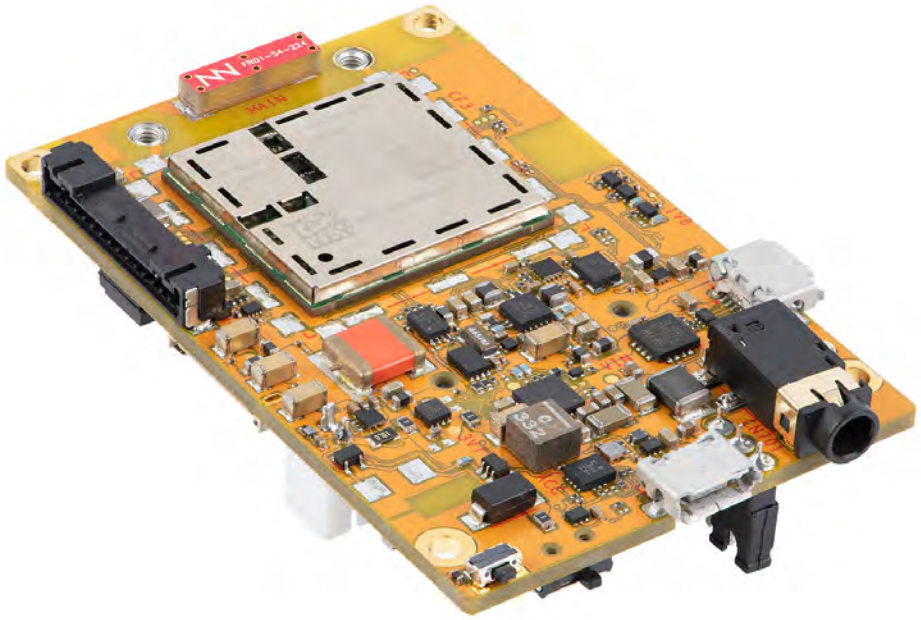
mangOH® Yellow

User Guide



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Revision History

Revision number	Release date	Changes
1	September 2019	Document created
1.01	September 2019	Document formatting changes
2	October 2019	Minor formatting corrections Added topic 2.2 (Windows only) Install Module Drivers Standardized references to "Power/Network/Cloud" LED Added notes to use battery in 2G situations Updated 3.5.3 Expansion Connector interfaces description Updated LED descriptions (Table 3-3) Corrected various schematic component reference numbers Updated TP1_BOOT description (Table 3-6)
3	June 2020	Changed mangOH™ to mangOH® Added Regulatory Compliance appendix

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1: Introduction

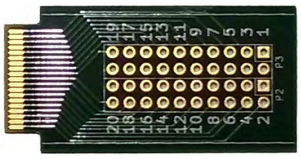
This user guide explains how to set up and begin using the mangOH® Yellow with CF3 (Common Flexible Form Factor) modules.

Once you have the mangOH Yellow set up, visit mangoh.io/mangoh-yellow-resources for developer documentation, code samples, and other materials.

1.1 mangOH Yellow Components and Accessories

Table 1-1 details the required and optional components needed to begin using the mangOH Yellow in your development environment. Some of these components are available in mangOH Yellow development kits (kit contents are supplier-dependent).

Table 1-1: mangOH Yellow Required and Optional Components

Item	Details	Example
(1) mangOH Yellow with integrated WP7702 CF3 module	Pre-configured development board for CF3 modules The integrated (soldered-down) WP7702 module includes a cellular modem and an application processor running Legato, an open source embedded platform built on Linux for hosting IoT applications (see legato.io for details).	
(2) Micro-USB cables (Included in kit)	Connects computer to the mangOH Yellow for communication and to provide power for non-transmitting tests.	
(1) Antenna, Ultra Wide Band (Included in kit)	Main RF antenna included.	
IoT breakout board	Breakout board for mangOH Yellow's IoT connector	
M2 screws (Included in kit)	Two M2 screws included for IoT card installation	
Audio cable (3.5 mm) (Not included in kit)	Optional audio cable or headset	

2: Setup and Installation

2.1 Safe Handling Recommendations

To help prevent accidental damage to the mangOH Yellow:

- Use safe ESD-handling practices (such as wearing proper ESD straps) to avoid possible ESD damage.
- Some options to avoid damage to components on the bottom side of the board include:
  - Attach standoffs (not included) to the mounting holes at each corner of the board, or
  - Install the mangOH Yellow in a case (forthcoming availability)

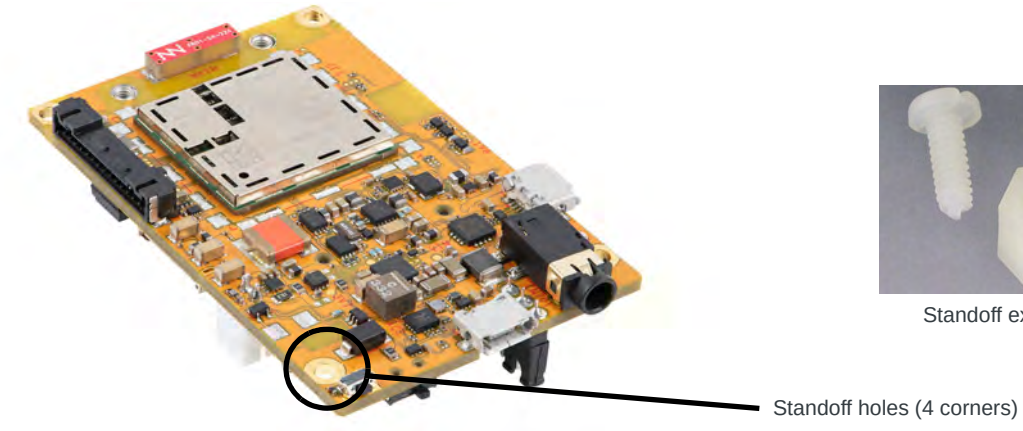


Figure 2-1: Module Standoff Placement

2.2 (Windows only) Install Module Drivers

Windows systems require drivers for the mangOH Yellow's CF3 module.

To download the drivers:

1. Go to https://mangoh.io/mangoh-yellow-resources-software.
2. Click **Download Drivers** to download the driver installation file.
3. Run the downloaded .exe file and follow the prompts to install the drivers.

2.3 Initial Setup

To begin using the mangOH Yellow, set up your hardware and software:

1. Verify the SW403 dip switch block pins are set correctly:
   a. Remove the protective film from the dip switch block:

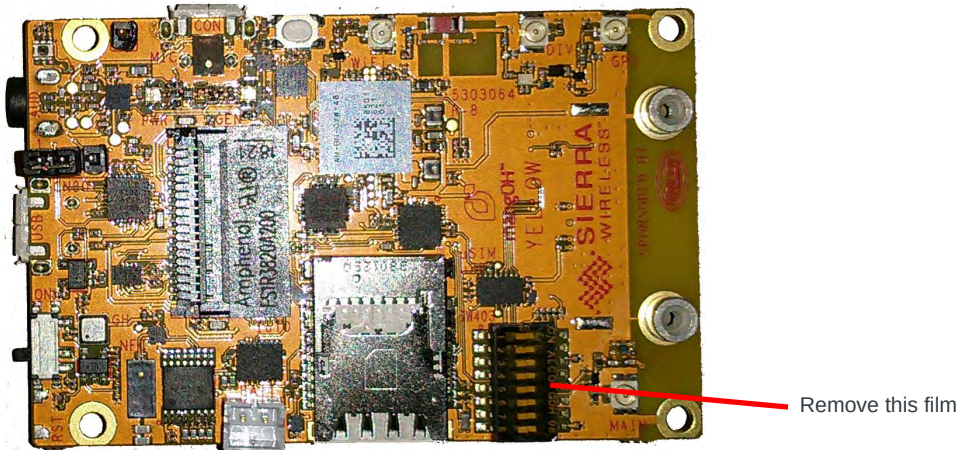


Figure 2-2: Remove Protective Film

   b. Make sure all the dip switches are OFF (factory default mode).

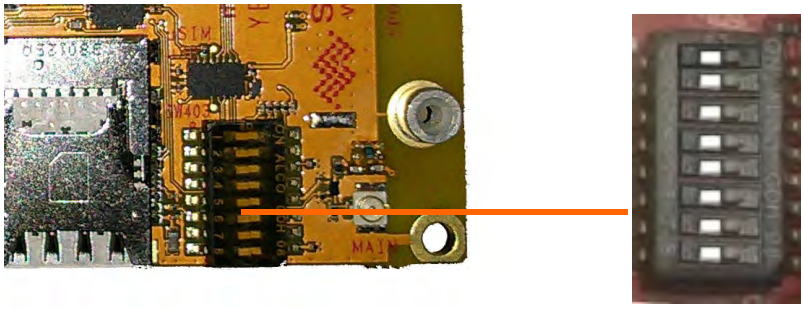


Figure 2-3: Dip Switch Positions (Factory Default)

2. If you will be establishing a mobile network connection using the external SIM slot instead of the WP7702 module's eSIM, insert a micro-SIM. See Inserting a micro-SIM Card on page 16.
3. Connect External Antenna(s). See page 15.
4. Select Power Supply. See page 13.

5. Power up the mangOH Yellow:
   a. Connect the selected power supply—Use a micro-USB cable to connect the mangOH Yellow USB connector to your computer or AC adapter, or use a 15-pin cable to connect the expansion connector to an external device that will provide power.

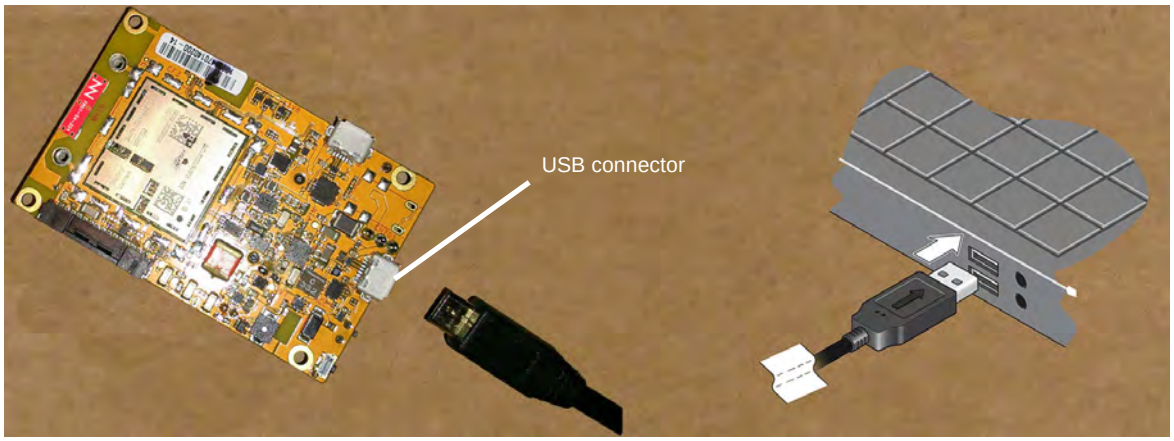


Figure 2-4: Connecting USB Power to the mangOH Yellow

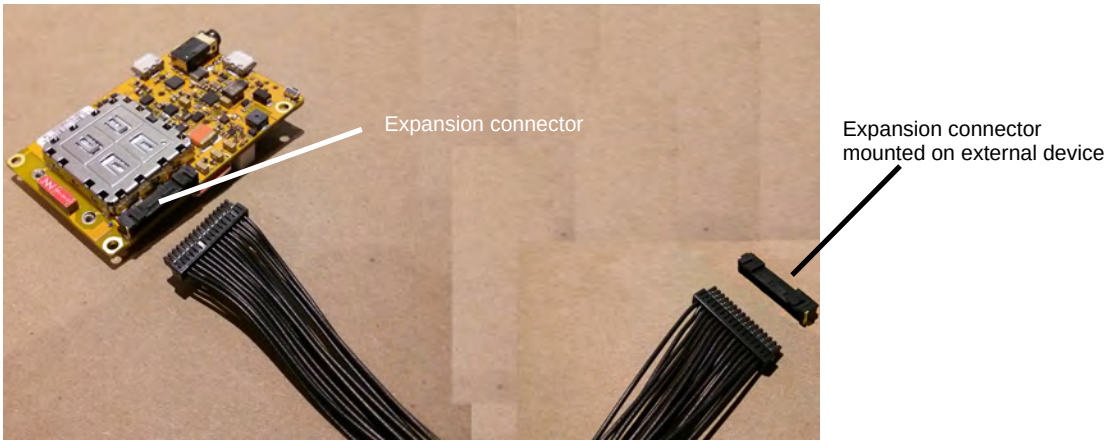


Figure 2-5: Connecting External Device via Expansion Connector to the mangOH Yellow

6. Slide the power switch toward the center to power up the board.

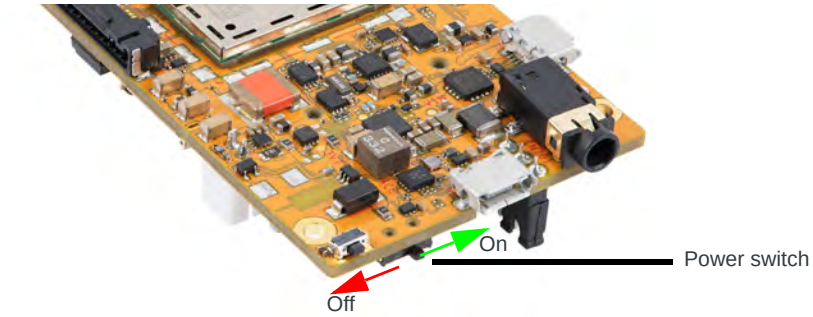


Figure 2-6: Power Switch Operation

When the mangOH Yellow is powered, the Power/Network/Cloud LED turns solid green, then turns yellow (when the cellular radio powers on), and then the generic LEDs begin blinking in sequence when the module has finished booting up.

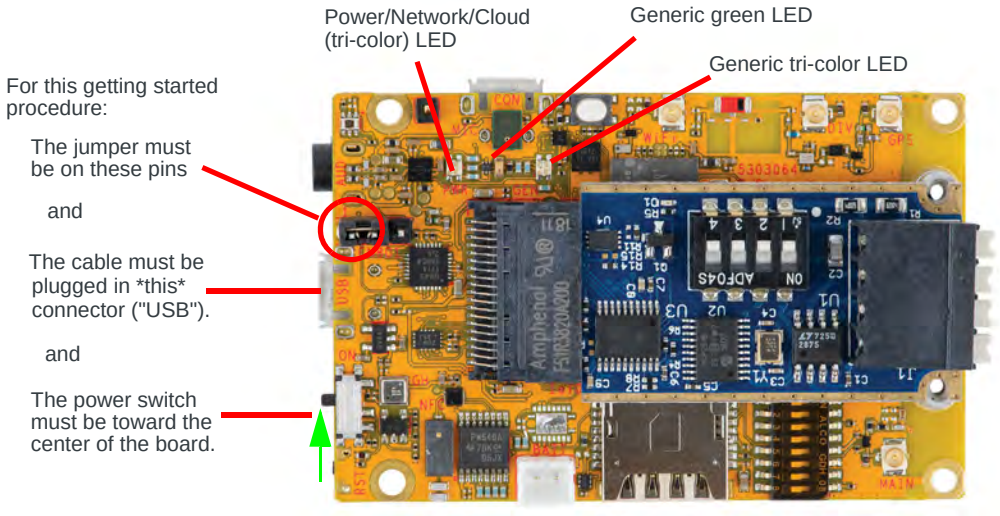


Figure 2-7: LEDs

Tip: *If the Power LED does not turn on:*

- *Make sure the USB cable is securely connected to the correct micro-B connector (as shown in Figure 2-7).*
- *Make sure the jumper block is on the correct pins (as shown in Figure 2-7).*
- *Make sure the power switch is in the ON position (toward the center of the board.*

Important: *If LTE-M coverage is not available, the mangOH Yellow's WP7702 module will fall back to 2G, which consumes up to 2 A of current for short bursts. In this case, USB power is insufficient (500 mA) and the module may repeatedly brown out and reboot. Use a battery (Connect Battery Backup on page 14) to supply sufficient power.*

7. Wait for the device to enumerate (1–4 minutes, typically).

   (Windows) You can confirm the device has enumerated by viewing Display Manager—the device appears under Modems, and its COM ports appear under Ports (COM & LPT):

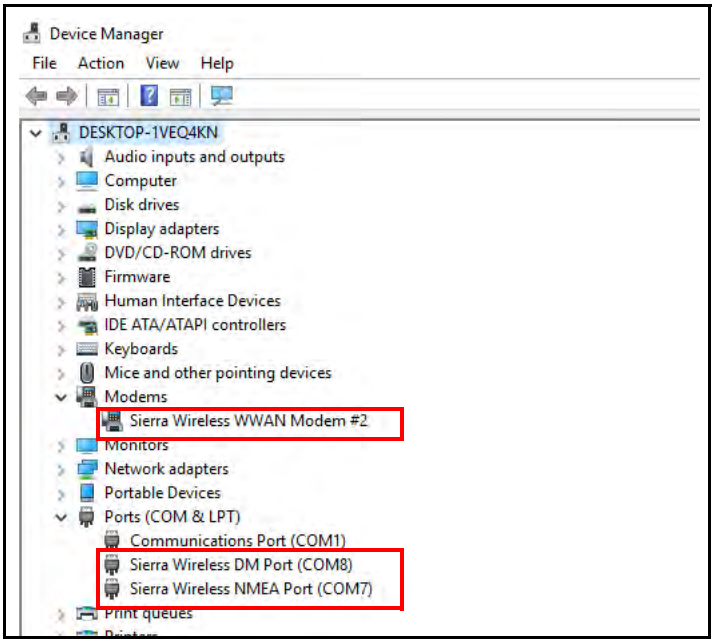


Figure 2-8: Windows Device Enumeration

8. Confirm the connection between the computer and mangOH Yellow is working:
   a. Open a command prompt window. (e.g. Linux Terminal window, Windows command prompt).
   b. Test the connection by 'pinging' the CF3 module (which has a default IP address of 192.168.2.2):

      `> ping 192.168.2.2`

      You should receive ping responses. Press Ctrl+C to return to the command prompt.

```
C:\Windows\System32>ping 192.168.2.2

Pinging 192.168.2.2 with 32 bytes of data:
Reply from 192.168.2.2: bytes=32 time<1ms TTL=64
Reply from 192.168.2.2: bytes=32 time=1ms TTL=64
Reply from 192.168.2.2: bytes=32 time=2ms TTL=64
Reply from 192.168.2.2: bytes=32 time=2ms TTL=64

Ping statistics for 192.168.2.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 2ms, Average = 1ms
```

9. Optionally, use a mini-USB cable to connect the remaining mangOH Yellow's "CON" USB connector to your computer. (This enables you to display diagnostic messages in one terminal window and work in another, as described in Console Access on page 28.)

The mangOH Yellow is now ready to be used.

For information on additional hardware features, see Hardware Setup and Features on page 12.

3: Hardware Setup and Features

This chapter describes:

- How to install various components on the mangOH Yellow
- Available connectors
- How to configure and control features using connectors and switches

3.1 Power Supply Sources

The mangOH Yellow is powered via the board's USB (CN802) micro-USB connector, the expansion connector, or an optional external backup battery. The micro-USB connector can connect to a computer's USB port or, if greater power is required, to an AC adapter.

Once the power source is connected, use the power switch to turn the power on/off.

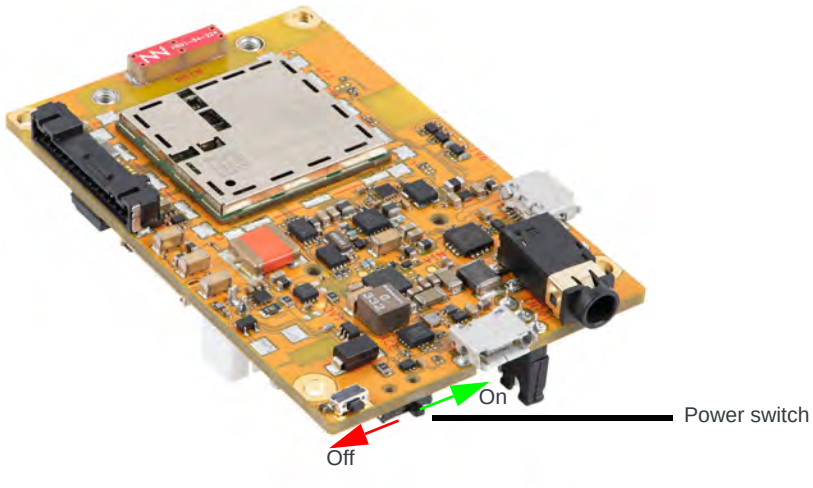


Figure 3-1: Power Switch

Table 3-1: mangOH Yellow Power Supplies

Supply		Details
Primary	CN802—"USB" USB connector	By default, USB connector provides power to the mangOH Yellow. The connector also provides access to CF3 interfaces (ECM port, AT port, etc.)
	CN805—Expansion connector	Allows connection to an external device, which can provide power to the mangOH Yellow, or can be powered by the mangOH Yellow.
Backup	CN1000—Battery	An optional Li-ion or Li-polymer (3.7 V nominal) rechargeable battery can be installed to power the board if the primary power supply fails.

3.1.1 Select Power Supply

To select the primary power supply:

1. Place the mangOH Yellow with the dip switch block facing up (module facing down) and locate the power select (PWR SEL) jumper pins (CN801).

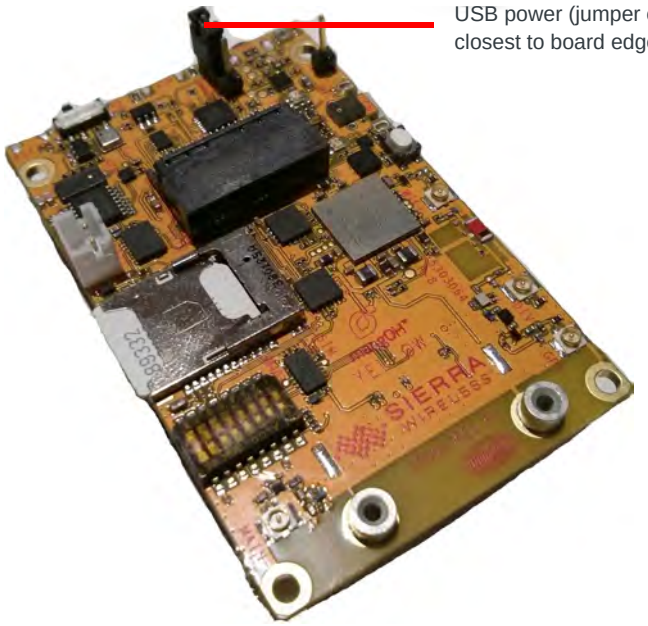


Figure 3-2: Power Supply Selector

2. Select the preferred power source:
   - USB connector—Place a jumper across the two pins closest to the edge of the board.
   - Expansion connector—Place a jumper across the two pins furthest from the edge of the board.

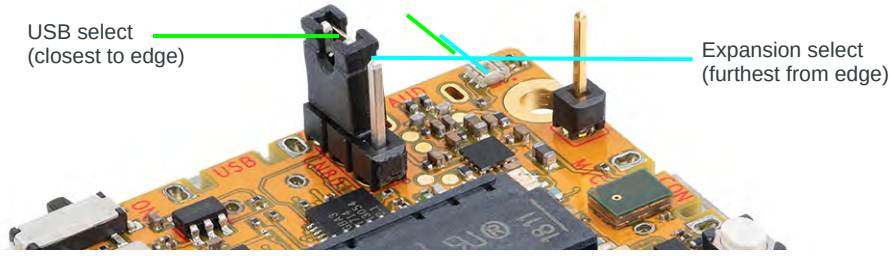


Figure 3-3: USB Power Supply Selection

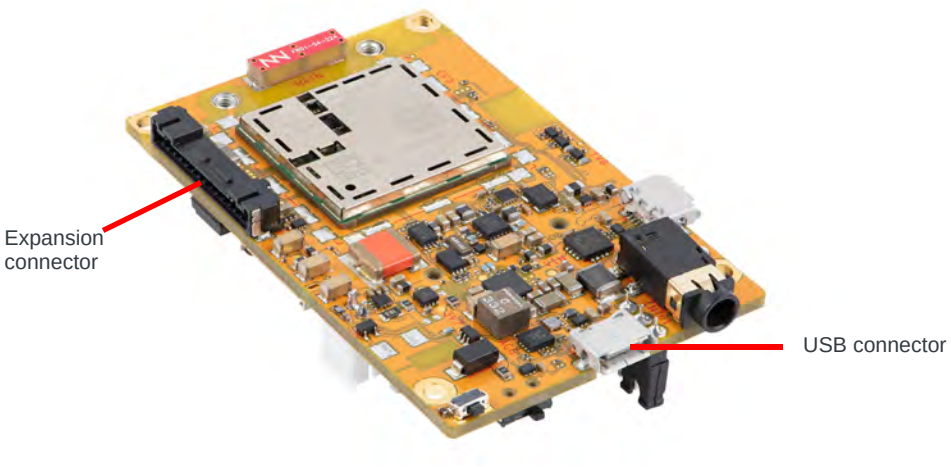


Figure 3-4: Power Supply Connectors

3.1.2 Connect Battery Backup

Optionally, you can connect a rechargeable Li-Ion/Li-Polymer battery to the mangOH Yellow to provide uninterrupted power in the event that the primary power supply fails.

Important: *If LTE-M coverage is not available, the mangOH Yellow's WP7702 module will fall back to 2G, which consumes up to 2 A of current for short bursts. In this case, USB power is insufficient (500 mA) and the module may repeatedly brown out and reboot. Use a battery to supply sufficient power.*

To connect a rechargeable Li-Ion/Li-Polymer battery to the mangOH Yellow:

1. Plug the battery into the battery connector (CN1000).

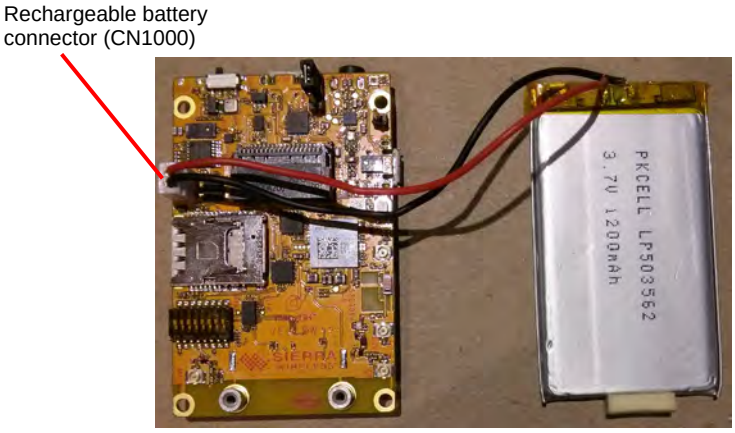


Figure 3-5: mangOH Yellow With Rechargeable Battery Connected

Warning: *The board is designed to use a rechargeable Li-Ion or Li-polymer battery. Regular (non-rechargeable) batteries must not be used, otherwise the mangOH Yellow and the battery will be damaged.*

3.2 Connect External Antenna(s)

The mangOH Yellow includes four external antenna connectors.

Table 3-2: External Antenna Connectors

Type	Connector[a]	Details
Main	CN307	Used to establish a mobile network data connection Disabled by default. (Default is internal antenna (ANT300).)
Diversity	CN304	Not used with the WP7702 module.
GNSS	CN306	Disabled by default. (Default is internal antenna (ANT301).) Used to enable access to GNSS functionality • Active • 3.3 V bias voltage
Wi-Fi/Bluetooth	CN308	Disabled by default. (Default is integrated antenna (ANT301).)

a. U.FL connectors

Note: The mangOH Yellow also includes an three integrated antennas—main (used by default), Wi-Fi/BT/GPS, and NFC.

To connect an external antenna to the Main antenna connector:

1. Place the mangOH Yellow with the dip switch block facing up.
2. Attach the main antenna—press the external antenna connector firmly to get a secure connection.

Note: The female connector on the external antenna is rated for a limited number of reconnects before the connector wears out, so should be left connected if possible. Use a U.FL extraction tool to put less strain on the connector during removal.)

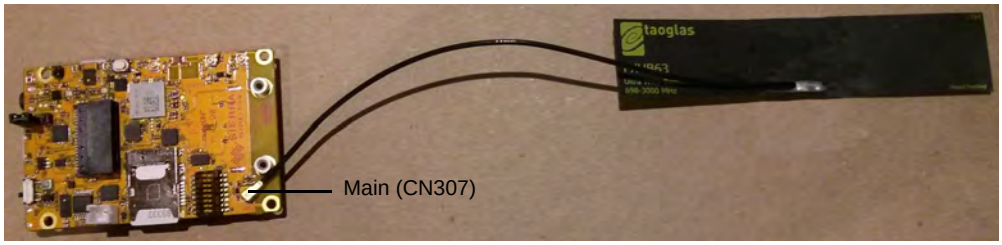


Figure 3-6: Antenna Connector Locations

Tip: *If you have trouble connecting an antenna, make sure it is positioned directly on the connector and push straight down. The antenna will not connect at an angle.*

3.3 SIM, SD, and IoT Expansion Cards

3.3.1 Inserting a micro-SIM Card

To establish a mobile network connection with a CF3 module, you must install a micro-SIM in the connector on the bottom side of the mangOH Yellow. Use either of the following:

- SIM card with activated account, *or*
- Test SIM card for use with a call box (for example, an Agilent 8960 or Rohde & Schwarz CMU200)

To install a SIM card:

1. Place the mangOH Yellow with the dip switch block facing up (as shown).

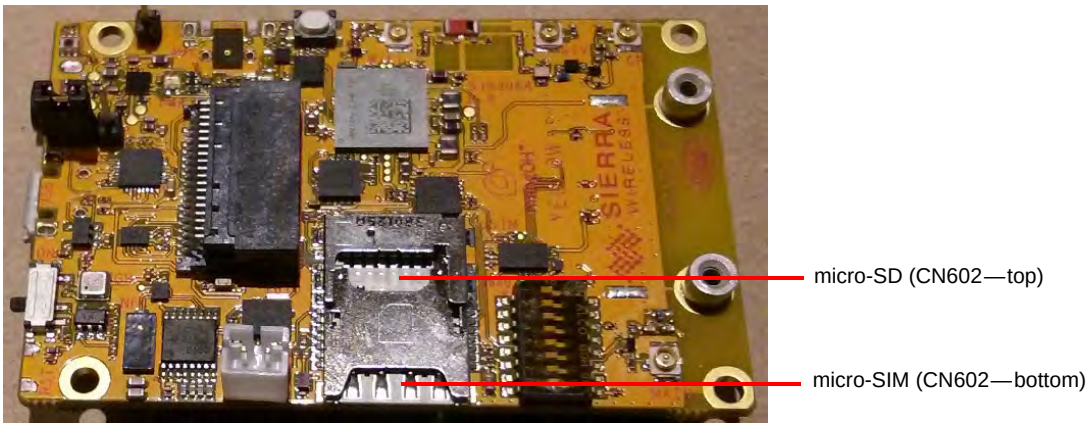


Figure 3-7: SIM Connector and micro-SD Locations

2. Insert the SIM card with contacts face-down into the desired slot—note the location of the notched corner of the card in Figure 3-8.

Note: CN602 is a dual-connector—the lower slot is for the micro-SIM, and the upper slot is for a microSD card.

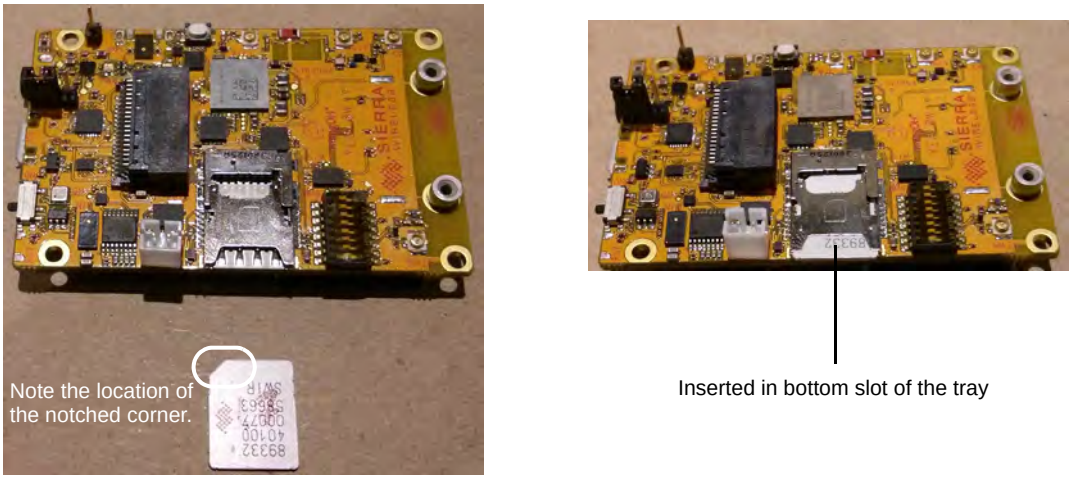


Figure 3-8: SIM Insertion

3.4 Inserting a microSD Card

To install a microSD card:

1. Place the mangOH Yellow with the dip switch block facing up (as shown).

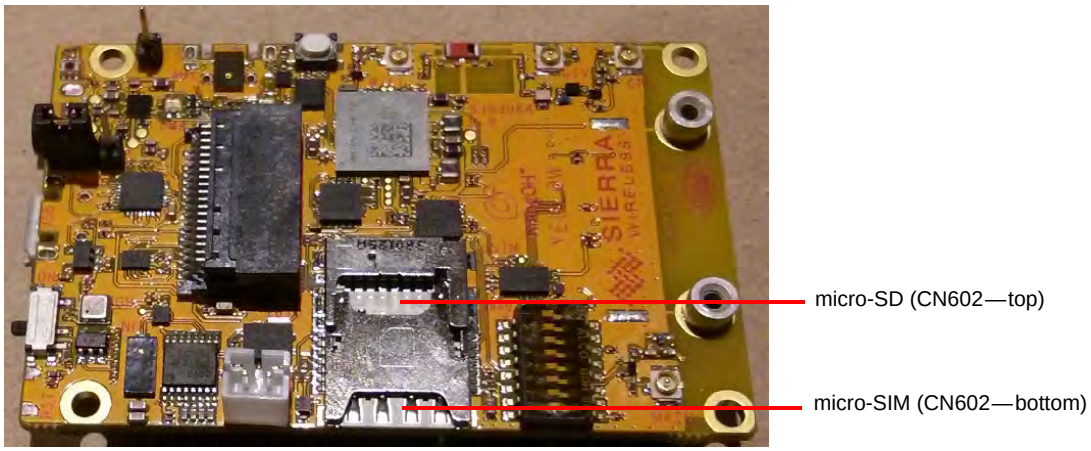


Figure 3-9: SIM Connector and micro-SD Locations

2. Insert the microSD card with contacts face-down into the top slot of CN602.

Note: CN602 is a dual-connector—the lower slot is for the micro-SIM, and the upper slot is for a microSD card.

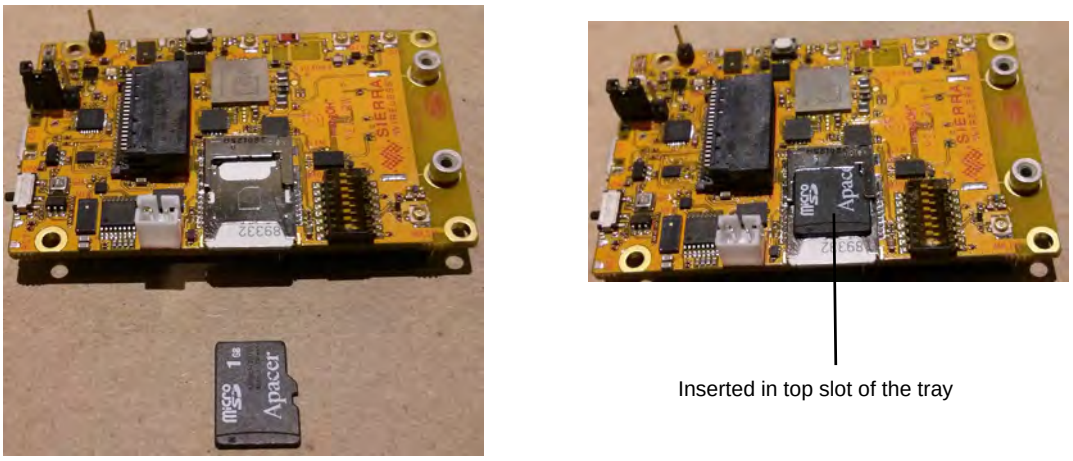


Figure 3-10: microSD Insertion

3.4.1 Inserting/Removing an IoT Expansion Card

The mangOH Yellow includes one IoT Expansion Card slot.

Caution: *Handle IoT Expansion Cards carefully to make sure components are not accidentally damaged. Hold them by their edges to avoid possible ESD damage.*

To install an IoT Expansion Card:

1. Turn off the mangOH Yellow's power—slide the power switch toward the edge of the board.

   Note: You must turn off the power because IoT Expansion Cards are not hot-swappable—the card will be recognized when power is turned back on.

2. Check the expansion card to make sure you know which side is the top. (Expansion cards must not be inserted upside-down.)
3. Slide the expansion card straight into the IoT Connector (CN601).
4. Use two M2 screws (included) to secure the expansion card to the standoffs.

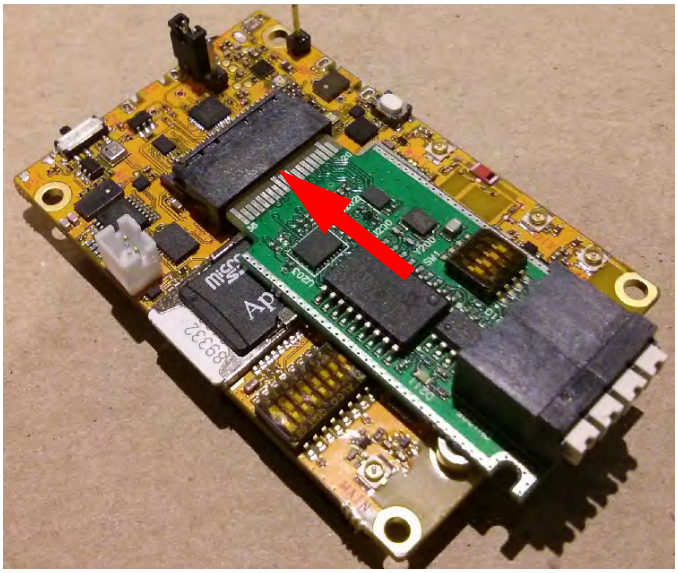


Figure 3-11: IoT Expansion Card Insertion

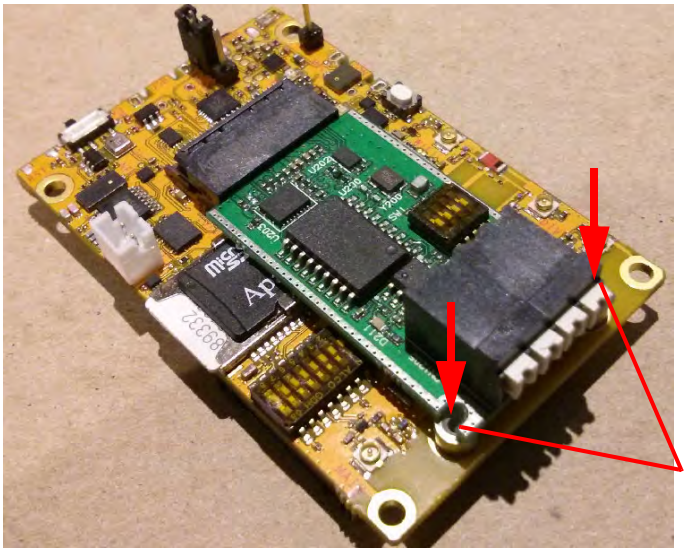


Figure 3-12: IoT Expansion Card Inserted

5. Turn the power back on—slide the power switch toward the center of the board.

To remove an IoT Expansion Card:

1. Turn off the mangOH Yellow's power—slide the power switch toward the edge of the board.
2. Remove the two screws.
3. Pull the expansion card straight out, using safe ESD-handling practices (such as wearing proper ESD straps).

For detailed IoT Expansion Card slot interface information, refer to the mangOH Yellow Hardware Architecture Guide. For detailed information about expansion cards, refer to the IoT Expansion Card Specification.

3.4.2 Audio Connection

The mangOH Yellow includes a 3.5 mm audio jack (CN701) for use with audio-enabled CF3 modules. If supported by the CF3 module, the jack can be used to make a voice call.

By default, the audio jack is connected to the onboard mangOH codec, and is configured for use with a CTIA/ AHJ-compatible headset.

Figure 3-13: Audio Output Jack

3.5 Control Connections

3.5.1 CON (Console) Connector

The mangOH Yellow includes a micro-USB 2.0 connector (CN800) for console access.

By default, this port is enabled and configured to connect to the CF3 module's four-wire UART interface (UART2).

The connection can be used to access the CF3 module's Linux console.

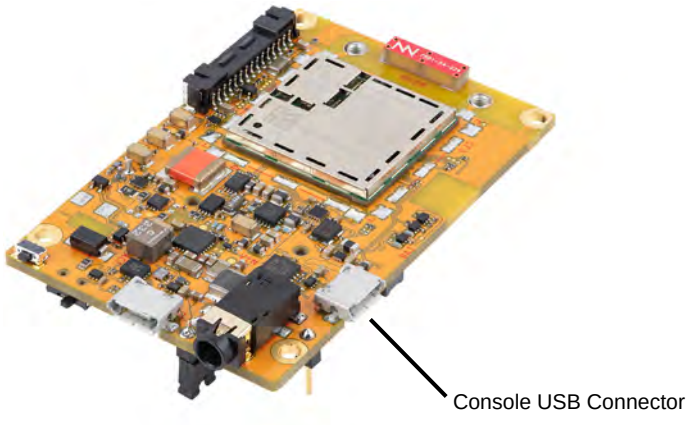


Figure 3-14: Console USB Output Connection

3.5.2 USB Connector

The mangOH Yellow includes a micro-USB 2.0 connector (CN802) for access to the CF3 module's interfaces (ECM, AT, etc.).

By default, this port is enabled and configured to connect to the CF3 module's USB interface.

Figure 3-15: CF3 USB Connector

3.5.3 Expansion Connector

The mangOH Yellow includes a 15-pin expansion connector (CN805) that can be used to connect an external device to the mangOH Yellow.

The connector supports several interfaces for communication between the external device and the mangOH Yellow's WP7702 module (ADC, GPIO, I2C, SPI, UART).

The connector also includes power pins that allow the mangOH Yellow to provide power to the external device, or for the external device to provide power to the mangOH Yellow.

For expansion connector details, refer to the mangOH Yellow Hardware Architecture Guide.

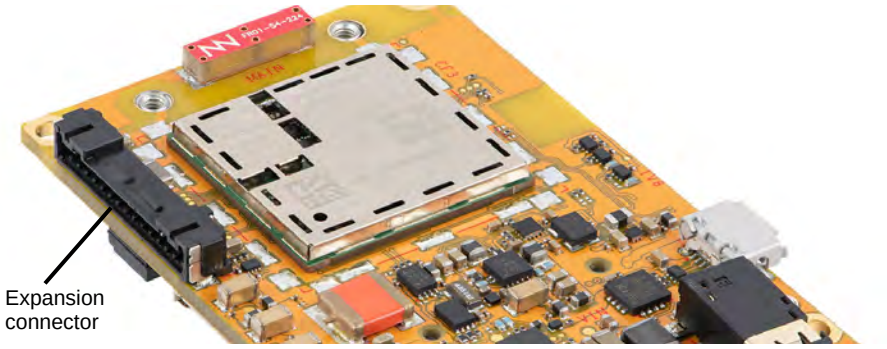


Figure 3-16: Expansion Connector

3.6 LED Indicators

The mangOH Yellow includes several LED indicators.

Table 3-3: mangOH Yellow LEDs

LED	Description
1—Power/Network/Cloud	D401—Tri-color (RGB), hardware-controlled Visible LED behavior: • Green—Power is on • Yellow—Power on + Cellular radio on • White—Power on + Cellular radio is transmitting/receiving *Note: D401 only appears as Green, Yellow (Green+Red), or White (Green+Red+Blue).*
2—Generic green	D402—Mono-color (Green), software-controllable
3—Generic tri-color	D500—Tri-color (RGB) software-controllable *Note: All color combinations can be used. (i.e. B, G, R, BG, BR, GR, BGR)*

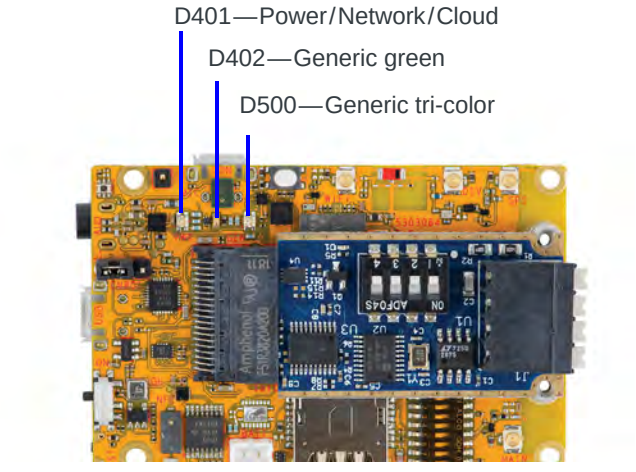


Figure 3-17: LED Indicators

3.7 Physical Switches/Buttons/Headers

3.7.1 Reset Button

The mangOH Yellow includes a board reset button (SW401). Press and release to reset the board.

For details on resetting the mangOH Yellow or specific application blocks, see the mangOH Yellow Hardware Architecture Guide.

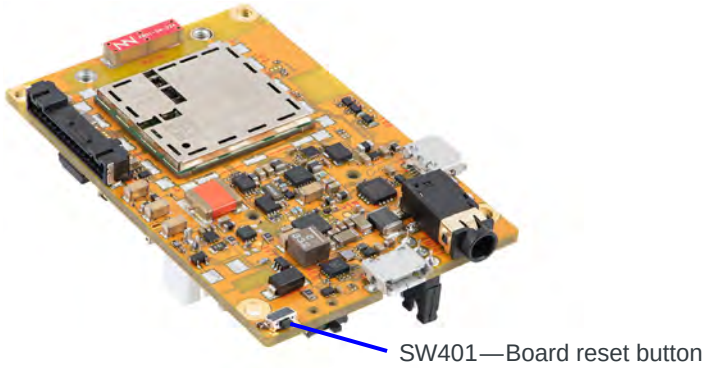


Figure 3-18: Reset Button

3.7.2 Generic Button

The mangOH Yellow includes one generic button (SW500) for user-defined purposes.

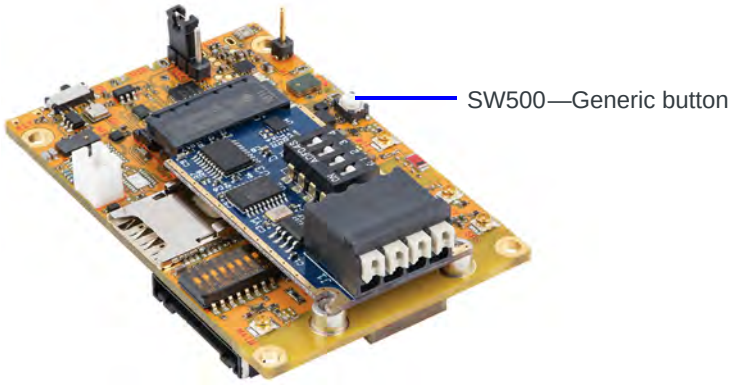


Figure 3-19: Generic Button

3.7.3 Power Switch

The mangOH Yellow includes a power switch (SW1002) that turns the mangOH Yellow on/off, regardless of which power source is being used.

To turn the power:

- ON—Slide the switch toward the center of the board.
- OFF— Slide the switch toward the edge of the board.

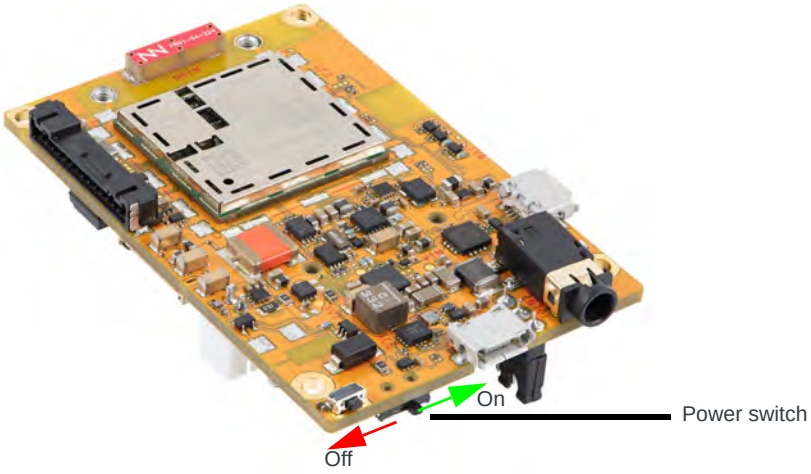


Figure 3-20: Power Switch

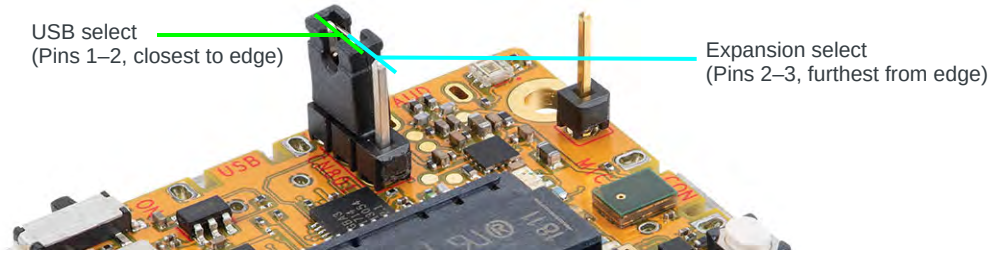
3.7.4 Power Source Selector

The mangOH Yellow uses a 3-pin header as the primary power source selector.

Table 3-4: CN801—Board Power Select[a]

Power supply selection	Jump 1–2	Jump 2–3
"USB" micro-USB connector (CN802)	Yes	
Expansion connector (CN805)		Yes

a. Required: Select one option only (Jump 1–2 *or* Jump 2–3). For details, see Select Power Supply on page 13.



3.8 mangOH Yellow Default Configuration

The mangOH Yellow's default configuration is described in Table 3-5.

Table 3-5: mangOH Yellow Default Configuration

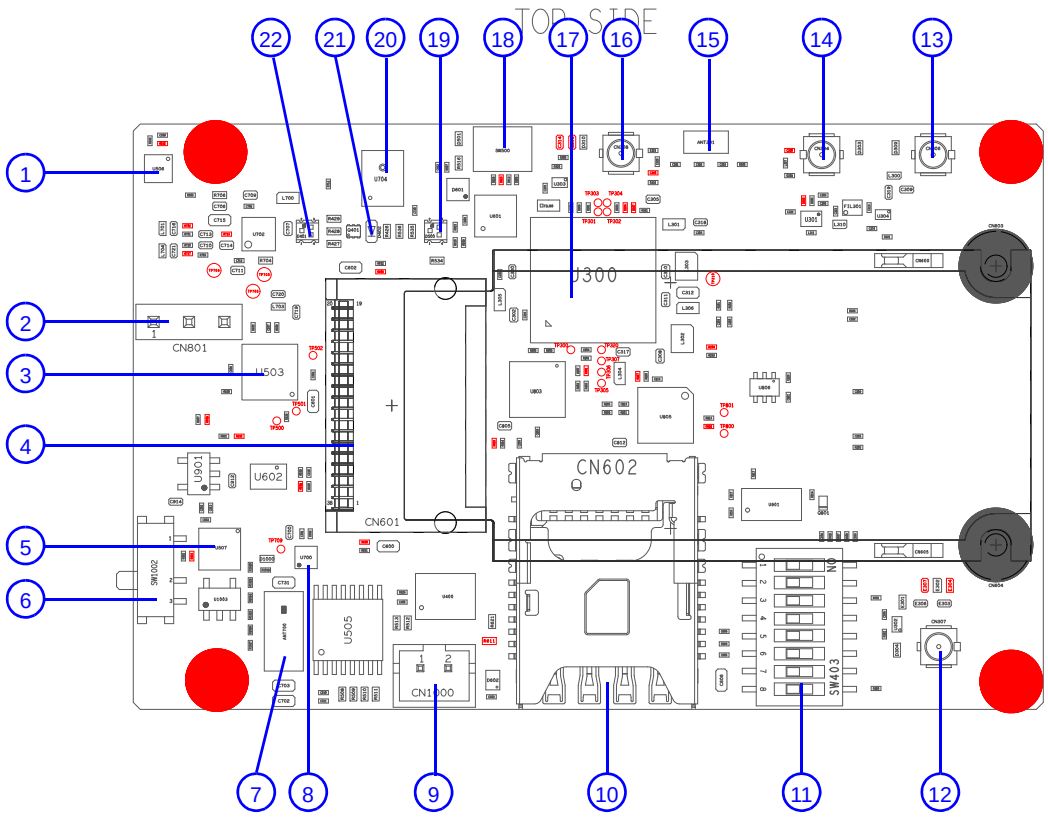
Function	Default Configuration / Behavior	Alternate Configuration / Notes
Module Signals Control	Dip switch block (SW403)—All pins OFF.	Refer to Module Signals Control on page 25 for details.
LTE (main) antenna	Integrated antenna	Controlled by SW403 dipswitch Alternate: u.FL connector (CN307) *Note: 3.3 V bias voltage for active antennas*
Wi-Fi/Bluetooth/ GPS antenna	Integrated antenna	Controlled by SW403 dipswitch Alternates: • Wi-Fi—u.FL connector (CN308) • GPS—u.FL connector (CN306) *Note: 3.3 V bias voltage for active antennas* *Note: No alternate Bluetooth antenna*
Power Source Selector	Primary power source selection via jumper position: • Pins 1–2: USB connector (CN802) • Pins 2–3: Expansion connector (CN805)	
Power source (primary)	Selectable (via Power source selector): • "USB" micro-USB connector (CN802). • Expansion connector (CN805)	Alternate: Hardware reconfiguration required to replace Expansion connector with "CON" micro-USB connector (CN800).
Power source (backup)	Not connected. External rechargeable battery may be connected to battery connector (CN1000)	
USB interface	"USB" micro-USB connector (CN802)	Serial connection to WP7702
UART2 interface	"CON" micro-USB connector (CN800)	Console connection to WP7702
SDIO interface	Wi-Fi/BT (U300) SDIO, unless card (microSD or IoT card) is inserted)	Controlled by SW403 dipswitch Alternate: microSD card connector (CN602) or IoT connector (CN601). *Note: If using a card for SDIO, use only a microSD card or an IoT card, not both. The interface will not work if both are inserted.*
Additional peripheral interfaces (UART, SPI, I2C, etc.)	See the mangOH Yellow Hardware Architecture Guide for details.	
Audio	Audio connector (CN701) connected to onboard mangOH codec	Supports CTIA/AHJ-compatible headset
LEDs	All LEDs (D401, D402, D500) enabled	Refer to LED Indicators on page 21 for behavior details.
Expansion connector (CN805)	• Enabled • Selectable as primary power source via Power Source Selector (CN801)	
System reset signal (RESET_IN_N)	Held LOW until CF3 module is fully booted	Peripherals on the mangOH Yellow are not activated until the module is fully booted.

3.9 Module Signals Control

The mangOH Yellow uses a multi-function switch (SW403) to control specific signals.

Table 3-6: SW403—Module Signals Control

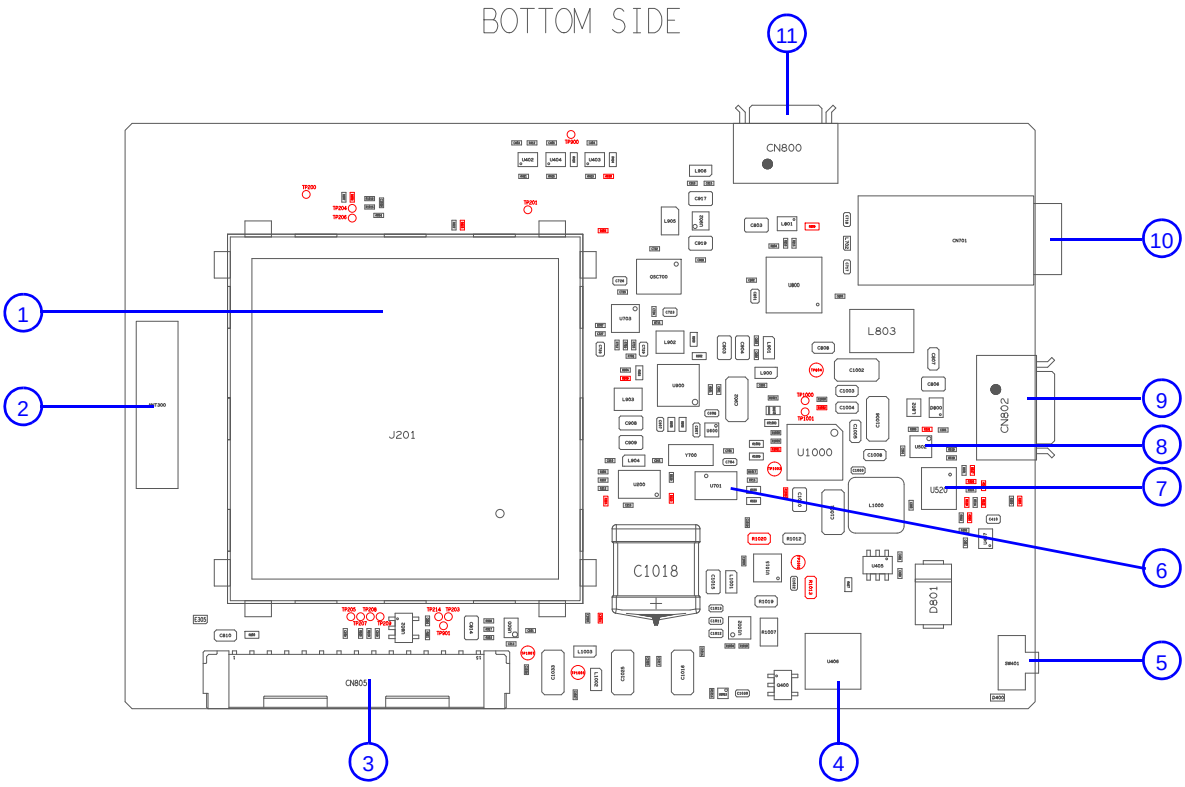
Signal	Dip	Dip switch position/State
HL78_MODE_ON	1	Module type installed: • ON—HL78 (Note: HL78 UART0 signals carried on CF3 socket's UIM2 pins.) • OFF—WP
TP1_BOOT	2	CF3 module's TP1 (boot) signal • ON—Stop boot process at primary bootloader and enter recovery programming mode • OFF—Boot normally
BUCK_DISABLE_N	3	Buck converter state, controls which components receive power • ON—Converter is off. Only CF3 module receives power. • OFF—Converter is on. All components receive power.
W_DISABLE_N	4	Radio state • ON—Disable • OFF—Enable
CELL_ANT_CNTR	5	Main antenna to use • ON—External (use Main u.FL connector) • OFF—Integrated
WIFI_ANT_CNTR	6	Wi-Fi antenna to use • ON—External (use WiFi u.FL connector) • OFF—Integrated
GPS_ANT_CNTR	7	GPS antenna to use • ON—External (use GPS u.FL connector) • OFF—Integrated
SDIO_SEL2	8	SD interface source • ON—microSD card/IoT card • OFF—Wi-Fi module



1—Light sensor (U506)
2—Power source selector (CN801)
3—GPIO expander (U503)
4—IoT connector (CN601)
5—Gas/Pressure/Humidity/Temperature sensor (U507)
6—Power switch (SW1002)
7—NFC antenna (ANT700)
8—NFC transponder (U700)
9—Battery connector (CN1000)
10—uSIM/uSD connector (CN602)
11—Multi-function switch (SW403)
12—Main antenna (CN307)
13—GPS Antenna (CN306)
14—Diversity antenna (CN304)
15—Integrated Wi-Fi/BT/GPS antenna (ANT301)
16—Wi-Fi/BT antenna (CN308)
17—Wi-Fi/BT module (U300)
18—Generic button (SW500)
19—Tricolor LED User-controlled (D500)
20—Digital microphone (U704)
21—Green LED User-defined (D402)
22—Tricolor LED Power/Network/Cloud (D401)

Figure 3-21: mangOH Yellow—Top Side Switches/Connectors

Note: For reference only. For latest schematic, visit mangoh.io/mangoh-yellow-resources-hardware.



1—CF3 socket (J201)
2—Integrated main antenna (ANT300)
3—Expansion connector (CN805)
4—Buzzer (U406)
5—Reset button (SW401)
6—RTC (U701)
7—Gyroscope/Accelerometer (U520)
8—Geomagnetic sensor (U502)
9—Client USB connector (CN802)
10—3.5 mm audio jack (CN701)
11—Console USB connector (CN800)

Figure 3-22: mangOH Yellow—Bottom Side Switches/Connectors

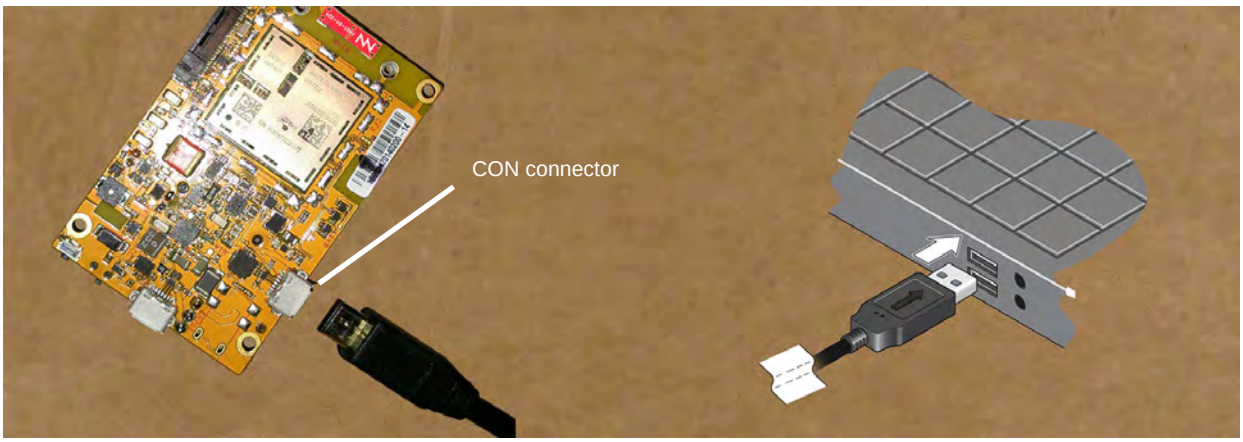
Note: For reference only. For latest schematics, visit mangoh.io/mangoh-yellow-resources-hardware.

A: Console Access

If you have two USB ports on your dev machine, you can use one of them to display the mangOH Yellow's diagnostic messages when the device boots, when certain commands are run, etc.

To set up a window to display diagnostic messages:

1. Use a micro-USB cable to connect the mangOH Yellow's CON port to a USB port on the dev machine.



2. Open and connect a terminal window to the WP7702 module to display its console messages (kernel messages, warnings, etc.):

- Linux

  i. In the terminal window, enter the following command to install the minicom application on your dev machine (if it is not already there):

  ```
  $ sudo apt-get install -y minicom
  ```

  Note: 'sudo' tells the dev machine to run the command as the 'superuser'. Each time you use sudo, you must enter your dev machine's password to continue.

  ii. Connect to the CF3 module's Linux console via the USB serial port (which enumerated when you connected the CON connector to the dev machine):

  ```
  $ minicom -D /dev/ttyUSB0
  ```

  A welcome message appears, and the window will show console messages when the mangOH Yellow powers on in the next step.

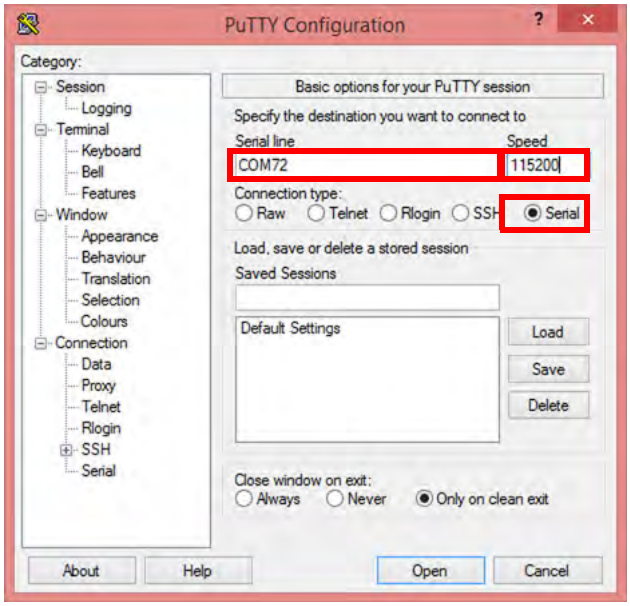
  ```
  Welcome to minicom 2.7

  Options: I18n
  Compiled on Feb 7 2016, 13:37:27.
  Port /dev/ttyUSB0, 20:04:25

  Press CTRL-A Z for help on special keys
  ```

  Note: The USB serial port enumerates as ttyUSB0 because you connected CON to the host before connecting USB to the host (which you will do later). However, if you connected USB first, it would enumerate ttyUSB0, ttyUSB1, and ttyUSB2. Then when CON is connected, it will enumerate as ttyUSB3.

Note: You can exit minicom at any time—the purpose of showing it here is to demonstrate how to display console messages for debugging purposes. To exit minicom, press Ctrl+A, then press X. When prompted, select Yes to leave minicom.

- Windows
  - **i.** If you do not have a terminal emulator program (e.g. PuTTY, Tera Term, etc.), download and install one now. The examples in this document use PuTTY.
  - **ii.** Open Windows Device Manager, then expand Ports (COM &LPT). The mangOH Yellow's CON port enumerates as USB Serial Port (COMxx). (In the example below, it enumerates as COM72.)

  - **iii.** Open a terminal window (e.g. PuTTY) connected to the mangOH Yellow's console using the following settings:
    - Connection type = Serial
    - Serial line = [USB Serial port COM port]
    - Speed = 115200



  - **iv.** Click Open. The window will remain empty until you power up the mangOH Yellow in the next step.

Note: Only one console connection can be opened at any time since it locks the USB serial port.

Example

If you open the console terminal window before you connect power to the mangOH Yellow, you will see the messages that are generated during the module boot process:

```
...
[    0.275753] cpu cpu0: dev_pm_opp_get_opp_count: device OPP not found (-19)
[    0.275772] msm_thermal:get_cpu_freq_plan_len Error reading CPU0 freq table len. error:-19
[    0.275788] cpu cpu0: dev_pm_opp_get_opp_count: device OPP not found (-19)
[    0.275801] msm_thermal:get_cpu_freq_plan_len Error reading CPU0 freq table len. error:-19
[    0.370170] AXI: msm_bus_scale_register_client(): msm_bus_scale_register_client: Bus driver
not ready.
[    0.371913] AXI: msm_bus_scale_register_client(): msm_bus_scale_register_client: Bus driver
not ready.[    0.372200] i2c-msm-v2 78b8000.i2c: NACK: slave not responding, ensure its powered:
msgs(n:1 cur:0 tx) bc(rx:0 tx:2) mode:FIFO slv_addr:0x3a MSTR_STS:0x081343c8 OPER:0x00000090
[    0.427857] msm_bus_fabric_init_driver
[    0.647191] uart_tx_gpio is not available
[    0.647211] uart_rx_gpio is not available
[    0.647230] uart_cts_gpio is not available
[    0.647250] uart_rfr_gpio is not available
[    0.647938] sps: BAM device 0x07884000 is not registered yet.
...
```

Console messages describing module boot-up process

B: Regulatory Compliance

B.1 Important Compliance Information for North American Users

Caution: *Changes or modifications not expressly approved by Sierra Wireless could void the user's authority to operate the equipment.*

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, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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.

Caution—At least 20 cm separation distance between the antenna and the user’s body must be maintained at all times.