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MCU-Link Pro

Rev. 1.0 — September 13, 2021   **User manual**

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1. Introduction

Jointly developed by NXP and Embedded Artists, MCU-Link Pro is a powerful and cost effective debug probe that can be used seamlessly with MCUXpresso IDE, and is also compatible with 3rd party IDEs that support CMSIS-DAP protocol. MCU-Link Pro includes many features to facilitate embedded software development, from basic debug to profiling, energy consumption analysis, and support of peripheral and host emulation via USB bridging functions. MCU-Link Pro is one of a range of debug solutions based on the MCU-Link architecture, which includes a very low cost base model and implementations built into NXP evaluation boards. MCU-Link solutions are based on the powerful, low power LPC55S69 microcontroller and all versions run the same firmware from NXP. The MCU-Link Pro can be programmed with a special version of firmware to implement a version of SEGGER's popular J-Link debug probe.
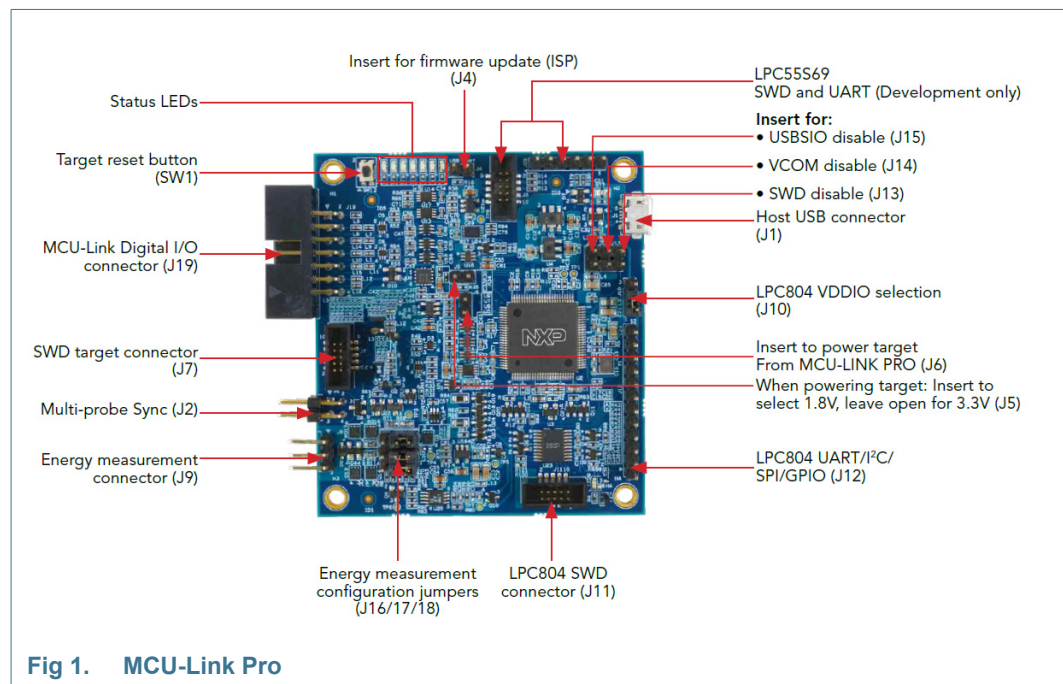

Fig 1.   MCU-Link Pro

The MCU-Link Pro includes following features:

- CMSIS-DAP firmware to support all NXP Arm® Cortex®-M based MCUs with SWD debug interfaces
- SEGGER J-Link firmware option
- High speed USB host interface
- USB to target UART bridge (VCOM)
- Simultaneous target supply and current measurement
- SWO profiling and I/O features
- USB SPI and I2C bridges for programming/provisioning and host-based application development
- Option to power target system at up to 350mA (at 1.8V or 3.3V)
- Analog signal trace input

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- On-board, user-programmable LPC804 for peripheral emulation
- Multiple status LEDs for diagnosis of issues
- Target reset button

2. Board layout and Settings

The connectors and jumpers on the MCU-Link Pro are shown in Figure 1 and descriptions of these are shown in Table 1.

Table 1.   Indicators, jumpers, buttons and connectors

Circuit ref	Description	Default	Ref
LED1-7	Status LEDs	n/a	4.7
J1	Host USB connector	n/a	2
J2	Multi-probe sync (reserved for future use)	n/a	n/a
J3	LPC55S69 SWD connector (for development of custom debug probe code only)	n/a	4.9
J4	Firmware update jumper (ISP)	Open	3.2
J5	Target voltage selection (when powering target) Open: 3.3V Closed: 1.8V	Open	4.2
J6	Insert to power target from MCU-Link Pro	Open	4.2
J7	SWD connector for connection to target system	n/a	4.1
J9	Energy measurement connector	n/a	4.4
J10	VDDIO selection for LPC804	3.3V (1-2)	4.8
J11	SWD connector for LPC804	n/a	4.8
J12	Connector for LPC804 peripherals	n/a	4.8
J13	SWD disable jumper (install to disable)	Open	4.1
J14	VCOM disable jumper (install to disable)	Open	4.3
J15	USBSIO (I2C/SPI USB bridge) disable jumper (install to disable)	Open	4.5
J16/17/18	Energy measurement range configuration	High (350mA) range (pos 1-2)	4.4
J19	MCU-Link digital connector (for VCOM, bridge and analog trace signals)	n/a	4
J26	UART connection to LPC55S69 (for development of custom debug probe code only)	n/a	4.9
SW1	Target reset button	n/a	4.1

3. Installation and firmware options

MCU-Link Pro debug probes are factory programmed with NXP's CMSIS-DAP protocol based firmware, which also supports all other features supported in hardware. A custom version of J-Link firmware to make MCU-Link Pro compatible with J-Link LITE is also available but note that this firmware is limited to supporting debug (including SWO) and VCOM features.

3.1 Host driver and utility installation

A step-by-step installation guide for MCU-Link Pro is provided at the board web page on nxp.com (https://www.nxp.com/demoboard/MCU-LINK-PRO.) The rest of this section explains the same steps as can be found on that page.

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MCU-Link debug probes are supported on Windows 10, MacOS X and Ubuntu Linux platforms. MCU-Link probes use standard OS drivers but the installation program for Windows includes information files to provide user friendly device names. To install these information files and the firmware MCU-Link Pro update utility, go to the Design Resources section of the board web page click on and then select "Development software" from the SOFTWARE section. Installation packages for each host OS will be shown.

Download the package for your host OS install (Linux or MacOS) or run the installer (Windows). After setting up the OS drivers, your host computer will be ready to use with MCU-Link Pro, however it is advisable to update to the latest version of the firmware as this may have changed since your MCU-Link Pro was manufactured; see Section 3.2 for the steps to do this update.

3.2 Updating MCU-Link Pro firmware

To update the MCU-Link's firmware it must be powered up in (USB) ISP mode. To do this insert jumper J4 then connect MCU-Link Pro to your host computer using a micro B USB cable connected to J1. The red STATUS LED (LED3) should light and stay on (for further information on LED status information refer to Section 4.7. The board will enumerate on the host computer as a HID class device. Navigate to the MCU-LINK_installer_Vx_xxx directory (where Vx_xxx indicates the version number, e.g. V2.244), then follow the installation instructions in the readme.txt to find and run the firmware update utilities for CMSIS-DAP or J-Link versions. After updating the firmware using one of these scripts, unplug the board from the host computer, remove J4 and then reconnect the board.

After programming the MCU-Link Pro with the CMSIS-DAP firmware three USB HID devices will enumerate, plus a virtual com port, as shown below (for Windows hosts):
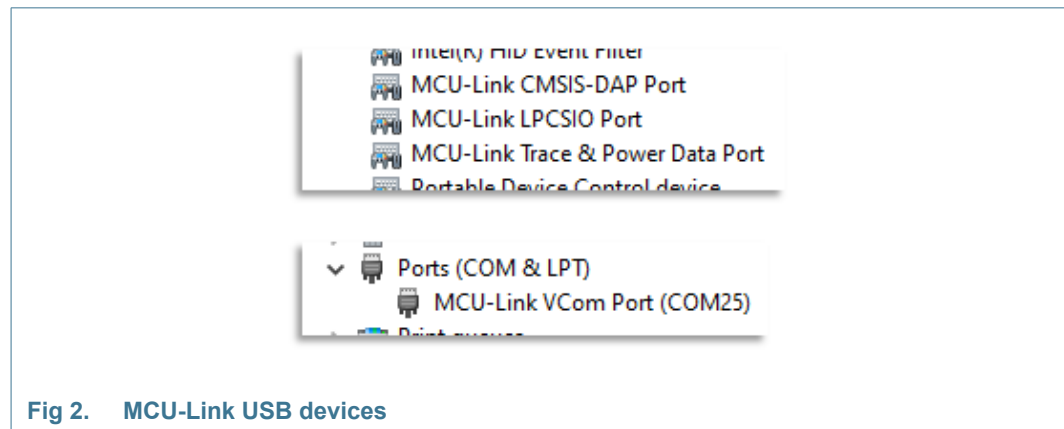

Fig 2. MCU-Link USB devices

The red status LED will repeatedly fade from on to off and back on again ("breathing"), while the green USB status LED will stay on constantly. For more information on the status LEDs when using CMSIS-DAP firmware please see Section 4.7.

If the J-Link firmware is programmed then only a J-Link device and single VCOM port will enumerate. Note that the J-Link firmware uses the VCOM LED to indicate status. The LED will illuminate after boot up then blink to indicate debug activity.

If a more recent firmware version is available for MCU-Link, MCUXpresso IDE (from version 11.3 onwards) will alert you to this when you use the probe in a debug session. If you are using another IDE with the MCU-Link Pro it is advisable to update the firmware to ensure the latest version of firmware is installed.

Once the J-Link firmware has been installed, the SEGGER device drivers will be able to perform subsequent firmware updates as these are released without the need to use the NXP supplied firmware update scripts and without having to install the ISP mode jumper. Note that if the CMSIS-DAP firmware is installed later then this update capability will be lost until the J-Link firmware is installed again using the NXP firmware update scripts.

3.3 Setup for use with development tools

The MCU-Link debug probe can be used with IDEs supported within the MCUXpresso ecosystem (MCUXpresso IDE, IAR Embedded Workbench, Keil MDK); for more information on getting started with these IDEs please visit the Getting Started section of the MCU-Link Pro page on nxp.com.

3.3.1 Use with MCUXpresso IDE

MCUXpresso IDE will recognize any type of MCU-Link probe, either with CMSIS-DAP or J-Link firmware, and will show the probe types and unique identifiers of all probes it finds in the probe discovery dialog when starting a debug session. This dialog will also show the firmware version, and will show a warning if the firmware is not the latest version. See Section 3.2 for information on how to update the firmware. MCUXpresso IDE 11.3 or later must be used when using MCU-Link Pro, and version 11.4.1 or later is required to use the Energy Measurement features.

3.3.2 Use with other IDEs

MCU-Link Pro should be recognized as a CMSIS-DAP or J-Link probe by other IDEs (depending on the firmware that is programmed), and should be usable with standard settings for that probe type. Follow IDE vendor instructions for setup and use of CMSIS-DAP and J-Link probe types.

4. Feature descriptions

This section describes the various features of MCU-Link Pro. The USB bridging, VCOM port, power measurement and analog trace features all utilize the Digital I/O Connector (J19), for which an accompanying cable is provided with the MCU-Link Pro. The table below shows the connections for J19. All the signal pins on J19 have ESD protection. SPI, I2C and triggering digital signals used can be in the range 1.2V to 5.5V; if no target VDD IO reference is used then the circuit will default to 3.3V. Note the Analog trace input should be kept in the 0 to 3.3V range to avoid damage to the voltage follower circuitry on MCU-Link Pro.

Table 2. Digital I/O Connector

Cable color	J19 pin	Signal	Feature
Black	1	GND	

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Table 2. Digital I/O Connector

Cable color	J19 pin	Signal	Feature
Brown	2	SPI SSEL	USB-SPI bridge
Red	3	SPI MOSI	
Orange	4	SPI CLK	
Yellow	5	SPI MISO	
Green	6	I2C SDA	USB-I2C bridge
Blue	7	I2C SCL	
Violet	8	UART IN (Target TXD)	VCOM
Gray	9	UART OUT (Target RXD)	
White	10	SYNC trigger (for future use)	
Black	11	GND	
Brown	12	Analog trace input	Analog trace
Red	13	Energy Measurement trigger	Energy measurement
Orange	14	Target VDD IO Reference voltage	

4.1 Target SWD/SWO interface

MCU-Link Pro provides support for SWD-based target debug, including features enabled by SWO. The MCU-Link Pro board includes footprints for both 10 (J7) and 20 pin (J8) Cortex debug connectors, with the 10-pin connector installed. MCU-Link Pro comes with cables for 10-pin to 10-pin and 10-pin to 20-pin target connections.

Level shifters are provided between the LPC55S69 MCU-Link Probe processor and the target to enable target processors running at between 1.2V and 5V to be debugged. A reference voltage tracking circuit is used to detect the target voltage at the SWD connector and set the level shifter target-side voltage appropriately (see schematic page 5.)

The Target SWD interface can be disabled by installed jumper J13 but note that the MCU-Link software only checks this jumper at boot up time.

SWO activity is indicated by the SWO status LED, which will illuminate/flicker when SWO data is being sent/received on this interface (this can happen during profiling and during energy measurement.)

A target reset button (SW1) is provided on MCU-Link Pro; note that this does not reset the LPC55S69 MCU-Link processor.

4.2 Powering the target

MCU-Link Pro provides an option power to the target system (via the target SWD connector) from one of its on-board regulators. The target supply voltage can be set to 1.8V or 3.3V using jumper J5 (open for 3.3V, closed for 1.8V). The maximum supply current from this regulator is 350mA. Note that the USB power capabilities of host computer being used may affect the maximum current available. When using the target powering feature jumper J6 must also be installed in order to correctly set the reference voltage level at the SWD connector. See the schematic page 5 for more information.

4.3 VCOM (USB to Target UART bridge)

MCU-Link Pro includes a UART to USB bridge (VCOM) function. A target system UART can be connected to the MCU-Link Pro via connector J19 (pin 8 and 9) using the supplied cable. The Violet wire connects to the MCU-Link Pro UART input (target TXD) and Gray to the UART output (target RXD). VCOM activity is indicated by the VCOM status LED, which will illuminate/flicker when traffic is present on this interface.

The MCU-Link Pro VCOM device will enumerate on the host computer system with a name MCU-Link Vcom Port (COMxx) where "xx" will be a dependent on host system. Each MCU-Link board will have a unique VCOM number associated with it. The VCOM function may be disabled by installing jumper J14 before powering the board. Note that installing/removing this jumper after powering the board will have no effect on the feature in terms of how the MCU-Link Pro software behaves since it is only checked at power up. It is not necessary to disable the VCOM function when not in use.

The VCOM device is configurable via the host computer (e.g. Device Manager in Windows), with the follow parameters:

- Word length 7 or 8 bits
- Stop bits: 1 or 2
- Parity: none / odd / even

Baud rates of up to 5.33Mbps are supported.

4.4 Energy measurement

MCU-Link includes circuitry to measure the Target's supply voltage and current drawn, and the Energy Measurement features in MCUXpresso IDE can display this measurement data along with energy and power consumption. For information on MCUXpresso IDE please visit https://www.nxp.com/mcuxpresso and follow links to the IDE page.

Current into the Target is measured at J9 by measuring the voltage drop across sense resistors on the MCU-Link Pro. J9 should be connected in line with the supply with pin 1 as the supply side connection and pin 3 as the target side. J9 pin 2 should be grounded close to these connections to provide good measurement integrity.

MCU-Link Pro has two current measurement configurations available, with each configuration having a maximum measurable current. This is to allow the maximum accuracy of measurement for various different targets. Within each configuration there are two, automatically controlled ranges in order to provide and even further higher accuracy to be achieved. The automatic switching from low current measurement to high current measurement is controlled solely by hardware in order to avoid excessive voltage drop across the sense resistor. When switching from high current to low current measurement the MCU-Link Pro firmware controls the switch back to low current measurements triggered by an interrupt from a monitoring circuit.

The measurement circuit self-calibrates each time the MCU-Link Pro is powered on. No user intervention is required to setup the calibration or adjust the measurement ranges. Transistors are used to isolate the sensing circuitry from the target supply to avoid contention and ensure a known voltage is applied to the system during calibration, so it is

not necessary to disconnect / reconnect the MCU-Link Pro. It is recommend to power the MCU-Link Pro first when not using the MCU-Link Pro to power the target as the MCU-Link could be back-powered through the current measurement circuit.

The power measurement feature is intended for low power measurements, with a target MCU running at up to 3.6V. The design uses the LPC55S69 16-bit ADC, with power data sampled at up to 100kS/s. At high sample rates MCUXpresso IDE may not be able to capture all data, so the sample rate may need to be adjusted using the configuration options in the Energy Measurement configuration settings in that tool.

4.4.1 Measurement range configuration

As mentioned above, MCU-Link Pro has two maximum current range measurement configurations, with the lower range providing better resolution at very low currents. If the target current exceeds the maximum current for the selected range then the measurement will clip and hence be inaccurate, but the target operation may continue as normal (provided the current is not high enough to cause a significant drop across the high current sense resistor and hence cause a brown out and/or trigger glitch security protection on some devices). Note that the MCU-Link Pro on-board regulator for the target is limited to a maximum of 350mA output.

Range configuration settings with corresponding accuracy and resolution are shown below. Note that all settings for J16/J17/J18 must be consistent for correct operation. Accuracy may vary with temperature and is provided for reference purposes only.

Table 3. Energy measurement range configuration (as at firmware revision 2.243)

Maximum measureable current	J16 setting	J17 setting	J18 setting	Measurement ranges	Resolution	Accuracy (typical)
50mA	2-3	2-3	2-3	200nA to 400uA >400uA to 50mA	200nA 5uA	1% 1%
350mA	1-2	1-2	1-2	10uA to 1.5mA >1.5mA to 350mA	1uA 20uA	1% 5%

4.5 SPI and I2C bridging (USB to Target SPI and/or I2C bridge, USBSIO)

MCU-Link Pro includes a capability to bridge SPI and/or I2C ports to a host computer via USB, called USBSIO. This port bridging function can be used for emulating a system host, peripherals (in the case of I2C) and/or for device programming via the ISP feature. NXP's MCUXpresso SEC tool has an option to program a target system via this bridge (see SEC tool documentation for details). USBSIO activity is indicated by the USBSIO status LED, which will illuminate/flicker when traffic is present on this interface. This feature is supported by a free host library from NXP called LIBUSBSIO; for more details on this library please visit https://www.nxp.com/libusbsio.

The SPI interface connections are routed via level shifters/buffers with the target side IO voltage determined by the voltage connected to the VDD_IO_REF signal at pin 14 of J19. The I2C interface connections are routed to an open drain buffer on the MCU-Link Pro.

USBSIO may be disabled by inserting jumper J15 before powering the MCU-Link Pro; this will instruct the firmware not to enumerate the USB end point for USBSIO (which is called "MCU-Link LPCSIO" for backward compatibility reasons). Note that installing/removing this jumper after powering the board will have no effect on the feature in terms of how the

MCU-Link software behaves since it is only checked at power up. While it is not necessary to disable this feature it may have benefits in performance of SWO profiling and power measurement as the MCU-Link Pro shares USB bandwidth between these devices.

4.6 Analog probe

MCU-Link Pro includes an analog signal input that can be used with MCUXpresso IDE to provide a basic signal tracing feature. As at version 11.4 of MCUXpresso IDE this feature is included with the energy measurement dialogs.

The analog input for this feature is located at pin 12 of the (Digital) I/O connector J19, as described at the start of this section. The input passes through a voltage follower/buffer and into an ADC input of the LPC55S69. Care should be taken not to apply voltages >3.3V to this input in order to avoid damage.

4.7 Status LEDs

MCU-Link Pro includes 7 LEDs to help diagnose issues and check that debug sessions are working as expected. The table below shows the purpose/function of each of these LEDs when using the CMSIS-DAP firmware. Note that the label for each LED can be found on the silkscreen on the back of the board.

Table 4.   MCU-Link Pro Firmware Status LEDs (CMSIS-DAP firmware)

Circuit Ref	Label: Purpose	Description	Color
LED1	USB: USB enumerated	Illuminated at start up after successful USB enumeration (remains lit). Does not light when in ISP mode.	Green
LED2	SWO: SWO activity	Indicates when SWO data is being received from the target. Does not light when in ISP mode.	Green
LED3	Status: Status / activity	Multi-function: Normal operation •Blinks rapidly if error occurs at start up. •Combination of heartbeat (slow fade in/out) when running normally, with SWD activity overlaid ISP mode (firmware update) •On when LPC55S69 is booted in ISP mode	Red
LED4	VCOM: VCOM activity	Indicates when VCOM interface is active (data transmission/reception). Does not light when in ISP mode.	Green
LED5	FUNC	Reserved for future use	Green
LED6	SIO: USBSIO active	Indicates when USBSIO bridge traffic is present. Does not light when in ISP mode	Green
LED7	NRG: Energy measurement active	Indicates when energy measurement communication is occurring between Target and MCU-Link. Does not light when in ISP mode.	Green

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4.8 LPC804 user-programmable processor

An LPC804 in a 20-pin package is included on MCU-Link Pro. This MCU can be used for any purpose but is intended for emulating peripherals or host computers to assist with prototyping.

The LPC804 can be operated at 1.8V or 3.3V, selected using jumper J10 (position 1-2 for 3.3V or 2-3 for 1.8V). The LPC804's UART port that supports ISP (in system programming boot) is connected to the LPC55S69 MCU-Link processor, and the LPC55S69 can also control the ISP and Reset of the LPC804. This hardware configuration will enable future tools from NXP to boot load the LPC804. Code can also be downloaded and debugged on the LPC804 using its SWD connector (J11).

There are two LEDs on MCU-Link Pro associated with the LPC804 and their functions are shown in the table below.

Table 5.   LPC804 LEDs

Circuit Ref	Function	Color
LED8	ISP/User LED for LPC804. Connected to PIO0_12 of the LPC804, this LED can be used by user applications running on this MCU. The LED will illuminate when the MCU-Link Pro asserts the ISP signal to the LPC804 in order to boot it (this functionality reserved for future use).	Red
LED9	User LED for LPC804, controlled by PIO0_13. Note that the factory default program for the LPC804 is a simple blinky example (based on the MCUXpresso SDK for LPC804) that blinks this LED.	Green

The J12 expansion connector provides access to UART, I2C, SPI and 3 GPIOs ports of the LPC804. This MCU has a switch matrix that allows re-mapping of most of its peripherals to most available pins, so the connections shown are suggested and not fixed function - refer to the LPC804 datasheet on nxp.com for more information.

Note that no ESD protection or level shifting is provided for these signals so appropriate connections should be made for the LPC804 supply voltage selected.

Table 6.   LPC804 Connector for demo signals (J12)

Pin	Interface signals
1	TXD (PIO0_1)
2	RXD (PIO_7)
3	SDA (PIO0_10)
4	SCL (PIO0_11)
5	SPI SSEL (PIO0_14)
6	SPI MOSI (PIO0_15)
7	SPI MISO (PIO0_16)
8	SPI SCK (PIO0_17)
9	GPIO (PIO0_8)
10	GPIO (PO0_9)
11	GPIO (same as Green user LED) (PIO0_13)
12	GND

4.9 LPC55S69 debug and UART connectors

Most users of MCU-Link Pro are expected to use the standard firmware from NXP and so will not need to debug the LPC55S69 MCU-Link processor, however SWD connector J3 and may be used to develop code on this processor. One of the available UARTs (Flexcomm 1, using PIO1_10 and PIO1_11) is also routed to connector J26, which has the signal connections for an FTDI TTL-232R-3V3 cable (see schematic page 3 for more information.)

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