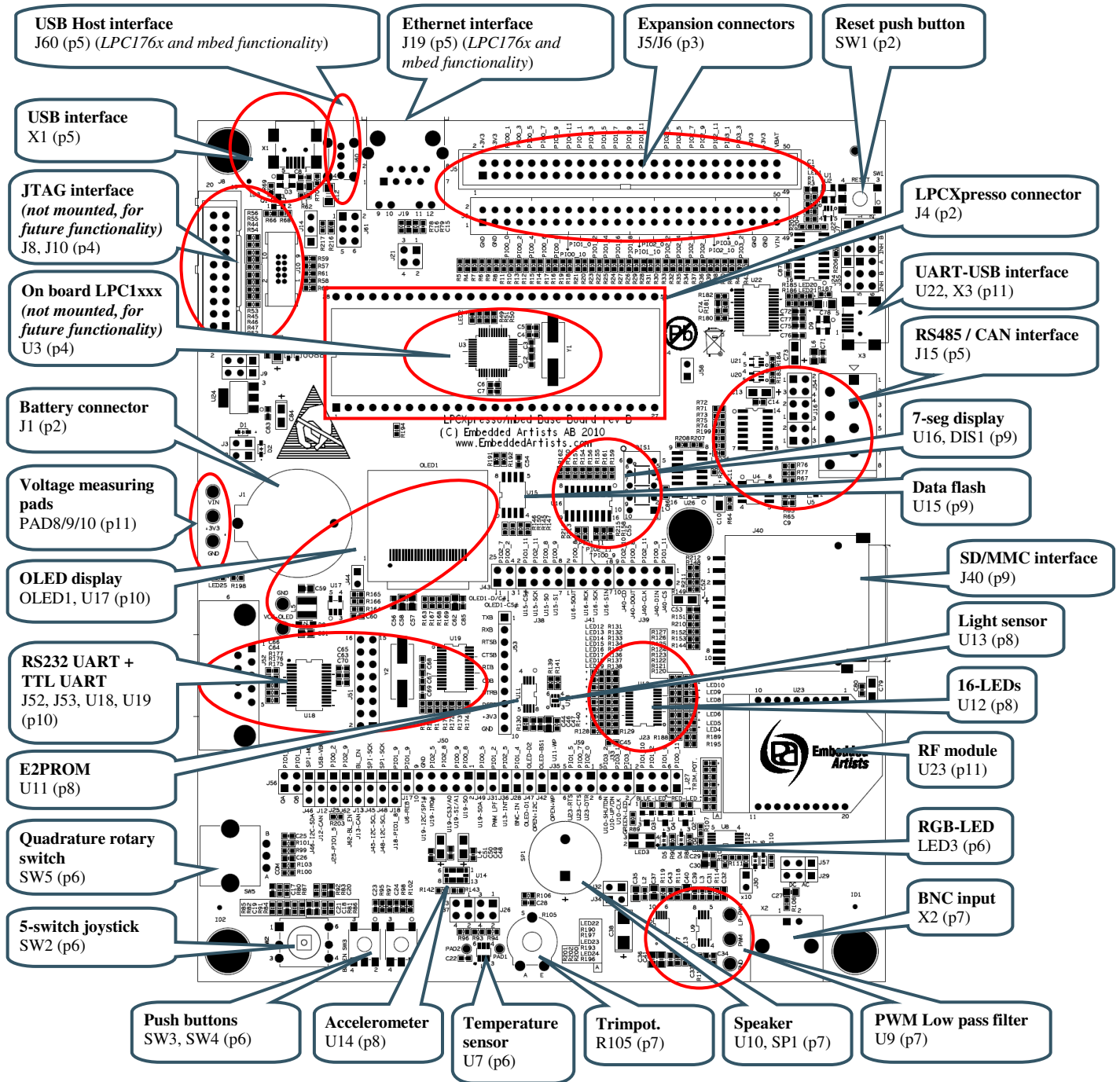


Figure 9 – LPCXpresso Base Board Main Components



### 3.6 Default Jumper Positions

Figure 10 below illustrates the default jumper positions as mounted when the board is delivered from Embedded Artists.

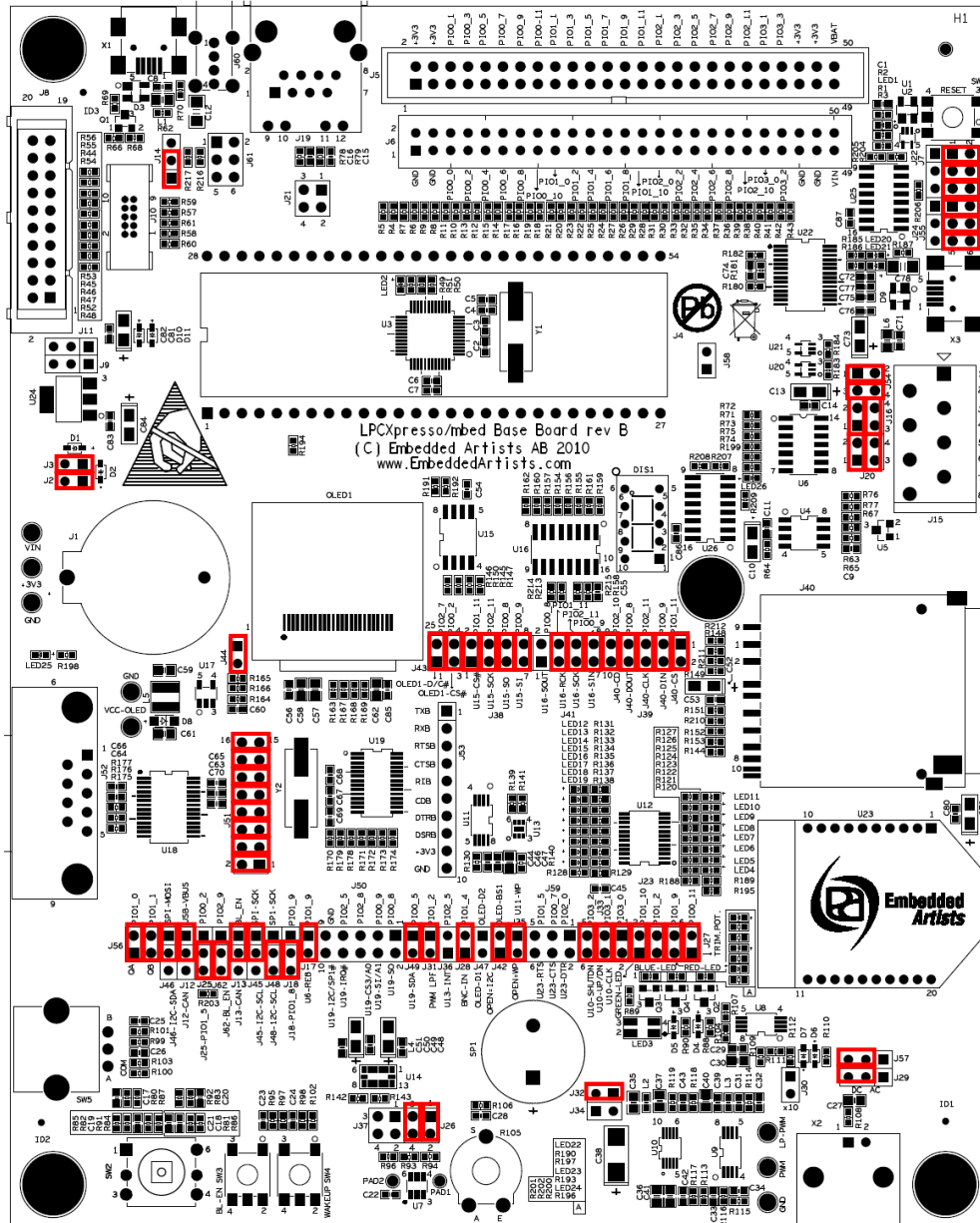


Figure 10 – LPCXpresso Base Board default Jumper Settings

#### 3.6.1 Illegal Jumper Combinations

The *LPCXpresso Base Board* has multiple peripherals that connect to the LPC1xxx processor. There is a shortage of pins to connect to and in a few cases different peripherals must share pins. See chapter 5 for an overview of all connections.

If an output is used by several peripherals it is less of a problem. The peripherals just cannot be used simultaneously. If outputs from peripherals can drive the same signal, there is a risk of contention and damages of output drivers due to short circuit conditions. 270 ohm series resistors have been added in all places where several outputs can drive the same signal. This limits any short circuit currents to reasonable levels. To avoid the situation in the first place, avoid the following contentions:

- GPIO\_4 can drive the OLED SPI-SSEL signal as well as being an output from the temperature sensor.
- GPIO\_16-WAKEUP can be driven by SW4 (wakeup) as well as the analog signal from the BNC analog input (U8).
- GPIO\_18 can drive the TX-EN signal as well as being an interrupt output from the accelerometer (U14).
- GPIO\_33 can be driven by three interrupt sources: accelerometer (U14), light sensor (U13) and dual uart (U19).

See the jumper settings for each specific peripheral in chapter 4 .

### 3.7 Import Sample Applications

This section describes how you import the sample applications available on Embedded Artists support site into the LPCXpresso IDE. The example below is for the LPC1343 target board, but samples exist for other target boards as well and the process is identical (just different names on file to work with).

1. Download the zip file from the support site and store it on your computer (e.g. to C:\temp\lpcxpresso\lpc1343\_base\_board\_100125.zip)
2. Start the LPCXpresso IDE and preferably select an empty workspace (an empty directory)
3. Press the "Import Example Projects" button from the Quickstart panel, see Figure 11.
4. A dialog window will be opened, see Figure 12. Browse to the previously downloaded zip file. Select the file and press the Next button followed by the Finish button.
5. When the zip file has been imported you will see all projects in the Project Explorer window, see Figure 13.
6. Select the project you would like to build and click the Build button in the Quickstart panel, see Figure 14.
7. Continue to section 3.8 for alternatives of how to download the program to the LPCXpresso board.

**Note:** All the projects with prefix Lib\_ are library projects and not sample applications. These library projects contain common code used by several of the sample applications.

- Lib\_CMSISv1p30\_LPC13xx – Cortex Microcontroller Software Interface Standard as defined by ARM
- Lib\_MCU – Drivers for peripherals on the LPC1343/LPC1114 microcontroller
- Lib\_EaBaseBoard – Drivers for peripherals on the Embedded Artists LPCXpresso Base Board
- Lib\_FatFs\_SD – ChaN's FAT Fs module ported to the LPCXpresso base Board (used with the MMC/SD card interface).

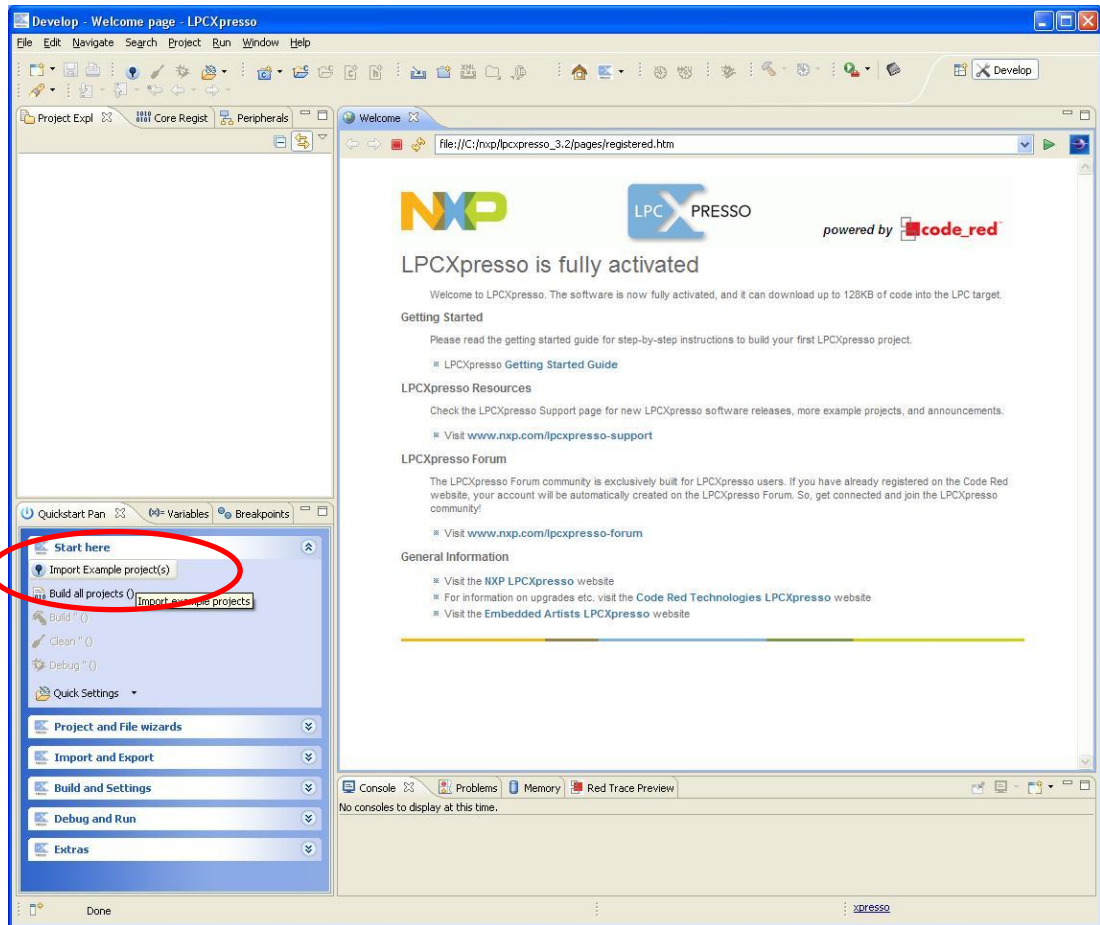


Figure 11 – Import project

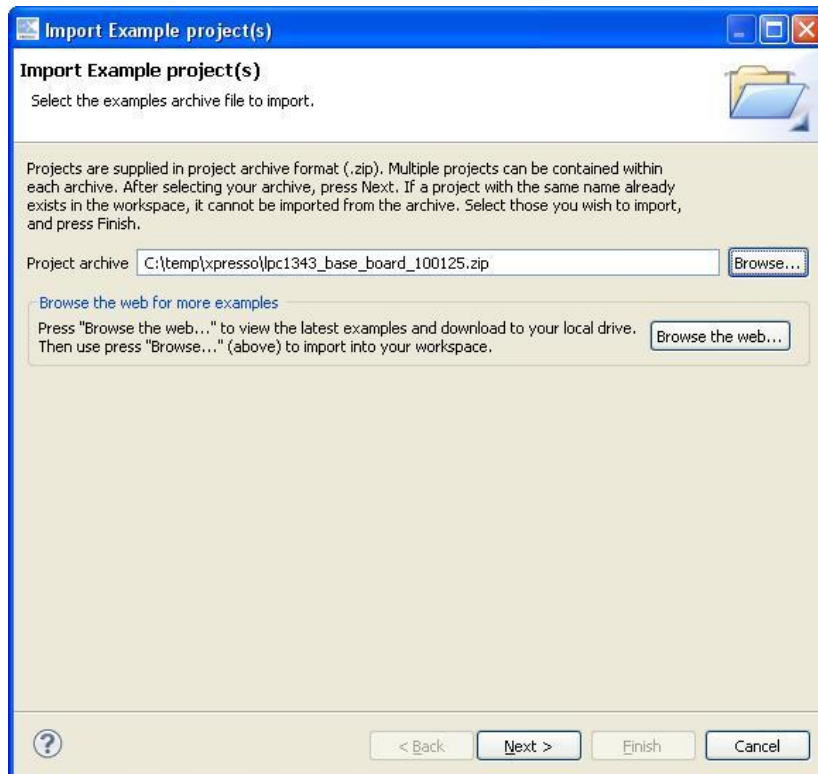


Figure 12 – LPCXpresso Import Dialog

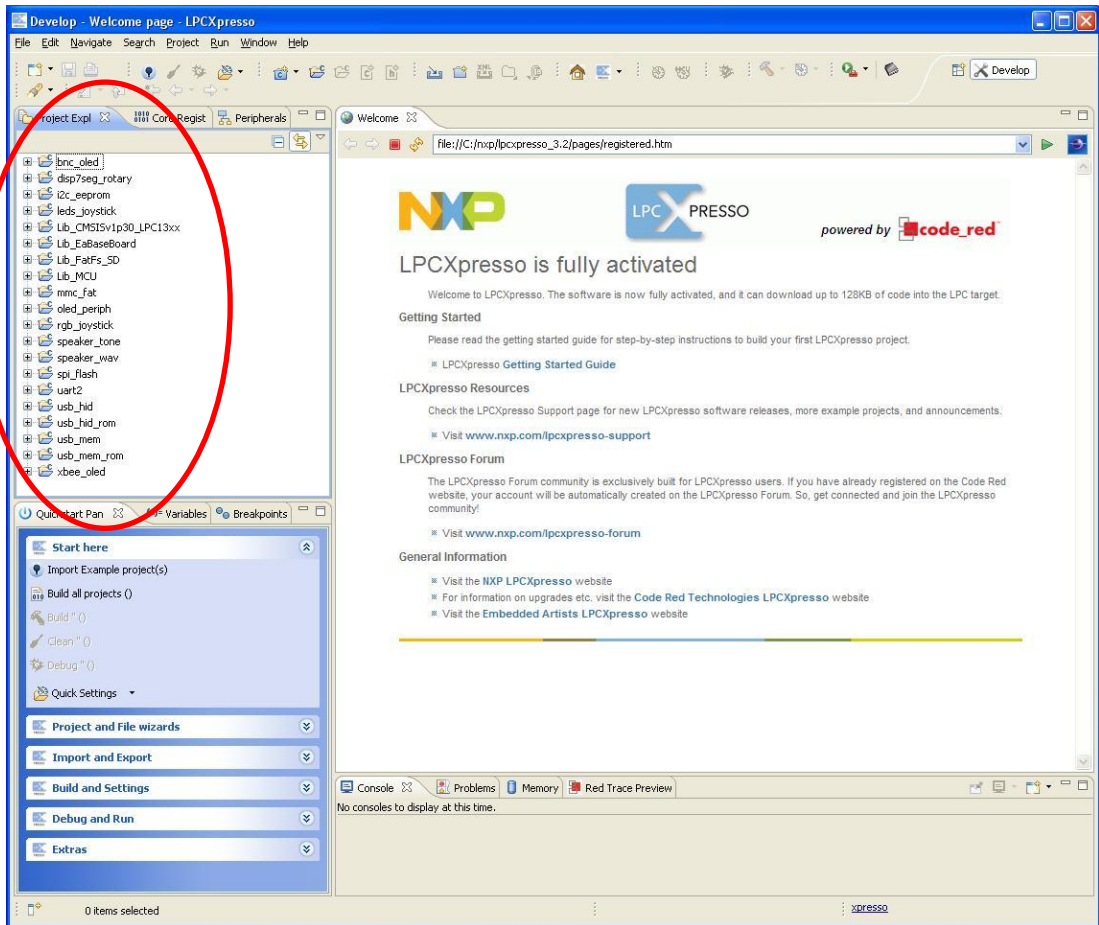


Figure 13 – LPCXpresso imported projects

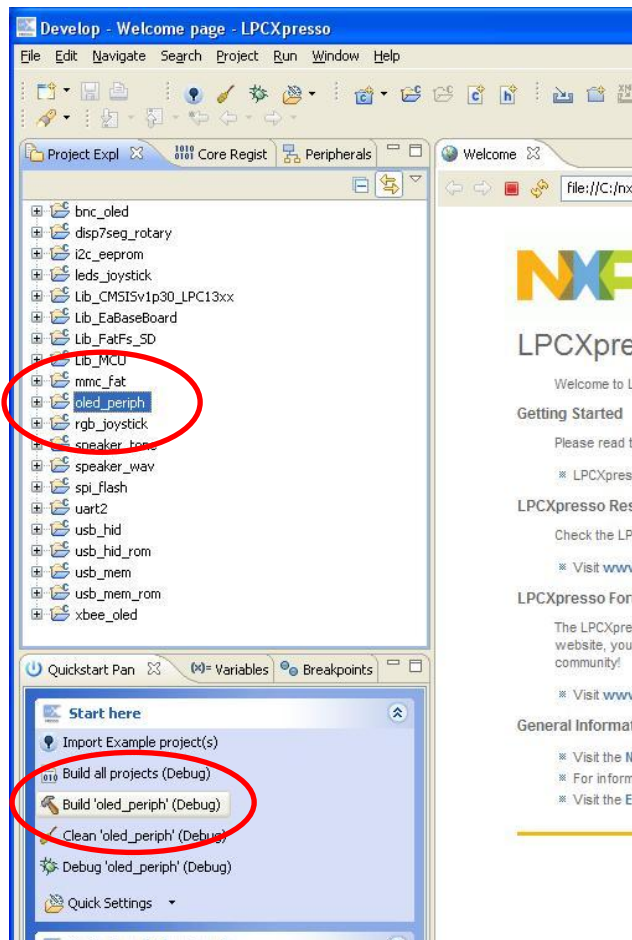


Figure 14 – LPCXpresso Build button

### 3.8 Demo Application

A suitable application to start with when checking the functionality of the LPCXpresso Base Board is the application called demo. This application is using several of the peripherals, such as the accelerometer, LEDs (connected to I/O port expander), joystick, OLED display, rotary switch, 7-segment display, SW3 button, speaker, trim potentiometer and RGB LED.

- 3 out of the 16 LEDs will always be lit and by tilting the board the LEDs that are lit will change (as a moving) bar. The way you move the board (in y-axis) will change the direction and speed of this bar.
- The joystick can be used to draw on the OLED display. It is like moving a pen you never lift from the paper. By using the center key on the joystick the display is cleared.
- Rotating the rotary switch will change which digit (0 to 9) is shown on the 7-segment display.
- Pressing the SW3 button will start playing a melody.
- Turning the trim potentiometer will turn on/off the RGB LEDs

Please **note** that P1.10 is used both to control power to the OLED display and to one of the RGB LEDs. This means that by changing the position of the trim potentiometer you can turn on/off both the green LED and the OLED display.

For the demo to work on LPC176x target boards J62 shall be in position 2-3 (which is the default position). Pressing SW3 will then play a melody. However, J62 should normally be in position 1-2 for LPC176x target boards (which is not the default position) in order to be able to invoke the ISP mode (be pulling P2.10 low during reset).

## 3.9 Program Download

### 3.9.1 Using LPCXpresso IDE/Debugger

If you are using the LPCXpresso IDE to develop and build your applications you can directly download the program to the LPCXpresso Board from within the IDE.

1. Make sure you have connected a USB cable (mini-B to A) between your computer and the LPCXpresso LPC1xxx board, see Figure 3 (USB interface 2).
2. Build your application as mentioned in section 3.7.
3. Click the Debug button in the Quickstart panel, see Figure 15. When the program has been downloaded, execution will stop at the first breakpoint which is the main function.
4. Press the F8 key on your keyboard to continue execution.

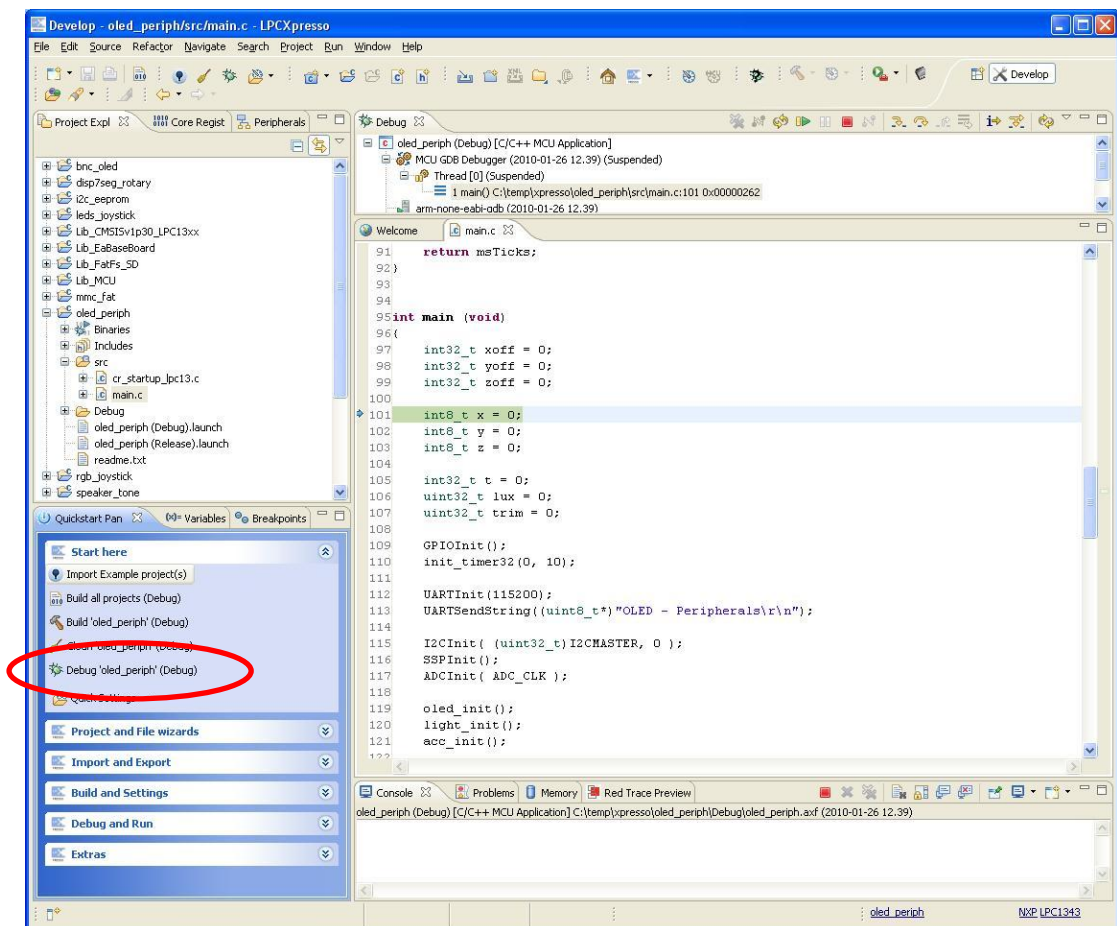


Figure 15 – LPCXpresso Debugging View

### 3.9.2 Using USB Boot Mode (LPC1343)

The LPC1343 supports In-System Programming (ISP) from the USB port through enumeration as a Mass Storage Class Device, i.e., you can drag and drop a binary file to the drive associated with the LPC1343.

This section describes how you generate the binary file, add the necessary checksum to the binary file and download the file to the target while it is mounted on the LPCXpresso Base Board.

For this to work you need to have some jumpers correctly set. If you have all jumpers in default position as described in section 3.6 USB boot mode will work; otherwise please check the following.

- USB interface – jumpers described in section 4.5.
- SW3 button – jumper described in section 4.6.1. You also need to make sure that the BL\_EN signal is connected to GPIO\_24-BL\_EN signal, see section 4.1.1.1 and Figure 22.

After you have checked the jumper settings continue with the steps described below.

1. Build your application in the LPCXpresso IDE as mentioned in section 3.7.
2. Right-click on the generated axf file, go to the Binary Utilities menu and select Create binary. See Figure 16.
3. Open a command prompt in the directory containing the axf file. This can be done from the Utilities menu, see Figure 17.
4. Update the binary file with a correct checksum. In the example below it is assumed that you are using LPCXpresso IDE 3.2 installed in C:\nxp\lpcxpresso\_3.2. It is also assumed that you are using a LPC1343 and the binary file is named oled\_periph.bin.

```
C:\nxp\lpcxpresso_3.2\bin\checksum.exe -p lpc1343 -v oled_periph.bin
```

5. You need to have a USB cable (mini-B to A) connected between your computer and the USB interface (interface 3 as shown in Figure 3).
6. Hold down the SW3 button and then press and release the reset button on the LPCXpresso base board. A storage device named CRP DISABLD will now appear on your computer, see Figure 18.
7. Open the Mass storage device and you will find a file named firmware.bin. Delete this file and then copy the file created in step 4 above to the CRP DISABLD drive.
8. Reset the board and your application will start.

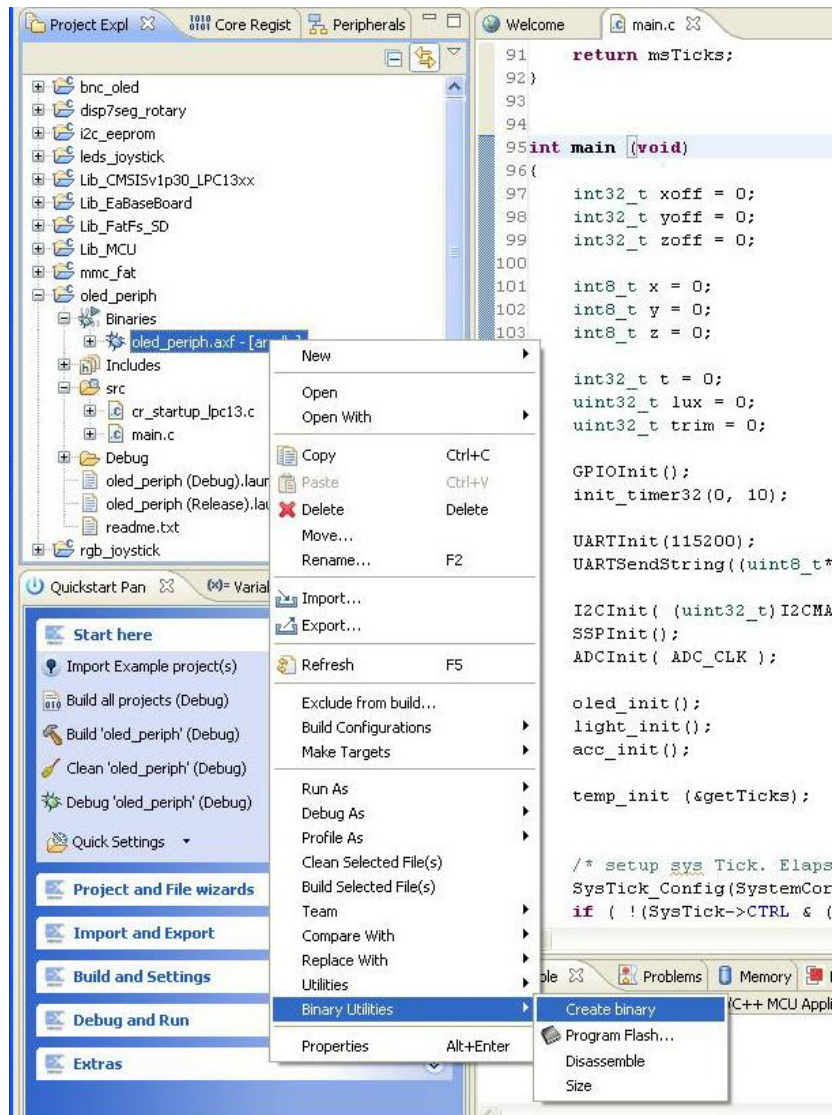


Figure 16 – LPCXpresso IDE Create a Binary File



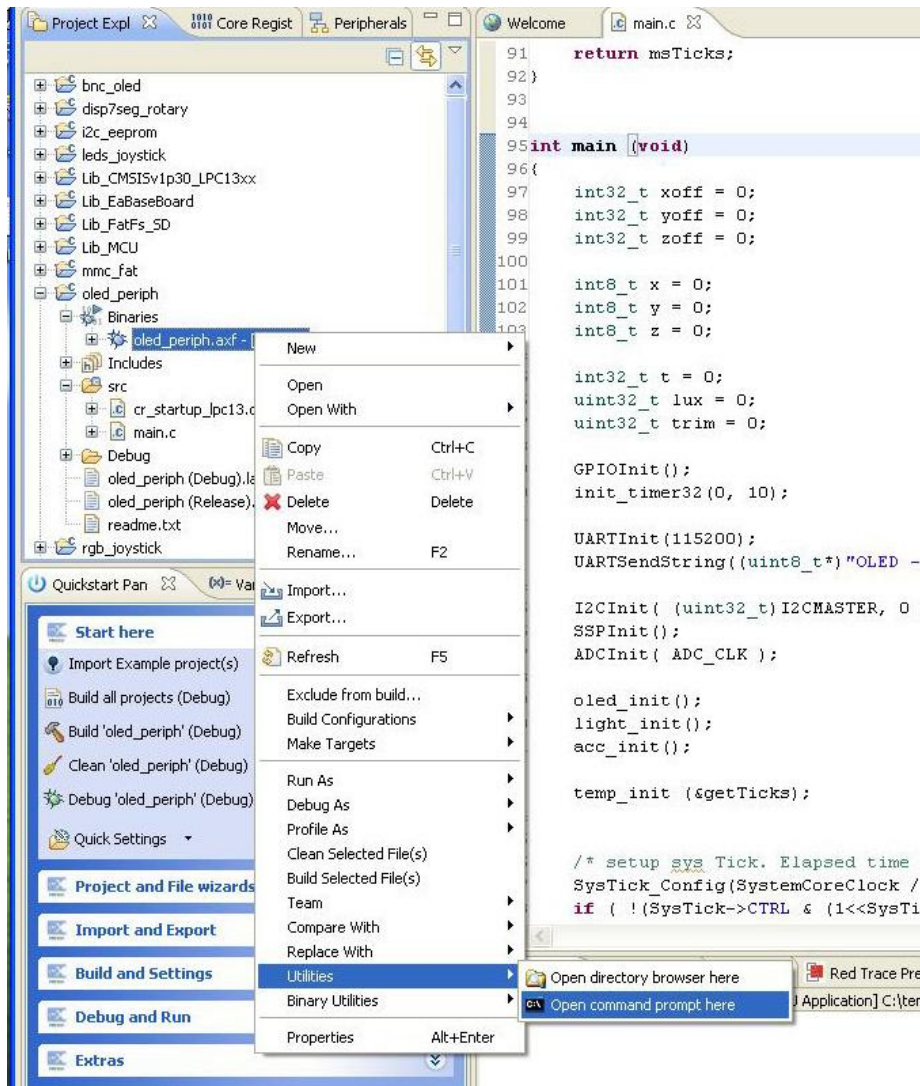


Figure 17 – LPCXpresso IDE Open Command Prompt

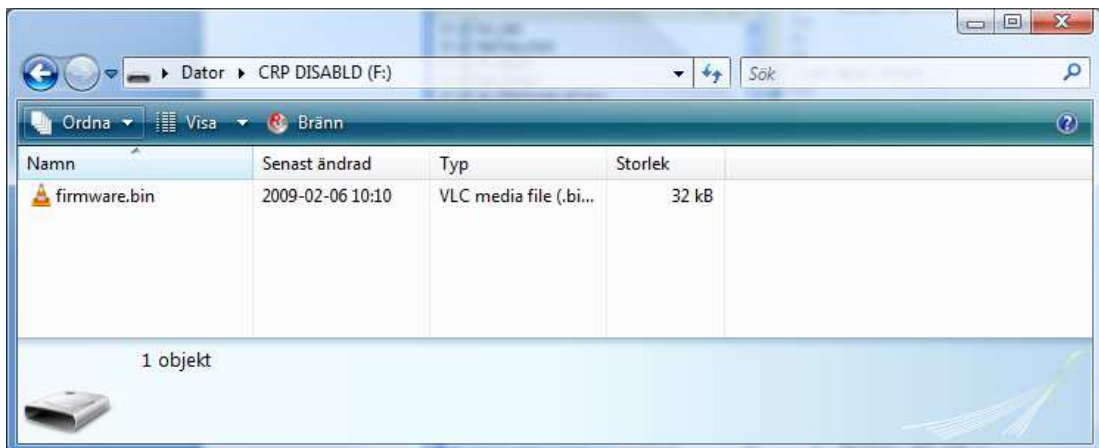


Figure 18 – Mass Storage Device

### 3.9.3 Using UART (ISP) Boot Mode for LPC1343 / 1227 / 11C24 / 11U14 / 1114

The LPC1343 / 1227 / 11C24 / 11U14 / 1114 all supports In-System Programming (ISP) from the UART.

This section describes how you generate the hex file and then download the file to the target while it is mounted on the LPCXpresso Base Board.

For this to work you need to have some jumpers correctly set. If you have all jumpers in default position, as described in section 3.6, all you need to do is **remove** the USB\_VBUS jumper. This jumper is shown in Figure 41. If USB\_VBUS is connected the LPC1343 (note that this doesn't apply for the other MCU:s) will not enter UART boot mode, only USB boot mode. If you don't have the jumpers in default position please make sure you at least have the UART related jumpers set as described in sections 4.1.1 and 4.1.1.1.

After you have checked the jumper settings continue with the steps described below.

1. Download and install Flash Magic (<http://www.flashmagictool.com/>). Always use the latest version.
2. Build your application in the LPCXpresso IDE as mentioned in section 3.7.
3. Open a command prompt in the directory containing the axf file. This can be done from the Utilities menu, see Figure 17.
4. Convert the axf file to a hex file. In this example it is assumed that your sample application is named oled\_periph.

```
arm-none-eabi-objcopy -O ihex oled_periph.axf oled_periph.hex
```

5. Start Flash Magic, select correct Device, COM Port (the COM port associated with the target, section 3.4.1 describes the USB-to-UART bridge). Set baud rate to 115200, Interface to None and Oscillator to 12 MHz. Browse to the hex file you would like to download, see Figure 19 for an example.
6. Click the Start button and your application will be downloaded to the target.