

# UM10855

LPCXpresso54102

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User manual

## Document information

| Info     | Content                     |
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**Revision history**

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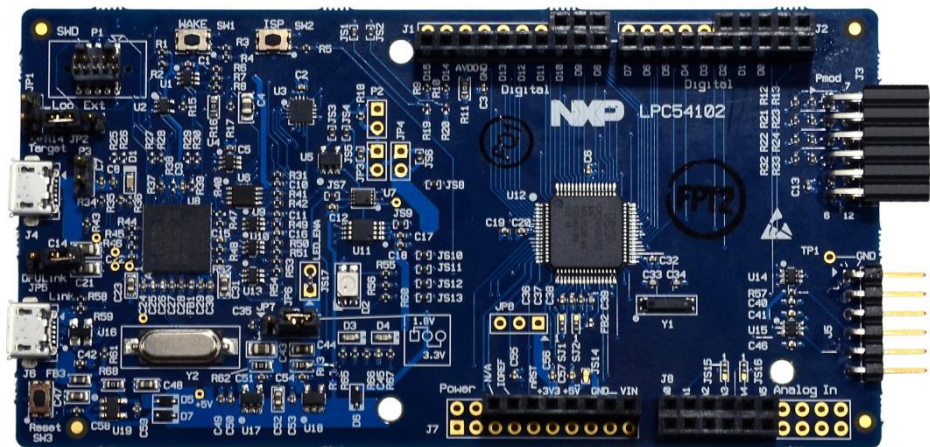
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## 1. Introduction

The LPCXpresso™ family of boards provides a powerful and flexible development system for NXP's Cortex®-M family of MCUs. They can be used with a wide range of development tools, including the NXP's LPCXpresso IDE. The LPCXpresso54102 board has been developed by NXP to enable evaluation of and prototyping with the LPC54100 family of MCUs, and is based on the LPC54102J512BD64 version of the MCU.



This document describes the LPC54102 LPCXpresso LQFP board hardware. The following aspects of interfacing to the board are covered by this guide:

- Main board features
- Setup for use with development tools
- Supporting software drivers
- Board interface connector pin out
- Jumper settings
- Powering the board
- Mechanical drawing

## 2. Feature summary

The LPCXpresso54102 board includes the following features:

- On-board, high-speed USB based, Link2 debug probe with ARM's CMSIS-DAP and LPCXpresso IDE Redlink protocol options
- Link2 probe can be used with on-board LPC54102 or external target
- Support for external debug probes
- Tri-color LED
- Target Reset, ISP and WAKE buttons
- Expansion options based on Arduino UNO and PMod™, plus additional expansion port pins

- On-board 1.8/3.3V or external power supply options
- Built-in power consumption and supply voltage measurement
- UART, I<sup>2</sup>C and SPI port bridging from LPC54102 target to USB via the on-board debug probe
- FTDI UART connector

2.1 Board layout and settings

This section provides a quick reference guide to the main board components, configurable items, visual indicators and expansion connectors. The layout of the components on the LPCXpresso54102 board is shown in Figure 1 below:

Figure 1 below:

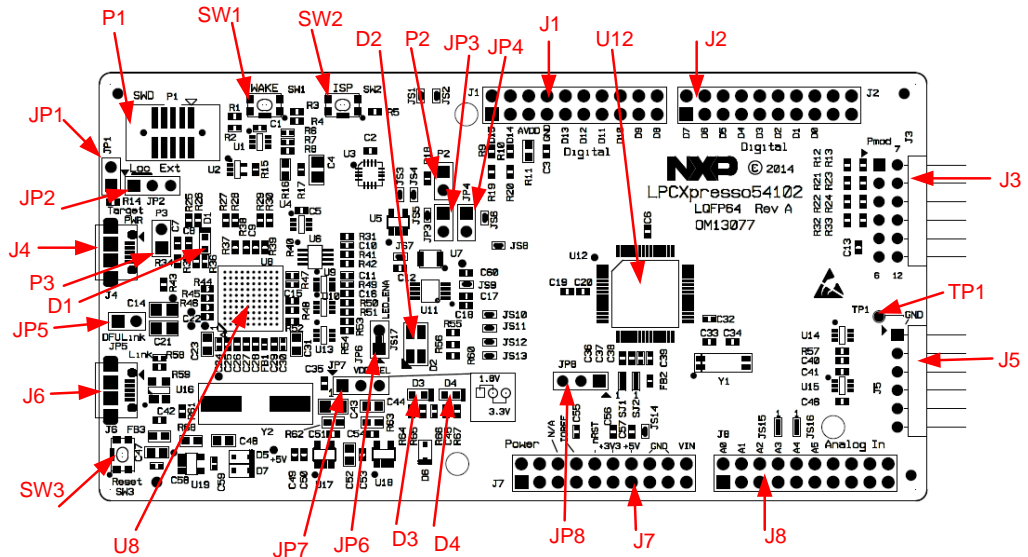


Figure 1 Board Layout

The function of each identified component is listed in Table 1.

Table 1 - Board interface components

| Designator     | Description   | Reference section |
|----------------|---|-------------------|
| D1             | Link2 LPC43xx BOOT0_LED indicator. Reflects the state of LPC43xx Link2 MCU P1_1. When the boot process fails, D1 will toggle at a 1 Hz rate for 60 seconds. After 60 seconds, the LPC43xx is reset. | 7                 |
| D2             | Tri-color LED – Driven by Target LPC54102 MCU. JP6 must be shunted for +3.3V to be applied to D2 anode. The default shunt for JP6 is a 0Ω resistor installed at JS17.                               | 7                 |
| D3             | Target LPC54102 Power LED.  | 7                 |
| D4             | Target LPC54102 Reset LED – LED is on anytime the Target RESETn is pulled low.  | 7                 |
| J1, J2, J7, J8 | Expansion connectors, including Arduino Uno rev3 compatible connectivity.   | 8                 |

| Designator | Description  | Reference section |
|------------|--|-------------------|
| J4         | LPC54102 Target Power input. Connect this micro USB B-type connector to a +5V power source when it is desired to power only the LPC54102 Target, and leave the on-board Link2 debug probe unpowered. This is useful when an external debug probe is used to debug the LPC54102 Target.   | 5                 |
| J3         | PMod™ (SPI / I <sup>2</sup> C) Bridge connector. An external Application Processor (AP) or PMod™ peripheral may be connected to the LPC54102 Target MCU SPI0 and I2C2 via this connector.  | 8                 |
| J5         | FTDI serial header. In addition to provide a serial output from LPC54102, the Target side of the board can be powered from the FTDI header. The LPC54102 supports serial ISP boot from the FTDI header.  | 4.1               |
| J6         | Link2 micro USB B-type connector. Powers both the Link2 side of the board and LPC54102 Target side of the board. Power the board from this connector when using the on-board debug probe to debug the LPC54102 Target MCU.   | 5                 |
| JP1        | LPC54102 Target SWD disable – 2-position jumper pins. <ul style="list-style-type: none"> <li>1) Jumper open (<b>default</b>) the LPC54102 Target SWD interface enabled. Normal operating mode where the Target SWD is connected to either the on-board Link2 debug probe or an external debug probe.</li> <li>2) Jumper shunted, the LPC54102 Target SWD interface is disabled. Use this setting only when the on-board Link2 debug probe is used to debug an off-board Target MCU.</li> </ul>   | 6                 |
| JP2        | SWD VREF power selection – 3 position jumper pins. <ul style="list-style-type: none"> <li>1) Jumper 1 – 2 (<b>default</b>) when on-board LPC54102 Target is connected to either the on-board Link2 debug probe or an external debug probe.</li> <li>2) Jumper 2 – 3 when on-board Link2 debug probe is used to debug an off-board Target MCU.</li> </ul>   | 5                 |
| JP3        | An alternate value voltage sense resistor may be installed across JP3 terminals. By default JP3 is shunted by a 0Ω resistor installed at JS5. Remove the shunt at JS5 to use an alternate voltage sense resistor.  | 5.1.2             |
| JP4        | A current meter may be installed across JP4 terminals to measure the LPC54102 current consumption. By default JP4 is shunted by a 0Ω resistor installed at JS6. Remove the shunt at JS6 to measure current at JP4.   | 5.1.3             |
| JP5        | Link2 (LPC43xx) force DFU boot – 2 position jumper pins. <ul style="list-style-type: none"> <li>1) Jumper open (<b>default</b>) for Link2 to follow the normal boot sequence. The Link2 will boot from internal flash if image is found there. With the internal flash erased the Link2 normal boot sequence will fall through to DFU boot.</li> <li>2) Jumper shunted to force the Link2 to DFU boot mode. Use this setting to reprogram the Link2 internal flash with a new image or to use the LPCXpresso IDE with Redlink protocol.</li> </ul> | 6.1.3             |

| Designator | Description  | Reference section    |
|------------|--|----------------------|
| JP6        | Tri-color LED anode voltage enable – 2-position jumper pins.<br>1) By default JP6 is shunted by a 0Ω resistor installed at JS17.<br>2) To disable +3.3V to the tri-color led common anode, remove the 0Ω resistor installed at JS17.                               | 5.1 and 7            |
| JP7        | LPC54102 VDD voltage select – 3-position jumper<br>1) Jumper 1 – 2 to select +1.8V LPC54102 VDD.<br>2) Jumper 2 – 3 ( <b>default</b> ) to select +3.3V LPC54102 VDD.   | 5                    |
| JP8        | LPC54102 ADC VREFP, VREFN off-board access – 3 position header. Can be used to apply different reference voltages for the LPC54102 ADC.  | LPC54100 User Manual |
| P1         | 10-pin SWD connector – The SWD connector is used to debug the LPC54102 Target from an external debug probe. The same SWD connector can also be used to connect the on-board Link2 debug probe to an off-board Target MCU (for this JP1 must be shunted).           | 6                    |
| P2         | LPC54102 VDD current monitor Vsense measurement. The Vsense can be measured with a volt meter. Pin 1 (square pad) is positive and pin 2 is negative. LPC54102 current is calculated by dividing the measured voltage at P2 by the Vsense resistance value of 8.2Ω. | 5.1.1                |
| P3         | +5V External Voltage Input allows for powering the LPC54102 Target side of the board from a bench-top power supply. Pin 1 (square pad) is +5V and pin 2 is gnd.  | 5                    |
| SW1        | LPC54102 Target WAKEUP pushbutton. When pressed the WAKEUP switch will drive LPC54102 P0_24 to a low level.  | 9.3                  |
| SW2        | LPC54102 ISP Bootload enable pushbutton. This switch drives LPC54102 P0_31 low. Holding SW2 pressed while powering up or resetting and the LPC54102 Target will enter ISP mode.  | 9.2                  |
| SW3        | LPC54102 Target Reset pushbutton.  | 9.1                  |
| TP1        | Ground terminal test point.  | n/a                  |
| U8         | Link2 MCU  | n/a                  |
| U12        | LPC54102 Target LQFP64 MCU   | n/a                  |

### 3. Getting Started

By default, the LPCXpresso54102 is configured to use the on-board debug probe (Link2) to debug the on-board target (LPC54102), using the CMSIS-DAP debug protocol pre-programmed into the Link2 Flash memory. The LPCXpresso IDE (available for free download at <http://www.lpcware.com/lpcxpresso/home>) or development tools that support the CMSIS-DAP protocol can be used in the default configuration. Check with your toolchain vendor for availability of specific device support packs for the LPC54100 family of devices. (Note that the LPCXpresso IDE can also be used with redlink protocol by booting the Link2 in DFU mode, by installing a jumper on JP5.)

Installation steps for use with LPCXpresso IDE (steps 1 and 2 apply to all use tool chains):

- 1) Download and install the LPCXpresso Link2 USB driver package installer from <http://www.lpcware.com/content/nxpfile/lpcxpresso-link2-usb-driver-package> (only required if using Windows).
- 2) When the installer has completed, connect the LPCXpresso54102 board to the USB port of your host computer, connecting a micro USB cable to connector J6 (“Link”).
- 3) Allow about 30 seconds for the LPCXpresso54102 devices to enumerate. There will be four devices: CMSIS-DAP, LPC-LinkII, LPC-SIO Port, and VCOM.
- 4) Download the LPCOpen examples & drivers from <http://www.lpcware.com/content/nxpfile/lpcopen-software-development-platform-lpc5410x-packages>, selecting the version for the toolchain you are using; project files for LPCXpresso IDE, Keil and IAR tools are available.
- 5) Start the LPCXpresso IDE and import the LPCOpen zip file by clicking Import project(s) in the “Start here panel.”
- 6) The simplest example is periph\_blinky, which will blink the tricolor LED on the LPCXpresso54102. Click on the periph\_blinky in the “Project Explorer” panel, then click Debug ‘periph\_blinky’ in the “Start here” panel. This will build the project and then launch the debug session.

The LPCXpresso IDE can also be used with the Link2 configured for DFU boot (JP5 fitted); in this configuration the LPCXpresso IDE will load the Redlink protocol driver into the Link2. Note that if the jumper setting of JP5 is changed with the board powered then the USB connection must be removed and reconnected to J6 in order to force the Link2 to reset and enter DFU boot mode. Redlink protocol is required for multicore debug using the LPCXpresso IDE.

## 4. LPC54102 Serial ports

By default the LPC54102 UART0 is connected to the FTDI header at J5. This can be used for ISP booting or sending debug messages out to a host computer via a suitable cable. The LPC54102 UART0 can also be connected through a virtual communication port (VCOM) UART bridge Link2 function to a host computer connected to the J6 USB Link2.

The factory default CMSIS-DAP Link2 image includes UART bridge functionality (VCOM support), and this firmware is also available with the Link Configuration Tool (LCT), available at <http://www.lpcware.com/>. When running this firmware the default source of data to the LPC54102 RXD is the FTDI header. Once the Link2 receives any data via the VCOM port of a host computer it will set P2\_2 low to select the Link2 UART0 data to the LPC54102. In order to reset this so the FTDI connection can be used it is necessary to power cycle the board.

### 4.1 J5 FTDI header

The FTDI header J5 mates with FTDI cable TTL-232R-3V3. J5 interfaces the LPC54102 UART0 to a Host PC virtual serial port. The J5 location is shown in Figure 2. The pin out and a description of the signals at J5 are listed in

Table 2. By default there may be no header installed at J5.

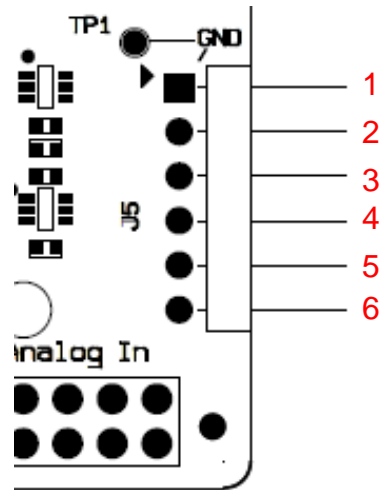


Figure 2 – FTDI (J5) LPC54102 serial port

Table 2 – J5 FTDI interface

| LPC54102 Signal | FTDI Signal | Pin # | Direction |
|-----------------|-------------|-------|-----------|
| GND             | GND         | 1     |           |
| No connect      | CTS         | 2     |           |
| Board +5V       | 5V          | 3     |           |
| UART0_RXD       | TXD         | 4     | From host |
| UART0_TXD       | RXD         | 5     | To host   |
| No connect      | RTS         | 6     |           |



## 5. Board power connections & measurement

The LPCXpresso54102 board requires +5V input to power the on-board voltage regulators which in turn power the Link2 debug probe and other +3.3V circuits, the LPC54102 target and other +1.8V circuits, and the Arduino +5V and +3.3V power rails. When the main external power source is from the Link2 side USB micro B-type connector (J6), both the Link side and LPC54102 Target sections of the board are powered. When the main external power is from the Target side USB micro B-type connector (J4), header P3, or FTDI header (J5) only the LPC54102 Target section of the board is powered.

A block diagram of the board power tree is shown in Figure 3. When the LPC54102 Target is to be debugged from an external debug probe, instead of the on-board Link2 debug probe, the Link USB connector (J6) must be disconnected. The circle with I indicates a current monitor chip. Note that the LPC54102 does not provide a USB interface, the Target USB connector J4 is for power only. The LPC54102 Target VDD selection of 1.8V or 3.3V is made at JP7, with 3.3V set as the default.

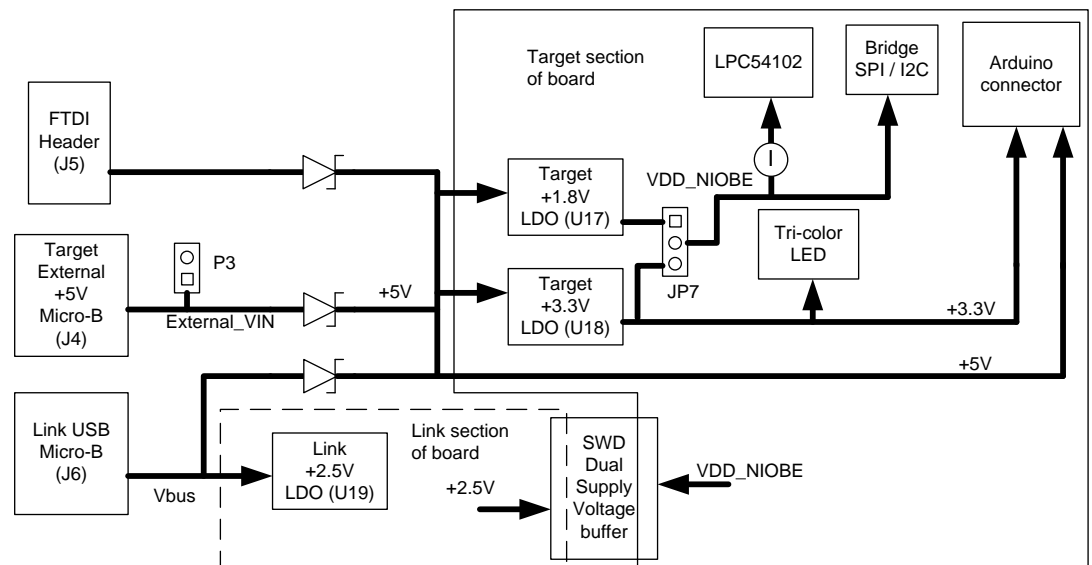


Figure 3 - Board Power block diagram

### 5.1 LPCXpresso54102 current measurement

The LPC54102 current can be measured by measuring the voltage across a sense resistor in series with the supply, a current meter or using the on board current measurement circuit. Each of these methods will be described in subsections below. There is no current monitoring of the Link section circuits on the board. The Target side power going to LEDs and support ICs is not monitored by the current measurement circuit. The LPC54102 LQFP package has the core and IO power both sourced from the same VDD pins.

When a shield board, such as the Sensor Shield Board in the Sensor Processing/Motion Solution (OM13078) is attached, attempting to measure the lowest possible power the LPC54102 IO pins must be configured according to how the software has configured the sensors on the Sensor shield board to ensure there is no extra current from the LPC54102 IO ports that have external pull-up or pull-down resistors enabled. JS17 should be opened to ensure no leakage through the tri-color LED and +3.3V supply.

**5.1.1 LPC54102 Vsense resistor current measurement**

The voltage across a series 8.2Ω resistor with the target LPC54102 VDD can be manually measured at P2 on the PCB. The voltmeter positive probe is applied to P2 pin 1 (square pad) and negative probe to P2 pin 2, see Figure 4. Use Ohm’s law to calculate the current (LPC54102 current = measured voltage / 8.2Ω). As an example if the measured voltage is 20mV, then  $20e-3 / 8.2\Omega = 2.44\text{mA}$ . Note that the input current to the MAX9634 used in the on-board current measurement will be included in the voltage measured across this resistor.

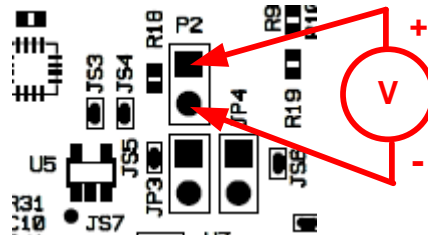


Figure 4 - Vsense measurement

**5.1.2 LPC54102 external sense resistor for VDD current measurement**

It is not required to use an external sense resistor for LPC54102 current measurement. To measure LPC54102 VDD current of less than 4 uA an external resistor is required. The external resistor should be installed between the JP3 terminals, and the 0Ω resistor at JS5 must be removed. The external resistor will be in series with the on-board 8.2Ω (R18), so the external resistor value is added to 8.2Ω to get the combined Vsense resistance. The voltage measurement is made across the total series resistance from P2-1 to JP3-2, as shown in Figure 5. To calculate the LPC54102 current divide the voltage read by the combined sense resistance. To restore the JS5 short around JP3, use a solder bridge across JS5.

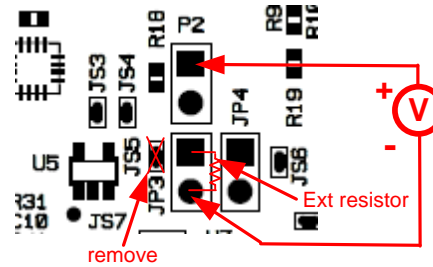


Figure 5 - External vSense resistor

**5.1.3 LPC54102 VDD current measurement using a current meter**

A current meter may be inserted at JP4 to measure the LPC54102 VDD input current. The 0Ω resistor at JS6 must be removed and the current meter connected at the positive input at JP4 pin 1 (square pad) and negative input at JP2 pin 2, as shown in Figure 6.

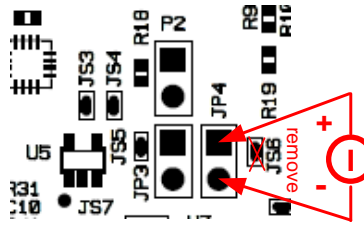


Figure 6 - Measuring LPC54102 VDD current with current meter

#### 5.1.4 LPC54102 VDD current measurement

The LPCXpresso54102 board has an on-board current measurement circuit consisting of a MAX9634T (U5) current monitor chip and a 12-bit ADC (ADC122S021, U11) with a 12-bit sample at 50k to 200ksps. The on-board MAX9634T current monitor measures the voltage across the LPC54102 VDD 8.2Ω vsense resistor. The MAX9634 multiplies the sense voltage by 25 to provide a voltage range suitable for the ADC to measure. A 2-input analog mux selects between the LPC54102 current monitor and the output on a MAX9634T current monitor chip on an expansion board (with compatible current measurement circuit on-board). The current measurement circuit is controlled by the Link2 processor and is not user programmable. For available power measurement utilities please visit <http://www.lpcware.com>.

#### 5.1.5 Shield board current measurement

To use the on-board current measurement circuitry, any expansion board must match the functionality of the LPCXpresso54102. Refer to the board schematics for more information.

## 6. Debug Configurations

The LPCXpresso54102 LQFP board has a built-in debug probe using the Link LPC43xx MCU. The LPC54102 target MCU can be debugged by the on-board Link debugging probe, or from an external debug probe installed at P1. On-board jumpers JP1 and JP2 must be correctly positioned for each mode. The on-board Link debug probe is capable of debugging target MCU's with a VDDIO range of 1.6V to 3.6V. Use JP7 to set the LPC54102 chip VDD to the desired voltage level (+1.8V or +3.3V). Check the sections below for the appropriate jumper settings and how to properly power the board.

#### 6.1.1 Debugging on-board LPC54102 target using on-board debug probe

To use the on-board Link debug probe, the LPCXpresso54102 board must be powered from the Link2 USB connector J6, and jumper JP2 must be fitted in position pin 1 - 2 (Local Target), as shown in Figure 7. Jumper JP1 must be open to enable the target LPC54102. Connecting the micro USB J6 to a host computer will power the Link and Target sections of the board and provide the USB link to the debug tool software.

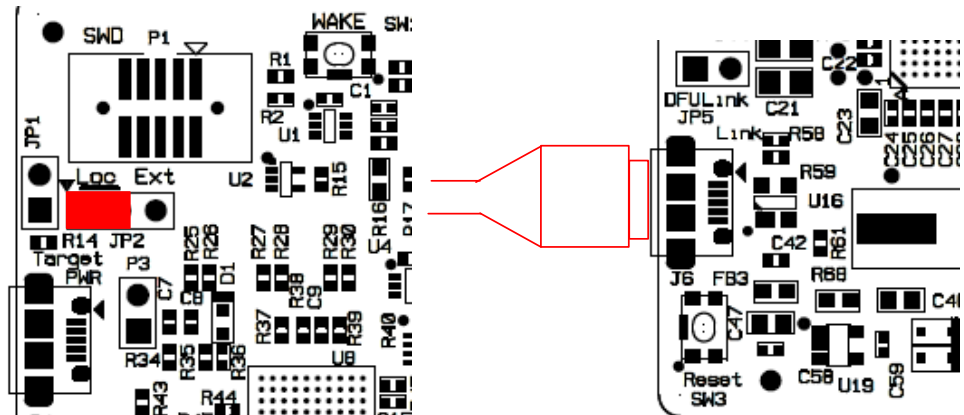


Figure 7 – Debug local LPC54102 target from on-board debug probe

### 6.1.2 Debug on-board LPC54102 target using external debug probe

To use an external debug probe, connect the probe to the SWD (P1) connector, power the LPC54102 Target section of the board from the Target power only micro USB connector J4, and fit a jumper to JP2 across pin 1 - 2 (Local Target), as shown in Figure 8. Jumper JP1 must be open to enable the target LPC54102. The on-board Link debug probe must be unpowered, by leaving J6 unconnected.

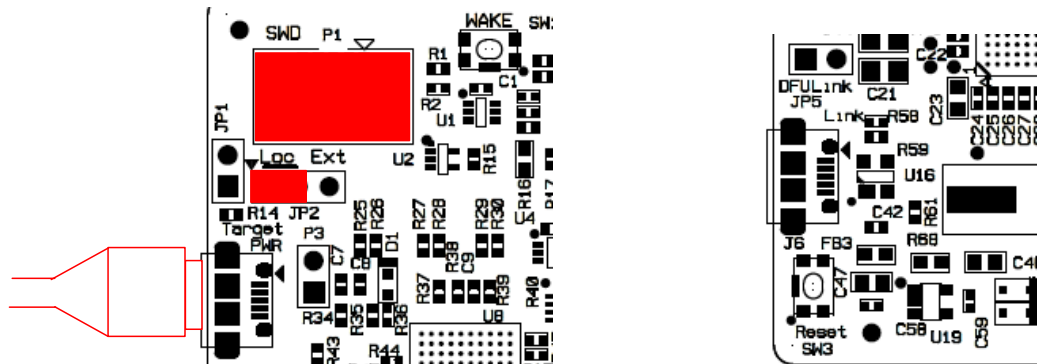


Figure 8 - Debug local LPC54102 target using external probe

### 6.1.3 On-board Link2 flash programming

To program the Link2 Flash the Link2 MCU must be in DFU mode. If the Link2 already has a valid image in the flash, you will need to force it into DFU mode by placing a jumper shunt on JP5, then power the board by connecting the micro USB J6 to a host computer, as shown in Figure 9. Link2 MCU programming is performed using DFUsec tool found on <http://www.lpcware.com/content/project/dfu-download-programming-utility-and-security-lpcdfusec-tool>. Instructions for using the tool are located at the same web page.

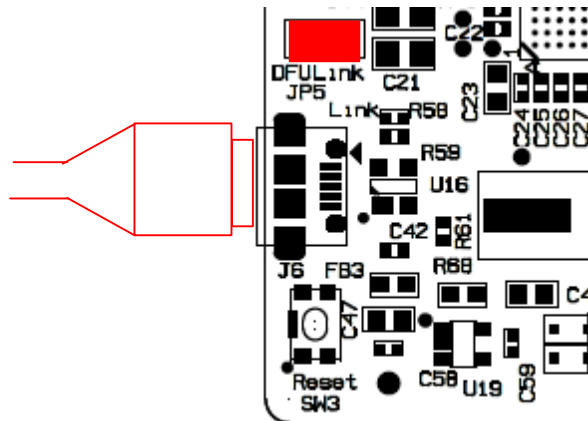


Figure 9 - Link LPC43xx MCU DFU mode

### 6.2 Using on-board Link2 to debug an off-board target LPC MCU

The LPCXpresso54102 board's Link2 debug probe may be used to debug an off-board target MCU. The on-board Link debug probe is capable of debugging target MCU's with a VDDIO range of 1.6V to 3.6V. To keep the on-board target LPC54102 MCU from interfering with the SWD interface, JP1 must be fitted. The Link2 debug probe SWD is connected by a ribbon cable between the P1 connector to the off-board target MCU SWD interface. Power the LPCXpresso54102 board from the Link USB connector J6, and jumper JP2 must be fitted across pins 2 - 3 (**External Target**), as shown in, as shown in Figure 10.

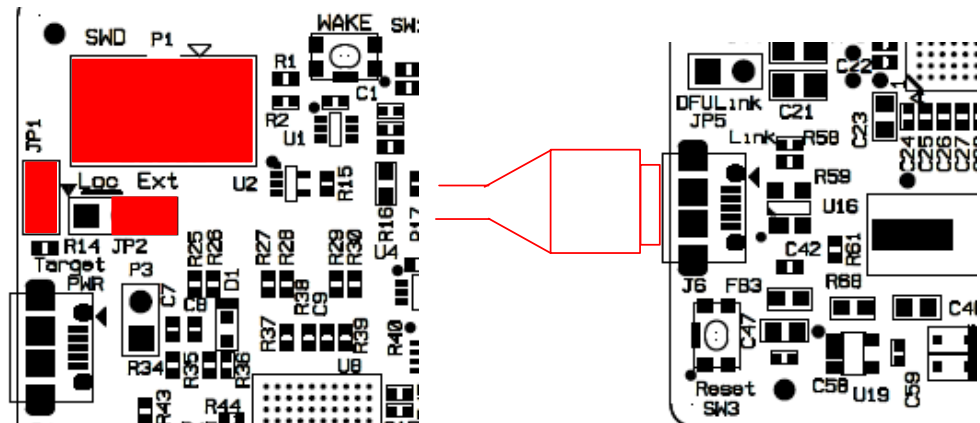


Figure 10 - Link debug probe debugging off-board target

## 7. LED indicators

The LPCXpresso54102 board LED locations are shown in Figure 11. A description of each on-board LED indicator is shown in Table 3. The current through the LEDs does not contribute to current monitored by the current monitor methods shown in this manual.

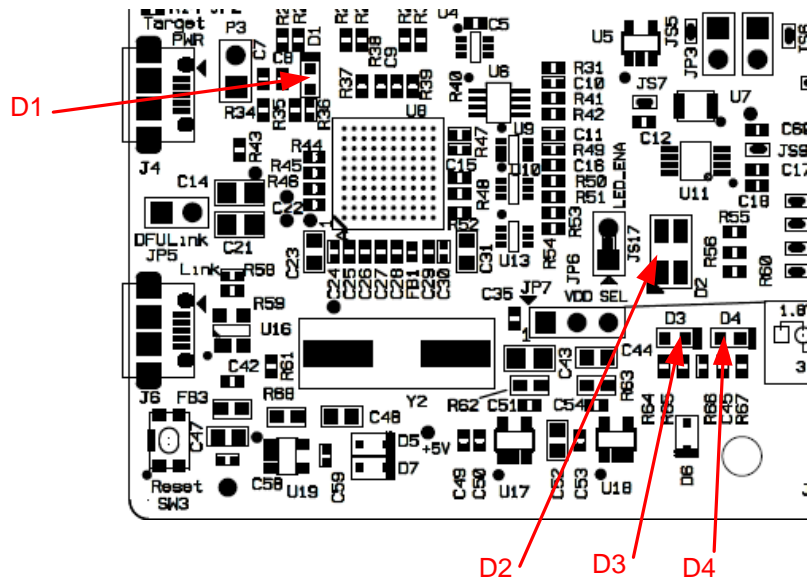


Figure 11 – LPCXpresso54102 LQFP board LED Indicators

Table 3 - Board LED indicators

| LED reference | Description  |
|---------------|--|
| D1            | Link2 Debug Probe BOOT0_LED indicator. Driven by P1_1 of the LPC43xx. This LED will remain unlit when using the CMSIS-DAP firmware image (normal boot). When using LPCXpresso with the board configured for DFU boot, this LED will flash during debug operations.   |
| D2            | Tri-color LED – Driven by Target LPC54102 MCU. The red led is driven by P0_29. The green led is driven by P0_30. The blue led is driven by P0_31. LEDs are on when the LPC54102 port is output low. To light any of the tri-color leds, JP6 must have a shunt between pins 1 – 2. By default the 0Ω resistor at JS17 provides the shunt for JP6. To measure the lowest possible current from LPC54102 remove the 0Ω resistor at JS17 (remove +3.3V from led common anode). |
| D3            | Target LPC54102 power LED. This LED is on any time power is applied to the Target LPC54102 MCU. LED will have a brighter intensity when the LPC54102 is powered from +3.3V than when powered by +1.8V.   |
| D4            | Target Reset LED. This LED is on anytime the Target RESETn is pulled low.  |

## 8. Expansion connectors

The LPCXpresso54102 board includes four expansion connectors plus a PMod™ compatible connector (J3). The expansion connectors (J1, J2, J7 and J8) incorporate an Arduino Uno revision 3 footprint in their inner rows. Not all connector locations are populated on the expansion connectors since the LPC54102 does not have enough I/O

to utilize all of the available connections (additional pin locations are provided for compatibility with future LPCXpresso boards.)

**Table 4 Expansion Connectors**

| Reference |   |
|-----------|---|
| J1        | The odd number pins are compatible with Arduino Uno rev3 Digital 15:8, AREF, SDA & SCL connector. The even numbered pins are used for external access and expansion of LPC54102 signals not used by the Arduino Uno rev3 compatible interface.                          |
| J2        | The odd numbered pins 1 – 13 are compatible with Arduino Uno rev3 Digital 7:0 connector. The even numbered pins, and odd numbered pins 17 and 19, are used for external access and expansion of LPC54102 signals not used by the Arduino Uno rev3 compatible interface. |
| J3        | PMod™ connector. Connected to the LPC54102 Target MCU SPI0 and I2C2.  |
| J7        | The even numbered pins 6 – 20 are compatible with Arduino Uno rev3 Power connector. The odd numbered pins, and even numbered pins 2 and 4 are used.   |
| J8        | The even numbered pins 2 – 12 are compatible with Arduino Uno rev3 Analog connector. The odd numbered pins are used for external access and expansion of LPC54102 signals not used by the Arduino Uno rev3 compatible interface.  |

## 9. Buttons

The LPCXpresso54102 board has 3 push buttons available to control the operation of the LPC54102 (target) MCU. Their functions are as described below.

### 9.1 Reset

This button is used to reset the LPC54102.

### 9.2 ISP

This button connects to the LPC54102 P0\_31 pin and may be used to force the LPC54102 into ISP boot mode. This can be useful when the LPC54102 flash has been programmed with code that disables the SWD debug pins or changes timing settings such that the debug probe has problems communicating with it. To force ISP boot, hold the ISP button down while pressing and releasing the reset button.

The ISP button can also be used to trigger an interrupt by configuring the P0\_31 pin and associated interrupt controls within your application code.

### 9.3 WAKEUP

Depressing this button triggers a wake interrupt by pulling down the WAKEUP input (P0\_24) of the LPC54102.

## 10. Legal information

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