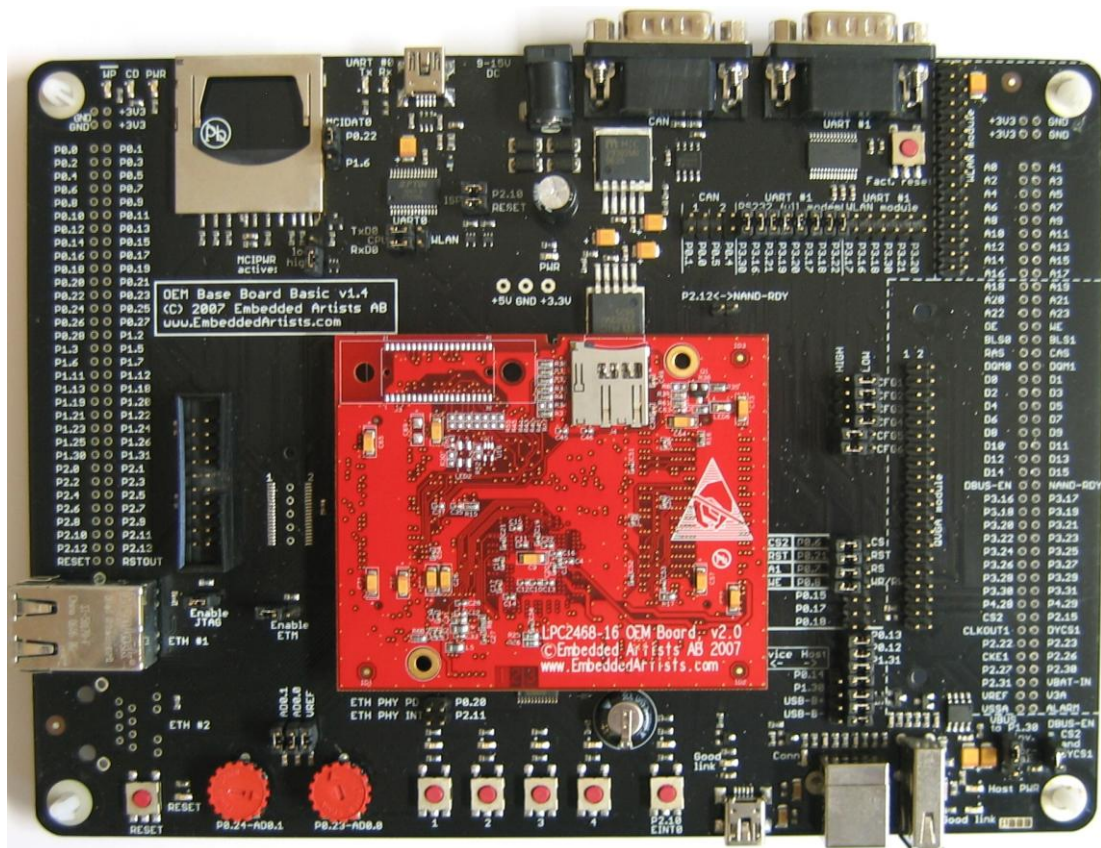


LPC2468 Developer's Kit User's Guide



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

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1 Introduction

Thank you for buying Embedded Artists' *LPC2468 Developer's Kit* based on NXP's ARM7TDMI-S LPC2468 microcontroller.

This document is a User's Guide that describes the *LPC2468 OEM Board* (both 16- and 32-bit data bus versions) and the *OEM Base Board Basic* hardware design. It is the User's Manual for both the *LPC2468 Developer's Kit* as well as for just the *LPC2468 OEM Board*. There is a separate document describing program development for the LPC2xxx series in general.

1.1 Features

Embedded Artists' *LPC2468 OEM Board* with NXP's ARM7TDMI LPC2468 microcontroller lets you get up-and-running quickly. The small form factor OEM board offers many unique features that ease your learning curve and program development. The board has also been designed for OEM applications with volume discount available.

- NXP's ARM7TDMI-S LPC2468 microcontroller in BGA package, with 512 KByte program FLASH and 96 KByte SRAM
- External FLASH memories: 128 MB NAND FLASH and 4 MB NOR FLASH
- External data memory: 32 MB SDRAM
- 12.0000 MHz crystal for maximum execution speed and standard serial bit rates, including CAN and USB requirements
- 32.768kHz RTC crystal
- 100/10M Ethernet PHY/interface based on Micrel KSZ8001L (16-bit data bus version) and National DP83848 (32-bit data bus version)
- USB-OTG support on USB-A channel via external ISP1301 chip
- 256 Kbit I2C E2PROM for storing non-volatile parameters
- Buffered 16- or 32-bit data bus for external expansion
- Connector: Two 100 pos connector (FX8C-100 from Hirose), 0.6mm pitch
 - All LPC2468 pins available (except a few used for Ethernet and USB-OTG interface)
- uSD/transflash interface and connector
- +3.3V only powering
- Onboard reset generation
- Compact dimension: 80 x 65 mm (16-bit data bus version), 75 x 40 mm (32-bit data bus version)
 - Six layer PCB design for best noise immunity

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

- Connectors
 - 2x100 pos, 0.6mm pitch connector for LPC2468 OEM Board
 - Ethernet connector (RJ45)
 - MMC/SD interface & connector
 - JTAG connector

- Pads for ETM connector
- Interfaces
 - USB OTG interface & connector
 - USB device interface & connector
 - USB host interface & connector
 - Full modem RS232 on UART #1
 - CAN interface & connector
- Power
 - Power supply, either via USB or external 9-15V DC
 - 0.3F capacitor backup power for RTC on LPC2468
- Expansion
 - Color QVGA LCD expansion connector (serial and parallel interface options)
 - Touch screen expansion connector to above display (on v1.5 of OEM Base Board)
- Other
 - 5 push-button keys (four via I2C and one on P2.10)
 - 5 LEDs (four via I2C and one on P2.10)
 - 2 Analog inputs
 - USB-to-serial bridge on UART #0 (FT232R) and ISP functionality
 - Reset push-button and LED
 - All OEM Board signals available on expansion connector/pads
 - Speaker output (on v1.5 of OEM Base Board)
 - 240x150 mm in size

1.2 ESD Precaution

Please note that the *LPC2468 OEM Board* and *OEM Base Board Basic* 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 always to first touch the metal surface of one of the USB connector for a few seconds with both hands before touching any other parts of the boards. That way, you will have the same potential as the board and therefore minimize the risk for ESD.

Never touch directly on the *LPC2468 OEM Board* and in general as little as possible on the *OEM Base Board Basic*. The keys on the *OEM 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.

1.3 Code Read Protection

The LPC2468 has a Code Read Protection function (specifically CRP3) that, if enabled, will make the LPC2468 impossible to reprogram (unless the user program has implemented such functionality).

Note that Embedded Artists does not replace LPC2468 OEM boards where the LPC2468 has CRP3 enabled. It's the user's responsibility to not invoke this mode by accident.

1.4 CE Assessment

The *LPC2468 Developers Kit* (consisting of the *LPC2468 OEM Board* and *Base Board Basic*) is CE marked. See separate *CE Declaration of Conformity* document.

The *LPC2468 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 *LPC2468 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 *LPC2468 Developers Kit*.

Due to the nature of the *LPC2468 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 *LPC2468 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.

1.5 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.

1.5.1 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.

1.5.2 OEM / Education / QuickStart Boards and Kits

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

2 LPC2468 OEM Board Design

This chapter contains detailed information about the electrical and mechanical design of the *LPC2468 OEM Board*, version 2.0, both 16- and 32-bit databus versions. 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.

2.1.1 CPU

The core part of the design is the NXP LPC2468 microcontroller. It's an ARM7TDMI-S CPU core with a lot of different peripheral units and on-chip memory (512 KByte FLASH and 96 KByte SRAM). There is also an external memory bus interface. Page 1 of the schematic contains the CPU section of the design.

The microcontroller crystal frequency is 12.0000 MHz. This frequency has been selected in order to allow maximum execution speed (the PLL can generate an 72 MHz core clock from this) as well as generating standard clock frequencies for the CAN and USB interfaces. The on-chip UART peripheral includes a fractional baud rate generator that allows standard baud rates to be generated with low frequency error.

Due to silicon errata, the highest internal core clock frequency on initial chip revisions (see errata for details) was 48 MHz. This corresponds to an internal PLL frequency of 288 MHz that is divided by 6 to get a 48 MHz clock for the USB interface. Later revisions of the chip can run at full 72 MHz (288 MHz divided by 4 equals 72 MHz).

There is a 32.768 kHz crystal clock for the on-chip real-time clock peripheral unit or RTC for short. The microcontroller can be placed in a very low power mode while the RTC operates and keeps track of time. Power for the RTC (during these low power modes) comes from the VBAT input pin. Power is sourced either from the +3.3V power supply or the external VBAT_IN signal (available on the expansion connector), depending on which one have highest voltage.

2.1.2 Powering

There is no internal power supply on the board. The LPC2468 contains an internal DC/DC converter to generate the internal 1.8V power needed by the core. The *LPC2468 OEM Board* module must be powered by a single, external +3.3V power supply. The supply must be stable and should have at least four 68uF bulk capacitor(s) close to the power pins on the expansion connectors.

2.1.3 Analog Inputs/Outputs

The LPC2468 contains analog peripherals that need a reference voltage, which is supplied from the VREF input pin. This reference voltage, that must be supplied externally, can be the VDDA power (which is a filtered +3.3V power supply). The VDDA power is available on the expansion connector under the name V3A. See schematic for details. A filtered version of analog ground is also available under the name VSSA.

2.1.4 Ethernet Interface

The LPC2468 have an internal Ethernet MAC peripheral with interface to an external PHY (i.e., the analog interface to an Ethernet interface). Page 2 of the schematic contains the Ethernet PHY. The KSZ8001L external Ethernet PHY from Micrel is used and interfaces the LPC2468 via the RMII interface (on 16-bit data bus version). The DP83848 from National is used on the 32-bit data bus board version.

The PHY is driven by an external 50 MHz clock that is also feed to the LPC2468. This is part of the RMII interface specification.

The PHY is always enables (can be disabled under program control) but have an external 'power down' signal that can be used by an external device. There is also an interrupt signal from the PHY

that can be used to signal link events (like connect/disconnect of a cable). Neither the power down nor the interrupt signal is used by the LPC2468 OEM Board but the signals are available on the expansion connector. If the signals are not used, just leave them unconnected.

Due to silicon errata on early chip revisions, the P1.6 pin is left unused. This blocks the use of the alternative function MCIDAT0, which is relevant for the MCI interface. In this case, pin P0.22 can be used instead since the MCIDAT0 signal is available in this pin also.

2.1.5 External Memories

There are three external memory chips connected to the external memory bus interface of the LPC2468. 16-bit databus width is used on the board.

- An external NOR FLASH (32 MBit = 4 MByte in size) addressed by CS0 (address range: 0x8000 0000 – 0x80FF FFFF). 16-bit databus width is used here.
- An external NAND FLASH (1 GBit = 128 MByte in size) addressed by CS1 (address range: 0x8100 0000 – 0x81FF FFFF). 8-bit databus width is used here.
- An external SDRAM (256 MBit = 32 MByte in size) addressed by DYCS0 (address range: 0xA000 0000 – 0xAFFF FFFF). Depending on board version, either 16-bit or 32-bit databus width is used here.

The NAND FLASH has an optional busy output that can be used for controlling the erase/program operations with better precision. The signal is available on the expansion connector. If needed the signal can be routed to a suitable (i.e., free) input pin. The busy status of the chip is also available under software control.

2.1.6 External Memory Interface

The LPC2468 memory interface is available on the expansion connector. The data bus width is either 16- or 32-bits on the external interface (depending on board version). All signals are buffered. The buffers are disabled unless enabled by external signals.

By pulling signal ABUF_EN low, the two buffers for address and control signals are enabled and act as outputs (from the LPC2468 OEM Board).

On some OEM Boards (notably on v2.0 OEM Boards mounted on v1.3 OEM Base Boards) signal ABUF_EN is always pulled low. This is due to a limitation on the OEM Base Board Basic v1.3 (which should pull this signal low, but lack this part). The effect is that the two address and control signal buffers are always enabled.

The data bus buffer is controlled by the signal DBUS_EN. By pulling this signal low, the data bus buffer is enabled. The LPC2468 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 DBUS_EN must not be pulled low constantly. In that case the buffer will collide with the board's internal data bus. DBUS_EN must only be pulled low when an external memory/IO device is accessed. If, for example, CS2 is used to decode and access an external device, connect the signal CS2 directly to DBUS_EN.

If more than one chip select signal is used, (logically) AND all chip select signal together before driving the DBUS_EN signal. The *OEM Base Board* contains an example of this.

If the external memory interface is not used, leave ABUS_EN and DBUS_EN unconnected.

2.1.7 USB-OTG

The LPC2468 contains both a USB device and USB host interface. Two alternative USB signal pairs exist, USB channel A and channel B. Some restrictions exist for how device and host interfaces can be mixed. See the LPC2468 User's Manual for details about this.

An external USB-OTG transceiver (ISP1301 from NXP) is connected to USB channel A. The chip is only active during initial OTG signaling (for deciding if the unit shall be a USB device or host). The chip also provides pull-up/pull-down functionality on D+/D- signals needed for USB device/host advertising.

If OTG functionality is not needed, the chip is inactive and does not interfere with the USB communication.

Note that the USB-OTG negotiation must be implemented in software, which is not provided for free.

2.1.8 Reset Generation

The reset generation is handled by a standard voltage supervisor chip, CAT811S from Catalyst Semiconductor. The reset signal will be held active (i.e., low) until the supply voltages, +3.3V, is within margins. The reset duration is typically 200 mS (consult the CAT811S 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).

The reset generator can be found on page 4 of the schematic.

2.1.9 I²C E²PROM

There is also a 256 kbit E²PROM accessible via the I²C interface. The LPC2468 microcontroller has three on-chip I²C communication channels. Channel #0 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.

There are 1.5 kohm pull-up resistors (which are always needed on I²C busses) included on the board.

The I²C E²PROM can be found on page 4 of the schematic.

2.1.10 uSD/transflash Connector

On page 4 of the schematic there is a uSD/transflash connector interface. Note that the polarity of the power control is reverse from the standard on the *OEM Base Board*. Also note that the memory card connectors cannot be used simultaneous on the *LPC2468 OEM Board* and the *OEM Base Board*. Only one at a time can be used.

2.1.11 Expansion Connectors

The *LPC2468 OEM Board* integrated the core part of a typical LPC2468 board design with a reasonable large amount of external memories. Almost all signals of LPC2468 are available on the two 100 pos, 0.6mm pitch expansion connectors (FX8C-100 from Hirose).

2.1.12 Not Mounted Components on Top Side

Page 6 of the schematic contains an interface to Bluetooth and WLAN modules from connectBlue that is only available on special order. These components are not mounted on standard boards and this part of the schematic is not public.

2.2 Memory Layout

The external memory controller on the LPC2468 defines eight memory regions, named: CS0, CS1, CS2, CS3, DYCS0, DYCS1, DYCS2, and DYCS3. Of these eight, three memory areas are used by the *LPC2468 OEM Board*. These are:

- CS0 (address range: 0x8000 0000 – 0x80FF FFFF)
An external NOR FLASH (32 MBit = 4 MByte in size) is addressed.
- CS1 (address range: 0x8100 0000 – 0x81FF FFFF)
An external NAND FLASH (1 GBit = 128 MByte in size) is addressed.
- DYCS0 (address range: 0xA000 0000 – 0xAFFF FFFF)
An external SDRAM (256 MBit = 32 MByte in size) is addressed.

These three memory regions cannot be used by external devices. CS2 and DYCS1 are however free for external use via the buffered memory interface. Both address and data busses are buffered.

2.3 Usage of CPU Pins

Almost all pins of the LPC2468 are directly available on the expansion connectors. Only in a few cases are pins used for dedicated functionality like Ethernet interface and USB-OTG. Such pins are not available on the expansion connector. The table below lists all pins and their possible restrictions.

Pin	Available on expansion connector
P0.0-P0.26	Yes
P0.27- P0.28	Yes, but I2C E2PROM connected to these pins.
P0.29-P0.30	Yes, but external USB-OTG transceiver connected to these pins.
P0.31	Yes
USBB-	Yes
P1.0-P1.1, P1.4, P1.8-P1.10, P1.14-P1.17	No, connected to Ethernet PHY
P1.2-P1.3, P1.5-P1.7, P1.11-P1.13, P1.18- P1.26, P1.30-P1.31	Yes
P1.27-P1.29	No, connected to external USB-OTG transceiver
P2.0-P2.15, P2.19, P2.21-P2.23, P2.25-P2.27	Yes
P2.16-P2.17	Yes, but used as RAS/CAS and only available as outputs via a buffer
P2.18, P2.20, P2.24	No, used as CLKOUT0/DYCS0/CKE0 for external SDRAM
P2.28-P2.29	Yes, but used as DQM0/DQM1 (for external SDRAM) and only available as outputs via a buffer
P2.30-P2.31	Yes, but used as DQM2/DQM3 (on 32-bit data bus version)
P3.0-P3.15	Yes, but used as data bus and only available via data bus buffer
P3.16-P3.31	Yes. On 32-bit data bus versions these pins are used for upper 16 bits of the data bus and are only available via the data bus buffer
P4.0-P4.23	Yes, but used as address bus and only available as outputs via buffers
P4.24-P4.27	Yes, but used as OE/WE/BLS0/BLS1 and only available as outputs via a buffer
P4.28-P4.29	Yes
P4.30-P4.31	No, used as CS0/CS1 for external NOR/NAND FLASH memories
VBAT	Yes, via forward diode
ALARM	Yes
VREF VDDA, VSSA	Yes. Note that VDDA is connected to +3.3V power supply
X1-X2, RTCX1- RTCX2	No, directly connected to on-board crystals
JTAG signals	Yes
RESET, RSTOUT	Yes

LPC2468 OEM Board - User's Guide

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The *OEM Base Board* illustrates how to typically connect external interfaces (like Ethernet, USB, external memory devices, etc) to the *LPC2468 OEM Board*. Study this schematic for details.

2.4 LPC2468 OEM Board Mechanical Dimensions

Figure 1 below contains a drawing of the board that includes mechanical measures. Two FX8C-100S connectors from Hirose are used as expansion connectors. Both the 16- and 32-bit data bus version of the board fit the same connector measurements. Mating connectors on the base board are FX8C-100P.

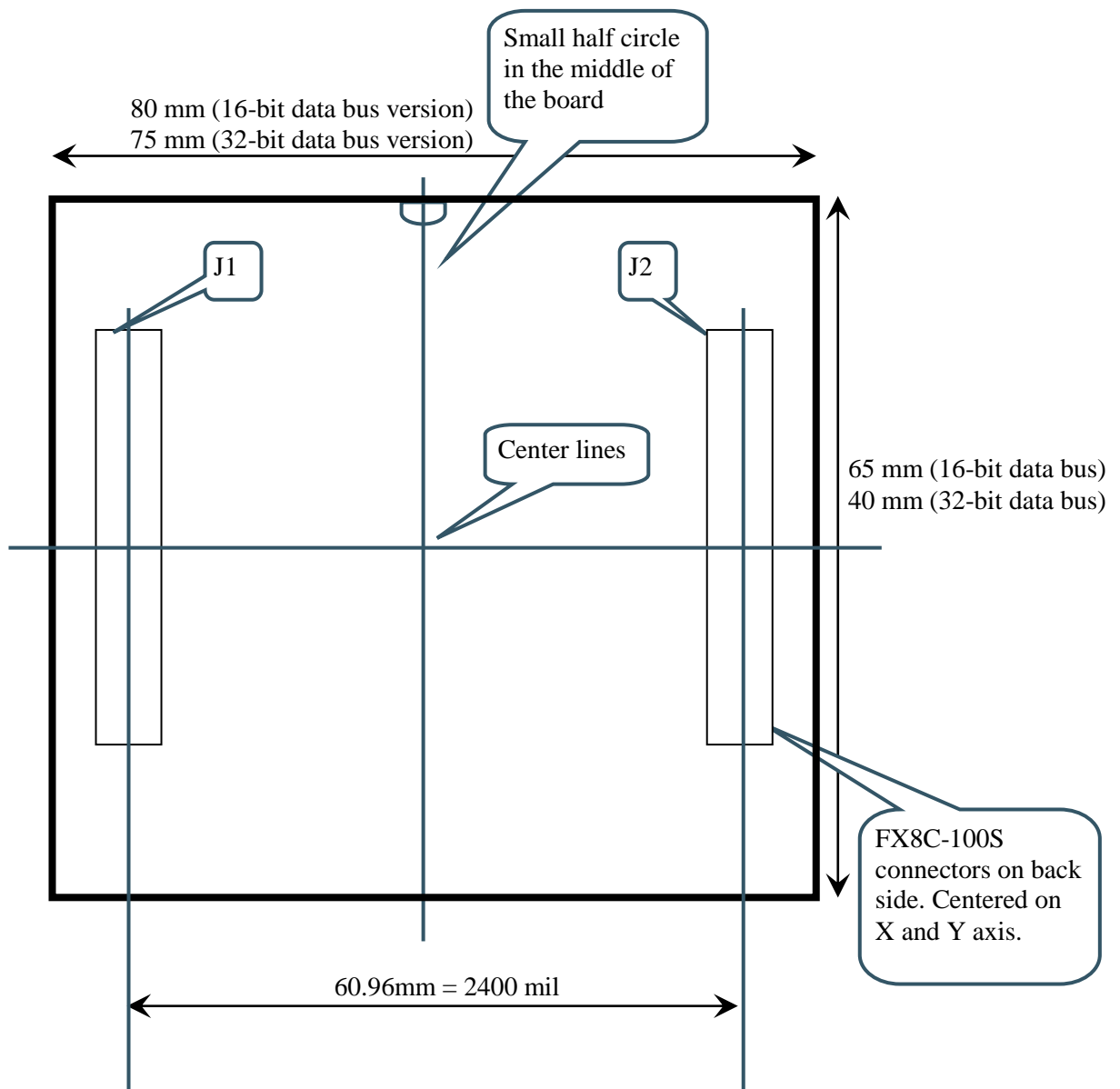


Figure 1 - LPC2468 OEM Board Mechanical Dimensions

2.5 Known Limitation of LPC2468 OEM Board

2.5.1 SDRAM Clock Frequency – 16-bit databus versions

There is one known limitation of the LPC2468-16 OEM Board. The cpu core clock frequency must not exceed 48 MHz on early boards when using the external SDRAM. Note that this limitation only applies when using the external SDRAM. If the SDRAM is not used, the cpu core frequency can be up to full specification of the LPC2468 (different for different chip revisions).

Normally the internal PLL frequency is set to 288 MHz (the external 12 MHz crystal frequency multiplied by 24). Dividing 288 MHz with 6 gives a core frequency of 48 MHz and dividing with 4 gives 72 MHz.

The table below lists the limitations on different versions of the LPC2468-16 OEM Board:

- **LPC2468-16 OEM Board ver 1.0**
Cpu core frequency must not exceed 48MHz when using external SDRAM.
- **LPC2468-16 OEM Board ver 2.0**
Cpu core frequency must not exceed 48MHz when using external SDRAM.
- **LPC2468-16 OEM Board ver 2.0a**
Cpu core frequency can be up to 72MHz.

2.5.2 SDRAM Clock Frequency – 32-bit databus versions

There is one known limitation of the LPC2468-32 OEM Board. The cpu core clock frequency must not exceed 48 MHz on boards with rev A LPC2468 chips when using the external SDRAM. Also, the cpu core clock frequency must not exceed 66 MHz on boards with rev B LPC2468 chips when using the external SDRAM. Note that this limitation only applies when using the external SDRAM. If the SDRAM is not used, the cpu core frequency can be up to full specification of the LPC2468 (different for different chip revisions).

On rev A chips, the internal PLL frequency is normally set to 288 MHz (the external 12 MHz crystal frequency multiplied by 24). Dividing 288 MHz with 6 gives a core frequency of 48 MHz and dividing with 4 gives 72 MHz.

On rev B chips, the internal PLL frequency can be set to 528 MHz (the external 12 MHz crystal frequency multiplied by 44). Dividing 528 MHz with 8 gives a core frequency of 66 MHz and dividing with 11 gives 48 MHz (for USB core).

2.5.3 Ethernet Clock – 32-bit databus versions

There is one known limitation of the LPC2468-32 OEM Board. Due to an error in clock routing between the Ethernet PHY and the LPC2468, the boards have been modified slightly. The error is also temperature dependent. Only a small number of boards have been shipped without this modification and these boards were tested not to have any problems. The schematic for the board illustrates the modification made on boards shipped after September 2008.

2.5.4 NAND FLASH Bad Block

The NAND Flash is the K9F1G08U0A from Samsung and contains 1G bit with a spare 32M bit capacity. The chip may include invalid blocks when shipped from factory. A maximum of 20 invalid blocks may exist initially, i.e., 1004-1024 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. Refer to technical notes from Samsung for appropriate management of invalid blocks.

2.5.5 Brand of Memory Chips

Note that there is no guarantee for a certain brand or version of memory chips; NOR flash, 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.

3 OEM Base Board Basic Design

This chapter contains detailed information about the electrical and mechanical design of the *OEM Board Basic*, version 1.3, v1.4, and v1.5. The schematic can be downloaded in pdf format from the support page, and is recommended to have printed out while reading this chapter.

The *OEM Base Board* contains a number interfaces and connectors to the *LPC2468 OEM Board*. The design can be viewed as a reference schematic for custom designs around the *LPC2468 OEM Board*. The features of the *OEM Base Board* can be summarized as below:

- Connectors
 - Two 100 pos, 0.6mm pitch connectors for LPC2468 OEM Board
 - Ethernet connector (RJ45)
 - MMC/SD interface & connector
 - JTAG connector
 - Pads for ETM connector
- Interfaces
 - USB OTG interface & connector
 - USB device interface & connector
 - USB host interface & connector
 - Full modem RS232 on UART #1
 - CAN interface & connector
- Power
 - Power supply, either via USB or external 9-15V DC
- Expansion
 - Color QVGA LCD expansion connector (serial and parallel interface options)
 - Touch screen interface to QVGA LCD on v1.5 OEM Base Boards
 - WLAN module (IEEE802.11b/g) expansion connector
- Other
 - 5 push-button keys (four via I2C and one on P2.10)
 - 5 LEDs (four via I2C and one on P2.10)
 - 2 Analog inputs
 - USB-to-serial bridge on UART #0 (FT232R) and ISP functionality
 - Reset push-button and LED
 - 0.3F backup capacitor for VBAT power signal to LPC2468 OEM Board. Can supply current for many days for the LPC2468 real-time clock module.
 - Speaker output on v1.5 OEM Base Boards
 - All OEM Board signals available on expansion connector/pads
 - 240x150 mm in size

3.1 Usage of CPU Pins

Almost all pins of the LPC2468 are directly available on the expansion connectors. Only in a few cases are pins used for dedicated functionality like Ethernet interface and USB-OTG. Such pins are not available on the expansion connector. The table below lists all pins and their possible restrictions.

Pin	Usage
P0.0	Can be connected to RD1 for CAN channel #1
P0.1	Can be connected to TD1 for CAN channel #1
P0.2	Can be connected to USB-to-serial bridge (TxD on UART #0)
P0.3	Can be connected to USB-to-serial bridge (RxD on UART #0)
P0.4	Can be connected to RD2 for CAN channel #2
P0.5	Can be connected to TD2 for CAN channel #2
P0.6	Can be used as CS input to QVGA display add-on module
P0.7	Can be used as RS input to QVGA display add-on module
P0.8	Can be used as WR/RW input to QVGA display add-on module
P0.9	No special usage on OEM Base Board
P0.10	No special usage on OEM Base Board
P0.11	No special usage on OEM Base Board
P0.12	Can be connected to enable USB-host power switch
P0.13	Can be connected to LED (active low) for USB-host indicator
P0.14	Can be connected to USB-device enable-device signal (USB channel B)
P0.15	Can be connected to QVGA display for serial interface (SPI-SCK)
P0.16	No special usage on OEM Base Board Can be connected to QVGA display with touch screen option; serial interface chip select for touch screen controller (OEM Base Board v1.5)
P0.17	Can be connected to QVGA display for serial interface (SPI-MISO)
P0.18	Can be connected to QVGA display for serial interface (SPI-MOSI)
P0.19	No special usage on OEM Base Board
P0.20	Can be connected to Ethernet PHY power down input
P0.21	Can be connected to QVGA display reset input
P0.22	Connects to MCIDAT0 on SD/MMC connector
P0.23	Can be connected to analog input (trimpot) #0
P0.24	Can be connected to analog input (trimpot) #1
P0.25	No special usage on OEM Base Board
P0.26	No special usage on OEM Base Board v1.3-v1.4 Speaker output on AOUT signal on OEM Base Board v1.5
P0.27	I2C-SDA0, connects to U2, PCA9532 (IO expander)

P0.28	I2C-SCL0, connects to U2, PCA9532 (IO expander)
P0.29-P0.30	Connects to mini-AB USB connector (J39)
P0.31, USBB-	Connect either to USB-device B-connector (CON1) or USB-Host A-connector (J43)
P1.2	Connects to MCICLK on SD/MMC connector
P1.3	Connects to MCICMD on SD/MMC connector
P1.5	Connects to MCIPWR on SD/MMC connector
P1.6	Should not be used due to silicon errata on LPC2468 when using Ethernet
P1.7	Connects to MCIDAT1 on SD/MMC connector
P1.11	Connects to MCIDAT2 on SD/MMC connector
P1.12	Connects to MCIDAT3 on SD/MMC connector
P1.13	No special usage on OEM Base Board
P1.14	No special usage on OEM Base Board
P1.15	No special usage on OEM Base Board
P1.16	No special usage on OEM Base Board
P1.17	No special usage on OEM Base Board
P1.18	Connects to LED (active low) to be used for USB channel A indicator
P1.19	No special usage on OEM Base Board
P1.20	No special usage on OEM Base Board
P1.21	No special usage on OEM Base Board
P1.22	No special usage on OEM Base Board
P1.23	No special usage on OEM Base Board
P1.24	No special usage on OEM Base Board
P1.25	No special usage on OEM Base Board
P1.26	No special usage on OEM Base Board
P1.30	Can be connected to VBUS signal from USB host power
P1.31	Can be connected to over-current error signal from USB host power switch
P2.0-P2.9	Connects to ETM pads, if connector mounted. Else these signals have no special usage on OEM Base Board
P2.10	Connected to push-button (for enabling bootloader during reset or EINT0 input). Also connects to LED (active low). Connects to USB-to-serial bridge (for automatic ISP functionality)
P2.11	Can be connected to Ethernet PHY interrupt output
P2.12	Can be connected to NAND FLASH busy output
P2.13	No special usage on OEM Base Board Can be connected to QVGA display with touch screen option; interrupt output from touch screen controller (only on OEM Base Board v1.5)

P2.14	When used as CS2, can be used to control DBUS_EN
P2.15	No special usage on OEM Base Board
P2.16	No special usage on OEM Base Board
P2.17	No special usage on OEM Base Board
P2.19	No special usage on OEM Base Board
P2.21	When used as DYCS1, can be used to control DBUS_EN
P2.22	No special usage on OEM Base Board
P2.23	No special usage on OEM Base Board
P2.25	No special usage on OEM Base Board
P2.26	No special usage on OEM Base Board
P2.27	No special usage on OEM Base Board
P2.28	No special usage on OEM Base Board
P2.29	No special usage on OEM Base Board
P2.30	No special usage on OEM Base Board
P2.31	No special usage on OEM Base Board
P3.0-P3.15	The 16-bit databus, connects to the QVGA display add-on module databus
P3.16	Can be connected to RS232 interface or WLAN add-on module
P3.17	Can be connected to RS232 interface or WLAN add-on module
P3.18	Can be connected to RS232 interface or WLAN add-on module
P3.19	Can be connected to RS232 interface
P3.20	Can be connected to RS232 interface or WLAN add-on module
P3.21	Can be connected to RS232 interface or WLAN add-on module
P3.22	Can be connected to RS232 interface
P3.23	No special usage on OEM Base Board
P3.24	No special usage on OEM Base Board
P3.25	No special usage on OEM Base Board
P3.26	No special usage on OEM Base Board
P3.27	No special usage on OEM Base Board
P3.28	Can be used to control backlight intensity of QVGA display add-on module
P3.29	No special usage on OEM Base Board
P3.30	Can be connected to RS232 interface or WLAN add-on module
P3.31	No special usage on OEM Base Board
P4.0-P4.23	The address bus, A1 connects to QVGA display add-on module RS input
P4.24	Connects to QVGA display add-on module RD_E input
P4.25	Connects to QVGA display add-on module WR_RW input

P4.26	No special usage on OEM Base Board
P4.27	No special usage on OEM Base Board
P4.28	No special usage on OEM Base Board
P4.29	No special usage on OEM Base Board
VBAT	No special usage on OEM Base Board
ALARM	No special usage on OEM Base Board
VREF	Connects to VDDA(V3A)
VDDA, VSSA	Used to generate reference voltage for trimpots (analog inputs)
JTAG signals	Connected to standard 20 pos (2x10 pin) JTAG connector 'JTAG Enable' jumper also exists
RESET	Connects to RESET push-button and USB-to-serial bridge (for automatic ISP functionality)
RSTOUT	Connects to RESET LED indicator. Used to reset U2, PCA9532. Can be connected to QVGA display reset input.

3.2 Jumpers

The *OEM Base Board* has a number of jumpers in order to be able to connect/disconnect and fully utilize all functionality of the LPC2468 and the boards. *Figure 2* below illustrates all jumpers and explains to what part of the design they belong. Board picture is from older revision of the board but all essential parts are identical.

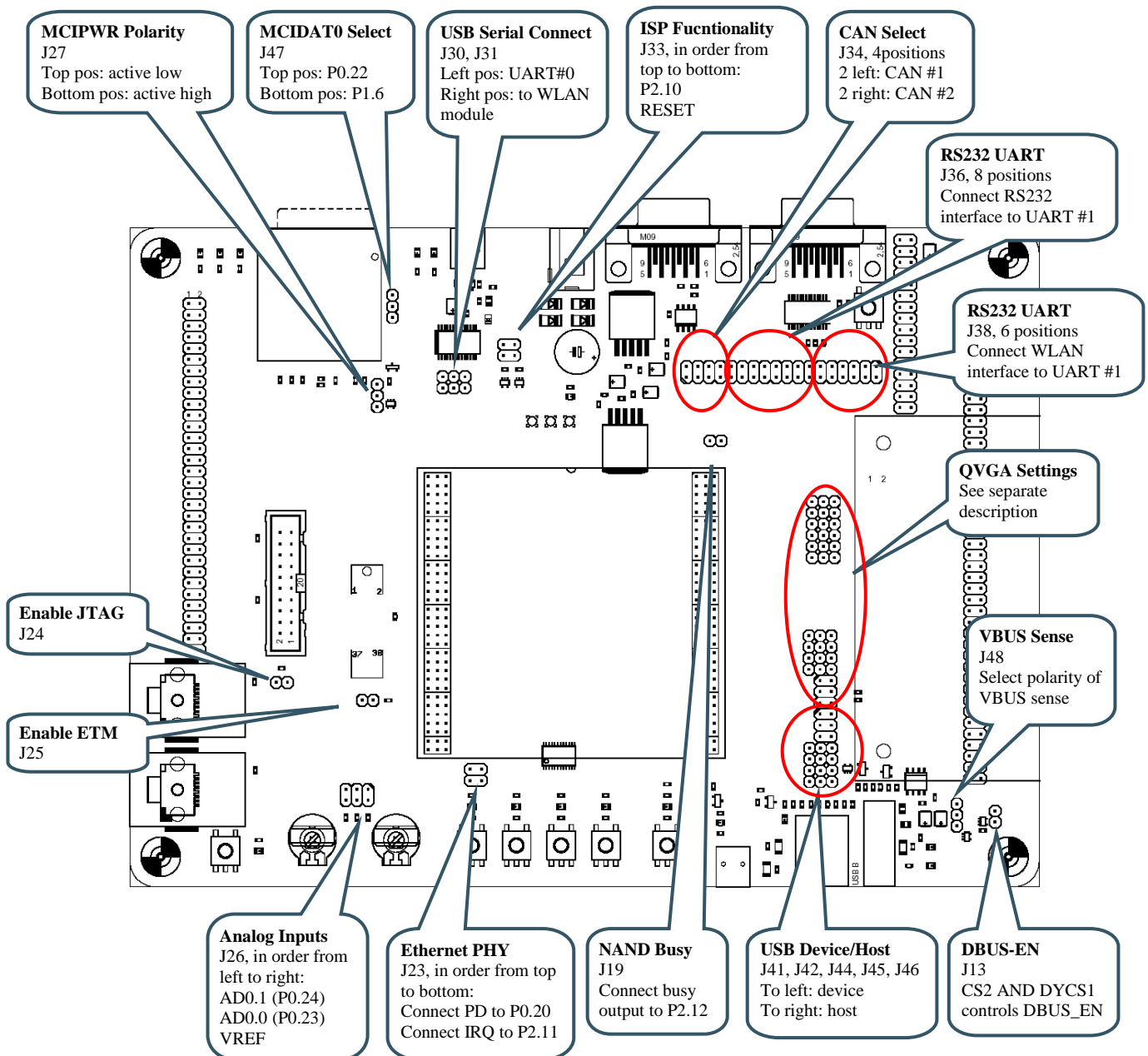


Figure 2 – OEM Base Board Basic Jumpers

3.2.1 USB-VBUS Sense

The polarity of the VBUS sense signal has changed between cpu revisions. Normal position on rev 'C' is to invert the VBUS signal. On rev 'A' and rev 'B' chips, the VBUS signal is non-inverted, i.e., normal. Inverted or normal polarity is selected with connector J48.

3.2.2 Illegal Jumper Combinations

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

- Jumpers for CAN channel #1 and channel #2 (J34) should not be inserted simultaneously.
- Jumpers for UART channel #1 external RS232 modem (J36) and the WLAN add-on module (J38) should not be inserted simultaneously.
- When using the 32-bit data bus version of the *LPC2468 OEM Board*, all jumpers in connectors J36 and J38 should always be removed. The UART signals (in signals P3.xx) else collide with the upper 16 data bits of the data bus.
J36 connects the RS232 interface to UART #1 and J38 connects the WLAN interface to UART #1.

3.3 Connectors

Figure 3 below illustrate the position of all external connectors on the *OEM Base Board Basic*. Board picture is from older revision of the board but all essential parts are identical.

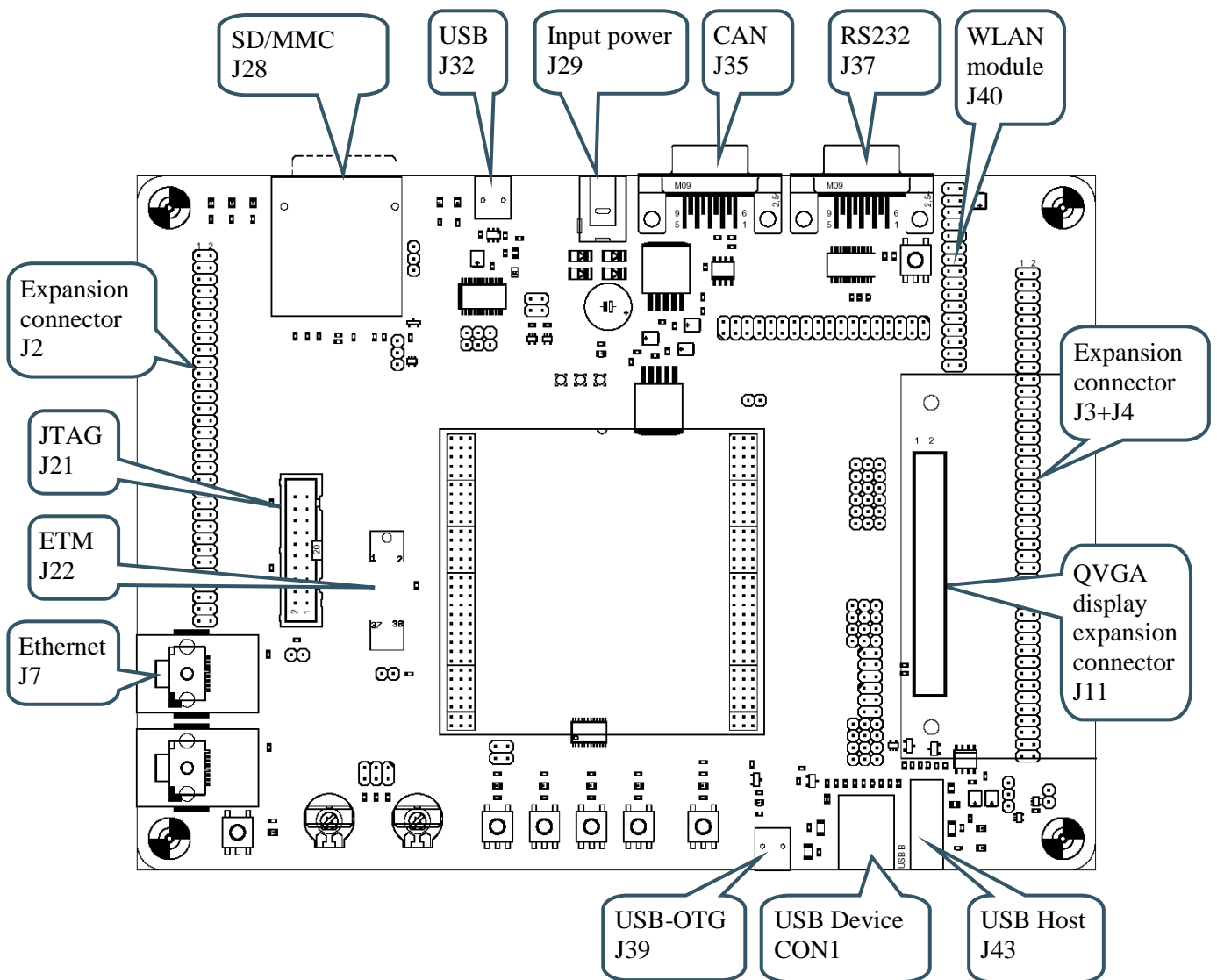


Figure 3 – OEM Base Board Basic External Connectors

3.3.1 JTAG Connector Issue

Note that pin 20 on the JTAG connector (J21) is left open. Most JTAG debuggers do not require this specific pin to be grounded. One known JTAG debugger however requires this pin to be grounded and that is Amontec JTAGkey-Tiny. In case you experience problems, test to ground pin 20 (for example by a soldering joint between pin 18 and 20 of the connector).

3.3.2 Mictor-38 ETM Connector

The ETM connector (J22) is not mounted on the board. It's designated J6. The connector can be soldered to the board if needed. The connector is from Tyco Electronics Amp and is a 38-way receptacle Mictor connector, 0.025" pitch, part number: 767054-1 or 2-5767004-2 (RoHS compliant).

3.4 Important Components

Figure 4 below illustrates the position on the *OEM Base Board Basic* for some important components in the design. Board picture is from older revision of the board but all essential parts are identical.

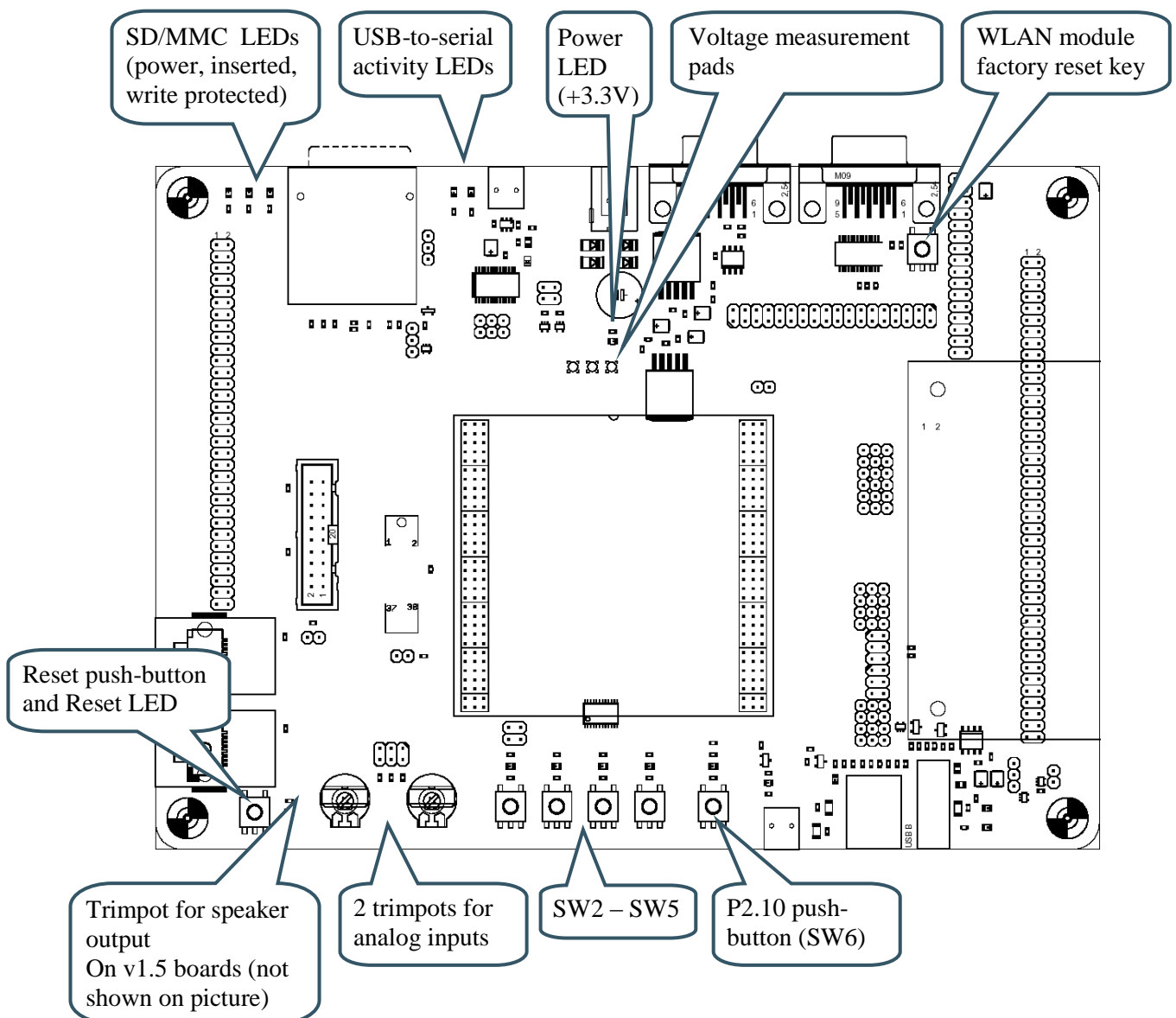


Figure 4 – OEM Base Board Basic Important Components

3.5 QVGA Display Add-on Board

The picture below illustrates how the display is used as an add-on module to the *OEM Base Board*. The LPC2468 CPU can access the display via an 8-bit parallel interface, 16-bit parallel interface or an 8-bit serial (SPI-like) interface. The 16-bit parallel interface is the fastest and result in quickest display update time.

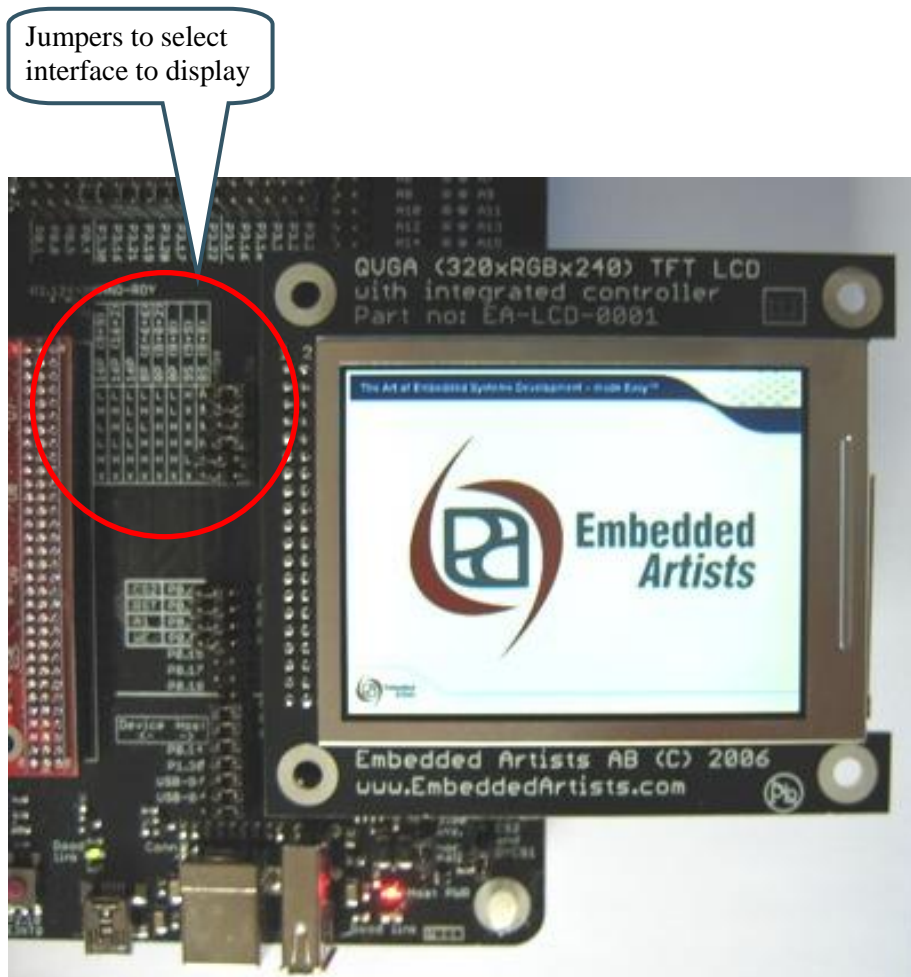


Figure 5 – QVGA Add-on Module Mounting on OEM Base Board

3.6 Display Version 1 vs. Version 2

There exist two versions of the display. Version 1 uses a display from one display manufacturer and version 2 uses a display from another manufacturer. The picture above is of display version 1.

The similarities between the versions are:

- Same physical size of display module.
- Same optical features and capabilities.
- Same main 2x20 pos interface connector (100 mil spacing).

The differences are:

- Different internal display controllers are used. The programming interface is not identical but very similar. A reference software driver exists that supports both versions simultaneously. The uClinux driver supports both versions automatically.
- Version 2 of the display module has a touch screen option.

- A 6 pos extra interface connector has been added beside the main 2x20 pos interface connector on version 2. This extra connector carries signals for touch screen interface and some extra signals for direct RGB-control of display (useful when interfacing the LPC2478 MCU from NXP).

3.7 Interface Configuration, Display Version 2

There are 6 pins that are used to configure the interface. The table below lists the different options. L is statically tied to low logic level and H is statically tied to high logic level.

Note that only 4 of the pins are used to configure the display. The four different relevant options are listed in the table below. Read the display controller documentation for further information about the other interface options.

16 bit parallel 8080-style i/f	9 bit parallel 8080-style i/f	8 bit parallel 8080-style i/f	4-wire serial SPI i/f	Configuration pins
Default Setting				
H	L	L	L	PS0 / CFG1
L	L	L	H	PS1 / CFG2
L	H	L	H	PS2 / CFG3
H	L	H	H	PS4 / CFG4
Does not matter. This pin is currently not used.				CFG5
Does not matter. This pin is currently not used.				CFG6

3.7.1 Touch Screen Option on Display Version 2

The touch screen controller used is TSC2046 from Texas Instruments. This chip has a SPI interface and shares the SI, SO, SCK pins in the main interface connector, with the LCD controller. The TSC2046 chip select (CS#) must be low (i.e., active) in order to communicate with the touch screen controller. See TSC2046 datasheet for details about the serial interface.

The SPI interface to the touch screen controller is configured as below:

- P0.15 – SCK, SPI clock signal
- P0.16 – SSEL, chip select for controller
- P0.17 – MISO, SPI master input, slave output
- P0.18 – MOSI, SPI master output, slave input
- P2.13 – Optional interrupt pin (connected via jumper)

The picture below illustrates the jumper settings for the touch screen option.

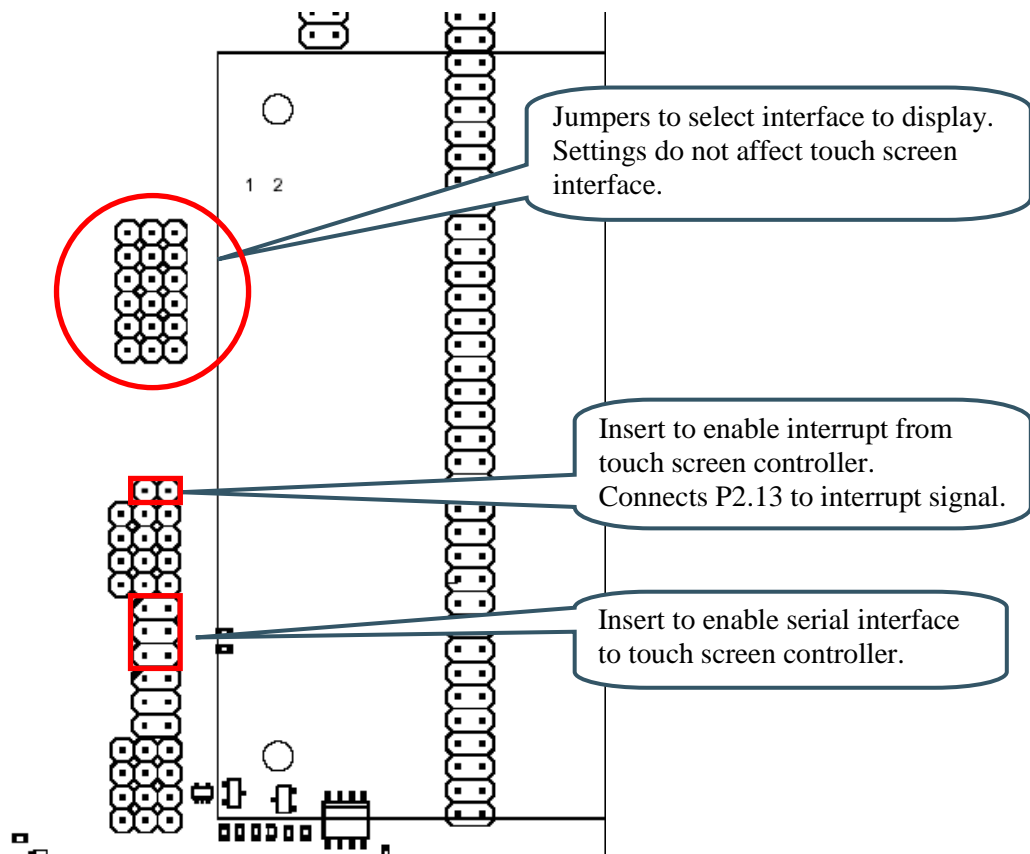


Figure 6 – QVGA Display Jumper Settings for Touch Screen Option on Display Version 2

3.8 Interface Configuration, Display Version 1

There are 6 pins that are used to configure the interface. The table below lists the different options. L is statically tied to low logic level and H is statically tied to high logic level.

16 bit parallel 18-bit color depth (9+9)	16 bit parallel 18-bit color depth (16+2)	16 bit parallel 16-bit color depth Default Setting	8 bit parallel 18-bit color depth (6+6+6)	8 bit parallel 18-bit color depth (8+8+2)	8 bit parallel 16-bit color depth (8+8)	9 bit serial 18-bit color depth (9+9)	8 bit serial 16-bit color depth (8+8)	Configuration pins
L	L	L	L	L	L	H	H	PSX / CFG1
H	H	L	H	H	L	-	-	DTX1 / CFG2
L	H	L	L	H	H	-	-	DTX2 / CFG3
L	L	L	H	H	H	H	H	BWS0 / CFG4
H	H	H	H	H	H	L	H	BWS1 / CFG5
Does not matter. This pin is currently not used. Set to L.								BWS2 / CFG6

If the parallel interface is selected the *i86 interface* is selected (since the C86 input pin is pulled low). See datasheet for details about timing and how the different control signals are used.

For the i86 interface, the RD/E signal is Read strobe and the WR/RW signal is Write strobe.

If a serial interface is used, see the datasheet for details about timing and how the different control signals are used. Note that maximum clock frequency is 10 MHz.

3.8.1 QVGA Display Jumper Settings

The picture below illustrates the jumper settings for the display.

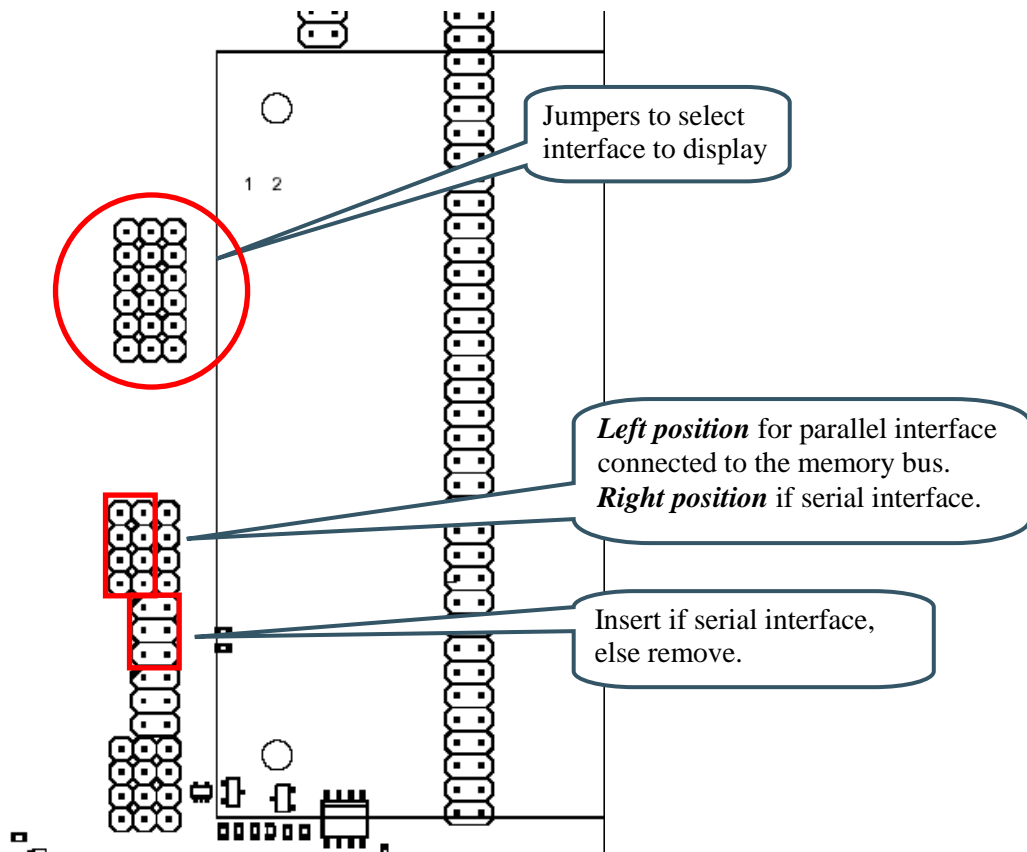


Figure 7 – QVGA Display Jumper Settings on the OEM Base Board Basic

4 Getting Started

This chapter contains information about how to get acquainted with the *LPC2468 OEM Board*, and the associated uClinux port. In this quick guide you get to take the first step and start using the board.

Please read this section first before you start using the board - it will be well spent time!

The board is pre-loaded with an uClinux distribution and some of the sections below focus on getting contact with the uClinux system console.

4.1 Basic Requirements

This is a list of what you need to have before you start:

- A Windows® PC with an Internet browser (e.g. Internet Explorer or Firefox), a Telnet client, a FTP client and/or a SSH client.
(A Windows PC has Internet Explorer, a Telnet and a FTP client as default.)
- A suitable terminal program.
- An Ethernet cable (LAN) cable to connect the board to your PC
(a crossed cable if direct connection to the PC or a normal cable if connected to a switch or hub).
- Optionally a power supply, 9-15V DC, 2 Amp. A 2.1mm standard power plug is used. Any polarity.

4.2 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 external USB devices). The power supply should be 9-15V DC, 2 Amp. A 2.1mm standard power plug is used to interface the board. Any polarity is accepted.

See *Figure 8* below for locating the USB connector and/or the 2.1mm power connector.

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

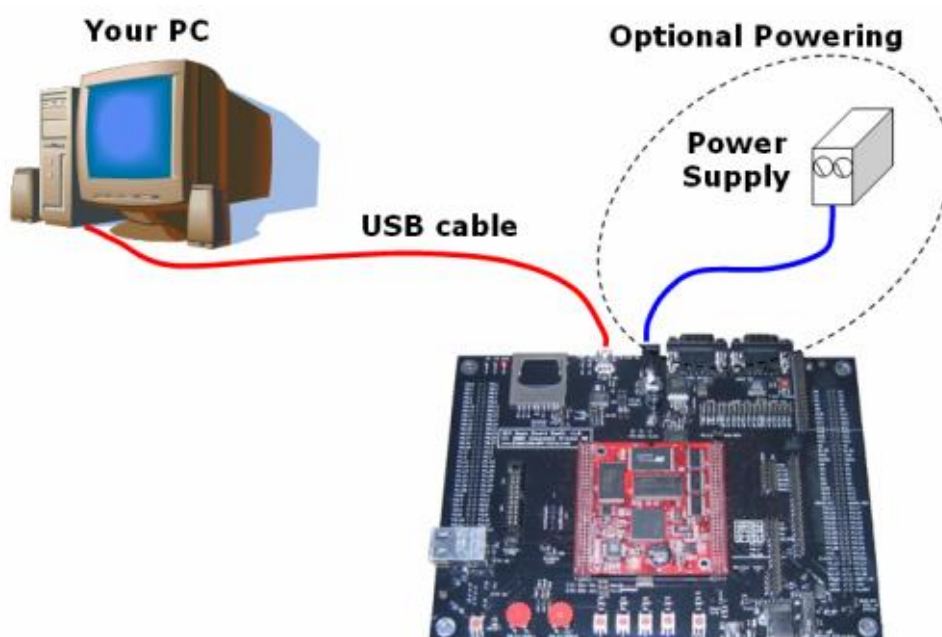


Figure 8 – Powering of OEM Base Board Basic

The *OEM Base Board* contains a USB-to-Serial bridge chip (FT232R from FTDI) that connects UART channel #0 on the LPC2468 to a virtual COM port on the PC (via USB). It is this serial channel that is the console interface to the uClinux system.

Special USB drivers must be installed on the PC in order for the virtual COM port to be created. See *Section 4.4* for a description of how to install the FTDI USB driver.

There are four jumpers on the *OEM Base Board* related to the USB serial channel, connected to UART #0 of the LPC2468. See *Figure 9* below for details about where the jumpers are located. Make sure the 'automatic ISP' jumpers are open. If not, it's possible that a terminal program resets the board and/or enable ISP mode by accident. These jumpers should normally always be open. The only exception is when updating the (u-boot) bootloader or downloading program code into the internal FLASH (via ISP functionality).

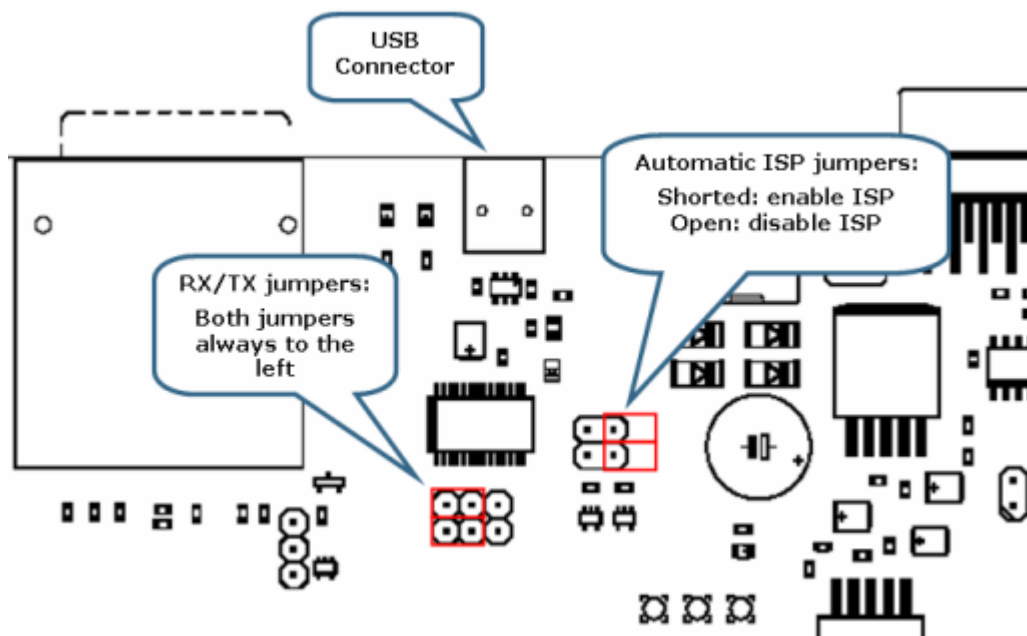


Figure 9 – Jumper Settings for USB/Serial Connection

Now follow the steps below to get contact with the (uClinux) console interface of the system:

1. Connect the USB cable between the PC and the *LPC2468 OEM board*.
2. Verify that the power LED on the *LPC2468 OEM Board* lights.
3. Search for the new (virtual) COM port that is created. This can be done from the 'Device Manager' in Windows.
4. Make sure the settings of the new COM port is: 38400 bps, 8N1 (8 databits, no parity, 1 stopbit). The COM port number should be a low number, preferably below 6, since some terminal programs can only handle COM port number up to 5.
5. Make sure the 'automatic ISP' jumpers are open and that the RX/TX jumpers are closed as in the picture above.
6. Start a terminal program and connect to the new COM port.
7. Press the reset button (lower left corner of the *OEM Base Board*) and observe the system console output in the terminal program window.

4.3 LAN/Ethernet Setup

Figure 10 below illustrates how to connect the *OEM Base Board* to your PC via Ethernet. Either directly (the red cable) or via an Ethernet switch/hub (the blue cable). The red cable is a crossed Ethernet cable and the blue is a normal cable.

The uClinux Ethernet driver (of the *LPC2468 OEM Board*) can automatically detect the type of cable and act accordingly, so different cables are not strictly needed.

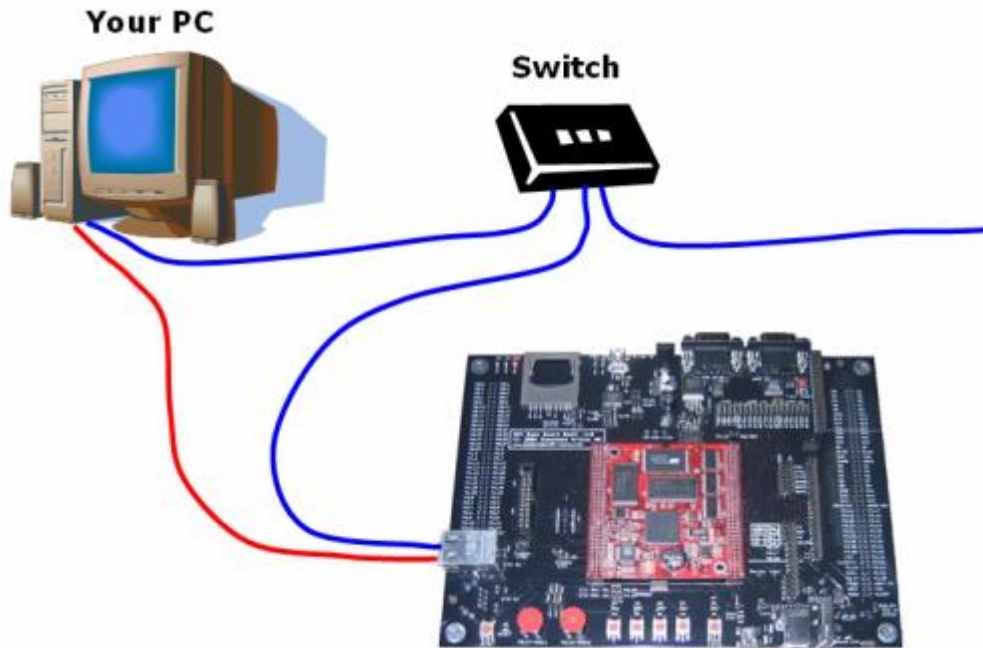


Figure 10 – Ethernet/LAN Cable Connection

The Ethernet cable should be connected during powerup. Else there will be a long timeout delay where the board waits for a valid Ethernet link.

The default network configuration of the *LPC2468 OEM Board* is:

IP address: 192.168.0.100

Netmask: 255.255.255.0

Default gateway: 192.168.0.1

Nodes on an IP network can communicate directly with each other if they are on the same LAN (i.e., Ethernet network) and is on the same IP subnet. This means that the *LPC2468 OEM Board* must be on the same IP subnet as your PC.

An IP address starting with 192.168.0.x is a common IP subnet for many PCs. If this does not match your PC either change the IP address of your PC or change the IP address of the *LPC2468 OEM Board* (see description of this at the last section of this page).

Make sure your PC does not have the IP address 192.168.0.100, but any other IP address in the range 192.168.0.X, where X is 1-99,101-254 will do.

Some valid IP addresses for your PC are for example: 192.168.0.2, 192.168.0.3 or 192.168.0.200.

Now it's time for the first test. Connect the Ethernet cable and power up the board. Make sure the PC and the *LPC2468 OEM Board* are in the same IP subnets.

An easy way to test if Ethernet/IP communication function properly is to ping the board. From a command prompt window, type:

ping 192.168.0.100

Note the green LEDs (on the Ethernet connector of the *OEM Base Board*) that flash every time an Ethernet frame is received. You should be able to see the LED flash at the same rate as the ping packages are sent. Other communication on your Ethernet network might make the LED flash much faster than this.

4.4 FTDI USB Driver

A USB driver must be installed on your PC computer in order for 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). Latest version of the driver (at the time of writing this document) is 2.00.00.

When the *OEM Base Board* is connected to the PC (via a 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 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 UART settings, first open the System Properties dialog, as illustrated in the figure below.

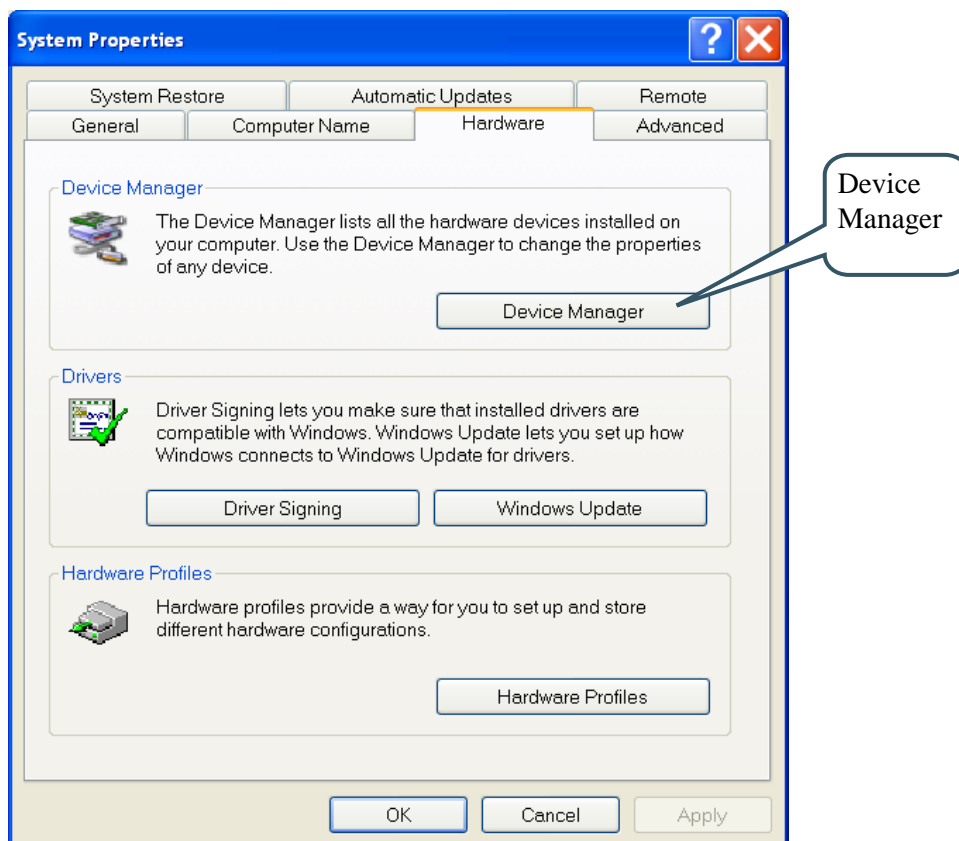


Figure 11 – System Settings Dialog

Then select the *Device Manager* and then open the *Ports* list, as illustrated in *Figure 12* below.

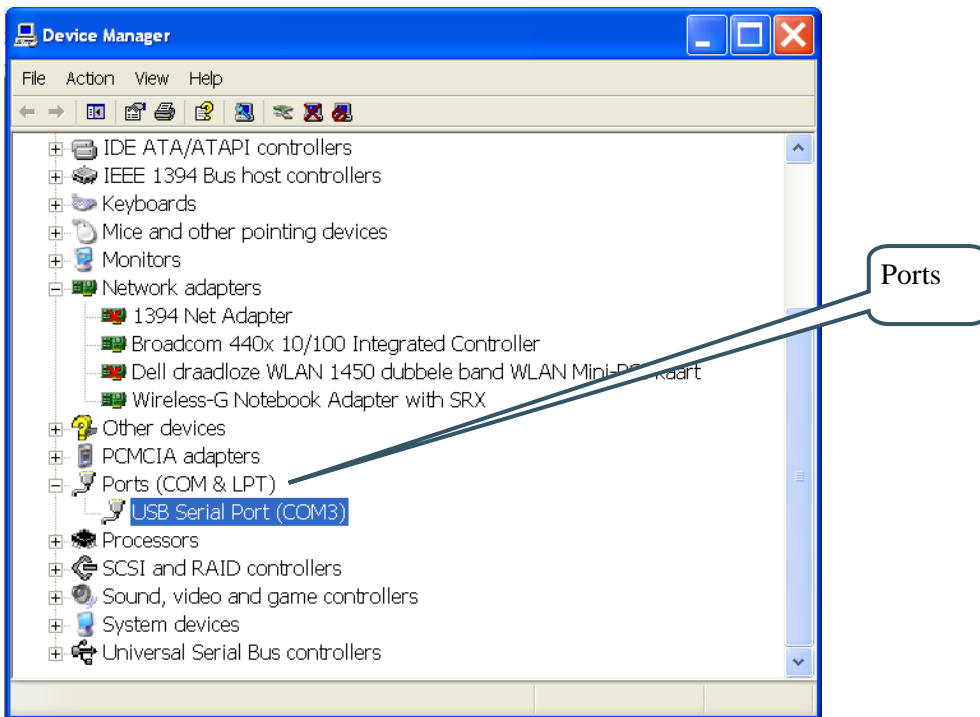


Figure 12 – Device Manager Dialog

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 13* below.

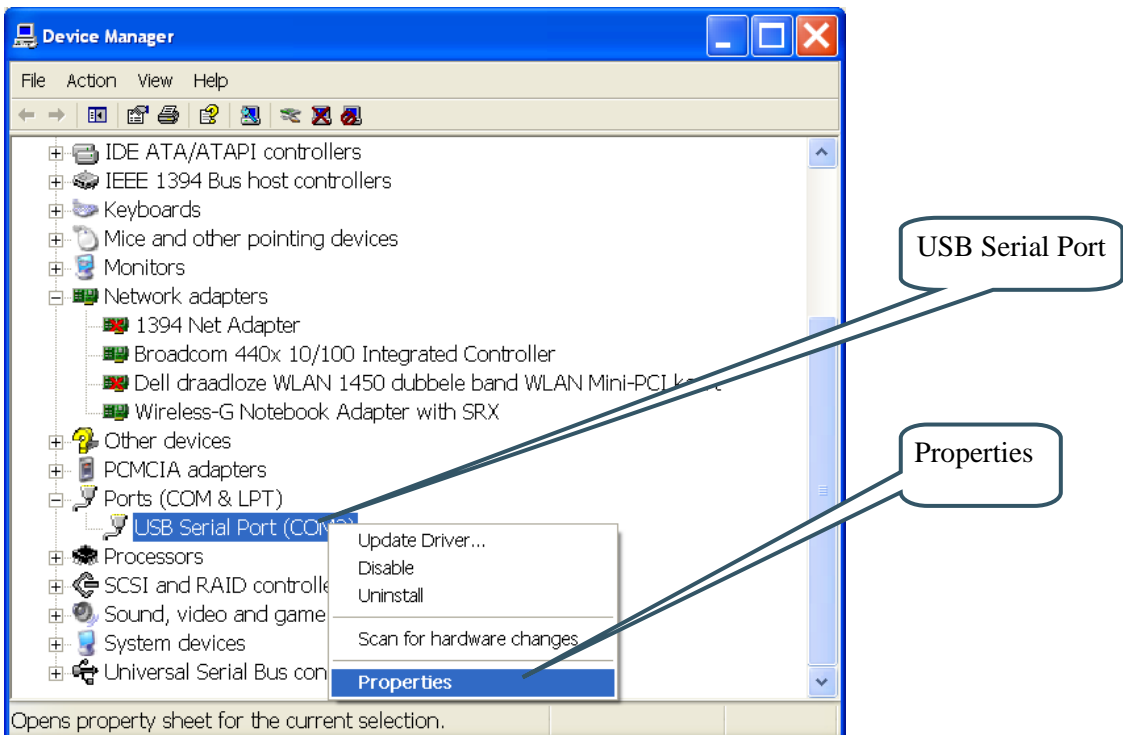


Figure 13 – Device Manager Port Dialog

Set 38400 bits per second, 8 data bits, none parity, 1 stop bit, and none flow control, as illustrated in *Figure 14* below. Then select *Advanced* settings.

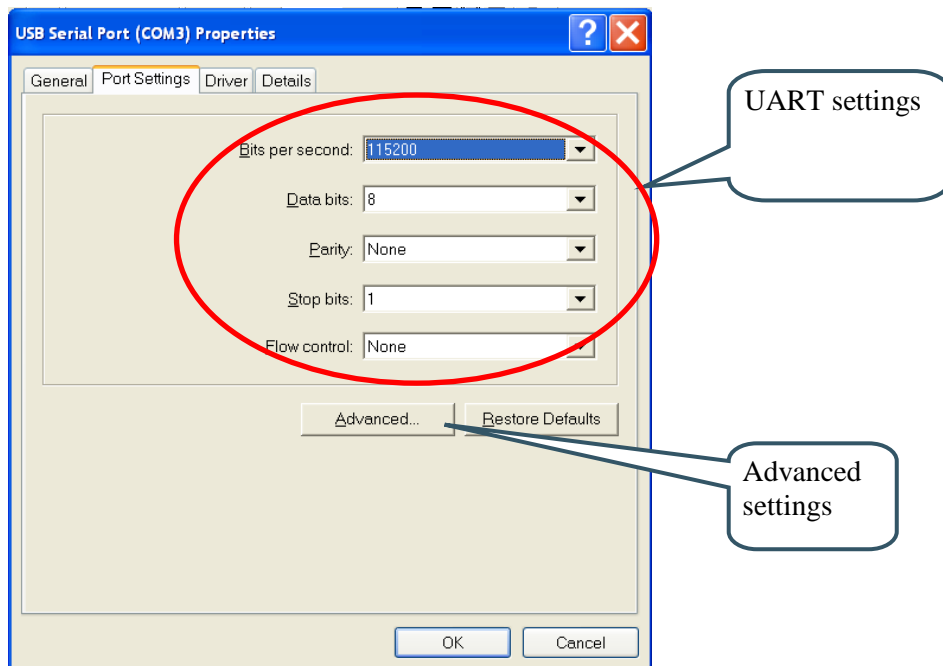


Figure 14 – USB Serial Port Properties Dialog

Set 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 selected but the USB Serial Port is higher than this, so 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 anyways. Very often it's no problem at all to do this.

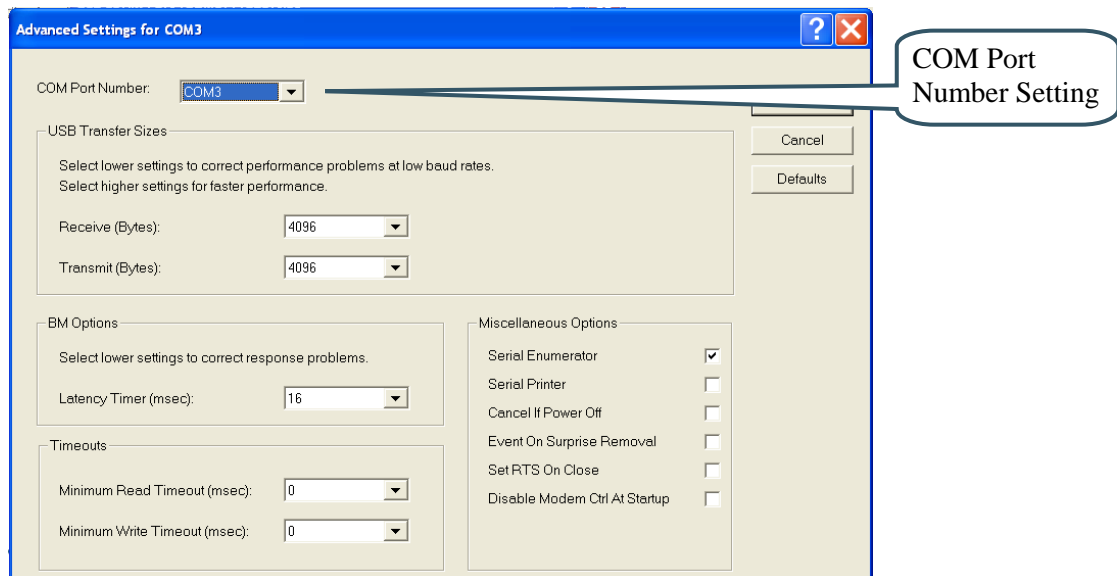


Figure 15 – Advanced USB Serial Port Properties Dialog

Finally it's 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 38400 bits per second, 8N1, no flow control. Remember to not have the USB-ISP jumpers inserted.

A message like below should be printed on the terminal. Please note that the picture below is just an example. The exact message will change for future program revisions.


```

LPC2xxx-gcc-newlib v2.1.0.0 - lpc21isp -termonly U-BOOT.HEX com5 38400 12000
RAMDISK: romfs filesystem found at block 0
RAMDISK: Loading 2253 blocks [1 disk] into ram disk... done.
UFS: Mounted root (romfs filesystem) readonly.
Freeing init memory: 56K
Welcome to

  uClinux

For further information check:
http://www.uclinux.org/

Board specific drivers by Embedded Artists AB
http://www.EmbeddedArtists.com

<Release 2007-02-25: Check for updates>

Using /drivers/lpc2468eth.ko
enac: found MAC address in u-boot env. = 00:d0:93:00:12:41:
enac: MAC address = 00:d0:93:00:12:41:
Using /drivers/lpc2468mmc.ko
mci: sector size = 512 (Bytes), card size = 512 (MBytes)
Using anticipatory io scheduler
mnc: mnc1
Using /drivers/lcd.ko
Using /drivers/adc.ko
Using /drivers/i2c.ko
Using /drivers/pwm.ko
Using /drivers/sfr.ko
Using /drivers/udc.ko
mnc: mnc1
enac: (reg 0x1e=0x 800, reg 0x1f=0x9598), link status = full duplex, 100Mbps
Using /lib/modules/2.6.5-ucLPC/kernel/drivers/usb/gadget/g_file_storage.ko
g_file_storage gadget: File-backed Storage Gadget, version: 26 January 2004
g_file_storage gadget: Number of LUNs=1
g_file_storage gadget-lun0: ro=0, file: /dev/mnc1
#

```

Figure 16 – Example Terminal Window, Startup Message from uClinux Console

4.4.1 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.

If the ISP jumpers are inserted, pressing the reset button is often required in order to startup the board (it can be placed in bootloader mode during startup due to RTS/DTR signal handling by the USB driver during startup).

5 Further Information

The LPC2468 microcontroller is a complex circuit and there exist a number of other documents with a lot more information. The following documents are recommended as a complement to this document.

- [1] NXP LPC2468 Datasheet
<http://ics.nxp.com/products/lpc2000/datasheet/lpc2468.pdf>
- [2] NXP LPC2468 User's Manual
<http://ics.nxp.com/support/documents/microcontrollers/pdf/user.manual.lpc24xx.pdf>
- [3] NXP LPC2468 Errata Sheet
<http://ics.nxp.com/support/documents/microcontrollers/pdf/errata.lpc2468.pdf>
- [4] ARM7TDMI Technical Reference Manual. Document identity: DDI0029G
http://www.arm.com/pdfs/DDI0029G_7TDMI_R3_trm.pdf
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Note that there can be newer versions of the documents than the ones linked to here. Always check for the latest information / version.