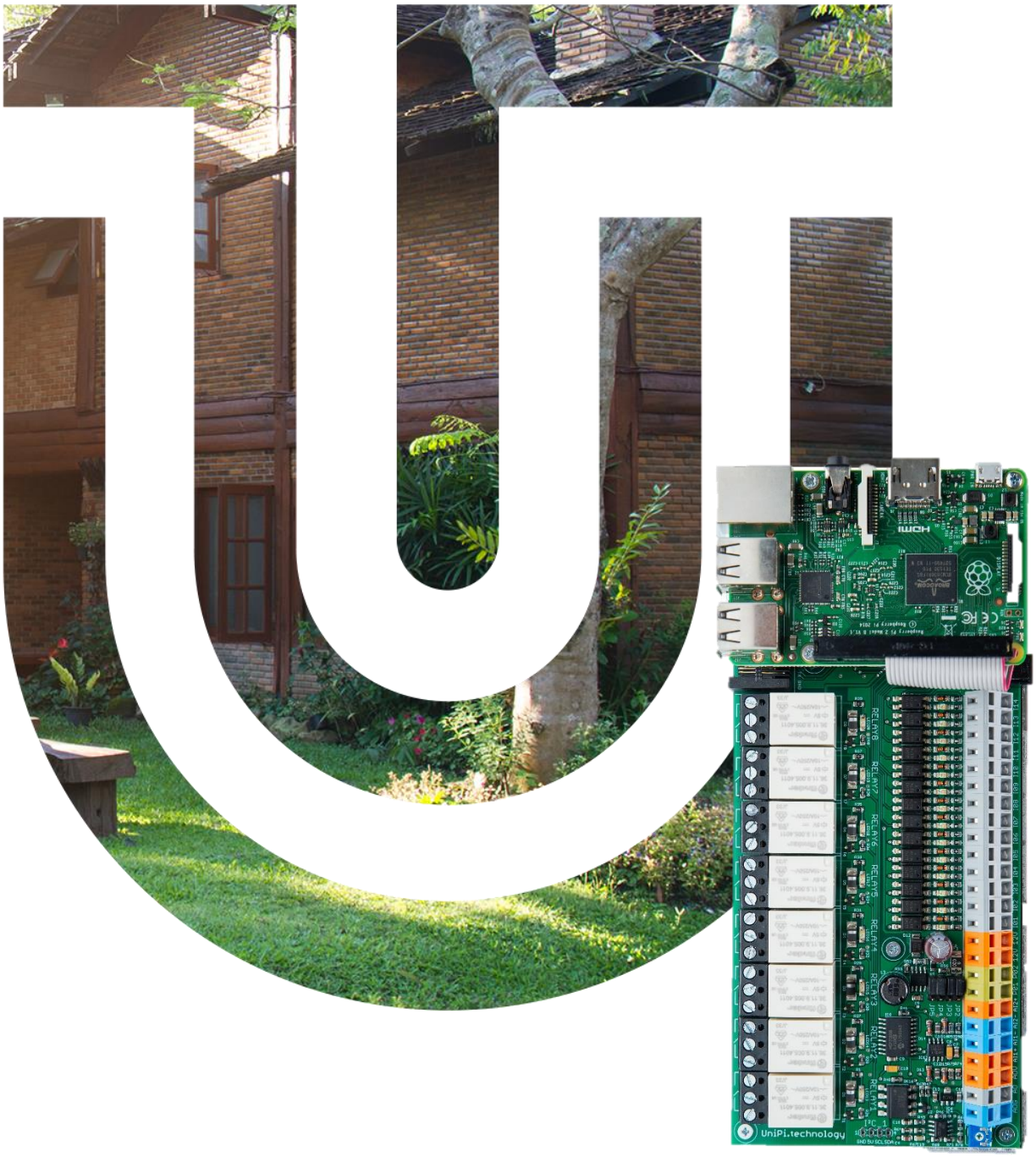
Automation Monitoring and control Remote access and management HVAC



Unipi 1.1

Extension board for the Raspberry Pi computer

unipi technology

www.unipi.technology

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1 Introduction

Unipi 1 is an add-on board for the Raspberry Pi (RPi). It features many components such as 12(+2) digital inputs with LED signalization, two 0–10 V analog inputs, one 0–10 V analog output, 8 changeover relays, single-channel 1wire master controller and a real-time clock module.

The two digital inputs I13, I14 and the I2C_0 bus are designed for connection via the P5 RPi B header (only), which is no longer available on newer Raspberry Pis (B+ and newer) models.

We provide open-source API EVOK and Modbus TCP server Unipi One for interfacing the Unipi 1 available on GitHub which is recommended to use.

There are also many platforms and libraries compatible with Unipi:

- Mervis
- Node-RED
- OpenPLC
- Others

Unipi is fully compatible with the following Raspberry Pi models

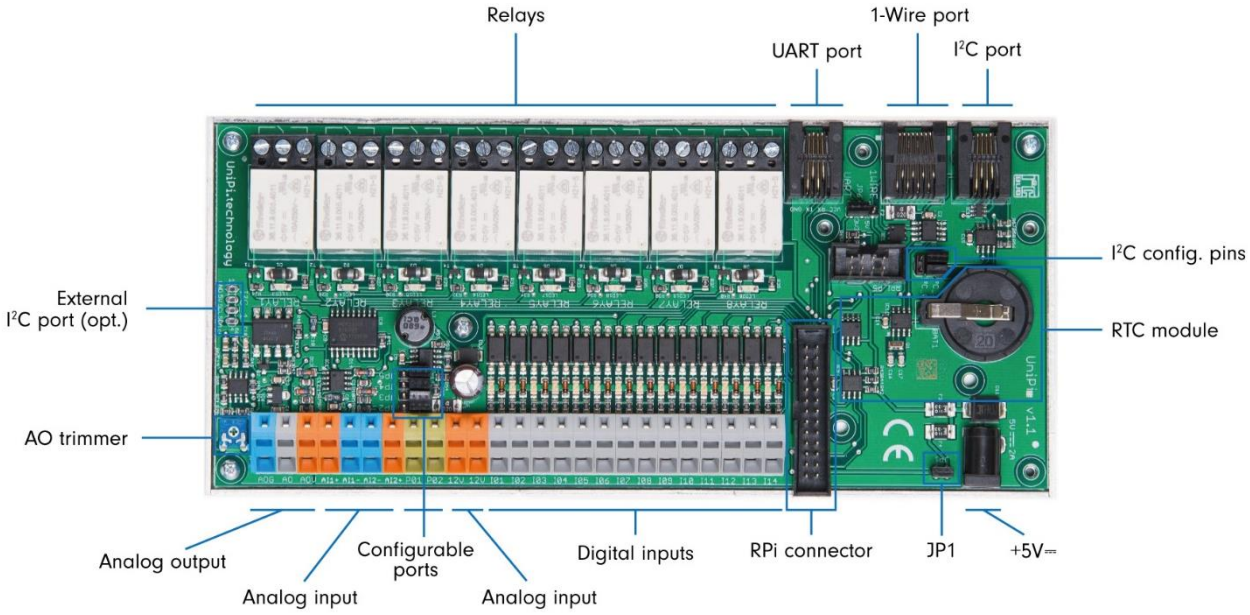
- **Raspberry Pi Model B+**
- **Raspberry Pi 2 Model B**
- **Raspberry Pi 3 Model B**
- **Raspberry Pi 3 Model B+**
- *** Raspberry Pi 4 Model B**

*** Note**: Raspberry Pi 4, unlike previous versions, requires a 5 V/3 A power supply. Unipi 1.1 is primarily designed for Raspberry Pi 2 and 3, which have lower power consumption. The Raspberry Pi 4 can still be operated with the board, but the USB output is limited to 400 mA total and the instructions in **chapter 2.2** must be followed. However, after disconnecting jumper JP1, it is possible to connect a separate power supply for Unipi 1.1 and for Raspberry Pi 4 to achieve full performance.

2 Description

Major building blocks of Unipi:

- **Relays**: 8 relays to control switching elements
- **UART port:** Standard serial port to connect serial console or many other devices (NFC readers, ..)
- **1Wire port**: Provides 1Wire bus interface to connect 1Wire devices such as temperature and humidity sensors
- **I2C port**: For connecting other extension modules for example relay or analog output modules
- **I2C configuration pins**: To connect the I2C_0 bus from the RPi (only for advanced users)
- **RTC (Real Time Clock) module**: Provides real-time in case of internet or power outage (backup battery not included in the package).
- **Power 5V**: 2.1 mm connector for power supply
- **RPI connector**: 26-pin connector for Raspberry Pi
- **Digital inputs**: 12(+2) galvanically isolated digital inputs for reading signals from external devices
- **12V out** Power supply 12 V DC / 200 mA - only for use with digital inputs of the Unipi
- **Configurable ports**: To configure digital inputs for use with an external power source
- **Analog in**: Two 0-10 V analog inputs for reading analog signals from external devices
- **Analog out**: One 0-10 V analog output for proportional controlling
- **AO trimmer**: For precise adjustment of the analog output



2.1 GPIO port map

2.1.1 Unipi 1 P1 header map

Unipi function	RPi BCM	Function	Description
AO	GPIO18	PWM	Analog Output 0-10V
I01	GPIO04	Digital Input	Digital Input 1
I02	GPIO17	Digital Input	Digital Input 2
I03	GPIO27	Digital Input	Digital Input 3
I04	GPIO23	Digital Input	Digital Input 4
I05	GPIO22	Digital Input	Digital Input 5
I06	GPIO24	Digital Input	Digital Input 6
I07	GPIO11	Digital Input	Digital Input 7
I08	GPIO07	Digital Input	Digital Input 8
I09	GPIO08	Digital Input	Digital Input 9
I10	GPIO09	Digital Input	Digital Input 10
I11	GPIO25	Digital Input	Digital Input 11
I12	GPIO10	Digital Input	Digital Input 12
I2C1_SCL	GPIO02	I2C1_SCL	Internal I²C_1, RJ11 connector
I2C1_SDA	GPIO03	I2C1_SDA	
UART RX	GPIO15	UART0_RXD	UART RJ11 connector
UART TX	GPIO14	UART0_TXD	

2.1.2 Unipi 1 P5 header map

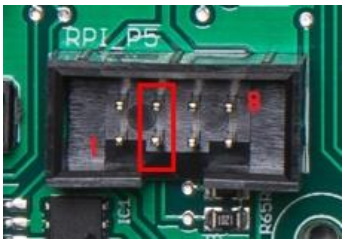
Unipi function	Unipi P5 header	RPi BCM	RPi (2+) header	Description
GND	1,2	–	–	–
I13	3	GPIO5	29	Digital Input 13
I14	4	GPIO6	31	Digital Input 14
I2C0_SDA	5	GPIO28	27	External I²C_0
I2C0_SCL	6	GPIO29	28	
3,3 V	7	–	–	–
5 V	8	–	–	–

You can also use any unused GPIO for connecting the pins.

2.1.2.1 Using I13 and I14

The default cable used to interconnect the Unipi 1.1 board and the Raspberry Pi computer does not support digital inputs 13 and 14. Meaning a separate connection is necessary for their use.

The picture on the right, shows the P5 header on the Unipi board. Pins for IN13 and IN14 inputs are highlighted by a red rectangle.



Note:
GND pins are not required. The 3V3 pin is required only if the second I2C bus pins are used.

2.1.3 MCP23008 pin map

Relay	MCP23008
8	GP0
7	GP1
6	GP2
5	GP3
4	GP4
3	GP5
2	GP6
1	GP7

2.2 Power Requirements

The main Unipi power connector is standard 2.1 mm inner diameter, 5.5 mm outer diameter with +5 V DC connected on the center.

There are two options of powering the Unipi board and Raspberry Pi:

- **A single power source** (RPi and Unipi are powered from the same power source)
  - Jumper JP1 mounted
  - 5 V DC, 2.4 A through the Unipi power connector (750 mA for Unipi + RPi requirements)
  - Please note that Unipi board can only provide 1.5 A to the RPi
  - Raspberry Pi (USB) power connector is not used
  - For **Raspberry Pi 4** it is advisable to increase the (no-load) voltage of the power supply to 5.3 - 5.4 V DC
- **A dual power source** (separate power source for each Unipi and Raspberry Pi)
  - Jumper JP1 dismounted
  - 5 V DC 750 mA through the Unipi power connector
  - Raspberry Pi is powered from the (USB) power connector according to the RPi requirements

Danger:
Powering the Unipi from the Raspberry Pi is not recommended and could damage the Raspberry Pi.

When using the Raspberry Pi in heavy load and multiple peripherals connected, we recommend the dual power source solution.

2.3 Connecting Raspberry Pi to Unipi

Before the first use, plug in a CR2032 battery to the battery holder.

Connecting Unipi to Raspberry Pi is straight forward:

1. Make sure you have properly configured the power jumper – see chapter 2.2)
2. Screw the spacers to the mounting holes of the Unipi
3. Connect the provided flat cable to the RPi connector
4. Screw the Raspberry Pi to the Unipi
5. Connect the other end of the flat cable to the RPi (make sure it is not twisted)
6. Plug the power supply in.

3 Building blogs

3.1 Relays

The relay outputs are located on the terminals marked with the schematic mark of the switch, they are used to switch two-state devices and can switch AC or DC voltage. The COM terminal is typically common, the voltage is then at the NO or NC terminal, depending on the relay state.

- NO - in the default state (no voltage), contacts are open
- NC - in the default state (no voltage), contacts are closed

The state (On/Off) of each relay is indicated by a LED with a corresponding label. Overload and overvoltage protection should be provided externally by a circuit breaker (ideally one for each output). Nominal current and circuit breaker type should be selected according to the load and its characteristics concerning the maximum current on the output.

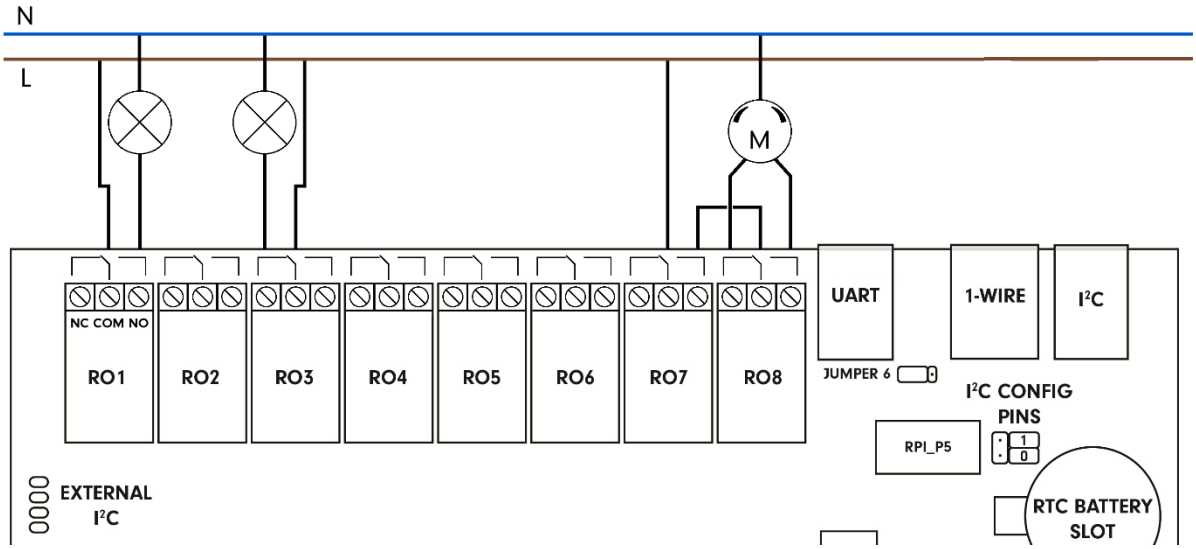
Caution:
If an inductive load is connected (e.g., electric motors, relay coils, contactors, or even the cables in extensive electric installations), it is necessary to protect the relay outputs with a corresponding external element (e.g., varistor, RC circuit, or a suitable diode).

If a capacitive load is connected (e.g., power sources of LED lights), it is necessary to protect the relay contacts against inrush current by connecting a corresponding thermistor to the relay's output.

Relays are controlled by the MCP23008 (address 0x20), see the map of MCP's GPIO to relays in chapter 2.1.3. Each relay has a LED indicating its state.

3.1.1 Connection

The following image depicts the connection of ohmic (resistance)load with alternating voltage and connection of a three-way valve to Unipi 1.1 relay outputs:



3.2 Digital Inputs

These inputs can be triggered by 7–24 V DC voltage with a minimum pulse length of debounce time. For the easy visual reading of their states, all inputs are equipped with LED.

When using the GPIOs make sure to set a software pull-up resistor on each GPIO to make it work properly otherwise state of the GPIO cannot be read properly.

3.2.1 5–12 V Step-up (internal 12 V power supply)

All digital inputs are primarily set to be driven by the internal 12 V power supply. The 12 V line is wired out via the orange connector marked as 12 V. Do not exceed 100 mA current draw.

Can be used only for DI, AI, and AO.

3.2.2 Jumper settings

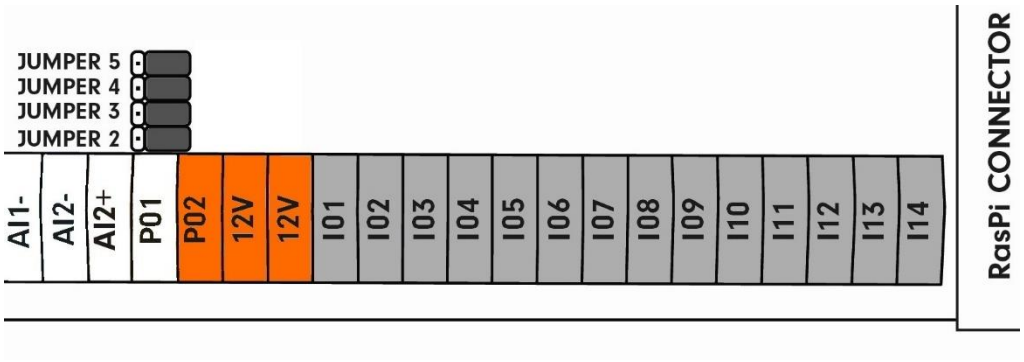
An external power supply can be used to power digital inputs using a correct configuration of jumpers JP2 - JP5. Using an external power supply also includes galvanic isolation of digital inputs. The Unipi 1.1 must be unplugged from power during jumper configuration. After finishing the adjustments and connecting the external power source's negative pole (see below), you can plug back the board's power.

Jumper configuration when using external power source:

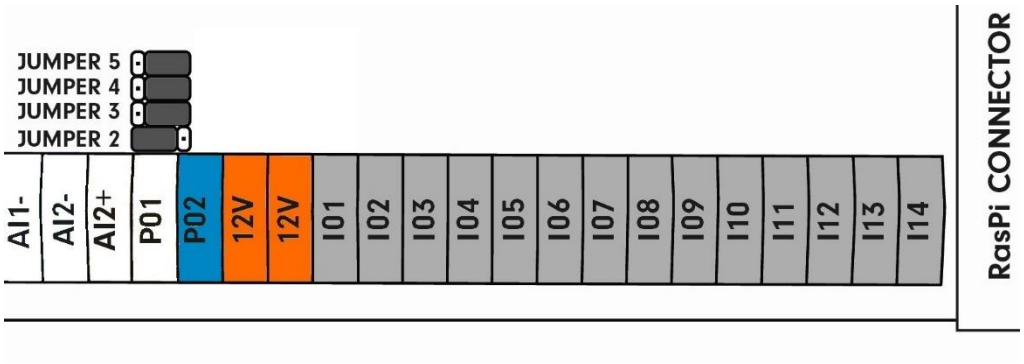
- JP2
  - Switching this jumper to the side of the JP2 label causes the P02 (green connector) to act as an input for ground from the external power source. Otherwise, P02 is connected to the internal 12V.
  - This step must be done as first when changing jumper settings.
  - Please note that after this step, the GND of Unipi is connected to P02! Make sure to proceed with JP3 settings after this step.
- JP3
  - When switched to the side of the JP3 label, inputs I01 and I02 act as inputs for the signal from the connected peripheral device via the external power source.
  - The ground of power supply for these inputs must be connected to the P02.
  - Please note that to set I01 and I02 for ext. power source, make sure to switch JP2 first and then JP3, after that you can safely connect the peripheral device.
- JP4
  - When switched to the side of the JP4 label, inputs I03 and I04 act as inputs for the signal from the connected peripherals via the external power source.
  - The ground of power supply for these inputs must be connected to P01.
- JP5
  - When switched to the side of the JP5 label, inputs I05 - I14 act as inputs for the signal from the connected peripherals via the external power source.
  - The ground of power supply for these inputs must be connected to P01.
  - Please note that I13 and I14 are wired out via the P5 header of Raspberry Pi (models before the PLUS versions).

Danger:
Only the combinations described below are supported. Any other configuration may cause damage to the device or connected peripherals.

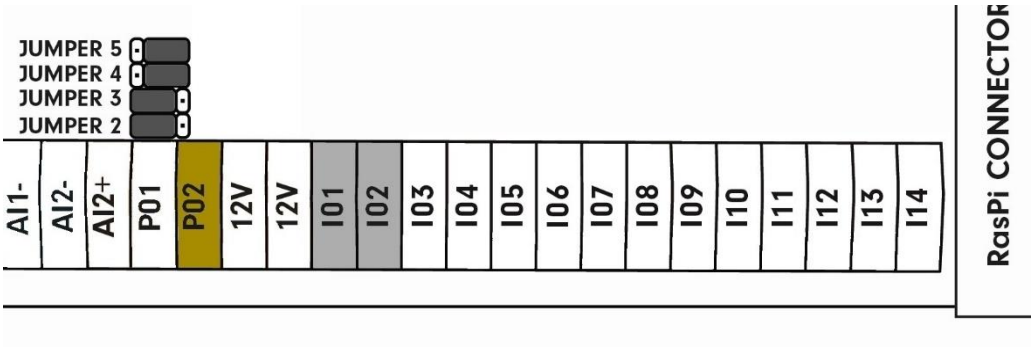
This picture shows the default jumper settings. Digital inputs are connected to the internal 12 V DC power supply. The P02 terminal now provides 12 V DC voltage.



The **JP2** jumper is moved away from the Raspberry Pi with digital inputs still connected to the 12 V DC internal power supply. The P02 terminal now acts as GND for the entire board:

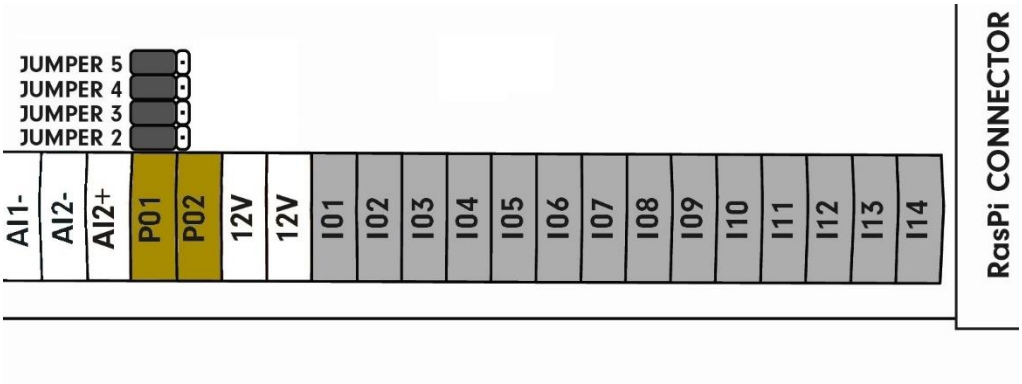


Jumpers **JP2** and **JP3** are moved, digital inputs I01 and I02 are ready for connection of an external power supply. Terminals I03 to I14 are connected to the internal 12 V DC power supply. The P02 terminal can be now used to connect the external power supply's negative pole for inputs I01 and I02:



Jumpers **JP2**, **JP3** and **JP4** are moved, digital inputs I01 to I04 are ready for connection of an external power source. Terminals I05 to I14 are connected to the internal 12 V DC power supply. The P02 terminal serves for connection of the external power supply's negative pole for I01 and I02. The I01 terminal can be now used to connect the negative pole of an external power supply for I03 and I04. Terminals P01 and P02 and their corresponding inputs are mutually isolated:

Jumpers **JP2**, **JP3**, **JP4** and **JP5** are moved, all digital terminals are ready for connection of an external power supply. The P02 terminal serves for connection of the external power supply's negative pole for I01 and I02. The P01 terminal now serves for connecting the external power supply's negative pole for outputs I03 to I14. Terminals P01 and P02 and their corresponding inputs are mutually isolated:



3.3 Analog Inputs

Unipi features two analog 0–10 V input channels (via the MCP3422, address 0x68) marked as AI1 and AI2. Each channel has its own + and – (e.g., AI1+ and AI1-). The + connector expects positive voltage from the connected device and – expects the negative pole (the GND). The guaranteed accuracy is 5% however 1% is commonly reachable.

To correctly calculate the input voltage, a coefficient of the resistor divider must be considered. The coefficient of each channel is saved in EEPROM as single-precision binary floating-point format binary32 (IEEE 754). Before version 1.1 the coefficient is not saved in the EEPROM and thus must be calculated during conversion in software (Typically the value is around 5.56). See chapter 4.2 (EEPROM) for more details.

3.4 Analog Output

Analog output is driven by the GPIO 18 PWM signal and is designed to run at 400 Hz. The GPIO port is galvanically isolated from the rest of the output. The maximum current driven from this output is 20 mA. This output is meant to control 3rd party devices that can adjust its power according to the 0–10 V. The precision of AO in Unipi v1.0 is ±5 % but also depends on the Raspberry Pi CPU usage.

External voltage must be connected to the AOV connector with a maximum voltage of 35 V DC.

Make sure to adjust output voltage using the blue trimmer (labelled as R49) before connecting devices to avoid causing damage.

Note:
AO is regulated using a 400 Hz PWM signal.

On the current Unipi 1.1 version, the 0 % PWM duty cycle is written onto output as 0 V DC. 100 % PWM duty cycle is interpreted as 10 V DC on the output. **That means 0–100 % duty cycle linearly corresponds to 0–10 V DC voltage on the analog output.**

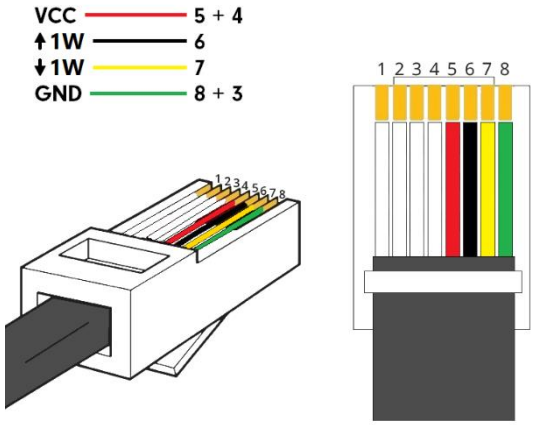
Older variants interpreted 0 % PWM duty cycle as AO equals 10 V DC, and 100 % PWM duty cycle as AO equals 0 V DC.

3.5 1-Wire sensors

Unipi features single-channel 1-Wire master controller (DS2482-100, address 0x18). The 1-Wire bus is wired out via the RJ45 connector (see table below for detailed description). The data line is ESD protected and the 5 V power current is limited to 200 mA.

3.5.1 1-Wire RJ45 connector

1-Wire RJ45 pin	Function
1	-
2	-
3	-
4	-
5	5V
6	-
7	DATA
8	GND

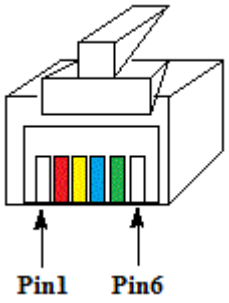


3.6 UART

The UART interface of Raspberry Pi is wired out via the RJ11 connector labelled UART. See table below UART RJ11 connector. This port does not have any protection, so make sure to be careful when connecting devices. Operating voltage of this port is 3V3.

3.6.1 UART RJ11 connector

RJ11 pin	Function
1	-
2	5V
3	RX
4	TX
5	GND
6	-



3.7 I²C ports

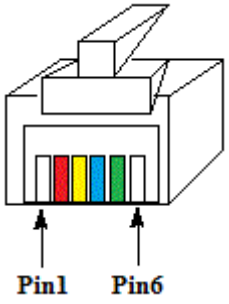
Raspberry Pi has two I²C interfaces. The I²C _1 of the RPi is connected via the main P1 connector and does not need any special modification. All the onboard ICs are connected to this bus. The second I²C bus, I²C_0, is wired out via the P5 connector which needs to be soldered from the bottom of the Raspberry Pi. Please check our online tutorial for further information.

The I²C _1 is by default wired out via the onboard RJ11 connector labelled I²C and features ESD protection. Unipi also features optional I2C port (labelled I²C_1) on the edge of the board but does not have any connector by default.

Please note that the I²C_0 has been reserved for special purpose starting with RPi models + and thus is no longer recommended to use.[1]

3.7.1 I²C RJ11 connector

RJ11 pin	Function
1	-
2	5V
3	I2C data (SDA)
4	I2C clock (SCL)
5	GND
6	-



4 Technical parameters

4.1 Onboard I²C ICs

All onboard I²C chips are connected to the main bus.

4.1.1 I²C chip addresses

Chip type	Address	Usage
MCP23008	0x20	Relays
DS2482-100	0x18	1-Wire master
MCP79410	0x6F, 0x57	RTC (Real Time Clock)
MCP3422	0x68	ADC
24AA00/24C02	0x50-0x57	EEPROM

4.2 EEPROM

Unipi features onboard EEPROM (24C02) for storing important information with 2k bit memory organized into a single block of 256 × 8-bit. We reserve address space 0xe0 – 0xff the rest is left for userspace. The rest of unused reserved bytes are nulled.

4.2.1 Memory organization

Starting address	Number of bytes	Example	Description
0xe0	2	fa-55	Unipi identification
0xe2	2	1.1	Unipi version
0xf0	4	0x40b089c5 (5.516818)	AI1 coefficient
0xf4	4	0x40b08b44 (5.517)	AI2 coefficient

4.3 Relays

Output type	Electromechanic non-shielded relay
Designation on the board	RELAYx (where **x** represents the relay number
Number of terminals per relay	3
Terminal designation	Schematic (on the board)
Common terminal (COM)	Middle terminal
Closed without voltage (NC)	Terminal engaged according to scheme
Open without voltage (NO)	Terminal disengaged according to scheme
Contact/Output type	Switchable NO/NC (SPDT)
Number and type of relays	8 × Finder 36.11.9.005.4011
Switching voltage	250 V AC 30 V DC
Max. current (resistive load)	10 A
Mechanical life (cycles)	10 000 000
Electrical lifespan	Up to 50 000 (according to the connected load)
Switching time	10 ms / 5 ms
Designed for load character	Resistive
Possible external snubber	RC, varistor, diode, thermistor
Short circuit protection	No
Overvoltage protection	No
Galvanic isolation	Yes
Insulation voltage	4 000 V

4.4 Digital Inputs

Input type	SINK
Input terminal	Ixx (**xx** represents the terminal's number)
Number of inputs	14*
Maximum voltage for log. 0	3 V DC
Minimum voltage for log. 1	7 V DC
Maximum voltage	24 V DC
Configurable terminals	P01, P02
Internal 12 V DC power supply positive pole	12 V
Galvanic isolation	Yes (if external power supply is used)

*see chapter 2.1.2

4.5 Analog Output

Output terminals	AO
Terminal for connecting the external power supply negative pole	AOG
Terminal for connecting the external power supply positive pole	AOV
Number of outputs	1
Output function	0–10 V DC voltage source
Maximum input voltage (AOV)	35 V DC
Maximum current on the AO terminal	20 mA
Measuring accuracy	±0.5 %
Galvanic isolation	Yes

4.6 Analog inputs

Input terminals	AI1+, AI2
Reference ground (GND)	AI1-, AI2-
Number of inputs	1
Input functions	0–10 V voltage measuring (can be used to resistance measurements if set as a voltage)
Maximum input voltage	12 V DC
Measuring accuracy	±0.5 %
Resolution	32 bits
Galvanic isolation	No

4.7 Power Requirements

Main power connector	Standard 2.1 mm inner diameter, 5.5 mm outer diameter
Single power supply mode (JP1 connected)	5 V DC, 2.4 A **Note:** for Raspberry Pi 4, see chapter 2.2
Dual power supply mode (JP1 disconnected)	5 V DC, 750 mA for Unipi board 5 V DC (value according to the RPi manual)

4.8 Dimensions

Width	198 mm
Height	86 mm
Depth	16 mm (without the RPi, cable, and spacers)
Weight	0.21 kg

Revision

Date	Version
2/2021	V 1.0
2/2023	V 1.1
8/2024	V 1.2

More information at Unipi technology and Knowledge base.

Compliance information
Unipi 1.1 complies with the requirements of EMC, LVD, and RoHS regulations relevant for European Union states.

WEEE Directive Statement for the European Union
Unipi 1.1 cannot be disposed of as household waste. Different rules for handling electric waste may apply in other jurisdictions.