KAmodESP32 ETH POE

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Źródło: https://wiki.kamamilabs.com/index.php?title=KAmodESP32_ETH_POE

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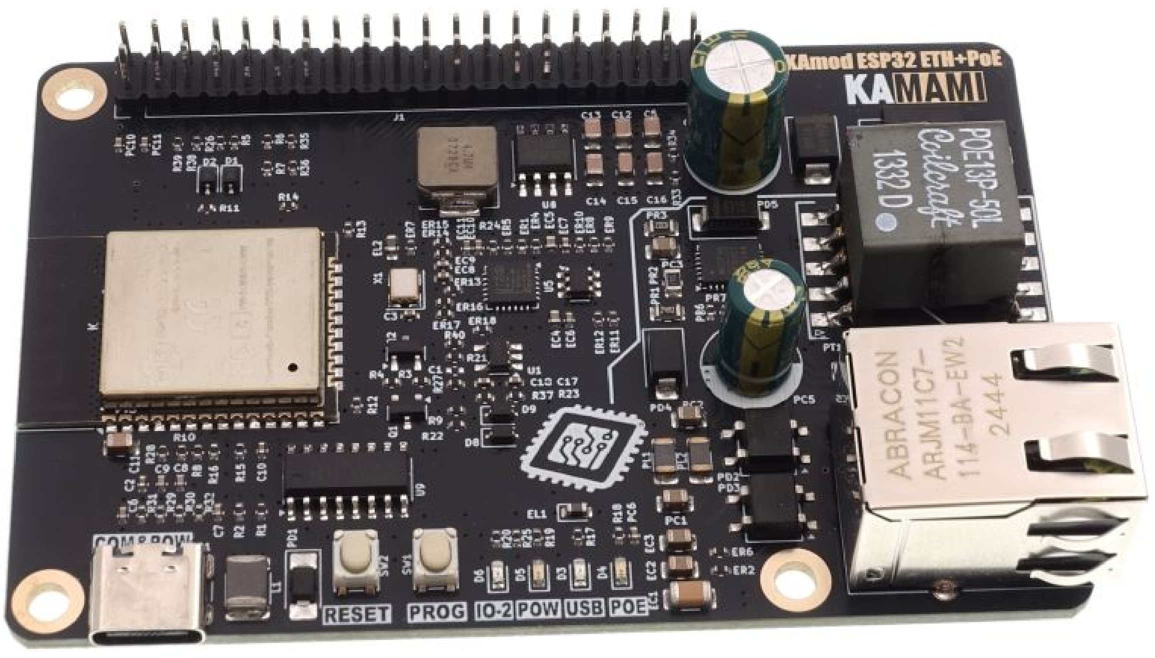
Description

KAmodESP32 ETH POE - Evaluation board with ESP32-WROOM module connected to Ethernet interface and PoE power supply system

The KAmod ESP32 ETH+POE board contains ESP32-WROOM module enabling communication in 2.4 GHz Wi-Fi wireless network, however it has been connected to Ethernet wired interface with typical RJ45 connector. Programming ESP32 module is possible with USB-UART converter with USB-C connector. The board is complemented by PoE power supply system - Power over Ethernet, thanks to which power supply of the module can be supplied from internet installation. The board design corresponds to SBC of Raspberry Pi family - it has dimensions 81x56 mm, and on characteristic 40-pin connector all important I/O ports and supply voltages 5 V and 3.3 V, which can power additional components connected to the board, have been led out.



Basic features and parameters

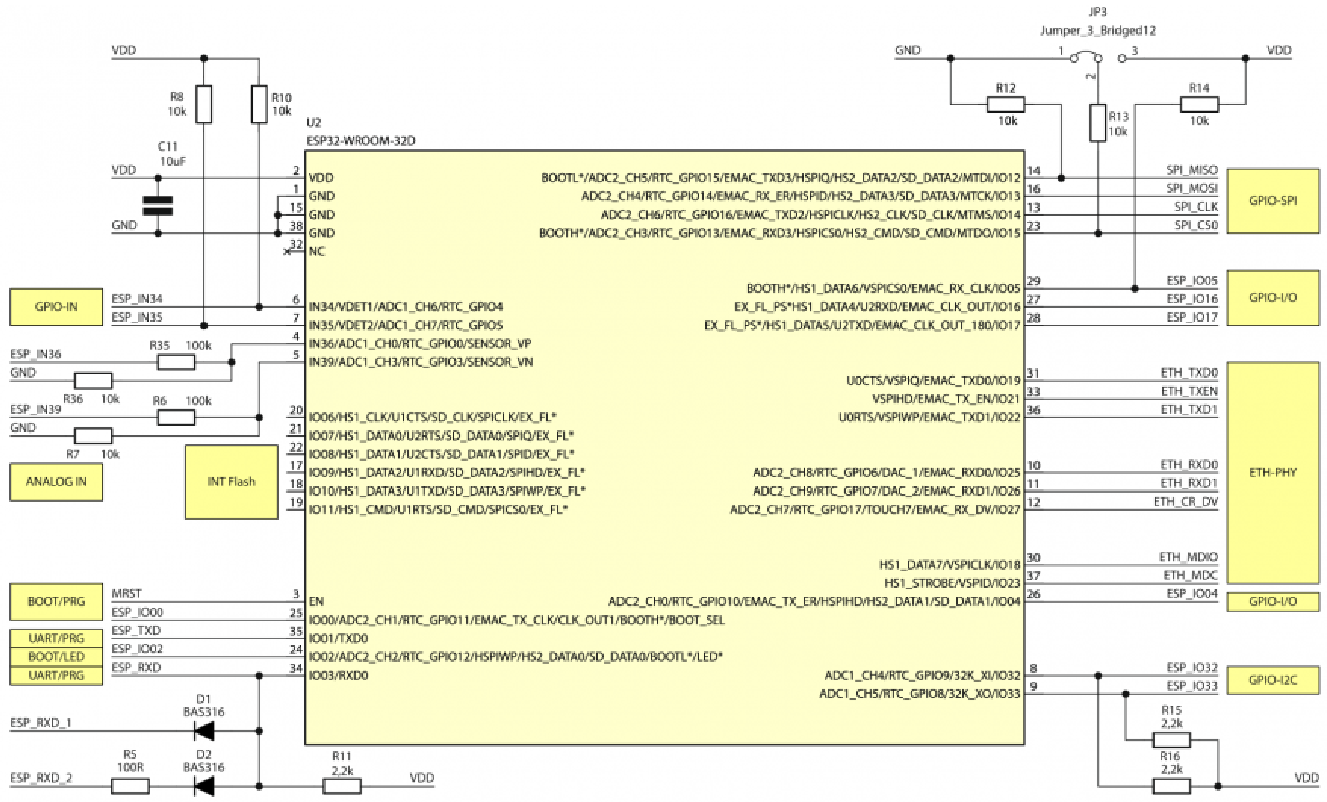
- ESP32-WROOM module enabling communication in a Wi-Fi network in the 2.4 GHz band
- Ethernet interface based on the LAN8742 system (100/10 M; full/half duplex)
- Integrated UART-USB converter with USB-C connector enabling programming of the ESP32 system
- PoE power supply system, compatible with the IEEE 802.3af/at Class 0 standard
- Provides stabilized voltages of 5 V (+/-10%) and 3.3 V (+/-5%) with a total current of up to 1.5 A
- Overvoltage, overload and thermal protection
- All important I/O ports and supply voltages have been led out to the 40-pin connector in the Raspberry Pi standard
- Board dimensions: 85x56 mm, height approx. 20 mm

Standard Equipment

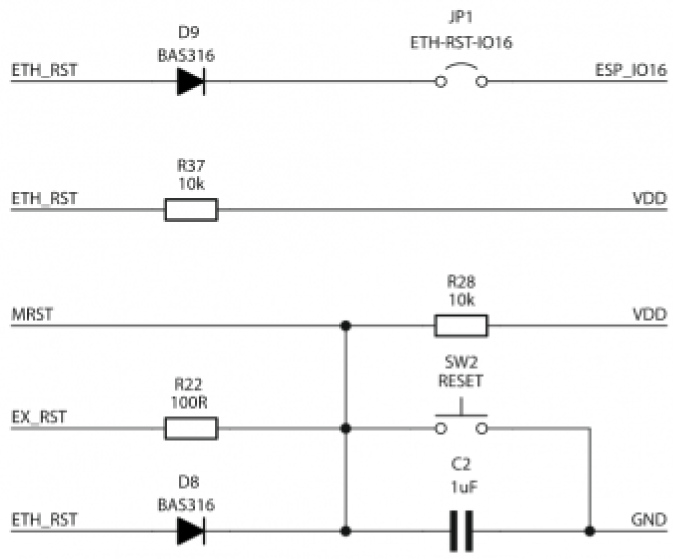
Code	Description
KAmodESP32 ETH+POE	Assembled and launched module

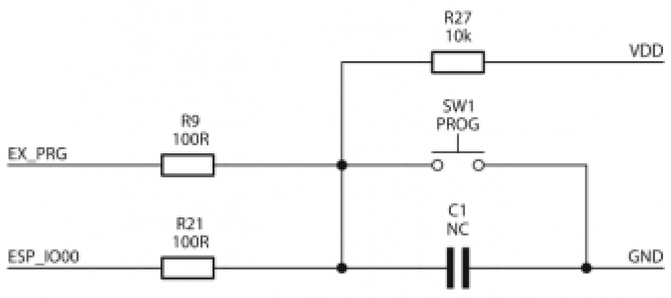
Electrical diagram

ESP32 module

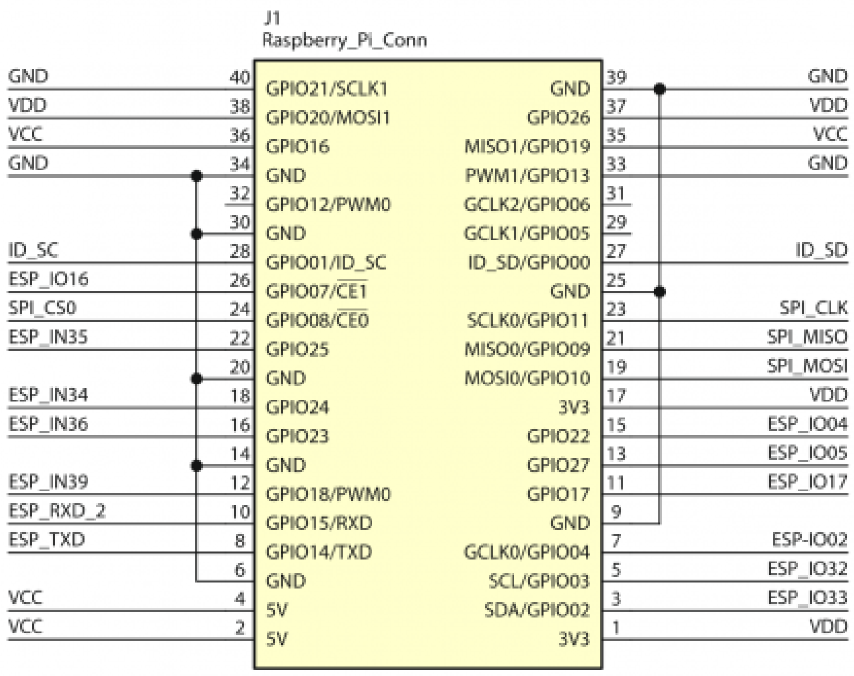


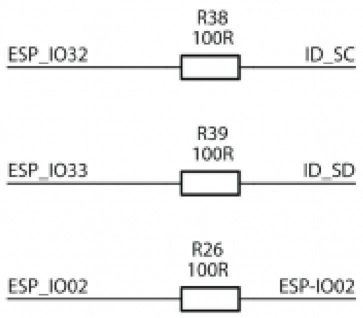
Elements responsible for reset and programming functions



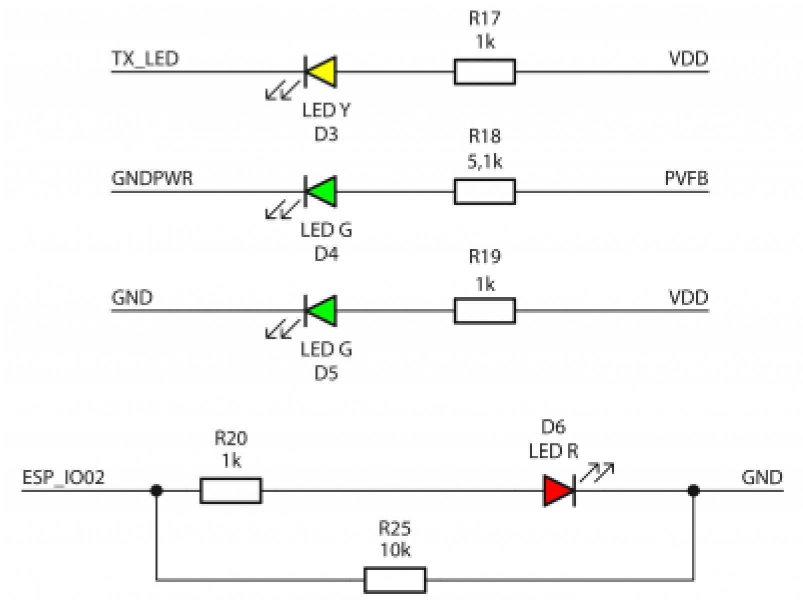


GPIO connector

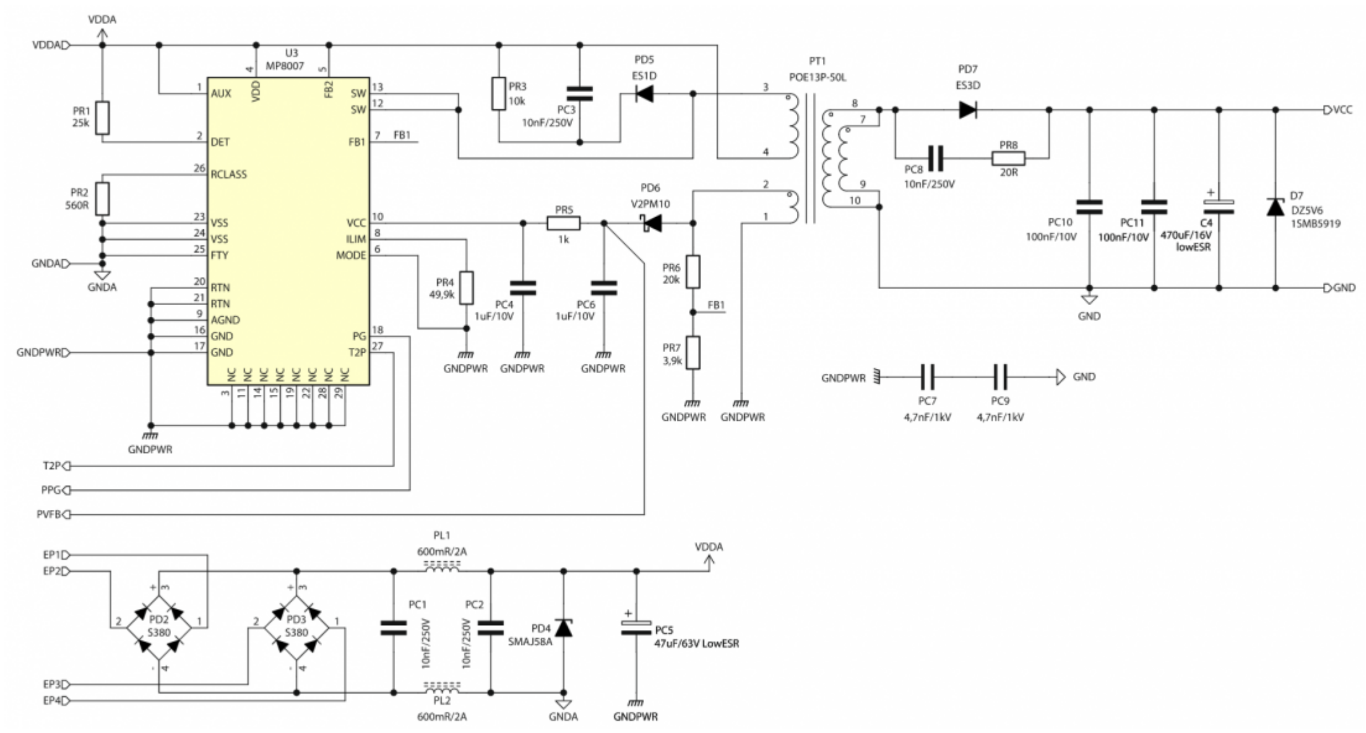

J1
Raspberry_Pi_Conn
GND 40 GPIO21/SCLK1 GND 39 GND
VDD 38 GPIO20/MOSI1 GPIO26 37 VDD
VCC 36 GPIO16 MISO1/GPIO19 35 VCC
GND 34 GND PWM1/GPIO13 33 GND
32 GPIO12/PWM0 GCLK2/GPIO06 31
30 GND GCLK1/GPIO05 29
ID_SC 28 GPIO01/ID_SC ID_SD/GPIO00 27 ID_SD
ESP_IO16 26 GPIO07/CE1 GND 25
SPI_CS0 24 GPIO08/CE0 SCLK0/GPIO11 23 SPI_CLK
ESP_IN35 22 GPIO25 MISO0/GPIO09 21 SPI_MISO
20 GND MOSI0/GPIO10 19 SPI_MOSI
ESP_IN34 18 GPIO24 3V3 17 VDD
ESP_IN36 16 GPIO23 GPIO22 15 ESP_IO04
14 GND GPIO27 13 ESP_IO05
ESP_IN39 12 GPIO18/PWM0 GPIO17 11 ESP_IO17
ESP_RXD_2 10 GPIO15/RXD GND 9
ESP_TXD 8 GPIO14/TXD GCLK0/GPIO04 7 ESP-IO02
6 GND SCL/GPIO03 5 ESP_IO32
VCC 4 5V SDA/GPIO02 3 ESP_IO33
VCC 2 5V 3V3 1 VDD



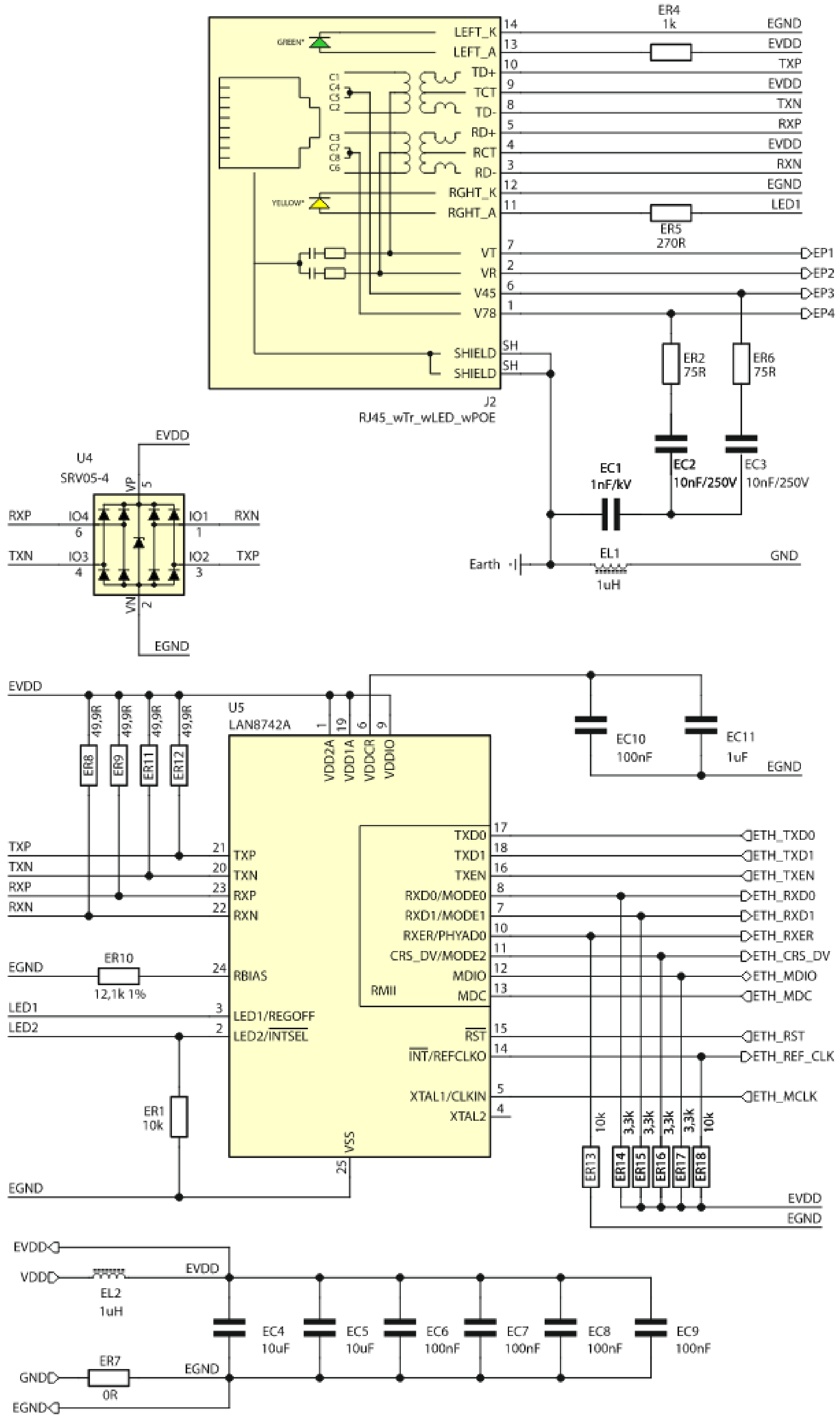
Indicator diodes



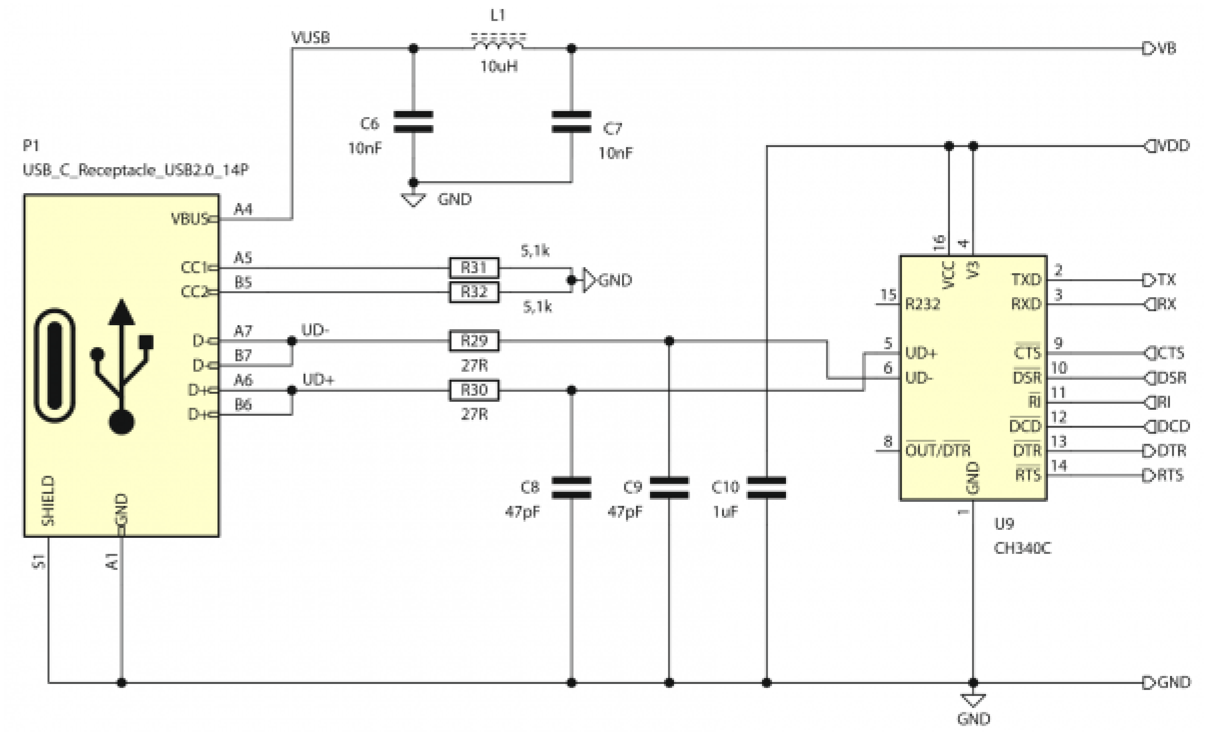
Ethernet interface



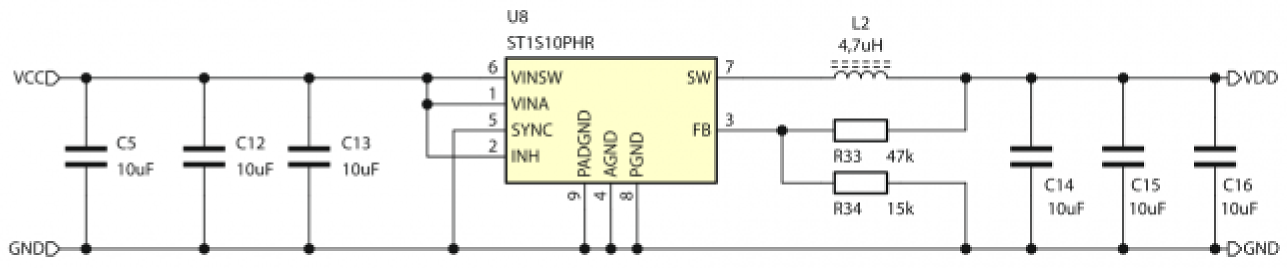
PoE power supply


J2
RJ45_wTr_wLED_wPOE
GREEN*
YELLOW*
LEFT_K
LEFT_A
TD+
TCT
TD-
RD+
RCT
RD-
RGHT_K
RGHT_A
VT
VR
V45
V78
SHIELD
SHIELD
SH
C1
C4
C2
C3
C7
C8
C6
ER4
1k
ER5
270R
EGND
EVDD
TXP
EVDD
TXN
RXP
EVDD
RXN
EGND
LED1
EP1
EP2
EP3
EP4
ER2
75R
ER6
75R
EC1
1nF/kV
EC2
10nF/250V
EC3
10nF/250V
Earth
EL1
1uH
GND
U4
SRV05-4
VP
VN
IO1
IO2
IO3
IO4
EVDD
EGND
RXP
RXN
TXN
TXP
U5
LAN8742A
VDD2A
VDD1A
VDDCR
VDDIO
ER8
ER9
ER11
ER12
49,9R
EC10
100nF
EC11
1uF
EGND
TXP
TXN
RXP
RXN
RBIAS
ER10
12,1k 1%
LED1/REGOFF
LED2/INTSEL
ER1
10k
VSS
RMII
TXD0
TXD1
TXEN
RXD0/MODE0
RXD1/MODE1
RXER/PHYAD0
CRS_DV/MODE2
MDIO
MDC
RST
INT/REFCLKO
XTAL1/CLKIN
XTAL2
ETH_TXD0
ETH_TXD1
ETH_TXEN
ETH_RXD0
ETH_RXD1
ETH_RXER
ETH_CRS_DV
ETH_MDIO
ETH_MDC
ETH_RST
ETH_REF_CLK
ETH_MCLK
ER13
ER14
ER15
ER16
ER17
ER18
10k
3,3k
EVDD
EGND
LED1
LED2
EVDD
VDD
EL2
1uH
GND
ER7
0R
EGND
EC4
10uF
EC5
10uF
EC6
100nF
EC7
100nF
EC8
100nF
EC9
100nF

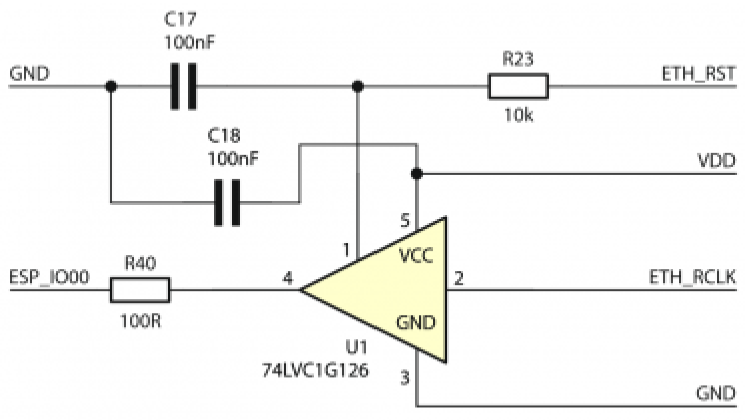
USB-UART interface



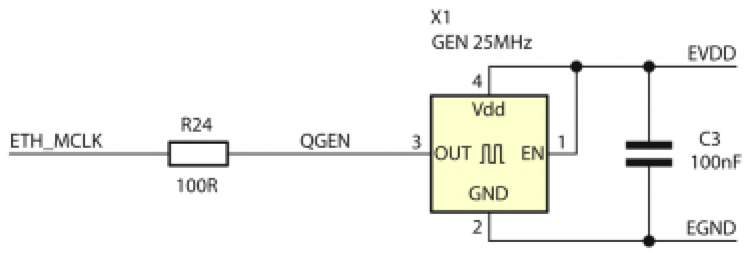
Source of the clocking signal



3.3V power block



C17
100nF
GND
R23
ETH_RST
10k
C18
100nF
VDD
5
1
VCC
ESP_IO00
R40
4
2
ETH_RCLK
100R
GND
U1
74LVC1G126
3
GND



X1
GEN 25MHz
EVDD
4
Vdd
ETH_MCLK
R24
QGEN
3
OUT
EN
1
C3
100nF
100R
GND
2
EGND

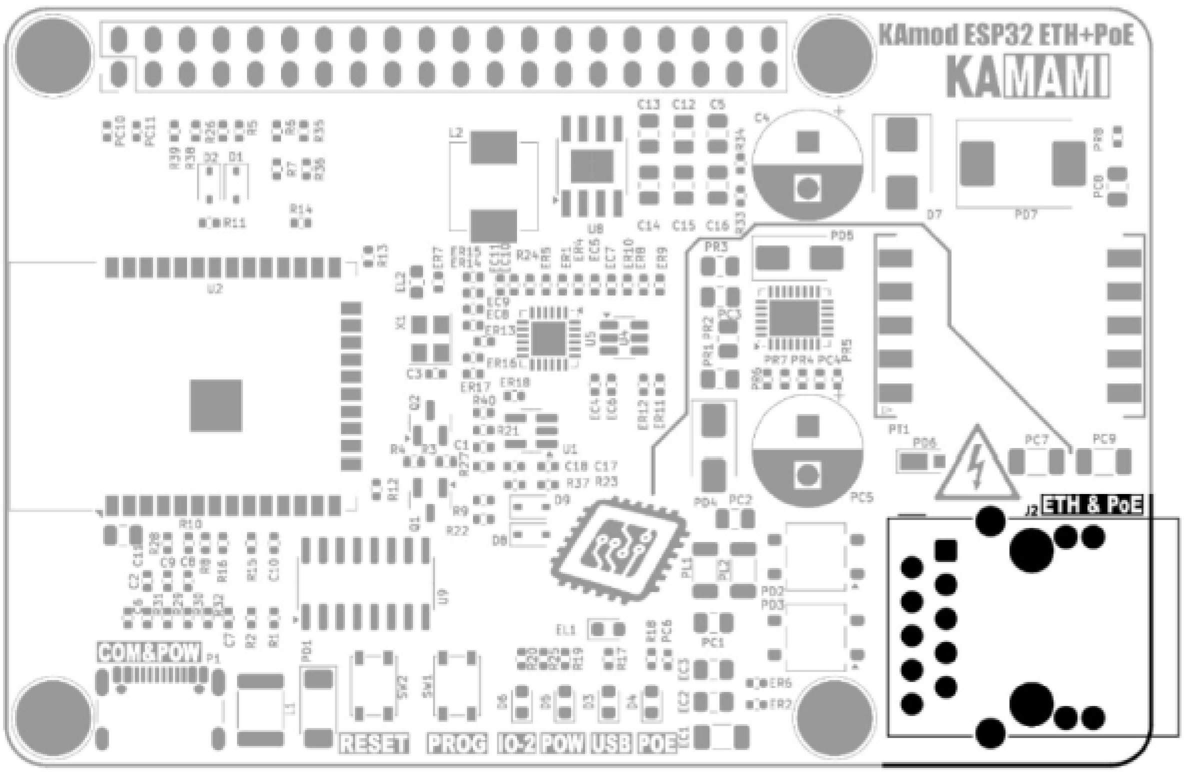
Ethernet Interface

Connector	Function
J2 – ETH & PoE (RJ45)	• Allows cable connection to the Internet

The KAmod ESP32 ETH+POE board implements a wired Ethernet interface with a classic RJ45 socket (J2). The **LAN8742** chip, which is compatible with **LAN8720** and supported in the Arduino environment, is used as the driver (PHY) of the Ethernet interface. It can operate at 100 Mb or 10 Mb in Full-Duplex or Half-Duplex mode.

The Ethernet driver is connected to the ESP32 module via the RMII interface (Reduced media-independent interface). The signal assignment is described in the table:

RMII Signal	Direction	ESP32 Module Pinout
TXD0	<-	GPIO19
TXD1	<-	GPIO22
TXEN	<-	GPIO21
RXD0	->	GPIO25
RXD1	->	GPIO26
CRS_DV	->	GPIO27
MDIO	<->	GPIO18
MDC	<-	GPIO23
REF_CLK	->	GPIO0
RESET	<-	GPIO16



Power by PoE

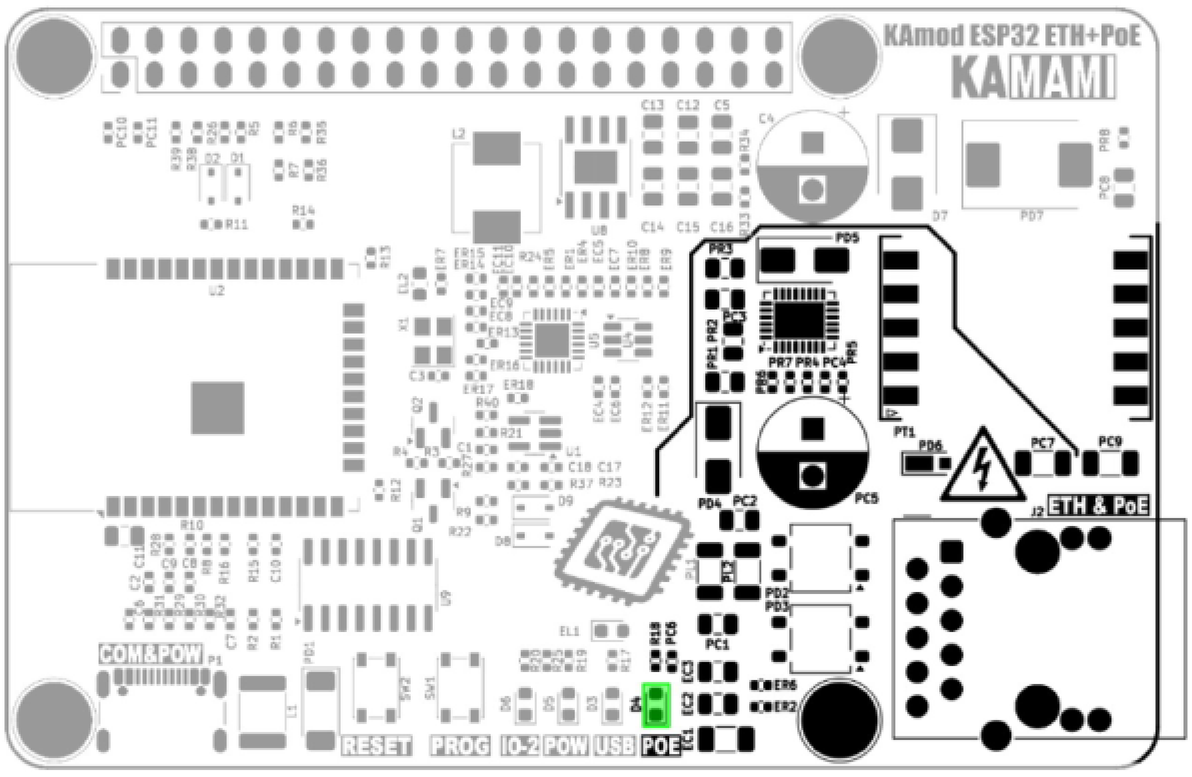
Connector	Function
J2 – ETH & PoE (RJ45)	• Receives power from PoE installation

The **ETH & PoE** connector (J2) can be used to supply power to the evaluation board. The PoE power controller used is based on the MP8007 system, which is compatible with the **IEEE 802.3af** - Powered Devices Type-1 and **IEEE 802.3at** - Powered Devices Type-2 standards. The PoE power block is configured to operate in Class 0, which defines the device's power consumption in the range of 0.5...13 W.

Power supply using the PoE method is only possible in a compatible installation containing a PSE (Power Sourcing Equipments) device that meets the IEEE 802.3af/at standard, e.g. a PoE router. The correct operation of the PoE power block is indicated by the lighting of the POE diode (D4). During the operation of the PoE power supply unit, noise or a quiet squeak may be heard - this is a natural phenomenon caused by the operation of the switching power supply (SMPS).

When the KAmod ESP32 ETH+POE evaluation board is properly powered, stabilized voltages of approx. 5 V and 3.3 V are generated, available on the J1 pin connector. They can be used to power other modules connected to the evaluation board, but remember that the total current should not exceed 1.5 A.

In the PoE installation, voltages with values of up to **60 V** occur. All activities performed in such installations using the KAmod ESP32 ETH+POE evaluation board should be performed with special caution and in compliance with safety rules.



USB Interface

Connector	Function
P1 – COM&POW (USB-C)	• Performs the function of a USB-UART converter • Allows programming of the ESP32 module • Is an alternative power input

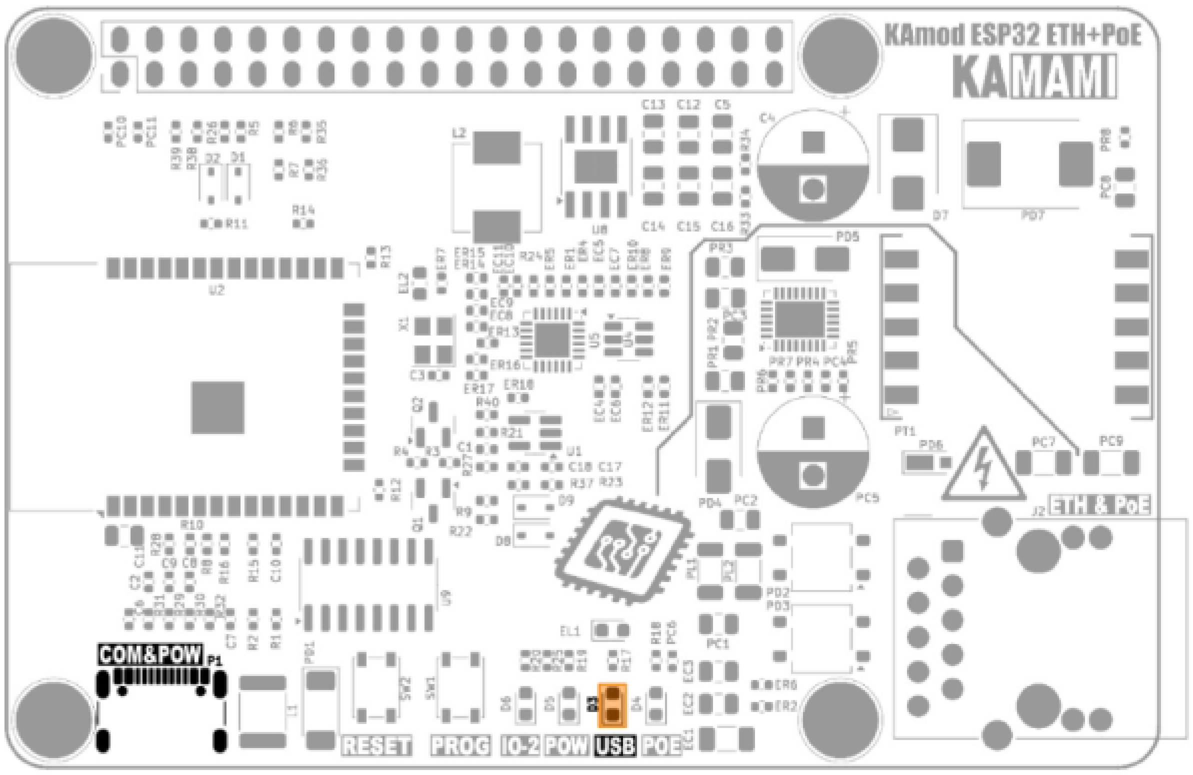
The P1 USB-C connector is connected to the CH340 type controller, which performs the functions of a USB-UART converter. The UART interface can be used in the target application, but it is also used to program the ESP32 module. The programming process can be completely automatic, because the CH340 controller controls the key pins of the ESP32 module (**GPIO0** - *Boot Select* and **EN** - *Chip Power-up*).

The signal connections between CH340 and ESP32 are as follows:

CH340 controller signal	ESP32 module pinout
TXD (data output)	GPIO03 (UART0 RXD)
RXD (data input)	GPIO01 (UART0 TXD)
DTR (transmission control output)	EN (Chip Power-up)
RTS (transmission control output)	GPIO0 (Boot Select)

The TXD line is connected to an LED marked USB (D3), which signals the reception of data from the USB interface. If a USB-UART converter is used in the target application, it is necessary to ensure that the DTR and RTS lines remain unsupported (*Handshaking: None*).

The USB-C connector can be used as an alternative power input for the KAmod ESP32 ETH+POE board, but then the parameters of the power supply circuits will not be met. The voltage on the 5 V line will be lower and will be around 4.5 V; the voltage on the 3.3 V line should not change; the current efficiency of the 5 V and 3.3 V voltages may be much lower and will depend on the power supply used on the USB-C connector.

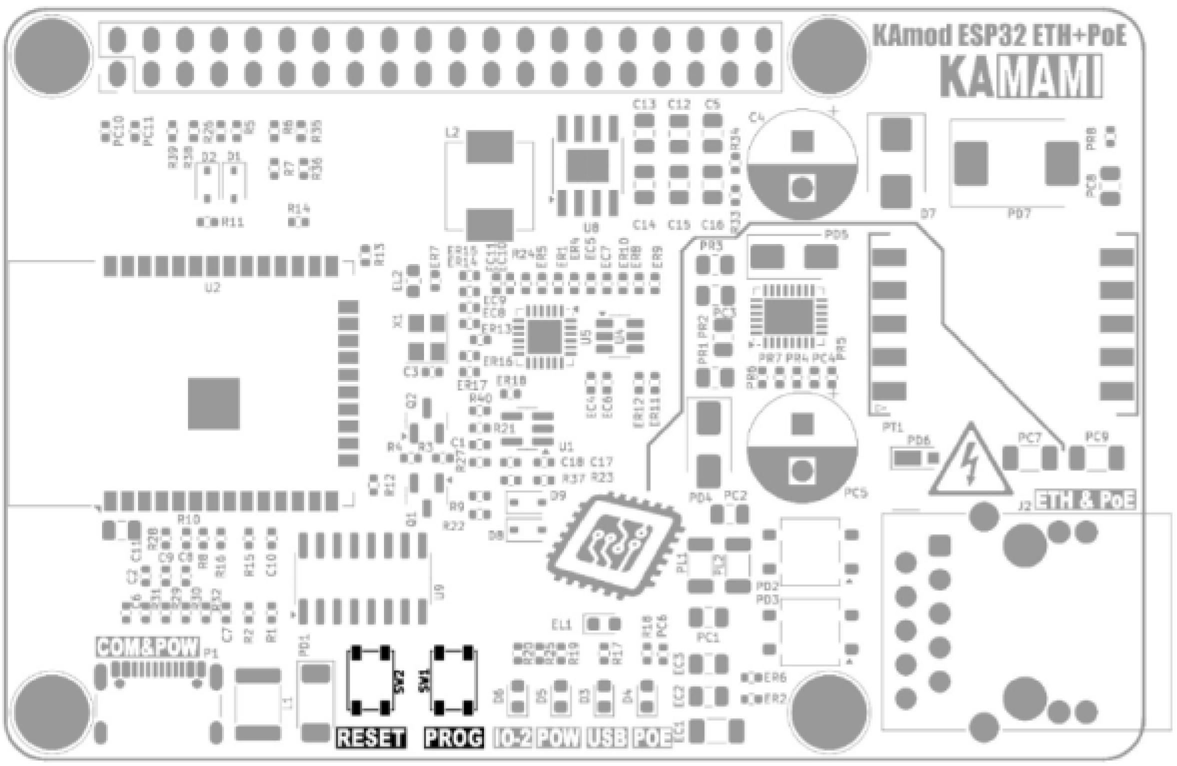


Reset and Programming Buttons

Component	Function
SW1 Button – **PROG**	• Starts programming mode via UART (only when the ESP32 module is restarted)
SW2 Button – **RESET**	• Restarts the ESP32 module and the Ethernet interface controller

The RESET button allows you to restart the ESP32 module and, at the same time, the Ethernet interface controller. It is connected to the EN (*Chip Power-up*) line of the ESP32 module.

The PROG button allows you to enter the ESP32 module into programming mode. Then you should press the RESET button, then, while holding RESET, hold the PROG button and then release RESET, while still holding PROG for a moment. This functionality can be useful when for some reason the programming mode is not started automatically via the USB-UART converter.



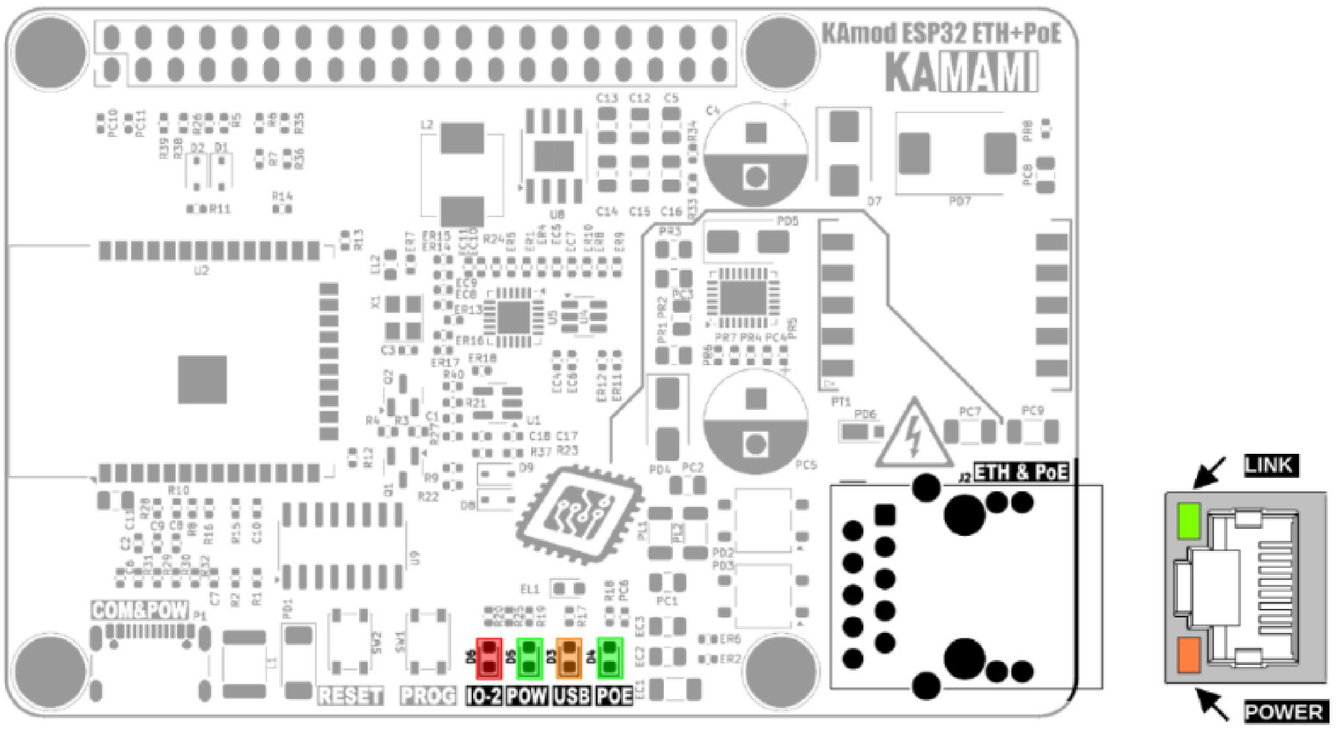
Signal lights

Component	Function
D3 – **USB**	• D3 LED flashing means data is being transferred from USB to the ESP32 module
D4 – **POE**	• D4 LED lighting means the PoE power supply module is working properly
D5 – **POW**	• The D5 diode lighting up indicates the presence of the main supply voltage - voltage 3.3 V
D6 – **IO-2**	• The D6 diode is connected to the GPIO2 pin of the ESP32 module and its lighting up can be controlled by software

There are 4 LEDs on the KAmod ESP32 ETH+POE board, which signal the operation of various components - according to the table above.

The D6 diode (LED IO-2) is connected to the GPIO2 pin of the ESP32 module. Its lighting up requires a programmatic setting of the high state on the GPIO2 pin.

The additional two signaling diodes are located on the J2 connector. The diode on the left (POWER) indicates the presence of the main supply voltage - voltage 3.3 V. The diode on the right (LINK) flashes to indicate the activity of the Ethernet interface.

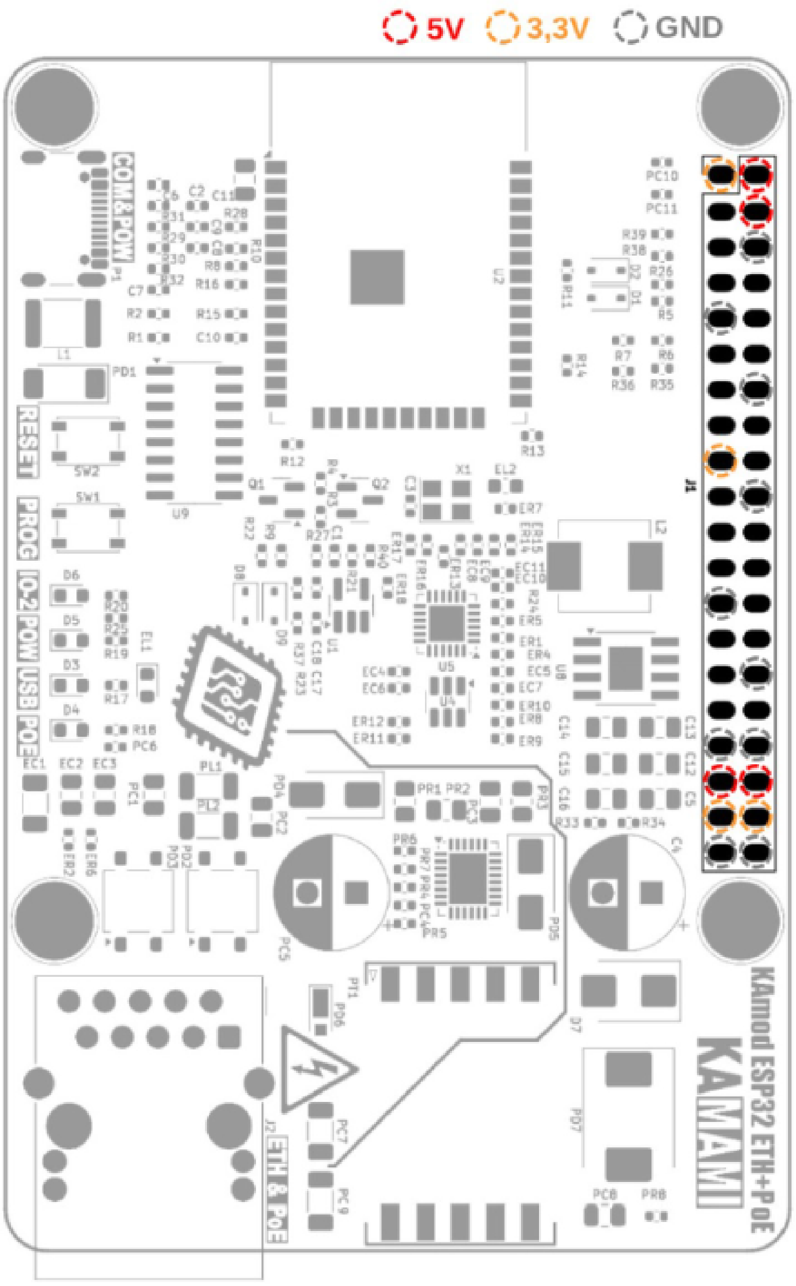


GPIO connector in RPi standard

Connector	Function
J1 – Goldpin 2x20	• Raspberry Pi standard connector • Some GPIO ports of the ESP32 module brought out • 5 V, 3.3 V, GND power lines brought out

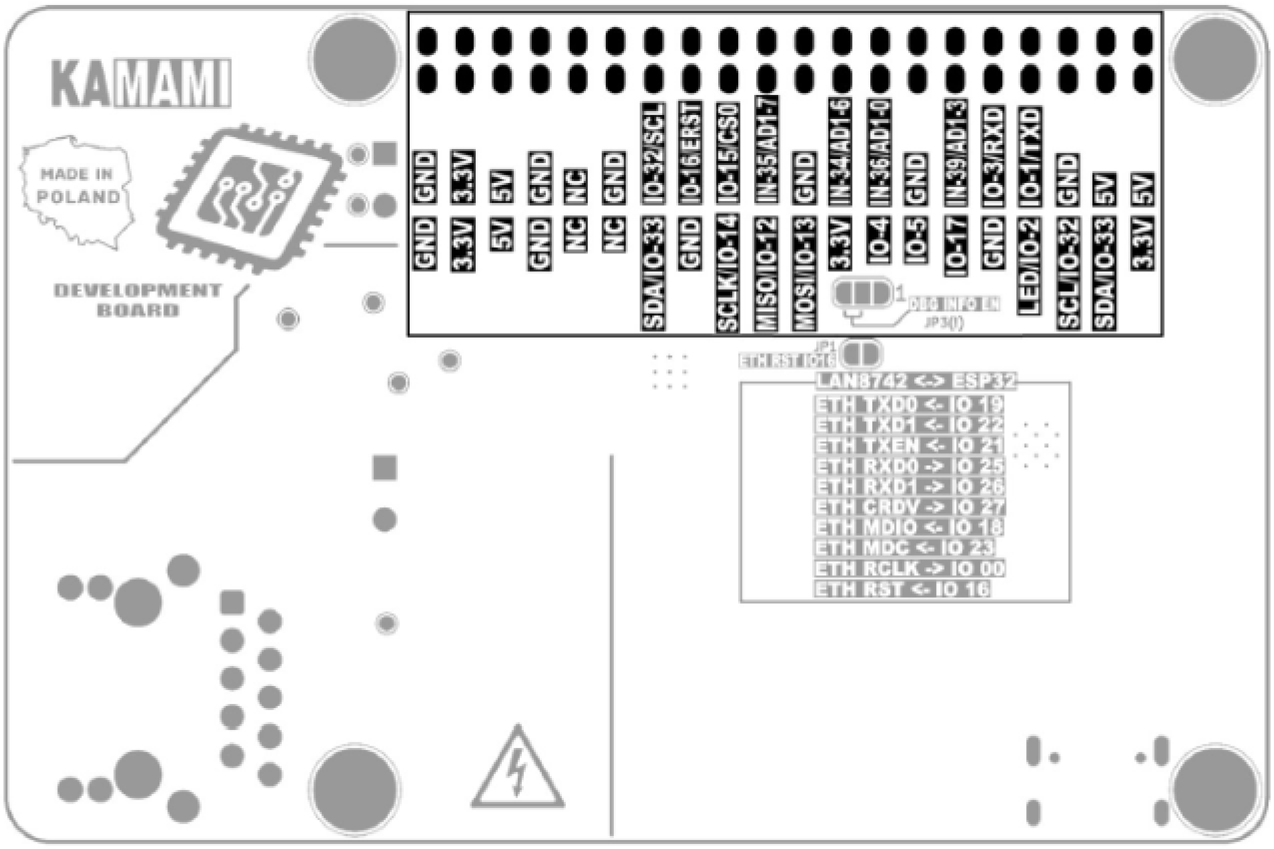
The Raspberry Pi standard GPIO connector (J1) contains 40 pins, to which the 5 V, 3.3 V, GND power lines and some GPIO pins of the ESP32 module are brought out. The UART (TXD, RXD), I2C (SDA, SCL) and SPI (MOSI, MISO, SCLK, CS0) interface pins have been arranged as they are in the Raspberry Pi family boards.

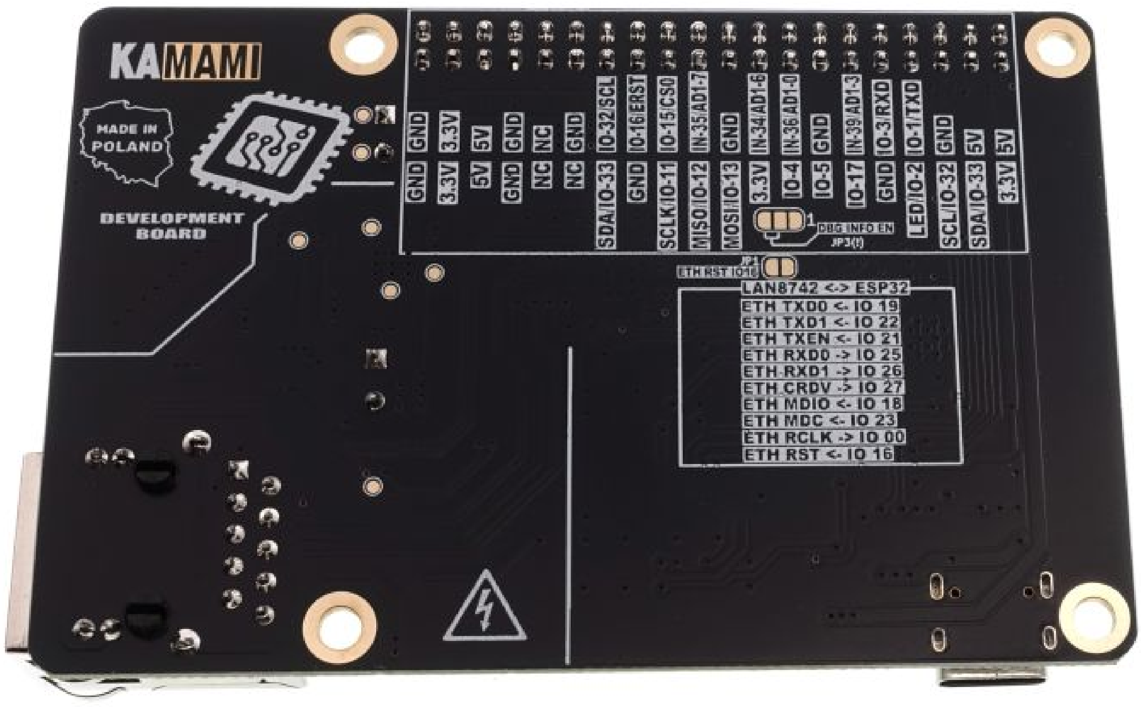
A detailed description of the pins and their functions is shown in the figure and table below:



J1	
3,3 V	5 V
GPIO33 (SDA)	5 V
GPIO32 (SCL)	GND
GPIO02 (LED D6)	GPIO1 (TXD)
GND	GPIO3 (RXD)
GPIO17	GPIO39 (IN)
GPIO5	GND
GPIO4	GPIO36 (IN)
3,3 V	GPIO34 (IN)
GPIO13 (MOSI)	GND
GPIO12 (MISO)	GPIO35 (IN)
GPIO14 (SCLK)	GPIO15 (SPI CS0)
GND	GPIO16 (ETH RST)
GPIO33 (SDA)	GPIO32 (SCL)
NC (niepodłączony)	GND
NC (niepodłączony)	NC (niepodłączony)
GPIO18	GND
5 V	5 V
3,3 V	3,3 V
GND	GND

The description of the pins has also been marked on the bottom of the KAmod ESP32 board ETH+POE:





Notes on signals output to GPIO connector

- Ports **GPIO 34**, **35**, **36** and **39** of the ESP32 module can only work as digital or analog inputs - they are marked with the symbol IN.

- Ports **GPIO 34** and **35** are equipped with 10k pull-up resistors.
- Ports **GPIO 36** and **39** are equipped with voltage dividers (100k/10k), thanks to which a maximum voltage of 35 V can be connected to them.
- Ports **GPIO 32** and **33** are adapted to the functionality of the I2C bus and contain 2.2k pull-up resistors.
- Ports **GPIO 1** and **GPIO 3** act as a UART interface and are connected to the USB-UART converter module and in parallel to the GPIO J1 connector. The UART interface sends/reads data to/from the GPIO J2 connector and the USB-UART converter simultaneously.
- Ports **GPIO5**, **GPIO12** and **GPIO15** configure certain parameters of the ESP32 module. Their state is read at the moment of starting (restarting) the ESP32 module, which is why they are equipped with pull-up resistors: GPIO5 – pull-up, GPIO12 – pull-down, GPIO15 – pull-down. It is necessary to ensure that the logical level on these pins at the moment of starting (restarting) corresponds to the state forced by the pull-up/down resistors.
- Port **GPIO16** has been connected to the Ethernet driver reset signal – LAN8742 system. Low state on this pin blocks the operation of the Ethernet interface.

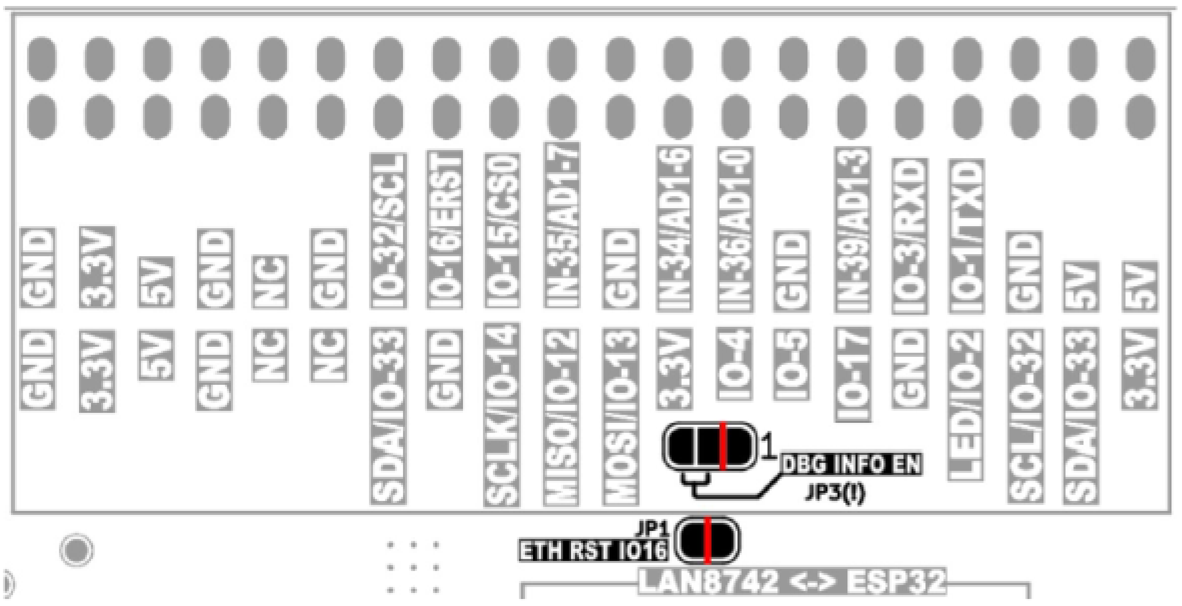
Advanced Features

Component	Function
JP1 – ETH RST IO16	• The SMD jumper, factory-closed, connects the GPIO16 port to the Ethernet driver reset signal
JP3 – DBG INFO EN	• SMD jumper, allows you to enable sending system messages – Debugging Log, via UART (USB) interface

Jumpers JP1 and JP3 are located on the bottom side of the evaluation board.

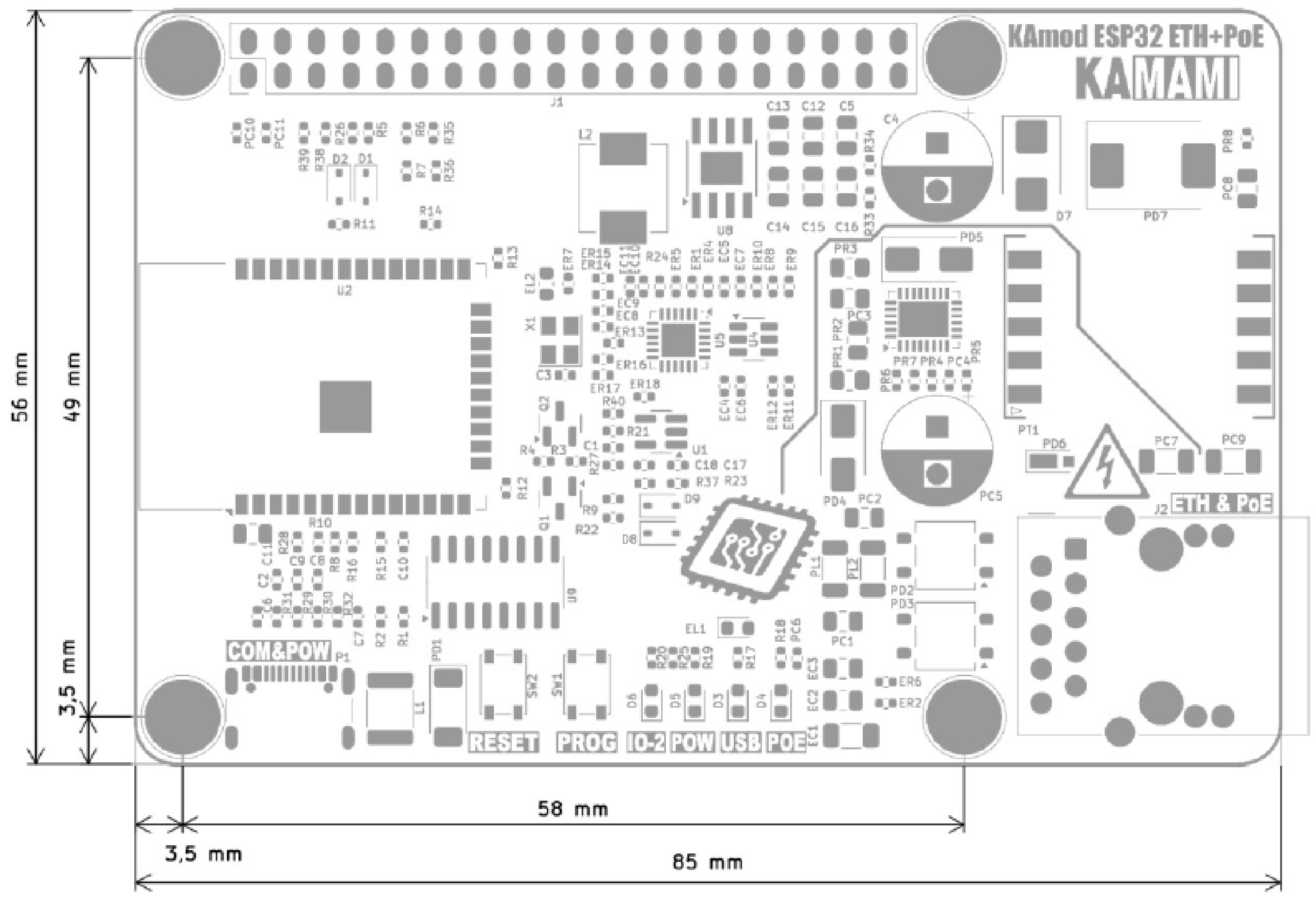
JP1 – ETH RST IO16 is factory-shorted (copper path between pads) and provides a connection between the GPIO16 port of the ESP32 module and the RESET input of the Ethernet interface driver. To disconnect the GPIO16 port from the Ethernet driver reset signal, cut the surface of the board with a sharp tool – as indicated by the red line at JP1 in the drawing below. Reconnecting the reset signal is possible by applying a drop of solder, which will connect both pads of the JP1 jumper.

JP3 - DBG INFO EN is factory connected between the middle pad and pad number 1 (power supply ground) and causes the system messages, so-called Debugging Log, to be silenced. To enable sending system messages, cut the surface of the board with a sharp tool as indicated by the red line at JP3 in the drawing below and apply a drop of solder, which will connect the pads on the opposite side, pads 2-3 (up to a voltage of 3.3 V). It is not allowed to connect pads 2-3 without first separating pads 1-2.



Dimensions

The dimensions of the KAmod ESP32 ETH+POE board are 85x56 mm. The maximum height is about 20 mm. The board has 4 mounting holes with a diameter of 3 mm, arranged similarly to the Raspberry Pi family boards.



Test program

The test program code is below, it can be compiled in the Arduino environment.

```
#include <ETH.h>
#include <WiFi.h>
/*
   * ETH_CLOCK_GPIO0_IN   - default: external clock from crystal oscillator
   * ETH_CLOCK_GPIO0_OUT  - 50MHz clock from internal APLL on GPIO0
   * ETH_CLOCK_GPIO16_OUT - 50MHz clock from internal APLL on GPIO16
   * ETH_CLOCK_GPIO17_OUT - 50MHz clock from internal APLL inverted on GPIO17
*/
#ifdef ETH_CLK_MODE
  #undef ETH_CLK_MODE
#endif
#define ETH_CLK_MODE    ETH_CLOCK_GPIO0_IN
// Pin# of the enable signal for the external crystal oscillator (-1 to disable for internal
APLL source)
#define ETH_POWER_PIN   -1
// Type of the Ethernet PHY (LAN8720 or TLK110)
#define ETH_TYPE        ETH_PHY_LAN8720
// I²C-address of Ethernet PHY (0 or 1 for LAN8720, 31 for TLK110)
#define ETH_ADDR        0
// Pin# of the I²C clock signal for the Ethernet PHY
#define ETH_MDC_PIN     23
// Pin# of the I²C IO signal for the Ethernet PHY
#define ETH_MDIO_PIN    18

#define ETH_RESET     16

#define LED_PIN       2

static bool eth_connected = false;

WiFiServer server(80);

// Select the IP address according to your local network
IPAddress myIP(10, 1, 0, 182);
IPAddress myGW(10, 1, 0, 252);
IPAddress mySN(255, 255, 0, 0);
IPAddress myDNS(8, 8, 8, 8);

void myEvent(WiFiEvent_t event) {
  switch (event) {
    case ARDUINO_EVENT_ETH_START:
      Serial.println("ETH Started");
      ETH.setHostname("esp32-ethernet");
      break;
    case ARDUINO_EVENT_ETH_CONNECTED:
      Serial.println("ETH Connected");
      break;
    case ARDUINO_EVENT_ETH_GOT_IP:
      //Serial.println("ETH Got IP");
      //Serial.println(ETH);
      Serial.print("ETH MAC: ");
      Serial.print(ETH.macAddress());
      Serial.print(", IPv4: ");
      Serial.print(ETH.localIP());
      if (ETH.fullDuplex()) {
        Serial.print(", FULL_DUPLEX");
      }
      Serial.print(", ");
      Serial.print(ETH.linkSpeed());
      Serial.println("Mbps");
      eth_connected = true;
      break;
    case ARDUINO_EVENT_ETH_LOST_IP:
      Serial.println("ETH Lost IP");
      eth_connected = false;
      break;
    case ARDUINO_EVENT_ETH_DISCONNECTED:
      Serial.println("ETH Disconnected");
      eth_connected = false;
      break;
    case ARDUINO_EVENT_ETH_STOP:
      Serial.println("ETH Stopped");
      eth_connected = false;
      break;
    default:
      break;
  }
}

void setup() {
  //ETH Reset assert
  pinMode(ETH_RESET, OUTPUT);
  digitalWrite(ETH_RESET, LOW);

  pinMode(LED_PIN, OUTPUT);
  for(int i=0; i<5; i++){
    digitalWrite(LED_PIN, HIGH);
    delay(200);
    digitalWrite(LED_PIN, LOW);
    delay(200);
  }

  //ETH Reset deassert
  digitalWrite(ETH_RESET, HIGH);
  delay(200);

  //Serial - start
  Serial.begin(115200);

  WiFi.onEvent(myEvent);
  ETH.begin(ETH_TYPE, ETH_ADDR,
            ETH_MDC_PIN, ETH_MDIO_PIN,
            ETH_POWER_PIN, ETH_CLK_MODE);
  //ETH.config(myIP, myGW, mySN, myDNS);

  while (!ETH.connected()){}
  server.begin();
}

void loop() {
  // listen for incoming clients
  WiFiClient client = server.available();
  if (client) {
    Serial.println("********New Client********");

    String currentLine = "";

    while (client.connected()) {
      if (client.available()) {
        char c = client.read();
        //Serial.write(c);
        if (c == '\n') {

          if (currentLine.length() == 0) {
            client.println("HTTP/1.1 200 OK");
            client.println("Content-type:text/html");
            client.println();
            client.print("<H2>Click <a href=\"/H\">here</a> to turn ON the LED.<br>");
            client.print("Click <a href=\"/L\">here</a> to turn OFF the LED.<br>");
            client.print("Click <a href=\"/SEND\">here</a> to write to Serial
(USB).<br></H2>");
            client.println();
            break;
          } else {
            currentLine = "";
          }
        } else if (c != '\r') {
          currentLine += c;
        }

        //if (currentLine.endsWith("GET /H")) {
        if (currentLine.indexOf("GET /H") >= 0) {
          digitalWrite(LED_PIN, HIGH);
        }
        //if (currentLine.endsWith("GET /L")) {
        if (currentLine.indexOf("GET /L") >= 0) {
          digitalWrite(LED_PIN, LOW);
        }
        if (currentLine.endsWith("GET /SEND")) {
          Serial.println("\r\nHELLO - you send message via Serial(USB)");
        }
      }
    }

    delay(10);
    client.stop();
    Serial.println("********Client Disconnected********");
  }
}
```

The test program configures the GPIO2 port as an output driving the LED (D6) and signals the start of operation with a few blinks. Then it starts the hardware UART interface and configures it to work as a serial interface connected to the UART-USB converter. Thanks to this, you can monitor the board's operation in any terminal program (Serial Monitor).

```
#define LED_PIN 2
pinMode(LED_PIN, OUTPUT);
for(int i=0; i<5; i++){
digitalWrite(LED_PIN, HIGH);
delay(200);
digitalWrite(LED_PIN, LOW);
delay(200);
}
//Serial - start
Serial.begin(115200);
```

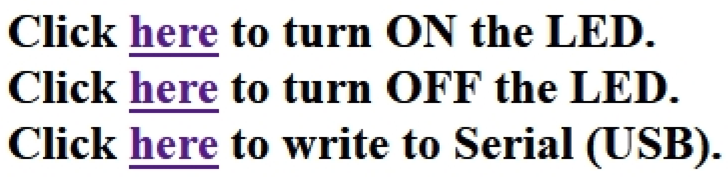
Preparing the Ethernet interface driver – LAN8742 system, requires adding the ETH.h library and defining the pin functions. The LAN8742 system is compatible with the LAN8720 system, which in turn is supported in the Arduino environment.

```
#include <ETH.h>
/*
* ETH_CLOCK_GPIO0_IN - default: external clock from crystal oscillator
* ETH_CLOCK_GPIO0_OUT - 50MHz clock from internal APLL on GPIO0
* ETH_CLOCK_GPIO16_OUT - 50MHz clock from internal APLL on GPIO16
* ETH_CLOCK_GPIO17_OUT - 50MHz clock from internal APLL inverted on GPIO17
*/
#ifdef ETH_CLK_MODE
#undef ETH_CLK_MODE
#endif
#define ETH_CLK_MODE ETH_CLOCK_GPIO0_IN
// Pin# of the enable signal for the external crystal oscillator (-1 to disable for internal
APLL source)
#define ETH_POWER_PIN -1
// Type of the Ethernet PHY (LAN8720 or TLK110)
#define ETH_TYPE ETH_PHY_LAN8720
// I²C-address of Ethernet PHY (0 or 1 for LAN8720, 31 for TLK110)
#define ETH_ADDR 0
// Pin# of the I²C clock signal for the Ethernet PHY
#define ETH_MDC_PIN 23
// Pin# of the I²C IO signal for the Ethernet PHY
#define ETH_MDIO_PIN 18
#define ETH_RESET 16
//ETH Reset assert
pinMode(ETH_RESET, OUTPUT);
digitalWrite(ETH_RESET, LOW);
...
//ETH Reset deassert
digitalWrite(ETH_RESET, HIGH);
delay(200);
```

Now you can start the interface and the web server:

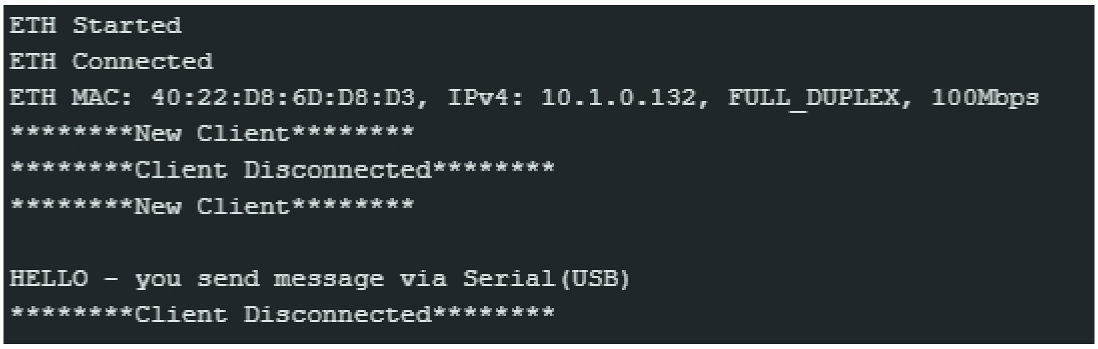
```
WiFiServer server(80);
ETH.begin(ETH_TYPE, ETH_ADDR,
ETH_MDC_PIN, ETH_MDIO_PIN,
ETH_POWER_PIN, ETH_CLK_MODE);
...
while (!ETH.connected()){}
server.begin();
```

After starting the test program, the www server will be launched with a very simple website that allows you to control the D6 LED and send a message via the serial port:



Click here to turn ON the LED.
Click here to turn OFF the LED.
Click here to write to Serial (USB).

The IP address that will be assigned to the www server in the LAN can be read from the messages sent via the serial port:



```
ETH Started
ETH Connected
ETH MAC: 40:22:D8:6D:D8:D3, IPv4: 10.1.0.132, FULL_DUPLEX, 100Mbps
********New Client********
********Client Disconnected********
********New Client********

HELLO - you send message via Serial(USB)
********Client Disconnected********
```

The IP address can also be specified in the program, then you need to specify four parameters:

```
IPAddress myIP(10, 1, 0, 182);
IPAddress myGW(10, 1, 0, 252);
IPAddress mySN(255, 255, 0, 0);
IPAddress myDNS(8, 8, 8, 8);
```

and then enter the command:

```
ETH.config(myIP, myGW, mySN, myDNS);
```

before the line:

```
server.begin();
```

Links

- LAN8742 datasheet
- MP8007 datasheet
- ESP32 datasheet
- Datasheet CH340
- Catalog card of the ST1S10 system
- Arduino test program

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