Test Report

2023-0080-EMC-TR-23-0053-V01_Andrew_CAP MX Band USA 700E_FCC

Designation:	CAP MX AC 6/7E/80-85/17E/19/23/25T
Manufacturer:	Andrew
Serial No(s):	TJCXAA2305302
ID No.	7830127-0001 Rev.: 04

Test Specification(s):	Class 2 Permissive Change ANSI C63.26:2015 Partly of FCC Rules and Regulations as listed in 47 CFR, Part 20:2019-10-01 EFFECTIVE RADIATED POWER, MEAN OUTPUT POWER AND ZONE ENHANCER GAIN OCCUPIED BANDWIDTH/INPUT-VERSUS-OUTPUT SPECTRUM OUT-OF-BAND EMISSION LIMITS OUT-OF-BAND REJECTION

Test Plan:	Measurement of Band 12/USA 700E, downlink

Test Result:	**Passed**

Date of issue:	2023-04-27		Signature:
Version:	01	Technical Reviewer:	Thomas Hufnagel Test Engineer Digitally signed by Thomas Hufnagel Date: 2023.04.28 10:09:27 +02'00'
Date of receipt EUT:	2023-03		
Performance date:	2023-03-29 to 2023-04-17	Report Reviewer:	Gerhard Gass Test Engineer Digital unterschrieben von Gerhard Gass DN: cn=Gerhard Gass, o=Bureau Veritas CPS Germany GmbH, ou=EMC, email=gerhard.gass@bureauveritas.com, c=DE Datum: 2023.04.28 08:46:44 +02'00'

Bundesnetzagentur

BNetzA-CAB-19/21-20

Deutsche Akkreditierungsstelle
D-PL-12024-06-04

The test results relates only to the tested item. The sample has been provided by the client.
Without the written consent of Burau Veritas Consumer Products Services Germany GmbH excerpts of this report shall not be reproduced.

Bureau Veritas
Consumer Products Services Germany GmbH
www.bureauveritas.de/cps
Phone: +49 (0)40 – 740 41 – 0

Schwerin
Wilhelm-Hennemann-Str. 8, 19061 Schwerin
cps-schwerin@de.bureauveritas.com

Tuerkheim
Businesspark A96, 86842 Tuerkheim
cps-tuerkheim@de.bureauveritas.com

Managing Director: Sebastian Doose/Stefan Kischka
Reg.No.: Schwerin HRB 3564

Hamburg
Oehleckerring 40, 22419 Hamburg
cps-hamburg@de.bureauveritas.com

Nuremberg
Thurn-und-Taxis-Str. 18, 90411 Nuremberg
cps-nuernberg@de.bureauveritas.com

Client:

Commscope
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

Test location:

Bureau Veritas Consumer Products Services Germany GmbH
Thurn-und-Taxis-Straße 18
D-90411 Nürnberg

Laboratory accreditation no:	DAkkS D-PL-12024-06-04
	BNETZA-CAB-19/21-20
FCC Designation Number:	DE0023
FCC Test Firm Registration:	366481
ISED CAB Identifier	DE0016
ISED Company Number	3475A

Versions management:

V 01.00	Initial release

Table of Contents

1 APPLIED STANDARDS AND TEST SUMMARY 4
1.1 APPLIED STANDARDS 4
1.2 FCC-IC CORRELATION TABLE 5
1.3 MEASUREMENT SUMMARY/SIGNATURES 6
2 ADMINISTRATIVE DATA 9
2.1 TESTING LABORATORY 9
2.2 APPLICANT DATA 9
2.3 MANUFACTURER DATA 9
3 TEST OBJECT DATA 10
3.1 GENERAL EUT DESCRIPTION 10
3.2 EUT MAIN COMPONENTS 11
3.3 ANCILLARY EQUIPMENT 11
3.4 AUXILIARY EQUIPMENT 12
3.5 EUT SETUPS 13
3.6 PRODUCT LABELLING 14
4 TEST RESULTS 15
4.1 EFFECTIVE RADIATED POWER, MEAN OUTPUT POWER AND ZONE ENHANCER GAIN 15
4.2 OCCUPIED BANDWIDTH/INPUT-VERSUS-OUTPUT SPECTRUM 22
4.3 OUT-OF-BAND EMISSION LIMITS 28
4.4 OUT-OF-BAND REJECTION 41
5 TEST EQUIPMENT 43
6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS 44
7 MEASUREMENT UNCERTAINTIES 45
8 PHOTO REPORT 46
Annex A: Accreditation certificate (for information) 47
Annex B: Additional information provided by client 48

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, 27. 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 27; Miscellaneous Wireless Communications Services
Subpart C – Technical standards

§ 27.50 – Power and duty cycle limits
§ 27.53 – Emission limits
§ 27.54 – Frequency stability

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, 2020-04-03.
- FCC Public Notice 971168 applying "Measurement guidance for certification of licensed digital transmitters" 971168 D01, 2018-04-09.
- 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

Measurement	FCC reference
Effective radiated power, mean output power and zone enhancer gain	§ 2.1046 § 27.50 KDB 935210 D05 v01r04: 3.5
Occupied bandwidth Input-versus-output spectrum	§ 2.1049 KDB 935210 D05 v01r04: 3.4
Out-of-band emissions limits	§ 2.1051 § 27.53 KDB 935210 D05 v01r04: 3.6
Frequency stability	§ 2.1055 § 27.54
Out-of-band rejection	KDB 935210 D05 v01r04: 3.3
All measurements	ANSI 63.26:2015

1.3 MEASUREMENT SUMMARY/SIGNATURES

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater]	**§ 2.1046, § 27.50**
Effective Radiated Power, mean output power and zone enhancer gain The measurement was performed according to ANSI C63.26:2015, KDB 935210 D05 v01r04: 3.5	**Final Result**
OP-Mode Frequency Band, Direction, Input Power, Signal Type	**FCC**
Band 12 USA 700E, RF downlink, 0.3 dB < AGC, Wideband	Passed
Band 12 USA 700E, RF downlink, 3 dB > AGC, Wideband	Passed
Band 12 USA 700E, RF downlink, 0.3 dB < AGC, Wideband 5G	Passed
Band 12 USA 700E, RF downlink, 3 dB > AGC, Wideband 5G	Passed
Band 12 USA 700E, RF downlink, 0.3 dB < AGC, Narrowband	Passed
Band 12 USA 700E, RF downlink, 3 dB > AGC, Narrowband	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater]	**§ 2.1049**
Occupied Bandwidth The measurement was performed according to ANSI C63.26:2015, KDB 935210 D05 v01r04: 3.4	**Final Result**
OP-Mode Frequency Band, Direction, Input Power, Signal Type	**FCC**
Band 12 USA 700E, RF downlink, 0.3 dB < AGC, Wideband	Done
Band 12 USA 700E, RF downlink, 3 dB > AGC, Wideband	Done
Band 12 USA 700E, RF downlink, 0.3 dB < AGC, Wideband 5G	Done
Band 12 USA 700E, RF downlink, 3 dB > AGC, Wideband 5G	Done
Band 12 USA 700E, RF downlink, 0.3 dB < AGC, Narrowband	Done
Band 12 USA 700E, RF downlink, 3 dB > AGC, Narrowband	Done

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **§ 2.1051, § 27.53**

Out-of-band emission limits
The measurement was performed according to ANSI C63.26:2015, KDB 935210 D05 v01r04: 3.6

Final Result

OP-Mode Band Edge, Frequency Band, Number of signals, Direction, Input Power, Signal Type	**FCC**
Lower, Band 12 USA 700E, 1, RF downlink, 0.3 dB < AGC, Wideband	Passed
Lower, Band 12 USA 700E, 1, RF downlink, 3 dB > AGC, Wideband	Passed
Lower, Band 12 USA 700E, 1, RF downlink, 0.3 dB < AGC, Wideband 5G	Passed
Lower, Band 12 USA 700E, 1, RF downlink, 3 dB > AGC, Wideband 5G	Passed
Lower, Band 12 USA 700E, 1, RF downlink, 0.3 dB < AGC, Narrowband	Passed
Lower, Band 12 USA 700E, 1, RF downlink, 3 dB > AGC, Narrowband	Passed
Lower, Band 12 USA 700E, 2, RF downlink, 0.3 dB < AGC, Wideband	Passed
Lower, Band 12 USA 700E, 2, RF downlink, 3 dB > AGC, Wideband	Passed
Lower, Band 12 USA 700E, 2, RF downlink, 0.3 dB < AGC, Narrowband	Passed
Lower, Band 12 USA 700E, 2, RF downlink, 3 dB > AGC, Narrowband	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater] **§ 2.1051, § 27.53**

Out-of-band emission limits
The measurement was performed according to ANSI C63.26:2015, KDB 935210 D05 v01r04: 3.6

Final Result

OP-Mode Band Edge, Frequency Band, Number of signals, Direction, Input Power, Signal Type	**FCC**
Upper, Band 12 USA 700E, 1, RF downlink, 0.3 dB < AGC, Wideband	Passed
Upper, Band 12 USA 700E, 1, RF downlink, 3 dB > AGC, Wideband	Passed
Upper, Band 12 USA 700E, 1, RF downlink, 0.3 dB < AGC, Wideband 5G	Passed
Upper, Band 12 USA 700E, 1, RF downlink, 3 dB > AGC, Wideband 5G	Passed
Upper, Band 12 USA 700E, 1, RF downlink, 0.3 dB < AGC, Narrowband	Passed
Upper, Band 12 USA 700E, 1, RF downlink, 3 dB > AGC, Narrowband	Passed
Upper, Band 12 USA 700E, 2, RF downlink, 0.3 dB < AGC, Wideband	Passed
Upper, Band 12 USA 700E, 2, RF downlink, 3 dB > AGC, Wideband	Passed
Upper, Band 12 USA 700E, 2, RF downlink, 0.3 dB < AGC, Narrowband	Passed
Upper, Band 12 USA 700E, 2, RF downlink, 3 dB > AGC, Narrowband	Passed

47 CFR CHAPTER I FCC PART 27 Subpart C [Base Stations/Repeater]	**KDB 935210 D05 v01r04: 3.3**
Out-of-band rejection The measurement was performed according to ANSI C63.26:2015	**Final Result**
OP-Mode Frequency Band, Direction	**FCC**
Band 12 USA 700E, RF downlink	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. Jiri.Cecka

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 71/USA 600 Band12/USA 700E Band 13/USA 750 Band 14/LMR 750 Band 27/CELL 800 Band 5/CELL 850 Band 70/Band 70 Band 66/AWS 1700E (partly) Band 25/PCS 1900 Band 30/WCS 2300 Band 41/BRS 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]	All bands: between 29 dBm and 33 dBm
Nominal Gain [Uplink]	-
Nominal Gain [Downlink]	All bands: 33 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**	
	XS5-CAPMX	
Sample Parameter	**Value**	
Serial Number	TJCXAA2305302	
HW Version	7830127-0001 Rev.: 04	
SW Version	4.15.10.5	
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; DM77662	Rack in Conjunction with AUX 2
AUX2	Commsope/General Electric; Power Supply Unit; LBGEPE17KZ39047532	Power Supply
AUX3	Commscope; ION-E WCS-2; SZAEAJ1952A0032	Subrack in Conjunction with AUX 4, 5,6, 7 and 8
AUX4	Commscope; ION-E OPT; SZBEAD1951A0011	Optical Card
AUX5	Commscope; ION-E SUI; SZBEAC1746A0015	LAN System Interface
AUX6	Commscope; ION-E RFD; SZBEAP1920A0057	RF Card
AUX7	Commscope; ION-E RFD; SZBEAP1924A0023	RF Card
AUX 8	Commscope; ION-E RFD; SZBEAP1946A0003	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
12 (USA 700E)	Downlink	728.00	746.00	737.00	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
12	Downlink	Narrowband	-2.6	-2.9	0.4	737.00	Mid
12	Downlink	Wideband	-2.8	-3.1	0.2	737.00	
12	Downlink	Wideband G5	-2.8	-3.1	0.2	737.00	
12	Downlink	Narrowband	-2.4	-2.7	0.6	728.20	Low
12	Downlink	Wideband	-2.4	-2.7	0.6	730.50	
12	Downlink	Wideband G5	-2.6	-2.9	0.4	735.50	
12	Downlink	Narrowband	-3.2	-3.5	-0.2	745.80	High
12	Downlink	Wideband	-3.2	-3.5	-0.2	743.50	
12	Downlink	Wideband G5	-2.8	-3.1	0.2	738.50	
12	Downlink	Narrowband	-3.2	-3.5	-0.2	743.71	Max.Power
12	Downlink	Wideband	-3.2	-3.5	-0.2	743.50	

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
AWGN-signal (wideband G5): 7.5 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 27, § 27.50

The test was performed according to:
ANSI C63.26:2015, KDB 935210 D05 v01r04: 3.5

Test date: 2023-03-29 to 2023-04-17

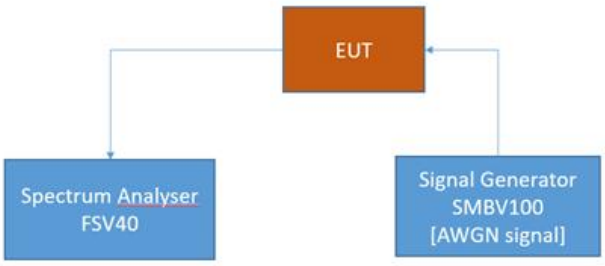
Environmental conditions: 21 … 26 °C; 25 .. 35 % r. H.

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 § 27.50.

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 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§ 27.50

Band 12:

Abstract § 27.50 from FCC:

(c) The following power and antenna height requirements apply to stations transmitting in the 600 MHz band and the 698-746 MHz band:

(1) Fixed and base stations transmitting a signal with an emission bandwidth of 1 MHz or less must not exceed an effective radiated power (ERP) of 1000 watts and an antenna height of 305 m height above average terrain (HAAT), except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of this section;

(2) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal with an emission bandwidth of 1 MHz or less must not exceed an ERP of 2000 watts and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts ERP in accordance with Table 2 of this section;

(3) Fixed and base stations transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed an ERP of 1000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts/MHz ERP in accordance with Table 3 of this section;

(4) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed an ERP of 2000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts/MHz ERP in accordance with Table 4 of this section;

5.2 Technical Criteria

20. This section covers technical criteria in regards to e.i.r.p., antenna height and use of multiple-inputmultiple-output (MIMO) antennas.

5.2.1 Radiated power and antenna height limits for fixed and base stations

21. For fixed and base stations transmitting in accordance with section 4, the maximum permissible equivalent isotropically radiated power (e.i.r.p.) is 1640 watts and 1640 watts/MHz for a channel bandwidth less than or equal to 1 MHz and greater than 1 MHz, respectively. These e.i.r.p. limits apply for stations with an antenna height above average terrain (HAAT)2 up to 305 metres.

22.Fixed and base stations located in geographical areas at a distance greater than 26 km from large or medium population centres3 and transmitting in accordance with section 4, may increase their e.i.r.p. up to a maximum of 3280 watts/MHz (i.e. no more than 3280 watts e.i.r.p. in any 1 MHz band segment), with an antenna HAAT up to 305 metres.

23. Within 26 km of any large or medium population centre, fixed and base stations may operate at increased e.i.r.p. if more than 50% of the population within a particular sector's coverage is located outside these large and medium population centres.

24. Fixed and base stations with increased e.i.r.p. must not be used to provide coverage to large and medium population centres. However, some incidental coverage of these large and medium population centres by stations with increased e.i.r.p. is permitted.

25. This provision also applies for fixed and base stations with a channel bandwidth equal to or less than 1 MHz (i.e. e.i.r.p. may be increased up to a maximum of 3280 watts).

26. For all installations with an antenna HAAT in excess of 305 metres, a corresponding reduction in e.i.r.p. according to the following formula shall be applied:

EIRP 20 log (HAAT/ 305) reduction = 10 dB

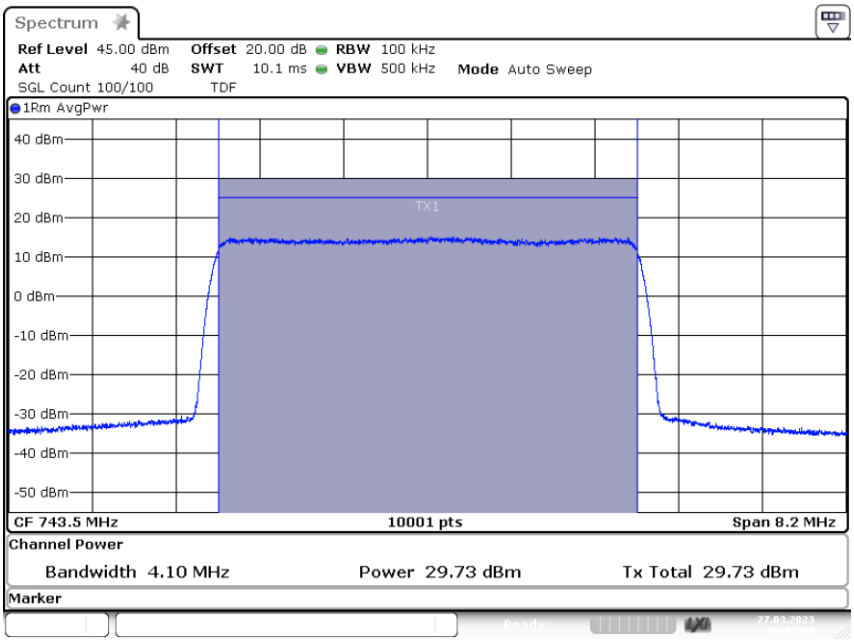
4.1.3 TEST PROTOCOL

Band 12, 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	743.50	-3.5	29.7	60.0	30.3	33.2
Wideband	3 dB > AGC	743.50	-0.2	29.3	60.0	30.7	29.5
Wideband 5G	0.3 dB < AGC	737.00	-3.1	29.7	60.0	30.3	32.8
Wideband 5G	3 dB > AGC	737.00	+0.2	29.3	60.0	30.7	29.1
Narrowband	0.3 dB < AGC	743.71	-3.5	30.0	60.0	30.0	33.5
Narrowband	3 dB > AGC	743.71	-0.2	29.8	60.0	30.2	30.0

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

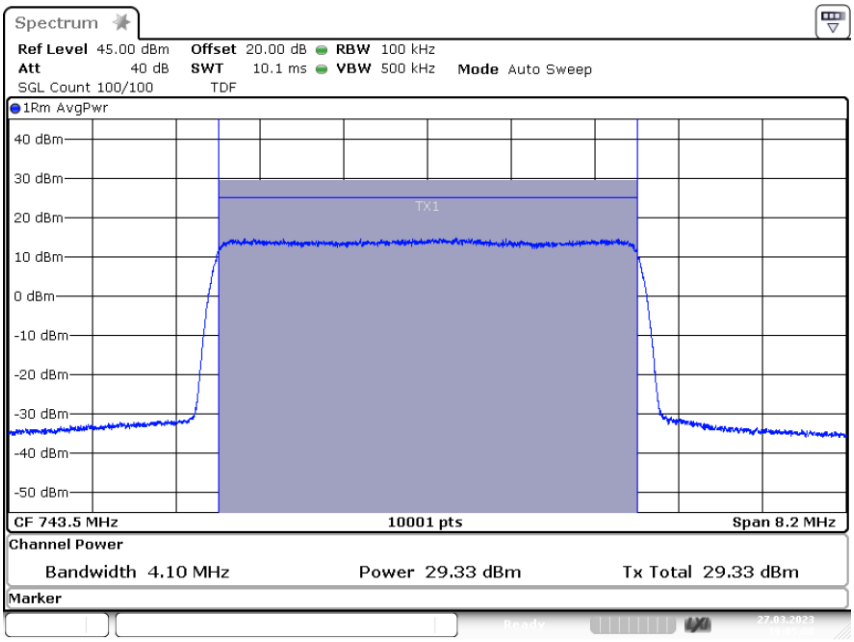
4.1.4 MEASUREMENT PLOT

Band: USA700E; Frequency: 743.7100 MHz; Band Edge: f0;
Mod: AWGN; Output Power 0.3 dB < AGC



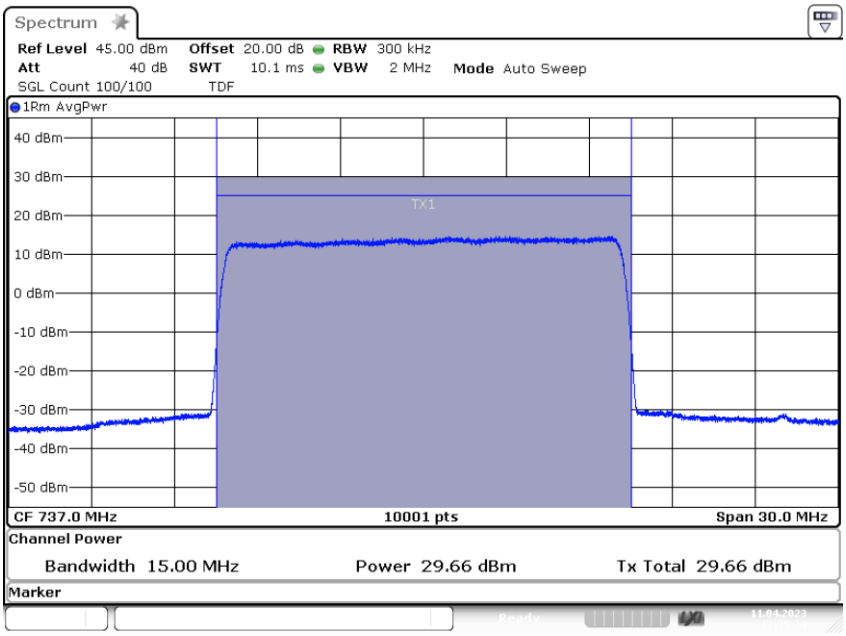
3.5.3 Power AWGN Out -0.3 743.50000M

Band: USA700E; Frequency: 743.7100 MHz; Band Edge: f0;
Mod: AWGN; Output Power 3 dB > AGC



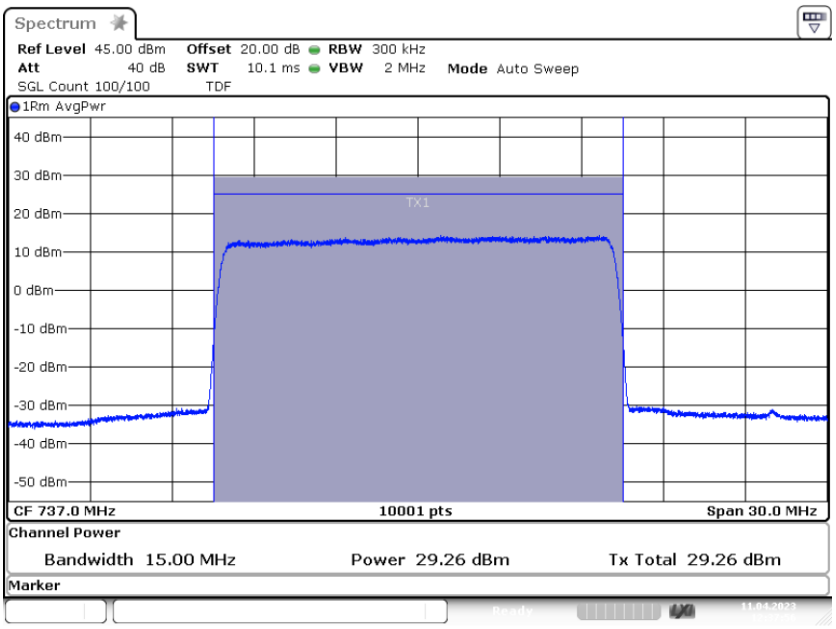
3.5.3 Power AWGN Out +3 743.50000M

Band: USA700E; Frequency: 743.7100 MHz; Band Edge: mid;
Mod: AWGN 15M; Output Power 0.3 dB < AGC



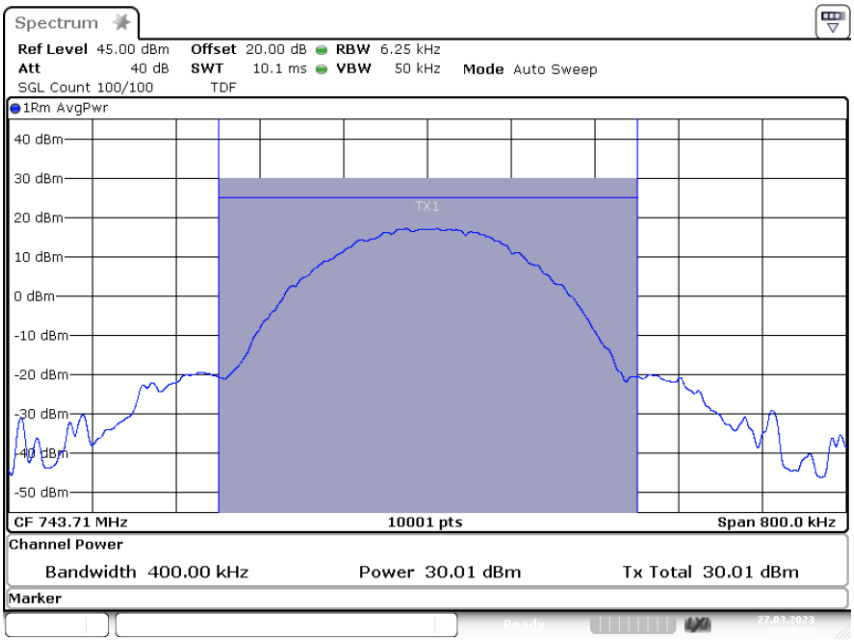
3.5.3 Power AWGN 15M-0.3 737.00000M

Band: USA700E; Frequency: 743.7100 MHz; Band Edge: mid;
Mod: AWGN 15M; Output Power 3 dB > AGC



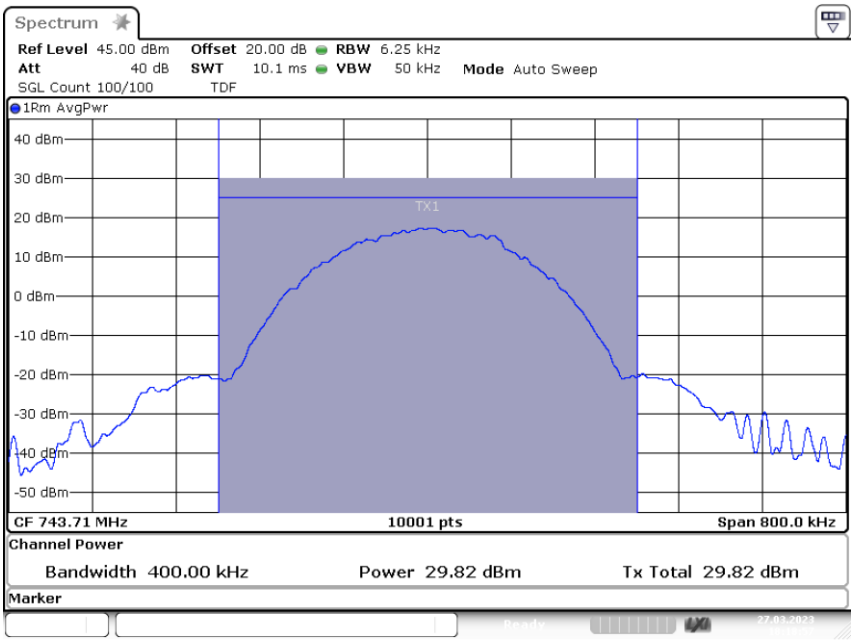
3.5.3 Power AWGN 15M+3 737.00000M

Band: USA700E; Frequency: 743.7100 MHz; Band Edge: f0;
Mod: GSM; Output Power 0.3 dB < AGC



3.5.3 Power GSM Out -0.3 743.71000M

Band: USA700E; Frequency: 743.7100 MHz; Band Edge: f0;
Mod: GSM; Output Power 3 dB > AGC



3.5.3 Power GSM Out +3 743.71000M

4.1.5 TEST EQUIPMENT USED

- Conducted

4.2 OCCUPIED BANDWIDTH/INPUT-VERSUS-OUTPUT SPECTRUM

Standard FCC Part 2.1049; Occupied Bandwidth

The test was performed according to:
ANSI C63.26:2015, KDB 935210 D05 v01r04: 3.4

Test date: 2023-03-29 to 2023-04-17

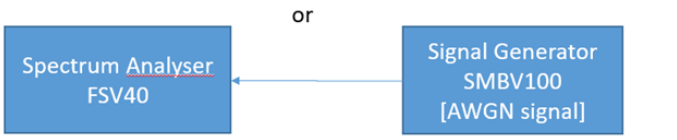
Environmental conditions: 21 … 26 °C; 25 .. 35 % r. H.

Test engineer: Thomas Hufnagel

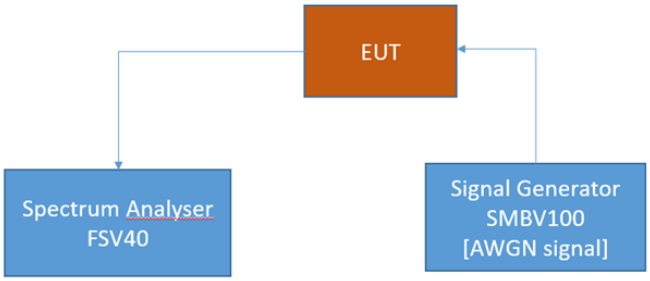
4.2.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable conducted spurious emission limits per FCC § 2.1049.

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.

4.2.2 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.

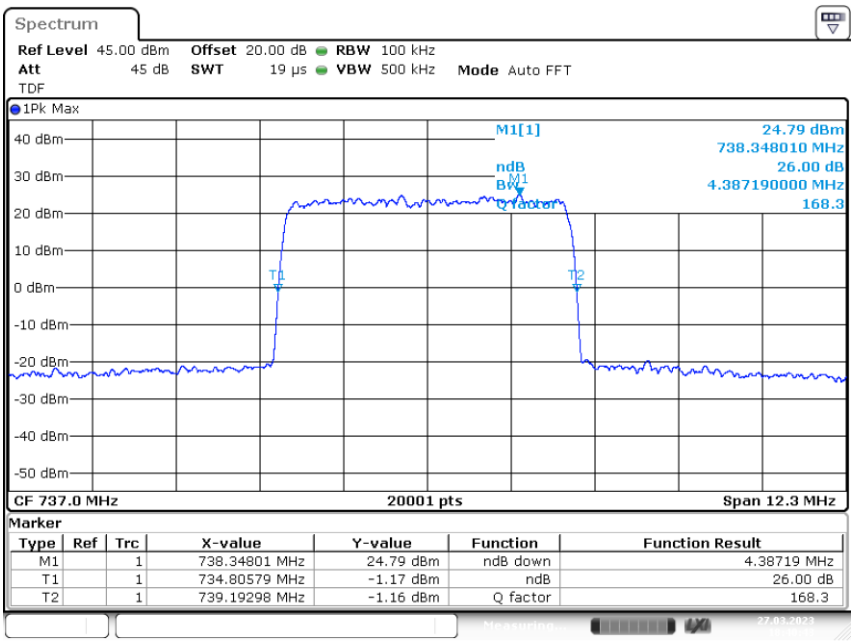
4.2.3 TEST PROTOCOL

Band 12, downlink			
Signal Type	**Input Power**	**Signal Frequency [MHz]**	**Occupied Bandwidth Booster [kHz]**
Wideband	0.3 dB < AGC	737.00	4387.2
Wideband	3 dB > AGC	737.00	4387.3
Wideband 5G	0.3 dB < AGC	737.00	14887.5
Wideband 5G	3 dB > AGC	737.00	14905.5
Narrowband	0.3 dB < AGC	737.00	315.2
Narrowband	3 dB > AGC	737.00	315.1

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

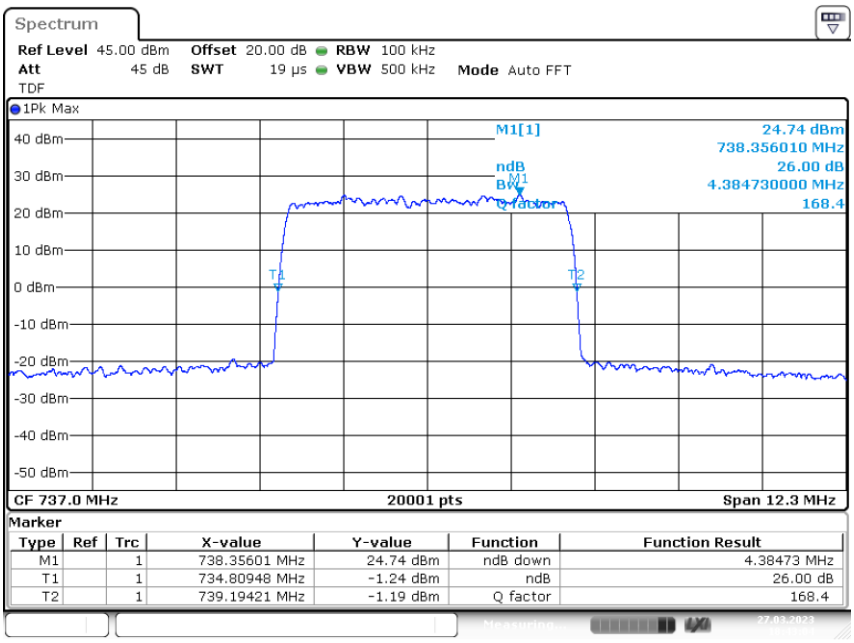
4.2.4 MEASUREMENT PLOT

Band: USA700E; Frequency: 737.0000 MHz; Band Edge: mid;
Mod: AWGN; Output OCBw 0.3 dB < AGC



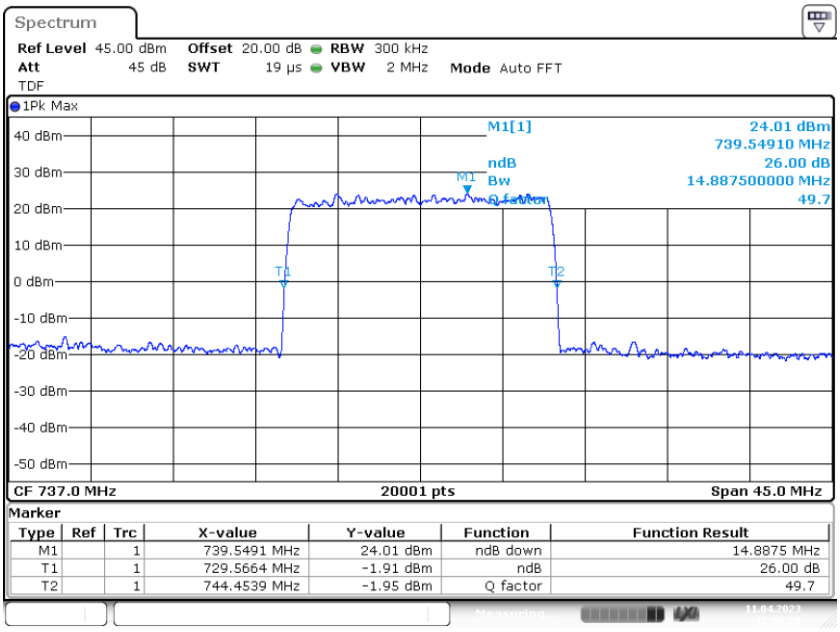
3.4 OCBw AWGN Out -0.3 737.0000M _26dB

Band: USA700E; Frequency: 737.0000 MHz; Band Edge: mid;
Mod: AWGN; Output OCBw 3 dB > AGC



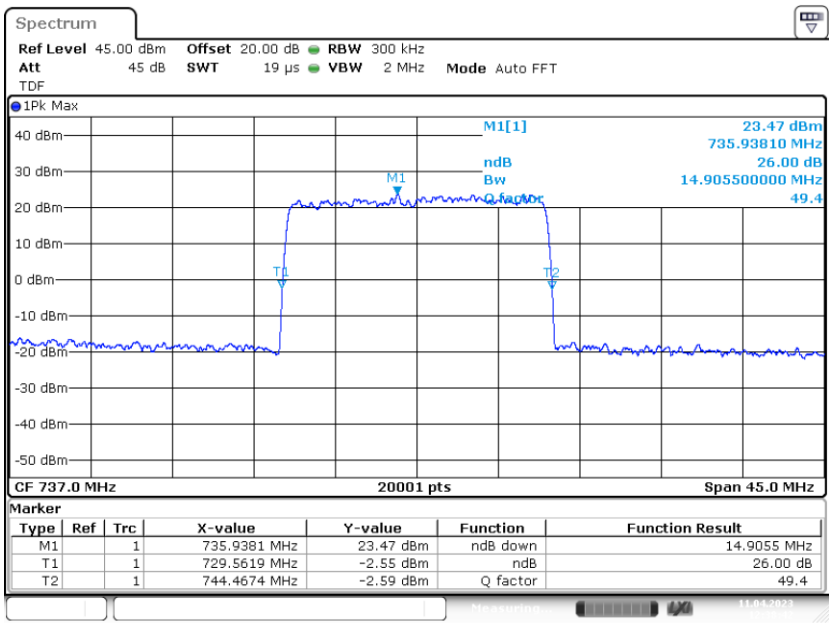
3.4 OCBw AWGN Out +3 737.0000M _26dB

Band: USA700E; Frequency: 737.0000 MHz; Band Edge: mid;
Mod: AWGN 15M; Output OCBw 0.3 dB < AGC



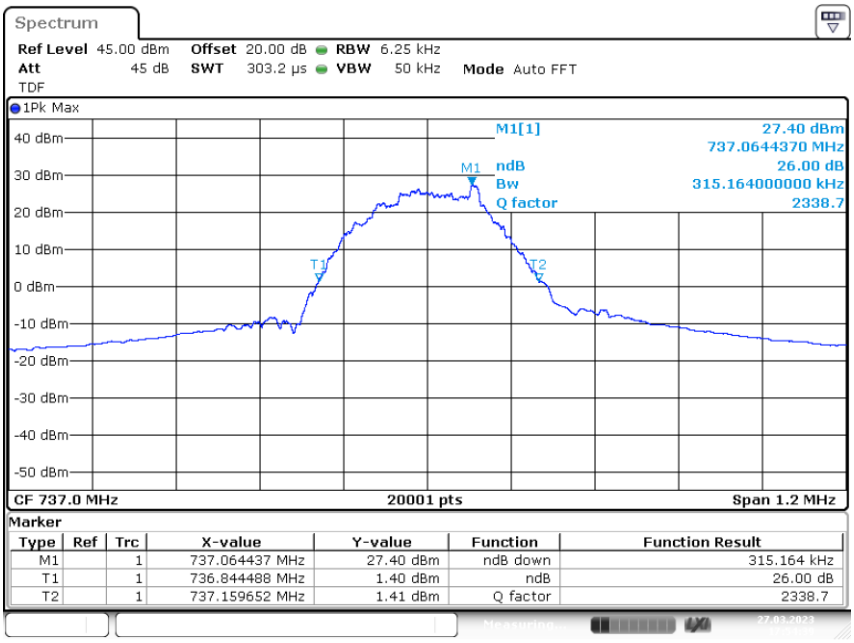
3.4 OCBw AWGN 15M-0.3 737.0000M _26dB

Band: USA700E; Frequency: 737.0000 MHz; Band Edge: mid;
Mod: AWGN 15M; Output OCBw 3 dB > AGC



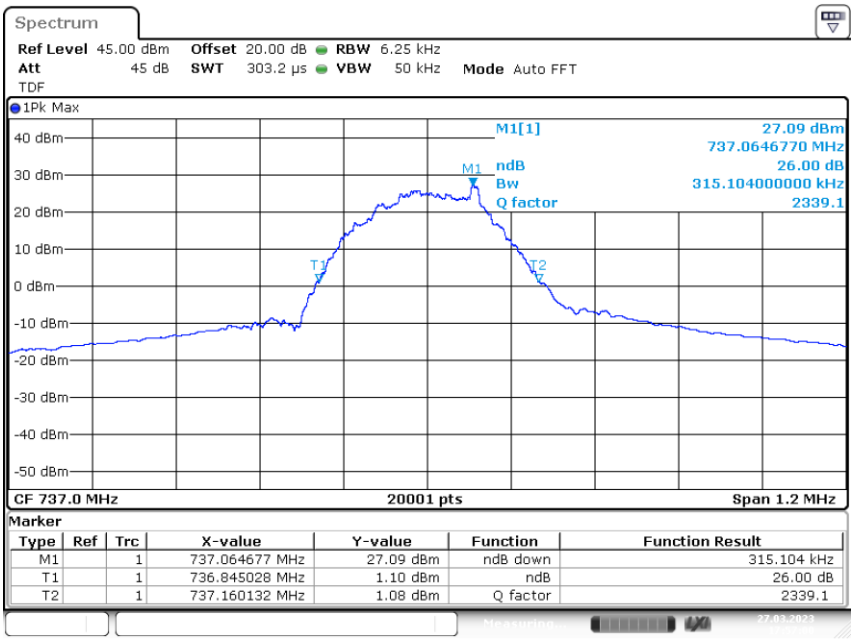
3.4 OCBw AWGN 15M+3 737.0000M _26dB

Band: USA700E; Frequency: 737.0000 MHz; Band Edge: mid;
Mod: GSM; Output OCBw 0.3 dB < AGC



3.4 OCBw GSM Out -0.3 737.0000M _26dB

Band: USA700E; Frequency: 737.0000 MHz; Band Edge: mid;
Mod: GSM; Output OCBw 3 dB > AGC



3.4 OCBw GSM Out +3 737.0000M _26dB

4.2.5 TEST EQUIPMENT USED

- Conducted

4.3 OUT-OF-BAND EMISSION LIMITS

Standard FCC Part § 2.1051, § 27.53

The test was performed according to:
ANSI C63.26:2015, KDB 935210 D05 v01r04: 3.6

Test date: 2023-03-29 to 2023-04-17

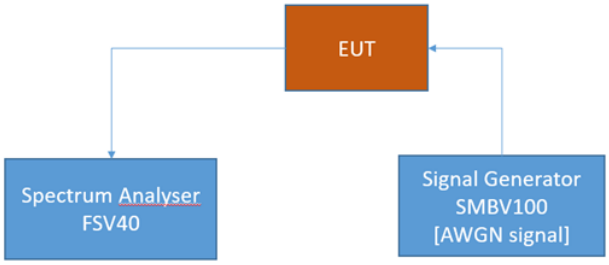
Environmental conditions: 21 … 26 °C; 25 .. 35 % r. H.

Test engineer: Thomas Hufnagel

4.3.1 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 § 27.53.

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.

4.3.2 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 § 27.53 FCC:

Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§ 27.53 – Emission limits

Band 12:
(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

4.3.3 TEST PROTOCOL

Band 12, 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	743.50	-3.3	-33.6	-13.0	20.6
Wideband	3 dB > AGC	upper	743.50	0.0	-33.3	-13.0	20.3
Wideband 5G	-0.3 dB < AGC	upper	738.50	-3,1	-35.6	-13.0	22.6
Wideband 5G	3 dB > AGC	upper	738.50	+0.2	-35.1	-13.0	22.1
Narrowband	-0.3 dB < AGC	upper	745.80	-3.3	-25.0	-13.0	12.0
Narrowband	3 dB > AGC	upper	745.80	0.0	-24.9	-13.0	11.9
Wideband	-0.3 dB < AGC	lower	730.50	-2.3	-34.4	-13.0	21.4
Wideband	3 dB > AGC	lower	730.50	+1.0	-34.5	-13.0	21.5
Wideband 5G	-0.3 dB < AGC	lower	735.50	-2,9	-35.8	-13.0	22.8
Wideband 5G	3 dB > AGC	lower	735.50	+0,4	-35.9	-13.0	22.9
Narrowband	-0.3 dB < AGC	lower	728.20	-2.3	-26.4	-13.0	13.4
Narrowband	3 dB > AGC	lower	728.20	+1.0	-26.8	-13.0	13.8

Band 12, 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	743.50	741.00	-3.3	-34.5	-13.0	21.5
WB	3 dB > AGC	upper	743.50	741.00	0.0	-35.0	-13.0	22.0
NB	-0.3 dB < AGC	upper	745.80	745.60	-3.3	-26.9	-13.0	13.9
NB	3 dB > AGC	upper	745.80	745.60	0.0	-27.1	-13.0	14.1
WB	-0.3 dB < AGC	lower	730.50	733.00	-2.3	-36.1	-13.0	23.1
WB	3 dB > AGC	lower	730.50	733.00	1.0	-35.8	-13.0	22.8
NB	-0.3 dB < AGC	lower	728.20	728.40	-2.3	-27.8	-13.0	14.8
NB	3 dB > AGC	lower	728.20	728.40	1.0	-28.7	-13.0	15.7

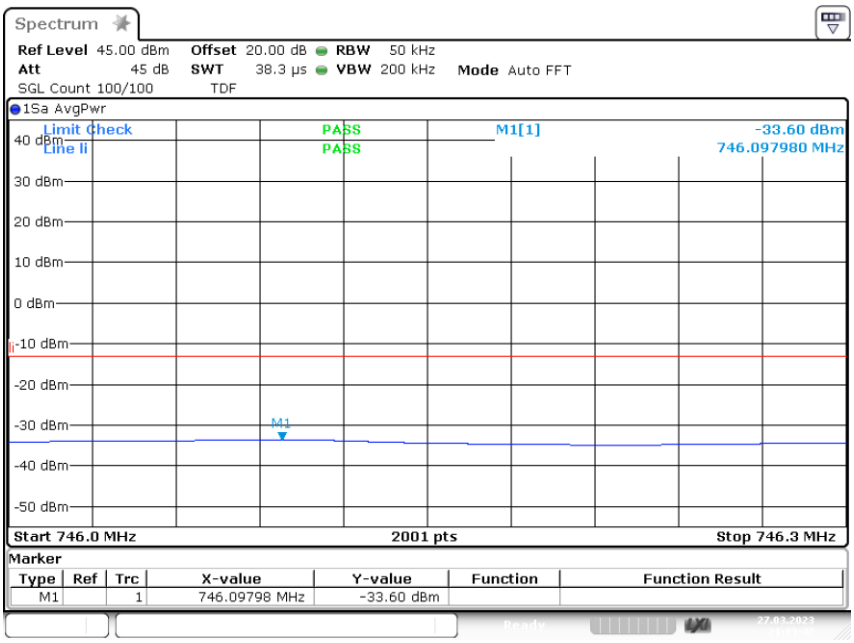
Remark: Please see next sub-clause for the measurement plot.

Explanations concering table with two input signals:

"WB" means Wideband.
"NB" means Narrowband.
Wideband 5G means Wideband 15M

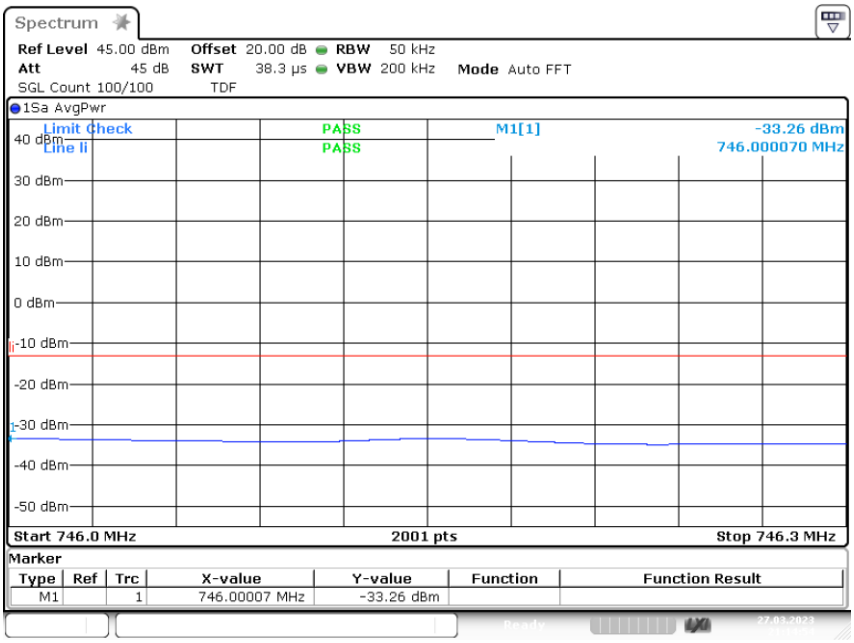
4.3.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



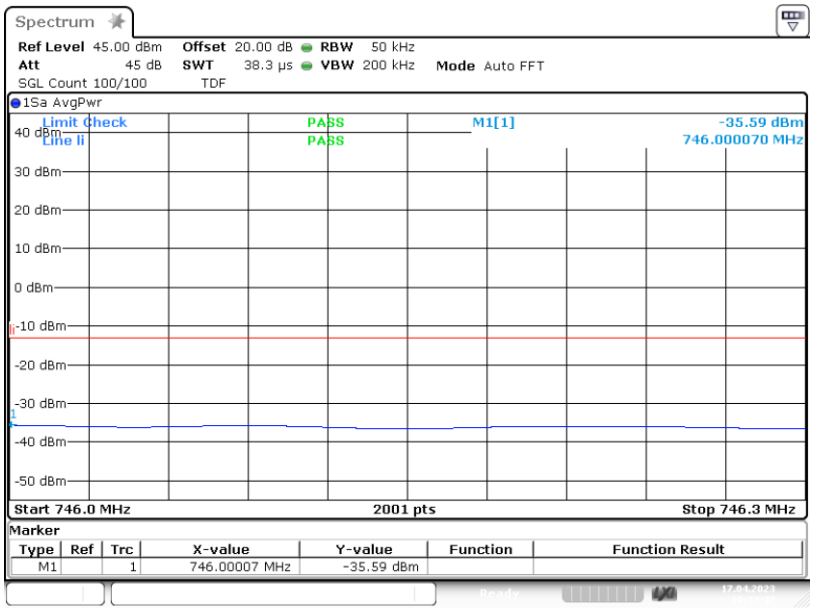
3.6.2 out of band emi USA700E AWGN upper 1carrier -0.3 dB 74
6.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



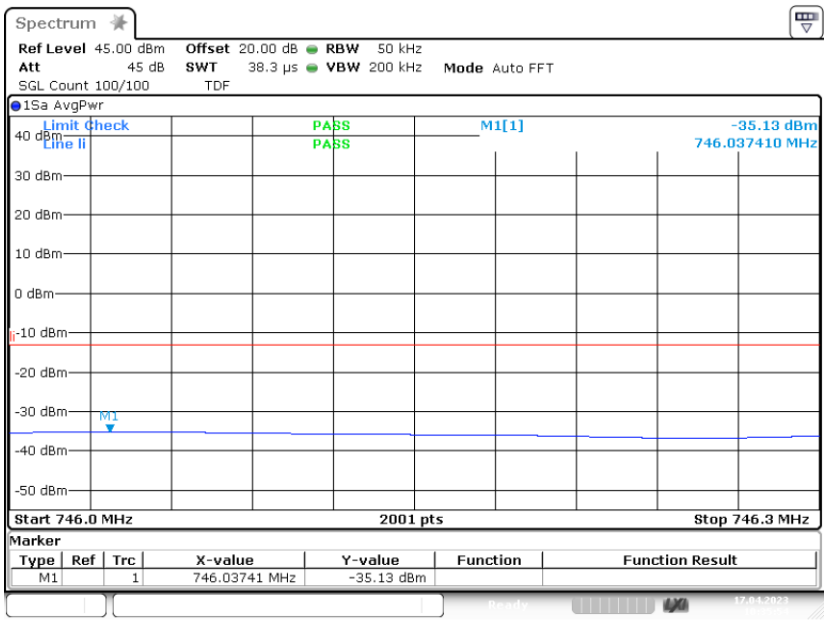
3.6.2 out of band emi USA700E AWGN upper 1carrier +3.0 dB 74
6.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: AWGN 15M; Input Power = 0.3 dB < AGC; Number of signals 1



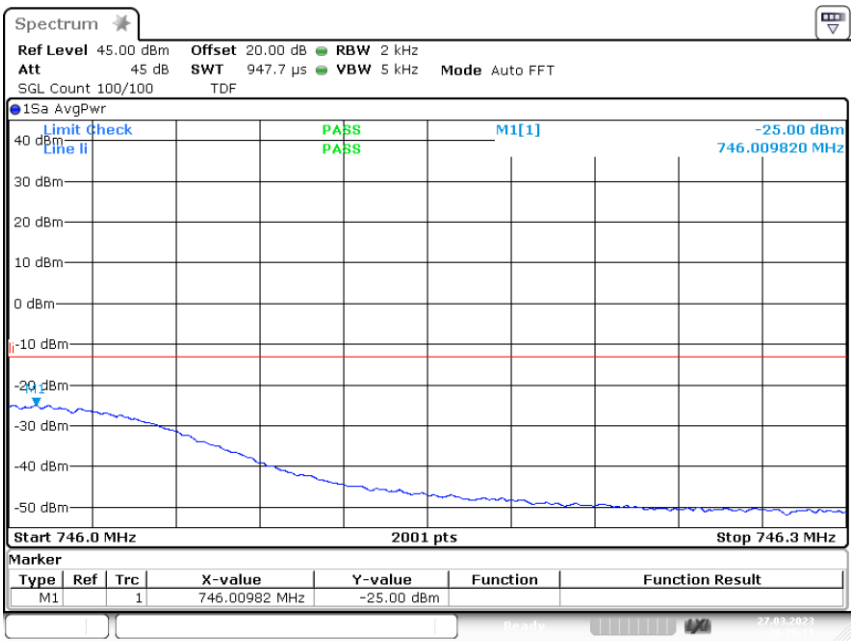
3.6.2 out of band emi USA700E AWGN 15M upper 1carrier -0.3 d
B 746.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: AWGN 15M; Input Power = 3 dB > AGC; Number of signals 1



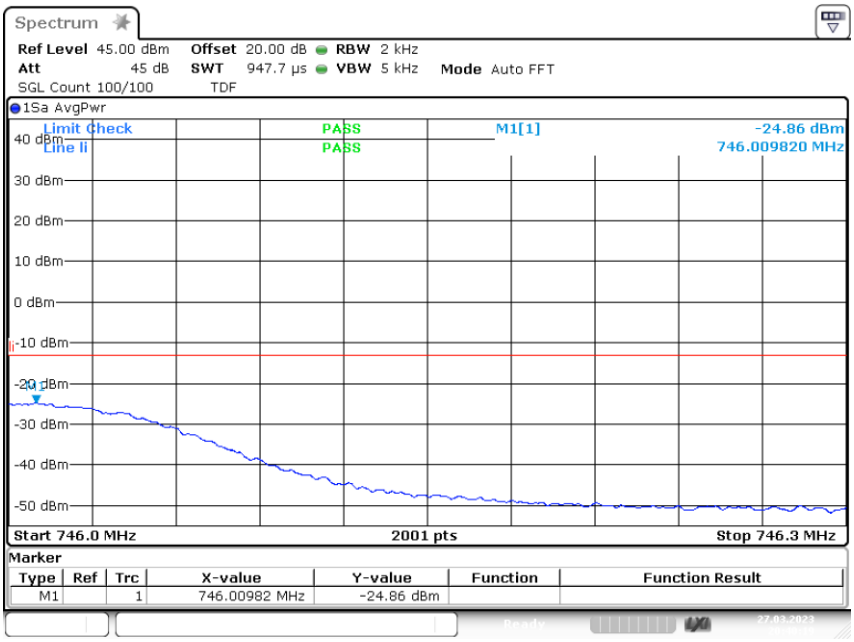
3.6.2 out of band emi USA700E AWGN 15M upper 1carrier +3.0 d
B 746.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



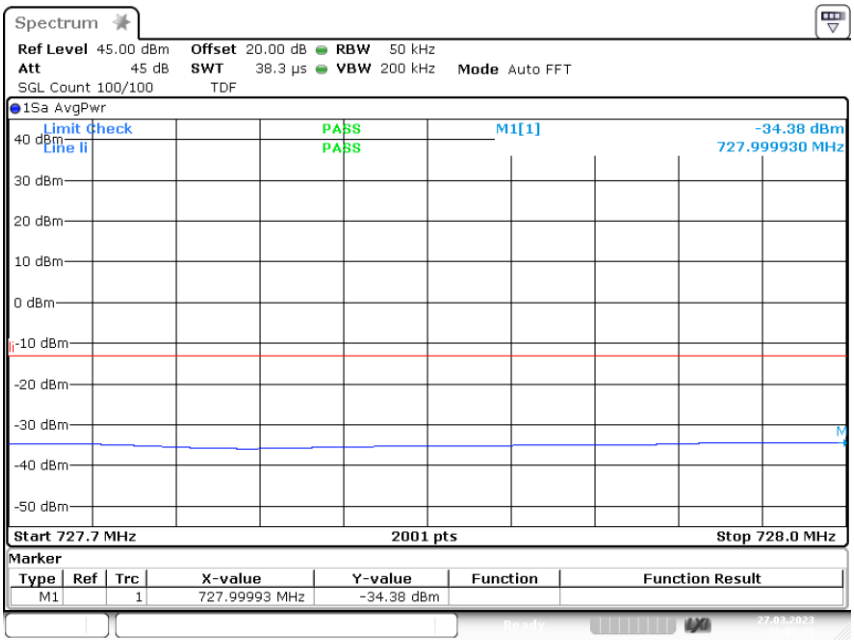
3.6.2 out of band emi USA700E GSM upper 1carrier -0.3 dB 746
.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



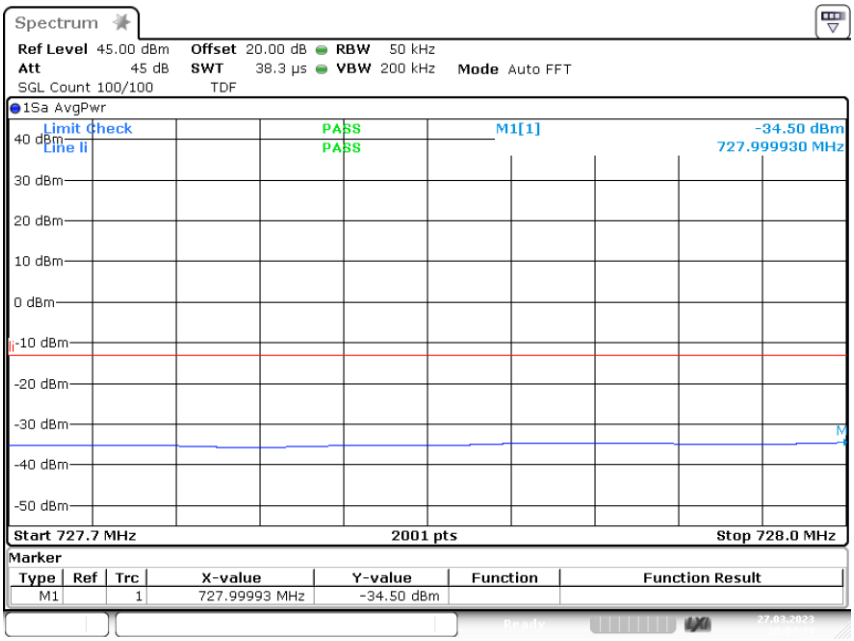
3.6.2 out of band emi USA700E GSM upper 1carrier +3.0 dB 746
.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower;
Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 1



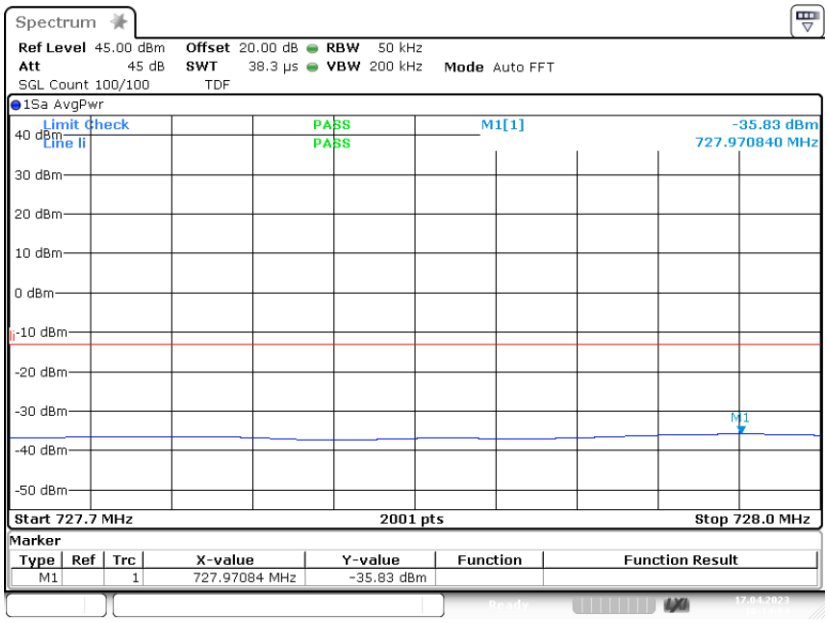
3.6.2 out of band emi USA700E AWGN lower 1carrier -0.3 dB 72
7.700M 728.000M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower;
Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 1



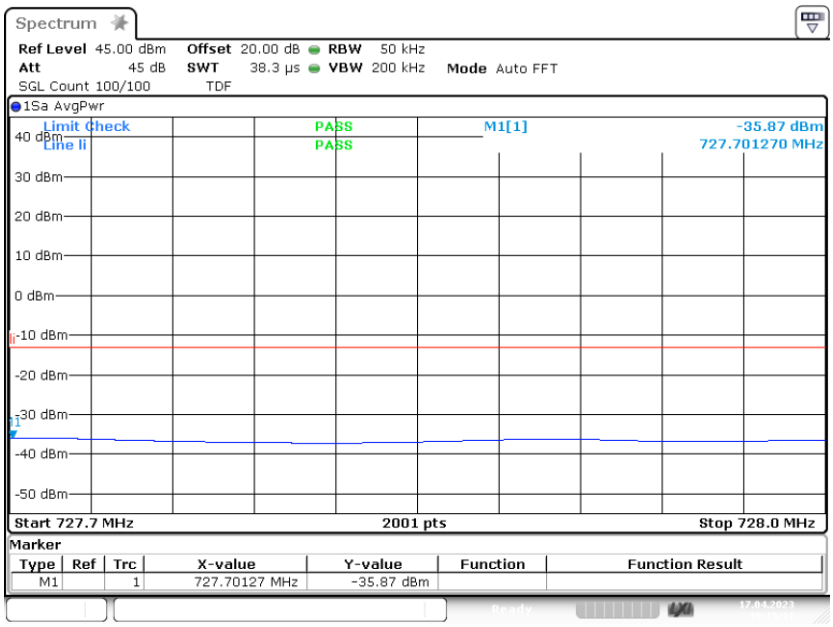
3.6.2 out of band emi USA700E AWGN lower 1carrier +3.0 dB 72
7.700M 728.000M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower;
Mod: AWGN 15M; Input Power = 0.3 dB < AGC; Number of signals 1



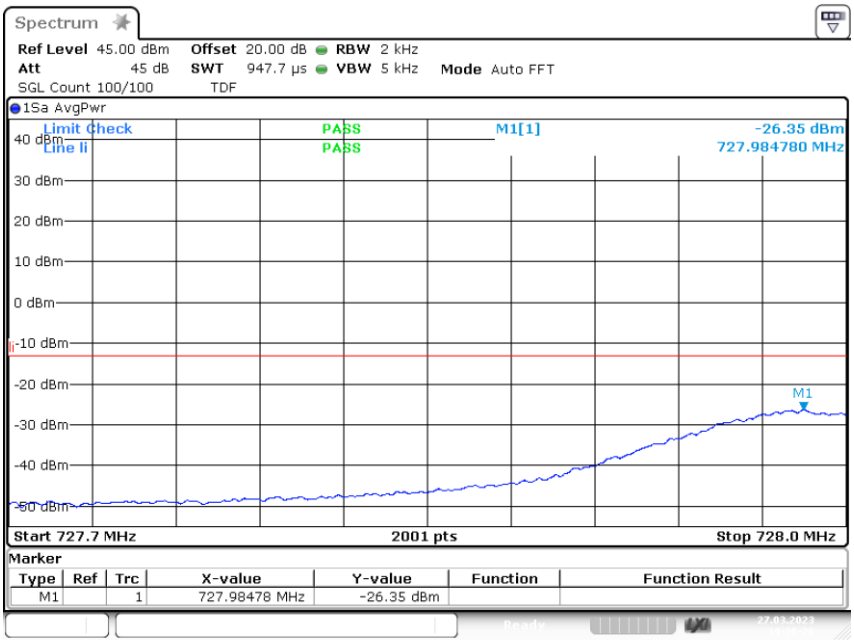
3.6.2 out of band emi USA700E AWGN 15M lower 1carrier -0.3 d
B 727.700M 728.000M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower;
Mod: AWGN 15M; Input Power = 3 dB > AGC; Number of signals 1



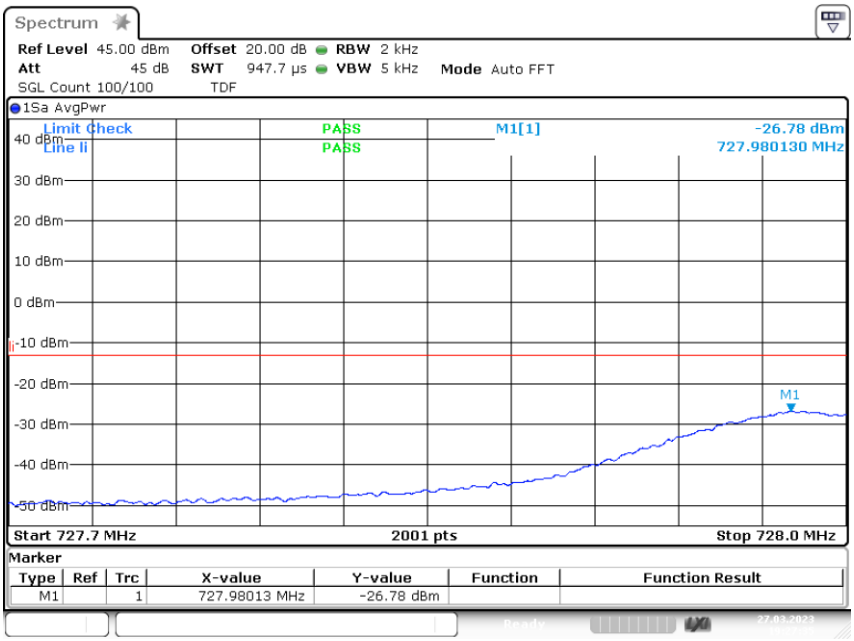
3.6.2 out of band emi USA700E AWGN 15M lower 1carrier +3.0 d
B 727.700M 728.000M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower;
Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 1



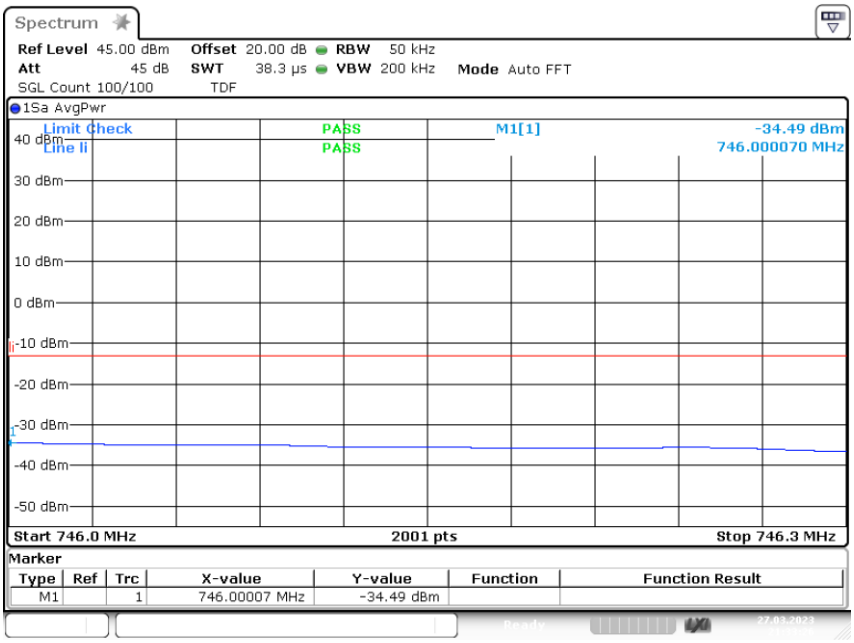
3.6.2 out of band emi USA700E GSM lower 1carrier -0.3 dB 727
.700M 728.000M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower;
Mod: GSM; Input Power = 3 dB > AGC; Number of signals 1



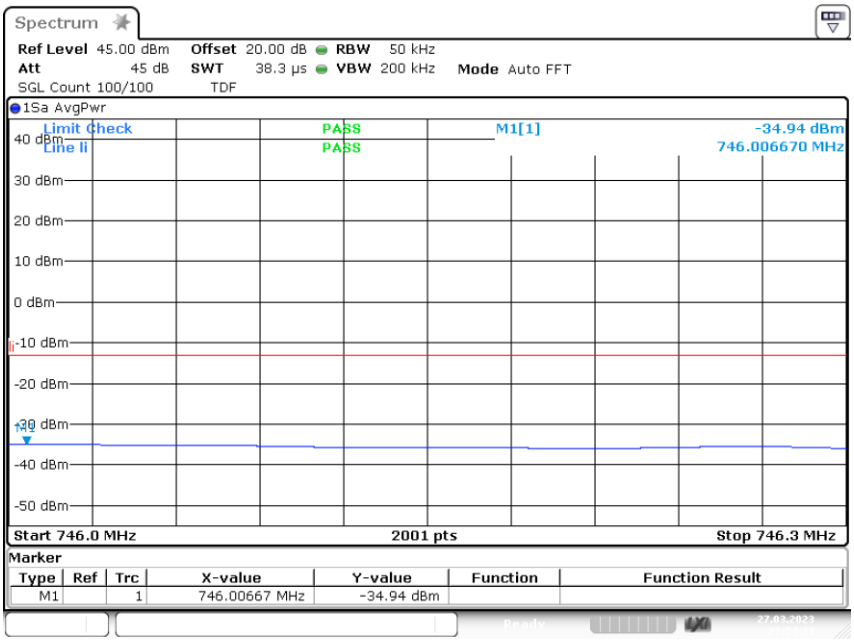
3.6.2 out of band emi USA700E GSM lower 1carrier +3.0 dB 727
.700M 728.000M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



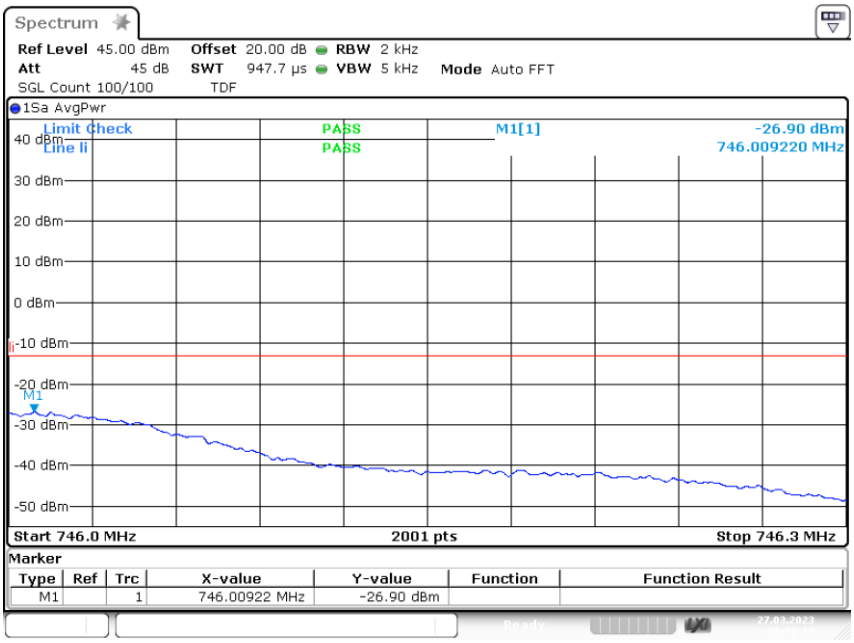
3.6.2 out of band emi USA700E AWGN upper 2carriers -0.3 dB 7
46.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



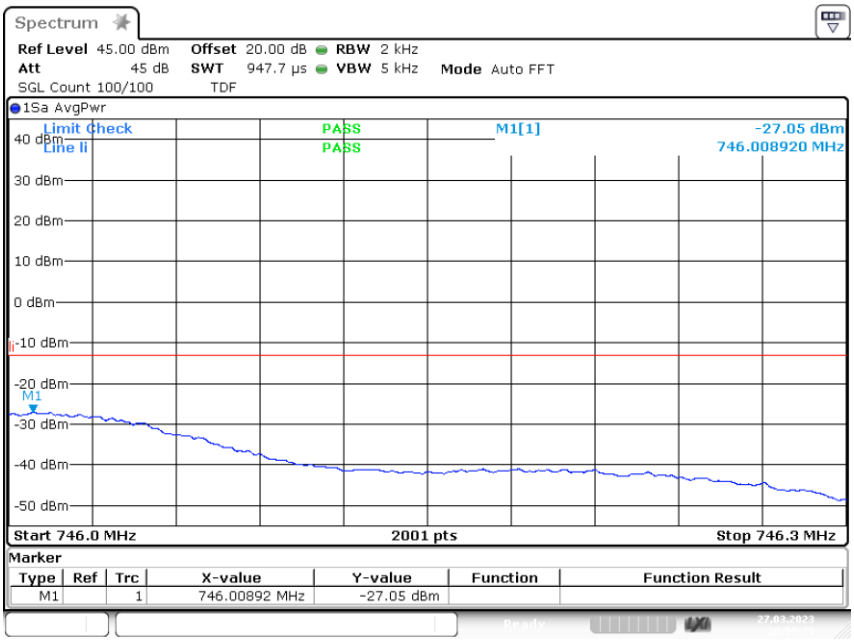
3.6.2 out of band emi USA700E AWGN upper 2carriers +3.0 dB 7
46.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



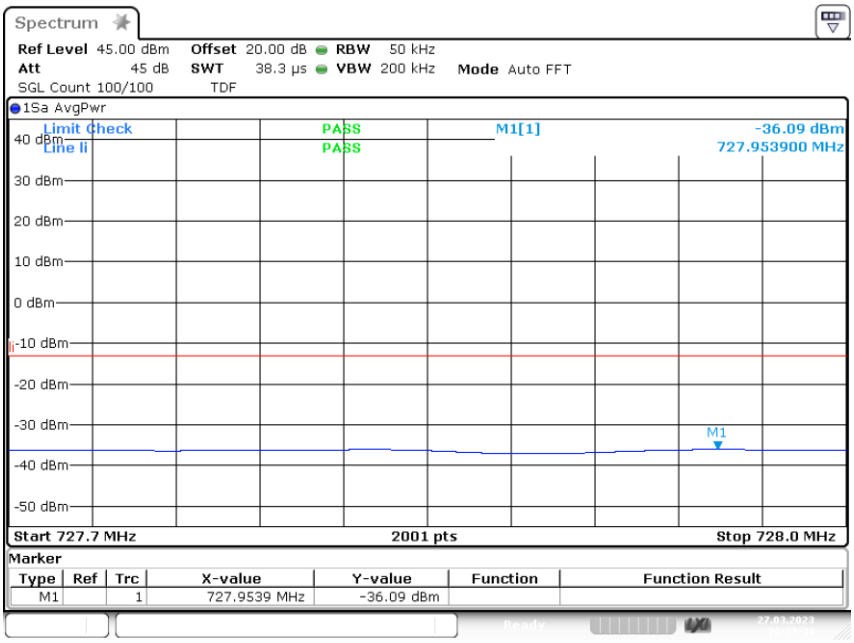
3.6.2 out of band emi USA700E GSM upper 2carriers -0.3 dB 74
6.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: upper;
Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



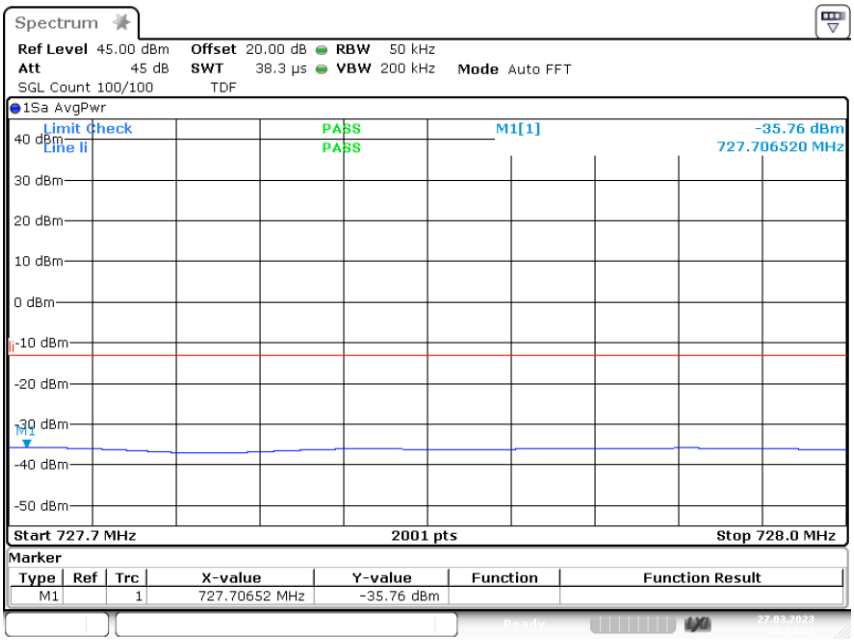
3.6.2 out of band emi USA700E GSM upper 2carriers +3.0 dB 74
6.000M 746.300M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 0.3 dB < AGC; Number of signals 2



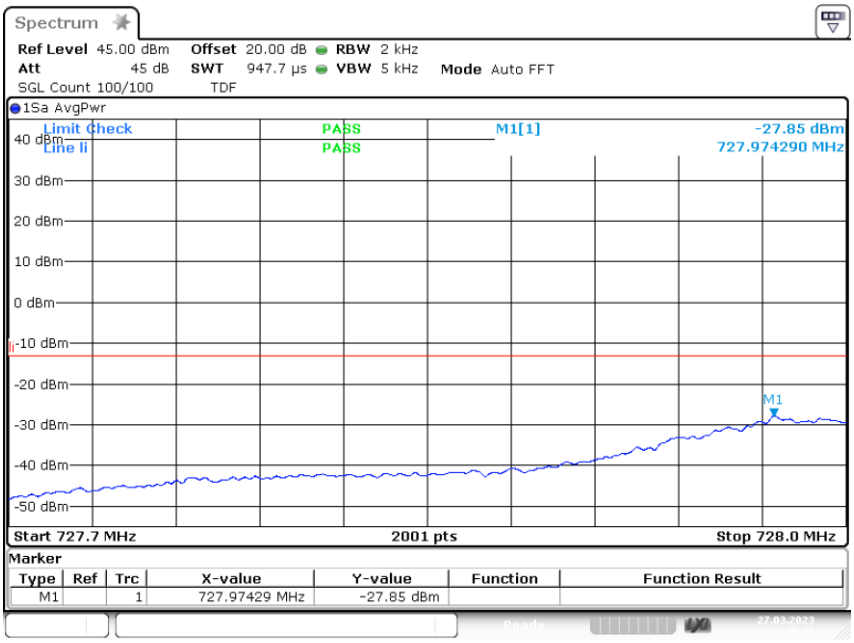
3.6.2 out of band emi USA700E AWGN lower 2carriers -0.3 dB 7
27.700M 728.000M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower; Mod: AWGN; Input Power = 3 dB > AGC; Number of signals 2



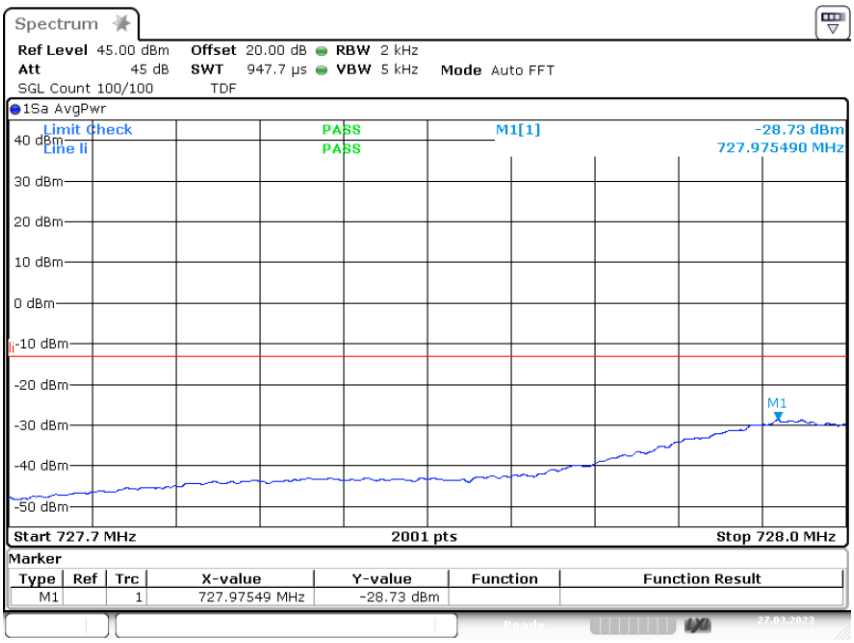
3.6.2 out of band emi USA700E AWGN lower 2carriers +3.0 dB 7
27.700M 728.000M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower;
Mod: GSM; Input Power = 0.3 dB < AGC; Number of signals 2



3.6.2 out of band emi USA700E GSM lower 2carriers -0.3 dB 72
7.700M 728.000M

Band: USA700E; Frequency: 728.0000 MHz to 746.0000 MHz; Band Edge: lower;
Mod: GSM; Input Power = 3 dB > AGC; Number of signals 2



3.6.2 out of band emi USA700E GSM lower 2carriers +3.0 dB 72
7.700M 728.000M

4.3.5 TEST EQUIPMENT USED

- Conducted

4.4 OUT-OF-BAND REJECTION

Standard FCC Part 20

The test was performed according to:
ANSI C63.26:2015; KDB 935210 D05

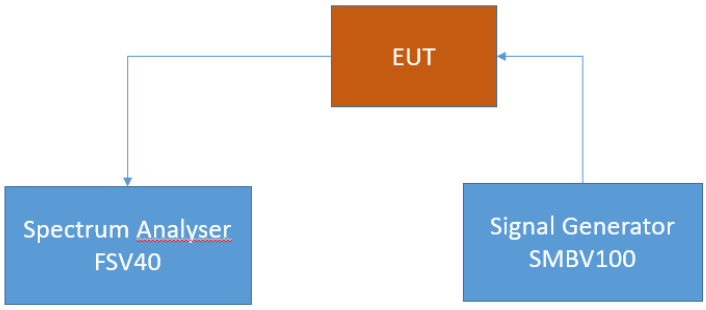
Test date: 2023-03-29 to 2023-04-17

Environmental conditions: 21 … 26 °C; 25 .. 35 % r. H.

Test engineer: Thomas Hufnagel

4.4.1 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.

4.4.2 TEST REQUIREMENTS/LIMITS

None.

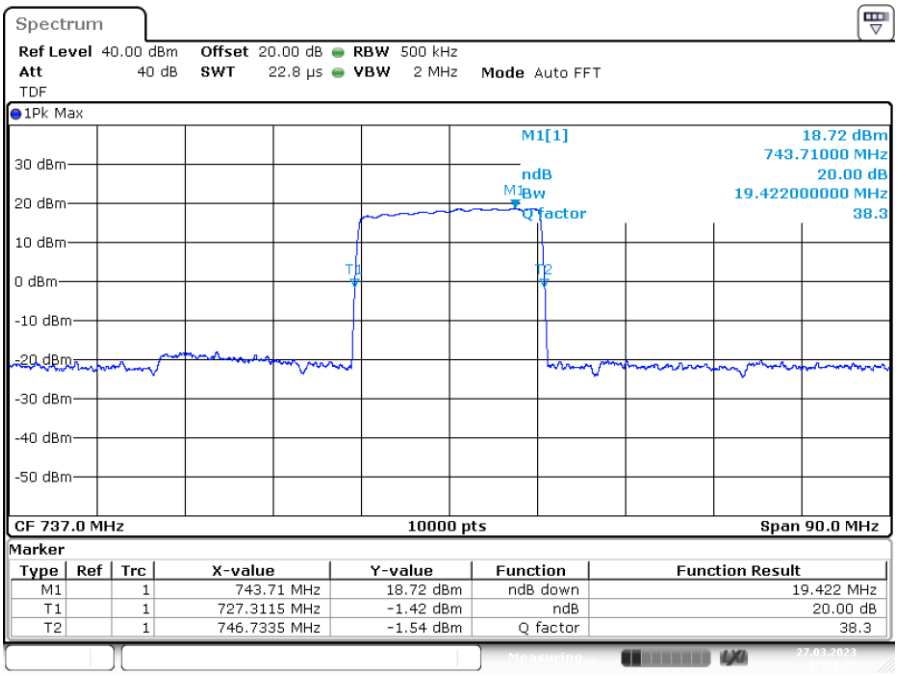
4.4.3 TEST PROTOCOL

Band 12, 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]**
743.71	18.72	727.3115	746.7335	19.4220

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

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

Frequency Band = Band 12, Direction = RF downlink



3.3 Out of band rejection USA700E 737.00000M
_20dB

4.4.5 TEST EQUIPMENT USED

- Conducted

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	E-003139	2022-10	2023-10
1.2	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	E-003206	2023-01	2025-01
1.3	Arduino & HTY939	ThermoHygro Datalogger	Eigenbau	E-003998	2022-09	2023-09
1.4	LabVIEW	Software	NI	----	---	---

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.

Frequency	20 dB attenuator Deviation to 20 dB	cable loss (to receiver)
MHz	dB	dB
100 MHz	-0.40	-0.19
200 MHz	-0.34	-0.29
300 MHz	-0.26	-0.37
400 MHz	-0.24	-0.41
500 MHz	-0.20	-0.45
600 MHz	-0.20	-0.51
700 MHz	-0.16	-0.56
800 MHz	-0.16	-0.58
900 MHz	-0.14	-0.63
1000 MHz	-0.12	-0.66
2000 MHz	0.02	-0.98
3000 MHz	0.10	-1.28
4000 MHz	0.09	-1.53
5000 MHz	0.01	-1.65
6000 MHz	-0.05	-1.77
7000 MHz	0.04	-2.07
8000 MHz	-0.07	-2.07
9000 MHz	-0.12	-2.55
10000 MHz	-0.08	-2.19
11000 MHz	-0.10	-2.37
12000 MHz	-0.12	-2.40
13000 MHz	-0.07	-2.29
14000 MHz	0.09	-2.57
15000 MHz	0.18	-2.42
16000 MHz	0.01	-2.59
17000 MHz	0.00	-2.75
18000 MHz	0.10	-2.83

Sample calculation

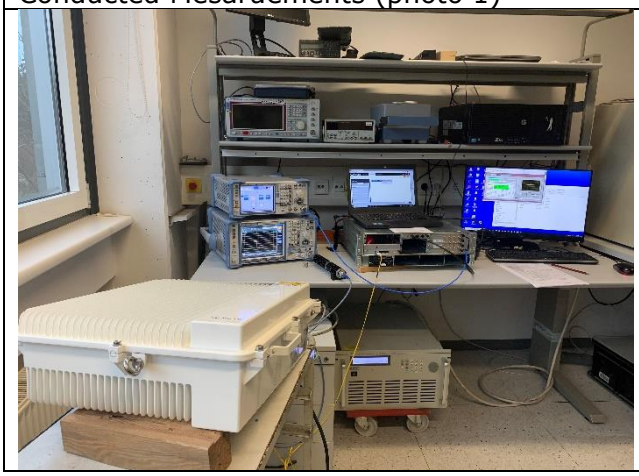
P_{ower} (dBm) = U (dBm) + $AT\Delta_{attenuator}$ (dB) + $AT_{attenuator}$ (dB) - AT_{Cable} (dB)
U = Receiver reading
$AT\Delta_{attenuator}$ = Deviation to 20 dB
$AT_{attenuator}$ = 20 dB
AT_{Cable}= cable loss

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 (photo 1)	Conducted Mesurements (photo 2)
	

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 *****