EMB-2238

Technical Specification Manual

Version: R1.00

Revisions

Version	Description of Version	Date Completed
R1.00	Release	12/27/2018

Preface

This Technical Specification Manual (TSM) specifies the board layout, components, connectors, and the I/O connection ports, motherboards features.

Intended Audience

The TSM is intended to provide detailed, technical information about the EMB-2238 and its components to the vendors, system integrators, and other engineers and technicians who need this level of information. It is specifically not intended for general audiences.

What This Document Contains

Chapter	Description
1	Introduction
2	Product Description
3	Technical Reference
4	Operating System

1. Introduction

1.1 Product introduction

The EMB-2238 is a Pico-ITX (100x 72mm) industrial motherboard based on NXP i.MX8M ARM application processor. The board features a Power over Ethernet (PoE) ready Gigabit Ethernet port, on-board WiFi/BT, MIPI LCD panel display interfaces support, on-board dual-core DSP that runs algorithms for voice control, noise suppression, and echo cancellation technology, extensive high-performance digital audio inputs/outputs and full set of I/Os including RS-232/485, I2C, SPI, digital IO and more..

1.2 Form Factor

The EMB-2238 is based on Pico-ITX .It is a small Single Board Computer Form factor with 100 x 72 mm (3.9” x 2,8”).

2. Product Description

2.1 Specification

Table 1 summarizes the major features of the board.

Table 1. Specification

Platform	NXP i.MX8M
Form Factor	Pico-ITX
Processor	i.MX 8MQuad
Core	4x ARM Cortex-A53 @ 1.5GHz 1x Arm Cortex-M4 @ 266MHz
System Memory	LPDDR4 @3200MT up to 4GB
Ethernet	Onboard Gigabit Ethernet with POE power option
Wireless	RL8723AU USB 2.0 802.11 b/g/n + Bluetooth V4.0
Audio	1x mono Class D speaker out, 2W(4Ω), 2 (R/L) x HP out header 8 channel digital audio input and 8 channel digital audio output (SAI1) interfaces with 32-bit @ 384 kHz fs and TDM support, 1x SPDIF
Voice Control Frontend	Dual digital MEMS microphone header via CS47L24 with dual DSP, support multi-mic noise suppression, acoustic echo cancellation (AEC), omni-directional spatial 8 channel digital audio/DMIC inputs (SAI5) via 40-pin expansion header
Storage	8GB iNand Flash, up to 16GB, 265K EEPROM with write protect control
Graphic Controller	GC7000L/GC7000LVX, supports OpenGL/ES 3.1, OpenGL 3.0, Vulkan, OpenCL 1.2
Display Interface	1x micro HDMI
LCD Interface	1 x 4-lane MIPI DSI + I2C 40-pin FPC header, 1 x 4-lane MIPI CSI2
Display Resolution	HDMI support maximum display resolution 4096x2160@60Hz
SD Card Socket	1 x micro SD Socket (not support hot plug)
USB	2 x 4-pin 2.0 mm pitch USB 2.0 pin header, 2 x USB 2.0 Type A
Boot Switch	1 x 2-bit DIP switch for iNAND and micro SD boot selection 1 x bootload button for USB and board boot
Power Switch	1 x on-board power switch
I/O Terminal Block	5-pin header with two combination of RS-232, RS-485 and 2 x GPIO
RTC	1 x RTC input, 2-pin wafe heder,1.25mm
Power Input	1 x 5VDC power input, 3-pin 2.54 header or POE with optional module
OTG	1 x USB 3.0 OTG
Expansion	2x 20-pin 2.0mm expansion header offers: x1 PCIe PHY, 1 x RS-232 (Rx, Tx) , IOMUX outputs: up to 1x UART, 8 ch DMIC in, 1x I2C and configurable GPIOs
Operating Temperature	-10 ~ 60° C (14 ~ 144° F)
Storage Temperature	-40 ~ 85° C (-40 ~ 185° F)
Operating Humidity	5% ~ 95%, 40ºC, non-condensing
Dimensions	100 x 72 mm (3.94" x 2.84")

2.2 Board Layout

Figure 1 shows the location of the major components on the top and bottom-side of the EMB-2230.

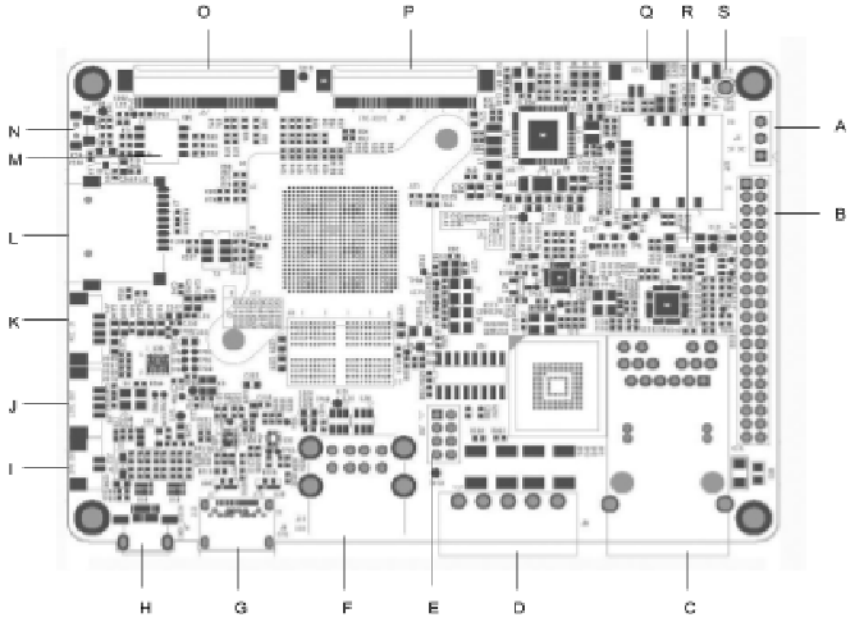

Figure1. Board Layout

Table 2. Components Show in Figure 1

Item from Figure 1	Connector	Description
A	J1	5V DC Input
B	J7	5V DC in,3.3V out, PCIe signals, SAI-In, RS-232, Power-on, Reset, I2C, GPIOs, POE power signals
C	U13	RJ45 connector for 1000M Ethernet with POE
D	J8	Modbus for RS232 or RS485 or GPIOs
E	J10	2x USB 2.0 headers
F	J11	USB Type A for 2x Host USB 2.0
G	J9	USB Type C for 1 x OTG USB 3.0
H	J4	Micro HDMI connector for HDMI port
I	J13	Mono Speaker out
J	J15	L/R HP out
K	J14	2x digital MEMS microphone in
L	J3	micro SD socket
M	SW1	4-bit switch for boot selection TF/eMMC
N	S1	Bootload Button for eMMC flash
O	J5	FPC connector for SAI1 Digital audio I/O and GPIO
P	J6	FPC connector for MIPI DSI, CSI and I2C
Q	J2	RTC Battery input
R	SW2	System Power On/Off
S	J12	2.4G antenna for Wifi/BTE
LED	D6	Green LED flashing for system working status
LED	D2	Green LED on for system power OK
LED	D1	Red LED light for power over voltage

2.3 Block Diagram

Figure 2 is a block diagram of the major functional areas of the board.

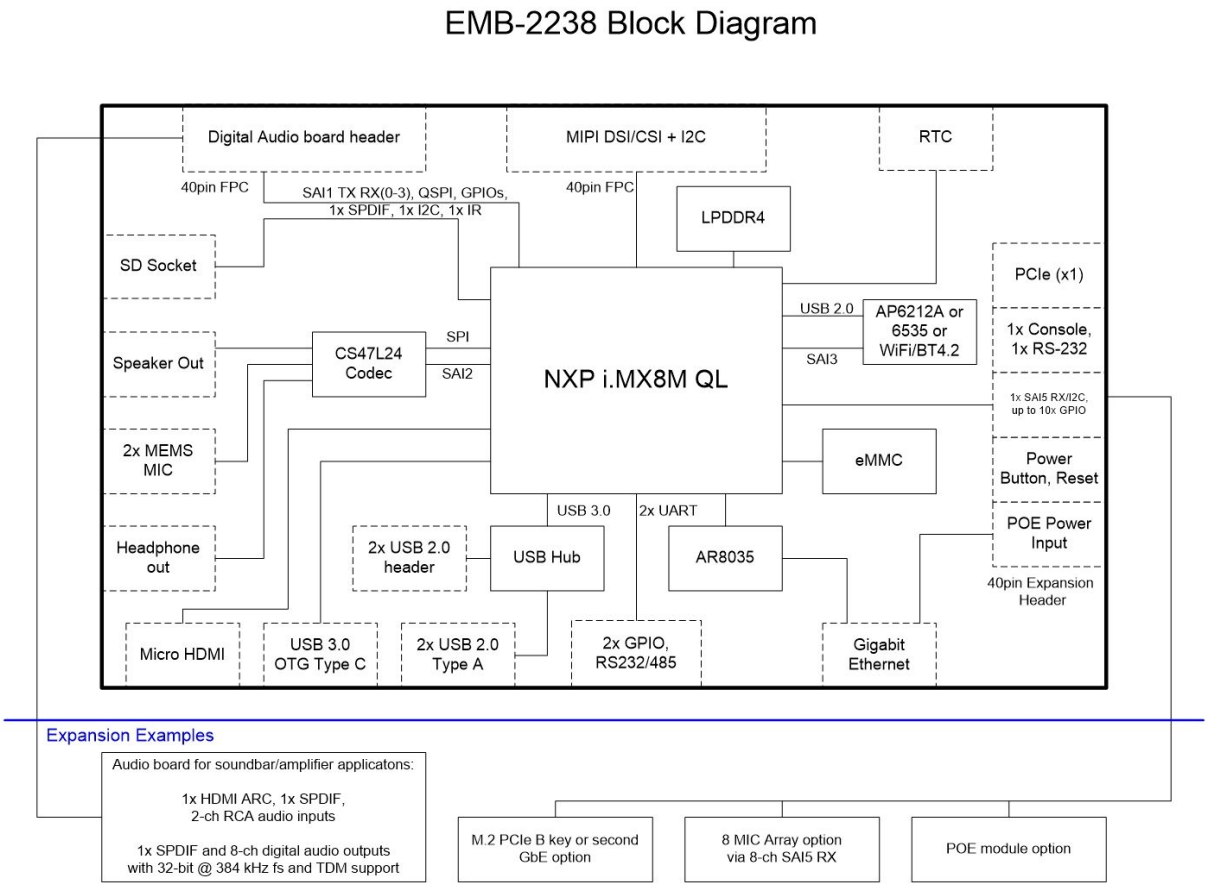

Figure 2. Block Diagram

2.4 Dimensions

Figure 3 is board layout dimensions (unit: mm).

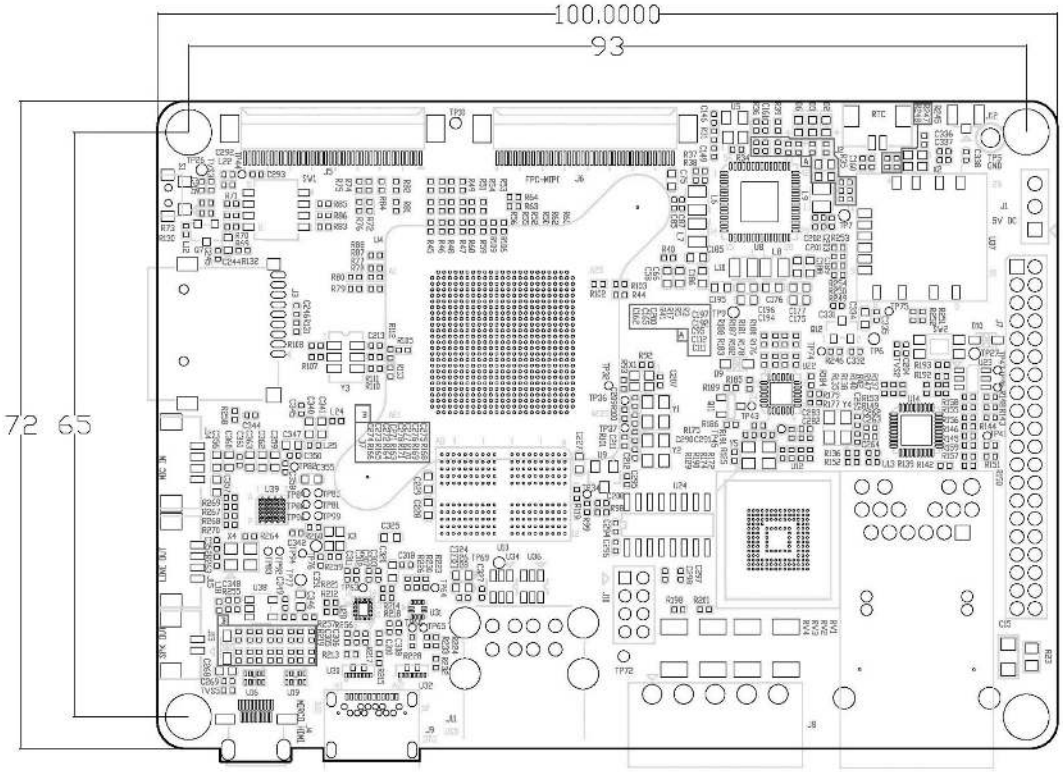

Figure 3. Dimensions

3. Technical Reference

3.1 Connectors and Headers

Table 4. J1 Header (Figure. 1. A)

Pin	Signal Name
1	+5V DC power input
2	+5V DC power input
3	GND

Table 5. J7 40-pin Expansion Header (Figure. 1. B)

Pin	Signal Name	Pin	Signal Name
1	GND	21	GPIO/SAI5MCLK (3.3V)
2	+5V IN	22	GPIO/REF_CLK_32K (3.3V)
3	PCIeCLK_N (2.5V)	23	GPIO/SAI5RXFS (3.3V)
4	+5V IN	24	GPIO/I2C2_SCL (3.3V)
5	PCIeCLK_P (2.5V)	25	GPIO/SAI5_RXC (3.3V)
6	+5V_IN	26	GPIO/I2C2_SDA (3.3V)
7	GND	27	GPIO/SAI5_RXD0 (3.3V)
8	+3.3V OUT	28	GPIO/SAI5_RXD3 (3.3V)
9	PCIeTX_N (2.5V)	29	GPIO/SAI5_RXD1 (3.3V)
10	PWR_BTN	30	GPIO/SAI5_RXD2 (3.3V)
11	PCIeTX_P (2.5V)	31	GND
12	BootLoad_BTN	32	GND
13	GND	33	VC1+ (POE Power In)
14	GND	34	VC2+ (POE Power In)
15	PCIeRX_N (2.5V)	35	VC1- (POE Power In)
16	GPIO/Uart2_TX (Console)	36	VC2- (POE Power In)
17	PCIeRX_P (2.5V)	37	GND
18	GPIO/Uart2_RX (Console)	38	GND
19	GND	39	RS232_TXD
20	GND	40	RS232_RXD

Table 6. J8 Modbus Port (Figure. 1. D)

Zero ohm resistor populated option	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5
1: R198, R201, R195, R194 (default)	GPIO_A	GPIO_B	GND	RS232_TX	RS232_RX
2: R198, R201, R204, R207	GPIO_A	GPIO_B	GND	RS485_A	RS485_B
4: R205, R209, R195, R194	RS485_A	RS485_B	GND	RS232_TX	RS232_RX

Table 7. J9 OTG Type C 3.1 Port (Figure. 1. G)

Pin	Signal Name	Pin	Signal Name
A1	GND	B1	GND
A2	SSTXP1	B2	SSTXP2
A3	SSTXN1	B3	SSTXN2
A4	OTG_PWR	B4	OTG_PWR
A5	CC1	B5	CC2
A6	USB_DP	B6	LVDS1_TX2_P
A7	USB_DN	B7	LVDS1_TX2_N
A8	SBU1	B8	SBU2
A9	OTG_PWR	B9	OTG_PWR
A10	SSRXN2	B10	SSRXN1
A11	SSRXP2	B11	SSRXP1
A12	GND	B12	GND

Table 8. J10 USB Header (Figure. 1. E)

Pin	Signal Name
1	USB_HOST_VBUS
3	USB_HUB_DM4
5	USB_HUB_DP4
7	GND
2	USB_HOST_VBUS
4	USB_HUB_DM3
6	USB_HUB_DP3
8	GND

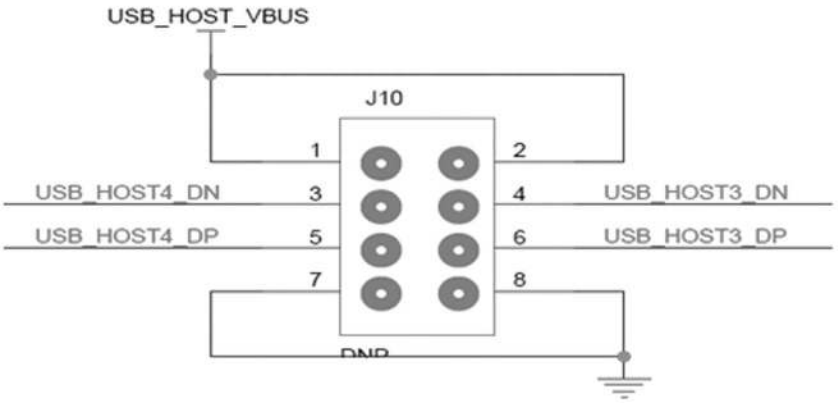

Table 9. J4 Micro HDMI Port (Figure. 1. H)

Pin	Signal Name
1	HPD_OUT
2	N/C
3	HDMI_D2P
4	GND
5	HDMI_D2N
6	HDMI_D1P
7	GND
8	HDMI_D1N
9	HDMI_D0P
10	GND
11	HDMI_D0N
12	HDMI_CLKP
13	GND
14	HDMI_CLKN
15	HDMI_CEC_OUT
16	GND
17	HDMI_DDC_CLK_OUT
18	HDMI_DDC_DAT_OUT
19	HDMI_5V_OUT

Table 10. J13 Mono Speaker Out Header (Figure. 1. I)

Pin	Signal Name	Pin	Signal Name
1	SPKOUTP	2	SPKOUTN

Table 11. J15 Headphone Out (Figure. 1. J)

Pin	Signal Name (Default)	
1	NC	
2	GND	
3	HP_out (R)	
4	HP_out (L)	

Table 12. J14 DMIC In (Figure. 1. K)

Pin	Signal Name
1	MICBIAS1
2	MICBIAS2
3	DMICCLK
4	DMICDAT

Table 13. J5 Digital Audio Header (Figure. 1. O)

Pin	Signal Name	Pin	Signal Name
1	5V_LCD	21	SPDIF_TX
2	5V_LCD	22	GND
3	SAI1_MCLK	23	I2C3_SCL/GPIO
4	GND	24	I2C3_SDA/GPIO
5	SAI1_TXC	25	GND
6	SAI1_TXFS	26	QSPIA_SCLK/GPIO
7	SAI1_TXD0	27	QSPIA_nSS0/GPIO
8	SAI1_TXD1	28	QSPIA_DATA0/GPIO
9	SAI1_TXD2	29	QSPIA_DATA1/GPIO
10	SAI1_TXD3	30	QSPIA_DATA2/GPIO
11	GND	31	QSPIA_DATA3/GPIO
12	SAI1_RXC	32	NAND_DATA4/GPIO
13	SAI1_RXFS	33	NAND_DATA5/GPIO
14	SAI1_RXD0	34	NAND_DATA6/GPIO
15	SAI1_RXD1	35	NAND_DATA7/GPIO
16	SAI1_RXD2	36	IR_CAP/GPIO
17	SAI1_RXD3	37	GND
18	GND	38	3.3V_VDDIO
19	SPDIF_CLK	39	3.3V_VDDIO
20	SPDIF_RX	40	3.3V_VDDIO

Table 14. J6 MIPI CSI DSI Header (Figure. 1. P)

Pin	Signal Name	Pin	Signal Name
1	+5V_LCD	21	I2C3_SCL/GPIO4_MIPI (3.3V)
2	5V_LCD	22	I2C3_SDA/GPIO5_MIPI (3.3V)
3	CLKO2/GPIO1_MIPI (3.3V)	23	TP_nRST/GPIO6_MIPI (3.3V)
4	DSI_TS_nINT/GPIO2_MIPI (3.3V)	24	DSI_EN/GPIO7_MIPI (3.3V)
5	CSI_P1_PWDN/GPIO3_MIPI (3.3V)	25	DSI_BL_PWM/GPIO8_MIPI (3.3V)
6	CSI_P1_CLK_P	26	GND
7	CSI_P1_CLK_N	27	DSI_CLK_P
8	GND	28	DSI_CLK_N
9	CSI_P1_DP0	29	GND
10	CSI_P1_DN0	30	DSI_DP0
11	GND	31	DSI_DN0
12	CSI_P1_DP1	32	GND
13	CSI_P1_DN1	33	DSI_DP1
14	GND	34	DSI_DN1
15	CSI_P1_DP2	35	GND
16	CSI_P1_DN2	36	DSI_DP2
17	GND	37	DSI_DN2
18	CSI_P1_DP3	38	DSI_DP3
19	CSI_P1_DN3	39	DSI_DN3
20	GND	40	3.3V_VDDIO

Table 15. J2 RTC Battery Header (Figure. 1. Q)

Pin	Signal Name	Pin	Signal Name
1	RTC Battery +	2	RTC Battery -

Table 16. Test Pads

Pin	Signal Name	Pin	Signal Name
TP1	5V_IN	TP23	I2C2_SCL
TP2	5V_PSU	TP24	BOOT_MODE0
TP3-4	3.3V_VDD	TP25	BOOT_MODE1
TP5-10	GND	TP26	BOOTLOARD_KEY
TP11	VDD_ARM_0V9	TP27	ON/OFF Button
TP12	VDD_SOC_0V9	TP28	JTAG_nTRST
TP13	3.3V_SYS	TP29	JTAG_TDI
TP16	I2C4_SDA	TP30	JTAG_TMS
TP17	CLKO_25MHz	TP31	JTAG_TCK
TP18	I2C1_SDA	TP32	RTC_CLK_32K768
TP19	I2C3_SDA	TP33	JTAG_TDO
TP20	I2C1_SCL	TP34	RTC_RESET_B
TP21	I2C3_SCL	TP35	POR_B
TP22	I2C2_SDA	TP50-59	MODBUS Signals
TP46	UART Debug_RXD	TP60-74	USB Signals
TP47	UART Debug_TXD	TP76-106	Audio Signals

3.2 Signal and Power Considerations

1. When providing power from the extension board via the expansion 40pin headers, not required connect the 5V DC power input header(J1) on the mainboard at the same time.
2. The VCC_5V output current from the expansion headers output has a limit of 1A
3. The USB_5V output current from the USB headers has a limit of 1A
4. When providing power from the expansion board via the expansion 40-pin headers, make sure to provide enough current (2A or more) to the mainboard
5. Speaker amplifier output: 2W/CH Into 4ohm 1.4W /CH Into 8ohm .

3.3 Boot Options

The board can be selected to boot up from on-board eMMC or micro-SD card. See Table 17.

Table 17. SW1 4bit Switch (Figure. 1. M)

Bit 1 (1,8)	Bit 2 (2, 7)	Bit 3 (3, 6)	Description
OFF			Boot eSDHC1
ON			Boot eSDHC2
OFF	OFF	ON	Boot MMC/eMMC
ON	ON	OFF	Boot SD/eSD

3.4 GPIO Configuration Table

Table 18. J7 40-pin Expansion Header (Figure. 1. B/Table 5)

Pad	Pin	MUX MODE						
		ALT6	ALT5	ALT4	ALT3	ALT2	ALT1	ALT0
SAI5_MCLK	21		GPIO3_IO25					SAI5_MCLK
SAI5_RXFS	23		GPIO3_IO19					SAI5_RXFS
SAI5_RXC	25		GPIO3_IO20					SAI5_RXC
SAI5_RXD0	27		GPIO3_IO21					SAI5_RXD0
SAI5_RXD1	29		GPIO3_IO22					SAI5_RXD1
UART2_TXD	16		GPIO5_IO25					UART2_TXD
UART2_RXD	18		GPIO5_IO24					UART2_RXD
GPIO1_IO00	22		ANAMIX_REF _CLK_32K					GPIO1_IO00
I2C2_SCL	24		GPIO5_IO16					I2C2_SCL
I2C2_SDA	26		GPIO5_IO17					I2C2_SDA
SAI5_RXD3	28		GPIO3_IO24					SAI5_RXD3
SAI5_RXD2	30		GPIO3_IO23					SAI5_RXD2
UART1_TXD	39		GPIO5_IO23					UART1_TXD
UART1_RXD	40		GPIO5_IO22					UART1_RXD

Table 19. J8 Modbus Port (Figure. 1. D/Table 6)

Pad	Pin	MUX MODE						
		ALT6	ALT5	ALT4	ALT3	ALT2	ALT1	ALT0
UART4_TXD	4	RS-232 RX, TX						UART4_TXD
UART4_RXD	5							UART4_RXD
NAND_READY_B	1		GPIO3_IO16					
NAND_WE_B	2		GPIO3_IO17					
UART3_RXD	1,4	RS-485 A, B						UART3_RXD
UART3_TXD	2,5							UART3_TXD
ECSPI1_MISO							UART3_CTS	

Table 20. J5 Digital Audio Header (Figure. 1. P/Table 13)

Pad	Pin	MUX MODE						
		ALT6	ALT5	ALT4	ALT3	ALT2	ALT1	ALT0
I2C3_SCL	23		GPIO5_IO18				PWM4_OUT	I2C3_SCL
I2C3_SDA	24		GPIO5_IO19				PWM3_OUT	I2C3_SDA
NAND_ALE	26		GPIO3_IO00				QSPI_A_SCLK	NAND_ALE
NAND_CE0_B	27		GPIO3_IO01				QSPI_A_SS0	NAND_CE0_B
NAND_DATA00	28		GPIO3_IO06				QSPI_A_DATA0	NAND_DATA00
NAND_DATA01	29		GPIO3_IO07				QSPI_A_DATA1	NAND_DATA01
NAND_DATA02	30		GPIO3_IO08				QSPI_A_DATA2	NAND_DATA02
NAND_DATA03	31		GPIO3_IO09				QSPI_A_DATA3	NAND_DATA03
NAND_DATA04	32		GPIO3_IO10				QSPI_B_DATA0	NAND_DATA04
NAND_DATA05	33		GPIO3_IO11				QSPI_B_DATA1	NAND_DATA05
NAND_DATA06	34		GPIO3_IO12				QSPI_B_DATA2	NAND_DATA06
NAND_DATA07	35		GPIO3_IO13				QSPI_B_DATA3	NAND_DATA07
GPIO1_IO12	36							GPIO1_IO12

Table 21. J6 MIPI CSI DSI Header (Figure. 1. Q/Table 14)

Pad	Pin	MUX MODE						
		ALT6	ALT5	ALT4	ALT3	ALT2	ALT1	ALT0
GPIO1_IO15	3	CCM_CLKO2	PWM4_OUT					GPIO1_IO15
ECSPI1_MOSI	4		GPIO5_IO07					
GPIO1_IO03	5							GPIO1_IO03
I2C3_SCL	21		GPIO5_IO18				PWM4_OUT	I2C3_SCL
I2C3_SDA	22		GPIO5_IO19				PWM3_OUT	I2C3_SDA
GPIO1_IO06	23	CCM_EXT_CLK3	GPIO5_IO12					GPIO1_IO06
ECSPI1_SCLK	24		GPIO5_IO06					ECSPI1_SCLK
GPIO1_IO01	25	CCM_EXT_CLK2	ANAMIX_REF _CLK_24M				PWM1_OUT	GPIO1_IO01

4. Operating System

4.1 Host Operating System

a. Host OS:Ubuntu 14.04 64-bit or newer
b. Host Build System: Yocto Embedded Linux

4.2 Target Operating System

a. Board u-boot version: based on NXP imx_v2017.03_4.9.51_imx8m_ga
b. Board kernel version: based on NXP imx_4.9.51_imx8m_ga
c. UI framework: Qt version 5.7, Wayland
d. Embedded Linux Distribution: Morty 2.2
e. Amazon AVS Device SDK V.1.1
f. Support Sensory TrulyHandsfree Wake Word Engine 6.4.0
g. BSP: http://wiki.estonetech.com/wiki/EMB-2238

4.3 U-boot Features

a. Support 7", 10" MIPI LCD panel option (models: INNOLUX N070ICN-GB1, AUO B101UAN01.7)
b. Support external USB drive image update via u-boot with push button
c. Support MFG tool image update via OTG with push button
d. Support HDMI display

4.4 Kernel Features

a. Based on NXP imx_4.9.51_imx8m_ga
b. Support HDMI and LCD display
c. Support analog speaker, digital audio interfaces
d. USB to SATA support (Genesys Logic GL830)
e. WiFi support (RL8723AU USB 2.0)
f. BT support on data, audio in and out (RL8723AU USB 2.0)

4.5 Other OS Support

a. Android Android8.1.0
b. Linux Ubuntu 16.04
c. Linux Debian 9

Refer to http://wiki.estonetech.com/wiki/EMB-2238 for instructions of building the file systems.