

# ETS IoT<sup>®</sup> - WDM Ver 2.0

# **Document Ver 1.0**



## What is WDM?

WDM is the Wireless Development Module suitable to comple your Proof of Concept in faster way. It supports Multiple Wireless Communication Protocol as follows

- Bluetooth Classic
- Bluetooth Low Energy (BLE ver 4.2)
- Wi-fi
- LoRa
- LoRaWAN

## **Features:**

- LoRaWAN 1.0.3 Class A
- LoRaWAN Activation Method Support: ABP & OTAA
- Low power consumption
- Suitable to Interface Different Sensors
- Onboard SHT31 Temperature and Humidity Sensor
- Bands: IN865
- Arduino Programmable
- LMIC Library Compatible
- Option for Battery Powered Device (3.7V 18650 rechargeable lithium Polymer battery) Not Included in the Pack
- Onboard Battery Recharge option



## **Specification:**

## MCU Specifications:

- CPU: Xtensa dual-core 32-bit LX6 microprocessor, up to 240MHz
- ROM: 448KB for booting and core functions
- SRAM: 520KB for booting and instructions
- SRAM: 16 KB in RTC
- SPI Flash: 4MB
- Ultra-Low Power (ULP) Co-processor
- Crystal oscillator: 40 MHz
- 8x Hybrid Digital IO with Special Functions
- Special Functions: 1x I2C, 1x SPI, 1x UART
- 4x Hybrid Analog & Digital IO: 4 No's
- 2x Hybrid Analog & Digital IN: 2 No's
- Analog Resolution: 8,10,12-bit configurable
- Pulse Width Modulation (PWM)
- Onboard Temperature Sensing (typ., -40°C to 90°C with Accuracy  $\Box$  0.3 °C)
- Onboard Humidity Sensing (typ., 0%RH to 100%RH with Accuracy  $\Box 2\%$ RH)
- Onboard LED: 1xRED
- Baud rate configurable
- 802.11 b/g/n Wi-Fi
- Bluetooth Classic and Bluetooth Low Energy (BLE) in the 2.4GHz band
- General ISM < 1GHz LoRa<sup>™</sup> Transceiver 868MHz Surface Mount
- Onboard Antenna for Wi-fi & Bluetooth
- Open source software

### LoRa Specification:

- LoRa Chip: RF96
- Data Rate: 300kbps
- Power Output: 20dBm
- Sensitivity: -148dBm
- Current Transmitting: 120mA
- Operating Temperature: -20°C ~ 70°C
- RF Family/Standard: General ISM < 1GHz
- Protocol: LoRa<sup>TM</sup>
- Modulation: FSK, GFSK, GMSK, MSK, OOK
- Frequency: 865-867 MHz
- Antenna Type External Antenna via SMA / I-Pex connector
- Supply Voltage: 1.8V ~ 3.7V
- Receiving Current: 12.1mA
- Transmitting Current: 120mA
- Operating Temperature: -20°C ~ 70°C



### <u>Wi-Fi:</u>

- 802.11b/g/n
- Bit rate: 802.11n up to 150 Mbps
- A-MPDU and A-MSDU aggregation
- 0.4 µs guard interval support
- Center frequency range of operating channel: 2412 ~ 2484 MHz

### **Bluetooth Specification:**

- Bluetooth v4.2 BR/EDR and BLE specification
- Class-1, class-2 and class-3 transmitter
- Adaptive Frequency Hopping (AFH)

### **Common DC Characteristics:**

- Supply Voltage: 5 V
- Operating Voltage: 3.0 3.6 V
- Minimum current delivered by power supply: 500 mA
- Battery Voltage: 3.7 V Li-Poly
- operating temperature range:  $-40 \degree C \sim 85 \degree C$
- Wake up from GPIO interrupt, timer, ADC measurements

### **Applications:**

- Home Automation
- Smart Building
- Industrial Automation
- Smart Agriculture



# ETS IoT<sup>®</sup> – WDM Ver2.0 Pin Description

Pin	Pin	IO No.	Type	Function
No.	Name		.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
1	CLK	14	I/O	GPIO, ADC, RTC, SPI_CLK, LoRa_SPI_CLK
2	MISO	12	I/O	GPIO, ADC, RTC, SPI_MISO, LoRa_SPI_MISO
3	MOSI	13	I/O	GPIO, ADC, RTC, SPI_MOSI, LoRa_SPI_MOSI
4	CS0	5	I/O	GPIO, SPI_CSO
5	GND		GND	GROUND
6	3V3		PWR	3.3V Power Supply while connecting Battery (or) USB
7	102	2	I/O	GPIO, ADC, RTC, On Board LED
8	1025	25	I/O	GPIO, ADC, RTC
9	1026	26	I/O	GPIO, ADC, RTC
10	1027	27	I/O	GPIO, ADC, RTC
11	1034	34	I	Input_Pin, ADC, RTC
12	1035	35	I	Input_Pin, ADC, RTC
13	1023	23	I/O	GPIO
14	5V		PWR	5V Power Supply while connecting USB Only
15	1019	19	I/O	GPIO
16	IO18	18	I/O	GPIO
17	RXD0	3	I/O	GPIO, UORXD
18	TXD0	1	I/O	GPIO, UOTXD
19	GND		GND	GROUND
20	3V3		PWR	3.3V Power Supply while connecting Battery (or) USB
21	3V3		PWR	3.3V Power Supply while connecting Battery (or) USB
22	GND		GND	GROUND
23	SCL	22	I/O	GPIO, I2C_SCL, Also Configured for Onboard SHT31 SCL
24	SDA	21	I/O	GPIO, I2C_SDA, Also Configured for Onboard SHT31 SDA
25	GND		GND	GROUND
26	GND		GND	GROUND
27	5V		PWR	5V Power Supply while connecting USB Only
28	5V		PWR	5V Power Supply while connecting USB Only

#### Note:

- I/O Input/Output, I Input, PWR Power Supply, GND Ground
- IO No. can be used for Programming the WDM
- IO15 is Internally Connected to LoRa\_NSS
- IO17 is Internally Connected to LoRa\_Reset
- IO4, IO33, IO32 is Internally Connected to LoRa DIO0, DIO1, DIO2 respectively



## Arduino Configuration for Getting Started with WDM

## **Prerequisite:**

- 1. ETS IoT<sup>®</sup> WDM Ver 2.0 (Buy at: <u>https://www.enthutech.in/shop/product/wdm-ets-iot-wdm-1591</u>)
- 2. PC / Laptop Installed with ArduinoIDE Ver 1.8.15 (Download at: <u>https://www.arduino.cc/en/software</u>)
- 3. Driver for CH340G (Download at: <u>https://www.enthutech.in/shop/product/wdm-ets-iot-wdm-1591</u>)
- 4. LMIC Library Files & Sample Codes (Download at: <u>https://www.arduinolibraries.info/libraries/mcci-lo-ra-wan-lmic-library</u>)

## Procedure for installing and uploading the code in WDM module:

- Arduino IDE Version 1.8.15 is used to program the WDM module
- Use the following link to download the Arduino IDE Version 1.8.15 <u>https://downloads.arduino.cc/arduino-1.8.15-windows.exe</u>



- After installing the ArduinoIDE we need to install the ESP32 board support package in the Arduino IDE software
- Open the Arduino IDE and go to Files -> Preferences and paste the below link <u>https://dl.espressif.com/dl/package\_esp32\_index.json</u> in Additional Board manager URL field





Preferences	×
Settings Network	
Sketchbook location:	
C:\Users\ruisantos\Documents\Arduino	Browse
Editor language: System Default v (requires restart of Arduino)	
Editor font size: 17	
Interface scale: Automatic 100 +% (requires restart of Arduino)	
Show verbose output during: compilation upload	
Compiler warnings: None 🗸	
Display line numbers	
Enable Code Folding	
☑ Verify code after upload	
Use external editor	
✓ Aggressively cache compiled core	
Check for updates on startup	
Update sketch files to new extension on save (.pde -> .ino)	
Save when verifying or uploading	
Additional Boards Manager URLs: https://dl.espressif.com/dl/package_esp32_index.json, http://arduino.esp8266.com/stable/package_esp32_index.json, http://arduino.esp8266.com/stable/package_esp	ackage_e
More preferences can be edited directly in the file	
C: \Users \ruisantos \AppData \Local \Arduino 15 \preferences. txt	
(edit only when Arduino is not running)	
ОК	Cancel

After pasting the link and go to Tools -> Boards ->Board Manager

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Boards Manager Type All esp32 by Espressif Sys Boards included in this ESP32 Dev Module, WEI More info	esp32 stems package: MOS LoLin32.					Installing	]



> After installing the ESP32, Go to Tools >> Board >> ESP32 Dev Module



- Connect WDM with PC/Laptop Via USB Cable
- Make ON OFF Switch in WDM to ON Position
- In ArduinoIDE, Go to Tools and select all the settings for ESP32 Dev Module as per below image

sketch_jun04a	Arduino 1.8.15		
File Edit Sketch	Tools Help		-
	Auto Format Archive Sketch	Ctrl+T	
sketch_jun04a	Fix Encoding & Reload		
	Manage Libraries	Ctrl+Shift+I	
vold set	Serial Monitor	Ctrl+Shift+M	
// put	Serial Plotter	Ctrl+Shift+L	
	WiFi101 / WiFiNINA Firmware Updater		
}	Board: "ESP32 Dev Module"	>	
	Upload Speed: "921600"	>	
void loc	CPU Frequency: "240MHz (WiFi/BT)"	>	
// put	Flash Frequency: "80MHz"	>	
// put	Flash Mode: "QIO"	>	
	Flash Size: "16MB (128Mb)"	>	
}	Partition Scheme: "Default 4MB with spiffs (1.2MB APP/1.5MB SPIFFS)"	>	
	Core Debug Level: "None"	>	
	PSRAM: "Disabled"	>	
	Port: "COM4"	>	Serial ports
	Get Board Info		COM12
	Programmer	>	COM13
	Burn Bootloader		✓ COM4

Here It was showing 3 COM Ports. To Identify right COM Port or to check status of Device driver Installation Check Device Manager in your PC/Laptop





- ➤ As per above Image, WDM is connected with USB-SERIAL CH340(COM4)
- In case, if the driver is not installed you will get the COM Port as follows (USB Serial Warning)



For Installing Driver: Download CH340G Driver for Arduino available at Documents section of <u>https://www.enthutech.in/shop/product/wdm-ets-iot-wdm-1591</u>

After Installing, Select right port at Tools >> Port

## **TO UPLOAD SKETCH IN WDM**

#### Go to Files >> Examples >> Basics >> Blink



➢ In Code, replace "LED\_BUILTIN" as 2 in all the places. Where Onboard LED is connected to IO2 of ESP32 as below

```
void setup() {
    // initialize digital pin LED_BUILTIN as an output.
    pinMode(2, OUTPUT);
}
// the loop function runs over and over again forever
void loop() {
    digitalWrite(2, HIGH); // turn the LED on (HIGH is the voltage level)
    delay(1000); // wait for a second
    digitalWrite(2, LOW); // turn the LED off by making the voltage LOW
    delay(1000); // wait for a second
}
```



➢ Before Uploading Code, Check Jumper Option for P6 & P4

	Jumper Position (P4 &	Operation
5/ 10. 02/ 102	<b>P6</b> )	
	1-2 (P6)	PWR LED for +5V
	2-3 (P6)	PWR LED for +3.3V
	4-5 (P4)	USB Power / Programming
	5-6 (P4)	Battery Power
4 5 6		•

Note: Keep P6 Jumper Open to make PWR LED OFF when connected to Battery it will save power.

After Changing above, click the upload icon in the Arduino IDE by clicking Upload Icon as below

File Edit Sketch Tools Help	
📀 🕂 🛅 🔛 Upload	
set up as a gateway.	

Tibrary Dependencies:

- > Your code will compile and then it will upload into the WDM module
- ▶ While uploading, in the bottom of the Arduino IDE it will show a message as below



Once it was trying to connect with Board, press and hold the BOOT button (*Don't Release*) and Reset the device by Pressing & Releasing RST Button then release BOOT button after releasing RST Button. If the coding is uploaded to the WDM module it will show "Done Uploading"



- > After Uploading code, press Reset Button in WDM to start executing the code
- Now Check IO2 LED in the WDM board started to Blink as per your code.



it

## **Onboard SHT31 Sensor Configuration in WDM**

To Install Library for SHT31 Library, Go to Sketch >> Include Library >> Manage Library

sketch	_jun04a   Arduino 1.8.15					
File Edit	Sketch Tools Help					
00	Verify/Compile Upload	Ctrl+R Ctrl+U				
sketch	Upload Using Programmer	Ctrl+Shift+U				
void	Show Sketch Folder	Ctrl+K				
//	Include Library	>	20.0	Δ	200	
	Add File			Manage Libraries	Ctrl+Shift+I	
}				Add .ZIP Library		
				Arduino libraries		

> In Manage Library, Search for SHT31 and Select Adafruit SHT31 Library and Install

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> After Installing, Open SHT31test code from Examples >> Adafruit SHT31 Library



> Comment the lines highlighted to avoid heater enabled test



```
if (! isnan(h)) { // check if 'is not a number'
   Serial.print("Hum. % = "); Serial.println(h);
  } else {
   Serial.println("Failed to read humidity");
  }
 delay(1000);
  // Toggle heater enabled state every 30 seconds
  // An ~3.0 degC temperature increase can be noted wh
// if (++loopCnt == 30) {
11
     enableHeater = !enableHeater;
     sht31.heater(enableHeater);
     Serial.print("Heater Enabled State: ");
     if (sht31.isHeaterEnabled())
        Serial.println("ENABLED");
     else
       Serial.println("DISABLED");
      loopCnt = 0;
   }
}
```

Save & Upload the sketch then press RST Button to see results as below in Serial Monitor. Wait for some time to get stable Temperature & Humidity





## LMIC LoRaWAN Library Customization for WDM

- Download LMIC Library from <u>https://www.arduinolibraries.info/libraries/mcci-lo-ra-wan-lmic-library</u>
- Current Version using for this Demo is MCCI\_LoRaWAN\_LMIC\_library-4.0.0.zip



➢ Extract the zip as Folder



MCCI\_LoRaWAN\_LMIC\_library-4.0.0

Go to location .....\MCCI\_LoRaWAN\_LMIC\_library-4.0.0\project\_config and open lmic\_project\_config.h and make changes as follows for Indian Frequency and save it.

```
// project-specific definitions
//#define CFG_eu868 1
//#define CFG_us915 1
//#define CFG_au915 1
//#define CFG_as923 1
// #define LMIC_COUNTRY_CODE LMIC_COUNTRY_CODE_JP /* for as923-JP */
//#define CFG_kr920 1
#define CFG_in866 1
#define CFG_in866 1
#define CFG_sx1276_radio 1
//#define LMIC_USE_INTERRUPTS
```

Go to location .....\MCCI\_LoRaWAN\_LMIC\_library-4.0.0\src\hal and open hal.cpp and find below line

**Before Change:** 

```
static void hal_spi_init () {
   SPI.begin();
}
```

> Make changes in SPI.begin() as follows and save it

```
static void hal_spi_init () {
    SPI.begin(14,12,13,15);
}
```

Note: The Pin definition for SPI Pins were as follows CLK – 14, MISO – 12, MOSI – 13, NSS – 15

Copy and paste this folder MCCI\_LoRaWAN\_LMIC\_library-4.0.0 in following location ....\Documents\Arduino\libraries



## **Registering Application & WDM Device in ABP mode with TTN v3**

Create a login in "<u>https://www.thethingsnetwork.org/</u>" and go to console



Choose your cluster. I am going to choose Europe 1 & Login with The ThingsID using your registered.





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➢ Give necessary details and create application.

Add application

- Owner\*

   gowthamrajenthu

   Application ID\*

   demo-application

   Application name

   demo-application

   Description

   demo-application description; can also be used to save notes about the application

   Optional application description; can also be used to save notes about the application
- Inside Applications Go to End Devices and click on "Add end device"

🚥 End de	evices - demo-application × +												-	٥	$\times$
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$\triangleright$	Go to	"Manually"	Section
------------------	-------	------------	---------



- Give following and click start
  - Select "Activation by personalization (ABP)"
  - LoRaWAN Version: "MAC V1.0.3"
  - Network & Application Server address: "eu1.cloud.thethings.network"
- Enter following details & Enter Network Layer Settings
  - End device ID: <Enter ID for your device>eg.node1
  - DevEUI: <Enter 8byte Unique ID for Device>
  - End Device Name: WDM
  - End Device Description: < give anything for your identification>
- Give Network Layer Settings as follows and Enter Application Layer Settings
  - o Frequency Plan: India 865-867 MHz
  - Don't Select anything for LoRaWAN Class Capabilities. WDM will support only for Class A

LoRaWAN class capabilities	?
----------------------------	---

Supports class B

Supports class C

- o Generate "Device address" automatically by clicking icon mentioned
- o Generate "NwkSKey" automatically by clicking icon mentioned
- Go to advanced Settings and enable Reset Frame counters. Keep all other settings default.

**Resets Frame Counters** 

🧹 Enabled

A Resetting is insecure and makes your device susceptible for replay attacks

- > Enter Application Layer settings as follows and Add End Device
  - Don't Enable Skip payload encryption and decryption

Skip payload encryption and decryption



Skip decryption of uplink payloads and encryption of downlink payloads

- o Generate "AppSKey" automatically by clicking icon mentioned
- ▶ Now we have Registered the Application & Device with TTN V3.



## ABP Uplink With WDM to TTN V3

Open ArduinoIDE 1.8.15 and go to File >> MCCI\_LoRaWAN\_LMIC\_library >> ttnabp



Need to change the LoRaWAN Keys (NWKSKEY, APPSKEY, DEVADDR) highlighted below



Copy the Keys from TTI V3 Devices Page as below and replace it in code in following format

Note:

- Click the eye icon & <> icon to change the view of keys
- While copying NwkSKey & AppSKey Ensure the keys are in MSB Position as highlighted in following image



. <u>.</u>	$ ightarrow$ C $ m \odot$ h	ttps://eu1.cloud.th	ethings.network/console/appli	cations/demo-application/devices/node1
11	demo-application		Overview Live data	Messaging Location Payload formatters General settin
	Overview		General information	
×	End devices		End device ID	node1
11.	Live data		Created at	Jun 4, 2021 18:27:38
<>	Payload formatters	~	Activation information	
¢	Integrations	~	AppEUI	n/a
*	Collaborators		DevEUI	64 89 29 28 37 AB CD EF 🗘 📭
От	API keys		Session information	
\$	General settings		Device address	26 0B 9A B0 🗘 🏠
			NwkSKey	0x0D, 0x88, 0xF9, 0xDB, 0xAC msb 🕫 🔇 🐚 🗞
			SNwkSIntKey	🖺 🛛
			NwkSEncKey	🖺 📀
			AppSKey	0x82, 0x90, 0x44, 0xDE, 0xE3 msb 🛹 🛟 🐚 🗞

< Hide sidebar

> After Changing the LoRaWAN Keys your code should like this,

// LoRaWAN NwkSKey, network session key
// This should be in big-endian (aka msb).
static const PROGMEM ul_t NWKSKEY[16] = { 0x0D, 0x88, 0xF9, 0xDB, 0xAC, 0x3E, 0x40, 0x95, 0xD3, 0x58, 0x40, 0x4A, 0xF2, 0xA1, 0x47, 0xE1 };
// LoRaWAN AppSKey, application session key
// This should also be in big-endian (aka msb).
static const u1_t PROGMEM APPSKEY[16] = { 0x82, 0x90, 0x44, 0xDE, 0xE3, 0x5D, 0xD3, 0xB6, 0x4B, 0x73, 0xB2, 0xA7, 0xE3, 0xBC, 0x72, 0x28 };
// LoRaWAN end-device address (DevAddr)
// See http://thethingsnetwork.org/wiki/AddressSpace
// The library converts the address to network byte order as needed, so this should be in big-endian (aka msb) too.
static const u4_t DEVADDR = 0x260B9AB0 ; // < Change this address for every node!

#### Note:

> Don't enter the above keys as same. Enter the keys as per your TTN account

Next, need to change the pin mapping as per WDM board Identify the following lines and change the pin map as follows

```
const lmic_pinmap lmic_pins = {
    .nss = 15,
    .rxtx = LMIC_UNUSED_PIN,
    .rst = 17,
    .dio = {4, 33, 32},
```

};



#### Comment following lines to disable European Frequency

```
#if defined(CFG eu868)
// Set up the channels used by the Things Network, which corresponds
// to the defaults of most gateways. Without this, only three base
// channels from the LoRaWAN specification are used, which certainly
// works, so it is good for debugging, but can overload those
// frequencies, so be sure to configure the full frequency range of
// your network here (unless your network autoconfigures them).
// Setting up channels should happen after LMIC_setSession, as that
// configures the minimal channel set. The LMIC doesn't let you change
// the three basic settings, but we show them here.
//LMIC setupChannel(0, 868100000, DR RANGE MAP(DR SF12, DR SF7), BAND CENTI);
                                                                                        // g-band
                                                                                        // g-band
//LMIC setupChannel(1, 868300000, DR RANGE MAP(DR SF12, DR SF7B), BAND CENTI);
//LMIC_setupChannel(2, 868500000, DR_RANGE_MAP(DR_SF12, DR_SF7), BAND_CENTI);
                                                                                        // g-band
//LMIC_setupChannel(3, 867100000, DR_RANGE_MAP(DR_SF12, DR_SF7), BAND_CENTI);
                                                                                        // g-band
//LMIC_setupChannel(4, 867300000, DR_RANGE_MAP(DR_SF12, DR_SF7), BAND_CENTI);
                                                                                        // g-band
//LMIC_setupChannel(5, 867500000, DR_RANGE_MAP(DR_SF12, DR_SF7), BAND_CENTI);
//LMIC_setupChannel(6, 867700000, DR_RANGE_MAP(DR_SF12, DR_SF7), BAND_CENTI);
                                                                                        // g-band
                                                                                        // g-band
//LMIC_setupChannel(7, 867900000, DR_RANGE_MAP(DR_SF12, DR_SF7), BAND_CENTI);
                                                                                        // g-band
//LMIC_setupChannel(8, 868800000, DR_RANGE_MAP(DR_FSK, DR_FSK), BAND MILLI);
                                                                                        // g2-band
// TTN defines an additional channel at 869.525Mhz using SF9 for class B
// devices' ping slots. LMIC does not have an easy way to define set this
// frequency and support for class {\tt B} is spotty and untested, so this
```

#### Uncomment Following lines to enable Indian Frequency

```
// ... extra definitions for channels 3..n here.
#elif defined(CFG_in866)
// Set up the channels used in your country. Three are defined by default,
// and they cannot be changed. Duty cycle doesn't matter, but is conventionally
// BAND_MILLI.
LMIC_setupChannel(0, 865062500, DR_RANGE_MAP(DR_SF12, DR_SF7), BAND_MILLI);
LMIC_setupChannel(1, 865402500, DR_RANGE_MAP(DR_SF12, DR_SF7), BAND_MILLI);
LMIC_setupChannel(2, 865985000, DR_RANGE_MAP(DR_SF12, DR_SF7), BAND_MILLI);
```

#### Enter Payload Decoder & save it to Decode the received bytes in TTN V3

→ G https://eu1.clou	d.thethings.network/console/applications/demo-application/payload-formatters/uplink	10 PJ Y VI VI	Ψ.
THE THINGS STACK Community Edition	Set Overview Applications	DELI Community Fair use policy applies O Gowth	am Raj
demo-application	Applications > demo-application > Payload formatters > Uplink		
Overview	Default uplink payload formatter		
End devices	You can use the "Payload formatter" tab of individual end devices to test uplink payload for	matters and to define individual payload formatter settings per end device.	
Live data	Satua		
Payload formatters	Formatter type *		
Downlink	Formatter parameter *		
Integrations ~ Collaborators	1 function Decoder(bytes) { 2 return { 1   Text: String.fromCharCode.apply(null,bytes) 4 } 5 }		
API keys	0		
General settings			



## > Now Upload the sketch in WDM and Reset the device to get data in TTN V3

				Seria
ttn-abp §				
} // Next TX is scheduled	after TX_COMPLETE eve	ent.		
		o cou		×
roid setup() (		COM4		Send
<pre>// pinMode(13, OUTPUT); while ([Serial): // wai</pre>	t for Serial to be ini	tializerst:0x1 (POWERON RESET) boot:0x13 (CDT	FAST FLASH BOOT)	^
Serial.begin(115200);	t for seriar to be in	configsip: 0, SPIWP:0xee	Inor_Lanon_boot,	
<pre>delay(100); // per Serial println(E("Start</pre>	<pre>sample code on RF_95 t ing"));</pre>	<pre>test clk_drv:0x00,q_drv:0x00,d_drv:0x00,cs0_ mode:DIO, clock div:1</pre>	_drv:0x00,hd_drv:0x00,wp_drv:0x00	
Serier.princin(r( Scare	ing ///	load:0x3fff0018,len:4		
<pre>#ifdef VCC_ENABLE // For Pinoccio Scout b</pre>	oards	load:0x3fff001c,len:1216 ho 0 tail 12 room 4		
pinMode (VCC_ENABLE, OUT	PUT);	load:0x40078000,len:9720		
digitalwrite(VCC_ENABLE delay(1000);	, HIGH);	load:0x40080400,len:6352		
#endif ·		entry 0x400806b8 Starting		
// LMIC init		10850: EV_TXSTART		
os_init(); // Reset the MAC state.	Session and pending of	Packet queued iata tr 141485: EV TXCOMPLETE (includes waiting	g for RX windows)	
LMIC_reset();	F			~
		Autoscroll Show timestamp	Newline V 115200 baud V Cl	ear output
Results in TTN V				
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Gateway should be in Coverage, Live & Connected to TTNv3 for getting data as above



## **Registering Application & WDM Device in OTAA mode with TTN v3**

Create a login in "<u>https://www.thethingsnetwork.org/</u>" and go to console



Choose your cluster. I am going to choose Europe 1 & Login with The ThingsID using your registered.





- 0	rerview - Console - The Thing: X	+								-	o ×
~ ~	→ C	.cloud.thethings.netw	ork/console/				* 13	۲	<ul> <li>1</li> <li>2</li> </ul>		
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			Welco	me back, Go	owtham Ra	aj! 🔇					
			Walk righ	nt through to your app	olications and/or ga	iteways.					
			Need help? Ha	ve a look at our 🛙 <u>Doo</u>	umentation 🛛 or G	et Support ∅.					
<b>C1</b> : 1	«A 11		ooo Co to applications			Go to gateways					
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				No items fr	sund						

➢ Give necessary details and create application.

Add application

- Owner\*

   gowthamrajenthu

   Application ID\*

   demo-application

   Application name

   demo-application

   Description

   demo-application description; can also be used to save notes about the application

   Optional application description; can also be used to save notes about the application
- Inside Applications Go to End Devices and click on "Add end device"

🚥 End de	evices - demo-application × +												-	٥	$\times$
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Ov	erview	ID \$	2	Name 🗢	DevEUI	JoinEUI				_			Les .	-	
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ılı Liv	e data				No items found										



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Go to "Manually"	'Section
	Applications > demo-application > End devices > Register manually
	Register end device
	From The LoRaWAN Device Repositor Manually
Give following ar	nd click start
	Preparation
	Activation mode *
	Over the air activation (OTAA)
	Activation by personalization (ABP)
	Multicast
	O not configure activation
	LoRaWAN version $\odot$ *
	MAC V1.0.3
	Network Server address
	eu1.cloud.thethings.network
	Application Server address
	eu1.cloud.thethings.network
	External Join Server 🗇
	Enabled
	Join Server address
	eu1.cloud.thethings.network
	Start

- > Enter following details & Enter Network Layer Settings
  - End device ID: <Enter ID for your device>eg.node2
  - DevEUI: <Enter 8byte Unique ID for Device>
  - End Device Name: WDM
  - End Device Description: < give anything for your identification>
- Give Network Layer Settings as follows and Enter Join Settings
  - Frequency Plan: India 865-867 MHz
  - Don't Select anything for LoRaWAN Class Capabilities. WDM will support only for Class A

 ${\tt LoRaWAN\ class\ capabilities}\, \oslash$ 

Supports class B

Supports class C

- Enter Join settings as follows and Add End Device
  - o Generate "AppKey" automatically by clicking icon mentioned
- Now we have Registered the Application & Device with TTN V3.



## **OTAA Uplink With WDM in TTN V3**

Open ArduinoIDE 1.8.15 and go to File >> MCCI\_LoRaWAN\_LMIC\_library >> ttnotaa



Need to change the LoRaWAN Keys (APPEUI, DEVEUI, APPKEY) highlighted below



Copy the Keys from TTI V3 Devices Page as below and replace it in code in following format

#### Note:

- Click the eye icon & < > icon to change the view of keys
- While copying APPEUI & DEVEUI Ensure the keys are in LSB Position as highlighted in following image
- While copying APPKEY Ensure the keys are in MSB Position as highlighted in following image



Applications > demo-a	application > End devices > WDM						
<b>WDM</b> ID: node2							
• Last seen info unavailable $ \  \  \  \  \  \  \  \  \  \  \  \  \$							
Overview Live da	ta Messaging Location Payload formatters Claimin						
General information							
End device ID	node2						
Description	WDM						
Created at	Jun 4, 2021 20:11:43						
Activation information							
AppEUI	0x92, 0x28, 0x67, 0x53, 0x76, 0x0  sb ++ <>						
DevEUI	0x29, 0x88, 0xCD, 0xAB, 0x29, 0x2 lsb ↔ ↔						
Root key ID	n/a						
АррКеу	0x39, 0xB4, 0x9D, 0x3E, 0x88 msb → 🗘 👔 🗞						
NwkKey	n/a						
Session information							
No data available							
	Last seen info unavail     Overview Live da     General information     End device ID     Description     Created at     Activation information     AppEUI     DevEUI     Root key ID     AppKey     NwkKey     Session information     No data available						

// This key should be in big endian format (or, since it is not really a
// number but a block of memory, endianness does not really apply). In
// practice, a key taken from thrctl can be copied as-is.
static const ul\_t PROGMEM APPKEY[16] = { 0x39, 0xB4, 0x9D, 0x3E, 0x88, 0xF8, 0x4F, 0x64, 0xF6, 0x23, 0xB6, 0x4B, 0x33, 0xD1, 0x4A, 0x1F };
void os\_getDevKey (ul\_t\* buf) { memcpy\_P(buf, APPKEY, 16);}



Next, need to change the pin mapping as per WDM board

Identify the following lines and change the pin map as follows

```
const lmic_pinmap lmic_pins = {
    .nss = 15,
    .rxtx = LMIC_UNUSED_PIN,
    .rst = 17,
    .dio = {4, 33, 32},
```

void os\_getDevEui (u1\_t\* buf) { memcpy\_P(buf, DEVEUI, 8);}

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Enter Payload Decoder & save it to Decode the received bytes in TTN V3



Now Upload the sketch in WDM and Reset the device to get data in TTN V3
It to rease | Architer 0 1815
The fore Sketch Track Help

tatic uint8_t mydata[] = "Hello, world!";		
<pre>catic osjob_t sendjob;</pre>	© COM4 -	×
Cabadula my anany this wary seconds (might become		Send
Schedule TX every this many seconds (might become	10 <sup>8</sup> 81 ، 111;H5;B5L5 ، 111;H5;B5L5	
cycle limitations).	! ?? Starting	_
onst unsigned TX_INTERVAL = 60;	Packet queued	_
	4530: EV_JOINING	_
/ Pin mapping	372181: EV_TXSTART	_
onst Imic_pinmap Imic_pins = {	693219: EV_JOINED	_
.nss = 15,	netid: 19	_
.rxtx = LMIC_UNUSED_PIN,	devaddr: 260B7518	_
.rst = 17,	AppSKey: 0E-79-0D-C2-9A-CE-8F-DA-A5-1C-53-42-B1-80-B6-3E	_
.dio = [[4, 33, 32],	NwkSKey: 4B-3A-30-6E-20-02-1B-30-26-60-1F-7F-52-48-48-15	_
;	695616: EV_TXSTART	_
	1015990: EV_TXCOMPLETE (includes waiting for KX windows)	_
pid printHex2(unsigned v) {	1400004. EV_TASTART	_
v &= Oxff;	1428084: EV_TACOMPLETE (Includes walling for RA windows)	_
if $(v < 16)$		_
<pre>Serial.print('0');</pre>		_
<pre>Serial.print(v, HEX);</pre>		_
	Autoscrell Show timestamp Newline V 9600 baud V C	lear output

Results in TTN V3 as follows



THE THINGS STACK	Overview	Applications	🚡 Gateways 🛛 👫 Organizations		D EU1 Commun No support plan	B Gowtham Raj •
ut demo-application	Appli	cations > demo-applic	ation 💈 Live data			
-	Time	Entity ID	Туре	Data preview	Ve	rbose stream 🔢 Pause 📋 Clear
Overview	↑ 20:34:14	node2	Forward uplink data message	<pre>Payload: { Text: "Hello, world!" }</pre>	48 65 6C 6C 6F 2C 20 77 6F 72 6C 64 21	FPort: 1 SNR: 10.5 RSSI: -64 Bar
🙏 End devices	GD 20:34:00	node2	Accept join-request			
The state of the s	GD 20:33:58	node2	Accept join-request			
Live data	<b>#</b> 19:35:03		Console: Events cleared	The events list has been cleared		
< > Payload formatters ~						
犬 Integrations ~						
Collaborators						
Ov API keys						
General settings						
< Hide sidebar						

# Note: Solution Gateway should be in Coverage, Live & Connected to TTNv3 for getting data as above