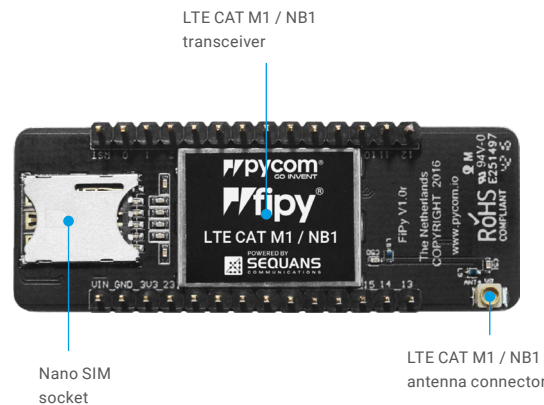
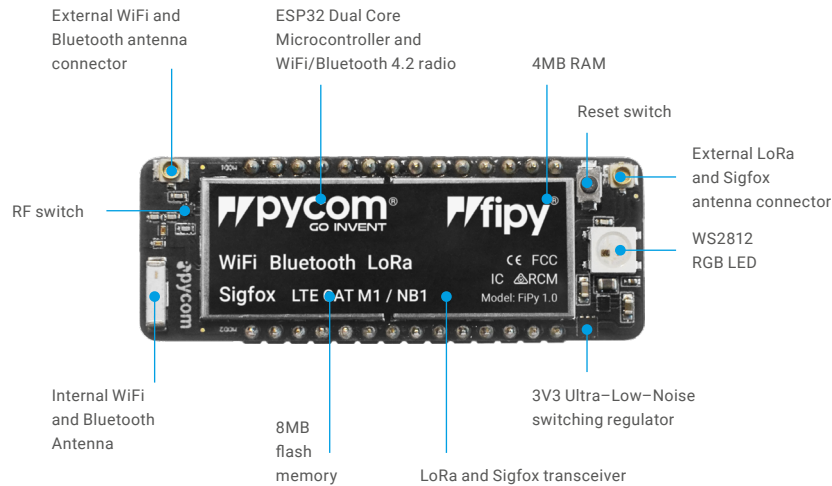




Datasheet
Version 1.0



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Size
55mm x 20mm x 9.7mm
(with headers)

Temperature Range
-20 to +85 °C

1.0 Overview

With Sigfox, LoRa, WiFi, BLE and cellular LTE-CAT M1/NB1, the FiPy is the latest Pycom MicroPython enabled micro controller on the market today – the perfect enterprise grade IoT platform for your connected Things. Create and connect your things everywhere. Fast.

2.0 Features

- Five Networks: WiFi, BLE, cellular LTE-CAT M1/NB1, LoRa and Sigfox
- Powerful CPU.
- Can also double up as a Nano LoRa gateway
- MicroPython enabled
- Fits in a standard breadboard (with headers)
- Ultra-low power usage: a fraction compared to other connected micro controllers
- World ready, one product covers all LTE-M bands

3.0 Specifications

3.1 CPU

- Xtensa® dual-core 32-bit LX6 microprocessor(s), up to 600 DMIPS
- Hardware floating point acceleration
- Python multi-threading
- An extra ULP-coprocessor that can monitor GPIOs, the ADC channels and control most of the internal peripherals during deep-sleep mode while only consuming 25uA.

3.2 Memory

- RAM: 520KB + 4MB
- External flash: 8MB

3.3 WiFi

- 802.11b/g/n 16mbps

3.4 Bluetooth

- Low energy and classic

3.5 LoRa

- LoRaWAN stack – Class A and C devices
- Node range: Up to 40km
- Nano-gateway: Up to 22km (Capacity up to 100 nodes)

3.6 Sigfox

- Class 0 device. Maximum Tx power:
 - +14dBm(Europe)
 - +20dBm (America)
 - +20dBm (Australia and New Zealand)
- Node range: Up to 50km

3.7 LTE CAT-M1/NB-IoT

- One single chip for both CAT M1 and NB1
- 3GPP release 13 LTE Advanced Pro
- Supports narrowband LTE UE categories M1/NB1
- Integrated baseband, RF, RAM memory and power management
- Reduced TX power class option
- Peak power estimations:
 - TX current = 420mA peak @1.5Watt
 - RX current = 330mA peak @1.2Watt
- Extended DRX (eDRX) and PSM features for long sleep duration use cases

3.8 RTC

- Running at 32KHz

3.9 Security

- SSL/TLS support
- WPA Enterprise security

3.10 Hash / encryption

- SHA
- MD5
- DES
- AES

4.0 Block Diagram

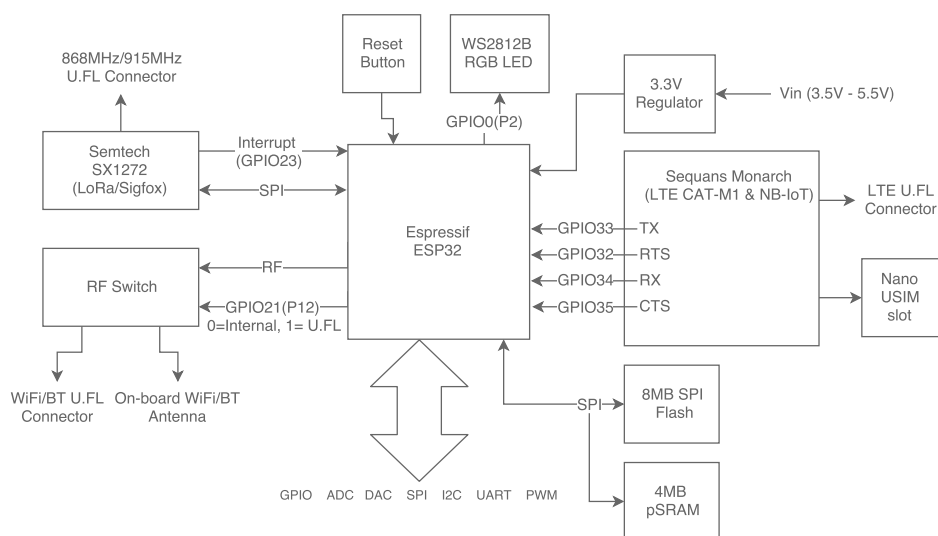
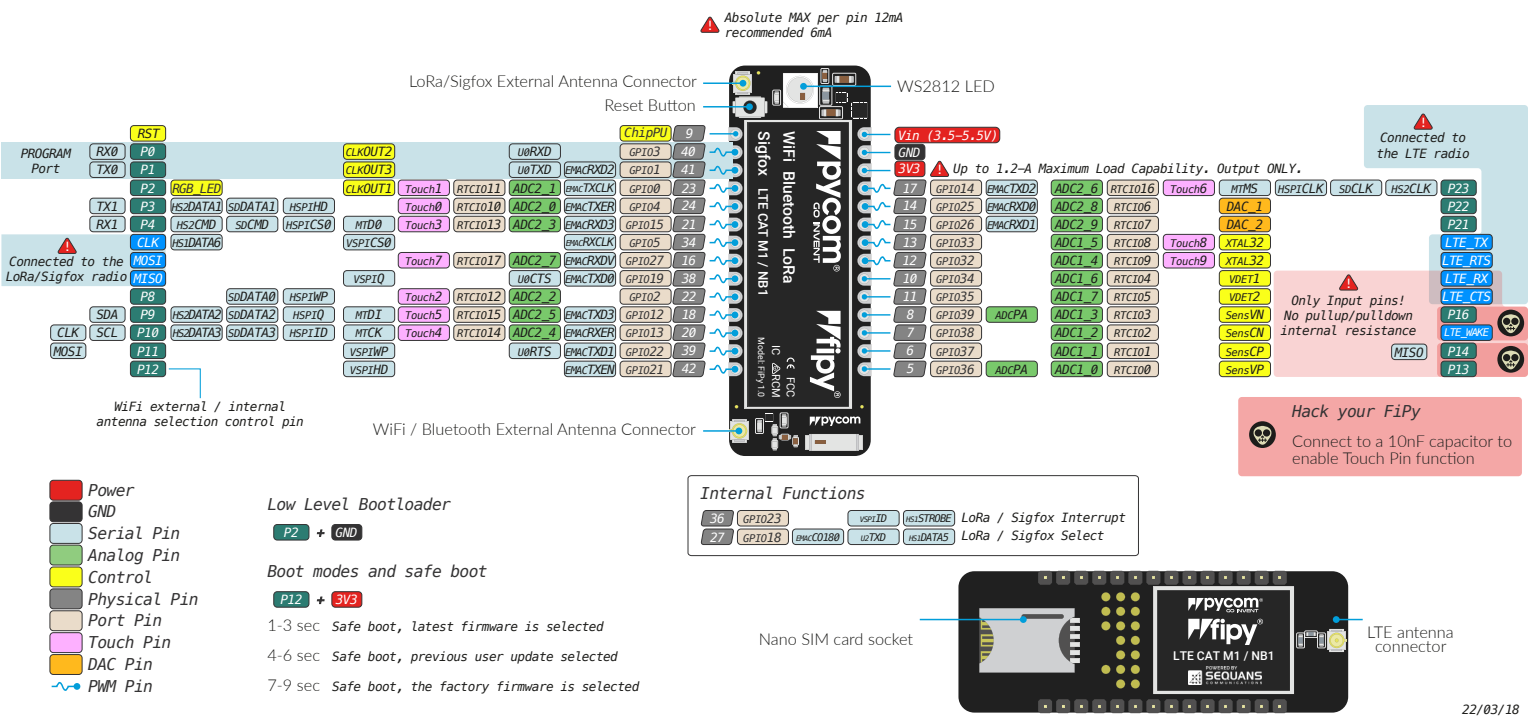


Figure 1 – System block diagram

5.0 Pinout



22/03/18

Figure 2 – Module pinout diagram

Note: The ESP32 supports remapping its peripherals to alternative pins. See below for a detailed list.

6.0 Pin Details

Table 1 – Module pinout

| Module Pin | ESP32 GPIO | Pin Name | Default Function | ADC | PWM | RTC+ | Notes |
|------------|------------|----------|----------------------------|-----|-----|------|---|
| 1 | – | | Reset | | | | Active Low, connected to on-board button |
| 2 | 3 | P0 | RX0 (Programming) | | • | | Used by the bootloader and to program the module |
| 3 | 1 | P1 | TX0 (Programming) | | • | | Used by the bootloader and to program the module |
| 4 | 0 | P2 | | 2* | • | • | If tied to GND during boot the device will enter bootloader mode. Connected to the on-board RGB LED |
| 5 | 4 | P3 | TX1 | 2* | • | • | |
| 6 | 15 | P4 | RX1 | 2* | • | • | JTAG TDO, SD card CMD |
| 7 | 5 | – | LoRa/Sigfox radio SPI CLK | | • | | Not recommended for external use |
| 8 | 27 | – | LoRa/Sigfox radio SPI MOSI | 2* | • | • | Not recommended for external use |
| 9 | 19 | – | LoRa/Sigfox radio SPI MISO | | • | | Not recommended for external use |
| 10 | 2 | P8 | | 2* | • | • | SD card DAT0 |
| 11 | 12 | P9 | SDA | 2* | • | • | JTAG TDI |
| 12 | 13 | P10 | SCL (I2C) / CLK (SPI) | 2* | • | • | JTAG TCK |
| 13 | 22 | P11 | MOSI | | • | | |
| 14 | 21 | P12 | | | • | | If tied to 3.3V during boot the device enters safe boot mode, JTAG MISO, External WiFi/BT antenna switch, Low = on-board, High = U.FL |
| 15 | 36 | P13 | | 1 | | • | Input only |
| 16 | 37 | P14 | MISO | 1 | | • | Input only |
| 17 | 38 | P15 | Sequans modem interrupt | 1 | | • | Input only, not recommended for external use |
| 18 | 39 | P16 | | 1 | | • | Input only |

6.0 Pin Details

Table 1 – Module pinout

| Module Pin | ESP32 GPIO | Pin Name | Default Function | ADC | PWM | RTC† | Notes |
|------------|------------|----------|-------------------------------|-----|-----|------|---|
| 19 | 35 | P17 | Sequans modem CTS | 1 | | • | Input only, not recommended for external use |
| 20 | 34 | P18 | Sequans modem RX | 1 | | • | Input only, not recommended for external use, 921600 Baud |
| 21 | 32 | P19 | Sequans modem RTS | 1 | • | • | Not recommended for external use |
| 22 | 33 | P20 | Sequans modem TX | 1 | • | • | Not recommended for external use, 921600 Baud |
| 23 | 26 | P21 | | 2* | • | • | DAC |
| 24 | 25 | P22 | | 2* | • | • | DAC |
| 25 | 14 | P23 | | 2* | • | • | JTAG TMS, SD card SCLK |
| 26 | – | – | Regulated 3.3V supply | | | | Output only, do not feed 3.3V into this pin or you can damage the regulator |
| 27 | – | – | Ground | | | | |
| 28 | – | – | Voltage Input | | | | Accepts a voltage between 3.5V and 5.5V |
| – | 23 | – | LoRa/Sigfox radio interrupt | | | | |
| – | 18 | – | LoRa/Sigfox radio chip select | | | | |

† The pins on the RTC power domain can be used during deep sleep, specifically GPIO pins will maintain their state while in deep sleep.

* ADC2 is currently not supported in the micropython firmware

6.1 Remapping Pins

The ESP32 features comprehensive pin remapping functionality. This allows peripherals to be mapped onto almost any available GPIO pins. The above table merely shows the default assignments. For example, the default mapping has the SPI and I2C clocks overlapping,

meaning both cannot be used simultaneously without remapping one to a different pin. For a detailed guide of what peripheral can be assigned to what pins please read “Appendix A – ESP32 Pin Lists” of the ESP32 datasheet.

7.0 ESP32 Peripherals

Table 2 – Peripherals

| Peripheral | Count | Pins |
|------------|-------|--|
| UART | 3 | Remappable to any GPIO. Note: P13–18 can only be mapped to RX or CTS since they are input only. |
| I2C | 2 | Remappable to any GPIO except P13–18 since they are input only and I2C is bi-directional. |
| SPI | 3 | Remappable to any GPIO. Note: P13–18 can only be mapped to MISO since they are input only. |
| CAN* | 1 | Remappable to any GPIO. Note: P13–18 can only be mapped to RX since they are input only. |
| JTAG | 1 | TDO = P4, TDI = P9, TCK = P10, TMS = P24 |
| PWM | 1 | All GPIO except P13–18 which are input only |
| ADC | 18 | Fixed mapping, see Table 1, Only ADC 1 is supported in our micropython firmware. |
| DAC | 2 | Only available on P21 and P22 |
| SD | 1 | DAT0 = P8, SCLK = P23, CMD = P4 |

* Requires an external CAN bus transceiver, we recommend the SN65HVD230 from Texas Instruments.

For a more detailed description of the ESP32 peripherals along with peripherals not currently supported by our firmware, please check the ESP32 datasheet.

7.1 RTC

Our modules by default all use the internal RC oscillator at 150kHz for the RTC. In the case of the FiPy, the external RTC pins are used by the LTE module, and therefore the external RTC oscillator is not available.

8.0 Programming the device

8.1 UART

By default, the modules run an interactive python REPL on UART0 which is connected to P0 (RX) and P1 (TX) running at 115200 baud. The easiest way to connect to the FiPy is via our expansion board, but any USB UART adapter will suffice. Code can be run via this interactive REPL or you can use our PyMakr plugin for Atom or Visual Studio Code to upload code to the board.

8.2 Wi-Fi

By default, the FiPy also acts as a Wi-Fi access point
SSID: fipy-wlan-XXXX
Password: www.pycom.io
Once connected to the FiPy's Wi-Fi network you can access it in two ways.

8.2.1 Telnet

Running on port 23 is a telnet server. This acts in a very similar way to the UART. It presents you with an interactive REPL and can also be used to upload code via PyMakr.

8.2.2 FTP

The FiPy also runs a FTP server that allows you to copy files to and from the device, include an SD card if one is connected. To connect to this FTP server, you need to use plain FTP (un-encrypted) with the following credentials:
User: micro
Password: python

9.0 Bootmodes

9.1 Bootloader mode

In order to update the firmware of the FiPy device, it needs to be placed into bootloader mode. In order to do this, P2 needs to be connected to ground when the device reboots. Once in bootloader mode you can use the Pycom firmware update tool to update to the latest official firmware. If you are developing your own firmware based on our open-source firmware, a flashing script is provided with the source code.

9.2 Safboot

The micropython firmware features a safe boot feature that skips the boot.py and main.py scripts and goes straight to the REPL. This is useful if the device is programmed with code that causes the device to crash or become inaccessible. To access this mode, you need to connect P12 to 3.3V and reset the device. Upon entering safe boot mode, the on-board LED will begin to blink orange. Depending on the duration the pin is held at 3.3V, a different firmware will be run.

Table 3 – Boot modes

| 0–3 Seconds | 3–6 Seconds |
|---|--|
| Current firmware without running boot.py or main.py | Previous firmware if the firmware was uploaded via OTA (without running boot.py and main.py) |

10.0 Power

The FiPy features an on-board voltage regulator that takes 3.5V – 5.5V from the VIN pin and regulates it to 3.3V. It is important to only use the 3.3V as an output and not try to feed 3.3V into this pin as this could damage the regulator.

10.1 Current consumption by power modes/features measured at 5V

Table 4 – Power consumption by feature

| Mode | Min | Avg. | Max | Units |
|-------------------|-----|------|-----|-------|
| Idle (no radios) | - | 62.7 | - | mA |
| LoRa Transmit* | - | 156 | - | mA |
| Sigfox Transmitt† | - | 192 | - | mA |
| LTE Transmit | - | 173 | 285 | mA |
| LTE Attached | - | 74.5 | - | mA |
| WiFi AP | - | 126 | - | mA |
| WiFi client | - | 137 | - | mA |
| Bluetooth | - | 121 | - | mA |
| Deep sleep | - | 24 | - | µA |

* More details can be found in section 14.2

† More details can be found in section 15.2

11.0 Memory Map

11.1 Flash

Table 5 – Flash memory map

| Name | Description | Start address | Size |
|-----------------|---|---------------|----------|
| NVS | Non-volatile RAM area. Used by the NVS API | 0x9000 | 0x7000 |
| Firmware Slot 0 | First firmware slot. Factory firmware is flashed here | 0x10000 | 0x180000 |
| OTA info | Information about the current active firmware | 0x190000 | 0x1000 |
| Firmware Slot 1 | Second firmware slot | 0x1A0000 | 0x180000 |
| File system | 504KB file system on devices with 4MB flash | 0x380000 | 0x7F000 |
| Config | Config area for LoRa, Sigfox and LTE | 0x3FF000 | 0x1000 |
| File system (2) | 4MB file system on devices with 8MB flash | 0x400000 | 0x400000 |

11.2 RAM

Table 6 – RAM memory map

| Name | Description | Size |
|----------------|---|-------|
| On-chip SRAM | Internal RAM memory used by the 2 xtensa CPUs | 520KB |
| Fast RTC RAM | Fast RAM area accessible by the xtensa cores during boot and sleep modes | 8KB |
| Slow RTC RAM | Slow RAM area accessible by the Ultra-Low Power Coprocessor during deep sleep | 8KB |
| External pSRAM | External QSPI RAM memory clocked @ 40MHz | 4MB |

11.3 ROM and eFuses

Table 7 – Miscellaneous memory

| Name | Description | Size |
|-------------|---|-------|
| On-chip ROM | Contains core functions and boot code. | 448KB |
| 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 | 1kbit |

12.0 WiFi

12.1 Supported features

- 802.11 b/g/n/e/i
- 802.11 n (2.4 GHz), up to 150 Mbps
- 802.11 e: QoS for wireless multimedia technology
- WMM-PS, UAPSD
- A-MPDU and A-MSDU aggregation
- Block ACK
- Fragmentation and defragmentation
- Automatic Beacon monitoring/scanning
- 802.11 i security features: pre-authentication and TSN
- Wi-Fi Protected Access (WPA)/WPA2/WPA2-Enterprise/Wi-Fi Protected Setup (WPS)
- Infrastructure BSS Station mode/SoftAP mode
- Wi-Fi Direct (P2P), P2P Discovery, P2P Group Owner mode and P2P Power Management

12.2 Specifications

Table 8 – WiFi specifications

| Description | Min | Typ. | Max | Unit |
|---|------|------|------|------|
| Input Frequency | 2412 | - | 2484 | MHz |
| Tx power Output power of PA for 72.2 Mbps | 13 | 14 | 15 | dBm |
| Output power of PA for 11b mode | 19.5 | 20 | 20.5 | dBm |
| Sensitivity | | | | |
| DSSS, 1Mbps | - | - | 98 | dBm |
| CCK, 11 Mbps | - | - | 91 | dBm |
| OFDM, 6 Mbps | - | - | 93 | dBm |
| OFDM, 54 Mbps | - | - | 75 | dBm |
| HT20, MCS0 | - | - | 93 | dBm |
| HT20, MCS7 | - | - | 73 | dBm |
| HT40, MCS0 | - | - | 90 | dBm |
| HT40, MCS7 | - | - | 70 | dBm |
| MCS32 | - | - | 89 | dBm |
| Adjacent channel rejection | | | | |
| OFDM, 6 Mbps | - | 37 | - | dB |
| OFDM, 54 Mbps | - | 21 | - | dB |
| HT20, MCS0 | - | 37 | - | dB |
| HT20, MCS7 | - | 20 | - | dB |

13.0 Bluetooth

13.1 Supported features

- Compliant with Bluetooth v4.2 BR/EDR and BLE specification
- Class-1, class-2 and class-3 transmitter without external power amplifier
- Enhanced power control
- +12 dBm transmitting power
- NZIF receiver with -97 dBm sensitivity
- Adaptive Frequency Hopping (AFH)
- Standard HCI based on SDIO/SPI/UART
- High-speed UART HCI, up to 4 Mbps
- BT 4.2 controller and host stack
- Service Discover Protocol (SDP)
- General Access Profile (GAP)
- Security Manage Protocol (SMP)
- ATT/GATT
- HID
- All GATT-based profile supported
- SPP-like GATT-based profile
- BLE Beacon
- A2DP/AVRCP/SPP, HSP/HFP, RFCOMM
- CVSD and SBC for audio codec
- Bluetooth Piconet and Scatternet

13.2 Specification

13.2.1 Receiver – Basic Data Rate

Table 9 – Receiver (basic data rate) specifications

| Parameter | Min | Typ. | Max | Unit |
|-----------------------------------|-------------------|------|-----|------|
| Sensitivity @0.1% BER | - | -94 | - | dBm |
| Maximum received signal @0.1% BER | 0 | - | - | dBm |
| Co-channel C/I | - | +7 | - | dB |
| Adjacent channel selectivity C/I | F = F0 + 1 MHz | - | -6 | dB |
| | F = F0 - 1 MHz | - | -6 | dB |
| | F = F0 + 2 MHz | - | -25 | dB |
| | F = F0 - 2 MHz | - | -33 | dB |
| | F = F0 + 3 MHz | - | -25 | dB |
| | F = F0 - 3 MHz | - | -45 | dB |
| Out-of-band blocking performance | 30Mhz ~ 2000MHz | -10 | - | dBm |
| | 2000MHz ~ 2400MHz | -27 | - | dBm |
| | 2500MHz ~ 3000MHz | -27 | - | dBm |
| | 3000MHz ~ 12.5GHz | -10 | - | dBm |
| Intermodulation | -36 | - | - | dBm |

13.2.2 Receiver – Enhanced Data Rate

Table 10 – Receiver (basic data rate) specifications

| Parameter | | Min | Typ. | Max | Unit |
|-----------------------------------|----------------|-----|------|-----|------|
| $\pi/4$ DQPSK | | | | | |
| Sensitivity @0.1% BER | | – | –90 | – | dBm |
| Maximum received signal @0.1% BER | | – | 0 | – | dBm |
| Co–channel C/I | | – | 11 | – | dB |
| Adjacent channel selectivity C/I | F = F0 + 1 MHz | – | –7 | – | dB |
| | F = F0 – 1 MHz | – | –7 | – | 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 |
| 8DPSK | | | | | |
| Sensitivity @0.1% BER | | – | –84 | – | dBm |
| Maximum received signal @0.1% BER | | – | –5 | – | dBm |
| C/I c–channel | | – | 18 | – | dB |
| Adjacent channel selectivity C/I | F = F0 + 1 MHz | – | 2 | – | dB |
| | F = F0 – 1 MHz | – | 2 | – | dB |
| | F = F0 + 2 MHz | – | –25 | – | dB |
| | F = F0 – 2 MHz | – | –25 | – | dB |
| | F = F0 + 3 MHz | – | –25 | – | dB |
| | F = F0 – 3 MHz | – | –38 | – | dB |

13.2.3 Receiver – Bluetooth LE

Table 11 – Receiver (BLE) specifications

| Parameter | | 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 + 1MHz | - | -5 | - | dB |
| | F = F0 - 1MHz | - | -5 | - | dB |
| | F = F0 + 2MHz | - | -25 | - | dB |
| | F = F0 - 2MHz | - | -35 | - | dB |
| | F = F0 + 3MHz | - | -35 | - | dB |
| | F = F0 - 3MHz | - | -45 | - | dB |
| Out-of-band blocking performance | 30MHz ~ 2000MHz | -10 | - | - | dB |
| | 2000MHz ~ 2400MHz | -27 | - | - | dBm |
| | 2500MHz ~ 3000MHz | -27 | - | - | dBm |
| | 3000MHz ~ 12.5GHZ | -10 | - | - | dBm |
| Intermodulation | | -36 | - | - | dBm |

13.2.4 Transmitter – Basic Data Rate

Table 12 – Transmitter (basic data rate) specifications

| Parameter | Min | Typ. | Max | Unit | |
|---|-----------------|------|-------|----------------|-----|
| RF transmit power | – | 0 | – | dBm | |
| Gain control step | – | ±3 | – | dBm | |
| RF power control range | –12 | – | +12 | dBm | |
| +20 dB bandwidth | – | 0.9 | – | MHz | |
| Adjacent channel transmit power | F = F0 + 1 MHz | – | –24 | – | dBm |
| | F = F0 – 1 MHz | – | –16.1 | – | dBm |
| | F = F0 + 2 MHz | – | –40.8 | – | dBm |
| | F = F0 – 2 MHz | – | –35.6 | – | dBm |
| | F = F0 + 3 MHz | – | –45.7 | – | dBm |
| | F = F0 – 3 MHz | – | –40.2 | – | dBm |
| | F = F0 + >3 MHz | – | 45.6 | – | dBm |
| | F = F0 – >3 MHz | – | 44.6 | – | dBm |
| $\Delta f_{1_{avg}}$ | – | – | 155 | KHz | |
| $\Delta f_{2_{max}}$ | 133.7 | | | KHz | |
| $\Delta f_{2_{avg}}/\Delta f_{1_{avg}}$ | – | 0.92 | – | – | |
| ICFT | – | –7 | – | KHz | |
| Drift rate | – | 0.7 | – | KHz/50 μ s | |
| Drift (1 slot packet) | – | 6 | – | KHz | |
| Drift (5 slot packet) | – | 6 | – | KHz | |

13.2.5 Transmitter – Enhanced Data Rate

Table 13 – Transmitter (enhanced data rate) specifications

| Parameter | Min | Typ. | Max | Unit | |
|-----------------------------------|----------------|-------|-------|-------|-----|
| RF transmit power | – | 0 | – | dBm | |
| Gain control step | – | ±3 | – | dBm | |
| RF power control range | –12 | – | +12 | dBm | |
| $\pi/4$ DQPSK max w_0 | – | –0.72 | – | KHz | |
| $\pi/4$ DQPSK max w_i | – | –6 | – | KHz | |
| $\pi/4$ DQPSK max $ w_i + w_0 $ | – | –7.42 | – | KHz | |
| 8DPSK max w_0 | – | 0.7 | – | KHz | |
| 8DPSK max w_i | – | –9.6 | – | KHz | |
| 8DPSK max $ w_i + w_0 $ | – | –10 | – | KHz | |
| $\pi/4$ DQPSK modulation accuracy | RMS DEVM | – | 4.28 | – | % |
| | 99% DEVM | – | – | 30 | % |
| | Peak DEVM | – | 13.3 | – | % |
| 8 DPSK modulation accuracy | RMS DEVM | – | 5.8 | – | % |
| | 99% DEVM | – | – | 20 | % |
| | Peak DEVM | – | 14 | – | % |
| In-band spurious emissions | F = F0 + 1MHz | – | –34 | – | dBm |
| | F = F0 – 1MHz | – | –40.2 | – | dBm |
| | F = F0 + 2MHz | – | –34 | – | dBm |
| | F = F0 – 2MHz | – | –36 | – | dBm |
| | F = F0 + 3MHz | – | –38 | – | dBm |
| | F = F0 – 3MHz | – | –40.3 | – | dBm |
| | F = F0 ± >3MHz | – | – | –41.5 | dBm |
| EDR differential phase coding | – | 100 | – | % | |

13.2.6 Transmitter – Bluetooth LE

Table 14 – Transmitter (BLE) specifications

| Parameter | Min | Typ. | Max | Unit | |
|---|----------------|-------|-------|----------|-----|
| RF transmit power | – | 0 | – | dBm | |
| Gain control step | – | ±3 | – | dBm | |
| RF power control range | –12 | – | +12 | dBm | |
| Adjacent channel transmit power | F = F0 + 1MHz | – | –14.6 | – | dBm |
| | F = F0 – 1MHz | – | –12.7 | – | dBm |
| | F = F0 + 2MHz | – | –44.3 | – | dBm |
| | F = F0 – 2MHz | – | –38.7 | – | dBm |
| | F = F0 + 3MHz | – | –49.2 | – | dBm |
| | F = F0 – 3MHz | – | –44.7 | – | dBm |
| | F = F0 + >3MHz | – | –50 | – | dBm |
| | F = F0 – >3MHz | – | –50 | – | dBm |
| $\Delta f_{1_{avg}}$ | – | – | 265 | KHz | |
| $\Delta f_{2_{max}}$ | 247 | – | – | KHz | |
| $\Delta f_{2_{avg}}/\Delta f_{1_{avg}}$ | – | –0.92 | – | – | |
| ICFT | – | –10 | – | KHz | |
| Drift rate | – | 0.7 | – | KHz/50µs | |
| Drift | – | 2 | – | KHz | |

14.0 LoRa

14.1 Supported features

Table 15 – Supported LoRa features

| Part Number | Frequency Range | LoRa Parameters | | | |
|----------------|-----------------|------------------|---------------|-------------------|------------------|
| | | Spreading factor | Bandwidth | Effective Bitrate | Sensitivity |
| Semtech SX1272 | 860–1020MHz | 6 – 12 | 125 – 500 kHz | 0.24 – 37.5 kpbs | –117 to –137 dBm |

The current micropython firmware supports LoRaWAN 1.0 acting as either a Class A or Class C node.

14.2 Specifications

Table 16 – LoRa modem performance

| Bandwidth (KHz) | Spreading Factor | Nominal Rb (bps) | Sensitivity (dBm) |
|-----------------|------------------|------------------|-------------------|
| 125 | 6 | 9380 | -122 |
| 125 | 12 | 293 | -137 |
| 250 | 6 | 18750 | -119 |
| 250 | 12 | 588 | -134 |
| 500 | 6 | 37500 | -116 |
| 500 | 12 | 1172 | -131 |

14.2 Specifications

Table 17 – LoRa electrical characteristics

| Symbol | Description | Conditions | Min | Typ. | Max | Unit |
|----------|--|---|------|-------|------|------|
| IDDR_L | Supply current in receiver LoRa mode | LNABoost Off, BW=125KHz | – | 9.7 | – | mA |
| | | LNABoost Off, BW=250KHz | – | 10.5 | – | mA |
| | | LNABoost Off, BW=500KHz | – | 12 | – | mA |
| | | LNABoost On, BW=125KHz | – | 10.8 | – | mA |
| | | LNABoost On, BW=250KHz | – | 11.6 | – | mA |
| | | LNABoost On, BW=500KHz | – | 13 | – | mA |
| IDDT_L | Supply current in transmitter mode | RFOP = 13dBm | – | 28 | – | mA |
| | | RFOP = 7dBm | – | 18 | – | mA |
| IDDT_H_L | Supply current in transmitter mode with an external impedance transformer | Using PA_BOOST pin RFOP = 17 dBm | – | 90 | – | mA |
| BI_L | Blocking Immunity, FRF=868MHz CW interferer | Offset = ±1 MHz | – | 82.5 | – | dB |
| | | Offset = ±2 MHz | – | 86.5 | – | dB |
| | | Offset = ±10 MHz | – | 89 | – | dB |
| IIP3_L | 3rd order input intercept point, highest LNA gain, FRF=868MHz, CW interferer | F1 = FRF + 1MHz F2 = FRF + 1.995MHz | – | –12.5 | – | dBm |
| IIP2_L | 2nd order input intercept point, highest LNA gain, FRF=868MHz, CW interferer | F1 = FRF + 20MHz F2 = FRF + 20MHz + Δf | – | 57 | – | dBm |
| BR_L | Bit rate, Long-Range Mode | From SF6, CR=4/5, BW=500 kHz to SF12, CR=4/8, BW = 125kHz | 0.24 | – | 37.5 | kbps |

14.2 Specifications

Table 17 – LoRa electrical characteristics

| Symbol | Description | Conditions | Min | Typ. | Max | Unit |
|----------|---|------------|-----|------|-----|------|
| RFS_L125 | RF sensitivity, Long-Range Mode, highest LNA gain, LNA boost, 125kHz bandwidth using split Rx/Tx path | SF = 6 | - | -121 | - | dBm |
| | | SF = 7 | - | -124 | - | dBm |
| | | SF = 8 | - | -127 | - | dBm |
| | | SF = 9 | - | -130 | - | dBm |
| | | SF = 10 | - | -133 | - | dBm |
| | | SF = 11 | - | -135 | - | dBm |
| | | SF = 12 | - | -137 | - | dBm |
| RFS_L250 | RF sensitivity, Long-Range Mode, highest LNA gain, LNA boost, 250kHz bandwidth using split Rx/Tx path | SF = 6 | - | -118 | - | dBm |
| | | SF = 7 | - | -122 | - | dBm |
| | | SF = 8 | - | -125 | - | dBm |
| | | SF = 9 | - | -128 | - | dBm |
| | | SF = 10 | - | -130 | - | dBm |
| | | SF = 11 | - | -132 | - | dBm |
| | | SF = 12 | - | -135 | - | dBm |
| RFS_L500 | RF sensitivity, Long-Range Mode, highest LNA gain, LNA boost, 500kHz bandwidth using split Rx/Tx path | SF = 6 | - | -111 | - | dBm |
| | | SF = 7 | - | -116 | - | dBm |
| | | SF = 8 | - | -119 | - | dBm |
| | | SF = 9 | - | -122 | - | dBm |
| | | SF = 10 | - | -125 | - | dBm |
| | | SF = 11 | - | -128 | - | dBm |
| | | SF = 12 | - | -129 | - | dBm |

14.2 Specifications

Table 17 – LoRa electrical characteristics

| Symbol | Description | Conditions | Min | Typ. | Max | Unit |
|---------|---|---|------|------|-----|------|
| CCR_LCW | | SF = 7 | - | 5 | - | dB |
| | | SF = 8 | - | 9.5 | - | dB |
| | | SF = 9 | - | 12 | - | dB |
| | | SF = 10 | - | 14.4 | - | dB |
| | | SF = 11 | - | 17 | - | dB |
| | | SF = 12 | - | 19.5 | - | dB |
| CCR_LL | Co-channel rejection | Interferer is a LoRa signal using the same BW and SF. Pw = sensitivity + 3dB | - | -6 | - | dB |
| ACR_LCW | Adjacent channel rejection FRF = 868 MHz | Interferer is 1.5*BW_L from the wanted signal centre frequency 1% PER, Single CW tone = Sensitivity + 3dB | | | | |
| | | SF = 7 | - | 60 | - | dB |
| | | SF = 12 | - | 72 | - | dB |
| IMR_LCW | Image rejection after calibration | 1% PER, Single CW tone = sensitivity + 3dB | - | 66 | - | dB |
| FERR_L | Maximum tolerated frequency offset between transmitter and receiver, no sensitivity degradation | BW_L = 125kHz | -30 | - | 30 | kHz |
| | | BW_L = 250kHz | -60 | - | 60 | kHz |
| | | BW_L = 500kHz | -120 | - | 120 | kHz |

14.2 Specifications

Table 18 – LoRa power consumption

| Symbol | Description | Conditions | Min | Typ. | Max | Unit |
|---------|---|----------------------------|-----|------|-----|------|
| IDDSL | Supply current in sleep mode | | – | 0.1 | 1 | μA |
| IDDIDLE | Supply current in idle mode | RC oscillator enabled | – | 1.5 | – | μA |
| IDDST | Supply current in standby mode | Crystal oscillator enabled | – | 1.4 | 1.6 | mA |
| IDDFS | Supply current in synthesizer mode | FSRx | – | 4.5 | – | mA |
| IDDR | Supply current in receive mode | LnaBoost Off | – | 10.5 | – | mA |
| | | LnaBoost On | – | 11.2 | – | mA |
| IDDT | Supply current in transmit mode with impedance matching | RFOP=+ 20 dBm on PA_BOOST | – | 125 | – | mA |
| | | RFOP=+ 17 dBm on PA_BOOST | – | 90 | – | mA |
| | | RFOP=+ 13 dBm on RFO pin | – | 28 | – | mA |
| | | RFOP=+ 7 dBm on RFO pin | – | 18 | – | mA |

15.0 Sigfox

15.1 Frequencies

Table 19 – Supported sigfox regions

| Region | Uplink Frequency (Hz) | Downlink Frequency (Hz) |
|--|-----------------------|-------------------------|
| RCZ1 (Europe) | 868130000 | 869525000 |
| RCZ2 (US) | 902200000 | 905200000 |
| RCZ3 (Korea and Japan) | 923200000 | 922200000 |
| RCZ4 (South America, Australia and New Zealand). | 920800000 | 922300000 |

15.2 Specifications

Table 20 – Sigfox modem performance

| Parameter | | Min | Typ. | Max | Unit |
|----------------|---------|-----|------|-----|------|
| Data Rate | RCZ1 | – | 100 | – | bps |
| | RCZ2 | – | 600 | – | bps |
| | RCZ3 | – | 100 | – | bps |
| | RCZ4 | – | 600 | – | bps |
| TX Power | RCZ1 | – | +14 | – | dBm |
| | RCZ2 | – | +20 | – | dBm |
| | RCZ3 | – | +14 | – | dBm |
| | RCZ4 | – | +20 | – | dBm |
| RX Sensitivity | | – | –126 | – | dBm |
| Current Draw | RCZ1 TX | – | 42 | – | mA |
| | RCZ1 RX | – | 11.2 | – | mA |
| | RCZ2 TX | – | 125 | – | mA |
| | RCZ2 RX | – | 11.2 | – | mA |
| | RCZ3 TX | – | 42 | – | mA |
| | RCZ3 RX | – | 11.2 | – | mA |
| | RCZ4 TX | – | 125 | – | mA |
| | RCZ4 RX | – | 11.2 | – | mA |

16.0 LTE CAT-M1/NB-IoT

16.1 Supported features

- 12 bands supported from 699MHz to 2690MHz (Total worldwide support)
- 3GPP release 13 LTE Advanced Pro
- Supports narrowband LTE UE categories M1/NB1
- Integrated baseband, RF, RAM memory and power management
- Reduced TX power class option
- Extended DRX (eDRX) and PSM features for long sleep duration use cases

16.2 Specifications

Table 21 – Supported LTE modes

| Parameter | Min | Typ. | Max | Unit | |
|-----------|-------------------------------------|------|-----|------|------|
| Data rate | LTE Cat M1 in 1.4 Mhz, HD-FDD – DL | – | 300 | – | kbps |
| | LTE Cat M1 in 1.4 Mhz, HD-FDD – UP | – | 375 | – | kbps |
| | LTE Cat NB1 in 200 kHz, HD-FDD – DL | – | 40 | – | kbps |
| | LTE Cat NB1 in 200 kHz, HD-FDD – UL | – | 55 | – | kbps |

16.2.1 Supported LTE bands

Table 22 – Supported LTE bands

| Bands | TX Frequencies | RX Frequencies |
|--|------------------|------------------|
| Low Bands 5, 8, 12, 13, 18, 19, 20, 28 | 699 to 915 MHz | 729 to 960 MHz |
| Mid Bands 1, 2, 3, 4 | 1710 to 1980 MHz | 1805 to 2170 MHz |

16.3 SIM Card requirements

Table 23 – SIM card specifications

| Parameter | Min. | Typ. | Max | Unit |
|----------------|------|----------|-----|------|
| Form factor | – | Nano-SIM | – | – |
| Variant | – | USIM | – | – |
| Supply Voltage | – | 1.8 | – | v |

16.4 Certified carriers

Table 24 – Certified carriers

| Carrier | Country | Network |
|------------|---------------|------------|
| Verizon US | United States | LTE CAT-M1 |

17.0 6LoWPAN

Pycom is currently working on adding 6LoWPAN support to this module and plan to release a new firmware with this functionality in Q2 2018.

18.0 Electrical Characteristics

18.1 Absolute maximum ratings

Table 25 – Absolute maximum ratings

| Parameter | Symbol | Min | Typ. | Max | Unit |
|----------------------------|-----------|-----|------|-----|------|
| Supply Input Voltage | V_{IN} | 3.5 | – | 5.5 | V |
| Supply Output Current | I_{OUT} | – | – | 1.2 | A |
| Supply Output Voltage | V_{3V3} | – | 3.3 | – | V |
| Storage Temperature | T_{STR} | – | – | – | °C |
| Operating Temperature | T_{OPR} | –40 | – | 85 | °C |
| Moisture Sensitivity Level | MSL | – | 1 | – | – |

18.2 Input/Output characteristics

Table 26 – Input/Output characteristics

| Parameter | Symbol | Min | Typ. | Max | Unit |
|---------------------------|--------------|-----------------------|------|-----------------------|------|
| Input low voltage | V_{IL} | –0.3 | – | $0.25 \times V_{3V3}$ | V |
| Input high voltage | V_{IH} | $0.75 \times V_{3V3}$ | – | $V_{3V3} + 0.3$ | V |
| Max Input sink current | I_{SINK} | – | 6 | 12 | mA |
| Input leakage current | I_{IL} | – | – | 50 | nA |
| Input pin capacitance | C_{pin} | – | – | 2 | pF |
| Output low voltage | V_{OL} | $0.1 \times V_{3V3}$ | – | – | V |
| Output high voltage | V_{OH} | $0.8 \times V_{3V3}$ | – | – | V |
| Max Output source current | I_{SOURCE} | – | 6 | 12 | mA |

19.0 Minimum Recommended Circuit

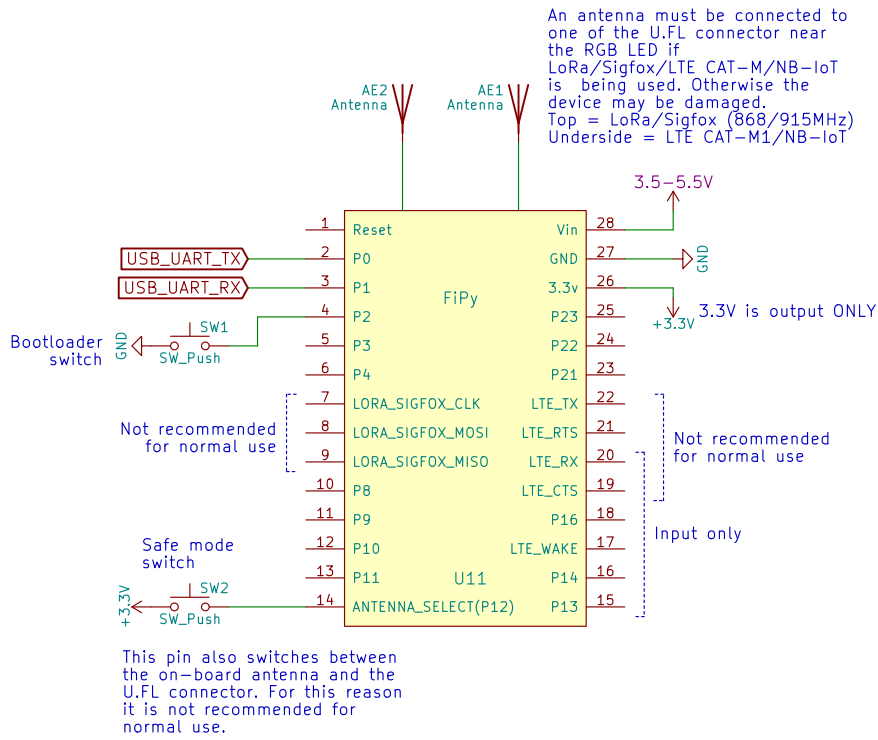


Figure 3 – Minimum required circuit

20.0 Mechanical Specifications

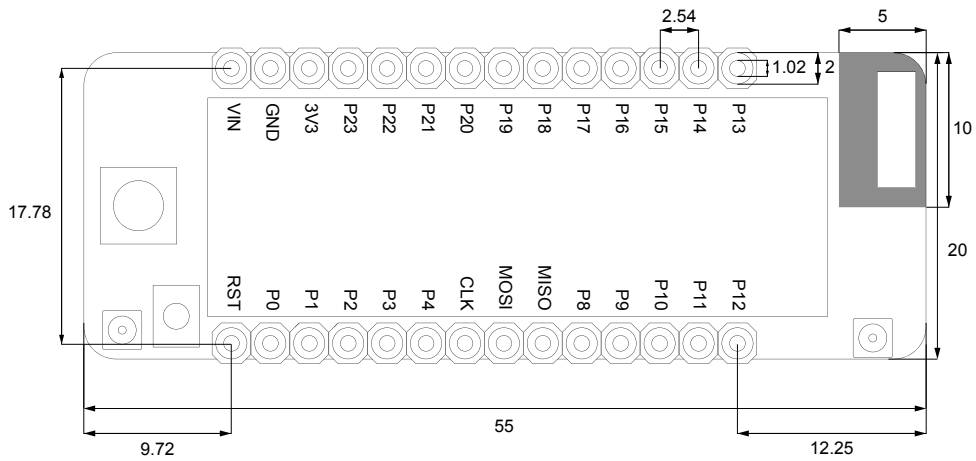


Figure 4 – Mechanical drawing (top down view) – Units: mm

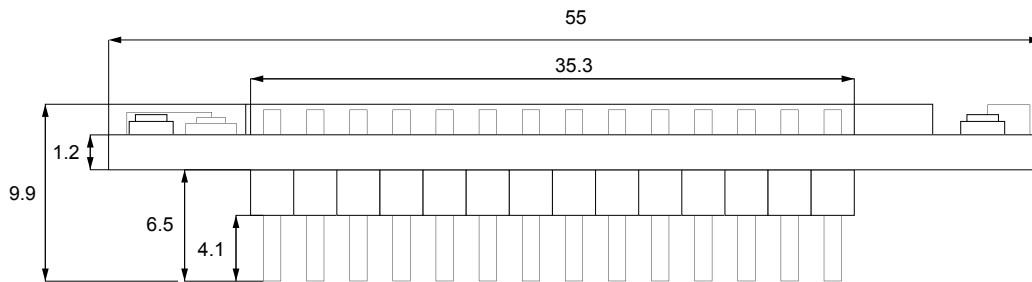


Figure 5 – Mechanical drawing (side view) – Units: mm

21.0 Recommended Land Pattern

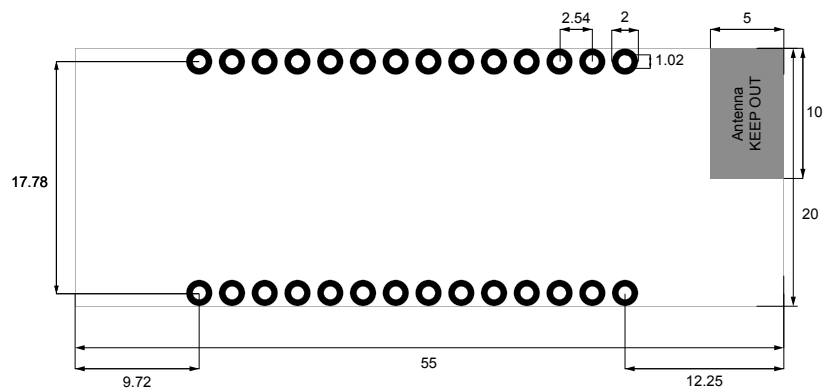


Figure 6 – Recommended land pattern (through hole) – Units: mm

22.0 Soldering Profile

This device is not recommended for reflow soldering. The plastic of the pin headers will melt, instead please hand solder the module or use sockets.

23.0 Ordering Information

Table 27 – Ordering information

| Product EAN | Description | Bundle | Contents |
|---------------|-----------------------|-----------------|---|
| 0700461341604 | FiPy 1.0 | | |
| 0700461341703 | LTE-M Antenna | | |
| 0700461341680 | External WiFi Antenna | | |
| 0700461341697 | IP67 Antenna Pigtail | | |
| | | FiPy Multi-Pack | 1x FiPy 1x Expansion Board or Pysense or Pytrack 1x LTE-M antenna Available in quantities of 1, 2 or 5 |

For more product accessories like expansion board or cases visit our website: <http://www.pycom.io>

24.0 Packaging



Figure 7 – Mechanical drawing of packaging – Units: mm

The module will come inside a reusable anti-static bag. If the module has headers it will also be inserted into anti-static foam. Total weight inc. packaging: 33g

25.0 Certification

FCC 2AJMTFIPY01R
IC 22263-FIPY01R
CE 0700

Copies of the certificates can be found on our website.

Regulator Information

25.1 EU Regulatory Conformance

Hereby, Pycom Ltd declares that this device is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC

25.2 Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

CAUTION: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

25.2.1 RF Warning Statement

To comply with FCC RF exposure compliance requirements, the antennas used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

25.2.2 OEM integrator conditions

This device is intended only for OEM integrators under the following conditions:

1. The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2. The transmitter module may not be co-located with any other transmitter or antenna.

As long as the two conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed. To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

The module is limited to OEM installation ONLY. The module is limited to installation in mobile or fixed application. We hereby acknowledge our responsibility to provide guidance to the host manufacturer in the event that they require assistance for ensuring compliance with the Part 15 Subpart B requirements.

IMPORTANT NOTE: In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

25.2.3 End Product Labelling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labelled in a visible area with the following: "Contains FCC ID: 2AJMTFIPY01R". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

The following FCC part 15.19 statement has to also be available on the label:

This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions:

1. this device may not cause harmful interference and
2. this device must accept any interference received, including interference that may cause undesired operation.

25.2.4 Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

In the user manual of the end product, the end user has to be informed that the equipment complies with FCC radio-frequency exposure guidelines set forth for an uncontrolled environment.

The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

The end user manual shall include all required regulatory information/warning as show in this manual.

The maximum operating ambient temperature of the equipment declared by the manufacturer is -40~+85C

Receiver category 3

26.0 Revision History

Table 28 – Document revision history

| Version 1.0 | Initial Release |
|-------------|-----------------|
|-------------|-----------------|