EM3576 Android14 User Manual

V1.0

Boardcon Embedded Designer

Overview

The content of this document is intended solely for the EM3576 development board, aiming to help users quickly understand, apply, and test the EM3576 development board.

System Support

Development Board	Android14
CM3576 V1 EM3576 V2	Y

Revision History

Version	Date	Author	Revision History
V1.0	2024-12-31	Boarcon Team	Initial version

Disclaimer

The information in this manual is for reference only. While Boardcon strives to ensure its accuracy, no guarantees are made regarding its completeness or correctness. All content is subject to change without prior notice. Boardcon reserves the right to revise the content of this manual without prior notification.

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Content

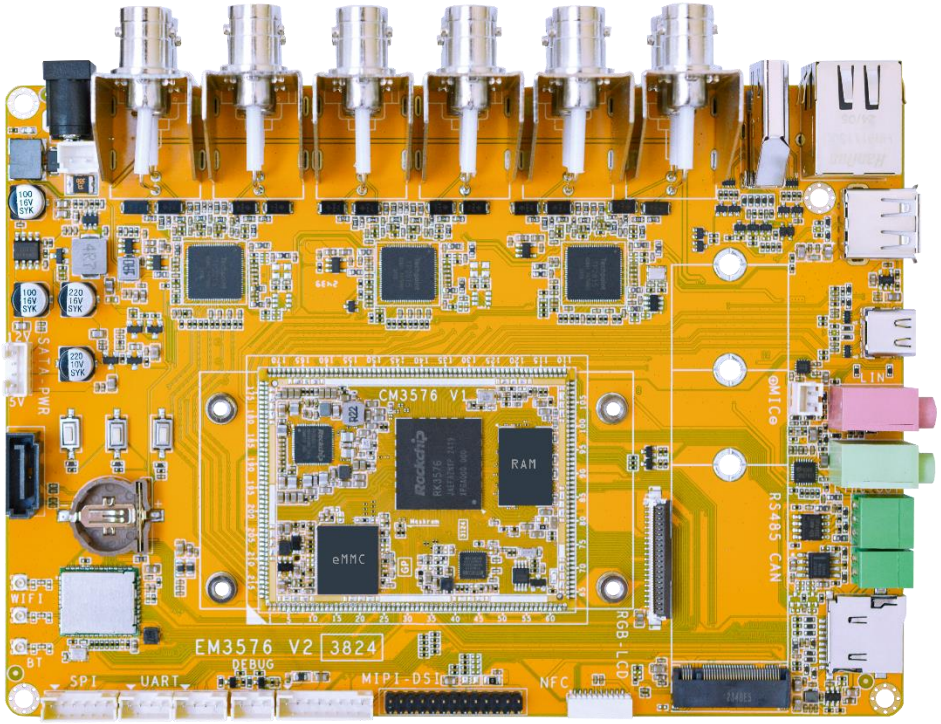
1.Introduction

1.1 Overview

The EM3576 development board is equipped with the RK3576 processor, featuring a quad-core Cortex-A72 and a quad-core Cortex-A53 architecture, providing powerful computing performance for smart devices and edge computing.

It includes a 16MP ISP that supports HDR, dehaze, sharpening, and other image optimization algorithms to enhance image quality, making it ideal for high-quality camera applications. The integrated AI computing unit supports popular neural network frameworks and offers robust inference capabilities to meet AI application needs.

The video decoder supports up to 8K@30fps and 4K@120fps, while the video encoder supports up to 4K@60fps. The board is equipped with a variety of peripheral interfaces, allowing flexible expansion and supporting diverse application scenarios to meet the requirements of different devices and applications.



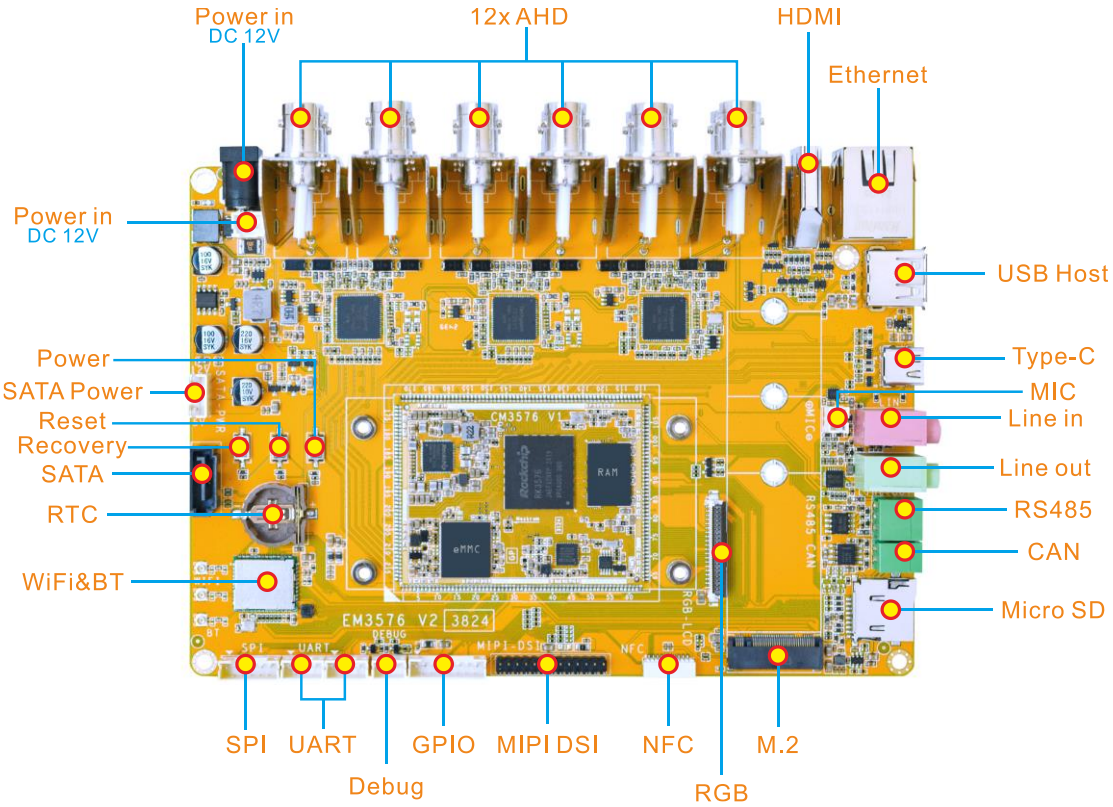
1.2 Product Parameters

Basic Parameters		
SOC		RK3576
CPU		• Octa-core 64-bit architecture (Quad-core Cortex-A72 + Quad-core Cortex-A53)
GPU		• ARM Mali-G52 MC3 GPU • Support OpenGL ES 1.1/2.0/3.2 • Support Vulkan 1.1 • Support OpenCL 2.0 Full Profile • Support AFBC
NPU		• 6 TOPS for INT8 operations. • Supports INT4, INT8, INT16, FP16, BF16, TF32 operation
Video	Decoder	• Supports up to 8K@30fps or 4K@120fps for H.265/HEVC, VP9, AVS2, and AV1 video decoding • Supports up to 4K@60fps for H.264/AVC and MVC video decoding
	Encoder	• Supports H.264/AVC, H.265/HEVC video encoding up to 4K@60fps
RAM		4GB (up to 8GB) LPDDR4X
ROM		32GB(up to 256GB) eMMC
Support system		Android, Debian, Buildroot, Yocto
Hardware Parameters		
Extended Storage		• Support 1x M.2 PCIe3.0 SSD • Support 1xSATA(Can not be used at the same time as USB 2.0) • Support 1x MicroSD Card

Display	• Support 1x HDMI2.1 output, up to 4K@120fps • Support 1x 4-lane MIPI output, up to 2560x1600@60fps • Support 1x DP AIT mode output(Type-C to DP), up to 4K@60fps
Audio	• Support 1x HDMI TX audio output • Support 1x DP AIT mode(Type-C to DP) audio output • Support 1x Headphone line output • Support 1x Headphone line input
USB	• Support 1xUSB2.0 • Support 1x USB3.1 Type-C (ADB/USB/DP AIT)
Network	• Support 1x Gigabit Ethernet • Support 1x WIFI/BT module
Camera	• Support 12xAHD
Peripheral communication	• Support 1xCAN • Support 1xRS485 • Support 2xUART • Support 1xSPI
Other parameters	Support 1xDebug, 1xRTC, 3xGPIO
Electrical Parameters	
Power supply input voltage	12V/3A
RTC input voltage	3V/0.6uA
Operating temperature	0~70°
Storage temperature	-40~85°
Structural Parameters	
Core board dimensions	57.5mm x 44.0mm

Motherboard dimensions	170mm x 120mm

1.3 Hardware Interface Introduction



Interface parameters	
Power in DC 12V	12V DC power input interface
12x AHD	12-channel AHD camera input interface
HDMI	HDMI2.1 TX interface
Ethernet	Gigabit Ethernet RJ45 interface
USB Host	USB2.0 Host interface
Type-C	USB Type-C interface, OTG download interface
MIC	Microphone input interface
Line in	Audio line-in interface

Line out	Audio line-out interface
RS485	RS485 communication interface
CAN	CAN communication interface
Micro SD	Micro SD card slot
M.2	M.2 interface for connecting SSD
RGB	RGB interface(multiplexed with SPI &2x UART)
NFC	NFC interface
MIPI DSI	MIPI DSI interface
GPIO	General Purpose Input/Output pins
Debug	debug the serial port
UART	• UART10, TTL level serial interface • UART11, TTL level serial interface
SPI	SPI interface
WIFI&BT	WIFI&Bluetooth module
RTC	RTC coin cell connector
SATA	SATA interface
Recovery	Recovery key
Reset	Reset key
SATA _Power	SATA Power interface
Power	Power key

2.Install Drivers and Tool

To download firmware and debug in the terminal, the following drivers and software need to be installed (for Windows computers):

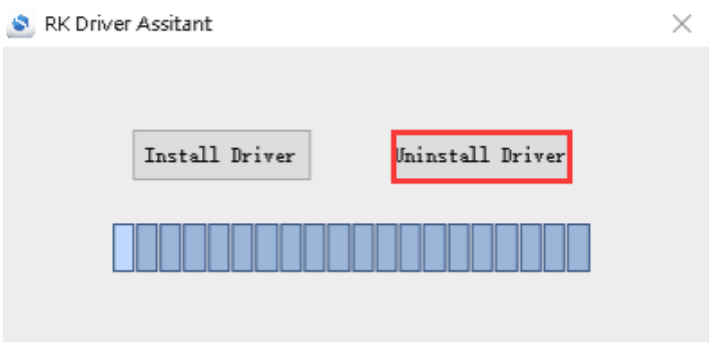
Number	Driver name	Driver	Use
1	RK Driver Assitant	DriverInstall.exe	OTG USB driver installation assitant

2	CH9102x	SETUP.EXE	Serial port debugging driver
3	Serial Terminal Tool	SecureCRT.exe	Debugging tool

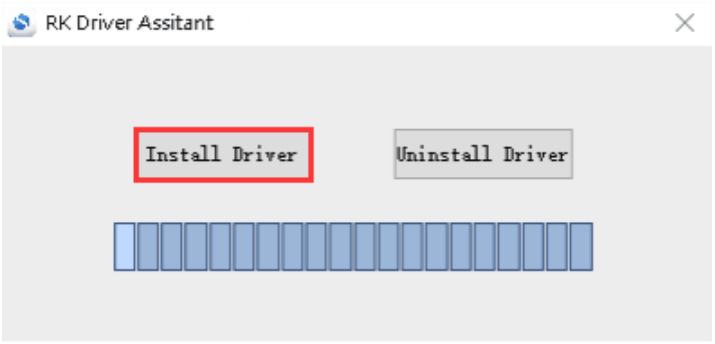
2.1 Install RK Driver Assitant

Step 1: Open *DriverAssitant_v5.1.13/DriverInstall.exe*.

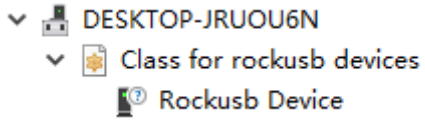
Step 2: To avoid driver conflicts, click **"Uninstall Driver"** to uninstall the driver.



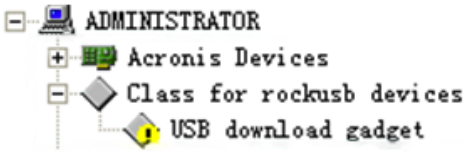
Step 3: Click button **"Install Driver"** to install.



Step 4: After the installation is complete, connect the board and PC with Type_C USB cable and press the **Recovery** key and hold then power the board, the following information is displayed in the Computer **Device Manager**, indicating that the USB driver was successfully installed.



Step 5: If the following device information appears in the **Device Manager** after the operation in Step 4, user need to proceed to the next step.

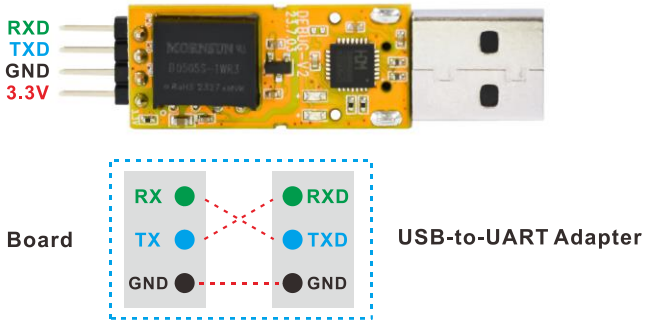


Step 6: The WINDOW will pop up found New Hardware Wizard dialog box, choose to install from the specified location, and then select: *DriverAssitant_v5.1.13/ADBDriver*.

Step 7: After the installation is completed, the following device information can be seen in the Computer **Device Manager**.

2.2 Install CH9102X Driver

2.2.1 How to Connect the Serial Port Tool



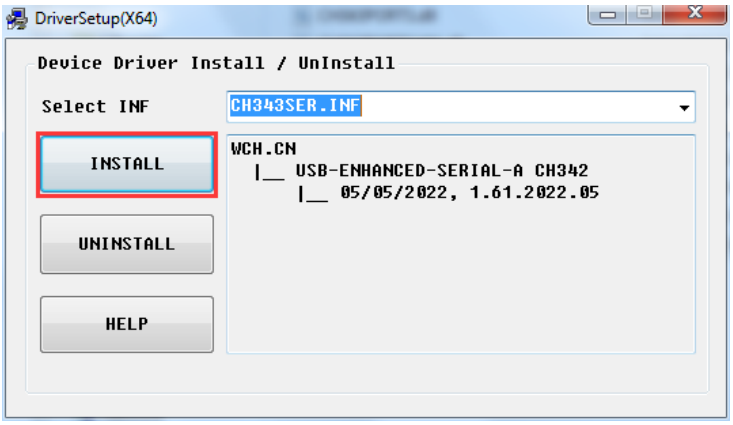
Pin	Connection Description
RXD	Receive, connect to TX pin of the board.
TXD	Transmit, connect to RX pin of the board.
GND	Ground, connect to GND pin of the board.
3V3	No need to connect.

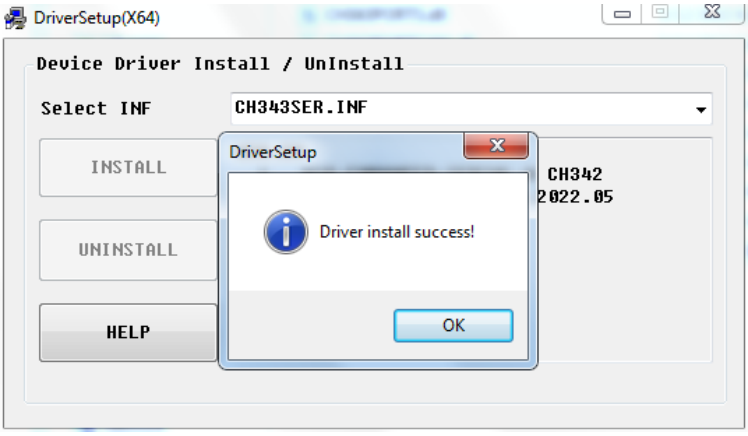
2.2.2 Install Driver

Step 1: Plug the CH9102X Module to the PC

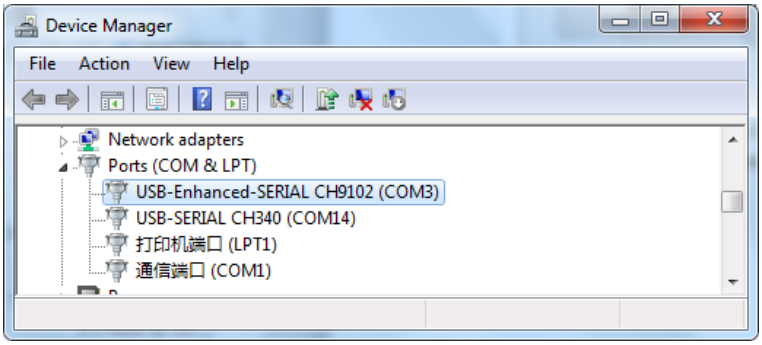
Step 2: Unzip *CH343SER.ZIP* on Windows.

Step 3: Select and install the corresponding *SETUP.EXE* according to the computer properties.





Step 4: After the installation is completed, the device will be listed under **Device Manager** ports with unique serial port assigned.

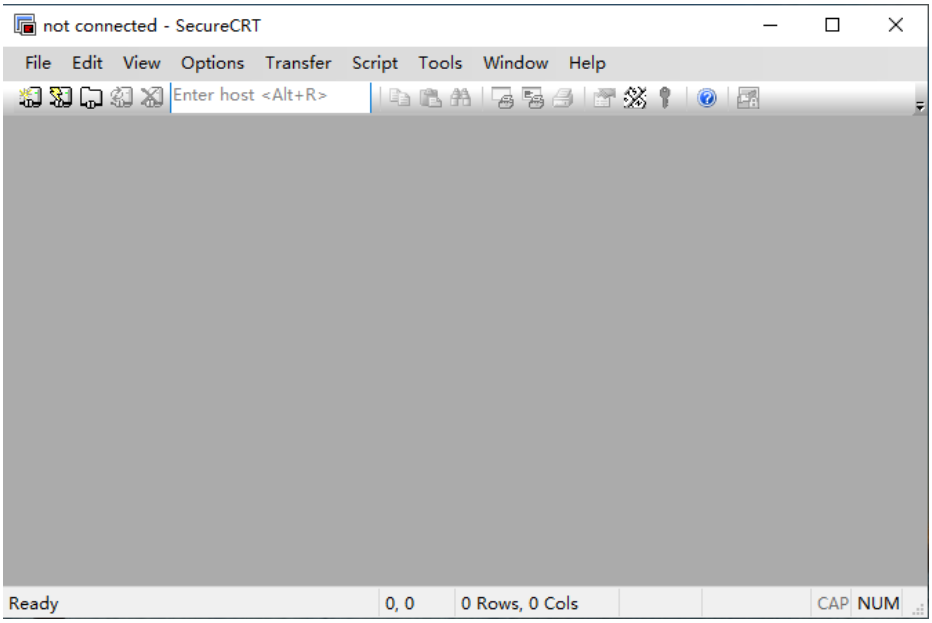


2.3 Install Serial Terminal Tool

The serial terminal SecureCRT is used for debugging in Windows. It can be used directly after decompression.

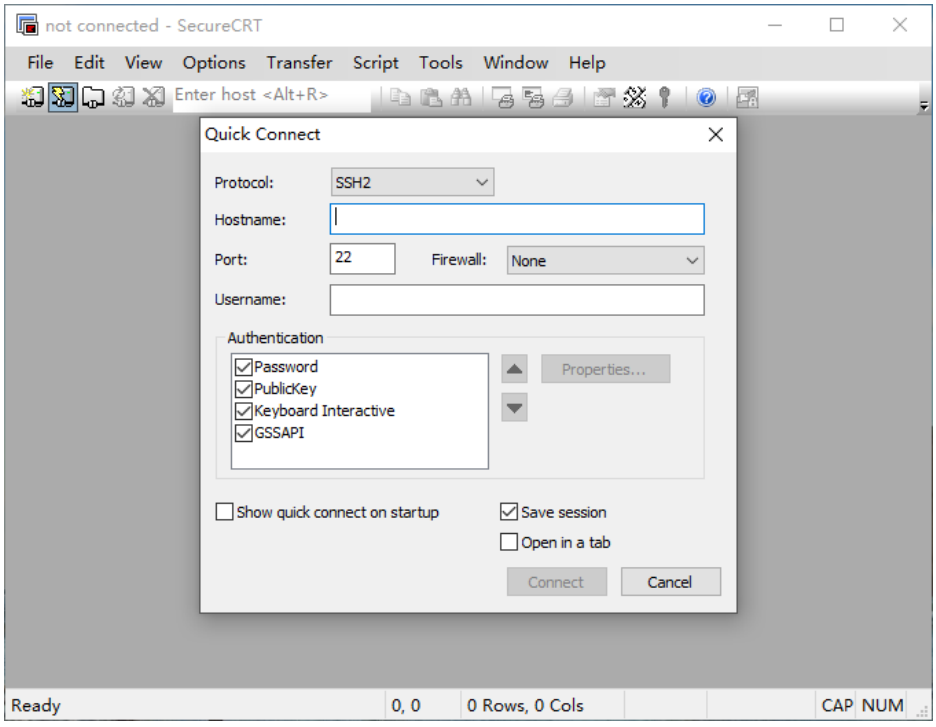
Step 1: Unzip *Platform/SecureCRT.rar* on PC.

Step 2: Click *SecureCRT/SecureCRT.exe* open the SecureCRT.

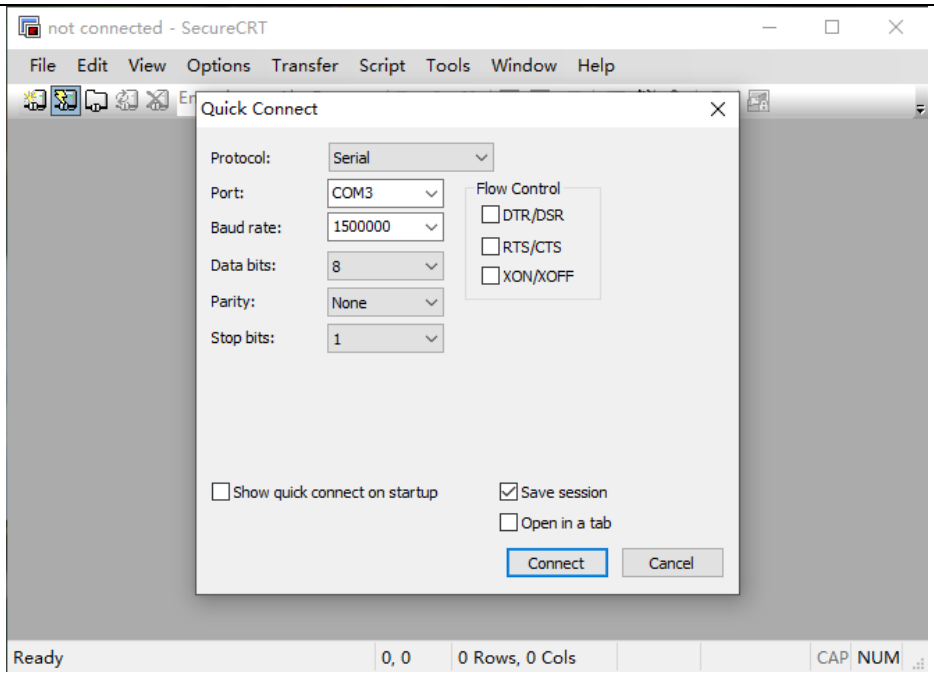


Step 3: Confirm that the CH9102X driver has been installed and the CH9102X module is connecting to the PC.

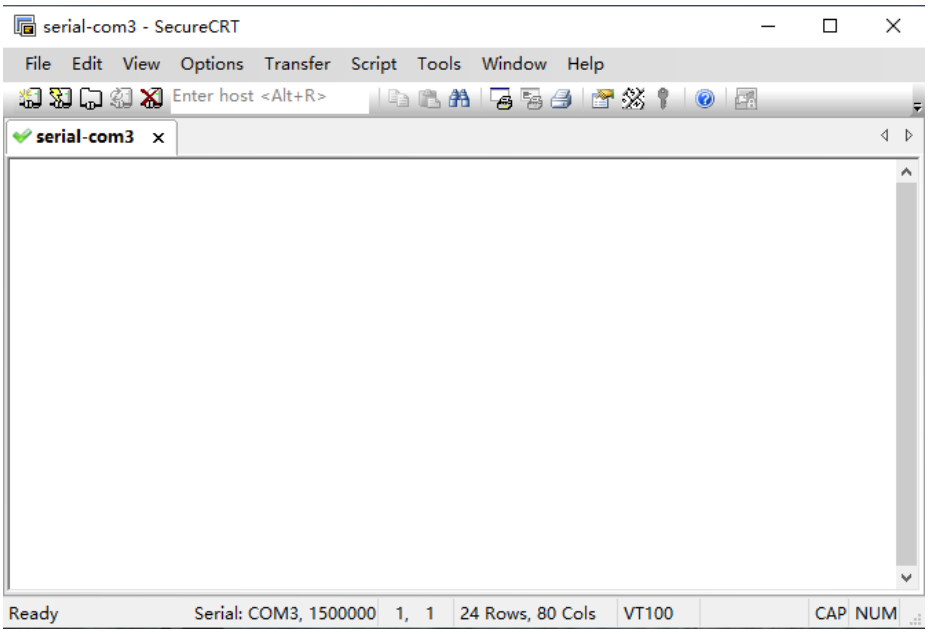
Step 4: Click the **"Quick Connect"** button to go to the Quick Connect configuration screen.



Step 5: Configure as shown in the following figure.



Step 6: After clicking **"Connect"** button, the terminal serial interface will be successfully accessed.



3.Upgrade Introduction

3.1 Upgrade Mode

The firmware can be upgraded via USB cable in two modes:

1. **Loader Mode:**

   The standard mode used for firmware upgrades.

2. **MaskRom Mode:**

   When the eMMC is empty, the board automatically enters the MASKROM Upgrade mode when it is powered on. Or a last-resort mode used when the device is bricked. Entering MaskRom mode requires hardware manipulation, which involves certain risks. It should only be attempted if Loader mode is unavailable.

• Prerequisite

Before upgrading the firmware via USB cable, ensure that the necessary drivers are installed. For installation instructions, refer to the section Install RK Driver Assistant.

3.1.1 How to Enter Loader Mode

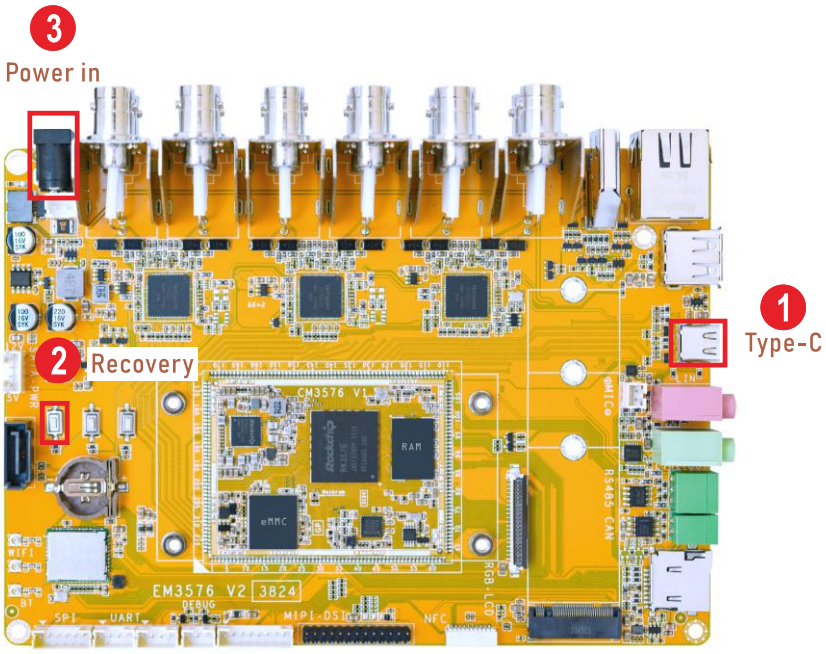
3.1.1.1 Hardware

Step 1: Disconnect the power adapter.

Step 2: Connect one end of the Type_C cable to the host and the other end to the development board.

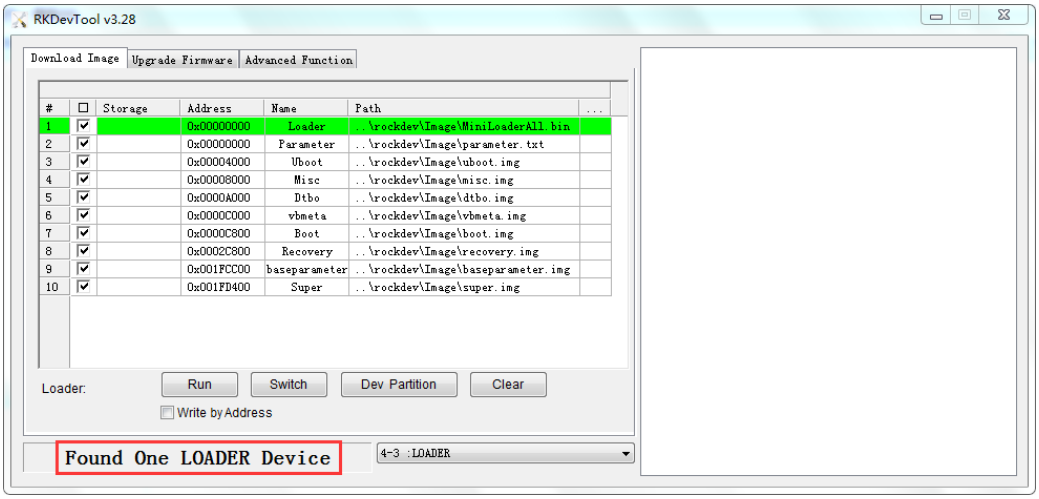
Step 3: Press and hold the **Recovery** button on the board

Step 4: Connect the power supply.



Step 5: After a few seconds, release the **Recovery** button when the flashing tool shows

"Found one LOADER Device".



3.1.1.2 Software

After connecting the Type_C USB cable, execute the following command in the serial debug terminal or adb shell.

```
# reboot loader
```

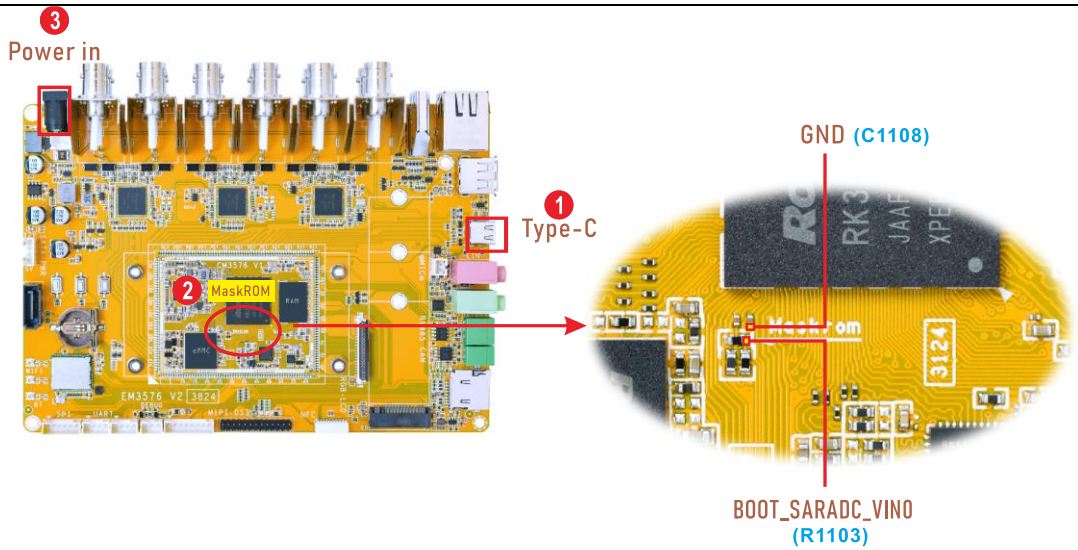
3.1.2 How to Enter MaskRom Mode

3.1.2.1 Hardware

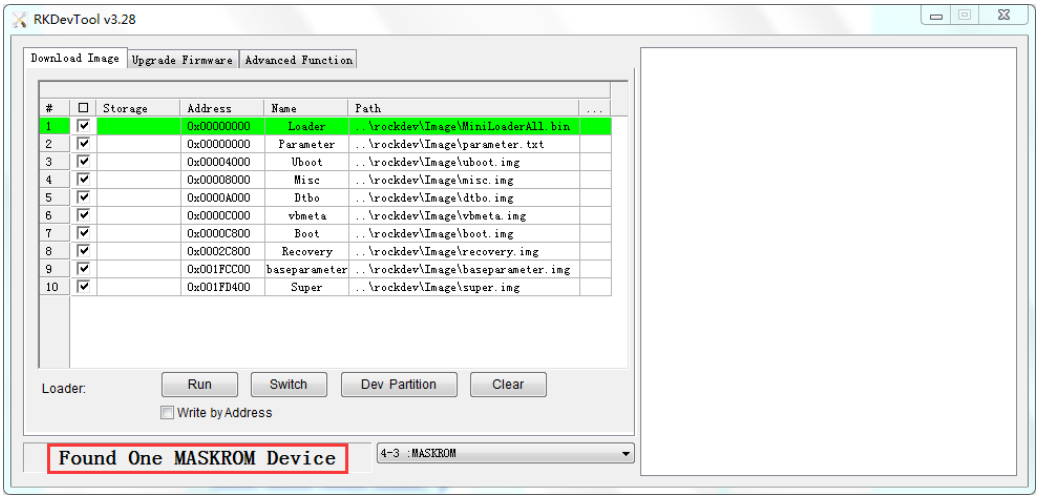
Step 1: Disconnect the power adapter.

Step 2: Connect one end of the Type_C cable to the host and the other end to the development board.

Step 3: Use tweezers to short the two test points on the CM3576.



Step 4: After connecting the power cable, the device will enter MaskRom mode. Then cancel shorting two test points.



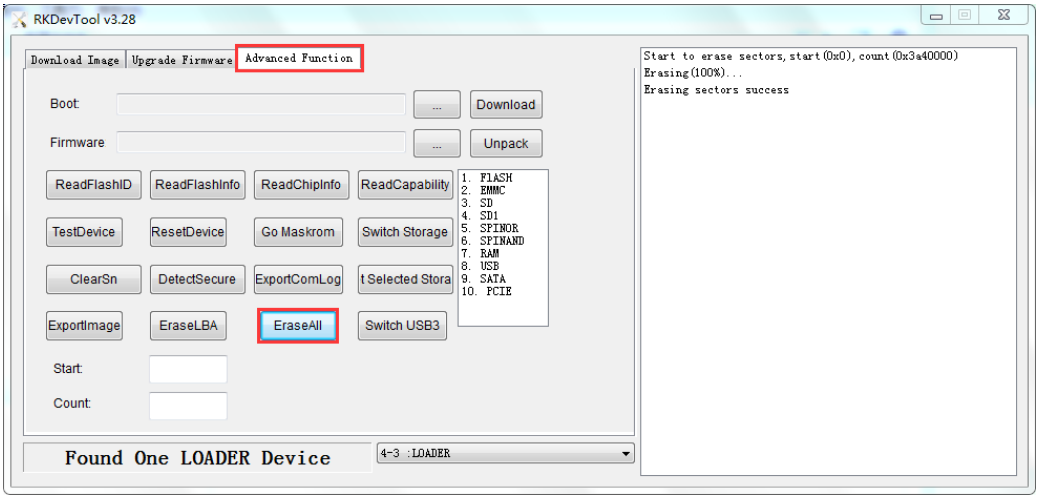
3.1.2.2 Software

Step 1: Disconnect the power adapter.

Step 2: Connect one end of the Type_C cable to the host and the other end to the development board.

Step 3: refer to the section 3.1.1, Let the board enter Loader mode.

Step 4: click **Advanced Function** -> **EraseAll** button to erase flash.



Step 5: after erase flash repower the board will enter MaskRom mode.

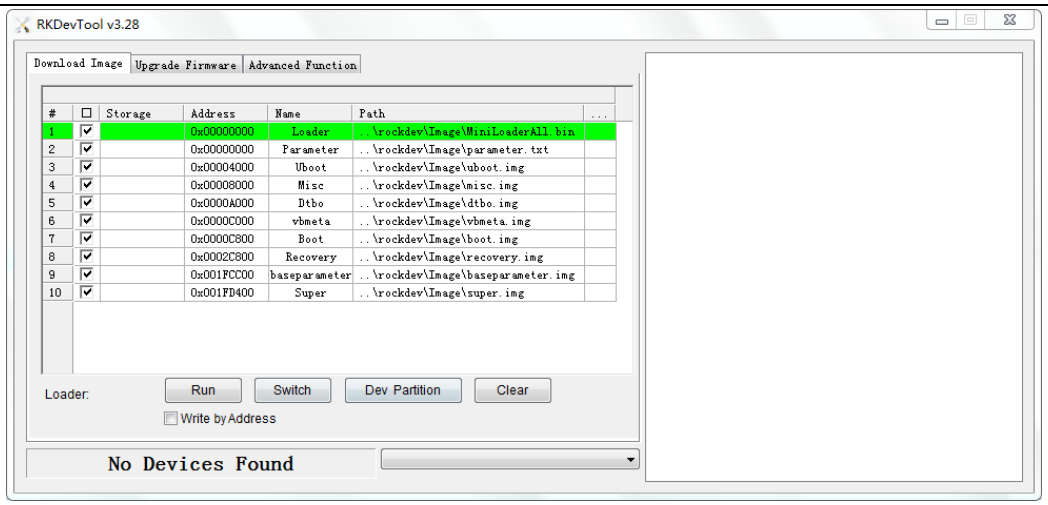
3.2 Burn Firmware

Environment: Windows OS (Operating System).

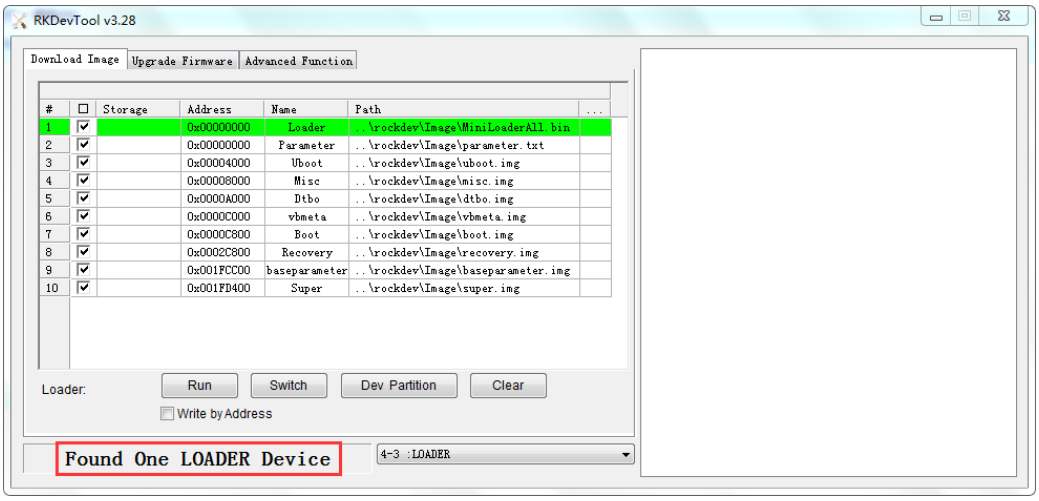
3.2.1 Burn Update.img Firmware

Step 1: Unzip *RKDevTool.rar* on Windows.

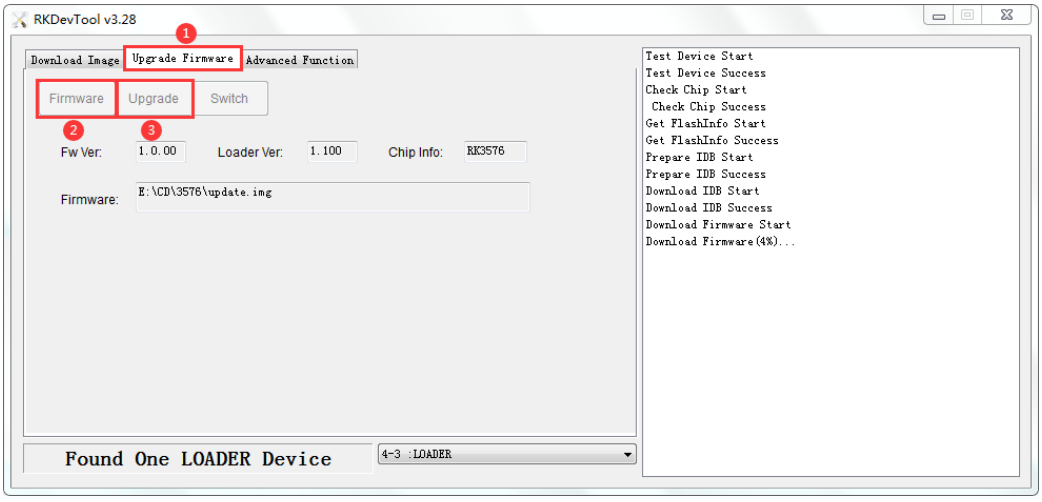
Step 2: Open *RKDevTool\RKDevTool_Release\RKDevTool.exe*.



Step 3: Switch to **loader mode**. (*How to Enter Loader Mode*)



Step 4: Click **Upgrade Firmware** -> **Firmware**, select **update.img**, then click **Upgrade** to flash.



After the flashing is complete, the board will automatically reboot.

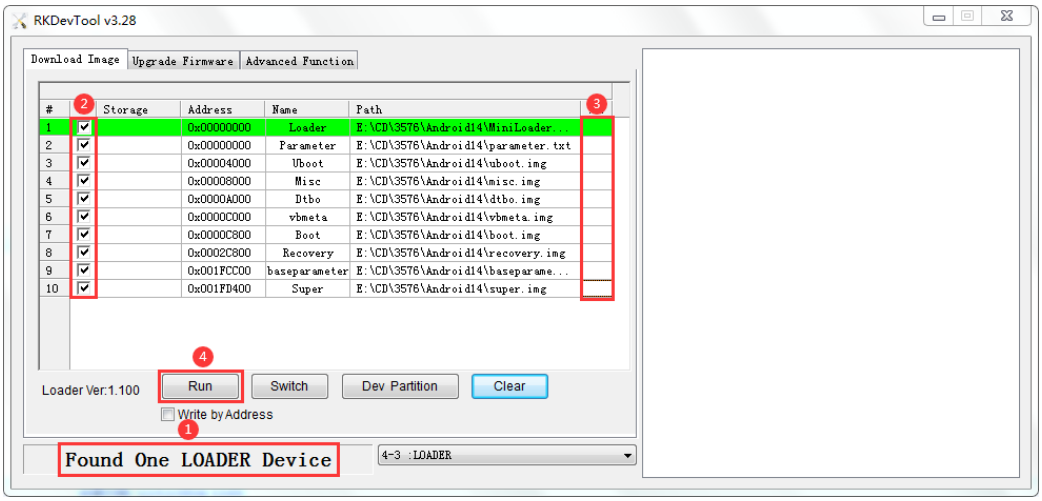
3.2.2 Burn Split Firmware

Step 1: Switch to **Loader mode**.

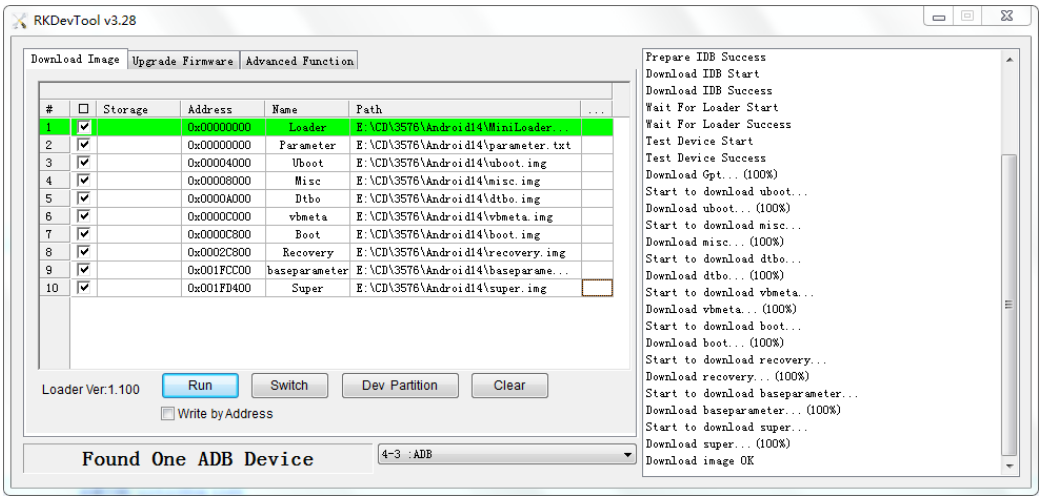
Step 2: Check the partitions to be flashed, multiple partitions can be selected.

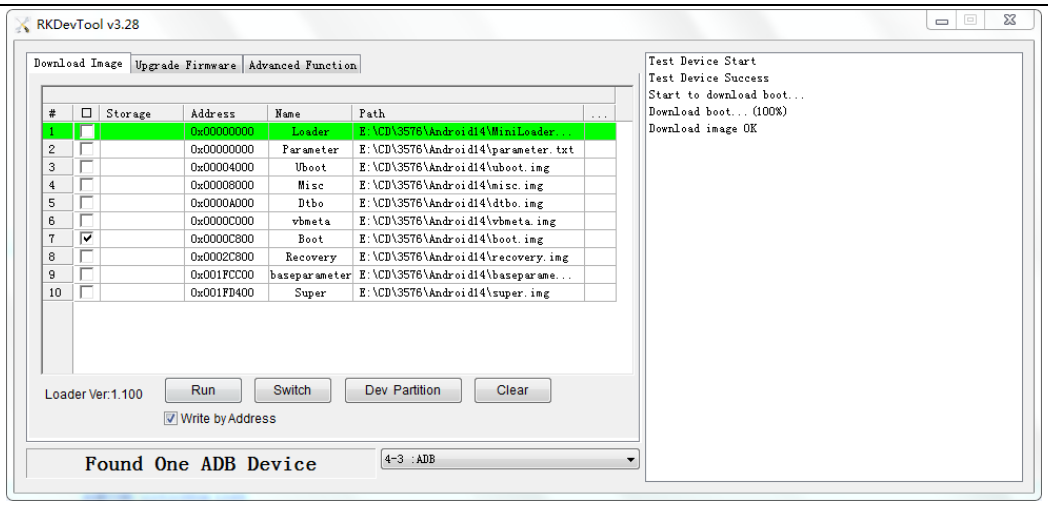
Step 3: Ensure the image file path is correct. If necessary, click the blank cell next to the path to reselect it.

Step 4: Click the **Run** button to flash the image.



After the flashing is complete, the board will automatically reboot.





①Note

① Without burning the parameter.txt file, please check the "Write by Address" checkbox, otherwise the flashing may fail with the "Image is larger than partition size" error.

4.Development Environment

4.1 Preparing the Development Environment

It is recommended to use Ubuntu 22.04 or higher version for compilation. If you encounter an error during compilation, user can check the error message and install the corresponding software packages accordingly. Other Linux versions may need to adjust the software package accordingly. In addition to the system requirements, there are other hardware and software requirements.

Hardware requirements	Software requirements
64-bit system, hard disk space should be greater than 200G. If you do multiple builds, you will need more hard drive space.	Ubuntu 22.04

4.2 Installing Libraries and Toolkits

The contents of this directory only provide the software package installation commands that are needed to build the compiled SDK environment. Please install other tools such

as samba and ssh by yourself.

PC OS	Network	Permission
Ubuntu 22.04	online	root

Execute the following commands to install the required tools:

```
$ sudo apt-get install u-boot-tools
$ sudo apt-get install git gnupg flex bison gperf build-essential zip curl libc6-dev libncurses5-dev:i386 x11proto-core-dev libx11-dev:i386 libreadline6-dev:i386 libgl1-mesa-dri:i386 libgl1-mesa-dev g++-multilib tofrodos libxml2-utils xsltproc zlib1g-dev:i386 dpkg-dev
$ sudo apt-get install libncurses5-dev
$ sudo apt-get install libsdl1.2-dev
$ sudo apt-get install lib32z-dev ccache
$ sudo apt-get install python3-pyelftools
$ sudo apt-get install libssl-dev
$ sudo apt-get install liblz4-tool
$ sudo ln -s /usr/bin/python3 /usr/bin/python
$ sudo apt-get install device-tree-compiler
$ sudo apt install apt-file
$ sudo apt-file update
$ sudo apt install libncurses5
$ sudo apt-file find libncurses.so.5
$ sudo apt-get install binfmt-support qemu-user-static live-build
```

5.Compile Source

Step 1: Unzip the Source

Execute the following commands to extract the source files:

```
$ tar xvfj rk3576_android14_sdk-20240730.tar.bz2
$ cd rk3576_android14_sdk
```

Step 2: Configure the Compiled Board

Execute the following commands to configure the board:

```
$ source build/envsetup.sh

$ lunch rk3576_u-userdebug
```

Step 3: One key compiling

```
$ ./build.sh -AUCKu
```

```
boardcon@boardcon:~/opt/rk3576/em3576/rk3576_android14_sdk$
boardcon@boardcon:~/opt/rk3576/em3576/rk3576_android14_sdk$ source build/envsetup.sh
boardcon@boardcon:~/opt/rk3576/em3576/rk3576_android14_sdk$ lunch rk3576_u-userdebug

============================================
PLATFORM_VERSION_CODENAME=REL
PLATFORM_VERSION=14
PRODUCT_INCLUDE_TAGS=com.android.mainline
TARGET_PRODUCT=rk3576_u
TARGET_BUILD_VARIANT=userdebug
TARGET_ARCH=arm64
TARGET_ARCH_VARIANT=armv8-a
TARGET_CPU_VARIANT=generic
TARGET_2ND_ARCH=arm
TARGET_2ND_ARCH_VARIANT=armv8-a
TARGET_2ND_CPU_VARIANT=generic
HOST_OS=linux
HOST_OS_EXTRA=Linux-6.8.0-49-generic-x86_64-Ubuntu-22.04.3-LTS
HOST_CROSS_OS=windows
BUILD_ID=UQ1A.240205.004.B1
OUT_DIR=out
============================================
boardcon@boardcon:~/opt/rk3576/em3576/rk3576_android14_sdk$ ./build.sh -AUCKu
will build android
will build u-boot
will build kernel with Clang
will build kernel
will build update.img
```

```
dress=0x0002c800
Add file: ./Image/baseparameter.img
baseparameter,Add file: ./Image/baseparameter.img done,offset=0x7f35800,size=0x100000,userspace=0x200,
flash_address=0x001fcc00
Add file: ./Image/super.img
super,Add file: ./Image/super.img done,offset=0x8035800,size=0x786e9c1c,userspace=0xf0dd4,flash_addres
s=0x001fd400
Add CRC...
Make firmware OK!
------ OK ------
********rkImageMaker ver 2.23********
Generating new image, please wait...
Writing head info...
Writing boot file...
Writing firmware...
Generating MD5 data...
MD5 data generated successfully!
New image generated successfully!
Making update.img  OK.
Make update image ok!
/home/boardcon/opt/rk3576/em3576/rk3576_android14_sdk
boardcon@boardcon:~/opt/rk3576/em3576/rk3576_android14_sdk$ ls rockdev/
Image-rk3576_u
boardcon@boardcon:~/opt/rk3576/em3576/rk3576_android14_sdk$ ls rockdev/Image-rk3576_u/
baseparameter.img  dtbo.img           pcba_small_misc.img  super.img
boot-debug.img     MiniLoaderAll.bin  pcba_whole_misc.img  uboot.img
boot.img           misc.img           recovery.img         update.img
config.cfg         parameter.txt      resource.img         vbmeta.img
boardcon@boardcon:~/opt/rk3576/em3576/rk3576_android14_sdk$
```

Step 4: Compile U-Boot

Execute the following command to compile uboot:

```
$ ./build.sh -U
```

Step 5: Compile Kernel

Execute the following command to compile kernel:

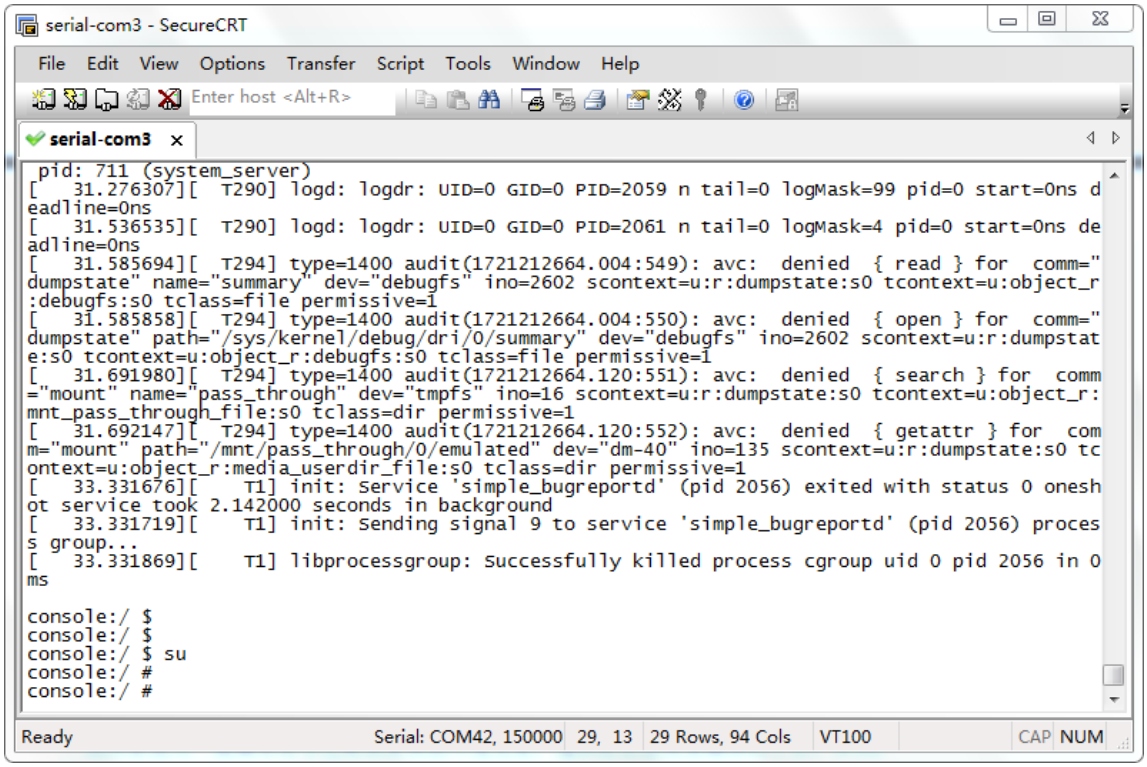
```
$ ./build.sh -K
```

6. Android14 Test

6.1 Serial Terminal

Connect the board and PC with USB Serial cable, then power on, the terminal will output

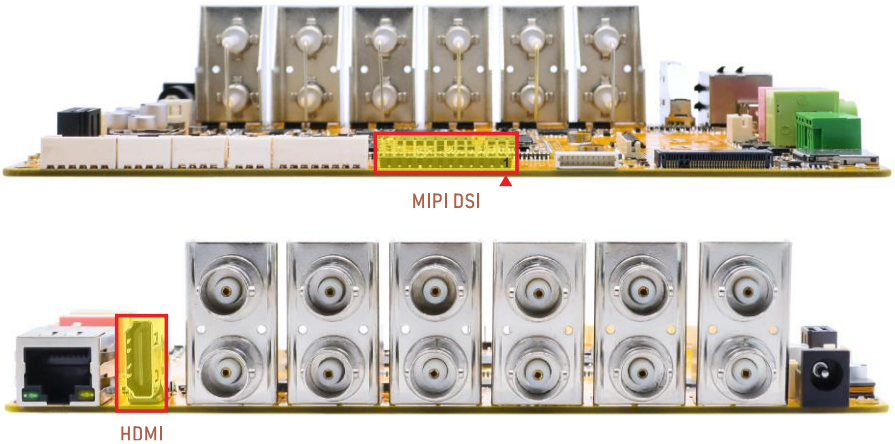
boot information. The default baudrate is 1500000.



Enter "**su**" into the root user interface.

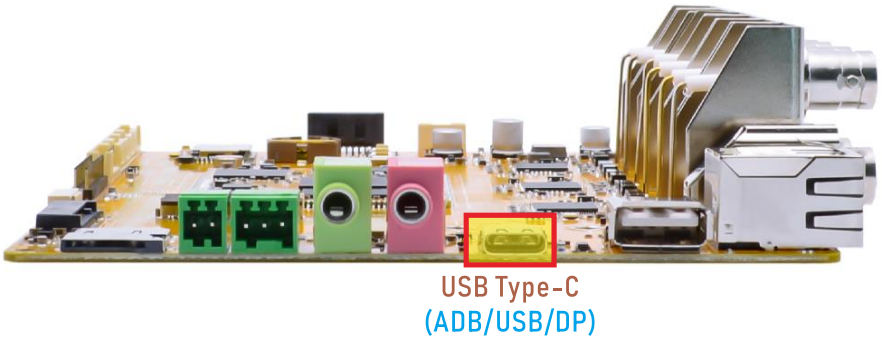
6.2 Display

The EM3576 supports three screen simultaneous displays, including default support MIPI DSI(10.1 inch MIPI LCD) and HDMI interfaces, as well as support for DP AIT functionality.



The display effect diagram is as follows:

6.3 USB Type-C



Features Supported by the Type-C Interface:

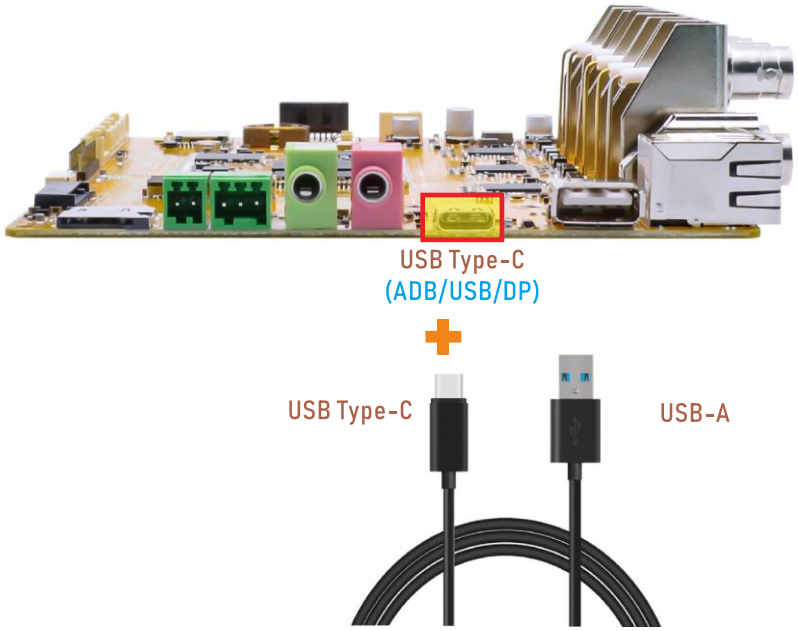
• **Reversible Design:** Allows insertion in either orientation for user convenience.

• **Data Transmission Roles:** Supports flexible designation of host and device roles.

• **Multiple Protocol Support:** Compatible with USB 3.0 and DisplayPort, enabling high-speed data transmission.

6.3.1 ADB

Step 1: Connect the board and PC host with Type-C cable.

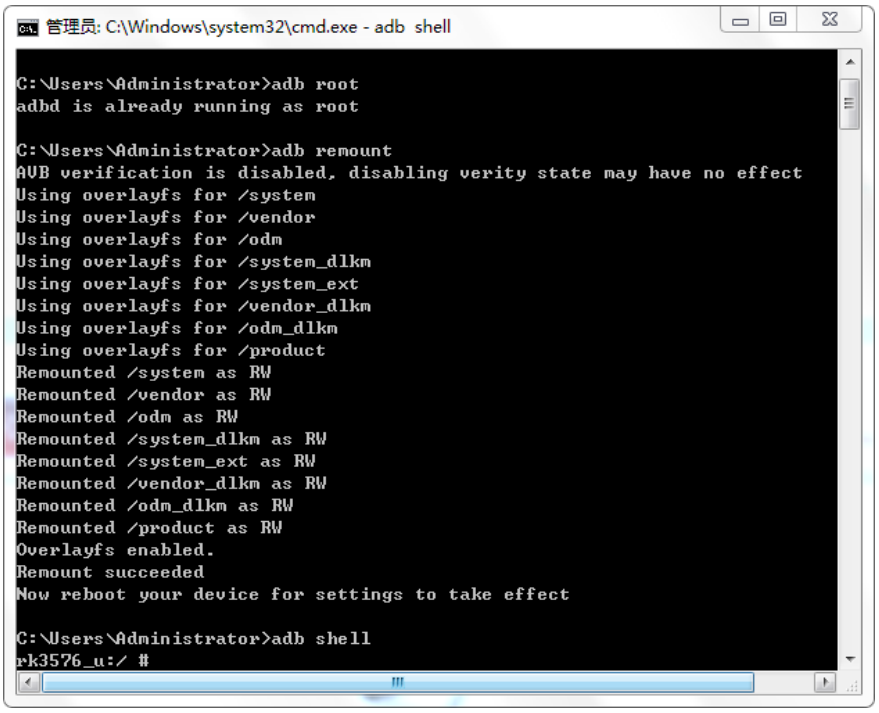


Step 2: Install ADB driver on Windows system.

Step 3: Press **Windows** + **R** to open the **Run** program. Type **"**cmd**"** and press Enter.

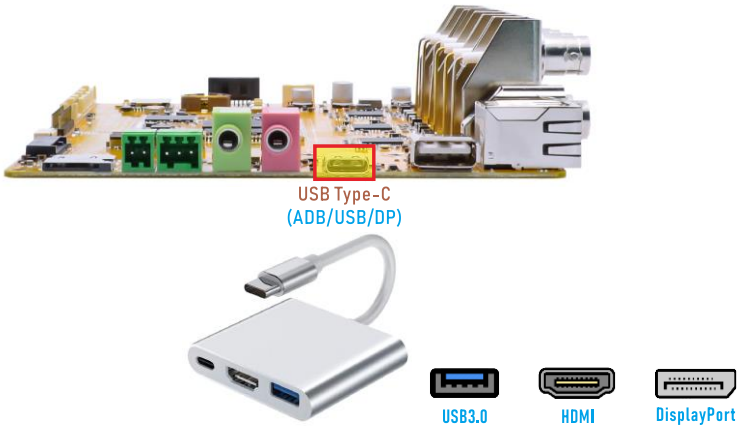
Step 4: Execute the following command to enable ADB.

```
# adb root

# adb remount

# adb shell
```

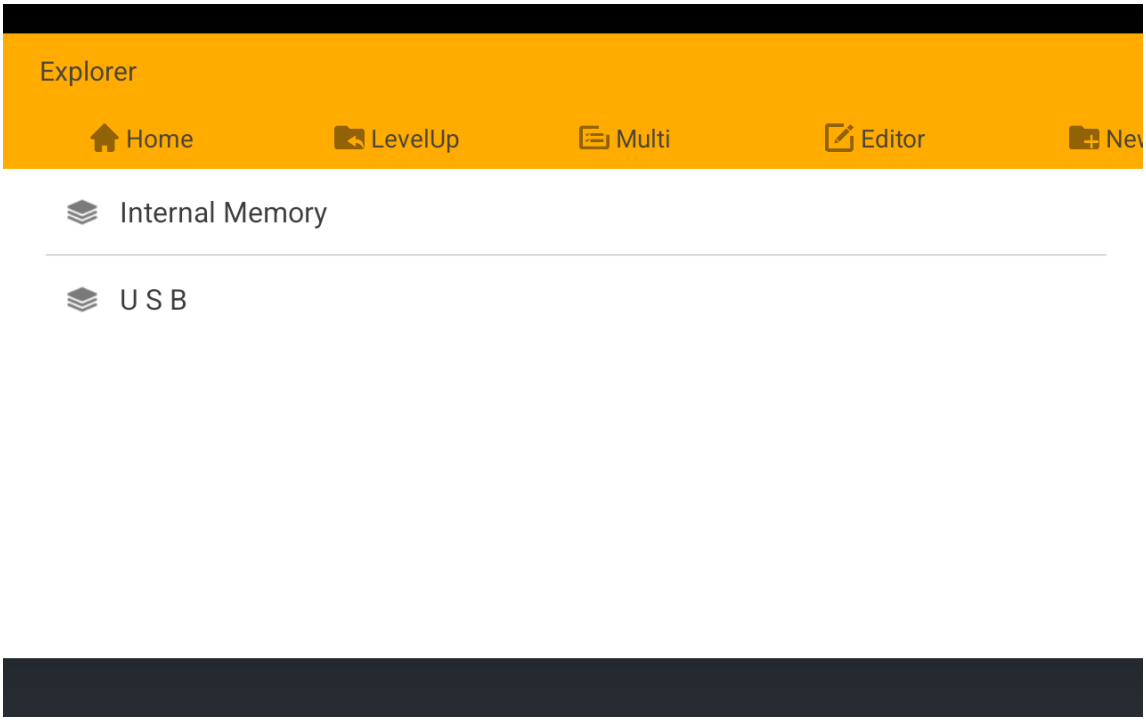


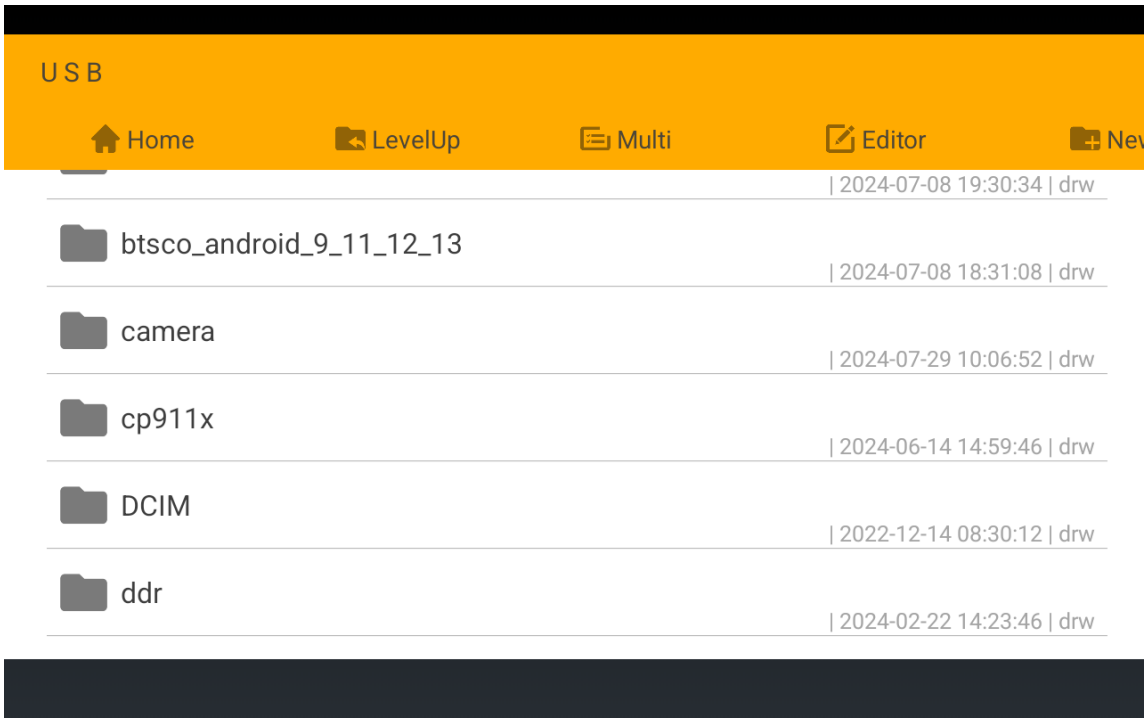
6.3.2 Type-C to USB

Step 1: Connect the Type-C of USB converter to the Type-C port of the development board, and then insert the USB flash drive into the USB port of the docking station.



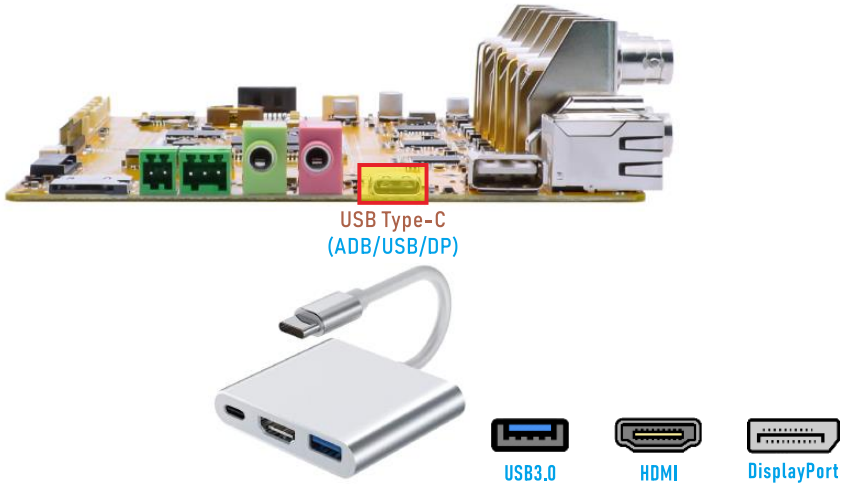
Step 2: After inserting the USB flash drive, if it is recognized successfully, User can Browse USB flash drive files through the file browser "**Explorer**".





6.3.3 DP Alt Mode

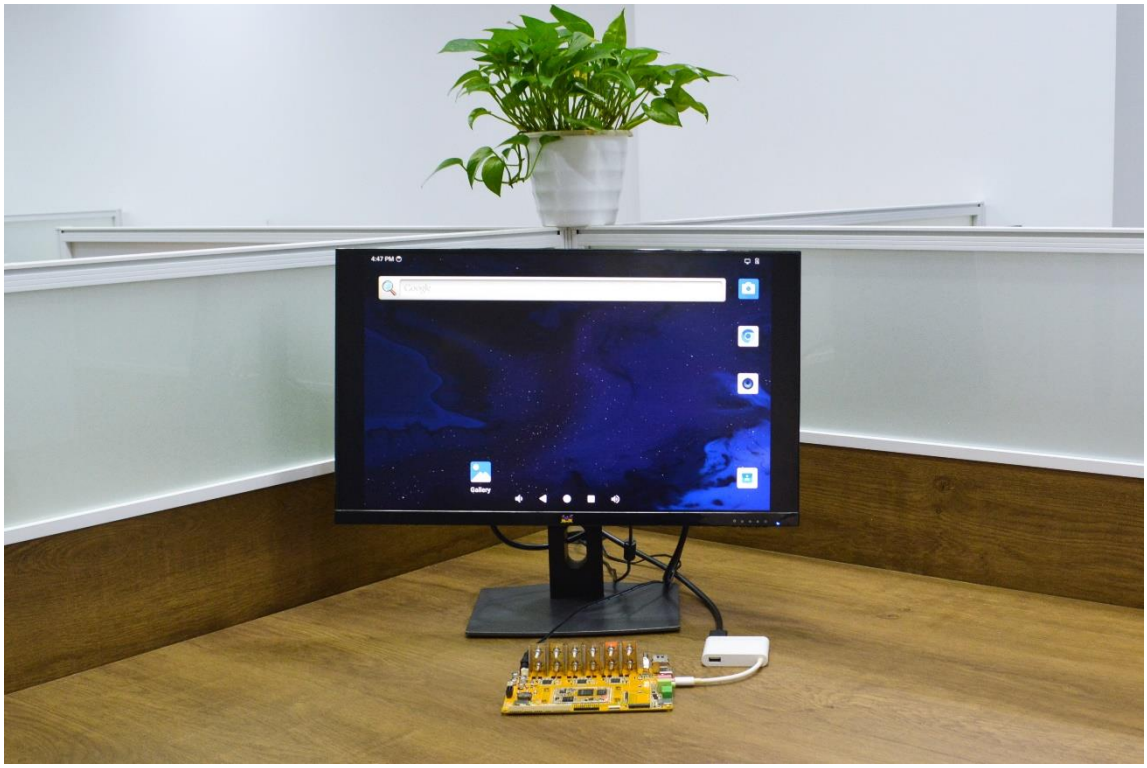
DisplayPort Alternate Mode (DP Alt Mode) is a technology that facilitates the transmission of DisplayPort video signals through a USB Type-C interface. It enables devices to output video and audio via a USB-C connection without requiring a dedicated DisplayPort connector. This allows users to connect a display using a single USB-C port while transmitting video, audio, and additional data.



Currently, Boardcon has conducted the following output tests:

• **Type-C to HDMI:** Supports 3840x2160p60 resolution.

• **Type-C to DisplayPort (DP):** Supports 3840x2160p60 resolution.



6.4 Ethernet

Step 1: Connect the network cable to the Ethernet port.

According to the log, it can be seen that the Gigabit Ethernet recognition is successful.

```
console:/ # [  110.719413][   T87] rk_gmac-dwmac 2a230000.ethernet eth0: Link is Up - 1Gbps/Full - flow
control rx/tx
```

Step 2: View network interface information.

```
# ifconfig
```

```
127|console:/ # ifconfig
lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope: Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:2 errors:0 dropped:0 overruns:0 frame:0
          TX packets:2 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:106 TX bytes:106

dummy0    Link encap:Ethernet  HWaddr 5e:b8:c7:bc:14:10
          inet6 addr: fe80::5cb8:c7ff:febc:1410/64 Scope: Link
          UP BROADCAST RUNNING NOARP  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 TX bytes:420

eth0      Link encap:Ethernet  HWaddr 6e:95:7b:2b:8a:ff  Driver rk_gmac-dwmac
          inet addr:192.168.0.140  Bcast:192.168.0.255  Mask:255.255.255.0
          inet6 addr: fe80::a9d5:e5cd:cbfc:f97b/64 Scope: Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:575 errors:0 dropped:0 overruns:0 frame:0
          TX packets:321 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:117763 TX bytes:34799
          Interrupt:63
```

Step 3: Users can test network connectivity using the UI app "**Lightning**" or verify it through the following command.

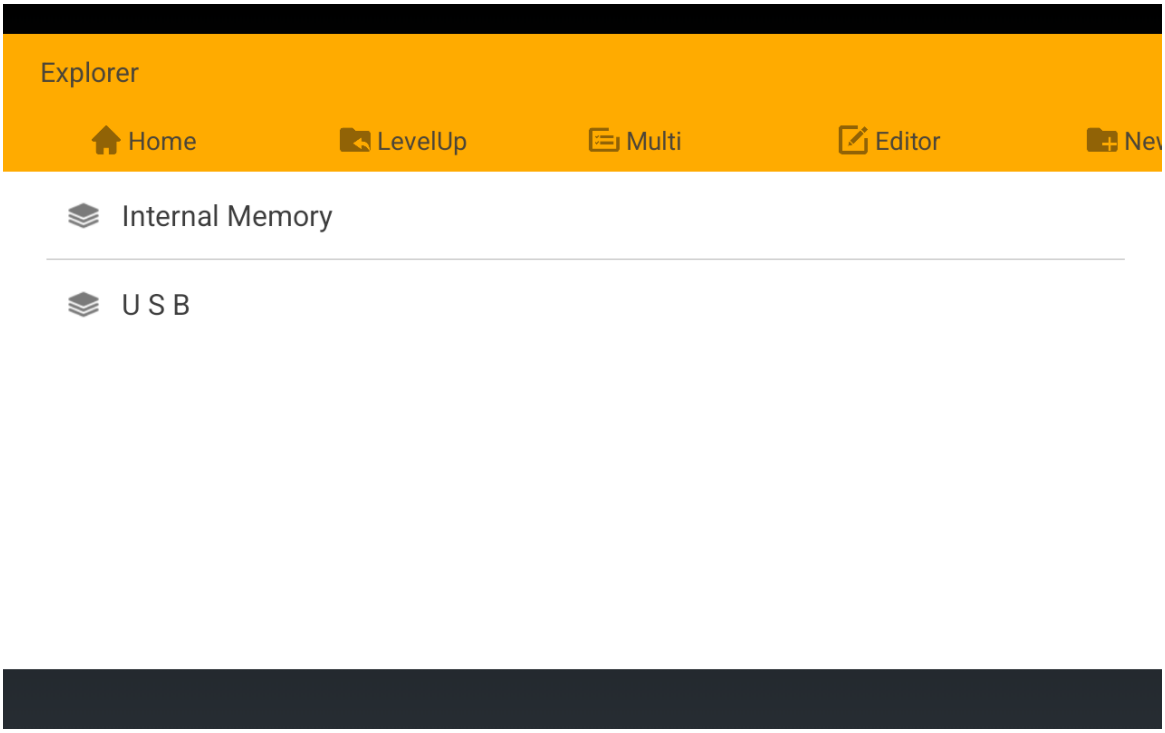
```
# ping -I eth0 www.armdesigner.com
```

```
130|console:/ # ping -I eth0 www.armdesigner.com
PING www.armdesigner.com (67.222.54.196) from 192.168.0.140 eth0: 56(84) bytes of data.
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=1 ttl=48 time=188 ms
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=2 ttl=48 time=191 ms
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=3 ttl=48 time=187 ms
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=4 ttl=48 time=188 ms
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=5 ttl=48 time=190 ms
^X64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=6 ttl=48 time=187 ms
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=7 ttl=48 time=190 ms
^C
--- www.armdesigner.com ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6002ms
rtt min/avg/max/mdev = 187.253/189.211/191.123/1.504 ms
```

6.5 USB Host

The USB host can be used to connect USB devices such as USB mouse, USB keyboards, USB flash drives, and other USB peripherals.

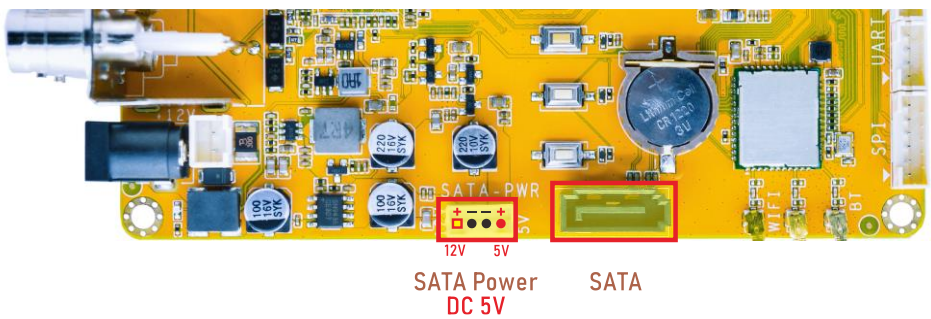
After connecting the USB flash drive, if the device is successfully recognized, Can Browse USB flash drive files through the file browser "**Explorer**".



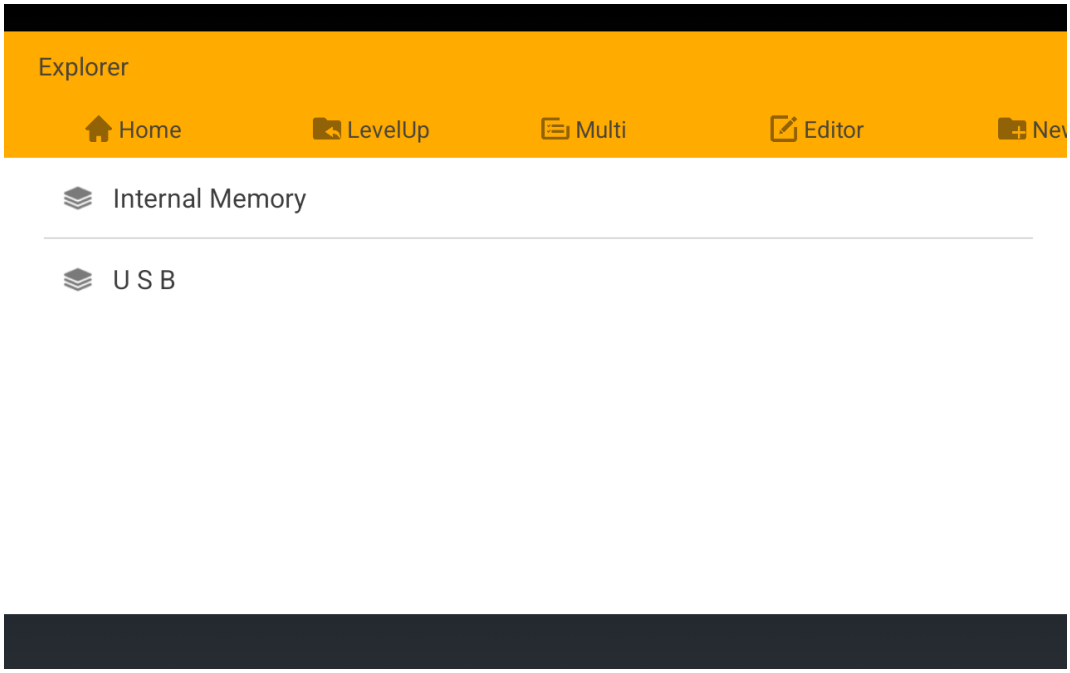
6.6 SATA (Multiplexed with USB Host)

The SATA on Android14 only supports the ext4 format.

Step 1: Connect the sata and sata power(5V), then power on.



Step 2: If the SATA device is successfully recognized, User can Browse SATA device files through the file browser "**Explorer**".

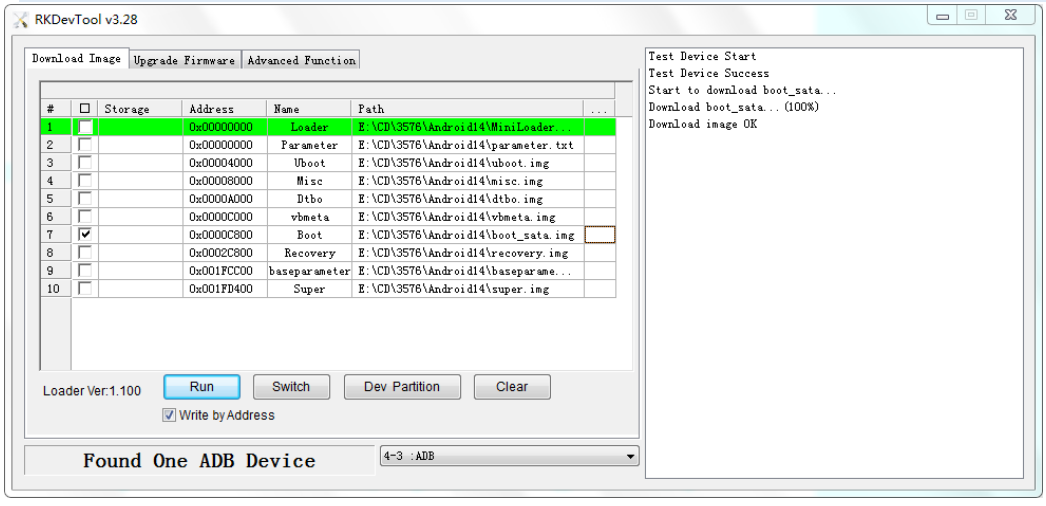


Note: If devices that are not in ext4 format, the user can choose to format them on the board. After formatting, the files on the device will be permanently lost, so please proceed with caution.

```
# mke2fs -t ext4 /dev/block/sda1
```

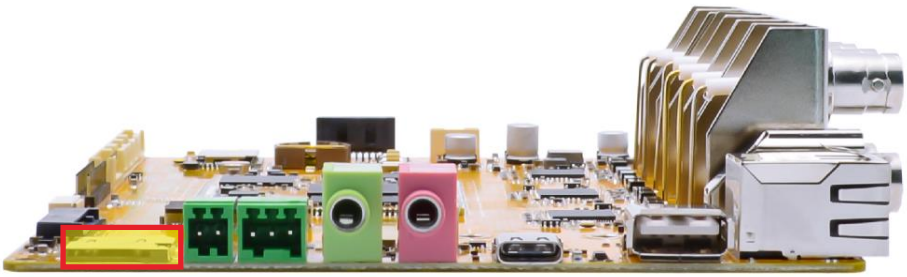
①Note

The update.img supports USB host functionality by default. If SATA functionality is required, users need to reflash the kernel image: boot-sata.img.

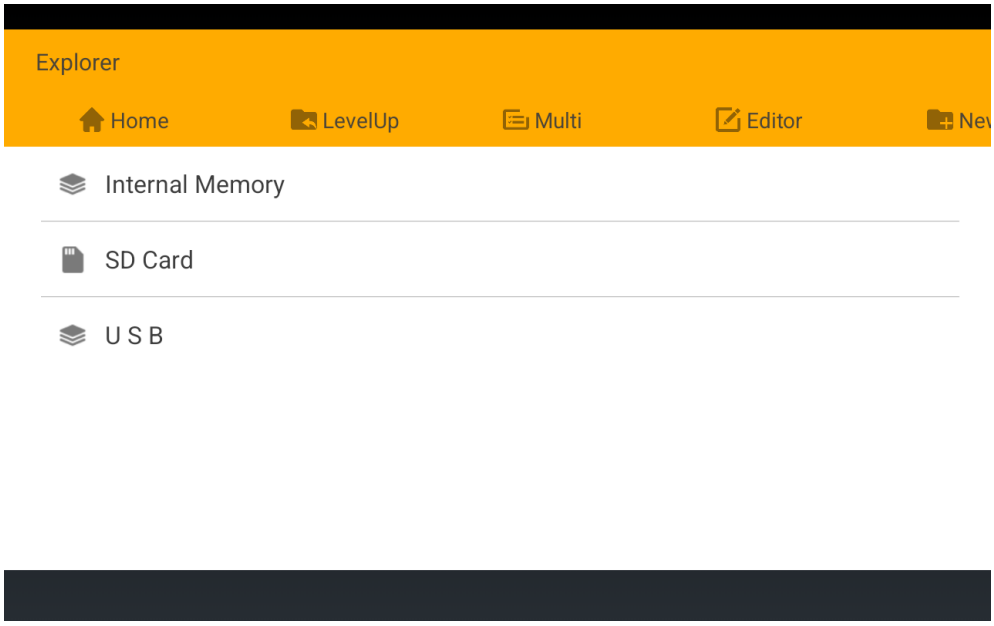


6.7 SD Card

Step 1: Insert the micro SD card into the card slot.



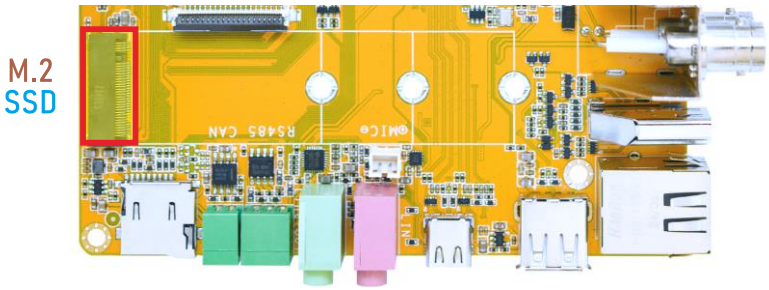
Step 2: After inserting the SD card, if it is recognized successfully, User can Browse SATA device files through the file browser "**Explorer**". EM3576 supports SD Hot-plug.



6.8 M.2 NVME SSD

The SSD on Android14 only supports the ext4 format.

Step 1: Connect the SSD, then power on.



Step 2: If the SSD device is successfully recognized, execute the following command to mount ssd:

```
# mkdir /data/ssd
# mount -t ext4 /dev/block/nvme0n1 /data/ssd
# ls /data/ssd
```

```
console:/ # mkdir /data/ssd
console:/ # mount -t ext4 /dev/block/nvme0n1 /data/ssd
[   72.937244][ T2210] EXT4-fs (nvme0n1): recovery complete
[   72.937552][ T2210] EXT4-fs (nvme0n1): mounted filesystem with ordered data mode. Quota mode: none.
console:/ # ls /data/ssd
lost+found
console:/ #
```

Note: If devices that are not in ext4 format, the user can choose to format them on the board. After formatting, the files on the device will be permanently lost, so please proceed with caution.

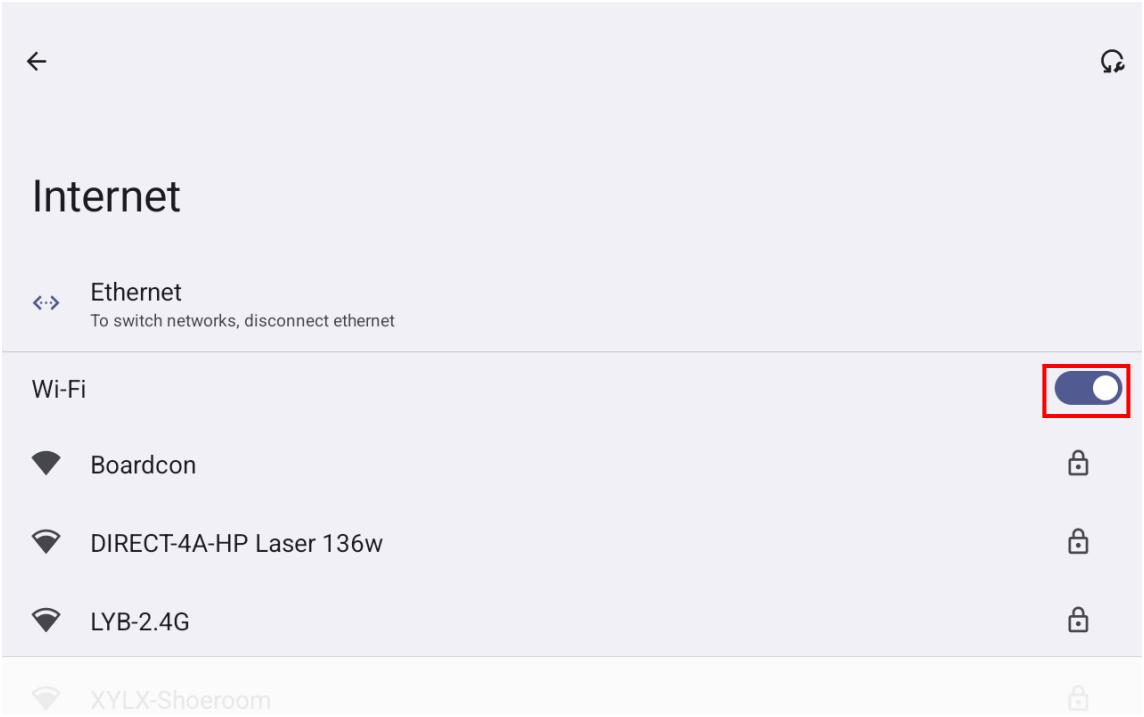
```
# mke2fs -t ext4 /dev/block/nvme0n1
```

6.9 WiFi & Bluetooth

To use Wi-Fi and Bluetooth functions properly, the antenna needs to be connected.

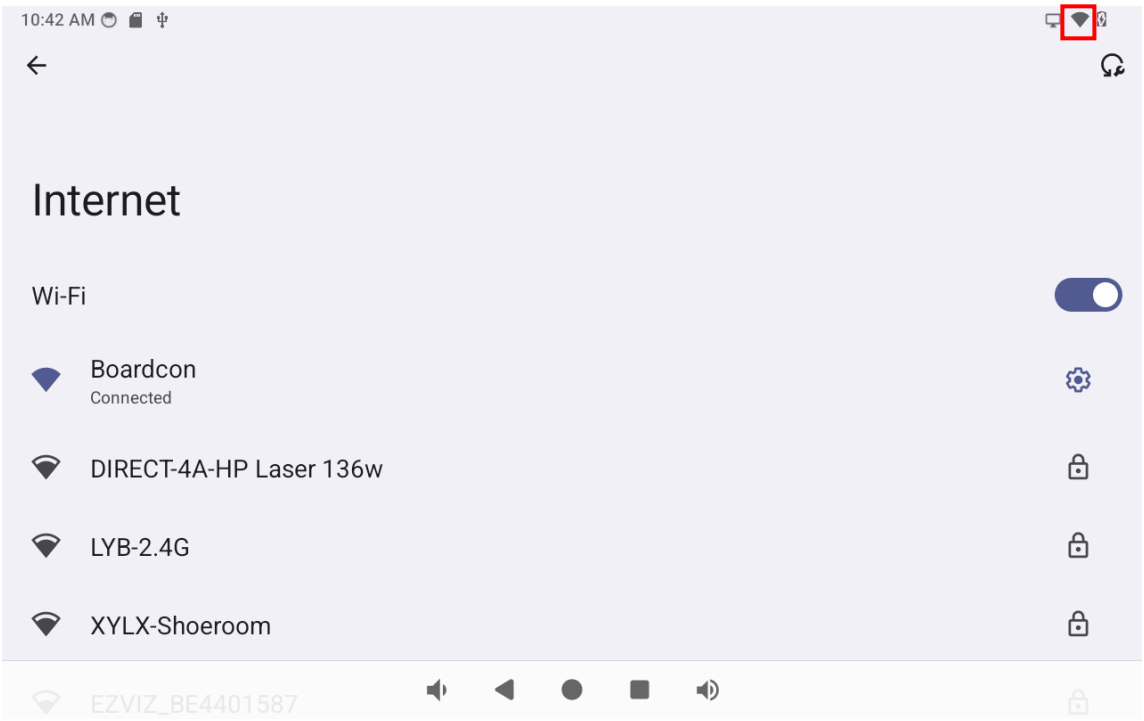
6.9.1 WiFi

Step 1: Open "**Settings** > **Network & internet** > **Internet** > **Wi-Fi**" turn on and connect WIFI.



Step 2: Select the SSID from the list of available networks and enter the password.

Step 3: After the WiFi successfully connects to the SSID, the system will display the corresponding connection status icon in the top right corner.



Step 4: Users can test network connectivity using the UI browser or verify it through the following command method.

(1) View network interface information.

```
# ifconfig
```

```
console:/ # ifconfig
lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope: Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:2 errors:0 dropped:0 overruns:0 frame:0
          TX packets:2 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:106 TX bytes:106

dummy0    Link encap:Ethernet  HWaddr 4a:b1:e3:60:12:91
          inet6 addr: fe80::48b1:e3ff:fe60:1291/64 Scope: Link
          UP BROADCAST RUNNING NOARP  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:5 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 TX bytes:350

eth0      Link encap:Ethernet  HWaddr 6e:95:7b:2b:8a:ff  Driver rk_gmac-dwmac
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 TX bytes:0
          Interrupt:63

wlan0     Link encap:Ethernet  HWaddr 38:7a:cc:2a:09:33  Driver rtl88x2cs
          inet addr:192.168.0.144  Bcast:192.168.0.255  Mask:255.255.255.0
          inet6 addr: fe80::4b77:5637:e9c3:7d69/64 Scope: Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:322 errors:0 dropped:1 overruns:0 frame:0
          TX packets:111 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:61593 TX bytes:15157

console:/ #
```

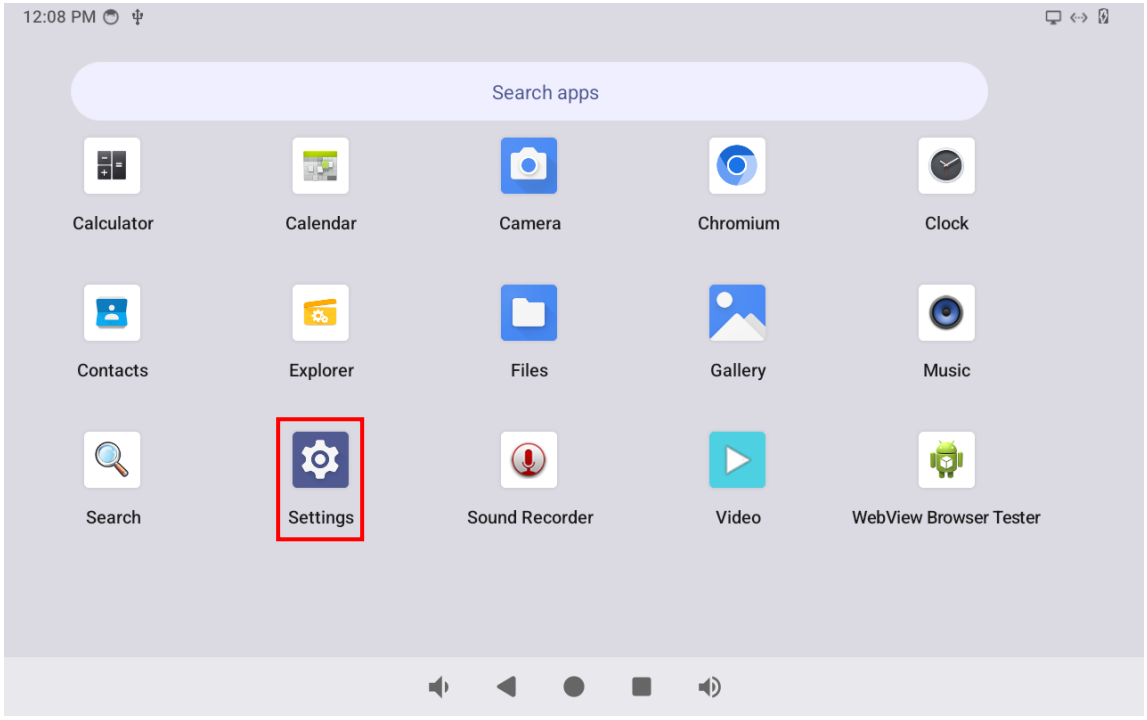
(2) Network connection test.

```
# ping -I wlan0 www.armdesigner.com
```

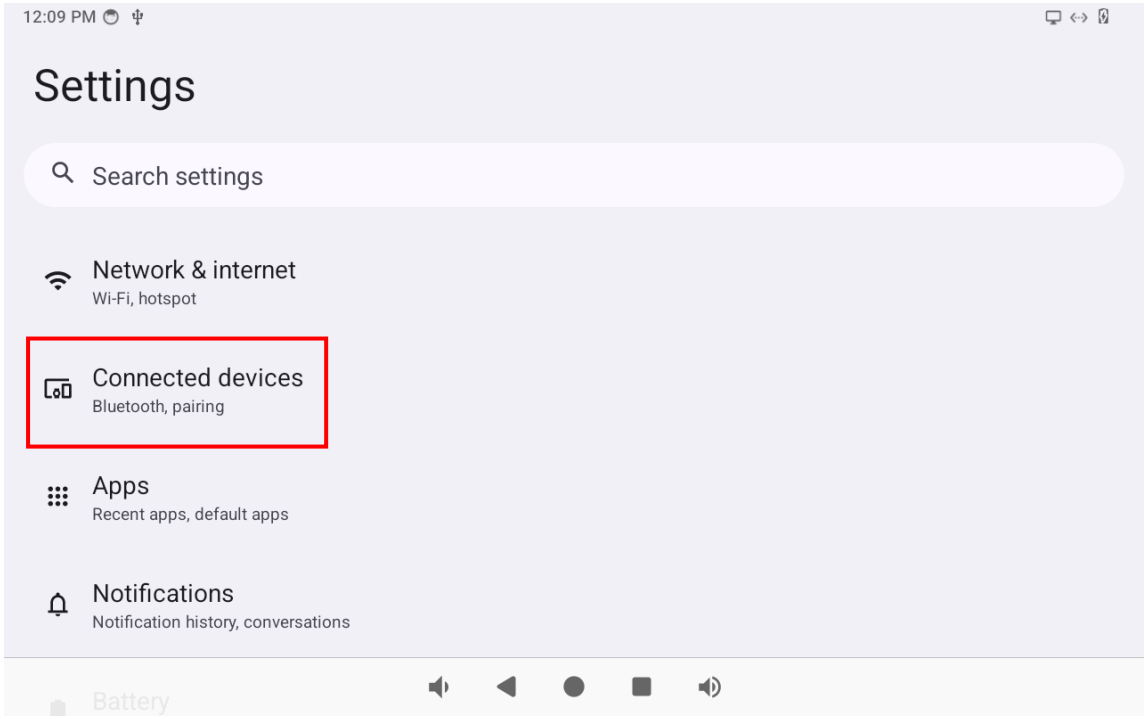
```
console:/ # ping -I wlan0 www.armdesigner.com
PING www.armdesigner.com (67.222.54.196) from 192.168.0.144 wlan0: 56(84) bytes of data.
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=1 ttl=48 time=196 ms
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=2 ttl=48 time=189 ms
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=3 ttl=48 time=189 ms
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=4 ttl=48 time=225 ms
64 bytes from 67-222-54-196.unifiedlayer.com (67.222.54.196): icmp_seq=5 ttl=48 time=248 ms
^C
--- www.armdesigner.com ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4464ms
rtt min/avg/max/mdev = 189.233/209.876/248.002/23.195 ms
console:/ #
```

6.9.2 Bluetooth

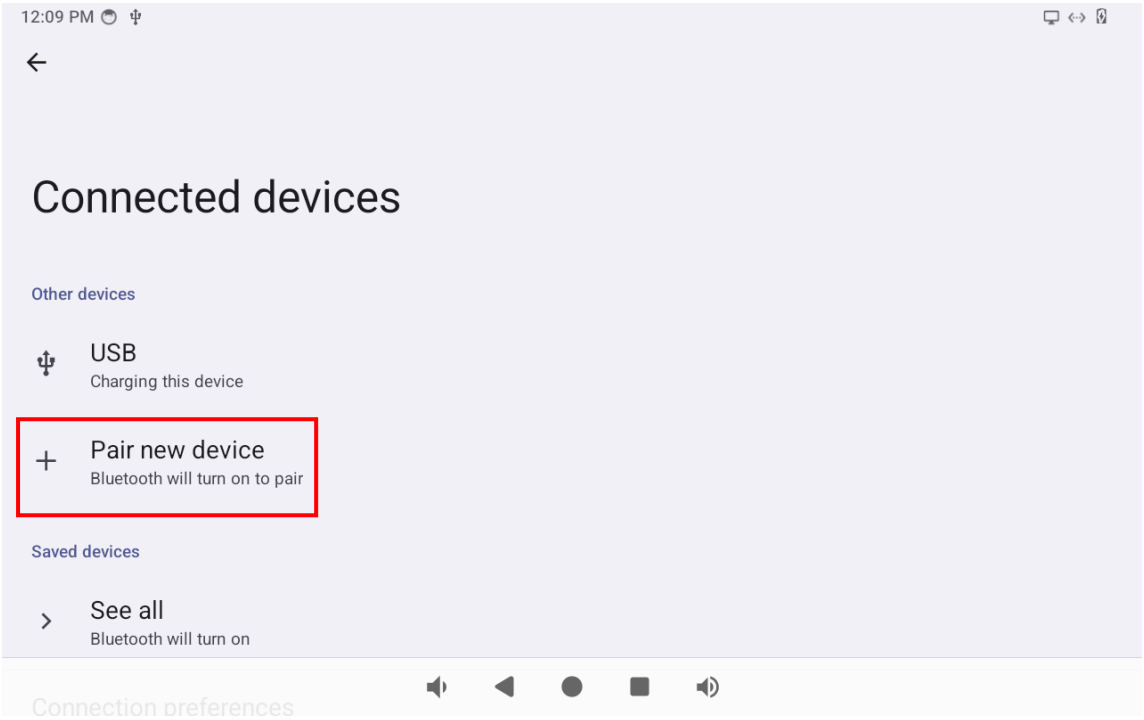
Step 1: Open the **Settings** app.



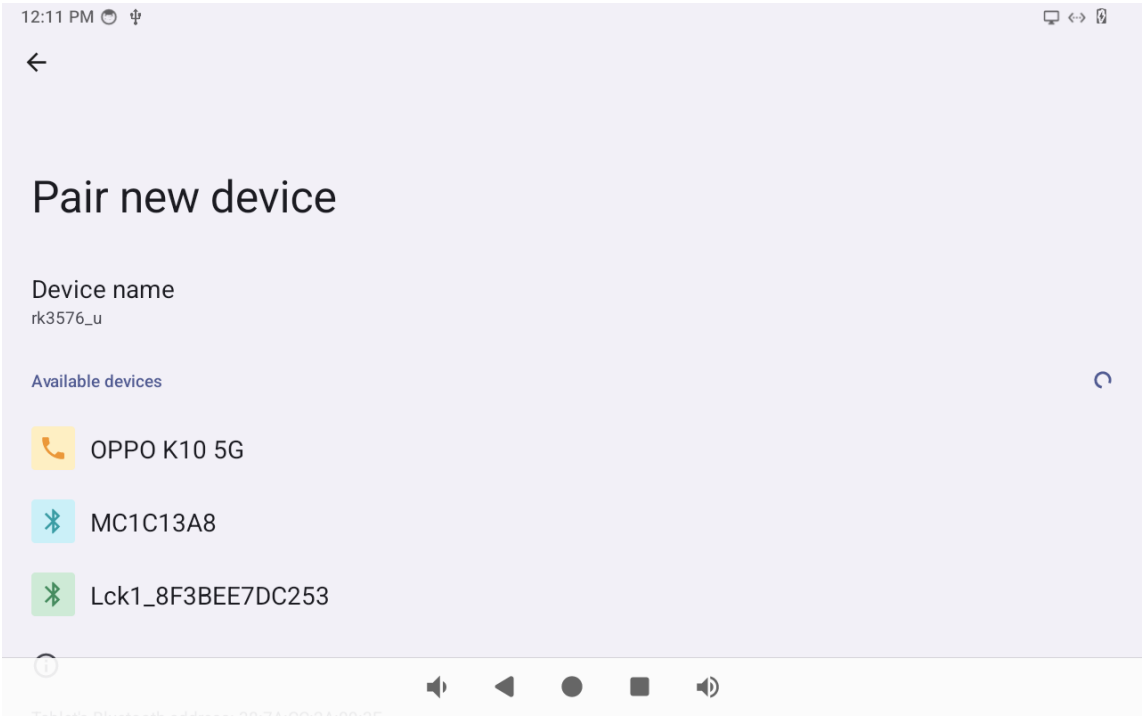
Step 2: Open the **"Connected devices"** option.



Step 3: Open the **"Pair new device"** option, and start scanning for devices.



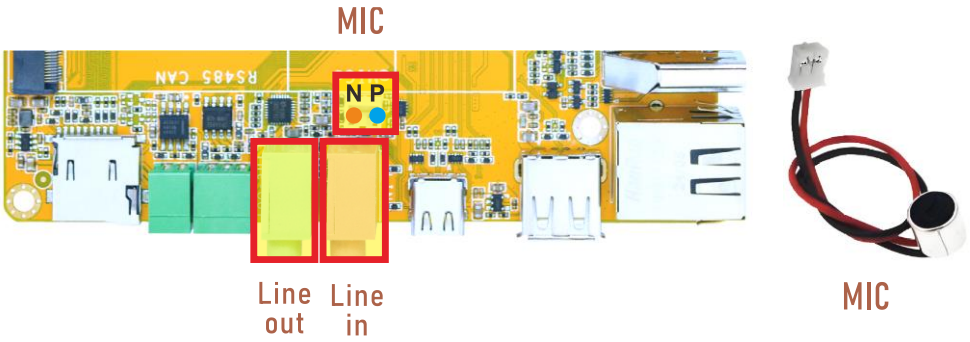
Step 4: User can pair themselves in the Bluetooth device list.



After successful configuration, Bluetooth devices can communicate with each other directly.

6.10 Audio

The audio input supports two channels: microphone (mic) and Line in, with the Line in channel as the default.

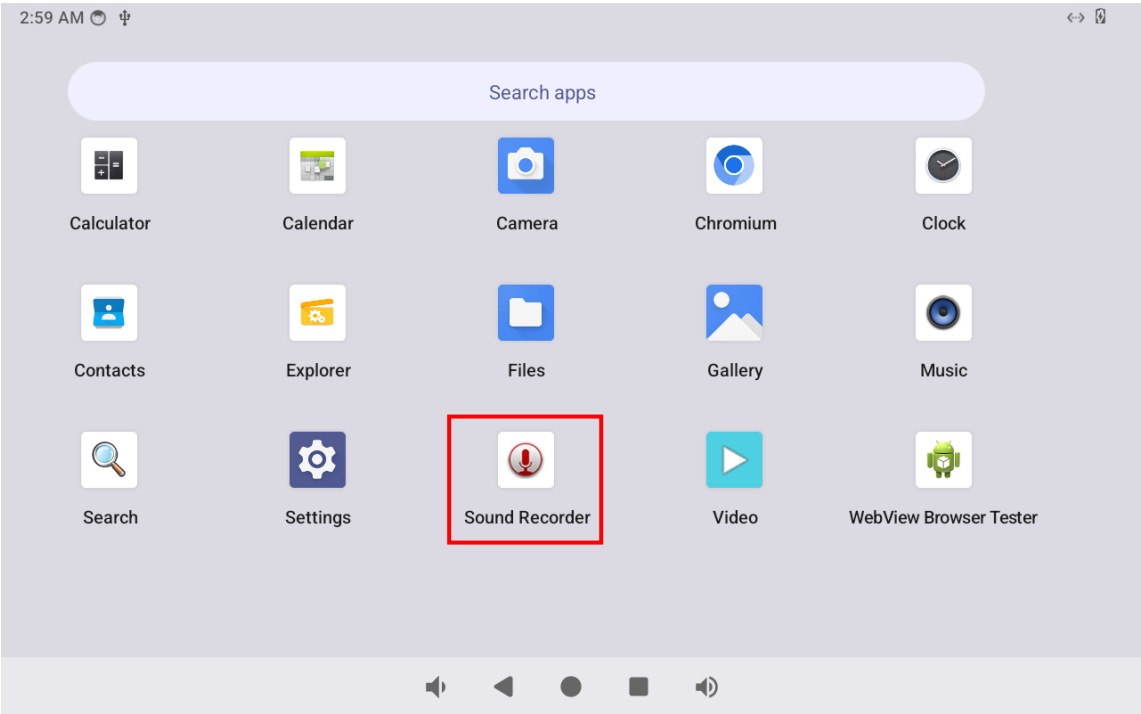


6.10.1 Audio input

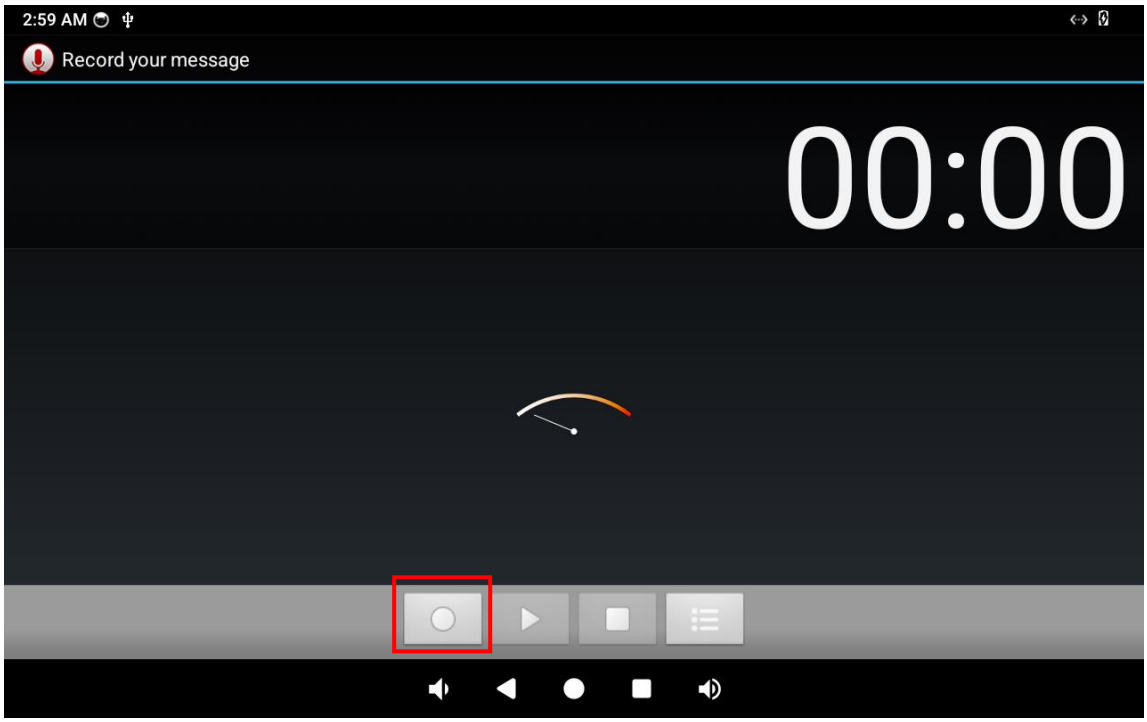
• **Line in record**.

Step 1, Connect the board Line in port and PC headphone jack with Line in cable.

Step 2, open the **Sound Recorder** app for a recording test.



Step 3, The PC play the recording audio then click the button as shown below to start recording.

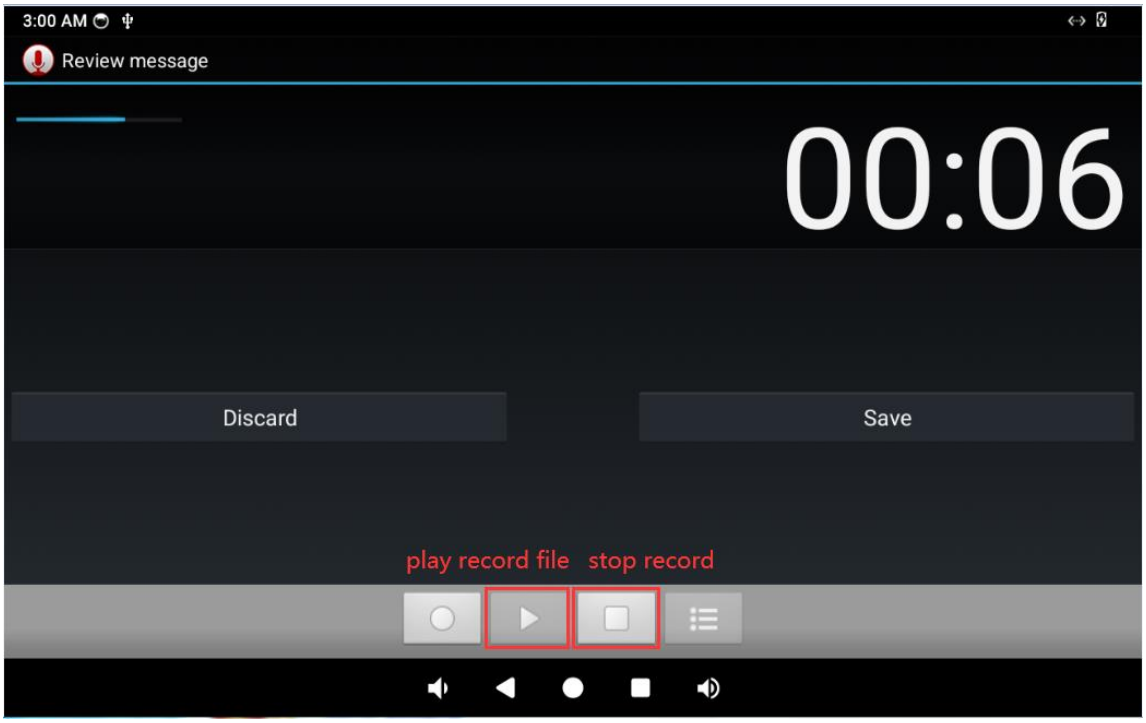


Then execute the following command to open record line.

```
# tinymix 67 1
# tinymix 68 1
```

```
130|console:/ # tinymix 67 1
console:/ # tinymix 68 1
console:/ # tinymix
Mixer name: 'rockchip-es8388'
Number of controls: 79
ctl     type    num     name                            value
61      BOOL    1       spk switch                      Off
62      BOOL    1       hp switch                       Off
63      BOOL    1       Headphone Switch                 On
64      BOOL    1       Speaker Switch                  On
65      BOOL    1       Main Mic Switch                 On
66      BOOL    1       Headset Mic Switch               On
67      ENUM    1       Left PGA Mux                    Line 2L
68      ENUM    1       Right PGA Mux                   Line 2R
69      ENUM    1       Differential Mux                 Line 2
```

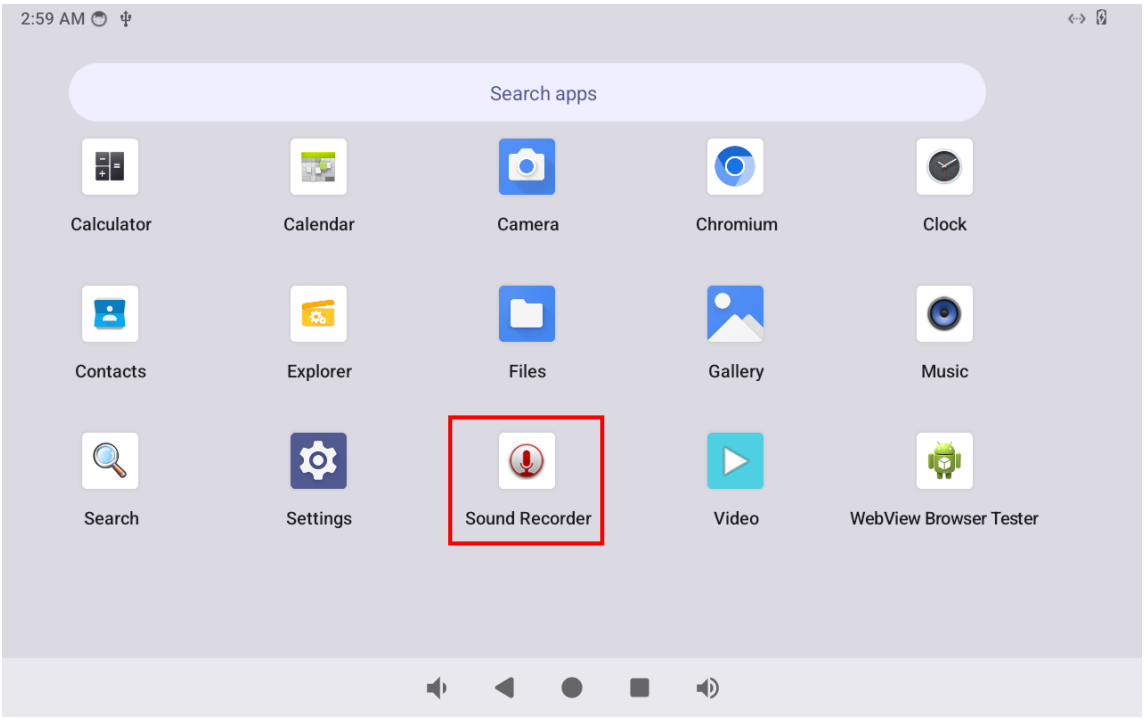
Step 4, click the button as shown below to stop recording and play.



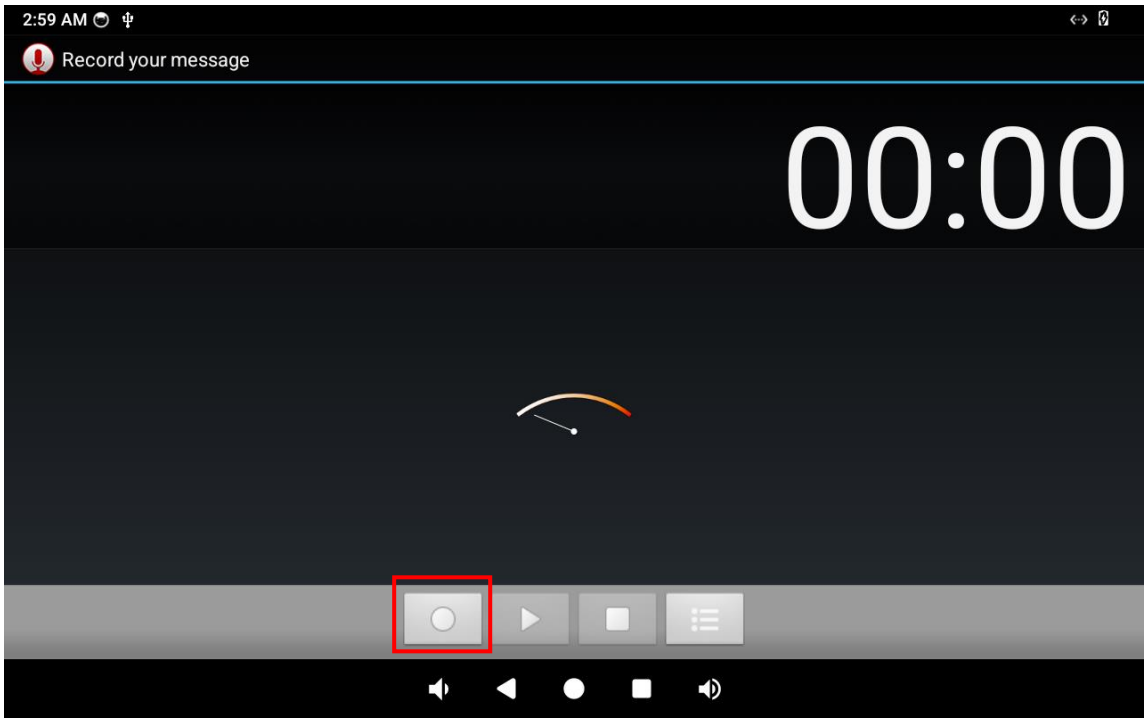
• **MIC record**

Step 1, Connect MIC to the board.

Step 2, open the **Sound Recorder** app for a recording test.



Step 3, Click the button as shown below to start recording.



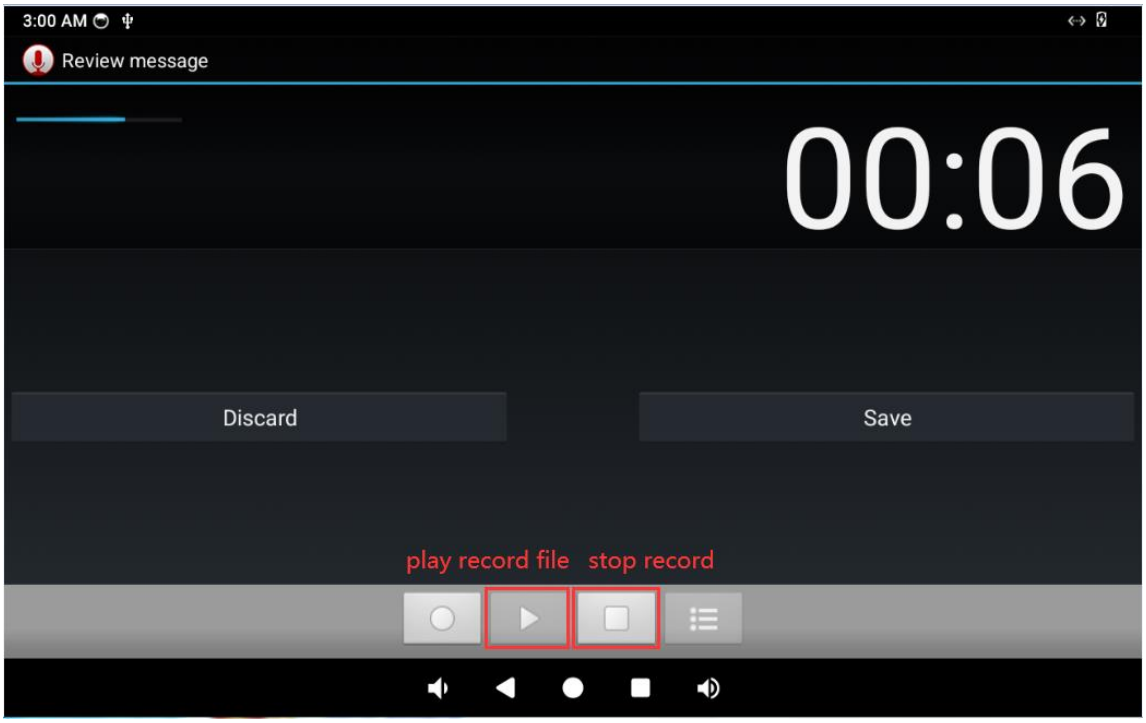
Execute the following command to switch the microphone (**mic**) channel to record.

```
# tinymix
# tinymix 69 0
```

```
130|console:/ #  tinymix 69 0
console:/ #  tinymix
Mixer name: 'rockchip-es8388'
Number of controls: 79
ctl     type    num     name                                value

54      ENUM    1       Capture Polarity                     Normal
55      INT     2       PCM Volume                          192 192
56      INT     1       Left Mixer Left Bypass Volume           0
57      INT     1       Right Mixer Right Bypass Volume         0
58      INT     2       Output 1 Playback Volume              0 0
59      INT     2       Output 2 Playback Volume              0 0
60      ENUM    1       ADC Data Select                     Left Left
61      BOOL    1       spk switch                          Off
62      BOOL    1       hp switch                           Off
63      BOOL    1       Headphone Switch                     On
64      BOOL    1       Speaker Switch                       On
65      BOOL    1       Main Mic Switch                      On
66      BOOL    1       Headset Mic Switch                   On
67      ENUM    1       Left PGA Mux                        Line 2L
68      ENUM    1       Right PGA Mux                       Line 2R
69      ENUM    1       Differential Mux                     Line 1
70      ENUM    1       Mono Mux                            Stereo
71      ENUM    1       Left Line Mux                       Line 1L
72      ENUM    1       Right Line Mux                      Line 1R
73      BOOL    1       Left Mixer Left Playback Switch         Off
74      BOOL    1       Left Mixer Left Bypass Switch           Off
75      BOOL    1       Right Mixer Right Playback Switch       Off
76      BOOL    1       Right Mixer Right Bypass Switch         Off
77      BOOL    1       OUT1 Switch                         Off
78      BOOL    1       OUT2 Switch                         Off
```

Then speak in the MIC can record.

Step 4, click the button as shown below to stop recording and play.



6.10.2 Audio output

• Test by command

Step 1: put the audio file the the sdcard or U-disk then execute the following command to view sound card.

```
# cat /proc/asound/cards
```

```
console:/ # cat /proc/asound/cards
 0 [rockchipes8388 ]: rockchip-es8388 - rockchip-es8388
                      rockchip-es8388
 1 [rockchipdp0    ]: rockchip-dp0 - rockchip-dp0
                      rockchip-dp0
 2 [rockchiphdmi   ]: rockchip-hdmi - rockchip-hdmi
                      rockchip-hdmi
```

Step 2: Execute the following command to open playback switch.

```
# tinymix 73 1
# tinymix 75 1
```

```
127|console:/ # tinymix 73 1
console:/ # tinymix 75 1
console:/ # tinymix
Mixer name: 'rockchip-es8388'
Number of controls: 79
ctl     type    num     name                                value

0       ENUM    1       SAI0 Transmit Start Mode Sel         Standalone
1       ENUM    1       SAI0 Receive Start Mode Sel          Standalone
2       ENUM    1       SAI0 Transmit SDOx Select            Auto
3       ENUM    1       SAI0 Receive SDIx Select             Auto
4       INT     1       SAI0 Receive Mono Slot Select        0
5       ENUM    1       SAI0 Receive Mono Switch             Disable
6       ENUM    1       SAI0 Transmit Mono Switch            Disable
7       ENUM    1       SAI0 SDI3 Loopback I2S LR Channel Sel  L:MIC R:LP
8       ENUM    1       SAI0 SDI2 Loopback I2S LR Channel Sel  L:MIC R:LP
9       ENUM    1       SAI0 SDI1 Loopback I2S LR Channel Sel  L:MIC R:LP
10      ENUM    1       SAI0 SDI0 Loopback I2S LR Channel Sel  L:MIC R:LP
11      ENUM    1       SAI0 SDI3 Loopback I2S LR Switch     Disable
12      ENUM    1       SAI0 SDI2 Loopback I2S LR Switch     Disable
13      ENUM    1       SAI0 SDI1 Loopback I2S LR Switch     Disable
14      ENUM    1       SAI0 SDI0 Loopback I2S LR Switch     Disable
15      ENUM    1       SAI0 SDI3 Loopback Src Select        From SDO0
16      ENUM    1       SAI0 SDI2 Loopback Src Select        From SDO0
17      ENUM    1       SAI0 SDI1 Loopback Src Select        From SDO0
18      ENUM    1       SAI0 SDI0 Loopback Src Select        From SDO0
19      ENUM    1       SAI0 SDI3 Loopback Switch            Disable
20      ENUM    1       SAI0 SDI2 Loopback Switch            Disable
21      ENUM    1       SAI0 SDI1 Loopback Switch            Disable
22      ENUM    1       SAI0 SDI0 Loopback Switch            Disable
23      ENUM    1       SAI0 Sync Out Switch                 From CRU
24      ENUM    1       SAI0 Sync In Switch                  From IO
25      ENUM    1       SAI0 Receive PATH3 Source Select      From SDI3
26      ENUM    1       SAI0 Receive PATH2 Source Select      From SDI2
27      ENUM    1       SAI0 Receive PATH1 Source Select      From SDI1
28      ENUM    1       SAI0 Receive PATH0 Source Select      From SDI0
29      ENUM    1       SAI0 Transmit SDO3 Source Select      From PATH3
30      ENUM    1       SAI0 Transmit SDO2 Source Select      From PATH2
31      ENUM    1       SAI0 Transmit SDO1 Source Select      From PATH1
32      ENUM    1       SAI0 Transmit SDO0 Source Select      From PATH0
33      BOOL    1       SAI0 Clk Auto Switch                 Off
34      INT     1       SAI0 PCM Read Wait Time MS           0
35      INT     1       SAI0 PCM Write Wait Time MS          0
36      ENUM    1       3D Mode                              Level 1
37      INT     1       ALC Capture Target Volume            12
38      INT     1       ALC Capture Max PGA                  0
39      INT     1       ALC Capture Min PGA                  0
40      ENUM    1       ALC Capture Function                 Off
41      BOOL    1       ALC Capture ZC Switch                Off
42      INT     1       ALC Capture Hold Time                0
43      INT     1       ALC Capture Decay Time               0
44      INT     1       ALC Capture Attack Time              5
45      INT     1       ALC Capture NG Threshold             10
46      ENUM    1       ALC Capture NG Type                  Mute ADC Output
47      BOOL    1       ALC Capture NG Switch                Off
48      BOOL    1       ZC Timeout Switch                    Off
49      INT     2       Capture Digital Volume               192 192
50      BOOL    1       Capture Mute                         On
51      INT     1       Left Channel Capture Volume          8
52      INT     1       Right Channel Capture Volume         8
53      ENUM    1       Playback De-emphasis                 None
54      ENUM    1       Capture Polarity                     Normal
55      INT     2       PCM Volume                           192 192
56      INT     1       Left Mixer Left Bypass Volume        0
57      INT     1       Right Mixer Right Bypass Volume      0
58      INT     2       Output 1 Playback Volume             0 0
59      INT     2       Output 2 Playback Volume             0 0
60      ENUM    1       ADC Data Select                      Left Left
61      BOOL    1       spk switch                           Off
62      BOOL    1       hp switch                            Off
63      BOOL    1       Headphone Switch                     On
64      BOOL    1       Speaker Switch                       On
65      BOOL    1       Main Mic Switch                      On
66      BOOL    1       Headset Mic Switch                   On
67      ENUM    1       Left PGA Mux                         DifferentialL
68      ENUM    1       Right PGA Mux                        Line 2R
69      ENUM    1       Differential Mux                     Line 1
70      ENUM    1       Mono Mux                             Stereo
71      ENUM    1       Left Line Mux                        Line 1L
72      ENUM    1       Right Line Mux                       Line 1R
73      BOOL    1       Left Mixer Left Playback Switch       On
74      BOOL    1       Left Mixer Left Bypass Switch         Off
75      BOOL    1       Right Mixer Right Playback Switch     On
76      BOOL    1       Right Mixer Right Bypass Switch       Off
77      BOOL    1       OUT1 Switch                          Off
78      BOOL    1       OUT2 Switch                          Off
```

Step 3: Execute the following command to play audio by Line out.

```
# tinyplay test.wav -D 0 -d 0 -p 1024 -n 3
```

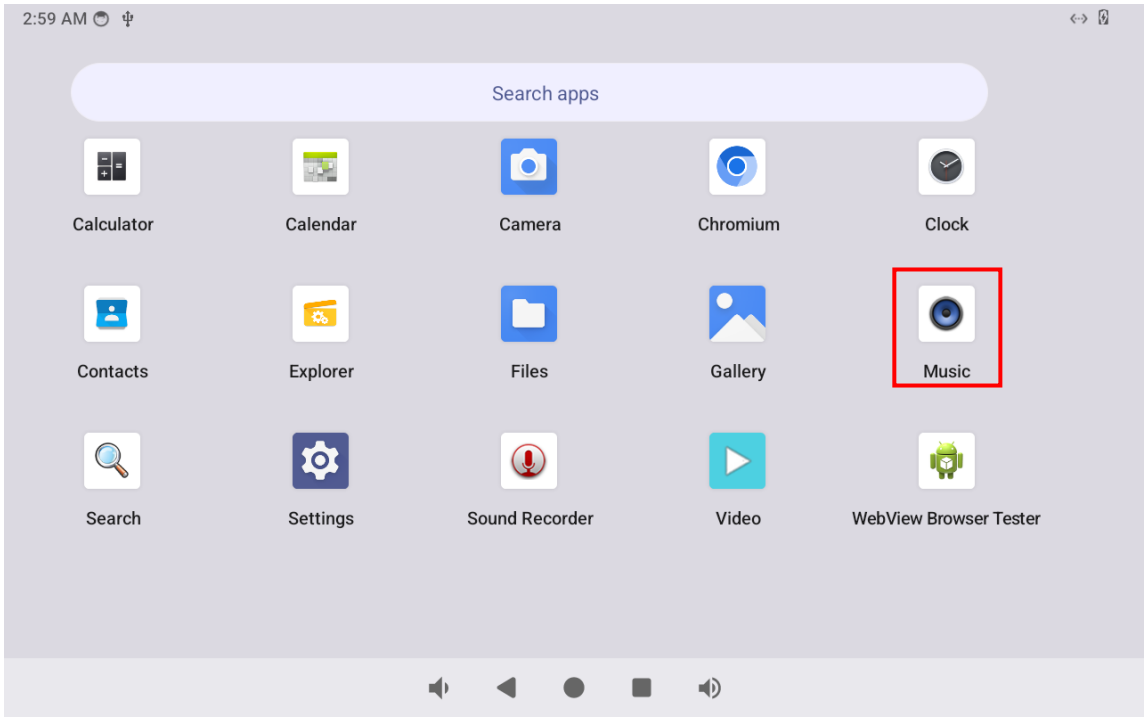
```
console:/mnt/media_rw/88E7-4C8E # tinyplay test.wav -D 0 -d 0 -p 1024 -n 3
Playing sample: 2 ch, 44100 hz, 16 bit 14590568 bytes
```

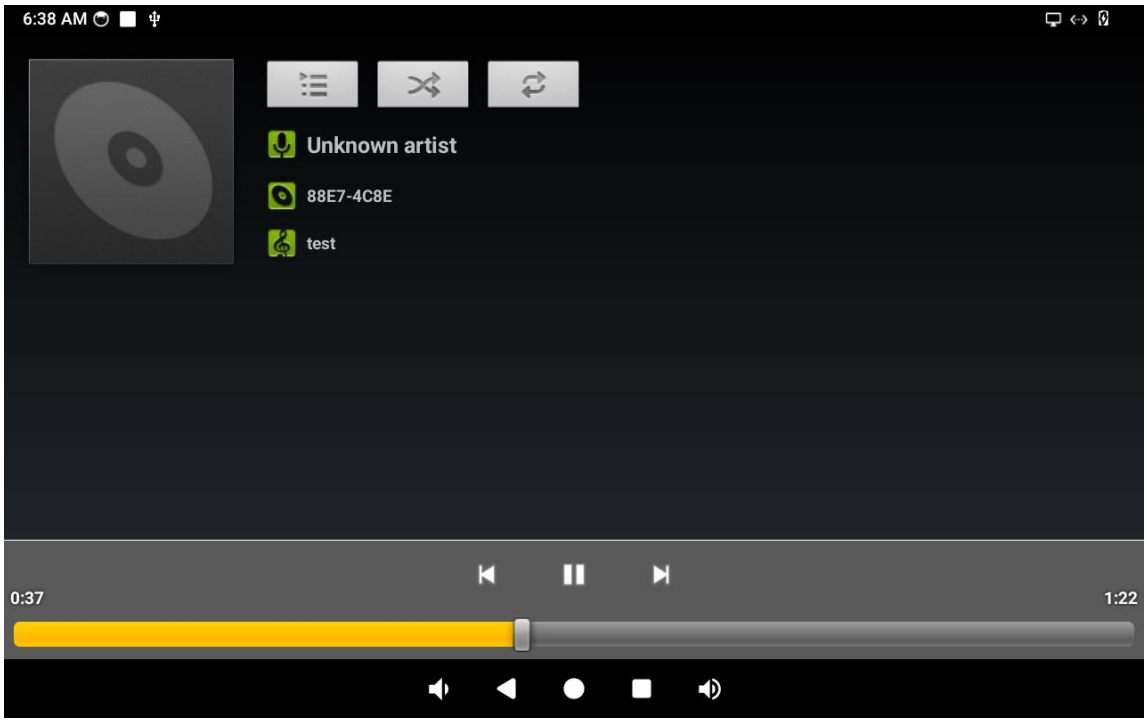
Supplementary instructions on audio output:

```
# tinyplay test.wav -D 0 -d 0 -p 1024 -n 3 // Line out audio output
# tinyplay test.wav -D 1 -d 0 -p 1024 -n 3 // DP AIT mode audio output
# tinyplay test.wav -D 2 -d 0 -p 1024 -n 3 // HDMI TX audio output
```

- **Test by APP**

Open the **Music** app for a audio test.

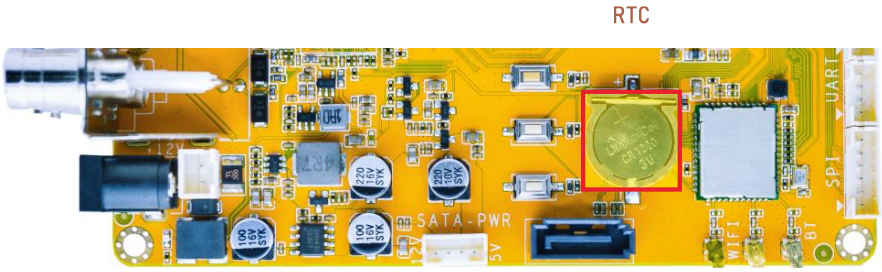




audio output priority: HDMI TX audio output > DP AIT mode audio output > Line out audio output.

6.11 RTC

Step 1: Install the coin cell battery.



Step 2: Set the system time.

```
# date -s "2025-01-14 14:53:00"
```

Step 3: Write the system time to the hardware clock.

```
# hwclock -w
```

Step 4: Display the current hardware clock time.

```
# hwclock
```

```
console:/ # date -s "2025-01-14 14:53:00"
Tue Jan 14 14:53:00 GMT 2025
console:/ # hwclock -w
console:/ # hwclock
2025-01-14 14:53:07+0000
console:/ # hwclock
2025-01-14 14:53:08+0000
console:/ # hwclock
2025-01-14 14:53:10+0000
console:/ # hwclock
2025-01-14 14:53:11+0000
console:/ # hwclock
2025-01-14 14:53:12+0000
console:/ # hwclock
2025-01-14 14:53:13+0000
```

Step 5: Power off, after a while to turn on the power again, check whether the time is saved.

```
130|console:/ # hwclock
2025-01-14 14:54:24+0000
console:/ # hwclock
2025-01-14 14:54:26+0000
console:/ # hwclock
2025-01-14 14:54:26+0000
console:/ # hwclock
2025-01-14 14:54:27+0000
console:/ # hwclock
2025-01-14 14:54:28+0000
```

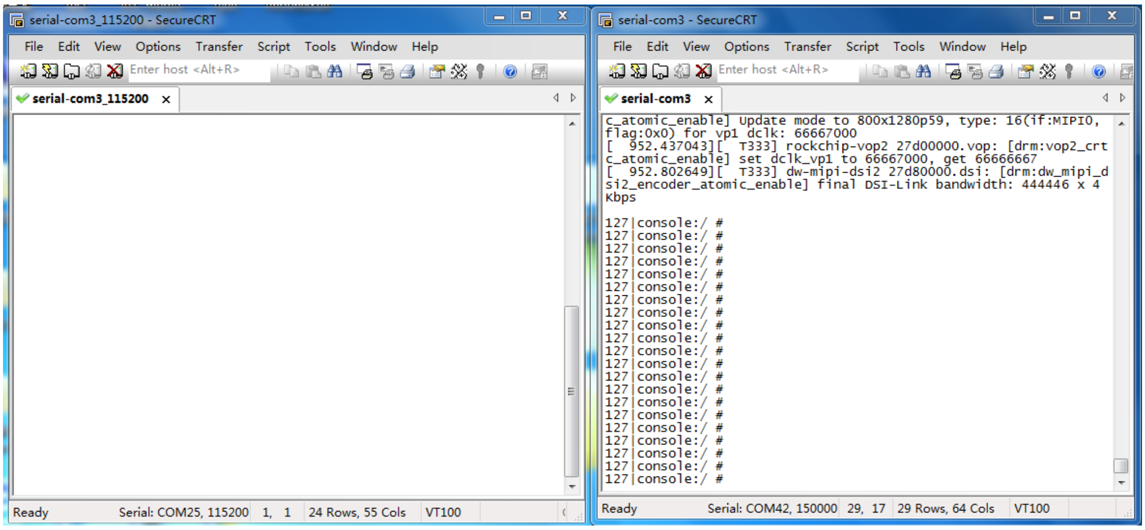
If the network is connected, the RTC can synchronize with the network time.

6.12 RS485

RS485

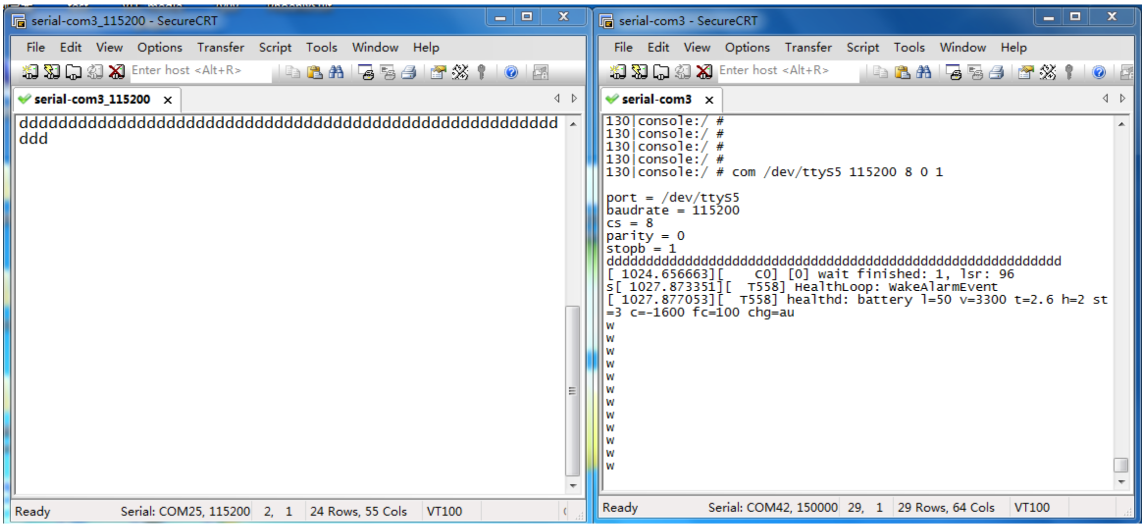
Step 1: As shown in the diagram, connect the RS485 test tool to the development board.

Step 2: Open the corresponding serial terminal, set the baud rate of the board to 1500000, and set the baud rate of the RS485 test tool to 115200.



Step 3: Execute the following command on the board to test the RS485 transmission and reception functionality.

```
# com /dev/ttyS5 115200 8 0 1
```

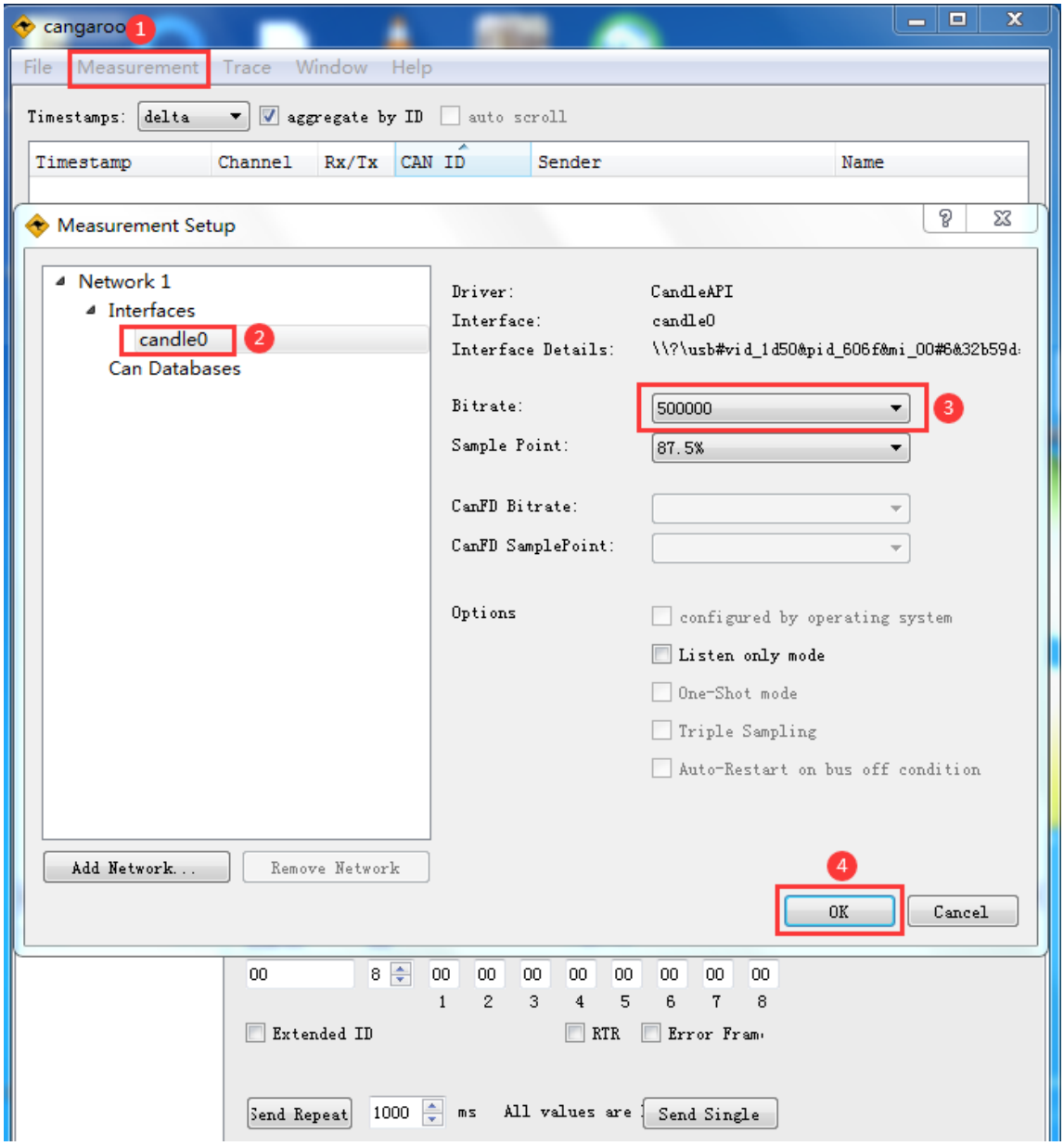


6.13 CAN

CAN

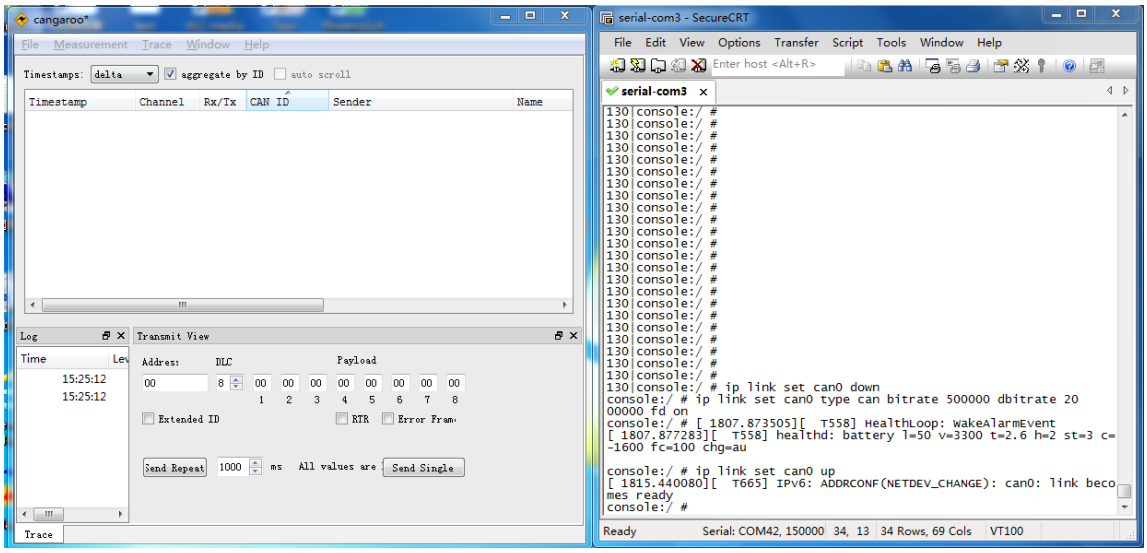
Step 1: Connect the CAN test tool to the board as shown in the diagram below.

Step 2: Open the CAN test software and set the baud rate to 500000.



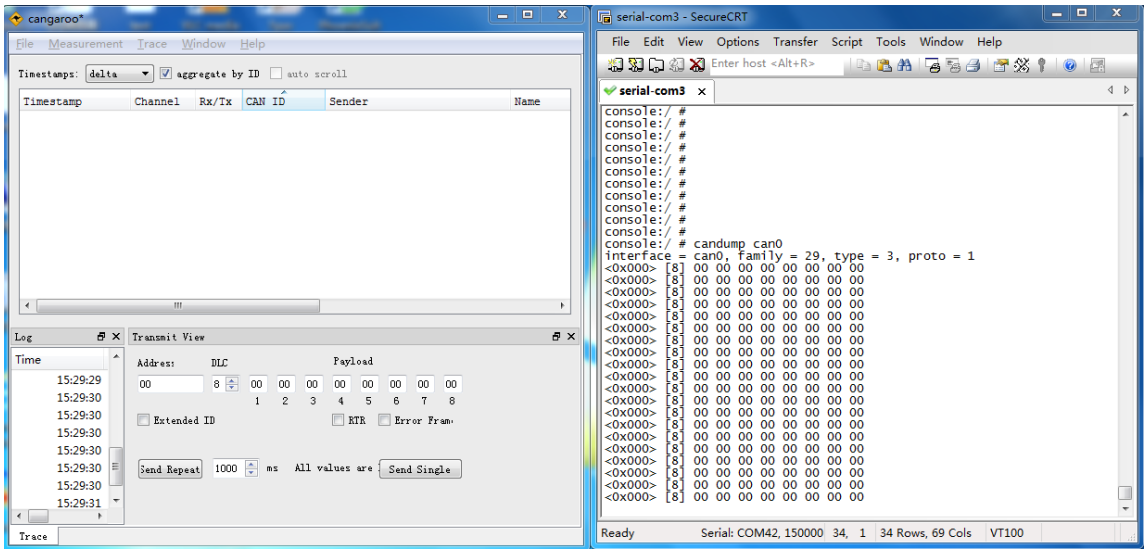
Step 3: Set up and activate the CAN network in CAN FD mode, with a nominal bitrate of 500000 and a data bitrate of 2000000.

```
# ip link set can0 down
# ip link set can0 type can bitrate 500000 dbitrate 2000000 fd on
# ip link set can0 up
```



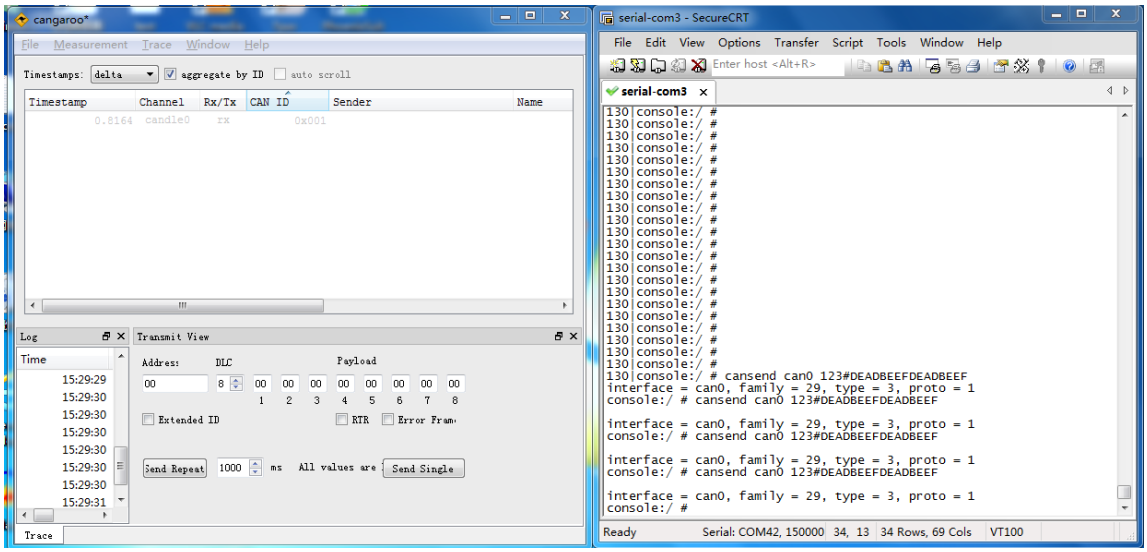
Step 4: Configure CAN as the receiver.

```
# candump can0
```



Step 5: Configure CAN as the sender.

```
# cansend can0 123#DEADBEEFDEADBEEF
```



6.14 UART

Step 1: Short circuit RX and TX pins of UART.

Step 2: UART10 test.

```
# com /dev/ttyS10 115200 8 0 1
```

```
130|console:/ # com /dev/ttyS10 115200 8 0 1
port = /dev/ttyS10
baudrate = 115200
cs = 8
parity = 0
stopb = 1

jjjjjjjjjjjjjjjjjj
iiiiiiiiiiiiiiiiii
```

Step 3: UART11 test.

```
# com /dev/ttyS11 115200 8 0 1
```

```
130|console:/ # com /dev/ttyS11 115200 8 0 1
port = /dev/ttyS11
baudrate = 115200
cs = 8
parity = 0
stopb = 1
kkkkkkkkkkkkkkkk
kkkkkkkkkkkkkkkk
```

6.15 SPI

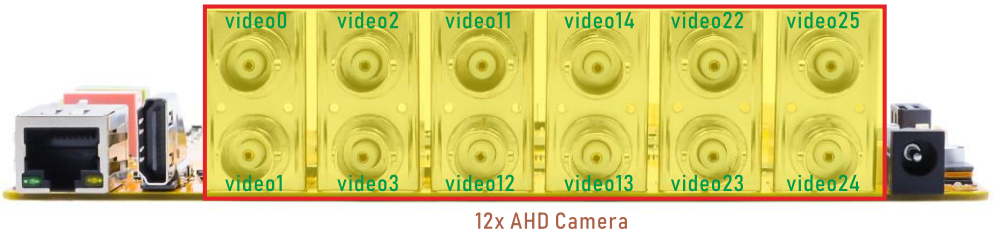
Step 1: short circuit SPI3_MISO and SPI3_MOSI pins of SPI.

Step 2: Execute the test script: **spidev_test**.

```
# spidev_test
```

```
console:/ # spidev_test
spi mode: 0
bits per word: 8
max speed: 500000 Hz (500 KHz)

FF FF FF FF FF FF
FF FF FF FF FF FF
FF FF FF FF FF FF
FF FF FF FF FF FF
FF FF FF FF FF FF
C0 00 00 00 00 00
00 00
console:/ # spidev_test
spi mode: 0
bits per word: 8
max speed: 500000 Hz (500 KHz)

FF FF FF FF FF FF
40 00 00 00 00 95
FF FF FF FF FF FF
FF FF FF FF FF FF
FF FF FF FF FF FF
DE AD BE EF BA AD
F0 0D
console:/ #
```

6.16 Camera



12x AHD Camera

• Single-camera preview, using video0 as an example.

```
# v4l2-ctl --verbose -d /dev/video0 --set-fmt-
video=width=1920,height=1080,pixelformat='NV12' --stream-mmap=4 --set-
selection=target=crop,flags=0,top=0,left=0,width=1920,height=1080 --stream-
to=./out0_0.yuv
```

```
console:/mnt/media_rw/8CF4-026D #
eft=0,width=1920,height=1080 --stream-to=./out0_0.yuv                    <
VIDIOC_QUERYCAP: ok
[  587.907508][ T2194] rkcif-mipi-lvds: static crop, S_SELECTION(1920x1080@0:0) target: 0
VIDIOC_G_FMT: ok
VIDIOC_S_FMT: ok
Format Video Capture Multiplanar:
        Width/Height      : 1920/1080
        Pixel Format      : 'NV12'
        Field             : None
        Number of planes  : 1
        Flags             :
        Colorspace        : Default
        Transfer Function : Default
        YCbCr Encoding    : Default
        Quantization      : Default
        Plane 0           :
           Bytes per Line : 1920
           Size Image     : 3110400
VIDIOC_G_SELECTION: ok
VIDIOC_S_SELECTION: ok
VIDIOC_REQBUFS: ok
VIDIOC_QUERYBUF: ok
VIDIOC_QUERYBUF: ok
VIDIOC_QBUF: ok
VIDIOC_QUERYBUF: ok
VIDIOC_QBUF: ok
VIDIOC_QUERYBUF: ok
VIDIOC_QBUF: ok
VIDIOC_QUERYBUF: ok
VIDIOC_QBUF: ok
[  587.917395][ T2194] rkcif-mipi-lvds: stream[0] start streaming
[  587.919464][ T2194] rkcif-mipi-lvds: Allocate dummy buffer, size: 0x003f5000
[  587.921716][ T2194] rockchip-mipi-csi2 mipi0-csi2: stream on, src_sd: 0000000040209343,
sd_name:rockchip-csi2-dphy0
[  587.921818][ T2194] rockchip-mipi-csi2 mipi0-csi2: stream ON
[  587.921872][ T2194] rockchip-csi2-dphy0: dphy0, data_rate_mbps 594
[  587.922174][ T2194] rockchip-csi2-dphy csi2-dphy0: csi2_dphy_s_stream stream on:1, dphy0, ret 0
[  587.923563][ T2194] reso_dtect = 7
[  587.923581][ T2194] techpoint 7-0047: detect channel 0 is not supported, default 1080P_25
[  587.924373][ T2194] techpoint 7-0047: set channel 0 1080P_25
[  587.967839][ T2194] reso_dtect = 3
[  587.968000][ T2194] techpoint 7-0047: detect channel 1 1080P_25
[  587.969050][ T2194] techpoint 7-0047: set channel 1 1080P_25
[  588.015133][ T2194] reso_dtect = 7
[  588.015288][ T2194] techpoint 7-0047: detect channel 2 is not supported, default 1080P_25
[  588.016347][ T2194] techpoint 7-0047: set channel 2 1080P_25
[  588.062278][ T2194] reso_dtect = 7
[  588.062423][ T2194] techpoint 7-0047: detect channel 3 is not supported, default 1080P_25
[  588.063482][ T2194] techpoint 7-0047: set channel 3 1080P_25
[  588.122844][    C0] (0x27c80000)MIPI_CSI2 ERR1:0xff0 (fs/fe mis,vc: 0 1 2 3) (f_seq,vc: 0 1 2 3)
VIDIOC_STREAMON: ok
idx: 0 seq:      0 bytesused: 3110400 ts: 587.268879
idx: 1 seq:      1 bytesused: 3110400 ts: 587.308881 delta: 40.002 ms
idx: 2 seq:      2 bytesused: 3110400 ts: 587.348899 delta: 40.018 ms
```

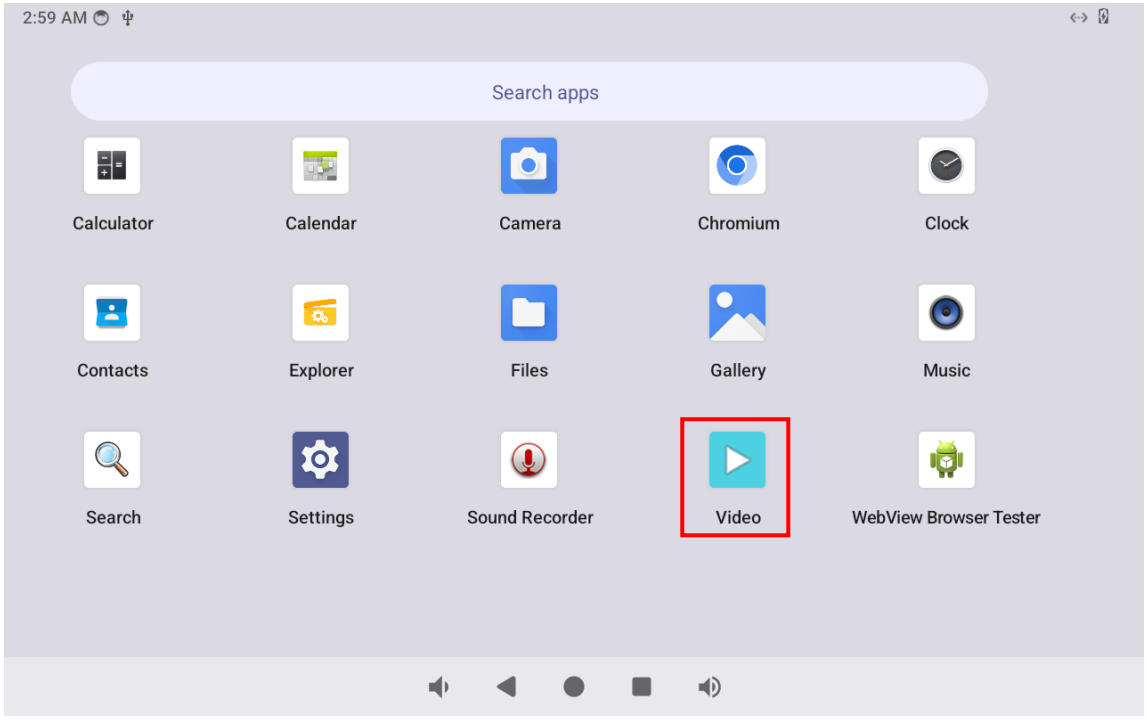
The file will save as under the current directory.

```
127|console:/mnt/media_rw/8CF4-026D # ls
1.png      Audiobooks         Pictures                  s.png
2.png      DCIM               Podcasts                  s1.png
3.png      Documents          Recordings                s2.png
4.png      Download           Ringtones                 s3.png
4k.mp4     Go-home.mp3        System\ Volume\ Information  s4.png
4k60.mp4   Hejie-jingguo.mp3  black_list                  snapshot
5.png      LOST.DIR           log                       test.wav
6.png      Movies             out0_0.yuv                video0
Alarms     Music              photo0                    video1
Android    Notifications      photo1                    white_list
console:/mnt/media_rw/8CF4-026D #
```

Copy the file to PC then play it by **7yuv**

6.17 Video Playback

Step 1, open the **Video** app for video playback test.



Step 2, Select video file to play.

• The EM3576 supports video playback up to 4K at 60Hz, with support for the following decoding formats: VP8, H.264, H.265, VP9, and AV1.

• However, it is only compatible with certain H.265 video files.