UM11083

User Manual for LPCXpresso804 Board

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Contact information

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1. Introduction

The LPCXpresso family of boards provides a powerful and flexible development system for NXP's Cortex-M MCUs. They can be used with a range of development tools, including the MCUXpresso IDE. The LPCXpresso804 board is developed by NXP to enable evaluation of and prototyping with the LPC804 MCU. Figure 1 shows the LPCXpresso804 main board. The board is also supplied with capacitive touch and PLU design prototyping shield boards.

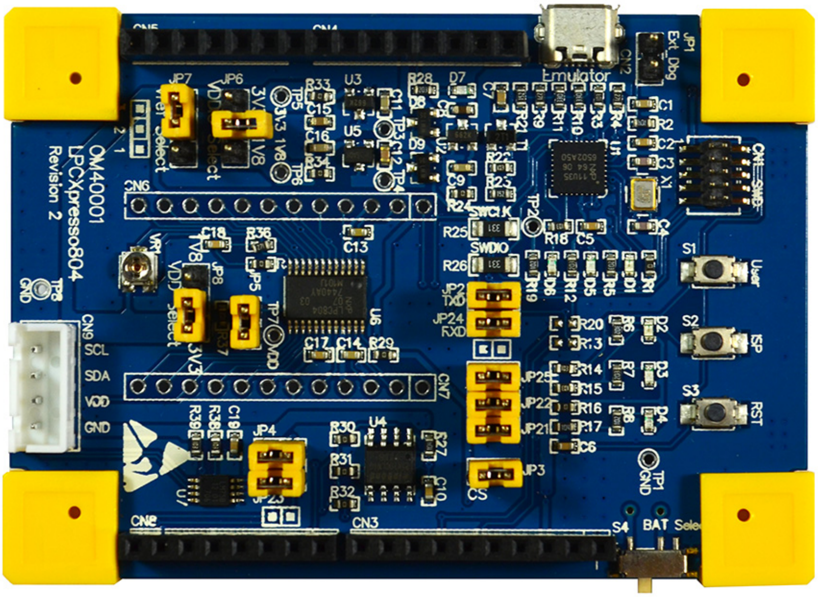

Fig 1. LPCXpresso804 Board

The LPCXpresso804 board includes the following features:

- Compatible with MCUXpresso IDE and other popular toolchains (incl. IAR and Keil)
- LPC804 Arm Cortex-M0+ MCU running at up to 15MHz
- On-board CMSIS-DAP (debug probe) with VCOM port, based on LPC11U35 MCU
- Debug connector to allow debug of target LPC804 MCU using an external probe
- LPC804 ISP and User/Wake buttons
- LPC804 Reset button
- 1Mb Winbond SPI flash
- NXP LM75BDP temperature sensor
- Programmable Logic Unit prototyping shield
- Capacitive Touch evaluation shield
- I^{2}C Grove connector for easy connection of sensors, or to use the LPCXpresso804 as an I/O expander peripheral

2. Board Layout

Figure 2 below shows the layout of the LPCXpresso804 board, indicating location of jumpers, buttons and connectors/expansion options.

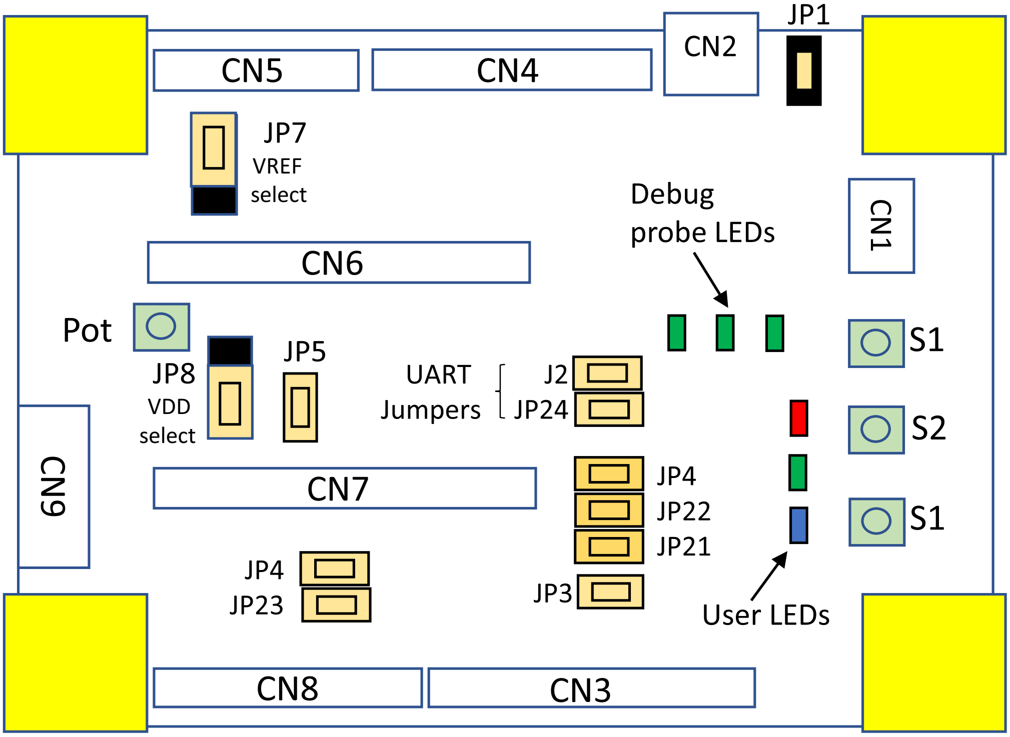

Fig 2. Board layout (top silkscreen)

Table 1 below shows the layout of the LPCXpresso804 board, indicating location of jumpers, buttons, connectors/expansion options and MCU devices.

Table 1. Jumpers and connectors (LPCXpresso804 board)

Circuit reference	Description	Reference section
JP1	On-chip debug probe disable. Insert a jumper on this header to disable the on-board debug probe and use an external probe.	[4]
JP2 and JP24	LPC804 UART connections to debug probe. Remove these jumpers to disconnect the LPC804 UART port default (ISP) pins from the debug probe (JP2 for PIO0_0 and JP24 for PIO0_4).	[4]
JP3	SPI flash select connection. Remove this jumper to disable the SPI flash for power measurement or to use the select signal pin for other purposes.	[7.5]
JP4 and JP23	Connections from SCL (JP4) and SDA (JP23) are routed from the LM75 to the LPC804 PIO0_14 and PIO0_7 via these jumpers. Remove the jumpers during low power measurements or if these LPC804 pins are being used for another function.	[7.4]
JP5	Install an ammeter across JP5 to measure current supplied to the LPC804 device. JP5 should be installed at all other times.	[6]
JP6	This jumper is not installed by default. It is provided for future support of dual rail versions of the LPC804.	See schematic.

Table 1. Jumpers and connectors (LPCXpresso804 board)

Circuit reference	Description	Reference section
JP7	ADC positive voltage reference (VREF). Selects between 3.3V and 1.8V for selection of the ADC voltage reference (default is 3.3V)	See schematic.
JP8	LPC804 VDD selection. Used to select between 3.3V and 1.8V supplies (default 3.3V)	See schematic.
JP21, JP22 and JP5	These jumpers are provided to allow the user LEDs to be disconnected from their respective LPC804 pins, enabling low power measurements and for those signals to be used for other purposes. JP21, JP22 and JP25 enabled/disable PIO11, PIO_12 and PIO0_13 respectively.	See schematic.
CN2	USB connection for power and debug probe connection to host computer.	[3][4]
CN3, CN4, CN5, CN8	Arduino connectors.	[5.1]
CN6, CN7	Expansion / device pin access connectors.	[5]
CN9	Grove I^{2}C connector.	[5.2]
VR1 (Pot)	Potentiometer to provide an analog signal to the LPC804 ADC.	See schematic.

3. Getting Started

This section describes how the operation of the factory programmed demo program, and how to set up your board for code development with MCUXpresso IDE and/or third party tools.

3.1 Initial setup and pre-programmed demo program

The LPCXpresso804 board is pre-programmed with a diagnostic demo program, which tests various features of the board. This program utilizes the UART LPC804 output, which is connected to the debug probe, which acts a serial to USB bridge to a host computer (as well as providing the CMSIS-DAP debug interface.) To ensure a correct operation, a VCOM serial port driver should be installed before powering the board when using Windows 7 or 8 driver. This driver is available from http://nxp.com/demoboard/OM40001 under the Software and Tools tab (look under “Software” download types). After downloading and unzipping the package, run the installer program provided to install the driver (see installation notes included in the package for further information.)

Connect a micro USB cable from connector CN2 to a host computer or power supply to power up the board and run the demo program. Open a terminal emulator program (such as Teraterm or PuTTY), and look for a port with a name of the form “NXP LPC11Uxx VCOM ...”, and connect to it. Set the serial port for 9600 baud, 8 bits, no parity.

- The Blue user LED will flash 3 times, then the green LED will flash 3 times, and the terminal will display “HelloWorld”, followed by “Press key to start LED test ...”
- Press the ISP button (S2). The green and blue user LEDs will flash, then each LED will be lit in turn twice before all three blink 3 times. The terminal will show “DONE”.
- The terminal will show “Press key to start SpiFlash test”. Press the ISP button. The LEDs will blink as the test is run, and the SPI flash device ID and name will be shown on the terminal.
- The terminal will show “Press key to start I2cTemperature test ...”. Press the ISP button to run this test, which checks communication with the LM75 temperature sensor.
- The terminal will show “Press key to start ADC Potentiometer test ...”. Press the ISP button to run this test. The test checks the LPC804 ADC and potentiometer (VR1), looking for the ADC reading to change at least once as it takes 6 samples over several seconds. Use the supplied screwdriver to adjust VR1 so the test passes.

3.2 Using the board with MCUXpresso IDE

Once the device drivers have been installed (as described above), to use the board during a debug session in MCUXpresso IDE, connect to the host computer then follow the steps below.

The earliest version of MCUXpresso IDE that should be used is version 10.1.1. This version does not have built-in knowledge of the LPC804 part family, so a patch needs to be installed before attempting to use this board. The patch is available from the same page as the MCUXpresso IDE download. From version 10.2 onwards (due for release in Q2 2018) LPC804 will be built into the IDE and the patch will not be required.

Follow the steps below to build and run a simple example from the LPC804 Code Bundles provided by NXP.

1. Code Bundles for the LPC8xx family are included in the MCUXpresso IDE installation. These can also be downloaded from nxp.com (in case of any updates between IDE releases): http://www.nxp.com/products/software-and-tools/software-development-tools/software-tools/lpc800-code-bundles:LPC800-Code-Bundles.
2. Open a new workspace in the IDE.
3. In the Quickstart panel of the IDE, click in "Import a new project from the file system"
4. In the "Import project(s) from file system..." dialog box that opens, click "Browse..." in the Project Archive (from zip) section, and select the LPC804 Code Bundle zip file from the Code Bundles directory in the MCUXpresso IDE installation (or select a version downloaded from nxp.com, as described in Step 1 above.) Click "Next >" on the "Import project(s) from file system..." dialog to continue.
5. You will see several projects listed in the Code Bundle; click "Finish" to import them all.
6. The dialog box will close, and you will see the imported projects in the Project tab at the upper left window of the IDE. Click on Example_Multi_Timer_Blinky to select it, then select Build from the Quickstart panel. You will see the build processing in the Console window to the right of the Quickstart panel. The projects are set up to include dependency checking, so the build process will automatically build the utility and peripheral libraries as well as the example program.
7. Ensuring the LPCXpresso804 is connected to the host computer, click Debug in the Quickstart panel. The IDE will search for available debug probes. Select the debug probe that appears for your board, then click OK. Note that the IDE will remember your selection for the next time you debug this project, so will not prompt for this again, unless it cannot find the board.
8. The code will execute to main. Press F8 to resume and run the program. You will now see the User LEDs light, each color in turn.

3.3 Using LPCXpresso804 with 3rd Party IDEs

Once the board device drivers have been installed (as described at the start of this section), the board can be used with 3rd party development tools. Set up will vary between Development Tools, but the board debug probe should supported as a CMSIS-DAP probe in all cases).

Code Bundles, including sample projects for Keil MDK and IAR EWARM, are available from NXP's website at http://www.nxp.com/products/software-and-tools/software-development-tools/software-tools/lpc800-code-bundles:LPC800-Code-Bundles. Refer to the readme files provided with each code bundle in order to build/debug.

When using Keil MDK, install the Device Pack for the LPC804 (available for download from within the Keil IDE) before attempting to use the board.

When using IAR EWARM, ensure that you have version 8.20.3 or later in order to have LPC804 device family support.

3.4 Debugger firmware update (optional)

The MP board comes pre-programmed with a CMSIS-DAP firmware image; it is not normally necessary to update the debugger firmware image, but this can be done by following the steps below.

1. Hold down the reset button and keep it held down while applying power to the board. Release reset. Using File Explorer (or equivalent on Mac/Linux platforms), look at the available drives on your system. A device called CRP_DISABLED will appear.
2. Delete the firmware.bin file on the CRP_DISABLED drive.
3. Drag and drop the firmware.bin file you downloaded from nxp.com on to the CRP_DISABLED drive.
4. Repower the board.
5. The board should now enumerate on your system - allow 20-30 seconds for this to complete.

4. Debug Probe

LPCXpresso804 boards are factory programmed with a CMSIS-DAP compatible firmware image, and a standard UART VCOM port. It should not be required to update the LPC11U35 firmware, but Section 3.4 provides information on how to update the debug probe firmware.

The CMSIS, DISK and COMM LEDs are connected to the LPC11U35 device. The behavior of the LEDs will vary depending on firmware used, typically the CMSIS LED will blink when debug communication is occurring, and the COMM LED will blink when data is being transferred over the VCOMM port.

4.1 Using an external debug probe

An external debug probe that supports ARM’s SWD interface, such as a SEGGER J-Link or PE Micro probe, can be used with the LPCXpresso804 board. The external probe must be connected to header CN1. When an external debug probe is used, the on-board probe must be held in reset by placing a jumper on JP1. It is recommended that JP1 is fitted before powering the board.

5. Expansion connectors/headers

The LPCXpresso804 board provides an Arduino UNO R3 shield site and a Grove I^{2}C connector to add additional peripherals, sensors or other circuitry, including off-the-shelf expansion boards; this section describes these options. All LPC804 signals are also available on breakout headers CN6 and CN7. For further details please refer to the board schematics.

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5.1 Arduino UNO Rev 3 expansion connectors

The Arduino UNO Rev 3 compatible connectors provided on the LPCXpresso804 board provide I^{2}C, SPI, UART, PWM and analog function connections to shield boards that are available from various 3rd part suppliers, or for customer use. The pin mappings are shown in the tables below. Some connections are shared with other board features, as shown (in addition to being available on breakout headers C6 and CN7.)

Table 2. Arduino expansion connector pin mappings (CN4)

Pin	Arduino signal	LPCXpresso804	Shared with
3	Reset (active low)	Reset/PIO0_5	Reset button, SWD reset input
4	3.3V	Regulator (U3) output	-
5	5V	To board regulator inputs (U3 and U5)	-
6	GND	GND	-
7	GND	GND	-

Table 3. Arduino expansion analog connector pin mappings (CN5)

Pin	Arduino signal	LPC804 pin	Shared with
1	A0	PIO0_10	CN6, potentiometer
2	A1	PIO0_16	CN6, SPI flash chip select
3	A2	PIO0_17	CN6
4	A3	PIO0_7	CN7, CN3, Grove connector, LM75
5	A4	PIO0_4	CN6, CN8
6	A5	PIO0_1	CN7, SPI Flash (clk)

Table 4. Arduino expansion connector pin mappings (CN3)

Pin	Arduino signal	LPC804 pin	Shared with
1	SCL	PIO0_14	CN7, Grove connector, LM75
2	SDA	PIO0_7	CN7, CN5, Grove connector, LM75
3	AREF	AREF	
4	GND	GND	
5	SPI SCK	PIO0_1	User button, SPI flash
6	SPI MISO	PIO0_9	CN7, SPI flash
7	SPI MOSI	PIO0_8	CN7, SPI flash
8	SPI SSEL	PIO0_15	CN7
9	PWM/GPIO	PIO0_18	CN6
10	PWM/GPIO	PIO0_20	CN7

Table 5. Arduino expansion connector pin mappings (CN8)

Pin	Arduino signal	LPC804 pin	Shared with
2	PWM/GPIO	PIO0_19	CN7
3	PWM/GPIO	PIO0_11	CN6, blue user LED
4	PWM/GPIO	PIO0_13	CN6, User button, red user LED
5	INT	PIO0_21	CN6

Table 5. Arduino expansion connector pin mappings (CN8)

Pin	Arduino signal	LPC804 pin	Shared with
6	INT	PIO0_12	CN6, green user LED
7	UART TX	PIO0_4	CN5, CN6, debug UART
8	UART RX	PIO0_0	CN7, debug UART

Note that the default ports for ISP UART boot are connected to CN2.

5.2 Grove connector

The LPCXpresso804 board includes a header for connection of Seeed Studio Grove I^{2}C sensors. This header supplies the I^{2}C connections plus 3.3V and ground.

6. Power supplies and supply current measurement

This section describes available power options for the board, and how current consumption of the LPC804 can be measured.

6.1 Board powering options

The Board may be powered by the USB connector (CN2), via the Arduino connector (5V input pin) or by a coin cell battery inserted into the holder on the underside of the board. When using the coin cell battery switch S4 must be closed to connect the battery. Protection diodes are provided to prevent any of the possible power sources from back powering another. Note that the LPC11U3x debug probe can only be powered by USB.

The LPC804 is powered from either a 1.8V or 3.3V (default) regulator, the selection of the voltage used is made using JP8. The remaining circuitry on the board is always powered by the 3.3V regulator, with the LPC11U3x debug probe having its own 3.3V regulator.

6.2 LPC804 supply current measurement

JP5 is provided as an insertion point for an ammeter to measure current flow to that MCU. This jumper is inserted in line between the center pin of JP8 and the VDD supply of the LPC804. When an ammeter is not being used, a jumper should be installed on JP5.

7. Other board features

This section describes other board features not detailed elsewhere in this document.

7.1 ISP booting and the ISP button

The LPC804 can be forced into ISP boot mode by holding down the ISP button (S2) and then holding and releasing the Reset button (S3). The ISP button is connected to LPC804 pin PIO0_12, which is also routed to the Arduino expansion connector and to the cathode of the green user LED3. LPC804 pin PIO0_12 can be reconfigured by software so that the button can be used by an application as a general purpose button (refer to the LPC804 User Manual).

7.2 User button

The User button (S1) is for general purpose use by LPC804 applications. It is connected to a 10K ohm pullup to 3.3V, and to the LPC804 PIO0_13 pin. It is also shared with the red User LED1.

7.3 User LEDs

Three users LEDs are provided on the board, one blue, one green and one red. The anodes of the LEDs are connected together, then through a zero ohm resistor to the 3.3V regulator output (each has its own current limit resistor in-line). Each LED has a jumper in series with it (JP21, JP22 and JP25) to prevent leakage from the LPC804 pins through the diodes if accurate power measurement measurements are being performed. All the PIOs used for these LEDs are also shared with the Arduino expansion connector, but those connections to the expansion connectors are not routed via the jumpers. The LEDs are connected to the LPC804 as shown in the table below.

Table 6. User LED connections

LED	LPC804 pin
Blue (D4)	PIO0_11
Red (D3)	PIO0_13
Green (D2)	PIO0_12

7.4 Temperature sensor (LM75, circuit ref U7)

An NXP temperature sensor is included on the LPCXpresso804. This device interfaces to the I^{2}C peripheral of the LPC804, with an address of 0x1001100. Jumpers (JP4 and JP23) are provided in-line with the SCL (PIO0_14) and SDA (PIO0_7) respectively so that this device may be disconnected if not required.

7.5 SPI flash (Winbond W25X10CLSNIG, circuit ref U4)

A 1Mb SPI flash from Winbond is included on the LPCXpresso804. This device interfaces to the SPI peripheral of the LPC804. A jumper (JP3) is provided to this device can be disconnected (by disabling the SPI chip select PIO_16).

8. PLU Shield

The OM40001 package includes a shield board for use with the LPCXpresso804 board when prototyping programmable logic unit (PLU) designs. The PLU shield provides the following features to assist with this type of development:

- 5 slide switches to enable 5 possible PLU inputs to be connected to VDD (marked as VCC on the Shield) or GND through a resistor (to set those inputs to a logic 1 or zero)
- 8 LEDs with jumpers to connect/disconnect possible PLU outputs for visual status indication
- Push button option for momentary / edge signal inputs
- Low frequency oscillator with 1024Hz and 8Hz outputs

The PLU shield also includes a test circuit that can be used to implement a simple continuity tester, for experimentation with the LPC804 ADC and DAC (requires some shield board modification.)

Several signals from the LPC804 used on the PLU Shield are shared with other functions on the main LPCXpresso804 board. Please review jumper settings on the LPCXpresso804 board carefully before installing the PLU Shield.

The PLU can be programmed using a PLU Configuration tool, available to download for free at https://www.nxp.com/demoboard/OM40001 under the Software and Tools tab.

8.1 PLU input options

On/off switches S1 through S5 connect possible PLU inputs to VDD or GND via a resistor, enabling those inputs to be driven to a known, fixed state. PIO0_8 is connected to a push button (S6) and a 100kohm pull up to VDD; PIO0_8 will be grounded when the button is pressed. Table 7 below shows these connections.

Table 7. PLU input on/off switches

Switch	LPC804 signal	Notes
S1	PIO0_0	Also connected to debug UART. Remove JP2 to avoid conflicts
S2	PIO0_10	Shared with potentiometer. Move potentiometer to center position to avoid conflicts.
S3	PIO0_11	Also connected to user LED; remove JP21 to disconnect LED
S4	PIO0_4	Also connected to debug UART. Remove JP24 to avoid conflicts
S5	PIO0_13	Also connected to user LED; remove JP25 to disconnect LED.
S6	PIO0_8	Also connected to SPI flash data input.

A digital oscillator circuit is also included on the Shield, with 1.024kHz and 8Hz outputs available. LPC804 signal PIO0_1 can be connected to these oscillator signals in order to provide a low speed clock to the flip-flops in the PLU block. The center pin (2) of JP12 connects to PIO0_1, so a jumper can be placed onto JP12 to connect this signal to the required clock (see markings on the Shield silk screen.) An external clock can be provided to the PLU by connecting it to the center pin of JP12.

8.2 PLU output options

On/off switches S1 through S5 connect possible PLU inputs to VDD or GND via a resistor, enabling those inputs to be driven to a known, fixed state. PIO0_8 is connected to a push button (S6) and a 100kohm pull up to VDD; PIO0_8 will be grounded when the button is pressed. Table 7 below shows these connections.

Table 8. PLU shield LEDs

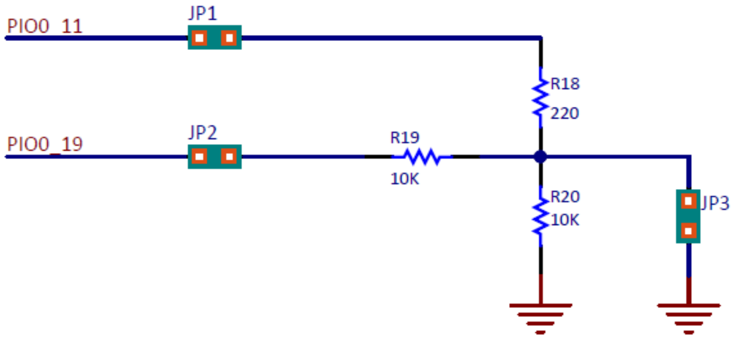
LED	LPC804 signal	Jumper installed to enable	Notes
D1	PIO0_15	JP6	
D2	PIO0_16	JP7	
D3	PIO0_10	JP8	Ensure S2 is in VCC position to use.
D4	PIO0_18	JP9	
D5	PIO0_12	JP10	Also used for green User LED. Remove JP22 to isolate.

Table 8. PLU shield LEDs

LED	LPC804 signal	Jumper installed to enable	Notes
D6	PIO0_20	JP11	
D7	PIO0_7	JP4	I^{2}C connections also used for LM75. Remove JP23 to isolate.
D8	PIO0_14	JP5	I^{2}C connections also used for LM75. Remove JP23 to isolate.

8.3 DAC/ADC continuity tester circuit

The PLU shield includes a simple circuit to implement a continuity tester, as shown below.



By enabling PIO0_11 as a DAC output, a test signal can be driven to a circuit probe connected to JP3, then the voltage at the voltage divider formed by R18 and R20 can be measured using an LPC804 ADC input (PIO0_19). In order to use this circuit it is recommended that R15 is removed and S3 set to the VCC position.

9. Capacitive Touch Shield

The OM40001 package includes a shield board for evaluation of the LPC804 capacitive touch feature. The Capacitive Touch Shield provides the following features:

- 5 capacitive touch buttons
- 5 LEDs, available for user applications (typically to indicate a button press)

The connections for the capacitive touch buttons are shown in Table 9. As some signals are shared with other functions, the jumpers shown in the table should be removed from the LPCXpresso804 board when using the capacitive touch shield.

Table 9. Capacitive touch button signals

Button	LPC804 I/O	Capacitive touch signal	Shared with / remove jumper
S1	PIO0_12	CAPT_X0	User LED / JP22
S2	PIO0_21	CAPT_X1	
S3	PIO0_13	CAPT_X2	User LED / JP25
S4	PIO0_11	CAPT_X3	User LED / JP21
S5	PIO0_19	CAPT_X4	

Table 9. Capacitive touch button signals

Button	LPC804 I/O	Capacitive touch signal	Shared with / remove jumper
Common	PIO0_7	CAPT_YL	LM75 / JP23
Common	PIO0_16	ACMP_I4 (not used by default)	(not used)
Common	PIO0_17	CAPT_YH	

The five user LEDs are active low (on when control signal is at logic 0). The signal assignments are shown in Table 10. Note that PI00_8 and PIO0_9 are also connected to the SPI flash data inputs/outputs, so it is advisable to remove JP3 on the LPCXpresso804 board (to disable the SPI flash memory) before installing this shield board.

Table 10. Capacitive touch LED signals

LED	LPC804 I/O
D1	PIO0_20
D2	PIO0_18
D3	PIO0_15
D4	PIO0_8
D5	PIO0_9

The LPC804 Code Bundle, available under the Software and Tools tab of the OM40001 board web page (http://www.nxp.com/demoboard/OM40001), includes driver and example code to show how to use the capacitive touch feature of the board.

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