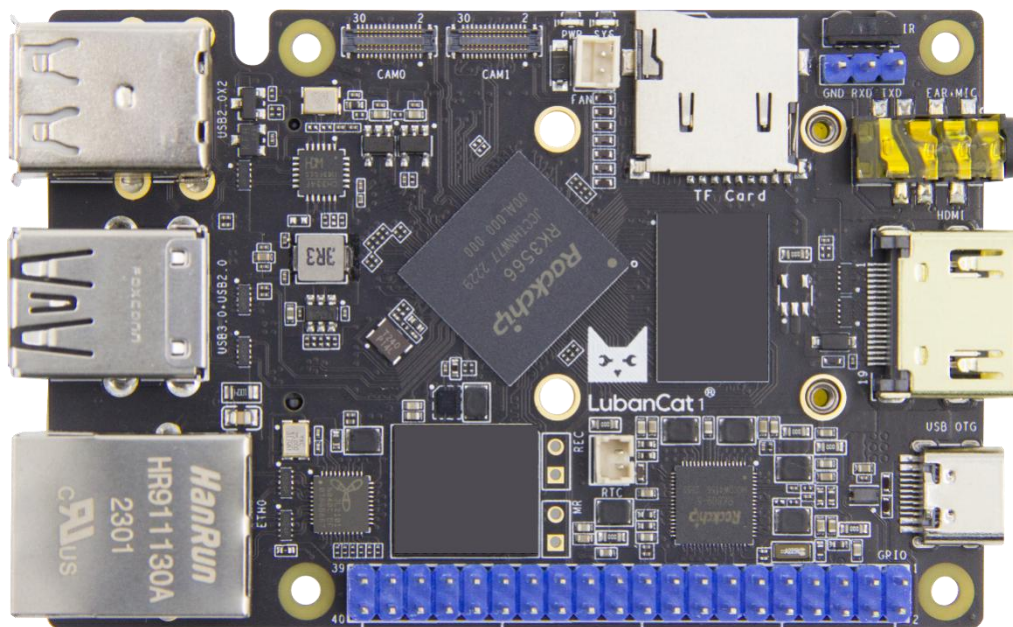


Luban Cat 1

LubanCat 1



Hardware specification

Rev. 1.4

2024/05/09

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Manual version

Manual version	date	Update Explanation
V 1.0	2023-10-15	• Initial version
V 1.1	2023-12-21	• Add reference power consumption data for each image configuration • Add operating current and startup power of the main power supply to the power supply parameters • Supplement power consumption of Ethernet port and HDMI port, as well as the current output capability of USB interfaces in the development board interface resources
V1.2	2023-12-21	• Revised Fan Interface Specifications
V1.3	2023-13-29	• Revise the descriptions of the DSI and CSI sections
V1.3.1	2024-03-06	• Reference power consumption section at the end
V1.4	2024-05-09	• Added the chapter "Introduction to Version Differences of LubanCat 1 Development Board", and moved part of the difference content into this chapter.
V1.4.1	2025-07-07	• Added support for operating system images and cameras. • Corrected errors in network port mode description, chip model, RTC positive and negative polarity, and other contents.

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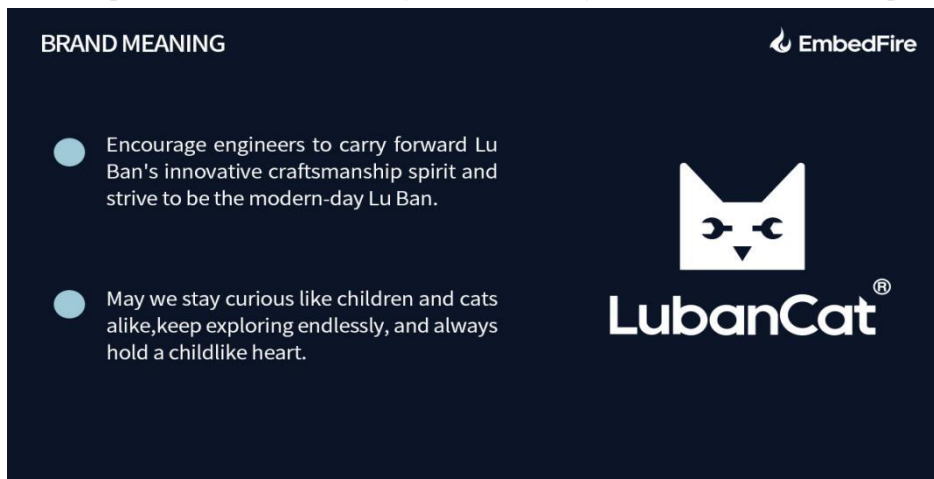
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Chapter 1 LubanCat Product Introduction

LubanCat is a Linux and Android card computer series brand launched by Embedfire. This series of card computers has a rich hardware product line, high compatibility with operating systems, numerous open-source teaching materials, and simple application development. With its superior performance and multiple product lines covering education, commercial applications, industrial control, and other fields, it has a wide range of application scenarios:

- Card computer: office, programming development, home entertainment, programming education, etc
- Linux servers: private cloud, soft router NAS, Personal web servers, etc
- Home intelligence center: TV box, smart home control, sensor data analysis, security monitoring, etc
- Industrialization: electronic billboards, vending machines, robots, drones, etc
- Embedded Development Board: Accelerating Embedded Project Validation and Development



The LubanCat series computers provide rich materials and versions from hardware to systems, textbooks, and applications, and strong versatility:

Hardware: controllers with different performance、 peripheral interfaces、 storage capacity、 and board size

System: Supports Ubuntu、 Debian、 OpenWrt、 Android、 OpenHarmony and other systems

Textbook: Provides multiple sets of textbooks, covering both pure application layer users and system development users, such as Python, Qt, Android application development, Linux system usage and kernel、 driver、 and image production

Application: Provide various application examples for the upper layer, such as using C/Python to control various hardware and developing applications based on ROS robot system

Complete open source materials, including but not limited to product manuals、 system source code、 schematic encapsulation libraries, various high-quality Linux development tutorials, etc. Even novice embedded players can complete development according to our tutorials, while experienced embedded veterans can accelerate the product's secondary development process.

Chapter 2 RK3566 Introduction

The entire LubanCat 1 series uses the Rockchip RK3566 chip as the main control chip.

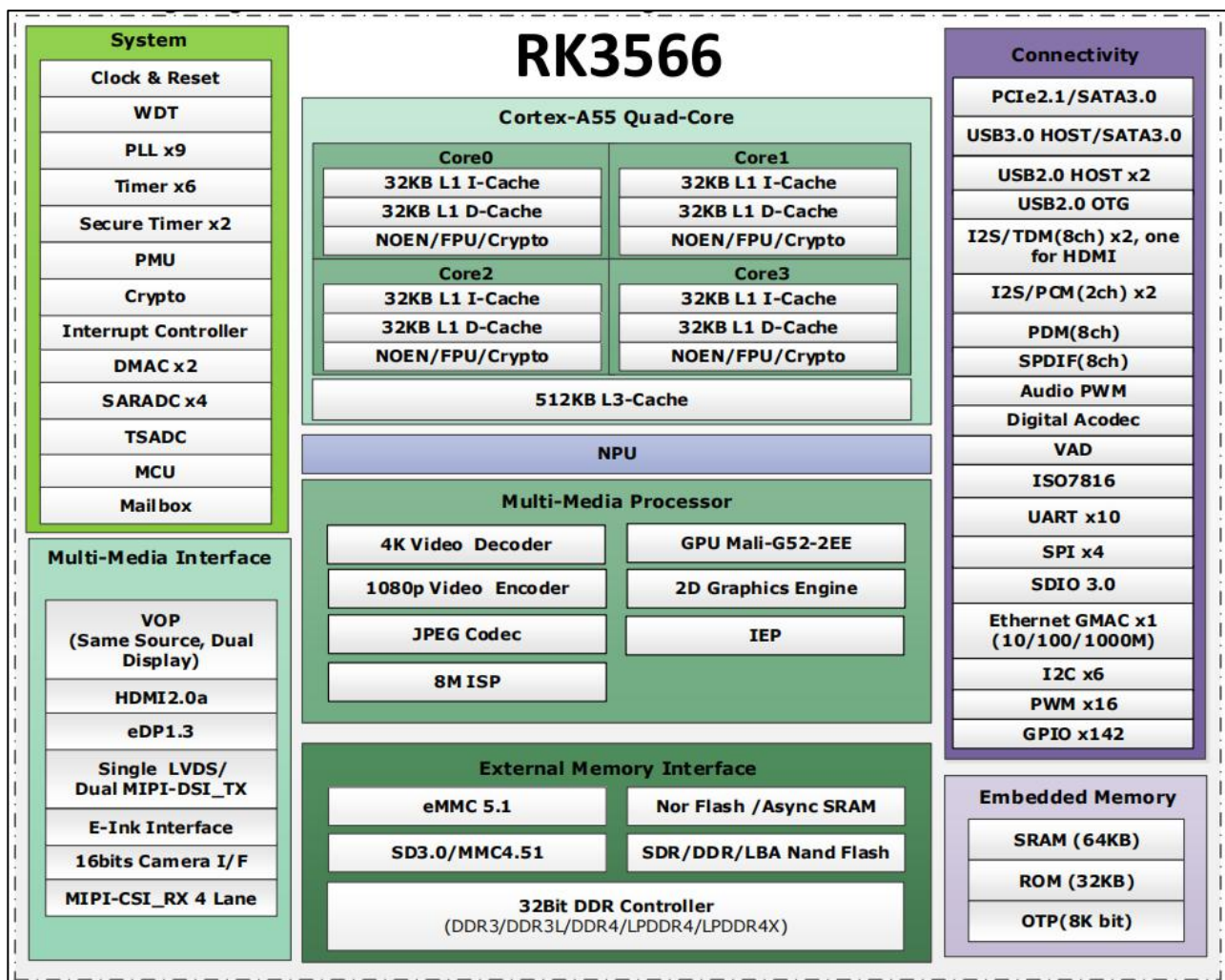
The Rockchip RK3566 is a general-purpose SoC based on the ARM architecture. It is equipped with a quad-core Cortex-A55 CPU, integrates a G52 GPU, and features a built-in independent NPU. The RK3566 is primarily designed for consumer products such as tablets, smart speakers with displays, Android laptops, and electronic translators, as well as industrial applications including face payment POS terminals, e-book readers, cloud terminals, video phones, and NAS storage devices.

The Rockchip RK3566 chip is a general-purpose SoC based on the ARM architecture. The CPU adopts a quad-core Cortex-A55 processor, integrates a G52 graphics processor, and has an independent NPU. The RK3566 is mainly customized for consumer products such as tablet computers, screen-equipped speakers, Android laptops, dictionary pens, etc., as well as industry products like facial payment POS machines, e-books, cloud terminals, video phones, and NAS storage.

The detailed parameters are as follows:

Detailed parameters	
CPU	• Quad-core Cortex-A55 architecture processor, with the maximum operating frequency of 1.8 GHz.
GPU	• ARM G52 2EE Graphics Processor
	• Supports OpenGL ES 1.1/2.0/3.2, OpenCL 2.0, Vulkan 1.1
	• Embedded high-performance 2D image acceleration module
NPU	• Rockchip self-developed NPU, with a maximum computing power of up to 1 TOPS.
	• Support one-click conversion of Caffe/TensorFlow/TFLite/ONNX/PyTorch/Keras/Darknet architecture models
display	• Single display, supports eDp/HDMI2.0/MIPI/LVDS/EBC
multi-media	• Supports 4K 60fps H.265/H.264/VP9 video decoding
	• Supports 1080P 60fps H.265/H.264 video encoding
	• Supports 8M ISP, which can be time-sharing multiplexed to meet the requirements of dual cameras.

The application diagram of RK3566 processor is as follows:



Chapter 3 Introduction to Version Differences of the LubanCat1 Development Board

This chapter mainly introduces the differences of the LubanCat 1 development board.

3.1 Version Changes

Currently, the Luban Cat 1 development board has been updated to Version V2. The specific changes are listed in the table below:

Board version	Board silk screen printing	Description of Changes
LubanCat 1	EBF41005 220220919	Initial version
	EBF410052V1 20221212	Correct the issue of RST pin level matching in the PHY chip
LubanCat 1-V2	EBF410077V2 20230512	Upgrade the original 1 MIPI CSI interface connector to two BTB interface connectors.
	EBF410077V2R2 20240309	New production version: tantalum capacitors are added at the mini PCIE interface to ensure stability.
	EBF410077V2R3 20240327	Since the built-in RTC circuit of the PMIC features high power consumption, the internal RTC circuit is disabled, and an external RTC module circuit is added instead. Circuits and components for RTC_INT wake-up are additionally integrated.

matters needing attention:

- (1) The board silkscreen is located on the back side.
- (2) Since the changes between LubanCat 1 and LubanCat 1-V2 do not involve software adjustments, the original LubanCat 1 image will continue to be used.
- (3) Users in need may refer to the 《Introduction Chapter of Luban Cat 1 Development Board》.

3.2 Version Comparison

3.2.1 Appearance Diagram

Appearance Diagram of LubanCat 1-V2 Development Board

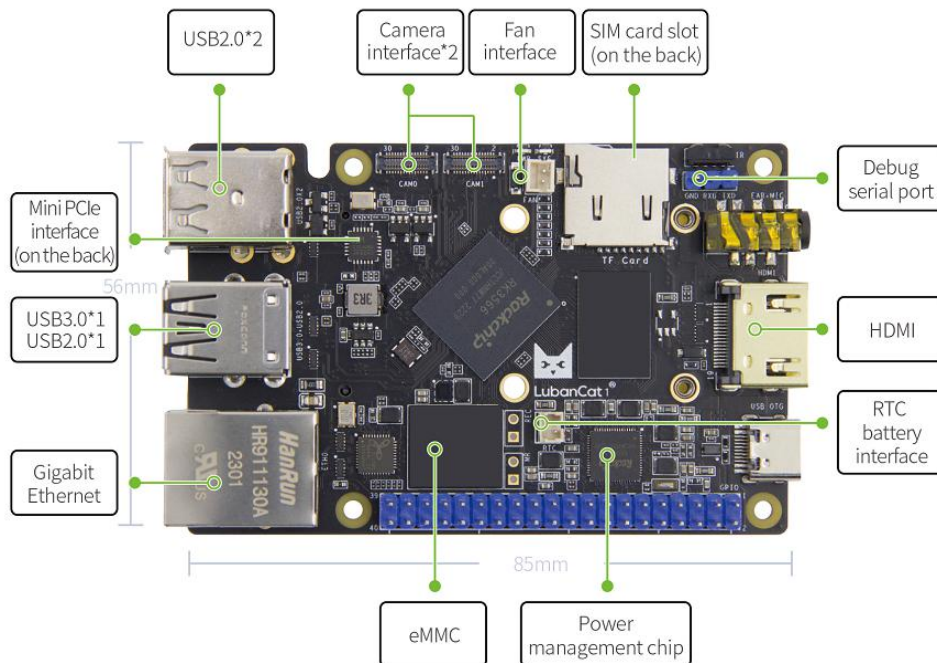


Figure 3.2.1-1 Front View 1 of LubanCat 1-V2

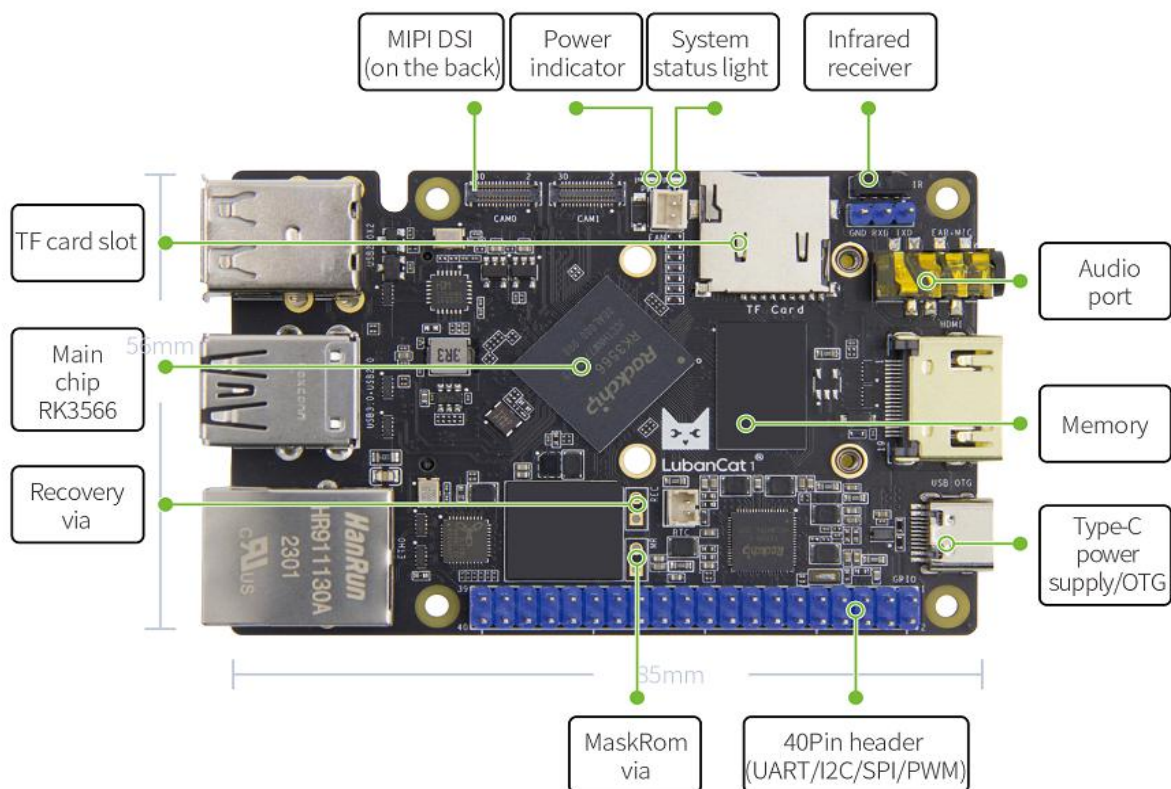


Figure 3.2.1-2 Front View 2 of LubanCat 1-V2

3.2.2 Mechanical Dimension Drawing

LubanCat 1 Development Board Dimension Drawing

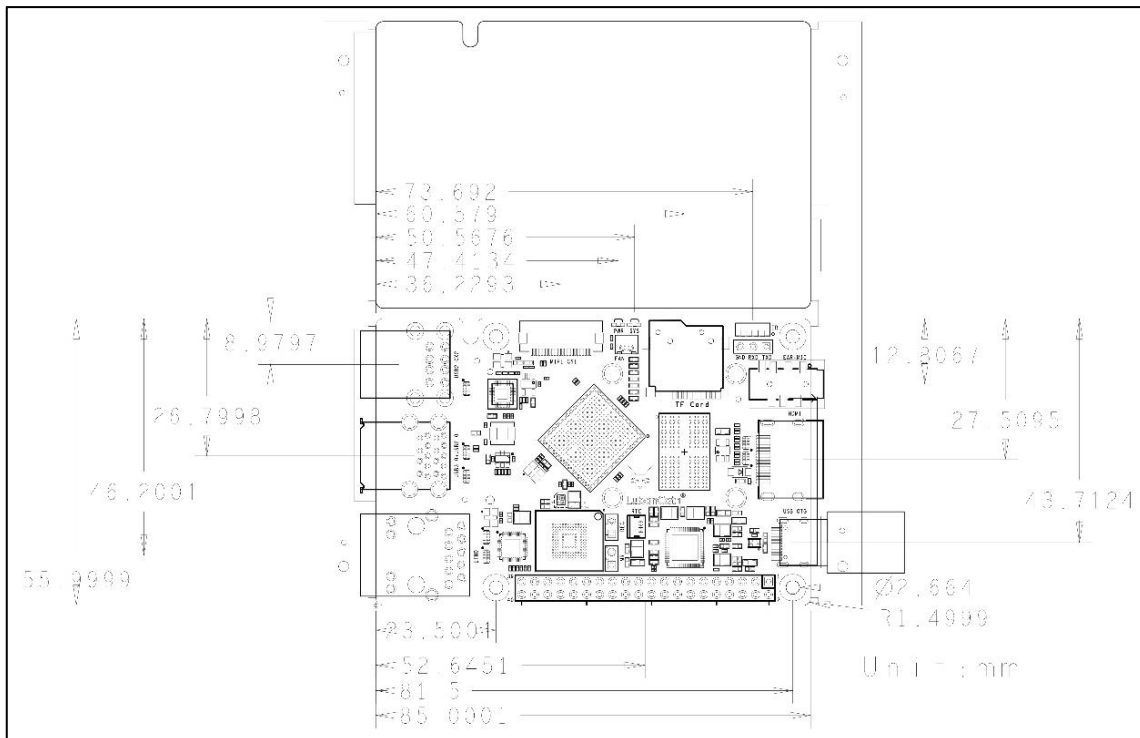


Figure 3.2.2-1 Mechanical Dimension Drawing of LubanCat 1

LubanCat 1-V2 Development Board Dimension Drawing

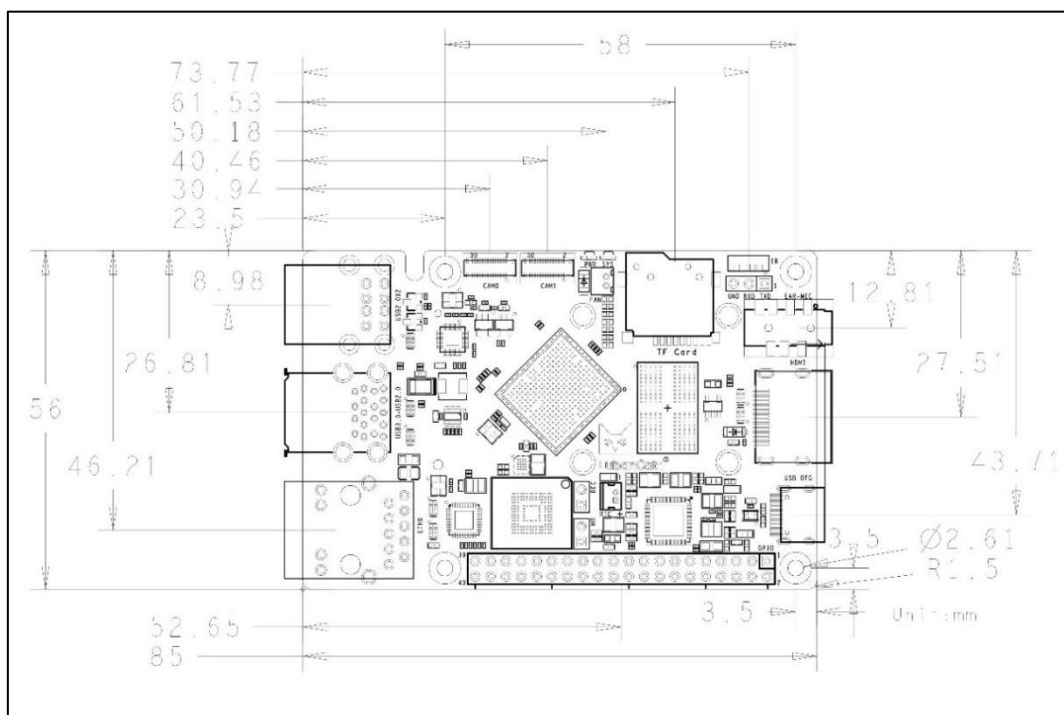


Figure 3.2.2-2 Mechanical Dimension Drawing of LubanCat 1-V2

3.2.3 Camera

The camera interfaces onboard the new V2 version adopt two 2×15Pin BTB sockets with a 0.4mm pitch. The socket model is AXE530127D, with silk screen labels CAM0 and CAM1 on the board respectively.

Corresponding adapter cables are required for camera connection. The connection diagram between the Luban Cat 1 board and the dual camera modules is shown below:



The onboard camera interface of the old version adopts a 24Pin FPC socket with a 0.5mm pitch. This interface supports connection with MIPI cameras and UVC cameras. For UVC cameras, applicable reference models include Firefly OV5693, OV2720, OV9762, etc. Compatible MIPI camera models cover Firefly mipi-imx415, Firefly mipi-gc08a8, Firefly mipi-gc2053, Firefly mipi-gc4653, Firefly mipi-ov8858, SC530AI, and Raspberry Pi OV5647 camera (an adapter board is required).

Chapter 4 Introduction to the LubanCat 1 Development Board

4.1 LubanCat 1 Hardware Specifications

LubanCat 1 hardware specifications	
SOC	Rockchip RK3566
PMU	Rockchip RK809-5
Memory	• The CXMT Changxin storage LPDDR4/LPDDR4X memory is adopted. The memory specifications include 1GB/2GB/4GB/8GB.
storage	• EMMC module: 8G/32GB/64GB/128GB • TF card: Supports TF card startup/expansion, up to 512GB
power supply	• Type-C 5V 3A
display	• Vertical standard HDMI interface, supporting up to 4K @ 60Hz • 1 x MIPI DSI 4-Lane interface, supporting up to 1080P @ 60Hz
Ethernet	• 1× Gigabit Ethernet, onboard PHY chip (RTL8211F or JL2101-N040C), supporting 10/100/1000 Mbps.
USB	• 1 x USB3.0 HOST • 1 x USB2.0 HOST • 1 x USB2.0 OTG
Camera	• The new V2 version is equipped with two 2 × 15Pin BTB CAM interfaces, supporting simultaneous connection of two BTB interface cameras. The old version features one MIPI CSI interface, which only supports a single MIPI CSI camera.
audio	• 1 x 3.5mm headphone jack, supporting audio input/output
FAN	• 2Pin 1.5mm specification 5V fan interface
RTC	• 2pin RTC battery interface with 1.25mm pitch specification
40Pin	• Compatible with Raspberry Pi 40Pin interface, supporting PWM, GPIO, I2C, SPI, UART functions
infrared	• Onboard IRM-V838M3-C/TR1 infrared remote control receiver head, supporting infrared remote control
SIM Card	• It needs to be used with Luban Cat compatible 4G/5G modules.
operating system	• Support Ubuntu 20.04, Debian 10, Android 11, Android 13, Android 14, Android TV, OpenWrt, and OpenHarmonyOS based on open-source HarmonyOS, etc.
size	• 85 x 56 mm

4.2 Performance Parameters

4.2.1 System Frequency

name	specifications				describe
	minimum	typical	maxim	unit	
System CPU frequency Arm Cortex-A5	408	600、816、1104、1416、1608	1800	MHz	Modifiable, default automatic
System GPU frequency Arm Mali-G52	-	-	800	MHz	-
System DDR frequency	324	528、780	1056	MHz	Modifiable, default automatic
System NPU clock frequency	200	-	900	MHz	Modifiable, default 600 MHz

4.2.2 Power supply parameters

name	specifications				describe
	minimum	typical	maximum	unit	
Main power supply operating voltage	4.7	5.0	5.2	V	-
Main power supply working current	0.4	0.8	3.0	A	-
Startup power (bare metal Linux)	3.63	3.85	3.98	W	100 startup tests
Startup power (for Android11 with MIPI 600P screen)	6.11	6.24	6.37	W	100 startup tests

Note: ① Main power supply operating voltage: The allowable main power supply voltage for normal operation of LubanCat 1.

② Main power supply working current: The main power supply current of the LubanCat 1 during normal operation, where the minimum working current refers to the standby current, the typical working current refers to the current when the CPU is fully loaded, and the maximum working current refers to the safe current allowed by the board. When working with external devices, please do not exceed the safe current.

③ Startup power (bare metal Linux): No peripherals, bare metal startup, test image is Debian10 lite image, test times 100 times.

④ Startup power (for Android11 with MIPI 800P screen): Only booting with the EmbedFire 7-inch MIPI screen. The tested system is Androi 11, and the test was conducted 100 times.

4.2.3 Working environment

parameter description		specifications				describe
		minimum	typical	maximum	unit	
operation temperature	work environment	0	25	60	°C	-
	storage environment	-40	25	+125	°C	
humidity	work environment	10	-	90	%RH	-
	storage environment	5	-	95	%RH	

4.2.4 Development board interface speed

parameter	specifications				describe
	minimum	typical	maximum	unit	
Serial communication speed	-	9600	4M	bps	-
USB 3.0 interface speed	-	-	5	Gbps	-
USB 2.0 interface speed	-	-	480	Mbps	-

SPI clock frequency	-	-	50	MHz	-
I2C communication speed	-	100	400	Kbps	-
MINI PCI-E / PCIe2.1 x 1	-	-	5	Gbps	最大 500MB/s

Note: For more interface speeds, please refer to the "Development Board Interface Resources" section.

4.3 Development Board Interface Resources

function	quantity	parameter
HDMI 2.0 output	1	Connected via standard HDMI socket, supporting: • 720p@30Hz、@60Hz、@120Hz • 1080p@30Hz、@60Hz、@120Hz • 1440p(2K)@30Hz、@60Hz • 2160p(4K)@30Hz、@60Hz The stable operating power consumption is approximately 0.25W, while the instantaneous power consumption during insertion or removal can reach up to 0.8W.
Ethernet	1	• Led out through one RJ45 interface; • Supports 10/100/1000 Mbps data transmission rate; • When connected to an Ethernet cable, the no-load power consumption is approximately 0.4W, and the power consumption during speed testing is about 0.8W.
USB3.0 Host	1	• Introduced through Type-A USB interface; • 1 USB 3.1 Gen1, with the data rate of up to 5Gbps; • Supports up to 2000mA current output;
USB2.0 Host	3	• Introduced through Type-A USB interface; • Supports three modes: high-speed (480Mbps), full speed (12Mbps), and low-speed (1.5Mbps); • Supports up to 1000mA current output;
USB2.0 OTG	1	• Introduced through Type-C interface; • Even the firmware burning interface shares the same socket as the power interface.
MINI PCIE	1	• MINI PCI-E specification: PCIe 2.0 x 1, with a maximum data rate of 5Gbps; • Compatible with full-height and half-height Wi-Fi network cards, 4G/5G modules; • Reusable as an mSATA interface for connecting mSATA hard drives; • Supports a maximum continuous output current of 2.5A and a peak current of 3A.
MIPI DSI	1	• Supports 4-lane output, with the maximum resolution being 1080x1920 at 60fps. • Compatible with Embedfire 5.5, 7, and 10.1 inch MIPI screens;
CAM/MIPI CSI	2	• The V2 version upgrades from one original MIPI CSI camera interface to two BTB camera interfaces; • Supports 2-lane input, adopting BTB sockets with 2 × 15Pin and 0.4mm pitch specification; • Compatible with Firefly IMX415/OV8858 cameras paired with BTB adapter boards, as well as Raspberry Pi OV5647 camera (adapter board required).

WIFI&BT	1	Supports WIFI & BT modules with MINI PCIE interface.
4G/5G	1	- Supports MINI PCI-E interface Wi-Fi & BT modules; - Requires a SIM card for operation.
Debug serial port	1	One Debug serial port, default parameters 1500000-8-N-1;
UART	5	- Lead out through a 40 pin pin pin with a spacing of 2.54mm; - Available serial ports: UART3, UART4, UART5, UART7, UART9; - The highest baud rate can reach 4Mbps;
SPI	1	- Lead out through 40 pin with spacing of 2.54mm; - Each controller supports two chip select outputs; - Support serial master and serial slave modes; - The maximum clock frequency is 50MHz;
I2C	2	- Lead out through 40 pin with spacing of 2.54mm; - Supports 7-bit and 10 bit address modes; - The standard mode data transmission rate can reach 100 Kbps, and in fast mode it can reach up to 400 Kbps;
I2S	1	- The transmitting and receiving clocks can reach up to 50 MHz. - Support Time Division Multiplexing (TDM), Inter-IC Sound (I2C) and similar formats - Supports digital audio interface transmission (SPDIF, IEC60958-1 and AES-3 formats) - Support audio reference output clock
PWM	12	Lead out through 40 pin with spacing of 2.54mm;
GPIO	28	- Lead out through a 40 pin with a spacing of 2.54mm; - In the 40 pin header, there are two 5V power pins, two 3V3 power pins, eight GND pins, The remaining 28 are GPIO pins, among which 9 of them do not have the pin re-mapping function.
TF card	1	Supports TF card for system booting. The maximum capacity supported is 512GB. The speed is SDR104. The actual limit is determined by the card.
audio	1	Comes out through a 3.5mm headphone jack, with a two-in-one headphone output and microphone input interface
RTC	1	Onboard RTC interface for connecting an RTC battery with a 2Pin 1.25mm connector.
FAN	1	Onboard fan interface, supporting 5V fans with 2Pin 1.5mm specification interface

Note 1: The parameters and quantities in the table are the theoretical maximum values defined by hardware design or the CPU, and most functional pins are multiplexed.

Note 2: When a Wi-Fi module is connected to the MINI PCI-E interface, it adopts the PCIe protocol. When a 4G/5G module is connected, although the physical interface is MINI PCI-E, the actual transmission adopts the USB protocol. When the MINI PCI-E interface is multiplexed as an mSATA interface to connect an mSATA hard disk, it adopts the SATA protocol.

Note 3: The power consumption values of the above peripheral interfaces refer to the increased power consumption of the system after connecting the corresponding peripherals.

4.4 Development Board 40Pin Definition

4.4.1 40Pin Schematic diagram

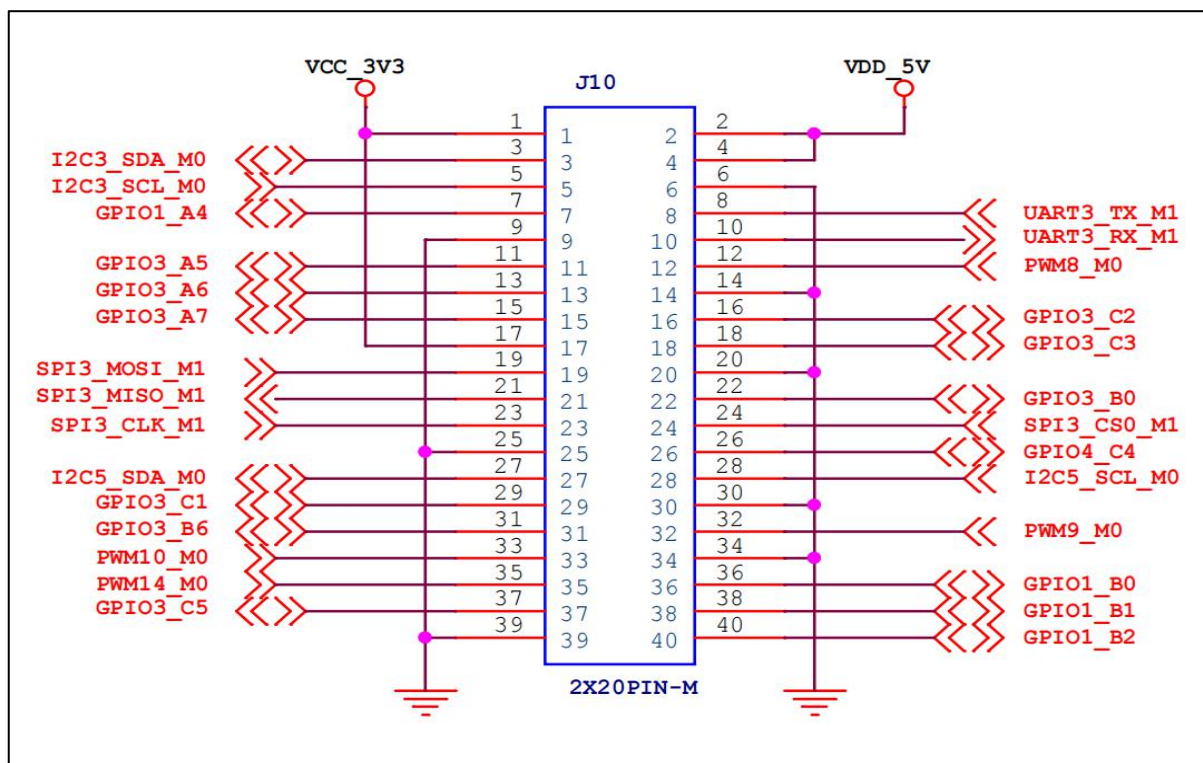


Figure 4.4-1 LubanCat 1 series pins Schematic diagram

4.4.2 40Pin Pin Function Diagram

LubanCat1 Series Pinout Diagram												
Function 4	Function 3	Function 2	Function 1	Number	GPIO	Physical Pin	GPIO	Number	Function 1	Function 2	Function 3	Function 4
					3.3V	1	2	5V				
		UART3_RX_M0	I2C3_SDA	32	GPIO1_A0	3	4	5V				
		UART3_TX_M0	I2C3_SCL	33	GPIO1_A1	5	6	GND				
				36	GPIO1_A4	7	8	GPIO3_B7	111	UART3_TX_M1	PWM12_M0	
					GND	9	10	GPIO3_C0	112	UART3_RX_M1	PWM13_M0	
				101	GPIO3_A5	11	12	GPIO3_B1	105	PWM8_M0	UART4_RX_M1	
				102	GPIO3_A6	13	14	GND				
				103	GPIO3_A7	15	16	GPIO3_C2	114		UART5_TX_M1	
					3.3V	17	18	GPIO3_C3	115		UART5_RX_M1	
I2S3_SCLK_M1		PWM15_IR_M1	MOSI	147	GPIO4_C3	19	20	GND				
I2S3_SDO_M1	UART9_TX_M1	PWM12_M1	MISO	149	GPIO4_C5	21	22	GPIO3_B0	104			
I2S3_MCLK_M1		PWM14_M1	SCLK	146	GPIO4_C2	23	24	GPIO4_C6	150	SPI3_CS0_M1	PWM13_M1	UART9_RX_M1
					GND	25	26	GPIO4_C4	148	CS1		I2S3_LRCK_M1
			I2C5_SDA	108	GPIO3_B4	27	28	GPIO3_B3	107	I2C5_SCL_M0		
				113	GPIO3_C1	29	30	GND				
		I2C3_SDA_M1	PWM11_IR_M0	110	GPIO3_B6	31	32	GPIO3_B2	106	PWM9_M0	UART4_TX_M1	
		I2C3_SCL_M1	PWM10_M0	109	GPIO3_B5	33	34	GND				
		UART7_TX_M1	PWM14_M0	116	GPIO3_C4	35	36	GPIO1_B0	40			
	PWM15_IR_M0	UART7_RX_M1		117	GPIO3_C5	37	38	GPIO1_B1	41			
					GND	39	40	GPIO1_B2	42			

Figure 4.4-2 LubanCat 1 Function Pin Diagram

4.4.3 40Pin Function Description

Note:

Pin -- Physical pin number;

GPIO -- The universal I/O serial number of the Rockchip RK3566 chip, consisting of a controller (bank), ports, and index pins;

Num -- GPIO number, mainly used for program control.

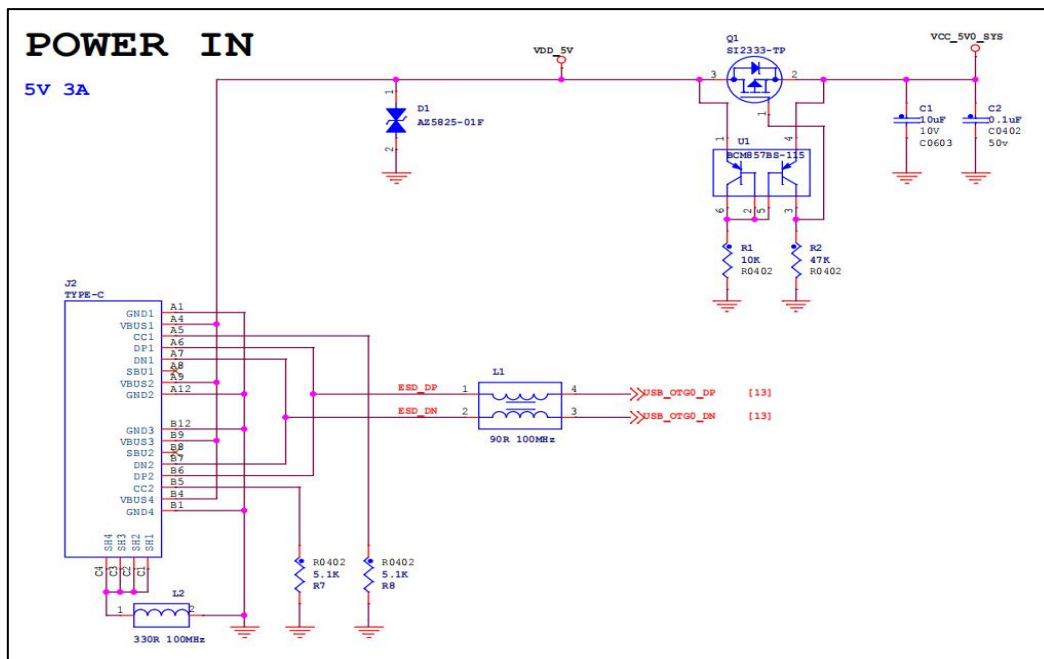
Table 4.6.3 LubanCat 1 40Pin Interface Definition

Pin	GPIO	Num	Pin Description	PWM	UART	SPI	I2C/I2S
1	3V3	-	3.3V pin				
2	5V	-	5V pin				
3	GPIO1_A0	32	GPIO、I2C、UART		UART3_RX_M0		I2C3_SDA_M0
4	5V	-	5Vpin				
5	GPIO1_A1	33	GPIO、I2C、UART		UART3_TX_M0		I2C3_SCL_M0
6	GND	-	GND				
7	GPIO1_A4	36	GPIO				
8	GPIO3_B7	111	GPIO、PWM、UART	PWM12_M0	UART3_TX_M1		
9	GND	-	GND				
10	GPIO3_C0	112	GPIO、PWM、UART	PWM13_M0	UART3_RX_M1		
11	GPIO3_A5	101	GPIO				
12	GPIO3_B1	105	GPIO、PWM、UART	PWM8_M0	UART4_RX_M1		
13	GPIO3_A6	102	GPIO				
14	GND	-	GND				
15	GPIO3_A7	103	GPIO				
16	GPIO3_C2	114	GPIO、UART		UART5_TX_M1		
17	3V3	-	3.3V pin				
18	GPIO3_C3	115	GPIO、UART		UART5_RX_M1		
19	GPIO4_C3	147	GPIO、PWM、SPI、I2S	PWM15_IR_M1		SPI3_MOSI_M1	I2S3_SCLK_M1
20	GND	-	GND				
21	GPIO4_C5	149	GPIO、PWM、UART、SPI、I2S	PWM12_M1	UART9_TX_M1	SPI3_MISO_M1	I2S3_SDO_M1
22	GPIO3_B0	104	GPIO				
23	GPIO4_C2	146	GPIO、PWM、SPI、I2S	PWM14_M1		SPI3_CLK_M1	I2S3_MCLK_M1
24	GPIO4_C6	150	GPIO、PWM、UART、SPI、I2S	PWM13_M1	UART9_RX_M1	SPI3_CS0_M1	I2S3_SDI_M1
25	GND	-	GND				
26	GPIO4_C4	148	GPIO、SPI、I2S			CS1	I2S_LRCK_M1
27	GPIO3_B4	108	GPIO、I2C				I2C5_SDA_M0
28	GPIO3_B3	107	GPIO、I2C				I2C5_SCL_M0
29	GPIO3_C1	113	GPIO				
30	GND	-	GND				
31	GPIO3_B6	110	GPIO、PWM、I2C	PWM11_IR_M0			I2C3_SDA_M1
32	GPIO3_B2	106	GPIO、PWM、UART	PWM9_M0	UART4_TX_M1		
33	GPIO3_B5	109	GPIO、PWM、I2C	PWM10_M0			I2C3_SCL_M1
34	GND	-	GND				
35	GPIO3_C4	116	GPIO、PWM、UART	PWM14_M0	UART7_TX_M1		
36	GPIO1_B0	40	GPIO				
37	GPIO3_C5	117	GPIO、PWM、UART	PWM15_IR_M0	UART7_RX_M1		
38	GPIO1_B1	41	GPIO				
39	GND	-	GND				
40	GPIO1_B2	42	GPIO				

4.5 Hardware Instructions for Development Board

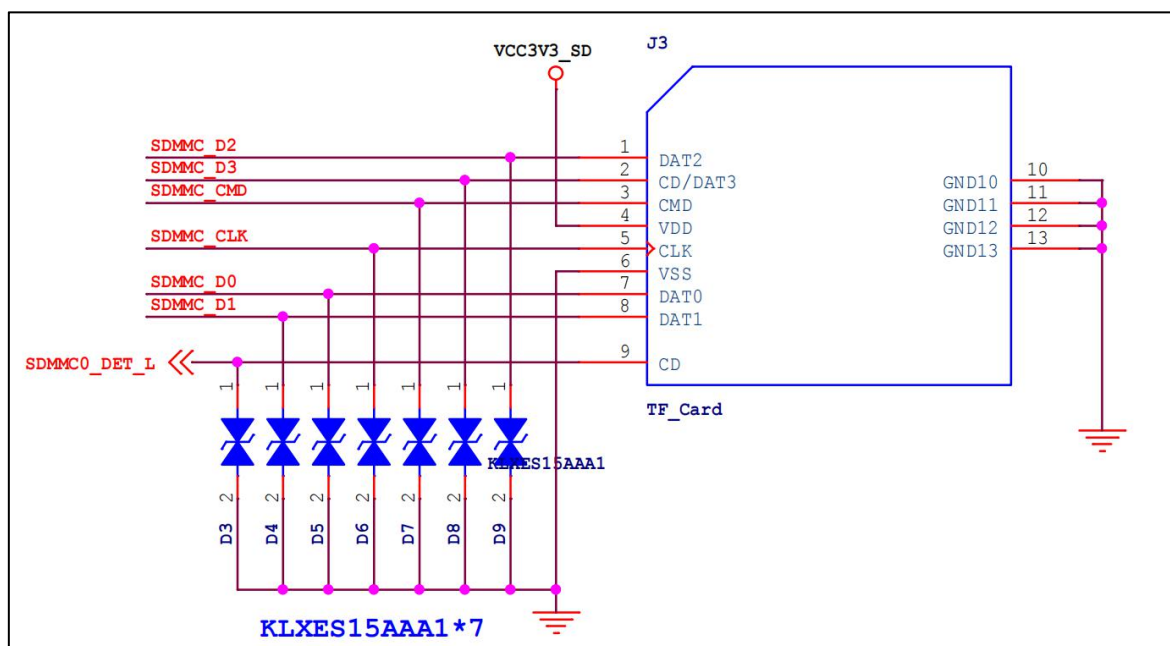
4.5.1 Power Supply

The LubanCat 1 is powered by a 5V 3A power adapter, and the power interface is a Type-C socket. The power system of the LubanCat 1 adopts the Rockchip RK809-5 chip, which in conjunction with peripheral DCDC and LDO circuits, provides stable power to DDR, Emmc, and related functional peripheral devices.



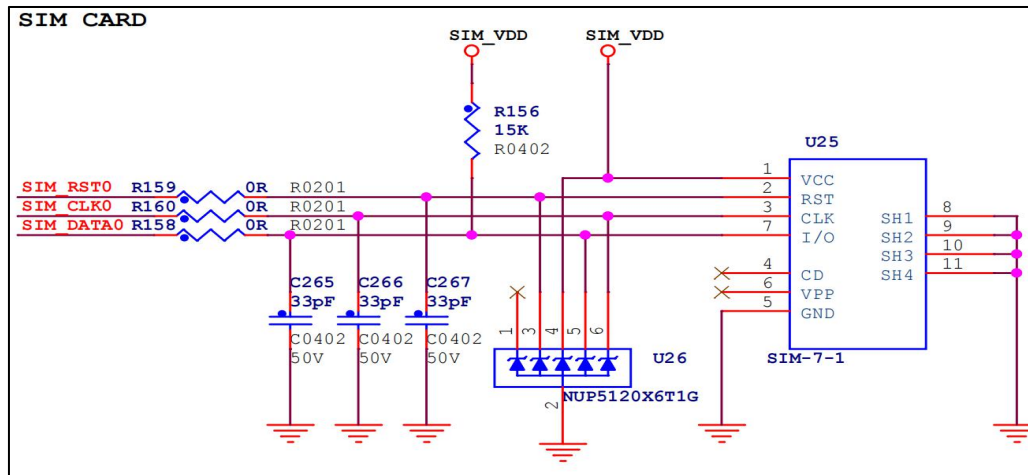
4.5.2 TF Card

The TF card slot is located on the front of the motherboard. It is a self-retracting TF card holder, capable of supporting a maximum capacity of 512G. It can also be used for system booting and writing.



4.5.3 SIM Card

The SIM card slot is located on the reverse side and supports Nano SIM cards. Its signal lines are directly connected to the MINI PCI-E interface. It is compatible with China Mobile, China Unicom and China Telecom networks. 4G/5G communication functions can only be realized when used with a 4G/5G module equipped with a MINI PCI-E interface:



4.5.4 Ethernet

The LubanCat 1 is equipped with an onboard PHY chip (RTL8211F or JL2101-N040C) and exposes one RJ45 interface, supporting 10/100/1000 Mbps data transmission rates. The onboard RJ45 port features two LED indicators controlled by the PHY chip, with distinct definitions for each lamp. The yellow indicator on the right indicates the network link status: steady on for successful connection, and off for connection failure or disconnection. The green indicator on the left reflects network data transmission activity: constant on means no data transceiving, while blinking signifies ongoing data sending and receiving. Its blink frequency corresponds to the real-time data throughput.

4.5.5 USB2.0/3.0

The RK3566 chip integrates one USB3.0 HOST controller, three USB2.0 HOST controllers and one USB2.0 OTG controller.

One channel of USB2.0 OTG is connected to the onboard Type-C interface, which is shared with the power interface and can be used for firmware burning and downloading. One USB3.0 HOST and one USB2.0 HOST are connected to the onboard USB 3.0 interface. For the remaining two USB2.0 HOST channels, one is directly connected to the onboard USB2.0 interface, while the other is connected to the USB2.0 HUB chip CH334F. The two channels of USB2.0 signals expanded by the USB HUB chip are respectively connected to the other two onboard USB2.0 interfaces.

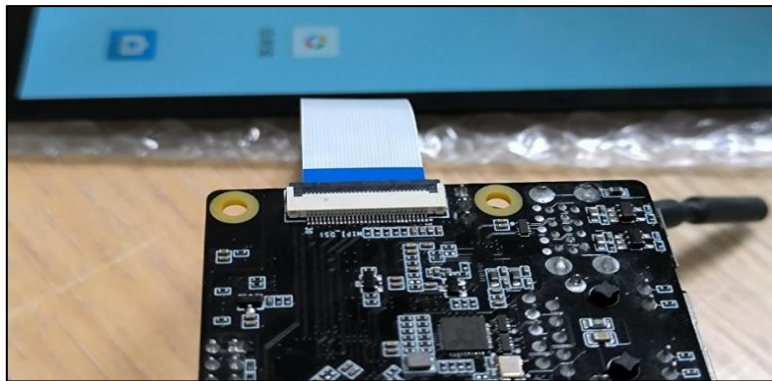
The onboard USB3.0 interface complies with USB3.1 Gen1 specification, delivering a maximum data rate of 5Gbps and being backward compatible with USB2.0. The onboard USB2.0 interfaces support three operating modes: High-Speed (480Mbps), Full-Speed (12Mbps) and Low-Speed (1.5Mbps). The system automatically selects the optimal mode according to the connected device.

4.5.6 Video output/display

The video output interfaces of LubanCat 1 mainly include a standard HDMI interface and a MIPI DSI interface. The standard HDMI interface is used for connecting external displays, while the MIPI DSI interface is compatible with dedicated MIPI screens for LubanCat series.

In terms of HDMI video output, the RK3566 chip supports HDMI 2.0 with backward compatibility for HDMI 1.4. It delivers a maximum resolution of 4K@60Hz and supports both video and audio output. The standard HDMI port onboard Luban Cat 1 can be directly connected to displays with standard HDMI connectors via a dual-head HDMI cable.

The MIPI DSI interface adopts a 30Pin FPC connector, supporting video output and touch functions. The connection method with the MIPI screen is shown in the figure below:



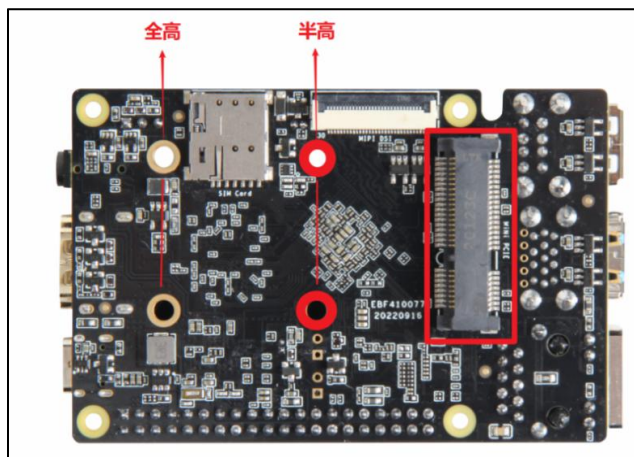
4.5.7 Audio Input/Output

The audio input/output interface is connected through the 3.5mm headphone jack, forming a 2-in-1 interface for headphones and microphone input. The audio input/output functions are realized by the power chip PMIC RK809-5.

4.5.8 MINI PCI-E

The MINI PCI-E interface is located on the back of the development board. Its PCIe specification is PCIe 2.0 x 1, supporting a maximum data rate of 5Gbps. It is compatible with full-height and half-height Wi-Fi network cards as well as 4G/5G modules, and can be multiplexed into an mSATA interface for connecting mSATA hard drives.

When a network card module is connected to the MINI PCI-E interface, the PCIe protocol is adopted. When a 4G/5G module is connected, the physical connector remains MINI PCI-E, but data transmission actually uses the USB protocol. Since the mSATA physical interface shares the same form factor as MINI PCI-E, and the RK3566 chip supports multiplexing PCIe into SATA mode, this interface can also work as an mSATA port. When an mSATA hard drive is connected to the MINI PCI-E interface, the SATA protocol is applied.



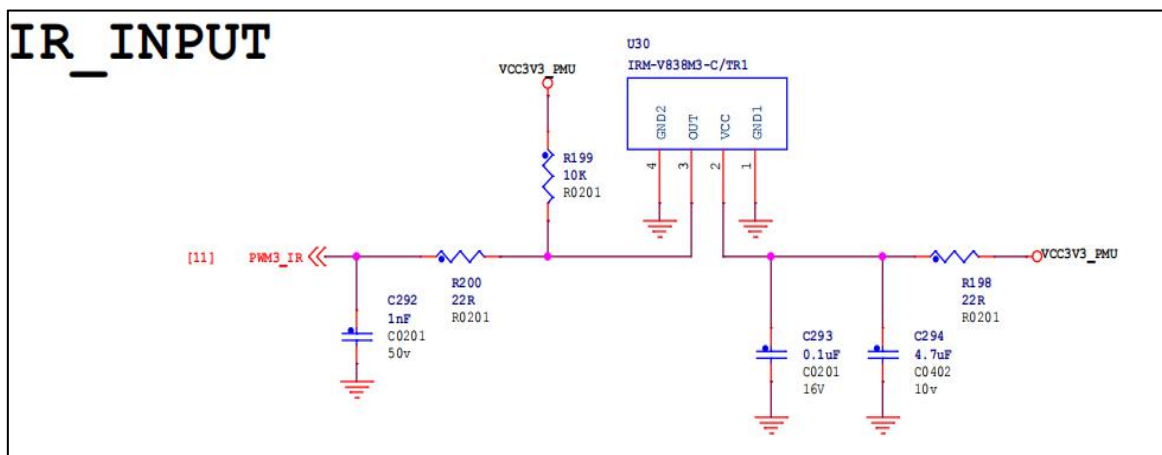
4.5.9 LED indicator

There are two LED indicators next to the onboard TF card slot. The LED marked with the silkscreen PWR is the power indicator, and the LED marked with the silkscreen SYS is the system status indicator (heartbeat LED).

The red power indicator stays steadily lit after power-on, indicating stable power supply operation. The system status indicator is a green LED. After the system boots normally, it enters heartbeat mode, flashing twice per cycle. Meanwhile, this indicator is programmable, allowing users to customize its control as needed.

4.5.10 IR indicator

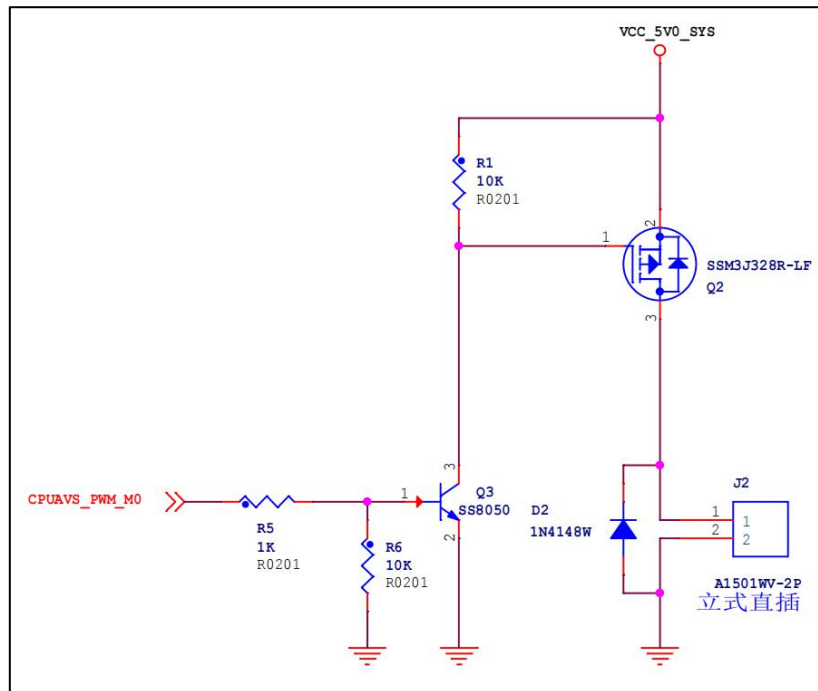
The IR infrared receiver is located next to the Wi-Fi module and uses the IRM-V838M3-C/TR1 infrared remote control receiver. The IR infrared receiving signal is received by the PWM3_IR pin. As shown in the following figure:



4.5.11 FAN indicator

The FAN interface reserved on the LubanCat 1 board card is located beside the TF card slot on the front of the board, and it is a 2-pin 1.5mm specification 5V fan power supply interface. It can control the conduction state of the SS8050 transistor through CPUAVS_PWM_M0, thereby controlling the conduction time of the MOS

transistor and achieving the speed control of the fan. The schematic diagram of the FAN fan driver is shown as follows:



4.5.12 RTC indicator

LubanCat 1 reserves a 2Pin 1.25mm-specification RTC battery interface, which can be connected to an external RTC battery for more accurate timing and lower power consumption. The positive and negative silkscreen labels of the onboard RTC interface are marked on the new version. The old version board has no silkscreen marking; polarity is determined by pad shape: the square pad is positive, and the round pad is negative.

4.5.13 Debug serial port

The onboard Debug serial port is led out via a 1×3Pin pin header with a 2.54mm pitch. The silkscreen markings of the three pins are GND, RXD and TXD respectively. The TX and RX signals of UART2 on the RK3566 chip are connected to the onboard TXD and RXD header pins through 74LVC1G125GW line drivers. When the IOFF circuit disables the output, it can prevent destructive reverse current generated through this device during power-off.

4.5.14 Camera

The camera interfaces on the new version adopt two 2×15 Pin BTB sockets with a 0.4 mm pitch, model AXE530127D, silkscreened as CAM0 and CAM1 on the board respectively. Corresponding adapter cables are required for camera connection.

The camera interface of Luban Cat 1 has been updated. Please refer to the version difference chapter for details.

Chapter 5 Reference power consumption

(1) Power consumption test of complete Linux systems

① Test Contents:

Startup/Standby Power Consumption Test: The test covers the process from system startup to entering the system's standby mode;

Sleep Power Consumption Test: The sleep mode used for the test is "freeze";

Full Load Power Consumption Test: A 10-minute quad-core full-load test is conducted using the s-tui and stress programs;

② Test Environment:

The test environment temperature is 25°C, with power supplied by the original 5V 3A power adapter. The peripherals connected during testing include the Debug serial port, HDMI port, Gigabit Ethernet port, and USB keyboard and mouse. For OpenWrt testing, only the Debug serial port and Gigabit Ethernet port are connected. The power consumption of partial peripherals is described in the "Development Board Interface Resources" section.

Table 5-1 Power Consumption of Each Linux Image in LubanCat 1

system	type		Instantaneous peak value	Stable value	Instantaneous power consumption	Stable power consumption	Stable/highest
Ubuntu20.04 20230826	lite	Start/standby test	769.0	373.8	3897	1902	45.0
		Sleep Test	-	134.5	-	697.0	-
		full loading	708	672	3580	3391	72.2
	xfce-full	Start/standby test	789.9	352.2	4030	1968	45.6
		Sleep Test	-	136.6	-	704.5	-
		full loading	715.6	684	3611	3420	73.9
Ubuntu22.04 20230713	lite	Start/standby test	785.0	382.0	3930	1941	46.1
		Sleep Test	-	119.6	-	620.3	-
		full loading	754.9	709.2	3850	3560	74.4
	xfce	Start/standby test	797.8	388.2	4010	1968	46.1
		Sleep Test	-	244.3	-	1252	-
		full loading	753.3	719.0	3850	3680	73.9
Debian10 20230905	lite	Start/standby test	781.7	347.6	3940	1780	45.6
		Sleep Test	-	111.5	-	580.9	-
		full loading	820.4	778.0	4130	3921	81.1
	xfce	Start/standby test	781.7	347.6	3940	1780	45.6
		Sleep Test	-	111.5	-	580.9	-
		full loading	820.4	778.0	4130	3921	81.1

OpenWrt	ext4	Start/standby test	650	287	3315	1466	-

Note:

Instantaneous peak current: The maximum current value during the start-up/test process;

Stable current value: The current value after the start-up process is completed and enters the system / The current value during the test process;

Instantaneous power consumption: The maximum power consumption during the start-up/test process, real-time power consumption = real-time voltage × real-time current;

Stable power consumption: The power consumption after the start-up process is completed and enters the system / The power consumption value when the power consumption during the test process remains relatively stable;

Soc temperature: The highest temperature is taken during the full-load test, and the stable temperature is taken during the start-up/idle test

(2) Whole-machine power consumption tests of Android/HarmonyOS images
The testing environment temperature is 15-25 °C, and the power supply uses the original 5V 4A power supply. The peripherals connected during different mirror tests are shown in the table below.

① Test Contents:

Startup/Standby Power Consumption Test: The test measures the power consumption from the system startup to the system's standby process;

Sleep Power Consumption Test: This test is the PWR button sleep test;

Antutu Benchmark: The stress test is conducted using the Antutu benchmark, version v10.1.0;

② Test Environment:

The test environment temperature is 25°C, and the power supply uses the original 5V 3A power supply. The external devices connected during the test are HDMI and USB keyboard/mouse; during the MIPI screen mirroring test, only the MIPI screen is connected, and no other external devices are connected.

Table 5-2: f LubanCat 1 Android/HarmonyOS System Image Complete Machine Power Consumption Table

mirror image		Test content	Working current (mA)		Power consumption (mW)	
system	type		Instantaneous peak value	Stable value	Instantaneous power consumption	Stable power consumption
Android 11	hdmi	Start/standby test	835	366	4210	1860
		Sleep Test	-	150	-	780
		Antutu Review	1100	750	5520	3800
	MIPI 600P	Start/standby test	1198.5	593	6020	3000
		Sleep Test	-	150	-	780
		Antutu Review	1250	1000	6270	5020
	mipi1080p	Start/standby test	1060	490	5300	2480
		Sleep Test	-	150	-	780
		Antutu Review	1240	800	6250	4020

Android TV	-	Start/standby test	840	400	4200	2040
Android 13	hdmi	Start/standby test	808.9	340	4075	1720
		Sleep Test	-	220	-	1100
		Antutu Review	1030	700	5180	3530
	mipi 1080p	Start/standby test	808.9	340	4075	1720
		Sleep Test	-	220	-	1100
		Antutu Review	1030	700	5180	3530
OpenHarmonyOS	-	Start/standby test	960	480	4840	2420

Note:

Instantaneous peak current: The maximum current value during the start-up/test process;

Stable current value: The current value after the start-up is completed and enters the system / The current value during the test process;

Instantaneous power consumption: The maximum power consumption during the start-up/test process, real-time power consumption = real-time voltage × real-time current;

Stable power consumption: The power consumption after the start-up is completed and enters the system / The power consumption that remains relatively stable during the test process;