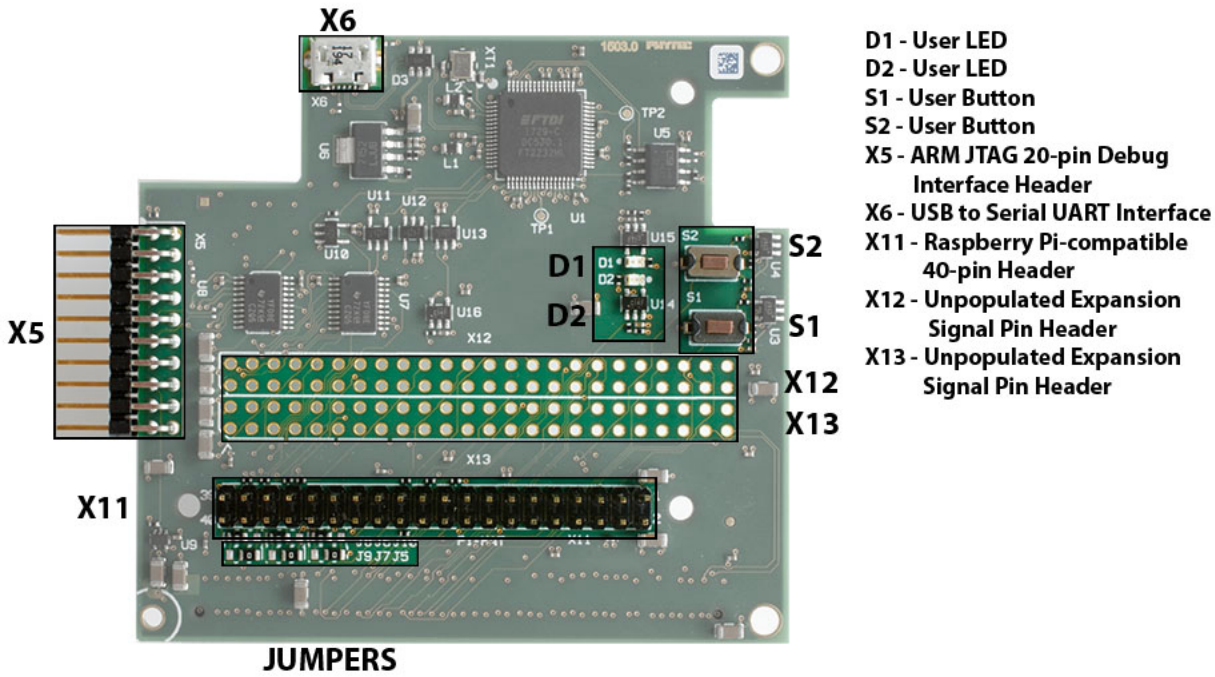
i.MX7: Evaluating the PEB-D-RPI Expansion Board

The phyBOARD-Zeta kit includes an expansion board (PEB-D-RPI) designed to facilitate the easy evaluation of certain interfaces available on PHYTEC i.MX7 platforms. The following sections will detail how to use these features in the environments in which they are supported. These instructions assume that you have properly connected the expansion board to the carrier board and have booted into a supported environment (U-Boot and/or Linux) using BSP version PD18.2.0 or newer. If you are looking for information regarding Raspberry Pi HAT support, please see i.MX7: Raspberry Pi HAT Support with PEB-D-RPI Expansion Board. The expansion board has the following features:

PEB-D-RPI Expansion Board Interfaces

Use the following as a reference for the connector interfaces on the PEB-D-RPI expansion board that will be used in this document.



USB to Serial UART Interface

The i.MX7 is configured by default to use UART5 for console input and output over the carrier board X2 connector shown in the Connector Interfaces section of the i.MX7 Quickstart. The USB to Serial UART interface on the PEB-D-RPI expansion board allows the use of UART1 and UART2 for serial data over connector X6 shown in the above PEB-D-RPI Expansion Board Interfaces section. However, only UART1 is configured in the BSP by default because UART2 is used by the M4 core in PHYTEC's FreeRTOS software.

Sending Serial Data Over USB

To send console data over USB, first connect the USB cable to the expansion board connector X6 and your host PC and power on the i.MX7 to boot into Linux. After booting, your host PC should have access to a serial port that can be connected to with a standard serial console program. Connect to the new serial port and run the following commands on the target over the UART5 serial connection. The first command sets the baud rate for UART1 and the second sends character data to UART1.

Target (Linux)

```
stty -F /dev/ttymxc0 115200
echo 'Testing UART1!' > /dev/ttymxc0
```

You should see 'Testing UART1!' output on the UART1 USB serial console. If not, check the USB serial port settings on the host PC and ensure that it is configured for 115200 baud rate.

Enable UART1 as Console in Linux

To enable UART1 as an additional console in Linux, run the following commands. Note that this setting will persist between boots but will not affect the default console in U-Boot and Linux.

Target (Linux)

```
systemctl enable serial-getty@ttymxc0.service
systemctl start serial-getty@ttymxc0.service
```

Configuring UART1 as Default Console in U-Boot and Linux

If you would like to use UART1 as the default console in U-Boot and Linux, boot into U-Boot and test the Linux configuration by running the following commands:

Target (U-Boot)

```
env set console=ttymxc0
boot
```

You should see the normal Linux boot output on the USB serial console. You should also be able to login, send commands, and receive expected output. If you would like to use UART1 as the default console, modify the U-Boot file 'include/configs/mx7d_phyboard_zeta.h' to match the following lines and recompile and re-deploy U-Boot onto your boot media:

Host (include/configs/mx7d_phyboard_zeta.h)

```
#define CONFIG_MXC_UART_BASE           UART1_IPS_BASE_ADDR
```

Host (include/configs/mx7d_phyboard_zeta.h)

```
#define CONFIG_CONS_INDEX              1
```

Host (include/configs/mx7d_phyboard_zeta.h)

```
/* under the define for CONFIG_EXTRA_ENV_SETTINGS */
"console=ttymxc0\0"
```

4KB EEPROM

This device allows you to use the I^2C4 interface to write and read small amounts of persistent data. The EEPROM is registered under the 'i2c4' node in the expansion board Linux device tree file 'imx7-peb-d-rpi.dtsi' and is accessible as a file in Linux's sysfs directory structure. To write to and read from the 4KB EEPROM on the expansion board, run the following commands on the target:

Target (Linux)

```
echo 'Testing EEPROM!!' > /sys/class/i2c-dev/i2c-3/device/3-0056/eeprom
hexdump -c -n 16 /sys/class/i2c-dev/i2c-3/device/3-0056/eeprom
```

You should see the values you wrote to the EEPROM displayed on your console in hexdump format.

Buttons

These buttons (S1 and S2) serve as an example of using GPIO pins as inputs to facilitate user input. The two buttons are registered under their own node, 'phytec_buttons', in the expansion board Linux device tree file 'imx7-peb-d-rpi.dtsi' and their status is accessible in Linux's debugfs directory structure. To poll the status of the buttons, run the following command on the target:

Target (Linux)

```
cat /sys/kernel/debug/gpio | grep pebdrpi_button
```

You should see the current state of the GPIO pins connected to the active-low buttons displayed on your console. Additionally, you should see the change in state if you run this command with one, or both, of the buttons held down.

LEDs

These LEDS (D1 and D2) serve as an example of using GPIO pins as outputs to control a device or devices. The two LEDs are registered under their own node, 'phytec_leds', in the expansion board Linux device tree file 'imx7-peb-d-rpi.dtsi' and their status and control are accessible in Linux's sysfs directory structure. To turn the LEDs on and off, run the following commands on the target:

Target (Linux)

```
cd /sys/class/leds
echo 0 > pebdrpi_led_1/brightness
echo 1 > pebdrpi_led_1/brightness
echo 0 > pebdrpi_led_2/brightness
echo 1 > pebdrpi_led_2/brightness
```

You should see the individual LEDs turn off and on based upon which digit you echoed and to which LED you echoed. If you would like to impress your friends or co-workers with your technical prowess, run the following commands on the target:

Target (Linux)

```
for i in `seq 1 20`; do
echo 0 > pebdrpi_led_1/brightness
echo 1 > pebdrpi_led_2/brightness
sleep 0.5
echo 1 > pebdrpi_led_1/brightness
echo 0 > pebdrpi_led_2/brightness
sleep 0.5
done
echo 0 > pebdrpi_led_1/brightness
```

Raspberry Pi-compatible 40-pin Header

This header (X11) serves as Raspberry Pi HAT hardware support and as a convenient location to connect to GPIO or other interface signals that are routed to the expansion board. If you are looking for information regarding Raspberry Pi HAT support, please see i.MX7: Raspberry Pi HAT Support with PEB-D-RPI Expansion Board.

GPIO and Interface Signals Map

The following tables show the GPIO bank and pin and Raspberry Pi-compatible interface signals mapping to the 40-pin header on the PEB-D-RPI expansion board:

GPIOs			
Pin Function	Pin Number		Pin Function
VCC_3V3MEM	1	2	VDD_5V0
I2C1_SDA	3	4	VDD_5V0
I2C1_SCL	5	6	GND
GPIO4_IO21	7	8	GPIO4_IO5
GND	9	10	GPIO4_IO4
GPIO4_IO20	11	12	GPIO5_IO15
GPIO4_IO22	13	14	GND
GPIO4_IO23	15	16	GPIO1_IO15
VCC_3V3MEM	17	18	GPIO1_IO14
GPIO6_IO20	19	20	GND
GPIO6_IO19	21	22	GPIO5_IO11
GPIO6_IO21	23	24	GPIO6_IO22
GND	25	26	GPIO5_IO9
I2C4_SDA	27	28	I2C4_SCL
GPIO5_IO14	29	30	GND
GPIO1_IO02	31	32	GPIO5_IO13
GPIO4_IO18	33	34	GND
GPIO5_IO16	35	36	GPIO4_IO19
GPIO4_IO16	37	38	GPIO4_IO17
GND	39	40	GPIO5_IO17

Interface Signals			
Pin Function	Pin Number		Pin Function
VCC_3V3MEM	1	2	VDD_5V0
I2C1_SDA	3	4	VDD_5V0
I2C1_SCL	5	6	GND
SPI2_MOSI	7	8	UART3_TX
GND	9	10	UART3_RX
SPI2_SCLK	11	12	SAI2_TX_BCLK
SPI2_MISO	13	14	GND
SPI2_SS0	15	16	GPIO1_IO15
VCC_3V3MEM	17	18	GPIO1_IO14
SPI3_MOSI	19	20	GND
SPI3_MOSI	21	22	GPIO5_IO11
SPI3_SCLK	23	24	SPI3_SS0
GND	25	26	SPI3_SS2
I2C4_SDA	27	28	I2C4_SCL
GPIO5_IO14	29	30	GND
PWM2_OUT	31	32	SAI2_RX_BCLK
SPI1_MISO	33	34	GND
SAI2_TX_SYNC	35	36	SPI1_SS0
SPI1_SCLK	37	38	SPI1_MOSI
GND	39	40	SAI2_TX_DATA0

The pin functions highlighted in blue are fixed and can not or should not be changed.

Jumpers

The 40-pin header also features a method to toggle the selection of specific Raspberry Pi-compatible interface signals to certain pins to support different Raspberry Pi HATs using soldered jumpers. The following table details the pins and signals that the jumpers control:

Jumper	Pin	Default Signal (position 1+2)	Alternative Signal (position 2+3)
J5	31	PWM2_OUT	SAI2_TX_BCLK
J6	33	SPI1_MISO	SAI2_TX_SYNC
J7	35	SD2_DATA2	SPI1_MISO
J8	37	SPI1_SCLK	SAI2_TX_DATA0
J9	40	SD2_DATA3	SPI1_SCLK
J10	12	SD2_DATA1	PWM2_OUT
J11	29	GPIO5_IO14	SPI1_MOSI
J12	38	SPI1_MOSI	GPIO5_IO14

Toggling GPIOs Connected to 40-pin Header

When a Raspberry Pi HAT isn't connected, you can use PHYTEC's RPi.GPIO Python library (included with BSP version PD18.2.0 or later) to control GPIOs connected to the 40-pin header. By default, only the following pins are configured for GPIO use in the PEB-D-RPI device tree file: 7, 11, 12, 13, 15, 16, 18, 22, 29, 32, 35, 40. For information on how to enable more GPIOs, please reference i.MX7: Raspberry Pi HAT Support with PEB-D-RPI Expansion Board.

To set pin 7 on the 40-pin header to be a GPIO output and toggle its value, open your Python interpreter on the target and input the following code:

Target (Python Interpreter)

```
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BOARD)
GPIO.setup(7, GPIO.OUT)
GPIO.output(7, GPIO.HIGH)
GPIO.output(7, GPIO.LOW)
GPIO.cleanup()
exit()
```

Using a digital multimeter or other suitable device, you can see the value on pin 7 of the 40-pin header go from 0 to 3.3 V and back to 0 V using the above code. You can also toggle GPIOs using the libgpiod utilities installed to the BSP file system. To toggle the same pin using libgpiod utilities, run the following commands on the target:

Target (Linux)

```
gpioset 3 21=1
gpioset 3 21=0
```

The above commands toggle GPIO chip 4, pin 21, which is routed to pin 7 of the 40-pin header on the PEB-D-RPI expansion board.

ARM JTAG 20-pin Debug Interface Header

This header (X5) allows you to connect an ARM JTAG 20-pin compatible debugger to the i.MX7. PHYTEC has tested the JTAG header and interface using an ARM DSTREAM debugger along with ARM DS-5 Development Studio. You will need to reference the documentation provided by the manufacturer of your debugger to configure and connect your debugger to the debug header.

Unpopulated Expansion Signal Pin Headers

These unpopulated headers (X12 and X13) can be used to access expansion board signals that are not brought out to the Raspberry Pi-compatible 40-pin header. The following tables show the signals brought out to the unpopulated headers:

Connector X12			
Signal	Pin Number		Signal
VCC_3V3MEM	1	2	VDD_5V0

GND	3	4	GND
SD2_DATA0	5	6	SD2_DATA3
SD2_DATA1	7	8	SD2_CLK
SD2_DATA2	9	10	SD2_CMD
SPI1_MISO	11	12	SPI1_MOSI
GND	13	14	GND
UART7_TX	15	16	UART7_RX
UART7_RTS	17	18	UART7_CTS
SPI1_SCLK	19	20	SPI1_SS0
X_POR_B	21	22	GND
X_SPI3_MISO	23	24	X_SPI3_SCLK
X_SPI3_MOSI	25	26	X_SPI3_SS0
GND	27	28	GND
X_SD2_CD_B	29	30	X_PWM2
X_SD2_WP	31	32	X_CAN2_TX
X_RD2_RESET_B	33	34	X_CAN2_RX
X_MX7_ONOFF	35	36	X_PMIC_PWRON
GND	37	38	GND
X_UART1_TX	39	40	X_UART3_TX
X_UART1_RX	41	42	X_UART3_RX
X_UART2_TX	43	44	X_UART6_TX
X_UART2_RX	45	46	X_UART6_RX
GND	47	48	GND

Connector X13

Signal	Pin Number		Signal
VCC_3V3MEM	1	2	VDD_5V0
X_I2C4_SDA	3	4	X_SNVS_TAMPER0
X_I2C4_SCL	5	6	GND
GND	7	8	X_GPIO2_30
X_NAND_CE1_B	9	10	X_NAND_CE2_B
X_NAND_CE0_B	11	12	X_NAND_CE3_B
X_NAND_DQS	13	14	X_NAND_READY_B
X_NAND_WP_B	15	16	GND
GND	17	18	EXP_CONN_MUX7
EXP_CONN_MUX1	19	20	EXP_CONN_MUX8
EXP_CONN_MUX2	21	22	EXP_CONN_MUX9
EXP_CONN_MUX3	23	24	GND
GND	25	26	EXP_CONN_MUX10
EXP_CONN_MUX4	27	28	EXP_CONN_MUX11
EXP_CONN_MUX5	29	30	EXP_CONN_MUX12
EXP_CONN_MUX6	31	32	GND
GND	33	34	X_GPIO2_10
X_ADC_IN0	35	36	X_GPIO2_11
X_ADC_IN1	37	38	X_GPIO2_12
X_ADC_IN2	39	40	X_GPIO2_13
X_ADC_IN3	41	42	X_GPIO2_14
GND	43	44	GND

X_USB_H_DATA	45	46	X_MDIO_D
X_USB_H_STROBE	47	48	X_MDIO_CLK