

# FCC Measurement/Technical Report on ION-M23 SDARS 3-Sector

## SDARS Remote Optical System

FCC ID: XS5-M23SDARS  
IC: -

**Test Report Reference:** MDE\_COMMS\_1704\_FCCa\_REV1

### Test Laboratory:

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40880 Ratingen  
Germany



### Note:

The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

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## **Applied Standards and Test Summary**

### **1.1 APPLIED STANDARDS**

#### **Type of Authorization**

Certification for a SDARS terrestrial repeater.

#### **Applicable FCC Rules**

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 25 (10/1/17 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 25, Satellite Communications  
Subpart C – Technical standards

§ 25.202 – Frequencies, frequency tolerance, and emission limits.

§ 25.214 – Technical requirements for space stations in the Satellite Digital Audio Radio Service and associated terrestrial repeaters

The tests were selected and performed with reference to:

- FCC Public Notice 935210 applying “Measurement guidance for industrial and non-consumer signal booster, repeater and amplifier devices” 935210 D05 v01r02, 2017-10-27.
- FCC Public Notice 971168 applying “Measurement guidance for certification of licensed digital transmitters” 971168 D01 v03, 2017-10-27
- ANSI C63.26: 2015

#### **Summary Test Results:**

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

## 1.2 MEASUREMENT SUMMARY / SIGNATURES

### 47 CFR CHAPTER I FCC PART 25 Subpart C

§2.1046, §25.214 (d) (1)

Average Radiated Power [EIRP]

The measurement was performed according to ANSI C63.26, KDB  
935210 D05 v01r02: 3.5

**Final Result**

#### OP-Mode

Frequency Band, Direction, Input Power, Signal Type,  
No of Input signals

#### Setup

#### FCC

#### IC

|                                                   |          |        |   |
|---------------------------------------------------|----------|--------|---|
| Low [Sirius], RF downlink, 0.3 dB < AGC, AWGN, 2  | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 0.3 dB < AGC, COFDM, 2 | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 3 dB > AGC, AWGN, 2    | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 3 dB > AGC, COFDM, 2   | S01_AA01 | Passed | - |
| High [XM], RF downlink, 0.3 dB < AGC, AWGN, 2     | S01_AA01 | Passed | - |
| High [XM], RF downlink, 0.3 dB < AGC, COFDM, 2    | S01_AA01 | Passed | - |
| High [XM], RF downlink, 3 dB > AGC, AWGN, 2       | S01_AA01 | Passed | - |
| High [XM], RF downlink, 3 dB > AGC, COFDM, 2      | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 0.3 dB < AGC, AWGN, 1  | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 0.3 dB < AGC, AWGN, 1  | S01_AA01 | Passed | - |
| High [XM], RF downlink, 3 dB > AGC, AWGN, 1       | S01_AA01 | Passed | - |
| High [XM], RF downlink, 3 dB > AGC, AWGN, 1       | S01_AA01 | Passed | - |

### 47 CFR CHAPTER I FCC PART 25 Subpart C

§25.214 (d) (1)

Peak to Average Ratio [PAPR]

The measurement was performed according to ANSI C63.26

**Final Result**

#### OP-Mode

Frequency Band, Direction, Input Power, Signal Type  
No of Input signals

#### Setup

#### FCC

#### IC

|                                                   |          |        |   |
|---------------------------------------------------|----------|--------|---|
| Low [Sirius], RF downlink, 0.3 dB < AGC, AWGN, 2  | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 0.3 dB < AGC, COFDM, 2 | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 3 dB > AGC, AWGN, 2    | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 3 dB > AGC, COFDM, 2   | S01_AA01 | Passed | - |
| High [XM], RF downlink, 0.3 dB < AGC, AWGN, 2     | S01_AA01 | Passed | - |
| High [XM], RF downlink, 0.3 dB < AGC, COFDM, 2    | S01_AA01 | Passed | - |
| High [XM], RF downlink, 3 dB > AGC, AWGN, 2       | S01_AA01 | Passed | - |
| High [XM], RF downlink, 3 dB > AGC, COFDM, 2      | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 0.3 dB < AGC, AWGN, 1  | S01_AA01 | Passed | - |
| Low [Sirius], RF downlink, 3 dB > AGC, AWGN, 1    | S01_AA01 | Passed | - |
| High [XM], RF downlink, 0.3 dB < AGC, AWGN, 1     | S01_AA01 | Passed | - |
| High [XM], RF downlink, 3 dB > AGC, AWGN, 1       | S01_AA01 | Passed | - |

#### 47 CFR CHAPTER I FCC PART 25 Subpart C

§2.1049

Occupied Bandwidth / Input-versus-output Spectrum

The measurement was performed according to ANSI C63.26, KDB 935210 D05 v01r02: 3.4

**Final Result**

##### OP-Mode

Frequency Band, Direction, Input Power, Signal Type

Low [Sirius], RF downlink, 0.3 dB < AGC, AWGN

Low [Sirius], RF downlink, 0.3 dB < AGC, COFDM

Low [Sirius], RF downlink, 3 dB > AGC, AWGN

Low [Sirius], RF downlink, 3 dB > AGC, COFDM

High [XM], RF downlink, 0.3 dB < AGC, AWGN

High [XM], RF downlink, 0.3 dB < AGC, COFDM

High [XM], RF downlink, 3 dB > AGC, AWGN

High [XM], RF downlink, 3 dB > AGC, COFDM

**Setup**

**FCC**

**IC**

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

#### 47 CFR CHAPTER I FCC PART 25 Subpart C

§2.1051, §25.202 (h) (1)

Conducted spurious emissions at antenna terminals

The measurement was performed according to ANSI C63.26

**Final Result**

##### OP-Mode

Frequency Band, Test Frequency, Direction, Signal Type

Low [Sirius], mid, RF downlink, AWGN

Low [Sirius], mid, RF downlink, COFDM

High [XM], mid, RF downlink, AWGN

High [XM], mid, RF downlink, COFDM

**Setup**

**FCC**

**IC**

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

#### 47 CFR CHAPTER I FCC PART 25 Subpart C

§2.1051, §25.202 (h) (1)

Out-of-band emission limits

The measurement was performed according to ANSI C63.26

**Final Result**

##### OP-Mode

Frequency Band, Test Frequency, Band Edge, Direction, Input Power, Signal Type

Low [Sirius], mid, Lower, RF downlink, 0.3 dB < AGC, AWGN

Low [Sirius], mid, Lower, RF downlink, 0.3 dB < AGC, COFDM

Low [Sirius], mid, Lower, RF downlink, 3 dB > AGC, AWGN

Low [Sirius], mid, Lower, RF downlink, 3 dB > AGC, COFDM

High [XM], mid, Lower, RF downlink, 0.3 dB < AGC, AWGN

High [XM], mid, Lower, RF downlink, 0.3 dB < AGC, COFDM

High [XM], mid, Lower, RF downlink, 3 dB > AGC, AWGN

High [XM], mid, Lower, RF downlink, 3 dB > AGC, COFDM

**Setup**

**FCC**

**IC**

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

S01\_AA01

Passed

-

**47 CFR CHAPTER I FCC PART 25 Subpart C**

**§2.1053, §25.202 (h) (1)**

Field strength of spurious radiation

The measurement was performed according to ANSI C63.26

**Final Result**

**OP-Mode**

Frequency Band, Test Frequency, Direction, Signal Type

Low [Sirius], mid, RF downlink, AWGN

Low [Sirius], mid, RF downlink, COFDM

High [XM], mid, RF downlink, AWGN

High [XM], mid, RF downlink, COFDM

**Setup**

S01\_AA01

S01\_AA01

S01\_AA01

S01\_AA01

**FCC**

Passed

Passed

Passed

Passed

**IC**

-

-

-

-

N/A: Not applicable

N/P: Not performed

The test case frequency stability [25.202 (d)] was not performed, since the EUT is not equipped with signal processing capabilities.

| Report version control |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |
|------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Version                | Release date | Change Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Version validity |
| initial                | 2018-06-11   | --                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | invalid          |
| REV1                   | 2018-07-12   | <ul style="list-style-type: none"> <li>Page 4ff: Measurement summary table updated with single signal "Radiated Output Power" and Peak-to-Average" results</li> <li>Page 9: Typing error in frequency band corrected.</li> <li>Page 9: Unit for Maximum downlink gain changed to dB.</li> <li>Page 11: AGC values for single input signals added.</li> <li>Page 13: Comment added, that maybe the maximum antenna gain cannot be exploited (due to SAR limitations).</li> <li>Page 13: Radiated output power results for single input signal added.</li> <li>Page 16-17: Measurement plots for single signal output power added.</li> <li>Page 19: Peak to Average Ratio results for single input signal added</li> <li>Page 24-25: Measurement plots for single signal Peak to Average Ratio added.</li> </ul> | valid            |

*M. Kullik*

(responsible for accreditation scope)  
Dipl.-Ing. Marco Kullik

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(responsible for testing and report)  
Dipl.-Ing. Daniel Gall



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## 2 ADMINISTRATIVE DATA

### 2.1 TESTING LABORATORY

Company Name: 7layers GmbH  
Address: Borsigstr. 11  
40880 Ratingen  
Germany

This facility has been fully described in a report submitted to the ISED and accepted under the registration number: Site# 3699A-1.

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no: DAKKS D-PL-12140-01-00  
FCC Designation Number: DE0015  
FCC Test Firm Registration: 929146  
Responsible for accreditation scope: Dipl.-Ing. Marco Kullik  
Report Template Version: 2018-01-03

### 2.2 PROJECT DATA

Responsible for testing and report: Dipl.-Ing. Daniel Gall  
Employees who performed the tests: documented internally at 7Layers  
Date of Report: 2018-07-12  
Testing Period: 2018-03-27 to 2018-07-11

### 2.3 APPLICANT DATA

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

### 2.4 MANUFACTURER DATA

Company Name: please see applicant data

### 3 TEST OBJECT DATA

#### 3.1 GENERAL EUT DESCRIPTION

|                                          |                                                                                                                                                    |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Kind of Device<br>product description    | SDARS Terrestrial Repeater                                                                                                                         |
| Product name                             | SDARS Remote Optical System                                                                                                                        |
| Type                                     | ION-M23 SDARS 3-Sector                                                                                                                             |
| <b>Declared EUT data by the supplier</b> |                                                                                                                                                    |
| General Product<br>Description           | The EUT is a SDARS terrestrial repeater supporting the following range:<br>2324 – 2341.5 MHz<br>A RF operation is only supported for the downlink. |
| Booster Type                             | SDARS Terrestrial Repeater                                                                                                                         |
| Voltage Type                             | AC & DC                                                                                                                                            |
| Voltage Level                            | AC: 100 – 240 V, 50 – 60 Hz<br>DC: 48 – 60 V                                                                                                       |
| Maximum Output<br>Donor Port [Uplink]    | -                                                                                                                                                  |
| Maximum Output<br>Server Port [Downlink] | 33 dBm [1 carrier]<br>30 dBm [2 carriers]                                                                                                          |
| Maximum Gain [Uplink]                    | -                                                                                                                                                  |
| Maximum Gain<br>[Downlink]               | 52 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      | Sample Code                              | Description |
|------------------|------------------------------------------|-------------|
| aa01             | DE1277004aa01                            | FCC sample  |
| Sample Parameter | Value                                    |             |
| Serial Number    | SN: 11                                   |             |
| HW Version       | ION-M23 SDARS 3-Sector (ID:7760774-0001) |             |
| SW Version       | SW V5.28.0.4 RCM161RU (ID: 7162793-28)   |             |
| 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<br>(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<br>(Manufacturer, HW, SW, S/N) | Description |
|--------|----------------------------------------|-------------|
| -      | --                                     | -           |

### 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 |
|----------|---------------------|---------------------------|
| S01_AA01 | aa01                | Setup for all tests       |

### 3.6 OPERATING MODES

This chapter describes the operating modes of the EUTs used for testing.

#### 3.6.1 TEST CHANNELS

| Band         | Direction | Lower Frequency Band Edge [MHz] | Upper Frequency Band Edge [MHz] | Center Frequency [MHz] | Port  |
|--------------|-----------|---------------------------------|---------------------------------|------------------------|-------|
| Low (Sirius) | downlink  | 2320.00                         | 2332.50                         | 2326.25                | Donor |
| High (XM)    | downlink  | 2332.50                         | 2345.00                         | 2338.75                | Donor |

#### 3.6.2 AUTOMATIC GAIN CONTROL LEVELS

| AGC Levels (Two simultaneous input signals) |           |             |                     |                             |                           |                 |           |
|---------------------------------------------|-----------|-------------|---------------------|-----------------------------|---------------------------|-----------------|-----------|
| Band                                        | Direction | Signal Type | AGC Start Pin [dBm] | AGC Start Pin -0.3 dB [dBm] | AGC Start Pin +3 dB [dBm] | Frequency [MHz] | Frequency |
| Low / High                                  | downlink  | COFDM       | 0.9                 | 0.6                         | 3.9                       | 2326.25         | Center    |
| Low / High                                  | downlink  | AWGN        | 1.0                 | 0.7                         | 4.0                       | 2338.75         |           |

| AGC Levels (One input signal) |           |             |                     |                             |                           |                 |           |
|-------------------------------|-----------|-------------|---------------------|-----------------------------|---------------------------|-----------------|-----------|
| Band                          | Direction | Signal Type | AGC Start Pin [dBm] | AGC Start Pin -0.3 dB [dBm] | AGC Start Pin +3 dB [dBm] | Frequency [MHz] | Frequency |
| Low                           | downlink  | AWGN        | 1.5                 | 1.2                         | 4.5                       | 2326.25         | Center    |
| High                          | downlink  | AWGN        | 1.7                 | 1.4                         | 4.7                       | 2338.75         |           |

### 3.7 PRODUCT LABELLING

#### 3.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

#### 3.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

## 4 TEST RESULTS

### 4.1 AVERAGE RADIATED POWER [EIRP]

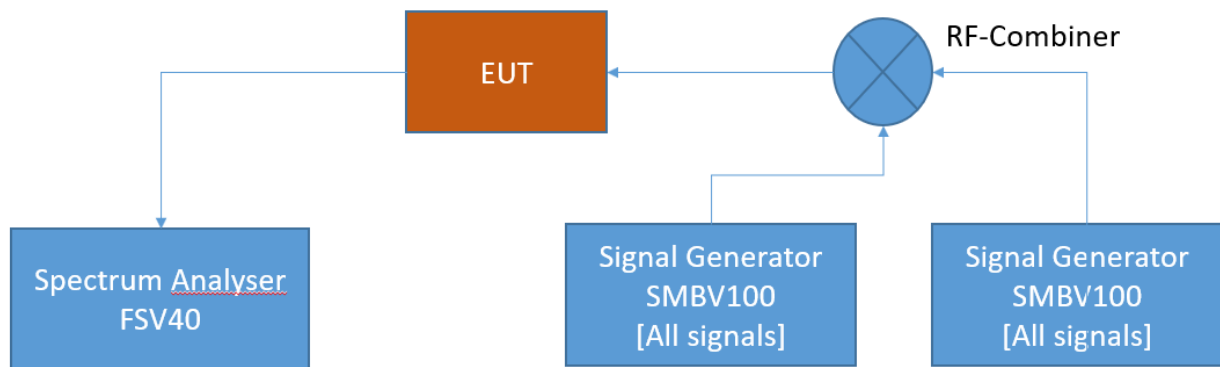
Standard FCC Part 25, §25.214

**The test was performed according to:**  
ANSI C63.26, KDB 935210 D05 v01r02: 3.5

#### 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.

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



FCC Part 25 Satellite signal booster – Test Setup; RF Output Power

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

##### Part 25; Satellite Communications

##### Subpart C – Technical standards

##### §25.214

d) *Power limit for SDARS terrestrial repeaters.* (1) SDARS terrestrial repeaters must be operated at a power level less than or equal to 12-kW average EIRP, with a maximum peak-to-average power ratio of 13 dB.

#### 4.1.3 TEST PROTOCOL

| Low [Sirius] / High [XM], downlink (Two simultaneous input signals) |              |                   |                                    |                                       |                      |
|---------------------------------------------------------------------|--------------|-------------------|------------------------------------|---------------------------------------|----------------------|
| Signal Type                                                         | Input Power  | Frequency [MHz]   | Maximum Average Output Power [dBm] | Limit Average Output Power EIRP [dBm] | Margin to Limit [dB] |
| AWGN                                                                | 0.3 dB < AGC | 2326.25 / 2338.75 | 32.8                               | 70.8                                  | 38.0                 |
| AWGN                                                                | 3 dB > AGC   | 2326.25 / 2338.75 | 32.9                               | 70.8                                  | 37.9                 |
| COFDM                                                               | 0.3 dB < AGC | 2326.25 / 2338.75 | 32.7                               | 70.8                                  | 38.1                 |
| COFDM                                                               | 3 dB > AGC   | 2326.25 / 2338.75 | 32.8                               | 70.8                                  | 38.0                 |

| Low [XM] / High [XM], downlink (one input signal) |              |                 |                                    |                                       |                      |
|---------------------------------------------------|--------------|-----------------|------------------------------------|---------------------------------------|----------------------|
| Signal Type                                       | Input Power  | Frequency [MHz] | Maximum Average Output Power [dBm] | Limit Average Output Power EIRP [dBm] | Margin to Limit [dB] |
| AWGN                                              | 0.3 dB < AGC | 2326.25         | 32.5                               | 70.8                                  | 38.3                 |
| AWGN                                              | 3 dB > AGC   | 2326.25         | 32.4                               | 70.8                                  | 38.4                 |
| AWGN                                              | 0.3 dB < AGC | 2338.75         | 32.6                               | 70.8                                  | 38.2                 |
| AWGN                                              | 3 dB > AGC   | 2338.75         | 32.6                               | 70.8                                  | 38.2                 |

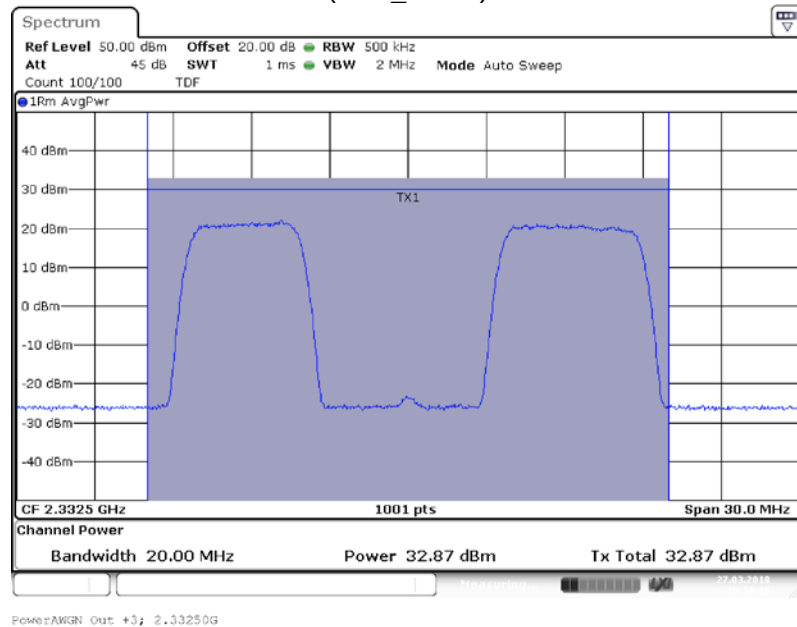
The "Maximum Average Output Power" is the conducted power value. Due to the fact, that the limit is an EIRP limit, the maximum antenna gain value is **37.8 dBi**

**Please note, that depending on SAR limits the maximum antenna gain may cannot be exploited.**

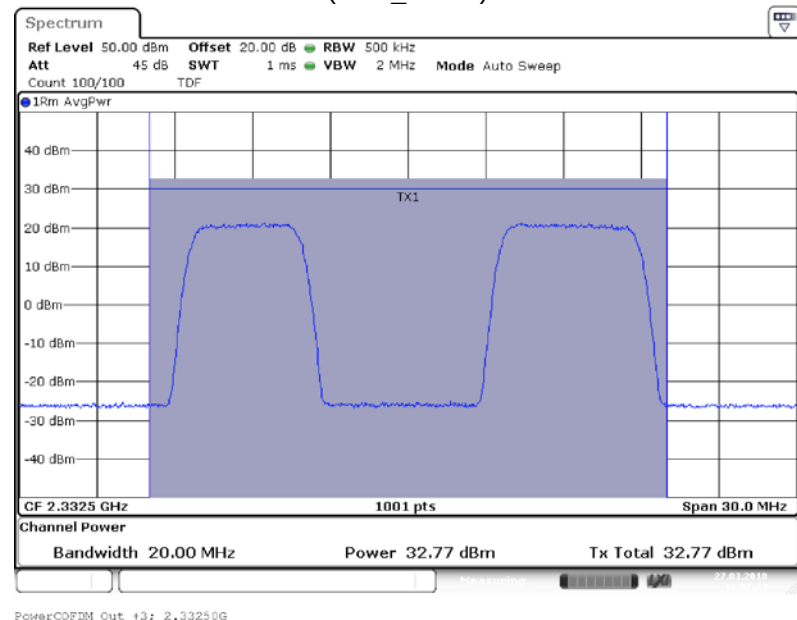
Remark: Please see next sub-clause for the measurement plot.

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

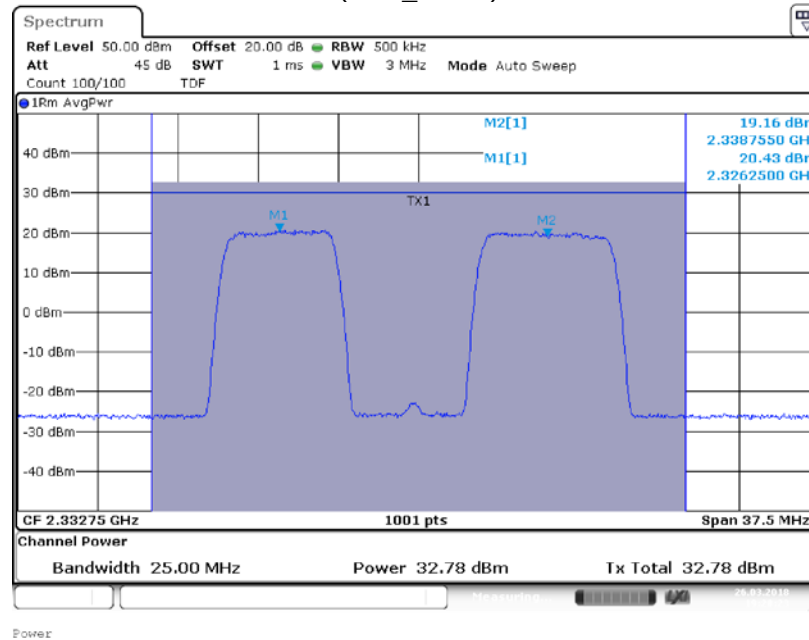
Frequency Band = Band Low/High, Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = AWGN, 2 input signals (S01\_AA01)



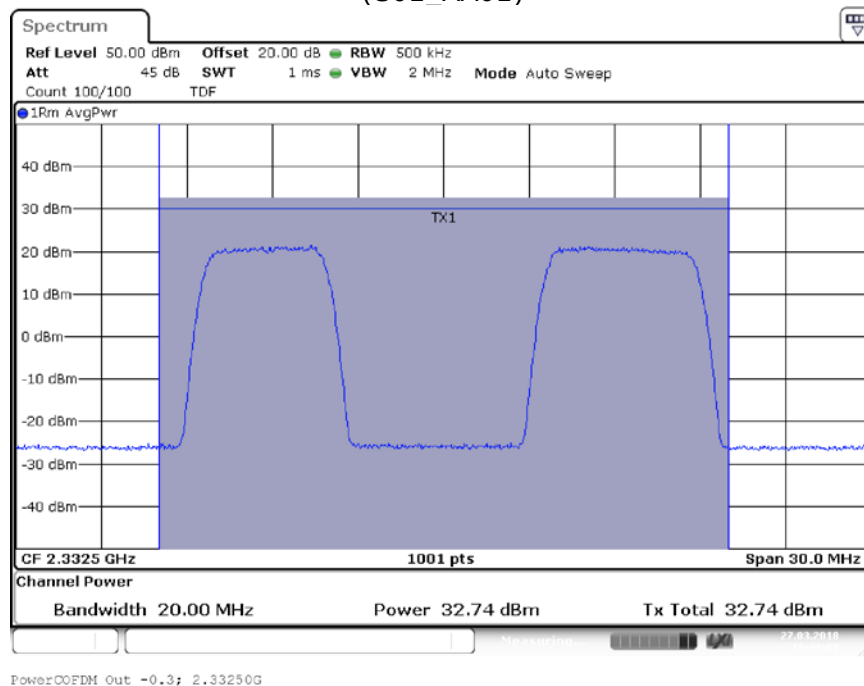
Frequency Band = Band Low/High, Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = COFDM, 2 input signals (S01\_AA01)



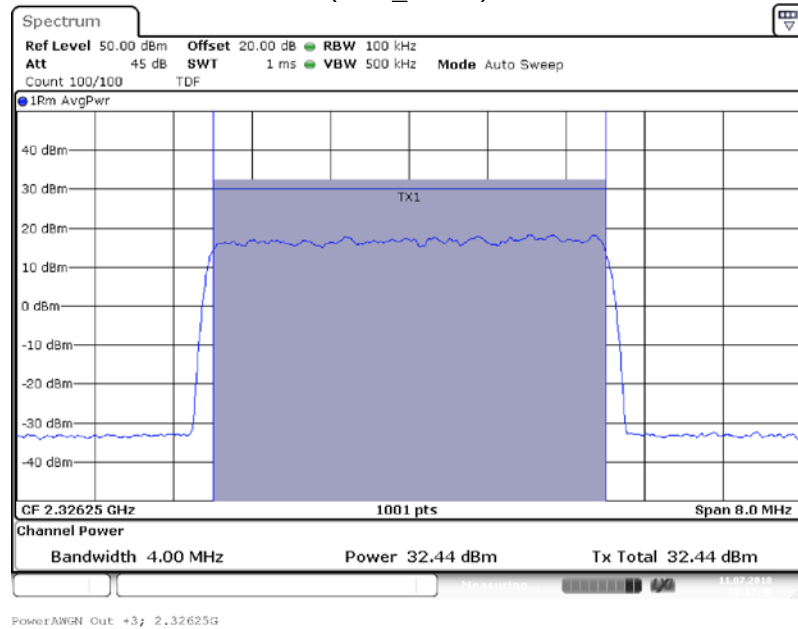
Frequency Band = Band Low/High, Direction = RF downlink, Input Power = 0.3 dB < AGC,  
Signal Type = AWGN, 2 input signals  
(S01\_AA01)



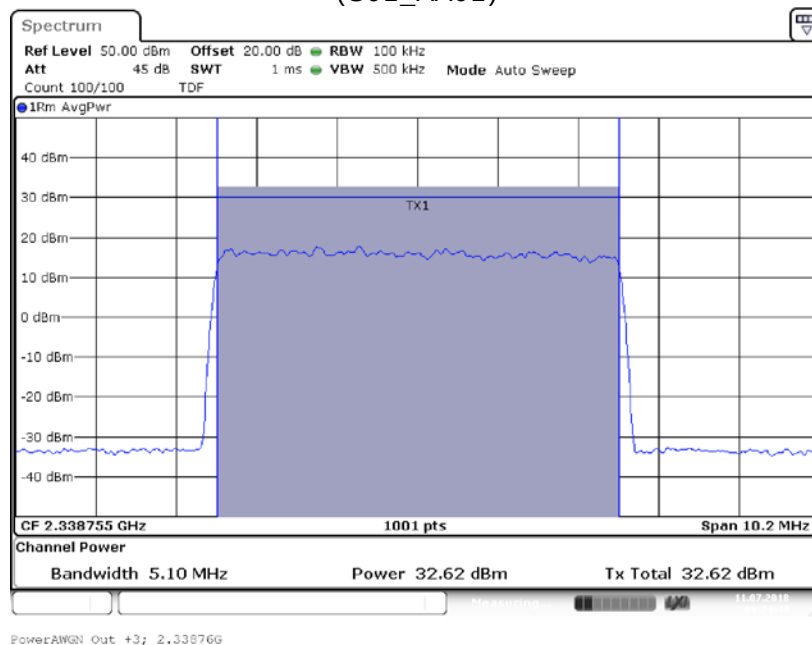
Frequency Band = Band Low/High, Direction = RF downlink, Input Power = 0.3 dB < AGC,  
Signal Type = COFDM, 2 input signals  
(S01\_AA01)



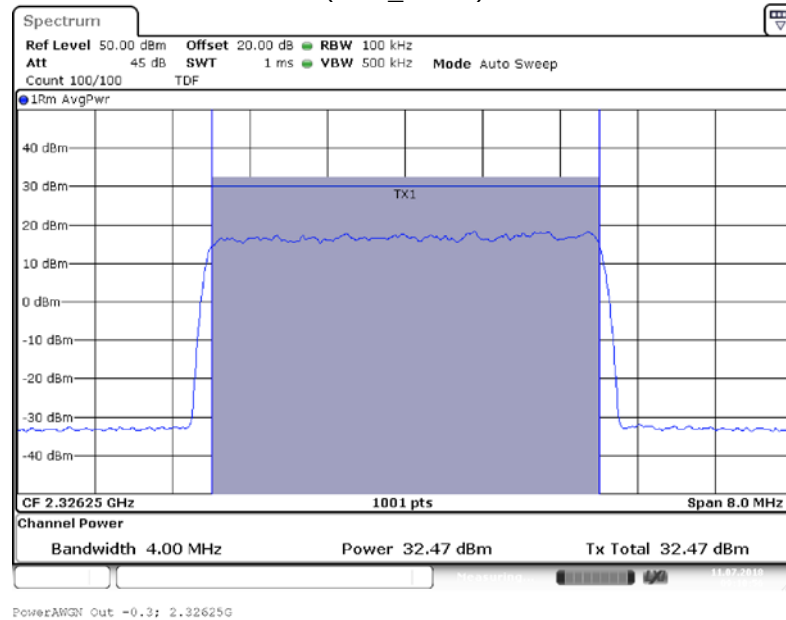
Frequency Band = Band Low, Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = AWGN, 1 input signal (S01\_AA01)



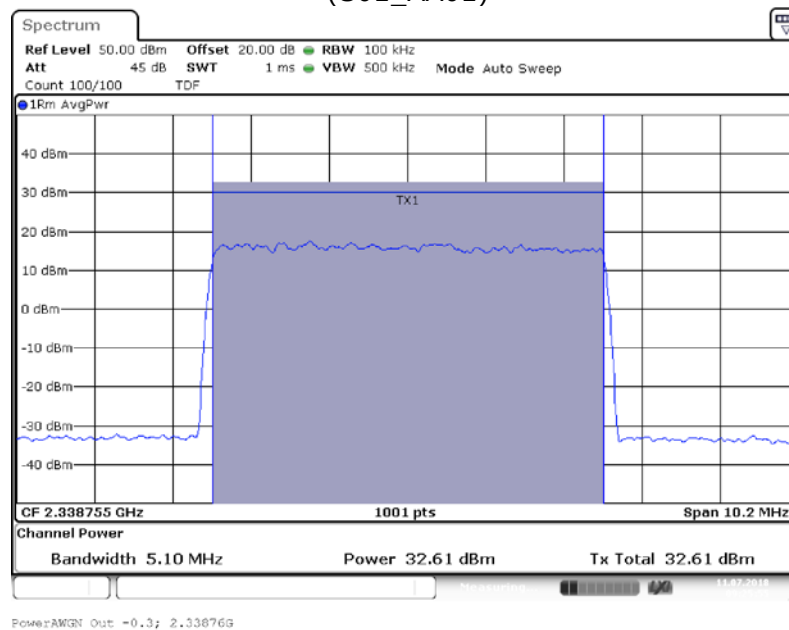
Frequency Band = Band High, Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = AWGN, 1 input signal (S01\_AA01)



Frequency Band = Band Low, Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = AWGN, 1 input signal (S01\_AA01)



Frequency Band = Band = High, Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = AWGN, 1 input signal (S01\_AA01)



#### 4.1.5 TEST EQUIPMENT USED

- FCC Conducted Base Station / Repeater

## 4.2 PEAK TO AVERAGE RATIO

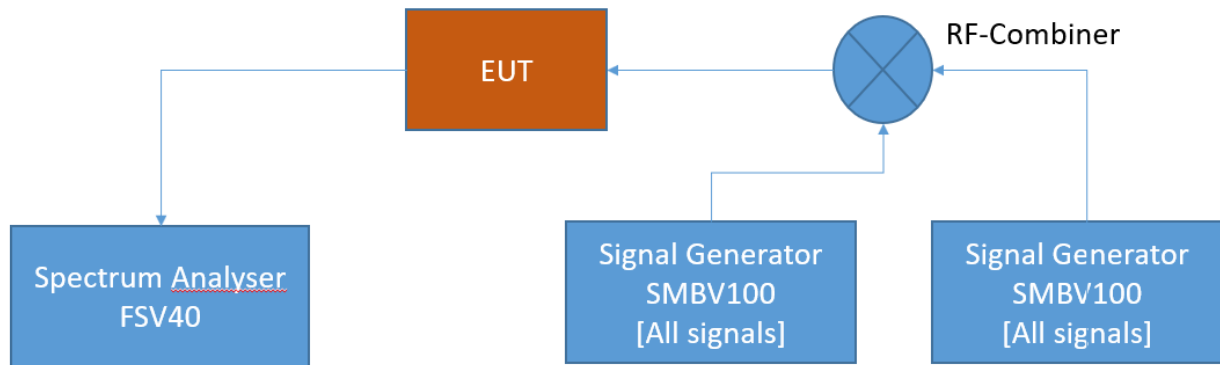
Standard FCC Part 25, §25.214

**The test was performed according to:**  
ANSI C63.26, KDB 935210 D05 v01r02: 3.5

### 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.

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



FCC Part 25 Satellite signal booster – Test Setup; RF Output Power

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 25; Satellite Communications

#### Subpart C – Technical standards

##### §25.214

d) *Power limit for SDARS terrestrial repeaters.* (1) SDARS terrestrial repeaters must be operated at a power level less than or equal to 12-kW average EIRP, with a maximum peak-to-average power ratio of 13 dB.

#### 4.2.3 TEST PROTOCOL

| Low [Sirius], downlink,<br>(Two simultaneous input signals) |              |                 |                   |           |                 |                      |
|-------------------------------------------------------------|--------------|-----------------|-------------------|-----------|-----------------|----------------------|
| Signal Type                                                 | Input Power  | Frequency [MHz] | Input Power [dBm] | PAPR [dB] | Limit PAPR [dB] | Margin to Limit [dB] |
| AWGN                                                        | 0.3 dB < AGC | 2326.25         | 0.7               | 8.4       | 13.0            | 4.6                  |
| AWGN                                                        | 3 dB > AGC   | 2326.25         | 4.0               | 8.4       | 13.0            | 4.6                  |
| COFDM                                                       | 0.3 dB < AGC | 2326.25         | 0.6               | 8.2       | 13.0            | 4.8                  |
| COFDM                                                       | 3 dB > AGC   | 2326.25         | 3.9               | 8.6       | 13.0            | 4.4                  |

| High [XM], downlink<br>(Two simultaneous input signals) |              |                 |                   |           |                 |                      |
|---------------------------------------------------------|--------------|-----------------|-------------------|-----------|-----------------|----------------------|
| Signal Type                                             | Input Power  | Frequency [MHz] | Input Power [dBm] | PAPR [dB] | Limit PAPR [dB] | Margin to Limit [dB] |
| AWGN                                                    | 0.3 dB < AGC | 2338.75         | 0.7               | 8.6       | 13.0            | 4.4                  |
| AWGN                                                    | 3 dB > AGC   | 2338.75         | 4.0               | 8.6       | 13.0            | 4.4                  |
| COFDM                                                   | 0.3 dB < AGC | 2338.75         | 0.6               | 8.6       | 13.0            | 4.4                  |
| COFDM                                                   | 3 dB > AGC   | 2338.75         | 3.9               | 8.2       | 13.0            | 4.8                  |

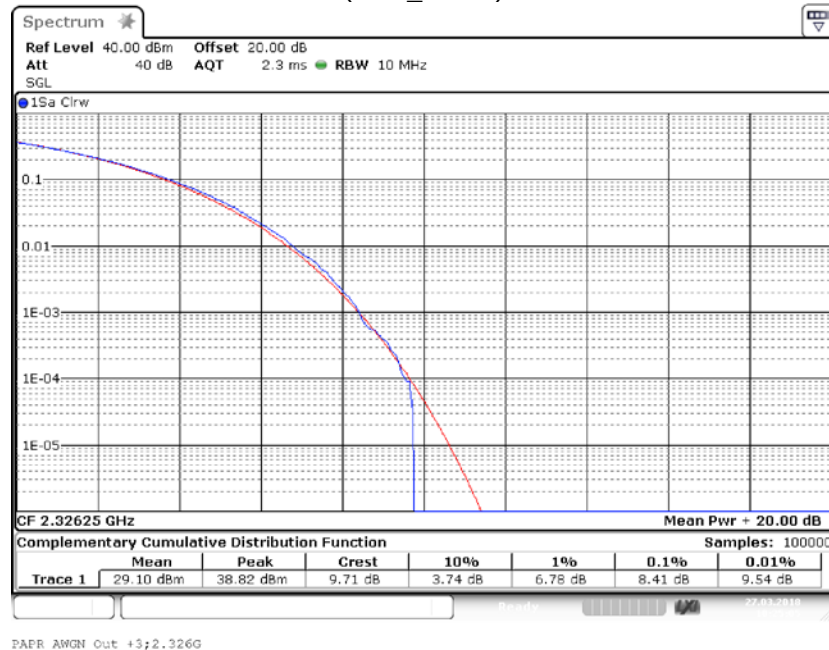
| Low [Sirius], downlink,<br>(One input signal) |              |                 |                   |           |                 |                      |
|-----------------------------------------------|--------------|-----------------|-------------------|-----------|-----------------|----------------------|
| Signal Type                                   | Input Power  | Frequency [MHz] | Input Power [dBm] | PAPR [dB] | Limit PAPR [dB] | Margin to Limit [dB] |
| AWGN                                          | 0.3 dB < AGC | 2326.25         | 0.7               | 8.4       | 13.0            | 4.6                  |
| AWGN                                          | 3 dB > AGC   | 2326.25         | 4.0               | 8.4       | 13.0            | 4.6                  |

| High [XM], downlink<br>(One input signal) |              |                 |                   |           |                 |                      |
|-------------------------------------------|--------------|-----------------|-------------------|-----------|-----------------|----------------------|
| Signal Type                               | Input Power  | Frequency [MHz] | Input Power [dBm] | PAPR [dB] | Limit PAPR [dB] | Margin to Limit [dB] |
| AWGN                                      | 0.3 dB < AGC | 2338.75         | 0.7               | 8.6       | 13.0            | 4.4                  |
| AWGN                                      | 3 dB > AGC   | 2338.75         | 4.0               | 8.6       | 13.0            | 4.4                  |

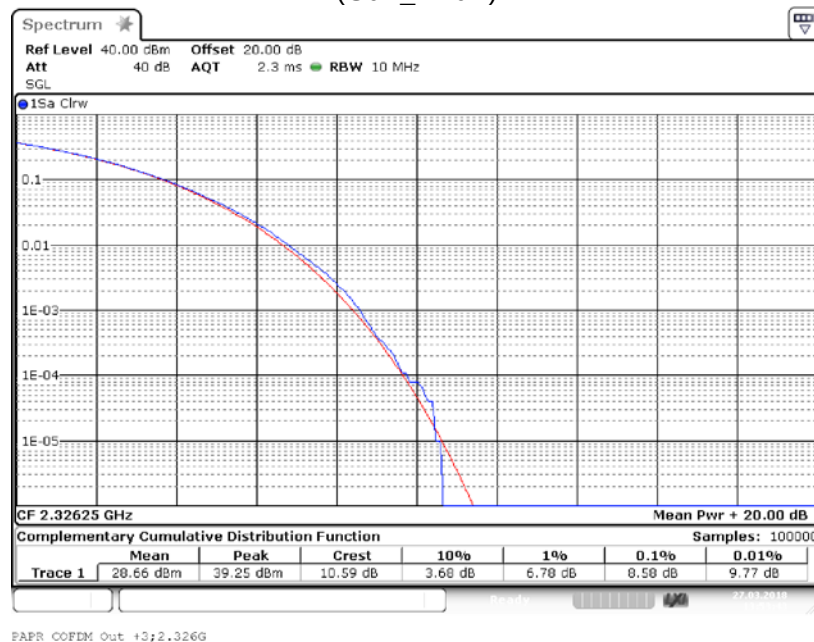
Remark: Please see next sub-clause for the measurement plot.

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

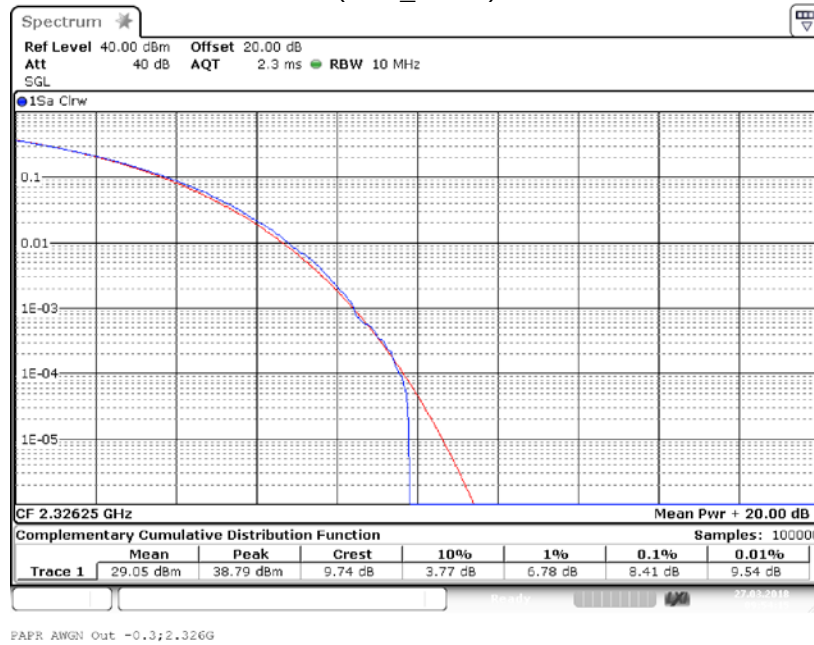
Frequency Band = Low [Sirius], Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = AWGN, 2 input signals (S01\_AA01)



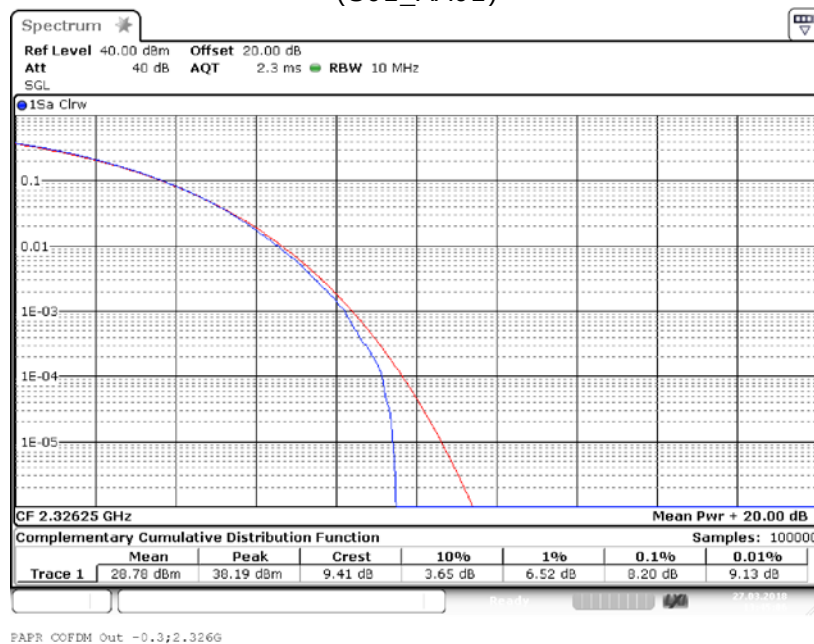
Frequency Band = Low [Sirius], Direction = RF downlink, , Input Power = 3 dB > AGC, Signal Type = COFDM, 2 input signals (S01\_AA01)



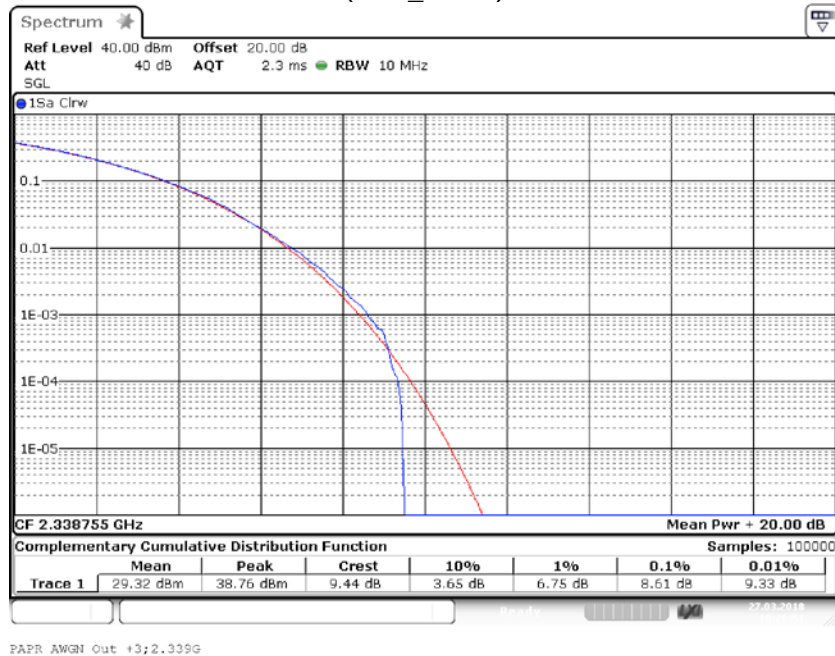
Frequency Band = Low [Sirius], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = AWGN, 2 input signals (S01\_AA01)



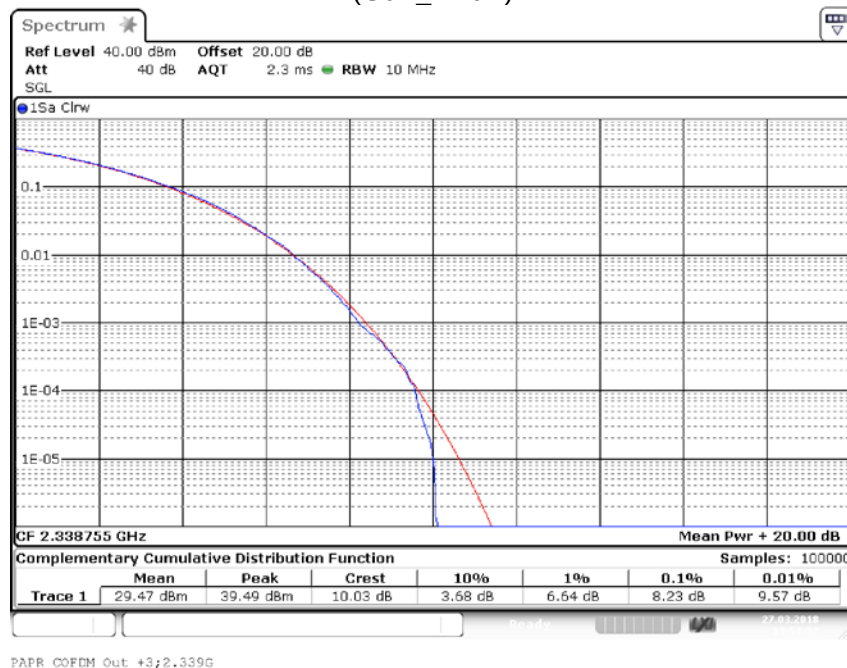
Frequency Band = Low [Sirius], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = COFDM, 2 input signals (S01\_AA01)



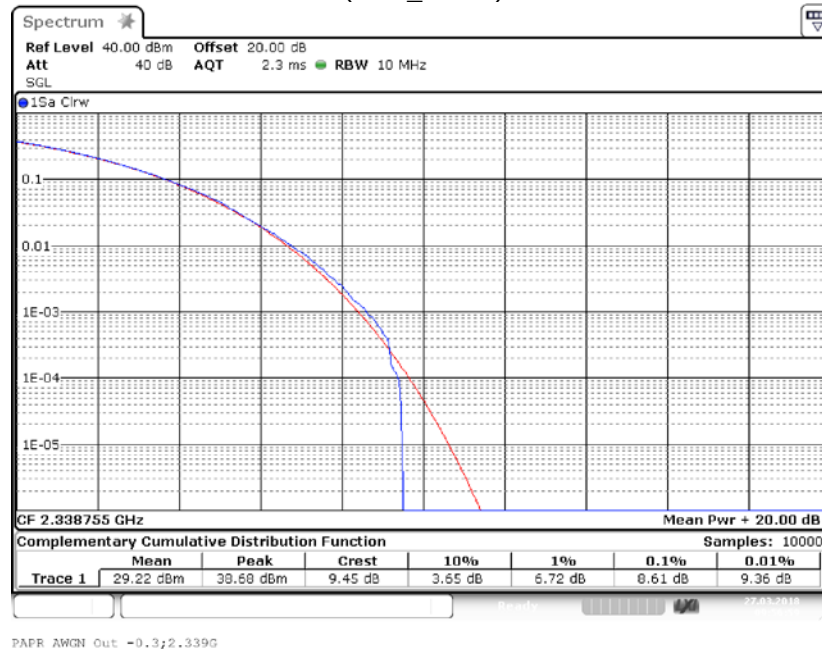
Frequency Band = High [XM], Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = AWGN, 2 input signals (S01\_AA01)



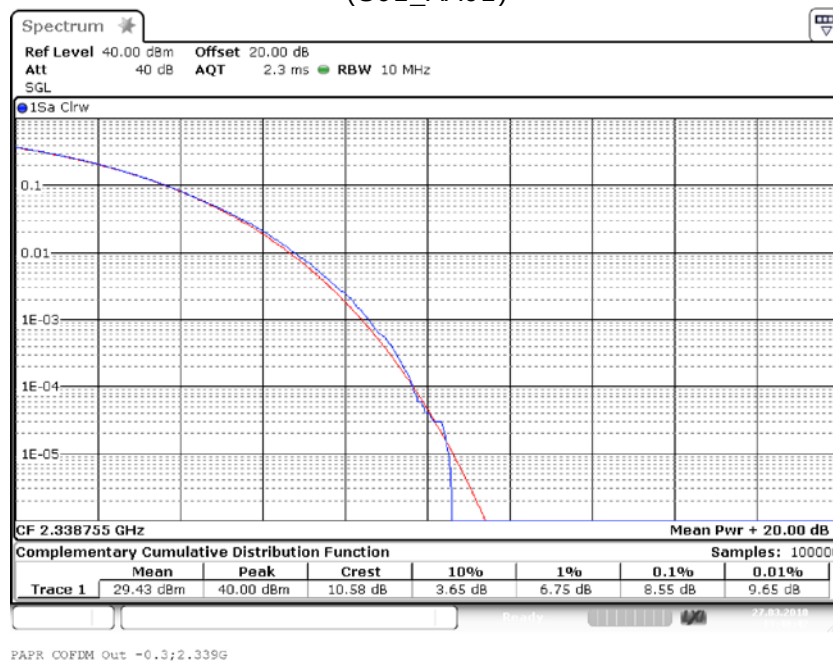
Frequency Band = High [XM], Direction = RF downlink, , Input Power = 3 dB > AGC, Signal Type = COFDM, 2 input signals (S01\_AA01)



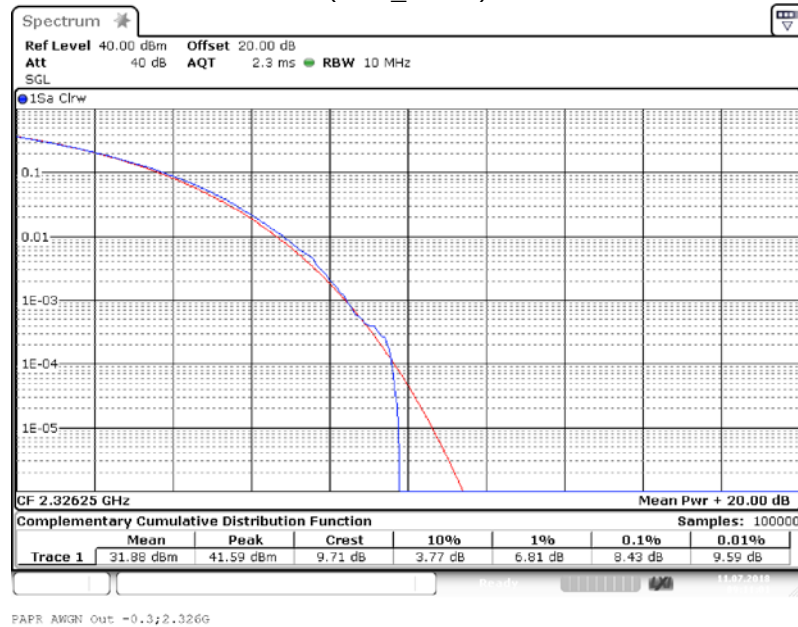
Frequency Band = High [XM], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = AWGN, 2 input signals (S01\_AA01)



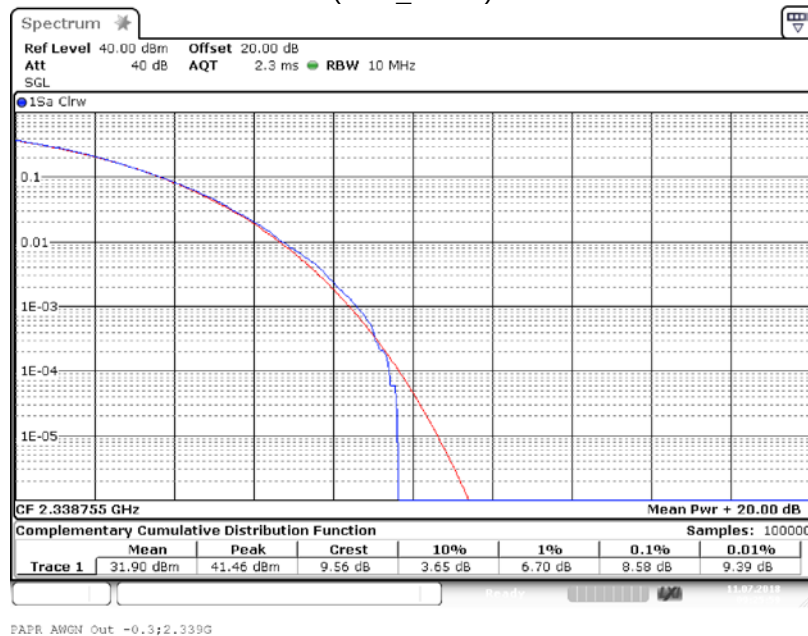
Frequency Band = High [XM], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = COFDM, 2 input signals (S01\_AA01)



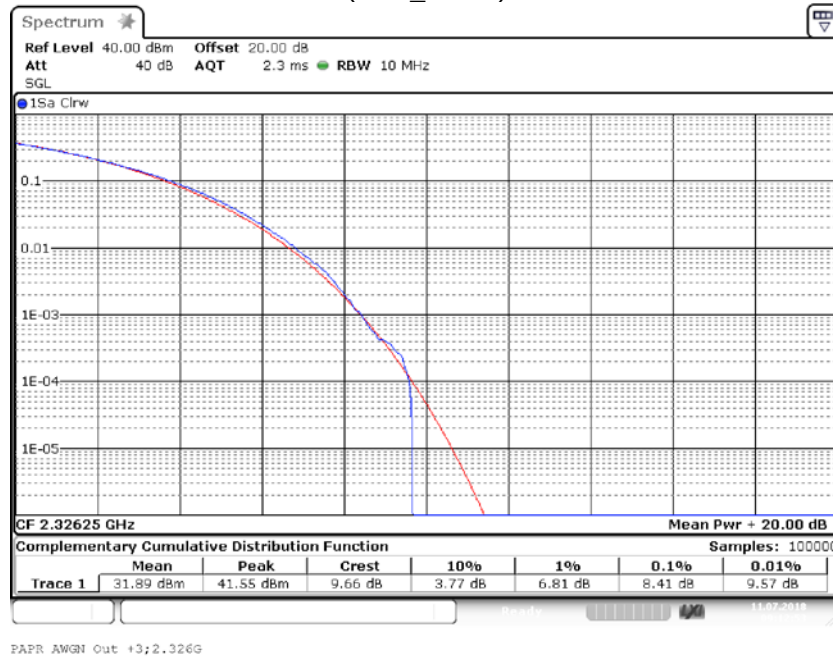
Frequency Band = Low [Sirius], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = AWGN, 1 input signal (S01\_AA01)



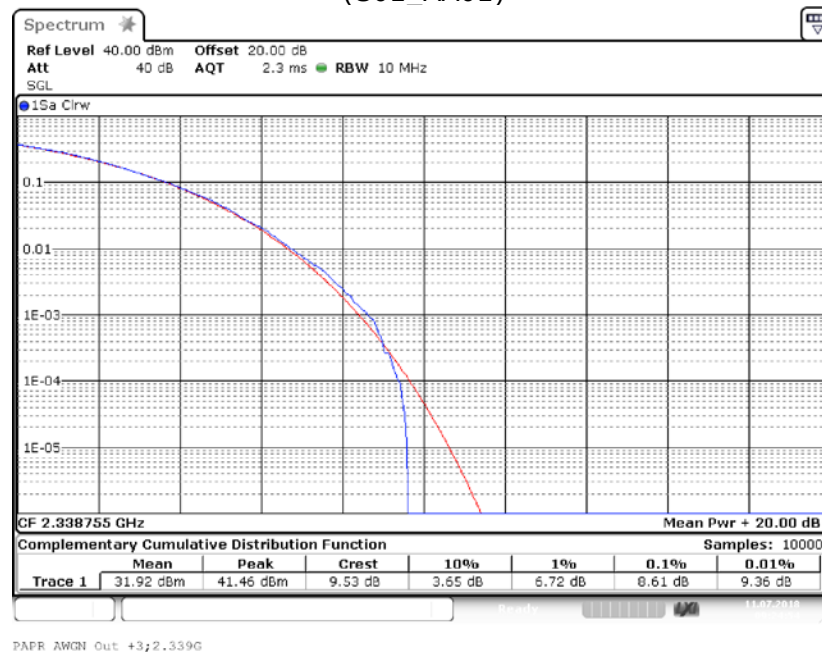
Frequency Band = High [XM], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = AWGN, 1 input signal (S01\_AA01)



Frequency Band = Low [Sirius], Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = AWGN, 1 input signal (S01\_AA01)



Frequency Band = High [XM], Direction = RF downlink, , Input Power = 3 dB > AGC, Signal Type = AWGN, 1 input signal (S01\_AA01)



#### 4.2.5 TEST EQUIPMENT USED

- FCC Conducted Base Station / Repeater

### 4.3 OCCUPIED BANDWIDTH

Standard FCC Part 2.1049; Occupied Bandwidth

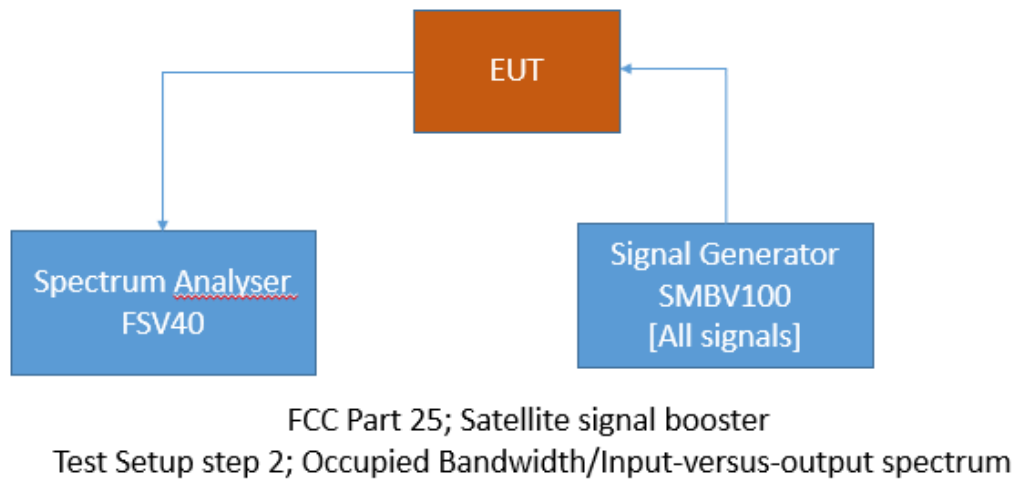
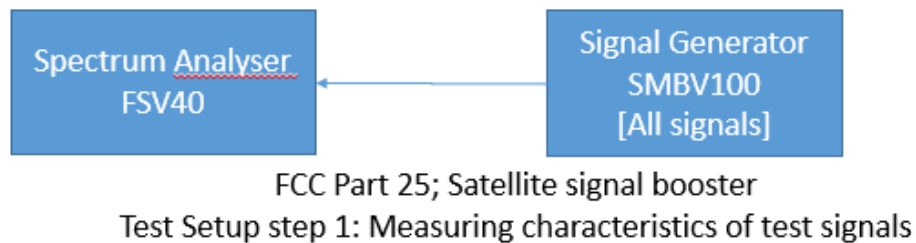
**The test was performed according to:**

ANSI C63.26, KDB 935210 D05 v01r02: 3.4

#### 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 6.4

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



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

##### 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.

#### 4.3.3 TEST PROTOCOL

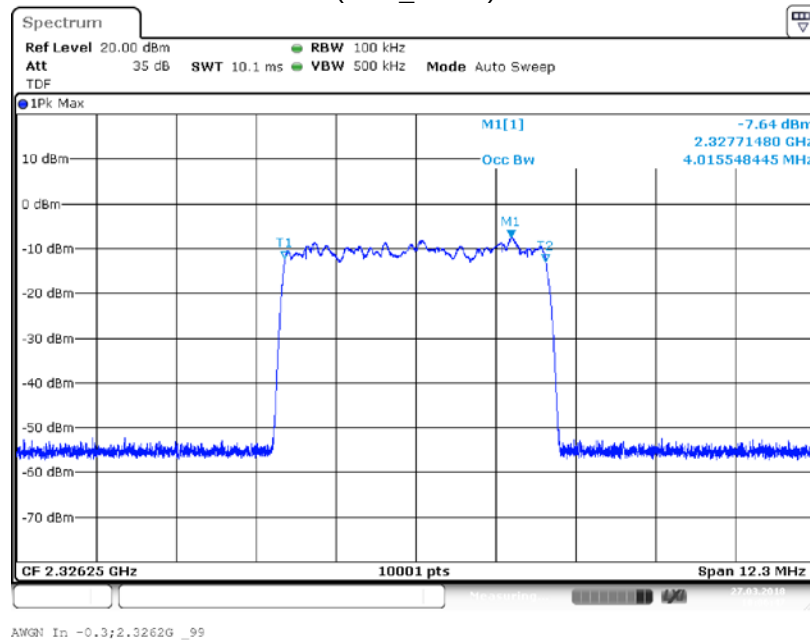
| Low [Sirius], downlink |              |                        |                             |                                  |                                |
|------------------------|--------------|------------------------|-----------------------------|----------------------------------|--------------------------------|
| Signal Type            | Input Power  | Signal Frequency [MHz] | Occupied Bandwidth SG [kHz] | Occupied Bandwidth Booster [kHz] | Delta Occupied Bandwidth [kHz] |
| AWGN                   | 0.3 dB < AGC | 2326.25                | 4015.5                      | 4014.3                           | 1.2                            |
| AWGN                   | 3 dB > AGC   | 2326.25                | 4015.5                      | 4014.3                           | 1.2                            |
| COFDM                  | 0.3 dB < AGC | 2326.25                | 4066.0                      | 4062.3                           | 3.7                            |
| COFDM                  | 3 dB > AGC   | 2326.25                | 4064.7                      | 4063.5                           | 1.2                            |

| High [XM], downlink |              |                        |                             |                                  |                                |
|---------------------|--------------|------------------------|-----------------------------|----------------------------------|--------------------------------|
| Signal Type         | Input Power  | Signal Frequency [MHz] | Occupied Bandwidth SG [kHz] | Occupied Bandwidth Booster [kHz] | Delta Occupied Bandwidth [kHz] |
| AWGN                | 0.3 dB < AGC | 2338.75                | 5052.3                      | 5042.5                           | 9.8                            |
| AWGN                | 3 dB > AGC   | 2338.75                | 5047.4                      | 5042.5                           | 4.9                            |
| COFDM               | 0.3 dB < AGC | 2338.75                | 5091.7                      | 5084.3                           | 7.4                            |
| COFDM               | 3 dB > AGC   | 2338.75                | 5089.2                      | 5085.5                           | 3.7                            |

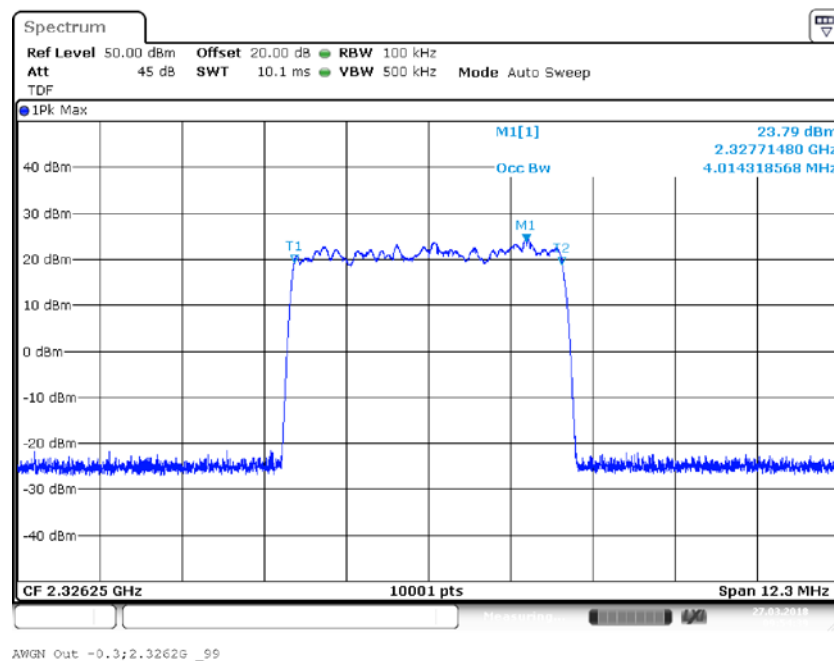
Remark: Please see next sub-clause for the measurement plot.

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

Frequency Band = Low [Sirius], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = AWGN  
(S01\_AA01)

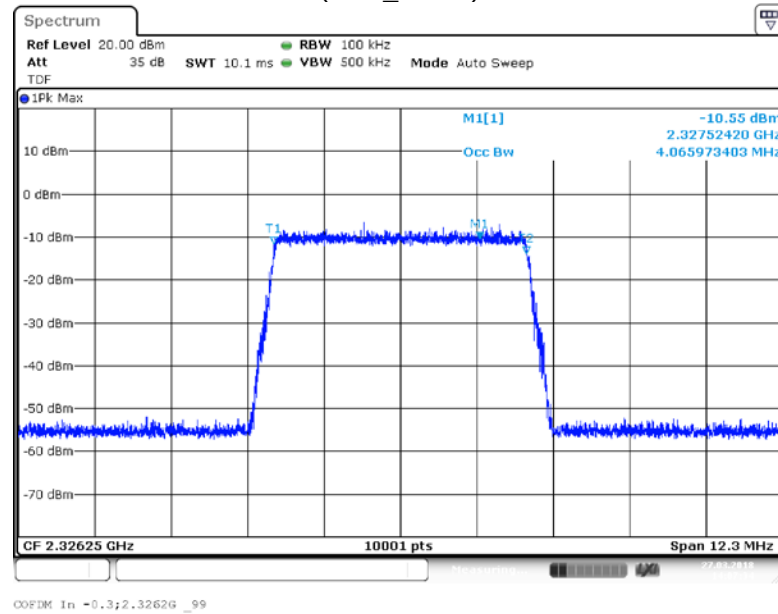


Input Signal

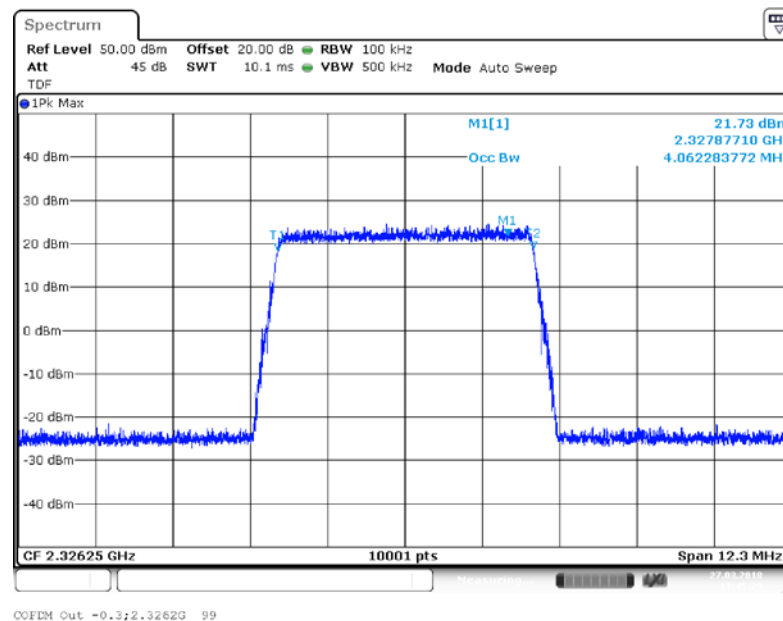


Output Signal

Frequency Band = Low [Sirius], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = COFDM (S01\_AA01)

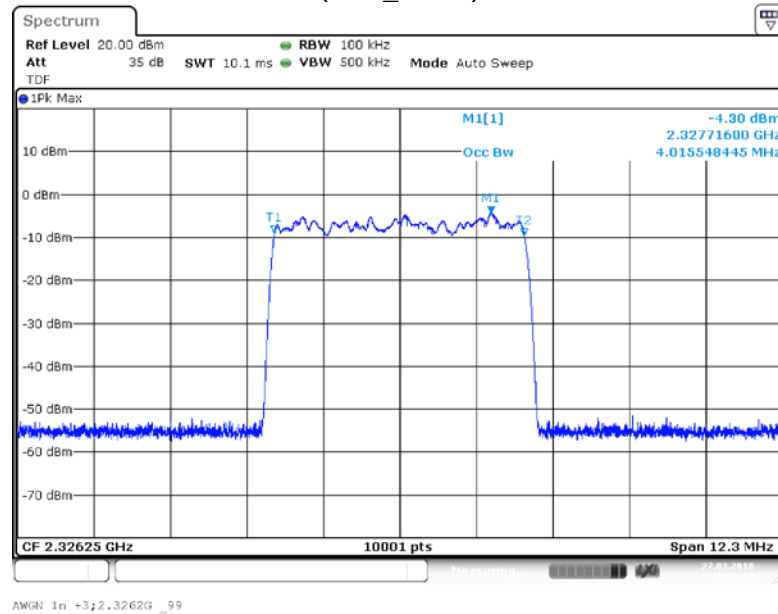


Input Signal

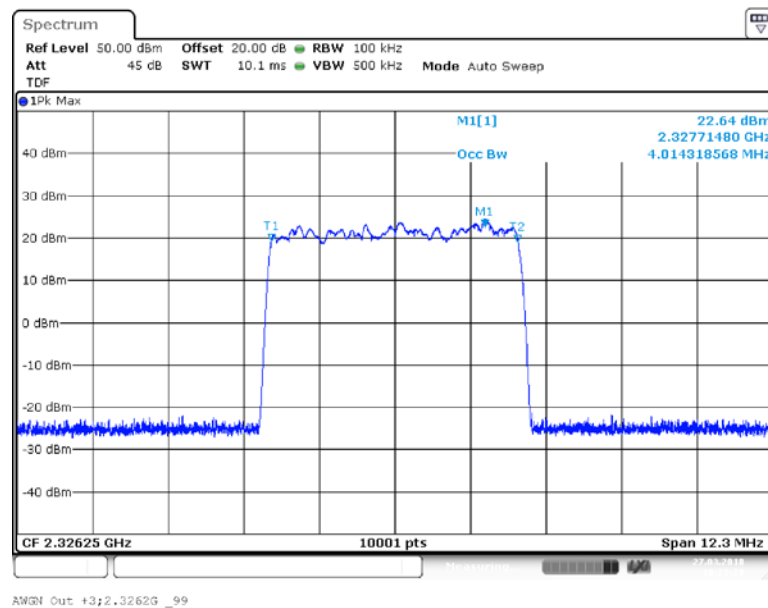


Output Signal

Frequency Band = Low [Sirius], Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = AWGN  
(S01\_AA01)

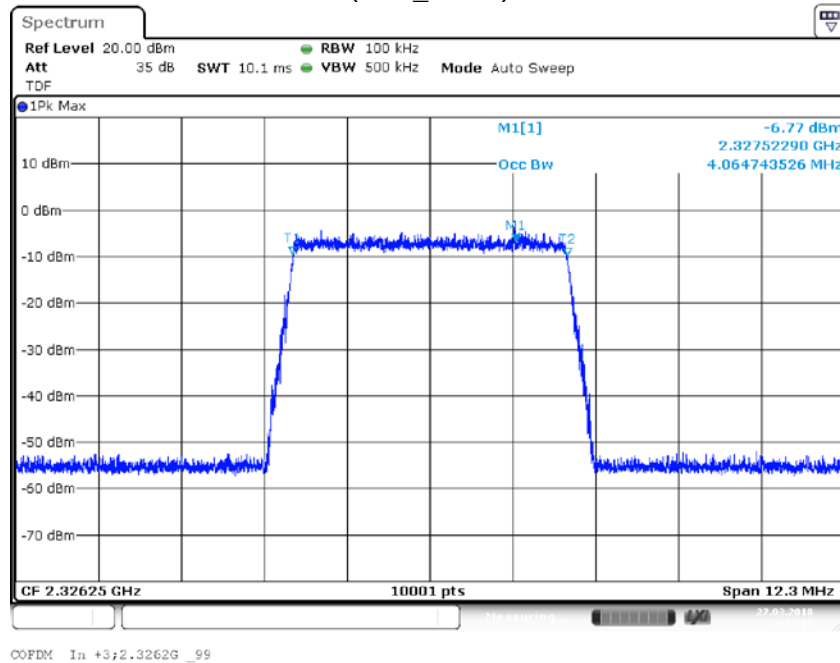


Input Signal

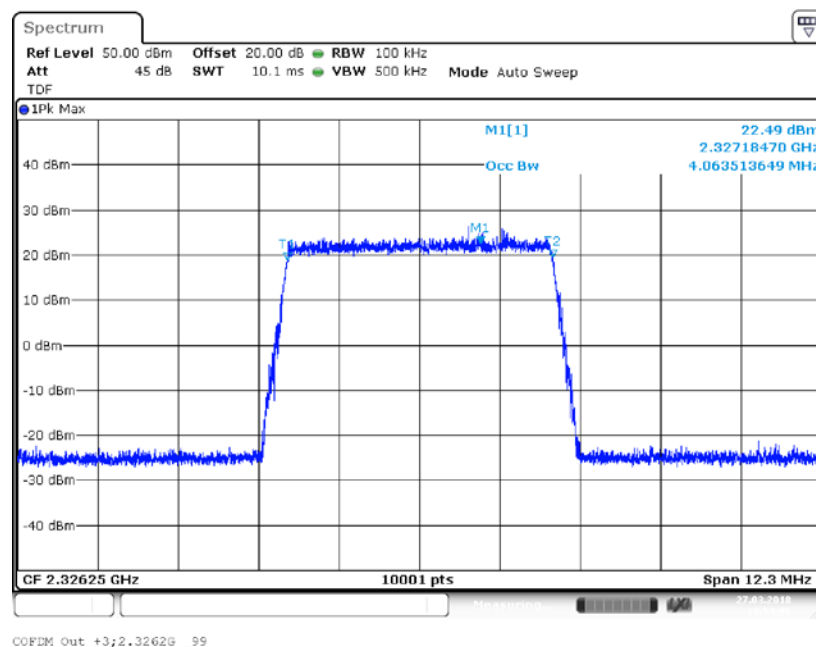


Output Signal

Frequency Band = Low [Sirius], Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = COFDN (S01\_AA01)

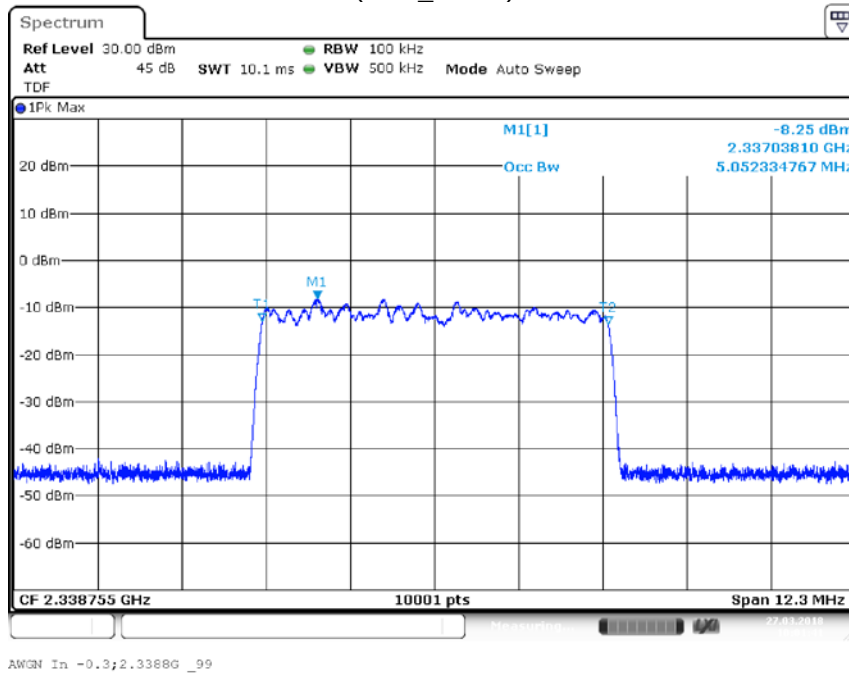


Input Signal

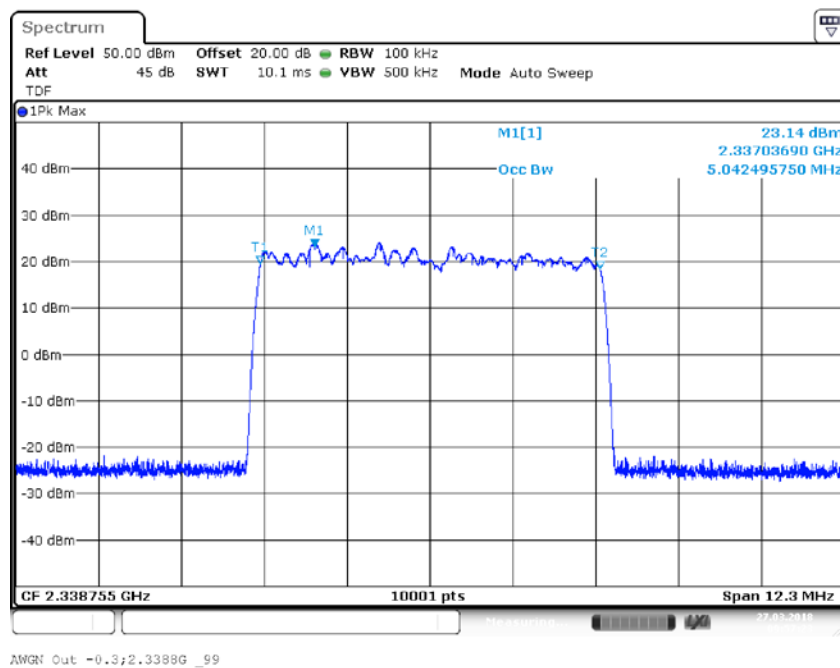


Output Signal

Frequency Band = High [XM], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = AWGN  
(S01\_AA01)

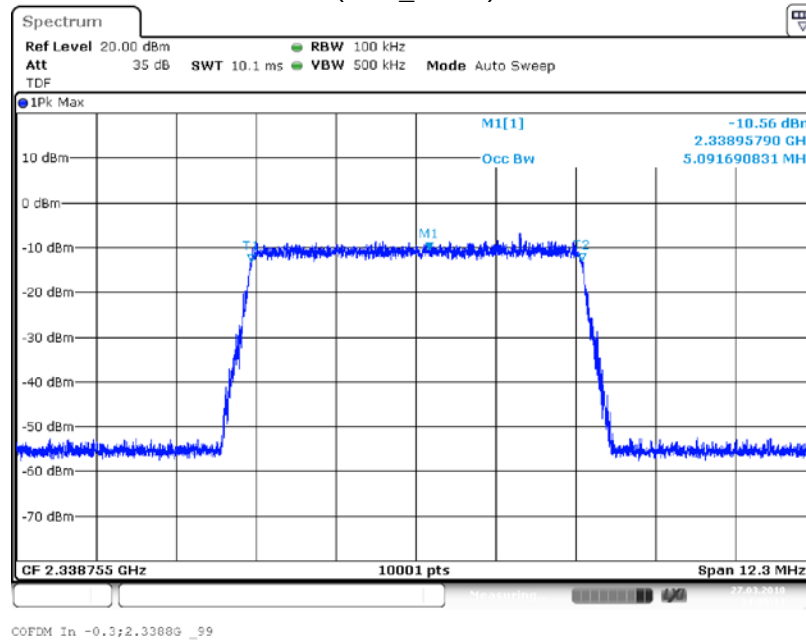


Input Signal

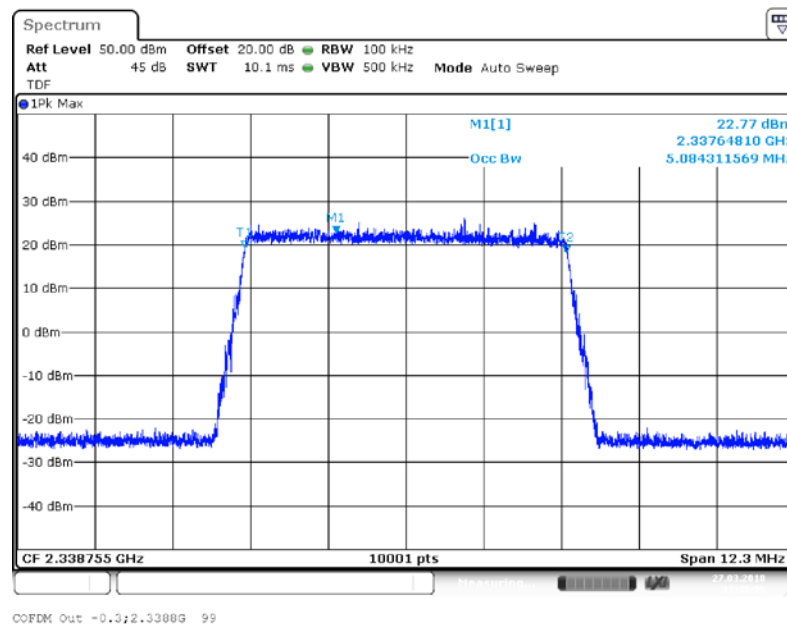


Output Signal

Frequency Band = High [XM], Direction = RF downlink, Input Power = 0.3 dB < AGC, Signal Type = COFDM (S01\_AA01)

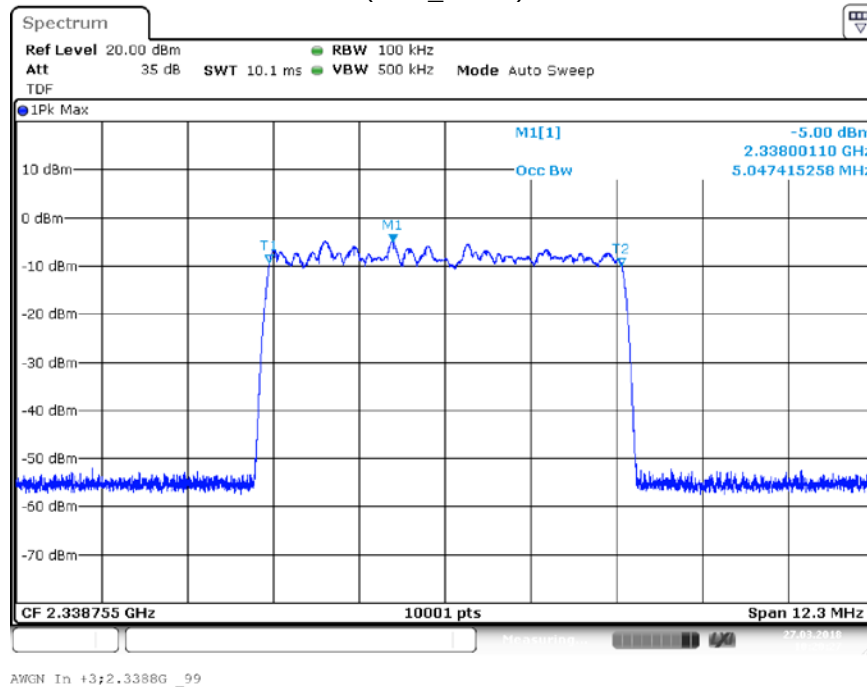


Input Signal

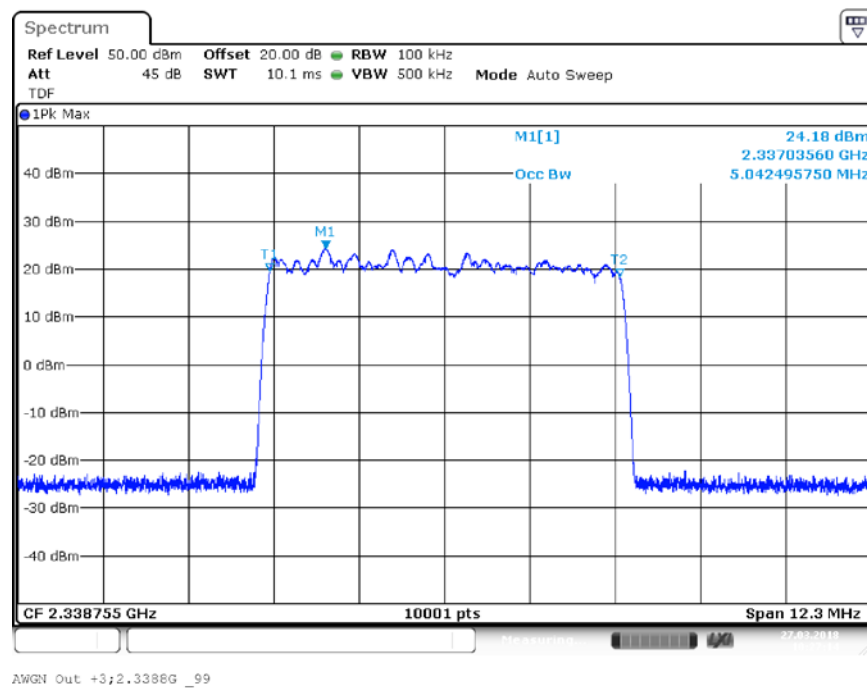


Output Signal

Frequency Band = High [XM], Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = AWGN  
(S01\_AA01)

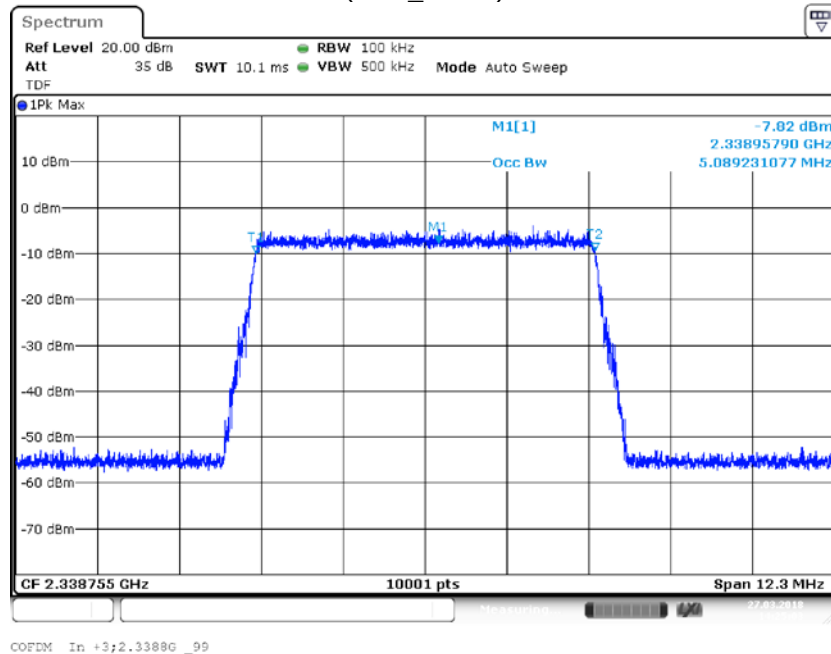


Input Signal

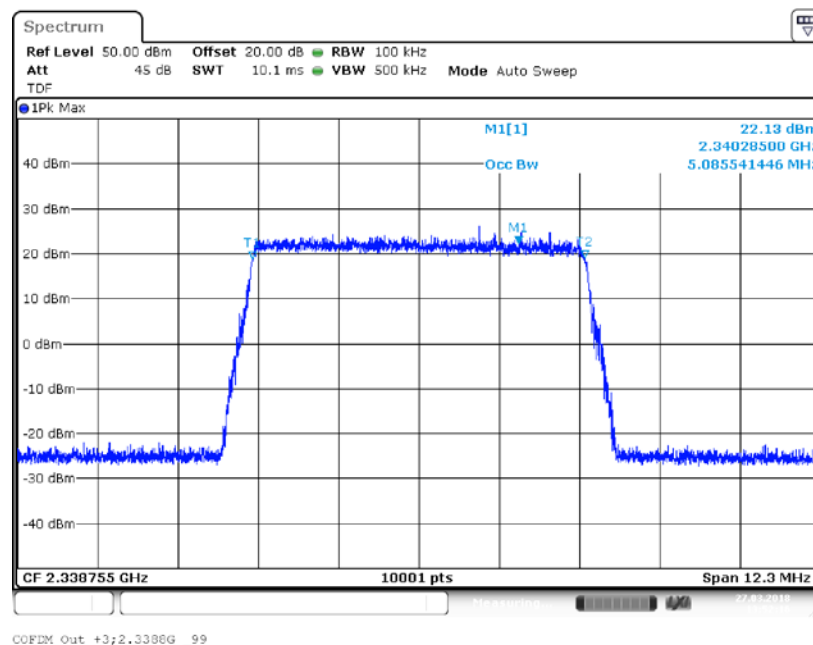


Output Signal

Frequency Band = High [XM], Direction = RF downlink, Input Power = 3 dB > AGC, Signal Type = COFDM (S01\_AA01)



Input Signal



Output Signal

#### 4.3.5 TEST EQUIPMENT USED

FCC Conducted Base Station / Repeater

#### 4.4 CONDUCTED SPURIOUS EMISSIONS AT ANTENNA TERMINALS

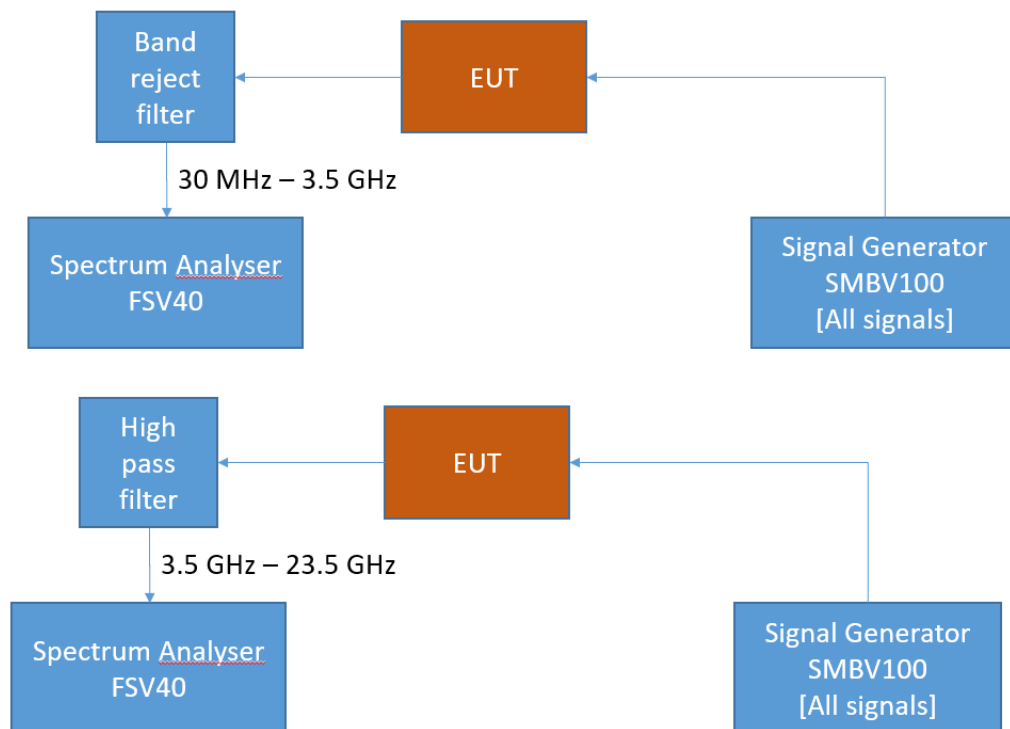
Standard FCC Part §2.1051, §25.202

**The test was performed according to:**  
ANSI C63.26

##### 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.

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



FCC Part 25; Satellite signal booster – Test Setup; Conducted Spurious 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.

#### 4.4.2 TEST REQUIREMENTS / LIMITS

##### **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.

#### **Part 25; Satellite Communications**

##### **Subpart C – Technical standards**

##### **§25.202 – Frequencies, frequency tolerance and emission limits**

h) *Out-of-band emission limitations for SDARS terrestrial repeaters.* (1) Any SDARS terrestrial repeater operating at a power level greater than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than  $90 + 10 \log (P)$  dB in a 1-megahertz bandwidth outside the 2320-2345 MHz band, where P is average transmitter output power in watts.

(2) Any SDARS terrestrial repeater operating at a power level equal to or less than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than  $75 + 10 \log (P)$  dB in a 1-megahertz bandwidth outside the 2320-2345 MHz band, where P is average transmitter output power in watts.

#### 4.4.3 TEST PROTOCOL

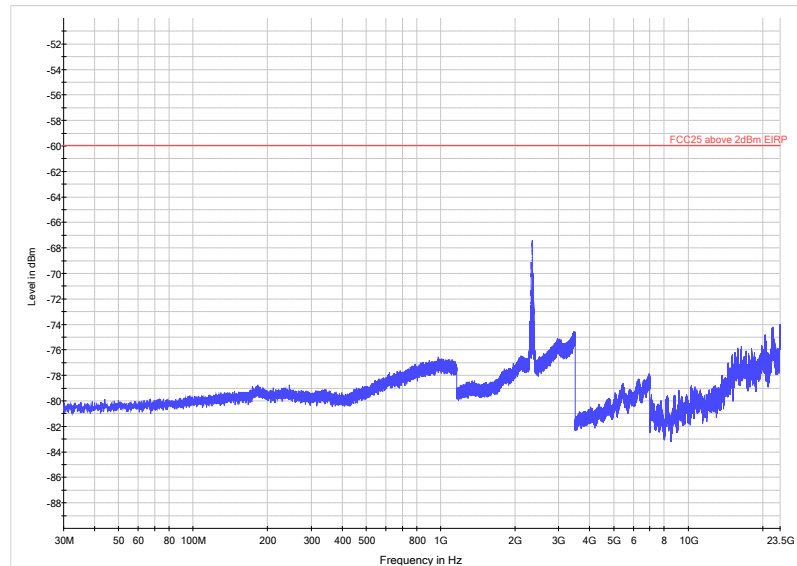
| Low [Sirius], downlink |             |                      |                      |          |           |             |                      |
|------------------------|-------------|----------------------|----------------------|----------|-----------|-------------|----------------------|
| Test Frequency         | Signal Type | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Limit [dBm] | Margin to Limit [dB] |
| mid                    | AWGN        | -                    | -                    | RMS      | 1000      | -60.0       | - - -                |
| mid                    | COFDM       | -                    | -                    | RMS      | 1000      | -60.0       | - - -                |

| High [XM], downlink |             |                      |                      |          |           |             |                      |
|---------------------|-------------|----------------------|----------------------|----------|-----------|-------------|----------------------|
| Test Frequency      | Signal Type | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Limit [dBm] | Margin to Limit [dB] |
| mid                 | AWGN        | -                    | -                    | RMS      | 1000      | -60.0       | - - -                |
| mid                 | COFDM       | -                    | -                    | RMS      | 1000      | -60.0       | - - -                |

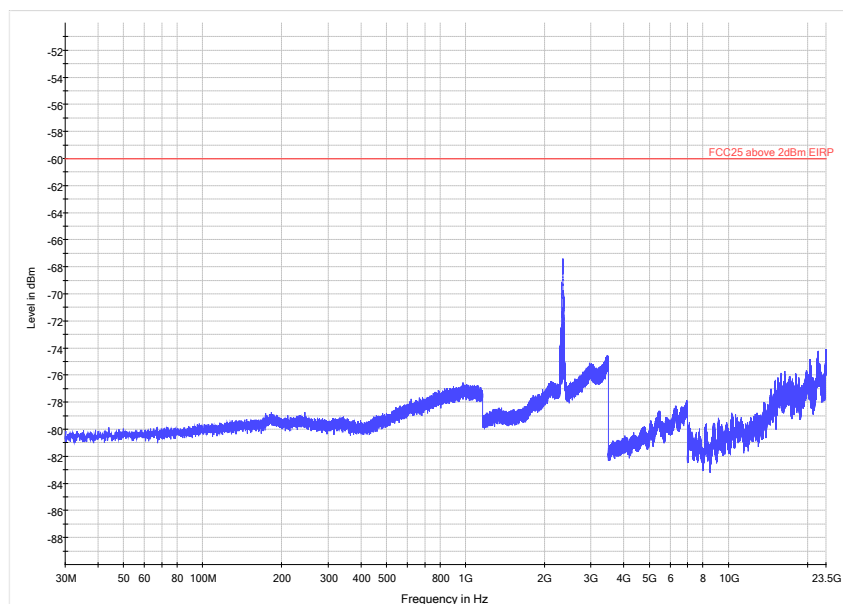
Remark: The two test signals were injected simultaneously conducted into the EUT.  
Please see next sub-clause for the measurement plot.

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

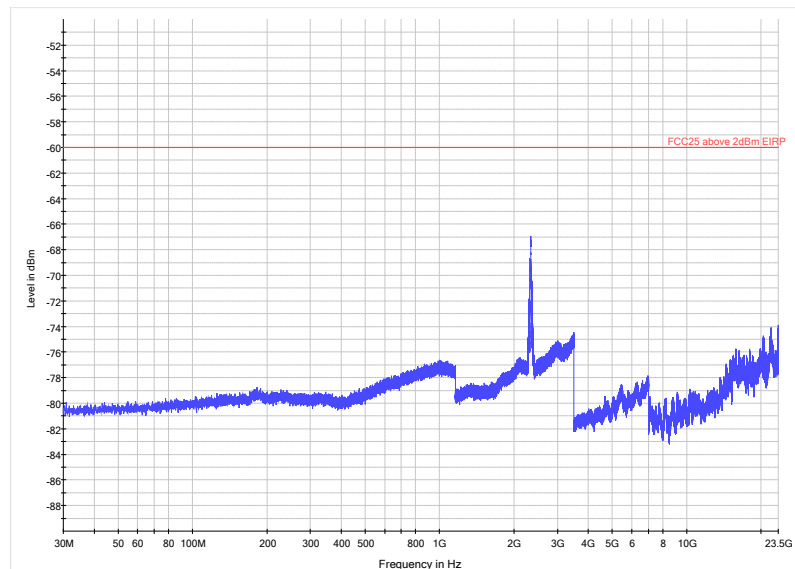
Frequency Band = Low [Sirius], Test Frequency = mid, Direction = RF downlink, Signal Type =  
AWGN  
(S01\_AA01)



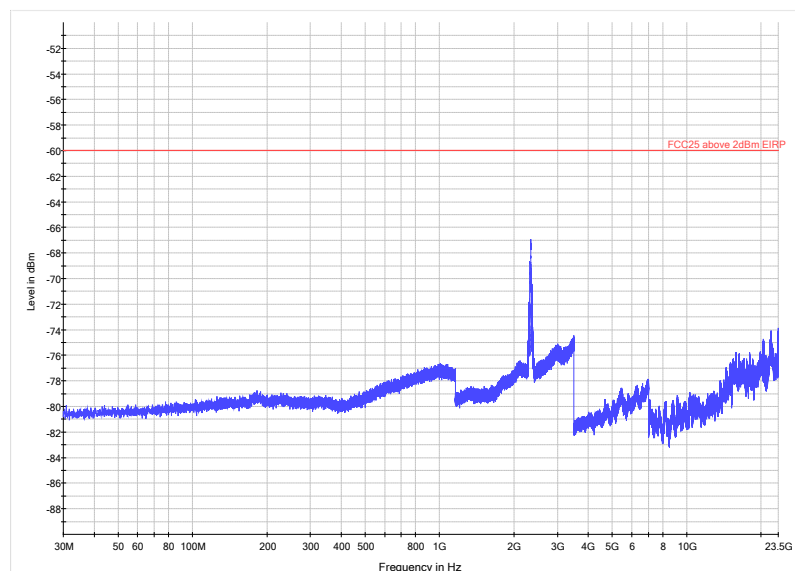
Frequency Band = High [XM], Test Frequency = mid, Direction = RF downlink, Signal Type =  
AWGN  
(S01\_AA01)



Frequency Band = Low [Sirius], Test Frequency = mid, Direction = RF downlink, Signal Type =  
COFDM  
(S01\_AA01)



Frequency Band = High [XM], Test Frequency = mid, Direction = RF downlink, Signal Type =  
COFDM  
(S01\_AA01)



#### 4.4.5 TEST EQUIPMENT USED

- R&S TS8997

## 4.5 OUT-OF-BAND EMISSION LIMITS

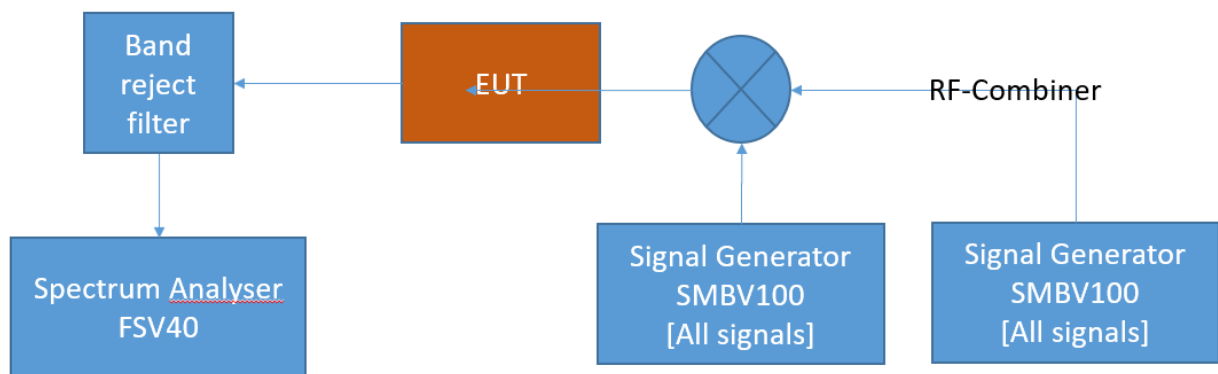
Standard FCC Part §2.1051, §25.202

**The test was performed according to:**  
ANSI C63.26

### 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.

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



FCC Part 25; Satellite 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

#### **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.

## Part 25; Satellite Communications

### Subpart C – Technical standards

#### §25.202 – Frequencies, frequency tolerance and emission limits

h) *Out-of-band emission limitations for SDARS terrestrial repeaters.* (1) Any SDARS terrestrial repeater operating at a power level greater than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than  $90 + 10 \log (P)$  dB in a 1-megahertz bandwidth outside the 2320-2345 MHz band, where P is average transmitter output power in watts.

(2) Any SDARS terrestrial repeater operating at a power level equal to or less than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than  $75 + 10 \log (P)$  dB in a 1-megahertz bandwidth outside the 2320-2345 MHz band, where P is average transmitter output power in watts.

#### 4.5.3 TEST PROTOCOL

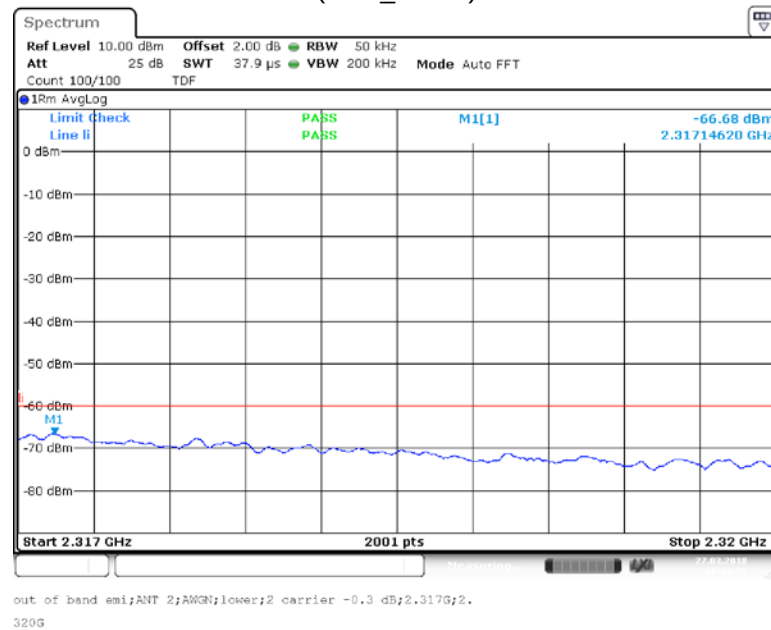
| Low [Sirius], downlink |             |              |           |                      |                      |          |           |             |                      |
|------------------------|-------------|--------------|-----------|----------------------|----------------------|----------|-----------|-------------|----------------------|
| Test Freq.             | Signal Type | Input Power  | Band Edge | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Limit [dBm] | Margin to Limit [dB] |
| mid                    | AWGN        | 0.3 dB < AGC | Low       | *)                   | -66.7                | RMS      | 1000      | -60.0       | 6.7                  |
| mid                    | COFDM       | 0.3 dB < AGC | Low       | *)                   | -70.1                | RMS      | 1000      | -60.0       | 9.9                  |
| mid                    | AWGN        | 3 dB > AGC   | Low       | *)                   | -71.3                | RMS      | 1000      | -60.0       | 11.3                 |
| mid                    | COFDM       | 3 dB > AGC   | Low       | *)                   | -71.8                | RMS      | 1000      | -60.0       | 11.8                 |

| High [XM], downlink |             |              |           |                      |                      |          |           |             |                      |
|---------------------|-------------|--------------|-----------|----------------------|----------------------|----------|-----------|-------------|----------------------|
| Test Freq.          | Signal Type | Input Power  | Band Edge | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Limit [dBm] | Margin to Limit [dB] |
| mid                 | AWGN        | 0.3 dB < AGC | High      | *)                   | -69.2                | RMS      | 1000      | -60.0       | 9.2                  |
| mid                 | COFDM       | 0.3 dB < AGC | High      | *)                   | -71.7                | RMS      | 1000      | -60.0       | 11.7                 |
| mid                 | AWGN        | 3 dB > AGC   | High      | *)                   | -72.7                | RMS      | 1000      | -60.0       | 12.7                 |
| mid                 | COFDM       | 3 dB > AGC   | High      | *)                   | -73.1                | RMS      | 1000      | -60.0       | 13.1                 |

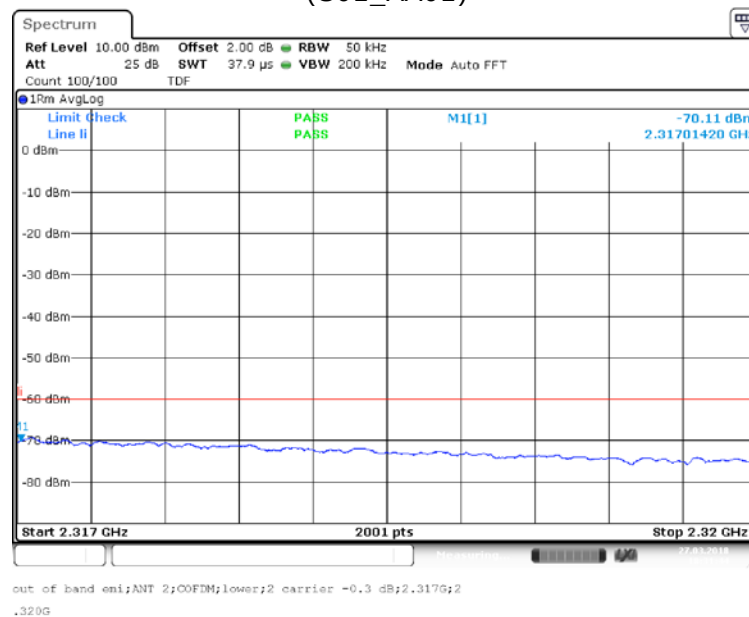
Remark: \*) For the spurious frequency please see measurement plot  
The two test signals were injected simultaneously conducted into the EUT.  
Since EUT cannot transmit at two adjacent frequencies simultaneously, intermodulation assessment is not applicable.  
Please see next sub-clause for the measurement plot

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

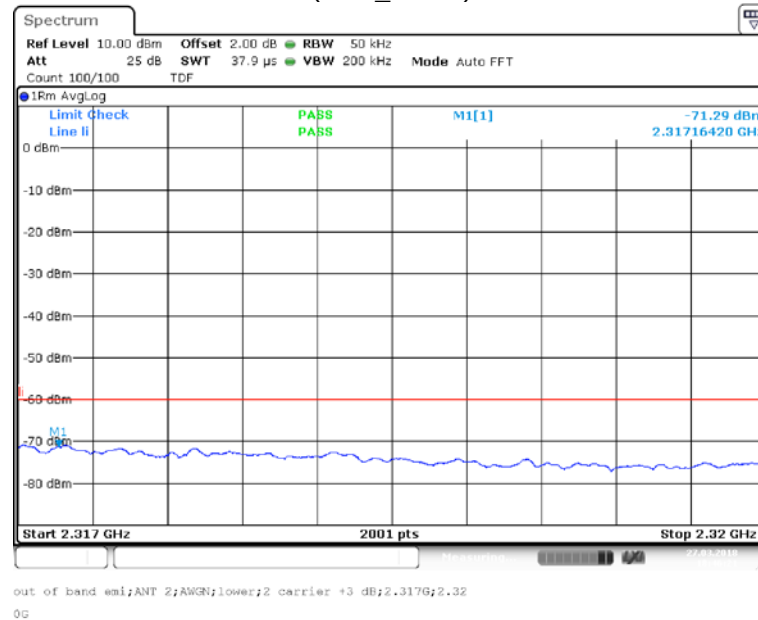
Band Edge = Low, Frequency Band = Low[Sirius], Direction = RF downlink,  
Input Power = 0.3 dB < AGC, Signal Type = AWGN, Test Frequency = mid  
(S01\_AA01)



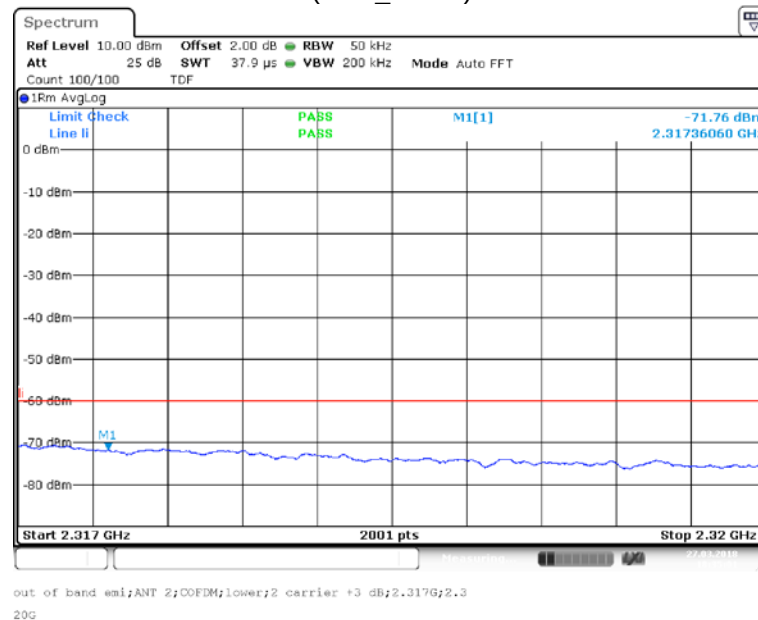
Band Edge = Low, Frequency Band = Low[Sirius], Direction = RF downlink,  
Input Power = 0.3 dB < AGC, Signal Type = COFDM, Test Frequency = mid  
(S01\_AA01)



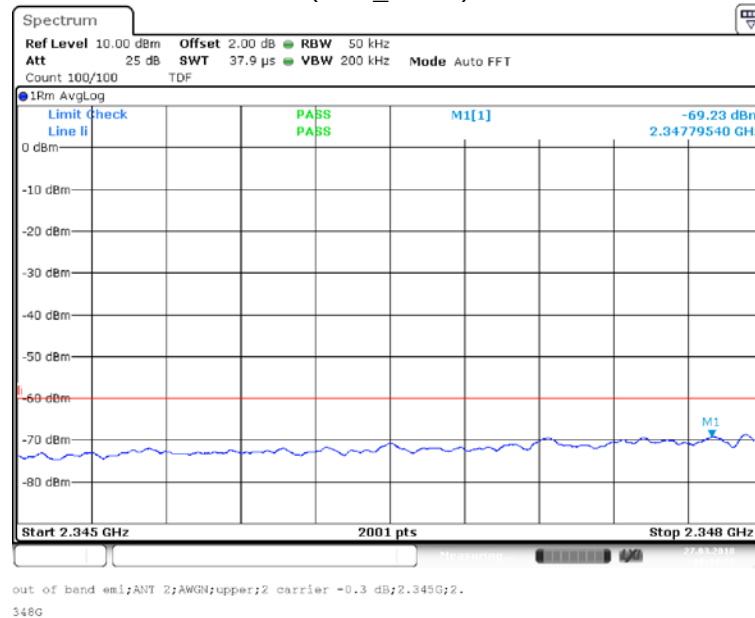
Band Edge = Lower, Frequency Band = Low[Sirius], Direction = RF downlink,  
Input Power = 3 dB > AGC, Signal Type = AWGN, Test Frequency = mid  
(S01\_AA01)



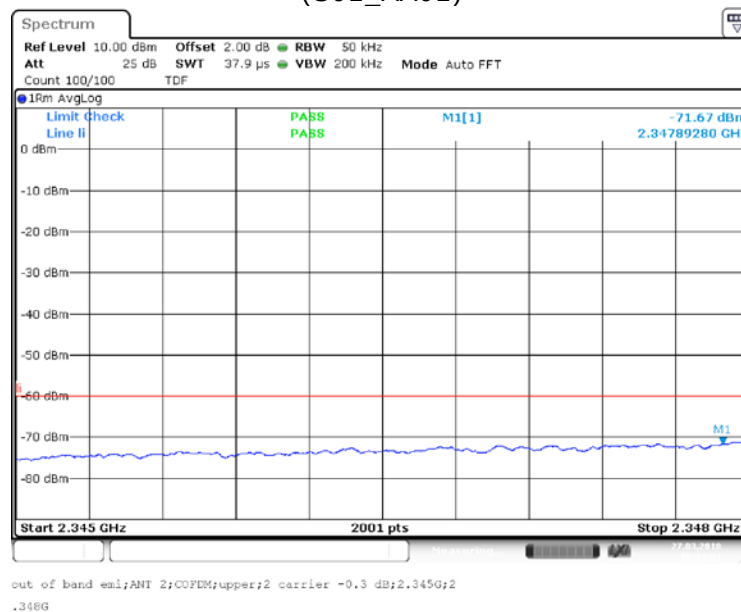
Band Edge = Lower, Frequency Band = Low[Sirius], Direction = RF downlink,  
Input Power = 3 dB > AGC, Signal Type = COFDM, Test Frequency = mid  
(S01\_AA01)



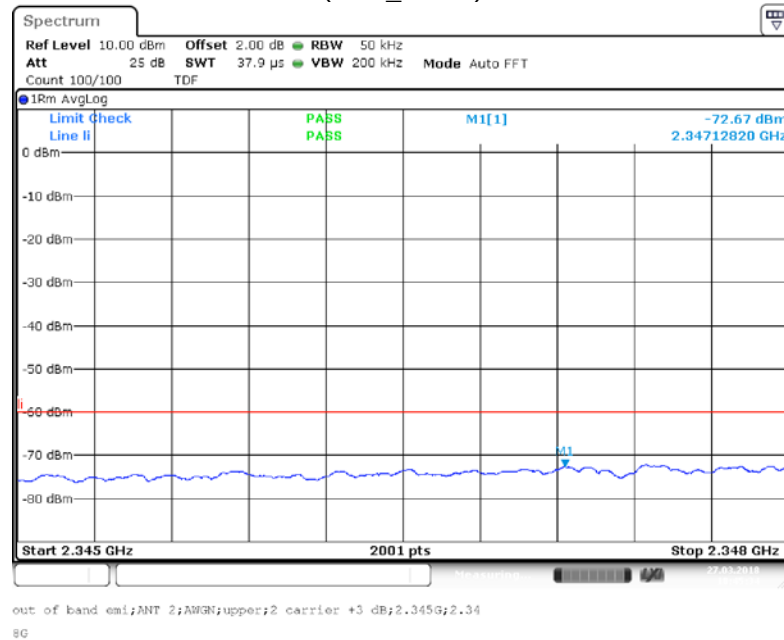
Band Edge = High, Frequency Band = High[XM], Direction = RF downlink,  
Input Power = 0.3 dB < AGC, Signal Type = AWGN, Test Frequency = mid  
(S01\_AA01)



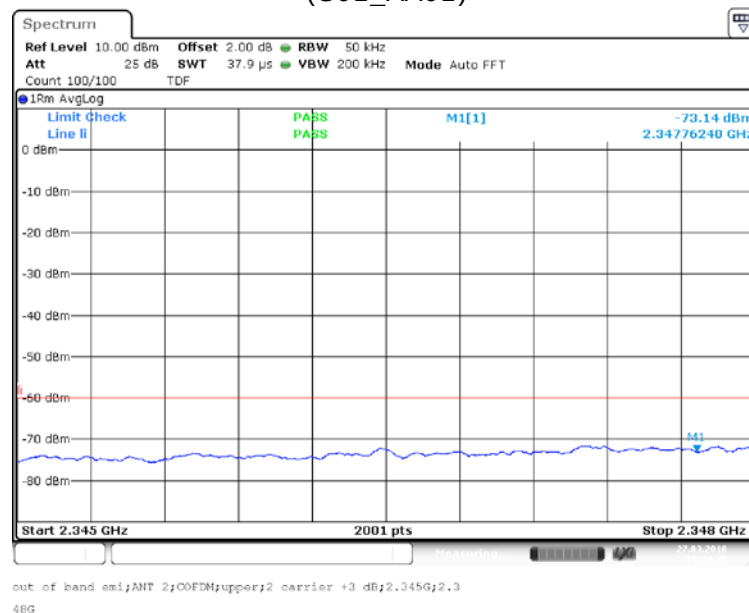
Band Edge = High, Frequency Band = High[XM], Direction = RF downlink,  
Input Power = 0.3 dB < AGC, Signal Type = COFDM, Test Frequency = mid  
(S01\_AA01)



Band Edge = High, Frequency Band = High[XM], Direction = RF downlink,  
Input Power = 3 dB > AGC, Signal Type = AWGN, Test Frequency = mid  
(S01\_AA01)



Band Edge = High, Frequency Band = High[XM], Direction = RF downlink,  
Input Power = 3 dB > AGC, Signal Type = COFDM, Test Frequency = mid  
(S01\_AA01)



#### 4.5.5 TEST EQUIPMENT USED

- FCC Conducted Base Station / Repeater

## 4.6 FIELD STRENGTH OF SPURIOUS RADIATION

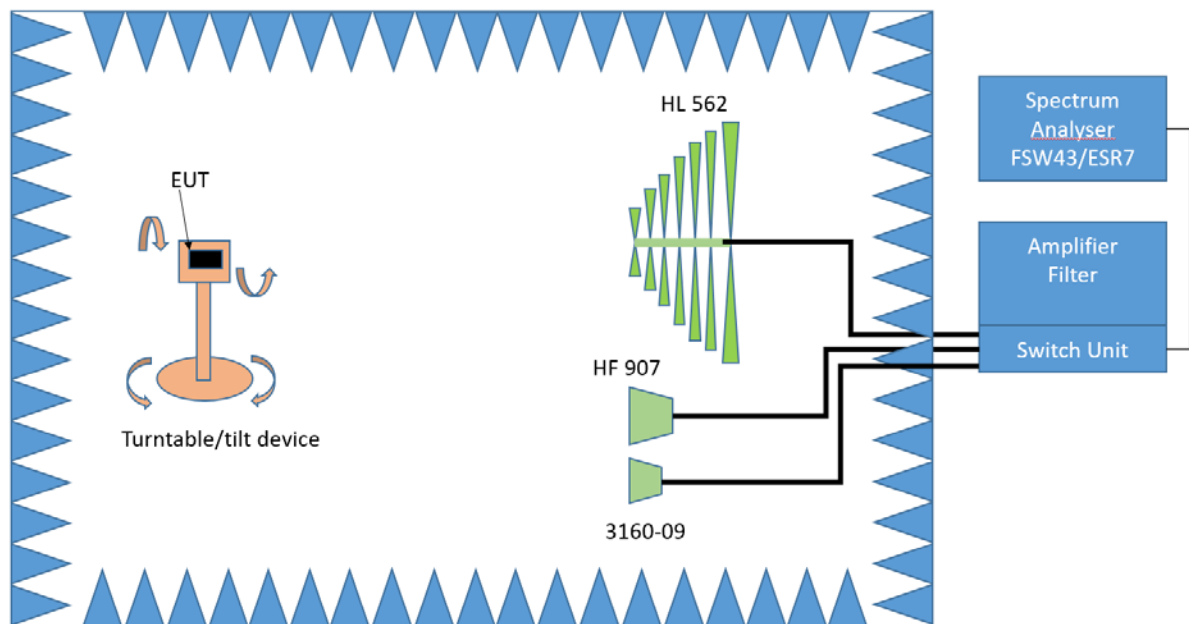
Standard FCC Part §2.1053, §25.202

**The test was performed according to:**  
ANSI C63.26

### 4.6.1 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:



FCC Part 22/24/27/90; Industrial Signal Booster – Test Setup; Field Strength of Spurious Radiation

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 1.0 x 2.0 m<sup>2</sup> in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.

The measurement procedure is implemented into the EMI test software EMC32 from R&S. 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 from 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: 3 m
- Detector: Peak-Maxhold / Quasipeak (FFT-based)

- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF-Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms
- Turntable angle range:  $-180^{\circ}$  to  $90^{\circ}$
- Turntable step size:  $90^{\circ}$
- Height variation range: 1 – 3 m
- Height variation step size: 2 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  $\pm 45^{\circ}$  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  $\pm 100$  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
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range:  $\pm 45^{\circ}$  around the determined value
- Height variation range:  $\pm 100$  cm 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)
- 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 (tilt device) at 1.5 m height in the fully-anechoic chamber.

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  $90^{\circ}$ .

The turn table step size (azimuth angle) for the preliminary measurement is  $45^{\circ}$ .

#### **Step 2:**

Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna in step 2 is omitted. Instead of this, a maximum search with a step size  $\pm 45^\circ$  for the elevation axis is performed.

The turn table azimuth will slowly vary by  $\pm 22.5^\circ$ .

The elevation angle will slowly vary by  $\pm 45^\circ$

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

#### 4.6.2 TEST REQUIREMENTS / LIMITS

**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.

**Part 25; Satellite Communications**

**Subpart C – Technical standards**

**§25.202 – Frequencies, frequency tolerance and emission limits**

h) *Out-of-band emission limitations for SDARS terrestrial repeaters.* (1) Any SDARS terrestrial repeater operating at a power level greater than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than  $90 + 10 \log (P)$  dB in a 1-megahertz bandwidth outside the 2320-2345 MHz band, where P is average transmitter output power in watts.

(2) Any SDARS terrestrial repeater operating at a power level equal to or less than 2-watt average EIRP is required to attenuate its out-of-band emissions below the transmitter power P by a factor of not less than  $75 + 10 \log (P)$  dB in a 1-megahertz bandwidth outside the 2320-2345 MHz band, where P is average transmitter output power in watts.

#### 4.6.3 TEST PROTOCOL

| Low [Sirius] / High [XM], downlink, AWGN |                      |           |          |           |             |                      |
|------------------------------------------|----------------------|-----------|----------|-----------|-------------|----------------------|
| Spurious Freq. [MHz]                     | Spurious Level [dBm] | Pin [dBm] | Detector | RBW [kHz] | Limit [dBm] | Margin to Limit [dB] |
| 30.097                                   | -62.2*)              | 4.0       | RMS      | 1000      | -60.0       | 2.2                  |
| 45.423                                   | -64.0*)              | 4.0       | RMS      | 1000      | -60.0       | 4.0                  |
| 62.883                                   | -60.7*)              | 4.0       | RMS      | 1000      | -60.0       | 0.7                  |
| 89.946                                   | -66.00*)             | 4.0       | RMS      | 1000      | -60.0       | 6.00                 |
| 122.150                                  | -70.4*)              | 4.0       | RMS      | 1000      | -60.0       | 10.4                 |
| 895.725                                  | -65.3*)              | 4.0       | RMS      | 1000      | -60.0       | 5.3                  |

| Low [Sirius] / High [XM], downlink, COFDM |                      |           |          |           |             |                      |
|-------------------------------------------|----------------------|-----------|----------|-----------|-------------|----------------------|
| Spurious Freq. [MHz]                      | Spurious Level [dBm] | Pin [dBm] | Detector | RBW [kHz] | Limit [dBm] | Margin to Limit [dB] |
| 30.097                                    | -64.7*)              | 3.9       | RMS      | 1000      | -60.0       | 4.7                  |
| 56.384                                    | -70.5*)              | 3.9       | RMS      | 1000      | -60.0       | 10.5                 |
| 63.174                                    | -66.8*)              | 3.9       | RMS      | 1000      | -60.0       | 6.8                  |
| 90.043                                    | -65.8*)              | 3.9       | RMS      | 1000      | -60.0       | 5.8                  |
| 126.806                                   | -70.1*)              | 3.9       | RMS      | 1000      | -60.0       | 10.1                 |
| 4678.000                                  | -62.5*)              | 3.9       | RMS      | 1000      | -60.0       | 2.5                  |

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

The two required test frequencies (low, , high) were injected simultaneously conducted into the EUT.

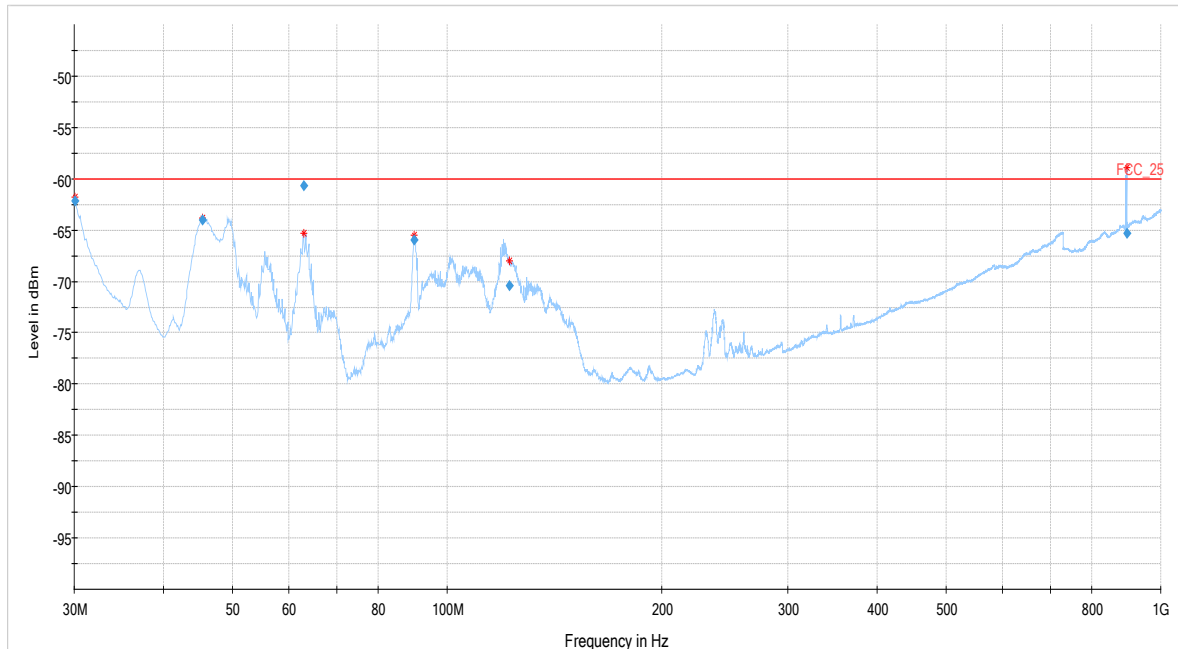
The RF output ports were terminated with 50 Ohm

Pin: The composite power of both signals.

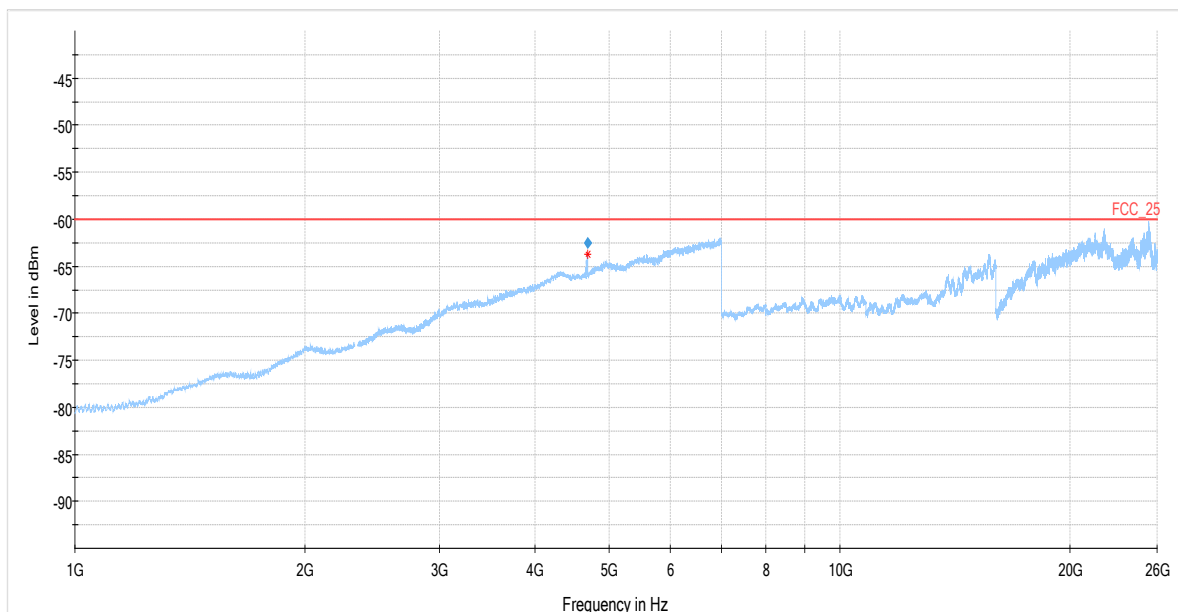
\*) → blue rhomb in measurement plot

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

Frequency Band = Band Low[Sirius] / High [XM], Test Frequency = mid,  
Direction = RF downlink, Test Signal = AWGN  
(S01\_AA01)

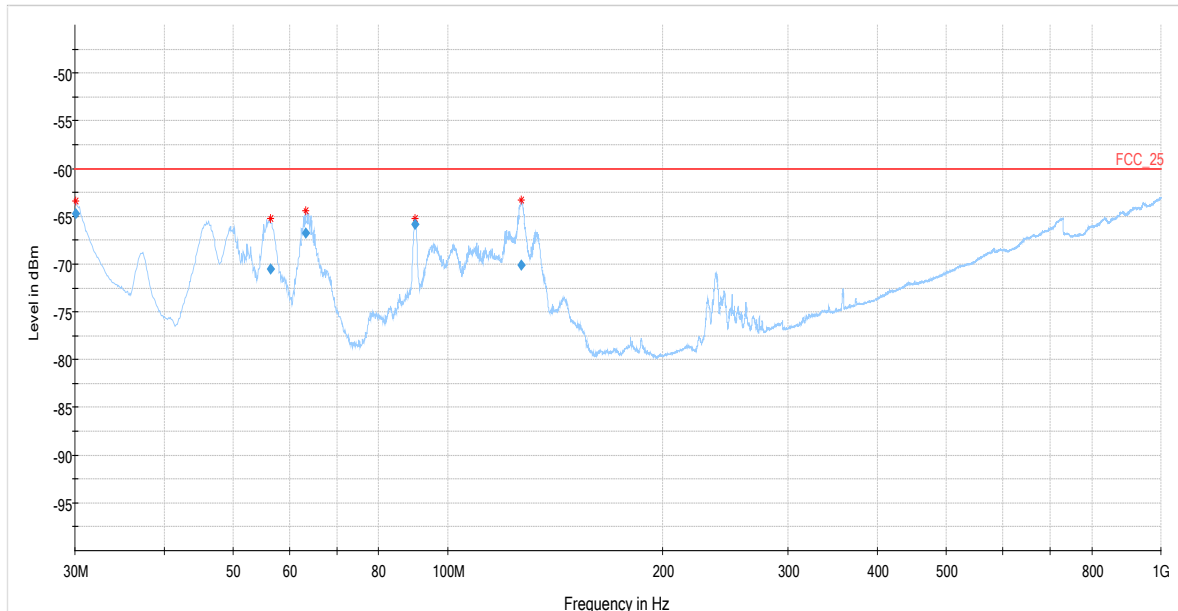


30 MHz - 1 GHz

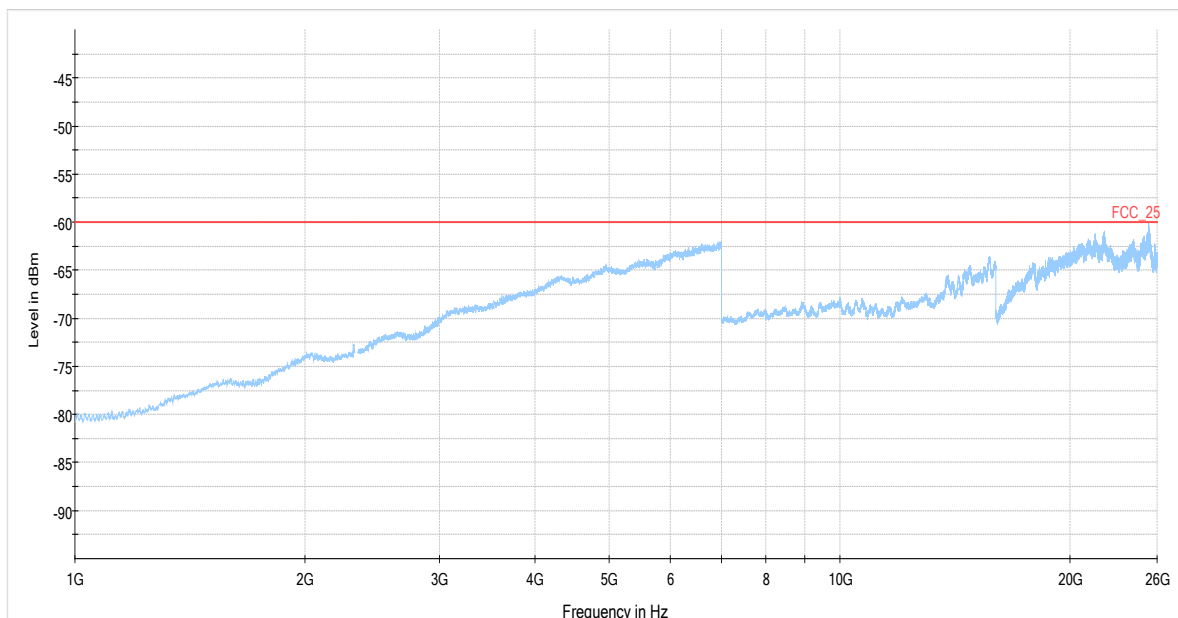


1 GHz - 26 GHz

Frequency Band = Band Low[Sirius] / High [XM], Test Frequency = mid,  
 Direction = RF downlink, Test Signal = COFDM  
 (S01\_AA01)



30 MHz - 1 GHz



1 GHz - 26 GHz

#### 4.6.5 TEST EQUIPMENT USED

- Radiated Emissions

## 5 TEST EQUIPMENT

1 R&S TS8997  
EN300328/301893/FCC cond. Test Lab

| Ref.No. | Device Name          | Description                                | Manufacturer                      | Serial Number | Last Calibration | Calibration Due |
|---------|----------------------|--------------------------------------------|-----------------------------------|---------------|------------------|-----------------|
| 1.1     | SMB100A              | Signal Generator 9 kHz - 6 GHz             | Rohde & Schwarz                   | 107695        | 2017-07          | 2020-07         |
| 1.2     | MFS                  | Rubidium Frequency Standard                | Datum-Beverly                     | 5489/001      | 2017-07          | 2018-07         |
| 1.3     | 1515 / 93459         | Broadband Power Divider SMA (Aux)          | Weinschel Associates              | LN673         |                  |                 |
| 1.4     | FSV30                | Signal Analyzer 10 Hz - 30 GHz             | Rohde & Schwarz                   | 103005        | 2018-03          | 2020-03         |
| 1.5     | Fluke 177            | Digital Multimeter 03 (Multimeter)         | Fluke Europe B.V.                 | 86670383      | 2018-03          | 2020-03         |
| 1.6     | A8455-4              | 4 Way Power Divider (SMA)                  |                                   | -             |                  |                 |
| 1.7     | Opus10 THI (8152.00) | ThermoHygro Datalogger 03 (Environ)        | Lufft Mess- und Regeltechnik GmbH | 7482          | 2017-03          | 2019-03         |
| 1.8     | SMBV100A             | Vector Signal Generator 9 kHz - 6 GHz      | Rohde & Schwarz                   | 259291        | 2016-10          | 2019-10         |
| 1.9     | OSP120               | Switching Unit with integrated power meter | Rohde & Schwarz                   | 101158        | 2016-11          | 2018-11         |

2 Radiated Emissions  
Lab to perform radiated emission tests

| Ref.No. | Device Name           | Description                               | Manufacturer                      | Serial Number      | Last Calibration | Calibration Due |
|---------|-----------------------|-------------------------------------------|-----------------------------------|--------------------|------------------|-----------------|
| 2.1     | NRV-Z1                | Sensor Head A                             | Rohde & Schwarz                   | 827753/005         | 2017-05          | 2018-05         |
| 2.2     | MFS                   | Rubidium Frequency Normal MFS             | Datum GmbH                        | 002                | 2017-10          | 2018-10         |
| 2.3     | Opus10 TPR (8253.00)  | ThermoAirpressure Datalogger 13 (Environ) | Lufft Mess- und Regeltechnik GmbH | 13936              | 2017-04          | 2019-04         |
| 2.4     | Anechoic Chamber      | 10.38 x 6.38 x 6.00 m <sup>3</sup>        | Frankonia                         | none               | 2016-05          | 2019-05         |
| 2.5     | HL 562                | Ultralog new biconicals                   | Rohde & Schwarz                   | 830547/003         | 2015-06          | 2018-06         |
| 2.6     | 5HC2700/12750 -1.5-KK | High Pass Filter                          | Trilithic                         | 9942012            |                  |                 |
| 2.7     | ASP 1.2/1.8-10 kg     | Antenna Mast                              | Maturo GmbH                       | -                  |                  |                 |
| 2.8     | Fully Anechoic Room   | 8.80m x 4.60m x 4.05m (l x w x h)         | Albatross Projects                | P26971-647-001-PRB | 2015-06          | 2018-06         |

| Ref.No. | Device Name                   | Description                                     | Manufacturer                      | Serial Number          | Last Calibration | Calibration Due |
|---------|-------------------------------|-------------------------------------------------|-----------------------------------|------------------------|------------------|-----------------|
| 2.9     | Fluke 177                     | Digital Multimeter 03 (Multimeter)              | Fluke Europe B.V.                 | 86670383               | 2018-03          | 2020-03         |
| 2.10    | JS4-18002600-32-5P            | Broadband Amplifier 18 GHz - 26 GHz             | Miteq                             | 849785                 |                  |                 |
| 2.11    | FSW 43                        | Spectrum Analyzer                               | Rohde & Schwarz                   | 103779                 | 2016-12          | 2018-12         |
| 2.12    | 3160-09                       | Standard Gain / Pyramidal Horn Antenna 26.5 GHz | EMCO Elektronik GmbH              | 00083069               |                  |                 |
| 2.13    | WHKX 7.0/18G-8SS              | High Pass Filter                                | Wainwright                        | 09                     |                  |                 |
| 2.14    | 4HC1600/12750-1.5-KK          | High Pass Filter                                | Trilithic                         | 9942011                |                  |                 |
| 2.15    | Chroma 6404                   | AC Power Source                                 | Chroma ATE INC.                   | 64040001304            |                  |                 |
| 2.16    | JS4-00102600-42-5A            | Broadband Amplifier 30 MHz - 26 GHz             | Miteq                             | 619368                 |                  |                 |
| 2.17    | TT 1.5 WI                     | Turn Table                                      | Maturo GmbH                       | -                      |                  |                 |
| 2.18    | HL 562 Ultralog               | Log.-per. Antenna                               | Rohde & Schwarz                   | 100609                 | 2016-04          | 2019-04         |
| 2.19    | 3160-10                       | Standard Gain / Pyramidal Horn Antenna 40 GHz   | EMCO Elektronik GmbH              | 00086675               |                  |                 |
| 2.20    | 5HC3500/18000-1.2-KK          | High Pass Filter                                | Trilithic                         | 200035008              |                  |                 |
| 2.21    | Opus10 THI (8152.00)          | ThermoHygro Datalogger 12 (Environ)             | Lufth Mess- und Regeltechnik GmbH | 12482                  | 2017-03          | 2019-03         |
| 2.22    | ESR 7                         | EMI Receiver / Spectrum Analyzer                | Rohde & Schwarz                   | 101424                 | 2016-11          | 2018-11         |
| 2.23    | JS4-00101800-35-5P            | Broadband Amplifier 30 MHz - 18 GHz             | Miteq                             | 896037                 |                  |                 |
| 2.24    | AS 620 P                      | Antenna mast                                    | HD GmbH                           | 620/37                 |                  |                 |
| 2.25    | Tilt device Maturo (Rohacell) | Antrieb TD1.5-10kg                              | Maturo GmbH                       | TD1.5-10kg/024/3790709 |                  |                 |
| 2.26    | PAS 2.5 - 10 kg               | Antenna Mast                                    | Maturo GmbH                       | -                      |                  |                 |
| 2.27    | AM 4.0                        | Antenna mast                                    | Maturo GmbH                       | AM4.0/180/11920513     |                  |                 |
| 2.28    | HF 907                        | Double-ridged horn                              | Rohde & Schwarz                   | 102444                 | 2015-05          | 2018-05         |

3 FCC Conducted Base Station / Repeater  
EN300328/301893/FCC cond. Test Lab

| Ref.No. | Device Name | Description                             | Manufacturer    | Serial Number | Last Calibration | Calibration Due |
|---------|-------------|-----------------------------------------|-----------------|---------------|------------------|-----------------|
| 3.1     | FSV40       | Signal Analyzer 10 Hz - 40 GHz          | Rohde & Schwarz | 100886        | 2017-08          | 2018-08         |
| 3.2     | SMBV100A    | Vector Signal Generator 9 kHz - 6 GHz   | Rohde & Schwarz | 255975        | 2017-08          | 2020-08         |
| 3.3     | SMIQ        | Vector Signal Generator 9 kHz – 3.3 GHz | Rohde & Schwarz | 831389/062    | 2016-08          | 2018-08         |
| 3.4     | SMIQ        | Vector Signal Generator 9 kHz – 3.3 GHz | Rohde & Schwarz | 831389/063    | 2016-10          | 2018-10         |

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”

## 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 as well as the insertion loss of the LISN.

### 6.1 LISN R&S ESH3-Z5 (150 KHZ – 30 MHZ)

| Frequency |  | Corr. | LISN<br>insertion<br>loss<br>ESH3-<br>Z5 | cable<br>loss<br>(incl. 10<br>dB<br>atten-<br>uator) |
|-----------|--|-------|------------------------------------------|------------------------------------------------------|
| MHz       |  | dB    | dB                                       | dB                                                   |
| 0.15      |  | 10.1  | 0.1                                      | 10.0                                                 |
| 5         |  | 10.3  | 0.1                                      | 10.2                                                 |
| 7         |  | 10.3  | 0.2                                      | 10.3                                                 |
| 10        |  | 10.3  | 0.2                                      | 10.3                                                 |
| 12        |  | 10.7  | 0.3                                      | 10.4                                                 |
| 14        |  | 10.7  | 0.3                                      | 10.4                                                 |
| 16        |  | 10.8  | 0.4                                      | 10.4                                                 |
| 18        |  | 10.9  | 0.4                                      | 10.3                                                 |
| 20        |  | 10.9  | 0.4                                      | 10.3                                                 |
| 22        |  | 11.1  | 0.3                                      | 10.6                                                 |
| 24        |  | 11.1  | 0.3                                      | 10.6                                                 |
| 26        |  | 11.2  | 0.3                                      | 10.7                                                 |
| 28        |  | 11.2  | 0.3                                      | 10.7                                                 |
| 30        |  | 11.3  | 0.3                                      | 10.8                                                 |

#### Sample calculation

$$U_{\text{LISN}} (\text{dB } \mu\text{V}) = U (\text{dB } \mu\text{V}) + \text{Corr. (dB)}$$

U = Receiver reading

LISN Insertion loss = Voltage Division Factor of LISN

Corr. = sum of single correction factors of used LISN, cables, switch units (if used)

Linear interpolation will be used for frequencies in between the values in the table.

## 6.2 ANTENNA R&S HFH2-Z2 (9 KHZ – 30 MHZ)

| Frequency | AF       | Corr. | cable loss 1     | cable loss 2      | cable loss 3  | cable loss 4  | distance corr.  | d <sub>Limit</sub>       | d <sub>used</sub>       |
|-----------|----------|-------|------------------|-------------------|---------------|---------------|-----------------|--------------------------|-------------------------|
| MHz       | dB (1/m) | dB    | (inside chamber) | (outside chamber) | (switch unit) | (to receiver) | (-40 dB/decade) | (meas. distance (limit)) | (meas. distance (used)) |
|           |          |       | dB               | dB                | dB            | dB            | dB              | m                        | m                       |
| 0.009     | 20.30    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.01      | 20.45    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.015     | 20.37    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.02      | 20.36    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.025     | 20.38    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.03      | 20.32    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.05      | 20.35    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.08      | 20.30    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.1       | 20.20    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.2       | 20.17    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.3       | 20.14    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.49      | 20.12    | -79.6 | 0.1              | 0.1               | 0.1           | 0.1           | -80             | 300                      | 3                       |
| 0.490001  | 20.12    | -39.6 | 0.1              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 0.3       | 20.11    | -39.6 | 0.1              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 0.8       | 20.10    | -39.6 | 0.1              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 1         | 20.09    | -39.6 | 0.1              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 2         | 20.08    | -39.6 | 0.1              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 3         | 20.06    | -39.6 | 0.1              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 4         | 20.05    | -39.5 | 0.2              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 5         | 20.05    | -39.5 | 0.2              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 6         | 20.02    | -39.5 | 0.2              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 8         | 19.95    | -39.5 | 0.2              | 0.1               | 0.1           | 0.1           | -40             | 30                       | 3                       |
| 10        | 19.83    | -39.4 | 0.2              | 0.1               | 0.2           | 0.1           | -40             | 30                       | 3                       |
| 12        | 19.71    | -39.4 | 0.2              | 0.1               | 0.2           | 0.1           | -40             | 30                       | 3                       |
| 14        | 19.54    | -39.4 | 0.2              | 0.1               | 0.2           | 0.1           | -40             | 30                       | 3                       |
| 16        | 19.53    | -39.3 | 0.3              | 0.1               | 0.2           | 0.1           | -40             | 30                       | 3                       |
| 18        | 19.50    | -39.3 | 0.3              | 0.1               | 0.2           | 0.1           | -40             | 30                       | 3                       |
| 20        | 19.57    | -39.3 | 0.3              | 0.1               | 0.2           | 0.1           | -40             | 30                       | 3                       |
| 22        | 19.61    | -39.3 | 0.3              | 0.1               | 0.2           | 0.1           | -40             | 30                       | 3                       |
| 24        | 19.61    | -39.3 | 0.3              | 0.1               | 0.2           | 0.1           | -40             | 30                       | 3                       |
| 26        | 19.54    | -39.3 | 0.3              | 0.1               | 0.2           | 0.1           | -40             | 30                       | 3                       |
| 28        | 19.46    | -39.2 | 0.3              | 0.1               | 0.3           | 0.1           | -40             | 30                       | 3                       |
| 30        | 19.73    | -39.1 | 0.4              | 0.1               | 0.3           | 0.1           | -40             | 30                       | 3                       |

### Sample calculation

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

distance correction =  $-40 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values

### 6.3 ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

( $d_{\text{Limit}} = 3 \text{ m}$ )

| Frequency | AF<br>R&S<br>HL562 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 30        | 18.6               | 0.6   |
| 50        | 6.0                | 0.9   |
| 100       | 9.7                | 1.2   |
| 150       | 7.9                | 1.6   |
| 200       | 7.6                | 1.9   |
| 250       | 9.5                | 2.1   |
| 300       | 11.0               | 2.3   |
| 350       | 12.4               | 2.6   |
| 400       | 13.6               | 2.9   |
| 450       | 14.7               | 3.1   |
| 500       | 15.6               | 3.2   |
| 550       | 16.3               | 3.5   |
| 600       | 17.2               | 3.5   |
| 650       | 18.1               | 3.6   |
| 700       | 18.5               | 3.6   |
| 750       | 19.1               | 4.1   |
| 800       | 19.6               | 4.1   |
| 850       | 20.1               | 4.4   |
| 900       | 20.8               | 4.7   |
| 950       | 21.1               | 4.8   |
| 1000      | 21.6               | 4.9   |

| cable<br>loss 1<br>(inside<br>chamber) | cable<br>loss 2<br>(outside<br>chamber) | cable<br>loss 3<br>(switch<br>unit) | cable<br>loss 4<br>(to<br>receiver) | distance<br>corr.<br>(-20 dB/<br>decade) | $d_{\text{Limit}}$<br>(meas.<br>distance<br>(limit)) | $d_{\text{used}}$<br>(meas.<br>distance<br>(used)) |
|----------------------------------------|-----------------------------------------|-------------------------------------|-------------------------------------|------------------------------------------|------------------------------------------------------|----------------------------------------------------|
| dB                                     | dB                                      | dB                                  | dB                                  | dB                                       | m                                                    | m                                                  |
| 0.29                                   | 0.04                                    | 0.23                                | 0.02                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.39                                   | 0.09                                    | 0.32                                | 0.08                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.36                                   | 0.14                                    | 0.47                                | 0.08                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.73                                   | 0.20                                    | 0.39                                | 0.12                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.84                                   | 0.21                                    | 0.70                                | 0.11                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.98                                   | 0.24                                    | 0.80                                | 0.13                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.04                                   | 0.26                                    | 0.89                                | 0.15                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.18                                   | 0.31                                    | 0.96                                | 0.13                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.28                                   | 0.35                                    | 1.03                                | 0.19                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.39                                   | 0.38                                    | 1.11                                | 0.22                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.44                                   | 0.39                                    | 1.20                                | 0.19                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.55                                   | 0.46                                    | 1.24                                | 0.23                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.59                                   | 0.43                                    | 1.29                                | 0.23                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.67                                   | 0.34                                    | 1.35                                | 0.22                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.67                                   | 0.42                                    | 1.41                                | 0.15                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.87                                   | 0.34                                    | 1.46                                | 0.25                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.90                                   | 0.46                                    | 1.51                                | 0.25                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.99                                   | 0.60                                    | 1.56                                | 0.27                                | 0.0                                      | 3                                                    | 3                                                  |
| 2.14                                   | 0.60                                    | 1.63                                | 0.29                                | 0.0                                      | 3                                                    | 3                                                  |
| 2.22                                   | 0.60                                    | 1.66                                | 0.33                                | 0.0                                      | 3                                                    | 3                                                  |
| 2.23                                   | 0.61                                    | 1.71                                | 0.30                                | 0.0                                      | 3                                                    | 3                                                  |

( $d_{\text{Limit}} = 10 \text{ m}$ )

|      |      |      |
|------|------|------|
| 30   | 18.6 | -9.9 |
| 50   | 6.0  | -9.6 |
| 100  | 9.7  | -9.2 |
| 150  | 7.9  | -8.8 |
| 200  | 7.6  | -8.6 |
| 250  | 9.5  | -8.3 |
| 300  | 11.0 | -8.1 |
| 350  | 12.4 | -7.9 |
| 400  | 13.6 | -7.6 |
| 450  | 14.7 | -7.4 |
| 500  | 15.6 | -7.2 |
| 550  | 16.3 | -7.0 |
| 600  | 17.2 | -6.9 |
| 650  | 18.1 | -6.9 |
| 700  | 18.5 | -6.8 |
| 750  | 19.1 | -6.3 |
| 800  | 19.6 | -6.3 |
| 850  | 20.1 | -6.0 |
| 900  | 20.8 | -5.8 |
| 950  | 21.1 | -5.6 |
| 1000 | 21.6 | -5.6 |

|      |      |      |      |       |    |   |
|------|------|------|------|-------|----|---|
| 0.29 | 0.04 | 0.23 | 0.02 | -10.3 | 10 | 3 |
| 0.39 | 0.09 | 0.32 | 0.08 | -10.3 | 10 | 3 |
| 0.36 | 0.14 | 0.47 | 0.08 | -10.3 | 10 | 3 |
| 0.73 | 0.20 | 0.39 | 0.12 | -10.3 | 10 | 3 |
| 0.84 | 0.21 | 0.70 | 0.11 | -10.3 | 10 | 3 |
| 0.98 | 0.24 | 0.80 | 0.13 | -10.3 | 10 | 3 |
| 1.04 | 0.26 | 0.89 | 0.15 | -10.3 | 10 | 3 |
| 1.18 | 0.31 | 0.96 | 0.13 | -10.3 | 10 | 3 |
| 1.28 | 0.35 | 1.03 | 0.19 | -10.3 | 10 | 3 |
| 1.39 | 0.38 | 1.11 | 0.22 | -10.3 | 10 | 3 |
| 1.44 | 0.39 | 1.20 | 0.19 | -10.3 | 10 | 3 |
| 1.55 | 0.46 | 1.24 | 0.23 | -10.3 | 10 | 3 |
| 1.59 | 0.43 | 1.29 | 0.23 | -10.3 | 10 | 3 |
| 1.67 | 0.34 | 1.35 | 0.22 | -10.3 | 10 | 3 |
| 1.67 | 0.42 | 1.41 | 0.15 | -10.3 | 10 | 3 |
| 1.87 | 0.34 | 1.46 | 0.25 | -10.3 | 10 | 3 |
| 1.90 | 0.46 | 1.51 | 0.25 | -10.3 | 10 | 3 |
| 1.99 | 0.60 | 1.56 | 0.27 | -10.3 | 10 | 3 |
| 2.14 | 0.60 | 1.63 | 0.29 | -10.3 | 10 | 3 |
| 2.22 | 0.60 | 1.66 | 0.33 | -10.3 | 10 | 3 |
| 2.23 | 0.61 | 1.71 | 0.30 | -10.3 | 10 | 3 |

#### Sample calculation

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

#### 6.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

| Frequency | AF<br>R&S<br>HF907 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 1000      | 24.4               | -19.4 |
| 2000      | 28.5               | -17.4 |
| 3000      | 31.0               | -16.1 |
| 4000      | 33.1               | -14.7 |
| 5000      | 34.4               | -13.7 |
| 6000      | 34.7               | -12.7 |
| 7000      | 35.6               | -11.0 |

| cable<br>loss 1<br>(relay +<br>cable<br>inside<br>chamber) | cable<br>loss 2<br>(outside<br>chamber) | cable<br>loss 3<br>(switch<br>unit,<br>atten-<br>uator &<br>pre-amp) | cable<br>loss 4 (to<br>receiver) |  |  |
|------------------------------------------------------------|-----------------------------------------|----------------------------------------------------------------------|----------------------------------|--|--|
| dB                                                         | dB                                      | dB                                                                   | dB                               |  |  |
| 0.99                                                       | 0.31                                    | -21.51                                                               | 0.79                             |  |  |
| 1.44                                                       | 0.44                                    | -20.63                                                               | 1.38                             |  |  |
| 1.87                                                       | 0.33                                    | -19.85                                                               | 1.33                             |  |  |
| 2.41                                                       | 0.67                                    | -19.13                                                               | 1.31                             |  |  |
| 2.78                                                       | 0.86                                    | -18.71                                                               | 1.40                             |  |  |
| 2.74                                                       | 0.90                                    | -17.83                                                               | 1.47                             |  |  |
| 2.82                                                       | 0.86                                    | -16.19                                                               | 1.46                             |  |  |

| Frequency | AF<br>R&S<br>HF907 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 3000      | 31.0               | -23.4 |
| 4000      | 33.1               | -23.3 |
| 5000      | 34.4               | -21.7 |
| 6000      | 34.7               | -21.2 |
| 7000      | 35.6               | -19.8 |

| cable<br>loss 1<br>(relay<br>inside<br>chamber) | cable<br>loss 2<br>(inside<br>chamber) | cable<br>loss 3<br>(outside<br>chamber) | cable<br>loss 4<br>(switch<br>unit,<br>atten-<br>uator &<br>pre-amp) | cable<br>loss 5 (to<br>receiver) | used<br>for<br>FCC<br>15.247 |
|-------------------------------------------------|----------------------------------------|-----------------------------------------|----------------------------------------------------------------------|----------------------------------|------------------------------|
| dB                                              | dB                                     | dB                                      | dB                                                                   | dB                               |                              |
| 0.47                                            | 1.87                                   | 0.33                                    | -27.58                                                               | 1.33                             |                              |
| 0.36                                            | 2.41                                   | 0.67                                    | -28.23                                                               | 1.31                             |                              |
| 0.61                                            | 2.78                                   | 0.86                                    | -27.35                                                               | 1.40                             |                              |
| 0.38                                            | 2.74                                   | 0.90                                    | -26.89                                                               | 1.47                             |                              |
| 0.66                                            | 2.82                                   | 0.86                                    | -25.58                                                               | 1.46                             |                              |

| Frequency | AF<br>R&S<br>HF907 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 7000      | 35.6               | -57.3 |
| 8000      | 36.3               | -56.3 |
| 9000      | 37.1               | -55.3 |
| 10000     | 37.5               | -56.2 |
| 11000     | 37.5               | -55.3 |
| 12000     | 37.6               | -53.7 |
| 13000     | 38.2               | -53.5 |
| 14000     | 39.9               | -56.3 |
| 15000     | 40.9               | -54.1 |
| 16000     | 41.3               | -54.1 |
| 17000     | 42.8               | -54.4 |
| 18000     | 44.2               | -54.7 |

| cable<br>loss 1<br>(relay<br>inside<br>chamber) | cable<br>loss 2<br>(High<br>Pass) | cable<br>loss 3<br>(pre-<br>amp) | cable<br>loss 4<br>(inside<br>chamber) | cable<br>loss 5<br>(outside<br>chamber) | cable<br>loss 6<br>(to<br>receiver) |
|-------------------------------------------------|-----------------------------------|----------------------------------|----------------------------------------|-----------------------------------------|-------------------------------------|
| dB                                              | dB                                | dB                               | dB                                     | dB                                      | dB                                  |
| 0.36                                            | 1.28                              | -62.72                           | 2.66                                   | 0.94                                    | 1.46                                |
| 0.69                                            | 0.71                              | -61.49                           | 2.84                                   | 1.00                                    | 1.53                                |
| 0.68                                            | 0.65                              | -60.80                           | 3.06                                   | 1.09                                    | 1.60                                |
| 0.70                                            | 0.34                              | -61.91                           | 3.28                                   | 1.20                                    | 1.67                                |
| 0.80                                            | 0.61                              | -61.40                           | 3.43                                   | 1.27                                    | 1.70                                |
| 0.84                                            | 0.42                              | -59.70                           | 3.53                                   | 1.26                                    | 1.73                                |
| 0.83                                            | 0.44                              | -59.81                           | 3.75                                   | 1.32                                    | 1.83                                |
| 0.91                                            | 0.33                              | -63.03                           | 3.91                                   | 1.40                                    | 1.77                                |
| 0.98                                            | 0.34                              | -61.05                           | 4.02                                   | 1.44                                    | 1.83                                |
| 1.23                                            | 0.49                              | -61.51                           | 4.17                                   | 1.51                                    | 1.85                                |
| 1.36                                            | 0.76                              | -62.36                           | 4.34                                   | 1.53                                    | 2.00                                |
| 1.70                                            | 0.33                              | -62.88                           | 4.41                                   | 1.55                                    | 1.91                                |

#### Sample calculation

$$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$$

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.

## 6.5 ANTENNA EMCO 3160-09 (18 GHZ – 26.5 GHZ)

| Frequency | AF<br>EMCO<br>3160-09 | Corr. | cable<br>loss 1<br>(inside<br>chamber) | cable<br>loss 2<br>(pre-<br>amp) | cable<br>loss 3<br>(inside<br>chamber) | cable<br>loss 4<br>(switch<br>unit) | cable<br>loss 5<br>(to<br>receiver) |
|-----------|-----------------------|-------|----------------------------------------|----------------------------------|----------------------------------------|-------------------------------------|-------------------------------------|
| MHz       | dB (1/m)              | dB    | dB                                     | dB                               | dB                                     | dB                                  | dB                                  |
| 18000     | 40.2                  | -23.5 | 0.72                                   | -35.85                           | 6.20                                   | 2.81                                | 2.65                                |
| 18500     | 40.2                  | -23.2 | 0.69                                   | -35.71                           | 6.46                                   | 2.76                                | 2.59                                |
| 19000     | 40.2                  | -22.0 | 0.76                                   | -35.44                           | 6.69                                   | 3.15                                | 2.79                                |
| 19500     | 40.3                  | -21.3 | 0.74                                   | -35.07                           | 7.04                                   | 3.11                                | 2.91                                |
| 20000     | 40.3                  | -20.3 | 0.72                                   | -34.49                           | 7.30                                   | 3.07                                | 3.05                                |
| 20500     | 40.3                  | -19.9 | 0.78                                   | -34.46                           | 7.48                                   | 3.12                                | 3.15                                |
| 21000     | 40.3                  | -19.1 | 0.87                                   | -34.07                           | 7.61                                   | 3.20                                | 3.33                                |
| 21500     | 40.3                  | -19.1 | 0.90                                   | -33.96                           | 7.47                                   | 3.28                                | 3.19                                |
| 22000     | 40.3                  | -18.7 | 0.89                                   | -33.57                           | 7.34                                   | 3.35                                | 3.28                                |
| 22500     | 40.4                  | -19.0 | 0.87                                   | -33.66                           | 7.06                                   | 3.75                                | 2.94                                |
| 23000     | 40.4                  | -19.5 | 0.88                                   | -33.75                           | 6.92                                   | 3.77                                | 2.70                                |
| 23500     | 40.4                  | -19.3 | 0.90                                   | -33.35                           | 6.99                                   | 3.52                                | 2.66                                |
| 24000     | 40.4                  | -19.8 | 0.88                                   | -33.99                           | 6.88                                   | 3.88                                | 2.58                                |
| 24500     | 40.4                  | -19.5 | 0.91                                   | -33.89                           | 7.01                                   | 3.93                                | 2.51                                |
| 25000     | 40.4                  | -19.3 | 0.88                                   | -33.00                           | 6.72                                   | 3.96                                | 2.14                                |
| 25500     | 40.3                  | -20.4 | 0.89                                   | -34.07                           | 6.90                                   | 3.66                                | 2.22                                |
| 26000     | 40.3                  | -21.3 | 0.86                                   | -35.11                           | 7.02                                   | 3.69                                | 2.28                                |
| 26500     | 40.3                  | -21.1 | 0.90                                   | -35.20                           | 7.15                                   | 3.91                                | 2.36                                |

### Sample calculation

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$

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.

## 6.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

| Frequency | AF<br>EMCO<br>3160-10 | Corr. | cable<br>loss 1<br>(inside<br>chamber) | cable<br>loss 2<br>(outside<br>chamber) | cable<br>loss 3<br>(switch<br>unit) | cable<br>loss 4<br>(to<br>receiver) | distance<br>corr.<br>(-20 dB/<br>decade) | d <sub>Limit</sub><br>(meas.<br>distance<br>(limit)) | d <sub>used</sub><br>(meas.<br>distance<br>(used)) |
|-----------|-----------------------|-------|----------------------------------------|-----------------------------------------|-------------------------------------|-------------------------------------|------------------------------------------|------------------------------------------------------|----------------------------------------------------|
| GHz       | dB (1/m)              | dB    | dB                                     | dB                                      | dB                                  | dB                                  | dB                                       | m                                                    | m                                                  |
| 26.5      | 43.4                  | -11.2 | 4.4                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 27.0      | 43.4                  | -11.2 | 4.4                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 28.0      | 43.4                  | -11.1 | 4.5                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 29.0      | 43.5                  | -11.0 | 4.6                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 30.0      | 43.5                  | -10.9 | 4.7                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 31.0      | 43.5                  | -10.8 | 4.7                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 32.0      | 43.5                  | -10.7 | 4.8                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 33.0      | 43.6                  | -10.7 | 4.9                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 34.0      | 43.6                  | -10.6 | 5.0                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 35.0      | 43.6                  | -10.3 | 5.1                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 36.0      | 43.6                  | -10.4 | 5.1                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 37.0      | 43.7                  | -10.3 | 5.2                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 38.0      | 43.7                  | -10.2 | 5.3                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 39.0      | 43.7                  | -10.2 | 5.4                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |
| 40.0      | 43.8                  | -10.1 | 5.5                                    |                                         |                                     |                                     | -15.6                                    | 3                                                    | 0.3                                                |

### Sample calculation

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$

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.

distance correction =  $-20 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

## 7 MEASUREMENT UNCERTAINTIES

| Test Case(s)                                                                                    | Parameter          | Uncertainty                    |
|-------------------------------------------------------------------------------------------------|--------------------|--------------------------------|
| - Field strength of spurious radiation                                                          | Power              | $\pm 5.5$ dB                   |
| - Out-of-band rejection<br>- Occupied Bandwidth<br>- Input versus output spectrum               | Power<br>Frequency | $\pm 2.9$ dB<br>$\pm 11.2$ kHz |
| - Effective radiated power, mean output power and zone enhancer gain<br>- Peak to Average Ratio | Power              | $\pm 2.2$ dB                   |
| - Out-of-band emission limits<br>- Conducted Spurious Emissions at Antenna Terminal             | Power<br>Frequency | $\pm 2.2$ dB<br>$\pm 11.2$ kHz |

## 8 PHOTO REPORT

Please see separate photo report.