Geniatech

Spec V1.0

# Geniatech Rockchip Series

## Android Software Development Instruction

# Preface

## Overview:

The document is for Geniatech Rockchip series Android software development instruction, it can help software development engineer and technician engineer make development and testing better, the updated products development instruction of Geniatech Rockchip will be updated based on this document persistently.

## Product Version：

| Product name | Kernel version | Buildroot version |
|---|---|---|
| XPI-RK3288 | Linux3.10 | Android7.1.2 |

## Reader Object:

This document is mainly for software development engineers.

## Revision Recording:

| Date | Version | Author | Approved by | Modification Instruction |
|---|---|---|---|---|
| 2020-11-23 | | | | |

# INDEX

# 1.Support List

## 1.1Product list

| SoC | Model No | Software doc support | Function instruction |
|---|---|---|---|
| RK3288 | XPI-3288 | Yes | Support DDR3/DDR3L/LPDDR2 |

## 1.2Document development support list:

| SoC | H/W type | Function instruction |
|---|---|---|
| RK3288 | Dev board | hdmi out、ent、usbx4、wifi、rtc、extend 40Pin ribbon cable |

# 2.Document/tool index

## 2.1 Document Index:

This Rockchip Linux SDK doc is to help developer to make developing and tuning quickly, the involved content in Document doesn't include all knowledge and questions, document list also will be updated continuingly , if you have any questions and requirement, pls contact me at any time.

Rockchp Android SDK mainly includes Android source code, tool chain, based C library, simulation environment and development environment.

## 2.2 Tool Index:

The Rockchip Android SDK released tool is used to develop/tune and MP stage, tool version will be updated following SDK updating, if you have any questions and requirement for tool, pls contact us. In Tool directory ,Rockchip Android SDK also includes using tool in Android O/S, Windows O/S.

# 3.SDK Software Construction

## 3.1 SDK directory and construction

| Android source code root directory | Description |
|---|---|
| abi | Appliaction binary interface |
| art | New ART running environment |
| bionic | System C library |
| bootable | Start guidance related code |
| build | Store system compiling rule and generic based development kits configuration |
| cts | Android compatibility testing suite standard |
| dalvik | Dalvik machine |
| developers | Developer directory |
| development | Appliaction development relation |
| device | Device related configuration |
| docs | Referenced document directory |
| external | Open source module related files |
| frameworks | Application frameworks, Android system kernel is edited by Jave and C++ |
| hardware | Hardware abstract level code |
| IMAGE | Compiling generated directory is used to store firmware. |
| kernel | Dirver and DTS etc… |
| libcore | Kernel library files |

| | |
|---|---|
| libnativehelper | Dynamic library is JNI library’ s base. |
| ndk | NDK code, help developer to embed C/C++ source code in application |
| out | After compiling, source code is exported through this directory. |
| packages | Application package |
| pdk | Plug Development Kit abbreviation, local development suite. |
| platform_testing | Platform testing |
| prebuilts | Pre-edit some resource in X86 and ARM |
| RKDocs | RK related development document |
| RKTools | Some RK tool, e.g. burning tool, production tool |
| rockdev | generated firmware by editing. |
| sdk | SDK and simulated machine. |
| system | bottom file system library ,application and components. |
| toolchain | Tool chain files |
| tools | Tool files |
| u-boot | Boot guidance related code |
| vendor | Manufacturer customization code |
| Makefile | Overall Makefile files is used to define editing rules. |

For above several folders, device, build, out, packages, vendor, kernel and frameworks folders often are used during development.

For device: it includes some configuration files, e.g. WiFi, ADB port, you can add property and set some parameters once this port is set to fixed parameters.

For Build, it includes some editing rules, e.g. you can set up some application installation.

For Out: it includes some generated varied files after editing, e.g. all kinds of system applications, these will be installed in Android deivces.

For Package: it includes many Android projects source code, in mobile phone, you can see some clickable icons, actually it is a separated Android item.

# 4. Edition Environment Set up

## 4.1.1 JDK installation

Android 7.1 system edition depends on Java 8, before editing, you need to install OpenJDK, installation command is as below:

sudo apt-get install openjdk-8-jdk

Configure Java environment variables, e.g. installing route: /usr/lib/jvm/java-8-openjdk-amd64, you can execute in terminal command and configure environment variables.

export JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64

export PATH=$JAVA_HOME/bin:$PATH

export CLASSPATH=.:$JAVA_HOME/lib:$JAVA_HOME/lib/tools.jar

SDK includes Open JDK8 script files, it is named javaenv.sh in engineering root directory.

You can execute below command, and set JDK:

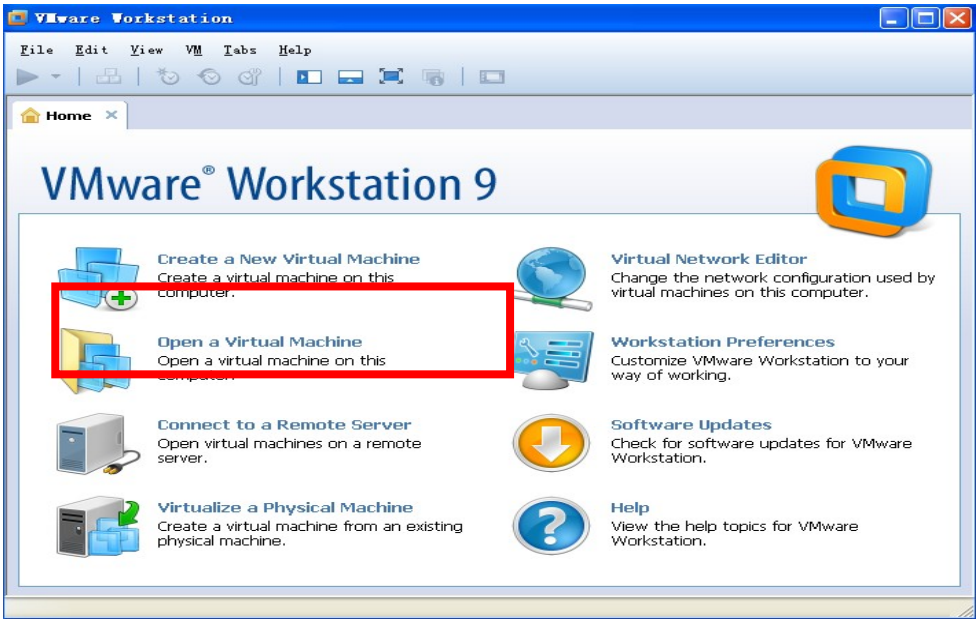
source javaenv.sh Linux

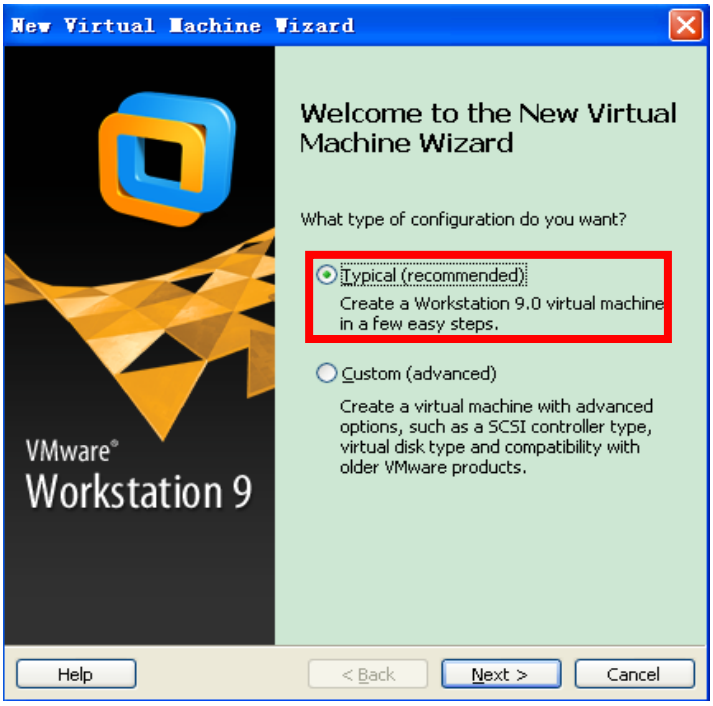
## 4.1.2 VMware Workstation installation ubuntu

4.1.2.1 You can download ubuntu-14.04.5-desktop-amd64.iso file in www.ubuntu.com

4.1.2.2 Build Virtual machine

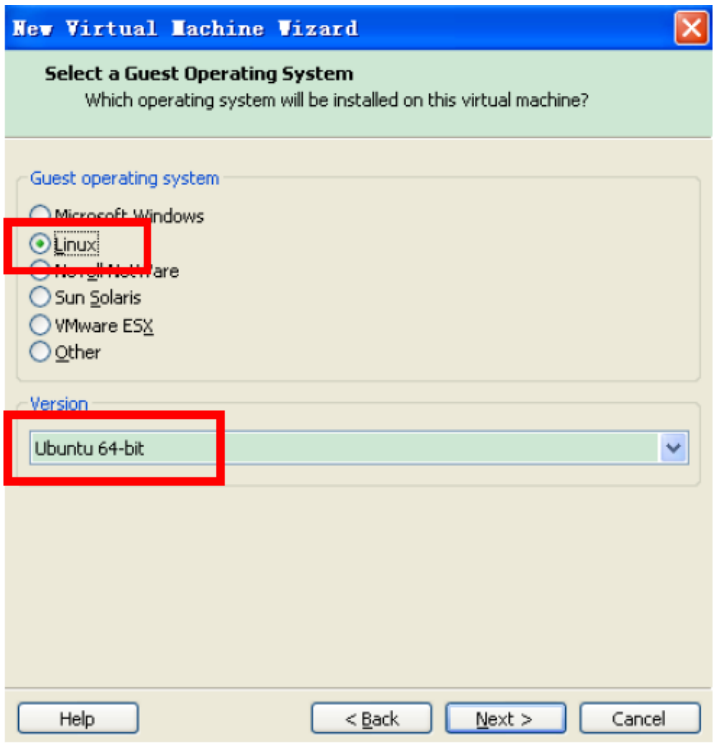
Open the Vmware Workstation, click on the graph of the "Create a New Virtual Machine", and open the "New Virtual Machine Wizard".



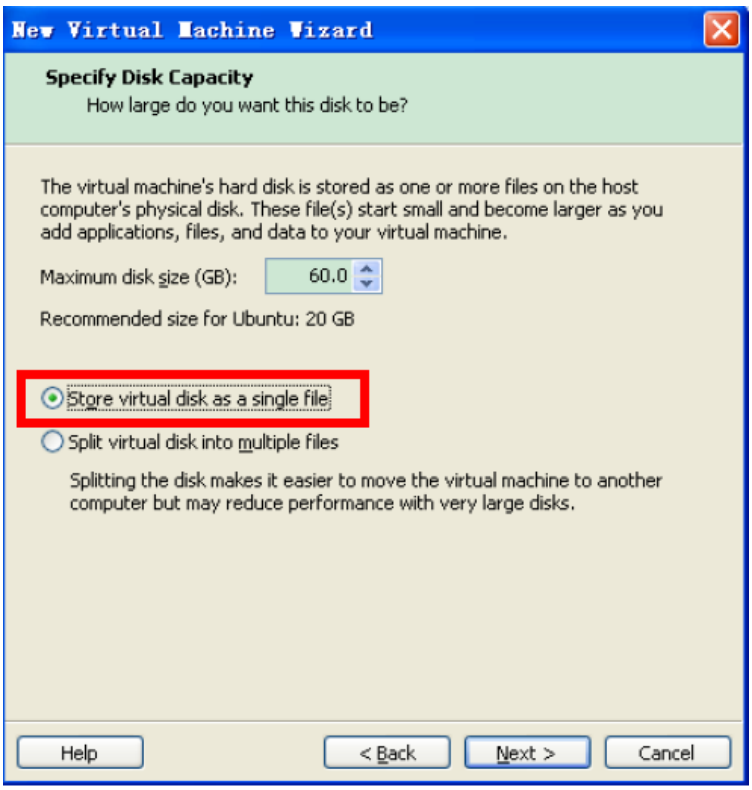

Default select "Typical" configuration and click on “Next” button, and then default select the “I will install the operating system later” item.

Click on the “Next” button to select a guest operating system, as in the following figure.



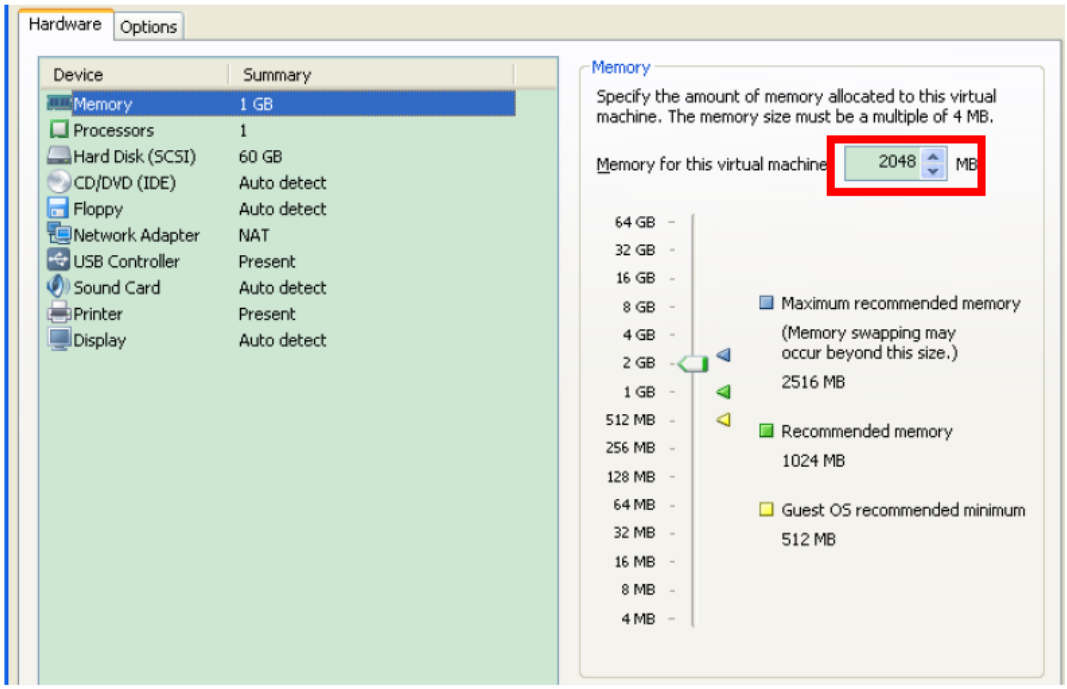

Click on the “Next” button, set the virtual machine name and path as you like

Click on the “Next” button, specify disk capacity, in general 60G is enough. Here select “Store virtual disk as a single file” item.



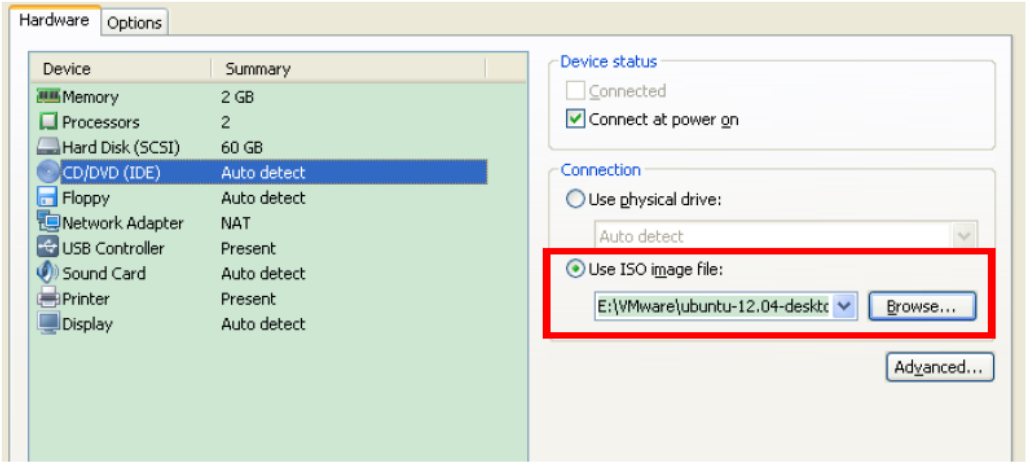
Click on the “Next” button, confirm setup information, after that click on the “finish” button to complete the configuration.

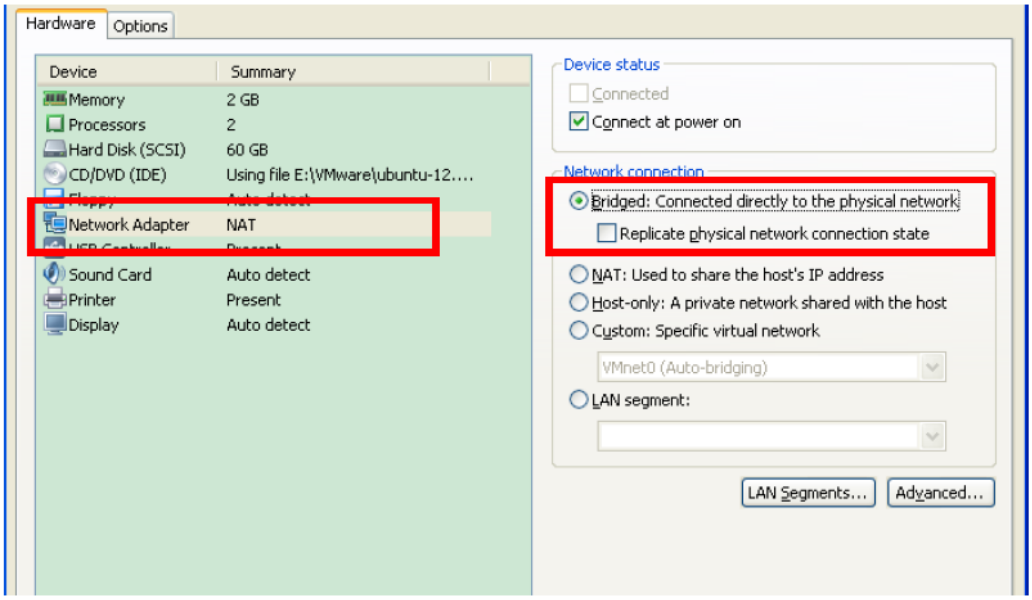
Now click on the “Edit virtual machine settings”, choose “Harware” tab, and set the memery to 2GB or more. You’d better set the processor to 2.


select “CD/DVD(IDE)” item on the hardware tab, afterwards choose the path to the ubuntu-12.04-desktop-amd64.iso image file in the right side bar, and then select “Network Adapter” item to choose bridged network connection for the convenience of

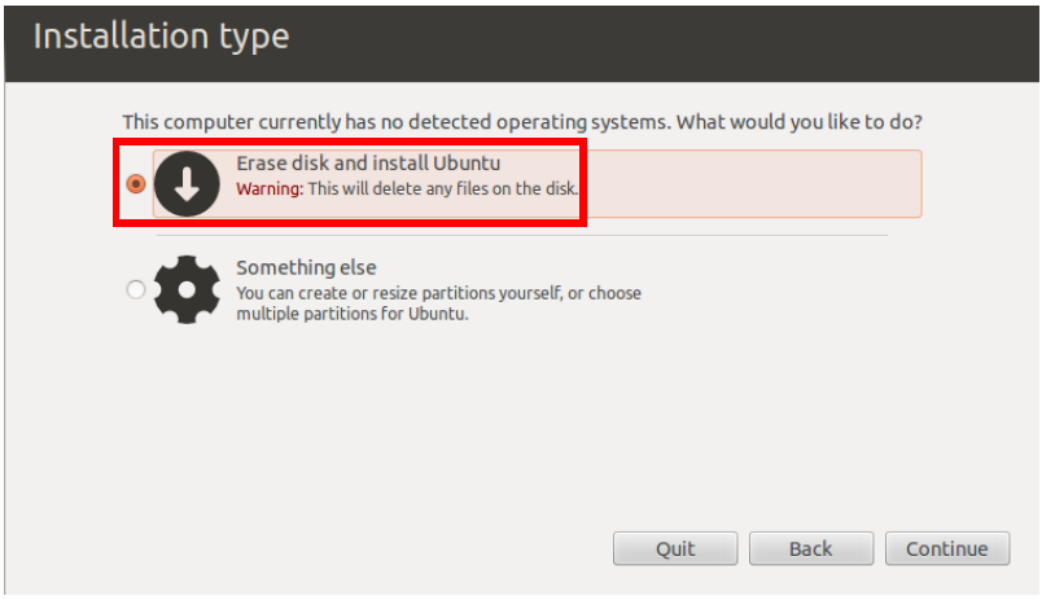
virtual machines and host access, just as followings. Click on the “ok” button to complete this configuration.

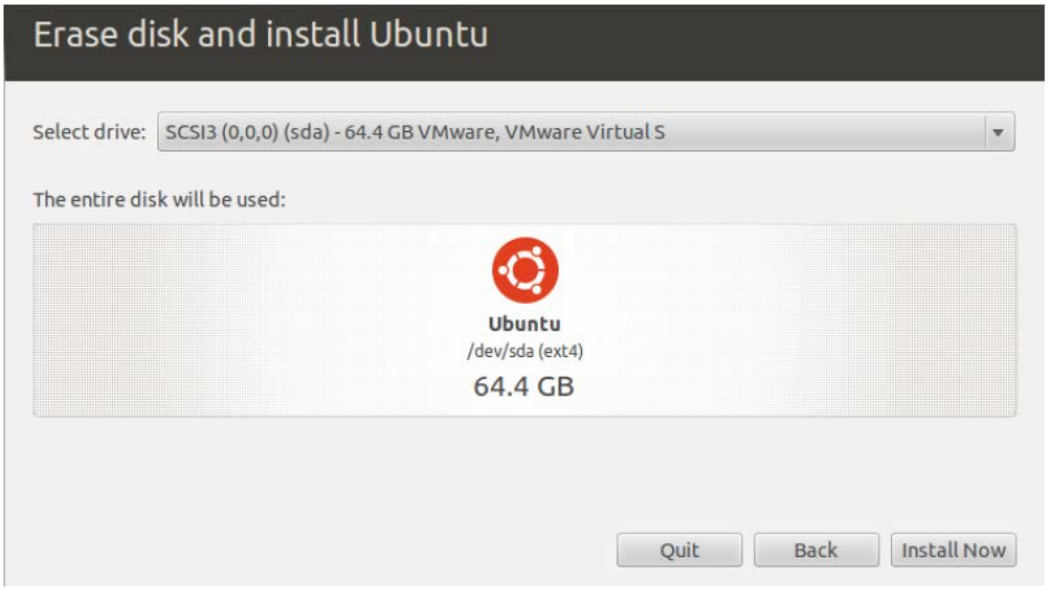


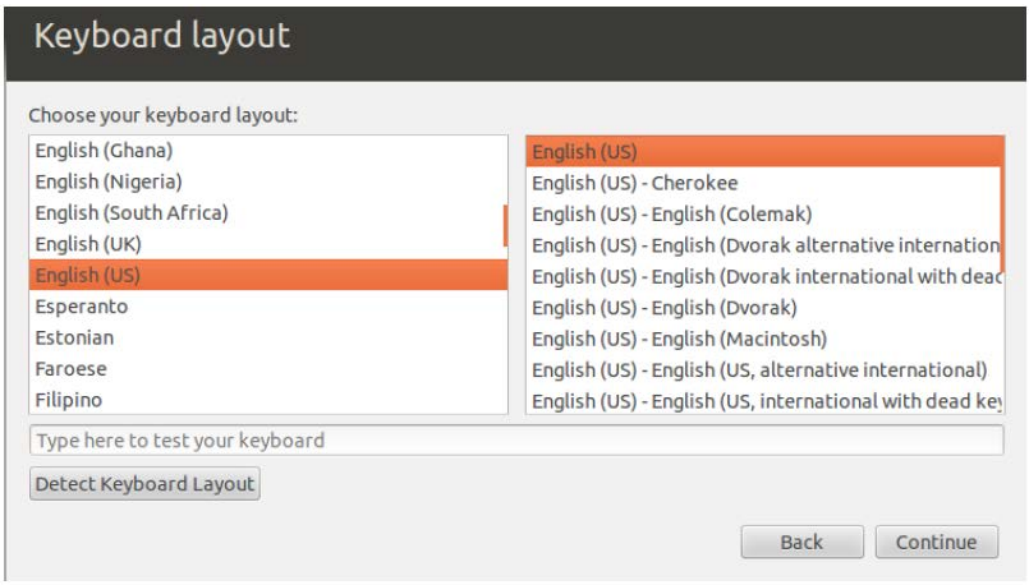

Click on “Power on this virtual machine” to start to install ubuntu operating system. Default select English language and press “Intall Ubuntu” to install the ubuntu operating system.


Click on “Continue” button to prepare to install Ubuntu. And prepare disk space, default select “Erase disk and install Ubuntu” item, and then click on the “Continue” button. Select the default driver and click on “Install Now” button to start to install the Ubuntu.






Choose a positon where you are, and click on “Continue” button. Select the default keyboard layout, just like below figures.




After that set your user name and password, click on the “Continue” button, and then pop up the installing interface. Please wait a moment for this process.



After installation, click on “Restart Now” button to restart into the Ubuntu login screen with the user name and password you set before.

# 5.Install compilation tools

Step 1，Install some necessary packages, which will be used later in the compilation process. You can enter the following commands in the terminal. During this process, enter "Y" to continue.

$ sudo apt-get install git-core gnupg flex bison gperf build-essential zip curl libc6-dev libncurses5-dev x11proto-core-dev libx11-dev libreadline6-dev libgl1-mesa-glx libgl1-mesa-dev g++-multilib mingw32 tofrodos python-markdown libxml2-utils xsltproc zlib1g-dev lib32z1 libxml2-utils lzop

```
root@jolie-ubt:/home/jp# apt-get install git-core gnupg flex bison  gperf build-e
ssential zip curl libc6-dev libncurses5-dev x11proto-core-dev libx11-dev libreadl
ine6-dev libgl1-mesa-glx libgl1-mesa-dev g++-multilib mingw32 tofrodos python-mar
kdown libxml2-utils xsltproc zlib1g-dev
```

Step 2，Download the cross compilation tool through the link as below

http://www.geniatech.net/down-eng/tools/aarch64-linux-gnu.tar.xz.zip

Step 3， Switch to the directory where the file you just downloaded, directly delete the .zip of the file name, without decompression, and then command to decompress the aarch64-linux-gnu.tar.xz file, and configure the environment variables as follows:

$ xz -d aarch64-linux-gnu.tar.xz

$ tar -xvf aarch64-linux-gnu.tar

$ export PATH=/opt/aarch64-linux-gnu/bin:$PATH

Step 4，Jack-server configuration

The Android7.1 system uses jack-server as the java code compiler, and the following similar errors may be encountered during the compilation process:

Jack server already installed in "/home/yhx/.jack-server"

Communication error with Jack server (1), try 'jack-diagnose' or see Jack server log

Communication error with Jack server 1. Try 'jack-diagnose'

Communication error with Jack server 1. Try 'jack-diagnose'

This situation is mainly due to the limitation of the jack-server compiler, and the same network port number cannot be used by multiple users at the same time.That is, in the process of collaborative development on the server, when multiple users compile Android 7.1 at the same time, they need to configure each to use a different network port number.

The two configuration files of jack-server (yhx is the user name of the corresponding user) determine the port number it uses:

/home/yhx/.jack-server/config.properties

/home/yhx/.jack-settings

These two configuration files need to be configured with two port numbers, namely the server port number and the client port number. The port numbers in the two configuration files must match.

jack.server.service.port=8074

jack.server.admin.port=8075

And

SERVER_PORT_SERVICE=8074

SERVER_PORT_ADMIN=8075

The configuration steps are as follows:

***4.1*** Make sure that two configuration files are existed and the permissions are set to 0600：

chmod 0600 /home/yhx/.jack-server/config.properties

chmod 0600 /home/yhx/.jack-settings

***4.2*** If the two configuration files do not exist, please refer to the following text to create these two configuration files.

config.properties The file example is as follows (the port number needs to be modified according to the actual situation)：

jack.server.max-jars-size=104857600

jack.server.max-service=4

jack.server.service.port=8074

jack.server.max-service.by-mem=1\=2147483648\:2\=3221225472\:3\=42949

67296

jack.server.admin.port=8075

jack.server.config.version=2

jack.server.time-out=7200

.jack-settings The file example is as follows (the port number needs to be modified according to the actual situation)：

# Server settings

SERVER_HOST=127.0.0.1

SERVER_PORT_SERVICE=8074

SERVER_PORT_ADMIN=8075

# Internal, do not touch

SETTING_VERSION=4

***4.3*** To modify the port number, please change the service port and admin port to other port numbers. The port numbers in the two configuration files need to match. Examples are as follows:

jack.server.service.port=8023

jack.server.admin.port=8024

SERVER_PORT_SERVICE=8023

SERVER_PORT_ADMIN=8024

***4.4***Recompile Android to see if it reports an error. If it still reports an error, please try to change other port numbers until the compilation passes.

***4.5*** If the compilation fails after 5 changes, you can execute the jack-admin dump-report command to decompress the compressed package generated by the command and analyze the log log. If the following log appears, you can reinstall libcurl:

$ JACK_EXTRA_CURL_OPTIONS=-v jack-admin list server

* Protocol https not supported or disabled in libcurl

* Closing connection -1

Communication error with Jack server 1. Try „jack-diagnose“

# 6.SDK Compile

The SDK is compiled in userdebug mode by default. When using ADB, you need to execute adb root first to make the shell obtain root privileges, and then perform other operations like adb remount, adb push, etc

## 6.1 Uboot compile

- XPI3288

$make rk3288_secure_defconfig

$./mkv7.sh

After compiling, files rk3288_loader_v2.05.240bin， trust.img and uboot.img will be generated

## 6.2 Kernel compile

- XPI3288

$make ARCH=arm rockchip_defconfig

$make ARCH=arm rk3288-evb-rk818-edp.img

or

$make ARCH=arm rk3288-evb-android-rk818-edp.img

The initial package is rk3288-evb-rk818-edp，，which will be cut to rk3288-evb-android-rk818-edp after update

After the compilation is complete, the kernel root directory will generate two image files, kernel.img and resource.img.

## 6.3 Android compilation and firmware generation

- XPI3288

After the customer configures the JDK environment variables according to the actual compilation environment, follow the steps below and execute make.

```
$ source build/envsetup.sh
$ lunch rk3288-userdebug
$ make -j4
```

After compiling, execute the mkimage.sh script in the root directory of the SDK to generate the firmware, and all the images required for programming will be copied to the rockdev/Image-rk3288 directory.

Or directly use the script to compile, the command is as follows:

```
$device/rockchip/rk3288/build.sh
```

# 7.SDK image burning

## 7.1 Overview

This chapter mainly introduces the process of how to program the completed image file (image) and run it on the hardware device. Several mirror programming tools provided by Rockchip platform are introduced as shown in the following table. You can choose a suitable programming method for programming. Before programming, you need to install the latest USB driver, see 4.3.2 USB Driver Installation for details.

| tool | system | description |
|---|---|---|
| Rockchip Development Tools | Windows | Discrete upgrade firmware and the entire update upgrade firmware tool |

## 7.2 Introduction to programming mode

Several modes of Rockchip platform hardware operation are shown in the table below. Only when the device is in Maskrom and Loader mode, can the firmware be programmed or the on-board firmware can be updated.

| mode | Tool burn | instruction |
|---|---|---|
| Maskrom | support | When Flash has not burned the firmware, the chip will boot into Maskrom mode, and the firmware can be burned for the first time; during development and debugging, if the Loader fails to start normally, you can also enter Maskrom mode to burn the firmware. |
| Loader | support | In Loader mode, firmware can be programmed and upgraded. A certain partition image file can be programmed separately through the tool to facilitate debugging. |

# 8.GPIO control

## 8.1 Driver files and DTS configuration

The location of the driver file: kernel/drivers/pinctrl/pinctrl-rk3368.c (note that because this set of drivers is inherited from rk3368, the pinctrl driver is the name.)

Drive DTS node to configure pinctrl, the driver will analyze and store the 3 sets of pinctrl configuration corresponding to "default", "idle", and "sleep" for use in specific occasions. Three commonly used states are given in Pinctrl-state.h: The default state represents the state of the device when it is active, which is generally configured in the .resume of the device driver. In addition, the pin will also be set to the default state at startup.

The idle state represents the pin state that needs to be configured when the system is idle, and the system does not enter deep sleep at this time.

The sleep state represents the pin state when the system is in deep sleep, which is generally configured in the .suspend of the device driver. For example, the configuration of the "default" group of pins will be configured in the register when the probe is driven, and the configuration of other groups need to be parsed out in the code, and then switch to use. For example, use in the DTS configuration and code of HDMI pinctrl:

```
hdmi: hdmi@ff3c0000 {
compatible = "rockchip,rk322xh-hdmi";
reg = <0x0 0xff3c0000 0x0 0x20000>,
<0x0 0xff430000 0x0 0x10000>;
pinctrl-names = "default", "gpio";
pinctrl-0 = <&hdmi_cec &hdmii2c_xfer &hdmi_hpd>;
pinctrl-1 = <&i2c3_gpio &hdmi_cec>;
rockchip,grf = <&grf>;
rockchip,hdmi_audio_source = <0>;
```

rockchip,hdcp_enable = <0>;

rockchip,cec_enable = <0>;

status = "disabled";

};

Used in the code:

The driver analyzes the gpio state and switches to gpio mode:

```
gpio_state = pinctrl_lookup_state(hdmi_dev->dev->pins->p, "gpio");
pinctrl_select_state(hdmi_dev->dev->pins->p, gpio_state);
default：
pinctrl_select_state(hdmi_dev->dev->pins->p,
hdmi_dev->dev->pins->default_state);
```

## 8.2 IOMUX configuration

The iomux configuration is to switch the mux value corresponding to the pin, which has the following definitions, which correspond to the corresponding

Register value:

```
#define RK_FUNC_GPIO 0
#define RK_FUNC_1 1
#define RK_FUNC_2 2


#define RK_FUNC_3 3
#define RK_FUNC_4 4
#define RK_FUNC_5  5
#define RK_FUNC_6  6
#define RK_FUNC_7  7
```

The following is still an example of hdmii2c_xfer; first, we find it in the GRF chapter of trm of 3228H

The two pins i2c3hdmi_scl and i2c3hdmi_sda correspond to gpio0a5 and gpio0a6. Both function pins are binary ‘01’ as the function value, that is, use RK_FUNC_1;

How to modify if the pin pin defined in the hardware schematic diagram is different from the given reference code or the mux value is different. Suppose there is a specific product that uses i2c2 to connect to HDMI for communication function.

The rk3228h-xxx.dts quoted coverage to achieve, the following is an example:

```
&hdmi_rk_fb {
status = "okay";
pinctrl-names = "default", "gpio";
pinctrl-0 = <&i2c2_xfer &hdmi_cec>;
pinctrl-1 = <&i2c2_gpio>;
};
```

## 8.3 Drive strength configuration

The drive strength configuration, that is, the drive strength current value corresponding to the configuration, respectively corresponds to the corresponding register value, similar to the usage of mux, the following is an example:

```
pcfg_pull_down_12ma: pcfg-pull-down-12ma {
bias-pull-down;
drive-strength = <12>;
};
```

If you want to increase or decrease the drive strength, but it is different from the drive strength defined by dtsi, how to modify it. It is similar to the modification of mux, after being quoted in the product DTS file, the modification is overwritten. Each pin has its own corresponding drive current intensity range, so when configuring it, select its effective configurable current value. If it is not the effective current value corresponding to the pin, the configuration will be wrong and cannot take effect.

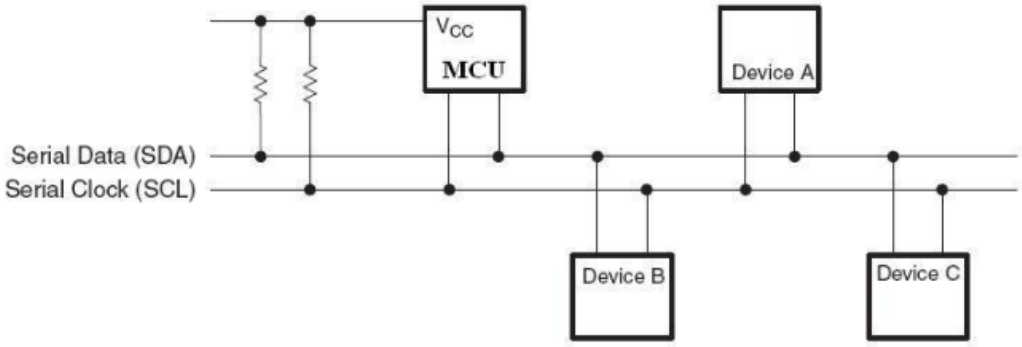
# 9.I2C control

The I2C (Inter-Integrated Circuit) bus is a two-wire serial bus developed by PHILIPS, which is used to connect the microcontroller and its peripherals; the I2C bus controller uses the serial data (SDA) line and the serial clock (SCL) ) The wire transfers information between devices connected to the bus. Each device has a unique address identification (whether it is a microcontroller-MCU, LCD driver, memory or keyboard interface), and can be used as a transmitter or receiver (determined by the function of the device).

Rockchip I2C controller supports the following functions:

- Compatible with I2C and SMBus bus
- Support I2C bus in master mode
- Software programmable clock frequency and transmission rate up to 1000kbps
- Support 7-bit and 10-bit addressing modes
- Interrupt or poll up to 32 bytes of data transmission at a time
- Clock stretching and waiting state

The following figure shows the hardware connection method of the I2C bus. A pull-up resistor is required. Changing the size of the pull-up resistor can adjust the pull-up strength of the I2C bus:




I²C 总线连线图

# 9.1dts node configuration

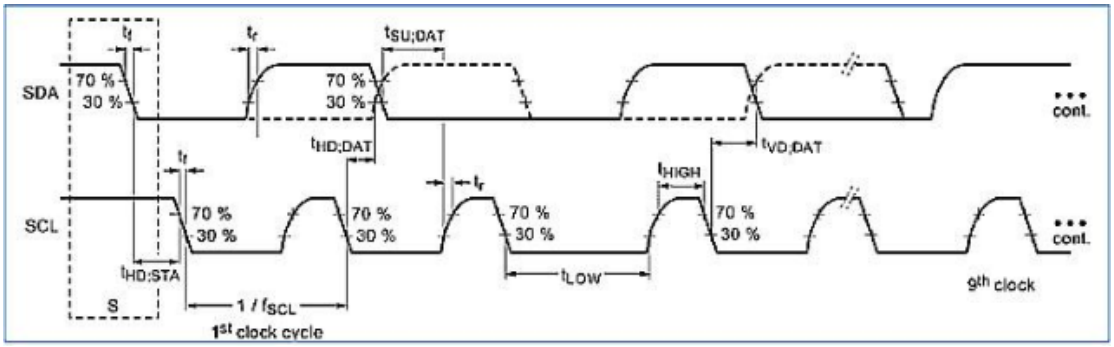
You can refer to the files in the Linux kernel directory:
Documentation/devicetree/bindings/i2c/i2c-rk3x.txt Dts node configuration can refer to the file in the Linux kernel directory: Documentation/devicetree/bindings/i2c/i2c-rk3x.txt

# 9.2 Need configuration items:

8.2.1 I2C rate configuration: Please refer to the datasheet of the device to determine the adaptable clock, generally 400k, 100k (default, optional), 200k, 1000k;
400k example:
clock-frequency = <400000>;
8.2.2 i2c_clk rising edge time, falling edge time;
When the I2C rate configuration is required to exceed 100k, the rising edge and falling edge time of i2c_clk must be measured by an oscilloscope; because the I2C protocol standard has regulations on the rising edge and falling edge time, especially the rising edge time, if it exceeds the protocol specified The maximum value, the I2C communication may fail. The following is the rising and falling edge time range specified by the protocol:

| Symbol | Parameter | Standard-mode | | Fast-mode | | Fast-mode Plus | | unit |
|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Min | Max | Min | Max | |
| fSCL | SCL clock frequency | | 100 | | 400 | | 1000 | KHZ |
| Tr | rise time of both SDA and SCL signals | | 1000 | 20 | 300 | | 120 | ns |
| Tf | fall time of both SDA and SCL signals | | 300 | 20× (VDD/5.5V | 300 | 20× (VDD/5.5V | 300 | ns |

Rising edge Tr, falling edge Tf, respectively take 30%~70% of the waveform time:




8.2.3 If the above two items are not configured, the calculation will be based on the max value of the rising edge and the falling edge by default, and the clk speed obtained will be nearly 90k. The default max value of 100k is 1000ns, which is in line with most hardware, so if the requirement is not high, it can not be configured.

8.2.4 The i2c1+es8316 codec example shows that a 400k i2c clock is needed, and the oscilloscope measured Tr=164ns, Tf=15ns:

```
&i2c1 {
status = "okay";
i2c-scl-rising-time-ns = <164>;


i2c-scl-falling-time-ns = <15>;
clock-frequency = <400000>;
es8316: es8316@10 {
#sound-dai-cells = <0>;
compatible = "everest,es8316";
reg = <0x10>;
clocks = <&cru SCLK_I2S_8CH_OUT>;
clock-names = "mclk";
spk-con-gpio = <&gpio0 11 GPIO_ACTIVE_HIGH>;
hp-det-gpio = <&gpio4 28 GPIO_ACTIVE_LOW>;
};
};
```

# 10 Serial port settings and calls

If you are developing U-Boot or kernel, the USB serial adapter (short for USB-to-serial TTL adapter) is very useful for checking the system boot log, especially when there is no graphical desktop display.

uart2 is generally used as a debugging serial port, but there is also multiplexing, which means that the TF card and the debugging serial port cannot be used at the same time:

- SDMMC_D0/UART2_TX
- SDMMC_D1/UART2_RX

## 10.1 Rockchip Uart features

UART (Universal Asynchronous Receiver/Transmitter), the following are some features supported by linux 3.10 uart driver:

Up to 4M baud rate

Support interrupt transmission mode

Support DMA transfer mode

Support 5, 6, 7, 8 data bits

Support automatic flow control

## 10.2 DTS node configuration

Serial DTS node:

```
uart0: serial@ff110000 {
compatible = "rockchip,serial";
reg = <0x0 0xff110000 0x0 0x100>;
interrupts = <GIC_SPI 55 IRQ_TYPE_LEVEL_HIGH>;
clock-frequency = <24000000>;
clocks = <&clk_uart0>, <&clk_gates16 11>;
clock-names = "sclk_uart", "pclk_uart";
reg-shift = <2>;
reg-io-width = <4>;
dmas = <&pdma 2>, <&pdma 3>;
#dma-cells = <2>;
```

```
pinctrl-names = "default";
pinctrl-0 = <&uart0_xfer &uart0_cts &uart0_rts>;

status = "disabled";
};
```

Add the following code to the board-level DTS file：

```
&uart0 {
dma-names = "tx", "rx"; Enable DMA receive and send
status = "okay";
};
```

Enable after /dev/ttys0 devices can be used

## 10.3Change the serial port for printing logs

```
fiq_debugger: fiq-debugger {
        compatible = "rockchip,fiq-debugger";
        rockchip,serial-id = <2>; Set the serial port ID

        rockchip,signal-irq = <182>;
        rockchip,wake-irq = <0>;
        rockchip,irq-mode-enable = <1>; /* If enable uart uses irq instead
of fiq */
        rockchip,baudrate = <1500000>; /* Only 115200 and 1500000 */
pinctrl-names = "default";
        pinctrl-0 = <&uart2c_xfer>; configuration iomux
};
```

The above required information can be obtained through the DTS node of the serial device, for example:

```
uart1: serial@ff190000 {
compatible = "rockchip,rk3399-uart", "snps,dw-apb-uart";
reg = <0x0 0xff190000 0x0 0x100>;
clocks = <&cru SCLK_UART1>, <&cru PCLK_UART1>;
clock-names = "baudclk", "apb_pclk";
interrupts = <GIC_SPI 98 IRQ_TYPE_LEVEL_HIGH>;
dmas = <&dmac_peri 2>, <&dmac_peri 3>;
dma-names = "tx", "rx";
reg-shift = <2>;
reg-io-width = <4>;
pinctrl-names = "default";
/*pinctrl-0 = <&uart1_xfer>;*/
status = "disabled";
};
```

Note, to ensure that the CLK of other serial ports is not turned off, otherwise the switching process may cause a crash.

## 10.4 Debug serial device

It is best not to use commands such as echo cat to debug the serial port device rudely, it is better to use the tested apk software, or contact our FAE to obtain the ts_uart test bin file

# 11 MIPI DSI Panel

## 11.1 Add the backlight information

**PWM driver file：**
drivers/pwm/pwm-rockchip.c

**DTS node：**
pwm0: pwm@ff1b0000 {
compatible = "rockchip,rk-pwm";
reg = <0x0 0xff1b0000 0x0 0x10>;
#pwm-cells = <2>;
pinctrl-names = "default";
pinctrl-0 = <&pwm0_pin>;
clocks = <&clk_gates2 8>, <&clk_gates16 6>;
clock-names = "pwm", "pclk"; status = "disabled";
};PWM 连续模式使用配置

**Backlight Node:**
backlight: backlight {
compatible = "pwm-backlight";
pwms = <&pwm0 0 25000>;
brightness-levels = < 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255>;
default-brightness-level = <200>;
enable-gpios = <&gpio1 13 GPIO_ACTIVE_HIGH>;
};

- pwms: OF device-tree PWM specification (see PWM binding[0]).
- brightness-levels: Array of distinct brightness levels. Typically these are in the range from 0 to 255, but any range starting at 0 will do.The actual brightness level (PWM duty cycle) will be interpolated from these values. 0 means a 0% duty cycle (darkest/off), while the last value in the array represents a 100% duty cycle(brightest).
- default-brightness-level: the default brightness level (index into the array defined by the "brightness-levels" property)
- enable-gpios: contains a single GPIO specifier for the GPIO which enables and disables the backlight

**Refer to the documents in the kernel directory：**
Documentation/devicetree/bindings/video/backlight/pwm-backlight.txt

## 11.2 Setting MIPI information

在 dtsi 中添加 MIPI 配置信息：

```
disp_mipi_init: mipi_dsi_init{
compatible = "rockchip,mipi_dsi_init";
rockchip,screen_init = <1>;
rockchip,dsi_lane = <4>;
rockchip,dsi_hs_clk = <1020>;
rockchip,mipi_dsi_num = <2>;
};
```

- rockchip,screen_init: Whether you need this screen initialization.
  <0>: Don't need to be initialized.
  <1>: Do need to be initialized.；
- rockchip,dsi_lane: mipi lcd data lane number.
- rockchip,dsi_hs_clk: mipi lcd high speed clock.

rockchip,mipi_dsi_num: mipi lcd dsi number.

**Refer to the documents in the kernel directory：**
Documentation/devicetree/bindings/video/rockchip_mipidsi_lcd.txt

## 11.3 Setting LCD PIN

**PIN MUX Information：**

```
disp_mipi_power_ctr: mipi_power_ctr{
mipi_lcd_rst:mipi_lcd_rst{
rockchip,gpios = <&gpio7 GPIO_B2 GPIO_ACTIVE_HIGH>;
        rockchip,delay = <10>;
};
/*mipi_lcd_en:mipi_lcd_en {
rockchip,gpios = <&gpio6 GPIO_A7 GPIO_ACTIVE_HIGH>;
    rockchip,delay = <10>;
 };*/
};
```

- mipi_lcd_en:mipi_lcd_en: Should specify pin control groups used for enable this lcd.
- rockchip,gpios: gpio pin.

- rockchip,delay: delay the millisecond.
- mipi_lcd_rst:mipi_lcd_rst: Should specify pin control groups used for reset this lcd.

## 11.4 Setting Init Command

**Command：**

disp_mipi_init_cmds**:** screen-on-cmds **{**
rockchip**,**cmd_debug = <0>**;**
rockchip**,**on-cmds1 **{**
rockchip**,**cmd_type = <LPDT>**;**
rockchip**,**dsi_id = <2>**;**
rockchip**,**cmd = <0x05 0x01>**;** //set soft reset
rockchip,cmd_delay = <10>;
**};**
**};**

- rockchip,cmd_debug : debug the cammands.

<0>: close the debug;
<1>: open the debug;

- rockchip,on-cmds1: write cammand to mipi lcd.
- rockchip,cmd_type:

<LPDT>: close the debug;
<HSDT>: open the debug;

- rockchip,dsi_id: write cammand to mipi lcd(left and right).

<0>: left dsi;
<1>: right dsi;
<2>: left and right dsis;

- rockchip,cmd: cammand context.

The first parameter was data type;
The second parameter was index(register);
The third and ... parameter are cammand context;

- rockchip,cmd_delay: delay the millisecond.

## 11.5 Configure display timing

**Timing：**

disp_timings**:** display-timings **{**
native-mode = <**&**timing0>**;**
timing0**:** timing0 **{**
screen-type = <SCREEN_DUAL_MIPI>**;**
lvds-format = <LVDS_8BIT_2>**;**
out-face = <OUT_P888>**;**
clock-frequency = <285000000>**;**
hactive = <2560>**;** vactive = <1600>**;**
hsync-len = <38>**;**//19
hback-porch = <80>**;**//40
hfront-porch = <246>**;**//123
vsync-len = <4>**;**
vback-porch = <4>**;**
vfront-porch = <12>**;**
hsync-active = <0>**;**

vsync-active = <0>;
de-active = <0>;
pixelclk-active = <0>;
swap-rb = <0>;
swap-rg = <0>;
swap-gb = <0>;
};
};

- screen-type: mipi lcd type.
  <SCREEN_DUAL_MIPI>: Dual channel mipi lcd.
  <SCREEN_MIPI>: single channel mipi lcd.
- lvds-format:No relationship.
- out-face: DPI color coding as follows:
  <OUT_P888>:24bit
  <OUT_P666>:18bit
  <OUT_P565>:16bit
- hactive, vactive: display resolution
- hfront-porch, hback-porch, hsync-len: horizontal display timing parameters in pixels;
- vfront-porch, vback-porch, vsync-len: vertical display timing parameters in lines
- clock-frequency: display clock in Hz
- swap-rb :exchange of red and blue.
- swap-rg :exchange of red and green.
- swap-gb :exchange of green and blue.
- hsync-active: hsync pulse is active low/high/ignored
- vsync-active: vsync pulse is active low/high/ignored
- de-active: data-enable pulse is active low/high/ignored

## 11.6 dsi host setting

While single mipi panel，need to enable dsihost0，as：

```
&dsihost0 {
status = "okay";
};
```