LAMPIRAN A

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN
POLITEKNIK NEGERI SRIWIJAYA
Jalan Srijaya Negara, Palembang 30139
Telp. 0711-353414 fax. 0711-355918
Website : www.polisriwijaya.ac.id E-mail : info@polsri.ac.id

REKOMENDASI SEMINAR PROPOSAL LAPORAN AKHIR (LA)

Pembimbing Laporan Akhir memberikan rekomendasi kepada,

Nama	:	Dastin Morenza
NIM	:	062030321036
Jurusan/Program Studi	:	Teknik Elektro/D3 Teknik Elektronika
Judul Laporan Akhir	:	Rancang Bangun Sistem Kendali PH dan Suhu Air Pada Kolam Pembibitan Ikan Lele Jenis Sangkuriang Menggunakan Mikrokontroler NodeMCU ESP32 Berbasis Internet Of Things (IoT)

Mahasiswa tersebut telah memenuhi persyaratan dan dapat mengikuti Ujian Laporan Akhir (LA) pada Tahun Akademik 2023

Palembang, 4/8/2023

Pembimbing I,	Pembimbing II,
(Ir. Faisal Damsi., M.T.)	**(Yurni Oktarina.,ST.,M.T)**
NIP 196302181994031001	NIP 197710162008122001

KEMENTERIAN RISET,TEKNOLOGI DAN PENDIDIKAN TINGGI
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KESEPAKATAN BIMBINGAN LAPORAN AKHIR (LA)

Kami yang bertanda tangan di bawah ini,

Pihak Pertama

Nama	: Dastin Morenza
NIM	: 062030321036
Jurusan	: Teknik Elektro
Program Studi	: DIII Teknik Elektronika

Pihak Kedua

Nama	: Ir. Faisal Damsi.,M.T.
NIP	: 196302181994031001
Jurusan	: Teknik Elektro
Program Studi	: DIII Teknik Elektronika

Pada hari ini ..... Senin ..... tanggal ..... 20 - maret - 2023 ..... telah sepakat untuk melakukan konsultasi bimbingan Laporan Akhir.

Konsultasi bimbingan sekurang-kurangnya 1 (satu) kali dalam satu minggu. Pelaksanaan bimbingan pada setiap hari ..... Senin ..... pukul ..... 13.00 ....., tempat di Politeknik Negeri Sriwijaya.

Demikianlah kesepakatan ini dibuat dengan penuh kesadaran guna kelancaran penyelesaian Laporan Akhir.

Palembang, 20 - maret - 2023

Pihak Pertama,

(Dastin Morenza)
NIM 062030321036

Pihak Kedua,

(Ir. Faisal Damsi.,M.T.)
NIP 196302181994031001

Mengetahui,
Ketua Jurusan

(Ir. Iskandar Lutfi, M.T.)
NIP 196501291991031002

KEMENTERIAN RISET,TEKNOLOGI DAN PENDIDIKAN TINGGI
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KESEPAKATAN BIMBINGAN LAPORAN AKHIR (LA)

Kami yang bertanda tangan di bawah ini,

Pihak Pertama

Nama	: Dastin Morenza
NIM	: 062030321036
Jurusan	: Teknik Elektro
Program Studi	: DIII Teknik Elektronika

Pihak Kedua

Nama	: Yurni Oktarina,ST.,M.T
NIP	: 197710162008122001
Jurusan	: Teknik Elektro
Program Studi	: DIII Teknik Elektronika

Pada hari ini ..Senin..... tanggal.....20 - maret - 2023 telah sepakat untuk melakukan konsultasi bimbingan Laporan Akhir.

Konsultasi bimbingan sekurang-kurangnya 1 (satu) kali dalam satu minggu. Pelaksanaan bimbingan pada setiap hari .....Senin..... pukul..10.00, tempat di Politeknik Negeri Sriwijaya.

Demikianlah kesepakatan ini dibuat dengan penuh kesadaran guna kelancaran penyelesaian Laporan Akhir.

Palembang, ..20 - maret - 2023.

Pihak Pertama,

(Dastin Morenza)
NIM 062030321036

Pihak Kedua,

(Yurni Oktarina,ST.,M.T)
NIP 197710162008122001

Mengetahui,
Ketua Jurusan

(Ir. Iskandar Lutfi, M.T.)
NIP 196501291991031002

No. Dok. : F-PBM-17 | Tgl. Berlaku : 13 Desember 2010 | No. Rev. : 00

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LEMBAR BIMBINGAN LAPORAN AKHIR

Lembar : 1

Nama : Dastin Morenza
NIM : 062030321036
Jurusan/Program Studi : Teknik Elektro/D3 Elektronika
Judul Laporan Akhir : RANCANG BANGUN SISTEM KENDALI PH DAN SUHU AIR PADA KOLAM PEMBIBITAN IKAN LELE JENIS SANGKURIANG MENGGUNAKAN MIKROKONTROLER NODEMCU ESP32 BERBASIS INTERNET OF THINGS (IoT)
Pembimbing II : Yurni Oktarina S.T.,M.T

No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
1.	15/6 2023	Pengajuan Bab I	
2.	19/6 2023	Perbaikan bab I	
3.	19/6 2023	ACC BAB I, Lanjut BAB II	
4.	22/6 2023	Perbaikan BAB II	
5.	27/6 2023	ACC BAB II, Lanjut BAB III	
6.	3/7 2023	Perbaikan BAB III	
7.	5/7 2023	ACC BAB III, Lanjut BAB IV	

No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
8.	29/7/2023	Pengajuan BAB IV	
9.	27/7/2023	Perbaikan BAB IV	
10.	1/8/2023	ACC BAB IV, lanjut BAB V	
11.	2/8/2023	Perbaikan BAB V	
12.	4/8/2023	Acc laporan akhir → ujian LK	

Palembang, 7 Agustus 2023

Ketua Jurusan/KPS,

(Dwi Permata Sari, S.T., M.Kom)
NIP 197612132000032001

Catatan:
*) melingkari angka yang sesuai.
Ketua Jurusan/Ketua Program Studi harus memeriksa jumlah pelaksanaan bimbingan sesuai yang dipersyaratkan dalam Pedoman Laporan Akhir sebelum menandatangani lembar bimbingan ini.
Lembar pembimbingan LA ini harus dilampirkan dalam Laporan Akhir.

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LEMBAR BIMBINGAN LAPORAN AKHIR

Lembar : 1

Nama : Dastin Morenza
NIM : 062030321036
Jurusan/Program Studi : Teknik Elektro/D3 Elektronika
Judul Laporan Akhir : Rancang Bangun Sistem Kendali pH dan Suhu Air Pada Kolam Pembibitan Ikan Lele Jenis Sangkuriang Menggunakan Mikrokontroller Modemcu ESP32 Berbasis IoT
Pembimbing II : Yumi Oktarina S.T.,M.T

No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
1.	16/3 2023	Konsultasi judul /tema penelitian	
2.	30/3 2023	Penelitian tetap : PH / monitoring SOT pd Pembibitan ikan lele	
3.	3/4 2023	buat proposal	
4.	6/4 2023	Revisi Bab I => batasan masalah	
5.	12/4 2023	Acc Bab I, lanjut Bab II	
6.	17/4 2023	Revisi Bab II => penjelasan gabar.	
7.	8/5 2023	Revisi Bab II => tambahkan teori pH	

No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
8.	10/5 2023	Acc Bab II, lanjut Bab III	
9.	15/5 2023	Perbaiki Metode	
10.	18/5 2023	Revisi / perbaiki TTL	
11.	22/5 2023	Acc Bab III, lanjut Bab IV	
12.	29/5 2023	Acc proposal	

Palembang, 29 Mei 2023

Ketua Jurusan/KPS,

(Dwi Permata Sari, S.T., M.Kom)
NIP 19761213200003 2001

Catatan:
*) melingkari angka yang sesuai.
Ketua Jurusan/Ketua Program Studi harus memeriksa jumlah pelaksanaan bimbingan sesuai yang dipersyaratkan dalam Pedoman Laporan Akhir sebelum menandatangani lembar bimbingan ini.
Lembar pembimbingan LA ini harus dilampirkan dalam Laporan Akhir.

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LEMBAR BIMBINGAN LAPORAN AKHIR

Nama : Dastin Morenza
NIM : 062030321036
Jurusan/Program Studi : Teknik Elektro / DIII Teknik Elektronika
Judul Laporan Akhir : RANCANG BANGUN SISTEM KENDALI PH DAN SUHU AIR PADA KOLAM PEMBIBITAN IKAN LELE JENIS SANGKURIANG MENGGUNAKAN MIKROKONTROLER NODEMCU ESP32 BERBASIS INTERNET OF THINGS (IoT)
Pembimbing I : Ir. Faisal Damsi.,M.T.

No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
1.	15/03 23	KONSULTASI JUDUL	
2.	21/02 23	MASALAH JUDUL	
3.	31/05 23	PERBAIKI BAB I, BATASAN MASALAH	
4.	05/06 23	PERBAIKI BAB I S/D III	
5.	31/07 23	ACC BAB I S/D III, LANJUTKAN BAB IV & V	
6.	04/08 23	PERBAIKI BAB IV & V	
7.			

No.	Tanggal	Uraian Bimbingan	Tanda Tangan Pembimbing
8.			
9.			
10.			
11.			
12.			

Palembang, 7 Agustus 2023

Ketua Jurusan/KPS,

(Ir. Iskandar Lutfi, M.T.)
NIP 196501291991031002

Catatan:
*) melingkari angka yang sesuai.

Ketua Jurusan/Ketua Program Studi harus memeriksa jumlah pelaksanaan bimbingan sesuai yang dipersyaratkan dalam Pedoman Laporan Akhir sebelum menandatangani lembar bimbingan ini.
Lembar pembimbingan LA ini harus dilampirkan dalam Laporan Akhir.

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN,
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PELAKSANAAN REVISI LAPORAN AKHIR

Mahasiswa berikut,

Nama	:	Dastin Morenza
NIM	:	062030321036
Jurusan/Program Studi	:	Teknik Elektro/ D3 Teknik Elektronika
Judul Laporan Akhir	:	Rancang Bangun Sistem Kendali pH dan Suhu Air Pada Kolam Ikan Lele Jenis Sangkuriang Menggunakan Mikrokontroler Nodemcu ESP32 Berbasis Internet Of Things (IoT)

Telah melaksanakan revisi terhadap Laporan Akhir yang diujikan pada hari rabu tanggal 16 bulan Agustus tahun 2023 Pelaksanaan revisi terhadap Laporan Akhir tersebut telah disetujui oleh Dosen Penguji yang memberikan revisi:

No.	Komentar	Nama Dosen Penguji *)	Tanggal	Tanda Tangan
1	Telah diperbaiki	Ir. M. Nawawi, M.T	24 Agt 2023	
2	Tolong Revisi.	Yudi Wijanarko, ST., MT	24/8 23	
3		Sabilal Rasyad, ST., M.kom	25/8 -23	
4	Ok	Yurni Oktarina, ST., MT	29/8 2023	

Palembang, 16 Agustus 2023
Ketua Penguji **),

(Ir. M. Nawawi, M.T)
NIP 196312221990031006

Catatan:
*) Dosen penguji yang memberikan revisi saat ujian laporan akhir.
**) Dosen penguji yang ditugaskan sebagai Ketua Penguji saat ujian LA.
Lembaran pelaksanaan revisi ini harus dilampirkan dalam Laporan Akhir.

KEMENTERIAN PENDIDIKAN DAN KEBUDAYAAN

RISET, DAN TEKNOLOGI

POLITEKNIK NEGERI SRIWIJAYA

Jalan Srijaya Negara, Palembang 30139

Telp. 0711-353414 fax. 0711-355918

Website : www.polisriwijaya.ac.id **E-mail :** info@polsri.ac.id

BUKTI PENYERAHAN HASIL KARYA/RANCANG BANGUN

Pada hari ini kamis tanggal 24 bulan agustus tahun 2023 telah diserahkan seperangkat karya/rancang bangun kepada Jurusan Teknik elektro Program Studi Teknik elektronika di Politeknik Negeri Sriwijaya,

Nama Perangkat	Spesifikasi
Rancang Bangun system kendali Ph dan suhu air pada kolam pembibitan ikan lele menggunakan mikrokontroller NODE MCU ESP32 Berbasis Internet Of Things (IoT)	

Hasil karya/rancang bangun dari,

Nama	NIM	Nama Pembimbing
Dastin Morenza	062030321036	Ir. Faisal Damsi., M.T. Yurni Oktarina, S.T., M.T

Palembang, September 2023

Yang menerima *),

(A.mukhlisin)

Yang menyerahkan **),

(Dastin Morenza)

NIM 062030321036

Mengetahui,

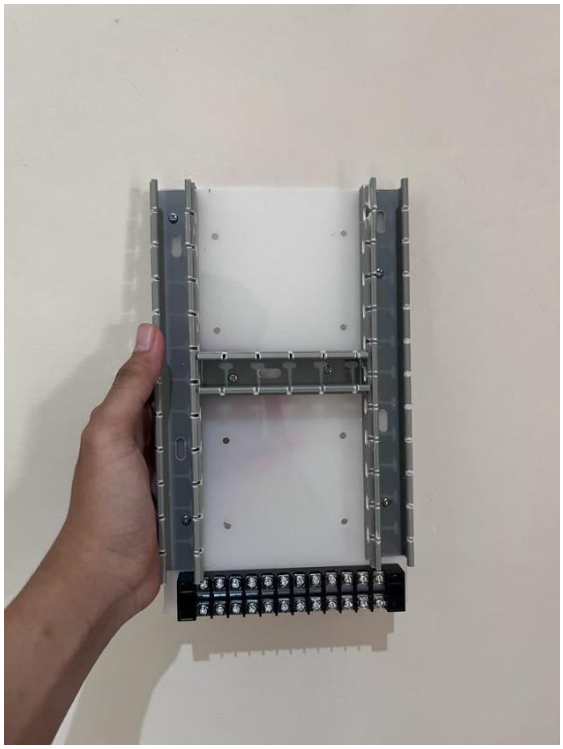
Koordinator Program Studi,
DIII Teknik Elektronika

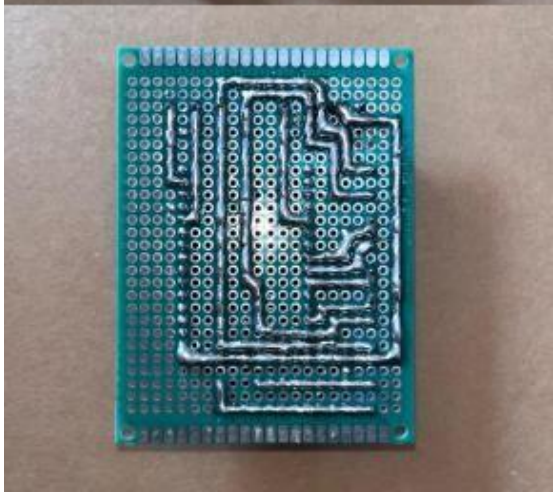
(Dewi Permata Sari,S.T.,M.Kom)

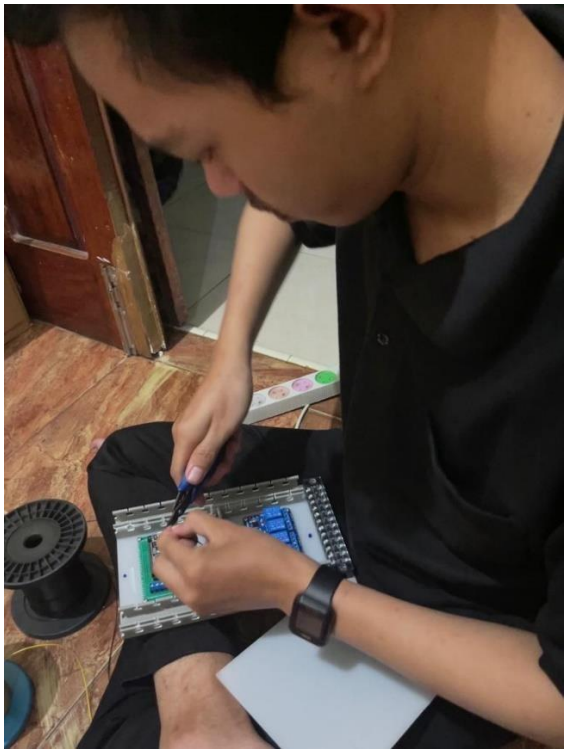
NIP 197612132000032001

LAMPIRAN B

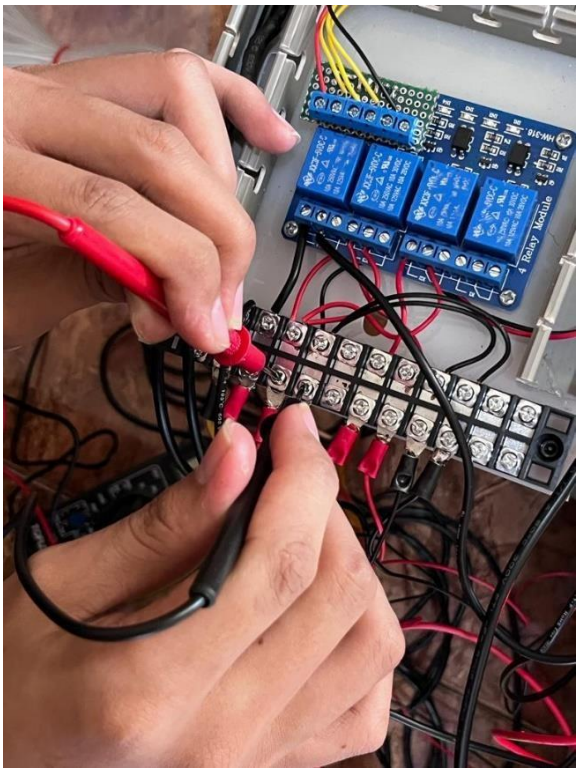
Proses Perakitan Alat







Pengambilan Data Pada Alat



Pemasangan Alat di Lokasi Pembibitan

Hasil Monitoring Pengambian Data Harian

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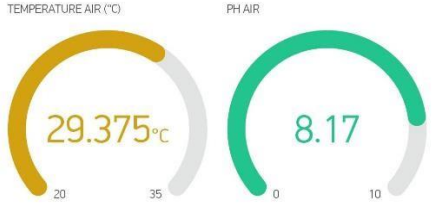
	12:00		
	15:00		
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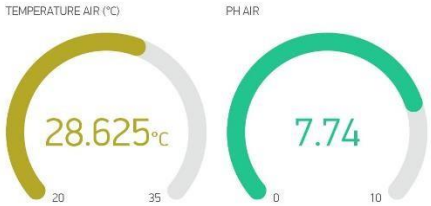
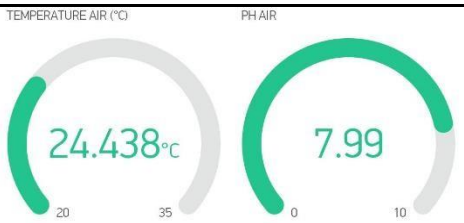
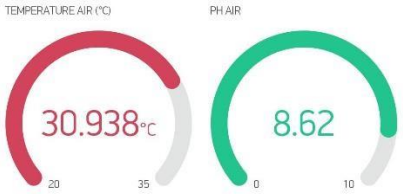
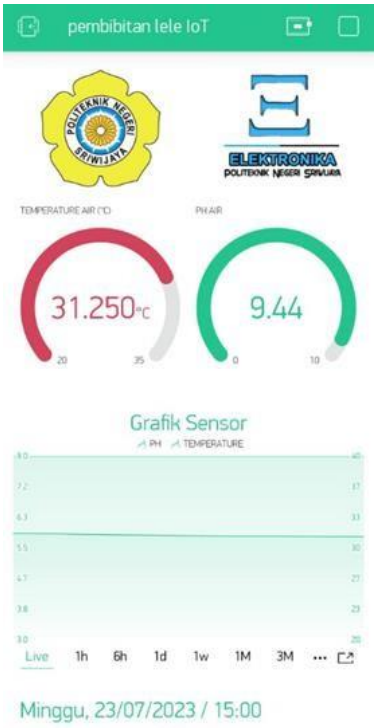
	12:00		
	15:00		

3	09:00		
	12:00		
	15:00		
4	09:00		
	12:00		
	15:00		
5	09:00		

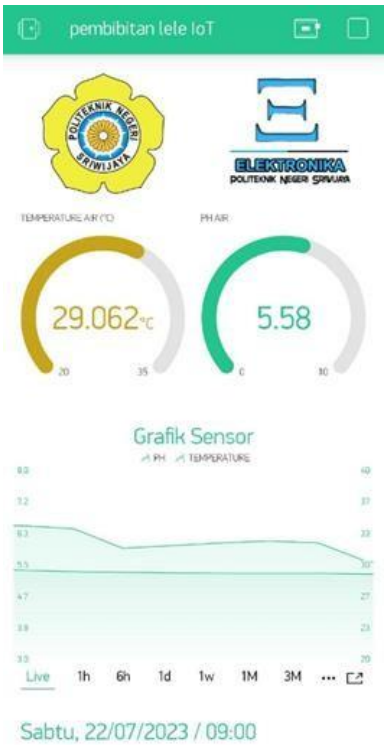
	12:00		
	15:00		
6	09:00		
	12:00		
	15:00		
7	09:00		
	12:00		

	15:00		

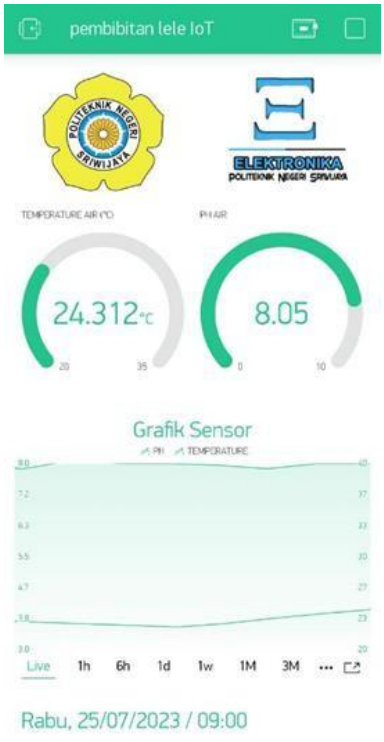
Tampilan Aplikasi Pada Kondisi Suhu dan pH Tertinggi



Tampilan Aplikasi Pada Kondisi pH Terendah



Tampilan Aplikasi Pada Kondisi Suhu Terendah



LAMPIRAN C

ESP32-WROOM-32D & ESP32-WROOM-32U

Datasheet

Version 1.9

Espressif Systems

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About This Document

This document provides the specifications for the ESP32-WROOM-32D and ESP32-WROOM-32U modules.

Revision History

For revision history of this document, please refer to the last page.

Documentation Change Notification

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Contents

List of Tables

List of Figures

1. Overview

ESP32-WROOM-32D and ESP32-WROOM-32U are powerful, generic Wi-Fi+BT+BLE MCU modules that target a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks, such as voice encoding, music streaming and MP3 decoding.

ESP32-WROOM-32U is different from ESP32-WROOM-32D in that ESP32-WROOM-32U integrates a U.FL connector. For detailed information of the U.FL connector please see Chapter 10. Note that the information in this data sheet is applicable to both modules. Any differences between them will be clearly specified in the course of this document. Table 1 lists the difference between ESP32-WROOM-32D and ESP32-WROOM-32U.

Table 1: ESP32-WROOM-32D vs. ESP32-WROOM-32U

Module	ESP32-WROOM-32D	ESP32-WROOM-32U
Core	ESP32-D0WD	ESP32-D0WD
SPI flash	32 Mbits, 3.3 V	32 Mbits, 3.3 V
Crystal	40 MHz	40 MHz
Antenna	onboard antenna	U.FL connector (which needs to be connected to an external IPEX antenna)
Dimensions (Unit: mm)	(18.00±0.10) × (25.50±0.10) × (3.10±0.10) (See Figure 6 for details)	(18.00±0.10) × (19.20±0.10) × (3.20±0.10) (See Figure 7 for details)
Schematics	See Figure 3 for details.	See Figure 4 for details.

At the core of the two modules is the ESP32-D0WD chip that belongs to the ESP32 series* of chips. The chip embedded is designed to be scalable and adaptive. There are two CPU cores that can be individually controlled, and the CPU clock frequency is adjustable from 80 MHz to 240 MHz. The user may also power off the CPU and make use of the low-power co-processor to constantly monitor the peripherals for changes or crossing of thresholds. ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, SD card interface, Ethernet, high-speed SPI, UART, I²S and I²C.

Note:
* For details on the part numbers of the ESP32 family of chips, please refer to the document *ESP32 Datasheet*.

The integration of Bluetooth, Bluetooth LE and Wi-Fi ensures that a wide range of applications can be targeted, and that the module is all-around: using Wi-Fi allows a large physical range and direct connection to the Internet through a Wi-Fi router, while using Bluetooth allows the user to conveniently connect to the phone or broadcast low energy beacons for its detection. The sleep current of the ESP32 chip is less than 5 μA, making it suitable for battery powered and wearable electronics applications. The module supports a data rate of up to 150 Mbps, and 20 dBm output power at the antenna to ensure the widest physical range. As such the module does offer industry-leading specifications and the best performance for electronic integration, range, power consumption, and connectivity.

The operating system chosen for ESP32 is freeRTOS with LwIP; TLS 1.2 with hardware acceleration is built in as well. Secure (encrypted) over the air (OTA) upgrade is also supported, so that users can upgrade their products even after their release, at minimum cost and effort.

Table 2 provides the specifications of ESP32-WROOM-32D and ESP32-WROOM-32U.

Table 2: ESP32-WROOM-32D and ESP32-WROOM-32U Specifications

Categories	Items	Specifications
Certification	RF Certification	FCC/CE-RED/IC/TELEC/KCC/SRRC/NCC
	Wi-Fi Certification	Wi-Fi Alliance
	Bluetooth certification	BQB
	Green Certification	REACH/RoHS
Test	Reliablity	HTOL/HTSL/uHAST/TCT/ESD
Wi-Fi	Protocols	802.11 b/g/n (802.11n up to 150 Mbps)
		A-MPDU and A-MSDU aggregation and 0.4 μs guard interval support
	Frequency range	2.4 GHz ~ 2.5 GHz
Bluetooth	Protocols	Bluetooth v4.2 BR/EDR and BLE specification
	Radio	NZIF receiver with –97 dBm sensitivity
		Class-1, class-2 and class-3 transmitter
		AFH
	Audio	CVSD and SBC
Hardware	Module interfaces	SD card, UART, SPI, SDIO, I^2C, LED PWM, Motor PWM, I^2S, IR, pulse counter, GPIO, capacitive touch sensor, ADC, DAC
	On-chip sensor	Hall sensor
	Integrated crystal	40 MHz crystal
	Integrated SPI flash [1]	4 MB
	Operating voltage/Power supply	3.0 V ~ 3.6 V
	Operating current	Average: 80 mA
	Minimum current delivered by power supply	500 mA
	Recommended operating temperature range [2]	–40 °C ~ +85 °C
	Moisture sensitivity level (MSL)	Level 3

Notice:

1. ESP32-WROOM-32D and ESP32-WROOM-32U with 8 MB flash or 16 MB flash are available for custom order.
2. ESP32-WROOM-32D and ESP32-WROOM-32U with high temperature range (–40 °C ~ +105 °C) option are available for custom order. 4 MB SPI flash is supported on the high temperature range version.
3. For detailed ordering information, please see *Espressif Product Ordering Information*.

2. Pin Definitions

2.1 Pin Layout

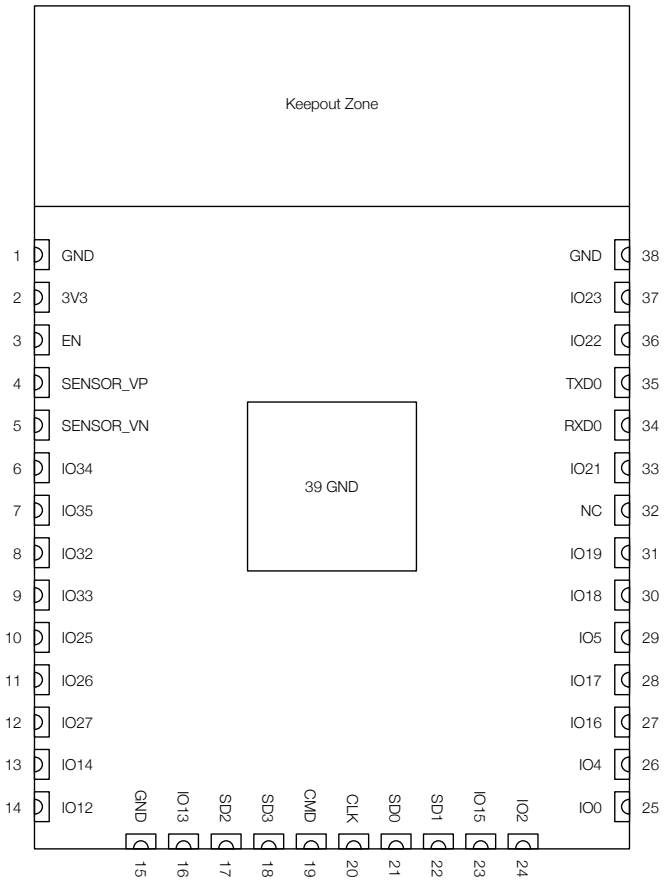


Figure 1: ESP32-WROOM-32D Pin Layout (Top View)

Note:
The pin layout of ESP32-WROOM-32U is the same as that of ESP32-WROOM-32D, except that ESP32-WROOM-32U has no keepout zone.

2.2 Pin Description

The ESP32-WROOM-32D and ESP32-WROOM-32U have 38 pins. See pin definitions in Table 3.

Table 3: Pin Definitions

Name	No.	Type	Function
GND	1	P	Ground
3V3	2	P	Power supply
EN	3	I	Module-enable signal. Active high.
SENSOR_VP	4	I	GPIO36, ADC1_CH0, RTC_GPIO0
SENSOR_VN	5	I	GPIO39, ADC1_CH3, RTC_GPIO3
IO34	6	I	GPIO34, ADC1_CH6, RTC_GPIO4
IO35	7	I	GPIO35, ADC1_CH7, RTC_GPIO5

Name	No.	Type	Function
IO32	8	I/O	GPIO32, XTAL_32K_P (32.768 kHz crystal oscillator input), ADC1_CH4, TOUCH9, RTC_GPIO9
IO33	9	I/O	GPIO33, XTAL_32K_N (32.768 kHz crystal oscillator output), ADC1_CH5, TOUCH8, RTC_GPIO8
IO25	10	I/O	GPIO25, DAC_1, ADC2_CH8, RTC_GPIO6, EMAC_RXD0
IO26	11	I/O	GPIO26, DAC_2, ADC2_CH9, RTC_GPIO7, EMAC_RXD1
IO27	12	I/O	GPIO27, ADC2_CH7, TOUCH7, RTC_GPIO17, EMAC_RX_DV
IO14	13	I/O	GPIO14, ADC2_CH6, TOUCH6, RTC_GPIO16, MTMS, HSPICLK, HS2_CLK, SD_CLK, EMAC_TXD2
IO12	14	I/O	GPIO12, ADC2_CH5, TOUCH5, RTC_GPIO15, MTDI, HSPIQ, HS2_DATA2, SD_DATA2, EMAC_TXD3
GND	15	P	Ground
IO13	16	I/O	GPIO13, ADC2_CH4, TOUCH4, RTC_GPIO14, MTCK, HSPID, HS2_DATA3, SD_DATA3, EMAC_RX_ER
SHD/SD2*	17	I/O	GPIO9, SD_DATA2, SPIHD, HS1_DATA2, U1RXD
SWP/SD3*	18	I/O	GPIO10, SD_DATA3, SPIWP, HS1_DATA3, U1TXD
SCS/CMD*	19	I/O	GPIO11, SD_CMD, SPICS0, HS1_CMD, U1RTS
SCK/CLK*	20	I/O	GPIO6, SD_CLK, SPICLK, HS1_CLK, U1CTS
SDO/SD0*	21	I/O	GPIO7, SD_DATA0, SPIQ, HS1_DATA0, U2RTS
SDI/SD1*	22	I/O	GPIO8, SD_DATA1, SPID, HS1_DATA1, U2CTS
IO15	23	I/O	GPIO15, ADC2_CH3, TOUCH3, MTDO, HSPICS0, RTC_GPIO13, HS2_CMD, SD_CMD, EMAC_RXD3
IO2	24	I/O	GPIO2, ADC2_CH2, TOUCH2, RTC_GPIO12, HSPIWP, HS2_DATA0, SD_DATA0
IO0	25	I/O	GPIO0, ADC2_CH1, TOUCH1, RTC_GPIO11, CLK_OUT1, EMAC_TX_CLK
IO4	26	I/O	GPIO4, ADC2_CH0, TOUCH0, RTC_GPIO10, HSPIHD, HS2_DATA1, SD_DATA1, EMAC_TX_ER
IO16	27	I/O	GPIO16, HS1_DATA4, U2RXD, EMAC_CLK_OUT
IO17	28	I/O	GPIO17, HS1_DATA5, U2TXD, EMAC_CLK_OUT_180
IO5	29	I/O	GPIO5, VSPICS0, HS1_DATA6, EMAC_RX_CLK
IO18	30	I/O	GPIO18, VSPICLK, HS1_DATA7
IO19	31	I/O	GPIO19, VSPIQ, U0CTS, EMAC_TXD0
NC	32	-	-
IO21	33	I/O	GPIO21, VSPIHD, EMAC_TX_EN
RXD0	34	I/O	GPIO3, U0RXD, CLK_OUT2
TXD0	35	I/O	GPIO1, U0TXD, CLK_OUT3, EMAC_RXD2
IO22	36	I/O	GPIO22, VSPIWP, U0RTS, EMAC_TXD1
IO23	37	I/O	GPIO23, VSPID, HS1_STROBE
GND	38	P	Ground

Notice:

* Pins SCK/CLK, SDO/SD0, SDI/SD1, SHD/SD2, SWP/SD3 and SCS/CMD, namely, GPIO6 to GPIO11 are connected to the integrated SPI flash integrated on the module and are not recommended for other uses.

2.3 Strapping Pins

ESP32 has five strapping pins, which can be seen in Chapter 6 Schematics:

- MTDI
- GPIO0
- GPIO2
- MTDO
- GPIO5

Software can read the values of these five bits from register "GPIO_STRAPPING".

During the chip's system reset release (power-on-reset, RTC watchdog reset and brownout reset), the latches of the strapping pins sample the voltage level as strapping bits of "0" or "1", and hold these bits until the chip is powered down or shut down. The strapping bits configure the device's boot mode, the operating voltage of VDD_SDIO and other initial system settings.

Each strapping pin is connected to its internal pull-up/pull-down during the chip reset. Consequently, if a strapping pin is unconnected or the connected external circuit is high-impedance, the internal weak pull-up/pull-down will determine the default input level of the strapping pins.

To change the strapping bit values, users can apply the external pull-down/pull-up resistances, or use the host MCU's GPIOs to control the voltage level of these pins when powering on ESP32.

After reset release, the strapping pins work as normal-function pins.

Refer to Table 4 for a detailed boot-mode configuration by strapping pins.

Table 4: Strapping Pins

Voltage of Internal LDO (VDD_SDIO)					
Pin	Default	3.3 V		1.8 V	
MTDI	Pull-down	0		1	
Booting Mode					
Pin	Default	SPI Boot		Download Boot	
GPIO0	Pull-up	1		0	
GPIO2	Pull-down	Don't-care		0	
Enabling/Disabling Debugging Log Print over U0TXD During Booting					
Pin	Default	U0TXD Active		U0TXD Silent	
MTDO	Pull-up	1		0	
Timing of SDIO Slave					
Pin	Default	Falling-edge Sampling Falling-edge Output	Falling-edge Sampling Rising-edge Output	Rising-edge Sampling Falling-edge Output	Rising-edge Sampling Rising-edge Output
MTDO	Pull-up	0	0	1	1
GPIO5	Pull-up	0	1	0	1

Note:

- Firmware can configure register bits to change the settings of "Voltage of Internal LDO (VDD_SDIO)" and "Timing of SDIO Slave" after booting.
- Both ESP32-WROOM-32D and ESP32-WROOM-32U integrate a 3.3 V SPI flash, so the pin MTDI cannot be set to 1 when the modules are powered up.

3. Functional Description

This chapter describes the modules and functions integrated in ESP32-WROOM-32D and ESP32-WROOM-32U.

3.1 CPU and Internal Memory

ESP32-D0WD contains a dual-core Xtensa® 32-bit LX6 MCU. The internal memory includes:

- 448 KB of ROM for booting and core functions.
- 520 KB of on-chip SRAM for data and instructions.
- 8 KB of SRAM in RTC, which is called RTC FAST Memory and can be used for data storage; it is accessed by the main CPU during RTC Boot from the Deep-sleep mode.
- 8 KB of SRAM in RTC, which is called RTC SLOW Memory and can be accessed by the co-processor during the Deep-sleep mode.
- 1 Kbit of eFuse: 256 bits are used for the system (MAC address and chip configuration) and the remaining 768 bits are reserved for customer applications, including flash-encryption and chip-ID.

3.2 External Flash and SRAM

ESP32 supports multiple external QSPI flash and SRAM chips. More details can be found in Chapter SPI in the *ESP32 Technical Reference Manual*. ESP32 also supports hardware encryption/decryption based on AES to protect developers' programs and data in flash.

ESP32 can access the external QSPI flash and SRAM through high-speed caches.

- The external flash can be mapped into CPU instruction memory space and read-only memory space simultaneously.
  - When external flash is mapped into CPU instruction memory space, up to 11 MB + 248 KB can be mapped at a time. Note that if more than 3 MB + 248 KB are mapped, cache performance will be reduced due to speculative reads by the CPU.
  - When external flash is mapped into read-only data memory space, up to 4 MB can be mapped at a time. 8-bit, 16-bit and 32-bit reads are supported.
- External SRAM can be mapped into CPU data memory space. Up to 4 MB can be mapped at a time. 8-bit, 16-bit and 32-bit reads and writes are supported.

Both ESP32-WROOM-32D and ESP32-WROOM-32U integrate a 4 MB of external SPI flash. The integrated SPI flash is connected to GPIO6, GPIO7, GPIO8, GPIO9, GPIO10 and GPIO11. These six pins cannot be used as regular GPIOs.

3.3 Crystal Oscillators

The module uses a 40-MHz crystal oscillator.

3.4 RTC and Low-Power Management

With the use of advanced power-management technologies, ESP32 can switch between different power modes.

For details on ESP32's power consumption in different power modes, please refer to section "RTC and Low-Power Management" in *ESP32 Datasheet*.

4. Peripherals and Sensors

Please refer to Section Peripherals and Sensors in *ESP32 Datasheet*.

Note:
External connections can be made to any GPIO except for GPIOs in the range 6-11. These six GPIOs are connected to the module's integrated SPI flash. For details, please see Section 6 Schematics.

5. Electrical Characteristics

5.1 Absolute Maximum Ratings

Stresses beyond the absolute maximum ratings listed in Table 5 below may cause permanent damage to the device. These are stress ratings only, and do not refer to the functional operation of the device that should follow the recommended operating conditions.

Table 5: Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDD33	Power supply voltage	–0.3	3.6	V
I_{output} [1]	Cumulative IO output current	-	1,100	mA
T_{store}	Storage temperature	–40	150	°C

1. The module worked properly after a 24-hour test in ambient temperature at 25 °C, and the IOs in three domains (VDD3P3_RTC, VDD3P3_CPU, VDD_SDIO) output high logic level to ground. Please note that pins occupied by flash and/or PSRAM in the VDD_SDIO power domain were excluded from the test.
2. Please see Appendix IO_MUX of *ESP32 Datasheet* for IO's power domain.

5.2 Recommended Operating Conditions

Table 6: Recommended Operating Conditions

Symbol	Parameter	Min	Typical	Max	Unit
VDD33	Power supply voltage	3.0	3.3	3.6	V
I_{VDD}	Current delivered by external power supply	0.5	-	-	A
T	Operating temperature	–40	-	85	°C

5.3 DC Characteristics (3.3 V, 25 °C)

Table 7: DC Characteristics (3.3 V, 25 °C)

Symbol	Parameter		Min	Typ	Max	Unit
C_{IN}	Pin capacitance		-	2	-	pF
V_{IH}	High-level input voltage		0.75×VDD[1]	-	VDD[1]+0.3	V
V_{IL}	Low-level input voltage		–0.3	-	0.25×VDD[1]	V
I_{IH}	High-level input current		-	-	50	nA
I_{IL}	Low-level input current		-	-	50	nA
V_{OH}	High-level output voltage		0.8×VDD[1]	-	-	V
V_{OL}	Low-level output voltage		-	-	0.1×VDD[1]	V
I_{OH}	High-level source current (VDD[1] = 3.3 V, V_{OH} >= 2.64 V, output drive strength set to the maximum)	VDD3P3_CPU power domain [1, 2]	-	40	-	mA
		VDD3P3_RTC power domain [1, 2]	-	40	-	mA
		VDD_SDIO power domain [1, 3]	-	20	-	mA

Symbol	Parameter	Min	Typ	Max	Unit
I_{OL}	Low-level sink current (VDD[1] = 3.3 V, V_{OL} = 0.495 V, output drive strength set to the maximum)	-	28	-	mA
R_{PU}	Resistance of internal pull-up resistor	-	45	-	kΩ
R_{PD}	Resistance of internal pull-down resistor	-	45	-	kΩ
V_{IL_nRST}	Low-level input voltage of CHIP_PU to power off the chip	-	-	0.6	V

Notes:

1. Please see Appendix IO_MUX of *ESP32 Datasheet* for IO's power domain. VDD is the I/O voltage for a particular power domain of pins.
2. For VDD3P3_CPU and VDD3P3_RTC power domain, per-pin current sourced in the same domain is gradually reduced from around 40 mA to around 29 mA, V_{OH}>=2.64 V, as the number of current-source pins increases.
3. Pins occupied by flash and/or PSRAM in the VDD_SDIO power domain were excluded from the test.

5.4 Wi-Fi Radio

Table 8: Wi-Fi Radio Characteristics

Parameter	Condition	Min	Typical	Max	Unit
Operating frequency range [note1]	-	2412	-	2484	MHz
Output impedance [note2]	-	-	*note 2*	-	Ω
TX power [note3]	11n, MCS7	12	13	14	dBm
	11b mode	17.5	18.5	20	dBm
Sensitivity	11b, 1 Mbps	-	–98	-	dBm
	11b, 11 Mbps	-	–89	-	dBm
	11g, 6 Mbps	-	–92	-	dBm
	11g, 54 Mbps	-	–74	-	dBm
	11n, HT20, MCS0	-	–91	-	dBm
	11n, HT20, MCS7	-	–71	-	dBm
	11n, HT40, MCS0	-	–89	-	dBm
	11n, HT40, MCS7	-	–69	-	dBm
Adjacent channel rejection	11g, 6 Mbps	-	31	-	dB
	11g, 54 Mbps	-	14	-	dB
	11n, HT20, MCS0	-	31	-	dB
	11n, HT20, MCS7	-	13	-	dB

1. Device should operate in the frequency range allocated by regional regulatory authorities. Target operating frequency range is configurable by software.
2. For the modules that use IPEX antennas, the output impedance is 50 Ω. For other modules without IPEX antennas, users do not need to concern about the output impedance.
3. Target TX power is configurable based on device or certification requirements.

5.5 BLE Radio

5.5.1 Receiver

Table 9: Receiver Characteristics – BLE

Parameter	Conditions	Min	Typ	Max	Unit
Sensitivity @30.8% PER	-	-	–97	-	dBm
Maximum received signal @30.8% PER	-	0	-	-	dBm
Co-channel C/I	-	-	+10	-	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	-	–5	-	dB
	F = F0 – 1 MHz	-	–5	-	dB
	F = F0 + 2 MHz	-	–25	-	dB
	F = F0 – 2 MHz	-	–35	-	dB
	F = F0 + 3 MHz	-	–25	-	dB
	F = F0 – 3 MHz	-	–45	-	dB
Out-of-band blocking performance	30 MHz ~ 2000 MHz	–10	-	-	dBm
	2000 MHz ~ 2400 MHz	–27	-	-	dBm
	2500 MHz ~ 3000 MHz	–27	-	-	dBm
	3000 MHz ~ 12.5 GHz	–10	-	-	dBm
Intermodulation	-	–36	-	-	dBm

5.5.2 Transmitter

Table 10: Transmitter Characteristics – BLE

Parameter	Conditions	Min	Typ	Max	Unit
RF transmit power	-	-	0	-	dBm
Gain control step	-	-	3	-	dBm
RF power control range	-	–12	-	+9	dBm
Adjacent channel transmit power	F = F0 ± 2 MHz	-	–52	-	dBm
	F = F0 ± 3 MHz	-	–58	-	dBm
	F = F0 ± > 3 MHz	-	–60	-	dBm
$\Delta f1_{avg}$	-	-	-	265	kHz
$\Delta f2_{max}$	-	247	-	-	kHz
$\Delta f2_{avg}/\Delta f1_{avg}$	-	-	–0.92	-	-
ICFT	-	-	–10	-	kHz
Drift rate	-	-	0.7	-	kHz/50 μs
Drift	-	-	2	-	kHz

5.6 Reflow Profile

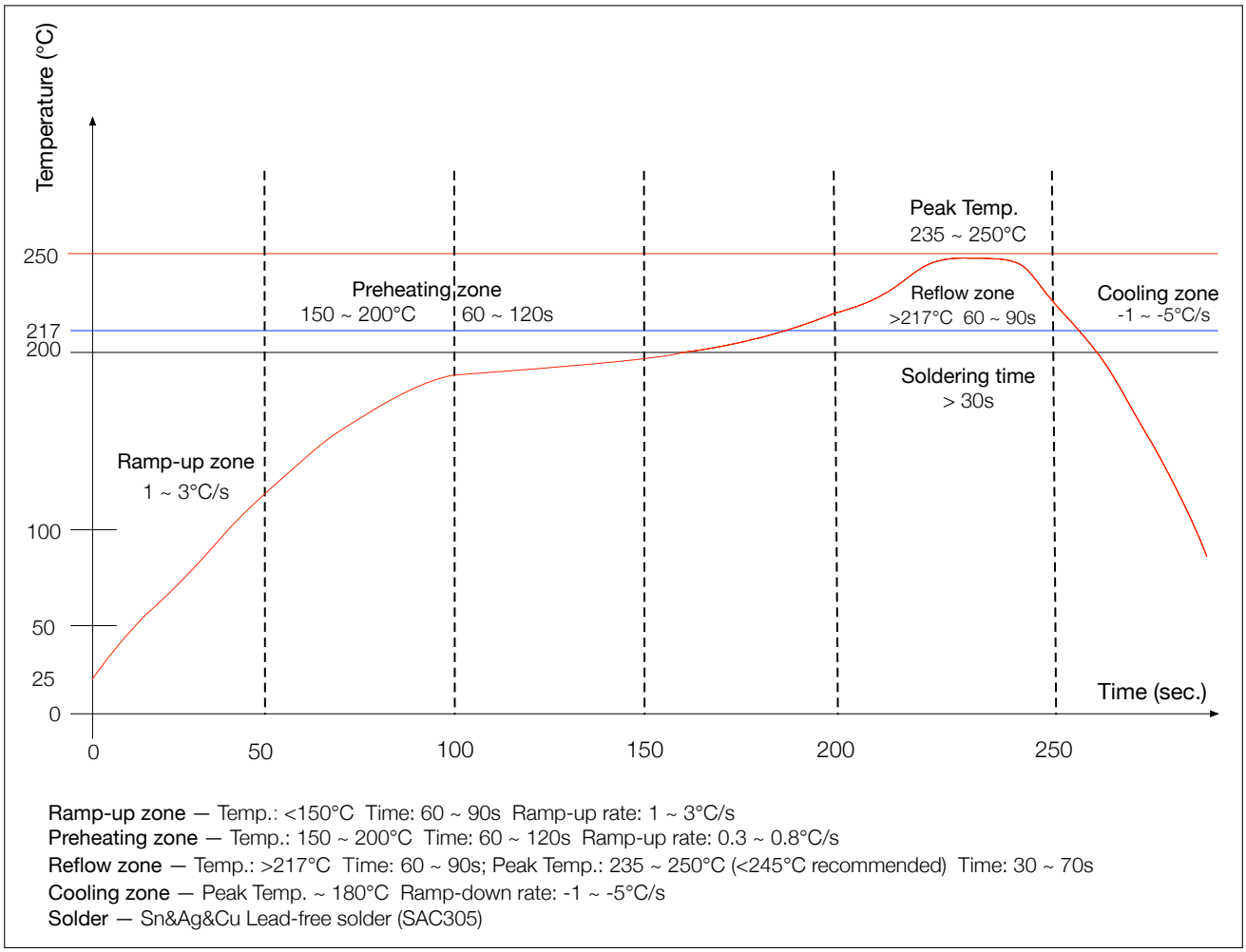


Figure 2: Reflow Profile

6. Schematics

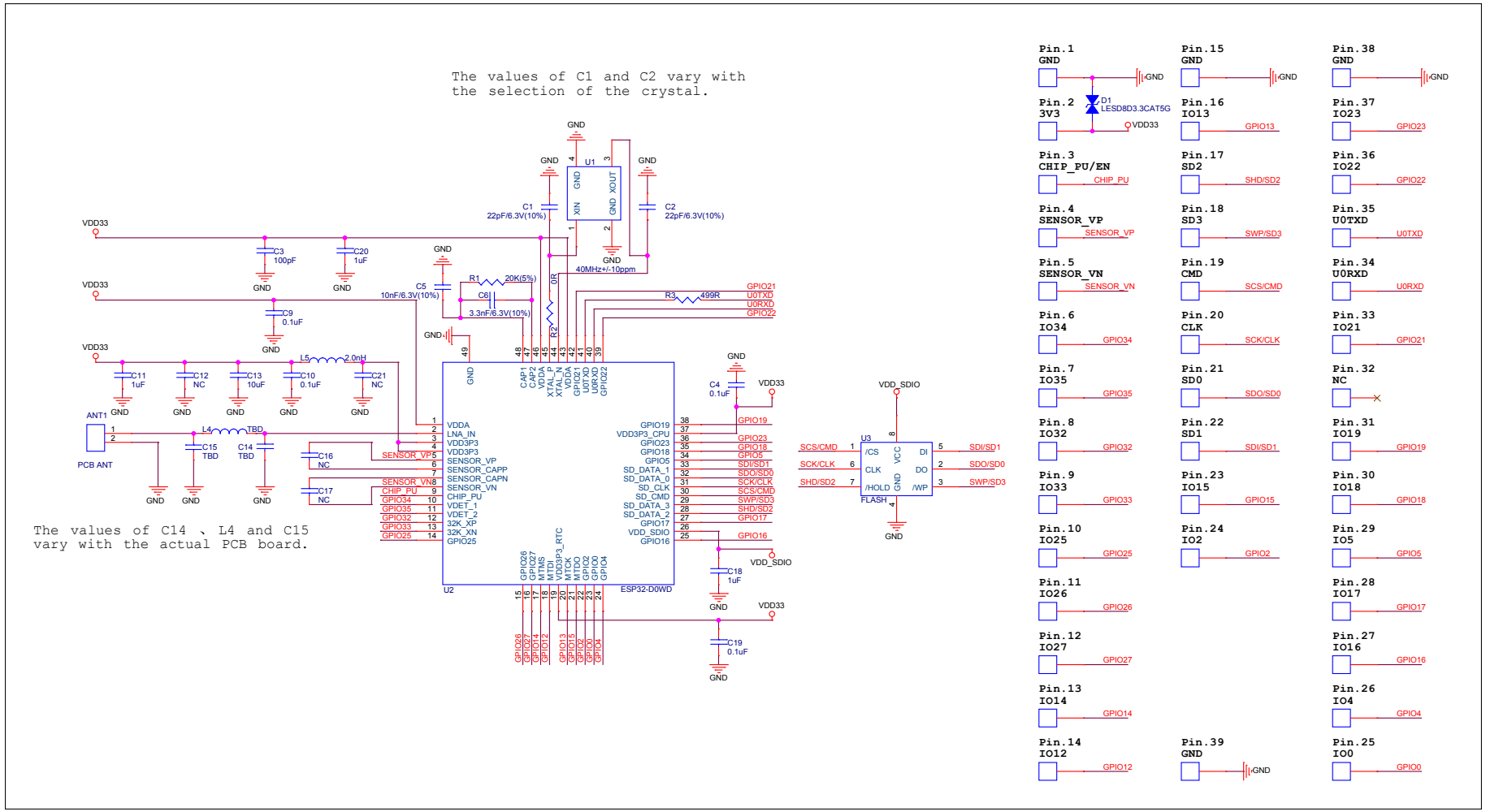


Figure 3: ESP32-WROOM-32D Schematics

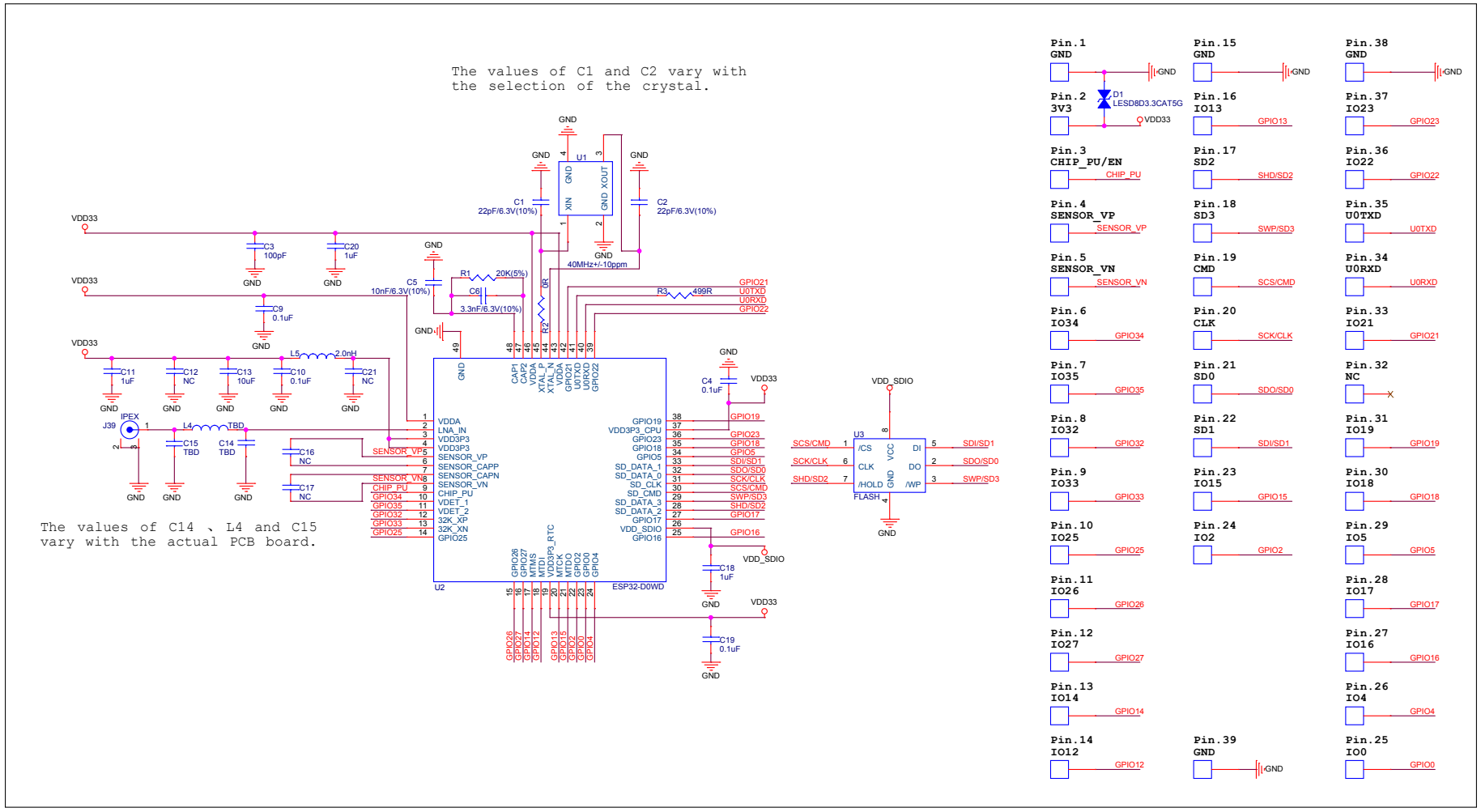


Figure 4: ESP32-WROOM-32U Schematics

7. Peripheral Schematics

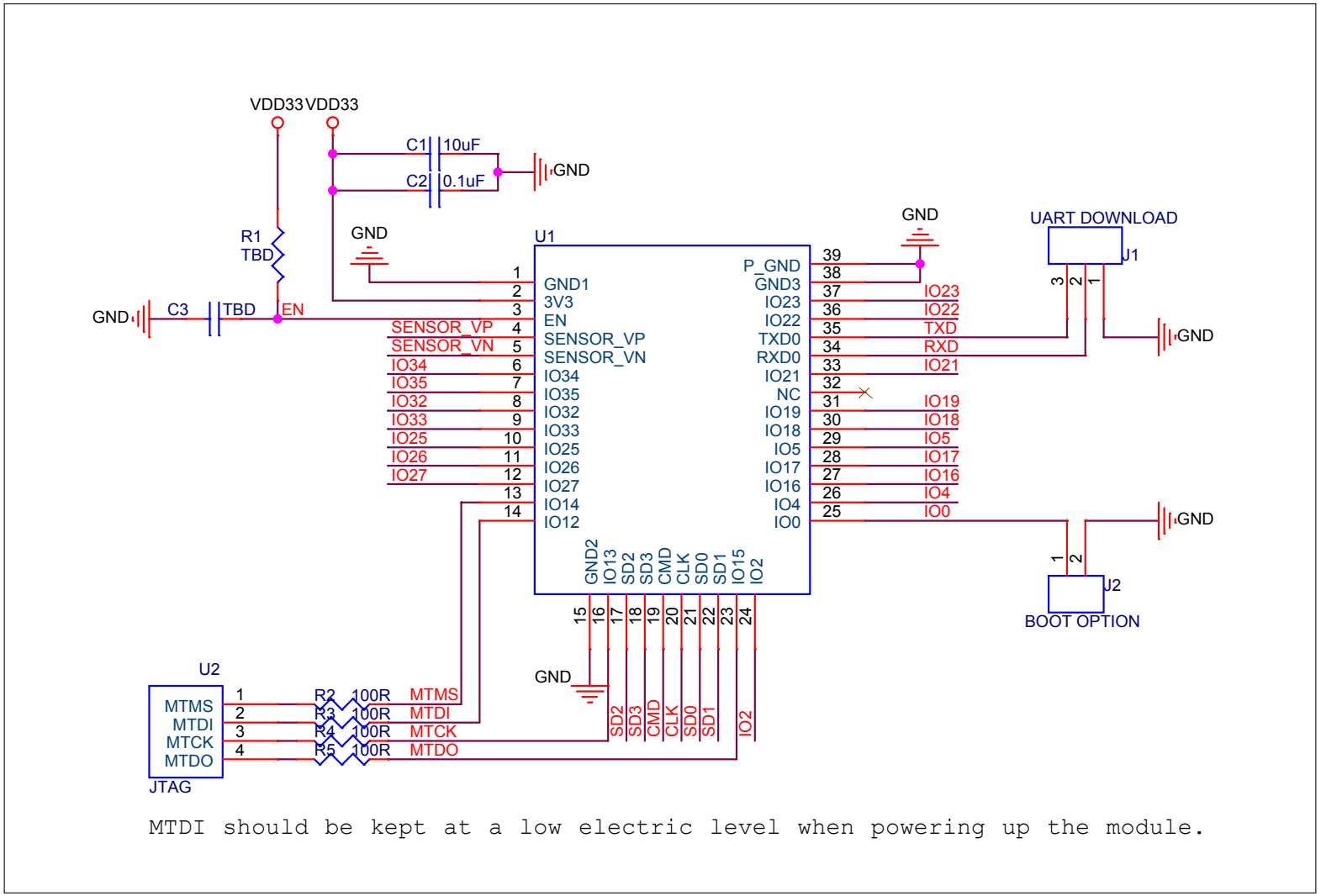


Figure 5: ESP32-WROOM-32D & ESP32-WROOM-32U Peripheral Schematics

Note:

- Soldering Pad 39 to the Ground is not necessary for a satisfactory thermal performance. If users do want to solder it, they need to ensure that the correct quantity of soldering paste is applied.
- When ESP32 is powered on and off repeatedly by switching the power rails, and there is a large capacitor on the 3V3 rail, a discharge circuit can be added to the 3V3 rail to ensure proper power-on-reset. Please find the discharge circuit in Chapter *Peripheral Schematics*, in *ESP32-WROOM-32 Datasheet*.
- When battery is used as the power supply for ESP32 series of chips and modules, a supply voltage supervisor is recommended to avoid boot failure due to low voltage. Users are recommended to pull CHIP_PU low if the power supply for ESP32 is below 2.3 V. For the reset circuit, please refer to Chapter *Peripheral Schematics*, in *ESP32-WROOM-32 Datasheet*.
- To ensure the power supply to the ESP32 chip during power-up, it is advised to add an RC delay circuit at the EN pin. The recommended setting for the RC delay circuit is usually R = 10 kΩ and C = 0.1 μF. However, specific parameters should be adjusted based on the power-up timing of the module and the power-up and reset sequence timing of the chip. For ESP32's power-up and reset sequence timing diagram, please refer to Section *Power Scheme* in *ESP32 Datasheet*.

8. Physical Dimensions

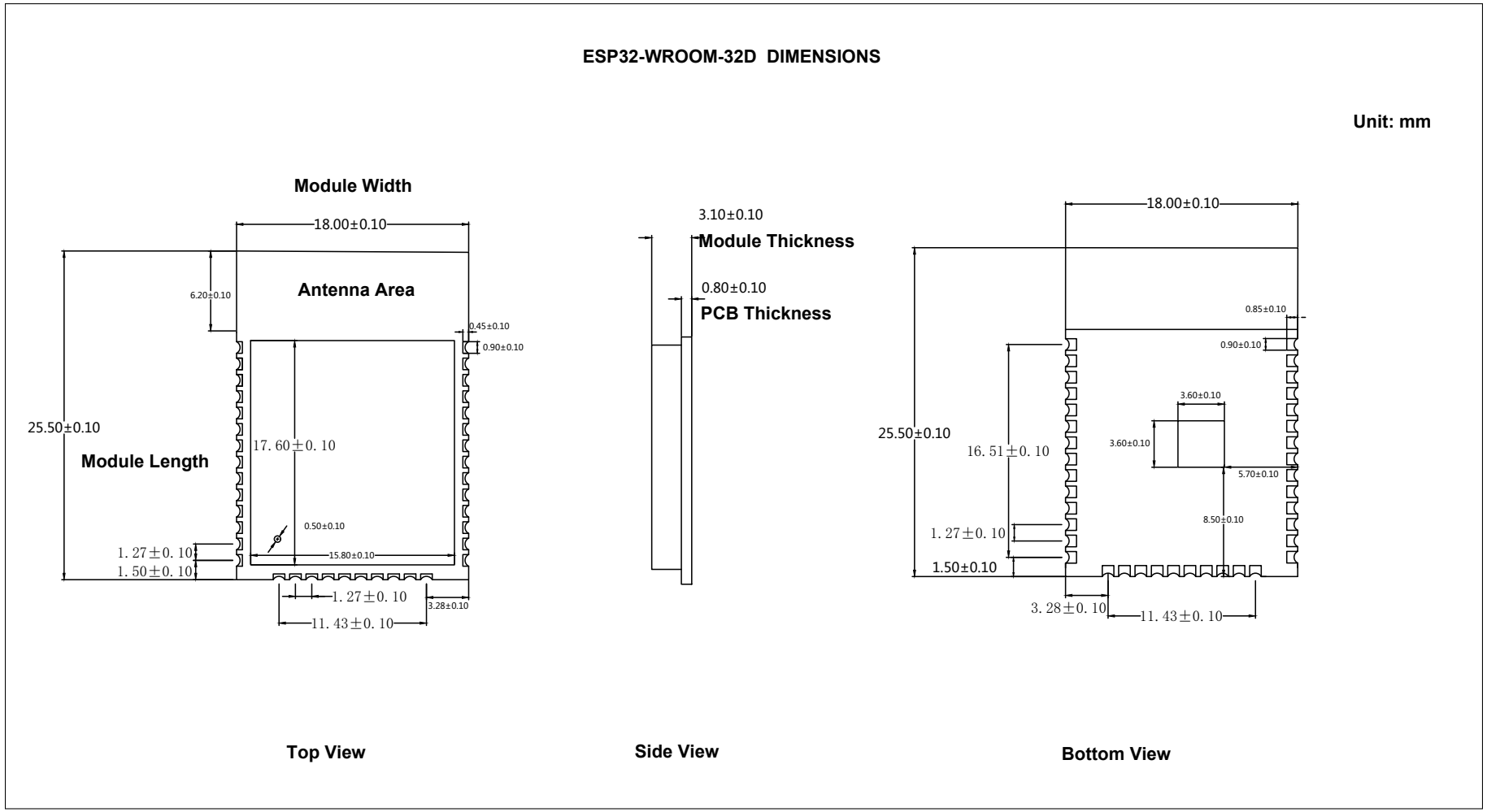


Figure 6: Physical Dimensions of ESP32-WROOM-32D

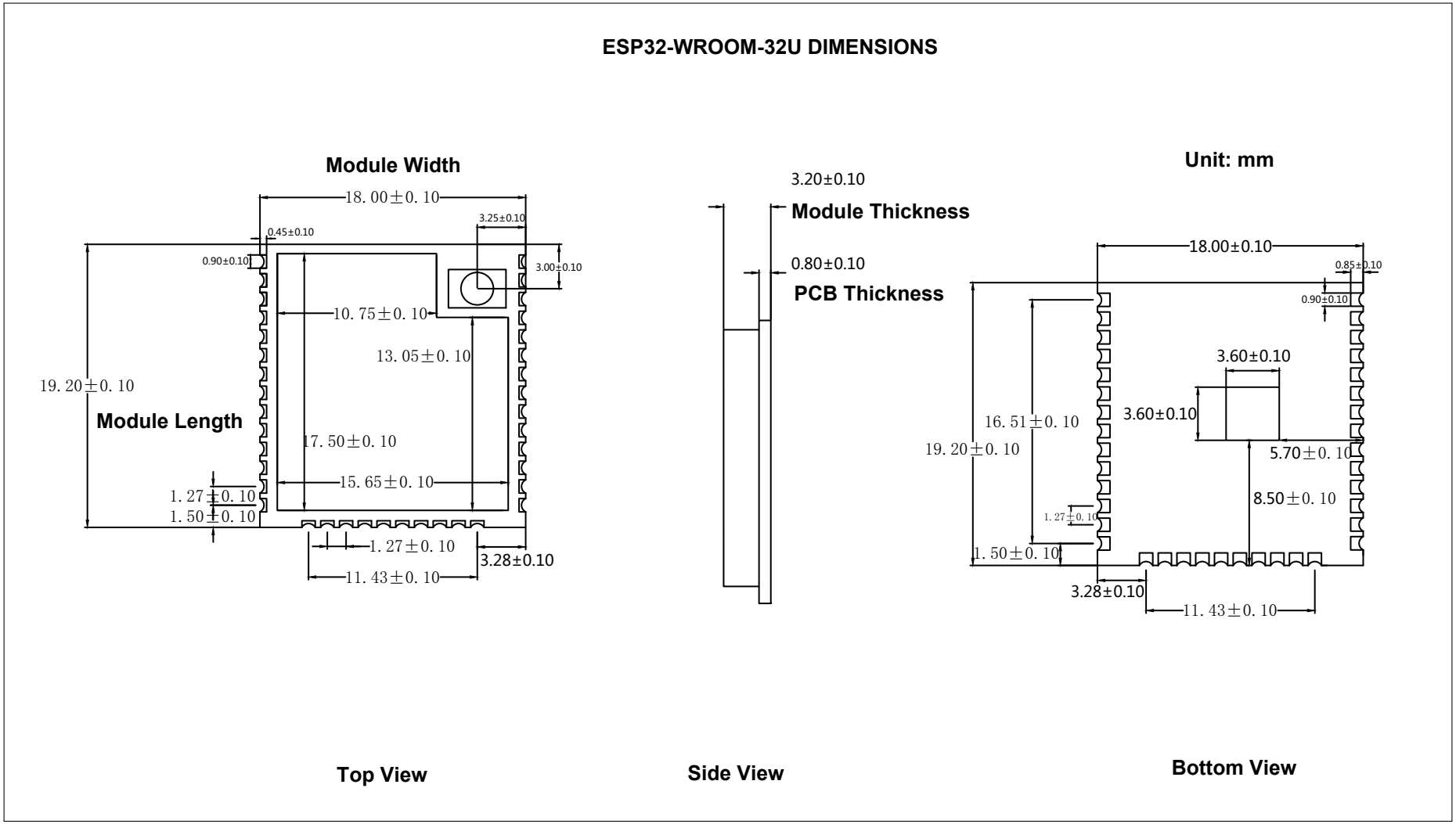


Figure 7: Physical Dimensions of ESP32-WROOM-32U

9. Recommended PCB Land Pattern

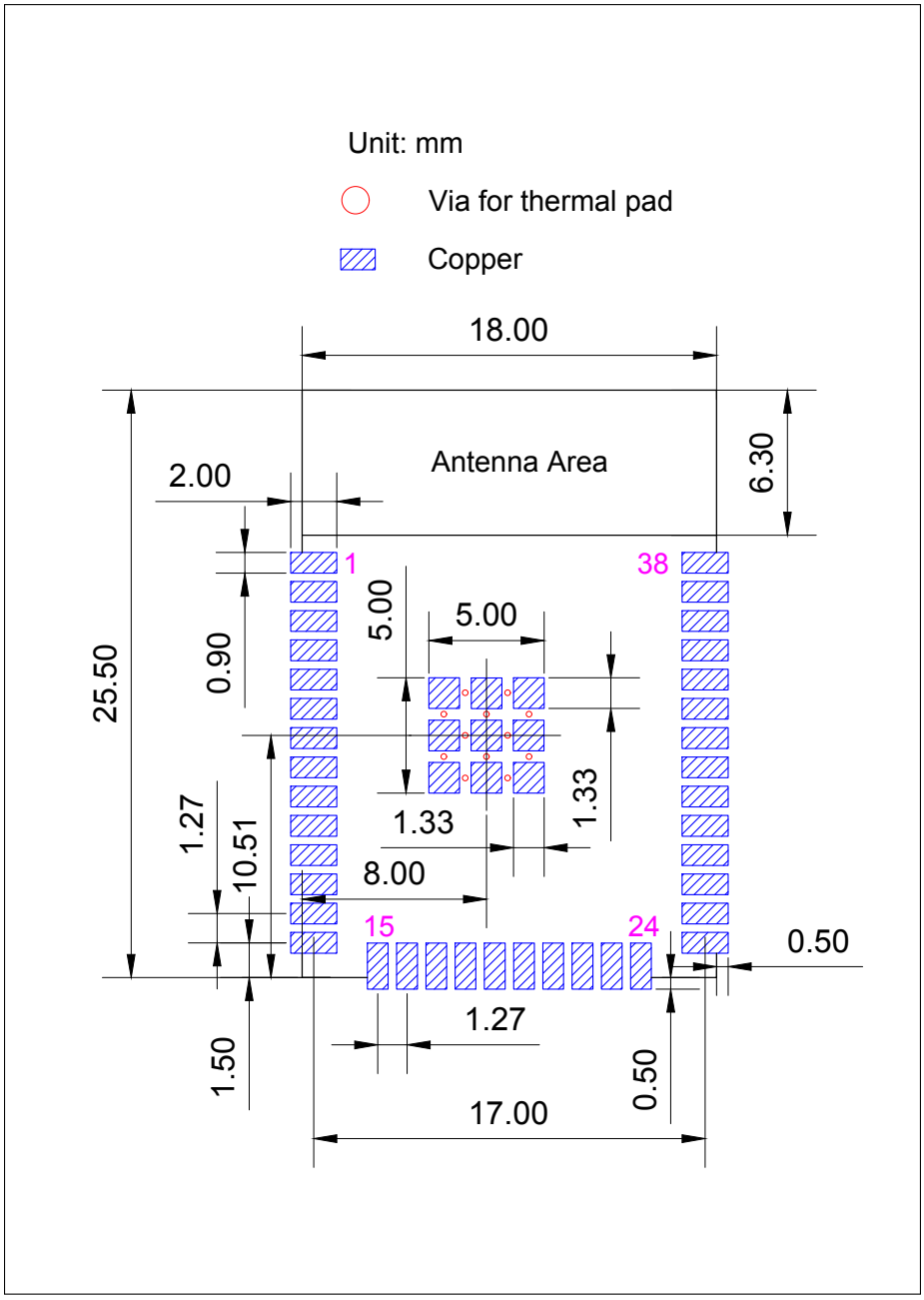


Figure 8: Recommended PCB Land Pattern of ESP32-WROOM-32D

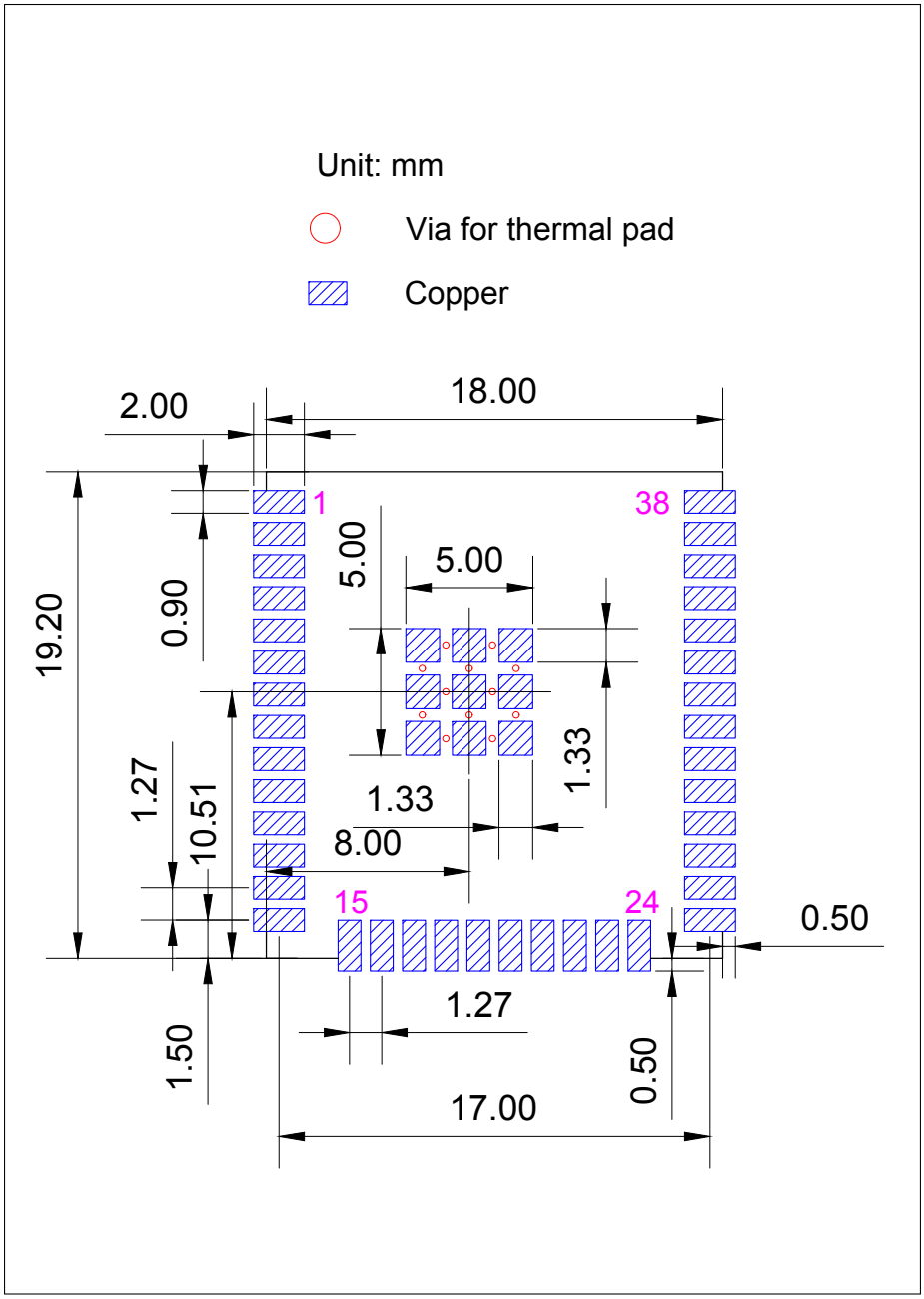
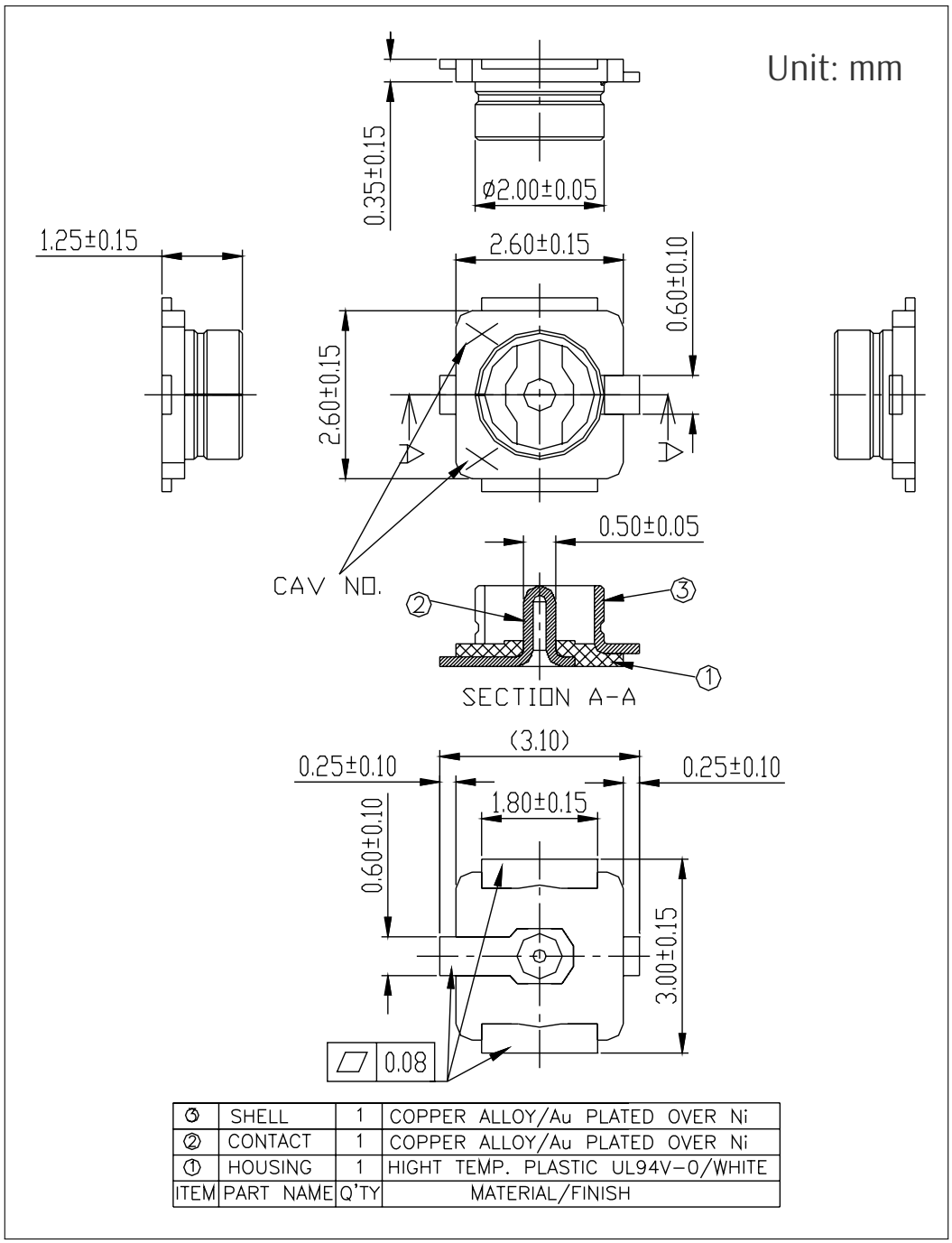


Figure 9: Recommended PCB Land Pattern of ESP32-WROOM-32U

10. U.FL Connector Dimensions



ITEM	PART NAME	Q'TY	MATERIAL/FINISH
③	SHELL	1	COPPER ALLOY/Au PLATED OVER Ni
②	CONTACT	1	COPPER ALLOY/Au PLATED OVER Ni
①	HOUSING	1	HIGHT TEMP. PLASTIC UL94V-0/WHITE

Figure 10: ESP32-WROOM-32U U.FL Dimensions

11. Learning Resources

11.1 Must-Read Documents

The following link provides documents related to ESP32.

- *ESP32 Datasheet*
  This document provides an introduction to the specifications of the ESP32 hardware, including overview, pin definitions, functional description, peripheral interface, electrical characteristics, etc.
- *ESP-IDF Programming Guide*
  It hosts extensive documentation for ESP-IDF ranging from hardware guides to API reference.
- *ESP32 Technical Reference Manual*
  The manual provides detailed information on how to use the ESP32 memory and peripherals.
- ESP32 Hardware Resources
  The zip files include the schematics, PCB layout, Gerber and BOM list of ESP32 modules and development boards.
- *ESP32 Hardware Design Guidelines*
  The guidelines outline recommended design practices when developing standalone or add-on systems based on the ESP32 series of products, including the ESP32 chip, the ESP32 modules and development boards.
- *ESP32 AT Instruction Set and Examples*
  This document introduces the ESP32 AT commands, explains how to use them, and provides examples of several common AT commands.
- *Espressif Products Ordering Information*

11.2 Must-Have Resources

Here are the ESP32-related must-have resources.

- ESP32 BBS
  This is an Engineer-to-Engineer (E2E) Community for ESP32 where you can post questions, share knowledge, explore ideas, and help solve problems with fellow engineers.
- ESP32 GitHub
  ESP32 development projects are freely distributed under Espressif's MIT license on GitHub. It is established to help developers get started with ESP32 and foster innovation and the growth of general knowledge about the hardware and software surrounding ESP32 devices.
- ESP32 Tools
  This is a webpage where users can download ESP32 Flash Download Tools and the zip file "ESP32 Certification and Test".
- ESP-IDF
  This webpage links users to the official IoT development framework for ESP32.
- ESP32 Resources
  This webpage provides the links to all available ESP32 documents, SDK and tools.

Revision History

Date	Version	Release notes
2019.09	V1.9	• Changed the supply voltage range from 2.7 V ~ 3.6 V to 3.0 V ~ 3.6 V; • Added Moisture sensitivity level (MSL) 3 in Table 2 *ESP32-WROOM-32D and ESP32-WROOM-32U Specifications*; • Added notes about "Operating frequency range" and "TX power" under Table 8 *Wi-Fi Radio Characteristics*; • Updated Section 7 *Peripheral Schematics* and added a note about RC delay circuit under it; • Updated Figure 8 and Figure 9 *Recommended PCB Land Pattern*.
2019.01	V1.8	Changed the RF power control range in Table 10 from –12 ~ +12 to –12 ~ +9 dBm.
2018.10	V1.7	Added notice on module custom options under Table 2; Added "Cumulative IO output current" entry to Table 5: Absolute Maximum Ratings; Added more parameters to Table 7: DC Characteristics.
2018.09	V1.6	Updated the hole diameter in the shield from 1.00 mm to 0.50 mm, in Figure 6.
2018.08	V1.5	• Added certifications and reliability test items the module has passed in Table 2: ESP32-WROOM-32D and ESP32-WROOM-32U Specifications, and removed software-specific information; • Updated section 3.4: RTC and Low-Power Management; • Changed the modules' dimensions; • Updated Figure 8 and 7: Physical Dimensions; • Updated Table 8: Wi-Fi Radio.
2018.06	V1.4	• Deleted Temperature Sensor in Table 2: ESP32-WROOM-32D & ESP32-WROOM-32U Specifications; • Updated Chapter 3: Functional Description; • Added notes to Chapter 7: Peripheral Schematics; • Added Chapter 8: Recommended PCB Land Pattern; Changes to electrical characteristics: • Updated Table 5: Absolute Maximum Ratings; • Added Table 6: Recommended Operating Conditions; • Added Table 7: DC Characteristics; • Updated the values of "Gain control step", "Adjacent channel transmit power" in Table 10: Transmitter Characteristics - BLE.
2018.04	V1.3	Updated Figure 4 ESP32-WROOM-32U Schematics and Figure 3 ESP32-WROOM-32D Schematics.
2018.02	V1.2	Update Figure 4 ESP32-WROOM-32U Schematics.
2018.02	V1.1	Updated Chapter 6 Schematics. Deleted description of low-noise amplifier. Replaced the module name ESP-WROOM-32D with ESP32-WROOM-32D. Added information about module certification in Table 2. Updated the description of eFuse bits in Section 3.1.
2017.11	V1.0	First release.

Introduction

This is a waterproofed version of the **DS18B20 Arduino Temperature sensor** (https://www.dfrobot.com/product-689.html). Handy for when you need to measure something far away, or in wet conditions. While the sensor is good up to 125℃ the cable is jacketed in PVC so we suggest keeping it under 100℃. Because they are digital, you don't get any signal degradation even over long distances! The DS18B20 provides 9 to 12-bit (configurable) temperature readings over a 1-Wire interface, so that only one wire (and ground) needs to be connected from a central microprocessor.Usable with 3.0-5.5V systems. Because each DS18B20 contains a unique silicon serial number, multiple DS18B20s can exist on the same 1-Wire bus. This allows for placing temperature sensors in many different places. Applications where this feature is useful include HVAC environmental controls, sensing temperatures inside buildings,equipment or machinery, and process monitoring and control.

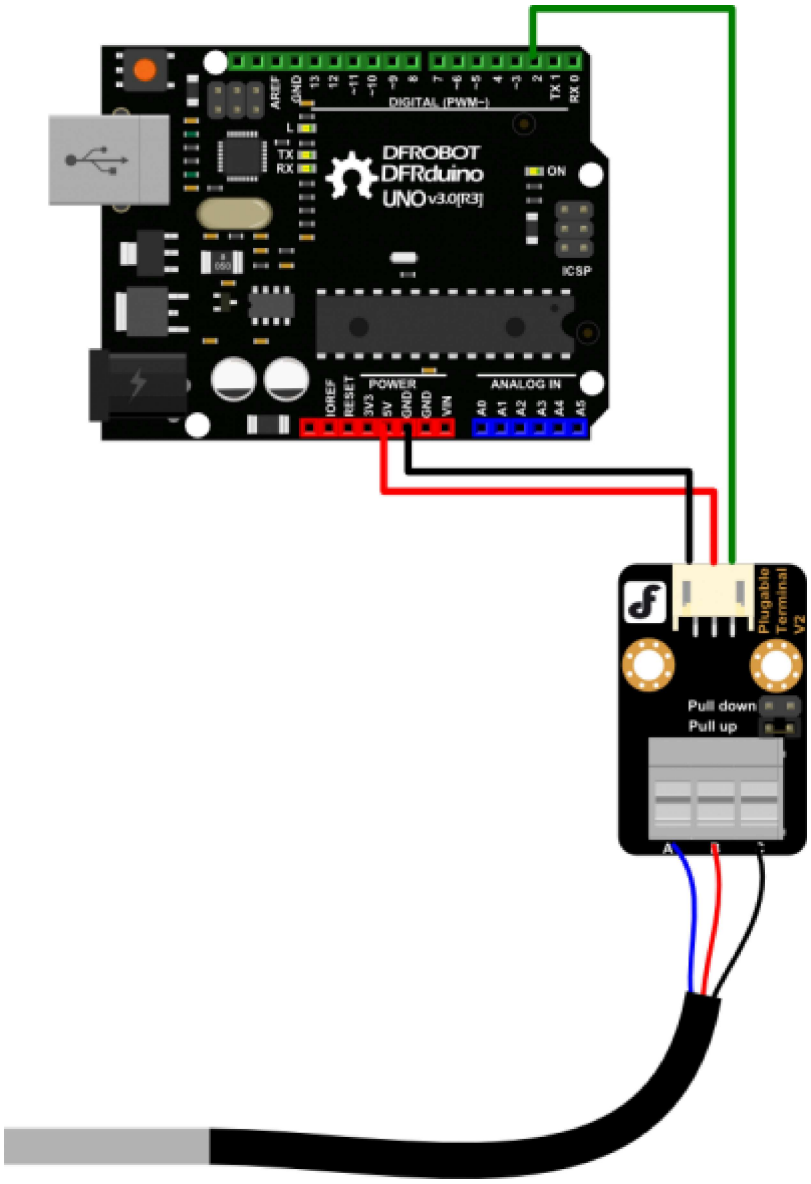
Specification

- Usable with 3.0V to 5.5V power/data
- ±0.5℃ Accuracy from -10℃ to +85℃
- Usable temperature range: -55 to 125℃ (-67℉ to +257℉)
- 9 to 12 bit selectable resolution
- Uses 1-Wire interface- requires only one digital pin for communication
- Unique 64 bit ID burned into chip
- Multiple sensors can share one pin
- Temperature-limit alarm system
- Query time is less than 750ms
- 3 wires interface:
  - Red wire - VCC
  - Black wire - GND
  - Yellow wire - DATA
- Stainless steel tube 6mm diameter by 35mm long
- Cable diameter: 4mm
- Length: 90cm

Sensor Connection

This sensor requires a 4.7K Ohm resistor between the voltage and Signal pin. as seen in the

picture below. Optionally you can use a Plugable Terminal sensor adapter (https://www.dfrobot.com/product-203.html) to help in making this connection secure.



Sample Code

Sample code for Arduino 1.0 and above.

```
#include <OneWire.h>

int DS18S20_Pin = 2; //DS18S20 Signal pin on digital 2

//Temperature chip i/o
OneWire ds(DS18S20_Pin);  // on digital pin 2

void setup(void) {
  Serial.begin(9600);
}

void loop(void) {
  float temperature = getTemp();
  Serial.println(temperature);

  delay(100); //just here to slow down the output so it is easier to read

}


float getTemp(){
  //returns the temperature from one DS18S20 in DEG Celsius

  byte data[12];
  byte addr[8];

  if ( !ds.search(addr)) {
      //no more sensors on chain, reset search
      ds.reset_search();
      return -1000;
  }

  if ( OneWire::crc8( addr, 7) != addr[7]) {
      Serial.println("CRC is not valid!");
      return -1000;
  }

  if ( addr[0] != 0x10 && addr[0] != 0x28) {
      Serial.print("Device is not recognized");
      return -1000;
  }

  ds.reset();
  ds.select(addr);
  ds.write(0x44,1); // start conversion, with parasite power on at the end

  byte present = ds.reset();
  ds.select(addr);
  ds.write(0xBE); // Read Scratchpad
```

```
  for (int i = 0; i < 9; i++) { // we need 9 bytes
    data[i] = ds.read();
  }

  ds.reset_search();

  byte MSB = data[1];
  byte LSB = data[0];

  float tempRead = ((MSB << 8) | LSB); //using two's compliment
  float TemperatureSum = tempRead / 16;

  return TemperatureSum;

}
```

Additional documentation

ZIP file (https://www.dfrobot.com/image/data/DFR0198/DFRobot%20DFR0198.zip) With sample codes, datasheet, and required libraries.

 Get **Waterproof DS18B20 Digital Temperature Sensor (SKU:DFR0198)** (https://www.dfrobot.com/product-689.html) from DFRobot Store or **DFRobot Distributor**. (https://www.dfrobot.com/index.php?route=information/distributorslogo)

Turn to the Top

Handson Technology

User Guide

I2C Serial Interface 1602 LCD Module

This is I2C interface 16x2 LCD display module, a high-quality 2 line 16 character LCD module with on-board contrast control adjustment, backlight and I2C communication interface. For Arduino beginners, no more cumbersome and complex LCD driver circuit connection. The real significance advantages of this I2C Serial LCD module will simplify the circuit connection, save some I/O pins on Arduino board, simplified firmware development with widely available Arduino library.

SKU: DSP-1182

Brief Data:

- Compatible with Arduino Board or other controller board with I2C bus.
- Display Type: Negative white on Blue backlight.
- I2C Address:0x38-0x3F (0x3F default)
- Supply voltage: 5V
- Interface: I2C to 4bits LCD data and control lines.
- Contrast Adjustment: built-in Potentiometer.
- Backlight Control: Firmware or jumper wire.
- Board Size: 80x36 mm.

Setting Up:

Hitachi's HD44780 based character LCD are very cheap and widely available, and is an essential part for any project that displays information. Using the LCD piggy-back board, desired data can be displayed on the LCD through the I2C bus. In principle, such backpacks are built around PCF8574 (from NXP) which is a general purpose bidirectional 8 bit I/O port expander that uses the I2C protocol. The PCF8574 is a silicon CMOS circuit provides general purpose remote I/O expansion (an 8-bit quasi-bidirectional) for most microcontroller families via the two-line bidirectional bus (I2C-bus). Note that most piggy-back modules are centered around PCF8574T (SO16 package of PCF8574 in DIP16 package) with a default slave address of 0x27. If your piggy-back board holds a PCF8574AT chip, then the default slave address will change to 0x3F. In short, if the piggy-back board is based on PCF8574T and the address connections (A0-A1-A2) are not bridged with solder it will have the slave address 0x27.

Address selection pads in the I2C-to-LCD piggy-back board.

Table 5. PCF8574A address map

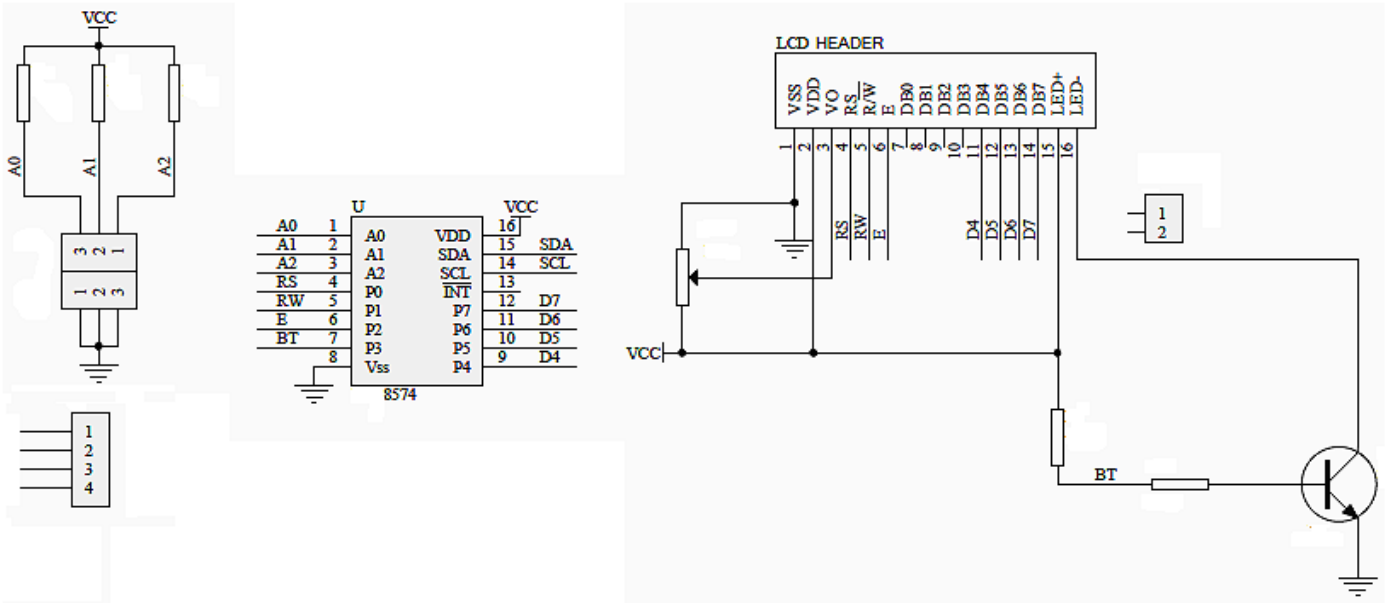
Pin connectivity			Address of PCF8574A								Address byte value		7-bit hexadecimal address without R/W
A2	A1	A0	A6	A5	A4	A3	A2	A1	A0	R/W	Write	Read	
V_{SS}	V_{SS}	V_{SS}	0	1	1	1	0	0	0	-	70h	71h	38h
V_{SS}	V_{SS}	V_{DD}	0	1	1	1	0	0	1	-	72h	73h	39h
V_{SS}	V_{DD}	V_{SS}	0	1	1	1	0	1	0	-	74h	75h	3Ah
V_{SS}	V_{DD}	V_{DD}	0	1	1	1	0	1	1	-	76h	77h	3Bh
V_{DD}	V_{SS}	V_{SS}	0	1	1	1	1	0	0	-	78h	79h	3Ch
V_{DD}	V_{SS}	V_{DD}	0	1	1	1	1	0	1	-	7Ah	7Bh	3Dh
V_{DD}	V_{DD}	V_{SS}	0	1	1	1	1	1	0	-	7Ch	7Dh	3Eh
V_{DD}	V_{DD}	V_{DD}	0	1	1	1	1	1	1	-	7Eh	7Fh	3Fh

Address Setting of PCD8574A (extract from PCF8574A data specs).

Note: When the pad A0~A2 is open, the pin is pull up to VDD. When the pin is solder shorted, it is pull down to VSS.

The default setting of this module is A0~A2 all open, so is pull up to VDD. The address is 3Fh in this case.

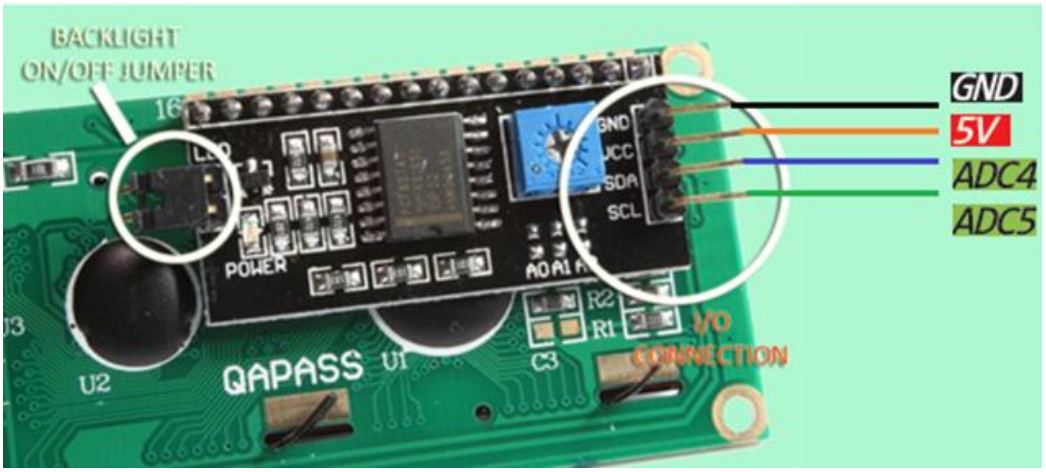
Reference circuit diagram of an Arduino-compatible LCD backpack is shown below. What follows next is information on how to use one of these inexpensive backpacks to interface with a microcontroller in ways it was exactly intended.



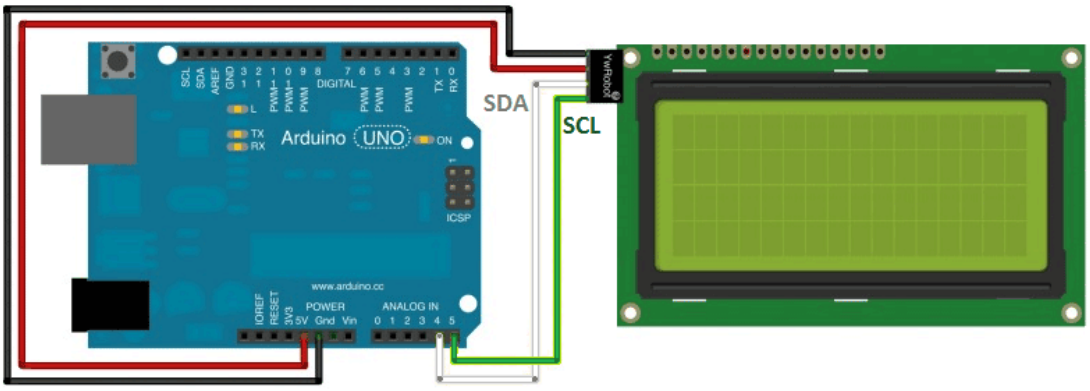
Reference circuit diagram of the I2C-to-LCD piggy-back board.

I2C LCD Display.

At first you need to solder the I2C-to-LCD piggy-back board to the 16-pins LCD module. Ensure that the I2C-to-LCD piggy-back board pins are straight and fit in the LCD module, then solder in the first pin while keeping the I2C-to-LCD piggy-back board in the same plane with the LCD module. Once you have finished the soldering work, get four jumper wires and connect the LCD module to your Arduino as per the instruction given below.



LCD display to Arduino wiring.



Arduino Setup

For this experiment it is necessary to download and install the "Arduino I2C LCD" library. First of all, rename the existing "LiquidCrystal" library folder in your Arduino libraries folder as a backup, and proceed to the rest of the process.

https://bitbucket.org/fmalpartida/new-liquidcrystal/downloads

Next, copy-paste this example sketch Listing-1 for the experiment into the blank code window, verify, and then upload.

Arduino Sketch Listing-1:

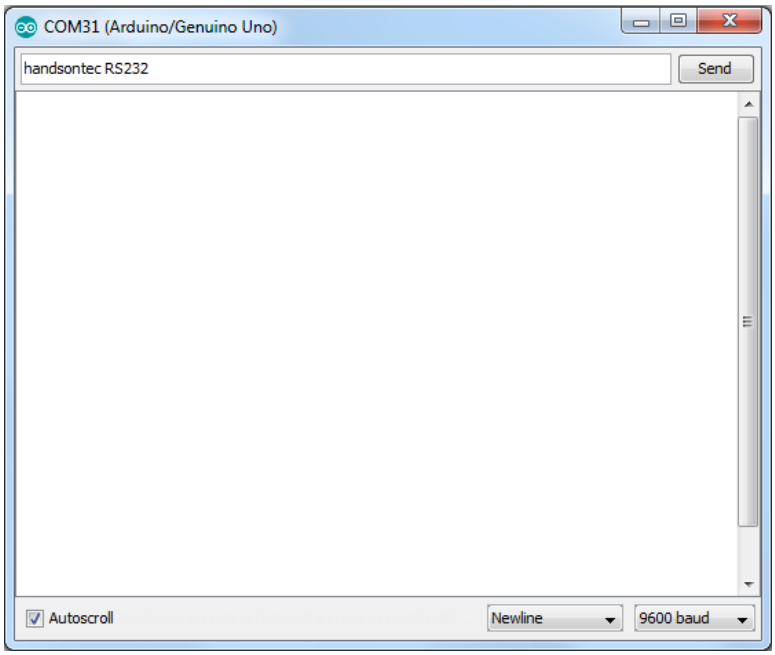
```
/*=========================================================================
//  Author      : Handson Technology
//  Project     : I2C to LCD with Arduino Uno
//  Description : LCD with I2C Interface.
//  LiquidCrystal Library - I2C Serial to LCD
//  Source-Code : I2C LCD.ino
//=========================================================================
*/

/*-----( Import needed libraries )-----*/
#include <Wire.h> // Comes with Arduino IDE
// Get the LCD I2C Library here:
// https://bitbucket.org/fmalpartida/new-liquidcrystal/downloads
// Move any other LCD libraries to another folder or delete them
// See Library "Docs" folder for possible commands etc.

#include <LiquidCrystal_I2C.h>
/*-----( Declare Constants )-----*/
// set the LCD address to 0x3F for PCF8574AT with A0,A1,A0 address line open, default
setting.
// Set the pins on the I2C chip used for LCD connections:
//                    (addr, en,rw,rs,d4,d5,d6,d7,bl,blpol)
LiquidCrystal_I2C lcd(0x3F, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE);  // Set the LCD I2C
address

/*-----( Declare Variables )-----*/


void setup()   /*----( SETUP: RUNS ONCE )----*/
{
  Serial.begin(9600);  // Used to type in characters

  lcd.begin(20,4);         // initialize the lcd for 20 chars 4 lines, turn on
backlight

// ------- Quick 3 blinks of backlight  -------------
  for(int i = 0; i< 3; i++)
  {
    lcd.backlight();
    delay(250);
    lcd.noBacklight();
    delay(250);
  }
  lcd.backlight(); // finish with backlight on

//-------- Write characters on the display ------------------
  // NOTE: Cursor Position: Lines and Characters start at 0
  lcd.setCursor(3,0); //Start at character 4 on line 0
  lcd.print("Hello, world!");
  delay(1000);
  lcd.setCursor(2,1);
  lcd.print("From Handsontec  ");
```

```
  delay(1000);
  lcd.setCursor(0,2);
  lcd.print("20 by 4 Line Display");
  lcd.setCursor(0,3);
  delay(2000);
  lcd.print(" www.handsontec.com ");
  delay(8000);
  // Wait and then tell user they can start the Serial Monitor and type in characters
to
  // Display. (Set Serial Monitor option to "No Line Ending")
  lcd.setCursor(0,0); //Start at character 0 on line 0
  lcd.print("Start Serial Monitor");
  lcd.setCursor(0,1);
  lcd.print("Type char to display");


}/*--(end setup )---*/


void loop()    /*----( LOOP: RUNS CONSTANTLY )----*/
{
  {
    // when characters arrive over the serial port...
    if (Serial.available()) {
      // wait a bit for the entire message to arrive
      delay(100);
      // clear the screen
      lcd.clear();
      // read all the available characters
      while (Serial.available() > 0) {
        // display each character to the LCD
        lcd.write(Serial.read());
      }
    }
  }

}/* --(end main loop )-- */


/* ( THE END ) */
```

If you are 100% sure that everything is okay, but you don't see any characters on the display, try to adjust the contrast control pot of the backpack and set it a position where the characters are bright and the background does not have dirty boxes behind the characters. Following is a partial view of author's experiment with the above described code with 20x4 display module. Since the display used by the author is a very clear bright "black on yellow" type, it is very difficult to get a good catch due to polarization effects.

This sketch will also display character send from serial Monitor:

In Arduino IDE, go to “Tools” > “Serial Monitor”. Set the correct baud rate at 9600. Type the character on the top empty space and hit “SEND”.



The string of character will be displayed on the LCD module.

Resources:

- Handson Technology
- Complete Guide to Arduino LCD Interfacing (PDF)

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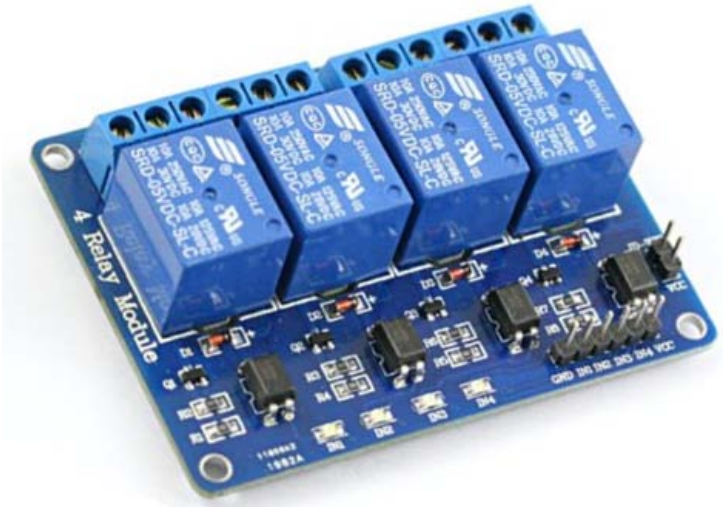
User Guide

4 Channel 5V Optical Isolated Relay Module

This is a LOW Level 5V 4-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller. This module is optically isolated from high voltage side for safety requirement and also prevent ground loop when interface to microcontroller.



Brief Data:

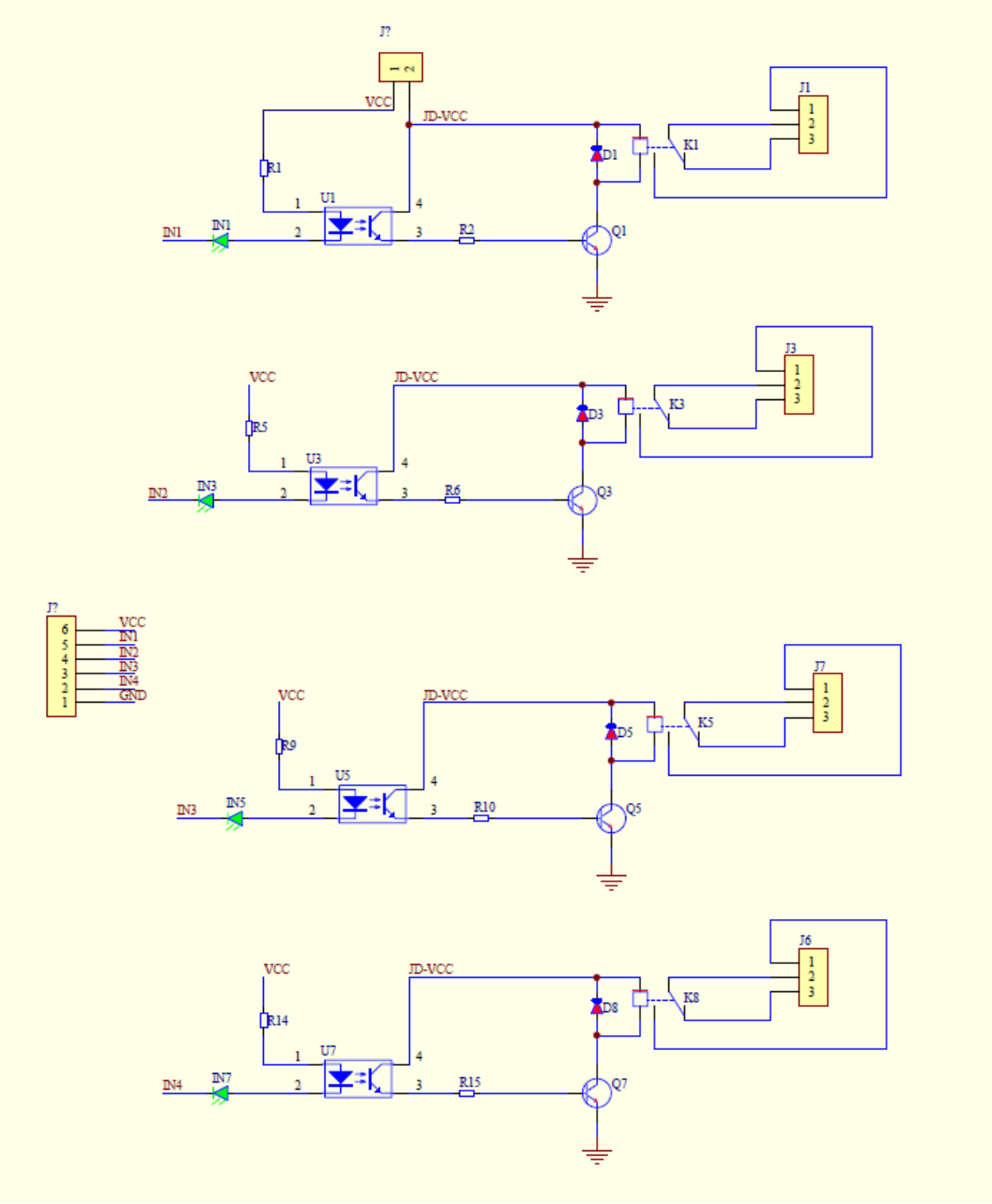
- Relay Maximum output: DC 30V/10A, AC 250V/10A.
- 4 Channel Relay Module with Opto-coupler. LOW Level Trigger expansion board, which is compatible with Arduino control board.
- Standard interface that can be controlled directly by microcontroller (8051, AVR, *PIC, DSP, ARM, ARM, MSP430, TTL logic).
- Relay of high quality low noise relays SPDT. A common terminal, a normally open, one normally closed terminal.
- Opto-Coupler isolation, for high voltage safety and prevent ground loop with microcontroller.

Schematic:

VCC and RY-VCC are also the power supply of the relay module. When you need to drive a large power load, you can take the jumper cap off and connect an extra power to RY-VCC to supply the relay; connect VCC to 5V of the MCU board to supply input signals.

NOTES: If you want complete optical isolation, connect "Vcc" to Arduino +5 volts but do NOT connect Arduino Ground. Remove the Vcc to JD-Vcc jumper. Connect a separate +5 supply to "JD-Vcc" and board Gnd. This will supply power to the transistor drivers and relay coils.

If relay isolation is enough for your application, connect Arduino +5 and Gnd, and leave Vcc to JD-Vcc jumper in place.



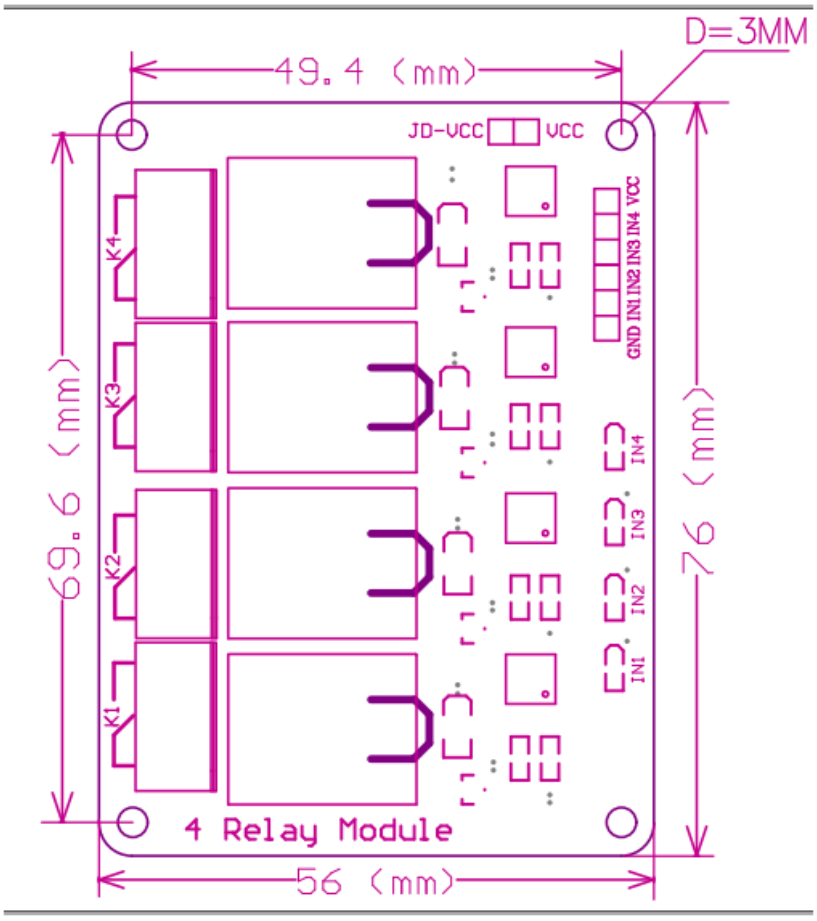
4 Channel Relay Module Schematic

It is sometimes possible to use this relay boards with 3.3V signals, if the JD-VCC (Relay Power) is provided from a +5V supply and the VCC to JD-VCC jumper is removed. That 5V relay supply could be totally isolated from the 3.3V device, or have a common ground if opto-isolation is not needed. If used with isolated 3.3V signals, VCC (To the input of the opto-isolator, next to the IN pins) should be connected to the 3.3V device's +3.3V supply.

NOTE: Some Raspberry-Pi users have found that some relays are reliable and others do not actuate sometimes. It may be necessary to change the value of R1 from 1000 ohms to something like 220 ohms, or supply +5V to the VCC connection.

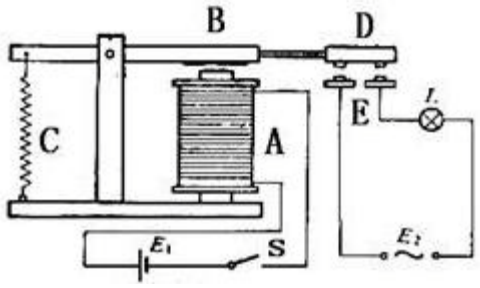
NOTE: The digital inputs from Arduino are Active LOW: The relay actuates and LED lights when the input pin is LOW, and turns off on HIGH.

Module Layout:



Operating Principle:

See the picture below: A is an electromagnet, B armature, C spring, D moving contact, and E fixed contacts. There are two fixed contacts, a normally closed one and a normally open one. When the coil is not energized, the normally open contact is the one that is off, while the normally closed one is the other that is on.



Supply voltage to the coil and some currents will pass through the coil thus generating the electromagnetic effect. So the armature overcomes the tension of the spring and is attracted to the core, thus closing the moving contact of the armature and the normally open (NO) contact or you may say releasing the former and the normally closed (NC) contact. After the coil is de-energized, the electromagnetic force disappears and the armature moves back to the original position, releasing the moving contact and normally closed contact. The closing and releasing of the contacts results in power on and off of the circuit.

Input:

VCC : Connected to positive supply voltage (supply power according to relay voltage)

GND : Connected to supply ground.

IN1: Signal triggering terminal 1 of relay module

IN2: Signal triggering terminal 2 of relay module

IN3: Signal triggering terminal 3 of relay module

IN4: Signal triggering terminal 4 of relay module

Output:

Each module of the relay has one NC (normally close), one NO (normally open) and one COM (Common) terminal. So there are 4 NC, 4 NO and 4 COM of the channel relay in total. NC stands for the normal close port contact and the state without power. NO stands for the normal open port contact and the state with power. COM means the common port. You can choose NC port or NO port according to whether power or not.

Testing Setup:

When a low level is supplied to signal terminal of the 4-channel relay, the LED at the output terminal will light up. Otherwise, it will turn off. If a periodic high and low level is supplied to the signal terminal, you can see the LED will cycle between on and off.

For Arduino：

Step 1：

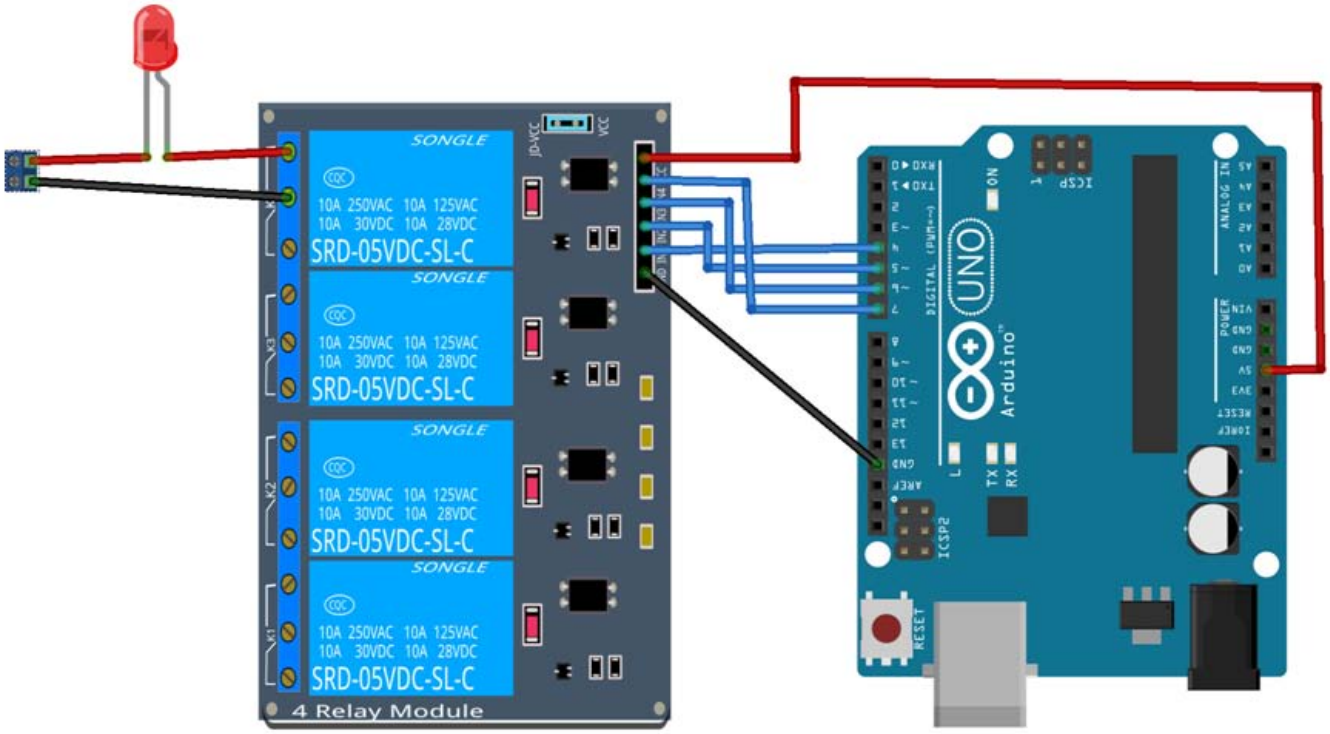
Connect the signal terminal IN1、IN2, IN3 & IN4 of 4-channel relay to digital pin 4, 5, 6, 7 of the Arduino Uno or ATMega2560 board, and connect an LED at the output terminal.

IN1> 4; IN2> 5; IN3>6; IN4>7

Step 2:

Upload the sketch "4 Channel Relay Demo " to the Arduino Uno or ATMega2560 board. Then you can see the LED cycle between on and off.

The actual figure is shown below:



Arduino Sketch: 4 Channel Relay Demo

```
/*************************************************
   Name: 4 channel_relay
   Description: control the 4 channel relay module to ON or OFF
   Website: www.handsontec.com
   Email: techsupport@handsontec.com
**************************************************/

//the relays connect to

int RelayControl1 = 4;    // Digital Arduino Pin used to control the motor
int RelayControl2 = 5;
int RelayControl3 = 6;
int RelayControl4 = 7;


void setup()
{
  Serial.begin(9600);
  pinMode(RelayControl1, OUTPUT);
  pinMode(RelayControl2, OUTPUT);
  pinMode(RelayControl3, OUTPUT);
  pinMode(RelayControl4, OUTPUT);
}


void loop()
{

  digitalWrite(RelayControl1,HIGH);// NO1 and COM1 Connected (LED on)
  delay(1000);
```

```
  digitalWrite(RelayControl1,LOW);// NO1 and COM1 disconnected (LED off)
  delay(1000);
  digitalWrite(RelayControl2,HIGH);
  delay(1000);
  digitalWrite(RelayControl2,LOW);
  delay(1000);
  digitalWrite(RelayControl3,HIGH);
  delay(1000);
  digitalWrite(RelayControl3,LOW);
  delay(1000);
  digitalWrite(RelayControl4,HIGH);
  delay(1000);
  digitalWrite(RelayControl4,LOW);
  delay(1000);
}
```

PS-601250
PS 12V/5A enclosed switch mode power supply

Edition: 9 from 27.05.2014
Supercedes edition: 8 from 07.03.2013

EN

Features of the power supply unit:

- power output 5A/12÷15VDC*
- universal AC input voltage range 85÷264V
- high efficiency 80%
- LED optical signalisation
- protections:
  - SCP short-circuit protection
  - overvoltage OVP
  - overvoltage protection
  - overload (OLP)
- warranty – 2 year from the production date

1. Technical description.

1.1. General description.

The power supply unit is intended for the feeding of alarm system equipments, which require 12V DC supply voltage and current load **I=5A**. The design enables simple changing of the output voltage, within the range of 12V÷15V DC, using a potentiometer. The power supply unit is protected against short-circuit, overload and overvoltage.

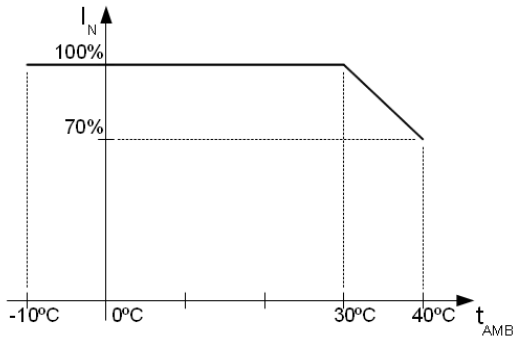
1.2. Technical parameters.

Supply voltage	85 ÷ 264 V AC, 120 ÷ 370 V DC
Current consumption	0,6A@230VAC max.
Supply power	60W max.
Efficiency	80%
Output voltage	12V DC
Output current t_{AMB}<30°C	**5A - see graph 1.**
Output current t_{AMB}=40°C	**3,5 A - see graph 1.**
Voltage adjustment range	12 V ÷ 15V DC
Ripple voltage	100mV p-p max.
Short-circuit protection SCP	electronic, automatic recovery
Overload protection OLP	105-150% of power supply, automatic recovery
Surge protection	varistors
Overvoltage protection OVP	>16V (automatic return)
Optical signalisation	green LED – presence of DC voltage
Operation conditions	2-nd enviromental class, temperature: -10 °C÷40 °C relative humidity 20%...90%, without condensation
Dimensions (LxWxH)	159 x 97 x 38 [mm]
Net/gross weight	0,48kg / 0,51kg
Protection class PN-EN 60950-1:2007	I (first) – requires a protective conductor (PE)
Connectors	power-supply:Φ0,63-2,50 (AWG 22-10) outputs : Φ0,63-2,50 (AWG 22-10)
Electrical strength of insulation: - between input (network) circuit and output circuits of power-supply (I/PO/P) - between input circuit and PE protection circuit (I/P-FG) - between output circuit and PE protection circuit (O/P-FG)	 3000 V/AC min. 1500 V/AC min. 500 V/AC min.
Insulation resistance: - between input circuit and output or protection circuit	 100 MΩ, 500V/DC
Storage temperature	-20ºC...+60ºC
Vibrations and impulse waves during transport	according to PN-83/T-42106

* In order to extend the life of the power supply, the load current of 3,5A is recommended.

* See graph 1.

1.3. Output current vs temperature.



Graph 1.
Allowable output current from the power supply depending on ambient temperature (instantaneous load).

2. Installation.

2.1. Requirements.

The power supply shall be mounted by the qualified installer having appropriate (required and necessary for a given country) permissions and qualifications for connecting (operating) low-voltage installations. The unit shall be mounted in closed rooms, according to the environment class II, of the normal air humidity (RH=90% max. without condensation) and the temperature within the range from -10°C to +40°C.

The power supply shall be mounted in a close casing (a cubicle, a terminal device) and in order to fulfill LVD and EMC requirements the rules for power-supply, encasing and shielding shall be observed according to application.

Due to the power supply design, the PE wire has to be connected to the corresponding connector of the supply unit. Operation without proper grounding of the power supply is not allowed!

2.2. Installation procedure.

1. Prior to installation of the power supply unit, make sure that power leads have been disconnected from the 230VAC mains.
2. Install the unit in the previously selected place.
3. Connect the 230VAC power leads. Connect the PE cable (yellow-green) to an appropriate terminal on the power supply unit (marked with ⏚).

The circuit of the shock protection shall be performed with a particular care, i.e. the yellow and green protection wire of the power cable shall be connected from one side to the terminal marked by the symbol of ⏚ in the casing of the power-supply. Operation of the power-supply without the properly made and fully operational circuit of the shock protection is UNACCEPTABLE!
It can result in failure of devices and electric shock.

---

4. Connect load/loads to proper output connectors of the power supply (positive end is marked as +V, negative end as -V).
5. Upon the completion of tests and trial activation, close the housing, cabinet etc.

2.3. Description of terminal.

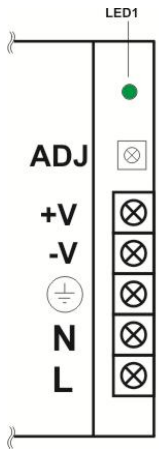


Fig.1. Description of terminal.

Elements/connectors [Fig.1]	Description
L, N, ⏚	**L-N** - input voltage connectors 230 V AC, ⏚ – protective conductor connector
-V	Power supply output (0V)
+V	Power supply output (+12V)
LED1	LED signals the presence of voltage at the unit's output
ADJ	Potentiometer - output voltage adjust

2.4. Dimensions and fitting of the PS-601250 power supply.

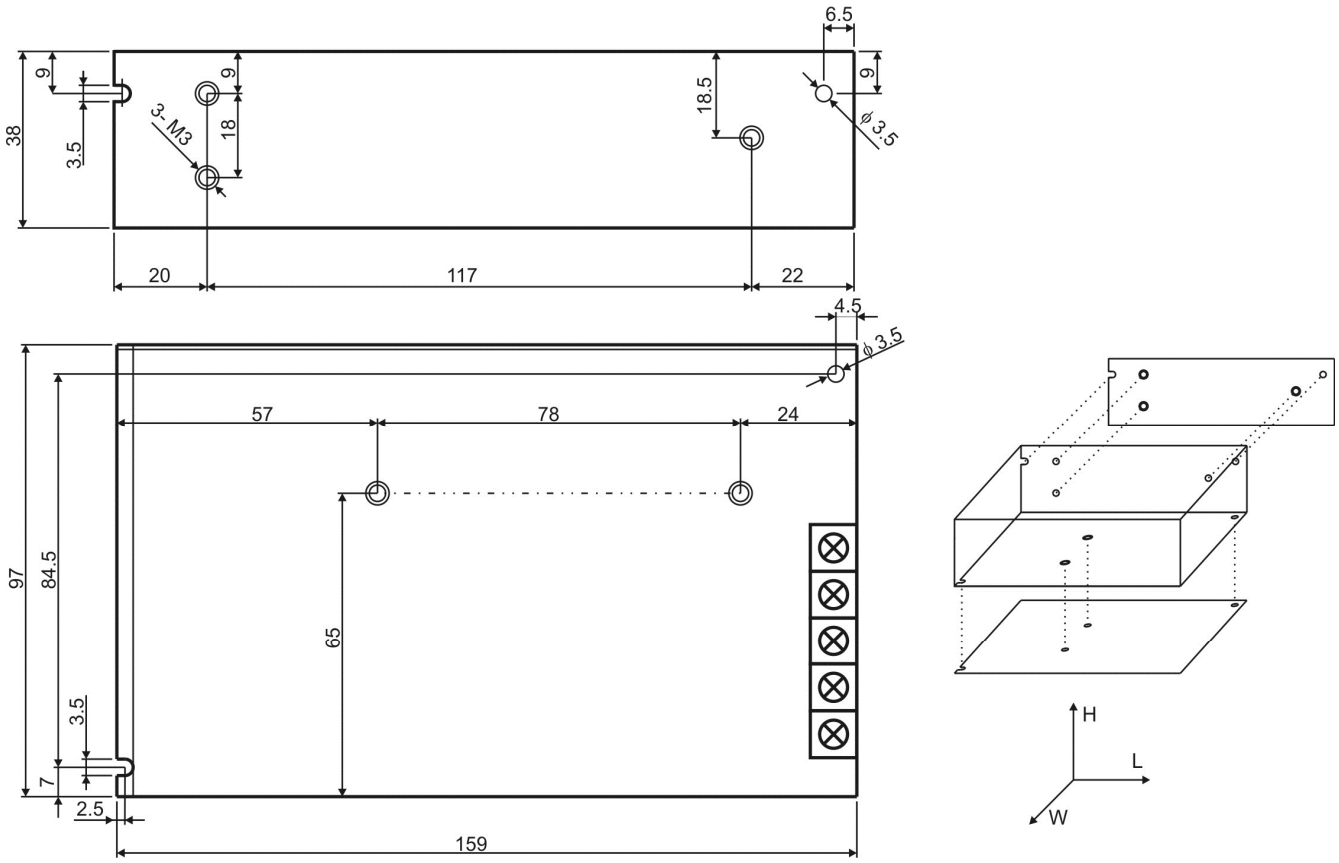


Fig.2. Dimensions of power supply.

3. Maintenance.

All maintenance procedures can be performed after the disconnection of the power supply from the electrical grid. The power supply does not require any special maintenance procedures, but in the case of significant dust accumulation, dusting using compressed air is recommended.

WEEE designation

The waste electric and electronic equipment worn out may not be disposed of together with standard household waste. According to the WEEE directive, applicable in the EU, the separate neutralization methods should be used for electric and electronic equipment.

GENERAL WARRANTY CONDITIONS

1. Pulsar K. Bogusz Sp.j. (the manufacturer) grants a two-year warranty for the equipment, , counted from the device's production date.
2. The warranty includes free-of-charge repair or replacement with an appropriate equivalent (the selection is at the manufacturer's discretion) if the malfunction is due to the manufacturer, includes manufacturing or material defects, unless such defects have been reported within the warranty period (item 1).
3. The equipment subject to warranty is to be brought to the place where it was purchased, or directly to the main office of the manufacturer.
4. The warranty applies to complete equipment, accompanied by a properly filled warranty claim with a description of the defect.
5. Should the claim be accepted, the manufacturer is obliged to provide warranty repairs, at the earliest convenienve, however not later that within 14 days from the delivery to the service centre of the manufacturer.
6. The repair period mentioned in item 5 may be prolonged, if there are no technical possibilities to carry out the repairs, or if the equipment has been conditionally accepted, due to the breaking warranty terms by the claimant.
7. All the services rendered by force of the warranty arecarried out at the service centre of the manufacturer, exclusively.
8. The warranty does not cover the defects of the equipment, resulting from:
- reasons beyond the manufacturer's control,
- mechanical damage,
- improper storage and transport,
- use that violates the operation manual or equipment's intended use
- fortuitous events, including lightning discharges, power failures, fire, flood, high temperatures and chemical agents,
- improper installation and configuration (in defiance with the manual),
9. The warranty is void in any of the following circumstances:
- construction changes
- repairs carried out by any unauthorized service center
- damage or removal of warranty labels
- modifications of the serial number
10. The liability of the manufacturer towards the buyer is limited to the value of the equipment, determined according to the wholesale prices suggested by the manufacturer on the day of purchase.
11. The manufacturer takes no reponsibility for the defects that result from:
- the damaging, malfunctioning or inability to operate the equipment
- defects that result from using the equipment outside its stated specifications and operating parameters failing to abide by the recommendations and requirements contained in the manual, or the use of the equipment.

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