ESP32 Ethernet, Wi-Fi & Serial Gateway

1. Overview

UYS2101IA and UYS2101CA are ESP32 based modules having Ethernet, Wi-Fi and serial connectivity. UYS2101 includes an ESP32-D0WD microcontroller, an onboard PCB antenna, an Ethernet transceiver, a 16 MB flash memory, a USB-Serial converter, a 3.3V linear voltage regulator and a voltage supervisory chip. There is also an automatic bootloader activation circuit compatible with ESP-IDF tools.

Default firmware has a serial interface over USB to issue AT commands in order to connect to Ethernet and Wi-Fi networks and use built-in TCP/IP network stack. A custom firmware can be used instead of the default one. When bootloader is activated, the USB port becomes a flash programming interface. This port is connected to UART0 of ESP32.

UYS2101 can work as a standalone serial to Wi-Fi or Ethernet converter. Power is supplied via USB port. UYS2101 has 2 extension headers, and it is possible to mount it to a baseboard and use like a serial modem with AT commands. 5V and 3.3V supply inputs, reset signals, GPIO and serial ports are available in these headers.

2. Interfaces

- 1 x 10/100 MBit Ethernet port
- 1 x USB 2.0 serial port
- 8 x Input and Output capable GPIOs
- 6 x Input only GPIOs
- 1 x Flash programming & general purpose serial port shared with USB
- 2 x General purpose serial ports on any GPIO
- 11 x ADC inputs
- 5 x Touch sensors
- 1 x SPI port on any GPIO
- 2 x I2C channels on any GPIO
- 1 x CAN port on any GPIO
- 1 x JTAG port
- 3 x Channels of motor PWM on any GPIO
- 8 x Channels of LED PWM on any GPIO
- 8 x Channels of IR transmitter on any GPIO
- 8 x Channels of pulse counters on any GPIO
- 1 x Push-pull reset output
- 1 x Open collector master reset input
- 1 x USB supply enable jumper
- 1 x Green power LED
- 2 x Ethernet status LEDs on Ethernet connector

Some interfaces of the module are multiplexed with the same GPIO pins on ESP32 and cannot be used simultaneously. Please refer to the ESP32 datasheet for details. Numbers are the maximum counts and may not be applicable for your use case.

3. Features

- ESP32-D0WD-V3 Xtensa dual-core 32bit LX6 240MHz MCU
- 520 KB SRAM & 448 KB ROM on ESP32
- 16 MB serial flash memory (W25Q128JVSIQ)
- 10/100 Mbit Ethernet (RTL8201F)
- Wi-Fi 802.11 b/g/n 2.4GHz
- Integrated 2.4GHz antenna
- USB 2.0 programming & monitoring interface
- USB to serial converter (CH340G)
- 5V to 3.3V voltage regulator (1117 series)
- 2.93V supply voltage supervisor (APX811-29UG-7)
- 40 MHz & 32.758 kHz MCU crystals
- Extension headers for GPIO, supply and reset
- Runs with 5V or 3.3V supply voltage
- Industrial temperature range version is available

4. Pin Order & Layout

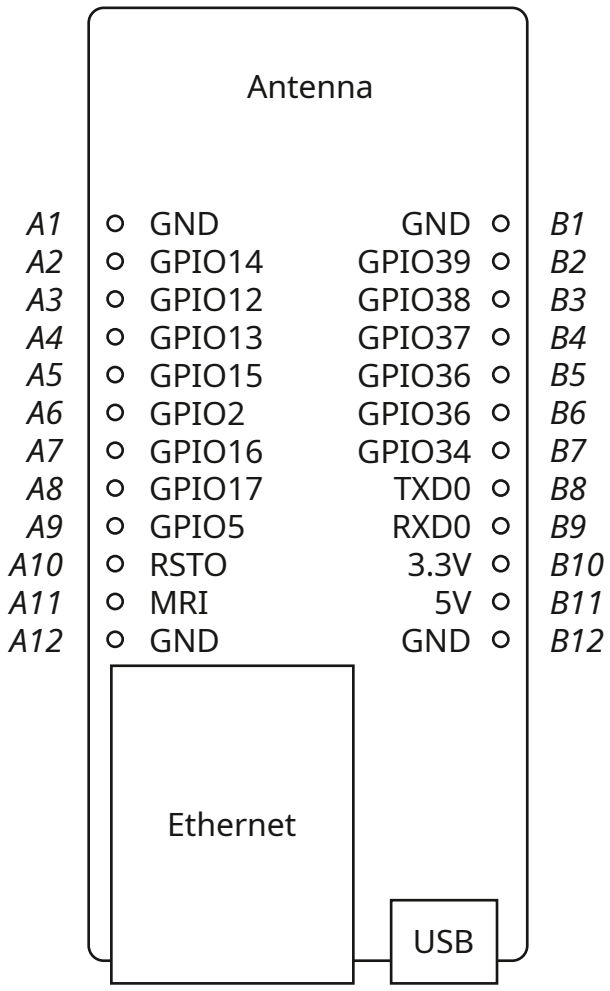


Figure 1. Pin order and layout (top view).

5. Pin Order and Functions

Table 1. Pin order and functions.

Pin	Name	ESP32 #	Details
A1	GND	-	Power, signal, reference and ESP32 ground connection.
A2	GPIO14	17 (1)	ADC2.6, RTCIO16, TOUCH6, EMAC_TXD2, HSPICLK, HS2_CLK, SD_CLK, MTMS
A3	GPIO12	18 (1)	ADC2.5, RTCIO15, TOUCH5, EMAC_TXD3, HSPIQ, HS2_DATA2, SD_DATA2, MTDI
A4	GPIO13	20 (1)	ADC2.4, RTCIO14, TOUCH4, EMAC_RXER, HSPID, HS2_DATA3, SD_DATA3, MTCK
A5	GPIO15	21 (1)	ADC2.3, RTCIO13, TOUCH3, EMAC_RXD3, HSPICS0, HS2_CMD, SD_CMD, MTDO
A6	GPIO2	22 (1)	ADC2.2, RTCIO12, TOUCH2, HSPIWP, HS2_DATA0, SD_DATA0
A7	GPIO16	25 (1)	HS1_DATA4, U2RXD, EMAC_CLK_OUT
A8	GPIO17	27 (1)	HS1_DATA5, U2TXD, EMAC_CLK_OUT_180
A9	GPIO5	34 (1)	HS1_DATA6, VSPICS0, EMAC_RX_CLK
A10	RSTO	- (4)	Push-pull reset output. Pulled low for about 200ms at reset.
A11	MRI	- (4)	Open collector master reset input. Pull down to reset the module.
A12	GND	-	Power, signal, reference and ESP32 ground connection.
B1	GND	-	Power, signal, reference and ESP32 ground connection.
B2	GPIO39	8 (2)	Input only. ADC1.3, RTCIO3
B3	GPIO38	7 (2)	Input only. ADC1.2, RTCIO2
B4	GPIO37	6 (2)	Input only. ADC1.1, RTCIO1
B5	GPIO36	5 (2)	Input only. ADC1.0, RTCIO0
B6	GPIO35	11 (2)	Input only. ADC1.7, RTCIO5
B7	GPIO34	10 (2)	Input only. ADC1.6, RTCIO4
B8	TXD0	41 (3)	UART0 transmit output. GPIO1, CLK_OUT3, EMAC_RXD2
B9	RXD0	40 (3)	UART0 receive input. GPIO3, CLK_OUT2
B10	3.3V	- (4)	3.3V supply output if 5V is supplied. 3.3V supply input if no 5V is available.
B11	5V	- (4)	5V supply output if 5V is supplied via USB. Otherwise 5V supply input.
B12	GND	-	Power, signal, reference and ESP32 ground connection.

- ESP32 pin numbering is according to the part number of ESP32-D0WD-V3 (QFN48 5x5mm).
(1) GPIO pins are protected with ESD suppressors and are connected to the ESP32.
(2) Input only pins have 470kOhm pull down resistors, are protected with ESD suppressors and are connected to the ESP32.
(3) GPIO pins shared with UART0 port, are not recommended to use as general purpose IO pins. They are multiplexed with the USB port as well.
(4) Reset and supply pins are protected with ESD suppressors.

6. Electrical And Environmental Characteristics

Table 2. Absolute maximum ratings.

Parameter		Min	Max	Unit
Supply Voltage (5V)		0	6	V
Supply Voltage (3.3V)		0	3.6	V
GPIO Input Voltage		0	3.6	V
Operating Temperature	for UYS2101IA	-40	85	^{0}C
	for UYS2101CA	0	70	^{0}C

Table 3. Transient immunity ratings.

Parameter		Value	Unit
V ESD (IEC 61000-4-2)	for header pins	30	kV
	for Ethernet and USB connectors	20	kV
	for antenna	15	kV
I EFT (IEC61000-4-4, 5/50ns)	for header pins	40	A
	for Ethernet and USB connectors	40	A
I Surge (IEC61000-4-5, 8/20us)	for header pins	4.5	A
	for Ethernet and USB on UYS2101IA	12	A
	for Ethernet and USB on UYS2101CA	5	A

Table 4. Recommended operating conditions.

Parameter		Min	Typical	Max	Unit
Supply Voltage (5V)		4.8	5	5.5	V
Supply Voltage (3.3V)		3	3.3	3.6	V
Temperature	for UYS2101IA	-40	25	85	°C
	for UYS2101CA	0	25	70	°C
Relative Humidity		10		90	%

Table 5. Electrical characteristics at 25 °C.

Parameter	Min	Typical	Max	Unit
Vih - Input High Voltage	2.5	3.3	3.6	V
Vil - Input Low Voltage	-0.3	0	0.8	V
Voh - Output High Voltage	2.65	3.3		V
Vol - Output Low Voltage		0	0.3	V
I3.3v - 3.3V Pin Output Current			0.5	A
Rp - Pull-up And Pull-down Resistances When Enabled		45		kOhm
Rpd - Pull-down Resistances of GPIO34 to GPIO39		470		kOhm
Vrt - 3.3 Supply Voltage Reset Threshold	2.89	2.93	2.98	V

- You may refer to ESP32 datasheet for electrical characteristics not found in this table.

Table 6. Timing and frequency characteristics at 25 °C.

Parameter		Min	Typical	Max	Unit
Rpwd - MRI Input Reset Pulse Width		100			ns
Rdt - RSTO Output Reset Delay Time		140	200	280	ms
Uart0 Baud Rate		1200	115200	500000	bps
Antenna Frequency	for SWR <= 2	2340	2440	2540	MHz

- You may refer to ESP32 datasheet for timing characteristics not found in this table.

7. Functional Blocks

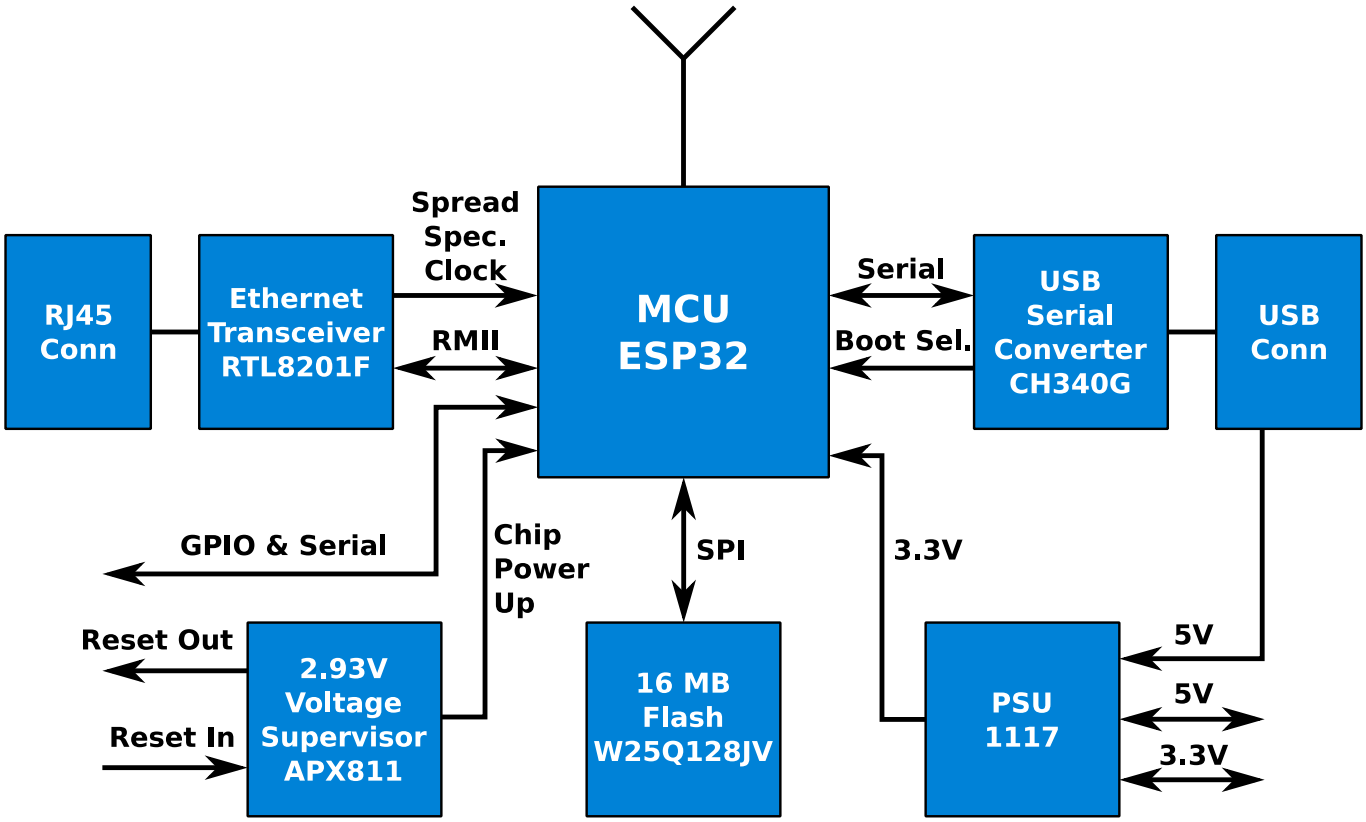


Figure 2. Functional blocks

8. Typical Applications

When UYS2101 runs as a standalone serial to Wi-Fi converter with default firmware, you may plug a USB cable from a main controller and supply 5V and issue AT commands. Ethernet cable is optional if you need a wired network. UYS2101 includes a main MCU (ESP32) so that you may program it with your custom firmware, and then it can run without another main controller.

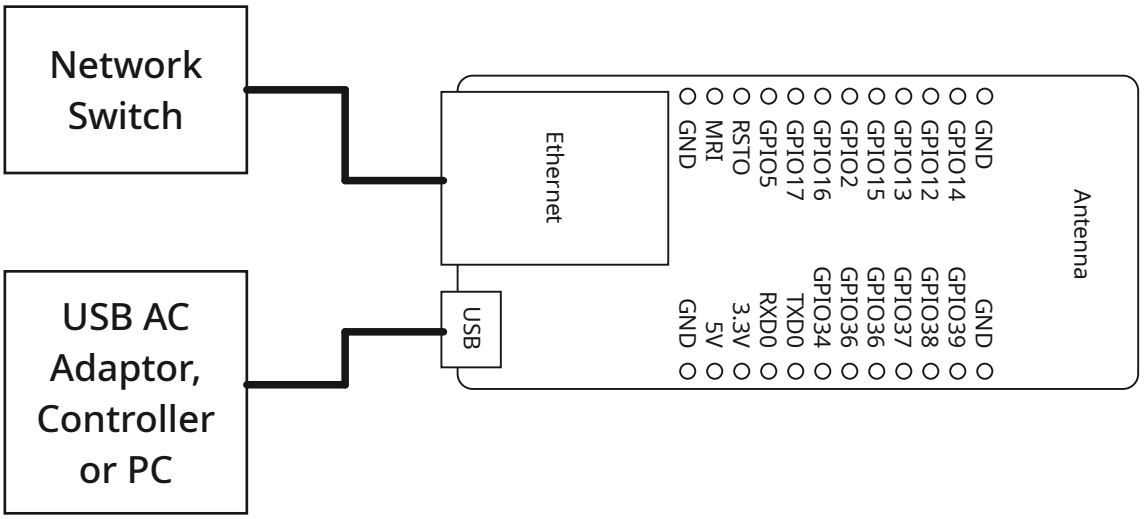


Figure 3. Application without using a base board.

When UYS2101 runs on a base board, you may supply either 5V or 3.3V. At commands can be issued over UART0 on the header pins. When 5V is available, 3.3V pin on the headers become a supply output pin. UYS2101 includes a main MCU (ESP32) so that you may program it with your custom firmware, and then it may run without the MCU. You can implement the power supply (i.e. 12V to 5V) and peripherals on the base board.

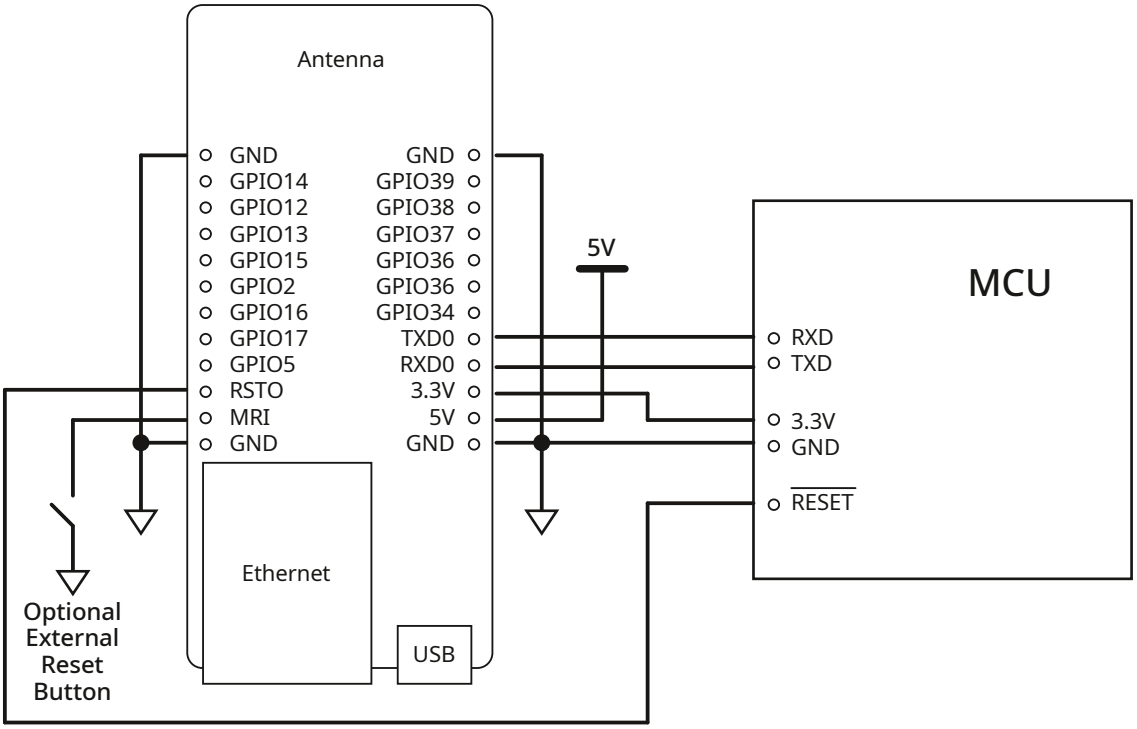


Figure 4. Application with a base board and a main MCU.

Some GPIO pins act as configuration inputs at boot time. Although you may use them regular GPIOs after boot, you need to pay attention while connecting pull-down or pull-up resistors to them. Table 7 gives a summary about default pull status.

Table 7. GPIO pin default (integrated) pull resistors and boot time configurations.

Pin	Name	Details	At Reset	After Reset
A2	GPIO14 (1)	MTMS.		pulled up
A3	GPIO12	MTDI. SDIO Voltage. 0: 3.3V, 1: 1.8V	pulled down	pulled down
A4	GPIO13	MTCK.		pulled down
A5	GPIO15 (1)	MTDO. Boot logs at TXD0. 1: Enabled, 0: Disabled	pulled up	pulled up
A6	GPIO2 (2)	Bootloader mode. 0: Enabled when GPIO0 is 0	pulled down	pulled down
A9	GPIO5 (1)	SDIO slave timing.	pulled up	pulled up
B8	TXD0	GPIO1.	pulled up	pulled up
B9	RXD0	GPIO3.	pulled up	pulled up

- ESP32 pin numbering is according to the part number of ESP32-D0WD-V3 (QFN48 5x5mm).
(1) These GPIOs output a PWM signal at boot time.
(2) GPIO0 is connected to BOOT button internally on board. This button and automatic bootloader activation works only if GPIO2 is pulled down at boot time.

Jumper J41 is for selecting between different supply options. The module can run from 5V or 3.3V from the header pins, or 5V from the USB connector.

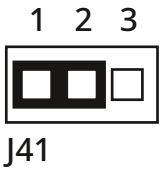


Figure 5. 5V on USB connector is shorted to module 5V net. Power is supplied from USB. 5V and 3.3V on pin headers are supply outputs.

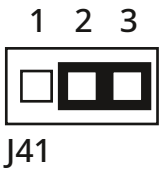


Figure 6. 5V on USB connector is disconnected. Power is supplied from 5V or 3.3V on pin headers. If 5V is supplied, 3.3V pin becomes supply output.

UYS2101 has an onboard, 2.4GHz PCB antenna. Although the antenna has a bandwidth of about 200MHz below SWR of 2, items in the close vicinity degrades its performance. A plastic enclosure or a base board PCB should be at least 10mm away from the antenna area to have acceptable radiation efficiency.

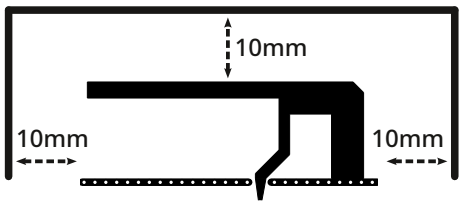


Figure 7. Minimum distances from a plastic enclosure to the PCB antenna.

9. Dimensions

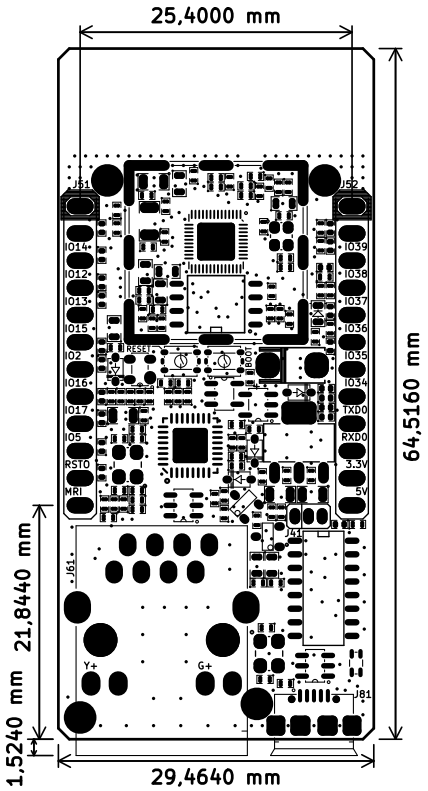
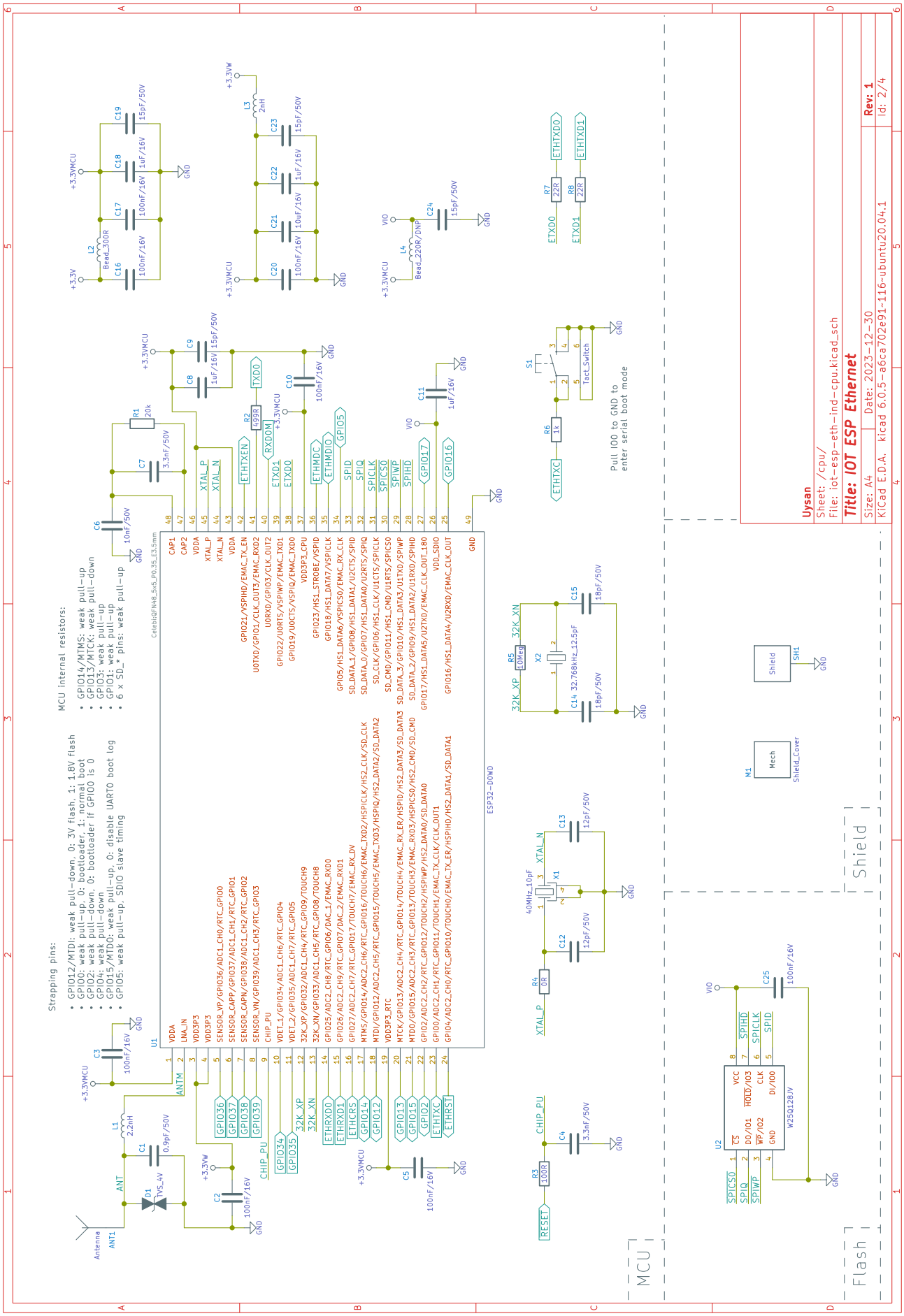


Figure 8. Dimensions.

10. Schematics

The design files for UYS2101 are publicly available. It is an open source hardware project licensed with "CERN Open Hardware License Version 2 - Permissive" license. This document includes the schematics on the next 3 pages. All the project files are shared on the below link:

https://github.com/uysan/iot-esp-eth


Strapping pins:
GPIO12/MTDI: weak pull-down, 0: 3V flash, 1: 1.8V flash
GPIO0: weak pull-up, 0: bootloader, 1: normal boot
GPIO2: weak pull-down, 0: bootloader if GPIO0 is 0
GPIO4: weak pull-down
GPIO15/MTDO: weak pull-up, 0: disable UART0 boot log
GPIO5: weak pull-up, SDIO slave timing
MCU internal resistors:
GPIO14/MTMS: weak pull-up
GPIO13/MTCK: weak pull-down
GPIO3: weak pull-up
GPIO1: weak pull-up
6 x SD_* pins: weak pull-up
ESP32-D0WD
CelebigFN48_5x5_P0.35_E3.5mm
Pull IO0 to GND to enter serial boot mode
Uysan
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Size: A4
Date: 2023-12-30
Rev: 1
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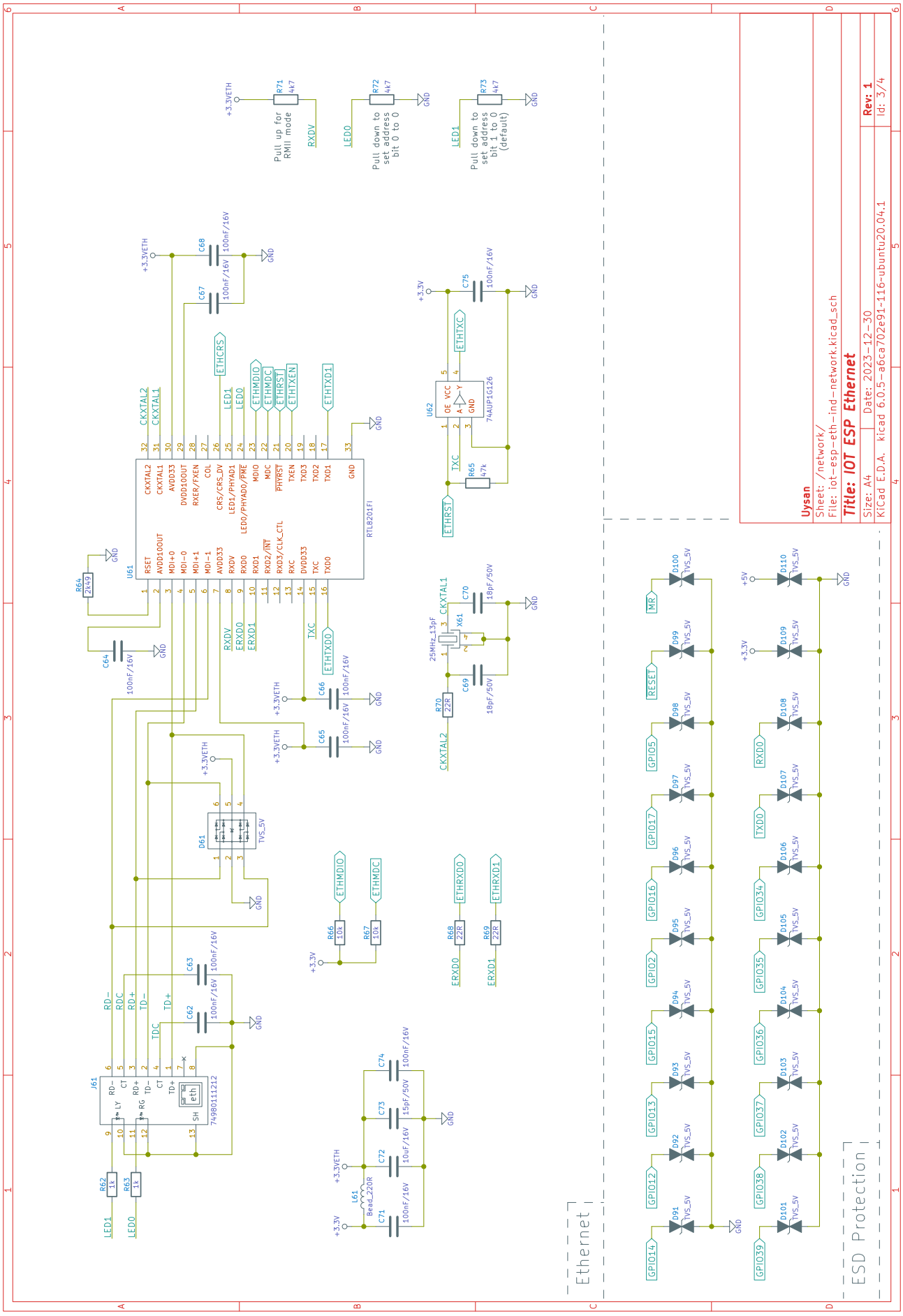
Id: 2/4
MCU
Flash
Shield


Uysan
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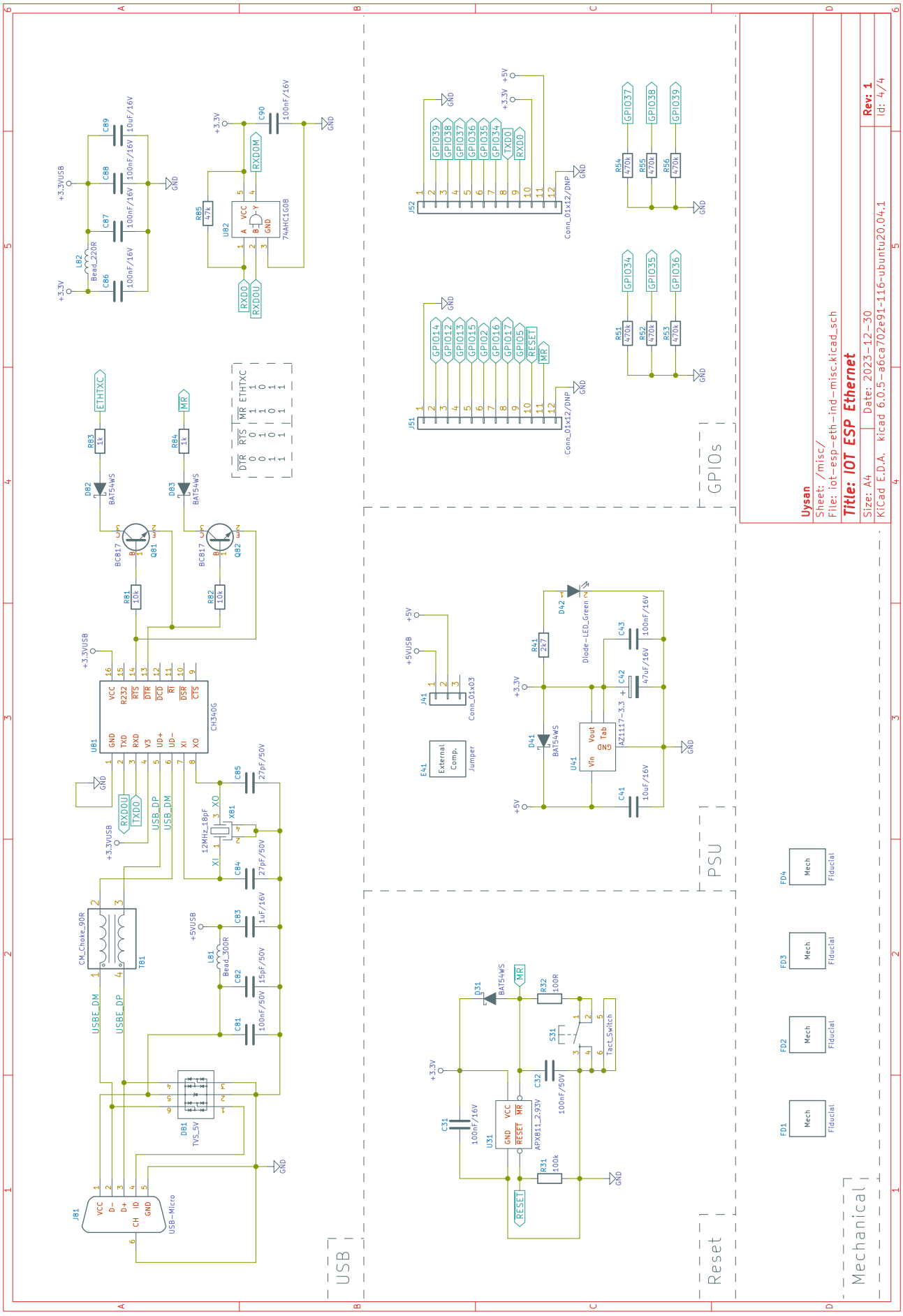
ESD Protection
RTL8201FI
74980111212
744UP1G126
25MHz_13pF
Pull up for RMII mode
Pull down to set address bit 0 to 0
Pull down to set address bit 1 to 0 (default)


Uysan
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Size: A4
Date: 2023-12-30
Rev: 1
KiCad E.D.A. kicad 6.0.5-a6ca702e91-116-ubuntu20.04.1
Id: 4/4
USB
PSU
GPIOs
Reset
Mechanical

11. Disclaimer And Liability

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