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# Radxa NIO 12L Product Brief

Low Power AI Single Board Computer

Revision 1.2

2024-02-21



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# 1 Revision Control Table

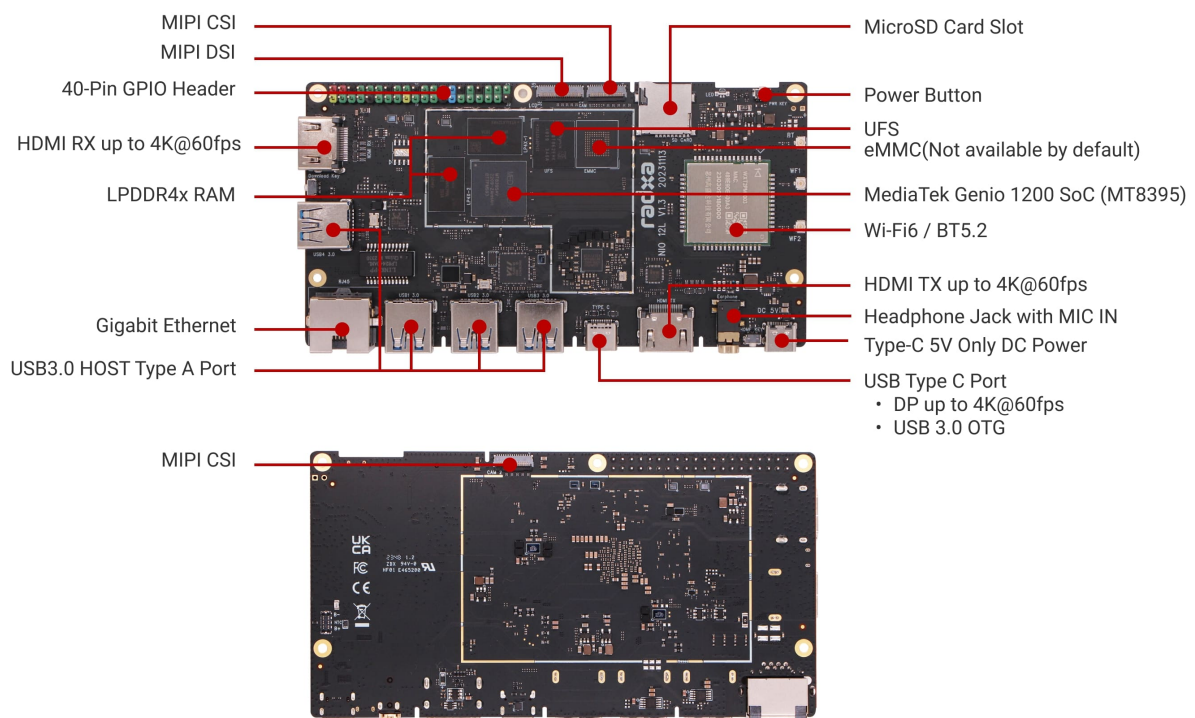
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Version	Date	Changes from previous version
1.0	2023/10/20	First version
1.1	2023/12/19	Update Information
1.2	2024/02/21	Update Picture

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## 2 Introduction

The Radxa NIO 12L is a Single Board Computer (SBC) in a compact form factor packed with a wide range of class-leading functionality, features and expansion options. The NIO 12L is an ideal choice for makers, IoT enthusiasts, hobbyists, gamers, PC users and everyone who need an extremely highly specified platform with outstanding performance and reliability. Radxa offers the NIO 12L in various LPDDR4x RAM memory and UFS storage options:



*Note:* The actual board layout or components' location may change during the time but the main connectors type and location will remain the same

## 3 Features

### 3.1 Hardware

- MediaTek Genio 1200 SoC (MT8395)
- Quad Cortex<sup>®</sup>-A78 @ 2.2~2.4GHz and a quad Cortex<sup>®</sup>-A55 @ 2.0GHz based on Arm<sup>®</sup> DynamIQ<sup>™</sup> configuration
- Arm Mali<sup>™</sup> G57 MC5 GPU supporting:

- OpenGL® ES1.1, ES2.0, and ES3.2
  - OpenCL® 1.1, 1.2 and 2.2
  - Vulkan® 1.1 and 1.2
  - Embedded high performance 2D image acceleration module
- Dual-core AI Processor Unit (APU) Cadence® Tensilica® VP6 processor with AI Accelerator (AIA)
  - APU computing power is up to 4TOPs
- Single-core Cadence HiFi 4 Audio Engine DSP
- 64bits LPDDR4x RAM up to 4266MT/s with options:
  - 4GB
  - 8GB
  - 16GB
- UFS (Universal Flash Storage) Version 2.1 with options:
  - 128GB
  - 256GB
  - 512GB
- Dual display outputs via any two of:
  - 1x HDMI TX up to 4Kp60
  - 1x DP (USB Type-C) up to 4Kp60
  - 1x MIPI DSI up to 2Kp60
- Single camera with image processing up to 48MP@30fps
- AV1/VP9/HEVC/H.264 multivideo decoder up to 4K@90fps
- HEVC/H.264 multivideo encoder up to 4K@60fps

### 3.2 Interfaces

- 1x USB Type-C™ port supporting:
  - DP display up to 4Kp60
  - USB 3.0 OTG
- 1x Micro SD Card
- 1x Standard HDMI output port supporting up to 4Kp60 display output
- 1x Standard HDMI input port, supporting up to 4Kp60 display input
- 4x USB 3.0 5Gbps Type A HOST Ports

- 1x Gigabit Ethernet Port
- 1x WiFi 6 / BT 5.2 with tripple antenna
- 1x on board eMMC with 8GB / 16GB / 32GB / 64GB storage options
- 1x on board UFS with 128GB / 256GB / 512GB storage options
- 1x 3.5mm audio jack with mic in
- 2x four-lane MIPI CSI ports
- 1x four-lane MIPI DSI port with touch screen support
- 3x Buttons
  - 1x power button
  - 1x user button
  - 1x force upgrade button
- Miscellaneous
  - 1x RTC battery connector
  - 1x RGB power/status/user LED
- 40 pin 0.1” (2.54mm) header supporting a wide range of interface options:
  - 2 x UART
  - 2 x SPI bus
  - 2 x I2C bus
  - 1 x PCM/I2S
  - 1 x SPDIF
  - 1 x PWM
  - 1 x ADC
  - 6 x GPIO
  - 2 x 5V DC power in/out
  - 2 x 3.3V power out

### 3.3 Software

- ARMV8 Instruction Set
- Debian / Ubuntu Linux support
- Yocto 23.1 or later BSP
- Android 11 support
- Mediatek APU SDK (NDA required)
- Hardware access/control library for Linux/Android



GPIO	Voltage Level	Tolerance
All GPIO	3.3V	3.63V
SARADC_IN4	1.8V	1.98V

## 6 Operating Conditions

The Radxa NIO 12L is engineered to function effectively within a defined temperature range of 0°C to 50°C. This temperature range has been thoughtfully selected to accommodate a variety of use cases, prioritizing efficient performance and minimal heat generation for an optimal user experience.

Similar to all electronic devices, heat is a natural byproduct of operation, and its intensity can be influenced by performance levels and workloads. During routine tasks like web browsing, text editing, or media playback, the Radxa NIO 12L intelligently manages its resources by allocating tasks to the most power-efficient processor cores or dedicated hardware accelerators, thus minimizing heat generation. This approach ensures that higher-performance processor cores and thermal headroom are reserved for more demanding tasks as the need arises.

The SoC, in this case, the MT8395, is designed with built-in temperature safeguards. It is configured to maintain reliable operation within the defined temperature range. In the event that the internal temperature approaches the specified limit of 80°C, the SoC will proactively adjust clock speeds to prevent overheating and ensure system stability. However, for continuous and demanding high-performance applications, it may be advisable to employ external cooling methods, such as heat sinks or fans. These additional cooling solutions can effectively enable the SoC to operate indefinitely at maximum clock speeds, staying comfortably below its predefined peak temperature limit of 80°C, which is particularly beneficial for sustained peak performance in high-demanding workloads.

## 7 Peripherals

### 7.1 GPIO Interface

The Radxa NIO 12L offers a 40 pin GPIO expansion header which provides extensive compatibility with a wide range of accessories developed for the SBC market.



### 7.1.1 GPIO Alternate Functions

PIN#	Function1	Function2	Function3	Function4	Function5	Function6	Function7	Function8
1	+3.3V							
2	+5.0V							
3	GPIO12	SDA2	DMIC3_DAT_R	I2SO1_D6			LVTS_SDI	DBG_MON_A4
4	+5.0V							
5	GPIO13	SCL2	DMIC4_DAT_R	I2SO1_D7				DBG_MON_A5
6	GND							
7	GPIO136	SPIM1_CSB	SCP_SPI1_A_CS	SPIS1_CSB	MD32_1_JTAG_TMSSCP_JTAG0_TMS	APU_JTAG_TMS		DBG_MON_A15
8	GPIO98	UART0_TXD						
9	GND							
10	GPIO99	UART0_RXD						
11	GPIO137	SPIM1_CLK	SCP_SPI1_A_CK	SPIS1_CLK	MD32_1_JTAG_TCKSCP_JTAG0_TCK	APU_JTAG_TCK		DBG_MON_A14
12	GPIO102 / GPIO104	UART1_TXD / KPROW0	VBUSVALID_2P / DISP_PWM1	I2SO1_D10	SSPM_UTXD_AO	TP_UTXD1_AO	MD32_1_TXD	I2SIN_D2
13	GPIO138	SPIM1_MO	SCP_SPI1_A_MO	SPIS1_SI	MD32_1_JTAG_TDOSCP_JTAG0_TDO	APU_JTAG_TDO		DBG_MON_A16
14	GND							
15	GPIO139	SPIM1_MI	SCP_SPI1_A_MI	SPIS1_SO	MD32_1_JTAG_TDI	SCP_JTAG0_TDI	APU_JTAG_TDI	DBG_MON_A17
16	GPIO61	DMIC1_CLK	I2SO2_BCK	SCP_SPI2_CK				DBG_MON_B19
17	+3.3V							
18	GPIO62	DMIC1_DAT	I2SO2_WS	SCP_SPI2_MI				DBG_MON_B20
19	GPIO142	SPIM2_MO	SPINOR_IO0	SNFI_MOSI	DMIC4_DAT			DBG_MON_A12
20	GND							
21	GPIO143	SPIM2_MI	SPINOR_IO1	SNFI_MISO	DMIC4_CLK			DBG_MON_A13
22	GPIO17	SCL4	DMIC4_CLK	TDMIN_BCK				DBG_MON_A9
23	GPIO141	SPIM2_CLK	SPINOR_CK	SNFI_CLK	DMIC3_CLK			DBG_MON_A10
24	GPIO140	SPIM2_CSB	SPINOR_CS	SNFI_CS	DMIC3_DAT			DBG_MON_A11
25	GND							
26	GPIO103	UART1_RXD	VBUSVALID_3P	I2SO1_D11	SSPM_URXD_AO	TP_URXD1_AO	MD32_1_RXD	I2SIN_D3
27	GPIO15	SCL3	DMIC3_CLK	TDMIN_DI				DBG_MON_A7
28	GPIO14	SDA3	DMIC3_DAT	TDMIN_MCK				DBG_MON_A6
29	GPIO57	I2SO2_MCK		LCM1_RST				DBG_MON_B15
30	GND							
31	GPIO58	I2SO2_BCK						DBG_MON_B16
32	GPIO16	SDA4	DMIC4_DAT	TDMIN_LRCK				DBG_MON_A8
33	GPIO59	I2SO2_WS						DBG_MON_B17
34	GND							
35	GPIO60	I2SO2_D0						DBG_MON_B18
36	GPIO47	I2SIN_BCK		SPLIN_LRCK				DBG_MON_B5
37	GPIO46	I2SIN_MCK		SPLIN_MCK				DBG_MON_B4
38	GPIO48	I2SIN_WS		SPLIN_BCK				DBG_MON_B6
39	GND							
40	GPIO49	I2SIN_D0		SPLIN_D0				DBG_MON_B7

## 7.2 Network

The NIO 12L offers a low profile 10/100/1000 Mbps RJ45 connector for wired networking.

### 7.3 Camera and Display Interfaces

The NIO 12L features two 4-lane MIPI CSI connectors for camera integration and one 4-lane MIPI DSI connector for display output. These interfaces are optimized for compatibility with Radxa's camera and display accessories. Additionally, they are backward-compatible with standard industrial camera and display peripherals when used with adapter FPC cables, available from Radxa or third-party suppliers.

### 7.4 USB

Radxa NIO 12L is equipped with a USB Type-C interface, featuring both DisplayPort (DP) functionality and USB3.0 OTG functionality. Its DisplayPort (DP) functionality supports video resolutions of up to 4K at 60 frames per second (4Kp60).

Additionally, the NIO 12L incorporates four USB 3.0 Host Type-A ports. The cumulative power output for each pair of Type-A ports is rated at 1.4A, providing consistent power distribution across the connectors.

### 7.5 HDMI Output

The NIO 12L has one HDMI output port (Type A), which supports HDMI 2.0 display with resolutions of 4Kp60.

### 7.6 HDMI Input

The NIO 12L has one HDMI input port (Type A), which supports HDMI 2.0 input with resolutions of 4Kp60.

### 7.7 Audio Jack

The NIO 12L supports high quality analogue audio output via a 4-ring 3.5mm headphone jack. The analog audio output can drive 32 Ohm headphones directly. The audio jack also supports microphone input as default.

### 8 Availability

Radxa guarantees availability of the Radxa NIO 12L until at least September 2032.

### 9 Support

For hardware related questions, please send email to [hw@radxa.com](mailto:hw@radxa.com). For software related questions, please send email to [dev@radxa.com](mailto:dev@radxa.com). For business and sales related questions, please send emails to [sales@radxa.com](mailto:sales@radxa.com).

