

# Test report

**299588-2R2TRFWL**

Date of issue: March 9, 2016

Applicant:

**ORBCOMM License Corp.**

Product:

**OG-ISAT**

Model:

**L900-300**

FCC ID:

**XGS-OGI100**

IC Registration number:

**11881A-OGI100**

Specifications:

◆ **FCC 47 CFR Part 25**

Satellite communications

◆ **RSS-170, Issue 3, July 9, 2015**

Mobile Earth Stations (MESs) and Ancillary Terrestrial Component (ATC) Equipment Operating in the Mobile-Satellite Service (MSS) Bands

#### Test location

|              |                                                      |
|--------------|------------------------------------------------------|
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| Website      | www.nemko.com                                        |
| Site number  | FCC: 176392; IC: 2040A-4 (3 m semi anechoic chamber) |

|                       |                                                                                     |
|-----------------------|-------------------------------------------------------------------------------------|
| Tested by             | Andrey Adelberg, Senior Wireless/EMC Specialist                                     |
| Reviewed by           | David Duchesne, Senior EMC/Wireless Specialist                                      |
| Date                  | March 9, 2016                                                                       |
| Signature of reviewer |  |

#### Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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## Section 1. Report summary

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### 1.1 Applicant and manufacturer

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|                 |                                    |
|-----------------|------------------------------------|
| Company name    | ORBCOMM License Corp.              |
| Address         | 395 West Passaic Street, Suite 325 |
| City            | Rochelle Park                      |
| Province/State  | NJ                                 |
| Postal/Zip code | 07662                              |
| Country         | United States                      |

### 1.2 Test specifications

---

|                                |                                                                                                                                        |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| FCC 47 CFR Part 25             | Satellite communications                                                                                                               |
| RSS-170, Issue 3, July 9, 2015 | Mobile Earth Stations (MESs) and Ancillary Terrestrial Component (ATC) Equipment Operating in the Mobile-Satellite Service (MSS) Bands |

### 1.3 Test methods

---

|                                                                 |                                                           |
|-----------------------------------------------------------------|-----------------------------------------------------------|
| 273109 D01 Equip Auth Guide Part 25<br>TXReceiver v02r02 (2011) | Equipment Authorization Guidance for Part 25 Transceivers |
|-----------------------------------------------------------------|-----------------------------------------------------------|

### 1.4 Statement of compliance

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In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

### 1.5 Exclusions

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None

### 1.6 Test report revision history

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| Revision # | Details of changes made to test report                  |
|------------|---------------------------------------------------------|
| TRF        | Original report issued                                  |
| R1TRF      | Model name, product name, FCC ID and IC ID were updated |
| R2TRF      | New OBW and emission mask data                          |

## Section 2. Summary of test results

### 2.1 FCC Part 25 test results

| Part      | Test description                                                                                                 | Verdict |
|-----------|------------------------------------------------------------------------------------------------------------------|---------|
| 25.204    | Power limit                                                                                                      | Pass    |
| 2.1046    | Occupied bandwidth                                                                                               | Pass    |
| 25.202(f) | Spurious emissions at the antenna terminal                                                                       | Pass    |
| 25.202(f) | Field strength of spurious emissions                                                                             | Pass    |
| 25.202(d) | Frequency tolerance, earth stations                                                                              | Pass    |
| 25.216    | Limits for emissions from mobile earth stations for protection of aeronautical radionavigation satellite service | Pass    |

Notes: <sup>1</sup> Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

<sup>2</sup> The Antennas are located within the enclosure of EUT and not user accessible.

### 2.2 IC RSS-GEN, Issue 4 test results

| Part  | Test description                                                         | Verdict                     |
|-------|--------------------------------------------------------------------------|-----------------------------|
| 6.6   | Occupied bandwidth                                                       | Pass                        |
| 7.1.2 | Receiver radiated emission limits                                        | Not applicable              |
| 7.1.3 | Receiver conducted emission limits                                       | Not applicable              |
| 8.8   | Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus | Not applicable <sup>2</sup> |

Notes: <sup>1</sup> According to sections 5.2 and 5.3 of RSS-Gen, Issue 4 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

<sup>2</sup> EUT is a battery operated device intended to be installed in a vehicle.

### 2.3 IC RSS-170, Issue 3 test results

| Part    | Test description                                                                                           | Verdict        |
|---------|------------------------------------------------------------------------------------------------------------|----------------|
| 5.1     | Frequency bands                                                                                            | Pass           |
| 5.2     | Frequency stability                                                                                        | Pass           |
| 5.3.1   | Transmitter e.i.r.p. for ATC equipment                                                                     | Not applicable |
| 5.3.2   | Transmitter e.i.r.p. for mobile earth stations (MESs)                                                      | Pass           |
| 5.4.1.1 | Transmitter unwanted emissions for ATC Base Station Equipment within 1525–1559 MHz band                    | Not applicable |
| 5.4.1.2 | Transmitter unwanted emissions for ATC Base Station Equipment within 2000–2020 MHz and 2180–2200 MHz bands | Not applicable |
| 5.4.1.3 | Transmitter unwanted emissions for ATC Base Station Equipment within 2483.5–2500 MHz band                  | Not applicable |
| 5.4.2.1 | Transmitter unwanted emissions for ATC Mobile Equipment within 1610–1626.5 MHz band                        | Not applicable |
| 5.4.2.2 | Transmitter unwanted emissions for ATC Mobile Equipment within 1626.5–1660.5 MHz band                      | Pass           |
| 5.4.2.3 | Transmitter unwanted emissions for ATC Mobile Equipment within 2000–2020 MHz band                          | Not applicable |
| 5.4.3.1 | Transmitter unwanted emissions for MESs in all frequency bands                                             | Pass           |
| 5.4.3.2 | Additional unwanted emission limits for MESs to protect radionavigation-satellite service                  | Pass           |
| 5.5     | Carrier-off state emissions                                                                                | Pass           |

Notes: None

## Section 3. Equipment under test (EUT) details

### 3.1 Sample information

|                        |                           |
|------------------------|---------------------------|
| Receipt date           | December 7, 2015          |
| Nemko sample ID number | 133-001748 and 133-001749 |

### 3.2 EUT information

|               |                                                                               |
|---------------|-------------------------------------------------------------------------------|
| Product name  | OG-ISAT                                                                       |
| Model         | L900-300                                                                      |
| Serial number | 15090076 (sample with Helix antenna) and 15090074 (sample with Patch antenna) |

### 3.3 Technical information

|                                         |                                                                                                                                                                              |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Applicant IC company number             | 11881A                                                                                                                                                                       |
| IC UPN number                           | OGI100                                                                                                                                                                       |
| All used IC test site(s) Reg. number    | 2040A-4                                                                                                                                                                      |
| RSS number and Issue number             | RSS-170, Issue 3, July 9, 2015                                                                                                                                               |
| Frequency band                          | 1626.5–1660.5 MHz                                                                                                                                                            |
| Frequency Min (MHz)                     | 1626.501                                                                                                                                                                     |
| Frequency Max (MHz)                     | 1660.499                                                                                                                                                                     |
| RF power Max (W)                        | 1.866 (32.71 dBm)                                                                                                                                                            |
| Field strength, Units @ distance        | N/A                                                                                                                                                                          |
| Measured BW (kHz) (99 %)                | 1.955                                                                                                                                                                        |
| Calculated BW (kHz), as per TRC-43      | N/A                                                                                                                                                                          |
| Type of modulation                      | OQPSK                                                                                                                                                                        |
| Emission classification (F1D, G1D, D1D) | G1D                                                                                                                                                                          |
| Transmitter spurious, Units @ distance  | –30.17 dBm at 3253 MHz @ 3 m                                                                                                                                                 |
| Power requirements                      | 5–15 V <sub>DC</sub>                                                                                                                                                         |
| Antenna information                     | Patch antenna with 4.5 dBi gain. Quadrifilar Helix antenna with 2.5 dBi gain.<br>The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator. |
| Stated EIRP                             | Inmarsat's requirement: 7 dBW (37 dBm)                                                                                                                                       |

### 3.4 Product description and theory of operation

The EUT is a low data rate land mobile satellite earth station (LMES) that operates in microwave L-band (1.5/1.6 GHz) and it is designed to be used within Inmarsat global satellite network for asset tracking and management systems.

### 3.5 EUT exercise details

EUT was controlled by TeraTerm Pro session from Laptop.

3.6 EUT setup diagram

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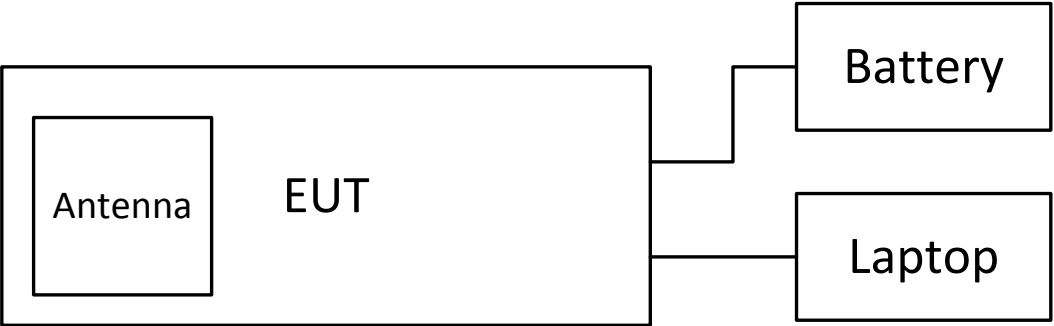


Figure 3.6-1: Setup diagram

**Section 4.**    Engineering considerations

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**4.1**    Modifications incorporated in the EUT

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There were no modifications performed to the EUT during this assessment.

**4.2**    Technical judgment

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None

**4.3**    Deviations from laboratory tests procedures

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No deviations were made from laboratory procedures.

# Section 5. Test conditions

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## 5.1 Atmospheric conditions

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|                   |               |
|-------------------|---------------|
| Temperature       | 15–30 °C      |
| Relative humidity | 20–75 %       |
| Air pressure      | 860–1060 mbar |

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

## 5.2 Power supply range

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The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages  $\pm 5\%$ , for which the equipment was designed.



**Section 6. Measurement uncertainty**

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**6.1 Uncertainty of measurement**

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Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of  $K = 2$  with 95% certainty.

| Test name                         | Measurement uncertainty, dB |
|-----------------------------------|-----------------------------|
| All antenna port measurements     | 0.55                        |
| Conducted spurious emissions      | 1.13                        |
| Radiated spurious emissions       | 3.78                        |
| AC power line conducted emissions | 3.55                        |

## Section 7. Test equipment

### 7.1 Test equipment list

*Table 7.1-1: Equipment list*

| Equipment                   | Manufacturer    | Model no.  | Asset no. | Cal cycle | Next cal.  |
|-----------------------------|-----------------|------------|-----------|-----------|------------|
| 3 m EMI test chamber        | TDK             | SAC-3      | FA002047  | 1 year    | Dec. 01/16 |
| Flush mount turntable       | Sunol           | FM2022     | FA002082  | —         | NCR        |
| Controller                  | Sunol           | SC104V     | FA002060  | —         | NCR        |
| Antenna mast                | Sunol           | TLT2       | FA002061  | —         | NCR        |
| Receiver/spectrum analyzer  | Rohde & Schwarz | ESU 26     | FA002043  | 1 year    | Jan. 07/16 |
| Spectrum analyzer           | Rohde & Schwarz | FSU        | FA001877  | 1 year    | Mar. 27/16 |
| Bilog antenna (20–3000 MHz) | Sunol           | JB3        | FA002108  | 1 year    | Apr. 12/16 |
| Horn antenna (1–18 GHz)     | EMCO            | 3115       | FA000825  | 1 year    | Apr. 01/16 |
| Pre-amplifier (1–18 GHz)    | JCA             | JCA118-503 | FA002091  | 1 year    | May 05/16  |
| Temperature chamber         | Thermotron      | SM-16C     | FA001030  | 1 year    | NCR        |

Note: NCR - no calibration required

## Section 8. Testing data

### 8.1 FCC 2.1049 and RSS-Gen 6.6 Occupied bandwidth

#### 8.1.1 Definitions and limits

**FCC:**

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 0.5 percent of the total mean power radiated by a given emission.

**IC:**

The emission bandwidth ( $\times$  dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated  $\times$  dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least  $3\times$  the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

#### 8.1.2 Test summary

|               |               |                   |           |
|---------------|---------------|-------------------|-----------|
| Test date     | March 8, 2016 | Temperature       | 22 °C     |
| Test engineer | Kevin Rose    | Air pressure      | 1003 mbar |
| Verdict       | Pass          | Relative humidity | 35 %      |

#### 8.1.3 Observations, settings and special notes

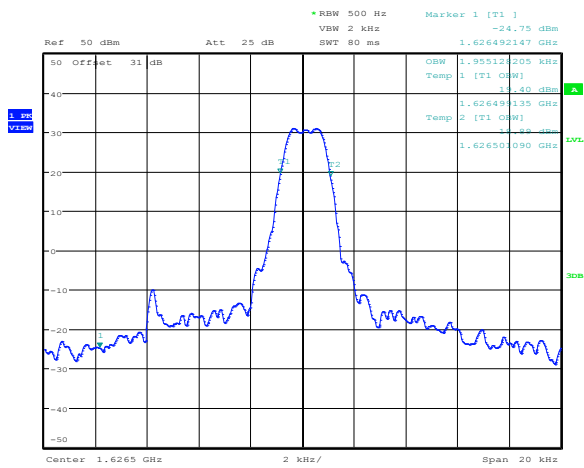
Spectrum analyser settings:

|                       |                     |
|-----------------------|---------------------|
| Resolution bandwidth: | $\geq 1\%$ of span  |
| Video bandwidth:      | $\geq 3 \times$ RBW |
| Detector mode:        | Peak                |
| Trace mode:           | Max Hold            |

#### 8.1.4 Test data

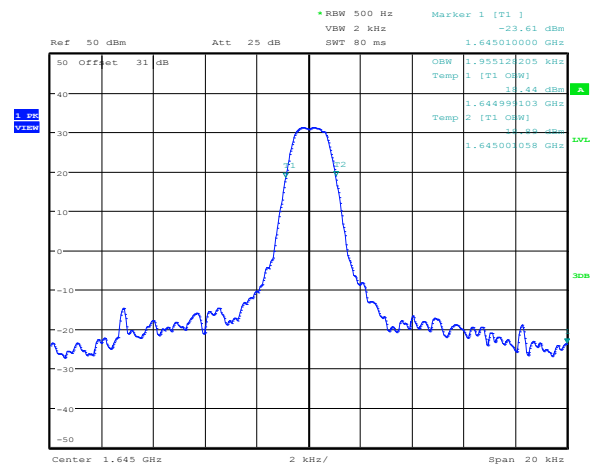
**Table 8.1-1:** 99 % bandwidth results

| Frequency, MHz | 99 % occupied bandwidth, kHz |
|----------------|------------------------------|
| 1626.501       | 1.955                        |
| 1642.000       | 1.955                        |
| 1660.499       | 1.955                        |



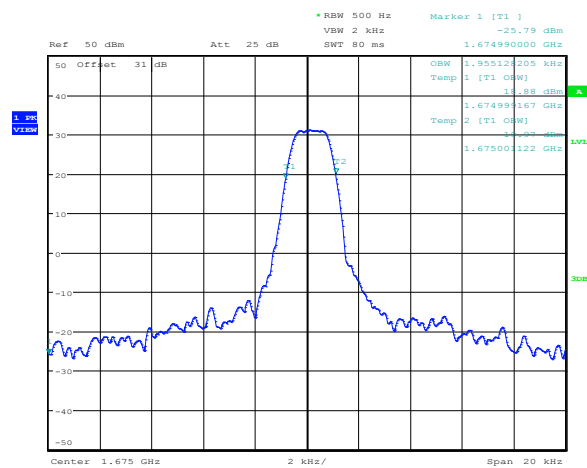
Date: 8.MAR.2016 14:27:43

**Figure 8.1-1: 99 % bandwidth on low channel**



Date: 8.MAR.2016 14:29:36

**Figure 8.1-2: 99 % bandwidth on mid channel**



Date: 8.MAR.2016 14:28:39

**Figure 8.1-3: 99 % bandwidth on high channel**

## 8.2 FCC 25.204 and RSS-170 5.3.2 Transmitter e.i.r.p. for mobile earth stations

### 8.2.1 Definitions and limits

#### FCC:

- (a) In bands shared coequally with terrestrial radio communication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station, other than an ESV, operating in frequency bands between 1 and 15 GHz, shall not exceed the following limits except as provided for in paragraph (c) below:  
+40 dBW (70 dBm) in any 4 kHz band for  $\Theta \leq 0^\circ$   
+40 + 3 $\Theta$  dBW in any 4 kHz band for  $0^\circ < \Theta \leq 5^\circ$   
where  $\Theta$  is the angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.
- (b) In bands shared coequally with terrestrial radiocommunication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station operating in frequency bands above 15 GHz shall not exceed the following limits except as provided for in paragraph (c) below:  
+64 dBW (94 dBm) in any 1 MHz band for  $\Theta \leq 0^\circ$   
+64 + 3  $\Theta$  dBW in any 1 MHz band for  $0^\circ < \Theta \leq 5^\circ$   
where  $\Theta$  is as defined in paragraph (a) above.
- (c) For angles of elevation of the horizon greater than  $5^\circ$  there shall be no restriction as to the equivalent isotropically radiated power transmitted by an earth station towards the horizon.
- (d) Notwithstanding the e.i.r.p. and e.i.r.p. density limits specified in the station authorization, each earth station transmission shall be conducted at the lowest power level that will provide the required signal quality as indicated in the application and further amended by coordination agreements.

#### IC:

The application for MES certification shall state the MES e.i.r.p. that is necessary for satisfactory communication. The maximum permissible e.i.r.p. will be the stated e.i.r.p. plus a 2 dB margin. If a detachable antenna is used, the certification application shall state the recommended antenna type and manufacturer, the antenna gain and the maximum transmitter output power at the antenna terminal.

### 8.2.2 Test summary

|               |                  |                   |           |
|---------------|------------------|-------------------|-----------|
| Test date     | December 7, 2015 | Temperature       | 22 °C     |
| Test engineer | Andrey Adelberg  | Air pressure      | 1006 mbar |
| Verdict       | Pass             | Relative humidity | 32 %      |

### 8.2.3 Observations, settings and special notes

#### Spectrum analyser settings:

|                      |          |
|----------------------|----------|
| Resolution bandwidth | 1 MHz    |
| Video bandwidth      | 3 MHz    |
| Detector mode        | Peak     |
| Trace mode           | Max Hold |

#### 8.2.4 Test data

**Table 8.2-1:** EIRP measurement result for Patch antenna

| Frequency, MHz | Output power, dBm | Antenna gain, dBi | Tested EIRP, dBm | Stated EIRP, dBm | Maximum permissible EIRP, dBm | Margin, dB |
|----------------|-------------------|-------------------|------------------|------------------|-------------------------------|------------|
| 1626.501       | 32.65             | 4.50              | 37.15            | 37.00            | 39.00                         | 1.85       |
| 1642.000       | 31.48             | 4.50              | 35.98            | 37.00            | 39.00                         | 3.02       |
| 1660.449       | 32.71             | 4.50              | 37.21            | 37.00            | 39.00                         | 1.79       |

Note: Margin = Maximum permissible EIRP – Tested EIRP

**Table 8.2-2:** EIRP measurement result for Helix antenna

| Frequency, MHz | Output power, dBm | Antenna gain, dBi | Tested EIRP, dBm | Stated EIRP, dBm | Maximum permissible EIRP, dBm | Margin, dB |
|----------------|-------------------|-------------------|------------------|------------------|-------------------------------|------------|
| 1626.501       | 32.65             | 2.50              | 35.15            | 37.00            | 39.00                         | 3.85       |
| 1642.000       | 31.48             | 2.50              | 33.98            | 37.00            | 39.00                         | 5.02       |
| 1660.449       | 32.71             | 2.50              | 35.21            | 37.00            | 39.00                         | 3.79       |

Note: Margin = Maximum permissible EIRP – Tested EIRP

## 8.3 FCC 25.202(f) and RSS-170 5.4 Field strength of spurious emissions

---

### 8.3.1 Definitions and limits

---

**FCC:**

(f) Emission limitations. The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

- (1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;
- (2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;
- (3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts (-13 dBm fixed);
- (4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (f) (1), (2) and (3) of this section.

**IC:**

The transmitter unwanted emissions shall be measured with the carrier frequency set at both the highest and lowest channels in which the equipment is designed to operate.

The e.i.r.p. density of unwanted and carrier-off emissions in this section shall be averaged over any 2 ms active transmission using a root-mean-square detector with a resolution bandwidth of 1 MHz for broadband emissions and a resolution bandwidth of 1 kHz for discrete emissions, unless stated otherwise.

**5.4.3 Mobile Earth Stations**

**5.4.3.1 Mobile Earth Stations in All Frequency Bands**

The average power of unwanted emissions shall be attenuated below the average output power, P(dBW), of the transmitter, as specified below:

- (1) 25 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 50%, up to and including 100% of the occupied bandwidth;
- (2) 35 dB in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 100%, up to and including 250% of the occupied bandwidth;
- (3)  $43 + 10 \log p$  (watts) in any 4 kHz band, the centre frequency of which is offset from the channel frequency by more than 250% of the occupied bandwidth.

**5.4.4 Carrier-off State Emissions**

Mobile equipment with transmitting frequencies between 1 GHz and 3 GHz shall have the e.i.r.p. density of carrier-off state emissions in the band 1559–1610 MHz not exceed -80 dBW/MHz.

### 8.3.2 Test summary

|               |                   |                   |           |
|---------------|-------------------|-------------------|-----------|
| Test date     | December 15, 2015 | Temperature       | 24 °C     |
| Test engineer | Andrey Adelberg   | Air pressure      | 1009 mbar |
| Verdict       | Pass              | Relative humidity | 32 %      |
| Test date     | March 8, 2016     | Temperature       | 22 °C     |
| Test engineer | Kevin Rose        | Air pressure      | 1003 mbar |
| Verdict       | Pass              | Relative humidity | 35 %      |

### 8.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10<sup>th</sup> harmonic.  
Radiated measurements were performed at a distance of 3 m.

Spectrum analyser settings mask measurements:

|                      |           |
|----------------------|-----------|
| Resolution bandwidth | 500 Hz    |
| Video bandwidth      | 5 kHz     |
| Detector mode        | RMS       |
| Trace mode           | Averaging |

Spectrum analyser settings for radiated spurious emissions measurements:

|                      |          |
|----------------------|----------|
| Resolution bandwidth | 1 MHz    |
| Video bandwidth      | 3 MHz    |
| Detector mode        | Peak     |
| Trace mode           | Max Hold |

Emission mask shifts:

Authorized bandwidth (occupied bandwidth) is 2 kHz.

50% is 1 kHz shift

100% is 2 kHz shift

250% is 5 kHz shift

8.3.4 Test data

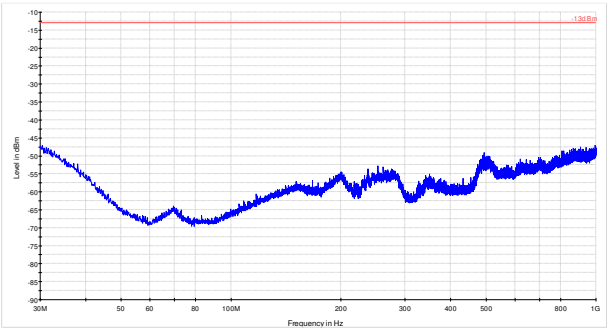


Figure 8.3-1: Spurious emissions below 1 GHz, Patch antenna

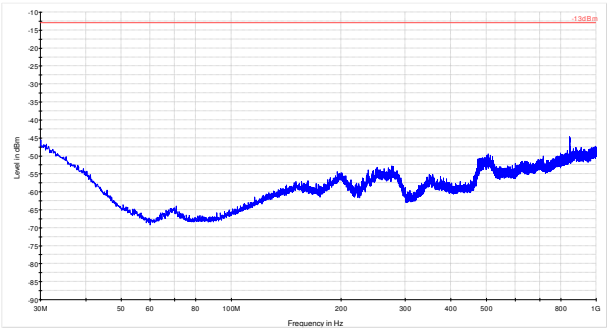


Figure 8.3-2: Spurious emissions below 1 GHz, Helix antenna

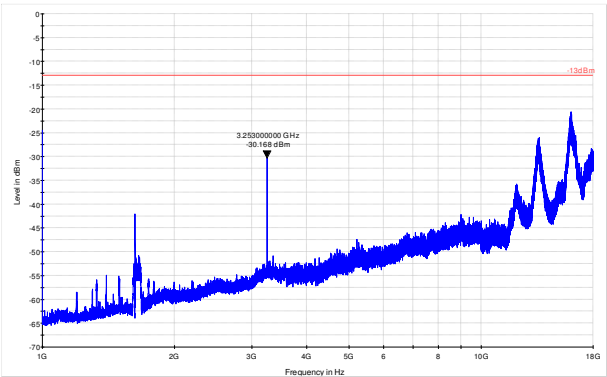


Figure 8.3-3: Spurious emissions above 1 GHz, Patch antenna, low channel

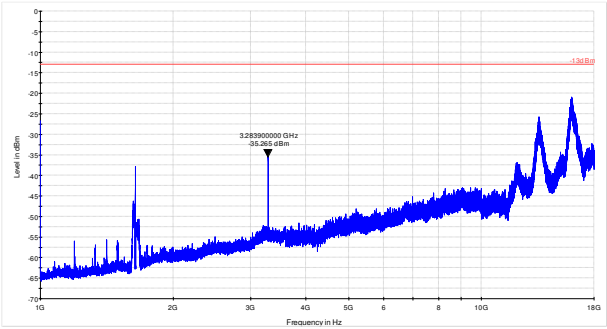


Figure 8.3-4: Spurious emissions above 1 GHz, Patch antenna, mid channel

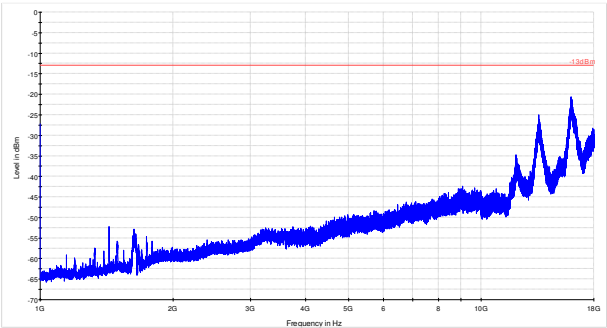


Figure 8.3-5: Spurious emissions above 1 GHz, Patch antenna, high channel

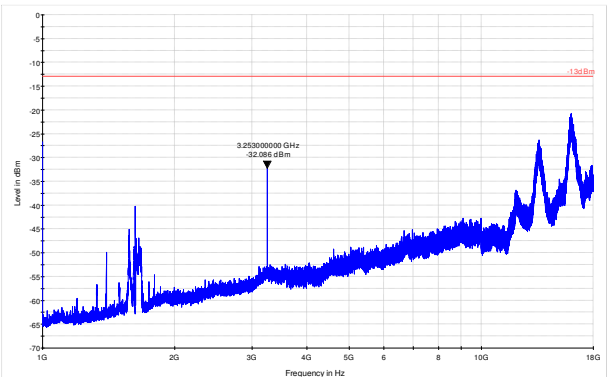


Figure 8.3-6: Spurious emissions above 1 GHz, Helix antenna, low channel

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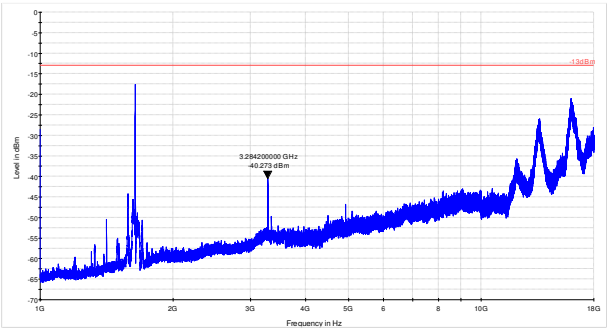


Figure 8.3-7: Spurious emissions above 1 GHz, Helix antenna, mid channel

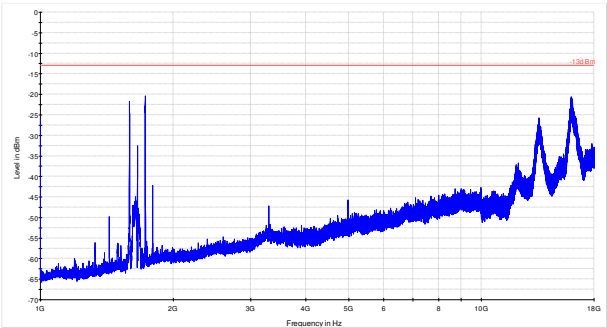
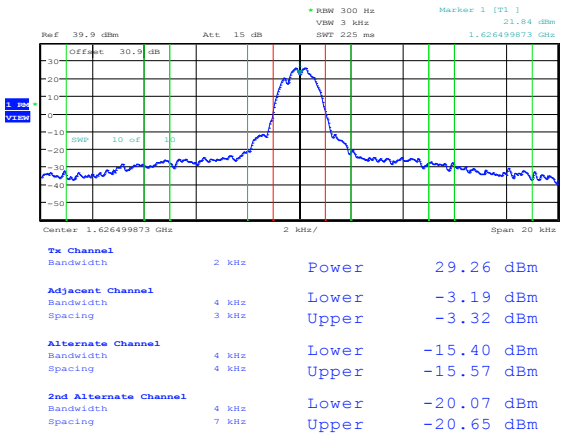
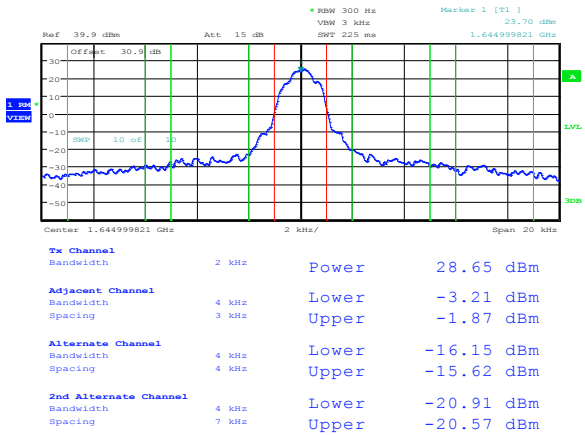


Figure 8.3-8: Spurious emissions above 1 GHz, Helix antenna, high channel



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Figure 8.3-9: Emissions Mask, low channel

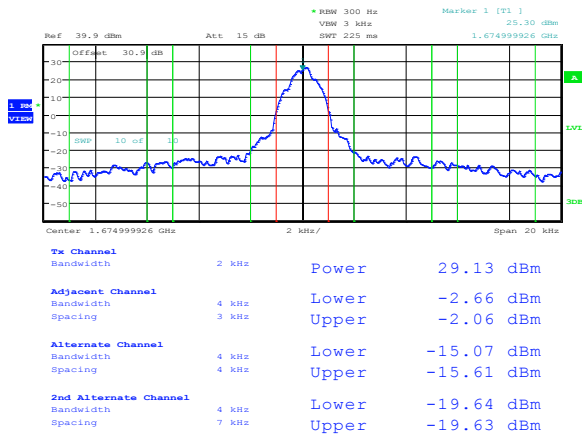


Date: 8.MAR.2016 15:05:33

Figure 8.3-10: Emissions Mask, mid channel

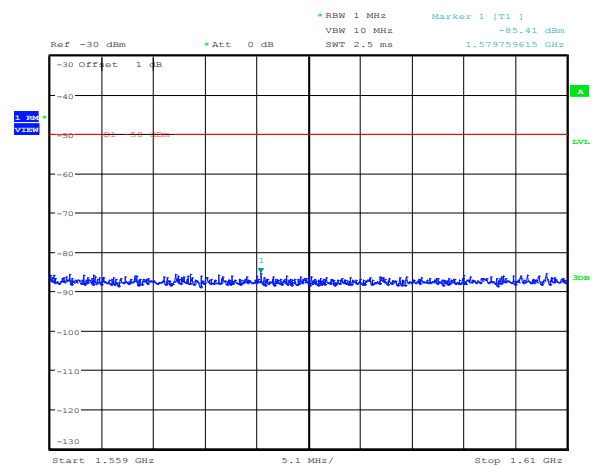
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Date: 8.MAR.2016 15:08:26

**Figure 8.3-11: Emissions Mask, high channel**



Date: 15.DEC.2015 10:51:33

**Figure 8.3-12: Carrier-off state**

**Table 8.3-1: Emission mask measurement results for frequencies below 250% of authorized BW**

| Channel | Frequency shift, kHz | Attenuation, dB | Minimum limit, dB | Margin, dB |
|---------|----------------------|-----------------|-------------------|------------|
| Low     | 1 to 2               | 44.77           | 25.00             | 19.77      |
| Low     | -1 to -2             | 44.60           | 25.00             | 19.60      |
| Low     | 2 to 5               | 45.90           | 35.00             | 10.90      |
| Low     | -2 to -5             | 45.75           | 35.00             | 10.75      |
| Mid     | 1 to 2               | 43.79           | 25.00             | 18.79      |
| Mid     | -1 to -2             | 44.53           | 25.00             | 19.53      |
| Mid     | 2 to 5               | 45.78           | 35.00             | 10.78      |
| Mid     | -2 to -5             | 46.11           | 35.00             | 11.11      |
| High    | 1 to 2               | 46.90           | 25.00             | 21.90      |
| High    | -1 to -2             | 46.31           | 25.00             | 21.31      |
| High    | 2 to 5               | 47.51           | 35.00             | 12.51      |
| High    | -2 to -5             | 48.04           | 35.00             | 13.04      |

Note: authorized/occupied bandwidth is 2 kHz.

**Table 8.3-2: Emission mask measurement results beyond 250% of authorized BW**

| Channel | Frequency shift, kHz | Level, dBm | Antenna gain, dBi | EIRP, dBm | Limit, dBm | Margin, dB |
|---------|----------------------|------------|-------------------|-----------|------------|------------|
| Low     | 5                    | -21.01     | 4.50              | -16.51    | -13.00     | 3.51       |
| Low     | -5                   | -20.63     | 4.50              | -16.13    | -13.00     | 3.13       |
| Mid     | 5                    | -20.57     | 4.50              | -16.07    | -13.00     | 3.07       |
| Mid     | -5                   | -20.74     | 4.50              | -16.24    | -13.00     | 3.24       |
| High    | 5                    | -21.35     | 4.50              | -16.85    | -13.00     | 3.85       |
| High    | -5                   | -22.12     | 4.50              | -17.62    | -13.00     | 4.62       |

Note: EUT comes with two different antennas. Highest antenna gain (4.5 dBi) was used in the calculation of EIRP as a worst-case scenario.

## 8.4 FCC 25.202(d) and RSS-170 5.2 Frequency tolerance, Earth stations

### 8.4.1 Definitions and limits

#### FCC:

The carrier frequency of each earth station transmitter authorized in these services shall be maintained within 0.001 percent ( $\pm 10$  ppm) of the reference frequency.

#### §2.1055 Frequency stability

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

(1) From  $-30^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$  for all equipment except that specified in paragraphs (a)(2) and (3) of this section

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than  $10^{\circ}\text{C}$  through the range.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

#### IC:

For mobile earth station equipment, the carrier frequency shall not depart from the reference frequency by more than  $\pm 10$  ppm.

### 8.4.2 Test summary

|               |                   |                   |           |
|---------------|-------------------|-------------------|-----------|
| Test date     | December 15, 2015 | Temperature       | 24 °C     |
| Test engineer | Andrey Adelberg   | Air pressure      | 1009 mbar |
| Verdict       | Pass              | Relative humidity | 32 %      |

### 8.4.3 Test data

Table 8.4-1: 20 dB bandwidth measurement result

| Test conditions | Frequency, Hz     | Offset, ppm | Limit, $\pm$ ppm | Margin, ppm |
|-----------------|-------------------|-------------|------------------|-------------|
| +50 °C, Nominal | 1642000696        | 0.27517142  | 10               | 9.7248286   |
| +40 °C, Nominal | 1642000507        | 0.15999351  | 10               | 9.8400065   |
| +30 °C, Nominal | 1642000536        | 0.17769562  | 10               | 9.8223044   |
| +20 °C, +15 %   | 1642000574        | 0.20111684  | 10               | 9.7988832   |
| +20 °C, Nominal | <b>1642000244</b> |             | Reference        |             |
| +20 °C, -15 %   | 1642000100        | -0.08770043 | 10               | 9.9122996   |
| +10 °C, Nominal | 1642000365        | 0.07373487  | 10               | 9.9262651   |
| 0 °C, Nominal   | 1642000280        | 0.0220229   | 10               | 9.9779771   |
| -10 °C, Nominal | 1642000413        | 0.10274861  | 10               | 9.8972514   |
| -20 °C, Nominal | 1641999985        | -0.15770837 | 10               | 9.8422916   |
| -30 °C, Nominal | 1642000087        | -0.09540043 | 10               | 9.9045996   |

Note: Offset was calculated as per the following formula:  $\frac{F_{\text{Measured}} - F_{\text{reference}}}{F_{\text{reference}}} \times 1 \cdot 10^6$

## 8.5 FCC 25.216 and RSS-170 5.4.3.2 Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service

### 8.5.1 Definitions and limits

#### FCC:

(c) The e.i.r.p. density of emissions from mobile earth stations with assigned uplink frequencies between 1610 MHz and 1660.5 MHz shall not exceed  $-70$  dBW/MHz ( $-40$  dBm/MHz), averaged over any 2 millisecond active transmission interval, in the band 1559–1605 MHz. The e.i.r.p. of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed  $-80$  dBW ( $-50$  dBm), averaged over any 2 millisecond active transmission interval, in the 1559–1605 MHz band.

(f) Mobile earth stations with assigned uplink frequencies in the 1610–1660.5 MHz band shall suppress the power density of emissions in the 1605–1610 MHz band to an extent determined by linear interpolation from  $-70$  dBW/MHz ( $-40$  dBm/MHz) at 1605 MHz to  $-10$  dBW/MHz ( $20$  dBm/MHz) at 1610 MHz.

#### IC:

Mobile earth stations with transmitting frequencies between 1626.5 and 1660.5 MHz shall have the e.i.r.p. density of unwanted emissions in the band 1605–1610 MHz, averaged over any 2 ms active transmission interval, not exceed the following limits:

- (1)  $-70$  dBW/MHz ( $-40$  dBm/MHz) at 1605 MHz, linearly interpolated to  $-46$  dBW/MHz ( $-16$  dBm/MHz) at 1610 MHz, for broadband emissions; and
- (2)  $-80$  dBW/kHz ( $-50$  dBm/kHz) at 1605 MHz, linearly interpolated to  $-56$  dBW/kHz ( $-26$  dBm/kHz) at 1610 MHz, for discrete emissions.

### 8.5.2 Test summary

|               |                   |                   |           |
|---------------|-------------------|-------------------|-----------|
| Test date     | December 10, 2015 | Temperature       | 23 °C     |
| Test engineer | Andrey Adelberg   | Air pressure      | 1005 mbar |
| Verdict       | Pass              | Relative humidity | 32 %      |

### 8.5.3 Observations, settings and special notes

The testing was performed radiated therefore the trace is in field strength measurement units. In order to comply with power limits, substitution factor of 95.23 dB was applied to the limit line, converting it to field strength at 3 m distance equivalent limit. Since all the field strength measured levels were more than 10 dB below the FS equivalent limit line, no actual power testing was performed.

Spectrum analyser settings:

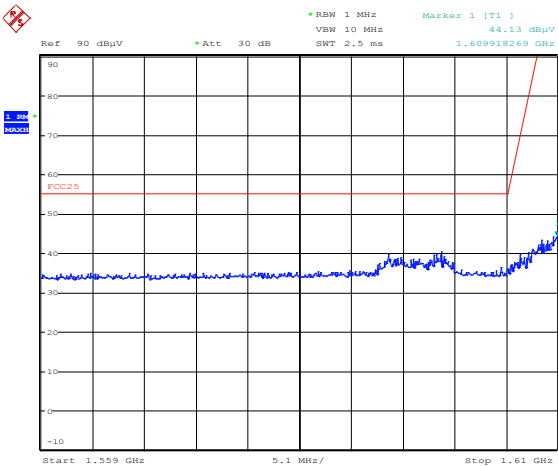
|                      |          |
|----------------------|----------|
| Resolution bandwidth | 1 MHz    |
| Video bandwidth      | 10 MHz   |
| Detector mode        | RMS      |
| Trace mode           | Max-hold |

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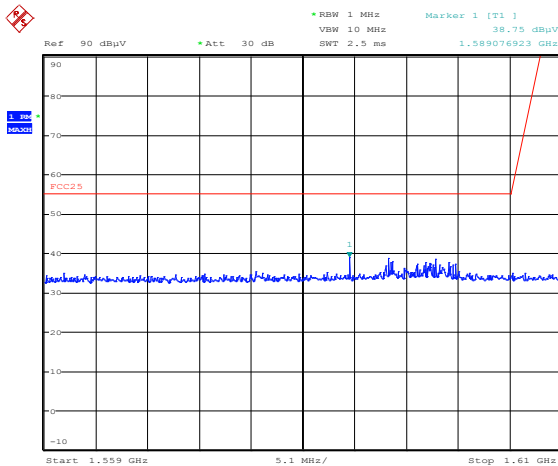


8.5.4 Test data



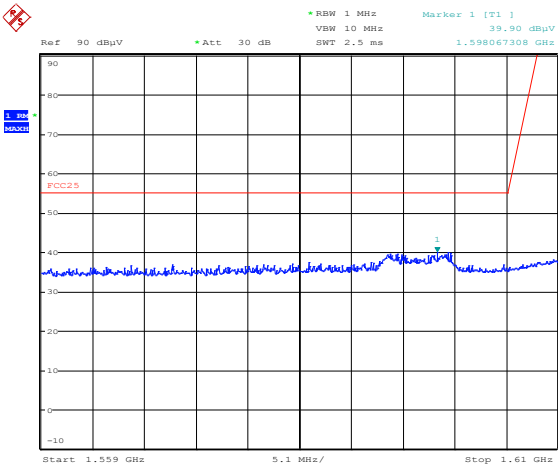
Date: 11.DEC.2015 13:56:58

Figure 8.5-1: Emissions within 1559–1605 MHz, Patch antenna, low channel



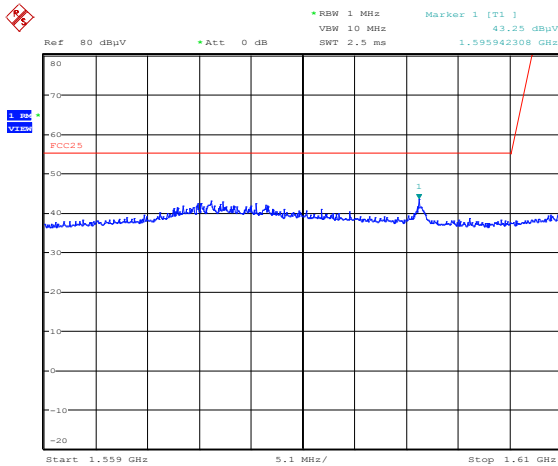
Date: 11.DEC.2015 13:58:13

Figure 8.5-2: Emissions within 1559–1605 MHz, Patch antenna, mid channel



Date: 11.DEC.2015 14:00:16

Figure 8.5-3: Emissions within 1559–1605 MHz, Patch antenna, high channel



Date: 10.DEC.2015 13:27:56

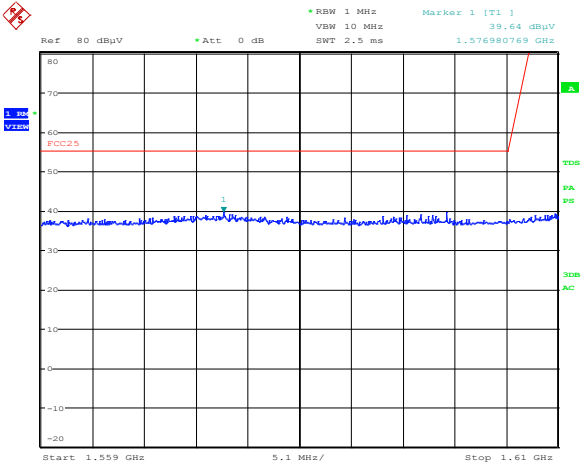
Figure 8.5-4: Emissions within 1559–1605 MHz, Helix antenna, low channel

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aeronautical radionavigation-satellite service  
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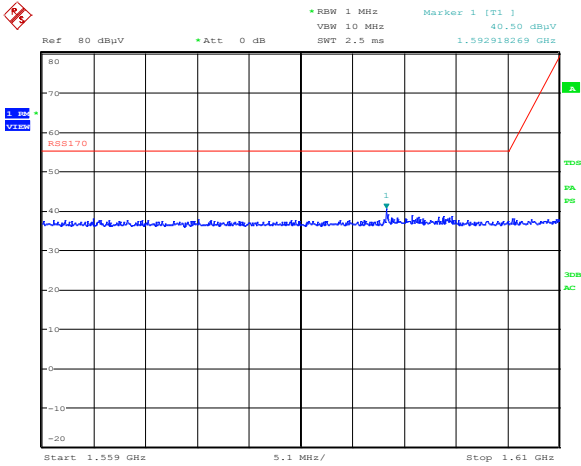


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Date: 10,DEC.2015 13:30:09

Figure 8.5-5: Emissions within 1559–1605 MHz, Helix antenna, mid channel

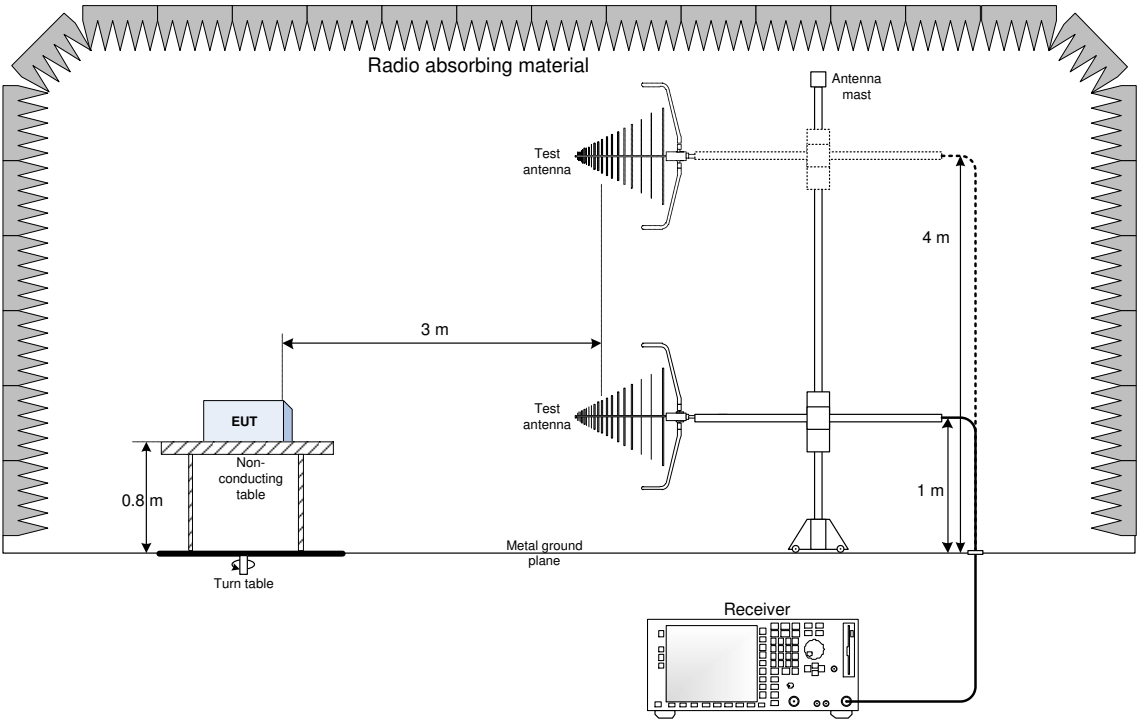


Date: 10,DEC.2015 13:32:47

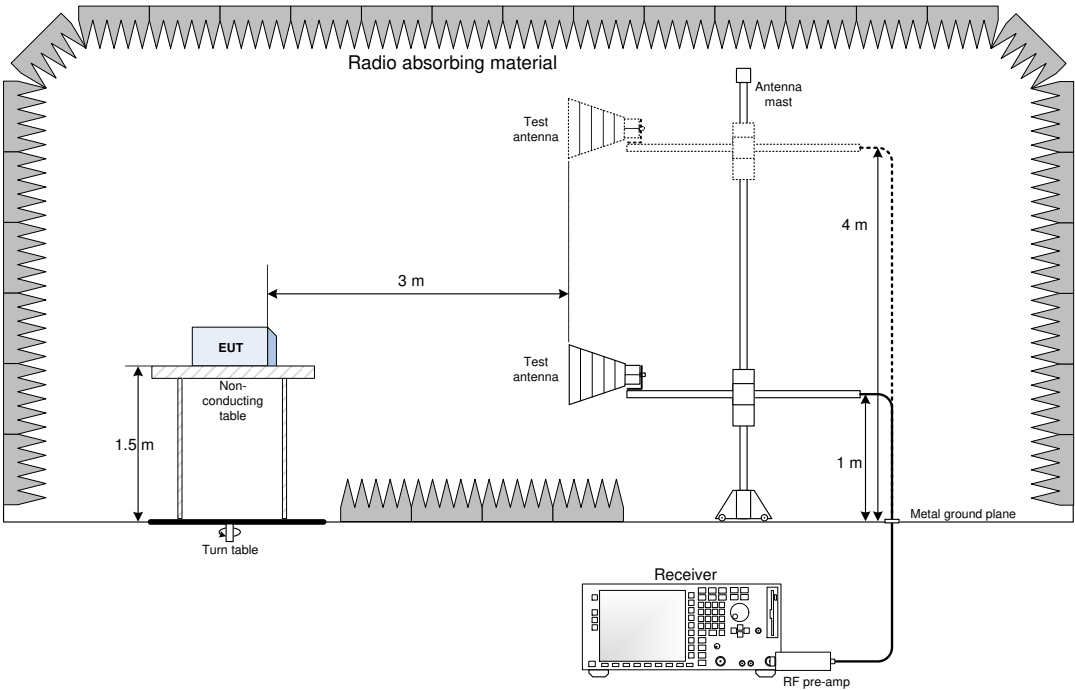
Figure 8.5-6: Emissions within 1559–1605 MHz, Helix antenna, high channel

**Section 9.** Block diagrams of test set-ups

**9.1** Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up

