

## Technical Summary for

### USB Multilink Universal, Rev. E (PART# USB-ML-UNIVERSAL) and USB Multilink Universal **FX**, Rev. C (PART# USB-ML-UNIVERSAL-FX)

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USB Multilink Universal & USB Multilink Universal FX

**Errata Notice:** Users of USB Multilink Universal Rev. E should read the Errata Sheet to determine whether their version of the debug probe is affected. The Errata Sheet is located at: [https://www.pemicro.com/blog/index.cfm?post\\_id=233](https://www.pemicro.com/blog/index.cfm?post_id=233)

## 1 Introduction

The Multilink Universal and Multilink Universal FX are all-in one debug interfaces which accelerate the debug and flash programming process, saving valuable development time. Both Multilinks provide access to debug modes on a wide range of NXP & other ARM Cortex microcontroller families by communicating between the target device and a laptop/PC via the target's standard debug header and the laptop/PC's USB port.

**FX Note:** USB Multilink Universal FX offers up to 10X faster download speeds, can provide target power, and supports some additional, older NXP architectures. The greatest speed boosts occur when working with synchronous devices.

## 2 Firmware Updates/Architecture Selection

The Multilink Universal and Universal FX use firmware updates to change between modes of operation to support different families of microcontrollers. Older versions of PEmicro's software and third-party software are not able to automatically configure these Multilinks when the target is switched to a different family of microcontrollers. If you are not using the latest version of PEmicro software, please contact us to determine if you are eligible for a discounted upgrade to the latest version of your software.

A utility called *PEFirmwareConfig.exe* is used to manually update the Multilink firmware. This application is included with the "USB Multilink Resources Install" which can be downloaded from the pemicro.com Support tab, the Multilink product page, or directly from the link below:

[http://www.pemicro.com/downloads/download\\_file.cfm?download\\_id=346](http://www.pemicro.com/downloads/download_file.cfm?download_id=346)

### 3 Supported Devices

Both the Multilink Universal and Multilink Universal FX support the following 8-/16-/32-bit NXP device families:

- |              |                             |                        |
|--------------|-----------------------------|------------------------|
| · Kinetis®   | · Vybrid                    | · RS08 <sup>1</sup>    |
| · LPC        | · MPC55xx-57xx              | · HC(S)12(X)           |
| · i.MX       | · ColdFire® V1/ColdFire+ V1 | · S12Z                 |
| · S32 (ARM)  | · S32 (Power)               | · DSC                  |
| · Automotive | · ColdFire V2-4             | · MPC5xx/8xx (FX only) |
| · Sensors    | · HCS08                     | · HC16/683xx (FX only) |

<sup>1</sup> RS08 users, please refer to Section 11 - RS08 Adapter (Port E).

**Note:** Both Multilink & Multilink FX models also support STMicroelectronics' SPC5 devices.

#### ARM Cortex-M Devices

In addition, the Multilink Universal and Multilink Universal FX support ARM Cortex-M devices from these manufacturers:

- |                         |                      |
|-------------------------|----------------------|
| · NXP (see above)       | · ON Semiconductor   |
| · AutoChips             | · Qorvo              |
| · Cypress Semiconductor | · Redpine Signals    |
| · GigaDevice            | · Renesas            |
| · indie Semiconductor   | · Silergy Teridian   |
| · Infineon              | · Silicon Labs       |
| · Maxim Integrated      | · STMicroelectronics |
| · Microchip             | · Texas Instruments  |
| · MindMotion            | · Toshiba            |
| · Nordic Semiconductor  | · WIZnet             |
| · Nuvoton               | · ZHIXIN             |
| · OnBright              |                      |

For a complete listing of supported ARM Cortex-M devices or to request support for a device, visit PEmicro at:

<http://www.pemicro.com/arm>

### 4 Debug Headers

Each of the supported families of NXP & other ARM Cortex microcontrollers are represented by headers located inside the unit. The headers for Ports A-D & Port H (Multilink FX only) are dual-row with a .100" pitch, and the headers for Ports F-G are dual-row with a .050" pitch. The pin-outs for these connections and the families that they support are shown below.

#### Multilink Universal and Multilink Universal FX Pinouts - Ports A-H

<p><b>Please note:</b></p> <p>Overlined text indicates an active low signal.</p>	<p align="center"><b>PORT A - JTAG/ONCE</b></p> <p align="center">MPC55xx-57xx, DSC, S32 (Power), STMicroelectronics' SPC5</p> <p align="center">           Pin 1: TDI • Pin 2: GND            Pin 3: TDO • Pin 4: GND            Pin 5: TCK • Pin 6: GND            Pin 7: NC • Pin 8: NC/KEY<sup>2</sup>            Pin 9: <u>RESET</u> • Pin 10: TMS            Pin 11: TVCC • Pin 12: GND            Pin 13: <u>RDY/NC</u><sup>2,3</sup> • Pin 14: JCOMP/TRST<sup>2</sup> </p> <p><sup>2</sup> Second signal listed is for DSC only.</p> <p><sup>3</sup> Pin 13 Signal "NC" is for DSC only: Pin 13 is reserved for use within the Multilink, for DSC only.</p>	<p align="center"><b>PORT B - STANDARD ARM</b></p> <p align="center">Kinetis, LPC, S32K/V, and other ARM Cortex devices</p> <p align="center">           Pin 1: TVCC • Pin 2: NC            Pin 3: <u>TRST</u> • Pin 4: GND            Pin 5: TDI • Pin 6: GND            Pin 7: TMS/SWD_DIO • Pin 8: GND            Pin 9: TCK/SWD_CLK • Pin 10: GND            Pin 11: NC • Pin 12: GND            Pin 13: TDO • Pin 14: GND            Pin 15: <u>RESET</u> • Pin 16: GND            Pin 17: NC • Pin 18: GND            Pin 19: NC • Pin 20: GND         </p>
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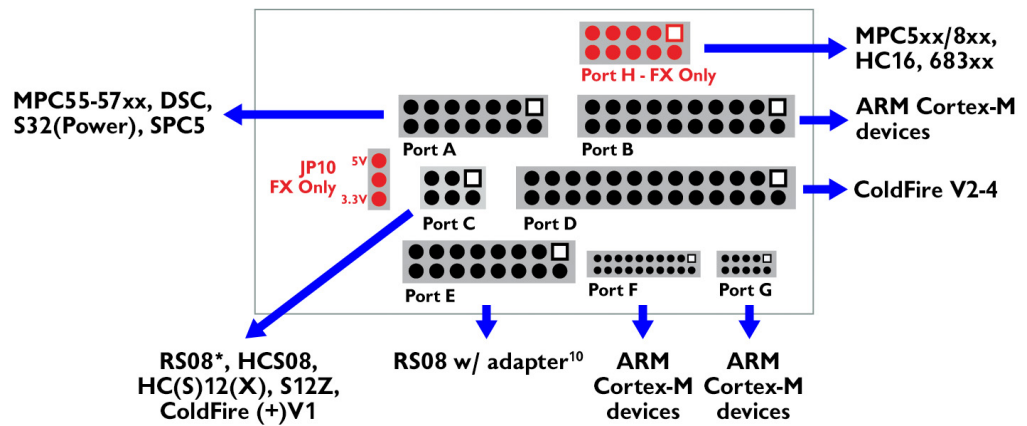
<p><b>PORT C - BDM</b></p> <p>RS08<sup>4</sup>, HCS08, HC(S)12(X), ColdFire+ V1/ColdFire V1</p> <p>Pin 1: BGND •• Pin 2: GND Pin 3: NC •• Pin 4: RESET Pin 5: NC •• Pin 6: TVCC</p> <p>S12Z</p> <p>Pin 1: BGND •• Pin 2: GND Pin 3: PDO<sup>5</sup> •• Pin 4: RESET Pin 5: PDOCLK<sup>5</sup> •• Pin 6: TVCC</p> <p><sup>4</sup>RS08 users, please refer to Section 11 - RS08 Adapter (Port E). <sup>5</sup>Indicates optional signal</p>	<p><b>PORT D - COLDFIRE BDM</b></p> <p>ColdFire V2-4</p> <p>Pin 1: NC •• Pin 2: BKPT Pin 3: GND •• Pin 4: DSCLK Pin 5: GND •• Pin 6: TCK Pin 7: RESET •• Pin 8: DSI Pin 9: TVCC •• Pin 10: DSO Pin 11: GND •• Pin 12: PST3/PSTDDATA7 Pin 13: PST2/PSTDDATA6 •• Pin 14: PST1/PSTDDATA5 Pin 15: PST0/PSTDDATA4 •• Pin 16: DDATA3/PSTDDATA3 Pin 17: DDATA2/PSTDDATA2 •• Pin 18: DDATA1/PSTDDATA1 Pin 19: DDATA0/PSTDDATA0 •• Pin 20: GND Pin 21: NC •• Pin 22: NC Pin 23: GND •• Pin 24: PSTCLK<sup>6</sup> Pin 25: TVCC •• Pin 26: TA</p> <p><sup>6</sup> Pin 24 of the ribbon cable is deliberately disconnected to reduce noise. If connecting to a ColdFire V2-4 processor which requires synchronous communication, such as the MCF5272 or MCF5206(E), a CABLE-CF-ADAPTER (sold separately) is required.</p>	<p><b>PORT E</b></p> <p>Used to connect RS08 adapter on Multilink Universal Rev. E</p> <p>Pin 1 ••</p>
<p><b>PORT F - MINI 20</b></p> <p>Kinetis, LPC, S32K/V, and other ARM Cortex devices</p> <p>Pin 1: TVCC •• Pin 2: TMS/SWD_DIO Pin 3: GND •• Pin 4: TCK/SWD_CLK Pin 5: GND •• Pin 6: TDO Pin 7: NC •• Pin 8: TDI Pin 9: NC<sup>7</sup> •• Pin 10: RESET Pin 11: NC •• Pin 12: TRACE_CLKOUT Pin 13: NC •• Pin 14: TRACE_D0 Pin 15: GND •• Pin 16: TRACE_D1 Pin 17: GND •• Pin 18: TRACE_D2 Pin 19: GND •• Pin 20: TRACE_D3</p> <p><sup>7</sup> Pin 9 is reserved for internal use within the Multilink interface.</p>	<p><b>PORT G - MINI 10</b></p> <p>Kinetis, LPC, S32K/V, and other ARM Cortex devices</p> <p>Pin 1: TVCC •• Pin 2: TMS/SWD_DIO Pin 3: GND •• Pin 4: TCK/SWD_CLK Pin 5: GND •• Pin 6: TDO Pin 7: NC •• Pin 8: TDI Pin 9: NC<sup>8</sup> •• Pin 10: RESET</p> <p><sup>8</sup> Pin 9 is reserved for internal use within the Multilink interface.</p>	<p><b>PORT H - BDM</b></p> <p>HC16/683xx (Multilink FX Only)</p> <p>Pin 1: DS •• Pin 2: BERR Pin 3: GND •• Pin 4: BKPT/DSCLK Pin 5: GND •• Pin 6: FREEZE Pin 7: RESET •• Pin 8: IPIPE1/DSI Pin 9: Vdd •• Pin 10: IPIPE0/DSO</p> <p>MPC5xx/8xx (Multilink FX Only)</p> <p>Pin 1: VFLS0<sup>9</sup> •• Pin 2: SRESET Pin 3: GND •• Pin 4: DSCK Pin 5: GND •• Pin 6: VFLS1<sup>9</sup> Pin 7: HRESET •• Pin 8: DSDI Pin 9: TVCC •• Pin 10: DSDO</p> <p><sup>9</sup> The pin is reserved for internal use within the Multilink interface.</p>

The user can take advantage of debug modes to halt normal processor execution and use a computer to control the processor. The user can then directly control the target's execution, read/write registers and memory values, debug code on the processor, and program internal or external FLASH memory devices.

**FX Note:** The USB Multilink Universal FX is capable of providing power (5V or 3.3V) directly to the target processor via the TVCC pin. This removes the need for an external power supply for systems requiring 200mA of current or less. The TVCC pin should be connected even in cases when the target is self-powered.

## 5 Usage

The user connects a ribbon cable between the target's debug header and one of the multiple ports on the Multilink. The layout of the ports and which device type each supports is shown in the figure below. Do not attempt to use multiple ports at once, as this may damage both the target processors as well as the Multilink.



**Universal/Universal FX Header Layout (Pin 1 Highlighted)**

<sup>10</sup> When working with RS08 devices, the Multilink Universal Rev. E requires an RS08 adapter on Port E, available at [pemicro.com/RS08](http://pemicro.com/RS08). Multilink Universal FX and earlier revisions of Multilink Universal use Port C.

The USB Multilink Universal and Universal FX interfaces will work with targets whose processor power supply is in the range of 1.8V to 5V. Both Multilink models have a female type B USB connector. Use a Type A to Type B male-to-male USB cable to connect the interface to the PC.

There are two LEDs on the Multilink interface. The blue LED indicates that the interface is powered and running. The yellow LED indicates that target power has been detected.

**Note:** To avoid improper connections, the red stripe of the ribbon cable should always be oriented towards Pin 1, both on the Multilink port and the target processor header. In the Header Layout figure above, Pin 1 for each header is indicated by a white square.

The USB Multilink Universal and Universal FX are USB devices. If a USB Hub is used, it must be a self-powered hub (i.e. with its own power supply). By default, the USB protocol used is USB 2.0.

### Providing Power To Target

When using the the Multilink Universal FX, if the user wishes to provide power to the target the JP10 Jumper (FX only) is used to enable this option and select the voltage. A shunt at position 1-2 enables 5V, while a shunt at position 2-3 enables 3.3V.

## 6 Driver Installation

Before connecting the Multilink to the PC, the appropriate drivers need to be installed on the PC. The Multilink drivers are supported on Windows XP, 2000, 2003, Vista, 7, 8, 10, and 11. These drivers are automatically installed with many development environments or any of PEMicro's recent software development packages. If you have installed a recent version of these then the instructions for manual installation that follow are not necessary. However, Windows 7 users who are installing software distributed before December 28, 2009 will need to obtain the latest version of the drivers and install them manually. A copy of the driver installation program may be downloaded from the "Downloads" section of PEMicro's "Support Center" located at <http://www.pemicro.com>. If you are using third-party software, make sure you have a version which supports your specific interface (Universal/FX). Once you have obtained the latest version of the driver installation program, please use the instructions below to manually install the drivers.

When the cable is plugged in, the operating system should indicate that it has found a driver for the attached interface. Follow the instructions in the "Found New Hardware Wizard" dialog for having Windows automatically install the driver.

If you connected the Multilink interface prior to installing the drivers, Windows will not have been able to find the appropriate driver and may have disabled the device. If you unplug the device and then plug it in again, Windows will automatically disable it even if you have installed the drivers. To force Windows to attempt to load the driver again, perform the following steps while the Multilink interface is plugged into the computer:

1. Open the Control Panel: Start Button [ ->Settings ] ->Control Panel. (You will not need to select "Settings" on Vista and Windows 7).
2. Double Click the "System" Icon. (Windows 7: "System and Security")
3. Select the "Hardware" Tab. (Windows 7: "Hardware and Sound", Windows Vista: skip this step)
4. Click the "Device Manager" Button. (Windows 7: "Devices and Printers -> Device Manager")

5. The “USB Multilink 2.0” device will be shown with an exclamation point next to it. Double-click this device.
6. Click the “Reinstall Driver...” button and follow the dialog instructions to have Windows automatically install the driver. (Windows 7: First click the “Driver” tab, then select “Update Driver...”)
7. If the hardware still has a yellow exclamation mark next to it, right click on it and select uninstall. The USB Multilink should disappear from the list. Unplug the USB Multilink and then plug it into the PC again. A new Hardware Found dialog will pop up; follow the dialog instructions and have Windows automatically install the driver.

## 7 Connecting To The Target

The following is the proper connection sequence to connect the PC to the target system via the Multilink interface:

1. Make sure the target power is OFF and the USB Multilink Universal or Universal FX is not connected to either the target or the PC
2. Open the Multilink and connect a ribbon cable from the correct Multilink port to the target. Make sure that the ribbon cable is plugged into the target with the proper orientation. PIN 1 is indicated by a 1 next to the port.
3. Connect the Multilink to the PC via a USB cable. The Blue LED on the Multilink should illuminate.
4. Turn the target power on. The Yellow LED on the Multilink should illuminate.

Before disconnecting the setup, turn the target power off.

## 8 Troubleshooting - Startup Reset Sequence

Note that if the Multilink does not enter debug mode, the program issues the error message “Cannot enter background mode.” If you receive this message you should check your hardware with a scope, logic analyzer or logic probe. First check for power on, then check to make sure the processor oscillator is running. Finally, look for the startup sequence for your microprocessor that is listed below.

### Port A – JTAG/ONCE – MPC55xx-57xx & STMicroelectronics SPC5, DSC, S32 (Power)

- a. RESET (Pin-9) is driven low (to processor).
- b. Activity appears on TCK (Pin-5), TDI (Pin-1) and TDO (Pin-3). (PC software instructs the processor to enable debug mode).
- c. RESET (Pin-9) is released by the interface and will go high.
- d. Activity appears on TCK (Pin-5), TDI (Pin-1) and TDO (Pin-3). (Debug activity).

### Ports B, F, G – ARM \*JTAG\* - Kinetis, LPC, S32 (ARM) & other ARM Cortex devices

- a. RESET is driven low (to processor).
- b. Activity appears on TCK, TDI and TDO (PC software instructs the processor to enable debug mode).
- c. RESET is released by the interface and will go high.
- d. Activity appears on TCK , TDI and TDO (Debug activity).

### Ports B, F, G – ARM \*SWD\* - Kinetis, LPC, S32 (ARM) & other ARM Cortex devices

- a. RESET is driven low (to processor).
- b. Activity appears on SWD\_CLK and SWD\_DIO (PC software instructs the processor to enable debug mode).
- c. RESET is released by the interface and will go high.
- d. Activity appears on SWD\_CLK and SWD\_DIO (Debug activity).

### Port C – BDM

#### HCS08, S12Z, ColdFire V1, RS08

- a. Debug activity is seen on BKGD (Pin-1).

#### HC(S)12(X)

- a. BKGD (Pin-1) and RESET (Pin-4) are pulled low by the interface.
- b. After 5 milliseconds, RESET (Pin-4) is released and goes high.
- c. After 10 milliseconds, BKGD (Pin-1) is released and goes high.
- d. After 20 more milliseconds, debug activity is seen on BKGD (Pin-1).

### Port D – Coldfire V2/V3/V4

- a. BKPT (Pin-2), DSI (Pin-8), and DSCLK (Pin-4) signals are driven low.
- b. RESET (Pin-7) is driven low for 20+ milliseconds and released.
- c. After RESET is released and if the processor has correctly entered background mode, the PST0 (Pin-15), PST1 (Pin-14), PST2 (Pin-13) and PST3 (Pin-12) lines should all be driven high by the processor.
- d. Activity (changing signals) is seen on the DSI, DSO, and DSCLK signals. The activity on the DSCLK and DSI lines is generated by the PC and the activity on the DSO line is generated by the processor.

### Port E – RS08 Adapter

- a. Debug activity is seen on BKGD (Pin-1).

## Port H

### HC16/683XX (FX Only)

- a. BKPT/DSCLK is pulled low (to processor).
- b. Delay ~1ms.
- c. RESET is pulled low (to processor).
- d. Delay ~20ms.
- e. RESET is released (tri state, should be pulled up on target).
- f. Wait for FREEZE (out of processor).
- g. Shifting activity appears on DSCLK, DSI and DSO.

### MPC5xx/8xx (FX Only)

- a. DSCK is driven high and DSI is driven low (to processor).
- b. Delay ~1ms.
- c. HRESET or SRESET is driven low (usually this will be HReset).
- d. Delay ~20ms.
- e. HRESET is released (tri-state, should be pulled up on target).
- f. Shifting activity appears on DSCLK, DSI and DSO. (PC software communicating with target to determine if debug mode was successfully entered).

## 9 Interface Libraries

PEmicro produces a set of interface libraries which allow the user to directly control the USB Multilink Universal or Universal FX from any Windows Development environment which can interact with a DLL. The interface libraries come with examples for controlling the Multilink interface from Microsoft Visual C as well as Borland Delphi. More details can be found on the Interface Libraries page on the PEmicro website:

[http://www.pemicro.com/products/product\\_processor.cfm?category=9](http://www.pemicro.com/products/product_processor.cfm?category=9)

## 10 Third Party IDEs & Other Compatible Software

The USB Multilink Universal and Universal FX are supported by recent versions of NXP's MCUXpresso, CodeWarrior, Kinetis Design Studio, and S32 Design Studio, as well as third-party toolchains such as those from IAR, Keil, Silicon Labs, Cosmic, and Mentor Graphics. A list of third party ARM IDEs can be found at:

<http://www.pemicro.com/arm/3rd-party/index.cfm>

Multilinks also work with PEmicro software, including our no-cost, fully-featured GDB Server Plug-in for Eclipse-based ARM IDEs.

It is recommended that you check with the vendor regarding support for your specific part. Information on compatible PEmicro software can be found in the "Products" section of PEmicro's website: [pemicro.com](http://pemicro.com).

## 11 RS08 Adapter (Port E)

Communication with RS08 devices requires a separate RS08 adapter on Port E when using **USB-ML-MULTILINK Rev. E and later**. Multilink Universal FX and earlier Revs. of Multilink Universal use Port C. Visit [pemicro.com/RS08](http://pemicro.com/RS08) for more details.

## 12 Transition To Production Programming

The USB Multilink Universal and Universal FX are intended for development and are not designed to accommodate the demands of production programming. However, PEmicro's Cyclone LC and Cyclone FX programmers are specifically engineered to withstand the rigors of a production environment and will provide a seamless transition from the Multilink. In addition, the Cyclone FX offers an expanded feature set which includes faster communications, larger storage, expandable storage, enhanced security including SAP image encryption and programming restrictions, and expansion ports. More information is available online at: [pemicro.com/cyclone](http://pemicro.com/cyclone).



**Cyclone LC programmer**