

# Rockchip Linux Software Developer Guide

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## **Preface**

### **Overview**

This document is a guide for Rockchip Buildroot/Debian/Yocto Linux system software and is designed to help software development engineers and technical support engineers get started with the development and debugging of the Rockchip Linux platform faster.

### **Intended Audience**

This document (this guide) is mainly intended for:

Technical support engineers

Software development engineers

### **Revision History**

| Date       | Author      | Version | Change Description   |
|------------|-------------|---------|--|
| 2021-04-10 | Caesar Wang | V1.0.0  | Initial version  |
| 2021-05-20 | Caesar Wang | V1.1.0  | Added support for rk3399, rk3288,rk3326/px30   |
| 2021-09-30 | Caesar Wang | V1.2.0  | Updated support for Linux4.4 and Linux4.19   |
| 2022-01-15 | Caesar Wang | V1.3.0  | Added support for RK3588 Linux5.10<br>Added support for RK3358 Linux4.19<br>Updated SDK version information  |
| 2022-04-14 | Caesar Wang | V1.4.0  | Added support for RK3326S<br>Updated RK3588<br>Updated FAQ   |
| 2022-05-20 | Caesar Wang | V1.4.1  | Updated chip support list and 2022 roadmap   |
| 2022-06-20 | Caesar Wang | V1.4.2  | Update SDK version and support   |
| 2022-09-20 | Caesar Wang | V1.5.0  | Updated support for Linux 5.10   |
| 2022-11-20 | Caesar Wang | V1.6.0  | Update the support status and roadmap of each chip system<br>Secure boot update instructions<br>Update FAQ   |
| 2023-04-20 | Caesar Wang | V1.7.0  | Update the support status and roadmap of each chip system<br>Update the latest SDK directory structure<br>Add support for RK3562<br>The document is split into multiple chapters |
| 2023-05-20 | Caesar Wang | V1.8.0  | Corrected some mistake<br>Version update<br>Added SDK version description<br>Updated the SDK development environment setup chapter   |
| 2023-06-20 | Caesar Wang | V1.9.0  | Updated documentation<br>Updated development environment setup chapter   |
| 2023-07-20 | Caesar Wang | V1.9.1  | Updated RK3566/RK3568/RK3399 Linux4.19 SDK version   |
| 2023-09-20 | Caesar Wang | V2.0.0  | Update the contents of each chapter  |
| 2023-12-05 | Ruby Zhang  | V2.0.1  | Fix some description   |

| Date       | Author      | Version | Change Description   |
|------------|-------------|---------|--|
| 2023-12-20 | Caesar Wang | V2.1.0  | Update chip system support status<br>Add Roadmap sections<br>Update documentation sections<br>Update SDK compilation instructions<br>Update SDK development sections<br>Update FAQ section |

**RK Linux SDK Supported System List**

**Linux6.1SDK**

| Chipset | Buildroot Version | DebianVersion | Yocto Version | Kernel Version | SDK Version     | TAG Version         |
|---------|-------------------|---------------|---------------|----------------|-----------------|---------------------|
| RK3588  | 2021.11           | 12            | 4.0           | 6.1            | V1.0.0_20231220 | linux-6.1-stan-rkr1 |

**Linux5.10 SDK**

| Chipset | Buildroot Version | DebianVersion | Yocto Version | Kernel Version | SDK Version     | TAG Version          |
|---------|-------------------|---------------|---------------|----------------|-----------------|----------------------|
| RK3588  | 2021.11           | 11            | 4.0           | 5.10           | V1.4.0_20231220 | linux-5.10-gen-rkr7  |
| RK3562  | 2021.11           | 11            | 4.0           | 5.10           | V1.1.0_20231220 | linux-5.10-stan-rkr2 |
| RK3566  | 2021.11           | 11            | 4.0           | 5.10           | V1.4.0_20231220 | linux-5.10-gen-rkr7  |
| RK3568  | 2021.11           | 11            | 4.0           | 5.10           | V1.4.0_20231220 | linux-5.10-gen-rkr7  |
| RK3399  | 2021.11           | 11            | 4.0           | 5.10           | V1.4.0_20231220 | linux-5.10-gen-rkr7  |
| RK3358  | 2021.11           | N/A           | N/A           | 5.10           | V1.3.0_20231220 | linux-5.10-gen-rkr7  |
| RK3328  | 2021.11           | N/A           | 4.0           | 5.10           | V1.0.0_20231220 | linux-5.10-gen-rkr7  |
| RK3326  | 2021.11           | N/A           | N/A           | 5.10           | V1.3.0_20231220 | linux-5.10-gen-rkr7  |
| PX30    | 2021.11           | 11            | 4.0           | 5.10           | V1.4.0_20231220 | linux-5.10-gen-rkr7  |
| RK3308  | 2021.11           | N/A           | N/A           | 5.10           | V1.3.0_20231220 | linux-5.10-gen-rkr7  |

| Chipset | Buildroot Version | DebianVersion | Yocto Version | Kernel Version | SDK Version     | TAG Version         |
|---------|-------------------|---------------|---------------|----------------|-----------------|---------------------|
| RK3288  | 2021.11           | 11            | 4.0           | 5.10           | V1.1.0_20231220 | linux-5.10-gen-rkr7 |
| RK312X  | 2021.11           | N/A           | N/A           | 5.10           | V1.3.0_20231220 | linux-5.10-gen-rkr7 |
| RK3036  | 2021.11           | N/A           | N/A           | 5.10           | V1.3.0_20231220 | linux-5.10-gen-rkr7 |

#### Linux4.19 SDK

| Chipset    | Buildroot Version | DebianVersion | Yocto Version | Kernel Version | SDK Version     | TAG Version           |
|------------|-------------------|---------------|---------------|----------------|-----------------|-----------------------|
| RK3566     | 2021.11           | 11            | 4.0           | 4.19           | V1.4.0_20230720 | linux-4.19-gen-rkr4   |
| RK3568     | 2021.11           | 11            | 4.0           | 4.19           | V1.4.0_20230720 | linux-4.19-gen-rkr4   |
| RK3399     | 2021.11           | 11            | 4.0           | 4.19           | V1.3.0_20230720 | linux-4.19-gen-rkr4   |
| RK3326     | 2018.02-rc3       | N/A           | N/A           | 4.19           | V1.2.2_20221220 | linux-4.19-gen-rkr3.2 |
| RK3358     | 2018.02-rc3       | N/A           | N/A           | 4.19           | V1.1.1_20220915 | linux-4.19-M-rkr1     |
| RK3288     | 2018.02-rc3       | 10            | 3.4           | 4.19           | V1.2.2_20221220 | linux-4.19-gen-rkr3.2 |
| PX30/PX30S | 2018.02-rc3       | 10            | 3.4           | 4.19           | V1.2.2_20221220 | linux-4.19-gen-rkr3.2 |

**Linux4.4 SDK**

| Chipset   | Buildroot Version | Debian Version | Yocto Version | Kernel Version | SDK Version     | TAG Version        |
|-----------|-------------------|----------------|---------------|----------------|-----------------|--------------------|
| RK3399PRO | 2018.02-rc3       | 10             | 3.2           | 4.4            | V1.4.2_20210202 | N/A                |
| RK1808    | 2018.02-rc3       | N/A            | N/A           | 4.4            | V2.3.8_20210820 | N/A                |
| RK3399    | 2018.02-rc3       | 10             | 3.4           | 4.4            | V2.9.0_20220620 | linux-4.4-gen-rkr1 |
| RK3326    | 2018.02-rc3       | N/A            | N/A           | 4.4            | V1.8.0_20220620 | linux-4.4-gen-rkr1 |
| RK3328    | 2018.02-rc3       | N/A            | N/A           | 4.4            | V1.1.0_20200603 | N/A                |
| RK3288    | 2018.02-rc3       | 10             | 3.4           | 4.4            | V2.6.0_20220620 | linux-4.4-gen-rkr1 |
| PX30      | 2018.02-rc3       | 10             | 3.4           | 4.4            | V1.8.0_20220620 | linux-4.4-gen-rkr1 |
| RK3308    | 2018.02-rc3       | N/A            | N/A           | 4.4            | V1.5.2_20220124 | N/A                |
| RK3358    | 2018.02-rc3       | N/A            | N/A           | 4.4            | V1.8.0_20220620 | linux-4.4-gen-rkr1 |
| RK312X    | 2018.02-rc3       | N/A            | N/A           | 4.4            | V1.3.0_20220620 | linux-4.4-gen-rkr1 |
| PX3SE     | 2018.02-rc3       | N/A            | N/A           | 4.4            | V1.0.0_20190124 | N/A                |

**2024-2025 Linux SDK Upgrade Schedule**



| Chipset | Buildroot<br>Version | Debian<br>Version | Yocto<br>Version | Kernel<br>Version | Release<br>schedule |
|---------|----------------------|-------------------|------------------|-------------------|---------------------|
| RK3568  | 2021.11              | 12                | 4.0              | 6.1               | 2024.Q2             |
| RK3566  | 2021.11              | 12                | 4.0              | 6.1               | 2024.Q2             |
| RK3562  | 2021.11              | 12                | 4.0              | 6.1               | 2024.Q2             |
| RK3399  | 2021.11              | 12                | 4.0              | 6.1               | 2024.Q4             |
| RK3328  | 2021.11              | N/A               | 4.0              | 6.1               | 2024.Q4             |
| RK3288  | 2021.11              | 12                | 4.0              | 6.1               | 2024.Q4             |

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# 1. Chapter-1 SDK Development Roadmap

## 1.1 SDK Roadmap

| Version    | SDK Released | Projected EOL (End of Life)                   |
|------------|--------------|---|
| Linux 4.4  | 2018-06-20   | Jun 2023                                      |
| Linux 4.19 | 2020-12-11   | Dec 2023                                      |
| Linux 5.10 | 2022-01-15   | Future - Long Term Support (Dec 2025)         |
| Linux 6.1  | 2023-12-20   | Future - Long Term Support (until April 2028) |

## 1.2 Kernel Roadmap

| Version | Kernel Released | SDK Released | Projected EOL |
|---------|-----------------|--------------|---------------|
| 4.4     | 2017-11-12      | 2018-06-20   | Jan 2024      |
| 4.19    | 2018-10-22      | 2020-12-11   | Dec 2024      |
| 5.10    | 2020-12-13      | 2022-01-15   | Dec 2026      |
| 6.1     | 2022-12-11      | 2023-12-20   | Dec 2026      |

The Linux Kernel's last stable release each year is designated as the LTS version. However, the exact number of versions released annually varies, usually around 5 to 6, making it difficult to predict the specific version number of the next LTS. The maintenance duration for LTS versions also varies, based on their usage extent. Typically, it starts with 2 years and may extend to 4 or 6 years (not guaranteed).

For specific Kernel EOL, refer to the official release:

[Kernel Release](#)

The currently released SDKs for Kernel versions 4.4, 4.19, 5.10, and 6.1 are long-term supported versions by Rockchip.

Minor versions are updated quarterly (e.g., 4.19.27 to 4.19.232).

Major versions are updated biennially (e.g., 4.4 to 4.19 to 5.10 to 6.1).

Regarding the next kernel LTS version: Rockchip's kernel update strategy involves releasing an LTS (Long-Term Support) version every two years, which is offset by one year compared to the mainline kernel's strategy of releasing an LTS version every year. For example, if the mainline releases one LTS version annually, Rockchip releases one every two years. Therefore, the subsequent LTS version for Rockchip will be released in 2024, followed by another in 2026, and so on.



## 1.3 Buildroot Roadmap

The current officially supported Buildroot versions by RK are `2018.02` and `2021.11`.

| Version | Buildroot Released | SDK Released | Projected EOL                                 |
|---------|--------------------|--------------|---|
| 2018.02 | 2018-03-04         | 2018-06-20   | Jan 2024                                      |
| 2021.11 | 2021-12-05         | 2022-05-20   | Dec 2026                                      |
| 2024.02 | Mar 2024           | Q4 2024      | Future - Long Term Support (until April 2028) |

The Buildroot community releases a new version every three months, and one stable version is released annually.

For more details, refer to the official Buildroot release information:

[Buildroot Release](#)

## 1.4 Yocto Roadmap

The current officially supported Yocto versions by RK range from Dunfell (3.1) to Kirkstone (4.0), with the main maintenance version being Kirkstone (4.0).

| Version         | Yocto Released | SDK Released | Support Level                                 |
|-----------------|----------------|--------------|---|
| Kirkstone (4.0) | May 2022       | 2022-12-20   | Long Term Support (Apr 2026 <sup>1</sup> )    |
| Scarthgap (5.0) | April 2024     | 2024-12-20   | Future - Long Term Support (until April 2028) |

The Yocto community typically releases two major versions each year, usually in the spring and autumn seasons.

For more details, refer to the official Yocto release information:

[Yocto Release](#)

## 1.5 Debian Roadmap

The current officially supported Debian versions by RK range from Stretch (9) to Bookworm (12), with the main maintenance version being Bullseye (11).

| Version       | Debian Released | SDK Released | EOL LTS    |
|---------------|-----------------|--------------|------------|
| Stretch (9)   | 2017-06-17      | 2018-06-20   | 2022-07-01 |
| Buster (10)   | 2019-07-06      | 2020-12-11   | 2024-06-30 |
| Bullseye (11) | 2021-08-14      | 2022-01-15   | ~ 2026     |
| Bookworm (12) | 2023-06-10      | Q4 2023      | ~ 2028     |

Debian LTS versions are updated biennially.

For more details, refer to the official Debian release information:

[Debian Release](#)

## 2. Chapter-2 SDK

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### 2.1 Overview

Rockchip Linux SDK supports Buildroot, Yocto and Debian systems. Kernel is based on Kernel 4.4, Kernel 4.19 or Kernel5.10, and boot is based on U-boot v2017.09. It is suitable for all Linux products developed or secondary developed based on Rockchip EVB development board.

The development kit is suitable for but not limited to industrial applications, smart homes, consumer electronics, office and conference and other AIoT products, and provides flexible data path combination interfaces to meet the customized requirement of customers for free combination. For specific function debugging and interface description, please read the documents under the project directory docs/.

### 2.2 Obtain the General SDK

#### 2.2.1 Get Source Code from Rockchip Code Server

To get Rockchip Linux SDK, customers need an account to access the source code repository provided by Rockchip. In order to get code synchronization permission, please provide SSH public key for server authentication and authorization when apply for SDK from Rockchip technical window. About Rockchip server SSH public key authorization, please refer to [SSH Public Key Operation Introduction](#).

##### 2.2.1.1 Rockchip Linux6.1 SDK Downloading

| Chipset | Version  | Download Command  |
|---------|----------|---|
| RK3588  | Linux6.1 | repo init --repo-url <a href="https://gerrit.rock-chips.com:8443/repo-release/tools/repo">https://gerrit.rock-chips.com:8443/repo-release/tools/repo</a> -u \<br><a href="https://gerrit.rock-chips.com:8443/linux/rockchip/platform/manifests">https://gerrit.rock-chips.com:8443/linux/rockchip/platform/manifests</a> -b rk3588<br>-m \<br>rk3588_linux6.1_release.xml |

##### 2.2.1.2 Rockchip Linux5.10 SDK Downloading

| Chipset           | Version   | Download Command  |
|-------------------|-----------|---|
| RK3562            | Linux5.10 | repo init --repo-url <a href="https://gerrit.rock-chips.com:8443/repo-release/tools/repo">https://gerrit.rock-chips.com:8443/repo-release/tools/repo</a> -u \<br><a href="https://gerrit.rock-chips.com:8443/linux/rockchip/platform/manifests">https://gerrit.rock-chips.com:8443/linux/rockchip/platform/manifests</a> -b rk3562 -m \<br>rk3562_linux_release.xml |
| RK3588            | Linux5.10 | repo init --repo-url ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /repo/rk/tools/repo -u \<br>ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /linux/rockchip/platform/manifests -b linux -m \<br>rk3588_linux_release.xml   |
| RK3566、<br>RK3568 | Linux5.10 | repo init --repo-url ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /repo/rk/tools/repo -u \<br>ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /linux/rockchip/platform/manifests -b linux -m \<br>rk356x_linux5.10_release.xml   |
| RK3399            | Linux5.10 | repo init --repo-url ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /repo/rk/tools/repo -u \<br>ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /linux/rockchip/platform/manifests -b linux -m \<br>rk3399_linux5.10_release.xml   |
| RK3328            | Linux5.10 | repo init --repo-url ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /repo/rk/tools/repo -u \<br>ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /linux/rockchip/platform/manifests -b linux -m \<br>rk3328_linux5.10_release.xml   |
| RK3326            | Linux5.10 | repo init --repo-url ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /repo/rk/tools/repo -u \<br>ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /linux/rockchip/platform/manifests -b linux -m \<br>rk3326_linux5.10_release.xml   |
| RK3358            | Linux5.10 | repo init --repo-url ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /repo/rk/tools/repo -u \<br>ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /linux/rockchip/platform/manifests -b linux -m \<br>rk3358_linux5.10_release.xml   |
| PX30              | Linux5.10 | repo init --repo-url ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /repo/rk/tools/repo -u \<br>ssh:// <a href="https://git@www.rockchip.com.cn">git@www.rockchip.com.cn</a> /linux/rockchip/platform/manifests -b linux -m \<br>px30_linux5.10_release.xml   |

| Chipset | Version   | Download Command  |
|---------|-----------|---|
| RK3308  | Linux5.10 | repo init --repo-url ssh://git@www.rockchip.com.cn/repo/rk/tools/repo<br>-u \<br>ssh://git@www.rockchip.com.cn/linux/rockchip/platform/manifests -b<br>linux -m \<br>rk3308_linux5.10_release.xml |
| RK312X  | Linux5.10 | repo init --repo-url ssh://git@www.rockchip.com.cn/repo/rk/tools/repo<br>-u \<br>ssh://git@www.rockchip.com.cn/linux/rockchip/platform/manifests -b<br>linux -m \<br>rk312x_linux5.10_release.xml |
| RK3036  | Linux5.10 | repo init --repo-url ssh://git@www.rockchip.com.cn/repo/rk/tools/repo<br>-u \<br>ssh://git@www.rockchip.com.cn/linux/rockchip/platform/manifests -b<br>linux -m \<br>rk3036_linux5.10_release.xml |

Repo, a tool built on Python script by Google to help manage git repositories, is mainly used to download and manage software repository of projects. The download address is as follows:

```
git clone ssh://git@www.rockchip.com.cn/repo/rk/tools/repo
```

## 2.2.2 Get Source Code from Local Compression Package

For quick access to SDK source code, Rockchip Technical Window usually provides corresponding version of SDK initial compression package. In this way, developers can get SDK source code through decompressing the initial compression package, which is the same as the one downloaded by repo.

Take RK3588\_LINUX6.1\_SDK\_RELEASE\_V1.0.0\_20231220.tgz for example, After getting a initialization package, you can get source code by running the following command:

```
mkdir rk3588
tar xvf RK3588_LINUX6.1_SDK_RELEASE_V1.0.0_20231220.tgz -C rk3588
cd rk3588
.repo/repo/repo sync -l
.repo/repo/repo sync -c
```

Developers can update via `.repo/repo/repo sync -c` command according to update introductions that are regularly released by FAE window.

Note:

The software release version can be checked through the project xml file. The detailed way is as follows:

```
.repo/manifests$ realpath rk3588_linux6.1_release.xml
In the following example: the printed version number is v1.0.0 and the update
time is 20231220
<SDK>/.repo/manifests/release/rk3588_linux6.1_release_v1.0.0_20231220.xml
```

The initial compressed SDK packages currently released for Linux5.10 are as follows:

| Chipset        | Compressed Package                               | Version |
|----------------|--|---------|
| RK3562         | RK3562_LINUX5.10_SDK_RELEASE_V1.0.0_20230520.tgz | v1.0.0  |
| RK3588         | RK3588_LINUX5.10_SDK_RELEASE_V1.0.0_20220520.tgz | v1.0.0  |
| RK3566, RK3568 | RK356X_LINUX5.10_SDK_RELEASE_V1.0.0_20220920.tgz | v1.0.0  |
| RK3399         | RK3399_LINUX5.10_SDK_RELEASE_V1.0.0_20220920.tgz | v1.0.0  |
| RK3326,RK3326S | RK3326_LINUX5.10_SDK_RELEASE_V1.0.0_20220920.tgz | v1.0.0  |
| RK3358         | RK3358_LINUX5.10_SDK_RELEASE_V1.0.0_20230420.tgz | v1.0.0  |
| PX30,PX30S     | PX30_LINUX5.10_SDK_RELEASE_V1.0.0_20220920.tgz   | v1.0.0  |
| RK3308         | RK3308_LINUX5.10_SDK_RELEASE_V1.0.0_20220920.tgz | v1.0.0  |
| RK312X         | RK312X_LINUX5.10_SDK_RELEASE_V1.0.0_20220420.tgz | v1.0.0  |
| RK3036         | RK3036_LINUX5.10_SDK_RELEASE_V1.0.0_20220420.tgz | v1.0.0  |

Notice:

The initial compressed package may be replaced and updated with a new version!

## 2.3 Summary of SDK Build Commands

| Chipset | Type                 | Reference model           | One-click Building  | rootfs Building      | kernel compilation  | uboot compilation                 |
|---------|----------------------|---------------------------|---|----------------------|---|-----------------------------------|
| RK3588S | EVB                  | RK3588S EVB1              | ./build.sh<br>lunch:rockchip_rk3588s_evb1_lp4x_v10_defconfig &&<br>./build.sh     | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig<br>rk3588_linux.config;<br>make ARCH=arm64 rk3588s-<br>evb1-lp4x-v10-linux.img -j24 | ./make.sh<br>rk3588 --<br>spl-new |
| RK3588  | EVB                  | RK3588 EVB1               | ./build.sh<br>lunch:rockchip_rk3588_evb1_lp4_v10_defconfig &&<br>./build.sh       | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig<br>rk3588_linux.config;<br>make ARCH=arm64 rk3588-<br>evb1-lp4-v10-linux.img -j24   | ./make.sh<br>rk3588 --<br>spl-new |
| RK3588  | EVB                  | RK3588 EVB7               | ./build.sh<br>lunch:rockchip_rk3588_evb7_lp4_v10_defconfig &&<br>./build.sh       | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig<br>rk3588_linux.config;<br>make ARCH=arm64 rk3588-<br>evb7-lp4-v10-linux.img -j24   | ./make.sh<br>rk3588 --<br>spl-new |
| RK3568  | EVB                  | RK3568 EVB1               | ./build.sh<br>lunch:rockchip_rk3568_evb1_ddr4_v10_defconfig &&<br>./build.sh      | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig;<br>make ARCH=arm64 rk3568-<br>evb1-ddr4-v10-linux.img -j24                         | ./make.sh<br>rk3568 --<br>spl-new |
| RK3568  | EVB                  | RK3568 EVB8               | ./build.sh<br>lunch:rockchip_rk3568_evb8_lp4_v10_defconfig &&<br>./build.sh       | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig;<br>make ARCH=arm64 rk3568-<br>evb8-lp4-v10-linux.img -j24                          | ./make.sh<br>rk3568 --<br>spl-new |
| RK3566  | EVB                  | RK3566 EVB2               | ./build.sh<br>lunch:rockchip_rk3566_evb2_lp4x_v10_defconfig &&<br>./build.sh      | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig;<br>make ARCH=arm64 rk3566-<br>evb2-lp4x-v10-linux.img -j24                         | ./make.sh<br>rk3566 --<br>spl-new |
| RK3562  | Porduct              | Dictionary pen            | ./build.sh<br>lunch:rockchip_rk3562_dictpen_test3_v20_defconfig &&<br>./build.sh  | ./build.sh<br>rootfs | make ARCH=arm64<br>rk3562_linux_dictpen_defconfig;<br>make ARCH=arm64 rk3562-<br>dictpen-test3-v20.img -j24                     | ./make.sh<br>rk3562 --<br>spl-new |
| RK3562  | Robot Vacuum Cleaner | RK3562 EVB1               | ./build.sh<br>lunch:rockchip_rk3562_evb1_lp4x_v10_defconfig &&<br>./build.sh      | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig<br>rk3562_robot.config;<br>make ARCH=arm64 rk3562-<br>evb1-lp4x-v10-linux.img -j24  | ./make.sh<br>rk3562 --<br>spl-new |
| RK3562  | Robot Vacuum Cleaner | RK3562 EVB2               | ./build.sh<br>lunch:rockchip_rk3562_evb2_ddr4_v10_defconfig &&<br>./build.sh      | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig<br>rk3562_robot.config;<br>make ARCH=arm64 rk3562-<br>evb2-ddr4-v10-linux.img -j24  | ./make.sh<br>rk3562 --<br>spl-new |
| RK3562  | EVB                  | RK3562 EVB1               | ./build.sh<br>lunch:rockchip_rk3562_evb1_lp4x_v10_defconfig &&<br>./build.sh      | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig;<br>make ARCH=arm64 rk3562-<br>evb1-lp4x-v10-linux.img -j24                         | ./make.sh<br>rk3562 --<br>spl-new |
| RK3562  | EVB                  | RK3562 EVB2               | ./build.sh<br>lunch:rockchip_rk3562_evb2_ddr4_v10_defconfig &&<br>./build.sh      | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig;<br>make ARCH=arm64 rk3562-<br>evb2-ddr4-v10-linux.img -j24                         | ./make.sh<br>rk3562 --<br>spl-new |
| RK3399  | Industry board       | RK3399 EVB IND            | ./build.sh<br>lunch:rockchip_rk3399_evb_ind_lpddr4_defconfig &&<br>./build.sh     | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig;<br>make ARCH=arm64 rk3399-evb-<br>ind-lpddr4-linux.img -j24                        | ./make.sh<br>rk3399               |
| RK3399  | excavator            | RK3399 SAPPHIRE EXCAVATOR | ./build.sh<br>lunch:rockchip_rk3399_sapphire_excavator_defconfig &&<br>./build.sh | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig;<br>make ARCH=arm64 rk3399-<br>sapphire-excavator-linux.img -j24                    | ./make.sh<br>rk3399               |
| RK3326  | EVB                  | RK3326 EVB                | ./build.sh<br>lunch:rockchip_rk3326_evb_lp3_v12_defconfig &&<br>./build.sh        | ./build.sh<br>rootfs | make ARCH=arm64<br>rockchip_linux_defconfig;<br>make ARCH=arm64 rk3399-<br>sapphire-excavator-linux.img -j24                    | ./make.sh<br>rk3399               |
| RK3288  | EVB                  | RK3288 EVB RK808          | ./build.sh<br>lunch:rockchip_rk3288w_evb_rk808_defconfig &&<br>./build.sh         | ./build.sh<br>rootfs | make ARCH=arm<br>rockchip_linux_defconfig;<br>make ARCH=arm rk3288-evb-<br>rk808-linux.img -j24                                 | ./make.sh<br>rk3288               |

Note:

- Rootfs Building:**

The SDK build Buildroot system by default. If you need other systems, you can set environment variables. for example:

Build Buildroot system: RK\_ROOTFS\_SYSTEM=buildroot ./build.sh

Build Debian system: `RK_ROOTFS_SYSTEM=debian ./build.sh`

Build Yocto system: `RK_ROOTFS_SYSTEM=yocto ./build.sh`

- **Build** Kernel, U-boot: a tool chain needs to be specified.
- SDK has a built-in 32-bit tool chain, for example:

```
export CROSS_COMPILE=./prebuilts/gcc/linux-x86/aarch64/gcc-arm-10.3-2021.07-x86_64-aarch64-  
none-linux-gnu/bin/aarch64-none-linux-gnu-
```

- SDK has a built-in 64-bit tool chain, for example:

```
export CROSS_COMPILE=./prebuilts/gcc/linux-x86/arm/gcc-arm-10.3-2021.07-x86_64-arm-none-  
linux-gnueabi/bin/arm-none-linux-gnueabi-
```



## 3. Chapter-3 Documents Introduction

Documents released with Rockchip Linux SDK are designed to help developers quickly get started with development and debugging. The content involved in the documents does not cover all development information and issues. The document list will also be constantly updated. If you have any questions or requirements about documents, please contact our FAE window [fae@rock-chips.com](mailto:fae@rock-chips.com).

The docs directory in Rockchip Linux SDK is divided into two parts: Chinese (cn) and English (en). The Chinese directory comes with Common (general development guidance documents), Socs (chip platform related documents), Linux (Linux system development related documents), Others (other reference documents), docs\_list\_cn.txt (docs file directory structure), and the detailed introduction as follows:

### 3.1 General Development Guidance Document (Common)

Please see the documentation in each subdirectory of `<SDK>/docs/cn/Common` for details.

#### 3.1.1 Asymmetric Multi-Processing System Development Guide (AMP)

For details, see the `<SDK>/docs/cn/Common/AMP` directory. The AMP system is a general-purpose multicore heterogeneous system solution provided by Rockchip, which has been widely used in industrial applications such as power and industrial control, as well as consumer products like vacuum cleaners.

#### 3.1.2 Peripheral Components Support List (AVL)

Please refer to `<SDK>/docs/cn/Common/AVL` directory for details, which contains the support list for DDR/eMMC/NAND FLASH/WIFI-BT/CAMERA. The support list is updated in real time on the redmine. The link is as follows:

<https://redmine.rockchip.com.cn/projects/fae/documents>

##### 3.1.2.1 DDR Support List

For the Rockchip platform DDR chip support list, please refer to "Rockchip\_Support\_List\_DDR\_Ver2.56.pdf" in the `<SDK>/docs/cn/Common/AVL` directory. The following table shows the support level of DDR. It is only recommended to use chips marked with √ and T/A.

Table 1-1 Rockchip DDR Support Symbol

| Symbol | Description                      |
|--------|----------------------------------|
| √      | Fully Tested and Mass production |
| T/A    | Fully Tested and Applicable      |
| N/A    | Not Applicable                   |

### 3.1.2.2 eMMC Support List

The eMMC chip support list for Rockchip platform can be found in the `<SDK>/docs/cn/Common/AVL` directory in the document titled 'RKeMMCSupportList\_Ver1.77\_20230825.pdf'. It is recommended to choose chips marked with √ or T/A in the support level table below.

Table 1-2 Rockchip eMMC Support Symbol

| Symbol | Description   |
|--------|---|
| √      | Fully Tested , Applicable and Mass Production           |
| T/A    | Fully Tested , Applicable and Ready for Mass Production |
| D/A    | Datasheet Applicable,Need Sample to Test                |
| N/A    | Not Applicable  |

- **Selection of High-Performance eMMC Chips**

To enhance system performance, it is necessary to choose high-performance eMMC chips. Before selecting an eMMC chip, please refer to the models in the support list provided by Rockchip and pay close attention to the `performance` section in the manufacturer's datasheet.

Please select eMMC chips based on the manufacturer's size specifications and the read/write speeds. It is recommended to choose chips with sequential read speeds >200MB/s and sequential write speeds >40MB/s.

If there are any doubts about selection, you can also directly contact the Rockchip FAE team [fae@rock-chips.com](mailto:fae@rock-chips.com).

#### 6.1.5 Performance

[Table 23] Performance

| Density | Partition Type | Performance |              |
|---------|----------------|-------------|--------------|
|         |                | Read(MB/s)  | Write (MB/s) |
| 16GB    | General        | 285         | 40           |
| 32GB    |                | 310         | 70           |
| 64GB    |                | 310         | 140          |
| 128GB   |                | 310         | 140          |
| 16GB    | Enhanced       | 295         | 80           |
| 32GB    |                | 320         | 150          |
| 64GB    |                | 320         | 245          |
| 128GB   |                | 320         | 245          |

Figure 1-1 eMMC Performance Example

### 3.1.2.3 SPI NOR and SLC NAND Flash Support List

The SPI NOR and SLC NAND Flash support list for Rockchip platform, can be found in the document titled "RK\_SpiNor\_and\_SLC\_Nand\_SupportList\_V1.44\_20230815.pdf" in the `<SDK>/docs/cn/Common/AVL` directory, the document also indicates the models of SPI NAND that can be selected. It is recommended to choose chips marked with √ or T/A in the support level table below.

Table 1-3 Rockchip SPI NOR and SLC NAND Support Symbol

| Symbol | Description   |
|--------|---|
| √      | Fully Tested , Applicable and Mass Production           |
| T/A    | Fully Tested , Applicable and Ready for Mass Production |
| D/A    | Datasheet Applicable,Need Sample to Test                |
| N/A    | Not Applicable  |

#### 3.1.2.4 NAND Flash Support List

Nand Flash support list for Rockchip platform, can be found in the /docs/Common/AVL` directory in the document titled “RKNandFlashSupportList Ver2.73\_20180615.pdf”.the document also indicates the models of Nand Flash that can be selected. It is recommended to choose chips marked with √ or T/A in the support level table below.

Table 1-4 Rockchip Nand Flash Support Symbol

| Symbol | Description   |
|--------|---|
| √      | Fully Tested , Applicable and Mass Production           |
| T/A    | Fully Tested , Applicable and Ready for Mass Production |
| D/A    | Datasheet Applicable,Need Sample to Test                |
| N/A    | Not Applicable  |

#### 3.1.2.5 WIFI/BT Support List

WIFI/BT Support List for Rockchip Platform can be found in the document titled Rockchip\_Support\_List\_Linux\_WiFi\_BT\_20230531.pdf' in the <SDK>/docs/cn/Common/AVL directory. This document contains a comprehensive list of WIFI/BT chips tested extensively on the Rockchip platform. It is advisable to select models based on the list. For the testing of other WIFI/BT chips, corresponding kernel drivers should be provided from the original manufacturers of the WIFI/BT chips.

For any questions about chip selection, it is recommended to contact the Rockchip FAE team at [fae@rock-chips.com](mailto:fae@rock-chips.com).

#### 3.1.2.6 Camera Support List

Camera Support List for Rockchip Platform can be found in the [Camera Module Support List](#). This online list contains a comprehensive collection of Camera Modules extensively tested on the Rockchip platform. It is advisable to select models based on the list.

For any questions about module selection, it is recommended to contact the Rockchip FAE team at [fae@rock-chips.com](mailto:fae@rock-chips.com).

### 3.1.3 Audio Module Document (AUDIO)

It includes audio algorithms for microphones and relevant development documents for audio/Pulseaudio modules. The reference documents are as follows:

```
docs/cn/Common/AUDIO/  
├─ Algorithms  
├─ Rockchip_Developer_Guide_Audio_EN.pdf  
└─ Rockchip_Developer_Guide_PulseAudio_EN.pdf
```

### 3.1.4 CAN Module Document (CAN)

CAN bus, also known as Controller Area Network, is an efficient serial communication network used for distributed control or real-time control. The following documents mainly cover CAN driver development, communication testing tools, common command interfaces, and frequently asked questions.

```
docs/cn/Common/CAN/  
├─ Rockchip_Developer_Guide_CAN_FD_EN.pdf  
└─ Rockchip_Developer_Guide_Can_EN.pdf
```

### 3.1.5 Clock Module Document (CLK)

This document primarily covers clock development on the Rockchip platform, including Clock, GPIO, PLL spreading, etc.

```
docs/cn/Common/CLK/  
├─ Rockchip_Developer_Guide_Clock_EN.pdf  
├─ Rockchip_Developer_Guide_Gpio_Output_Clocks_EN.pdf  
└─ Rockchip_Developer_Guide_Pll_Ssmod_Clock_EN.pdf
```

### 3.1.6 CRYPTO Module Document (CRYPTO)

The following documents primarily focus on the development of Rockchip Crypto and HWRNG (TRNG), including driver development and upper-layer application development.

```
docs/cn/Common/CRYPTO/  
└─ Rockchip_Developer_Guide_Crypto_HWRNG_EN.pdf
```

### 3.1.7 DDR Module Document (DDR)

This module document mainly includes DDR development guide, DDR issue troubleshooting, DDR chip validation process, DDR board layout instructions, DDR bandwidth tool usage, and DDR DQ eye diagram tool, etc. for Rockchip platform.

```
docs/cn/Common/DDR/  
├─ Rockchip_Developer_Guide-DDR-EN.pdf
```

### 3.1.8 Debug Module Document (DEBUG)

This module document mainly includes introduction to the use of debugging tools such as DS5, FT232H\_USB2JTAG, GDB\_ADB, Eclipse\_OpenOCD, etc. for Rockchip platform.

```
docs/cn/Common/DEBUG/  
├─ Rockchip_Developer_Guide_DS5_EN.pdf  
├─ Rockchip_Developer_Guide_FT232H_USB2JTAG.pdf  
├─ Rockchip_Developer_Guide_GDB_Over_ADB_EN.pdf  
└─ Rockchip_Developer_Guide_GNU_MCU_Eclipse_OpenOCD_EN.pdf
```

### 3.1.9 Display Module Document (DISPLAY)

This module document mainly includes development documents about DRM, DP, HDMI, MIPI, RK628 and other display modules for Rockchip platform.

```
docs/cn/Common/DISPLAY/  
├─ DP  
├─ HDMI  
├─ MIPI  
├─ RK628  
├─ Rockchip_BT656_TX_AND_BT1120_TX_Developer_Guide_EN.pdf  
├─ Rockchip_Developer_Guide_Baseparameter_Format_Define_And_Use_EN.pdf  
├─ Rockchip_Developer_Guide_DRM_Display_Driver_EN.pdf  
├─ Rockchip_Developer_Guide_RGB_MCU_EN.pdf  
├─ Rockchip_Develop_Guide_DRM_Direct_Show_EN.pdf  
├─ Rockchip_DRM_Panel_Porting_Guide_V1.6_20190228.pdf  
└─ Rockchip_RK3588_Developer_Guide_MIPI_DSI2_EN.pdf
```

### 3.1.10 Dynamic Frequency and Voltage Adjustment Module Documentation (DVFS)

This module document primarily covers CPU/GPU/DDR and other dynamic frequency and voltage adjustment modules for Rockchip platform.

Cpufreq and Devfreq are a set of framework models defined by kernel developers that support dynamic frequency and voltage adjustment based on specified governors. It effectively reduces power consumption while balancing performance.

```
docs/cn/Common/DVFS/  
├─ Rockchip_Developer_Guide_CPUFreq_EN.pdf  
└─ Rockchip_Developer_Guide_Devfreq_EN.pdf
```

### 3.1.11 File System Module Documentation

This module document primarily includes the development documentation related to the file system on the Rockchip platform.

```
docs/cn/Common/FS/  
└─ Rockchip_Developer_FAQ_FileSystem_EN.pdf
```

### 3.1.12 Ethernet Module Document (GMAC)

This module document primarily includes the development documentation related to the Ethernet GMAC interface on the Rockchip platform.

```
docs/cn/Common/GMAC/  
├─ Rockchip_Developer_Guide_Linux_GMAC_EN.pdf  
├─ Rockchip_Developer_Guide_Linux_GMAC_DPDK_EN.pdf  
├─ Rockchip_Developer_Guide_Linux_GMAC_Mode_Configuration_EN.pdf  
├─ Rockchip_Developer_Guide_Linux_GMAC_RGMII_Delayline_EN.pdf  
└─ Rockchip_Developer_Guide_Linux_MAC_TO_MAC_EN.pdf
```

### 3.1.13 HDMI-IN Module Document (HDMI-IN)

This module document mainly contains development documents related to the HDMI-IN interface of the Rockchip platform.

```
docs/cn/Common/HDMI-IN/  
├─ Rockchip_Developer_Guide_HDMI_IN_Based_On_CameraHal3_EN.pdf  
└─ Rockchip_Developer_Guide_HDMI_RX_EN.pdf
```

### 3.1.14 I2C Module Document (I2C)

This module document mainly contains development documents related to I2C interface of the Rockchip platform.

```
docs/cn/Common/I2C/  
└─ Rockchip_Developer_Guide_I2C_EN.pdf
```

### 3.1.15 IO Power Domain Module Document (IO-DOMAIN)

In the Rockchip platform, IO voltages generally include 1.8V, 3.3V, 2.5V, 5.0V, etc. Some IO interfaces support multiple voltage levels. The io-domain is responsible for configuring the IO power domain registers. It configures the corresponding voltage registers based on the actual hardware voltage range. Without proper configuration, the IO interfaces cannot function correctly.

```
docs/cn/Common/IO-DOMAIN/  
└─ Rockchip_Developer_Guide_Linux_IO_DOMAIN_EN.pdf
```

### 3.1.16 IOMMU Module Document (IOMMU)

It mainly introduces the Rockchip platform IOMMU for converting 32-bit virtual addresses and physical addresses. It has read and write control bits and can generate page missing exceptions and bus exception interrupts.

```
docs/cn/Common/IOMMU/  
└─ Rockchip_Developer_Guide_Linux_IOMMU_EN.pdf
```

### 3.1.17 Image Module Document (ISP)

ISP1.X is mainly suitable for RK3399/RK3288/PX30/RK3326/RK1808, etc.

ISP21 is mainly suitable for RK3566\_RK3568, etc.

ISP30 is mainly suitable for RK3588, etc.

ISP32-lite is mainly suitable for RK3562, etc.

It contains ISP development documents, VI driver development documents, IQ Tool development documents, debugging documents and color debugging documents. The reference documents are as follows:

```
docs/cn/Common/ISP/  
├─ ISP1.X  
├─ ISP21  
├─ ISP30  
├─ ISP32-lite  
└─ The-Latest-Camera-Documents-Link.txt
```

#### Note:

Reference documents about RK3288/RK3399/RK3326/RK1808 Linux(kernel-4.4) rkisp1 driver, sensor driver, vcm driver is: "RKISP\_Driver\_User\_Manual\_v1.3\_20190919";

RK3288/RK3399/RK3326/RK1808 Linux(kernel-4.4) camera\_engine\_rkisp (3A repository) reference documents is: "camera\_engine\_rkisp\_user\_manual\_v2.0";

Reference document for IQ effect file parameters of RK3288/RK3399/RK3326/RK1808 Linux(kernel-4.4) camera\_engine\_rkisp v2.0.0 version v2.0.0 and above is:

"RKISP1\_IQ\_Parameters\_User\_Guide\_v1.0\_20190606".

### 3.1.18 MCU Module Document (MCU)

MCU development guide on the Rockchip platform.

```
docs/cn/Common/MCU/  
└─ Rockchip_RK3399_Developer_Guide_MCU_EN.pdf
```

### 3.1.19 MMC Module Document (MMC)

Development guide for interfaces such as SDIO, SDMMC, and eMMC on the Rockchip platform.

```
docs/cn/Common/MMC/
├── Rockchip_Developer_Guide_SDMMC_SDIO_eMMC_EN.pdf
└── Rockchip_Developer_Guide_SD_Boot_EN.pdf
```

### 3.1.20 Memory Module Document (MEMORY)

Process memory module mechanisms such as CMA and DMABUF on the Rockchip platform.

```
docs/cn/Common/MEMORY/
├── Rockchip_Developer_Guide_Linux_CMA_EN.pdf
├── Rockchip_Developer_Guide_Linux_DMABUF_EN.pdf
├── Rockchip_Developer_Guide_Linux_Meminfo_EN.pdf
└── Rockchip_Developer_Guide_Linux_Memory_Allocator_EN.pdf
```

### 3.1.21 MPP Module Document (MPP)

MPP development instructions on the Rockchip platform.

```
docs/cn/Common/MPP/
└── Rockchip_Developer_Guide_MPP_EN.pdf
```

### 3.1.22 Watchdog Module Document (WATCHDOG)

Development instructions for Watchdog on the Rockchip platform.

```
docs/cn/Common/WATCHDOG/
└── Rockchip_Developer_Guide_Linux_WDT_EN.pdf
```

### 3.1.23 NPU Module Document (NPU)

The SDK provides RKNPU-related development tools, as follows:

#### 3.1.23.1 RKNN-TOOLKIT2

RKNN-Toolkit2 is a development kit for generating and evaluating RKNN models on a PC:

The development kit is located in the `external/rknn-toolkit2` directory, primarily used for model conversion, optimization, quantization, inference, performance evaluation, and accuracy analysis, and other functions.

Basic functionalities include:



| Function             | Description  |
|----------------------|--|
| Model Conversion     | Supports Pytorch / TensorFlow / TFLite / ONNX / Caffe / Darknet floating-point models<br>Supports Pytorch / TensorFlow / TFLite Quantization Aware Models (QAT)<br>Supports dynamic input models (Dynamicization/Native Dynamics)<br>Supports large models |
| Model Optimization   | Constant folding/ OP correction/ OP Fuse&Convert / Weight Sparsification/ Model Pruning  |
| Model Quantization   | Supports quantization types: Asymmetric i8/ fp16<br>Supports Layer / Channel quantization methods;<br>Normal / KL/ MMSE quantization algorithms<br>Supports mixed quantization for balancing performance and accuracy                                      |
| Model Inference      | Supports model inference on PC via emulator<br>Supports transferring models to NPU hardware for inference (connected board inference)<br>Supports inference in quantities and multi-input models   |
| Model Evaluation     | Supports performance and memory evaluation of models on NPU hardware   |
| Accuracy Analysis    | Supports quantization accuracy analysis (emulator/ NPU)  |
| Additional Functions | Supports version/device query functions, etc.  |

For more detailed instructions, please refer to the current doc/ directory documents:

```

|— 01_Rockchip_RKNPU_Quick_Start_RKNN_SDK_V1.6.0_EN.pdf
|— 01_Rockchip_RKNPU_Quick_Start_RKNN_SDK_V1.6.0_EN.pdf
|— 02_Rockchip_RKNPU_User_Guide_RKNN_SDK_V1.6.0_EN.pdf
|— 02_Rockchip_RKNPU_User_Guide_RKNN_SDK_V1.6.0_EN.pdf
...
|— RKNN-Toolkit2_OP_Support-1.6.0.md

```

### 3.1.23.2 RKNN API

RKNN API development materials are located in the project directory `external/rknpu2`, which are used for inferring rknn models generated by RKNN-Toolkit2.

For more detailed instructions, please refer to the current doc/ directory documents:

```

...
|— 03_Rockchip_RKNPU_API_Reference_RKNN_Toolkit2_V1.6.0_EN.pdf
|— 03_Rockchip_RKNPU_API_Reference_RKNN_Toolkit2_V1.6.0_EN.pdf
|— 04_Rockchip_RKNPU_API_Reference_RKNNRT_V1.6.0_EN.pdf
|— 04_Rockchip_RKNPU_API_Reference_RKNNRT_V1.6.0_EN.pdf
|— 05_RKNN_Compiler_Support_Operator_List_v1.6.0.pdf
|— RKNN-Toolkit2_API_Difference_With_Toolkit1-1.6.0.md

```

### 3.1.24 NVM Module Document (NVM)

It mainly introduces the boot process on the Rockchip platform, configuring and debugging storage, OTP OEM area burning and other security interfaces.

```
docs/cn/Common/NVM/  
├─ Rockchip_Application_Notes_Storage_EN.pdf  
├─ Rockchip_Developer_FAQ_Storage_EN.pdf  
├─ Rockchip_Developer_Guide_Dual_Storage_EN.pdf  
└─ Rockchip_Developer_Guide_SATA_EN.pdf
```

### 3.1.25 PCIe Module Document (PCIe)

It mainly introduces the development instructions of PCIe on Rockchip platform.

```
docs/cn/Common/PCIe/  
├─ Rockchip_Developer_Guide_PCIe_EN.pdf  
├─ Rockchip_Developer_Guide_PCIe_EP_Standard_Card_EN.pdf  
├─ Rockchip_Developer_Guide_PCIe_Performance_EN.pdf  
├─ Rockchip_PCIe_Virtualization_Developer_Guide_EN.pdf  
└─ Rockchip_RK3399_Developer_Guide_PCIe_EN.pdf
```

### 3.1.26 Performance Module Document (PERF)

Introduction to PERF Performance analysis on Rockchip Platform

```
docs/cn/Common/PERF/  
├─ Rockchip_Develop_Guide_Linux_RealTime_Performance_Test_Report_EN.pdf  
├─ Rockchip_Optimize_Tutorial_Linux_IO_EN.pdf  
├─ Rockchip_Quick_Start_Linux_Perf_EN.pdf  
├─ Rockchip_Quick_Start_Linux_Performance_Analyse_EN.pdf  
├─ Rockchip_Quick_Start_Linux_Streamline_EN.pdf  
└─ Rockchip_Quick_Start_Linux_Systrace_EN.pdf
```

### 3.1.27 GPIO Module Document (PINCTRL)

PIN-CTRL driver and DTS usage method on Rockchip platform.

```
docs/cn/Common/PINCTRL/  
└─ Rockchip_Developer_Guide_Linux_Pinctrl_EN.pdf
```

### 3.1.28 PMIC Module Document (PMIC)

Developer guide for PMICs such as RK805, RK806, RK808, RK809, and RK817 on the Rockchip platform.

```
docs/cn/Common/PMIC/
├─ Rockchip_RK805_Developer_Guide_EN.pdf
├─ Rockchip_RK806_Developer_Guide_EN.pdf
├─ Rockchip_RK808_Developer_Guide_EN.pdf
├─ Rockchip_RK809_Developer_Guide_EN.pdf
├─ Rockchip_RK816_Developer_Guide_EN.pdf
├─ Rockchip_RK817_Developer_Guide_EN.pdf
├─ Rockchip_RK818_Developer_Guide_EN.pdf
├─ Rockchip_RK818_RK816_Developer_Guide_Fuel_Gauge_EN.pdf
└─ Rockchip_RK818_RK816_Introduction_Fuel_Gauge_Log_EN.pdf
```

### 3.1.29 Power Module Document (POWER)

Basic concepts and optimization methods for chip power consumption on Rockchip platform.

```
docs/cn/Common/POWER/
└─ Rockchip_Developer_Guide_Power_Analysis_EN.pdf
```

### 3.1.30 PWM Module Document (PWM)

PWM developer guide on the Rockchip platform.

```
docs/cn/Common/PWM
└─ Rockchip_Developer_Guide_Linux_PWM_EN.pdf
```

### 3.1.31 RGA Module Document (RGA)

RGA developer guide on the Rockchip platform.

```
docs/cn/Common/RGA/
├─ Rockchip_Developer_Guide_RGA_EN.pdf
└─ Rockchip_FAQ_RGA_EN.pdf
```

### 3.1.32 SARADC Module Document (SARADC)

SARADC developer guide on the Rockchip platform.

```
docs/cn/Common/SARADC/
└─ Rockchip_Developer_Guide_Linux_SARADC_EN.pdf
```

### 3.1.33 SPI Module Document (SPI)

SPI developer guide on the Rockchip platform.

```
docs/cn/Common/SPI/  
└─ Rockchip_Developer_Guide_Linux_SPI_EN.pdf
```

### 3.1.34 Thermal Module Document (THERMAL)

Thermal developer guide on the Rockchip platform.

```
docs/cn/Common/THERMAL/  
└─ Rockchip_Developer_Guide_Thermal_EN.pdf
```

### 3.1.35 Tools Module Document (TOOL)

Instructions for using tools such as partitioning, mass production burning, and factory line burning on the Rockchip platform.

```
docs/cn/Common/TOOL/  
├─ Production-Guide-For-Firmware-Download.pdf  
├─ RKUpgrade_Dll_UserManual.pdf  
├─ Rockchip-User-Guide-ProductionTool-EN.pdf  
├─ Rockchip_Introduction_Partition_EN.pdf  
└─ Rockchip_User_Guide_Production_For_Firmware_Download_EN.pdf
```

### 3.1.36 Security Module Document (TRUST)

Introduction to functions such as TRUST and sleep & wake-up on the Rockchip platform

```
docs/cn/Common/TRUST/  
├─ Rockchip_Developer_Guide_Trust_EN.pdf  
├─ Rockchip_RK3308_Developer_Guide_System_Suspend_EN.pdf  
├─ Rockchip_RK3399_Developer_Guide_System_Suspend_EN.pdf  
├─ Rockchip_RK356X_Developer_Guide_System_Suspend_EN.pdf  
└─ Rockchip_RK3588_Developer_Guide_System_Suspend_EN.pdf
```

### 3.1.37 UART Module Document (UART)

Introduction to serial port functions and debugging on the Rockchip Platform

```
docs/cn/Common/UART/  
├─ Rockchip_Developer_Guide_UART_EN.pdf  
└─ Rockchip_Developer_Guide_UART_FAQ_EN.pdf
```

### 3.1.38 UBOOT Module Document (UBOOT)

Introduction to U-Boot related development on the Rockchip platform

```
docs/cn/Common/UBOOT/  
├─ Rockchip_Developer_Guide_Linux_AB_System_EN.pdf  
├─ Rockchip_Developer_Guide_U-Boot_TFTP_Upgrade_EN.pdf  
├─ Rockchip_Developer_Guide_UBoot_MMC_Device_Analysis_EN.pdf  
├─ Rockchip_Developer_Guide_UBoot_MTD_Block_Device_Design_EN.pdf  
├─ Rockchip_Developer_Guide_UBoot_Nextdev_EN.pdf  
└─ Rockchip_Introduction_UBoot_rkdevelop_vs_nextdev_EN.pdf
```

### 3.1.39 USB Module Document (USB)

Introduction to USB development guide, USB signal testing and debugging tools on the Rockchip platform

```
docs/cn/Common/USB/  
├─ Rockchip_Developer_Guide_Linux_USB_Initialization_Log_Analysis_EN.pdf  
├─ Rockchip_Developer_Guide_Linux_USB_PHY_EN.pdf  
├─ Rockchip_Developer_Guide_Linux_USB_Performance_Analysis_EN.pdf  
├─ Rockchip_Developer_Guide_USB2_Compliance_Test_EN.pdf  
├─ Rockchip_Developer_Guide_USB_EN.pdf  
├─ Rockchip_Developer_Guide_USB_FFS_Test_Demo_EN.pdf  
├─ Rockchip_Developer_Guide_USB_Gadget_UAC_EN.pdf  
├─ Rockchip_Developer_Guide_USB_SQ_Test_EN.pdf  
├─ Rockchip_Introduction_USB_SQ_Tool_EN.pdf  
├─ Rockchip_RK3399_Developer_Guide_USB_EN.pdf  
├─ Rockchip_RK3399_Developer_Guide_USB_DTS_EN.pdf  
├─ Rockchip_RK356x_Developer_Guide_USB_EN.pdf  
├─ Rockchip_RK3588_Developer_Guide_USB_EN.pdf  
├─ Rockchip_Trouble_Shooting_Linux4.19_USB_Gadget_UVC_EN.pdf  
└─ Rockchip_Trouble_Shooting_Linux_USB_Host_UVC_EN.pdf
```

## 3.2 Linux System Development Documents (Linux)

Please refer to documents under the `<SDK>/docs/cn/Linux` :

```
├─ ApplicationNote  
├─ Audio  
├─ Camera  
├─ Docker  
├─ Graphics  
├─ Multimedia  
├─ Profile  
├─ Recovery  
├─ Security  
├─ System  
├─ Uefi  
└─ Wifibt
```

### 3.2.1 ApplicationNote

Development instructions for applications on the Rockchip platform, such as ROS, RetroArch, USB, etc

```
docs/cn/Linux/ApplicationNote/  
├─ Rockchip_Developer_Guide_Linux_Flash_Open_Source_Solution_EN.pdf  
├─ Rockchip_Instruction_Linux_ROS2_EN.pdf  
├─ Rockchip_Instruction_Linux_ROS_EN.pdf  
├─ Rockchip_Quick_Start_Linux_USB_Gadget_EN.pdf  
└─ Rockchip_Use_Guide_Linux_RetroArch_EN.pdf
```

### 3.2.2 Audio Development Documents (Audio)

Self developed audio algorithm on Rockchip platform.

```
docs/cn/Linux/Audio/  
├─ Rockchip_Developer_Guide_Microphone_Array_TEST_EN.pdf  
├─ Rockchip_Developer_Guide_Microphone_Array_Tuning.pdf  
└─ Rockchip_Introduction_Linux_Audio_3A_Algorithm_EN.pdf
```

### 3.2.3 Camera Development Documents (Camera)

MIPI/CSI Camera and Structured Light Development Guide on the Rockchip Platform

```
docs/cn/Linux/Camera/  
├─ Rockchip_Developer_Guide_Linux4.4_Camera_EN.pdf  
├─ Rockchip_Developer_Guide_Linux_RMSL_EN.pdf  
└─ Rockchip_Trouble_Shooting_Linux4.4_Camera_EN.pdf
```

### 3.2.4 Docker Development Documents (Docker)

Docker build and development of third-party systems such as Debian/Buildroot on the Rockchip platform.

```
docs/cn/Linux/Docker/  
├─ Rockchip_Developer_Guide_Debian_Docker_EN.pdf  
├─ Rockchip_Developer_Guide_Linux_Docker_Deploy_EN.pdf  
└─ Rockchip_User_Guide_SDK_Docker_EN.pdf
```

### 3.2.5 Graphics Development Documents (Graphics)

Linux Graphics related development on Rockchip Platform.

```
docs/cn/Linux/Graphics/  
├─ Rockchip_Developer_Guide_Buildroot_Weston_EN.pdf  
└─ Rockchip_Developer_Guide_Linux_Graphics_EN.pdf
```

## 3.2.6 Multimedia

The general process of video encoding and decoding on the Rockchip Linux platform:

```
vpu_service --> mpp --> gstreamer/rockit --> app
vpu_service: driver
MPP: A video encoding and decoding middleware for the Rockchip platform. Please
refer to the MPP documentation for detailed instructions
Gstreamer/rockit: used to connect components such as apps
```

Currently, gstreamer is used in Debian/Buildroot systems by default to connect apps and codec components.

Currently, the key development documents are as follows:

```
docs/cn/Linux/Multimedia/
├─ Rockchip_Developer_Guide_Linux_RKADK_EN.pdf
├─ Rockchip_User_Guide_Linux_Gstreamer_EN.pdf
└─ Rockchip_User_Guide_Linux_Rockit_EN.pdf
```

Encoding and decoding functionalities can also be tested directly through the testing interfaces provided by MPP (such as `mpi_dec_test`/`mpi_enc_test`...). MPP source code reference is located in `<SDK>/external/mpp/`. For testing demos, please refer to `<SDK>/external/mpp/test`. Please refer to the SDK document `Rockchip_Developer_Guide_MPP_EN.pdf` for details.

Rockchip chips like RK3588 support powerful multimedia capabilities:

- Supports H.265/H.264/AV1/VP9/AVS2 video decoding, up to 8K60FPS, also supports 1080P multi-format video decoding (H.263, MPEG1/2/4, VP8, JPEG).
- Supports 8K H.264/H.265 video encoding and 1080P VP8, JPEG video encoding.
- Video post-processing: deinterlacing, noise reduction, edge/detail/color optimization.

Below are the reference specifications for common chip encoding and decoding capabilities on each platform.

**Note:** The maximum testing specifications are related to numerous factors, so the same decoding IP specifications might differ among different chips. Chip support may vary in different systems, leading to differences in supported formats and performance.

### • Decoding Capability Specification Table

| Chip          | H264          | H265          | VP9           | JPEG           |
|---------------|---------------|---------------|---------------|----------------|
| RK3588        | 7680X4320@30f | 7680X4320@60f | 7680X4320@60f | 1920x1088@200f |
| RK3566/RK3568 | 4096x2304@60f | 4096x2304@60f | 4096x2304@60f | 1920x1080@60f  |
| RK3562        | 1920x1088@60f | 2304x1440@30f | 4096x2304@30f | 1920x1080@120f |
| RK3399        | 4096x2304@30f | 4096x2304@60f | 4096x2304@60f | 1920x1088@30f  |
| RK3328        | 4096x2304@30f | 4096x2304@60f | 4096x2304@60f | 1920x1088@30f  |
| RK3288        | 3840x2160@30f | 4096x2304@60f | N/A           | 1920x1080@30f  |
| RK3326        | 1920x1088@60f | 1920x1088@60f | N/A           | 1920x1080@30f  |
| PX30          | 1920x1088@60f | 1920x1088@60f | N/A           | 1920x1080@30f  |
| RK312X        | 1920x1088@30f | 1920x1088@60f | N/A           | 1920x1080@30f  |

- **Coding Capability Specification Table**

| Chip          | H264          | H265          | VP8           |
|---------------|---------------|---------------|---------------|
| RK3588        | 7680x4320@30f | 7680x4320@30f | 1920x1088@30f |
| RK3566/RK3568 | 1920x1088@60f | 1920x1088@60f | N/A           |
| RK3562        | 1920x1088@60f | N/A           | N/A           |
| RK3399        | 1920x1088@30f | N/A           | 1920x1088@30f |
| RK3328        | 1920x1088@30f | 1920x1088@30f | 1920x1088@30f |
| RK3288        | 1920x1088@30f | N/A           | 1920x1088@30f |
| RK3326        | 1920x1088@30f | N/A           | 1920x1088@30f |
| PX30          | 1920x1088@30f | N/A           | 1920x1088@30f |
| RK312X        | 1920x1088@30f | N/A           | 1920x1088@30f |

### 3.2.7 SDK Profile introduction (Profile)

Including software testing, benchmarks, etc. on Rockchip Linux platform.

```
docs/cn/Linux/Profile/  
├─ Rockchip_Developer_Guide_Linux_PCBA_EN.pdf  
├─ Rockchip_Introduction_Linux_Benchmark_KPI_EN.pdf  
├─ Rockchip_Introduction_Linux_PLT_EN.pdf  
└─ Rockchip_User_Guide_Linux_Software_Test_EN.pdf
```

### 3.2.8 OTA Upgrade (Recovery)

An introduction to the recovery development process and upgrade during OTA upgrade of Rockchip Linux platform.

```
docs/cn/Linux/Recovery/  
├─ Rockchip_Developer_Guide_Linux_DFU_Upgrade_EN.pdf  
├─ Rockchip_Developer_Guide_Linux_Recovery_EN.pdf  
├─ Rockchip_Developer_Guide_Linux_Upgrade_EN.pdf  
└─ Rockchip_Introduction_Smart_Screen_OTA_EN.pdf
```

### 3.2.9 Security Solution (Security)

Introduction to the secure boot solution of Securoboot and TEE on Rockchip Linux platform

```
docs/cn/Linux/Security/  
├─ Rockchip_Developer_Guide_Linux_Secure_Boot_EN.pdf  
└─ Rockchip_Developer_Guide_TEE_SDK_EN.pdf
```



### 3.2.10 System Development (System)

Introduction to the porting and development guide for Debian and other third-party systems on the Rockchip Linux platform

```
docs/cn/Linux/System/  
├─ Rockchip_Developer_Guide_Buildroot_EN.pdf  
├─ Rockchip_Developer_Guide_Debian_EN.pdf  
└─ Rockchip_Developer_Guide_Third_Party_System_Adaptation_EN.pdf
```

### 3.2.11 UEFI Booting (UEFI)

Introduction to UEFI boot solution on Rockchip Linux platform.

```
docs/cn/Linux/Uefi/  
└─ Rockchip_Developer_Guide_UEFI_EN.pdf
```

### 3.2.12 Network Module (RKWIFIBT)

Introduction to the development of WIFI, BT, etc. on Rockchip Linux platform.

```
docs/cn/Linux/Wifibt/  
├─ AP module RF test document  
├─ REALTEK module RF test document  
├─ Rockchip_Developer_Guide_Linux_WIFI_BT_EN.pdf  
├─ WIFIBT programming interface  
└─ WIFI performance testing PC tool
```

### 3.2.13 DPDK Module (DPDK)

DPDK development guide on Rockchip Linux platform.

```
docs/cn/Linux/DPDK/  
└─ Rockchip_Developer_Guide_Linux_DPDK_EN.pdf
```

## 3.3 Chip Platform Related Documents (Socs)

Refer to the documentation in the `<SDK>/docs/cn/<chipset_name>` directory. Normally, it will include the release notes, quick start, software development guide, hardware development guide, Datasheet, etc.

### 3.3.1 Release Note

It contains an overview of the chip, supported main functions, instructions for obtaining the SDK, etc.

Reference document is in the `<SDK>/docs/cn/<chipset_name>` directory:

`Rockchip_<chipset_name>_Linux_SDK_Release_<version>_EN.pdf`

### 3.3.2 Quick Start

Normally, it will include software and hardware development guide, SDK build, SDK pre-build firmware, SDK burning, etc.

Please refer to the documentation in the `<SDK>/docs/cn/<chipset_name>/Quick-start` directory.

### 3.3.3 Software Development Guide

In order to help developers get familiar with the development and debugging of the SDK faster, the "Rockchip\_Developer\_Guide\_Linux\_Software\_EN.pdf" document can be obtained from the `/docs/cn/<chip_name>/` directory and will be continuously improved and updated.

## 3.4 Datasheet

In order to help developers get familiar with chip development and debugging faster, a chip datasheet is released with the SDK.

Please refer to the documentation in the `<SDK>/docs/cn/<chipset_name>/Datasheet` directory.

### 3.4.1 Hardware Development Guide

Rockchip platform will have corresponding hardware reference documents released with the SDK software package. The hardware user guide mainly introduces the basic features, hardware interfaces, and usage methods of the reference hardware board. It aims to assist developers in using the EVB more quickly and accurately, and in developing related products. For more details, please refer to the documents in the

`<SDK>/docs/cn/<chip_name>/Hardware` directory.

## 3.5 Other Documents (Others)

For other reference documents, such as Repo mirror environment construction, Rockchip SDK application and synchronization guide, Rockchip Bug system usage guide, etc., please refer to the documents in the

`<SDK>/docs/cn/Others` directory.

`docs/cn/Others/`

- |— `Rockchip_Developer_Guide_Repo_Mirror_Server_Deploy_EN.pdf`
- |— `Rockchip_Trouble_Shooting_Linux_Real-Time_Performance_EN.pdf`
- |— `Rockchip_User_Guide_Bug_System_EN.pdf`
- |— `Rockchip_User_Guide_SDK_Application_And_Synchronization_EN.pdf`

### 3.6 Documents List (docs\_list\_cn.txt)

Please refer to the document in the `/docs/cn/docs_list_cn.txt`` directory.

```
|— Common
|— Linux
|— Others
|— Rockchip_Developer_Guide_Linux_Software_EN.pdf
|—<chipset_name>
└— docs_list_cn.txt
```

## 4. Chapter-4 Tools Introduction

Tools released with the Rockchip Linux SDK are used for development, debugging, and mass production process. The tool versions will be continuously updated along with SDK updates. If you have any questions or requirements about the tools, please contact our FAE team: [fae@rock-chips.com](mailto:fae@rock-chips.com).

In the Rockchip Linux SDK, tools are included in the `tools` directory for use in Linux (tools for Linux operating system environment), Mac (tools for macOS operating system environment), and Windows (tools for Windows operating system environment).

- Windows Tools

Tool usage instructions: `<SDK>/tools/windows/ToolsRelease.txt`

| Tool name               | Description   |
|-------------------------|---|
| boot_merger             | Packing or unpacking loader tool                          |
| DDR_UserTool            | DDR user testing tool                                     |
| DriverAssitant          | Driver installation tool                                  |
| EfuseTool               | efuse burning tool  |
| FactoryTool             | Mass production upgrade tool                              |
| ParameterTool           | Partition table modification tool                         |
| pin_debug_tool          | GPIO debugging tool                                       |
| programmer_image_tool   | Programmer upgrade tool                                   |
| rk_ddrbin_tool          | RK ddrbin debugging tool                                  |
| RKDevInfoWriteTool      | Device information writing tool                           |
| RKDevTool               | Discrete firmware upgrade and entire update firmware tool |
| RKDevTool_Release       | Firmware burning tool                                     |
| RKPCBATool              | PCBA board testing tool                                   |
| rk_sign_tool            | Secureboot signature tool                                 |
| Rockchip_HdcpKey_Writer | HDCP key burning tool                                     |
| Rockchip_USB_SQ_Tool    | USB PHY signal quality debugging work                     |
| SDDiskTool              | SD card boot or upgrade image creation                    |
| SecureBootTool          | Firmware Signature Tool                                   |
| upgrade_tool            | Command line upgrade tool                                 |
| RKImageMaker            | Command line packaging tool                               |

- Linux Tools

Tool usage instructions: `<SDK>/tools/linux/ToolsRelease.txt`

| Tool name                | Description  |
|--------------------------|--|
| boot_merger              | Packing or unpacking loader tool   |
| Firmware_Merger          | SPI NOR firmware packing tool (the generated firmware can be used in the programmer) |
| Linux_DDR_Bandwidth_Tool | DDR bandwidth statistics tool  |
| Linux_Diff_Firmware      | OTA differential package tool  |
| Linux_Pack_Firmware      | Firmware packaging tool (packaged into updata.img)                                   |
| Linux_SecureBoot         | Firmware Signature Tool  |
| Linux_SecurityAVB        | AVB Signature tool   |
| Linux_SecurityDM         | DM Signature Tool  |
| Linux_Upgrade_Tool       | Firmware burning tool  |
| pin_debug_tool           | GPIO debugging tool  |
| programmimg_image_tool   | Packaged SPI NOR/SPI NAND/SLC NAND/eMMC programmer firmware                          |
| rk_ddrbin_tool           | RK ddrbin debugging tool   |
| rk_sign_tool             | Secureboot signature tool  |

- Mac tools

Tool documentation: `<SDK>/tools/mac/ToolsRelease.txt`

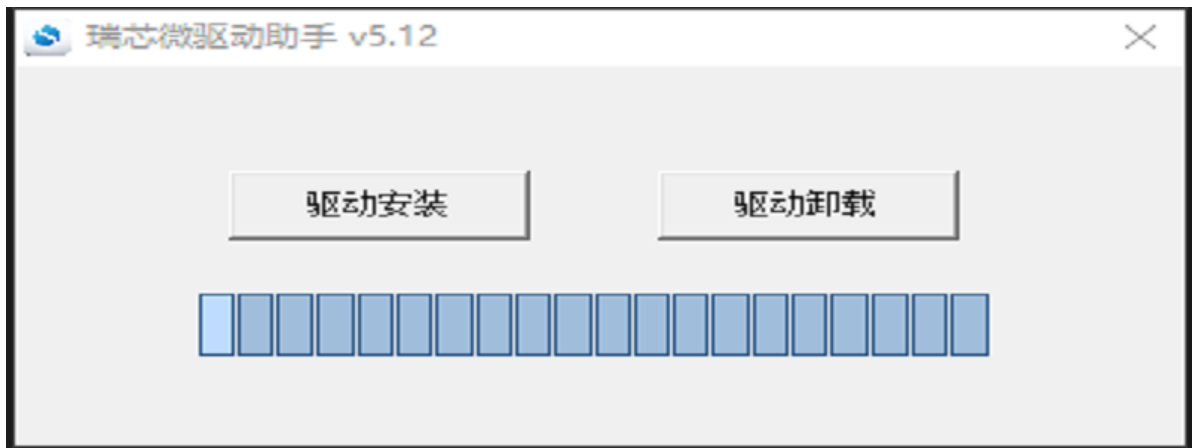
| Tool name    | Description                      |
|--------------|----------------------------------|
| boot_merger  | Packing or unpacking loader tool |
| upgrade_tool | Command line upgrade tool        |
| rk_sign_tool | Secureboot signature tool        |

## 4.1 Driver Installation Tool

Rockchip USB driver installation assistant is stored in

`<SDK>/tools/windows/DriverAssitant_v5.12.zip`. xp, win7\_32, win7\_64, win10\_32, win10\_64 and other operating systems are supported.

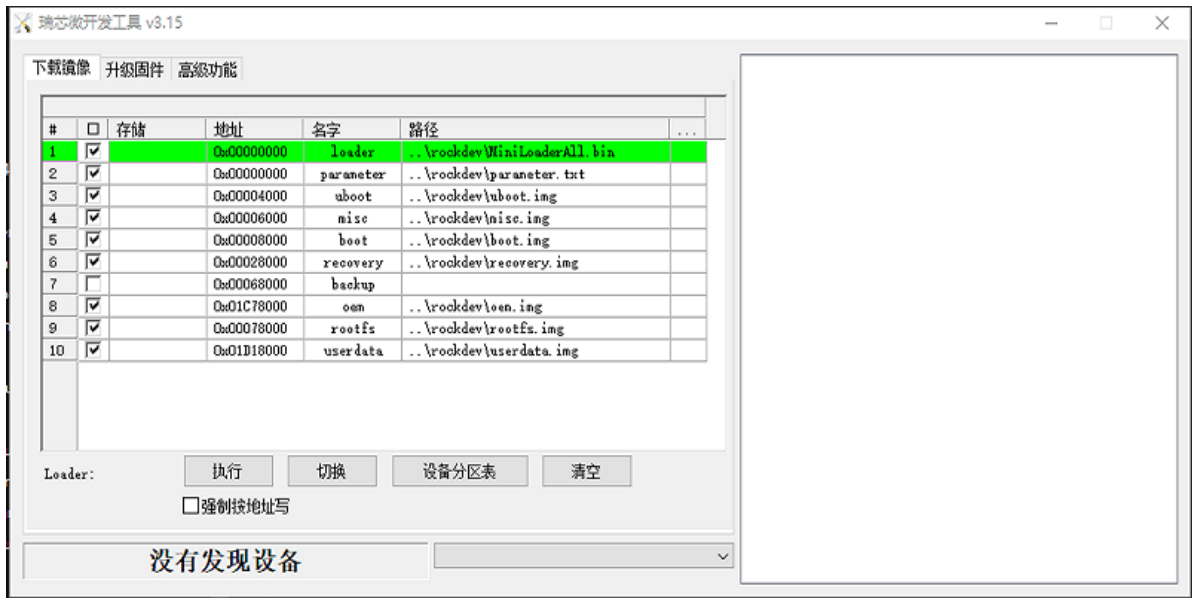
The installation steps are as follows:



## 4.2 Burning Tools

- The SDK provides Windows burning tools (the tool version requires V3.15 or above), which is located in the project root directory:

```
<SDK>/tools/windows/RKDevTool/
```



- The SDK provides Linux burning tools (the version of Linux\_Upgrade\_Tool requires V2.17 or above), the tool is located in the project root directory:

```
<SDK>/tools/linux/Linux_Upgrade_Tool/Linux_Upgrade_Tool
```

```
Linux_Upgrade_Tool$ sudo ./upgrade_tool -h
```

```
-----Tool Usage -----
Help:          H
Version:       V
Log:           LG
-----Upgrade Command -----
ChooseDevice:  CD
ListDevice:    LD
SwitchDevice:  SD
UpgradeFirmware:  UF <Firmware> [-noreset]
UpgradeLoader:  UL <Loader> [-noreset] [FLASH|EMMC|SPINOR|SPINAND]
DownloadImage:  DI <-p|-b|-k|-s|-r|-m|-u|-t|-re image>
DownloadBoot:   DB <Loader>
EraseFlash:     EF <Loader|firmware>
PartitionList:  PL
WriteSN:        SN <serial number>
ReadSN:         RSN
ReadComLog:     RCL <File>
CreateGPT:      GPT <Input Parameter> <Output Gpt>
SwitchStorage:  SSD
-----Professional Command -----
TestDevice:     TD
ResetDevice:     RD [subcode]
ResetPipe:       RP [pipe]
ReadCapability:  RCB
ReadFlashID:     RID
ReadFlashInfo:   RFI
ReadChipInfo:    RCI
ReadSecureMode:  RSM
WriteSector:     WS <BeginSec> <PageSizeK> <PageSpareB> <File>
ReadLBA:         RL <BeginSec> <SectorLen> [File]
WriteLBA:        WL <BeginSec> [SizeSec] <File>
EraseLBA:        EL <BeginSec> <EraseCount>
```

```
EraseBlock:      EB <CS> <BeginBlock> <BlockLen> [--Force]
RunSystem:       RUN <uboot_addr> <trust_addr> <boot_addr> <uboot> <trust> <boot>
-----
```

## 4.3 Packaging Tools

Mainly used to package each discrete firmware into a complete update.img firmware for easy upgrade.

- How to package update.img firmware in Windows environment, run the following command to generate update.img

```
<SDK>/tools/windows/RKDevTool/rockdev/mkupdate.bat
```

- How to package update.img firmware in Linux environment, run the following command to generate update.img

```
<SDK>/tools/linux/Linux_Pack_Firmware/rockdev/mkupdate.sh
```

## 4.4 Tools used to Make SD Card Upgrading and Booting

It is used for making SD card upgrades, SD card booting, and SD card PCBA testing.

```
<SDK>/tools/windows/SDDiskTool_v1.74.zip
```

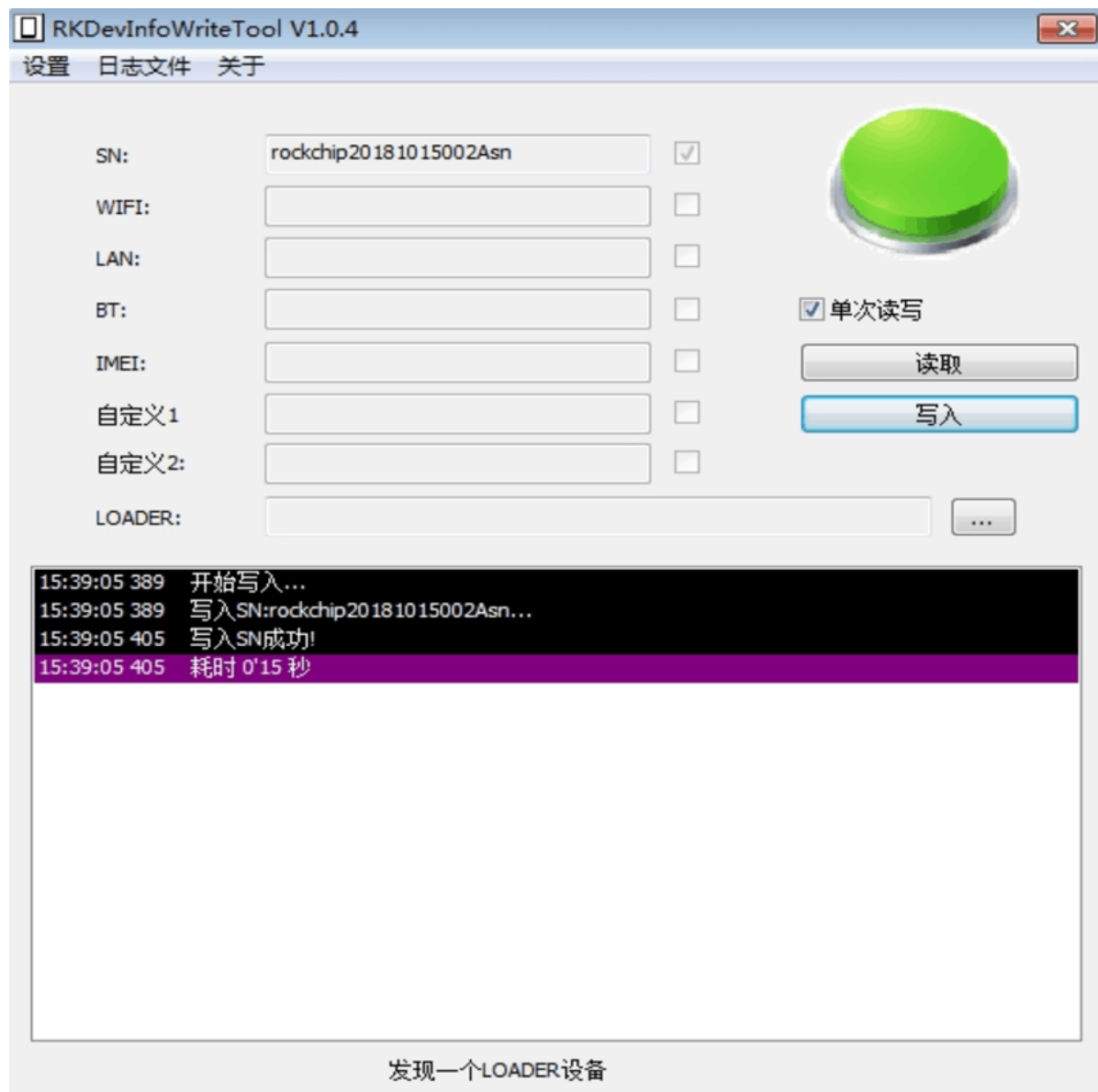




## 4.5 Device Information Writing Tool

```
<SDK>/tools/windows/RKDevInfoWriteTool*
```

Unzip RKDevInfoWriteTool-1.3.0.7z and install it. Open the software with administrator rights. Please refer to the [Rockchip\\_User\\_Guide\\_RKDevInfoWriteTool\\_CN.pdf](#) in the current directory for tool usage,.

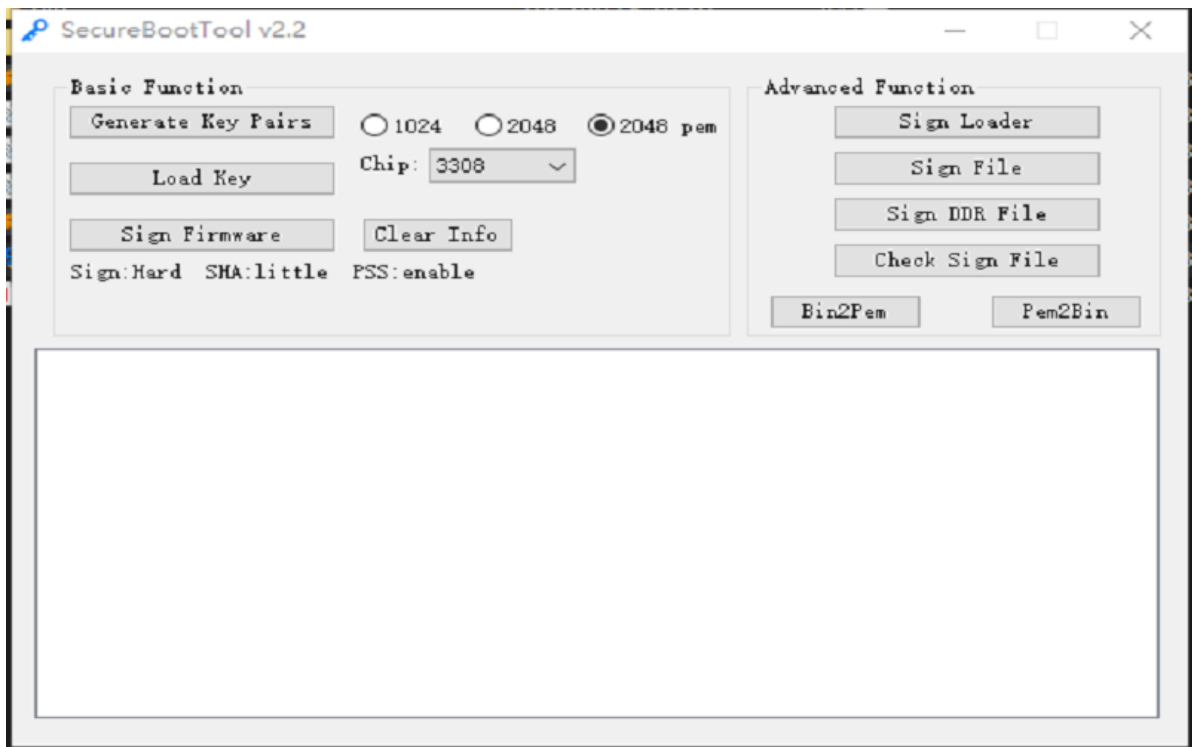


## 4.6 Firmware Signature Tool

It is used for efuse/otp signing of firmware.

- The SDK provides Windows signature tool which is located in the project root directory:

```
<SDK>/tools/windows/SecureBootTool_v2.2
```



- The SDK provides Linux signing tool which is located in the project root directory:

```
<SDK>/tools/linux/rk_sign_tool_v1.31_linux.zip

rk_sign_tool_v1.3_linux$ ./rk_sign_tool
rk_sign_tool is a tool signing firmware and loader for secureboot
usage of rk_sign_tool v1.3:
CC <--chip chip_id> //select sign options by chip
KK [--bits default=2048] <--out> //generating rsa key pairs
LK <--key> <--pubkey> //loading rsa key pairs
SI [--key] <--img> [--pss] //signing image like boot uboot trust
SL [--key] [--pubkey] <--loader> [--little] [--pss] //signing loader like
RKXX_loader.bin
SF [--key] [--pubkey] <--firmware> [--little] [--pss] //signing firmware like
update.img
SB [--key] <--bin> [--pss] //signing binary file
GH <--bin> <--sha 160|256> [--little] //computing sha of binary file
*****rk_sign_tool XX -h to get more help*****
```

Please refer to the document:

/docs/cn/Linux/Security/Rockchip\_Developer\_Guide\_Linux4.4\_SecureBoot\_CN.pdf for details.

## 4.7 Programmer Upgrade Tool

It is used for mass production of programmer image making tools, this tool is located at:

```
<SDK>/tools/windows/programmer_image_tool or
<SDK>/tools/linux/programmer_image_tool
```

```

PS D:\Rockchip\vs_projects\programmer_image_tool> .\programmer_image_tool -h
NAME
    programmer_image_tool - creating image for programming on flash
SYNOPSIS
    programmer_image_tool [-iotbpsvh]
    This tool aims to convert firmware into image for programming
    From now on, it can support slc nand(rk)|spi nand|nor|emmc.
OPTIONS:
    -i    input firmware
    -o    output directory
    -t    storage type,range in[SLC|SPINAND|SPINOR|EMMC]
    -b    block size,unit KB
    -p    page size,unit KB
    -s    oob size,unit B
    -2    2k data in one page
    -l    using page linked list
    -v    show version

```

Programmer image creation steps:

- Burn image to eMMC

```
./programmer_image_tool -i update.img -t emmc
```

- Burn image to SPI Nor Flash

```
./programmer_image_tool -i update.img -t spinor
```

Please refer to the [user\\_manual.pdf](#) document in the tool directory for more instructions.

## 4.8 PCBA Testing Tools

PCBA testing tools are used to help quickly identify the quality of product functions during mass production and improve production efficiency. Currently includes screen(LCD), wireless (Wi-Fi), Bluetooth (bluetooth), DDR/eMMC storage, SD card (sdcard), USB HOST, key (KEY), speaker and earphone (Codec) and other test items.

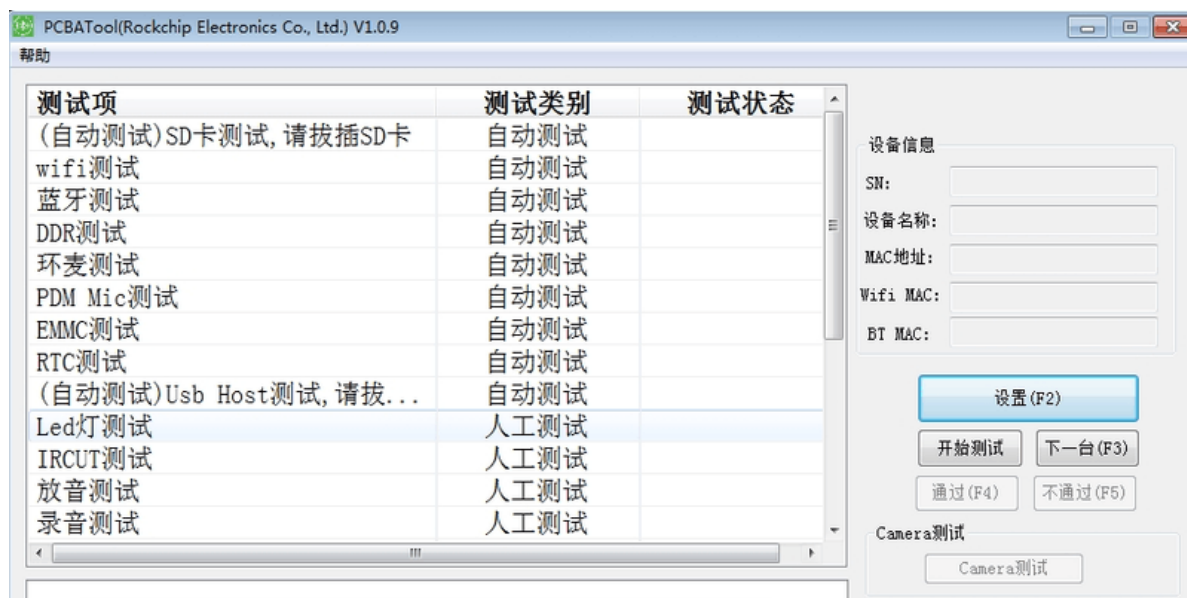
These test items include automatic test items and manual test items. Wireless network, DDR/eMMC, and Ethernet are automatic test items. Button, SD card, USB HOST, Codec are manual test items.

PCBA tools are located at:

```
<SDK>/tools/windows/RKPCBATool_V1.0.9.zip
```

For detailed PCBA function configuration and usage instructions, please refer to:

/tools/windows/RKPCBATool\_V1.0.9/Rockchip PCBA Test Development Guide\_1.10.pdf



## 4.9 DDR Soldering Test Tool

It is used to test the hardware connection of DDR and troubleshoot hardware problems such as false soldering:

```
<SDK>/tools/windows/DDR_UserTool_v1.41.zip
```

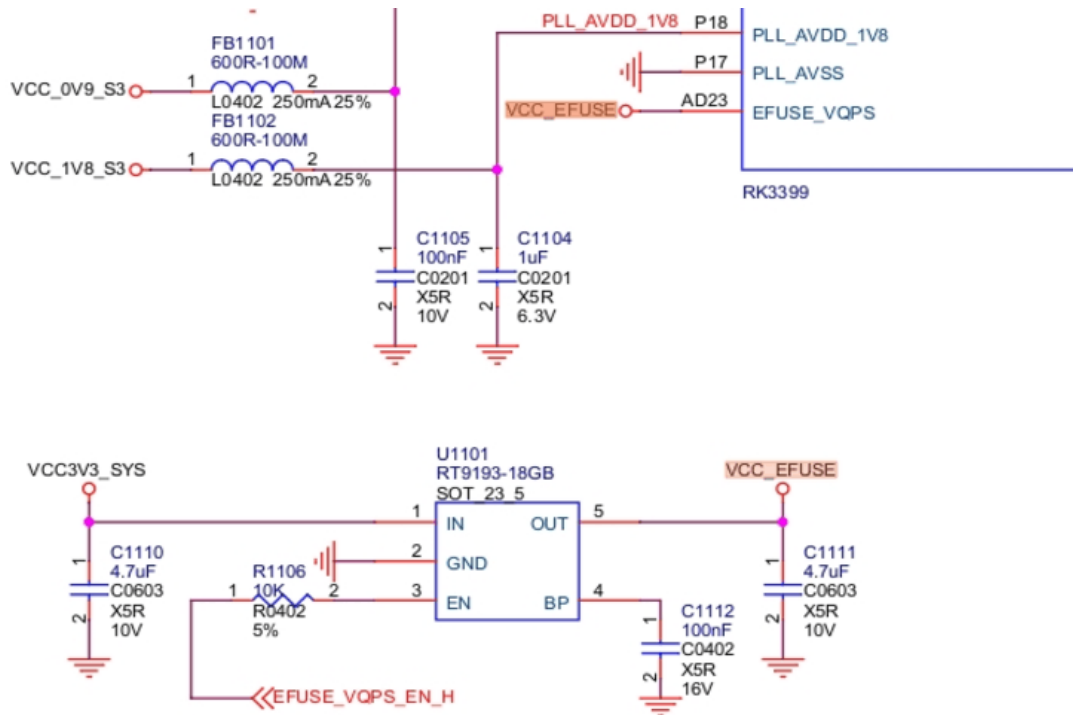


## 4.10 eFuse Programming Tool

It is used for eFuse programming, suitable for RK3288/RK3368/RK3399/RK3399Pro and other platforms.

```
<SDK>/tools/windows/EfuseTool_v1.42zip
```

If the chip uses eFuse to enable the SecureBoot function, please ensure that there is no problem with the hardware connection, because when eFuse is programmed, Kernel has not been started yet, so please ensure that VCC\_EFUSE has power in MaskRom state before it can be used.



The /Tools/windows/EfuseTool\_v1.4.zip is used to let the board enter MaskRom state.

Click "Firmware", select the signed update.img, or Miniloader.bin, click "Start" to start programming eFuse.

## 4.11 Mass Production Upgrade Tool

It is used for burning firmware during mass production in factory:

```
<SDK>/tools/windows/FactoryTool_v1.76.zip
```

## 4.12 Partition Modification Tool

The tool is used for partition modification in Parameter.txt:

<SDK>/tools/windows/ParameterTool\_v1.2.zip

Parameter:

parameter.txt

Browse

| Name          | Offset      | Secotr Offset | Size   |  |
|---------------|-------------|---------------|--------|--|
| uboot         | 0x800000    | 0x4000        | 4MB    |  |
| trust         | 0xC00000    | 0x6000        | 4MB    |  |
| misc          | 0x1000000   | 0x8000        | 4MB    |  |
| boot          | 0x1400000   | 0xA000        | 32MB   |  |
| recovery      | 0x3400000   | 0x1A000       | 32MB   |  |
| backup        | 0x5400000   | 0x2A000       | 32MB   |  |
| oem           | 0x7400000   | 0x3A000       | 64MB   |  |
| rootfs        | 0xB400000   | 0x5A000       | 6144MB |  |
| userdata:g... | 0x18B400000 | 0xC5A000      | -      |  |

Offset:

Size:

☒ KB

☐ MB

Name:

Modify

Revoke

Save

## 5. Chapter-5 SDK Software Framework

---

### 5.1 Introduction to SDK project Directory

A typical Linux SDK project directory includes buildroot, debian, app, kernel, u-boot, device, docs, external, etc. Repositories are managed by manifests, and the `repo` tool is utilized to manage each directory or its corresponding Git project, including the following subdirectories:

- `app` : Contains upper-level application apps, mainly various application demos.
- `buildroot` : Contains the root file system developed with Buildroot.
- `debian` : Contains the root file system developed with Debian.
- `device/rockchip` : Contains chip board-level configurations and scripts/files for compiling and packaging firmware.
- `docs` : Contains general development guides, Linux system development guides, chip platform-related documents, etc.
- `external` : Contains third-party related repositories, including display, audio/video, camera, network, security, etc.
- `kernel` : Contains Kernel development code.
- `output` : Contains firmware information, compilation details, XML files, host environment, etc., generated during each build.
- `prebuilts` : Contains cross-compilation toolchains.
- `rkbin` : Contains Rockchip-related binaries and tools.
- `rockdev` : Contains compiled output firmware, actually, it soft link to xxx `output/firmware`.
- `tools` : Contains commonly used tools for both Linux and Windows operating systems.
- `u-boot` : Contains U-Boot code developed based on version v2017.09.
- `yocto` : Contains the root file system developed with Yocto.

#### 5.1.1 SDK Overview

The general Linux SDK currently integrates several mainstream Linux distributions. Distributions refer to the systems we commonly use on Linux hosts, providing users with pre-integrated Linux operating systems and various application software. Linux distributions come in various forms, ranging from fully-featured desktop systems to server versions and lightweight systems for small devices. For example, Debian supports desktop versions, and there are customizable lightweight systems like Buildroot and Yocto.

Customers can choose the system of product based on detailed product requirements. The specific system description are as follows:

#### 5.1.2 Buildroot System

The Buildroot system in Rockchip Linux SDK includes various system source code, drivers, tools, and application software packages used for Linux system development. Buildroot is an open-source embedded Linux system automatic build framework on the Linux platform. The entire Buildroot consists of Makefile scripts and Kconfig configuration files. By configuring Buildroot, a complete Linux system software that can be directly flashed and run on the device.

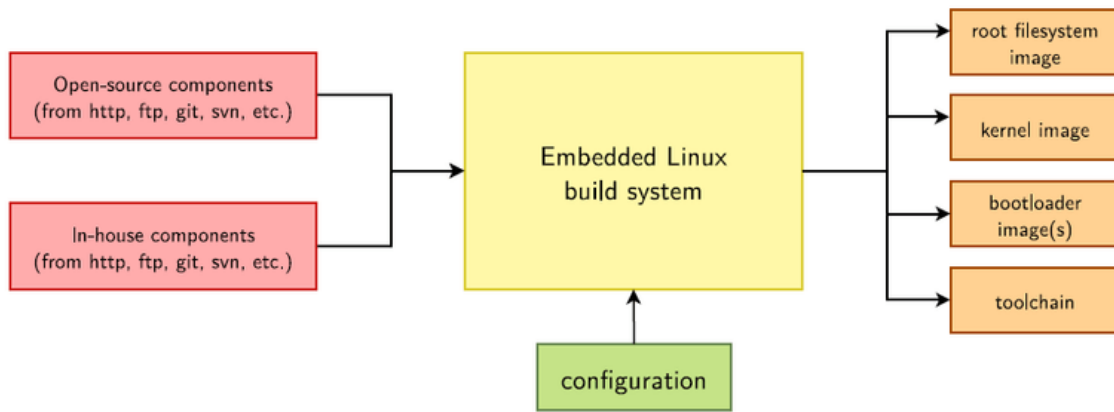


Figure 1-1 Buildroot Compilation Block Diagram

#### Advantages of Buildroot:

- **Source Code Building:** Buildroot offers great flexibility through source code building.
- **Convenient Cross-Compilation Environment:** It provides an easy-to-use cross-compilation environment for quick and efficient building, making it beginner-friendly.
- **Component Configuration:** Buildroot allows easy customization of various system components, facilitating tailored development.

One of the most famous projects using Buildroot is OpenWrt. Images created with OpenWrt can run on routers with 16 M SPI NOR flash memory, containing only essential components. This simplicity is achieved thanks to Buildroot. The entire Buildroot project is maintained in a single Git repository.

[Buildroot](#) uses kconfig and make, a [defconfig](#) configuration represents a BSP support.

Buildroot itself does not have the ability to expand, and users need to complete the work through scripts. These listed features are all different from Yocto.

At present, Buildroot is a critical system that we develop and maintain internally.

### 5.1.3 Yocto

Yocto, like Buildroot, is a set of tools for building embedded systems, but their styles are completely different. Yocto projects are maintained through individual packages (meta), with some packages responsible for the core and others for peripherals. Some packages are designed for running Rockchip chips, some for installing Weston, and others for running Debian. Similar mechanisms are used for Node.js. The Yocto community is highly active and expansive, allowing everyone to share their achievements on GitHub. This mechanism ensures that we can reuse others' work from the internet, which is very valuable. Compared to the Buildroot system, Yocto has a stronger compilation mechanism. It automatically handles dependencies and recompilation of third-party packages. However, it is relatively complex and requires a VPN network.



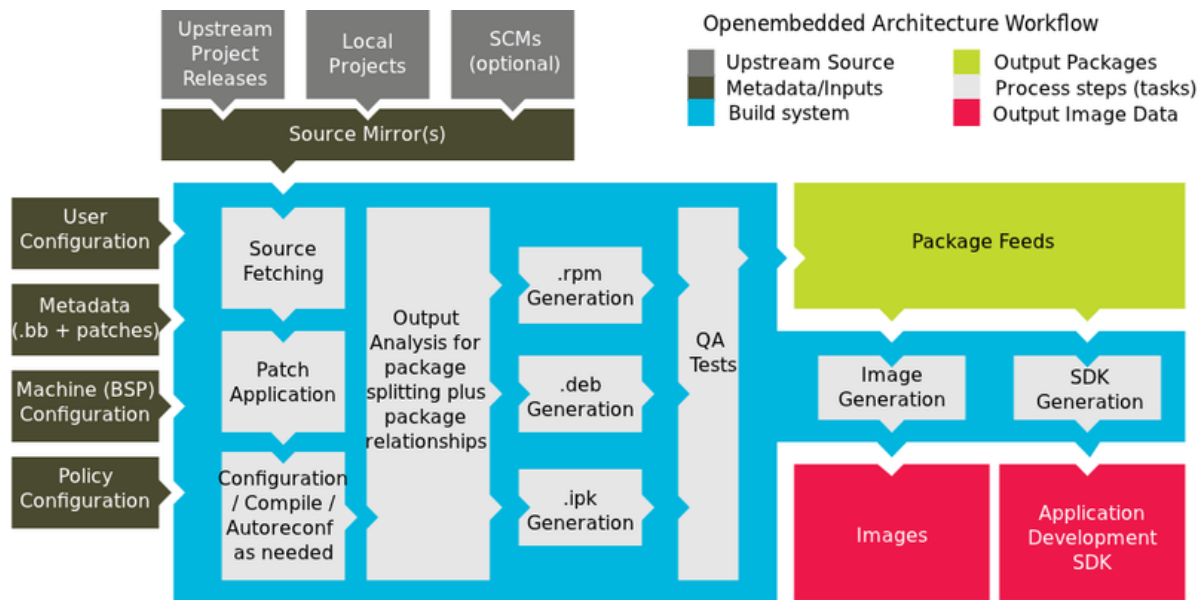


Figure 2-1 Yocto Compilation block diagram

Yocto is a very flexible build system that allows users to use the shell and Python to handle a variety of special cases. Currently, the system is mainly targeted at foreign customers. If you need more information about Yocto, check out the following references:

[Yocto](#)

[Rockchip Yocto](#)

[Yocto stable branch](#)

At present, Yocto system is mainly used by overseas, enthusiasts or customers with secondary development capabilities.

## 5.1.4 Debian

Debian is a Linux operating system that is completely free, open-source, and widely used on various devices. The reasons for choosing Debian include:

- Debian is Free Software:**  
 Debian is composed of free and open-source software and will always remain 100% free. Everyone can use, modify, and distribute it freely. Developers can build upon the Debian system created based on Rockchip.
- Debian is Stable and Secure:**  
 Debian is a stable and secure operating system based on Linux, widely used across devices, including laptops, desktops, and servers. Since 1993, its stability and reliability have made it popular among users. Debian provides reasonable default configurations for each software package, and developers strive to provide security updates throughout its lifecycle.
- Wide Hardware Support:**  
 Most hardware is supported by the Linux kernel. When free software cannot provide sufficient support, dedicated hardware drivers can be used. Currently, chips such as Rockchip RK3588/RK3568/RK3566/RK3399/RK3288 have been adapted and supported.
- Smooth Updates:**  
 Debian is known for its smooth updates within its release cycle, allowing easy transitions to the next major version. Rockchip has upgraded from Debian Stretch (9) to Debian Buster (10) and Bullseye (11).
- Foundation for Many Other Distributions:**  
 Debian serves as the foundation for many popular Linux distributions such as Ubuntu, Knoppix, PureOS, SteamOS, and Tails. Debian provides all the tools so that anyone can extend the software packages in the Debian archive to meet their requirements.

- **A Community Project:**

Debian is not just a Linux operating system; it is created collaboratively by hundreds of volunteers from around the world. Anyone can be a part of the Debian community, even if they are not a programmer or system administrator.

The customized version of Debian for Rockchip is created through shell scripts, which involve obtaining Debian distribution source code, compiling, and installing the Rockchip hardware acceleration package into the operating system.

Currently, Debian system is mainly aimed at customer preliminary evaluations, third-party system porting references, and products with complex desktop requirements.

## 5.2 SDK Software Architecture

As illustrated in Figure 3-1 of the SDK software architecture, it is divided into four layers from bottom to top: the Boot Layer, Kernel Layer, Libraries, and Application Layer. Each layer is described as follows:

- **Boot Layer:** This layer primarily handles system booting processes and provides support for components such as BootROM, U-Boot, ATF, and related functionalities.
- **Kernel Layer:** The Kernel Layer provides the standard implementation of the Linux Kernel. Linux is an open-source operating system. The core of the Rockchip platform's Linux system is based on the standard Linux 4.4/4.19/5.10 kernel versions. It offers foundational support for security, memory management, process management, network protocol stack, etc. The Linux kernel manages hardware resources of devices, such as CPU scheduling, caching, memory, I/O, etc.
- **Libraries:** This layer corresponds to general embedded systems and functions as middleware. It includes various system basic libraries and support for third-party open-source libraries. Libraries provide API interfaces to the application layer. System customizers and application developers can develop new applications based on the API provided by the Libraries layer.
- **Application Layer:** The Application Layer implements specific product features and interaction logic. It requires support from system basic libraries and third-party libraries. Developers can create their own applications, leveraging various system capabilities to deliver the final user experience.

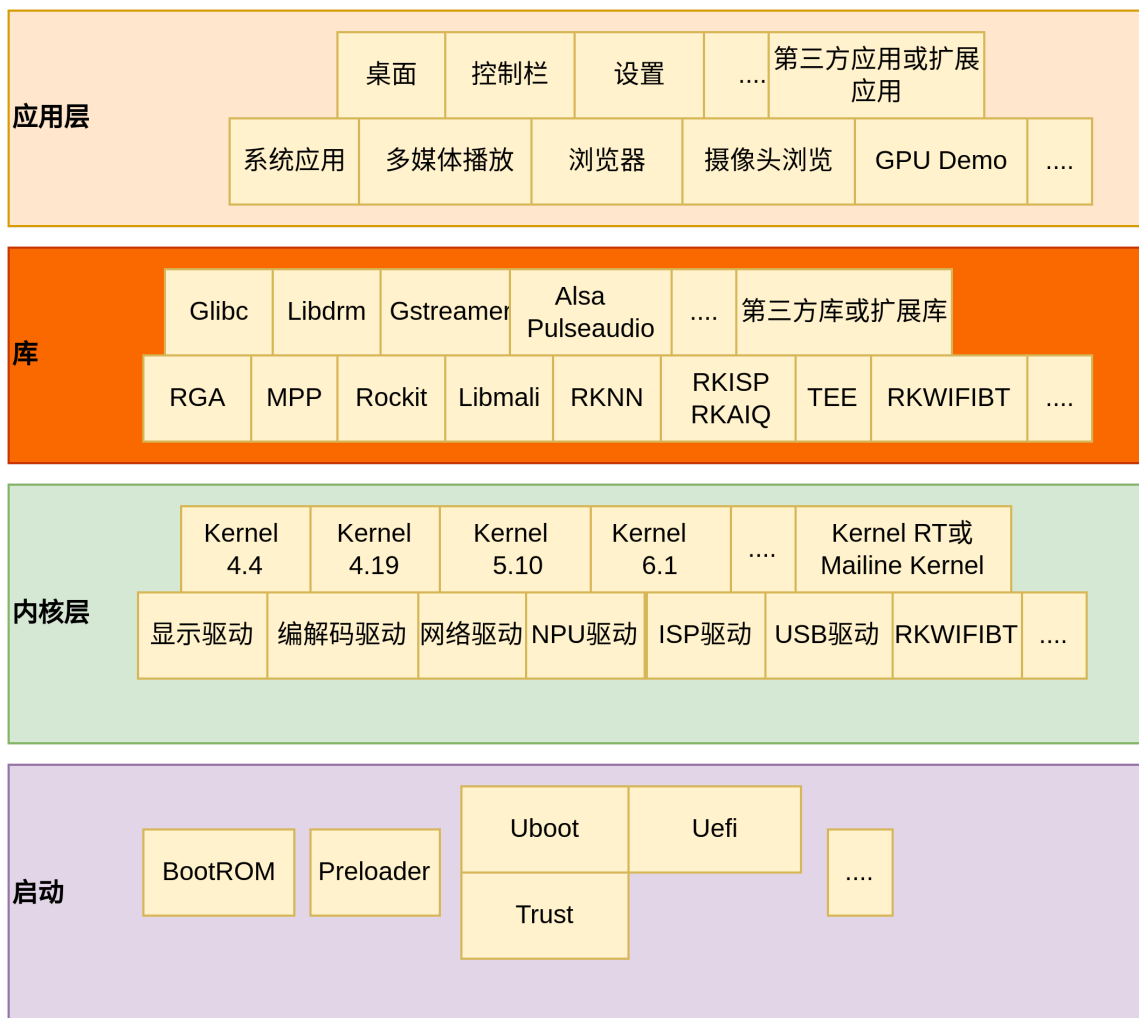
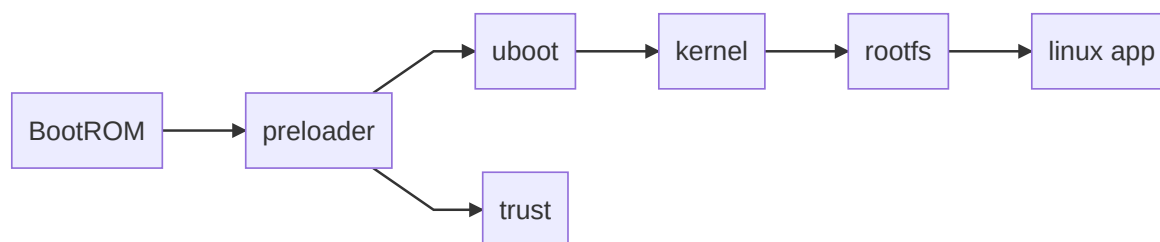


Figure 3-1 SDK Software Block Diagram

The SDK system startup process refers to a software process from system power on to completion of system startup. The following is the Linux system startup process:



**Description:**

Both AP and MCU have a BOOTROM integrated inside. When the system is powered on, it will first run the BOOTROM code, and then the BOOTROM code will detect the peripheral memory and load the Loader code.

There are currently 3 Pre Loaders: miniloader (non-open source), uboot spl and loader.

## 5.3 SDK Development Process

The Rockchip Linux system is based on the Buildroot/Yocto/Debian system, and kernel is developed based on kernel 4.4/4.19/5.10. It is an SDK developed for a variety of different product forms. Based on this SDK, system customization and application porting development can be effectively realized.

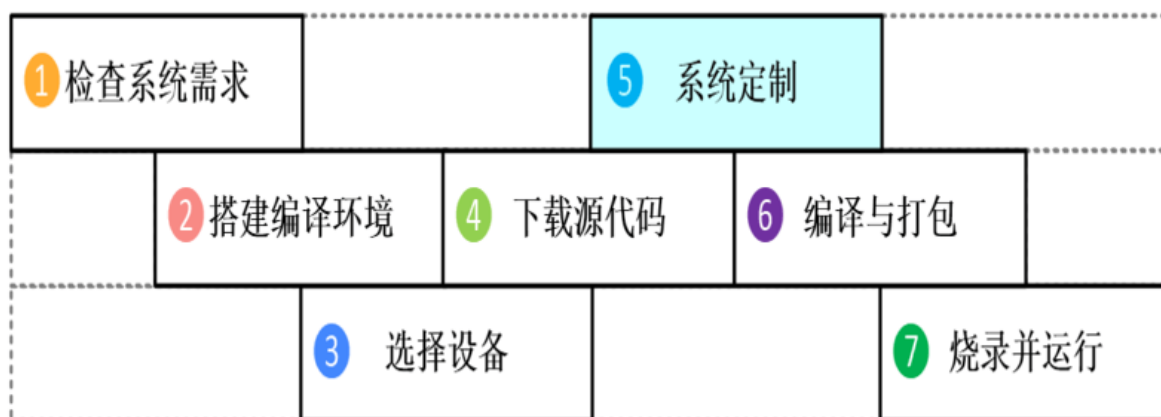


Figure 4-1 SDK Development Process

As shown in Figure 4-1, developers can follow the development process described above to quickly set up the Rockchip Linux system development environment and build code locally. Here is a brief overview of this process:

- **Check System Requirements:** Before downloading code and compiling, ensure that the local development device meets the requirements, including hardware capabilities, software system, toolchain, etc. Currently, the SDK supports compilation under the Linux operating system environment and provides toolchain support only for Linux. Other systems like MacOS and Windows are not supported at the moment.
- **Set Up Compilation Environment:** Provide information about the various software packages and tools that need to be installed on the development device. For details, please refer to [SDK Development Environment Setup](#).
- **Select Device:** During the development process, developers need to choose the appropriate hardware board based on their requirements. Please refer to [SDK Adapted Hardware Automatic Compilation Summary](#).
- **Download Source Code:** After selecting the device type, install the repo tool for batch downloading of source code. For details, please refer to [SDK Software Packages](#).
- **System Customization:** Developers can customize U-Boot, Kernel, and Rootfs based on the hardware board and product definition. Please refer to [SDK Development](#).
- **Compile and Package:** After setting up the source code and selecting the product, initialize the relevant compilation environment. Then execute compilation commands, including overall or module compilation, and cleanup work. For further details, please refer to [SDK Compilation Instructions](#).
- **Flash and Run:** After generating the image files, learn how to flash the image and run it on the hardware device. For further details, please refer to [SDK Firmware Upgrade](#).

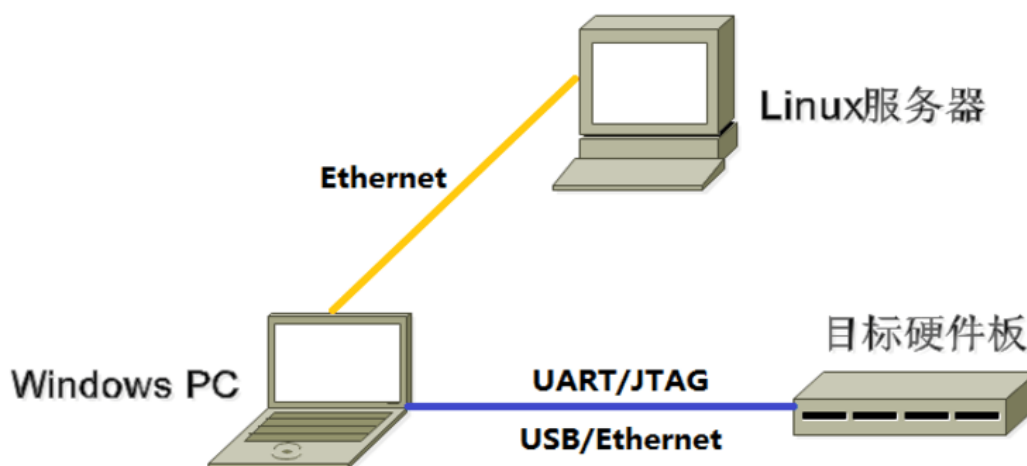
## 6. Chapter-6 SDK Development Environment Setup

### 6.1 Overview

This section mainly introduces how to set up a local compilation environment to build Rockchip Linux SDK source code. Currently, the SDK only supports compilation and secondary development in a Linux environment.

A typical embedded development environment typically includes a Linux server, PC, and target hardware board, as shown in the diagram below.

- Set up a cross-compilation environment on the Linux server to provide services such as code provision, updates downloading, and compilation for software development.
- Share programs between the PC and Linux server, and install Putty or Minicom. Remote login to the Linux server over the network is used for cross-compilation and development code debugging.
- Connect the PC to the target hardware board via serial ports and USB. The compiled image file can be flashed onto the target hardware board, and the system or application program can be debugged.



Note: Windows PC is used in the development environment. In fact, many tasks can also be completed on Linux PC, such as using Minicom instead of Putty. Users can choose by themselves.

### 6.2 Preparation Work before SDK Development

The code and related documents of Rockchip Linux SDK are divided into several git repositories for version management. Developers can use repo to download, submit, switch branches, and other operations on these git repositories.

#### 6.2.1 Install and Configure Git

Please configure your own git information before using repo, otherwise subsequent operations may encounter hook checking errors:

- Update sources and install git

```
sudo apt update && sudo apt-get install git
```

- Configure user information

```
git config --global user.name "your name"
git config --global user.email "your mail"
```

## 6.2.2 Install and Configure repo

repo is a script written by Google using Python script to call git. It is mainly used to download and manage the project's software repositories.

The installation path in the following commands takes "~/bin" as an example. Users should create the required directories themselves.

```
mkdir ~/bin
cd ~/bin
git clone ssh://git@www.rockchip.com.cn/repo/rk/tools/repo
chmod a+x ~/bin/repo/repo
export PATH=~/bin/repo:$PATH
```

In addition to the above methods, you can also use the following command to obtain repo

- In foreign regions, you can download the repo tool from the Google mirror site:

```
mkdir ~/bin
curl https://storage.googleapis.com/git-repo-downloads/repo -o ~/bin/repo
chmod a+x ~/bin/repo
export PATH=~/bin:$PATH
```

- In domestic areas, you can download the repo tool from the tsinghua.edu.cn site:

```
mkdir ~/bin
curl https://mirrors.tuna.tsinghua.edu.cn/git/git-repo -o ~/bin/repo
chmod a+x ~/bin/repo
export PATH=~/bin:$PATH
```

## 6.2.3 SDK Obtaining

The SDK is released through Rockchip code server. When customers apply for the SDK through Rockchip's technical window, they need an account to access the source code repository provided by Rockchip. In order to be able to obtain code synchronization, please provide SSH public key for server authentication and authorization when apply for SDK from Rockchip technical window. About Rockchip server SSH public key authorization, please refer to the Chapter [SSH Public Key Operation Instructions](#) in this document.

### 6.2.3.1 SDK Download Command

Rockchip Linux SDK can be adapted to different chip platforms, such as RK3588, RK3562, RK3566, RK3568, RK3308, RK3288, RK3326/PX30, RK3399, RK3399Pro, RK1808, etc. The source code of different chip platforms will be different to a certain extent. Developers need to declare the chip platform they want when downloading the source code, so as to avoid downloading code they don't need.

SDK uses different XML to declare the corresponding chip platform you want to download.

Please refer to the Chapter [Download through code server](#) in this document.

When the code start to download automatically, just wait patiently. The source code files will be located in the working directory under the corresponding project name. The initial sync operation will take an hour or more to complete.

### 6.2.3.2 Compressed Package of SDK Code

For quick access to SDK source code, Rockchip Technical Window usually provides corresponding version of SDK initial compression package. In this way, developers can get SDK source code through decompressing the initial compression package, which is the same as the one downloaded by repo.

Please refer to the Chapter [Obtain by decompressing the local compressed package](#) in this document.

### 6.2.3.3 Software Update History

The software release version upgrade can be viewed through the project xml. For example, the way for the RK3588 chip is as follows:

```
.repo/manifests$ realpath rk3588_linux_release.xml
In the example: the printed version number is v1.3.0 and the update time is
20230920
<SDK>/.repo/manifests/rk3588_linux_release_v1.3.0_20230920.xml
```

Software release version upgrade and update content can be viewed through the project text. Please refer to the project directory. For example, check the version of RK3588 as follows:

```
<SDK>/.repo/manifests/rk3588_linux/RK3588_Linux5.10_SDK_Note.md

<SDK>/docs/cn/RK3588/RK3588_Linux5.10_SDK_Note.md
```

### 6.2.3.4 SDK Update

Developers can synchronize updates through commands according to the update instructions published regularly in the FAE window.

```
.repo/repo/repo sync -c
```

### 6.2.3.5 SDK Issue Feedback

In order to better assist customer development, the Rockchip bug system (Redmine) records the user problem handling process and status, making it easier for both parties to track at the same time, making issue processing more timely and efficient. SDK issues, specific technical issues, technical consultation, etc. can be submitted to this bug system, and Rockchip technical services will distribute, handle and track the issues in a timely manner. For more detailed instructions, please refer to the documentation

```
<SDK>/docs/cn/Others/Rockchip_User_Guide_SDK_Application_And_Synchronization_CN.pdf
```

## 6.3 Set up an Development Environment

### 6.3.1 Preparing the development environment

It is recommended to use Ubuntu 22.04 for compilation. 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: 64-bit system, hard disk space should be greater than 40G. If you do multiple builds, you will need more hard drive space

### 6.3.2 Install libraries and toolsets

When using the command line for device development, you can install the libraries and tools required for compiling the SDK by the following steps.

Use the following `apt-get` command to install the libraries and tools required for the following operations:

```
sudo apt-get update && sudo apt-get install git ssh make gcc libssl-dev \
liblz4-tool expect expect-dev g++ patchelf chrpath gawk texinfo chrpath \
diffstat binfmt-support qemu-user-static live-build bison flex fakeroot \
cmake gcc-multilib g++-multilib unzip device-tree-compiler ncurses-dev \
libgucharmap-2-90-dev bzip2 expat gpgv2 cpp-aarch64-linux-gnu libgmp-dev \
libmpc-dev bc python-is-python3 python2
```

#### Description:

The installation command is applicable to Ubuntu22.04. For other versions, please use the corresponding installation command according to the name of the installation package. If you encounter an error when compiling, you can install the corresponding software package according to the error message. in:

- Python 3.6 or later versions is required to be installed, and python 3.6 is used as an example here.
- make requires make 4.0 and above to be installed, take make 4.2 as an example here.
- lz4 1.7.3 or later versions is required to be installed.
- Compiling yocto requires a VPN network, and git does not have the CVE-2022-39253 security detection patch.

#### 6.3.2.1 Check and upgrade the `python` version of the host

The method of checking and upgrading the `python` version of the host is as follows:

- Check host `python` version

```
$ python3 --version
Python 3.10.6
```

If you do not meet the requirements of `python>=3.6` version, you can upgrade it in the following way:

- Upgrade `python 3.6.15` new version



```
PYTHON3_VER=3.6.15
echo "wget
•https://www.python.org/ftp/python/${PYTHON3_VER}/Python-${PYTHON3_VER}.tgz"
echo "tar xf Python-${PYTHON3_VER}.tgz"
echo "cd Python-${PYTHON3_VER}"
echo "sudo apt-get install libsqlite3-dev"
echo "./configure --enable-optimizations"
echo "sudo make install -j8"
```

### 6.3.2.2 Check and Upgrade the `make` Version on the Host

The method to check and upgrade the `make` version on the host is as follows:

- Check the `make` version on the host

```
$ make -v/
GNU Make 4.2
Built for x86_64-pc-linux-gnu
```

- Upgrade to the new version of `make 4.2`

```
$ sudo apt update && sudo apt install -y autoconf autopoint

git clone https://gitee.com/mirrors/make.git
cd make
git checkout 4.2
git am $BUILDROOT_DIR/package/make/*.patch
autoreconf -f -i
./configure
make make -j8
sudo install -m 0755 make /usr/bin/make
```

### 6.3.2.3 Check and Upgrade the `lz4` Version on the Host

The method to check and upgrade the `lz4` version on the host is as follows:

- Check the `lz4` version on the host

```
$ lz4 -v
*** LZ4 command line interface 64-bits v1.9.3, by Yann Collet ***
refusing to read from a console
```

- Upgrade to the new version of `lz4`

```
git clone https://gitee.com/mirrors/LZ4_old1.git
cd LZ4_old1

make
sudo make install
sudo install -m 0755 lz4 /usr/bin/lz4
```

#### 6.3.2.4 Check and Upgrade the `git` Version on the Host

- Check the `git` version on the host

```
$ /usr/bin/git -v
git version 2.38.0
```

- Upgrade to the new version of `git`

```
$ sudo apt update && sudo apt install -y libcurl4-gnutls-dev

git clone https://gitee.com/mirrors/git.git --depth 1 -b v2.38.0
cd git
make git -j8
make install
sudo install -m 0755 git /usr/bin/git
```

## 6.4 Docker Environment Setup

To help developers quickly complete the complex development environment preparation mentioned above, we also provide a cross-compiler Docker image. This enables customers to rapidly verify and then shorten the build time of the compilation environment.

Before using the Docker environment, you can refer to the following document for instructions:

`<SDK>/docs/cn/Linux/Docker/Rockchip_Developer_Guide_Linux_Docker_Deploy_CN.pdf`.

The following systems have been verified:

| Distribution Version | Docker Version | Image Loading | Firmware Compilation |
|----------------------|----------------|---------------|----------------------|
| ubuntu 22.04         | 24.0.5         | pass          | pass                 |
| ubuntu 21.10         | 20.10.12       | pass          | pass                 |
| ubuntu 21.04         | 20.10.7        | pass          | pass                 |
| ubuntu 18.04         | 20.10.7        | pass          | pass                 |
| fedora35             | 20.10.12       | pass          | NR (not run)         |

The Docker image can be obtained from the website [Docker Image](#).

## 6.5 Introduction to Cross-compilation Tool Chain

Since Rockchip Linux SDK is currently only built in the Linux PC environment, we only provide the cross-compilation tool chain under Linux. The tool chain in the prebuilt directory is used by U-Boot and Kernel. Specifically, Rootfs needs to use its corresponding tool chain, or use a third-party tool chain for building.

## 6.5.1 U-Boot and Kernel Compilation Tool Chain

```
Linux4.4/4.19 SDK:  
prebuilts/gcc/linux-x86/aarch64/gcc-linaro-6.3.1-2017.05-x86_64-aarch64-linux-  
gnu/bin/aarch64-linux-gnu-
```

```
Linux5.10 SDK:  
prebuilts/gcc/linux-x86/aarch64/gcc-arm-10.3-2021.07-x86_64-aarch64-none-linux-  
gnu/bin/aarch64-none-linux-gnu-
```

Corresponding version:

```
Linux4.4/4.19 SDK:  
gcc version 6.3.1 20170404 (Linaro GCC 6.3-2017.05)  
  
Linux5.10 SDK:  
gcc version 10.3.1 20210621 (GNU Toolchain for the A-profile Architecture 10.3-  
2021.07 (arm-10.29))
```

## 6.5.2 Buildroot Tool Chain

If you need to build a single module or third-party application, you need to configure the cross-compilation environment. For example, RK3588, its cross-compilation tool is located in the `buildroot/output/rockchip_rk3588/host/usr` directory, you need to add the tool's `bin/` directory and set the `aarch64-buildroot-linux-gnu/bin/` directory as an environment variable, and execute a script to automatically configure environment variables in the top-level directory:

```
source buildroot/envsetup.sh
```

Enter the command to view:

```
cd buildroot/output/rockchip_rk3588/host/usr/bin  
./aarch64-linux-gcc --version
```

The following information will be printed:

```
aarch64-linux-gcc.br_real (Buildroot linux-5.10-gen-rkr6) 12.3.0
```

If you need tool chains for other platforms or versions, you need to build them by yourself.

After the above environment is prepared, the Linux server development environment has been set up and the source code can be downloaded and built.

Please refer to the following documents for details:

```
buildroot/docs/manual/using-buildroot-toolchain.txt  
buildroot/docs/manual/adding-packages.txt
```

### 6.5.3 Debian Toolchain

Use docker on the device, gcc or `dpkg-buildpackage` to build.

### 6.5.4 Yocto Toolchain

Reference is as follows:

```
https://wiki.yoctoproject.org/wiki/Building_your_own_recipes_from_first_principles#Adding_new_recipes_to_the_build_system
https://docs.yoctoproject.org/dev/dev-manual/new-recipe.html
```

## 6.6 Window PC Development Environment Setup

### 6.6.1 Development Tool Installation

- Users should install editing software such as Vim and Notepad++ by themselves.
- Download [Virtual-Box](#) (software that provides a virtual development environment)
- Download [XShell6](#) (used to establish interaction with Linux system)

### 6.6.2 Rockchip USB Driver Installation

During the development and debugging process, the device needs to be switched to Loader mode or Maskrom mode, and Rockusb driver should be installed, then the device can be recognized normally.

Rockchip USB driver installation assistant is stored in tools/windows/DriverAssitant\_v5.x.zip. support xp, win7\_32, win7\_64, win10\_32, win10\_64 and other operating systems.

The installation steps are as follows:





### 6.6.3 Windows Burning Tool Usage

The burning tool for Windows systems is released in

`<SDK>/tools/windows/RKDevTool/RKDevTool_Release`, which can be used for development, debugging and firmware burning in Windows environment. Please refer to [Development and programming tools](#) for details.

### 6.6.4 Target Hardware Board Preparation

Please refer to the SDK software package applicable hardware list [SDK software package applicable hardware list](#) to select the corresponding hardware board for development and debugging. The corresponding hardware instruction document will introduce the hardware interface, usage instructions and burning operation methods.

## 7. Chapter-7 SDK Version and Update Instructions

---

The Linux SDK currently has different versions such as Linux 4.4, Linux 4.19, and Linux 5.10. Use repo to manage the SDK and use tags to manage versions. The various components and modules of the SDK are stored in different Git repositories, and the repo tool is used to coordinate version and code synchronization between them. Each component's Git repository has its own branch and commit history.

### 7.1 SDK Naming Rules

#### 7.1.1 SDK tag Naming Rules

System - System version - form - rkr Release version

For example: Linux5.10 SDK tag is linux-5.10-gen-rkr1`

Note:

- System: Linux, Android, RTOS, etc.
- System version: Linux4.4, Linux4.19, Linux5.10, etc.
- Form: gen, common, standard, ipc, chip model, etc.
- Release version: external: alpha, beta, release; internal: rka1, rkb1, rkr1

#### 7.1.2 SDK Release Document Naming Rules

Rockchip[1]RK3399[2]Linux5.10[3]SDK[4]Release[5]V1.0.0[6]20220920[7]\_CN [8]

Note:

[1]: Rockchip, required. Documents released by RK must begin with Rockchip.

[2]: Chip model. The initial letter of the chip is uniformly capitalized, the suffix depends on the chip and remains consistent with the official website definition. If there are two chips, connect them with an underscore such as (RK3566\_RK3568).

[3]: Linux, Android, FreeRTOS, etc., the first letter is capitalized.

[4]: Optional, indicating the target market. If it is a general SDK, this item is omitted.

[5] and [6]: Release type (Alpha/Beta/Release) and version number. The version number style is defined as follows: "Vn.n.n". The letter "V" remains capitalized and n represents an integer. It can be seen that the version number consists of three numbers with 2 dots in the middle.

- Alpha version starts from V0.0.1, that is, the first two digits keep the number 0, and the last digit is incremented according to the actual testing/release situation;
- The Beta version starts from V0.1.1, that is, the first digit is kept as 0, the increment of the second digit indicates the addition of functional modules or major updates of functions, and the increment of the third digit indicates bug correction;
- Release version starts from V1.0.0, the first digit indicates a major update, and the second and third digits refer to the Beta version.

[7]: Release date. Use the format 20220920 uniformly.

[8]: Document language version information. CN: Chinese, EN: English

### 7.1.3 SDK Compressed Package Naming Rules

Chip platform - software version - [target market] + SDK + version number + release date

Example:

RK3399\_LINUX5.10\_SDK\_RELEASE\_V1.0.0\_20220920

Note:

- All English letters are capitalized
- Software platform: LINUX5.10
- The target market is enclosed in square brackets to indicate optional options. If it is a general SDK, this item is omitted.
- The version number of the SDK compressed package continues to retain 3 digits with two dots in the middle.

## 7.2 SDK Update Mechanism

### 7.2.1 SDK Update

If there is an update to the SDK, it will be updated around the 20th of each month, and an Change Notice will be sent out at the end of the month. The update mechanism is a one-month small update (such as V1.0.x), and the version has been fully tested by QA (such as V1.x.0).

### 7.2.2 SDK Release Patch

If any important issues are encountered when releasing the SDK, they will be pushed to customers in the form of the following patches:

[rockchip-patch](#)

## 7.3 How to Build Server to Sync the SDK

How to build a Gitolite server and use it for management and maintenance of SDK code. Please refer to the following documents for details.

<SDK>/docs/cn/Others/Rockchip\_Developer\_Guide\_Repo\_Mirror\_Server\_Deploy.pdf

## 8. Chapter-8 SDK Compilation Instructions

The SDK can be configured and compiled with `make` or `./build.sh` along with target parameters. For specific references, see the compilation instructions in `device/rockchip/common/README.md`.

To ensure SDK updates smoothly each time, it is recommended to clean previous compilation products before updating. This avoids potential compatibility issues or compilation errors, as old compilation products may not be suitable for the new version of the SDK. Run the following command to clean these compilation products:

```
./build.sh cleanall.
```

### 8.1 SDK Compilation Command

`make help`, for example:

```
$ make help
  menuconfig          - interactive curses-based configurator
  oldconfig           - resolve any unresolved symbols in .config
  synconfig           - Same as oldconfig, but quietly, additionally update
  deps               -
  olddefconfig        - Same as synconfig but sets new symbols to their
  default value       -
  savedefconfig       - Save current config to RK_DEFCONFIG (minimal config)
  ...
```

`make` is used to run `./build.sh`

That is, you can also run `./build.sh <target>` to build related functions. You can view the detailed compilation commands through `./build.sh help`.

```
$ ./build.sh -h
##### Rockchip Linux SDK #####

Manifest: rk3562_linux_release_v1.1.0_20231220.xml

Log colors: message notice warning error fatal

Usage: build.sh [OPTIONS]
Available options:
chip[:<chip>[:<config>]]      choose chip
defconfig[:<config>]         choose defconfig
config                       modify SDK defconfig
...
updateimg                   build update image
otapackage                  build A/B OTA update image
all                         build images
release                    release images and build info
save                       alias of release
all-release                build and release images
allsave                   alias of all-release
shell                     setup a shell for developing
```



|                            |                                  |
|----------------------------|----------------------------------|
| cleanall                   | cleanup                          |
| clean[:module[:module]]... | cleanup modules                  |
| post-rootfs <rootfs dir>   | trigger post-rootfs hook scripts |
| help                       | usage                            |

Default option is 'all'.

## 8.2 SDK Board Level Configuration

`make rockchip_defconfig`, the detailed board-level configuration instructions are as follows:

Enter the project `<SDK>/device/rockchip/<chipset_name>` directory:

| Board Level Configuration                | Description  |
|--|--|
| rockchip_rk3588_evb1_lp4_v10_defconfig   | Suitable for RK3588 EVB1 with LPDDR4 development board   |
| rockchip_rk3588_evb3_lp5_v10_defconfig   | Suitable for RK3588 EVB3 with LPDDR5 development board   |
| rockchip_rk3588_evb7_lp4_v10_defconfig   | Suitable for RK3588 EVB7 with LPDDR4 development board   |
| rockchip_rk3588s_evb1_lp4x_v10_defconfig | Suitable for RK3588S EVB1 with LPDDR4 development board  |
| rockchip_rk3562_evb1_lp4x_v10_defconfig  | Suitable for RK3562 EVB1 with LPDDR4 development board   |
| rockchip_rk3562_evb2_ddr4_v10_defconfig  | Suitable for RK3562 EVB2 with DDR4 development board   |
| rockchip_defconfig                       | The default configuration will be linked to the default board level configuration through <code>make lunch</code> or <code>./build.sh lunch</code> for configuration |
| Take RK3562 for example:                 |  |

```
$ ./build.sh lunch
```

You're building on Linux  
Lunch menu...pick a combo:

```
1. rockchip_defconfig
2. rockchip_rk3562_evb1_lp4x_v10_defconfig
3. rockchip_rk3562_evb2_ddr4_v10_defconfig
Which would you like? [1]:
```

The configuration of other functions can be configured through `make menuconfig` to configure related properties.

## 8.3 SDK Customization Configuration

The SDK can be configured through `make menuconfig`, with the main components currently available for configuration being:

```
(rk3562) SoC
  Rootfs --->
  Loader (u-boot) --->
  RTOS --->
  Kernel --->
  Boot --->
  Recovery (based on buildroot) --->
  PCBA test (based on buildroot) --->
  Security --->
  Extra partitions --->
  Firmware --->
  Update (Rockchip update image) --->
  Others configurations --->
```

- Rootfs: This represents the "Root File System". Here, you can choose different root file systems like Buildroot, Yocto, Debian, etc.
- Loader (u-boot): This is the boot loader configuration, usually u-boot, which initializes hardware and loads the main operating system.
- RTOS: Real-Time Operating System (RTOS) configuration options, suitable for applications requiring real-time performance.
- Kernel: Configure kernel options here, customizing a Linux kernel suitable for your hardware and application needs.
- Boot: Configure Boot partition support formats here.
- Recovery (based on buildroot): This is the configuration for the recovery environment based on buildroot, used for system recovery and upgrade.
- PCBA test (based on buildroot): This is a configuration for a PCBA (Printed Circuit Board Assembly) testing environment based on buildroot.
- Security: Indicates that certain security features will depend on the buildroot configuration chosen for Rootfs, mainly the Secureboot feature activation.
- Extra partitions: Used to configure additional partitions.
- Firmware: Configure firmware-related options here.
- Update (Rockchip update image): Used to configure options for Rockchip's complete firmware.
- Others configurations: Other additional configuration options.

The `make menuconfig` interface provides a text-based user interface to select and configure various options. Once configuration is complete, use the command `make savedefconfig` to save these settings, so that custom builds will be done based on these settings.

With the above configs, you can choose different Rootfs/Loader/Kernel configurations for various custom builds, allowing flexible selection and configuration of system components to meet specific needs.

## 8.4 SDK Environment Variable Configuration

Configurations for different chips and target functions can be set via `source envsetup.sh`.

```
$ source envsetup.sh
Top of tree: /home/wxt/linux-develop/rk3562
```

You're building on Linux

Pick a board:

1. rockchip\_px30\_32
  2. rockchip\_px30\_64
  3. rockchip\_px30\_recovery
  4. rockchip\_rk3036
  5. rockchip\_rk3036\_recovery
  6. rockchip\_rk3126c
  7. rockchip\_rk312x
  8. rockchip\_rk312x\_recovery
  9. rockchip\_rk3288
  10. rockchip\_rk3288\_recovery
  11. rockchip\_rk3308\_32\_release
  12. rockchip\_rk3308\_b\_32\_release
  13. rockchip\_rk3308\_b\_release
  14. rockchip\_rk3308\_bs\_32\_release
  15. rockchip\_rk3308\_bs\_release
  16. rockchip\_rk3308\_h\_32\_release
  17. rockchip\_rk3308\_recovery
  18. rockchip\_rk3308\_release
  19. rockchip\_rk3326\_64
  20. rockchip\_rk3326\_recovery
  21. rockchip\_rk3358\_32
  22. rockchip\_rk3358\_64
  23. rockchip\_rk3358\_recovery
  24. rockchip\_rk3399
  25. rockchip\_rk3399\_base
  26. rockchip\_rk3399\_recovery
  27. rockchip\_rk3399pro
  28. rockchip\_rk3399pro-multi-cam
  29. rockchip\_rk3399pro-npu
  30. rockchip\_rk3399pro-npu-multi-cam
  31. rockchip\_rk3399pro\_combine
  32. rockchip\_rk3399pro\_recovery
  33. rockchip\_rk3528
  34. rockchip\_rk3528\_recovery
  35. rockchip\_rk3562
  36. rockchip\_rk3562\_32
  37. rockchip\_rk3562\_recovery
  38. rockchip\_rk3566
  39. rockchip\_rk3566\_32
  40. rockchip\_rk3566\_recovery
  41. rockchip\_rk3566\_rk3568\_base
  42. rockchip\_rk3566\_rk3568\_ramboot
  43. rockchip\_rk3568
  44. rockchip\_rk3568\_32
  45. rockchip\_rk3568\_recovery
  46. rockchip\_rk3588
  47. rockchip\_rk3588\_base
  48. rockchip\_rk3588\_ramboot
  49. rockchip\_rk3588\_recovery
- Which would you like? [1]:

For example, select 35 `rockchip_rk3562`

Then go to the Buildroot directory of RK3562 and start compiling the relevant modules.

## 8.5 Fully Automatic Compilation

Enter the project root directory and execute the following command to automatically complete all compilation:

```
./build.sh all # Only build module code (u-Boot, kernel, Rootfs, Recovery)
               # Need to execute ./mkfirmware.sh again to package the firmware

./build.sh      # build module code (u-Boot, kernel, Rootfs, Recovery)
               # Package into update.img complete upgrade package
               #Copy and generate all compilation information to the out
directory
```

It is Buildroot by default, you can specify different rootfs by setting the environment variable `RK_ROOTFS_SYSTEM`, which can set three systems currently: Buildroot, Debian, and Yocto.

For example, if you need Debain, you can generate it with the following command:

```
export RK_ROOTFS_SYSTEM=debian
./build.sh
or
RK_ROOTFS_SYSTEM=debian ./build.sh
```

## 8.6 Build Modules

### 8.6.1 Build U-Boot

Enter the SDK project. Run the following command to build:

```
<SDK>#./build.sh uboot
```

For detailed board-level build, please refer to the build instructions in the SDK release document.

### 8.6.2 Build Kernel

Enter the root directory of the project directory and execute the following command to automatically build and package kernel.

```
<SDK>#./build.sh kernel
```

For detailed board-level compilation, please refer to the release notes or the compilation instructions in Quick Start.

### 8.6.3 Build Recovery

Enter the root directory of the project and execute the following command to automatically complete the compilation and packaging of Recovery.

```
<SDK>#./build.sh recovery
```

After compilation, a recovery.img is generated in the Buildroot directory

output/rockchip\_rk3562\_recovery/images.

Note: recovery.img includes Kernel, so every time Kernel changes, Recovery needs to be repackaged. The method for repackaging Recovery is as follows:

```
<SDK>#source buildroot/envsetup.sh
<SDK>#cd buildroot
<SDK>#make recovery-reconfigure
<SDK>#cd -
<SDK>#./build.sh recovery
```

Note: Recovery is not a mandatory feature, some board configurations might not set it

## 8.6.4 Build Buildroot

Enter the root directory of the project and execute the following command to automatically complete the compilation and packaging of Rootfs:

```
./build.sh rootfs
```

After compilation, different formats of images are generated in the Buildroot directory

output/rockchip\_rk3562/images, rootfs.ext4 format is used by default.

For more information, please refer to the Buildroot development document:

```
<SDK>/docs/cn/Linux/ApplicationNote/Rockchip_Developer_Guide_Buildroot_CN.pdf
```

## 8.6.5 Build Debian

```
./build.sh debian
```

After compilation, a linaro-rootfs.img is generated in the debian directory.

**Note: Related dependencies must be installed beforehand**

```
sudo apt-get install binfmt-support qemu-user-static live-build
sudo dpkg -i ubuntu-build-service/packages/*
sudo apt-get install -f
```

For more information, please refer to the Debian development document:

```
<SDK>/docs/cn/Linux/ApplicationNote/Rockchip_Developer_Guide_Debian_CN.pdf
```

## 8.6.6 Build Yocto

Enter the root directory of the project and execute the following command to automatically complete the compilation and packaging of Rootfs:

```
./build.sh yocto
```

After compilation, a rootfs.img is generated in the yocto directory build/latest.

The default login username is root. For more information on Yocto, please refer to [Rockchip Wiki](#).

FAQ:

- If you encounter the following issue during compilation:

```
Please use a locale setting which supports UTF-8 (such as LANG=en_US.UTF-8).
Python can't change the filesystem locale after loading so we need a UTF-8
when Python starts or things won't work.
```

Solution:

```
locale-gen en_US.UTF-8
export LANG=en_US.UTF-8 LANGUAGE=en_US.en LC_ALL=en_US.UTF-8
```

Or refer to [setup-locale-python3](#).

## 8.6.7 Cross-Compilation

### 8.6.7.1 SDK Directory Built-in Cross-Compilation

The SDK prebuilts directory built-in cross-compilation are as follows:

| Contents   | Description                     |
|--|---------------------------------|
| prebuilts/gcc/linux-x86/aarch64/gcc-arm-10.3-2021.07-x86_64-aarch64-none-linux-gnu | gcc arm 10.3.1 64-bit toolchain |
| prebuilts/gcc/linux-x86/arm/gcc-arm-10.3-2021.07-x86_64-arm-none-linux-gnueabi     | gcc arm 10.3.1 32-bit toolchain |

The toolchain can be downloaded from the following address:

[Click here](#)

### 8.6.7.2 Built-in Cross Compilation in Buildroot

Different chip and target feature configurations can be set via `source buildroot/envsetup.sh`

```
$ source buildroot/envsetup.sh
Top of tree: rk3562

You're building on Linux
Lunch menu...pick a combo:

44. rockchip_rk3562
45. rockchip_rk3562_32
46. rockchip_rk3562_dictpen
```

```
47. rockchip_rk3562_ramboot
48. rockchip_rk3562_recovery
49. rockchip_rk3562_robot
...

Which would you like? [1]:
```

Default choice is 44, `rockchip_rk3562`. Then, enter the RK3562 Buildroot directory to start compiling related modules.

`rockchip_rk3562_32` is for compiling a 32-bit Buildroot system, and `rockchip_rk3562_recovery` is used to compile the Recovery module.

For example, to compile the rockchip-test module, commonly used compilation commands are as follows:

Enter the buildroot directory

```
SDK#cd buildroot
```

- Delete and recompile rockchip-test

```
buildroot#make rockchip-test-recreate
```

- Recompile rockchip-test

```
buildroot#make rockchip-test-rebuild
```

- Delete rockchip-test

```
buildroot#make rockchip-test-dirclean
or
buildroot#rm -rf output/rockchip_rk3562/build/rockchip-test-master/
```

To compile an individual module or third-party application, a cross-compilation environment needs to be configured. For instance, for RK3562, its cross-compilation tools are located in `buildroot/output/rockchip_rk3562/host/usr`. You need to set the `bin/` directory of the tool and `aarch64-buildroot-linux-gnu/bin/` as environment variables and run the script for auto-configuring environment variables in the top-level directory:

```
source buildroot/envsetup.sh rockchip_rk3562
```

Enter the command to check,:

```
cd buildroot/output/rockchip_rk3562/host/usr/bin
./aarch64-linux-gcc --version
```

The following information will be printed:

```
aarch64-linux-gcc.br_real (Buildroot) 12.3.0
```

```
Save to the rootfs configuration file
buildroot$ make update-defconfig
```

## 9. Chapter-9 SDK Firmware Upgrade

This chapter mainly introduces the process of building a complete image file (image), burning it and running it on a hardware device.

The introduction of several image burning tools provided by Rockchip platform is as follows. You can choose the appropriate burning method for burning. Before burning, you need to install the latest USB driver. For details, please see [Rockchip USB Driver Installation](#).

| Tools              | Run System | Description  |
|--------------------|------------|--|
| RKDevTool          | Windows    | Rockchip development tools, discrete firmware upgrade and entire update firmware upgrade tools |
| FactoryTool        | Windows    | Mass production upgrade tool, supports USB one-to-multiple burning                             |
| Linux_Upgrade_Tool | Linux      | A tool developed under Linux to support firmware upgrades                                      |

### 9.1 Burning Mode Introduction

The several modes of Rockchip platform hardware operation are as shown in the following table. Firmware can only be burned or updated on the board when the device is in Maskrom or Loader mode.

| Mode        | Tool Burn     | Description  |
|-------------|---------------|--|
| Maskrom     | Support       | When firmware is not yet burned into the Flash, the Chip will enter Maskrom mode, allowing the initial firmware burning. During the development and debugging process, if Loader fails to start normally, firmware can also be burned in Maskrom mode. |
| Loader      | Support       | In Loader mode, firmware can be burned and upgraded. You can use tools to burn a certain partition image file separately to facilitate debugging.  |
| Recovery    | Not supported | System boot recovery starts, its main function is to upgrade and restore factory settings.   |
| Normal Boot | Not supported | System boot rootfs starts, loads rootfs, most development is debugged in this mode.  |

There are several ways to enter the burning mode:

- The board has not been burned with firmware. Power on and enter Maskrom mode.
- The board has been burned with firmware, press and hold the recovery button to power on or reset, and the system will enter the Loader firmware burning mode.
- The board has been burned with firmware, press and hold the Maskrom button to power on or reset, and the system will enter the MaskRom firmware burning mode.



- The board has been burned with firmware, and the board enters the system normally after powering on or resetting, Rockchip's development tool displays "An ADB device was found" or "An MSC device was found", and then click the "Switch" button on the tool to enter Loader mode.
- The board has been burned with firmware, you can enter `reboot loader` command in the serial port or ADB command line mode to enter the Loader mode.

### 9.1.1 Windows Flashing Instructions

Rockchip's SDK provides a Windows burning tool (the tool version requires V3.15 or above). The tool is located in the project root directory:

```
tools/
└─ windows/RKDevTool
```

As shown in the figure below, after compiling and generating the corresponding firmware, the device needs to enter the MASKROM or BootROM burning mode.

After connecting the USB download cable, press and hold the "MASKROM" button and press the reset button "RST" and then release it to enter MASKROM mode, after loading the corresponding path of the compiled and generated firmware, click "Execute" to burn. You can also press and hold the "recovery" button and press the reset button "RST" and then release it to enter the loader mode for burning. The following is the partition offset and burning file in the MASKROM mode . (Note: Windows PC requires administrator rights to run the tool before it can be executed)

Note: Before burning, you need to install the latest USB driver. For driver details, please see:

```
<SDK>/tools/windows/DriverAssitant_v5.12.zip
```

### 9.1.2 Linux Flashing Instructions

The Linux burning tool is located in the tools/linux directory (Linux\_Upgrade\_Tool tool version requires V2.17 or above), please make sure your board is connected to MASKROM/loader rockusb. For example, if the generated firmware is in the rockdev directory, the upgrade command is as follows:

```
sudo ./upgrade_tool ul rockdev/MiniLoaderAll.bin -noreset
sudo ./upgrade_tool di -p rockdev/parameter.txt
sudo ./upgrade_tool di -u rockdev/uboot.img
sudo ./upgrade_tool di -trust rockdev/trust.img ##For new chips, trust has been
merged into the uboot partition
sudo ./upgrade_tool di -misc rockdev/misc.img
sudo ./upgrade_tool di -b rockdev/boot.img
sudo ./upgrade_tool di -recovery rockdev/recovery.img
sudo ./upgrade_tool di -oem rockdev/oem.img
sudo ./upgrade_tool di -rootfs rockdev/rootfs.img
sudo ./upgrade_tool di -userdata rockdev/userdata.img
sudo ./upgrade_tool rd
```

Or upgrade the packaged complete firmware:

```
sudo ./upgrade_tool uf rockdev/update.img
```

Or in the root directory, run the following command to upgrade when the device is in MASKROM mode:

```
./rkflash.sh
```

### 9.1.3 System Partition Introduction

Default partition description is showed as follows: (below is the RK3562 EVB partition reference)

| Number | Start (sector) | End (sector) | Size  | Name     |
|--------|----------------|--------------|-------|----------|
| 1      | 16384          | 24575        | 4M    | uboot    |
| 2      | 24576          | 32767        | 4M    | misc     |
| 3      | 32768          | 163839       | 64M   | boot     |
| 4      | 163840         | 294911       | 32M   | recovery |
| 5      | 294912         | 360447       | 32M   | bakcup   |
| 6      | 360448         | 12943359     | 6144M | rootfs   |
| 7      | 12943360       | 12943359     | 128M  | oem      |
| 8      | 13205504       | 61120478     | 22.8G | userdata |

- uboot partition: uboot.img compiled by uboot.
- misc partition: for misc.img, used by recovery.
- boot partition: boot.img compiled by kernel.
- recovery partition: recovery.img compiled by recovery.
- backup partition: reserved, temporarily unused.
- rootfs partition: rootfs.img compiled by Buildroot, Debian or Yocto.
- oem partition: used by manufacturers to store their APP or data. Mounted in the /oem directory.
- userdata partition: used for APP to temporarily generate files or for end users, mounted in the /userdata directory.

## 10. Chapter-10 SDK Development

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This chapter mainly introduces the development of some core modules in SDK development, such as U-Boot, Kernel, Recovery, Buildroot, Debian, Yocto, Multivideo, Graphics

### 10.1 U-Boot Development

This section briefly introduces the basic concepts of U-Boot and compilation precautions to help customers understand the U-Boot framework of the RK platform. For detailed U-Boot development details, please refer to the document `Rockchip-Developer-Guide-UBoot-*.pdf` in the `<SDK>/docs/cn/Common/U-Boot` directory.

#### 10.1.1 U-Boot Introduction

The v2017 (next-dev) is a version developed by Rockchip from the official v2017.09 official version of U-Boot. It currently supports all mainstream chips on sale in Rockchip. The supported functions mainly include:

- Support RK Android firmware booting;
- Support Android AOSP firmware booting;
- Support Linux Distro firmware booting;
- Supports Rockchip miniloader and SPL/TPL pre-loader boot;
- Supports LVDS, EDP, MIPI, HDMI, CVBS, RGB and other display devices;
- Supports booting from storage devices such as eMMC, Nand Flash, SPI Nand Flash, SPI NOR Flash, SD card, U disk, etc.;
- Support FAT, EXT2, EXT4 file systems;
- Support GPT, Rockchip parameter partition table;
- Supports boot LOGO, charging animation, low battery management, and power management;
- Supports I2C, PMIC, CHARGE, FUEL GUAGE, USB, GPIO, PWM, GMAC, eMMC, NAND, Interrupt, etc.;
- Support Vendor storage to save user data and configuration;
- Supports RockUSB and Google Fastboot USB gadgets to burn eMMC;
- Supports USB devices such as Mass storage, ethernet, HID, etc.;
- Support dynamic selection of kernel DTB based on hardware status;

#### 10.1.2 Version

There are two versions of RK U-Boot: the old version v2014 and the new version v2017. The internal names are rkdevelop and next-dev respectively. Users have two ways to confirm whether the current U-Boot is version v2017.

Method 1: Confirm whether the version number of Makefile in the root directory is 2017.

```
#
### Chapter-1 SPDX-License-Identifier:      GPL-2.0+
#

VERSION = 2017
PATCHLEVEL = 09
SUBLEVEL =
EXTRAVERSION =
NAME =
.....
```

Method 2: Confirm whether the first line officially printed on boot is U-Boot 2017.09.

```
U-Boot 2017.09-01818-g11818ff-dirty (Nov 14 2019 - 11:11:47 +0800)
.....
```

Open source project : v2017 has been open source and regularly updated to Github: <https://github.com/rockchip-linux/u-boot>

Kernel version: v2017 requires RK kernel version >= 4.4

### 10.1.3 Preparation in Advance

- Download rabin

This is a toolkit repository used to store bins, scripts, and packaging tools of RK that are not open source. When U-Boot is compiled, it will index relevant files from this repository and package them to generate loader, trust, and uboot firmware. The rabin and U-Boot projects should keep in the a same level of directory.

Repository downloading: please refer to the appendix chapter.

- Download GCC

The GCC compiler uses gcc-linaro-6.3.1 and is placed in the prebuilts directory. prebuilts and U-Boot should keep in the a same level of directory. as follows:

```
// 32 bit:
prebuilts/gcc/linux-x86/arm/gcc-linaro-6.3.1-2017.05-x86_64_arm-linux-
gnueabihf
// 64 bit:
prebuilts/gcc/linux-x86/aarch64/gcc-linaro-6.3.1-2017.05-x86_64_aarch64-
linux-gnu/
```

GCC downloading: please refer to the appendix chapter

- Select defconfig

Defconfig support status of each platform (subject to release SDK):

"[Chip]\_defconfig" or "[Chip].config" are usually full-featured versions, and the rest are Version of specific features.

| Chip          | defconfig   | Supported kernel dtb | Description   |
|---------------|---|----------------------|---|
| RK1808        | rk1808_defconfig  | Y                    | General version   |
| RK1806        | rk1806_defconfig  | Y                    | General version   |
| RK3036        | rk3036_defconfig  | Y                    | General version   |
| RK3128x       | rk3128x_defconfig   | Y                    | General version   |
| RK3126        | rk3126_defconfig  | Y                    | General version   |
| RK322x        | rk322x_defconfig  | Y                    | General version   |
| RK3288        | rk3288_defconfig  | Y                    | General version   |
| RK3368        | rk3368_defconfig  | Y                    | General version   |
| RK3328        | rk3328_defconfig  | Y                    | General version   |
| RK3399        | rk3399_defconfig  | Y                    | General version   |
| RK3399Pro     | rk3399pro_defconfig   | Y                    | General version   |
| RK3399Pro-npu | rknpu-lion_defconfig  | Y                    | General version   |
| RK3308        | rk3308_defconfig<br>rk3308-aarch32_defconfig  | Y                    | General version<br>Support aarch32 mode   |
| PX30          | px30_defconfig  | Y                    | General version   |
| RK3326        | rk3326_defconfig<br>rk3326-aarch32_defconfig  | Y                    | General version<br>Support aarch32 mode   |
| RK3568        | rk3568_defconfig<br>rk3568-dfu.config<br>rk3568-nand.config<br>rk3568-spl-spi-nand_defconfig<br>rk3568-aarch32.config<br>rk3568-usbplug. config |                      |   |
| RK3566        | rk3566.config<br>rk3566-eink.config   | Y                    | General version<br>E-book version   |
| RK3588        | rk3588_defconfig<br>rk3588-ramboot.config<br>rk3588-sata.config<br>rk3588-aarch32.config<br>rk3588-ipc.config                                   | Y                    | General version<br>None Storage device (memory boot)<br>Dual storage supports sata boot<br>Supports aarch32 mode<br>Used in ipc sdk |
| RK3528        | rk3528_defconfig  | Y                    | General version   |
| RK3562        | rk3562_defconfig  | Y                    | General version   |

Note: If the table is different from the defconfig released by the SDK, please refer to the SDK.

### 10.1.4 Start the process

The U-Boot startup process of the RK platform is as follows, below are only some important steps listed:

```
start.s
    // Assembly environment
    => IRQ/FIQ/lowlevel/vbar/errata/cp15/gic    // ARM architecture related
lowlevel initialization
    => _main
        => stack                                // Prepare the stack required for
the C environment
        // 【Phase 1】 C environment initialization, initiating a series of
function calls
        => board_init_f: init_sequence_f[]
            initf_malloc
            arch_cpu_init                        // 【SoC lowlevel initialization】
            serial_init                          // Serial port initialization
            dram_init                            // 【Get ddr capacity information】
            reserve_mmu                          // Reserve memory from the end of
ddr to lower addresses
            reserve_video
            reserve_uboot
            reserve_malloc
            reserve_global_data
            reserve_fdt
            reserve_stacks
            dram_init_banksize
            system_init
            setup_reloc                          // Determine the address to be
relocated by U-Boot itself
            // Assembly environment
            => relocate_code                      // Implements U-Boot code
relocation by assembly
            // 【Phase 2】 C environment is initialized and a series of function calls
are initiated.
            => board_init_r: init_sequence_r[]
                intr_caches                      // Enable MMU and I/Dcache
                intr_malloc
                bidram_initr
                system_initr
                intr_of_live                      // Initialize of_live
                intr_dm                          // Initialize dm framework
                board_init                       // 【Platform initialization, this
is the core part】
                    board_debug_uart_init        // Serial port iomux, clk
configuration
                    init_kernel_dtb              // 【switch to kernel dtb】 !
                    clks_probe                   // Initialize system frequency
                    regulators_enable_boot_on    // Initialize system power
                    io_domain_init              // Initialize io-domain
                    set_armclk_rate             // __weak, ARM frequency increase
(implemented only when the platform requires it)
                    dvfs_init                   // Frequency and voltage
regulation of wide temperature chip
```

```

rk_board_init // __weak, implemented by each
chip platform
    console_init_r
    board_late_init // 【Initialize Platform late】
    rockchip_set_ethaddr // Set mac address
    rockchip_set_serialno // Set serialno
    setup_boot_mode // Parse "reboot xxx" command,
                    // Identify buttons and loader
burning mode, recovery
    charge_display // U-Boot charging
    rockchip_show_logo // Show boot logo
    soc_clk_dump // print clk tree
    rk_board_late_init // __weak, implemented by each
chip platform
    run_main_loop // 【Enter command line mode, or
execute the boot command】

```

### 10.1.5 Shortcut Keys

RK platform provides serial port key combinations to trigger some events for debugging and burning (if it cannot be triggered, please try a few more times; it will not work when secure-boot is enabled). **Long press when powering on:**

- ctrl+c: Enter U-Boot command line mode;
- ctrl+d: Enter loader burning mode;
- ctrl+b: Enter maskrom burning mode;
- ctrl+f: enter fastboot mode;
- ctrl+m: print bidram/system information;
- ctrl+i: enable kernel initcall\_debug;
- ctrl+p: print cmdline information;
- ctrl+s: after "Starting kernel...", enter the U-Boot command line;

## 10.2 Kernel Development

This section briefly introduces some common configuration modifications of the kernel, mainly the configuration of DTS, to help customers make some simple modifications faster and more conveniently. The Kernel version is based on 4.4 and will be introduced accordingly.

### 10.2.1 DTS Introduction

#### 10.2.1.1 DTS Overview

Device Tree Source (DTS) files are a data structure used to describe hardware devices, defining and configuring hardware devices in the Linux kernel. These files utilize a text-like format, representing hardware devices and their relationships through a hierarchical structure and attribute descriptions.

Device Tree Source files are built into Device Tree Blob (DTB) files, which the kernel loads and parses during startup. The kernel extracts hardware device information from these files for initialization and configuration.

The introduction of Device Tree addresses solves the inflexibility and maintainability issues of traditional "hard-coded" methods when dealing with different hardware configurations. By abstracting hardware descriptions and configurations, the kernel can adapt to various hardware platforms without modifying the kernel code. In this way, the same kernel can run on multiple different hardware devices, requiring only the loading of the appropriate device tree.

This chapter aims to introduce how to add a new board DTS configuration and provides some common syntax introduction. For more detailed information about DTS, please refer to [devicetree-specifications](#) and [devicetree-bindings](#).

### 10.2.1.2 Add a DTS of a new product

- Create dts file

Currently, Linux Kernel supports using dts on multiple platforms. The dts files of RK platform are stored in:

```
ARM:arch/arm/boot/dts/  
ARM64:arch/arm64/boot/dts/rockchip
```

The general naming rule for dts files is "soc-board-name.dts", such as rk3399-evb-ind-lpddr4-linux.dts. soc refers to the chip model, and board\_name is usually named according to the silk of the board. If your board is an integrated board, you only need a dts file to describe it.

If the hardware is designed with a core board and base board, or the product has multiple product forms, you can put the common hardware description in the dtsi file, the dts file describes different hardware modules, and includes common hardware descriptions through include "xxx.dtsi".

```
|—rk3399-evb-ind-lpddr4-linux.dts  
| |— rk3399-evb-ind.dtsi  
| |— rk3399-linux.dtsi
```

- Modify the Makefile in the directory where dts is located

```
--- a/arch/arm64/boot/dts/rockchip/Makefile  
+++ b/arch/arm64/boot/dts/rockchip/Makefile  
@@ -50,6 +50,7 @@ dtb-$(CONFIG_ARCH_ROCKCHIP) += rk3368-tablet.dtb  
dtb-$(CONFIG_ARCH_ROCKCHIP) += rk3399-evb.dtb  
dtb-$(CONFIG_ARCH_ROCKCHIP) += rk3399-evb-ind-lpddr4-android.dtb  
dtb-$(CONFIG_ARCH_ROCKCHIP) += rk3399-evb-ind-lpddr4-android-avb.dtb  
+dtb-$(CONFIG_ARCH_ROCKCHIP) += rk3399-evb-ind-lpddr4-linux.dtb
```

When building Kenrel, you can directly `make dts-name.img` (such as rk3399-evb-ind-lpddr4-linux.img) to generate the corresponding boot.img (including dtb data).

- Several description on dts syntax

The dts syntax just like c/c++, by `#include xxx.dtsi` to include other public dts data. The dts file will inherit all the device nodes' properties and values included in the dtsi files. If a property is defined in multiple dts/dtsi files, its value is ultimately the definition of dts. All controller nodes related to the chip will be defined in soc.dtsi. If you need to enable the device function, you need to set its status to "okay" in the dts file. To shut down the device, you need to set its status to "disabled" in the dts file.

```
/dts-v1/;
```



```
#include "rk3399-evb-ind.dtsi"
#include "rk3399-linux.dtsi"
...
&i2s2 {
    #sound-dai-cells = <0>;
    status = "okay";
};

&hdmi_sound {
    status = "okay";
};
```

## 10.2.2 Kernel Module Development Documentation

The corresponding development documents are released for functional modules under the

<SDK>/docs/cn/Common/ directory. This section mainly make a summary index of these development documents. Based on the issues encountered in actual development, refer to the following table to read and learn the corresponding development guide. It can be obtained under docs/cn/Common and will be continuously improved and updated. For more details, please refer to [Documentation Description](#).

## 10.2.3 GPIO

For example, RK3399/RK3399Pro provides 5 groups of GPIOs (GPIO0~GPIO4), a total of 122. All GPIOs can be used as interrupts. GPIO0/GPIO1 can be used as system wake-up pins. All GPIOs can be configured as pull-up or pull-down by software. All GPIOs are default for input, GPIO drive capabilities are software configurable. About the correspondence relationship between the GPIO on the schematic diagram and the GPIO in the dts, for example, GPIO4C0, then the corresponding dts should be "gpio4 16". Because GPIO4A has 8 pins and GPIO4B also has 8 pins, so the c0 port is 16, the c1 port is 17, and so on; for the use of GPIO, please refer to

<SDK>/docs/cn/Common/PinCtrl/ Rockchip\_Developer\_Guide\_Linux\_Pinctrl\_CN.pdf for details.

## 10.2.4 CPU, GPU, DDR Frequency Modification

Dynamic Voltage and Frequency Scaling(DVFS) is a real-time voltage and frequency adjustment technology. Currently, the modules supporting DVFS in the 4.4 kernel include CPU, GPU, and DDR. CPUFreq is a set of framework models defined by kernel developers that support dynamic scaling of CPU frequency and voltage. It can effectively reduce CPU power consumption while taking into account CPU performance. CPUFreq selects a suitable frequency for CPU to use through different frequency conversion strategies. The current kernel version provides the following strategies:

- interactive: Dynamically adjust frequency and voltage according to CPU load;
- conservative: Conservative strategy, adjust frequency and voltage step by step;
- ondemand: Dynamic frequency and voltage adjustment based on CPU load, slower response than interactive strategy;
- userspace: User set the voltage and frequency by himself, and the system will not automatically adjust;
- powersave: power consumption priority and always set the frequency to the lowest value;
- performance: Performance priority, always set the frequency to the highest value;

For detailed module functions and configuration, please refer to the documents in the `<SDK>/docs/cn/Common/DVFS/` directory. ARM/GPU/DDR have corresponding debugging interfaces respectively, which can be operated through ADB commands. The corresponding interface directories are as follows:

```
CPU small core: /sys/devices/system/cpu/cpu0/cpufreq/
CPU big: /sys/devices/system/cpu/cpu4/cpufreq/
GPU: /sys/class/devfreq/ff9a0000.gpu/
DDR: /sys/class/devfreq/dmc/
```

There are nodes similar to the following in these directories:

- `available_frequencies`: displays supported frequencies
- `available_governors`: displays supported frequency conversion strategies
- `cur_freq`: displays the current frequency
- `governor`: displays the current frequency conversion strategy
- `max_freq`: Displays the current highest running frequency
- `min_freq`: Displays the current lowest running frequency

Taking RK3399/RK3399pro GPU as an example to perform fixed frequency operation, the process is as follows:

Check which frequencies are supported:

```
cat /sys/class/devfreq/ff9a0000.gpu/available_frequencies
```

Switch frequency conversion strategy:

```
echo userspace > /sys/class/devfreq/ff9a0000.gpu/governor
```

Fixed frequency:

```
echo 400000000 > /sys/class/devfreq/ff9a0000.gpu/userspace/set_freq
cat /sys/class/devfreq/ff9a0000.gpu/cur_freq
```

## 10.2.5 Temperature Control Configuration

There are temperature control sensors in the ARM core and GPU core of RK3399/RK3399Pro chips respectively, which can monitor the temperature of CPU and GPU in real time, and control the frequencies of CPU and GPU through algorithms to control the temperatures of CPU and GPU. The heat dissipation conditions corresponding to different hardware designs and molds of each product are also different. The temperature control parameters can be appropriately adjusted through the following configuration in dts to adapt to the product.

Set the temperature at which the temperature control is turned on:

```
&threshold {
    temperature = ; /* millicelsius */
};
```

Set the upper limit of temperature control

```
&target {
    temperature = ; /* millicelsius */
};
```

Set software shutdown temperature:

```
&soc_crit {
    temperature = ; /* millicelsius */
};
```

Configure hardware shutdown temperature:

```
&tsadc {
    rockchip,hw-tshut-mode = ; /* tshut mode 0:CRU 1:GPIO */
    rockchip,hw-tshut-polarity = ; /* tshut polarity 0:LOW 1:HIGh */
    rockchip,hw-tshut-temp = ;
    status = "okay";
};
```

For detailed instructions on temperature control, please refer to the relevant documents in the `<SDK>/docs/cn/Common/THERMAL` directory.

## 10.2.6 LPDDR4 Configuration

For DDR configuration instructions, please refer to the relevant documents in the `<SDK>/docs/cn/Common/DDR` directory.

For the dts configuration of RK3399Pro using LPDDR4, please refer to the file:

`arch/arm64/boot/dts/rockchip/rk3399pro-evb-lp4-v11-avb.dts`. Just copy the following 3 nodes in the file to the corresponding product dts:

```
&dfi {
    status = "okay";
};
&dmc {
    status = "okay";
    center-supply = <vdd_center>; //Customers need to configure according to the
    actual hardware circuit here
    upthreshold = <40>;
    downdifferential = <20>;
    system-status-freq = <
        /*system status freq(KHz)*/
        SYS_STATUS_NORMAL 856000
        SYS_STATUS_REBOOT 416000
        SYS_STATUS_SUSPEND 416000
        SYS_STATUS_VIDEO_1080P 416000
        SYS_STATUS_VIDEO_4K 856000
        SYS_STATUS_VIDEO_4K_10B 856000
        SYS_STATUS_PERFORMANCE 856000
        SYS_STATUS_BOOST 856000
        SYS_STATUS_DUALVIEW 856000
        SYS_STATUS_ISP 856000
    >;
```

```

vop-pn-msch-readlatency = <
    /* plane_number readlatency */
    0 0
    4 0x20
>;
vop-bw-dmc-freq = <
    /* min_bw(MB/s) max_bw(MB/s) freq(KHz) */
    763 1893 416000
    3013 99999 856000 \
>;
auto-min-freq = <0>;
};

&dmc_opp_table {
    compatible = "operating-points-v2";
    opp-2000000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000> ;
        status = "disabled";
    };
    opp-3000000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000> ;
        status = "disabled";
    };
    opp-4000000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000> ;
        status = "disabled";
    };
    opp-4160000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000> ;
    };
    opp-5280000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000> ;
        status = "disabled";
    };
    opp-6000000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000>;
        status = "disabled";
    };
    opp-8000000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000>;
        status = "disabled";
    };
    opp-8560000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000>;
    };
    opp-9280000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000>;
        status = "disabled";
    };
};

```

```

    opp-1056000000 {
        opp-hz = /bits/ 64 ;
        opp-microvolt = <900000>;
        status = "disabled";
    };
};

```

What needs to be noted here is:

For LPDDR4, only the two frequencies: 416M and 856M are supported. Other frequencies have been disabled, so if customers want to use the same dts to support LPDDR4 and other types of DDR will only be able to support 416M and 856M frequencies. At this time please be sure to configure the DDR frequency conversion function to be enabled by default. The frequency conversion function of LPDDR4 limits the number of sound cards for the following reasons:

- If LPDDR4 requires frequency conversion function, the audio buffer needs to be moved to sram. The sram memory of RK3399Pro is limited, and the available memory is 128k. Currently, the memory pre-allocated to a single audio stream is 32k, so the maximum number of sound cards supported by the system is only 2 (32k/2, each sound card includes playback and recording). More sound cards cannot be created successfully unless the pre-allocated memory size for a single audio stream is reduced. but this also relatively reduces the maximum buffer size supported underlying. If the user layer uses a sound card and wants to set a larger buffer, it will be limited. Please note that USB sound cards are not within the restriction because they do not use dma. In other words, you can have 2 sound cards (including sound cards with HDMI, spdif, i2s and other interfaces) and multiple USB sound cards.
- If LPDDR4 frequency conversion is required, the audio buffer needs to be moved to sram. At this time, the system can only support up to 2 sound cards.

Please configure as follows:

Add sram node in dts

```

/* first 64k(0xff8c0000~0xff8d0000) for ddr and suspend */
iram: sram@ff8d0000 {
    compatible = "mmio-sram";
    reg = ; /* 128k */
};

```

Reference the iram node in the corresponding product dts.

```

&dmac_bus {
    iram = <&iram>;
    rockchip,force-iram;
};

```

- If you do not need LPDDR4 frequency conversion, since LPDDR4 frequency conversion is limited to 2 sound cards, if you need more than 3 sound cards, you need to turn off LPDDR4 frequency conversion, that is, disable the dmc node in the dts of the corresponding product, as shown below:

```

&dmc {
    status = "disabled";
    ...
};

```

In addition, you need to make sure that the following two configurations in the kernel are deleted:

Delete the following configuration in dts:

```
/* first 64k(0xff8c0000~0xff8d0000) for ddr and suspend */
iram: sram@ff8d0000 {
    compatible = "mmio-sram";
    reg = ; /* 128k */
};

&dmac_bus {
    iram = <&iram>;
    rockchip,force-iram;
};
```

## 10.2.7 SD Card Configuration

For detailed instructions on SD Card configuration, please refer to the relevant documents in the `<SDK>/docs/cn/Common/MMC` directory.

The UART debug of some chips such as RK3326/RK3399PRO is multiplexed with SD Card. The default configuration is to turn on debug. If you want to use SD Card, the following configuration is needed:

```
&fiq_debugger {
    status = "disabled";
    pinctrl-0 = <&uart2a_xfer>;
};

&sdmmc {
    ...
    sd-uhs-sdr104;
    status = "okay";
};
```

## 10.3 Recovery Development

### 10.3.1 Introduction

The development of Recovery mechanism is similar to the development of Android's Recovery function. The main function is to erase user data and upgrade system.

Recovery mode in Linux is to add an additional Recovery partition on the device. This partition is composed of kernel+resource+ramdisk and is mainly used for upgrade operations. u-boot will determine whether the system to be booted is a Normal system or a Recovery system based on the fields stored in the misc partition. Due to the independence of the system, Recovery mode can ensure the integrity of the upgrade. That is, if the upgrade process is interrupted, such as an abnormal power off, the upgrade can still continue.

### 10.3.2 Debug

A common debugging method is to enable debug

Create a hidden file `.rkdebug` in the `buildroot/output/rockchip_xxx_recovery/target` directory,

```
touch .rkdebug
```

The log upgraded in Recovery mode is printed on the serial port. Another way is to check the userdata/recovery/Log file

For more Recovery development information, please refer to the documentation :

```
<SDK>/docs/cn/Linux/Recovery/Rockchip_Developer_Guide_Linux_Recovery_CN.pdf
```

## 10.4 Buildroot Development

Buildroot is a tool that uses cross-compilation to build a complete Linux system for embedded systems. The operation is simple and automatic.

Based on the native Buildroot, Rockchip has integrated BSP configuration of relevant chips, the configuration of the acceleration functions of each hardware module, and the in-depth customization development of third-party packages to facilitate customers to deeply customize and secondary develop products.

For more Buildroot development information, please refer to the documentation :

```
<SDK>/docs/cn/Linux/System/Rockchip_Developer_Guide_Buildroot_CN.pdf
```

## 10.5 Debian Development

Rockchip provides support for Debian 10/11 based on X11 display architecture and is based on the Linaro version. The support also includes graphics and video acceleration functions. Related software packages include libmali, xserver, gstreamer rockchip, etc. These software packages can be built by setting up an environment in Docker, and the generated deb packages are stored in the `<SDK>/debian/packages/*` directory.

For detailed steps on how to use Docker to build the deb packages, please refer to the documentation:

```
<SDK>/docs/cn/Linux/Docker/Rockchip_Developer_Guide_Debian_Docker_CN.pdf
```

Debian development documentation reference:

```
<SDK>/docs/cn/Linux/System/Rockchip_Developer_Guide_Debian_CN.pdf
```

## 10.6 Yocto Development

For more information, please refer to: <http://opensource.rock-chips.com/wiki/Yocto>

## 10.7 Audio Development

### 10.7.1 Kernel Audio Driver Development

The kernel driver uses `soc/rockchip/rockchip_multicodecs.c` instead of `soc/generic/simple-card.c`, In other words, the kernel-driven simple card is just a sample and cannot meet the requirement of some complex products.

The difference between rockchip\_multicodecs driver and simple-card is as follows:

- Mainly compatible with one sound card and one or more codec support.
- Headphones and other tests support adc. Currently, gpio is commonly used in simple-card.
- The i2stdm controller is divided into tx/rx, multicodecs supports tx/rx independently, and adding it to simple-card will affect third parties.

## 10.7.2 Audio Pulseaudio Channel Adaptation

Audio uses pulseaudio by default. Normally, you only need to configure `/etc/pulse/default.pa`

For example, the two Codecs of ES8388 and RK809 is adapted in RK3588.

```
+set-default-source alsa_input.platform-es8388-
sound.HiFi__hw_rockchipes8388__source
+set-default-sink alsa_output.platform-es8388-sound.HiFi__hw_rockchipes8388__sink
+set-default-source alsa_input.platform-rk809-
sound.HiFi__hw_rockchiprk809__source
+set-default-sink alsa_output.platform-rk809-sound.HiFi__hw_rockchiprk809__sink
```

If you need to add more Codec support, obtain relevant information through the following command:

```
pactl list sinks short
pactl list sources short
```

For more reference, please refer to Debian official [Pulseaudio](#) and

`<SDK>/docs/Common/AUDIO/Rockchip_Developer_Guide_PulseAudio_CN.pdf`

## 10.8 Multimedia Development

GStreamer or rockit is used to develop multimedia on the rockchip platform.

```
vpu_service --> mpp --> gstreamer/rockit --> app
```

vpu\_service: driver

mpp: Video encoding and decoding middleware for the rockchip platform. For related instructions, please refer to the mpp document.

gstreamer/rockit: components for docking apps

Currently, the complete solution provided by Rockchip Linux Universal SDK is based on GStreamer. The advantage of using GStreamer is that it can more conveniently complete applications such as players and encoders based on pipelines. If you need customized development based on rockit, please refer to the relevant release documents of rockit.

Reference documents:

```
<SDK>/docs/cn/Linux/Multimedia
├─ Rockchip_Developer_Guide_Linux_RKADK_CN.pdf
├─ Rockchip_User_Guide_Linux_Gstreamer_CN.pdf
└─ Rockchip_User_Guide_Linux_Rockit_CN.pdf
```



## 10.9 Graphics Development

Graphics of Rockchip Linux Platform is an ARM Linux platform that utilizes DRM and DMA BUF. The advantage is that with a universal architecture, customized development based on this architecture is easier, and many existing components can be utilized. The development of many existing open source projects has started to use the Rockchip platform as an adaptation platform for ARM. But the disadvantage is that many people do not fully understand these contents, and practical application requires a learning process. For more information, please refer to the [Rockchip wiki](#) and the following documents.

```
<SDK>/docs/cn/Linux/Graphics/  
├─ Rockchip_Developer_Guide_Buildroot_Weston_CN.pdf  
├─ Rockchip_Developer_Guide_Linux_Graphics_CN.pdf
```

## 10.10 Application Development

Commonly used applications of SDK include Weston, EFL, ROS and other application development. Please refer to the documents in the /docs/cn/Linux/Graphics/ApplicationNote directory.

## 10.11 Security Mechanism Development

Please refer to the documentation in the `<SDK>/docs/cn/Linux/Security` directory

## 10.12 Secureboot

Secureboot is not enabled by default. If verification is required, the steps are as follows:

### 10.12.1 Enables Security Configuration in the SDK

```
$make menuconfig  
Enable Security ---> [*] security feature
```

### 10.12.2 Saves Security Configuration in the SDK

```
$ make savedefconfig
```

Take RK3568 as an example:

```
-- a/.chips/rk3566_rk3568/rockchip_rk3568_evb1_ddr4_v10_defconfig  
+++ b/.chips/rk3566_rk3568/rockchip_rk3568_evb1_ddr4_v10_defconfig  
@@ -3,3 +3,4 @@ RK_KERNEL_DTS_NAME="rk3568-evb1-ddr4-v10-linux"  
RK_USE_FIT_IMG=y  
RK_WIFIBT_TTY="ttyS8"  
RK_PARAMETER="parameter-buildroot-fit.txt"  
+RK_SECURITY=y
```

## 10.12.3 Build Secureboot

- Directly run `./build.sh` and follow the compilation error instructions and operate step by step:

\$ `./build.sh`

```
ERROR: No root keys(u-boot/keys) found in u-boot
      Create it by ./build.sh createkeys or move your key to it
```

```
$ ./build.sh createkeys
```

```
$ ./build.sh
```

```
=====
ERROR: No root passwd(u-boot/keys/root_passwd) found in u-boot
      echo your root key for sudo to u-boot/keys/root_passwd
```

```
Write your PC root password into `u-boot/keys/root_passwd`
```

```
$ ./build.sh
Security: No found config CONFIG_BLK_DEV_DM in
kernel/arch/arm64/configs/rockchip_linux_defconfig
make sure your config include this list
```

```
-----
CONFIG_BLK_DEV_DM
CONFIG_DM_CRYPT
CONFIG_BLK_DEV_CRYPTOLLOOP
CONFIG_DM_VERITY
CONFIG_TEE
CONFIG_OPTEE
```

```
Add related configuration to kernel
```

```
kernel$ git diff
diff --git a/arch/arm64/configs/rockchip_linux_defconfig
b/arch/arm64/configs/rockchip_linux_defconfig
index d8757f713ec4..7beca18172e0 100644
--- a/arch/arm64/configs/rockchip_linux_defconfig
+++ b/arch/arm64/configs/rockchip_linux_defconfig
@@ -590,3 +590,9 @@ CONFIG_RCU_CPU_STALL_TIMEOUT=60
 CONFIG_FUNCTION_TRACER=y
 CONFIG_BLK_DEV_IO_TRACE=y
 CONFIG_LKDTM=y
+CONFIG_BLK_DEV_DM=y
+CONFIG_DM_CRYPT=y
+CONFIG_BLK_DEV_CRYPTOLLOOP=y
+CONFIG_DM_VERITY=y
+CONFIG_TEE=y
+CONFIG_OPTEE=y
```

```
Security: No found config CONFIG_FIT_SIGNATURE in u-boot/configs/rk3568_defconfig
make sure your config include this list
```

```
-----
CONFIG_FIT_SIGNATURE
CONFIG_SPL_FIT_SIGNATURE
```

u-boot adds related configuration:

```
u-boot$ git diff
diff --git a/configs/rk3568_defconfig b/configs/rk3568_defconfig
index fbd9820acc..6efdaac1d6 100644
--- a/configs/rk3568_defconfig
+++ b/configs/rk3568_defconfig
@@ -220,3 +220,5 @@ CONFIG_RK_AVB_LIBAVB_USER=y
 CONFIG_OPTEE_CLIENT=y
 CONFIG_OPTEE_V2=y
 CONFIG_OPTEE_ALWAYS_USE_SECURITY_PARTITION=y
+CONFIG_FIT_SIGNATURE=y
+CONFIG_SPL_FIT_SIGNATURE=y
```

Security: No found config BR2\_PACKAGE\_RECOVERY in  
buildroot/configs/rockchip\_rk3566\_rk3568\_ramboot\_defconfig  
Security: No found config BR2\_PACKAGE\_RECOVERY\_UPDATEENGINEBIN in  
buildroot/configs/rockchip\_rk3566\_rk3568\_ramboot\_defconfig

buildroot adds related configuration:

```
--- a/configs/rockchip_rk3566_rk3568_ramboot_defconfig
+++ b/configs/rockchip_rk3566_rk3568_ramboot_defconfig
@@ -4,6 +4,8 @@
 BR2_PACKAGE_LUKSMETA=y
+BR2_PACKAGE_RECOVERY=y
+BR2_PACKAGE_RECOVERY_UPDATEENGINEBIN=y
```

Security: No found string BR2\_ROOTFS\_OVERLAY=".\*board/rockchip/common/security-system-overlay.\*" in buildroot/configs/rockchip\_rk3568\_defconfig  
ERROR: Running check\_security\_condition failed!  
ERROR: exit code 255 from line 982:

buildroot adds related configuration:

```
buildroot$ git diff
diff --git a/configs/rockchip_rk3568_defconfig
b/configs/rockchip_rk3568_defconfig
index 6cdd795c64..5244694c7d 100644
--- a/configs/rockchip_rk3568_defconfig
+++ b/configs/rockchip_rk3568_defconfig
@@ -23,3 +23,4 @@
 BR2_PACKAGE_RKWIFIBT_AP6398S=y
 BR2_PACKAGE_RKWIFIBT_BTUART="ttyS8"
 BR2_PACKAGE_RKNPU2=y
+BR2_ROOTFS_OVERLAY="board/rockchip/common/security-system-overlay"
```

Environment installation:

If the compilation error is `No module named Crypto.Signature`, this is because the computer used for development does not have a Python algorithm library installed. Simply execute the following command:

```
pip uninstall Crypto
```

```
pip uninstall pycrypto
```

```
pip install pycrypto
```

2. If the following error occurs: ModuleNotFoundError: No module named 'Cryptodome'

```
Please install the python package on the development host: pip3 install [--user] pycryptodomex
```

- When verifying, find a device that has not burned rpmb. If there is an encryption key in the device, it will be used first. If the device encryption key is different from the encryption key we compiled, the startup will fail.
- The encryption key is placed in the rpmb area and can be rewritten. If the key is different and the system cannot be loaded, you can turn on `FORCE_KEY_WRITE=true` in `buildroot/board/rockchip/common/security-ramdisk-overlay/init.in` to force the key to be updated.

For details, please refer to

- Linux secureboot software developer guid:  
`<SDK>/docs/cn/Linux/Security/Rockchip_Developer_Guide_Linux_Secure_Boot_CN.pdf`
- TEE developer guid:  
`<SDK>/docs/cn/Linux/Security/Rockchip_Developer_Guide_TEE_SDK_CN`

## 10.13 WIFI/BT Development

Please refer to the document in the directory `<SDK>/docs/cn/Linux/Wifibt`

## 10.14 SDK Booting Way

Currently, there are three booting ways provided in the Linux SDK: Sysv, Busybox, and Systemd init.

Yocto system uses Sysv init by default to manage booting, and `update-rc.d.bbclass` is used to manage the booting configuration of services.

Buildroot system uses the Busybox init way to manage booting by default. Busybox init will read the inittab file in the `/etc/` directory after booting.

Debian system uses Systemd way to manage booting by default. Systemd init will read related services in the `/etc/systemd/system/` directory after booting.

SDK has some different processing for different booting services. For example:

```
<SDK>/device/rockchip/common/scripts/post-disk.sh

if [ "$POST_INIT_BUSYBOX" ]; then
    mkdir -p "$TARGET_DIR/etc/init.d"
    install -m 0755 external/rkscript/$SCRIPT "$TARGET_DIR/etc/init.d/"
fi

if [ "$POST_INIT_SYSTEMD" ]; then
    mkdir -p "$TARGET_DIR/lib/systemd/system"
    install -m 0755 external/rkscript/$DISK_HELPER_TYPE-all.service \
        "$TARGET_DIR/lib/systemd/system/"
    mkdir -p "$TARGET_DIR/etc/systemd/system/sysinit.target.wants"
    ln -sf /lib/systemd/system/$DISK_HELPER_TYPE-all.service \
        "$TARGET_DIR/etc/systemd/system/sysinit.target.wants/"
fi

if [ "$POST_INIT_SYSV" ]; then
```

```

mkdir -p "$TARGET_DIR/etc/init.d"
install -m 0755 external/rkscript/$SCRIPT \
"$TARGET_DIR/etc/init.d/${DISK_HELPER_TYPE}all.sh"
mkdir -p "$TARGET_DIR/etc/rcS.d"
ln -sf ../init.d/${DISK_HELPER_TYPE}all.sh \
"$TARGET_DIR/etc/rcS.d/$SCRIPT"
fi

```

## 10.15 SDK Test

### 10.15.1 Integrated Rockchip Stress Test Script

`rockchip_test` integrates functional, stress, and performance related tests

```

ROCKCHIPS TEST TOOLS

ddr test:          1 (ddr stress test)
cpu test:          2 (cpu stress test)
gpu test:          3 (gpu stress test)
npu test:          4 (npu stress test)
suspend_resume test: 5 (suspend resume)
reboot test:       6 (auto reboot test)
power lost test:   7 (power lost test)
flash stress test: 8 (flash stress test)
recovery test:     9 (recovery wipe all test)
audio test:        10 (audio test)
camera test:       11 (camera test)
video test:        12 (video test)
bluetooth test:    13 (bluetooth on off test)
wifi test:         14 (wifi on off test)
chromium test:     15 (chromium with video test)
*****

please input your test moudle:

```

### 10.15.2 Benchmark Test

The following are reference data for some commonly used benchmark tests. You can find more information in the following test documents:

<SDK>/docs/cn/Linux/Profile/Rockchip\_Introduction\_Linux\_Benchmark\_KPI\_CN.pdf

### 10.15.3 Rockchip Modules and Stress Testing

Some common module functions and stress testing methods are provided below. You can find more detailed information in the following documents:

<SDK>/docs/cn/Linux/Profile/Rockchip\_User\_Guide\_Linux\_Software\_Test\_CN.pdf

## 11. Chapter-11 SDK System Debugging Tools Introduction

There are some commonly used debugging tools for static compilation are pre-installed in the SDK , as follows:

```
device/rockchip/common/tools/  
├─ adb  
├─ busybox  
├─ gdb  
├─ io  
├─ kmsgrab  
├─ modetest  
├─ perf-4.19  
├─ perf-4.4  
├─ perf-5.10  
├─ pmap  
├─ procrank  
├─ ps  
├─ slabtop  
├─ strace  
├─ top  
├─ update  
├─ vendor_storage  
├─ vmstat  
└─ watch
```

Just `make menuconfig` in the SDK directory and select the relevant configuration.

```
| Symbol: RK_ROOTFS_PREBUILT_TOOLS [=y]  
|  
| Type : bool  
|  
| Prompt: prebuilt tools  
|  
| Location:  
|  
| -> Rootfs  
|  
| -> Post rootfs installs  
|  
| Defined at Config.in.post-rootfs:263
```

Save the configuration, for example, the detailed modifications of RK3588 EVB1 are as follows:

```
device/rockchip/rk3588/rockchip_rk3588_evb1_lp4_v10_defconfig  
@@ -1,4 +1,7 @@  
RK_YOCTO_CFG="rockchip-rk3588-evb"  
RK_WIFIBT_TTY="ttyS8"  
+RK_ROOTFS_PREBUILT_TOOLS=y
```

## 11.1 ADB Tool

You can open the following macros in Buildroot to build and obtain:

```
BR2_PACKAGE_ANDROID_TOOLS=y  
BR2_PACKAGE_ANDROID_TOOLS_STATIC=y
```

For details usage of ADB tools, please refer to [ADB official guidance document](#).

### 11.1.1 Overview

- Run the device's shell (command line)
- Manage port mapping for emulators or devices
- Upload/download files between computer and device
- Install local software to Debian, Buildroot and other Linux devices
- ADB is a "client-server" program, where the client mainly refers to a PC and a server is an entity device or a virtual device of Debian. Depending on how the PC connects to Debian devices, ADB can be divided into two types:

**Network ADB:** The host is connected to the STB device via a wired/wireless network (same LAN)

**USB ADB:** The host is connected to the STB device through a USB cable

### 11.1.2 USB ADB Usage Instructions

USB adb usage has the following restrictions:

- Only supports USB OTG port
- Does not support using of multiple clients at the same time
- Only supports the host to connect to one device, does not support connecting to multiple devices. To test whether the connection is successful, run the "adb devices" command. If the serial number of the device is displayed, the connection is successful.

## 11.2 Busybox Tool

You can open the following macros in Buildroot to build and obtain:

```
BR2_PACKAGE_BUSYBOX=y  
BR2_PACKAGE_BUSYBOX_STATIC=y
```

Busybox is similar to a Linux toolbox. It integrates and compresses many tools and commands of Linux.

```
## Chapter-11 ./busybox  
BusyBox v1.36.0 (2023-05-20 11:25:39 CST) multi-call binary.  
BusyBox is copyrighted by many authors between 1998-2015.  
Licensed under GPLv2. See source distribution for detailed  
copyright notices.  
  
Usage: busybox [function [arguments]...]  
       or: busybox --list[-full]
```

```
or: busybox --show SCRIPT
or: busybox --install [-s] [DIR]
or: function [arguments]...
```

BusyBox is a multi-call binary that combines many common Unix utilities into a single executable. Most people will create a link to busybox for each function they wish to use and BusyBox will act like whatever it was invoked as.

Currently defined functions:

```
[, [[, addgroup, adduser, ar, arch, arp, arping, ascii, ash, awk,
base32, base64, basename, bc, blkid, bunzip2, bzip2, cat, chat,
chgrp, chmod, chown, chroot, chrt, chvt, cksum, clear, cmp, cp, cpio,
crc32, crond, crontab, cut, date, dc, dd, deallocvt, delgroup, deluser,
devmem, df, diff, dirname, dmesg, dnsd, dnsdomainname, dos2unix, du,
dumpkmap, echo, egrep, eject, env, ether-wake, expr, factor, falloccat,
false, fbset, fdflush, fdformat, fdisk, fgrep, find, flock, fold, free,
freeramdisk, fsck, fsfreeze, fstrim, fuser, getopt, getty, grep,
groups, gunzip, gzip, halt, hdparm, head, hexdump, hexedit, hostid,
hostname, hwclock, i2cdetect, i2cdump, i2cget, i2cset, i2ctransfer, id,
ifconfig, ifdown, ifup, inetd, init, insmod, install, ip, ipaddr,
ipcrm, ipcs, iplink, ipneigh, iproute, iprule, iptunnel, kill, killall,
killall5, klogd, last, less, link, linux32, linux64, linuxrc, ln,
loadfont, loadkmap, logger, login, logname, losetup, ls, lsattr, lsmod,
lsof, lspci, lsscsi, lsusb, lzcat, lzma, lzopcat, makedevs, md5sum,
mdev, mesg, microcom, mim, mkdir, mkdosfs, mke2fs, mkfifo, mknod,
mkpasswd, mkswap, mktmp, modprobe, more, mount, mountpoint, mt, mv,
nameif, netstat, nice, nl, nohup, nologin, nproc, nslookup, nuke, od,
openvt, partprobe, passwd, paste, patch, pidof, ping, pipe_progress,
pivot_root, pmap, poweroff, printenv, printf, ps, pwd, rdate, readlink,
readprofile, realpath, reboot, renice, reset, resize, resume, rm,
rmdir, rmmod, route, run-init, run-parts, runlevel, sed, seedrng, seq,
setarch, setconsole, setfattr, setkeycodes, setlogcons, setpriv,
setserial, setsid, sh, sha1sum, sha256sum, sha3sum, sha512sum, shred,
sleep, sort, start-stop-daemon, strings, stty, su, sulogin, svc, svok,
swapoff, swapon, switch_root, sync, sysctl, syslogd, tail, tar,
taskset, tc, tee, telnet, test, tftp, time, timeout, top, touch, tr,
traceroute, tree, true, truncate, ts, tsort, tty, ubirename, udhcpc,
uevent, umount, uname, uniq, unix2dos, unlink, unlzma, unlzop, unxz,
unzip, uptime, usleep, uudecode, uuencode, vconfig, vi, vlock, w,
watch, watchdog, wc, wget, which, who, whoami, xargs, xxd, xz, xzcat,
yes, zcat
```

## 11.3 GDB Tool

You can open the following macros in Buildroot to build and obtain:

```
BR2_PACKAGE_GDB=y
BR2_PACKAGE_GDB_STATIC=y
BR2_PACKAGE_GDB_DEBUGGER=y
```

GDB, a commonly used debugging tool in Linux, is a powerful program debugger. Please refer to [GDB](#) for more usage instructions.



## 11.4 IO Tool

You can open the following macros in Buildroot to build and obtain:

```
BR2_PACKAGE_RKTOOLKIT=y
BR2_PACKAGE_RKTOOLKIT_STATIC=y
```

Memory can be accessed through /dev/mem, with permission to read and write chip registers.

## 11.5 kmsgrab Tool

In the SDK project, you can build and obtain it as follows.

```
For building kmsgrab:
1/ ./build.sh shell
2/ source ./buildroot/output/$RK_BUILDROOT_CFG/host/environment-setup
3/ $CC $RK_DATA_DIR/kmsgrab.c $(pkg-config --cflags --libs libdrm) -static -o
kmsgrab
```

Captures the KMS scan-out framebuffer associated with the specified CRTC or screen as a DRM object that can be passed to other hardware functions.

## 11.6 modetest Tool

Modetest is a debugging tool that comes with the libdrm source code, which can perform some basic debugging on drm.

The help information of modetest is as follows:

```
(shell)# modetest -h
usage: modetest [-cDdefMPpsCvw]
Query options:
  -c    list connectors
  -e    list encoders
  -f    list framebuffers
  -p    list CRTCs and planes (pipes)
Test options:
  -P <crtc_id>:<w>x<h>[+<x>+<y>][*<scale>][@<format>]    set a plane
  -s <connector_id>[,<connector_id>][@<crtc_id>]:<mode>[-<vrefresh>][@<format>]
set a mode
  -C    test hw cursor
  -v    test vsynced page flipping
  -w <obj_id>:<prop_name>:<value>    set property
Generic options:
  -d    drop master after mode set
  -M module    use the given driver
  -D device    use the given device
Default is to dump all info.
```

## 11.7 Perf Tool

You can open the following macros in Buildroot to build and obtain:

```
For building perf:
1/ Build dynamic version firstly
2/ Enable BR2_PACKAGE_LINUX_TOOLS_PERF_STATIC
3/ Run: make linux-tools-reconfigure
```

Perf is a Linux performance analysis tool.

## 11.8 Pmap Tool

To see how much memory a process uses, pmap provides a memory mapping of a process. The pmap command is used to display the memory status of one or more processes. It reports the address space and memory status information of the process.

```
#pmap PID
```

## 11.9 ProcrankTool

You can open the following macros in Buildroot to build and obtain:

```
BR2_PACKAGE_PROCRANK_LINUX=y
BR2_PACKAGE_PROCRANK_LINUX_STATIC=y
```

Use procrank to analyze memory utilization and analyze source code. procrank is a tool that counts memory usage, including detailed parameters of VSS, PSS, PSS and USS. It is commonly used memory analysis tool.

## 11.10 PS Tool

The Linux PS (process status) command is used to display the status of the current process, similar to the Windows Task Manager.

There are many parameters of PS. Here we only list a few commonly used parameters and briefly introduce them.

- A: lists all processes
- w: display more information by widening the display
- au: displays more detailed information
- aux: displays all processes containing other users

```
au(x) output format:
USER PID %CPU %MEM VSZ RSS TTY STAT START TIME COMMAND

USER: process owner
PID: pid
%CPU: occupied CPU usage
%MEM: occupied memory usage
VSZ: size of virtual memory occupied
```

```
RSS: memory size occupied
TTY: minor device number of tty
STAT: The status of the process:

D: Uninterruptible sleep state (usually, it is IO process)
R: Running
S: stationary state
T: pause execution
Z: Does not exist but cannot be eliminated temporarily
W: Not enough memory pages available to allocate
<: High priority itinerary
N: low priority itinerary
L: There are memory pages allocated and locked in the memory
START: The start time of the process
TIME: execution time
COMMAND: command executed
```

## 11.11 Slabtop Tool

Display kernel slab buffer information in real time.

Refresh the slab buffer information every ten seconds:

```
slabtop -d 10
```

## 11.12 Strace Tool

Strace is a Linux user space tracer that can be used for tracking and debugging.

## 11.13 Top Tools

The top command is a commonly used performance analysis tool under Linux. It can display the resource usage of each process in the system in real time and is often used for server-side performance analysis.

## 11.14 Update Tool

Enter the recovery program to update and format, then reboot into the normal system.

## 11.15 Vendor\_storage Tool

Read and write on the Vendor partition.

```
root@rk3588-buildroot:/armhf# ./vendor_storage --help
vendor storage tool - Revision: 2.0

./vendor_storage [-r/w <vendor_id> -t <pr_type> -i <input>] [-R]
-r                Read specify vendor_id
```

```

-R          Read common vendor_id
-w          Write specify vendor_id
-t          print type
-i          input string
<vendor_id> There are 16 types
            "VENDOR_SN_ID"
            "VENDOR_WIFI_MAC_ID"
            "VENDOR_LAN_MAC_ID"
            "VENDOR_BT_MAC_ID"
            "VENDOR_HDCP_14_HDMI_ID"
            "VENDOR_HDCP_14_DP_ID"
            "VENDOR_HDCP_2x_ID"
            "VENDOR_DRM_KEY_ID"
            "VENDOR_PLAYREADY_Cert_ID"
            "VENDOR_ATTENTION_KEY_ID"
            "VENDOR_PLAYREADY_ROOT_KEY_0_ID"
            "VENDOR_PLAYREADY_ROOT_KEY_1_ID"
            "VENDOR_SENSOR_CALIBRATION_ID"
            "VENDOR_RESERVE_ID_14"
            "VENDOR_IMEI_ID"
            "VENDOR_CUSTOM_ID"
            And custom can define other id like
            VENDOR_CUSTOM_ID_1A (define ID = 26)
<pr_type>  In write case, used with -i <input>
            There are 3 types
            "hex": <input> must be hex form like 0123
            "string": <input> must be ASCII string
            "file": <input> must be path to file
            Note: If use "file" and -i with read, it means save storage to
file
Examples:
./vendor_storage -w VENDOR_CUSTOM_ID_1A -t file -i /userdata/test.bin
                write userdata/test.bin to storage
                Or -t string -i test_storage
                write string "test_storage" to storage
                ID = 26
./vendor_storage -r VENDOR_CUSTOM_ID_1A -t file -i /userdata/read.bin
                read storage(ID=26) to userdata/read.bin
                Or -t string
                print storage(ID=26) with ASCII string

```

## 11.16 Vmstat Tool

The vmstat command reports statistics on kernel threads, virtual memory, disks, hypervisor pages, traps, and processor activity.

## 11.17 Watch Tool

Watch can help monitor the results of a command.

```
## Chapter-11 watch
```

```

Usage:
  watch [options] command

Options:
  -b, --beep                beep if command has a non-zero exit
  -c, --color                interpret ANSI color and style sequences
  -d, --differences[=<permanent>]
                             highlight changes between updates
  -e, --errexit             exit if command has a non-zero exit
  -g, --chgexit             exit when output from command changes
  -n, --interval <secs>    seconds to wait between updates
  -p, --precise              attempt run command in precise intervals
  -t, --no-title            turn off header
  -w, --no-wrap             turn off line wrapping
  -x, --exec                pass command to exec instead of "sh -c"

  -h, --help               display this help and exit
  -v, --version            output version information and exit

```

## 11.18 weston Debugging Method

```
root@rk3288-buildroot:/# WAYLAND_DEBUG=1 weston --debug
```

Weston related parameters are as follows:

```

root@rk3288-buildroot:/# weston --help
Usage: weston [OPTIONS]

This is weston version 12.0.1, the Wayland reference compositor.
Weston supports multiple backends, and depending on which backend is in use
different options will be accepted.

Core options:

  --version                Print weston version
  -B, --backend=BACKEND   Backend module, one of
                           drm
  --renderer=NAME          Renderer to use, one of
                           auto    Automatic selection of one of the below
renderers
                           gl      OpenGL ES
                           noop    No-op renderer for testing only
                           pixman  Pixman software renderer
  --shell=NAME             Shell to load, defaults to desktop
  -S, --socket=NAME        Name of socket to listen on
  -i, --idle-time=SECS     Idle time in seconds
  --modules                Load the comma-separated list of modules
  --log=FILE               Log to the given file
  -c, --config=FILE        Config file to load, defaults to weston.ini
  --no-config              Do not read weston.ini
  --wait-for-debugger      Raise SIGSTOP on start-up
  --debug                  Enable debug extension
  -l, --logger-scopes=SCOPE
                           Specify log scopes to subscribe to.
                           Can specify multiple scopes, each followed by comma

```

```

-f, --flight-rec-scopes=SCOPE      Specify log scopes to subscribe to.
                                   Can specify multiple scopes, each followed by comma
-w, --warm-up                      Hold display for the first app
-h, --help                          This help message

```

Options for drm:

```

--seat=SEAT                        The seat that weston should run on, instead of the seat
defined in XDG_SEAT
--drm-device=CARD                  The DRM device to use, e.g. "card0".
--use-pixman                       Use the pixman (CPU) renderer (deprecated alias for --
renderer=pixman)
--current-mode                     Prefer current KMS mode over EDID preferred mode
--continue-without-input           Allow the compositor to start without input
devices

```

## 11.19 Obtain System Log Information Automatically

The log information will be automatically obtained in the /info directory. The main log information is as follows:

```

/info/
├─ clk_summary -> /sys/kernel/debug/clk/clk_summary
├─ cmdline -> /proc/cmdline
├─ cpuinfo -> /proc/cpuinfo
├─ device-tree -> /proc/device-tree
├─ diskstats -> /proc/diskstats
├─ dma_buf -> /sys/kernel/debug/dma_buf
├─ dri -> /sys/kernel/debug/dri
├─ fstab -> /etc/fstab
├─ gpio -> /sys/kernel/debug/gpio
├─ interrupts -> /proc/interrupts
├─ iomem -> /proc/iomem
├─ kallsyms -> /proc/kallsyms
├─ log -> /var/log
├─ meminfo -> /proc/meminfo
├─ mountall.log -> /tmp/mountall.log
├─ os-release -> /etc/os-release
├─ partitions -> /proc/partitions
├─ pinctrl -> /sys/kernel/debug/pinctrl/
├─ rkCIF-mipi-lvds -> /proc/rkCIF-mipi-lvds
├─ rk_dma_buf -> /proc/rk_dma_buf
├─ rkisp0-vir0 -> /proc/rkisp0-vir0
├─ slabinfo -> /proc/slabinfo
├─ softirqs -> /proc/softirqs
├─ version -> /proc/version
├─ wakeup_sources -> /sys/kernel/debug/wakeup_sources
...

```

## 12. Chapter-12 SDK Software License Instructions

---

Before customers obtain the SDK, they need to sign the SDK agreement. This agreement states specific rights and obligations.

### 12.1 Copyright Detection Tool

#### 12.1.1 Buildroot

```
make legal-info
```

The SDK project can automatically generate relevant License information by running the `make legal-info` command, Like RK3566 project:

```
$ source buildroot/envsetup.sh rockchip_rk3566
buildroot$ make legal-info
```

Executing the above command will generate the following information:

```
buildroot$ tree -L 1 output/rockchip_rk3566/legal-info/
output/rockchip_rk3566/legal-info/
├─ buildroot.config
├─ host-licenses
├─ host-manifest.csv
├─ host-sources
├─ legal-info.sha256
├─ licenses
├─ manifest.csv
├─ README
└─ sources
```

The `manifest.csv` is the license information of the relevant repository used by RK3566 project.

The `host-manifest.csv` is the license information of the third-party tools of the PC used by RK3566 project.

#### 12.1.2 Debian

For license detection, please refer to [Official Tool](#)

```
licensecheck --check '.*' --recursive --copyright --deb-fmt \
--lines 0 * | /usr/lib/cdb/lscdb/licensecheck2dep5
```

The relevant copyright instructions for each source code package are located in `/usr/share/doc/*/copyright`

### 12.1.3 Yocto

The relevant copyright instructions for each source code package are located in `build/tmp/deploy/licenses/*/recipeinfo`

## 12.2 License List

For the current mainstream License list, please refer to the following link

[license-list](#)



## 13. Chapter-13 Rockchip open source information

---

### 13.1 Github

Rockchip Code Open Source repositories [rockchip-github](#)。

### 13.2 Wiki

Rockchip open source materials [rockchip-wiki](#)

### 13.3 Upstream

- Rockchip upstream uboot:

```
git clone https://gitlab.denx.de/u-boot/custodians/u-boot-rockchip.git
```

Upstream U-Boot support the following Rockchip SoCs:

RK3036, RK3188, RK3288, RK3328, RK3399, RK3566, RK3568

- Rockchip upstream kernel

```
git clone git://git.kernel.org/pub/scm/linux/kernel/git/mmind/linux-rockchip.git
```

Mainline kernel supports:

RV1108, RK3036, RK3066, RK3188, RK3228, RK3288, RK3368, RK3399, RK3566, RK3568

## 14. Chapter-14 SDK FAQ

---

The following offers answers and clarifications to common questions about various aspects of the SDK. Here are some potential questions that might be included in an SDK FAQ.

### 14.1 How to Confirm the Current SDK Version and System/Kernel Version

Relevant information can be obtained through the `/info/` directory or `/etc/os-release`, such as

```
root@rk3588:/# cat /etc/os-release
NAME=Buildroot
VERSION=linux-5.10-gen-rkr3.4-48-gb0d2bfa6
ID=buildroot
VERSION_ID=2021.11
PRETTY_NAME="Buildroot 2021.11"
BUILD_INFO="wxt@ubuntu-191 Wed Nov 23 09:17:44 CST 2022 -
/home/wxt/test/rk3588/buildroot/configs/rockchip_rk3588_defconfig"
KERNEL="5.10 - rockchip_linux_defconfig"
```

### 14.2 Issues about SDK Building

#### 14.2.1 Sync Issues Caused by Repo

During the update with `repo sync -c`, the prompt `No module named formatter` occurs because your host machine is using a newer version of Python, such as Python 3.8+, which has completely removed the `formatter` module. This issue is caused by the outdated version of the `repo` tool in the external SDK. To resolve this problem, updating the version of `repo` is necessary. An example of how to do this is as follows:

```
$ cd .repo/repo/
$ git checkout origin/stable
```

This branch `repo` is the 2022 version, and the default master branch is the 2020 version. Or add `--repo-rev=stable` during the `repo init` project to switch to the new version `repo`.

```
repo init --repo-url ssh://git@www.rockchip.com.cn/repo/rk/tools/repo --repo-
rev=stable \
-u ssh://git@www.rockchip.com.cn/linux/rockchip/platform/manifests -b linux -m \
rk3588_linux_release.xml
```

## 14.2.2 Abnormal Issues Caused by ./build.sh Building

The following error will be prompted:

```
Adding information to /etc/os-release...
Traceback (most recent call last):
  file "rk356x/.repo/repo/main.py", line 56, in <module>
    from subcmds.version import Version
  File "rk356x/.repo/repo/subcmds/__init__.py", line 35, in <module>
    ModuleNotFoundError: No module named 'formatter'
```

Due to the matching problem between python3 and project repo versions in buildroot, `device/rockchip` can be modified as follows:

```
--- a/common/post-build.sh
+++ b/common/post-build.sh
@@ -171,8 +171,6 @@ function add_build_info()

    mkdir -p "$INFO_DIR"

-   yes | python3 .repo/repo/repo manifest -r -o "$INFO_DIR/manifest.xml"
```

## 14.2.3 Buildroot Building Issues

If some network reasons cause buildroot compilation to fail. This can be solved by using the following ways:

Preset dl directory, dl is a pre-compiled package that can be integrated into buildroot in advance. Reduce download time and improve compilation efficiency.

For example, rk3588 Linux SDK can be modified to add the dl directory as follows

```
$ cd .repo/manifests
$ Change the rk3588_linux_release.xml file as follows:

diff --git a/rk3588_linux_release.xml
b/rrk3588_linux_release.xml
index 5082dea..626f094 100644
--- a/rk3588_linux/rk3588_linux_release.xml
+++ b/rk3588_linux/rk3588_linux_release.xml
@@ -14,6 +14,7 @@

+ <project name="linux/buildroot/dl" path="buildroot/dl" revision="next"/>

$ cd -
$.repo/repo sync -c
```

The modification methods for other chip SDKs are similar.

## 14.3 Buildroot FAQ

### 14.3.1 Dual Screen Asynchronous Clock Times

The clock format can be configured in `/etc/xdg/weston/weston.ini` to compare in seconds:

`clock-format=seconds`

The default configuration updates the time every minute separately, initiating the update when a specific screen is enabled. The first update aligns with the current time to the nearest whole minute.

From the previous description, it seems likely that the screens were not enabled together, and then the system time changed (either through network synchronization or manual setting), causing the two to be out of sync.

If minute-level accuracy is essential and this scenario needs to be considered, you could modify Weston. Otherwise, using the second-level format should suffice.

```
diff --git a/clients/desktop-shell.c b/clients/desktop-shell.c
index bf75927..67289e2 100644
--- a/clients/desktop-shell.c
+++ b/clients/desktop-shell.c
@@ -531,12 +531,16 @@ panel_launcher_tablet_tool_button_handler(struct widget
 *widget,
     launcher_activate(launcher->argp, launcher->envp);
 }

+static int clock_timer_reset(struct panel_clock *clock);
+
+static void
+clock_func(struct toytimer *tt)
+{
+    struct panel_clock *clock = container_of(tt, struct panel_clock, timer);

+    widget_schedule_redraw(clock->widget);
+
+    clock_timer_reset(clock);
+}

static void
@@ -589,7 +593,7 @@ clock_timer_reset(struct panel_clock *clock)
    clock_gettime(CLOCK_REALTIME, &ts);
    tm = localtime(&ts.tv_sec);

-    its.it_interval.tv_sec = clock->refresh_timer;
+    its.it_interval.tv_sec = 0;
+    its.it_interval.tv_nsec = 0;
+    its.it_value.tv_sec = clock->refresh_timer - tm->tm_sec % clock->refresh_timer;
+    its.it_value.tv_nsec = 100000000; /* 10 ms late to ensure the clock digit has
actually changed */
```

### 14.3.2 How to Set Buildroot System to Boot into Command Line Mode

To disable Weston in buildroot (remove the include of weston.config in the corresponding board defconfig), then:

- Enable CONFIG\_VT, CONFIG\_VT\_CONSOLE, CONFIG\_FRAMEBUFFER\_CONSOLE, CONFIG\_DRM\_FBDEV\_EMULATION in kernel defconfig.
- Enable BR2\_PACKAGE\_FRECON, BR2\_PACKAGE\_FRECON\_VT in buildroot.

The difference is that frecon supports rotation, scaling, and Chinese characters, but it can only display on a single screen.

## 14.4 Debian FAQ

This chapter is going to answer some frequently asked questions about Debian GNU/Linux based on the Rockchip platform. For other questions, please refer to the official website [Debian FAQ](#).

### 14.4.1 "noexec or nodev" Issue

```
noexec or nodev issue /usr/share/debootstrap/functions: line 1450:
.../rootfs/ubuntu-build-service/buster-desktop-arm64/chroot/test-dev-null:
Permission denied E: Cannot install into target '/rootfs/ubuntu-build-
service/buster-desktop-arm64/chroot' mounted with noexec or nodev
```

Solution:

```
mount -o remount,exec,dev xxx
(The xxx is the path of project's directory, and then rebuild)
```

In addition, if other compilation exceptions are encountered, first check that the compilation system used is not the system type of ext2/ext4.

### 14.4.2 Failed to Download "Base Debian"

- Since building Base Debian needs to visit foreign websites, and when using domestic networks to visit foreign websites, download failures often occur:

To use live build in Debian, configured like followings to change the image source to domestic:

32-bit system:

```
+++ b/ubuntu-build-service/{buster/bullseye}-desktop-armhf/configure
@@ -11,6 +11,11 @@ set -e
echo "I: create configuration"
export LB_BOOTSTRAP_INCLUDE="apt-transport-https gnupg"
lb config \
+ --mirror-bootstrap "http://mirrors.ustc.edu.cn/debian" \
+ --mirror-chroot "http://mirrors.ustc.edu.cn/debian" \
+ --mirror-chroot-security "http://mirrors.ustc.edu.cn/debian-security" \
+ --mirror-binary "http://mirrors.ustc.edu.cn/debian" \
+ --mirror-binary-security "http://mirrors.ustc.edu.cn/debian-security" \
```

```

--apt-indices false \
--apt-recommends false \
--apt-secure false \

64-bit system:
-- a/ubuntu-build-service/{buster/bullseye}-desktop-arm64/configure
+++ b/ubuntu-build-service/{buster/bullseye}-desktop-arm64/configure
@@ -11,6 +11,11 @@ set -e
echo "I: create configuration"
export LB_BOOTSTRAP_INCLUDE="apt-transport-https gnupg"
lb config \
+ --mirror-bootstrap "http://mirrors.ustc.edu.cn/debian" \
+ --mirror-chroot "http://mirrors.ustc.edu.cn/debian" \
+ --mirror-chroot-security "http://mirrors.ustc.edu.cn/debian-security" \
+ --mirror-binary "http://mirrors.ustc.edu.cn/debian" \
+ --mirror-binary-security "http://mirrors.ustc.edu.cn/debian-security" \
--apt-indices false \
--apt-recommends false \
--apt-secure false \

```

If the package cannot be downloaded due to other network reasons, there is a pre-built package to share in [Baidu Cloud Network Disk](#), place it in the current directory and execute the next step directly .

### 14.4.3 Abnormal Operation Causes an error to Mount /dev

For example, like "askpass command or cannot use one" appears

It may be frequent abnormal operations (CTRL+C) during the compilation process, and the above errors can be fixed by the following way:

```
sudo -S umount /dev
```

### 14.4.4 Multiple Mounts lead to /dev error

For example: sudo: unable to allocate pty: No such device appears

The reason may be that the compilation process has been mounted multiple times, resulting in the above error, which can be fixed by the following way:

```
ssh <username>@<IP address> -T sudo -S umount /dev -l
```

### 14.4.5 How to Check System Related Information

#### 14.4.5.1 How to Check the Debian Version of Your System

```

root@linaro-alip:~# cat /etc/debian_version
11.1

```

#### 14.4.5.2 How to Check Whether the Debian Display Uses X11 or Wayland

On X11 systems:

```
$ echo $XDG_SESSION_TYPE
x11
```

On X11 systems:

```
$ echo $XDG_SESSION_TYPE
wayland
```

#### 14.4.5.3 How to Check System Partition Status

```
root@linaro-alip:~# parted -l

Model: MMC BJTD4R (sd/mmc)
Disk /dev/mmcblk0: 31.3GB
Sector size (logical/physical): 512B/512B
Partition Table: gpt
Disk Flags:

Number   Start    End      Size    File system  Name      Flags
  1       8389kB   12.6MB   4194kB                uboot
  2       12.6MB   16.8MB   4194kB                misc
  3       16.8MB   83.9MB   67.1MB                boot
  4       83.9MB   218MB    134MB                recovery
  5       218MB    252MB    33.6MB                backup
  6       252MB    15.3GB   15.0GB   ext4            rootfs
  7       15.3GB   15.4GB   134MB    ext2            oem
  8       15.6GB   31.3GB   15.6GB    ext2            userdata
```

#### 14.4.5.4 The ssh.service Is Abnormal in System

This is a problem of Debian10 or earlier version, please add the following code in the /etc/rc.local:

```
#!/bin/sh -e
#
## Chapter-14 rc.local
#
## Chapter-14 This script is executed at the end of each multiuser runlevel.
## Chapter-14 Make sure that the script will "exit 0" on success or any other
## Chapter-14 value on error.
#
## Chapter-14 In order to enable or disable this script just change the execution
## Chapter-14 bits.
#
## Chapter-14 By default this script does nothing.
## Chapter-14 Generate the SSH keys if non-existent
if [ ! -f /etc/ssh/ssh_host_rsa_key ]
then
```

```
# else ssh service start in dpkg-reconfigure will fail
systemctl stop ssh.socket||true
dpkg-reconfigure openssh-server

fi

exit 0
```

#### 14.4.6 Debian11 Base Package Fails to Build

An error similar to the following will be encountered:

```
W: Failure trying to run: /sbin/ldconfig
W: See //debootstrap/debootstrap.log for details
```

It is mainly required that the kernel version of the PC should be 5.10+, which is a bug in the old QEMU. There are two solutions:

- The kernel version that comes with the PC must meet the requirements of 5.10+.

The way to check PC's Kernel Version:

```
cat /proc/version
Linux version 5.13.0-39-generic
```

- Update system's qemu

Please refer to [qemu](#).

#### 14.4.7 How to Decompress, Modify and Repackage Debian deb Package

If you want to modify and repackage on the original deb, please refer to the follow way:

```
#Decompress the files in the package to the extract directory
dpkg -X xxx.deb extract/

#Decompress the control information of the package under extract/DEBIAN/:
dpkg -e xxx.deb extract /DEBIAN/

#Modify the file XXX

## Chapter-14 Repackage the modified content to generate a deb package
dpkg-deb -b extract/ .
```

#### 14.4.8 How to Add the Swap Partition in Debian

When the physical memory of the system is not enough, you can add Debian's swap virtual memory partition for the current running program. For example, create a 2G virtual memory

- Create a swap file



```
cd /opt
mkdir swap
dd if=/dev/zero of=swapfile bs=1024 count=2000000
## Chapter-14 count represents the size, here is 2G.
```

- Convert files to swap files

```
sudo mkswap swapfile
```

- Activate the swap file

```
swapon /opt/swapfile
```

Uninstall:

```
swapoff /opt/swapfile
```

If it is automatically mounted after booting, you can add it to the /etc/fstab file

eg : /opt/swapfile swap swap defaults 0 0

- Verify whether it is in effect

```
root@linaro-alip:/opt# free -h
```

|         | total | used  | free  | shared | buff/cache | available |
|---------|-------|-------|-------|--------|------------|-----------|
| memory: | 1.9Gi | 390Mi | 91Mi  | 75Mi   | 1.5Gi      | 1.4Gi     |
| swap:   | 1.9Gi | 0B    | 1.9Gi |        |            |           |

e =h

### 14.4.9 Update Debian System for the First Time Will Restart the Display Service

In general, in order to be compatible with different chips, when Debian starts for the first time, /etc/init.d/rockchip.sh will install various differential packages according to the chip, such as libmali isp and other packages. After installation, the display service will be restarted. If it is an independent project, it can be placed in the image to process this difference.

### 14.4.10 Errors Occurring in Debian When Calling libGL related dri.so

Introduction as follows:

- EGL is an extension of OpenGL on the ARM platform for the x window system, and its function is equivalent to the glx library under x86.
- Since the driver modesettings used by Xorg will load libglx.so by default (disabling glx will cause some applications which detecting through glx environment fail to start), libglx.so will search for the dri library in the system. However, Xorg 2D acceleration is implemented directly based on DRM and does not implement the dri library, so libglx.so will report the following error during booting.

```
AIGLX error: dlopen of /usr/lib/aarch64-linux-gnu/dri/rockchip_dri.so failed`
```

It has no influence on system operation, please ignore it.

Similarly, the following errors will also be reported during the booting process of some applications, please ignore it for it has not influence on applications operation.

```
libGL error: unable to load driver: rockchip_dri.so
libGL error: driver pointer missing
libGL error: failed to load driver: rockchip
```

#### 14.4.11 How to Confirm that the Hardware Mouse Layer is Useful in Debian

- Configure kernel dts

Similar to the following log:

```
root@linaro-alip:~# dmesg |grep cursor
[ 2.062561] rockchip-vop2 fe040000.vop: [drm:vop2_bind] Cluster1-win0 as cursor
plane for vp0
[ 2.062669] rockchip-vop2 fe040000.vop: [drm:vop2_bind] Cluster0-win0 as cursor
plane for vp1
```

- modetest test whether the layer has been reported

```
102      0      0      0,0      0,0      0      0x00000002
  formats: XR30 AR30 XB30 AB30 XR24 AR24 XB24 AB24 RG24 BG24 RG16 BG16 YU08 YU10
YUYV Y210
  props:
    8 type:
      flags: immutable enum
      enums: Overlay=0 Primary=1 Cursor=2
      value: 2
```

- Check if the summary has called the hardware mouse layer

```
root@linaro-alip:~# cat /sys/kernel/debug/dri/0/summary |grep 64x64
```

If there are steps 1/2, and there are still problems, then check whether /var/log/drm-cursor.log has abnormalities.

#### 14.4.12 The log is Too Large in Debian

Debian provides **logrotate** to manage log files. Logrotate is intended to simplify log file management for systems that will generate many log files. Logrotate supports automatic rotation compression, deletion and sending log related emails. Logrotate can be run daily, weekly, monthly or when the log file size reaches a certain value. Typically, logrotate is run as a daily cron job.

```
apt install -fy logrotate cron
```

#### 14.4.13 Debian Setting Multi User Mode Issue

When the system starts, the 'systemd' process will try to start '/lib/systemd/system/default.target' (usually the graphical interface system is a symbolic link to "graphical.target"). The status can be obtained through the following command:

```
systemctl get-default graphical.target
```

Setting multi user mode (command line system):

```
systemctl set-default multi-user.target
```

After restarting, it was found that the interface was suspended at the logo and could not access the system. The normal startup sequence of the system is 'sysinit -> multi user -> graphic '. If it is set to ' multi user. target ', it means that the graphical interface has not been started. In this case, VT2 (terminal interaction needs to be enabled) is required, which means that the kernel needs to open the following two macros

```
CONFIG_ FRAMEBUFFER_ CONSOLE=y  
CONFIG_ VT=y
```

#### 14.4.14 Debian Username and Password

The default username and password for the system are 'linaro' and 'linaro',

Root 'can log in without a password, and can be accessed through the command line to' sudo su '

#### 14.4.15 Debian XFCE Desktop icon Double-click Abnormal

XFCE desktop native bug can be resolved by checking 'Settings -> Desktop -> Icon' and clicking on 'Activate Project'.

#### 14.4.16 Chromium browsers will have a command line flag: --no-sandbox

Unless using non-hardware accelerated, official native browser version. Otherwise, the customized browser version needs to be started with the `-no-sandbox` parameter, because the sandbox is a permission management and controls file access, and only without a sandbox can access to the hardware node is allowed to achieve hardware acceleration.

#### 14.4.17 Setting Up DRI2 Extension in Debian System's X11

In the SDK, `glmark2-es2` uses the `dri2` interface for display with the Mali GPU library.

For specific implementation, refer to the relevant code in `xserver` :

- File Path: `./hw/xfree86/drivers/modesetting/dri2.c`
- Functions: `ms_dri2_get_msc` and `ms_dri2_schedule_wait_msc`

To confirm if Xserver supports DRI2, check the following log:

```
root@linaro-alip:/# grep -i dri2 /var/log/Xorg.0.log  
[ 47.696] (II) modeset(0): [DRI2] Setup complete  
[ 47.699] (II) modeset(0): [DRI2] DRI driver: rockchip  
[ 47.712] (II) modeset(0): [DRI2] VDPAU driver: rockchip  
[ 48.502] (II) Initializing extension DRI2
```

Below is a segment of the test code named `dri2-test.c` for DRI2.

```
#include <stdlib.h>
#include <stdio.h>
#include <xcb/xcb.h>
#include <xcb/dri2.h>
#include <X11/Xlib.h>
#include <X11/Xlib-xcb.h>

int main(void)
{
    xcb_connection_t *c;
    xcb_dri2_connect_cookie_t cookie;
    xcb_dri2_connect_reply_t *reply;
    Display *display = XOpenDisplay(NULL);
    Window window = DefaultRootWindow(display);
    c = XGetXCBConnection(display);
    cookie = xcb_dri2_connect(c, window, XCB_DRI2_DRIVER_TYPE_DRI);
    reply = xcb_dri2_connect_reply(c, cookie, 0);
    printf("%s[%d] device(%s)\n", __func__, __LINE__,
xcb_dri2_connect_device_name (reply));
    c = xcb_connect(NULL, NULL);
    xcb_screen_t *screen = xcb_setup_roots_iterator(xcb_get_setup(c)).data;
    cookie = xcb_dri2_connect(c, screen->root, XCB_DRI2_DRIVER_TYPE_DRI);
    reply = xcb_dri2_connect_reply(c, cookie, 0);
    printf("%s[%d] device(%s)\n", __func__, __LINE__,
xcb_dri2_connect_device_name (reply));
    return 0;
}

build and test:

## Chapter-14 gcc dri2-test.c -lxcb -lxcb-dri2 -lX11 -lX11-xcb -o dri2-test
## Chapter-14 ./dri2-test
main[21] device(/dev/dri/card0)
main[27] device(/dev/dri/card0)
```

### 14.4.18 Installing GCC Toolchain on Debian

To install, run the following command:

```
apt update && apt install -y build-essential manpages-dev
```

After installation, confirm the GCC version:

```
root@linaro-alip:/# gcc -v
Using built-in specs.
COLLECT_GCC=gcc
COLLECT_LTO_WRAPPER=/usr/lib/gcc/aarch64-linux-gnu/10/lto-wrapper
Target: aarch64-linux-gnu
Configured with: ../src/configure -v --with-pkgversion='Debian 10.2.1-6' --with-
bugurl=file:///usr/share/doc/gcc-10/README.Bugs --enable-
languages=c,ada,c++,go,d,fortranx
Thread model: posix
Supported LTO compression algorithms: zlib zstd
gcc version 10.2.1 20210110 (Debian 10.2.1-6)
```

#### 14.4.19 Auto-Completion for Installing Packages on Debian

This is a common operation in Linux systems. Normally, you need to install the `bash-completion` package.

For specific instructions, search online, but it generally involves:

```
sudo apt-get install bash-completion
source /etc/bash_completion
```

#### 14.4.20 Supporting DRI3 Extension in Debian X11 System

DRI3 extension, part of X11, provides improved support for direct rendering. It's usually enabled by default in Debian. As a low-level protocol, it's not directly executed without external calls.

To use the DRI3 extension in applications, refer to DRI3 documentation and write code to call the respective interfaces. For example, use DRI3 interfaces provided by the XCB (X protocol C-language Binding) library. Here's how to install and view these interfaces in Debian:

- **Installing XCB DRI3 Development Libraries**

Install the `libxcb-dri3-dev` library with:

```
sudo apt-get install libxcb-dri3-dev
```

This installs the necessary libraries and headers for using DRI3 functions in your applications.

- **Viewing DRI3 Interfaces**

To view the definitions and functions of DRI3 interfaces, check the `dri3.h` header file:

```
vi /usr/include/xcb/dri3.h
```

This file contains specific implementations of the DRI3 interface, helping you understand how to use the DRI3 extension in your applications.

Follow these steps to start using the DRI3 extension in Debian for developing or improving your graphics applications. Remember to refer to official XCB and DRI3 documentation for correct and efficient use of these interfaces.

### 14.4.21 Setting System to Boot into Command Line Mode

The general method involves:

- Uninstalling xserver
- Enabling `CONFIG_FRAMEBUFFER_CONSOLE`, `CONFIG_DRM_FBDEV_EMULATION`, `CONFIG_VT`, `CONFIG_VT_CONSOLE` in the kernel

### 14.4.22 Configuring Screen Rotation

Refer to `/etc/X11/xorg.conf.d/20-modesetting.conf`

```
...
Section "Screen"
    Identifier "Default Screen"
    Device     "Rockchip Graphics"
    Monitor    "Default Monitor"
    DefaultDepth      24
    SubSection "Display"
        Depth      24
        Modes      "1024x600"
    EndSubSection
EndSection

#### Valid values for rotation are "normal", "left", "right"
Section "Monitor"
    Identifier "HDMI-A-1"
    Option     "Rotate" "inverted"
    Option     "Position" "0x0"
EndSection
Section "Monitor"
    Identifier "DSI-1"
    Option     "Rotate" "left"
    Option     "Position" "0x0"
EndSection
```

### 14.4.23 Implementing No Black Screen Function in Debian

Black screen refers to the time from X service startup to desktop application display (dependent on the desktop application itself).

To maintain a logo during this time, add the following before executing `Xorg.wrap` in `/usr/bin/X:`

```
export XSERVER_FREEZE_DISPLAY=/ .freeze_xserver
touch $XSERVER_FREEZE_DISPLAY
$(sleep 6; rm $XSERVER_FREEZE_DISPLAY)&
```

Freeze for 6 seconds, then display the desktop. Adjust the freeze duration as needed.

Alternatively:

```
{
    export XSERVER_FREEZE_DISPLAY=./freeze_xserver
    touch $XSERVER_FREEZE_DISPLAY
    while sleep .5; do
        pgrep panel && break # Waiting for status bar service
    done
    sleep 2 # Waiting for status bar rendering
    rm $XSERVER_FREEZE_DISPLAY
}&
```

#### 14.4.24 Removing Desktop Mouse Pointer Display in Debian System

The native mechanism is designed for compatibility with some non-touch applications, where Xserver converts the first touch event into a mouse event.

To bypass, try:

- Using a transparent mouse theme (search online for specifics)
- Modify `hw/xfree86/drivers/modesetting/drmmode_display.c` source code, removing `drmModeSetCursor`, `drmModeMoveCursor` calls
- If the SDK includes a `drm-cursor` library, modify `/etc/drm-cursor.conf` and add `hide=1`

#### 14.4.25 Steps for Compiling and Porting the rkaiq/rkisp Repository in Debian

To port the `rkaiq/rkisp` functionality from Buildroot to Debian:

##### 14.4.25.1 Overview of Steps

For chips like RK3588, switch to a lower version of GCC and GLIBC for porting to a third-party system.

**Step 1:** Modify the Buildroot configuration to support GCC 8.

```
[Various changes to the configuration files, including switching from
BR2_cortex_a76_a55 to BR2_cortex_a72_a53 and setting the GCC version to 8.x]
```

**Step 2:** Set the Buildroot configuration to use GCC 8 and GLIBC 2.28 by default.

```
buildroot# cat configs/rockchip_rk3588_glibc2.28_defconfig

[Configuration for rockchip_rk3588 with GCC version 8.x and GLIBC 2.28]
```

**Step 3:** Compile with Buildroot using the configured settings.

Set up the Buildroot environment and compile the `camera-engine-rkaiq` module.

```
<SDK># source buildroot/envsetup.sh rockchip_rk3588_glibc2.28
<SDK>## cd buildroot
buildroot# make camera-engine-rkaiq
```

After compilation, port the generated files (e.g., `output/rockchip_rk3588_glibc2.28/build/camera-engine-rkaiq-1.0/camera-engine-rkaiq-1.0.tar`) to the Debian system.

## 14.4.26 How to Download Offline Deb Packages in Debian

```
root@linaro-alip:/# apt-get download <package name>
```

## 14.4.27 How to Check glibc Version in Debian

```
root@linaro-alip:/# ldd --version
ldd (Debian GLIBC 2.31-13+deb11u7) 2.31
or
## Chapter-14 /lib/libc.so.6
GNU C Library (GNU libc) stable release version 2.35.
```

## 14.4.28 Support for Screen Splitting in Debian Systems

For a physically split screen with a resolution of 3840x2160 cut into 3840x720, the output resolution must be 3840x2160 to light up the screen, but only the 720 part is displayed.

The latest xserver added padding support.

Setting method:

```
+++ b/overlay/etc/X11/xorg.conf.d/20-modesetting.conf
[Configuration changes to set VirtualSize and Padding for the display]
```

Modify `/etc/X11/xorg.conf.d/20-modesetting.conf` as above. `VirtualSize` is configured as the desired resolution, and `Padding` is configured for the pixels cut off in the order top, bottom, left, right.

For unclear text on the screen, modify the padding order.

```
Option "VirtualSize" "DSI-1:1920x316"
Option "Padding" "DSI-1:0,0,0,764"
```

Mouse movement is relative and usually doesn't require special modifications. If there are ratio or position issues, consider using a software cursor (remove the mouse layer in kernel dts configuration or configure SWcursor in the modesetting conf).

To remove the cursor in kernel dts, search and delete, like:

```
kernel/arch/arm64/boot/dts/rockchip# ag cursor
rk3566-evb2-lp4x-v10-linux.dts
12:      cursor-win-id = <ROCKCHIP_VOP2_CLUSTER0>;
```

Or configure SWcursor in modesetting conf:



```
--- a/overlay/etc/X11/xorg.conf.d/20-modesetting.conf
+++ b/overlay/etc/X11/xorg.conf.d/20-modesetting.conf
@@ -2,6 +2,8 @@ Section "Device"
     Identifier   "Rockchip Graphics"
     Driver       "modesetting"

+    Option       "Swcursor"          "TRUE"
+
```

## 14.5 Linux Video Related Issues

### 14.5.1 When playing videos, there is stuttering, and the logs show frame dropping errors

Using `fpsdisplaysink` to confirm the maximum frame rate. If the maximum frame rate is close to the expected frame rate, you can specify `sync=false` to solve the problem, some platforms can enable AFBC. About video playback freezes, you can also check the hardware running time by `echo 0x100 > /sys/module/rk_vcodec/parameters/mpp_dev_debug`

### 14.5.2 gst-launch-1.0 Camera Video Preview Command

You can use `v4l2src` plugin, such as `gst-launch-1.0 v4l2src ! autovideosink`

### 14.5.3 The Playback Screen Jitters after Turning on AFBC

Screen jitter is generally caused by insufficient DDR bandwidth. You can try the fixed performance mode. In addition, due to the display hardware implementation, If there is scaling in the vertical direction, the required performance and bandwidth will be relatively high, which is easily insufficient, and other scaling methods should to be used (such as `rga/gpu`).

### 14.5.4 How does GStreamer implement zero-copy

Use `dmabuf` related interfaces for data processing to achieve zero copy

### 14.5.5 How to Test the Highest Decoding Performance of gst-launch-1.0

Set the performance mode, use the official `fpsdisplaysink` to check the frame rate, and the driver's debugging interface to check the driver frame rate.

### 14.5.6 The Screen Jitters or Ripples Appear during Playback

Jitter is generally caused by insufficient performance of the display hardware, mostly due to insufficient DDR bandwidth. DDR performance mode can be used to fix the highest frequency

## **14.5.7 How to Quickly Connect GStreamer to Opengles**

Generally, the synthesis is supported by the gl plug-in, and the display is supported by a third-party display service. Display services that can be synthesized internally through opengles (such as Weston)

## **14.6 Third-party OS Porting Issues**

### **14.6.1 Is There Any Introduction to Kylin System Porting, Which is to Download the Standard iso Image and Extract rootfs.squafs for Porting**

You can refer to the introduction of the porting document in the SDK, which is also applicable to Kirin os, but Kirin os is relatively closed. If you want better performance, you can ask Kirin for images of RK platform.

### **14.6.2 Which Domestic OS Have Been Adapted**

Tongxin and Kirin have adapted. In addition, the HarmonyOS community is currently working on the adaptation of RK3588, RK356X, and RK3399. For detailed progress, you can also consult our company's business, or follow the HarmonyOS open source community.

### **14.6.3 Whether to Support UEFI Booting**

RK3588 will give priority to supporting UEFI

## **14.7 Display Related Issues**

### **14.7.1 How to Send Video to the Video Layer**

There are interface of drm to query the type of plane. For details, please refer to kmssink method of gstreamer.

### **14.7.2 How to Configure the Position of Each Screen in Wayland Multi-screen with Differential Display Mode, Such As Left and Right or Up and Down Positions**

Weston's differential display only supports left and right arrangement, according to the screen loading order. please refer to

`<SDK>/docs/cn/Linux/*/Rockchip_Developer_Guide_Buildroot_Weston_CN.pdf` 2.9 Multi-screen configuration for details.

### **14.7.3 What is the Debian Xserver Version**

Debian10 uses xserver1.20.4, Debian11 uses xserver1.20.11

## 15. Chapter-15 SSH Public Key Operation Introduction

Please follow the introduction in the “Rockchip\_User\_Guide\_SDK\_Application\_And\_Synchronization\_CN” to generate an SSH public key and send the email to [fae@rock-chips.com](mailto:fae@rock-chips.com) to get the SDK code.

This document will be released to customers during the process of applying for permission.

### 15.1 Multiple Device Use the Same SSH Public Key

If the same SSH public key should be used in different machines, you can copy the SSH private key file `id_rsa` to “`~/.ssh/id_rsa`” of the machine you want to use.

The following prompt will appear when using a wrong private key, please be careful to replace it with the correct private key.

```
~/tmp$ git clone git@172.16.10.211:rk292x/mid/4.1.1_r1
Initialized empty Git repository in /home/cody/tmp/4.1.1_r1/.git/
The authenticity of host '172.16.10.211 (172.16.10.211)' can't be established.
RSA key fingerprint is fe:36:dd:30:bb:83:73:e1:0b:df:90:e2:73:e4:61:46.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '172.16.10.211' (RSA) to the list of known hosts.
git@172.16.10.211's password: █
```

After adding the correct private key, you can use git to clone code, as shown below.

```
~$ cd tmp/
~/tmp$ git clone git@172.16.10.211:rk292x/mid/4.1.1_r1
Initialized empty Git repository in /home/cody/tmp/4.1.1_r1/.git/
The authenticity of host '172.16.10.211 (172.16.10.211)' can't be established.
RSA key fingerprint is fe:36:dd:30:bb:83:73:e1:0b:df:90:e2:73:e4:61:46.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '172.16.10.211' (RSA) to the list of known hosts.
remote: Counting objects: 237923, done.
remote: Compressing objects: 100% (168382/168382), done.
Receiving objects: 9% (21570/237923), 61.52 MiB | 11.14 MiB/s
```

Adding ssh private key may result in the following error.

```
Agent admitted failure to sign using the key
```

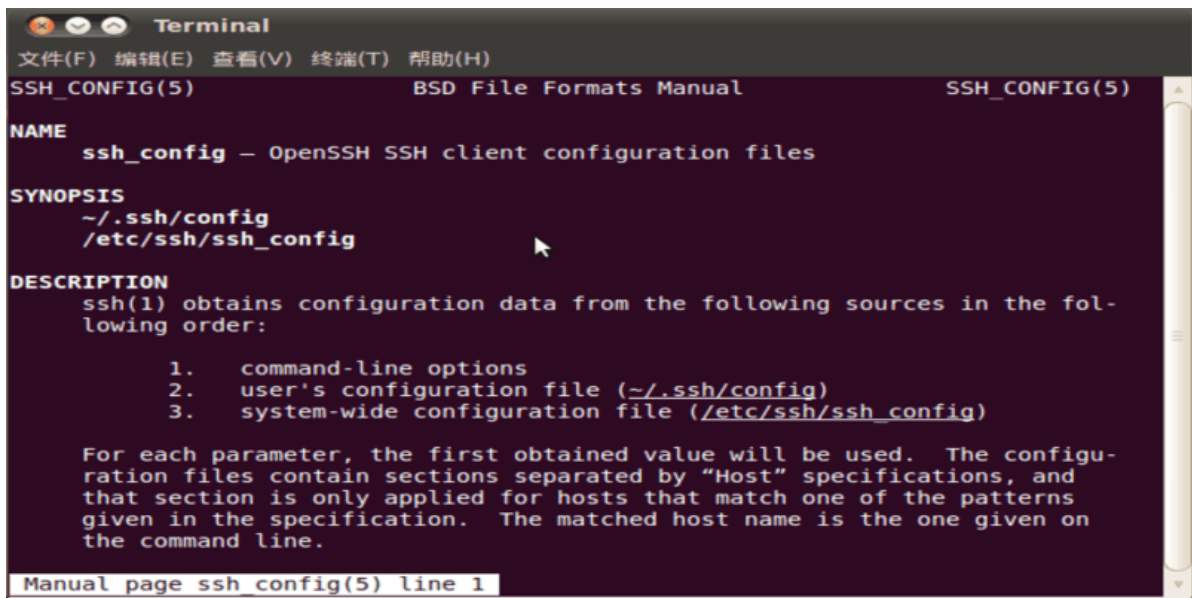
Enter the following command in console to solve:

```
ssh-add ~/.ssh/id_rsa
```

### 15.2 Switches Different SSH Public Keys on One Device

You can configure SSH by referring to `ssh_config` documentation.

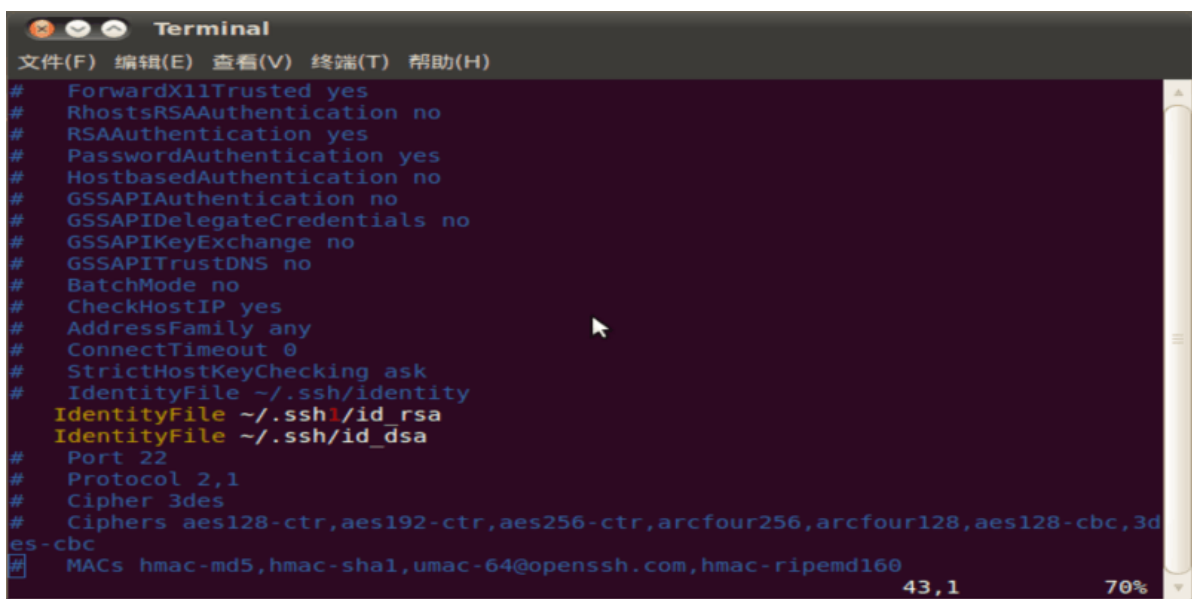
```
~$ man ssh_config
```



Run the following command to configure SSH configuration of current user.

```
~$ cp /etc/ssh/ssh_config ~/.ssh/config
~$ vi .ssh/config
```

As shown in the figure, SSH uses the file “~/.ssh1/id\_rsa” of another directory as an authentication private key. In this way, different keys can be switched.



## 15.3 Key Authority Management

Server can monitor download times and IP information of a key in real time. If an abnormality is found, download permission of the corresponding key will be disabled.

Keep the private key file properly. Do not grant second authorization to third parties.

## 15.4 Reference Documents

For more details, please refer to document

`<SDK>/docs/en/0thers/Rockchip_User_Guide_SDK_Application_And_Synchronization_EN.pdf`.