ioNODE Series LoRa End Device RF Module

MiniMOD_2.0

Datasheet

Document Version: SSTPL/HW/EDDS/MMD/2.0.2

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1. Brief Description

MiniMOD_2.0 is a compact, low cost, low power wide area network (LPWAN) wireless module that supports the Semtech LoRaWAN® long range wireless protocol.

This new stand-alone module measures just 28*23 mm, is constructed in a metal shielded package and comprises a Semtech SX1272 ultra-long range spread spectrum wireless transceiver and STM32 series ARM Cortex-M0 + 32 Bit microcontroller (MCU). The MiniMOD_2.0 module complies with the latest LoRaWAN® Class A & C protocol specifications; it is simple to access LoRaWAN® IoT platforms.

1.1 Features

- RF output power up-to +20 dBm.
- It supports LoRa® Point to Point communications as well as LoRaWAN® protocol. Different Firmware required.
- Built-in EEPROM, data kept unchanged even powered off.
- Small size (28*23 mm)
- Wide range of working voltage 3V to 3.7 V, Option of 5V supply on different pin
- Sensitivity -137dBm
- Wide range of temperatures -40°C to +85°C.

1.2 Applications

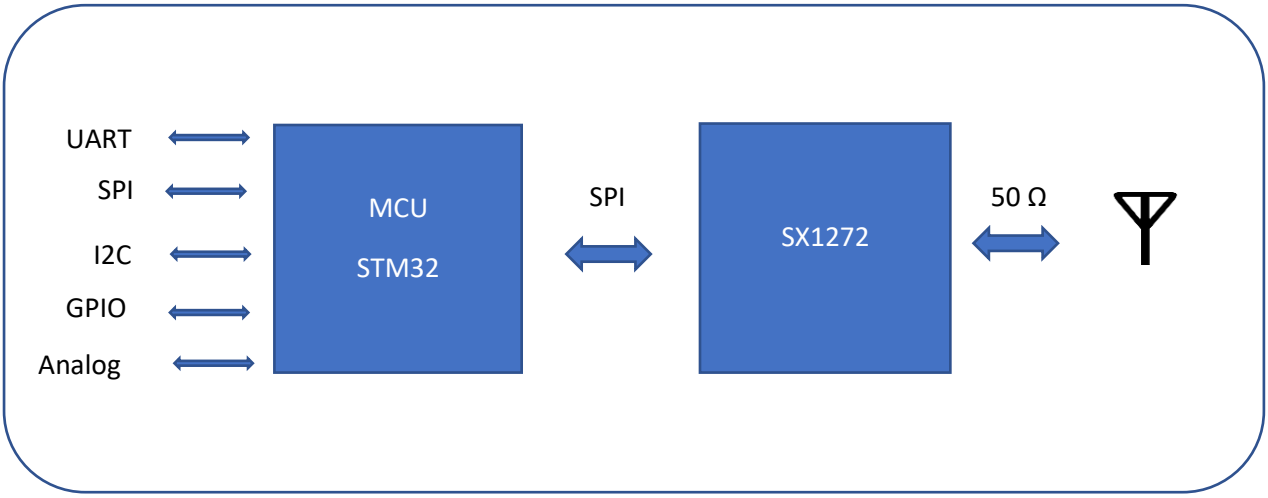
Typical applications for this module include smart metering, wearables, tracking, M2M and internet of things (IoT) edge nodes.

The module's applications are as following -

- Automated Meters Reading
- Home and Building Automation
- Wireless Alarm and Security Systems
- Industrial Monitoring and Control
- Long Range Irrigation Systems

2. Module Overview:

MiniMOD_2.0 is an ultra-long range, high-performance, RF module for wireless communication. It operates in the license free 865-867 MHz ISM frequency band and includes all necessary passive components for wireless communication as depicted in the following figure.



Frequency range	865 to 867 MHz
Modulation	LoRa® Spread-Spectrum
RF output power	Up to 20 dBm
Receiver sensitivity	-137 dBm (SF 12; SB 125 kHz, CR 4/6)
RF data rate	0.24 to 5 kbps
RF range	up to 5000 m (line of sight)
Operating voltage	3 V to 3.7 V, Separate 5V option
Current consumption	< 10 µA (module in sleep, RTC running) 23 mA (Rx) 123 mA (Tx mode)
Interfaces	UART, SPI, I2C
IO's	Digital IOs Analog Inputs
Dimension	28x23 mm
Operating temperature	-40°C to +85°C

3. Electrical Characteristics

3.1 Maximum Ratings

Condition	Min	Typ.	Max	Unit
Supply Voltage (VDD)	3.0	3.5	3.7	V
Storage Temperature	-40	+25	+85	°C
Operating Temperature	-40	+25	+85	°C
RF Input Power	+10			dBm
ESD (Human Body Model)	2000			V
ESD (Charge Device Model)	500			V
Notes: 1) Unless otherwise noted, all voltages are with respect to GND				

3.2 General Electrical Characteristics

T = 25°C, VDD = 3.3 V (typ.) if nothing else stated					
Parameter	Condition	Min	Typ.	Max	Unit
Supply Voltage (VDD)		2.8	3.3	3.6	V
Current Consumption System IDLE	TRX idle mode, µC idle mode		10		µA
Current Consumption RECEIVE LoRa	TRX receive mode, µC sleep mode		23		mA
Current Consumption TRANSMIT	TRX transmit mode, µC sleep mode, all µC units off, max. RF power level		123		mA
MCU operation frequency		32 MHz & 32.768 KHz			

3.3 Module Interface Characteristics

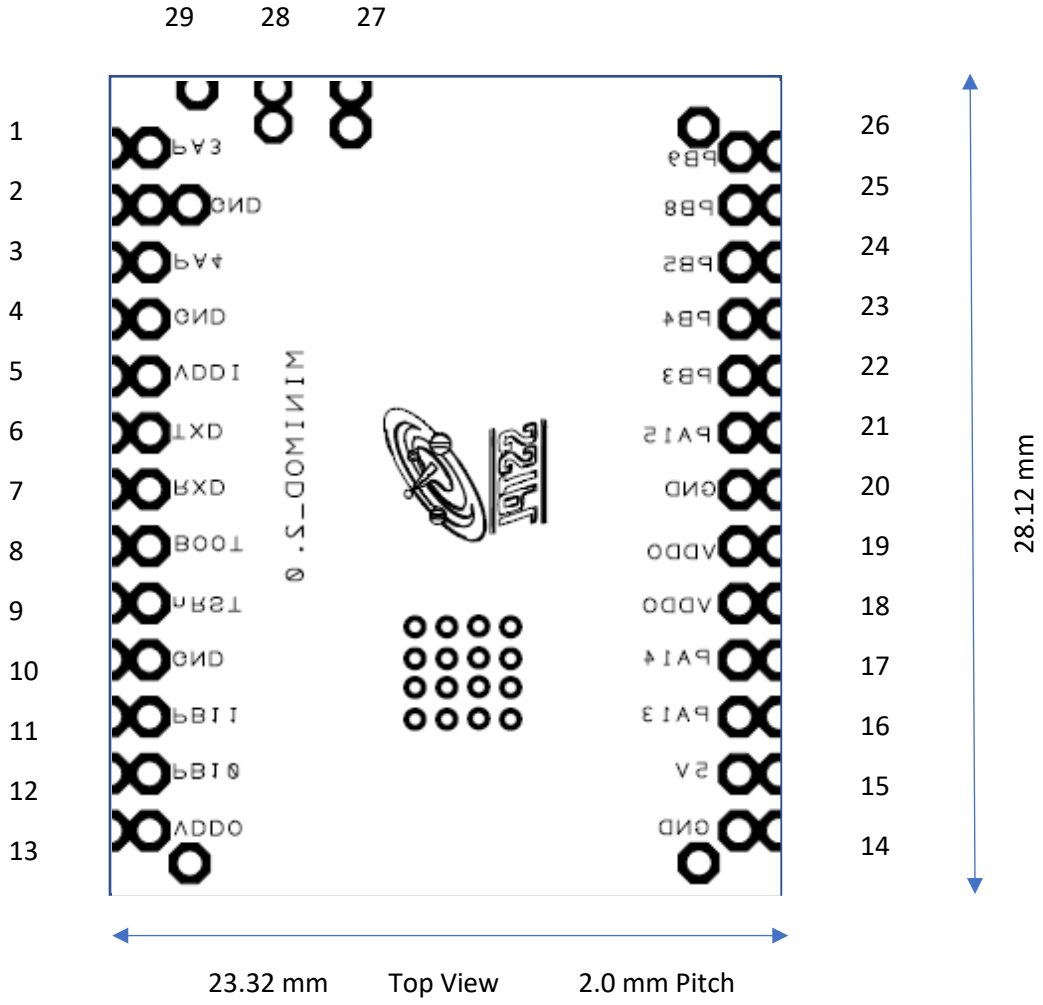
Symbol	Parameter	Conditions	Min.	Max.	Unit
VOL	Output Low level voltage for an I/O pin	CMOS port, IIO = +8 mA 2.8V ≤ VDD ≤ 3.7V	-	0.4	V
VOH	Output High level voltage for an I/O pin		VDD - 0.4	-	
VOL	Output Low level voltage for an I/O pin	TTL port, IIO = +8 mA 2.8V ≤ VDD ≤ 3.7V	-	0.4	V
VOH	Output High level voltage for an I/O pin	TTL port IIO = -6 mA 2.8V ≤ VDD ≤ 3.7V	2.4	-	V
VOL	Output Low level voltage for an I/O pin	IIO = +15 mA 2.8V ≤ VDD ≤ 3.7V	-	1.3	V
VOH	Output High level voltage for an I/O pin	IIO = -15 mA 2.8V ≤ VDD ≤ 3.7V	VDD-1.3	-	V
VOL	Output Low level voltage for an I/O pin	IIO = +4 mA 1.65V ≤ VDD ≤ 3.7V	-	0.45	V
VOH	Output High level voltage for an I/O pin	IIO = -4 mA 1.65V ≤ VDD ≤ 3.7V	VDD-0.45	-	V
VOLFM+	Output low level voltage for an FTf I/O pin in FM+ mode	IIO = 20 mA 2.8V ≤ VDD ≤ 3.7V	-	0.4	V
		I_{IO} = 10mA 1.65V ≤ V_{DD} ≤ 3.7V	-	0.4	

3.4 Transmitter RF Characteristics

T = 25°C, VDD = 3 V (typ.), 866 MHz if nothing else stated					
Parameter	Condition	Min	Typ.	Max	Unit
Frequency Range		865	-	867	MHz
RF Output Power - 865 MHz Band		18.5	19.5	20	dBm
Modulation Techniques			LoRa™		
TX Frequency Variation vs. Temperature	-40 to +85°C	-	±10	-	kHz
TX Power Variation vs. Temperature		-	±0.5	-	dB

4. Module Package

4.1 Module Dimension



4.2 Pinout Description

PIN	PIN Name	PIN Type	MCU Pin (number)	5 V Tolerance	Description
1	PA3	D I/O	PA3	Yes	ADC IN3
2	GND	Supply			Ground connection
3	PA4	D I/O	PA4	Yes	SPI1_NSS
4	GND	Supply		No	Ground connection
5	VDD1	Supply		No	Main Supply
6	TXD	D I/O	PA9	No	Digital IO / USART1-TX
7	RXD	D I/O	PA10	No	Digital IO / USART1-RX

8	Boot	D IN	BOOT0	No	Bootloader Pin 0, internally pulled-down by 47 kΩ
9	nRst	D IN	NRST	NO	NReset, internally pulled-up by 47 kΩ
10	GND	Supply			Ground connection
11	PB11	D I/O	PB11	Yes	LPUART1_RX/ LPUART1_TX/ I2C2_SDA (Ext. pullup required)
12	PB10	D I/O	PB10	Yes	LPUART1_TX/ LPUART1_RX/ I2C2_SCL (Ext. pullup required)
13	VddO	Supply			3.3V out up-to 20 mA
14	GND	Supply			Ground connection
15	5V	Supply			5V input to 3.3V LDO
16	PA13	D I/O	PA13	Yes	SWDIO
17	PA14	D I/O	PA14	Yes	SWCLK
18	VDDO	Supply			3.3V out up-to 20 mA
19	VDDO	Supply			3.3V out up-to 20 mA
20	GND	Supply			Ground connection
21	PA15	D I/O	PA12	Yes	SPI1_NSS/Digital IO
22	PB3	Supply	PB3	Yes	SPI1_SCK/ USART5_TX
23	PB4	D I/O	PB4	Yes	SPI1_MISO/ USART5_RX
24	PB5	D I/O	PB5	Yes	SPI1_MOSI
25	PB8	D I/O	PB8	Yes	I2C1_SCL
26	PB9	D I/O	PB9	Yes	I2C1_SDA
27	GND	Supply			Ground connection
28	RF	A IN/OUT			External 50Ω port for antenna connection
29	GND	Supply		No	Ground connection

5. RF Test Report (Conducted Measurement)

EUT Test Configuration: - Transmit on Max power on each 125 KHz Channel, Transmission on 1st, Mid and Last channel in each 15 minutes.

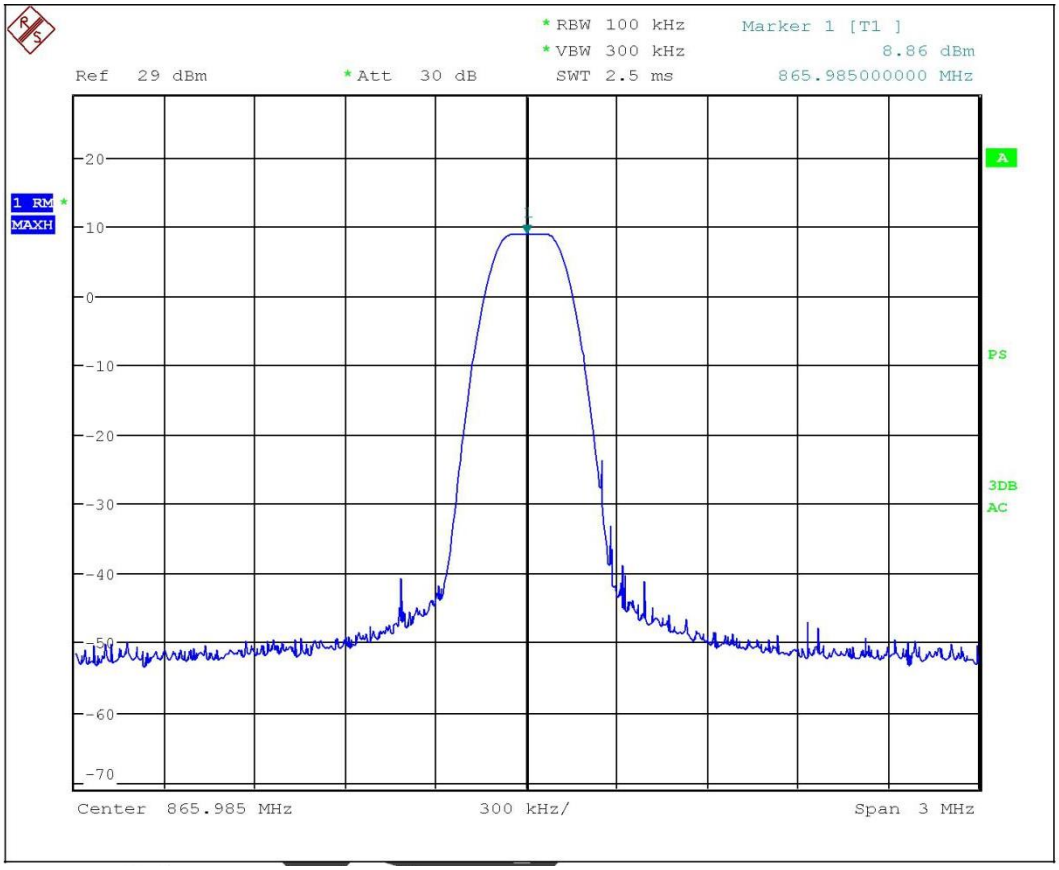
EUT Height: - 0.8m from Ground (EUT placed on nonconductive table).

Voltage: - + 3.5V DC

EUT antenna port connected to RF connector.

5.1 Effective Radiated Power (ERP)

Observation Graph: - ERP Channel 5 (865.985 MHz)



Observation Table: -

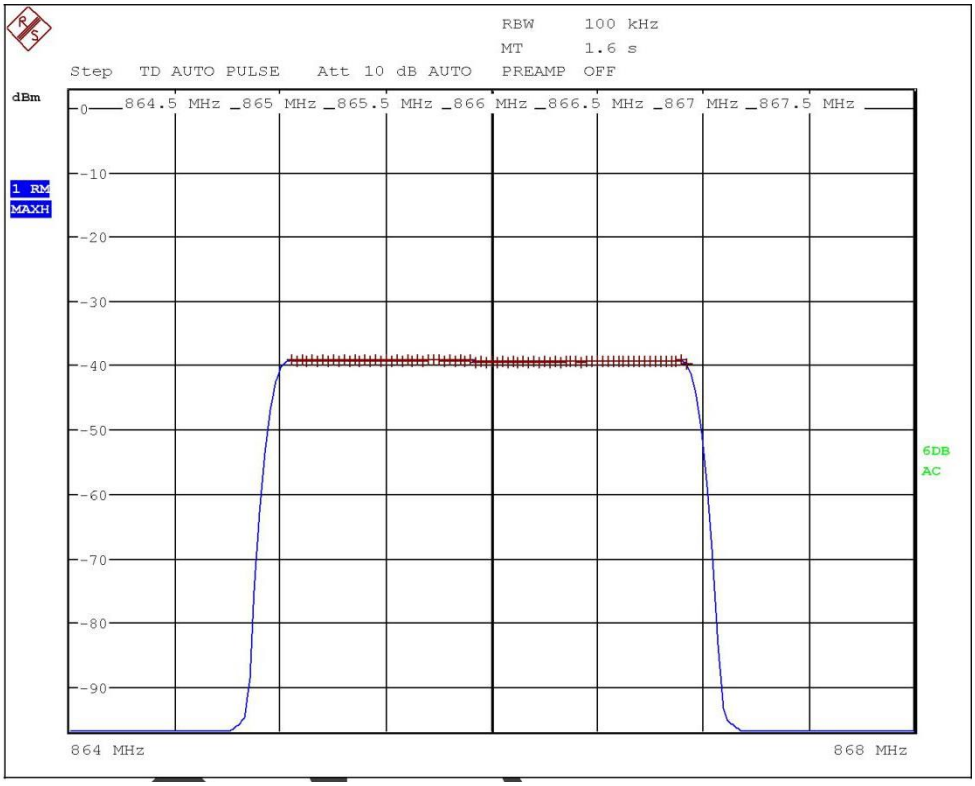
Channel Frequency (MHz)	ERP Measured (A) (dBm)	Correction Factor (F): = Attenuator(B)+ Cable loss (C) (dB)	ERP Standard Limit India (dBm)	ERP Calculated (D) = (A+F) (dBm)	EIRP Calculated = D+E (dBm)	Result
865.985	8.86*	10.64	36	19.46	21.61	Pass

B = Cable loss (dB)	0.83
C = Attenuator correction (dB)	9.81
E = EUT Antenna Gain (dBi)	2.15

***10 dB Attenuator is used on receiver**

5.2 Maximum Effective Radiated Power Spectral Density

Observation Graph: - Maximum Effective Radiated Power Spectral Density.



Observation Table: -

Serial No.	Centre Frequency (MHz)	Power Spectral Density Measured (A) (dBm/100KHz)	Correction Factor (F): = Cable loss(B) + Attenuators (C) (dBm)	Power Spectral Density calculated (A+F)(dBm/100KHz)
1	865.05	-39.165	30.26	-8.905
2	865.40	-39.116	30.26	-8.856
3	865.58	-39.259	30.26	-8.999
4	865.75	-39.102	30.26	-8.842
5	865.98	-39.495	30.26	-9.235
6	866.33	-39.447	30.26	-9.187
7	866.50	-39.291	30.26	-9.031
8	866.65	-39.267	30.26	-9.007

B = Cable loss (dB)	0.83
C = Attenuator correction (dB)	29.43

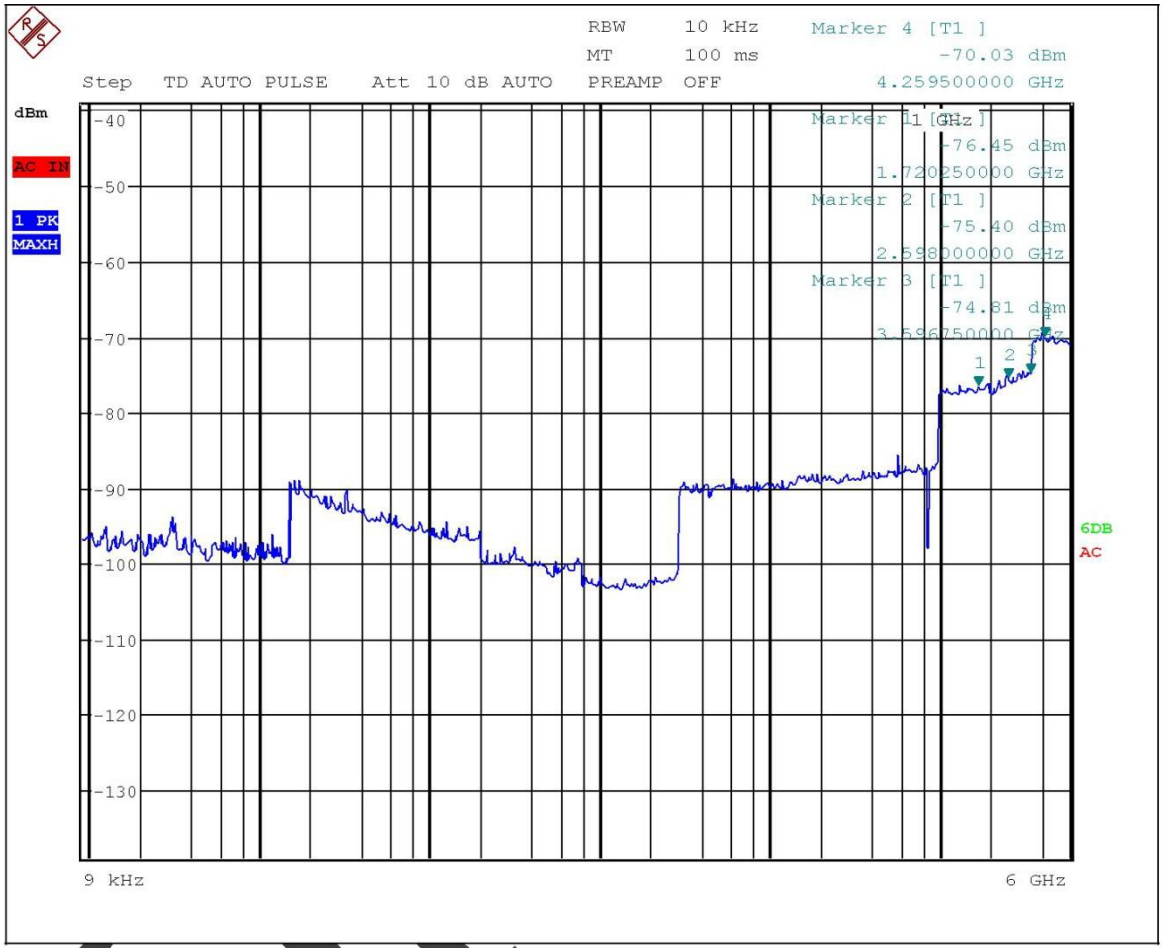
***30 dB Attenuator is used on receiver**

5.3 Unwanted emissions in the spurious domain for Tx mode

Observation Table: - Unwanted emission in the spurious domain of Mid Channel (865.9850 MHz)

Serial No.	Frequency (MHz)	Spurious Level Measured(A) (dBm)	Cable loss + attenuators(C) (dB)	Standard Limit (dBm)	Spurious level Including correction factors: A+B+C (dBm)	Result
1	1731.970	-76.45	30.44	-30	-46.01	Pass
2	2597.955	-75.40	30.81	-30	-44.59	Pass
3	3463.940	-74.81	31.07	-30	-43.74	Pass
4	4329.925	-70.03	30.76	-30	-39.27	Pass
5	5195.910	-70.09	31.47	-30	-38.62	Pass

Observation Graph: - Unwanted emission in the spurious domain of Mid Channel (865.9850 MHz).

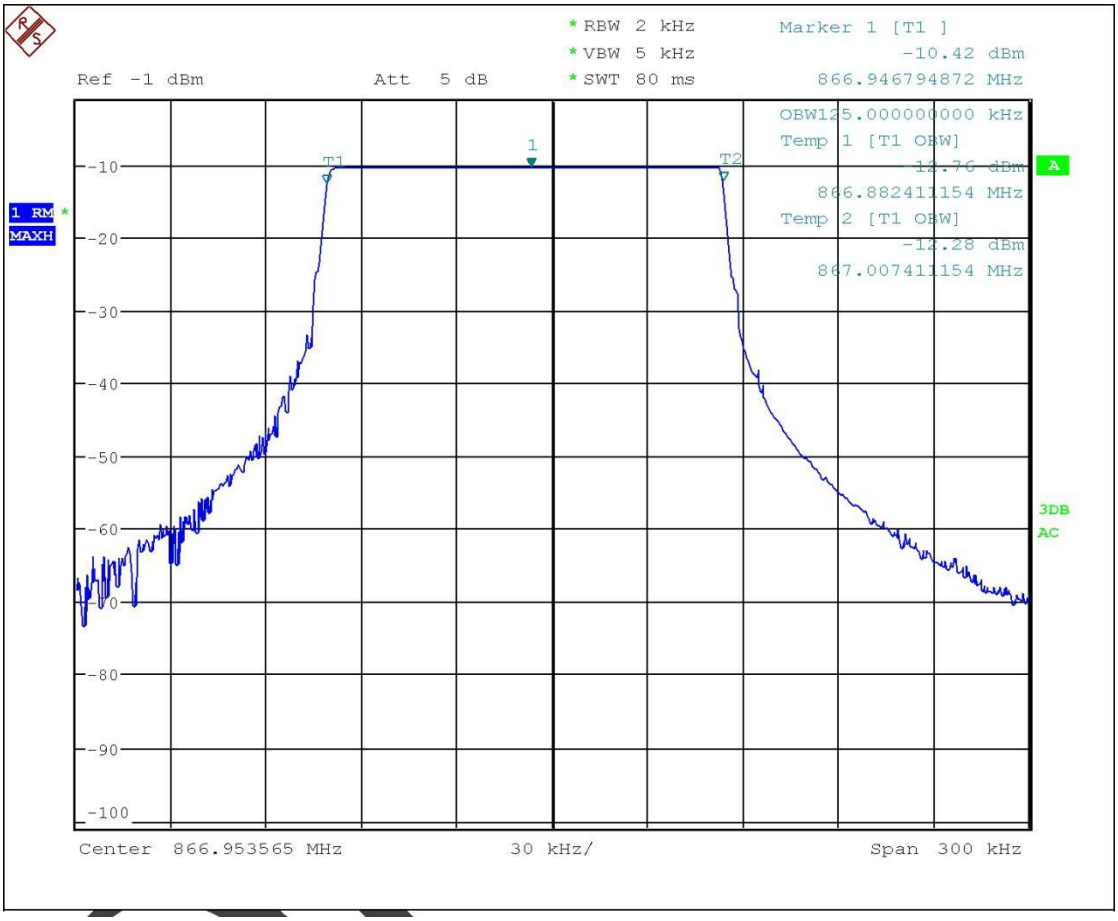


5.4 Occupied Bandwidth

Observation Table: -

Channel Frequency (MHz)	Occupied bandwidth Measured (KHz)	Standard Limit (KHz)	Result
866.9467	125.00	< 200	Pass

Observation Graph: - Occupied Bandwidth (Channel - 866.9467 MHz)



6. Antenna Mounting Options

To serve the propose of multiple antenna requirement, MiniMOD_2.0 comes with multiple options. Below are the MiniMOD_2.0 Antenna options:

1. Connect an external antenna thru the UFL connector mounted on PCB. It can be Simply connected thru a UFL Pigtail to antenna of your choice. Here 50Ω impedance matched antenna will work.
2. Through Hole Spring Helical antenna can also be used if antenna needs to be integral part of module. Just unmount the UFL connector and used through hole beneath the UFL connector pad to connect Spring Helical or other wire antenna. The recommend thick ness of wire is 0.7 to 0.9 mm to get it mounted in the PCB hole.
3. MiniMOD_2.0 has edge half cut pads to extend the RF signals on Daughter Board PCB and antenna can be mounted separately on DB PCB. Here needs to take care the 50Ω impedance characteristics of the RF track.

7. Important Notice

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