

Stream810_HW_Specification_V_2_0_20180116.docx
January 16, 2018

Hardware Product Specification

MOZART3 v2 module

Version: 2.0
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Reviewer: C. Apel, R. Gruber
Date: January 16, 2018

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2. Document History

No.	Primary Author(s)	Description of Version	Date Completed
0.1	T. Gruber	Initial version	2016-07-07
0.2	T. Gruber	Review by R. Gruber	2016-07-11
0.3	T. Gruber	Updated LCD interface (HSYNC, VSYNC, DE)	2016-07-18
0.4	T. Gruber	Added Audio Configurations	2016-07-19
0.5	C. Apel	Reviewed by C. Apel	2016-07-21
1.0	T. Gruber	Document release version. Added actual product picture. Added DSD application example. Improved graphics for circuit examples.	2016-07-27
1.1	T. Gruber	Reduced size of the document (using vector graphics)	2016-07-28
1.2	C. Apel	Added information about under voltage lockout, brown-out behavior, mechanical alignment pins of connectors and 2 nd DSD application example.	2016-08-02
1.3	T. Gruber	Added more review inputs. Updated the audio configurations. (especially regarding SPDIF input). Added ETH magnetics example.	2016-09-26
1.3.1	C. Apel	Added remark on difference in CON100 pinning to B version also to E version (was only stated for HE version)	2016-10-24
1.4	T. Gruber	Added new module naming, HostLink application example	2016-11-17
1.5	T. Gruber C. Apel	Updated suggested pin usage Removed 62 pin interface from orderable versions	2016-12-02

No.	Primary Author(s)	Description of Version	Date Completed
1.6	C. Apel	Added 1.2GHz CPU variant to "3. Production Options and Variants". Added 4.2 "Default Software Configuration and Security". Added 6.2 "CPU Operating Frequency Control and Temperature Protection". Changed 6.3 to "Power Supply and Low Power Mode" and added current consumption values. Mentioned LCD and USB as not supported in low power mode. Added USB overload check description to USB OTG section. Added 6.4 regulatory approvals (FCC)	2017-01-20
1.7	C. Apel, T. Gruber	- Renamed I2S_MCLK_INOUT to I2S_MCLK_OUT - updated I2S/TDM connection diagrams - updated chapter 4.2 - corrected typo "656" to "565" in RGB interface - updated block diagrams to reflect single 4Gb RAM option - updated 6.4 "Regulatory Approvals", add 6.5 Bluetooth certification, 6.6 Wi-Fi certification	If using external clock it should be input via I2S_BCLK line(s). External clock input is not default configuration anyway;
1.8	C. Apel	remove heatsink reference from general application notes, add 6.8 Thermal application notes, recommend heatsink/heat-spreader for 1.2GHz operation	
1.8.1	T. Gruber	Updated to final board dimensions (U.FL placement changed slightly from Lab1 to Lab2) including also the position of the new mounting hole.	
1.9	C. Apel	Add RF specification, add Stream810B4.4W version; update interface description to reflect this version	

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No.	Primary Author(s)	Description of Version	Date Completed
2.0	T. Gruber, C. Apel	Added power consumption measurements for GVA operation. Updated DSD Block Diagrams. Updated minimum supply voltage. Corrected BT QDIDs, added DFS statement to regulatory approvals chapter, removed RED notified body opinion since RED standards fully harmonized already	2018-01-16

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Document Version Management Notice

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3. Product Options and Versions

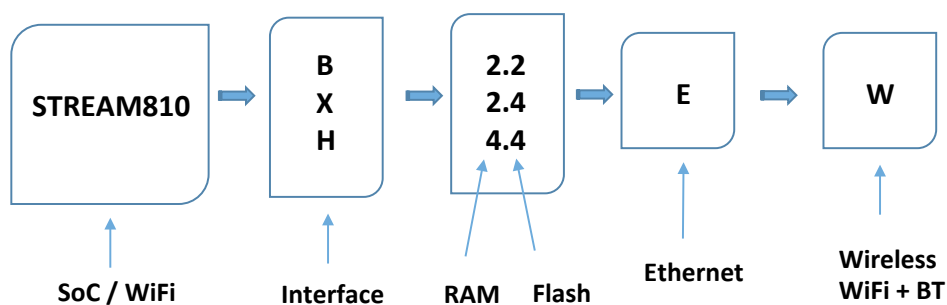
Possible hardware configurations include:

On-board RAM:	4GBit (min 2GBit)
On-board Flash:	4GBit (min 2GBit)
On-board WLAN:	IEEE 802.11a/b/g/n/ac
On-board Bluetooth (+BLE):	4.2
CPU Speed Grade:	1.2GHz dual ARM® Cortex®-A7 cores and Cortex-M4 core
Ethernet:	100MBit
Interfaces:	Basic (2x20 pin, with GVA option) / Extended (2x50 pin) /
Extended+ (2x62 pin)	
Display Interface:	None/16Bit RGB

Available versions for ordering:

Version ID	CPU	Speed [MHz]	RAM	USB OTG	Display	Ethernet	Flash	Interface
Stream810X4.4EW	i.MX 7	1200	4GBit	2x	RGB	100MBit	4GBit	Extended (2x50Pin)

Other versions on request:



4. Functional Description

4.1 General

The Stream810 module contains the core functions of a network audio streaming client featuring a dual core ARM® Cortex microprocessor and a variety of data and control interfaces for flexible and economical use. Stream810 also contains the digital signal processing and networking functions required for many kinds of next generation network enabled products. The module can be the core of a complete, stand-alone network player or can serve as an add-in module providing network and USB playback capability for a more sophisticated audio product.

A high quality clock is provided to support high performance A/D and D/A converters. Advanced clock synchronization features allow support of multi-room audio applications. When used in stand-alone mode, the audio output of Stream810 can be synchronized to an external I²S Master Clock for ultimate audio performance (lowest jitter).

Dual band WLAN 802.11a/b/g/n/ac and an Ethernet interface are provided for network connection. Two antennas are supported in 2T2R configuration; one of these is shared between WLAN and Bluetooth. Up to two USB OTG interfaces are supported.

Bluetooth 4.2 is supported with internal WLAN coexistence interface. However, WLAN throughput may be reduced while Bluetooth A2DP audio is received.

All functions are incorporated on a small footprint 47x51mm low-profile PCB board featuring dual 1.27mm male headers providing both mechanical and electrical connection to base board.

Only few external components are required to build up a complete product, however Stream810 also fits perfectly into complex product architectures.

Typical applications include:

- Consumer Electronics
 - Connected Speakers
 - Mainstream CE products such as connected AV receivers
 - Premium CE products
- Building Technology
 - Residential Audio
 - Home Automation
- Institutional Audio/Video
 - Audio distribution in Hotels, Supermarkets, Airports...
- Professional Audio
- Gateways between internet and proprietary interfaces

4.2 Default Software Configuration and Security

The Stream810 supports secure boot and Trustzone. The boot sequence is configured to NAND flash boot regardless of state of pins on the external interfaces.

Secure boot prevents that the module is booted with a non-authenticated bootloader.

Trustzone is a secure sub-system in which calculations involving secret keys can be executed.

Updating Stream810 to customized SW, enabling security

- StreamUnlimited provides modules with a generic software (bootloader/linux image for upgrade/recovery)
- USB thumbdrive or network (tftp) can be used to program customized software image. For large volume production, a special programming jig is recommended, StreamUnlimited can provide reference schematics and layout. Although the update will start and complete autonomously, a PC or microcontroller should be used to monitor UART output of the module to notify operator when update has completed
- The customized software image has to be signed by module customer (referred to as "OEM" in this section). Signing happens offline, once per software release. This protects the software image against modification by third party (hacker), it is a requirement for GoogleCast enabled products. This Key will be referred to as "OEM private Key"
- StreamUnlimited provides tools and instructions for creation of key and signing of images. Only module customer/OEM knows the key, StreamUnlimited does not. If the key would be made publicly available, hackers could modify the software image and sign it again after the modification such that the module accepts booting it
- Modules delivered by StreamUnlimited accept any signed or unsigned software. After programming custom software which is signed using OEM private key, modules must be locked via UART to accept only images with the correct OEM key. No one except OEM (also not StreamUnlimited) will be able to run their own SW on such locked modules. Thus modules must only be locked AFTER product-level testing.
- To use GoogleCast and Google Voice Assistant, authentication with Google servers is required. Every module using these services must contain a secret key. It is usually unique for a product model but not unique for each sample, it is referred to as the "Google model key"
- For security reasons, this "model key" is not part of the software image but needs to be inserted on the production line via UART
- The "model key" must be inserted AFTER module is locked
- For security reasons, locked modules do not provide access to linux debug shell via UART. They only allow insertion of "model key" via UART using a special protocol
- The "Google model key" is also created by OEM using tools provided by StreamUnlimited. It is only known to OEM, if it is made publicly available and used by hackers Google may revoke access to their services for all products based on this key
- StreamUnlimited will ensure that the key is registered at Google. OEM creates a public key using tools provided by SUE and transfers this to StreamUnlimited. StreamUnlimited will return a "certificate" based on this key. OEM must patch the customized SW image using this certificate
- During development, special keys and certificates can be created which have shorter validity than production keys

SUMMARY:

- OEM must create OEM key and Google model key, add Google certificate and sign image
- OEM production must lock modules after testing and insert Google key
- **Both Google model key and OEM key are to be treated highly confidential, if they leak to the public products may stop to function in the field**
- **Backups of Google model key and OEM key need to be kept, if the keys are lost, field-upgrades of products will not be possible anymore. SUE cannot retrieve the keys**

4.3 Interfaces

Stream810B / Basic Interface

- Single +5V power supply
- 100MBit Ethernet (on board PHY)
- Dual-band 802.11a/b/g/n/ac, 2 U.FL connectors to external antennas
- Bluetooth 4.2
- Up to 5 GPIOs (typically one used as mute output)
- UART1 or 2 additional GPIOs. This UART is normally used for debug purposes. If UART1 pins are used for other function, debugging is possible via UART6 which is available on testpoints (not connected to interface header).
- High speed USB2.0 OTG port
- 10 bit ADC input (typically used for board revision detection)
- Audio interfaces:
 - I²S out, up to two data lines
 - I²S in
- 1x I²C (Master or Slave)

Stream810B4.4W Interface

To address the need for basic Voice Assistant products which only feature wireless network connection, a special interface option was introduced which replaces Ethernet lines with one additional I2S digital audio input for digital microphones. Separate clock lines are provided to be able to interface directly to digital (I2S-) microphones running at 16kHz. A third input is provided as echo-cancellation back-channel from external audio DSP. This back-channel line runs synchronously to the audio outputs.

Stream810X / Extended Interface

Interface options:

- Three digital audio ports
 - Separate clock lines for input and output
 - Up to 3 I2S data input and output lines (up to 6 channels)
- One port can be run at different sampling frequency or even different format (TDM) than other two ports
- Two USB2.0 OTG interfaces
- 16 bit (RGB 565) LCD interface plus PWM output for external Backlight converter
- LCD pins can be used as GPIOs
- Two UARTs
- Three I²C interfaces
- SPI interface with single chip select (Stream810 is master, to control more SPI peripherals, use GPIO in combination with hardware chip select)
- Three analog inputs (10 bit)
- I2C and I2S port pins can be used as GPIOs if primary function not required

Stream810H / Extended+ Interface

Additional interface options:

- RMI for second 100MBit Ethernet (off board PHY)
- UART with Flow Control
- 6 more GPIOs (or SDIO via optional stuffing option)

4.4 Stream810 Block Diagram

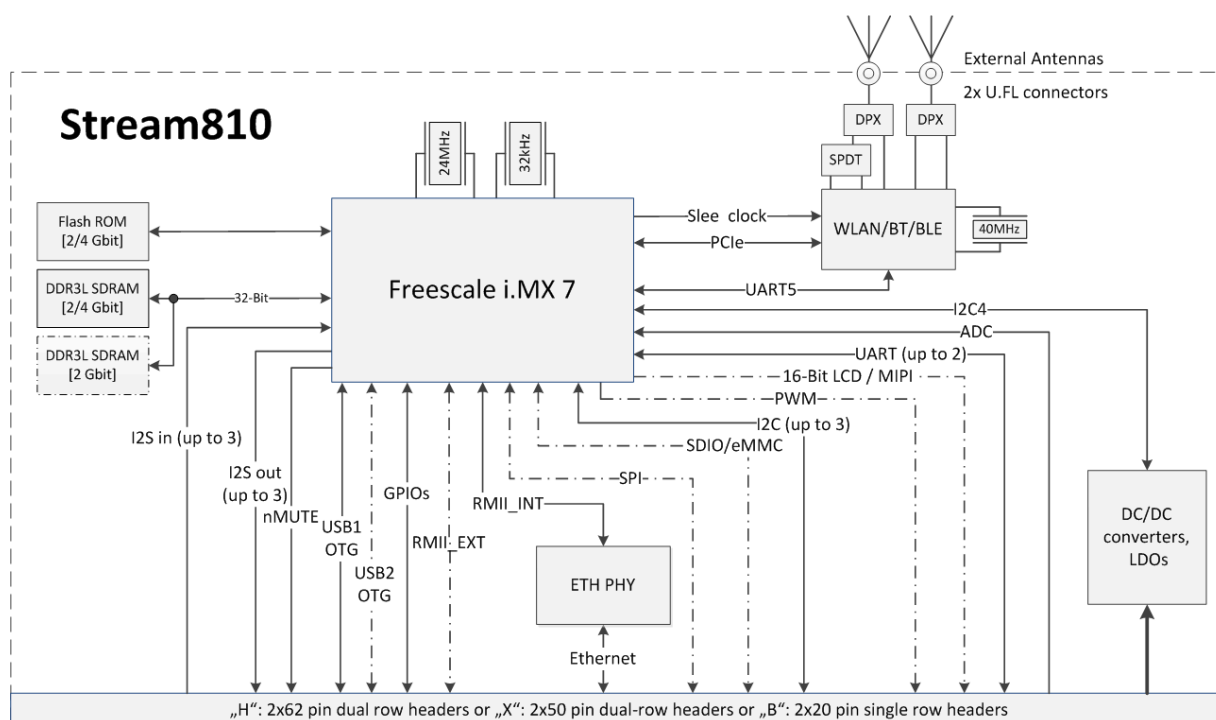


Figure 1 Stream810 Block Diagram

4.5 Example Product Block Diagram

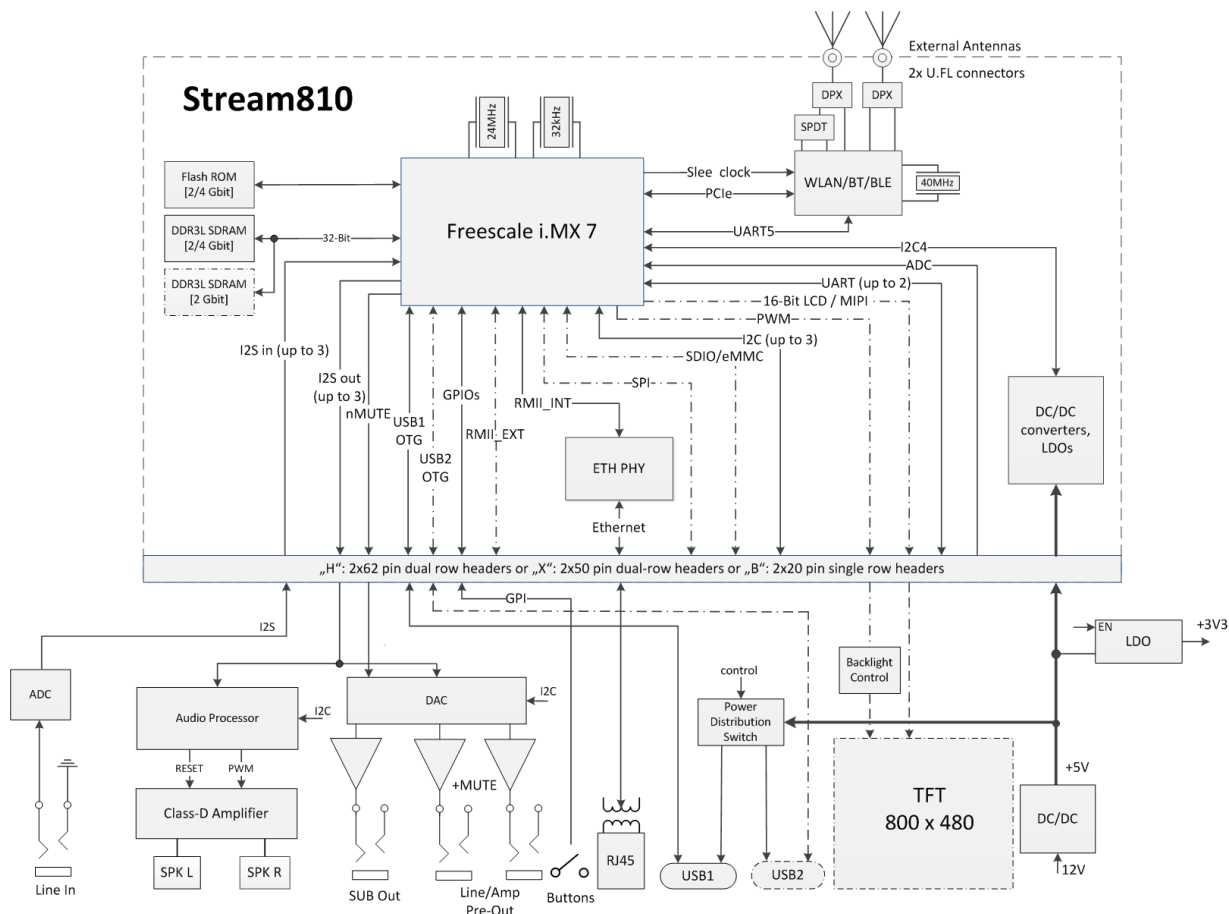


Figure 2 Example Product Block Diagram

Notes:

- For Stream810B (Basic version), I2S in- and outputs share clock lines, external ADC and DAC operate synchronously.
- iDevice compatibility (MFi) requires the proper external hardware connection on the USB port and the proper iDevice control and interface firmware modules. Please contact StreamUnlimited if your product requires iDevice compatibility.
- Connection to external host processor is possible via I2C (using the StreamUnlimited HostLink protocol).

5. Interface Specification

5.1 Connector Pin Definition

Stream810B (Basic Interface)

CON100, CON102; 2x 1.27mm 20 pin single row THT male header

CON102	Signal Name	CON100	Signal Name
1	GND	1	AIN3 (Board MSB)
2	NPB_IN	2	VDD_1V8_OUT (200mA max)
3	GPIO1_11 / NMUTE*	3	I2S_DATA_OUT3
4	SYSRESETN_INOUT	4	GND
5	GND	5	I2S_BCLK_OUT1_3
6	+5V0	6	I2S_WCLK_OUT1_3
7	+5V0	7	GND
8	+5V0	8	I2S_DATA_IN1
9	GND	9	I2S_DATA_OUT1
10	GND	10	GND
11	GND	11	GPIO5_12 / STATUS_LED*
12	I2C1_SCL / SPI3_MISO	12	GND
13	I2C1_SDA / SPI3_MOSI	13	I2S_MCLK_OUT
14	GPIO4_10 / SPI3_SCLK / HOST_NIRQ*	14	3V3_OUT (100mA max)
15	GPIO4_11 / SPI3_SS0 / CODEC_RESET_N*	15	UART1_RXD
16	USB1_ID	16	UART1_TXD
17	USB1_DRVVBUS	17	ETH_TRXN1 / I2S_DATA_IN2 (MIC)**
18	USB1_VBUS	18	ETH_TRXP1 / I2S_BCLK_IN2 (MIC)**
19	USB1_DP	19	ETH_TRXN0 / I2S_WCLK_IN2 (MIC)**
20	USB1_DN	20	ETH_TRXP0 / I2S_DATA_IN3 (BACKCHANNEL)**

Reference for mating connector on Carrier Board: M52-500**2045**

* suggested pin use

** for version Stream810B4.4W

Note: when using SMD headers, tolerance issues may arise since the headers may shift during reflow process. It is therefore recommended to use headers with mechanical alignment pins or through-hole headers.

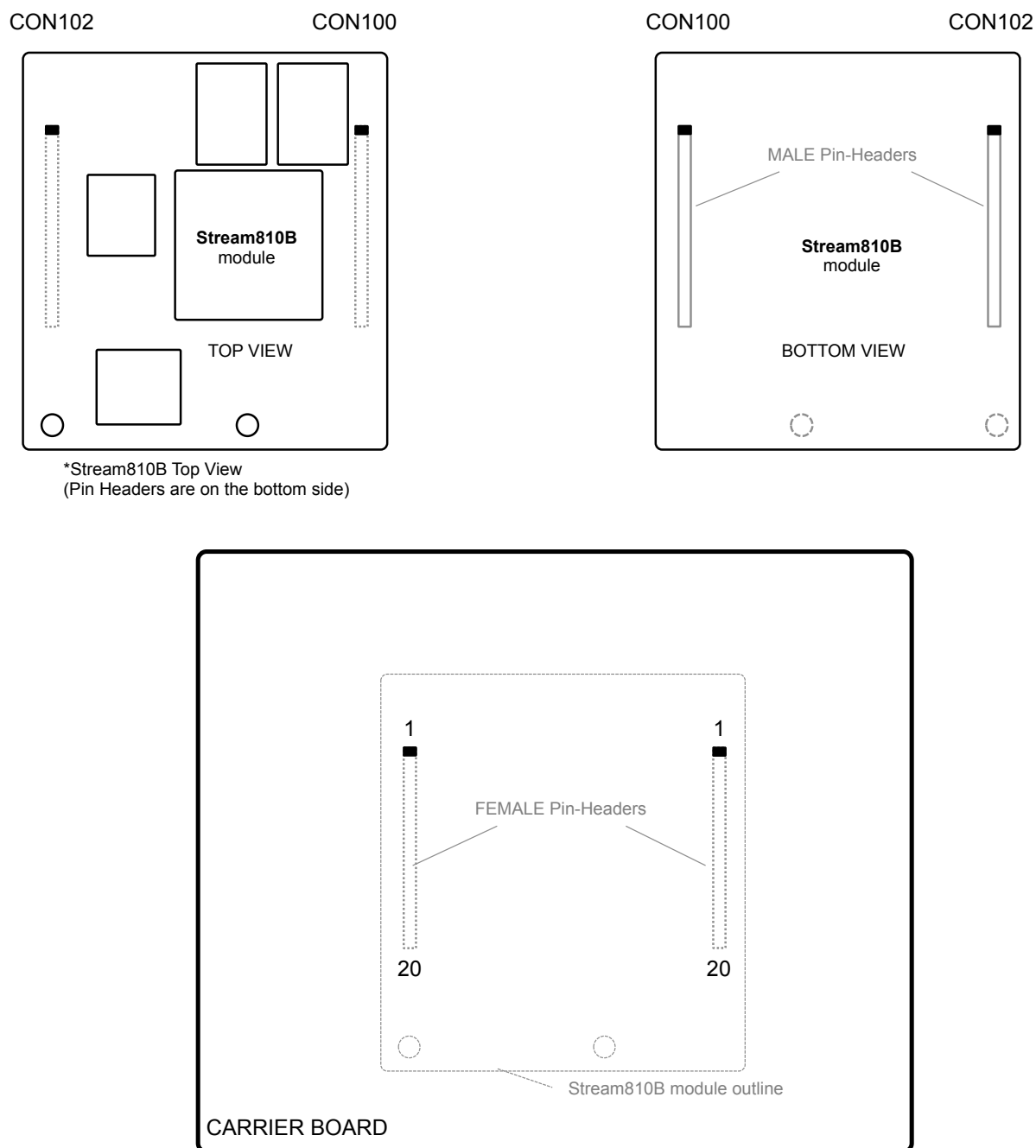


Figure 3 Stream810B Connectors and Carrier Board

See "Board Dimensions and Mechanical Interfaces" for exact connector positions

Stream810X (Extended Interface)

CON103, CON104; 2x 1.27mm 50 pin dual row SMD male header

Signal Name	CON103		Signal Name
GND	2	1	GND
LCD_PCLK	4	3	GND
GND	6	5	LCD_DATA0
NPB_IN	8	7	LCD_DATA1
GPIO1_11 / NMUTE*	10	9	LCD_DATA2
SYSRESETN_INOUT	12	11	LCD_DATA3
GND	14	13	LCD_DATA4
+5V0	16	15	LCD_DATA5
+5V0	18	17	LCD_DATA6
+5V0	20	19	LCD_DATA7
GND	22	21	GND
GND	24	23	LCD_DATA8
GND	26	25	LCD_DATA9 / MIPI_DSI_CLK_N
SPI3_MISO / I2C1_SCL / CODEC_RESET_N*	28	27	LCD_DATA10 / MIPI_DSI_CLK_P
SPI3_SCLK / GPIO4_10	30	29	LCD_DATA11 / MIPI_DSI_D0_N
SPI3_MOSI / I2C1_SDA	32	31	LCD_DATA12 / MIPI_DSI_D0_P
SPI3_SS0 / GPIO4_11 / HOST_NIRQ*	34	33	LCD_DATA13 / MIPI_DSI_D1_N
USB1_ID	36	35	LCD_DATA14 / MIPI_DSI_D1_P
USB1_DRVBUS	38	37	LCD_DATA15
USB1_VBUS	40	39	LCD_DIM_PWM
USB1_DP	42	41	GND
USB1_DN	44	43	USB2_VBUS
USB2_DP	46	45	USB2_DRVBUS
USB2_DN	48	47	USB2_ID
GND	50	49	GND

Note that the pinning for the SPI port is different compared to the Stream810B (Basic Interface) due to compatibility to other modules.

* suggested pin use

Signal Name	CON104		Signal Name
GND	2	1	AIN1 (Application use)
LCD_VSYNC	4	3	AIN2 (Board LSB)
LCD_HSYNC	6	5	AIN3 (Board MSB)
LCD_ENABLE	8	7	VDD_1V8
GND	10	9	I2S_DATA_OUT3
I2S_DATA_IN2	12	11	GND
GND	14	13	I2S_BCLK_OUT1_3
I2S_BCLK_IN1_3	16	15	I2S_WCLK_OUT1_3
I2S_WCLK_IN1_3	18	17	GND
GND	20	19	I2S_DATA_IN1
UART3_TXD	22	21	I2S_DATA_OUT1
UART3_RXD	24	23	GND
GND	26	25	I2S_WCLK_IN2
I2S_BCLK_IN2 / GPIO1_3	28	27	GND
I2S_DATA_OUT2	30	29	I2S_MCLK_OUT
GND	32	31	3V3_OUT (100mA max.)
UART1_RXD	34	33	I2S_DATA_IN3
UART1_TXD	36	35	GND
GND	38	37	ETH_TRXN1
I2C2_SCL	40	39	ETH_TRXP1
I2C2_SDA	42	41	ETH_TRXN0
GND	44	43	ETH_TRXP0
I2C3_SCL	46	45	GND
I2C3_SDA	48	47	I2S_BCLK_OUT2 / GPIO1_12
GND	50	49	I2S_WCLK_OUT2 / GPIO1_0

Reference for mating connector: M50-3122545.

Note: when using SMD headers, tolerance issues may arise since the headers may shift during reflow process. It is therefore recommended to use headers with mechanical alignment pins or through-hole headers.

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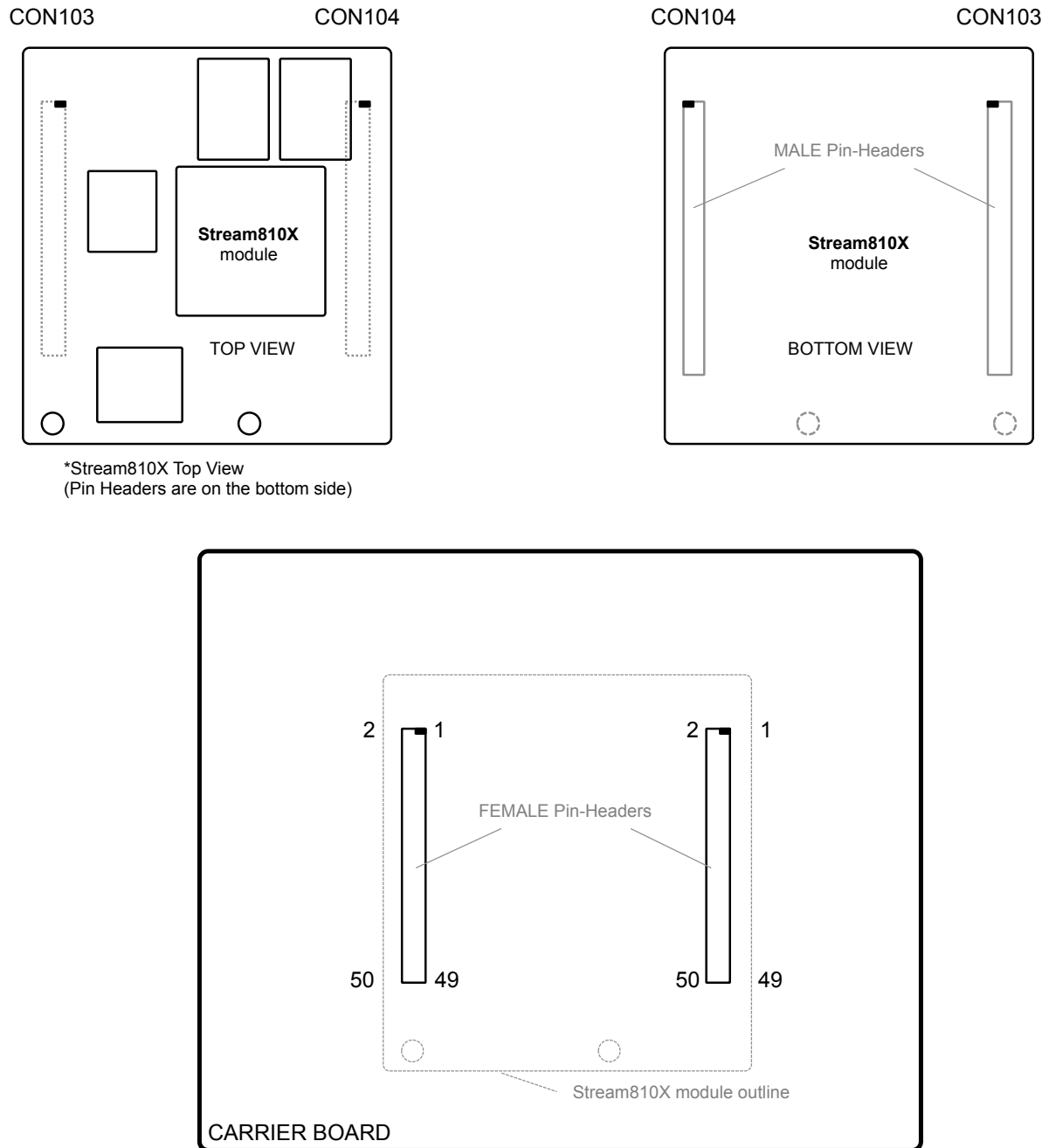


Figure 4 Stream810X Connectors and Carrier Board

Stream810H (Extended+ Interface)

CON106, CON109; 2x 1.27mm 62 pin dual row SMD male header

Signal Name	CON106		Signal Name
GND	2	1	GND
LCD_PCLK	4	3	GND
GND	6	5	LCD_DATA0
NPB_IN	8	7	LCD_DATA1
GPIO1_11 / NMUTE	10	9	LCD_DATA2
SYSRESETN_INOUT	12	11	LCD_DATA3
GND	14	13	LCD_DATA4
+5V0	16	15	LCD_DATA5
+5V0	18	17	LCD_DATA6
+5V0	20	19	LCD_DATA7
GND	22	21	GND
GND	24	23	LCD_DATA8
GND	26	25	LCD_DATA9 / MIPI_DSI_CLK_N
SPI3_MISO / I2C1_SCL	28	27	LCD_DATA10 / MIPI_DSI_CLK_P
SPI3_SCLK / GPIO4_10	30	29	LCD_DATA11 / MIPI_DSI_D0_N
SPI3_MOSI / I2C1_SDA	32	31	LCD_DATA12 / MIPI_DSI_D0_P
SPI3_SS0 / GPIO4_11 / HOST_NIRQ	34	33	LCD_DATA13 / MIPI_DSI_D1_N
USB1_ID	36	35	LCD_DATA14 / MIPI_DSI_D1_P
USB1_DRVVBUS	38	37	LCD_DATA15
USB1_VBUS	40	39	LCD_DIM_PWM
USB1_DP	42	41	GND
USB1_DN	44	43	USB2_VBUS
USB2_DP	46	45	USB2_DRVVBUS
USB2_DN	48	47	USB2_ID
GND	50	49	GND
RMII_EXT_TX_CTL	52	51	RMII_EXT_TX_CLK
RMII_EXT_RX_ER	54	53	RMII_EXT_CRS
RMII_EXT_TD1	56	55	RMII_EXT_RD1
RMII_EXT_TD0	58	57	GND
MDIO_CLK	60	59	RMII_EXT_RD0
GND	62	61	MDIO_DATA

Note that the pinning for the SPI port is different compared to the Stream810B (Basic Interface) due to compatibility to other modules.

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Signal Name	CON109		Signal Name
GND	2	1	AIN1 (Application use)
LCD_VSYNC	4	3	AIN2 (Board LSB)
LCD_HSYNC	6	5	AIN3 (Board MSB)
LCD_ENABLE	8	7	VDD_1V8
GND	10	9	I2S_DATA_OUT3
I2S_DATA_IN2	12	11	GND
GND	14	13	I2S_BCLK_OUT1_3
I2S_BCLK_IN1_3	16	15	I2S_WCLK_OUT1_3
I2S_WCLK_IN1_3	18	17	GND
GND	20	19	I2S_DATA_IN1
UART3_TXD	22	21	I2S_DATA_OUT1
UART3_RXD	24	23	GND
GND	26	25	I2S_WCLK_IN2
I2S_BCLK_IN2 / GPIO1_3	28	27	GND
I2S_DATA_OUT2	30	29	I2S_MCLK_OUT
GND	32	31	3V3_OUT (100mA max.)
UART1_RXD	34	33	I2S_DATA_IN3
UART1_TXD	36	35	GND
GND	38	37	ETH_TRXN1
I2C2_SCL	40	39	ETH_TRXP1
I2C2_SDA	42	41	ETH_TRXN0
GND	44	43	ETH_TRXP0
I2C3_SCL	46	45	GND
I2C3_SDA	48	47	I2S_BCLK_OUT2 / GPIO1_12
GND	50	49	I2S_WCLK_OUT2 / GPIO1_0
SD2_DATA7 / UART6_CTS	52	51	SD2_DATA6 / UART6_RTS
SD2_DATA4 / UART6_RXD	54	53	SD2_DATA5 / UART6_TXD
GND	56	55	GND
SD2_CMD/GPIO5_13	58	57	SD2_CLK / GPIO5_12
SD2_DATA1 / GPIO5_15	60	59	SD2_DATA0 / GPIO5_14
SD2_DATA3 / GPIO5_17	62	61	SD2_DATA2 / GPIO5_16

Reference for mating connector: M50-3122545.

Note: when using SMD headers, tolerance issues may arise since the headers may shift during reflow process. It is therefore recommended to use headers with mechanical alignment pins or through-hole headers.

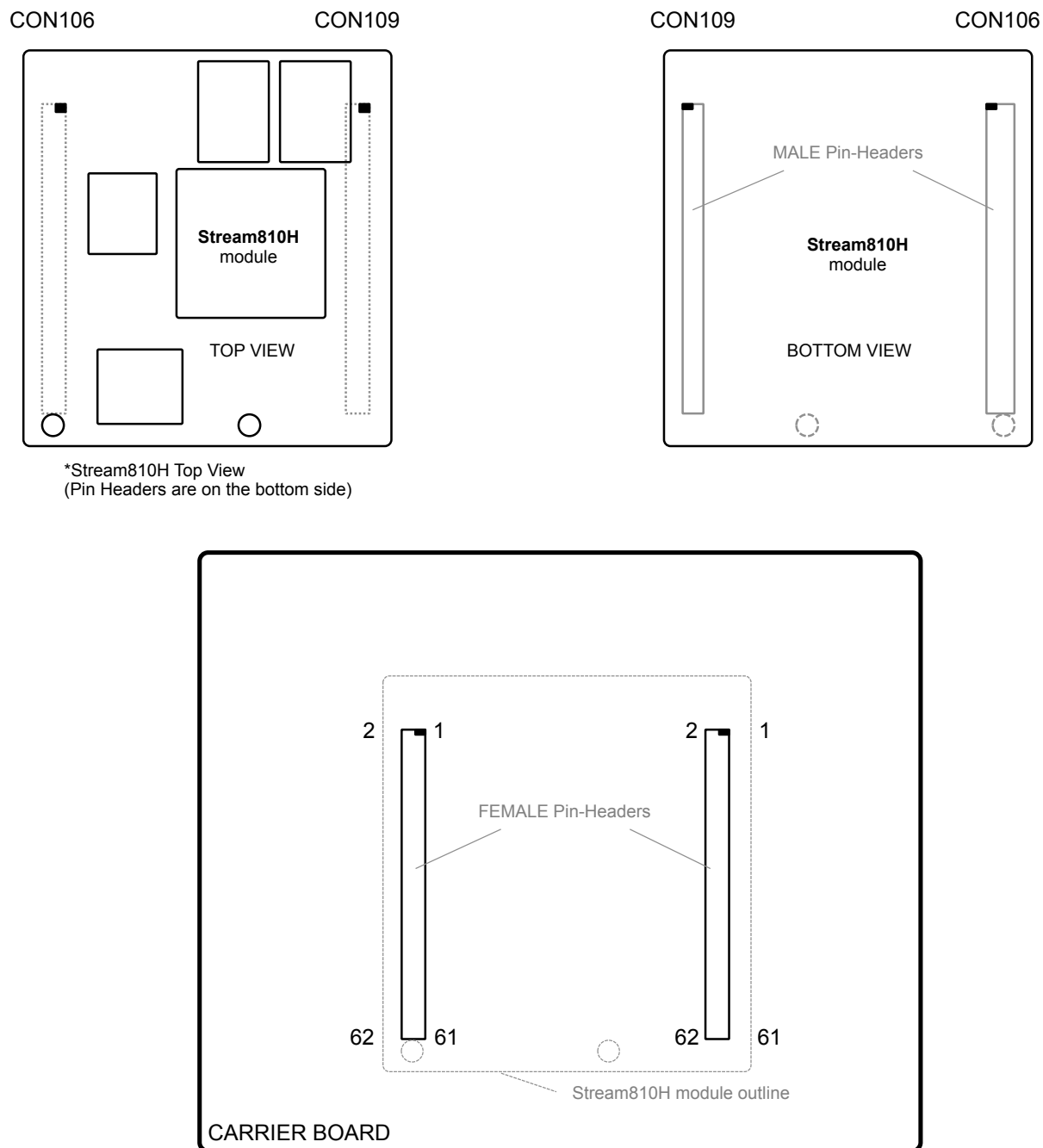


Figure 5 Stream810H Connectors and Carrier Board

5.2 Interface Details

Pull-Up resistors, 3V3_OUT

Since most pins have alternative functions, only UART0_RXD signal is equipped with internal pull-up resistor. **All other pull-up resistors (including those for I2C) must be placed on application level.** Supply pin 3V3_OUT is provided for that purpose. This supply output can be switched off to save power in a standby mode if Ethernet is not present on the product or not required to remain connected in a standby mode. Maximum external load on 3V3_OUT is 100mA.

On-board Ethernet port

Stream810 offers an integrated Fast Ethernet PHY. Magnetics and ESD protection has to be provided externally from the Stream810 module. No LED outputs are provided. Network connection status is available on host interface (HostLink). For host-less applications, LED for connection status (including WLAN) can be driven by GPIO or PWM.

Route the Ethernet lines as differential pairs with differential impedance of 100 Ohms.

Note that the Center Tap of Ethernet magnetic should be connected to 3V3_OUT.

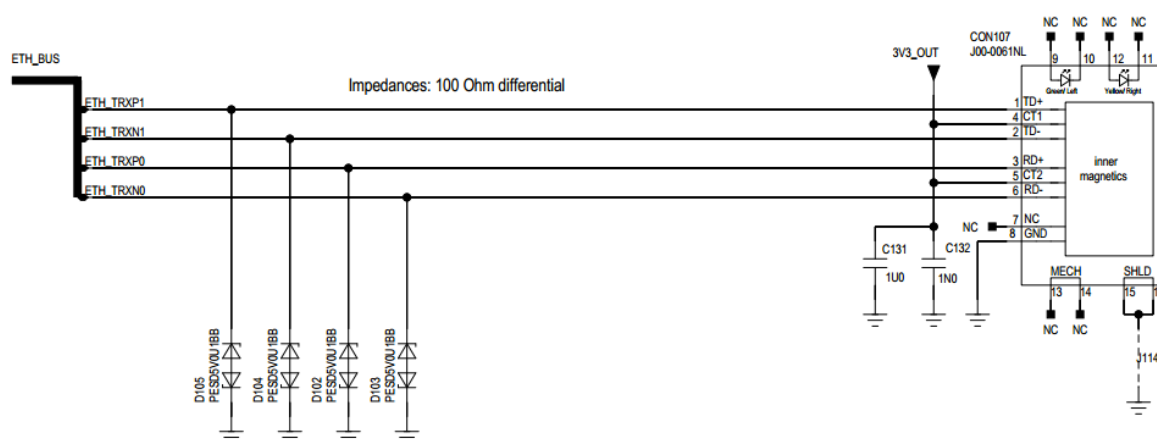


Figure 6 Ethernet Example Schematics

MAC addresses: Stream810 is delivered with unique MAC address.

Application Example using the external RMI interface from Stream810H

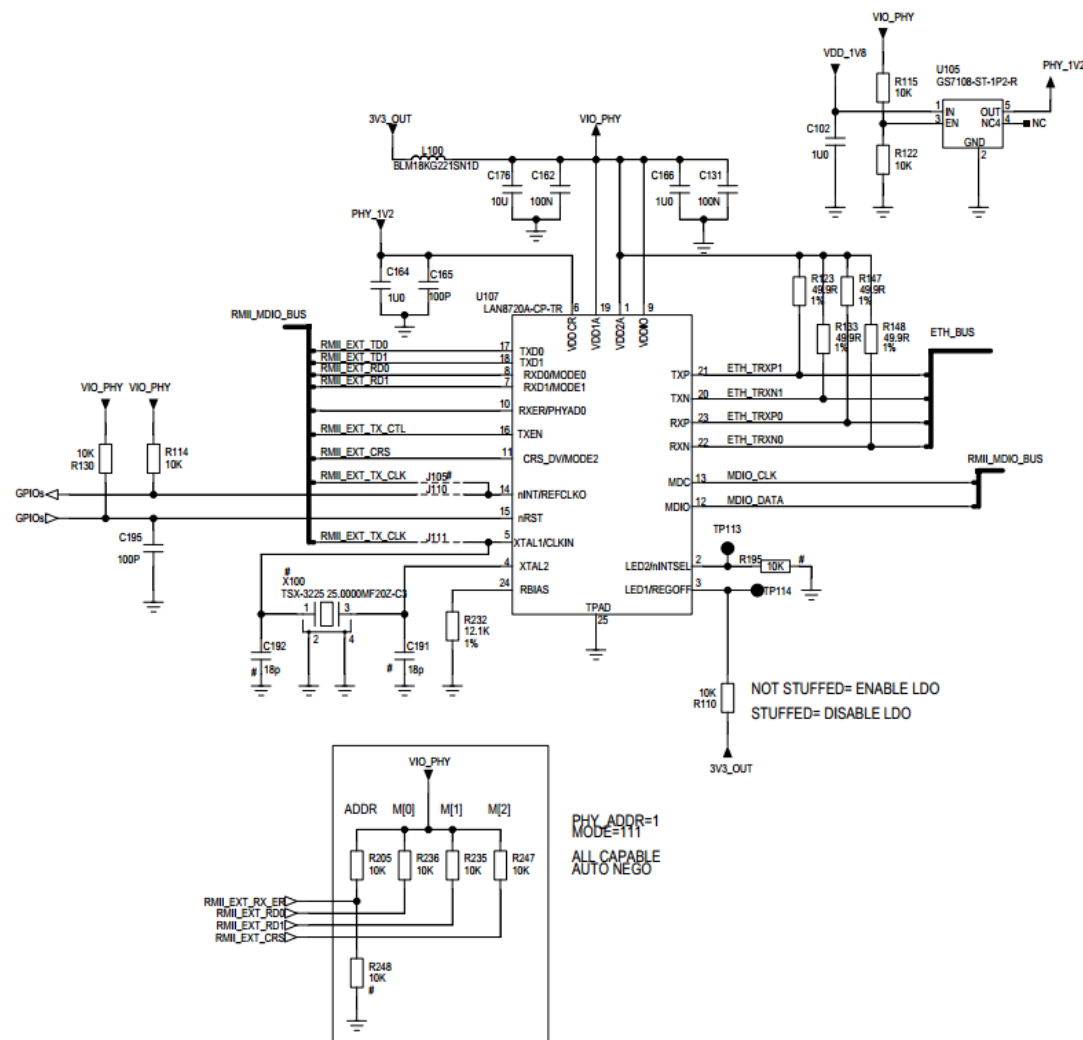
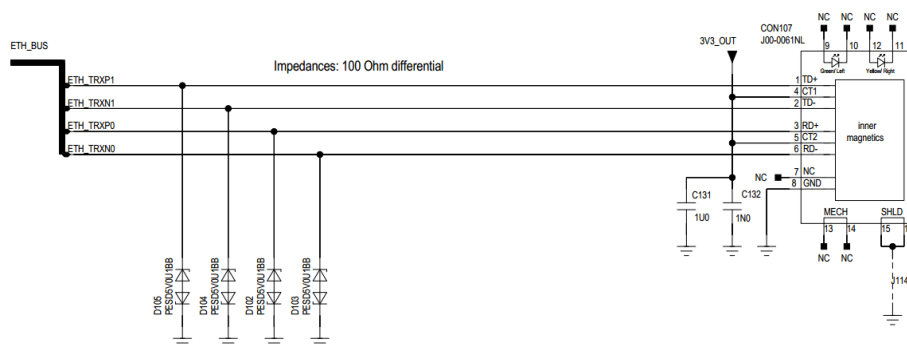


Figure 7 External PHY connected to EXT_RMII interface ('#' means "not stuffed")



USB2.0 OTG

Up to two Hi-speed USB2.0 OTG ports are provided. The ID pin should be grounded on application level to select host mode.

Although the hardware is able to serve as USB device, only host mode is supported in software. Voltages on USB1_VBUS and USB2_VBUS must be within 4.5V and 5.2V when USB is active. These voltages must follow control signals USB1_DRVVBUS and USB2_DRVVBUS (high-active, 3V3 logic).

When VBUS voltage of active port drops below 4.5V then an overload/short circuit condition is assumed and the port will be disabled by application software. The VBUS level will subsequently be checked every second and the port will be enabled again as soon as the voltage recovers. If a port is not used/connected on product level it must be disabled in “devicetree” configuration which describes the hardware.

Note that the overload/short circuit checking algorithm is only enabled after booting completed, it is not present in the bootloader.

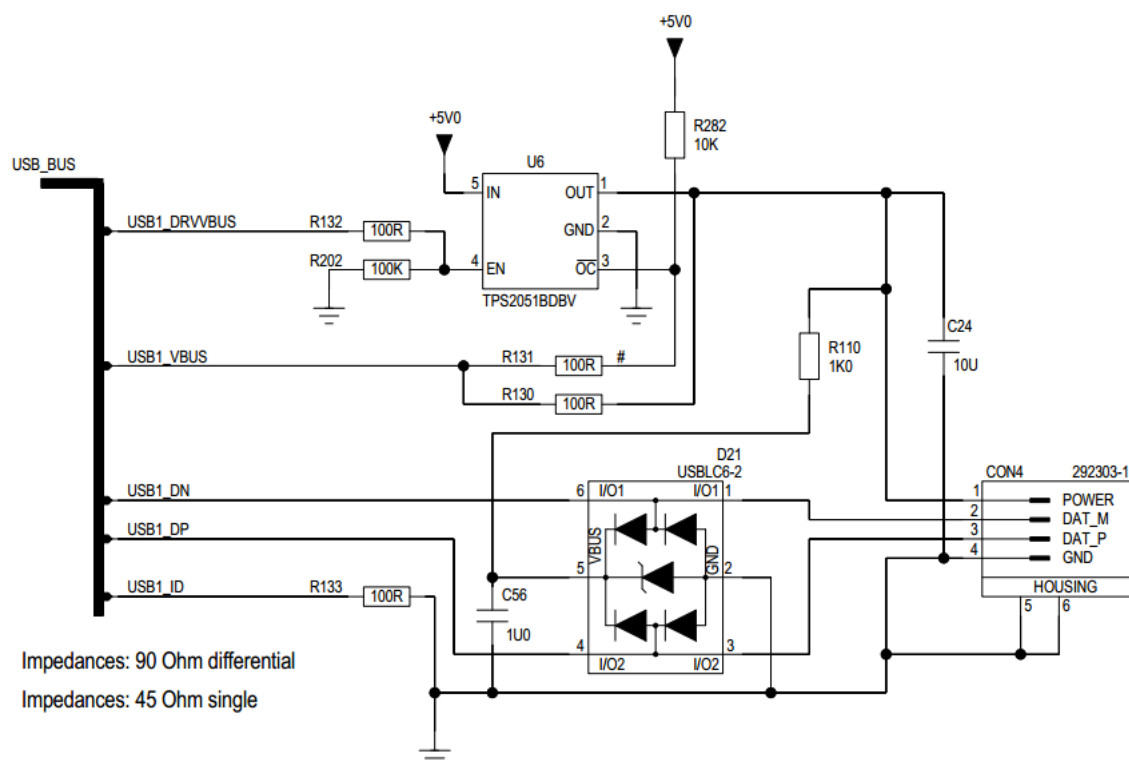


Figure 8 USB1 Example Schematics ('#' means “not stuffed”)

Please note that special requirements exist to charge iDevices, which require a stronger power switch and a precise current limitation.

A license agreement with Apple must be in place in order to sell products that use iOS device docking over USB. Contact StreamUnlimited in case iOS device docking is required for your product.

LCD Interface

Stream810X and Stream810H interfaces allow direct interfacing to an LCD via 16bit RGB interface (565 mode). An external display backlight converter is required. The converter can be controlled via LCD_DIM_PWM for on/off and brightness level control. See below for schematics example.

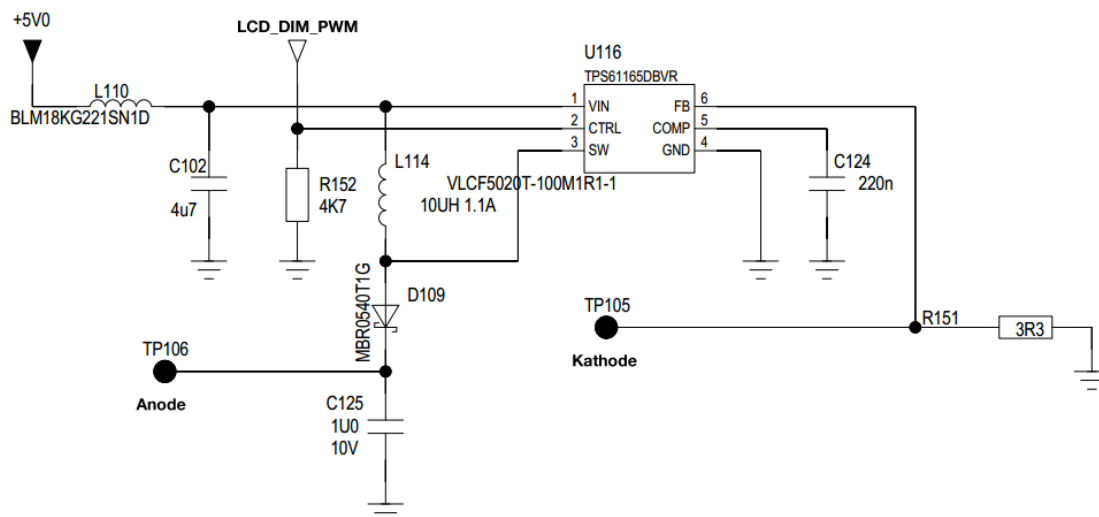


Figure 9 LCD Backlight dimming example

Please note that Stream810 does not feature an OpenGL graphics accelerator to offload the CPU. Any rendering is done via CPU. Optionally the integrated "pixel processor" could be used which offers acceleration of basic GUI related operations such as scaling and alpha-blending.

Note that higher display resolution will increase both EMI and CPU load. A resolution of 800x480 or lower is recommended.

HostLink

The Stream HostLink is a lightweight protocol intended to communicate simple data structures between a master microcontroller running StreamSDK and a slave microcontroller (host).

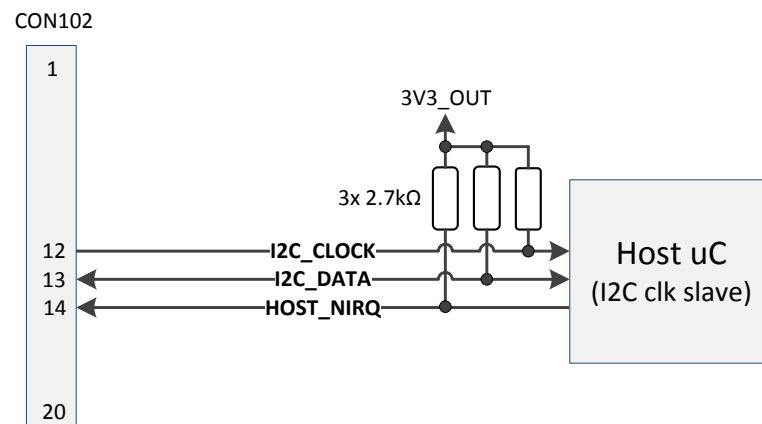


Figure 10 Connecting a Host uC to Stream810

Stream810_HW_Specification_V_2_0_20180116.docx
January 16, 2018

Digital Audio In- and Outputs

Stream810 provides a stereo I2S input and a stereo I2S output of up to 384 kHz audio sample rate. The Master clock is by default provided from an on-board PLL or provided from an external clock generator. The on board PLL allows fine-adjustment to synchronize multiple clients playing the same content synchronously.

For Stream810B (Basic Interface) the input and output must run synchronously. This is also the preferred operating mode for Stream810X and Stream810H, however dedicated input and output clock lines are provided on the extended interface. These can also be used for other purposes such as additional GPIOs or I2S data lines.

Default clock ratios/frequency

I2S_BCLK / I2S_WCLK: 64

I2S_MCLK: 22.5792MHz or 24.576MHz

If SPDIF output is required use of an external SPDIF transmitter (such as AK4104) driven from I2S output is recommended.

Contact StreamUnlimited should you wish to use an external audio clock. Adding the required host interface and appropriate clock control algorithms may require customization work. A tune-able external clock is required.

Possible Audio Configurations

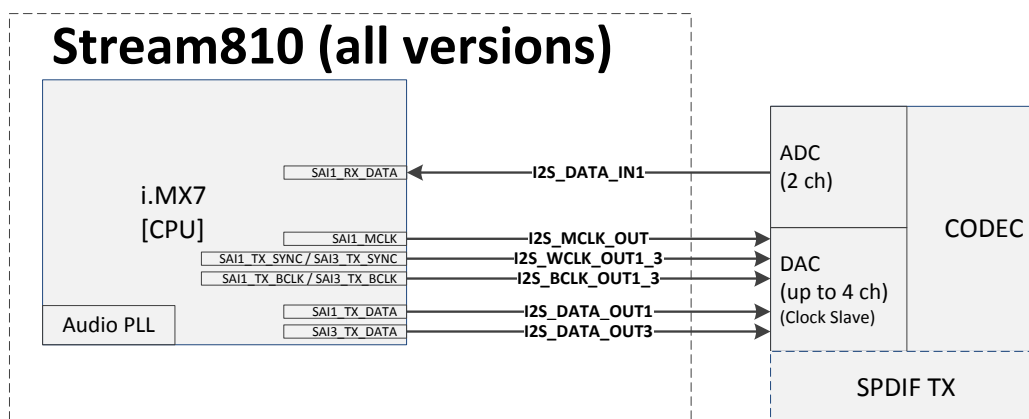


Figure 11 Synchronous I2S I/O

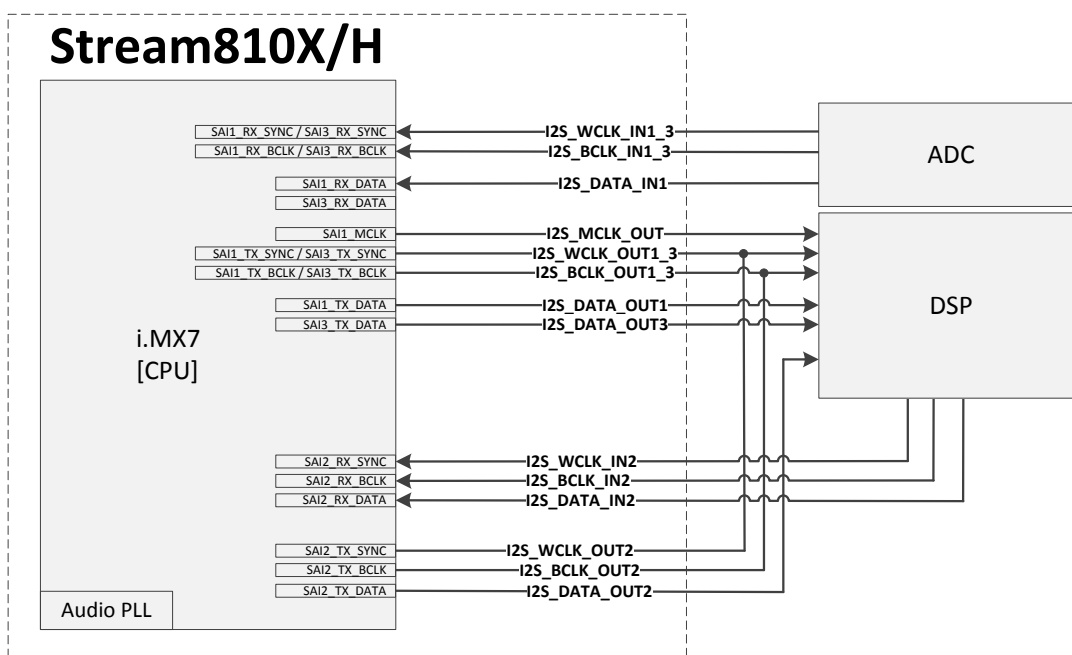


Figure 12 Audio DSP with Loopback

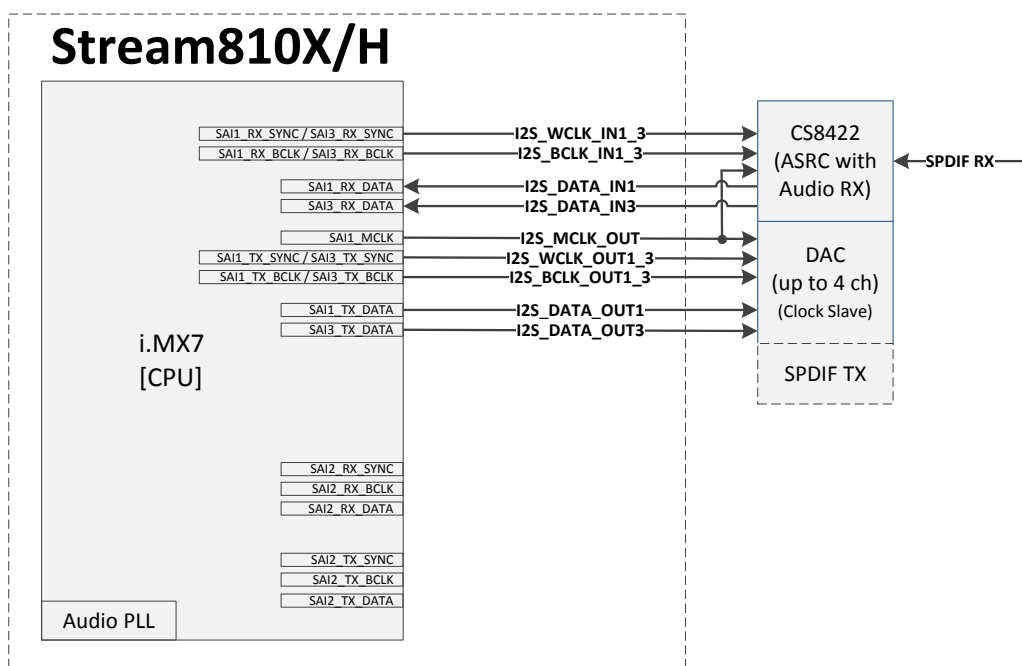


Figure 13 SPDIF Input

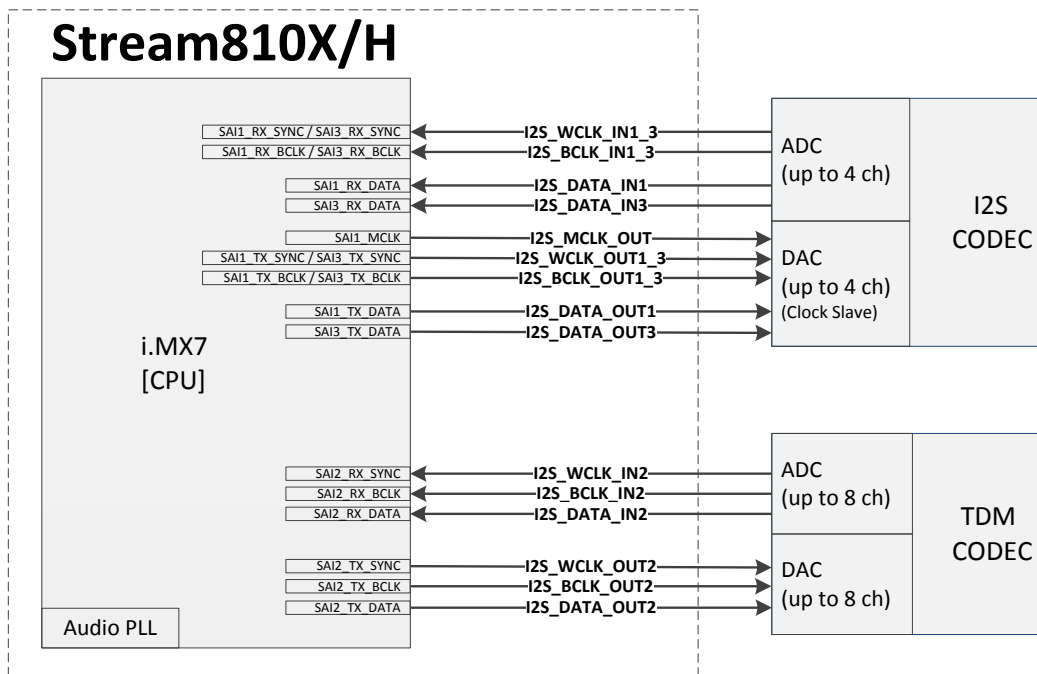


Figure 14 I2S + TDM mode

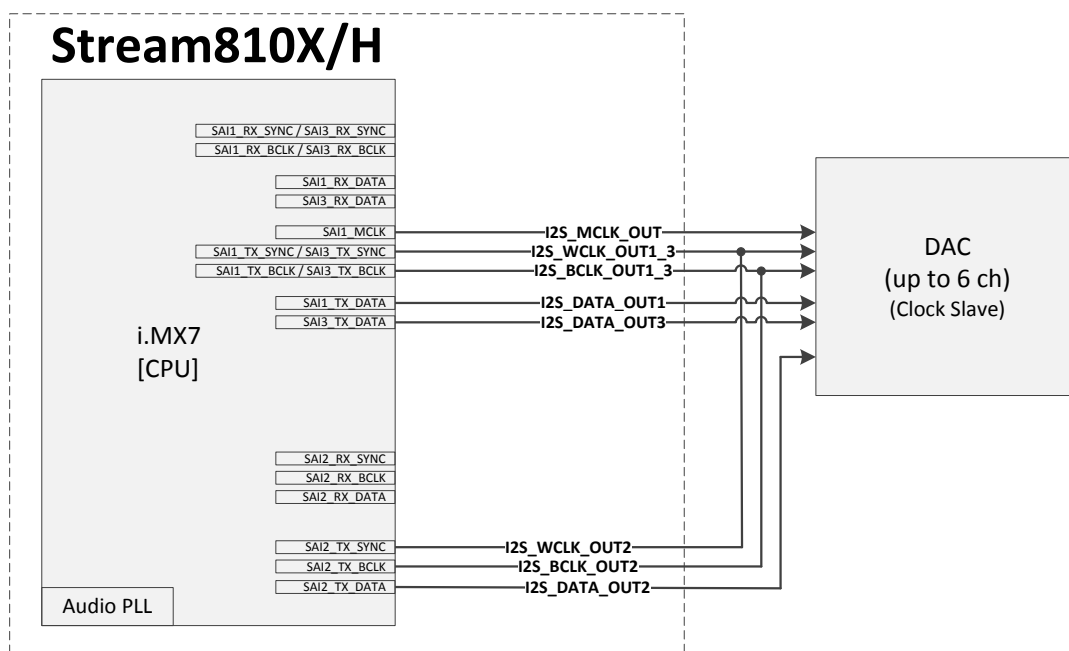


Figure 15 6-channel I2S Example

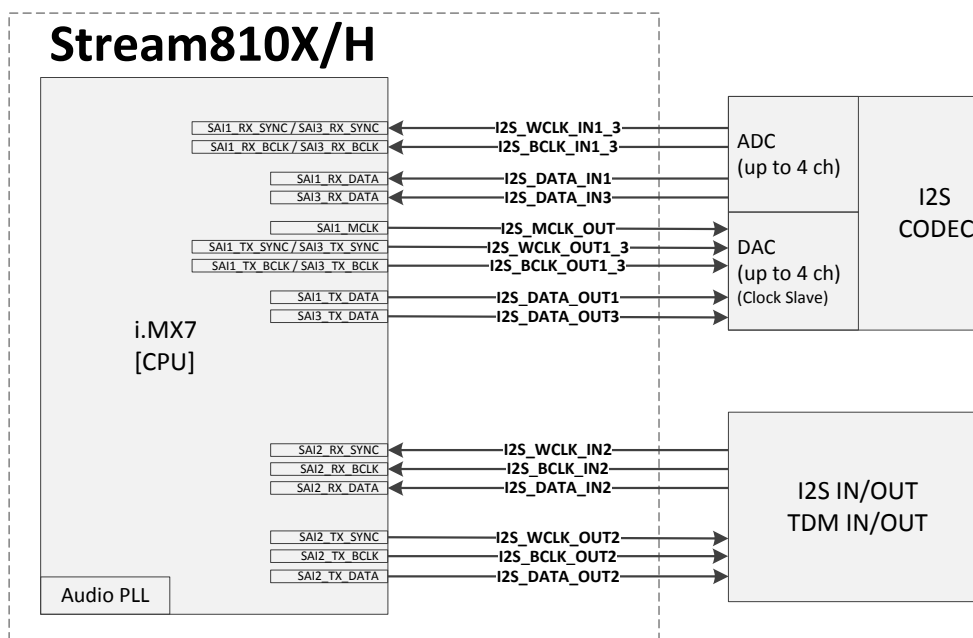


Figure 16 Mixed I2S/TDM mode

Stream810_HW_Specification_V_2_0_20180116.docx

January 16, 2018

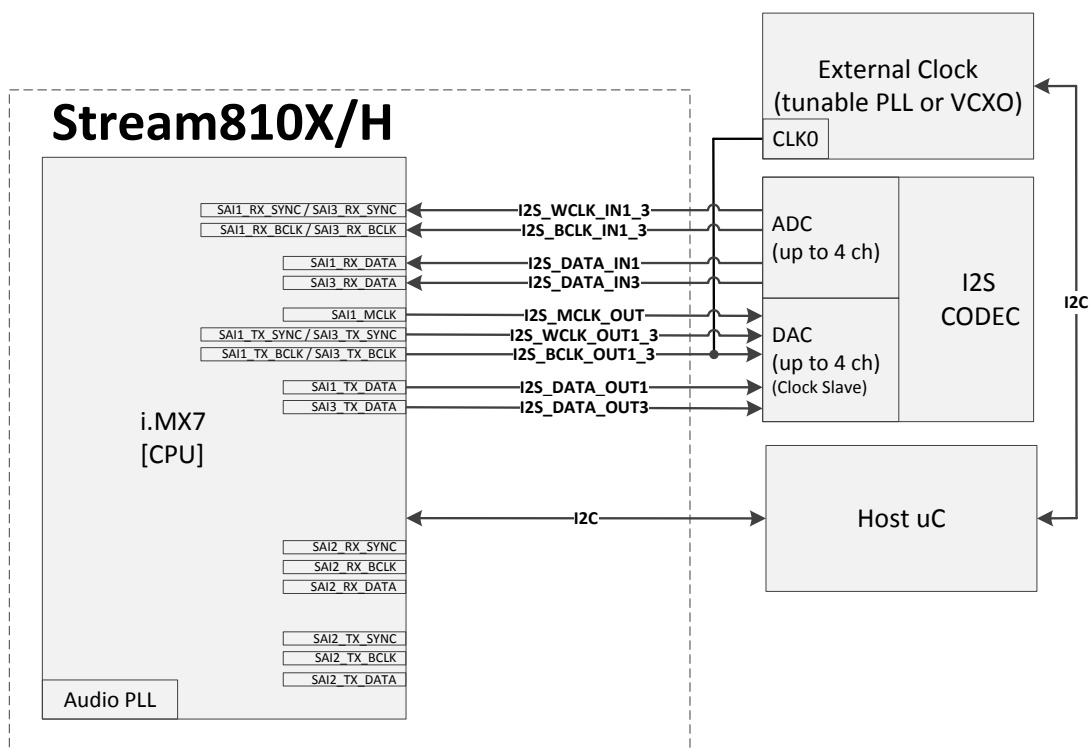


Figure 17 Lowest Jitter / External Clock

DSD Application Example

Stream810 supports playback of native DSD1x, DSD2x formats. An application example using the AKM AK4495, the ESS ES9018K2M or the TI PCM1795 PCM/DSD DAC is shown in the below figures.

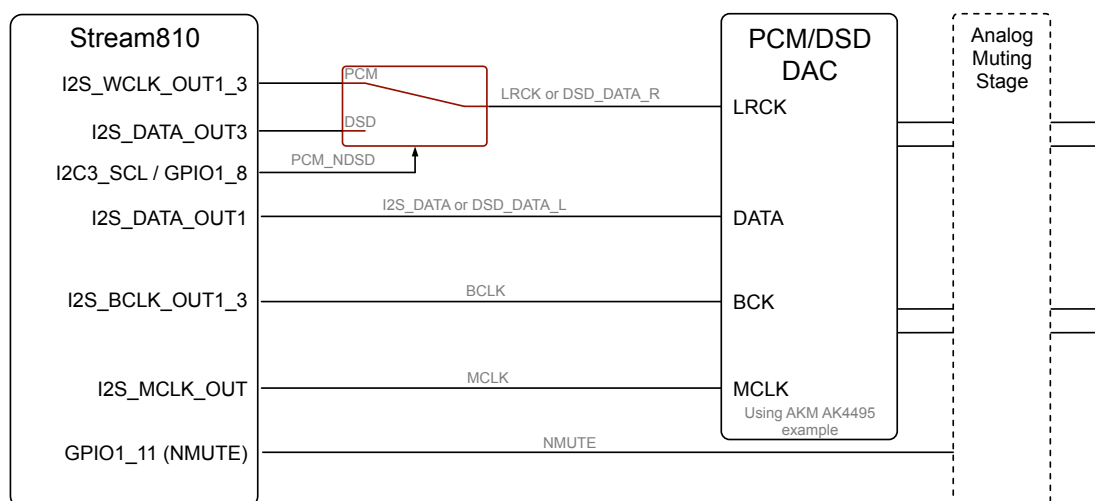


Figure 18 DSD Application Example using AK4495

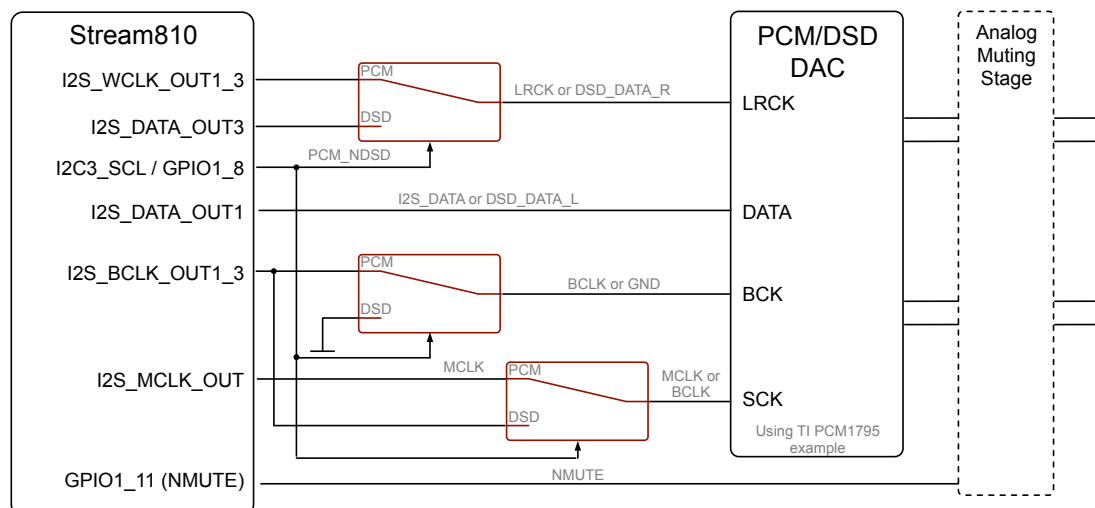


Figure 19 DSD Application Example using PCM1795

Stream810_HW_Specification_V_2_0_20180116.docx
January 16, 2018

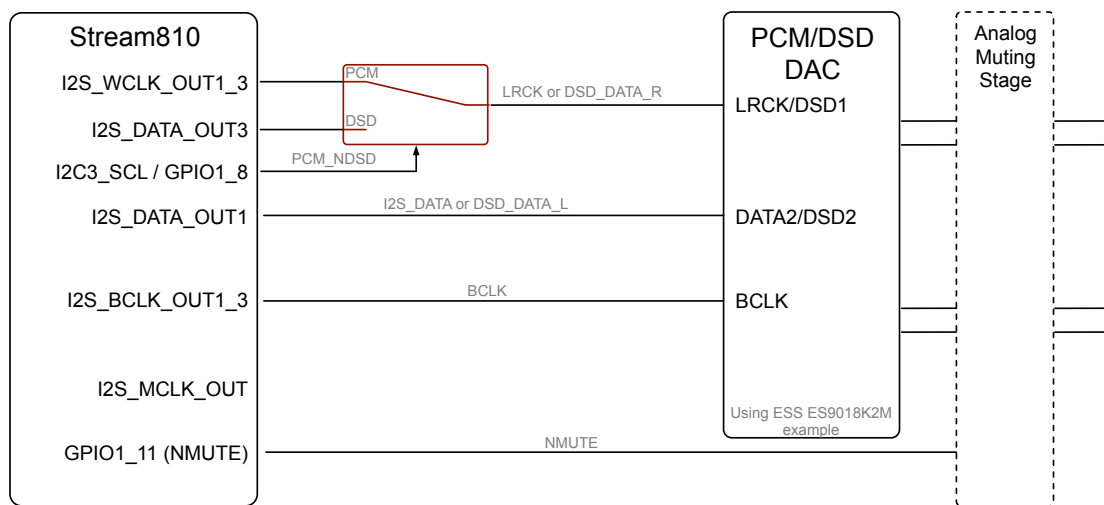


Figure 20 DSD Application Example using ES9018K2M

WLAN

Stream810 offers an on board dual-band WLAN interface, integrating the Marvel 88W8897. The WLAN interface is IEEE 802.11ac compliant, with 2x2 MIMO spatial stream multiplexing with data rates up to MSC9.

Antenna ports are 50 Ohms using IPEX (U.F.L.) type connectors, no external matching components are required.

CON107 is only for WLAN, CON108 is shared between WLAN and Bluetooth. CON108 is located near to corner of module pcb.

Module Reset

Stream810 features a reset input. To avoid corruption of the NAND flash content it is recommended to pull the module reset line low immediately when the external supply voltage decreases below the specified minimum voltage.

As an example, if the product is supplied by 12V AC/DC adapter and a 5V DC/DC converter is used to supply Stream810, the reset line can be activated when external supply drops below 10V in which case the 5V DC/DC converter will still keep the supply of Stream810 stable long enough to allow the internal NAND flash controller to finish the write access before NAND flash supply drops and thus flash integrity is maintained. To reset the module via an external controller an open drain output must be used.

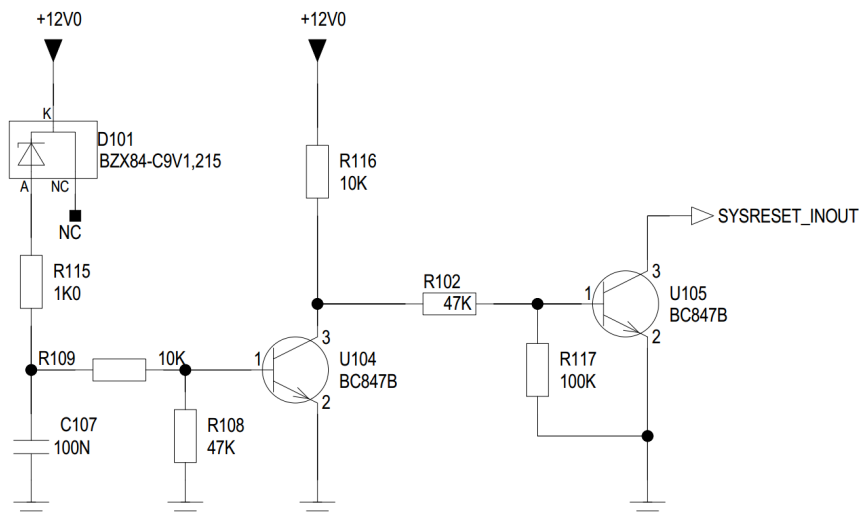


Figure 21 Reset schematic suggestion

Made For iDevice / AirPlay

The Stream810 can support AirPlay, *iDevice* control and audio over USB. These features require the Apple authentication co-processor to be mounted externally to the Stream810 (connected via I2C). A license agreement with Apple must be in place in order to sell products that use either of these features.

StreamUnlimited will provide reference schematics for interfacing to the Apple Authentication Processor to MFi licensees on request. If you are interested in using the *iDevice* control feature please register at <https://mfi.apple.com> and send us your registration confirmation. We will then forward you the reference schematics and the interface specification to the Stream810 as soon as possible.

Power On/Off and Software recovery

Stream810 can be powered on and off by a push button or host microcontroller using NPB_IN signal. When powered off, the module consumes less than 10mW.

NPB_IN signal is connected to onboard power management IC but also sensed by software, the implementation is as follows:

- When 5V comes up, the onboard power controller will activate the supplies automatically. There is no need to toggle NPB_IN in this case. NPB_IN should remain floating (a pullup resistor is included in the Stream810; do not overrule externally). See *Figure 22*.
- As soon as linux is booted (typically 30s), the NPB_IN signal is monitored by software. When NPB_IN is pulled low externally for more than 10ms but less than 1s, the Stream810 will stop playback, deregister on the network and shut down. The Stream810 will then issue a power off command to the power management IC. The complete shutdown sequence may take 10 seconds. VDD_1V8 and 3V3_OUT drops to zero volts after completion of the shutdown sequence. See *Figure 23*.
- To power the module on again without toggling 5V supply, pull the NPB_IN line low for more than 2 seconds. The power management IC will then re-enable the supplies. The NPB_IN line should be returned to High-Z state after being held low for more than 2 seconds.
- The power management IC includes a hard power off function similar to a PC. When the system is booted but for some reason not responsive, the Stream810 can be powered down by keeping NPB_IN low for 10 or more seconds, and simultaneously driving SYSRESETN_INOUT low. See *Figure 25*. Do not use this method during a software update, since the Stream810 may be unresponsive for long periods during a software update.
- Should it be required that the Stream810 does not boot up when 5V becomes active, keep SYSRESETN_INOUT low and pull NPB_IN low for more than 15 seconds. See *Figure 24*.
- The Stream810 will only sense NPB_IN after the Linux kernel is booted, pulling NPB_IN low within the first 30 seconds after power on may be ignored by the Stream810. Please make sure that the Linux kernel is booted before driving NPB_IN.

Software recovery using push-button input NPB_IN

Normally, a software-update is initiated via the user interface. However, for factory-programming or to recover a module which does not boot correctly, the software image can be updated from a USB mass storage device attached to a Stream810 USB port. This method requires that the onboard flash still contains a valid bootloader.

The recovery mode is triggered by pulling NPB_IN low for >3s and <10s, rather than only for 2s for normal power up. See *Figure 26*. Software recovery can also be initiated after the Stream810 has been powered off, see *Figure 23*. If no mass storage device is connected or no software image file found, the module will boot up normally. This will avoid malfunction if the NPB_IN is held low for >3s and <10s accidentally, for example if the customer keeps the power button pressed too long.

NPB_IN Functionality

NPB_IN is connected directly to the PWRON pin of the PMIC (Power Management IC). It is the Power On-Off key (PEK) input with an internal 100kΩ pull-up resistor.

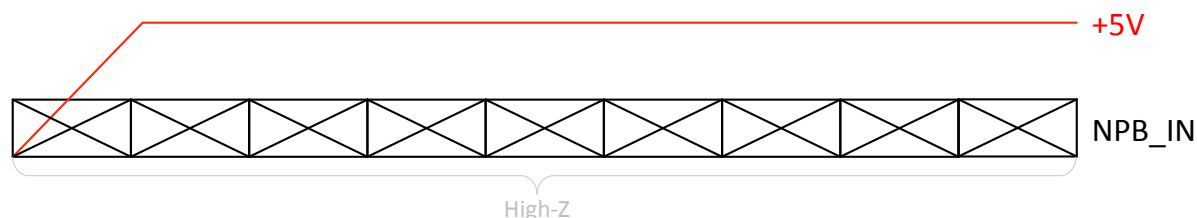


Figure 22 Normal ON

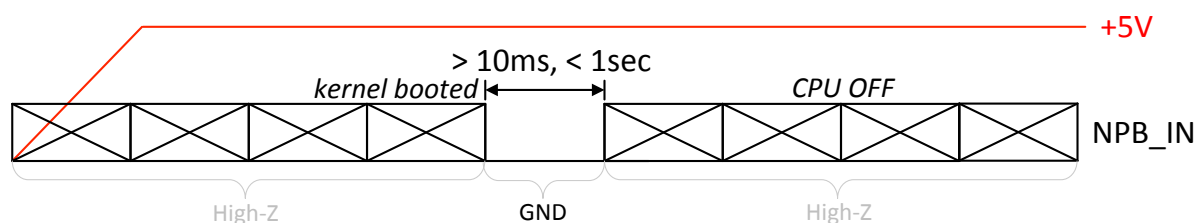


Figure 23 Normal OFF

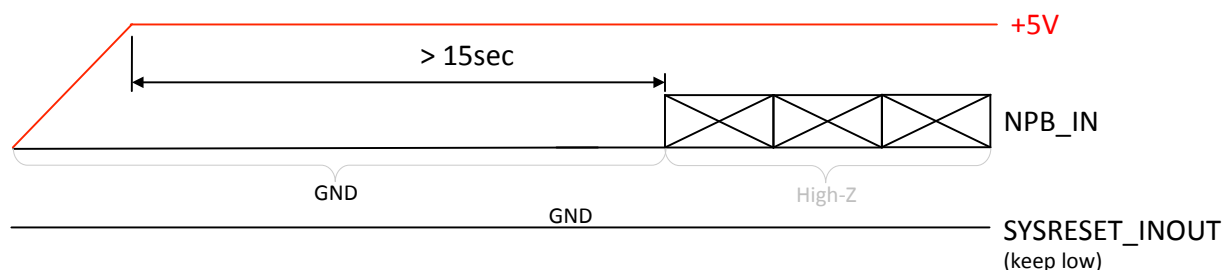
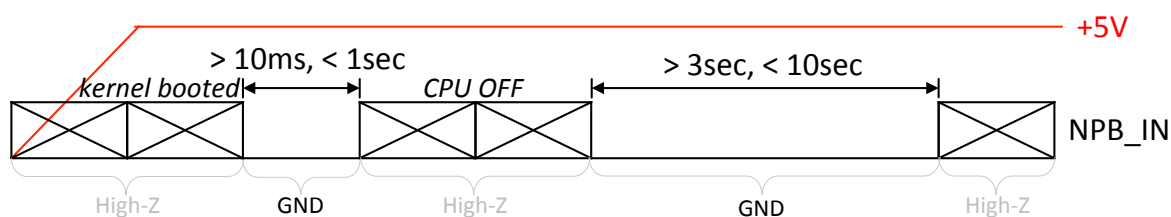
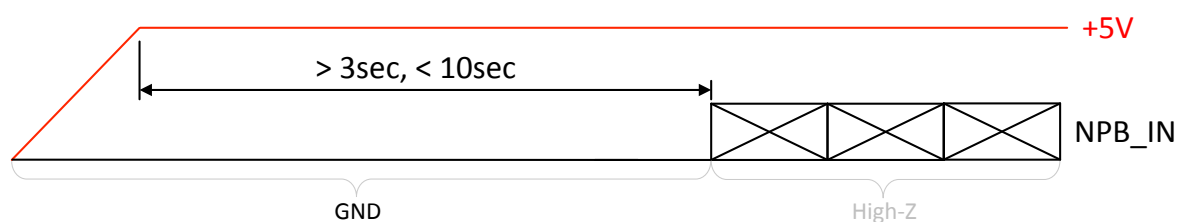
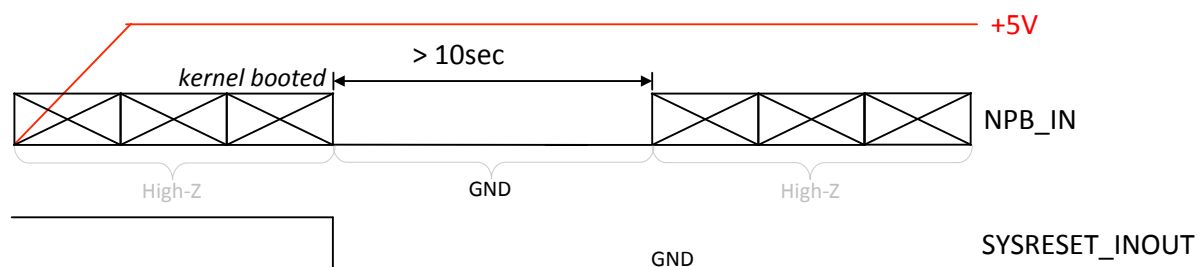


Figure 24 Keep OFF





Under Voltage Lockout, Brown-out behavior

When 5V input voltage drops below 3.3V but remains above 0.5V, the built-in power controller will switch off (under voltage lockout feature). To recover from this state either pull the NPB_IN signal low for more than 2 seconds or switch 5V input off long enough to ensure that the voltage drops below 0.5V.

5.3 Board Dimensions and Mechanical Interfaces

Length: 47mm

Width: 51mm

PCB Thickness: 1.2mm

Max component height bottom side: 1.8mm (excludes pin headers)

Max component height top side (shielding): 3.5mm

TOP SIDE with antenna connector positions

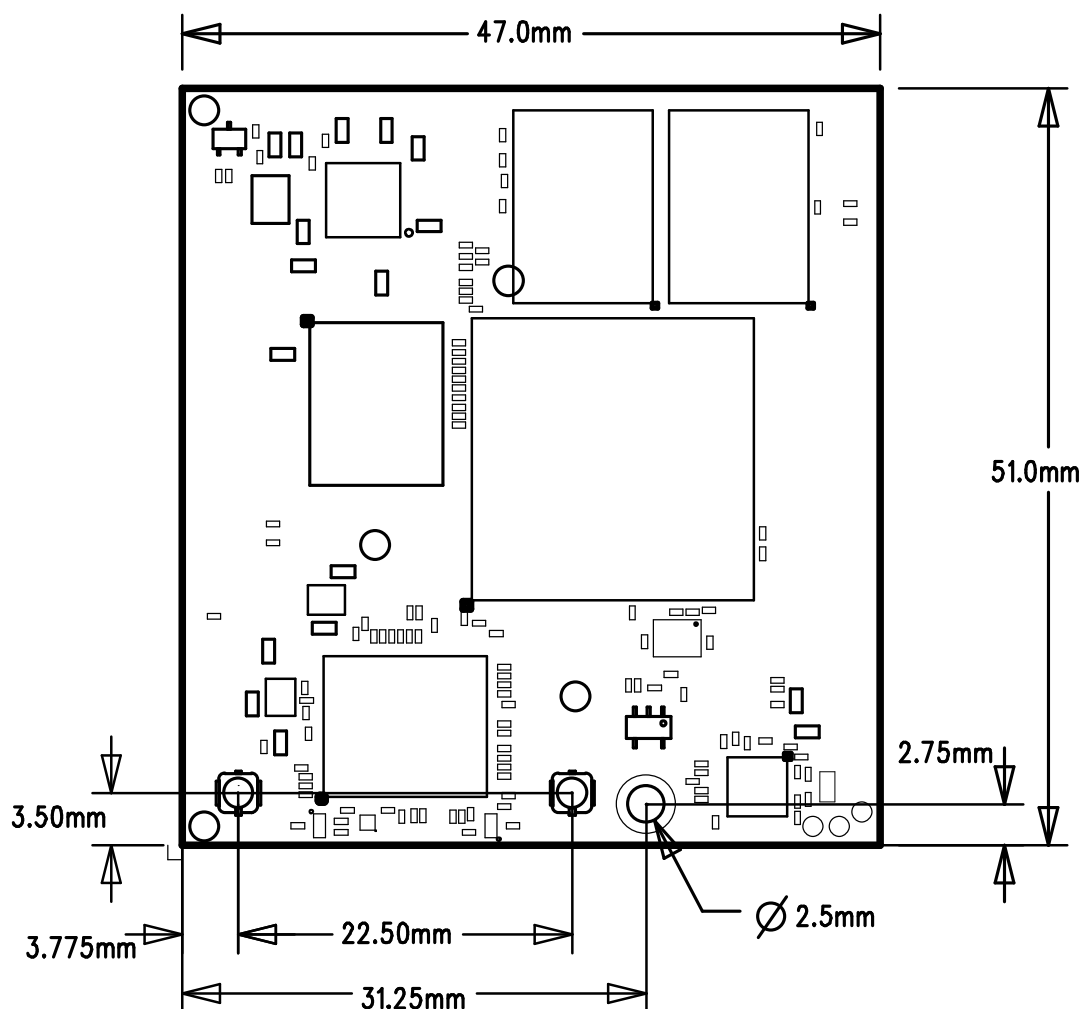
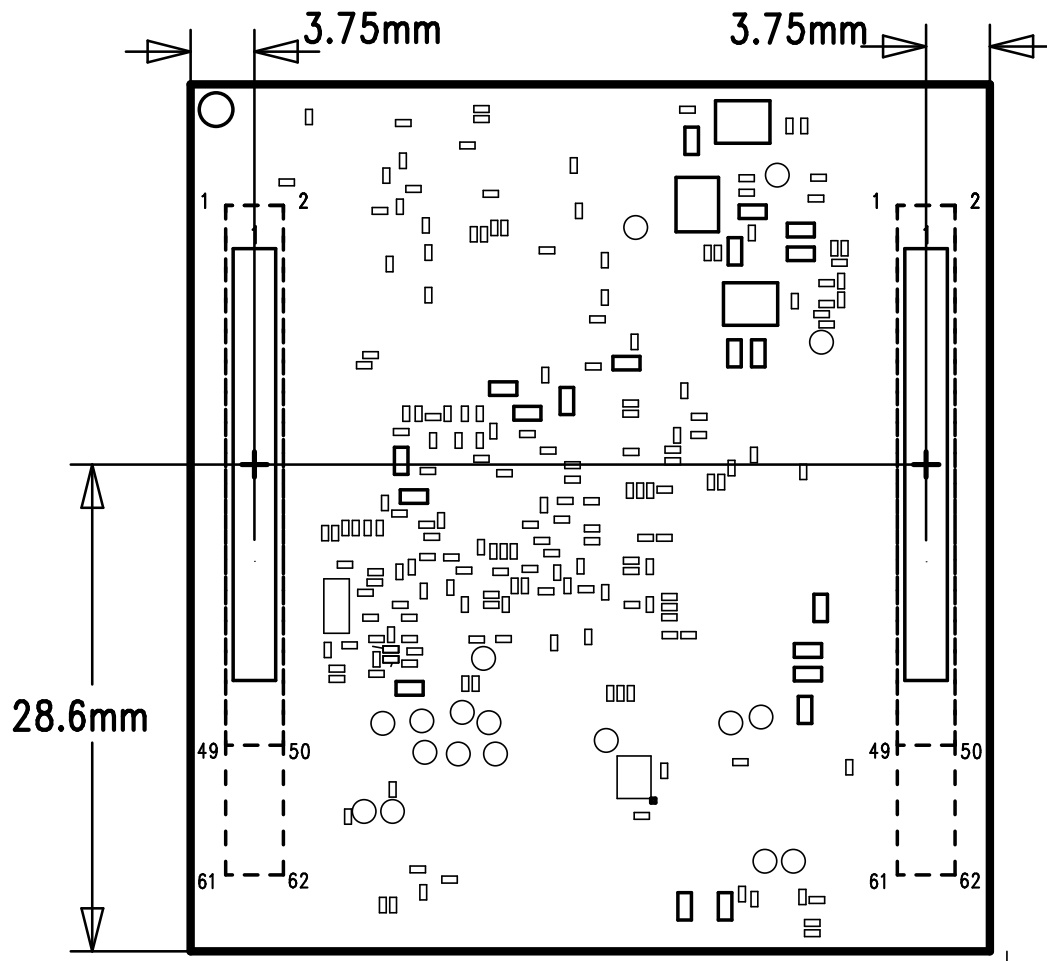
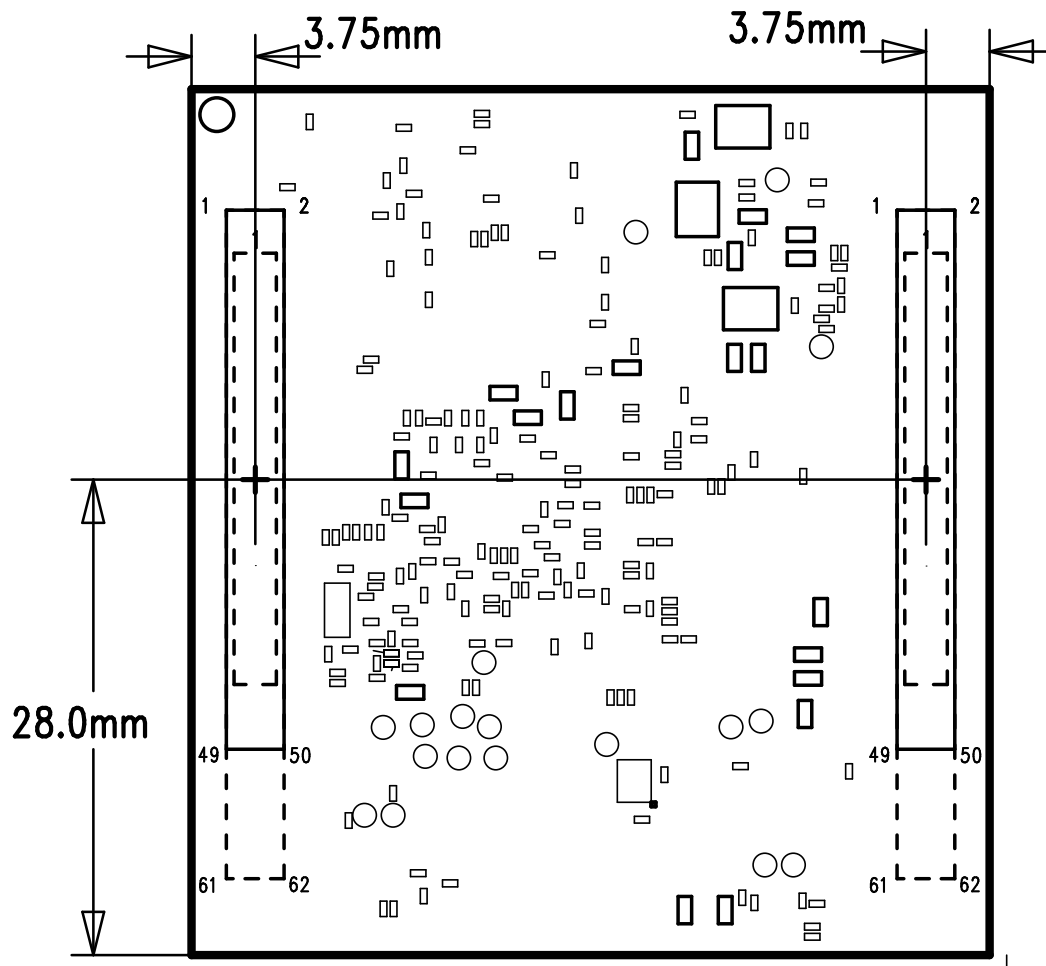
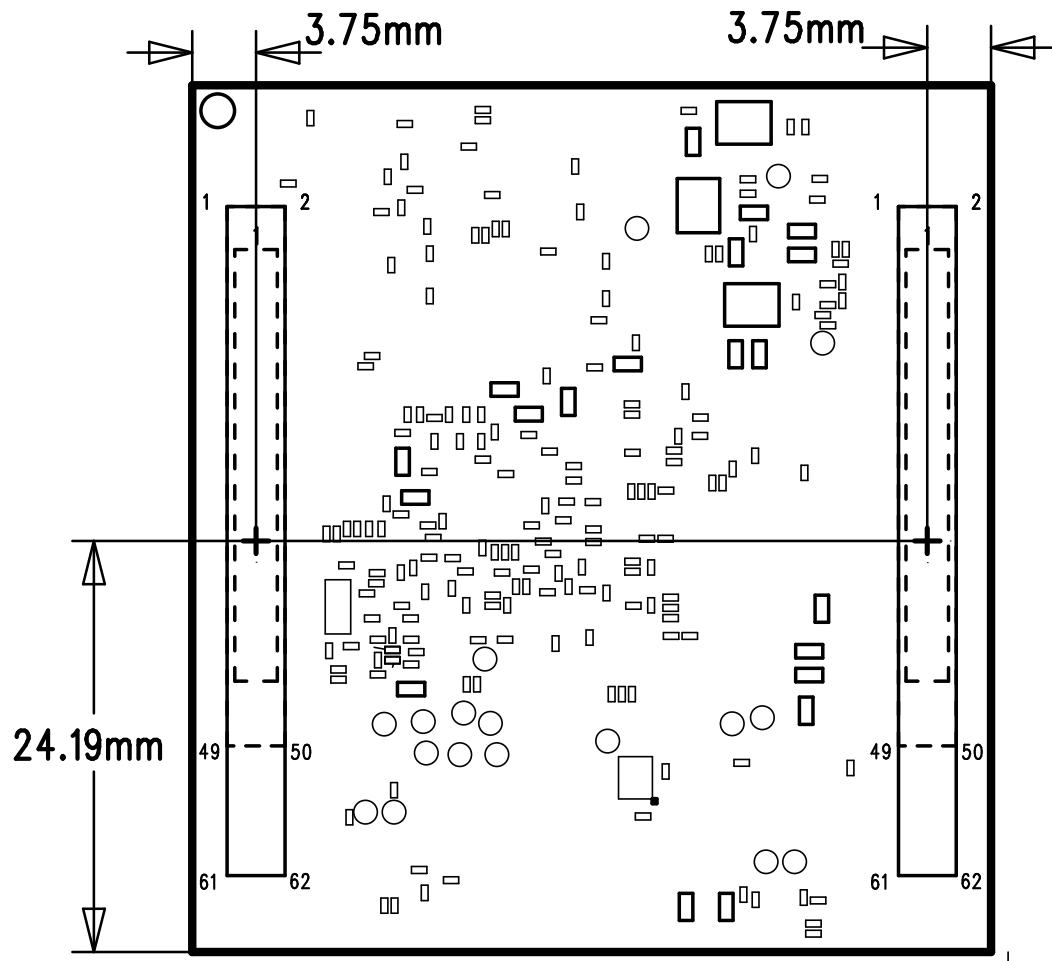


Figure 28 Dimensions, board assembly – top side

Bottom Side (Stream810B)*Figure 29 Dimensions, board assembly Stream810B – bottom side*

Bottom Side (Stream810X)*Figure 30 Dimensions, board assembly Stream810X – bottom side*

Bottom Side (Stream810H)*Figure 31 Dimensions, board assembly Stream810H – bottom side*

Note: The total height of all versions can be reduced by using low profile mating connectors such as Wurth 623 350 235 321. However, these may be more expensive than standard headers.

6. Electrical Specifications

6.1 Environmental Conditions

Minimum ambient temperature operational	0 °C
Maximum ambient temperature operational	65 °C
Minimum ambient storage temperature	-30 °C
Maximum ambient storage temperature	85 °C

6.2 CPU Operating Frequency Control and Temperature Protection

Modules with Serial Number 171600000 and below are specified and configured for 1GHz operation, modules with higher Serial Number are specified and configured for 1.2GHz operation.

Modules specified for 1.2 GHz operation can be limited to 1GHz operation to be used in applications which were developed and released using 1GHz modules.

Modules specified for 1GHz operation can be over-clocked to 1.2GHz for development and release activities, they should however not be used for final products since operation at 1.2GHz is not guaranteed.

Contact StreamUnlimited should you wish to change the default configuration.
When CPU junction temperature exceeds 85°C, the operating frequency will be limited by software to 800MHz to avoid damage or reduction of lifetime. When the temperature drops below 83°C again, the limit is disabled and full CPU speed becomes available. See also "thermal application notes" at the end of this document

6.3 Power Supply and Low Power Mode

Supply voltage requirements

Minimum supply voltage:	3.7V
Maximum supply voltage:	5.25V
Absolute maximum rating:	6V

Power modes / Operating modes

Off:

- Module is powered down
- 3V3_OUT is off
- VDD_1V8 is off

Booting:

- Module is powered up, booting in process
- 3V3_OUT is on
- VDD_1V8 is on
- USB overload detection is not performed
- NPB_IN is sensed initially only, if low firmware recovery process from USB will be started. Pulling NPB_IN low at later stage during the boot process will not have an effect unless if pulled low for 10 seconds or longer which causes PMIC to power down

On:

- Linux application is running
- USB overload detection is performed
- NPB_IN is sensed, pulling it low will trigger shutdown
- All peripherals can be used
- CPU frequency is adjusted automatically depending on system load and temperature

Soft reset (transition state)

- Internal PMIC is disabled temporarily to toggle all internal supplies for a proper reset
- **3V3_OUT and VDD_1V8 show a short gap of about 15ms. The voltage levels may not reach 0V**

Low power

- Transition from ON mode to low power mode and back is under control of application software
- Internal bus frequencies are reduced to reduce power consumption
- CPU frequency is adjusted automatically depending on system load and temperature
- **Following peripherals are not functional in low power mode *)**
 - USB
 - LCD
- NPB_IN is sensed, pulling it low will trigger shutdown

Shutting down

- Entered under control of application software (e.g. by sensing NPB_IN)
- 3V3_OUT will be disabled
- VDD_1V8 will be disabled
- Transition to OFF mode

*) ... operation of these peripherals is currently not possible at reduced bus frequency. Powering a graphical LCD or a USB harddrive in network standby would also make the product fail to meet legal requirements for network standby in Europe. Products using an external USB to Ethernet adapter should disable internal Ethernet port and Wi-Fi interface while connected to a network via the external adapter, related power consumption is provided in below table.

Power Consumption (typical values)

Operation mode	avg [mA]	Avg [mW]	peak [mA]	peak [mW]	Remark
Off Mode	< 0.5	< 2.5	< 0.5	< 2.5	
GC4A play via WLAN 2.4GHz (Cast from Google Play Music)	270	1350	410	2050	
GC4A play via WLAN 5GHz (Cast from Google Play Music)	275	1375	470	2350	
GC4A play via LAN	300	1500	330	1650	
Full CPU load, high network load *)	430	2150	940	4700	"stress" tool, "iperf" over 5GHz WLAN
Network stdby LAN	190	950			with power save enabled
Network stdby LAN	140	700			with power save enabled, WLAN and PCIe disabled
Network stdby WLAN 2.4GHz	154	770			with power save enabled, LAN disconnected
Network stdby WLAN 5GHz	166	830			with power save enabled, LAN disconnected
Network stdby WLAN 5GHz, LAN disabled	150	750			with power save enabled, no detection of LAN cable insertion
Idle, LCD off, LAN down, WLAN down	180	900	240	1200	power save disabled, USB ports available
GVA play via WLAN 2.4GHz (Google Play Music)	320	1600	440	2200	100% CPU artificial load
GVA play via WLAN 5GHz (Google Play Music)	350	1750	680	3400	100% CPU artificial load

*) see 6.2: when operating permanently under full load without a heatsink attached, the operating frequency will be reduced to 800MHz when CPU junction temperature reaches 85°C to avoid damage. See also "thermal application notes at end of this document"

6.4 RF specification

Feature	Description
WLAN Standard	IEEE 802.11a/b/g/n/ac 2x2 MIMO
Bluetooth Standard	Bluetooth 4.2 (BDR/EDR) (includes Low Energy (LE))
Frequency Bands	2.412 – 2.472 GHz (2.4GHz ISM Band, 13 Channels) Channel 1 – Channel 13 North America FCC, Japan Telec, Europe ETSI 5.180-5.825 GHz (5GHz UNII-1/2/3 Band, 24 Channels) Channel 36 – Channel 165 North America FCC, Japan Telec, Europe ETSI 2.400 – 2.4835 GHz (Bluetooth 4.2 (includes Low Energy (LE)) North America FCC, Japan Telec, Europe ETSI
WLAN Modulation	DSSS, OFDM (DBPSK, DQPSK, CCK, 16-QAM, 64-QAM, 256-QAM)
Bluetooth Modulation	DSSS, GFSK, $\pi/4$ DQPSK, 8DPSK
Antenna	Two antenna terminals, use antennas with gain max. 3.5dBi (see section “regulatory approvals” for reference)
Transmission Speed	802.11b: 1Mbps, 2Mbps, 5.5Mbps, 11Mbps 802.11a/g: 6Mbps, 9Mbps, 12Mbps, 18Mbps, 24Mbps, 36Mbps, 48Mbps, 54Mbps 802.11n/ac: MIMO with maximum data rates up to: 196.2 Mbps (HT20) 400 Mbps (HT40) 866.7 Mbps (HT80)
WLAN Tx Power	802.11b: typical 16dBm +/-2dBm 802.11g: typical 14dBm +/-2dBm 802.11n/ac HT20: typical 14dBm +/-2dBm 802.11n/ac HT40 at 2.4 GHz: typical 12dBm +/-2dBm 802.11n/ac HT40 at 5 GHz: typical 9dBm +/-2dBm 802.11n/ac HT80 at 5 GHz: typical 6dBm +/-2dBm
Bluetooth Tx Power	class 2 (4dBm)

IC STATEMENT

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

- (1) This device may not cause interference.
- (2) This device must accept any interference, including interference that may cause undesired operation of the device

Cet appareil contient des émetteurs / récepteurs exemptés de licence conformes aux RSS (RSS) d'Innovation, Sciences et Développement économique Canada. Le fonctionnement est soumis aux deux conditions suivantes :

- (1) Cet appareil ne doit pas causer d'interférences.
- (2) Cet appareil doit accepter toutes les interférences, y compris celles susceptibles de provoquer un fonctionnement indésirable de l'appareil.

Indooruseronly

IC Radiation Exposure Statement

The modular can be installed or integrated in mobile or fix devices only. This modular cannot be installed in any portable device.

This modular complies with IC RF radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This modular must be installed and operated with a minimum distance of 20 cm between the radiator and user body. Cette modulaire doit être installé et utilisé à une distance minimum de 20 cm entre le radiateur et le corps de l'utilisateur.

If the IC number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

“ContainsIC:29050-8A1C6D”

when the module is installed inside another device, the user manual of this device must contain below warning statements;

1. This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Scienceand Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

- (1) This device may not cause interference.
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

2. Cet appareil contient des émetteurs / récepteurs exemptés de licence conformes aux RSS (RSS) d'Innovation, Sciences et Développement économique Canada. Le fonctionnement est soumis aux deux conditions suivantes :

- (1) Cet appareil ne doit pas causer d'interférences.
- (2) Cet appareil doit accepter toutes les interférences, y compris celles susceptibles de provoquer un fonctionnement indésirable de l'appareil.

Indooruseronly

The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product

FCC Statement

FCC standards: FCC CFR Title 47 Part 15 Subpart C Section 15.407,15.247

Device is equipped with PIFA antenna (reversed polarity unique antenna port), Antenna gain 1.2dBi

Indoor use only

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

We will retain control over the final installation of the modular such that compliance of the end product is assured. In such cases, an operating condition on the limit modular approval for the module must be only approved for use when installed in devices produced by a specific manufacturer. If any hardware modify or RF control software modify will be made by host manufacturer, C2PC or new certificate should be apply to get approval, if those change and modification made by host manufacturer not expressly approved by the party responsible for compliance, then it is illegal.

FCC Radiation Exposure Statement

The modular can be installed or integrated in mobile or fix devices. This modular cannot be installed in any portable device if without further certifications such as C2PC with SAR. This modular complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This modular must be installed and operated with a minimum distance of 20 cm between the radiator and user body.

If the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID: 2ACK6-CD68T2 Or Contains FCC ID: 2ACK6-CD68T2”

Indoor use only

When the module is installed inside another device, the user manual of the host must contain below warning statements;

1. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
 - (1) This device may not cause harmful interference;
 - (2) This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

2. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product.

Any company or the host device which install the modular with limit modular approval should perform the test of radiated & conducted emission and spurious emission, etc. according to FCC part

15C : 15.407, 15.247 and 15.209 & 15.207, 15B Class B requirement, Only if the test result comply with FCC part 15C : 15.407, 15.247 and 15.209 & 15.207, 15B Class B requirement, then the host can be sold legally.