HF-PICOW Datasheet

An RP2040-based microcontroller board

with Wi-Fi&BLE support
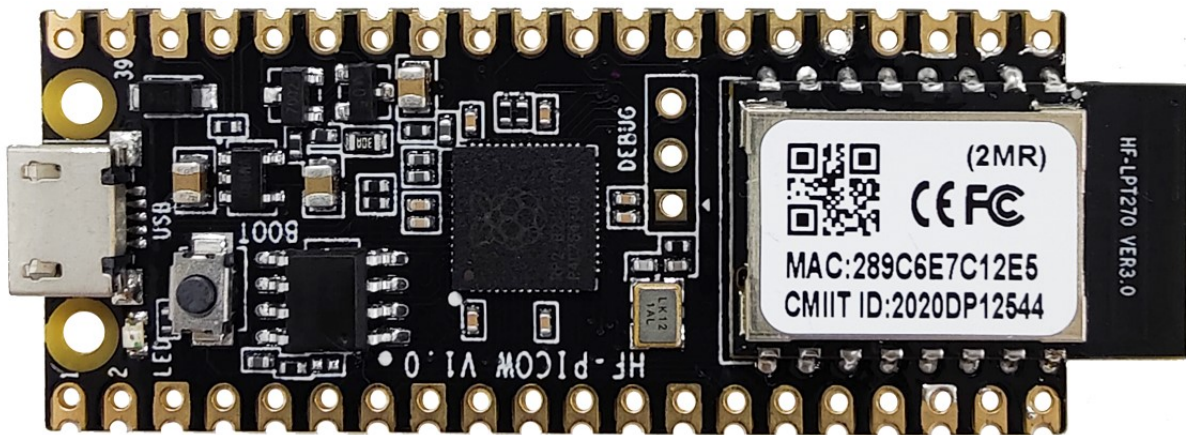
V1.0

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Ed. V1.0   2023-07-27   First Version.

1. PRODUCT OVERVIEW

1.1. General Description

HF-PICOW is a Raspberry Pi RP2040 microcontroller board with WiFi&BLE module HF-LPT270 on it.

HF-PICOW has been designed to be a low cost yet flexible development platform for RP2040 with wireless support and the following key features:

- RP2040 microcontrollerwith 2MB of flash memory
- On-board single-band 2.5GHz wireless module HF-LPT270(802.11bgn, Bluetooth 5.0)
- Micro USB B port for power and data (and for reprogramming the flash)
- 40-pin 21mm×51mm 'DIP' style 1mm thick PCB with 0.1" through-hole pins also with edge castellations
  - Exposes 26 multi-function 3.3V general purpose I/O (GPIO)
  - 23 GPIO are digital-only, with three also being ADC capable
  - Can be surface-mounted as a module
- 3-pin Arm serial wire debug (SWD) port
- Simple yet highly flexible power supply architecture
  - Various options for easily powering the unit from microUSB, external supplies or batteries
- High quality, low cost, high availability
- Comprehensive SDK, software examples and documentation

For full details of the RP2040 microcontroller please see the RP2040 Datasheet. Key features include:

- Dual-core cortex M0+ at up to 133MHz
  - On-chip PLL allows variable core frequency
- 264kB multi-bank high performance SRAM
- External Quad-SPI flash with eXecute In Place (XIP) and 16kB on-chip cache
- High performance full-crossbar bus fabric
- On-board USB1.1 (device or host)
- 30 multi-function general purpose I/O (four can be used for ADC)
  - 1.8-3.3V I/O voltage
- 12-bit 500ksps analogue to digital converter (ADC)
- Various digital peripherals
  - 2 × UART, 2 × I2C, 2 × SPI, 16 × PWM channels
  - 1 × timer with 4 alarms, 1 × real time clock
- 2 × programmable I/O (PIO) blocks, 8 state machines in total
  - Flexible, user-programmable high-speed I/O
  - Can emulate interfaces such as SD card and VGA

HF-PICOW provides a minimal yet flexible external circuitry to support the RP2040 chip: flash memory, a crystal, power supplies and decoupling, and USB connector. The majority of the RP2040 microcontroller pins are brought to the user I/O pins on the left and right edge of the board. Four

RP2040 I/O are used for internal functions: on-board switch mode power supply (SMPS) power control, and sensing the system voltages.

HF-PICOW has an on-board 2.4GHz wireless interface using an HF-LPT270 module. HF-PICOW-1 for PCB antenna(with HF-LPT270-1 on it) or HF-PICOW-0 for 1gen IPEX connector(with HF-LPT270-0 on it), RP2040 use UART interface to communicate with inside HF-LPT270.

HF-PICOW has been designed to use either soldered 0.1-inch pin-headers (it is one 0.1-inch pitch wider than a standard 40-pin DIP package), or to be positioned as a surface-mountable 'module', as the user I/O pins are also castellated. There are SMT pads underneath the USB connector and BOOTSEL button, which allow these signals to be accessed if used as a reflow-soldered SMT module.

More about our HF-LPT270 module information, refer to our website.

http://www.hi-flying.com/hf-lpt270?search=HF-LPT270

Description	Specification	Downloads
User Guide	High Flying Wi-Fi Module Operation Guide_20210222	[Download Times: 1908, Date Update: 2021-02-22 18:09:58]
	HF-LPX70 Series Wi-Fi_BLE Module User Manual-V2.5(20230222)	[Download Times: 506, Date Update: 2023-02-23 17:41:59]
Application Notes	EVK Evaluation Board Design Data_20210518	[Download Times: 1036, Date Update: 2021-05-18 15:21:32]
	HF-LPX30 Series_HF-LPX70 Series_HF-LPD1X0 Series Module Webpage	[Download Times: 1064, Date Update: 2023-05-05 16:15:16]

1.1.1 On Board Wireless HF-LPT270 Paremeters

Table1.   HF-LPT270 Module Technical Specifications

Class	Item	Parameters
Wi-Fi Parameters	Wireless standard	802.11 b/g/n
	Frequency range	2.412GHz-2.472GHz
	Transmit Power	802.11b: +17dBm ± 1.5dBm (@11Mbps)
		802.11g: +15dBm ± 1.5dBm (@54Mbps)
		802.11n: +14dBm ± 1.5dBm (@HT20, MCS7)
	Receiver Sensitivity	802.11b: -96dBm (@1Mbps)
		802.11b: -89dBm (@11Mbps)
		802.11g: -91dBm (@6Mbps)
		802.11g: -76dBm (@54Mbps)
		802.11n: -91dBm (@MCS0)
		802.11n: -73dBm (@MCS7)
BLE Parameters	Wireless standard	BLE5.0
	Frequency range	2.402GHz-2.480GHz
	Transmit Power	Max 15dBm
	Receiver Sensitivity	-97dBm

Hardware Parameters	Antenna Option	HF-LPT270:
		    Internal: PCB antenna
		    External: 1st IPEX antenna

	Data Interface	UART
	Operating Voltage	2.7~3.6V
	Operating Current	Peak (1ms for every 100ms): <350mA Average (STA, No data): 40mA Average (STA, Continuous TX): 60mA Average (AP): 70mA Standby: 310uA (Reset Pin set to low)

	Operating Temp.	-40℃- 85℃
	Storage Temp.	-40℃- 125℃
	Humidity	<85%
	MSL	Level 3
	Dimensions and Size	HF-LPT270: 22.5±0.2mm x 13.5±0.2mm x 3.5±0.2mm
Software Parameters	Network Type	STA/AP/APSTA
	Security Mechanisms	WEP/WPA-PSK/WPA2-PSK/WPA3-SAE
	Encryption	WEP64/WEP128/TKIP/AES
	Update Firmware	Local Wireless, Remote OTA
	Customization	Support SDK for application develop
	Network Protocol	IPv4, TCP/UDP/HTTP/TLS 1.2
	User Configuration	AT+instruction set. SmartBLELink BLE Config SmartAPLink AP Config

1.1.2 Recommended Operating conditioins

Operating conditions for the HF-PICOW are largely a function of the operating conditions specified by its components.

Table2. HF-PICOW Working Condition

Describtion	Comments
Operating Temp Max	70°C (including self-heating)
Operating Temp Min	-20°C
VBUS	5V ± 10%
VSYS Min	2V
VSYS Max	6V

Note that VBUS and VSYS current will depend on use-case

Recommended maximum ambient temperature of operation is 70°C.

1.2. HF-PICOW Hardware Introduction

HF-PICOW uses an on-board buck-boost SMPS which is able to generate the required 3.3V (to power RP2040 and external circuitry) from a wide range of input voltages (~2 to 6V). This allows significant flexibility in powering the unit from various sources, such as a single lithium-ion cell, or three AA cells in series. Battery chargers can also be very easily integrated with the powerchain.

Reprogramming the HF-PICOW flash can be done using USB (simply drag and drop a file onto the board, which appears as a mass storage device), or the standard serial wire debug (SWD) port can reset the system and load and run code without any button presses. The SWD port can also be used to interactively debug code running on the RP2040.
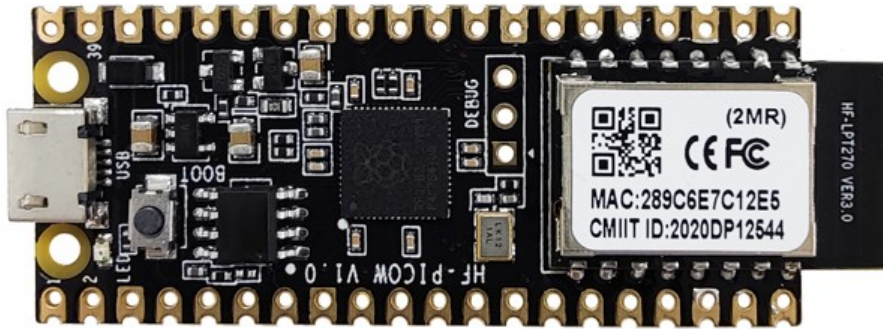
HF-PICOW appearance is as following.
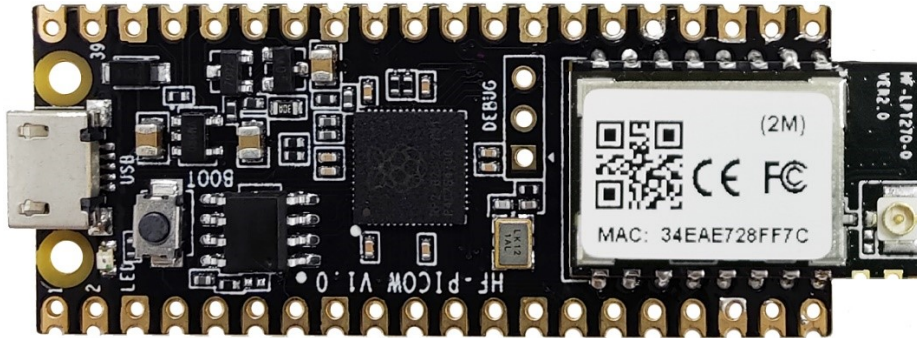
Figure 1.   HF-PICOW-1 Appearance
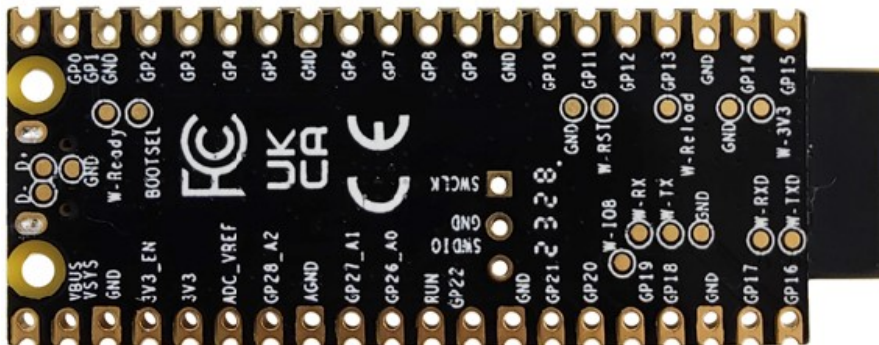

Figure 2.   HF-PICOW-0 Appearance

Figure 3.   HF-PICOW-1 Back Appearance
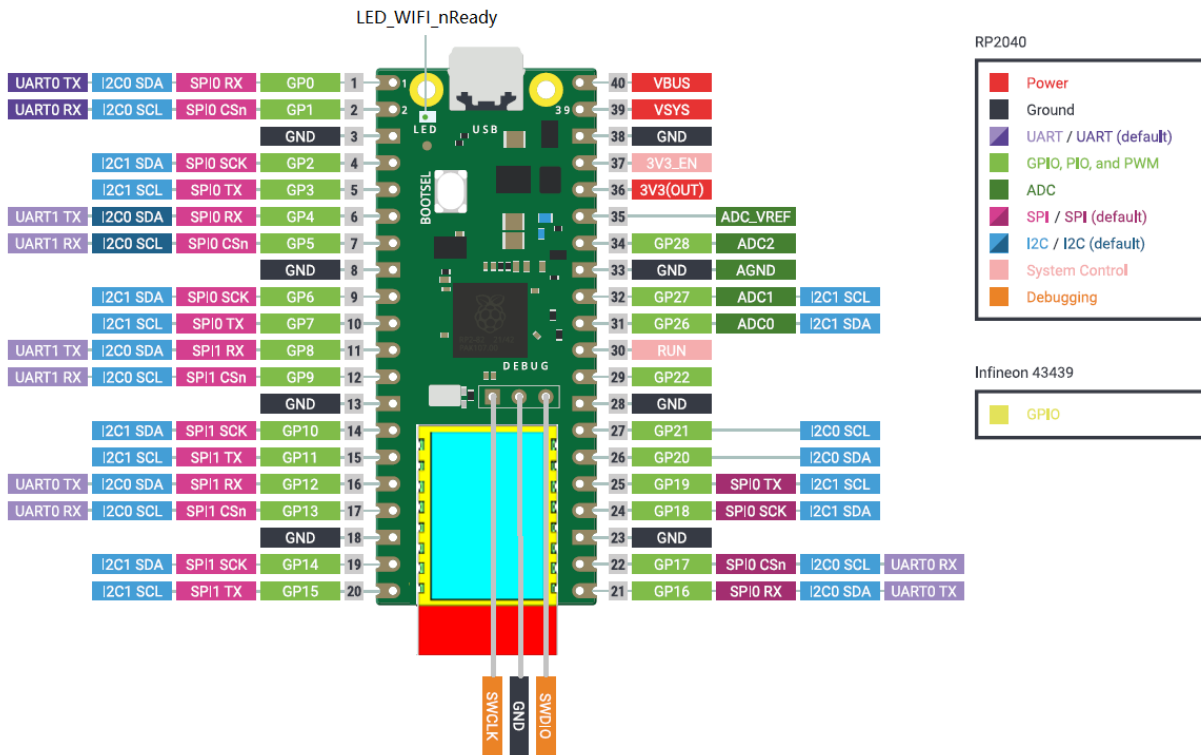
1.2.1. HF-PICOW Pins Definition

Figure 4.　HF-PICOW Pins Map

The HF-PICOW pinout has been designed to directly bring out as much of the RP2040 GPIO and internal circuitry function as possible, while also providing a suitable number of ground pins to reduce electro-magnetic interference (EMI) and signal crosstalk. RP2040 is built on a modern 40nm silicon process, so its digital I/O edge rates are very fast.

The LED_WIFI_nReady LED incidate HF-LPT270 module boot up.

A few RP2040 GPIO pins are used for internal board functions, RP2040 and works as UART connect to wireless module HF-LPT270. All communication procedure is done by UART

Table3.　HF-PICOW Inside Pins Definition

Description	Comments
GPIO29	Not fan out
GPIO25	UART1_RX, connect to HF-LPT270 module TX
GPIO24	UART1_TX, connect to HF-LPT270 module RX
GPIO23	Wireless module HF-LPT270 power control signal

There are also six test points of HF-LPT270 which can be accessed if required, more details see HF-LPT270 PIN defination.

Table4.　HF-PICOW onboard HF-LPT270 Test Pin Definition

Description	Comments
W-TXD	DEBUG_UART1_TX

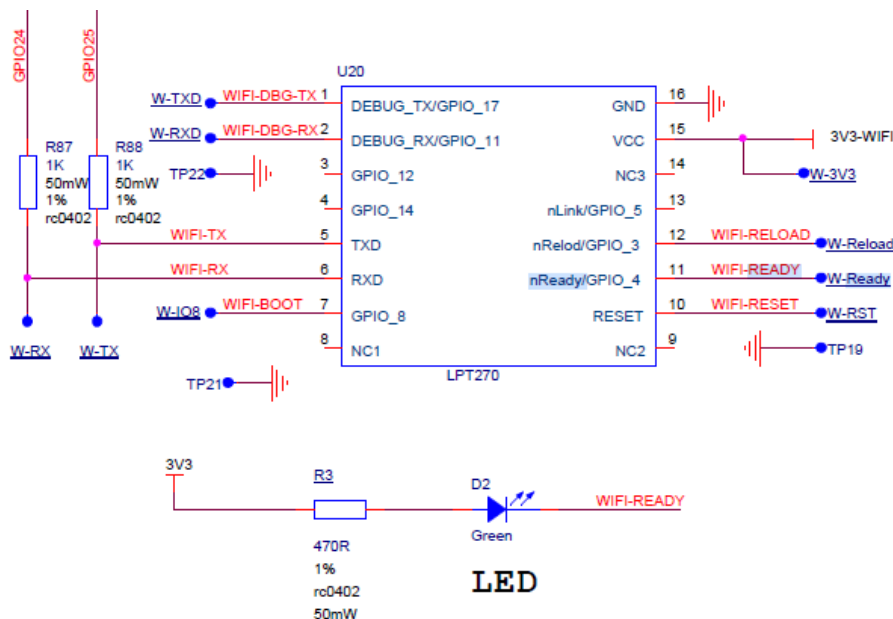| Describtion	Comments
W-RXD	DEBUG_UART1_RX.
W-TX	UART0_TX
W-RX	UART0_RX
W-IO8	GPIO8
W-RST	RESET
W-Ready	nReady
W-Reload	nReload
W-3V3	VDD

Figure 5.　　HF-PICOW onboard HF-LPT270 connection

Apart from GPIO and ground pins, there are seven other pins on the main 40-pin interface:

Table5.　　HF-PICOW Pins Definition

No	Description	Comments
40	VBUS	VBUS is the micro-USB input voltage, connected to micro-USB port pin 1. This is nominally 5V (or 0V if the USB is not connected or not powered).
39	VSYS	is the main system input voltage, which can vary in the allowed range 1.8V to 5.5V, and is used by the on-board SMPS to generate the 3.3V for the RP2040 and its GPIO.
37	3V3_EN	connects to the on-board SMPS enable pin, and is pulled high (to VSYS) via a 100k Ω resistor. To disable the 3.3V (which also de-powers the RP2040), short this pin low.
36	3V3	is the main 3.3V supply to RP2040 and its I/O, generated by the on-board SMPS. This pin can be used to power external circuitry (maximum output current will depend on RP2040 load and VSYS voltage; it is recommended to keep the load on this pin under 300mA).
35	ADC_REF	is the ADC power supply (and reference) voltage, and is generated on HF-PICOW by filtering the 3.3V supply. This pin can be used with an external reference if better ADC performance is required

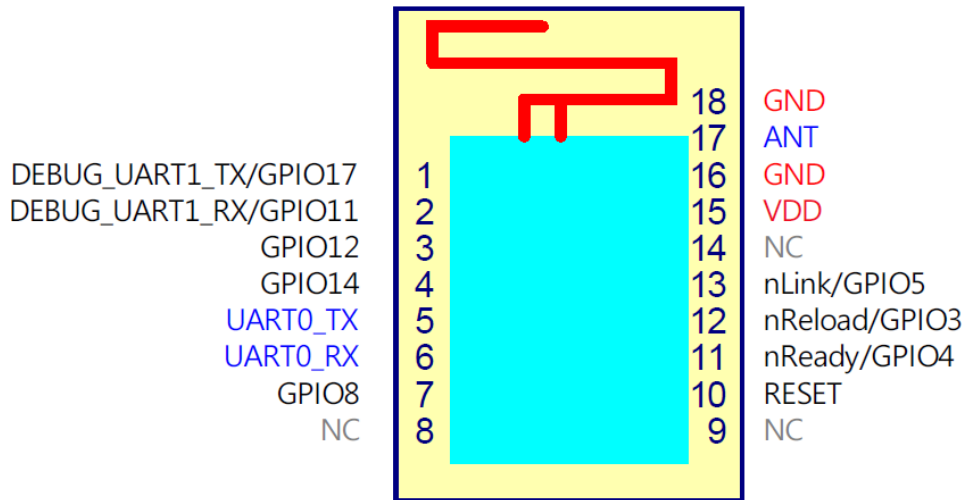| No	Description	Comments
33	AGND	is the ground reference for GPIO26-29. There is a separate analogue ground plane running under these signals and terminating at this pin. If the ADC is not used or ADC performance is not critical, this pin can be connected to digital ground
30	RUN	is the RP2040 enable pin, and has an internal (on-chip) pull-up resistor to 3.3V of about ~50kΩ. To reset RP2040, short this pin low.

1.2.2. Onboard HF-LPT270 Pins Definition

Figure 6.   HF-LPT270 Pins Map

Table6.   HF-LPT270 Pins Definition

Pin	Describtion	Net Name	Signal Type	Comments
1	UART1_TX	DEBUG_UART1_TX	O	3.3V TTL UART1 Debug Output GPIO17, SPI function
2	UART1_RX	DEBUG_UART1_RX	I	3.3V TTL UART1 Debug Input GPIO11, SPI, PWM1 function
3	UART0_RTS	GPIO12	O	used as RTS when enable flow control GPIO12, SPI, PWM2, ADC function
4	UART0_CTS	GPIO14	I	used as CTS when enable flow control GPIO14, SPI, DAC, ADC function
5	UART0	UART0_TX	O	3.3V TTL UART0 Communication Output GPIO16
6	UART0	UART0_RX	I	3.3V TTL UART0 Communication Input GPIO7
7	GPIO8	GPIO8	IPD	Internal 10K pull-down resistor, Boot select: Low: boot from module flash. High: boot from external UART. This is used for HF factory firmware program, leave it unconnected for user application
8,9		NC		
10	Module Reset	RESET	I,PU	"Low" effective reset input. There is RC

Pin	Describtion	Net Name	Signal Type	Comments
				reset circuit internally. No need of external RC reset circuit.
11	Module Boot Up Indicator	nReady	O	"0" – Boot-up OK; "1" – Boot-up Fail; GPIO4, PWM4
12	Multi-Function	nReload	I,PU	Detailed functions see <Notes> GPIO3, PWM3
13	Wi-Fi Status	nLink	O	"0" – Wi-Fi connect to router "1" – Wi-Fi unconncted; Detailed functions see <Notes> GPIO5, PWM5
14		NC		
15	+3.3V Power	VDD	Power	
16	Ground	GND	Power	
17		ANT	Signal	Only -0 have these two pins
18	Ground	GND	Power	

- -0 use external IPEX antenna, PIN17 is useless.

  nReload Pin (Button) function:
  1. **After module is powered up, short press this button (0.2s < "Low" < 1.5s) and loose to make the module go into SmartBLELink config mode, waiting for APP to set router SSID and password, config module connect to router.**
  2. **After module is powered up, long press this button ("Low" > 4s) and loose to make the module recover to factory setting.**

  nReady Pin (LED) function(Low effective):
  1. **OS initial finished indicator. Only after this pin output low, can the UART function be used.**

  nLink Pin (LED) function(Low effective):
  1. **At "SmartLink" config mode, this LED is used to indicate APP to finish setting.**
  2. **At normal mode, it's Wi-Fi link status indicator. Output Low when STA mode connect to router AP or other STA connect to it when in AP mode.**
  3. **Flash when in WPS config mode**
  High-Flying strongly suggest customer fan out this pin to LED.

  UART1 Debug :
  1. **Is used for debug log or firmware program, baud rate 921600.**

1.2.3. HF-PICOW Mechanical Size

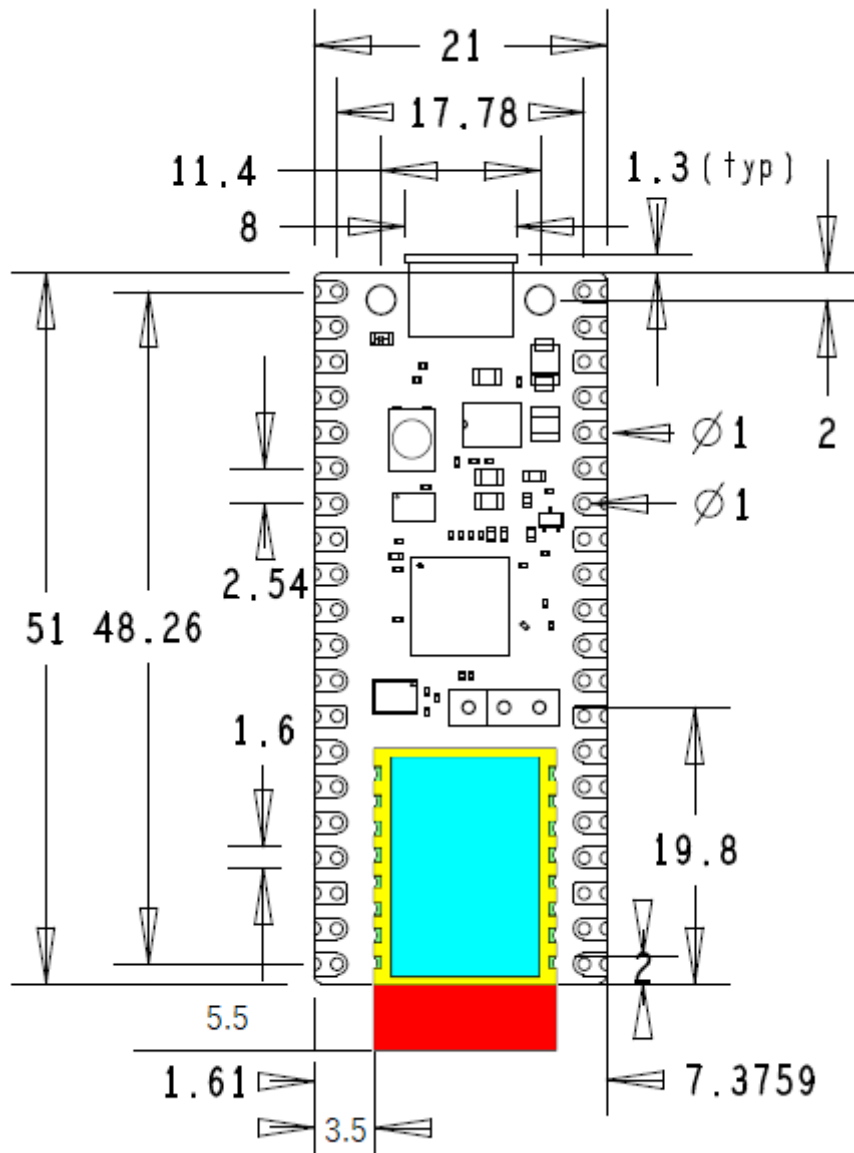HF-PICOW physical size （Unit: mm） as follows:

Figure 7.   HF-LPT270 Mechanical Dimension

1.2.4.   Surface-mount Footprint

The following footprint is recommended for systems which will be reflow-soldering HF-PICOW units as modules.

The footprint shows the test point locations and pad sizes as well as the 4 USB connector shell ground pads (A,B,C,D). The USB connector on HF-PICOW is a through-hole part, which provides it with mechanical strength. The USB socket pins do not protrude all the way through the board, however solder does pool at these pads during manufacture and can stop the module sitting completely flat. Hence we provide pads on the SMT module footprint to allow this solder to reflow in a controlled manner when HF-PICOW goes through reflow again.

For test points that are not used, it is acceptable to void any copper under these (with suitable clearance) on the carrier board.
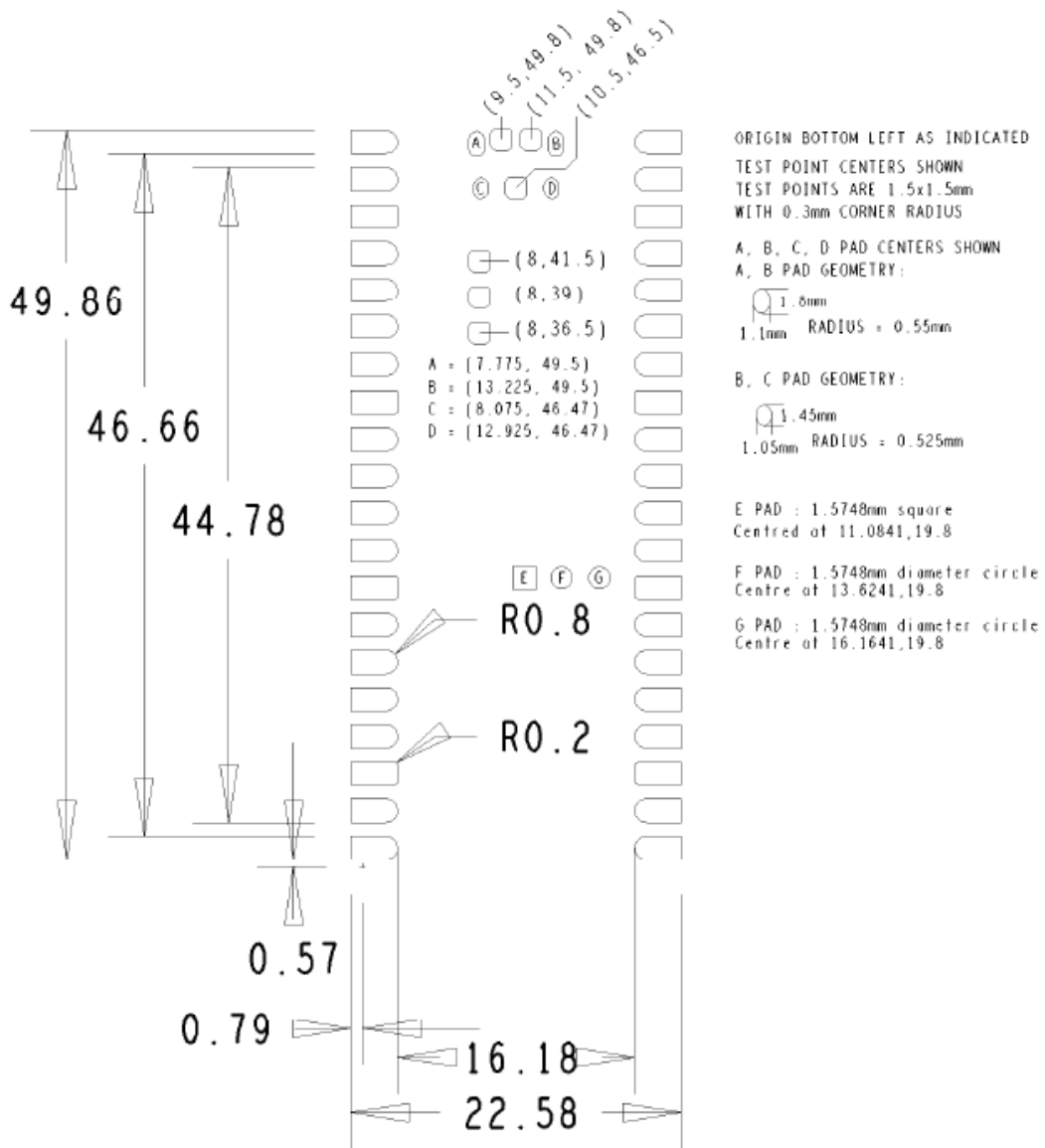
Figure 8.   Recommend surface mount footprint

1.2.5. On-board Chip Antenna

HF-PICOW support internal on-board PCB antenna. When customer select internal antenna, you shall comply with following antenna design rules and module location suggestions:

➢ For customer PCB, module antenna area can't put componet or paste GND net;(See the following red arrow area)

➢ Antenna must away from metal or high components at least 16mm;

➢ Antenna can't be shieldedby any meal enclosure; All cover, include plastic, shall away from antenna at least 16mm;

High-Flying suggest module better locate in following region at customer board, which to reduce the effect to antenna and wireless signal, and better consult High-Flying technical people when you structure your module placement and PCB layout.
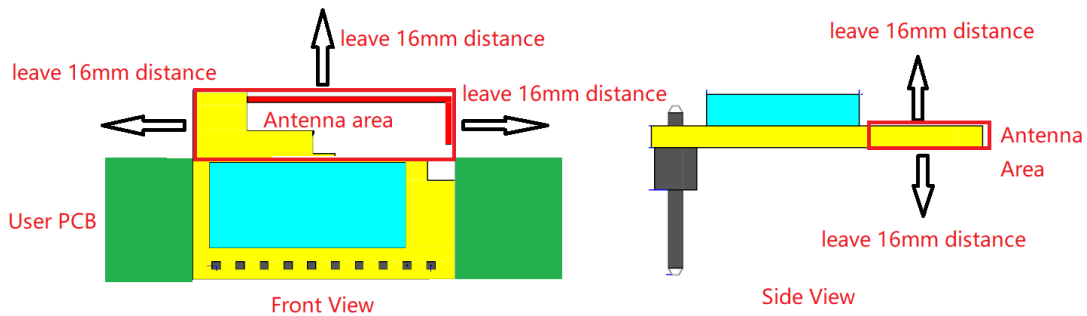

Figure 9.   Suggested Module Placement Region

1.2.6. External Antenna

HF-PICOW-0 supports external antenna(I-PEX) option for user dedicated application.

If user select external antenna, modules must be connected to the 2.4G antenna according to IEEE 802.11b/g/n standards. We can provide external antenna if needed. Contact with our salesman.
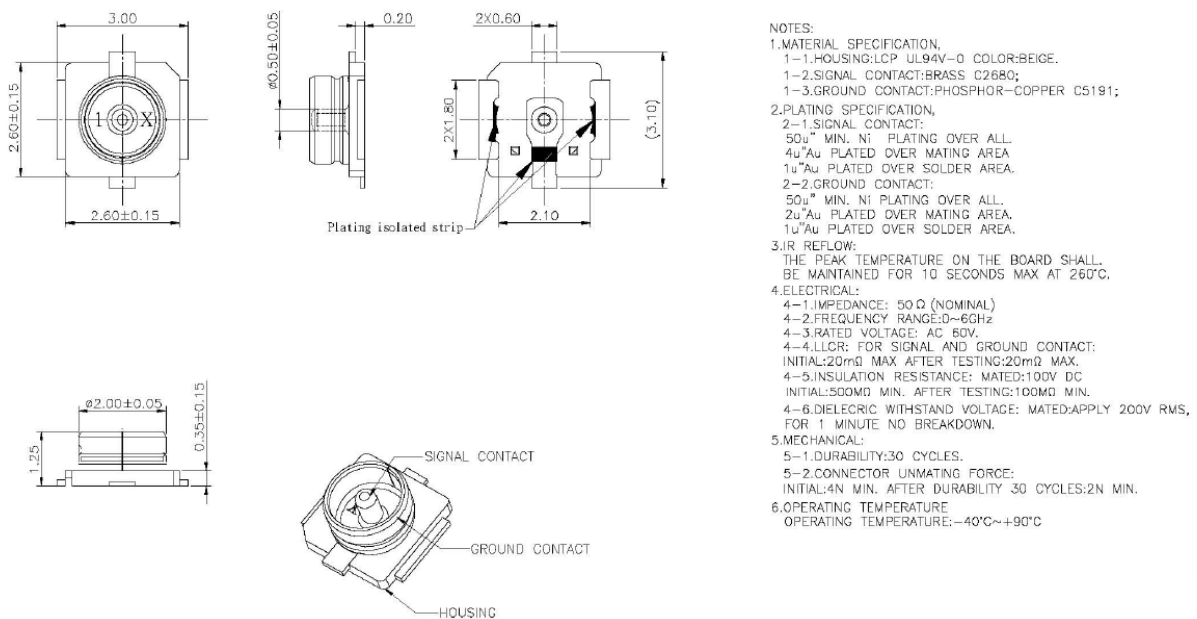

Figure 10.   1st IPEX Connector

The antenna parameters required as follows:

Table7.　External Antenna Parameters

Item	Parameters
Frequency range	2.4~2.5GHz
Impedance	50 Ohm
VSWR	2 (Max)
Return Loss	-10dB (Max)
Connector Type	I-PEX or populate directly

1.2.7.　Order Information

Base on customer detailed requirement, we provide different variants and physical type for detailed application.
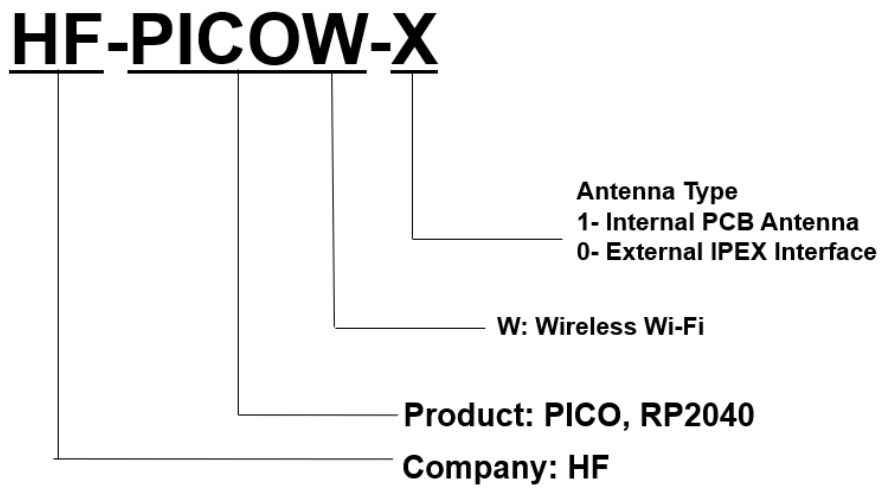

Figure 11.　Order Information

2. APPICATIONS INFORMATION

2.1. Progamming the flash

The on-board 2MB QSPI flash can be (re)programmed either using the serial wire debug port or by the special USB mass storage device mode.

The simplest way to reprogram the flash is to use the USB mode. To do this, power-down the board, then hold the BOOTSEL button down during board power-up (e.g. hold BOOTSEL down while connecting the USB). The board will then appear as a USB mass storage device. Dragging a special '.uf2' file onto the disk will write this file to the flash and restart the board

The USB boot code is stored in ROM on RP2040, so can not be accidentally overwritten.

To get started using the SWD port see the Debugging with SWD section in the Getting started with Raspberry Pi Pico book.

2.2. General Purpose IO

The HF-PICOW GPIO is powered from the on-board 3.3V rail, and is fixed at 3.3V.

HF-PICOW exposes 26 of the 30 possible RP2040 GPIO pins by routing them straight out to HF-PICOW header pins. GPIO0 to GPIO22 are digital only, and GPIO 26-28 can be used either as digital GPIO or as ADC inputs (software selectable).

GPIO 26-29 are ADC-capable and have an internal reverse diode to the VDDIO (3.3V) rail, so the input voltage must not exceed VDDIO plus about 300mV. If the RP2040 is unpowered, applying a voltage to these GPIO pins will 'leak' through the diode into the VDDIO rail. GPIO pins 0-25 (and the debug pins) do not have this restriction and therefore voltage can safely be applied to these pins when RP2040 is unpowered up to 3.3V.

2.3. Using the ADC

The RP2040 ADC does not have an on-chip reference; it uses its own power supply as a reference. On HF-PICOW the ADC_AVDD pin (the ADC supply) is generated from the SMPS 3.3V.

1. This solution relies on the 3.3V SMPS output accuracy

2. Some PSU noise will not be filtered

3. The ADC draws current (about 150μA if the temperature sense diode is disabled, which can vary between chips); there will be an inherent offset of about 150μA*200 = ~30mV. There is a small difference in current draw when the ADC is sampling (about +20μA), so that offset will also vary with sampling as well as operating temperature.

Changing the resistance between the ADC_VREF and 3.3V pin can reduce the offset at the expense of more noise, which is helpful if the use case can support averaging over multiple samples.

The ADC offset can be reduced by tying a second channel of the ADC to ground, and using this zero measurement as an approximation to the offset.

For much improved ADC performance, an external 3.0V shunt reference, such as LM4040, can be connected from the ADC_VREF pin to ground. Note that if doing this the ADC range is limited to 0V

- 3.0V signals (rather than 0V - 3.3V), and the shunt reference will draw continuous current through the 200 Ω filter resistor (3.3V - 3.0V)/200 = ~1.5mA.

Note that the 1 Ω resistor on HF-PICOW (R9) is designed to help with shunt references that would otherwise become unstable when directly connected to 2.2 μ F. It also ensures there is filtering even in the case that 3.3V and ADC_VREF are shorted together (which users who are tolerant to noise and want to reduce the inherent offset may wish to do).

R7 is a physically large 1608 metric (0603) package resistor, so can be removed easily if a user wants to isolate ADC_VREF and make their own changes to the ADC voltage, for example powering it from an entirely separate voltage (e.g. 2.5V). Note that the ADC on RP2040 has only been qualified at 3.0/3.3V, but should work down to about 2V.

2.4. Power Supply

Use AP7365 to generate 3.3V power supply for RP2040, use GPIO23 to contorl wireless module HF-LPT270 power.
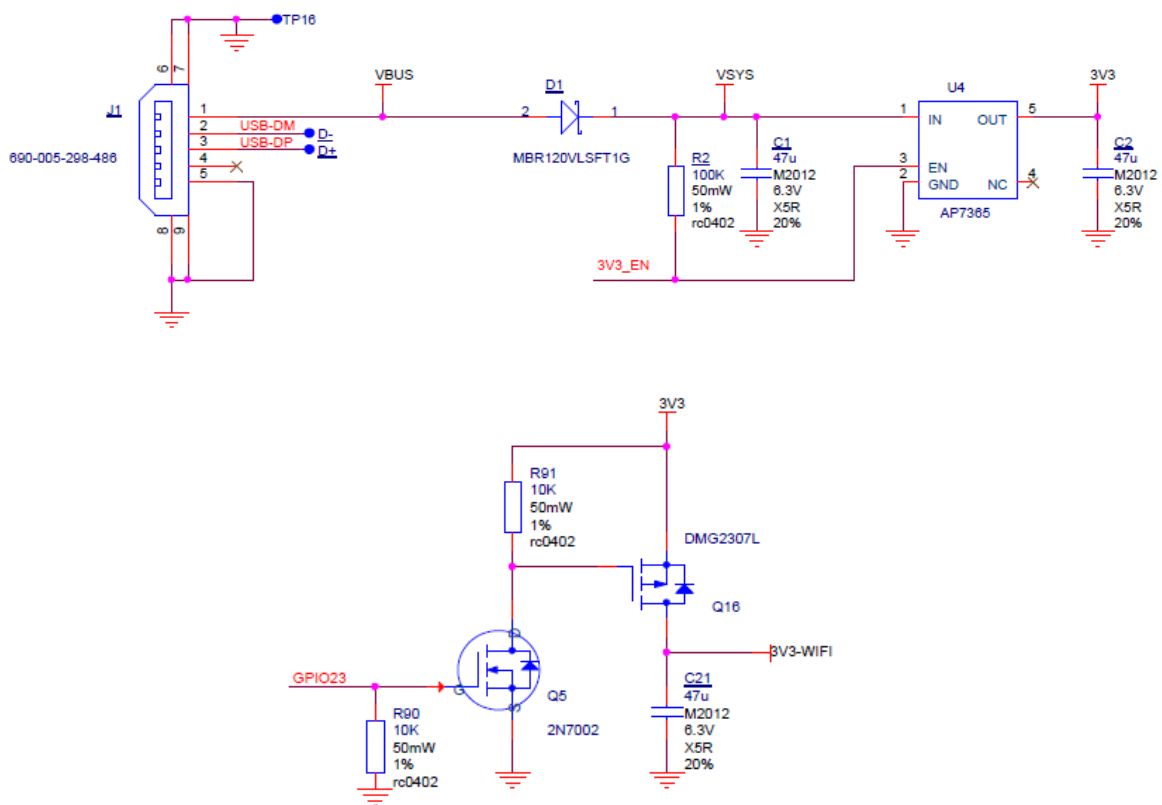

Figure 12.   Power Schemetic

2.5. USB

RP2040 has an integrated USB1.1 PHY and controller which can be used in both device and host mode. HF-PICOW adds the two required 27 Ω external resistors and brings this interface to a standard micro-USB port.

The USB port can be used to access the USB bootloader (BOOTSEL mode) stored in the RP2040 boot ROM. It can also be used by user code, to access an external USB device or host.

2.6. Debugging

HF-PICOW brings the RP2040 serial wire debug (SWD) interface to a three-pin debug header. To get started using the debug port see the Debugging with SWD section in the Getting started with Raspberry Pi Pico book.

The RP2040 chip has internal pull-up resistors on the SWDIO and SWCLK pins, both nominally 60kΩ.

3. SMT INFORMATION
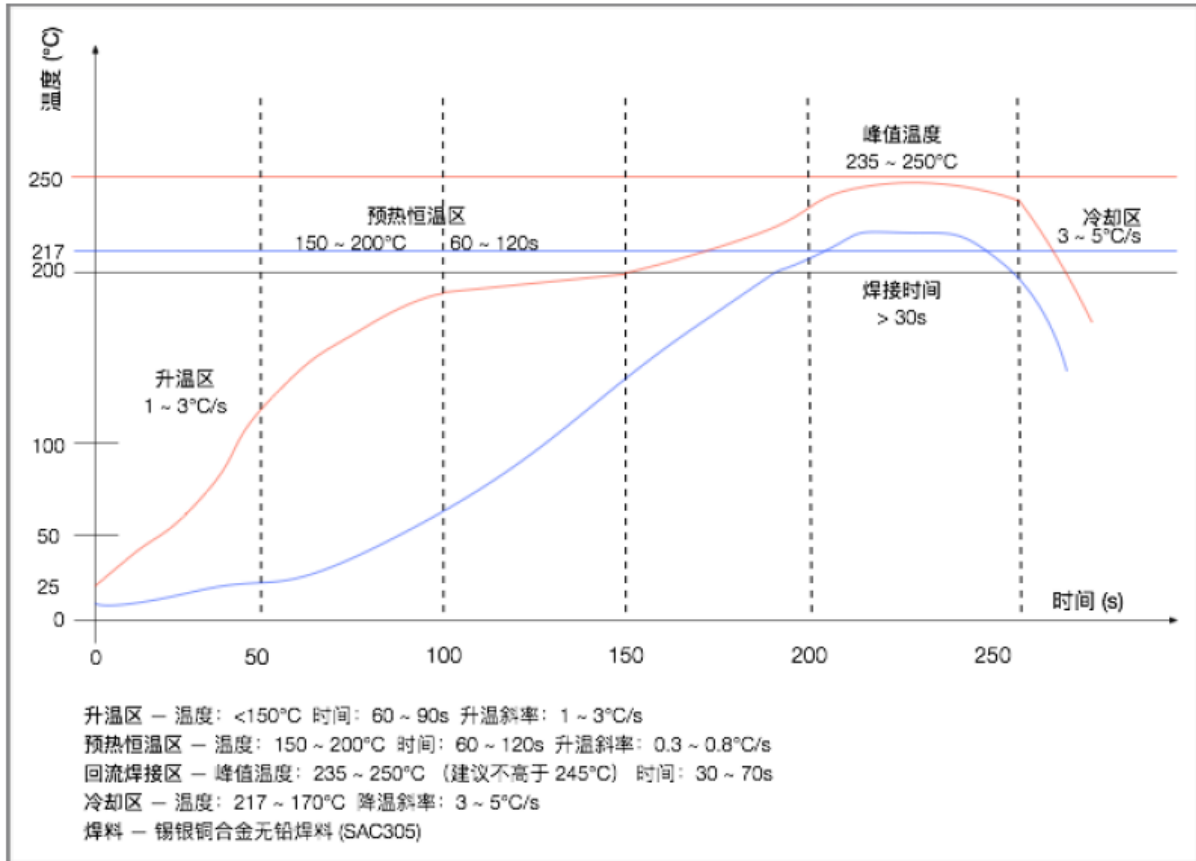
3.1. Recommended Reflow Profile

Figure 13.   Reflow Soldering Profile

3.2. Device Handling Instruction (Module IC SMT Preparation)

1. Shelf life in sealed bag: 12 months, at <30℃ and <60% relative humidity (RH)
2. After bag is opened, devices that will be re-baked required after last baked with window time 168 hours.
3. Recommend to oven bake with N2 supplied
4. Recommend end to reflow oven with N2 supplied
5. Baked required with 24 hours at 125+-5℃ before rework process.
6. Recommend to store at ≦10% RH with vacuum packing
7. If SMT process needs twice reflow:

    (1) Top side SMT and reflow   (2) Bottom side SMT and reflow

    Case 1: Wifi module mounted on top side. Need to bake when bottom side process over 168 hours window time, no need to bake within 168 hours

    Case 2: Wifi module mounted on bottom side, follow normal bake rule before process

    Note: Window time means from last bake end to next reflow start that has 168 hours space.
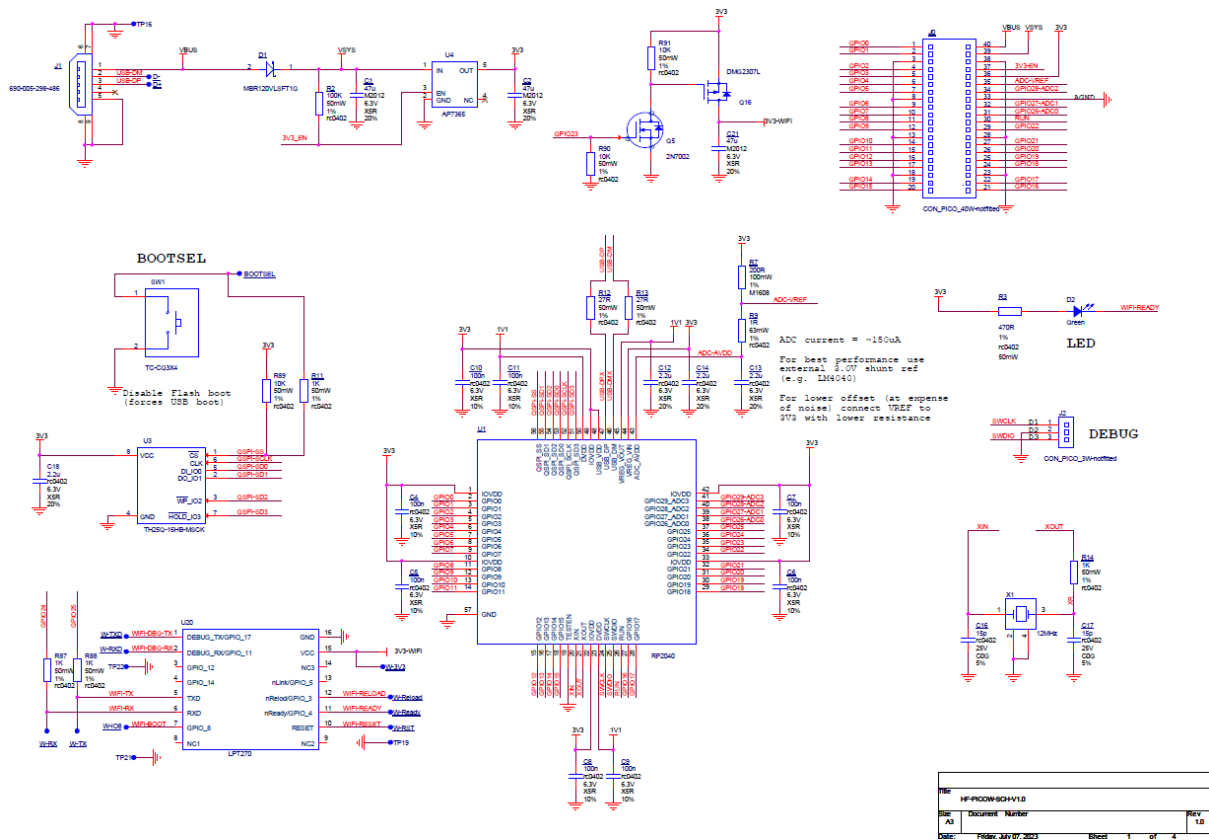
APPENDIX A: HARDWARE DESIGN

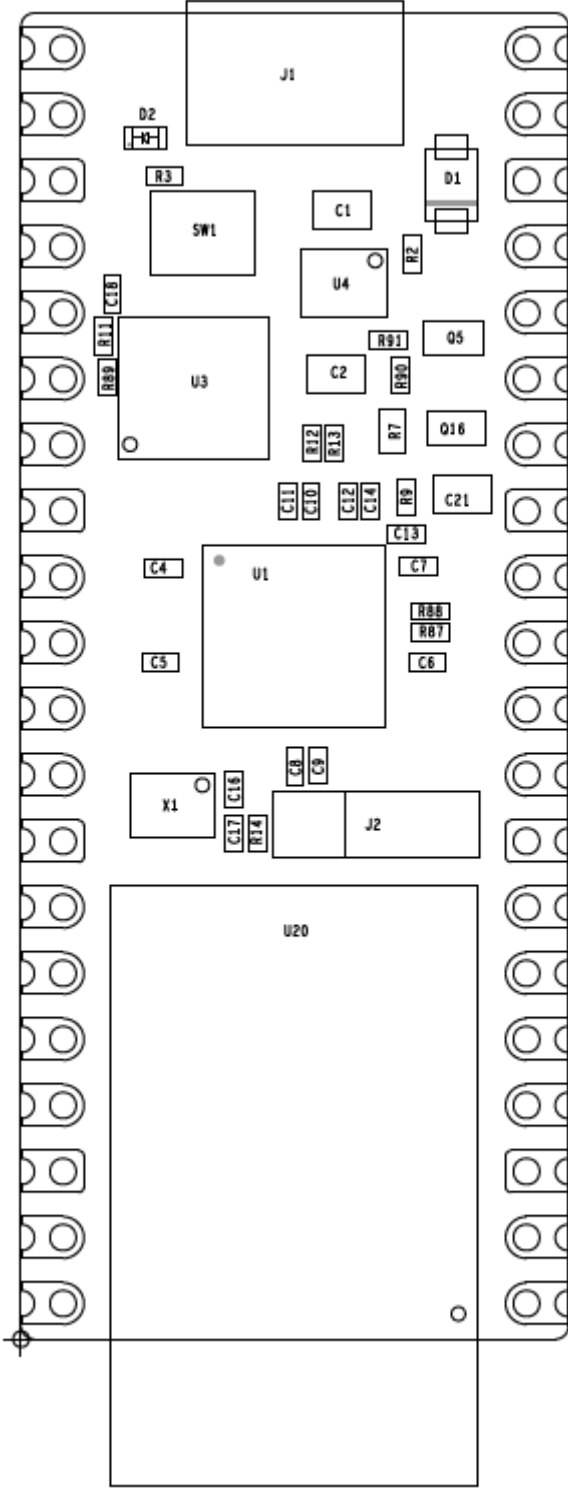

Figure 14. HF-PICOW Schematic

Figure 15.   HF-PICOW Component locations

APPENDIX B: CONTACT INFORMATION

Web: www.hi-flying.com
Service Online: 400-189-3108/18616078755
Sales Contact: sales@hi-flying.com

For more information about High-Flying modules, applications, and solutions, please visit our web site http://www.hi-flying.com/en/

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