RK3399 EVB User Guide

Release Version: V1.0

Release Date: Aug 22, 2016

Foreword

Overview

This document mainly introduces the basic functions, hardware features, multi-functional hardware configuration and software debugging method of Excavator and Sapphire, aimed at helping developers exploit RK3399 EVB faster and more accurately.

Product Version

Relevant product versions are shown as below:

Product name	Product Version
Sapphire	RK_SAPPHINERE_SOCBOARD_RK3399_LPDDR3D178P232SD8
Excavator	RK_Excavator_MAIN
eDP Screen (Resolution 1536 x 2048)	RK_Excavator_eDP

Product Object

This document is mainly suitable for the following engineers:

- Field application engineer
- Hardware development & PCB layout engineer
- Embedded Software Development Engineer
- Test engineer

Revision History

Version	Modified by	Revision Date	Revision Description	Remark
V1.0	黄雄山	2016-08-22	Initial Release	

Acronym

Acronym includes the abbreviations of phases commonly used in this document.

eDP	Embedded DisplayPort	嵌入式数码音视讯传输接口
DP	DisplayPort	高清数字显示接口
HDMI	High Definition Multimedia Interface	高清晰度多媒体接口
I^{2}C	Inter-Integrated Circuit	内部整合电路(两线式串行通讯总线)
JTAG	Joint Test Action Group	联合测试行为组织定义的一种国际标准测试协议(IEEE 1149.1 兼容)
LDO	Low Drop Out Linear Regulator	低压差线性稳压器
MIPI	Mobile Industry Processor Interface	移动产业处理器接口
PMIC	Power Management IC	电源管理芯片
PMU	Power Management Unit	电源管理单元
RK	Rockchip Electronics Co.,Ltd.	瑞芯微电子股份有限公司
SD Card	Secure Digital Memory Card	安全数码卡
SPDIF	Sony/Philips Digital Interface Format	SONY、PHILIPS 数字音频接口
TF Card	Micro SD Card(Trans-flash Card)	外置记忆卡
USB 2.0	Universal Serial Bus	通用串行总线
USB 3.0	Universal Serial Bus	通用串行总线
TYPE-C	Universal Serial Bus TYPE-C	通用串行总线
PCIE	Peripheral Component Interconnect Express	外围组件快速互连

Contents

Chapter 1 System Overview

1.1　Overview

RK3399 is a low power, high performance processor for computing, personal mobile internet devices and digital multimedia devices; it integrates dual-core Cortex-A72 and quad-core Cortex-A53. RK3399 supports multi-format video decoders including H.264/H.265/VP9 up to 4Kx2K@60fps, especially, H.264/H.265 decoders support 10bits coding, and also supports H.264/MVC/VP8 encoders by 1080p@30fps, high-quality JPEG encoder/decoder, and special image preprocessor and postprocessor. RK3399 has high-performance dual channel external memory interface (2x32bit LPDDR3) capable of sustaining demanding memory bandwidths.

1.2　Features

1.2.1 CPU
✧ Big.Little architecture: Dual Cortex-A72 + Quad Cortex-A53, 64-bit CPU Frequency is over 2.0GHz (Big cluster)

1.2.2 GPU
✧ Mali-T864 GPU, OpenGL ES1.1/2.0/3.0/3.1, OpenVG1.1, OpenCL, DX11 Supports AFBC (ARM Frame Buffer Compression)
✧
1.2.3 Memory
✧ Dual channel LPDDR3 Support
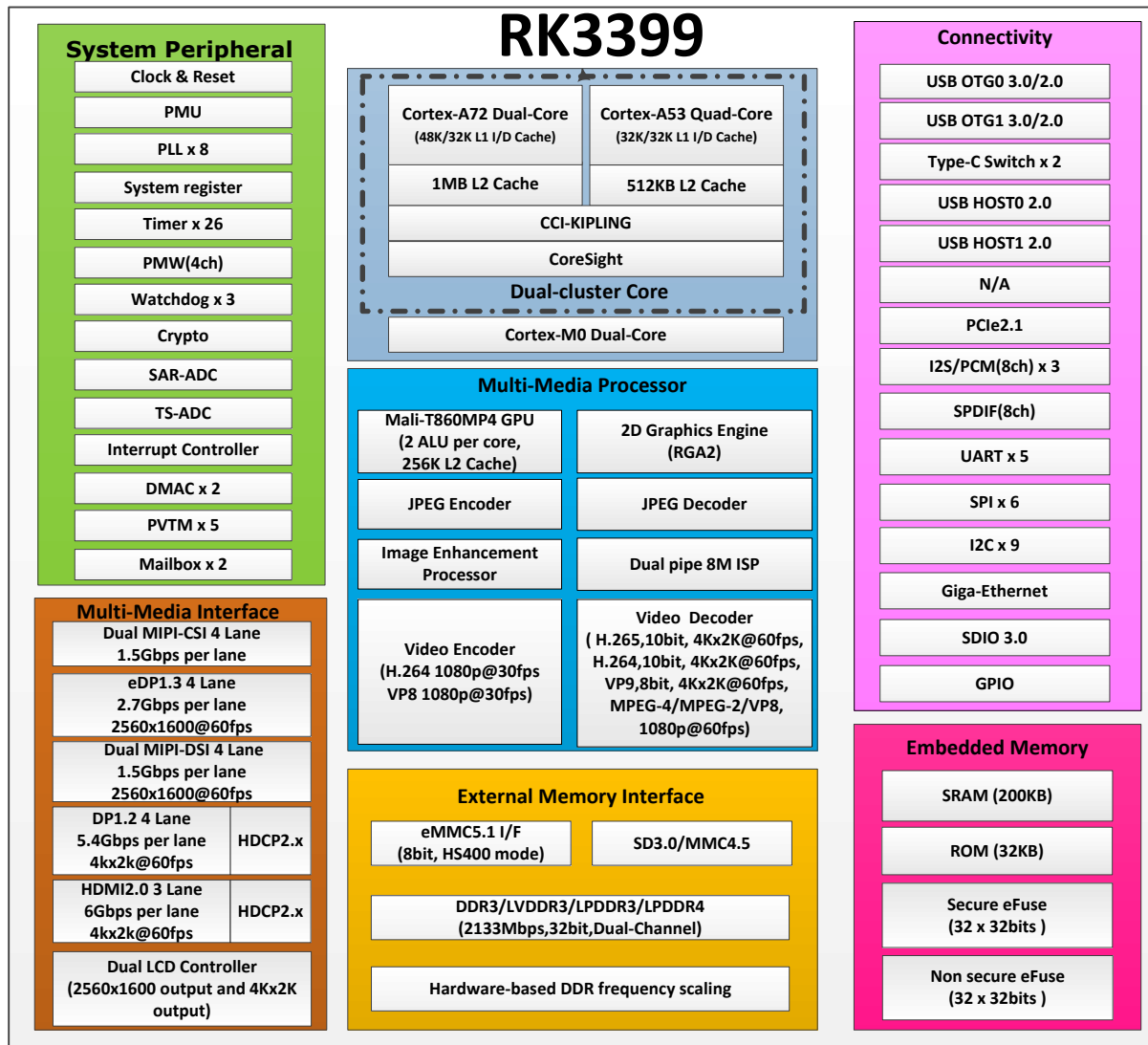✧ emmc 5.1 with HS400, SDIO 3.0 with HS200

1.2.4 Multi-Media：
✧ 4K VP9 and 4K 10bits H265/H.264 Video decoders,up to 60fps
✧ 1080P other video decoders (MPEG-1/2/4, VP8)
✧ 1080P video encoders for H.264 and VP8
✧ Video post processor: de-interlace, de-noise, enhancement for edge/detail/color

1.2.5 Functional interface：
✧ MIPI TX、MIPI_RX、MIPI_TX/RX
✧ GPIO/SPI/I2Cinterface
✧ MIC Array ：I2S Signal（8 channel）
✧ TF Card (sd/mmc 3.0)
✧ USB 3.0 HOST
✧ USB 2.0 HOST
✧ eDP 1.3 (4 lanes with 10.8Gbps) to support display
✧ HDMI 2.0 for 4K 60Hz with HDCP 1.4/2.2
✧ System Key：Power、Menu、Esc、VOL+、VOL-
✧ 1000M Ethernet
✧ Audio out

- ✧ MIC
- ✧ FAN
- ✧ HDMI IN
- ✧ SDIO 3.0 Wifi （2x2 wifi & 4.1 bt）
- ✧ PCIE 2.0 interface
- ✧ IR Receive
- ✧ Uart Debug
- ✧ Sensor ：Light Sensor、Gyroscope、G-sensor、Compass、Hall IC
- ✧ USB TYPE-C (with DP out)
- ✧ DisplayPort

- ✧ MIC
- ✧ FAN

1.3   RK3399 Diagram

RK3399

System Peripheral
Clock & Reset
PMU
PLL x 8
System register
Timer x 26
PMW(4ch)
Watchdog x 3
Crypto
SAR-ADC
TS-ADC
Interrupt Controller
DMAC x 2
PVTM x 5
Mailbox x 2

Dual-cluster Core

Cortex-A72 Dual-Core (48K/32K L1 I/D Cache)	Cortex-A53 Quad-Core (32K/32K L1 I/D Cache)
1MB L2 Cache	512KB L2 Cache
CCI-KIPLING	
CoreSight	

Cortex-M0 Dual-Core

Multi-Media Processor

Mali-T860MP4 GPU (2 ALU per core, 256K L2 Cache)	2D Graphics Engine (RGA2)
JPEG Encoder	JPEG Decoder
Image Enhancement Processor	Dual pipe 8M ISP
Video Encoder (H.264 1080p@30fps VP8 1080p@30fps)	Video Decoder (H.265,10bit, 4Kx2K@60fps, H.264,10bit, 4Kx2K@60fps, VP9,8bit, 4Kx2K@60fps, MPEG-4/MPEG-2/VP8, 1080p@60fps)

External Memory Interface

eMMC5.1 I/F (8bit, HS400 mode)	SD3.0/MMC4.5
DDR3/LVDDR3/LPDDR3/LPDDR4 (2133Mbps,32bit,Dual-Channel)	
Hardware-based DDR frequency scaling	

Multi-Media Interface
Dual MIPI-CSI 4 Lane 1.5Gbps per lane
eDP1.3 4 Lane 2.7Gbps per lane 2560x1600@60fps
Dual MIPI-DSI 4 Lane 1.5Gbps per lane 2560x1600@60fps

DP1.2 4 Lane 5.4Gbps per lane 4kx2k@60fps	HDCP2.x
HDMI2.0 3 Lane 6Gbps per lane 4kx2k@60fps	HDCP2.x

Dual LCD Controller (2560x1600 output and 4Kx2K output)

Connectivity
USB OTG0 3.0/2.0
USB OTG1 3.0/2.0
Type-C Switch x 2
USB HOST0 2.0
USB HOST1 2.0
N/A
PCIe2.1
I2S/PCM(8ch) x 3
SPDIF(8ch)
UART x 5
SPI x 6
I2C x 9
Giga-Ethernet
SDIO 3.0
GPIO

Embedded Memory
SRAM (200KB)
ROM (32KB)
Secure eFuse (32 x 32bits)
Non secure eFuse (32 x 32bits)

1.4   EVB Board Components

This EVB board has 3 configurations targeting to different Users:

1. Open source users & development enthusiasts: Sapphire

2. Tablet and VR users: Sapphire, Excavator, eDP screen (Resolution 1536 x 2048)；

3. BOX Users: Sapphire, Excavator.

Three kinds of configuration have the same standard power supply specifications: Input 100V AC~240V AC, 50Hz; Output 12V DC, 2A.

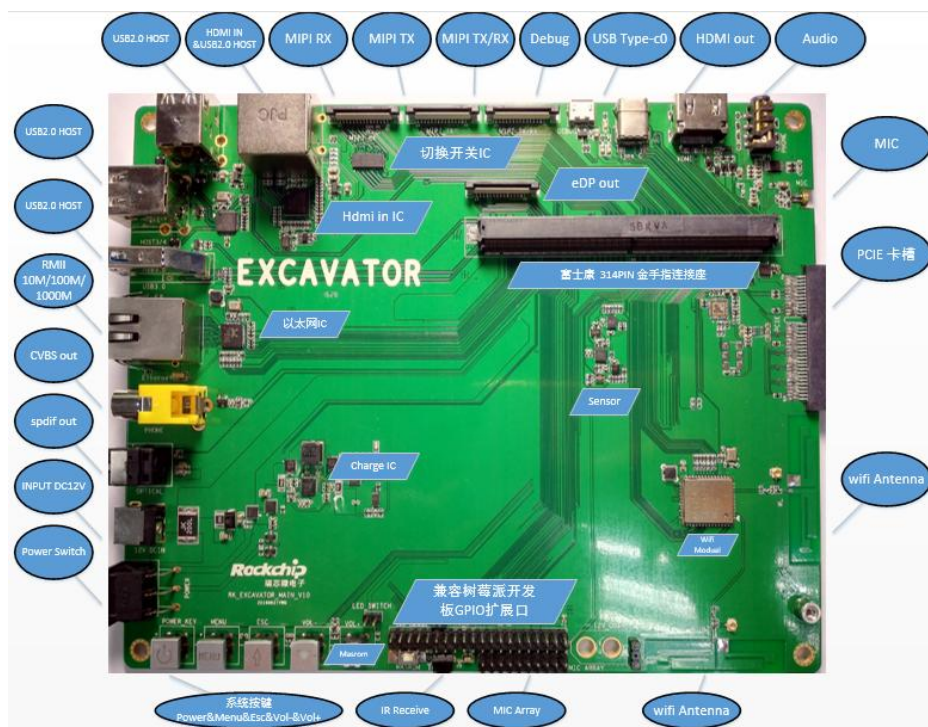# Chapter 2 EVB Board Hardware Introduction

This EVB board has 3 PCBA：：Sapphire, Excavator and eDP screen (Resolution 1536 x 2048）, Physical diagram and assembly diagram shown as the picture below:
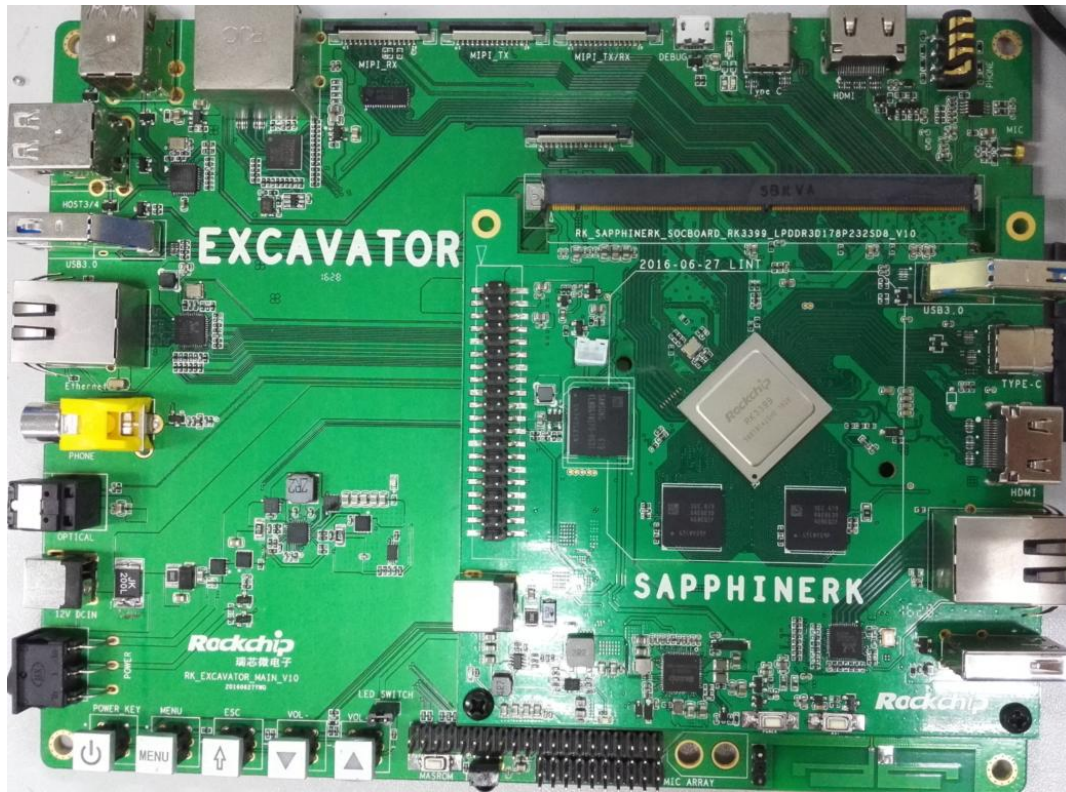
2.1 Overall Effect Diagram

2.1.1 Sapphire Diagram：
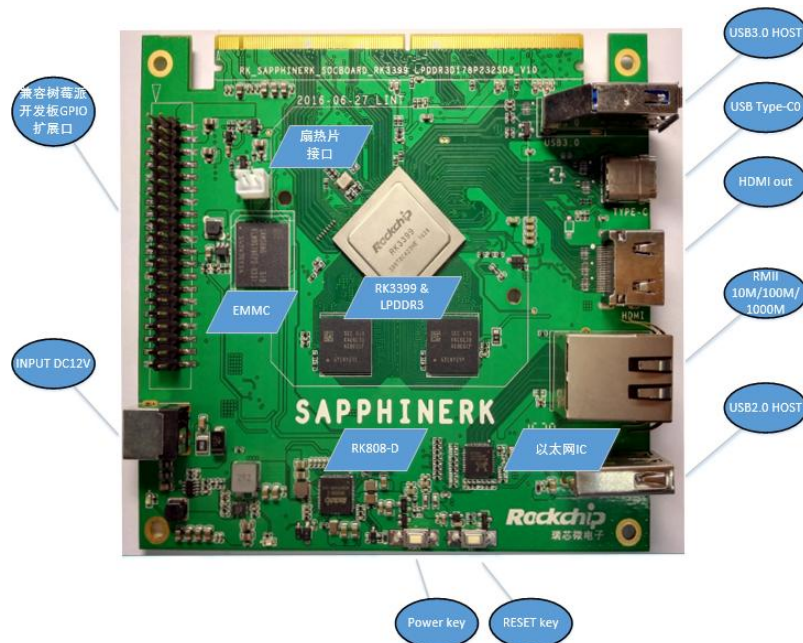
2.1.2 Excavator Diagram：

2.1.3 Assembly Diagram of Excavator and Sapphire:

2.1.4 Overall Assembly Diagram:

2.2 PCB Function Interface:

Sapphire Function		Excavator Function	
LPDDR3（2x32bit total capacity 2G）	YES	HDMI IN	YES
EMMC（total capacity 8G）	YES	System keys	YES
Heat Sink	YES	Spdif out	YES
TF Card	YES	SDIO Wifi（2x2 wifi&bt 4.1）	YES
		Pcie interface	YES
		Audio out（ALC5651）	YES
		Mic IN	YES
		LIGHT-Sensor（CM32181）	YES
		Gyroscope（LSM6DS3）	YES
		HALL IC（HAL248TWCL）	YES
		G-sensor（MPU6500）	YES
		Compass（LIS3MDL）	YES
		eDP out（1536x204）	YES
		MIPI_TX interface	YES
		MIPI_RX interface	YES
		MIPI_TX/RX interface	YES
		UART Debug	YES
		Mic Array interface	YES
		IR Receive	YES
		CVBS out	NO
Both Sapphire and Excavator have interfaces, use the interface on Sapphire.			
Sapphire Function		Excavator Function	
Raspberry Pi compatible interface	YES	Raspberry Pi compatible interface	YES
usb2.0 host(1 Port)	YES	USB2.0 Host(5 Port)	YES
USB3.0 host(1 Port)	YES	USB3.0 host(1 Port)	NO
USB Type-C0&DP out	YES	USB Type-C0&DP out	NO
HDMI out	YES	HDMI out	NO
GMII 10M/100M/1000M	YES	GMII 10M/100M/1000M	NO

Note: "YES" means the available functions on pcb, "No" means the functions are not available.

2.3 EVB Structure and Interface Description:

No.	Name	Description
1	Heat Sink Interface	Power supply interface for heat sink with fan
2	Standard graphics card connector	Sapphire and Excavator signal connector
3	Goldfinger	Sapphire PCB copper keep-out area , touch point of connector
4	Power Supply Rocker switch	EVB power switch
5	12V power input	12V 2A input
6	Headset output	Three-Stage Headset jack
7	Mic input	Electret microphone
8	Speaker output (L Sound track)	Can drive 1.5W/8ohm or 2.5W/4ohm speaker
9	Speaker output (R Sound track)	Can drive 1.5W/8ohm or 2.5W/4ohm speaker
10	infrared receiver head	
11	Key	Power Key Reset Key Menu Key Return Key VOL+/Recovery Key VOL- Key
12	TF Card Interface	
13	UART Debug Interface	Software debug and log scan
14	USB TYPE-C Interface	Support DP output
15	USB HOST2.0 Interface	Support USB 2.0 only
16	USB HOST3.0 Interface	Support USB 3.0, downward compatible with USB2.0
17	RJ45 Internet Interface	Gigabit Ethernet connection
18	Update Key	Firmware update Key, used for entering Maskrom mode
19	eDP Screen Interface	
20	HDMI Output Interface	
21	MIPI DSI Output Interface 1	
22	MIPI CSI Input Interface	
23	GPIO Extended Port	Support Raspberry Pi general interface, I2C, SPI, GPIO
24	HDMI IN Input Interface	
25	SPDIF fibre optic cable input	
26	CVBS out	
27	PCIE interface	

2.4 Power Diagram

The EVB board uses PMIC RK808-D and external DC/DC step-down (buck) regulators and LDOs for system power supply.

2.5 I2C Address

The I2C devices address (7bit) on the EVB configuration is shown in below table:

I2C Channel	Component	I2C Address	Power Domain
I2C0	RK808-D	0x1b	3.0V
I2C0	SYR838PKC	0x41	3.0V
I2C0	SYR837PKC	0x40	3.0V
I2C1	TC358749XBG	0x1F	1.8V
I2C1	GLS3673 (Touch IC）	0x40	1.8V
I2C1	ALC5651	0x1A	1.8V
I2C4	FUSB302MPX (CC IC)	0x44	3.3V
I2C4	MPU6500	0x68	3.3V
I2C4	LIS3MDL	0x36	3.3V
I2C4	LSM6DS3	0x23	3.3V
I2C4	CM32181	0x10	3.3V
I2C4	BQ25700	0x55	3.3V
I2C4	CW2013	0x62	3.3V

Note: When extender board is used, make sure I2C address on extender board will not conflict with I2C address one EVB board.

2.6 EVB Board Reference Diagram

Reference diagram Version of PCB is shown as below, please contact with RK FAE.

1、**Sapphire**：

  RK_SAPPHINERK_SOCBOARD_RK3399_LPDDR3D178P232SD8

  RK_SAPPHINERK_SOCBOARD_RK3399_LPDDR3D178P232SD8

2、**Excavator**：

  RK_excavator_main

  RK_EXCAVATOR_MAIN

3、**eDP Screen**：

  RK_EVB_EXCAVATOR_EDP

  RK_EXCAVATOR_ExtBOARD

Chapter 3 EVB Main Board Description

3.1 Power Supply Input

1. The EVB input power is DC12V/2A, and the system power VCC_SYS is generated by

Charger IC. It supplies to RK808-D for DC/DC regulators, LDOs and external MOSFET circuits

2. 2-serial lion batteries input from VBAT, which is switched by Charger IC to get VCC_SYS voltage, to supply for DC/DC regulators, LDOs and external MOSFET circuits.

Power adapter input port and charger IC:
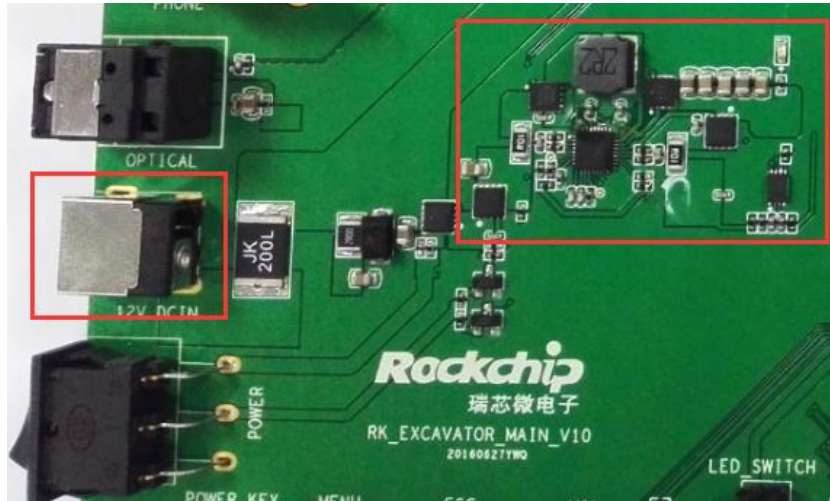
2-serial lion batteries input port:
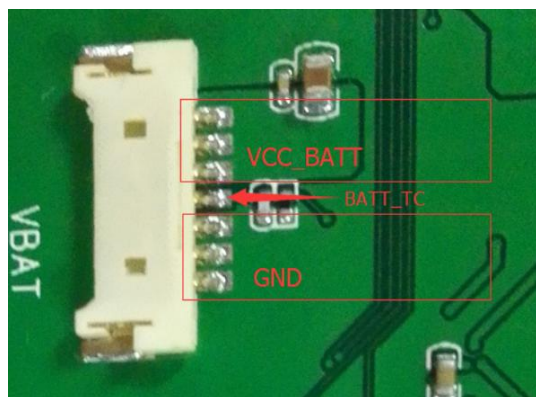
3.2 314PIN Graphics Card Connector

Top Board high-speed connector adopt 314PIN Standard Graphics Card Connector, Sapphire is fixed on Excavator by soldering nut and M3 screw to reduce Insert and Draw Frequency, to avoid damage of gold plating, to extend service life of connector.

3.3 Storage

3.3.1 EMMC：

1. Storage Class on EVB is eMMC FLASH, default size is 8G.

2. Excavator has a Maskrom Key, which is convenient for updating firmware with Maskrom Mode. First connecting USB cable, pressing the key to power up or reset the Excavator, then the system will enter Maskrom mode.

3.3.2 DDR

Sapphire DDR adopt 2x32bit LPDDR3, with total size 4G.

EMMC&LPDDR3：

Excavator Maskrom Key Location:

3.4 Key input

1. EVB uses ADC for key combination application, support 10-bit native resolution and ADC_IN1 is used for recovery detection.

2. ADC voltage is supplied by Top Board Sapphire, reference supply is 1.8V, all the key value can be calculated according to resistance parameter on below diagram.

3. Some common keys are defined on EVB: VOL+/ VOL-/ MENU / ESC/ POWER_KEY.

4. Connecting USB cable, pressing VOL+/Recovery key to power up (or reset) the Excavator, system will enter Rockusb update mode.

5. Keys used on EVB have led lights, which is convenient to use at night.

Schematic Resistance Key Combinations:
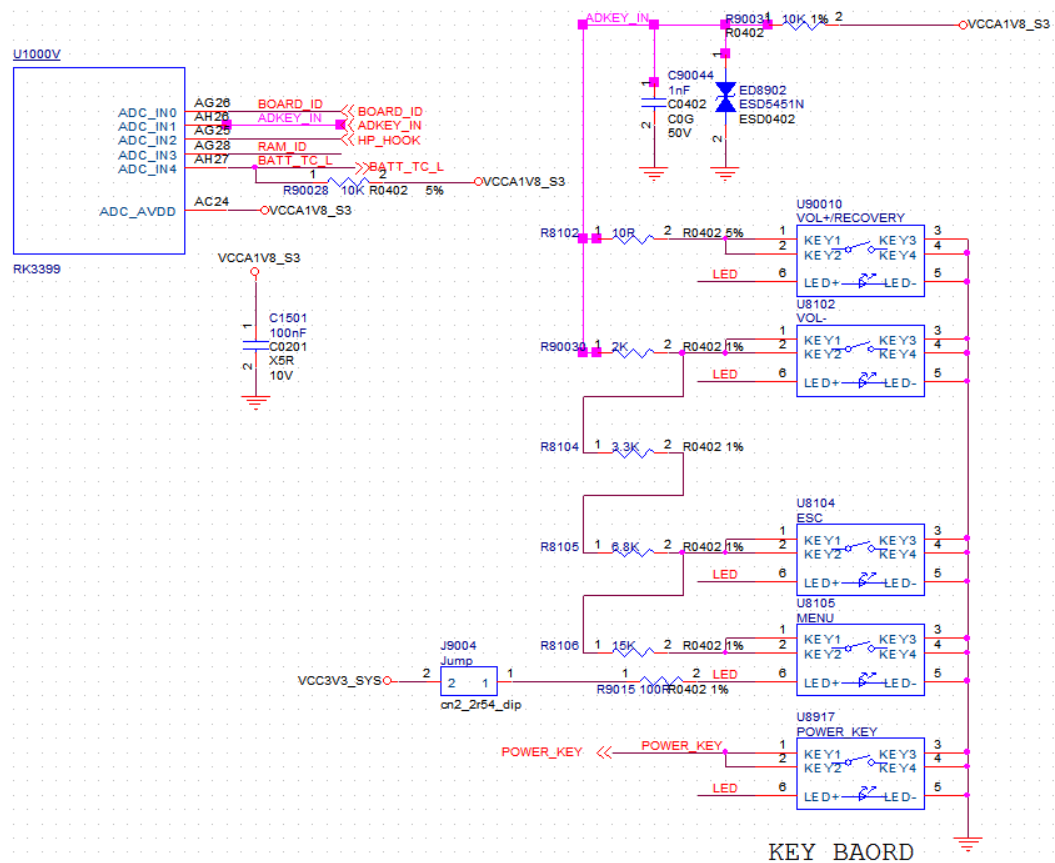
Button Effect Show:

3.5 Infrared Receiver

EVB has a small Infrared Receiver; the common type is FT-009 series, with central frequency 38KHz.
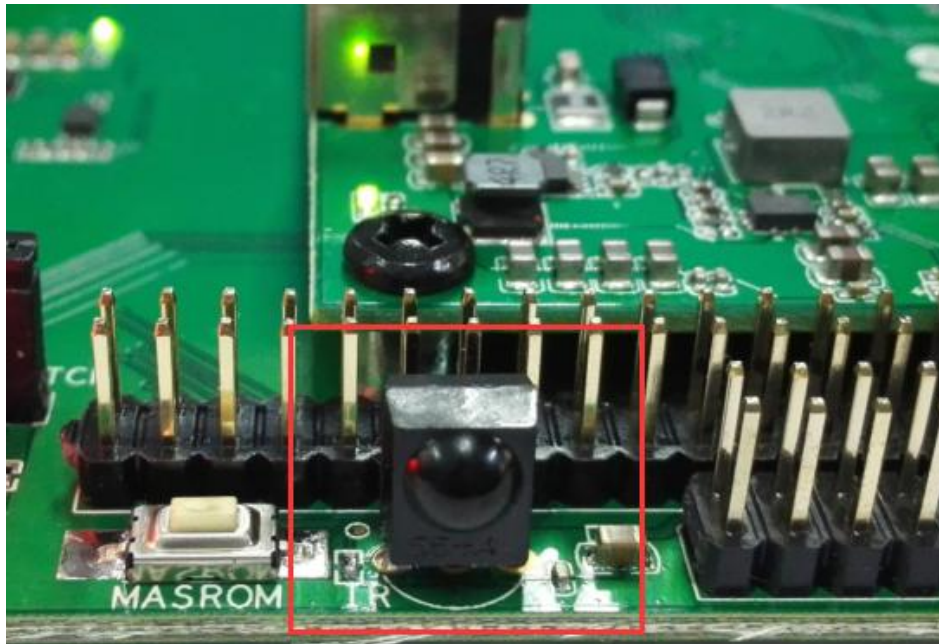
3.6 G-Sensor

G-Sensor used on EVB is MPU6500, it is a 6-axis motiontracking device that combines a 3-axis digital accelerometer, 3-axis gyroscope and a digital motion processor, communicating with CPU by I2C sensor bus.

3.7 Gyroscope

Gyroscope Sensor used on EVB is LSM6DS3, communicating with CPU by I2C bus.

3.8 Compass

Compass used on EVB is LIS3MDL, communicating with CPU by I2C bus.

3.9 Hall sensor

Hall sensor used on EVB is HAL248TWCL, Unipolar magnetic field output.

3.10 Light sensor

Light sensor used on EVB is CM32181, with max detecting light intensity 140K Lux, communicating with CPU by I2C bus.
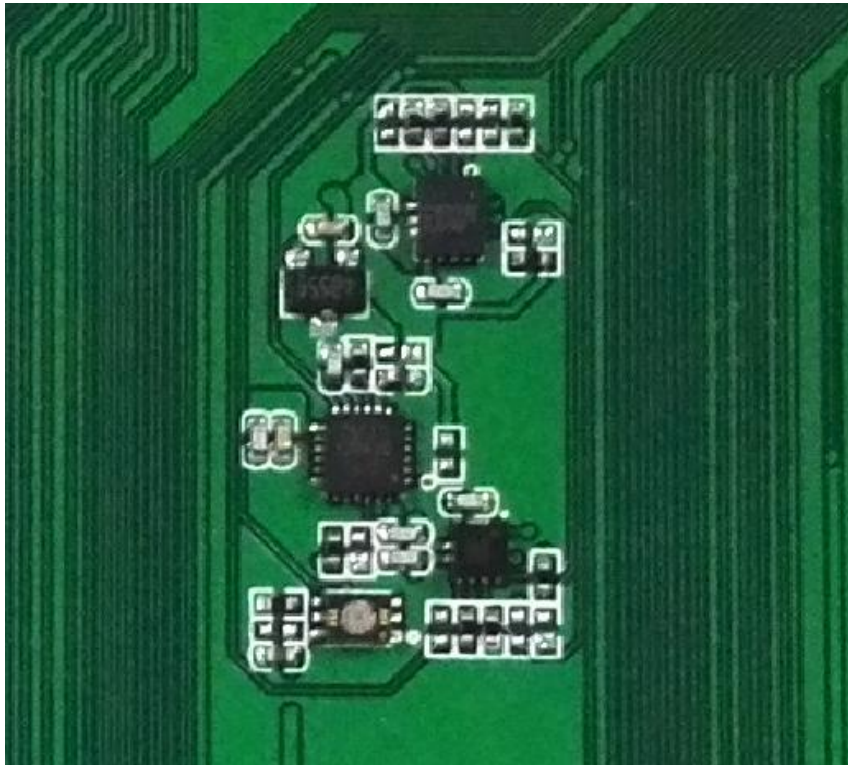
3.11 Video Output interface

EVB supports multiple LCD display output interfaces:

- Single MIPI Output
- Dual MIPI Output
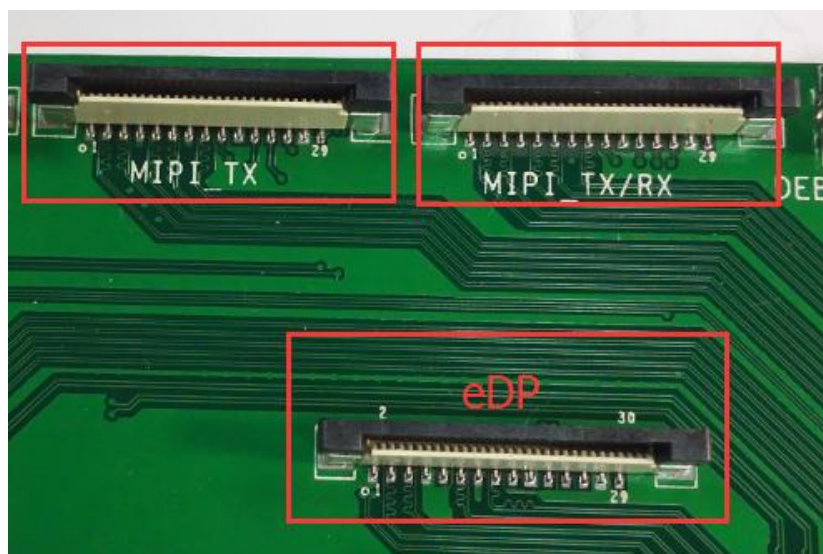
0.5mm between two vertical connectors:

As shown in the pictures above, connectors' up and down locations correspond to signal sequence shown in below table:

MIPI_TX two-line signal sequence is shown in below table:

MIPI_TX	MIPI_TX0_D0P	GND	MIPI_TX0_D1P	MIPI_TX0_CLKP	GND	MIPI_TX0_D2P	MIPI_TX0_D3P	GND	LCD_RST_H	LCD_EN_H	I2C_SDA_TP	TOUCH_RST_L	VCC5V0_SYS	VCC5V0_SYS
GND	MIPI_TX0_D0N	MIPI_TX0_D1N	GND	MIPI_TX0_CLKN	MIPI_TX0_D2N	GND	MIPI_TX0_D3N	VCC1V8_S3	CABC_EN	I2C_SCL_TP	TOUCH_INT_L	GND	VCC5V0_SYS	

MIPI_TX/RX two-line signal sequence is shown in below table:

MIPI_TX/RX	MIPI_TX1/RX1_D3P	GND	MIPI_TX1/RX1_D2N	GND	MIPI_TX1/RX1_CLKP	MIPI_TX1/RX1_D1N	GND	MIPI_TX1/RX1_D0P	LCD_BL_PWM	VCC1V8_S3	I2C_SCL_TP	TOUCH_INT_L	GND	VCC5V0_SYS
GND	MIPI_TX1/RX1_D3N	GND	MIPI_TX1/RX1_D2P	MIPI_TX1/RX1_CLKN	GND	MIPI_TX1/RX1_D1P	MIPI_TX1/RX1_D0N	GND	GND	LCD_RST_H	I2C_SDA_TP	TOUCH_RST_L	VCC5V0_SYS	VCC5V0_SYS

eDP two-line signal sequence is shown in below table:

eDP Display	EDP_TX0N	GND	EDP_TX1P	EDP_AUXN	GND	EDP_TX2P	EDP_TX3N	GND	LCD_RST_H	I2C_SDA_TP	TOUCH_RST_L	VCC5V0_SYS	VCC5V0_SYS
GND	EDP_TX0P	EDP_TX1N	GND	EDP_AUXP	EDP_TX2N	GND	EDP_TX3P	LCD_BL_PWM	VCC1V8_S3	I2C_SCL_TP	TOUCH_INT_L	GND	VCC5V0_SYS

3.12 HDMI Output

EVB board supports the latest HDMI 2.0 protocol, and output interface is type A
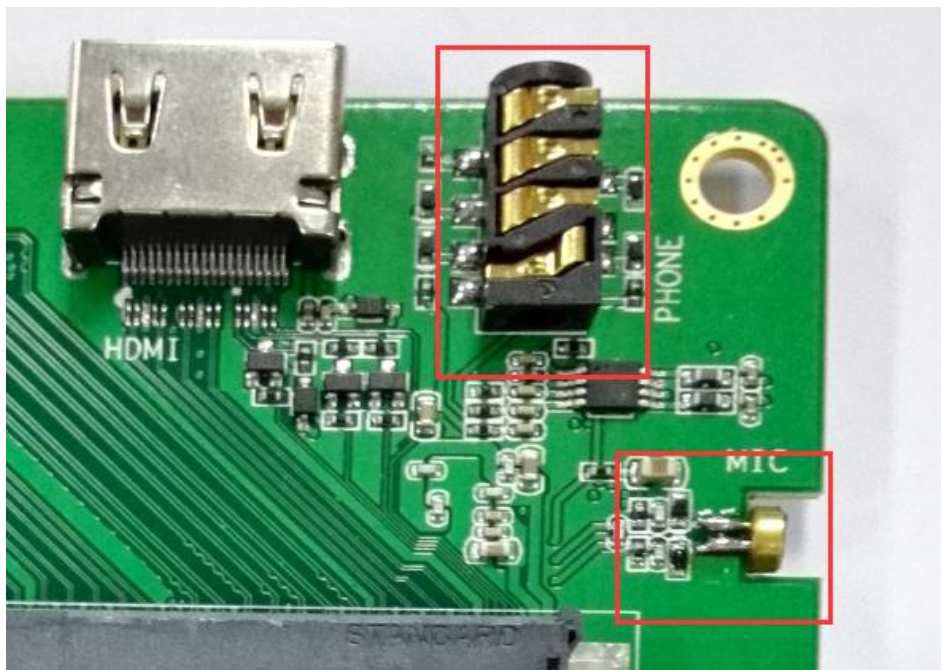
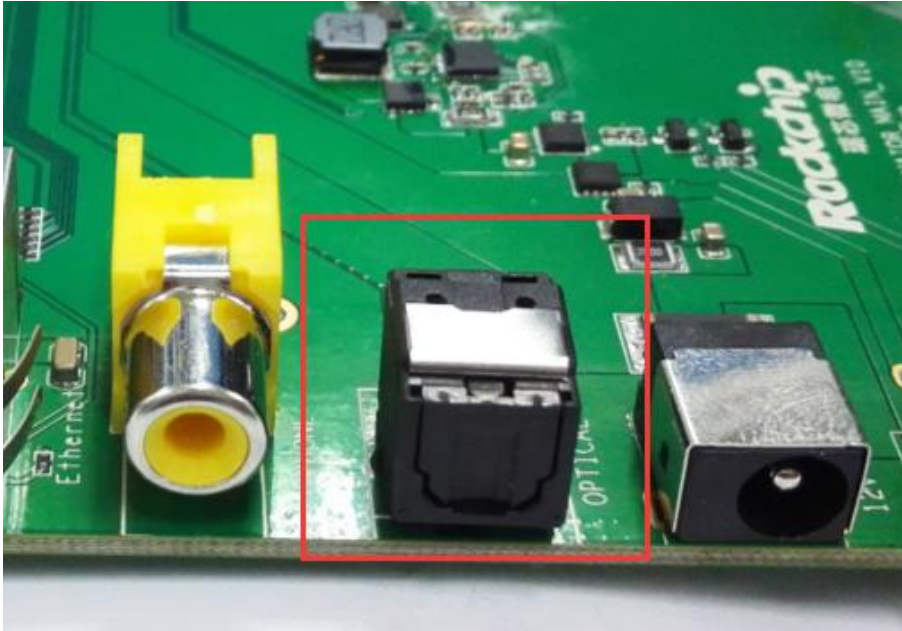connector.
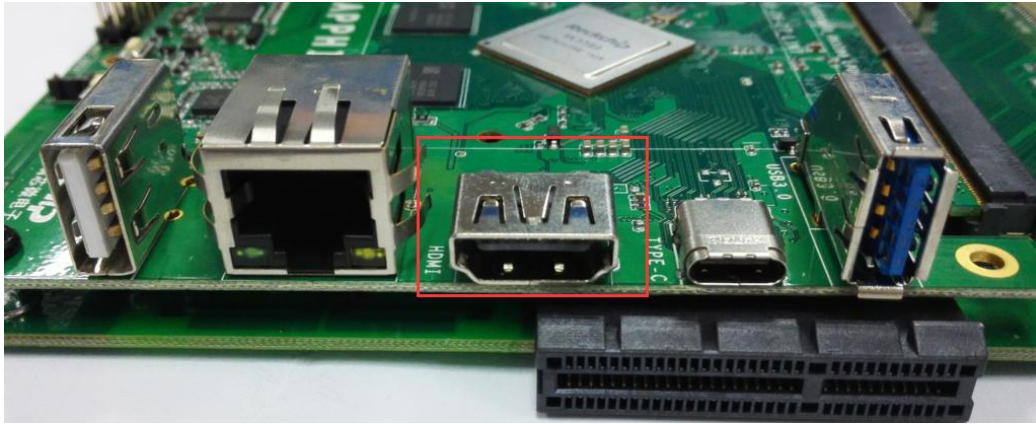
3.13 Audio Input/Output

Audio Codec of EVB board is Realtek ALC5651, its features shown as below:

● Embedded Charge Pump, supports stereo headphone output without capacity coupling.

● Microphone differential input.

3.14 SPDIF Output

EVB supports SONY, PHILIPS digital audio interface output, transmission hardware interface adopt optical fiber.
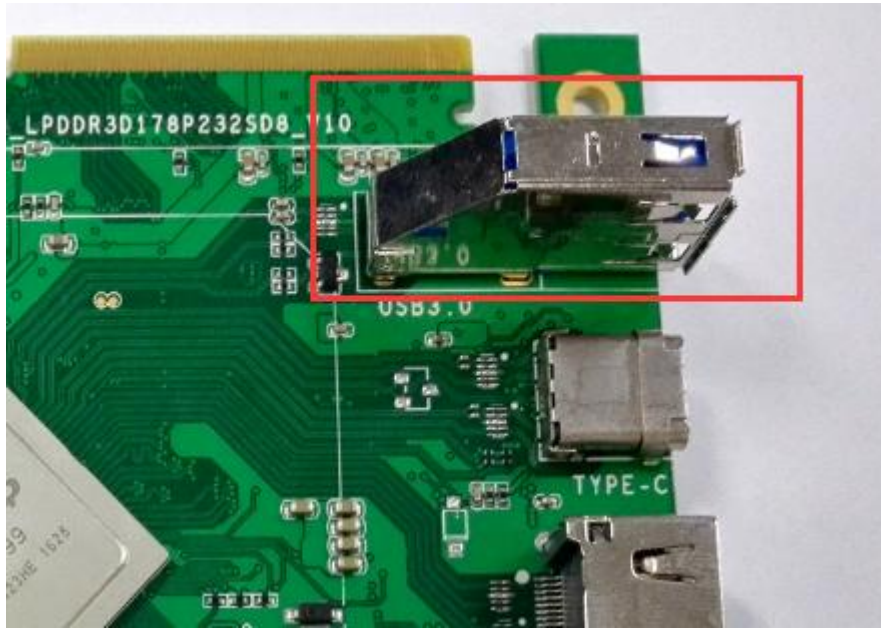
3.15 USB OTG/HOST Interface

EVB has USB OTG and USB HOST interfaces:

- Excavator uses a USB HUB, connected to RK3399 HOST0, which supports 4 USB2.0 HOST. Two Type-A connectors are overlaid to deeply reduce the space on PCB.

- Sapphire has USB HOST 3.0 interface, connected to DP/DM of CPU TYPE-C1, which is USB 3.0 Standard-A interface, downward compatible with USB 2.0.

- Sapphire also has a USB 2.0 interface, connected to RK3399 HOST1, which can be connected to peripheral devices such as U disk, mouse.

- HDMI IN interface is reused on Excavator. There is also one USB Host2.0, connected to HOST1, with hdmi and USB Host interface reused to reduce space on PCB.

- RK3399 TYPE-C interface supports full-functional TYPE-C protocol, also supports DP output, DP display.

TYPE-C interface signal sequence:

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1−	VBUS	CC1	D+	D−	SBU1	VBUS	RX2−	RX2+	GND
GND	RX1+	RX1−	VBUS	SBU2	D−	D+	CC2	VBUS	TX2−	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

DP signal's relevant TYPE-C connector location:

A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
GND	DP3+	DP3−	Vbus	CC1	D+	D−	auxN	Vbus	DP1−	DP1+	GND
GND	DP2+	DP2−	Vbus	auxP	D−	D+	CC2	Vbus	DP0−	DP0+	GND
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12

TYPE-C's location on Sapphire:
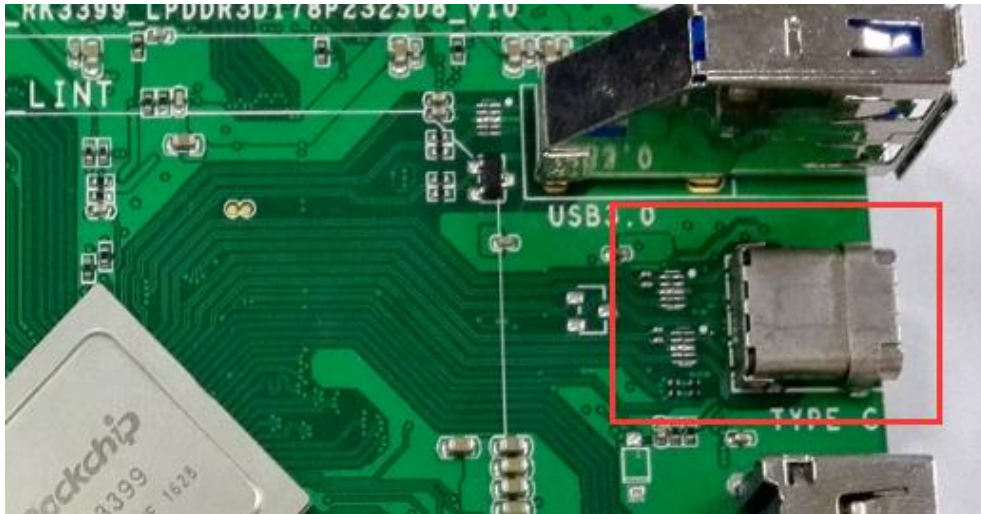
3.16 Ethernet

EVB supports RJ45 interface, which can be connected by gigabit Ethernet, RTL8211E-VB-CG is the PHY used, its features shown as below:

● Compatible with IEEE802.3 standard, supports full duplex and half duplex operation, supports cross detection and self-adaption

● Supports 10/100/1000M data rate

● RJ45 interface adopted has LED light and isolation transformer
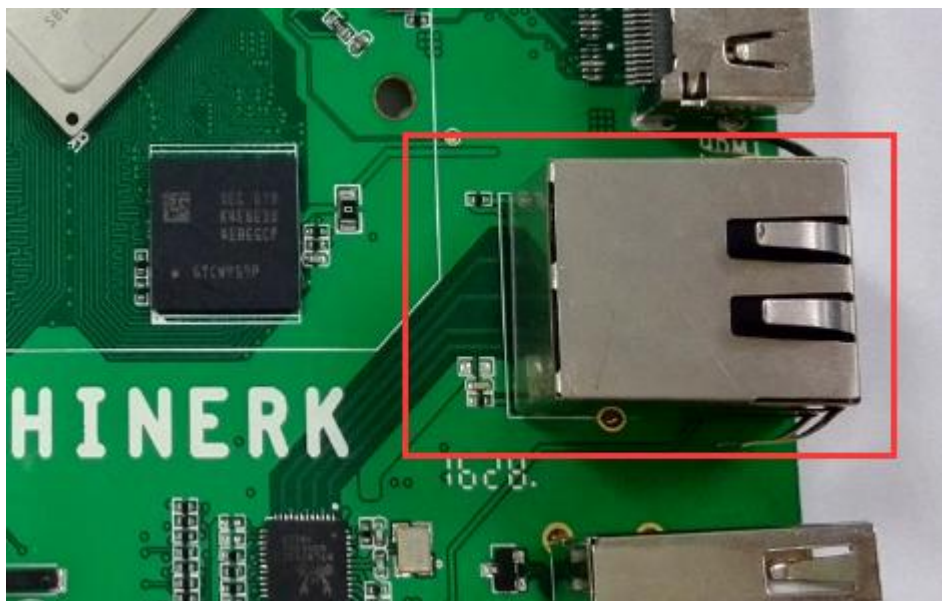
3.17 TF/SD Card Interface

RK3399 SDMMC0 is used, with 4 bits data bus width, which supports SDMMC 3.0 protocol. The Max capacity is 32G under Windows system, no limitation under linux system.
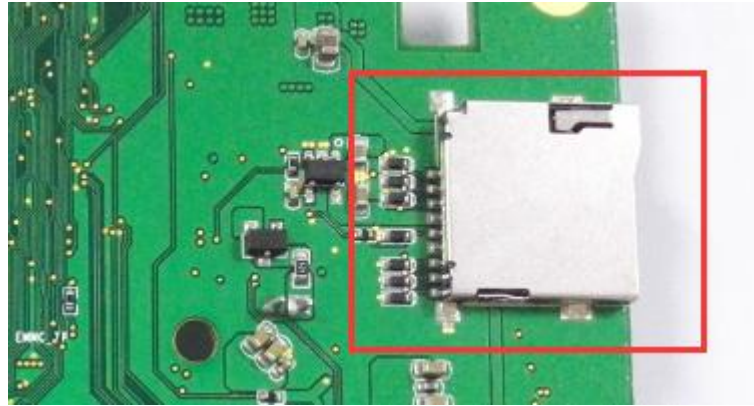
3.18 GPIO/I2C/SPI Extended Port

CIF signals is reused, and compatible with GPIO interface of Raspberry PI, which can be debugged by peripheral devices supplied by multichannel low-speed control units such as I2C, SPI, UART signals.
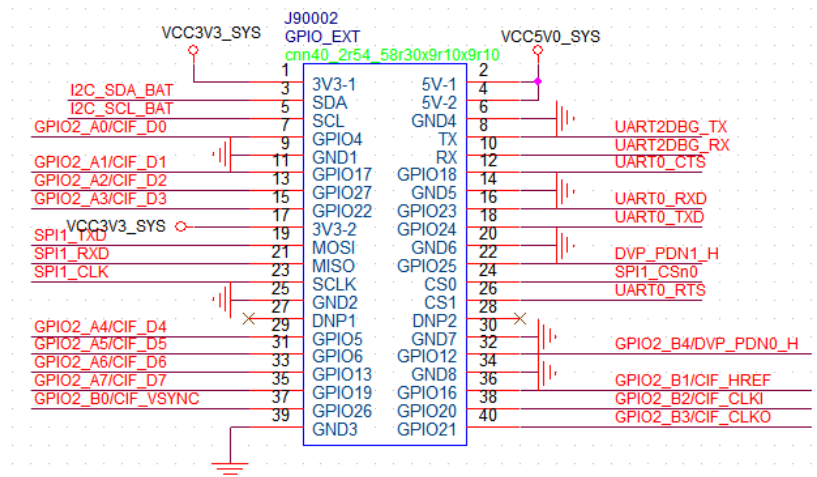
Relevant Reuse table:

func1	func2	func3
GPIO2_A0/CIF_D0		I2C2_SDA
GPIO2_A1/CIF_D1		I2C2_SCL
GPIO2_A7/CIF_D7		I2C7_SDA
GPIO2_B0/CIF_VSYNC		I2C7_SCL
GPIO2_B1/CIF_HREF	SPI2_RXD	I2C6_SDA
GPIO2_B2/CIF_CLKI	SPI2_TXD	I2C6_SCL
GPIO2_B3/CIF_CLKO	SPI2_CLK	
GPIO2_B4/DVP_PDN0_H	SPI2_CSN	

Connector's Location on Sapphire:

Connector's Location on Excavator:
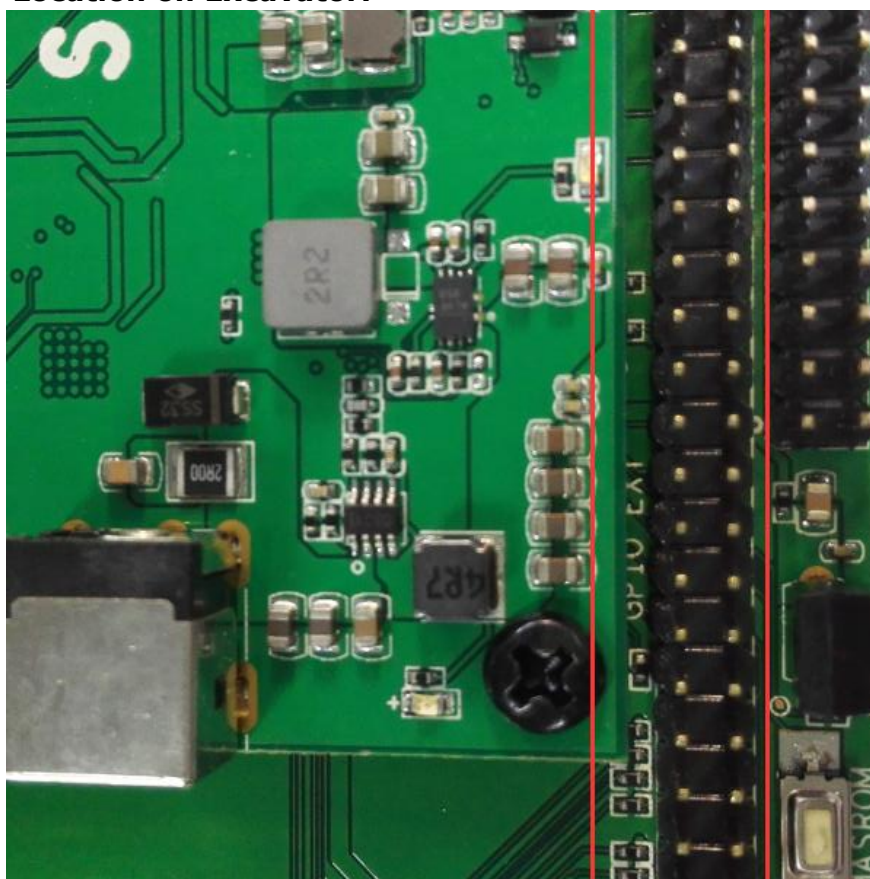
For the convenience to fly line of necessary signals, relevant signal sequence on PCB is shown in table below:

Left Column	Right Column
VCC3V3_SYS	VCC5V0_SYS
I2C_SDA_BAT	VCC5V0_SYS
I2C_SCL_BAT	GND
GPIO2_A0/CIF_D0	UART2DBG_TX
GND	UART2DBG_RX
GPIO2_A1/CIF_D1	UART0_CTS
GPIO2_A2/CIF_D2	GND
GPIO2_A3/CIF_D3	UART0_RXD
VCC3V3_SYS	UART0_TXD
SPI1_TXD	GND
SPI1_RXD	DVP_PDN1_H
SPI1_CLK	SPI1_CSn0
GND	UART0_RTS
空	空
GPIO2_A4/CIF_D4	GND
GPIO2_A5/CIF_D5	GPIO2_B4/DVP_PDN0_H
GPIO2_A6/CIF_D6	GND
GPIO2_A7/CIF_D7	GPIO2_B1/CIF_HREF
GPIO2_B0/CIF_VSYNC	GPIO2_B2/CIF_CLKI
GND	GPIO2_B3/CIF_CLKO

3.19 WIFI+BT Module

WIFI+BT Module adopted is AP6354 chipset from Taiwan AMPK Technology, its features shown as below:

- Supports WIFI(2.4G and 5G，802.11 ac), BT4.1.

- BT data is transformed by UART.

- BT audio connected to CPU PCM interface.

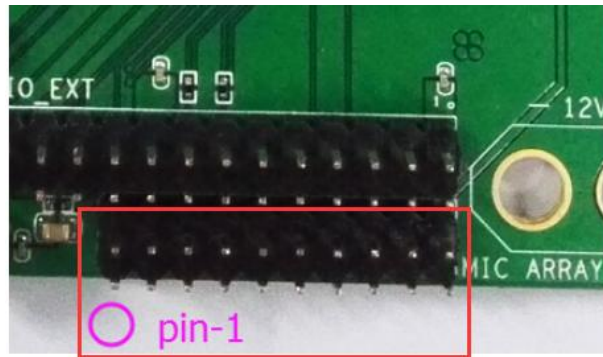- WIFI data adopts 4bits SDIO data width.
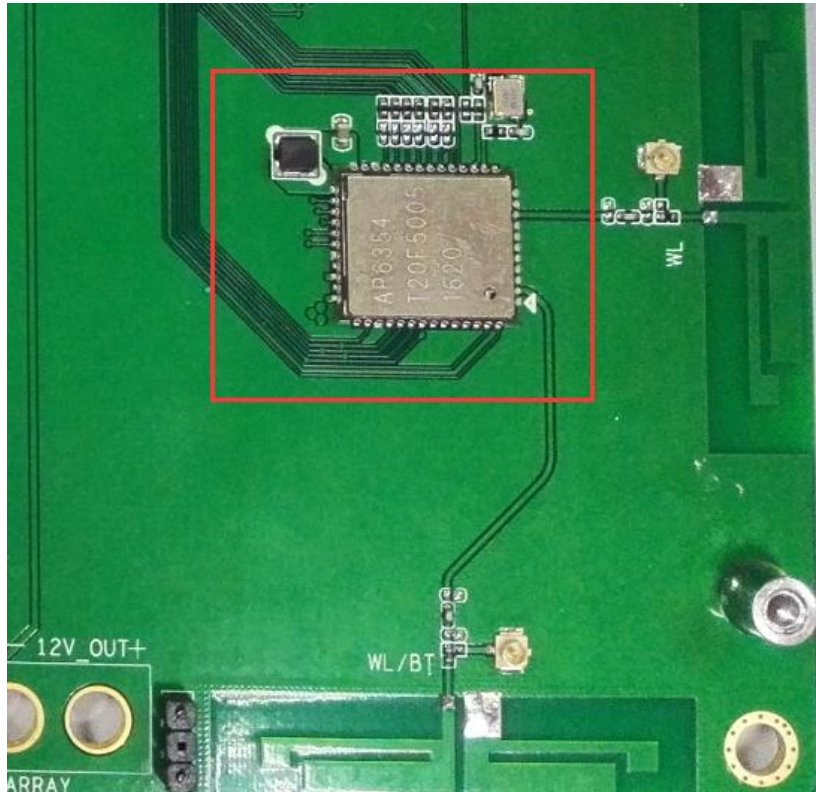
3.20 UART Debug Socket

UART is supplied for debug, the default connector is Uart2. FT232RL highly-integrated interface converting chip is used, its Baud Rate supports 1.5M chose by RK3399.
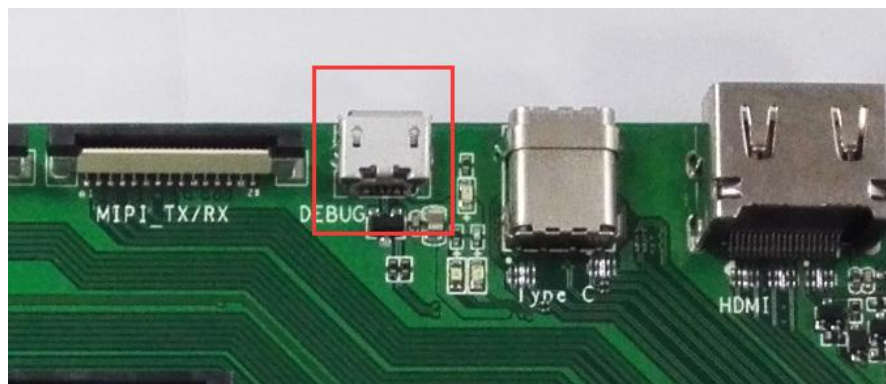
3.21 MIC Array

This function can be realized only when special MIC array board is used, relevant signal sequence on connector shown as below:

Relevant signal sequence on PCB shown as below: as shown in picture above, PIN-1 is stipulated.

3.22 Pcie Interace

● RK3399 has a PCIE interface, which supports standard PCI Express 2.1 Protocol.

● Duplex mode: Root Complex(RC)and End Point(EP).

● Supports up to 4 lane, with bidirectional communication.

● Supports 100Mhz differential signal output.

Splint-type connector is used on EVB, external PCIE board card is linked to PCIE on Excavator from the side.
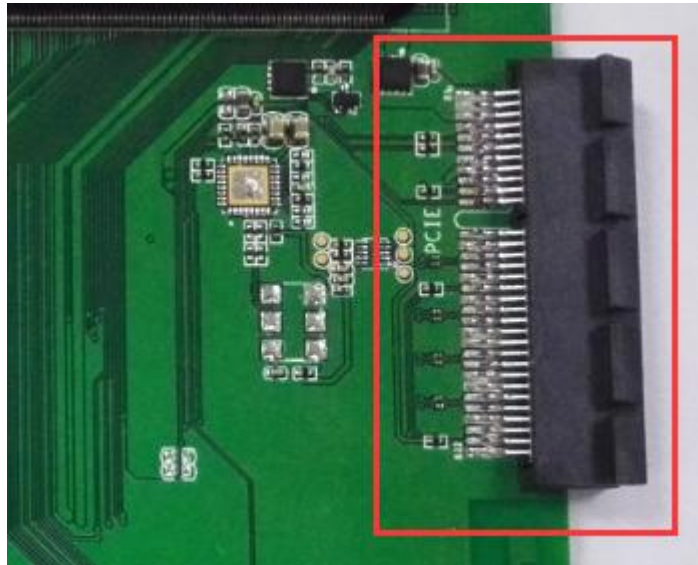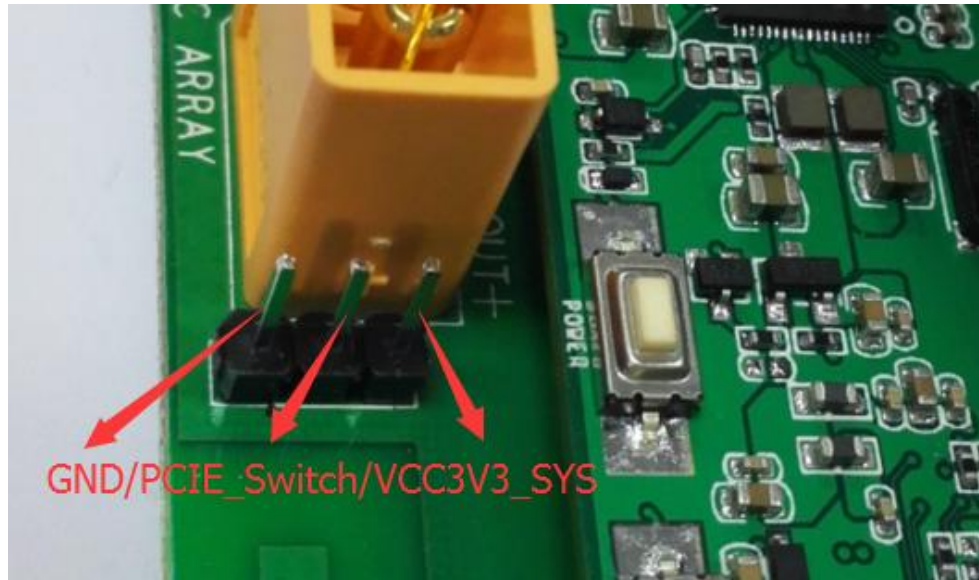
Since external PCIE board card current is larger, PCIE 12V power is supplied by two sources.

External 12V input and 12V power supply on board (default) are Jump Cap switched:

PCIE_Switch = 12V power supply on GND board

PCIE_Switch = VCC3V3_SYS external input 12v power, connected to the end of yellow interface.

Chapter 4 Firmware Update Mode

Sapphire has two firmware update modes:

First: entering RK3399 Maskrom mode.

Basal principle is EMMC_CLKO short to GND before system power on. Operation is to connect USB to computer, press the Maskrom Key on Excavator board, system power on. Then a Maskrom device will be detected on update tool, make sure relevant Loader is chose under Maskrom state.
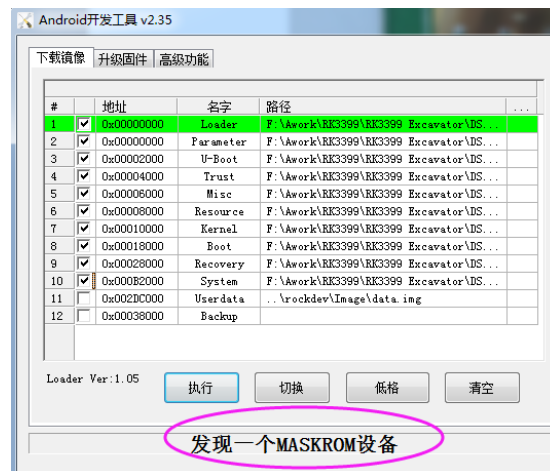
Second: entering RK3399 Loader mode.

Basal principle is to make sure ADKEY_IN is low level before system power on. Operation is to connect USB to computer, press Vol+ key on Excavator, system power on. Then a Loader device will be detected on update tool.
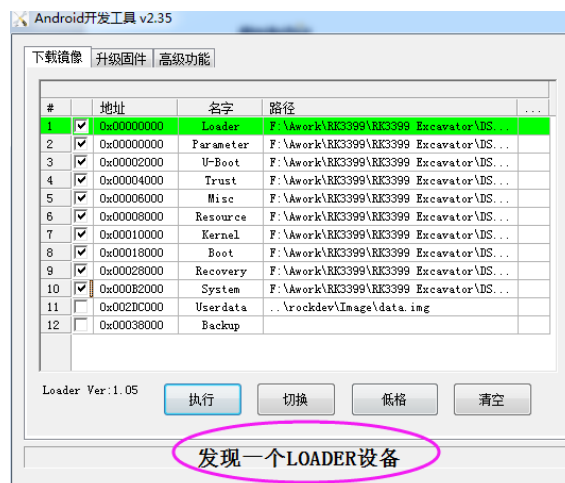
Chapter 5 Operation Guide

5.1 Notes

Excavator board is suitable for laboratory or engineering development environment; please refer to below notes before any operations:

- Sapphire, power board, screen interface and extended board can't be hot plugged under any conditions.

- To avoid hardware damage to EVB caused by ESD, please take necessary anti-static measures before opening the packaging and installing the EVB.

- Please take the edge of EVB, don't touch any mental portion of EVB to avoid components damage caused by ESD.

- Please put the EVB on dry plane, make sure to keep it away from heat, Electromagnetic interference sources, radiation source and electromagnetic radiation sensitive devices (such as medical equipment), etc.