ETSI EN 300 220-1 V3.1.1 (2017-02)
ETSI EN 300 220-2 V3.1.1 (2017-02)
TEST REPORT

For

Dragino Technology Co., Limited

Room 202, Block B, BCT Incubation Bases (BaoChengTai), No.8 CaiYunRoad LongCheng Street, LongGang District, Shenzhen 518116, China

Tested Model: RS485-BL
Multiple Model: LSE01, LDDS20, LDDS75

Report Type:	**Product Type:**
Original Report	LoRaWAN IoT Sensor

Report Number: SZ1210331-09263E-22A

Report Date: 2021-04-15

Candy Li

Reviewed By: RF Engineer

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ACCURATE TECHNOLOGY CO. LTD ATC APPROVED

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	LoRaWAN IoT Sensor
Tested Model	RS485-BL
Multiple Model	LSE01, LDDS20, LDDS75
Model Differences	Refer to the DoS letter
Frequency Range	863-870 MHz
Transmit Maximum ERP	9.14dBm
Modulation Technique	GFSK
Antenna Specification	2dBi
Voltage Range	DC3.6V from battery
Date of Test	2021-03-25 to 2021-04-11
Sample serial number	SZ1210331-09263E-RF-S1(Assigned by ATC)
Received date	2021-03-17
Sample/EUT Status	Good condition
Normal/Extreme Condition*	N.T.: Normal temperature:25℃ , N.V.: Normal voltage: 3.6V_{DC} L.T.: Low temperature:-40℃ , L.V.: Low voltage: 3.3V_{DC} H.T.: High temperature:+65℃ , H.V.: High voltage: 4.2V_{DC} *(Note: The extreme condition was declared by manufacturer)*

Objective

The test report is in accordance with ETSI EN 300 220-2 V3.1.1 (2017-02), short range devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 2: Harmonised standard covering the essential requirements of article 3.2 of Directive 2014/53/EU for non specific radio equipment

The objective is to determine the compliance of the EUT with ETSI EN 300 220-2 V3.1.1 (2017-02).

Test Methodology

All measurements contained in this report were conducted with ETSI EN 300 220-1 V3.1.1 (2017-02).

Measurement Uncertainty

Parameter		Uncertainty
Spurious Emissions, Radiated	9k-30MHz	±2.66dB
	30MHz-1000MHz	±4.28dB
	1GHz-18GHz	±4.75dB
	18GHz-26.5GHz	±4.88dB

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in engineering mode.

Channel List

Channel	Freq. (MHz)
1	863.1
2	868.1
3	869.9

Channel 1 and 3 were tested.

EUT Exercise Software

Software: CRT Control panel and the power level is default.

Special Accessories

No special accessories.

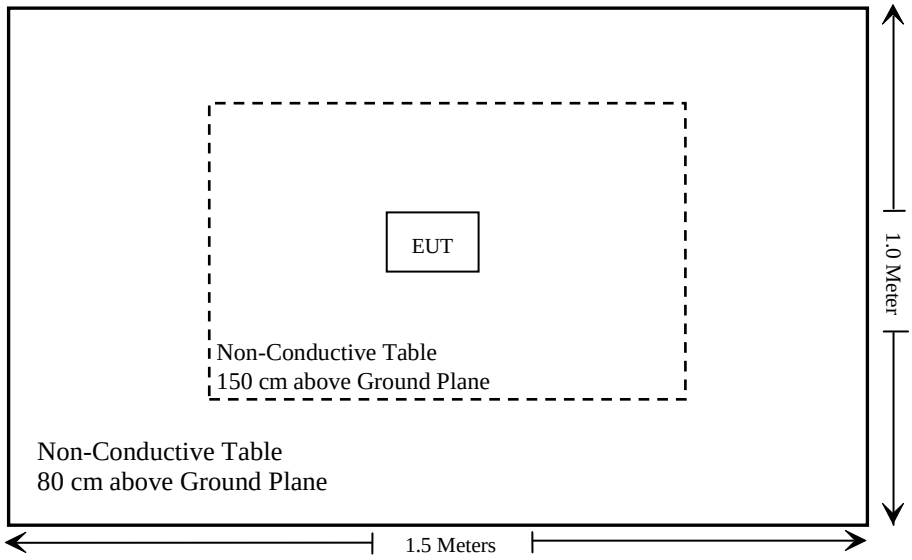
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

Cable Description	Length (m)	From Port	To
/	/	/	/

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

ETSI EN 300 220-2 V3.1.1 (2017-02)

Rules	Description of Test	Result	Condition
§4.2.1	Operating frequency	Compliance	/
§4.2.2	Unwanted emissions in the spurious domain	Compliance	/
§4.3.1	Effective radiated power	Compliance	/
§4.3.2	Maximum e.r.p. spectral density	Not Applicable	Applies to EUT using annex B bands I, L. Applies to EUT using DSSS or wideband techniques other than FHSS modulation, using annex C band X.
§4.3.3	Duty cycle	Compliance	/
§4.3.4	Occupied Bandwidth	Compliance	/
§4.3.5	Tx Out of Band Emissions	Compliance	Applies to EUT with OCW > 25 kHz.
§4.3.6	Transient Power	Compliance	/
§4.3.7	Adjacent channel power	Not Applicable	Applies to EUT with OCW ≤ 25 kHz.
§4.3.8	TX behaviour under Low Voltage Conditions	Compliance	Applies to battery powered EUT.
§4.3.9	Adaptive Power Control	Not Applicable	Applies to EUT with adaptive power control using annex C band AA.
§4.3.10	FHSS equipment	Not Applicable	Applies to FHSS EUT.
§4.3.11	Short term behaviour	Not Applicable	Applies to EUT using annex C bands Y, Z, AA, AB, AC, AD.
§4.4.1	RX sensitivity	Not Applicable	Applies to EUT with polite spectrum access.
§4.4.2	Blocking	Compliance	/
§4.5.2	Clear Channel Assessment threshold	Not Applicable	Applies to EUT with polite spectrum access.
§4.5.3	Polite spectrum access timing parameters	Not Applicable	Applies to EUT with polite spectrum access.
§4.5.4	Adaptive Frequency Agility	Not Applicable	Applies to EUT with AFA.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Test Receiver	Rohde&Schwarz	ESR	101817	2020/12/24	2021/12/23
SONOMA INSTRUMENT	Amplifier	310 N	186131	2020/12/25	2021/12/24
A.H. Systems, inc.	Preamplifier	PAM-0118P	531	2020/07/08	2021/07/07
Bilog Antenna	Schwarzbeck	VULB9163	9163-323	2020/01/05	2023/01/04
Bilog Antenna	Schwarzbeck	VULB9163	9163-194	2020/01/05	2023/01/04
Horn Antenna	Schwarzbeck	BBHA9120D	9120D-655	2020/01/05	2023/01/04
Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2020/12/24	2021/12/23
Rohde & Schwarz	Vector Signal Generator	SMBV100A	260434	2020/12/24	2021/12/23
Rohde & Schwarz	Signal Generator	SMB100A	108362	2020/12/24	2021/12/23
Agilent	Signal Generator	N5183A	MY51040755	2020/12/24	2021/12/23
Gongwen	Temp. & Humid. Chamber	JB913R	GZ-WS004	2020/12/25	2021/12/24
UNI-T	DC Power Supply	UTP8305B	10584	NCR	NCR
Fluke	Desktop Multi Meter	45	7664009	2020/12/25	2021/12/24

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

ETSI EN 300 220-2 V3.1.1 (2017-02) §4.2.1 – OPERATING FREQUENCY

Applicable Standard

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.1.1, the nominal operating frequency is the centre of a channel of width OCW.

Limit: The manufacturer may declare either one or more operating frequencies and operating channels. Operating channel(s) shall be be entirely within operational frequency bands allowed by annexes B, C or any NRI

The below information shall be recorded in the test report

Value	Note
Operational Frequency band or bands	Declared by the manufacturer
Nominal Operating Frequency or Frequencies	Declared by the manufacturer
Operating Channel width(s) - OCW	Declared by the manufacturer

Test Result

The operational frequency band or bands, nominal operating frequency or Frequencies and operating channel width(s) – OCW are declared by the manufacturer

Note: Compliance, which is declared by the manufacturer.

Operating frequency (MHz)	Operating frequency band (MHz)	Operating channel width (kHz)
863.1	863-870 (Band X)	130
868.1		
869.9		

ETSI EN 300 220-2 V3.1.1 (2017-02) §4.2.2 – UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN

Applicable Standard

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.9.1.

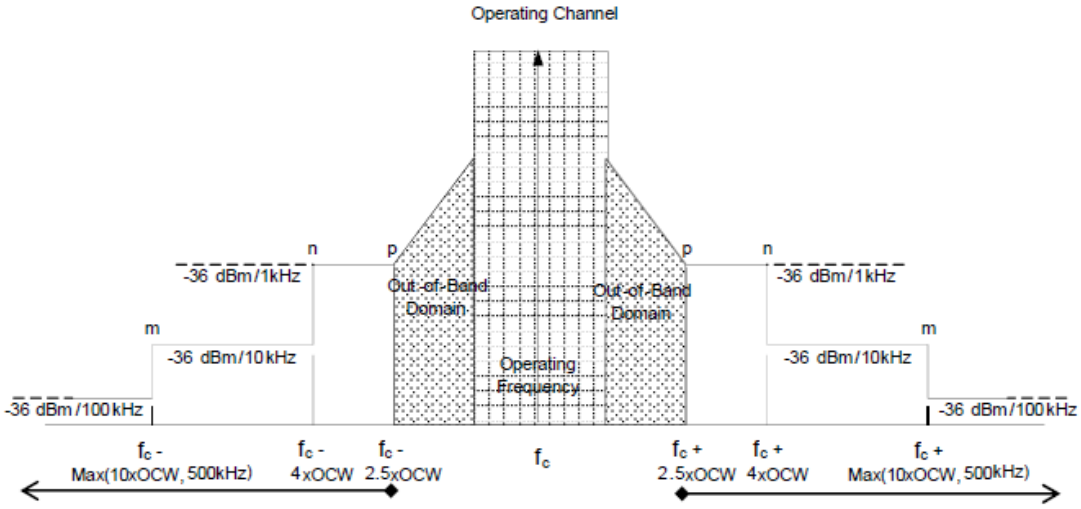


Figure 7: Spectrum Mask for Unwanted Emissions in the Spurious Domain with reference BW

Spurious emissions are unwanted emissions in the spurious domain at frequencies other than those of the Operating Channel and its Out Of Band Domain. The relevant spurious domain is shown in Figure 7.

Limit: The power of any unwanted emission in the spurious domain shall not exceed the values given in Table 19.

Table 19: Spurious domain emission limits

Frequency / State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 790 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
TX mode	-54 dBm	-36 dBm	-30 dBm
RX and all other modes	-57 dBm	-57 dBm	-47 dBm

Method of Measurement

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.9.3.

Test Data

Environmental Conditions

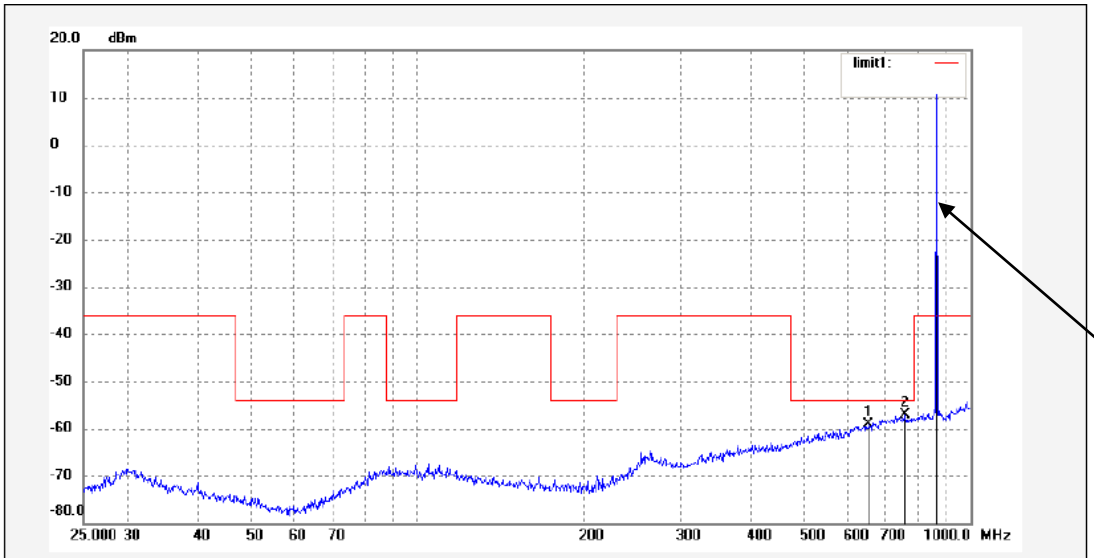
Temperature:	24-25 ℃
Relative Humidity:	53-55 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2021-04-08 to 2021-04-10 for conducted emission, on 2021-03-25 for radiated emission.

Test result: Compliance. Please refer to the following tables.

Radiated spurious emissions:
TX- BELOW 1G

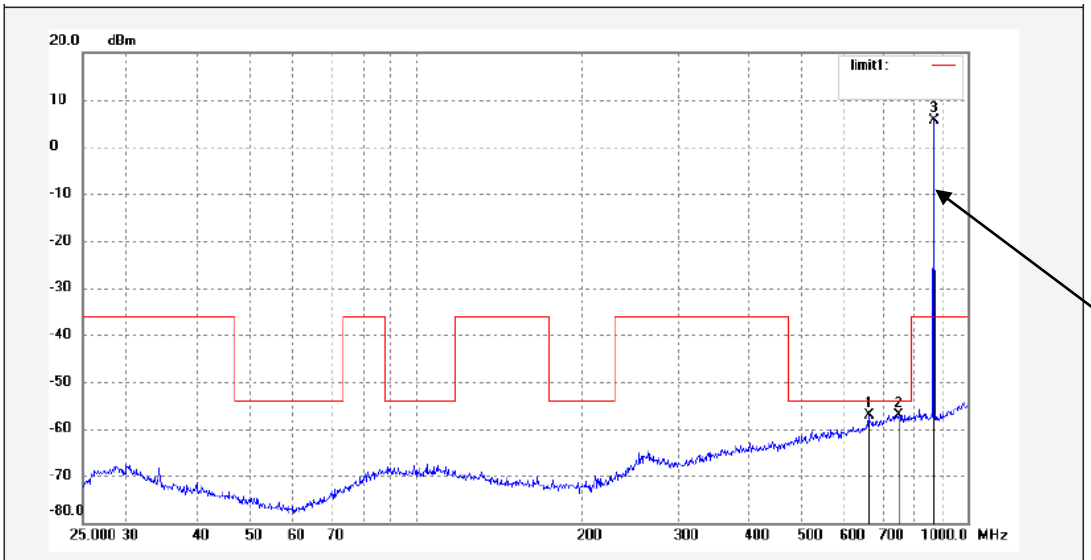
863.1MHz
Horizontal



Fundamental Test

No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	654.2790	-67.21	7.97	-59.24	-54.00	-5.24	peak			
2	761.1100	-67.59	10.51	-57.08	-54.00	-3.08	peak			

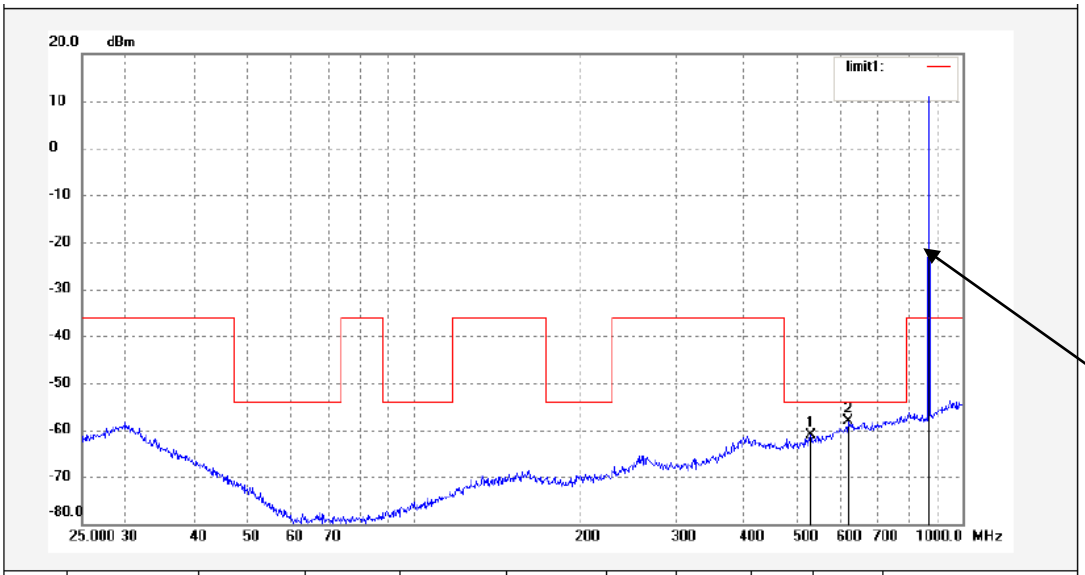
Vertical



Fundamental Test

No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	661.5601	-64.92	7.82	-57.10	-54.00	-3.10	peak			
2	749.9620	-66.82	9.79	-57.03	-54.00	-3.03	peak			

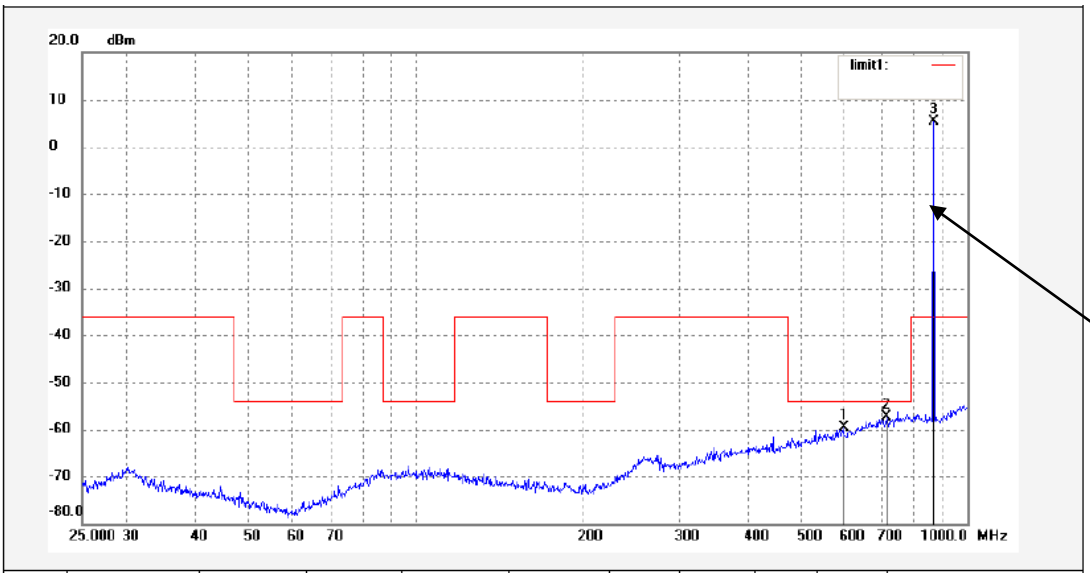
869.9MHz
Horizontal



Fundamental Test

No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	528.2550	-66.35	5.14	-61.21	-54.00	-7.21	peak			
2	619.0591	-65.89	7.76	-58.13	-54.00	-4.13	peak			

Vertical

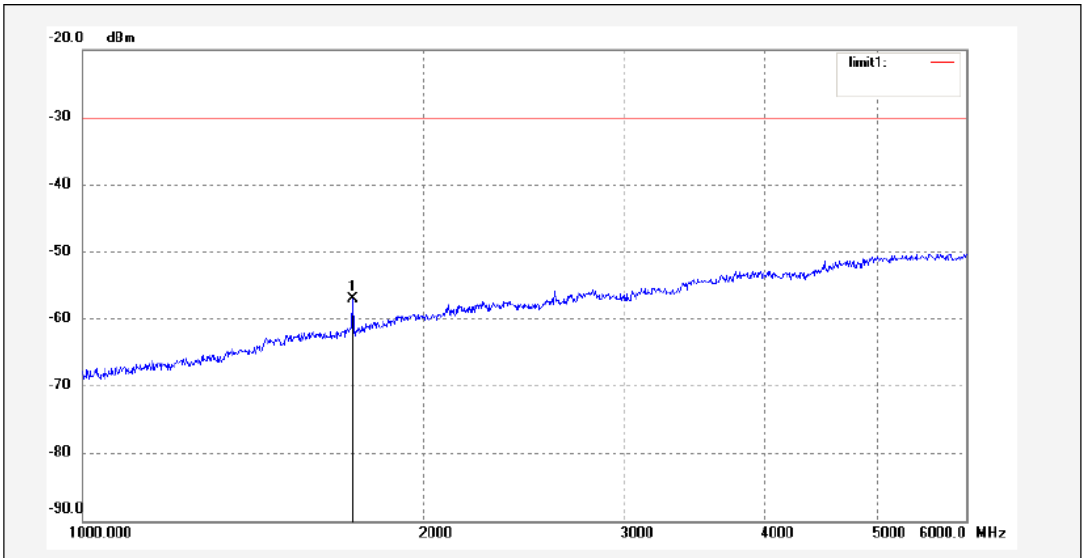


Fundamental Test

No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	596.6389	-66.05	6.35	-59.70	-54.00	-5.70	peak			
2	712.2140	-67.51	10.05	-57.46	-54.00	-3.46	peak			

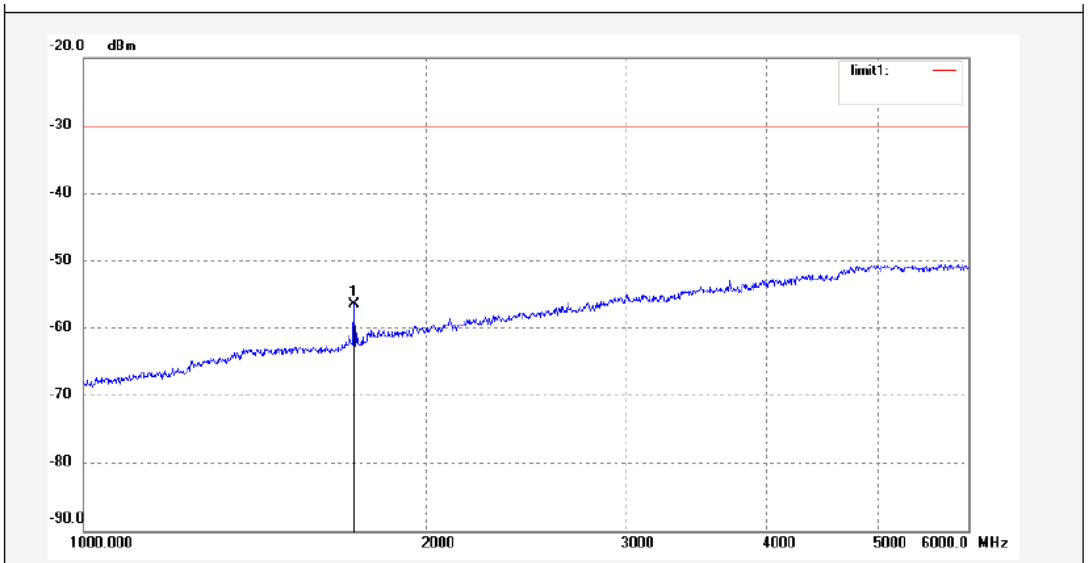
TX- ABOVE 1G

863.1MHz
Horizontal



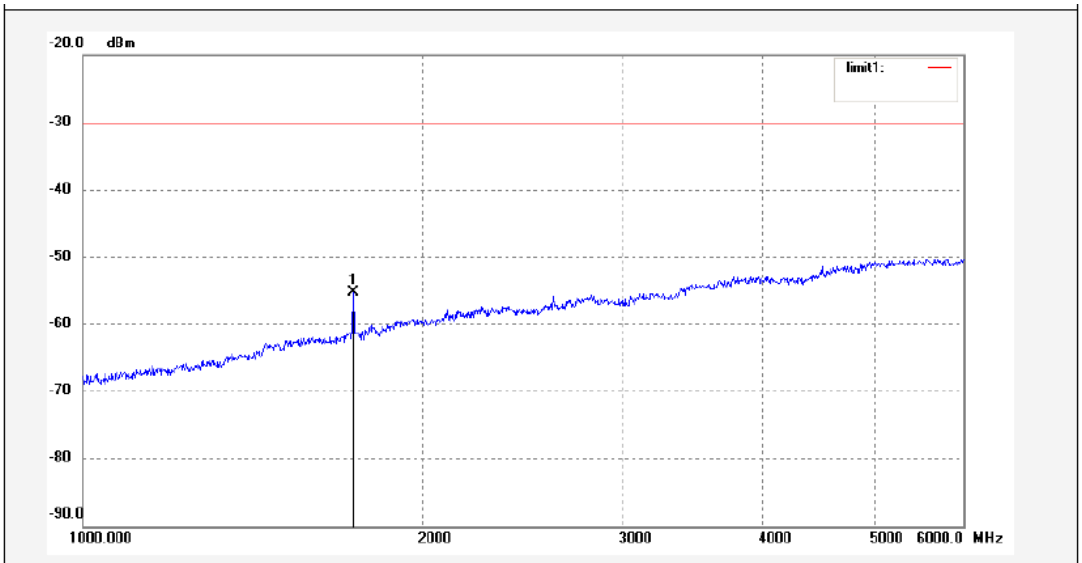
No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	1730.272	-54.38	-2.59	-56.97	-30.00	-26.97	peak			

Vertical



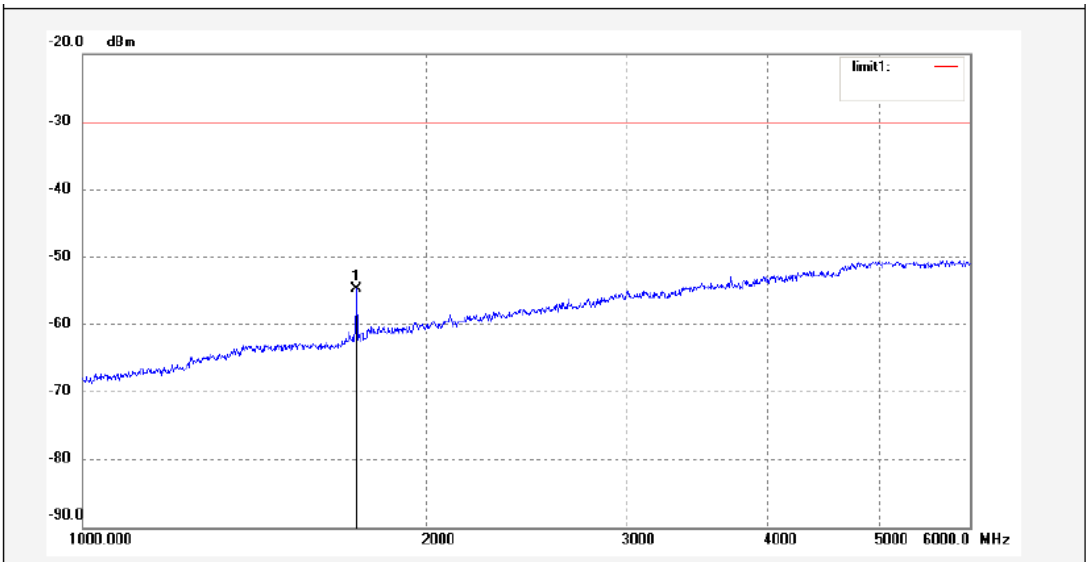
No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	1730.272	-53.77	-2.63	-56.40	-30.00	-26.40	peak			

869.9MHz
Horizontal



No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	1733.375	-52.63	-2.58	-55.21	-30.00	-25.21	peak			

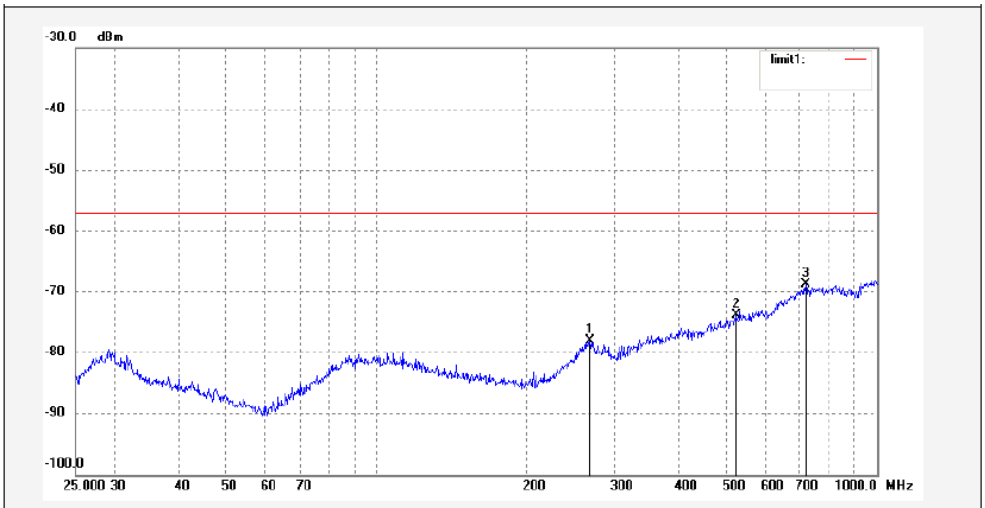
Vertical



No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	1739.597	-52.12	-2.61	-54.73	-30.00	-24.73	peak			

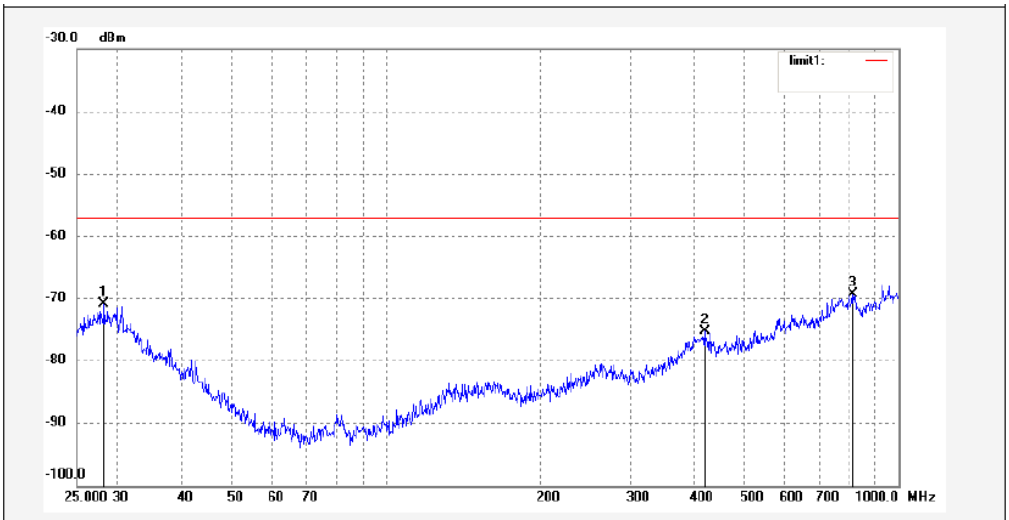
RX- Below 1G

863.1MHz (Worst case)
Horizontal



No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	266.9700	-79.53	1.50	-78.03	-57.00	-21.03	peak			
2	522.4412	-79.37	5.47	-73.90	-57.00	-16.90	peak			
3	720.1395	-78.40	9.57	-68.83	-57.00	-11.83	peak			

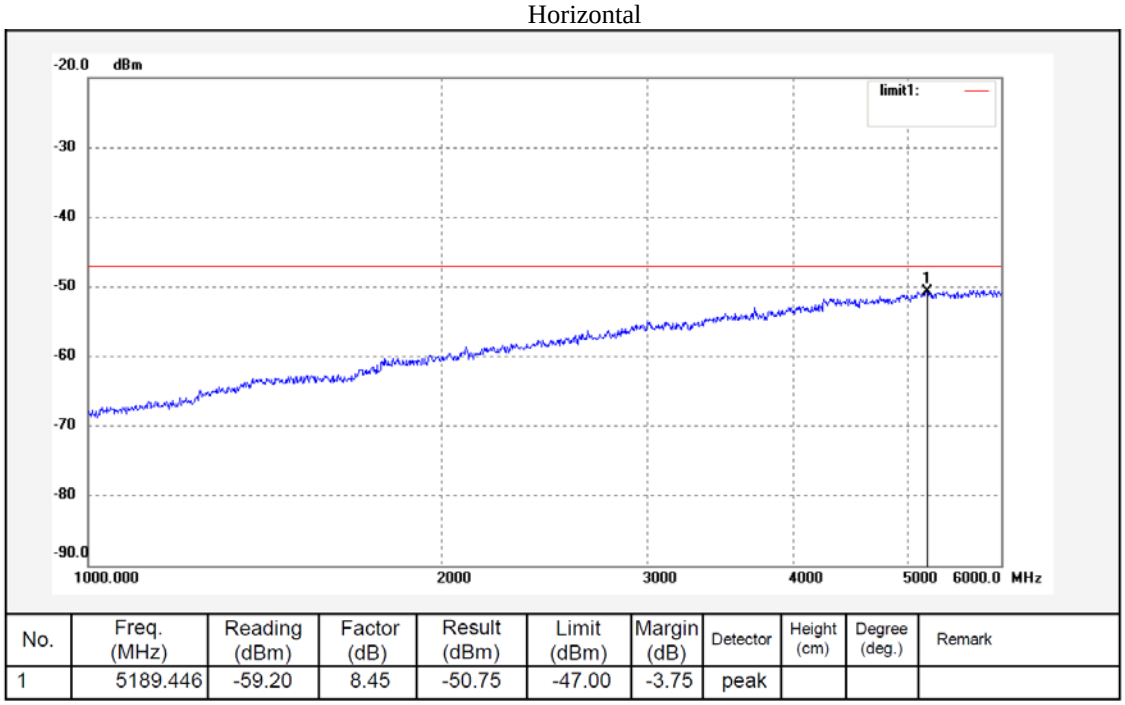
Vertical



No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	28.2363	-75.98	5.18	-70.80	-57.00	-13.80	peak			
2	418.7105	-79.95	4.64	-75.31	-57.00	-18.31	peak			
3	813.3634	-79.49	10.28	-69.21	-57.00	-12.21	peak			

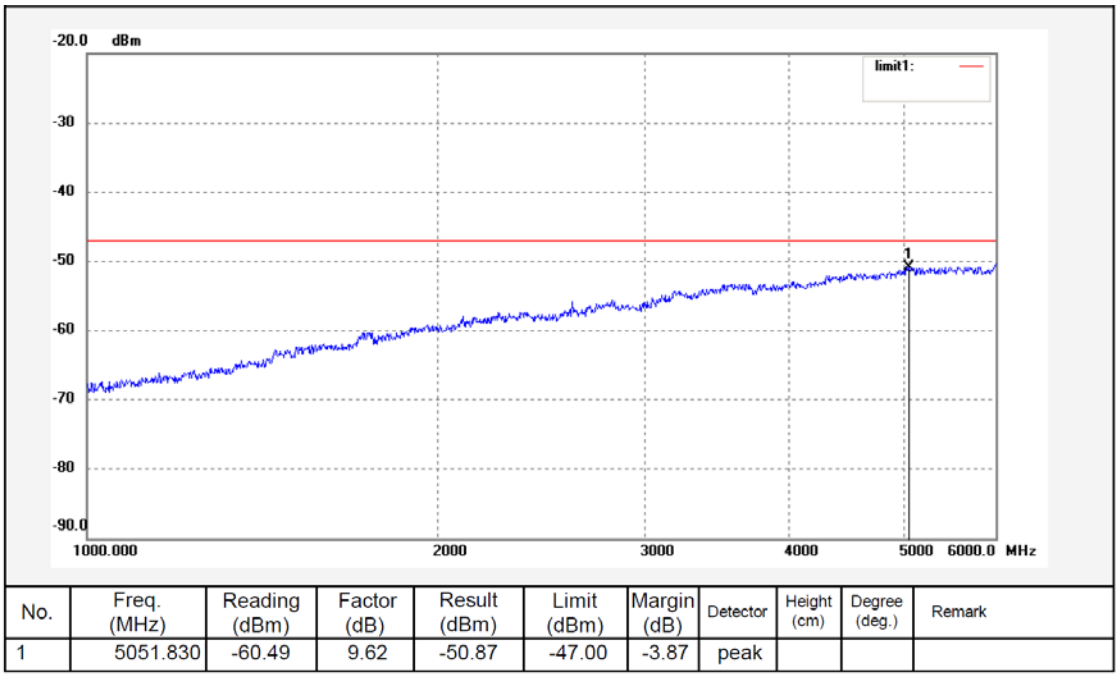
RX- ABOVE 1G

869.9MHz (worst case)
Horizontal



No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	5189.446	-59.20	8.45	-50.75	-47.00	-3.75	peak			

Vertical

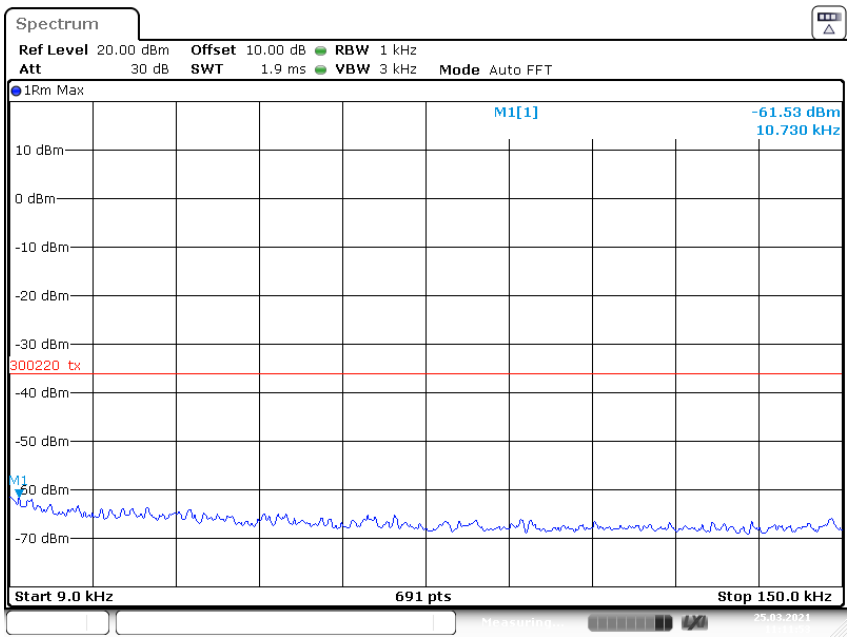


No.	Freq. (MHz)	Reading (dBm)	Factor (dB)	Result (dBm)	Limit (dBm)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	5051.830	-60.49	9.62	-50.87	-47.00	-3.87	peak			

Conducted spurious emissions:

Test mode: Transmitting

Low channel



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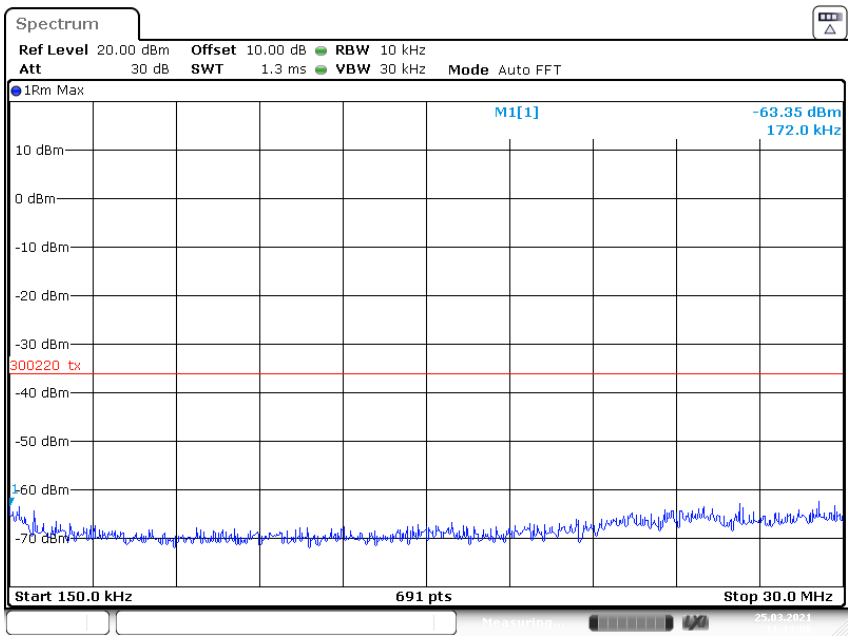

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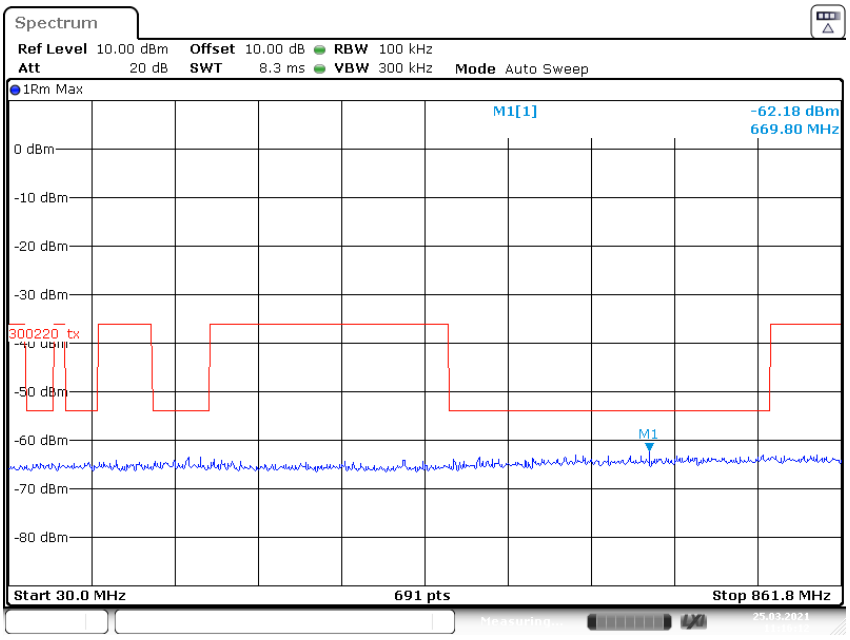

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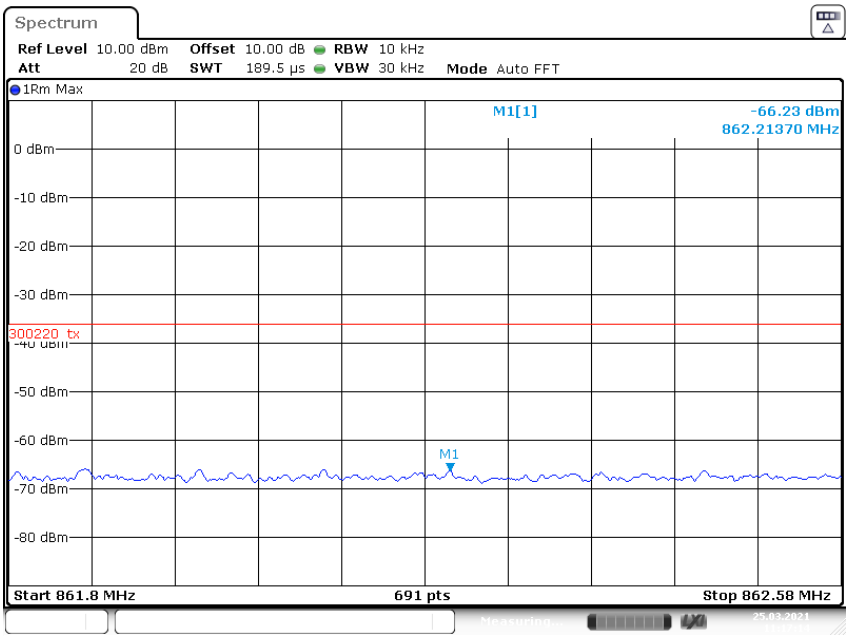

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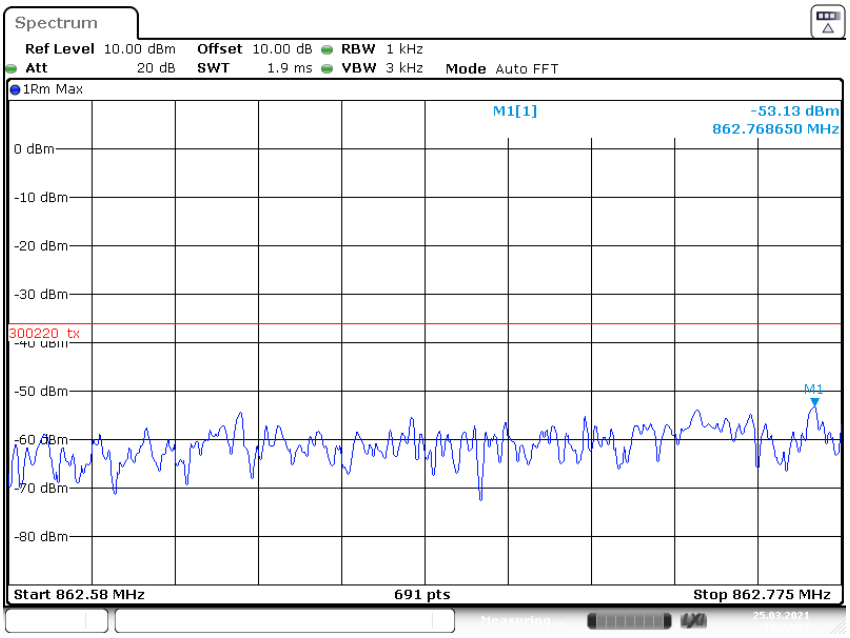

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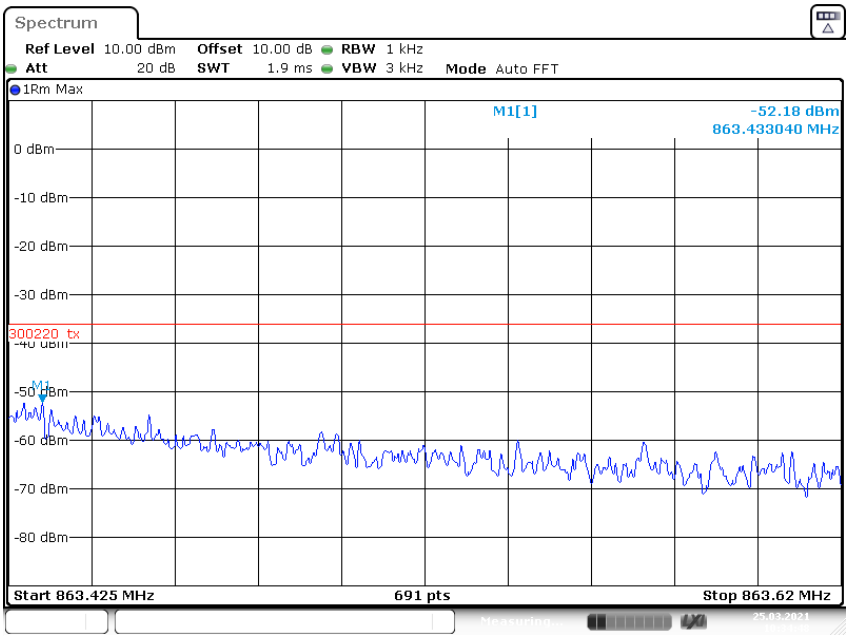

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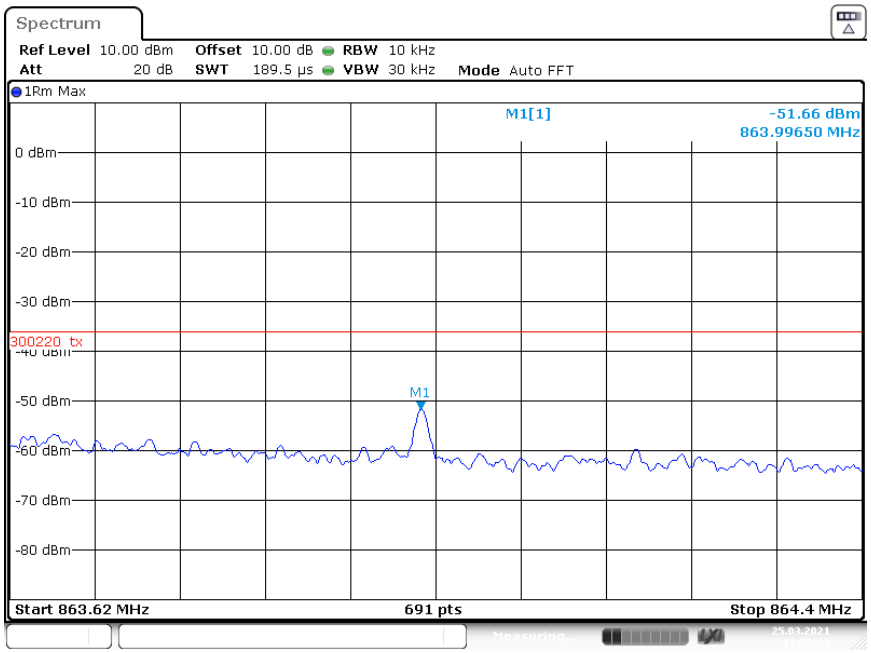

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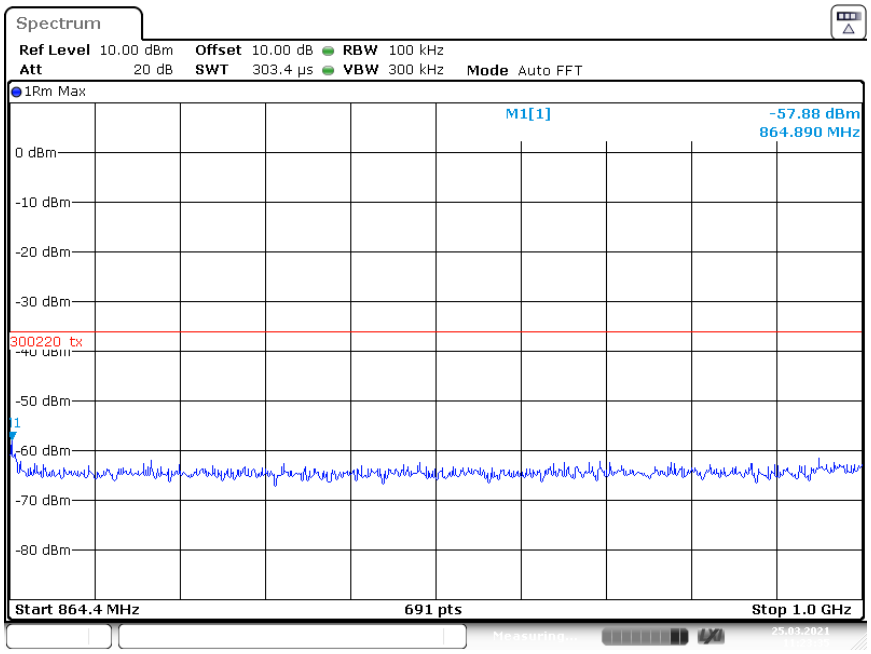

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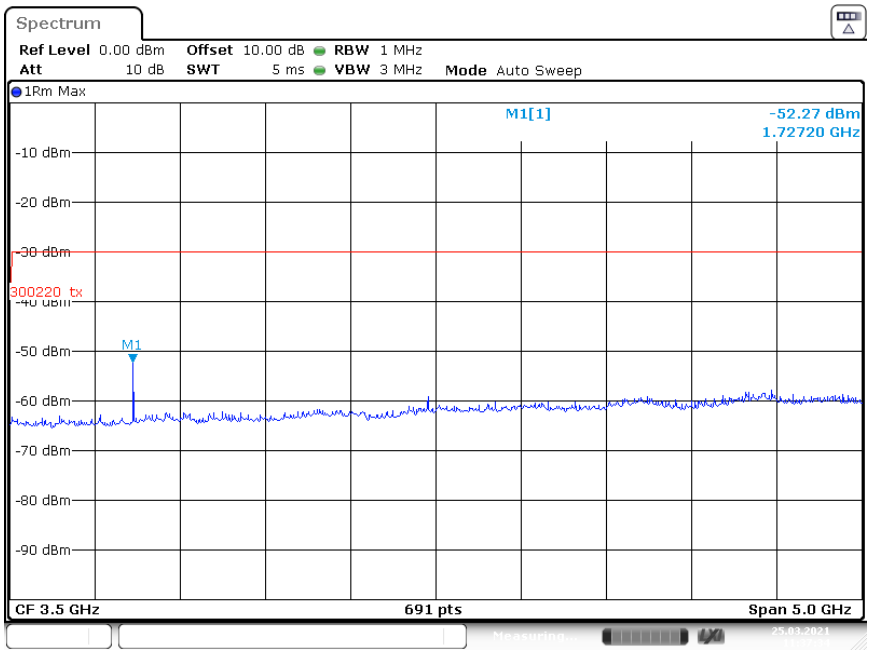

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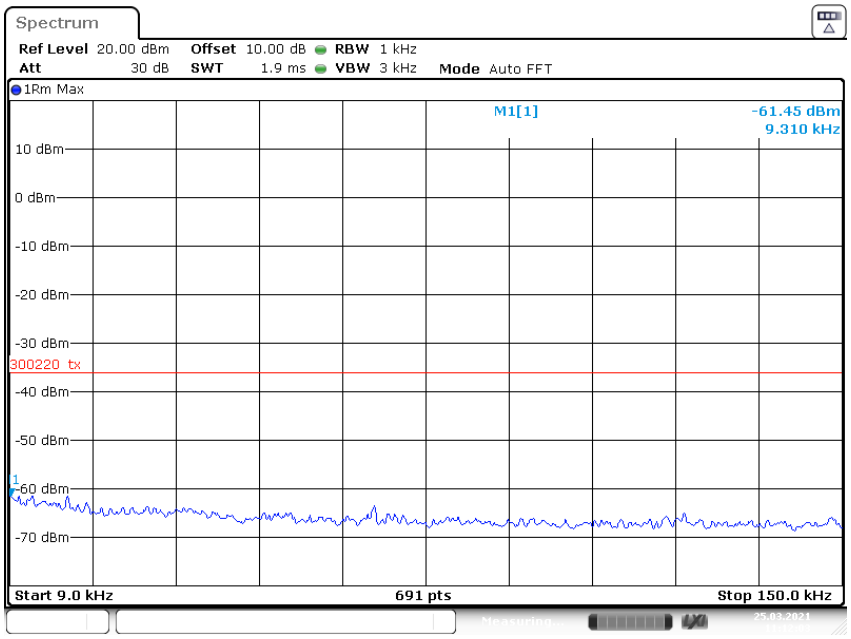
High channel



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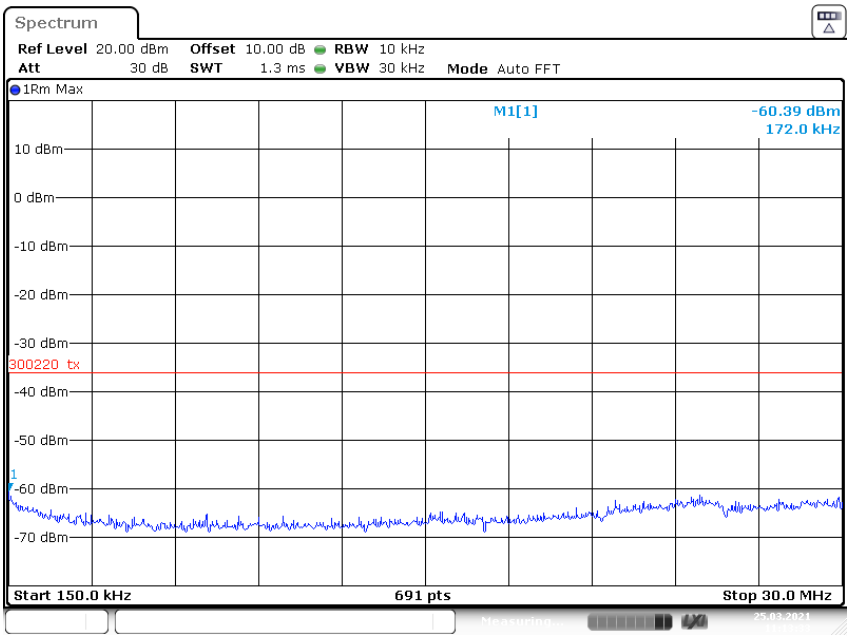

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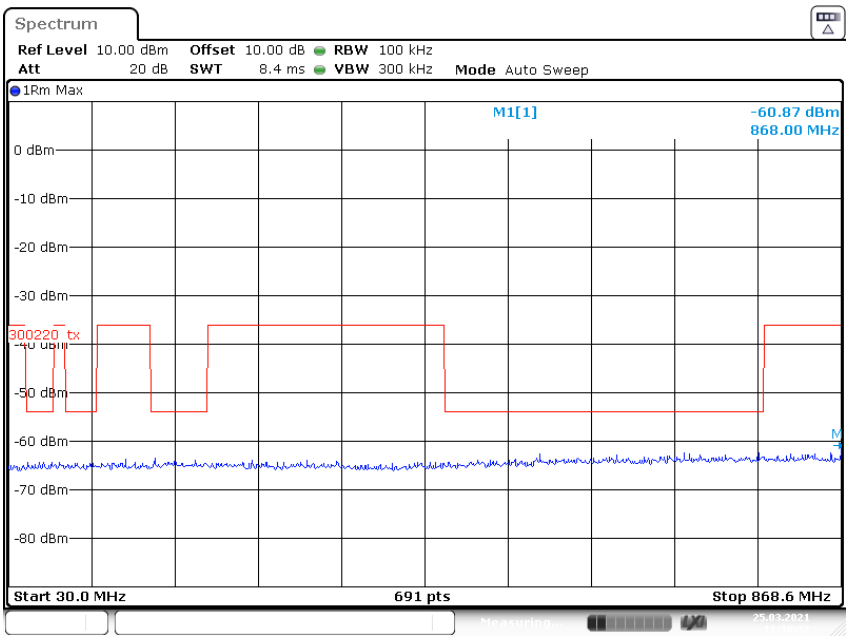

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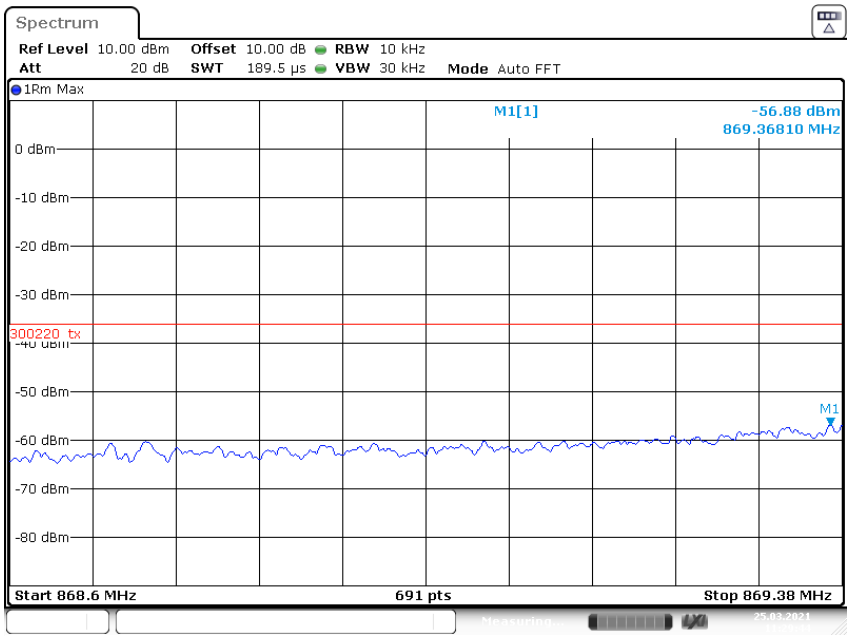

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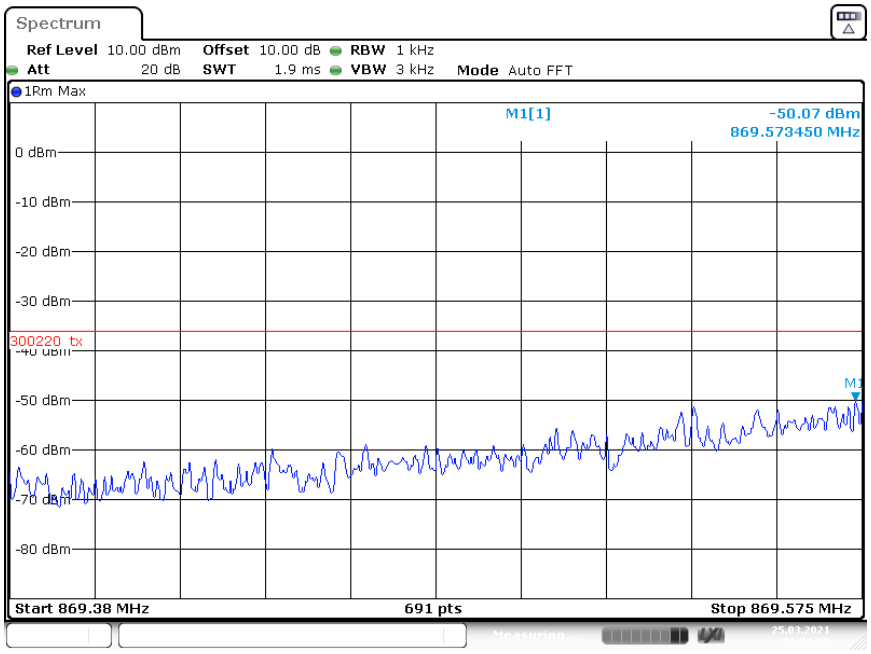

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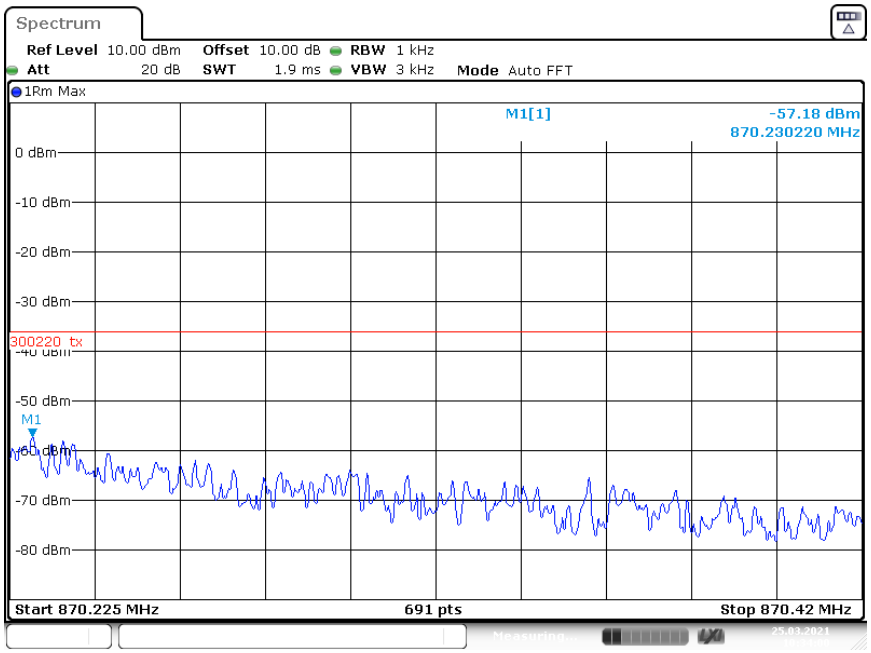

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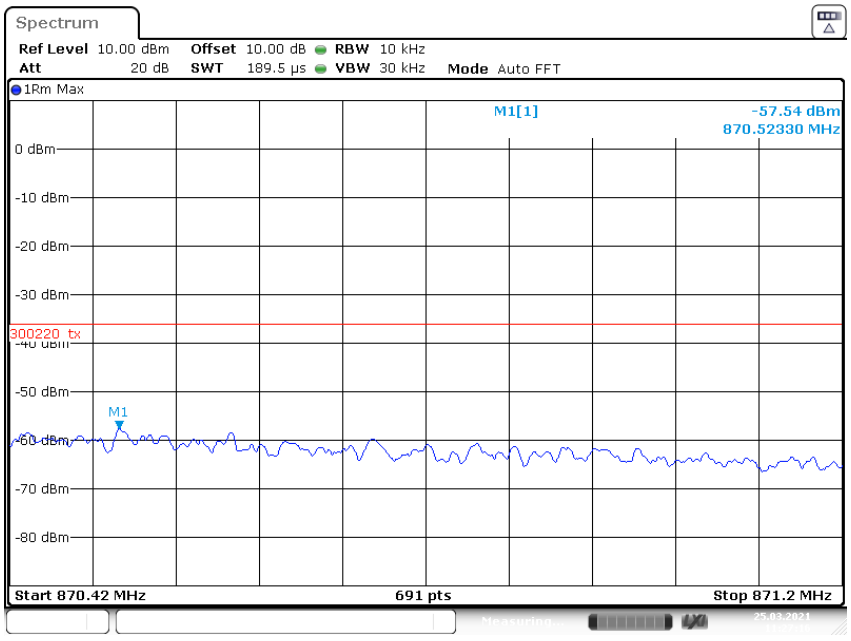

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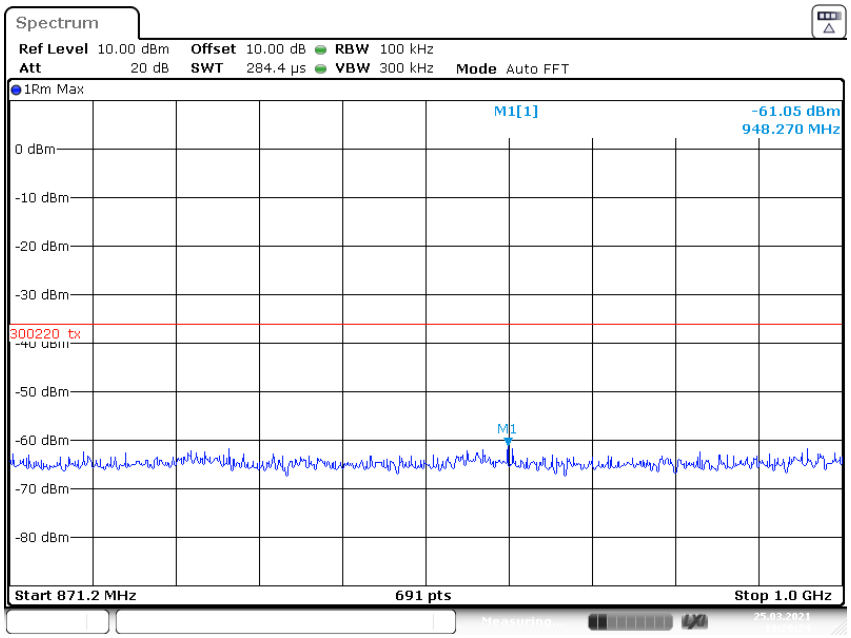

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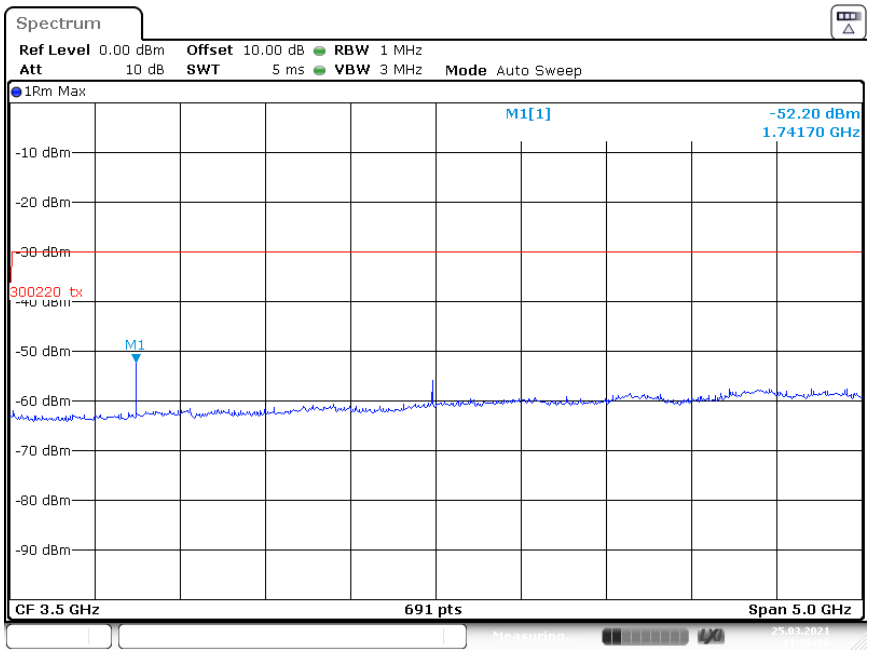
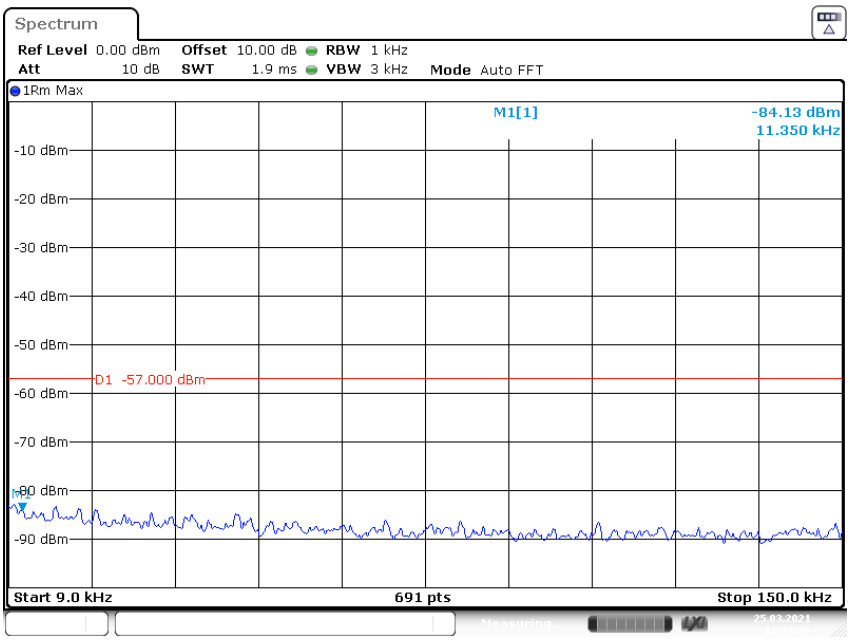


Date: 25.MAR.2021 11:36:57

Test mode: Receiving

Low channel



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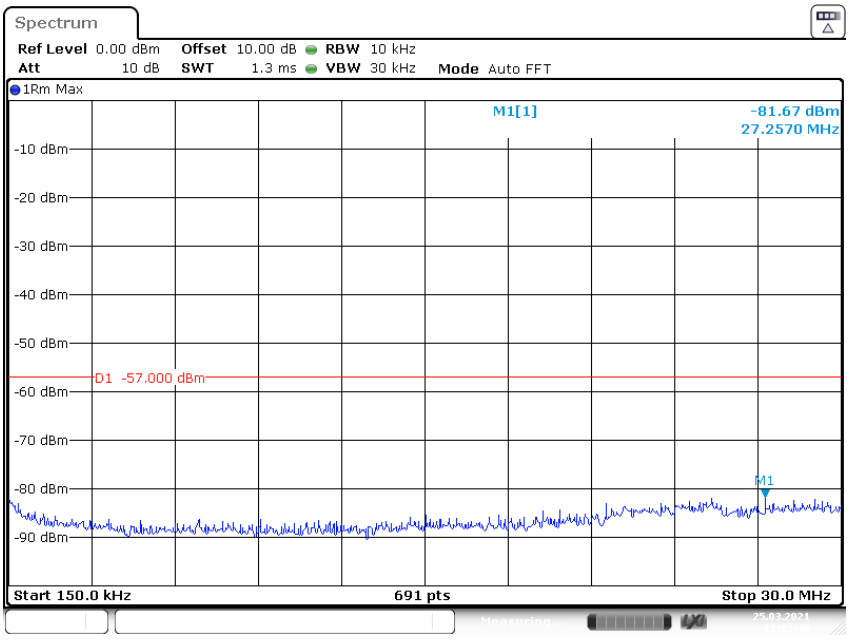

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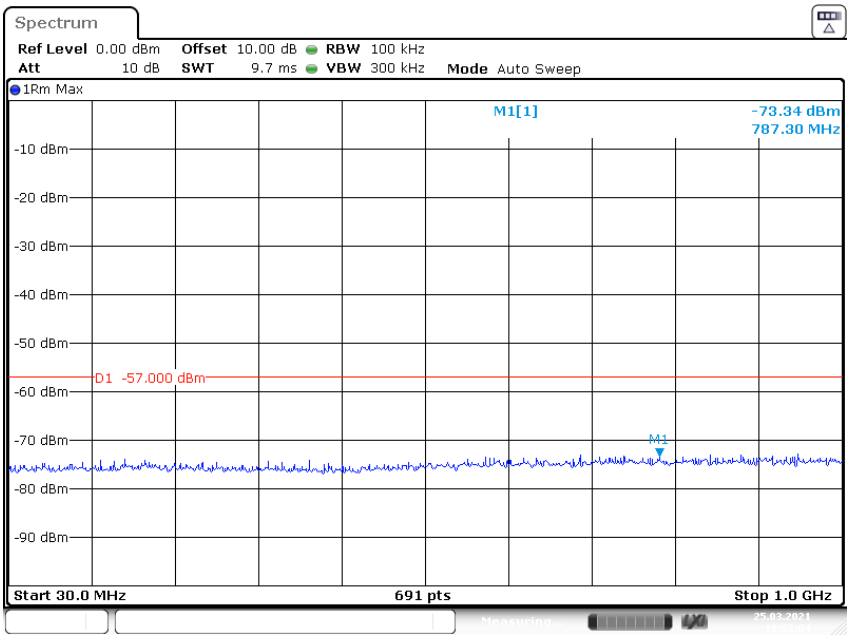

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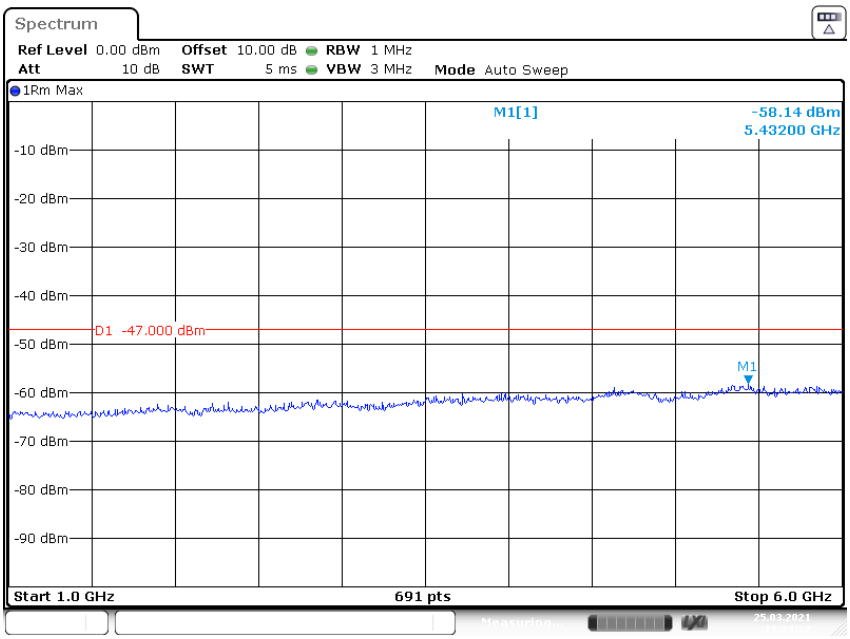
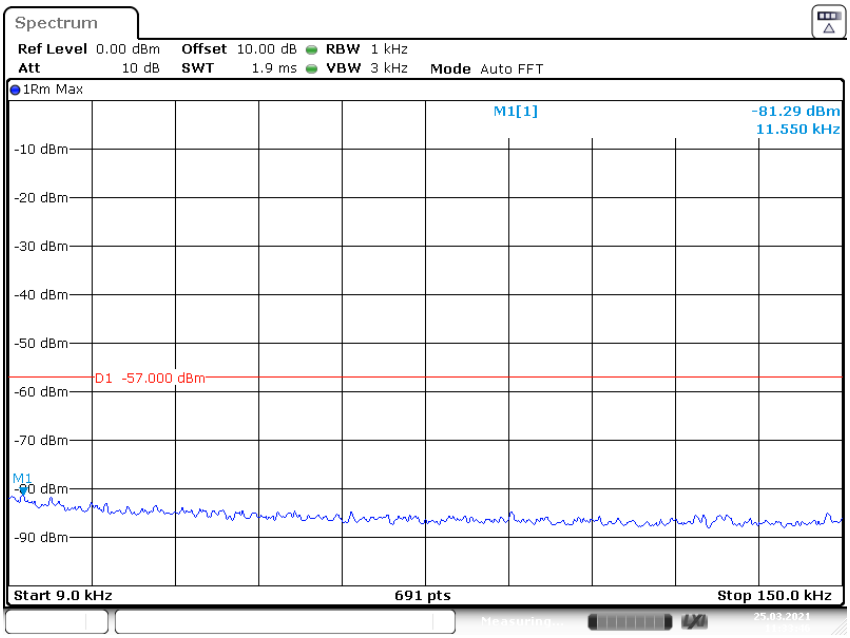


Date: 25.MAR.2021 11:34:23

High channel



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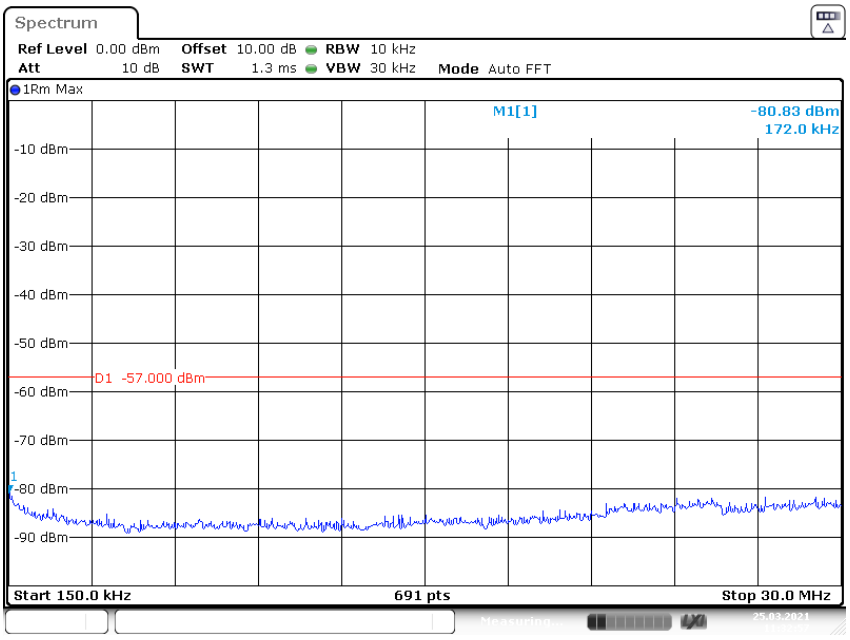

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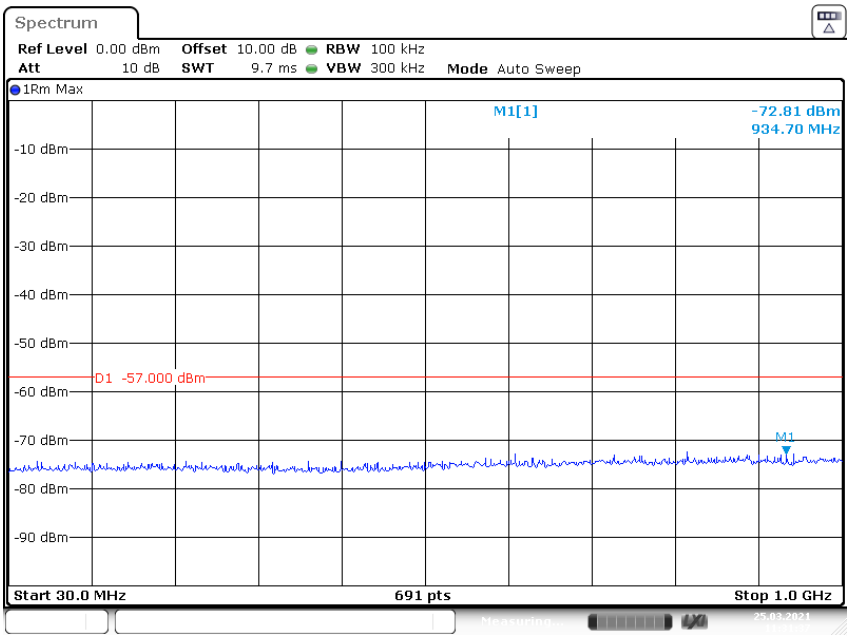

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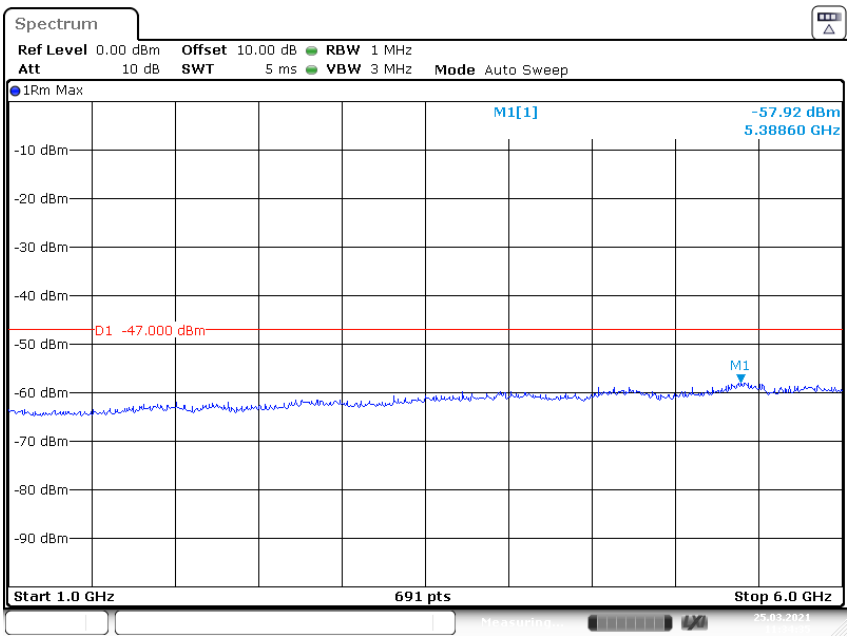

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ETSI EN 300 220-2 V3.1.1 (2017-02) §4.3.1 - EFFECTIVE RADIATED POWER

Applicable Standard

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.2.1:

The effective radiated power (e.r.p) is the power radiated in the direction of the maximum radiated power under specified conditions of measurements for any condition of modulation. For equipment with a permanent or temporary antenna connection it may be taken as the power delivered from that connector taking into account the antenna gain.

According to ETSI EN 300 220-2 V3.1.1 (2017-02) clause 4.3.1.2:

Limit: The effective radiated power shall not be greater than the value allowed in annexes B or C for the chosen operational frequency band(s).

Method of Measurement

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.2.2.1:

Effective Radiated Power (conducted measurement):

This method applies only to EUT with a permanent external antenna connector.

The transmitter shall be connected to a dummy load as described in clause 4.3.7 and the conducted power delivered shall be measured with a measurement receiver according to clause 4.3.10.

In the case of non-constant envelope modulation, a peak detector shall be used.

The maximum gain of the antenna to be used together with the equipment shall be declared by the manufacturer and this shall be recorded in the test report.

Perp, the radiated power (e.r.p.) limit applies to the maximum measured conducted power (Pconducted) value adjusted by the antenna gain (relative to a dipole) (Perp=Pconducted+antenna gain).

The information shown in Table 7 shall be recorded in the test report.

Table 7: Information Recorded in the Test Report for conducted Effective Radiated Power

Value	Notes
Test environment	Normal operation or unmodulated carrier
Centre frequency	Nominal Operating Frequency
Measured Effective Radiated Power	maximum measured conducted power value adjusted by the antenna gain (relative to a dipole)
NOTE: In case of a dedicated antenna the antenna gain (in dB, i.e. relative to a dipole) is declared by the manufacturer.	

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.2.2.2:

Effective radiated power (radiated measurement):

This measurement method applies to EUT other than those measured using clause 5.2.2.1.

A suitable test site shall be selected from those described in clause C.1 and the radiated power established using the procedures described in clause C.5.1 (or clause C.5.2) depending on the test site, followed by clause C.5.3.

In the case of non-constant envelope modulation, a peak detector shall be used.

The information shown in Table 8 shall be recorded in the test report.

Table 8: Information Recorded in the Test Report for Effective Radiated Power

Value	Notes
Test environment	Normal operation or unmodulated carrier
Centre frequency	Nominal Operating Frequency
Measure of Effective Radiated Power	Larger value from horizontal and vertical measurement equivalent radiated power, plus equipment antenna gain
NOTE: In case of a removable antenna the antenna gain (in dB, i.e. relative to a dipole) is declared by the manufacturer.	

Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0kPa

The testing was performed by Black Ding on 2020-03-25

Test Mode: Transmitting

Test Frequency (MHz)	Test Condition					Result
863.1	Normal	L.V. L.T.	L.V. H.T.	H.V.L.T	H.V. H.T	Compliance
869.9	Normal	L.V. L.T.	L.V. H.T.	H.V.L.T	H.V. H.T	Compliance

Frequency (MHz)	Test Condition	Conducted Power Reading (dBm)	Antenna gain (dBd)	ERP (dBm)	Limit (dBm)
863.1	Normal	9.29	-0.15	9.14	14
869.9	Normal	9.29	-0.15	9.14	14

Note:
Maximum Antenna Gain=2dBi (-0.15dBd), which was declared by manufacturer.
0dBd=2.15dBi

ETSI EN 300 220-2 V3.1.1 (2017-02) §4.3.3 - DUTY CYCLE

Applicable Standard

According to ETSI EN 300 220-2 V3.1.1 (2017-02) clause 4.3.3:

Duty cycle applies to all transmitters except EUT with polite spectrum access (described in clause 4.5) where permitted in annex B, table B.1 or annex C, table C.1 or any NRI.

Limit: The Duty Cycle at the operating frequency shall not be greater than values in annex B or C for the chosen operational frequency band(s).

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.4.1:

Duty cycle is the ratio expressed as a percentage, of the cumulative duration of transmissions T_{on_cum} within an observation interval T_{obs}. $DC = \left(\frac{T_{on\_cum}}{T_{obs}}\right)_{Fobs}$ on an observation bandwidth F_{obs}.

Unless otherwise specified, Tobs is 1 hour and the observation bandwidth Fobs is the operational frequency band. Each transmission consists of an RF emission, or sequence of RF emissions separated by intervals < T_{Dis}.

An equipment may operate on several bands simultaneously (i.e. multi transmissions), Duty Cycle limit of each individual band applies to each transmission within that band.

In case of a multicarrier modulation in a band, the duty cycle applies to the whole signal used for a transmission (e.g. OFDM).

It has to be noted that on some bands Duty Cycle value may depend on the presence of a primary radio service.

Equipment may be triggered manually, by internal timing or by external stimulus. Depending on the method of triggering the timing may be predictable or random.

Method of Measurement

An assessment of the overall Duty Cycle shall be made for a representative period of T_{obs} over the observation bandwidth Fobs. Unless otherwise specified, T_{obs} is 1 hour and the observation bandwidth F_{obs} is the operational frequency band.

The representative period shall be the most active one in normal use of the device. As a guide "Normal use" is considered as representing the behaviour of the device during transmission of 99 % of transmissions generated during its operational lifetime.

Procedures such as setup, commissioning and maintenance are not considered part of normal operation.

Where an acknowledgement is used, the additional transmitter on-time from a message responder shall be declared only once whether included in the message initiator Duty Cycle or in the message responder Duty Cycle.

NOTE: The intention of this rule is not to allow EUT to exceed the maximum duty cycle value.

Test Data

Test Mode: Transmitting (Normal use state)

Test result: Compliant.

The duty cycle was not exceeded 0.1 % in a period of 1 hour, which was declared by the manufacturer.

ETSI EN 300 220-2 V3.1.1 (2017-02) §4.3.4 - OCCUPIED BANDWIDTH

Applicable Standard

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.6:

The occupied bandwidth (OBW) is the Frequency Range in which 99 % of the total mean power of a given emission falls. The residual part of the total power being denoted as β, which, in cases of symmetrical spectra, splits up into β/2 on each side of the spectrum. Unless otherwise specified, β/2 is taken as 0,5 % as described in Figure 3.

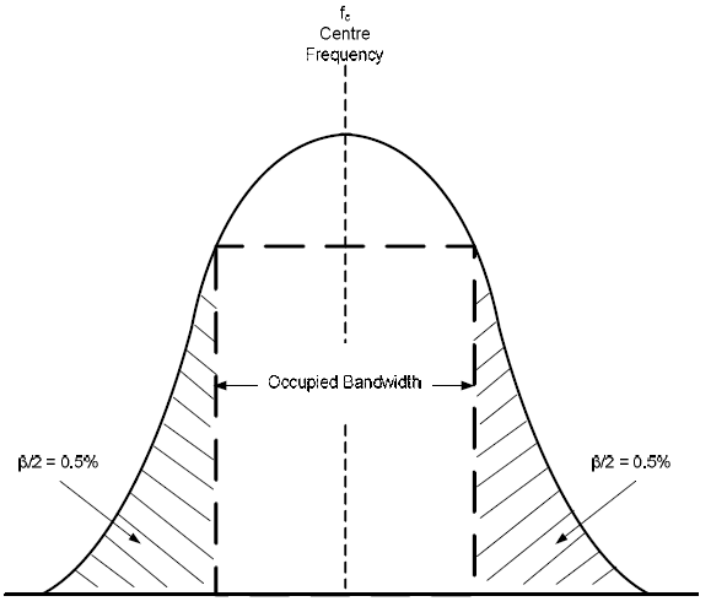


Figure 3: Signal occupied bandwidth

The maximum occupied bandwidth includes all associated side bands above the appropriate emissions level and the frequency error or drift under extreme test conditions.

Limit:
The Operating Channel shall be declared and shall reside entirely within the Operational Frequency Band.

The Maximum Occupied Bandwidth at 99 % shall reside entirely within the Operating Channel defined by F_{low} and F_{high}.

Method of measurement

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.6.3:

The spectrum analyser shall be configured as appropriate for the parameters shown in Table 12.

Table 12: Test Parameters for Max Occupied Bandwidth Measurement

Setting	Value	Notes
Centre frequency	The nominal Operating Frequency	The highest or lowest Operating Frequency as declared by the manufacturer
RBW	1 % to 3 % of OCW without being below 100 Hz	
VBW	3 x RBW	Nearest available analyser setting to 3 x RBW
Span	At least 2 x Operating Channel width	Span should be large enough to include all major components of the signal and its side bands
Detector Mode	RMS	
Trace	Max hold	

If the equipment is capable of producing an unmodulated carrier and the test in clause 5.7 is performed, then the OBW measurements need only be performed under normal test conditions. Any required results for Maximum OBW under extreme conditions are obtained by addition and substraction of the upper and lower frequency error results to each bandwidth measurement obtained in this test.

Step 1: Operation of the EUT shall be started, on the highest operating frequency as declared by the manufacturer, with the appropriate test signal.

The signal attenuation shall be adjusted to ensure that the signal power envelope is sufficiently above the noise floor of the analyser to avoid the noise signals on either side of the power envelope being included in the measurement.

Step 2: When the trace is completed the peak value of the trace shall be located and the analyser marker placed on this peak.

Step 3: The 99 % occupied bandwidth function of the spectrum analyser shall be used to measure the occupied bandwidth of the signal.

Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2021-03-25.

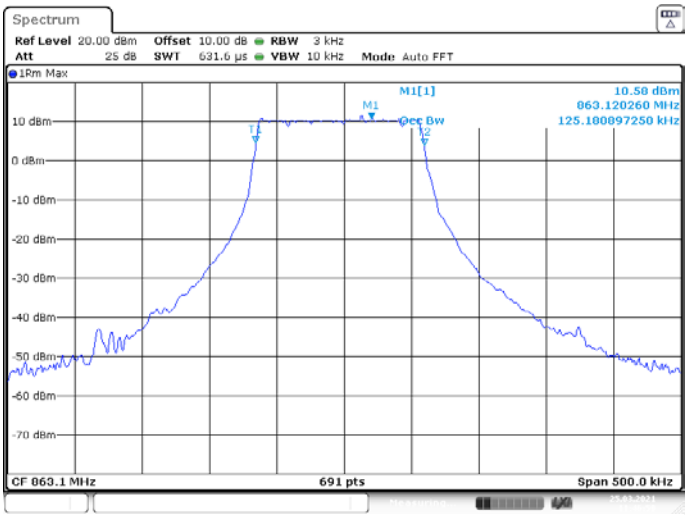
Test Mode: Transmitting

Test Frequency (MHz)	Test Condition					Result
863.5	Normal	L.V. L.T.	L.V. H.T.	H.V.L.T	H.V. H.T	Compliance
869.5	Normal	L.V. L.T.	L.V. H.T.	H.V.L.T	H.V. H.T	Compliance

Normal Condition Test plots as below:

Test Frequency (MHz)	Test Condition	Occupied Bandwidth (kHz)	Limit (MHz)
863.1	Normal	125.18	Within 863-870
869.9	Normal	125.18	Within 863-870

863.1MHz



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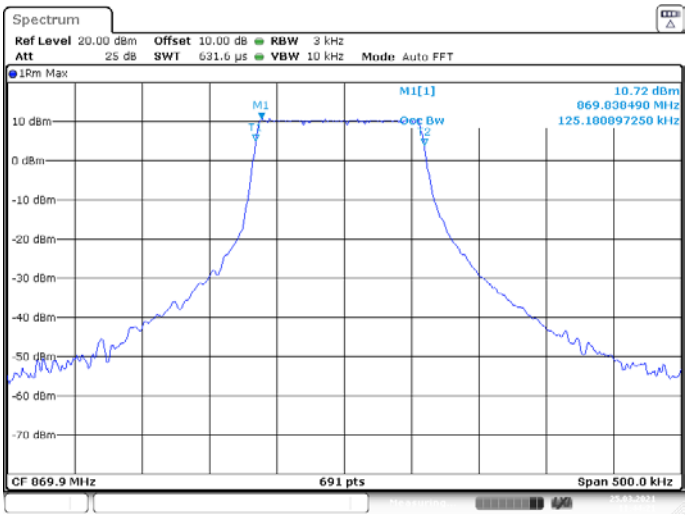
869.9MHz



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ETSI EN 300 220-2 V3.1.1 (2017-02) §4.3.5–TX OUT OF BAND EMISSIONS

Applicable Standard

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.8:

Two OOB domains are defined, one for OC (see Figure 5) and one for Operational Frequency band (see Figure 6). The spectrum masks for these two OOB domains may overlap.

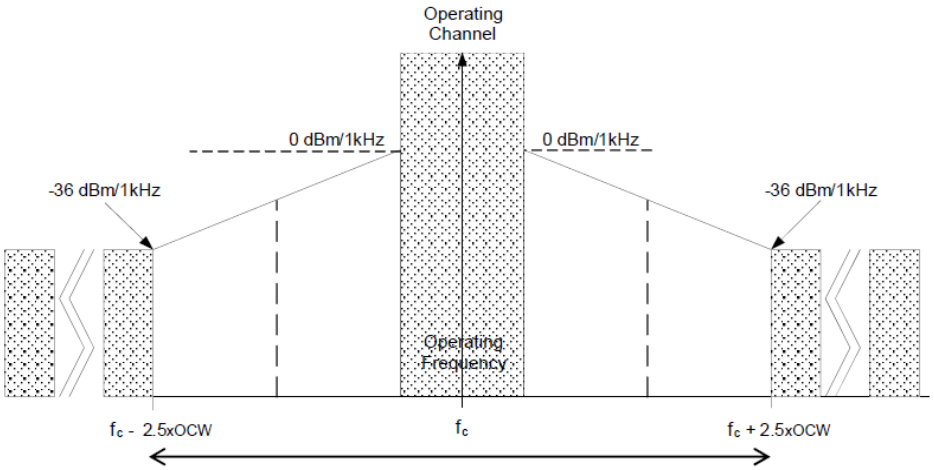


Figure 5: Out Of Band Domain for Operating Channel with reference BW

Unwanted emissions in the Out Of Band domain are those falling in the frequency range immediately below the lower, and above the upper, frequency of the Operating Channel. The OOB domain includes both frequencies outside the Operating Channel within the Operational Frequency Band and frequencies outside the Operational Frequency Band.

The relevant Out Of Band domain is shown in Figure 5 and applies within the Operational Frequency Band.

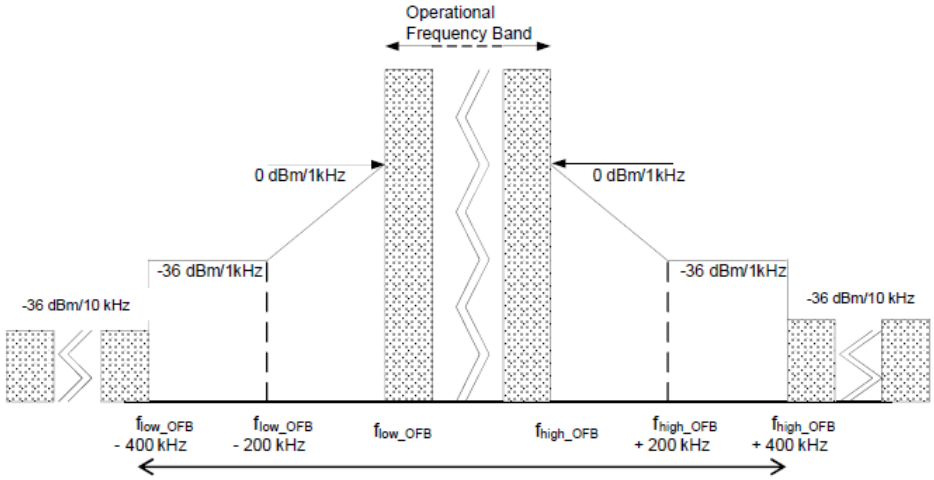


Figure 6: Out Of Band Domain for Operational Frequency Band with reference BW

Specific limits apply at frequencies immediately above and below the Operational Frequency Band as shown in Figure 6.

NOTE: f_{low_OFB} is the lower edge of the Operational Frequency Band.
f_{high_OFB} is the upper edge of the Operational Frequency Band.

Limit: The EUT emissions level in OOB domains for the Operating Channel and the Operational Frequency Band shall be less or equal to Table 15 spectrum mask.

Table 15: Emission limits in the Out Of Band domains

Domain	Frequency Range	RBW_{REF}	Max power limit
OOB limits applicable to Operational Frequency Band (See Figure 6)	$f \le f_{low\_OFB}$ - 400 kHz	10 kHz	-36 dBm
	F_{low_OFB} - 400 kHz ≤ f ≤ f_{low_OFB} - 200 kHz	1 kHz	-36 dBm
	f_{low} - 200 kHz ≤ f < f_{low_OFB}	1 kHz	See Figure 6
	$f = f_{low\_OFB}$	1 kHz	0 dBm
	$f = f_{high\_OFB}$	1 kHz	0 dBm
	F_{high_OFB} < f ≤ f_{high_OFB} + 200 kHz	1 kHz	See Figure 6
	F_{high_OFB} + 200 kHz ≤ f ≤ f_{high_OFB} + 400 kHz	1 kHz	-36 dBm
	F_{high_OFB} + 400 kHz ≤ f	10 kHz	-36 dBm
OOB limits applicable to Operating Channel (See Figure 5)	$f = f_c$ - 2.5 x OCW	1 kHz	-36 dBm
	f_c - 2,5 x OCW ≤ f ≤ f_c - 0,5 x OCW	1 kHz	See Figure 5
	$f = f_c$ - 0,5 x OCW	1 kHz	0 dBm
	$f = f_c$ + 0,5 x OCW	1 kHz	0 dBm
	f_c + 0,5 x OCW ≤ f ≤ f_c + 2,5 x OCW	1 kHz	See Figure 5
	$f = f_c$ + 2,5 x OCW	1 kHz	-36 dBm
NOTE: f is the measurement frequency. f_c is the Operating Frequency. F_{low_OFB} is the lower edge of the Operational Frequency Band. F_{high_OFB} is the upper edge of the Operational Frequency Band. OCW is the operating channel bandwidth.			

Method of measurement

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.8.3.

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2020-03-25.

Test Mode: Transmitting

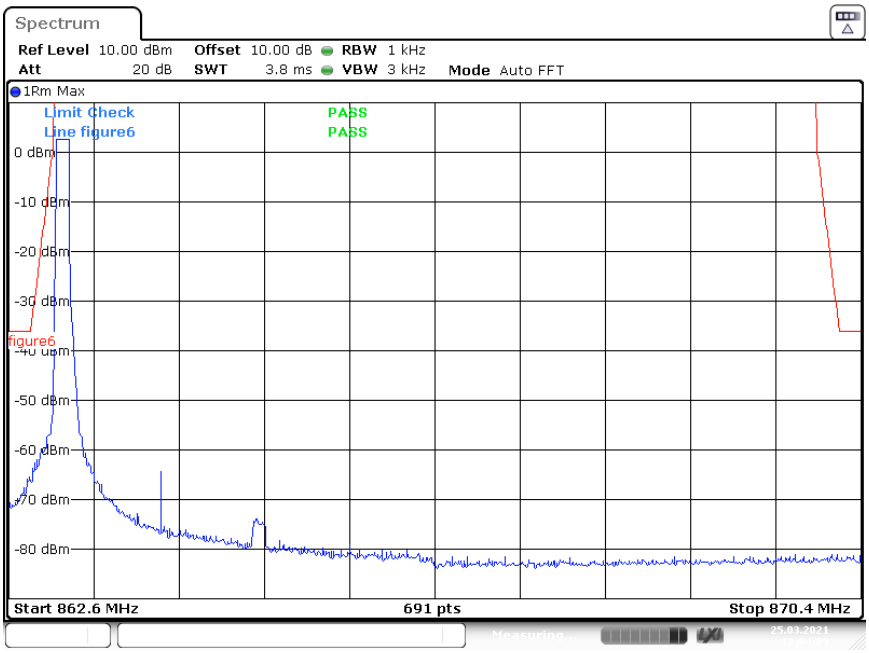
Test Frequency (MHz)	Test Condition					Result
863.1	Normal	L.V. L.T.	L.V. H.T.	N.V.L.T	N.V. H.T	Compliance
869.9	Normal	L.V. L.T.	L.V. H.T.	N.V.L.T	N.V. H.T	Compliance

Normal Condition Test Data as below:

Test with conducted measurement.

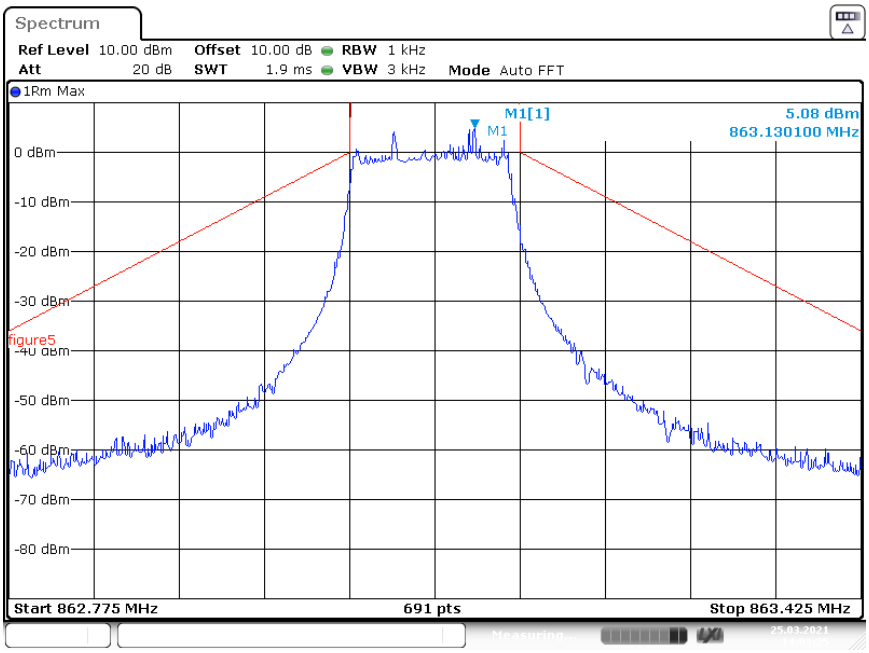
Please refer to the below plots:

863.1MHz
OOB for OFB



Date: 25.MAR.2021 12:04:10

OOB for OC



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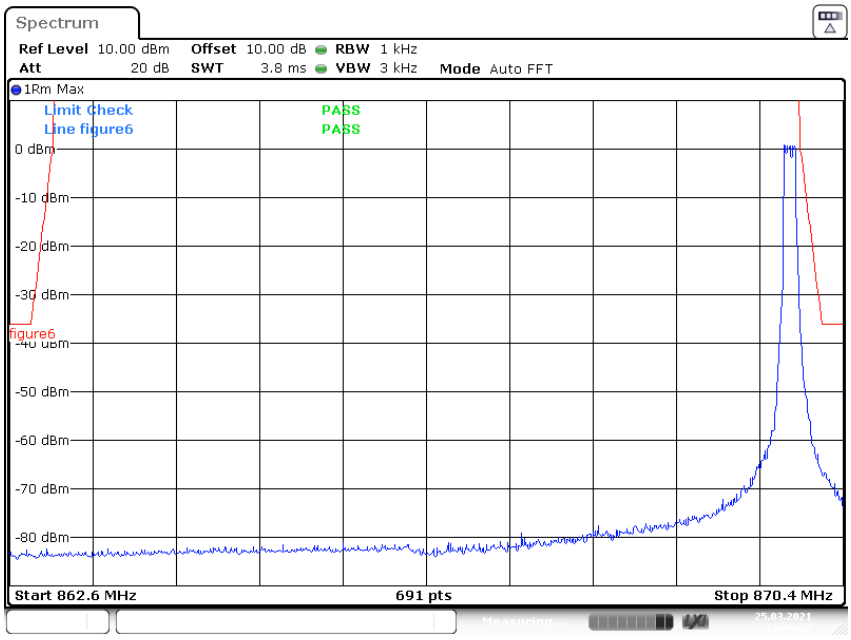
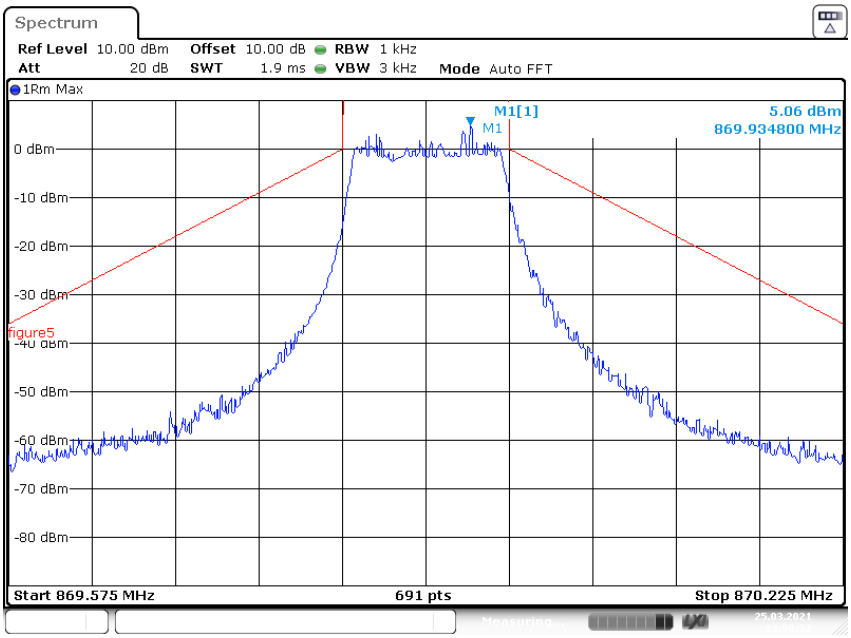
869.9MHz
OOB for OFB



Date: 25.MAR.2021 12:06:37

OOB for OC



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ETSI EN 300 220-2 V3.1.1 (2017-02) §4.3.6 - TRANSIENT POWER

Applicable Standard

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.10:

Transmitter transient power is power falling into frequencies other than the operating channel as a result of the transmitter being switched on and off.

Limit: The transient power shall not exceed the values given in Table 23.

Table 23: Transmitter Transient Power limits

Absolute offset from centre frequency	RBW_{REF}	Peak power limit applicable at measurement points
≤ 400 kHz	1 kHz	0 dBm
> 400 kHz	1 kHz	-27 dBm

Method of measurement

The output of the EUT shall be connected to a spectrum analyser or equivalent measuring equipment.

The measurement shall be undertaken in zero span mode. The analyser's centre frequency shall be set to an offset from the operating centre frequency. These offset values and their corresponding RBW configurations are listed in Table 24.

Table 24: RBW for Transient Measurement

Measurement points: offset from centre frequency	Analyser RBW	RBW_{REF}
-0,5 x OCW - 3 kHz 0,5 x OCW + 3 kHz Not applicable for OCW < 25 kHz	1 kHz	1kHz
±12,5 kHz or ±OCW whichever is the greater	Max (RBW pattern 1, 3, 10 kHz) ≤ Offset frequency/6 (see note)	1 kHz
-0,5 x OCW - 400 kHz 0,5 x OCW + 400 kHz	100 kHz	1 kHz
-0,5 x OCW -1 200 kHz 0,5 x OCW + 1 200 kHz	300 kHz	1 kHz
NOTE: Max (RBW pattern 1, 3, 10 kHz) means the maximum bandwidth that falls into the commonly implemented 1, 3, 10 kHz RBW filter bandwidth incremental pattern of spectrum analysers. EXAMPLE: If OCW is 25 kHz then the RBW value corresponding to one OCW offset frequency is 3 kHz. The rest of the analyser settings are listed in Table 25, and if OCW is 250 kHz then the RBW value corresponding to one OCW offset frequency is 30 kHz.		

The used modulation shall be D-M3. The analyser shall be set to the settings of Table 25 and a measurement shall be started for each offset frequency. The EUT shall transmit at least five D-M3 test signal. The peak value shall be recorded and the measurement shall be repeated at each offset frequency mentioned in Table 24.

The recorded power values shall be converted to power values measured in RBWREF by the formula in clause 4.3.10.1.

Table 25: Parameters for Transient Measurement

Spectrum Analyser Setting	Value	Notes
VBW/RBW	10	At higher RBW values VBW may be clipped to its maximum value
Sweep time	500 ms	
RBW filter	Gaussian	
Trace Detector Function	RMS	
Trace Mode	Max hold	
Sweep points	501	
Measurement mode	Continuous sweep	
NOTE: The ratio between the number of sweep points and the sweep time shall be the same ratio as above if different number of sweep points is used.		

The used modulation shall be D-M3. The analyser shall be set to the settings of Table 25 and a measurement shall be started for each offset frequency. The EUT shall transmit at least five D-M3 test signal. The peak value shall be recorded and the measurement shall be repeated at each offset frequency mentioned in Table 24.

The recorded power values shall be converted to power values measured in RBWREF by the formula in clause 4.3.10.1.

When $RBW_{measured} > RBW_{REF}$ the result for broadband emissions should be normalized to the bandwidth Ratio according to the formula (2):

$$B = A + 10 \log \frac{RBWref}{RBW_{MEASURED}} \quad (2)$$

Where:

- A is the measured value at the wider measurement bandwidth $RBW_{measured}$;
- B is the corresponding value at RBW_{REF}.

Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2021-03-25.

Test mode: Transmitting. Please refer to the below tables and plots

863.1MHz

Item	Test Frequency Offset From Centre Frequency	Reading (dBm)	RBWref/ RBWmeas (kHz)	Correct Factor (dB)	Transient Power (dBm)	Limit (dBm)	Result
Offset *1	-0.5*OCW-3kHz	-18.95	1/1	0	-18.95	0	Pass
Offset *2	-OCW	-38.16	1/10	-10	-48.16	0	Pass
Offset *3	-0.5*OCW-400kHz	-53.32	1/100	-20	-73.32	-27	Pass
Offset *4	-0.5*OCW-1200kHz	-55.37	1/300	-24.8	-80.17	-27	Pass
Offset *5	+0.5*OCW+3kHz	-16.07	1/1	0	-16.07	0	Pass
Offset *6	+OCW	-39.57	1/10	-10	-49.57	0	Pass
Offset *7	+0.5*OCW+400kHz	-52.56	1/100	-20	-72.56	-27	Pass
Offset *8	+0.5*OCW+1200kHz	-55.62	1/300	-24.8	-80.42	-27	Pass

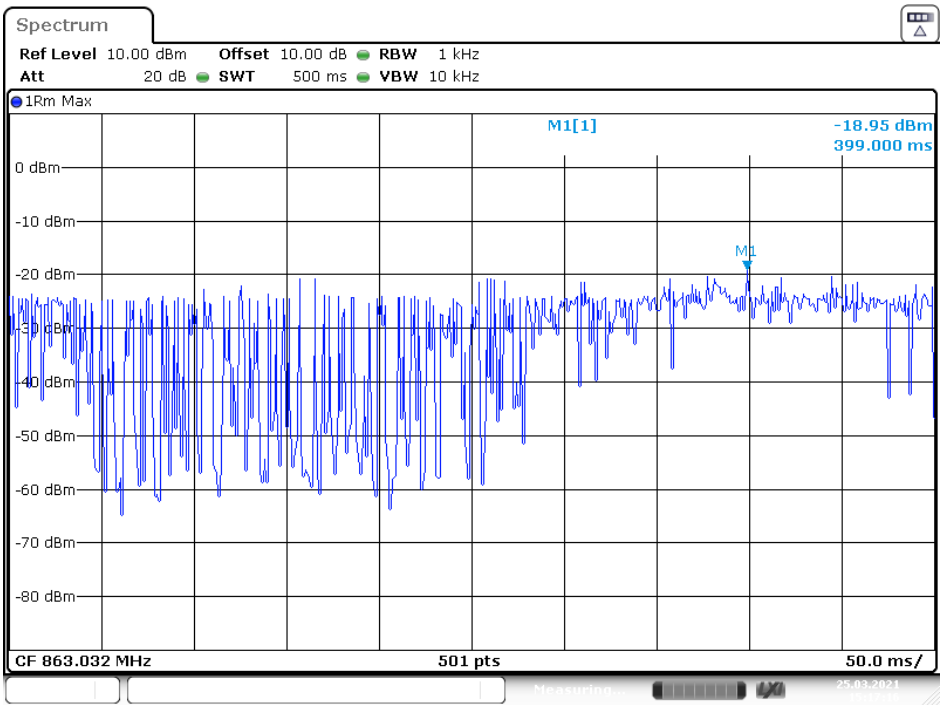
869.9MHz

Item	Test Frequency Offset From Centre Frequency	Reading (dBm)	RBWref/ RBWmeas (kHz)	Correct Factor (dB)	Transient Power (dBm)	Limit (dBm)	Result
Offset *1	-0.5*OCW-3kHz	-17.36	1/1	0	-17.36	0	Pass
Offset *2	-OCW	-38.77	1/10	-10	-48.77	0	Pass
Offset *3	-0.5*OCW-400kHz	-52.27	1/100	-20	-72.77	-27	Pass
Offset *4	-0.5*OCW-1200kHz	-55.39	1/300	-24.8	-80.19	-27	Pass
Offset *5	+0.5*OCW+3kHz	-13.51	1/1	0	-13.51	0	Pass
Offset *6	+OCW	-35.62	1/10	-10	-45.62	0	Pass
Offset *7	+0.5*OCW+400kHz	-52.47	1/100	-20	-72.47	-27	Pass
Offset *8	+0.5*OCW+1200kHz	-55.64	1/300	-24.8	-80.44	-27	Pass

Note: Correct factor=10*log(RBWref/RBWmeas)
Transient power=Reading+Correct factor
Test with conducted method.

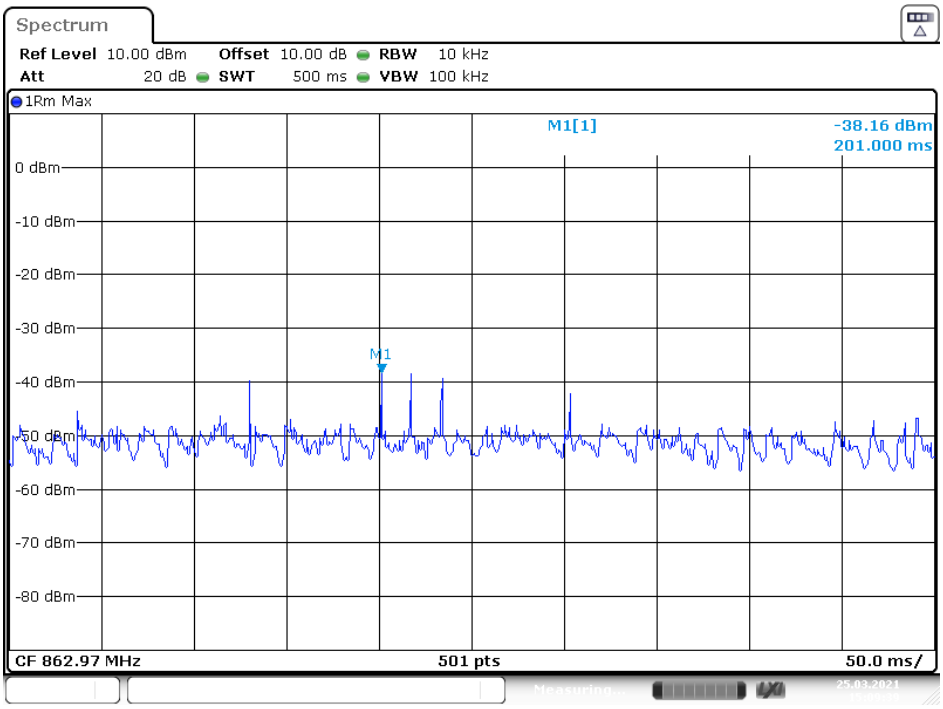
863.1MHz

Offset *1



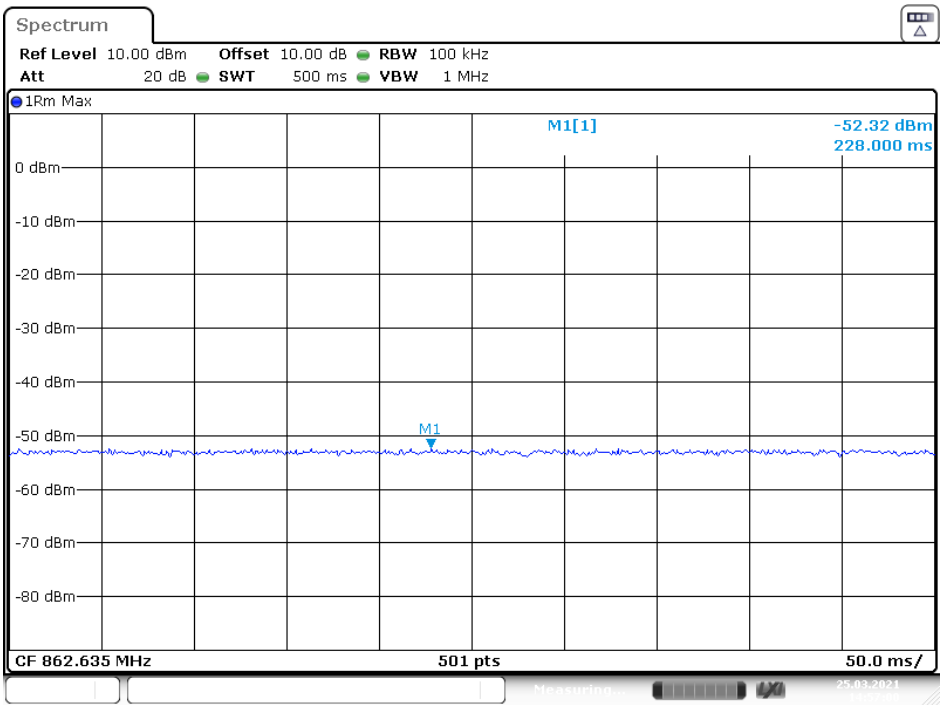
Date: 25.MAR.2021 15:17:16

Offset *2



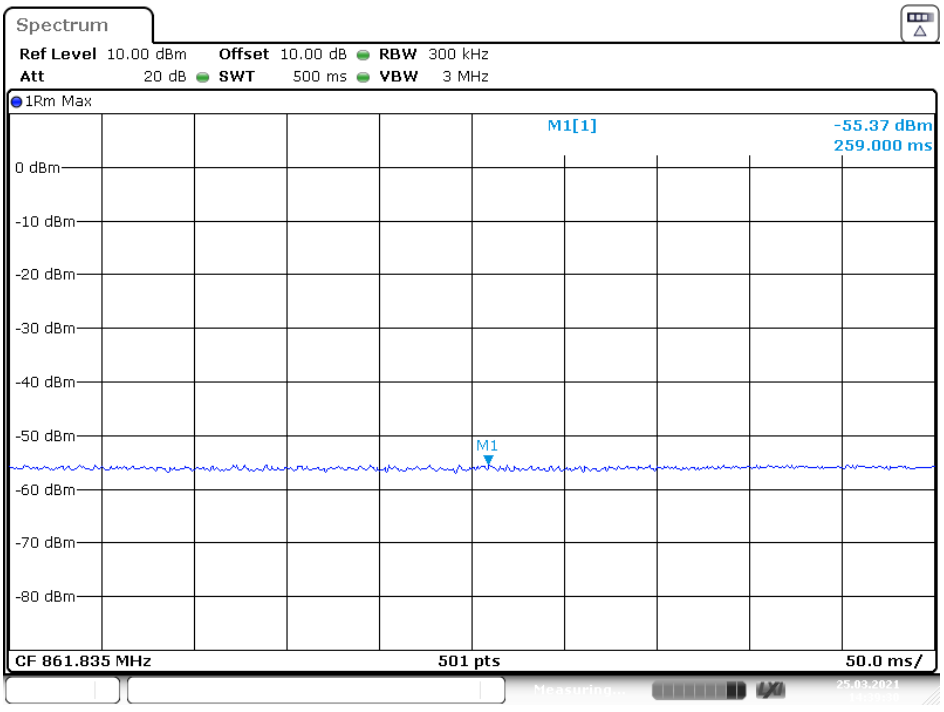
Date: 25.MAR.2021 15:09:39

Offset *3



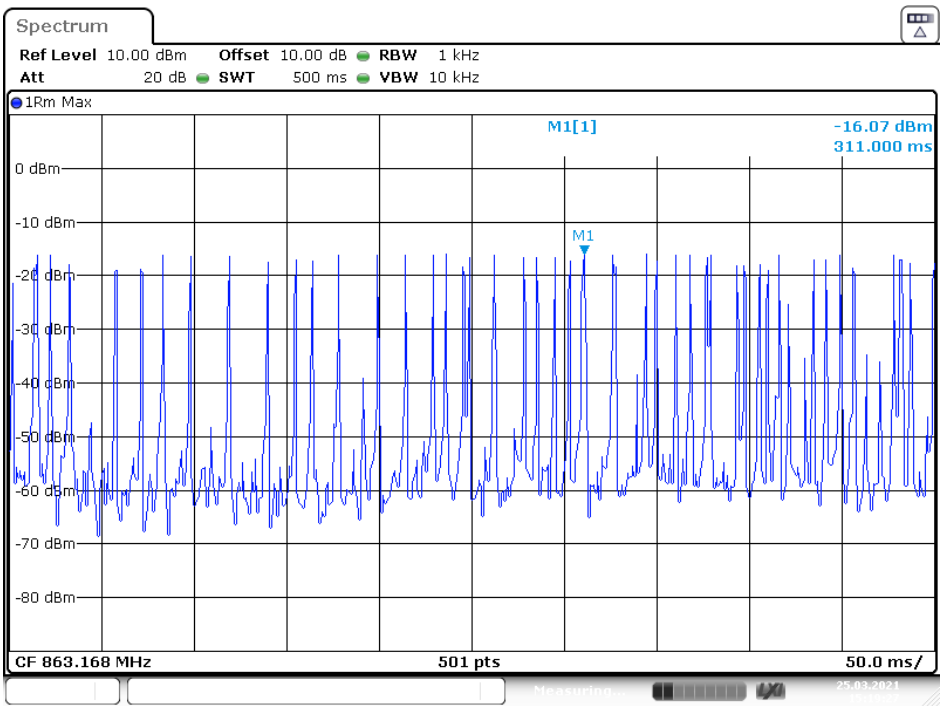
Date: 25.MAR.2021 14:57:01

Offset *4



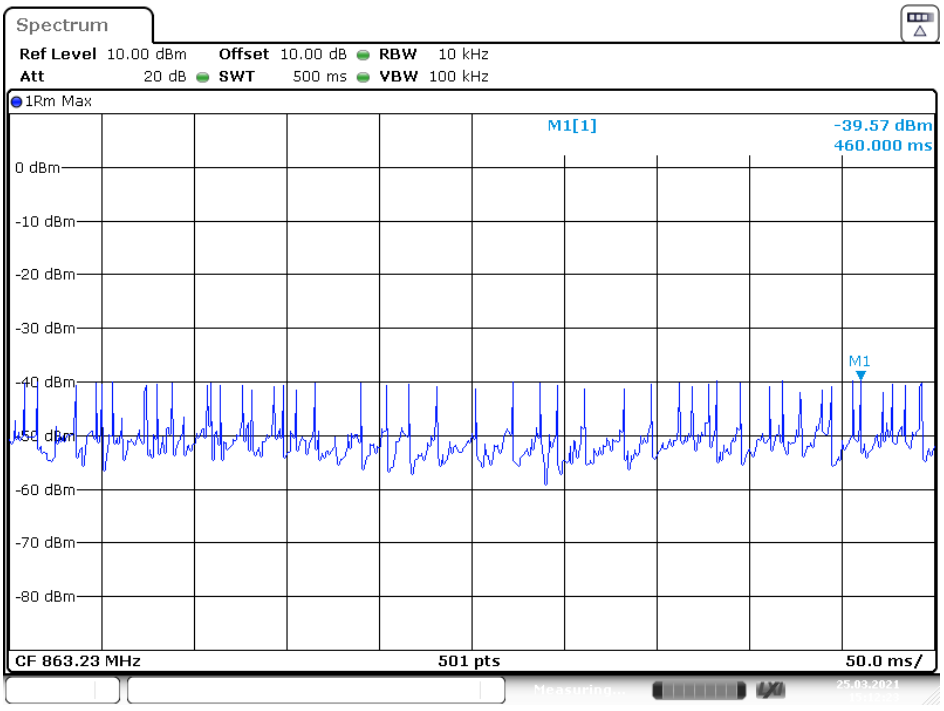
Date: 25.MAR.2021 14:39:31

Offset *5



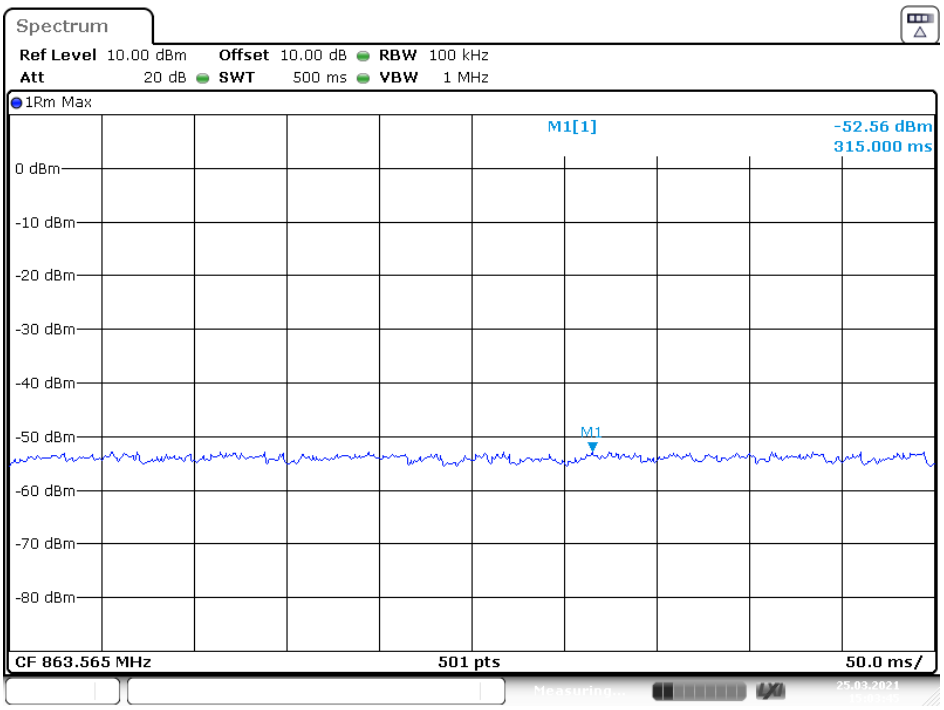
Date: 25.MAR.2021 15:19:28

Offset *6



Date: 25.MAR.2021 15:12:24

Offset *7



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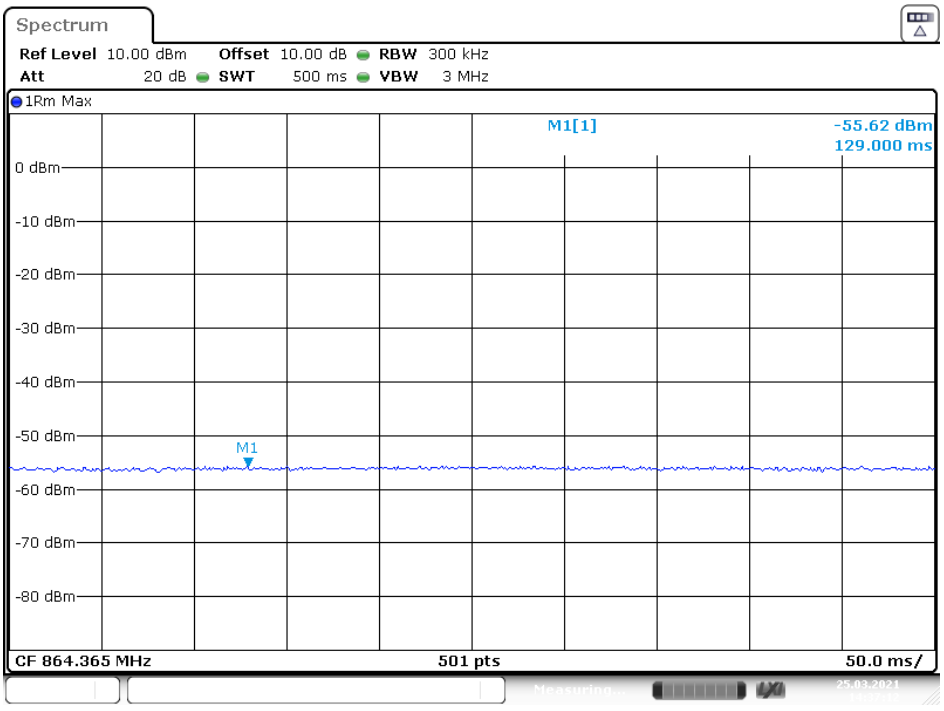
Offset *8



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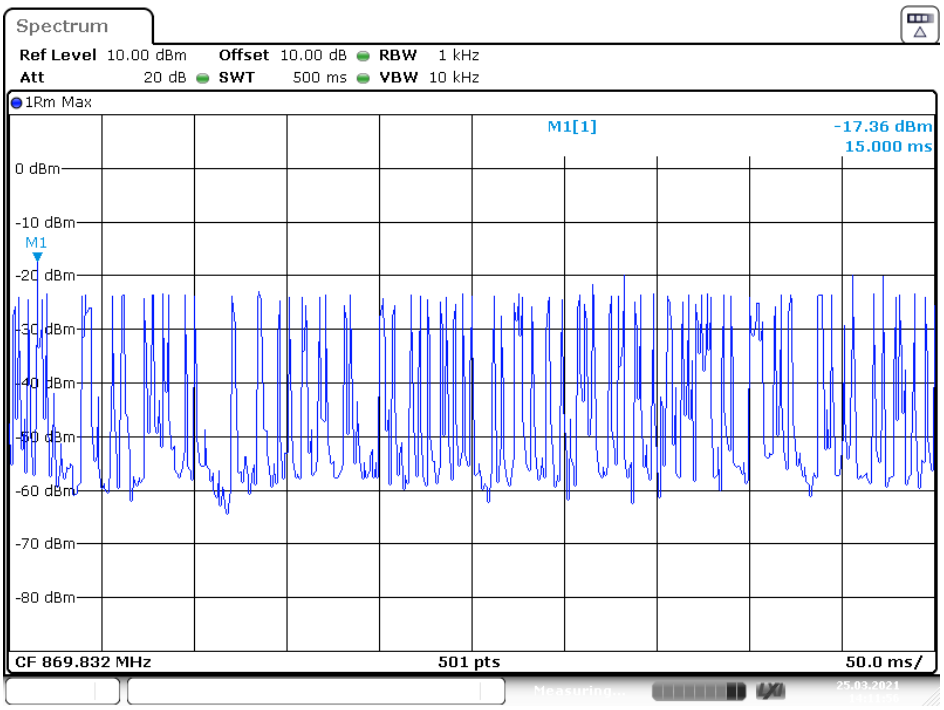
869.9MHz

Offset *1



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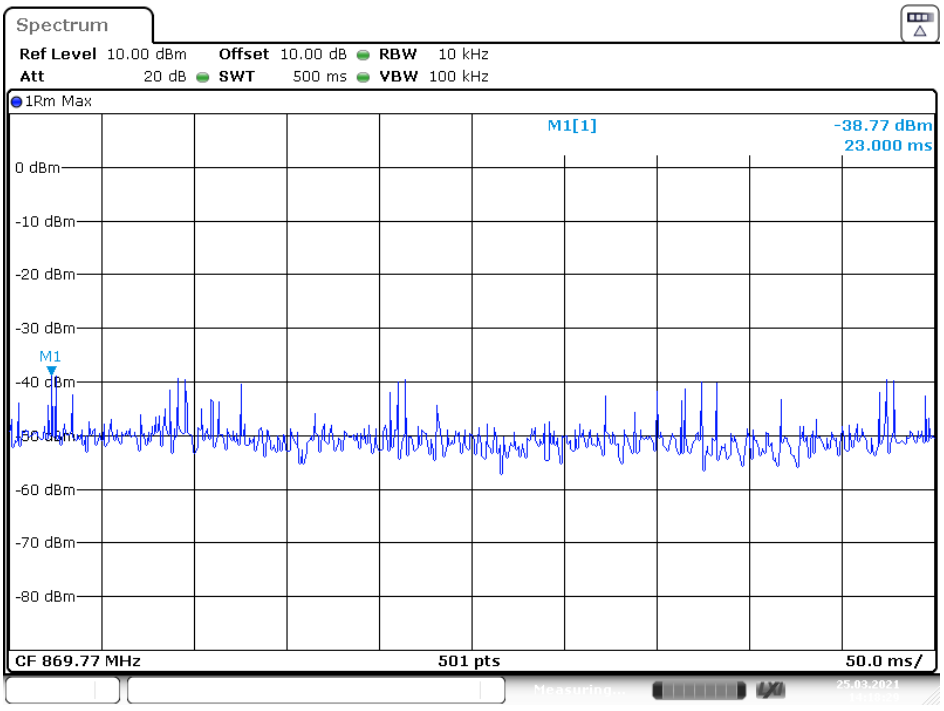
Offset *2



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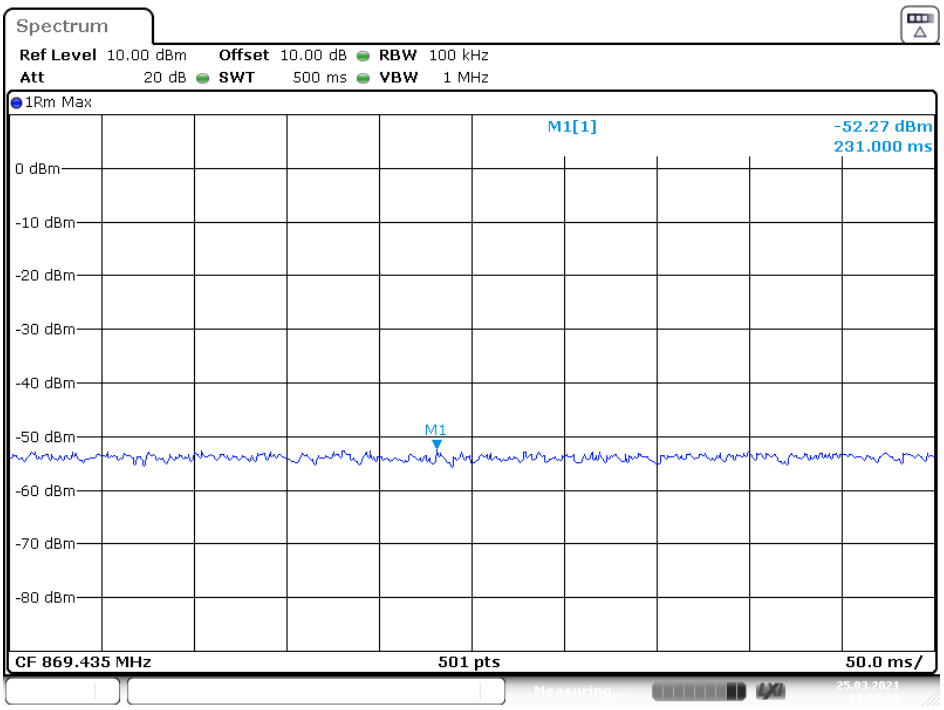
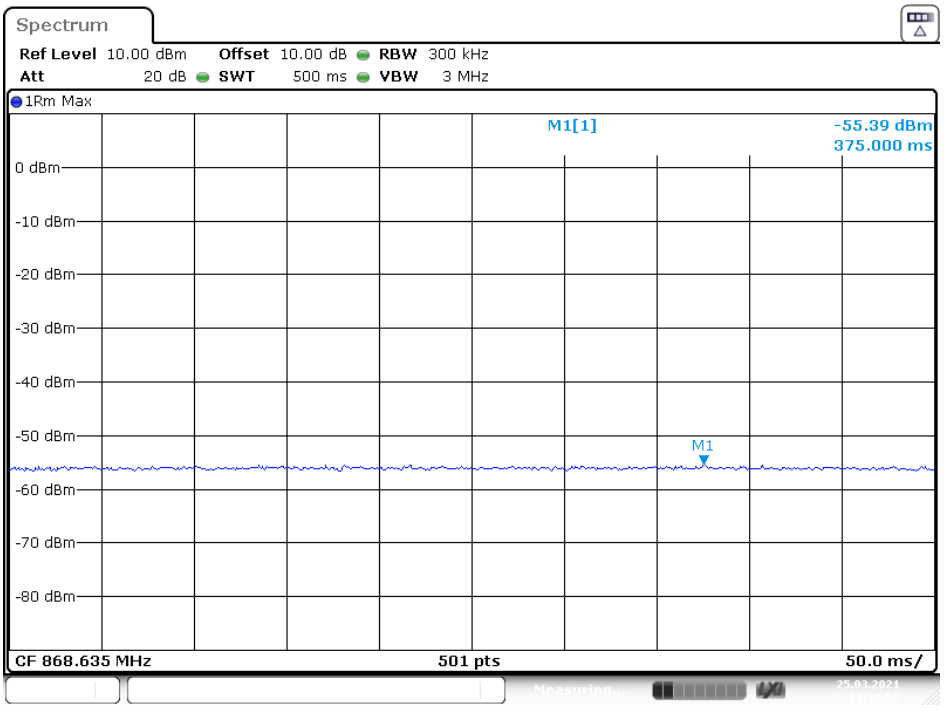
Offset *3



Date: 25.MAR.2021 14:27:09

Offset *4



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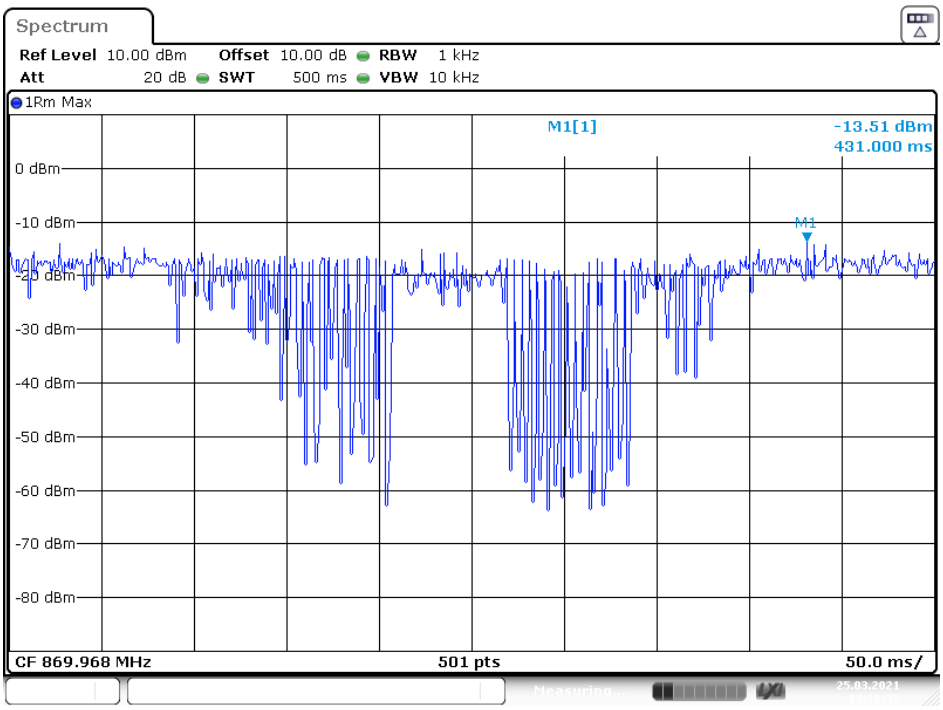
Offset *5



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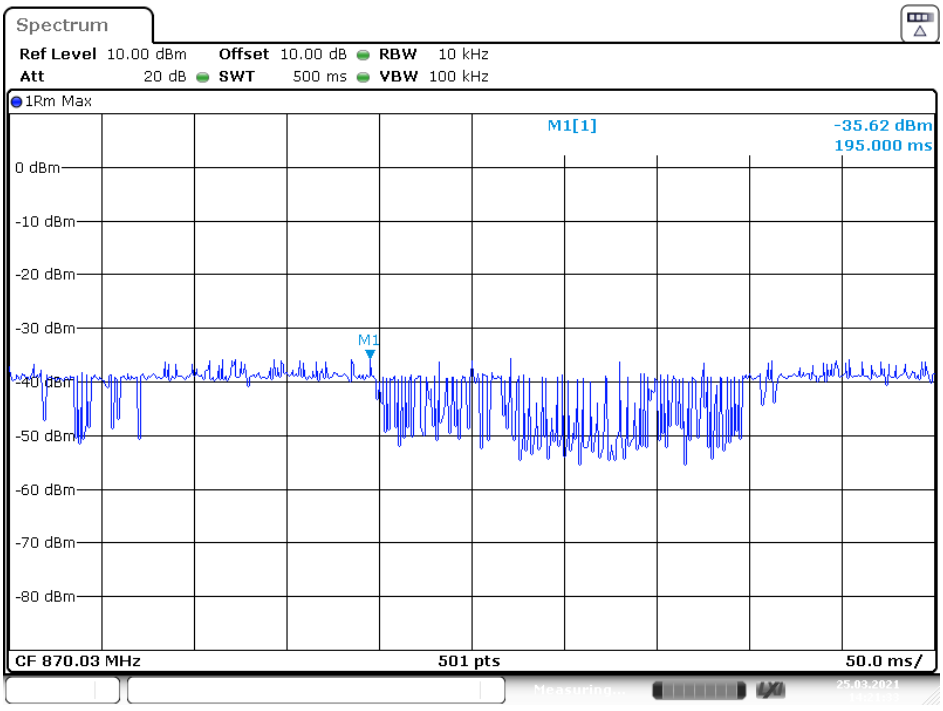
Offset *6



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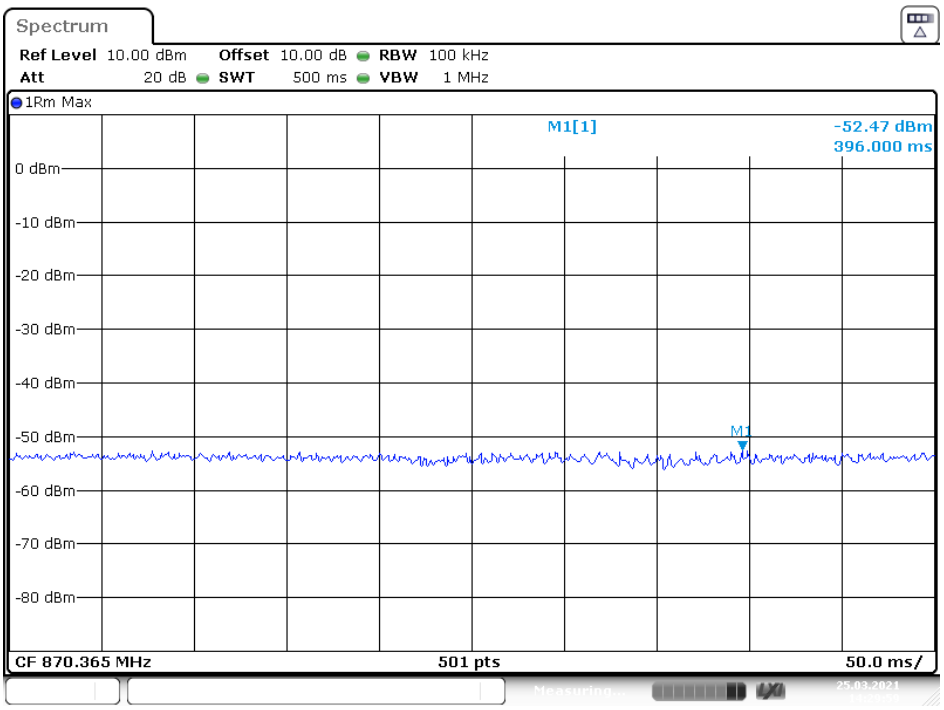
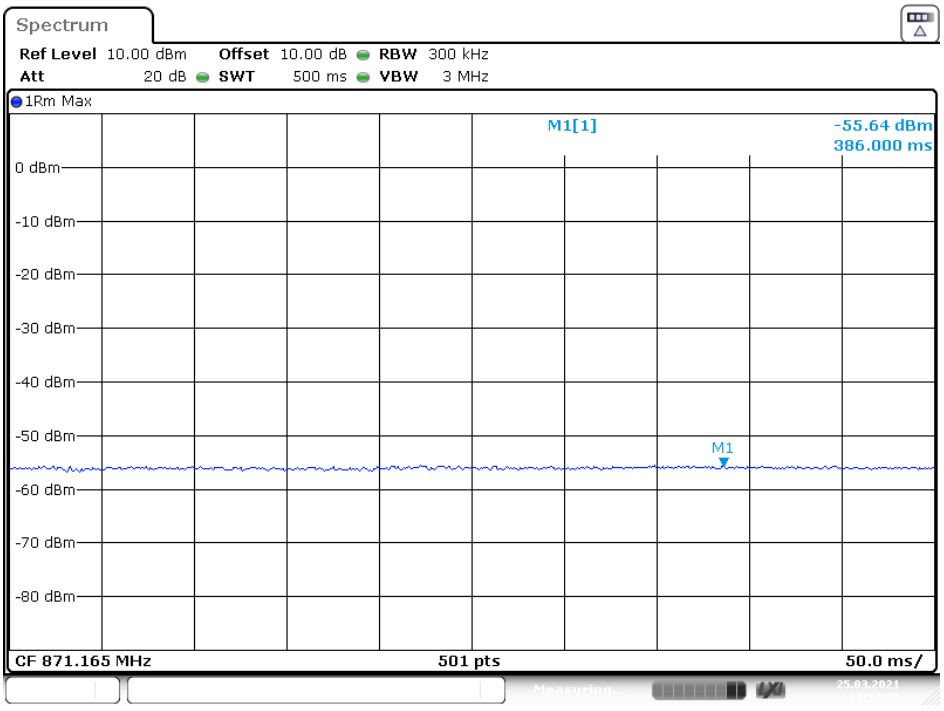
Offset *7



Date: 25.MAR.2021 14:29:59

Offset *8



Date: 25.MAR.2021 14:34:21

ETSI EN 300 220-2 V3.1.1 (2017-02) §4.3.8 – TX BEHAVIOUR LOW VOLTAGE CONDITIONS

Applicable Standard

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.12:

The TX behaviour under low voltage condition is the ability of the equipment to maintain its operating frequency and not produce emissions which exceed any relevant limit when the battery voltage falls below the lower extreme voltage level.

Limit:

The equipment shall either:

a) remain in the Operating Channel OC without exceeding any applicable limits (e.g. Duty Cycle); or
b) reduce its effective radiated power below the Spurious Emission limits without exceeding any applicable limits(e.g. Duty Cycle); or
c) shut down, (ceasing function);
as the voltage falls below the manufacturers declared operating voltage.

Method of measurement

Step 1:
Operation of the EUT shall be started, on Operating Frequency as declared by the manufacturer, with the appropriate test signal and with the EUT operating at nominal operating voltage.
The centre frequency of the transmitted signal shall be measured and noted.

Step 2:
The operating voltage shall be reduced by appropriate steps until the voltage reaches zero.
The centre frequency of the transmitted signal shall be measured and noted.
Any abnormal behaviour shall be noted.

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2020-03-25.

Test Mode: Transmitting

Nominal Frequency: 863.1 MHz		
Temperature & Humidity (℃ & %)	**Voltage (V_{DC})**	**Result (Note)**
25℃ & 56%	3.6	Within Operating frequency band and without exceeding any applicable limits
	3.3	Within Operating frequency band and without exceeding any applicable limits
	3.0	Shut down s
	2.7	Shut down
	0	Shut down

Nominal Frequency: 869.9 MHz		
Temperature & Humidity (℃ & %)	**Voltage (V_{DC})**	**Result (Note)**
25℃ & 56%	3.6	Within Operating frequency band and without exceeding any applicable limits
	3.3	Within Operating frequency band and without exceeding any applicable limits
	3.0	Shut down
	2.7	Shut down
	0	Shut down

Note*: No any other abnormal behaviour was observed.

ETSI EN 300 220-2 V3.1.1 (2017-02) §4.4.2 – BLOCKING

Applicable Standard

According to ETSI EN 300 220-1 V3.1.1 (2017-02) clause 5.18.1.

Limit: The blocking level shall be better or equal to category 3 reference limits level defined in ETSI EN 300 220-1 [1], clause 5.18.2.

NOTE: After December 31st, 2018, the receiver category 3 will be withdrawn, therefore receiver category 2 will be the minimum applicable level.

Method of measurement

Signal generator A shall be set to an appropriate modulated test signal at the operating frequency of the EUT receiver.

Signal generator B shall be unmodulated.

Measurements shall be carried out at frequencies of the unwanted signal at approximately the frequency(ies) offset(s) defined in technical requirement avoiding those frequencies at which spurious responses occur. Additional measurement points may be requested by technical requirements clause.

If several operational frequency bands are used by the equipment, at least one blocking measurement by bands has to be performed.

Step 1: Signal generator B shall be powered off. Signal generator A shall be set to the minimum level which gives the wanted performance criterion of EUT or the reference level in Table 32, whichever is the higher The output level of generator A shall then be increased by 3 dB unless otherwise specified in technical requirement.

Step 2: Signal generator B is powered on and set to operate at the nominal operating frequency - offset frequency.
Signal generator B is then switched on and the signal amplitude is adjusted to the minimum level at which the wanted performance criterion is not achieved.
With signal generator B settings unchanged, the receiver shall be replaced with a suitable RF power measuring equipment. The power into the measuring equipment shall be measured and noted.
The blocking level is then the conducted power received from generator B at the EUT antenna connector. This can either be measured on the antenna connector for conducted test or be calculated for radiated test (see clause C.5.4).
The blocking level shall be higher or equal to the blocking power level requested in the technical requirement clause.

Step 3: The measurement in steps 1 to 3 shall be repeated with signal offsets at required frequencies.

Step 4: The information shown in Table 44 shall be recorded in the test report for each measured signal level and unwanted signal offset.

Table 44: Information Recorded in the Test Report

Value	Notes
Operating Frequency	Nominal centre frequency of the receiver
Signal generator A	Power level of signal generator A
Blocking level	Power level of signal generator B

For equipment using CCA whatever is the receiver category, steps 1 to 4 shall be repeated with signal generator A level adjusted +13 dB higher than in the measurements in clause 5.18.6.4

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2020-03-25.

Test result: Compliance.

Frequency	Frequency offset (MHz)	Test result (dBm)	Limit (dBm)	Result
863.1 MHz	-2 MHz from OC edge f_{low}	-52.52	-69	PASS
	+2 MHz from OC edge f_{high}	-53.60	-69	PASS
	-10 MHz from OC edge f_{low}	-43.25	-44	PASS
	+10 MHz from OC edge f_{high}	-41.41	-44	PASS
	-5 % of Centre Frequency	-41.67	-44	PASS
	+5 % of Centre Frequency	-42.19	-44	PASS

Frequency	Frequency offset (MHz)	Test result (dBm)	Limit (dBm)	Result
869.9MHz	-2 MHz from OC edge f_{low}	-52.72	-69	PASS
	+2 MHz from OC edge f_{high}	-52.63	-69	PASS
	-10 MHz from OC edge f_{low}	-42.42	-44	PASS
	+10 MHz from OC edge f_{high}	-42.25	-44	PASS
	-5 % of Centre Frequency	-41.69	-44	PASS
	+5 % of Centre Frequency	-41.41	-44	PASS

Note: The equipment provider declared that the receiver category for the EUT is 2.

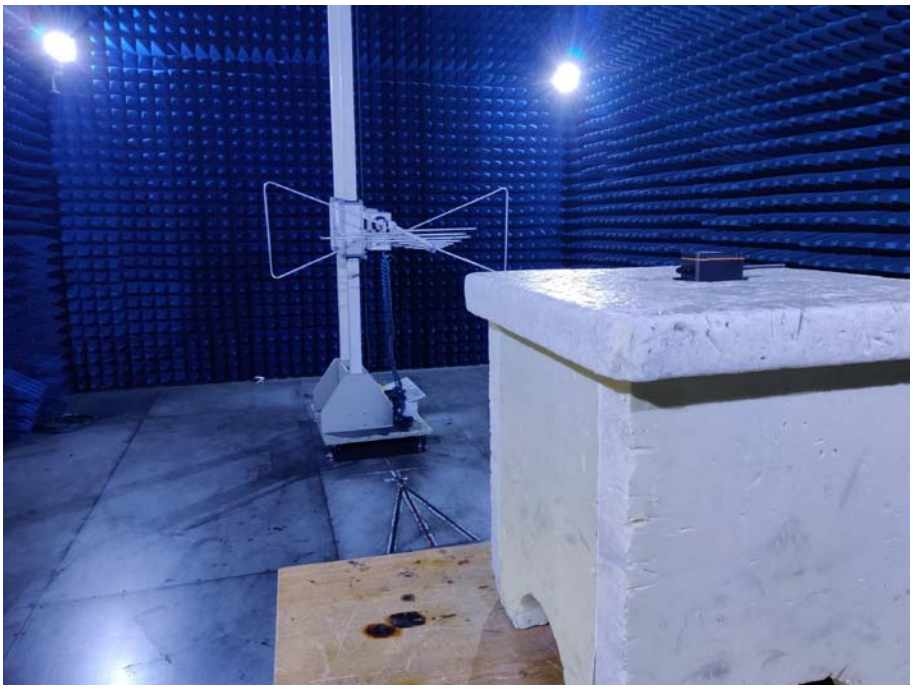
f_{low} is the low edge of OC, f_{high} is the high edge of OC, f_c is the center frequency.

EXHIBIT A - EUT PHOTOGRAPHS

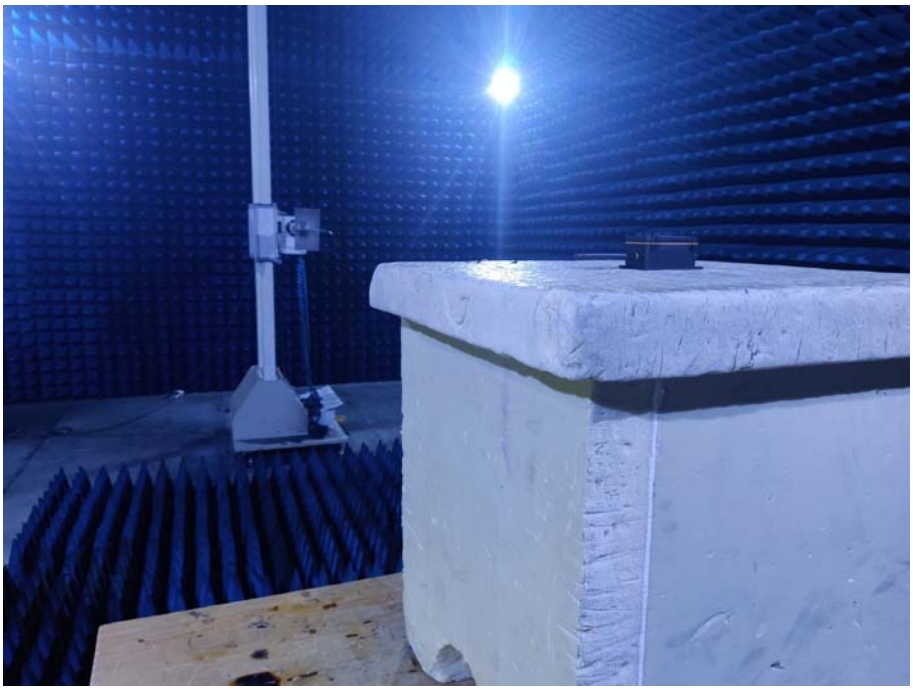
Please refer to the attachment.

EXHIBIT B - TEST SETUP PHOTOGRAPHS

Radiated Spurious Emissions Test View (Below 1GHz)



Radiated Spurious Emissions Test View (Above 1GHz)



******* END OF REPORT *******