VK-RZ/A1LU
ver. 2.2

Embedded camera to USB/Wi-Fi/BLE small form factor module with Renesas Electronics RZ/A1LU ARM Cortex-A9 LSI

R7S721030VCFP
- 384MHz,176 QFP, Fanless

3 MByte OnChip RAM
- Can RUN without ext. SDRAM

Up to 64 MByte NOR-Flash / 16 MB on board
- QSPI, 64MHz, Quad (Burst), 4-bit
- Direct fetch is possible

Up to 64 MByte SDRAM / 32 MB on board
- 64MHz, 16-bit

1 x USB Function
- USB 2.0, Micro USB connector

Micro SD
- SDHI1

User interface
- LED
- Push button

CMOS camera interface
- KBCR-M04VG-HPB2033VGA 640x480, up to 60fps, horizontal angle 98 degrees, vertical angle 75 degrees

Audio codec MAX9867ETJ+
- 3.5mm , 4 pole audio input / output jack

Wi-Fi / BLE
- Pre certified ESP32 wireless module

Exp. Ports
- RZ/A1LU - 14 I/O 3.3V
- UART
- SPI
- I2C
- ADC

Debug ports:
- RZ/A1 J-TAG 2x5 pins,Coresight™

DC IN +5V
- Consumption 250mA max

Operating temperature:
- -40 ... +85°

Dimensions:
- 45 mm x 45 mm
- Mounting holes 4 x Ø2 mm (40 mm x 40mm)

Planned Board Support Packages:

- H.264 video encoding
- H.264/MJPG IP camera over RTSP/RTP
- UVC 1.0 compliant USB 2.0 camera supporting YUV, MJPEG,H.264
- MBED enabled
- u-boot, Linux - GCC
- FreeRTOS - IAR
- OpenCV V3.2
- IS2T MicroEJ demos - IAR
- .NET Micro Framework - GCC

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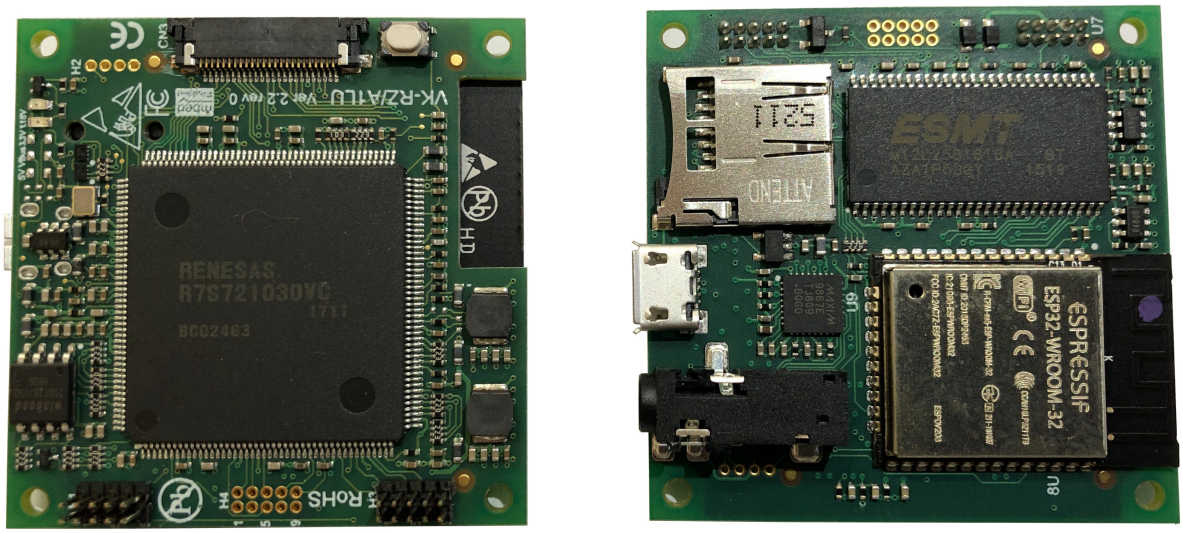
Content:

1. Introduction

VK-RZ/A1LU is a starter kit, equipped with R7S721030VCFP MCU from Renesas Electronics. This powerful LSI single-chip microcontroller includes an ARM Cortex™-A9 processor along with the integrated peripheral functions required to configure a system.



VK-RZ/A1LU board (Top & Bottom view)

The core includes:

- ✔ 32-KB L1 instruction cache, 32-KB L1 data cache
- ✔ 128-KB L2 cache

Integrated various on-chip peripheral functions and interfaces such as:

- ✔ 3-MB large-capacity RAM (128 KB are shared by the data-retention RAM).
- ✔ Data-retention RAM
- ✔ Multi-function timer pulse unit 2, OS timer, Realtime clock
- ✔ UART, UART with FIFO, I^2C, SPI, SPI multi I/O bus controller, CAN
- ✔ I^2S, SPDIF
- ✔ A/D converter, SCUX
- ✔ SD host interface, MMC host interface
- ✔ Ethernet controller, Ethernet AVB
- ✔ USB 2.0 (host/functions)
- ✔ video display controller 5
- ✔ JPEG codec unit, Capture engine unit
- ✔ Interrupt controller modules, General I/O ports

Kit supports:

- ✔ WiFi/BLE connectivity
- ✔ CMOS camera input
- ✔ up to 64 MB QSPI FLASH
- ✔ up to 64 MB SDRAM
- ✔ Micro SD cards
- ✔ Micro USB 2.0
- ✔ Stereo audio output & mono input
- ✔ 1 push button
- ✔ JTAG interface

All this along with DC/DC power supply on board and pin headers with unused pins of RZ/A1LU allows you to build a diversity of powerful applications which can be used in a wide range of embedded tasks.

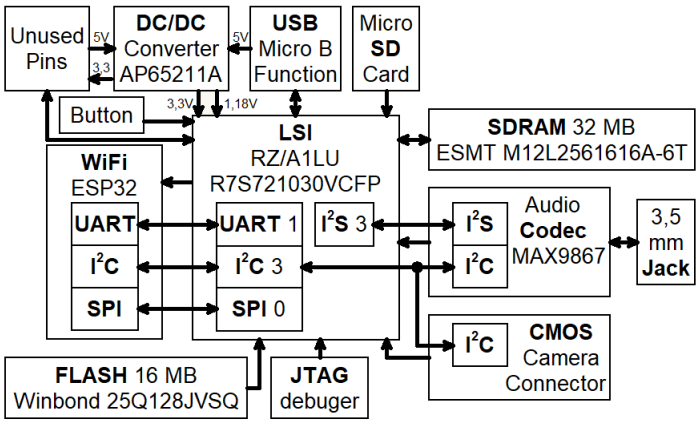
2. Board Features

- ✔ LSI: RZ/ALU (R7S721030VCFP)
  - ➢ Power supply voltage: $\mathbf{V_{DD}}$ 3.0 ÷ 3.6 V
  - ➢ Operating ambient temperature: $\mathbf{T_A}$ -40 ÷ +85 °C
  - ➢ Max CPU clock: **Iϕ** 400 MHz
- ✔ Micro USB (B type connector ↔ USB[function] ↔ RZ/ALU[device])
- ✔ 16 MB FLASH (Winbond 25Q128JVSQ ↔ QSPI ↔ RZ/ALU)
- ✔ 32 MB SDRAM (ESMT M12L2561616A-6T ↔ RZ/ALU)
- ✔ Micro SD card connector (RZ/ALU)
- ✔ WiFi module (Espressif ESP32 WROOM32 ↔ UART/SPI ↔ RZ/ALU)
- ✔ Audio codec (4 pin 3.5 mm jack ↔ MAX9867ETJ ↔ I^2S ↔ RZ/ALU)
- ✔ CMOS camera interface (KBCR-M04VG-HPB2033VGA ↔ DV0[8bit] ↔ RZ/ALU)
- ✔ User Button (↔ RZ/ALU)
- ✔ JTAG debug/programing interface (10 pin connector ↔ RZ/ALU)
- ✔ FR-4, 1.6 mm, 6 Layers, Green solder mask, White component print
- ✔ Dimensions: 45.0 mm x 45.0 mm (Holes: 4x 2 mm, between centers: 40 mm)

3. Electrostatic WARNING

VK-RZ/A1LU board is shipped in protective anti-static packaging. The board must not be subject to high electrostatic potentials. General practice for working with static sensitive devices should be applied when working with this board.

4. Block Diagram



5. External SDRAM

CS3: ORIGIN = **0x0C000000** LENGTH = **64 MB**

CS3 mirror ORIGIN = **0x4C000000** LENGTH = **64 MB**

!!! SDRAM chip is accessed with 16bit data width !!!

6. Power supply

VK-RZ/A1LU is powered by **5 V** DC. The voltage can come either from external header or USB Micro B connector. Consumption of the board may vary and the maximum is **250 mA**.

7. Clock Circuits

Quartz Generator 48.0000 MHz is connected to **USB_X1,** pin# **139** of **RZ/A1LU**

USB_X1/2 (**CLK-CAM**) 24.0000 MHz is connected to **XClk,** pin# **13** of **CN2**

USB_X1/4 (**CLK-AUD**) 12 MHz is connected to **AUDIO_X1,** pin# **91** of **RZ/A1LU**

USB_X1/4 (**CLK-Codec**) 12 MHz is connected to **MClk,** pin# **31** of **MAX9867**

8. Push button

SB1			
Pin #	**Name**	**Signal Name**	**Tied to pin #**
1	-	P1_12	82 (RZ/A1LU)
2	-	GND	-

9. External connectors

9.1 USB & Power

CN1			
Pin #	**Name**	**Signal Name**	**Tied to pin #**
1	+5V	VBUS	152 (RZ/A1LU)
2	D-	DM0	150 (RZ/A1LU)
3	D+	DP0	151 (RZ/A1LU)
4	ID	NC	-
5	G	GND	-

9.2 JTAG

H1			
Pin #	**Name**	**Signal Name**	**Tied to pin #**
1	VREF	3.3V	-
2	TMS	JTAG-TMS	100 (RZ/A1LU)
3	GND	GND	-
4	TCK	JTAG-CLK	101 (RZ/A1LU)
5	GND	GND	-
6	TDO	JTAG-TDO	98 (RZ/A1LU)
7	GND	GND	-
8	TDI	JTAG-TDI	99 (RZ/A1LU)
9	GND	GND	-
10	RESET	$\overline{\text{RZRST}}$	76 (RZ/A1LU)

9.3 WiFi Module

ESP32 - WROOM - 32			
Pin #	**Name**	**Signal Name**	**Tide to pin #**
1	g	GND	-
2	3V3	3.3V	-
3	EN	ESP_EN	135 (RZ/A1LU)
4	Sensor VP	NC	-
5	Sensor VN	NC	-
6	IO34	NC	-
7	IO35	NC	-
8	IO32	NC	-
9	IO33	NC	-
10	IO25	SCL3	131 (RZ/A1LU)
11	IO26	SDA3	132 (RZ/A1LU)
12	IO27	NC	-
13	IO14	SCLK0	17 (RZ/A1LU)
14	IO12	MISO0	22 (RZ/A1LU)
15	g	GND	-
16	IO13	MOSI0	20 (RZ/A1LU)
17	SD2	NC	-
18	SD3	NC	-
19	CMD	NC	-
20	CLK	NC	-
21	SD0	NC	-
22	SD1	NC	-
23	IO15	SSL0	19 (RZ/A1LU)
24	IO2	ESP_IO2	137 (RZ/A1LU)
25	IO0	ESP_IO0	136 (RZ/A1LU)
26	IO4	NC	-
27	IO16	NC	-
28	IO17	NC	-
29	IO5	NC	-
30	IO18	NC	-
31	IO19	RTS1	165 (RZ/A1LU)
32	NC	NC	-
33	IO21	NC	-
34	RXD0	TxD1	133 (RZ/A1LU)
35	TXD0	RxD1	65 (RZ/A1LU)
36	IO22	CTS1	164 (RZ/A1LU)
37	IO23	NC	-
38	g	GND	-
39	g	GND	-

9.4 Micro SD card slot

CN3			
Pin #	**Name**	**Signal Name**	**Tied to pin #**
1	DAT2	SDC-D2	51 (RZ/A1LU)
2	CD/DAT3	SDC-D3	49 (RZ/A1LU)
3	CMD	SD-CMD	48 (RZ/A1LU)
4	Vdd	3.3V	-
5	CLK	SDC-CLK	47 (RZ/A1LU)
6	Vss	GND	-
7	DAT0	SDC-D0	45 (RZ/A1LU)
8	DAT1	SDC-D1	44 (RZ/A1LU)
9	S1	NC	-
10	G1	GND	-
11	S2	-	External logic
12	G2	GND	-
13	Gnd	GND	-
14	Gnd	GND	-

9.5 Audio Jack

J1			
Pin #	**Name**	**Signal Name**	**Tied to pin #**
1	JACKSNS	Mic	17 (MAX9867)
2	LOutP	Left	22 (MAX9867)
3	ROutP	Right	19 (MAX9867)
4	LOutN	Common	21 (MAX9867)

9.6 CMOS Camera input

CN2			
Pin #	**Name**	**Signal Name**	**Tied to pin #**
1	SFin	-	-
2	AGND	GND	-
3	SIOD	SDA3	132 (RZ/A1LU)
4	AVdd	3.3V	-
5	SIOC	SCL3	131 (RZ/A1LU)
6	Reset	CAM_RSTB	55 (RZ/A1LU)
7	VSYNC	DV0-VSYNC	53 (RZ/A1LU)
8	PWDN	CAM-PWDN	33 (RZ/A1LU)
9	HREF	DV0-HSYNC	54 (RZ/A1LU)
10	VCore	NC	-
11	DVdd	3.3V	-
12	Y9	DV0-DATA7	81 (RZ/A1LU)
13	XClk	CLK-CAM	-
14	Y8	DV0-DATA6	80 (RZ/A1LU)
15	DGND	GND	-
16	Y7	DV0-DATA5	79 (RZ/A1LU)
17	PClk	DV0-CLK	52 (RZ/A1LU)
18	Y6	DV0-DATA4	78 (RZ/A1LU)
19	Y2	DV0-DATA0	125 (RZ/A1LU)
20	Y5	DV0-DATA3	128 (RZ/A1LU)
21	Y3	DV0-DATA1	126 (RZ/A1LU)
22	Y4	DV0-DATA2	127 (RZ/A1LU)
23	Y1	NC	-
24	Y0	NC	-

10. Unused Pin Headers

H3	
Pin #	**Functions**
1	3.3V
2	P6-12/D28/LCD0_DATA20/SCLK1/SSISCK2/$\overline{\text{RTS0}}$/DV0_DATA0
3	3.3V
4	P6-13/D29/LCD0_DATA21/SSL10/SSIWS2/$\overline{\text{CTS0}}$/DV0_DATA1
5	5V
6	P6-14/D30/LCD0_DATA22/MOSI1/SSIDATA2/RxD0/DV0_DATA2
7	5V
8	P6-15/D31/LCD0_DATA23/MISO1/TxD0/DV0_DATA3
9	GND
10	GND

H4	
Pin #	**Functions**
1	P1-4/SCL2/IRQ0/DREQ0/VIO_D0
2	P6-1/D17/LCD0_DATA9/SSL00/TCLKB
3	P1-5/SDA2/IRQ1/VIO_D1
4	P6-2/D18/LCD0_DATA10/MOSI0/TCLKC
5	P6-0/D16/LCD0_DATA8/SCLK0/TCLKA/WDTOVF
6	P6-3/D19/LCD0_DATA11/MISO0/TCLKD
7	P1-13/AN5/IRQ5/ET_RXD1/VIO_D5
8	P6-9/D25/LCD0_DATA17/SSIWS0/IRQ2/TIOC3C/TRACED_ATA2
9	P1-14/AN6/IRQ6/ET_RXD2/VIO_D6
10	P6-10/D26/LCD0_DATA18/SSITxD0/IRQ3/TIOC3D/CAN1TX/ TRACED_ATA3

11. Available Demo Software

11.1 Audio Wave Demo

This Demo reads *.wav files from SD card and plays them through the **MAX9867** stereo audio codec. When you press the button, you can skip currently played song and next found in SD card will be played. You will need a headphones to hear the songs.

11.2 UVC JPEG Demo

This Demo turns VK-RZ/A1LU board in to a standard USB Camera. Every USB host which supports the standard **UVC** protocol (v1.0), should be able to get the stream and play it. The format of the stream is **MJPEG** and supported resolution is 640 x 480 @ 30 fps.

Here are some examples how to grab the stream from the USB:

➢ Using VLC as a player:

Go to: "Media" → "Open Capture Device…"

for "Video device name" select: **UVC**, for "Audio device name" select: **None**

Press **Play**.

➢ Using FFMPEG as a player:

Open a CMD/BASH terminal

Insert: `ffplay -f dshow -i video="UVC"` / `ffplay -i /dev/video0`

A window will be opened and you will be able to see the stream.

11.3 x264/MJPEG WiFi Streaming Demo

This Demo turns VK-RZ/A1LU board in to standalone RTSP server. On startup this demo waits SD card and looks for a file `STARTUP.json`. It contains WiFi Access Point's credential information. After the file is found, the board connects to the specific AP's SSID, creates RTSP server & waits for a client. This state is indicated with a continuous lighting of LED1. Currently only 1 client can be connected to the server. If you want to change credential information or the stream format, you should alter the `STARTUP.json`. file.

Second variant of this demo is available, which takes advantage of the ESP's SPI bus.
The actual communication channel [MCU <-> ESP32] becomes faster & allows higher fps rate in MJPEG format. The rate in x264 format, remains intact.

```
{
    "CFG": {
        "WIFI_SSID":          "VT",
        "WIFI_PASSWORD":      "vekatech1560",
        "STREAM_TARGET":      "192.168.2.123",
        "STREAM_FORMAT":      "X264",
        "STREAM_STATUS":      "YES"
    }
}
```

STARTUP.json listing

`STREAM_FORMAT` parameter can be either **X264** or **MJPEG**

- ➢ For X264 supported resolution is 320 x 240 @ 15 fps
- ➢ For MJPEG supported resolution is 320 x 240 @ 5 fps (UART) / 15 fps (SPI).

`STREAM_TARGET` is used as destination IP when RTP is used **alone**, but when RTSP is used, this parameter is ignored.

`STREAM_STATUS` parameter can be either **YES** or **NO**. It enables or disables logging of statistics information on UART 0. (Header H3) This information is actually the generated network traffic by the RTP/RTSP server. (you will need USB serial adapter to see this information).

Here are some examples how to grab the stream from the RTSP server:

- ➢ Using VLC as a player:

Go to: "Media" → "Open Network Stream…"

for "URL" enter this: `rtsp://VK_RZ_A1LU's_IP:554/Cam`

Check "Show more options" & in "Edit Options" add this: `:ipv4-timeout=20000`

Press Play.

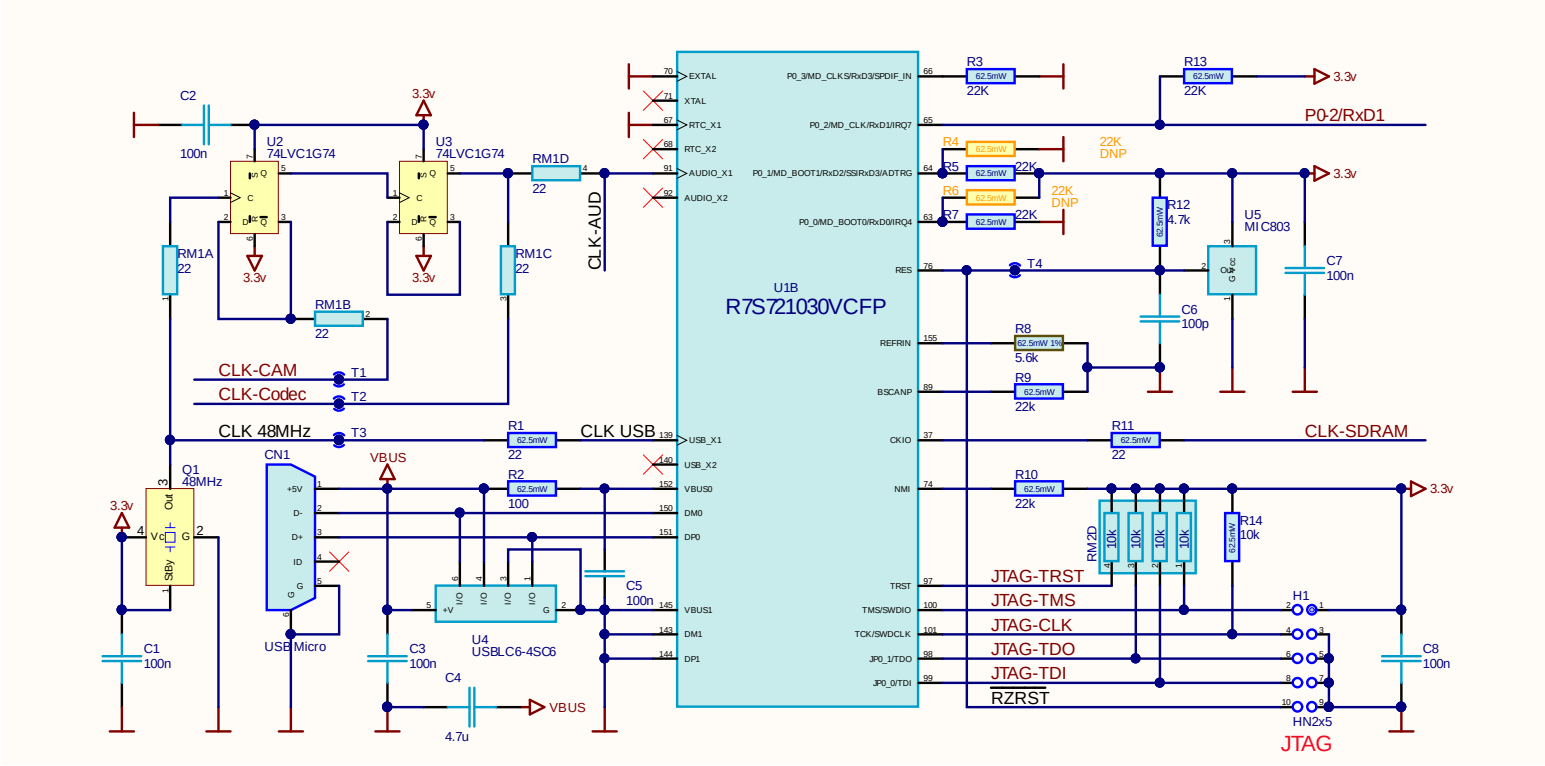
- ➢ Using FFMPEG as a player:

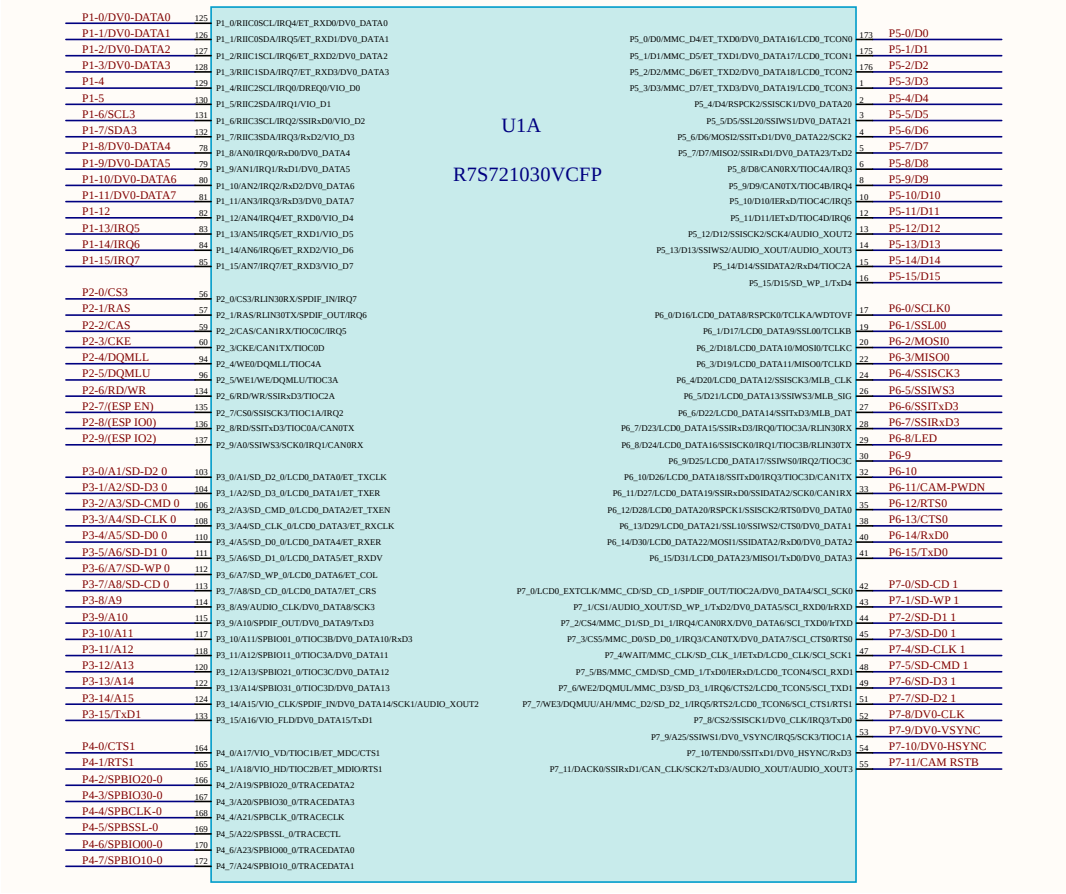
Open a CMD/BASH terminal

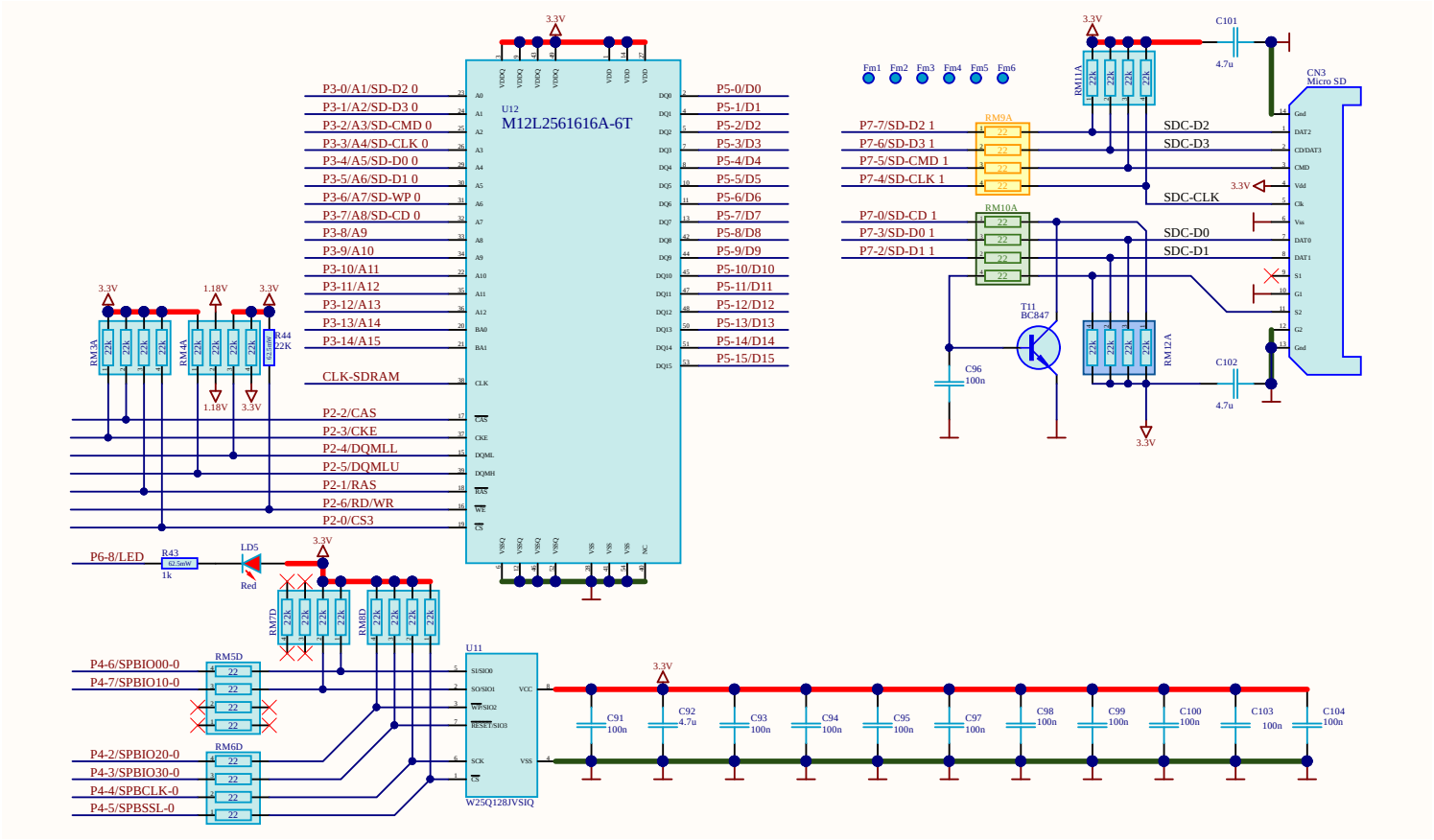
Insert: `ffplay rtsp://VK_RZ_A1LU's_IP:554/Cam`

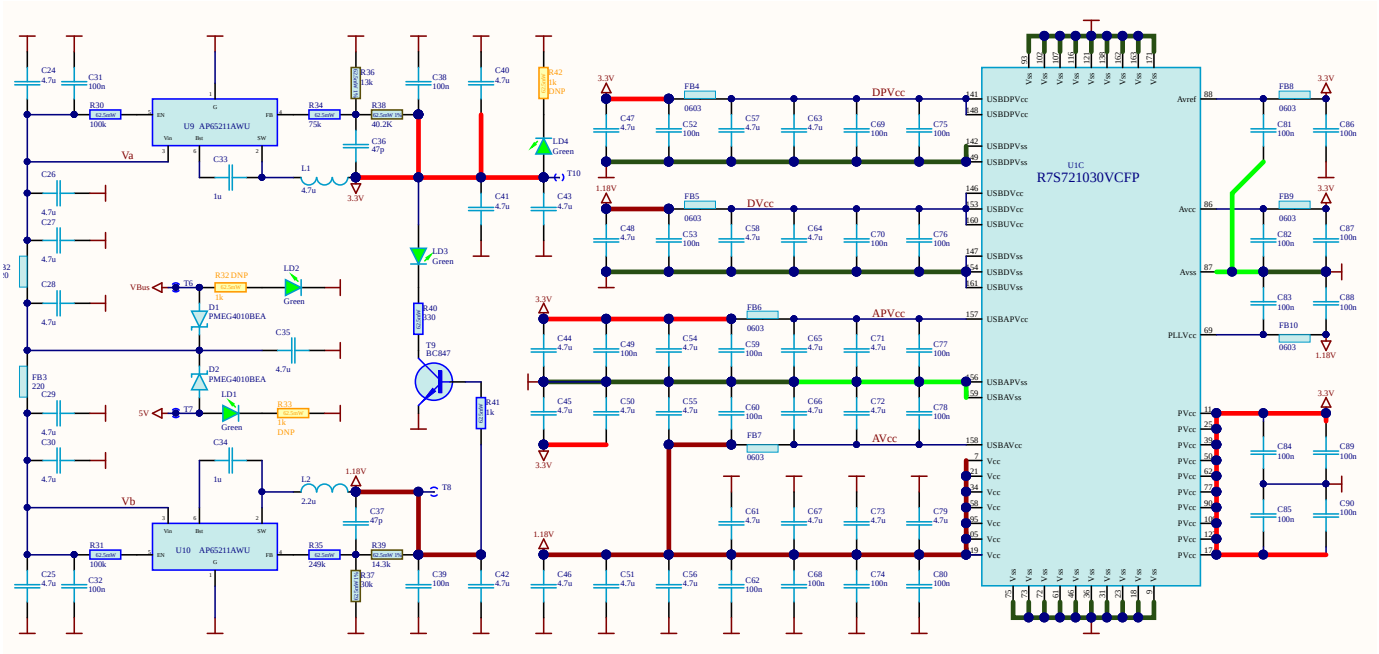
A window will be opened and you will be able to see the stream.

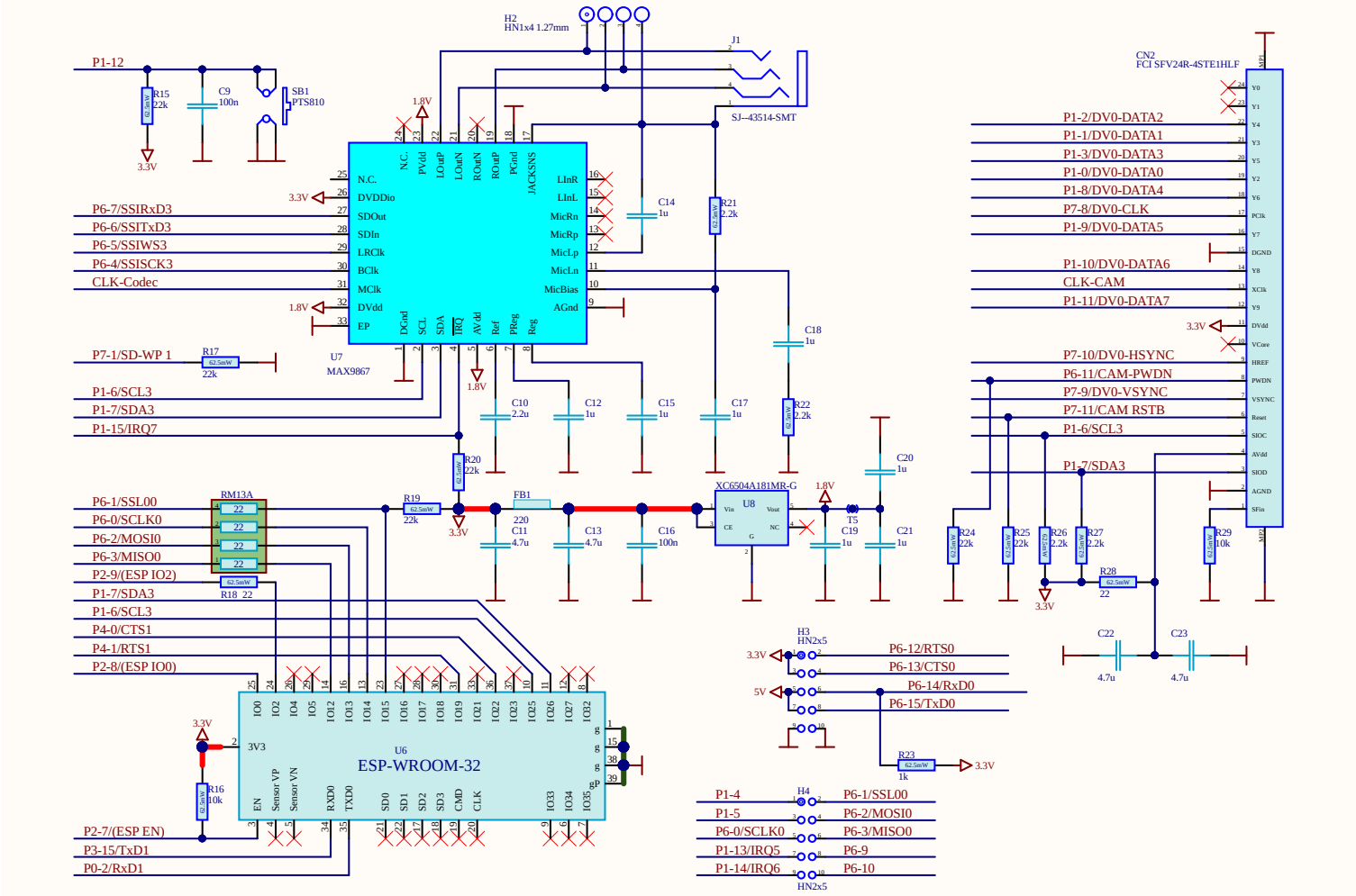
12. Schematics



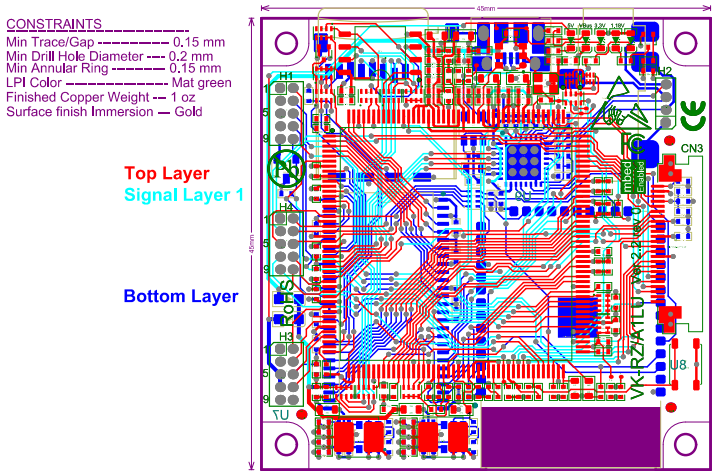



U12
M12L2561616A-6T
P3-0/A1/SD-D2 0
P3-1/A2/SD-D3 0
P3-2/A3/SD-CMD 0
P3-3/A4/SD-CLK 0
P3-4/A5/SD-D0 0
P3-5/A6/SD-D1 0
P3-6/A7/SD-WP 0
P3-7/A8/SD-CD 0
P3-8/A9
P3-9/A10
P3-10/A11
P3-11/A12
P3-12/A13
P3-13/A14
P3-14/A15
CLK-SDRAM
P2-2/CAS
P2-3/CKE
P2-4/DQML
P2-5/DQMLU
P2-1/RAS
P2-6/RD/WR
P2-0/CS3
P5-0/D0
P5-1/D1
P5-2/D2
P5-3/D3
P5-4/D4
P5-5/D5
P5-6/D6
P5-7/D7
P5-8/D8
P5-9/D9
P5-10/D10
P5-11/D11
P5-12/D12
P5-13/D13
P5-14/D14
P5-15/D15
P7-7/SD-D2 1
P7-6/SD-D3 1
P7-5/SD-CMD 1
P7-4/SD-CLK 1
P7-0/SD-CD 1
P7-3/SD-D0 1
P7-2/SD-D1 1
SDC-D2
SDC-D3
SDC-CLK
SDC-D0
SDC-D1
CN3
Micro SD
P6-8/LED
P4-6/SPBIO00-0
P4-7/SPBIO10-0
P4-2/SPBIO20-0
P4-3/SPBIO30-0
P4-4/SPBCLK-0
P4-5/SPBSSL-0
U11
W25Q128JVSIQ


U1C
R7S721030VCFP
U9 AP65211AWU
U10 AP65211AWU
DPVcc
DVcc
APVcc
AVcc

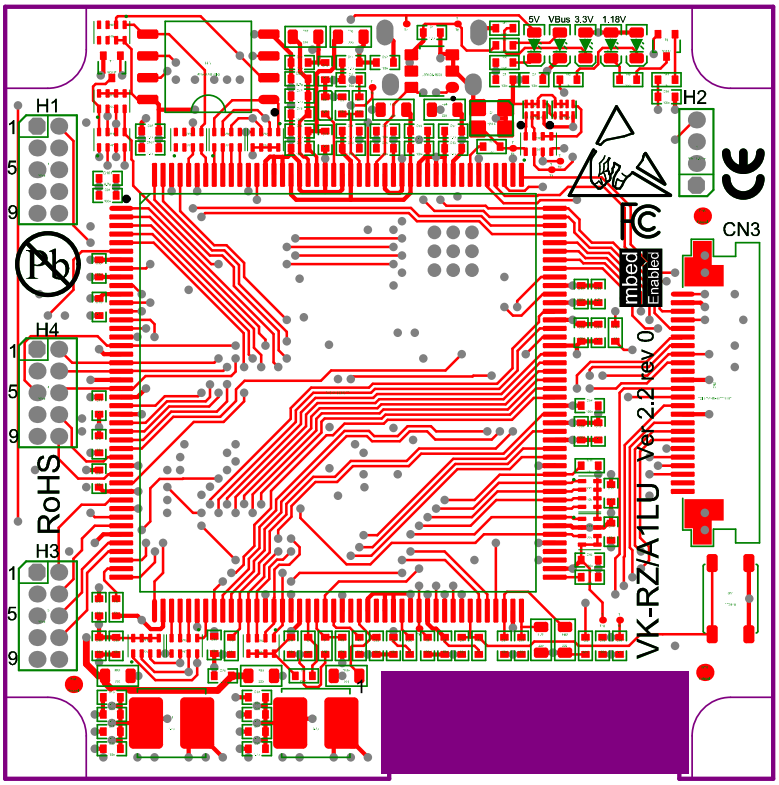


13. PCB

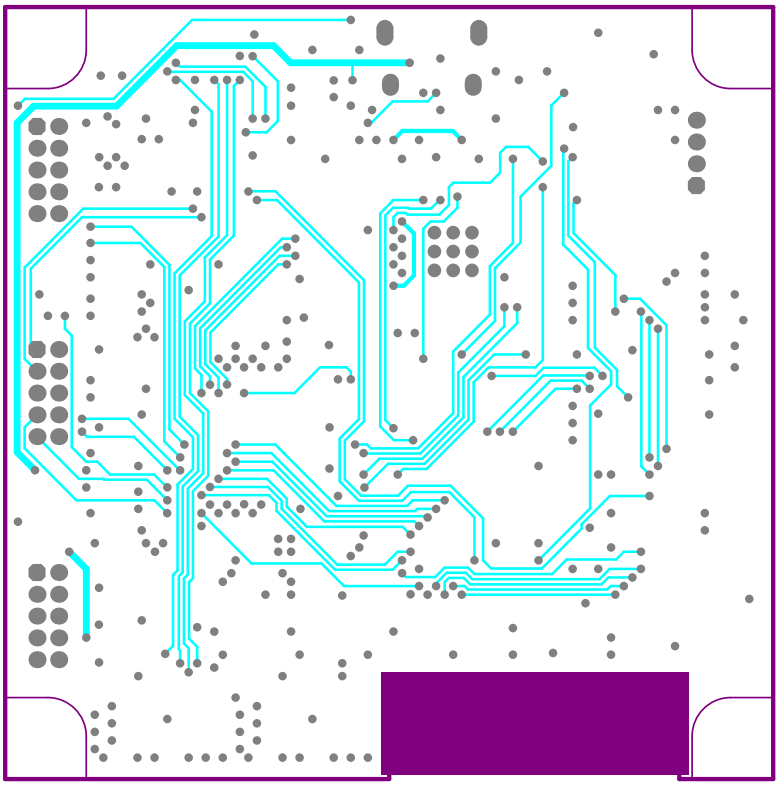


Layer	Name	Material	Thickness	Constant	Board Layer Stack
1	Top Overlay				
2	Top Solder	Solder Resist	0.010mm	3.5	
3	Top Layer	Copper	0.035mm		
4	Dielectric 1	FR-4	0.254mm	4.2	
5	Signal Layer 1	Copper	0.035mm		
6	Dielectric 4		0.254mm	4.2	
7	1.18V	Copper	0.035mm		
8	Dielectric 2		0.254mm	4.2	
9	3.3V	Copper	0.035mm		
10	Dielectric 6		0.254mm	4.2	
11	Gnd	Copper	0.035mm		
12	Dielectric 5		0.254mm	4.2	
13	Bottom Layer	Copper	0.035mm		
14	Bottom Solder	Solder Resist	0.010mm	3.5	
15	Bottom Overlay				

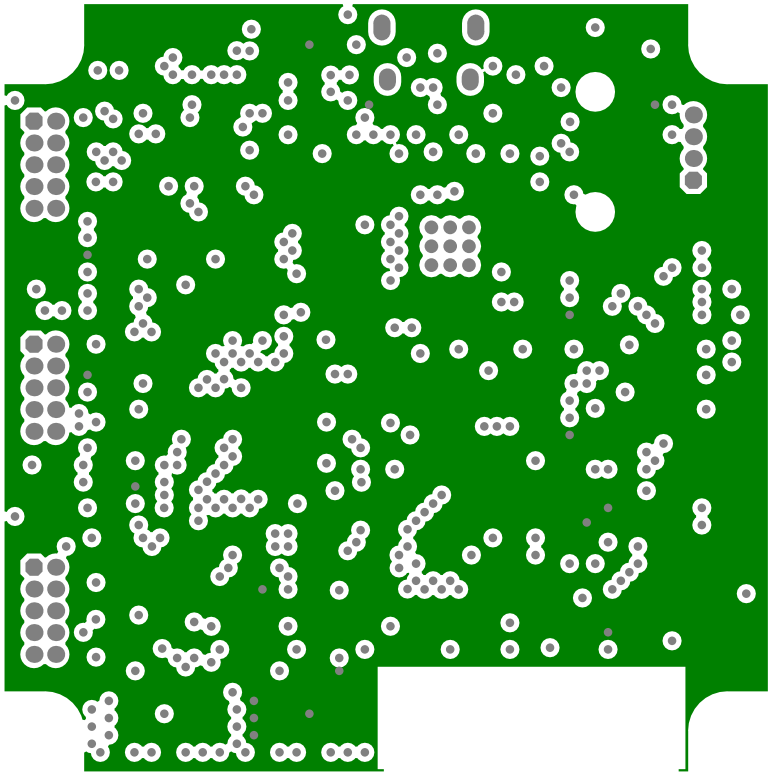
Top Layer



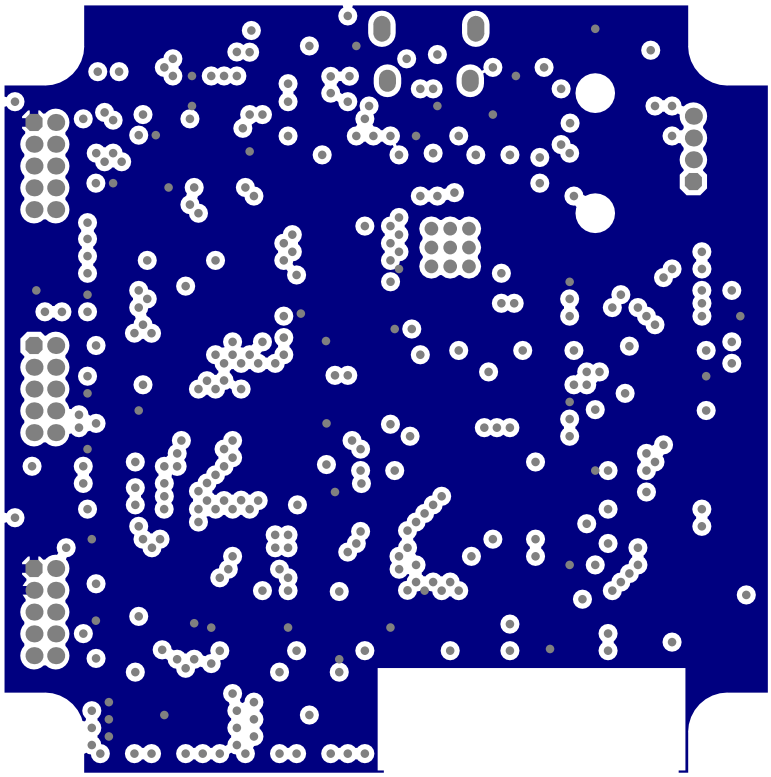
Signal Layer 1



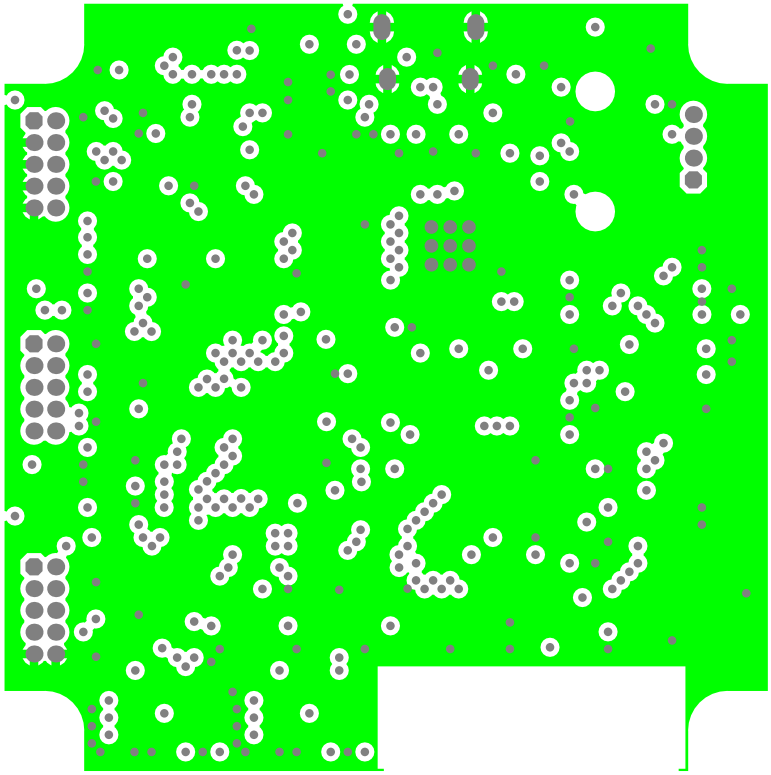
1.18V



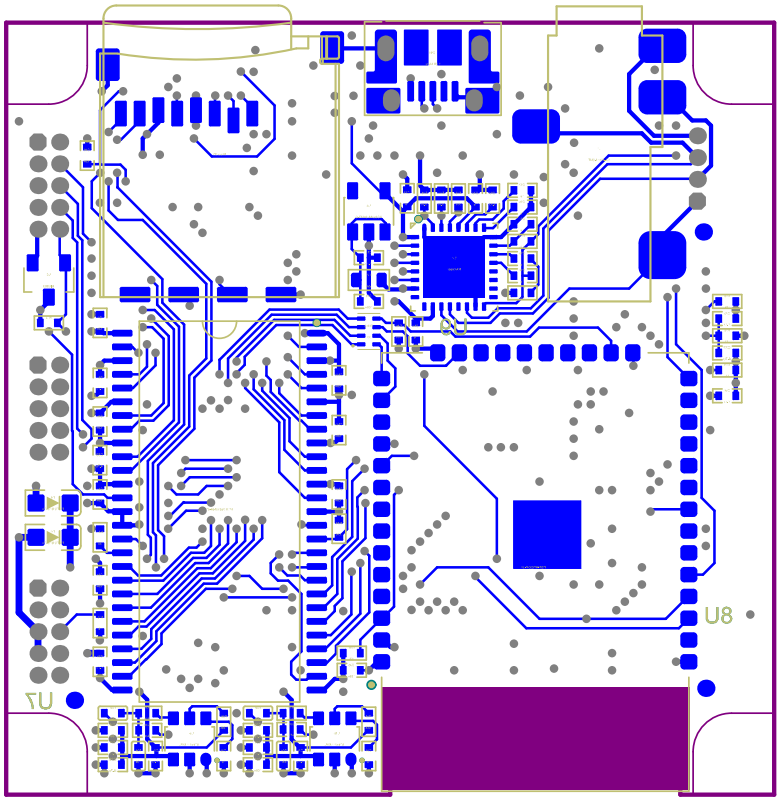
3.3V



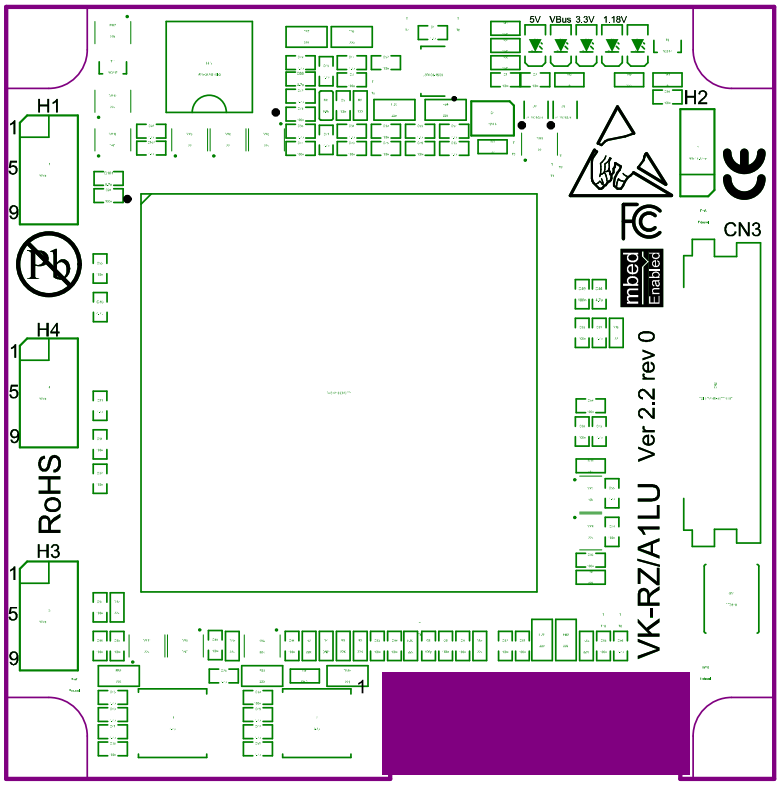
Gnd

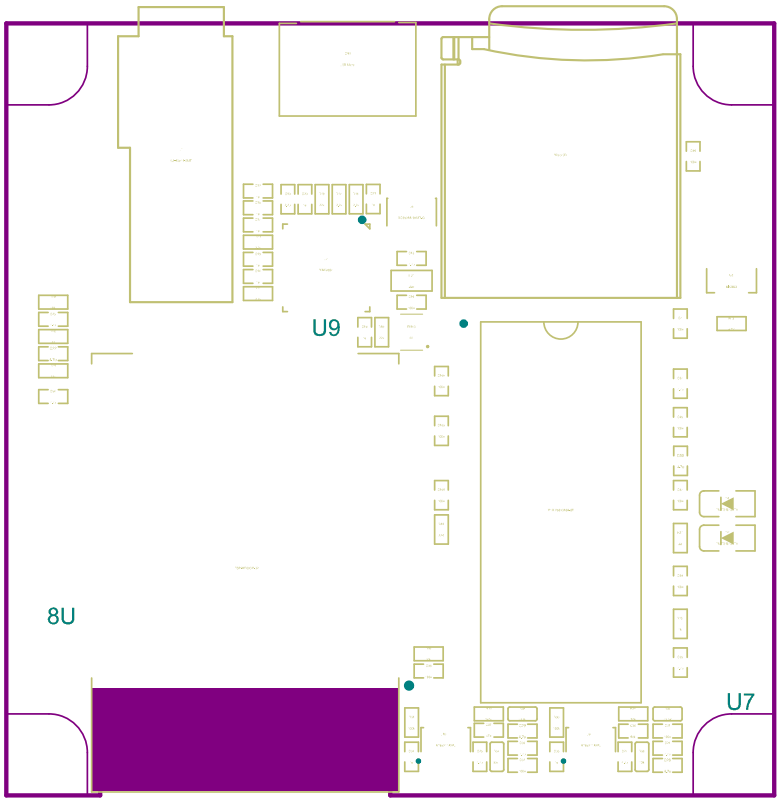


Bottom Layer



14. Arrangement





Revision overview list

Revision number	Description changes
1.0	Initial

Vekatech Ltd.

59, Sankt Peterburg blvd.
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