

Datasheet

# F1 Smart Module

July 2024 V1.2



## Introduction

The F1 Smart Module (order part number SGW3501) is a compact OEM module equipped with BLE, Wi-Fi, LoRa(WAN), and LTE CAT-M1/NB1/NB2 to support various connectivity needs. Running on a MicroPython-programmable microcontroller with a no-barrier entry into the SG Wireless Ctrl. Cloud Platform, the module enables truly limitless IoT application development with multi-network creation flexibility and rapid scaling capacity.

The F1 Smart Module has four variants with various connectivity options, under each variant, there are two sub-variants with advanced security element option.

- Multi-connectivity:
  - Wi-Fi 802.11b/g/n (2.4GHz)
  - Bluetooth BLE 5.0
  - Cellular LTE-CAT M1/NB1/NB2
  - Semtech LoRa(WAN) 868MHz/915MHz
- Powerful Espressif ESP32 S3 CPU
- MicroPython programmable with 27 IOs on module pads
- SMT-friendly semi-hole pins at module edges
- Operating temperature: 0°C to 85°C
- Advanced Security IC NXP SE050 (for “s” suffix models)
- Compact size-to-functionality ratio: 42.6mm x 17.6mm x 3.6mm

| Order Part Number | Description                                              |
|-------------------|----------------------------------------------------------|
| <b>SGW3531</b>    | F1s Smart Module: BLE, Wi-Fi, LoRa, LTE & Secure element |
| <b>SGW3501</b>    | F1 Smart Module: BLE, Wi-Fi, LoRa, LTE                   |
| <b>SGW3431</b>    | F1/Cs Cellular Module: BLE, Wi-Fi, LTE & Secure element  |
| <b>SGW3401</b>    | F1/C LoRa Module: BLE, Wi-Fi, LTE                        |
| <b>SGW3231</b>    | F1/Ls LoRa Module: BLE, Wi-Fi, LoRa & Secure element     |
| <b>SGW3201</b>    | F1/L LoRa Module: BLE, Wi-Fi, LoRa                       |
| <b>SGW3131</b>    | F1/Ws Wi-Fi BLE Module: BLE, Wi-Fi & Secure element      |
| <b>SGW3101</b>    | F1/W Wi-Fi BLE Module: BLE, Wi-Fi                        |

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## 1. General Features

### a. Feature Specifications

| CPU                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Xtensa® dual-core 32-bit LX7 microprocessor, up to 240Mhz</li> <li>On-chip 384KB ROM and 512KB SRAM, on-board 8MB PSRAM and 16MB Flash</li> <li>Deep Sleep Mode: 10µA</li> </ul>                                                                          |
| Wi-Fi/BLE                                                                                                                                                                                                                                                                                        |
| <ul style="list-style-type: none"> <li>Espressif ESP32-S3 on-chip RF frontend</li> <li>Wi-Fi: IEEE 802.11b/g/n (2.4GHz band); Data Rate: 1M up to 54Mbps (MCS7); Max Tx Power: 20dBm</li> <li>BLE: Bluetooth LE 5.0, Bluetooth mesh; Data Rate: 125kbps to 2Mbps; Max Tx Power: 20dBm</li> </ul> |
| LTE                                                                                                                                                                                                                                                                                              |
| <ul style="list-style-type: none"> <li>Sequans Monarch2 GM02S for CAT-M1, CAT-NB1 and CAT-NB2 support</li> <li>LTE CAT-M1/NB1/NB2 transmit power up to +23dBm</li> <li>PTCRB and GCF 1.3 3GPP release 13 compliant; Operator Approval: Verizon, AT&amp;T, T-Mobile, Vodafone, Orange</li> </ul>  |
| LoRa                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>Semtech SX1262 RF transceiver, 868/915MHz LPWAN Module</li> <li>TX Power: Up to +22dBm; Sensitivity: -127dBm</li> <li>LoRaWAN stack – Class A and Class C Device</li> </ul>                                                                               |

## b. Block Diagram

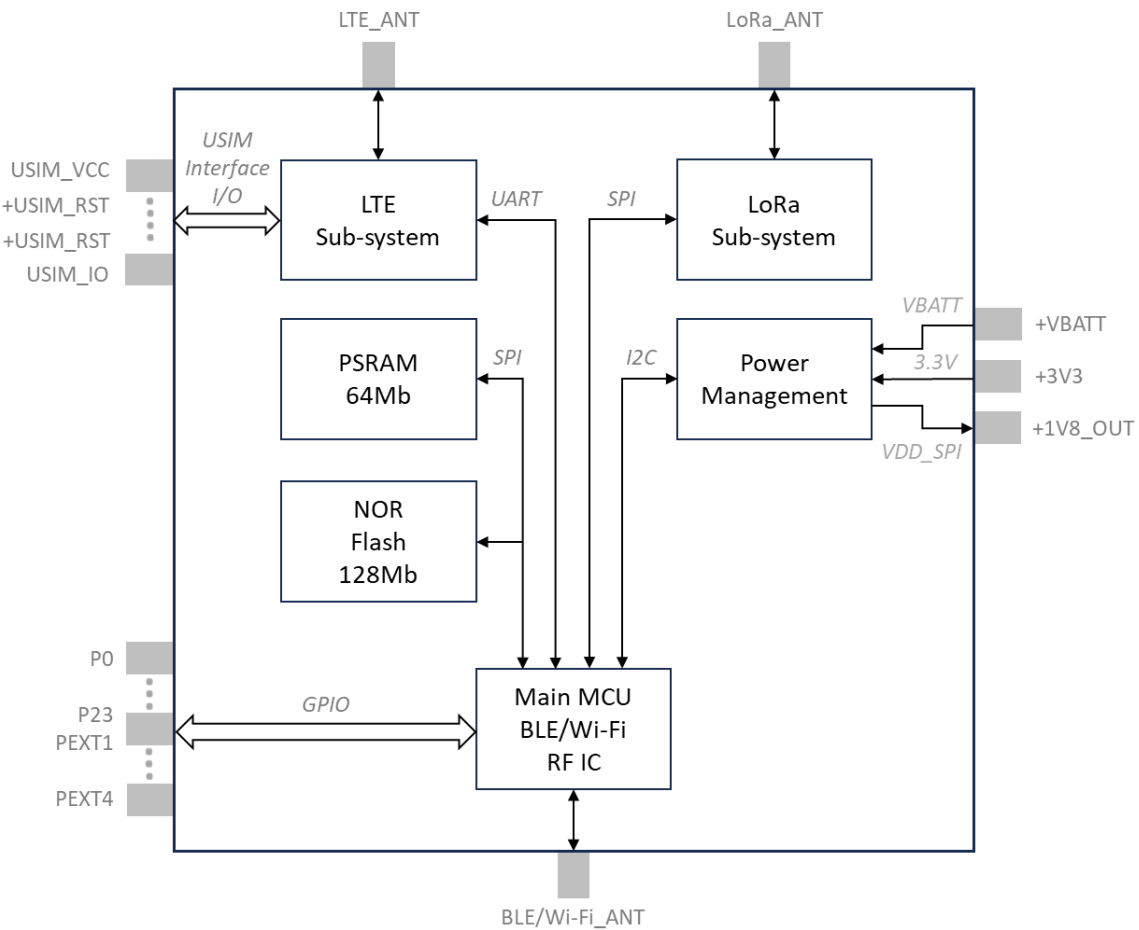


Figure 1: F1 Smart Module Block Diagram

## 2. Electrical Specifications

### a. Absolute Rating and Operating Conditions

**Table 1: Absolute Rating and Operating Conditions Specifications**

| Symbol                                      | Parameter                                                                              | Min        | Typ | Max        | Unit |
|---------------------------------------------|----------------------------------------------------------------------------------------|------------|-----|------------|------|
| <b>Absolute Rating</b>                      |                                                                                        |            |     |            |      |
| +VBATT                                      | Supply voltage to Sequans GM02S LTE module                                             |            | 5.0 | 5.8        | V    |
| +3V3                                        | Supply voltage to Espressif ESP32-S3 and module main circuit                           | 3.0        | 3.3 | 3.6        | V    |
| +1V8_OUT*                                   | SPI supply voltage (output) of SPI flash and PSRAM for decoupling capacitor connection |            | 1.8 | 2.3        | V    |
| T(OPR)                                      | Operating temperature                                                                  | -40        |     | 85         | °C   |
| <b>Operating Conditions</b>                 |                                                                                        |            |     |            |      |
| +VBATT                                      | Supply voltage to Sequans GM02S LTE module                                             | 2.5        | 5.0 | 5.5        | V    |
| +3V3                                        | Supply voltage to Espressif ESP32-S3 and module main circuit                           | 3.2        | 3.3 | 3.4        | V    |
| +1V8_OUT*                                   | SPI supply voltage (output) of SPI flash and PSRAM for decoupling capacitor connection | 1.7        | 1.8 | 1.9        | V    |
| <b>CPU IO (3.3V power domain, VDD=3.3V)</b> |                                                                                        |            |     |            |      |
| VIH                                         | Input high voltage for GPIOs                                                           | 0.75 x VDD |     | VDD + 0.3  | V    |
| VIL                                         | Input low voltage for GPIOs                                                            | -0.3       |     | 0.25 x VDD | V    |
| VOH                                         | Input high voltage for GPIOs                                                           | 0.8 x VDD  |     |            | V    |
| VOL                                         | Input low voltage for GPIOs                                                            |            |     | 0.1 x VDD  | V    |
| <b>Radio IO (1.8V power domain)</b>         |                                                                                        |            |     |            |      |
| VIH                                         | Input high voltage for GPIOs                                                           | 1.26       |     | 1.8        | V    |
| VIL                                         | Input low voltage for GPIOs                                                            | 0          |     | 0.54       | V    |
| VOH                                         | Input high voltage for GPIOs                                                           | 1.44       |     | 1.8        | V    |
| VOL                                         | Input low voltage for GPIOs                                                            | 0          |     | 0.36       | V    |

\* The +1V8\_OUT pin is to connect an external capacitor to the module internal SPI flash and PSRAM for a more robust VDD\_SPI supply. This pin should not be connected to any external circuits that may draw more than 20mA. Voltage of this pin will vary in module light sleep mode and approach zero in module deep sleep mode.

**b. Wi-Fi**

Standard: 802.11b/g/n (2.4GHz ONLY) – 1T1R

**Table 2: Wi-Fi Specifications**

| Parameter              | Description                                                      | Min   | Typ   | Max   | Unit |
|------------------------|------------------------------------------------------------------|-------|-------|-------|------|
| <b>General</b>         |                                                                  |       |       |       |      |
| Freq. (EU)             | Operating frequency (EU)                                         | 2.402 |       | 2.482 | GHz  |
| Ch. (EU)               | Channel (EU)                                                     | 1     |       | 13    |      |
| Freq. (US)             | Operating frequency (US)                                         | 2.402 |       | 2.472 | GHz  |
| Ch. (US)               | Channel (US)                                                     | 1     |       | 11    |      |
| Power max. (EU/US)     | Maximum power (EU/US)                                            |       |       | 20    | dBm  |
| <b>Tx</b>              |                                                                  |       |       |       |      |
| Tx Power @B – 1Mbps    | Tx power at B mode with data rate 1Mbps                          |       | 18    | 20    | dBm  |
| EVM (Peak) @B – 1Mbps  | EVM(Peak) at B mode with data rate 1Mbps                         |       |       | 8     | %    |
| Freq. Err. @B – 1Mbps  | Frequency error at B mode with data rate 1Mbps                   | -40   | 0     | 40    | kHz  |
| Tx Power @G – 54Mbps   | Tx power at G mode with data rate 54Mbps                         |       | 16    | 20    | dBm  |
| EVM (RMS) @G – 54Mbps  | EVM(RMS) at G mode with data rate 54Mbps                         |       |       | -25   | dB   |
| Freq. Err. @G – 54Mbps | Frequency error at G mode with data rate 54Mbps                  | -40   | 0     | 40    | kHz  |
| Tx Power @N20 – MCS7   | Tx power at N mode with data rate MCS7 and 20MHz bandwidth       |       | 15    | 20    | dBm  |
| EVM (RMS) @N20 – MCS7  | EVM rms at N mode with data rate MCS7 and 20MHz bandwidth        |       |       | -27   | dB   |
| Freq. Err. @N20 – MCS7 | Frequency error @ N mode with data rate MCS7 and 20MHz bandwidth | -40   | 0     | 40    | kHz  |
| Tx Power @B – 1Mbps    | Tx power at B mode with data rate 1Mbps                          |       | 18    | 20    | dBm  |
| <b>Rx</b>              |                                                                  |       |       |       |      |
| Rx Sens. @B – 1Mbps    | Tx power at B mode with data rate 1Mbps                          |       | -92.0 | -82.0 | dBm  |
| Rx Sens. @G – 54Mbps   | Tx power at G mode with data rate 54Mbps                         |       | -76.5 | -66.0 | dBm  |
| Rx Sens. @N20 – MCS7   | Tx power at N mode with data rate MCS7 and 20MHz bandwidth       |       | -71.4 | -64.0 | dBm  |

### c. Bluetooth

Standard: BLE 5.0 – 1T1R

**Table 3: Bluetooth Specifications**

| Parameter                    | Description                                                        | Min    | Typ    | Max    | Unit |
|------------------------------|--------------------------------------------------------------------|--------|--------|--------|------|
| <b>General</b>               |                                                                    |        |        |        |      |
| Freq.                        | Operating frequency                                                | 2.4000 |        | 2.4835 | GHz  |
| Ch.                          | Channel                                                            | 0      |        | 39     |      |
| Power max.                   | Maximum power                                                      |        |        | 20     | dBm  |
| <b>Tx</b>                    |                                                                    |        |        |        |      |
| Tx Power<br>@Ch.37 – 1 Mbps  | Tx power at channel 37 (freq.=2402MHz) with data rate 1Mbps        |        | 17     | 20     | dBm  |
| Freq. Err.<br>@Ch.37 – 1Mbps | Frequency error at channel 37 (freq.=2402MHz) with data rate 1Mbps | -50    | 0      | 50     | %    |
| Tx Power<br>@Ch.38 – 1Mbps   | Tx power at channel 38 (freq.=2426MHz) with data rate 1Mbps        |        | 17     | 20     | kHz  |
| Freq. Err.<br>@Ch.38 – 1Mbps | Frequency error at channel 38 (freq.=2426MHz) with data rate 1Mbps | -50    | 0      | 50     | dBm  |
| Tx Power<br>@Ch.39 – 1Mbps   | Tx power at channel 39 (freq.=2480MHz) with data rate 1Mbps        |        | 17     | 20     | dBm  |
| Freq. Err.<br>@Ch.39 – 1Mbps | Frequency error at channel 39 (freq.=2480MHz) with data rate 1Mbps | -50    | 0      | 50     | kHz  |
| <b>Rx</b>                    |                                                                    |        |        |        |      |
| Rx Sens.<br>@Ch.38 – 2Mbps   | Tx power at channel 38 (freq.=2426MHz) with data rate 2Mbps        |        | -93.5  |        | dBm  |
| Rx Sens.<br>@Ch.38 – 1Mbps   | Tx power at channel 38 (freq.=2426MHz) with data rate 1Mbps        |        | -97.5  | -70.0  | dBm  |
| Rx Sens.<br>@Ch.38 – 500kbps | Tx power at channel 38 (freq.=2426MHz) with data rate 500kbps      |        | -100.0 |        | dBm  |



**d. LTE**

Standard: CAT-M1, CAT-NB1, CAT-NB2

**Table 4: LTE Frequency Bands (in MHz)**

| Band No. | Duplex Type | Uplink Frequency (MHz) | Uplink Bandwidth (MHz) | Downlink Frequency (MHz) | Downlink Bandwidth (MHz) | For LTE-M | For NB-IoT |
|----------|-------------|------------------------|------------------------|--------------------------|--------------------------|-----------|------------|
| 1        | FDD         | 1920 – 1980            | 60                     | 2110 – 2170              | 60                       | ✓         | ✓          |
| 2        | FDD         | 1850 – 1910            | 60                     | 1930 – 1990              | 60                       | ✓         | ✓          |
| 3        | FDD         | 1710 – 1785            | 75                     | 1805 – 1880              | 75                       | ✓         | ✓          |
| 4        | FDD         | 1710 – 1755            | 45                     | 2110 – 2155              | 45                       | ✓         | ✓          |
| 5        | FDD         | 824 – 849              | 25                     | 869 – 894                | 25                       | ✓         | ✓          |
| 8        | FDD         | 880 – 915              | 35                     | 925 – 960                | 35                       | ✓         | ✓          |
| 12       | FDD         | 699 – 716              | 17                     | 729 – 746                | 17                       | ✓         | ✓          |
| 13       | FDD         | 777 – 787              | 10                     | 746 – 756                | 10                       | ✓         | ✓          |
| 14       | FDD         | 788 – 798              | 10                     | 758 – 768                | 10                       | ✓         | ✓          |
| 17       | FDD         | 704 – 716              | 12                     | 734 – 746                | 12                       | ✗         | ✓          |
| 18       | FDD         | 815 – 830              | 15                     | 860 – 875                | 15                       | ✓         | ✓          |
| 19       | FDD         | 830 – 845              | 15                     | 875 – 890                | 15                       | ✓         | ✓          |
| 20       | FDD         | 832 – 862              | 30                     | 791 – 821                | 30                       | ✓         | ✓          |
| 25       | FDD         | 1850 – 1915            | 65                     | 1930 – 1995              | 65                       | ✓         | ✓          |
| 26       | FDD         | 814 – 849              | 35                     | 859 – 894                | 35                       | ✓         | ✓          |
| 28       | FDD         | 703 – 748              | 45                     | 758 – 803                | 45                       | ✓         | ✓          |
| 66       | FDD         | 1710 – 1780            | 70                     | 2110 – 2200              | 90                       | ✓         | ✓          |
| 85       | FDD         | 698 – 716              | 18                     | 728 – 746                | 18                       | ✓         | ✓          |

**Table 5: LTE Specifications**

| Parameter                      | Description                            | Min | Typ  | Max  | Unit |
|--------------------------------|----------------------------------------|-----|------|------|------|
| <b>General</b>                 |                                        |     |      |      |      |
| Power max.                     | Maximum power                          |     |      | 23   | dBm  |
| <b>Tx</b>                      |                                        |     |      |      |      |
| Tx power @Band 8 (900MHz GSM)  | Tx power at Band 8 (900MHz GSM)        |     | 22   | 23   | dBm  |
| Tx power @Band 2 (1900MHz PCS) | Tx power at Band 2 (1900MHz PCS)       |     | 22   | 23   | dBm  |
| <b>Rx</b>                      |                                        |     |      |      |      |
| Rx sens. @Band 8 (900MHz GSM)  | Rx sensitivity at Band 8 (900MHz GSM)  |     | -103 | -100 | dBm  |
| Rx sens. @Band 2 (1900MHz PCS) | Rx sensitivity at Band 2 (1900MHz PCS) |     | -103 | -100 | dBm  |

**e. LoRa**

Mode: LoRa RAW mode and LoRa WAN mode

LoRaWAN Node Type: Class Type A, Class Type C

Frequency Band: EU868, US915

**Table 6: LoRa Specifications**

| Parameter                                    | Description                                            | Min | Typ  | Max | Unit |
|----------------------------------------------|--------------------------------------------------------|-----|------|-----|------|
| <b>General</b>                               |                                                        |     |      |     |      |
| Freq. (EU)                                   | Frequency band (EU)                                    | 863 |      | 870 | GHz  |
| Freq. (US)                                   | Frequency band (US)                                    | 902 |      | 928 | GHz  |
| Power max. (EU)                              | Maximum power (EU)                                     |     |      | 15  | dBm  |
| Power max. (US)                              | Maximum power (US)                                     |     |      | 22  | dBm  |
| <b>Tx</b>                                    |                                                        |     |      |     |      |
| Tx power (Tx tone) @866.4MHz [EU868 band]    | Tx power (Tx tone) at 866.4MHz                         |     | 14   | 15  | dBm  |
| Tx power (Tx tone) @918.2MHz [US915 band]    | Tx power (Tx tone) at 918.2MHz                         |     | 21   | 22  | %    |
| <b>Rx</b>                                    |                                                        |     |      |     |      |
| Rx Sens.<br>@freq=866.4MHz, BW=500kHz, SF=12 | Rx sensitivity at 866.4MHz, 500kHz bandwidth and SF=12 |     | -127 |     | dBm  |
| Rx Sens.<br>@freq=866.4MHz, BW=500kHz, SF=12 | Rx sensitivity at 866.4MHz, 500kHz bandwidth and SF=12 |     | -127 |     | dBm  |

## 3. Module Interface

### a. Power Management

**Table 7: Power Consumption by Mode of Operation**

| Mode of Operation                                                   | Min | Typ | Max | Unit |
|---------------------------------------------------------------------|-----|-----|-----|------|
| Idle (no radio but MicroPython is running)                          |     | 30  |     | mA   |
| Light sleep (wake up or restart is required for MicroPython to run) |     | 800 |     | μA   |
| Deep sleep (wake up or restart is required for MicroPython to run)  |     | 10  |     | μA   |

### b. Memory Allocation

Module OS firmware, OTA and user space sizes:

- Module OS firmware: 2,560Kb
- OTA1 space: 2,560Kb
- OTA2 space: 2,560Kb
- User space: 8Mb

## 4. Mechanical Data

### a. Mechanical Specification

All pins have a pin width of 0.7mm with the exception of pin VBATT (pin #A4) with pin width 1.0mm.

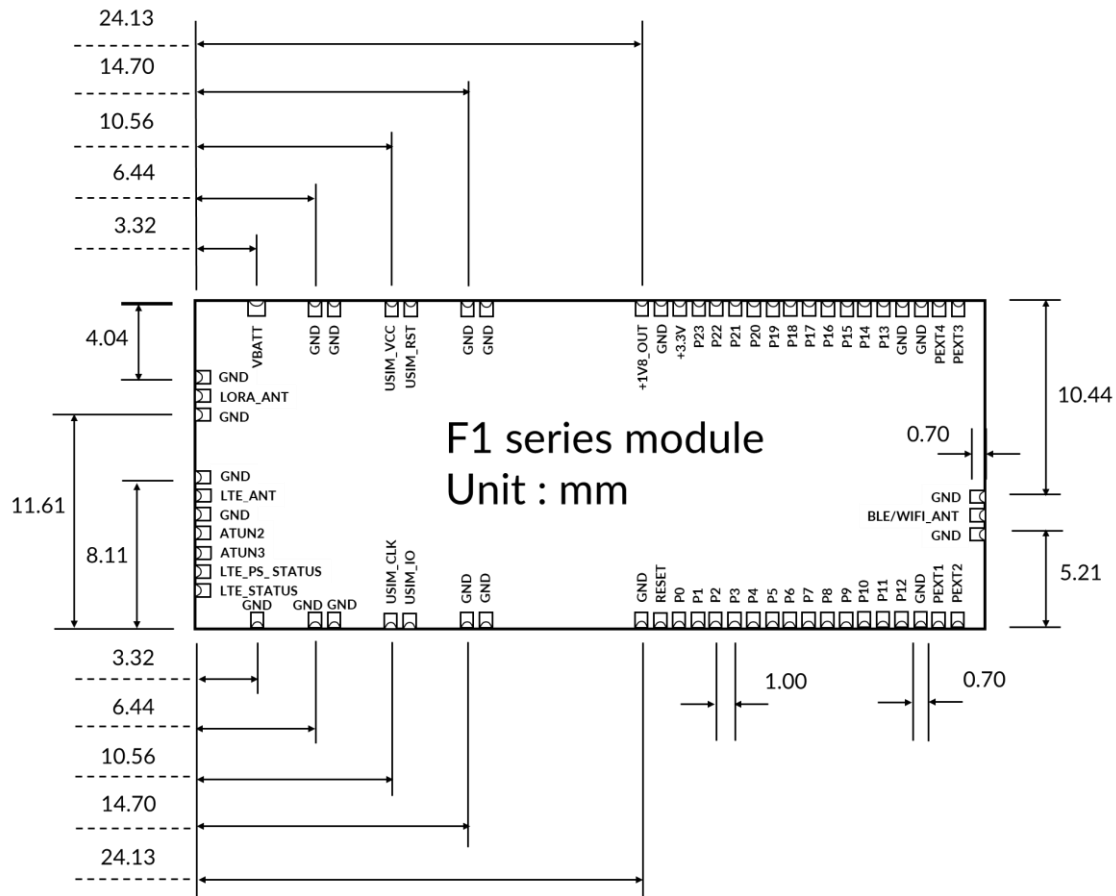


Figure 2: F1 Smart Module Pin Dimensions, Pin Pitches and Pin Locations (Top View)

## b. Module Pin-out

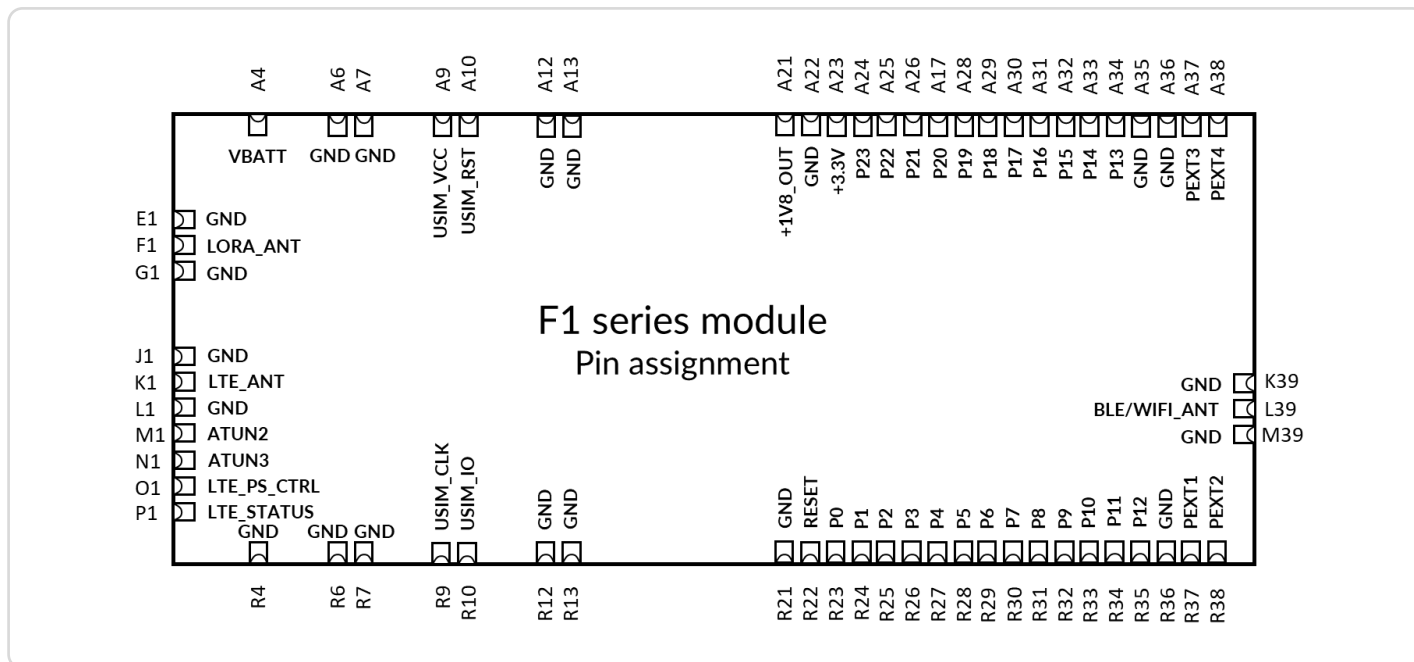


Figure 3: F1 Smart Module Pin-out (Top View)

**Table 8: F1 Smart Module Pin-out**

| Pin Number | Pin Name | MCU Pin | LTE Module Pin | Type                      | Description                               |
|------------|----------|---------|----------------|---------------------------|-------------------------------------------|
| R4         | GND      |         |                | Power                     | Ground signal                             |
| R6         | GND      |         |                | Power                     | Ground signal                             |
| R7         | GND      |         |                | Power                     | Ground signal                             |
| R9         | USIM_CLK |         | SIM0_CLK       | Analog I/O                | USIM interface I/O to GM02S               |
| R10        | USIM_IO  |         | SIM0_IO        | Digital I/O               | USIM interface I/O to GM02S               |
| R12        | GND      |         |                | Power                     | Ground signal                             |
| R13        | GND      |         |                | Power                     | Ground signal                             |
| R21        | GND      |         |                | Power                     | Ground signal                             |
| R22        | RESET    | CHIP_PU |                | Analog I/O                | Reset pin to ESP32-S3 for module reset    |
| R23        | P0       | U0RXD   |                | Analog I/O                | UART0 RXD to ESP32-S3                     |
| R24        | P1       | U0TXD   |                | Analog I/O                | UART0 TXD to ESP32-S3                     |
| R25        | P2       | GPIO0   |                | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3     |
| R26        | P3       | GPIO4   |                | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3     |
| R27        | P4       | MTDO    |                | Digital I/O               | Digital I/O to ESP32-S3                   |
| R28        | P5       | GPIO5   |                | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3     |
| *R29       | P6       | GPIO6   |                |                           | Reserved – Leave floating, do not connect |

|     |              |                                            |  |                           |                                                         |
|-----|--------------|--------------------------------------------|--|---------------------------|---------------------------------------------------------|
| R30 | P7           | GPIO3                                      |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| R31 | P8           | GPIO46                                     |  | Digital I/O               | Digital I/O to ESP32-S3                                 |
| R32 | P9           | GPIO45                                     |  | Digital I/O               | Digital I/O to ESP32-S3                                 |
| R33 | P10          | MTCK                                       |  | Digital I/O               | Digital I/O to ESP32-S3                                 |
| R34 | P11          | GPIO11                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| R35 | P12          | GPIO21                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| R36 | GND          |                                            |  | Power                     | Ground signal                                           |
| R37 | PEXT1        | GPIO1                                      |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| R38 | PEXT2        | GPIO12                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| M39 | GND          |                                            |  | Power                     | Ground signal                                           |
| L39 | BLE/WIFI_ANT |                                            |  | RF I/O                    | RF interface to ESP32-S3 for BLE and/or Wi-Fi interface |
| K39 | GND          |                                            |  | Power                     | Ground signal                                           |
| A38 | PEXT4        | GPIO14                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| A37 | PEXT3        | GPIO13                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| A36 | GND          |                                            |  | Power                     | Ground signal                                           |
| A35 | GND          |                                            |  | Power                     | Ground signal                                           |
| A34 | P13          | GPIO20                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3 /USB OTG D+       |
| A33 | P14          | GPIO19                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3 /USB OTG D-       |
| A32 | P15          | GPIO38                                     |  | Digital I/O               | Digital I/O to ESP32-S3                                 |
| A31 | P16          | GPIO41                                     |  | Digital I/O               | Digital I/O to ESP32-S3                                 |
| A30 | P17          | GPIO2                                      |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| A29 | P18          | GPIO10                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| A28 | P19          | GPIO15                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| A27 | P20          | GPIO16                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| A26 | P21          | GPIO17                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| A25 | P22          | GPIO18                                     |  | Analog I/O or Digital I/O | Analog I/O or Digital I/O to ESP32-S3                   |
| A24 | P23          | GPIO42                                     |  | Digital I/O               | Digital I/O to ESP32-S3                                 |
| A23 | +3.3V        | VDD3P3_CPU<br>VDD3P3_RTC<br>VDD3P3<br>VDDA |  | Power                     | Voltage supply to ESP32-S3 and module main circuit      |
| A22 | GND          |                                            |  | Power                     | Ground signal                                           |

|     |             |         |                      |             |                                                                |
|-----|-------------|---------|----------------------|-------------|----------------------------------------------------------------|
| A21 | +1.8V_OUT   | VDD_SPI |                      | Power       | Voltage supply VDD_SPI to ESP32-S3 for SPI flash and PSRAM     |
| A13 | GND         |         |                      | Power       | Ground signal                                                  |
| A12 | GND         |         |                      | Power       | Ground signal                                                  |
| A10 | USIM_RST    |         | SIM0_RSTN            | Digital I/O | USIM interface I/O to GM02S                                    |
| A9  | USIM_VCC    |         | SIM0_VCC             | Power       | USIM voltage supply to GM02S                                   |
| A7  | GND         |         |                      | Power       | Ground signal                                                  |
| A6  | GND         |         |                      | Power       | Ground signal                                                  |
| A4  | +VBATT      |         | VBAT                 | Power       | Voltage supply to GM02S                                        |
| E1  | GND         |         |                      | Power       | Ground signal                                                  |
| F1  | LORA_ANT    |         |                      | RF I/O      | RF interface to SX1262 for LoRa interface                      |
| G1  | GND         |         |                      | Power       | Ground signal                                                  |
| J1  | GND         |         |                      | Power       | Ground signal                                                  |
| K1  | LTE_ANT     |         | LTE_ANT              | RF I/O      | RF interface to GM02S for LTE CAT-M1/CAT-NB1/CAT-NB2 interface |
| L1  | GND         |         |                      | Power       | Ground signal                                                  |
| M1  | ATUN2       |         | GPIO34/<br>ANT_TUNE0 | Analog I/O  | ANT_TUNE I/O to GM02S                                          |
| N1  | ATUN3       |         | GPIO35/<br>ANT_TUNE1 | Analog I/O  | ANT_TUNE I/O to GM02S                                          |
| O1  | LTE_PS_CTRL |         | GPIO2/<br>PS_STATUS  | Digital I/O | Power saving status I/O from GM02S                             |
| P1  | LTE_STATUS  |         | GPIO1/<br>STATUS_LED | Digital I/O | LTE status I/O from GM02S                                      |

### c. Recommended PCB Landing Pattern

All pins have a pin width of 0.7mm with the exception of pin VBATT (pin #A4) with pin width 1.0mm.

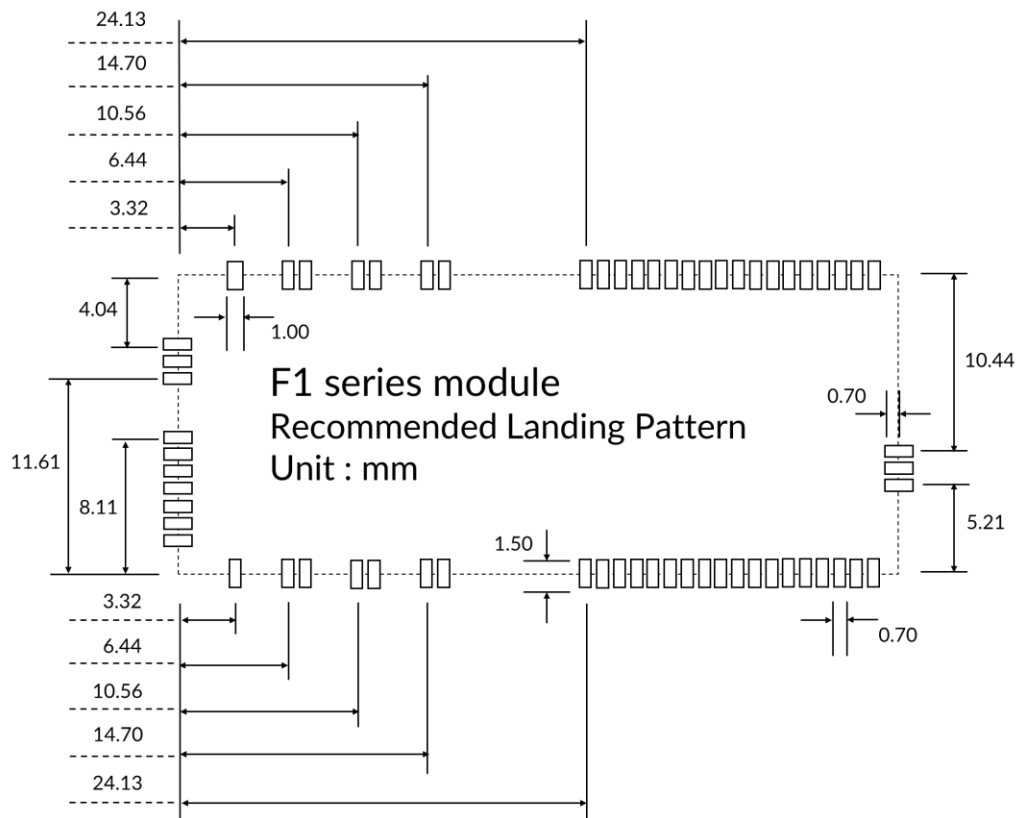


Figure 4: F1 Smart Module Recommended PCB Landing Pattern (Top View)



### d. Recommended Basic Circuit

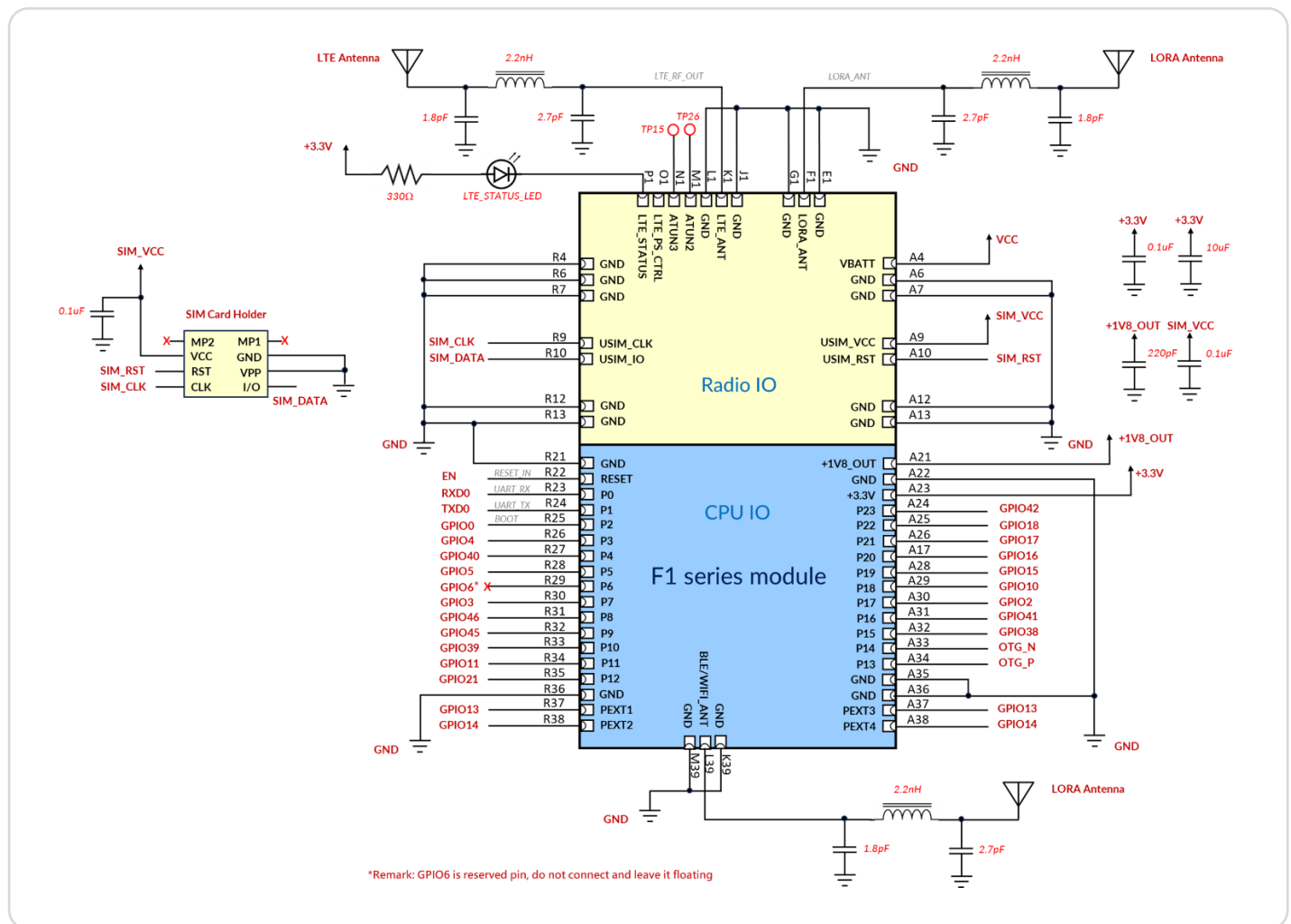


Figure 5: F1 Smart Module Recommended Basic Circuit

### e. Recommended Soldering Profile

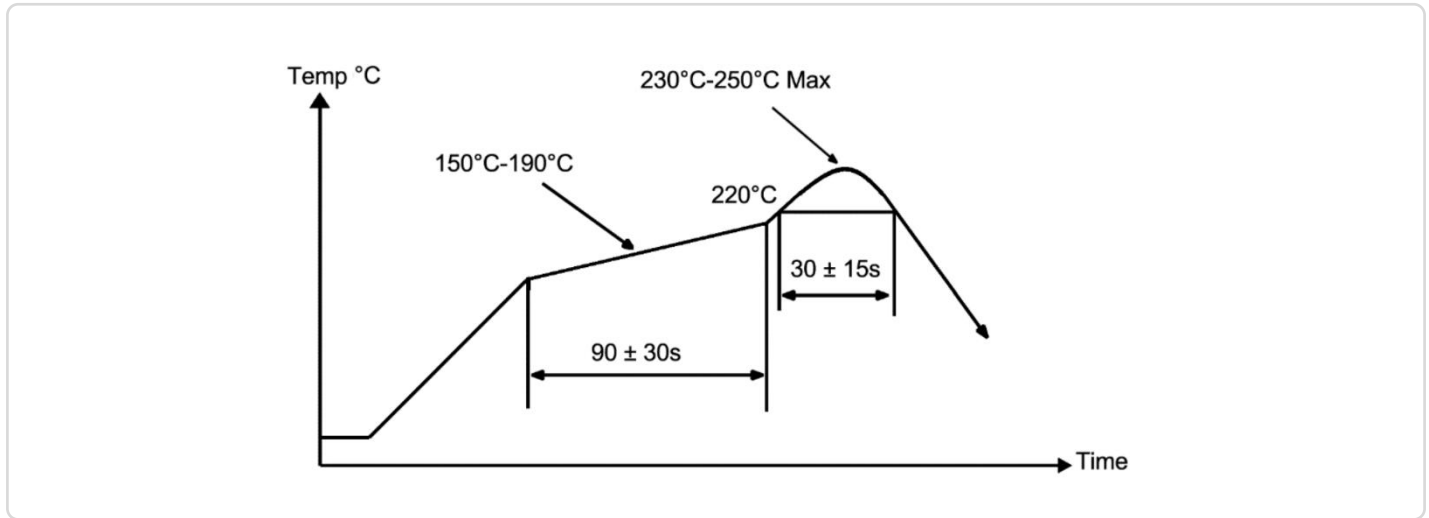


Figure 6: F1 Smart Module Recommended Reflow Soldering Profile

## 5. MicroPython Application Development on F1

### a. Device Programming via UART

- By default, the F1 Smart Module runs an interactive python REPL (Read-Eval-Print-Loop) on UART0 which is connected to P0 (RX) and P1 (TX) running at 115200 baud.
- The Module can be connected via a development board or any USB UART adapter. Code can be run via the REPL and the SG Wireless CtrlR. Visual Studio Code plug-in can also be used to upload code to the board.

### b. Module-supported Libraries

**Table 9: F1 Smart Module Supported Libraries**

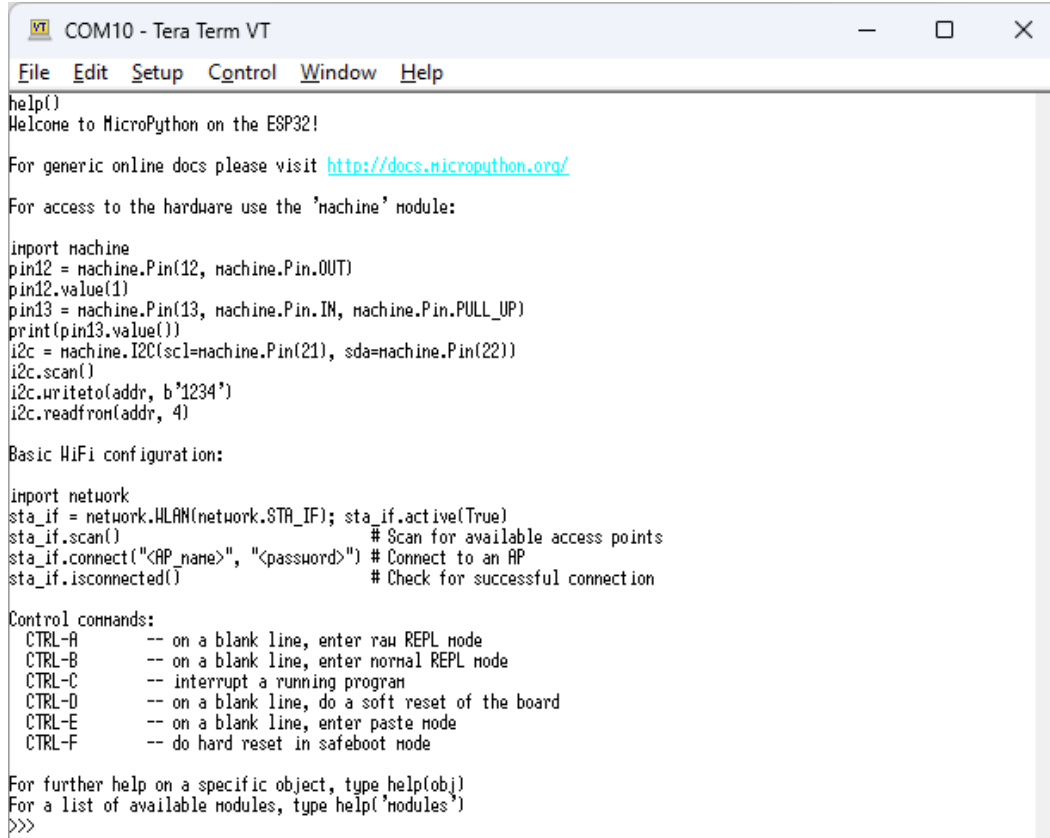
| Library                             | Min                                                                                                                                                                                          |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Python Standard Libraries*          | array, aysncio, binascii, builtins, cmath, collections, errno, gc, gzip, hashlib, heapq, io, json, math, os, platform, random, re, select, socket, ssl, struct, sys, time, zlib, _thread     |
| MicroPython-specific Libraries*     | Bluetooth, btree, cryptolib, deflate, framebuf, machine, micropython, neopixel, network, uctypes, esp, esp32                                                                                 |
| F1 Smart Module-specific Libraries† | lte: Ready-to-use LTE CAT-M1/NB1/NB2 library<br>lora: Ready-to-use LoRa RAW and full stack LoRa WAN device Class A, Class C library<br>ctrl: Ready-to-use Ctrl Cloud Platform client library |

\* MicroPython documentation library with API function calls (<https://docs.micropython.org/en/latest/library/>).

† SG Wireless F1 Smart Module documentation library with API function calls.

### c. MicroPython Capability – REPL (Read-Eval-Print Loop)

The MicroPython-ready F1 Smart Module carries the REPL shell that can execute codes in real-time, as well as enable section-by-section of code execution through a copy-and-paste function, both of which facilitate real-time debugging and instant application code prototyping.



```

COM10 - Tera Term VT
File Edit Setup Control Window Help
help()
Welcome to MicroPython on the ESP32!

For generic online docs please visit http://docs.micropython.org/

For access to the hardware use the 'machine' module:

import machine
pin12 = machine.Pin(12, machine.Pin.OUT)
pin12.value(1)
pin13 = machine.Pin(13, machine.Pin.IN, machine.Pin.PULL_UP)
print(pin13.value())
i2c = machine.I2C(scl=machine.Pin(21), sda=machine.Pin(22))
i2c.scan()
i2c.writeto(addr, b'1234')
i2c.readfrom(addr, 4)

Basic WiFi configuration:

import network
sta_if = network.WLAN(network.STA_IF); sta_if.active(True)
sta_if.scan() # Scan for available access points
sta_if.connect("<AP_name>", "<password>") # Connect to an AP
sta_if.isconnected() # Check for successful connection

Control commands:
CTRL-A -- on a blank line, enter raw REPL mode
CTRL-B -- on a blank line, enter normal REPL mode
CTRL-C -- interrupt a running program
CTRL-D -- on a blank line, do a soft reset of the board
CTRL-E -- on a blank line, enter paste mode
CTRL-F -- do hard reset in safeboot mode

For further help on a specific object, type help(obj)
For a list of available modules, type help('modules')
>>>
  
```

Figure 7: F1 Smart Module Code Sample in REPL Shell

## 6. Product Packaging

Modules are packed in tape-and-reel packaging and shipped out in carton boxes.

|                                                               |                                                                                                                         |
|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| <p><b>a. Tape</b><br/>MSL (Moisture sensitivity level): 1</p> | <p>Technical drawing of a tape carrier showing dimensions: 19.2, 24.2, 44, 56, 4.1, 1.6, 4.0, and <math>K_o</math>.</p> |
| <p><b>b. Reel</b><br/>250pcs per reel</p>                     | <p>Technical drawing of a reel showing dimensions: 330, 58, and 64.</p>                                                 |
| <p><b>c. Box</b></p>                                          | <p>Technical drawing of a box showing dimensions: 335, 350, and 65.</p>                                                 |

## 7. Certification

### a. CE Statements

#### EU Declaration of Conformity (DOC)

Hereby, SG Wireless Limited declares that the F1 Smart Module series is in compliance with Radio Equipment Directive (RED) 2014/53/EU.

The full text of the EU declaration of conformity is available at the following Internet address:

<https://docs.sgwireless.com>

#### RF exposure statement

RF exposure information: The Maximum Permissible Exposure (MPE) level has been calculated based on a distance of  $d=20\text{cm}$  between the device and the human body. To maintain compliance with RF exposure requirement, use product that maintain a 20cm distance between the device and human body.

#### CE marking and labeling

By complying to CE standard, all modules are laser printed with “CE” marking and part number at surface of the module shield can; and manufacturer information is printed with label at shipping box/packages.

CE marking on module:



SGW3501



SGW3531



SGW3401



SGW3431



SGW3201



SGW3231



SGW3101



SGW3131

Manufacturer information at shipping package/box:



## b. FCC Statements

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.

### FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

## 8. Orderable part number/Model no. comparison table

| Orderable part number | Model no. | BLE/Wi-Fi | LTE Cat-M1/<br>NB-IoT | LoRa(WAN) | Security element |
|-----------------------|-----------|-----------|-----------------------|-----------|------------------|
| SGW3531               | F1s       | ✓         | ✓                     | ✓         | ✓                |
| SGW3501               | F1        | ✓         | ✓                     | ✓         | ✕                |
| SGW3431               | F1/Cs     | ✓         | ✓                     | ✕         | ✓                |
| SGW3401               | F1/C      | ✓         | ✓                     | ✕         | ✕                |
| SGW3231               | F1/Ls     | ✓         | ✕                     | ✓         | ✓                |
| SGW3201               | F1/L      | ✓         | ✕                     | ✓         | ✕                |
| SGW3131               | F1/Ws     | ✓         | ✕                     | ✕         | ✓                |
| SGW3101               | F1/W      | ✓         | ✕                     | ✕         | ✕                |



## 9. Revision History

| Version | Released Date | Description                                                                                                                                                                                                              |
|---------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.0     | Feb 7, 2024   | Initial document release                                                                                                                                                                                                 |
| 1.1     | Mar 6, 2024   | Branding revised with updates:<br>Introduction: Operating temperature updated<br>Section 4: Pin number updated (A38 and A37)<br>Section 5b: Link to MicroPython documentation library updated<br>Section 6a: MSL updated |
| 1.2     | Jul 7, 2024   | Adding following section:<br>Section 7: Certification<br>Section 8: Part number/Model no. comparison table                                                                                                               |

## 10.Contact

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