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# 1 Document Revision History

<i>Revision</i>	<i>Date</i>	<i>Description</i>
A	2009-05-25	Original version
B	2009-09-09	Added 'known issues' <i>section 4.2.2</i> and <i>4.2.3</i> (information about H_L_CC jumper and information about NAND boot and LCD/Ethernet problem).  Added <i>section 5.3.6</i> .
C	2009-11-27	Changed title of manual to 'Developer's Kit' manual.  Replaced earlier <i>section 5.3.6</i> with new <i>section</i> about NAND boot and LCD/Ethernet problem ( <i>section 4.6</i> ).
D	2010-07-05	Added information in <i>section 4.2</i> about things to note about the LPC31xx Base Board (SD card detect logic, USB Host powering).
E	2010-11-15	Updated information about NAND boot problem.
F	2011-08-24	Added information about VBUS over-current sense for USB Host applications ( <i>section 4.2.5</i> ).
G	2011-12-19	Added note about CE marking.  Removed schematics from document.
H	2012-05-10	Updated <i>section 5.3.4</i> about SPI NOR boot. Added <i>section 5.3.7</i> about booting from NAND flash.

## 2 Introduction

Thank you for buying Embedded Artists' *LPC3152 Developer's Kit* based on NXP's ARM926EJ-S LPC3152 microcontroller.

This document is a User's Guide that describes the *LPC3152 OEM Board* and the *LPC31xx Base Board* hardware design. It is the User's Manual for both the *LPC3152 Developer's Kit* as well as for just the *LPC3152 OEM Board*.

### 2.1 Features

Embedded Artists' *LPC3152 Developer's Kit* with NXP's ARM926EJ-S LPC3152 microcontroller lets you get up-and-running quickly. The small sized OEM board offers many unique features that ease your learning curve and speed up your program development. The board has also been designed for OEM applications with volume discount available. The features of the LPC3152 OEM board are:

- NXP's ARM926EJ-S LPC3152 microcontroller in BGA package, with 192 KByte internal RAM
- External data memory: 64 MB SDRAM (16-bit databus width)
- External FLASH memories: 256 MB (2Gbit) NAND FLASH and 4 MB (32Mbit) SPI-NOR FLASH
- 12.0000 MHz crystal for maximum execution speed and standard serial bit rates, including CAN and USB requirements
- 256 Kbit I2C E2PROM for storing non-volatile parameters
- Buffered 16-bit data bus for external expansion
- 200 pos expansion connector (SODIMM-200 format, 0.6mm pitch)
  - All LPC3152 pins available (except dedicated pins for on-board memories and internal powering)
- Li-ion battery or +5V powering
- Onboard reset generation
- Compact SODIMM size: 66 x 48 mm
  - Six layer PCB design for best noise immunity

There is an accompanying *LPC31xx Base Board* that can be used for initial prototyping work. The features of the board are:

- Connectors
  - 200 pos, 0.6mm pitch SODIMM connector for LPC3152 OEM Board
  - RJ45 Ethernet connector
  - Expansion connector to 3.2 inch QVGA TFT color LCD with touch panel
  - Three expansion connectors with all SODIMM signals
  - MMC/SD interface and connector
  - USB OTG or Host connectors
  - Four 3.5mm audio connectors
    - Internal codec; mic in, 2x line in, headphone out
    - External codec; mic in, line in, line out, headphone out

- JTAG connector
- 2.1mm power input
- Connector for external Li-ion battery
- Power
  - Power supply, either via USB or external 9-15V DC (*LPC3152 OEM Board* is powered by Li-ion battery or +5V)
  - Current monitors on input voltages
- Other
  - 100/10Mbps Ethernet interface base on DM9000A chip (available on base board from v2.0)
  - UDA1380 I2S codec with mic in, line in, line out, and headphone out
  - 5-key joystick (via I2C)
  - 3-axis accelerometer
  - 8 LEDs (via I2C)
  - Trimming potentiometer analog input
  - USB-to-serial bridge on UART (FT232R)
  - RS232 alternative interface on UART
  - XBee™ RF-module alternative interface on UART (note that XBee module is not included in bundle)
  - Reset push-button and LED
  - 205x135 mm in size

## 2.2 ESD and Handling Precaution

Please note that the *LPC3152 OEM Board* and *LPC31xx 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.

Never touch directly on the *LPC3152 OEM Board* and in general as little as possible on the *LPC31xx Base Board*. The keys on the *LPC31xx Base Board* have grounded shields to minimize the effect of ESD.

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

In case you have also connected the *QVGA Display Module* to the *LPC31xx Base Board*, do not exercise excessive pressure on the LCD glass area. That will damage the display. Also, do not apply pressure on the two flex cables connecting the LCD. These are relatively sensitive and can be damaged if too much pressure is applied to them.

***Note that Embedded Artists do not replace QVGA Display Modules where the LCD has been improperly handled.***

## 2.3 CE Assessment

The *LPC3152 Developers Kit* (consisting of the *LPC3152 OEM Board* and *LPC31xx Base Board*) is CE marked. See separate *CE Declaration of Conformity* document.

The *LPC3152 Developers Kit* 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 *LPC3152 Developers Kit*. 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 *LPC3152 Developers Kit*.

Due to the nature of the *LPC3152 Developers Kit* – 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.

Note that the *LPC3152 OEM board* is classified as a component and is hence not CE marked separately. It can perform different functions in different integrations and it does not have a direct function. It is therefore not in the scope of the CE Directive. An end product, where an *OEM Board* is integration into, is however very likely to need CE marking.

## 2.4 Other Products from Embedded Artists

Embedded Artists have a broad range of LPC1xxx/LPC2xxx/LPC3xxx/LPC4xxx based boards that are very low cost and 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 family 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 Kits

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



## 3 LPC3152 OEM Board Design

This chapter contains detailed information about the electrical and mechanical design of the *LPC3152 OEM Board*. Note that it is version 1.1 of the board that is presented. Differences from version 1.0 are small and can be found in the schematic (see schematic page 1). The schematic can be downloaded in pdf format from the support page, and is recommended to have printed out while reading this chapter.

The following subsections describe in more detail each part of the design.

### 3.1 Schematic Page 2: Powering

Page 2 of the schematic contains the power supplies of the *LPC3152 OEM Board*. The LPC3152 contains internal voltage converters that create the three main voltages; 1.2V for internal digital part, 1.8V for external powering of memories and 3.2V for external interfaces like JTAG and GPIO:s. It also contains Li-Ion battery charging functionality and USB OTG +5V generation.

#### 3.1.1.1 Powering

The input voltage to the *LPC3152 OEM Board* is given by the requirements of the LPC3152 internal power converters. There are multiple options how to power the LPC3152:

- Li-Ion battery 2.7V – 4.2V
- USB, which is nominally 5V.
- VIN, which is an external source nominally 5V, just like USB.

Normally powering comes from a Li-Ion battery, but USB powering is also supported. USB powering is under software control. Signal PWR\_CTRL controls Q1 power switch to enable powering from a USB source.

An external +5V power source can power the board via VIN.

#### 3.1.1.2 Internal Voltage Converters

The LPC3152 contains internal voltage converters, both switched and linear, designed to operate on battery power. See the LPC3152 user's manual for details. The generated voltages can be monitored via test points. The current consumption can also be measured if needed. Just replace the R1-R3 zero ohm resistors with low ohm current measuring resistors (typically less than 0.1 ohm).

The voltage converters can be controlled via software. Normally control is not needed but in certain cases it can be needed.

A high input on signal PSU\_PLAY will start the voltage converters. A high input on signal PSU\_STOP will place the chip in power off state.

**Note that it is the user's responsibility not to program the internal LPC3152 converters so that the external memory chips (1.8V powering) are damaged by too high voltage (which is possible).**

#### 3.1.1.3 Li-Ion Battery Charging

Note that this description is just an overview of the Li-Ion battery charger functionality. Read the LPC3152 User's Manual for details.

The charger is suitable for charging Li-Ion batteries from the USB supply. Main functions implemented in the charger are as follows:

- Trickle charging, with 10% of the nominal current.
- Fast charging or constant current charging with the nominal current adjusted by an external resistance value.

- Constant voltage charging, to charge the battery on maximum capacity. Normally the current reduces in time from 100% to 10%.

When charging batteries, safety as well as charge capacity and lifetime are important factors. The charge process has to be monitored and controlled carefully for maximum battery charge and to protect the battery from damage. There are several safety functions implemented:

- Current limiting in constant voltage charging
- Current limiting by chip temperature
- Current blocking by battery temperature sensing (via an NTC resistor)

### Battery current setting

The nominal charge current is set with a resistor between pin CHARGE\_CC\_REF and ground. The selected resistor on the *LPC3152 OEM Board* (R8, 1 kohm) gives a nominal charge current of 100 mA. A resistance value of 400 ohm gives a nominal charge current of 250 mA. This is the maximum current setting. The circuit involving R5 and R8 allows setting the resistance to 400 ohm by pulling the signal HIGH\_LOW\_CC low. This signal is controlled from the PCA9532 I2C port expander. Pulling the signal low will place R5 in parallel with R8, resulting in a resistance of 404 ohm. Note that the signal HIGH\_LOW\_CC should only be low or high-impedance. It should never be driven high.

### Battery voltage sensing

The battery voltage is accurately sensed via the CHARGE\_BAT\_SENSE pin (signal called VBAT\_SENSE in the schematic). The sense point should be as close as possible to the battery, in order to remove the effect of voltage drops.

### VNTC sensing for guarding the battery temperature

An NTC resistor can be used to monitor the battery temperature. A cold temperature limit is set to about 25% of VBUS voltage and a high temperature limit is set to about 6%. There is a small hysteresis implemented also. The table below lists the temperature thresholds resulting when R4 = 56 kohm and R7 = 82 kohm. A 10k NTC from Vishay Dale is placed in parallel over R7. The NTC should be placed on the battery and connected to signal CHARGE\_VNTC and GND.

	Low off	Low on	High on	High off
NTC curve1	4° C	7° C	49° C	51° C
NTC curve2	1° C	5° C	52° C	56° C

#### 3.1.1.4 Real-time Clock

The LPC3152 contains an internal real-time clock (RTC) block that can be used to provide actual time and alarm function. The 32.768 kHz crystal gives the base frequency for the RTC. The output RTC\_INT can be used to wake up the chip at regular points of time. This output is normally connected to the PSU\_PLAY input.

#### 3.1.1.5 OTP VPP Voltage

The VPP power to the LPC3152 can be controlled by the OTP signal. The on-chip OTP (One-Time Programmable) fuses on the LPC3152 can be programmed. 3.3V must be applied to VPP during programming, or else 1.2V should be applied. Note that programming the fuses should be done with great care. R69 is not mounted in order to remove the risk of programming by mistakes. R69 can easily be 'mounted' by placing a solder bump between the two pads, i.e., R69 is a zero ohm resistor.

Note that a jumper (J14, pin 13/14) on the *LPC31xx Base Board* must also be inserted in order to control the OTP signal from the PCA9532 I2C port expander.

## 3.2 Schematic Page 3: LPC3152 CPU

Page 3 of the schematic contains the core part of the design, which of course is the LPC3152 microcontroller. It is an ARM926EJ-S cpu core with a lot of different peripheral units and on-chip memory (192 KByte SRAM).

### 3.2.1.1 12MHz Crystal and PLLs

The microcontroller crystal frequency is 12.0000 MHz. This frequency is the recommended from NXP. There is dual on-chip PLLs on the LPC3152 in order to generate different needed frequencies for the chip. **Note that the clocking structure is very different from the LPC2xxx family. It is a more complex structure but also much more versatile and flexible. There is no shortcut but to read the LPC3152 User's Manual in detail and understand the options and settings.**

### 3.2.1.2 Booting

The LPC3152 starts executing from an on-chip ROM, containing the bootloader. Note that the LPC3152 does not contain any on-chip FLASH memory. Program code must be loaded from an external source into the on-chip SRAM.

There are multiple boot options, as indicated in the schematic. The default is set to UART mode booting. Normally the default boot option can be controlled/changed from the *LPC31xx Base Board*, but the default resistors can also be changed for special orders of the board. The *LPC3152 OEM Board* contains both SPI NOR flash and NAND flash in order to support stand alone booting.

Section 4.6 contains important information if NAND boot is used.

### 3.2.1.3 JTAG interface

The JTAG interface is a standard ARM-compatible JTAG interface. There is a special feature on the LPC3152 that can bypass the ARM core scan chain (i.e. the debug access), by pulling JTAGSEL low. In that case, the JTAG interface is used for boundary scan access.

### 3.2.1.4 SPI NOR FLASH

There is a 32Mbit (4 MByte) NOR flash connected to the SPI bus. There is an option to mount one of two different manufacturers; either S25FL032 from Spansion or AT45DB321 from Atmel. Embedded Artists can choose to mount any one of these chips on the board and it depends in component availability at the time of production. Both are compatible for the relevant commands. In case special commands are used, it is possible to read out chip id and determine type.

### 3.2.1.5 Reset Generation

The reset generation is handled by a standard voltage supervisor chip, CAT811R from Catalyst Semiconductor. The reset signal will be held active (i.e., low) until the supply voltages, +3.3V, is within margins (above 2.63V). The reset duration is typically 200 mS (consult the CAT811R datasheet for exact details). The output reset signal is push/pull output that is converted to an open-collector / open-drain output via the 74LVC1G125 buffer. An external reset source can pull the reset signal low (with an open-collector/open-drain output).

### 3.2.1.6 I2C E2PROM

There is a 256 kbit E2PROM accessible via the I2C interface. The LPC3152 has two on-chip I2C communication channels. Channel #0 is available externally and is used for communicating with the E2PROM. More peripheral units are easily connected to the two-wire I2C bus, just as long as the addresses do not collide. The address of the 256kbit E2PROM is 0xA0, which is also indicated in the schematic.

There are 1.5 kohm pull-up resistors (pull-ups are always needed on I2C busses) included on the board on I2C channel #0.

I2C channel #1 is internal for communicating with the analog part of the chip. It is not available externally.

#### 3.2.1.7 USB Interface

There is a high-speed USB 2.0 (OTG, Host, Device) interface with on-chip PHY on the LPC3152. Note that special care must be taken for layout of the USB signals. This also applies for the external connector, connected to the expansion interface of the *LPC3152 OEM Board*.

### 3.3 Schematic Page 4: Analog and Audio Interfaces

Page 4 of the schematic contains the analog and audio interfaces.

#### 3.3.1.1 Audio Interface

The LPC3152 contains an on-chip audio codec with a microphone input, two line inputs and headphone outputs. Power supplies to the analog functions are carefully filtered in order to minimize power supply noise.

#### 3.3.1.2 Analog Inputs

The LPC3152 contains a 10-bit ADC (Analog to Digital Converter). The positive reference voltage is ADC\_VREFP. It is a filtered version of the 3.2V voltage. The voltage ADC\_VREFP is available on the expansion connector. There is also an associated analog ground reference available on the expansion connector (connected to pin ADC10B\_GNDA on the LPC3152).

### 3.4 Schematic Page 5: External Memories

Page 5 of the schematic contains the external memory interface and the external memories. There are two memory components connected to the external 16-bit memory bus interface. Note that the LCD interface and external memory bus interface are multiplexed over the same pins. It is the memory bus interface that is used in the *LPC3152 OEM Board*. The LCD interface cannot be used and shall not be enabled in the cpu.

Also note that three different types of memories share the same bus interface:

- Dynamic memories (SDRAM)  
Using signals RAS/CAS/DQM0/DQM1/ CLOCKOUT/CKE, etc.
- Static memories or general peripherals  
Using signals OE/WE/BLOUT0/BLOUT1, etc.
- NAND Flash memories  
Using signals CLE/ALE, etc.

Many of the signals are multiplexed on the same pins. The memory interface operates at 1.8V level, which minimizes power consumption.

#### 3.4.1.1 Memory Layout

The external memory controller on the LPC3152 defines a number of memory regions, as listed below:

- External SDRAM bank 0 (0x3000 0000 – 0x33FF FFFF)  
16-bit databus width and 64MByte in size.
- External SRAM bank 0 (0x2000 0000 – 0x2000 FFFF / 0x2001 FFFF)  
128 kByte in size for 16-bit databus width and 64 kByte in size for 8-bit databus.
- External SRAM bank 1 (0x2002 0000 – 0x2002 FFFF / 0x2003 FFFF)  
128 kByte in size for 16-bit databus width and 64 kByte in size for 8-bit databus.
- NAND band 0-3 (accessible via NAND flash controller, not directly via memory address)

The *LPC3152 OEM Board* uses the external SDRAM bank 0 as well as NAND bank 0. It is mainly the two external SRAM banks that are available for the off-board external memory interface of the *LPC3152 OEM Board*. Chip select signals N\_STCS0 and N\_STCS1 are free for external use via the buffered memory interface. Both the address and the data busses are buffered.

#### 3.4.1.2 SDRAM

A 512 MBit (64 MByte) Mobile SDRAM is used, MT48H32M16LF from Micron. The chip is powered by 1.8V and is organized as 32Mbit x16, i.e. it has 16-bit databus width. The chip occupies the only available memory bank for dynamic RAM at address range 0x3000 0000 – 0x33FF FFFF.

#### 3.4.1.3 NAND Flash

A 2 Gbit (256) NAND flash is used, MT29F2G08ABDHC from Micron. The chip is powered by 1.8V and has 8-bit databus width. The NAND flash builds on a single-level cell (SLC) technology and has a page size of 2112 bytes (2,048 + 64 bytes). The chip is connected to NAND bank 0. Note that the chip is not directly accessible via the memory bus. Instead, all accesses must be done via the on-chip NAND flash controller of the LPC3152.

Embedded Artists can choose to mount a different brand of NAND flash dependent on component availability at the time of production. The application program should always read out the NAND flash chip id and determine type and features.

#### 3.4.1.4 Buffers to External Interface

The LPC3152 memory interface is available on the expansion connector. The data bus width is 16-bits on the external interface. The relevant signals are buffered. The buffers are disabled by default unless enabled by external signals.

By pulling signal N\_ABUF\_EN low, the two buffers for address and control signals are enabled and act as outputs (from the *LPC3152 OEM Board*).

The data bus buffer is controlled by the signal N\_DBUF\_EN. By pulling this signal low, the data bus buffer is enabled. The buffered version of the LPC3152 signal OE controls the direction of the data bus buffer. During read operations the buffer acts as an input and during write operations it acts as an output.

Note that N\_DBUF\_EN must not be pulled low constantly. In that case the buffer will collide with the board's internal data bus. N\_DBUF\_EN must only be pulled low when an external memory/IO device is accessed. If only one of the static chip selects is used externally, just connect that signal to N\_DBUF\_EN. If more than one chip select signal is used, (logically) AND all chip select signal together before driving the N\_DBUF\_EN signal, in this case, just AND the two signals B\_N\_STCS0 and B\_N\_STCS1.

*There is an additional important note when booting from NAND flash, read section 4.6 for details about the N\_DBUF\_EN signal.*

If the external memory interface is not used, leave ABUS\_EN and DBUS\_EN unconnected.

The buffers are dual voltage buffers and act as level translators between the internal 1.8V signal levels and the external levels. Connect the external bus voltage to VDD\_EXT. See the datasheet of 74AVCA164245 for exact details about voltage range. Normally 3.3V powering is used.

## 3.5 Schematic Page 6: Expansion Connector

The *LPC3152 OEM Board* integrates the core part of a typical LPC3152 board design with a reasonable large amount of external memories. All relevant signals of LPC3152 are available on the 200 pos, 0.6mm pitch expansion connector (SODIMM-200 format). See the next section for a detailed list of available pins.

### 3.6 Usage of CPU Pins

Almost all pins of the LPC3152 are directly available on the expansion connectors. Only in a few cases pins are used for dedicated functionality like (dynamic) memory control signals, chip select signals and power supply. Such pins are not available on the expansion connector. The table below lists all pins and their possible restrictions.

<b>Pin</b>	<b>Available on expansion connector</b>
USB_VBUS USB_DM USB_DP USB_ID	Yes
I2C_SDA0 I2C_SCL0	Yes, but I2C E2PROM connected to these pins.
SPI_CS_OUT0	No, signal used for chip select of SPI NOR flash (U7 or U10).
SPI_SCK SPI_MISO SPI_MOSI SPI_CS_IN	Yes, but note that SPI NOR flash is connected to SPI_SCK, SPI_MISO, SPI_MOSI.
UART_RXD UART_TXD UART_CTS/SPI_CS_OUT1 UART_RTS/SPI_CS_OUT2	Yes
I2SRX_DATA0 I2SRX_WS0 I2SRX_BCK0 I2STX_DATA0 I2STX_WS0 I2STX_BCK0 I2STX_CLK0	Yes
GPIO0 GPIO1 GPIO2	Yes, but pull-ups/pull-downs are used to set default boot mode to booting from the UART.
GPIO3-GPIO10	Yes
PWM_DATA	Yes
ADC10B_GPA0-ADC10B_GPA2	Yes
ADC_MIC ADC_TINL ADC_TINR ADC_VINL ADC_VINR HP_OUTR HP_OUTL	Yes

CLOCK_OUT	Yes
EBI_D0-EBI_D15	Yes, but only available via the data bus buffer
MLCD_A0/ALE MLCD_A1/CLK MLCD_DB2/EBI_A2 MLCD_DB3/EBI_A3 MLCD_DB4/EBI_A4 MLCD_DB5/EBI_A5 MLCD_DB6/EBI_A6 MLCD_DB7/EBI_A7 MLCD_DB8/EBI_A8 MLCD_DB9/EBI_A9 MLCD_DB10/EBI_A10 MLCD_DB11/EBI_A11 MLCD_DB12/EBI_A12 MLCD_DB13/EBI_A13 MLCD_DB14/EBI_A14 MLCD_DB15/EBI_A15	Yes, but only available via the address bus buffer
EBI_DQM0/NOE EBI_NWE EBI_NCAS/BLOUT0 EBI_NRAS/BLOUT1 MLCD_CSB/EBI_NSTCS0 MLCD_DB1/EBI_NSTCS1	Yes, but only available via the buffer
NAND_NCS0 MNAND_RYBN0/MCI_DATA4	No, used for internal NAND flash memory.
NAND_NCS1 NAND_NCS2 NAND_NCS3 MNAND_RYBN1/MCI_DATA5 MNAND_RYBN2/MCI_DATA6 MNAND_RYBN3/MCI_DATA7	Yes
MLCD_DB0/EBI_CLKOUT MLCD_RS/EBI_NDYCS MLCD_RW_WR/EBI_DQM1 MLCD_E_RD/EBI_CKE	No, used for internal SDRAM.
ADC_VREFP ADC_VREFN	Yes. Note that VDDA is connected to +3.2V power supply
FFAST_IN FFAST_OUT	No, directly connected to on-board crystals
FSLOW_IN FSLOW_OUT	No, directly connected to on-board crystals
RTC_INT RTC_CLK PSU_PLAY PSU_STOP CHARGE_VNTC	Yes

CHARGE_BAT_SENSE	
JTAG signals	Yes
VPP	Can be indirectly controlled by OTP signal
RESET_IN	Yes

The *LPC31xx Base Board* illustrates how to typically connect external interfaces (like USB, external memory devices, etc) to the *LPC3152 OEM Board*. Study this schematic for details.

### 3.7 LPC3152 OEM Board Mechanical Dimensions and Connector

Figure 1 below contains a drawing of the board that includes mechanical measures. See SODIMM-200 standard for exact measures. 1.8V keying is used (SODIMM-200 boards are either 1.8V or 2.5V keyed).

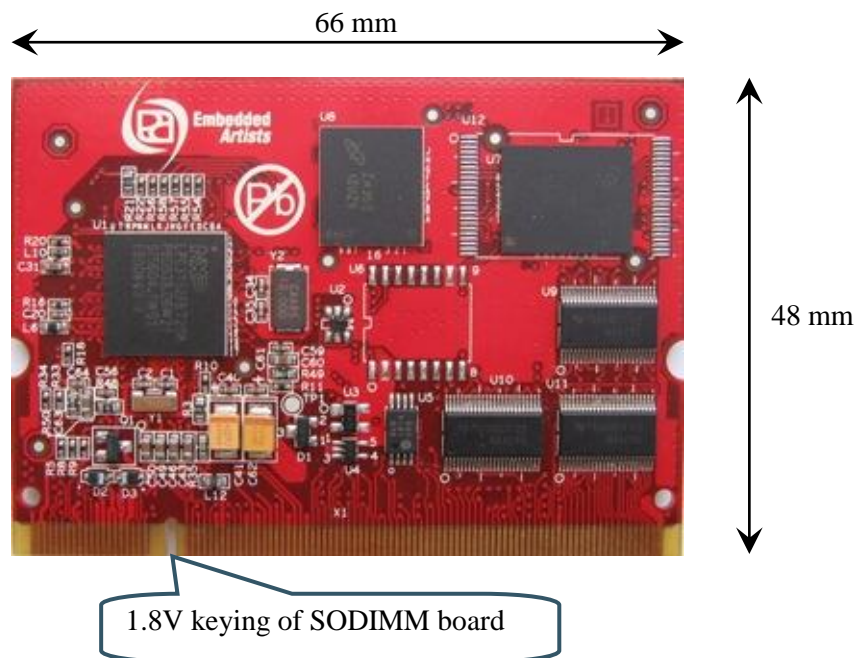


Figure 1 – LPC3152 OEM Board Mechanical Dimensions

The SODIMM-200 format is a standard and there are many connectors that are suitable from many different manufacturers. The many sources also keep the connector cost very low. Note that the connector should be 1.8V keyed.

One suitable connector is 0-1473005-4 from Tyco/AMP. Basically any SODIMM, DDR2, 200pos, 1.8V, right-angled connector will do.

### 3.8 Things to note about the LPC3152 OEM Board

#### 3.8.1 NAND FLASH Bad Block

The NAND Flash is the MT29F2G08ABDHC from Micron and contains 2 GBit capacity. The chip may include invalid blocks when shipped from factory. A maximum of 40 invalid blocks may exist initially, i.e., 2008-2048 valid blocks. Additional invalid blocks may develop while being used. Invalid blocks are defined as blocks that contain one or more bad bits. Do not erase or program factory-marked bad



blocks. More information about appropriate management of invalid blocks can be found in technical notes and datasheet from Micron.

### 3.8.2 Brand of Memory Chips

Note that there is no guarantee for a certain brand or version of memory chips; SPI-NOR flash, parallel NAND flash and SDRAM. The lifetime of memory chips is limited and availability can also be limited from time to time. Embedded Artists make every effort to mount the original design chip on the board. In case that is impossible a compatible chip will instead be mounted without any prior notice. There can be small programming differences between mounted brands. The application program shall always read the chip id of flash devices to make certain which chip is actually mounted on the board.

The support page contains datasheets to the different memory devices and information about mounted devices on different board versions.

## 4 LPC31xx Base Board Design

This chapter contains detailed information about the electrical and mechanical design of the *LPC31xx Base Board*, version 2.0. The difference between v1.1 and v2.0 is that a 100/10Mbps Ethernet interface was added in v2.0. This new functionality is found on page 8 of the schematic. The differences between version 1.0 and v1.1 are very small and can be seen on revision comments on the first page of the schematic. The schematic can be downloaded in pdf format from the support page, and is recommended to have printed out while reading this chapter.

The *LPC31xx Base Board* contains a number of interfaces and connectors to the *LPC3152 OEM Board*. The design can be viewed as a reference schematic for custom designs around the *LPC3152 OEM Board*.

Note that the *LPC31xx Base Board* supports different members of the LPC31xx family. All functionalities on the board do not directly apply for the *LPC3152 OEM Board*, for example the I2S codec (since the LPC3152 has an internal codec).

Note that the codec on the *LPC31xx Base Board* cannot be accessed by the LPC3152. The used I2C and I2S channels are not available on the LPC3152 chip.

### 4.1 Usage of CPU Pins

Almost all pins of the LPC3152 are directly available on the expansion connectors. Only in a few cases pins are used for dedicated functionality like (dynamic) memory control signals and chip select signals. Such pins are not available on the expansion connector. The table below lists all pins and their possible restrictions.

<b>Pin</b>	<b>Usage on LPC31xx Base Board</b>
USB_VBUS USB_DM USB_DP USB_ID	Connected to USB connectors; mini-AB and A.
I2C_SDA0 I2C_SCL0	Connected to PCA9532 port expander.
SPI_SCK SPI_MISO SPI_MOSI	Can be connected to QVGA display for touch screen controller SPI interface.
SPI_CS_IN	No usage.
UART_RXD UART_TXD	Can be connected to the USB-to-serial bridge, RS232 interface or XBee module.
UART_CTS/SPI_CS_OUT1	Can be connected to QVGA display for touch screen controller SPI interface (chip select). Can be connected to RS232 interface or XBee module.
UART_RTS/SPI_CS_OUT2	Can be connected to RS232 interface or XBee module.
I2SRX_DATA0	Can be used to detect presence of +5V.
I2SRX_WS0	Can be used to detect USB power switch over-current status

I2SRX_BCK0 I2STX_WS0 I2STX_CLK0	No usage.
I2STX_DATA0	Can be used to control powering of MMC/SD memory card interface.
I2STX_BCK0	Can be used to detect MMC/SD memory card presence.
GPIO0 GPIO1 GPIO2	Can be connected to jumpers for controlling boot mode.
GPIO3	No usage.
GPIO4	Can be used as QVGA display touch screen controller interrupt pin.
GPIO5	Can be used as MCI_CLK (MMC/SD interface)
GPIO6	Can be used as MCI_CMD (MMC/SD interface)
GPIO7	Can be used as MCI_DAT0 (MMC/SD interface)
GPIO8	Can be used as MCI_DAT1 (MMC/SD interface)
GPIO9	Can be used as MCI_DAT2 (MMC/SD interface)
GPIO10	Can be used as MCI_DAT3 (MMC/SD interface)
PWM_DATA	Can be used to control backlight intensity on QVGA display
ADC10B_GPA0	X-output from accelerometer.
ADC10B_GPA1	Y-output from accelerometer.
ADC10B_GPA2	Either z-output from accelerometer or trim pot.
CLOCK_OUT	No usage.
EBI_D0-EBI_D15	Connect to QVGA display module connector and DM9000 Ethernet interface.
MLCD_A0/ALE MLCD_A1/CLK MLCD_DB2/EBI_A2 MLCD_DB3/EBI_A3 MLCD_DB4/EBI_A4 MLCD_DB5/EBI_A5 MLCD_DB6/EBI_A6 MLCD_DB7/EBI_A7 MLCD_DB8/EBI_A8 MLCD_DB9/EBI_A9 MLCD_DB10/EBI_A10 MLCD_DB11/EBI_A11 MLCD_DB12/EBI_A12 MLCD_DB13/EBI_A13 MLCD_DB14/EBI_A14	No usage.
MLCD_DB15/EBI_A15	Connect to QVGA display module connector and DM9000 Ethernet interface.

EBI_DQM0/NOE EBI_NWE	Connect to QVGA display module connector and DM9000 Ethernet interface.
MLCD_CSB/EBI_NSTCS0	Connect to QVGA display module connector.
MLCD_DB1/EBI_NSTCS1	Connect to DM9000 Ethernet interface.
EBI_NCAS/BLOUT0 EBI_NRAS/BLOUT1	No usage.
NAND_NCS1 NAND_NCS2 NAND_NCS3 MNAND_RYBN1/MCI_DATA5 MNAND_RYBN2/MCI_DATA6 MNAND_RYBN3/MCI_DATA7	No usage.
ADC_MIC ADC_TINL ADC_TINR ADC_VINL ADC_VINR HP_OUTR HP_OUTL	Connect to 3.5mm audio connectors
RTC_INT RTC_CLK PSU_PLAY PSU_STOP CHARGE_VNTC CHARGE_BAT_SENSE	RTC_INT can be connected to PSU_PLAY via jumper. PSU_PLAY can be connected to push-button. CHARGE_BAT_SENSE available on battery connector.
ADC_REFP ADC_REFN	Used as references to generate analog signal from trip pot.
JTAG signals	Connected to standard ARM 2x10 pos JTAG connector.
RESET_IN	Connected to Reset push-button and LED.

## 4.2 Known Limitation of LPC31xx Base Board

### 4.2.1 MMC/SD Memory Card Detect Signal (J13)

J13 is not assembled on *LPC31xx Base Boards* version 1.1. Instead a 3K resistor is soldered between the pins. The reason is that the signal I2STX\_BCK0 acts as an output during booting in most boot modes. Since the MMC/SD connector will drive the signal to GND if a memory card is inserted the signal will be shorted to ground resulting in excessive current flowing. The 3K resistor limits the current to a reasonable level. *Figure 2* below illustrates the rework needed.

**Note that a few boards of version 1.1 have been shipped without the 3K resistor. In this case, a jumper shall never be inserted in J13, or a 3K resistor shall be soldered between the pins.**

**Note that the problem is fixed on v2.0 of the LPC31xx Base Board.**

Also note that the pull-up on the SD card detect pin is after the power switch. Due to this there is a need to enable power to the SD/MMC slot to even detect the card insertion.

**Note that this problem is fixed on v2.2 of the LPC31xx Base Board.**

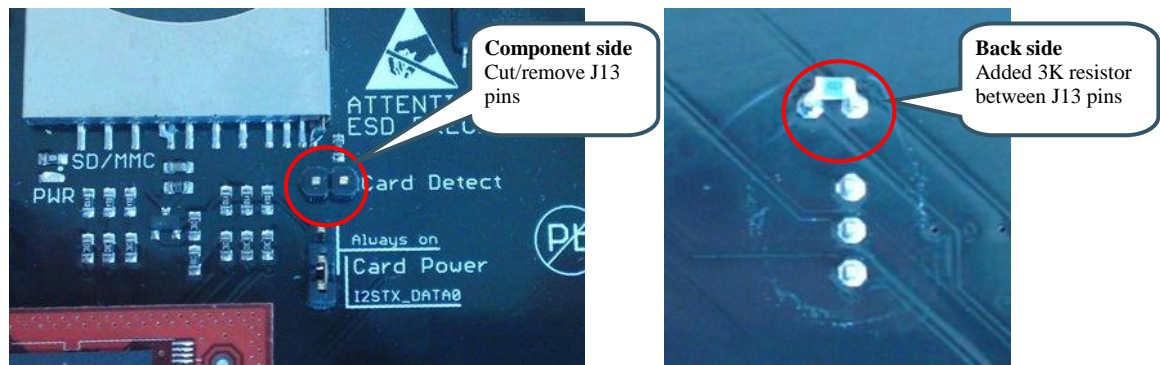


Figure 2 – MMC/SD Card Detect Fix

#### 4.2.2 H\_L\_CC Jumper

When the H\_L\_CC jumper is inserted, it will pull signal GPIO1\_BOOT1 low despite boot jumper settings. Do not insert H\_L\_CC jumper (pin 1-2 on J14 on the LPC31xx Base Board) in case a boot mode where GPIO1\_BOOT1 is high (specifically *UART boot* and two test boot modes).

Previously the H\_L\_CC jumper was inserted by default. The factory/default setting has now been changed to 'not inserted'.

#### 4.2.3 NAND Booting

Read [section 4.6](#) for details about N\_DBUF\_EN signal during NAND boot.

#### 4.2.4 USB Host applications – power supply

When running USB Host applications where the external USB Device draw a considerable amount of current (>100mA), the LPC31xx Base Board must be powered with an external power supply (as opposed to being powered via the USB-to-UART mini-B USB connector). See [section 5.1](#) for details about the external power supply.

#### 4.2.5 USB Host applications – over current sense

U3 is an over-current protected distribution switch for VBUS (+5V) – for feeding external USB devices. There is a status flag feedback signal from U3. If this is used (for example by the latest Linux distribution), a jumper must be inserted in J14, pin 9-10. This will bridge the status signal to pin I2SRX\_WS0. **This jumper is not inserted by default.**

If the over-current flag on VBUS circuit is not getting set (in case of an over-current situation) it is a sign of too weak external power supply. The problem is typically that when the external load is increasing (on VBUS) the power supply circuit is reducing the output voltage rather than keeping voltage constant and increase the current draw. Due to this the over-current flag is not getting set and eventually the complete board can go “down”, i.e., it resets since the supply voltage is out of range. A possible workaround (if the external power supply cannot keep the voltage at correct level) is to monitor the VBUS voltage to detect an over-current condition and switch VBUS off when it goes below a certain level.

### 4.3 Jumpers

The *LPC31xx Base Board* has a number of jumpers in order to be able to connect/disconnect and fully utilize all functionality of the LPC3152 and the *LPC31xx Base Board*. Figure 3 below illustrates all jumpers and explains to what part of the design they belong.

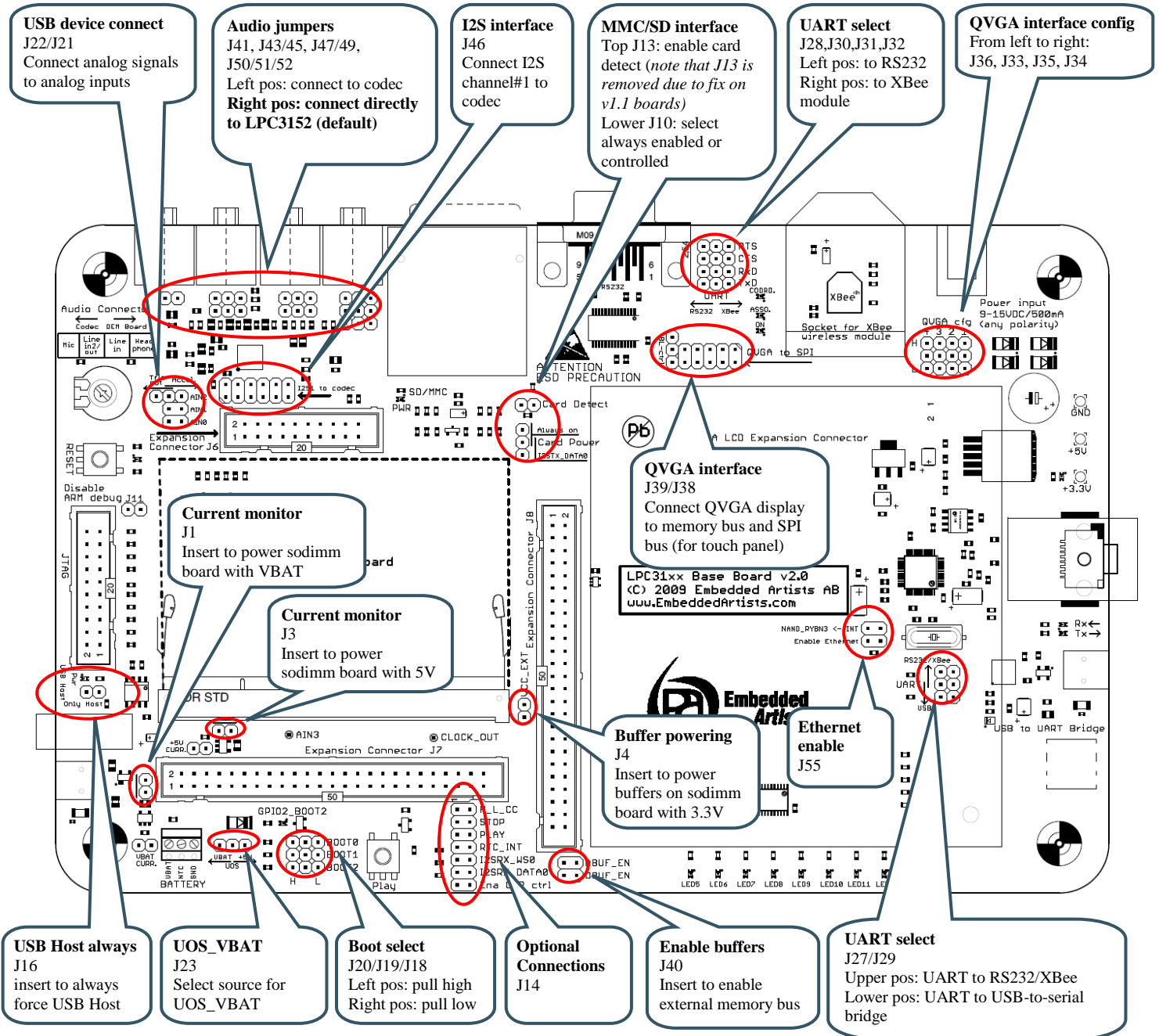


Figure 3 – LPC31xx Base Board Jumper Positions

### 4.3.1 Default Jumper Positions

Figure 4 below illustrates the default jumper positions as mounted when the board is delivered from Embedded Artists.

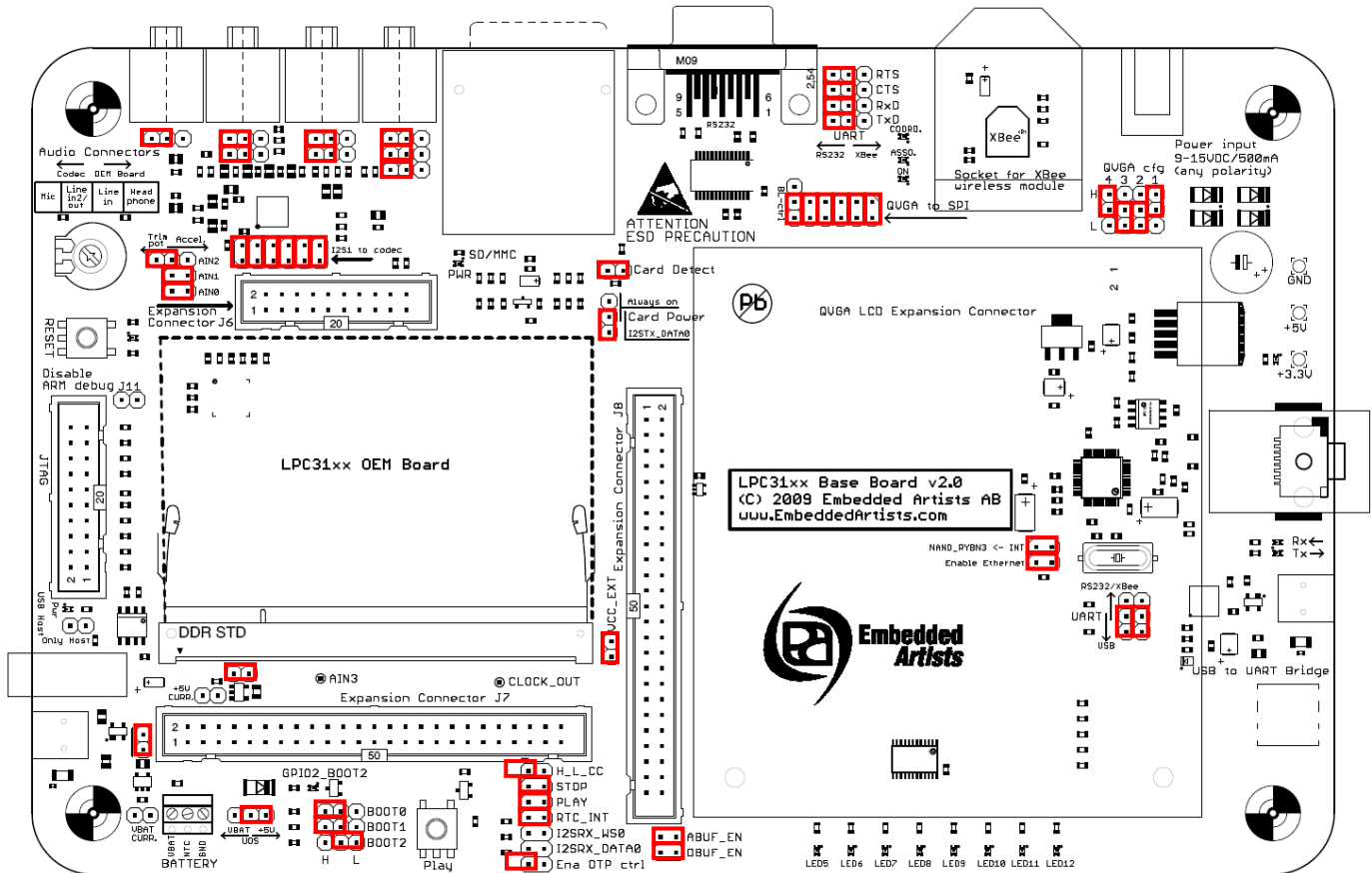


Figure 4 – LPC31xx Base Board Default Jumper Positions

### 4.3.2 Illegal Jumper Combinations

Note that some jumpers are mutual exclusive and should not be inserted simultaneously.

- Note that the spi chip select on the QVGA display touch controller use the signal UART\_CTS\_SPI\_CS\_OUT1. Hence, a jumper between pin 1-2 on J38 should not be inserted while a jumper on J31 is inserted since RTS from the RS232 interface or CTS# from the XBee module will also drive this signal.

### 4.4 Connectors

Figure 5 below illustrate the position of all external connectors on the LPC31xx Base Board.

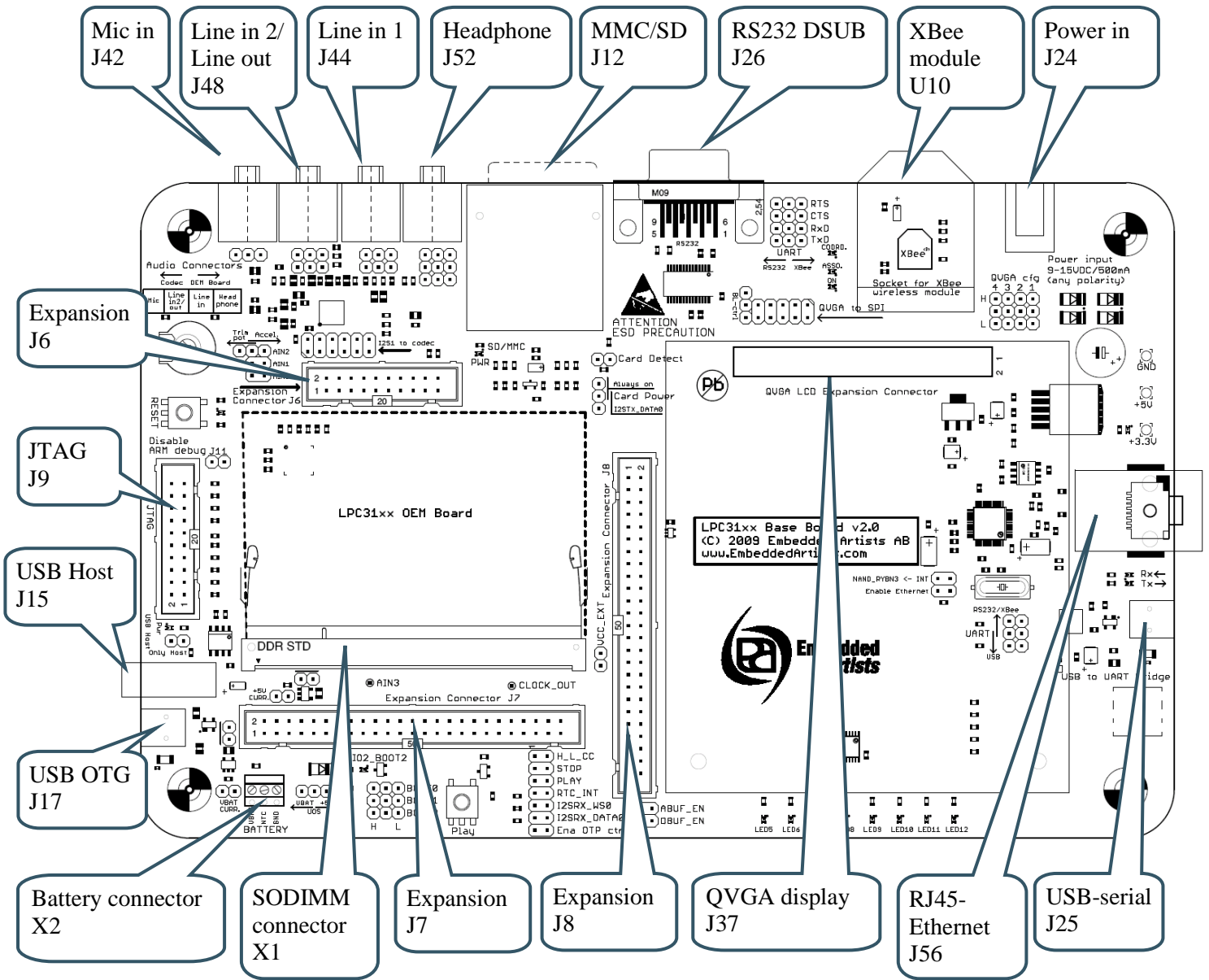


Figure 5 – LPC31xx Base Board External Connectors



### 4.5 Important Components

Figure 6 below illustrates the position on the LPC31xx Base Board for some important components in the design.

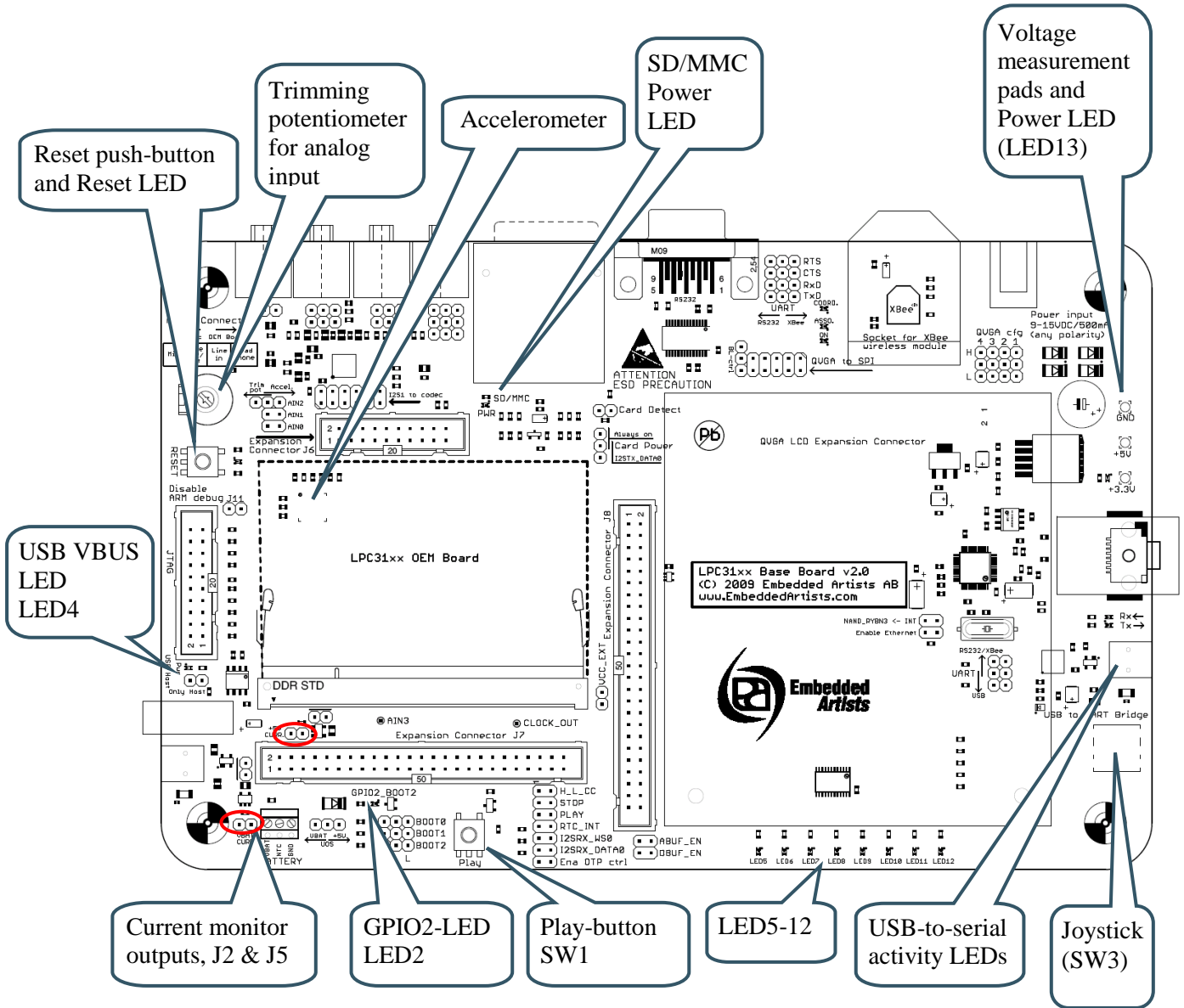


Figure 6 – LPC31xx Base Board Important Components

## 4.6 NAND Boot Problem Fix

This note does **NOT** affect boards marked with WO-0246-1033. See picture below where to find production marking. The picture illustrates a board that is not affected. The last four numbers represent a year-week marking. '1033' means produced: 2010, week 33. Boards marked with production dates earlier than 1033 are affected.

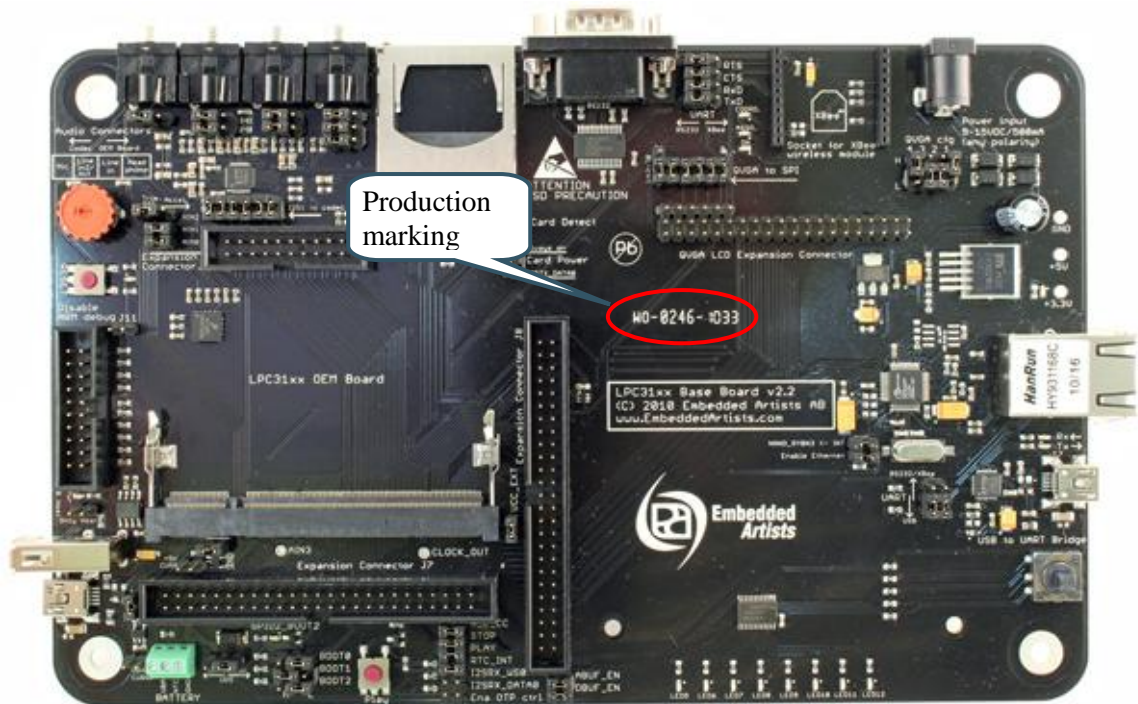


Figure 7 – LPC31xx Base Board Production Marking

Note that there is a conflict on the databus when booting via NAND flash. The problem is that signals N\_STCS0 and N\_STCS1 are low during NAND boot. The signal DBUF\_EN on the *LPC31xx Base Board* is formed by AND:ing N\_STCS0 and N\_STCS1. This, in turn, enables the databus buffer (U11 on *LPC3152 OEM Board*) when the DBUF\_EN jumper (pin 1-2 on J40) is inserted on the *LPC31xx Base Board*. See *Figure 8* to locate DBUF\_EN jumper on the *LPC31xx Base Board*.

After NAND flash boot is completed the active level changes for the signals N\_STCS0 and N\_STCS1. Their inactive state is then high and their active state is low, just as expected for memory bus chip select signals. There is unfortunately no way to detect when the NAND boot process is complete. There are however two workarounds for this problem:

1. Remove the DBUF\_EN jumper during the boot process and then insert the jumper again in order to use the QVGA and Ethernet functionality on the *LPC31xx Base Board*.

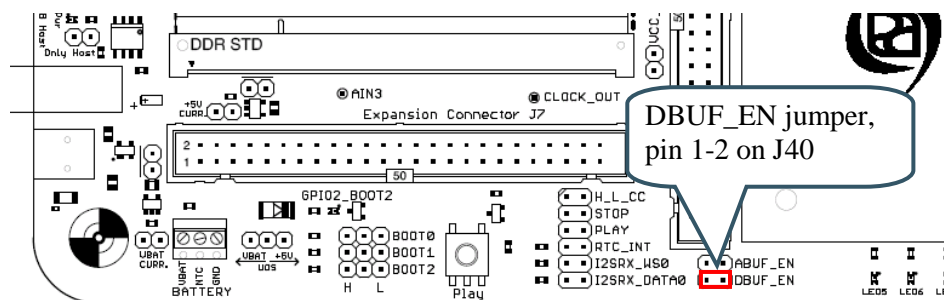


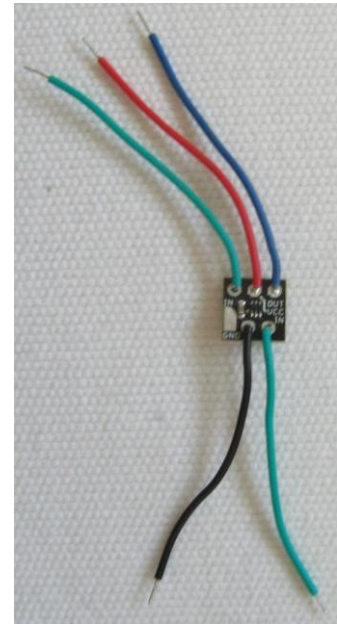
Figure 8 – DBUF\_EN jumper location on LPC31xx Base Board

2. Replace U11 (74LVC1G08), the AND gate found on page 6 of the *LPC31xx Base Board* schematic. Replace it with a XNOR-gate. The AND and XNOR gates have the same truth table except when both input signals are low. For the XNOR gate the output is high when both inputs are low. This will also solve the problem, since the databus buffer (U11 on *LPC3152 OEM Board*) will not be enabled during NAND boot when both N\_STCS0 and N\_STCS1 are low.

Embedded Artists has created a small board with a XNOR gate that can be soldered to the *LPC31xx Base Board*. This board can be ordered free of charge from the support page. The board is delivered with a detailed instruction how to solder the board (5 wires needs to be soldered on the back side of the *LPC31xx Base Board*).

The picture to the right shows the small board with the XNOR gate.

After the small board has been soldered to the back side of the *LPC31xx Base Board*, the DBUF-EN jumper (pin 1-2 on J40) shall **NOT** be inserted.



## 5 Getting Started

This chapter contains information about how to get acquainted with the *LPC3152 OEM Board and LPC31xx Base Board Bundle*. **Please read this section first before you start using the board - it will be worthwhile!**

### 5.1 Initial Setup and Powering

The board can be powered from a PC via the included USB cable (mini-B to A cable). A separate power supply is however needed in stand-alone situations or when running USB Host application (when powering heavy load external USB devices). The power supply should be 9-15V DC. When powering heavy external load on USB devices a 2 Amp supply is needed. Else a 0.5A supply is enough. A 2.1mm standard power plug is used to interface the board. Any polarity is accepted.

It is possible to have both the USB cable and external powering connected to the board at the same time.

The *LPC31xx Base Board* contains a USB-to-Serial bridge chip (FT232R from FTDI) that connects the UART channel on the LPC3152 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 *Section 5.2* for a description of how to install the FTDI USB driver.

### 5.2 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 *LPC31xx 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.

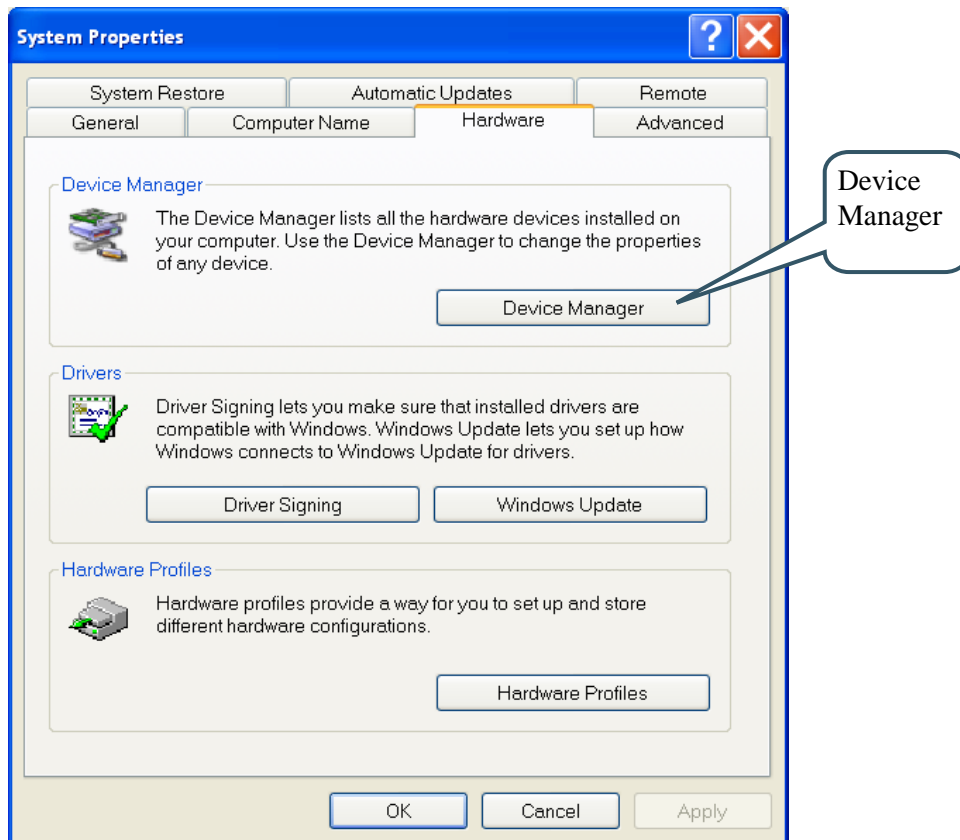


Figure 9 – System Settings Dialog

Then select the *Device Manager* and open the *Ports* list, as illustrated in *Figure 10* below.

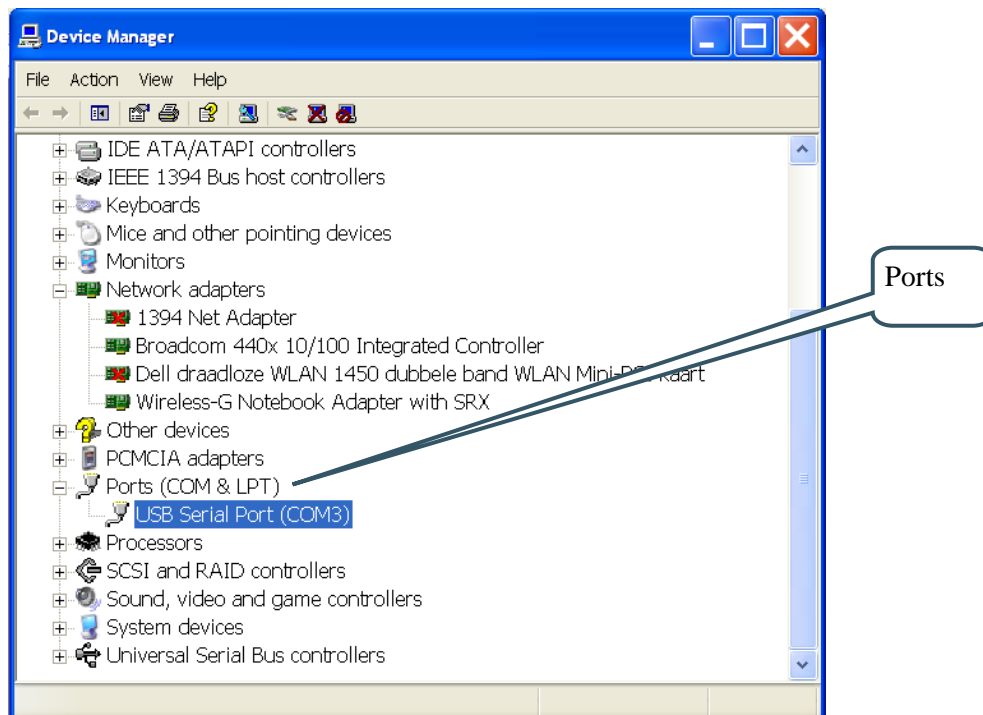


Figure 10 – Device Manager Dialog

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 11* below.

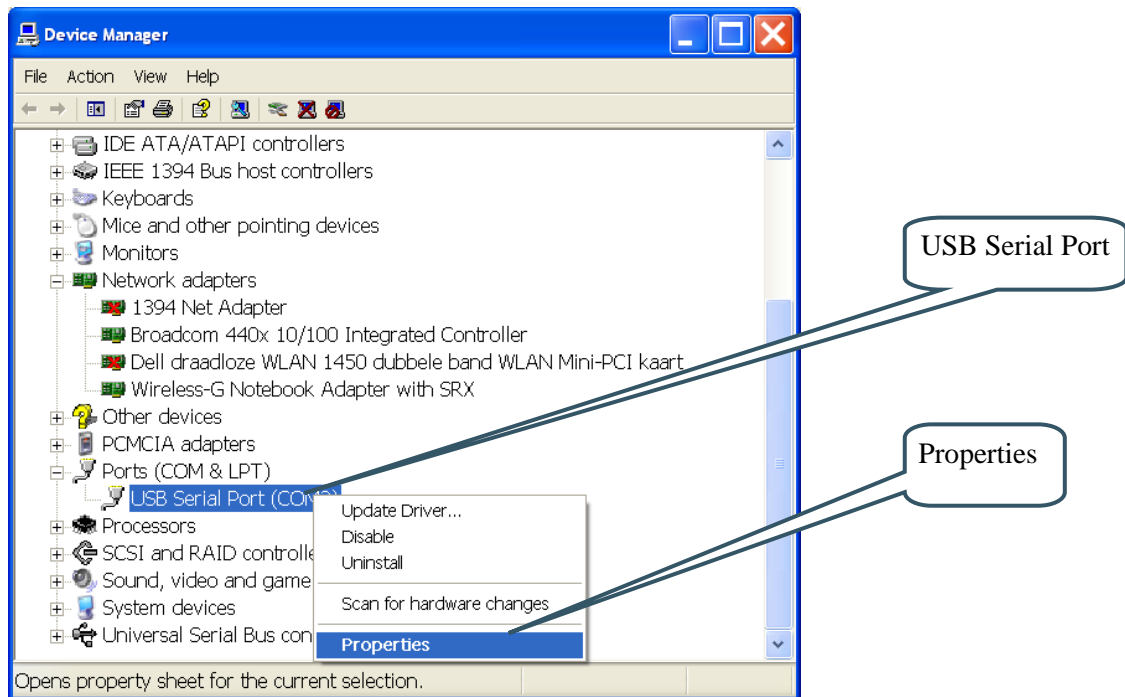


Figure 11 – Device Manager Port Dialog

Select 115200 bits per second, 8 data bits, none parity, 1 stop bit, and none flow control, as illustrated in *Figure 12* 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.

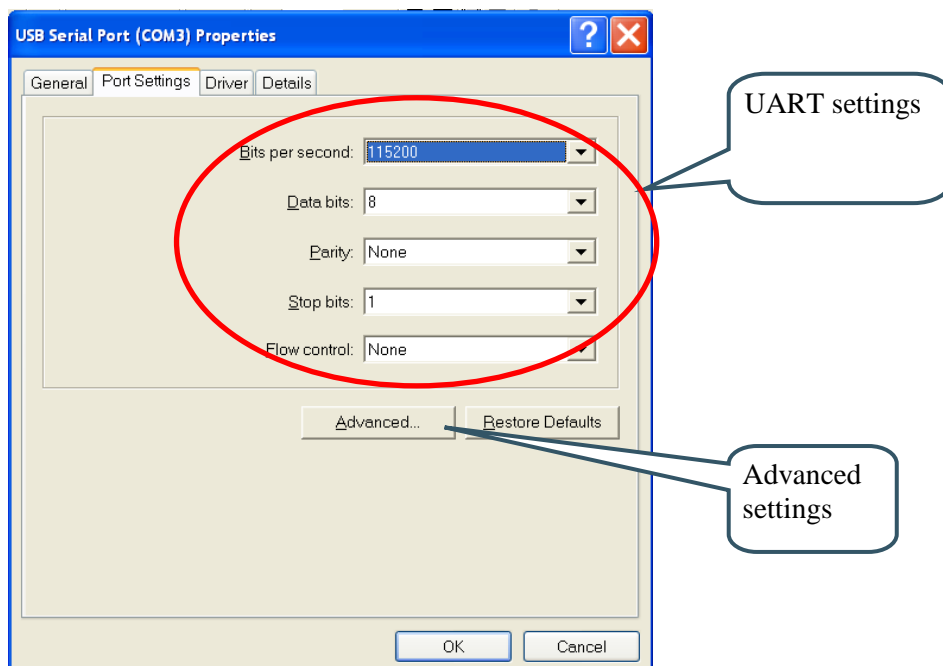


Figure 12 – USB Serial Port Properties Dialog

Select the desired COM port number under the *Advanced* settings dialog. NXP's FLASH Utility program (for ISP program download) needs, for example, a COM port number between 1 and 5. Very often the COM port number is selected but the USB Serial Port is higher than this, therefore this need 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.

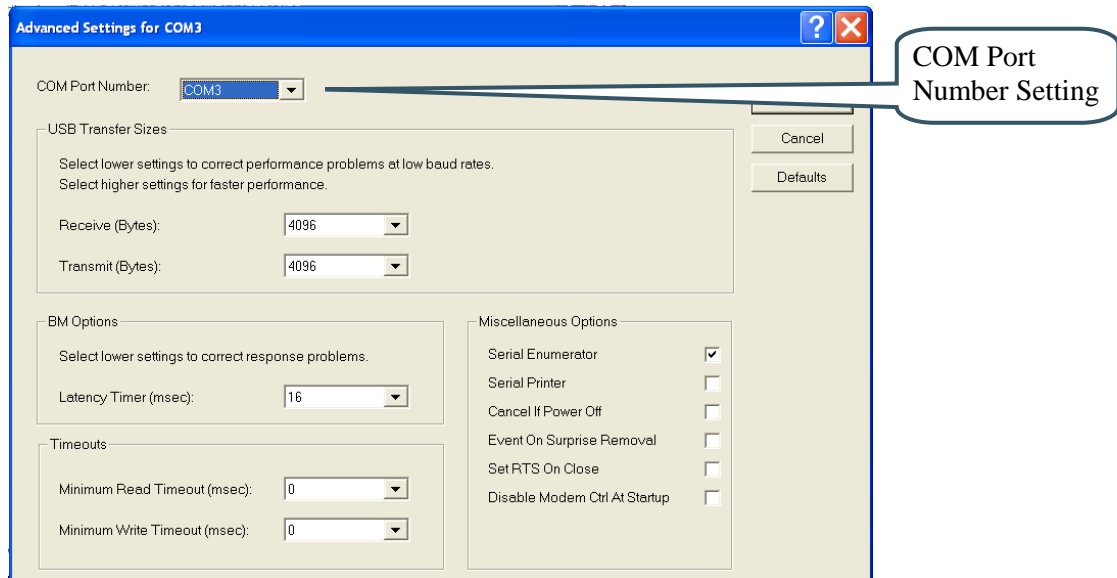


Figure 13 – Advanced USB Serial Port Properties Dialog

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

### 5.2.1 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 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.

## 5.3 Booting

The processor will start its code execution from an internal ROM, containing the boot code. This code determines the boot mode by sampling the reset state of the pins GPIO0, GPIO1 and GPIO2. Multiple boot options are supported:

- Booting from different sources; SPI flash, NAND flash, SD/SDHC/MMC cards, UART and USB (DFU class) interfaces
- Option to perform CRC32 checking on the boot image

The boot code copies/downloads the boot image to internal SRAM at location 0x1102 9000 and jumps to that location (sets ARM's program counter register to 0x1102 9000) after image verification. Hence the boot images should be compiled with entry point at 0x1102 9000. The boot code can handle boot images up to 128 kByte in size on the LPC3152. For larger applications, the booting has to be done in more steps, i.e., a second stage boot loader has to be added.

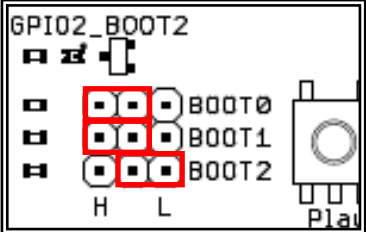
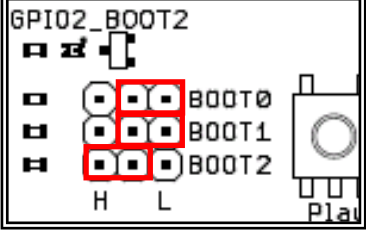
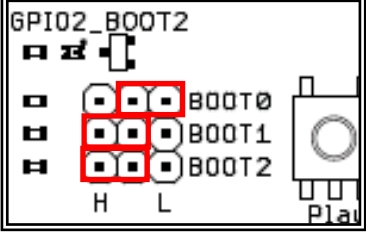
Note that the boot code initializes the MMU (Memory Management Unit) with a pre-defined MMU table. This table is 16 kByte in size, so systems with RAM constraints (or small and simple systems) can

utilize this pre-defined MMU table. If this is not sufficient, the MMU must be further initialized in the beginning of the user code (i.e., the boot image).

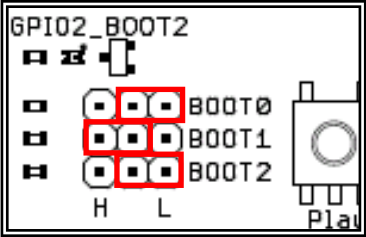
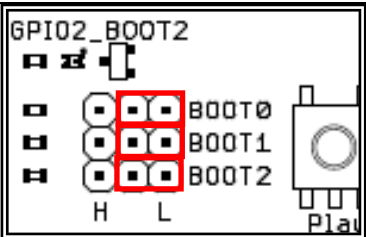
The LPC3152 User's Manual from NXP contains all details about booting including the pre-defined MMU table. The rest of this section gives an overview of what is supported by the *LPC3152 OEM Board* and *LPC31xx Base Board*, and how to quickly get started with the download process.

### 5.3.1 Jumper Settings

The table below lists the boot sources supported by the *LPC3152 OEM Board* and how to set the jumpers on the *LPC31xx Base Board*.

<b>Way of booting</b> (source for boot image)	<b>Jumper settings</b> (on <i>LPC31xx Base Board</i> )	<b>Description</b>
UART (default mode)		<p>The boot image is downloaded via the UART. The download format is 115.2 kbps, 8 data bits, no parity and one stop bit (8N1).</p> <p>It is recommended to download a CRC check boot image since there is no flow control or handshake mechanism implemented in the UART protocol.</p> <p>Note that no jumpers need to be set for this boot mode since this is the default. However, it is good practice to set the jumpers anyways, since future revisions or special versions of the <i>LPC3152 OEM Board</i> might change default boot mode.</p>
SPI NOR flash		<p>The boot image is stored on the SPI NOR flash.</p> <p>A CRC check boot image should be used.</p> <p>The boot image is downloaded into SPI NOR flash with the help of a special loader application. For a description of how this could be done, see further down in this section.</p>
MMC/SD		<p>The boot image is stored on a MMC/SD memory card. See the LPC3152 User's Manual from NXP for details about how to format and prepare the memory card.</p>



USB – DFU class		<p>The boot image is downloaded via the USB by utilizing the DFU class (Device Firmware Upgrade).</p> <p>A Windows application exists that connect to the DFU device (that the LPC3152 implement in boot mode). This application is used to download the boot image.</p> <p>Note that a special format of the boot image must be used. For a description of how this could be done, see further down in this section.</p>
NAND flash		<p>The boot image is stored on the NAND flash.</p> <p>The boot image is downloaded into NAND flash with the help of a special loader application. At the time of writing, no such application has been created.</p> <p><b>Read section 4.6 about NAND boot issue when using QVGA display and Ethernet controller on LPC31xx Base Board.</b></p>

### 5.3.2 Creating a Boot Image

Note that this section describes how to create a boot image for the LPC313x family. The principles are exactly the same for the LPC315x family and the exact same conversion program is used (even though the somewhat bad naming of the program).

The first step is to create a pure binary file. This is normally done from the build output file (often an elf or elf-compatible file).

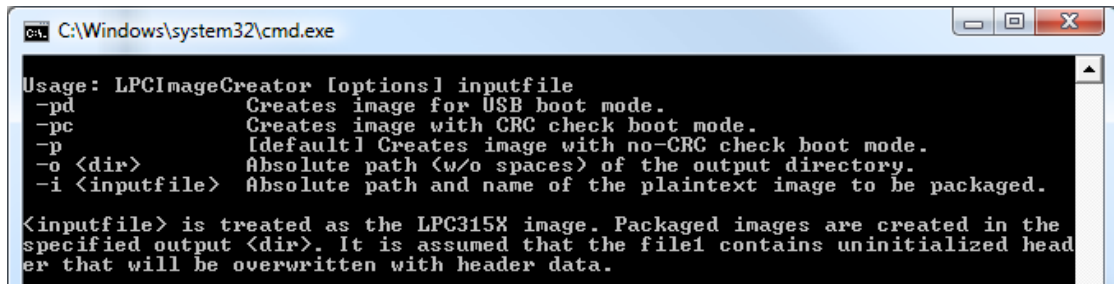
Under a GCC environment, the command to create a binary file, named *lpc313x.bin* is:

```
arm-elf-objcopy -I elf32-little -O binary --strip-debug
--strip-unneeded --verbose <input-file> lpc313x.bin
```

Under uVision (Keil's IDE), the command to create a binary file, named *lpc313x.bin* is as shown below. The input file is in this case typically the output file with axf-ending.

```
fromelf.exe --output lpc313x.bin -bin <input-file>
```

The second step is to create a CRC attached boot image for the LPC3131. There is a command line tool from NXP, bundled in the CDL package named: *lpc313xImgCreator*. See program output explaining the command line options below.



```
ca: C:\Windows\system32\cmd.exe

Usage: LPCImageCreator [options] inputfile
-pd          Creates image for USB boot mode.
-pc          Creates image with CRC check boot mode.
-p          [default] Creates image with no-CRC check boot mode.
-o <dir>     Absolute path (w/o spaces) of the output directory.
-i <inputfile> Absolute path and name of the plaintext image to be packaged.

<inputfile> is treated as the LPC315X image. Packaged images are created in the
specified output <dir>. It is assumed that the file contains uninitialized head
er that will be overwritten with header data.
```

Figure 14 – lpc313xImgCreator Command Line Options

To add a CRC header to the binary file, i.e., to create a CRC attached boot image, the command is:

```
lpc313xImgCreator -o ./ -pc -i lpc313x.bin
```

The `-o` option specifies the output directory (the current directory in this case). The `-pc` option specifies that a CRC header should be appended. The `-i` option specifies the input file. An output file called `lpc313x.rom` will be generated in the command line example above.

To create a boot image for USB DFU booting, the command is:

```
lpc313xImgCreator -o ./ -pd -i lpc313x.bin
```

The `-o` option specifies the output directory (the current directory in this case). The `-pd` option specifies that a file for USB boot mode should be generated. The `-i` option specifies the input file. An output file called `lpc313x.rom` will be generated in the command line example above.

It is possible to automatically create the boot image when compiling/building. The example below illustrates how to configure a project in uVision (the Keil IDE). In the *Options for Target* window, select the *User* tab. Then configure the *Run #1* and *Run #2* options according to the picture below. These commands lines are run after the application is built. *Run #1* creates a binary file named `lpc313x.bin`. *Run #2* creates a CRC attached rom-file. The `-pc` command line option can be changed to `-pd` if USB DFU booting method is used.

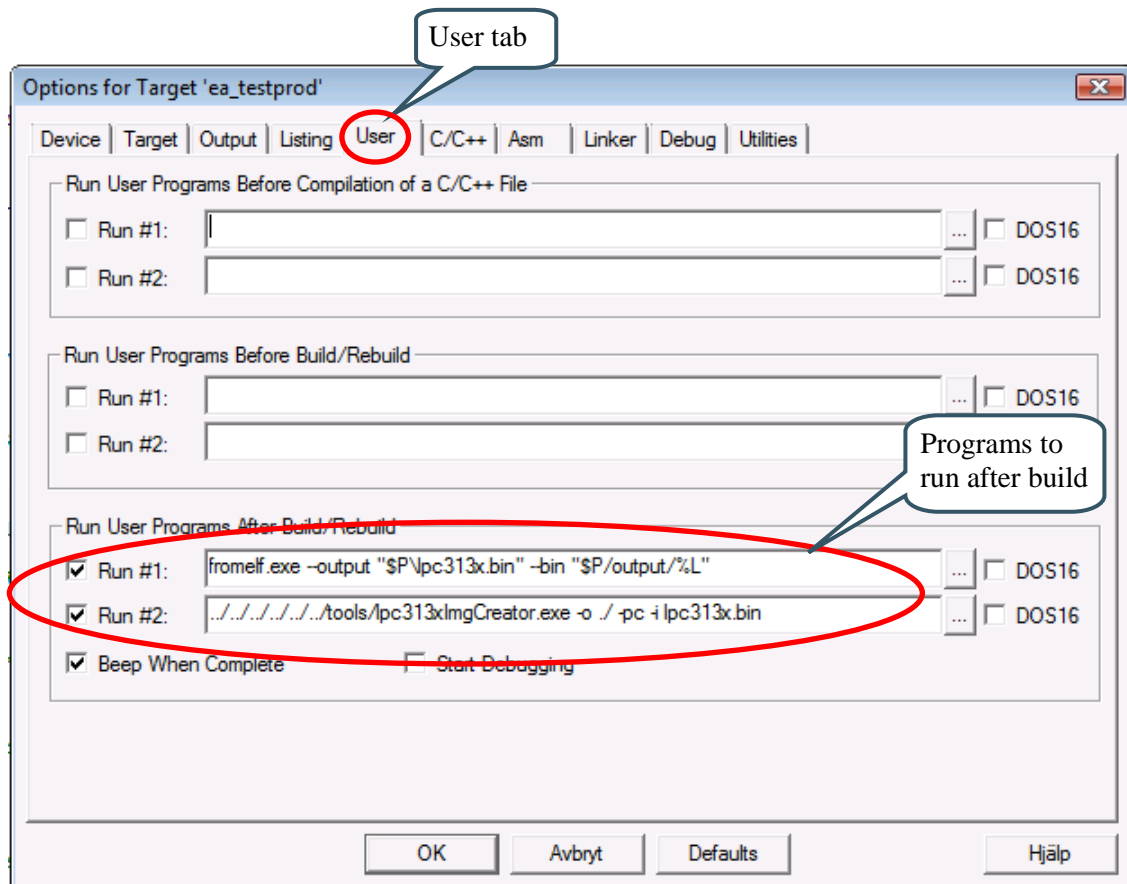


Figure 15 – uVision Options for Target

Note that similar settings can be done in IDE's from other vendors. It could also just as well be added to a makefile, for example when developing in a GCC environment.

### 5.3.3 Booting via UART

When booting via UART, a terminal program (on a PC) that can send binary images must be connected to the LPC3152 UART channel. The USB-to-serial bridge can be used to connect to the LPC3152 UART channel. Alternatively the RS232 interface can be used directly. Make sure the jumpers on the *LPC31xx Base Board* are correctly set for the interface option selected. Terminal setting is: 115.2kbps, 8N1.

The boot code will output the following string over the UART channel:

```
LPC31xx READY FOR PLAIN IMAGE>
```

The download of the binary file should start within 2 minutes from this message. When the boot image is downloaded the following string will be sent from the boot code:

```
Download finished
```

Execution of the downloaded boot image will begin immediately after this. The picture below illustrates how it typically looks in the terminal program.

```
LPC31xx READY FOR PLAIN IMAGE>
Download finished
```

Figure 16 – Terminal Output for UART Boot

Note that the boot image must be 128kByte, or less, for LPC3152.

### 5.3.4 Booting via SPI NOR flash

When booting via SPI the boot image is downloaded from the SPI NOR flash into LPC3152 internal RAM immediately after reset. Execution is also started immediately after download. No message is sent to the UART channel.

Downloading a boot image into the SPI NOR flash is a two step process, as explained below:

1. First set the system to UART boot, and download a 'SPI NOR flash program' program. This is done via normal UART booting, just like described in the previous section. The 'SPI NOR flash program' is one of the sample applications found in the CDL package from NXP.
2. The 'SPI NOR flash program' will output the following string over the UART channel:

```
SPI programer is ready for download>
```

Now, download the actual boot image to be used for SPI booting. Please note that you need to download a CRC attached boot image. Section 5.3.2 describes how to create such an image.

The download process should start within 2 minutes after this message has appeared. When the boot image is downloaded the following string will be sent from the 'SPI NOR flash program':

```
Download finished
Programing flash
##### <multiple hashes> #####
Verifying flash
##### <multiple hashes> #####
Done!!!
```

3. Set the boot jumpers to NOR flash boot as described in section 5.3.1
4. Click the reset button to restart the board and load the application from NOR flash

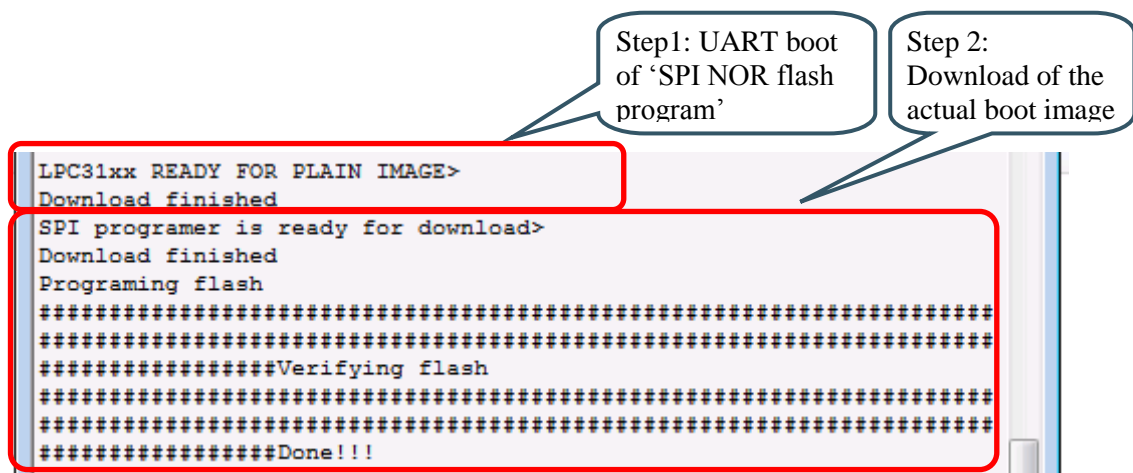


Figure 17 – Terminal Output for download of an image to SPI flash

Note that the SPI boot image must be 128kByte, or less, for LPC3152.

### 5.3.5 Booting via USB DFU class

When booting via USB, a special (PC) program must be used to connect to the DFU device that the boot code implements in the LPC3152. Follow the list below to download a boot image.

1. Connect a USB cable (mini-B to A) from your computer to the *LPC31xx Base Board*. Note that it is the LPC3152 USB connection that should be connected to, not the UART-to-serial bridge on the *LPC31xx Base Board*. See Figure 19 for an illustration where the correct USB connector can be found.
2. Install DFU drivers (available on the Embedded Artists support site).
3. Start the DFU application (DFUAPP.exe). The connected LPC3152 can be seen in the list of devices.
4. Select a file to download (named \*\_usb.rom in the pre-compiled applications available on the Embedded Artists support site).
5. Warning about the file not containing a suffix can sometimes be generated. Just ignore such messages and click 'Yes' to continue.
6. Select Start Download.

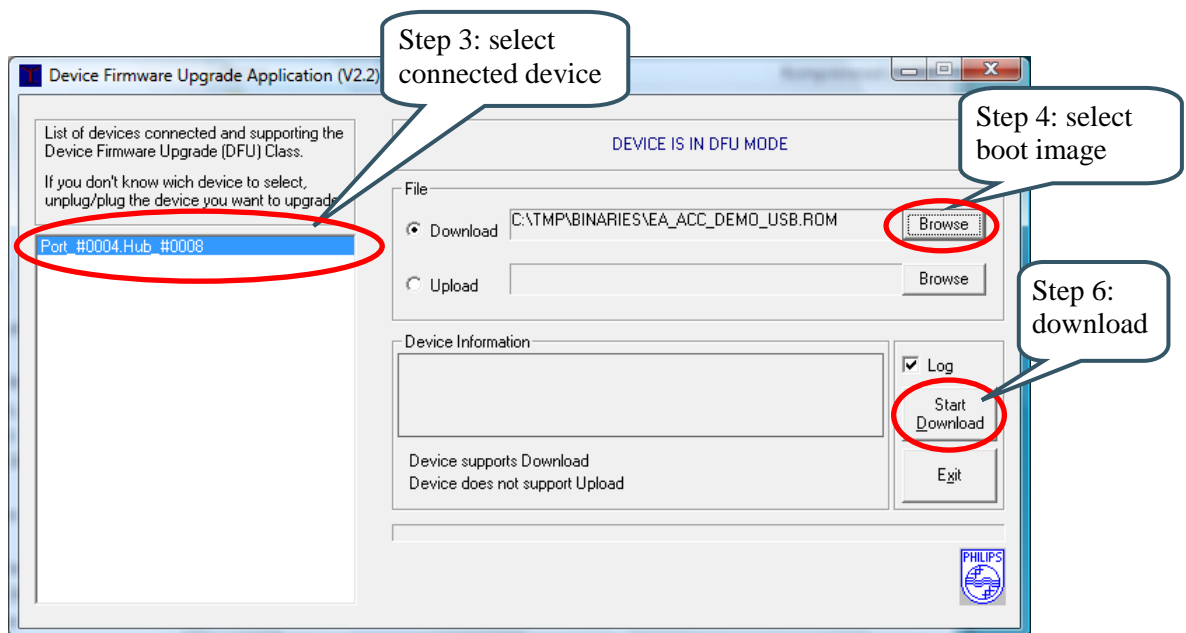
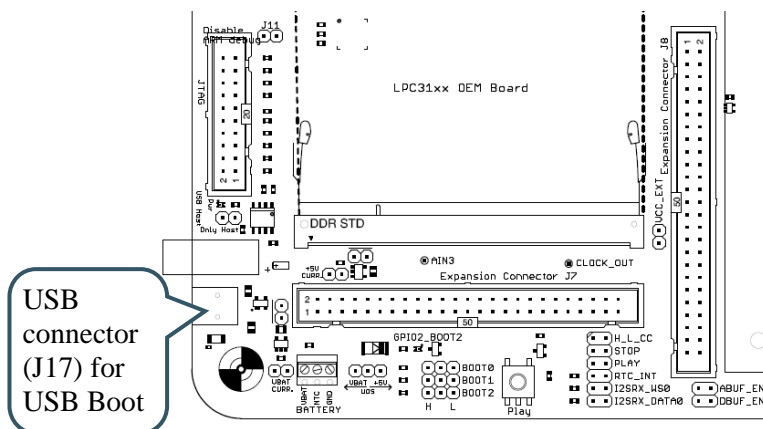


Figure 18 – Device Firmware Upgrade Application Screenshot



### 5.3.6 LED on GPIO2

The boot code will signal any error during boot process by toggling GPIO2 pin. There is a LED connected to this pin for direct visual feedback. The picture below illustrates the position of the LED in relation to the boot jumpers.

Typical errors could be that booting has timed out (must be done within 2 minutes after reset), wrong boot image format or CRC error detected in the downloaded boot image.

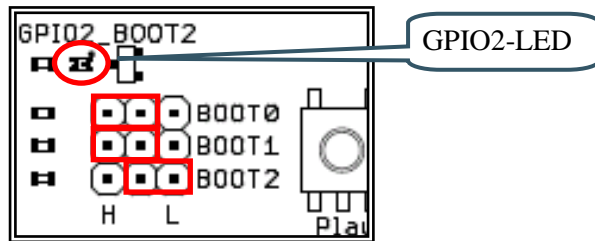


Figure 20 – GPIO2-LED Position

### 5.3.7 Booting via NAND Flash

NXP has written detailed instructions of how to use the u-boot or Apex bootloaders to program the NAND flash on the LPC31xx OEM Boards with a bootable image. Please follow the links below for more information.

#### Program NAND flash using u-boot

[http://www.lpclinux.com/LPC313x/LPC313xUbootNand#Programming\\_NAND\\_flash\\_using\\_Uboot](http://www.lpclinux.com/LPC313x/LPC313xUbootNand#Programming_NAND_flash_using_Uboot)

#### Program NAND flash using Apex

[http://www.lpclinux.com/LPC313x/LPC313xApexNand#Programming\\_NAND\\_flash\\_using\\_Apex](http://www.lpclinux.com/LPC313x/LPC313xApexNand#Programming_NAND_flash_using_Apex)

## 6 Further Information

The LPC3152 microcontroller is a complex circuit and there are a number of other documents with more information. The following documents are recommended as a complement to this document.

- [1] NXP LPC3152 Datasheet  
<http://ics.nxp.com/products/lpc3000/datasheet/lpc3152.lpc3154.pdf>
- [2] NXP LPC3152 User's Manual  
<http://ics.nxp.com/support/documents/microcontrollers/pdf/user.manual.lpc315x.pdf>
- [3] ARM926EJ-S Technical Reference Manual. Document identity: DDI0198E  
[http://infocenter.arm.com/help/topic/com.arm.doc.ddi0198e/DDI0198E\\_arm926ejs\\_r0p5\\_trm.pdf](http://infocenter.arm.com/help/topic/com.arm.doc.ddi0198e/DDI0198E_arm926ejs_r0p5_trm.pdf)
- [4] ARM Architecture Reference Manual. Document identity: DDI0100E  
Book, Second Edition, edited by David Seal, Addison-Wesley: ISBN 0-201-73719-1  
Also available in PDF form on the ARM Technical Publications CD
- [5] ARM System Developer's Guide – Designing and Optimizing System Software, by A.N. Sloss, D Symes, C. Wright. Elsevier: ISBN 1-55860-874-5
- [6] ARM9 vs ARM7 core comparison  
This document from ARM gives a good overview of the ARM9 core, compared to the ARM7 core that for example is found in the LPC2xxx family.  
<http://www.arm.com/pdfs/comparison-arm7-arm9-v1.pdf>
- [7] Embedded System Design on a Shoestring, by Lewin Edwards.  
Newnes: ISBN 0750676094.
- [8] GNU Manuals  
<http://www.gnu.org/manual/>
- [9] GNU ARM tool chain for Cygwin  
<http://www.gnuarm.com>
- [10] An Introduction to the GNU Compiler and Linker, by Bill Gatliff  
<http://www.billgatliff.com>
- [11] LPC3000 Yahoo Group. A discussion forum dedicated entirely to the NXP LPC3xxx series of microcontrollers.  
<http://groups.yahoo.com/group/lpc3000/>
- [12] LPC2000 Yahoo Group. A discussion forum dedicated entirely to the NXP LPC2xxx series of microcontrollers.  
<http://groups.yahoo.com/group/lpc2000/>
- [13] AN10901: Programming and booting from NAND flash on the EA3100  
[http://www.nxp.com/documents/application\\_note/AN10901.pdf](http://www.nxp.com/documents/application_note/AN10901.pdf)
- [14] AN10811: EA3131 SPI Flash Programming Sample Code  
<http://www.lpcware.com/content/nxpfiler/an10811-ea3131-spi-flash-programming-sample-code>

Note that there can be newer versions of the documents than the ones linked to here. Always check for the latest information / version.

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