UM12527

FRDM-IMX95-PRO Board User Manual

Rev. 1.0 — 22 June 2026 User manual

Document information

Information	Content
Keywords	i.MX 95, UM12527, FRDM-IMX95-PRO
Abstract	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 FRDM-IMX95-PRO overview

The FRDM-IMX95-PRO development board is a low-cost platform. It is designed to showcase the key features of the i.MX 95 applications processor. It enables developers to familiarize themselves with the device and evaluate its performance before committing to production designs. The processor is packaged in a 19 mm × 19 mm form factor and supports a wide range of industrial and embedded applications.

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-IMX95-PRO block diagram.

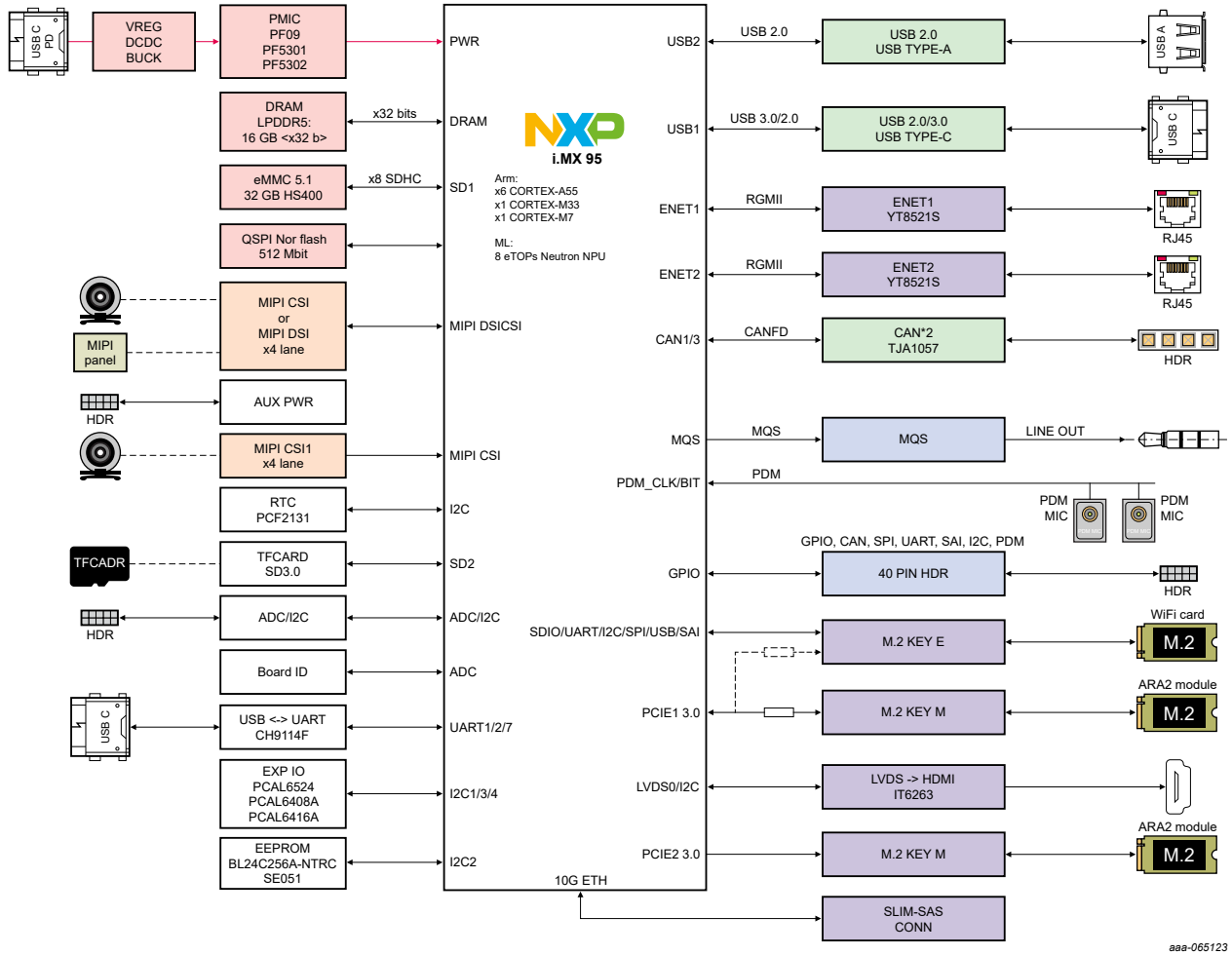


Figure 1. FRDM-IMX95-PRO block diagram

1.2 Board features

Table 1 lists the features of FRDM-IMX95-PRO.

Table 1. FRDM-IMX95-PRO features

Board feature	Target processor feature used	Description
Applications processor (MIMX9596 AVZXNAC)	i.MX 95 19 mm x 19 mm	• i.MX 95 applications processor features up to six Arm Cortex-A55 cores, one Arm Cortex-M33 core, and one Arm Cortex-M7 core • Integrated Neural Processing Unit (NPU) providing up to 8 eTOPS of AI acceleration ***Note:*** *For more details on the i.MX 95 processor, see the i.MX 95 Applications Processor Data Sheet.*
DRAM	DRAM controller and PHY	16 GB LPDDR5 (Micron MT62F4G32D8DV-023FAIT) memory for high-bandwidth data processing
Mass storage	uSDHC	• 32 GB eMMC 5.1 (Micron MTFC32GBCAQTC-IT) • microSD card connector (SD3.0 supported)
USB interface	Two USB controllers and PHYs: USB1 and USB2	• 1 × USB Type-C port connected to USB1 controller (supports USB 3.0 standard) • 1 × USB Type-A port connected to USB2 controller (supports USB 2.0 standard)
QSPI flash	XSPI controller	512 Mbit Quad SPI Nor Flash
MIPI CSI interface	MIPI-CSI controller (#0)	Connects to a 22-pin FPC connector using a x4 lane configuration
MIPI DSICSI interface	MIPI-CSI controller (#1) and DSI controller	• Connects to a 22-pin FPC connector using a x4 lane configuration • Shared between the DSI controller and the CSI-2 controller (#1); therefore, the CSI and DSI cannot be used simultaneously on this port
HDMI interface	LVDS TX display controller	Connects to an HDMI connector through a x4 lane LVDS to HDMI converter chip (IT6263)
Ethernet interface	Two ENET controllers	• Two tri-speed (10 Mbit/s/100 Mbit/s/1000 Mbit/s) RGMII interfaces are supported through two YT8521S Ethernet PHYs • Two RJ45 connectors with link and activity status indicators
	One 10G ETH controller	• A SlimSAS connector is reserved for a 10G ETH expansion card
CAN interface	CAN controller	Two high-speed CAN transceiver connections using TJA1057
NXP custom interface	I2C, ADC	One 4-pin (1 × 4), 2.54 mm connector provides: • One I2C interface • Two ADC inputs
M.2 interface	PCIe	Two M.2 Key-M 75-pin connectors supporting x1 lane PCIe interface
	PCIe, USB, SDIO, SAI, UART, I2C, SPI, and GPIO	One M.2 Key-E 75-pin connector supporting PCIe, USB, SDIO, SAI, UART, I2C, and SPI interfaces, with SDIO enabled by default and PCIe disabled by default
Audio	MQS	One 3.5 mm, 4-pole audio jack for connecting to a stereo speaker or headphones
	Pulse-Density Modulation (PDM)	Two digital microphones (DMIC) are supported, each providing a single-bit PDM output
Boot configuration		• The default boot mode is boot from an eMMC device • Supports boot from an SD card and FlexSPI Serial NOR flash
Debug interface		• USB-to-UART device, CH9114F • One USB 2.0 Type-C connector on the CH9114F provides four COM ports: – One port dedicated to Arm Cortex-A55 system debug

Table 1. FRDM-IMX95-PRO features*...continued*

Board feature	Target processor feature used	Description
		– One port dedicated to Arm Cortex-M33 system debug – One port dedicated to Arm Cortex-M7 system debug
Expansion Interface (EXPI)		One 2 × 20-pin expansion interface supporting SAI, UART, I2C, SPI, PDM, and GPIO expansion
Power		• One USB Type-C connector for power delivery only • Power Management Integrated Circuit (PMIC): PPF0900AMBA1ES • Voltage regulators: PF5301 and PF5302 • Discrete DC-DC converters and Low Drop Out (LDO) regulators
PCB		100 mm × 90 mm × 1.6 mm, 10-layer HDI
Orderable part number		FRDM-IMX95-PRO

1.3 Board kit contents

Table 2 lists the items included in the FRDM-IMX95-PRO board kit.

Table 2. Board kit contents

Item description	Quantity
FRDM-IMX95-PRO board	1
USB Type-C male to Type-C male assembly cable, white	1
USB Type-C male to Type-C male assembly cable with e-marker and 20 V power delivery (PD), black	1
Fastener, M2.5 x 20 mm + 6 mm nylon standoff	4
M.2 module, PN: LBES5PL2EL; Wi-Fi 6 / BT 5.3 / IEEE802.15.4	1
Quick Start Guide	1

1.4 Board pictures

Figure 2 shows the top-side view of the FRDM-IMX95-PRO board.

Figure 2. FRDM-IMX95-PRO board top side

Figure 3 shows the connectors, onboard switches, buttons, and LEDs available on the top side of the FRDM-IMX95-PRO board.

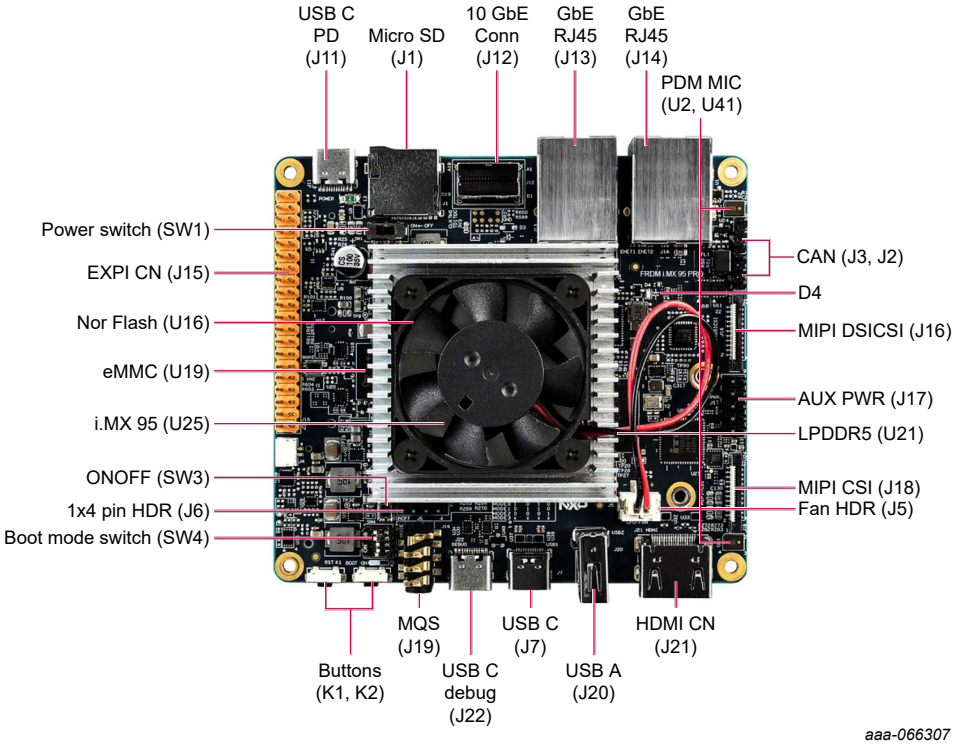


Figure 3. FRDM-IMX95-PRO board

Figure 4 shows the bottom-side view, and also highlights the connectors and LEDs available at the bottom side of the FRDM-IMX95-PRO board.

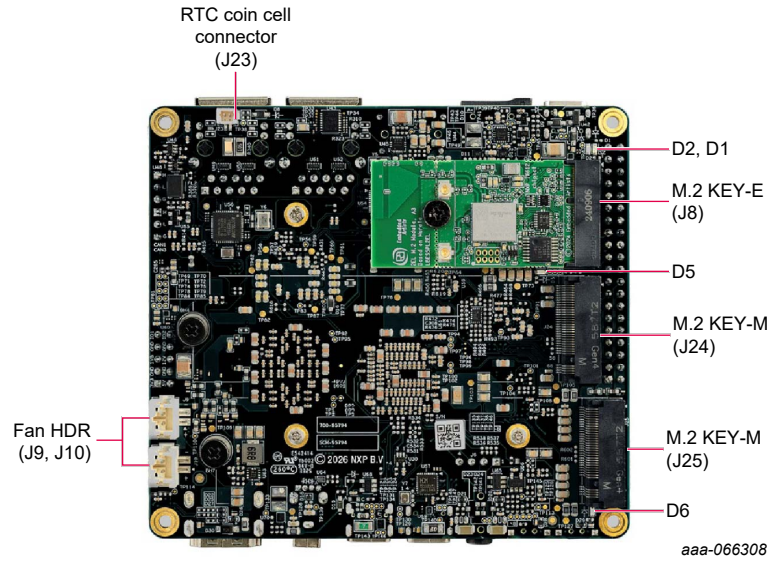


Figure 4. FRDM-IMX95-PRO board bottom side

1.5 Connectors

See Figure 3 and Figure 4 for connectors position on the board. Table 3 describes the FRDM-IMX95-PRO board connectors.

Table 3. FRDM-IMX95-PRO connectors

Part identifier	Connector type	Description	Reference section
J1	MicroSD push- push connector	MicroSD card connector	Section "SD card interface"
J2, J3	3-pin connector	CAN connectors	Section "CAN interface"
J4	2-pin header	It is used for secure element control or configuration signals related to the SE051 secure element device.	For details, refer to the board schematic
J5	2-pin connector	FAN connector	For details, refer to the board schematic
J6	1×4-pin header	I2C/ADC connector	Section "Expansion connectors"
J7	USB Type-C	USB 3.0 connector	Section "USB interface"
J8	75-pin connector	M.2 socket Key-E	Section "M.2 Key-E interface"
J9	2-pin connector	FAN connector	For details, refer to the board schematic
J10	2-pin connector	FAN connector	For details, refer to the board schematic
J11	USB Type-C	Power supply	Section "Power supply"
J12	10G ETH	SlimSAS connector	Section "Ethernet interface"
J13, J14	RJ45 jack	Ethernet connectors	Section "Ethernet interface"
J15	2×20-pin header (2.54 mm)	EXPI connector	Section "Expansion connectors"
J16	22-pin FPC connector	MIPI DSICSI FPC connector	Section "MIPI DSICSI interface"
J17	2×5-pin header	AUX power connector	Section "Expansion connectors"
J18	22-pin FPC connector	MIPI CSI FPC connector	Section "MIPI CSI interface"
J19	3.5 mm Audio Jack	MQS connector	Section "Audio interface"
J20	USB Type-A	USB 2.0 connector	Section "USB interface"
J21	HDMI Type-A	HDMI connector	Section "HDMI interface"
J22	USB Type-C	Debug connector	Section "USB debug interface"
J23	2-pin connector	To connect an external battery to maintain the Real-Time Clock (RTC) when the main board power is removed. This ensures retention of time and date information during power off conditions.	For details, refer to the board schematic
J24	75-pin connector	M.2 socket Key-M	Section "M.2 Key-M interface"
J25	75-pin connector	M.2 socket Key-M	Section "M.2 Key-M interface"

1.6 DIP switch

Figure 3 shows the DIP switch available on the board.

SW4 is a 4-position DIP switch used to select different boot modes. For boot mode settings, refer to Section 2.3.

1.7 Push buttons/slide switches

Figure 3 shows the push buttons/slide switches available on the board. Table 4 describes the FRDM-IMX95-PRO push buttons/slide switches.

Table 4. FRDM-IMX95-PRO push buttons

Part identifier	Switch name	Description
K1	Reset button	K1 is a momentary push button switch used to generate a manual reset signal for the PF09 PMIC. When activated, it generates a falling edge to PF09 FCCU1 pin and forces the PF09 PMIC to initiate a system cold reset. During a cold reset, the PMIC power cycles all system power rails and reinitializes the entire platform, except for the NVCC_BBSM_1P8 supply. The NVCC_BBSM_1P8 supply remains powered throughout the reset sequence.
SW3	ONOFF button	SW3 provides the ONOFF control input for the i.MX 95. It is used by the SoC to request power state transitions via the PMIC. • Short press: Sends an ON/OFF request to transition the system between OFF and ON states depending on the current state. • Long press (~5 seconds or more): When in the ON state, this action causes a forced OFF.
SW1	System power switch	The 6-pin slide switch controls the CC (NX20P0407) for the USB Type-C PD power supply ON/OFF function. • Pins 1-2 and pins 4-5 shorted (default): The USB Type-C power delivery adapter is OFF (default). • Pins 3-2 and pins 6-5 shorted: The USB Type-C power delivery adapter is ON.
K2	Boot override button	It is a momentary push button used to temporarily override the default boot configuration of the board. When K2 is pressed and held during power up or reset, the board boots from the microSD card instead of the default eMMC device. This action does not change the boot mode settings of the SW4 DIP switch. Releasing the button restores normal boot behavior on subsequent resets.

1.8 LEDs

The FRDM-IMX95-PRO board includes Light-Emitting Diodes (LEDs) for monitoring system functions, such as power statuses and fault conditions. These LEDs provide visual indicators that can assist in debugging.

Figure 3 and Figure 4 show the LEDs available on the board. Table 5 describes the FRDM-IMX95-PRO LEDs.

Table 5. FRDM-IMX95-PRO LEDs

Part identifier	LED color	LED name	Description (When LED is ON)
D4	Green	PWR LED	D4 indicates PF09 PMIC power on status. When PF09 works normally, the LED turns ON.
D5, D6	Green	M.2 Key-M LED	Indicates activity on the M.2 Key-M device.
D2	Yellow-Green	WLAN STAT	Indicates the operational status of the wireless LAN interface and Bluetooth interface provided by the M.2 Key-E module. • D2 ON – WLAN connection is established. • D1 ON – Bluetooth connection is established.
D1	Yellow-Green	BT STAT	

2 FRDM-IMX95-PRO functional description

This chapter describes the features and functions of the FRDM-IMX95-PRO board.

Note: *For details of the i.MX 95 features, see the i.MX 95 Applications Processor Data Sheet.*

This section is divided into the following subsections:

2.1 Processor

The i.MX 95 applications processor delivers safe, secure, and power-efficient edge computing. It targets automotive, industrial, networking, and advanced HMI applications.

The i.MX 95 applications processor integrates up to six Arm Cortex-A55 processors. It also includes two independent real-time domains based on Arm Cortex-M7 and Arm Cortex-M33 cores for safety/low-power and high-performance real-time use. It also combines a Neural Processing Unit (NPU) and an Image Signal Processor (ISP) with advanced processing and machine learning capabilities.

For further details about the processor, see the *i.MX 95 data sheet* and *i.MX 95 Applications Processor Reference Manual* at i.MX 95 Applications Processor Family webpage.

2.2 Power supply

The board is powered through a USB Type-C connector compliant with the USB Power Delivery (PD) standard. For full performance, a 65 W (or higher) USB-PD supply is recommended. Power delivery to the board is controlled by the system power slide switch (SW1). When SW1 is set to the ON position, the USB-C PD input is enabled and supplies power to the onboard power management circuitry.

The USB Type-C port (J11) is used for the power supply only. It does not support USB data transfer.

The 6-pin slide switch (SW1) controls the CC signals to enable or disable power delivery to the board.

- Pin 1-2 and Pin 4-5 shorted (default): Power from the USB Type-C PD port is OFF.

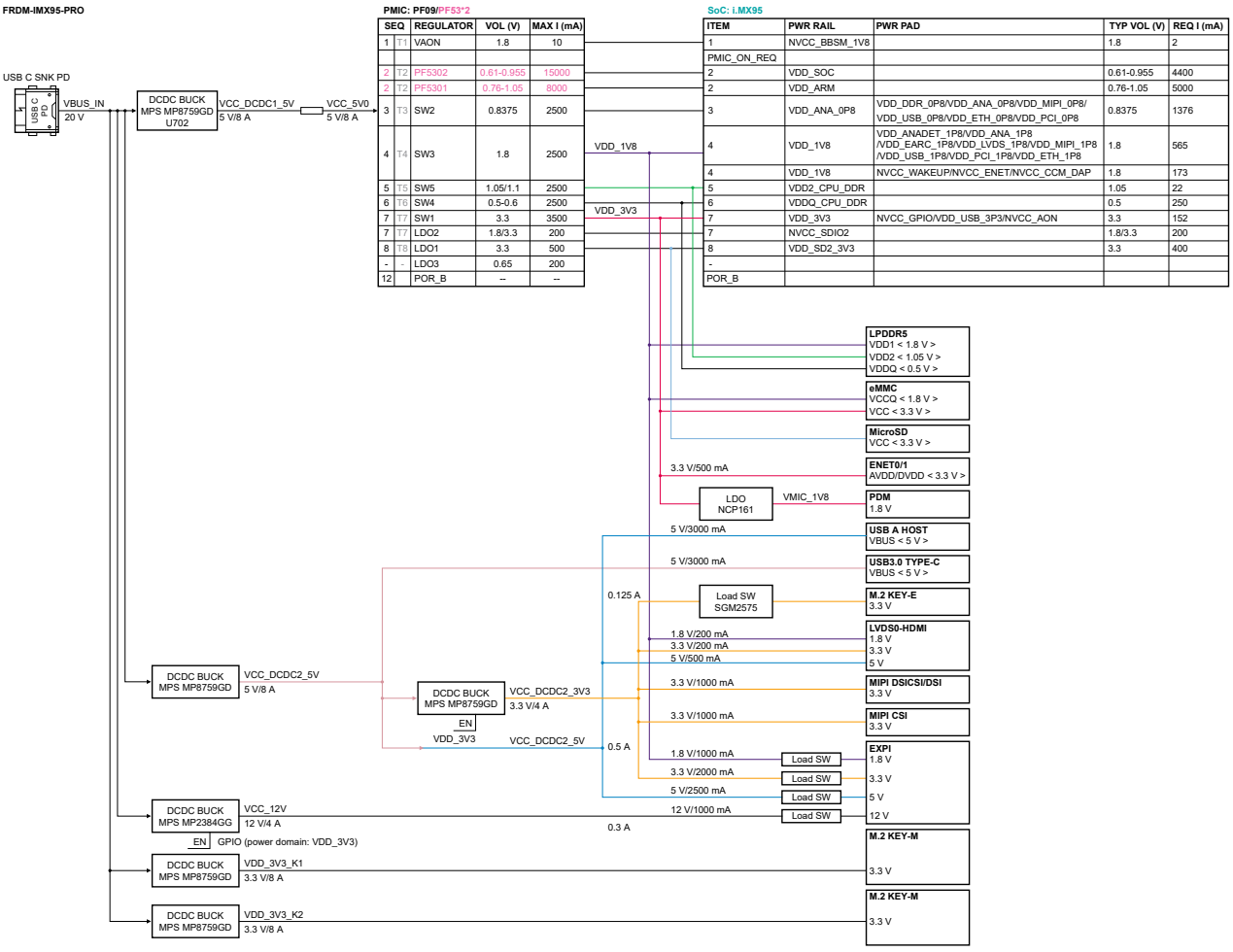
- Pin 3-2 and Pin 6-5 shorted: Power from the USB Type-C PD port is ON.

Note:

The board kit does not include a USB Power Delivery (PD) power supply. Use a USB Type-C to Type-C cable to connect the power adapter to the USB Type-C power connector (J11), unless the adapter provides an integrated Type-C cable. Do not use a Type-A to Type-C cable, because power delivery cannot be controlled by the SW1 system power switch.

The primary power management device is the PF09 PMIC, which generates and sequences the core and peripheral supply rails required by the i.MX 95 processor.

Section 2.2 shows the FRDM-IMX95-PRO power supply block diagram.



SEQ		REGULATOR	VOL (V)	MAX I (mA)
1	T1	VAON	1.8	10
2	T2	PF5302	0.61-0.955	15000
2	T2	PF5301	0.76-1.05	8000
3	T3	SW2	0.8375	2500
4	T4	SW3	1.8	2500
5	T5	SW5	1.05/1.1	2500
6	T6	SW4	0.5-0.6	2500
7	T7	SW1	3.3	3500
7	T7	LDO2	1.8/3.3	200
8	T8	LDO1	3.3	500
-	-	LDO3	0.65	200
12		POR_B	--	--

ITEM	PWR RAIL	PWR PAD	TYP VOL (V)	REQ I (mA)
1	NVCC_BBSM_1V8		1.8	2
PMIC_ON_REQ				
2	VDD_SOC		0.61-0.955	4400
2	VDD_ARM		0.76-1.05	5000
3	VDD_ANA_0P8	VDD_DDR_0P8/VDD_ANA_0P8/VDD_MIPI_0P8/ VDD_USB_0P8/VDD_ETH_0P8/VDD_PCI_0P8	0.8375	1376
4	VDD_1V8	VDD_ANADET_1P8/VDD_ANA_1P8 /VDD_EARC_1P8/VDD_LVDS_1P8/VDD_MIPI_1P8 /VDD_USB_1P8/VDD_PCI_1P8/VDD_ETH_1P8	1.8	565
4	VDD_1V8	NVCC_WAKEUP/NVCC_ENET/NVCC_CCM_DAP	1.8	173
5	VDD2_CPU_DDR		1.05	22
6	VDDQ_CPU_DDR		0.5	250
7	VDD_3V3	NVCC_GPIO/VDD_USB_3P3/NVCC_AON	3.3	152
7	NVCC_SDIO2		1.8/3.3	200
8	VDD_SD2_3V3		3.3	400
-				
POR_B				

Figure 5. FRDM-IMX95-PRO power supply block diagram

Table 6. Core power supplies

Power Rail	Voltage	Source	Description
VAON	1.8 V	PF09	Always-on supply for low-power and RTC domains
VDD_SOC	0.61 V–0.95 V	PF5302	Supplies the i.MX 95 SoC core logic
VDD_ARM	0.76 V–1.05 V	PF5301	Supplies Arm Cortex-A55 CPU cores
VDD_1V8	1.8 V	PF09 LDO	Supplies IO and peripheral domains

Table 6. Core power supplies...*continued*

Power Rail	Voltage	Source	Description
VDD_3V3	3.3 V	DC-DC	Supplies connectors, Ethernet PHYs, USB, and expansion interfaces
VDD_12V	12 V	DC-DC	Supplies fan connector and expansion power

2.2.1 Power sequencing

Power-up and power-down sequencing of all processor rails is handled internally by the PF09 PMIC in accordance with i.MX 95 requirements. No user configuration is required. All rails are enabled automatically when the system power switch (SW1) is turned ON and a valid USB-C PD supply is present.

2.3 Boot mode and boot device configuration

Boot sources include eMMC (default), MicroSD, and FlexSPI NOR flash. Boot mode selection is performed using the SW4 DIP switch. The i.MX 95 also supports USB serial download mode for recovery and image provisioning.

The processor provides four dedicated boot mode pins, which connect to the SW4 switch to enable selection of different boot modes.

- If the DIP switch pin is OFF, the pin value is 0.
- If the DIP switch pin is ON, the pin value is 1.

Figure 6 shows the boot mode selection switch.

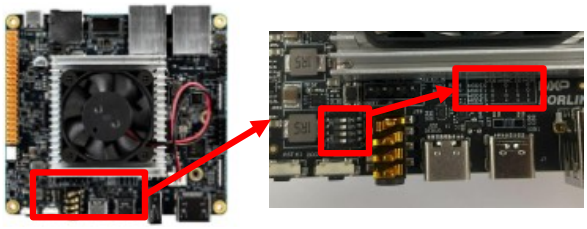


Figure 6. Boot mode selection switch

Table 7 describes the SW4 values used in different boot modes.

Table 7. Boot mode settings[1]

SW4 [1]	SW4 [2]	SW4 [3]	SW4 [4]	Boot core	Boot device
BOOT_MODE3	BOOT_MODE2	BOOT_MODE1	BOOT_MODE0		
x	0	0	1	Cortex-M33	Serial downloader (USB)
x	0	1	0		uSDHC1 8-bit eMMC 5.1
x	0	1	1		uSDHC2 4-bit SD3.0
x	1	0	0		FlexSPI Serial NOR flash

[1] 1 = ON, 0 = OFF, x = ON or OFF.

On the FRDM-IMX95-PRO board, the default boot device is the eMMC (uSDHC1). Alternative devices are the microSD (uSDHC2) and NOR flash.

Note: *By default, the configuration supports USB serial download on USB1 only. To enable USB serial download on USB2, a specific part number is required. For details about the boot modes and boot device configuration, see the* ***System Boot*** *chapter in the i.MX 95 Applications Processor Reference Manual.*

2.4 Clocks

FRDM-IMX95-PRO provides all the clocks required for the processor and peripheral interfaces. Table 8 summarizes the specifications of each clock and the component that provides it.

Table 8. FRDM-IMX95-PRO clocks

Part identifier	Type	Clock	Frequency	Destination
Y1	Differential oscillator	ETH_CLKIN	156.25 MHz	10G ETH reference clock for target processor
Y2	Crystal oscillator	XTALIN XTALOUT	27 MHz	LVDS to HDMI converter IT6263 (U23)
Y3	Crystal oscillator	RTC_XTALI RTC_XTALO	32.768 kHz	NVCC_BBSM block of target processor
Y4	Crystal oscillator	XTALI_24M XTALO_24M	24 MHz	Target processor
Y5	Crystal oscillator	XTAL_I XTAL_O	25 MHz	Ethernet RGMII PHY1 YT8521SH_CA (U54)
Y6	Crystal oscillator	XTAL_I XTAL_O	25 MHz	Ethernet RGMII PHY1 YT8521SH_CA (U56)
Y7	Crystal oscillator	XI XO	24 MHz	USB to quad UART IC CH9114 (U67)
U18, U20	Clock generator	PCI Express reference clock	100 MHz	PCI Express Root Complex (RC) and EndPoint (EP) reference clock

2.5 I2C interface

The i.MX 95 processor supports a low-power Inter-Integrated Circuit (I2C) module that supports an efficient interface to an I2C-bus as a controller. The I2C provides a method of communication between various devices available on the FRDM-IMX95-PRO board.

Table 9 describes the I2C devices and their I2C addresses (7-bit) on the board.

Table 9. I2C devices

Part identifier	Device	I2C address (7-bit)	Port	Speed	Voltage	Description
U15	PPF0900AMBA1ES	0x08 (0b'0001000x)	MX-I2C1	3.4 MHz	3.3 V	PMIC
U14	PPF5302 AMMAAES	0x29 (0b'0101001x)	MX-I2C1	3.4 MHz	3.3 V	Voltage regulator to produce VDD_SOC
U22	PPF5301 AMMABES	0x2A (0b'0101010x)	MX-I2C1	3.4 MHz	3.3 V	Voltage regulator to produce VDD_ARM
U61	PCAL6408AHK	0x20 (0b'0100000x)	MX-I2C1	400 kHz	3.3 V	8-bit I2C I/O expander
U43	PCF2131	0x53 (0b'1010011x)	MX-I2C1	400 kHz	3.3 V	External RTC
U36	BL24C256A-NTRC	0x50 (0b'1010000x)	MX-I2C2	400 kHz	3.3 V	EEPROM

Table 9. I2C devices...*continued*

Part identifier	Device	I2C address (7-bit)	Port	Speed	Voltage	Description
U28	SE051C2HQ1/Z01XD	0x48 (0b'1001000x)	MX-I2C2	400 kHz	3.3 V	Security
U23	IT6263	0x4C (0b'1001100x)	MX-I2C2	1 MHz	3.3 V	LVDS to HDMI converter
U7	PCAL6416AHF	0x20 (0b'0100000x)	MX-I2C3	400 kHz	3.3 V	16-bit I2C I/O expander
U53	NX20P3483UK	0x71 (0b'1110001x)	MX-I2C3	1 MHz	3.3 V	USB Type-C load switch
U45	PTN5110NHQZ	0x50 (0b'1010000x)	MX-I2C3	1 MHz	3.3 V	USB Type-C Power Delivery PHY
U44	PTN5110NHQZ	0x52 (0b'1010010x)	MX-I2C3	1 MHz	3.3 V	USB Type-C Power Delivery PHY
U17	PCAL6524HEAZ	0x22 (0b'0100010x)	MX-I2C4	1 MHz	3.3 V	24-bit I2C I/O expander

2.6 FlexSPI interface

The FRDM-IMX95-PRO board includes an onboard serial NOR flash memory device connected to the FlexSPI (XSPI) interface of the i.MX 95 processor.

A Winbond W25Q512NWEIQ serial NOR flash device (U16) is populated on the board and powered from the 1.8 V supply (VDD_1V8). The device provides nonvolatile storage for boot images and firmware and supports high-speed FlexSPI/XSPI operation.

The NOR flash device is connected to the processor using the following FlexSPI signals:

- XSPI_FLASH_CS: Chip select input of the NOR flash
- XSPI_CLK: Serial clock output from the processor
- XSPI_DATA[0:3]: Bidirectional data lines for quad-SPI operation
- HOLD#/RESET#: Pulled up to VDD_1V8 to ensure normal operation during reset

The onboard serial NOR flash serves as an optional boot source and nonvolatile storage. When the boot mode is configured for FlexSPI boot, the i.MX 95 processor fetches the boot image directly from this NOR flash device during system startup. For boot mode configurations details, see Section 2.3.

2.7 Audio interface

The Pulse Density Modulated (PDM) microphone interface of the processor provides full PDM support on the FRDM-IMX95-PRO. A pair of microphones is used for the PDM interface, with approximately 70 mm spacing to support audio processing algorithms.

The Medium Quality Sound (MQS) is multiplexed from SAI1 and is used to generate medium-quality audio. The MQS supports a 3.5 mm audio jack, which can be used to connect stereo speakers or headphones.

Table 10 describes the microphones and other devices used for the PDM and MQS interfaces on the board.

Table 10. Devices used for PDM and MQS interfaces

Part identifier	Manufacturing part number	Description
U41	SPK0641HT4H-1	MIC (high) as SEL is connected to VDD. Asserts DATA on CLK rising edge and latch DATA on CLK falling edge.
U2	SPK0641HT4H-1	MIC (low) as SEL is connected to GND. Asserts DATA on CLK falling edge and latch DATA on CLK rising edge.
J19	PJ_3536X	3.5 mm audio jack for onboard MQS analog output

2.8 LPDDR5 interface

The FRDM-IMX95-PRO board features one 4 Gig × 32 (2 channels × 16 I/O) LPDDR5 DRAM chip (Micron MT62F4G32D8DV-023FAIT:C), providing a total memory size of 16 GB. The LPDDR5 DRAM is connected to the i.MX 95 32-bit DRAM controller, which supports speed up to 6400 MT/s.

Table 11 provides details of the LPDDR5 DRAM on the board.

Table 11. LPDDR5 DRAM description

Part identifier	Part name	Manufacturer	Description
U21	MT62F4G32D8DV-023FAIT:C	Micron Technology	LPDDR5 memory of 16 GB memory size

2.9 eMMC interface

The target processor includes three Ultra Secured Digital Host Controller (uSDHC) modules for SD/eMMC interface support. The eMMC memory is connected to the uSDHC1 interface of the i.MX 95 processor, which supports eMMC 5.1 devices. It is the default boot device for the board. Table 7 describes the boot settings.

Note: *NVCC_WAKEUP must be supplied with 1.8 V if HS200 or HS400 mode is required for the eMMC.*

Table 12 describes the eMMC memory device that is supported by the uSDHC1 interface.

Table 12. Supported eMMC device

Part identifier	Part number	FBGA	Manufacturer	Memory size
U19	MTFC32GBCAQTC-IT	LFBGA-153	Micron	32 GB

2.10 SD card interface

The uSDHC2 interface of the i.MX 95 processor is connected to the microSD card slot (J1) on the FRDM-IMX95-PRO board. This connector supports one 4-bit SD3.0 microSD card. To select it as the boot device, see Section 2.3.

2.11 M.2 Key-E interface

The FRDM-IMX95-PRO board supports an M.2/NGFF Key-E mini card 75-pin connector (J8). This M.2 connector provides interfaces for USB, SDIO, SAI, UART, I2C, SPI, and GPIO, and it also supports PCIe (disabled by default).

If PCIe functionality is required, several resistors must be reworked. Do not populate (DNP) R611, R612, R614, R615, R616, and R617. Populate R67, R70, R42, R52, R57, R60, R100, R101, and R403.

Note: *After the rework, the M.2 Key-M connector(J25) cannot be used as they share PCIe interface.*

It can be used for Wi-Fi/Bluetooth cards with IEEE 802.15.4 Radio support.

By default, the board is assembled with the Murata Type-2EL module (PN: LBES5PL2EL), which is based on an NXP IW612 chip. This module supports Wi-Fi 6, Bluetooth 5.3, and 802.15.4.

Note: *Wireless functionality is only available when an optional Wi-Fi card is installed in the M.2 Key-E slot.*

Some of the signals defined in the M.2 Key-E connector pinout are used to connect optional sideband and debug signals used by NXP Wi-Fi/Bluetooth/802.15.4 radios. For more details, refer to the *Wi-Fi/Bluetooth/802.15.4 M.2 Key E Pinout Definition* (document AN13049).

2.12 M.2 Key-M interface

The FRDM-IMX95-PRO board is equipped with two M.2/NGFF Key M mini card connectors (J24 and J25), each implemented as a 75-pin M.2 socket.

The M.2 Key-M connectors provide a PCIe–based interface routed from the i.MX 95 processor. In addition to PCIe signals, the M.2 Key-M pinout includes optional management and sideband signals (such as I2C and GPIO), which are available at the connector level and are module-dependent.

On the FRDM-IMX95-PRO board, the M.2 Key-M connectors can be used with the Ara240 16GB M.2 Module (ARA2-M2-16G-GT) or with standard PCIe-based M.2 SSD cards. Both connectors may be populated simultaneously, enabling parallel development and evaluation scenarios.

When used with the ARA2-M2-16G-GT module, the interface operates exclusively over PCIe, while other optional M.2 signals are not required. Section 2.12.1 describes how to use this module on the FRDM-IMX95-PRO board.

2.12.1 ARA2-M2-16G-GT module

The Ara240 16 GB M.2 Module (ARA2-M2-16G-GT) is an AI accelerator module based on the Ara240 discrete Neural Processing Unit (NPU). The module delivers up to 40 eTOPS of AI acceleration with flexible precision.

The ARA2-M2-16G-GT uses the M.2 M-Key (NGFF 2280) form factor and supports up to four lanes of PCI Express 4.0 (PCIe Gen4 x4). It works as a companion processing unit on any NXP i.MX or S32 platform with M.2 M-Key PCIe capability. On the FRDM-IMX95-PRO board, the module can be installed in either M.2 Key-M connector J24 or J25. It enables the use of one or two Ara240 modules simultaneously for parallel AI development and testing.

Interface Usage

When installed on the FRDM-IMX95-PRO board, the ARA2-M2-16G-GT module communicates exclusively through the PCI Express interface provided by the M.2 Key-M connector. Other signals defined by the M.2 specification (such as I2C or management sideband signals) are module-dependent and not required for basic Ara240 operation.

Power requirements

The ARA2-M2-16G-GT module is designed to operate with 3.3 V power supplied through the M.2 edge connector. For host systems that cannot meet the power demand of the module through the M.2 3.3 V supply, the ARA2-M2-16G-GT module provides an auxiliary 5 V input solder pad option. For detail, see *ARA2-M2-16G-GT Board User Manual* (document UM12420) or refer to the following NXP webpage.

2.12.2 Connection between ARA2-M2-16G-GT and FRDM-IMX95-PRO

To install the ARA2-M2-16G-GT module into an M.2 Key-M slot (J24 or J25), follow these steps:

1. Install all eight standoffs included in the package onto the board. Proper installation of all standoffs is essential to maintain adequate airflow around the module and ensure effective thermal management during operation. For details, see Heat dissipation.
2. The M.2 slot has a mounting standoff and screw at the end. Unscrew the mounting screw and keep it nearby.
3. Align the notch (M-key notch) of the module with the connector.
4. Insert the module into the slot at an angle of approximately 25° to 30°.
5. Gently push the module until it is fully seated in the connector.
6. Once inserted, gently press the module down horizontally until the mounting hole aligns with the standoff.
7. Use the mounting screw to secure the module to the standoff.

8. Insert the fan cable terminal into the corresponding fan connector (J9 or J10) on the board.

Figure 7 and Figure 8 show the connection between ARA2-M2-16G-GT and FRDM-IMX95-PRO.

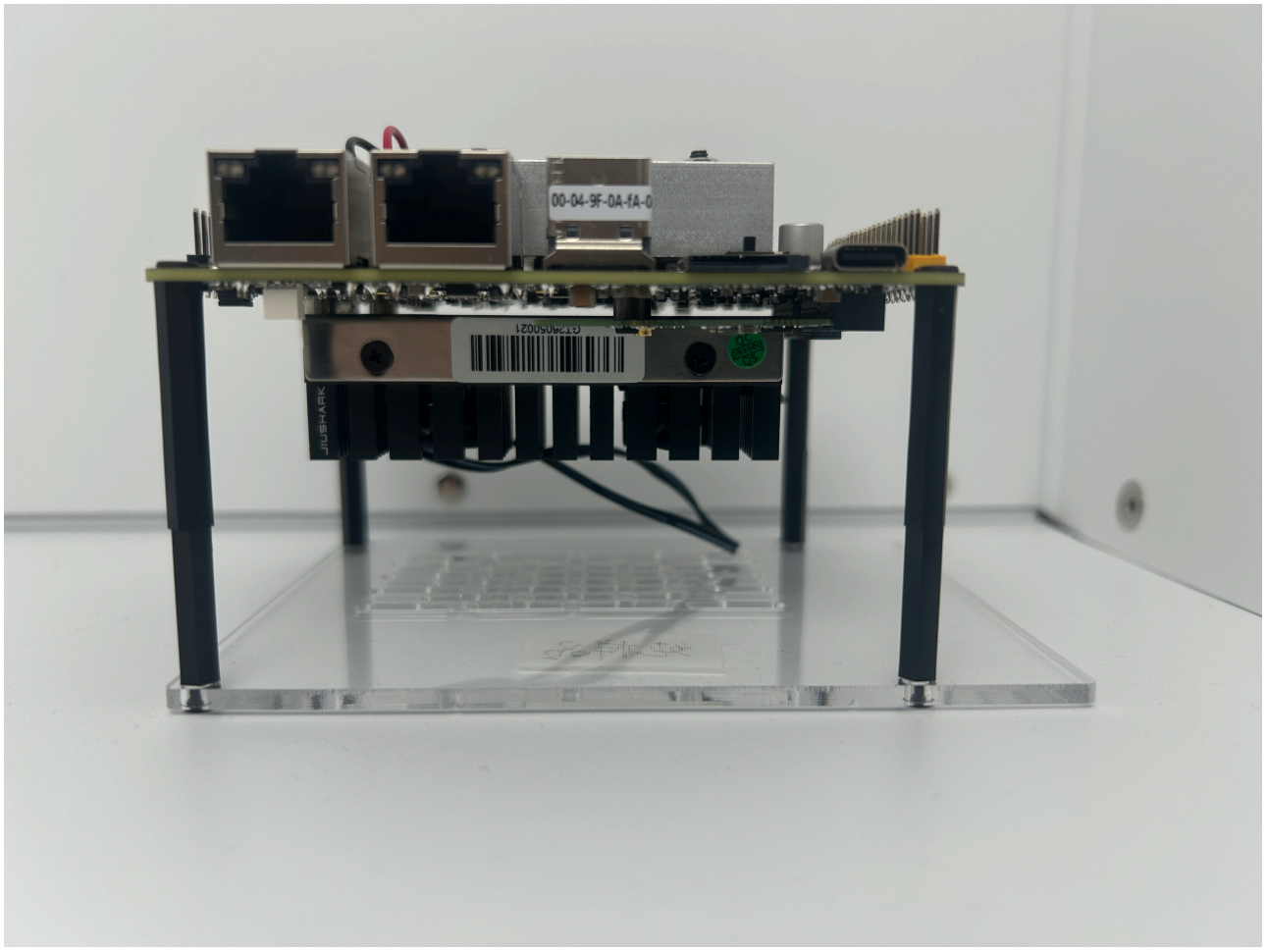


Figure 7. ARA2-M2-16G-GT to FRDM-IMX95-PRO connection — Top view

Figure 8. ARA2-M2-16G-GT to FRDM-IMX95-PRO connection — Front view

Heat dissipation

To improve heat dissipation and ensure stable operation of the ARA2-M2-16G-GT module, perform the following steps:

1. From the bottom side of the board, remove the four corner standoffs.
2. Remove the acrylic plate from the board.
3. Install the four additional standoffs included in the kit onto the board.
4. Reposition the acrylic plate onto the newly installed standoffs.
5. Secure the acrylic plate in place using the original fasteners.

With the increased spacing between the ARA2-M2-16G-GT module and the acrylic plate, airflow is improved. It results in better heat dissipation and more stable operation.

2.13 CAN interface

The i.MX 95 processor includes a Controller Area Network (CAN) module compliant with CAN Flexible Data Rate (CAN FD) and CAN 2.0B specifications. The processor provides one FlexCAN instance (CAN1) in the AON domain, and four other FlexCAN instances (CAN2 through CAN5), which are routed through the GPIO IOMUX. On the FRDM-IMX95-PRO board, CAN1 and CAN3 are available for use.

CAN1 and CAN3 are connected to two 3-pin 2.0 mm headers (J2 and J3) through high-speed CAN transceivers TJA1057 (U11 and U10). The CAN3_TX and CAN3_RX signals are multiplexed with CCM_CLKO3 and CCM_CLKO4.

The CAN_STBY signals generated by the IO expander PCAL6524HEAZ (U17, P1_3 and P1_5, I2C address: 0x22) controls the silent mode operation of the CAN transceivers.

Table 13 describes the High-Speed CAN (HS-CAN) transceiver and header.

Table 13. High-speed CAN transceiver and header

Part identifier	Manufacturing part number	Description
U10, U11	TJA1057	High-speed CAN transceiver. Provides the interface between the CAN protocol controller and the physical two-wire CAN bus.
J2, J3	—	3-pin 2.0 mm connector. It is connected to the CAN bus and allows external connection with the bus.

Note: *For details about TJA1057, see the TJA1057 data sheet at High-Speed CAN Transceiver.*

2.14 USB interface

The i.MX 95 processor includes two USB controllers (USB1 and USB2) with two integrated USB PHYs. The USB1 controller and PHY support both USB2.0 and USB3.0 operation, while the USB2 controller and PHY support USB2.0 operation only.

On the FRDM-IMX95-PRO board, USB1 is connected to the USB3.0 Type-C Port (J7) and USB2 is connected to USB2.0 Type-A Port (J20).

Table 14 describes the functions of USB ports.

Table 14. USB ports

Part identifier	USB port type	Description
J7	USB3.0 Type-C	Connects to the USB controller (USB1) of the target processor. It supports both device and host mode operation. The VBUS power is managed by the USB PD PHY PTN5110NHQZ (U45) together with the USB PD power switch NX20P3483UK (U53). This port operates exclusively as a dual-role port (DRP). When functioning as a source, it provides 5 V to a connected USB device. When acting as a sink, it can accept power input up to 20 V. However, this power path is disabled by default to prevent conflicts with the dedicated power port (J11).
J20	USB2.0 Type-A	Connects to the USB controller (USB2) of the target processor. It supports both device and host mode operation. The VBUS power is managed by the USB power switch NX5P3090UK (U70). ***Note:*** *By default, the USB2_DP and USB2_DN signals from the USB2 controller of the processor are routed to the USB2 Type A port (J20). These signals can be rerouted to the M.2 card connector (J8) by populating R298 and R297 and depopulating R549 and R554.*

2.15 MIPI DSICSI interface

The i.MX 95 processor supports one MIPI DSICSI interface. The DSI and CSI controllers share the 4-lane D-PHY (RX/TX), so the DSI interface and the second CSI interface cannot be used simultaneously.

The MIPI DSICSI data and clock signals are connected to a 22-pin FPC connector (J16). This interface can be connected to the following accessory cards：

- 7-inch Waveshare LCD
- Camera module EXPI-OS08A20, refer to Section 2.16

2.15.1 7-inch Waveshare LCD

This section explains how to connect a 7-inch Waveshare LCD to the FRDM-IMX95-PRO board using the MIPI DSI interface and I2C.

2.15.1.1 MIPI DSI interface connection

To connect the 7-inch Waveshare LCD to the FRDM-IMX95-PRO board via the MIPI DSI interface, make sure the following cable orientation and connections.

- LCD side:
  - FPC cable orientation: Conductive side up, stiffener side down.
  - Insert the FPC cable into the FPC connector of the LCD.
- FRDM-IMX95-PRO board side:
  - FPC cable orientation: Conductive side up, stiffener side down.
  - Insert the FPC cable into the FPC connector (J16).

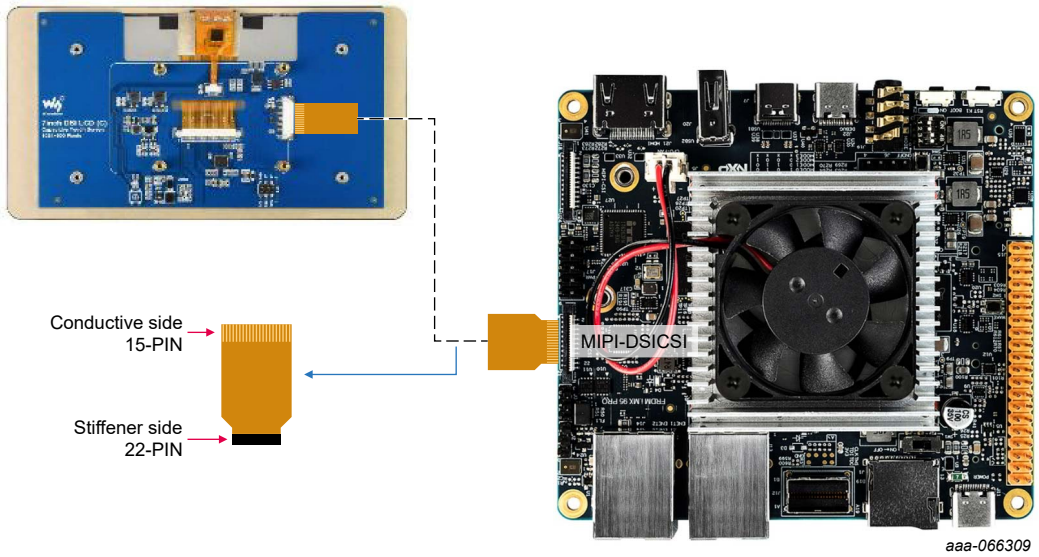


Figure 9. FPC cable connection between 7-Inch Waveshare LCD and FRDM-IMX95-PRO

2.15.1.2 I2C connection

Figure 10 shows the I2C signal wires connection between 7-Inch Waveshare LCD and FRDM-IMX95-PRO.

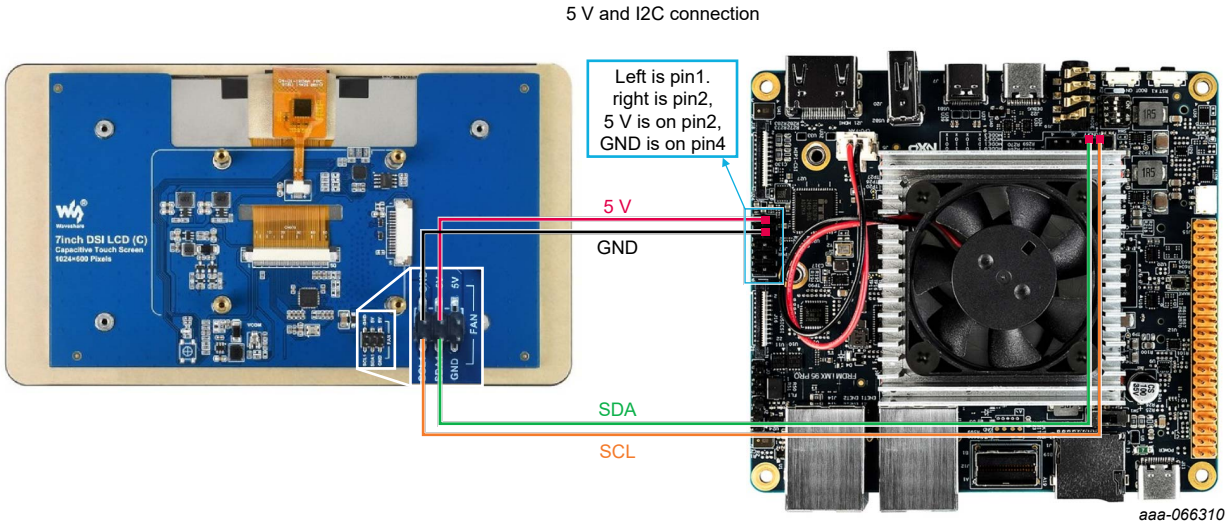


Figure 10. I2C connection between 7-Inch waveshare LCD and FRDM-IMX95-PRO

2.16 MIPI CSI interface

The i.MX 95 processor supports two MIPI camera serial interfaces (CSI-2).

- One CSI interface includes a 4-lane RX D-PHY, CSI-2 host controller (#0), and CSI-2 pixel formatting. This interface connects to a 22-pin FPC connector (J18).
- The other CSI interface includes a 4-lane TX/RX D-PHY shared with the DSI controller, CSI-2 host controller (#1), and CSI-2 pixel formatting. This interface connects to a 22-pin FPC connector (J16).

The following accessory cards can be connected to the J18/J16 connector.

- Camera module EXPI-OS08A20

2.16.1 EXPI-OS08A20

The EXPI-OS08A20 is a high-resolution 4K complementary metal-oxide-semiconductor (CMOS) camera module featuring superior image quality for consumer applications. It integrates the OmniVision OS08A20 —a high-performance, 1/2-inch, 8-megapixel (8 MP) complementary metal-oxide-semiconductor (CMOS) image sensor capable of 3840×2160 resolution at 30 FPS. This module includes an optic lens and an 8 MP image sensor board with a Flexible Printed Circuit (FPC) 22-pin connector. For details, visit the EXPI-OS08A20 module webpage.

The EXPI-OS08A20 connects to the FRDM-IMX95-PRO board through a MIPI-CSI-2 interface using a 22-pin flexible printed circuit (FPC) connector. The camera module is intended for evaluation and development of imaging and vision-based applications.

On the FRDM-IMX95-PRO board, the EXPI-OS08A20 module is supported on the MIPI-CSI connector (J18). By default, the software supports one EXPI-OS08A20 camera module connected to this interface.

For details on physical connection and cable orientation, see Section 2.16.1.1.

2.16.1.1 EXPI-OS08A20 to FRDM-IMX95-PRO connection

Figure 11 shows the FPC cable connection between EXPI-OS08A20 and FRDM-IMX95-PRO. By default, the software supports one EXPI-OS08A20 camera module connected to the MIPI-CSI connector J18.

To connect the EXPI-OS08A20 camera module to the FRDM-IMX95-PRO board through the MIPI-CSI interface, ensure the correct cable orientation and follow the steps below:

- EXPI-OS08A20 side:
  1. Position the FPC cable with the **conductive side facing up** and the **stiffener side facing down**.
  2. Insert the FPC cable fully into the connector on the EXPI-OS08A20 camera module.
- FRDM-IMX95-PRO board side:
  1. Position the FPC cable with the **conductive side facing up** and the **stiffener side facing down**.
  2. Insert the FPC cable into the MIPI-CSI connector (J18) on the FRDM-IMX95-PRO board.

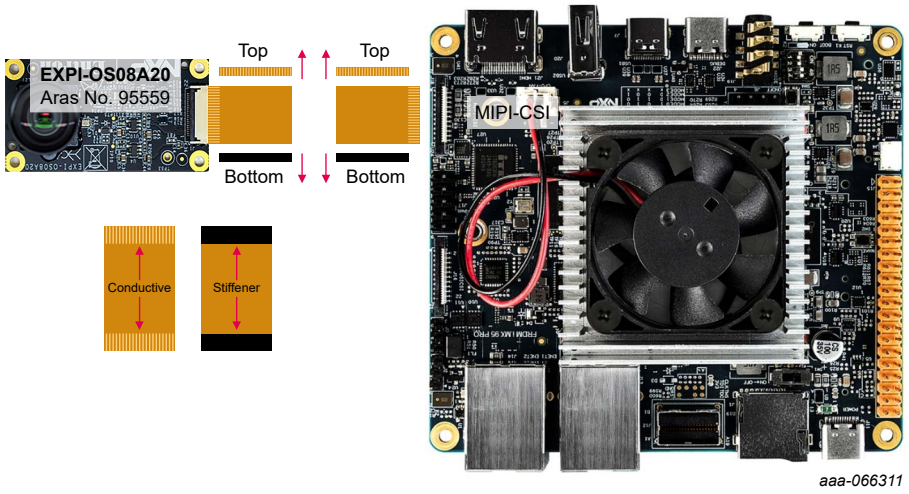


Figure 11. FPC connection between EXPI-OS08A20 and FRDM-IMX95-PRO

2.17 HDMI interface

The 4-lane LVDS0 interface on the FRDM-IMX95-PRO is used to provide an HDMI output. The board features an IT6263 chip, which converts the LVDS to an HDMI 1.4a compliant signal. The output signals from the IT6263 are connected to a standard HDMI Type-A connector (J21). The supported output resolution is up to 1920x1080p60. The connector is as shown in Figure 3.

2.18 Ethernet interface

The i.MX 95 processor supports two Gigabit Ethernet controllers capable of simultaneous operation, along with an additional 10 GbE controller. All Ethernet interfaces provide Time-Sensitive Networking (TSN) capabilities and support Energy-Efficient Ethernet (EEE), Ethernet AVB, and IEEE 1588.

The FRDM-IMX95-PRO board provides two 1 Gbit/s Ethernet ports for external communication. Two RGMII Ethernet interfaces from the i.MX 95 processor route to YT8521SH-CA Ethernet PHY transceivers (U54 and U56), which connect to RJ45 connectors J13 and J14.

The board also includes a 10 GbE Slim-SAS connector (J12) to attach a 10 GbE expansion card, enabling high-bandwidth data communication for applications requiring increased throughput. The expansion card connects to FRDM-IMX95-PRO with a Slim-SAS cable.

Each Ethernet port has three consecutive Media Access Control (MAC) addresses. The first MAC address for each Ethernet port is labeled on its corresponding RJ45 connector or Slim-SAS connector.

Note: *All Ethernet PHYs must share an MDIO/MDC interface from the Ethernet controller. On the FRDM-IMX95-PRO board, the ENET2 MDIO/MDC interface is used for the connected Ethernet PHYs.*

2.19 USB debug interface

The FRDM-IMX95-PRO board features a high-speed USB-to-UART device, CH9114F (U67), which provides a debug interface for the i.MX 95 processor. This device acts as a bridge, enabling communication between the target processor and the host computer via the USB Type-C connector (J22) through a USB cable.

The CH9144F device provides four UART channels (0, 1, 2, and 3). The driver can be downloaded from the WCH website.

To enable debug under Linux, ensure that the CH9114 Linux driver is installed. After installation, the PC/USB host counts four COM ports when connected to the USB Type-C connector (J22) via a USB cable. One port for Arm Cortex-A55 debugging, one port for Arm Cortex-M33 debugging, and another port for Arm Cortex-M7 debugging. The recommendation is to open all four ports every time, since the port mapping for A55, M33, and M7 cores is not fixed.

You can use the following terminal tools for debugging purposes.

- Putty
- Tera Term
- Xshell
- Minicom ≥ 2.9

Table 15 describes the required settings.

Table 15. Terminal setting parameters

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

The USB debug connector J22 is shown in Figure 3.

2.20 Expansion connectors

The FRDM-IMX95-PRO board provides three expansion interfaces to offer flexibility for various application needs.

One 2x20-pin EXPI connector (J15) is provided on the FRDM-IMX95-PRO board to support SAI, UART, I2C, SPI, PDM, and GPIO connections. The header can be used to access various pins or to connect accessory cards, such as MX93AUD-HAT and 8MIC-RPI-MX8.

Figure 12 shows the connection between FRDM-IMX95-PRO, MX93AUD-HAT, and 8MIC-RPI-MX8.

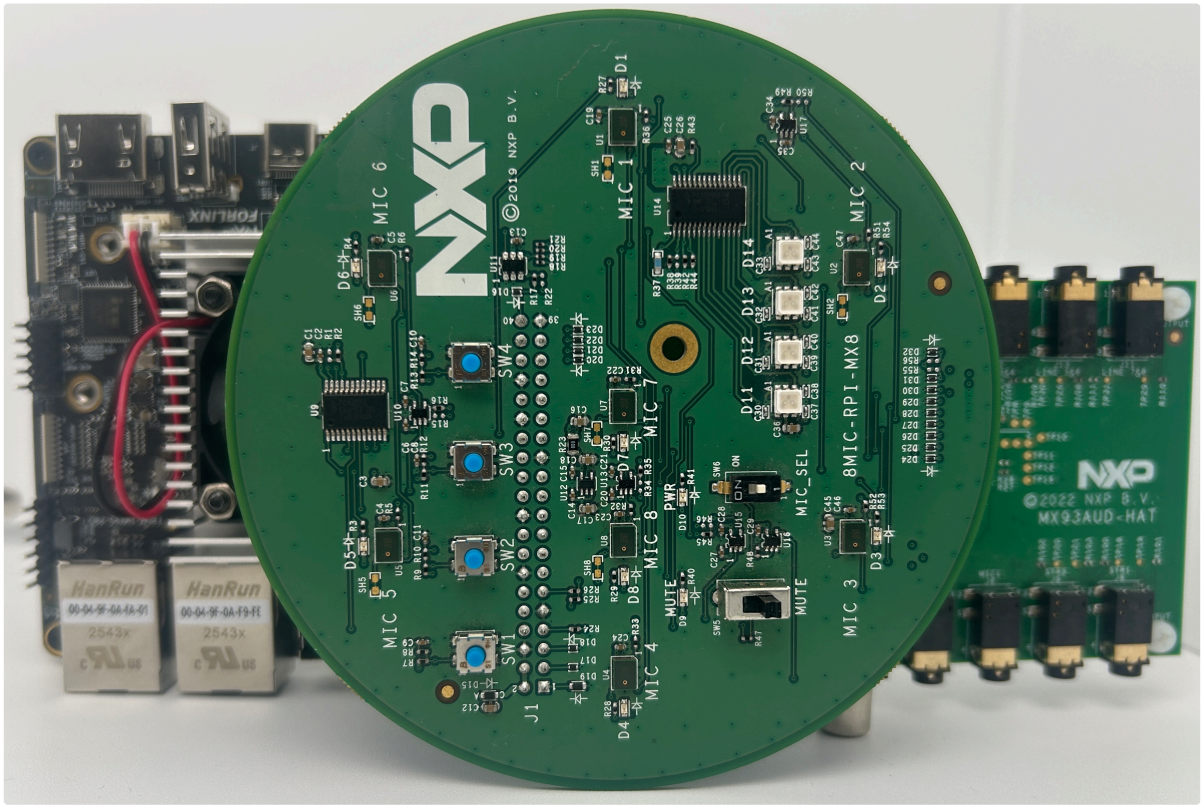


Figure 12. MX93AUD-HAT and 8MIC-RPI-MX8 connection to FRDM-IMX95-PRO

One 4-pin (1x4, 2.54 mm pitch) header (J6) is available to support I2C and ADC connections. Table 16 describes the J6 header pinout.

Table 16. J6 header pinout

Pin	Signal name	Description
1	I2C4_SCL_3V3	I2C4 is reserved for use with the 7-inch Waveshare LCD panel. These two pins can alternatively be configured for tamper functionality with the following rework modifications: • Do not populate R626 and R625 • Populate R624 and R623
2	I2C4_SDA_3V3	
3	ADC_IN2	ADC input channel 2
4	ADC_IN3	ADC input channel 3

Another 10-pin (2x5, 2.54 mm pitch) connector (J17) is available to support power supply rails and GPIOs connections.

Table 17 describes the J17 header pinout.

Table 17. J17 header pin description

Pin number	Signal	Description
3, 4, 7, 8	GND	Ground
1	VEXP_3V3	3.3 V power supply
2	VEXP_5V	5 V power supply
5	VEXP_1V8	1.8 V power supply

Table 17. J17 header pin description*...continued*

Pin number	Signal	Description
6	VDD_12V	12 V power supply
9	EXP_IO1	GPIO1
10	EXP_IO2	GPIO2

2.21 Board errata

No board errata.

3 PCB information

The board uses a 10-layer 3-stage HDI PCB stack-up composed of FR4 material. Table 18 describes the PCB stack-up information.

Table 18. FRDM-IMX95-PRO board stack-up information

Layer	Description	Copper (mil)	Generic	Er	Dielectric thickness (mil)
	Solder mask		—	3.4	1
1	TOP	1.57	—	—	
—	Dielectric	—	S1000-2M	3.74	2.64
2	GND02	1.14	—	—	—
—	Dielectric	—	S1000-2M	3.57	2.76
3	ART03	1.14	—	—	—
—	Dielectric	—	S1000-2M	3.54	3.27
4	GND04	1.3	—	—	—
—	Dielectric	—	S1000-2M	3.6	5.91
5	POWER05	1.3			
—	Dielectric	—	S1000-2M	4.2	18.11
6	POWER06	1.3			
—	Dielectric	—	S1000-2M	3.6	5.91
7	GND07	1.3	—	—	—
—	Dielectric	—	S1000-2M	3.54	3.27
8	ART08	1.14	—	—	—
—	Dielectric	—	S1000-2M	3.57	2.76
9	GND09	1.14	—	—	—
—	Dielectric	—	S1000-2M	3.74	2.64
10	BOTTOM	1.57	—	—	—
—	Solder mask	—	—	3.4	1
Finished:	62.17 mil			1.579 mm	
Material:	S1000-2M				

4 European Union regulatory compliance

The following information is provided per Article 10.8 of the Radio Equipment Directive 2014/53/EU:

- Frequency bands in which the equipment operates
- Maximum radio-frequency power transmitted in one or more frequency bands in which the radio equipment operates

Table 19. EU regulatory compliance

Part number	RF technology	Frequency ranges (EU)	Maximum transmitted
FRDM-IMX95-PRO	WLAN 2.4 GHz mode 802.11b/g/n/ax	2400 MHz – 2500 MHz	18 dBm
	WLAN 5 GHz mode 802.11a/n/ac/ax	4900 MHz – 5895 MHz	18 dBm
	Bluetooth LE	2402 MHz – 2480 MHz	19 dBm
	BT BR/EDR	2402 MHz – 2480 MHz	19 dBm
	IEEE 802.15.4	2405 MHz - 2480 MHz	19 dBm

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

This apparatus, namely FRDM-IMX95-PRO, conforms to the Radio Equipment Directive 2014/53/EU. The full EU Declaration of Conformity for this apparatus can be found at FRDM-IMX95-PRO.

5 Acronyms

Table 20 lists and defines the acronyms used in this document.

Table 20. Acronyms

Term	Description
BGA	Ball Grid Array
CAN	Controller Area Network
CSI-2	Camera Serial Interface 2
DNP	Do Not Populate
DSI	Display Serial Interface
eMMC	Embedded Multimedia Card
EXPI	Expansion Interface
FD	Flexible Data Rate
FPC	Flexible Printed Circuit
FPS	Frames Per Second
HDI	High-Density Interconnector
GPIO	General-Purpose Input/Output
HDMI	High-Definition Multimedia Interface
HS	High-Speed
I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound

Table 20. Acronyms...*continued*

Term	Description
I3C	Improved Inter-Integrated Circuit
LDO	Low Dropout Regulator
LED	Light-Emitting Diode
MAC	Media Access Control
MIPI	Mobile Industry Processor Interface
MPU	Microprocessor Unit
NGFF	Next-Generation Form Factor
PCB	Printed Circuit Board
PDM	Pulse-Density Modulation
PMIC	Power Management-Integrated Circuit
PWM	Pulse Width Modulation
RTC	Real Time Clock
SDIO	Secure Digital Input/Output
SPI	Serial Peripheral Interface
TSN	Time Sensitive Networking
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
uSDHC	Ultra Secured Digital Host Controller
WLAN	Wireless Local Area Network

6 Related documentation

Section 6 lists and explains the additional documents and resources that you can refer to for more information on the FRDM-IMX95-PRO board.

Table 21. Related documentation

Document	Description	Link/how to access
i.MX 95 Applications Processor Reference Manual	Intended for system software and hardware developers and application programmers who want to develop products with i.MX 95 applications processor.	IMX95RM
i.MX 95 Industrial Application Processors Data Sheet	Provides information about electrical characteristics, hardware design considerations, and ordering information.	IMX95IEC
i.MX 95 Hardware Design Guide	This document aims to help hardware engineers design and to test their i.MX 95 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.	IMX95HDG

7 Revision history

Table 22 summarizes the revisions to this document.

Table 22. Revision history

Document ID	Release date	Description
UM12527 v.1.0	22 June 2026	Initial public release

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