Software User Guide
ECB32 Series



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1. Overview

This document focuses on how to test and use the functions provided by the Ebyte ECB 32 series single-board computers. If users need to port and adapt specific functions based on this, please also refer to the "ECK32_T527_Software_Development_Guide", which will be referred to as the "Software Development Guide" in the following text . This document can be used as a preliminary evaluation guide or as a test guide for general system development.

1.1. Software Resources

The ECB32 runs the Linux 5.15 operating system. Both the single-board computer and the Pi board come with the cross-compilation toolchain required for embedded Linux system development, U-boot source code, the source code for the Linux kernel and various driver modules, as well as various development and debugging tools and application development samples for both Windows and Linux desktop environments .

2. Preparation Before Use

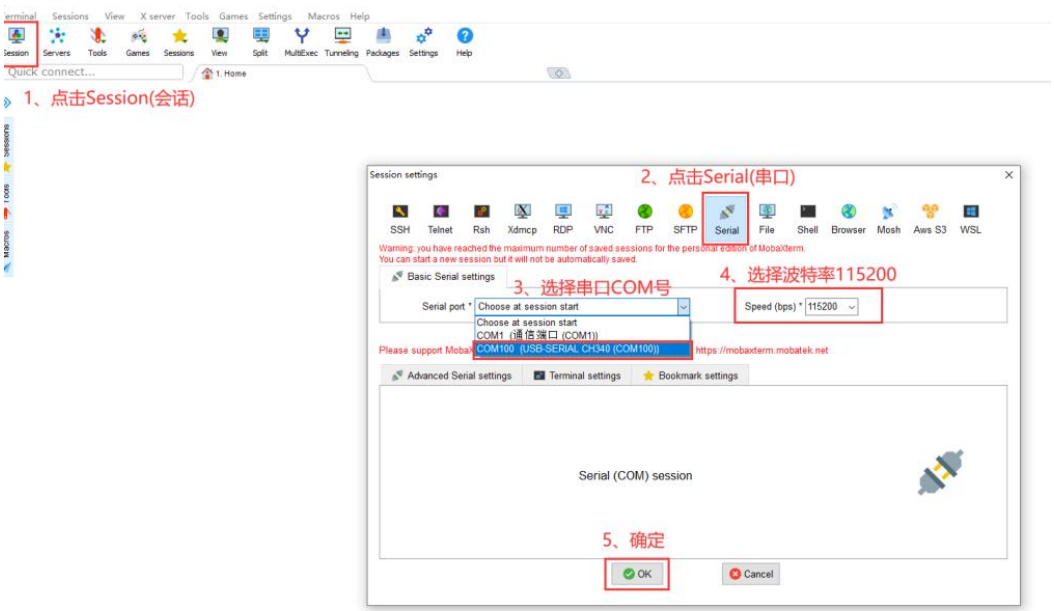
2.1. Serial Port Software Installation

Before using the serial port, you need to install the CH340 serial port driver and the MobaXterm serial terminal. For detailed installation and usage instructions, see the Software Development Guide .

After connecting the serial port, install MobaXterm and configure it, then open the serial port as follows.

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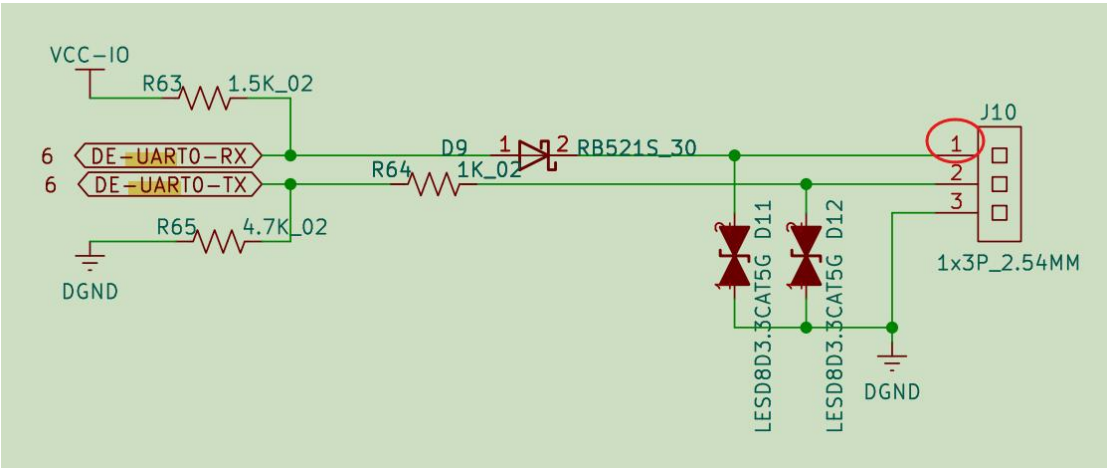


3. Quick Start

3.1. Serial port configuration

The serial port used by T527 uses a baud rate of 115200 and no hardware flow cont rol.

For the Pi board, use the TTL serial port, located next to the headphone jack. The o ne with the small arrow printed on it corresponds to pin 1 in the schematic diagram belo w.



For single-board computers, you can directly use the USB data cable without distingu ishing the connection lines.

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3.2. Image Burning

Ebyte's single-board computers and Pi boards come out factory without bootable firmware by default. Users must burn the firmware to the onboard eMMC or SD card. Users can choose the firmware to burn based on the SBC model. This article focuses on helping users quickly boot up their SBCs and only explains how to burn the firmware to the eMMC using official tools. For more information on burning methods and issues encountered during burning, see the Software Development Guide .

3.2.1. Image Selection

Image Description Table

Image name	Illustrate
t527_linux_ebyte_linux_t527_uart0_hdmi.img	The single-board computer uses HDMI and DP interfaces for display, Debian 11 system
t527_linux_ebyte_linux_t527_uart0_ mipi .img	Single board computer using dual MIPI-DSI interface display, Debian 11 system
a527_linux_pi_ebyte_a527_uart0 _hdmi .img	Using HDMI display on the A527 Pi board with Debian 12
a527_linux_pi_ebyte_a527_uart0 _mipi .img	A527 Pi board uses MIPI display, no display required, Debian 12 system
a527_linux_pi_ebyte_a527_uart0 _nor .img	A527 Pi board image for nor-flash boot, using ramfs
t 527_linux_pi_ebyte_ t 527_uart0 _hdmi .img	Using HDMI display on the T527 Pi board with Debian 12
t 527_linux_pi_ebyte_ t 527_uart0 _mipi .img	T527 Pi board uses MIPI display, no display required, Debian 12 system
t 527_linux_pi_ebyte_ t 527_uart0 _nor .img	T527 Pi board image for nor-flash boot, using ramfs

Images with HDMI suffixes must be connected to a monitor. Nor-flash images do not support display and NPU functions.

For nor-flash, you can modify the uboot env variable to specify the rootfs path and jump to the new system through ramfs.

3.2.2. Burn onboard eMMC

First, you need to use a USB data cable to connect the single-board computer and the computer, and then access the OTG port of the single-board computer . Then use the official Allwinner tool PhoenixSuit to achieve USB fast burning.

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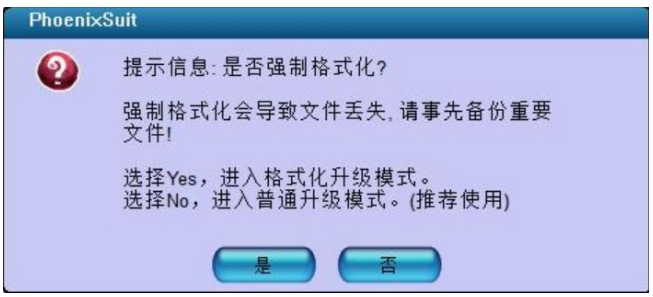
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" One-click flash " item above and enter the image selection . **Be careful not to click the upgrade button immediately** .

Next, we use a type-c data cable to connect the OTG interface to the PC. After the connection is completed, we need to enter the burning mode.

ECB32 introduces the FEL button. The user can press and hold FEL, then press the reset button or power on the board to enter the programming mode, which will pop up a programming inquiry box. If the user is not convenient to press the FEL button , you can first open the serial terminal software, then press and hold the keypad 2 on the serial terminal, and then press the reset button or power on the board to enter the programming mode. The programming tool will pop up a programming inquiry box.



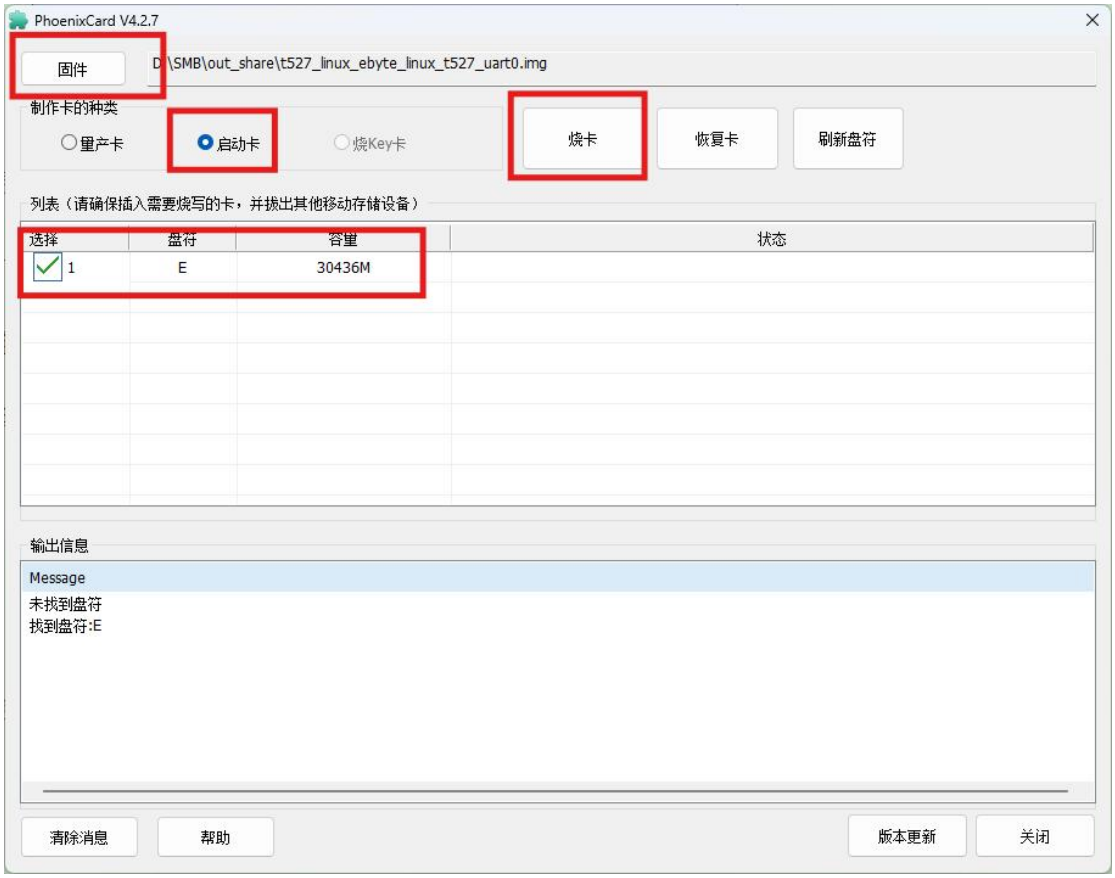
Users can choose whether to format and upgrade as needed and wait for the burning to be completed . Generally, the default is Yes .

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3.2.3. Burn SD card

In addition to burning directly to the eMMC on the board, you can also choose to burn to an SD card and then boot. Here we use the PhoenixCard provided by Allwinner to burn the SD card .



Select the firmware to be burned, choosing the image corresponding to the board being burned. Select the card type as "Boot Card" and then select the SD card device to be burned. The software will automatically scan for available removable storage devices, so be careful not to select the wrong device. Finally, click the "Burn Card" button. The progress of the burning process will be displayed in real time until the progress bar turns green, indicating that the burning is complete.

Note that the T527 boot order is SD -> eMMC -> other (non-flash, etc.). This means that as long as a bootable SD card is present, the eMMC will not boot. After burning the program to the onboard flash , remove the SD card to boot from the eMMC .

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3.3. Power on

Please note that if the display interface selected is not MIPI-DSI as the display output, you need to connect at least one of the displays before powering on. Otherwise, Uboot will not be able to boot into the kernel or the system will fail to provide display function after entering the kernel.

4. Quick Experience

This chapter will test according to functional modules and provide a preliminary function application method. **When the system to be used is not explicitly specified, the single-board computer defaults to the system built by buildroot for verification, and the Pi board defaults to the Debian system for verification**.

4.1. CPU

4.1.1. Check CPU information

Run the following command to view CPU information.

```
# cat /proc/cpuinfo
processor : 0
BogoMIPS: 48.00
Features: fp asimd aes pmull sha1 sha2 crc32 atomics fphp asimdhp cpuid asimdrdm lrcpc dcpop asimddp
CPU implementer: 0x41
CPU architecture: 8
CPU variant: 0x2
CPU part: 0xd05
CPU revision: 0

processor : 1
BogoMIPS: 48.00
```

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```
Features: fp asimd aes pmull sha1 sha2 crc32 atomics fphp asimdhp cpuid asimdrdm lrcpc dcpop asimddp
CPU implementer: 0x41
CPU architecture: 8
CPU variant: 0x2
CPU part: 0xd05
CPU revision: 0
.....
processor: 7
BogoMIPS: 48.00
Features: fp asimd aes pmull sha1 sha2 crc32 atomics fphp asimdhp cpuid asimdrdm lrcpc dcpop asimddp
CPU implementer: 0x41
CPU architecture: 8
CPU variant: 0x2
CPU part: 0xd05
CPU revision: 0
```

Processor: The number of the logical processing core in the system. For a multi-core processor, it can be a physical core or a virtual logical core using hyperthreading technology .

BogoMIPS: Million Instructions Per Second (MILLION INSTRUCTIONS PER SECOND) is a rough estimate of how many instructions the CPU can run when the system kernel boots up.

Features : Instruction functions supported by the CPU

4.1.2. Check CPU usage

Use the following command to check CPU usage

```
# htop
0[ 0.0%] 4[**************************100.0%]
```


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```
1[  0.0%]  5[  0.0%]
2[  0.0%]  6[  0.0%]
3[  0.0%]  7[  0.0%]
Mem[|||||#*@@@@@  258M/1.88G]  Tasks:  20,  45  thr,  124  kthr;  1  running
Swp[  0K/0K]  Load  average:  1.41  0.31  0.10
Uptime:  00:00:13


[Main]  [I/O]
PID  USER  PRI  NI  VIRT  RES  SHR  S  CPU%  -MEM%  TIME+  Command
626  root  20  0  4268  2552  2068  R  66.7  0.1  0:00.08  htop
1  root  20  0  3316  1688  1552  S  0.0  0.1  0:00.63  init
178  root  20  0  3316  528  456  S  0.0  0.0  0:00.02  /sbin/syslogd  -
182  root  20  0  3316  556  488  S  0.0  0.0  0:00.03  /sbin/klogd  -n
194  root  20  0  15968  2676  1656  S  0.0  0.1  0:00.33  /sbin/udevd  -d
284  root  20  0  3744  228  0  S  0.0  0.0  0:00.00  dbus-daemon  --s
288  root  20  0  2536  176  0  S  0.0  0.0  0:00.00  /usr/sbin/rpcbi
303  root  20  0  404M  77012  59384  S  0.0  3.9  0:00.41  weston  --backen
307  root  20  0  3196  2364  1784  S  0.0  0.1  0:00.04  dhcpcd:  [manage
327  root  20  0  404M  77012  59384  S  0.0  3.9  0:00.00  weston  --backen
328  root  20  0  404M  77012  59384  S  0.0  3.9  0:00.00  weston  --backen
329  root  20  0  404M  77012  59384  S  0.0  3.9  0:00.00  weston  --backen
```

4.1.3. Check CPU temperature

Use the following command to view the current CPU temperature:

```
# cat /sys/class/thermal/thermal_zone*/type
cpul_thermal_zone
cpub_thermal_zone
gpu_thermal_zone
```

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```
npu_thermal_zone
ddr_thermal_zone
axp2202-usb
# cat /sys/class/thermal/thermal_zone*/temp
38702
38036
38480
38480
33374
32900
```

Through the type, we can find which node corresponds to the module we need to focus on, and then the temp return value of the corresponding node is divided by 1000 to get the actual temperature. For example, the temp value corresponding to cpub_thermal_zone is 38036 , and the actual temperature is 38 degrees Celsius .

4.2. GPU

For the GPU (mali-g57) on the T527, after connecting to the corresponding display and starting the desktop, you can run the following command to view the GPU usage:

```
# Check gpu usage
# mtop
```

On a system built with buildroot, you can test the GPU performance using the following command:

```
# export XDG_RUNTIME_DIR="/tmp/wayland"
# glmark2-es2-wayland
```

On a system built with Debian bookworm, you can test the GPU performance with the following command:

```
# export XDG_RUNTIME_DIR="/run/user/0"
```

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```
# glmark2-es2-wayland
```

On a system built with Debian Bullseye, you can test the GPU performance using th e following command:

```
# export DISPLAY=:0.0
# glmark2
```

For Debian bullseye, since it uses X11 for testing, its test results will be weaker than bookworm, but the actual performance difference is not much, both of them use drm + Wayland to run.

4.3. NPU

Some of our models provide a 2 TOPS NPU. For the relevant test usage process, ple ase refer to the "t527_npu" document in the development notes. This article will not go i nto details.

4.4. Video decoding

Currently, gstreamer is used to provide video decoding functions. Users can use the f ollowing command to play an H264 video:

On a system built with buildroot, you can test the GPU performance using the follow ing command:

```
# export XDG_RUNTIME_DIR="/tmp/wayland"
# gst-play-1.0 your.mp4
```

On a Debian-based system, you can test the GPU performance using the following co mmand:

```
# export XDG_RUNTIME_DIR="/run/user/0"
# gst-play-1.0 your.mp4
```

For Debian systems, you can install and use the Totem player, which uses gstreamer to provide decoding support at the back end. For parts beyond gstreamer, software decodi

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ng is used.

Alternatively, you can use gst-lunch-1.0 to play, which provides more detailed configu ration.

4.5. Memory

4.5.1. Memory information

Use the following command to view memory information:

```
# cat /proc/meminfo
MemTotal: 1968224 kB
MemFree: 1491108 kB
MemAvailable: 1661780 kB
Buffers: 5272 kB
Cached: 180740 kB
SwapCached: 0 kB
Active: 15232 kB
Inactive: 261972 kB
Active(anon): 520 kB
Inactive(anon): 108548 kB
Active(file): 14712 kB
Inactive(file): 153424 kB
Unevictable: 0 kB
Mlocked: 0 kB
SwapTotal: 0 kB
SwapFree: 0 kB
Dirty: 0 kB
Writeback: 0 kB
AnonPages: 91280 kB
Mapped: 110508 kB
```

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```
Shmem:  17876  kB
KReclaimable:  27216  kB
Slab:  87728  kB
SReclaimable:  27216  kB
SUnreclaim:  60512  kB
KernelStack:  3104  kB
PageTables:  1872  kB
NFS_Unstable:  0  kB
Bounce:  0  kB
WritebackTmp:  0  kB
CommitLimit:  984112  kB
Committed_AS:  630164  kB
VmallocTotal:  259653632  kB
VmallocUsed:  6476  kB
VmallocChunk:  0  kB
Percpu:  864  kB
CmaTotal:  65536  kB
CmaFree:  64356  kB
```

MemTotal: Total memory. The value shown here is 498788 kB, indicating that the sy stem has approximately 487 MB of physical memory available. Since the conversion here is 1024, while the conventional sales process generally uses 1000, the size here can also be regarded as 510.76 MB. Adding some memory reserved for other uses, this size is als o normal.

MemFree: The amount of free memory. The value shown here is 369352 kB, which means that there are about 360 MB of memory in the current system that is free and not in use.

MemAvailable: The amount of available memory. The value shown here is 396952 k B, which represents the total amount of memory currently available to the system, includi

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ng cached memory and free memory.

Buffers: Buffer usage. The value shown here is 0 kB, indicating that the system is not currently using any memory as a buffer.

Cached: The amount of cached memory. The value shown here is 39208 kB, which represents the amount of memory currently used for caching on the system.

SwapCached: The amount of memory used for swap cache. The value shown here is 0 kB, indicating memory that is not currently cached in swap space.

Active: The amount of active memory. The value shown here is 8576 kB , which indicates the amount of memory currently in use.

4.5.2. Memory Test

Use the following command to get the memory size available for testing:

```
# free -h
total used free shared buff/cache available
Mem: 1.9G 257.2M 1.4G 17.5M 208.2M 1.6G
Swap: 0 0 0
```

The maximum memory size that can be used for testing here is 1.6G, but considering the stable operation of other subsequent programs, the following memory test is performed with 100MB as an example:

```
# memtester 100M 1
memtester version 4.5.0 (64-bit)
Copyright (C) 2001-2020 Charles Cazabon.
Licensed under the GNU General Public License version 2 (only).


pagesize is 4096
pagesizemask is 0xfffffffffffff000
want 100MB (104857600 bytes)
got 100MB (104857600 bytes), trying mlock ...locked.
Loop 1/1:
```

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```
Stuck Address : ok
Random Value : ok
Compare XOR : ok
Compare SUB : ok
Compare MUL : ok
Compare DIV : ok
Compare OR : ok
Compare AND : ok
Sequential Increment: ok
Solid Bits : ok
Block Sequential : ok
Checkerboard: ok
Bit Spread : ok
Bit Flip : ok
Walking Ones : ok
Walking Zeroes : ok
8-bit Writes : ok
16-bit Writes : ok


Done.
```

You can see that all test items here are in the `ok` state, indicating that the test pass ed and there are no obvious errors in the memory.

Note: For Debian systems, memtester is not included by default and needs to be inst alled manually through apt.

4.6. eMMC test

4.6.1. View eMMC information

Use the following command to obtain the eMMC device capacity and partition status

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table. **For users who use SD card boot, use /dev/mmcblk1 to view eMMC information** :

```
# fdisk -l /dev/mmcblk0
Disk /dev/mmcblk0: 14.58 GiB, 15655239680 bytes, 30576640 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: gpt
Disk identifier: AB6F3888-569A-4926-9668-80941DCB40BC

Device Start End Sectors Size Type
/dev/mmcblk0p1 73728 139263 65536 32M Microsoft basic data
/dev/mmcblk0p2 139264 172031 32768 16M Microsoft basic data
/dev/mmcblk0p3 172032 368639 196608 96M Microsoft basic data
/dev/mmcblk0p4 368640 17145855 16777216 8G Microsoft basic data
/dev/mmcblk0p5 17145856 30576606 13430751 6.4G Microsoft basic data
```

Here, the eMMC is divided into five partitions, and the p4 partition is used for the file system. You can get the partition type by the following command:

```
# lsblk -f
NAME FSTYPE FSVER LABEL UUID FSAVAIL FSUSE% MOUNTPOINTS
mmcblk0
|-mmcblk0p1 vfat FAT16 Volumen
|-mmcblk0p2
|-mmcblk0p3
|-mmcblk0p4 ext4 1.0 57f8f4bc-abf4-655f-bf67-946fc0f9f25b 7.2G 7% /var/lib/docker
| /
`-mmcblk0p5
```

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4.6.2. eMMC read and write

You can use the following command to test the eMMC read and write performance:

```
# time dd if=/dev/zero of=test.bin bs=1M count=1024 conv=fsync
1024+0 records in
1024+0 records out

real 0m9.172s
user 0m0.023s
sys 0m3.991s
# echo 3 > /proc/sys/vm/drop_caches
# time dd if=test.bin of=/dev/null bs=1M
1024+0 records in
1024+0 records out

real 0m4.573s
user 0m0.000s
sys 0m1.192s
```

Based on the above content, we can know that the current single-board computer's wr ite speed is 1024/ 9.172 = 111.6MB/s, and the read speed is 1024/4.572 = 223.9MB/s.

At the same time, the above `echo 3 > /proc/sys/vm/drop_caches` is to eliminate the influence of system cache and obtain the actual read speed.

4.7.Watchdog

Use the following command to configure the watchdog timeout to 5 seconds and rest art the single-board computer:

```
# watchdog -T 5 -t 10 /dev/watchdog
```

During this process, the system will automatically restart after about 5 seconds.

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4.8. Power Management

This section demonstrates the Suspend function of Linux power management, which allows the board to sleep and be awakened by external events.

The Linux kernel provides multiple suspend methods. The following are supported on the ECB32 series single-board computers:

```
# cat /sys/power/state
freeze mem
```

In user space, write "freeze" and "mem" to the "/sys/power/state" file respectively to enter the corresponding sleep mode. After entering this mode, you will find that the power is reduced. **Please note: If you use mem to enter sleep mode, only the PL group pins in the single-board computer will continue to be powered. If additional wake-up function is required, please use these pins.** If not, you can **short-press** the power button to wake up:

```
# Provides wake-up function after freeze sleep, and any input from the serial port can wake up after sleep
# echo enabled > /sys/class/tty/ttyAS0/power/wakeup
# echo freeze > /sys/power/state
# echo mem > /sys/power/state
```

If you are using a Debian system and the computer automatically shuts down after pressing the power button, be sure to configure the power button to do nothing. For example, in the GNOME desktop, go to settings -> power -> Power Button Behavior and set it to `Nothing`.

4.9. RTC

The Linux system is divided into a system clock (software clock) and an RTC clock (hardware clock). The system clock disappears when power is lost, while the RTC clock continues to run permanently when a battery is installed. To use an external RTC clock, in

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stall an ML2032 (3V rechargeable) or CR2032 (3V non-rechargeable) battery in the RTC button battery holder, marked as `VBAT` on the single-board computer.

1. Set the current time:

```
# date -s "2010-10-10 10:10:10"
Sun Oct 10 10:10:10 CST 2010
```

2. Write the system time to the external RTC and check whether it is written:

```
# hwclock -w -f /dev/rtc1
# hwclock -f /dev/rtc1
Sun Oct 10 10:10:12 2010 0.000000 seconds
```

3. Shut down the device, unplug the power supply, wait for a while, then power on again to check the RTC time:

```
# hwclock -f /dev/rtc1
Sun Oct 10 10:11:24 2010 0.000000 seconds
```

4.10.Network

4.10.1. ETH

The current single-board computer has two network ports, and the Pi board has one network port. Use ifconfig in the net-tools toolkit to manually configure the network. First, use the ifconfig command to view the network device information as follows :

```
# ifconfig
docker0 Link encap:Ethernet HWaddr 02:42:29:6D:EC:BD
inet addr:172.17.0.1 Bcast:172.17.255.255 Mask:255.255.0.0
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:0
RX bytes:0 (0.0 B) TX bytes:0 (0.0 B)
```

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```
eth0  Link  encap:Ethernet  HWaddr  D2:09:15:64:BA:64
inet  addr:192.168.20.31  Bcast:192.168.20.255  Mask:255.255.255.0
inet6  addr:  fe80::2a5:c1ad:5f72:115a/64  Scope:Link
UP  BROADCAST  RUNNING  MULTICAST  MTU:1500  Metric:1
RX  packets:538  errors:0  dropped:0  overruns:0  frame:0
TX  packets:102  errors:0  dropped:0  overruns:0  carrier:0
collisions:0  txqueuelen:1000
RX  bytes:274417  (267.9  KiB)  TX  bytes:8614  (8.4  KiB)
Interrupt:98

eth1  Link  encap:Ethernet  HWaddr  46:3E:24:75:A2:77
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  (0.0  B)  TX  bytes:0  (0.0  B)
Interrupt:99

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:130  errors:0  dropped:0  overruns:0  frame:0
TX  packets:130  errors:0  dropped:0  overruns:0  carrier:0
collisions:0  txqueuelen:1000
RX  bytes:9612  (9.3  KiB)  TX  bytes:9612  (9.3  KiB)
```

The current root file system is configured with automatic DHCP function, but users c

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an also manually configure a static IP.

4.10.1.1. Static address

The following describes how to manually configure the IP address 192.168.1.253 for eth0 in the buildroot system. The command is as follows:

```
# ifconfig eth0 192.168.0.253 netmask 255.255.255.0 up
# ifconfig
eth0 Link encap:Ethernet HWaddr 4E:42:0B:5A:EE:7F
inet addr:192.168.0.253 Bcast:192.168.0.255 Mask:255.255.255.0
UP BROADCAST MULTICAST MTU:1500 Metric:1
RX packets:118 errors:0 dropped:0 overruns:0 frame:0
TX packets:92 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:13846 (13.5 KiB) TX bytes:8610 (8.4 KiB)
```

For Debian systems, you can use nmtui or gnome-settings to configure the system wi thout using command configuration.

4.10.2. WIFI/BT

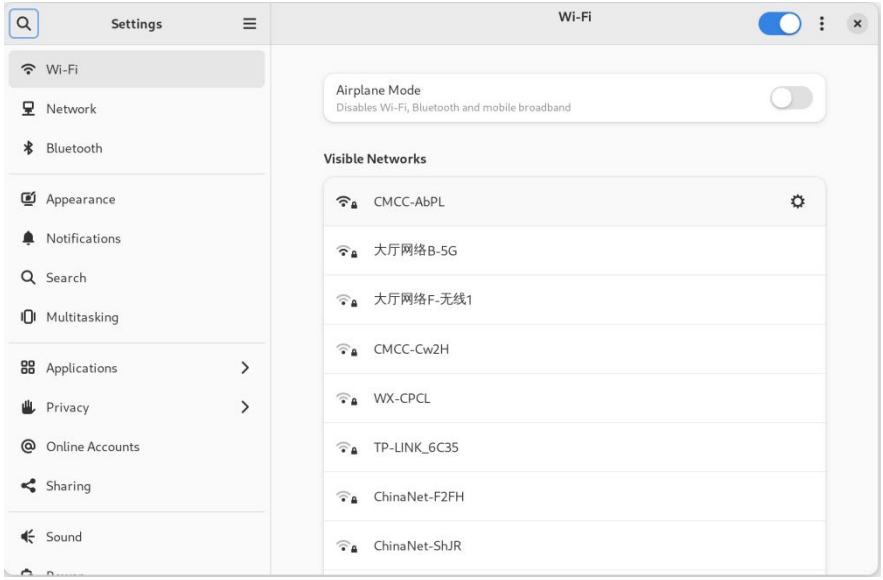
This section is limited to Pi board support. Single-board computers do not have corresponding devices. It is strongly recommended to add an antenna. Otherwise, the signal will be extremely weak and may damage the device.

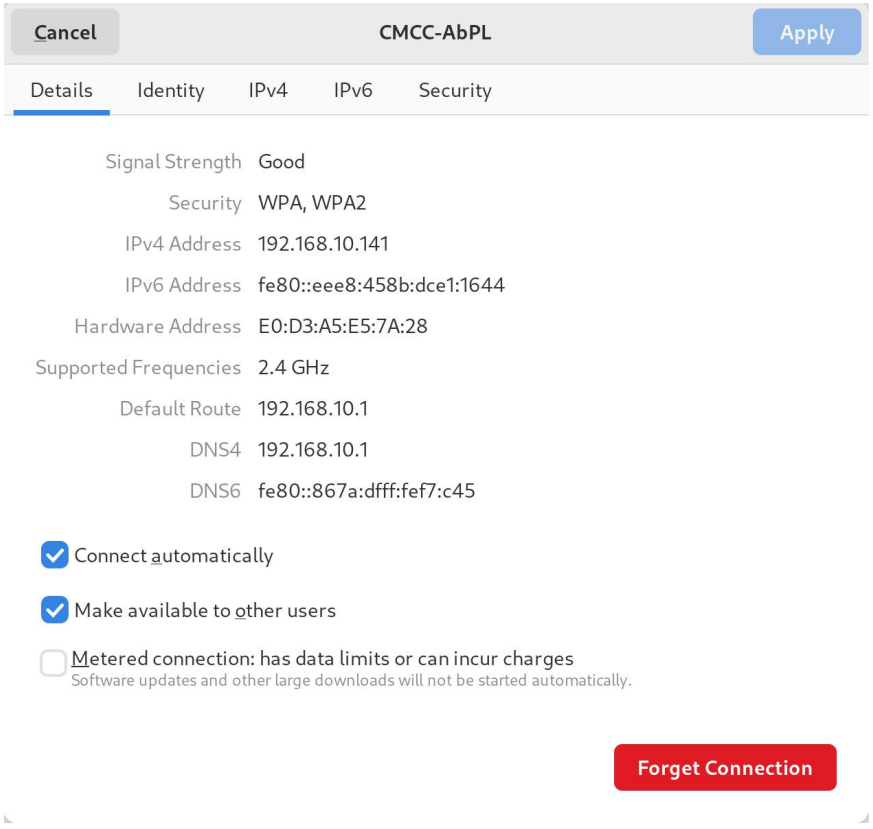
This feature can be configured through the UI in Debian, which is simple and conve nient. This article does not go into details about the configuration methods using nmtui an d bluez-utils.

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4.10.2.1. Wi-Fi

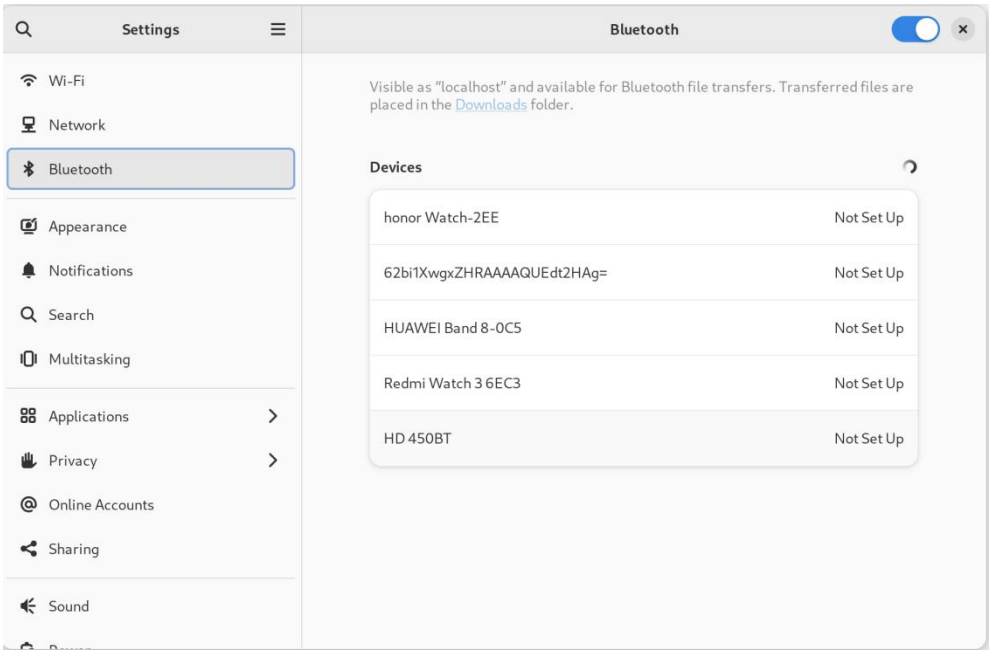


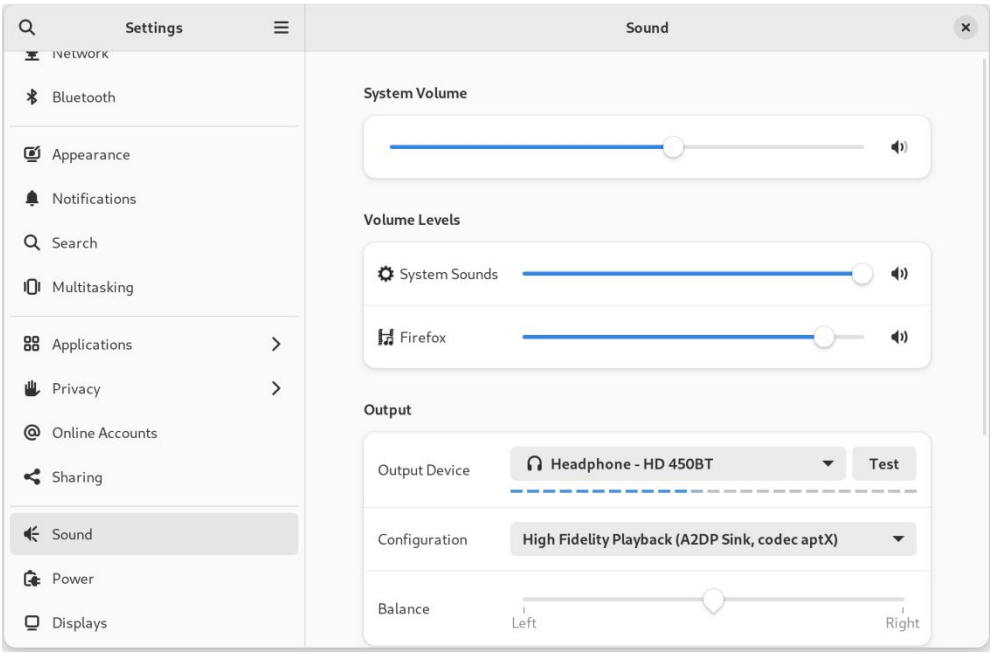


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4.10.2.2. Bluetooth





4.11.Display

Debian + gnome: Provides HDMI and DP display for Pi boards and single-board com puters.

Buildroot + weston: Provides MIPI display for single-board computers. Users can conf igure it to use the Debian system.

4.11.1. Gnome

Single-board computers support both HDMI and DP, but the Pi board lacks a DP por

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t. **When not using MIPI-DSI for dual-display configuration, it's important to connect an HDMI/DP monitor before powering on** . Otherwise, the display parameters won't be retrieved via EDID, halting subsequent boot. To ensure HDMI and DP display support, use the Debian GNOME desktop.

After connecting to the screen, the screen parameters will be obtained through EDID information, and the best resolution will be automatically selected for display. Users can also configure different resolutions through gnome after entering the system.

If gnome fails, you can restart the desktop by executing the following command in the serial port

```
systemctl restart gdm3
```

Note: Because the DP interface requires training, if the DP monitor fails to display content after the system starts, you can try resetting the system and retraining, which may restore normal display. However, incompatibility issues with some monitors cannot be ruled out.

4.11.1.1. Chinese interface

For the current system, the default display is English. Users can configure it to use Chinese display by running the following command

```
dpkg-reconfigure locales
reboot
```

After execution, users will need to enable `zh_CN.UTF-8 UTF-8` support and choose to use it as the default. After the system restarts, the Chinese interface will be displayed.

At this time, Chinese characters will be printed on the serial port, but some garbled characters may be present. You can add the following command to /root/.bashrc to force the serial port to display English characters:

```
if [ $XDG_SESSION_TYPE = "tty" ]; then
export LANG='C.UTF-8'
fi
```

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4.11.2. Weston

The MIPI-DSI system of the single-board computer is built using buildroot, the desktop environment is weston, and the configuration file is located in /etc/xdg/weston.

After entering the system normally, the following image will be displayed:



For more specific usage of weston, please consult relevant information yourself.

4.12.Camera

The T527 provides a MIPI-CSI interface with a maximum speed of 8M@30fps RAW 12 2F-WDR, up to 3264(H) x 2448(V). For detailed usage, refer to the "T527_CSI" document in the development notes. This article will not go into details.

4.13.TF card

The SD card is located on the back of the single-board computer and is printed with "TF Card".

4.13.1. Check TF card information

You can view the current TF card status information through the following command:

```
# mount -t debugfs debugfs /sys/kernel/debug/
# cat /sys/kernel/debug/mmc*/ios
```

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```
# fdisk -l
```

After checking the iOS information, the nodes related to SD indicate the SD card, and the nodes related to MMC indicate the eMMC. Remember whether mmc is 0 or 1. If booting from an SD card, the device node corresponding to the SD card is generally mmc 0, and its corresponding block device is /dev/mmcblk0.

4.13.2. Test TF card speed

Test the SD card read and write speed using the following command:

```
# mkdir -p /root/tmp
# mount /dev/mmcblk 0 p 4 /root/tmp
# time dd if=/dev/zero of= /root/tmp /test.bin bs=1M count=4096 conv=fsync
# echo 3 > /proc/sys/vm/drop_caches
# time dd if=/mnt/test.bin of=/dev/zero bs=1M
# umount /root/tmp
```

4.14.PCIE

The T527 series supports PCI interfaces and can be connected to M.2 hard drives via adapter boards. **For single-board computers, the PCI interface is MIPI-PCI and also supports an additional USB 2.0 interface for connecting 4G modules** .

Here we use a connected hard drive as an example. The hard drive model is Yangtze Memory, PC210. Use the following command to test the read and write performance:

```
# fdisk /dev/nvme0n1

Welcome to fdisk (util-linux 2.38).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

Command (m for help): n
```


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Partition type

p primary (0 primary, 0 extended, 4 free)

e extended (container for logical partitions)

Select (default p): p

Partition number (1-4, default 1): 1

First sector (2048-250069679, default 2048): 2048

Last sector, +/-sectors or +/-size{K,M,G,T,P} (2048-250069679, default 250069679): +10G

Created a new partition 1 of type 'Linux' and of size 10 GiB.

Partition #1 contains an ext4 signature.

Do you want to remove the signature? [Y]es/[N]o: Y

The signature will be removed by a write command.

Command (m for help): w

The partition table has been altered.

Calling ioctl() to re-read partition table.

Syncing disks.

mkfs.ext4 /dev/nvme0n1p1

mkdir -p /root/tmp

mount /dev/nvme0n1p1 /root/tmp

time dd if=/dev/zero of= /root/tmp /test.bin bs=1M count= 4096 conv=fsync

echo 3 > /proc/sys/vm/drop_caches

time dd if=/mnt/test.bin of=/dev/zero bs=1M

4096+0 records in

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```
4096+0 records out


real 0m10.157s
user 0m0.032s
sys 0m6.226s
# umount /root/tmp
```

From the above situation, we can find that the read speed of the hard disk in the current environment is 4096/10.157=403MB/s.

4.15.USB

4.15.1. OTG

4.15.1.1. Buildroot

There is a USB-OTG interface on the single-board computer. If you connect a USB device via a Type-C to USB connector, it will be automatically mounted, such as a mouse or a USB flash drive.

Connect the PC to the OTG interface of the single-board computer and open the Allwinner programming software PhoenixSuit. By default, you will find the following information, indicating that the OTG function is working properly:

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4.15.1.2. Debian

For Debian systems, the adb function is not provided by default. Users can use the f ollowing script to simulate the system as a USB flash drive after connecting to the comp uter:

```
#!/bin/bash

if ! grep -q "/sys/kernel/config" /proc/mounts; then
mount -t configfs configfs /sys/kernel/config
fi
if ! which mkfs.fat ; then
apt update && apt install -y dosfstools
fi
dd if=/dev/zero of=/root/a.bin bs=10M count=10
mkfs.fat -F 32 /root/a.bin
mkdir -p /sys/kernel/config/usb_gadget/g1
```


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```
echo "0x18d1" > /sys/kernel/config/usb_gadget/g1/idVendor
echo "0x0001" > /sys/kernel/config/usb_gadget/g1/idProduct
mkdir -p /sys/kernel/config/usb_gadget/g1/strings/0x409
mkdir -p /sys/kernel/config/usb_gadget/g1/functions/mass_storage.usb0
echo /root/a.bin > /sys/kernel/config/usb_gadget/g1/functions/mass_storage.usb0/lun.0/file
mkdir -p /sys/kernel/config/usb_gadget/g1/configs/c.1
echo 0xc0 > /sys/kernel/config/usb_gadget/g1/configs/c.1/bmAttributes
echo 500 > /sys/kernel/config/usb_gadget/g1/configs/c.1/MaxPower
mkdir -p /sys/kernel/config/usb_gadget/g1/configs/c.1/strings/0x409
ln -sf /sys/kernel/config/usb_gadget/g1/functions/mass_storage.usb0/ /sys/kernel/config/usb_gadget/g1/configs/c.1/
ls /sys/class/udc/ | xargs echo > /sys/kernel/config/usb_gadget/g1/UDC
```

To end the simulation, use the following command:

```
if [ -d /sys/kernel/config/usb_gadget/g1 ]; then
echo "" > /sys/kernel/config/usb_gadget/g1/UDC 2>/dev/null
rm -f /sys/kernel/config/usb_gadget/g1/configs/c.1/mass_storage.usb0
rmdir /sys/kernel/config/usb_gadget/g1/functions/mass_storage.usb0 2>/dev/null
rmdir /sys/kernel/config/usb_gadget/g1/configs/c.1/strings/0x409 2>/dev/null
rmdir /sys/kernel/config/usb_gadget/g1/configs/c.1 2>/dev/null
rmdir /sys/kernel/config/usb_gadget/g1/strings/0x409 2>/dev/null
rmdir /sys/kernel/config/usb_gadget/g1 2>/dev/null
fi
```

This function is not applicable to Pi boards. The power supply interface is shared with OTG. After emulation, the power supply provided by the PC will be confused and cause unknown problems. In addition, in most cases, the power provided by the computer USB interface is insufficient and a dedicated charger is required. The interface on the Pi board is only recommended for connecting to the PC during programming. In other cases, please use a dedicated charger for power supply.

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4.15.2. HOST

This section verifies the feasibility of the USB Host driver through related commands or hot plugging and USB HUB, and realizes the functions of reading and writing USB disks and USB enumeration.

After inserting the USB flash drive, you can use the following command to search for the storage device.

```
# lsblk
NAME MAJ:MIN RM SIZE RO TYPE MOUNTPOINTS
sda 8:0 1 28.7G 0 disk
`-sda1 8:1 1 28.7G 0 part
mmcblk0 179:0 0 14.6G 0 disk
|-mmcblk0p1 179:1 0 32M 0 part
|-mmcblk0p2 179:2 0 16M 0 part
|-mmcblk0p3 179:3 0 96M 0 part
|-mmcblk0p4 179:4 0 8G 0 part /var/lib/docker
| /
`-mmcblk0p5 179:5 0 6.4G 0 part
nvme0n1 259:0 0 119.2G 0 disk
`-nvme0n1p1 259:1 0 10G 0 part /mnt
```

You can see that there is an additional sda device here. Mount sda1 to /root/tmp. Enter this directory to find the files in the USB flash drive. You can also test the read and write performance of the current USB flash drive with the following command:

```
# dd if=/dev/zero of=/root/dd.bin bs=1M count=128 conv=fsync
# echo 3 > /proc/sys/vm/drop_caches
# time dd of=/dev/zero if=/root/tmp/dd.bin bs=1M
128+0 records in
128+0 records out
```

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```
real  0m3.881s
user  0m0.000s
sys  0m0.236s
```

It can be seen that the reading speed of the USB flash drive at this time is 32.98MB/s, which is in line with the normal reading speed of a USB 2.0 USB flash drive.

4.16.Audio

The single-board computer provides audio functionality, supporting audio output from HPOUT and simultaneous audio recording via MIC1. This is already configured by default and does not require user intervention. **The Pi board also provides HDMI audio output, but the default is still HPOUT. Users need to configure the default HDMI output in the appropriate desktop environment**.

You can use the following command to view the functions supported by the current codec:

```
# aplay --dump-hw-params /dev/zero
Playing raw data '/dev/zero' : Unsigned 8 bit, Rate 8000 Hz, Mono
HW Params of device "PlaybackHP":
--------------------
ACCESS: MMAP_INTERLEAVED RW_INTERLEAVED
FORMAT: S16_LE S24_LE S32_LE
SUBFORMAT: STD
SAMPLE_BITS: [16 32]
FRAME_BITS: [16 64]
CHANNELS: [1 2]
RATE: (0 4294967295]
PERIOD_TIME: (0 4294967295]
PERIOD_SIZE: [32 32768]
PERIOD_BYTES: [256 65536]
```

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```
PERIODS: [1 8]
BUFFER_TIME: (0 4294967295]
BUFFER_SIZE: [32 65536]
BUFFER_BYTES: [256 131072]
TICK_TIME: ALL
--------------------
aplay: set_params:1352: Sample format non available
Available formats:
- S16_LE
- S24_LE
- S32_LE
```

After the user connects to the headset, you can use the following command to test th e audio output function:

```
# speaker-test -c 2 -t wav


speaker-test 1.2.6


Playback device is default
Stream parameters are 48000Hz, S16_LE, 2 channels
Using 16 octaves of pink noise
Rate set to 48000Hz (requested 48000Hz)
Buffer size range from 64 to 32768
Period size range from 64 to 16384
Using max buffer size 32768
Periods = 4
was set period_size = 8192
was set buffer_size = 32768
0 - Front Left
```

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```
1 - Front Right
```

Use the following command to record a 5-second audio:

```
# arecord -f S16_LE -r 48000 -d 5 test.wav
Recording WAVE 'test.wav' : Signed 16 bit Little Endian, Rate 48000 Hz, Mono
```

Note: For Debian systems, since the audio interface is managed by pipewire/pulseaudio, resources may be occupied during playback. You need to manually disable the relevant services before testing.

```
# systemctl --user stop pipewire # debian bookworm
# systemctl --user stop pulseaudio # debian bullseye
```

After the test is completed, replace the above stop with restart to re-enable the function.

4.17.LED

The Linux system provides a separate subsystem for convenient userspace operation of LED devices. This subsystem provides interfaces for LED devices in the form of files. These interfaces are located in the /sys/class/leds directory. In the hardware resource list, we have listed all the LEDs on the single-board computer. Next, we will test the LEDs using commands to read and write to sysfs.

The following commands are all common commands and are also common methods for controlling LEDs.

View all LEDs configured in the current system

```
ls /sys/class/leds/
```

Check the current status of the heartbeat light

```
cat /sys/class/leds/run/brightness
```

Configure the heartbeat light to be controllable

```
echo none > /sys/class/leds/run/trigger
```

Control the on and off changes of the heartbeat light

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```
echo 1 > /sys/class/leds/run/brightness
echo 0 > /sys/class/leds/run/brightness
```

Check which peripherals' working status the heartbeat light supports.

```
cat /sys/class/leds/run/trigger
```

Control the heartbeat light to flash according to the working status of mmc0

```
echo mmc 0 > /sys/class/leds/run/trigger
```

Test whether the LED flashes according to the working status of mmc0. Use the following method to make the LED light up for a short time when writing data until the writing is completed.

```
dd if=/dev/zero of=test.bin bs=1M count=10 conv=fsync
```

4.18.button

There are three buttons on the board: RESET, FEL and POWER, which correspond to reset function, burning function and power on/off function respectively.

4.18.1. Reset

When the RESET button is pressed, the system will restart immediately.

```
# memtester 100M 1
memtester version 4.5.0 (64-bit)
Copyright (C) 2001-2020 Charles Cazabon.
Licensed under the GNU General Public License version 2 (only).

pagesize is 4096
pagesizemask is 0xfffffffffffff000
want 100MB (104857600 bytes)
got 100MB (104857600 bytes), trying mlock ...locked.
Loop 1/1:
Stuck Address : ok
```


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```
Random Value: |[80]HELLO! BOOT0 is starting!
[83]BOOT0 commit : ad8b4b44ac
[87]periph0 has been enabled
[90]set pll end
[92]PL gpio voltage: 3.3V
[96][pmu]: bus read error
[99]PMU: AXP2202
[104]PMU: AXP1530
[109]power mode:33, sys_vol:920
[114]vaild para:1 select dram para0
[117]board init ok
[120]rtc[3] value = 0xb00f
[123]rtc[7] value = 0x1
[125]enable_jtag
```

From the log information above, we can see that the system is still executing memtester, but immediately enters the boot0 information printing. This is when I press the RESET button.

4.18.2. Power supply

The power button is used to power on the system after it is powered off, or to force a shutdown by long pressing it. After the system is powered off, the system cannot be restarted by RESET and must be restarted using the POWER button.

```
Requesting system poweroff
[146.085755] reboot: Power down
[80]HELLO! BOOT0 is starting!
[83]BOOT0 commit : ad8b4b44ac
[87]periph0 has been enabled
[90]set pll end
[92]PL gpio voltage: 3.3V
```


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```
[96][pmu]: bus read error
[99]PMU: AXP2202
[104]PMU: AXP1530
[109]power mode:33, sys_vol:920
[114]vaild para:1 select dram para0
[117]board init ok
[120]rtc[3] value = 0xa300
[122]rtc[7] value = 0x2
[125]enable_jtag
```

The log information above is the process from system shutdown to restarting by press ing the POWER button.

4.18.3. FEL

Refer to the Quick Start section above.

4.19.Fan

This section only supports Pi boards. There is no corresponding device for single -board computers, but users can refer to the Pi board for porting. It should be note d that the default governor used by the system is power_allocator by default for sing le-board computers. In this case, the fan will run at the highest speed level.

```
cd $(dirname $(grep -rn fan /sys/class/thermal/cooling_device*/type | cut -d ":" -f 1))
cat cur_state # Read the current fan speed level
cat max_state # View the highest supported fan speed level
echo 4 > cur_state # Set to the highest fan speed
```

4.20.GPIO

Use the following command to control an IO, here we take PK23 as an example:

```
# mount -t debugfs debugfs /sys/kernel/debug/
```

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```
# grep PK23 /sys/kernel/debug/pinctrl/2000000.pinctrl/pinmux-pins
pin 343 (PK23): UNCLAIMED
# cd /sys/class/gpio/
# echo 343 > export
# echo out > gpio343/direction
# echo 1 > gpio343/value
```

At this time, the voltage checked by the multimeter does not change according to the actual situation. This is due to the conflict between the PK group pins and the sensor m odule. After restarting, press and hold `s` to enter the uboot command line and execute th e following command to disable the sensor function:

```
=> fdt set /soc/vind status disabled
=> fdt set /soc/pd-vi-test status disabled
```

The above command is equivalent to disabling the vind0 and pd-vi-test nodes in the device tree. **Users can refer to the Software Development Guide to modify the device tree to support the use of both the camera and other PK group pins** .

5. References

- Linux kernel open source community: https://www.kernel.org/
- Allwinner Development Community: https://bbs.aw-ol.com/
- Buildroot-manual: https://buildroot.org/downloads/manual/manual.html
- Debian wiki: https://wiki.debian.org/

6. Revision Notes

Revision Notes Table

Version	Modifications	Modification time	prepared by	Proofreading	Approval
V1.0	First Draft	2025.03.19	WQ	HSL	WFX
V1.1	Add Pi board usage instructions	July 31, 2025	WYQ	HSL	WFX

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