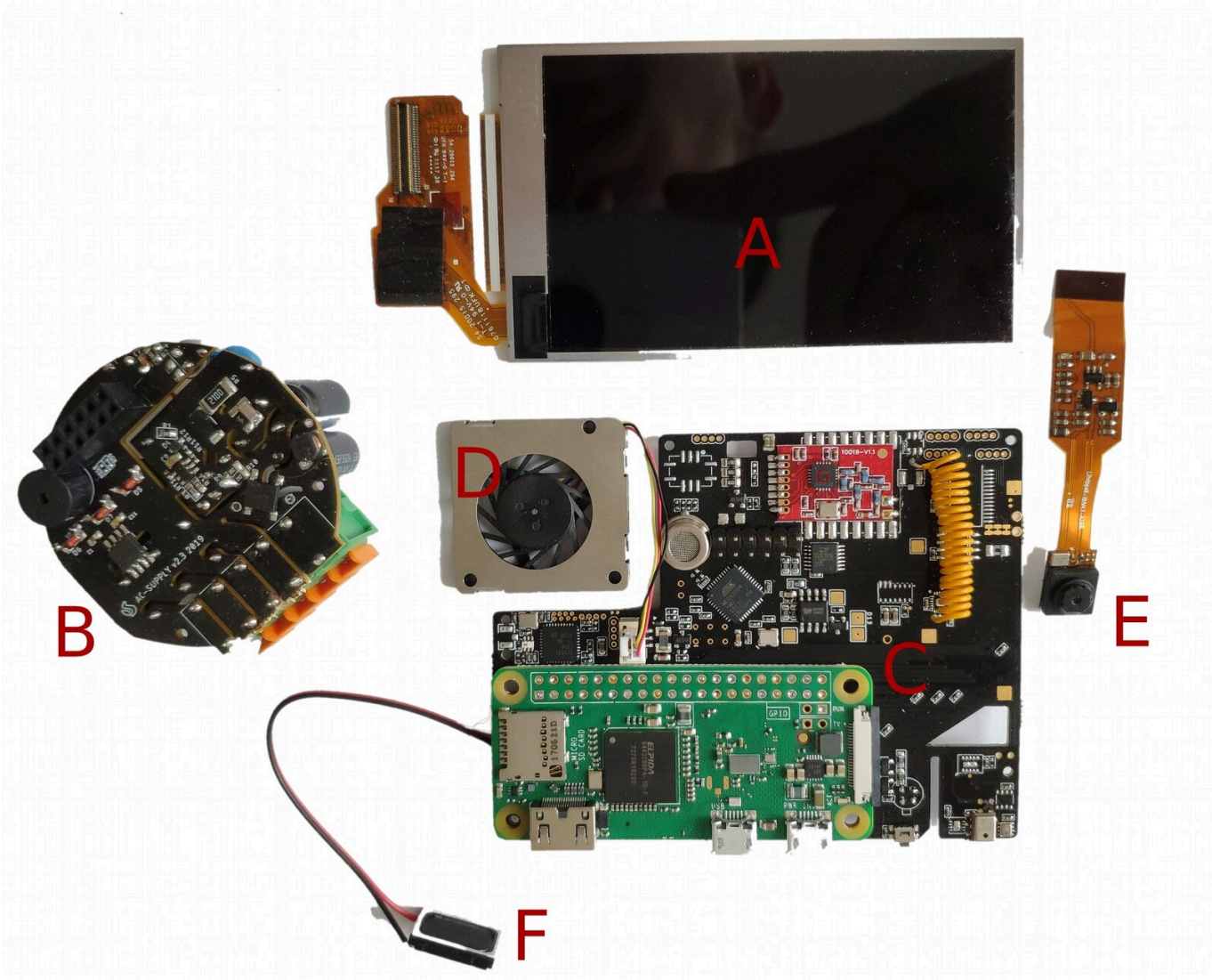
Hardware Documentation

SHPI.zero with AC supply · based on Raspberry Pi Zero W / Zero 2 W

Overview of the internals



A – AUO A035VW01 display, 3.5″, 800 × 480

B – AC power supply 100–240 V AC, 50/60 Hz, with three relays

C – Main board with soldered Raspberry Pi Zero W / Zero 2 W

D – PWM controlled micro blower

E – Camera for the Pi Zero (optional)

F – Speaker (optional)

G – TI CC1101 radio module with antenna (DIY, optional)

> Schematics, bill of materials, pinouts, firmware and the system image are available at **www.shpi.de**. Optional parts are not populated and not covered by the certification of the device.

GPIO Documentation

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Raspberry Pi – 40 contacts

Supply 3.3 V	3.3 V	1	2	5 V	Supply 5 V
Display VSYNC	GPIO 2	3	4	5 V	Supply 5 V
Display HSYNC	GPIO 3	5	6	GND	Ground
Display blue, bit 2	GPIO 4	7	8	GPIO 14	Display green, bit 4
Ground	GND	9	10	GPIO 15	Display green, bit 5
Display green, bit 7	GPIO 17	11	12	GPIO 18	PIR motion sensor
CC2531 debug data (P2.1)	GPIO 27	13	14	GND	Ground
Display red, bit 4	GPIO 22	15	16	GPIO 23	Display red, bit 5
Supply 3.3 V	3.3 V	17	18	GPIO 24	Display red, bit 6
CC2531 debug clock (P2.2)	GPIO 10	19	20	GND	Ground
Display blue, bit 7	GPIO 9	21	22	GPIO 25	Display red, bit 7
Reset ATmega32U4, CC2531, display	GPIO 11	23	24	GPIO 8	Display blue, bit 6
Ground	GND	25	26	GPIO 7	Display blue, bit 5
Display pixel clock	GPIO 0	27	28	GPIO 1	Display DE
Display blue, bit 3	GPIO 5	29	30	GND	Ground
Display blue, bit 4	GPIO 6	31	32	GPIO 12	Display green, bit 2
Display green, bit 3	GPIO 13	33	34	GND	Ground
not connected	GPIO 19	35	36	GPIO 16	Display green, bit 6
Touch interrupt	GPIO 26	37	38	GPIO 20	Display red, bit 2
Ground	GND	39	40	GPIO 21	Display red, bit 3

display red · display green · display blue · display clock / sync · output (relay, LED, blower …) · input (sensor, touch) · reset / programming · 5 V · 3.3 V · ground · not connected

I²C addresses (bus 2, pads PP37/PP38)

0x23	ROHM BH1750 – ambient light
0x2A	ATmega32U4 – relays, blower, LED, analog values
0x38	Asair AHT10 – temperature, humidity
0x5B	Melexis MLX90615 – infrared temperature
0x5C	Touch controller
0x77	Bosch BMP280 – barometric pressure

Options, not populated: 0x20 MCP23017 · 0x40 SHT2x · 0x44 SHT3x · 0x45 INA219 · 0x48 ADS1015 · 0x5A CCS811 · 0x60 MCP4725 · 0x68 DS1307 / MPU-9250 · 0x69 AMG8833 · 0x76 BME680

ATmega32U4

Port	Arduino	Function
PF0	A5	Supply connector: free for NTC 10 kΩ / OneWire with the AC supply, input voltage with the DC supply
PF1	A4	Air quality sensor MP503
PF4–PF6	A3–A1	Option: gas sensor MICS6814 (NH_3, NO_2, CO)
PF7	A0	GDO0 radio module (option)
PD2 / PD3	D0 / D1	RX / TX, RS-485 transceiver
PD1 / PD0	D2 / D3	I²C SDA / SCL (5 V side), slave address 0x2A
PD4	D4	Display chip select, backlight control
PC6	D5	Relay 1 → terminal R3 (with current measurement)
PD7	D6 / A7	Current sensor of terminal R3: ACS720 (AC supply), ACS712 (DC supply)
PE6	D7	GDO2 / INT radio module (option)
PB4	D8	Relay 2 → terminal R2
PB5	D9	Buzzer
PB6	D10	Relay 3 → terminal R1
PB7	D11	Blower PWM
PD6	D12	CSN radio module (option)
PC7	D13	Reset of the Raspberry Pi (solder jumper, watchdog)
PD5	TXLED	RGB LED SK6812
PB0	RXLED	Blower speed signal
PB1–PB3	SCK, MOSI, MISO	SPI: display initialisation, ISP; radio module (MISO max. 3.3 V)
PE2	HWB	Heater of the air quality sensor on/off

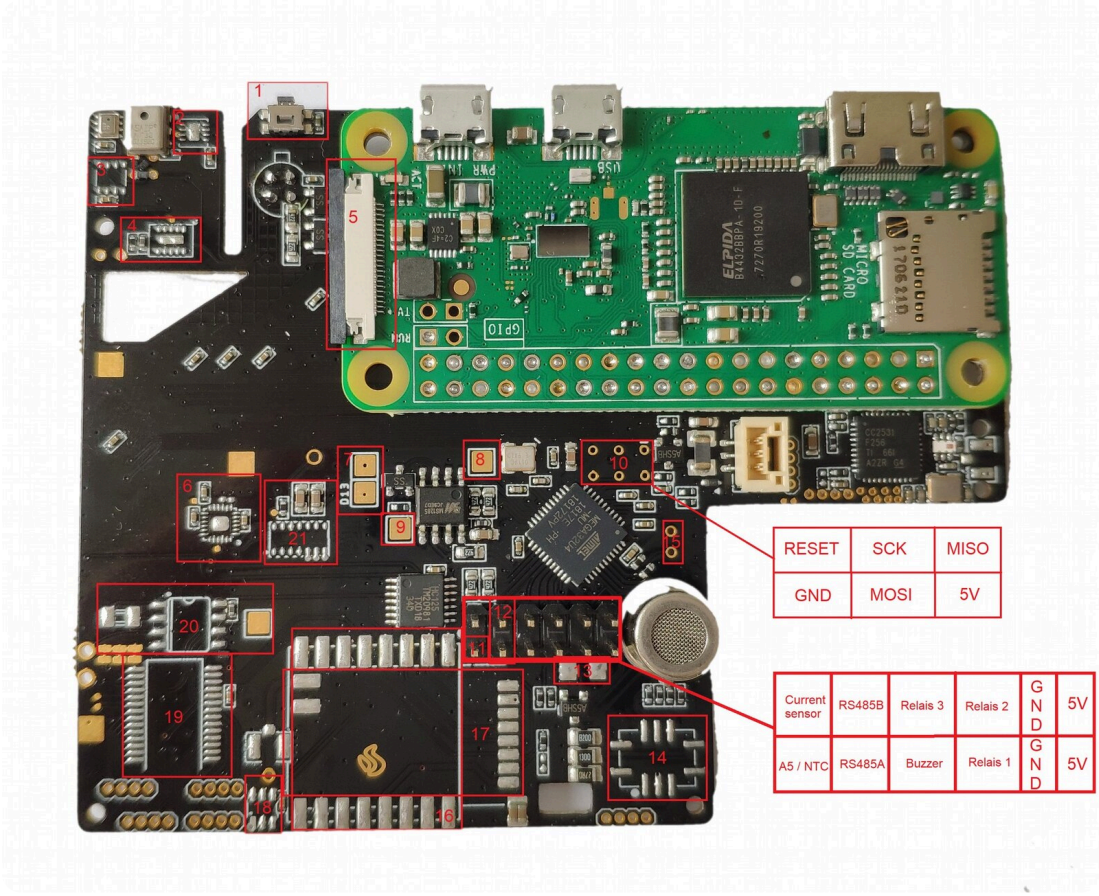
Violet: output · teal: input / measurement · blue: bus · brown: reset · grey: option, not populated

Relay outputs

Relays HF46F-G: 7 A / 250 V AC resistive each, all three fed through terminal L: 10 A in total. Outputs are connected to L, not floating and not fused.

Mainboard Top

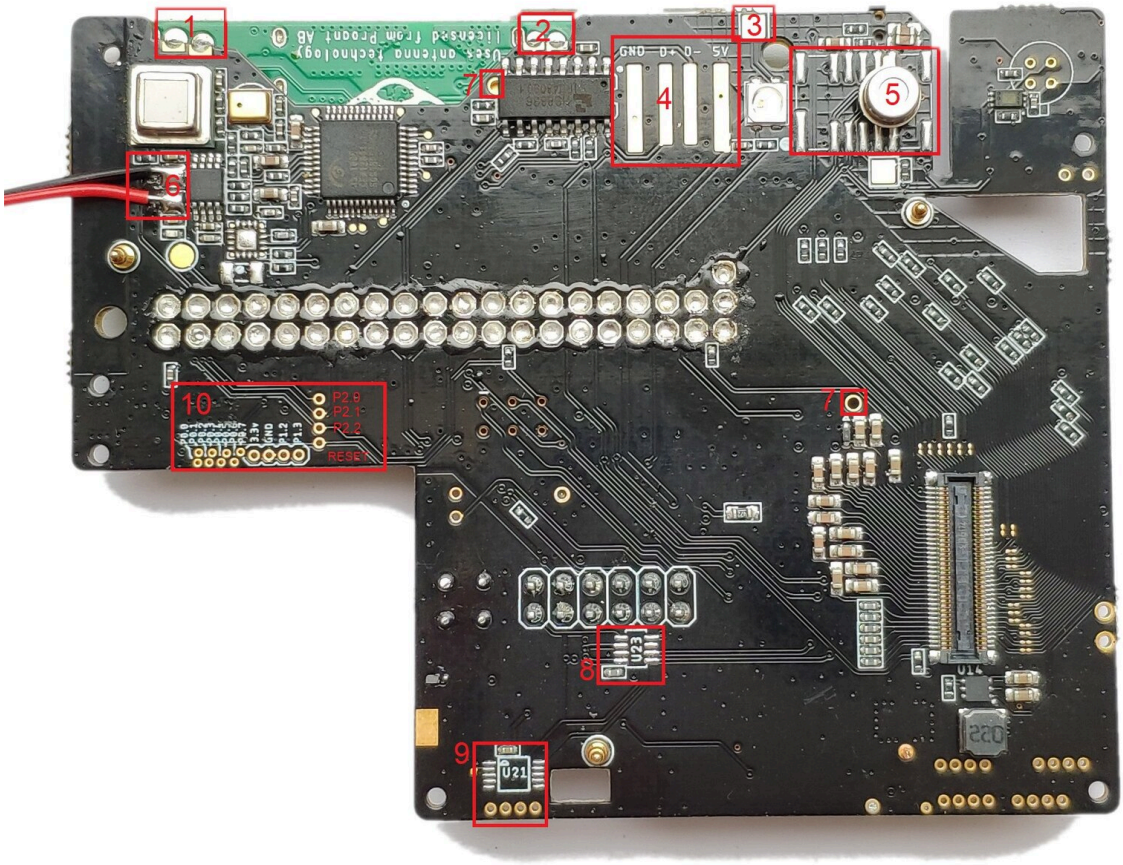
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1. Reset for the Raspberry Pi
2. Footprint for Sensirion SHT2x
3. Footprint for Bosch BME680
4. Footprint for ams CCS811
5. Connector for the Pi Zero camera
6. Footprint for InvenSense MPU-9250 / ICM-20948
7. Solder jumper between ATmega32U4 PC7 (D13) and the Raspberry Pi reset, enables a hardware watchdog for the Linux system
8. RX of the ATmega32U4 (TTL level), connected to the RS-485 transceiver
9. TX of the ATmega32U4 (TTL level), connected to the RS-485 transceiver
10. ISP connector for the ATmega32U4. Mind the DFU bootloader and USB boot. With a CC1101 module MISO is only 3.3 V tolerant.
11. A5 input of the ATmega32U4 on the power supply connector, for an external NTC 10 kΩ or OneWire temperature sensors
12. RS-485 connections
13. Shunt position for INA219 (U23, bottom). Recommended 50–100 mΩ; cut the trace below the resistor first.
14. Footprint for MICS6814
15. Solder points for NTC 10 kΩ (also connected to A5)
16. Footprint for HopeRF RFM69HCW
17. Footprint for CC1101 module
18. Footprint for MCP4725 (SOT-23-6)
19. Footprint for MCP23017 port expander (SSOP-28)
20. Footprint for RTC DS1307 and 32 kHz crystal
21. Footprint for MAX30105

Mainboard Bottom

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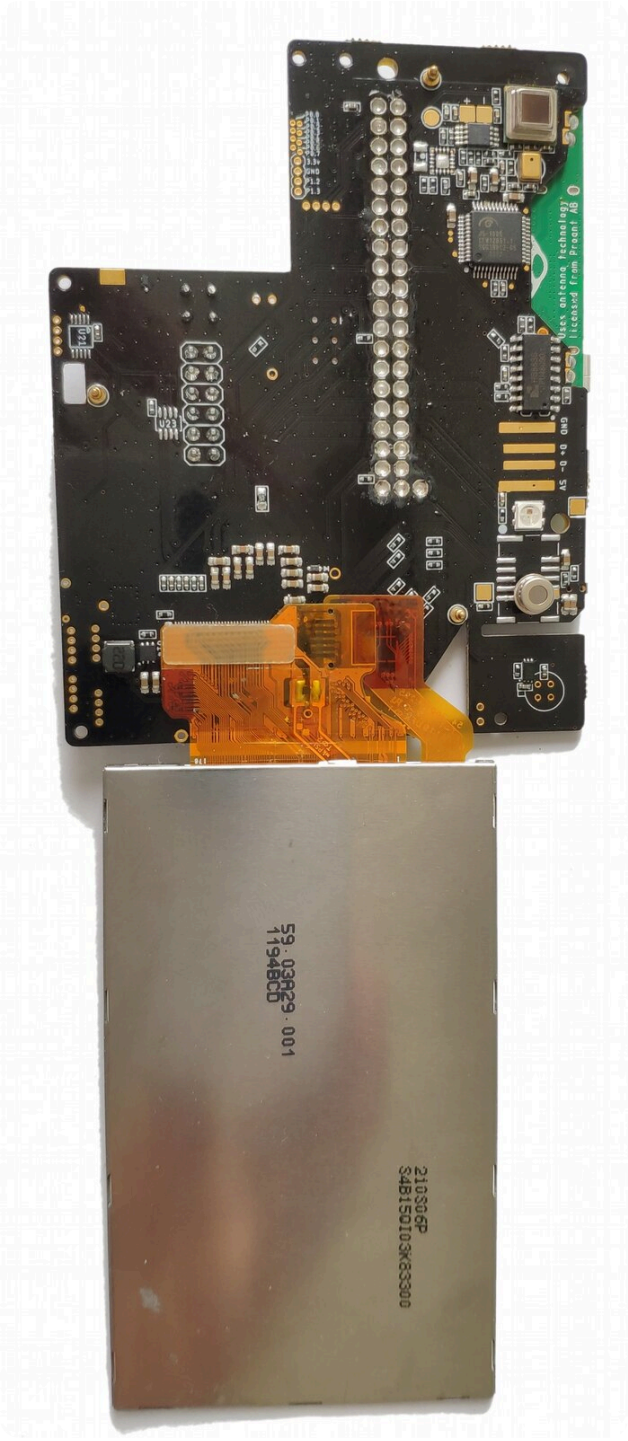


1. I²C connection to the Raspberry Pi (HDMI DDC pads PP37/PP38, bus 2)
2. USB connection to the Raspberry Pi (pads PP22/PP23)
3. LED output for further WS2812B / SK6812 LEDs
4. USB footprint for chip-on-board memory sticks
5. Footprint for Panasonic AMG8833; needs removal of the MLX90615
6. Speaker connection
7. 1.8 V connection for MAX30105; connect both vias with a thin wire
8. Footprint for TI INA219 (SOT-23-6)
9. Footprint for ADS1015 (MSOP-10)
10. TI CC2531 Zigbee SoC. P2.1 and P2.2 (debug data / clock) are connected to GPIO 27 and GPIO 10 of the Raspberry Pi; the flash tool and firmware are part of the system image and the driver sources at www.shpi.de.

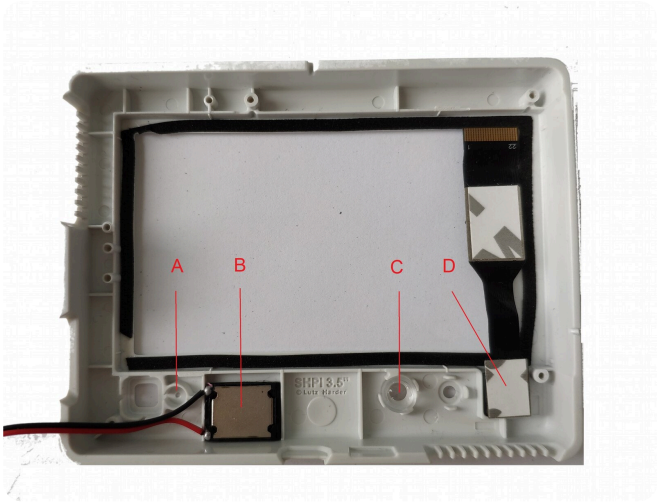
Display mounting and front housing

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Display mounting



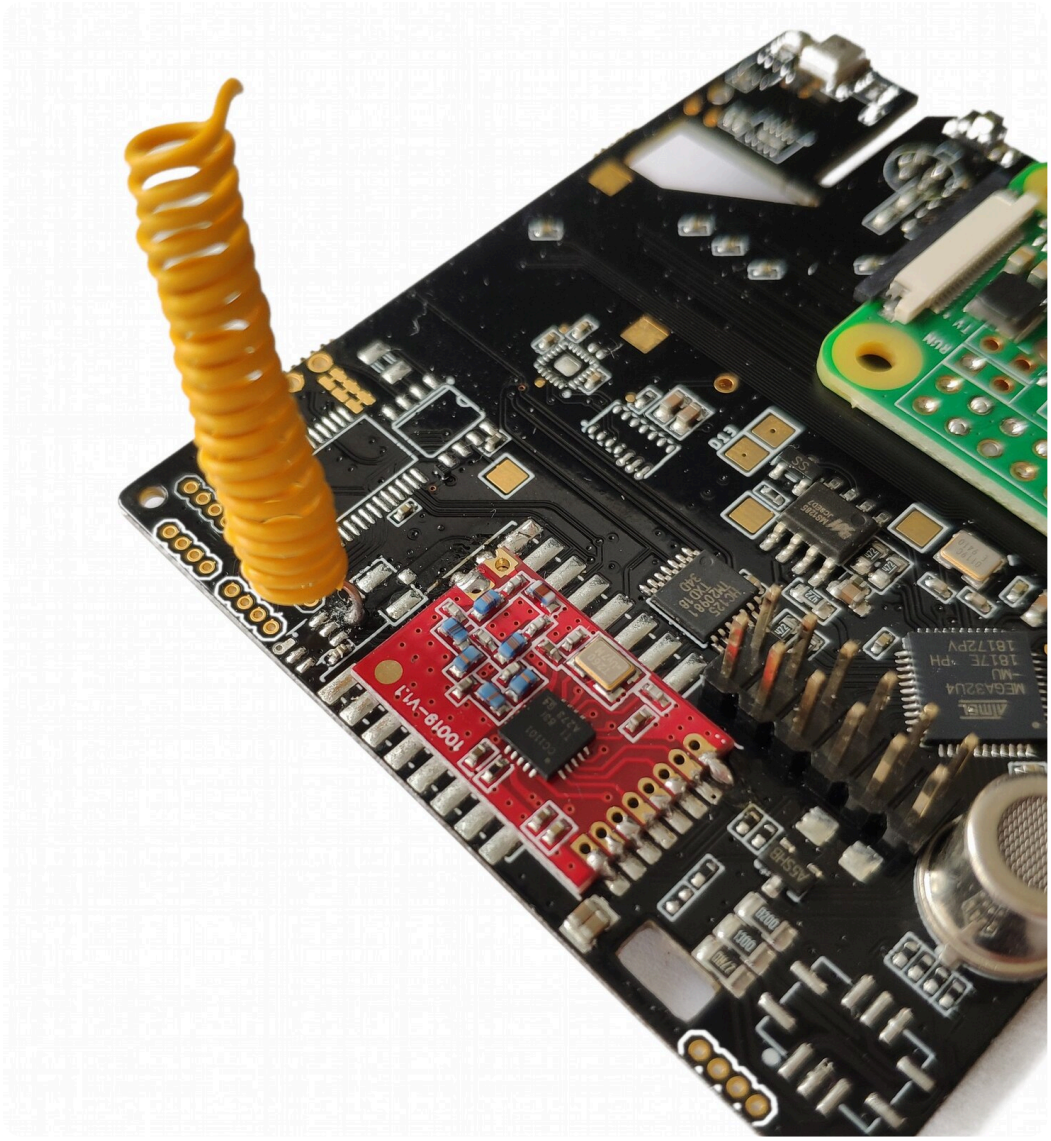
Front housing



A – Microphone opening. Use a 1 mm drill to open it.
B – Position of the speaker
C – LED lens
D – Orientation of the camera mount

CC1101 radio module mounting

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Notes

- Suitable modules: Ebyte E07-868MS10, E07-M1101S (CC1101) or HopeRF RFM69HCW. A wire antenna is sufficient.
- The module is driven by the ATmega32U4 over SPI (CSN on D12, GDO0 on A0, GDO2 on D7). MISO is only 3.3 V tolerant.
- A CUL-compatible firmware (culfw) for the ATmega32U4 allows using the SHPI.zero without an external CUL stick.
- The device is not certified with any radio module. Retrofitting is at your own risk; the user is responsible for compliance with all legal requirements.