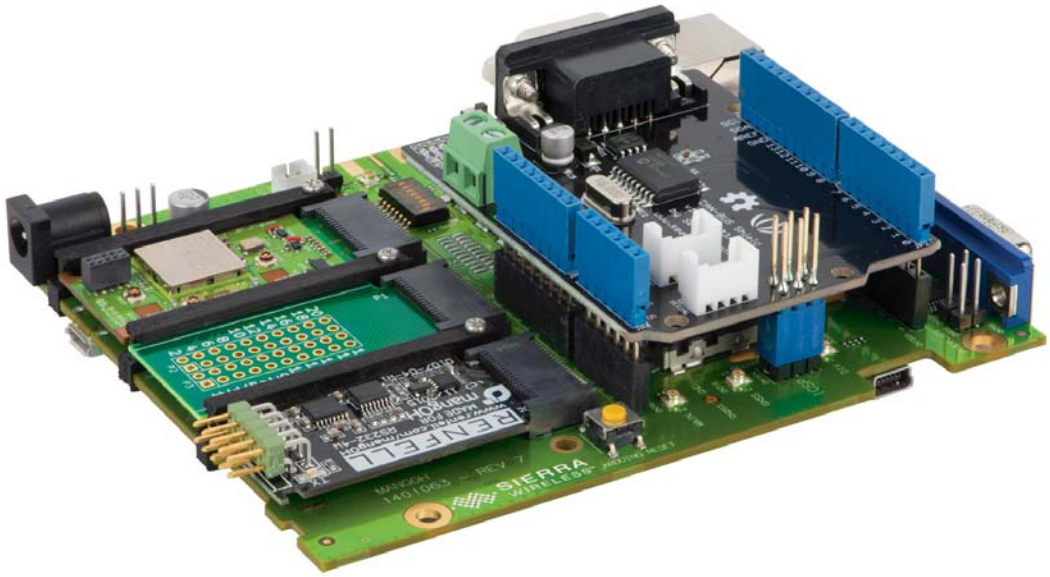
mangOH™ Green (DV4)

Developer's Guide



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Revision History

Revision number	Release date	Changes
1	March 2016	Document created based on DV3 document
2	June 2016	Replaced ‘IOT Connector’ references with ‘IOT Expansion Card’
3	November 2016	Updated Figures 2-6, 2-7

Contents

1: Introduction

The mangOH Green is an open-source hardware development platform for CF3 modules that incorporates several hardware interfaces and standardized IoT Expansion Card slots for expanded functionality.

The purpose of this developer's guide is to describe the mangOH Green's architecture and provide details on how to develop applications for CF3 modules.

Important: *This Developer's Guide applies to mangOH Green DV4. The guide for mangOH Green DV3 is available at mangoh.io.*

The standard mangOH Green documentation suite, available at mangoh.io, includes:

- mangOH Green Getting Started Guide
- mangOH Green User Guide
- **mangOH Green Developer's Guide** (This document)
- mangOH Green AirVantage Developer's Guide (forthcoming)
- Project mangOH IoT Expansion Card Design Specification
- Product Specifications for Sierra Wireless IoT Expansion Cards (forthcoming)

2: Hardware

This chapter describes the mangOH Green platform's hardware components and interfaces.

mangOH Green Hardware Overview

Figure 2-1 provides an overview of the mangOH Green's hardware components relative to the primary CF3 module, and Figure 2-2 and Figure 2-3 show their locations.

For additional details, see the following documents available at mangoh.io.

- Sierra Wireless CF3 module Product Specifications
- CF3 specification
- mangOH Green User Guide for instructions on setting up the hardware components

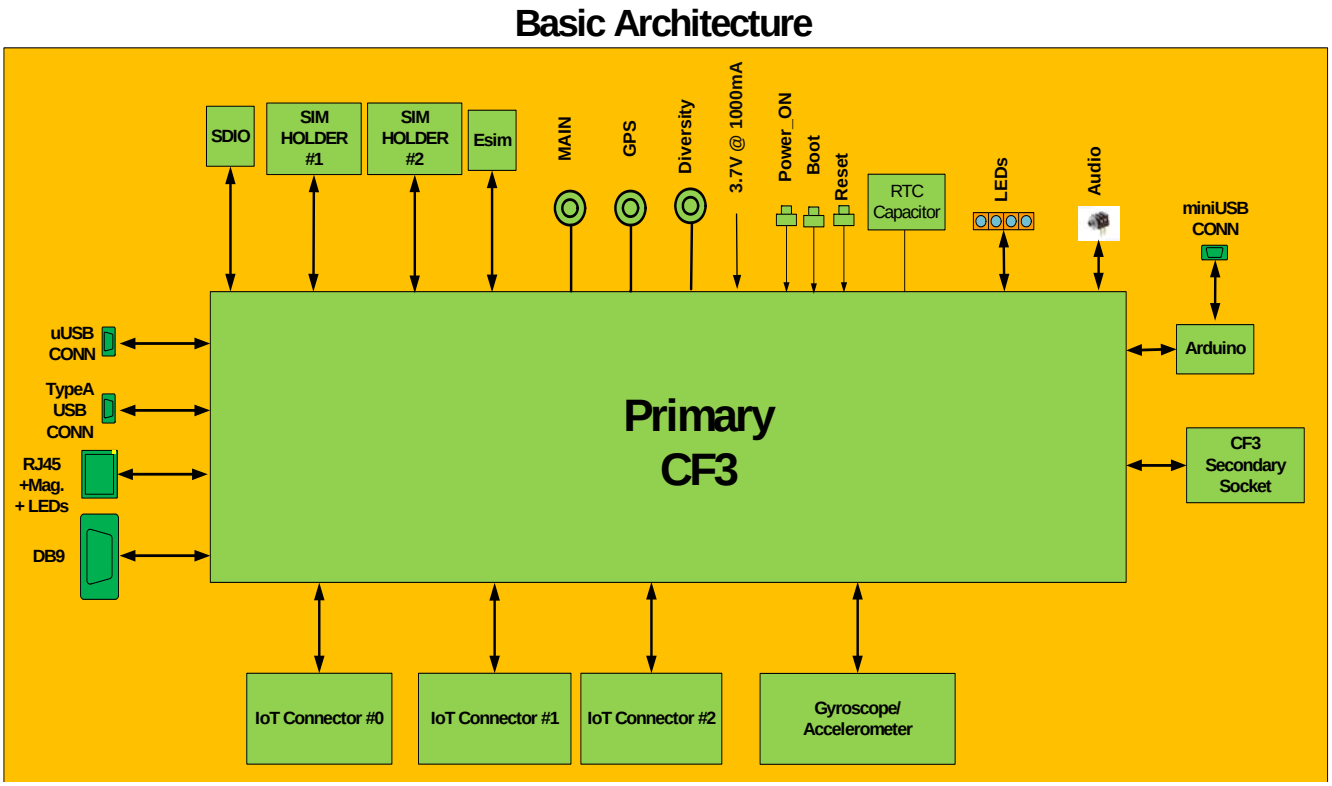

Figure 2-1: mangOH Green Hardware Components Overview

1—IoT Expansion Card slot #2 (IOT2)
2—IoT Expansion Card slot #1 (IOT1)
3—IoT Expansion Card slot #0 (IOT0)
4—DC power (CN1200)
5—Power supply select (CN1204)
6—Battery connector (CN1202)
7—Recharge select (CN1203)
8—Signals control (SW401)
9—Main antenna
10—GNSS antenna
11—Diversity antenna
12—Ethernet
13—USB Host
14—Audio
15—Module reset
16—Capacitor discharge (DNI)
17—RS-232 DB9 console output
18—Arduino-compatible circuit header
19—RTC backup capacitor
20—Secondary Main
21—Secondary GNSS
22—Secondary Diversity
23—Arduino-compatible circuit header
24—Arduino-compatible circuit reset
25—Secondary CF3 socket
26—Primary CF3 socket

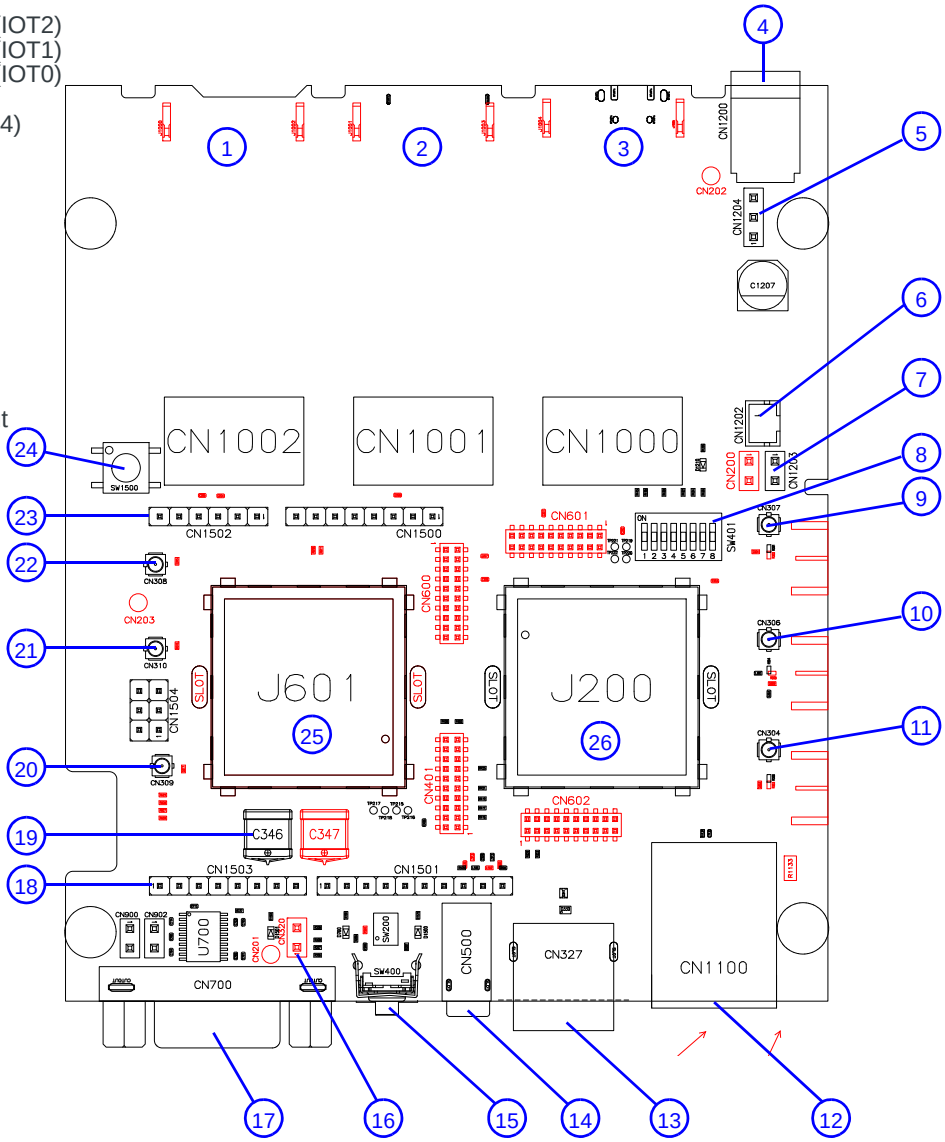

Figure 2-2: mangOH Green—Top Side Switches/Connectors

Note: For reference only. For latest schematic, visit mangoh.io.

1—USB power
2—micro-SIM (bottom slot)
3—microSD (top slot)
4—mini-SIM
5—Arduino-compatible circuit mini-USB
6—ATmega32U4

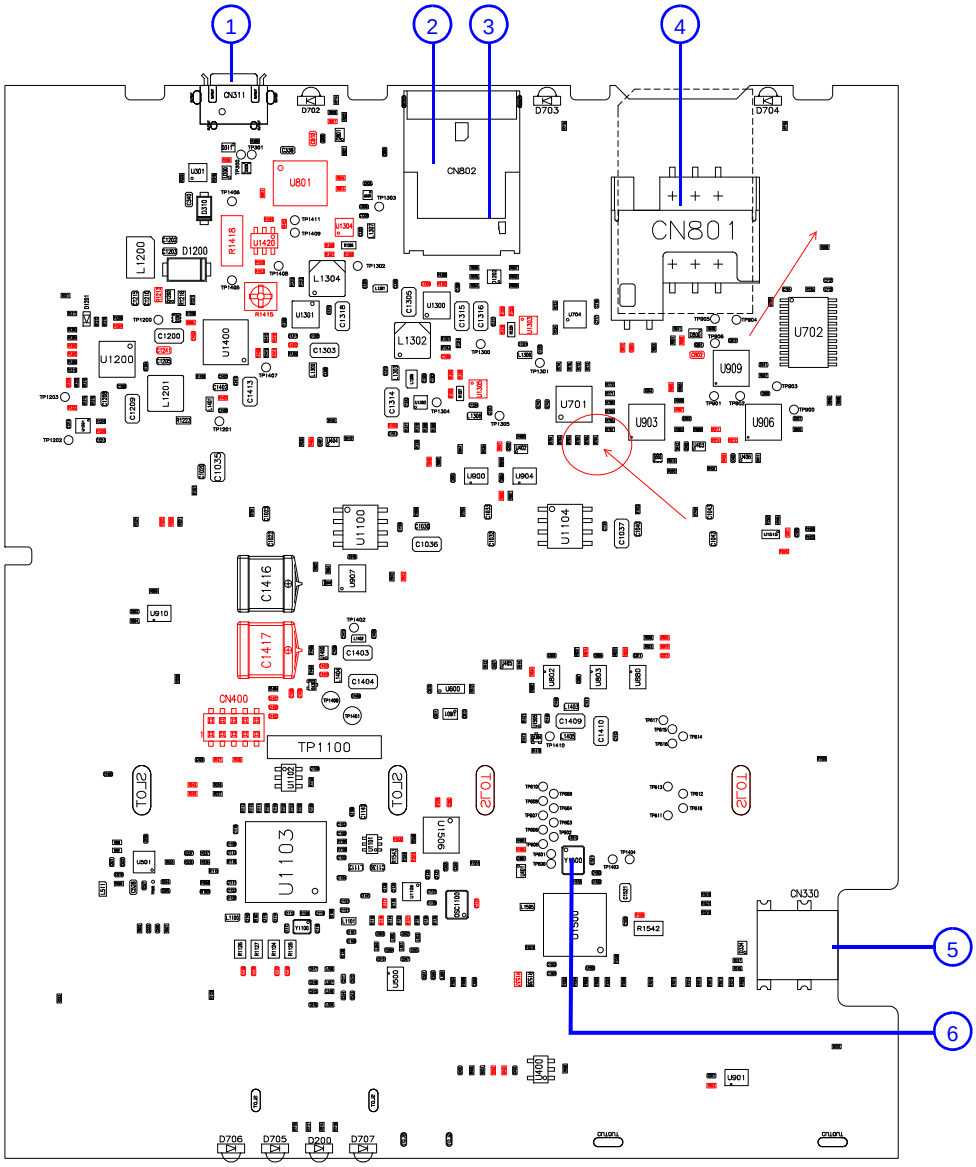

Figure 2-3: mangOH Green—Bottom Side Switches/Connectors

Note: For reference only. For latest schematics, visit mangoh.io.

mangOH Green Hardware Architecture

The mangOH Green platform provides several hardware components, including:

- CF3 module sockets (main and secondary)
- Pluggable IoT Connectors (sockets for IoT Expansion Cards)
- Integrated Arduino-compatible circuit with an on-board ATmega32U4 microcontroller
- Several I/O connectors (SIM, SD, Audio, USB, Ethernet, etc.)

Figure 2-4 illustrates the hardware architecture of the mangOH Green platform (connectors and signals), and the following sections describe their interfaces in greater detail:

- mangOH Green Hardware Components on page 11—Describes the hardware components available to the CF3 modules and Arduino-compatible circuit.
- Primary CF3 Module Signals on page 18—Describes how Primary CF3 module signals connect to the mangOH Green hardware components.
- Secondary CF3 Module Signals on page 32—Describes how Secondary CF3 module signals connect to the mangOH Green hardware components.
- IoT Connector Interfaces on page 33—Describes how IoT Expansion Card signals connect to the mangOH Green hardware components.

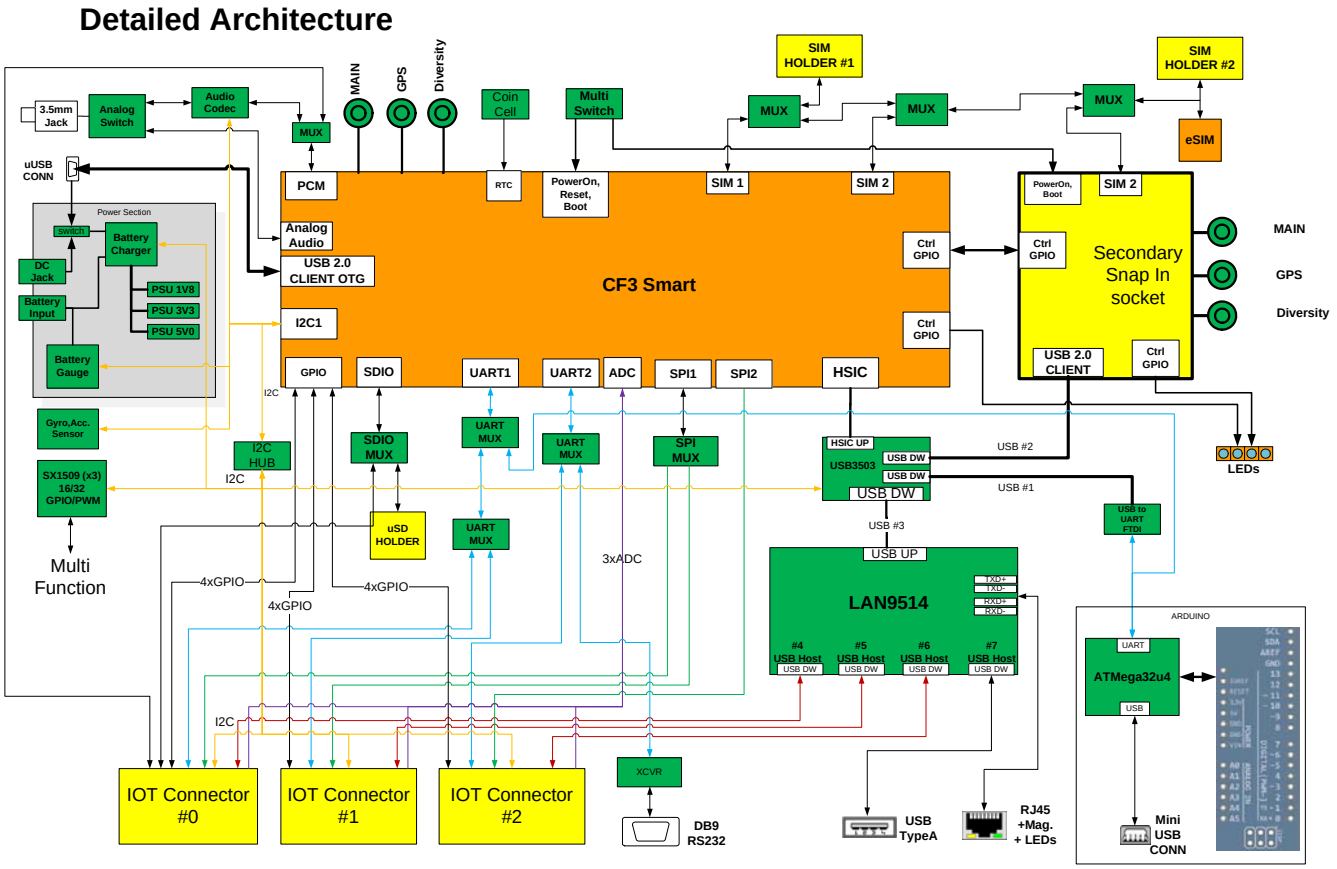

Figure 2-4: mangOH Green Hardware Architecture

mangOH Green Hardware Components

The mangOH Green hardware components that interact with installed CF3 modules and with the integrated Arduino-compatible circuit are listed in Table 2-1. Details shown include:

- Hardware component type, PCB schematic designator, and description
- CF3 module signal(s) connected to the hardware component
- Component to signal path type
  - Single—Component connects directly to one signal only.
  - MUX—A hardware switch that connects one component to one of several signals, or one of several components to one signal.
  - Hub—One signal is connected to multiple components via a signal expander.
- Notes (purpose, usage, etc.)
- Links to detailed descriptions

The mangOH Green's default configuration enables specific interfaces when the platform boots. For interface details, see:

- MUXing on page 17
- Primary CF3 Module Signals on page 18
- Secondary CF3 Module Signals on page 32
- IoT Connector Interfaces on page 33
- Arduino-compatible Circuit Signals on page 34
- Reset Methods on page 35
- Power Management on page 37

Table 2-1: mangOH Green Hardware Components

mangOH Green Components		CF3/Arduino-compatible Circuit Signal(s)			
Type and Designator[a]	**Description**	**Signal(s) and Module Pins**	**Path[b]**	**Notes**	**See also ...**
Modules/Processors/etc.					
Primary CF3 (J200)	See Primary CF3 Module Signals on page 18 for details.				
Secondary CF3 (J601)	See Secondary CF3 Module Signals on page 32 for details.				
IOT0, IOT1, IOT2 (CN1000, CN1001, CN1002)	IoT Expansion Cards	Multiple connections to Primary CF3 and Secondary CF3 interfaces.	See IoT Expansion Cards on page 16 for details.		

Table 2-1: mangOH Green Hardware Components (Continued)

mangOH Green Components		CF3 / Arduino-compatible Circuit Signal(s)			
Type and Designator[a]	**Description**	**Signal(s) and Module Pins**	**Path[b]**	**Notes**	**See also ...**
ATmega32U4 (U1500)	Microcontroller for integrated Arduino-compatible circuit	Primary CF3 HSIC interface (Pins: 14, 15)	Hub	Purpose: • Control interface for Arduino-compatible circuit. • Connects to mini-USB for direct interaction with computer • UART interface to a UART-USB converter, that connects to a USB3503 hub, for control by primary CF3 module.	Arduino-compatible Circuit Signals on page 34
Card slots					
Mini-SIM (CN801)	Mini-SIM holder	Primary CF3 UIM1 (Pins: 26–29)	Single	Purpose: UIM required to establish mobile network connection.	UIM1 on page 30
Micro-SIM (CN802)	Micro-SIM/ microSD holder (bottom slot)	• Primary CF3 UIM2 (Pins: 55–58) • Primary CF3 UIM1 (Pins: 26–29) • Secondary CF3 UIM1 (Pins: 55–58)	MUX	Purpose: UIM required to establish mobile network connection through primary CF3, or through secondary CF3 for dual data streams.	• UIM2 on page 30 • UIM1 on page 30 • Secondary CF3 Module Signals on page 32 • MUXing on page 17
micro-SD (CN802)	Micro-SIM/ microSD holder (top slot)	Primary CF3 SDIO (Pins: 161–166)	MUX	Purpose: Provide access to microSD card.	• SDIO on page 25 • MUXing on page 17
USB-type connectors					
micro-USB (CN311)	micro-USB connector	• Primary CF3 USB (Pins: 12, 13, 16) • Power (if selected)	Single	Purpose: • Direct connection to primary CF3 module USB signals • Power supply when selected by the Power Supply Selection Jumper (CN1204). See mangOH Green User Guide for details. • USB OTG	USB 2.0 on page 30
mini-USB (CN330)	mini-USB connector	ATmega32U4 USB	Single	Purpose: Interact directly with Arduino-compatible circuit from connected computer.	Arduino-compatible Circuit Signals on page 34

Table 2-1: mangOH Green Hardware Components (Continued)

mangOH Green Components		CF3/Arduino-compatible Circuit Signal(s)			
Type and Designator[a]	Description	Signal(s) and Module Pins	Path[b]	Notes	See also ...
USB Host (CN327)	USB Type A connector	Primary CF3 HSIC (Pins: 14, 15)	Hub	Purpose: Provides USB host capability to primary CF3 module.	HSIC (USB/Ethernet) on page 23
Cable connectors					
Ethernet (CN1100)	RJ-45 connector	Primary CF3 HSIC (Pins: 14, 15)	Hub	Purpose: Provides Ethernet connection to primary CF3 module.	HSIC (USB/Ethernet) on page 23
RS-232 (CN700)	DB9 serial connector	Primary CF3 UART2 (Pins: 96–99)	MUX	Purpose: Provide a serial connection over the DB9 connector.	• UART2 on page 28 • MUXing on page 17
RF and Audio connectors					
RF Antennas Main (CN307) GNSS (CN306) Diversity (CN304)	u.FL connectors	Primary CF3 RF (Pins: 49 (Main), 38 (GNSS), 31 (Diversity))	Single		RF on page 25
Audio (CN500)	3.5 mm connector	Primary CF3 digital or analog audio signals (Pins: 17–20 (analog), 30–33 (digital))	MUX	Purpose: Provide audio capability to primary CF3 module.	• Audio (Analog and PCM) on page 18 • MUXing on page 17
Other ICs and components					
Gyroscope + Accelerometer (U704)	Integrated LSM6DS3 inertial module	Primary CF3 I2C1 interface (Pins: 1, 6)	Hub	Purpose: Provides rotation and acceleration measurements to primary CF3 module.	I2C1 on page 24
RTC capacitor (CN320)[c]	Keep-alive circuit	BAT_RTC (Pin 21)	Single	Purpose: Keeps the real time clock powered when DC, USB, and battery power are not provided.	
GPIO/PWM expanders	Integrated SX1509 expanders	Primary CF3 I2C1 interface (Pins: 1, 6)	Hub	Purpose: Provides additional GPIOs.	• GPIO Expanders on page 21 • I2C1 on page 24
LEDs					
IoT Expansion Card 0 (D702)	Green LED	LED_CARD_DETECT_IOT0		Purpose: Indicates IoT Expansion Card is in slot IOT0.	
IoT Expansion Card 1 (D703)	Green LED	LED_CARD_DETECT_IOT1		Purpose: Indicates IoT Expansion Card is in slot IOT1.	

Table 2-1: mangOH Green Hardware Components (Continued)

mangOH Green Components		CF3 / Arduino-compatible Circuit Signal(s)			
Type and Designator[a]	Description	Signal(s) and Module Pins	Path[b]	Notes	See also ...
IoT Expansion Card 2 (D704)	Green LED	LED_CARD_DETECT_IOT2		Purpose: Indicates IoT Expansion Card is in slot IOT2.	
Rx/Tx (Primary CF3 module) (D705)	Green LED	2G_TX_ON		Purpose: Indicates primary CF3 module is transmitting/ receiving.	
Rx/Tx (Secondary CF3 module) (D706)	Green LED	S_2G_TX_ON		Purpose: Indicates secondary CF3 module is transmitting/receiving.	
RF Disabled (D707)	Green LED	W_DISABLE_N		Purpose: Indicates RF power is disabled for primary CF3 module.	
WLAN Connected (D200)	Green LED	WWAN_LED_N		Purpose: Indicates device is connected to a WLAN.	
AirVantage Connected (D760)	Green LED	AV_LED		Purpose: Indicates device is connected to AirVantage.	
Rx (Arduino-compatible circuit) (D1501)	Green LED	RXLED/SS		Purpose: Indicates Arduino-compatible circuit is receiving.	
Tx (Arduino-compatible circuit) (D1500)	Green LED	TXLED		Purpose: Indicates Arduino-compatible circuit is transmitting.	
V_SYS_BAT (D1201)	Green LED	V_SYS_BAT		Purpose: Indicates battery is charging.	
VCC_3V7 (D1210)	Green LED	VCC_3V7		Purpose: Indicates device is powered on.	

Table 2-1: mangOH Green Hardware Components (Continued)

mangOH Green Components		CF3/Arduino-compatible Circuit Signal(s)			
Type and Designator[a]	Description	Signal(s) and Module Pins	Path[b]	Notes	See also ...
Platform controls					
Multi-switch (SW401)	Module signals control	Eight dipswitches:			mangOH Green User Guide
		1. POWER_ON (Pri CF3 Pin 59)	Single	Enable/disable primary CF3 module's POWER_ON signal	
		2. MDM_Power	Single	Reserved for future use	
		3. W_DISABLE_N (Pri CF3 Pin 151)	Single	Enable/disable RF power for primary CF3 module	RF on page 25
		4. SIM2_Detect (Pri CF3 Pin 65)	Single	Manual switch to indicate when a second SIM card is inserted/removed.	UIM Signals on page 29
		5. SW_PWR_ON (Sec CF3 Pin 59)	Single	Enable/disable secondary CF3 module's POWER_ON signal.	
		6. UART_CTRL (Pri CF3 Pins 96–97)	Mux	Connect primary CF3 module's UART1 signal (RX/TX) to IoT Connector UART (slot IOT0 or IOT1) or ATmega32U4.	
		7. TP1_BOOT (Pri CF3 Pin 47)	Single	Enable/disable primary CF3 module's TP1 (boot) signal.	
		8. DCDC_shutdown	Single	Enable/disable secondary power supplies (1.8V and 5V) to put mangOH Green in basic mode (only primary CF3 module powered) or normal mode (all powered).	Power Management on page 37

a. Board designators (e.g. CN311, SW401, etc.) are for reference against the published mangOH Green schematic. For component locations on the board, see Figure 2-2 and Figure 2-3.
b. Single (dedicated); MUX (simple switch); Hub (signal expander)
c. By default, RTC capacitor is not installed. See mangOH Green schematic for details if you want to install it.

IoT Expansion Cards

mangOH Green includes three IoT Expansion Card slots (IOT0, IOT1, IOT2). Each slot has an IoT Connector that connects to the primary CF3's signals as detailed in Table 2-2.

In general, these slots support IoT Expansion Card specification signals as follows:

- IOT0—Full support
- IOT1, IOT2—Partial support

By default, specific signals are enabled for each slot when the mangOH Green boots. For additional information, including default configurations and how to temporarily change them, see IoT Connector Interfaces on page 33.

For detailed information about expansion cards, see the Project mangOH IoT Expansion Card Design Specification available at mangoh.io.

Table 2-2: IoT Expansion Card Signal Connections to Primary CF3 Module

IoT Signal	CF3 Signal(s)		Notes	Supported?			See also
	Signal	Path		IoT 0	IoT 1	IoT 2	
USB	HSIC (Pins 14, 15)	Single	Purpose: Data transfer; application control	Yes	Yes	Yes	HSIC (USB/ Ethernet) on page 23
UART	UART1 (Pins 2, 9)	MUX	Purpose: Data transfer	Yes	Yes	No	• UART1 on page 27 • MUXing on page 17
	UART2 (Pins 96–99)	Yes	Purpose: Data transfer	No	No	Yes	• UART2 on page 28 • MUXing on page 17
SPI	SPI1 (Pins 51–54)	Yes	Purpose: Data transfer	Yes	Yes	No	• SPI1 on page 26 • MUXing on page 17
	SPI2 (Pins 92–95)	Single	Purpose: Data transfer	No	No	Yes	SPI2 on page 27
I2C	I2C1 (Pins 1, 6)	Hub	Purpose: Data transfer (standard mode). Higher speeds possible if supproted by host application.	Yes	Yes	Yes	I2C1 on page 24
GPIO	GPIO	Single	Purpose: Customer-defined data communication	Yes	Yes	Yes	Primary CF3 GPIOs on page 19
SDIO	SDIO (Pins 161–166)	Yes	Purpose: Data transfer	Yes	No	No	• SDIO on page 25 • MUXing on page 17

Table 2-2: IoT Expansion Card Signal Connections to Primary CF3 Module (Continued)

IoT Signal	CF3 Signal(s)		Notes	Supported?			See also
	Signal	Path		IoT 0	IoT 1	IoT 2	
ADC0	ADC0 (Pin 25)	Single	Purpose: General purpose ADC output to host application (e.g. indicate when a sensor has triggered)	Yes	No	No	ADC on page 18
	ADC1 (Pin 24)	Single	Purpose: General purpose ADC output to host application (e.g. indicate when a sensor has triggered)	No	Yes	No	ADC on page 18
	ADC2 (Pin 107)	Single	Purpose: General purpose ADC output to host application (e.g. indicate when a sensor has triggered)	No	No	Yes	ADC on page 18
Power	Power	n/a	Receives three power inputs: • 5.0V @ 500 mA • 3.3V @ 200 mA • 1.8V @ 50 mA	Yes	Yes	Yes	Power Management on page 37

MUXing

Several interfaces use MUXing (simple switches) to associate multiple hardware connectors with a single CF3 or Arduino-compatible circuit signal, or multiple CF3/ Arduino-compatible circuit signals with a single hardware connector.

The following sections describe these MUX implementations

- MUX
  - Audio (Analog and PCM) on page 18
  - SDIO on page 25
  - SPI1 on page 26
  - UART1 on page 27
  - UART2 on page 28
  - UIM Signals on page 29
- Hubs
  - HSIC (USB/Ethernet) on page 23
  - I2C1 on page 24

Primary CF3 Module Signals

This section describes how the primary CF3 module's signals connect to the platform hardware described in mangOH Green Hardware Components on page 11.

Important: *CF3 module signal availability depends on the type of module used—some modules may not implement certain Extension signals from the CF3 specification.*

ADC

mangOH Green provides three ADC (Analog to Digital converter) signal sources (ADC0, ADC1, ADC2) defined by the CF3 specification.

Note: The CF3 specification includes ADC3, which is not supported by the mangOH Green.

The primary CF3 module's ADC signals connect directly to the mangOH Green IoT Connectors (pin 20), as shown in Figure 2-5:

- ADC0—IoT Connector 0 (CN1000, slot IOT0)
- ADC1—IoT Connector 1 (CN1001, slot IOT1)
- ADC2—IoT Connector 2 (CN1002, slot IOT2)

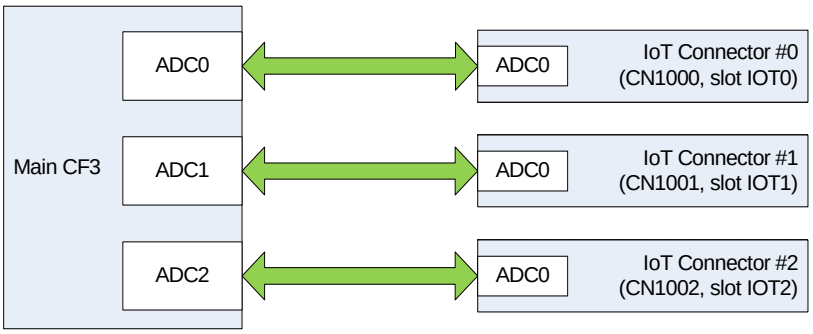

Figure 2-5: ADC Configuration

Audio (Analog and PCM)

The primary CF3 module's audio signals—analog and PCM (digital)—connect via an analog switch to the mangOH Green's 3.5 mm analog audio jack as shown in Figure 2-6.

The audio interface configuration can be modified as described in Table 2-3.

Table 2-3: Audio Interface Configuration Changes

Change type	Change effect	Method	Change duration
Software	Mux1—Use default or alternate configuration.	API command	Modifies running configuration until device reboots or another change is made.
Hardware	Mux1—Use default or alternate configuration	Set resistor on Mux1: • Low—Default • High—Alternate	Selected configuration used every time device boots up.

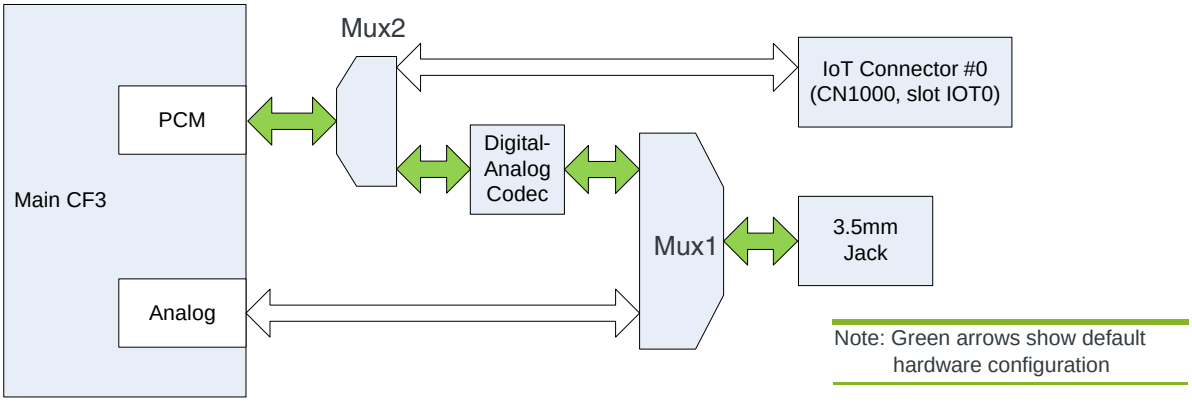

Figure 2-6: Audio Configuration

Primary CF3 GPIOs

The mangOH Green connects a subset of the GPIOs defined in the CF3 specification, as shown in Figure 2-7 (it does not connect to any other GPIOs defined in the CF3 specification):

- Each GPIO signal passes through a debug connector.
  By default, the debug connectors (CN601, CN602) are not installed. To use them, you must solder on appropriate connectors. For location and details, see the mangOH Green schematics at mangoh.io.
- Twelve GPIOs connect to IoT slots (four for each slot)
- One GPIO (GPIO2) is connected to the NINT (active low interrupt) output signal from a GPIO expander (U906). To enable this signal a jumper must be placed on CN900.

Note: The mangOH Green uses GPIO expanders for additional I/O functions. See GPIO Expanders on page 21.

The CF3 GPIO configuration can be modified as described in Table 2-4.

Table 2-4: CF3 GPIO Interface Configuration Changes

Change type	Change effect	Method	Change duration
Jumper	• Off—Connect GPIO2 to GPIO expander NINT signal • Off—Not connected	Install a jumper on CN900 to connect GPIO2 to NINT	Remains in effect until jumper is added or removed.

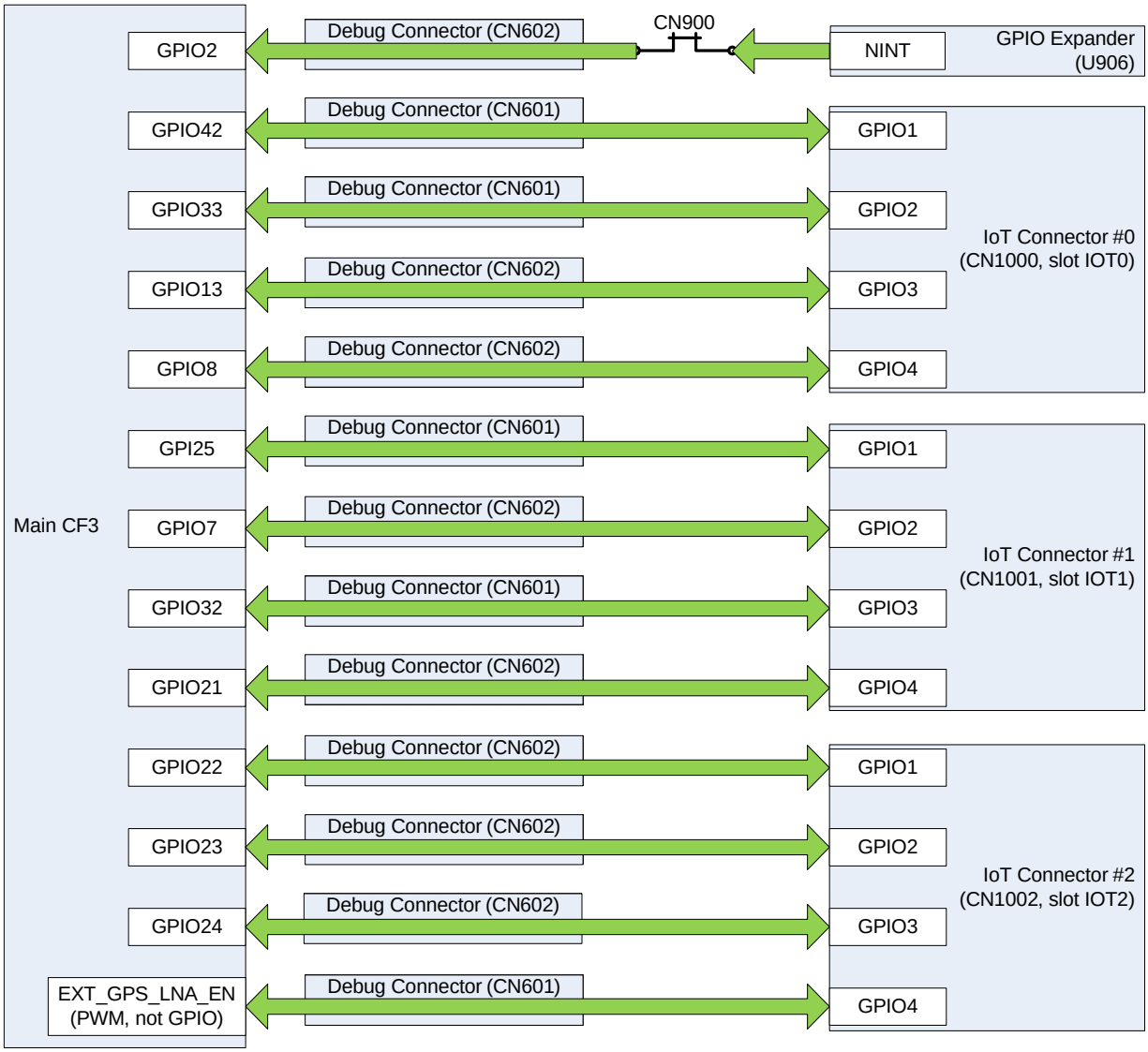

Figure 2-7: GPIO Configuration

Note: CF3 pin 43 (EXT_GPS_LNA_EN) is not currently available for use by IoT Expansion Card #2.

GPIO Expanders

The mangOH Green includes three SX1509 16/32 GPIO/PWM expanders, as detailed in Table 2-5. These provide additional GPIOs (over the primary CF3 module's I2C1 interface) used for internal I/O functions such as driving LEDs, resetting board components, etc.

For detailed specifications, see the mangOH Green schematics at mangoh.io.

Table 2-5: GPIO Expander Signals

Desig	GPIO	Pin	Signal Name	Purpose
U903	I/O_0	27	ARDUINO_RESET_Level shift	Arduino-compatible circuit reset (connected to reset button (SW1500)
	I/O_1	28	BattChrgr_PG_N	Indicate 'power good' from battery charger
	I/O_2	1	BattGauge_GPIO	Query battery charge level
	I/O_3	2	LED_ON	Set HIGH to disable LEDs on-board (see U702 on schematic)
	I/O_4	5	ATmega_reset_GPIO	Arduino-compatible circuit reset (via system reset)
	I/O_5	6	connect_to_AV_LED	Input from onboard function button used to connect to AirVantage server
	I/O_6	7	PCM_ANALOG_SELECT	S/W control (via API) to select either digital or analog audio for primary CF3
	I/O_7	8	connect_to_AV_LED	LED to indicate AirVantage connection
	I/O_8	13	Board_rev_res1	User-configurable
	I/O_9	14	Board_rev_res2	User-configurable
	I/O_10	15	UART_EXP1_ENn	UART multiplexer control (internal)
	I/O_11	16	UART_EXP1_IN	UART multiplexer control (internal)
	I/O_12	17	UART_EXP2_IN	UART multiplexer control (internal)
	I/O_13	20	SDIO_SEL	SDIO multiplexer control (internal)
	I/O_14	21	SPI_EXP1_ENn	SPI multiplexer control (internal)
	I/O_15	22	SPI_EXP1_IN	SPI multiplexer control (internal)

Table 2-5: GPIO Expander Signals (Continued)

Desig	GPIO	Pin	Signal Name	Purpose
U906	I/O_0	27	GPIOEXP_INT1	Interrupt input from other GPIO expander (internal)
	I/O_1	28	Battery_detect	Input that indicates whether a battery is connected to the mangOH Green
	I/O_2	1	GPIO_SCF3_RESET	Reset Secondary CF3
	I/O_3	2	LED_CARD_DETECT_IOT0	Input that indicates when IoT Expansion Card is in slot IOT0
	I/O_4	5	LED_CARD_DETECT_IOT1	Input that indicates when IoT Expansion Card is in slot IOT1
	I/O_5	6	LED_CARD_DETECT_IOT2	Input that indicates when IoT Expansion Card is in slot IOT2
	I/O_6	7	UIM2_PWM_SELECT	SIM cards multiplexer (internal)
	I/O_7	8	UIM2_M2_S_SELECT	SIM cards multiplexer (internal)
	I/O_8	13	TP900	Test point
	I/O_9	14	SENSOR_INT1	Interrupt from accel sensor (internal)
	I/O_10	15	SENSOT_INT2	Interrupt from accel sensor (internal)
	I/O_11	16	CARD_DETECT_IOT0	Indicates IoT Expansion Card is in slot IOT0
	I/O_12	17	CARD_DETECT_IOT2	Indicates IoT Expansion Card is in slot IOT2
	I/O_13	20	CARD_DETECT_IOT1	Indicates IoT Expansion Card is in slot IOT1
	I/O_14	21	GPIOEXP_INT3	Interrupt input from other GPIO expander (internal)
	I/O_15	22	BattChrgr_INT_N	Interrupt line from battery charger (internal)
U909	I/O_0	27	USB_HUB_INTn	Interrupt line from USB hub (internal)
	I/O_1	28	HUB_CONNECT	HUB connect signal (internal)
	I/O_2	1	GPIO_IOT2_RESET	Send reset signal to IoT Expansion Card in slot IOT2
	I/O_3	2	GPIO_IOT1_RESET	Send reset signal to IoT Expansion Card in slot IOT1
	I/O_4	5	GPIO_IOT0_RESET	Send reset signal to IoT Expansion Card in slot IOT0
	I/O_5	6	TP901	Test point
	I/O_6	7	TP902	Test point
	I/O_7	8	TP903	Test point
	I/O_8	13	UART_EXP2_ENn	UART multiplexer control (internal)
	I/O_9	14	PCM_EXP1_ENn	PCM multiplexer control (internal)
	I/O_10	15	PCM_EXP1_SEL	PCM multiplexer control (internal)
	I/O_11	16	ARD_FTDI	CF3 to Arduino-compatible circuit serial port transceiver reset
	I/O_12	17	TP904	Test point
	I/O_13	20	TP905	Test point
	I/O_14	21	TP906	Test point
	I/O_15	22	RS232_Enable	Enable/disable console port (DB9 connector)

HSIC (USB/Ethernet)

The primary CF3 module's HSIC signal connects through a pair of hub controllers to the following sources, as shown in Figure 2-8:

- USB1—Connects via a USB–UART FTDI (bridge) to the Arduino-compatible circuit's ATmega32U4 UART signal
- USB2—Connects to the secondary CF3 module's USB2.0 CLIENT
- USB3— Connects to a USB Hub controller for:
  - USB4—IoT Connector 0 (CN1000)—Connects to USB signal
  - USB5—IoT Connector 1 (CN1001)—Connects to USB signal
  - USB6—IoT Connector 2 (CN1002)—Connects to USB signal
  - USB7—USB Host connector (CN327)
  - RJ45 (Ethernet) connector (CN1100)

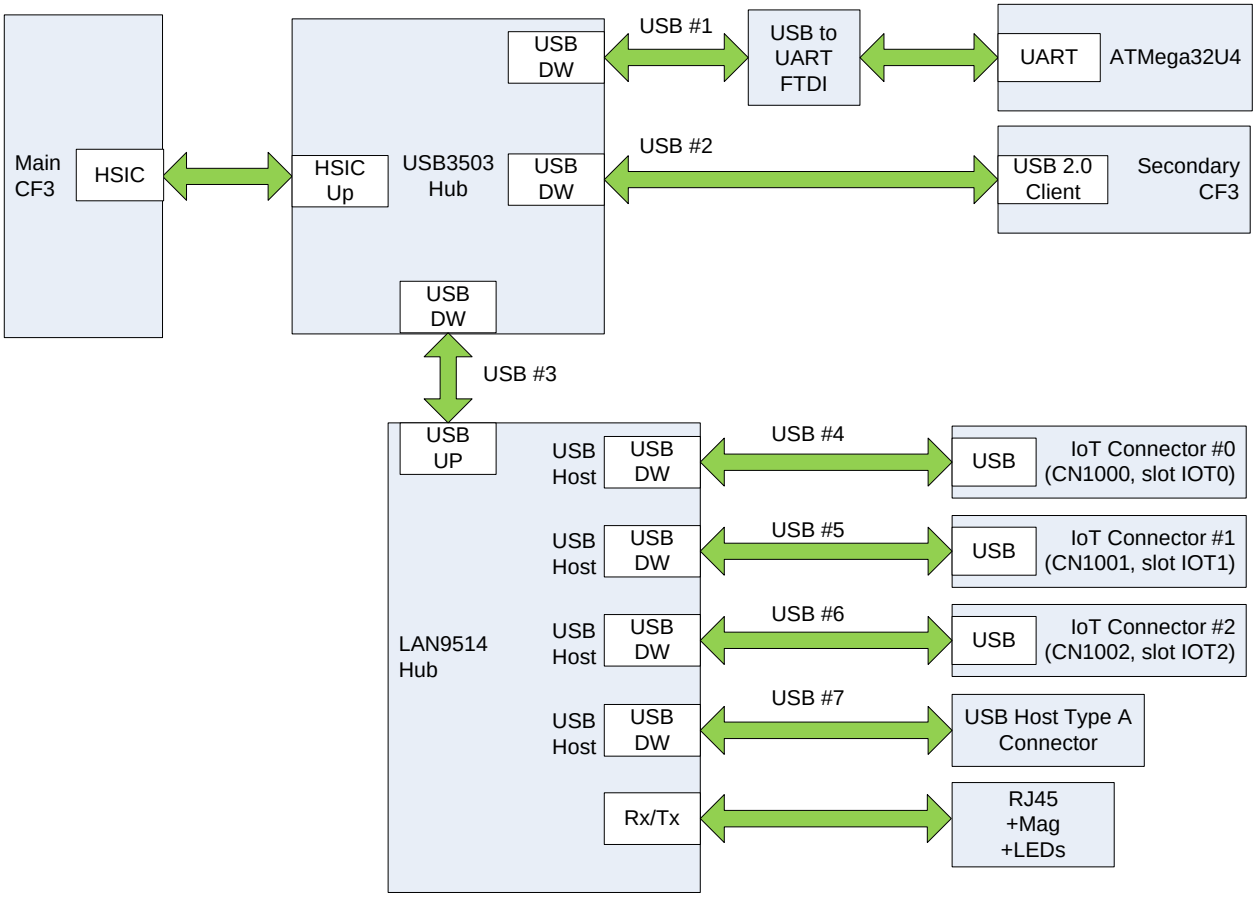

Figure 2-8: HSIC Configuration

I2C1

The primary CF3 module's I2C1 signal connects to a hub that expands to the following sources, as shown in Figure 2-9:

- GPIO/PWM expanders—Used internally on the mangOH Green for I/O functions such as driving LEDs, resetting board components, etc. For detailed information, refer to mangOH Green schematics available at mangoh.io.
- Accelerometer/Gyroscope—Accessible via API commands.
- Battery gauge—Accessible via API commands.
- Battery charger—Accessible via API commands.
- IoT Connector 0 (CN1000)
- IoT Connector 1 (CN1001)
- IoT Connector 2 (CN1002)
- Audio codec (U501)

All signal sources are enabled by default.

Note: The mangOH Green I2C interface operates in a single-master/multi-slave setup.

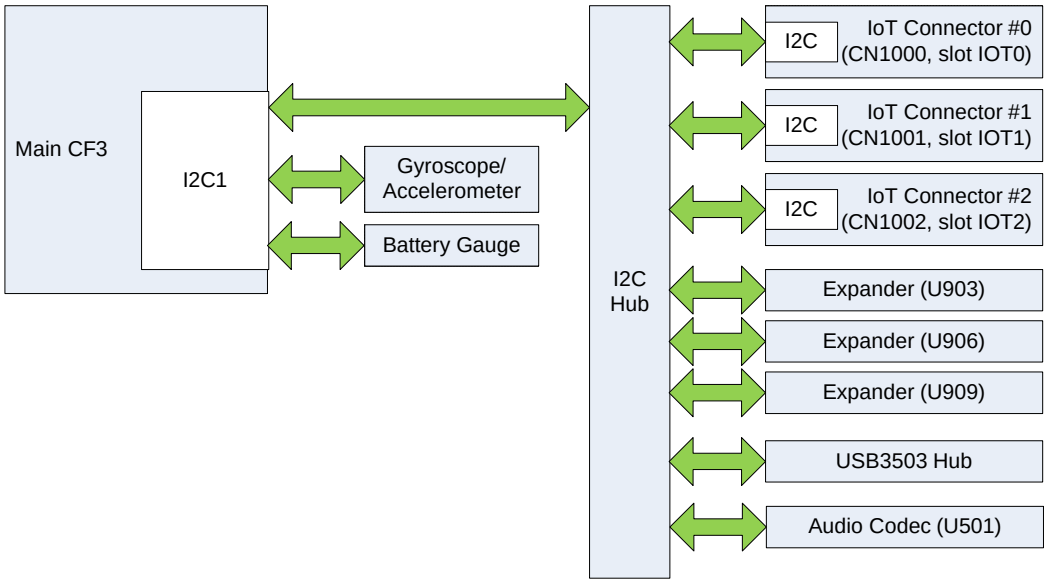

Figure 2-9: I2C1 Configuration

RF

The primary CF3 module's RF signals (RF_MAIN, RF_GPS, RF_DIV) connect directly to the following u.FL connectors on the mangOH Green:

- RF_MAIN—CN307
- RF_GPS—CN306
- RF_DIV—CN304

Power for these signals can be enabled/disabled as described in Table 2-6.

Table 2-6: CF3 GPIO Interface Configuration Changes

Change type	Change effect	Method	Change duration
Hardware	Enable/disable RF power for primary CF3 module	Set SW401 switch 3 (W_DISABLE_N): • OFF—Enable RF power (Default configuration) • ON—Disable RF power	Until switch position changes

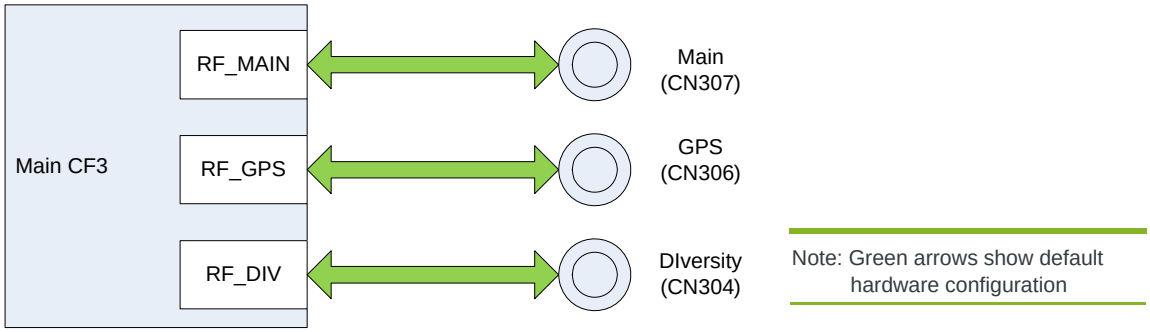

Figure 2-10: Primary CF3 module RF Connections

SDIO

The primary CF3 module's SDIO signal connects via a MUX to one of the following sources, as shown in Figure 2-11:

- microSD holder (CN802)—Default configuration
- IOT Connector 0 (CN1000)

The SDIO interface configuration can be modified as detailed in Table 2-7.

Table 2-7: SDIO Interface Configuration Changes

Change type	Change effect	Method	Change duration
Software	• Use default or alternate configu-ration.	API command	Selected configuration used every time device boots up.
Hardware	• Jumper off—Use uSD holder • Jumper on—Use IOT Connector #0	Place or remove jumper on CN902 to select configuration.	Selected configuration used every time device boots up.

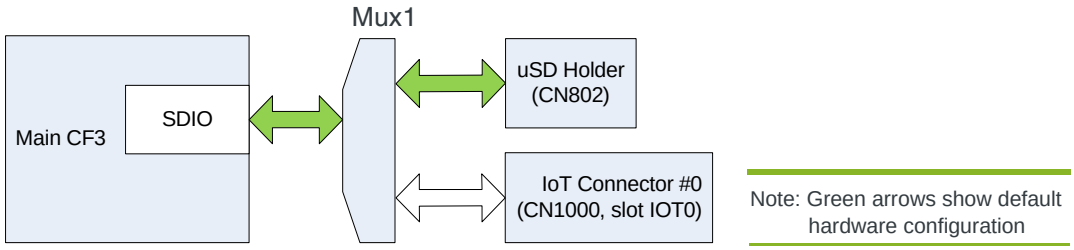

Figure 2-11: SDIO Configuration

SPI1

The primary CF3 module's SPI1 signal connects via a MUX to one of the following sources, as shown in Figure 2-12:

- IOT Connector 0 (CN1000)—Default configuration
- IOT Connector 1 (CN1001)

The SPI1 interface configuration can be modified as detailed in Table 2-8.

Table 2-8: SPI1 Interface Configuration Changes

Change type	Change effect	Method	Change duration
Software	Mux1—Use default or alternate configuration.	API command	Modifies running configuration until device reboots or another change is made.
Hardware	Mux1—Use default or alternate configuration	Set resistor on Mux1: • Low—Alternate • High—Default	Selected configuration used every time device boots up.

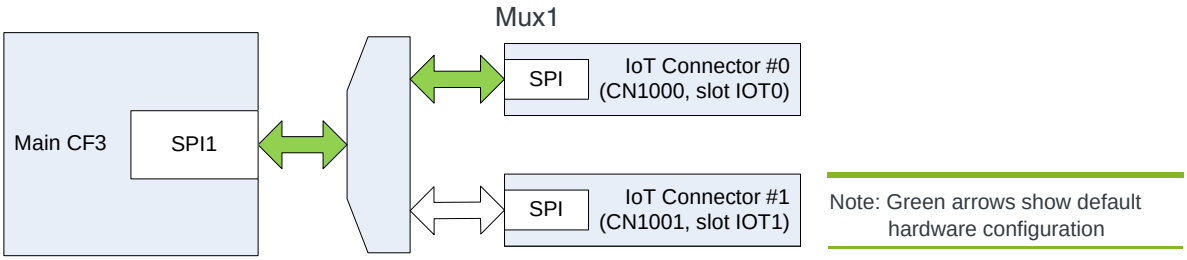

Figure 2-12: SPI1 Configuration

SPI2

The primary CF3 module's SPI2 signal connects directly to the mangOH Green's IoT Connector 2 (CN1002) as shown in Figure 2-13.

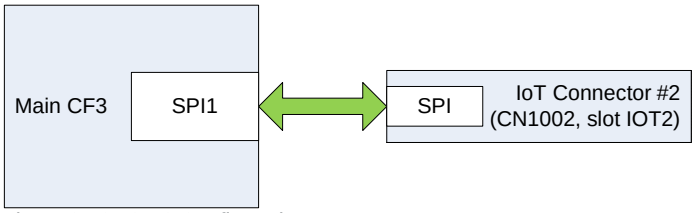

Figure 2-13: SPI2 Configuration

UART1

The primary CF3 module's UART1 signal connects through MUXes to one of the following sources, as shown in Figure 2-14:

- IoT Connector 0 (CN1000)—Default configuration
- IoT Connector 1 (CN1001)
- ATMega32U4 (U1500)

The UART1 interface configuration can be modified as detailed in Table 2-9.

Table 2-9: UART1 Interface Configuration Changes

Change type	Change effect	Method	Change duration
Software	• Mux1—Use default or alternate configuration. • Mux2—Use default or alternate configuration.	API command	Modifies running configuration until device reboots or another change is made.

Table 2-9: UART1 Interface Configuration Changes (Continued)

Change type	Change effect	Method	Change duration
Hardware	Mux1—Use default or alternate configuration	Set resistor on Mux1: • Low—Default • High—Alternate	Selected configuration used every time device boots up.
		SW401 Dipswitch 6 (UART_CTRL) • ON—IoT Connector • OFF—ATMega32U4	Selected configuration used until switch position changes.
	Mux2—Use default or alternate configuration	Set resistor on Mux2: • Low—Alternate • High—Default	Selected configuration used every time device boots up.

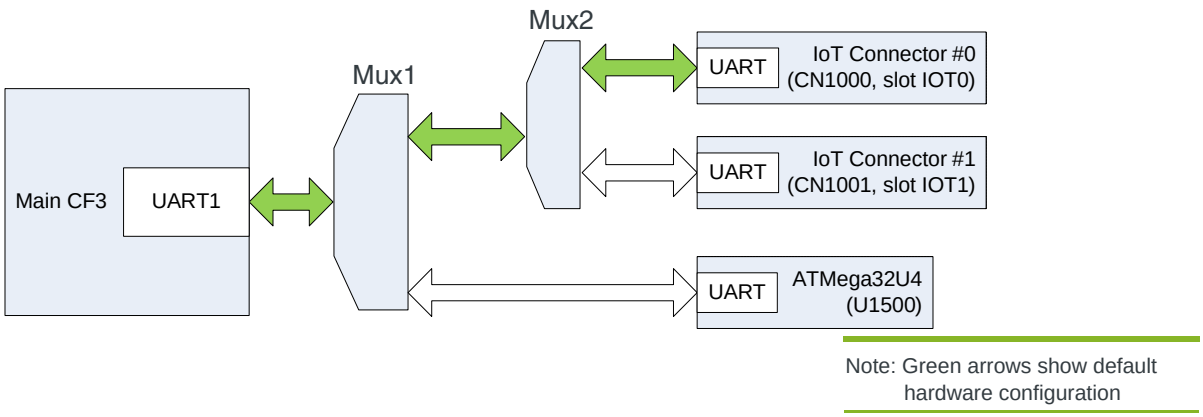

Figure 2-14: UART1 Configuration

UART2

The primary CF3 module's UART2 signal connects via a MUX to one of the following sources, as shown in Figure 2-15:

- RS-232 DB9 serial connector (CN700)—Default configuration
- IoT Connector 2 (CN1002)

The UART2 interface configuration can be modified as detailed in Table 2-10.

Table 2-10: UART2 Interface Configuration Changes

Change type	Change effect	Method	Change duration
Software	Mux1—Use default or alternate configuration.	API command	Modifies running configuration until device reboots or another change is made.
Hardware	Mux1—Use default or alternate configuration	Set resistor on Mux1: • Low—Default • High—Alternate	Selected configuration used every time device boots up.

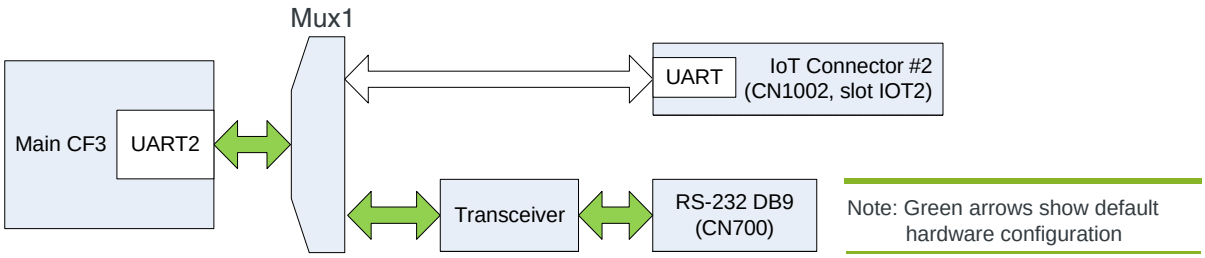

Figure 2-15: UART2 Configuration

UIM Signals

The mangOH Green implements both UIM interfaces (UIM1, UIM2) defined by the CF3 specification. Figure 2-16 shows the default configuration used when the board boots.

Note: Throughout this document, 'UIM' is used to refer to UIM, USIM, SIM, UICC.

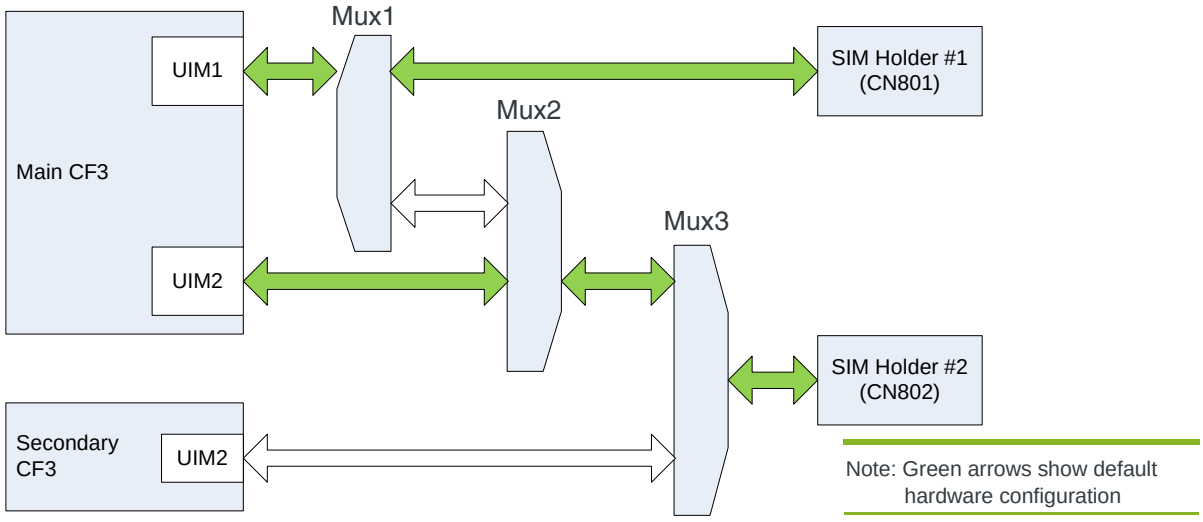

Figure 2-16: SIM Interfaces Configuration

The UIM interface configuration can be modified as detailed in Table 2-11.

Table 2-11: UIM Interface Configuration Changes

Change type	Change effect	Method	Change duration
Software	• Mux2—Use default or alternate configuration. • Mux3—Use default or alternate configuration.	API command	Modifies running configuration until device reboots or another change is made.
Hardware	Mux1, Mux2, Mux3—Use default or alternate configuration	Set resistor on Mux: • Low—Default • High—Alternate	Selected configuration used every time device boots up.

UIM1

The primary CF3 module's UIM1 signal connects through multiplexers (as shown in Figure 2-16) to:

- mini-SIM holder (CN801)—Default connection
- micro-SIM holder (CN802)

Note: The primary CF3 module's UIM1_DET signal will indicate when a SIM is present in the holder.

To switch the connected component, see Table 2-11.

UIM2

The primary CF3 module's UIM2 signal connects through multiplexers (as shown in Figure 2-16) to:

- micro-SIM holder (CN802)—Default connection

  Note: If CN802 has been connected to the secondary CF3 module's UIM2 signal, then the primary CF3 module's UIM2 is unused.

Note: The primary CF3 module's UIM2_DET signal must be triggered using SW401 switch_4 to indicate when a SIM is present in the holder. Set switch 4 to:

- *OFF—Indicate that a SIM is in the holder (Default setting)*
- *ON—Indicate that the holder is empty*

To switch the connected component, see Table 2-11.

USB 2.0

The primary CF3 module's USB signal connects directly to the mangOH Green's micro-USB connector (CN311) as shown in Figure 2-17, for control by a connected computer.

Note: The micro-USB connector also acts as a power source, if selected. See Power Management on page 37.

The USB 2.0 interface configuration can be modified as detailed in Table 2-12.

Table 2-12: USB 2.0 Interface Configuration Changes

Change type	Change effect	Method	Change duration
Hardware	• Jumper on pins closest to DC jack—Select DC Power • Jumper on pins furthest from DC jack—Select USB Power • Jumper off—Use battery if connected, otherwise no power supplied	Position jumper on CN1204 to choose DC or USB power. *Note: mangOH Green ships with DC power selected (jumper on pins closes to DC jack).*	mangOH Green uses the selected power supply until the jumper changes.

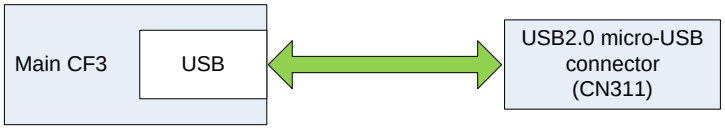

Figure 2-17: USB_2.0 Configuration

Secondary CF3 Module Signals

This section describes how the secondary CF3 module's signals connect to the platform hardware described in mangOH Green Hardware Components on page 11.

Important: *CF3 module signal availability depends on the type of module used—some modules may not implement certain Extension signals from the CF3 specification.*

RF

The secondary CF3 module's RF signals (RF_MAIN, RF_GPS, RF_DIV) connect directly to the following u.FL connectors on the mangOH Green:

- RF_MAIN—CN309
- RF_GPS—CN310
- RF_DIV—CN308

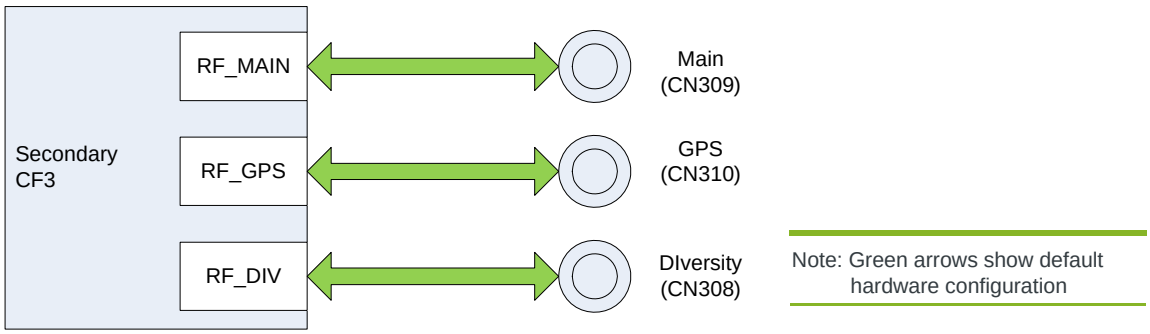

Figure 2-18: Secondary CF3 module RF Connections

UIM2

The secondary CF3 module's UIM2 signal connects through a multiplexer (as shown in Figure 2-16) to:

- micro-SIM holder (CN802)

Note: By default, this holder is connected to the primary CF3 module's UIM2 signal.

To switch the connected component, see Table 2-11.

USB 2.0

The secondary CF3 module's USB signal connects through a hub controller to the primary CF3 module's HSIC signal, as shown in Figure 2-8.

IoT Connector Interfaces

The mangOH Green provides three IoT Connectors (in slots IOT0, IOT1, and IOT2) that each support a set of the signals defined in the Project mangOH IoT Expansion Card Design Specification, as detailed in Table 2-2.

The default configurations (enabled signals) for the IoT Connectors are shown in Figure 2-19.

The IoT Connector interface configurations can be modified as detailed in Table 2-13.

Table 2-13: IoT Connector Interface Configuration Changes

Change type	Change effect	Method	Change duration
Software	Enable/disable identified signal(s) on a specific IoT Connector.	API command	Modifies running configuration until device reboots or another change is made.

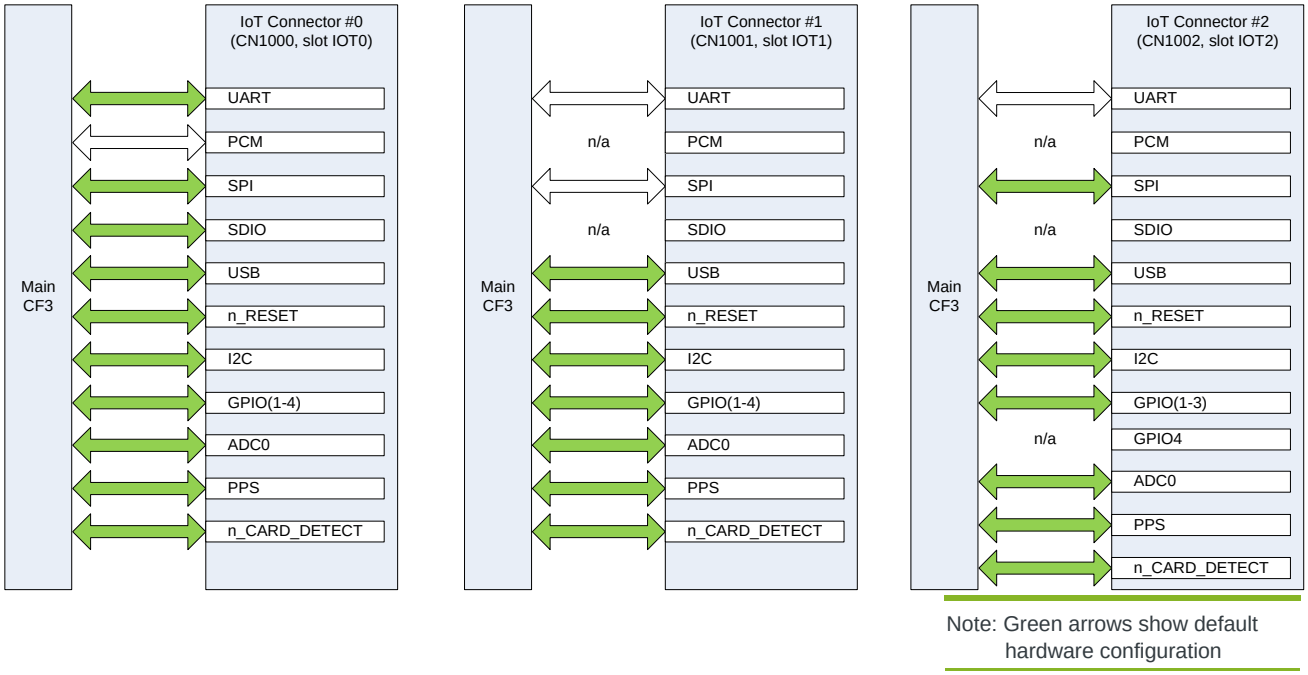

Figure 2-19: IoT Connector Configuration

Arduino-compatible Circuit Signals

The mangOH Green's integrated Arduino-compatible circuit is accessed via an on-board ATmega32U4 micro-controller (U1500):

- UART—The ATmega32U4's UART signal connects through a USB–UART FTDI (bridge) to the primary CF3 module's HSIC signal, as shown in Figure 2-8.
- USB—The ATmega32U4's USB signal connects directly to a mini-USB connector (CN330) for control by a connected computer.

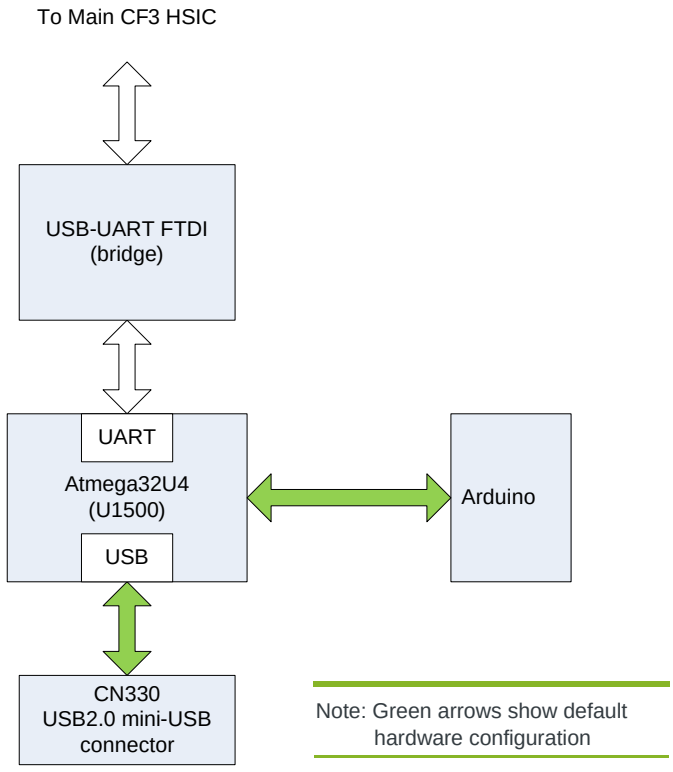

Figure 2-20: Arduino-compatible Circuit Signals

Reset Methods

The mangOH Green supports hardware and software resets of the entire board or certain parts of the board, as shown in Figure 2-21:

- Reset entire board, including the primary CF3 module, via the primary CF3 module's RESET_IN_N signal:
  - Hardware (manual)—Press the Reset button (SW400)).
  - Hardware (automatic)—When the low current detector is triggered.

  When the board resets, it stays in the reset state as long as low current is detected.
- Reset everything except the primary CF3 module:
  - Software—Use an API command to trigger GPIO6 (primary CF3 module pin 46), which connects to the mangOH Green's System_reset.
- Reset individual IoT Expansion Cards:
  - Software—Use an API command to trigger specific GPIO expander signals:
    - GPIO_IOT0_RESET—Reset IoT Expansion Card in slot IOT0.
    - GPIO_IOT1_RESET—Reset IoT Expansion Card in slot IOT1.
    - GPIO_IOT2_RESET—Reset IoT Expansion Card in slot IOT2.
- Reset the secondary CF3 module—use an API command to trigger the GPIO_SCF3_RESET expander signal, which connects to the secondary CF3 module's RESET_IN_N signal.

For detailed specifications showing how full or partial resets are enabled, see the mangOH Green schematics available at mangoh.io.

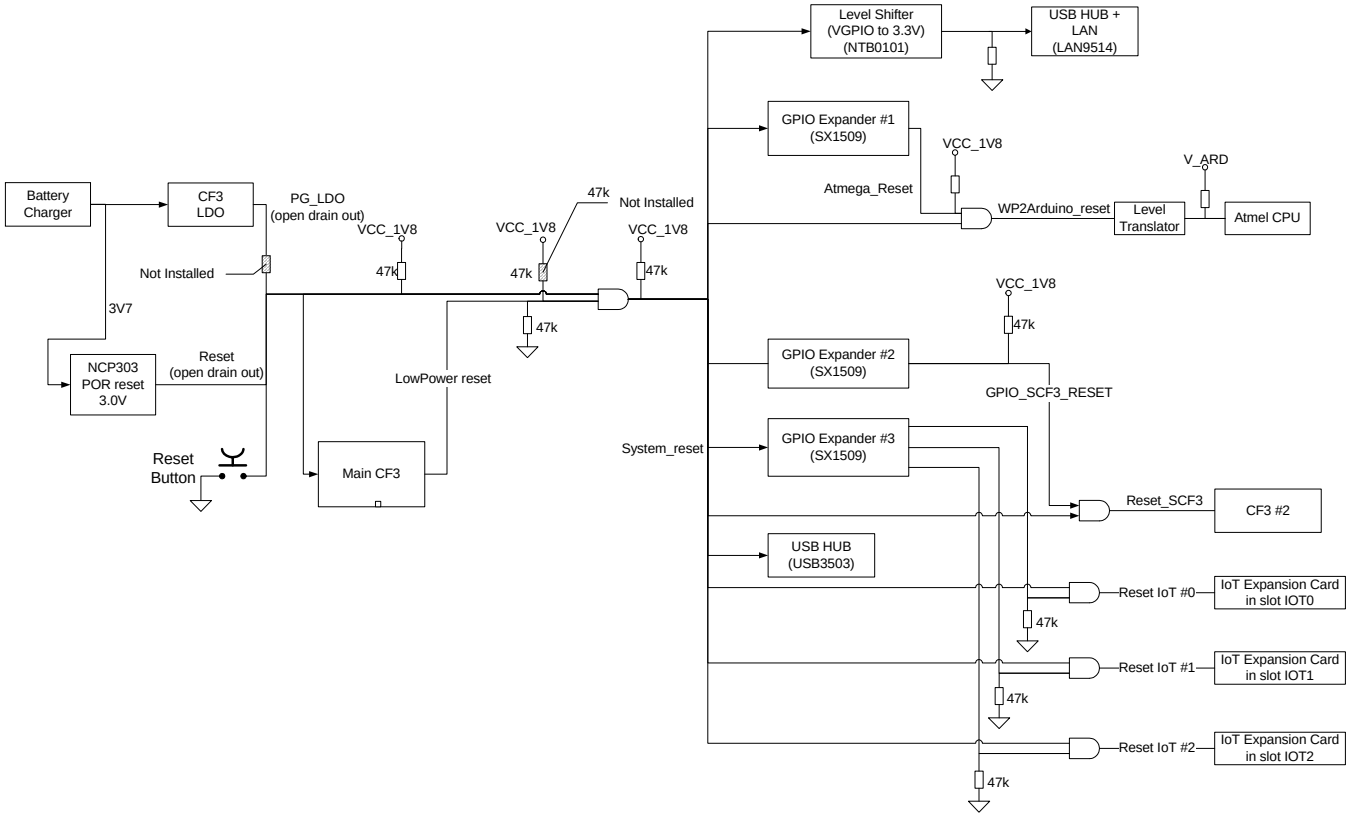

Figure 2-21: Reset Methods

Power Management

The mangOH Green has two primary power supplies (DC power and USB), and a rechargeable backup battery power supply option.

Figure 2-22 illustrates these power supplies, their voltage/current specifications, and how they supply various components on the mangOH Green platform.

A multi-function switch (SW401) controls some power-related features (see Multi-switch (SW401) on page 15), including:

- Switch 1—Enables/disables primary CF3 module's POWER_ON signal.
- Switch 5—Enables/disables secondary CF3 module's POWER_ON signal.
- Switch 8—Turns on/off power to everything except the primary CF3 module. Set the switch to ON to turn off the power.

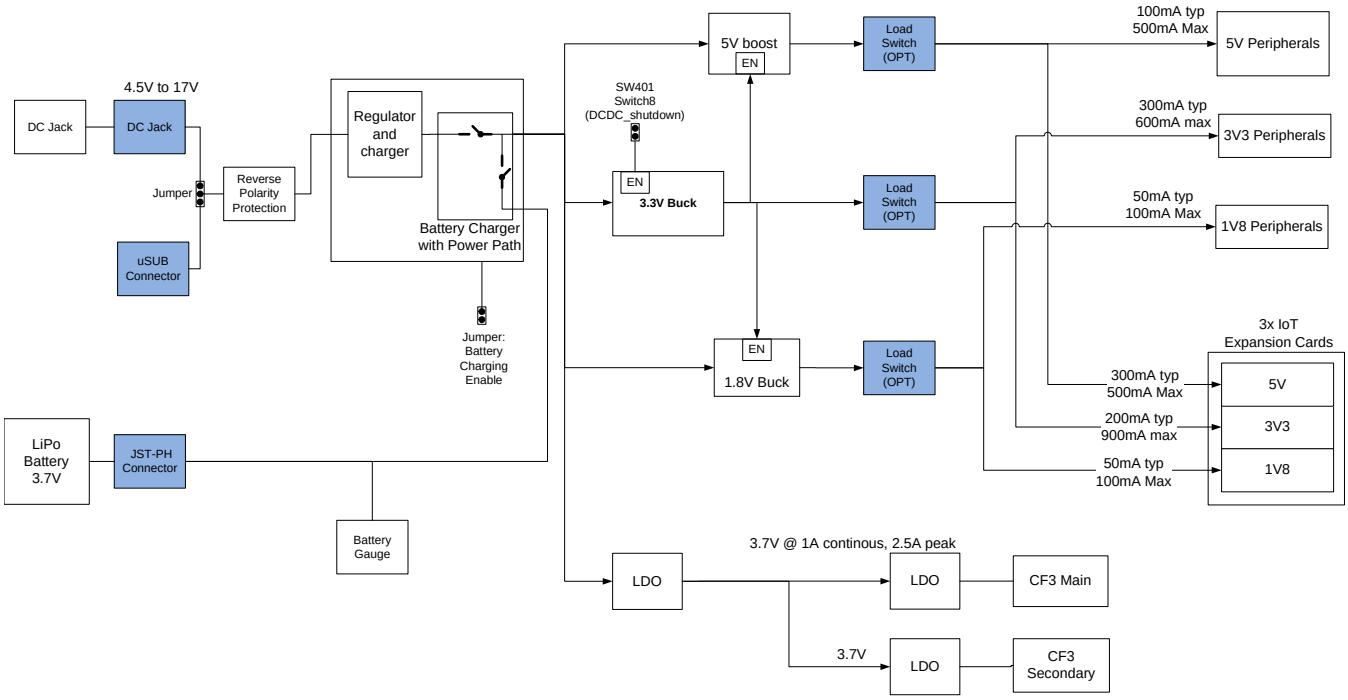

Figure 2-22: Power Management