ECL-TA Test Report No.: 20-019

Designation:	CAP H 80-85_17E_19_26 F-AC-F1-APE, SMR Band
Manufacturer:	Andrew
Serial No(s):	BGCHIA2043001
ID No.	7841153-0001
Test Specification(s):	ANSI 63.26:2015 FCC Rules and Regulations as listed in 47 CFR, Part 20:2019-10-01 FCC Rules and Regulations as listed in 47 CFR, Part 90.219:2019-10-01
Test Plan:	Measurement of Band SMR, downlink.
Test Result:	**Passed**

Date of issue:	2021-01-27		Signature:
Version:	01	Technical Reviewer:	Thomas Gerngroß Test Engineer Digitally signed by Thomas Gerngroß DN: cn=Thomas Gerngroß, o=Bureau Veritas CPS Germany GmbH, ou=ECL, email=thomas.gerngross@bureauveritas.com, c=DE Date: 2021.01.27 08:19:56 +01'00'
Date of delivery:	2020-12		
Performance date:	2020-12-14. – 2020-12-21	Report Reviewer:	Thomas Hufnagel Test Engineer Digitally signed by Thomas Hufnagel DN: cn=Thomas Hufnagel, o=Bureau Veritas CPS Germany GmbH, ou=ECL, email=thomas.hufnagel@de.bureauveritas.com, c=DE Date: 2021.01.27 11:59:58 +01'00'

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Versions management:

V01.00	Initial release

Table of Contents

1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization
Certification for an Industrial Signal Booster.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2, 20 and 90. The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 20, Commercial Mobiles Services

§ 20.21 Signal Boosters

Part 90; Private Land Mobile Radio Services

Subpart S – Regulations Governing Licensing and Use fo Frequencies in the 806 – 824, 851 – 869, 896 – 901 and 935 – 940 MHz Bands

§ 90.635 – Limitations on power and antenna height
$ 90.691 – Emission mask requirements for EA-based systems

The tests were selected and performed with reference to:

- FCC Public Notice 935210 applying "Signal Boosters Basic Certification Requirements" 935210 D02, 2019-15-04.
- FCC Public Notice 935210 applying "Measurement guidance for industrial and non-consumer signal booster, repeater and amplifier devices"
- 935210 D05, 2019-04-03.
- FCC Public Notice 971168 applying "Measurement guidance for certification of licensed digital transmitters" 971168 D01, 2019-04-09.
- ANSI C63.26: 2015

Summary Test Results:

The EUT complies with all performed tests as listed in chapter 1.3 Measurement Summary/Signatures.

1.2 FCC-ISED CORRELATION TABLE

Correlation of measurement requirements for Industrial Signal Booster from FCC and ISED Canada

Measurement	FCC reference	ISED reference
Effective radiated power, mean output power and zone enhancer gain	§ 2.1046 § 90.635 KDB 935210 D05 v01r04: 3.5	RSS-GEN Issue 5, 6.12 RSS-119 Issue 2, 5.4
Peak to Average Ratio	---	---
Occupied bandwidth Input-versus-output spectrum	§ 2.1049 KDB 935210 D05 v01r04:3.4	RSS-GEN Issue 5, 6.7 RSS-131 Issue 3: 5.2.2
Conducted spurious Emission at Antenna Terminal	§ 2.1051 § 90.691 KDB 935210 D05 v01r04: 3.6	RSS-GEN Issue 5, 6.13 RSS-119 Issue 12, 5.8.9.2
Out-of-band emissions limits	§ 2.1051 § 90.691 KDB 935210 D05 v01r04: 3.6	RSS-GEN Issue 5, 6.13 RSS-119 Issue 12, 5.8.9.2
Frequency stability	§ 2.1055 KDB 935210 D05 v01r04: 3.7	RSS-GEN Issue 5, 6.11 RSS-131 Issue 3: 5.2.4
Field strength of spurious radiation	§ 2.1053 § 90.691	RSS-GEN Issue 5, 6.13 RSS-119 Issue 12, 5.8.9.2
Out-of-band rejection	KDB 935210 D05 v01r04: 3.3	RSS-131 Issue 3: 5.2.1
All measurements	ANSI 63.26	ANSI 63.26

The test case frequency stability was not performed since the EUT is not equipped with signal processing capabilities. According KDB 935210 D05 in this case a measurement is not required.

Also the test case noise and noise figure was not performed since in this test the booster performes commercial radio services: According KDB 935210 D05 in this case the measuring of noise and noise figure is not required.

1.3 MEASUREMENT SUMMARY/SIGNATURES

Downlink frequencies: 862 MHz to 869 MHz

47 CFR CHAPTER I FCC PART 90 Subpart S § 2.1046, § 90.635 (a), [Base Stations/Repeater]

Effective Radiated Power, mean output power and zone enhancer gain
The measurement was performed according to ANSI C63.26, KDB 935210 D05 v01r04: 3.5 **Final Result**

OP-Mode	**FCC**	**IC**
Frequency Band, Direction, Input Power, Signal Type		
SMR, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
SMR, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
SMR, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
SMR, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC [Base Stations/Repeater]

Peak to Average Ratio
The measurement was performed according to ANSI C63.26 **Final Result**

OP-Mode	**FCC**	**IC**
Frequency Band, Direction, Input Power, Signal Type		
SMR, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
SMR, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
SMR, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
SMR, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC § 2.1049, [Base Stations/Repeater]

Occupied Bandwidth/Input-versus-output Spectrum
The measurement was performed according to ANSI C63.26, KDB 935210 D05 v01r04: 3.4 **Final Result**

OP-Mode	**FCC**	**IC**
Frequency Band, Direction, Input Power, Signal Type		
SMR, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
SMR, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
SMR, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
SMR, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC PART 90 Subpart S [Base Stations/Repeater] **§ 2.1051, § 90.691 (a)(2)**

Conducted spurious emissions at antenna terminals
The measurement was performed according to ANSI C63.26 **Final Result**

OP-Mode Frequency Band, Direction, Input Power, Signal Type	**FCC**	**IC**
SMR, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
SMR, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
SMR, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
SMR, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC PART 90 Subpart S [Base Stations/Repeater] **§ 2.1053, § 90.691 (a)(2)**

Out-of-band emission limits
The measurement was performed according to ANSI C63.26, KDB 935210 D05 v01r04: 3.6 **Final Result**

OP-Mode Band Edge, Frequency Band, Number of signals, Direction, Input Power, Signal Type	**FCC**	**IC**
Lower, SMR, 1, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
Lower, SMR, 1, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
Lower, SMR, 1, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
Lower, SMR, 1, RF downlink, 3 dB > AGC, Wideband	Passed	Passed
Lower, SMR, 2, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
Lower, SMR, 2, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
Lower, SMR, 2, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
Lower, SMR, 2, RF downlink, 3 dB > AGC, Wideband	Passed	Passed
Upper, SMR, 1, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
Upper, SMR, 1, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
Upper, SMR, 1, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
Upper, SMR, 1, RF downlink, 3 dB > AGC, Wideband	Passed	Passed
Upper, SMR, 2, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
Upper, SMR, 2, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
Upper, SMR, 2, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
Upper, SMR, 2, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC PART 90 Subpart S
[Base Stations/Repeater]

Out-of-band rejection
The measurement was performed according to ANSI C63.26, 935210 D05 v01r04: 3.3

Final Result

OP-Mode	**Setup**	**FCC**	**IC**
Frequency Band, Direction			
SMR, RF downlink		Passed	Passed

47 CFR CHAPTER I FCC PART 90 Subpart S **§ 2.1053, § 90.691 (a)(2)**
[Base Stations/Repeater]

Field strength of spurious radiation
The measurement was performed according to ANSI C63.26

Final Result

OP-Mode	**FCC**	**IC**
Frequency Band, Test Frequency, Direction		
SMR, high, RF downlink	Passed	Passed
SMR, low, RF downlink	Passed	Passed
SMR, mid, RF downlink	Passed	Passed

2 ADMINISTRATIVE DATA

2.1 TESTING LABORATORY

Bureau Veritas Consumer Products Services Germany GmbH
Thurn-und-Taxis-Straße 18
D-90411 Nürnberg
Tel.: +49 40 74041 0
Fax: +49 40 74041-2755

2.2 APPLICANT DATA

Company Name:	Commscope Andrew Wireless Systems GmbH
Address:	Industriering 10 86675 Buchdorf Germany
Contact Person:	Mr. Frank Futter

2.3 MANUFACTURER DATA

Company Name:	Please see applicant data.
Address:	

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Cellular Repeater
Product name	Cellular Repeater
Type	
Declared EUT data by the supplier	
General Product Description	The EUT is an industrial signal booster supporting the following: Band SMR: downlink: 862 MHz - 869 MHz; uplink: 817 MHz to 824 MHz A RF operation is supported for downlink.
Booster Type	Industrial Signal Booster
Voltage Type	AC/50 Hz – 60 Hz
Voltage Level	100 V - 240 V
Nominal Output Donor Port [Uplink]	-----
Nominal Output Server Port [Downlink]	42.5 dBm
Nominal Gain [Uplink]	-----
Nominal Gain [Downlink]	37.5 dB

The main components of the EUT are listed and described in chapter 3.2 EUT Main components.

3.2 EUT MAIN COMPONENTS

Sample Name	**FCC-ID**	**ISED-ID**
	XS5-CAPH8171926	2237E-CAPH8171926
Sample Parameter	**Value**	
Serial Number	BGCHIA2043001	
HW Version	7841153-0001	
SW Version	SW 2.8.2.42	
Comment	-----	

NOTE: The short description is used to simplify the identification of the EUT in this test report.

3.3 ANCILLARY EQUIPMENT

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Device	**Details (Manufacturer, Type Model, OUT Code)**	**Description**
-	-	-

3.4 AUXILIARY EQUIPMENT

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it.
But nevertheless Auxiliary Equipment can influence the test results.

Device	**Details (Manufacturer; Type; S/N)**	**Description**
AUX1	Lineage Power; SP800; XK20007	Rack in Conjunction with AUX 2 and AUX 3
AUX2	Cherokee International; CAR1212FPBC-Z;AF09676	Power Supply
AUX 3	Lineage Power; CP2000AC54TEP; CC109167565	Power Supply
AUX4	Commscope; ION-E WCS-2; SZAEAJ1819A0009	Subrack in Conjunction with AUX 5,6. 7, 8 and 9
AUX5	Commscope; ION-E OPT; SZBEAD1722A0035	Optical Card
AUX6	Avago; AFBR 7095MZ 850 nm; AD170230AM1	O/E-Converter
AUX7	Commscope; 7642124-ENG-03; (e1)MA22	LAN System Interface
AUX8	Commscope; ION-E RFD; SZBEAG1825A0002	RF Card
AUX9	Commscope; ION-E RFD; SZBEAG1825A0012	RF Card

3.5 EUT SETUPS

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup	Combination of EUTs	Description and Rationale
	,	Setup for all tests

OPERATING MODES
This chapter describes the operating modes of the EUT used for testing.

3.5.1 TEST CHANNELS

Band [MHz]	Direction	Lower Frequency Band Edge [MHz]	Upper Frequency Band Edge [MHz]	Center Frequency [MHz]	Output-Port
862 – 869	downlink	862.00	869.00	865.50	ANT

3.5.2 AUTOMATIC GAIN CONTROL LEVELS

AGC Levels							
Band [MHz]	**Direction**	**Signal Type**	**AGC Start Pin [dBm]**	**AGC Start Pin -0.3 dB [dBm]**	**AGC Start Pin +3 dB [dBm]**	**Frequency [MHz]**	**Frequency**
862 – 869	Downlink	Narrowband	6.0	5.7	9.0	865.50	Mid
862 – 869	Downlink	Wideband	6.0	5.7	9.0	865.50	
862 – 869	Downlink	Narrowband	5.6	5.3	8.6	862.20	Low
862 – 869	Downlink	Wideband	5.8	5.5	8.8	864.50	
862 – 869	Downlink	Narrowband	5.8	5.5	8.8	868.80	High
862 – 869	Downlink	Wideband	5.8	5.5	8.8	866.50	
862 – 869	Downlink	Narrowband	6.4	6.1	9.4	868.37	Max.Power
862 – 869	Downlink	Wideband	6.0	5.7	9.0	866.50	

Remark:

If the measured frequency f_0 for the max power has a too low distance to the band edges, because in the tests modulated signals must be used: The next possible frequency to the according band edge is used.
For example for minimum distances to the band edges:
GSM-Signal (narrowband): 0.2 MHz
AWGN-signal (wideband): 2.5 MHz

3.6 PRODUCT LABELLING

3.6.1 FCC ID LABEL

Please refer to the documentation of the applicant.

3.6.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

4 TEST RESULTS

4.1 EFFECTIVE RADIATED POWER, MEAN OUTPUT POWER AND ZONE ENHANCER GAIN

Standard FCC Part 90, § 90.635

The test was performed according to:
ANSI C63.26, KDB 935210 D05 v01r04: 3.5

Test date: 2020-12-15

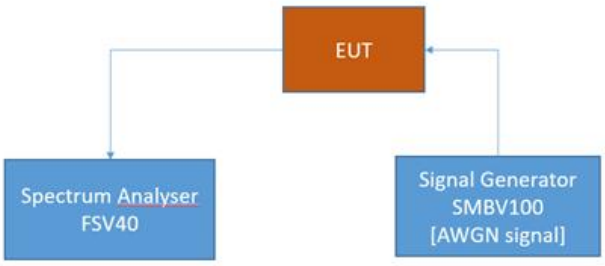
Environmental conditions: 23 ° C; 31 % r. F.

Test engineer: Thomas Gerngroß

4.1.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the signal booster power and gain limits and requirements for industrial signal boosters per FCC § 90.635. 635 and RSS-119 with subpart 5.4.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; RF Output Power / Gain

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.1.2 TEST REQUIREMENTS/LIMITS: ABSTRACTS FROM STANDARDS

Part 90;

Subpart S—Regulations Governing Licensing and Use of Frequencies in the 806-824, 851-869, 896-901, and 935-940 MHz Bands

§ 90.635

Abstract § 90.635 from FCC:

Band 862 MHz – 869 MHz

§ 90.635

(a) The effective radiated power and antenna height for base stations may not exceed 1 kilowatt (30 dBw) and 304 m. (1,000 ft.) above average terrain (AAT), respectively, or the equivalent thereof as determined from the Table. These are maximum values, and applicants will be required to justify power levels and antenna heights requested.

(a) The effective radiated power and antenna height for base stations may not exceed 1 kilowatt (30 dBw) and 304 m. (1,000 ft.) above average terrain (AAT), respectively, or the equivalent thereof as determined from the Table. These are maximum values, and applicants will be required to justify power levels and antenna heights requested.

(b) The maximum output power of the transmitter for mobile stations is 100 watts (20 dBw).

Table—Equivalent Power and Antenna Heights for Base Stations in the 851-869 MHz and 935-940 MHz Bands Which Have a Requirement for a 32 km (20 mi) Service Area Radius

Antenna height (ATT) meters (feet)	Effective radiated power (watts)[1 2 4]
Above 1,372 (4,500)	65
Above 1,220 (4,000) to 1,372 (4,500)	70
Above 1,067 (3,500) to 1,220 (4,000)	75
Above 915 (3,000) to 1,067 (3,500)	100
Above 763 (2,500) to 915 (3,000)	140
Above 610 (2,000) to 763 (2,500)	200
Above 458 (1,500) to 610 (2,000)	350
Above 305 (1,000) to 458 (1,500)	600
Up to 305 (1,000)	[3]1,000

1Power is given in terms of effective radiated power (ERP).

2Applicants in the Los Angeles, CA, area who demonstrate a need to serve both the downtown and fringe areas will be permitted to utilize an ERP of 1 kw at the following mountaintop sites: Santiago Park, Sierra Peak, Mount Lukens, and Mount Wilson.

3Stations with antennas below 305 m (1,000 ft) (AAT) will be restricted to a maximum power of 1 kw (ERP).

4Licensees in San Diego, CA, will be permitted to utilize an ERP of 500 watts at the following mountaintop sites: Palomar, Otay, Woodson and Miguel.

Abstract RSS-119 from ISED:

RSS-119; 5.4 Transmitter Output Power

Table 2 – Transmitter Output Power

Frequency Bands (MHz)	Transmitter Output Power (W)	
	Base/Fixed Equipment	Mobile Equipment
27.41-28 and 29.7-50	300	30
72-76	No limit	1
138-174	110	60
217-218 and 219-220	110	30*
220-222	See SRSP-512 for ERP limit	50
406.1-430 and 450-470	110	60
768-776 and 798-806	See SRSP-511 for ERP limit	30 3 W ERP for portable equipment
806-821/851-866 and 821-824/866-869	110	30
896-901/935-940	110	60
929-930/931-932	110	30
928-929/952-953 and 932-932.5/941-941.5	110	30
932.5-935/941.5-944	110	30

*Equipment is generally authorized for effective radiated power (ERP) of less than 5 W.

4.1.3 TEST PROTOCOL

FCC Table

Band SMR, 862 MHz – 869 MHz, downlink							
Signal Type	**Input Power**	**Frequency [MHz]**	**Input Power [dBm]**	**Maximum Average Output Power [dBm]**	**Limit Average Output Power [dBm]**	**Margin to Limit [dB]**	**Gain [dB]**
Wideband	0.3 dB < AGC	866.50	5.5	41.9	48.1	6.2	36.4
Wideband	3 dB > AGC	866.50	8.8	42.0	48.1	6.1	33.2
Narrowband	0.3 dB < AGC	868.37	6.1	42.2	48.1	5.9	36.1
Narrowband	3 dB > AGC	868.37	9.4	42.2	48.1	5.9	32.8

:

For the output power limit the lowest value of the FCC table from § 90.635 at a height of above 1372 m is taken. This is 65 watts which equates 48.1 dBm according the given formula:

$$p_{dBm} = 10 \log_{10} \frac{65\,W}{0.001\,W} = 48.1 \text{ dBm}$$

ISED Table

Band SMR, 862 MHz – 869 MHz, downlink							
Signal Type	**Input Power**	**Frequency [MHz]**	**Input Power [dBm]**	**Maximum Average Output Power [W]**	**Limit Average Output Power [W]**	**Margin to Limit [dB]**	**Gain [dB]**
Wideband	0.3 dB < AGC	866.50	5.5	15.9	110	8.4	36.5
Wideband	3 dB > AGC	866.50	8.8	15.9	110	8.4	33.2
Narrowband	0.3 dB < AGC	868.37	6.1	16.4	110	8.3	36.1
Narrowband	3 dB > AGC	868.37	9.4	16.5	110	8.2	32.8

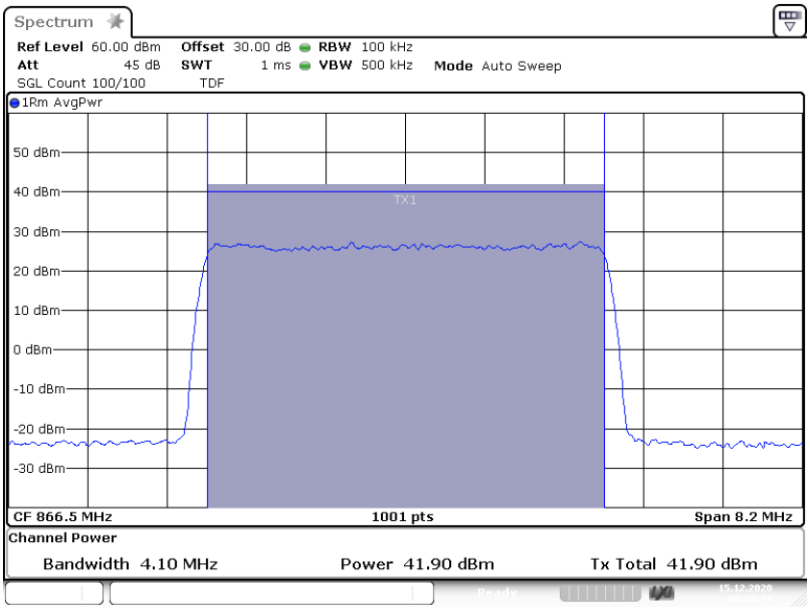
Remarks:
For the output power limit the value of the ISED table from RSS-119; 5.4 is taken.

Please see next sub-clause for the measurement plot.

4.1.4 MEASUREMENT PLOT

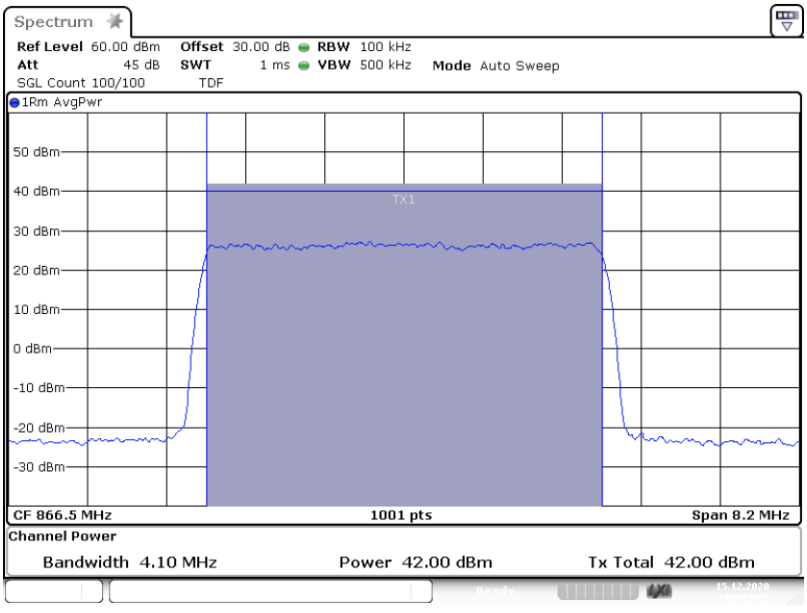
FCC Plots

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 866.5000 MHz; Band Edge: f0; Mod: AWGN; Output Power 0.3 dB < AGC



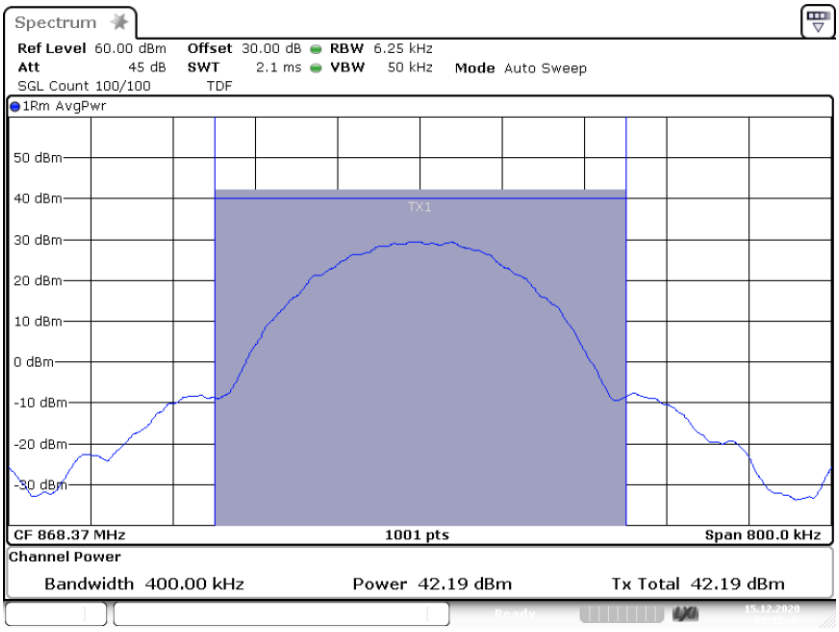
3.5.3 Power AWGN Out -0.3 866.50000M

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 866.5000 MHz; Band Edge: f0; Mod: AWGN; Output Power 3 dB > AGC



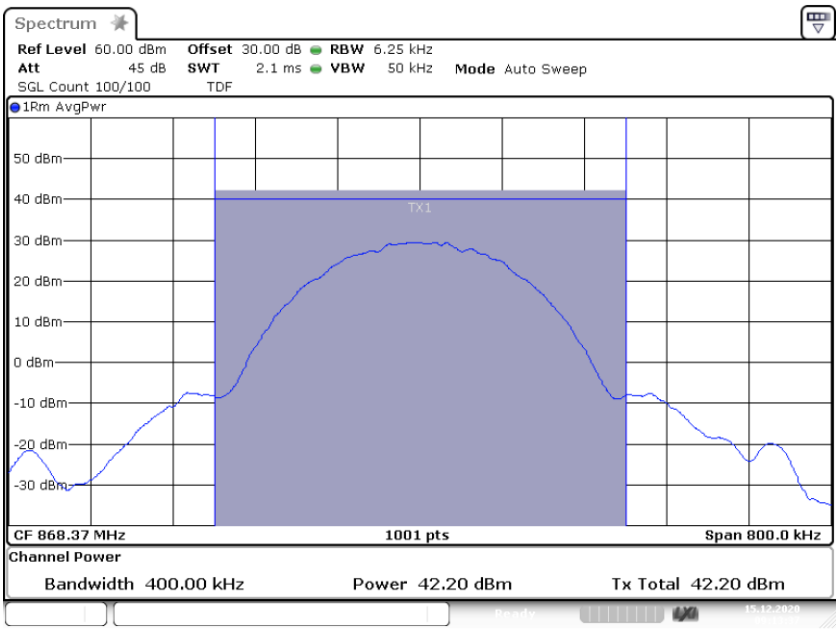
3.5.3 Power AWGN Out +3 866.50000M

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 868.37 MHz; Band Edge: f0; Mod: GSM; Input Power 0.3 dB < AGC



3.5.3 Power GSM Out -0.3 868.37000M

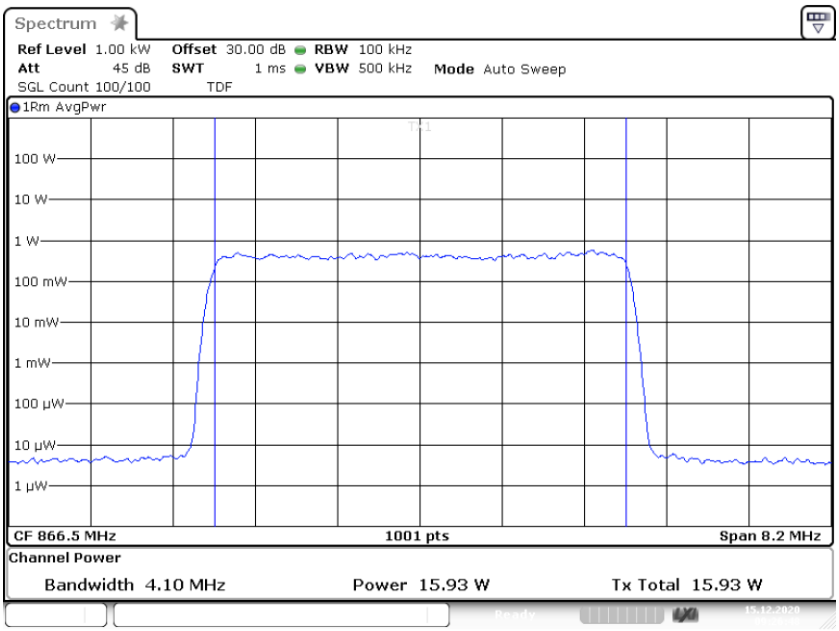
Downlink: Band SMR, 862 MHz - 869 MHz; 868.37 MHz; Band Edge: f0; Mod: GSM; Output Power 3 dB > AGC



3.5.3 Power GSM Out +3 868.37000M

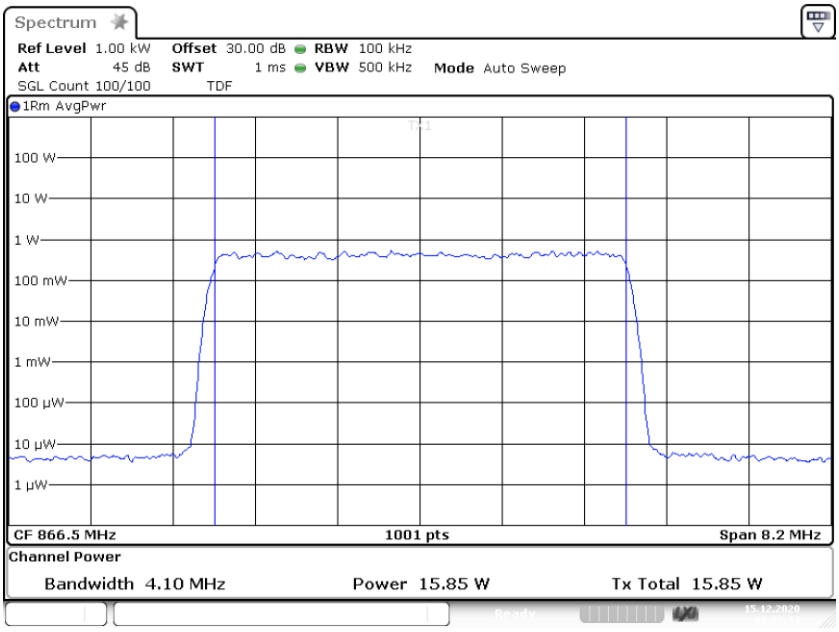
ISED Plots

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 866.5000 MHz; Band Edge: f0; Mod: AWGN; Output Power 0.3 dB < AGC



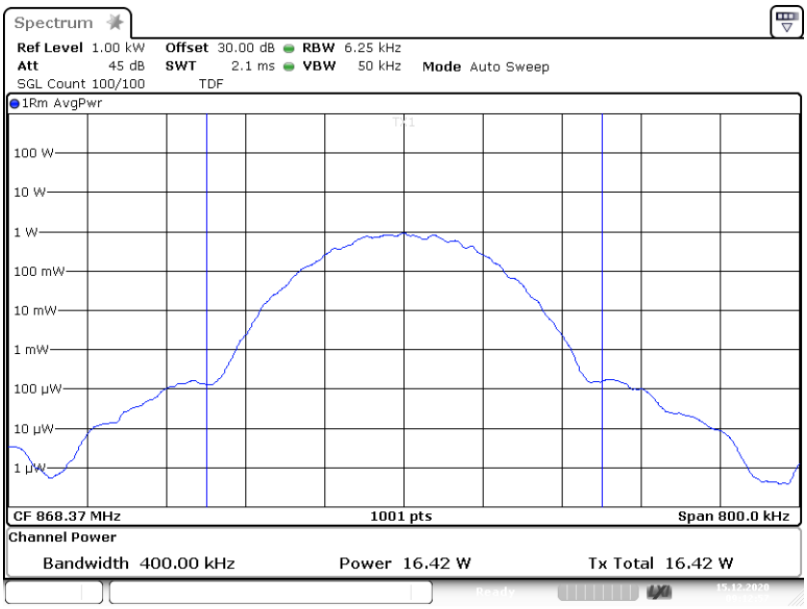
3.5.3 Power_W AWGN Out -0.3 866.50000M

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 866.5000 MHz; Band Edge: f0; Mod: AWGN; Output Power 3 dB > AGC



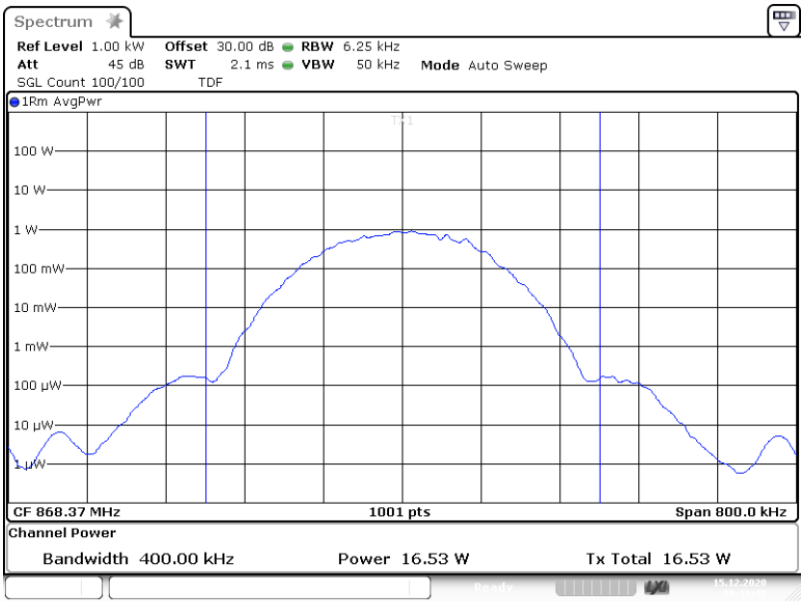
3.5.3 Power_W AWGN Out +3 866.50000M

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 868.37 MHz; Band Edge: f0; Mod: GSM; Input Power 0.3 dB < AGC



3.5.3 Power_W GSM Out -0.3 868.37000M

Downlink: Band SMR, 862 MHz - 869 MHz; 868.37 MHz; Band Edge: f0; Mod: GSM; Output Power 3 dB > AGC



3.5.3 Power_W GSM Out +3 868.37000M

4.1.5 TEST EQUIPMENT USED

- Conducted

4.2 PEAK TO AVERAGE RATIO

Standard ---

The test was performed according to:
ANSI C63.26

Test date: 2020-12-15

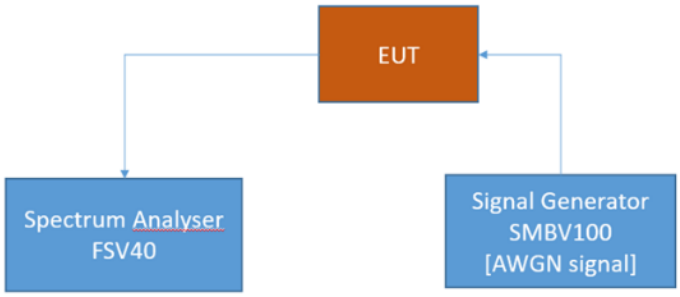
Environmental conditions: 23 ° C; 31 % r. F.

Test engineer: Thomas Gerngroß

4.2.1 TEST DESCRIPTION

This test case is intended to measure the peak to average ratio.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; RF Output Power / Gain

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.2.2 TEST REQUIREMENTS/LIMITS

There is no requirement for the Peak-to-Average value in the applicable rule parts, therefore a fictive limit of 13 dB is set.

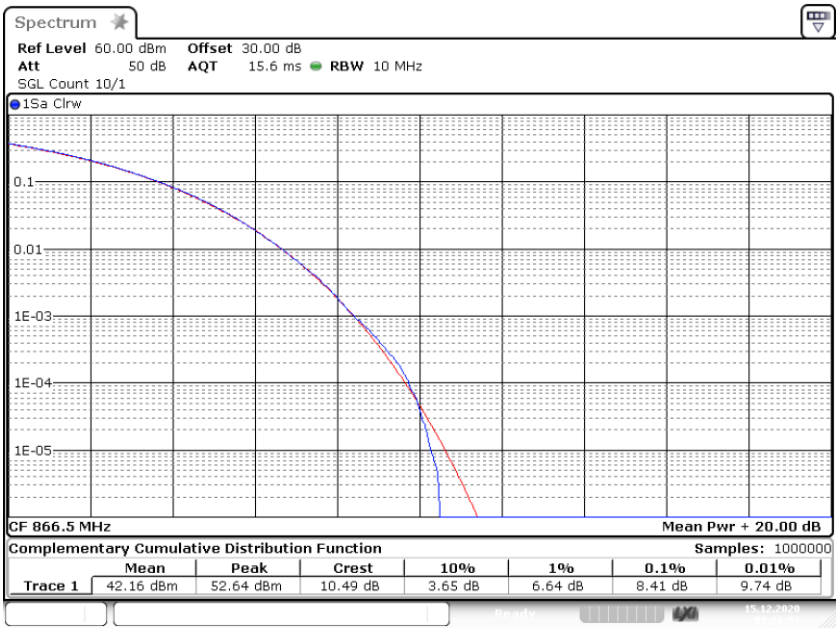
4.2.3 TEST PROTOCOL

Band SMR, 862 MHz - 869 MHz, downlink						
Signal Type	**Input Power**	**Frequency [MHz]**	**Input Power [dBm]**	**PAPR [dB]**	**Fictive Limit PAPR [dB]**	**Margin to fictive Limit [dB]**
Wideband	0.3 dB < AGC	866.50	5.5	8.41	13.00	4.59
Wideband	3 dB > AGC	866.50	8.8	8.41	13.00	4.59
Narrowband	0.3 dB < AGC	865.50	5.7	0.20	13.00	12.80
Narrowband	3 dB > AGC	865.50	9.0	0.29	13.00	12.71

Remark: Please see next sub-clause for the measurement plot.

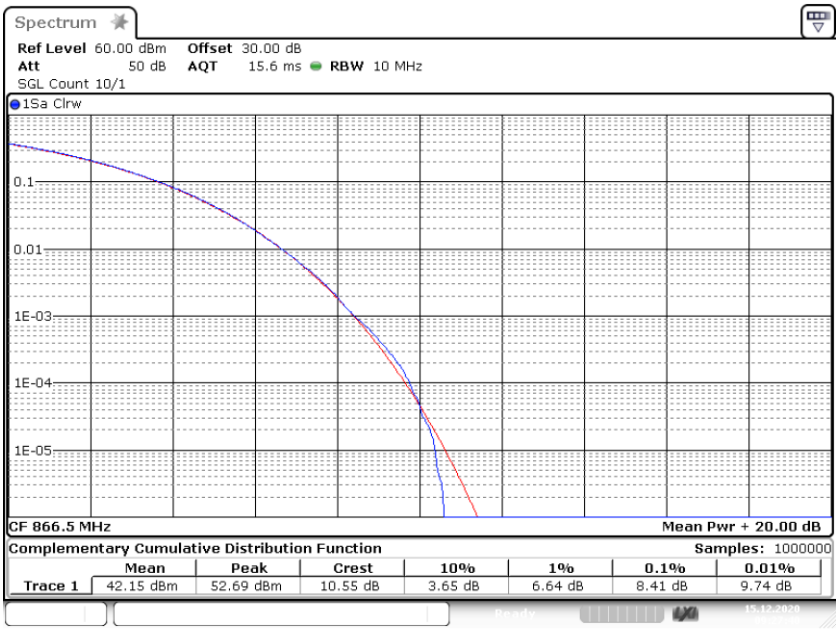
4.2.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 866.50 MHz; Band Edge: f0; Mod: AWGN; PAPR 0.3 dB < AGC



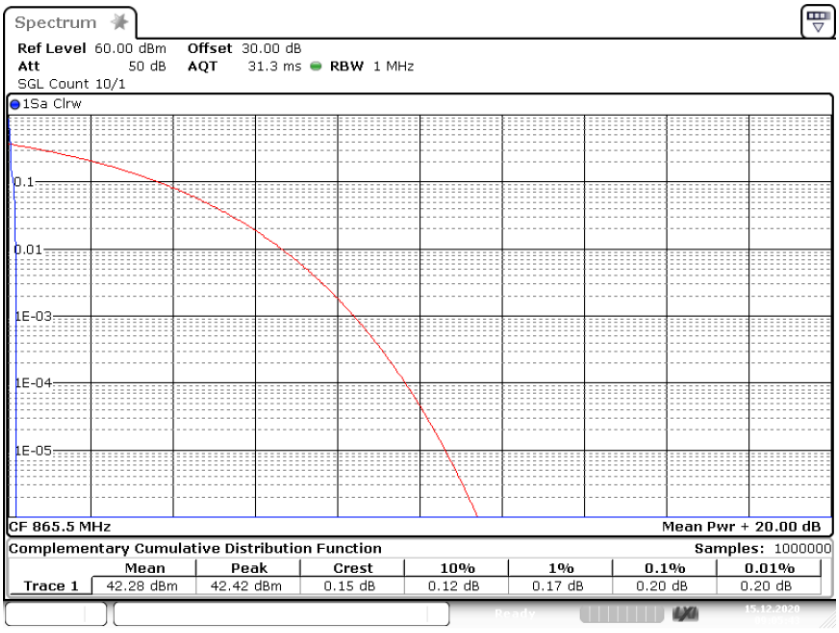
4.0 PAPR AWGN Out -0.3 866.500M

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 866.500 MHz; Band Edge: f0; Mod: AWGN; PAPR 3 dB > AGC



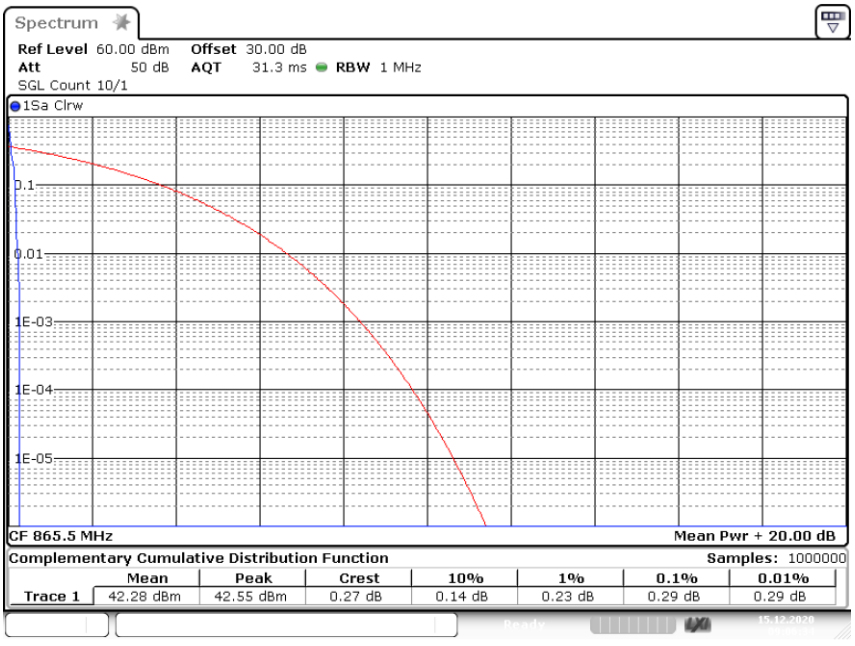
4.0 PAPR AWGN Out +3 866.500M

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 865.50 MHz; Band Edge: mid; Mod: GSM; PAPR 0.3 dB < AGC



4.0 PAPR GSM Out -0.3 865.500M

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 865.50 MHz; Band Edge: mid; Mod: GSM; PAPR 3 dB > AGC



4.0 PAPR GSM Out +3 865.500M

4.2.5 TEST EQUIPMENT USED

- Conducted

4.3 OCCUPIED BANDWIDTH/INPUT-VERSUS-OUTPUT SPECTRUM

Standard FCC Part 2.1049

The test was performed according to:
ANSI C63.26, KDB 935210 D05 v01r04: 3.4

Test date: 2020-12-15

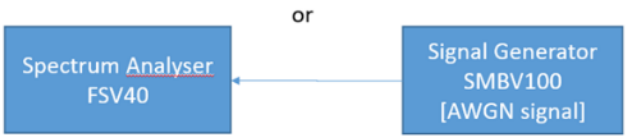
Environmental conditions: 23 ° C; 31 % r. F.

Test engineer: Thomas Gerngroß

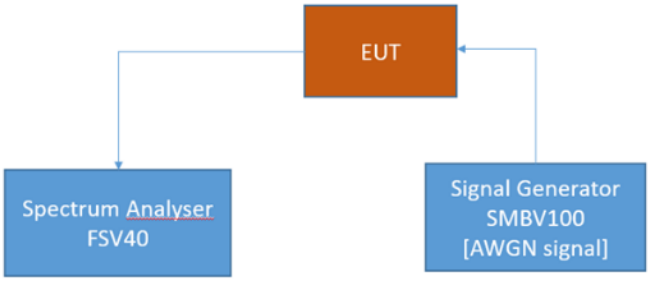
4.3.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable conducted spurious emission limits per FCC § 2.1049, RSS-GEN with subpart 6.7 and RSS-131 with subpart 5.2.2.

The EUT was connected to the test setups according to the following diagram:



FCC Part 22/24/27/90; Industrial Signal Booster
Test Setup step 1: Measuring characteristics of test signals



FCC Part 22/24/27/90; Industrial Signal Booster
Test Setup step 2; Occupied Bandwidth/Input-versus-output spectrum

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.3.2 TEST REQUIREMENTS/LIMITS

Abstract § 2.1049 from FCC:

FCC Part 2.1049; Occupied Bandwidth:

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.3 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(h) Transmitters employing digital modulation techniques—when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

(i) Transmitters designed for other types of modulation—when modulated by an appropriate signal of sufficient amplitude to be representative of the type of service in which used. A description of the input signal should be supplied.

Abstract RSS-GEN from ISED:

RSS-GEN; 6.7 Occupied Bandwidth

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the "x dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

- The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

Abstract RSS-131 from ISED:

RSS-131; 5.2.2 Input-versus-output spectrum

The spectral growth of the 26 dB bandwidth of the output signal shall be less than 5% of the input signal spectrum.

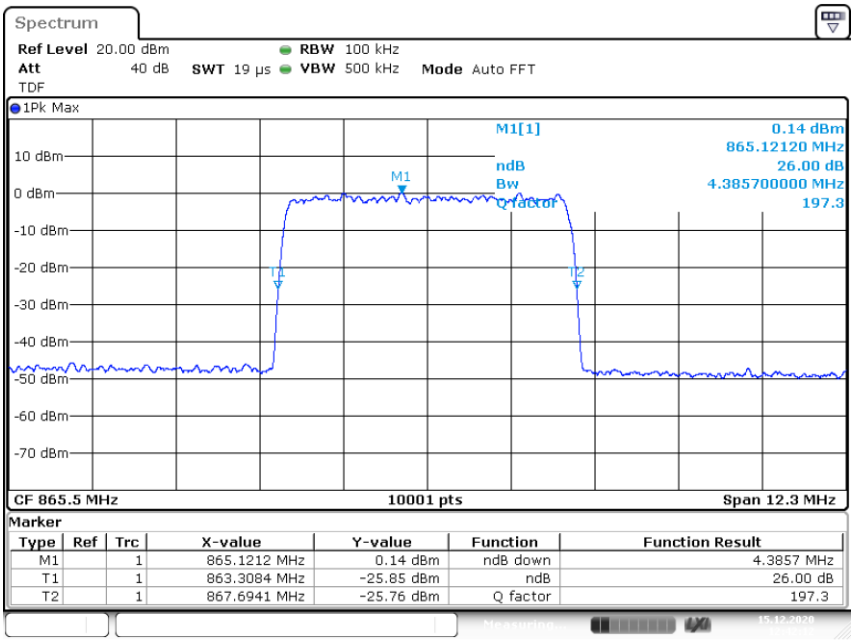
4.3.3 TEST PROTOCOL

Band SMR, 862 MHz - 869 MHz, downlink							
Signal Type	**Input Power**	**Signal Frequency [MHz]**	**Occupied Bandwidth SG [kHz]**	**Occupied Bandwidth Booster [kHz]**	**Delta Occupied Bandwidth [kHz]**	**Limit Delta Occupied Bandwidth [kHz]**	**Margin to Limit [kHz]**
Wideband	0.3 dB < AGC	865.50	4385.7	4388.2	2.5	205.0	202.5
Wideband	3 dB > AGC	865.50	4391.9	4388.2	3.7	205.0	201.3
Narrowband	0.3 dB < AGC	865.50	316.5	318.2	1.7	10.0	8.3
Narrowband	3 dB > AGC	865.50	318.5	322.5	4.1	10.0	5.9

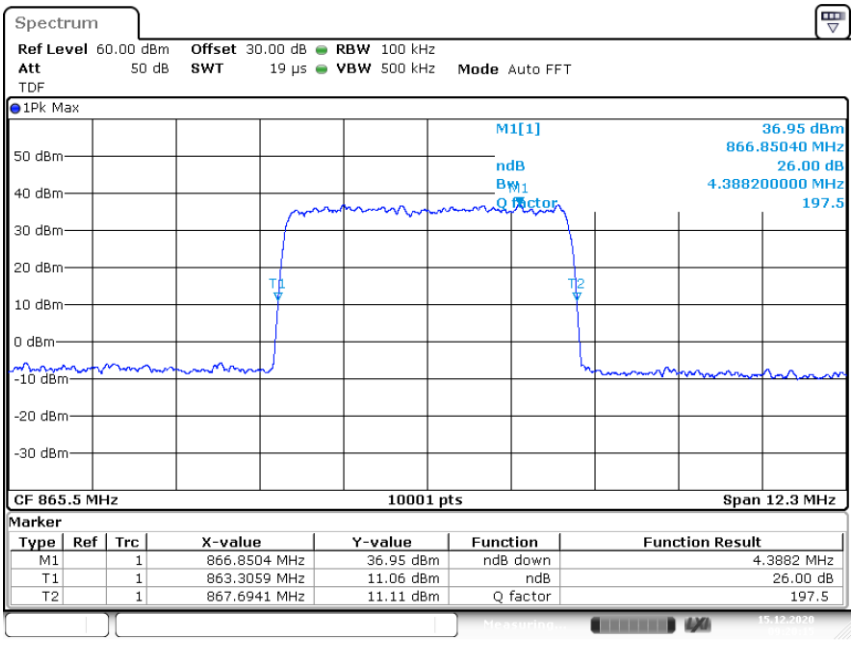
Remark: Please see next sub-clause for the measurement plot.

4.3.4 MEASUREMENT PLOT

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 865.50 MHz; Band Edge: mid; Mod: AWGN; Input OCBw 0.3 dB < AGC

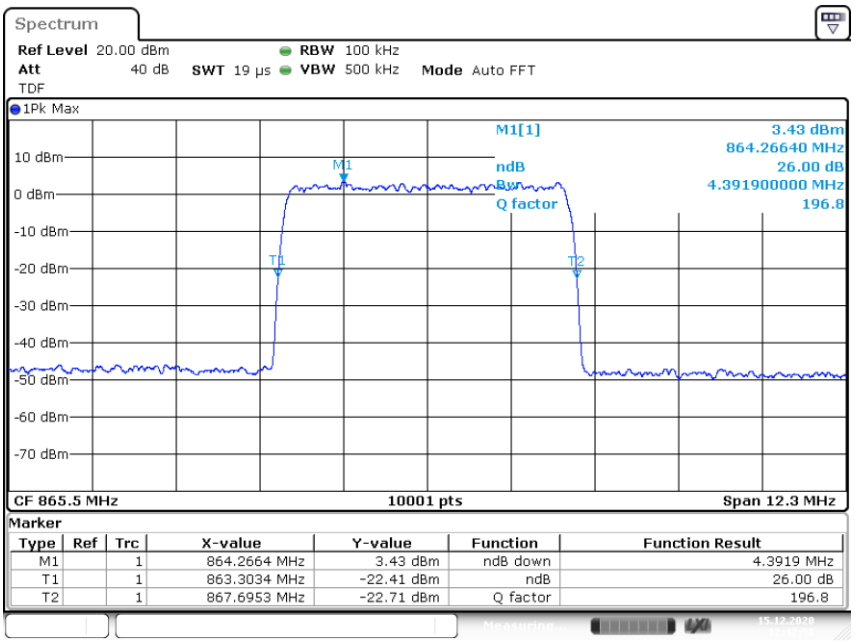


Input Signal



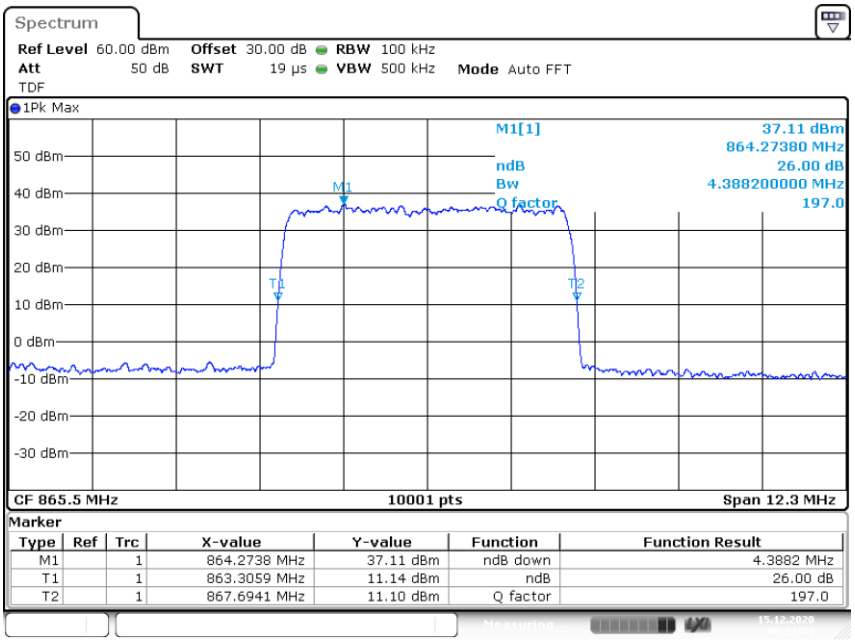
Output Signal

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 865.00 MHz; Band Edge: mid; Mod: AWGN; Input OCBw 3 dB > AGC



3.4 OCBw AWGN In +3 865.5000M _26dB

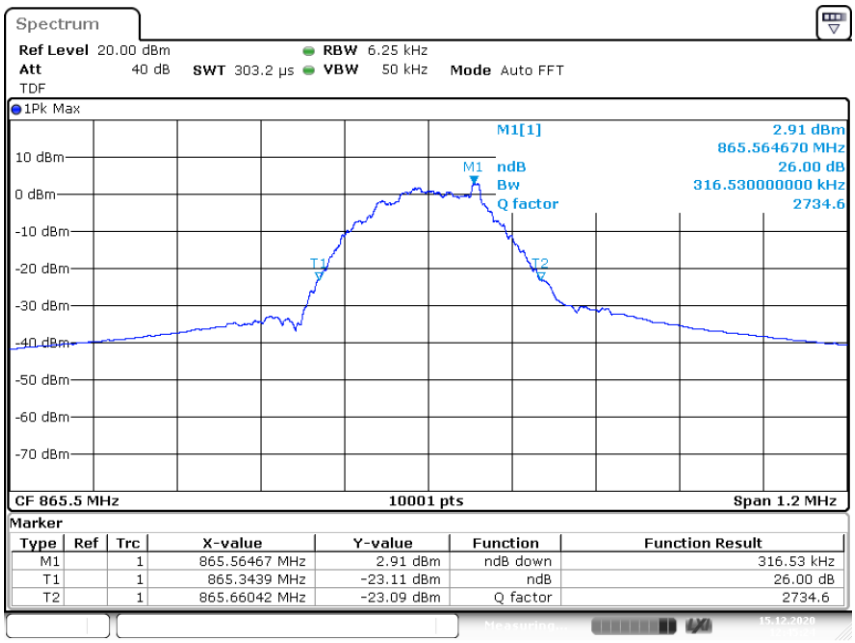
Input Signal



3.4 OCBw AWGN Out +3 865.5000M _26dB

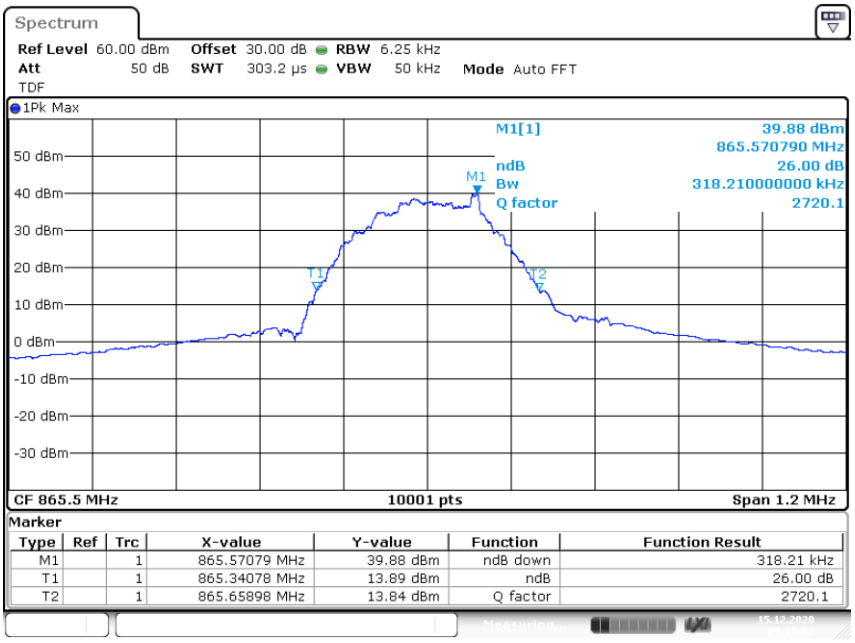
Output Signal

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 865.50 MHz; Band Edge: mid; Mod: GSM; Input OCBw 0.3 dB < AGC



3.4 OCBw GSM In -0.3 865.5000M _26dB

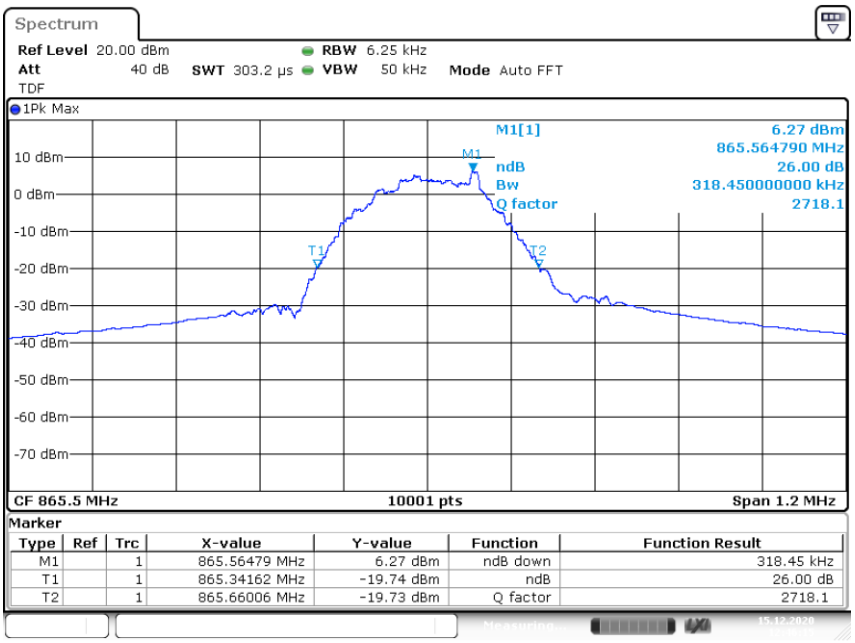
Input Signal



3.4 OCBw GSM Out -0.3 865.5000M _26dB

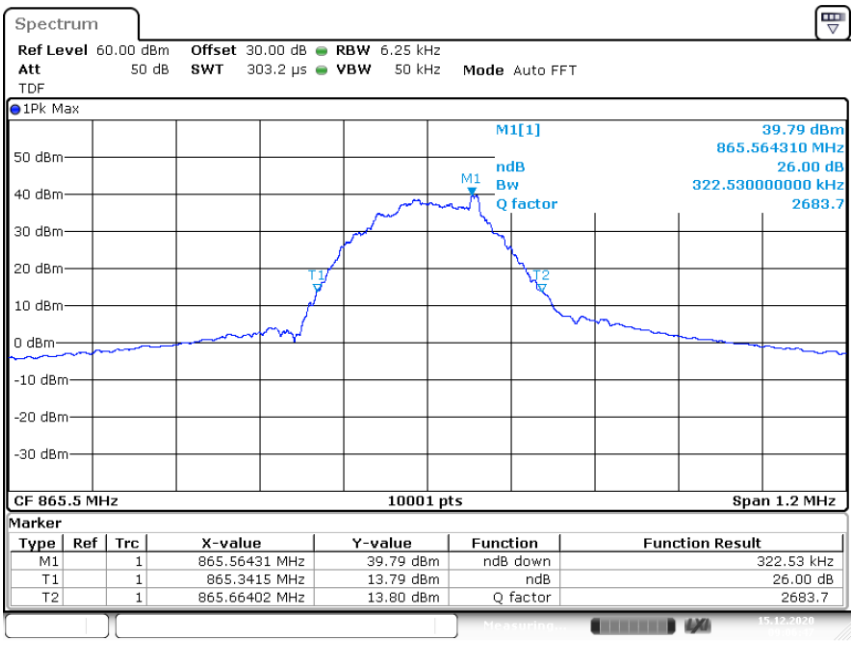
Output Signal

Downlink: Band SMR, 862 MHz - 869 MHz; Frequency: 865.50 MHz; Band Edge: mid; Mod: GSM; Input OCBw 3 dB > AGC



7

Input Signal



Output Signal

4.3.5 TEST EQUIPMENT USED

- Conducted

4.4 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Standard FCC Part § 2.1051, § 90.691

The test was performed according to:
ANSI C63.26, KDB 935210 D05 v01r04: 3.6

Test date: 2020-12-16

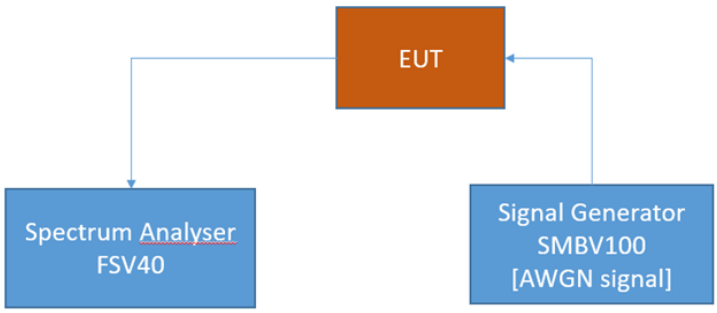
Environmental conditions: 23 ° C; 34 % r. F.

Test engineer: Thomas Gerngroß

4.4.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the signal booster power and gain limits and requirements for industrial signal boosters per FCC § 2.1051, FCC § 90.691, RSS-GEN with subpart 6.13 and RSS-119 with subpart 5.8.9.2.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; RF Output Power / Gain

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.4.2 TEST REQUIREMENTS/LIMITS

Abstract § 2.1051 from FCC:

FCC Part 2.1051; Measurement required: Spurious emissions at antenna terminal:

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

Abstract § 90.691 FCC:

§ 90.691 Emission mask requirements for EA-based systems.

(a) Out-of-band emission requirement shall apply only to the "outer" channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

(2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $43 + 10\text{Log}_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

Abstract RSS-119 5.8.9.2 from ISED:

5.8.9.2 Out-of-Band Emission Limit

On any frequency outside of the ranges specified in the ACP tables 13 to 16, the power of any emission shall be attenuated below the mean output power P (dBW) by at least 43 + 10 log10(p), measured in a 100 kHz bandwidth for frequencies less than or equal to 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz..

4.4.3 TEST PROTOCOL

Band SMR, 862 MHz - 869 MHz, downlink							
Test Frequency	**Signal Type**	**Spurious Freq. [MHz]**	**Spurious Level [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
low	Wideband	0.015328	-48.1	RMS	1	-33.0	15.1
low	Wideband	0.062498	-41.3	RMS	10	-23.0	18.3
low	Wideband	73.6	-35.3	RMS	100	-13.0	22.3
low	Wideband	704.6	-34.3	RMS	100	-13.0	21.3
low	Wideband	849.9	-40.9	RMS	10	-23.0	17.9
low	Wideband	869.2	-41.3	RMS	10	-23.0	18.3
low	Wideband	950.0	-34.3	RMS	100	-13.0	21.3
low	Wideband	1962.2	-17.0	RMS	1000	-13.0	4.0
mid	Wideband	0.009676	-48.0	RMS	1	-33.0	15.0
mid	Wideband	0.132486	-41.3	RMS	10	-23.0	18.3
mid	Wideband	67.8	-35.8	RMS	100	-13.0	22.8
mid	Wideband	705.1	-35.1	RMS	100	-13.0	22.1
mid	Wideband	850.3	-40.8	RMS	10	-23.0	17.8
mid	Wideband	869.2	-38.8	RMS	10	-23.0	15.8
mid	Wideband	949.2	-33.9	RMS	100	-13.0	20.9
mid	Wideband	1964.7	-17.8	RMS	1000	-13.0	4.8
high	Wideband	0.016147	-48.3	RMS	1	-33.0	15.3
high	Wideband	0.067497	-40.5	RMS	10	-23.0	17.5
high	Wideband	121.2	-35.7	RMS	100	-13.0	22.7
high	Wideband	705.1	-33.8	RMS	100	-13.0	20.8
high	Wideband	849.9	-41.1	RMS	10	-23.0	18.1
high	Wideband	869.1	-37.8	RMS	10	-23.0	14.8
high	Wideband	955.3	-33.9	RMS	100	-13.0	20.9
high	Wideband	2141.2	-17.8	RMS	1000	-13.0	4.8

Band SMR, 862 MHz - 869 MHz, downlink							
Test Frequency	**Signal Type**	**Spurious Freq. [MHz]**	**Spurious Level [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
low	Narrowband	0.011519	-50.4	RMS	1	-33.0	17.4
low	Narrowband	0.082495	-44.8	RMS	10	-23.0	21.8
low	Narrowband	67.3	-35.1	RMS	100	-13.0	22.1
low	Narrowband	703.2	-33.9	RMS	100	-13.0	20.9
low	Narrowband	861.9	-28.3	RMS	10	-23.0	5.3
low	Narrowband	869.5	-44.7	RMS	10	-23.0	21.7
low	Narrowband	950.5	-33.8	RMS	100	-13.0	20.8
low	Narrowband	1962.7	-17.5	RMS	1000	-13.0	4.5
mid	Narrowband	0.00902	-50.7	RMS	1	-33.0	17.7
mid	Narrowband	0.072496	-45.1	RMS	10	-23.0	22.1
mid	Narrowband	68.2	-35.9	RMS	100	-13.0	22.9
mid	Narrowband	807.9	-34.4	RMS	100	-13.0	21.4
mid	Narrowband	861.8	-43.0	RMS	10	-23.0	20.0
mid	Narrowband	869.3	-43.2	RMS	10	-23.0	20.2
mid	Narrowband	949.1	-33.1	RMS	100	-13.0	20.1
mid	Narrowband	1962.7	-17.3	RMS	1000	-13.0	4.3
high	Narrowband	0.009676	-50.7	RMS	1	-33.0	17.7
high	Narrowband	0.062498	-45.5	RMS	10	-23.0	22.5
high	Narrowband	118.9	-35.9	RMS	100	-13.0	22.9
high	Narrowband	804.7	-32.6	RMS	100	-13.0	19.6
high	Narrowband	861.3	-45.5	RMS	10	-23.0	22.5
high	Narrowband	869.1	-28.3	RMS	10	-23.0	5.3
high	Narrowband	948.4	-33.8	RMS	100	-13.0	20.8
high	Narrowband	2145.7	-17.5	RMS	1000	-13.0	4.5

Remark: Please see next sub-clause for the measurement plot.

General considerations concerning the measurement plots:

The measuring bandwidth of 100 kHz was chosen according the test requirements exept at the band edges: At the band edges reducing of measurement bandwidth was necessary to prevent overlaying the RF-signal over the spurious emissions.
Also outside the downlink frequency band ath lower frequencies the measurement bandwidths were reduced to have the possibility to record the spurious emissions at these lower frequencies.

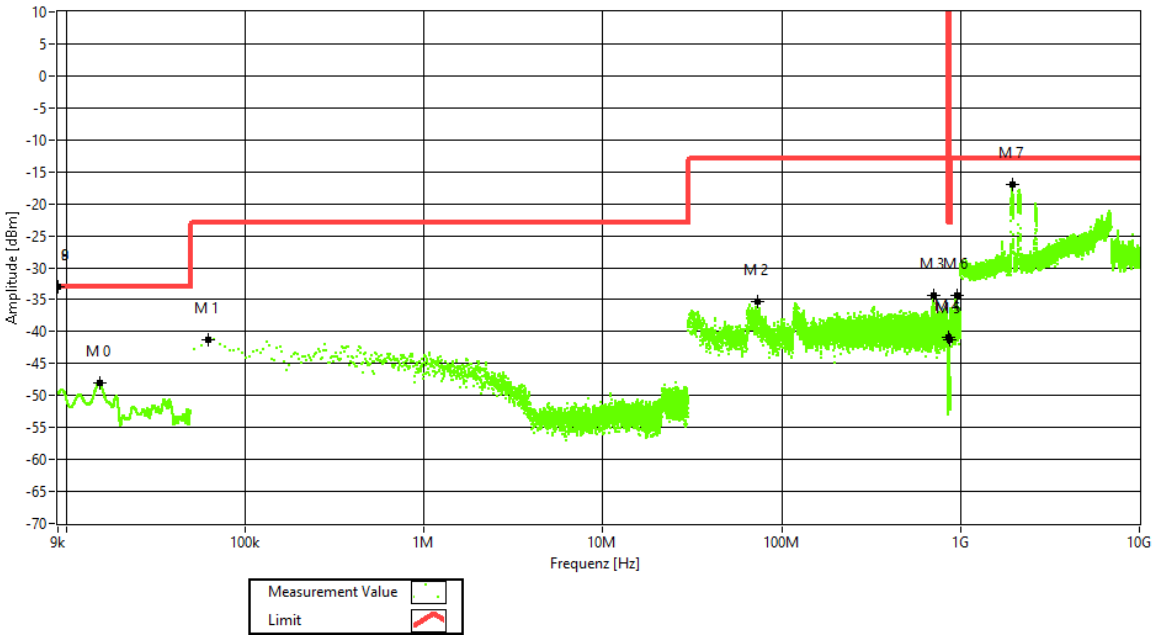
At frequencies were measuring bandwidths were reduced also the border lines were reduced acoording the given formula:

$$p\,RBWreduced\,[dBm] = 10 * \log\left(RBWreduced\,[kHz] - 100\,kHz\right) + pRBW\,100\,kHz[dBm]$$

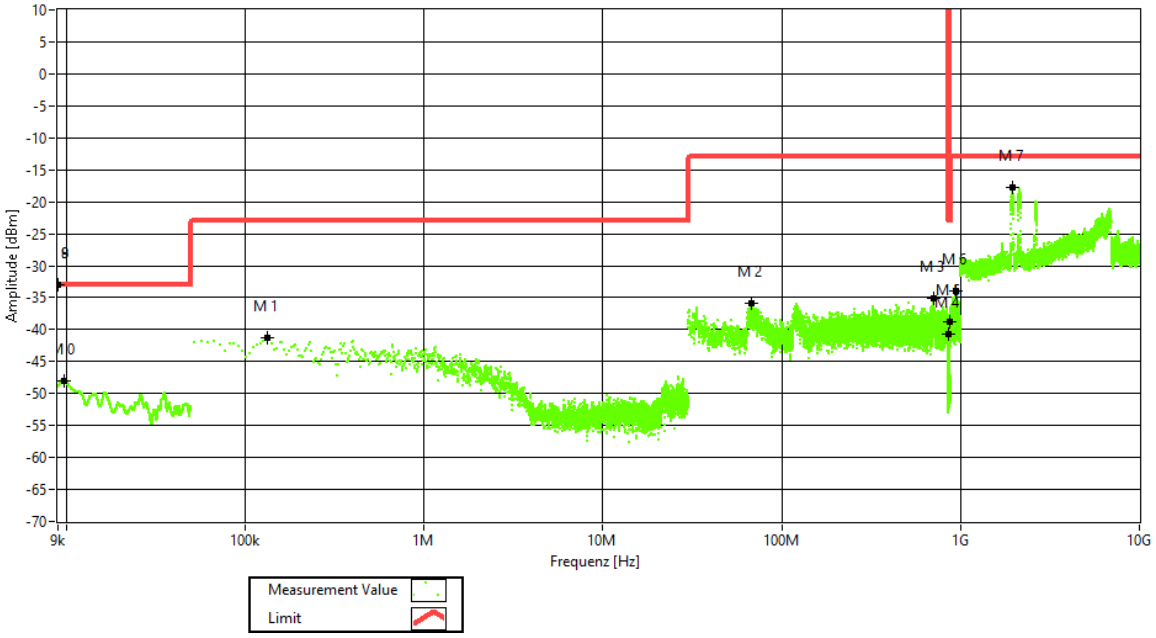
Hereby "p" are the border lines' values.

4.4.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

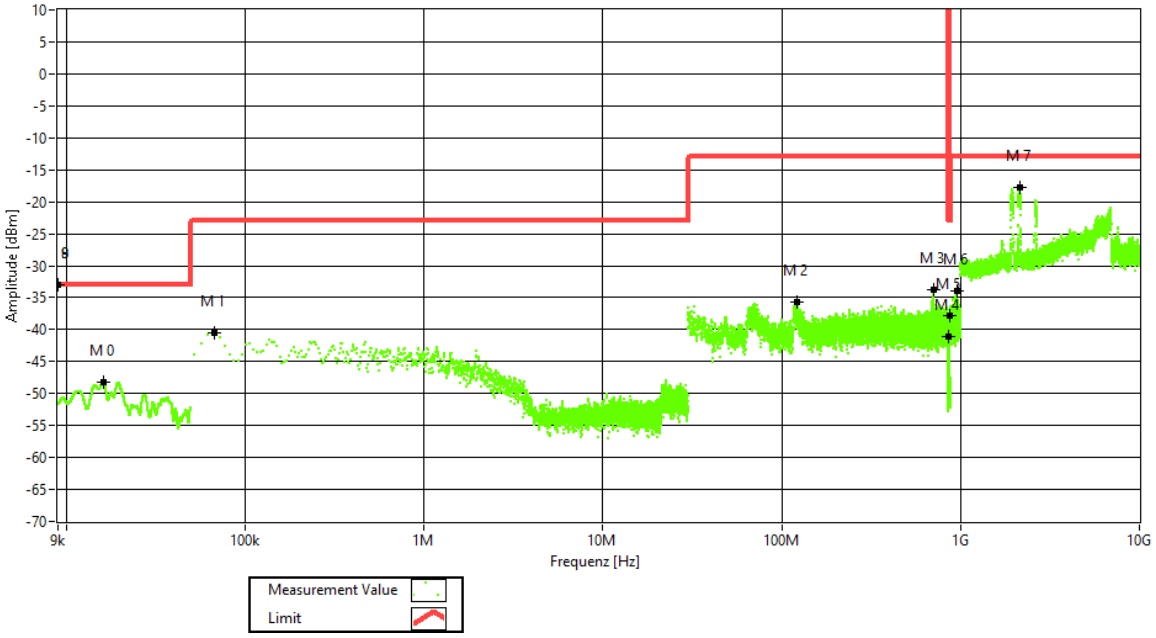
Frequency Band = Band SMR, 862 MHz - 869 MHz, Test Frequency = low, Direction = RF downlink, Signal Type = AWGN



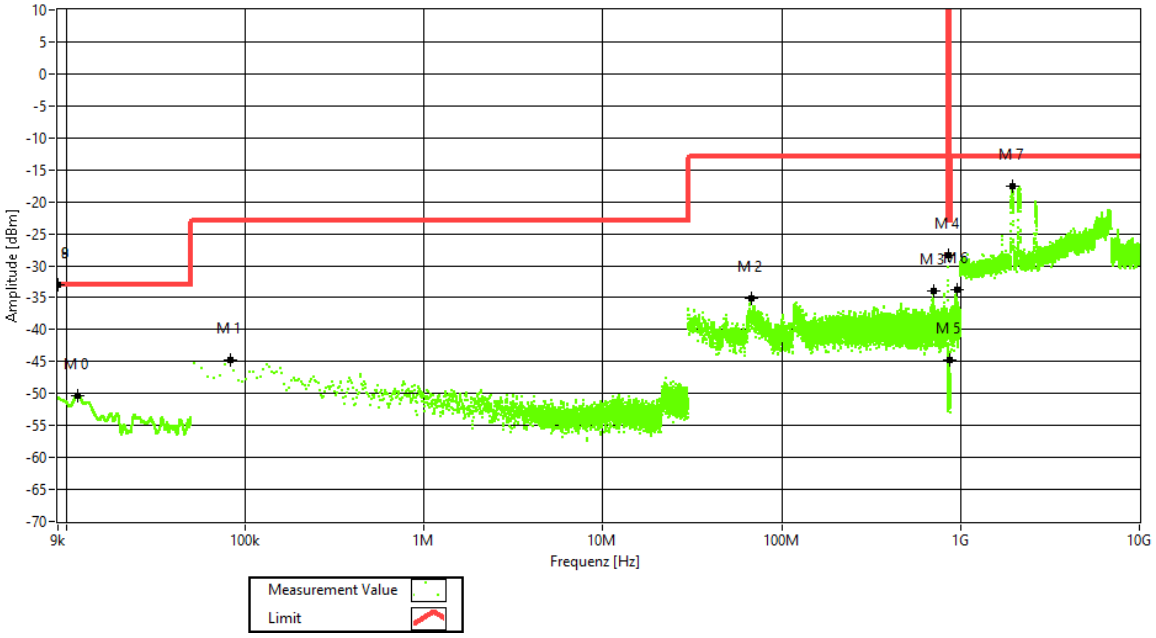
Frequency Band = Band SMR, 862 MHz - 869 MHz, Test Frequency = mid, Direction = RF downlink, Signal Type = AWGN



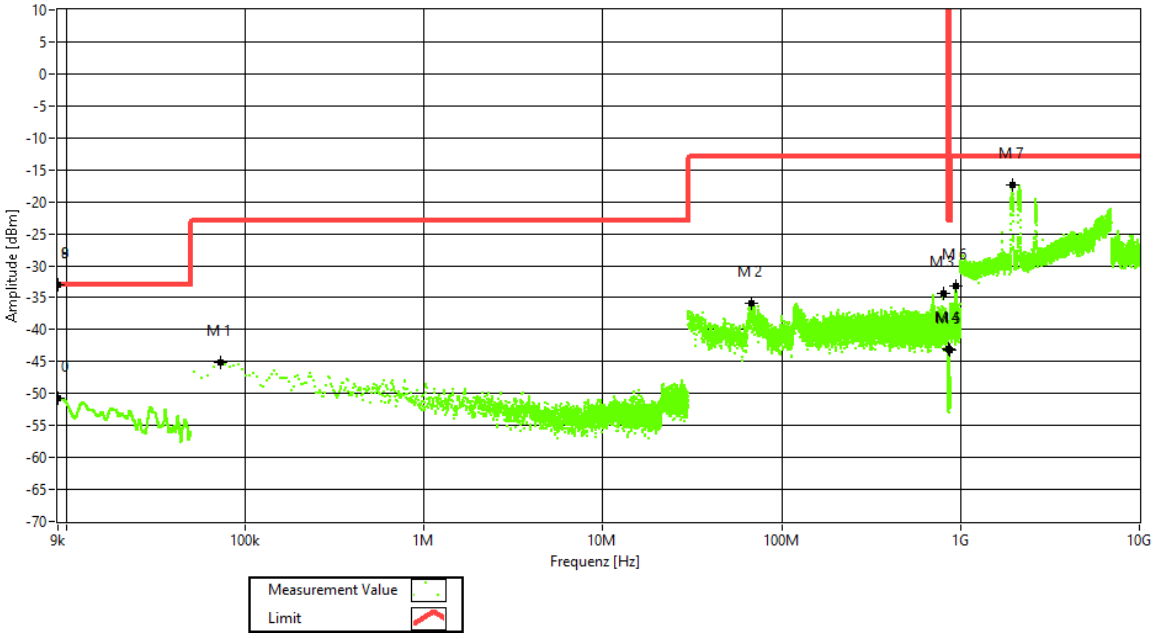
Frequency Band = Band SMR, 862 MHz - 869 MHz, Test Frequency = high, Direction = RF downlink, Signal Type = AWGN



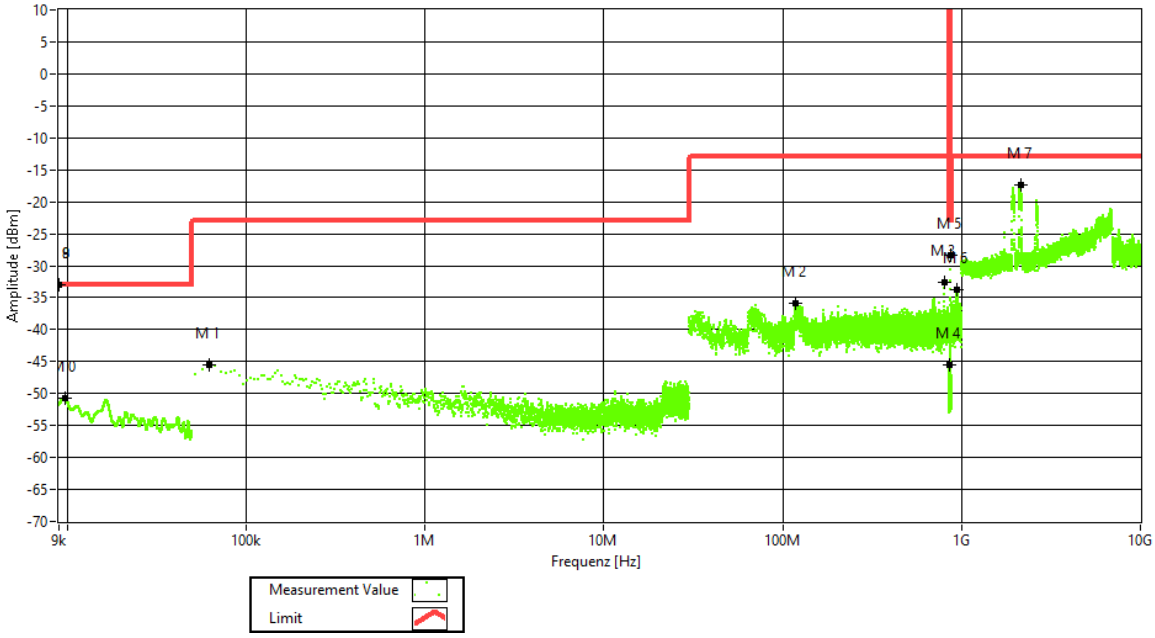
Frequency Band = Band SMR, 862 MHz - 869 MHz, Test Frequency = low, Direction = RF downlink, Signal Type = GSM



Frequency Band = Band SMR, 862MHz - 869 MHz, Test Frequency = mid, Direction = RF downlink, Signal Type = GSM



Frequency Band = Band SMR, 862 MHz - 869 MHz, Test Frequency = high, Direction = RF downlink, Signal Type = GSM



4.4.5 TEST EQUIPMENT USED

- Conducted

4.5 OUT-OF-BAND EMISSION LIMITS

Standard FCC Part § 2.1051, § 90.691

The test was performed according to:
ANSI C63.26, KDB 935210 D05 v01r04: 3.6

Test date: 2020-12-15

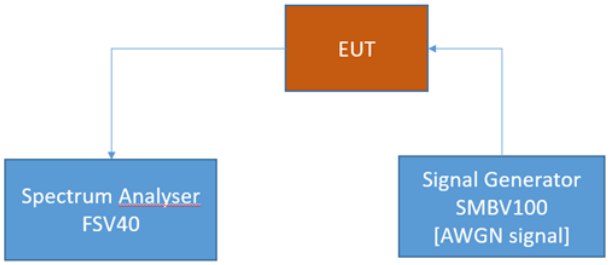
Environmental conditions: 23 ° C; 31 % r. F.

Test engineer: Thomas Gerngroß

4.5.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the out-of-band emission limit for industrial signal boosters. The limits itself come from the applicable rule part for each operating band per FCC § 2.1051 and FCC § 90.691, RSS-GEN with subpart 6.13 and RSS-119 with subpart 5.8.9.2.

The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; Out-of-band emissions

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.5.2 TEST REQUIREMENTS/LIMITS

Abstract § 2.1051 from FCC:

FCC Part 2.1051; Measurement required: Spurious emissions at antenna terminal:

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

Abstract § 90.691 FCC:

§ 90.691 Emission mask requirements for EA-based systems.

(a) Out-of-band emission requirement shall apply only to the "outer" channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

(2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $43 + 10\text{Log}_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

Abstract RSS-119 5.8.9.2 from ISED:

5.8.9.2 Out-of-Band Emission Limit

On any frequency outside of the ranges specified in the ACP tables 13 to 16, the power of any emission shall be attenuated below the mean output power P (dBW) by at least 43 + 10 log10(p), measured in a 100 kHz bandwidth for frequencies less than or equal to 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz..

4.5.3 TEST PROTOCOL

Band SMR, 862 MHz - 869 MHz, downlink, Number of input signals = 1							
Signal Type	**Input Power**	**Band Edge**	**Signal Frequency [MHz]**	**Input Power [dBm]**	**Maximum Out-of-band Power [dBm]**	**Limit Out-of-band Power [dBm]**	**Margin to Limit [dB]**
Wideband	-0.3 dB < AGC	upper	866.5000	5.5	-22.7	-13.0	9.7
Wideband	3 dB > AGC	upper	866.5000	8.5	-22.6	-13.0	9.6
Narrowband	-0.3 dB < AGC	upper	868.8000	5.5	-13.5	-13.0	0.5
Narrowband	3 dB > AGC	upper	868.8000	8.8	-13.1	-13.0	0.1
Wideband	-0.3 dB < AGC	lower	864.5000	5.5	-22.9	-13.0	9.9
Wideband	3 dB > AGC	lower	864.5000	8.8	-23.0	-13.0	10.0
Narrowband	-0.3 dB < AGC	lower	862.2000	5.3	-14.4	-13.0	1.4
Narrowband	3 dB > AGC	lower	862.2000	8.6	-14.2	-13.0	1.2

Band SMR, 862 MHz - 869 MHz, downlink, Number of input signals = 2								
Signal Type	**Input Power**	**Band Edge**	**Signal Frequency f1 [MHz]**	**Signal Frequency f2 [MHz]**	**Input Power [dBm]**	**Maximum Out-of-band Power [dBm]**	**Limit Out-of-band Power [dBm]**	**Margin to Limit [dB]**
WB	-0.3 dB < AGC	upper	866.5000	864.0000	5.5	-22.4	-13.0	9.4
WB	3 dB > AGC	upper	866.5000	864.0000	8.5	-22.7	-13.0	9.7
NB	-0.3 dB < AGC	upper	868.8000	868.6000	5.5	-16.4	-13.0	3.4
NB	3 dB > AGC	upper	868.8000	868.6000	8.8	-16.3	-13.0	3.3
WB	-0.3 dB < AGC	lower	864.5000	867.0000	5.5	-22.9	-13.0	9.9
WB	3 dB > AGC	lower	864.5000	867.0000	8.8	-23.3	-13.0	10.3
NB	-0.3 dB < AGC	lower	862.2000	862.4000	5.3	-17.4	-13.0	4.4
NB	3 dB > AGC	lower	862.2000	862.4000	8.6	-17.9	-13.0	4.9

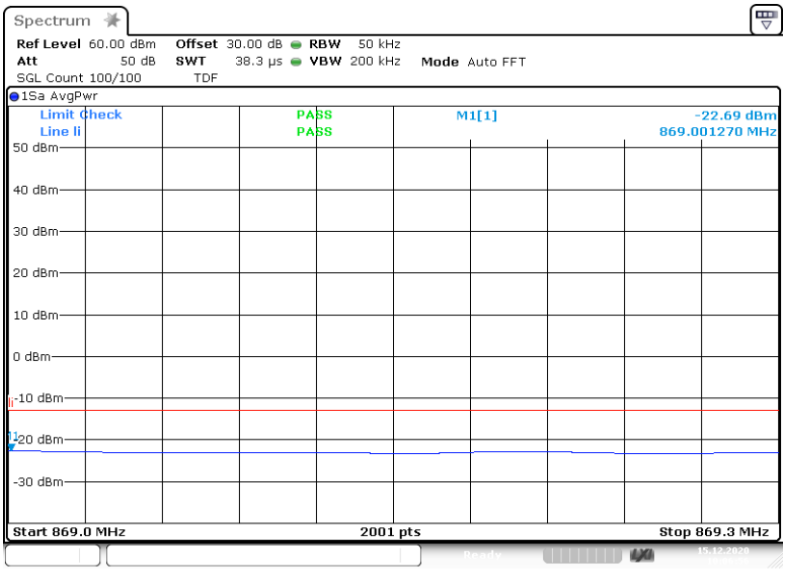
Remark: Please see next sub-clause for the measurement plot.

Explanations concering table with two input signals:

"WB" means Wideband.
"NB" means Narrowband.

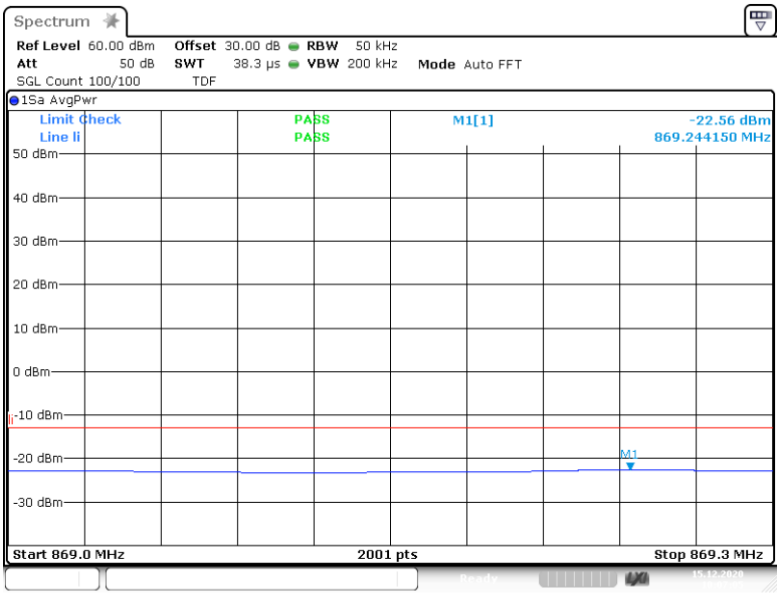
4.5.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



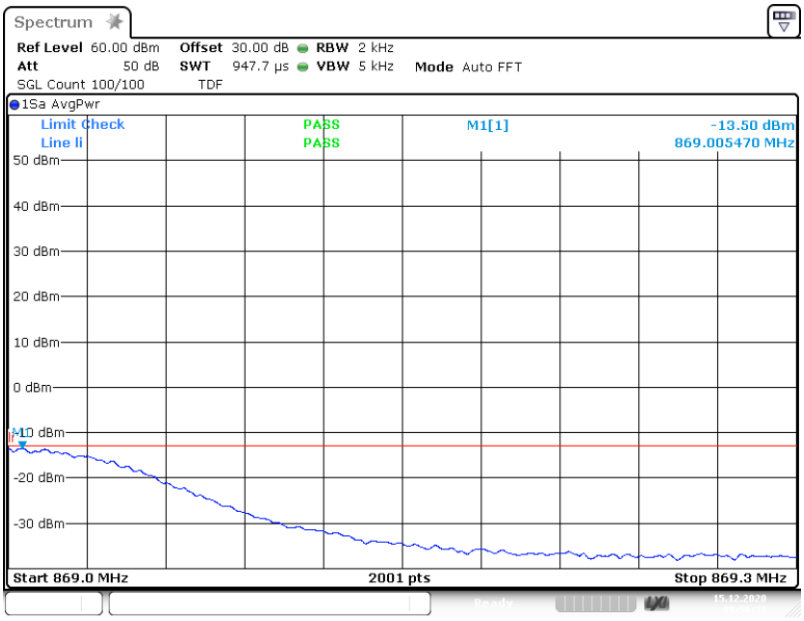
3.6.2 out of band emi SMR Band AWGN upper 1carrier -0.3 dB 8
69.000M 869.300M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



3.6.2 out of band emi SMR Band AWGN upper 1carrier +3.0 dB 8
69.000M 869.300M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1

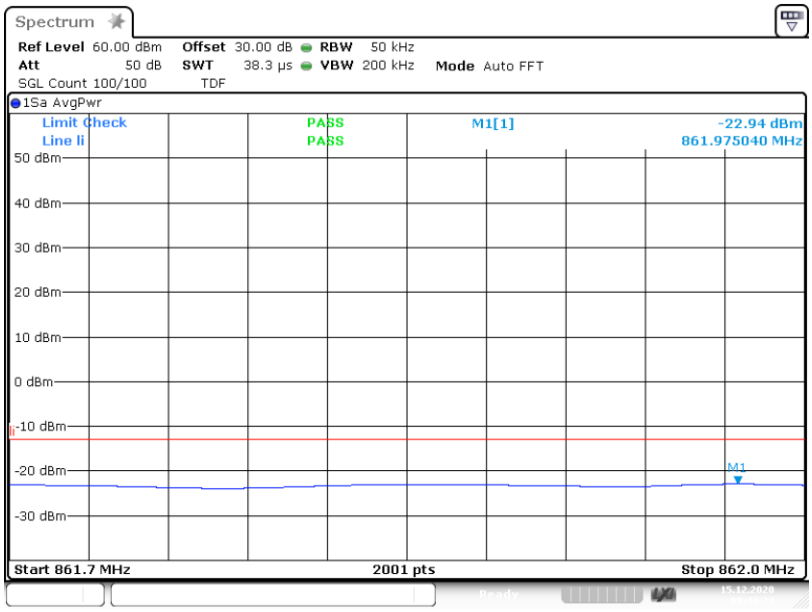


3.6.2 out of band emi SMR Band GSM upper 1carrier -0.3 dB 86
9.000M 869.300M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1

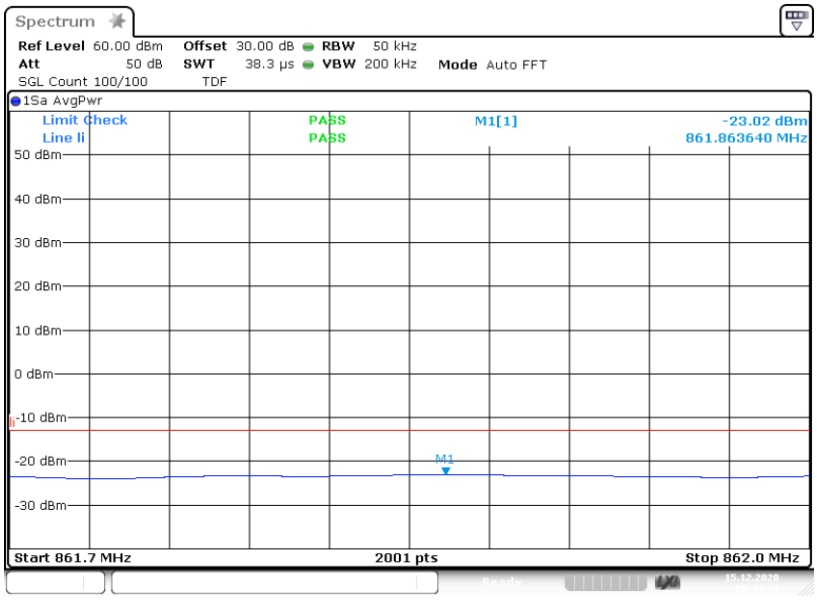
3.6.2 out of band emi SMR Band GSM upper 1carrier +3.0 dB 86
9.000M 869.300M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



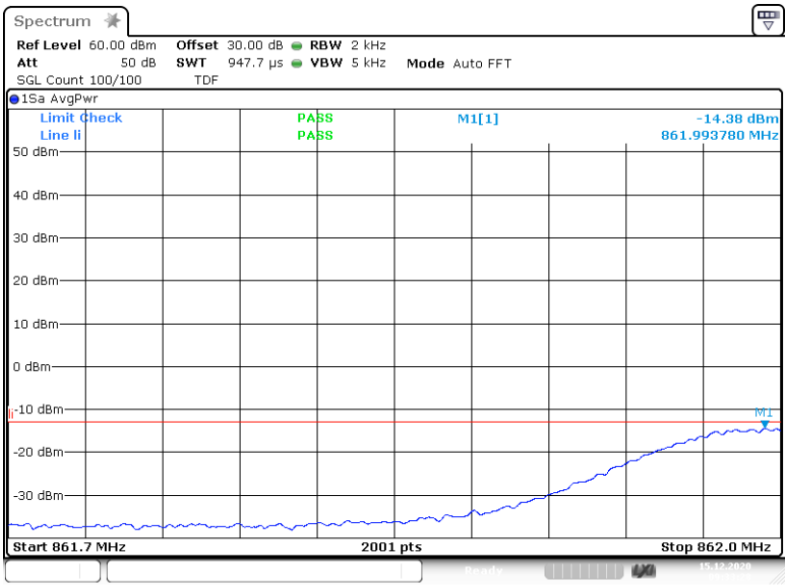
3.6.2 out of band emi SMR Band AWGN lower 1carrier -0.3 dB 8
61.700M 862.000M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



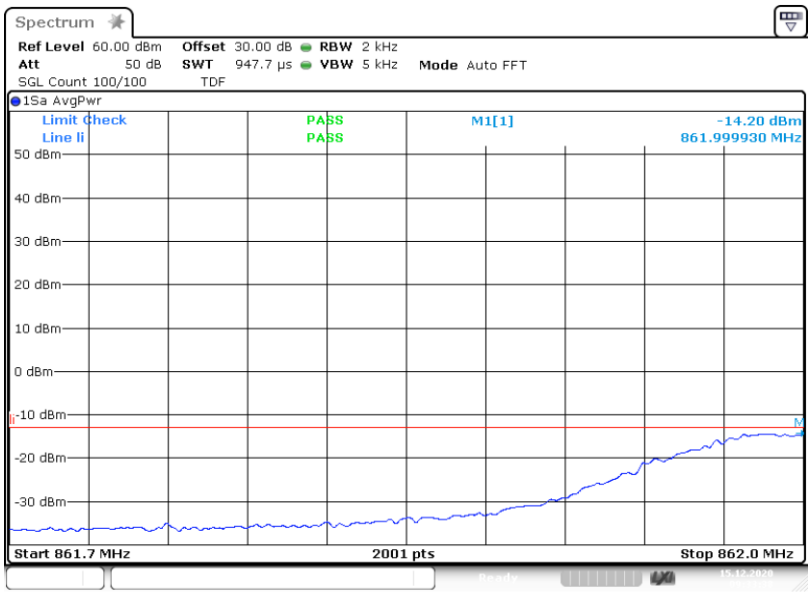
3.6.2 out of band emi SMR Band AWGN lower 1carrier +3.0 dB 8
61.700M 862.000M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



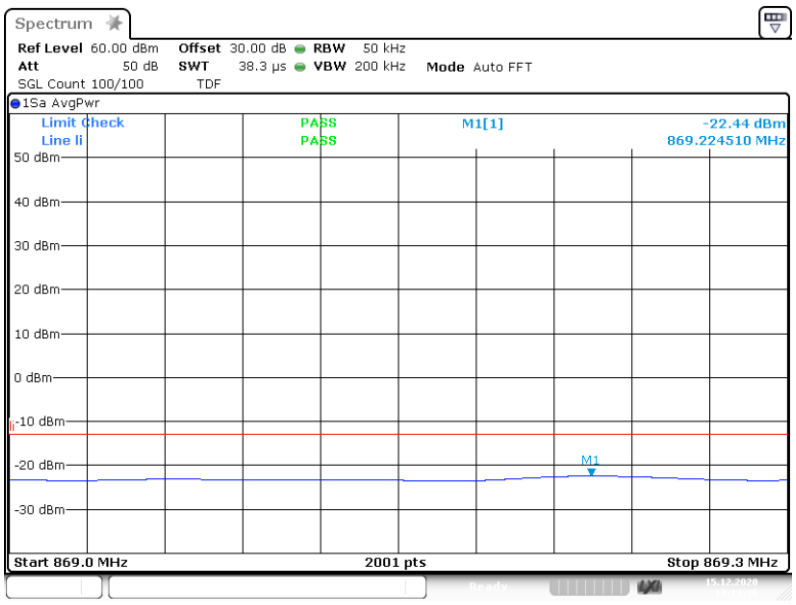
3.6.2 out of band emi SMR Band GSM lower 1carrier -0.3 dB 86
1.700M 862.000M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



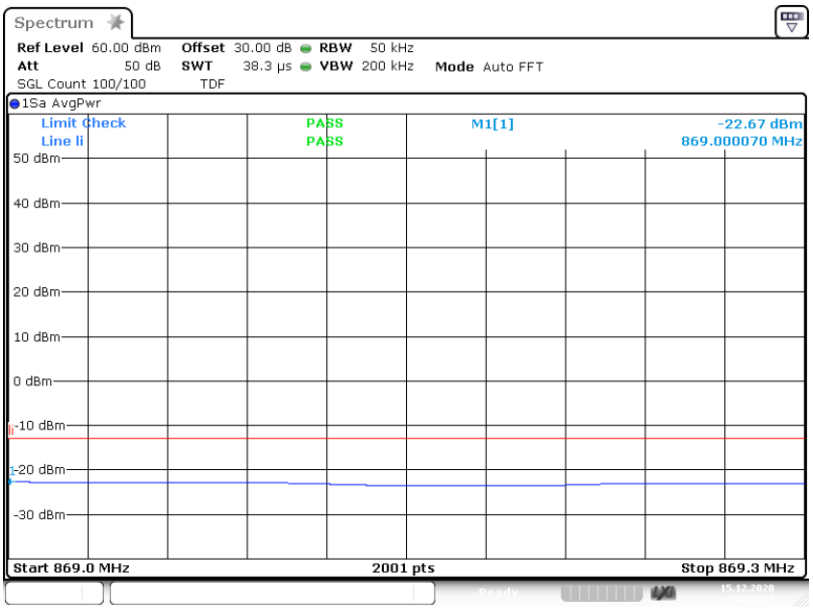
3.6.2 out of band emi SMR Band GSM lower 1carrier +3.0 dB 86
1.700M 862.000M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



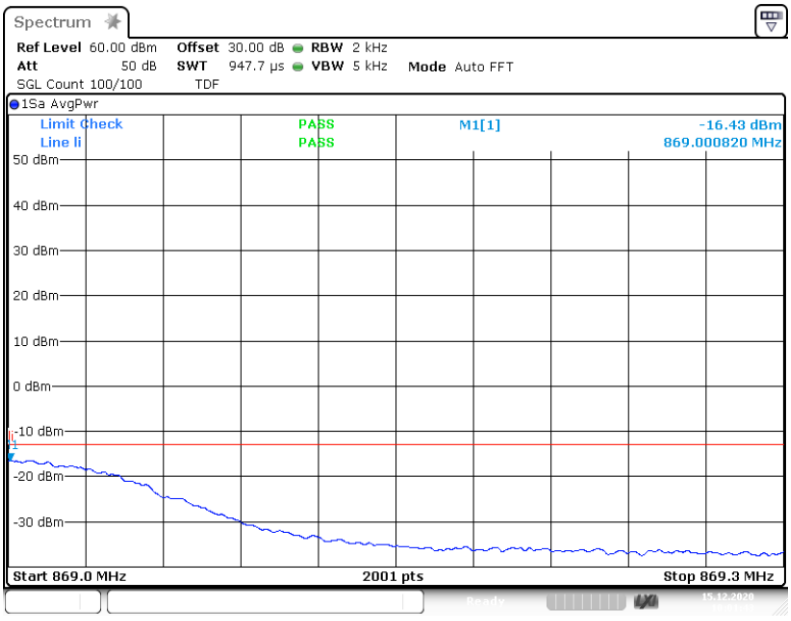
3.6.2 out of band emi SMR Band AWGN upper 2carriers -0.3 dB
869.000M 869.300M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



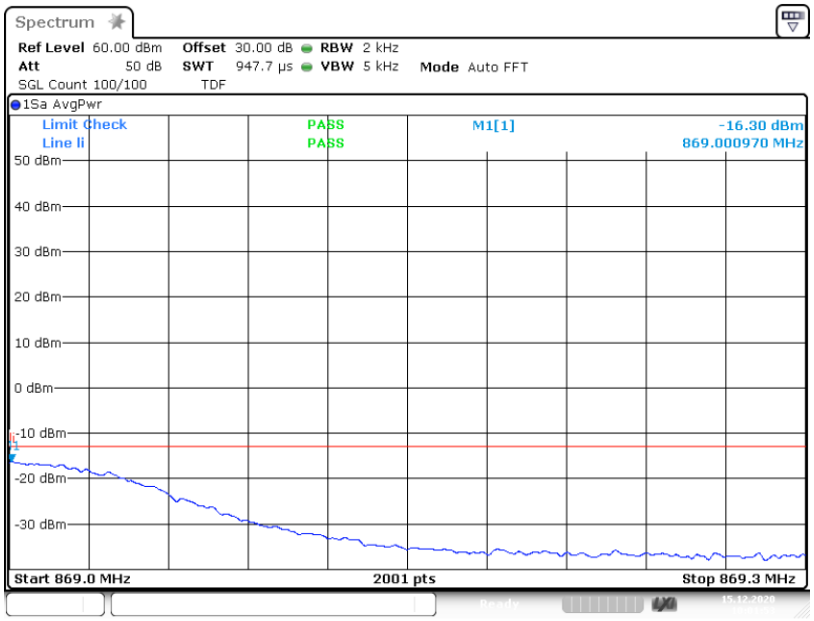
3.6.2 out of band emi SMR Band AWGN upper 2carriers +3.0 dB
869.000M 869.300M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



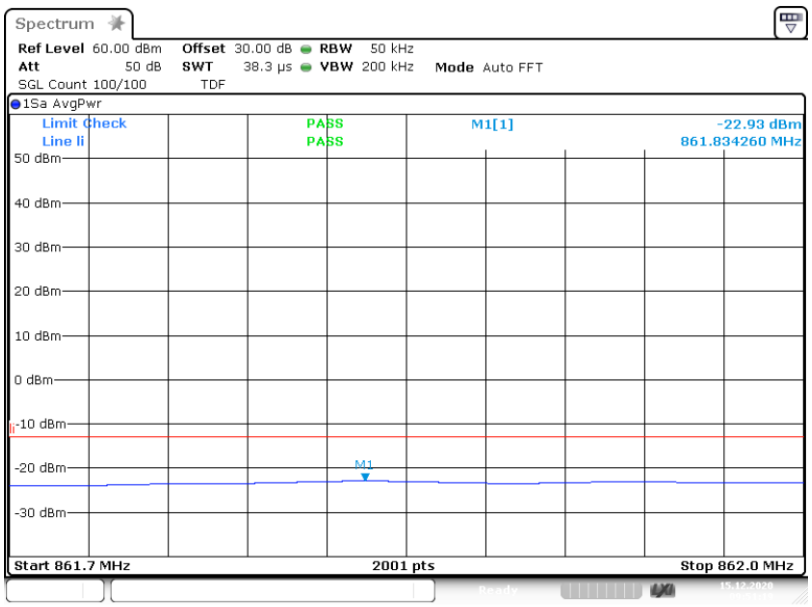
3.6.2 out of band emi SMR Band GSM upper 2carriers -0.3 dB 8
69.000M 869.300M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



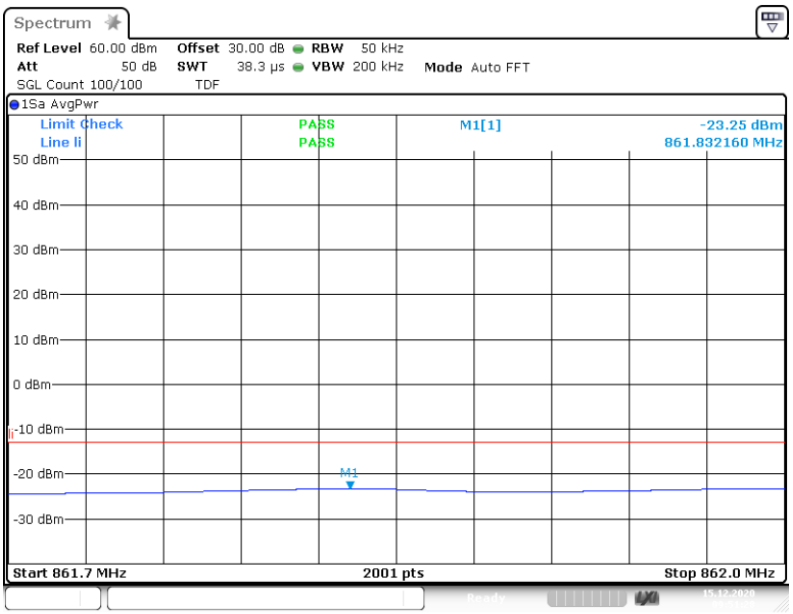
3.6.2 out of band emi SMR Band GSM upper 2carriers +3.0 dB 8
69.000M 869.300M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



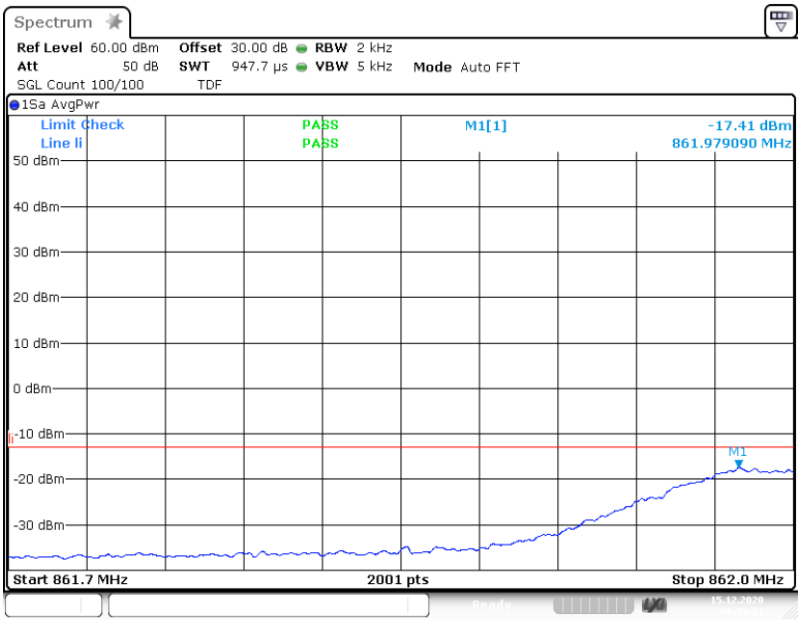
3.6.2 out of band emi SMR Band AWGN lower 2carriers -0.3 dB
861.700M 862.000M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



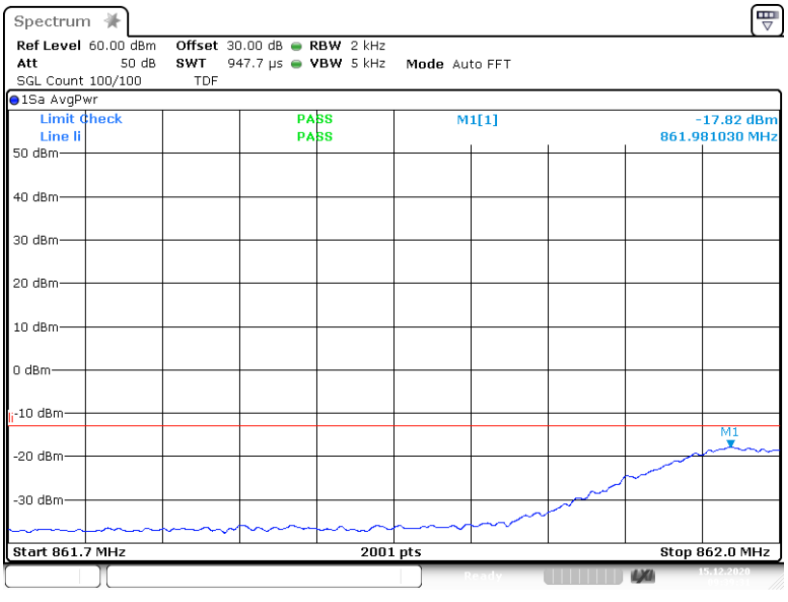
3.6.2 out of band emi SMR Band AWGN lower 2carriers +3.0 dB
861.700M 862.000M

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



-16

Downlink: SMR Band; Frequency: 862.0000 MHz to 869.0000 MHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



TEST EQUIPMENT USED

- Conducted

4.6 OUT-OF-BAND REJECTION

Standard KDB 935210 D05

The test was performed according to:
ANSI C63.26; KDB 935210 D05

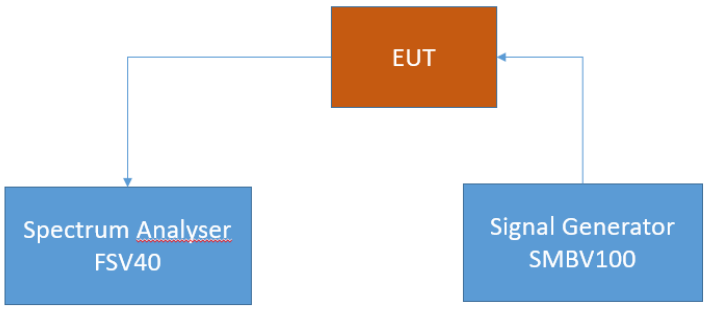
Test date: 2020-12-15

Environmental conditions: 22 ° C; 31 % r. F.

Test engineer: Thomas Gerngroß

4.6.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the out-of-band rejection test case for industrial signal boosters.
The EUT was connected to the test setup according to the following diagram:



FCC Part 22/24/27/90 Industrial signal booster – Test Setup; Out-of-band rejection

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

4.6.2 TEST REQUIREMENTS/LIMITS

Abstract RSS-131 from ISED:

RSS-131; 5.2.1 Out-of-band rejection

The gain-versus-frequency response and the 20 dB bandwidth of the zone enhancer shall be reported. The zone enhancer shall reject amplification of other signals outside the passband of the zone enhancer.

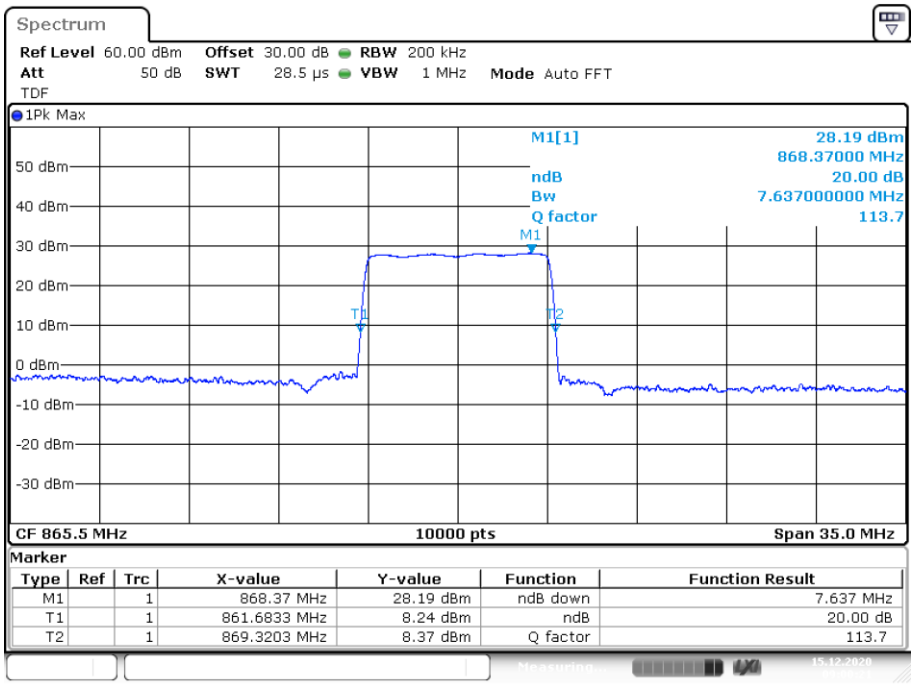
4.6.3 TEST PROTOCOL

Band SMR, 862 MHz - 869 MHz, downlink				
Highest Power Frequency [MHz]	**Output Power [dBm]**	**Lower Highest Power -20 dB Frequency [MHz]**	**Upper Highest Power -20 dB Frequency [MHz]**	**20 dB Bandwidth [MHz]**
868.37	28.19	861.6833	869.3202	7.6370

Remark: Please see next sub-clause for the measurement plot.

4.6.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Frequency Band = Band SMR, 862 MHz - 869 MHz, Direction = RF downlink



3.3 Out of band rejection SMR Band 865.50000M
_20dB

4.6.5 TEST EQUIPMENT USED

- Conducted

4.7 FIELD STRENGTH OF SPURIOUS RADIATION

Standard FCC Part90, § 90.691

The test was performed according to:
ANSI C63.26

Test date: 2020-12-17; 2020-12-21

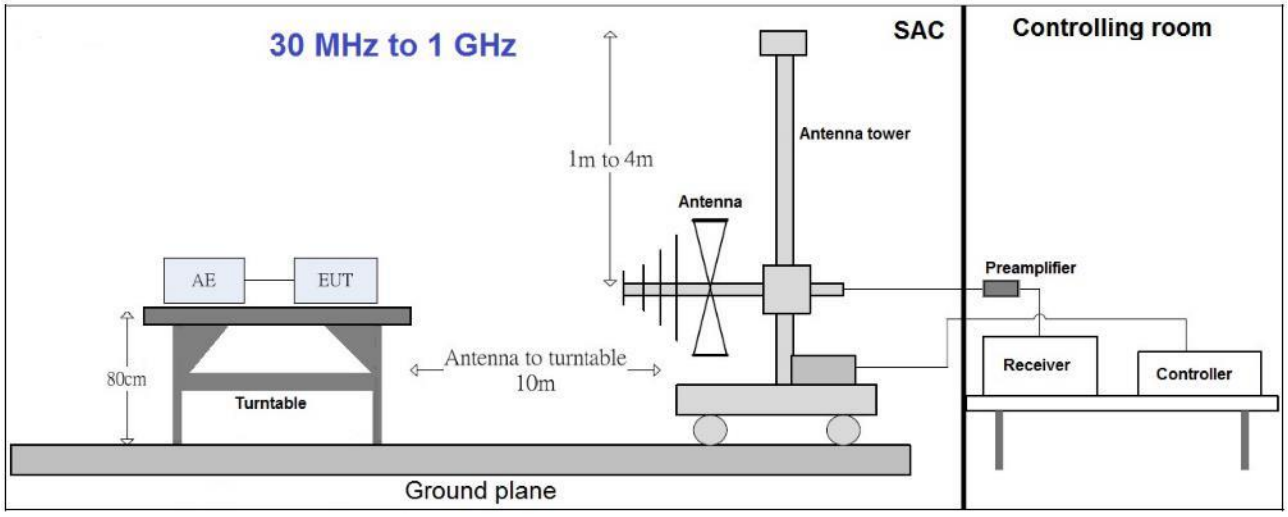
Environmental conditions: 20 ° C; 40 % r. F.

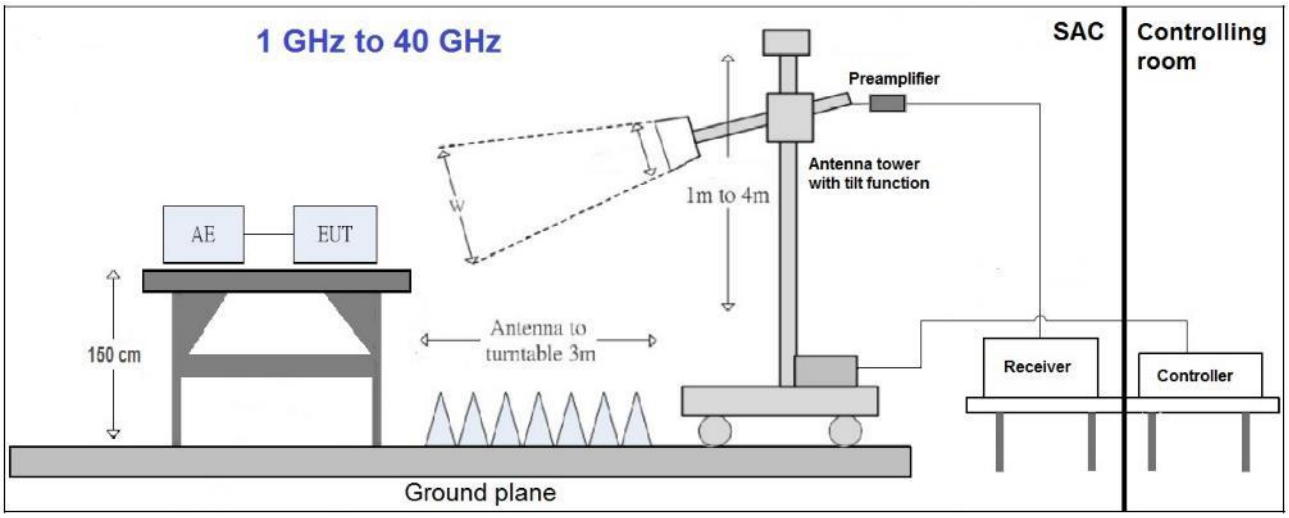
Test engineer: Thomas Hufnagel

4.7.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable radiated spurious emission measurements per § 2.1053

The EUT was connected to the test setup according to the following diagram:





1. Measurement above 30 MHz and up to 1 GHz

The test set-up was made in accordance to the general provisions of ANSI C63.4 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.5 x 1.5 m² in the semi-anechoic chamber, 0.8 meter above the ground or floor-standing arrangement shall be placed on the horizontal ground reference plane.. The influence of the EUT support table that is used between 30–1000 MHz was evaluated. For the initial measurements, the receiving antenna is varied from 1-4 meter height and is changed in the vertical plane from vertical to horizontal polarization at each frequency. The highest emissions between 30 MHz to 1000 MHz were analyzed in details by operating the spectrum analyzer and/or EMI receiver in quasi-peak mode to determine the precise amplitude of the emissions.

The measurement procedure is implemented into the EMI test software BAT EMC from NEXIO. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered by a DC power source. ?

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 10 m
- Detector: Peak-Maxhold/RMS (FFT-based)
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF–Bandwidth: 120 kHz
- Measuring time/Frequency step: 5 ms
- Turntable angle range: –180° to 180°
- Turntable step size: 30°
- Height variation range: 1 – 4 m
- Height variation step size: 1 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.
- Detector: Peak – Maxhold; RMS
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: ± 30 ° around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: Quasi-Peak (< 1 GHz); RMS; Peak
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

3. Measurement above 1 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
Step 1:
The Equipment Under Test (EUT) was set up on a non-conductive support at 1.5 m height in the semi-anechoic chamber. Absorbers are placed around and between the turn table and the antenna tower.
All steps were performed with one height (1.5 m) of the receiving antenna only.
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 30 °.
The turn table step size (azimuth angle) for the preliminary measurement is 15 °.
Step 2:
The maximum RFI field strength was determined during the measurement by rotating the turntable (±180 degrees) and varying the height of the receive antenna (h = 1 ... 4 m) with a additional tilt function of the antenna.The turn table azimuth will slowly vary by ± 15°.
EMI receiver settings (for all steps):
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

Step 3:
Spectrum analyser settings for step 3:
- Detector: Peak/Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 1 s

4.7.2 TEST REQUIREMENTS/LIMITS

Abstract from FCC Part § 2.1053:

FCC Part 2.1053; Measurement required: Field strength of spurious radiation:

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate.

Abstract § 90.691 FCC:

§ 90.691 Emission mask requirements for EA-based systems.

(a) Out-of-band emission requirement shall apply only to the "outer" channels included in an EA license and to spectrum adjacent to interior channels used by incumbent licensees. The emission limits are as follows:

(2) For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $43 + 10\text{Log}_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

Abstract RSS-133 from ISED:

RSS-133; 6.5 Transmitter Unwanted Emissions

6.5.1 Out-of-Block Emissions

Equipment shall comply with the limits in (i) and (ii) below.

(i) In the 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the emission power per any 1% of the emission bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p(watts).

(ii) After the first 1.0 MHz, the emission power in any 1 MHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p(watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

4.7.3 TEST PROTOCOL

30 MHz to 1 GHz:

Band SMR, 862 MHz - 869 MHz, downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin (Sum Level) [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
71.0	-68.9	4.5	PEAK	120	-13.0	55.9
200.0	-68.0	4.5	PEAK	120	-13.0	55.0
207.4	-64.9	4.5	PEAK	120	-13.0	51.9
868.8	-45.5	4.5	PEAK	120	-13.0	32.5
207.3	-67.8	4.5	PEAK	120	-13.0	54.8
868.8	-51.2	4.5	PEAK	120	-13.0	38.2

Above 1 GHz:

Band SMR, 862 MHz - 869 MHz, downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin (Sum Level) [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
3538.7	-41.6	4.5	PEAK	1000	-13.0	28.6
11499.2	-24.3	4.5	PEAK	1000	-13.0	11.3
17780.7	-20.1	4.5	PEAK	1000	-13.0	7.1
3555.7	-41.0	4.5	PEAK	1000	-13.0	28.0
16272.8	-21.4	4.5	PEAK	1000	-13.0	8.4
17805.6	-19.9	4.5	PEAK	1000	-13.0	6.9

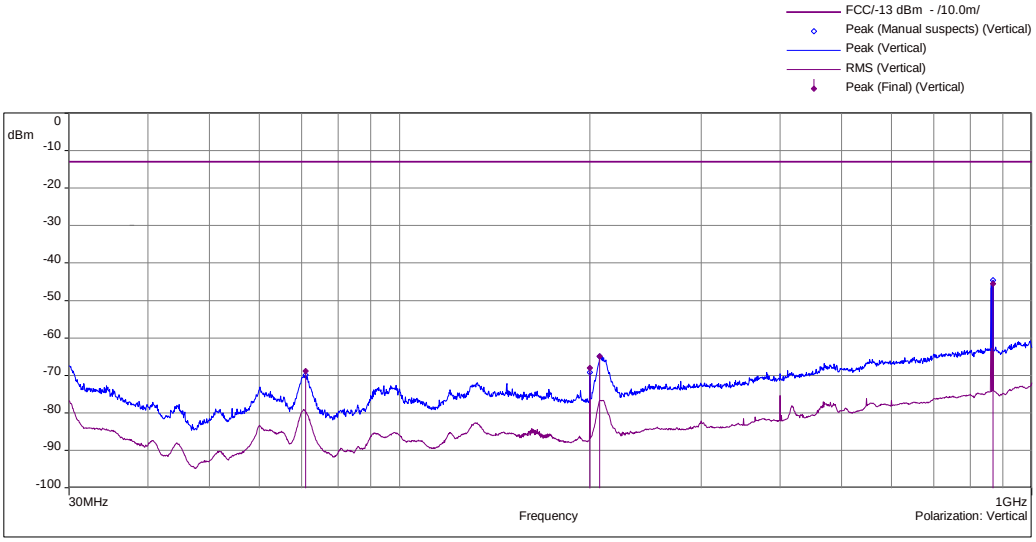
Remarks: Please see next sub-clause for the measurement plot.

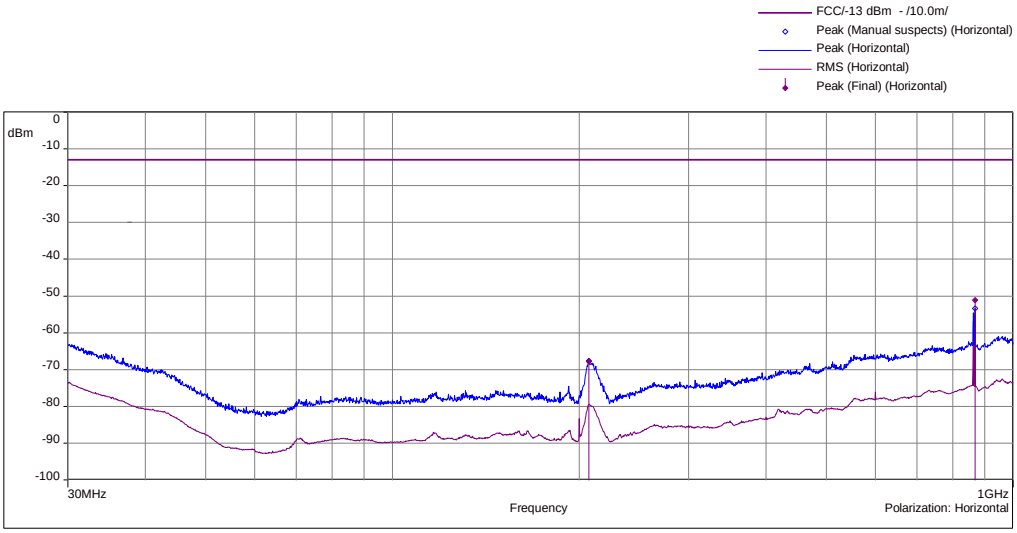
Although ususally a RMS detector is used for measruements in this cases a PEAK detector was used.
The limits are values for use of a RMS detector, but it is so, that the use of a PEAK detector results in readings with higher measured levels. Because the levels with the higher values with PEAK detector are in tolerance, the limits with a RMS detector are definately also in tolerance.

4.7.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

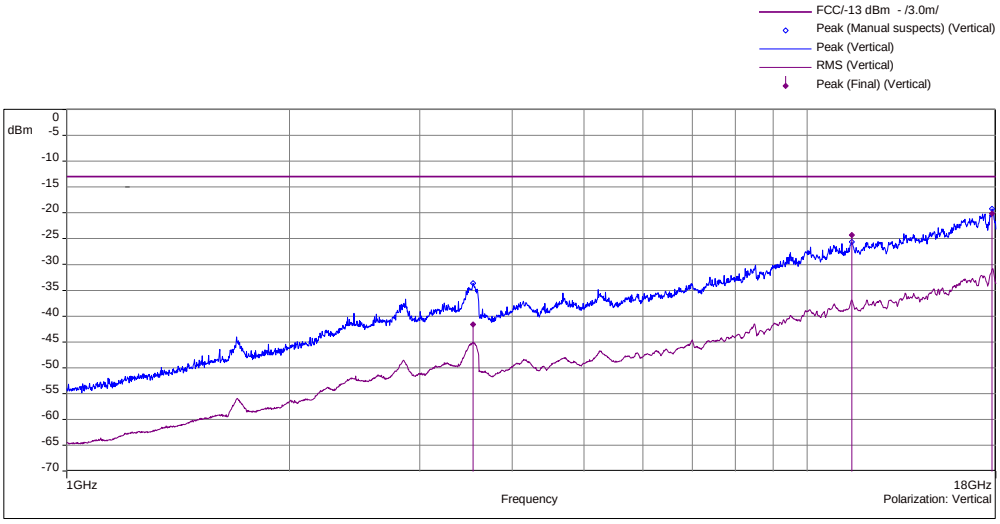
Frequency Band = Band SMR, 862 MHz - 869 MHz, Test Frequency = low, Direction = RF downlink

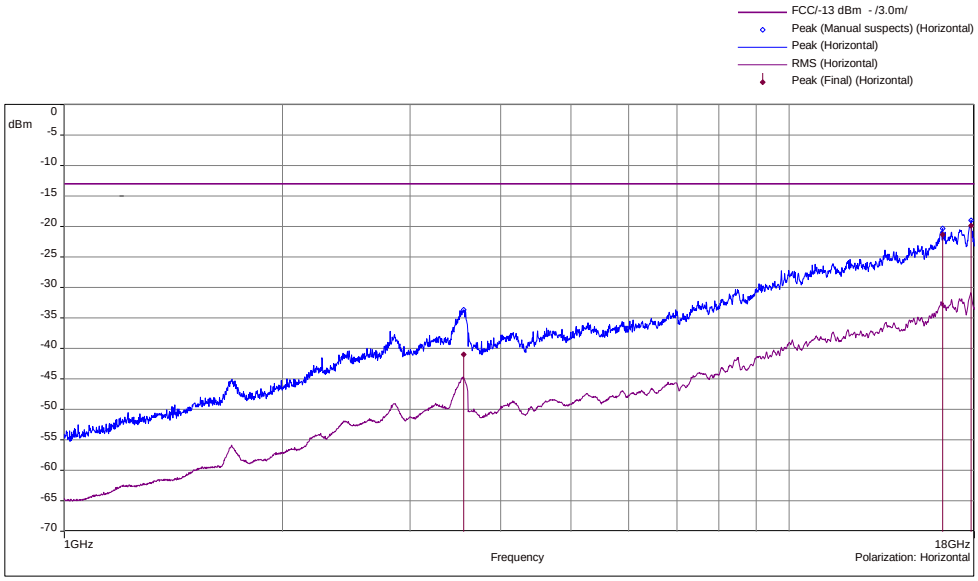
30 MHz - 1 GHz





1 GHz - 18 GHz


FCC/-13 dBm - /3.0m/
Peak (Manual suspects) (Vertical)
Peak (Vertical)
RMS (Vertical)
Peak (Final) (Vertical)
dBm
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
1GHz
Frequency
18GHz
Polarization: Vertical


FCC/-13 dBm - /3.0m/
Peak (Manual suspects) (Horizontal)
Peak (Horizontal)
RMS (Horizontal)
Peak (Final) (Horizontal)
dBm
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
1GHz
Frequency
18GHz
Polarization: Horizontal

4.7.5 FIELD STRENGTH CALCULATIONS

FS = SA + AF + CL + PA

Where as:

FS = Field strength
SA = EMC test receiver reading
AF = Antenna factor
CL = Cable loss
PA = Preamplifier

4.7.6 TEST EQUIPMENT USED

- Radiated Emissions

5 TEST EQUIPMENT

1 Conducted

Ref.No.	Type	Description	Manufacturer	Inventory no.	Last Calibration	Calibration Due
1.1	FSV40	Signal Analyzer 10 Hz - 40 GHz	Rohde & Schwarz	E2050	2020-12	2021-12
1.2	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	G2089	2020-08	2022-08
1.3	KlimaLogg Pro	Thermo-Hygrometer	TFA	X546	2020-05	2021-05

2 Radiated Emissions

Ref.No.	Type	Description	Manufacturer	Inventory no.	Last Calibration	Calibration Due
2.1	ESU40	EMI test receiver 10 Hz - 40 GHz	Rohde & Schwarz	E2025	2020-12	2021-12
2.2	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	G2089	2020-08	2022-08
2.3	CBL 6111C	Antenna 30 MHz – 1 GHz	Chase	K1026	2020-01	2021-01
2.4	HL 025	Antenna 1 GHz - 18 GHz	Rohde & Schwarz	K1114	2019-06	2021-06
2.5	AM1431	Pre amplifier 10 kHz – 1 GHz	Miteq	K1721	2020-12	2021-12
2.6	AFS4-00102000	Preamplifier 100 MHz - 20 GHz	Miteq	K838	2010-12	2021-12
2.7	30.3015	ThermoHygro Datalogger	TFA	X 507	2018-08	2021-08
2.8	BAT-EMC	Software	Nexio	V3.20.0.10	---	---

6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas.

6.1 ANTENNA CHASE CBL 6111C (30 MHZ – 1 GHZ)

(d = 10 m)

Frequency	AF Horizontal R&S CBL 6111C	AF Vertikal R&S CBL 6111C	Corr.
30	47.9	38.1	-38.1
50	34.4	26.4	-38.0
100	31.6	32.8	-38.0
150	33.7	33.9	-37.9
200	30.3	32.8	-37.7
250	33.6	36.5	-37.5
300	34.5	36.8	-37.1
350	36.3	37.2	-37.0
400	36.9	38.3	-36.8
450	38.0	39.6	-36.5
500	39.2	40.4	-36.0
550	41.2	42.1	-35.9
600	41.6	41.7	-35.7
650	41.9	42.9	-35.9
700	42.3	43.4	-35.6
750	43.5	43.9	-35.7
800	43.6	44.6	-36.0
850	45.0	45.1	-36.1
900	45.2	45.1	-36.6
950	46.4	46.4	-36.4
1000	45.8	47.0	-36.0

cable loss (antenna - pre-amp)	pre-amp	cable loss (inside chamber)	cable loss (to receiver)
-0,01	-38.3	0.0	0.1
0,28	-38.4	0.3	0.1
0,52	-38.7	0.5	0.2
0,73	-38.8	0.7	0.2
0,95	-38.9	1.0	0.3
1,10	-38.9	1.1	0.3
1,20	-38.6	1.2	0.3
1,29	-38.6	1.3	0.3
1,36	-38.5	1.4	0.3
1,42	-38.2	1.4	0.4
1,48	-37.9	1.5	0.4
1,54	-37.8	1.5	0.4
1,60	-37.7	1.6	0.4
1,64	-38.0	1.6	0.5
1,71	-37.8	1.7	0.5
1,76	-38.0	1.8	0.5
1,80	-38.3	1.8	0.5
1,84	-38.4	1.8	0.5
1,91	-39.0	1.9	0.5
1,93	-38.9	1.9	0.6
1,99	-38.6	2.0	0.6

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.2 ANTENNA ROHDE & SCHWARZ HL 025 (1 GHZ – 18 GHZ)

Frequency	AF R&S HL 025	Corr.	pre-amp	cable loss (to receiver)
MHz	dB (1/m)	dB	dB	dB
1000	33.2	-18.9	-20.92	2.01
2000	39.4	-17.8	-20.60	2.78
3000	42.8	-17.0	-20.44	3.42
4000	45.1	-16.6	-20.58	3.99
5000	46.8	-16.6	-21.08	4.46
6000	48.5	-16.7	-21.53	4.87
7000	50.2	-16.2	-21.53	5.35
8000	50.4	-15.3	-20.97	5.66
9000	51.9	-14.4	-20.44	6.05
10000	53.8	-14.0	-20.43	6.45
11000	54.5	-14.1	-20.84	6.69
12000	55.3	-14.4	-21.41	7.04
13000	55.7	-14.7	-22.09	7.36
14000	56.5	-14.8	-22.48	7.66
15000	56.4	-14.7	-22.56	7.90
16000	57.2	-14.3	-22.49	8.20
17000	57.6	-14.5	-22.90	8.45
18000	57.6	-14.6	-23.27	8.71

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

7 MEASUREMENT UNCERTAINTIES

KDB 935210 D05	ECL
Power measurement	0,68 dB
Measuring AGC threshold level	0,90 dB
Out of band rejection	0,90 dB
Input-versus-output signal comparison	0,91 dB
Mean power output	0,90 dB
Measuring out-of-band/out-of-block (including intermodulation) emissions and spurious emissions	0,90 dB
Out-of-band/out-of-block emissions conducted measurements	0,90 dB
Spurious emissions conducted	2,18 dB
Spurious emissions radiated mesurements	5,38 dB
Total frequency uncertainty	2×10^{-7}

Reference : ECL-MU5.4.6.3-EMC-14-001-V03.00 MU Wireless.xlsx

ANNEX A: ACCREDITATION CERTIFICATE (FOR INFORMATION)

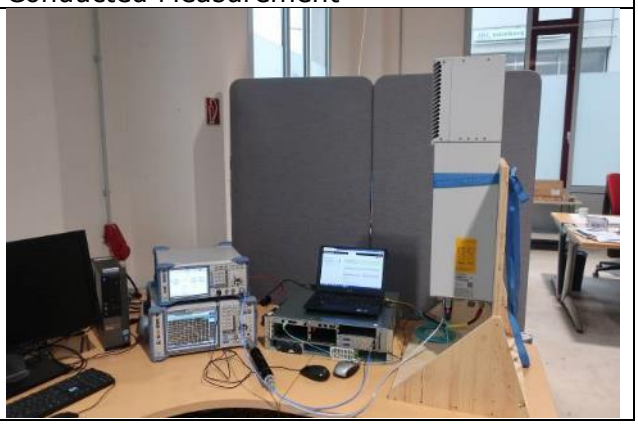
The accreditation relates to competences stated on the accreditation certificate. The current certificate is available on the homepage of the DAkkS and can be downloaded under accredited bodies with the processing number:

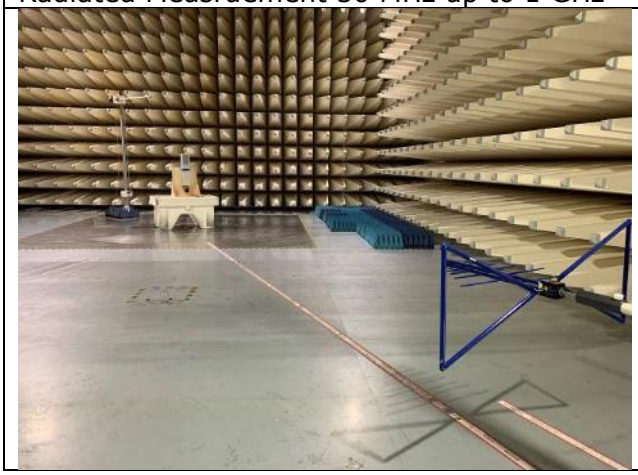
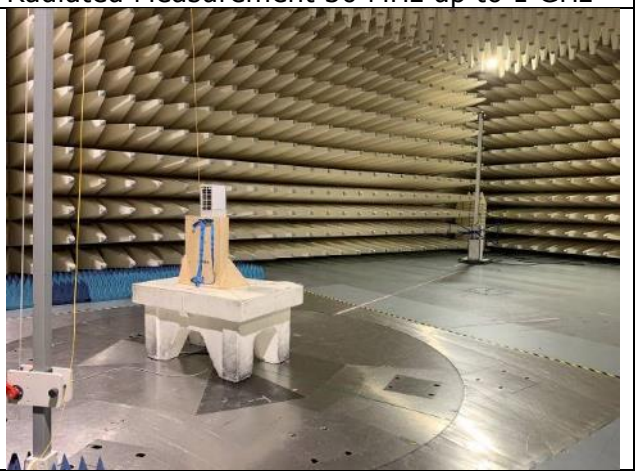
https://www.dakks.de/en

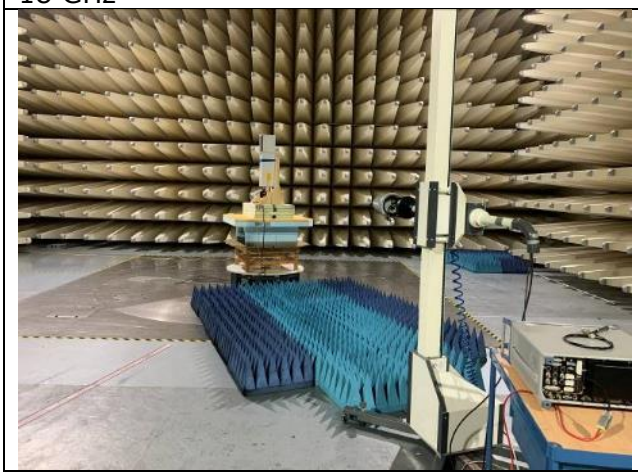
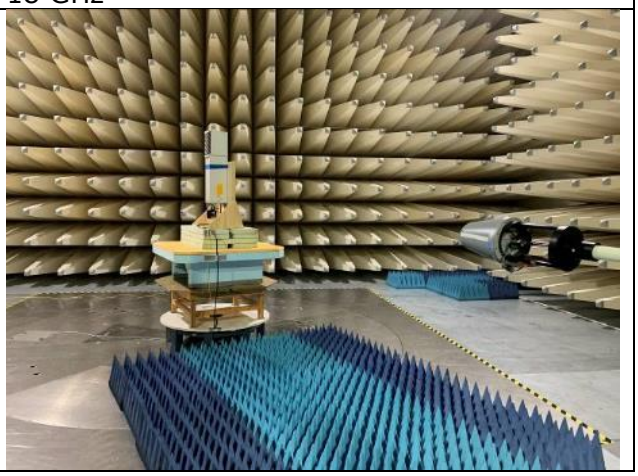
ANNEX B: ADDITIONAL INFORMATION PROVIDED BY CLIENT

None.

ANNEX C: PHOTO REPORT

Conducted Measurement	Conducted Measurement
	

Radiated Measruement 30 MHz up to 1 GHz	Radiated Measurement 30 MHz up to 1 GHz
	

Radiated Measurement over 1 GHz up to 18 GHz	Radiated Measruement over 1 GHz up to 18 GHz
	

****** End of test report *****