UM12181

FRDM-IMX93 Board User Manual

Rev. 1.0 — 9 December 2024 User manual

Document information

Information	Content
Keywords	i.MX 93, FRDM-IMX93, UM12181
Abstract	The FRDM i.MX 93 development board (FRDM-IMX93 board) is a low-cost platform designed to show the most commonly used features of the i.MX 93 applications processor in a small and low-cost package.

1 FRDM-IMX93 overview

The FRDM i.MX 93 development board (FRDM-IMX93 board) is a low-cost platform designed to show the most commonly used features of the i.MX 93 Applications Processor in a small and low-cost package. The FRDM-IMX93 board is an entry-level development board, which helps developers to get familiar with the processor before investing a large amount of resources in more specific designs.

This document includes system setup and configurations, and provides detailed information on the overall design and usage of the FRDM board from a hardware system perspective.

1.1 Block diagram

Figure 1 shows the FRDM-IMX93 block diagram.

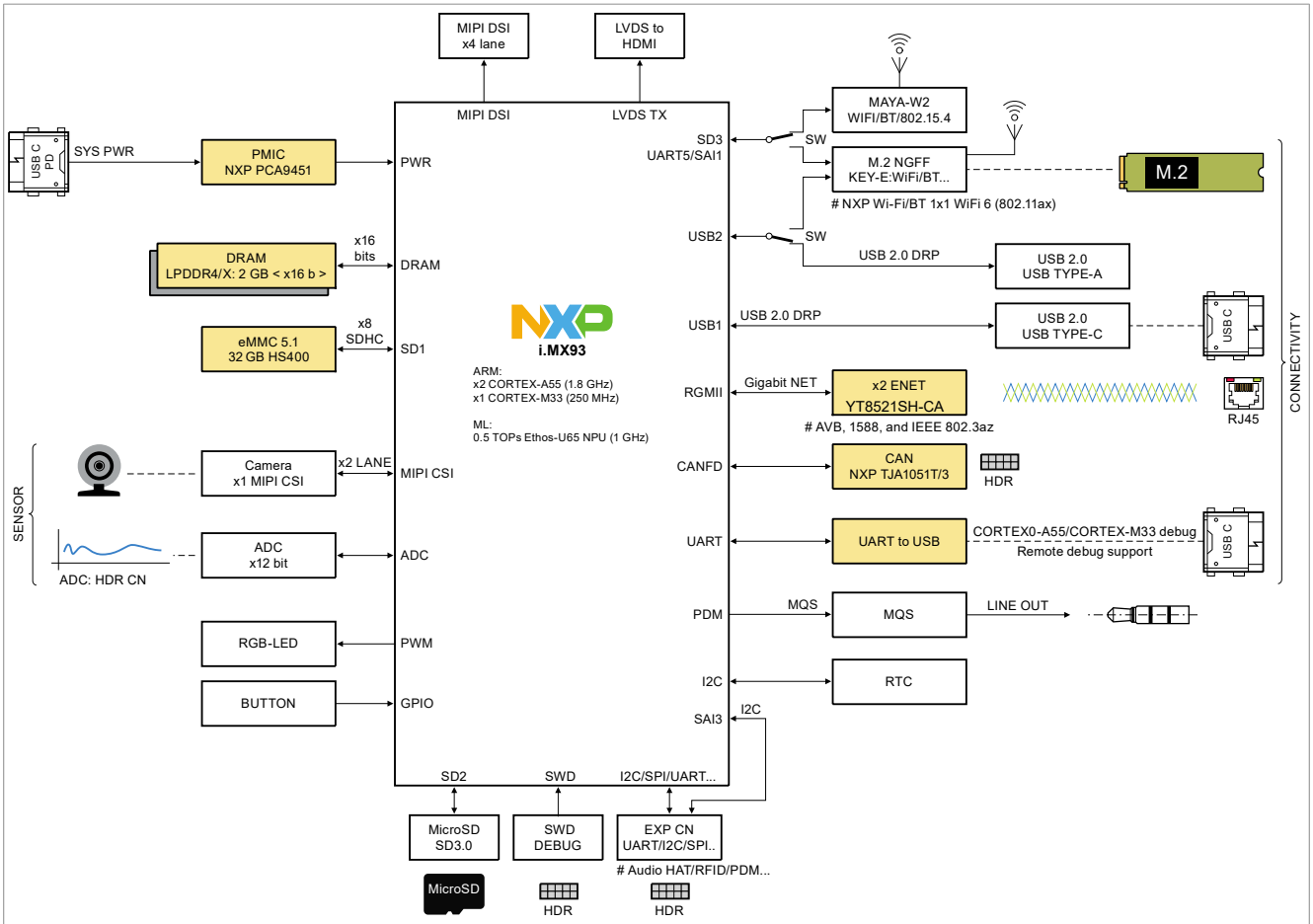


Figure 1. FRDM-IMX93 block diagram

1.2 Board features

Table 1 lists the features of FRDM-IMX93.

Table 1. FRDM-IMX93 features

Board feature	Target processor feature used	Description
Applications processor		The i.MX 93 applications processor features a dual Arm Cortex-A55 + Arm Cortex-M33 core speeding up to 1.7 GHz, a neural processing unit (NPU) of 0.5 TOPS ***Note:*** *For more detail on the i.MX 93 processor, see the i.MX 93 Applications Processor Reference Manual.*
USB interface	USB 2.0 high-speed host and device controller	• x1 USB 2.0 Type C connector • x1 USB 2.0 Type A connector
DRAM memory	DRAM controller and PHY	2 GB LPDDR4X (Micron MT53E1G16D1FW-046 AAT:A)
Mass storage	uSDHC	• 32 GB eMMC5.1 (FEMDRM032G-A3A55) • MicroSD card connector (SD3.0 supported)
Boot configuration		• Default boot mode is single boot from the eMMC device • Board also supports SD card boot
Camera interface	MIPI CSI	One CSI (x2 data lane) interface, FPC cable connector (P6)
Display interface	MIPI DSI	x4 data lane MIPI DSI interface, FPC cable connector (P7)
	HDMI	x4 data lane LVDS to HDMI converter chip (IT6263) connected to HDMI connector, P5
Ethernet interface	Two ENET controllers	• 10/100/1000 Mbit/s RGMII Ethernet with one RJ45 connector with TSN support (P3) connected with external PHY, YT8521 • 10/100/1000 Mbit/s RGMII Ethernet with one RJ45 connector (P4) connected with external PHY, YT8521
I/O expanders	CAN, I2C/I3C, analog-to-digital converter (ADC)	One 10-pin 2x5 2.54 mm connector P12 provides: • One high-speed CAN transceiver TJA1051GT/3 connection • 3-pin header for I2C/I3C expansion • Two-channel ADC support
Onboard Wi-Fi	SDIO, UART, SPI, SAI	Onboard Wi-Fi 6 / Bluetooth 5.4 module
Wi-Fi/Bluetooth interface	USB, SDIO, SAI, UART, I2C, and GPIO	One M.2/NGFF Key E mini card 75-pin connector, P8, supporting USB, SDIO, SAI, UART, I2C, and Vendor-defined SPI interfaces ***Note:*** *By default, these signals are connected with the onboard Wi-Fi module, however, to use this M.2 slot, you must rework resistors (see Table 15).*
Audio	MQS	MQS support
Debug interface		• USB-to-UART device, CH342F • One USB 2.0 Type-C connector (P16) of CH342F provides two COM ports: – The first COM port is used for Cortex A55 system debug – The second COM port is used for Cortex M33 system debug • Serial Wire Debug (SWD), P14
Expansion port		One 40-pin dual-row pin header for I2S, UART, I2C, and GPIO expansion
Power		• One USB 2.0 Type-C connector for power delivery only • PCA9451AHNY PMIC • Discrete DCDC/LDO
PCB		FRDM-IMX93: 105 mm × 65 mm, 10-layer

Table 1. FRDM-IMX93 features*...continued*

Board feature	Target processor feature used	Description
Orderable part number		FRDM-IMX93

1.3 Board kit contents

Table 2 lists the items included in the FRDM-IMX93 board kit.

Table 2. Board kit contents

Item description	Quantity
FRDM-IMX93 board	1
USB 2.0 Type-C Male to Type-A Male assembly cable	2
FRDM-IMX93 Quick Start Guide	1

1.4 Board pictures

Figure 2 shows the top-side view of the FRDM-IMX93 board.

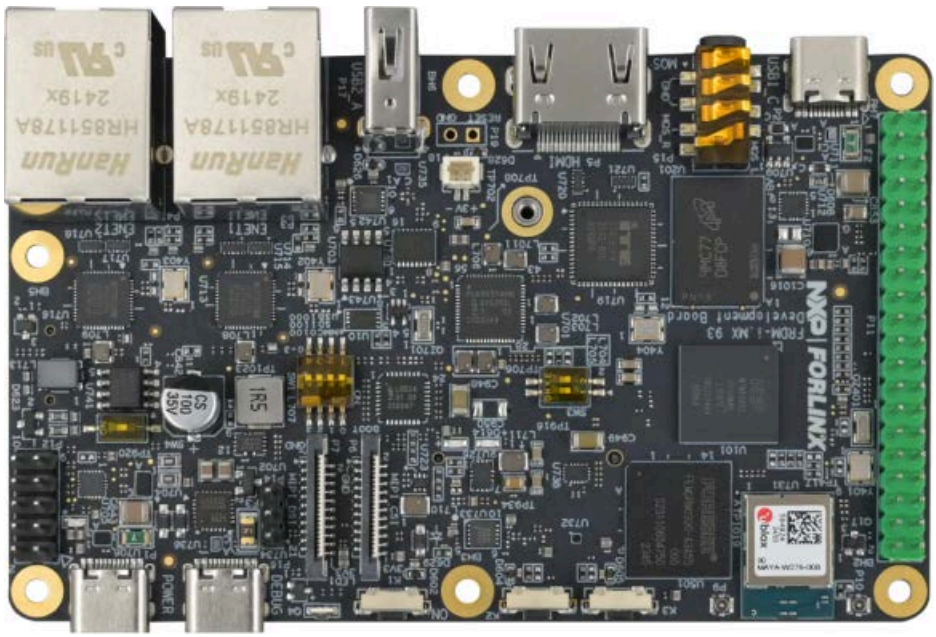
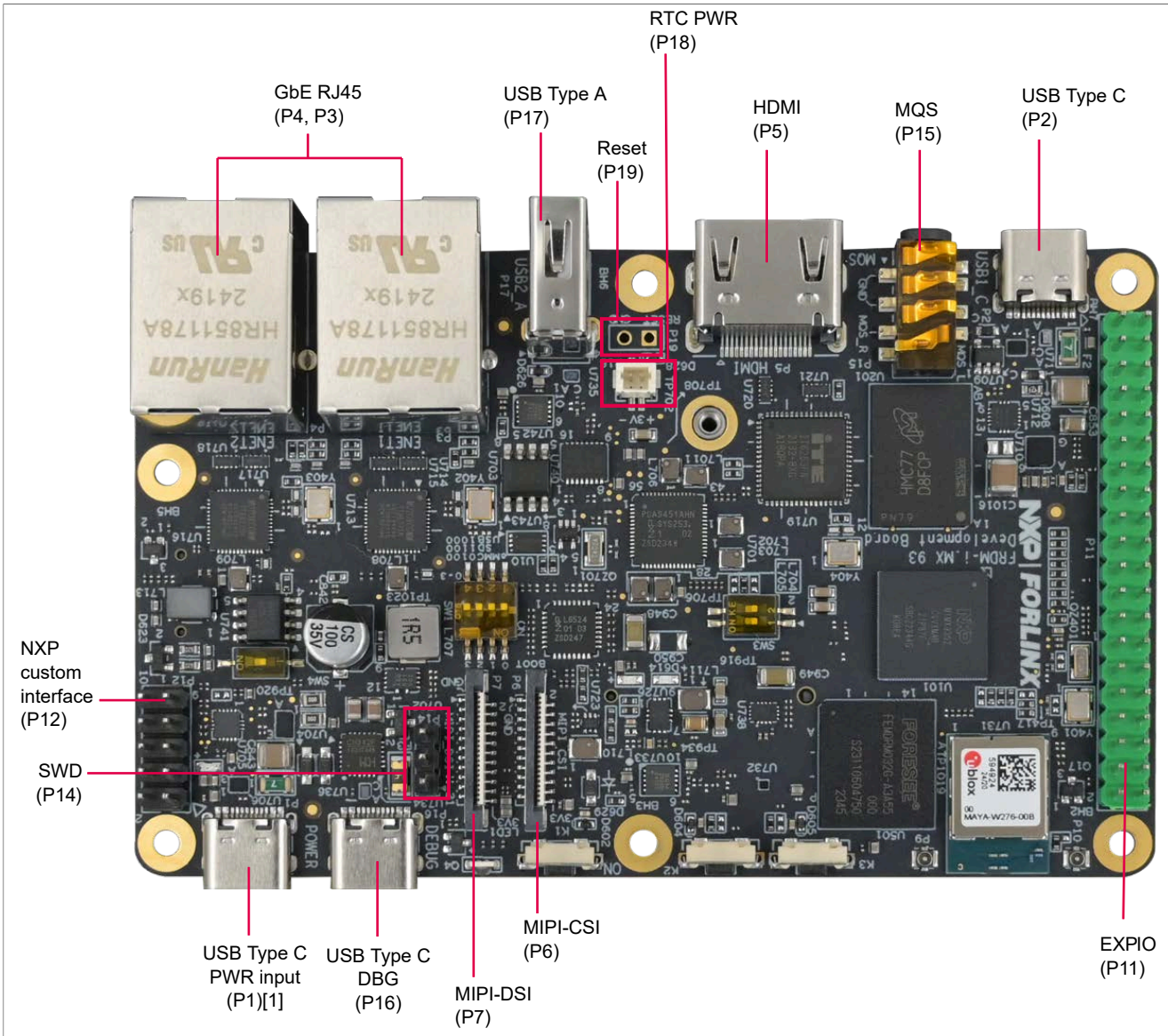


Figure 2. FRDM-IMX93 top-side view

Figure 3 shows the connectors available on the top side of the FRDM-IMX93 board.



[1] - USB Type C PWR input (P1) shown in the figure is the only power supply port, and must always be supplied for system running.

Figure 3. FRDM-IMX93 connectors

Figure 4 shows the onboard switches, buttons, and LEDs available on the FRDM-IMX93 board.

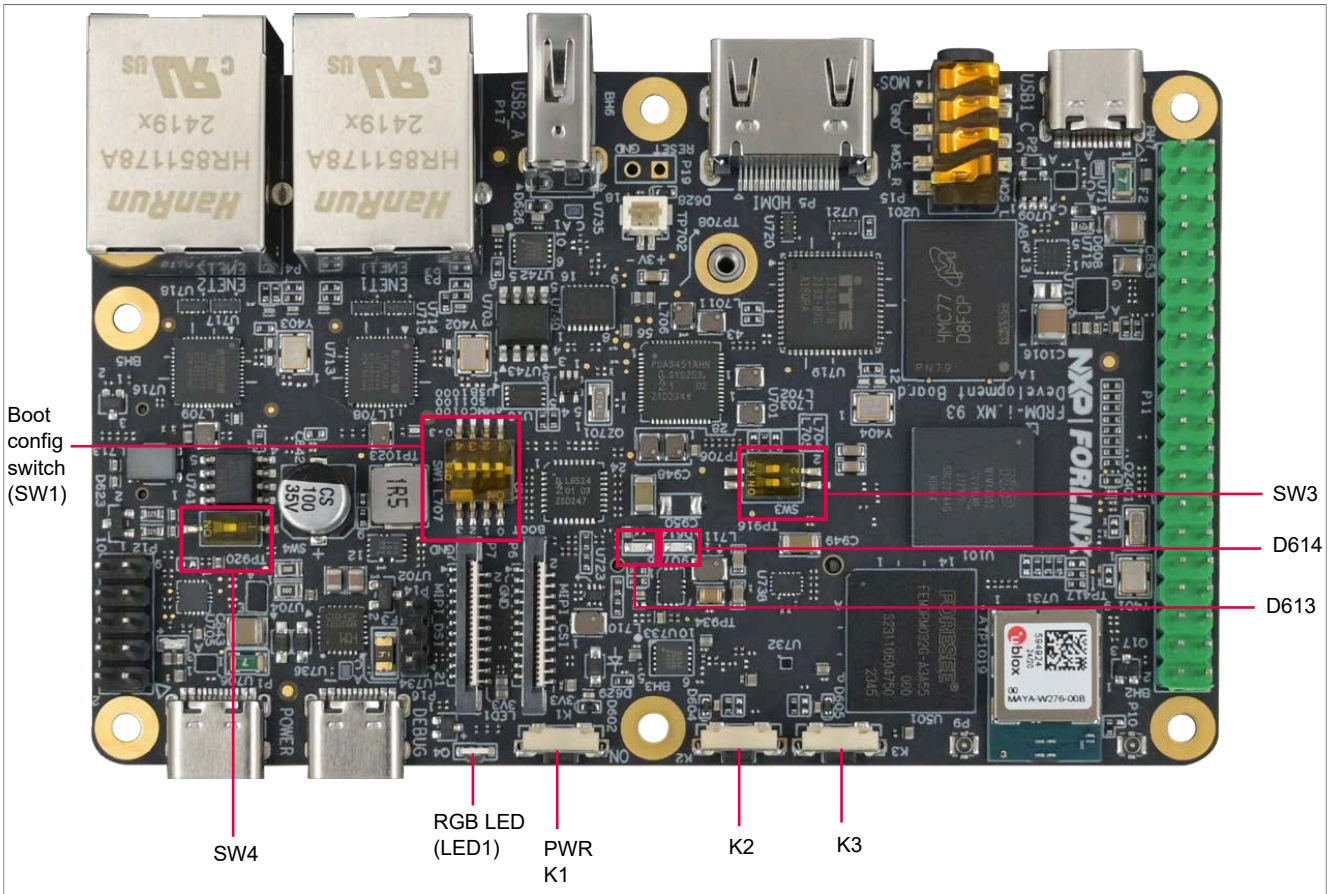


Figure 4. FRDM-IMX93 onboard switches, buttons, and LEDs

Figure 5 shows the bottom-side view, and also highlights the connectors available at the bottom side of the FRDM-IMX93 board.

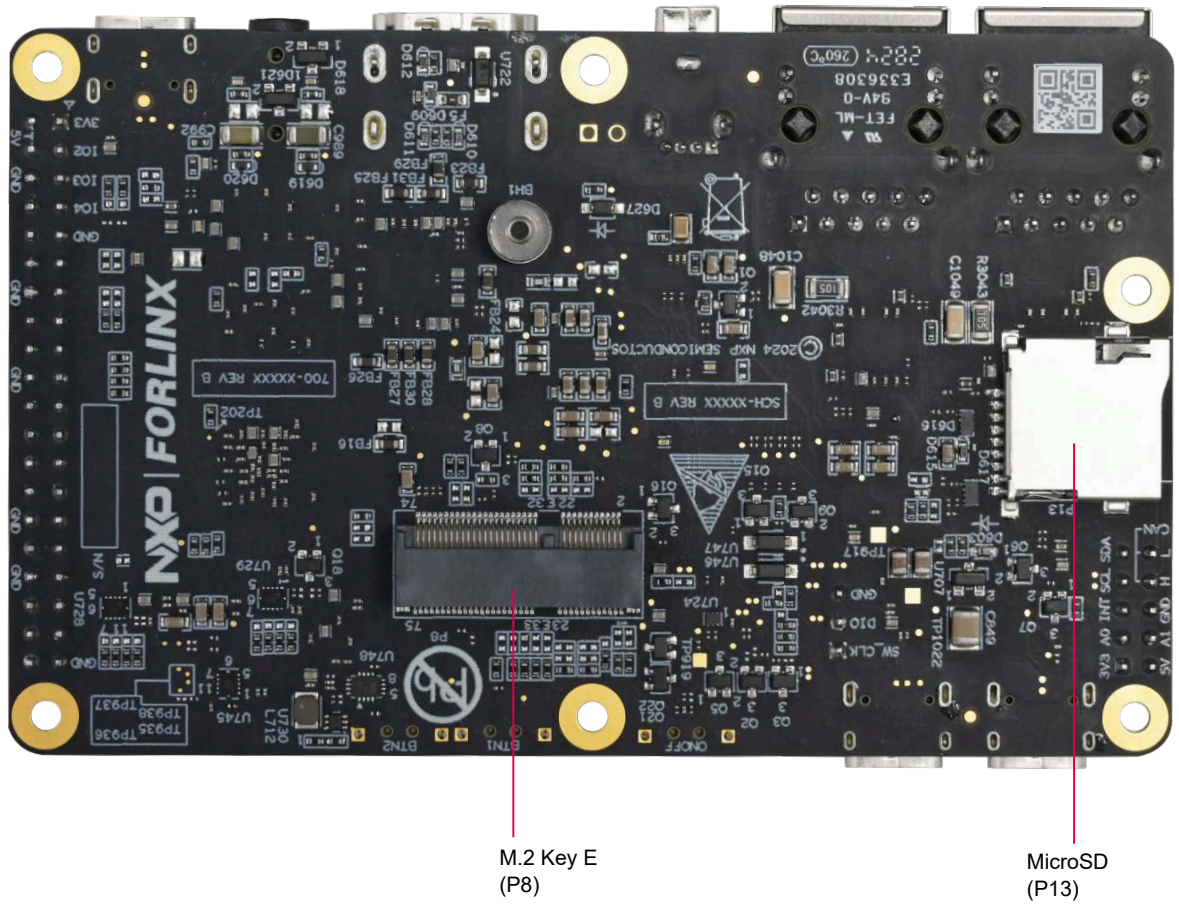


Figure 5. FRDM-IMX93 bottom-side view

1.5 Connectors

See Figure 3 and Figure 5 for connectors position on the board. Table 3 describes the FRDM-IMX93 board connectors.

Table 3. FRDM-IMX93 connectors

Part identifier	Connector type	Description	Reference section
P1, P2, P16	USB 2.0 Type C	USB connector	Section 2.19.2
P3, P4	RJ45 jack	Ethernet connectors	Section 2.17
P5	HDMI A connector	HDMI connector	Section 2.16
P6	22-pin FPC connector	MIPI CSI FPC connector	Section 2.14
P7	22-pin FPC connector	MIPI DSI FPC connector	Section 2.15
P9 (DNP)	U.FL connector	RF antenna connector	Section 2.11
P10 (DNP)	U.FL connector	RF connector	Section 2.11
P8	75-pin connector	M.2 socket KEY-E	Section 2.10
P11	2x20-pin connector	GPIO expansion	Section 2.18
P12	2x5-pin connector	I/O connector	Section 2.4

Table 3. FRDM-IMX93 connectors*...continued*

Part identifier	Connector type	Description	Reference section
P13	MicroSD push- push connector	MicroSD 3.0	Section 2.8
P14	1x3-pin 2.54 mm connector	SWD connector	Section 2.19.1
P15	3.5 mm headphone jack	MQS connector	Section 2.6
P17	USB 2.0 Type A	USB connector	Section 2.13
P18	JST_SH_2P	RTC battery connector	For detail, see the board schematic
P19	1x2-pin connector	SYS_nRST connector	For detail, see the board schematic

1.6 Push buttons

Figure 4 shows the push buttons available on the board.

Table 4 describes the push buttons available on FRDM-IMX93.

Table 4. FRDM-IMX93 push buttons

Part identifier	Switch name	Description
K1	Power button	The i.MX 93 applications processor supports the use of a button input signal to request main SoC power state changes (that is, ON or OFF) from the PMIC. The ON/OFF button is connected to the ONOFF pin of the i.MX 93 processor. • In the ON state: – If the ON/OFF button is held longer than the debounce time, the power off interrupt is generated – If the button is held longer than the defined max timeout (approx. 5 s), the state will transit from ON to OFF, and send PMIC_ON_ REQ signal to turn off the powers of PMIC • In the OFF state: – If the ON/OFF button is held longer than the OFF-to-ON time, the state will transit from OFF to ON, and send PMIC_ON_REQ signal to turn on the powers of PMIC
K2, K3	User button	The User buttons are kept for customized use cases.

1.7 DIP switch

The following DIP switches are used on the FRDM-IMX93 board.

- 4-bit DIP switch – SW1
- 2-bit DIP switch – SW3
- 1-bit DIP switch – SW4

If a DIP switch pin is:

- OFF – pin value is 0
- ON – pin value is 1

The following list describes the description and configuration of the DIP switches available on the board.

- SW1 – Provides control for boot mode configuration. For detail, see Section 2.5.
- SW3 – Provides control for enabling or disabling the CAN interface signals, CAN_TXD (GPIO_IO25) and CAN_RXD (GPIO_IO27), on the board.

Table 5. SW3 configuration

Switch	Signal	Description
SW3[1]	CAN_TXD (GPIO_IO25)	– ON (default setting): Enables CAN_TXD signal – OFF: Disables CAN_TXD signal
SW3[2]	CAN_RXD (GPIO_IO27)	– ON (default setting): Enables CAN_RXD signal – OFF: Disables CAN_RXD signal

- SW4 – Provides control for enabling or disabling the CAN split termination RC filter.

Table 6. SW3 configuration

Switch	Signal	Description
SW4[1]		– ON (default setting): Enables RC termination filter (62 Ω + 56 pF) and configures CAN bus for normal operation. – OFF: Disables RC termination filter for test mode.

1.8 LEDs

The FRDM-IMX93 board has light-emitting diodes (LEDs) to monitor system functions, such as power-on and board faults. The information collected from LEDs can be used for debugging purposes.

Figure 4 shows the LEDs available on the board.

Table 7 describes the FRDM-IMX93 LEDs.

Table 7. FRDM-IMX93 LEDs

Part identifier	LED color	LED name	Description (When LED in ON)
D601	Red	PWR LED	Indicates 3.3 V power-on status. When 3.3 V is available on board, the D601 LED turns ON.
LED1	Red / Green / Blue	RGB_LED	User application LEDs. Each of these LEDs can be controlled through a user application. • Red LED connects to target MPU pin GPIO_IO13 • Green LED connects to target MPU pin GPIO_IO04 • Blue LED connects to target MPU pin GPIO_IO12
D613	GREEN	LED_GREEN	• D613 ON – WLAN status indicator. When ON, indicates that the WLAN connection is established. • D614 ON – Bluetooth status indicator. When ON, indicates that the Bluetooth connection is established.
D614	ORANGE	LED_ORANGE	

2 FRDM-IMX93 functional description

This chapter describes the features and functions of the FRDM-IMX93 board. ***Note:*** *For details of the i.MX93 MPU features, see i.MX 93 Applications Processor Reference Manual*. The chapter is divided into the following sections:

- Section "Processor"
- Section "Power supply"
- Section "Clocks"
- Section "I2C interface"

- Section "Boot mode and boot device configuration"
- Section "PDM interface"
- Section "LPDDR4x DRAM memory"
- Section "SD card interface"
- Section "eMMC memory"
- Section "M.2 connector and Wi-Fi/Bluetooth module"
- Section "CAN interface"
- Section "USB interface"
- Section "Camera interface"
- Section "MIPI DSI"
- Section "HDMI interface"
- Section "Ethernet"
- Section "Expansion connector"
- Section "Debug interface"
- Section "Board errata"

2.1 Processor

The i.MX 93 applications processor includes dual Arm Cortex-A55 processors with speeds up to 1.7 GHz integrated with an NPU that accelerates machine learning inference. The general-purpose Arm Cortex-M33 running up to 250 MHz is for real-time and low-power processing. Robust control networks are possible via the CAN-FD interface. Also, dual 1 Gbit/s Ethernet controllers, one supporting time sensitive networking (TSN), drive gateway applications with low latency.

The i.MX 93 is useful for applications such as:

- Smart home
- Building control
- Contactless HMI
- Commercial
- Healthcare
- Media IoT

Each processor provides a 16-bit LPDDR4/LPDDR4X memory interface and other interfaces for connecting peripherals, such as MIPI LCD, MIPI Camera, LVDS, WLAN, Bluetooth, USB2.0, uSDHC, Ethernet, FlexCAN, and multisensors.

For more detailed information about the processor, see the *i.MX93 data sheet* and *i.MX 93 Applications Processor Reference Manual* at https://www.nxp.com/imx93.

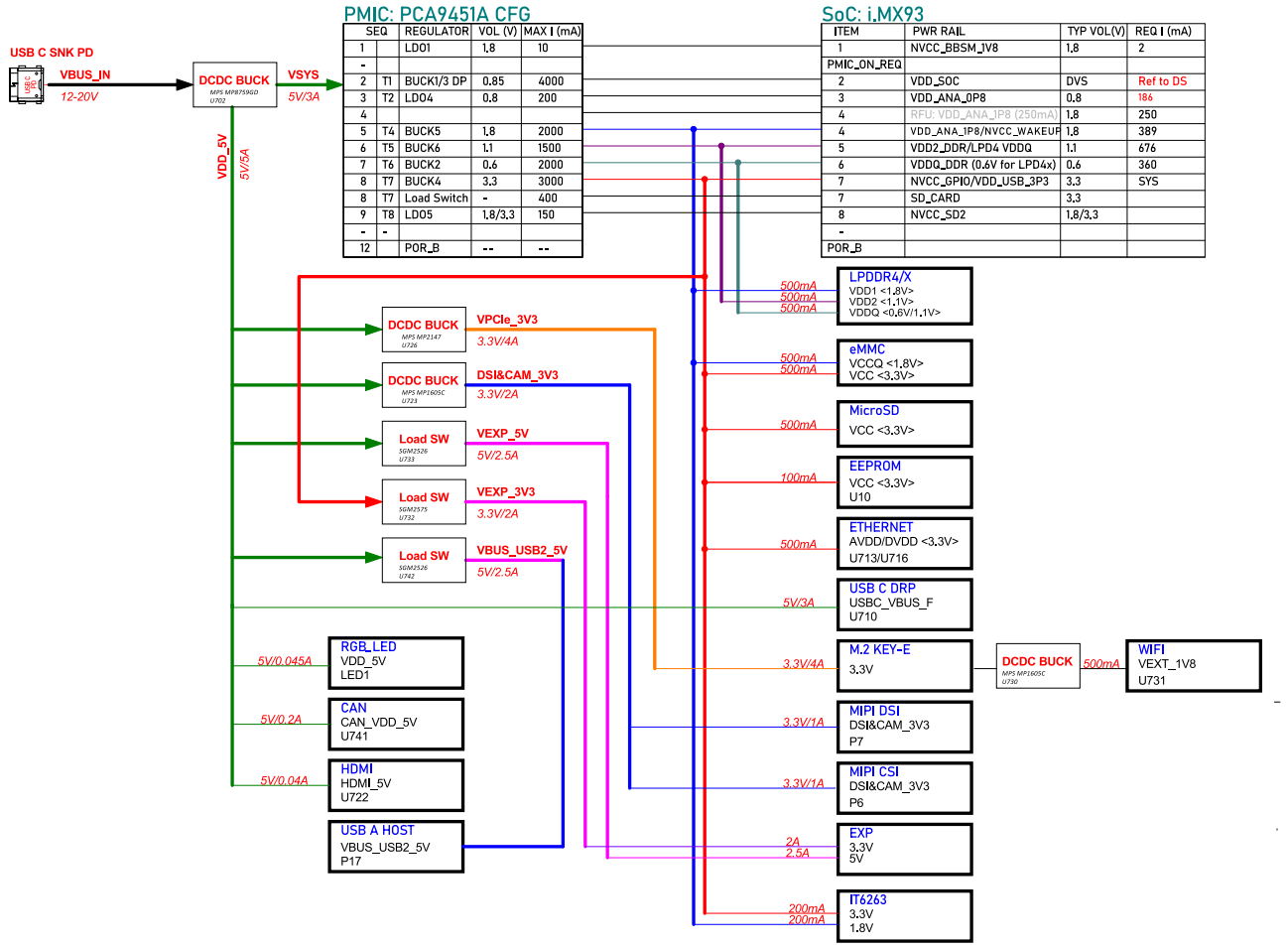
2.2 Power supply

The primary power supply to the FRDM-IMX93 board is VBUS_IN (12 V - 20 V) through USB Type-C PD connector (P1).

Four DC buck switching regulators are used:

- MP8759GD (U702) switches VBUS_IN supply to SYS_5V (5 V) power supply, which is input power supply for PCA9451AHNY PMIC (U701) and other discrete devices on the board.
- MP1605C (U723) switches VDD_5V supply to DSI&CAM_3V3 (3.3 V / 2 A) for MIPI CSI and MIPI DSI.
- MP2147GD (U726) switches VDD_5V supply to VPCIe_3V3 (3.3 V / 4 A) for M.2 / NGFF module (P8).
- MP1605C (U730) switches VPCIe_3V3 supply to VEXT_1V8 (3.3 V / 500 mA) for on-board Wi-Fi module MAYA-W27x (U731).

Figure 6 shows the FRDM-IMX93 power supply block diagram.



SEQ		REGULATOR	VOL (V)	MAX I (mA)
1		LDO1	1.8	10
-				
2	T1	BUCK1/3 DP	0.85	4000
3	T2	LDO4	0.8	200
4				
5	T4	BUCK5	1.8	2000
6	T5	BUCK6	1.1	1500
7	T6	BUCK2	0.6	2000
8	T7	BUCK4	3.3	3000
8	T7	Load Switch	-	400
9	T8	LDO5	1.8/3.3	150
-	-			
12		POR_B	--	--

ITEM	PWR RAIL	TYP VOL(V)	REQ I (mA)
1	NVCC_BBSM_1V8	1.8	2
PMIC_ON_REQ			
2	VDD_SOC	DVS	Ref to DS
3	VDD_ANA_0P8	0.8	186
4	RFU: VDD_ANA_1P8 (250mA)	1.8	250
4	VDD_ANA_1P8/NVCC_WAKEUP	1.8	389
5	VDD2_DDR/LPD4 VDDQ	1.1	676
6	VDDQ_DDR (0.6V for LPD4x)	0.6	360
7	NVCC_GPIO/VDD_USB_3P3	3.3	SYS
7	SD_CARD	3.3	
8	NVCC_SD2	1.8/3.3	
-			
POR_B			

Figure 6. FRDM-IMX93 power supply

Table 8 describes different power sources available on the board.

Table 8. FRDM-IMX93 power supply devices

Part identifier designator	Manufacturing part number	Part manufacturer	Power supply	Specifications	Description
U702	MP8759GD	Monolithic Power Systems Inc.	• DCDC_5V • VSYS_5V	• 5 V at 8 A	Supplies power to: • PMIC PCA9451AHNY (U701) • NX20P3483UK USB PD and Type-C switches (U710) • DC buck MP2147GD (U726) for VPCIe_3V3 • DC buck MP1605C (U723) for DSI&CAM_3V3 • Load switch SGM2526 (U733) for VRPi_5V • Load switch SGM2526 (U742) for VBUS_USB2_5V
U726	MP2147GD	Monolithic Power Systems Inc.	VPCIe_3V3	3.3 V at 3 A	• Input supply for switch-mode converter MP1605C (U730)

Table 8. FRDM-IMX93 power supply devices*...continued*

Part identifier designator	Manufacturing part number	Part manufacturer	Power supply	Specifications	Description
					• Supply for WLAN and Bluetooth status indicating LEDs (D613 and D614) • Supply for onboard Wi-Fi module u-blox MAYA-W27x (U731)
U723	MP1605C	Monolithic Power Systems Inc.	DSI&CAM_3V3	3.3 V at 2 A	Supplies power to MIPI CSI (P6) and MIPI DSI (P7) interface
U730	MP1605C	Monolithic Power Systems Inc.	VEXT_1V8	1.8 V at 500 mA	Supplies power to onboard Wi-Fi u-blox MAYA-W27x module
U701	PCA9451AHNY	NXP Semiconductors	BUCK2: LPD4/x_VDDQ_0V6	• 0.6 V at 2000 mA	Supplies power to VDDQ_DDR power supply for CPU DRAM PHY I/O (LPDDR4/X)
			BUCK1/3: VDD_SOC_0V8[1][2]	• VOL (V): 0.8 • Typ VOL (V): Dynamic voltage scaling (DVS) ***Note:*** *Refer to SoC data sheet.*	VDD_SOC, power supply for SoC logic and Arm core
			BUCK4: • VDD_3V3	3.3 V at 3000 mA	Supplies power to: • MIPI DSI/LVDS • NVCC_GPIO, power supply for GPIO when it is in 3.3 V mode • VDD_USB_3P3 pin for USB PHY power • eMMC 5.1 device • MicroSD • EEPROM • Ethernet ports (P3 and P4) • LVDS to HDMI converter • I2C IO expander PCAL6524 HEAZ (U725, I2C address: 0x22) Power source for: • ENET1_DVDD3 and ENET1_AVDD3 supplies • OVDD_3V3 for AVCC_3V3 supplies
			BUCK5: • VDD_1V8	1.8 V at 2000 mA	Supplies to: • LPD4/x_VDD1 • eMMC 5.1 device • LVDS to HDMI converter • VDD_ANA_1P8, analog core supply voltage • NVCC_WAKEUP, digital I/O supply

Table 8. FRDM-IMX93 power supply devices*...continued*

Part identifier designator	Manufacturing part number	Part manufacturer	Power supply	Specifications	Description
			BUCK6: • LPD4/x_ VDD2_1V1	1.1 V at 2000 mA	Supplies to: • VDD2_DDR, DDR PHY supply voltage
			LDO1: NVCC_ BBSM_ 1V8	1.8 V at 10 mA	NVCC BBSM I/O supply
			LDO4: VDD_ ANA_0 P8	0.8 V at 200 mA	Analog core supply voltage
			LDO5: NVCC_SD	1.8 V / 3.3 V	MicroSD card
			Load Switch: VSDs_3V3	3.3 V	MicroSD card
U703	FDS4435 (Power Trench MOSFET)	SG MICRO CORP	VDD_5V	5 V / 2.5 A	Supplies to: • 10-pin dual-row header (P12) • CAN transceiver through CAN_ VDD_5V • RGB LED Power source for: • HDMI_5V • DSI&CAM_3V3 • VPCIe_3V3 • VRPi_5V • VBUS_USB2_5V
U732	SGM2525 (Load switch)	SG MICRO CORP	VRPi_3V3	3.3 V at 2.5 A	• 40-pin dual-row pin header (P11)
U733	SGM2525 (Load switch)	SG MICRO CORP	VRPi_5V	5 V at 2.5 A	• 40-pin dual-row pin header (P11)
U737	TLV76033DBZR (Voltage regulator)	Texas Instruments	VCC_3V3_ DEBUG	3.3 V	Supplies to 4-bit voltage-level translator used for USB-to-dual UART debug interface
U742	SGM2526 (Load switch)	SG MICRO CORP	VBUS_USB2_5 V	5 V / 2.5 A	Supplies to USB2.0 Type-A Host

[1] BUCK1 and BUCK3 are configured as dual phase mode.
[2] PCA9451 BUCK1/3 dual phase default output voltage is 0.8 V. Software changes it to 0.95 V for overdrive mode.

For further details on the power sequence needed by the i.MX 93, refer to section "Power sequence" in the *i.MX 93 Reference Manual*.

2.3 Clocks

FRDM-IMX93 provides all the clocks required for the processor and peripheral interfaces. Table 9 summarizes the specifications of each clock and the component that provides it.

Table 9. FRDM-IMX93 clocks

Part identifier	Clock generator	Clock	Specifications	Destination
Y401	Crystal oscillator	XTALI_24M	Frequency: 24 MHz	Target processor

Table 9. FRDM-IMX93 clocks*...continued*

Part identifier	Clock generator	Clock	Specifications	Destination
		XTALO_24M		
QZ401	Crystal oscillator	XTALI_32K XTALO_32K	Frequency: 32.768 kHz	NVCC_BBSM block of target processor
QZ701	Crystal oscillator	XIN_32K XOUT_32K	Frequency: 32.768 kHz	PCA9451AHNY PMIC
Y402	Crystal oscillator	PHY1_XTAL_I PHY1_XTAL_O	Frequency: 25 MHz	Ethernet RMII PHY1
Y403	Crystal oscillator	PHY2_XTAL_I PHY2_XTAL_O	Frequency: 25 MHz	Ethernet RMII PHY2
Y404	Crystal oscillator	HDMI_XTALIN HDMI_XTALOUT	Frequency: 27 MHz	Onboard LVDS to HDMI converter module IT6263 (U719)

2.4 I2C interface

The i.MX 93 processor supports a low-power inter-integrated circuit (I2C) module that supports an efficient interface to an I2C-bus as a master. The I2C provides a method of communication between a number of devices available on the FRDM-IMX93 board.

One 10-pin 2x5 2.54 mm connector P12 is provided on the board to support I2C, CAN, and ADC connections. The developers can use the port for some specific application development.

Table 10 explains the I2C, CAN, and ADC header, P12, pinout.

Table 10. 10-pin 2x5 2.54mm I2C, CAN, and ADC header (P12) pinout

Pin	Signal name	Description
1	VDD_3V3	3.3 V power supply
2	VDD_5V	5 V power supply
3	ADC_IN0	ADC input channel 0
4	ADC_IN1	ADC input channel 1
5	I3C_INT	I2C/I3C interrupt signal
6	GND	Ground
7	I3C_SCL	I2C/I3C SCL signal
8	CAN_H	CAN transceiver high signal
9	I3C_SDA	I2C/I3C SDA signal
10	CAN_L	CAN transceiver low signal

Table 11 describes the I2C devices and their I2C addresses (7-bit) on the board.

Table 11. I2C devices

Part identifier	Device	I2C address (7-bit)	Port	Speed	Voltage	Description
U719	IT6263	0x4C (0b'1001100x)	MX-I2C1	1 MHz Fm+	3.3 V	LVDS to HDMI converter
U748	PCAL6408AHK	0x20 (0b'0100000x)	MX-I2C1	1 MHz Fm+	3.3 V	I/O expander for IRQ / OUTPUT

Table 11. I2C devices*...continued*

Part identifier	Device	I2C address (7-bit)	Port	Speed	Voltage	Description
U701	PCA9451AHNY	0x25 (0b'0100101x)	MX-I2C2	1 MHz Fm+	3.3 V	PMIC
U725	PCAL6524HEAZ	0x22 (0b'01000[10]x)	MX-I2C2	1 MHz Fm+	3.3 V	IO expander for IRQ/ OUTPUT
U10	AT24C256D	0x50 (0b'1010000x)	MX-I2C2	1 MHz Fm+	3.3 V	EEPROM
U705	PTN5110NHQZ	0x52 (0b'10100[10]x)	MX-I2C3	1 MHz Fm+	3.3 V	USB Type-C Power Delivery PHY
U712	PTN5110NHQZ	0x50 (0b'10100[00]x)	MX-I2C3	1 MHz Fm+	3.3 V	USB Type-C Power Delivery PHY
U710	NX20P3483UK	0x71 (0b'11100[01]x)	MX-I2C3	1 MHz Fm+	3.3 V	USB load switch
U740	PCF2131	0x 53 (0b'110101[0]x)	MX-I2C3	1 MHz Fm+	3.3 V	External RTC

2.5 Boot mode and boot device configuration

The i.MX 93 processor offers multiple boot configurations, which can be selected by SW1 on the FRDM-IMX93 board or from the boot configuration stored on the internal eFUSE of the processor. In addition, the i.MX 93 can download a program image from a USB connection when configured in serial download mode. The four dedicated BOOT MODE pins are used to select the various boot modes.

Figure 7 shows the boot mode selection switch.

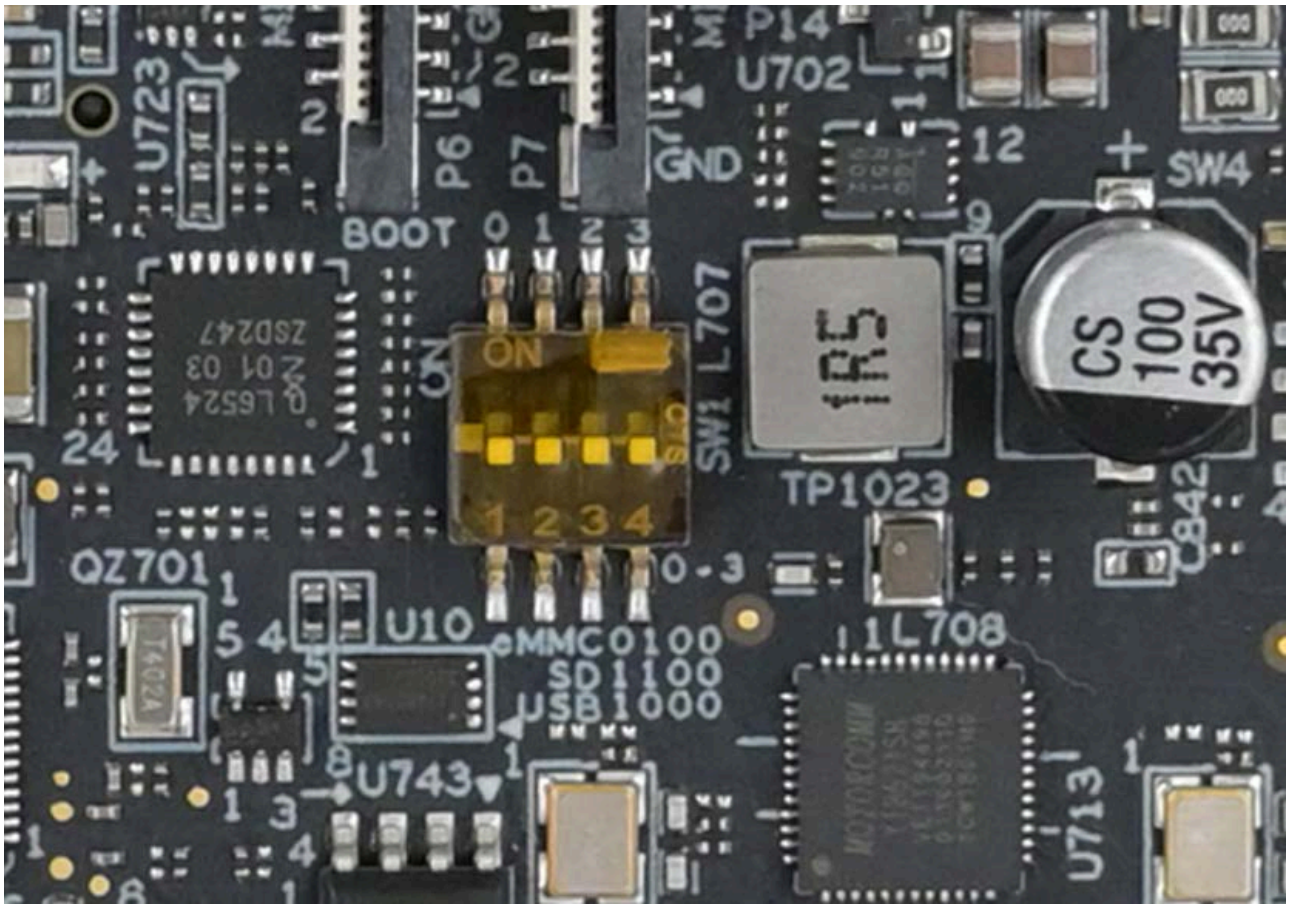


Figure 7. Boot mode selection switch

Table 12 describes the SW1 values used in different boot modes.

Table 12. Boot mode settings

SW1 [3:0]	BOOT_MODE[3:0]	Boot core	Boot device
0001	0001	Cortex-A	Serial downloader (USB)
0010	0010		uSDHC1 8-bit eMMC 5.1
0011	0011		uSDHC2 4-bit SD3.0

On the FRDM-IMX93 board, the default boot mode is from the eMMC device. The other boot device is the microSD connector. Set SW1[3:0] as 0010 to choose uSDHC1 (eMMC) as boot device, set 0011 to choose uSDHC2 (SD), and set 0001 to enter USB serial download.

Note: *For more information about the boot modes and boot device configuration, see chapter "System Boot" in the i.MX 93 Applications Processor Reference Manual.*

Figure 8 shows the connection of SW1 and i.MX 93 boot mode signals.

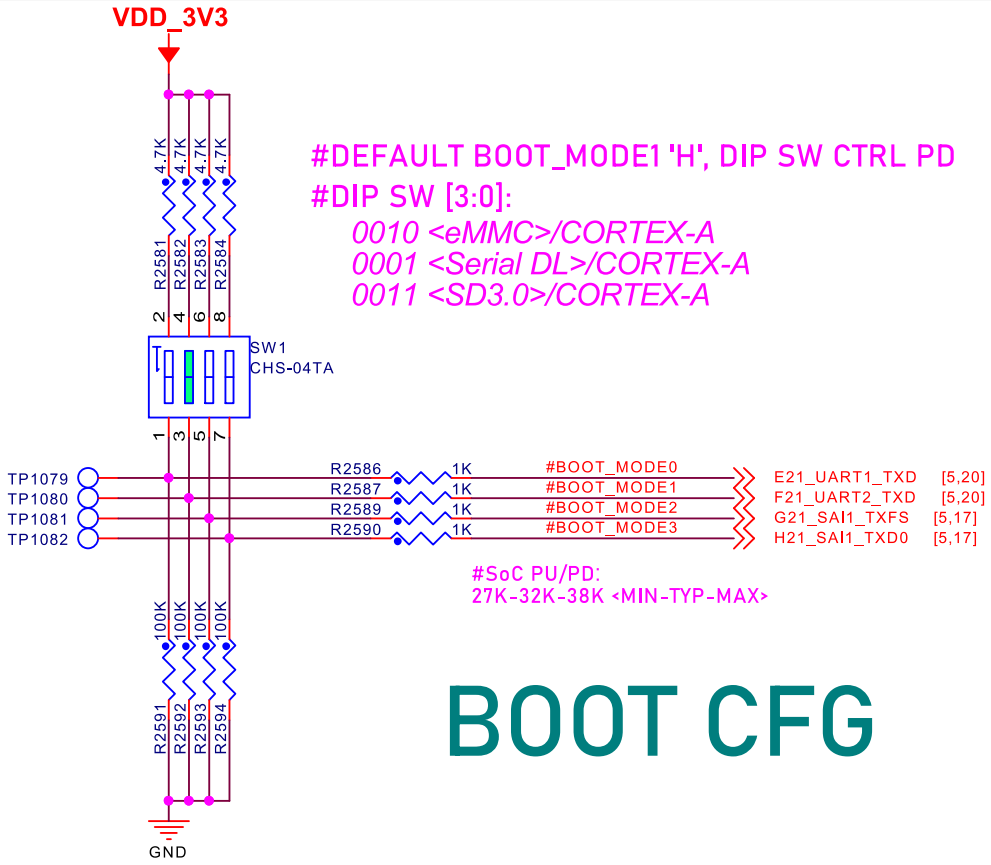


Figure 8. Boot configuration schematic

2.6 PDM interface

The pulse density modulated (PDM) microphone interface of the processor provides PDM/MQS support on the FRDM-IMX93, and it connects to a 3.5 mm audio jack (P15).

Table 13. Audio jack

Part identifier	Manufacturing part number	Description
P15	PJ_3536X	3.5 mm audio jack for onboard MQS analog input / output

2.7 LPDDR4x DRAM memory

The FRDM-IMX93 board features one 1 Gig × 16 (1 channel ×16 I/O × 1 rank) LPDDR4X SDRAM chip (MT53E1G16D1FW-046 AAT:A) for a total of 2 GB of RAM memory. The LPDDR4x DRAM memory is connected to the i.MX 93 DRAM controller.

The ZQ calibration resistors (R209 and R2941) used by the LPDDR4x chip are 240 Ω 1% to LPD4/x_VDDQ and the ZQ calibration resistor DRAM_ZQ used at i.MX93 SoC side is 120 Ω 1% to GND.

In the physical layout, the LPDDR4X chip is placed at the top side of the board. The data traces are not necessarily connected to the LPDDR4x chips in sequential order. Instead, the data traces are connected as best determined by the layout and other critical traces for the ease of routing.

2.7.1 LPDDR4X to LPDDR4 migration

The FRDM-IMX93 DRAM part is MT53E1G16D1FW-046 AAT:A that supports both LPDDR4X and LPDDR4 modes, however, LPDDR4X has been selected as the default option on the board. To verify LPDDR4, the two ways are as follows:

- Rework DRAM VDDQ power to 1.1 V to support LPDDR4 by performing the following steps:
  1. Remove R704
  2. Install R702
  3. Make sure that the DRAM parameters meet the LPDDR4 requirement

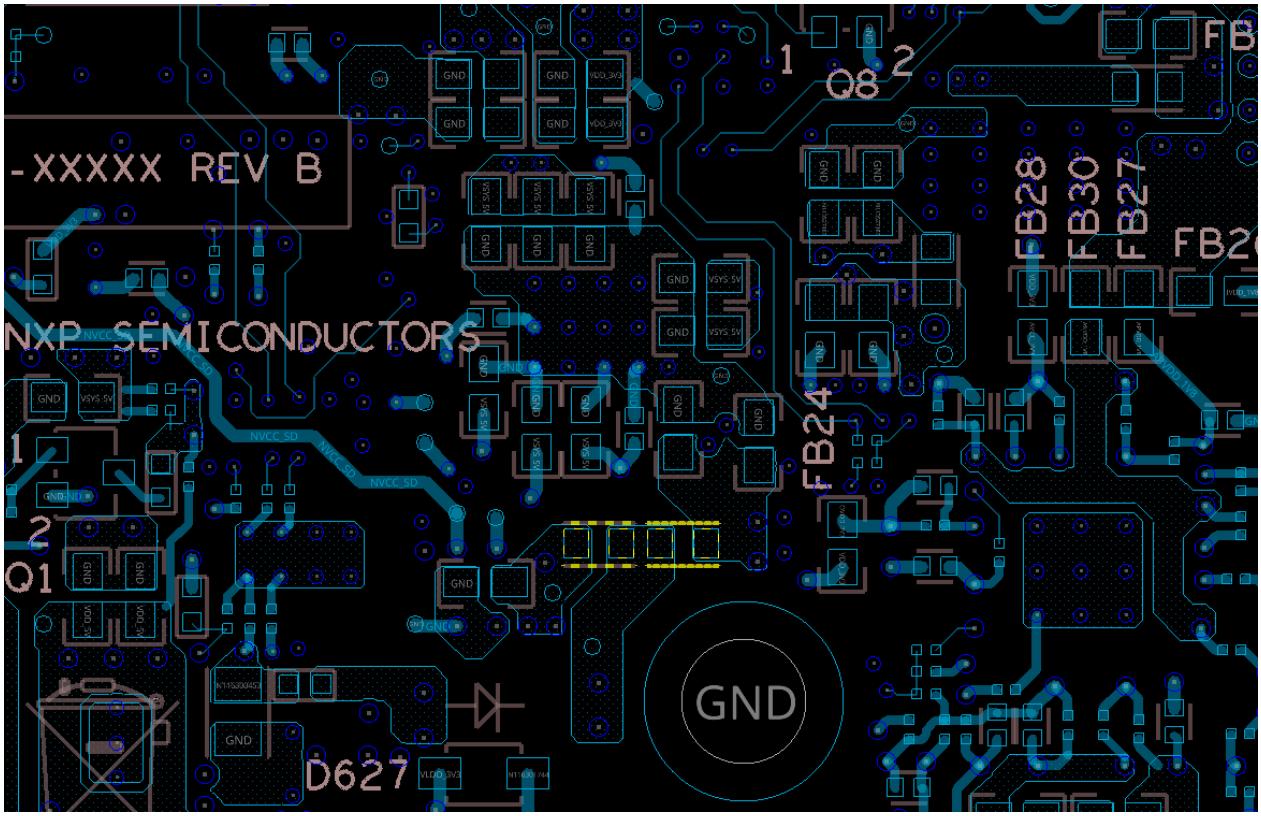


Figure 9. LPDDR4 rework

- No hardware rework is required. Change the DRAM VDDQ power to 1.1 V by software to configure the PMIC by I2C after system power on.

2.8 SD card interface

The target processor has three ultra secured digital host controller (uSDHC) modules for SD/eMMC interface support. The uSDHC2 interface of the i.MX 93 processor connects to the MicroSD card slot (P13) on the FRDM-IMX93 board. This connector supports one 4-bit SD3.0 MicroSD card. To select it as the boot device of the board, see Section 2.5.

2.9 eMMC memory

The eMMC memory (at the SOM board) is connected to the uSDHC1 interface of the i.MX 93 processor, which can support eMMC 5.1 devices. It is the default boot device of the board. Table 12 describes the boot settings.

Table 14 describes the eMMC memory device that is supported by the uSDHC1 interface.

Table 14. Supported eMMC device

Part identifier	Part number	Configuration	FBGA	Manufacturer	Memory size
U501	FEMDRM032G-A3A55	256 Gb x1	TFBGA-153	FORESEE	32 GB

2.10 M.2 connector and Wi-Fi/Bluetooth module

The FRDM-IMX93 board supports the M.2/NGFF Key E mini card 75-pin connector, P8. The M.2 mini card connector supports USB, SDIO, SAI, UART, I2C, and GPIO connection. By default, these signals are connected with the onboard Wi-Fi module, however, to use this M.2 slot, the following resistors must be reworked.

Table 15. Resistors rework for M.2 slot usage

Resistors DNP	Resistors install
R2808, R2809, R2812, R2819, R2820, R2821	R2824, R2825, R2826, R2827, R2828, R2829
R3023, R3024, R2958, R3028	R2960, R2860
R2854, R2855	R2851, R2853
R3038, R2870, R2871	R3037, R2866, R2867
R2796, R2798, R2800, R2802	R2788, R2791, R2792, R2794
R2797, R2799, R2801, R2805	R2789, R2790, R2793, R2795
R2832, R2834, R2836, R2838	R2833, R2835, R2837, R2839

The M.2 connector can be used for Wi-Fi / Bluetooth card, IEEE802.15.4 Radio, or 3G / 4G cards.

Table 16 describes the pinout of the M.2 mini card connector (P8).

Table 16. M.2 mini card connector (P8) pinout

Pin number	M.2 mini card connector pin	Connection details
2, 4, 72, 74	3V3_1, 3V3_2, 3V3_3, 3V3_4	Connected to VPCIe_3V3 power supply
6	LED1	Connected to M.2 Green LED, D613
8	I2S_SCK	Connected to SAI1_TXC processor pin if R2788 is populated
10	I2S_WS	Connected to SAI1_TXFS processor pin if R2791 is populated
12	I2S_SD_IN	Connected to SAI1_RXD processor pin if R2794 is populated
14	I2S_SD_OUT	Connected to SAI1_TXD processor pin if R2792 is populated
16	LED2	Connected to M.2 Orange LED, D614
20	UART_WAKE	`M2_UART_nWAKE` input for I/O expander (PCAL6524HEAZ, P0_3, I2C address: 0x22) if R2853 is populated
22	UART_RXD	Connected to UART5_RXD if R2835 is populated
32	UART_TXD	Connected to UART5_TXD if R2833 is populated
34	UART_CTS	Connected to UART5_CTSI if R2839 is populated
36	UART_RTS	Connected to UART5_RTSO if R2837 is populated
38	VEN_DEF1	Connected to SPI3_MOSI if R2790 is populated
40	VEN_DEF2	Connected to SPI3_MISO if R2795 is populated
42	VEN_DEF3	Connected to SPI3_CLK if R2793 is populated

Table 16. M.2 mini card connector (P8) pinout*...continued*

Pin number	M.2 mini card connector pin	Connection details
50	SUSCLK	Connected to PMIC_32K_OUT, generated by PCA9451AHNY PMIC
52	PERST0	M2_nRST input for I/O expander (PCAL6524HEAZ, P2_2, I2C address: 0x22)
54	W_DISABLE2	M2_nDIS2 input for I/O expander (PCAL6524HEAZ, P2_3, I2C address: 0x22) if R2867 is populated
56	W_DISABLE1	M2_nDIS1 input for I/O expander (PCAL6524HEAZ, P2_4, I2C address: 0x22) if R2866 is populated
58	I2C_DATA	Connected to SDAL pin of PCA9451AHNY PMIC
60	I2C_CLK	Connected to SCLL pin of PCA9451AHNY PMIC
62	ALERT	M2_nALERT input for I/O expander (PCAL6524HEAZ, P1_2, I2C address: 0x22) if R2860 is populated
3	USB_D+	Connected to USB2_D_P processor pin if R2806 is populated
5	USB_D-	Connected to USB2_D_N if R2807 is populated
9	SDIO_CLK	Connected to the SD3_CLK processor pin and processor interface SDHC3 if R2824 is populated
11	SDIO_CMD	Connected to the SD3_CMD processor pin and processor interface SDHC3 if R2825 is populated
13	SDIO_DATA0	Connected to the SD3_DATA0 processor pin and processor interface SDHC3 if R2826 is populated
15	SDIO_DATA1	Connected to the SD3_DATA1 processor pin and processor interface SDHC3 if R2827 is populated
17	SDIO_DATA2	Connected to the SD3_DATA2 processor pin and processor interface SDHC3 if R2828 is populated
19	SDIO_DATA3	Connected to the SD3_DATA3 processor pin and processor interface SDHC3 if R2829 is populated
21	SDIO_WAKE	Connected to the CCM_CLKO1 processor pin of NVCC_WAKEUP module if R2851 is populated
23	SDIO_RST	SD3_nRST output from I/O expander (PCAL6524HEAZ, P1_4, I2C address: 0x22) if R3037 is populated
55	PEWAKE0	PCIE_nWAKE input for I/O expander (PCAL6524HEAZ, P0_2, I2C address: 0x22) if R2868 is populated

For further details about i.MX 93 interfaces, see *i.MX 93 Applications Processor Reference Manual*.

2.11 Tri-radio module interface

The FRDM-IMX93 board features a Tri-radio (Wi-Fi 6, Bluetooth 5.4, and 802.15.4) module that interfaces with the SD2, UART5, SAI1, and SPI3 controller of the target processor.

Table 17. Tri-radio module

Part identifier	Manufacturing part number	Description
U731	MAYA-W27x (u-blox)	Host-based Wi-Fi 6, Bluetooth 5.4, and 802.15.4 modules for the IoT applications

The two antenna pins (RF_ANT0 and RF_ANT1) of the module connects to U.FL connectors P9 and P10 (DNP by default). The module is supplied with VPCIe_3V3, VEXT_1V8, and VDD_1V8.

The MAYA-W27x module and M.2 connector share several interface lines on the FRDM-IMX93 board. Zero-ohm resistors enable signal selection between these components.

SD3 Interface

The SD3 interface lines are shared between the MAYA-W27x module and the M.2 connector. Zero-ohm resistors select either the MAYA-W27x module (default setting) or the M.2 connector.

UART5 Interface

Similarly, the UART5 interface lines are shared between the MAYA-W27x module and the M.2 connector. Zero-ohm resistors select either the MAYA-W27x module (default setting) or the M.2 connector.

SAI1 Interface

The SAI1 interface lines are shared between the MAYA-W27x module and the M.2 connector. Zero-ohm resistors select either the MAYA-W27x module (default setting) or the M.2 connector for 1.8 V translated signals, generated using the 74AVC4T3144 bidirectional voltage translator (U728).

SPI3 Interface

The SPI3 signals (CLK, MOSI, MISO, and CS0) are multiplexed with GPIO_IO[08, 09, 10, 11] signals, respectively. These SPI3 signals are shared between the MAYA-W27x module and the M.2 connector. Zero-ohm resistors select either the MAYA-W27x module (default setting) or the M.2 connector for 1.8 V translated signals, generated using the 74AVC4T3144 bidirectional voltage translator (U729).

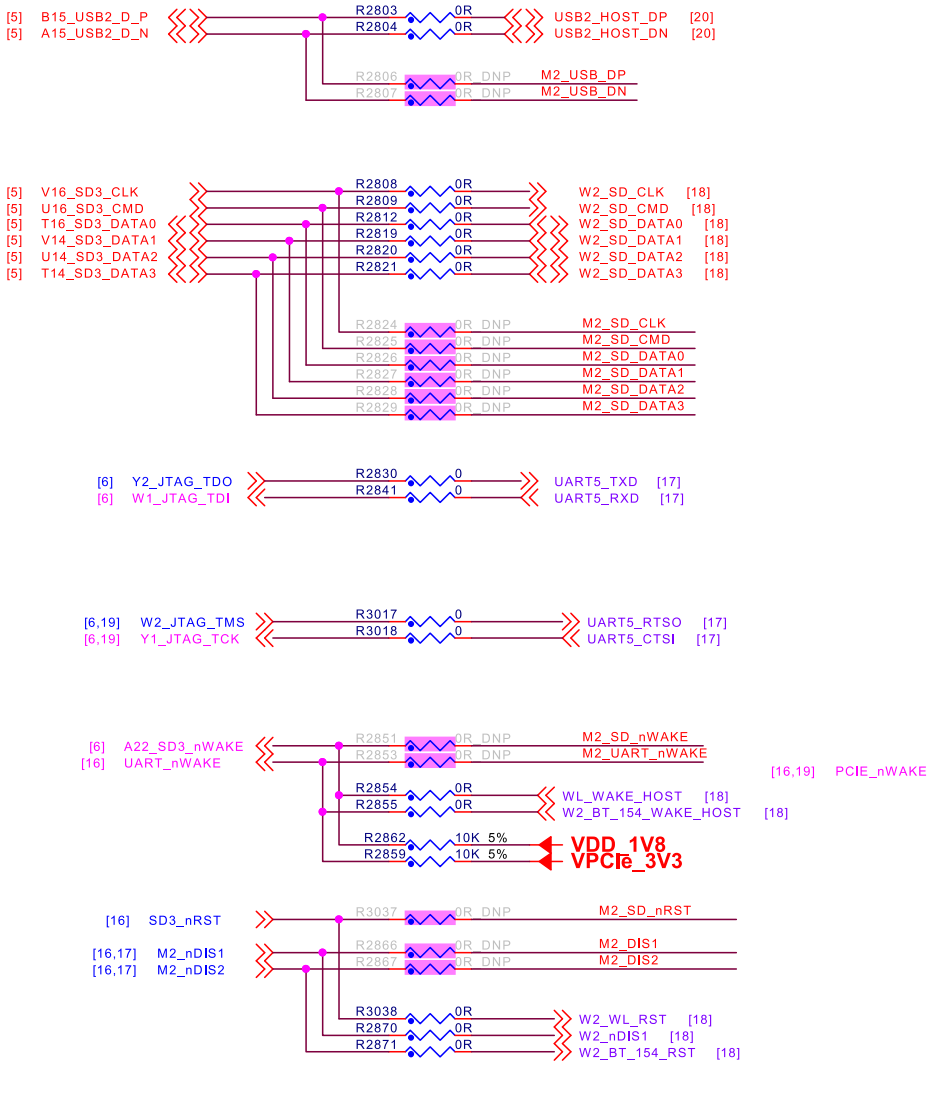


Figure 10. Resistors configuration for SD3

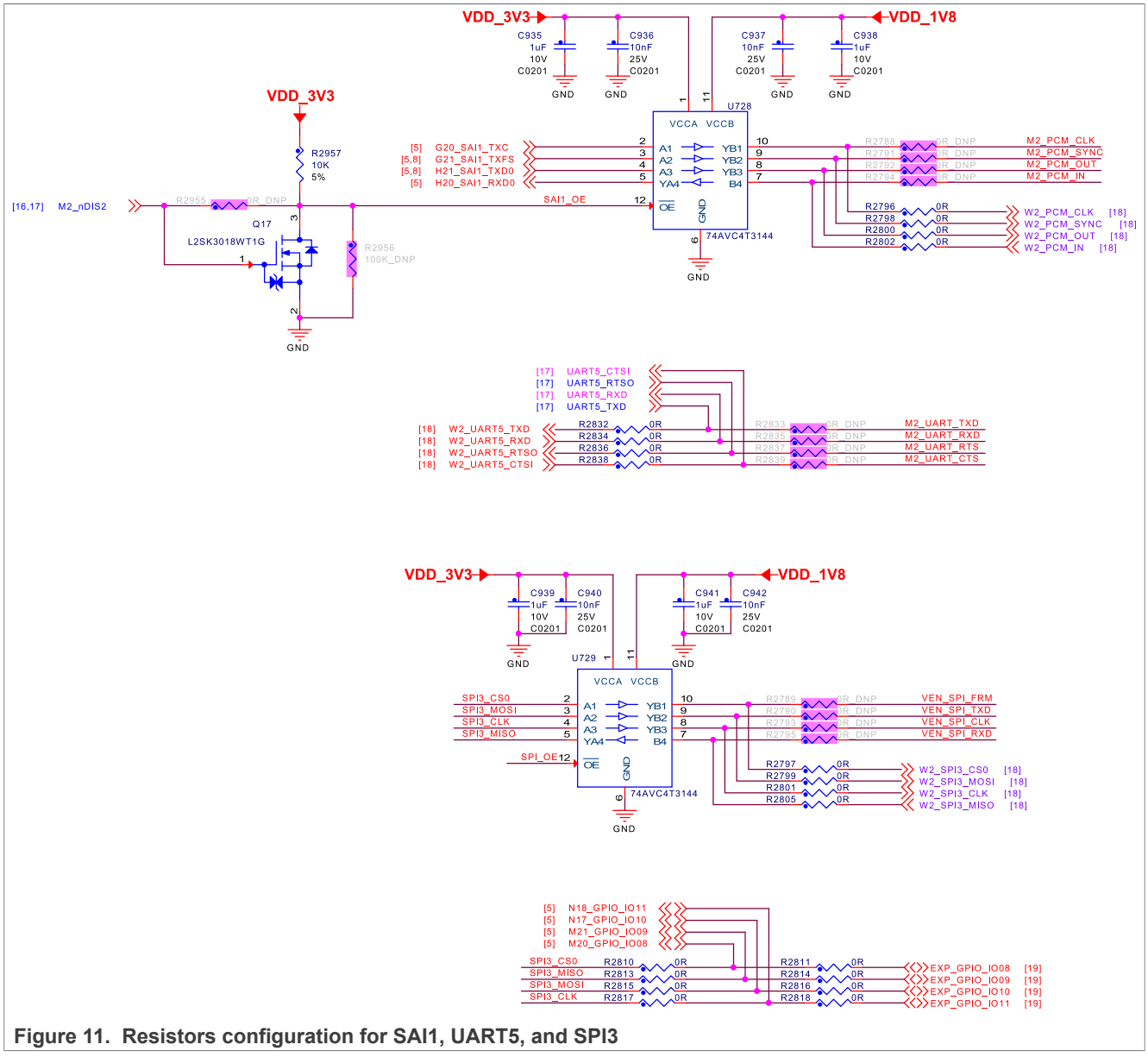


Figure 11. Resistors configuration for SAI1, UART5, and SPI3

2.12 CAN interface

The i.MX93 processor supports a controller area network (CAN) module that is a communication controller implementing the CAN protocol according to the CAN with flexible data rate (CAN FD) protocol and the CAN 2.0B protocol specification. The processor supports two CAN FD controllers.

On the FRDM-IMX93 board, one of the controllers is connected to the high-speed CAN transceiver TJA1051T/3. The high-speed CAN transceiver drives CAN signals between the target processor and a 10-pin 2x5 2.54 mm header (P12) to its physical two-wire CAN bus.

The CAN_TXD and CAN_RXD signals are multiplexed on GPIO_IO25 and GPIO_IO27, respectively. On the board, a 2-bit DIP switch (SW3) is used to control the CAN signals. For SW3 detail, see Section 1.7. The CAN_STBY signal from the IO expander PCAL6524HEAZ (U725, P2_7, I2C address: 22) enables / disables CAN standby mode.

The CAN interface circuit includes the split termination RC filter (62Ω + 56pF) for noise rejection and signal integrity. The switch SW4 is provided for enabling/disabling the RC filter. For SW4 detail, see Section 1.7.

The HS-CAN transceiver and header are described in Table 18.

Table 18. High-speed CAN transceiver and header

Part identifier	Manufacturing part number	Description
U741	TJA1051T/3	High-speed CAN transceiver. Provides an interface between a CAN protocol controller and the physical two-wire CAN bus.
P12	Not applicable	10-pin 2x5 2.54 mm connector (P12). It is connected to the CAN bus and allows external connection with the bus. ***Note:*** *Table 10 explains pinout for the 10-pin 2x5 2.54 mm connector P12.*

Note: *For details about TJA1051, see TJA1051 data sheet at nxp.com.*

2.13 USB interface

The i.MX 93 applications processor features two USB 2.0 controllers, with two integrated USB PHYs. On the FRDM-IMX93 board, one is used for the USB2.0 Type-C Port (P2) and the other is used for USB2.0 Type-A Port (P17).

Table 19 describes the USB ports available on the board.

Table 19. USB ports

Part identifier	USB Port Type	Description
P2	USB2.0 Type-C	Connects to full-speed USB host and device controller (USB 1) of target processor. It can operate as a device or host. The USBC_VBUS signal controls the VBUS drive for the USB port.
P17	USB2.0 Type-A	Connects to full-speed USB host and device controller (USB 2) of target processor. It can operate as a device or host. The USB2_VBUS signal controls the VBUS drive for the USB port. The USB2_DP and USB2_DN signals from the USB2 controller of the target processor connect to USB2 Type A port (P17) by default. These signals can be connected to M.2 card connecter (P6) by solder/DNP R2803, R2804, R2806, R2807.
P1	USB Type-C PD	It is used for power only. It does not support USB data transfer. It is the only power supply port therefore it must always be supplied for system power.
P16	USB Type-C	It is used for system debug purpose. For detail, see the system debug section.

2.14 Camera interface

The i.MX 93 processor includes a mobile industry processor interface (MIPI) camera serial interface 2 (CSI-2) receiver that handles image sensor data from camera modules and supports up to 2 data lanes. The MIPI CSI-2 signals are connected to an FPC connector to which the RPI-CAM-MIPI (Agile Number: 53206) accessory card can be plugged in. The description of the FPC connector is as below:

- Part identifier: P6
- Table 20 describes FPC connector pinout

Table 20. MIPI CSI connector (P6) pinout

Pin number	Signal	Description
1, 4, 7, 10, 13, 16, 19	GND	Ground
2	MIPI_CSI1_D0_N	MIPI CSI data channel 0
3	MIPI_CSI1_D0_P	
5	MIPI_CSI1_D1_N	MIPI CSI data channel 1
6	MIPI_CSI1_D1_P	
8	MIPI_CSI1_CLK_N	MIPI CSI clock signal
9	MIPI_CSI1_CLK_P	
17	CSI_nRST	Reset signal from I/O expander U725 (PCAL6524HEAZ, P2_6, I2C address: 0x22)
18	CAM_MCLK	3.3 V voltage translated input from CCM_CLKO3 pin (CSI_MCLK) of the target processor
20	USB_I2C_SCL	3.3 V I2C3 SCL signal
21	USB_I2C_SDA	3.3 V I2C3 SDA signal
22	DSI&CAM_3V3	3.3 V power supply

2.15 MIPI DSI

The i.MX 93 processor supports MIPI display serial interface (DSI) that supports up to four lanes and the resolution can be up to 1080p60 or 1920x1200p60.

The MIPI DSI data and clock signals from the target processor are connected to one 22-pin FPC connector (P7).

Table 21 describes DSI connector pinout.

Table 21. MIPI DSI connector (P7) pinout

Pin number	Signal	Description
1, 4, 7, 10, 13, 16, 19	GND	Ground
2	DSI_DN0	MIPI DSI data channel 0
3	DSI_DP0	
5	DSI_DN1	MIPI DSI data channel 1
6	DSI_DP1	
8	DSI_CN	MIPI DSI clock signal
9	DSI_CP	
11	DSI_DN2	MIPI DSI data channel 2
12	DSI_DP2	
14	DSI_DN3	MIPI DSI data channel 3
15	DSI_DP3	
17	CTP_RST	Reset signal from I/O expander U725 (PCAL6524HEAZ, P2_1, I2C address: 0x22)
18	DSI_CTP_nINT	Interrupt signal to I/O expander U725 (PCAL6524HEAZ, P0_7, I2C address: 0x22)

Table 21. MIPI DSI connector (P7) pinout...*continued*

Pin number	Signal	Description
20	USB_I2C_SCL	3.3 V I2C3 SCL signal
21	USB_I2C_SDA	3.3 V I2C3 SDA signal
22	DSI&CAM_3V3	3.3 V power supply

2.16 HDMI interface

The i.MX 93 processor supports a four data lane LVDS TX display, the resolution can be up to 1366x768p60 or 1280x800p60. These signals are connected to one high-performance single-chip De-SSC LVDS to HDMI converter IT6263. The output of the IT6263 connects to the HDMI connector P5. The connector is as shown in Figure 3.

2.17 Ethernet

The i.MX 93 processor supports two Gigabit Ethernet controllers (capable of simultaneous operation) with support for Energy-Efficient Ethernet (EEE), Ethernet AVB, and IEEE 1588.

The Ethernet subsystem of the board is provided by the Motorcomm YT8521SH-CA Ethernet transceivers (U713, U716) which support RGMII and connect to RJ45 connectors (P3, P4). The Ethernet transceivers (or PHYs) receive standard RGMII Ethernet signals from i.MX 93. The RJ45 connectors integrate Magnetic transformer inside, so they can be directly connected to Ethernet transceivers (or PHYs).

Each Ethernet port has a unique MAC address, which is fused into i.MX 93. The Ethernet connectors are labeled clearly on the board.

2.18 Expansion connector

One 40-pin dual-row pin connector (P11) is provided on the FRDM-IMX93 board to support I2S, UART, I2C, and GPIO connections. The header can be used to access various pins or to plug in accessory cards, such as the LCD display TM050RDH03, 8MIC-RPI-MX8 card, MX93AUD-HAT.

The connector is shown in Figure 3.

Table 22. P11 pin definition

Pin number	Net name	Pin number	Net name
1	VRPi_3V3	2	VRPi_5V
3	GPIO_IO02	4	VRPi_5V
5	GPIO_IO03	6	GND
7	GPIO_IO04	8	GPIO_IO14
9	GND	10	GPIO_IO15
11	GPIO_IO17	12	GPIO_IO18
13	GPIO_IO27	14	GND
15	GPIO_IO22	16	GPIO_IO23
17	VRPi_3V3	18	GPIO_IO24
19	GPIO_IO10	20	GND
21	GPIO_IO09	22	GPIO_IO25
23	GPIO_IO11	24	GPIO_IO08

Table 22. P11 pin definition...*continued*

Pin number	Net name	Pin number	Net name
25	GND	26	GPIO_IO07
27	GPIO_IO00	28	GPIO_IO01
29	GPIO_IO05	30	GND
31	GPIO_IO06	32	GPIO_IO12
33	GPIO_IO13	34	GND
35	GPIO_IO19	36	GPIO_IO16
37	GPIO_IO26	38	GPIO_IO20
39	GND	40	GPIO_IO21

2.19 Debug interface

The FRDM-IMX93 board features two independent debug interfaces.

- Serial wire debug (SWD) header (Section 2.19.1)
- USB-to-Dual UART debug port (Section 2.19.2)

2.19.1 SWD interface

The i.MX 93 applications processor has two serial wire debug (SWD) signals on dedicated pins, and those signals are directly connected to the standard 3-pin 2.54 mm connector P14. The two SWD signals used by the processor are:

- SWCLK (Serial wire clock)
- SWDIO (Serial wire data input / output)

The SWD connector P14 is shown in Figure 3.

2.19.2 USB debug interface

The i.MX 93 applications processor has six independent UART ports (UART1 – UART6). On the FRDM-IMX93 board, UART1 is used for Cortex-A55 core, and UART2 is used for Cortex-M33 core. A single chip USB to dual UART is used for the debug purpose. The part number is CH342F. You can download the driver from WCH Website.

After installing the CH342F driver, the PC / USB host enumerates two COM ports connected to the P16 connector through a USB cable:

- COM Port 1: Cortex-A55 system debugging
- COM Port 2: Cortex-M33 system debugging

You can use the following terminal tools for debugging purposes:

- Putty
- Tera Term
- Xshell
- Minicom>=2.9

To debug under Linux, make sure CH342F Linux driver is installed.

Table 23 describes the required settings.

Table 23. Terminal setting parameters

Data rate	115,200 Baud
Data bits	8
Parity	None
Stop bits	1

The USB debug connector P16 is shown in Figure 3.

2.20 Board errata

No board errata.

3 Working with accessories

This section describes how a connection can be established between with the FRDM-IMX93 board and compatible accessory boards.

3.1 7-inch Waveshare LCD

This section describes how to connect the FRDM-IMX93 board with a 7-inch Waveshare LCD using MIPI DSI interface and I2C. It also specifies the changes required in the software configuration to support Waveshare LCD.

3.1.1 Connection of the MIPI DSI interface

To make a connection between a 7-inch Waveshare LCD and the FRDM-IMX93 board through the MIPI DSI interface, ensure the following:

At LCD side:

- FPC cable orientation: Conductive side up and stiffener side down
- Insert the FPC cable into LCD's FPC connector

At FRDM-IMX93 board side:

- FPC cable orientation: Conductive side right and stiffener side left
- Insert FPC cable into the board's FPC connector (P7)

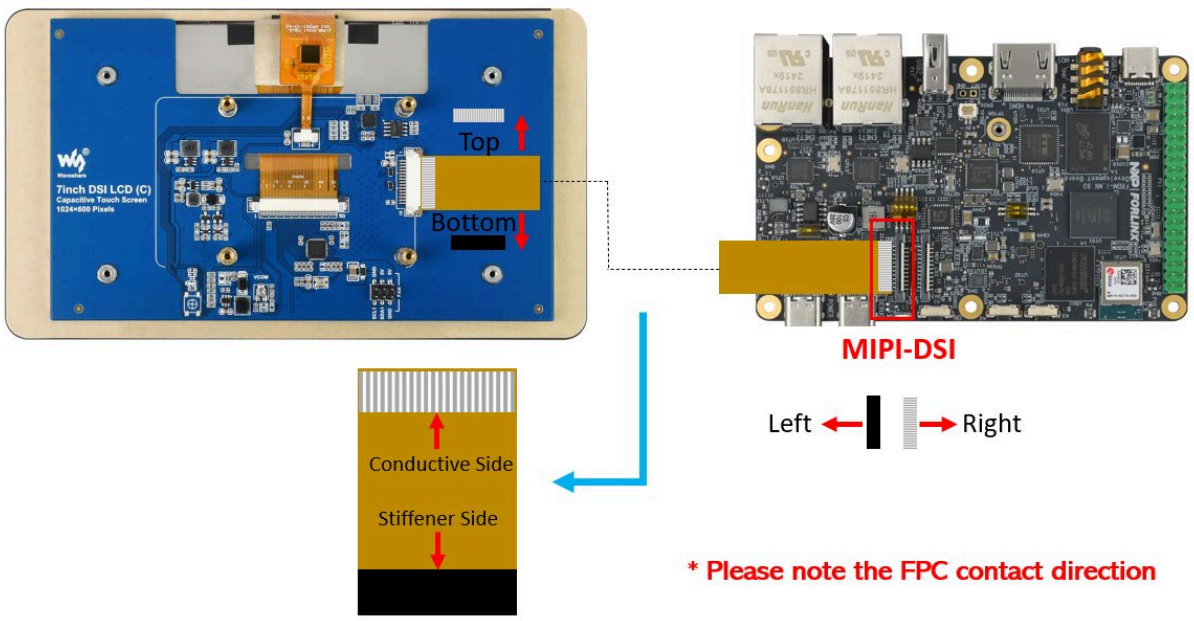


Figure 12. FPC cable connection between 7-Inch Waveshare LCD and FRDM-IMX93

3.1.2 Connection of I2C

Figure 13 shows the I2C signal wires connection between 7-Inch Waveshare LCD and FRDM-IMX93.

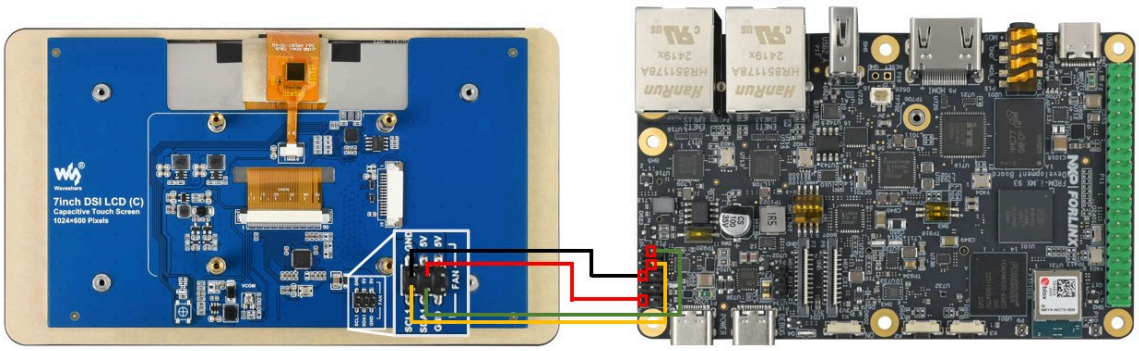


Figure 13. I2C connection between 7-Inch Waveshare LCD and FRDM-IMX93

3.1.3 Software configuration update

The following steps specify how to replace the default dtb with the custom dtb (imx93-11x11-frdm-dsi.dtb) that supports Waveshare LCD.

1. Stop at U-Boot
2. Use the below commands to replace the default dtb:

```
$setenv fdtfile imx93-11x11-frdm-dsi.dtb
$saveenv
$boot
```

3.2 5-inch Tianma LCD

TM050RDH03-41 is a 5" TFT LCD display with 800x480 resolution. This industrial-grade display uses an RGB interface without a touch panel. This display module connects to the FRDM-IMX93 through the EXPI 40-pin connector (P11).

3.2.1 Connection between Tianma panel and adapter board

Figure 14 shows the FPC connection between the 5-inch Tianma LCD panel and adapter board. Insert the FPC connector with the conductive side up (stiffener side down).

Figure 14. FPC connection between 5-inch Tianma LCD panel and adapter board

3.2.2 Connection between adapter board and FRDM-IMX93

Plug 5'' Tianma LCD to FRDM-MIX93 through the EXPI 40-pin connector (P11) as shown in Figure 15

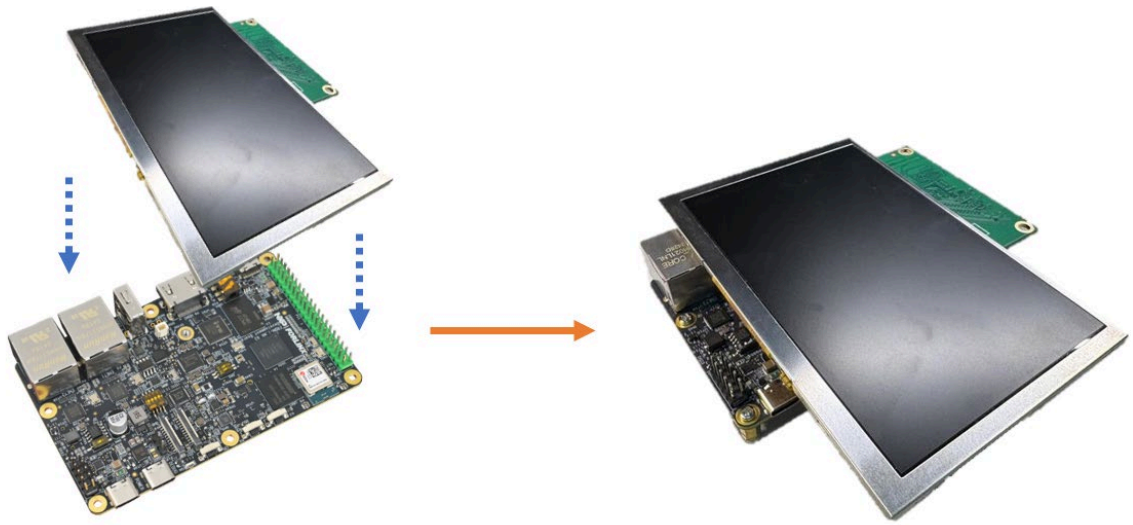


Figure 15. 5-inch Tianma LCD connection with FRDM-MIX93 through 40-pin connector

3.2.3 Software configuration update

The following steps specify how to replace the default dtb with the custom dtb (imx93-11x11-frdm-tianma-wvga-panel.dtb) that supports Tianma LCD.

1. Stop at U-Boot
2. Use the below commands to replace the default dtb:

```
$setenv fdtfile imx93-11x11-frdm-tianma-wvga-panel.dtb
$saveenv
$boot
```

3.3 Camera module (RPI-CAM-MIPI)

The RPI-CAM-MIPI accessory board is a MIPI-CSI camera module adapter. The adapter is based on the AR0144 CMOS image sensor with ONSEMI IAS interface by default, which features a 1/4-inch 1.0 Mp with an active-pixel array of 1280 (H) x 800 (V). The bypassable onboard ISP chip allows it to be used with a wide range of SoCs. This accessory board connects to the FRDM-IMX93 board through the 22-pin / 0.5 mm pitch FPC cable.

3.3.1 Connection between RPI-CAM-MIPI and FRDM-IMX93

Figure 16 shows the FPC cable connection between RPI-CAM-MIPI and FRDM-IMX93.

At the RPI-CAM-MIPI side:

- FPC cable orientation: Stiffener side up and conductive side down
- Insert FPC cable into RPI-CAM-MIPI FPC connector

At FRDM-IMX93 board side:

- FPC cable orientation: Conductive side right and stiffener side left
- Insert the FPC cable into the FPC connector (P7) of the board

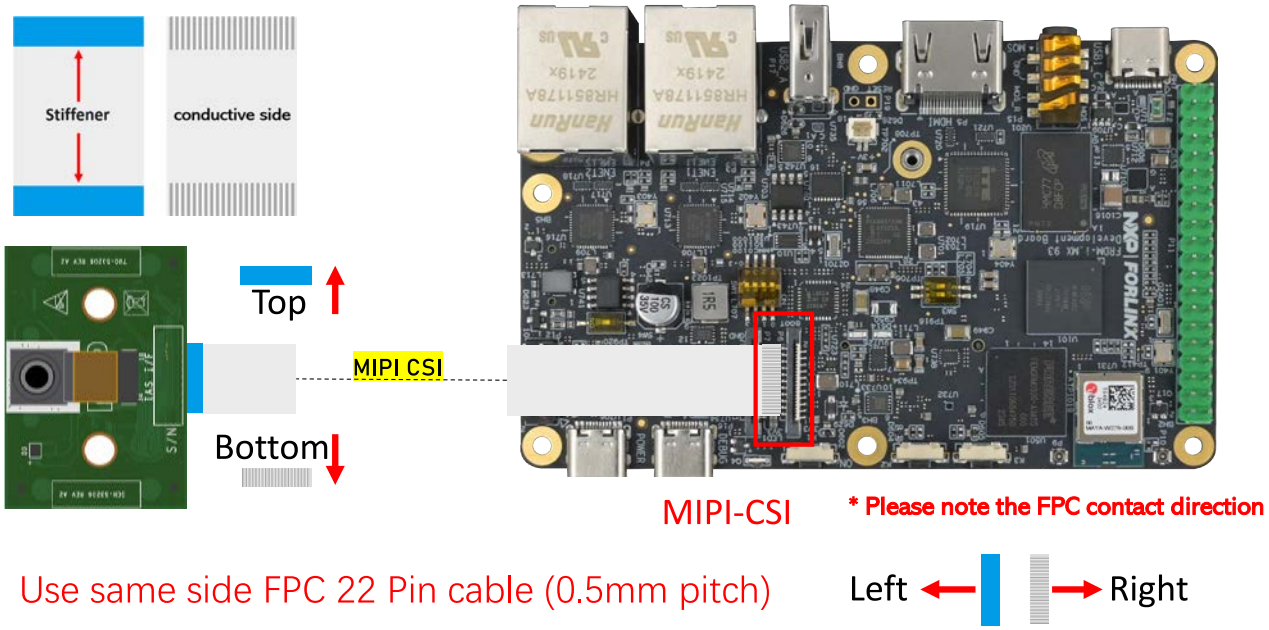


Figure 16. FPC connection between RPI-CAM-MIPI and FRDM-IMX93

3.3.2 Software configuration update

In default BSP, FRDM-IMX93 supports ap1302 + ar0144.

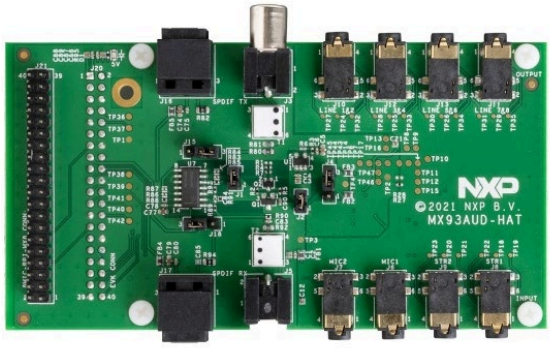
For the first time use, follow the below steps:

- Download ap1302 firmware from ONSEMI github, and rename it as ap1302.fw
- Copy ap1302.fw to the target board under path /lib/firmware/imx/camera/ (if the folder does not exist, create it)
- Reboot the board as FRDM dtb supports the camera
- Check whether the camera is probed:

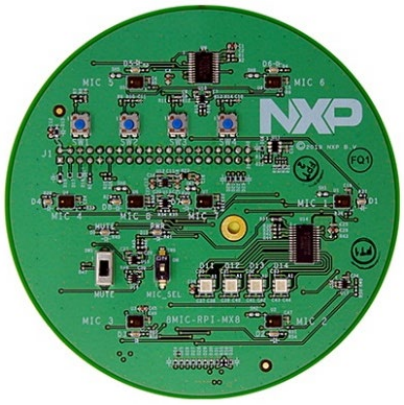
```
root@imx93frdm:~# dmesg | grep ap1302
[2.565423]ap1302 mipi2-003c:AP1302 Chip ID is 0x265
[2.577072]ap1302 mipi 2-003c: AP1302 is found
[7.477363]mx8-img-md: Registered sensor subdevice: ap1302 mipi 2-003c (1)
[7.513503]mx8-img-md: created link
[ap1302 mipi 2-003c]=> [mxc-mipi-csi2.0]7.988932]ap1302 mipi 2-003c: Load
 firmware successfully.
```

3.4 Other accessory boards

There are other accessory boards also that can work with FRDM-IMX93 through EXPI 40-pin interface, such as MX93AUD-HAT and 8MIC-RPI-MX8. To use any such board, check the schematic and layout to determine the direction of the connection between FRDM-IMX93 and the accessory board in advance. Also, choose the right dtb file in the U-Boot stage.



MX93AUD-HAT



8MIC-RPI-MX8

Figure 17. Accessory boards

3.5 Software configuration update

- To use the MX93AUD-HAT and 8MIC-RPI-MX8 boards together or use the MX93AUD-HAT board alone, run the following commands at U-Boot to replace the default dtb:

```
$setenv fdtfile imx93-11x11-frdm-aud-hat.dtb
$saveenv
$boot
```

- To use the 8MIC-RPI-MX8 board alone, run the following commands at U-Boot to replace the default dtb:

```
$setenv fdtfile imx93-11x11-frdm-8mic.dtb
$saveenv
```

```
$boot
```

4 PCB information

The FRDM-IMX93 is made with standard 10-layer technology. The material is FR-4, and the PCB stack-up information is described in Table 24.

Table 24. FRDM-IMX93 board stack up information

Layer	Description	Copper (mil)	Generic	Er	Dielectric thickness (mil)
1	TOP	0.7+Plating	-	-	1.3
-	Dielectric	-			2.61
2	GND02	1.4	-	-	-
-	Dielectric	-			3
3	ART03	1.4	-	-	-
-	Dielectric	-			8.8
4	PWR04	1.4	-	-	-
-	Dielectric	-			4
5	PWR05	1.4	-	-	-
-	Dielectric	-			8.8
6	ART06	1.4	-	-	-
-	Dielectric	-			4
7	GND07	1.4	-	-	-
-	Dielectric	-			8.8
8	ART08	1.4	-	-	-
-	Dielectric	-			3
9	GND09	1.4	-	-	-
-	Dielectric	-			2.61
10	BOTTOM	0.7+Plating	-	-	1.3
Finished:	1.6 mm				
Designed:	71.304 mil			1.811 mm	
Material:	FR-4				

5 Acronyms

Table 25 lists and explains the acronyms and abbreviations used in this document.

Table 25. Acronyms

Term	Description
BGA	Ball grid array
CAN	Controller area network
CSI-2	Camera serial interface 2

Table 25. Acronyms...*continued*

Term	Description
DNP	Do not populate
DSI	Display serial interface
eMMC	Embedded multimedia card
EXPI	Expansion interface
FD	Flexible data rate
GPIO	General-purpose input/output
HS	High-speed
I2C	Inter-integrated circuit
I2S	Inter-IC sound
I3C	Improved inter-integrated circuit
LDO	Low dropout regulator
LED	Light-emitting diode
MIPI	Mobile industry processor interface
MISO	Master input slave output
MOSI	Master output slave input
NGFF	Next-generation form factor
PDM	Pulse-density modulation
PMIC	Power management-integrated circuit
PWM	Pulse width modulation
UART	Universal asynchronous receiver/transmitter
USB	Universal serial bus
uSDHC	Ultra secured digital host controller

6 Related documentation

Table 26 lists and explains the additional documents and resources that you can refer to for more information on the FRDM-IMX93 board. Some of the documents listed below may be available only under a nondisclosure agreement (NDA). To request access to these documents, contact your local field applications engineer (FAE) or sales representative.

Table 26. Related documentation

Document	Description	Link / how to access
i.MX 93 Applications Processor Reference Manual	Intended for system software and hardware developers and application programmers who want to develop products with i.MX 93 MPU	IMX93RM
i.MX 93 Industrial Application Processors Data Sheet	Provides information about electrical characteristics, hardware design considerations, and ordering information	IMX93IEC
i.MX93 Hardware Design Guide	This document aims to help hardware engineers design and to test their i.MX 93 processor-based designs. It provides information about board layout	IMX93HDG

Table 26. Related documentation*...continued*

Document	Description	Link / how to access
	recommendations and design checklists to ensure first-pass success and avoidance of board bring-up problems.	

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8 Revision history

Table 27 summarizes the revisions to this document.

Table 27. Revision history

Document ID	Release date	Description
UM12181 v.1.0	9 December 2024	Initial public release.

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