Board for XIAO LoRa V2 020123 – TTN Node Build

Important !

To use the Board_for_XIAO_LoRa_V2 as a TTN\LoRaWAN node you will need to be familiar with using the TTN console for setting up devices for OTAA authentication and for your part of the World.

Producing a detailed list of instructions and 'free' support for using the TTN console and the example sketch provided; that would apply to all parts of the World is beyond the scope of the instructions that are being provided for a bare circuit board that costs only £1.

Board Build

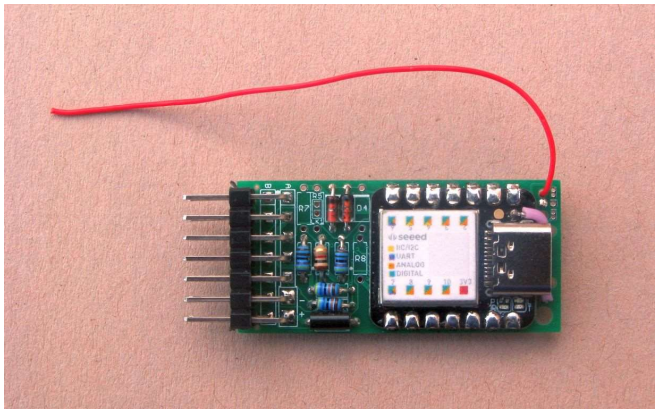
It makes sense to build this board up in stages. It can be difficult to identify what is at fault if you assemble it all and the end construction fails. There are choices to be made during the build also, which components to fit and why you might need them. There is a series of test programs in the device repository and they will help to test the board in stages as you build.

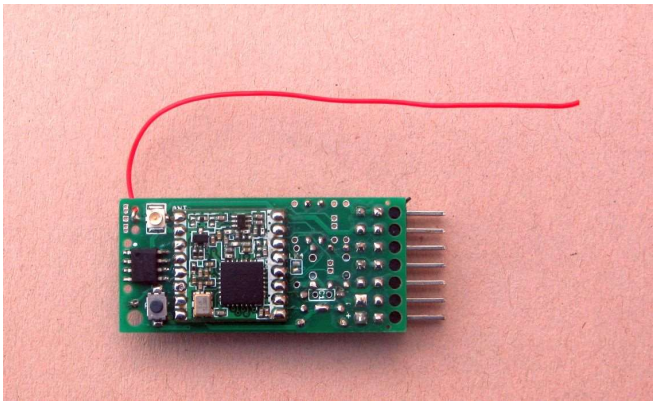
Note: Be sure to close the Arduino IDE Serial monitor before programming or applying power to the XIAO.

Carry out visual check on both sides of the PCB, a loupe or magnifying glass is needed for this. Do a basic multimeter short test on the pads for the XIAO and LoRa devices. Put the multimeter on a pad in one corner and test for continuity for each of the adjacent pads. When finished move the multimeter probe to the next pad and repeat the test on each of the other pads. What you looking for is shorts when there should not be, these would be faults. Note the LoRa module does have several pads connected to GND so expect these to be connected.

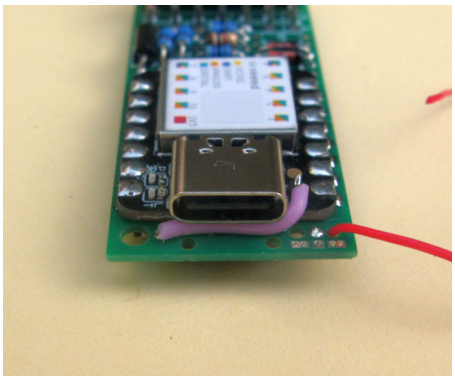
Before soldering the XIAO SAMD21 into place, load up program 1_LED_Blink to check that the XIAO itself is working. The program should make the yellow user LED and the blue TX and RX LEDs flash.

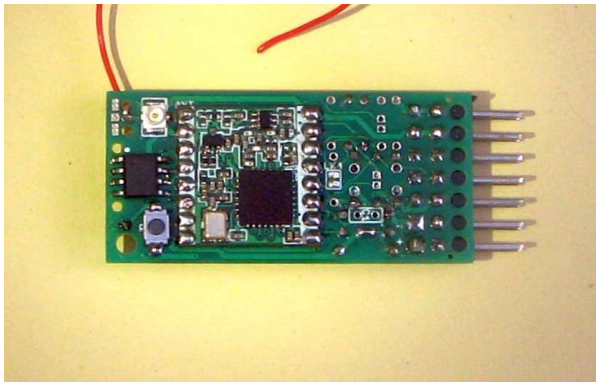
Pictures of the top and bottom of the board when built as a basic TTN node are below.





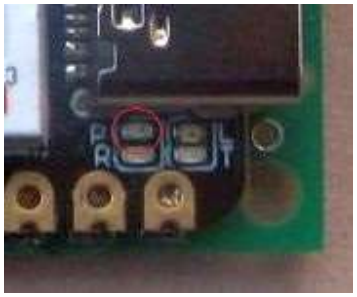
Solder the XIAO in place, the USB connector is at the antenna end of the board, see picture above. Optional. If fitting the (small) reset switch on the bottom (LoRa module side) of the PCB solder it in place now. Solder a short wire from the XIAO RESET pad to the P1 pad on the PCB, see picture.





Optional. If fitting U.FL antenna socket do it now, see pictures of fully assembled board above.
Fit diode D1 in place and connect a battery of no more than 5V to the battery pads on CONB, they are labelled + and -.

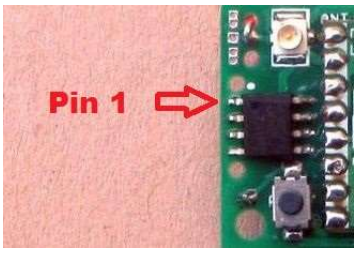
Run the RTC wakeup and test sleep current program; **2_RTC_Alarm_Sleep_Wakeup** Remove the USB cable and check the board runs on battery. The yellow LED on the XIAO will flash when it wakes up. With the green power LED removed, its the top left white oblong shaped part labelled P in the picture below, the deep sleep current should be circa 5uA.



If fitting battery voltage read resistor divider circuit, R1 and R2, do so now and make link LK3 with a bit of wire or a solder blob. Load program **3_Battery_Voltage_Read** and check that the battery voltage is correct. If not make adjustments to the ADMultiplier value in the sketch.

For the TTN node program you need to fit the FRAM so add that now. Pin 1 of the FRAM is next to the end of the PCB, and there will either be a small indent on the top of the FRAM indicating pin 1

or that edge is chamfered. Get the orientation correct, the board wont work if the FRAM is the wrong way around, also see file; Board_for_XIAO_LoRa_V2_PCB_BOTTOM.pdf, and the picture below;



Fit R3 and R4 the I2C pull up resistors. Then load program **13_I2C_Scanner.**

A MB85RC16PNF FRAM should be detected as addresses 0x50, 0x51, 0x52, 0x53, 0x54, 0x55, 0x56 and 0x57. An FM24CL64 FRAM should be detected as address 0x50. Next load the FRAM test program **4_FRAM_Memory_Test** which will tell you if the FRAM is working correctly.
If your not using the U.FL antenna socket, fit a wire antenna now, normally ¼ wavelength at the frequency in use. There is a hole beside the antenna wire pad and you can use this to loop the antenna wire back through to act as a strain relief.

There are choices as to how to connect the DIO0, DIO1 and DIO2 pins of the LoRa device to the XIAO. If your not using the Serial port XIAO pins on A6 and A7 then you can fit a wire link in the D2 location then make links LK1 and LK2. The the pin definitions in the sketch would then be;

```
const lmic_pinmap lmic_pins = {
  .nss = A3,
  .rxtx = LMIC_UNUSED_PIN,
  .rst = A2,
  .dio = {A1, A6, A7},
};
```

The LMIC code does not actually read the DIO0,DIO1 and DIO2 pins to work out which interrupt has triggered, it reads the LoRa device registers. Thus you can Diode OR the DIO0, DIO1 and DIO2 pins together, and they will be sensed on XIAO pin A1, so the Serial port on A6 and A7 is free to use. This is the option used in the provided sketch, so fit D2 and D3 now, then the pin definition in the sketch are as follows;

```
const lmic_pinmap lmic_pins = {
  .nss = A3,
  .rxtx = LMIC_UNUSED_PIN,
  .rst = A2,
  .dio = {A1, A1, LMIC_UNUSED_PIN},
};
```

DIO2 is not used its for FSK data packet sensing, so D4 is not needed. In the provided TTN node sketch the Serial1 TX pin on A6 is used to send debug messages so you can see what happening to the node, without needing the USB port connected.

Fit the LoRa device, note the orientation, the bottom of the LoRa module has a pad labelled ‘ANT’ be sure that goes next to the antenna connection of the PCB. Be sure to check the picture of the bottom of the PCB above to ensure you solder the LoRa module in the correct orientation.

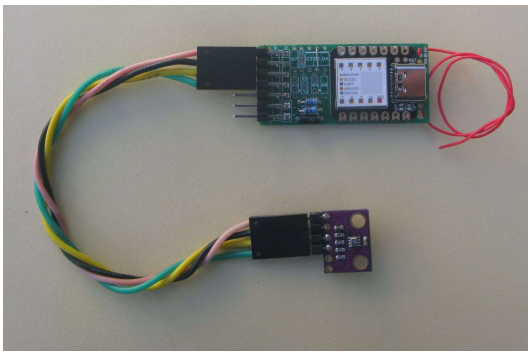
Load program **5_LoRa_Register_Test** that will confirm if the LoRa device can be read over the SPI interface. The notes to that program show what the register print should look like.

At this point we could proceed to check if the LoRa module is transmitting. Unfortunately to receive the transmitted packets you need a working LoRa receiver so you will need to build another device as a receiver.

So if you have another board to act as a receiver, load program **6_LoRa_Transmitter** on one board and load program **7_LoRa_Receiver** on the other. Check and be sure the transmitter and receiver have the same LoRa settings which would be;

```
Frequency = 868000000;              //frequency of transmissions in hertz, for Europe TTN
Offset = 0;                          //offset frequency for calibration purposes
Bandwidth = LORA_BW_125;             //LoRa bandwidth
SpreadingFactor = LORA_SF7;          //LoRa spreading factor
CodeRate = LORA_CR_4_5;              //LoRa coding rate
Optimisation = LDRO_AUTO;            //low data rate optimisation setting, normally set to auto
```

BME280 Sensor



If your going to fit an I2C sensor, such as the BME280, for the TTN node program provided, then either fit pin headers for CONA and use DuPont connectors for the wiring to the BME280, or you can solder the BME280 directly onto the PCB. Make sure your using a BME280 sensor designed for 3.3V use. The 5V versions ‘might’ work but can cause a significant increase in sleep current. Check the wiring of your BME280 does match the pinout of CONA. Load program **11_BME280_Sensor_Test** to check the sensor is working.

Now you can load the **25_LMIC_low_power_OTAA_XIAO_SAMD21_FRAM** and configure it for TTN use.

Powering up and clearing FRAM

When the built node is first powered up and has not connected to TTN there will not be any session authentication data in the FRAM memory. The node program detects this and instigates an OTAA join in the first instance. When this has succeeded the authentication information is saved in FRAM and a marker code is also saved in the FRAM so the program knows there is authentication data saved in the FRAM that can be re-used. Thus after the initial OTAA join the node program should, on reset or power up of the XIAO, not attempt to do the OTAA again.

However you may need to actively force an new OTAA re-join, you could for instance be configuring the board as another node number, so you need a way of clearing the previous stored session data in FRAM. There are two ways you can do this, first you could load the program **5_FRAM_Memory_Clear** from the device repository, or you can start the TTN node program (**25_LMIC_low_power_OTAA_XIAO_SAMD21_FRAM**) and then reset the XIAO at the correct time. When the node program starts the XIAO yellow LED will flash about 4 times a second for 5 seconds. Then it will flash a lot faster for another 5 seconds. If during this second 5 second period reset is activated the OTAA session data in FRAM is cleared and the node will do a fresh join.

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Parts and what do to with them

This is a list of the parts on the board, and the purpose behind fitting them. Many of the parts are optional, you don’t have to fit them all.

ANT1 Pad for connection of a wire antenna, normally ¼ wavelength at the frequency being used.

C1 Can be fitted to smooth the voltage at the centre of the resistor divider formed by R1 ad R2.

CONA Connector for I2C devices, i.e. sensors or displays.

CONB Connector for Serial devices, i.e. GPS.

D1 Reverse polarity protection for incoming battery supply.

D2 Used to allow DIO0 on LoRa module to be read on one IO pin of XIAO, A1. Used as pin saver for LoRaWAN nodes.

D3 Used to allow DIO1 on LoRa module to be read on one IO pin of XIAO, A1. Used as pin saver for LoRaWAN nodes.

D4 Used to allow DIO2 on LoRa module to be read on one IO pin of XIAO, A1. Used as pin saver for LoRaWAN nodes.

IC1 Seeeduino XIAO SAMD21 Microcontroller.

IC2 RFM9X LoRa module.

IC3 MB85RC16PNF or FM24CL64 FRAM.

L1 Can be 1.8mm LED, current limit resistor would be R1.

L2 Can be 1.8mm LED, current limit resistor would be R6.

LK1 Allows LoRa pin DIO1 to be directly connected to XIAO pin A6.

LK2 Allows LoRa pin DIO2 to be directly connected to XIAO pin A7.

LK3 Connects VIN of XIAO module to top of R1,R2 resistor divider.

LK4 SMT pad link that can be cut so that pin A2 of XIAO module is not connected to LoRa module pin NRESET.

P1 Single pad, used to connect wire between XIAO SAMD21 gold reset pad and reset switch on board.

R1 Select value to suit. Can be used to sense a high voltage, keep current to less than circa 500uA. Can be used together with R2 to form a resistor divider to read battery

voltage on XIAO pin A0. For the resistor divider values as high as 470K seem to work OK and keep sleep current low.

R2 Select value to suit. Can be used together with R1 to form a resistor divider to read battery voltage on XIAO pin A0. For the resistor divider values as high as 470K seem to work OK and keep sleep current low.

R3 SDA pin for I2C interface pull up resistor, typically 4K7.

R4 SCL pin for I2C interface pull up resistor, typically 4K7.

R5 Pull up for MISO pin on SPI interface, not normally needed.

R6 Can be used to read a high voltage, say from a 5V serial device, but keep current to less than circa 500uA. Needed if you want to read a GPS or other serial device connected to CONB

R7 Pull up for SCK pin on SPI interface, not normally needed.

R8 Pull up for NSS pin on LoRa device, not normally needed.

RESET Small SMT switch that makes resetting the XIAO SAMD21 for programming heaps easier.

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