ECL-TA Test Report No.: 20-017

Designation:	CAP M 80-85/17E/19/26 F-AC
Manufacturer:	Andrew
Serial No(s):	FICMHA2030001
ID No.	7840984-0001, Rev.: 00
Test Specification(s):	ANSI 63.26:2015 FCC Rules and Regulations as listed in 47 CFR, Part 20:2019-10-01
Test Plan:	Measurement of Band CELL 850 downlink.
Test Result:	**Passed**

Date of issue:	2020-11-12		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: 2020.11.12 11:53:18 +01'00'
Date of delivery:	2020-07		
Performance date:	2020-08-24 – 2020-09-30-	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: 2020.11.12 13:55:54 +01'00'

Deutsche Akkreditierungsstelle
D-PL-12024-06-02

The test results relates only to the tested item. The sample has been provided by the client.
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	Commscope
Client:	Andrew Wireless System GmbH
	Industriering 10
	86675 Buchdorf Germany

Test 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

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 and 20 and 22. 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 22, Subpart H – Cellular Radiotelephone Service

§ 22.905 – Channesl for cellular service
§ 22.913 – Effective radiated power limits
§ 22.917 – Emission limitations for cellular equuipment

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-IC 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 § 22.913 KDB 935210 D05 v01r04: 3.5	RSS-GEN Issue 5, 6.12 RSS-131 Issue 3: 5.2.3 RSS-132 Issue 3, 5.4 SRSP-503, Issue 7, 5.1.1
Peak to Average Ratio	§ 22.913	RSS-132 Issue 3, 5.4
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 § 22.917 KDB 935210 D05 v01r04: 3.6	RSS-GEN Issue 5, 6.13 RSS-132 Issue 3, 5.5
Out-of-band emissions limits	§ 2.1051 § 22.917 KDB 935210 D05 v01r04: 3.6	RSS-GEN Issue 5, 6.13 RSS-132 Issue 3, 5.5
Frequency stability	§ 2.1055 § 22.355	RSS-GEN Issue 5, 6.11 RSS-131 Issue 3: 5.2.4 RSS-132 Issue 3, 5.3
Field strength of spurious radiation	§ 2.1053 § 22.917	RSS-GEN Issue 5, 6.13 RSS-132 Issue 3, 5.5
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

1.3 MEASUREMENT SUMMARY/SIGNATURES

47 CFR CHAPTER I FCC PART 22 Subpart H [Base Stations/Repeater] **§ 2.1046, § 22.913**

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 Frequency Band, Direction, Input Power, Signal Type	**FCC**	**IC**
CELL 850, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
CELL 850, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
CELL 850, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
CELL 850, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC PART 22 Subpart H [Base Stations/Repeater] **§ 22.913**

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

CELL 850, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
CELL 850, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
CELL 850, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
CELL 850, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC PART 22 Subpart H [Base Stations/Repeater] **§ 2.1049**

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 Frequency Band, Direction, Input Power, Signal Type	**FCC**	**IC**
CELL 850, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
CELL 850, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
CELL 850, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
CELL 850, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC PART 22 Subpart H [Base Stations/Repeater] **§ 2.1051, § 22.917**

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**
CELL 850, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
CELL 850, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
CELL 850, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
CELL 850, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC PART 22 Subpart H [Base Stations/Repeater] **§ 2.1051, § 22.917**

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, CELL 850, 1, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
Lower, CELL 850, 1, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
Lower, CELL 850, 1, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
Lower, CELL 850, 1, RF downlink, 3 dB > AGC, Wideband	Passed	Passed
Lower, CELL 850, 2, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
Lower, CELL 850, 2, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
Lower, CELL 850, 2, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
Lower, CELL 850, 2, RF downlink, 3 dB > AGC, Wideband	Passed	Passed
Upper, CELL 850, 1, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
Upper, CELL 850, 1, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
Upper, CELL 850, 1, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
Upper, CELL 850, 1, RF downlink, 3 dB > AGC, Wideband	Passed	Passed
Upper, CELL 850, 2, RF downlink, 0.3 dB < AGC, Narrowband	Passed	Passed
Upper, CELL 850, 2, RF downlink, 0.3 dB < AGC, Wideband	Passed	Passed
Upper, CELL 850, 2, RF downlink, 3 dB > AGC, Narrowband	Passed	Passed
Upper, CELL 850, 2, RF downlink, 3 dB > AGC, Wideband	Passed	Passed

47 CFR CHAPTER I FCC PART 22 Subpart H [Base Stations/Repeater] **KDB 935210 D05 v01r04: 3.3**

Out-of-band rejection

The measurement was performed according to ANSI C63.26; KDB 935210 D05 v01r04: 3.3 **Final Result**

OP-Mode Frequency Band, Direction	**Setup**	**FCC**	**IC**
CELL 850, RF downlink		Passed	Passed

47 CFR CHAPTER I FCC PART 22 Subpart H [Base Stations/Repeater] **§ 2.1053, § 22.917**

Field strength of spurious radiation

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

OP-Mode Frequency Band, Test Frequency, Direction	**FCC**	**IC**
CELL 850, high, RF downlink	Passed	Passed
CELL 850, low, RF downlink	Passed	Passed
CELL 850, mid, RF downlink	Passed	Passed

The test case frequency stability was not performed, since the EUT is not equipped with signal processing capabilities.

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 5/CELL 850 Band 25/PCS 1900 Band 27/CELL 800 Band 66/AWS 1700E (partly) Band IMT 2600 A RF operation is only supported for the downlink.
Booster Type	Industrial Signal Booster
Voltage Type	AC/50 Hz – 60 Hz
Voltage Level	100 V - 240 V
Maximum Output Donor Port [Uplink]	-
Nominal Output Server Port [Downlink]	Band 5/CELL 850: 26 dBm Band 25/PCS 1900: 30 dBm Band 27/CELL 800: 26 dBm Band 66/AWS 2100 (partly): 30 dBm Band IMT 2600: 31 dBm
Nominal Gain [Uplink]	-
Nominal Gain [Downlink]	Band 5/CELL 850: 31 dB Band 25/PCS 1900: 35 dB Band 27/CELL 800:31 dB Band 66/AWS 1700E (partly): 35 dB Band IMT 2600: 36 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-CAPM8171926	2237E-CAPM8171926
Sample Parameter	**Value**	
Serial Number	FICMHA2030001	
HW Version	7840984-0001 Rev.: 00	
SW Version	2.9.0.229	
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	Commscope/General Electric; ION-E PSU Shelf, AC; n. a.	Rack in Conjunction with AUX 2
AUX2	Commsope/General Electric; Power Supply Unit CAR1212FPBC-Z; DF36545	Power Supply
AUX3	Commscope; ION-E WCS-2; SZAEAJ1914A0054	Subrack in Conjunction with AUX 4, 5,6 amd 7
AUX4	Commscope; ION-E OPT; SZBEAD1912A0052	Optical Card
AUX5	Commscope; ION-E SUI; SZBEAC1913A0041	LAN System Interface
AUX6	Commscope; ION-E RFD; SZBEAG1814A0004	RF Card
AUX7	Commscope; ION-E RFD; SZBEAP1912A0087	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	Direction	Lower Frequency Band Edge [MHz]	Upper Frequency Band Edge [MHz]	Center Frequency [MHz]	Port
5 (CELL 850)	Downlink	869.00	894.00	881.50	Donor

3.5.2 AUTOMATIC GAIN CONTROL LEVELS

AGC Levels							
Band	**Direction**	**Signal Type**	**AGC Start Pin [dBm]**	**AGC Start Pin -0.3 dB [dBm]**	**AGC Start Pin +3 dB [dBm]**	**Frequency [MHz]**	**Frequency**
5	Downlink	Narrowband	-2.8	-3.1	0.2	881.50	Mid
5	Downlink	Wideband	-2.8	-3.1	0.2	881.50	
5	Downlink	Narrowband	-3.0	-3.3	0.0	869.20	Low
5	Downlink	Wideband	-2.6	-2.9	0.4	891.50	
5	Downlink	Narrowband	-3.8	-4.1	-0.8	893.80	High
5	Downlink	Wideband	-3.2	-3.5	-0.2	891.50	
5	Downlink	Narrowband	-3.8	-4.1	-0.8	893.80	Max.Power
5	Downlink	Wideband	-3.2	-3.5	-0.2	891.50	

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

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

Standard FCC Part 22, § 22.913

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

Test date: 2020-09-16

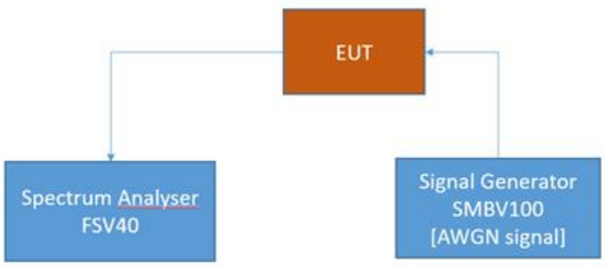
Environmental conditions: 24 ° C; 45% r. F.

Test engineer: Thomas Hufnagel

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 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 22; Public Mobile Services

Subpart H – Cellular Radiotelephone Service

§ 22.913

Abstract § 22.913 from FCC:

(a) *Maximum ERP.* The ERP of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.

(1) Except as described in paragraphs (a)(2), (3), and (4) of this section, the ERP of base stations and repeaters must not exceed—

(i) 500 watts per emission; or

(ii) 400 watts/MHz (PSD) per sector.

(2) Except as described in paragraphs (a)(3) and (4) of this section, for systems operating in areas more than 72 kilometers (45 miles) from international borders that:

(i) Are located in counties with population densities of 100 persons or fewer per square mile, based upon the most recently available population statistics from the Bureau of the Census; or

(ii) Extend coverage into Unserved Area on a secondary basis (*see* § 22.949), the ERP of base transmitters and repeaters must not exceed—

(A) 1000 watts per emission; or

(B) 800 watts/MHz (PSD) per sector.

(3) Provided that they also comply with paragraphs (b) and (c) of this section, licensees are permitted to operate their base transmitters and repeaters with an ERP greater than 400 watts/MHz (PSD) per sector, up to a maximum ERP of 1000 watts/MHz (PSD) per sector unless they meet the conditions in paragraph (a)(4) of this section.

(4) Provided that they also comply with paragraphs (b) and (c) of this section, licensees of systems operating in areas more than 72 kilometers (45 miles) from international borders that:

(i) Are located in counties with population densities of 100 persons or fewer per square mile, based upon the most recently available population statistics from the Bureau of the Census; or

(ii) Extend coverage into Unserved Area on a secondary basis (*see* § 22.949), are permitted to operate base transmitters and repeaters with an ERP greater than 800 watts/MHz (PSD) per sector, up to a maximum of 2000 watts/MHz (PSD) per sector.

Abstract RSS-132 from ISED:

RSS-132; 5.4 Transmitter Output Power and Equivalent Isotropically Radiated Power

The transmitter output power shall be measured in terms of average power. The equivalent isotropically radiated power (e.i.r.p.) for mobile equipment shall not exceed 11.5 watts. Refer to SRSP-503 for base station e.i.r.p. limits.

Abstract SRSP-503 from ISED:

SRSP-503; 5.1.1 Transmitter Output Power and Equivalent Isotropically Radiated Power

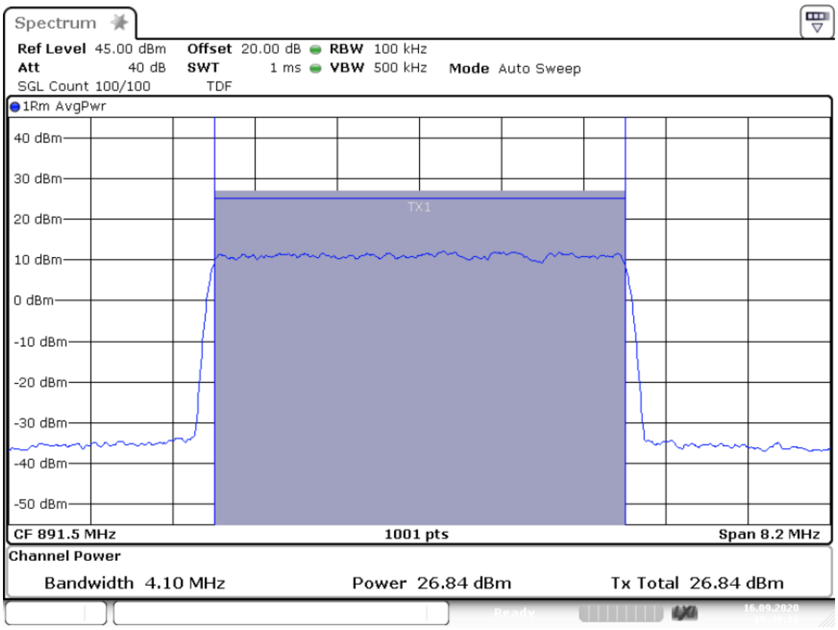
The transmitter output power shall be measured in terms of average power. The equivalent isotropically radiated power (e.i.r.p.) for mobile equipment shall not exceed 11.5 watts. Refer to SRSP-503 for base station e.i.r.p. limits.

4.1.3 TEST PROTOCOL

Band 5 CELL 850, 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	891.50	-3.5	26.8	60.0	33.2	30.3
Wideband	3 dB > AGC	891.50	-0.2	27.2	60.0	32.9	27.0
Narrowband	0.3 dB < AGC	893.80	-4.1	26.7	60.0	33.3	30.8
Narrowband	3 dB > AGC	893.80	0.8	26.5	60.0	33.5	25.7

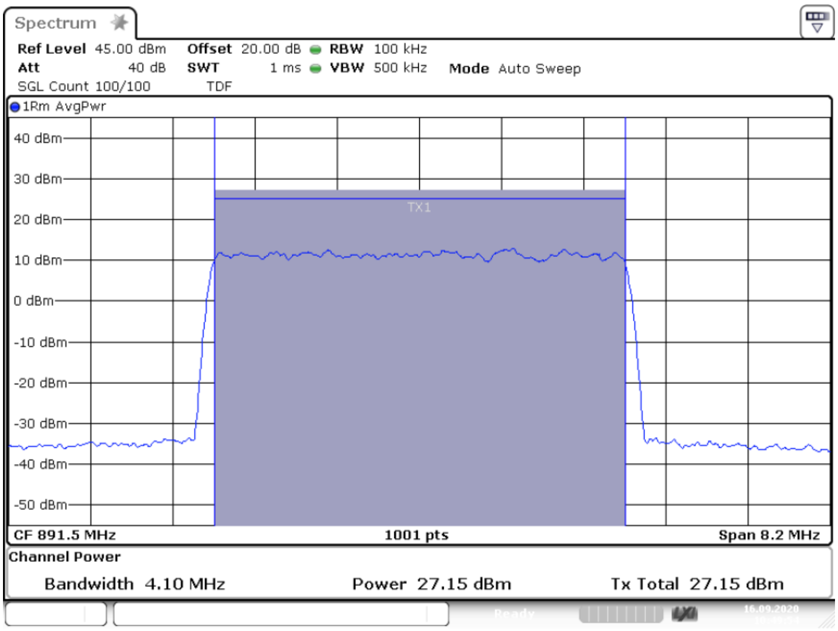
4.1.4 MEASUREMENT PLOT

Band: CELL850; Frequency: 1.9700 GHz; Band Edge: f0; Mod: AWGN; Output Power 0.3 dB < AGC



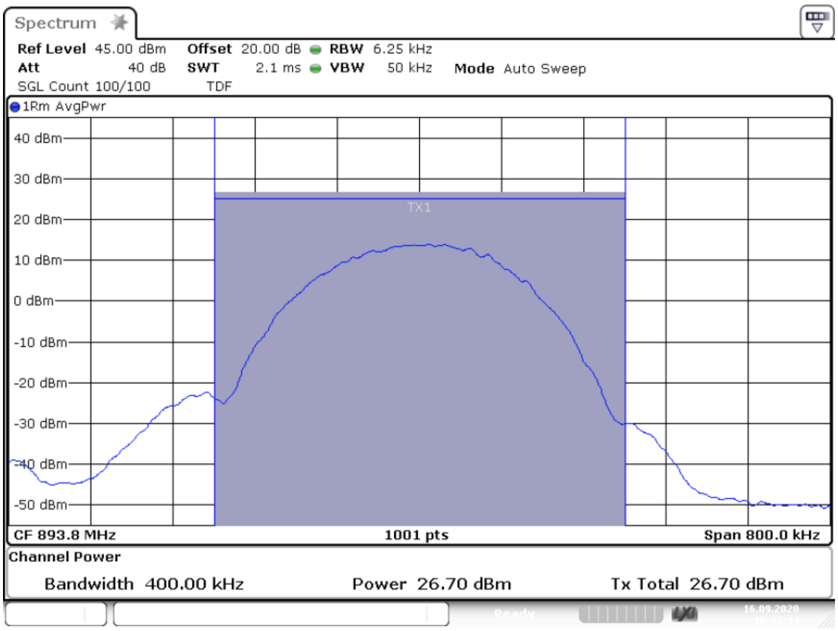
3.5.3 Power AWGN Out -0.3 891.50000M

Band: CELL850; Frequency: 1.9700 GHz; Band Edge: f0; Mod: AWGN; Output Power 3 dB > AGC



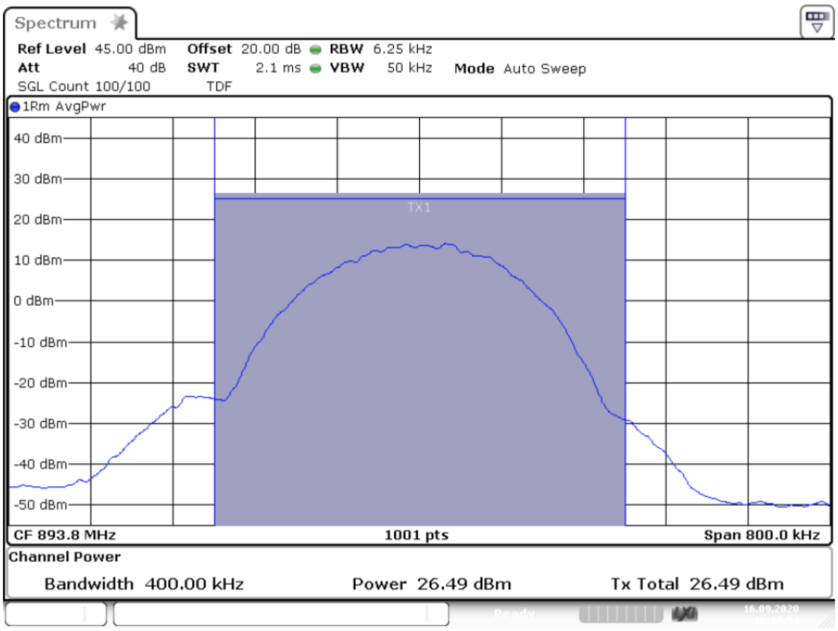
3.5.3 Power AWGN Out +3 891.50000M

Band: CELL850; Frequency: 893.8000 GHz; Band Edge: f0; Mod: GSM; Output Power 0.3 dB < AGC



3.5.3 Power GSM Out -0.3 893.80000M

Band: CELL850; Frequency: 893.8000; Band Edge: f0; Mod: GSM; Output Power 3 dB > AGC



3.5.3 Power GSM Out +3 893.80000M

4.1.5 TEST EQUIPMENT USED

- Conducted

4.2 PEAK TO AVERAGE RATIO

Standard FCC Part 22, § 22.913

The test was performed according to:
ANSI C63.26

Test date: .2020-09-16

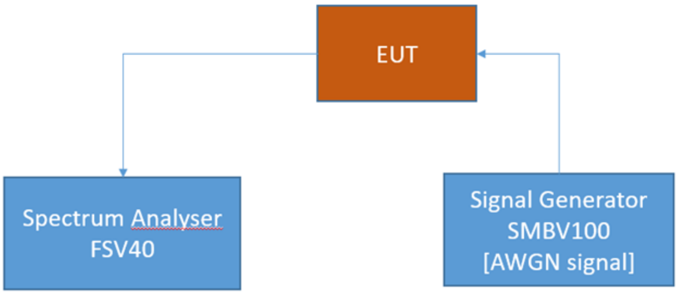
Environmental conditions: 24 ° C; 45% r. F.

Test engineer: Thomas Hufnagel

4.2.1 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 § 27.50 and RSS-199 with subpart 4.4.

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.

4.2.2 TEST REQUIREMENTS/LIMITS

Part 22; Public Mobile Services

Subpart H – Cellular Radiotelephone Service

§ 22.913

Abstract § 22.913 from FCC:

(d) *Power measurement.* Measurement of the ERP of Cellular base transmitters and repeaters must be made using an average power measurement technique. The peak-to-average ratio (PAR) of the transmission must not exceed 13 dB.

Abstract RSS-132 from ISED:

RSS-132; 5.4 Transmitter Output Power and Equivalent Isotropically Radiated Power

In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.

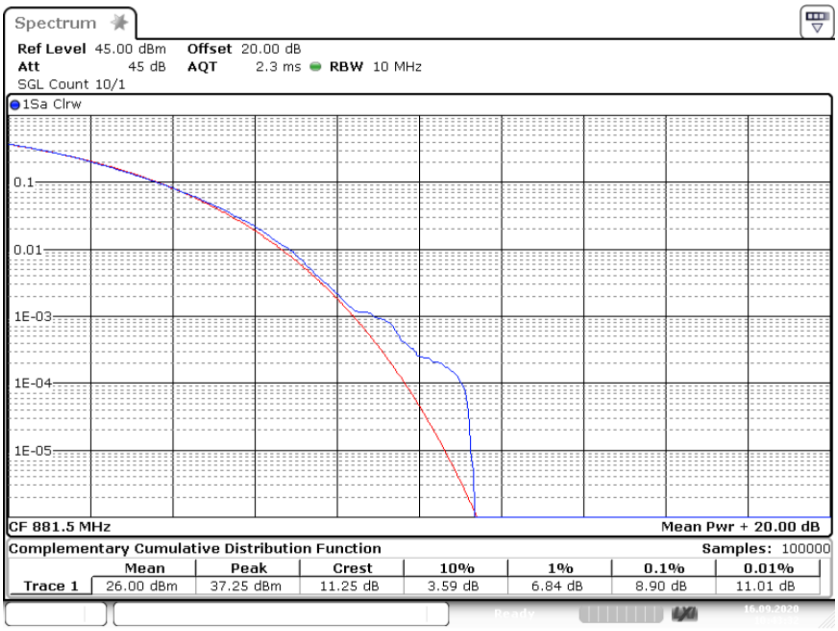
4.2.3 TEST PROTOCOL

Band 5 CELL 850, downlink						
Signal Type	**Input Power**	**Frequency [MHz]**	**Input Power [dBm]**	**PAPR [dB]**	**Fictive Limit PAPR [dB]**	**Margin to Limit [dB]**
Wideband	0.3 dB < AGC	891.50	-3.1	8.9	13.0	4.1
Wideband	3 dB > AGC	891.50	0.2	9.0	13.0	4.0
Narrowband	0.3 dB < AGC	893.80	-4.1	0.4	13.0	12.6
Narrowband	3 dB > AGC	893.80	0.8	0.3	13.0	12.7

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

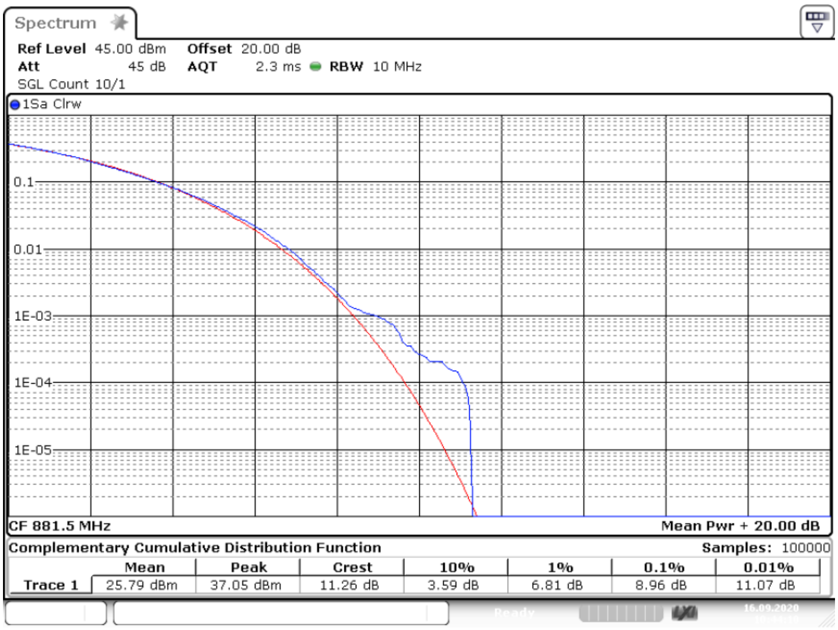
4.2.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, “WORST CASE”)

Band: CELL850; Frequency: 881.5000 MHz; Band Edge: mid; Mod: AWGN; PAPR 0.3 dB < AGC



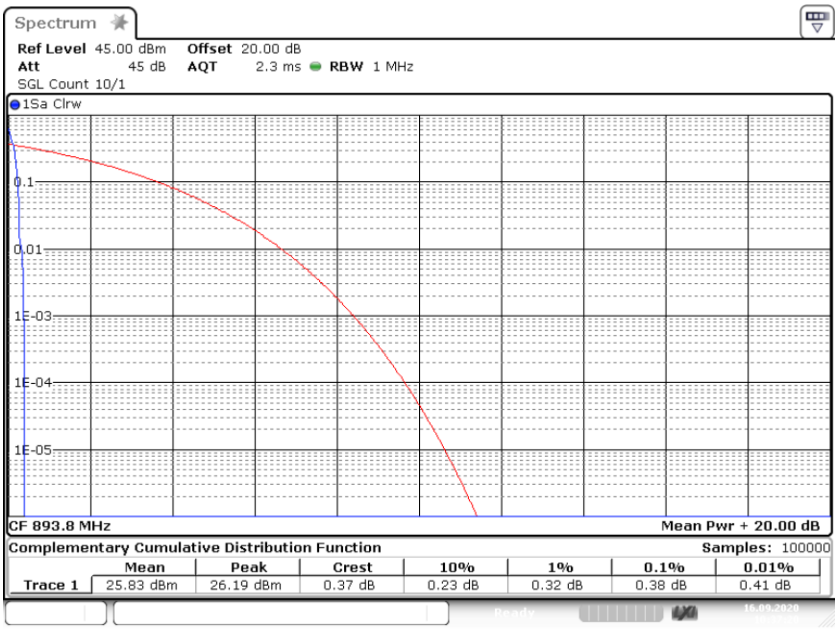
4.0 PAPR AWGN Out -0.3 881.500M

Band: CELL850; Frequency: 881.5000 MHz; Band Edge: mid; Mod: AWGN; PAPR 3 dB > AGC



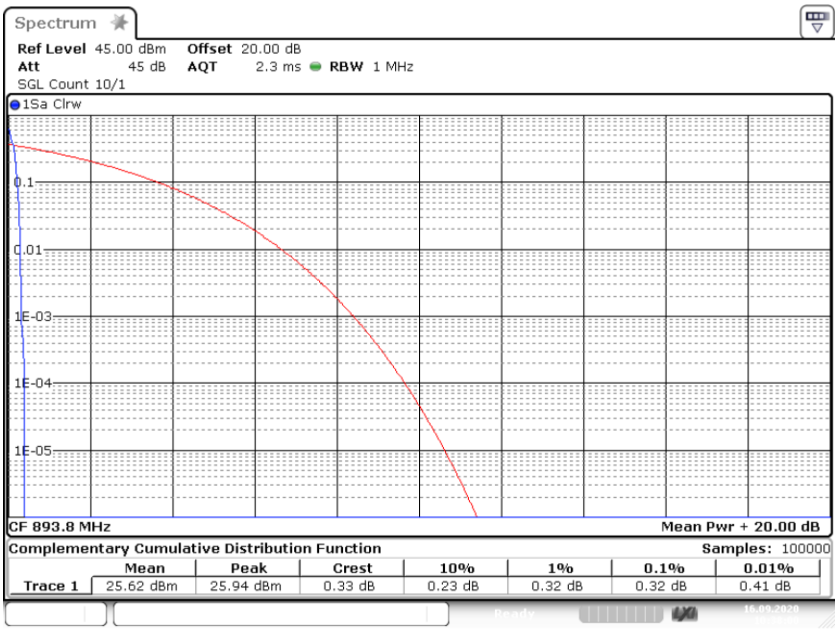
4.0 PAPR AWGN Out +3 881.500M

Band: CELL850; Frequency: 893.8000 GHz; Band Edge: f0; Mod: GSM; PAPR 0.3 dB < AGC



4.0 PAPR GSM Out -0.3 893.800M

Band: CELL850; Frequency: 893.8000 GHz; Band Edge: f0; Mod: GSM; PAPR 3 dB > AGC



4.0 PAPR GSM Out +3 893.800M

4.2.5 TEST EQUIPMENT USED

- Conducted

4.3 OCCUPIED BANDWIDTH/INPUT-VERSUS-OUTPUT SPECTRUM

Standard FCC Part 2.1049; Occupied Bandwidth

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

Test date: .2020-09-16

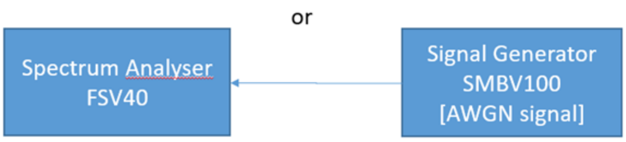
Environmental conditions: 24 ° C; 45% r. F.

Test engineer: Thomas Hufnagel

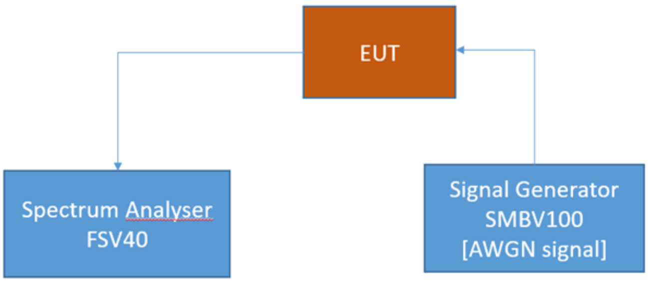
4.3.1 TEST DESCRIPTION

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.

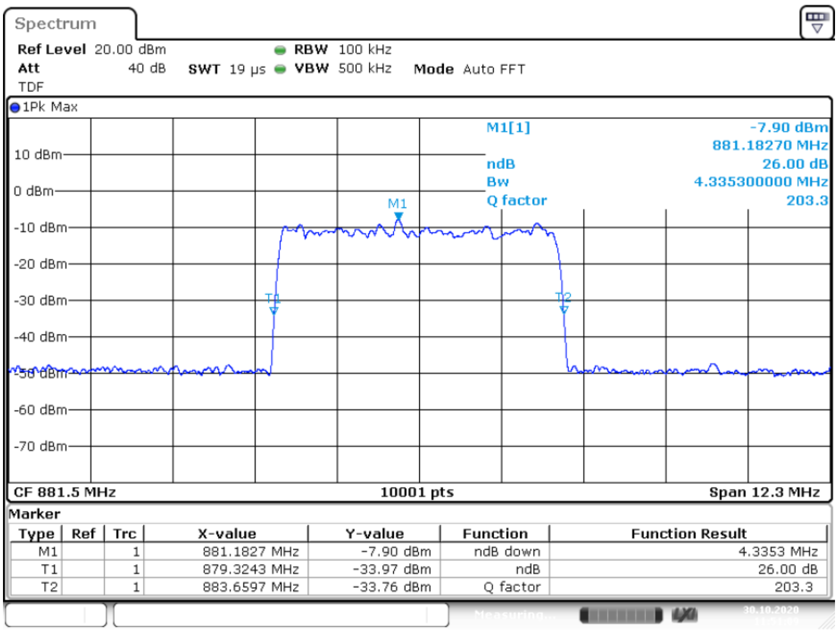
4.3.3 TEST PROTOCOL

Band 5 CELL 850, 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	881.50	4335.3	4334.1	1.2	205.0	203.8
Wideband	3 dB > AGC	881.50	4334.1	4334.1	0.0	205.0	205.0
Narrowband	0.3 dB < AGC	881.50	320.3	320.3	0.0	10.0	10.0
Narrowband	3 dB > AGC	881.50	319.9	319.8	0.1	10.0	9.9

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

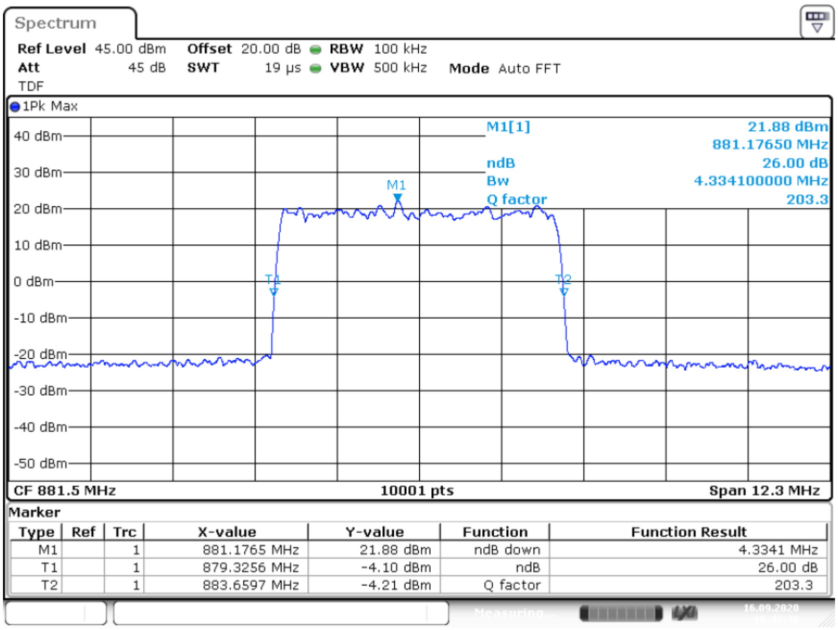
4.3.4 MEASUREMENT PLOT

Band: CELL850; Frequency: 881.5000 MHz; Band Edge: mid; Mod: AWGN; OCBw; 0.3 dB < AGC



3.4 OCBw AWGN In -0.3 881.5000M _26dB

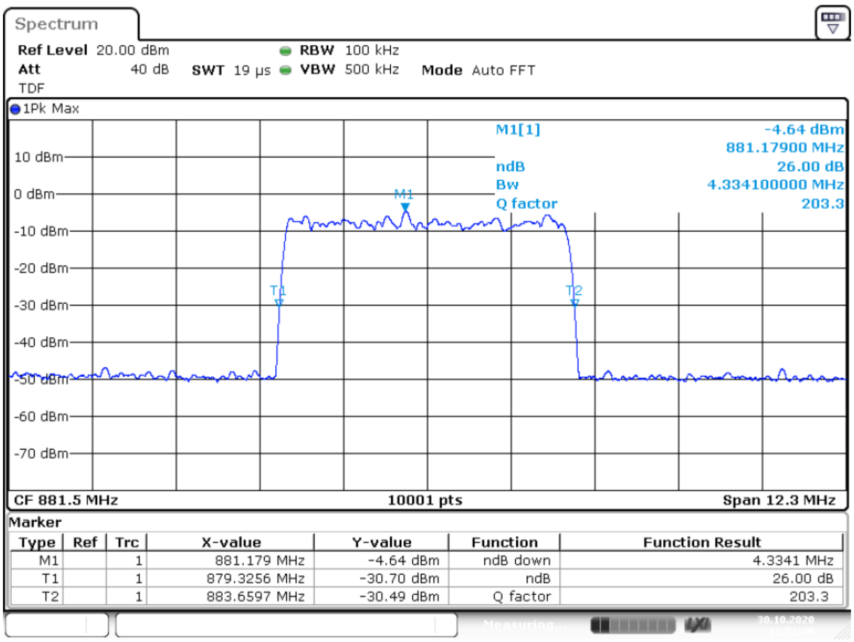
Input Signal



3.4 OCBw AWGN Out -0.3 881.5000M _26dB

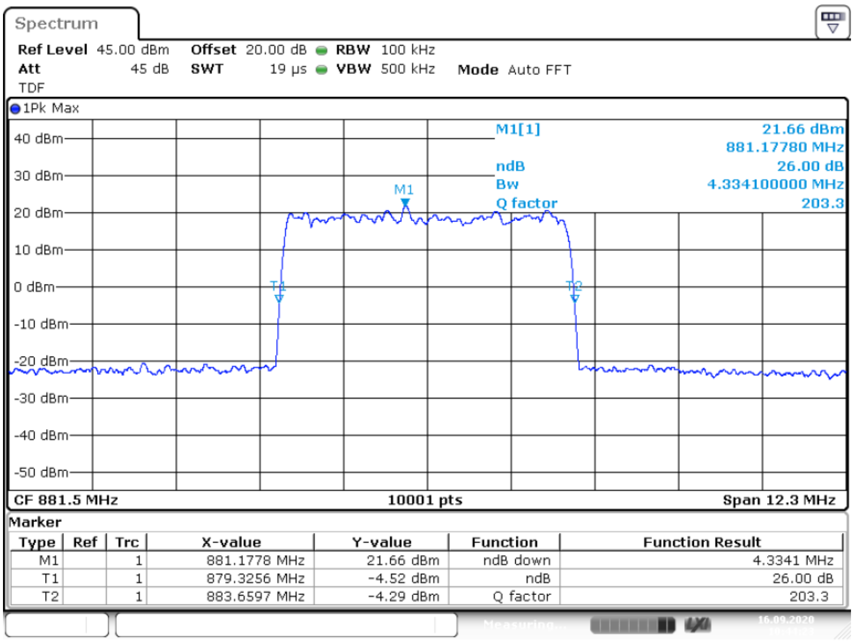
Output Signal

Band: CELL850; Frequency: 881.5000 MHz; Band Edge: mid; Mod: AWGN; OCBw; 3 dB > AGC



3.4 OCBw AWGN In +3 881.5000M _26dB

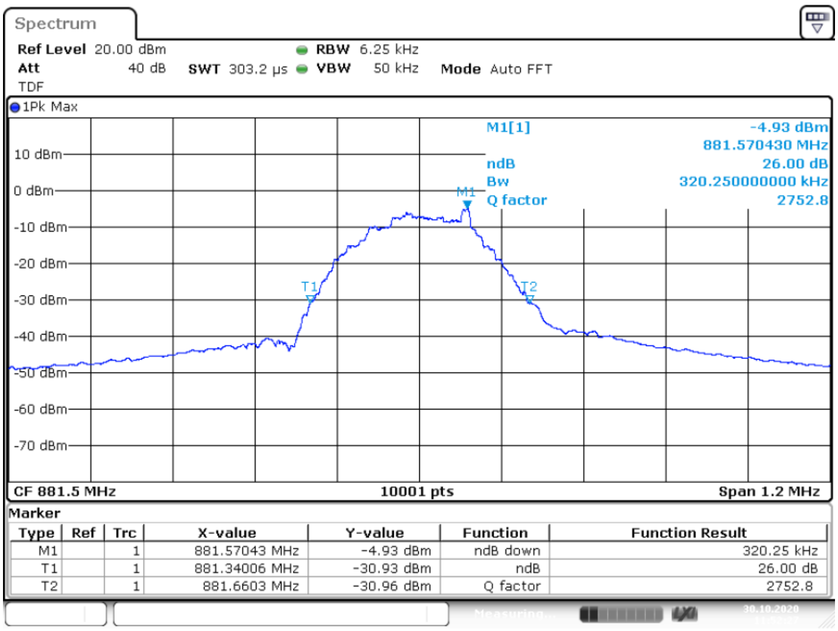
Input Signal



3.4 OCBw AWGN Out +3 881.5000M _26dB

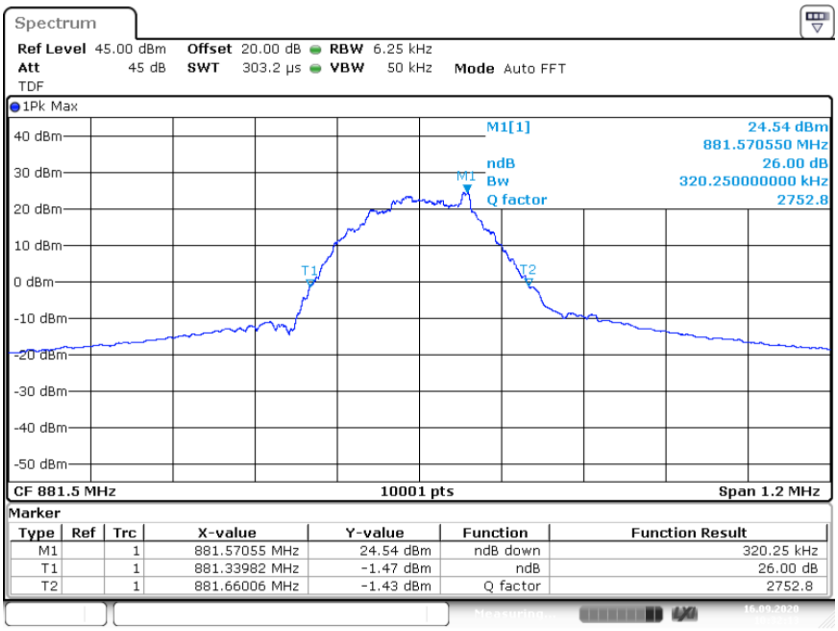
Output Signal

Band: CELL850; Frequency: 881.5000 MHz; Band Edge: mid; Mod: GSM; OCBw; 0.3 dB < AGC



3.4 OCBw GSM In -0.3 881.5000M _26dB

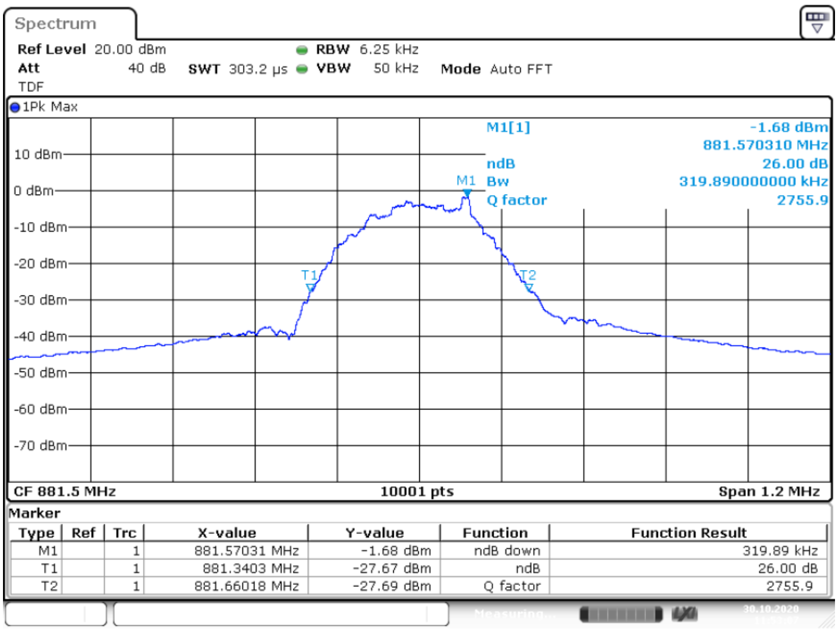
Input Signal



3.4 OCBw GSM Out -0.3 881.5000M _26dB

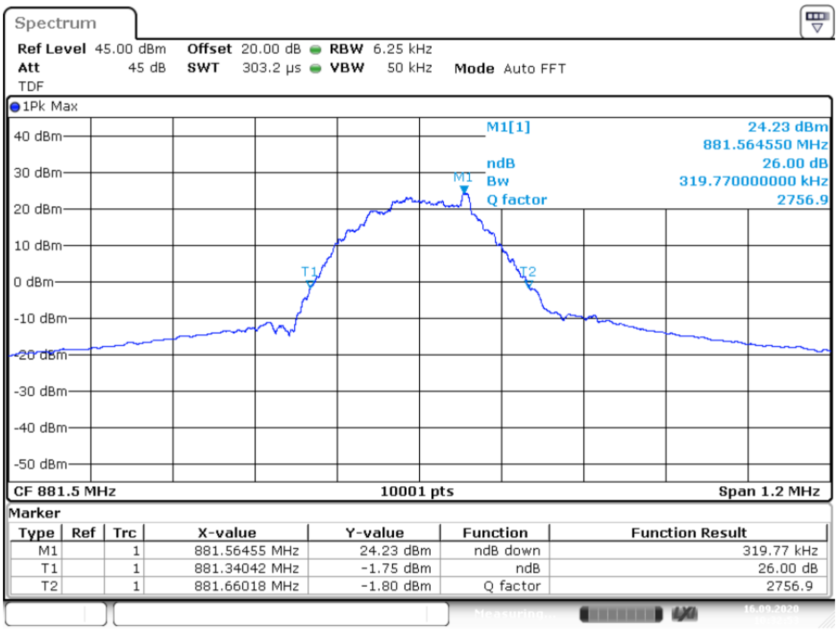
Output Signal

Band: CELL850; Frequency: 881.5000 MHz; Band Edge: mid; Mod: GSM; OCBw; 3 dB > AGC



3.4 OCBw GSM In +3 881.5000M _26dB

Input Signal



3.4 OCBw GSM Out +3 881.5000M _26dB

Output Signal

4.3.5 TEST EQUIPMENT USED

- Conducted

4.4 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Standard FCC Part § 2.1051, § 22.917

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

Test date: 2020-09-17

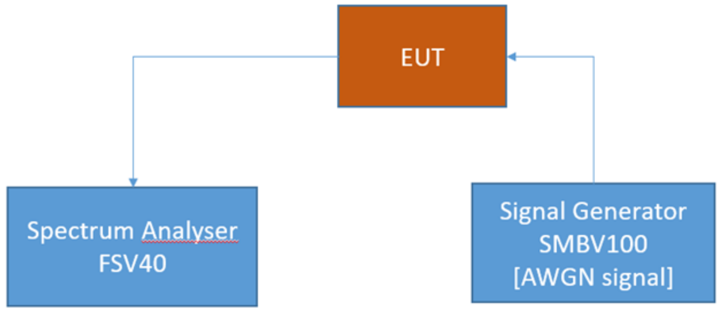
Environmental conditions: 24 ° C; 43% r. F.

Test engineer: Thomas Hufnagel

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 § 27.53, RSS-GEN with subpart 6.13 and RSS-130 with subpart 4.7.

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 § 22.917 FCC:

Part 22, Subpart H – Cellular Radiotelephone Service; Band 5

§ 22.917 Emission limitations for cellular equipment.

The rules in this section govern the spectral characteristics of emissions in the Cellular Radiotelephone Service.

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

Abstract RSS-132 from ISED:

RSS-132; 5.5 Transmitter Unwanted Emissions

Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

(i) In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied 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 immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz 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 occupied bandwidth, power integration over 100 kHz is required.

4.4.3 TEST PROTOCOL

Band CELL 850, downlink							
Test Frequency	**Signal Type**	**Spurious Freq. [MHz]**	**Spurious Level [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
low	Wideband	0.0117238	-60.8	RMS	1	-33	27.8
low	Wideband	0.1574821	-54.2	RMS	10	-23	31.2
low	Wideband	124.8649	-45.6	RMS	100	-13	32.6
low	Wideband	707.7462	-44.6	RMS	100	-13	31.6
low	Wideband	868.6826	-43.2	RMS	10	-23	20.2
low	Wideband	894.1125	-55.8	RMS	10	-23	32.8
low	Wideband	958.4464	-43.5	RMS	100	-13	30.5
low	Wideband	2648.7	-30.3	RMS	1000	-13	17.3
mid	Wideband	0.0101673	-60.5	RMS	1	-33	27.5
mid	Wideband	0.1274871	-54.9	RMS	10	-23	31.9
mid	Wideband	120.9153	-46.0	RMS	100	-13	33.0
mid	Wideband	707.4462	-44.1	RMS	100	-13	31.1
mid	Wideband	861.2718	-56.7	RMS	10	-23	33.7
mid	Wideband	899.0298	-56.9	RMS	10	-23	33.9
mid	Wideband	938.3068	-43.2	RMS	100	-13	30.2
mid	Wideband	2638.7	-30.1	RMS	1000	-13	17.1
high	Wideband	0.0109865	-60.9	RMS	1	-33	27.9
high	Wideband	0.0624979	-52.7	RMS	10	-23	29.7
high	Wideband	120.8153	-45.6	RMS	100	-13	32.6
high	Wideband	710.7957	-44.5	RMS	100	-13	31.5
high	Wideband	864.8897	-56.5	RMS	10	-23	33.5
high	Wideband	894.2374	-45.1	RMS	10	-23	22.1
high	Wideband	936.3578	-43.6	RMS	100	-13	30.6
high	Wideband	2645.7	-29.7	RMS	1000	-13	16.7

Band CELL 850, downlink

Test Frequency	Signal Type	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
low	Narrowband	0.0090205	-60.4	RMS	1	-33	27.4
low	Narrowband	0.1124896	-54.3	RMS	10	-23	31.3
low	Narrowband	119.2155	-45.9	RMS	100	-13	32.9
low	Narrowband	814.8813	-44.2	RMS	100	-13	31.2
low	Narrowband	868.8975	-50.5	RMS	10	-23	27.5
low	Narrowband	894.1125	-56.6	RMS	10	-23	33.6
low	Narrowband	957.0472	-42.4	RMS	100	-13	29.4
low	Narrowband	2631.2	-30.6	RMS	1000	-13	17.6
mid	Narrowband	0.0090205	-59.9	RMS	1	-33	26.9
mid	Narrowband	0.0524996	-54.5	RMS	10	-23	31.5
mid	Narrowband	124.2650	-45.3	RMS	100	-13	32.3
mid	Narrowband	814.9313	-44.1	RMS	100	-13	31.1
mid	Narrowband	860.5422	-56.3	RMS	10	-23	33.3
mid	Narrowband	894.9121	-56.3	RMS	10	-23	33.3
mid	Narrowband	938.4067	-42.6	RMS	100	-13	29.6
mid	Narrowband	2647.7	-30.2	RMS	1000	-13	17.2
high	Narrowband	0.0090205	-59.3	RMS	1	-33	26.3
high	Narrowband	0.0724962	-54.0	RMS	10	-23	31.0
high	Narrowband	120.2154	-45.4	RMS	100	-13	32.4
high	Narrowband	813.2815	-44.3	RMS	100	-13	31.3
high	Narrowband	863.9953	-57.0	RMS	10	-23	34.0
high	Narrowband	894.1325	-51.1	RMS	10	-23	28.1
high	Narrowband	937.1574	-43.8	RMS	100	-13	30.8
high	Narrowband	2627.7	-30.0	RMS	1000	-13	17.0

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

General cosiderations 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.

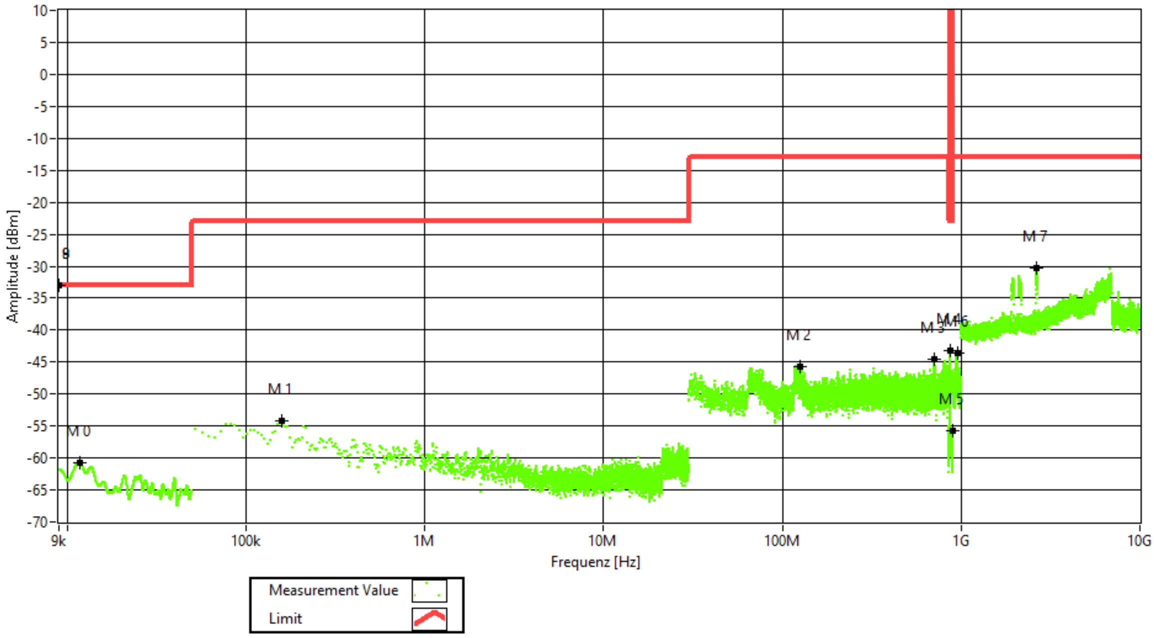
At frequencies were measuring bandwidths were reduced also the border lines were reduced acoording the given formula:

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

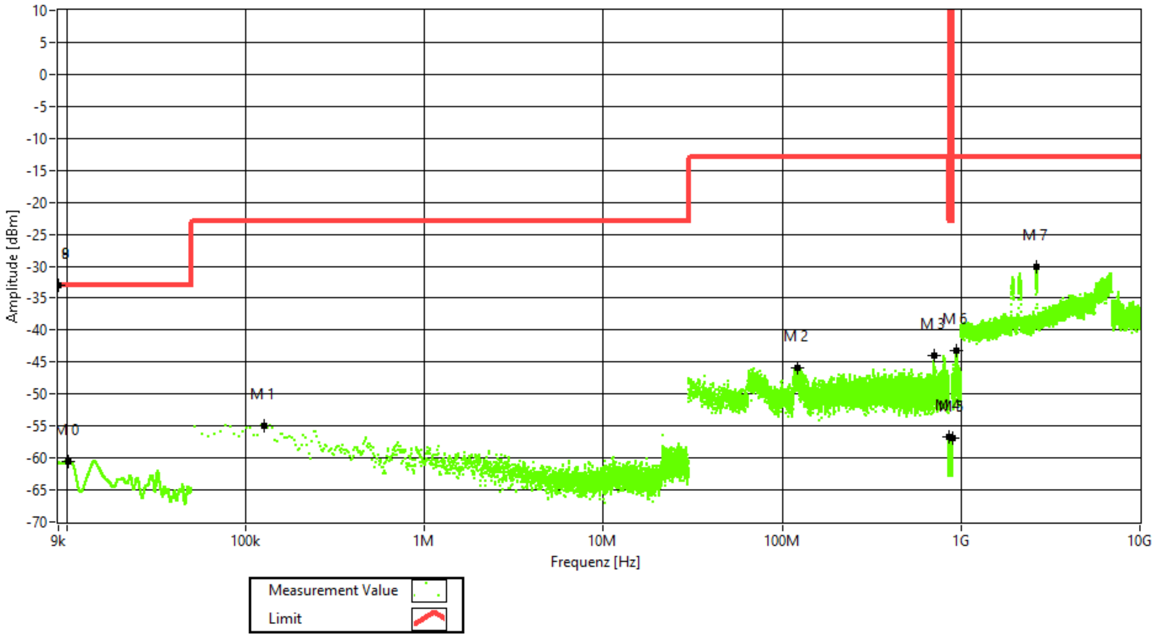
Hereby “p” are the border lines’ values.

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

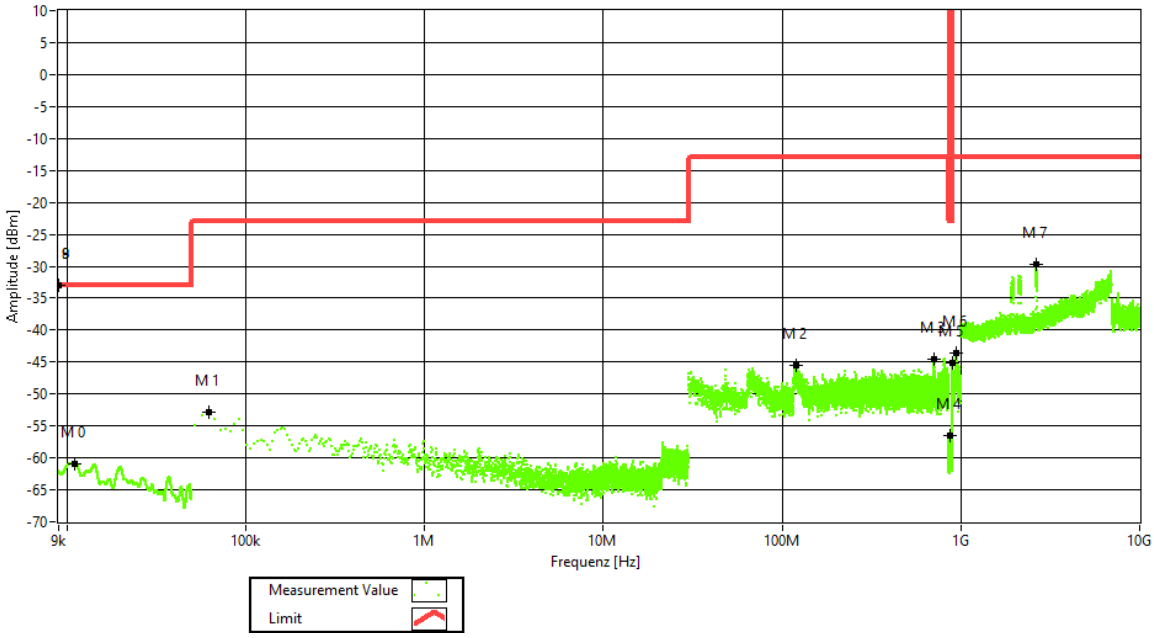
Frequency Band = CELL 850, Test Frequency = low, Direction = RF downlink, Signal Type = AWGN



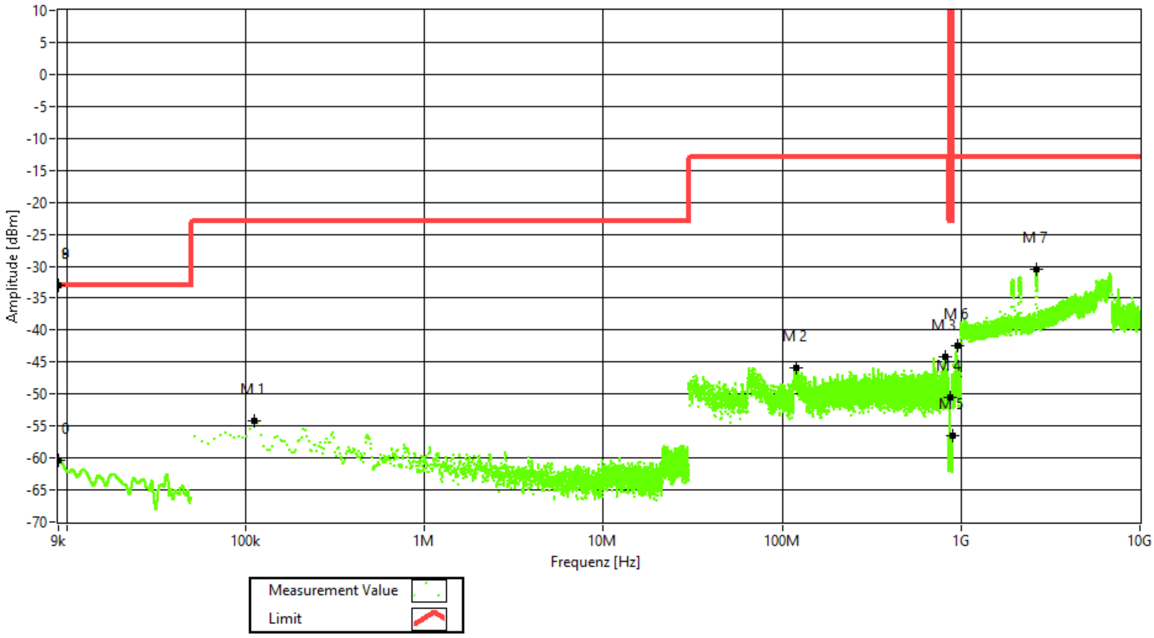
Frequency Band = CELL 850, Test Frequency = mid, Direction = RF downlink, Signal Type = AWGN



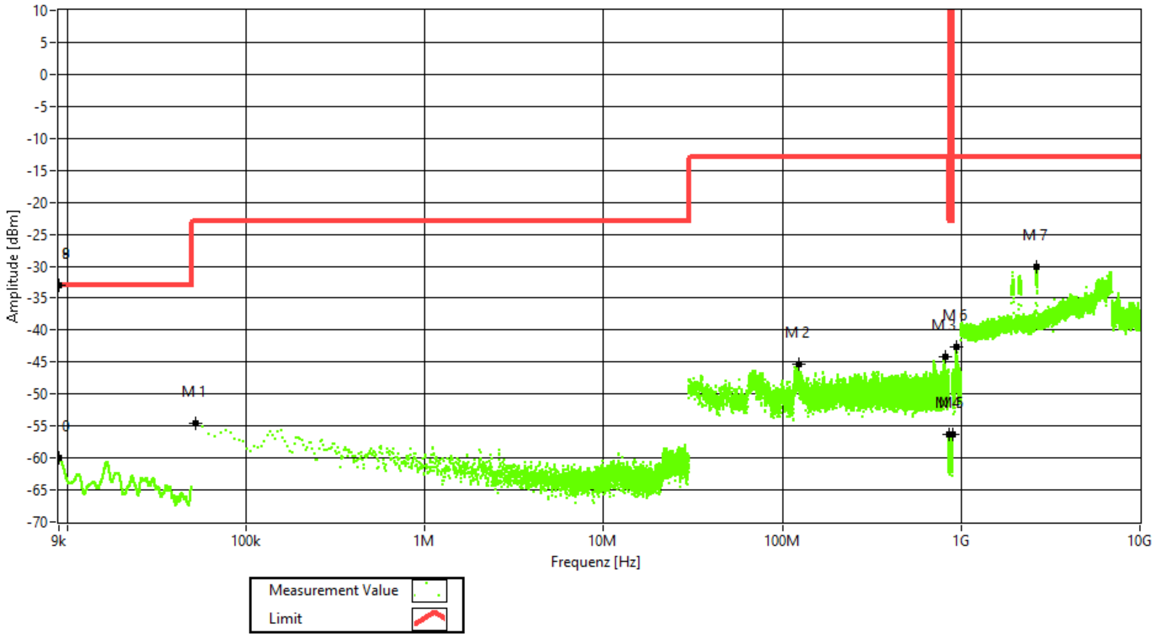
Frequency Band = CELL 850, Test Frequency = high, Direction = RF downlink, Signal Type = AWGN



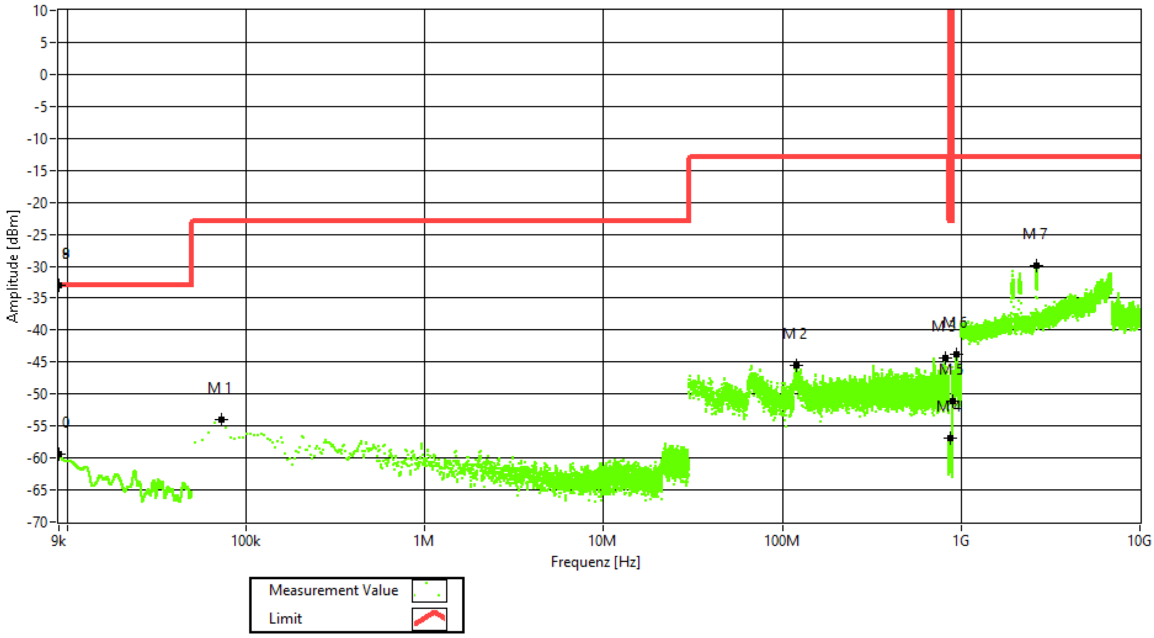
Frequency Band = CELL 850, Test Frequency = low, Direction = RF downlink, Signal Type = GSM



Frequency Band = CELL 850, Test Frequency = mid, Direction = RF downlink, Signal Type = GSM



Frequency Band = CELL 850, 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, § 22.917

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

Test date: .2020-09-16

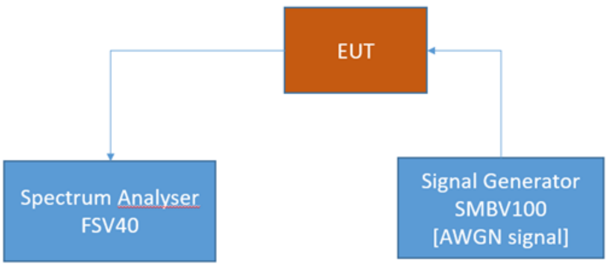
Environmental conditions: 24 ° C; 45% r. F.

Test engineer: Thomas Hufnagel

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, FCC § 27.53, RSS-GEN with subpart 6.13 and RSS-130 with subpart 4.7.

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 § 22.917 FCC:

Part 22, Subpart H – Cellular Radiotelephone Service; Band 5

§ 22.917 Emission limitations for cellular equipment.

The rules in this section govern the spectral characteristics of emissions in the Cellular Radiotelephone Service.

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

Abstract RSS-132 from ISED:

RSS-132; 5.5 Transmitter Unwanted Emissions

Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

(i) In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied 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 immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz 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 occupied bandwidth, power integration over 100 kHz is required.

4.5.3 -31,TEST PROTOCOL

Band 27, 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	891.50	-3.5	-35.0	-13.0	22.0
Wideband	3 dB > AGC	upper	891.50	-0.2	-35.0	-13.0	22.0
Narrowband	-0.3 dB < AGC	upper	893.80	-4.1	-34.2	-13.0	21.2
Narrowband	3 dB > AGC	upper	893.80	-0.8	-34.1	-13.0	21.1
Wideband	-0.3 dB < AGC	lower	891.50	-3.5	-34.6	-13.0	21.6
Wideband	3 dB > AGC	lower	891.50	-0.2	-34.6	-13.0	21.6
Narrowband	-0.3 dB < AGC	lower	869.20	-3.3	-34.9	-13.0	21.9
Narrowband	3 dB > AGC	lower	869.20	0.0	-34.5	-13.0	21.5

Band 27, 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	891.50	889.00	-3.5	-35.4	-13.0	22.4
WB	3 dB > AGC	upper	891.50	889.00	-0.2	-35.9	-13.0	22.9
NB	-0.3 dB < AGC	upper	893.80	893.60	-4.1	-34.9	-13.0	21.9
NB	3 dB > AGC	upper	893.80	893.60	-0.8	-34.2	-13.0	21.2
WB	-0.3 dB < AGC	lower	891.50	894.00	-3.5	-35.6	-13.0	22.6
WB	3 dB > AGC	lower	891.50	894.00	-0.2	-35.7	-13.0	22.7
NB	-0.3 dB < AGC	lower	869.20	869.40	-3.3	-37.0	-13.0	24.0
NB	3 dB > AGC	lower	869.20	869.40	0.0	-36.3	-13.0	23.3

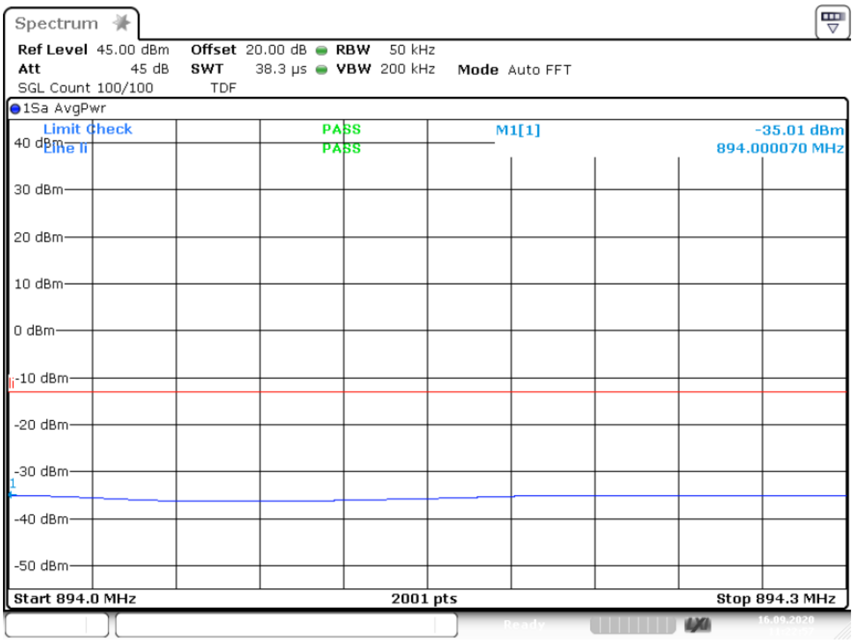
Remark: Please see next sub-clause for the measurement plot.

Explanations concering table with two input signals:

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

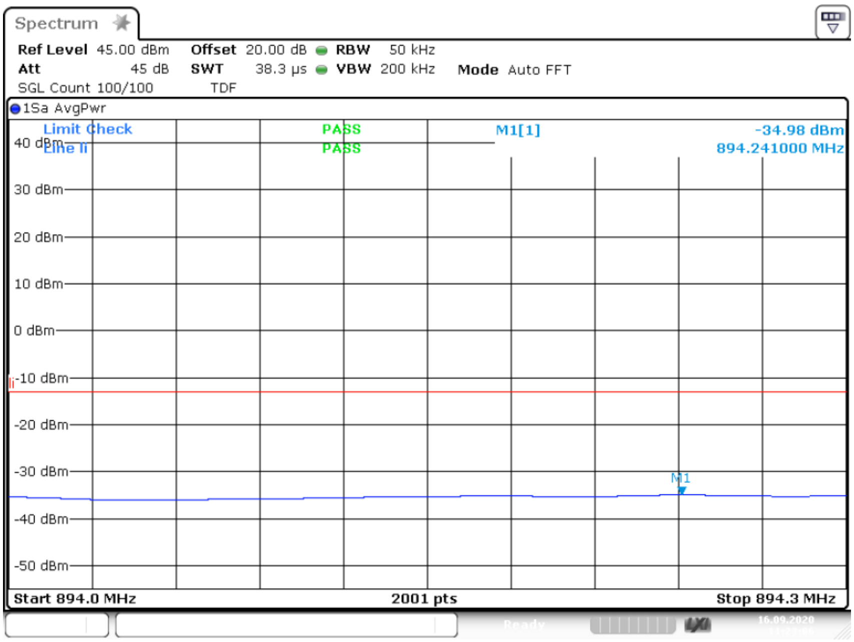
4.5.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



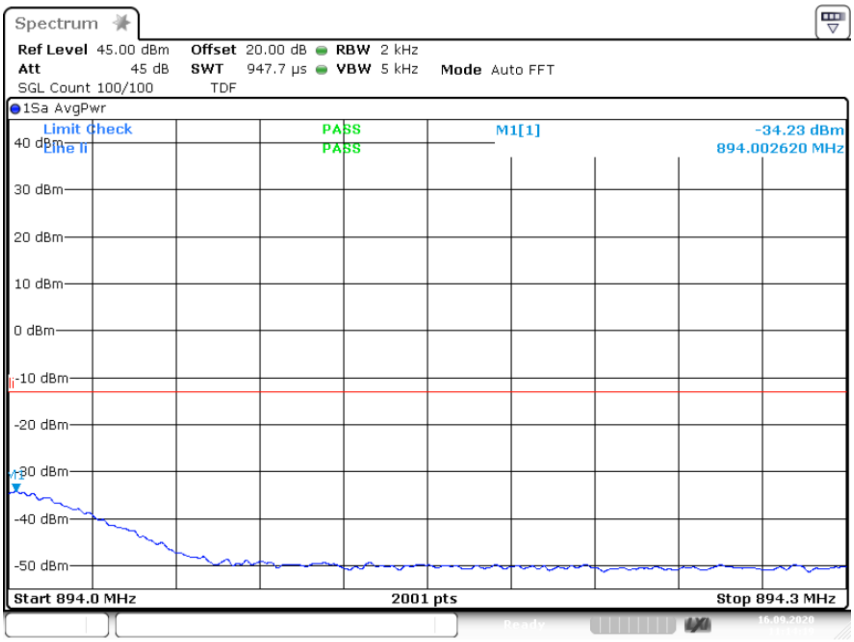
3.6.2 out of band emi CELL850 AWGN upper 1carrier -0.3 dB 89
4.000M 894.300M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



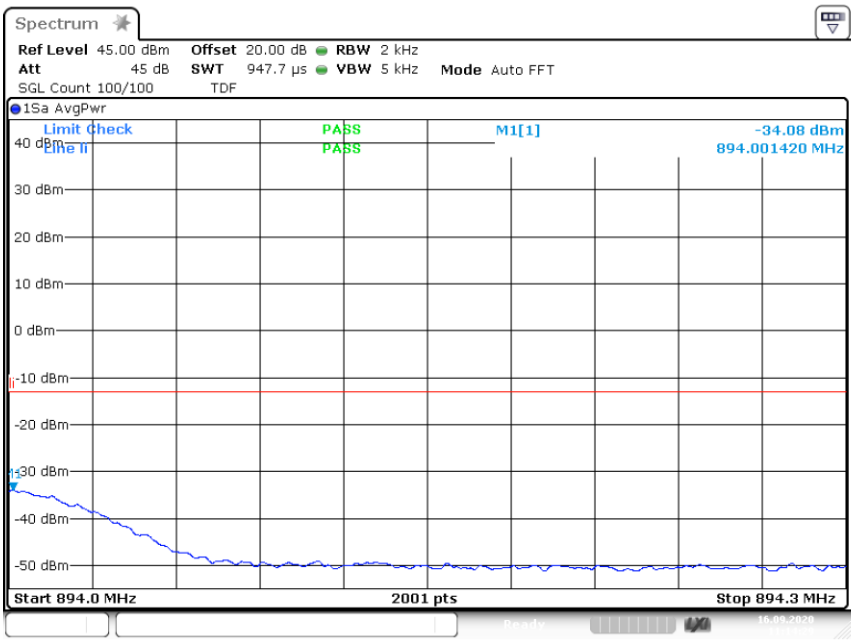
3.6.2 out of band emi CELL850 AWGN upper 1carrier +3.0 dB 89
4.000M 894.300M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



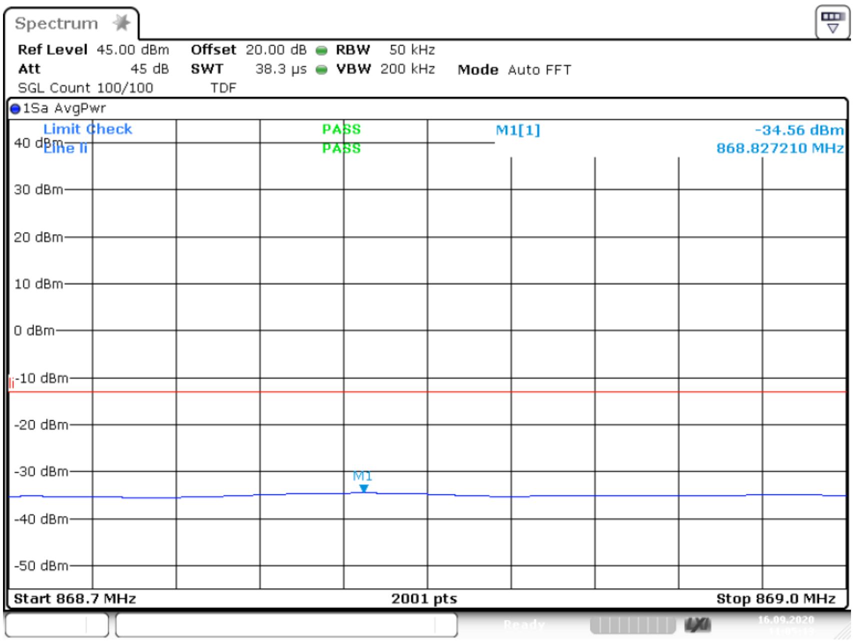
3.6.2 out of band emi CELL850 GSM upper 1carrier -0.3 dB 894
.000M 894.300M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



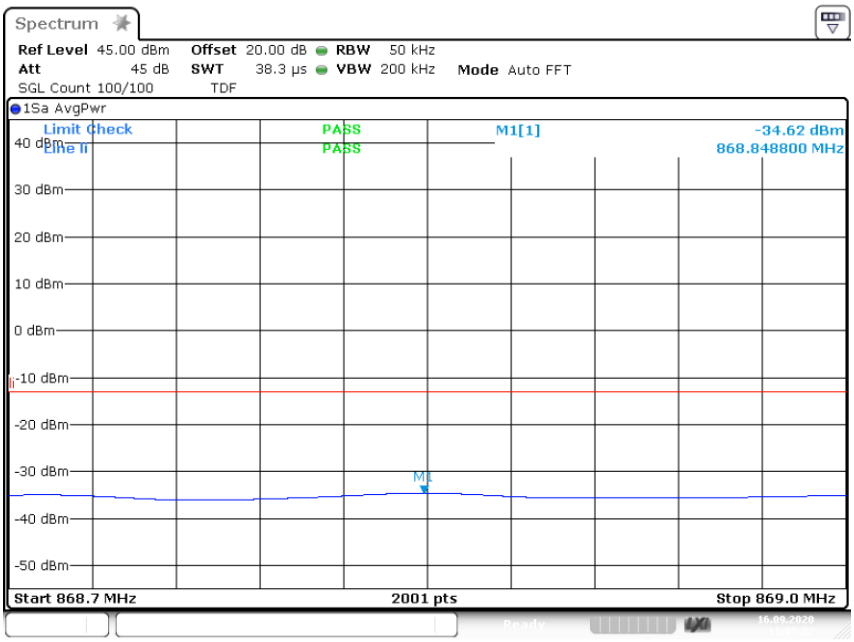
3.6.2 out of band emi CELL850 GSM upper 1carrier +3.0 dB 894
.000M 894.300M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



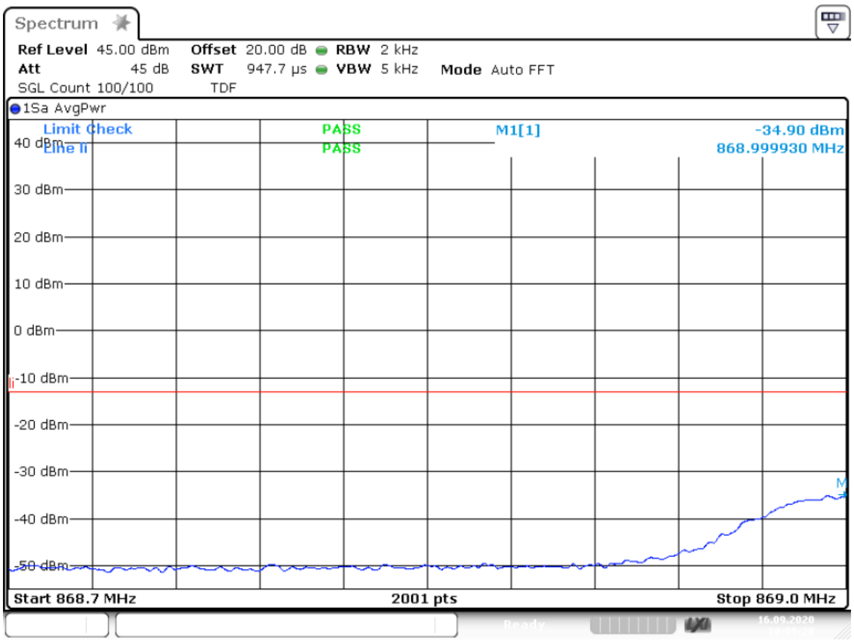
3.6.2 out of band emi CELL850 AWGN lower 1carrier -0.3 dB 86
8.700M 869.000M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



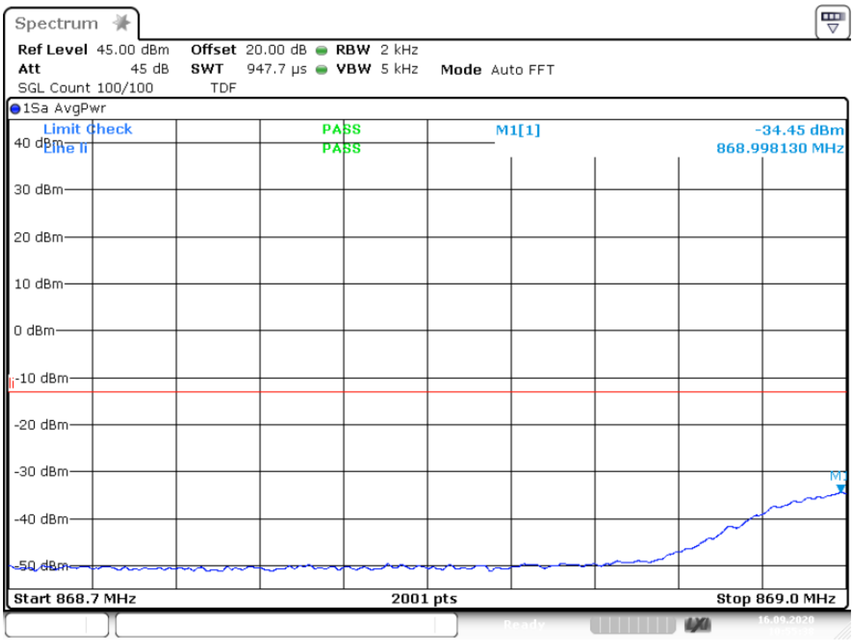
3.6.2 out of band emi CELL850 AWGN lower 1carrier +3.0 dB 86
8.700M 869.000M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



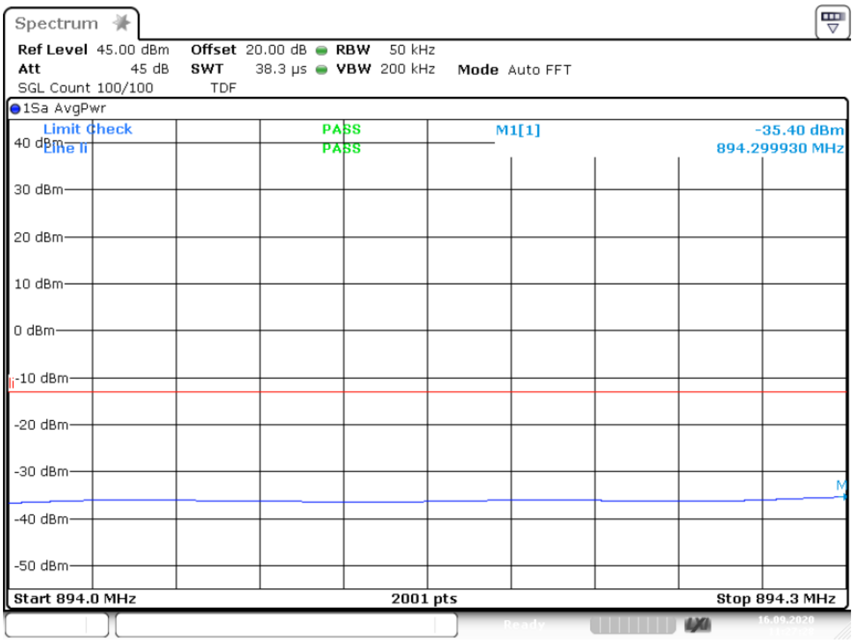
3.6.2 out of band emi CELL850 GSM lower 1carrier -0.3 dB 868
.700M 869.000M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



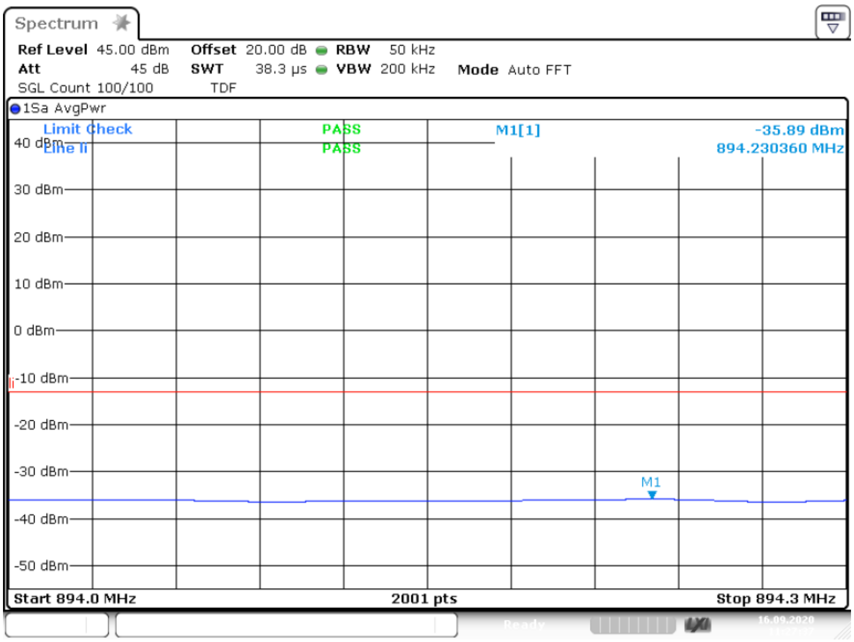
3.6.2 out of band emi CELL850 GSM lower 1carrier +3.0 dB 868
.700M 869.000M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: upper; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



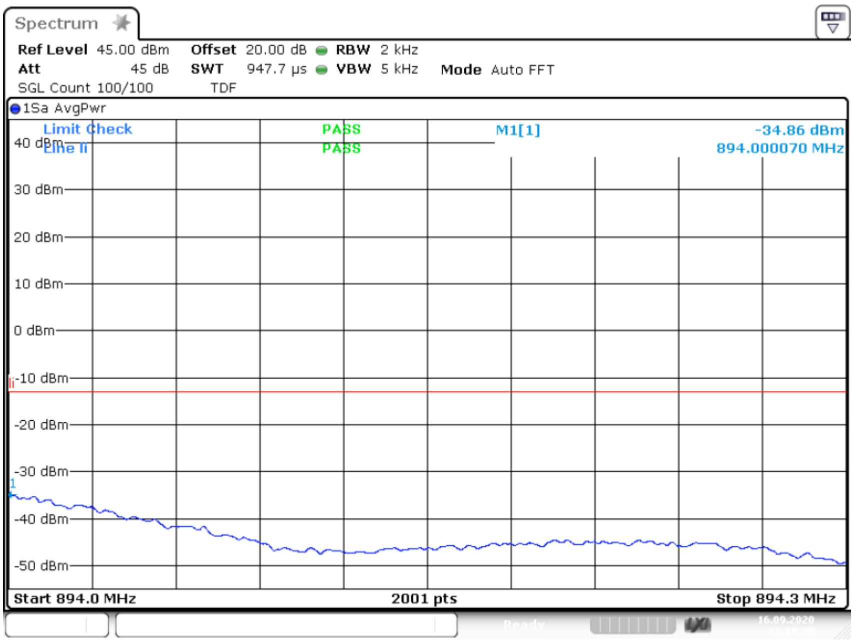
3.6.2 out of band emi CELL850 AWGN upper 2carriers -0.3 dB 894.000M 894.300M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: upper; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



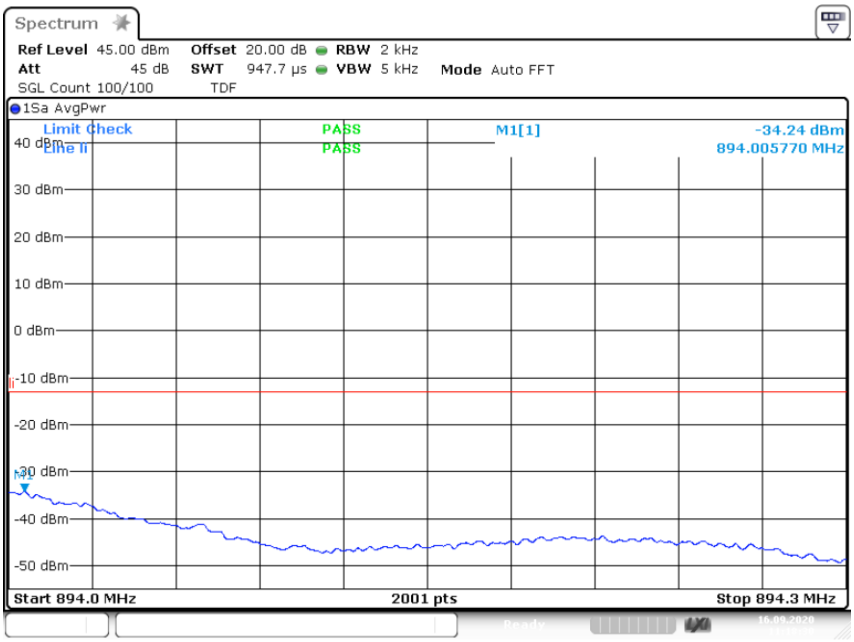
3.6.2 out of band emi CELL850 AWGN upper 2carriers +3.0 dB 894.000M 894.300M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: upper; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



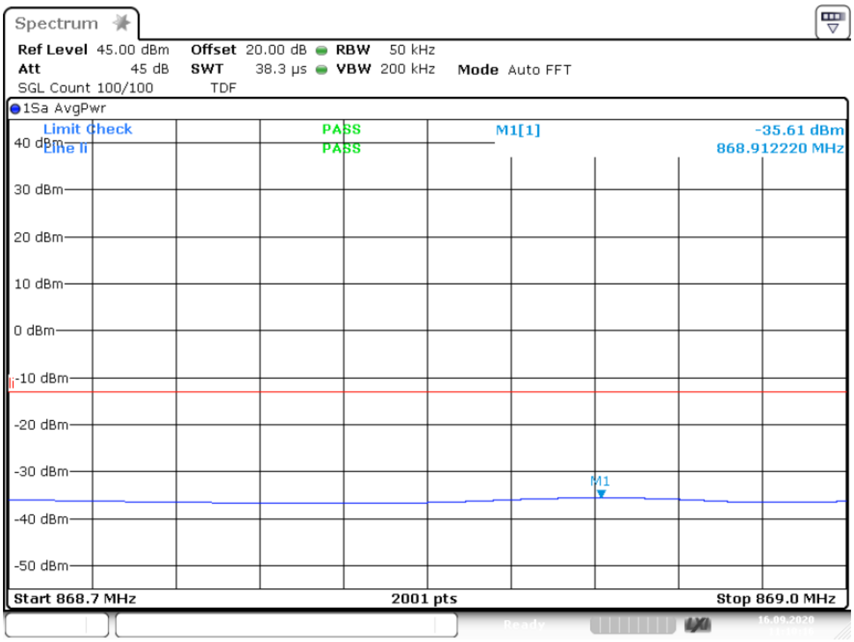
3.6.2 out of band emi CELL850 GSM upper 2carriers -0.3 dB 89
4.000M 894.300M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: upper; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



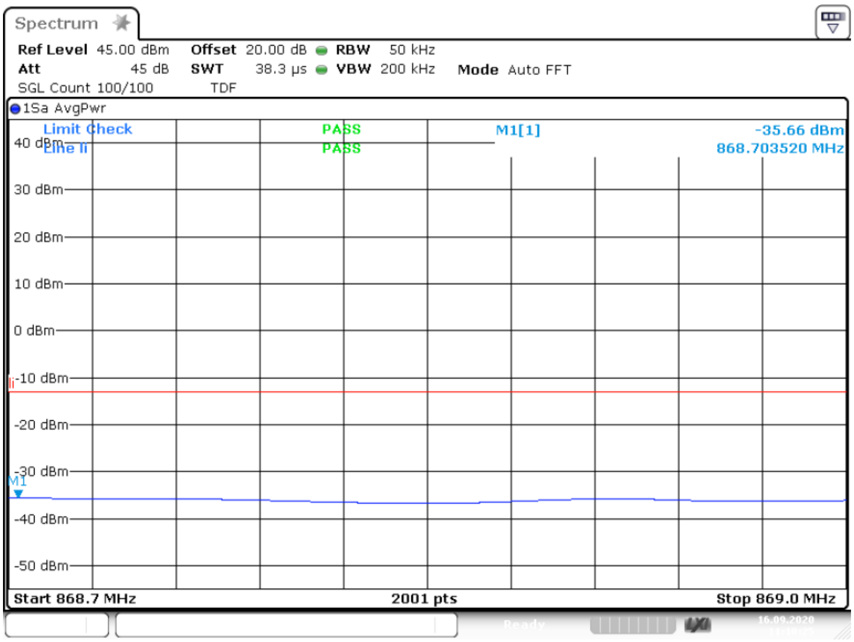
3.6.2 out of band emi CELL850 GSM upper 2carriers +3.0 dB 89
4.000M 894.300M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



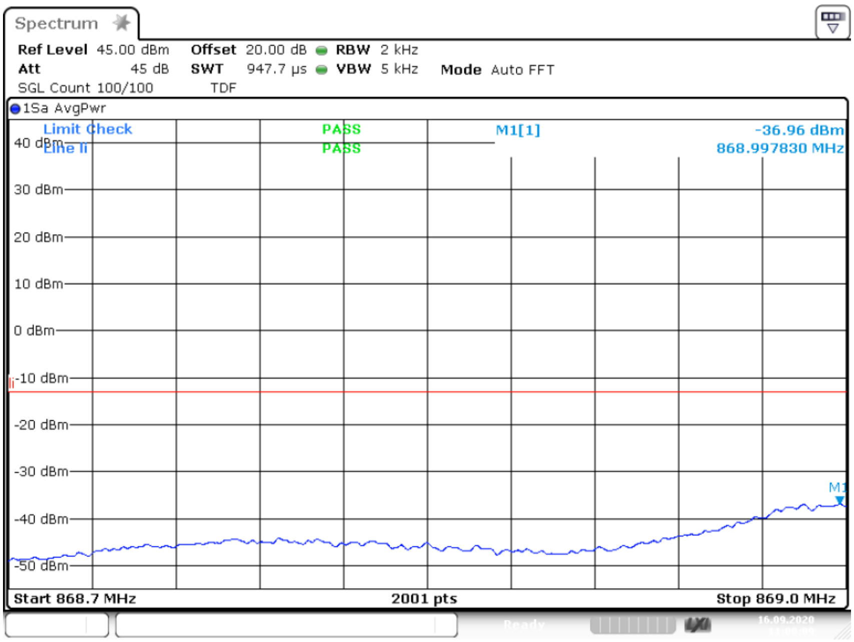
3.6.2 out of band emi CELL850 AWGN lower 2carriers -0.3 dB 8
68.700M 869.000M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



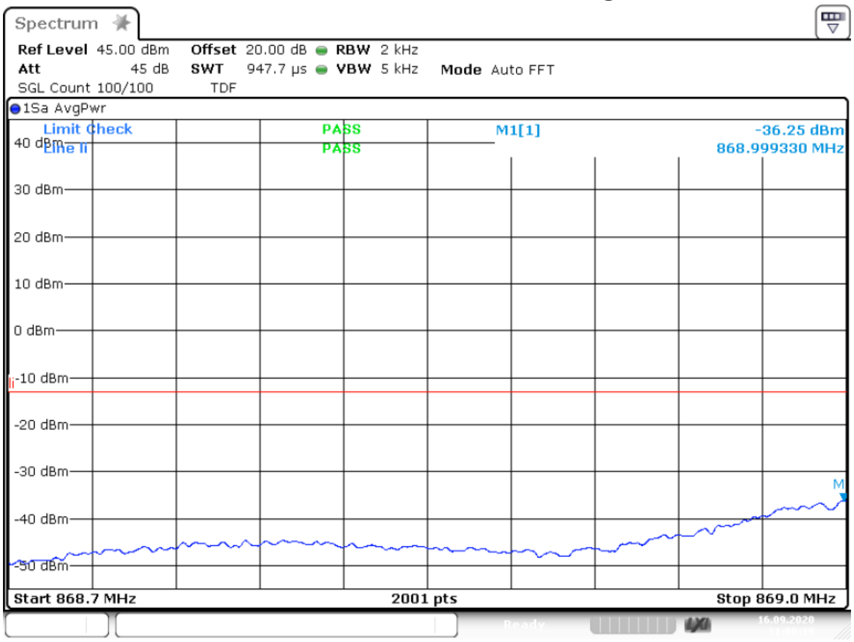
3.6.2 out of band emi CELL850 AWGN lower 2carriers +3.0 dB 8
68.700M 869.000M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: lower; Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



3.6.2 out of band emi CELL850 GSM lower 2carriers -0.3 dB 86
8.700M 869.000M

Band: CELL850; Frequency: 869.0000 MHz to 894.0000 MHz; Band Edge: lower; Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



3.6.2 out of band emi CELL850 GSM lower 2carriers +3.0 dB 86
8.700M 869.000M

4.5.5 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

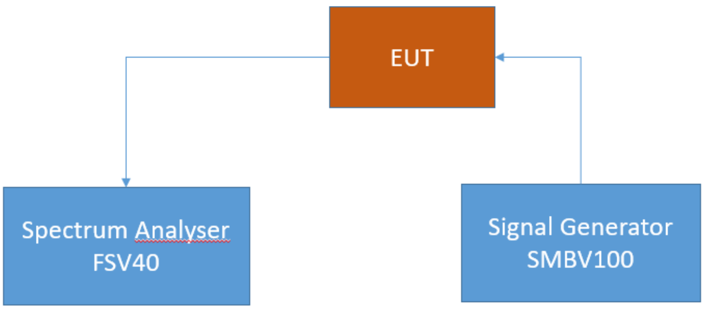
Test date: .2020-08-24

Environmental conditions: 26 ° C; 41% r. F.

Test engineer: Thomas Hufnagel

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

<u>Abstract RSS-131 from ISED:</u>

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.

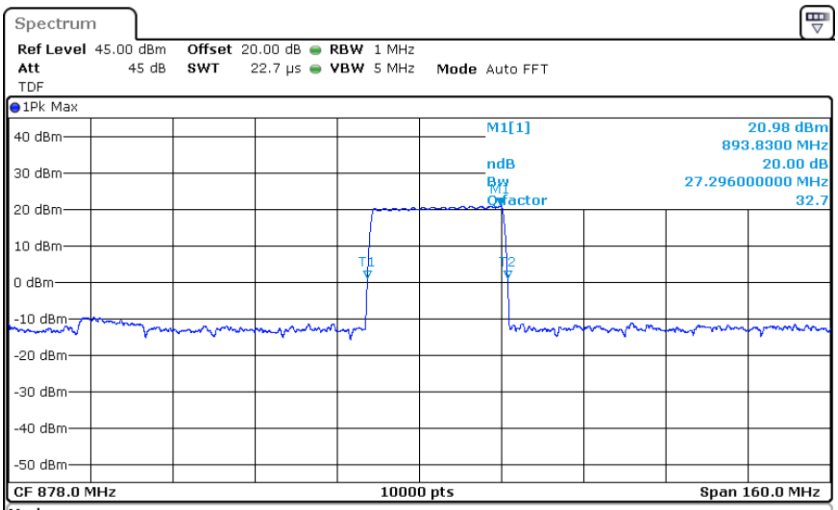
4.6.3 TEST PROTOCOL

Band 5 CELL 850, 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]**
893.83	20.98	867.8640	895.1600	27.2960

Remark: Please see next sub-clause for the measurem

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

Frequency Band = CELL 850, Direction = RF downlink



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	893.83 MHz	20.98 dBm	ndB down	27.296 MHz
T1		1	867.864 MHz	1.11 dBm	ndB	20.00 dB
T2		1	895.16 MHz	0.90 dBm	Q factor	32.7

3.3 Out of band rejection CELL850 878.00000M
_20dB

4.6.5 TEST EQUIPMENT USED

- Conducted

4.7 FIELD STRENGTH OF SPURIOUS RADIATION

Standard FCC Part § 2.1053, § 22.917

The test was performed according to:
ANSI C63.26

Test date: 2020-09-30

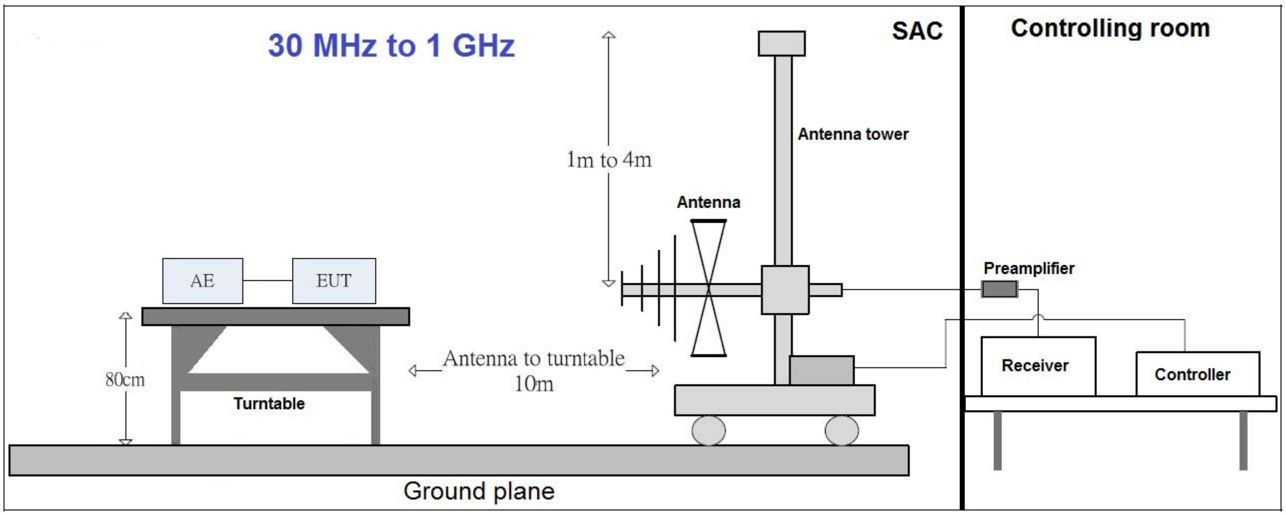
Environmental conditions: 23 ° C; 44 % r. F.

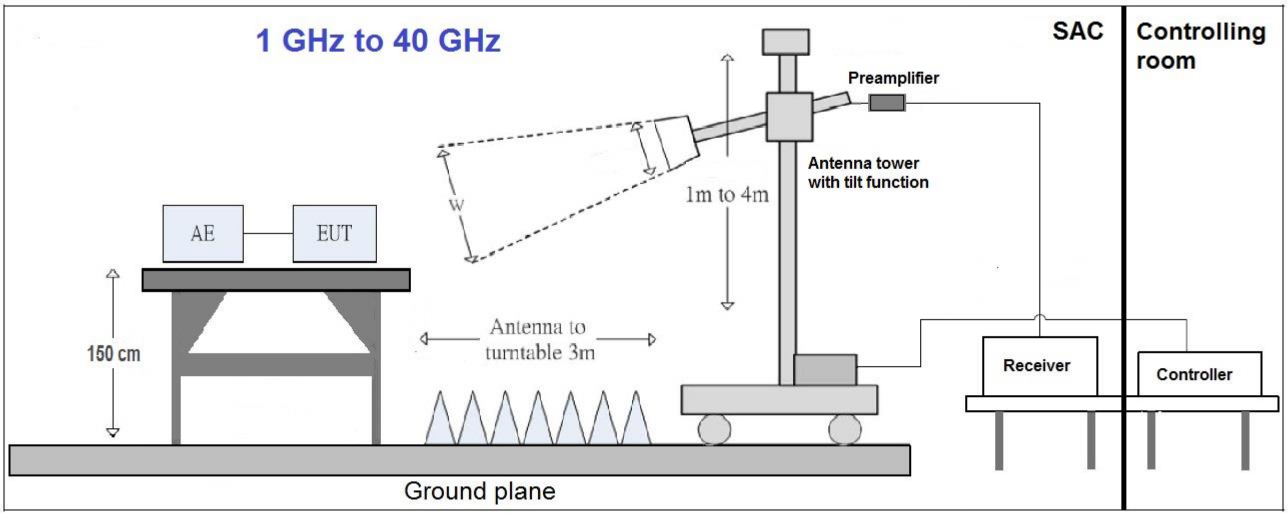
Test engineer: Thomas Hufnagel

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:





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. ?

1. Measurement above 30 MHz and up to 1 GHz

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

<u>Abstract from FCC Part § 2.1053:</u>

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.

<u>Abstract RSS-132 from ISED:</u>

RSS-132; 5.5 Transmitter Unwanted Emissions

Mobile and base station equipment shall comply with the limits in (i) and (ii) below.

(i) In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied 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 immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz 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 occupied bandwidth, power integration over 100 kHz is required.

4.7.3 TEST PROTOCOL

30 MHz to 1 GHz:

CELL 850, downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin (Sum Level) [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
63,79	-90,9	-3.4	QUASI PEAK	120	-13.0	77,9
299,98	-70,3	-3.4	QUASI PEAK	120	-13.0	57,3
499,99	-65,7	-3.4	QUASI PEAK	120	-13.0	52,7
881,53	-60,5	-3.4	QUASI PEAK	120	-13.0	47,5
199,99	-73,0	-3.4	QUASI PEAK	120	-13.0	60,0
300,01	-66,4	-3.4	QUASI PEAK	120	-13.0	53,4
349,99	-68,3	-3.4	QUASI PEAK	120	-13.0	55,3

"None" in that case means, that the spurious radiation is very small and with a great span to the limit.

1 GHz to 18 GHz:

CELL 850, downlink;						
Spurious Freq. [MHz]	**Spurious Level [dBm]**	**Pin (Sum Level) [dBm]**	**Detector**	**RBW [kHz]**	**Limit [dBm]**	**Margin to Limit [dB]**
1699,7	-47,6	-3.4	PEAK	1000	-13.0	34,6
3566,8	-41,3	-3.4	PEAK	1000	-13.0	28,3
17817,2	-19,1	-3.4	PEAK	1000	-13.0	6,1
2854,5	-43,8	-3.4	PEAK	1000	-13.0	30,8
3551,3	-41,5	-3.4	PEAK	1000	-13.0	28,5
17805,1	-20,2	-3.4	PEAK	1000	-13.0	7,2

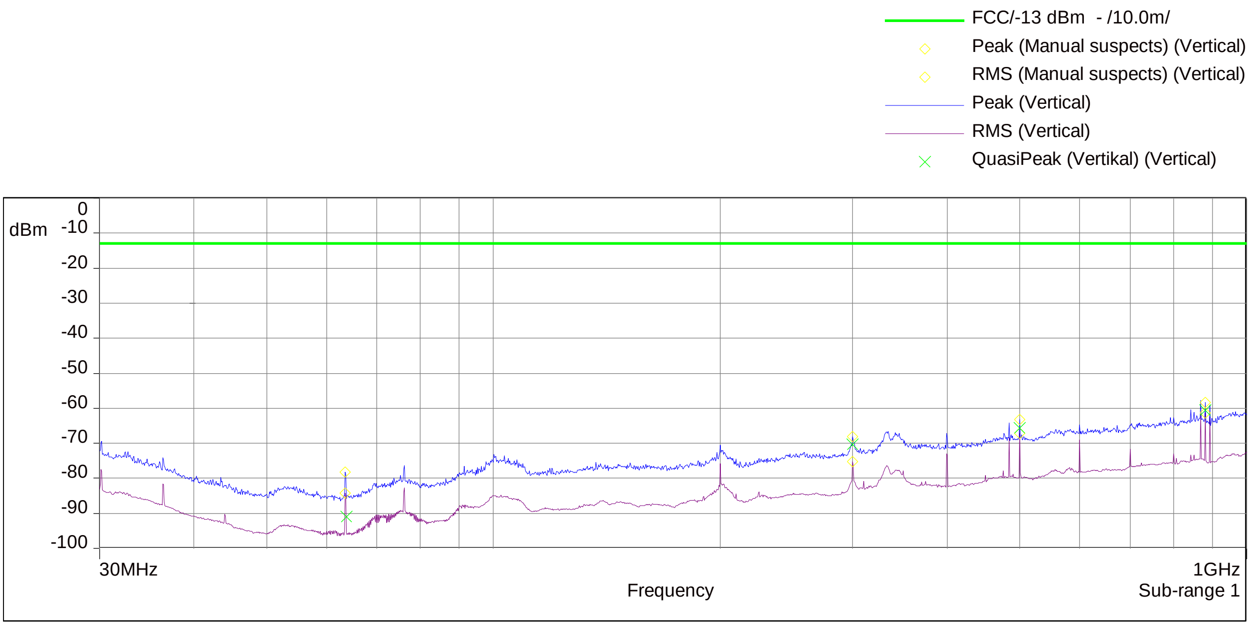
Remarks: Please see next sub-clause for the measurement plot.

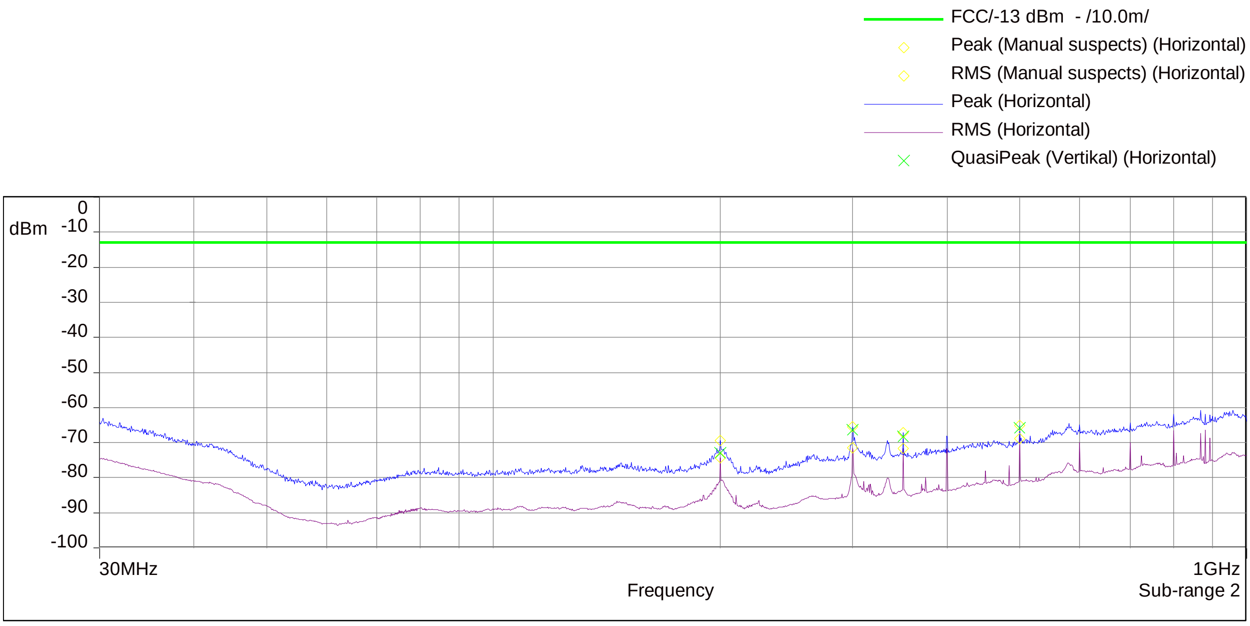
Although ususally a RMS detector is used for measruements in this cases a PEAK detector was used.
The limits are values for use of a RMS detector, but it is so, that the use of a PEAK detector results in readings with higher measured levels. Because the levels with the higher values with PEAK detector 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 = CELL 850, Test Frequency = low, Direction = RF downlink

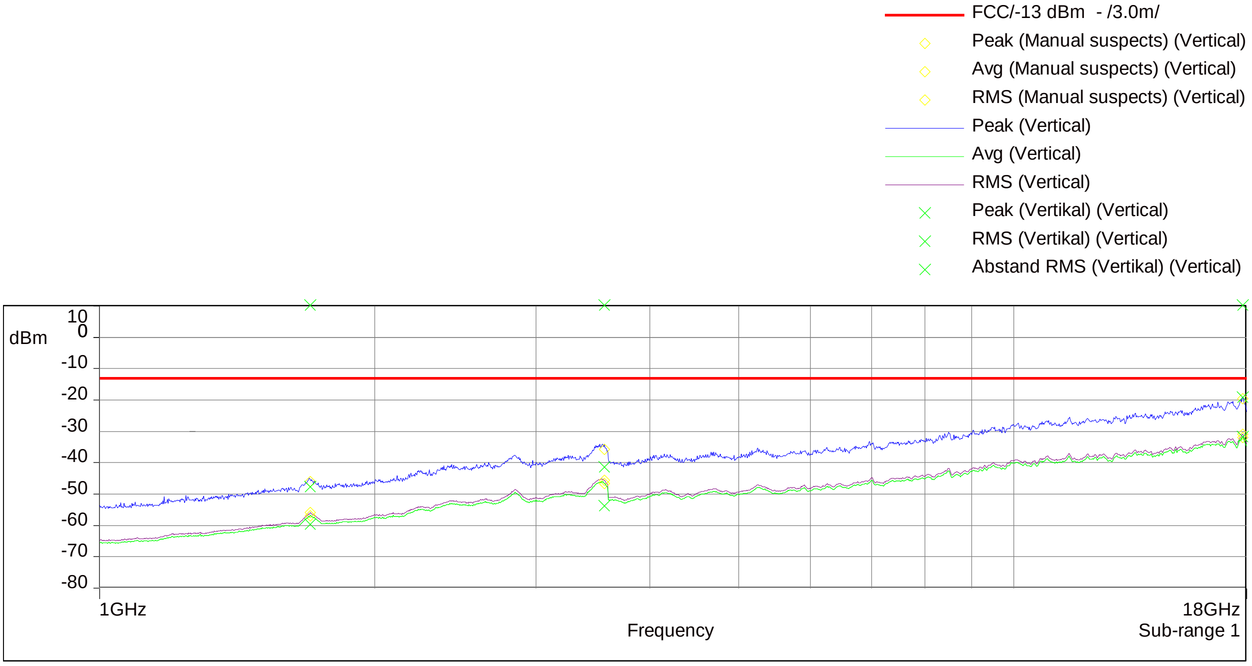
30 MHz - 1 GHz

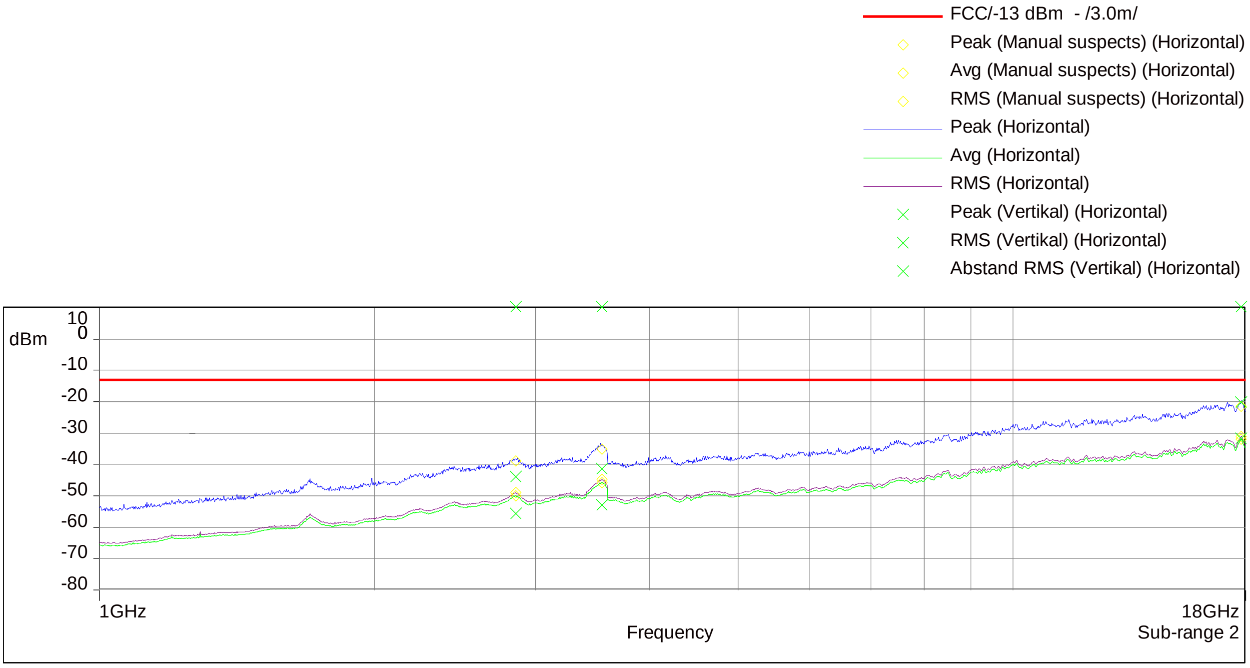




Frequency Band = CELL 850, Test Frequency = low, Direction = RF downlink

1 GHz - 18 GHz





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	2019-10	2021-01
1.2	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	G2089	2017-08/ 2020-08	2022-08
1.3	SMIQ	Vector Signal Generator 9 kHz – 3.3 GHz	Rohde & Schwarz	G1509	2018-10	2021-10
1.4	SMIQ	Vector Signal Generator 9 kHz – 3.3 GHz	Rohde & Schwarz	G1510	2018-10	2021-10
1.5	ESH3-Z5	Line Impedance Stabilisation Network (LISN) 150 Hz – 30 MHz	Rohde & Schwarz	K794	2019-02	2021-01
1.6	30.3015	ThermoHygro Datalogger	TFA	X 507	2018-08	2021-08
1.7	BAT-EMC	Software	Nexio	V3.17.0.26	---	---

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	2018-10	2021-01
2.2	HFH2-Z2	Antenna 9 kHz – 30 MHz	Rohde & Schwarz	K549	2018-10	2021-01
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	MWH-1826/B	Antenna 18 GHz – 26.5 GHz	ARA Inc.	K1042	2018-11	2020-11
2.6	MWH-2640/B	Antenna 26 GHz - 40 GHz	ARA Inc.	K1043	2018-11	2020-11
2.7	AM1431	Pre amplifier 10 kHz – 1 GHz	Miteq	K1721	2019-10	2021-01
2.8	AFS4-00102000	Preamplifier 100 MHz - 20 GHz	Miteq	K817	2019-08	2021-08.
2.9	AFS4-00102000	Preamplifier 100 MHz - 20 GHz	Miteq	K838	2019-10	2021-01
2.10	JS43-1800-4000	Preamplifier 18 GHz - 40 GHz	Miteq	K1104	2019-05	2021-01
2.11	BAT-EMC	Software	Nexio	V3.17.0.26	---	---

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.
MHz	dB (1/m)	dB
1000	33.2	-18.9
2000	39.4	-17.8
3000	42.8	-17.0
4000	45.1	-16.6
5000	46.8	-16.6
6000	48.5	-16.7
7000	50.2	-16.2
8000	50.4	-15.3
9000	51.9	-14.4
10000	53.8	-14.0
11000	54.5	-14.1
12000	55.3	-14.4
13000	55.7	-14.7
14000	56.5	-14.8
15000	56.4	-14.7
16000	57.2	-14.3
17000	57.6	-14.5
18000	57.6	-14.6

pre-amp	cable loss (to receiver)
dB	dB
-20.92	2.01
-20.60	2.78
-20.44	3.42
-20.58	3.99
-21.08	4.46
-21.53	4.87
-21.53	5.35
-20.97	5.66
-20.44	6.05
-20.43	6.45
-20.84	6.69
-21.41	7.04
-22.09	7.36
-22.48	7.66
-22.56	7.90
-22.49	8.20
-22.90	8.45
-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.

6.3 ANTENNA ARA INC. MWH-1826-B (18 GHZ – 26.5 GHZ) PARTIALLY IN CONJUNCTION WITH PRE-AMPLIFIER MITEQ JS43-1800-4000: THE USE OF THE PRE-AMPLIFIER IS DEPENDENT FROM THE FIELD STRENGTH

Frequency	AF EMCO 3160-09	Corr.
MHz	dB (1/m)	dB
18000	44.3	-37.5
18500	43.9	-37.6
19000	44.4	-36.9
19500	44.1	-36.1
20000	44.6	-36.3
20500	44.9	-36.1
21000	45.2	-35.9
21500	45.0	-35.7
22000	45.1	-35.3
22500	45.4	-35.0
23000	45.7	-35.6
23500	45.8	-34.3
24000	45.3	-34.8
24500	45.3	-35.0
25000	46.1	-34.3
25500	46.5	-34.2
26000	46.7	-34.8
26500	46.5	-34.4
27000	46.4	-35.1

pre-amp	cable loss (to receiver)
dB	dB
-46.2	8.7
-46.4	8.8
-45.9	9.0
-45.2	9.1
-45.6	9.3
-45.5	9.4
-45.3	9.4
-45.3	9.7
-45.1	9.8
-44.8	9.8
-45.5	9.9
-44.4	10.1
-45.0	10.2
-45.3	10.4
-44.8	10.5
-44.7	10.5
-45.4	10.6
-45.1	10.7
-46.0	10.9

Sample calculation

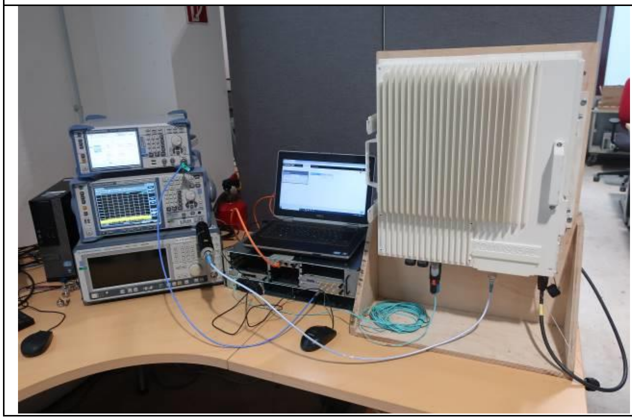
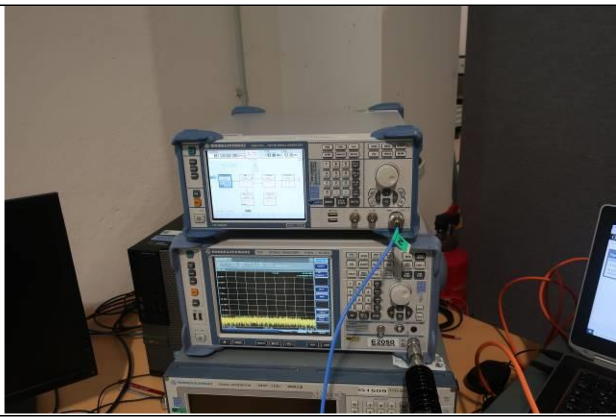
E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Table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

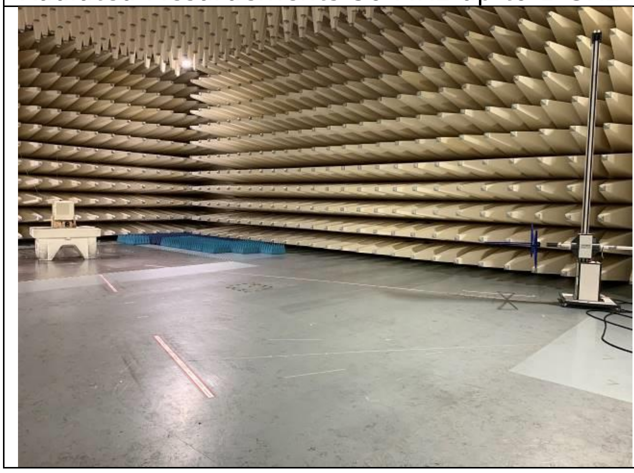
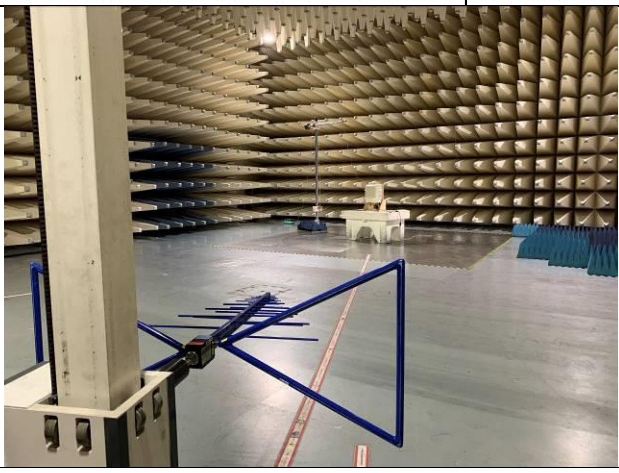
7 MEASUREMENT UNCERTAINTIES

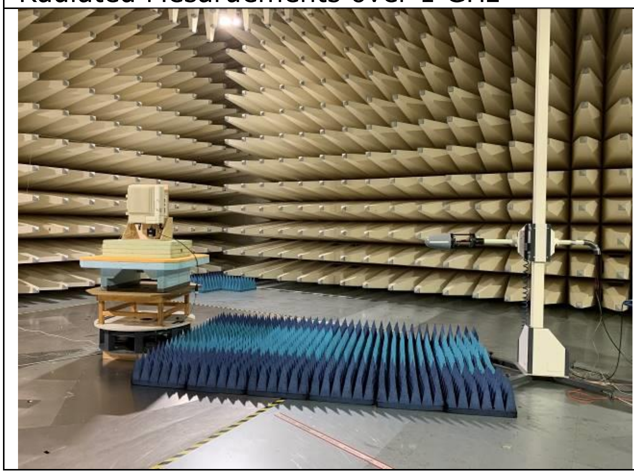
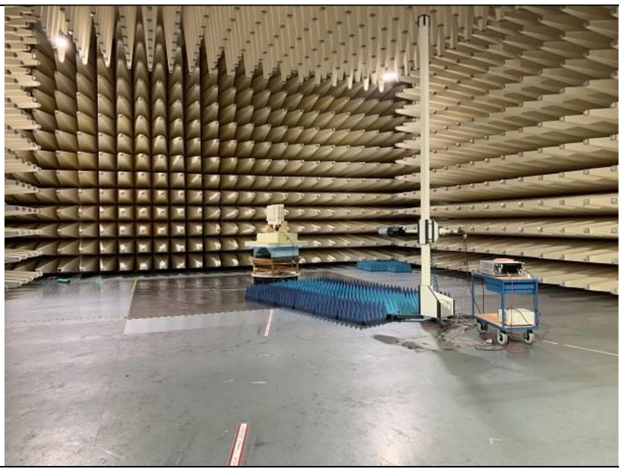
KDB 935210 D05	ECL
Power measurement	0,68 dB
Measuring AGC threshold level	0,90 dB
Out of band rejection	0,90 dB
Input-versus-output signal comparison	0,91 dB
Mean power output	0,90 dB
Measuring out-of-band/out-of-block (including intermodulation) emissions and spurious emissions	0,90 dB
Out-of-band/out-of-block 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

8 PHOTO REPORT

Conducted Mesaruements	Conducted Mesurements
	

Radiated Mesaruements 30 MHz up to 1 GHz	Radiated Mesaruements 30 MHz up to 1 GHz
	

Radiated Mesaruements over 1 GHz	Radiated Mesaruements over 1 GHz
	

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.

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