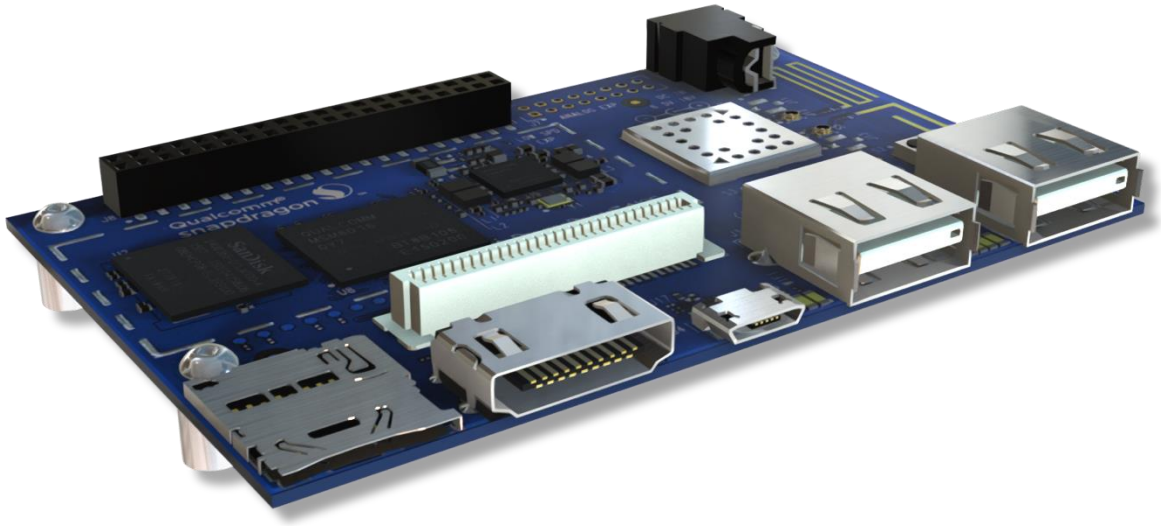
DragonBoard™ 410c

Hardware Manual



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Contents

1 Introduction

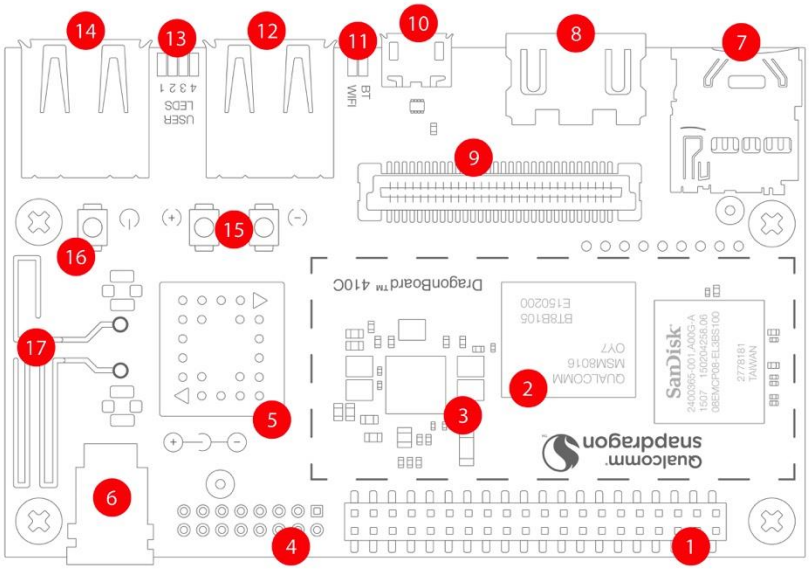
The DragonBoard 410C (‘410C’) board is a 96Boards compliant community board based on Qualcomm® SnapDragon 400 series of SoC’s.

The following table lists its key features:

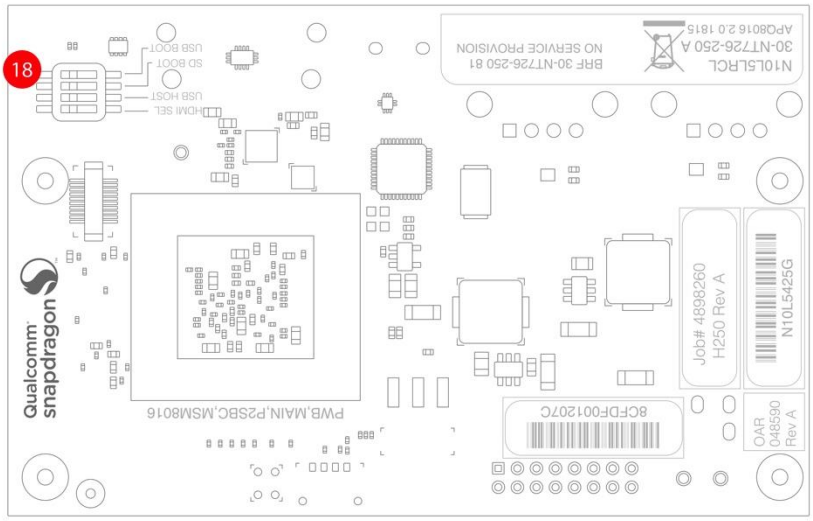
Processor	Qualcomm Snapdragon 410 Quad-core ARM® Cortex® A53 at up to 1.2 GHz per core 64-Bit capable Qualcomm Adreno 306 400MHz GPU for PC-class graphics with support for advanced APIs, including OpenGL ES 3.0, OpenCL, DirectX, and content security
Memory/ Storage	1GB LPDDR3 533MHz 8GB e.MMC 4.51 SD 3.0 (UHS-I)
Video	1080p@30fps HD video playback and capture with H.264 (AVC), and 720p playback with H.265 (HEVC)
Camera Support	Integrated ISP with support for image sensors up to 13MP
Audio	PCM/AAC+/MP3/WMA, ECNS, Audio+ post-processing (optional)
Connectivity	WLAN 802.11a/b/g/n 2.4GHz Bluetooth 4.1 One USB 2.0 micro B (device mode only) Two USB 2.0 (host mode only) GPS On-board GPS antenna On-board BT and WLAN antenna
I/O Interfaces	One 40-pin Low Speed (LS) expansion connector • UART, SPI, I2S, I2C x2, GPIO x12, DC power One 60-pin High Speed (HS) expansion connector • 4L-MIPI DSI, USB, I2C x2, 2L+4LMIPI CSI Footprint for one optional 16-pin analog expansion connector for stereo headset/ line-out, speaker and analog line-in The board can be made compatible with Arduino using an add-on mezzanine board
External Storage	Micro SD card slot

User Interface	Power/Reset Volume Up/down 6 LED indicators • 4 - user controllable • 2 - for radios (BT and WLAN activity)
OS-support	Android 5.1 Linux based on Ubuntu Windows 10 (planned support)
Power, Mechanical and Environmental	Power: +6.5V to +18V Dimensions: 54cm by 85cm meeting 96Boards™ Consumer Edition standard dimensions specifications. Operating Temp: 0°C to +70°C RoHS and Reach compliant

1.1 Board overview

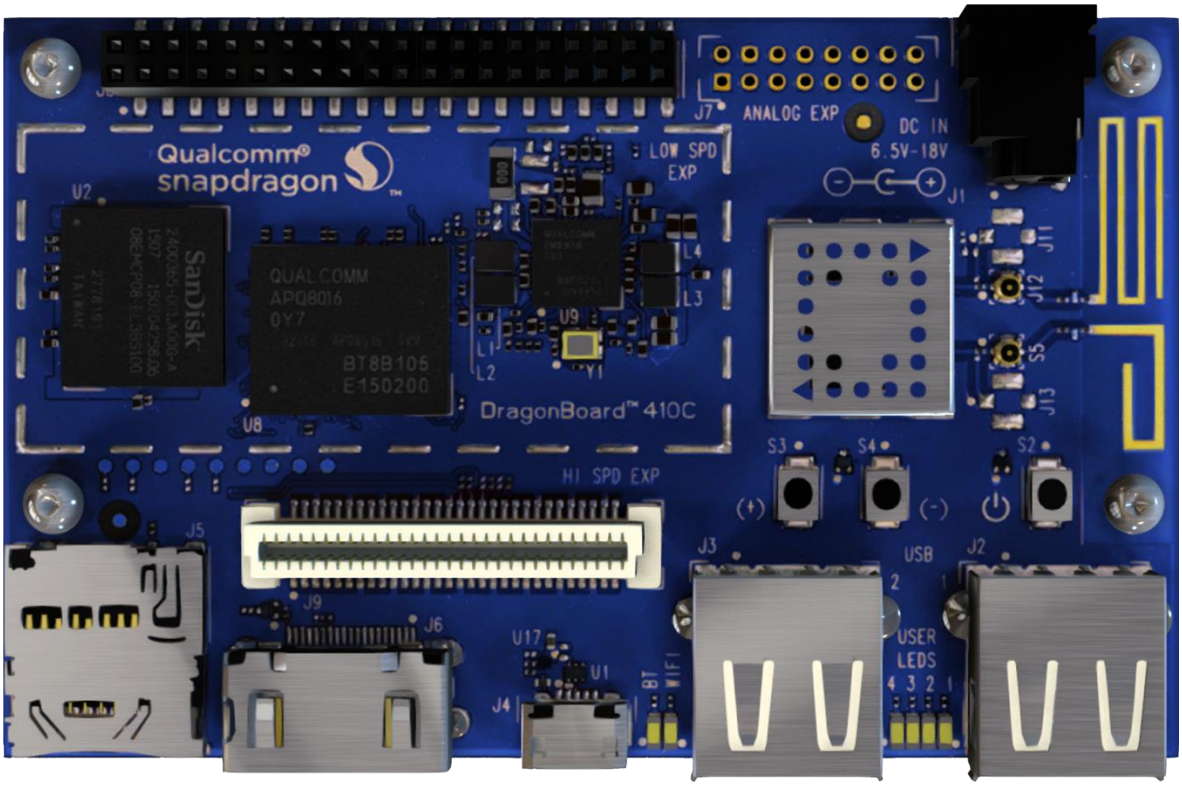


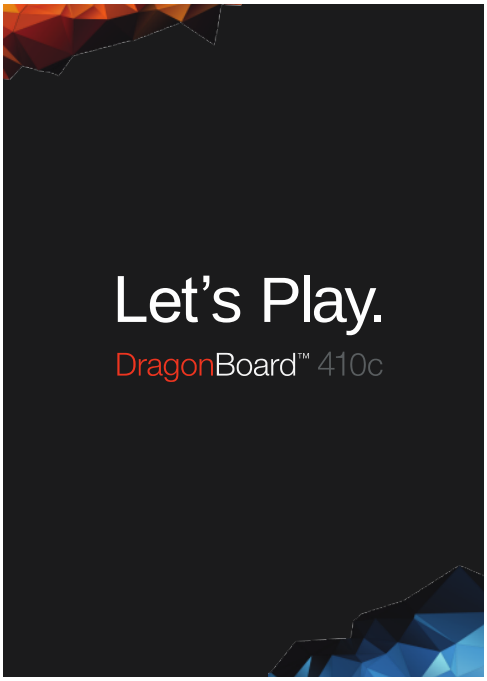
1.	(J8) Low Speed Expansion Connector
2.	APQ8016 Snapdragon processor
3.	(U9) Power Management PMIC
4.	(J7) Analog Expansion Connector
5.	Wireless Bluetooth
6.	(J1) Power Jack
7.	(J5) uSD Card Socket
8.	(J6) HDMI Port
9.	(J9) High Speed Connector
10.	(J4) USB OTF Connector
11.	Bluetooth/WiFi LED's
12.	(J3) USB Host2 Connector
13.	User LED's 1-4
14.	(J2) USB Host1 Connector
15.	(S3-4) Vol+/Vol- Buttons
16.	(S2) Power Button
17.	Bluetooth/WiFi Antenna
18.	(S6) Boot swithes



2 What's in the Box

The box contains one 410C board and a quick start guide.





3 Getting started

3.1 Prerequisites

Before you power up your 410C board for the first time you will need the following:

- 410C board
- A 96Boards compliant power supply (sold separately by Arrow)
- A HDMI or DVI LCD Monitor that supports a resolution of 1080P
- HDMI-HDMI cable or HDMI-DVI cable to connect the board to the Monitor
- A computer keyboard with USB interface
- A computer mouse with USB interface

3.2 Starting the board for the first time

To start the board, follow these simple steps:

step 1. Connect the HDMI cable to the 410C HDMI connector (marked J6) and to the LCD Monitor.

step 2. Connect the keyboard to the boards USB connector marked J3 and the mouse to the USB connector marked J2.

step 3. Ensure that the boot switches S6 are set to 0000.

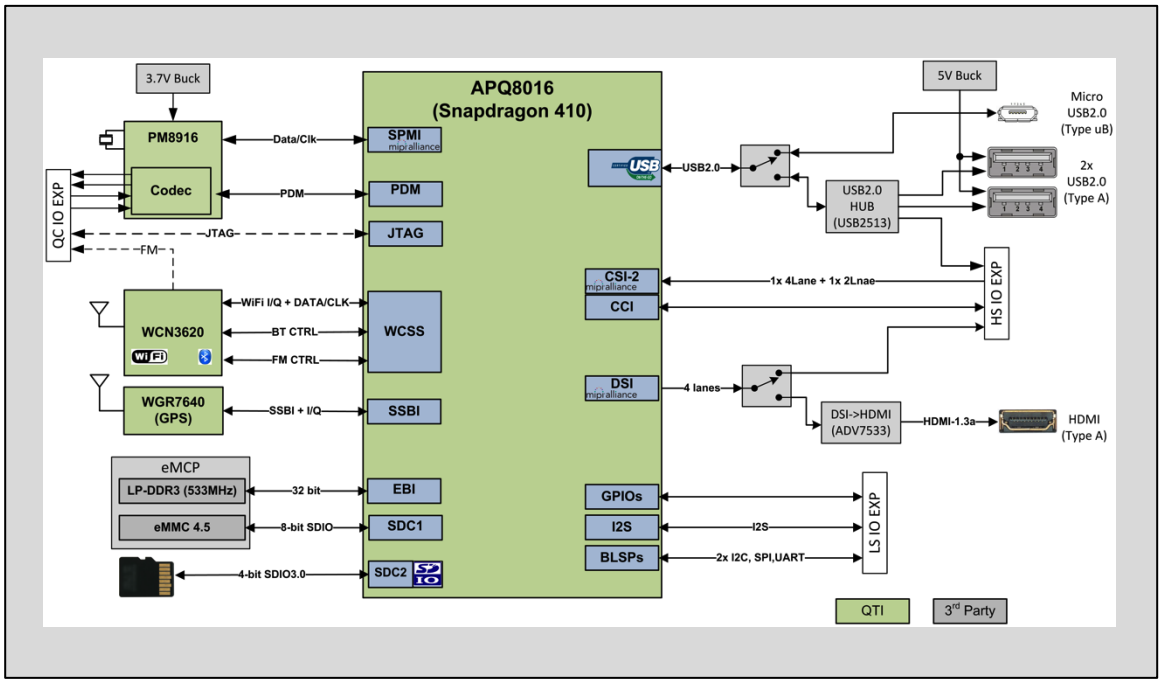
step 4. Connect the power supply to power connector J1.

Once you plug the power supply into a power outlet the board will start the booting process, and you should see Android boot up.

Please note that the first boot takes several minutes due to Androids initialization. Subsequent boot times should be faster.

4 Dragonboard Overview

4.1 System Block diagram



4.2 Processor

The SnapDragon 410 APQ8016 is a quad 64-bit ARM Cortex-A53 MPcore Harvard Superscalar core, supports both LP-DDR2 / LP-DDR3 SDRAM interface, Hexagon QDSP6, 13.5 MP camera input support, Adreno 306 GPU, 1080p video encode/decode, gpsOneGen 8A with GLONASS, Bluetooth 4.0, OpenGL ES 3.0, DirectX, OpenCL, Renderscript Compute, FlexRender support.

4.3 Memory

The 410C uses a singel package dual function LPDDR3/eMMC memory solution. The installed chip provides 8Gbyte of solid state storage and 1Gbyte of LPDDR.

- The LPDDR3 is a 32bit width bus implementation interfacing directly to the APQ8016 build-in LPDDR controller. The maximum DDR clock is 533Mhz
- The eMMC is an 8bit implementation interfacing with APQ8016 SDC1 interface supporting eMMC 4.5 specifications.

4.4 MicroSDHC

The 96Boards specification calls for a microSDHC socket to be present on the board.

The 410C board µSD slot (J5) signals are routed directly to the APQ8016 SDC2 interface. The slot is a push-push type with a dedicated support for card detect signal (many µSD slots do not have a dedicated CD pins, they use DATA3 state as the card detected signal). The 410C board uses APQ GPIO_38 as the SD_CARD_DET_N.

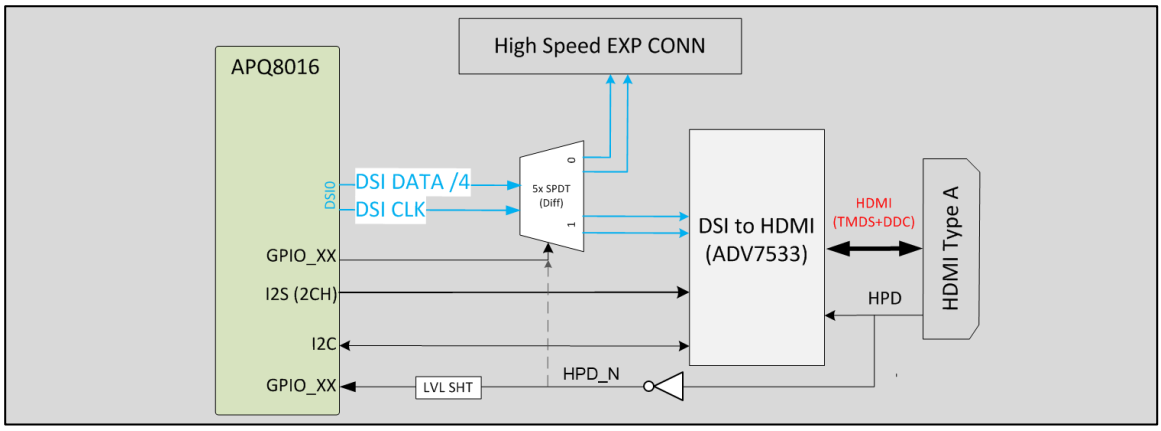
4.5 Wifi/BT/RF

The 96Boards specifications calls for a WiFi (minimally 802.11g/n) and Bluetooth 4.0 (Bluetooth Low Energy)

The 410C board deployed Qualcomm's RF chip WCN3620 (U5) solution that integrates three different wireless connectivity technologies into a single device, the interfaces are:

- WLAN compliant with IEEE 802.11 b/g/n specifications, meeting 96Boards minimal requirements for WiFi.
- Bluetooth compliant with the BT specifications version 4.0 (BR/EDT + BLE), meeting the 96Boards requirements for BT
- Worldwide FM radio, while this interface is not part of the 96Boards specifications mandatory specifications, it adheres to additional functionality closure

4.6 Display Interface



4.6.1 HDMI

The 96Boards specification calls for an HDMI port to be present on the board. The APQ8016 doesn't include a built-in HDMI interface. The 410C deploy the built-in MIPI-DSI 4 lanes interface as the source for the HDMI output. A peripheral DSI to HDMI Bridge (U3, Analog Devices ADV7533) performs this task and it supports a resolution from 480i to 1080p at 30Hz.

While the ADV7533 supports automatic input video format timing detection (CEA-861E), an I2C channel from the APQ8016 allows the user to configure the operation of this bridge. It is I2C3 interface from the SoC that connects to the bridge.

This bridge support audio as well (meeting the 96Boards requirements to provide audio via HDMI). The 410C a single bit I2S2 interface from the APQ8016 is used for this task.

Please note that the 96Boards specifications calls for a MIPI-DSI interface to be routed to the High Speed Expansion connector. Since the APQ8016 has only one MIPI-DSI interface. A muxing device(U11, FSA644UCK) is being use on the board. Only one interface, HDMI, or the Expansion MIPI-DSI can be active at a given time. The controlling signal is named 'DSI_SW_SEL_APQ'. When this signal is logic low, '0', the MIPI-DSI is routed to the DSI-HDMI Bridge. When 'DSI_SW_SEL_APQ' is logic level high, '1', the MIPI-DSI is routed to the High Speed Expansion connector. This design assigned the 'DSI_SW_SEL_APQ' function to GPIO_32.

User can overwrite the software control by sliding switch 4 of DipSwitch S6 to the 'ON' position. That action forces the DSI mux to route the MIPI-DSI to the DSI-HDMI Bridge. The overwrite option exist for the HDMI only, you cannot hardware overwrite the mux to the High Speed Expansion connector.

4.6.2 MIPI-DSI

The 96Boards specification calls for a MIPI-DSI implementation via the High Speed Expansion Connector.

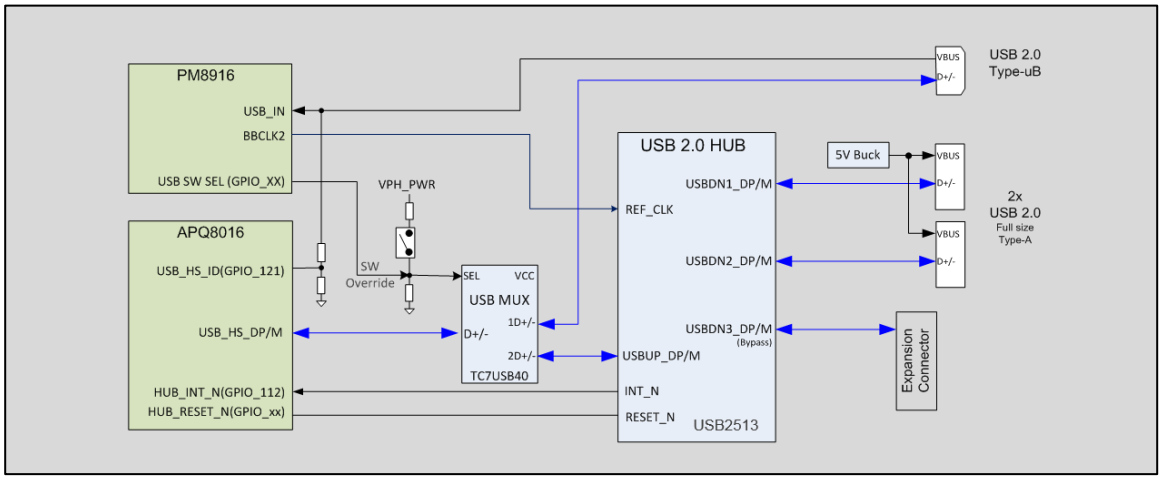
The 410C implemented a four-lane MIPI_DSI interface meeting this requirement. More information about this implementation can be found in chapter 6 High speed expansion connector.

4.7 Camera Interfaces

The 96Boards specification calls for two camera interfaces.

The 410C implemented two camera interfaces, one with a four-lane MIPI_CSI interface and one with two-lane MIPI_SCI interface, meeting this requirement. More information about this implementation can be found in chapter 6 High speed expansion connector.

4.8 USB Ports



4.8.1 USB-Host ports

The 96Boards specification calls for three USB host ports. The APQ8016 includes a single USBOTG channel. A USB switch, S1, routes this single USB channel to a USB HUB or to the MicroUSB connector (J4). The control of S1 is done via a software controlled GPIO(USB_SW_SEL_PM). When this signal is logic low, '0', the USB data lines are routed to the MicroUSB connector and the APQ8016 built-in USBOTG port is set to device mode. When 'USB_SW_SEL_PM is logic level high, '1', the USB data lines are routed to the USB HUB and the APQ8016 built-in USBOTG port is set to host mode. User can overwrite the software control by sliding switch 3 of DipSwitch S6 to the 'ON' position. That action force S1 mux to route the built-in USBOTG data lines to the USB HUB. The overwrite option exist for the host mode only, you cannot hardware overwrite the mux to the device mode. USB_SW_SEL_PM (PM GPIO_4) is a borrowed GPIO form the board PMIC.

When S1 is set to host mode (USB_SW_SEL_PM is '1'), the built-in USBOTG data lines are routed to U10, a three-ports USB HUB.

Port 1 of the USB HUB is routed to J3, a Type 'A' USB Host connector. A current limited controller (U4) sets the Power Current limit to 1.18A. This port is named HOST2 in the board schematic.

Port 2 of the USB HUB is routed to J2, a Type 'A' USB Host connector. A current limited controller (U6) sets the Power Current limit to 1.18A. This port is named HOST1 in the board schematic.

Port 3 of the USB HUB is routed to the High Speed Expansion connector. No current limited controller is implemented on the board for this channel.

Please note: *the board can work in one node at a time, Host mode or Device mode, not both.*

4.8.2 USB-Device port

The 96Boards specification calls for a USB port to be implemented as an OTG port or a device port.

The 410C board implemented a device port. The port is located at J4, a MicroUSB type B. If an application requires the use of the device port, USB_SW_SEL_PM signal must be set to low '0' and the user must verify that switch 3 of DipSwitch S6 is set to the 'OFF' position.

Please note: *the board can work in one node at a time, Host mode or Device mode, not both.*

4.9 Audio

The 96Boards specifications calls for a minimum of single channel audio through two interfaces, BT and HDMI/MHL/DisplayPort

The 410C meets this requirement and has additional audio channels. More information about these additional channels can be found in chapter 4.18 Additional Functionality)

4.9.1 BT Audio

The BT implementation on the 410C is via a MAC in the APQ8016 and an external modem, WCN3620 (U5). A two wire interface between the SoC and the modem carries all communication including audio.

4.9.2 HDMI Audio

A 3-wire (audio out only) I2S channel is routed directly from the APQ8016 SoC I2S interface pins to the DSI-HDMI bridge (U3).

4.10 DC-power and Battery Power

The 96Boards specification calls for power to be provided to the board in one of the following ways:

- An 8V to 18V power from a dedicated DC jack
- An 8V to 18V power from the SYS_DCIN pins on the Low Speed Expansion Connector
- A USB Type C port at 5V

Please see section 9.1 for detailed information on 410C implementation of DC Power

4.11 Measurements

The 96Boards specification calls for support for measuring power consumptions of the board.

Please see section 9.6 for detailed information on 410C implementation power measurements

4.12 Buttons

The 96Boards specification calls for the present of two buttons, a Power on/off button and a reset button.

The 410C meet these requirement, please see section 10 for detailed information on the buttons of the 410c board.

4.13 External Fan connection

The 96Boards specification calls for support for an external fan. That can be achieved by using the 5V or the SYS_DCIN, both present on the Low Speed Expansion connector.

4.14 UART

The 96Boards specification calls for support for one SoC UART and an optional second UART both to be routed to the Low Speed Expansion Connector.

The 410C meet these requirement and additionally routes UART0 Tx/Rx lines to an on-board connector (J15). If the user want to use this on-board UART, J8 need to be soldered to the board as well as R173 and R174 (0 ohm 0201).

4.15 JTAG

APQ8016 SoC JTAG interface is routed to J15. If the use of JTAG is required, J8 need to be soldered to the board. The connections and connector pitch meets the 96Boards specification for the JTAG interface.

4.16 System and user LED

The 96Boards specifications calls for six LED's to be implemented on the board, the specification defines the LEDs color and their mechanical location on the board.

Two activity LEDs:

- WiFi activity LED – 410C board drives this Blue LED via MMP_2, an IO from the PMIC. This
- BT activity LED – 410C board drives this Yellow LED via MPP_3, an IO from the PMIC

Four User-LED's:

The four user LEDs are surface mount Green LED in 0603 size located next to the two USB type A connector and labeled 'USER LEDS 4 3 2 1'. The 410C board drives two LED's from the SoC GPIO, APQ GPIO_21 and APQ GPIO_120. The other two User LEDs are driven by the PMIC via PM GPIO_1 and PM GPIO_2.

4.17 Expansion Connector

The 96Boards specification calls for two Expansion Connectors, a Low Speed and a High Speed.

The 410C meets this requirement, please review section 6.0 for detailed information regarding the Low Speed Expansion Connector and section 7.0 for detailed information regarding the High Speed Expansion Connector.

4.18 Additional Functionality

The 96Boards specifications allows for additional functionality provided that all mandatory functionality is available and there is no impact on the physical footprint specifications including height and do not prevent the use of the 96Boards CE low speed and high speed expansion facilities

The 410C board implemented few additional functions, which are listed in the following sub-chapters.

4.18.1 GPS

The GPS implementation is based on Qualcomm WGR760 GNSS RF receiver (U7) supporting GPS, GLONASS and COMPASS. The APQ8016 communicate directly with the WGR760.

4.18.2 On Board Analog Microphone

Info on the on board microphone can be found in section 8.2

4.18.3 Analog Connector

Detailed info on the analog connector is provided in section 8.0

5 Low speed Expansion connector

The following tables show the Low Speed Expansion Connector pin out:

PIN	96Boards Signals	T410 Signals	Note
1	GND	GND	
3	UART0_CTS	UART0_CTS_N (APQ GPIO_2)	
5	UART0_TxD	UART0_TX (APQ GPIO_0)	
7	UART0_RxD	UART0_RX (APQ GPIO_1)	
9	UART0_RTS	UART0_RTS_N (APQ GPIO_3)	
11	UART1_TxD	UART1_TX (APQ GPIO_4)	
13	UART1_RxD	UART1_RX (APQ GPIO_5)	
15	I2C0_SCL	I2C0_SCL (APQ GPIO_7)	
17	I2C0_SDA	I2C0_SDA (APQ GPIO_6)	
19	I2C1_SCL	I2C1_SCL (APQ GPIO_23)	
21	I2C1_SDA	I2C1_SDA (APQ GPIO_22)	
23	GPIO-A	LS_EXP_GPIO_A (APQ GPIO_36) (APQ INT)	
25	GPIO-C	LS_EXP_GPIO_C (APQ GPIO_13) (TS_INT_N)	
27	GPIO-E	LS_EXP_GPIO_E (APQ GPIO_115) (GYRO_ACCL_INT_N)	
29	GPIO-G	LS_EXP_GPIO_G (APQ GPIO_24) (DSI_VSYNC)	
31	GPIO-I	LS_EXP_GPIO_I (APQ GPIO_35) (CSI0_RST)	
33	GPIO-K	LS_EXP_GPIO_K (APQ GPIO_28) (CSI1_RST)	
35	+1V8	LS_EXP_1P8	
37	+5V	SYS_5P0	
39	GND	GND	

PIN	96Boards Signals	T410 Signals	Note
2	GND	GND	
4	PWR_BTN_N	PHONE_ON_N	
6	RST_BTN_N	PM_RESIN_N	
8	SPI0_SCLK	SPI0_CLK (APQ GPIO_19)	
10	SPI0_DIN	SPI0_MISO (APQ GPIO_17)	
12	SPI0_CS	SPI0_CS_N (APQ GPIO_18)	
14	SPI0_DOUT	SPI0_MOSI (APQ GPIO_16)	
16	PCM_FS	LS_EXP_MI2S_WS (APQ GPIO_110)	
18	PCM_CLK	LS_EXP_MI2S_SCK (APQ GPIO_113) (ALPS_INT)	
20	PCM_DO	LS_EXP_Mi2S_DATA0 (APQ GPIO_114)	
22	PCM_DI	N.C.	***I2S only supports audio out***
24	GPIO-B	LS_EXP_GPIO_B (APQ GPIO_12) (TS_RST_N)	
26	GPIO-D	LS_EXP_GPIO_D (APQ GPIO_69) (MAG_INT)	
28	GPIO-F	LS_EXP_GPIO_F (PM_MPP_4) (DSI_BLCTRL))	***Borrowed GPIO from PMIC***
30	GPIO-H	LS_EXP_GPIO_H (APQ GPIO_25) (DSI_RST)	
32	GPIO-J	LS_EXP_GPIO_J (APQ GPIO_34) (CSI0_PWDN)	
34	GPIO-L	LS_EXP_GPIO_L (APQ GPIO_33) (CSI1_PWDN)	
36	SYS_DCIN	SYS_DCIN	
38	SYC_DCIN	SYS_DCIN	
40	GND	GND	

5.1 UART {0/1}

The 96Boards specifications calls for a 4-wire UART implementation, UART0 and an optimal second 2-wire UART, UART1 on the Low Speed Expansion Connector.

The 410C board implemented UART0 as a 4-wire UART that connects directly to the APQ8016 SoC. These signals are driven at 1.8V.

The 410C board implemented UART1 as a 2-wire UART that connects directly to the APQ8016 SoC. These signals are driven at 1.8V.

5.2 I2C {0/1}

The 96Boards specification calls for two I2C interface to be implemented on the Low Speed Expansion Connector.

The 410C board implemented both interfaces, I2C0 and I2C1 that connects directly to the APQ8016SoC. A 2K resistor is provided as pull-up for each of the I2C lines per the I2C specifications, these pull-ups are connected to the 1.8V voltage rail.

5.3 GPIO {A-L}

The 96Boards specifications calls for 12 GPIO lines to be implemented on the Low Speed Expansion Connector, some of these GPIOs should support an alternate function for DSI/CSI control

The 410C board implemented this requirement, 11 GPIOs are routed to the APQ8016 SoC and one GPIO is connected to the on-board PMIC.

- GPIO A - Connects to GPIO_36 of APQ8016 SoC, can serves as AQP_INT supporting the 96Boards requirements to create a wake-up event for the SoC. It is a 1.8V signal
- GPIO B - Connects to GPIO_12 of APQ8016 SoC. It is a 1.8V signal
- GPIO C - Connects to GPIO_13 of APQ8016 SoC. It is a 1.8V signal. Can be configured to be an IRQ line
- GPIO D - Connects to GPIO_69 of APQ8016 SoC. It is a 1.8V signal. Can be configured to be an IRQ line
- GPIO E - Connects to GPIO_115 of APQ8016 SoC. It is a 1.8V signal. Can be configured to be an IRQ line
- GPIO F - Connects to MPP_4 of PM8916 PMIC. It is a 1.8V signal. Can be configured to be the DSI backlight control
- GPIO G - Connects to GPIO_24 of APQ8016 SoC. It is a 1.8V signal. Can be configured to be DSI VSYNC signal.
- GPIO H - Connects to GPIO_25 of APQ8016 SoC. It is a 1.8V signal. Can be configured to be a DSI_RST signal.
- GPIO I - Connects to GPIO_35 of APQ8016 SoC. It is a 1.8V signal. Can be configured to be a CSI0_RST signal.
- GPIO J - Connects to GPIO_34 of APQ8016 SoC. It is a 1.8V signal. Can be configured to be a CSI0_PWDN signal.
- GPIO K - Connects to GPIO_28 of APQ8016 SoC. It is a 1.8V signal. Can be configured to be a CSI1_RST signal.
- GPIO L - Connects to GPIO_33 of APQ8016 SoC. It is a 1.8V signal. Can be configured to be a CSI1_PWDN signal.

5.4 SPI 0

The 96Boards specification calls for one SPI bus master to be provided on the Low Speed Expansion Connector.

The 410C board implemented a full SPI master with 4 wires, CLK, CS, MOSI and MISO all connect directly to the APQ8016 SoC. These signals are driven at 1.8V.

5.5 PCM/I2S

The 96Boards specification calls for one PCM/I2S bus to be provided on the Low Speed Expansion Connector. The CLK, FS and DO signals are required while the DI is optional.

The 410C board implemented a PCM/I2S with 3 wires, CLK, FS and DO, the optional DI signal is not implemented on the 410C board. The I2S signals are connected directly to the APQ8016 SoC. These signals are driven at 1.8V.

5.6 Power and Reset

The 96Boards specification calls for a signal on the Low Speed Expansion Connector that can power on/off the board and a signal that serves as a board reset signal.

The 410C board routes the PWR_BTN_N (named PHONE_ON_N on 410C schematic) signal to the KYPDPWR_N pin of the PM8916 PMIC. This signal is driven by S2 as well, the on-board power on/off push-button switch.

A mezzanine implementation of this signals should not drive it with any voltage, the only allowed operation is to force it to GND to start the board from a sleep mode. A board shut-done will occur when this signal is ground for more than x seconds

The 410C board routes the RST_BTN_N (named PM_RESIN_N on 410C schematic) signal to the RESIN_N pin of the PM8916 PMIC. This signal is driven by S4 as well. This signals is a dual purpose, any press lasting less than 10 seconds serves as Volume Down or Zoom out, a press longer than 10 seconds will reset the board.

5.7 Power Supplies

The 96Boards specification calls for three power rails to be present on the Low Speed Expansion Connector:

- +1.8V : Max of 0.1A
- +5V : Able to provide a minimum of 5W of power
- SYS_DCIN : 9-18V input with enough current to support all the board functions or the output DCIN from on-board DC Connector able to provide a minimum of 7W of power.

The 410C board supports these requiems as follow:

+1.8V : Driven by two PMIC LDOs, LDO15 and LDO16, each can provide 55mA. The PM8916 allows chaining them together to providing 110mA on a 1.8V rail which meets the 96Boards requirements.

+5V : Driven by the 4A 5.0V back switcher (U13). This rail powers both USB limit current devices at 1.18A max each allow a max current of 1.64A to the Low Speed Expansion Connector, a total of 8.2W which meets the 96Boards requirements.

SYS_DCIN: Can serves as the board mail power source or will receive power from the board to the connector.

6 High speed expansion connector

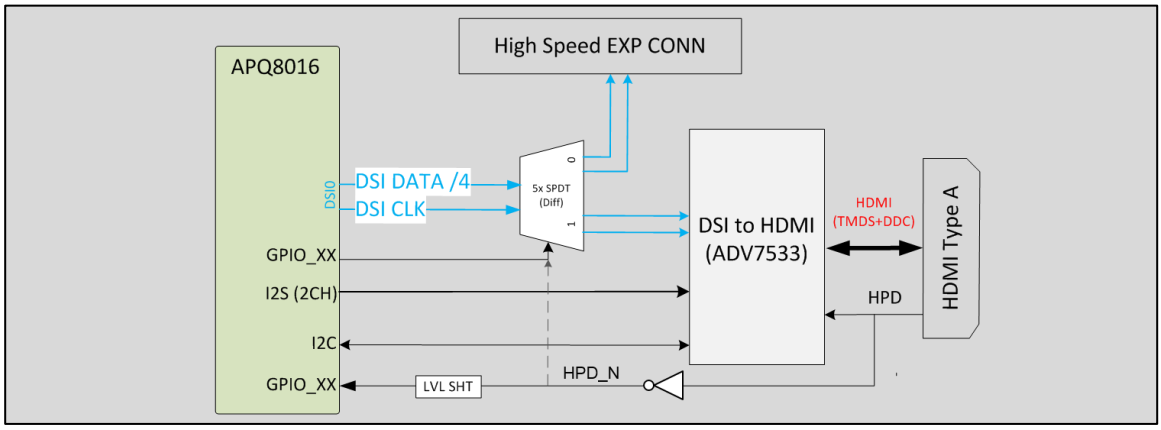
The following table shows the High Speed Expansion Connector pin out:

PIN	96Boards Signals	T410 Signals	Note
1	SD_DAT0/SPI1_DOUT	SPI1_MOSI (APQ GPIO_8)	
3	SD_DAT1	N.C.	
5	SD_DAT2	N.C.	***This is a SPI implementation. not an SD interface***
7	SD_DAT3/SPI1_CS	SPI1_CS_N (APQ GPIO_10)	
9	SD_SCLK/SPI1_SCLK	SPI1_CLK (APQ GPIO_11)	
11	SD_CMD/SPI1_DIN	SPI1_MISO (APQ GPIO_9)	
13	GND	GND	
15	CLK0/CSI0_MCLK	CSI0_MCLK (APQ GPIO_26)	
17	CLK1/CSI1_MCLK	CSI1_MCLK (APQ GPIO_27)	
19	GND	GND	
21	DSI_CLK+	MIPI_DSI0_CLK_P_EXP_CONN	
23	DSI_CLK-	MIPI_DSI0_CLK_M_EXP_CONN	
25	GND	GND	
27	DSI_D0+	MIPI_DSI0_DATA0_P_EXP_CONN	
29	DSI_D0-	MIPI_DSI0_DATA0_M_EXP_CONN	
31	GND	GND	
33	DSI_D1+	MIPI_DSI0_DATA1_P_EXP_CONN	
35	DSI_D1-	MIPI_DSI0_DATA1_M_EXP_CONN	
37	GND	GND	
39	DSI_D2+	MIPI_DSI0_DATA2_P_EXP_CONN	
41	DSI_D2-	MIPI_DSI0_DATA2_M_EXP_CONN	
43	GND	GND	
45	DSI_D3+	MIPI_DSI0_DATA3_P_EXP_CONN	
47	DSI_D3-	MIPI_DSI0_DATA3_M_EXP_CONN	
49	GND	GND	
51	USB_D+	USB_HS_D_P_EXP	
53	USB_D-	USB_HS_D_M_EXP	
55	GND	GND	
57	HSIC_STR	N.C.	***No HSIC implementation***
59	HSIC_DATA	N.C.	

PIN	96Boards Signals	T410 Signals	Note
2	CSI0_C+	MIPI_CSI0_CLK_P	
4	CSI0_C-	MIPI_CSI0_CLK_M	
6	GND	GND	
8	CSI0_D0+	MIPI_CSI0_DATA0_P	
10	CSI0_D0-	MIPI_CSI0_DATA0_M	
12	GND	GND	
14	CSI0_D1+	MIPI_CSI0_DATA1_P	
16	CCSI0_D1-	MIPI_CSI0_DATA1_M	

18	GND	GND	
20	CSI0_D2+	MIPI_CSI0_DATA2_P	
22	CSI0_D2-	MIPI_CSI0_DATA2_M	
24	GND	GND	
26	CSI0_D3+	MIPI_CSI0_DATA3_P	
28	CSI0_D3-	MIPI_CSI0_DATA3_M	
30	GND	GND	
32	I2C2_SCL	I2C2_SCL (APQ GPIO_30)	
34	I2C2_SCL	I2C2_SDA (APQ GPIO_29)	
36	I2C3_SDA	I2C3_SCL (APQ GPIO_15)	***R62 need to be installed***
38	I2C3_SDA	I2C3_SDA (APQ GPIO_14)	***R61 need to be installed***
40	GND	GND	
42	CSI1_D0+	MIPI_CSI1_DATA0_P	
44	CSI1_D0-	MIPI_CSI1_DATA0_M	
46	GND	GND	
48	CSI1_D1+	MIPI_CSI1_DATA1_P	
50	CSI1_D1-	MIPI_CSI1_DATA1_M	
52	GND	GND	
54	CSI1_C+	MIPI_CSI1_CLK_P	
56	CSI1_C-	MIPI_CSI1_CLK_M	
58	GND	GND	
60	RESERVED	N.C.	

6.1 MIPI DSI 0



The 96Boards specification calls for a MIPI-DSI to be present on the High Speed Expansion Connector. A minimum of one lane is required and up to four lanes can be accommodated on the connector.

The current 410C board implementation support a full four lane MIPI-DSI interface that is routed to the High Speed Expansion Connector. Since the APQ8016 has only single MIPI-DSI interface and it may be used to drive the DSI-HDMI Bridge, a DSI muxing is required.

A muxing device, U11 (FSA644UCK) is being use on the board. Only one interface, HDMI, or the Expansion MIPI-DSI can be active at a given time. The controlling signal is named 'DSI_SW_SEL_APQ'. When this signal is logic low, '0', the MIPI-DSI is routed to the DSI-HDMI Bridge.

When 'DSI_SW_SEL_APQ' is logic level high, '1', the MIPI-DSI is routed to the High Speed Expansion connector. This design assigned the 'DSI_SW_SEL_APQ' function to GPIO_32.

The user can overwrite the software control by sliding switch 4 of DipSwitch S6 to the 'ON' position. That action forces the DSI mux to route the MIPI-DSI to the DSI-HDMI Bridge. The overwrite option exist for the HDMI only, you cannot hardware overwrite the mux to the High Speed Expansion connector.

***Please note**: Configuring the board to use the MIPI-DSI is done via software. User must verify the switch 4 of DipSwitch S6 is set to the 'off' position*

6.2 MIPI CSI {0/1}

The 96Boards specification calls for two MIPI-CSI interfaces to be present on the High Speed Expansion Connector. Both interfaces are optional. CSI0 interface can be up to four lanes while CSI1 is up to two lanes.

The current 410C board implementation supports a full four lane MIPI-CSI interface on CSI0 and two lanes of MIPI-CSI on CSI1. All MIPI-SCIx signals are routed directly to/from the APQ8016.

6.3 I2C {2/3}

The 96Boards specification calls for two I2C interfaces to be present on the High Speed Expansion Connector. Both interfaces are optional unless a MIPI-CSI interface had been implemented. With that an I2C interface shall be implemented.

The current 410C board implementation supports two MIPI-SCI interfaces and therefor it supports two I2C interfaces.

For MIPI-CSI0 the companion I2C2 is routed directly from the APQ8016. For MIPI-CSI1, the companion I2C is I2C3, please note that you will need to add R61 and R62, a 0 ohm 0201 resistors to the board to support the routing of I2C3 interface to the High Speed Expansion Connector. Both interfaces, I2C2 and I2C3 have an on-board 2K pull-up resistor, pulled-up to 1.8V voltage rail.

6.4 HSIC

The 96Boards specification calls for an optional MIPI-HSIC interface to be present on the High Speed Expansion Connector.

The 410C board implemented doesn't support this optional requirement.

6.5 Reserved

The 96Boards specification calls for a 10K pull-up to 1.8V to be connected to pin 60 of the High Speed Expansion Connector.

The current 410C board implemented doesn't support this requirement; it will be addressed with the next revision of the 410C board.

6.6 SD/SPI

The 96Boards specification calls for an SD interface or a SPI port to be part of the High Speed Expansion Connector.

The 410C board implemented a full SPI master with 4 wires (96Boards SPI Configuration), CLK, CS, MOSI and MISO all connect directly to the APQ8016 SoC. These signals are driven at 1.8V.

6.7 Clocks

The 96Boards specification calls for one or two programmable clock interfaces to be provided on the High Speed Expansion Connector. These clocks may have a secondary function of being CSI0_MCLK and CSI1_MCLK. If these clocks can't be supported by the SoC than an alternative GPIO or No-Connect is allowed by the specifications.

The 410C board implemented two CSI clocks, CSI0_MCLK via APQ GPIO_26 and CSI1_MCLK via APQ GPIO_27. These signals are driven at 1.8V.

6.8 USB

The 96Boards specification calls for a USB Data line interface to be present on the High Speed Expansion Connector.

The 410C board implemented this requirements by routing USB channel 3 of the USB HUB to the High Speed Expansion Connector.

7 Analog Expansion Connector

PIN	Function	Connect to	Note
		PM8916 Audio signal	
1	SPKR_OUT_P	CDC_SPKDRV_P	Datasheet pin SPKR_DRV_P
		PM8916 Audio signal	
2	SPKR_OUT_M	CDC_SPKDRV_M	Datasheet pin SPKR_DRV_M
3	VPH_PWR	A 3.7V from U12 back switcher	
4	GND		
		PM8916 Audio signal	
5	GND_CFILT	CDC_GND_CFILT	
6	CDC_MIC2_P	PM8916 Audio signal CDC_IN2_P	Datasheet pin MIC2_IN
7	CDC_MIC3_P	PM8916 Audio signal CDC_IN3_P	Datasheet pin MIC3_IN
8	CDC_HPH_R	PM8916 Audio signal CDC_HPH_R	
9	CDC_HPH_REF	PM8916 Audio signal CDC_HPH_REF	
1	CDC_HPH_L	PM8916 Audio signal CDC_HPH_L	
0	CDC_HS_DET	PM8916 Audio signal CDC_HS_DET	
		PM8916 Audio signal	
11	CDC_MIC_BIAS1	CDC_MIC_BIAS1	
12	N.C.		
13	N.C.		
14	N.C.		
15	FM_RX_ANT	WCN3620 RF signal FM_HS_RX	
16	N.C.		

7.1 Speaker

The speaker signals are routed from the PM8916 PMIC built-in Audio CODEC, the two signals are:

- SKPR_DRV_P - Class-D speaker amplifier output+
- SKPR_DRV_M - Class-D speaker amplifier output-

7.2 Mic

The microphone signals are rounded to the PM8916 PMIC Built-In CODEC, the two signals are:

- MIC2_IN - Headset mic
- MIC3_IN - Second mic, please note that the first microphone input, MIC1_IN is routed from an on-board analog microphone (not installed on current 410C build)
- Two more of the connector signals are part of the microphone (signal in) circuit:
- GND_CFILT - Class-D speaker amplifier output+
- MIC_BIAS1 - Ground reference for PMIC bias

7.3 Headset

The headset signals are rounded from the PM8916 PMIC Built-In CODEC, one signal is routed from the connector to the CODEC, the singles are:

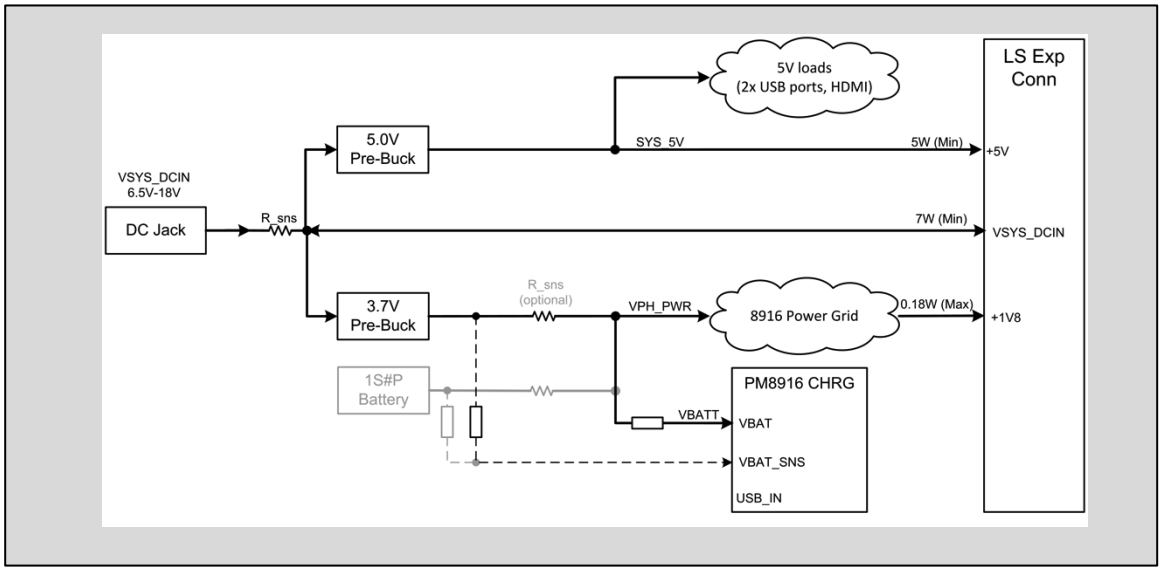
- HPH_R - Headphone PA right channel output
- HPH_L - Headphone PA left channel output
- HPH_REF - Headphone PA ground sensing
- HS_DET - Headset detection

7.4 FM Antenna

The FM_RX_ANT signal is the path for the FM antenna to reach the WCN3620 (u5), an integrated three different connectivity technologies device:

- WLAN IEE802.11 b/g/n
- BT 4.0 (BR/EDR/BLE)
- Worldwide FM radio

8 Power management



The 96Boards specification defines how power arrives to the board and few supplies that the board need to provide. The on board power requirement for each 96Boards implementation depends on the SoC and the set of peripherals that are specific to that implementation.

The 410C board uses two buck regulators, U13 and U12. U13 takes the power in to the board and generates 5V at 4A. This voltage feeds the USB HOST power limit switches and provides power to the Low Speed Expansion port. U12 takes the power in to the board and generates 3.7V at 4A. This voltage serves as the power in voltage to the on-board PMIC, PM8916 (U9). The PM8916 can generate 25 different voltage rails.

8.1 DC Power Input

The 96Boards specification calls for a power to be provided to the board in one of the following ways:

- An 8V to 18V power from a dedicated DC jack.
  The 410C board supports this requirement through the use of J1, 'SYS_DCIN' power connector.
- An 8V to 18V power from the SYS_DCIN pins on the Low Speed Expansion Connector.
  The 410C board supports incoming power through this connector.
- A USB Type C port at 5V.
  The 410C board doesn't have a USB Type C port implemented and ***therefore should not be powered over USB.***

8.2 Power Source Selection

Following the information in section 9.1, the 410C board has only two sources for board incoming power. The 96Boards specification calls for only one power source to be applied to the board at any given time. Following this requirement, the user of the 410C board should never apply power to the board from J1 and the Low Speed Expansion connector at the same time. There is no active or passive mechanism on the 410C board to prioritize one source over the other.

8.3 Power Consumption

TBD

8.4 Power Sequencing

Upon applying power to the 410C board (either one of the two sources), both buck regulator will be enabled and will start regulating their target voltage. When the output of U12 is on, it will power the on-board PMIC, the PM8916. This PMIC has

four buck regulators, one boost regulator and 20 LODs. The sequencing of all this power rails was set within the PM8916 configuration scheme during the production of this part. The user has no access to alter, modify or change the PMIC power up sequencing.

8.5 Voltage Rails

Please see section 10 for detailed list of the power rails o the 410C board.

8.6 Power Measurements

The 96Boards specification calls for a minimum of one current sense resistor to be placed on the board permitting a basic power measurement functions.

The 410C implanted two different power measurements in the following manors:

8.6.1 Power-In measurement

A 0.1ohm resistor is place inline on SYS_DCIN power line coming from J1 (please note that this power in measurement only works for SYS_DCIN from J1, it will not measure SYS_DCIN applied from the Low Speed Expansion Connector). Placing a probe over this resistor will provide a voltage read of the voltage that falls on the resistor. Dividing this value by 0.1 will result the amount of the current flow into the board. The board provides a means to use ARM Energy probe for this measurement, please verify that JP3 and JP4 are each shorted and J10 is soldered to the board to take advantage of this probe.

8.6.2 PMIC Power-In measurement

A 0.1ohm resistor should replace the existing inline 0 ohm resistor on VPH_PWR line, the output of U12 back regulator that feed the PMIC. Placing a probe over this resistor will provide a voltage read of the voltage that falls on the resistor. Dividing this value by 0.1 will result the amount of the current flow into the PMIC. The board provide a means to use ARM Energy probe for this measurement, the following steps are requires to get this probe measuring this rail:

1. ***Please verify that JP3 and JP4 are not shorted***,
2. J10 need to be soldered to the board
3. R124 and R125, a 0 ohm 0201 resistor need to be soldered to the board
4. JP10 and JP11 need to be shorted
5. It is recommended to remove R122 and R123 from the board to prevent any potential short between SYS_DCIN and VPH_PWR

9 Buttons and status LED's

9.1 Buttons

9.1.1 Volume up

The Volume UP button is used to control the output speaker volume of the 410C Board.

9.1.2 Volume down

The Volume Down button is used to control the output speaker volume of the 410C Board.

9.1.3 Power Button

The on-board S2 push-button serves as the power-on/power-off button. Upon applying power the board, the boot process will start. Once the board is running you can turn power-off by pressing the power button for more than x second. If the board is in a sleep mode, pressing the power bottom for more than 3 second will wake up the board.

9.1.4 Reset Button

The on-board S4 push-button has two functions, it serves as a reset button and as a Volume/Zoom- button.

Button press with a duration of less than 10 second will be interrupted by software as a volume done or zoom out request. A duration of more than 10 second will cause a system reset.

9.2 LED's

There are two status LEDs and four User LEDs on the 410C board. The Status LEDs report the status of the Bluetooth and Wi-Fi devices onboard. The user LEDs are driven by the SoC directly.

9.2.1 User LED 1-4

The four user LEDs are surface mount Green LED, 0603 size, located next to the two USB type A connector and labeled 'USER LEDS 4 3 2 1'.

9.2.2 Bluetooth status

The BT LED on the 410C board is located next to the USBOTG connector; this LED reflects the status of the Bluetooth device.

9.2.3 Wifi status

The WIFI LED on the 410C is located right to the BT LED, this LED reflects the status of the Wi-Fi device.

10 Boot configuration

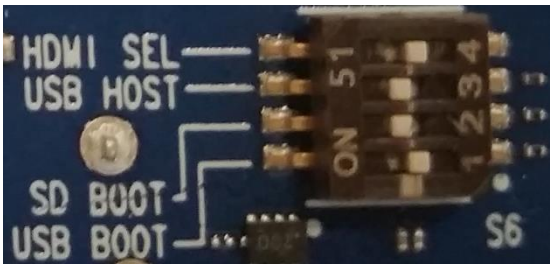
There is a 4 switch DipSwitch marked S6 located at the bottom side of the 410C board. For normal operation all four switched need to be set to the ‘off’ position.

Switch 1, ‘USB BOOT’, when set to ‘on’ position will force boot over USB connection with a PC. It only serves as a method for eMMC boot image upgrade. Please review the proper OS User Guide for more information on this process.

Switch 2, ‘SD BOOT’, when set to ‘on’ position, will force the µSD, J5, to serve as the boot source for the 410C board when se. You can use it as the main boot source or it can serves as a method for eMMC boot image upgrade. Please review the proper OS User Guide for more information on this process.

Switch 3, ‘USB HOST’, is described in section 5.8. This switch in not part of the boot configuration.

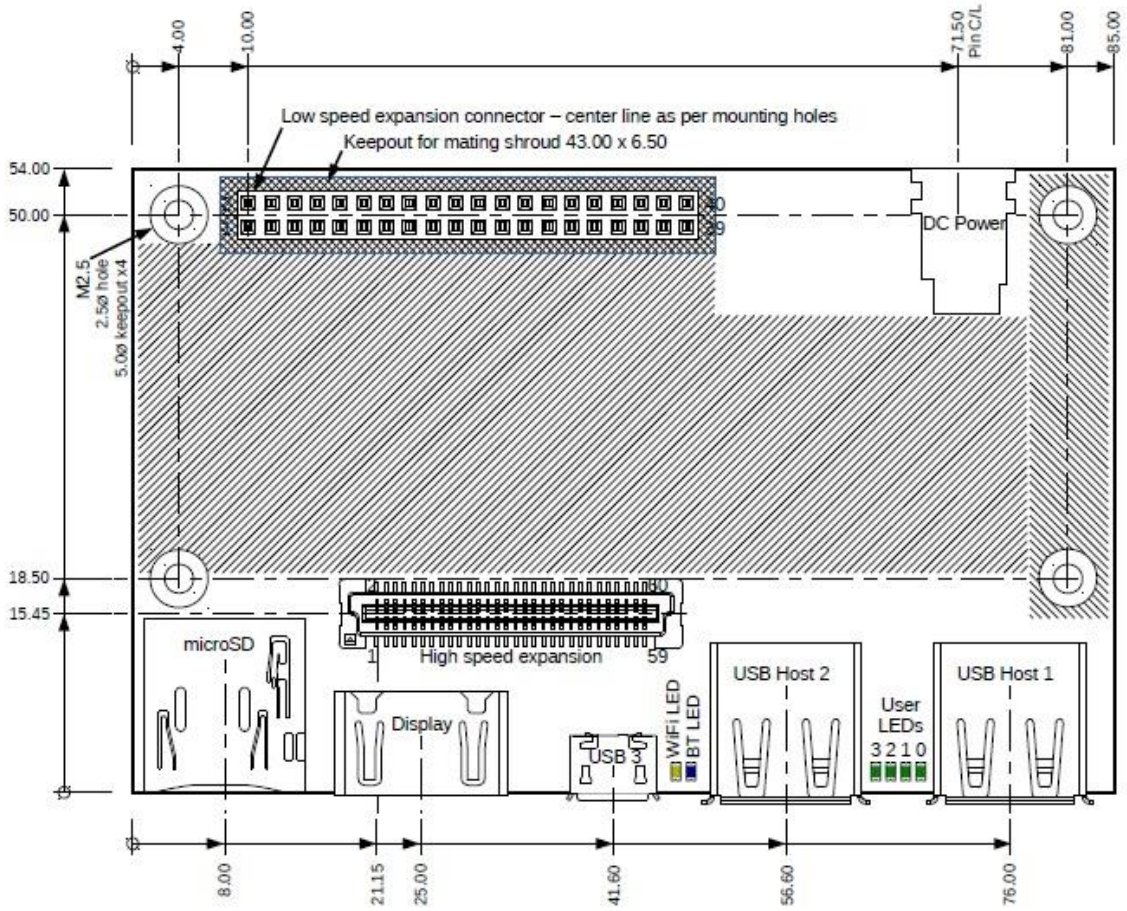
Switch 4, ‘HDMI SEL’, is described in section 5.6.1. This switch is not part of the boot configuration.



11 Mechanical specification

11.1 Board dimensions

2D Reference Drawing



General Top component max height = 6.5mm, except Type A USB connectors <= 7.0mm

PCB/Chip WiFi antenna on top or bottom. Follow antenna specification keepout areas.

Top component max height = 4.0mm except user link headers and thermal management such as fan/heatsink <= 6.5mm

96Boards Consumer		
TITLE: **96Boards Consumer Edition**		
VERSION: 1.0	SCALE: 1:2	DATE: 1 FEB 2015
ALL DIMENSIONS IN MM		Linaro
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12 Special care when using USB

Since the APQ8016 has a single USBOTG channel, care needs to be taken when the USB HOST function is to be use, please verify that no cable is connected to the MicroUSB type B connector (and to a host on the other side of the cable) as the hardware of this 410C board will inform software about the present of a request to configure the USBOTG to a device mode. Depend on the software release that is used on the board, the driver will configure the USB switch to Device mode and none of the USB HOST port will be connected to the SoC.