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Catena 4801 User Manual

Engineering Report 234001157
Rev A
Date: 2019-08-29

PROPRIETARY NOTICE AND DISCLAIMER

Document Release History

Rev A	2019-08-29	Initial Release

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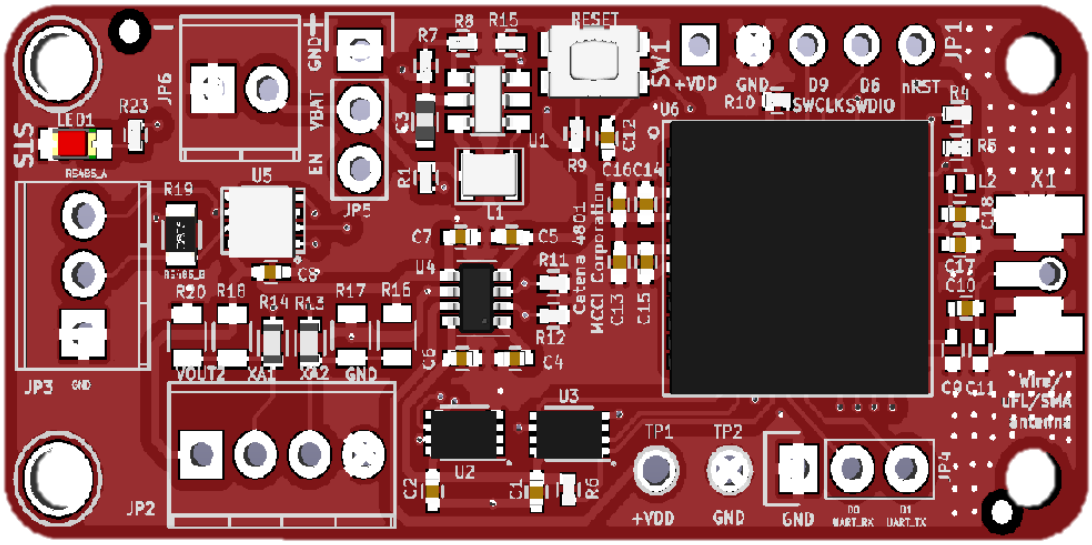
1 Introduction

The MCCI Catena® 4801 RS-485 Node for LoRaWAN™ technology networks is a complete open-source single-board IoT device that can monitor and control remote Modbus, M-Bus and other industrial devices.

Based on the Murata CMWX1ZZABZ-078, the Catena 4801 is a great platform for RS-485/Modbus based LoRaWAN investigation and deployment. It works well with The Things Network, or any LoRaWAN 1.02 or 1.1 network in the 865 to 923 MHz range.

As a Modbus controller, the Catena 4801 can control a large number of Modbus devices and communicate results via the LoRaWAN network, limited only by system memory and polling rate. As a Modbus device, the Catena 4801 can bridge an existing Modbus controller to the LoRaWAN network.

Figure 1 Catena 4801



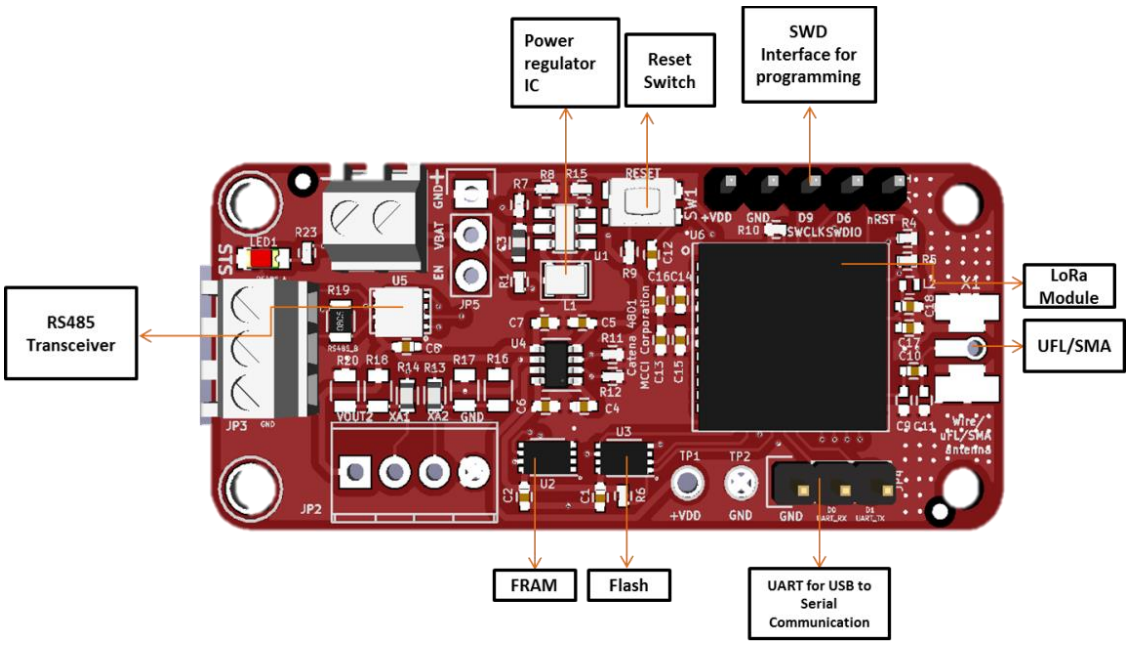
2 Specifications and Features

The specifications and features of Catena 4801 are given below:

Murata LoRaWAN module

- Semtech SX1276 LoRa radio
- STM32L082 CPU (Cortex M0+, 24 MHz, 192K flash, 20K RAM)
- High quality RF engineering
- Certified for US and EU
- Compatible with IN866, AS923, AU921 bands

Figure 2 Catena 4801 Description



2.1 Additional Features

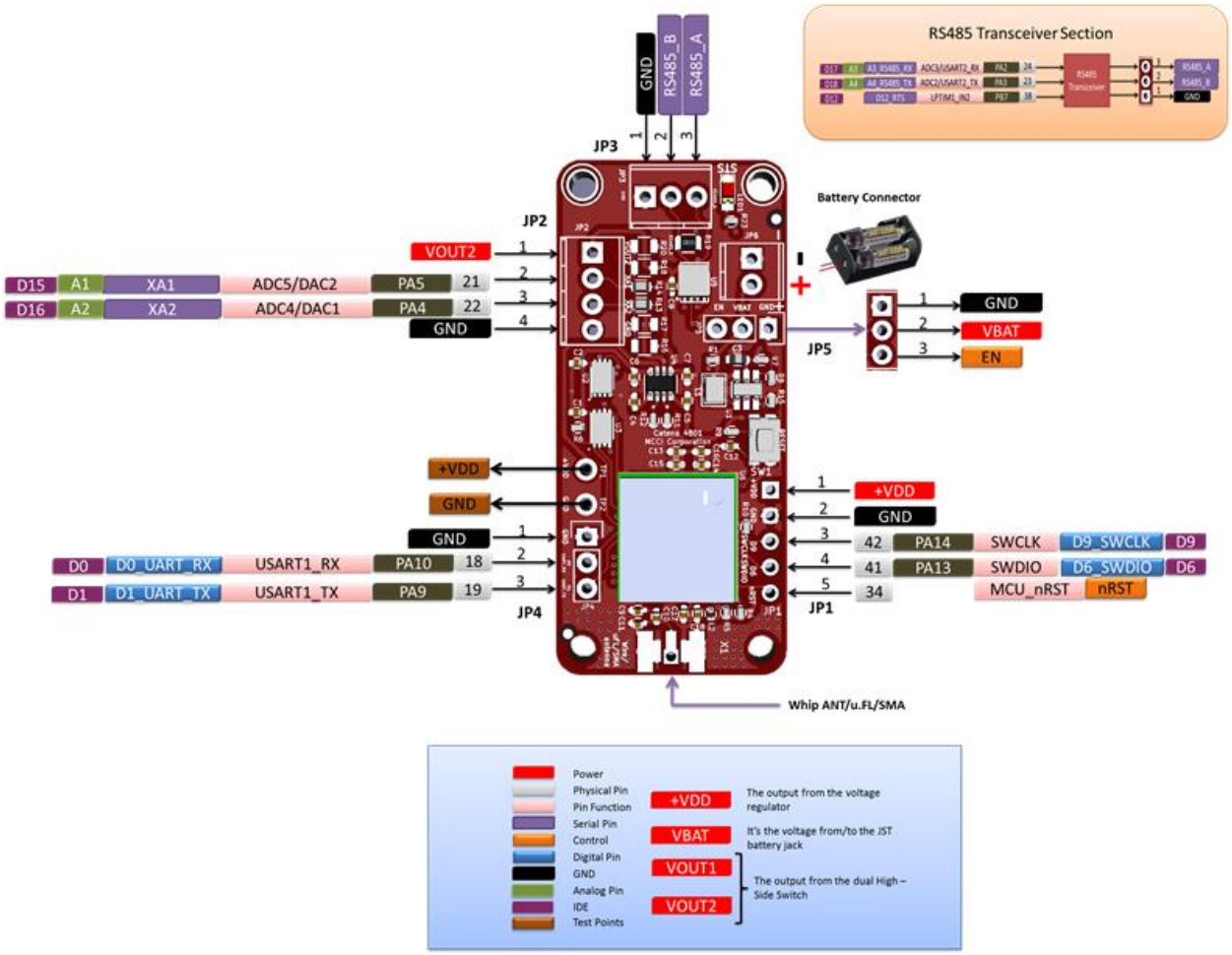
- RS-485 transceiver for connecting to Modbus, M-bus, or other RS-485 networks.
- Laid out to accept screw terminals for to field wiring to the RS-485 network, and for connecting to additional external sensors or providing local control (pulse, analog or digital).
- Processor-controlled power switches for the RS-485 transceiver, the external sensors, FRAM and flash ICs, allowing very low standby current.
- 8K bytes FRAM for LoRaWAN provisioning info and frame counters — power can be removed completely without requiring a new join to the network, and without losing uplink and downlink count values (required for LoRaWAN 1.1)
- 1M byte SPI Flash for bulk data storage, future FoTA firmware storage, etc.
- Switchable boost converter for powering from disposable batteries (such as 2x AAA cells) — input range 1.8V to 3.3V. Processor can disable boost converter when regulated 3.3V is not required, for additional power savings. (Note: in contrast to the Catena 4450 and Catena 4610, there is no charger in this model.)
- Standby current < 10 uA.
- SWD for download and debug
- UART port for provisioning and logging.
- Arduino-compatible
- Designed for use with The Things Network (open-source, user-owned IoT network based on LoRaWAN); but can be used with any LoRaWAN-compatible network
- Whip, u.FL, or SMA antenna
- Battery termination: rising cage screw terminals, 20 to 30 AWG.
- Size: 0.9″ x 2.0″ .

- Open source hardware and software (https://github.com/mcci-catena)
- Hardware is configured to support the Sigfox FSK stacks (however, Sigfox support has not been tested).
- ST Micro tools may also be used.

3 Catena 4801 Pinouts

Catena 4801 Pinout and the usage of each connector(JP) is given below:

Figure 3 Catena 4801 pinout



3.1 Programming Header (JP1)

JP1 has five pins (*+VDD, GND, SWCLK, SWDIO* and *nRST*), which are used for the purpose of programming. The pins in JP1 are compatible to ST-Link programmer.

3.2 External GPIO Terminal Header (JP2)

JP2 has two *GPIO* pins, with a power pin and GND. These pins can be used for the customized usage by the user.

3.3 RS485 Terminal Header (JP3)

JP3 is used for the RS-485 communication. It has three pins(*A, B* and *GND*).

3.4 Serial Header (JP4)

JP4 is used for the purpose of USART communication. It has three pins (*GND, USART1_RX* and *USART1_TX*).

3.5 Booster Enable Jumper (JP5)

JP5 has three pins (*EN, VBAT* and *GND*), used to enable booster when connecting *EN* with *VBAT*. By Default booster is OFF.EN pin is pull-down to ground.

3.6 Power source (JP6)

JP6 is used to power Catena 4801. It has two pins(*+VBAT* and *GND*). Should use 3 – 3.3V power supply.

4 Power Source

Any power source which provide 3V to 3.3V can be used to power Catena-4801.

In our application, We use 2 AAA battery cell with a battery holder. Red Wire of the battery to the Power Supply and the Black wire to the Ground

Figure 4 Battery

5 Antenna Options

Catena devices to communicate over network, any of the following three Antennas can be used.

- Whip Antenna
- u.FL
- SMA

Please specify the antenna requirement while placing the order. Contact MCCI for special variant.

5.1 Whip antenna

A whip antenna is an antenna consisting of a straight flexible wire or rod. The bottom end of the whip is connected to the radio receiver or transmitter. The antenna specifications are shown in Table 1

Figure 5 Whip Antenna

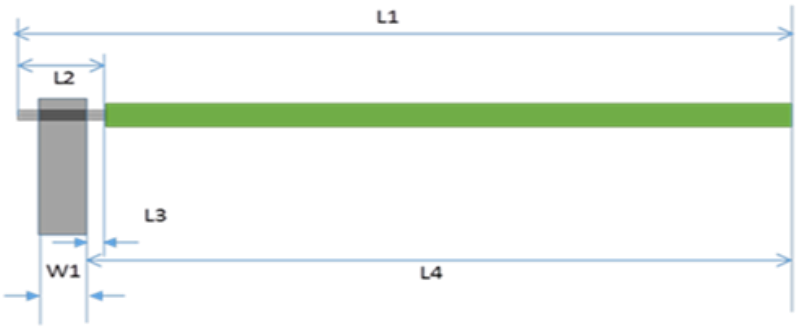


Figure 6 Catena 4801 with whip antenna

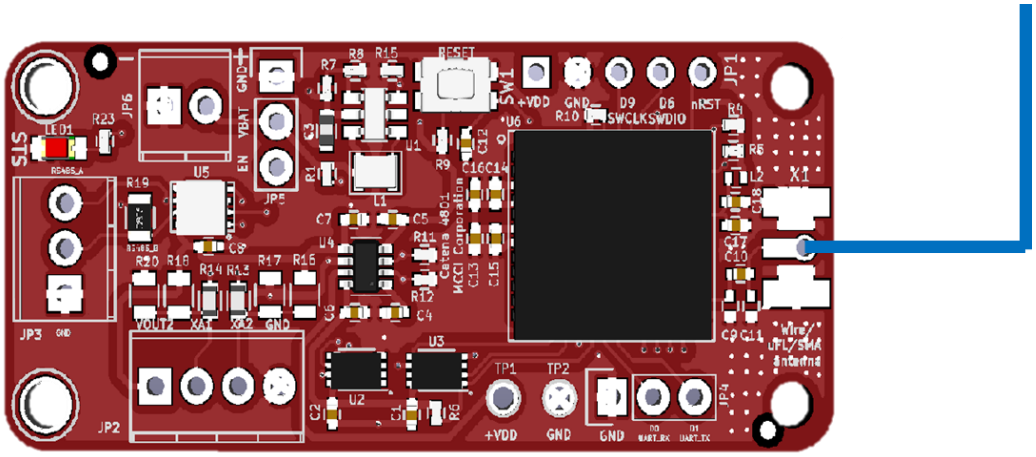


Table 1 Antenna Specification

Parameters	Reference	US Version	EU Version	IN Version	AU Version	AS Version
Wire Color		Yellow	Green	Blue	Yellow	Yellow
Reference Number		123001007	123001069	123001070	123001007	123001007
Wire length	L1	88.6	84.2	88.9	82	82
Tolerance	-	+/- 0.3 mm	+/- 0.3 mm	+/- 0.3 mm	+/- 0.3 mm	+/- 0.3 mm
Board thickness	W1	1.5748	1.5748	1.5748	1.5748	1.5748
Tin length	L2	3 mm	3 mm	3 mm	3 mm	3 mm
Tin tolerance	-	+/- 0.03 mm	+/- 0.03 mm	+/- 0.03 mm	+/- 0.03 mm	+/- 0.03 mm
Slop from soldering	L3	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm
Minimum length	-	80.9	80.9	85.6	80.9	80.9
Maximum length	-	82.9	82.9	86.6	82.9	82.9
Typical length	L4	81.9	81.9	87.6	81.9	81.9
Minimum f	-	903.83 MHz	903.83 MHz	855.33 MHz	915 MHz	920 MHz
Maximum f	-	928.80 MHz	928.80 MHz	875.87 MHz	928 MHz	925 MHz
Typical f	-	915 MHz	915 MHz	866 MHz	921 MHz	923 MHz

5.2 U.FL

If wants to use u.FL antenna, then have to install u.FL SMT Connector in the board as in Figure 9. Then connects the u.FL antenna to the board.

NOTE: User can also connect an SMA antenna with the help of u.FL/SMA adapter cable.

Figure 7 uFL antenna

Figure 8 uFL/SMA adapter cable

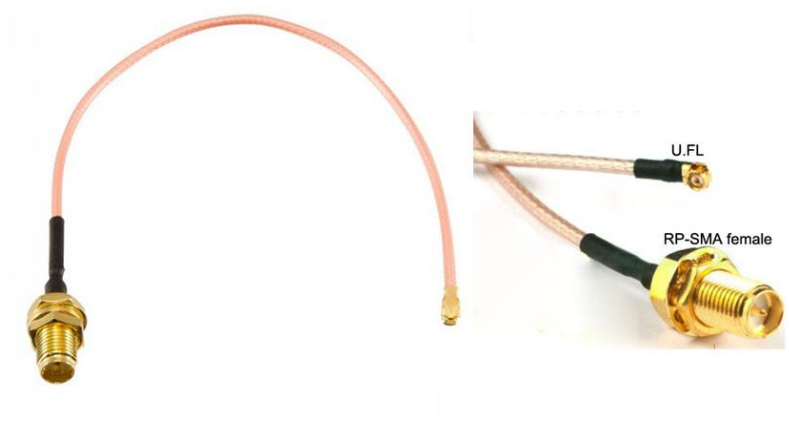
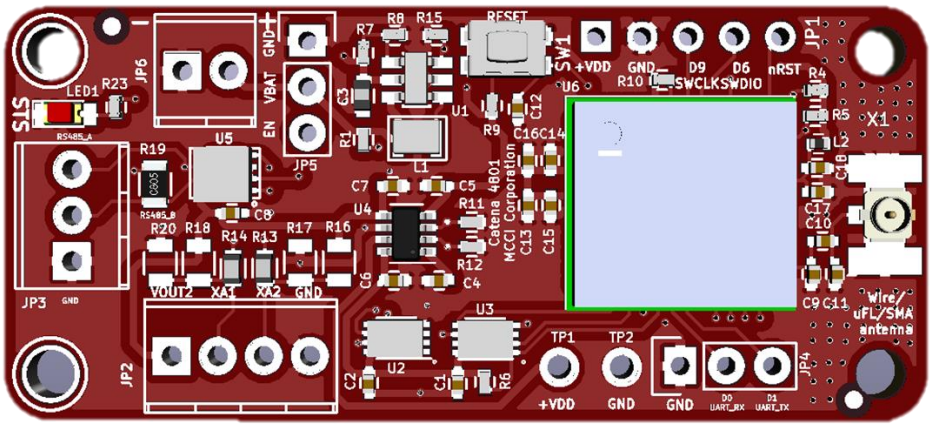


Figure 9 Catena 4801 with uFL connector

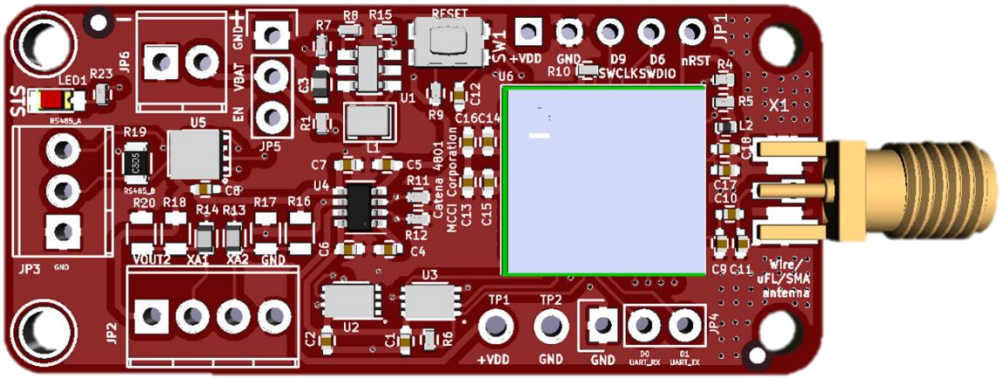


5.3 SMA

If the user wants to install an SMA connector to the Catena board to use SMA antenna. Then install the SMA connector as shown in Figure 11

Figure 10 SMA antenna

Figure 11 Catena 4801 with SMA connector



6 Additional Accessories

Catena 4801 can also have some of the optional accessories for their connectors to have easy interface.

6.1.1 1x03 Screw Terminals

1X03 screw terminal can be installed in JP3 to connect the board with RS485 module.

Figure 12 1X03 Screw Terminal

6.1.2 1x02 Screw Terminals

1X02 screw Terminalcan be installed in JP6 to connect the battery to the board to provide Power.

Figure 13 1X02 Screw Terminal

6.1.3 1X05 Pin Header

1X05 pin header can be installed in JP1 to program the board using ST Link.

Figure 14 1X05 Pin Header

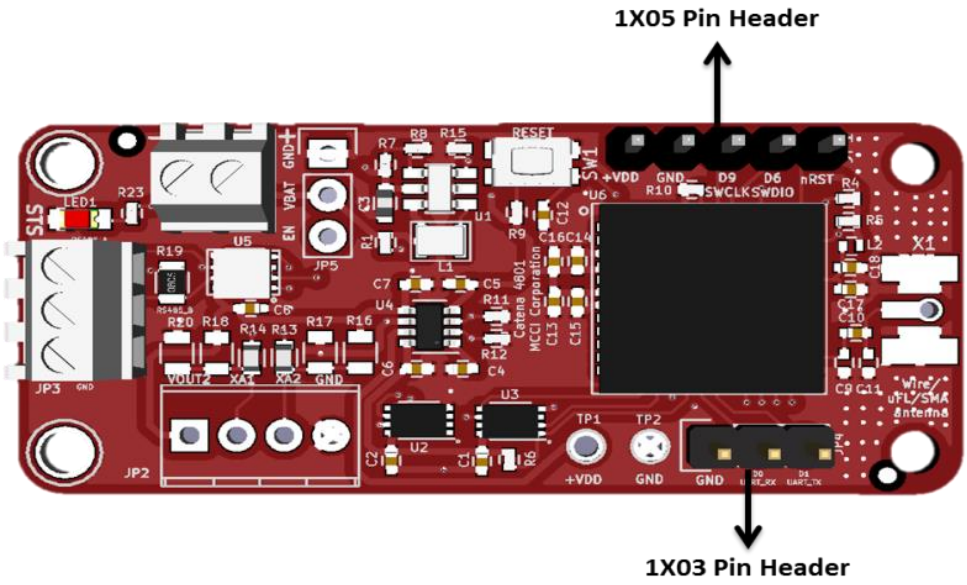
6.1.4 1X03 Pin Header

1X03 Pin headercan be installed in JP4 which is used for Serial communication.

Figure 15 1X03 Pin Header

7 Assembled Catena 4801

Figure 16 Assembled Catena 4801



8 Software support

MCCI provides a full Arduino board-support package, available here.

MCCI also provides libraries to allow rapid prototyping and experimenting, including an open-source LoRaWAN stack that supports the EU868, US915, AS923, AU921 and IN866 regional plans.

9 Arduino IDE Setup

- **Arduino IDE** for windows/linux/Mac can be downloaded from below link:
  - https://www.arduino.cc/en/Main/Software
  - Open the Arduino IDE. Go to File>Preferences>Settings. Add "*https://github.com/mcci-catena/arduino-boards/raw/master/BoardManagerFiles/package_mcci_index.json*" to the list in Additional Boards Manager URLs.
  - If you already have entries in that list, use a comma (,) to separate the entry you're adding from the entries that are already there.
  - Next, open the board manager. Tools->Board: Search for MCCI's BSPs
  - Install the latest BSP for MCCI Catena STM32 to add support for featured enhancements of Catena STM32 boards.
  - **MCCI Catena STM32 Boards** should be installed from the Boards Manager.

Figure 17 Selecting Boards Manager

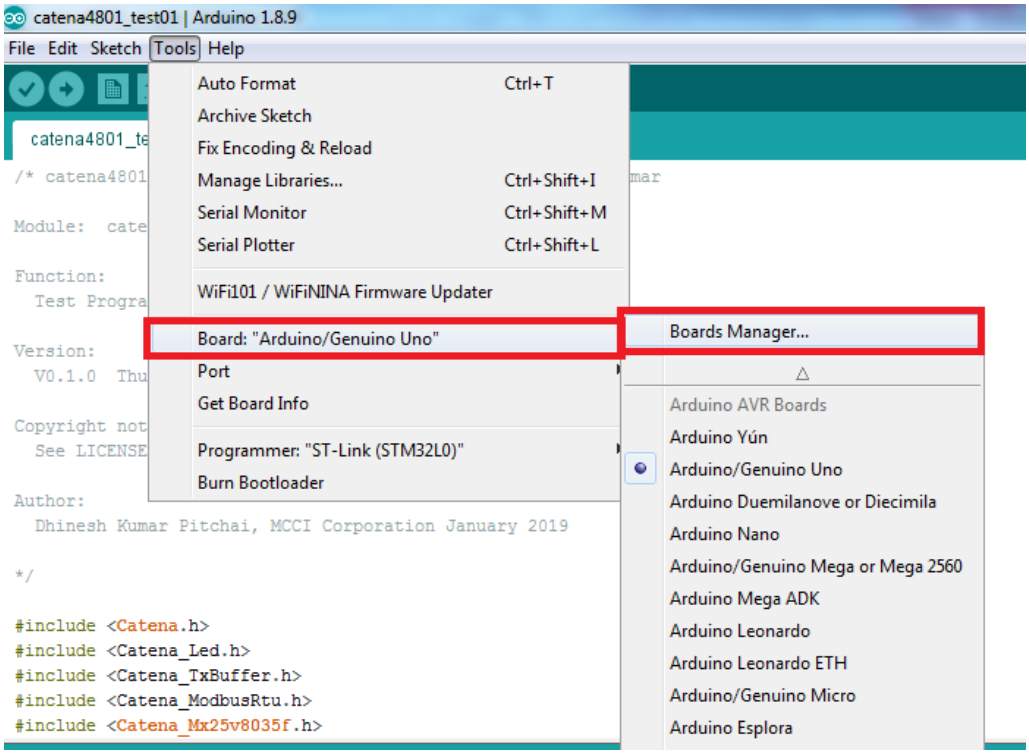
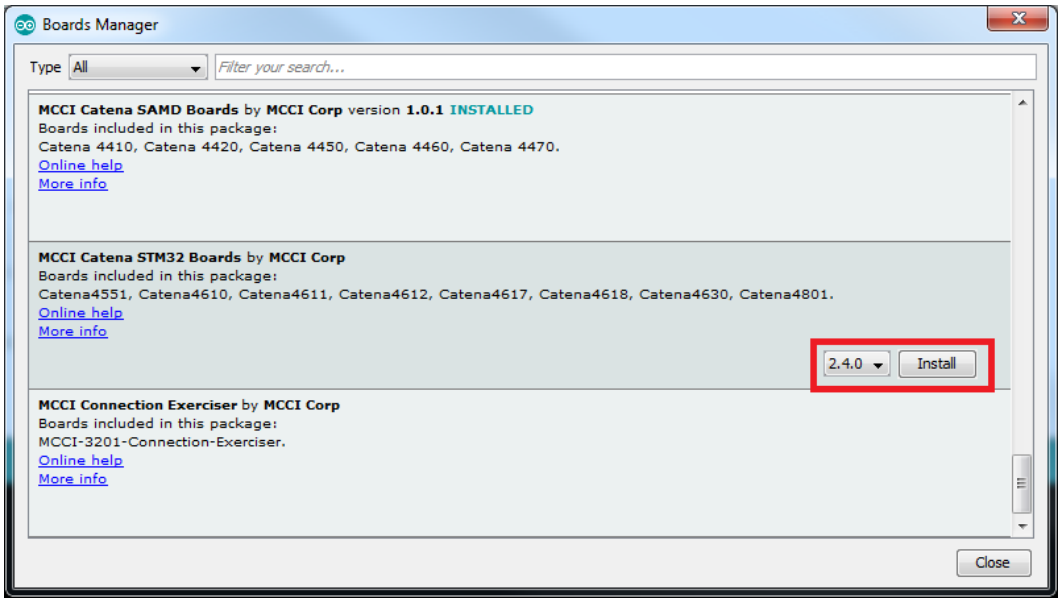
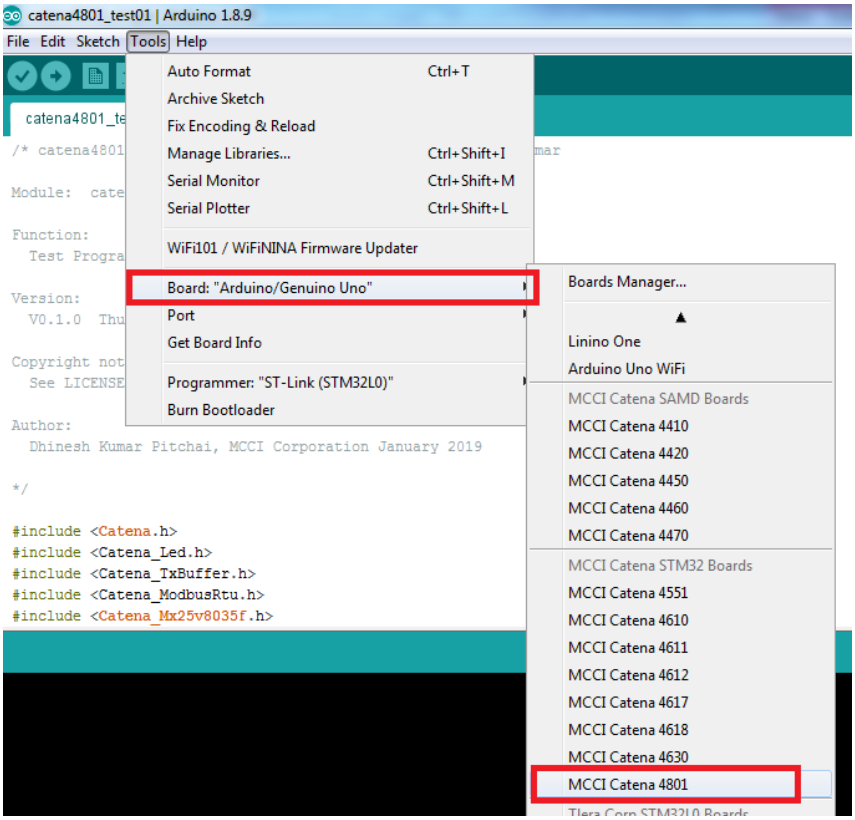


Figure 18 Installing the latest STM32 BSP



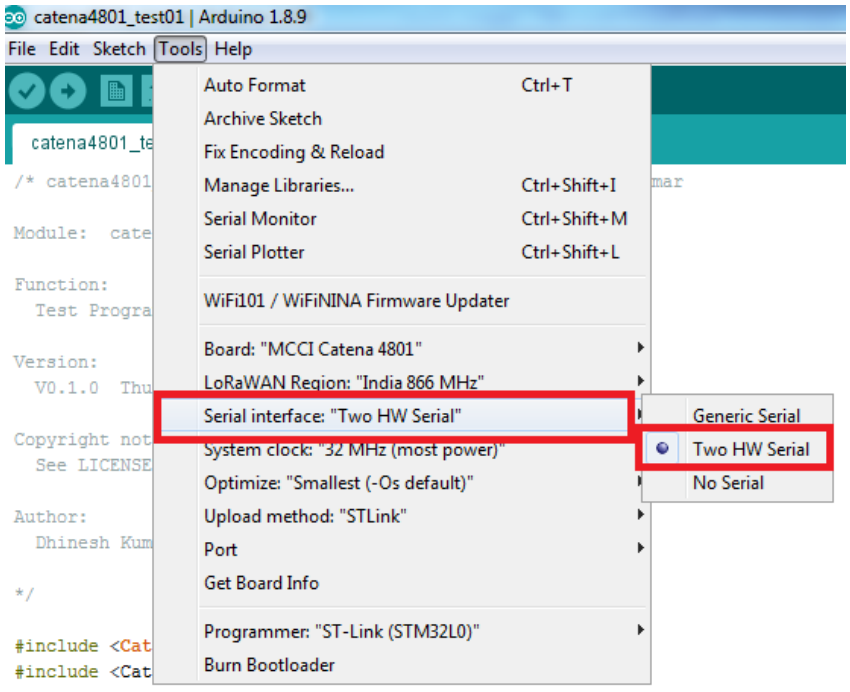
- Once the board has been installed**, Catena 4801** board has to be selected under **MCCI Catena STM32 Boards.**

Figure 19 Selection of board



- RS-485 module uses the second serial of Catena 4801. To use RS-485 in your application, select **Two HW Serial** in the **Serial interface** menu from the **Tools** tab.

Figure 20 Selecting the Serial Interface

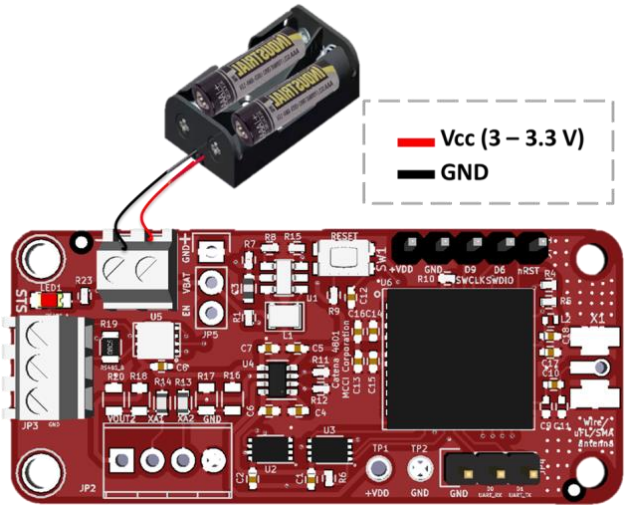


9.1 Catena 4801 Configuration

Catena 4801 configurations are described below with connections made during testing.

1. Connect the Battery or any power source to the JP6 of the board.

Figure 21 Catena 4801 with Battery



2. Catena 4801 with a Modbus device

Figure 22 Catena 4801 with RS485

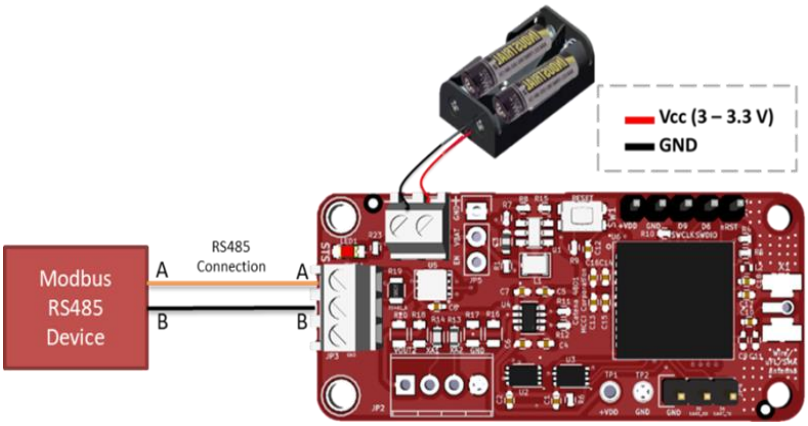


Table 2 Catena 4801 to RS485 Connection

RS485 connection	
Catena 4801 (JP3)	**Modbus device**
Terminal A	Terminal A
Terminal B	Terminal B

10 Programming Requirements

Catena 4801 requires ST-Link programmer for programming. For debugging and provisioning you might need a USB to serial converter also.

10.1 ST-LINK/V2 in-circuit debugger/programmer

The ST-LINK/V2 is an in-circuit debugger and programmer for the STM8 and STM32 microcontroller families. The single wire interface module (SWIM) and JTAG/serial wire debugging (SWD) interfaces are used to communicate with any STM8/STM32 microcontroller located on application board.

Figure 23 ST Link Programmer

10.1.1 ST Link Configuration

STLink Configuration is shown in Table 3.

Table 3 Catena4801 to STLink connection

ST-Link connection	
Catena 4801 (JP1)	**ST-Link**
GND	Pin 3
NRST	Pin 15
3.3V	Pin 1
SWCLK	Pin 9
SWDIO	Pin 7

Connect the pins of ST-Link debugger with Catena 4801 as mentioned in Table 3, for programming. The STLink programmer is to be connected with a PC. For Windows PC install the STLink debugger driver

10.2 USB to Serial Cable

USB to Serial Cable is used for debugging and provisioning the Catena.

Figure 24 USB to Serial Cable

Catena 4801 Serial connection – USB to Serial Cable TTL-232R-RPI has been used for Serial monitor.

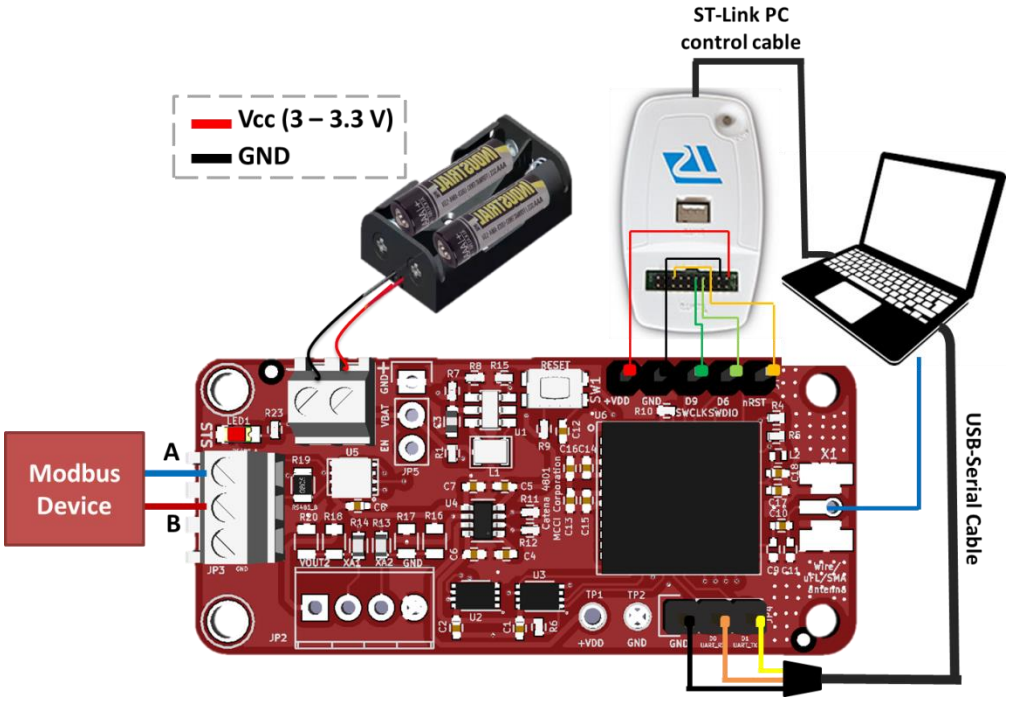
Table 4 USB to Serial Connection

Catena 4801 (JP4)	USB-Serial cable (color)
GND	Black
D1_UART_RX	Orange
D0_UART_TX	Yellow

10.3 Catena 4801 overall test setup

Catena 4801 overall setup includes a Modbus device, ST-Link programmer, USB-Serial cable, Battery and Antenna as shown in below Figure 25

Figure 25 Catena 4801 complete test setup



10.4 Simple Example sketch:

After the installation of STLink driver and the upload setup, clone the Catena-Sketches open the example sketch **catena4801_simple** in Arduino IDE. Now follow the below steps to upload the test sketch using Arduino IDE:

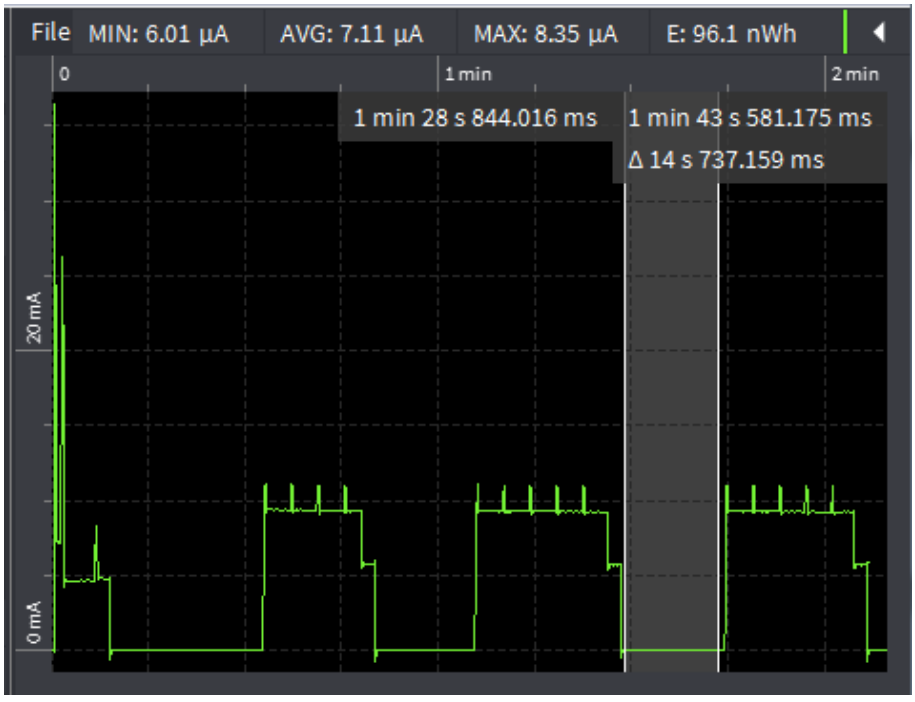
1. Make sure all the required libraries have been cloned. Please refer to **Installing the required libraries** section in README.md.
2. Follow steps in **Arduino IDE Setup** to configure for Catena 4801.
3. Make sure to configure Modbus parameters (*u8addr, u16RegAdd, u16CoilsNo* and *baudrate*) in catena4801_simple to match the Modbus device paramenters.
4. Now upload the sketch.

For more information and information regarding **Platform provisioning** and **Lorawan provisioning**, please have a look at README.md of catena4801_simple.

11 Power consumption

We exclusively developed a test sketch to measure the sleep power of STM32 based Catena devices. The user can clone it from Github repository stm32l0_pwrtest to test the power consumption of Catena 4801. The Catena 4801 records average sleep power as 7uA approximately. The below Figure 26 shows the power consumption graph.

Figure 26 Catena 4801 sleep power consumption



When the user develops a customized sketch, Catena 4801 requires the following configurations to achieve low power (**~7 uA**) consumption.

1. Turn OFF power to FRAM and RS-485
2. Terminate the flash, Serial and Wire

In order to configure the Catena device with above settings, user must add the following four headers in their customized sketch:

- Wire.h
- Catena_Mx25v8035f.h
- SPI.h

Also customer has to make sure create object of the class to access flash. Below Figure 27, shows the declaration of objects and variables in global.

Figure 27 Declaration of class objects in global

```
// The flash
Catena_Mx25v8035f gFlash;
bool fFlash;

SPIClass gSPI2(
    Catena::PIN_SPI2_MOSI,
    Catena::PIN_SPI2_MISO,
    Catena::PIN_SPI2_SCK
    );
```

11.1 Turn OFF power to FRAM and RS-485

The power to FRAM and RS-485 can be turned OFF by configuring the digital pins as INPUT with LOW signals passed. The below Figure 28 shows the configuration of digital pins as INPUT.

Figure 28 Functions to Turn-OFF FRAM and RS-485

```
/* Turn-off power to RS-485 */
static inline void powerOff(void)
  {
  pinMode(kRs485PowerOn, INPUT);
  digitalWrite(kRs485PowerOn, LOW);
  }

/* Turn-off power to FRAM */
static inline void fRAMpowerOff(void)
  {
  pinMode(kFramPowerOn, INPUT);
  digitalWrite(kFramPowerOn, LOW);
  }
```

These two functions in Figure 28 have to be called before the user calls the sleep. Also the user have to configure these digital pins as OUTPUT pin by calling functions *"powerOn"* and *"fRAMpowerOn"*.

11.2 Terminate the flash, Serial and Wire

Before configuring the device to sleep, it is always recommended to terminate the flash, Serial and Wire properly to achieve the low power consumption. Also once the sleep period is over, these peripherals should be initialized again. The below Figure 29 shows the APIs to be called to terminate and initialize these peripherals (inclucing FRAM and RS-485).

Figure 29 Prepare for sleep and Recover from sleep

```
void deepSleepPrepare(void)
        {
        Serial.end();
        Wire.end();
        SPI.end();
        if (fFlash)
                gSPI2.end();

        fRAMpowerOff(); // FRAM/Flash Power off, specific to 4801.
        powerOff(); // turn off the transceiver, specific to 4801.
        }

void deepSleepRecovery(void)
        {
        fRAMpowerOn();  // FRAM/Flash PowerOn, specific to 4801.
        powerOn();  // turn on the transceiver, specific to 4801.
        Serial.begin();
        Wire.begin();
        SPI.begin();
        if (fFlash)
                gSPI2.begin();
        }
```

12 Getting Help

If you have a question about using the Catena 4801, please visit MCCI's support community for the Catena 4801. Feel free to post a question! We'll do our best to assist, and you may benefit from the experience of others. You may also post private questions to MCCI by opening a ticket or by sending email to techsupport@mcci.com.