

# UP Square (UP<sup>2</sup>) Board Firmware Settings to Enable SPI/I2C/GPIO/UART for Windows 10 IoT Enterprise

By Sean D. Liming and John R. Malin

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Windows 10 Enterprise LTSC 2019

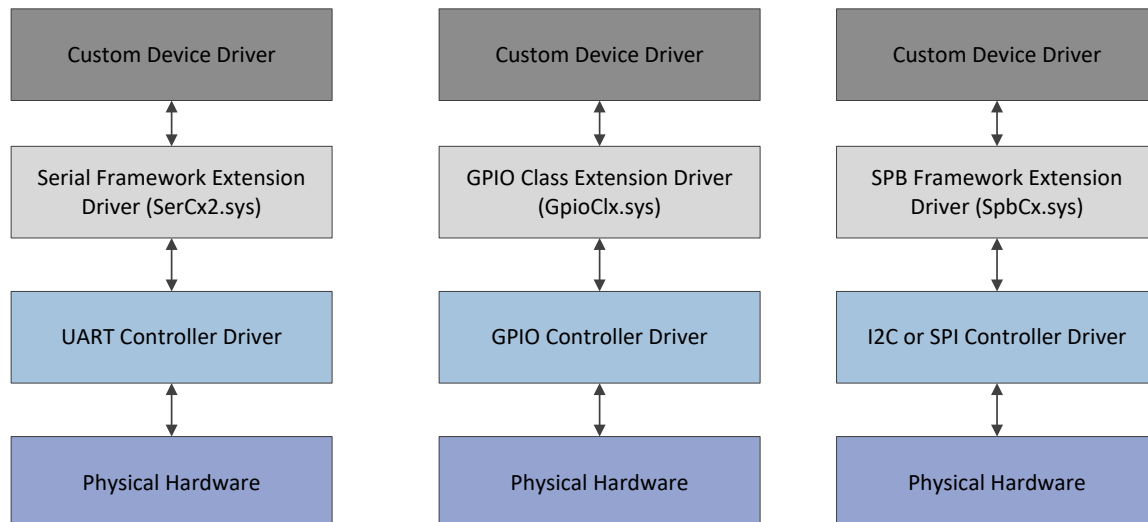
UP<sup>2</sup> Board BIOS Version: UP-APL01 R5.2 (UPA1AM52) 8/4/2020

CPU: Intel N3350

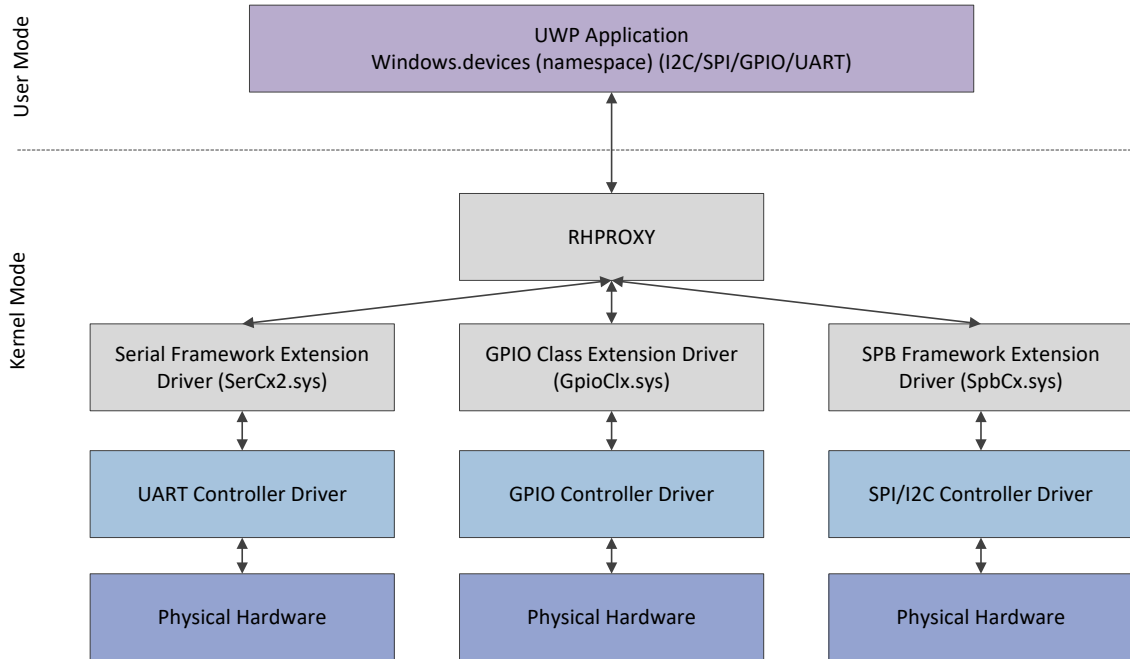
Back in January 2018, we released an article titled “[Industrial PC Requirements to Access GPIO/I2C/SPI/UART from Windows 10 UWP Applications](#)”. The article discusses how Microsoft is requiring Resource HUB Proxy (RHProxy) support in the firmware for UWP applications to interact with GPIO, I2C, SPI, and UART. The UP Board was one of the platforms we investigated to see what was possible; but at the time, the firmware didn't have RHProxy support. We tested a later version, the UP<sup>2</sup> Board, and found the same issue. Now, a few years later, the firmware for both platforms has been updated to support RHProxy and Windows IoT Core, so it is now possible to access the available GPIO, I2C, SPI, and UART I/O on the 40-pin HAT connector. As there is not much documentation discussing the firmware setup, this article will cover the firmware settings that need to be set to access the I/O. Before we go further, it is a good idea to review RHProxy.

## Resource Hub Proxy (RHProxy)

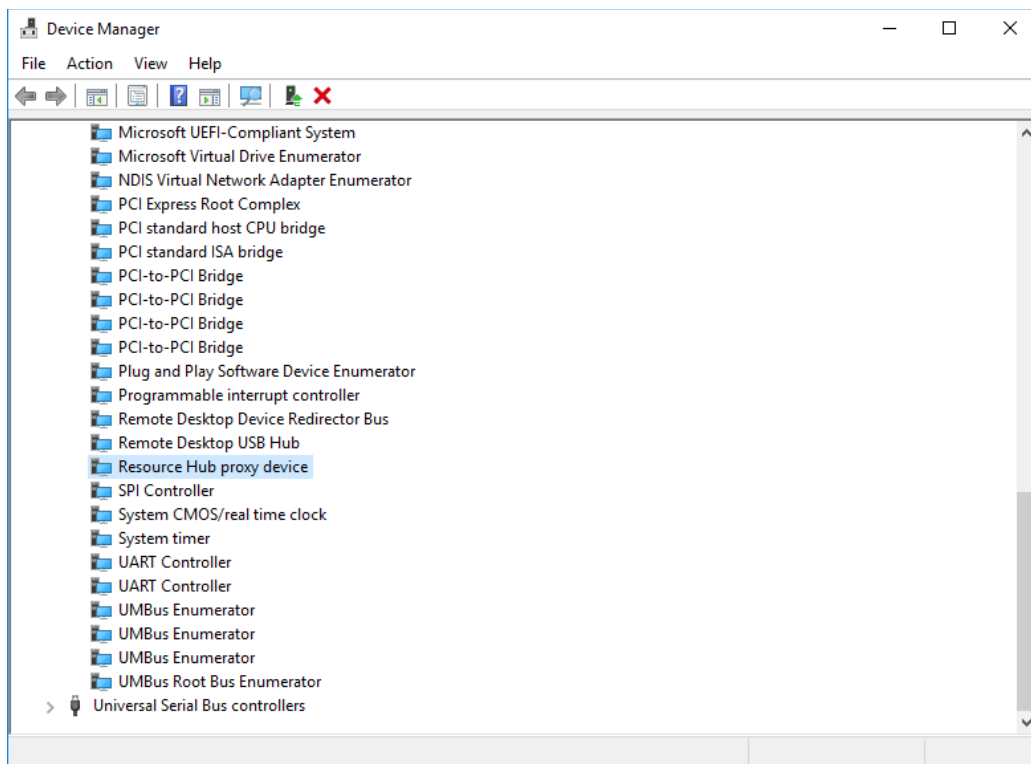
In Windows 8, three driver frameworks were created to support the different microcontroller IO. Mobile OEMs could write device drivers for dedicated devices attached to the IO.



The extension drivers were designed to make device driver development easier, but device driver development is tricky. Writing applications is much easier, thus using a cut-down Windows 8.1, the Windows for Devices program looked into a solution to access microcontroller IO from user-mode applications. The Resource Hub Proxy (RHProxy) was developed to interact directly with the Framework Extension drivers to provide access to the microcontroller IO. Since the different IO can be wired to different devices, i.e. SPI can be used to program a firmware chip rather than be exposed to IO headers for general access. RHProxy lets the board manufacturers define in their firmware what IO is available to the programmers. Setup is performed in the firmware as described in [Guidelines to add RHProxy support to the firmware is on the Windows Dev Center site](#).



RHProxy is a driver that shows up under the System Devices in Device Manager.



### UP<sup>2</sup> Board BIOS Settings for HAT Connector

When Windows 10 IoT Core support was added to the UP<sup>2</sup> Board, the firmware was updated to support RHProxy. The latest version, as of this writing, is posted at the beginning of this article. To enable RHProxy support, you have to set which operating system is running. In the BIOS setup, set the following:

**Boot -> OS Selection: Windows 10 IoT Core**

Since Windows 10 IoT Core and Windows 10 Enterprise LTSC 2019 (aka Windows 10 IoT Enterprise) are the same operating system, the setting applies to both. With the OS Image ID set, RHPROXY is enabled in the firmware. According to the UP<sup>2</sup> Board specification, the I/O from the Intel Atom goes through a CPLD to the 40-pin HAT connector. The CPLD acts as a voltage level shifter so the 40-pin HAT connector has 3.3V tolerant pins. The HAT connector has two 3.3v out pins, two 5v out pins, and 8 ground (GND) pins. The rest of the 28 pins are for GPIO, I2C, UART, SPI, ADC, PWM, and SDIO.

There is UWP API support for I2C, UART, SPI, ADC, and PWM, but there is driver support only for I2C, UART, and SPI on the UP<sup>2</sup> Board. The UP<sup>2</sup> Board documentation on the HAT connector is a little different from what the firmware is showing and what Windows is supporting. The differences can cause some confusion for the developers. Here is what we have found in our lab testing:

- The firmware has a list of GPIO and their pin assignments. Lab testing shows that these don't match. The pinout table shows what we have found with the current version of the firmware.
- The firmware has I2C1, I2C2, I2C6, and I2C7, but Windows only supports the firmware's I2C1, and Windows sees this as I2C0.
- There is the ability to enable SP1 and SPI3, but SPI3 pin assignments are unknown. There is also no mention of SPI3 in any documentation on the forum at the time of this writing.

In the **Advanced-> HAT Configuration** section of the firmware, there are two steps to set up the I/O. The first is to enable the serial I/O, so the shared GPIO on the pin is disabled. The table below lists the firmware options and the settings to enable the Serial I/O.

Firmware Option	Setting	Notes
LPSS HSUART#2 Support	<b>ACPI Mode</b>	UART2 in Windows
LPSS SPI #1 Support	<b>ACPI Mode</b>	SPI1 in Windows
LPSS SPI #2 Support	<b>Disabled</b>	
LPSS SPI #3 Support	<b>Disabled</b>	SPI3 shows up for Pins 7, 13, 15, and 29, but function assignments are unknown
LPSS I2C #1 Support	<b>ACPI</b>	I2C0 in Windows
LPSS I2C #2 Support	<b>Disabled</b>	
LPSS I2C #6 Support	<b>Disabled</b>	Shows up on EX-HAT as I2C5
LPSS I2C #7 Support	<b>Disabled</b>	Shows up on EX-HAT as I2C6
GPIO / PWM #0 Selection	<b>GPIO</b>	
GPIO / PWM #1 Selection	<b>GPIO</b>	
GPIO / PWM #3 Selection	<b>GPIO</b>	
GPIO / I2S5 Selection	<b>GPIO</b>	
HD-Audio / I2S6 Selection	<b>Disabled</b>	
GPIO / I2S2 Selection	<b>GPIO</b>	
GPIO / Speaker Selection	<b>GPIO</b>	
GPIO / SP1 Selection	<b>GPIO</b>	Enabled SPI1 on EX HAT Pins 37,39,41,43,45 – But are not functional.
GPIO / DMIC / I2S4 Selection	<b>GPIO</b>	

If SPI, UART, I2C along with ADC, SDIO, I2S, and PWM were disabled, in theory, the pins all become GPIO pins, but this is not the case. Several pins are tied to the output of GPIO 48, but are inverted. Once SPI, UART, and I2C are enabled, the pins for these I/O are dedicated to the serial devices and cannot be used for GPIO.

The second step is to configure the GPIO, which is below the settings for the serial setup. Scroll down to set any enabled GPIO for input or output. If set to output the initial state of Low (Logic 0 / 0V) or High (Logic 1 / 3.3v) can also be set.

If the above table has the settings to enable I2C0, SPI, and UART1, the following table for the 40-pin HAT header shows the I/O in **bold** that is available for Windows UWP applications.

OS-Serial I/O	OS-GPIO	BIOS	UP <sup>2</sup> Board Documentation	HAT Header		UP <sup>2</sup> Board Documentation	BIOS	OS-GPIO	OS-Serial I/O
				Odd Pin	Even Pin				
			3.3V	1	2	5V			
		GPIO1	GPIO0/I2C1_SDA	3	4	5V			
		GPIO2	GPIO1/I2C1_SCL	5	6	GND			
		GPIO3	GPIO2/ADC	7	8	GPIO15/UART1-TX	GPIO16		UART2-TX
			GND	9	10	GPIO16/UART1-RX	GPIO17		UART2-RX
UART2-RTS	GPIO2	GPIO4	GPIO3/UART1_RTS	11	12	GPIO17	GPIO18	GPIO41	
	GPIO5	GPIO5	GPIO4/ADC	13	14	GND			
	GPIO6	GPIO6	GPIO5/ADC	15	16	GPIO18	GPIO19	GPIO48	
			3.3V	17	18	GPIO19	GPIO20	GPIO11	
SPI1-MOSI	/GPIO48	GPIO7	GPIO6/SPI1-MOSI	19	20	GND			
SPI1-MISO	/GPIO48	GPIO8	GPIO7/SPI1-MISO	21	22	GPIO20	GPIO21	GPIO10	
SPI1-CLK	/GPIO48	GPIO9	GPIO8/SPI1-CLK	23	24	GPIO21/SPI1-CS0N	GPIO22	/GPIO48	SPI1-CS0
			GND	25	26	GPIO22/SPI1-CS1N	GPIO23	/GPIO48	SPI1-CS0
I2C0_SDA	/GPIO48	GPIO10	GPIO9/I2C0_SDA	27	28	GPIO23/I2C0_SCL	GPIO24	/GPIO48	I2C0_SCL
	GPIO7	GPIO11	GPIO10	29	30	GND			
	GPIO14	GPIO12	GPIO11	31	32	GPIO24/PWM0	GPIO25	/GPIO48	
	GPIO24	GPIO13	GPIO12/PWM1	33	34	GND			
	GPIO40	GPIO14	GPIO13	35	36	GPIO25/UART1_CTS	GPIO26		UART2-CTS
	GPIO13	GPIO15	GPIO14	37	38	GPIO26 / I2S-D+	GPIO27	/GPIO48	
			GND	39	40	GPIO27 / I2S-D0	GPIO28	/GPIO48	

**Note:** The I/O that is crossed out is not available for Windows at the time of this writing.

**Note:** Pins 3, 5, and 7 are not tied to any I/O. Future BIOS versions might change this support

Once you save the changes and boot into Windows, Device Manager will show RHPROXY support, and UWP applications can be developed to access the I/O.

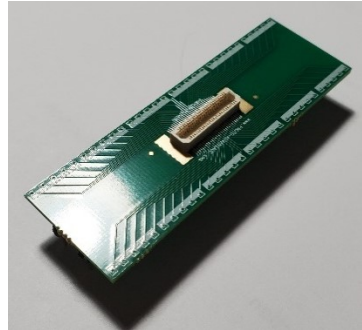
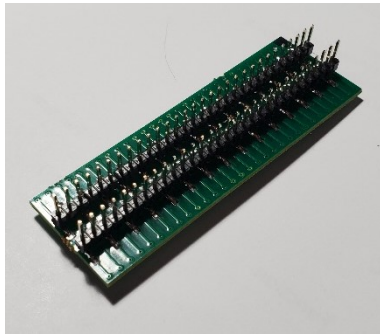
### EX HAT Connector

There is a 60 pin Panasonic P5K header (Part No. AXK6S60547YG) on the board that is called the EX HAT connector. It exposes LVDS, SPI, 2 I2C ports, DMIC, and ADC. If none of these options are selected, the pins become GPIO. Although the BIOS settings appear to configure the EX HAT pins, nothing appears to be functioning as expected, and Windows doesn't have driver support for the EX HAT connector at the time of this writing.

If support becomes available, there is a solution to expose the pins for the tiny header. The socket for the EX HAT connector is Panasonic Part No. AXK5S60047YG. Proto Advantage ([www.proto-advantage.com](http://www.proto-advantage.com)) offers a surface-mount adapter that can accommodate the socket connector: "Dual Row 0.5mm Pitch 60-Pin Connector to DIP-60 Adapter" (Part No. DR050D254P060) ([Proto](#)

[Advantage - Dual Row 0.5mm Pitch 60-Pin Connector to DIP-60 Adapter \(proto-advantage.com\)](http://proto-advantage.com).

A DIP Pin can be added to create headers for each pin.



### **Summary**

GPIO, I2C, SPI, PWM, ADC, and UART have been standard IO on microcontrollers for decades. Many microcontrollers have these IO features multiplexed on pins, so care should be taken by the developer to properly configure these multiplexed pins. Intel added support for these microcontroller I/Os on their latest Atom™ processors. It is up to the board manufacturer to make these I/Os available to the developer. For Windows support, the firmware has to support RHPROXY.

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