Instructions to Build System Images Separately

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Preface

Overview

The document presents how to build kernel, U-Boot or Rootfs of Rockchip RV1126/RV1109 Linux SDK separately, aiming to help engineers get started with RV1126/RV1109 Linux SDK faster.

[NOTICE]: Please update SDK version to V1.3.0 or the latest version

Get the version of SDK: `realpath .repo/manifests/rv1126_rv1109_linux_release.xml`

Product Version

Chipset	Kernel Version
RV1126/RV1109	Linux 4.19

Intended Audience

This document (this guide) is mainly intended for:

- Technical support engineers
- Software development engineers

Revision History

Version	Author	Date	Revision History
2020-08-10	V1.0.0	CWW	alpha
2020-08-12	V1.1.0	CWW	1. Add idblock.bin compile instructions 2. Add drivers insmod
2020-09-01	V1.2.0	CWW	1. Support eMMC compile instructions
2020-09-10	V1.3.0	CWW	1. Add Debug info chapter
2020-09-15	V1.4.0	CWW	1. Support AB system compilation
2020-09-27	V1.5.0	CWW	1. Fix BSP library build 2. Add print cif info
2020-12-08	V1.5.1	CWW	1. Fix insmod driver module
2021-01-14	V1.6.0	CWW	1. Update manufacture programmer firmware image
2021-02-18	V1.6.1	CWW	1. Update BSP library
2021-03-01	V1.6.2	CWW	1. Update CIF driver module to clear unready dev
2021-03-17	V1.6.3	CWW	1. Add the chapter of instructions to camera-related drivers insmod
2021-04-29	V1.6.4	CWW	1. Remove ./make.sh spl-s
2021-08-06	V1.6.5	CWW	1. Fix isp and cif insmod 2. Add jffs2 rootfs 3. Add Encode Debug Info

Instructions to Build System Images Separately

1. U-Boot Compilation

1.1 Get U-Boot Code from SDK

Get thses directories from root directory of SDK:

Directory or File	Description
rkbin	about DDR and prebuilt loader bin
u-boot	U-Boot code
prebuilts	cross-compile tool

1.2 For SPI NOR U-Boot Compilation

```
cd u-boot
./make.sh rv1126-spi-nor-tiny
./make.sh --spl
./make.sh --idblock --spl
```

1.3 For eMMC U-Boot Compilation

1.3.1 AB System Is Not Supported

```
cd u-boot
./make.sh rv1126
./make.sh --spl
# parameter e.g.
#
mtdparts=rk29xxnand:0x00002000@0x00004000(uboot),0x00010000@0x00006000(boot),0x00
010000@0x00016000(rootfs),-@0x00026000(data:grow)
```

1.3.2 AB System Is Supported

```
cd u-boot
./make.sh rv1126-ab
./make.sh --spl
# parameter e.g.
#
mtdparts=rk29xxnand:0x00002000@0x00004000(uboot_a),0x00002000@0x00006000(uboot_b)
,0x00001000@0x00008000(misc),0x00010000@0x00009000(boot_a),0x00010000@0x00019000(
boot_b),0x00020000@0x00029000(system_a),0x00020000@0x00049000(system_b),-
@0x00069000(data:grow)
```

1.4 Instructions to U-Boot Images

The name of image	Description
rv1126_spl_loader_***.bin	loader file
uboot.img	U-Boot image
idblock.bin	the IDBlock partition file for firmware_merger tool

2. Linux Kernel Compilation

2.1 Get Linux Kernel Code from SDK

Get thses directories from root directory of SDK:

Directory or File	Description
kernel	linux kernel code
prebuilts	cross-compile tool

2.2 Build Command Introduction

Build command format:

```
# configure linux kernel
# args1: chip architecture (e.g. arm)
# args2: linux kernel defconfig filename (e.g. xxx_defconfig)
# args3: linux kernel defconfig fragment filename (option)
make ARCH=args1 args2 args3
make menuconfig # this step is optinal

# make kernel image
# args1: chip architecture (e.g. arm)
# args2: linux kernel dts's filename (e.g. arch/arm/boot/dts/rv1126-38x38-v10-
emmc.dts)
# -j12: allow 12 jobs compilation at once
make ARCH=args1 args2.img -j12
```

2.3 For SPI NOR Linux Kernel Compilation

```
make ARCH=arm rv1126_defconfig rv1126-spi-nor.config
make ARCH=arm rv1126-38x38-v10-spi-nor.img -j12
```

2.4 For eMMC Linux Kernel Compilation

2.4.1 Build eMMC Kernel Without Peripheral Drivers

```
make ARCH=arm rv1126_defconfig rv1126-emmc-drivers-modules.config
make ARCH=arm rv1126-38x38-v10-emmc.img -j12
```

2.4.2 Build eMMC Kernel with Peripheral Drivers

```
make ARCH=arm rv1126_defconfig rv1126-emmc-drivers-builtin.config
make ARCH=arm rv1126-38x38-v10-emmc.img -j12
```

2.5 Package Drivers (only for building without peripheral drivers into kernel)

```
make modules_install ARCH=arm INSTALL_MOD_STRIP=1 INSTALL_MOD_PATH=./drivers-ko
# remove unused soft link
rm -f drivers-ko/lib/modules/4.19.111/build drivers-
ko/lib/modules/4.19.111/source
```

2.6 Instructions to Linux Kernel Image

The name of image	Description
zboot.img	linux kernel image
drivers-ko	the directory of linux kernel drivers

2.7 Instructions to Drivers insmod (only for building without peripheral drivers into kernel)

```
# stop udevd before insmod driver modules
udevadm control --stop-exec-queue

# insmod videobuf2
insmod kernel/drivers/media/common/videobuf2/videobuf2-memops.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-dma-contig.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-common.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-v4l2.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-dma-sg.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-vmalloc.ko

# insmod drm
insmod kernel/drivers/gpu/drm/drm_kms_helper.ko
insmod kernel/drivers/gpu/drm/rockchip/rockchipdrm.ko

# insmod audio
insmod kernel/sound/soundcore.ko
insmod kernel/sound/core/snd.ko
insmod kernel/sound/core/snd-timer.ko
insmod kernel/sound/core/snd-pcm.ko
insmod kernel/sound/core/snd-pcm-dmaengine.ko
insmod kernel/sound/soc/snd-soc-core.ko
insmod kernel/sound/soc/codecs/snd-soc-dummy-codec.ko
insmod kernel/sound/soc/codecs/snd-soc-rk817.ko
insmod kernel/sound/soc/rockchip/snd-soc-rockchip-i2s-tdm.ko
insmod kernel/sound/soc/generic/snd-soc-simple-card-utils.ko
insmod kernel/sound/soc/generic/snd-soc-simple-card.ko

# insmod isp ispp cif rk_ircut and sensor
insmod kernel/drivers/media/v4l2-core/v4l2-fwnode.ko
insmod kernel/drivers/media/i2c/os04a10.ko
insmod kernel/drivers/media/i2c/imx415.ko
insmod kernel/drivers/media/i2c/rk_ircut.ko
insmod kernel/drivers/phy/rockchip/phy-rockchip-mipi-rx.ko
insmod kernel/drivers/media/platform/rockchip/cif/video_rkcif.ko
insmod kernel/drivers/media/platform/rockchip/isp/video_rkisp.ko
insmod kernel/drivers/media/platform/rockchip/ispp/video_rkispp.ko
echo 1 > /sys/module/video_rkcif/parameters/clr_unready_dev
echo 1 > /sys/module/video_rkisp/parameters/clr_unready_dev

# insmod vcodec
insmod kernel/drivers/video/rockchip/mpp/rk_vcodec.ko
```

```
# insmod usb for adb
insmod kernel/drivers/phy/rockchip/phy-rockchip-naneng-usb2.ko
insmod kernel/drivers/usb/dwc3/dwc3-of-simple.ko
insmod kernel/drivers/usb/dwc3/dwc3.ko

# insmod for adc key
insmod kernel/drivers/input/keyboard/adc-keys.ko

# insmod for led flash
insmod kernel/drivers/leds/led-class-flash.ko
insmod kernel/drivers/leds/leds-rgb13h.ko

# insmod sdcard ko
insmod kernel/drivers/mmc/host/dw_mmc.ko
insmod kernel/drivers/mmc/host/dw_mmc-pltfm.ko
insmod kernel/drivers/mmc/host/dw_mmc-rockchip.ko
insmod kernel/drivers/mmc/host/rk_sdmmc_ops.ko

# audio codec
insmod kernel/sound/soc/codecs/snd-soc-es8311.ko

# rtc
insmod kernel/drivers/rtc/rtc-pcf8563.ko

# pwm fill light
insmod kernel/drivers/leds/leds-pwm.ko

# restart udevd after insmod driver modules
udevadm control --start-exec-queue
```

2.7.1 Instructions to Camera-related Drivers insmod

Modify `rv1126-emmc-drivers-modules.config` as follows:

```
CONFIG_PHY_ROCKCHIP_MIPI_RX=m
# CONFIG_USB_CONFIGFS_F_UAC1 is not set
# CONFIG_USB_CONFIGFS_F_UAC2 is not set
# CONFIG_USB_CONFIGFS_F_UVC is not set
# CONFIG_USB_CONFIGFS_RNDIS is not set
CONFIG_V4L2_FWNODE=m
CONFIG_VIDEOBUF2_CORE=m
CONFIG_VIDEOBUF2_DMA_CONTIG=m
CONFIG_VIDEOBUF2_MEMOPS=m
CONFIG_VIDEOBUF2_V4L2=m
CONFIG_VIDEOBUF2_VMALLOC=m
### disable others sensor to be built-in kernel
# CONFIG_VIDEO_GC2053 is not set
# CONFIG_VIDEO_OV2718 is not set
# CONFIG_VIDEO_SC2232 is not set
# CONFIG_VIDEO_SC2310 is not set
# CONFIG_VIDEO_GC4C33 is not set
# CONFIG_VIDEO_IMX347 is not set
# CONFIG_VIDEO_IMX378 is not set
# CONFIG_VIDEO_OS04A10 is not set
```

```
# CONFIG_VIDEO_OV4689 is not set
CONFIG_VIDEO_SC200AI=m
CONFIG_VIDEO_ROCKCHIP_CIF=m
CONFIG_VIDEO_ROCKCHIP_ISP=m
CONFIG_VIDEO_ROCKCHIP_ISPP=m
```

Build kernel (`rv1126-38x38-v10-emmc` is the basename of dts) and install to the dir of drivers-ko.

```
make ARCH=arm rv1126_defconfig rv1126-emmc-drivers-modules.config
make ARCH=arm rv1126-38x38-v10-emmc.img -j12
make modules_install ARCH=arm INSTALL_MOD_STRIP=1 INSTALL_MOD_PATH=./drivers-ko
```

The script of insmod camera-related drivers:

```
#!/bin/sh

udevadm control --stop-exec-queue

insmod kernel/drivers/media/common/videobuf2/videobuf2-common.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-v4l2.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-memops.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-dma-contig.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-dma-sg.ko
insmod kernel/drivers/media/common/videobuf2/videobuf2-vmalloc.ko
insmod kernel/drivers/media/v4l2-core/v4l2-fwnode.ko
insmod kernel/drivers/media/i2c/sc200ai.ko
insmod kernel/drivers/phy/rockchip/phy-rockchip-mipi-rx.ko
insmod kernel/drivers/media/platform/rockchip/cif/video_rkcif.ko
insmod kernel/drivers/media/platform/rockchip/isp/video_rkisp.ko
insmod kernel/drivers/media/platform/rockchip/ispp/video_rkispp.ko

echo 1 > /sys/module/video_rkisp/parameters/clr_unready_dev
echo 1 > /sys/module/video_rkcif/parameters/clr_unready_dev

udevadm control --start-exec-queue
```

3. Root Filesystem Compilation

3.1 Get tarball of build-busybox and Compile

Get busybox tarball from path: `device/rockchip/rv1126_rv1109/prebuilt-packages/build-busybox`

```
# unpackage busybox tarball
tar xjf busybox-1.27.2-patch-reboot-arg.tar.bz2

# copy rockchip's busybox defconfig
# busybox_spi_nor_defconfig used for spi nor
# busybox_emmc_defconfig used for eMMC (default)
cp busybox-1.27.2-patch/configs/busybox_defconfig busybox-
1.27.2/configs/busybox_defconfig
```

```
# change directory to busybox
cd busybox-1.27.2

# config defconfig
make busybox_defconfig

# compile, Notice: the cross compile tool is in the prebuilts directory of SDK
make ARCH=arm install CROSS_COMPILE=~/RV1109-SDK/prebuilts/gcc/linux-x86/arm/gcc-
arm-8.3-2019.03-x86_64-arm-linux-gnueabihf/bin/arm-linux-gnueabihf- -j32

# unpackage base root filesystem which is prebuilt bin, e.g. target-emmc-
v1.0.0.tar.bz2
tar xjf target-emmc-v1.0.0.tar.bz2

# copy busybox target bin and libs to target directory (option)
cp busybox-1.27.2/_install/* target/ -rfa

# package root filesystem with squashfs
mksquashfs target rootfs.squashfs -noappend -comp xz

# package root filesystem with squashfs
# --pad : partition size
mkfs.jffs2 -r target -o rootfs.jffs2 --pad=0x400000 -n

# package root filesystem with ext4, e.g.
tar xjf tools.tar.bz2
./tools/mkfs-ext4/do-mkfs.ext4.sh target rootfs.ext4 64M

# the command of unpackage squashfs filesystem : unsquashfs ./rootfs.squashfs
```

NOTICE: The library named /usr/lib/libv4l/plugins/libv4l-mplane.so MUST be placed in the rootfs.

3.2 Instructions to Auto Mount Partition

target-emmc-v1.0.0.tar.bz2 support auto mount the partitions which config in the file of /etc/fstab. Auto mount script: target/etc/init.d/S21mountall.sh

Refer to the partition of userdata

```
cat target/etc/fstab
# <file system> <mount pt>       <type>  <options>          <dump>  <pass>
/dev/root       /                ext2    rw,noauto          0       1
proc            /proc            proc    defaults           0       0
devpts          /dev/pts         devpts  defaults,gid=5,mode=620 0   0
tmpfs           /dev/shm         tmpfs   mode=0777          0       0
tmpfs           /tmp             tmpfs   mode=1777          0       0
tmpfs           /run             tmpfs   mode=0755,nosuid,nodev 0   0
sysfs           /sys             sysfs   defaults           0       0
debug           /sys/kernel/debug  debugfs  defaults    0       0
/dev/block/by-name/userdata      /userdata  ext2  defaults   0       2
```

4. Manufacture Programmer Firmware Image

4.1 Building for SPI NOR and eMMC

- Build udpate.img

```
# e.g. select eMMC reference BoardConfig for building eMMC update.img
./build.sh device/rockchip/rv1126_rv1109/BoardConfig.mk
# or select SPI NOR reference BoardConfig for building SPI NOR update.img
# ./build.sh device/rockchip/rv1126_rv1109/BoardConfig-spi-nor-v12.mk
./build.sh all
./mkfirmware.sh
./build.sh updateimg
ls rockdev/update.img
```

- Convert update.img to Manufacture programmer firmware (date.bin)

Get tool from `<SDK>/tools/windows/SpiImageTools_***.zip`.

4.2 Building for SPI NAND and SLC NAND

See the document:
`<SDK>/docs/Linux/ApplicationNote/Rockchip_Developer_Guide_Linux_Nand_Flash_Open_Source_Solution_CN.pdf`.

5. Instructions to Build BSP Libraries

Get thses directories from root directory of SDK:

Directory or File	Description
buildroot	buildroot's source
external	rockchip BSP codes
prebuilts	cross-compile tool
envsetup.sh	link to buildroot/build/envsetup.sh
Makefile	link to buildroot/build/Makefile

5.1 Command to Build BSP Libraries

The SDK BSP package only contains audio and video codec libraries, NPU libraries, and header files. Note: BSP package does not include file system.

```
source envsetup.sh rockchip_rv1126_rv1109_libs

make -j12
```

5.2 BSP Files

```
tree buildroot/output/rockchip_rv1126_rv1109_libs/BSP/
buildroot/output/rockchip_rv1126_rv1109_libs/BSP/
├── example
│   ├── common
│   ├── iqfiles
│   ├── librtsp
│   ├── multi_audio_test
│   ├── rknn_model
│   ├── stressTest
│   └── vqefiles
├── include
│   ├── rga
│   ├── rkaiq
│   └── rkmedia
├── lib
└── npu
    ├── include
    ├── ko
    └── lib
```

6. Debug Info

6.1 CPU Debug Info

6.1.1 CPU Frequency Debug

6.1.1.1 Print CPU Frequency

```
# print current cpu frequency
cat /sys/devices/system/cpu/cpu0/cpufreq/scaling_cur_freq
1008000

# print cpu available frequencies
cat /sys/devices/system/cpu/cpu0/cpufreq/scaling_available_frequencies
408000 600000 816000 1008000 1200000 1296000
```

6.1.1.2 Fix the Frequency of CPU

```
# set CPU 600MHz fixed frequency
echo userspace > /sys/devices/system/cpu/cpu0/cpufreq/scaling_governor
echo 600000 > /sys/devices/system/cpu/cpu0/cpufreq/scaling_setspeed
```

6.1.2 Print CPU Thermal

`cat /sys/class/thermal/thermal_zone0/temp`

6.1.3 Disable CPU Thermal Control

```
# diable thermal control
echo user_space > /sys/class/thermal/thermal_zone0/policy
# disable frequency limit
echo 0 > /sys/class/thermal/thermal_zone0/cdev0/cur_state
echo 0 > /sys/class/thermal/thermal_zone0/cdev1/cur_state
```

6.2 Encode Debug Info

6.2.1 Print Encode Frame Rate

```
# enable print fps log
echo 0x100 > /sys/module/rk_vcodec/parameters/mpp_dev_debug

# disable print fps log
echo 0 > /sys/module/rk_vcodec/parameters/mpp_dev_debug
```

```
# See mpp summary information
# cat /proc/mpp_service/session_summary

[root@RV1126_RV1109:/]# cat /proc/mpp_service/session_summary
--------------------------------------------------------------------------------------------------
| session| device|
| 5bf7cd58|  VEPU2|
--------------------------------------------------------------------------------------------------
| session| device|  width| height| format| fps_in| fps_out| rc_mode| bitrate|gop_size|fps_calc| profile|
| 52127d8e| RKVENC|   2688|   1520|   h264|     25|      25|     cbr| 7549747|      50|   24.85|    high|
--------------------------------------------------------------------------------------------------
| session| device|
| fc55943b|  VEPU2|
--------------------------------------------------------------------------------------------------
| session| device|  width| height| format| fps_in| fps_out| rc_mode| bitrate|gop_size|fps_calc| profile|
| c110fc71| RKVENC|    640|    480|   h264|     25|      25|     cbr|  943718|      50|   25.05|    high|
--------------------------------------------------------------------------------------------------
| session| device|  width| height| format| fps_in| fps_out| rc_mode| bitrate|gop_size|fps_calc| profile|
| d8485bb6| RKVENC|   1920|   1080|   h264|     25|      25|     cbr| 1887436|      50|   25.34|    high|
```

6.3 Print CIF Info

cat /proc/rkcif_mipi_lvds

```
Driver Version:v00.01.08
Work Mode:ping pong
aclk_cif:500000000
hclk_cif:250000000
dclk_cif:297000000
Input Info:
        src subdev:m01_f_os04a10 1-0036-1
        interface:mipi csi2
        lanes:4
        vc channel: 0 1
        hdr mode: hdr_x2
        format:SBGGR10_1X10/2688x1520@30
        crop.bounds:(0, 0)/2688x1520
Output Info:
        format:BG10/2688x1520(0,0)
        compact:enable
        frame amount:79
        fps:30
        irq statistics:
                        total:158
                        csi over flow:0
                        csi bandwidth lack:0
                        all err count:0
                        frame dma end:158
```

6.4 Print ISPP Info

cat /proc/rkispp0

```
cat /proc/rkispp0
rkispp0     Version:v00.01.05
Input      rkisp0 Format:FBC420 Size:3840x2160 (frame:15441 rate:41ms delay:20ms)
Output     rkispp_m_bypass Format:FBC0 Size:3840x2160 (frame:15440 rate:41ms
delay:45ms)
Output     rkispp_scale0 Format:NV12 Size:1280x720 (frame:15440 rate:41ms
delay:45ms)
```

```
Output     rkispp_scale1 Format:NV12 Size:720x480 (frame:15440 rate:41ms
delay:45ms)
Output     rkispp_scale2 Format:NV12 Size:1280x720 (frame:15440 rate:41ms
delay:45ms)
TNR        ON(0xd00000d) (mode: 2to1) (global gain: disable) (frame:15441
time:12ms) CNT:0x0 STATE:0x1e000000
NR         ON(0x47) (external gain: enable) (frame:15441 time:12ms) 0x5f0:0x0
0x5f4:0x0
SHARP      ON(0x1b) (YNR input filter: ON) (local ratio: ON) 0x630:0x0
FEC        OFF(0x2) (frame:0 time:0ms) 0xc90:0x0
ORB        OFF(0x0)
Interrupt  Cnt:46278 ErrCnt:0
clk_ispp   500000000
aclk_ispp  500000000
hclk_ispp  250000000
```

6.5 Print ISP Info

`cat /proc/rkisp0`

```
cat /proc/rkisp0
rkisp0     Version:v00.01.05
Input      rkcif_mipi_lvds Format:SGBRG10_1X10 Size:3840x2160@30fps Offset(0,0) |
RDBK_X1(frame:15584 rate:40ms)
Output     rkispp0 Format:FBC420 Size:3840x2160 (frame:15583 rate:39ms)
Interrupt  Cnt:62011 ErrCnt:0
clk_isp    594000000
aclk_isp   500000000
hclk_isp   250000000
DPCC0      ON(0x40000005)
DPCC1      ON(0x40000005)
DPCC2      ON(0x40000005)
BLS        ON(0x40000001)
SDG        OFF(0x80446197)
LSC        ON(0x1)
AWBGAIN    ON(0x80446197) (gain: 0x010d010d, 0x02260227)
DEBAYER    ON(0xf000111)
CCM        ON(0xc0000001)
GAMMA_OUT  ON(0xc0000001)
CPROC      ON(0xf)
IE         OFF(0x0) (effect: BLACKWHITE)
WDR        OFF(0x30cf0)
HDRTMO     ON(0xc8505a25)
HDRMGE     OFF(0x0)
RAWNR      ON(0xc0100001)
GIC        OFF(0x0)
DHAZ       ON(0xc0001009)
3DLUT      OFF(0x2)
GAIN       ON(0xc0010010)
LDCH       OFF(0x0)
CSM        FULL(0x80446197)
SIAF       OFF(0x0)
SIAWB      OFF(0x0)
YUVAE      ON(0x400100f3)
SIHST      ON(0x38000107)
```

```
RAWAF      ON(0x7)
RAWAWB     ON(0x4037e887)
RAWAE0     ON(0x40000003)
RAWAE1     ON(0x400000f5)
RAWAE2     ON(0x400000f5)
RAWAE3     ON(0x400000f5)
RAWHIST0   ON(0x40000501)
RAWHIST1   ON(0x60000501)
RAWHIST2   ON(0x60000501)
RAWHIST3   ON(0x60000501)
```