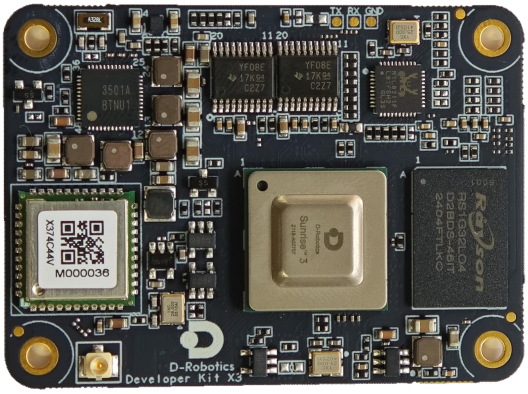
RDK X3 Module Datasheet

v1.0

RDK X3 Module, equipped with D-Robotics Sunrise ®3 series of high-performance intelligent chips, provides powerful end-side general and artificial intelligence computing power. The hardware design is compatible with the Raspberry PI CM4, which is convenient for users to quickly integrate and produce.

1. summarize



The RDK X3 Module features a quad-core Cortex® A53 processor, 5Tops computing power, up to 4GB memory, and support for 4K@60 frame video editing. The main interfaces include HDMI, Gigabit Ethernet, USB 3.0, MIPI CSI, MIPI DSI, etc.

Some models are equipped with dual-band 2.4/5.0GHz wireless LAN and Bluetooth 4.2 modules. Used with an external antenna kit, it enables wireless connectivity, reduces user development and test costs, and reduces time to market.

RDK X3 Module Optional on-board RAM capacity includes 2GB, 4GB, on-board eMMC capacity includes 16GB, 32GB, 64GB.

2. specification

Dimensions: 55 mm x 40 mm

Processor: Quad-core Arm® Cortex® A53 64-bit @ 1.5GHz

Memory: 2GB or 4GB LPDDR4

Peripheral interface:

- **Optional onboard 2.4GHz and 5GHz IEEE 802.11a/b/g/n/ac WLAN, Bluetooth 4.2 module and external antenna**
- **1 x Gigabit Ethernet PHY**
- **1 x USB 3.0 port**
- **32 GPIOs**
- **1 x MicroSD card port**

Graphics:

- **1 x 4-lane MIPI CSI interface**
- **2 x 2-lane MIPI CSI interface**

Display:

- **1 x HDMI port, supports up to 1080p60**
- **1 x MIPI DSI interface, supports a maximum of 1080p60**

Multimedia:

- **Support H.265 / H.264 codec, maximum 4K@60 frame**
- **Supports MJEPG codec**

Power input: 5V/3A DC

Operating temperature: -20 to 60°C

Life cycle: Maintain mass production until at least 2028

3. Function introduction

3.1 CPU

- Quad-core Arm® Cortex® A53 with 32 KB/32 KB L1 cache and 512 KB L2 cache
- Typical operating frequency: 1.2GHz
- Maximum operating frequency: 1.5GHz

Supports dynamic voltage and frequency regulation (DVFS)

3.2 BPU

- Dual core Bernoulli architecture BPU, composed of BPU0 and BPU1, equivalent to 5Tops computing power
- Typical operating frequency: 1.0GHz

3.3 Memory

- Support 2GB or 4GB LPDDR4
- Maximum speed up to 3200 MT/s

3.4 External storage

- Support 16GB/32GB/64GB eMMC
- Supports MicroSD memory card interface

3.5 Sensor Port

- 3x MIPI CSI interfaces: 1x 4-lane, 2x 2-lane
- Up to 2.0 Gbps per data channel
- Maximum access capability 4096x2160@60fps

RAW 8-/10-/12-/14-/16 bit format and 8-/10 bit YUV format are supported

PIN#	Signal Name	Description	Direction	Pin Type
128	CAM0_D0_N	Input Camera0 D0 negative	I	/

130	CAM0_D0_P	Input Camera0 D0 positive	I	
134	CAM0_D1_N	Input Camera0 D1 negative	I	
136	CAM0_D1_P	Input Camera0 D1 positive	I	
140	CAM0_C_N	Input Camera0 clock negative	I	
142	CAM0_C_P	Input Camera0 clock positive	I	

PIN#	Signal Name	Description	Direction	Pin Type
115	CAM1_D0_N	Input Camera1 D0 negative	I	
117	CAM1_D0_P	Input Camera1 D0 positive	I	
121	CAM1_D1_N	Input Camera1 D1 negative	I	
123	CAM1_D1_P	Input Camera1 D1 positive	I	
127	CAM1_C_N	Input Camera1 clock negative	I	/
129	CAM1_C_P	Input Camera1 clock positive	I	
133	CAM1_D2_N	Input Camera1 D2 negative	I	
135	CAM1_D2_P	Input Camera1 D2 positive	I	
139	CAM1_D3_N	Input Camera1 D3 negative	I	
141	CAM1_D3_P	Input Camera1 D3 positive	I	
157	CAM2_D0_N	Input Camera2 D0 negative	I	
159	CAM2_D0_P	Input Camera2 D0 positive	I	
163	CAM2_D1_N	Input Camera2 D1 negative	I	/
165	CAM2_D1_P	Input Camera2 D1 positive	I	
169	CAM2_C_N	Input Camera2 clock negative	I	
171	CAM2_C_P	Input Camera2 clock positive	I	

3.6 ISP

- Built-in image signal processor (ISP) to support RAW to YUV conversion
- Supports high dynamic range (HDR) sensors:
  - Digital Overlap (DOL) HDR sensors are supported
  - Supports linearized HDR sensors
  - Support native (on the sensor) compactor HDR sensor
- Supports auto-exposure, auto-white balance, and auto-focus (3A) histogram statistics
- Supports lens shadow correction
- Support for defect pixel correction (DPC)

- Supports spatial noise reduction
- Supports temporary noise reduction (3DNR)
- Support color noise reduction
- Support purple edge correction
- Support lens distortion correction (LDC)
- Supports cropping from input images
- Support 3D Color Lookup Table (LUT)
- Support RGB sharpening and edge enhancement
- Support gamma correction
- Lens GDC and fisheye correction
- ISP adjustment tool on PC
- Maximum processing capacity 4096x2160@60fps

3.7 Display Port

Module support HDMI, MIPI DSI two display interfaces, the function of time-sharing multiplexing.

3.7.1 HDMI Port

- Support one HDMI output
- Compatible with HDMI1.4 and HDCP1.4
- Maximum 1080P resolution output
- Integrated CEC controller
- Integrate EDID shadow RAM and embedded EDID

5V Tolerance DDC/HPD I/O

PIN#	Signal Name	Description	Direction	Pin Type
188	HDMI0_CLK_P	Output HDMI1 clock positive	O	/
190	HDMI0_CLK_N	Output HDMI1 clock negative		
182	HDMI0_TX0_P	Output HDMI0 TX0 positive		

184	HDMI0_TX0_N	Output HDMI0 TX0 negative		
176	HDMI0_TX1_P	Output HDMI0 TX1 positive		
178	HDMI0_TX1_N	Output HDMI0 TX1 negative		
170	HDMI0_TX2_P	Output HDMI0 TX2 positive		
172	HDMI0_TX2_N	Output HDMI0 TX2 negative		
200	HDMI0_SCL	Bidirectional HDMI0 SCL. Internally pulled up with a 2kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the Module by an on-board HDMI05-CL02F3)	O	5V0
199	HDMI0_SDA	Bidirectional HDMI0 SDA. Internally pulled up with a 2kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the Module by an on-board HDMI05-CL02F3)	I/O	5V0
151	HDMI0_CEC	Input HDMI0 CEC. 5V tolerant (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the Module by an on-board HDMI05-CL02F3)	I/O	5V0
PIN#	Signal Name	Description	Direction	Pin Type
153	HDMI0_HPD	Input HDMI0 hotplug. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the Module by an on-board HDMI05-CL02F3)	I	5V0

3.7.2 MIPI DSI

- Supports one MIPI DSI output
- 1 clock channel and up to 4 data channels
- Maximum 1080P resolution output

Supports 24-bit RGB888 format

PIN#	Signal Name	Description	Direction	Pin Type
175	DSI1_D0_N	Output Display1 D0 negative	0	/
177	DSI1_D0_P	Output Display1 D0 positive		
181	DSI1_D1_N	Output Display1 D1negative		
183	DSI1_D1_P	Output Display1 D1 positive		
187	DSI1_C_N	Output Display1 clock negative		
189	DSI1_C_P	Output Display1 clock positive		
193	DSI1_D2_N	Output Display1 D2 negative		
195	DSI1_D2_P	Output Display1 D2 positive		
194	DSI1_D3_N	Output Display1 D3 negative		
196	DSI1_D3_P	Output Display1 D3 positive		

3.8 Video codec

- Support H.265 (HEVC) encoding and decoding:
  - Main profile @L5.1
  - Supports I/P/B frames
- Support H.264 encoding and decoding:
  - Baseline/Main/High profiles@L5.1
  - H.264 supports SVC-T encoding
- H265/H264 codec performance:
  - 3840 x 2160p@60fps encoding/decoding + 1280 x 720p@30fps encoding/decoding
  - 4096 x 2160p@60fps encoding/decoding
  - 3840 x 2160p@30fps encoding/decoding + 1920 x 1080p@30fps encoding/decoding + 1280 x 720p@30fps encoding/decoding
  - 3840 x 2160p@30fps encoding/decoding + 3840 x 2160p@30fps encoding/decoding
- Support JPEG encoding and decoding:
  - Baseline profile
  - Supports the CBR, VBR, AVBR, FixQp, and QpMap bit rate control modes

3.9 Wireless network

Module integrated WIFI&BT module.

- Support WLAN 2.4GHz and 5GHz channels

Supports BT 4.2+HS, BLE and ANT+, and is backward compatible with BT 1.x and BT 2.x+ enhanced data rates

- Support 1×1 IEEE 802.11a/b/g/n/ac WLAN

- Provides single-ended ipex RF connectors, users can expand the antenna according to application requirements, to achieve easy to use, low-cost design.

Antenna configuration parameters:

Frequency range	2400-2500/5150-5850 MHz	Maximum power	10 W
Operating frequency band	100–700 MHz	Antenna size	109 × 10 mm
Standing-wave ratio	≤1.92	Connector type	SMA 内针
Peak gain	2±0.5 dBi	Housing material	TPEE
Output impedance	50 Ω	Operating temperature	-20˚C ~ + 70˚C
Polarization mode	perpendicularity	Radiation direction	全向

- Supports low power management

PIN#	Signal Name	Description	Direction	Pin Type
89	WL_ndisable	Can be left floating; if driven low the wireless interface will be disabled. Internally pulled up via 4kΩ to 3.3V	I	MD_3.3V
91	BT_ndisable	Can be left floating; if driven low the Bluetooth interface will be disabled. Internally pulled up via4kΩ to 3.3V	I	MD_3.3V

3.10 Interface description

3.10.1USB 3.0

Module support 1 USB3.0 DRD, speed up to 5Gbps; Supports the master/slave mode.

PIN#	Signal Name	Description	Direction	Pin Type
103	USB_N	USB D-	I/O	/
105	USB_P	USB D+	I/O	
116	USB_RX_P	USB3.0 RX positive	I	
118	USB_RX_N	USB3.0 RX negative	I	
122	USB_TX_P	USB3.0 TX positive	O	
124	USB_TX_N	USB3.0 TX negative	O	
101	USB_OTG_ID	Input (3.3V signal) USB OTG Pin. Internally pulled up 4K to MD_3.3V. When grounded the Module becomes a USB host but the correct OS driver also needs to be used	I	MD_3.3V

3.10.2 SPI

The module supports two SPI interfaces with the following features:

• In host mode, MOSI and MISO full duplex synchronous serial data transfer, host mode only.

Programmable SCLK frequency, polarity, and phase up to 48MHz.

• Only one CSN signal is supported with programmable polarity.

• Support MSB or LSB 8-bit or 16-bit data length transmission mode,

• Supports TX and RX registers to send and receive data.

• Support for embedded DMA controller for data sending and receiving with 32 byte TX FIFO and 32 byte RX FIFO.

• DMA supports RX FIFO refresh operations under timeout conditions for real-time applications.

Comprehensive status and outage reporting.

PIN#	Signal Name	Description	Direction	Pin Type
38	SPI1_SCLK	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
39	SPI1_CSN	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
44	SPI1_MOSI	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
40	SPI1_MISO	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I	GPIO_VREF

PIN#	Signal Name	Description	Direction	Pin Type
50	SPI2_MOSI	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
48	SPI2_MISO	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I	GPIO_VREF
35	SPI2_SCLK	(BCM2711 GPIO 1) GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
36	SPI2_CSN	(BCM2711 GPIO 0) GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF

For details about the interface multiplexing relationship, see《RDK X3 Module PINMUX》。

3.10.3 UART

The module supports three UART interfaces with the following features:

- Full duplex operation using TXD and RXD.
- Data reception with x16 oversampling and noise filtering.
- Configurable frame formats:
  - Data bits: 7 or 8 bits.
  - Parity bits: None, even, or odd.
  - Stop bit: 1 or 2 bits.
- Programmable baud rate generator with integer and decimal divisor.

- Support standard baud rate 921600 (x 16 oversampling).
- Support for sending and receiving data via UART_RDR and UART_TDR registers.
- Support for embedded DMA Controller for data transfer and reception with 64-byte TX FIFO and 64-byte RX FIFO.

DMA supports RX FIFO refresh operations for real-time applications under timeout conditions.

- Comprehensive status and outage reporting.

Support for software flow control capabilities with programmable XON/XOFF characters.

PIN#	Signal Name	Description	Direction	Pin Type
55	UART3_TXD	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
51	UART3_RXD	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I	GPIO_VREF

PIN#	Signal Name	Description	Direction	Pin Type
64	UART2_TXD	Uart Data TX pin: Internal 4kΩ pull up to GPIO_VREF	O	GPIO_VREF
68	UART2_RXD	Uart Data RX pin: Internal 4kΩ pull up to GPIO_VREF	I	GPIO_VREF
18	DEBUG_UART0_TX	Uart Data TX pin:Debug,a 1.8V signal	O	MD_1.8V
16	DEBUG_UART0_RX	Uart Data RX pin:Debug,a 1.8V signal	I	MD_1.8V

For details about the interface multiplexing relationship, see《RDK X3 Module PINMUX》。

3.10.4 I2C

The module supports four i2c ports with the following features:

- Conforms to Philips I2C bus specification version 2.1.
- Supports only host mode for single-master multi-slave systems.
- Support standard mode (up to 100Kbps) and fast mode (up to 400Kbps).
- Support 7-bit and 10-bit device addressing modes.

Comprehensive status and outage reporting.

PIN#	Signal Name	Description	Direction	Pin Type
56	I2C0_SCL	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V. Internal 1.8kΩ pull up to GPIO_VREF	O	GPIO_VREF
58	I2C0_SDA	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V. Internal 1.8kΩ pull up to GPIO_VREF	I/O	GPIO_VREF
50	I2C2_SCL	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
48	I2C2_SDA	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I/O	GPIO_VREF
35	I2C3_SCL	(BCM2711 GPIO 1) GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
36	I2C3_SDA	(BCM2711 GPIO 0) GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I/O	GPIO_VREF

PIN#	Signal Name	Description	Direction	Pin Type
80	I2C1_SCL	I2C clock pin: typically used for Camera and Display. Internal 4kΩ pull up to MD_3.3V	O	MD_3.3V
82	I2C1_SDA	I2C Data pin: typically used for Camera and Display. Internal 4kΩ pull up to MD_3.3V	I/O	MD_3.3V

For details about the interface multiplexing relationship, see《RDK X3 Module PINMUX》。

3.10.5 PCM

The module supports one PCM interface with the following features:

- Support master/slave mode.
- Full duplex mode.
- RX supports 1/2/4/8/16 audio inputs.
- TX supports 1/2 channel audio output.
- Supports 8-bit / 16-bit sampling accuracy.
- Support 8/16/32/44.1/48/64 KHz sampling rate.
- Support I2S/DSP mode.

- Configurable LRCK polarity in I2S mode.

Comprehensive status and outage reporting.

PIN#	Signal Name	Description	Direction	Pin Type
54	PCM_MCLK	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
49	PCM_BCLK	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
26	PCM_LRCK	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
25	PCM_OUT	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
27	PCM_IN	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I	GPIO_VREF

3.10.6 Ethernet

The module supports one Gigabit Ethernet port and has the following features:

- Support 100BASE-TX IEEE802.3u /1000Base-T IEEE 802.3ab standard.
- Support IEEE 802.3az-2010 (Energy Saving Ethernet).
- Built-in network wake-up.
- Support parallel detection, cross detection and automatic correction, automatic polarity correction, interrupt function, baseline drift correction.
- Support 1000Base-T CAT.5 cable 120m.

2 network status leds are available.

PIN#	Signal Name	Description	Direction	Pin Type
4	Ethernet_Pair1_P	Ethernet pair 1 positive (connect to transformer or MagJack)	I/O	/
6	Ethernet_Pair1_N	Ethernet pair 1 negative (connect to transformer or MagJack)		
3	Ethernet_Pair3_P	Ethernet pair 3 positive (connect to transformer or MagJack)		
5	Ethernet_Pair3_N	Ethernet pair 3 negative (connect to transformer or MagJack)		
10	Ethernet_Pair0_N	Ethernet pair 0 negative (connect to transformer or MagJack)		

12	Ethernet_Pair0_P	Ethernet pair 0 positive (connect to transformer or MagJack)		
9	Ethernet_Pair2_N	Ethernet pair 2 negative (connect to transformer or MagJack)		
11	Ethernet_Pair2_P	Ethernet pair 2 positive (connect to transformer or MagJack)		
15	Ethernet_nLED3	Active-low Ethernet speed indicator (3.3V signal): typically a yellow LED is connected to this pin. A low state indicates the 1Gbit or 100Mbit link: IOL = 8mA @ VOL < 0.4V	O	MD_3.3V
17	Ethernet_nLED2	Active-low Ethernet speed indicator (3.3V signal): typically a yellow LED is connected to this pin. A low state indicates the 1Gbit or 100Mbit link: IOL = 8mA @ VOL < 0.4V	O	MD_3.3V

3.10.7 SDIO

1.10.7.1 Introducion

The module provides an MMC Host Controller that supports the eMMC/SD protocol and controls devices that comply with the SD memory specification version 3.0 and SDIO Specification version 3.0.
The MMC Controller supports SD 3.0 ultra-high speed (UHS-1) and offers up to SDR104 mode.

1.10.7.2 trait

The SDIO module has the following main features:

- Supports up to 4 lines of data bus
- SD/SDIO supports up to SDR104 mode with transmission clocks up to 192 MHz.

Comprehensive outage and status reporting.

PIN#	Signal Name	Description	Direction	Pin Type
57	SD_CLK	SD card clock signal	O	MD_3.3V/MD_1.8V
62	SD_CMD	SD card/eMMC Command signal	I/O	
63	SD_DATA0	SD card/eMMC Data0 signal	I/O	
67	SD_DATA1	SD card/eMMC Data1 signal	I/O	
69	SD_DATA2	SD card/eMMC Data2 signal	I/O	
61	SD_DATA3	SD card/eMMC Data3 signal	I/O	
75	SD_PWR_ON	Output to power-switch for the SD card. The Module sets this pin high (3.3V) to signal that power to the SD card should be turned on.defaults Output low. If booting from the SD card is required then a pullup should also be fitted so the power-switch defaults to on.	O	MD_3.3V

1.10.8 PWM

1.10.8.1 introduce

The pulse width modulation (PWM) module is used to generate square waves with variable pulse width and frequency. PWM(Pulse-Width Modulation) is widely used in motor speed regulation, LED brightness regulation, rectifiers, audio output, etc.

1.10.8.2 trait

PWM module has the following main features:

- 5 PWM signals

The frequency range is 46.8khz-192mhz

PIN#	Signal Name	Description	Direction	Pin Type
13	PWM0	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
45	PWM1	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF

PIN#	Signal Name	Description	Direction	Pin Type
31	PWM4	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
50	PWM7	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF
48	PWM8	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	O	GPIO_VREF

1.10.9 nPRIBOOT

This pin is used to control the entry of fastboot burn mode. When this pin is lowered during boot, the system will enter USB fastboot mode, and the eMMC system image can be burned through the hbupdate tool.

1.10.10 LED_nACT

This pin is used to indicate the operating status of the system, which is blinking or off during normal operation. If any errors occur during system startup, this LED will remain on.

1.10.11 PI_LED_nPWR

This pin is used to indicate the power supply status of the system. It is always on when the power supply is normal.

4. Power and system management

PIN#	Signal Name	Description	Direction	Pin Type
77	+5V (Input)	Main power input.	Input	4.75V-5.25V
79				
81				
83				
85				
87				
88	MD_1.8V (Output)	Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low	Output	1.8V ± 2.5%
90				
84	MD_3.3V (Output)	Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low	Output	3.3V ± 2.5%
86				
99	GLOBAL_EN	Input. Drive low to power off RDK X3 Module. Internally pulled up with a 100kΩ to +5V	Input	CMOS-5V

PIN#	Signal Name	Description	Direction	Pin Type
78	GPIO_VREF	Must be connected to MD_3.3V (pins 84 and 86) for 3.3V GPIO or MD_1.8V (pins 88 and 90) for 1.8V GPIO. This pin can not be floating or connected to ground.	Input	MD_1.8V or MD_3.3V
92	RUN_PG	Bidirectional pin. Can be driven low (via a 220Ω resistor) to reset the RDK X3 Module CPU. As an output, a high signals that power is good and CPU is running. Internally pulled up to +3.3V via 10kΩ	Input/Output	MD_3.3V

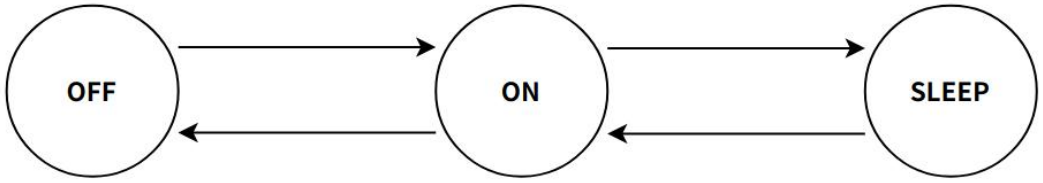
4.1 Power rail

The +5V input is provided by the base plate of the module

GPIO_VREF is provided by the modules MD_1.8V or MD_3.3V

4.2 电源管理

The module supports dynamic voltage regulation to give full play to the performance of CPU&BPU. At the same time, the SOC supports deep sleep, and the module enters the low power mode. When in low power mode, either a GPIO (choose any 4 GPIOs) or an RTC can be used as a wake-up source.



4.3 RUN_PG

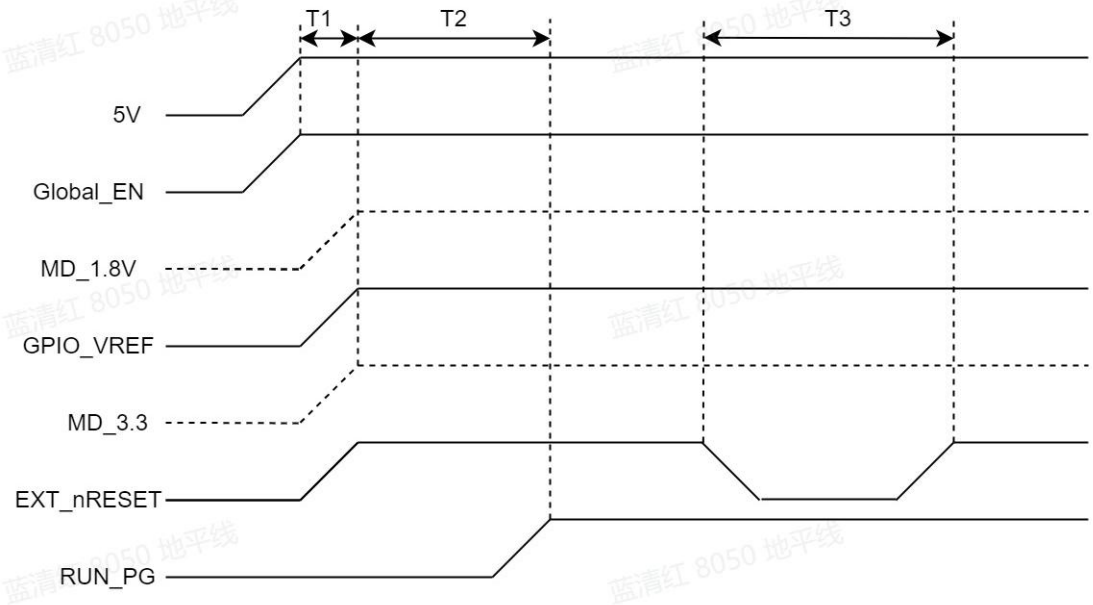
RUN_PG is a bidirectional pin, the module is powered on, and the pin output is high. This pin can also be used as an input pin to pull down the reset SOC, and the pull down time does not exceed 500ms.

4.4 GLOBAL_EN

Global_EN is an input pin, the pin external pull down, pull down time is more than 400ms, the module into power state.

4.5 Power on timing

The module power-on timing requirements are as follows:
Power on at 1.5V
2.Global_EN can be powered on at the same time as 5V, or it can be delayed to pull up
3. The external IO connected to the module needs to be powered on later than MD_3.3V & MD_1.8V
4.RUN_PG will be raised after the system power on is completed
The EXT_nRESET signal acts as a watchdog signal for the chip and is only pulled down when the system is rebooted



T1≥13ms，T2 > 75ms T3= 20ms(only reboot)

4.6 Power down timing

There are two working modes of module power down, 5V input power down directly, and Global_EN can also be pulled down.

The power-on time interval needs to be controlled to be greater than 1s.

4.7 Thermal management mechanism

In order to operate stably under various workloads and environmental conditions, users are provided with active or passive heat sink solutions. By means of hardware and software, the temperature of the module is controlled within the limit. See RDK X3 Module Thermal Design Guide for more information.

5. Pin function definition

5.1 GPIO

The SOM module has multiple GPIO pins, each GPIO pin can be configured as input, output or interrupt source, some pins support SFIO function (UART, SPI, I2S,I2C etc.). For more information, see RDK X3 Module PINMUX. Here are some GPIO functions:

PIN#	Signal Name	Description	Direction	Pin Type
38	GPIO11	GPIO	I/O	GPIO_VREF
28	GPIO13	GPIO	I/O	GPIO_VREF
39	GPIO8	GPIO	I/O	GPIO_VREF
44	GPIO10	GPIO	I/O	GPIO_VREF

40	GPIO9	GPIO	I/O	GPIO_VREF
47	GPIO23	GPIO	I/O	GPIO_VREF
37	GPIO7	GPIO	I/O	GPIO_VREF
41	GPIO25	GPIO	I/O	GPIO_VREF
46	GPIO22	GPIO	I/O	GPIO_VREF
29	GPIO16	GPIO	I/O	GPIO_VREF
45	GPIO24	GPIO	I/O	GPIO_VREF
31	GPIO12	GPIO	I/O	GPIO_VREF
24	GPIO26	GPIO	I/O	GPIO_VREF
30	GPIO6	GPIO	I/O	GPIO_VREF
34	GPIO5	GPIO	I/O	GPIO_VREF
54	GPIO4	GPIO	I/O	GPIO_VREF
49	GPIO18	GPIO	I/O	GPIO_VREF
26	GPIO19	GPIO	I/O	GPIO_VREF
25	GPIO21	GPIO	I/O	GPIO_VREF
27	GPIO20	GPIO	I/O	GPIO_VREF
56	GPIO3	GPIO	I/O	GPIO_VREF
58	GPIO2	GPIO	I/O	GPIO_VREF
55	GPIO14	GPIO	I/O	GPIO_VREF
51	GPIO15	GPIO	I/O	GPIO_VREF
50	GPIO17	GPIO	I/O	GPIO_VREF
48	GPIO27	GPIO	I/O	GPIO_VREF
35	GPIO1	GPIO	I/O	GPIO_VREF
36	GPIO0	GPIO	I/O	GPIO_VREF
97	Camera_GPIO	GPIO	I/O	MD_3.3V
76	SDO_DET_N	GPIO	I/O	MD_1.8V
70	SENSOR0_MCLK	GPIO	I/O	MD_1.8V
72	SENSOR1_MCLK	GPIO	I/O	MD_1.8V

5.2 Module interface definition

Pin	Signal	Description
1	GND	Ground (0V)
2	GND	Ground (0V)
3	Ethernet_Pair3_P	Ethernet pair 3 positive (connect to transformer or MagJack)
4	Ethernet_Pair1_P	Ethernet pair 1 positive (connect to transformer or MagJack)
5	Ethernet_Pair3_N	Ethernet pair 3 negative (connect to transformer or MagJack)
6	Ethernet_Pair1_N	Ethernet pair 1 negative (connect to transformer or MagJack)
7	GND	Ground (0V)

8	GND	Ground (0V)
9	Ethernet_Pair2_N	Ethernet pair 2 negative (connect to transformer or MagJack)
10	Ethernet_Pair0_N	Ethernet pair 0 negative (connect to transformer or MagJack)
11	Ethernet_Pair2_P	Ethernet pair 2 positive (connect to transformer or MagJack)
12	Ethernet_Pair0_P	Ethernet pair 0 positive (connect to transformer or MagJack)
13	GND	Ground (0V)
14	GND	Ground (0V)
15	Ethernet_nLED3	Active-low Ethernet speed indicator (3.3V signal): typically a yellow LED is connected to this pin. A low state indicates the 1Gbit or 100Mbit link: IOL = 8mA @ VOL < 0.4V
16	Debug_Uart0_RX	Uart Data RX pin:Debug,a 1.8V signal
17	Ethernet_nLED2	Active-low Ethernet speed indicator (3.3V signal): typically a yellow LED is connected to this pin. A low state indicates the 1Gbit or 100Mbit link: IOL = 8mA @ VOL < 0.4V
18	Debug_Uart0_TX	Uart Data TX pin:Debug,a 1.8V signal
19	NC	
20	NC	NC
21	Pi_nLED_Activity	Active-low Pi activity LED. 20mA Max 5V tolerant (VOL < 0.4V).
22	GND	Ground (0V)
23	GND	Ground (0V)
24	GPIO26	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
25	GPIO21	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
26	GPIO19	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
27	GPIO20	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
28	GPIO13	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
29	GPIO16	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
30	GPIO6	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
31	GPIO12	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
32	GND	Ground (0V)
33	GND	Ground (0V)
34	GPIO5	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
35	ID_SC	(BCM2711 GPIO 1) GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
36	ID_SD	(BCM2711 GPIO 0) GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
37	GPIO7	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
38	GPIO11	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
39	GPIO8	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
40	GPIO9	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
41	GPIO25	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
42	GND	Ground (0V)
43	GND	Ground (0V)
44	GPIO10	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
Pin	**Signal**	**Description**
45	GPIO24	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
46	GPIO22	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
47	GPIO23	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
48	GPIO27	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
49	GPIO18	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
50	GPIO17	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
51	GPIO15	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
52	GND	Ground (0V)
53	GND	Ground (0V)
54	GPIO4	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V

55	GPIO14	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V
56	GPIO3	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V. Internal 1.8kΩ pull up to GPIO_VREF
57	SD_CLK	SD card clock signal
58	GPIO2	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V. Internal 1.8kΩ pull up to GPIO_VREF
59	GND	Ground (0V)
60	GND	Ground (0V)
61	SD_DAT3	SD card/eMMC Data3 signal
62	SD_CMD	SD card/eMMC Command signal
63	SD_DAT0	SD card/eMMC Data0 signal
64	UART2_TXD	Uart Data TX pin: Internal 4kΩ pull up to GPIO_VREF
65	GND	Ground (0V)
66	GND	Ground (0V)
67	SD_DAT1	SD card/eMMC Data1 signal
68	UART2_RXD	Uart Data RX pin: Internal 4kΩ pull up to GPIO_VREF
69	SD_DAT2	SD card/eMMC Data2 signal
70	SENSOR0_MCLK	GPIO: typically a 1.8V signal
71	GND	Ground (0V)
72	SENSOR1_MCLK	GPIO: typically a 1.8V signal
73	NC	NC
74	GND	Ground (0V)
75	SD_PWR_ON	Output to power-switch for the SD card. The module sets this pin high (3.3V) to signal that power to the SD card should be turned on.defaults Output low. If booting from the SD card is required then a pullup should also be fitted so the power-switch defaults to on.
76	SD0_DET_N	GPIO: typically a 1.8V signal
77	+5V (Input)	4.75V-5.25V. Main power input
78	GPIO_VREF	Must be connected to MD_3.3V (pins 84 and 86) for 3.3V GPIO or MD_1.8V (pins 88 and 90) for 1.8V GPIO. This pin cannot be floating or connected to ground.
79	+5V (Input)	4.75V-5.25V. Main power input
80	SCL1	I2C clock pin: typically used for Camera and Display. Internal 4kΩ pull up to MD_3.3V
81	+5V (Input)	4.75V-5.25V. Main power input
82	SDA1	I2C Data pin: typically used for Camera and Display. Internal 4kΩ pull up to MD_3.3V
83	+5V (Input)	4.75V-5.25V. Main power input
84	MD_3.3V (Output)	3.3V ± 2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low
85	+5V (Input)	4.75V-5.25V. Main power input
86	MD_3.3V (Output)	3.3V ± 2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low
87	+5V (Input)	4.75V-5.25V. Main power input
88	MD_1.8V (Output)	1.8V ± 2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low
89	WL_nDisable	Can be left floating; if driven low the wireless interface will be disabled. Internally pulled up via 4kΩ to 3.3V
Pin	**Signal**	**Description**
90	MD_1.8V (Output)	1.8V ± 2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power-off or GLOBAL_EN being set low
91	BT_nDisable	Can be left floating; if driven low the Bluetooth interface will be disabled. Internally pulled up via4kΩ to 3.3V
92	RUN_PG	Bidirectional pin. Can be driven low (via a 220Ω resistor) to reset the CPU. As an output, a high signals that power is good and CPU is running. Internally pulled up to 3.3V via 2kΩ
93	nRPIBOOT	A low on this pin forces booting from an RPI server (e.g. PC or a Raspberry Pi); if not used leave floating. Internally pulled up via 4kΩ to 3.3V
94	NC	NC
95	PI_LED_nPWR	Active-low output to drive Power On LED. This signal needs to be buffered.
96	NC	NC

97	Camera_GPIO	Typically used to shut down the camera to reduce power. Reassigning this pin to another function isn't recommended. MD_3.3V signalling
98	GND	Ground (0V)
99	GLOBAL_EN	Input. Drive low to power off Module. Internally pulled up with a 47kΩ to +5V
100	nEXTRST	Output. Driven low during reset; Driven high (MD_3.3V) once Module CPU has started to boot. Internally pulled up via4kΩ to 3.3V
101	USB_OTG_ID	Input (3.3V signal) USB OTG Pin. Internally pulled up 4K to MD_3.3V. When grounded the Module becomes a USB host but the correct OS driver also needs to be used
102	NC	NC
103	USB_N	USB D-
104	5V	4.75V-5.25V. Main power input
105	USB_P	USB D+
106	5V	4.75V-5.25V. Main power input
107	GND	Ground (0V)
108	GND	Ground (0V)
109	NC	NC
110	NC	NC
111	NC	NC
112	NC	NC
113	GND	Ground (0V)
114	GND	Ground (0V)
115	CAM1_D0_N	Input Camera1 D0 negative
116	USB_RX_P	USB3.0 RX positive
117	CAM1_D0_P	Input Camera1 D0 positive
118	USB_RX_N	USB3.0 RX negative
119	GND	Ground (0V)
120	GND	Ground (0V)
121	CAM1_D1_N	Input Camera1 D1 negative
122	USB_TX_P	USB3.0 TX positive
123	CAM1_D1_P	Input Camera1 D1 positive
124	USB_TX_N	USB3.0 TX negative
125	GND	Ground (0V)
126	GND	Ground (0V)
127	CAM1_C_N	Input Camera1 clock negative
128	CAM0_D0_N	Input Camera0 D0 negative
129	CAM1_C_P	Input Camera1 clock positive
130	CAM0_D0_P	Input Camera0 D0 positive
131	GND	Ground (0V)
132	GND	Ground (0V)
133	CAM1_D2_N	Input Camera1 D2 negative
134	CAM0_D1_N	Input Camera0 D1 negative
135	CAM1_D2_P	Input Camera1 D2 positive
Pin	**Signal**	**Description**
136	CAM0_D1_P	Input Camera0 D1 positive
137	GND	Ground (0V)
138	GND	Ground (0V)
139	CAM1_D3_N	Input Camera1 D3 negative
140	CAM0_C_N	Input Camera0 clock negative
141	CAM1_D3_P	Input Camera1 D3 positive
142	CAM0_C_P	Input Camera0 clock positive
143	NC	NC
144	GND	Ground (0V)

145	NC	NC
146	NC	NC
147	NC	NC
148	NC	NC
149	NC	NC
150	GND	Ground (0V)
151	HDMI0_CEC	Input HDMI0 CEC. 5V tolerant (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the Module by an on-board HDMI05-CL02F3)
152	NC	NC
153	HDMI0_HPD	Input HDMI0 hotplug. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the Module by an on-board HDMI05-CL02F3)
154	NC	NC
155	GND	Ground (0V)
156	GND	Ground (0V)
157	CAM2_D0_N	Input Camera2 D0 negative
158	NC	NC
159	CAM2_D0_P	Input Camera2 D0 positive
160	NC	NC
161	GND	Ground (0V)
162	GND	Ground (0V)
163	CAM2_D1_N	Input Camera2 D1 negative
164	NC	NC
165	CAM2_D1_P	Input Camera2 D1 positive
166	NC	NC
167	GND	Ground (0V)
168	GND	Ground (0V)
169	CAM2_C_N	Input Camera2 clock negative
170	HDMI0_TX2_P	Output HDMI0 TX2 positive
171	CAM2_C_P	Input Camera2 clock positive
172	HDMI0_TX2_N	Output HDMI0 TX2 negative
173	GND	Ground (0V)
174	GND	Ground (0V)
175	DSI1_D0_N	Output Display1 D0 negative
176	HDMI0_TX1_P	Output HDMI0 TX1 positive
177	DSI1_D0_P	Output Display1 D0 positive
178	HDMI0_TX1_N	Output HDMI0 TX1 negative
179	GND	Ground (0V)
180	GND	Ground (0V)
181	DSI1_D1_N	Output Display1 D1 negative
182	HDMI0_TX0_P	Output HDMI0 TX0 positive
183	DSI1_D1_P	Output Display1 D1 positive
Pin	**Signal**	**Description**
184	HDMI0_TX0_N	Output HDMI0 TX0 negative
185	GND	Ground (0V)
186	GND	Ground (0V)
187	DSI1_C_N	Output Display1 clock negative
188	HDMI0_CLK_P	Output HDMI0 clock positive
189	DSI1_C_P	Output Display1 clock positive
190	HDMI0_CLK_N	Output HDMI0 clock negative
191	GND	Ground (0V)
192	GND	Ground (0V)

193	DSI1_D2_N	Output Display1 D2 negative
194	DSI1_D3_N	Output Display1 D3 negative
195	DSI1_D2_P	Output Display1 D2 positive
196	DSI1_D3_P	Output Display1 D3 positive
197	GND	Ground (0V)
198	GND	Ground (0V)
199	HDMI0_SDA	Bidirectional HDMI0 SDA. Internally pulled up with a 2kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the Module by an on-board HDMI05-CL02F3)
200	HDMI0_SCL	Bidirectional HDMI0 SCL. Internally pulled up with a 2kΩ. 5V tolerant. (It can be connected directly to a HDMI connector; a small amount of ESD protection is provided on the Module by an on-board HDMI05-CL02F3)

6. DC characteristic

6.1 Maximum operating voltage rating

Symbol	Description	Min	Typical	Max	Units
Vin	+5V (Input)	4.75	5	5.25	V
Vgpio_vref	MD_1.8V	1.71	1.8	1.88	V
	MD_3.3V	3.135	3.3	3.465	V

6.2 Digital IO logic level

Digital IO Electrical performance:

Symbol	Description	Voltage	Min	Typical	Max	Units
Vil	Input Low Voltage	U	0		0.25xU	V
Vih	Input High Voltage		0.625xU		U	V
Voh	Output High Voltage	U	0.75xU			V
Vol	Output Low Voltage		0		0.125xU	V

The electrical performance of the following functional pins is as follows:

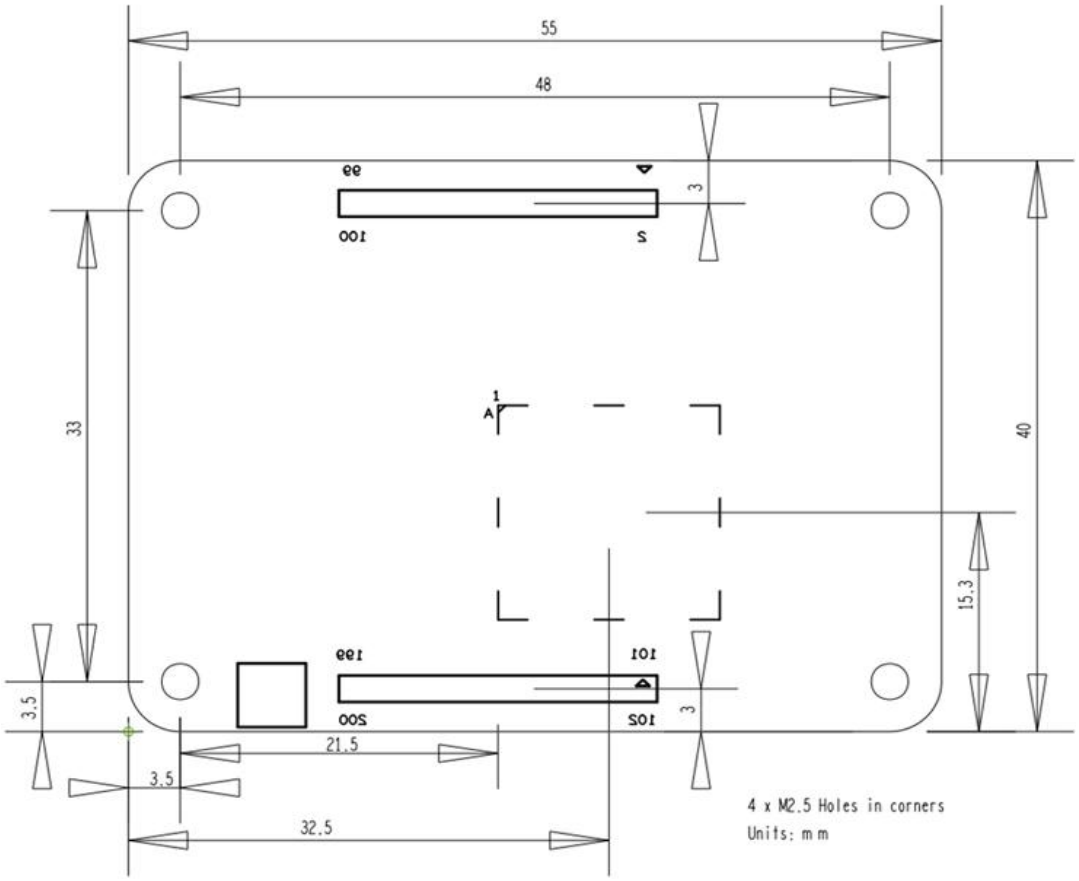
Symbol	Description	Voltage	Min	Typical	Max	Units
Vih	Input High Voltage	U=3.3V	U-0.4		U	V
Vil	Input Low Voltage		0		0.15	V
Vih	Input High Voltage	U=1.8V	U-0.4		U	V
Vil	Input Low Voltage		0		0.15	V
Voh	Output High Voltage	U=3.3V	0.75xU			V
Vol	Output Low Voltage		0		0.55	V
Voh	Output High Voltage	U=1.8V	0.75xU			V
Vol	Output Low Voltage		0		0.4	V

PIN#	Signal Name	Description	Direction	Pin Type
54	GPIO4	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I/O	GPIO_VREF
49	GPIO18	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I/O	GPIO_VREF
26	GPIO19	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I/O	GPIO_VREF
25	GPIO21	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I/O	GPIO_VREF
27	GPIO20	GPIO: typically a 3.3V signal, but can be a 1.8V signal by connecting GPIO_VREF to 1.8V	I/O	GPIO_VREF
80	SCL1	I2C clock pin: typically used for Camera and Display. Internal 4kΩ pull up to MD_3.3V	I	MD_3.3V
82	SDA1	I2C Data pin: typically used for Camera and Display. Internal 4kΩ pull up to MD_3.3V	I/O	MD_3.3V
64	UART2_TXD	Uart Data TX pin: Internal 4kΩ pull up to GPIO_VREF	I	GPIO_VREF
68	UART2_RXD	Uart Data RX pin: Internal 4kΩ pull up to GPIO_VREF	O	GPIO_VREF
93	nRPIBOOT	A low on this pin forces booting from an RPI server (e.g. PC or a Raspberry Pi); if not used leave floating. Internally pulled up via 4kΩ to 3.3V	I	MD_3.3V
89	WL_ndisable	Can be left floating; if driven low the wireless interface will be disabled. Internally pulled up via 4kΩ to 3.3V	I	MD_3.3V
91	BT_ndisable	Can be left floating; if driven low the Bluetooth interface will be disabled. Internally pulled up via4kΩ to 3.3V	I	MD_3.3V
100	nEXTRST	Output. Driven low during reset; Driven high (MD_3.3V) once Module CPU has started to boot. Internally pulled up via4kΩ to 3.3V	O	MD_3.3V

PIN#	Signal Name	Description	Direction	Pin Type
101	USB_OTG_ID	Input (3.3V signal) USB OTG Pin. Internally pulled up 4K to MD_3.3V. When grounded the Module becomes a USB host but the correct OS driver also needs to be used	I	MD_3.3V
97	Camera_GPIO	Typically used to shut down the camera to reduce power. Reassigning this pin to another function isn't recommended. MD_3.3V signalling	O	MD_3.3V

7. Size drawing

RDK X3 Module LxH:55x40, PCB thickness is 1.2mm, front SOC is 3.5mm at the highest
point



8. 修订记录

Version	Date	Description
v1.0	2023.05.23	Initial documentation