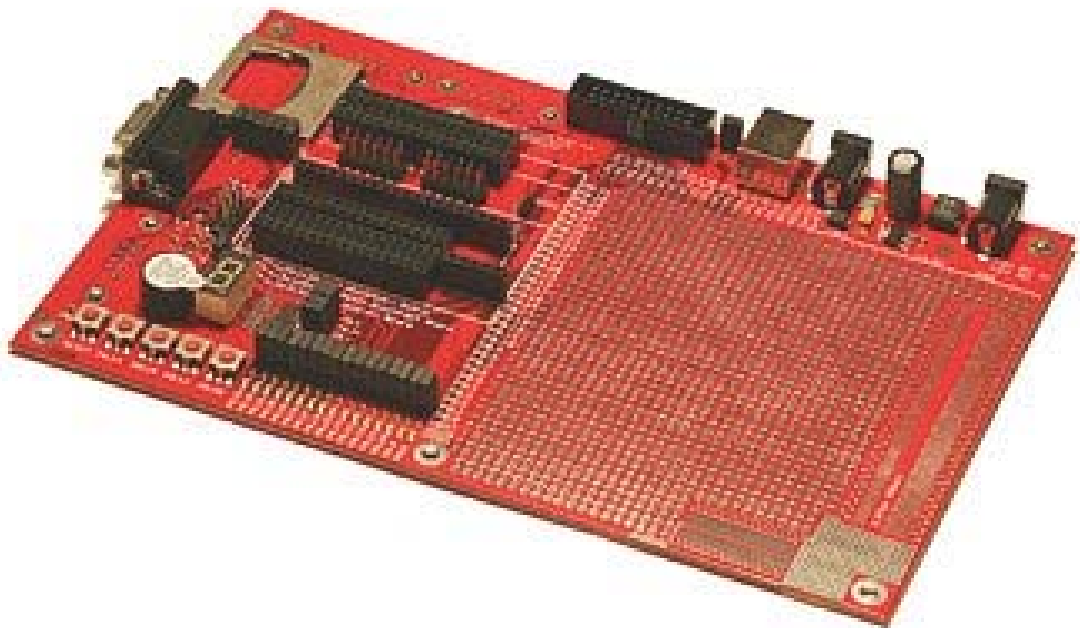


# Prototype QuickStart Board User's Guide



*Get Up-and-Running Quickly and  
Start Developing on Day 1...*

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# 1 Introduction

Thank you for buying Embedded Artists' *Prototype QuickStart Board*, possibly together with another *QuickStart Board* based on Philips ARM7TDMI LPC2xxx microcontroller family.

This document is a User's Guide that describes the *Prototype QuickStart Board* design. For information regarding program development with our *QuickStart Development Environment* see the document: *QuickStart Program Development User's Guide*.

## 1.1 Contents

The box received when ordering the *Prototype QuickStart Board* contains the following:

- The *Prototype QuickStart Board*.
- CD-ROM which includes additional material and programs, including complete and evaluation versions of different development environments.
- Possibly also another *QuickStart Board* with a LPC2xxx microcontroller.

## 1.2 Features

Embedded Artists' *Prototype QuickStart Board* lets you get up-and-running quickly with our *LPC2xxx QuickStart Boards* in general and in particular with Philips ARM7TDMI LPC2xxx microcontroller. The features are summarized below:

- Prototype board for many different *QuickStart Boards*. Different headers are used for different boards.
  - LPC2106 QuickStart Board
  - LPC2106 RS232 QuickStart Board
  - LPC2129 CAN QuickStart Board
  - LPC213x QuickStart Board
  - LPC2148 USB QuickStart Board
  - LPC2103 USB QuickStart Board
- Large prototype area (100 mil hole spacing)
- Smaller prototype area with 50 mil hole spacing
- SMD area for 50 mil SO circuits
- SMD area for 0.65 mm SSOP circuits
- MMC/SD connector, connected to SPI bus
- 7-segment display connected to SPI bus
- 16 LEDs
- 4 switches
- Reset button
- JTAG connector
- 9-pole DSUB connector for UART #1

- Power supply 5VDC (center pin negative) or 9VDC (any polarity) or 6VAC or from USB connector (5V DC)
- Two 9-pole DSUB connectors for CAN board (not mounted)
- RS232 circuit for LPC2106 board (only partly mounted)
- 2x32 pole expansion connector compatible with the *Education Board* series.
- 196 x 125 mm in size

### 1.3 Low Cost QuickStart Boards

Embedded Artists' *LPC2xxx QuickStart Boards* are very low cost and can be used 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.

#### 1.3.1 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 Philips LPC2xxx 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.

### 1.4 Other QuickStart Boards and Kits

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

## 2 Getting Started

### 2.1 Power Supply

There are four options for powering the *Prototype QuickStart Board*:

- A DC power supply, 5 volt, capable of providing at least 150 mA (more if external circuits need power from the 3.3 volt supply on the LPC2xxx *QuickStart Boards*). The 2.1mm connector have negative center pin. The board contains reverse polarity protection.
- A DC power supply, 9 volt, with any polarity on the 2.1mm connector. Also in this case, the power supply should be capable of providing at least 150 mA (more if external circuits need power from the 3.3 volt supply on the LPC2xxx *QuickStart Boards*).
- An AC power supply, 6 volt. Also in this case, the power supply should be capable of providing at least 150 mA (more if external circuits need power from the 3.3 volt supply on the LPC2xxx *QuickStart Boards*).
- Powering via a USB cable of type: B-to-A, both male connectors. In this case, the power comes from a PC or a USB hub.

See *Figure 1* below for details about power supply connectors (upper right corner of the board).

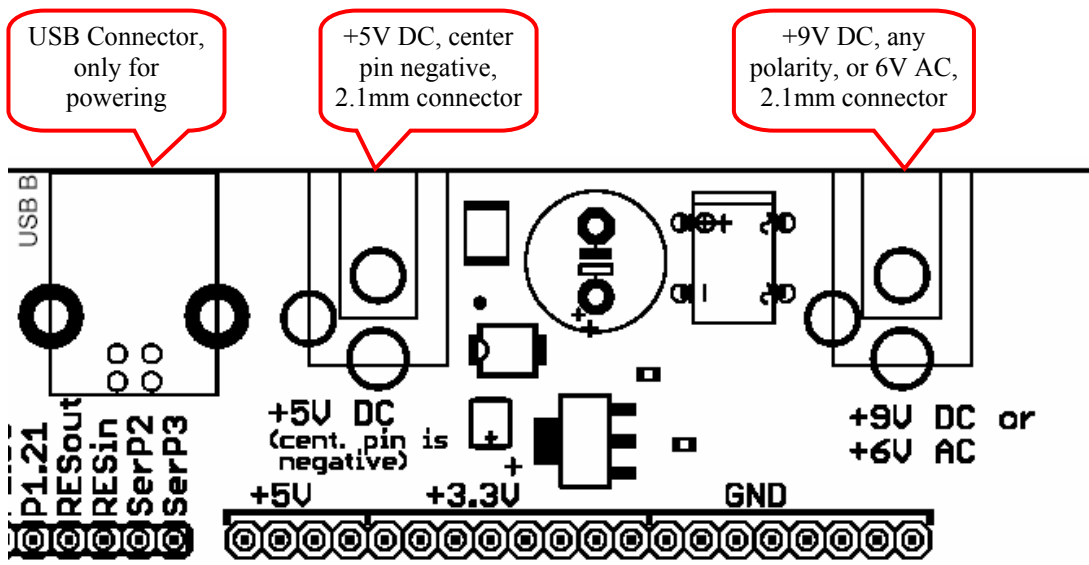


Figure 1 – Power Supply Connectors

## 2.2 QuickStart Board Mounting

Many different QuickStart Boards can be mounted on the *Prototype QuickStart Board*. The following subsection describes how to mount each different *QuickStart Board*.

### 2.2.1 LPC2106 QuickStart Board

The *LPC2106 QuickStart Board* is the only QuickStart board that does not have on-board ISP functionality, i.e., a RS232 serial channel and automatic control of the bootloader. *Figure 2* below illustrates how the board shall be mounted on the *Prototype QuickStart Board*. The orientation of the board has been indicated with where the crystal is on the board and where the power supply is located (where the 20-pin chip is).

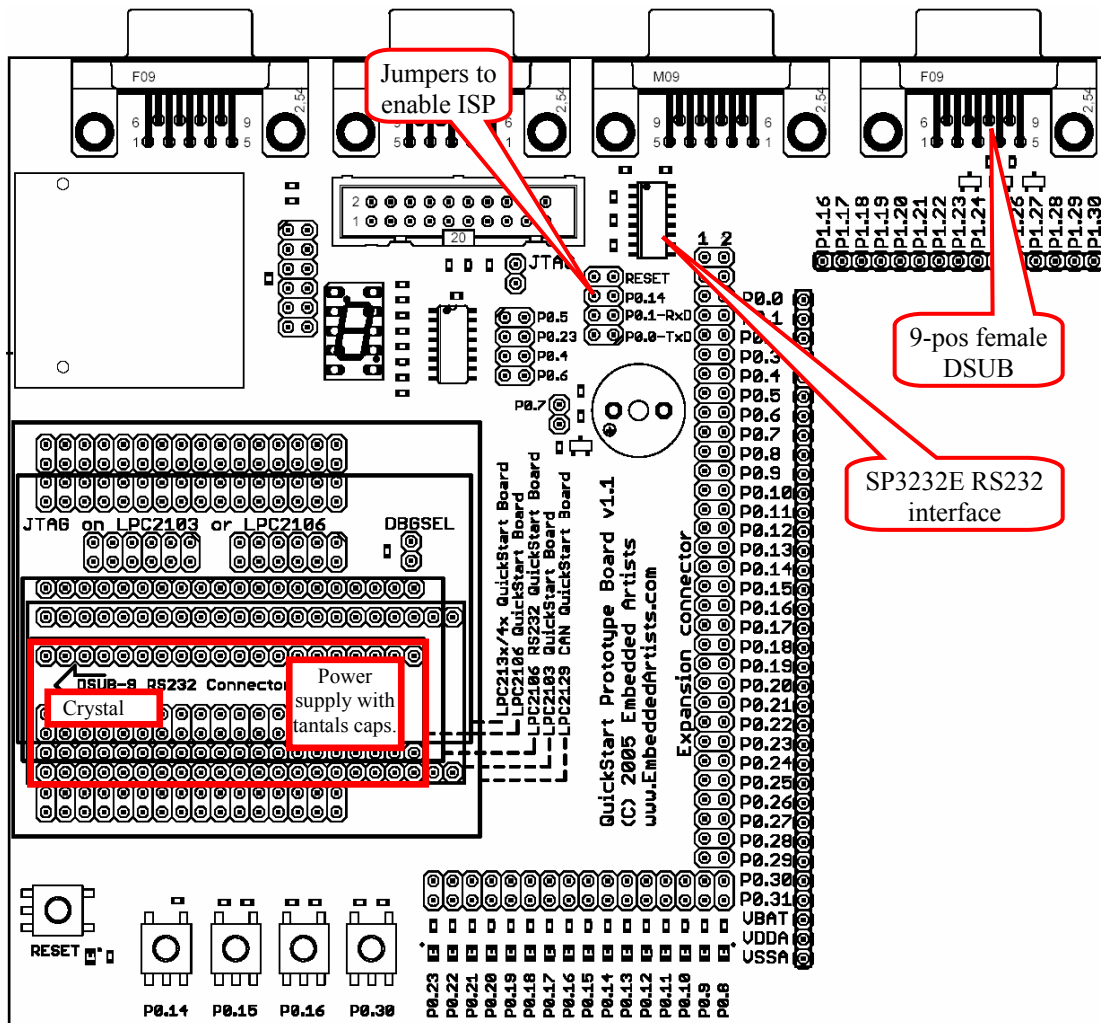


Figure 2 – Mounting of the LPC2106 QuickStart Board

Almost all components for the ISP functionality have been mounted. The only things missing are the SP3232E RS232 interface chip (in SO16) and the 9-pole female DSUB connector. The 3232E chip is a standard ship that many produce. Sipex or any other manufacturer can be used. The reason why these two components are not mounted is cost. All other *QuickStart Boards* have on-board ISP functionality and it's wasteful to mount these components on all boards when only a few uses it. This allows us to produce and offer the board to a lower cost.

The jumpers (as indicated in the picture above) are used to enable the ISP functionality. Insert all four jumpers to enable automatic program download.

### 2.2.2 LPC2106 RS232 QuickStart Board

Figure 3 below illustrates how the *LPC2106 RS232 QuickStart Board* shall be mounted on the *Prototype QuickStart Board*. The orientation of the board has been indicated with where the on-board DSUB connector is directed.

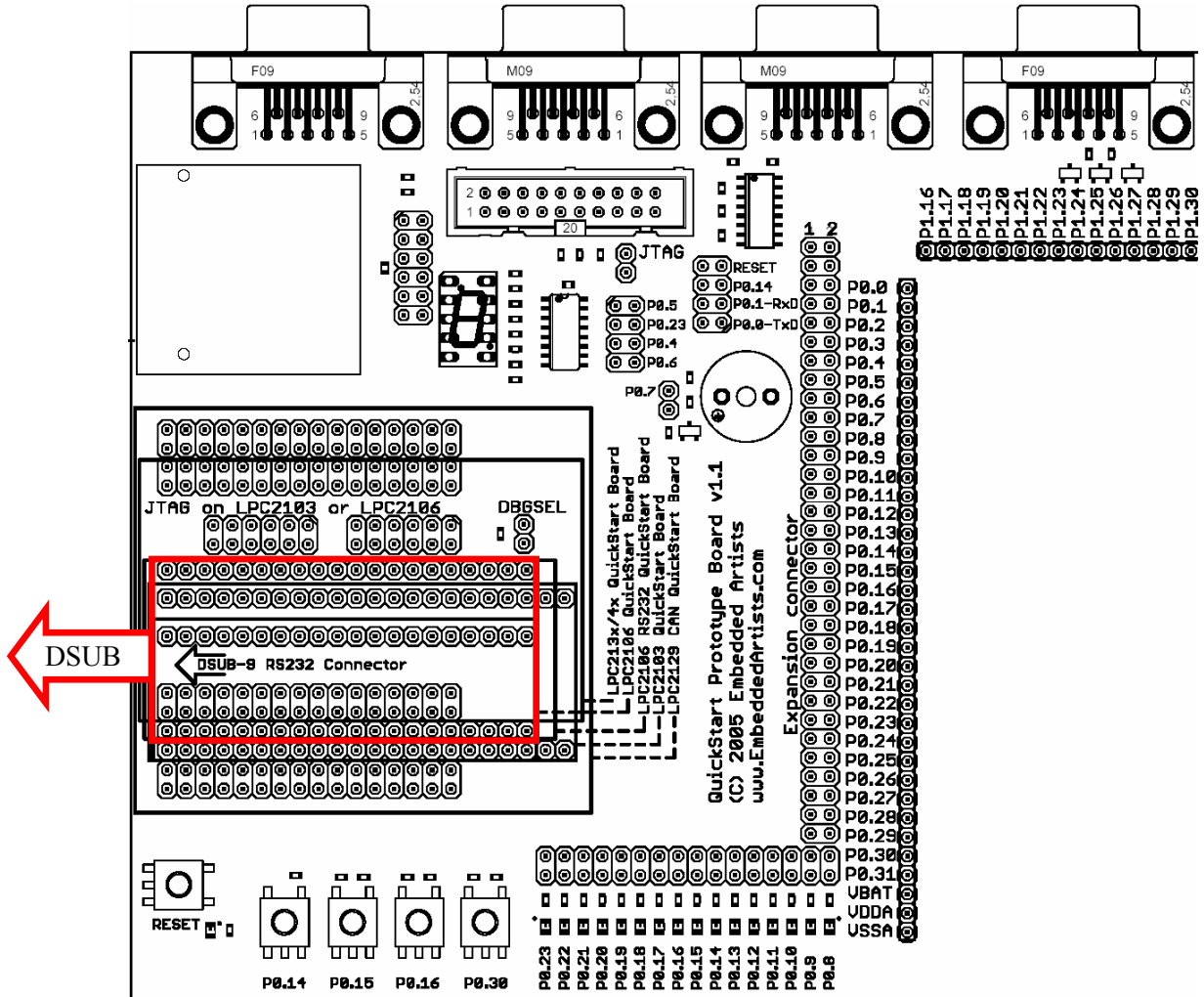


Figure 3 – Mounting of the LPC2106 RS232 QuickStart Board



### 2.2.3 LPC2129 CAN QuickStart Board

Figure 4 below illustrates how the board shall be mounted on the *Prototype QuickStart Board*. The orientation of the board has been indicated with where the on-board DSUB connector is directed.

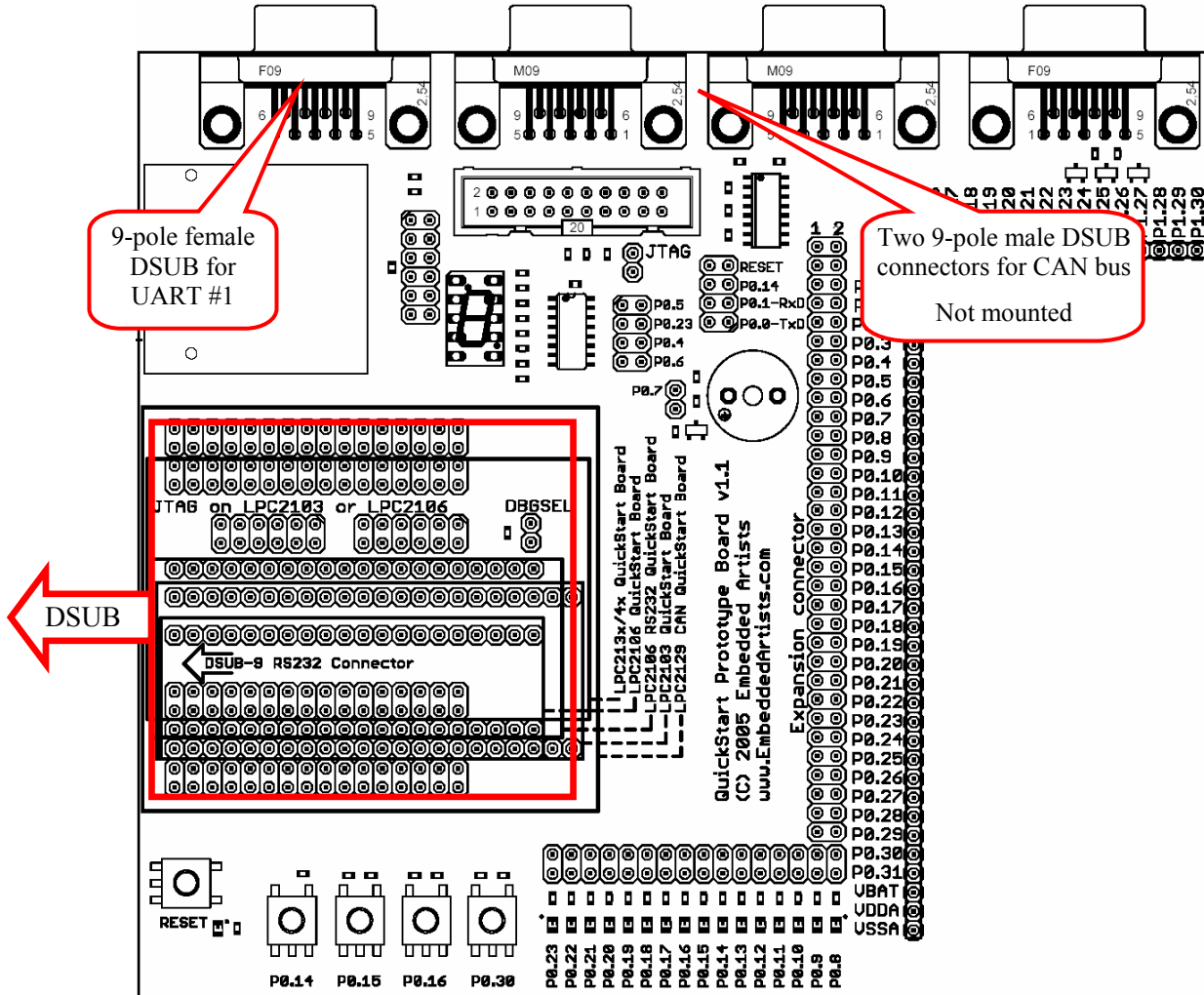


Figure 4 – Mounting of the LPC2129 CAN QuickStart Board

The two CAN connectors can be mounted if needed. Use 9-pole male DSUB connectors. The connectors are not mounted as standard since not all *QuickStart Board* have CAN interface.

The RS232 channel for UART #1 is available on the 9-pole female DSUB connector in the upper left corner of the board (see picture above).

### 2.2.4 LPC213x and LPC2148 USB QuickStart Board

Figure 5 below illustrates how the board shall be mounted on the *Prototype QuickStart Board*. The orientation of the board has been indicated with where the on-board DSUB and USB connectors are directed.

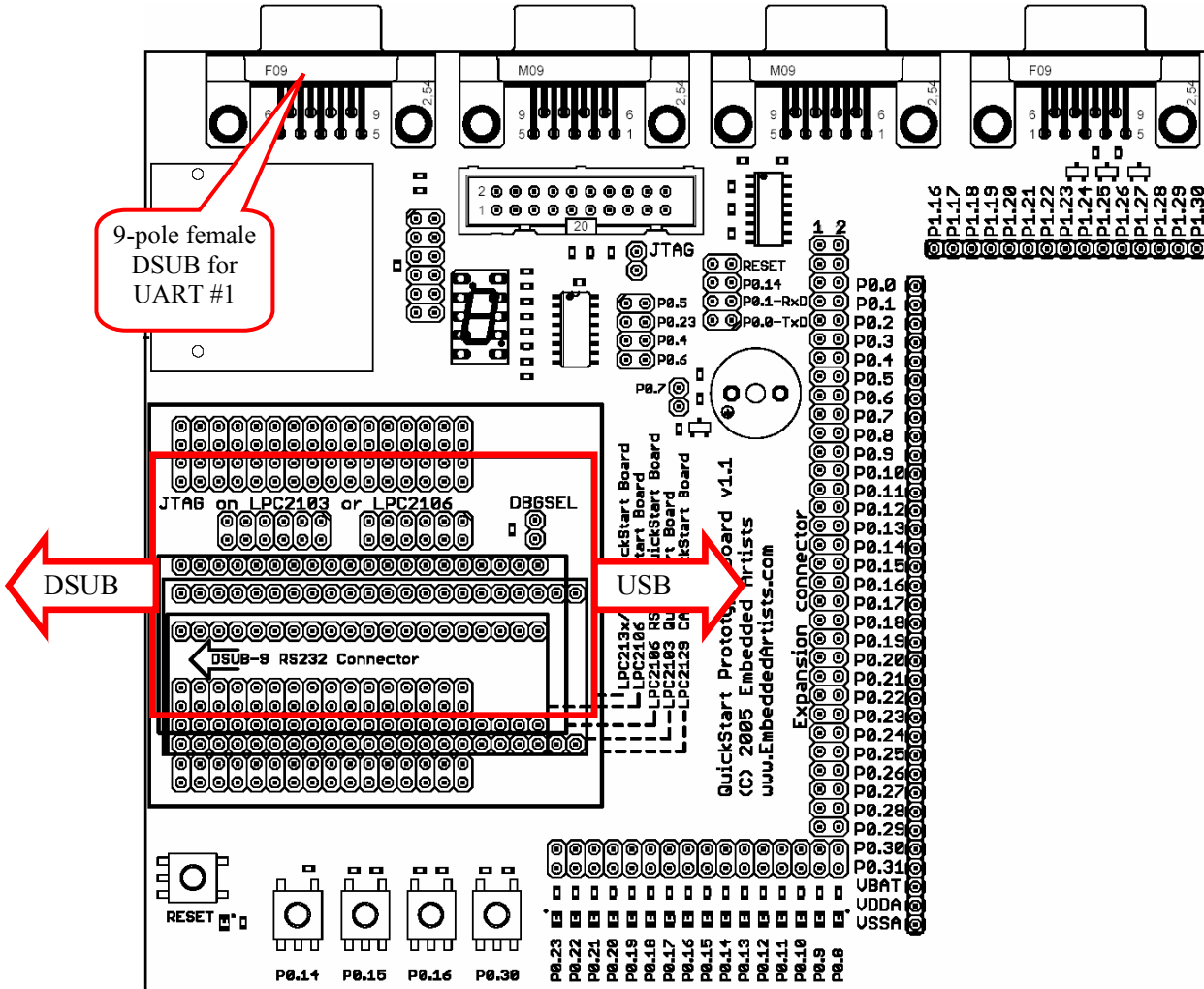


Figure 5 – Mounting of the LPC213x QuickStart Board and LPC2148 USB QuickStart Board

The RS232 channel for UART #1 is available on the 9-pole female DSUB connector in the upper left corner of the board (see picture above).

Note that the USB connector on the *LPC213x QuickStart Board* is only for powering the board.

### 2.2.5 LPC2103 USB QuickStart Board

Figure 6 below illustrates how the board shall be mounted on the *Prototype QuickStart Board*. The orientation of the board has been indicated with where the on-board DSUB and USB connectors are directed.

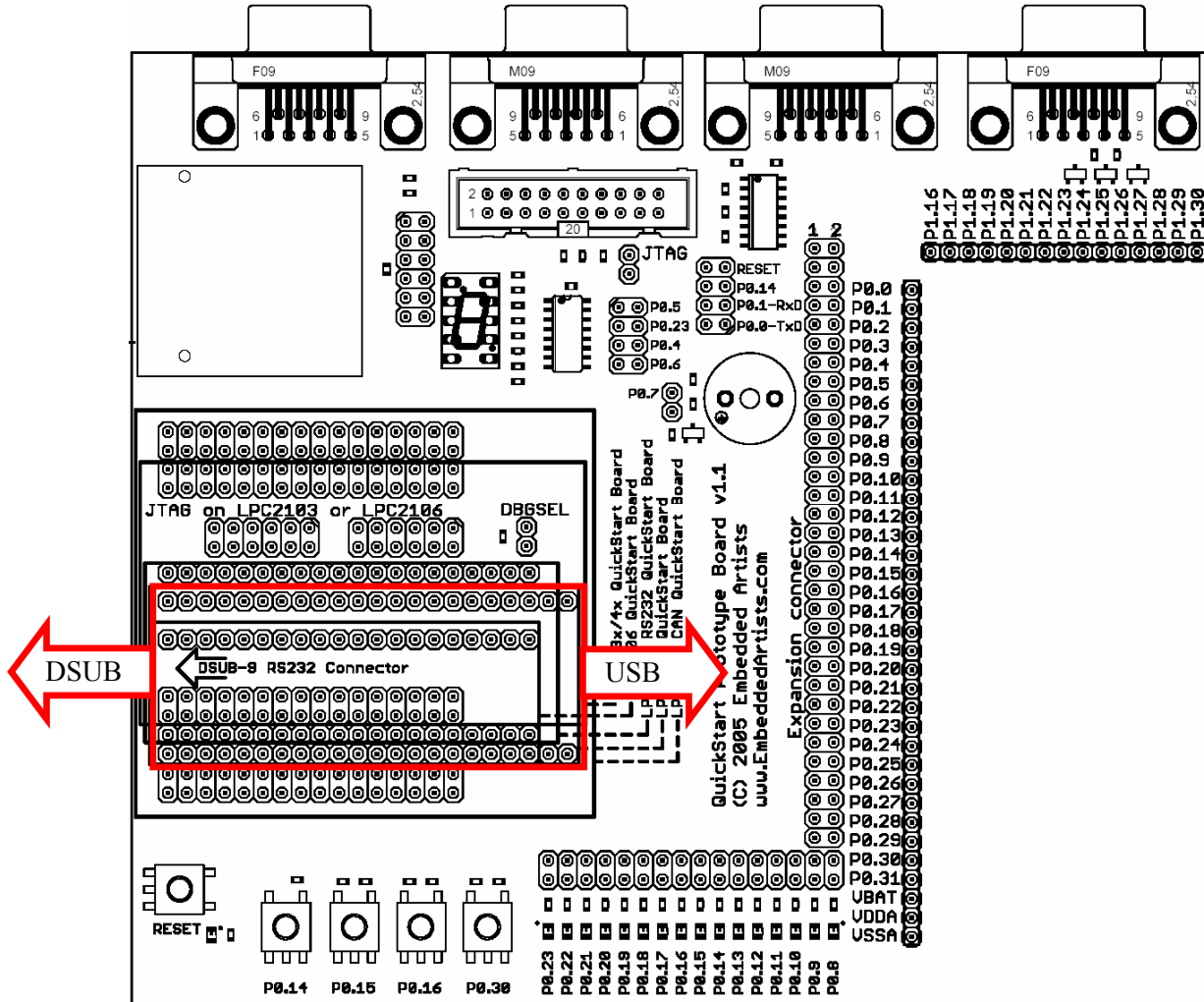


Figure 6 – Mounting of the LPC2103 USB QuickStart Board

This board has not been released when this User's Manual is being written, but is expected to be available in February 2006.

# 3 Board Design

This chapter contains detailed information about the electrical design of the *Prototype QuickStart Board*.

## 3.1 Board Schematics

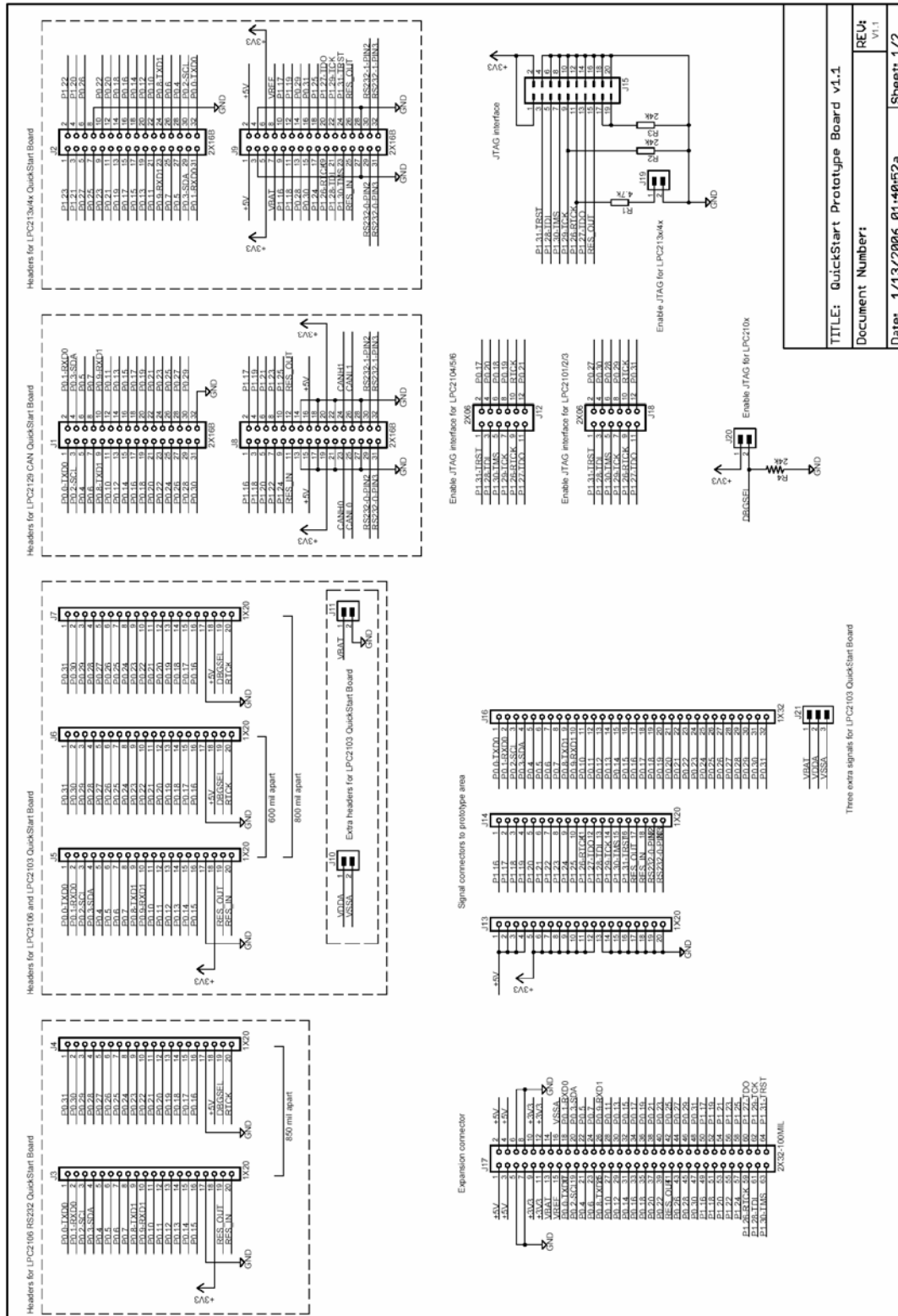


Figure 7 – Prototype QuickStart Board Schematic, page 1

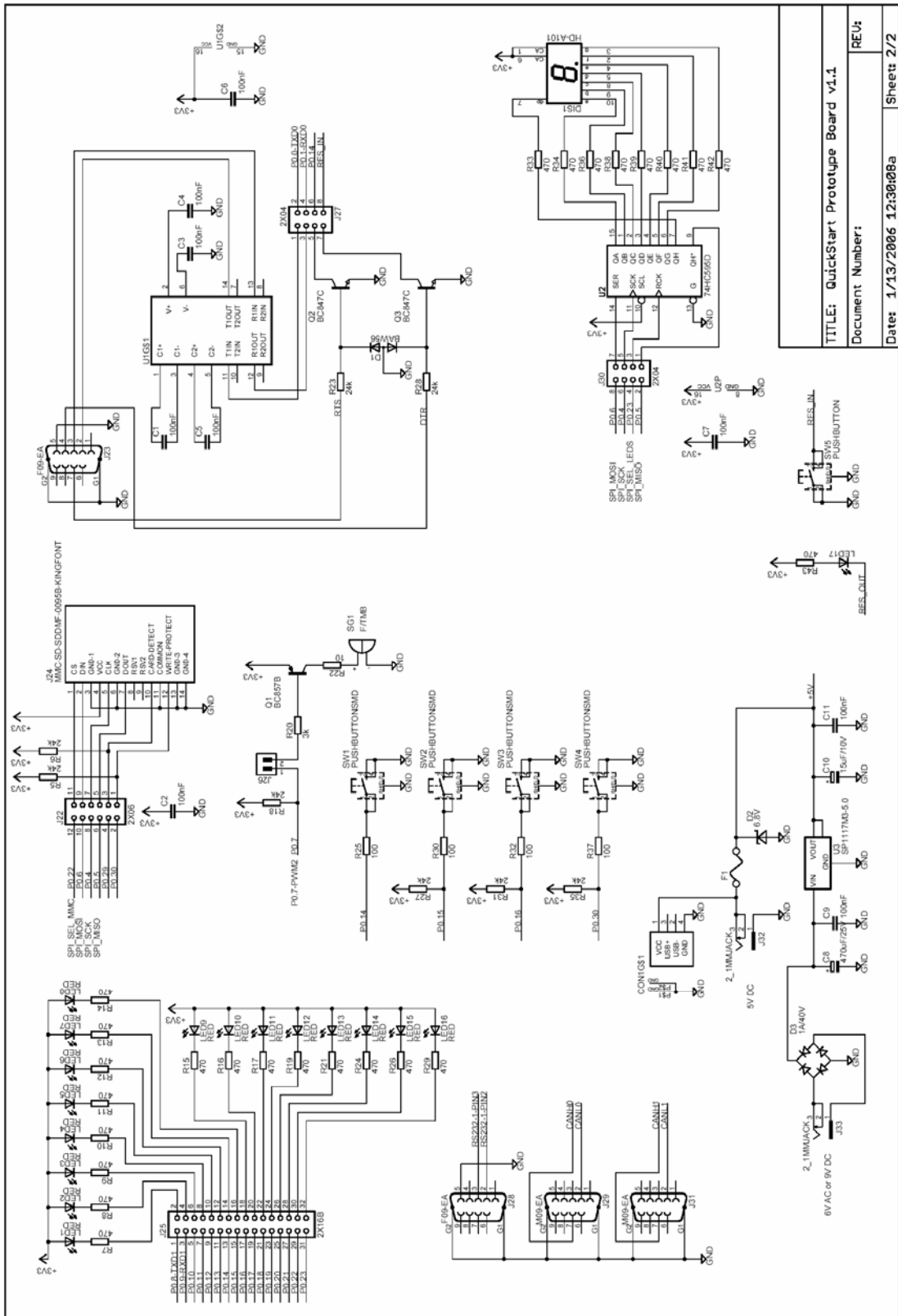


Figure 8 – Prototype QuickStart Board Schematic, page 2

### 3.2 7-segment Display

The 7-segment display is connected to the SPI bus. P0.23 is used as chip select for the shift register that is used to shift in the display content. *Figure 9* below lists a small example

program how to control the display. Note that the decimal dot on the 7-segment display does not work (there is no LED).

```
#
# Example program to control the 7-segment display
#

#include <lpc2xxx.h>

#define SPI_CS 0x00800000 //P0.23

const tU8 to7Segment[10] = {0x3f,0x06,0x5b,0x4f,0x66,0x6d,0x7d,0x07,0x7f,0x6f};

void
initDisplay(void)
{
    //enable SPI in pins
    PINSEL0  &= 0xffff00ff; //or 0xffff30ff if LPC2148
    PINSEL0  |= 0x00005500; //or 0x00001500 if LPC2148

    //initialize SPI to highest speed
    SPI_SPCCR = 0x00000008;
    SPI_SPCR  = 0x00000038;

    //Set P0.23 as output and set the pin high
    IODIRO    |= SPI_CS;
    IOSET0    = SPI_CS;

    //blank the display, a high bit = LED segment off
    sendSPI(0xff);
}

void
sendSPI(unsigned char inData)
{
    IOCLR0 = SPI_CS; //Activate SPI slave
    SPI_SPDR = inData;
    while((SPI_SPSR & 0x80) == 0)
        ;
    IOSET0 = SPI_CS; //Deactivate SPI slave
}

void
setDisplay(unsigned char digit)
{
    sendSPI(~to7Segment[digit]);
}
```

Figure 9 – Example program to control the 7-segment display

Note that there is normally no need to have SPI\_MISO (P0.5) jumper in J30 inserted.

### 3.3 MMC/SD Memory Card Interface

The MMC/SD memory card interface is also connected to the SPI bus. In this case, P0.22 is used as chip select of the memory card.

There is an application note from Philips (*AN10406\_1: Accessing SD/MMC card using SPI on LPC2000*) that describes how to create a low level interface (read/write sectors) to the memory cards.

The memory card connector also contains switches to detect if a card is inserted or not. P0.29 is connected to the card detect switch. A low level indicated that a memory card is present/inserted in the connector. There is also a write protect switch that is used on SD memory cards (note that MMC cards do not include this feature). A low level on pin P0.30 indicates that write operations are allowed on the memory card.

Do not forget that you must insert the jumpers in pin list J22 in order to use the interface. J41 can be found just to the right of the memory card connector. If you do not use the extra switches (for insertion detection and write protect detection) just do not insert these corresponding jumpers. These are the two top-most jumpers on J22.

### 3.4 Buzzer

The buzzer is connected to pin P0.7. Either the buzzer is controlled by a simple digital signal; high is off, and a low signal turns the buzzer on. In this case, the buzzer oscillates in its self-frequency. As an alternative, a PWM signal can be used to control the frequency of the oscillations. The signal PWM2 is available as an alternative signal on pin P0.7. *Figure 10* below lists a small example program how to control the buzzer with a PWM signal.

```
#
# Example program to control the buzzer
#

#include <lpc2xxx.h>

void
initPWM2(void)
{
    //enable PWM2 on P0.7
    PINSEL0  &= 0xffff3fff;
    PINSEL0  |= 0x00008000;

    //initialize PWM2
    PWM_PR  = 0x00;    //Prescale Register
    PWM_MCR = 0x02;    //Match Control Register
    PWM_MR0 = 0x1000;
    PWM_MR2 = 0x1000;
    PWM_LER = 0x05;    //Latch Enable Register
    PWM_PCR = 0x0400; //Prescale Counter Register PWMENA2
    PWM_TCR = 0x09;    //Counter Enable och PWM Enable
}

void
setBuzzer(unsigned int frequency)
{
    PWM_MR0 = frequency;
    PWM_MR2 = frequency / 2;
    PWM_LER = 0x05;
}

```

Figure 10 – Example program to control the buzzer

### 3.5 LEDs

16 LEDs are connected to pins P0.8 – P0.15. A low pin level drives current through the LED (i.e., LED is on). *Figure 11* below lists a small example program how to control the LEDs in a running-one pattern.

```
#
# Example program to control the LEDs
#

#include <lpc2xxx.h>

void
initLEDs(void)
{
    //set P0.8-p0.23 to outputs
    PINSEL0 &= 0x0000ffff;
    PINSEL1 &= 0xffff0000;
    IODIR  |= 0x00ffff00;
    IOSET  = 0x00ffff00; //turn all LEDs off
}

```

```
void
runningLEDs(unsigned int rounds)
{
    unsigned int pattern;

    while(rounds-- > 0)
    {
        pattern = 0x00000100;
        while (pattern < 0x01000000)
        {
            IOCLR0 = pattern;
            delay();                //user-defined delay function
            IOSET0 = pattern;
            pattern <<= 1;
        }
    }
}
```

Figure 11 – Example program to control the LEDs

### 3.6 Push Buttons

There are five push buttons on the *Prototype QuickStart Board*. One is for reset and the four other are connected to pins: P0.14, P0.15, P0.16 and P0.30 respectively.

These pins can be useful to have a push button connected to. As alternative signals these pins can be used as interrupt inputs.

### 3.7 RS232 ISP

As explained in *Section 2.2.1*, this circuit is only included since the *LPC2106 QuickStart Boards* do not include the ISP functionality. You must add a SP3232E circuit as well as a 9-pole female DSUB connector in order to make use of this functionality.

### 3.8 CAN Connectors

These connectors are only used with the LPC2129 CAN QuickStart Board. The two 9-pole male DSUB connectors must be manually soldered in order to use this interface.

### 3.9 UART #1 Connector

The *LPC2129*, *LPC213x*, and *LPC2148 QuickStart Boards* have also on-board RS232 support for UART channel #1. When these boards are used, this 9-pole female DSUB connector can be used to access UART #1.

### 3.10 Expansion Connector

The 2x32 pin expansion connector allows the *Expansion Boards* in the *Education Board* series to be used and connected to the *Prototype QuickStart Board*. The list below presents the first set of available expansion boards. As seen, many of the boards are communication oriented.

- Ethernet board (10Mbps) with SPI interface
- Bluetooth™ board with UART interface
- ZigBee™ board with SPI interface
- MP3 decoder board with SPI interface
- Graphical LCD (240x120 pixels) with parallel interface
- Modem (UART#1) and RS485 board
- Prototype board

More boards are in preparation, for example:



- GSM/GPRS modem board
- GPS board
- WLAN (IEEE802.11) board

...and many more to come!

### 3.11 JTAG Interface

There is also a JTAG interface for users that want to make full use of the debug possibilities in the ARM7TDMI-S processor core. The JTAG interface is a 2x10 pin 100 mil pin list with shoulders, and is the standard 20-pin JTAG connector for all ARM7-processors.

The LPC2129 CAN QuickStart Board already contains a JTAG interface connector so for this board, this feature is not needed. Just use the on-board connector instead.

The different processors in the LPC2xxx family use different pins for the JTAG interface:

- LPC2101/2/3 uses pins P0.27-P0.31 for the JTAG interface
- LPC2104/5/6 uses pins P0.17-P0.21 for the primary JTAG interface and P0.27-P0.31 for the secondary interface.
- LPC212x/3x/4x uses pins P1.27-P1.31 for the JTAG interface

For the LPC2101/2/3 processors; insert all jumpers in pin list J32 and use jumper DBGSEL to enable the JTAG interface.

For LPC2104/5/6 processors, insert all jumpers in pin list J12 and use jumper DBGSEL to enable the JTAG interface. Alternatively, insert all jumpers in pin list J18 if the secondary JTAG interface is used.

For LPC213x/4x processors, just use the JTAG interface connector on the *Prototype QuickStart Board* and use jumper RTCK to enable the JTAG interface.

Figure 12 below illustrates all connectors related to the JTAG interface.

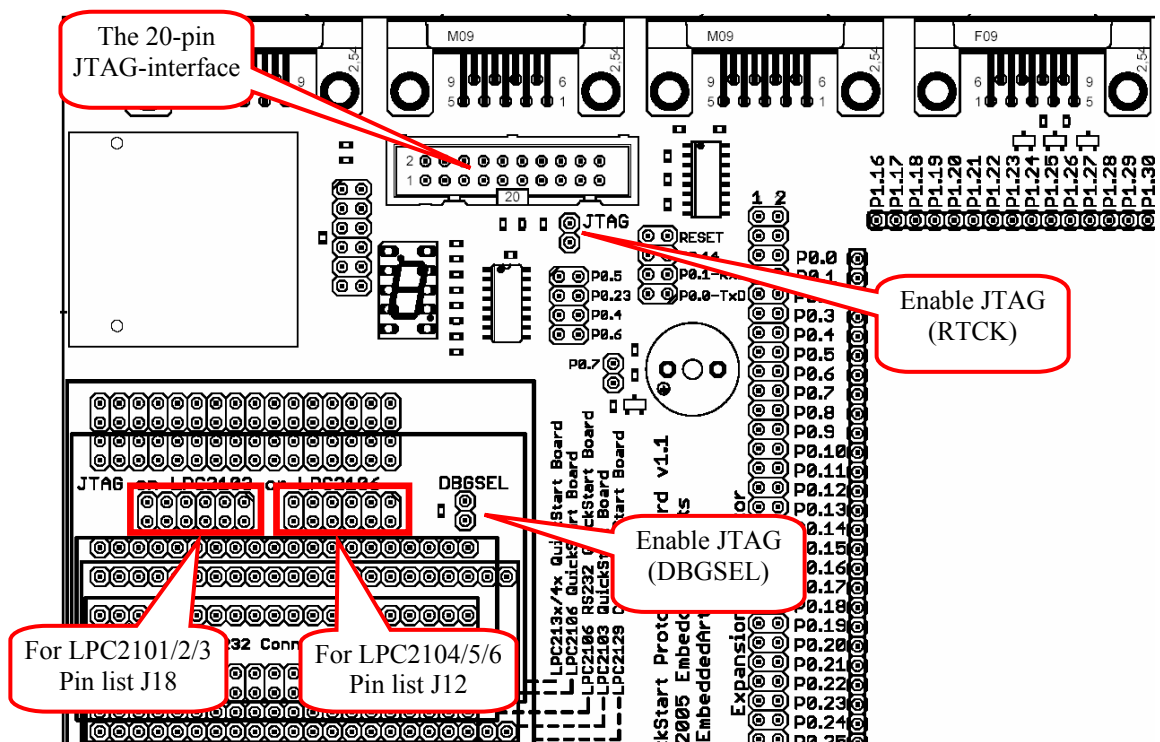


Figure 12 – JTAG connectors

### 3.12 Prototype Area

Finally, and maybe most importantly, there are six different parts that make up the prototype area:

- The largest and most obvious part is the 100 mil connection array.
- All pins signals from the QuickStart Boards are available at the left and upper edges of the area.
- The top right edge of the area contains power connections for +5 Volt, +3.3 Volt, and GND.
- A small 50 mil connection area at the right bottom area.
- A 50 mil (1.27 mm) area at the right edge for connecting SO-sized circuits.
- A 0.65mm area at the bottom for connecting SSOP-sized circuits.

## 4 Getting Started

### 4.1 Test Program

The *Prototype QuickStart Board* does not contain a processor and can therefore not have any preloaded test program. However, there exist two different test programs that can be downloaded in the *LPC2xxx QuickStart Board* that is connected to the *Prototype QuickStart Board*:

- Test program for QuickStart Boards with a 12.0000MHz crystal.  
*Use terminal baud rate 38400 bps, 8 data bits, no parity bit, one stop bit.*
- Test program for QuickStart Boards with a 14.745600MHz crystal.  
*Use terminal baud rate 115200 bps, 8 data bits, no parity bit, one stop bit.*

The test program outputs a running-one on the LEDs, writes digits to the 7-segment display and plays a simple song on the buzzer.

### 4.2 Program Development

Consult the *QuickStart Program Development User's Manual* for more information about the *QuickStart Build Environment* from Embedded Artists, and program development for the ARM7 in general.

## 5 CD-ROM and Product Registration

The accompanying CD-ROM contains a lot of information and programs that will QuickStart your program development! Note that there may be newer versions of different documents and programs available than the ones on the CD-ROM. See *Section 5.2* for information about the product registration process, which allows you to always have access to the latest versions.

### 5.1 CD-ROM

The following is included on the CD-ROM:

- The test programs as HEX-files.
- The two different ISP download programs.
- Datasheets of all circuits on the *Prototype QuickStart Board*.
- *QuickStart Build Environment* from Embedded Artists, which contains a complete setup of a build environment for GCC.
- A complete development environment: Rowley Associates CrossWorks for ARM, 30-day evaluation version.
- A complete development environment: IAR Embedded Workbench for ARM, Kickstart Edition with 32 Kbyte program size limit.
- Another complete development environment: GCC, GNUARM distribution, including compiler, linker, make, and debugger.
- The program Programmers Notepad, which is a very good program development editor and project manager.
- The Eclipse development environment including the CDT (C/C++ Development Tools) project.

### 5.2 Product Registration

By registering as a customer of Embedded Artists you will always have access to the latest versions of all information and programs on the CD-ROM.

Registering is easy and done quickly.

- 1) Go to <http://www.EmbeddedArtists.com>, select *Support* and then *Register*.
- 2) Type in the products serial number (can be found on the *Prototype QuickStart Board* or on the package carrying the board) along with your personal information.

## 6 Further Information

LPC2xxx microcontrollers are complex circuits 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] Philips LPC2xxx Datasheet
- [2] Philips LPC2xxx User's Manual
- [3] Philips LPC2xxx Errata Sheet
- [4] ARM7TDMI Technical Reference Manual. Document identity: DDI0029G  
[http://www.arm.com/pdfs/DDI0029G\\_7TDMI\\_R3\\_trm.pdf](http://www.arm.com/pdfs/DDI0029G_7TDMI_R3_trm.pdf)
- [5] 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
- [6] ARM System Developer's Guide – Designing and Optimizing System Software, by A.N. Sloss, D Symes, C. Wright. Elsevier: ISBN 1-55860-874-5
- [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] LPC2000 Yahoo Group. A discussion forum dedicated entirely to the Philips LPC2xxx series of microcontrollers.  
<http://groups.yahoo.com/group/lpc2000/>
- [12] The Insider's Guide to the Philips ARM7-Based Microcontrollers, by Trevor Martin.  
<http://www.hitex.co.uk/arm/lpc2000book/index.html>

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