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NXP UM12262 Development Board User Manual

NXP UM12262 Development Board.webp

Document information

| Information	Content
Keywords	i.MX 91, FRDM-IMX91, UM12262
Abstract	The FRDM i.MX 91 development board (FRDM-IMX91 board) is a low-cost platform designed to show the most commonly used features of the i.MX 91 applications processor in a small and low-cost package.

1 FRDM-IMX91 overview

The FRDM i.MX 91 development board (FRDM-IMX91 board) is a low-cost platform designed to show the most commonly used features of the i.MX 91 Applications Processor in a small and low-cost package. The FRDMIMX91 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-IMX91 block diagram.

Figure 1. FRDM-IMX91 block diagram
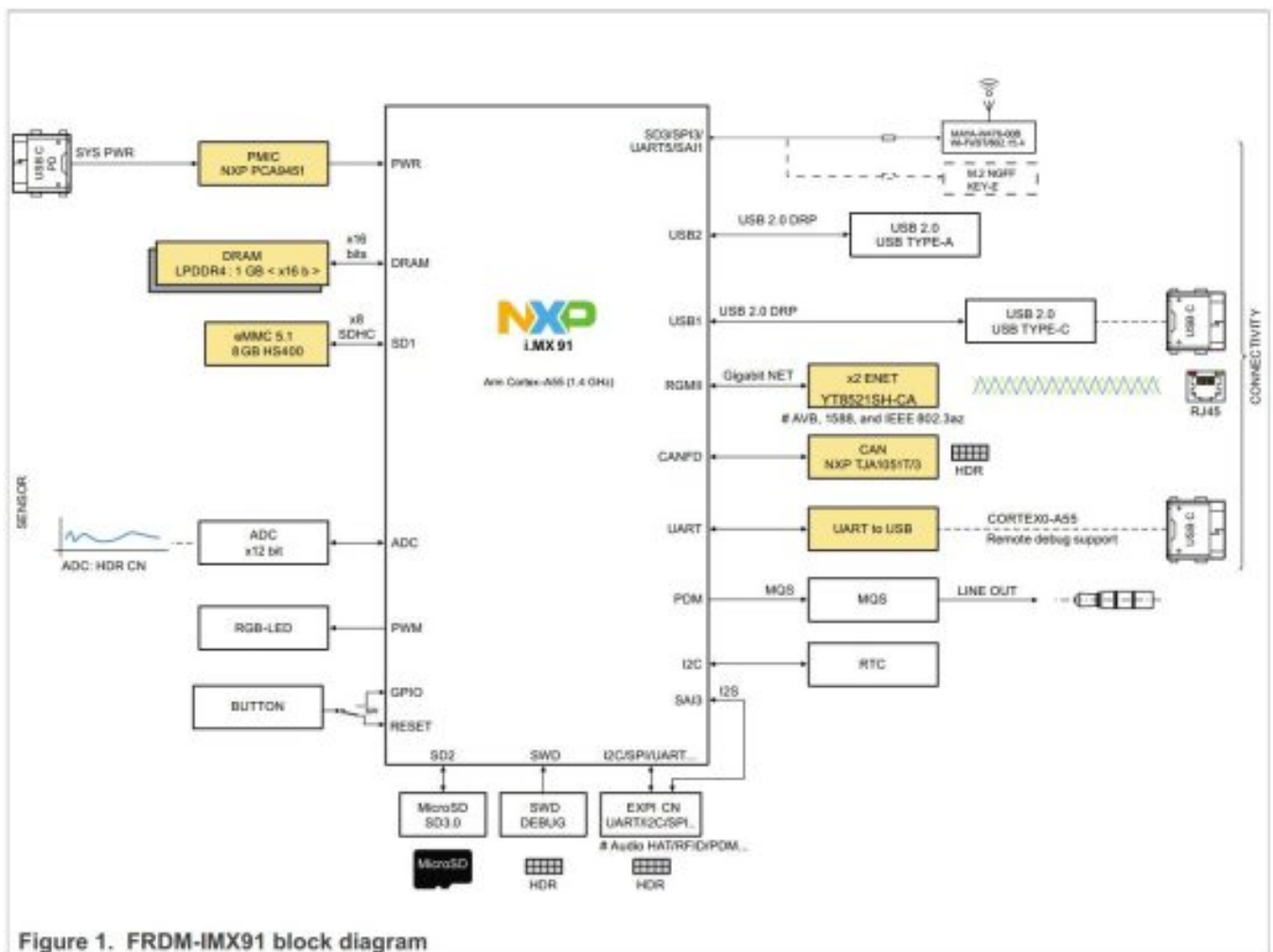
1.2 Board features

Table 1 lists the features of FRDM-IMX91.

Table 1. FRDM-IMX91 features

Board feature	Target processor feature used	Description
Applications processor		The i.MX 91 applications processor features a single Arm Cortex-A55 core speeding up to 1.4 GHz. **Note:** *For more detail on the i.MX 91 processor, see the i.MX 91 Applications Processor Reference Manual.*
USB interface	USB2.0 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	1 GB LPDDR4 (Nanya NT6AN512M16AV-J1)
Mass storage	uSDHC	• 8 GB eMMC5.1 (FEMDRM008G-58A39) • MicroSD card connector (SD3.0 supported)
Boot configuration		• Default boot mode is single boot from the eMMC device • Board also supports SD card boot
Display interface	Parallel display	Parallel display support
Ethernet interface	Two ENET controllers	• 10/100/1000 Mbit/s RGMII Ethernet with one RJ45 connector (P3) supporting TSN and 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
Tri-radio module	SDIO, UART, SPI, SAI	U-blox MAYA-W476-00B module supporting Wi-Fi 6, Bluetooth Low Energy 5.4, and 802.15.4

M.2 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 tri-radio module, however, to use this M.2 slot, you must rework resistors (see Table 15).*
Audio	MQS	MQS support

Debug interface		• USB2.0 Type-C connector (P16) with USB-to-UART device, CH342F. CH342F provides two COM ports:
		  – First COM port is used for Cortex A55 system debug
		  – Second COM port is reserved
		• Serial wire debug (SWD), P14

EXPI		One 2x20-pin EXPI for I2S, UART, I2C, and GPIO expansion
Power		• One USB 2.0 Type-C connector for power delivery only • PCA9451AHNYPMIC • Discrete DCDC/LDO
PCB		FRDM-IMX91: 105 mm × 65 mm, 10-layer
Orderable part number		FRDM-IMX91

1.3 Board kit contents

Table 2 lists the items included in the FRDM-IMX91 board kit.

Table 2. Board kit contents

Item description	Quantity
FRDM-IMX91 board	1
USB 2.0 Type-C Male to Type-A Male assembly cable	2
FRDM-IMX91 Quick Start Guide	1

1.4 Board pictures

Figure 2 shows the top-side view of the FRDM-IMX91 board.

Figure 2. FRDM-IMX91 top-side view

Figure 3 shows the connectors available on the top side of the FRDM-IMX91 board.

Figure 3. FRDM-IMX91 connectors

[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.
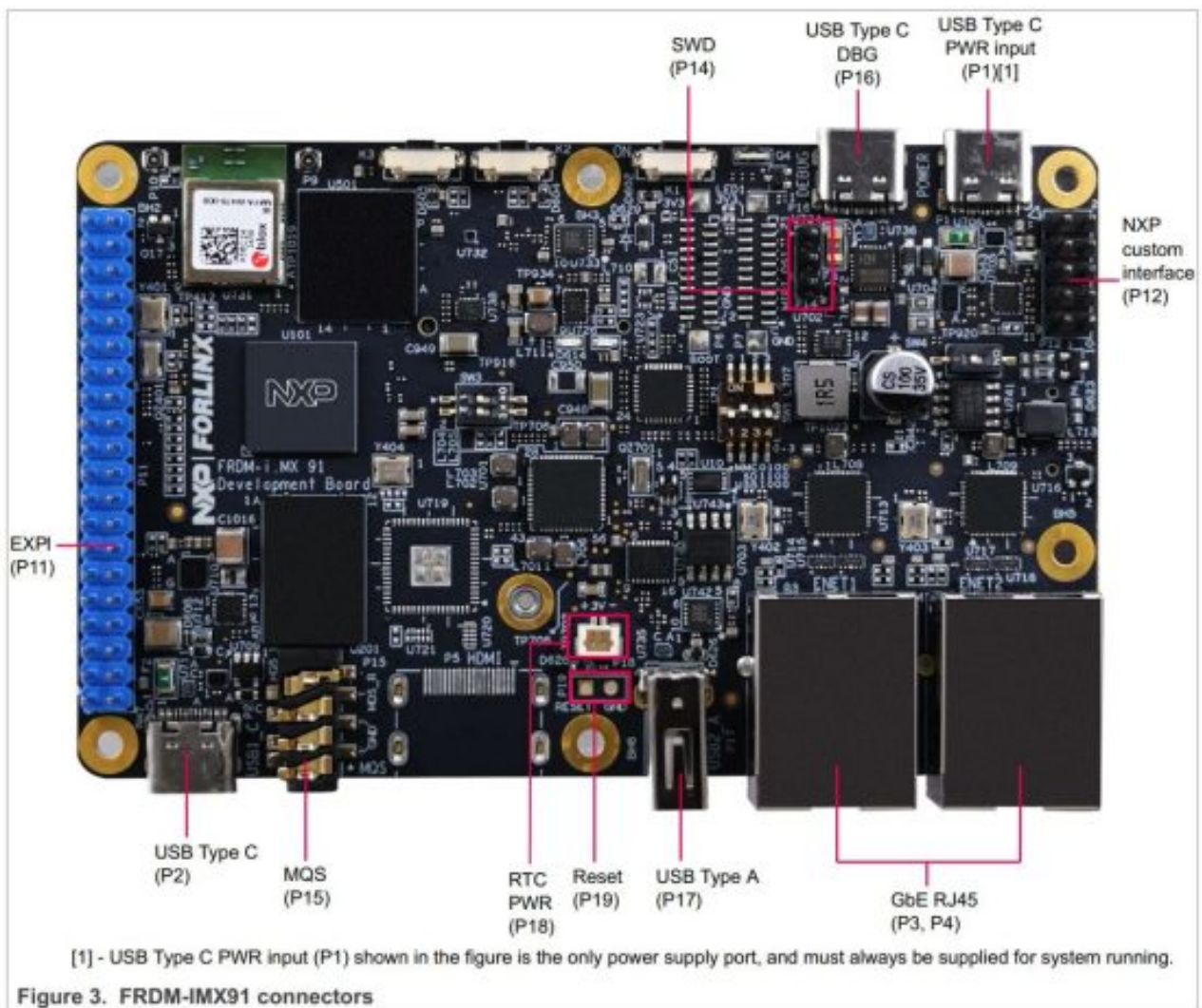
Figure 4 shows the onboard switches, buttons, and LEDs available on the FRDM-IMX91 board.
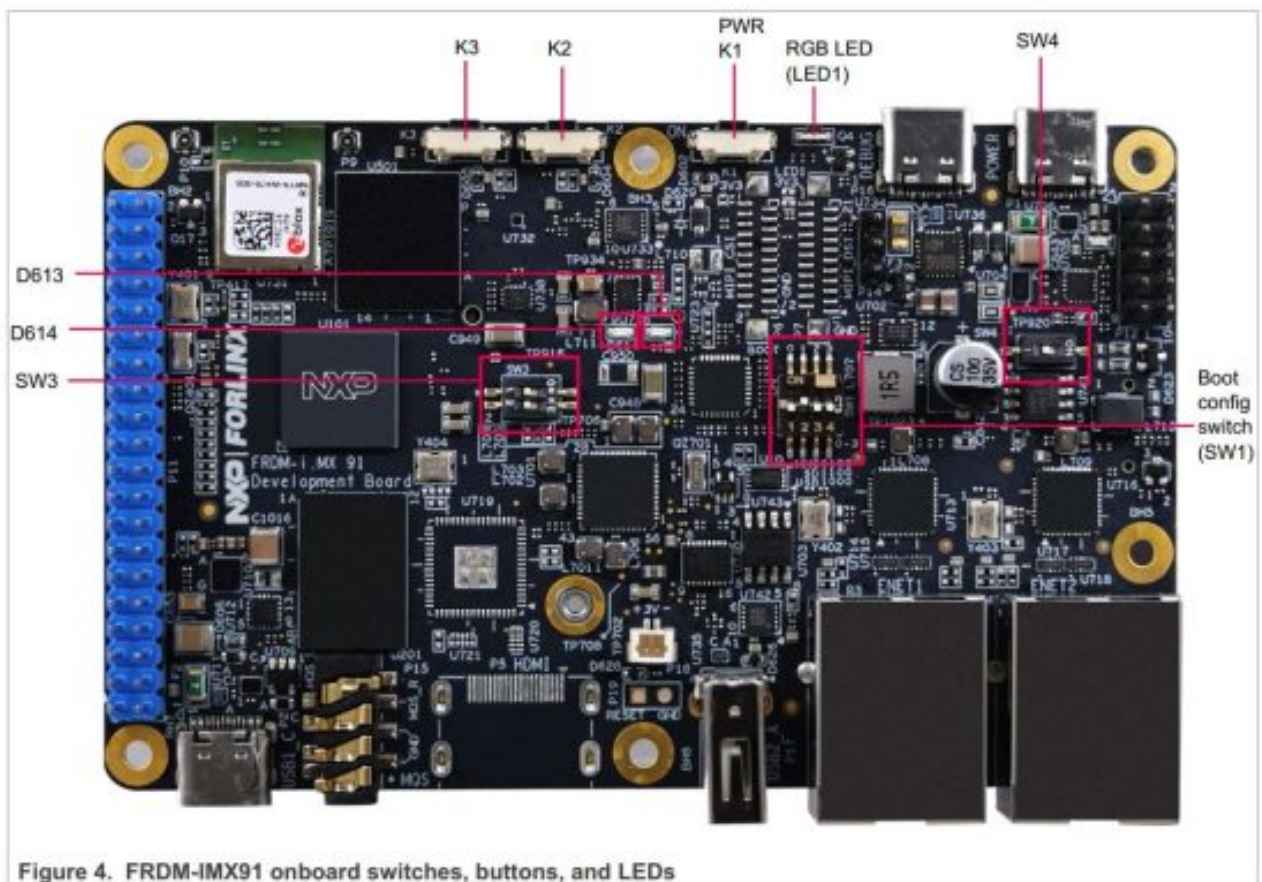
Figure 4. FRDM-IMX91 onboard switches, buttons, and LEDs

Figure 5 shows the bottom-side view, and also highlights the connectors available at the bottom side of the FRDM-IMX91 board.
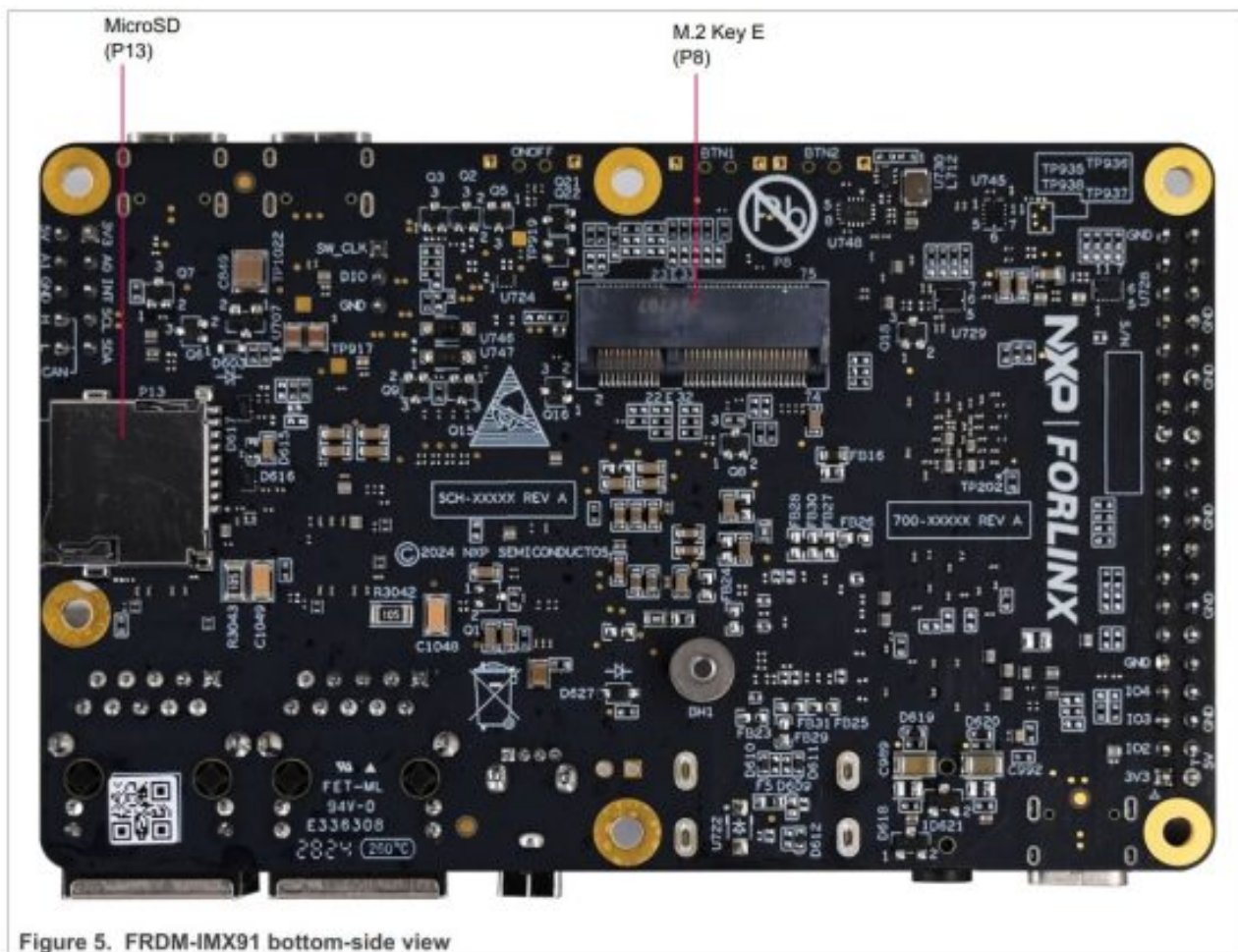
Figure 5. FRDM-IMX91 bottom-side view

1.5 Connectors

See Figure 3 and Figure 5 for connectors position on the board. Table 3 describes the FRDM-IMX91 board connectors.

Table 3. FRDM-IMX91 connectors

Part identifier	Connector type	Description	Reference section
P1, P2, P16	USB 2.0 Type C	USB connector	Section 2.16.2
P3, P4	RJ45 jack	Ethernet connectors	Section 2.14
P9 (DNP)	U.FL connector	RF antenna connector	Section 2.11
P10 (DNP)	U.FL connector	RF antenna connector	Section 2.11
P8	75-pin connector	M.2 socket KEY-E	Section 2.10
P11	2x20-pin connector	EXPI	Section 2.15
P12	2x5-pin connector	I/O connector	Section 2.4
P13	MicroSD push- push connector	MicroSD 3.0	Section 2.8
P14	1x3-pin 2.54 mm connector	SWD connector	Section 2.16.1

Part identifier	Connector type	Description	Reference section
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

1.6 Push buttons

Figure 4 shows the push buttons available on the board.

Table 4 describes the push buttons available on FRDM-IMX91.

Table 4. FRDM-IMX91 push buttons

Part identifier	Switch name	Description

K1	Power button	The i.MX 91 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 91 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	User button	The User button is kept for customized use cases.
K3	Reset / User button	By default, K3 is connected with SYS_nRST and used as a reset function. To use K3 as a customized function, remove the R3061 resistor and install the R2612 resistor.

1.7 DIP switch

The following DIP switches are used on the FRDM-IMX91 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. SW4 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-IMX91 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-IMX91 LEDs.

Table 7. FRDM-IMX91 LEDs

Part identifier	LED color	LED name	Description (When LED is 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	ORANGE	LED_ORANGE	D614 ON – Bluetooth status indicator. When ON, indicates that the Bluetooth connection is established.

2 FRDM-IMX91 functional description

This chapter describes the features and functions of the FRDM-IMX91 board.

Note: For details of the i.MX 91 MPU features, see i.MX 91 Applications Processor Reference Manual.

The chapter is divided into the following sections:

• Section "Procesor"

• Section "Power supply"

• Section "Clocks"

• Section "I2C interface"

• Section "Boot mode and boot device configuration"

• Section "PDM interface"

• Section "LPDDR4 DRAM memory"

• Section "SD card interface"

• Section "eMMC memory"

• Section "M.2 interface"

• Section "CAN interface"

• Section "USB interface"

• Section "Ethernet"

• Section "EXPI connector"

• Section "Debug interface"

• Section "Board errata"

2.1 Processor

The i.MX 91 applications processor includes single Arm Cortex-A55 processors with speeds up to 1.4 GHz.

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 91 is useful for applications such as:

• Smart home

• Building control

- Contactless HMI

- Commercial

- Healthcare

- Industrial

Each processor provides a 16-bit LPDDR4 memory interface and other interfaces for connecting peripherals, such as WLAN, Bluetooth, USB2.0, uSDHC, Ethernet, CAN, and multisensors.

For more detailed information about the processor, see the i.MX 91 data sheet and i.MX 91 Applications
Processor Reference Manual at https://www.nxp.com/imx91.

2.2 Power supply

The primary power supply to the FRDM-IMX91 board is VBUS_IN (12 V – 20 V) through USB Type-C PD connector (P1).
Three 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 devices on board.
- 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 onboard tri-radio module
MAYA-W476-00B (U731).

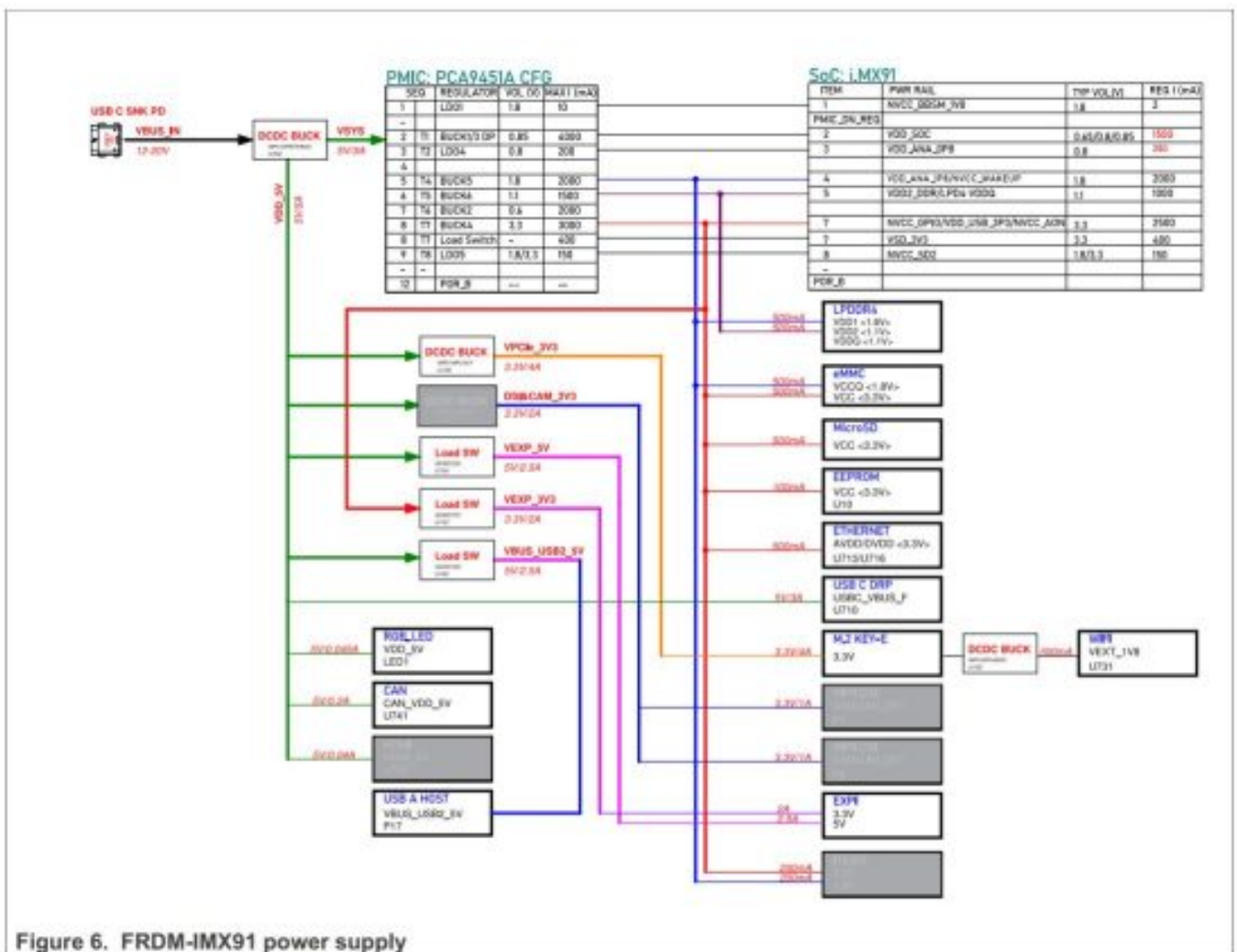**Figure 6 shows the FRDM-IMX91 power supply block diagram.**

Figure 6. FRDM-IMX91 power supply

Table 8 describes different power sources available on the board.

Table 8. FRDM-IMX91 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 • 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) • Supply for onboard tri-radio module u-blox MAYA-W476-00B (U731)

Table 8. FRDM-IMX91 power supply devices…continued

Part identifier designator	Manufacturing part number	Part manufacturer	Power supply	Specifications	Description
U730	MP1605C	Monolithic Power Systems Inc.	VEXT_1V8	1.8 V at 500 mA	Supplies power to onboard tri-radio u-blox MAYA-W476-00B 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)
			BUCK1/3: VDD_SOC_0V8[1][2]	• VOL (V): 0.85 • 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: • 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) • I2C IO expander PCAL6524 HEAZ (U725, I2C address: 0x22) Power source for: • ENET1_DVDD3 and ENET1_AVDD3 supplies
			BUCK5: • VDD_1V8	1.8 V at 2000 mA	Supplies to: • LPD4/x_VDD1 • eMMC 5.1 device • VDD_ANA_1P8, analog core supply voltage • NVCC_WAKEUP, digital I/O supply
			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: VSD_3V3	3.3 V	MicroSD card

Part identifier designator	Manufacturing part number	Part manufacturer	Power supply	Specifications	Description
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: • VPCIe_3V3 • VRPi_5V • VBUS_USB2_5V
U732	SGM2525 (Load switch)	SG MICRO CORP	VRPi_3V3	3.3 V at 2.5 A	• 2x20-pin EXPI connector (P11)
U733	SGM2525 (Load switch)	SG MICRO CORP	VRPi_5V	5 V at 2.5 A	• 2x20-pin EXPI connector (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_5V	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 0.85 V.

For further details on the power sequence needed by the i.MX 91, see section "Power sequence" in the i.MX 91 Reference Manual.

2.3 Clocks

FRDM-IMX91 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-IMX91 clocks

Part identifier	Clock generator	Clock	Specifications	Destination
Y401	Crystal oscillator	XTALI_24M XTALO_24M	Frequency: 24 MHz	Target processor
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

2.4 I2C interface

The i.MX 91 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-IMX91 board.

One 10-pin 2×5 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 2×5 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
U748	PCAL6408AHK	0x20 (0b'0100000x)	MX-I2C1	1 MHz Fm+	3.3 V	I/O expander for IRQ / OUTPUT
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	FT24C256A	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	400 kHz Fm	3.3 V	External RTC

2.5 Boot mode and boot device configuration

The i.MX 91 processor offers multiple boot configurations, selectable by SW1 on the FRDM-IMX91 board.

In addition, the i.MX 91 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-A55	Serial downloader (USB)
0010	0010		uSDHC1 8-bit eMMC 5.1
0011	0011		uSDHC2 4-bit SD3.0

On the FRDM-IMX91 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 91 Applications Processor Reference Manual. Figure 8 shows the connection of SW1 and i.MX 91 boot mode signals.

Figure 8. Boot configuration schematic
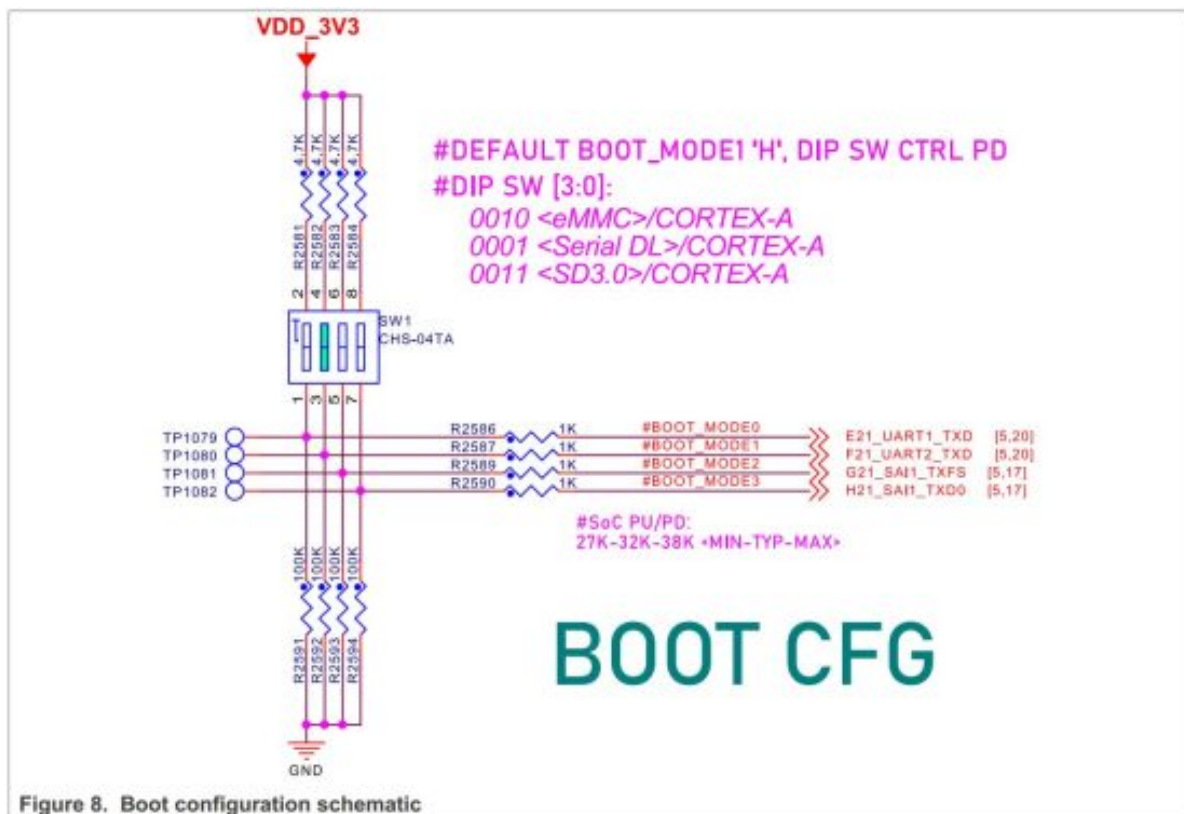
2.6 PDM interface

The pulse density modulated (PDM) microphone interface of the processor provides PDM/MQS support on the FRDM-IMX91, 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 LPDDR4 DRAM memory

The FRDM-IMX91 board features one 512 M × 16 (1 channel ×16 I/O × 1 rank) LPDDR4 SDRAM chip (NT6AN512M16AV-J1) for a total of 1 GB of RAM memory. The LPDDR4 DRAM memory is connected to the i.MX 91 DRAM controller.

The ZQ calibration resistors (R209 and R2941) used by the LPDDR4 chip are 240 Ω 1% to LPD4/x_VDDQ and the ZQ calibration resistor DRAM_ZQ used at i.MX 91 SoC side is 120 Ω 1% to GND.

In the physical layout, the LPDDR4 chip is placed at the top side of the board. The data traces are not necessarily connected to the LPDDR4 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.

2.8 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 91 processor connects to the MicroSD card slot (P13) on the FRDM-IMX91 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 91 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	FEMDRM008G-58A39	64 Gb x1	TFBGA-153	FORESEE	8 GB

2.10 M.2 interface

The FRDM-IMX91 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 tri-radio MAYA-W476-00B 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, IEEE 802.15.4 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

Pin number	M.2 mini card connector pin	Connection details
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
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

Pin number	M.2 mini card connector pin	Connection details
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

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

Pin number	M.2 mini card connector pin	Connection details
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 91 interfaces, see _i.MX 91 Applications Processor Reference Manual._

2.11 Tri-radio module interface

The FRDM-IMX91 board features a Tri-radio (Wi-Fi 6, Bluetooth Low Energy 5.4, and 802.15.4) module based on the NXP IW612 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-W476-00B (u-blox)	Host-based Wi-Fi 6, Bluetooth Low Energy 5.4, and 802.15.4 modules for 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-W476-00B module and M.2 connector share several interface lines on the FRDM-IMX91 board.

Zero-ohm resistors enable signal selection between these components.

SD3 interface

The SD3 interface lines are shared between the MAYA-W476-00B module and the M.2 connector. Zero-ohm resistors select either the MAYA-W476-00B module (default setting) or the M.2 connector.

UART5 interface

Similarly, the UART5 interface lines are shared between the MAYA-W476-00B module and the M.2 connector.

Zero-ohm resistors select either the MAYA-W476-00B module (default setting) or the M.2 connector.

SAI1 interface

The SAI1 interface lines are shared between the MAYA-W476-00B module and the M.2 connector. Zero-ohm resistors select either the MAYA-W476-00B module (default setting) or the M.2 connector for 1.8 V translated signals, generated using the 74AVC4T3144 bidirectional voltage translator (U728).
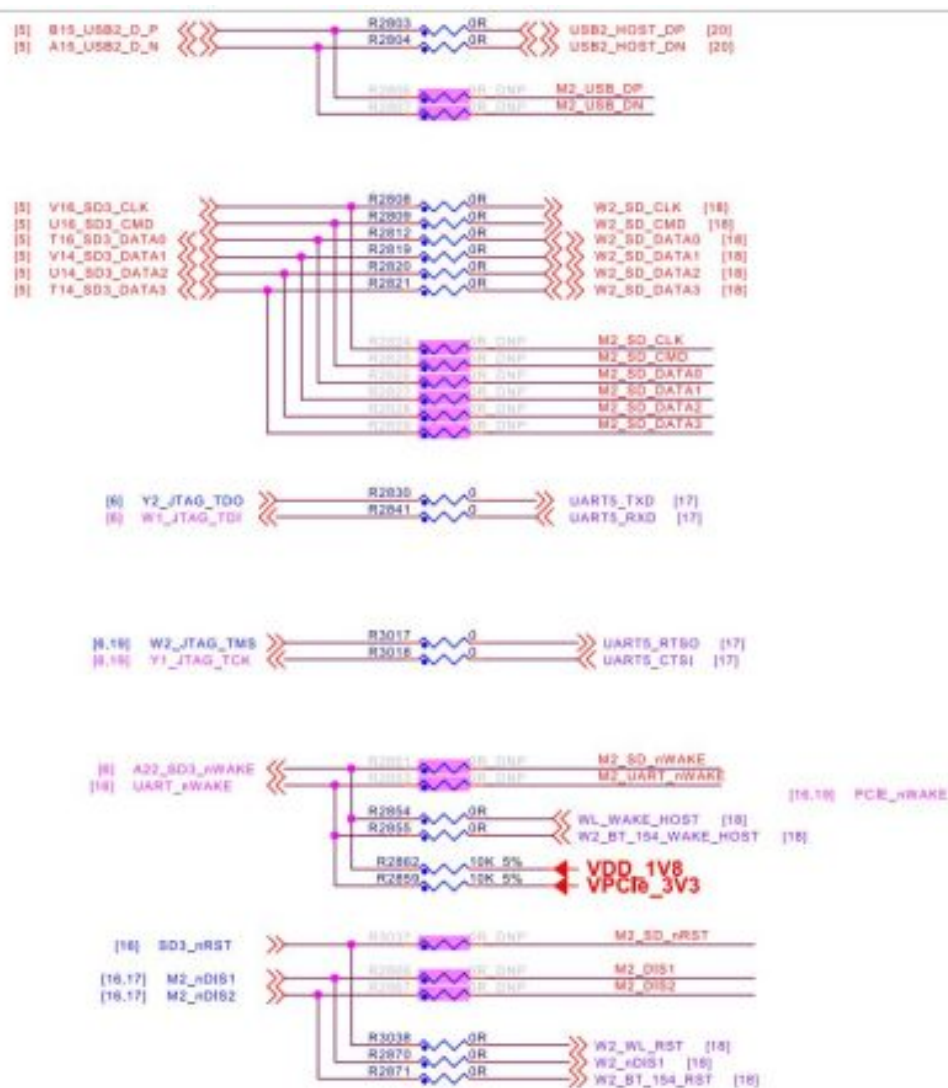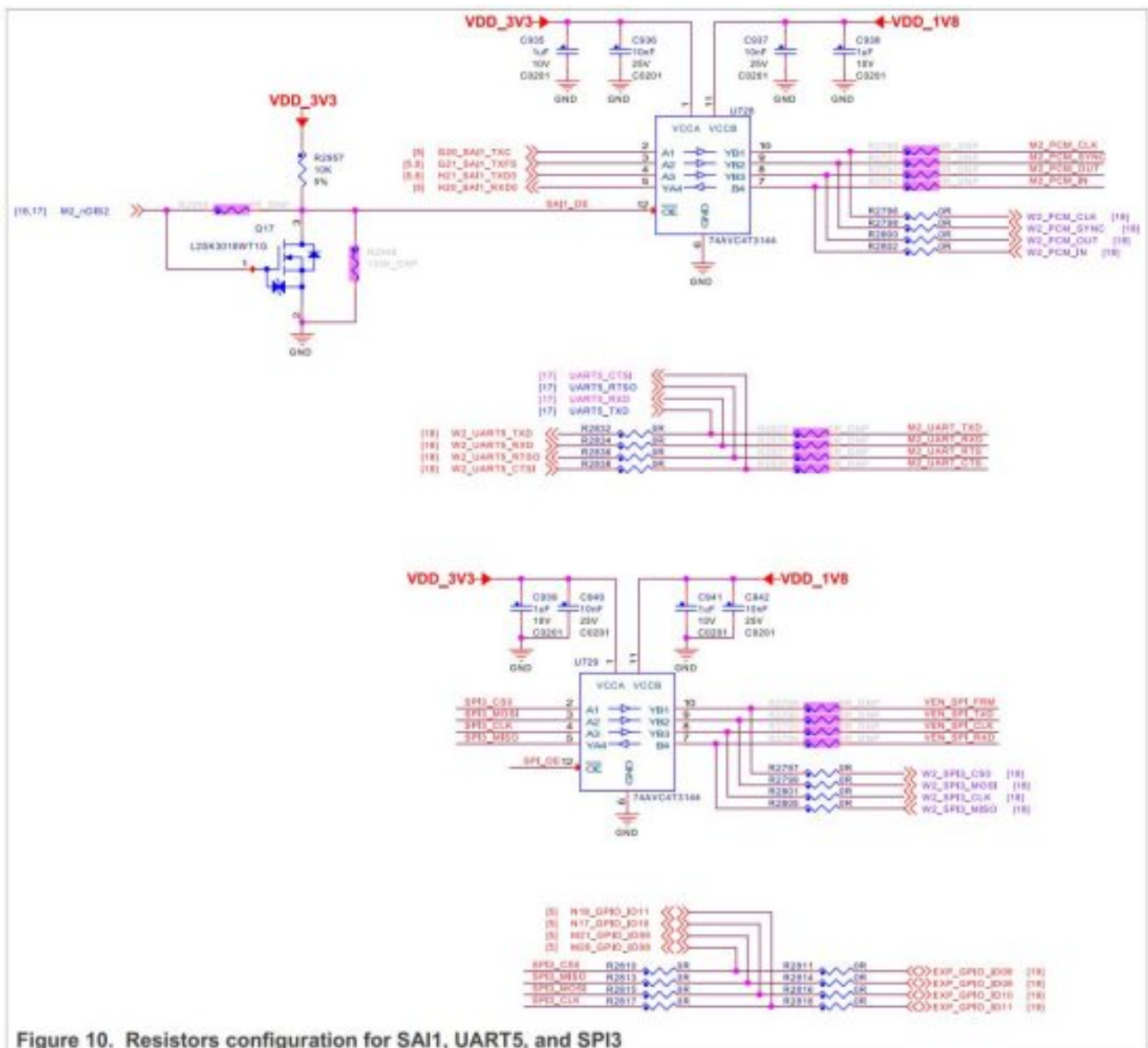
SPI3 interface

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-W476-00B module and the M.2 connector.

Zero-ohm resistors select either the MAYA-W476-00B module (default setting) or the M.2 connector for 1.8 V translated signals, generated using the 74AVC4T3144 bidirectional voltage translator (U729).

Figure 9. Resistors configuration for SD3

Figure 10. Resistors configuration for SAI1, UART5, and SPI3

2.12 CAN interface

The i.MX 91 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-IMX91 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 2×5 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 91 applications processor features two USB 2.0 controllers, with two integrated USB PHYs. On the FRDM-IMX91 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 Ethernet

The i.MX 91 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 91. 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 91. The Ethernet connectors are labeled clearly on the board.

2.15 EXPI connector

One 2×20-pin EXPI connector (P11) is provided on the FRDM-IMX91 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 TM050RDH03-41, 8MIC-RPI-MX8 card, and MX93AUD-HAT.

The connector is shown in Figure 3.

Table 20. 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
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

2.16 Debug interface

The FRDM-IMX91 board features two independent debug interfaces.

• Serial wire debug (SWD) header (Section 2.16.1)

• USB-to-dual UART debug port (Section 2.16.2)

2.16.1 SWD interface

The i.MX 91 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.

2.16.2 USB debug interface

The i.MX 91 applications processor has six independent UART ports (UART1 – UART6). On the FRDM-IMX91 board, UART1 is used for Cortex-A55 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: Reserved

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 21 describes the required settings.

Table 21. 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.

2.17 Board errata
No board errata.

3 Working with accessories

This section describes how a connection can be established between with the FRDM-IMX91 board and compatible accessory boards.

3.1 5-inch Tianma LCD
TM050RDH03-41 is a 5" TFT LCD display with 800×480 resolution. This industrial-grade

display uses an RGB interface without a touch panel. This display module connects to the FRDM-IMX91 through the EXPI 2×20-pin connector (P11).

3.1.1 Connection between Tianma panel and adapter board

Figure 11 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).
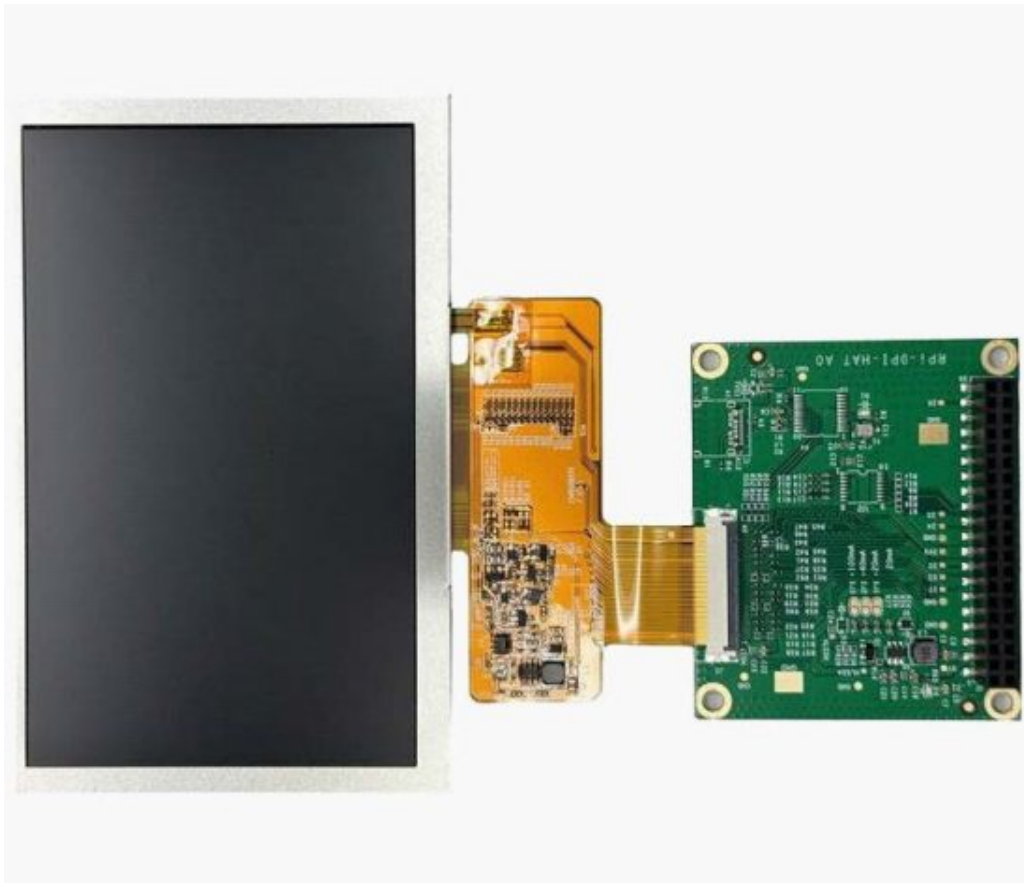
Figure 11. FPC connection between 5-inch Tianma LCD panel and adapter board

3.1.2 Connection between adapter board and FRDM-IMX91

Plug 5'' Tianma LCD to FRDM-IMX91 through the EXPI 2×20-pin connector (P11) as shown in Figure 12

Figure 12. 5-inch Tianma LCD connection with FRDM-IMX91 through 2x20-pin EXPI connector

3.1.3 Software configuration update

The following steps specify how to replace the default dtb with the custom dtb (imx91-11×11-frdm-tianma-wvgapanel. dtb) that supports Tianma LCD.

1. Stop at U-Boot

2. Use the below commands to replace the default dtb:

```
$setenv fdtfile imx91-11x11-frdm-tianma-wvga-panel.dtb
$saveenv
$boot
```

3.2 Other accessory boards

There are other accessory boards also that can work with FRDM-IMX91 through EXPI 2×20-pin interface, such as 8MIC-RPI-MX8 and MX93AUD-HAT. To use any such board, check the schematic and layout to determine the direction of the connection between FRDM-IMX91 and the accessory board in advance. Also, choose the right dtb file in the U-Boot stage.

Figure 13. Accessory boards

3.2.1 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 imx91-11x11-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 imx91-11x11-frdm-8mic.dtb
$saveenv
$boot
```

4 PCB information

The FRDM-IMX91 is made with standard 10-layer technology. The material is FR-4, and the PCB stack-up information is described in Table 22.

Table 22. FRDM-IMX91 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	-	-	-

Layer	Description	Copper (mil)	Generic	Er	Dielectric thickness (mil)
-	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				

Layer	Description	Copper (mil)	Generic	Er	Dielectric thickness (mil)
-	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 European Union regulatory compliance

Table 23 is provided as per Article 10.8 of the Radio Equipment Directive 2014/53/EU.

(a) Frequency bands in which the equipment operates.

(b) The maximum RF power transmitted.

Table 23. EU regulatory compliance

Part number	RF technology	(a) Frequency range	(b) Maximum transmitted power
FRDM-IMX91	Bluetooth Low Energy 5.4	2402 MHz - 2480 MHz	13 dBm
	IEEE 802.15.4	2405 MHz - 2480 MHz	13 dBm
	Wi-Fi IEEE 802.11b/g/n/ax	2400 MHz - 2500 MHz	16 dBm
	Wi-Fi IEEE 802.11a/n/ac/ax	4900 MHz - 5895 MHz	18 dBm

EUROPEAN DECLARATION OF CONFORMITY (Simplified DoC per Article 10.9 of the Radio Equipment Directive 2014/53/EU)

This apparatus, namely FRDM-IMX91 Freedom Development Platform, conforms to the Radio Equipment Directive 2014/53/EU. The full EU Declaration of Conformity for this apparatus can be found at the NXP website: FRDM-IMX91.

6 Acronyms

Table 24 lists and explains the acronyms and abbreviations used in this document.

Table 24. Acronyms

Term	Description
BGA	Ball grid array

Term	Description
CAN	Controller area network
DNP	Do not populate
DRAM	Dynamic random access memory
DSI	Display serial interface
eMMC	Embedded multimedia card
ENET	Ethernet transceiver
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
MISO	Master input slave output
MOSI	Master output slave input

MQS	Medium quality sound
NGFF	Next-generation form factor
PCB	Printed circuit board
PDM	Pulse-density modulation
PMIC	Power management-integrated circuit
PWM	Pulse width modulation
RGMII	Reduced gigabit media independent interface
SAI	Serial audio interface
SDIO	Secure digital I/O
SPI	Serial peripheral interface
SWD	Serial wire debug
TSN	Time-sensitive networking
UART	Universal asynchronous receiver/transmitter
USB	Universal serial bus
uSDHC	Ultra secured digital host controller

7 Related documentation

Table 25 lists and explains the additional documents and resources that you can refer to for more information on the FRDM-IMX91 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 25. Related documentation

Document	Description	Link / how to access
i.MX 91 Applications Processor Reference Manual	Intended for system software and hardware developers and application programmers who want to develop products with i.MX 91 MPU	IMX91RM
i.MX 91 Industrial Application Processors Data Sheet	Provides information about electrical characteristics, hardware design considerations, and ordering information	IMX91IEC
i.MX 91 Hardware Design Guide	This document aims to help hardware engineers design and to test their i.MX 91 processor-based designs. It provides information about board layout recommendations and design checklists to ensure first-pass success and avoidance of board bring-up problems.	UG10147

8 Note about the source code in the document

9 Revision history

Table 26 summarizes the revisions to this document.

Document ID	Release date	Description
UM12262 v.3.0	22 April 2025	Updated link in Section 5
UM12262 v.2.0	5 March 2025	Updated Section 5
UM12262 v.1.0	25 February 2025	Initial public release

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References

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