Prüfbericht - Nr.: *Test Report No.:*	**NN20DMQO 001**	**Auftrags-Nr.:** *Order No:*	180191544	Seite 1 von 109 *Page 1 of 109*
Kunden-Referenz-Nr.: *Client Reference No.:*	N/A	**Auftragsdatum:** *Order date:*	2020.09.09	
Auftraggeber: *Client:*	Ring LLC 1523 26th St, Santa Monica, CA 90404, USA			
Prüfgegenstand: *Test item:*	Mailbox Sensor			
Bezeichnung / Typ-Nr. : *Identification / Type No. :*	5D22E3			
Auftrags-Inhalt: *Order content:*	TÜV Rheinland – FCC/IC Service			
Prüfgrundlage: *Test specification:*	CFR47 FCC Part 15: Subpart C Section 15.209 CFR47 FCC Part 15: Subpart C Section 15.247 RSS-247 Issue 2 February 2017 RSS-Gen Issue 5 March 2019			
Wareneingangsdatum: *Date of receipt:*	2020.09.09			
Prüfmuster-Nr.: *Test sample No.:*	A002911576 001-002			
Prüfzeitraum: *Testing period:*	2020.09.15-2020.09.19			
Ort der Prüfung: *Place of testing:*	Refer to section 1.1.			
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland / CCIC (Ningbo) Co., Ltd.			
Prüfergebnis∗: *Test result∗:*	Pass			

geprüft von / *tested by:*

2020.10.16	Caidong Xie/PE	
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

kontrolliert von / *reviewed by:*

2020.10.16	Feng Liang/TC	
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

Sonstiges/ *Other:* Refer to the test report NN206RFD 001 for the conformance of Radio Frequency Exposure requirement. Refer to page 5 to 6 for more information.

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery :*	Prüfmuster vollständing und unbeschädigt *Test item complete and undamaged*

∗Legende:	1= Sehr gut	2 = gut	3= befriedigend	4= ausreichend	5 = mangelhaft
	P(ass) =entspricht o.g. Prüfgrundlage(n)		F(ail)= entspricht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T =nicht getestet
Legend:	*1= very good*	*2 = good*	*3= satisfactory*	*4= sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail)= failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

TEST SUMMARY

4.1.1 ANTENNA REQUIREMENT
Result:
Pass
4.1.2 6DB AND 20DB BANDWIDTH MEASUREMENT
Result:
Pass
4.1.3 99% EMISSION BANDWIDTH MEASUREMENT
Result:
Pass
4.1.4 MAXIMUM PEAK CONDUCTED OUTPUT POWER
Result:
Pass
4.1.5 EQUIVALENT ISOTROPICALLY RADIATED POWER
Result:
Pass
4.1.6 PEAK POWER SPECTRAL DENSITY
Result:
Pass
4.1.7 CONDUCTED SPURIOUS EMISSIONS MEASURED IN 100 KHZ BANDWIDTH
Result:
Pass
4.1.8 CARRIER SEPARATION MEASUREMENT
Result:
Pass
4.1.9 THE NUMBER OF HOPPING CHANNELS
Result:
Pass
4.1.10 CHANNEL OCCUPANCY TIME
Result:
Pass
4.1.11 CONDUCTED EMISSION (AC POWER-LINE)
Result:
N.A
4.1.12 RADIATED EMISSION
Result:
Pass

Contents

1 Test Sites

1.1 Test Facilities

Laboratory: TÜV Rheinland /CCIC(Ningbo) Co., Ltd.

1st Floor, Building 11, Scholar Innovation Park, No.1188 Zhongguan Road, Zhenhai District, Ningbo 315200 P.R. China.

The used test equipment is in accordance with CISPR 16-1 series standards for measurement of radio interference.

1.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

No.	Equipment	Model	Inventory no.	Last cal. date	Cal. due date
1.	EMI test receiver	ESR7	101929	2019.11.26	2020.11.25
2.	Spectrum analyzer	FSV40	101412	2019.11.26	2020.11.25
3.	Pre-amplifier	SCU-18F	180051	2019.11.26	2020.11.25
4.	Horn antenna	HF907	102653	2020.08.03	2021.08.02
5.	Bilog Antenna	CBL6112D	49033	2018.04.13	2021.04.12

1.3 Measurement Uncertainty

Test Item	Expanded Measurement Uncertainty (k=2)
Conducted Emission (9-150kHz)	3.70dB
Conducted Emission (150k-30MHz)	3.30dB
Radiated Emission (30-1000MHz)	4.52dB
Radiated Emission (1-18GHz)	4.37dB

2 General Product Information

2.1 Product Function and Intended Use

The EUT(equipment under test) is a Mailbox Sensor which support Bluetooth, LoRa DTS, LoRa FHSS and FSK HFSS function operated at 2400-2483.5MHz and 902-928MHz respectively. For the further information, refer to the user's manual.

Model list:

Model name	Function
5D22E3	Block A: BLE operated at 2.4GHz
	Block B: LoRa DTS, LoRa FHSS and FSK FHSS operated at 902-928MHz. This block has two antennas, not operating simultaneously. Therefor block B is only in SISO working mode.

2.2 Ratings and System Details

Rated input : DC 4.5V 3AAA Cells
Protection Class : Class III
FCC ID : 2AEUPRBMB001
IC : 20271-RBMB001
HVIN : 5D22E3
FVIN : 1.7.16-56
PMN : Mailbox Sensor

Technical Specification of BLE

Technical Specification	BLE
Operating Frequency band	2402 – 2480 MHz
Bluetooth Core Version	Bluetooth Low Energy 4.2
Channel separation	2MHz
Extreme Temperature Range	-20℃ ~ 50℃
Modulation	GFSK
Antenna Type	PCB Layout Antenna
Antenna Gain(dBi)	3.26
Channel	0-39

Technical Specification of LoRa DTS

Technical Specification	LoRa DTS 500kHz 902.5-926.5MHz
Operating Frequency band	902 – 928 MHz
Extreme Temperature Range	-20℃ ~ 50℃
Bandwidth(kHz)	500
Modulation	LoRa DTS
Antenna Type	PIFA Antenna for external antenna LTCC Antenna for internal antenna
Antenna Gain(dBi)	1.0 dBi for external antenna 1.1 dBi for internal antenna
Channel Separation (kHz)	800
Channel Number	31
Channel (MHz)	902.5, 903.3, 904.1, 904.9, 905.7, 906.5, 907.3, 908.1, 908.9, 909.7, 910.5, 911.3, 912.1, 912.9, 913.7, 914.5,

	915.3, 916.1, 916.9, 917.7, 918.5, 919.3, 920.1, 920.9, 921.7, 922.5, 923.3, 924.1, 924.9, 925.7, 926.5

Technical Specification of LoRa FHSS

Technical Specification	LoRa 125kHz FHSS 902.2-927.8MHz
Operating Frequency band	902 – 928 MHz
Extreme Temperature Range	-20℃ ~ 50℃
Modulation	LoRa FHSS
Antenna Type	PIFA Antenna for external antenna LTCC Antenna for internal antenna
Antenna Gain(dBi)	1.0 dBi for external antenna 1.1 dBi for internal antenna
Channel Separation (kHz)	200
Channel Number	129
Bandwidth (kHz)	125
Hopping channel(MHz)	902.2-927.8

Technical Specification of FSK FHSS

Technical Specification	FSK150Kbps FHSS	FSK 50Kbps FHSS	FSK 250Kbps FHSS
Operating Frequency band	902 – 928 MHz		
Extreme Temperature Range	-20℃ ~ 50℃		
Modulation	FSK FHSS		
Antenna Type	PIFA Antenna for external antenna LTCC Antenna for internal antenna		
Antenna Gain(dBi)	1.0 dBi for external antenna 1.1 dBi for internal antenna		
Channel Separation (kHz)	400	200	500
Channel Number	64	129	51
Data Rate (Kbps)	150	50	250
Hopping Channel(MHz)	902.4-927.6	902.2-927.8	902.5-927.5

2.3 Independent Operation Modes

The basic operation modes are:
Mode A: Transmitting continuously in a channel for BLE
Mode B: Hopping in a sequence of hopping channels and Transmitting
Mode C: Transmitting continuously or Receiving continuously in a channel, the worst case recorded
Ant. 1#: RF path of BLE module.
Ant. 2#: RF path using external antenna of LoRa&FSK module.
Ant. 3#: RF path using internal antenna of LoRa&FSK module.

2.4 Noise Generating and Noise Suppressing Parts

Refer to the Circuit diagram for further information.

2.5 Submitted Documents

Circuit diagram, PCB layout, Labels, user's manual, etc.

3 Test Set-up and Operation Modes

3.1 Principle of Configuration Selection

The equipment under test (EUT) was configured to measure its maximum power level. The Mode Cs were adapted accordingly in reference to the instructions for use.

3.2 Test Operation and Test Software

During testing, Channel & Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power was selected according to the instruction given by the manufacturer. The setting of the RF output power expected by the customer shall be fixed on the firmware of the final end product.

All testing were performed according to the procedures in ANSI C63.10: 2013.

Test Software EMC32 V10.30 was used in the radiated emission test.

3.3 Special Accessories and Auxiliary Equipment

Description	Manufacturer	Model No.
notebook	Lenovo	T420

3.4 Countermeasures to achieve EMC Compliance

The tested sample contained noise suppression components as specified in the circuit diagram. No special measure is employed to achieve the requirement.

3.5 Test set-up

Diagram of Measurement Configuration for Radiation Test (Below 1GHz)

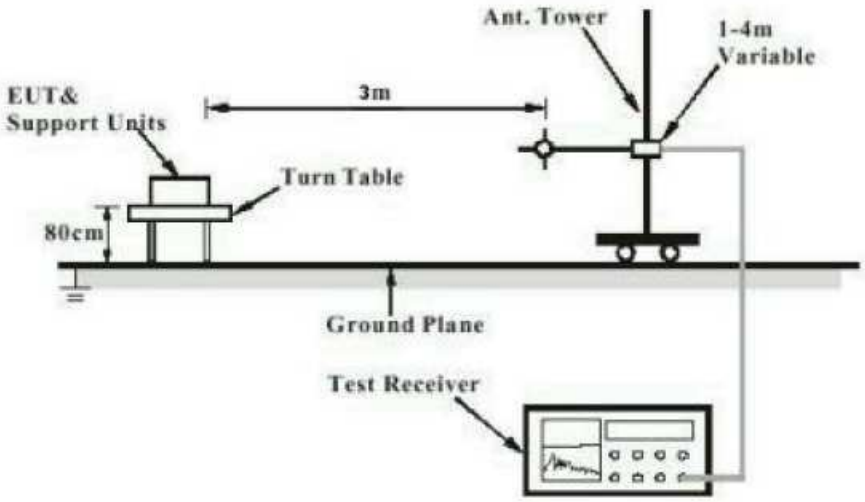


Diagram of Measurement Configuration for Radiation Test (Above 1GHz)

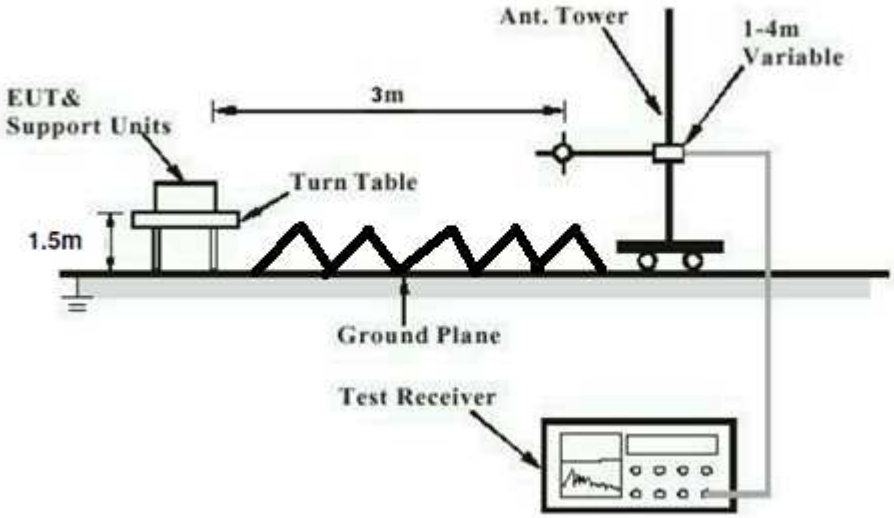
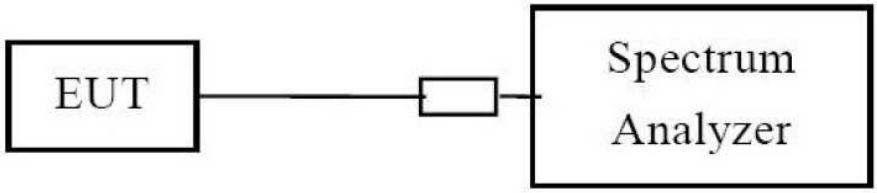


Diagram of Measurement Configuration for Conducted Transmitter Measurement



4 Test Results

4.1 Transmitter Requirement & Test Suites

4.1.1 Antenna Requirement

Result: **Pass**

Test Specification
Test standard : FCC Part 15.203

The EUT has two internal antennas and one external antenna, which permanently attached and no consideration of replacement. The external antenna is nonstandard one and cannot be replaced by others. Therefore, the EUT is considered sufficient to comply with the provision. Refer to EUT Photo for further details.

4.1.2 6dB and 20dB Bandwidth Measurement

Result: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(a)(1)(i), (a)(2) RSS-247 Issue 2 February 2017 Clause 5.1, Clause5.2
Basic standard	:	ANSI C63.10: 2013, clause 6.9.2 KDB558074 D01v05r02, clause 8.3.1.1
Limits	:	At least 500kHz for 6dB bandwidth(DTS) Not more than 500kHz for 20dB bandwidth(FHSS)
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2020.09.18-2020.09.19
Input voltage	:	DC 4.5V
Operational mode	:	Mode A
Test channel	:	Lo, Mi, Hi
Temperature	:	19°C
Relative humidity	:	55%
Atmospheric pressure	:	101 kPa

Table 2: Test result of 6dB Bandwidth for BLE and LoRa DTS, 20dB Bandwidth for LoRa FHSS and FSK FHSS

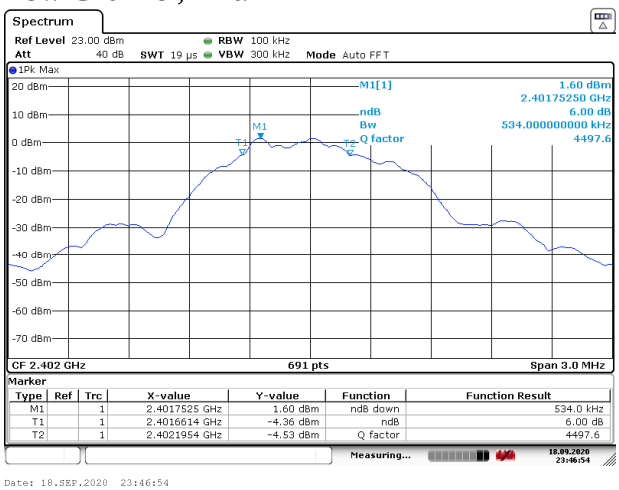
Modulation Type and Operation band	Ant. No.	Channel	Channel Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Result
1. BLE 2402MHz~2480MHz 6dB Bandwidth	1#	Low Channel	2402	534.00	500	Pass
		Mid Channel	2440	534.00	500	Pass
		High Channel	2480	516.60	500	Pass
2. LoRa 500kHz DTS 902.5MHz~926.5MHz 6dB Bandwidth	2#	Low Channel	902.5	620.80	500	Pass
		Mid Channel	914.5	620.80	500	Pass
		High Channel	926.5	616.50	500	Pass
	3#	Low Channel	902.5	625.20	500	Pass
		Mid Channel	914.5	629.50	500	Pass
		High Channel	926.5	616.50	500	Pass
3. LoRa 125kHz FHSS 902.2-927.8MHz 20dB Bandwidth	2#	Low Channel	902.2	145.44	500	Pass
		Mid Channel	915	148.34	500	Pass
		High Channel	927.8	146.16	500	Pass
	3#	Low Channel	902.2	149.06	500	Pass
		Mid Channel	915	143.99	500	Pass
		High Channel	927.8	144.72	500	Pass

4. FSK 150Kbps FHSS 902.4MHz~927.6MHz 20dB Bandwidth	2#	Low Channel	902.4	172.94	500	Pass
		Mid Channel	914.8	171.49	500	Pass
		High Channel	927.6	175.83	500	Pass
	3#	Low Channel	902.4	174.38	500	Pass
		Mid Channel	914.8	173.66	500	Pass
		High Channel	927.6	174.38	500	Pass
5. FSK 50Kbps FHSS 902.2MHz~927.8MHz 20dB Bandwidth	2#	Low Channel	902.2	107.81	500	Pass
		Mid Channel	915	108.54	500	Pass
		High Channel	927.8	108.54	500	Pass
	3#	Low Channel	902.2	107.81	500	Pass
		Mid Channel	915	110.71	500	Pass
		High Channel	927.8	109.99	500	Pass
6. FSK 250Kbps FHSS 902.5MHz~927.5MHz 20dB Bandwidth	2#	Low Channel	902.5	282.20	500	Pass
		Mid Channel	915	280.80	500	Pass
		High Channel	927.5	276.40	500	Pass
	3#	Low Channel	902.5	279.30	500	Pass
		Mid Channel	915	282.20	500	Pass
		High Channel	927.5	276.40	500	Pass

Figure 1: 6dB&20dB Bandwidth Measurement

1. BLE, 6dB Bandwidth, 2402MHz~2480MHz

Low Channel, Ant. 1#



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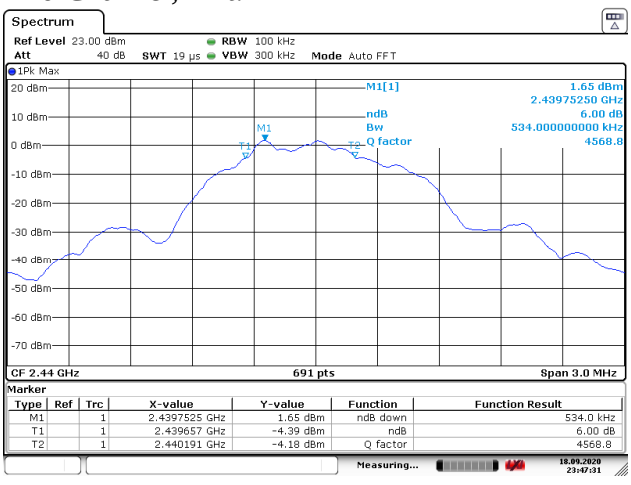
Mid Channel, Ant. 1#



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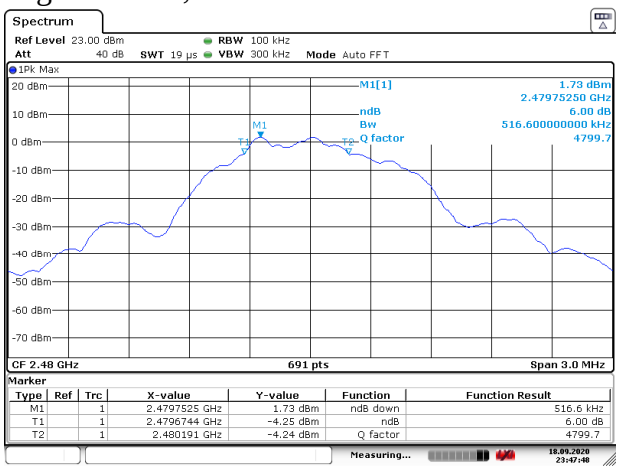
High Channel, Ant. 1#



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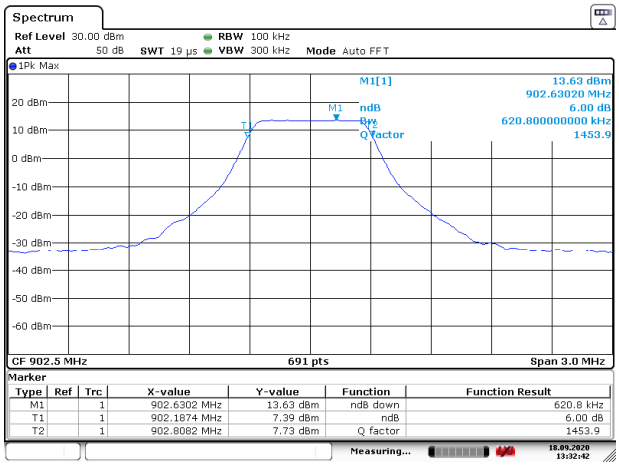
2. LoRa 500kHz DTS, 6dB Bandwidth, 902.5MHz~926.5MHz

Ant. 2#

Low Channel



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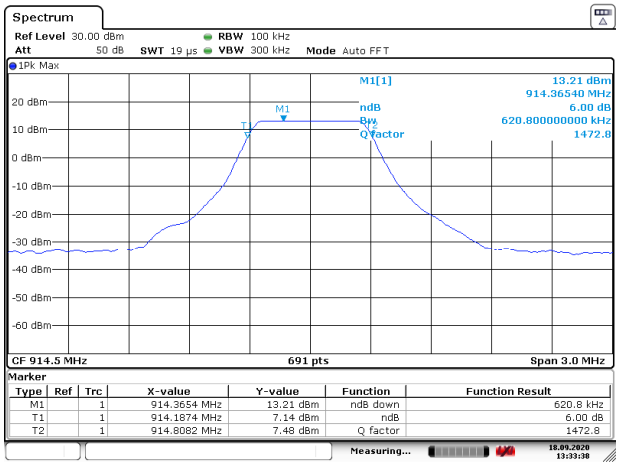

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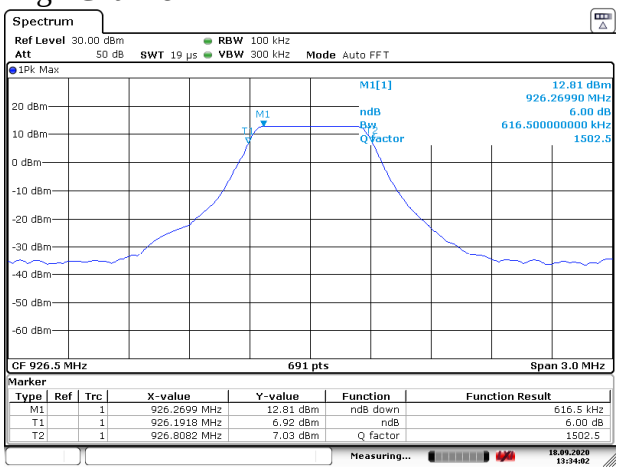
High Channel



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Ant. 3#

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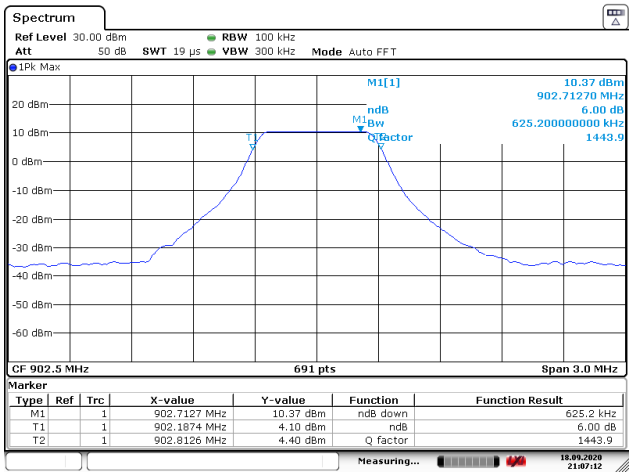

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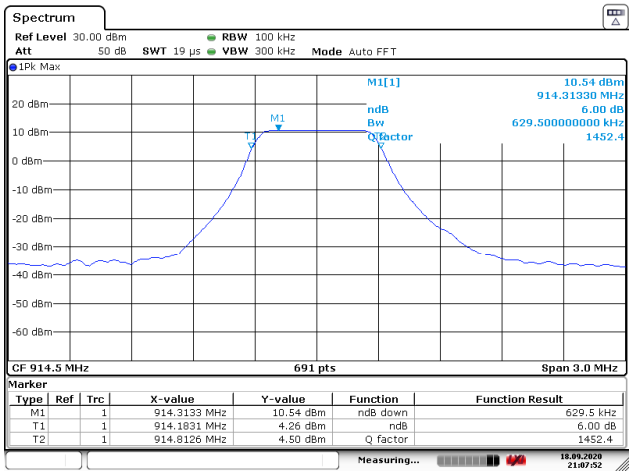

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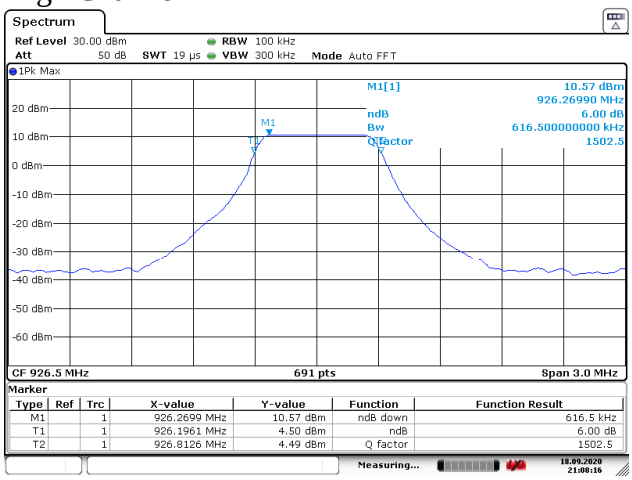

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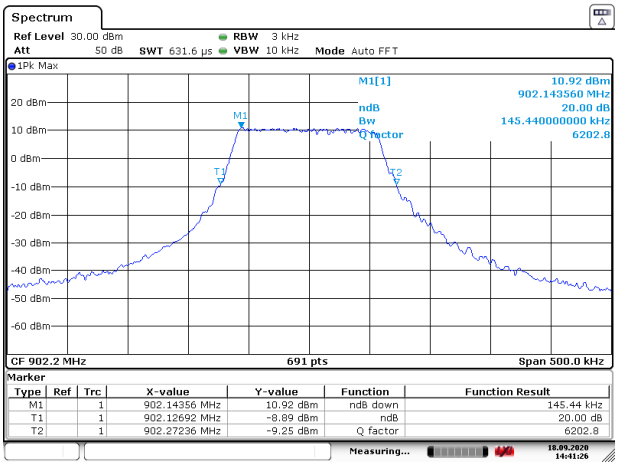
3. LoRa 125kHz FHSS, 20dB Bandwidth, 902.2MHz-927.8MHz

Ant. 2#

Low Channel



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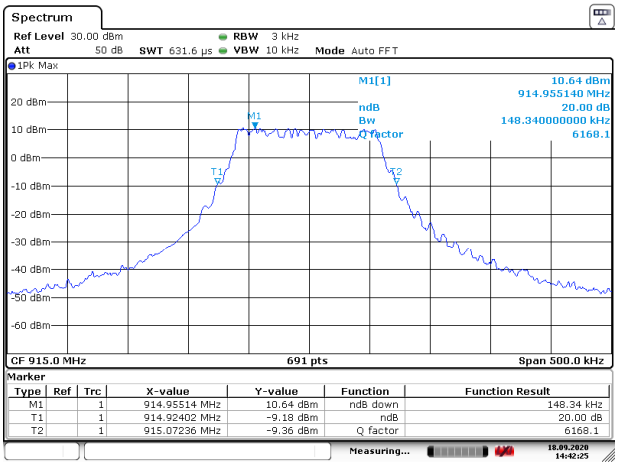
Mid Channel



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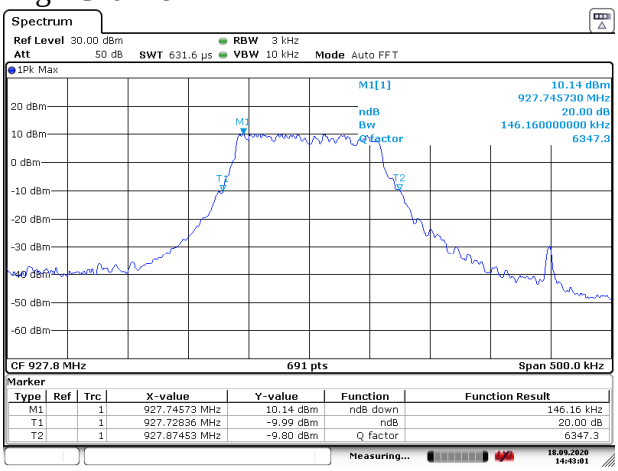
High Channel



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Ant. 3#

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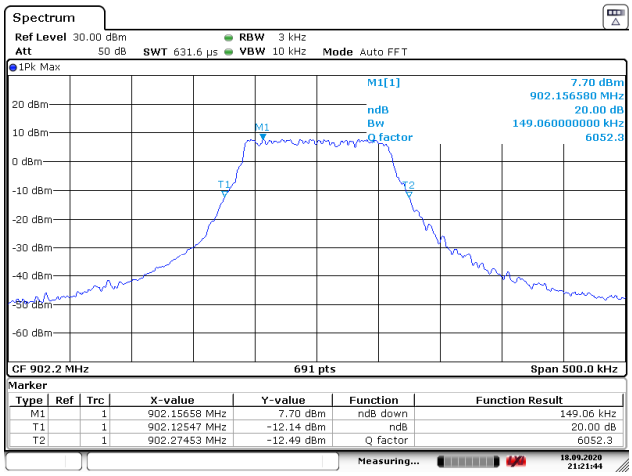

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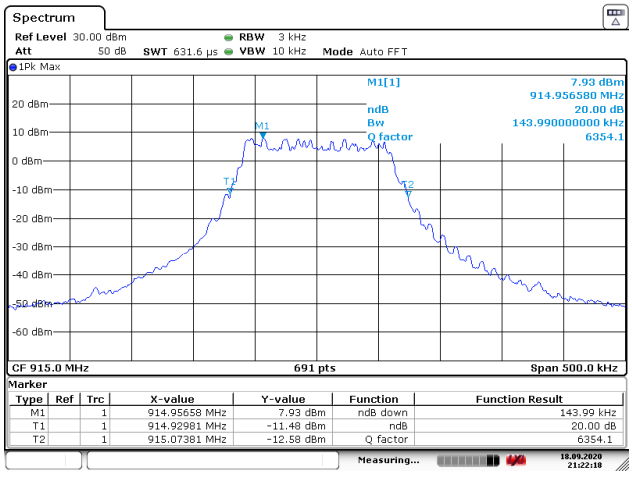
Mid Channel



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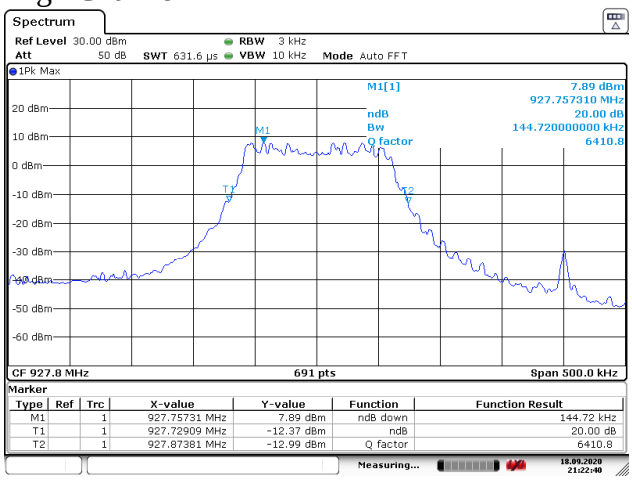

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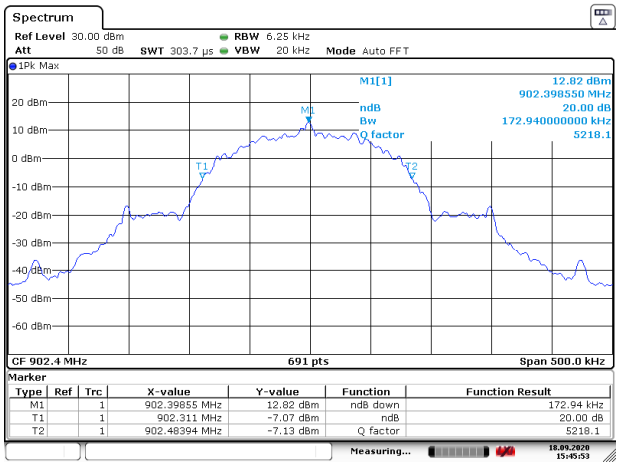
4. FSK 150Kbps FHSS, 20dB Bandwidth, 902.4MHz~927.6MHz

Ant. 2#

Low Channel



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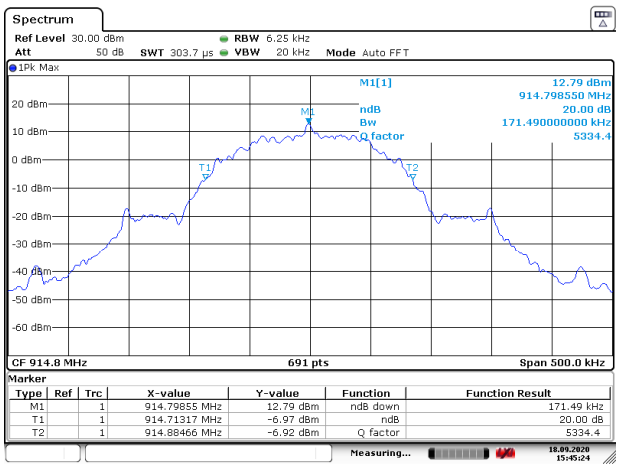
Mid Channel



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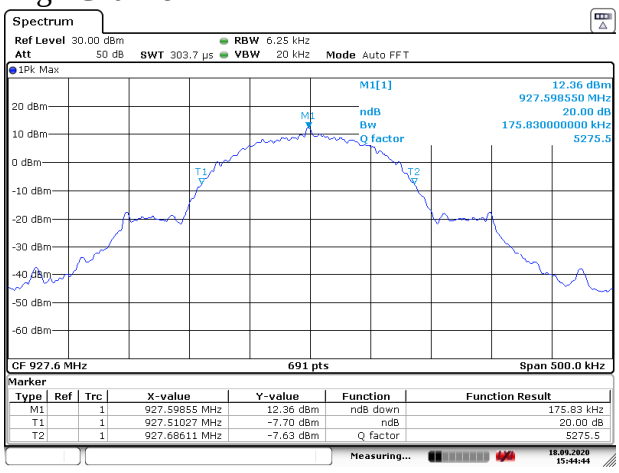

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Ant. 3#

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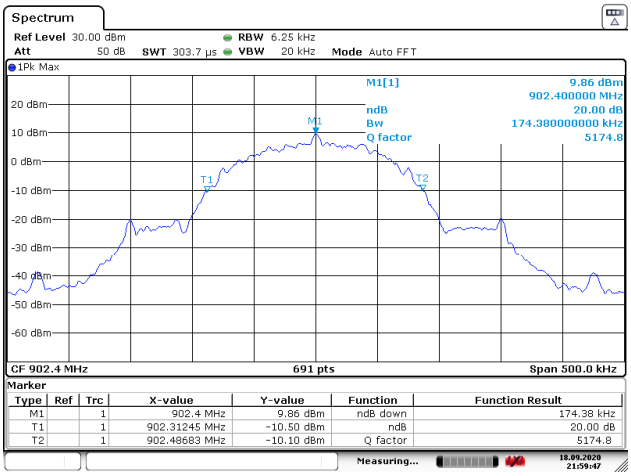

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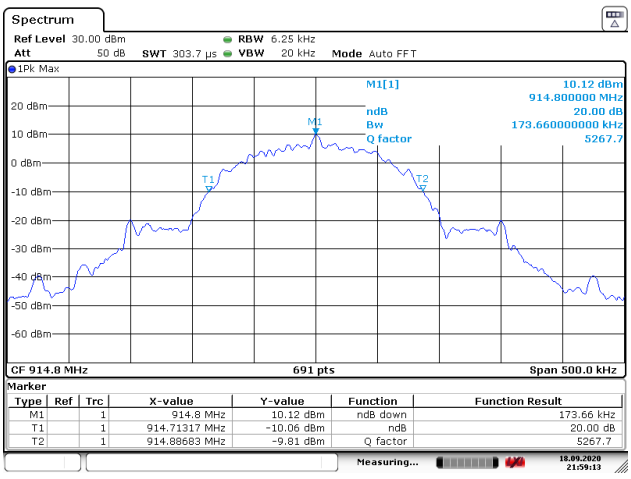
Mid Channel



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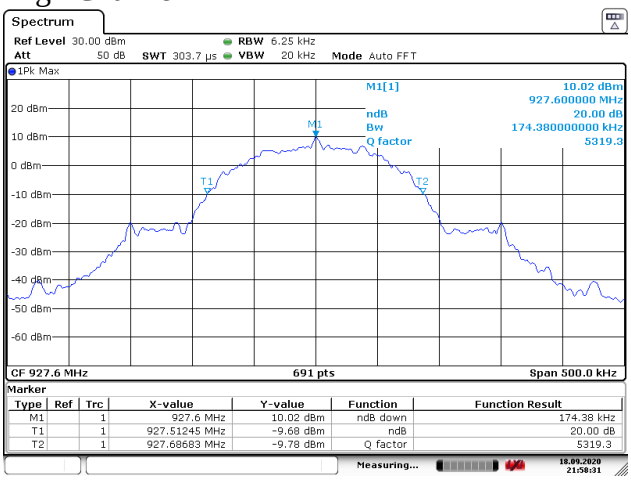
High Channel



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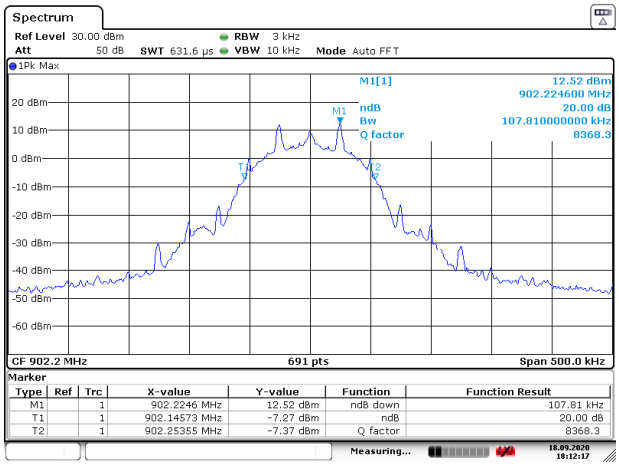
5. FSK 50Kbps FHSS, 20dB Bandwidth, 902.2MHz~927.8MHz

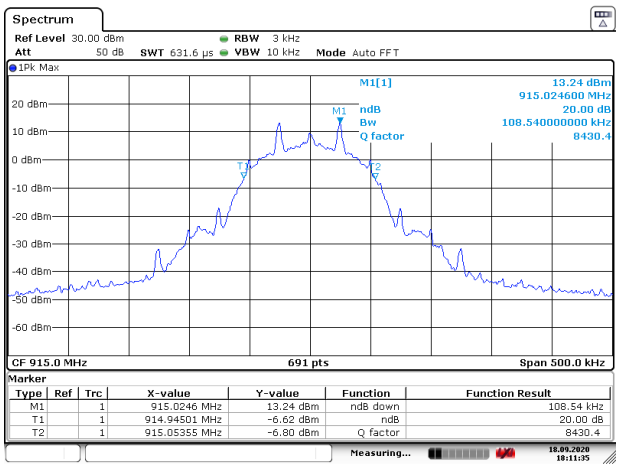
Ant. 2#

Low Channel



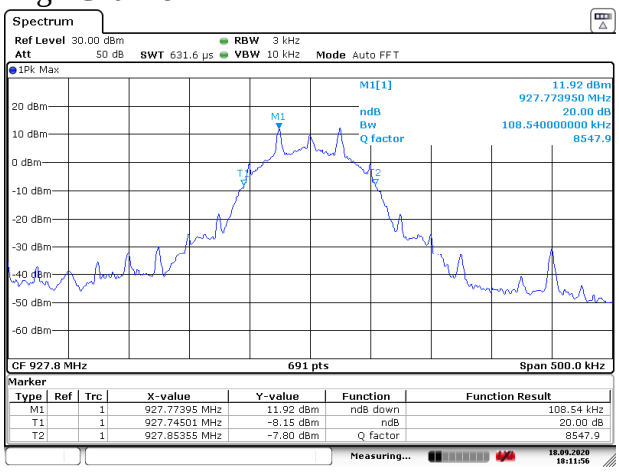
Date: 18.SEP.2020 18:12:17

Mid Channel



Date: 18.SEP.2020 18:11:36

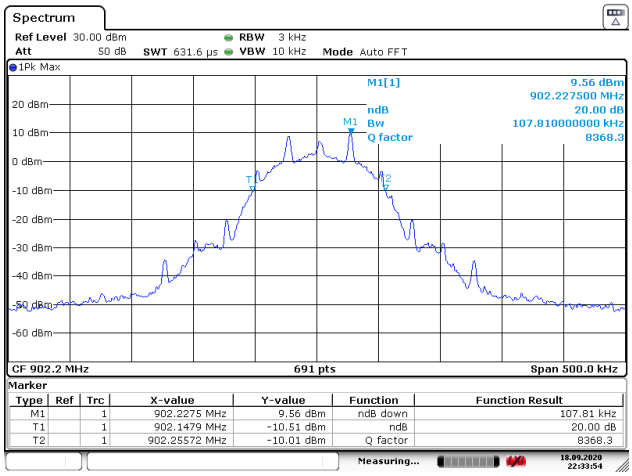
High Channel



Date: 18.SEP.2020 18:11:57

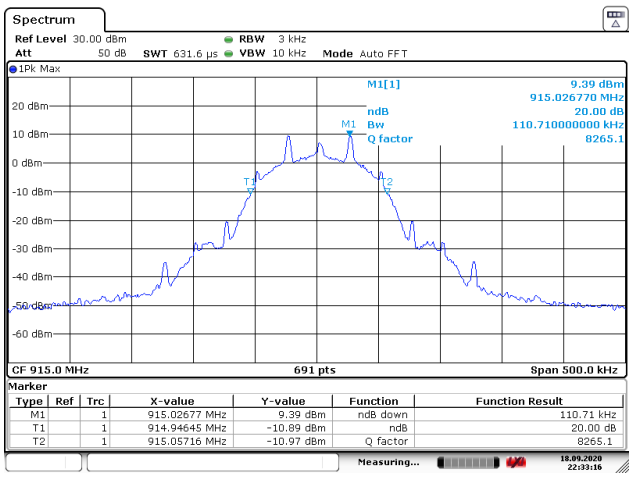
Ant. 3#

Low Channel



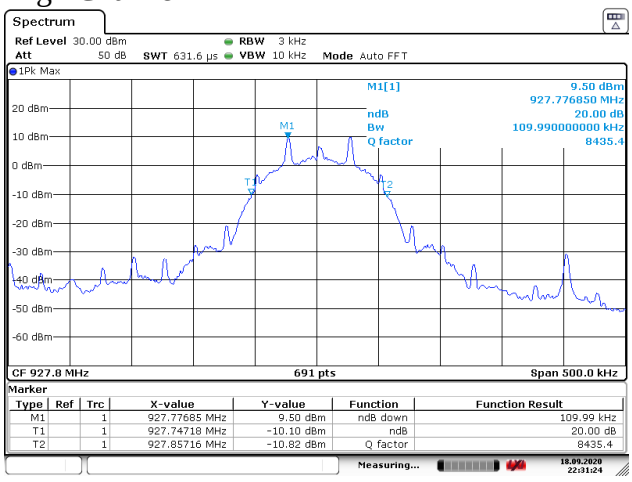
Date: 18.SEP.2020 22:33:54

Mid Channel



Date: 18.SEP.2020 22:33:16

High Channel

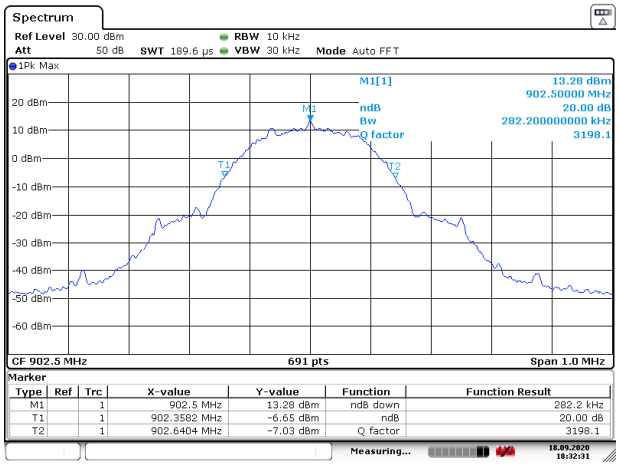


Date: 18.SEP.2020 22:31:24

6. FSK 250Kbps FHSS, 20dB Bandwidth, 902.5MHz~927.5MHz

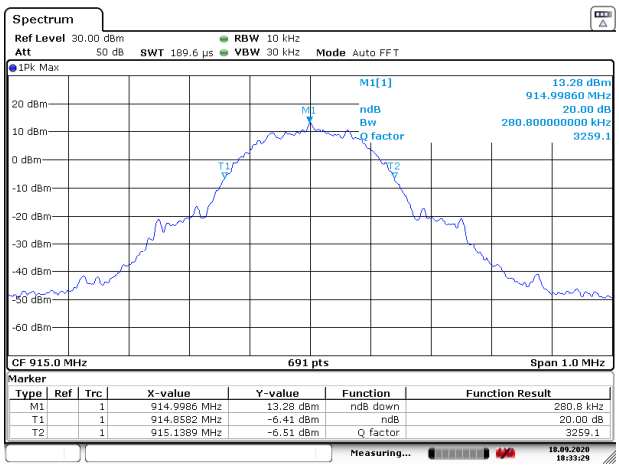
Ant. 2#

Low Channel



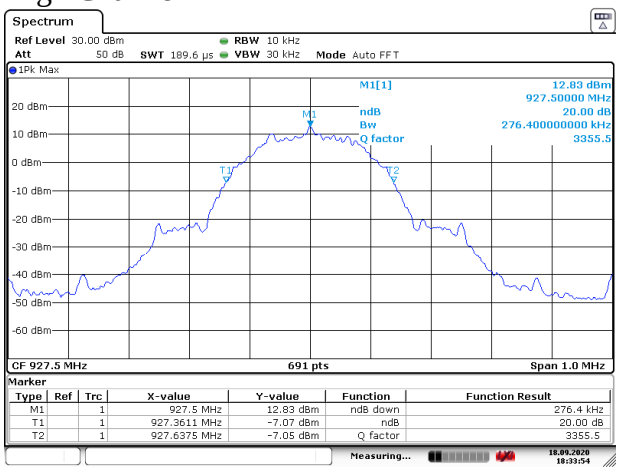
Date: 18.SEP.2020 18:32:32

Mid Channel



Date: 18.SEP.2020 18:33:29

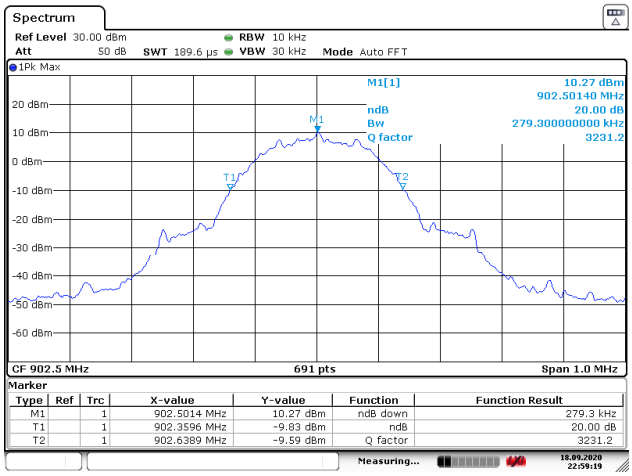
High Channel



Date: 18.SEP.2020 18:33:54

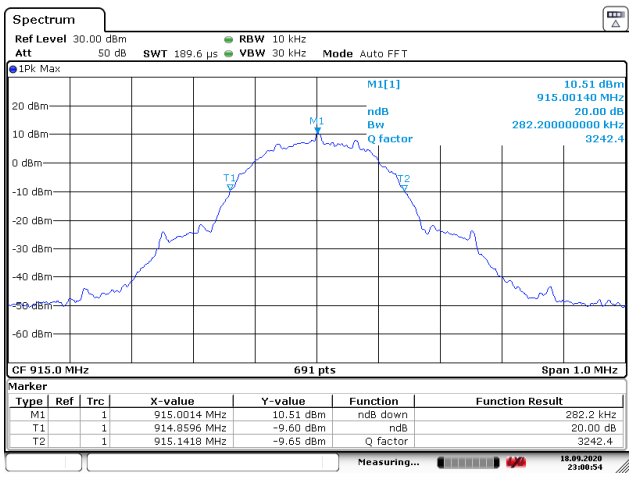
Ant. 3#

Low Channel



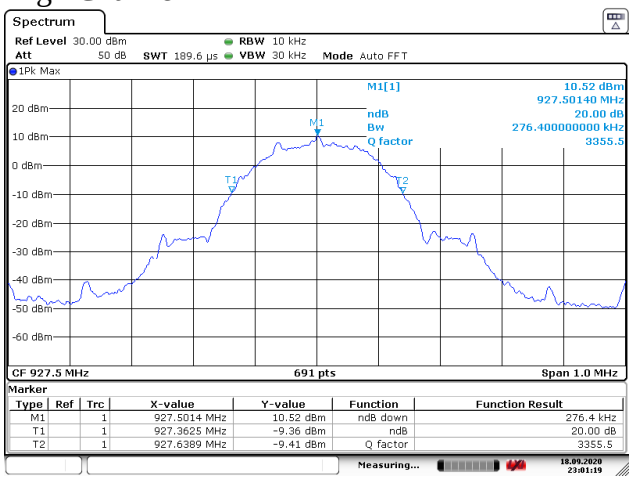
Date: 18.SEP.2020 22:59:20

Mid Channel



Date: 18.SEP.2020 23:00:54

High Channel



Date: 18.SEP.2020 23:01:20

4.1.3 99% Emission Bandwidth Measurement

Result: **Pass**

Test Specification

Test standard	:	RSS Gen Issue 5 March 2019, clause 6.7
Basic standard	:	ANSI C63.10: 2013, clause 6.9.3
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2020.09.18-2020.09.19
Input voltage	:	DC 4.5V
Operational mode	:	Mode A
Test channel	:	Lo, Mi, Hi
Temperature	:	19°C
Relative humidity	:	55%
Atmospheric pressure	:	101 kPa

Table 3 Test result of 99% Emission Bandwidth for BLE, LoRa DTS, LoRa FHSS and FSK FHSS

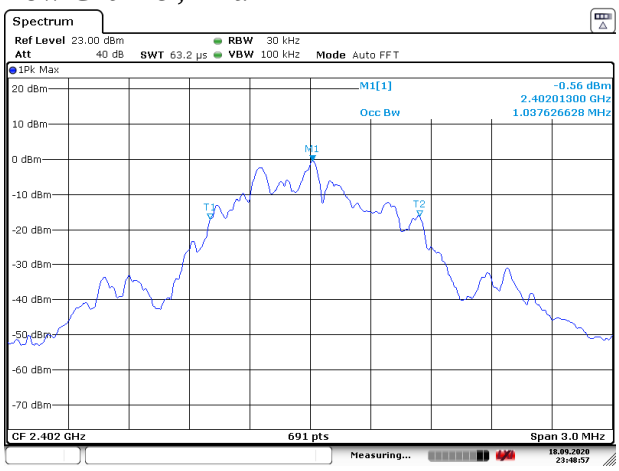
Modulation Type and Operation band	Ant. No.	Channel	Channel Frequency (MHz)	Bandwidth (kHz)
1. BLE 2402MHz~2480MHz 99% Emisson Bandwidth	1#	Low Channel	2402	1037.63
		Mid Channel	2440	1037.63
		High Channel	2480	1037.63
2. LoRa 500kHz DTS 902.5MHz~926.5MHz 99% Emisson Bandwidth	2#	Low Channel	902.5	500.72
		Mid Channel	914.5	515.20
		High Channel	926.5	503.62
	3#	Low Channel	902.5	506.51
		Mid Channel	914.5	518.09
		High Channel	926.5	509.41
3. LoRa 125kHz FHSS 902.2MHz~927.8MHz 99% Emisson Bandwidth	2#	Low Channel	902.2	125.90
		Mid Channel	915	125.90
		High Channel	927.8	125.90
	3#	Low Channel	902.2	126.63
		Mid Channel	915	128.08
		High Channel	927.8	125.90
4. FSK 150Kbps FHSS 902.4MHz~927.6MHz 99% Emisson Bandwidth	2#	Low Channel	902.4	159.19
		Mid Cha1nnel	914.8	157.74
		High Channel	927.6	159.19
	3#	Low Channel	902.4	157.74
		Mid Cha1nnel	914.8	157.02
		High Channel	927.6	159.91

5. FSK 50Kbps FHSS 902.2MHz~927.8MHz 99% Emisson Bandwidth	2#	Low Channel	902.2	103.47
		Mid Channel	915	103.47
		High Channel	927.8	104.20
	3#	Low Channel	902.2	102.75
		Mid Channel	915	104.20
		High Channel	927.8	103.47
6. FSK 250Kbps FHSS 902.5MHz~927.5MHz 99% Emisson Bandwidth	2#	Low Channel	902.5	253.26
		Mid Channel	915	253.26
		High Channel	927.5	251.81
	3#	Low Channel	902.5	253.26
		Mid Channel	915	253.26
		High Channel	927.5	251.81

Figure 2: 99% Emission Bandwidth Measurement

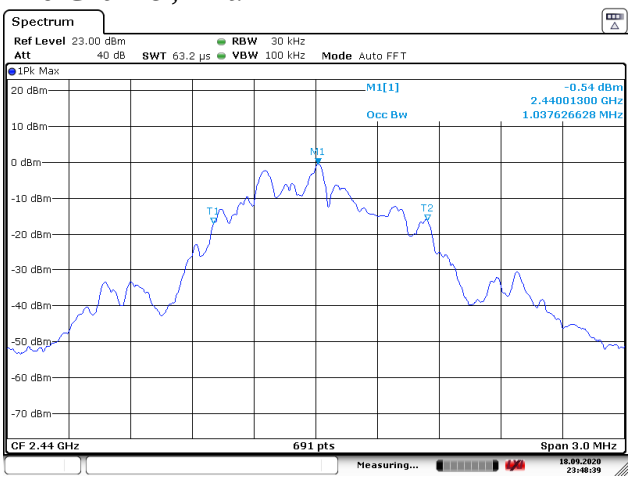
1. BLE, 99% Emission Bandwidth, 2402MHz~2480MHz

Low Channel, Ant. 1#



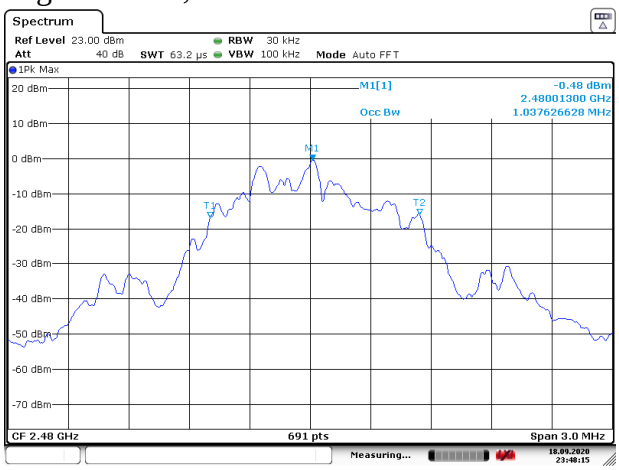
Date: 18.SEP.2020 23:48:58

Mid Channel, Ant. 1#



Date: 18.SEP.2020 23:48:40

High Channel, Ant. 1#

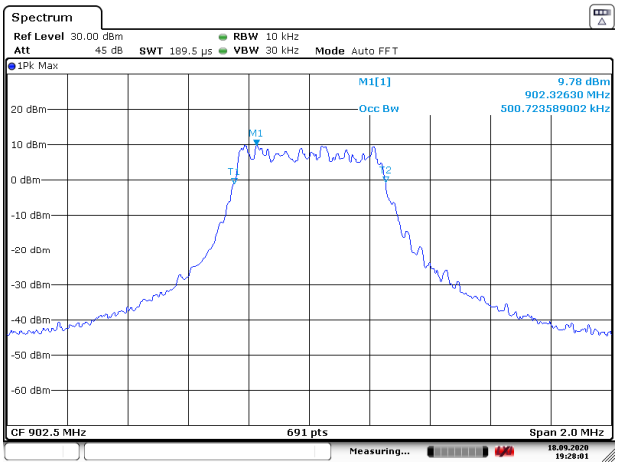


Date: 18.SEP.2020 23:48:16

2. LoRa 500kHz DTS, 99% Emission Bandwidth, 902.5MHz~926.5MHz

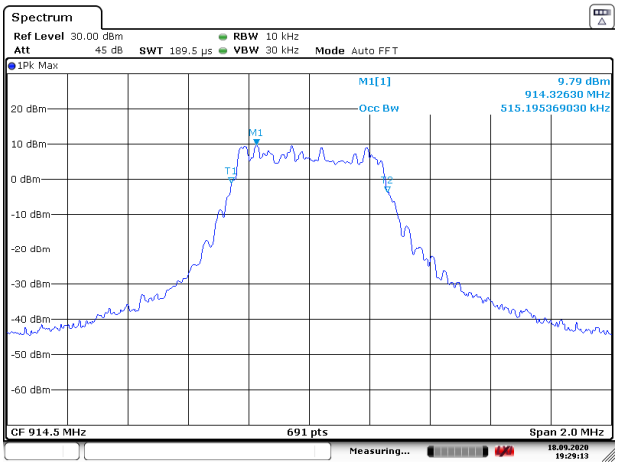
Ant. 2#

Low Channel



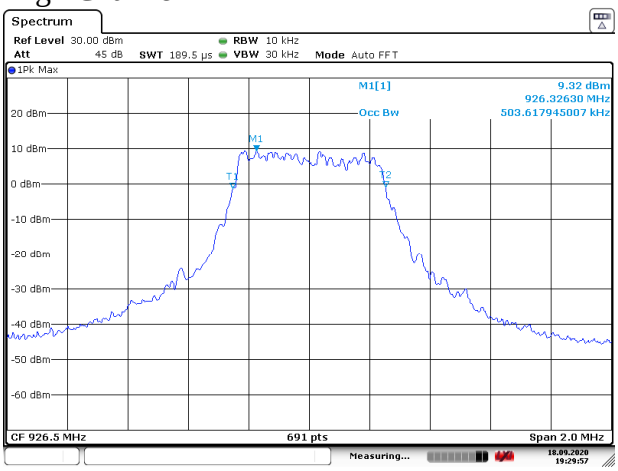
Date: 18.SEP.2020 19:28:01

Mid Channel



Date: 18.SEP.2020 19:29:14

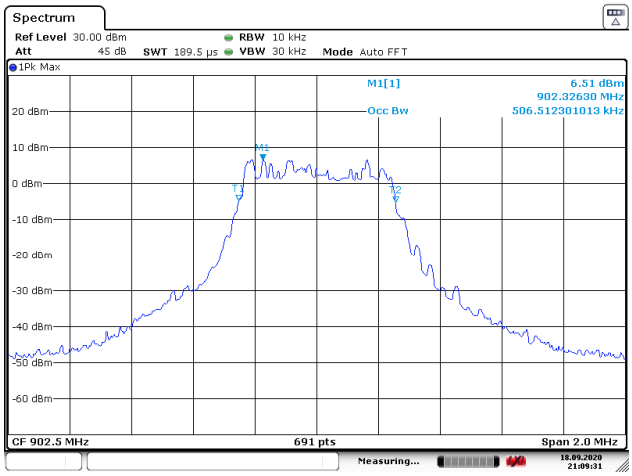
High Channel



Date: 18.SEP.2020 19:29:58

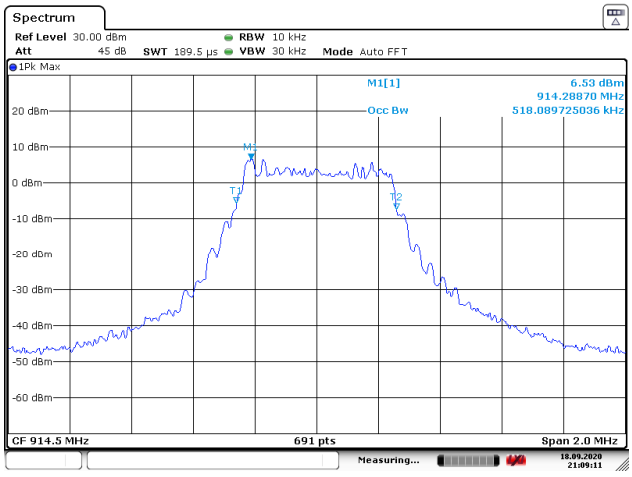
Ant. 3#

Low Channel



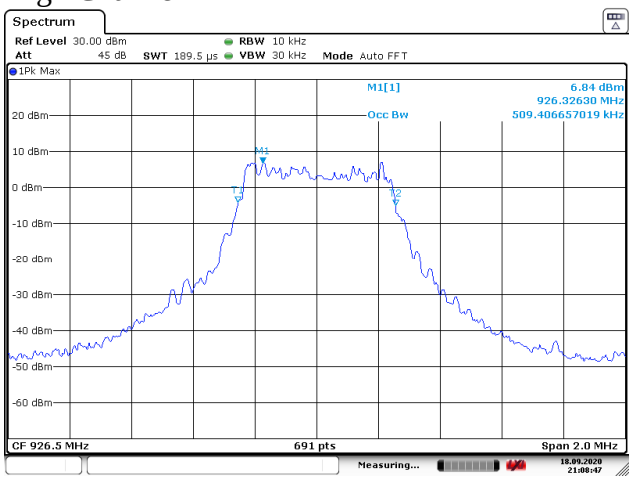
Date: 18.SEP.2020 21:09:31

Mid Channel



Date: 18.SEP.2020 21:09:11

High Channel

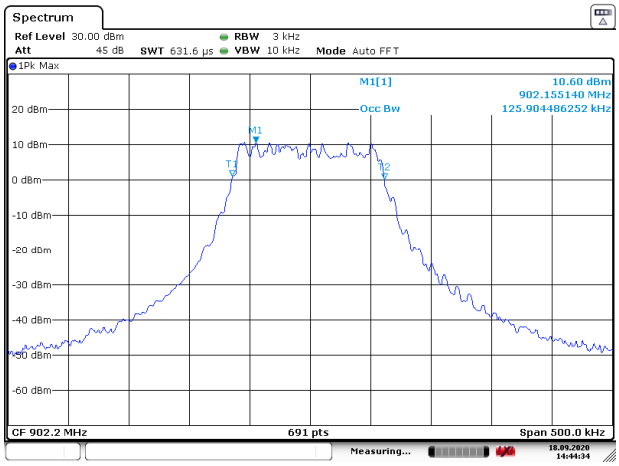


Date: 18.SEP.2020 21:08:48

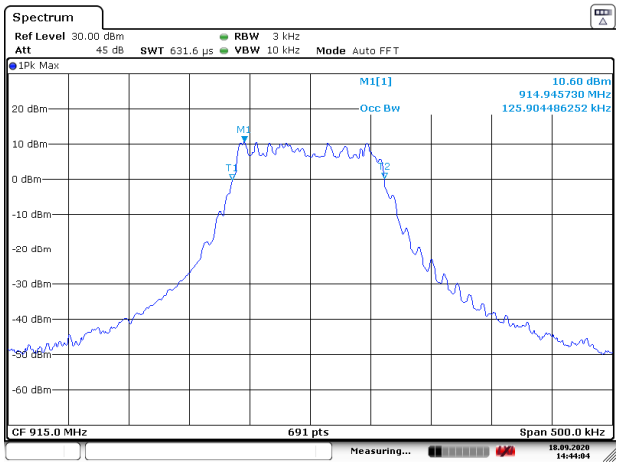
3. LoRa 125kHz FHSS, 99% Emission Bandwidth, 902.2MHz~927.8MHz

Ant. 2#

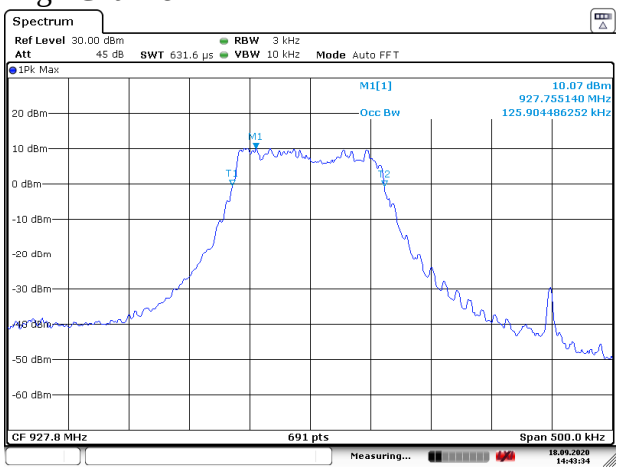
Low Channel



Mid Channel

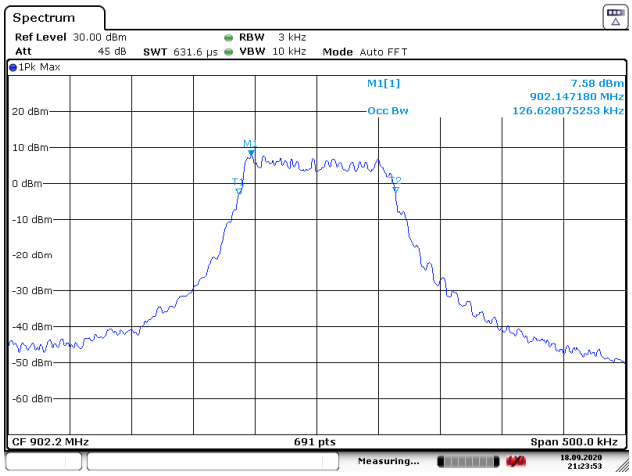


High Channel

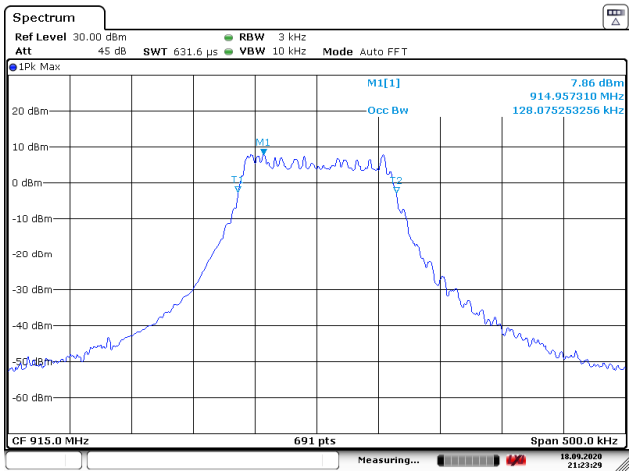


Ant. 3#

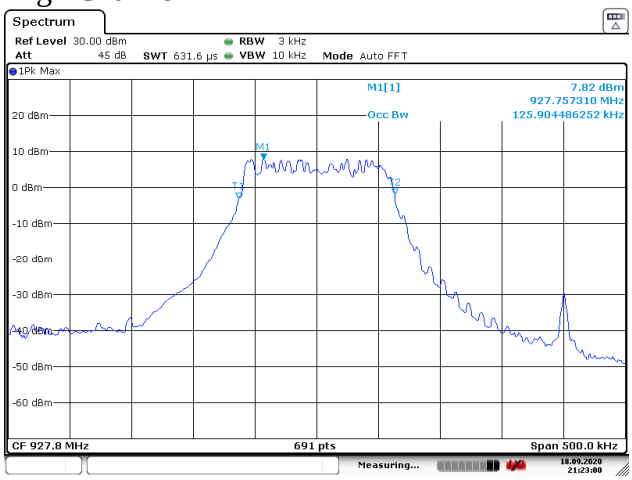
Low Channel



Mid Channel



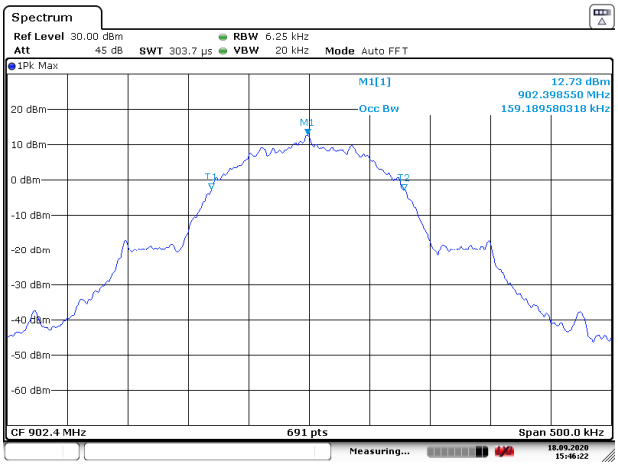
High Channel



4. FSK 150Kbps FHSS, 99% Emission Bandwidth, 902.4MHz~927.6MHz

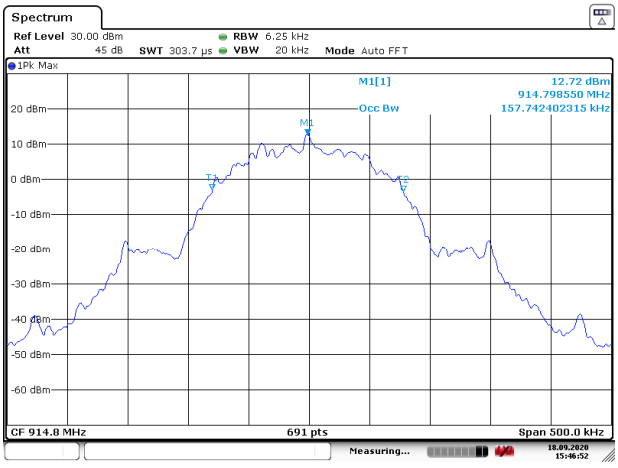
Ant. 2#

Low Channel



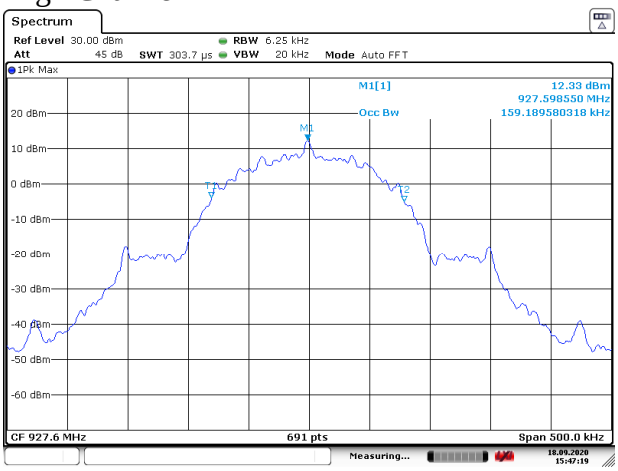
Date: 18.SEP.2020 15:46:22

Mid Channel



Date: 18.SEP.2020 15:46:53

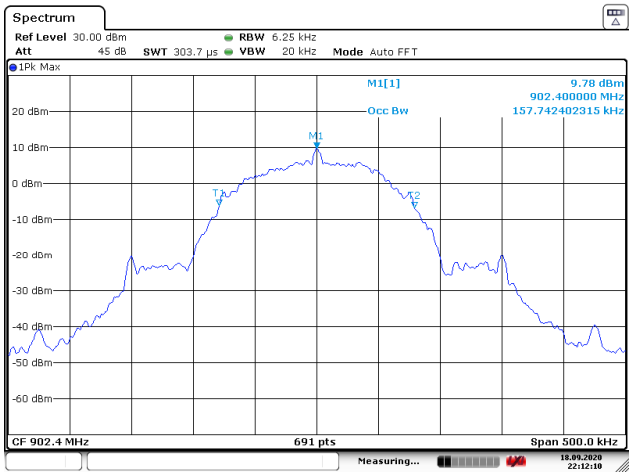
High Channel



Date: 18.SEP.2020 15:47:19

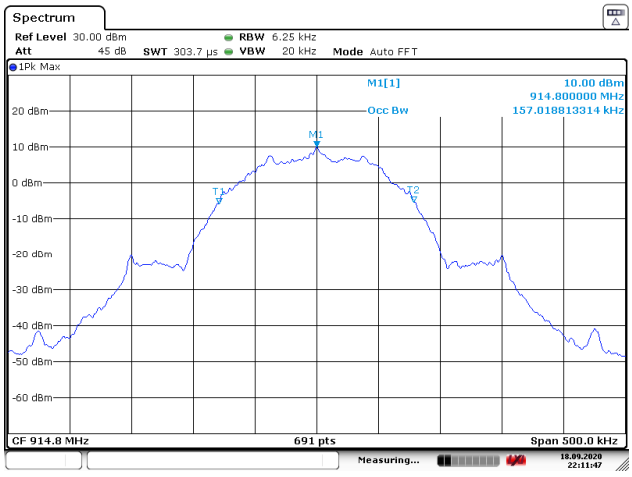
Ant. 3#

Low Channel



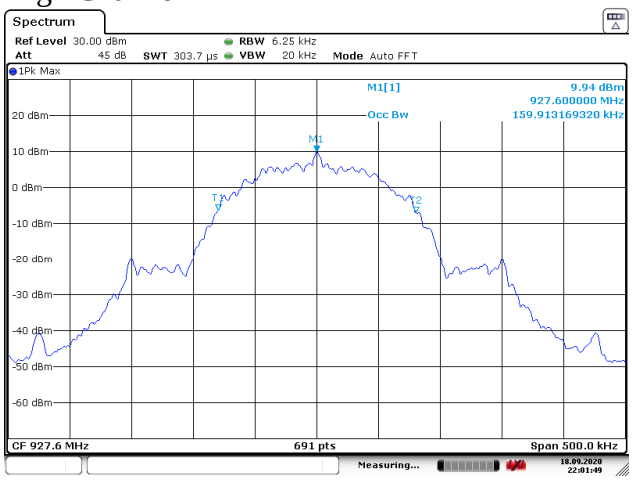
Date: 18.SEP.2020 22:12:11

Mid Channel



Date: 18.SEP.2020 22:11:47

High Channel

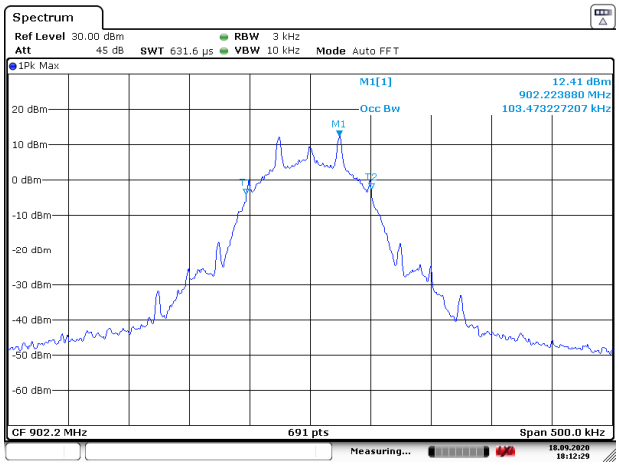


Date: 18.SEP.2020 22:01:49

5. FSK 50Kbps FHSS, 99% Emission Bandwidth, 902.2MHz~927.8MHz

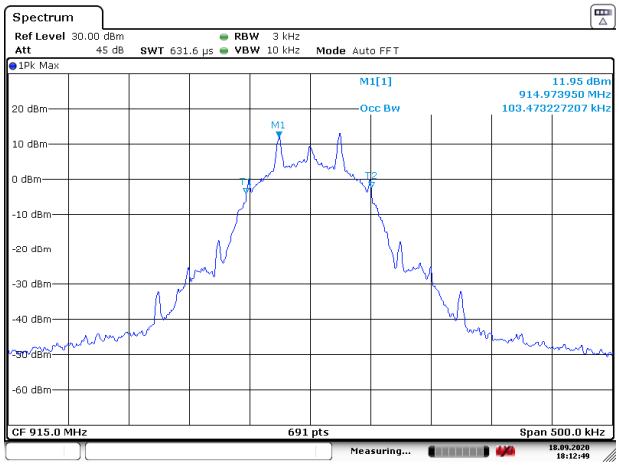
Ant. 2#

Low Channel



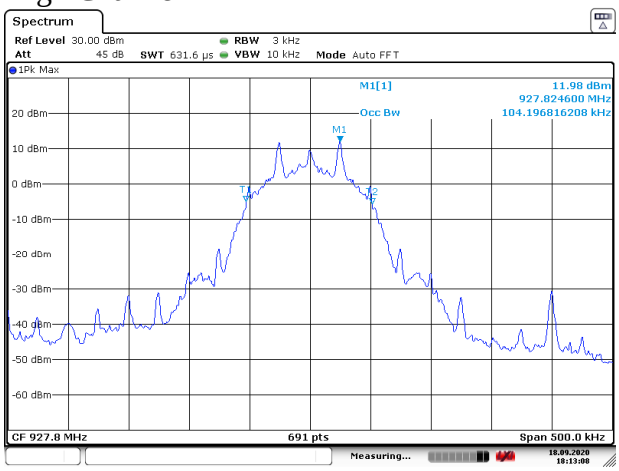
Date: 18.SEP.2020 18:12:29

Mid Channel



Date: 18.SEP.2020 18:12:50

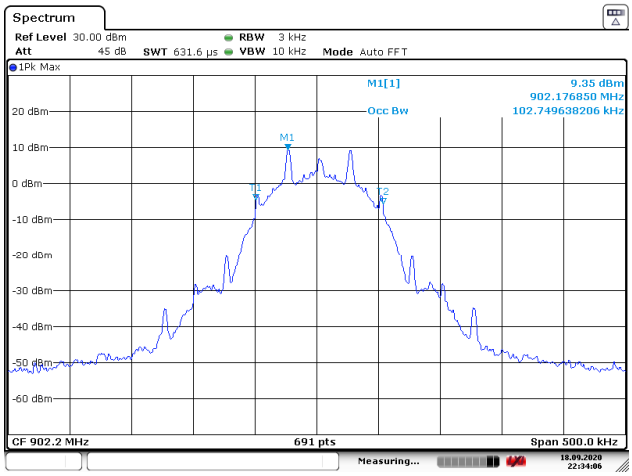
High Channel



Date: 18.SEP.2020 18:13:08

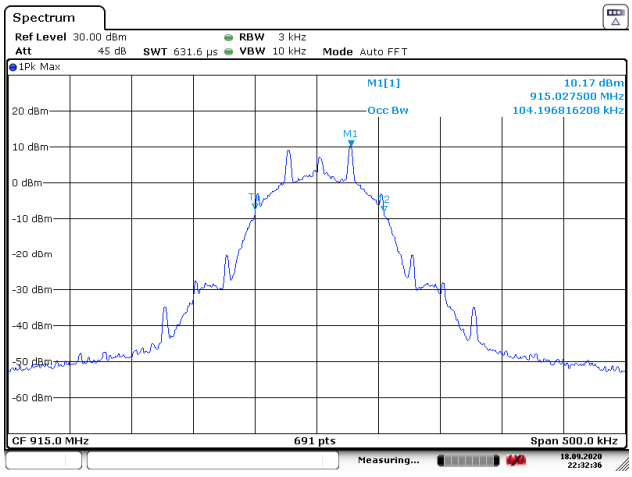
Ant. 3#

Low Channel



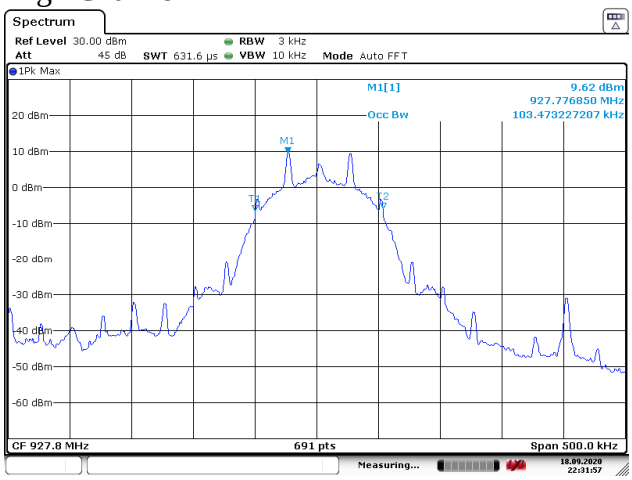
Date: 18.SEP.2020 22:34:07

Mid Channel



Date: 18.SEP.2020 22:32:37

High Channel

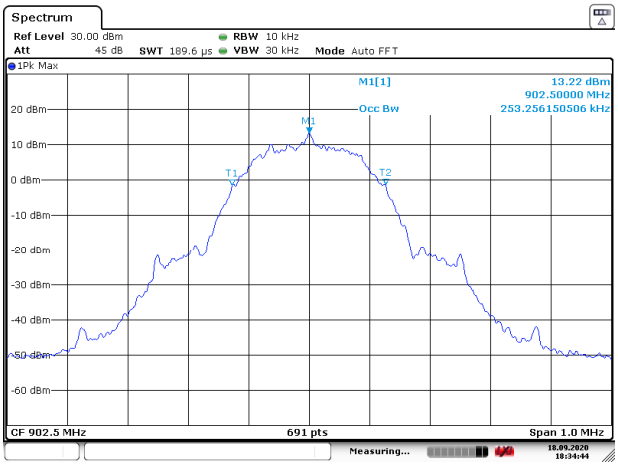


Date: 18.SEP.2020 22:31:57

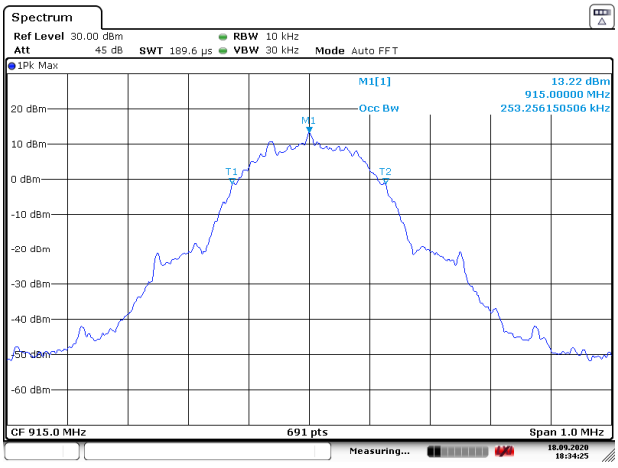
6. FSK 250Kbps FHSS, 99% Emission Bandwidth, 902.5MHz~927.5MHz

Ant. 2#

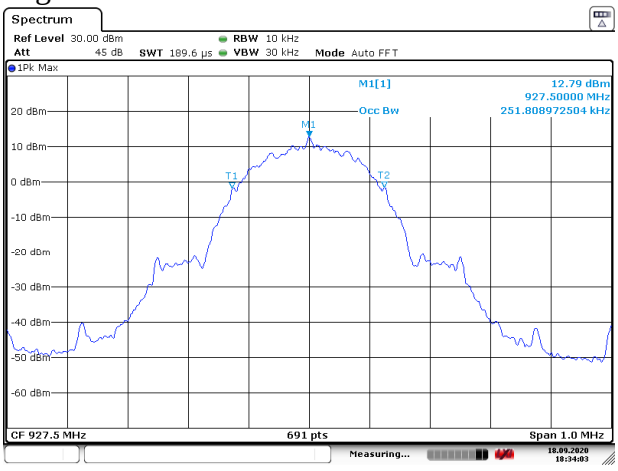
Low Channel



Mid Channel

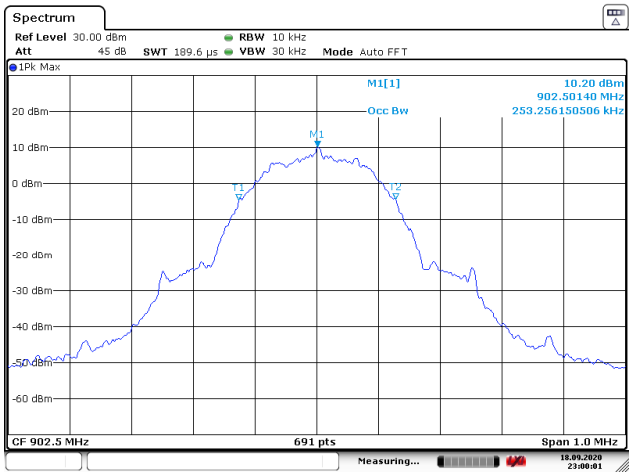


High Channel

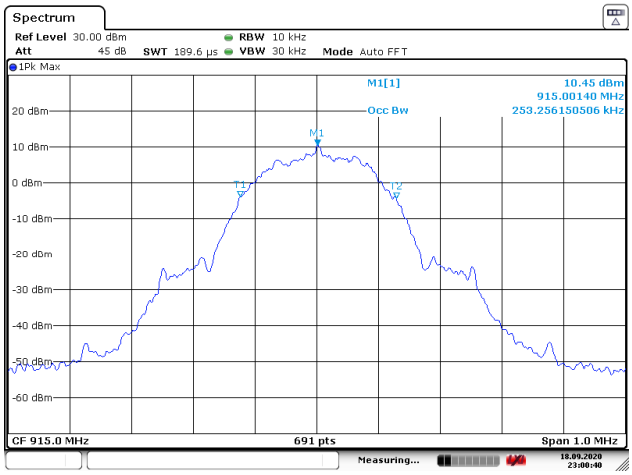


Ant. 3#

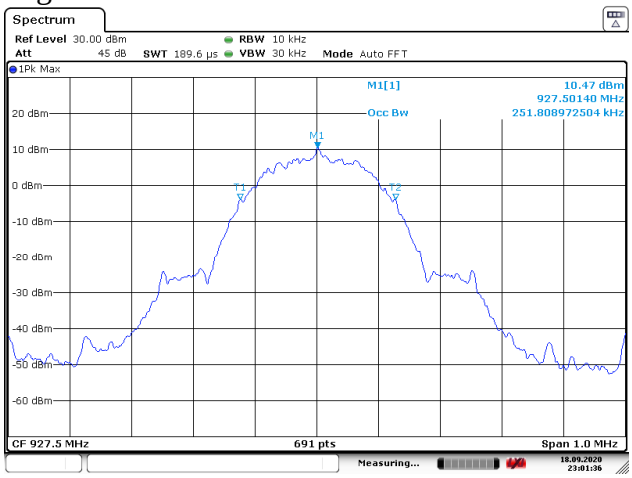
Low Channel



Mid Channel



High Channel



4.1.4 Maximum Peak Conducted Output Power

Result: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(b)(2), (3) RSS-247 Issue 2 February 2017 Clause 5.4(a), (d)
Basic standard	:	ANSI C63.10: 2013, clause 11.9.1 KDB558074 D01v05r02, clause 8.3.1.3
Limits	:	Not more than 1Watt(30dBm) for DTS in the band 902-928MHz and 2400-2483.5MHz; Not more than 1Watt(30dBm) for FHSS with at least 50 hopping channels in the band 902-928MHz
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2020.09.18-2020.09.19
Input voltage	:	DC 4.5V
Operational mode	:	Mode A
Test channel	:	Lo, Mi, Hi
Temperature	:	19°C
Relative humidity	:	55%
Atmospheric pressure	:	101 kPa

Table 4: Test result of Maximum Peak Output Power for BLE, LoRa DTS, LoRa FHSS and FSK FHSS

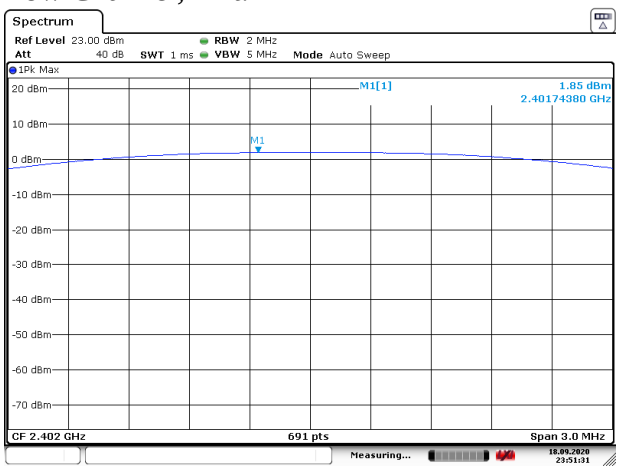
Modulation Type and Operation band	Ant. No.	Channel	Channel Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)
1. BLE 2402MHz~2480MHz	1#	Low Channel	2402	1.85	30
		Mid Channel	2440	1.87	30
		High Channel	2480	1.91	30
2. LoRa 500kHz DTS 902.5MHz~926.5MHz	2#	Low Channel	902.5	13.39	30
		Mid Channel	914.5	13.34	30
		High Channel	926.5	13.13	30
	3#	Low Channel	902.5	10.40	30
		Mid Channel	914.5	10.61	30
		High Channel	926.5	10.61	30
3. LoRa 125kHz FHSS 902.2MHz~927.8MHz	2#	Low Channel	902.2	13.25	30
		Mid Channel	915	13.22	30
		High Channel	927.8	12.74	30
	3#	Low Channel	902.2	10.33	30
		Mid Channel	915	10.86	30
		High Channel	927.8	10.53	30
4. FSK 150Kbps FHSS 902.4MHz~927.6MHz	2#	Low Channel	902.4	13.32	30
		Mid Channel	914.8	13.29	30
		High Channel	927.6	12.80	30

	3#	Low Channel	902.4	10.36	30
		Mid Channel	914.8	10.56	30
		High Channel	927.6	10.53	30
5. FSK 50Kbps FHSS 902.2MHz~927.8MHz	2#	Low Channel	902.2	13.64	30
		Mid Channel	915	13.65	30
		High Channel	927.8	13.16	30
	3#	Low Channel	902.2	10.67	30
		Mid Channel	915	10.95	30
		High Channel	927.8	10.94	30
6. FSK 250Kbps FHSS 902.5MHz~927.5MHz 20dB Bandwidth	2#	Low Channel	902.5	13.59	30
		Mid Channel	915	13.57	30
		High Channel	927.5	13.11	30
	3#	Low Channel	902.5	10.60	30
		Mid Channel	915	10.86	30
		High Channel	927.5	10.83	30

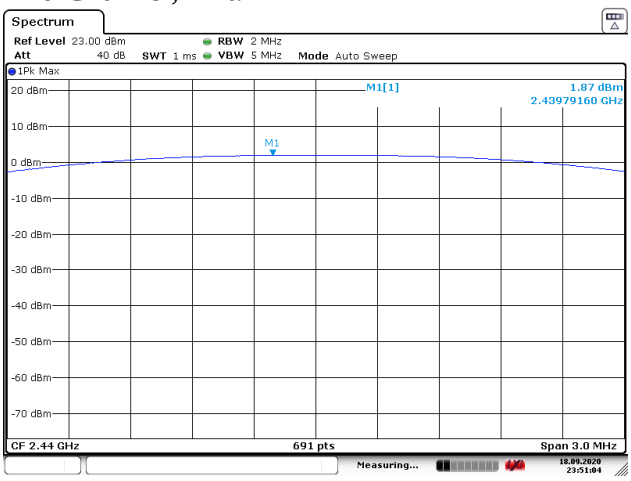
Figure 3: Maximum peak Conducted Output Power

1. BLE, Maximum Peak Conducted Output Power, 2402MHz~2480MHz

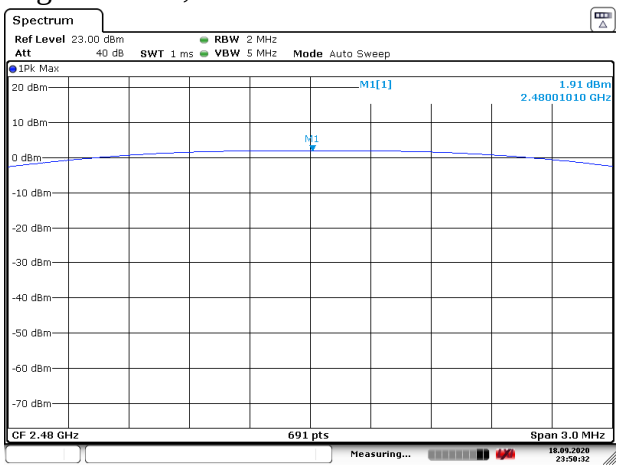
Low Channel, Ant. 1#



Mid Channel, Ant. 1#



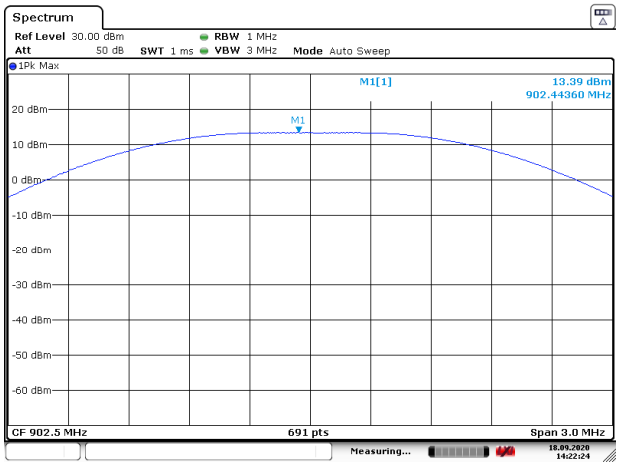
High Channel, Ant. 1#



2. LoRa 500kHz DTS, Maximum Peak Conducted Output Power, 902.5MHz~926.5MHz

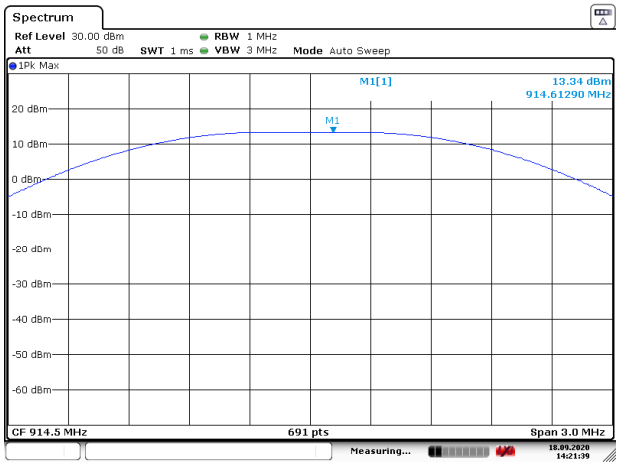
Ant. 2#

Low Channel



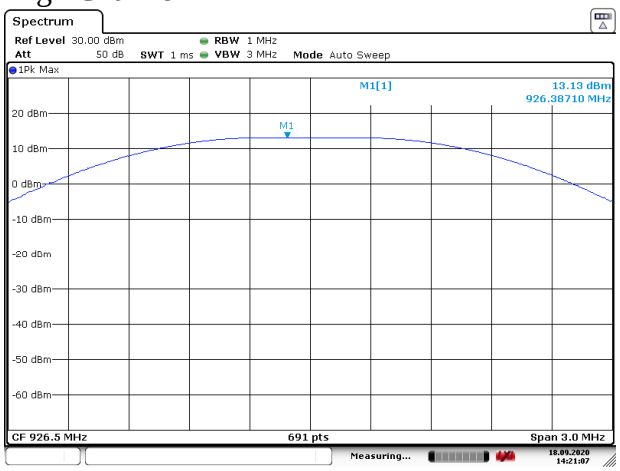
Date: 18.SEP.2020 14:22:24

Mid Channel



Date: 18.SEP.2020 14:21:40

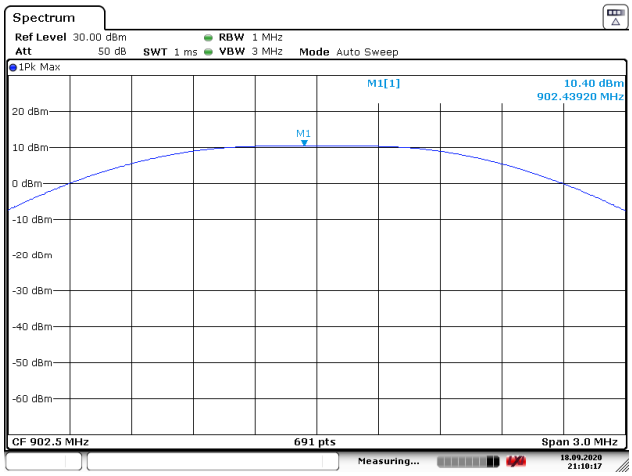
High Channel



Date: 18.SEP.2020 14:21:08

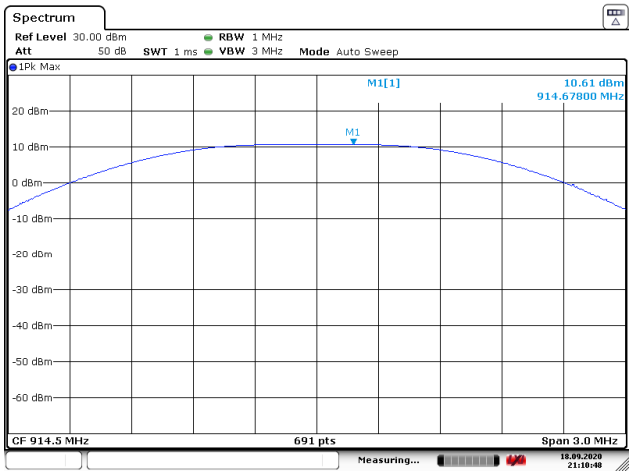
Ant. 3#

Low Channel



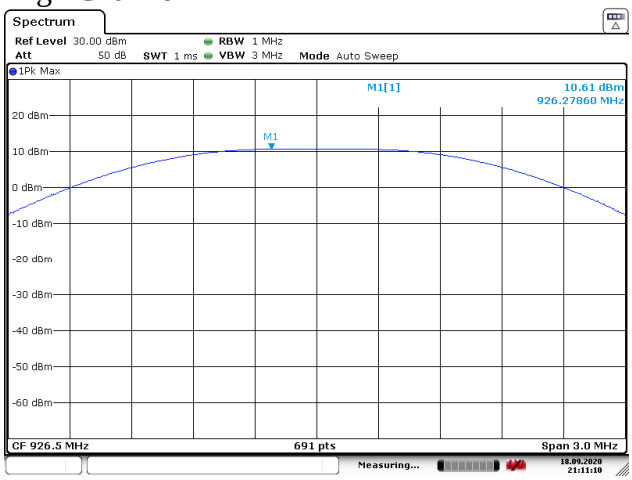
Date: 18.SEP.2020 21:10:18

Mid Channel



Date: 18.SEP.2020 21:10:49

High Channel

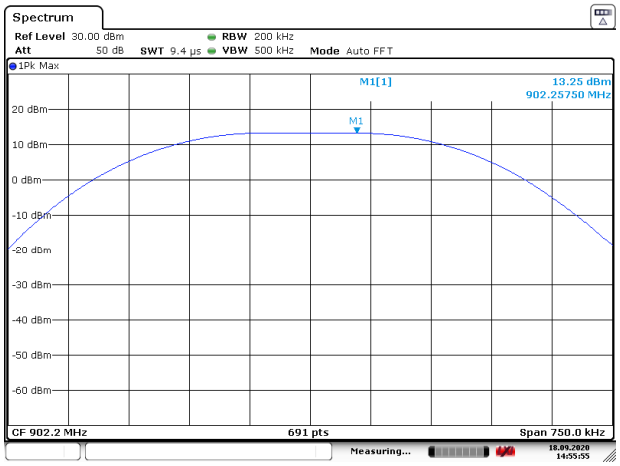


Date: 18.SEP.2020 21:11:11

3. LoRa 125kHz FHSS, Maximum Peak Conducted Output Power, 902.2MHz~927.8MHz

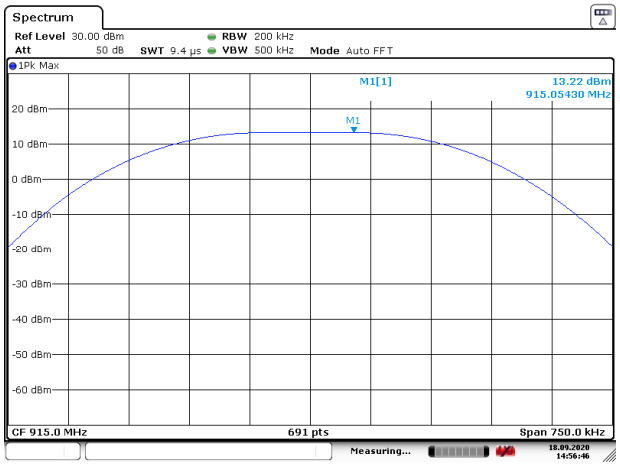
Ant. 2#

Low Channel



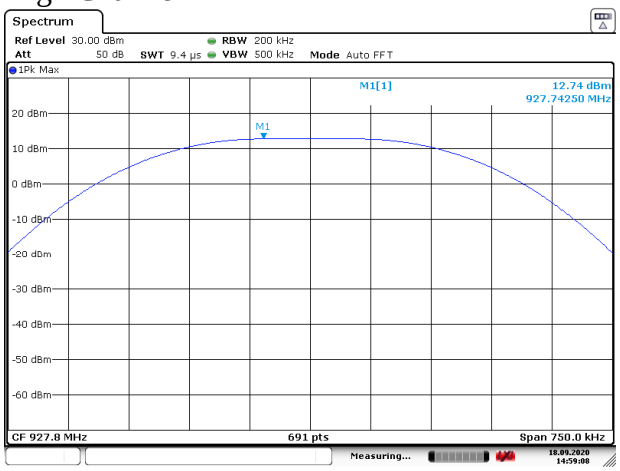
Date: 18.SEP.2020 14:55:55

Mid Channel



Date: 18.SEP.2020 14:56:46

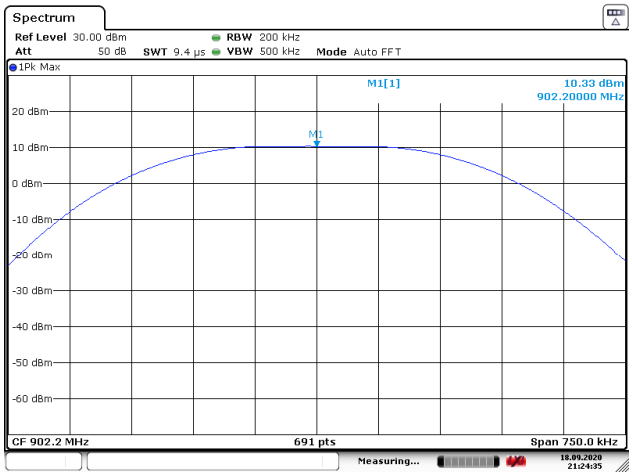
High Channel



Date: 18.SEP.2020 14:59:08

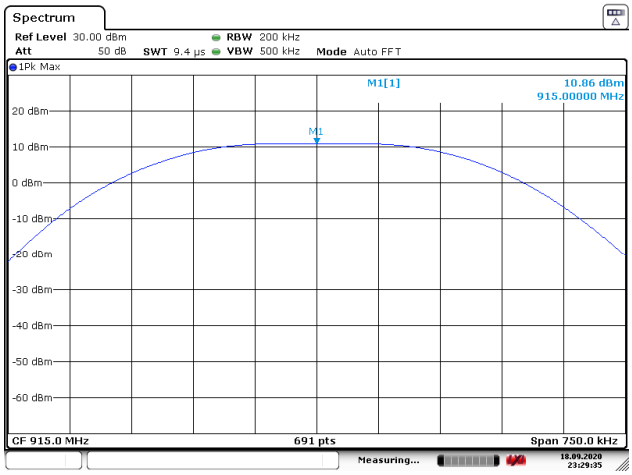
Ant. 3#

Low Channel



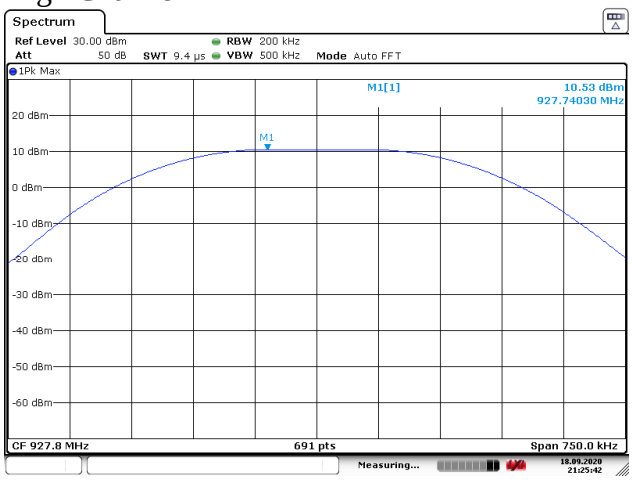
Date: 18.SEP.2020 21:24:36

Mid Channel



Date: 18.SEP.2020 23:29:36

High Channel

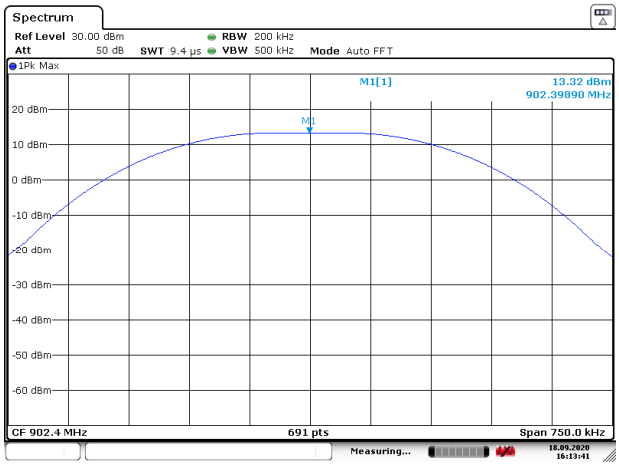


Date: 18.SEP.2020 21:25:42

4. FSK 150Kbps FHSS, Maximum Peak Conducted Output Power, 902.4MHz~927.6MHz

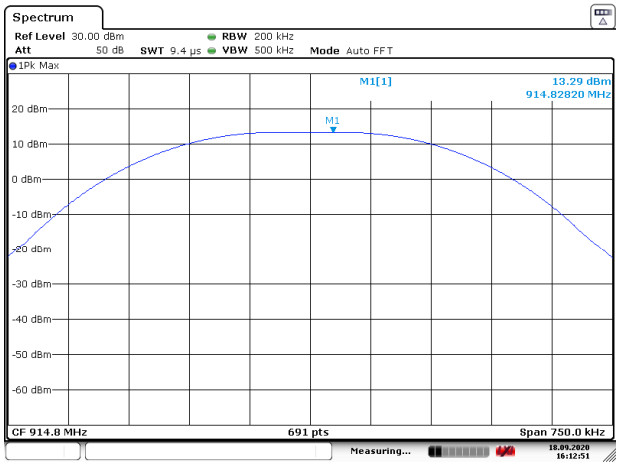
Ant. 2#

Low Channel



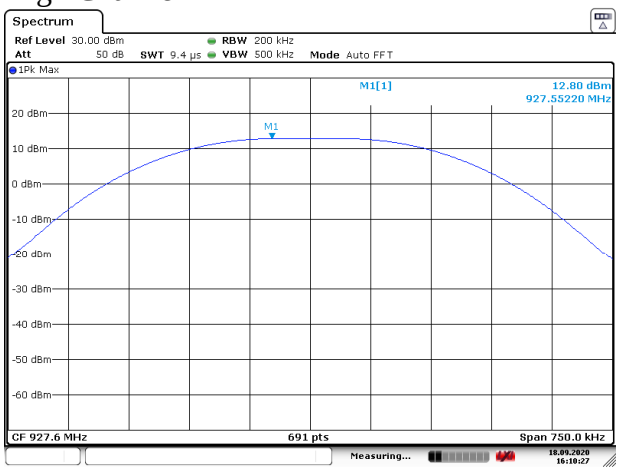
Date: 18.SEP.2020 16:13:41

Mid Channel



Date: 18.SEP.2020 16:12:52

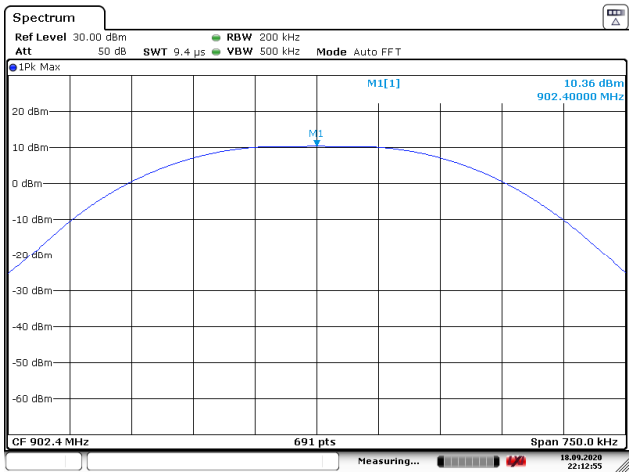
High Channel



Date: 18.SEP.2020 16:10:27

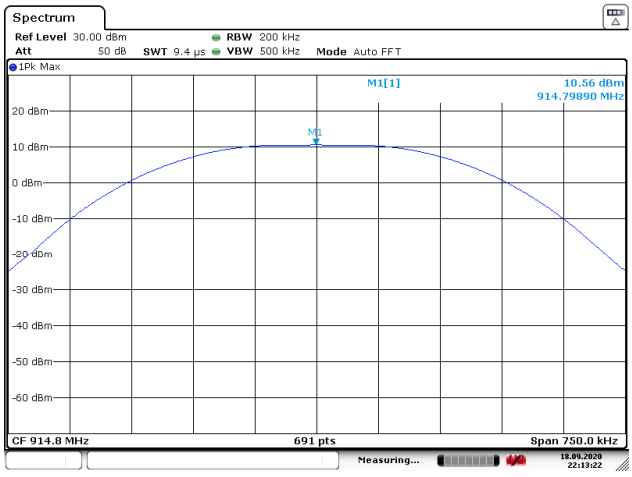
Ant. 3#

Low Channel



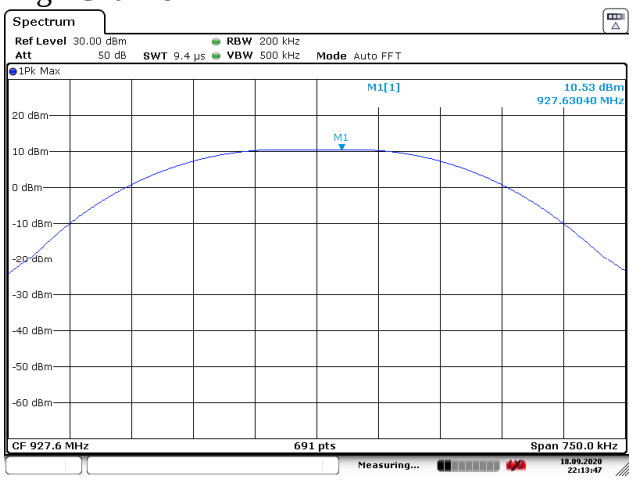
Date: 18.SEP.2020 22:12:56

Mid Channel



Date: 18.SEP.2020 22:13:23

High Channel

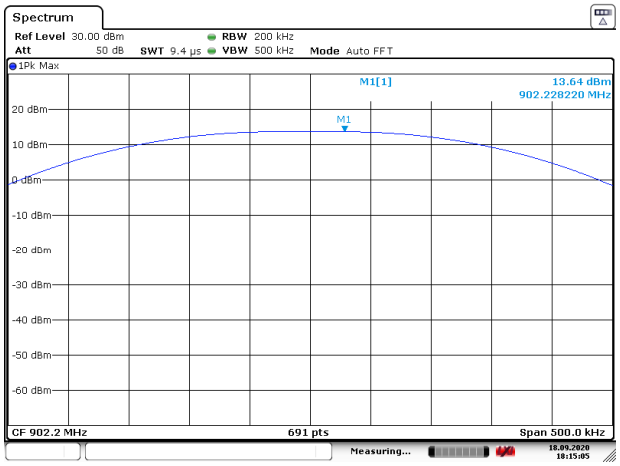


Date: 18.SEP.2020 22:13:47

5. FSK 50Kbps FHSS, Maximum Peak Conducted Output Power, 902.2MHz~927.8MHz

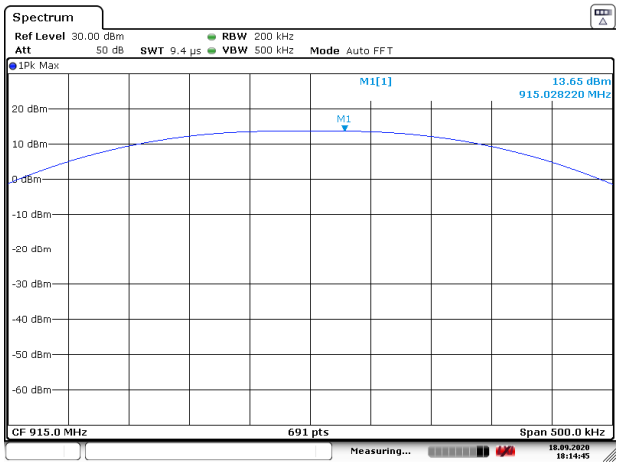
Ant. 2#

Low Channel



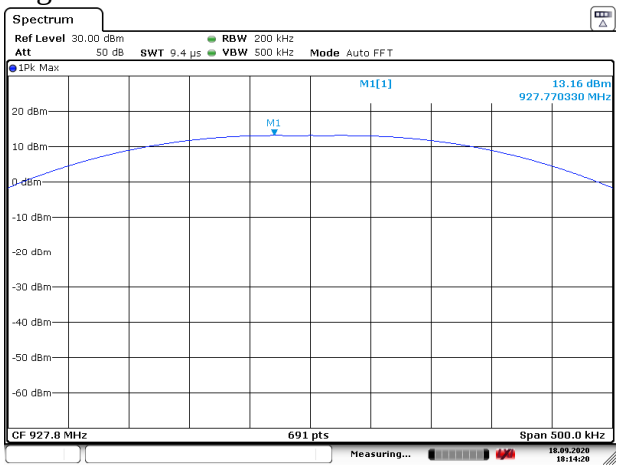
Date: 18.SEP.2020 18:15:05

Mid Channel



Date: 18.SEP.2020 18:14:46

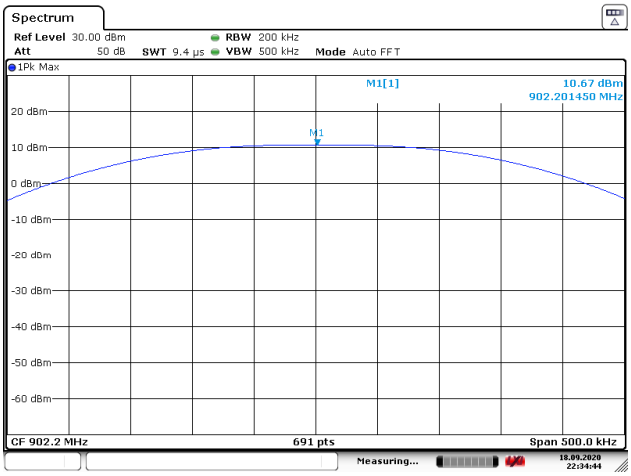
High Channel



Date: 18.SEP.2020 18:14:21

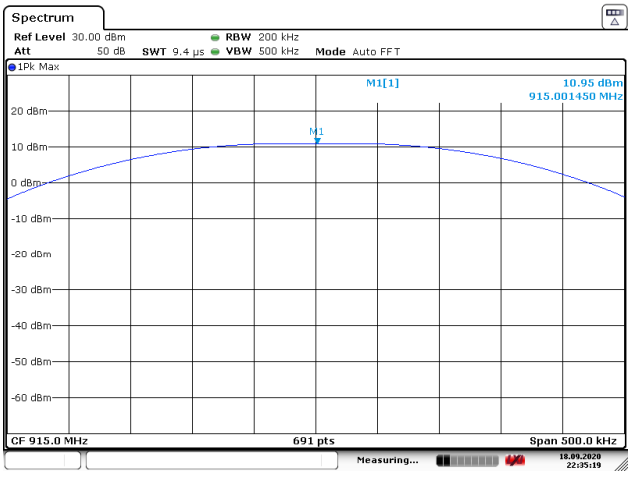
Ant. 3#

Low Channel



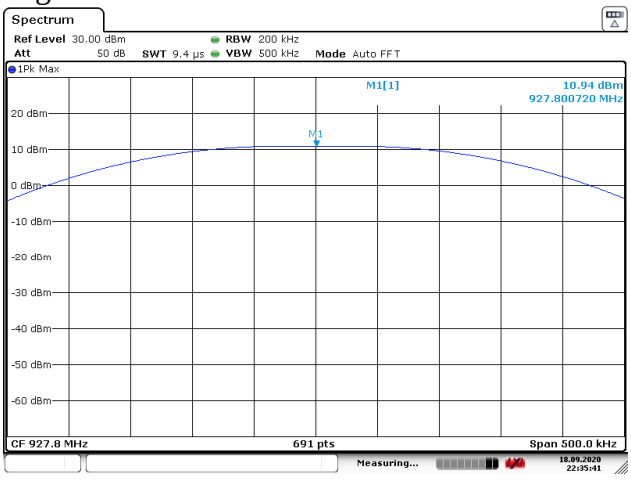
Date: 18.SEP.2020 22:34:44

Mid Channel



Date: 18.SEP.2020 22:35:19

High Channel

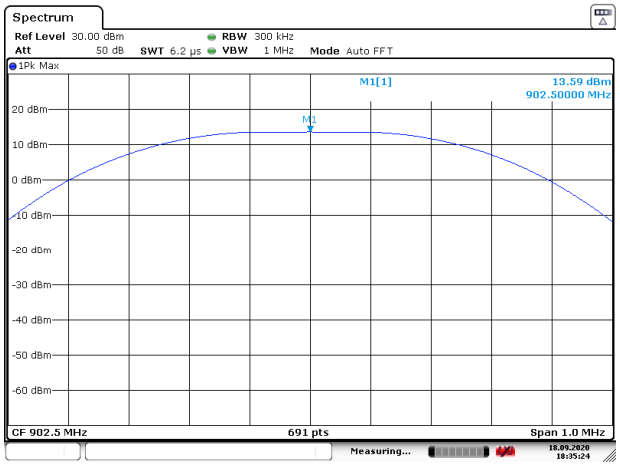


Date: 18.SEP.2020 22:35:42

6. FSK 250Kbps FHSS, Maximum Peak Conducted Output Power, 902.5MHz~927.5MHz

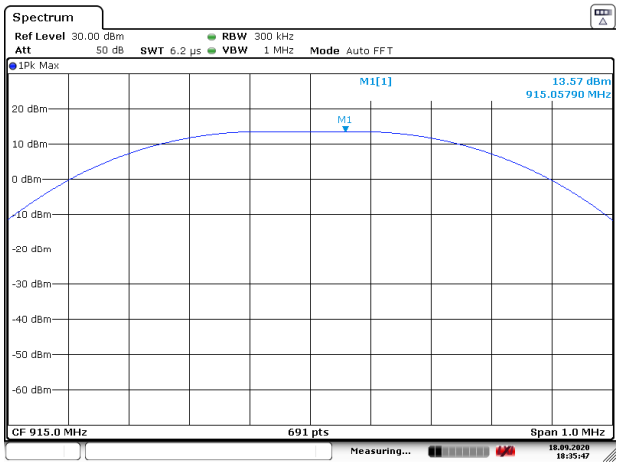
Ant. 2#

Low Channel



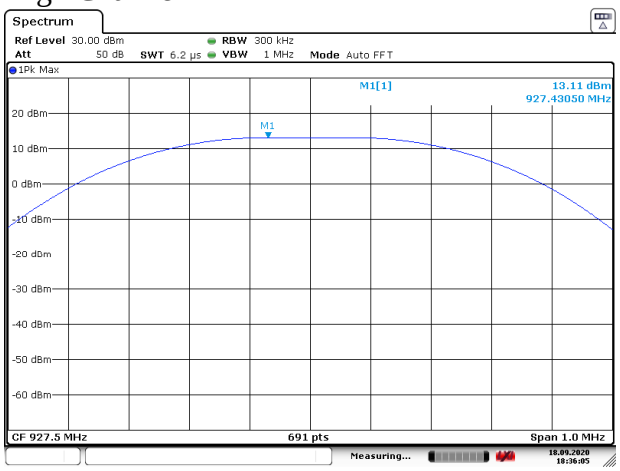
Date: 18.SEP.2020 18:35:24

Mid Channel



Date: 18.SEP.2020 18:35:47

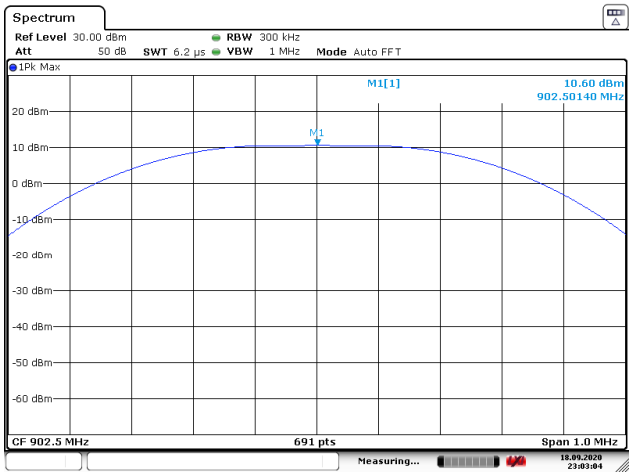
High Channel



Date: 18.SEP.2020 18:36:05

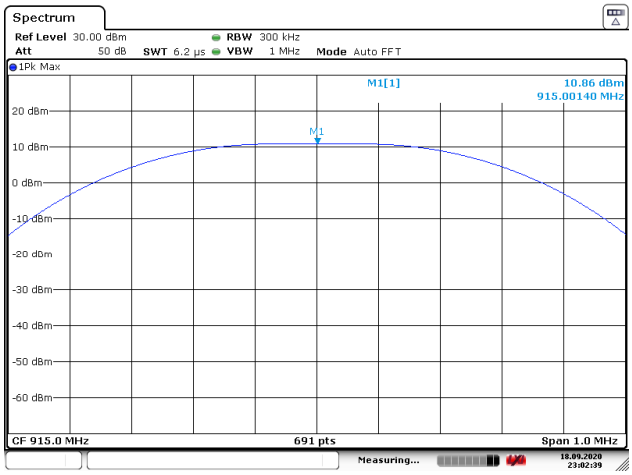
Ant. 3#

Low Channel



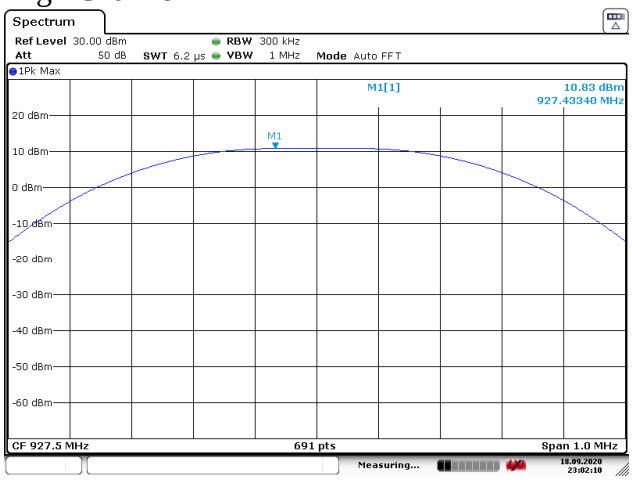
Date: 18.SEP.2020 23:03:05

Mid Channel



Date: 18.SEP.2020 23:02:40

High Channel



Date: 18.SEP.2020 23:02:11

4.1.5 Equivalent Isotropically Radiated Power

Result: **Pass**

Test Specification		
Test standard	:	RSS-247 Issue 2 February 2017 Clause 5.4(a), (d)
Basic standard	:	ANSI C63.10: 2013, clause 9.5
Limits	:	Not more than 4Watt(36dBm) for DTS in the band 902-928MHz and 2400-2483.5MHz; Not more than 4Watt(36dBm) for FHSS system with at least 50 hopping channels in the band 902-928MHz
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2020.09.18-2020.09.19
Input voltage	:	DC 4.5V
Operational mode	:	Mode A
Test channel	:	Lo, Mi, Hi
Temperature	:	19 °C
Relative humidity	:	55%
Atmospheric pressure	:	101 kPa

Table 5: Test result of E.I.R.P. for BLE, LoRa DTS, LoRa FHSS and FSK FHSS

Modulation Type and Operation band	Ant. No.	Channel	Channel Frequency (MHz)	Peak Output Power (dBm)	Ant. Gain (dBi)	E.I.R.P. (dBm)	Limit (dBm)
1. BLE 2402MHz~2480MHz	1#	Low Channel	2402	1.85	3.26	5.11	36
		Mid Channel	2440	1.87	3.26	5.13	36
		High Channel	2480	1.91	3.26	5.17	36
2. LoRa 500kHz DTS 902.5MHz~926.5MHz	2#	Low Channel	902.5	13.39	1.0	14.39	36
		Mid Channel	914.5	13.34	1.0	14.34	36
		High Channel	926.5	13.13	1.0	14.13	36
	3#	Low Channel	902.5	10.40	1.1	11.50	36
		Mid Channel	914.5	10.61	1.1	11.71	36
		High Channel	926.5	10.61	1.1	11.71	36
3. LoRa 125kHz FHSS 902.2MHz~927.8MHz	2#	Low Channel	902.2	13.25	1.0	14.25	36
		Mid Channel	915	13.22	1.0	14.22	36
		High Channel	927.8	12.74	1.0	13.74	36
	3#	Low Channel	902.2	10.33	1.1	11.43	36
		Mid Channel	915	10.86	1.1	11.96	36
		High Channel	927.8	10.53	1.1	11.63	36
4. FSK 150Kbps FHSS 902.4MHz~927.6MHz	2#	Low Channel	902.4	13.32	1.0	14.32	36
		Mid Channel	914.8	13.29	1.0	14.29	36
		High Channel	927.6	12.80	1.0	13.80	36

	3#	Low Channel	902.4	10.36	1.1	11.46	36
		Mid Channel	914.8	10.56	1.1	11.66	36
		High Channel	927.6	10.53	1.1	11.63	36
5. FSK 50Kbps FHSS 902.2MHz~927.8MHz	2#	Low Channel	902.2	13.64	1.0	14.64	36
		Mid Channel	915	13.65	1.0	14.65	36
		High Channel	927.8	13.16	1.0	14.16	36
	3#	Low Channel	902.2	10.67	1.1	11.77	36
		Mid Channel	915	10.95	1.1	12.05	36
		High Channel	927.8	10.94	1.1	12.04	36
6. FSK 250Kbps FHSS 902.5MHz~927.5MHz	2#	Low Channel	902.5	13.59	1.0	14.59	36
		Mid Channel	915	13.57	1.0	14.57	36
		High Channel	927.5	13.11	1.0	14.11	36
	3#	Low Channel	902.5	10.60	1.1	11.70	36
		Mid Channel	915	10.86	1.1	11.96	36
		High Channel	927.5	10.83	1.1	11.93	36

4.1.6 Peak Power Spectral Density

Result: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(e) RSS-247 Issue 2 February 2017 Clause 5.2(b)
Basic standard	:	ANSI C63.10: 2013, clause 11.10.2 KDB558074 D01v05r02, clause 8.4
Limits	:	Not more than 8 dBm in any 3 kHz band
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2020.09.18
Input voltage	:	DC 4.5V
Operational mode	:	Mode A
Test channel	:	Lo, Mi, Hi
Temperature	:	19°C
Relative humidity	:	55%
Atmospheric pressure	:	101 kPa

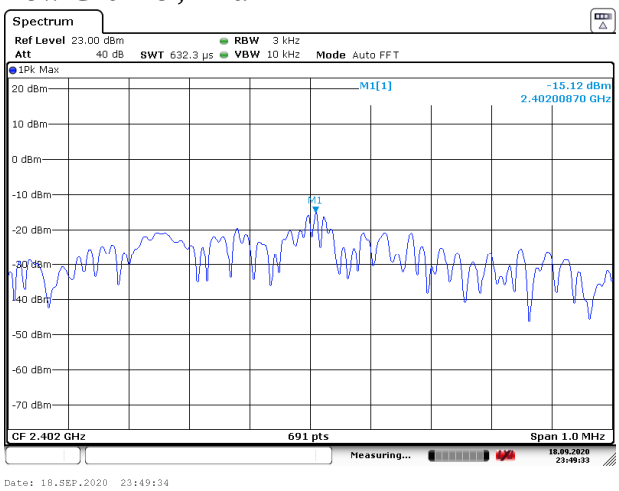
Table 6: Test result of Power Spectral Density for BLE, LoRa DTS

Modulation Type and Operation band	Ant. No.	Channel	Channel Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Result
1. BLE 2402MHz~2480MHz	1#	Low Channel	2402	-15.12	8.0	Pass
		Mid Channel	2440	-15.08	8.0	Pass
		High Channel	2480	-14.99	8.0	Pass
2. LoRa 500kHz DTS 902.5MHz~926.5MHz	2#	Low Channel	902.5	0.70	8.0	Pass
		Mid Channel	914.5	0.95	8.0	Pass
		High Channel	926.5	0.77	8.0	Pass
	3#	Low Channel	902.5	-1.96	8.0	Pass
		Mid Channel	914.5	-2.47	8.0	Pass
		High Channel	926.5	-2.06	8.0	Pass

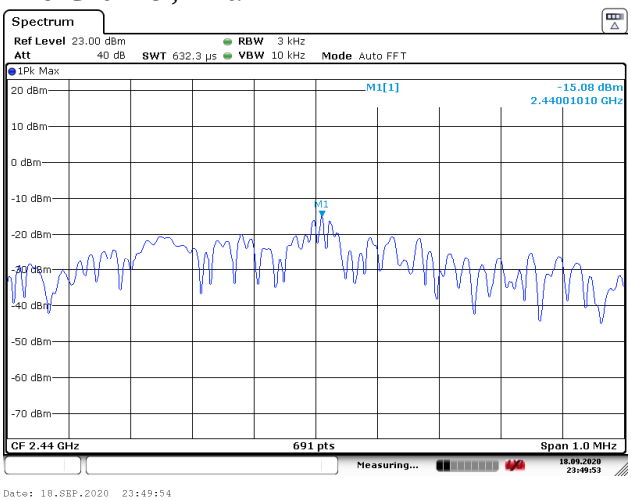
Figure 4: Power Spectral Density

1. BLE, PSD, 2402MHz~2480MHz

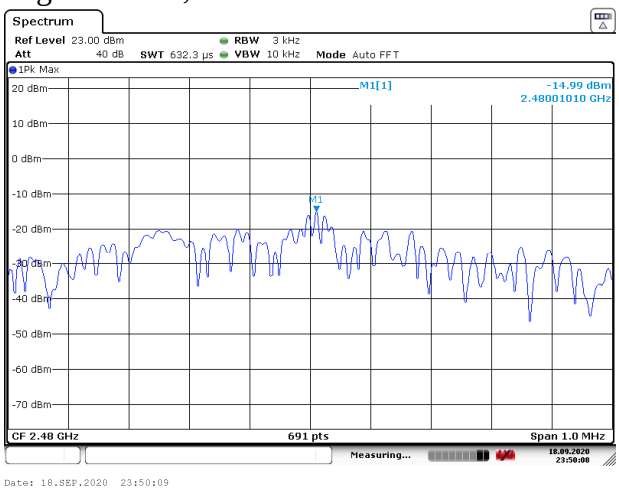
Low Channel, Ant. 1#



Mid Channel, Ant. 1#



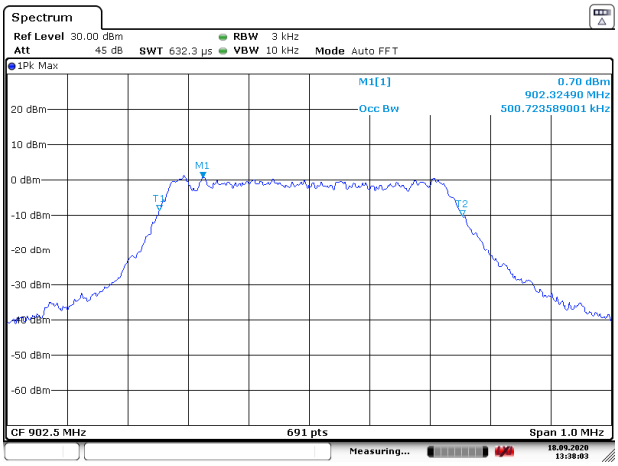
High Channel, Ant. 1#



2. LoRa 500KHz DTS, PSD, 902.5MHz~926.5MHz

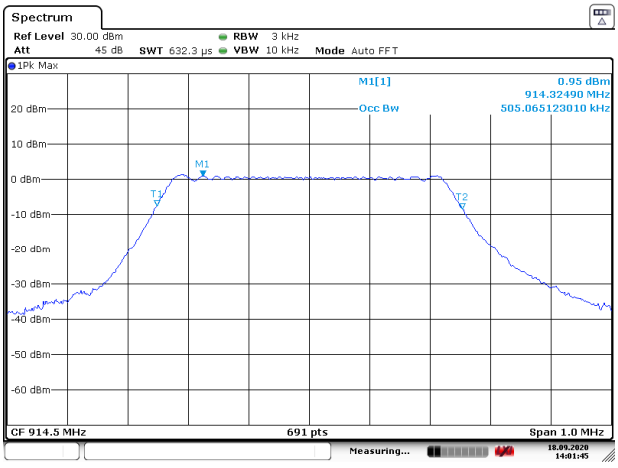
Ant. 2#

Low Channel



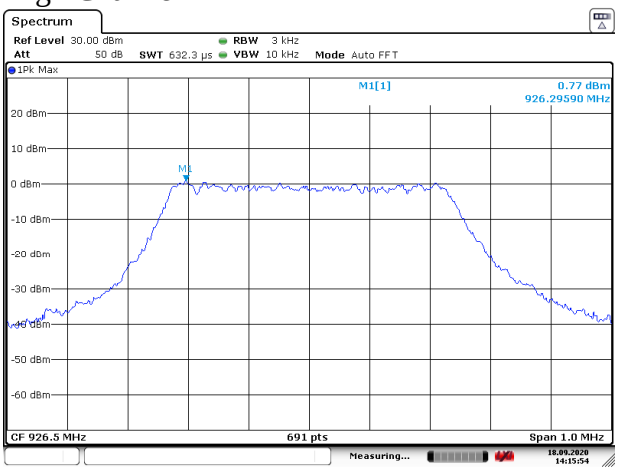
Date: 18.SEP.2020 13:38:03

Mid Channel



Date: 18.SEP.2020 14:01:45

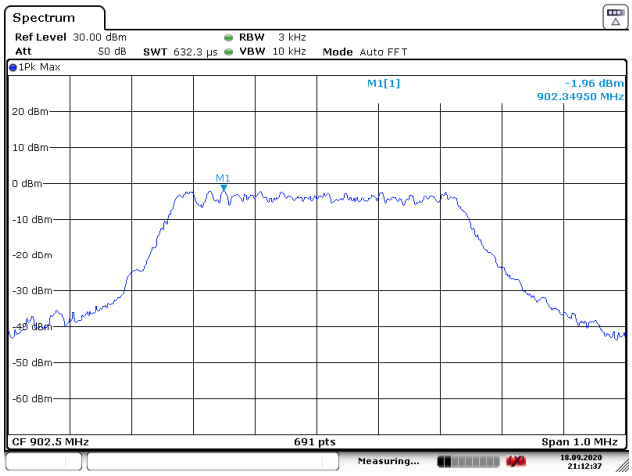
High Channel



Date: 18.SEP.2020 14:15:54

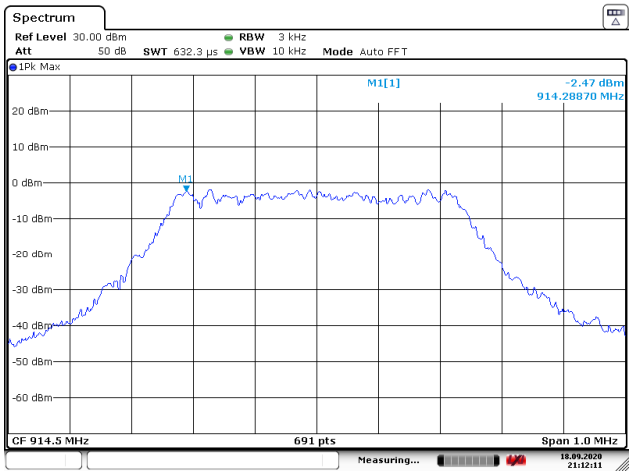
Ant. 3#

Low Channel



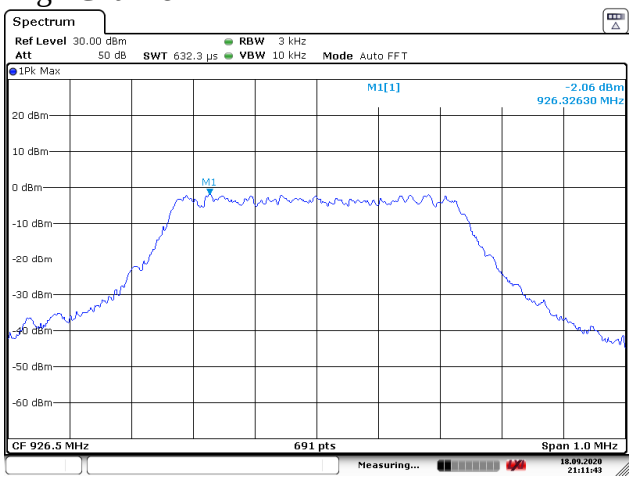
Date: 18.SEP.2020 21:12:37

Mid Channel



Date: 18.SEP.2020 21:12:11

High Channel



Date: 18.SEP.2020 21:11:43

4.1.7 Conducted Spurious Emissions Measured in 100 kHz Bandwidth

Result: **Pass**

Test Specification		
Test standard	:	FCC Part 15.247(d) RSS-247 Issue 2 February 2017 Clause 5.5
Basic standard	:	ANSI C63.10: 2013, 14.3.3(Spurious) ANSI C63.10: 2013, 6.10(Band edge) KDB 558074 D01 v05r02, clause 8.5
Limits	:	20dB (below that in the 100kHz bandwidth within the band that contains the highest level of the desired power);
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2020.09.18-2020.09.19
Input voltage	:	DC 4.5V
Operational mode	:	Mode A, Mode B
Test channel	:	Lo, Mi, Hi
Temperature	:	19°C
Relative humidity	:	55%
Atmospheric pressure	:	101 kPa

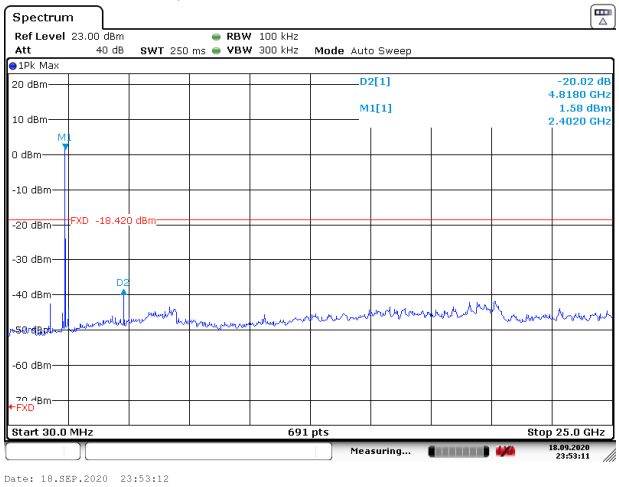
All emissions are more than 20dB below fundamental, compliance is achieved as well.

Figure 5: Conducted Spurious Emission

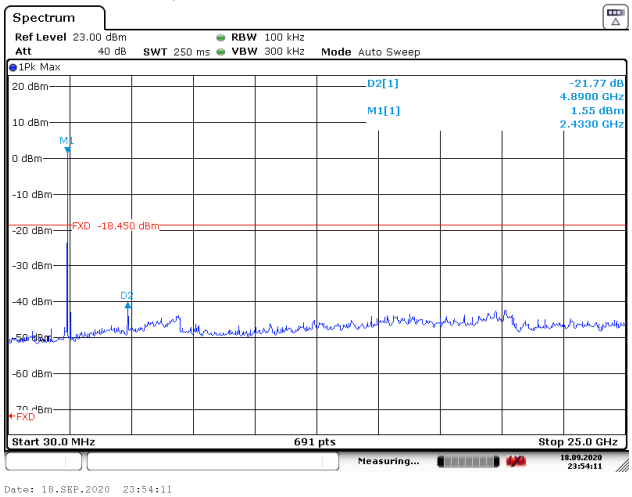
1. BLE, Conducted Spurious Emission and Band edge, 2402MHz~2480MHz

Conducted Spurious Emission

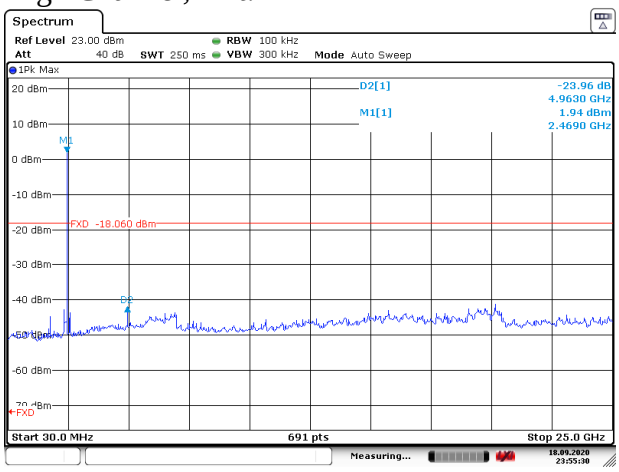
Low Channel, Ant. 1#



Mid Channel, Ant. 1#

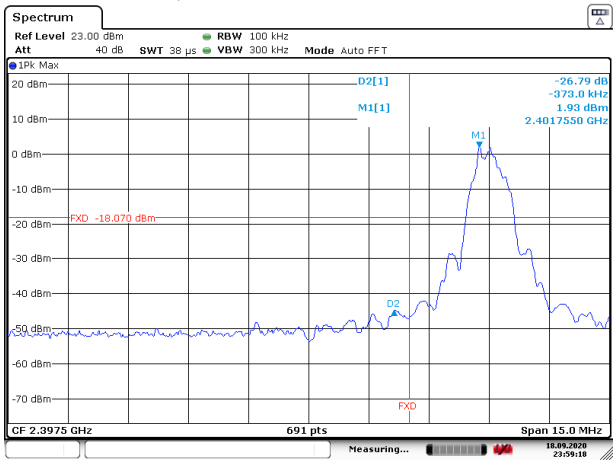


High Channel, Ant. 1#



Band edge

Low Channel, Ant. 1#



High Channel, Ant. 1#