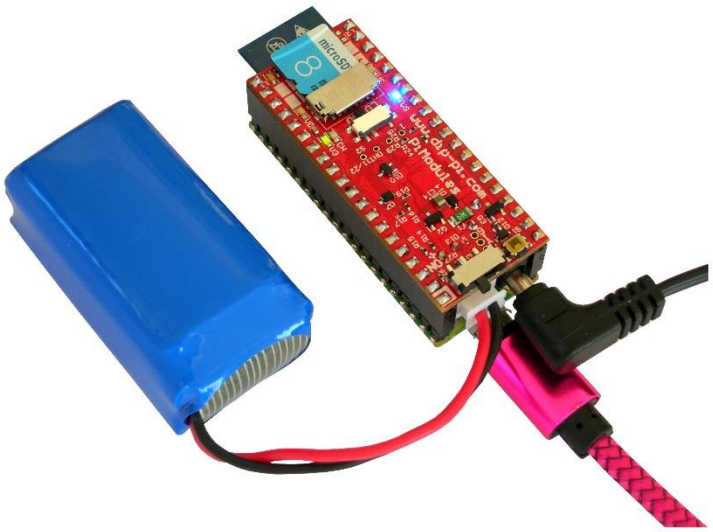
Dual in-line Package Raspberry Pi PICO

For Battery, USB and Extended Powered IoT WiFi Applications

with Embedded UPS Functionality

DiP-Pi PIoT

Supported Models PIoT: Full, Power Master and WiFi Master



No Solder – No cables – No Lost Time

User Guide

Especially designed for the Raspberry Pi® PICO

"Raspberry Pi" is a trademark of the Raspberry Pi® Foundation.

Designed and Manufactured by www.pimodules.com

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System Overview

Introduction

Dual **i**n-L**i**ne **P**ackage Raspberry **Pi PICO** (**DiP-Pi PICO**) is a family of self-containing, stackable add-ons to the Raspberry Pi PICO® that decrease to the minimum user involvement for hardware development of application/idea testing based on Raspberry Pi PICO. **DiP-Pi PICO** takes care to support with all basic functionalities possible required by under development user application. User can easy stack-up (if used Stack headers) 2, 3 or more separated **DiP-Pi PICO**, possible add own PCB and rapidly run their application or use as a standalone self-containing device together with Raspberry Pi PICO® (if used Top-End headers). If designed application fulfills required needs; after successfully testing, user has 3 solutions:

- It is possible to use selected and tested **DiP-Pi** set and use them as it is for the application,
- User design the hardware by himself based on selected and tested **DiP-Pi**,
- And finally, ask Designer and Manufacturer company (**www.pimodules.com**) to design a single PCB (and if needed manufacture) based on tested **DiP-Pi** set. Pi Modules has signed agreement with Raspberry Pi and currently is "Raspberry Pi Approved Design Partner"

The list of available **DiP-Pi** is long and continuously updated with new **DiP-Pi**. Each **DiP-Pi** is supported with a simple code supporting its features (written in micro-Python or C).

The **DiP-Pi PICO PIoT** (named also DiP-Pi PIoT) is an advanced powering system, with **UPS functionality**, that cover all possible powering needs for application build-up based on Raspberry Pi PICO. It is supplying the system with up to 1.5A@5V from 6-18 VDC on various powering sources like Cars, Solar Panels industrial plant etc. It supports LiPo or Li-Ion Battery charger as also simply switching from cable powering to battery powering or reverse (**UPS functionality**). The EPR power source is protected with PPTC Resettable fuse, Reverse Polarity, as also ESD. The **DiP-Pi PIoT** contains Raspberry Pi PICO embedded RESET button and ON/OFF switch on all powering sources (USB, EPR or Battery). User can monitor (via A/D) battery level and External Powering Level with PICO's A/D converters. Both A/Ds are protected also from ESD spikes with additional protection TVS. If for any reason user needs to use those PICO pins for their own application a simple 0402 resistors (0 OHM) need to be easy removed.

The charger is automatically charging connected battery (if used) but in addition user can switch it ON/OFF if their application needs it.

Each powering source or battery charger status is indicated by separate informative LEDs (VBUS, VSYS, VEPR, 3V3, CHGR).

User can use any capacity of LiPo or Li-Ion type, however, must take care to use PCB protected batteries. The charger is set to charge battery with 240 mA current. This current is set by resistor so if user need can himself change it to higher or lower value adjusting current to application exact needs. It can be done also by Manufacturer on customer request.

Available DiP-Pi PIoT Models

The **DiP-Pi PICO PIoT** is assembled around of a single PCB and is offering 3 different devices. There are:

DiP-Pi PICO PIoT Full

This model is equipped with all available features, including extended powering, Battery Charger, UPS Functionality, micro–SD Card, WiFi Module, Interfaces and ON/OFF features.

A detailed list of features is provided below on **Table 1** DiP-Pi PIoT Technical Specifications

DiP-Pi PICO Power Master

This model is equipped with reduced set of features, and including extended powering, Battery Charger, UPS Functionality, Interfaces and ON/OFF features.

A detailed list of features is provided below on **Table 2** DiP-Pi PIoT Technical Specifications

DiP-Pi PICO WiFi Master

This model is equipped with reduced set of features including micro–SD Card, WiFi Module, Interfaces and ON/OFF features.

A detailed list of features is provided below on **Table 3** DiP-Pi PIoT Technical Specifications

DiP-Pi PIoT Technical Specifications

Mechanical		PIoT	WiFi Master	Power Master
DiP-Pi PCB dimensions	21mm x 51mm	YES	YES	YES
Raspberry Pi PICO Footprint compliance	Yes, size and pinout	YES	YES	YES
Raspberry Pi PICO headers	Male, female, or female-male (pass thru)	YES	YES	YES
External Cable Powering				
EPR Power Input	6-18V DC	YES	NO	YES
Current/Voltage Supply	1.5A@4.8V	YES	NO	YES
EPR Power Input Protections	Reverse Polarity, PPTC FUSE, ESD	YES	NO	YES
Recommended EPR Power Input Plug	Plug; DC supply; female; 3.4/1.4mm	YES	NO	YES
EPR Power Input Socket	Socket, DC Supply, male, Contact size 3.4/1.3mm or 3.5/1.3mm	YES	NO	YES
EPR Level monitoring	Yes, via ADC1 (GP27), pass thru 0R 0402 resistor, easy to be removed if this specific GP is needed for other application	YES	NO	YES
External Powering and USB Powering ON/OFF	Supported by ON/OFF Slide Switch	YES	YES	YES
Raspberry Pi PICO USB Powering	Compliant	YES	YES	YES

Raspberry Pi PICO Power Entry Point	VSYS Pin	YES	NO	YES
Battery Powering				
Supported Battery Types	PCM Protected (2A Max allowed Current – 2A) LiPo and Li-Ion Batteries	YES	NO	YES
Battery Socket	Male JST 2.5mm	YES	NO	YES
Battery Charger Current	240 mA	YES	NO	YES
Battery Fuel Gauge	Software - provided by Manufacturer	YES	NO	YES
(optional) Charger ON/OFF. Normally charger is working automatically, and not need any user intervention	Yes, via GP21, pass thru 0R 0402 resistor, easy to be removed if this specific GP is needed for other application	YES	NO	YES
BAT Level monitoring	Yes, via ADC1 (GP26), pass thru 0R 0402 resistor, easy to be removed if this specific GP is needed for other application	YES	NO	YES
ON/OFF Functionality	Supported by ON/OFF Slide Switch on All Power Sources	YES	NO	YES
UPS Functionality	Yes, automatic if Cable power missing (EPR, USB) both directions (from missing cable to battery powering and vice versa)	YES	NO	YES
Indicators - Switches				
Informative LEDs	VB (VUSB), VS (VSYS), VE (VEPR), CH(VCHR), V3(V3.3)	YES	YES	YES
Switches	PICO Reset, ON/OFF on all Powering Sources (EPR, USB and BAT), WiFi LD-NO (Normal usage, Loading ESP new firmware – usually not needed)	YES	YES	YES
WiFi				
WiFi Module	Based on clone ESP8266 Clone – WT8266	YES	YES	NO
Connectivity with Raspberry Pi PICO	UART0RX(GP13), UART0TX(GP12), WiFi Reset (GP15), WiFi ENABLE(GP11) used when ultra-low power is needed. Examples provided contains simple WEB server set up. Interaction with WiFi is done via AT commands.	YES	YES	NO
Micro SD Card Socket				
Interface Type	Standard micro–SD Cards Interface recommended by Raspberry Pi (single bit interface - SPI). Raspberry Pi PICO can store/read data or	YES	YES	NO

	run software from the SD card.			
Connectivity with Raspberry Pi PICO	SPI0 SD_MISO(GP16), SD_CS(GP17), SD_CLK(GP18), SD_MOSI(GP19), SD_DET(GP20), – if SD card is not used the GPXX can be used in other applications	YES	YES	NO
Embedded ESD protected 1-wire interface				
Type 1-Wire Interface	Direct independent Interface (separated 3V3 and GND independent) with ESD protection and 4K7 resistor	YES	YES	YES
Connectivity with Raspberry Pi PICO	1-Wire (GP10) routed to independent 3 pins interface (3V3, 1-Wire, GND)	YES	YES	YES
1-Wire powering	Independent LDO 3V3@600mA used for WiFi, 1-Wire and DHT11/22, independent from PIco 3V3 Powering, Current Limit and Short Circuit Protection, Thermal Shutdown Protection	YES	YES	YES
1-Wire Connectivity	3 pins (holes) independent connectivity	YES	YES	YES
DHT22 and DHT11 interface				
Humidity/Temperature Sensor Interface	Direct independent Interface (separated 3V3 and GND independent) with 10K resistor	YES	YES	YES
DHT11	Supported	YES	YES	YES
DHT22	Supported	YES	YES	YES
Additional User Application 3V3 LDO				
Type of Powering	independent LDO 3V3@600mA used for WiFi, 1-Wire and DHT11/22, separated from PIco 3V3 Powering, Current Limit and Short Circuit Protection, Thermal Shutdown Protection. Can be used for any user application. 3V3 is sourced from VSYS.	YES	YES	YES
Weather Station Capabilities				
Humidity/Temperature Sensor Interface	DHT22, or DHT11 (only one can be used at the time)	YES	YES	YES
Used/Free Raspberry Pi PICO Pins				
USED PINS	FREE PINS	YES	YES	YES
<u>Left Side</u> GP10 (if used for the 1-wire) – all versions GP11 (if WiFi is assembled) – WiFi and PIoT	<u>Left Side</u> GP00 GP01 GP02 GP03	YES	YES	YES

GP12 (if WiFi is assembled) – WiFi and PIoT GP13 (if WiFi is assembled) – WiFi and PIoT GP14 used for User LEDs (optional) GP15 (if WiFi is assembled) – WiFi and PIoT <u>Right Side</u> GP27 (if used for EPR monitoring) GP26 (if used for BAT monitoring) GP22 (if used for DHT11/22 monitoring) GP21 (if used for Charger Control) GP20 (if SD Card is used) – PIoT only GP19 (if SD Card is used) – PIoT only GP18 (if SD Card is used) – PIoT only GP17 (if SD Card is used) – PIoT only GP16 (if SD Card is used) – PIoT only	GP04 GP05 GP06 GP07 GP08 GP09 GP10 (if not used for the 1-wire) <u>Right Side</u> GP28 GP27 (if not used for EPR monitoring) GP26 (if not used for BAT monitoring) GP22 (if not used for DHT11/22 monitoring) GP21 (if not used for Charger Control) GP20 (if SD Card is not used) GP19 (if SD Card is not used) GP18 (if SD Card is not used) GP17 (if SD Card is not used) GP16 (if SD Card is not used)			

Table 4 DiP-Pi PIoT Technical Specifications

Setting up Procedure

Installing Thonny and testing your Raspberry Pi Pico

The **DiP-Pi**s are offered to user with a set ready to use interfaces as also access to WiFi network combined with extended Powering and UPS functionality, all-in-one! Some simple and more complicated examples **ready-to-use** are available **here**. This set of **ready-to-use** examples is under continuously update with new one. They have been written on **Micro Python** and suggested tool for using them is **Thonny**, as it is extremely user friendly. It is obviously that, user can use any other tool as also language i.e., C or C++. As most of the users are using their Windows PC, we provide installation instruction for Windows, however they are similar for macOS and Raspberry Pi.

Thonny is an integrated development environment for Python that is designed for beginners. It supports different ways of stepping through the code, step-by-step expression evaluation, detailed visualization of the call stack and a mode for explaining the concepts of references and heap. It is extremely user friendly fro beginner but also for experienced users.

Simple Instructions for Downloading and installing **Thonny** for Raspberry Pi Pico.

- Download and install **Thonny** from below link

  https://thonny.org

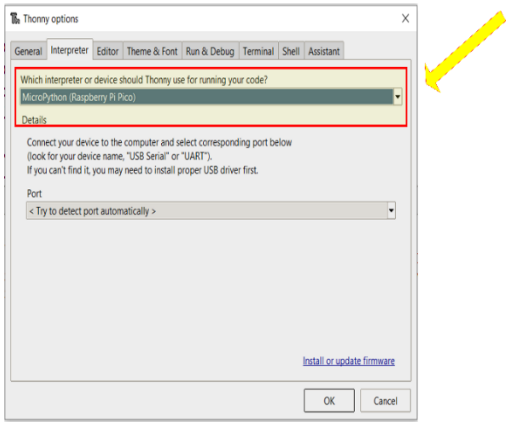


Figure 1 Installing Thonny

- Connect the Raspberry Pi Pico to your computer and in **Thonny** go to **Tools > Options** and click on the Interpreter tab. From the interpreter drop-down list select **Micro Python** (Raspberry Pi Pico). The port drop-down menu can be left to automatically detect the Pico. Click OK to close.

- Press the BOOT button on Pico and enter micro-USB Cable, proceed with installation. Then press Close

- You should see (if click on) the Serial Port assigned to Pico

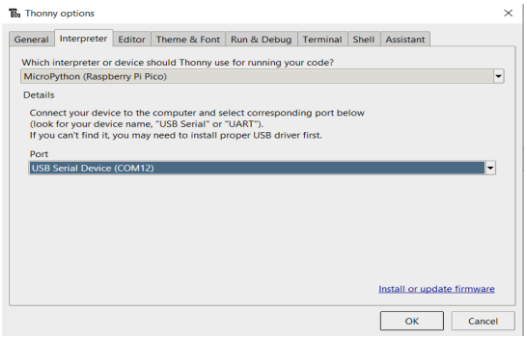


Figure 2 Installing Thonny

- The Python Shell (called also REPL) will now update to show that the Pico is connected and working.

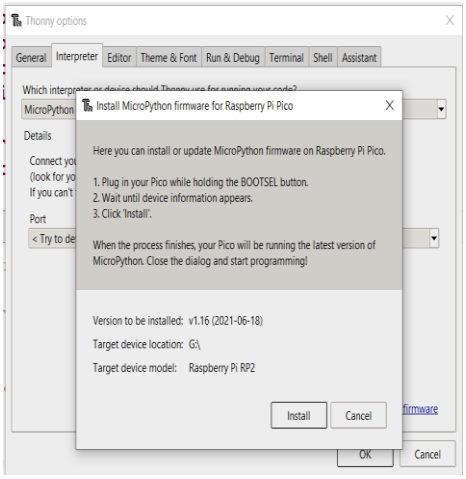


Figure 3 Installing Thonny

- The Python Shell (called also REPL) will now update to show that the Pico is connected and working.

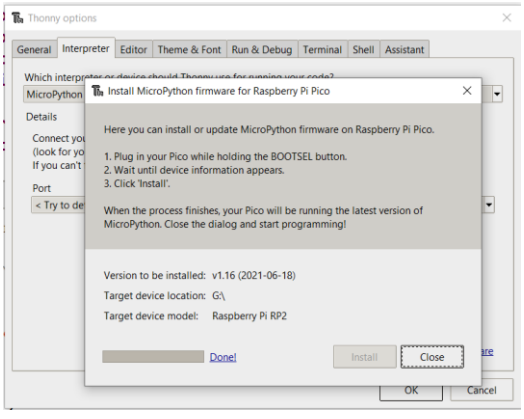


Figure 4 Installing Thonny

- To test we can write a quick print function to say, "**Hi DiP-Pi**" Point mouse on the REPL window and press some time the Enter. Then write *print('Hi DiP-Pi')* and press Enter to run the code.

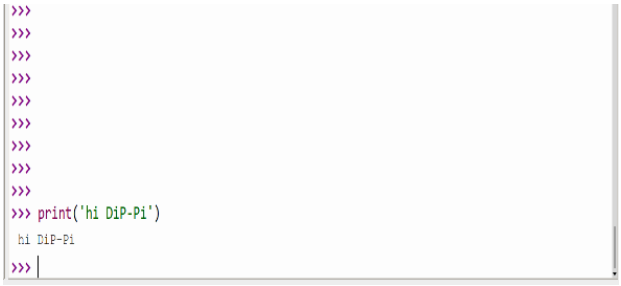


Figure 5 Installing Thonny

Simple Blinking Raspberry Pi© Pico LED Micro-Python Program

To further test that we can successfully program the Raspberry Pi Pico. We wrote a simple program that is flashing Embedded **Blinking Raspberry Pi© Pico** LED. This quick test ensures us, that our hardware is working, and it will introduce the **Micro-Python** language and syntax in the simplest form. It can be downloaded from **here**. Please download it to your PC and then open with Thonny.

```
# www.dip-pi.com
# DiP-Pi PIoT Powered IoT for Raspberry Pi Pico
# MicroPython Raspberry Pi PICO LED  ON/OFF demo software
# demo written by Ioannis A.Mourtsiadis by www.pimodules.com
# -*- coding: utf-8 -*-
from machine import Pin, Timer
from time import sleep_ms
led = Pin(25, Pin.OUT)
LED_state = True
tim = Timer()

def tick(timer):
    global led, LED_state
    LED_state = not LED_state
    led.value(LED_state)
```

Press Green Button (called: **Run Current Script**) and your program will start execution and LED blinking every second. Before you start experimenting with DiP-Pi, you need to make the last test, to have your **Blinking Raspberry Pi© Pico** fully operative. You need to make the system running without need to have loaded the Thonny**.** Your system must be independent from your PCB. To do that, you need to save your software to Pico, and say to the Pico "when wake-up, run this script". This is standard procedure for all demo programs we demonstrate here. To achieve this, you need your script to save to your Pico, called as "**main.py**".

Go to the ***File->Save*** as and when you see picture like this below select Raspberry Pi Pico and save with a name **main.py**.

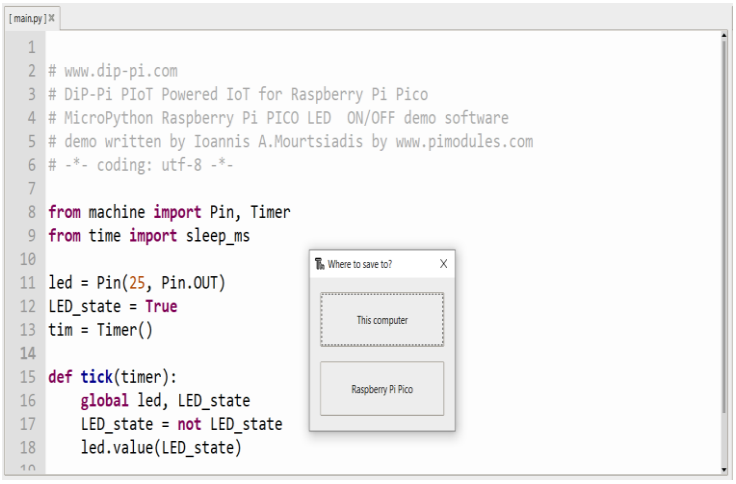


Figure 6 Installing Thonny

Now, whenever your Raspberry Pi Pico will be powered, will run your **main.py** script.

You are ready to use **Raspberry Pi© Pico** with **DiP-Pi** and develop professional applications.

Hardware installing on Raspberry Pi PICO

The DiP-Pi PICO is designed and manufactured on the way to minimize need for hand work on the user. However, some very basic steps need to be proceeded to develop a fully operable system based on DiP-Pi PICO and Raspberry Pi PICO. On the most cases there is no need to use soldering iron. It is very important to plug in properly DiP-Pi to the Raspberry Pi PICO. Each DiP-Pi is clearly marked with **PIN 1**, that should be placed on Raspberry Pi PICO Pin 1. To avoid any misunderstanding there is glued in addition a paper label that mind the user how to plug the DiP-Pi on the Raspberry Pi PICO. Users need to remove this label before plug the DiP-Pi to Raspberry Pi PICO. Below Picture shows **PIN 1** Label as also **PIN 1** market on DiP-Pi PCB.

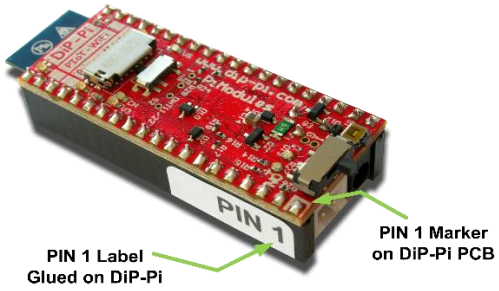


Figure 7 Pin 1 Placement

User should mind that Raspberry Pi PICO USB socket needs to be on the same side of the DiP-Pi PIN1 marker when plugged to the **DiP-Pi**. **Opposite plugging-in cause after power connection destroy of the system.**

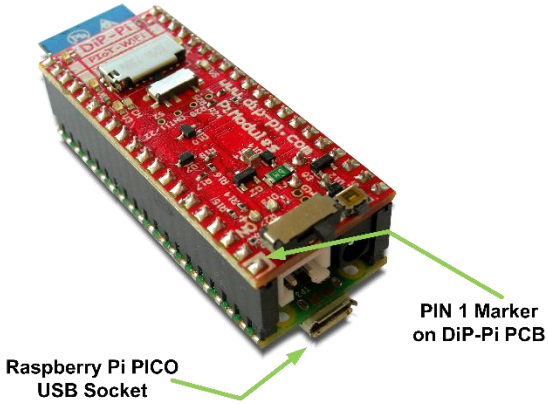


Figure 8 micro USB Placement

Based on the same PCB there has been released 3 versions of **DiP-Pi PIoT**:

1. DiP-Pi PIoT Full
2. DiP-Pi PIoT WiFi Master
3. DiP-Pi PIoT Power Master

Depending to application user need to select the proper one. Below table shows differenced on each DiP-Pi PIoT. It is also available to download a big A3 page from **here**

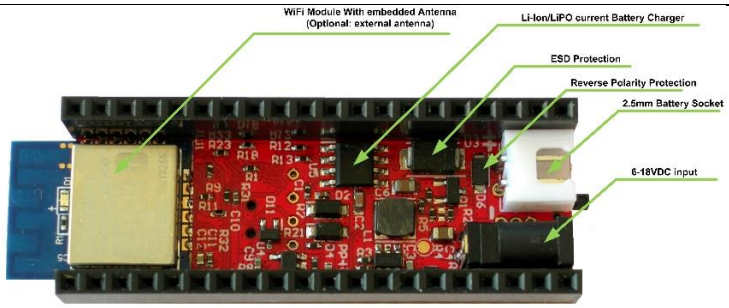
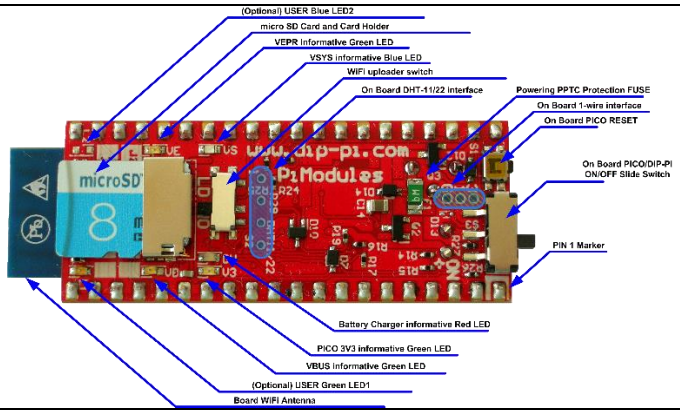
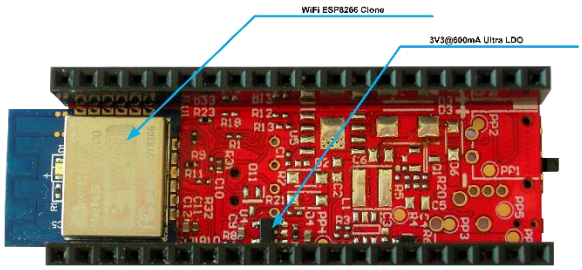
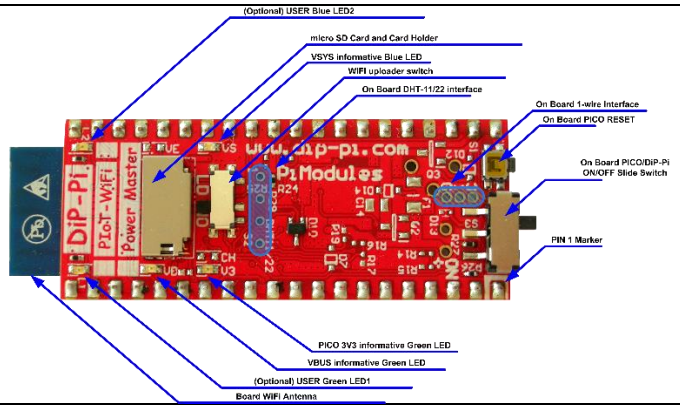
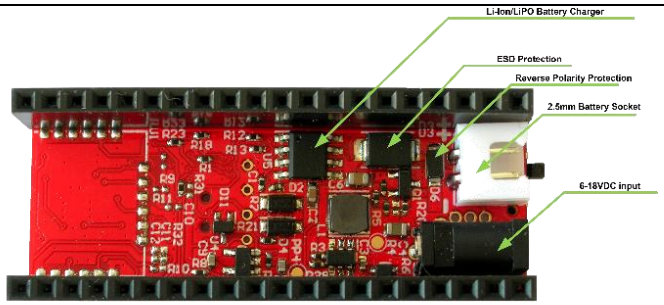
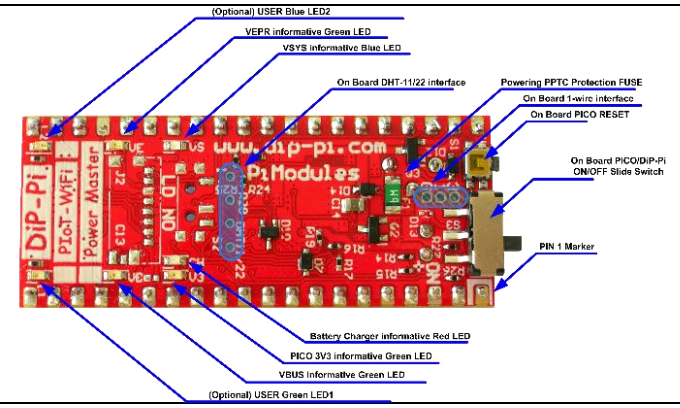
Top Side	Bottom Side
DiP-Pi PIoT Full	
	
DiP-Pi PIoT WiFi Master	
	
DiP-Pi PIoT Power Master	
	

Table 5 DiP-Pi PIoT Moldels

Hardware Interfacing/Interaction with Raspberry Pi® PICO

The core goal of the **DiP-Pi** is to minimize pins required to be interfaced with and left them for user applications. Therefore, for WiFi interfacing has been selected Serial Port of Raspberry Pi PICO and AT Commands instead of SPI, for micro-SD Card single line SPI (not 4 bits), as also A/D Pins if not used for monitoring of are bridged by 0402 0R resistor that in a case user does not need it, can be easy removed. The 1-wire and DHT11/22 interfaces if not used for their scope, can be used by user application. A detailed usage of Raspberry Pi PICO Pins is presented for each model on **Table 6** DiP-Pi PIoT Moldels

Battery Connection

The **DiP-Pi PIoT Full** and **DiP-Pi PIoT Power Master** both are equipped with **UPS functionality** and allow to use connected external battery. Used Battery must be **PCM** protected, and protection must not allow current higher than 2 A. There is also needed to take a special care how to connect battery polarity to avoid miss working or destroying of the device. There are special makers on the PCB showing where should be connected "**+** " and "**–**" of the battery. Battery can be used independently from the Cable powering and can be switched ON/OFF with the slide switch for battery powered applications as also as automatic power backup **UPS functionality**.

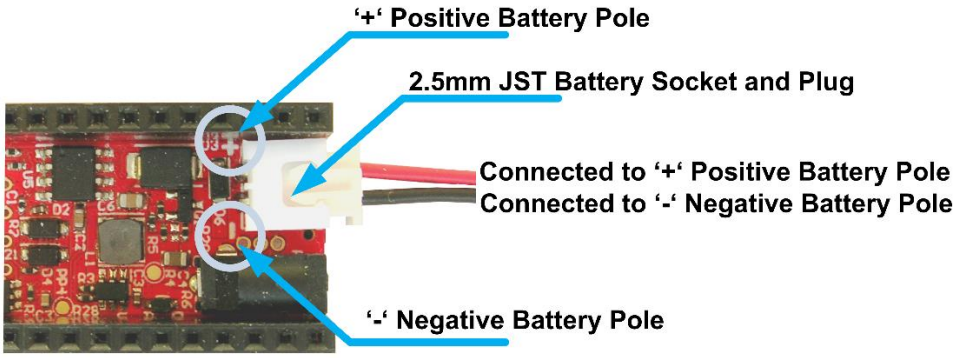


Figure 9 Battery fitting

Extended Powering Cable Connection

The **DiP-Pi PIoT Full** and **DiP-Pi PIoT Power Master** are offering to be powered also with **E**xtended **P**ower**i**ng Input (**6-18V DC**). This EPR input can be used for industrial applications powering. It is reverse polarity, ESD and PPT fuse protected.

The power input is done via Socket, DC Supply, male, Contact size 3.4/1.3mm or 3.5/1.3mm. The plug is included in the package. Polarity should follow below diagram.

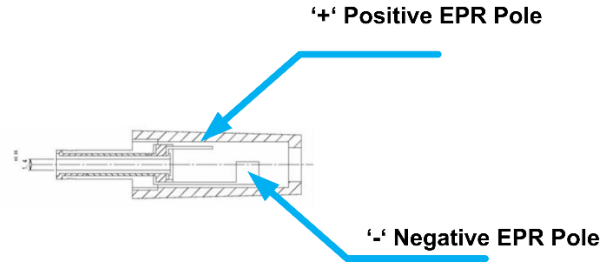


Figure 10 EPR Plug Soldering

ON/OFF Slide Switch and Reset Switch

The **DiP-Pi PIoT Full, DiP-Pi PIoT WiFi Master** and **DiP-Pi PIoT Power Master** are equipped with **ON/OFF Slide Switch** and **PICO RESET Button**. It switches power of the Raspberry Pi PICO ON/OFF on all power sources (USB, EPR and Battery). The position of the slide switch moved to the PIN 1 side

make the system **Powered** as shown on the below picture. If system is powered by USB can be used for firmware download instead of removing the USB cable. The **PICO RESET Button** is connected directly to the Raspberry Pi® PICO Reset pin, and when pressed resets the Raspberry Pi® PICO and can be also used as alternative for the firmware download instead of removing the USB cable. Details are shown on the picture below.

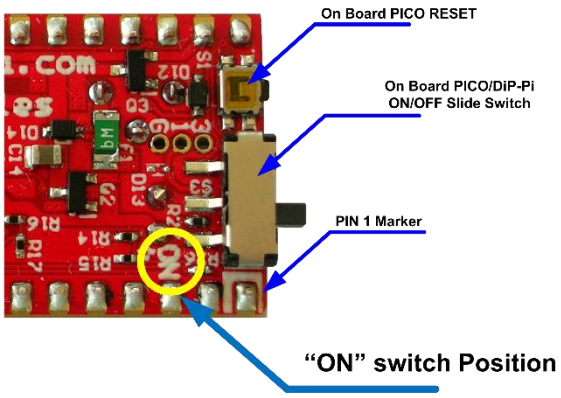


Figure 11 ON/OFF Switch Positioning

UPS Functionality

The **UPS Functionality** is an integrated part of the powered DiP-Pi PIoT versions (**DiP-Pi PIoT Full** and **DiP-Pi PIoT Power Master**). It is automatic and whenever cable powering is missing it is automatically switching to battery and vice-versa. The UPS Functionality is working when ON/OFF Slide switch is on Position **ON**. Whenever used system can be switched OFF with their Slide ON/OFF Switch.

Embedded Li-Ion LiPo Charger

The **DiP-Pi PICO PIoT Full** and **Power Master** are equipped with embedded I-Ion and LiPo charger. It is working automatically and charging battery when needed. When Battery is charged then the CHG LED is ON, when battery is not connected or faulty the CHG LED is blinking.

Connectivity with Raspberry Pi PICO:

- BATLEVEL ADC0 (GP26) measures Battery Level
- CHG_ACTIVE (GP21) activate/deactivate Battery Charger

ESP8266 WiFi Embedded Module

The DiP-Pi PICO PIoT and WiFi Master are equipped with embedded Integrated ESP8266 clone (**WT8266)**. It is handled by **AT Commands**, and practically can be used for all of the WiFi Applications. They include simple interactive WEBSERVER, email client, UBIdots client, data access to SD card logger etc. The default speed of the **AT Commands** is **115200** bps. The range of baud rates supported: **110~115200*40**.

Connectivity with Raspberry Pi PICO:

- UART0RX(GP13)
- UART0TX(GP12)

- WiFi Reset (GP15)
- WiFi ENABLE(GP11)

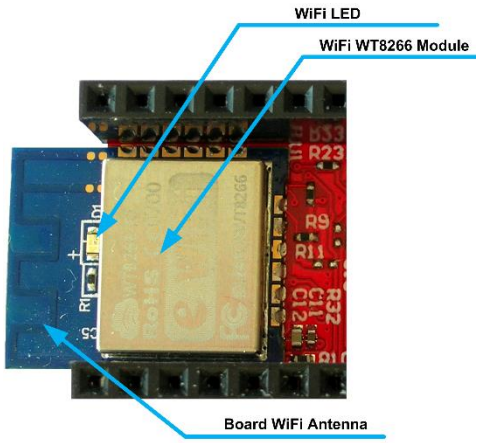


Figure 12 WiFi Module

WT8266 WiFi Embedded Module AT Commands Set

The **WT8266** AT Commands detailed specification can be found in different manual listed **here**

WiFi Firmware Uploader switch

The Uploader Switch is used to upload the newer firmware (only if really needed – under normal conditions NOT needed) for **WT8266 WiFi Module**. Under normal usage should be on position **NO** (**NO**rmal). If it is on position **LD** (**L**oa**D**) the WiFi Module will not working properly as will be waiting for new firmware. The update switch is connected directly to the **WT8266 WiFi Module**.

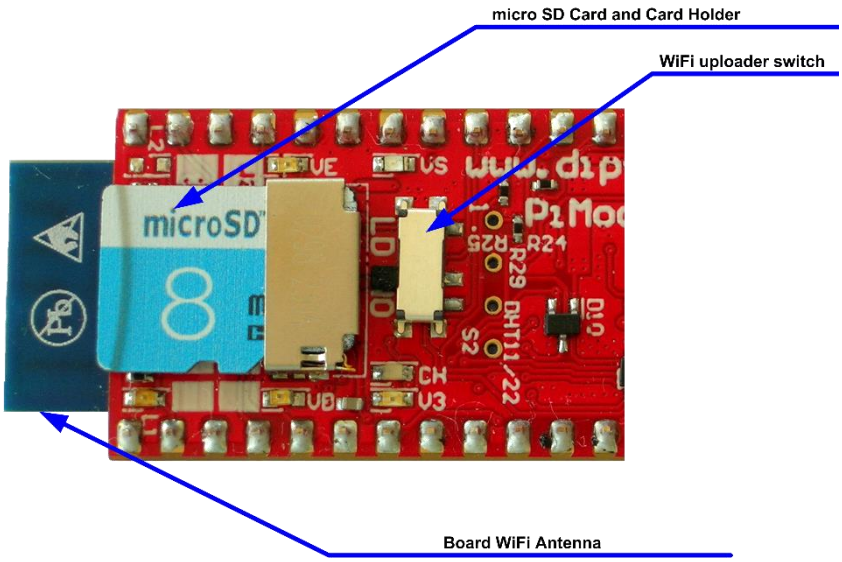


Figure 13 micro-SD Card and WiFi

Micro SD Card Socket

Is used to hold data, or Raspberry Pi® PICO executable software. Therefore, allow user to execute micro-python directly from it. Above picture shows the micro-SD Card inserted.

Connectivity with Raspberry Pi PICO:

- SD_MISO (GP16)
- SD_CS (GP17)
- SD_CLK (GP18)
- SD_MOSI (GP19)
- SD_DET (GP20)

Informative LEDs

The **DiP-Pi PICO PIoT** is equipped with multiple Colored Informative LEDs. They are:

- **VE** – ON when VEPR 6-18VDC is applied (**Green**)
- **VS** – ON when VSYS is applied (**Blue**)
- **VB** – ON when VBUS is applied (**GREEN**)
- **V3** – ON when V3V3 is generated (**GREEN**)
- **CH** – ON when VCHG is generated (**RED**)

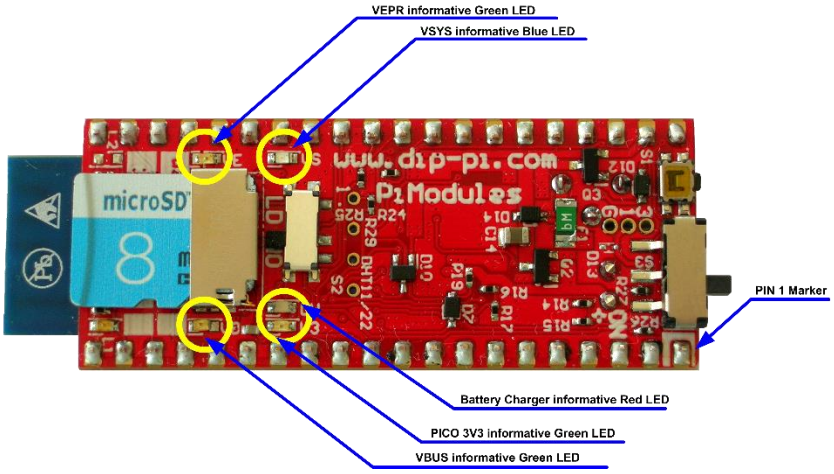


Figure 14 Informative LEDs

DiP-Pi PIoT Interfaces

Each DiP-Pi PIoT Modules is equiped with with some basic intefaces. There are:

- A/D inerface that measure Battery Level (where is implemented – Version **Full** and **Power Master**)

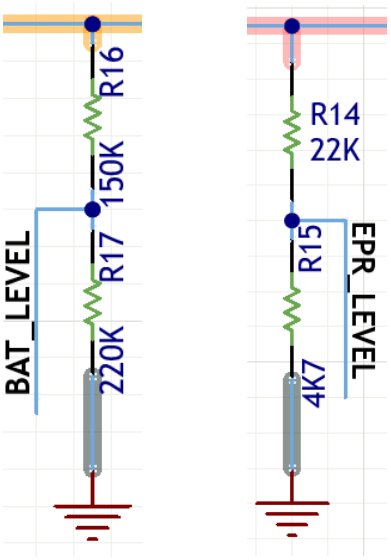
- A/D inerface that measure EPR Level (where is implemented – Version **Full** and **Power Master**)
- 1-wire embedded Intreface ESD Protected (all versions)
- DHT11/22 embedded Intreface ESD Protected (all versions)

A/D interfaces

Two of existing Raspberry Pi PICO A/D are used by the **DiP-Pi**. They are:

- BATLEVEL ADC0 (GP26) measures Battery Level
- EPRLEVEL ADC1 (GP27) measures EPR (6-18VDC) Level

Both are equipped with serial 0402 0R Resistor that can be easy removed if this functionality is not needed. Both A/D are based on Resistor Dividers to cover PICO limited voltage inputs.



A detailed examples how to read A/D data and convert to voltages as also implementation of **Olympic Score** de-noising filtering algorithm are provided **here**.

1-wire interface

The **DiP-PIoT** is equipped with 1-wire interface. It contains resistor 4K7K as also ESD protection. This interface can be used with temperature sensors and i-button (making sophisticated lock systems). Due to reduced available space the sensor needs to be soldered to **DiP-Pi PIoT**. If user do not have soldering skills our company is offering the soldering service.

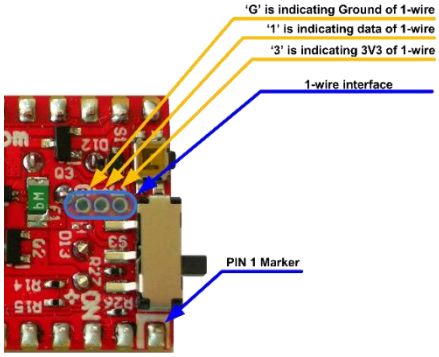


Figure 15 1-wire interface

Connectivity with Raspberry Pi PICO:

- 1-wire data (GP10)

The 3V3 powering for the 1-wire interface is provided by **DiP-Pi** from a separate protected LDO @600mA, therefore there is no risk if short circuit.

A detailed examples in micro-python are provided **here**.

DHT11/22 Interface

The **DiP-PIoT** is equipped with DHT11 or 22 interface. It contains resistor 10K. This interface can be used with temperature/humidity environmental sensors for application like weather station. Due to reduced available space the sensor needs to be soldered to **DiP-Pi PIoT**. If user do not have soldering skills our company is offering the soldering service. DiP-Pi PIoT is supporting also cabled sensor co can be placed away of the system.

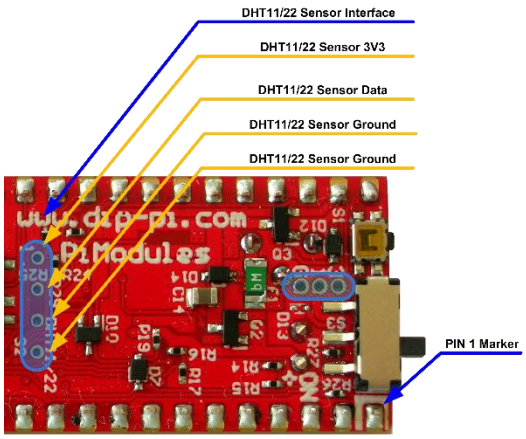


Figure 16 DHT11/22 Interface

Connectivity with Raspberry Pi PICO:

- DHT11/22 data (GP22)

The 3V3 powering for the DHT11/ 22 interface is provided by **DiP-Pi** from a separate protected LDO @600mA, therefore there is no risk if short circuit.

A detailed examples in micro-python are provided **here**.

Ready-To-Use Examples

Library and Ready-to-Use examples can be downloaded from **here**.

Common Problems & Solutions

Can I connect EPR (6-18VDC) input and Raspberry Pi PICO micro-USB at the same time?

Yes, you can. They are electrically separated and can be used at the same time. The ENTRY point for the EPR (4.8V) is the VSYS, so they are separated by diode on the Raspberry Pi PICO.

When I switch OFF with the Slide Switch and micro-USB is connected, the VUSB and is still light.

It is normal, as the VUSB (VB) LED is powered via VUSB so as far the USB is connected the LED is powered. Similar with VSYS, as is originated form the VUSB. The OFF signal (LOW) is attached to the Raspberry Pi PICO OFF pin, that cause stopping of Buck/Boost converter working. Therefore, when powered by micro-USB the ON/OFF witching will cause V3V3 voltage LED (V3) switching.

Document Revisions

Version	Date	Modified Sections	Comments
N.A.	01/09/2021	N.A.	First Preliminary Public Document Release

DiP-Pi PIoT Schematic

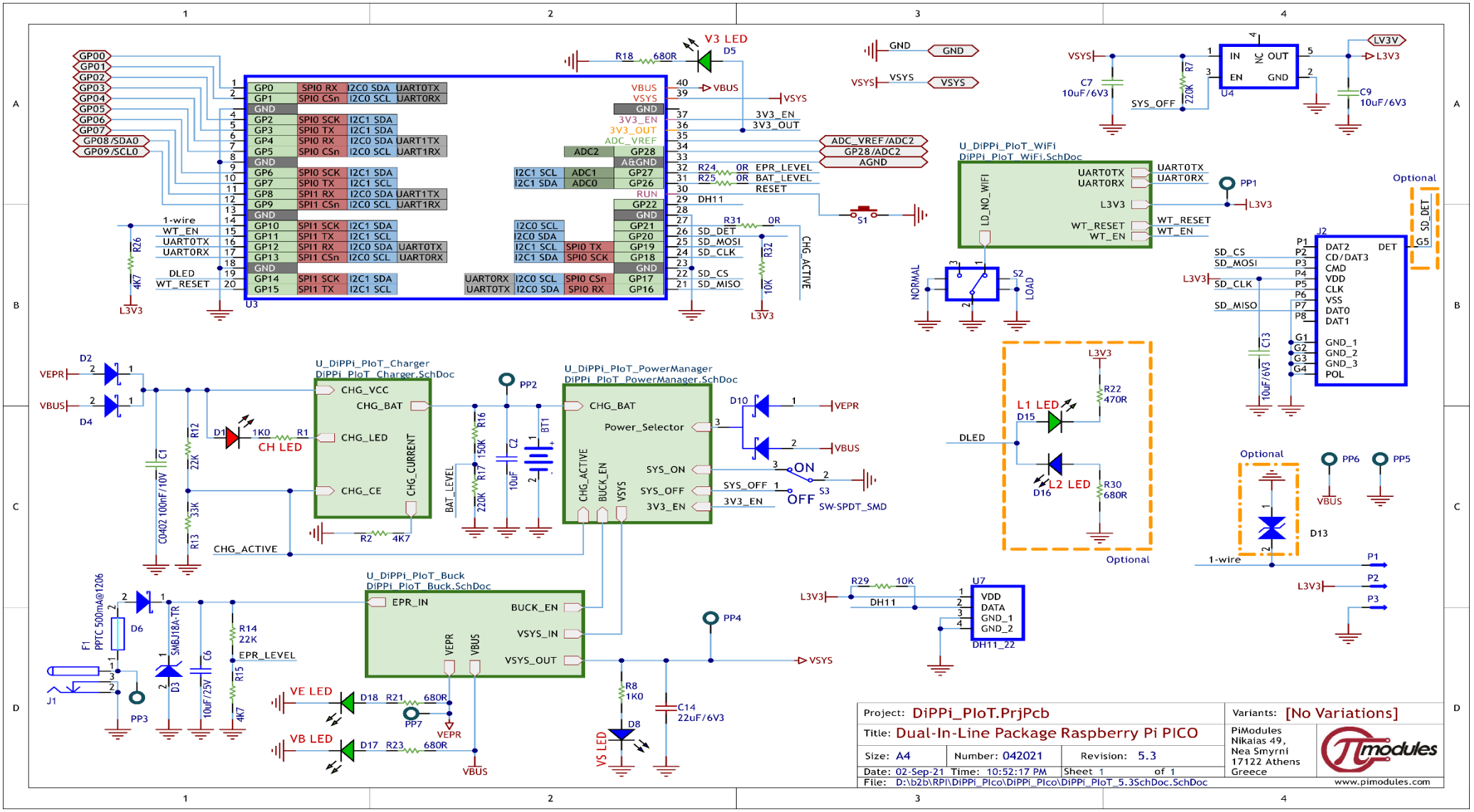


Figure 17 Detailed Schematic