Heltec CubeCell Programming

Additional Tips and information

Version 1 **Date 3/11/19**

Scope - Covers Board, Module and Capsule items

Introduction

This document was written, to provide some additional information based on experience using the above products. I am not associated with Heltec and provide this information as additional to that provided by them, to help the LoRaWAN community.

The CubeCell product is very good in that it has:

- Low standby power consumption,
- Arduino IDE configured and using simple script and settings in the board manager
- Ability to be configured by AT commands such as keys
- Has a convenient way to handle Sensor types and code
- Very small 41.5 x 24.1 x 7.2 mm
- It is based on the Semtech LoRaMac-node reference implementation and documentation in GitHub LoRa-Net network node. Release Version 4.4.1 Release date 2018.03.07 which is LoRaWAN version 1.0.2.

The information supplied by Heltec is sometimes difficult to fully understand and often has items missing that can lead to problems. This guide is design to assist with the issues. It is recommended that the user fully follows the Software download and installing process, this seems to work for most people.

CubeCell setting

As explained in the Heltec information the basic settings are held related to the board under the tools tab of the Arduino IDE for:

- LORAWAN_REGION – Your region E.G. EU868
- LORAWAN_MODE – CLASS A or CLASS C
- LORAWAN_RGB – ACTIVE or DEACTIVE

LoRaWAN Keys Installation

This is supposed to be carried out via the use of AT commands, but this can cause problems as every time you reload the firmware you lose the previously programmed keys. So, if you want to set AT Support to off, to save power, then you lose the keys previously loaded when you reload the firmware. And you will not be able to access AT commands.

If you are happy with loading keys via AT commands and leave the feature active this will lead to increased standby power consumption.

If you need to have keys installed so that you don't lose them on reload of firmware, you need to change the information in the commissioning.h files which will live in the following in your Arduino Application file \ASR650x-Arduino\libraries\LoRa\src\commissioning.h. If you have loaded the initial files in a different location then just search for the respective commissioning.h file and change the keys here. I use notepad++ as it is fast and works well.

The keys can be taken for the TTN in a hexadecimal format in Big Endian format i.e. "msb" showing in the Things Network Console for the Application.

RGB Neo pixel Control

The RGB Neo Pixel display provides a good indicator of LoRaWAN activity. The display has the following meaning:

- Red = Sending;
- Purple= Joined done;
- Blue = RxWindow1;
- Yellow = RxWindow2;
- Green = Receiving finished

To minimise the power consumption, turning off the display helps when connected to battery. It should be noted that to enable or disable this feature you need to select it in the tools tab, In Arduino IDE for the board as explained above.

Tx Power Control

The TX power control is set in the default TX power conditions in the region file for EU868. I was advised in can be changed in the \ASR650x-Arduino\libraries\LoRa\src\LoRa_APP.cpp file, with Uint8_t Lora_TXPW = 10. Changing this did not make any difference and the **power output was +8dBm**

not 14dBm in the tests carried out. The region file Max_EIRP setting is 0 (This should be 14dBm but have yet to confirm) with it reducing by 2db for each step so for Value of 7 would be Max_EIRP-14dB.

I2C control

It I first, worth saying that the SCL and SDA lines on the CubeCell boards do not have pullup resistors fitted. I2C requires for resistors to be fitted to both the SCL and SDA lines 4k7, or 10k ohms. There are pads on the reverse of the board R23, R25 for these but they go to the VDD and so would be always draining the battery. It would have been better to have them connected to Vext. In most cases resistors to pull up the SCL and SDA are not needed on CubeCell as the Sensor Boards have them fitted, you just need to check the sensor board.

Care need to be taken in the use of the I2C bus Vext, Gnd, SCL, SDA. Many of the original scripts held in Heltec libraries are based on ESP32 libraries. I have found by testing with digital analyser that the Vext Power line for peripherals such as I2C, requires a setting time from when enabled. It was found if you turned on Vext and then called, say Wire.begin (); then the power line was not stable. A small delay is needed to allow setting time. It recommends that the following is added below the

pinMode(Vext,OUTPUT);

digitalWrite(Vext,LOW);//set vext to high

delay(500);// To allow the Powerline to settle

The above has helped to make several of the Heltec library Scripts work. Though there are still issues with some of the libraries.

Antenna

The Antenna supplied, is a small helical with a nominal λ/4 coiled counter poise. The one tested was for 868MHz EU Band. The antenna was tested on a VNA, was compared to many, previous tested and was reasonable. It should be noted that the resonate point of the antenna varies considerably in free air at 900 MHz and reduces when in a box or held at around 830Mhz. The antenna

resonated at 868MHz when the coils were placed vertically on a metal ground plain.

I would recommend that an IPEX to SMA cable is used and a better antenna is used that is connected to the SMA connector where possible.

DC Power

The board and Capsule have 1S Lithium/LiPo battery, Solar Cell and USB connections. The power consumption is stated as having a Deep Sleep of 3.5uA. In testing it has been found that this as not the case, in normal cases when it was connected to battery or USB. The best current consumption was about **20µA and not 3.5µA**. It is understood that the 3.5µA is when powered by a direct VDD (3.3V) connection. When the battery is connected, there is an LDO and the battery charging chip involved and this increases the current consumption. Based on tests the following was found:

Condition	Current consumption
Deep sleep with 3.3v VDD connection	3.5 µA
Deep sleep with Battery connected	20 µA
Connection to USB	21 µA
Charging current to battery via USB	40 mA
LoRaWAN in Receive mode	10 mA
LoRaWAN Tx 14dBm	100 mA

Based on the above figures and using a LoRaWAN Power consumption calculator TBA on this site, it shows that for typical settings the life of the node is 1.7 and a maximum life of 2.2 years sending every 5 minutes with a payload of 29 bytes and SF7 on average .

AT Commands

This provides for the programming of the Node by a simple set of commands Sent from a serial console. The use of the serial console in Arduino IDE can be used and is convenient, but some aspects need to be considered.

- The console setting at the bottom of the **page needs to be set to “No line Ending” and do not use “New Line”" or "Carriage Return or both**. The later are the normal settings, so this needs to be changed for it to work with this node.

- When adding the keys, be careful not to have spaces at the end of the keys as this will be taken as a character and be rejected by the length checks in the input of keys.

The following are the known set of AT commands that can be used. These are prefixed with AT+xxxxxxxxxx E.g. AT+RESET=1

AT Command	Value	Notes
+LORAWAN=1	LoRaWAN is used 1 or Not	
+OTAA=1	OTAA -1, ABP-0	
+Class=A	Class A or C	
+ADR=1	1 on 0 for off	
+IsTxConfirmed=1	LoRaWAN ACK Message 1 on, 0 off.	
+AppPort=2	The Application Port 2 for general APPs and 10 for TTN MAPPER.	
+DutyCycle=60000	The time between transmission in mS. Typically, 15000 to 3600000	
+ConfirmedNbTrials=8	The number of adaptive rate changes allowed.	
+DevEui=2232330000888802	Unique for Node (For OTAA Mode) 16	
+AppEui=0000000000000000	Unique for Node (For OTAA Mode) 16	
+AppKey=88888888888888888888888886601	Unique for Node (For OTAA Mode) 32	

+NwkSKey=D72C787 58CDCCABF55EE4A7 78D16EF67	Unique for Node (For ABP Mode) 32	
+Passkey=15B1D0EF A463DFBE3D11181E 1EC7DA85	Unique for Node (For ABP Mode) 32	
+DevAddr=0x007E6A E1	Unique for Node (For ABP Mode) 8	

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