Sulis Consultants
CE Marking and Product Approvals

# RF Test Report:

# Zinwave ORU

# FCC part 27 cellular

FCC ID: UPO302-1107

# SC_TR_221_B

Sulis Consultants Limited
Mead House, Longwater Road, Eversley, Hampshire, RG27 0NW, UK
Registered in England & Wales, number 05466247
http://www.sulisconsultants.com

## Contents

## Tables

## Figures

# 1 Revision History

| Revision | Originator | Date | Comment | Signature |
|---|---|---|---|---|
| A | C Blackham<br>Director,<br>Sulis Consultants Ltd | 23 Oct 2016 | 1st release | |
| B | C Blackham<br>Director,<br>Sulis Consultants Ltd | 31 Oct 2016 | Updated to correct typos | |

# 2 Purpose

This document details the Zinwave Optical Remote Unit, ORU, model number 302-1107**,** whilst operating in the following bands under FCC Part 27:

2180 – 2200 MHz.

2345 – 2360 MHz.

2496 – 2690 MHz.

# 3 Reference Documents


| | | |
|---|---|---|
| [1] | 47CFR2 | Title 47 Code of Federal Regulations Part 2: frequency allocations and radio treaty matters; general rules and regulations |
| [2] | 47 CFR27 | Title 47 Code of Federal Regulations Part 27: Miscellaneous Communications Services |
| [3] | TIA-603-D | Land Mobile FM or PM – Communications Equipment – Measurement and Performance Standards |
| [4] | KDB 935210 D05 V01r01 | Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement guidance for Industrial and Non-consumer signal booster, repeater and amplifier devices |
| [5] | KDB971168 DO1 v02r02 | Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement guidance for certification of licensed digital transmitters. |

# 4 Test Information

## 4.1 Client and manufacturer

Zinwave Ltd

Harston Mill

Harston

Cambridge

CB22 7GG

UK

## 4.2 Test Locations

Antenna port testing was performed by Charlie Blackham of Sulis Consultants Ltd between 15th September and 23rd October 2016, at Sulis Consultants offices as detailed on cover page

Radiated Spurious Emissions testing was performed at Hursley EMC Service on 23rd September 2016 under job number 16R471

## 4.3 Test sample

The results herein only refer to sample detailed in section 5

# 5 Test Configuration

## 5.1 Test sample and Operating mode

The equipment under test (EUT) was:

| Manufacturer | Name | Model Number | Serial Number |
|---|---|---|---|
| Zinwave | ORU | 302-1107 | #10 |

**Table 1: Equipment under test**

Modifications during test: None

**Procedure:**

- Set the system to maximum gain using the network management software
- Connect the signal generator to the RF service module of the Primary Hub
- Raise the signal level until the maximum output power is reached
- Perform the required test.

**Test modulations:**

- The system supports operation with a number of wideband services, so testing was performed with AWGN signal as per KDB 935210 D05.

## 5.2 Support equipment

The following equipment shall be used, configured as shown in Figure 1:

| Name | Part Number | Serial Number |
|---|---|---|
| Chassis | 302-1001 | 00-17-68-00-09-B7 |
| RF Service module | Service Module | SM 15 1/6 |
| Optical module | Optical module | OM 15 5/6 |
| Chassis | 302-1001 | 00-17-68-00-09-67 |
| Input Optical module | Optical module | OM 15 1/6 |
| Optical module | Optical module | OM 6/6 |

**Table 2: Support Equipment**

## 5.3 Equipment arrangement

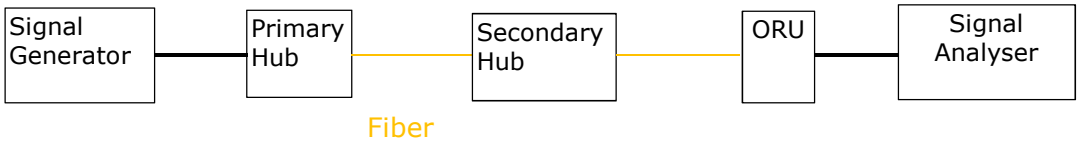



**Figure 1: Test configuration – single channel**

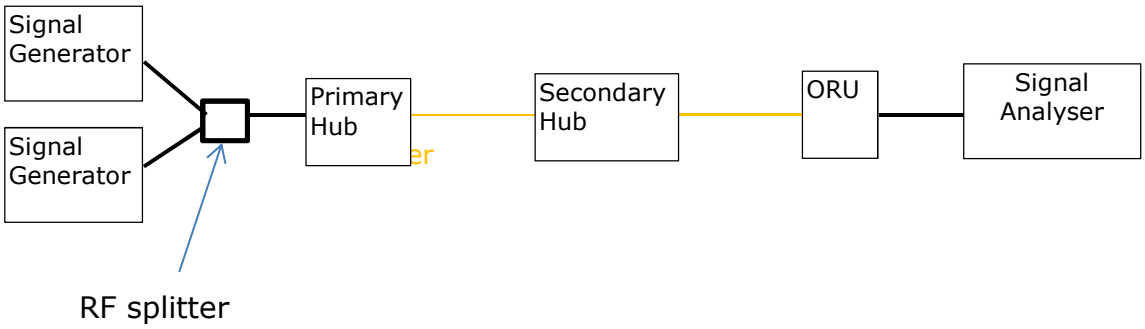



**Figure 2: Test configuration – dual channel**

# 6 Summary of Tests performed

| Test | Band (MHz) | 47 CFR Part | FCC limit | Section | Result |
|---|---|---|---|---|---|
| Determination of $f_0$ | 2180 - 2200 | KDB 935210 D05 Section 3.3 | None | 7 | N/A |
| | 2345 - 2360 | | | 7 | N/A |
| | 2496 - 2690 | | | 7 | N/A |
| Transmit Power | 2180 - 2200 | 27.50(d) | 1,640 W EIRP | 8 | Pass |
| | 2345 - 2360 | 27.50(a) | 2,000 W / 5 MHz EIRP | 11 | |
| | 2496 - 2690 | 27.50(h) | 2,000 W EIRP | 14 | Pass |
| Occupied Bandwidth | 2180 - 2200 | 2.1049 KDB 935210 D05 Section 3.4 | None | 9 | Pass |
| | 2345 - 2360 | | | 12 | |
| | 2496 - 2690 | | | 15 | Pass |
| Conducted Spurious Emissions inc. band edge | 2180 - 2200 | 27.53(h) | -13dBm / MHz | 10 | Pass |
| | 2345 - 2360 | 27.53(a)(1) | Various, see section 13.1 | 13 | |
| | 2496 - 2690 | 27.53(m) | -13dBm / MHz | 16 | Pass |
| Radiated Spurious Emissions | 2180 - 2200 | 27.53(h) | -13dBm / MHz | 17 | Pass |
| | 2345 - 2360 | 27.53(a)(1) | Various, see section 13.1 | 17 | |
| | 2496 - 2690 | 27.53(m) | -13dBm / MHz | 17 | Pass |

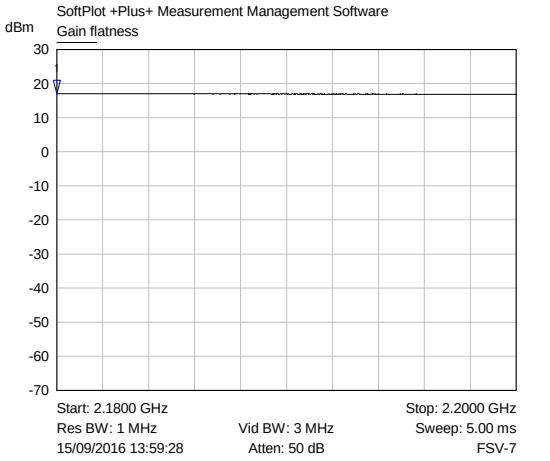
**Table 3: Summary of tests performed**

## *6.1 Comments on requirements in KDB 935210 D05 V01:*

| Section | Comment |
|---|---|
| 3.1 General | As the bands under investigation are for LTE operation only, one signal sources shall be used:<br>• "wideband" 4.2 MHz AWGN |
| 3.2 Measuring the EUT AGC threshold | **Not applicable to ORU and 3000 DAS**<br>"Devices intended to be directly connected to an RF source only need to be evaluated for any over-the-air transmit paths."<br>There are no such over-the-air paths so increased input level testing is not required |
| 3.7 EUT frequency stability measurements | Not required as DAS does not contain oscillator and therefore has no ability to change frequency. |

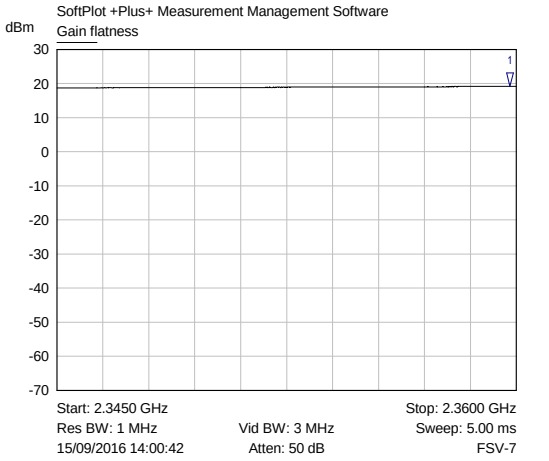
# 7 Determination of $f_0$

As per kDB 935210 D05 section 3.3, but measurement was performed over the service band frequency range only.



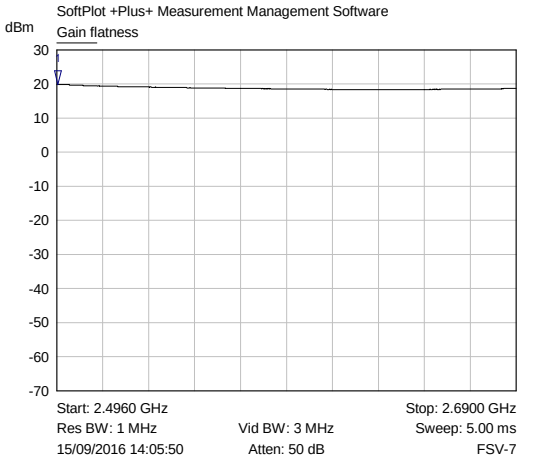

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Gain flatness | 2.1800 GHz | 17.00 dBm | Max gain, f0 |

2180 - 2200 MHz




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Gain flatness | 2.3598 GHz | 19.15 dBm | Max gain, f0 |

2345 – 2360 MHz




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Gain flatness | 2.4966 GHz | 19.89 dBm | Max gain, f0 |

2496 – 2690 MHz

Intentionally blank

**Figure 3: Determination of $f_0$ for the bands of operation**

# 8 Transmit Power: 2180 - 2200 MHz

## 8.1 Test method

The equipment was configured with maximum gain of 25dB and connected as per figure 1.

The signal generator was set to provide -5dBm to the input of the hub and the frequency set to an appropriate channel to include $f_0$ as determined in section 7.

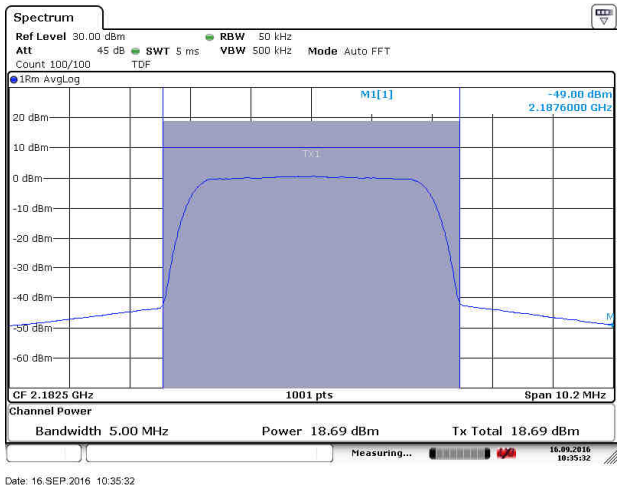
Measurements were made in accordance with KDB 971168 D01 using an RMS detector and the Peak to Average ratio was measured using the CCDF function of the analyser.

## 8.2 Test results

| Frequency | TX power (dBm) | TX power EIRP (dBm) | TX power EIRP (W) | Limit EIRP (W) | 0.1% PAR | Result |
|---|---|---|---|---|---|---|
| 2182.5 | 18.69 | 26.69 | 0.47 | 3280.0 | 8.38 dB | Pass |

**Table 4: Transmit power and Peak-to-Average ratio**

Peak to Average (PAR) ratio was measured using the analyser in-built CCDF function.




| 2182.5 MHz, AWGN modulation | Peak to Average |
|---|---|

**Figure 4: Power and Peak to Average (PAR) plots**

# 9 Occupied bandwidth: 2180 - 2200 MHz

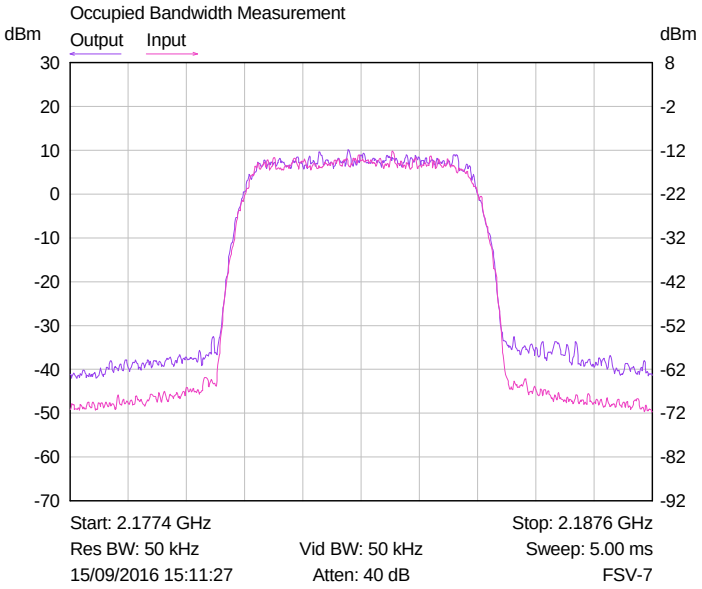
## 9.1 Test method

KDB 935210 D05 section 3.4.

The occupied bandwidth was measured using the inbuilt function on the Signal Analyser set to measure the 99% occupied bandwidth. Measurement was made using peak detector and max hold.

The two plots are overlaid on the same graph by using different vertical axes for input and output signals.

## 9.2 Test results




Output

| Measurement Parameter | Value |
|---|---|
| Occupied Power Bandwidth | 4.0963 MHz |

Input

| Measurement Parameter | Value |
|---|---|
| Occupied Power Bandwidth | 4.0861 MHz |

**Figure 5: Input vs output plot for 2180 – 2200 MHz band**

# 10 FCC CSE inc. Band Edge: 2180 - 2200 MHz

## *10.1 Requirement and test method*

27.53

(h) AWS emission limits—(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

(3) Measurement procedure.

(i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(ii) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.

(iii) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

The licensed band of operation was considered to be a single 5 MHz channel for the 5 MHz operation.

Some emissions > 1 MHz from bandedge were measured using the spectrum analyser adjacent channel power function that integrated power from a lower resolution bandwidth into the 1 MHz required by the rule part.

## *10.2 Test results*

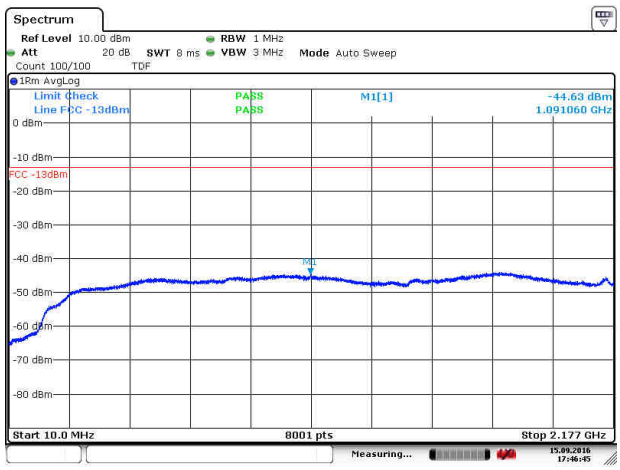
Plots are included for all modes up to 7GHz.

No emissions above noise floor above 7 GHz for any frequency of operation

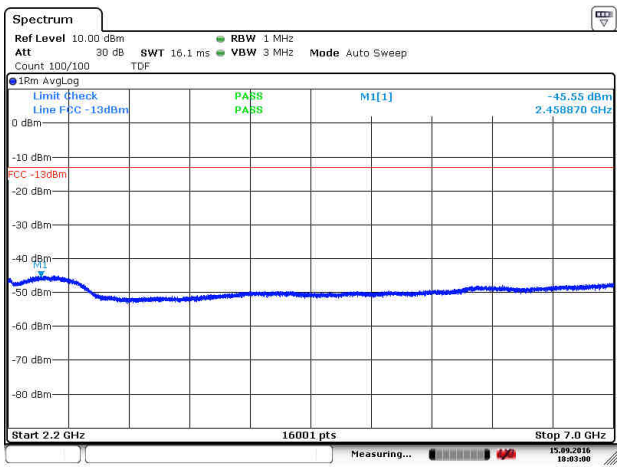
Single channel measurements were > 25 dB below the limit

Dual channel measurements were > 9 dB below the limit

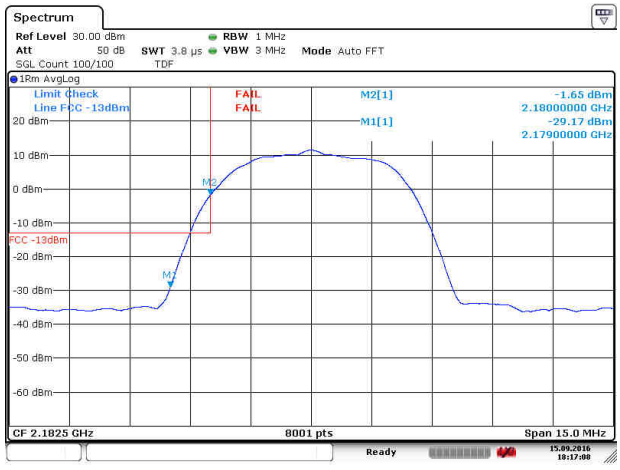
## 10.2.1 Single frequency, inc. band edge



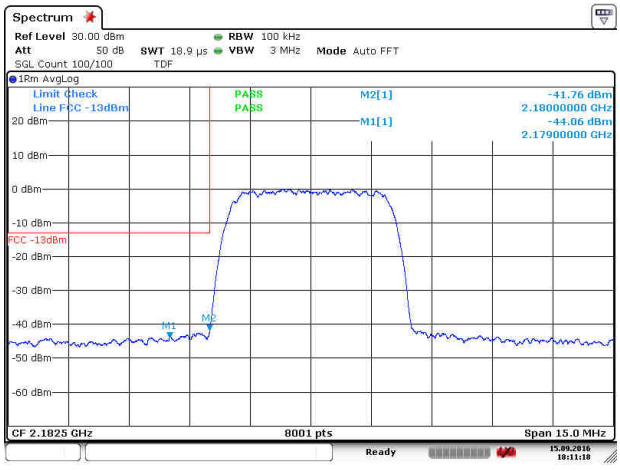

2182.5 below "band edge -3MHz"



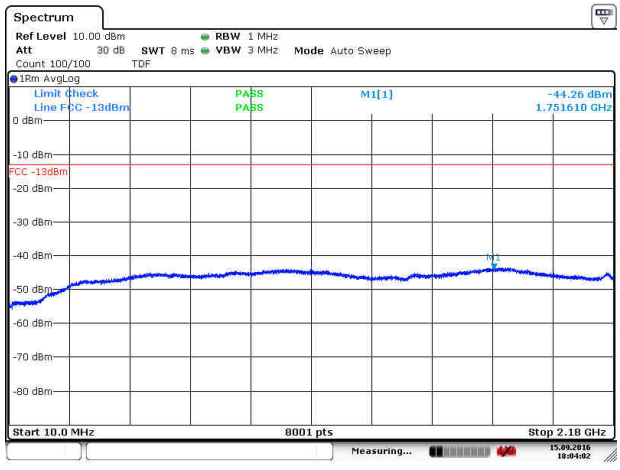

2182.5 above band edge



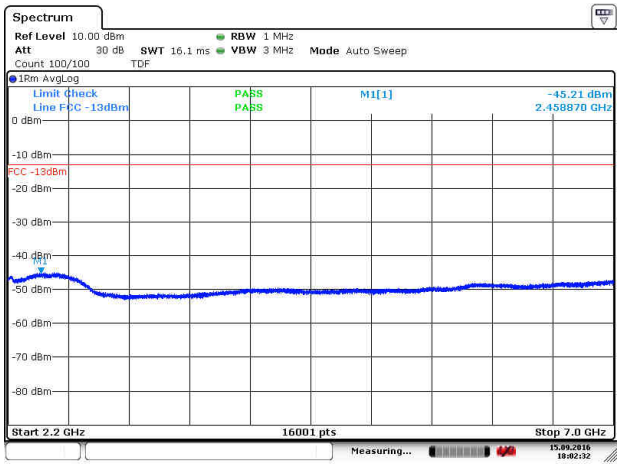

2182.5 MHz band edge (1MHz RBW)



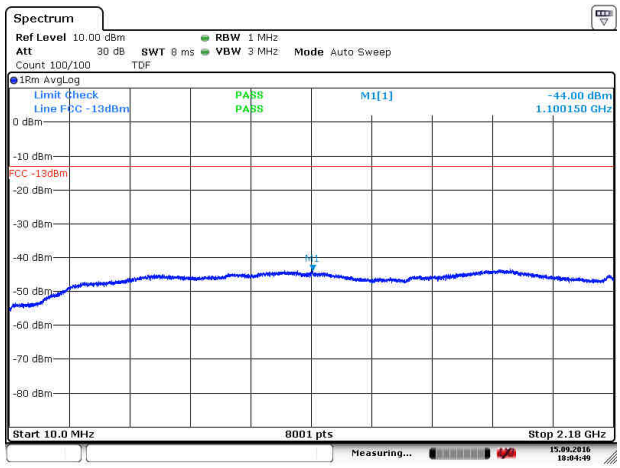

2182.5 MHz band edge (100 kHz RBW)



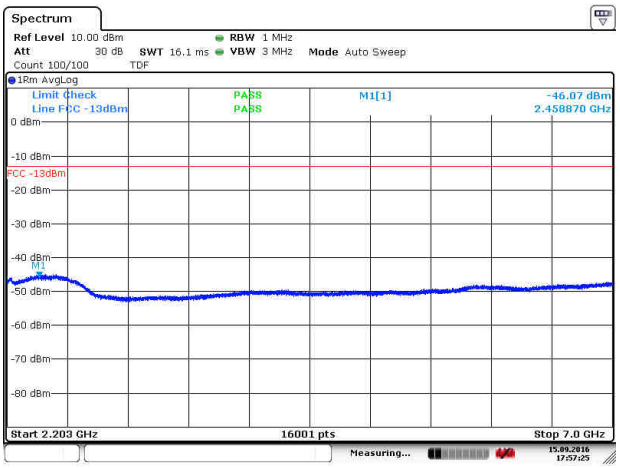

2190 MHz below band edge



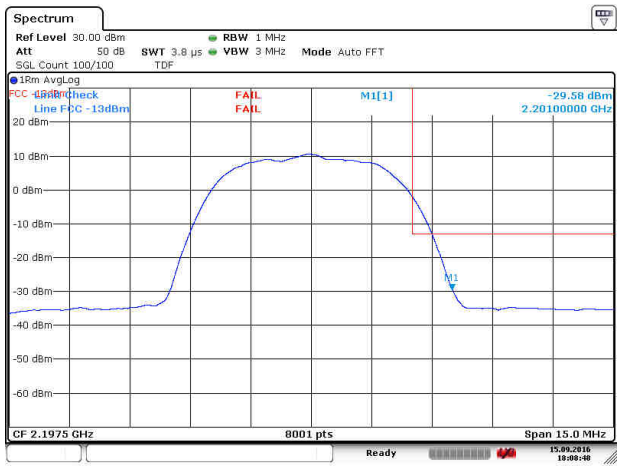

2190 MHz above band edge



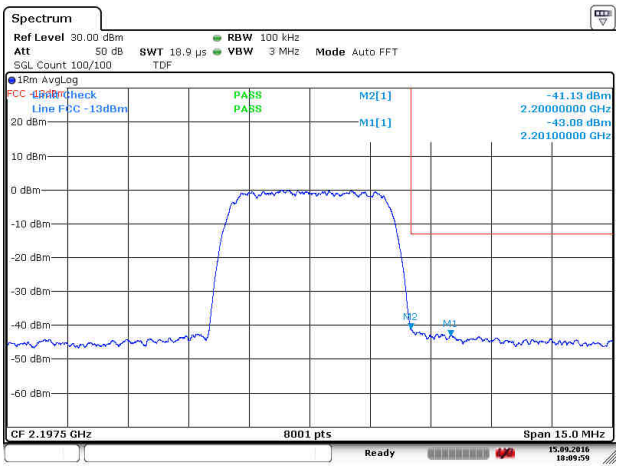

2197.5 below band edge




2197.5 above "band edge + 3MHz"



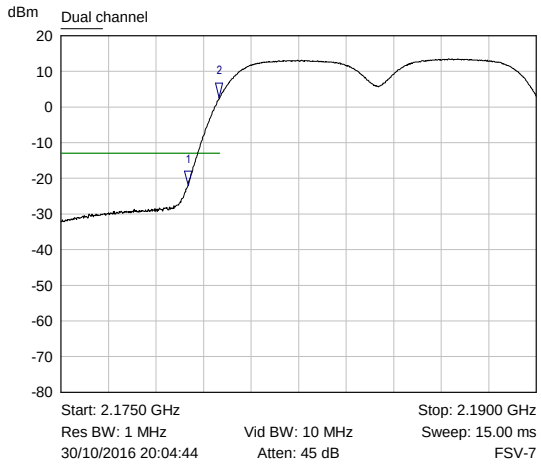

2197.5 MHz band edge (1MHz RBW)




2197.5 MHz band edge (100 kHz RBW)

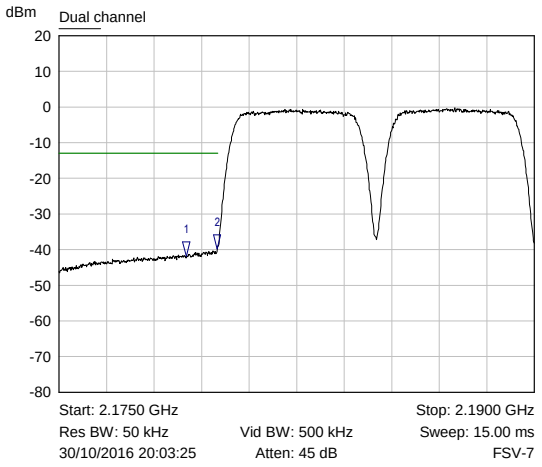
**Figure 6: CSE including band edge for 2180 - 2200 MHz band**

## 10.2.2 Dual Channel: AWGN



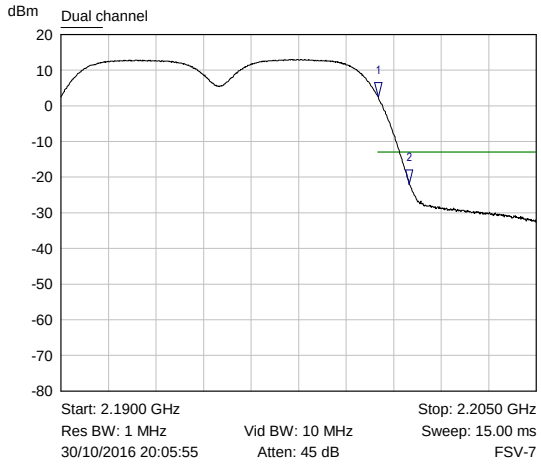

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Dual channel | 2.1790 GHz | -8.97 dBm | Relative to limit |
| 2 | Dual channel | 2.1800 GHz | 15.57 dBm | Relative to limit |

Lower band edge: 1 MHz RBW



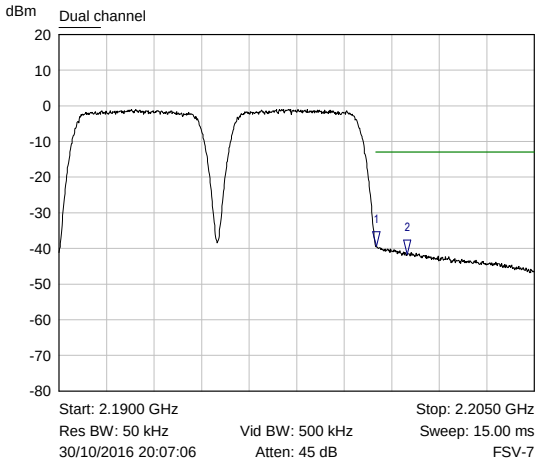

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Dual channel | 2.1790 GHz | -28.91 dBm | Relative to limit |
| 2 | Dual channel | 2.1800 GHz | -26.86 dBm | Relative to limit |

Lower band edge: 50kHz RBW for adjacent 1 MHz band




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Dual channel | 2.2000 GHz | 15.54 dBm | Relative to limit |
| 2 | Dual channel | 2.2010 GHz | -9.01 dBm | Relative to limit |

Upper band edge: 1 MHz RBW




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | Dual channel | 2.2000 GHz | -26.46 dBm | Relative to limit |
| 2 | Dual channel | 2.2010 GHz | -28.77 dBm | Relative to limit |

Upper band edge: 50kHz RBW for adjacent 1 MHz band

**Figure 7: CSE band edge for 2180 - 2200 MHz band – dual channel**

# 11 Transmit Power: 2345 - 2360 MHz

## 11.1 Test method

The equipment was configured with maximum gain of 25dB and connected as per figure 1.

The signal generator was set to provide -6 dBm to the input of the hub and the frequency set to an appropriate channel to include $f_0$ as determined in section 7.

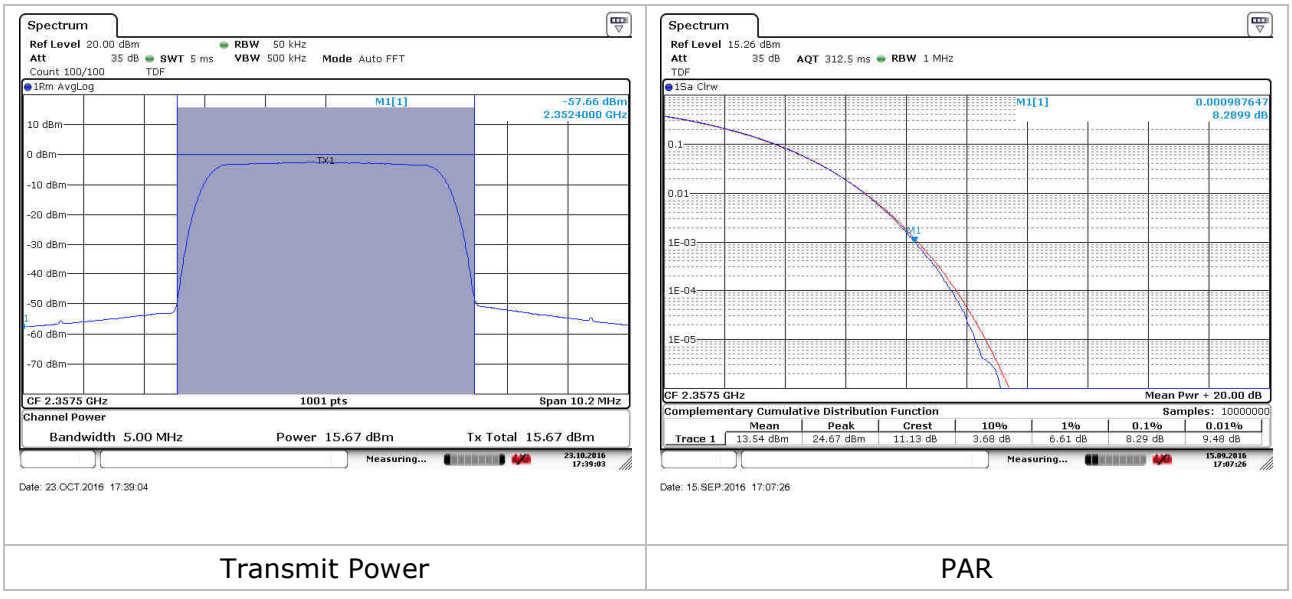
Measurements were made in accordance with KDB 971168 D01 using an RMS detector and the Peak to Average ratio was measured using the CCDF function of the analyser.

## 11.2 Test results

| Frequency | TX power (dBm) | TX power EIRP (dBm) | TX power EIRP (W) | Limit EIRP (W) | 0.1% PAR | Result |
|---|---|---|---|---|---|---|
| 2357.5 | 15.7 | 23.7 | 0.23 | 2000.0 | 8.29 dB | Pass |

**Table 5: Transmit power and Peak-to-Average ratio**

Peak to Average (PAR) ratio was measured using the analyser in-built CCDF function.




Transmit Power | PAR

**Figure 8: Peak to Average (PAR) plots**

# 12 Occupied Bandwidth: 2345 - 2360 MHz

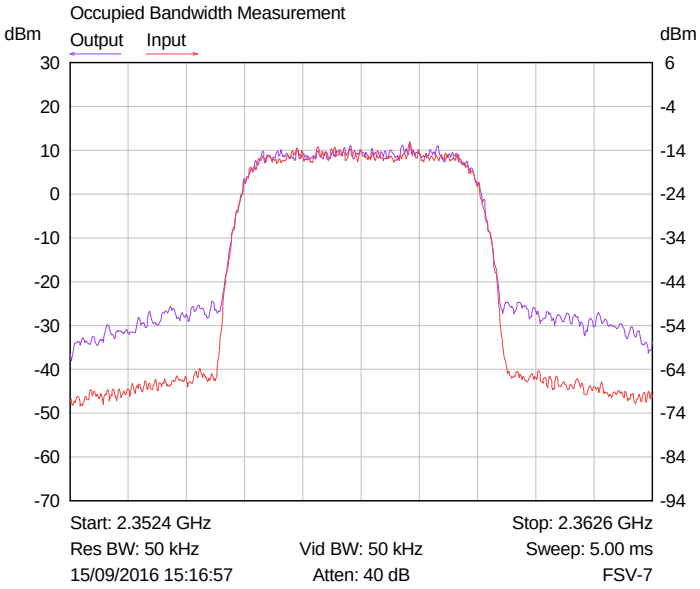
## *12.1 Test method*

KDB 935210 D05 section 3.4.

The occupied bandwidth was measured using the inbuilt function on the Signal Analyser set to measure the 99% occupied bandwidth. Measurement was made using peak detector and max hold.

The two plots are overlaid on the same graph by using different vertical axes for input and output signals.

## *12.2 Test results*




Output

| Measurement Parameter | Value |
|---|---|
| Occupied Power Bandwidth | 4.1065 MHz |

Input

| Measurement Parameter | Value |
|---|---|
| Occupied Power Bandwidth | 4.0861 MHz |

**Figure 9: Input vs output plot for 2345 – 2360 MHz band**

# 13 CSE inc. Band Edge: 2345 - 2360 MHz

## *13.1 Requirement and test method*

27.53 (a) For operations in the 2305-2320 MHz band and the 2345-2360 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power P (with averaging performed only during periods of transmission) within the licensed band(s) of operation, in watts, by the following amounts:

(1) For base and fixed stations' operations in the 2305-2320 MHz band and the 2345-2360 MHz band:

(i) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2305 and 2320 MHz and on all frequencies between 2345 and 2360 MHz that are outside the licensed band(s) of operation, and not less than 75 + 10 log (P) dB on all frequencies between 2320 and 2345 MHz;

(ii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2300 and 2305 MHz, 70 + 10 log (P) dB on all frequencies between 2287.5 and 2300 MHz, 72 + 10 log (P) dB on all frequencies between 2285 and 2287.5 MHz, and 75 + 10 log (P) dB below 2285 MHz;

(iii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2360 and 2362.5 MHz, 55 + 10 log (P) dB on all frequencies between 2362.5 and 2365 MHz, 70 + 10 log (P) dB on all frequencies between 2365 and 2367.5 MHz, 72 + 10 log (P) dB on all frequencies between 2367.5 and 2370 MHz, and 75 + 10 log (P) dB above 2370 MHz.

(5) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the channel blocks at 2305, 2310, 2315, 2320, 2345, 2350, 2355, and 2360 MHz, a resolution bandwidth of at least 1 percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e., 1 MHz). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

The licensed band of operation was considered to be a single 5 MHz channel for the 5 MHz operation.

Some emissions > 1 MHz from bandedge were measured using the spectrum analyser adjacent channel power function that integrated power from a lower resolution bandwidth into the 1 MHz required by the rule part.

## *13.2 Test results*

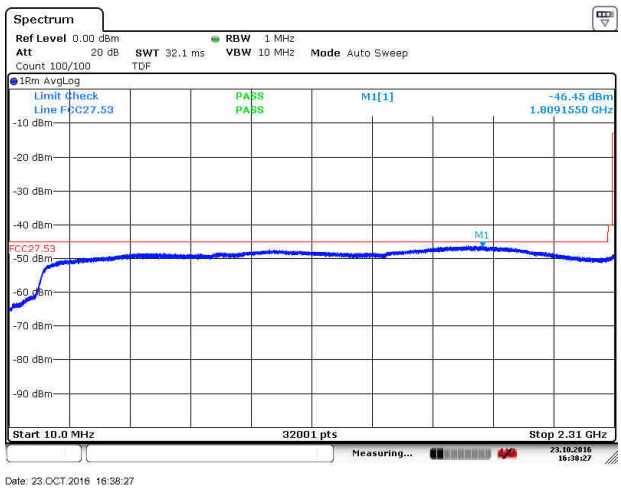
Measurements were performed on the following three channels, each representing a 5 MHz licensed band:

- Bottom channel: 2347.5 MHz
- Middle channel: 2352.5 MHz
- Top channel: 2357.5 MHz

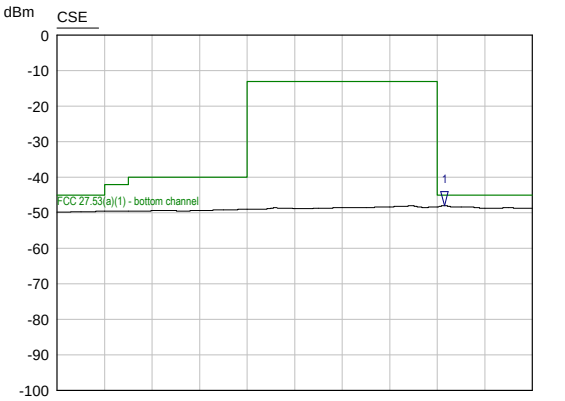
Plots are included for all modes up to 7GHz.

No emissions above noise floor above 7 GHz for any frequency of operation

## 13.2.1 Bottom Channel

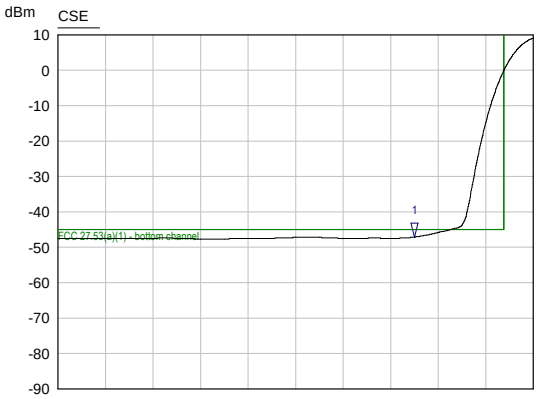



10 MHz to 2310 MHz



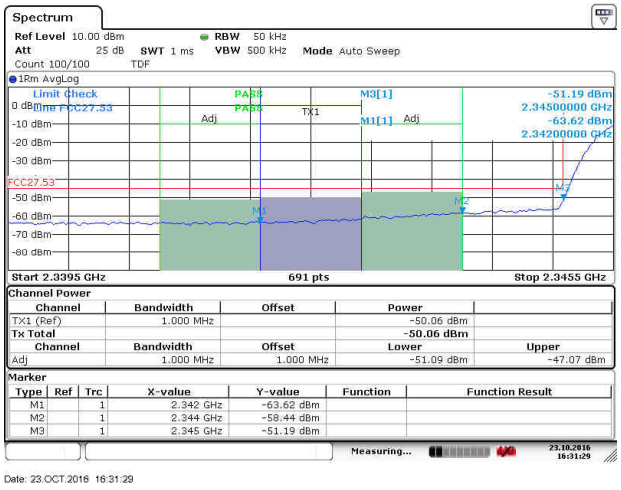

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ∇ | CSE | 2.3208 GHz | -3.00 dBm | relative to limit |

2280 – 2330 MHz




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ∇ | CSE | 2.3420 GHz | -2.13 dBm | relative to limit |

CSE lower band edge pt 1




CSE lower band edge pt 2

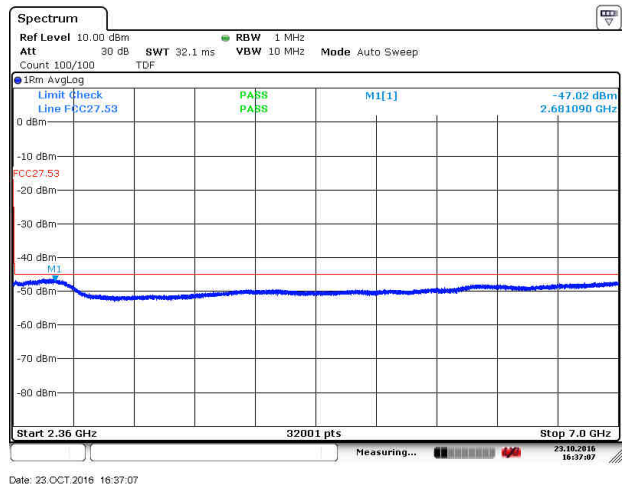
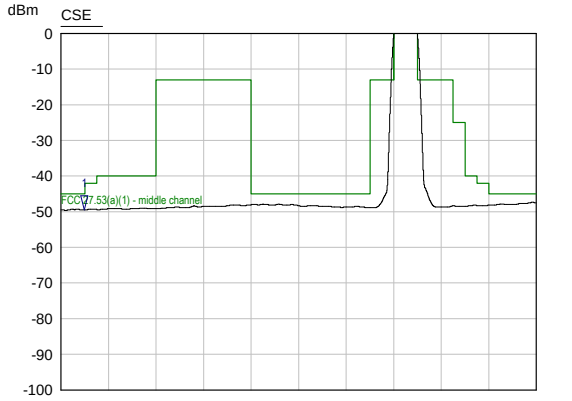
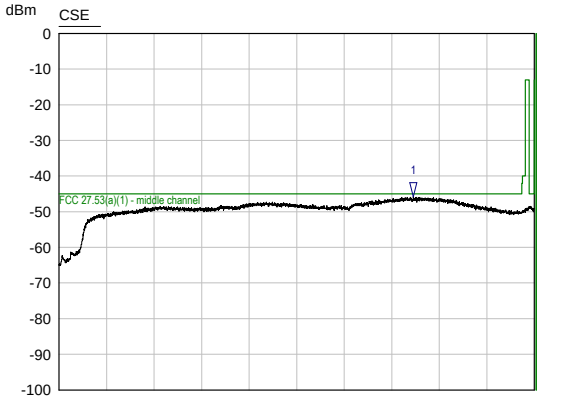
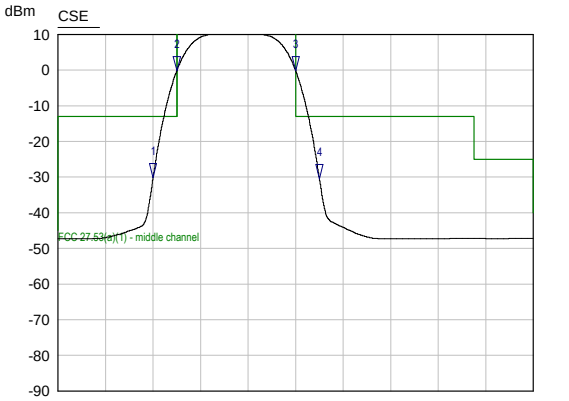
| | |
|---|---|
|  | No emissions above noise floor |
| 2360 – 7000 MHz | > 7 GHz |

**Figure 10: CSE bottom channel: 2347.5 MHz**

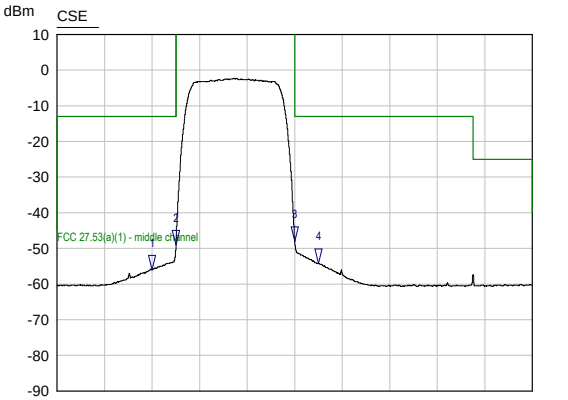
## *13.2.2 Middle Channel*

| | |
|---|---|
|  <br>Mkr \| Trace \| X-Axis \| Value \| Notes<br>1 ▽ \| CSE \| 2.5928 GHz \| -17.71 dBm \| relative to limit |  <br>Mkr \| Trace \| X-Axis \| Value \| Notes<br>1 ▽ \| CSE \| 1.7505 GHz \| -0.83 dBm \| relative to limit |
| 2280 – 2380 MHz to show limit line | 10 MHz to 2345 MHz |



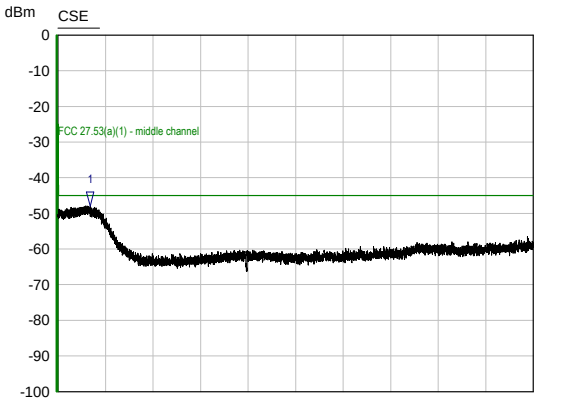

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | CSE | 2.3490 GHz | -17.22 dBm | relative to limit |
| 2 | CSE | 2.3500 GHz | -40.10 dBm | relative to limit |
| 3 | CSE | 2.3550 GHz | -40.21 dBm | relative to upper limit |
| 4 | CSE | 2.3560 GHz | -17.45 dBm | relative to limit |

2345 – 2365 MHz




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | CSE | 2.3490 GHz | -43.05 dBm | relative to limit |
| 2 | CSE | 2.3500 GHz | -89.05 dBm | relative to limit |
| 3 | CSE | 2.3550 GHz | -88.05 dBm | relative to upper limit |
| 4 | CSE | 2.3560 GHz | -41.14 dBm | relative to limit |

2345 – 2365 MHz lower RBW




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | CSE | 2.6770 GHz | -2.97 dBm | relative to limit |

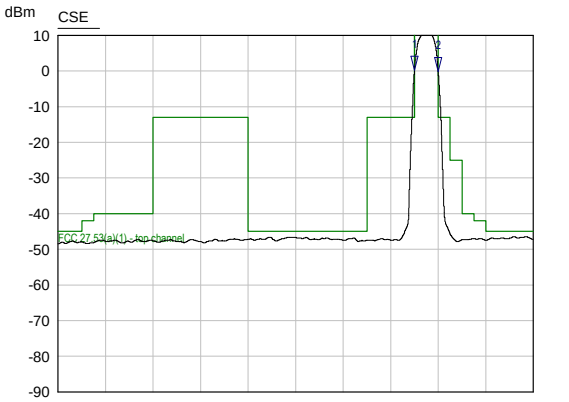
2365 – 7000 MHz

No emissions above noise floor

> 7 GHz

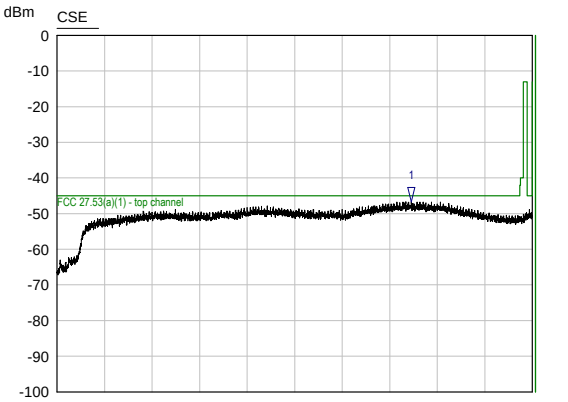
**Figure 11: CSE middle channel: 2352.5 MHz**

## 13.2.3 Top Channel



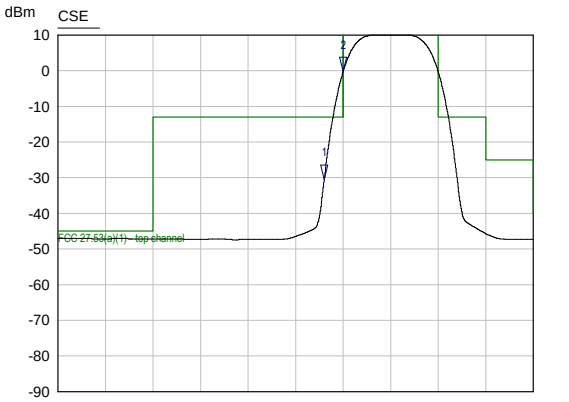

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | CSE | 2.3550 GHz | 0.14 dBm | |
| 2 ▽ | CSE | 2.3600 GHz | -0.20 dBm | |

2280 – 2380 MHz to show limit line



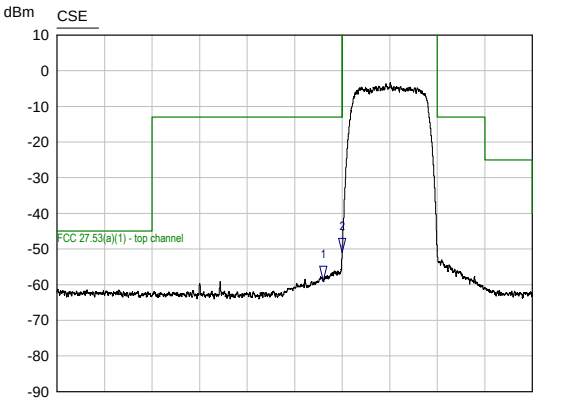

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | CSE | 1.7506 GHz | -1.61 dBm | relative to limit |

10 MHz to 2345 MHz



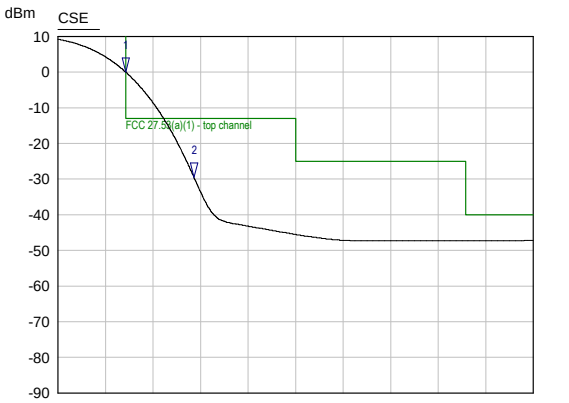

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | CSE | 2.3540 GHz | -17.56 dBm | relative to limit |
| 2 ▽ | CSE | 2.3550 GHz | -0.17 dBm | relative to limit |

2355MHz lower band edge pt1



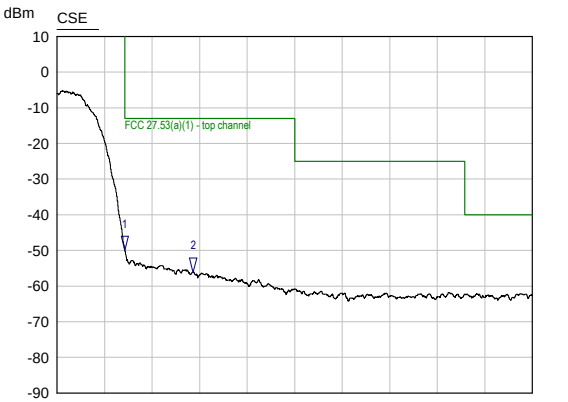

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | CSE | 2.3540 GHz | -45.89 dBm | relative to limit |
| 2 ▽ | CSE | 2.3550 GHz | -51.07 dBm | relative to limit |

2355MHz lower band edge pt2 (lower RBW)



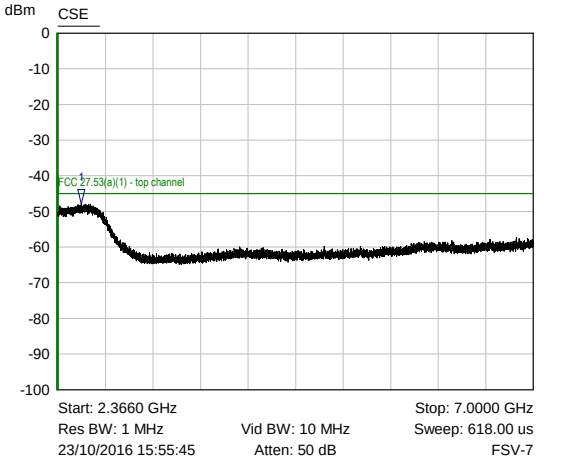

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | CSE | 2.3600 GHz | 12.94 dBm | relative to limit |
| 2 ▽ | CSE | 2.3610 GHz | -29.42 dBm | relative to limit |

2360MHz upper band edge pt1




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | CSE | 2.3600 GHz | -90.08 dBm | relative to limit |
| 2 ▽ | CSE | 2.3610 GHz | -56.11 dBm | relative to limit |

2360MHz upper band edge pt2 (lower RBW)




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | CSE | 2.5928 GHz | -2.84 dBm | relative to limit |

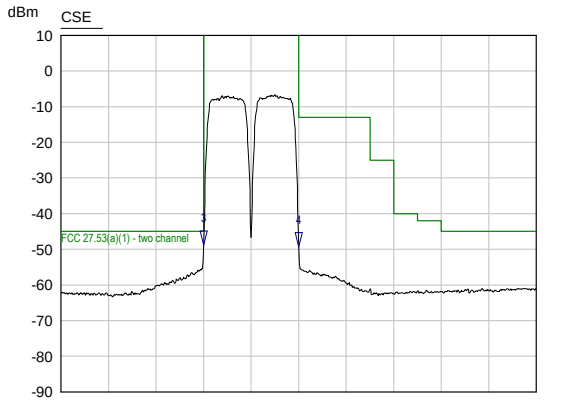
2360 – 7000 MHz

No emissions above noise floor

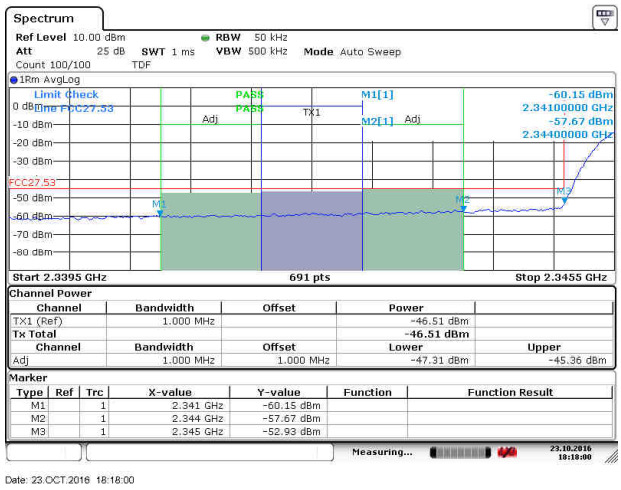
> 7 GHz

**Figure 12: CSE top channel: 2357.5 MHz**

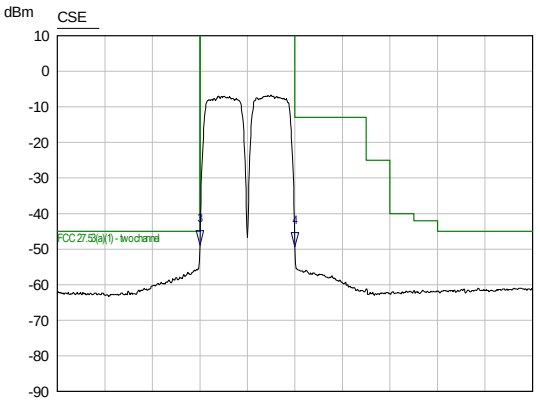
## 13.2.4 Dual Channel: AWGN




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 3 | CSE | 2.3450 GHz | -3.82 dBm | relative to limit |
| 4 | CSE | 2.3550 GHz | -36.25 dBm | relative to limit |

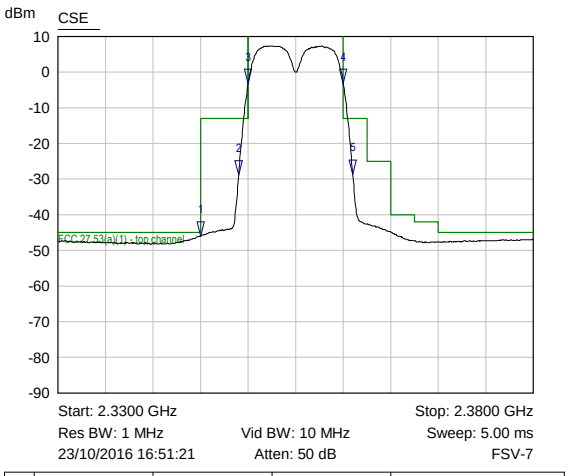



Band edge 2347.5 and 2352.5 MHz signals (Channel power measurement for 2341 – 2344 MHz band)



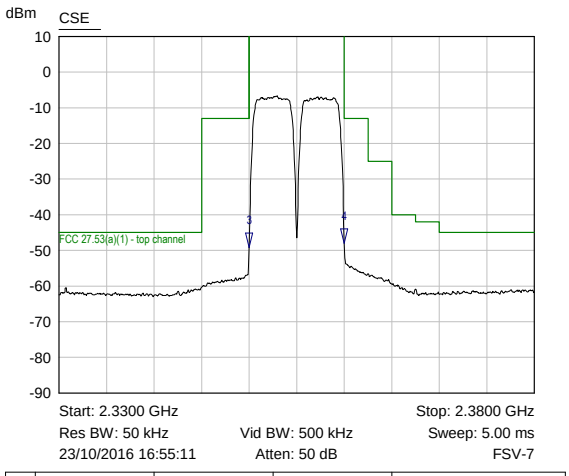

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 3 | CSE | 2.3450 GHz | -3.82 dBm | relative to limit |
| 4 | CSE | 2.3550 GHz | -36.25 dBm | relative to limit |

Band edge 2347.5 and 2352.5 MHz signals with lower RBW for 1 MHz adjacent to bandedge




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 | CSE | 2.3450 GHz | -0.96 dBm | relative to limit |
| 2 | CSE | 2.3490 GHz | -15.91 dBm | relative to limit |
| 3 | CSE | 2.3500 GHz | -43.10 dBm | relative to limit |
| 4 | CSE | 2.3600 GHz | -43.09 dBm | relative to limit |
| 5 | CSE | 2.3610 GHz | -15.63 dBm | relative to limit |

Band edge 2352.5 and 2357.5 MHz signals




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 3 | CSE | 2.3500 GHz | -36.11 dBm | relative to limit |
| 4 | CSE | 2.3600 GHz | -34.94 dBm | relative to limit |

Band edge 2352.5 and 2357.5 MHz signals with lower RBW

**Figure 13: CSE and band edge 2345 - 2360 MHz Band dual channel**

# 14 Transmit Power: 2496 - 2690 MHz

## 14.1 Test method

The equipment was configured with maximum gain of 25dB and connected as per figure 1.

The signal generator was set to provide -5 dBm to the input of the hub and the frequency set to an appropriate channel to include $f_0$ as determined in section 7.

Measurements were made in accordance with KDB 971168 D01 using an RMS detector and the Peak to Average ratio was measured using the CCDF function of the analyser.

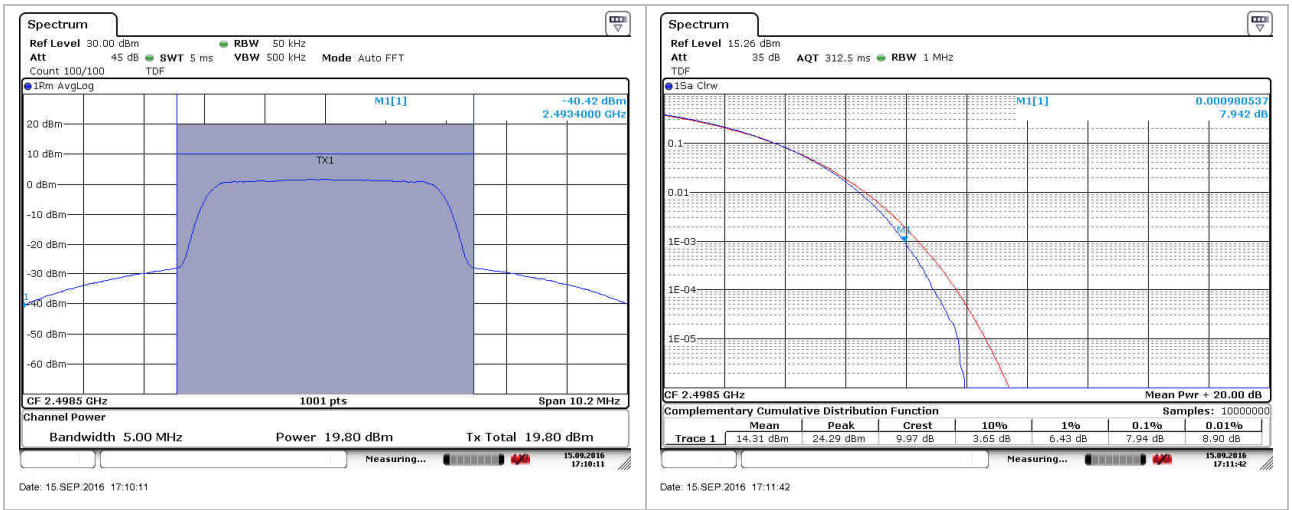
## 14.2 Test results

| Frequency | TX power (dBm) | TX power EIRP (dBm) | TX power EIRP (W) | Limit EIRP (W) | 0.1% PAR | Result |
|---|---|---|---|---|---|---|
| 2498.5 | 19.80 | 27.80 | 0.60 | 2000.0 | 7.94 dB | Pass |

**Table 6: Transmit power and Peak-to-Average ratio**

Plots may be seen in figures 7 and 13.

Peak to Average (PAR) ratio was measured using the analyser in-built CCDF function.




| 2498.5 MHz, AWGN modulation | Peak to Average |
|---|---|

**Figure 14: Power and Peak to Average (PAR) plots**

# 15 Occupied Bandwidth: 2496 - 2690 MHz

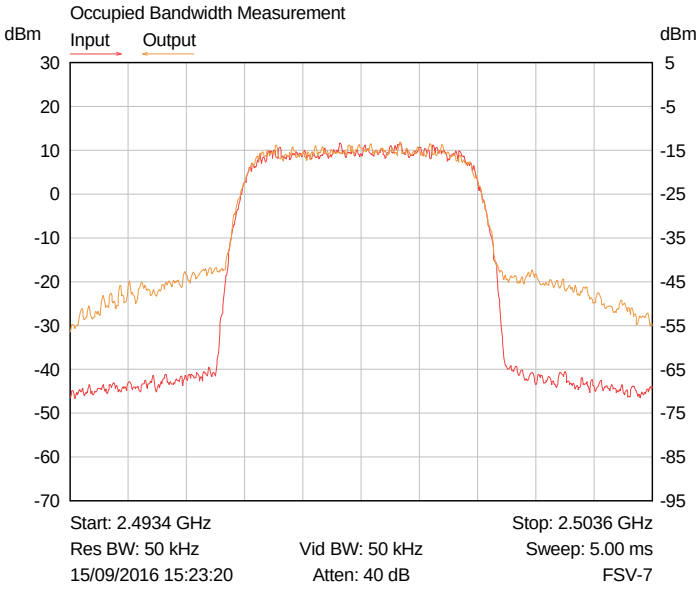
## *15.1 Test method*

KDB 935210 D05 section 3.4.

The occupied bandwidth was measured using the inbuilt function on the Signal Analyser set to measure the 99% occupied bandwidth. Measurement was made using peak detector and max hold.

The two plots are overlaid on the same graph by using different vertical axes for input and output signals.

## *15.2 Test results*




Output

| Measurement Parameter | Value |
|---|---|
| Occupied Power Bandwidth | 4.1167 MHz |

Input

| Measurement Parameter | Value |
|---|---|
| Occupied Power Bandwidth | 4.0861 MHz |

**Figure 15: Input vs output plot for 2496 - 2690 MHz band**

# 16 CSE inc. Band Edge: 2496 - 2690 MHz

## *16.1 Requirement and test method*

27.53.

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(2) For digital base stations, the attenuation shall be not less than 43 + 10 log (P) dB, unless a documented interference complaint is received from an adjacent channel licensee with an overlapping Geographic Service Area. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS No. 1 on the same terms and conditions as adjacent channel BRS or EBS licensees. Provided that a documented interference complaint cannot be mutually resolved between the parties prior to the applicable deadline, then the following additional attenuation requirements shall apply:

(6) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed; for mobile digital stations, in the 1 megahertz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least two percent may be employed, except when the 1 megahertz band is 2495-2496 MHz, in which case a resolution bandwidth of at least one percent may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 megahertz or 1 percent of emission bandwidth, as specified; or 1 megahertz or 2 percent for mobile digital stations, except in the band 2495-2496 MHz). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

The licensed band of operation was considered to be a single 5 MHz channel for the 5 MHz operation.

Some emissions > 1 MHz from bandedge were measured using the spectrum analyser adjacent channel power function that integrated power from a lower resolution bandwidth into the 1 MHz required by the rule part.

## *16.2 Test results*

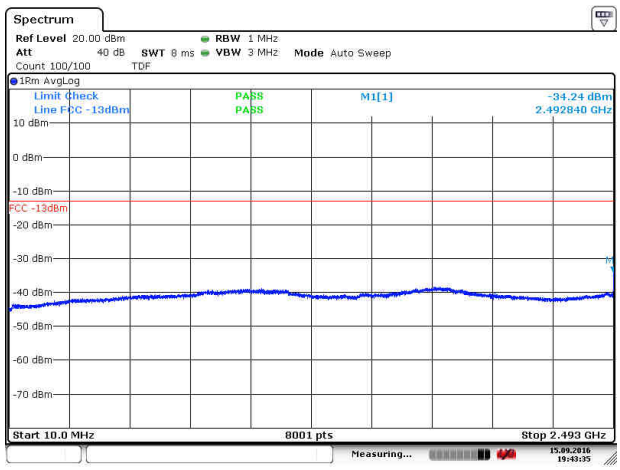
Single channel measurements were > 3.5 dB below the limit

Dual channel measurements were > 3 dB below the limit

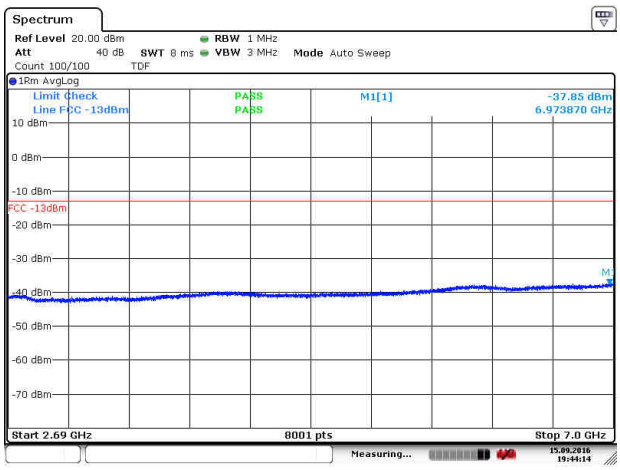
Plots are included for all modes up to 7GHz.

No emissions above noise floor above 7 GHz for any frequency of operation

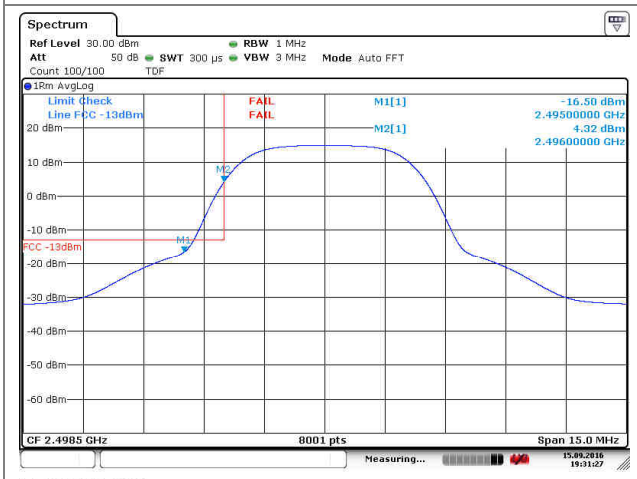
## 16.2.1 Wideband single frequency



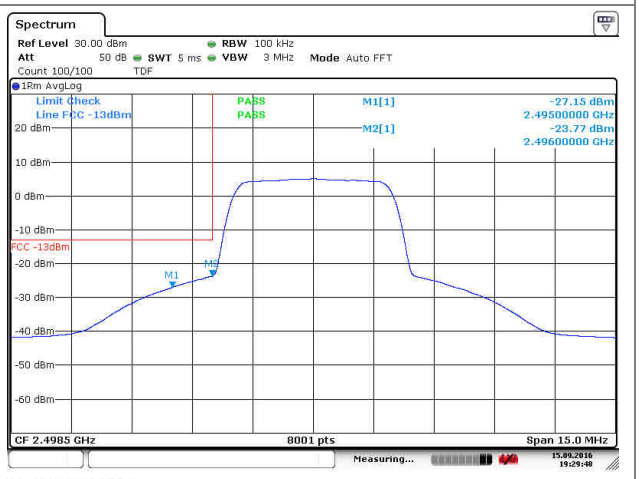

2498.5 below "band edge -3MHz"



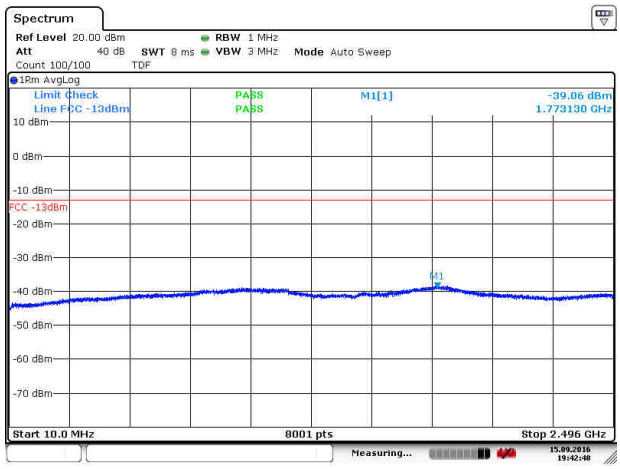

2498.5 above band edge



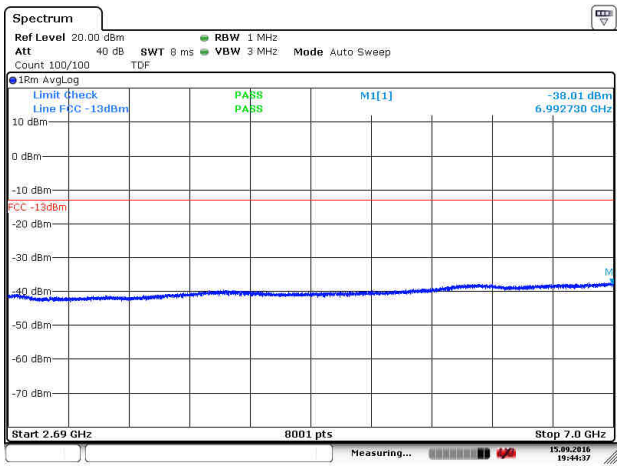

2498.5 MHz band edge (1MHz RBW)



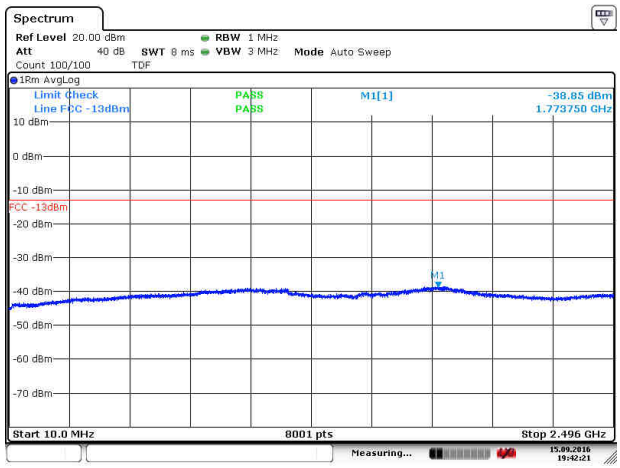

2498.5 MHz band edge (100 kHz RBW)



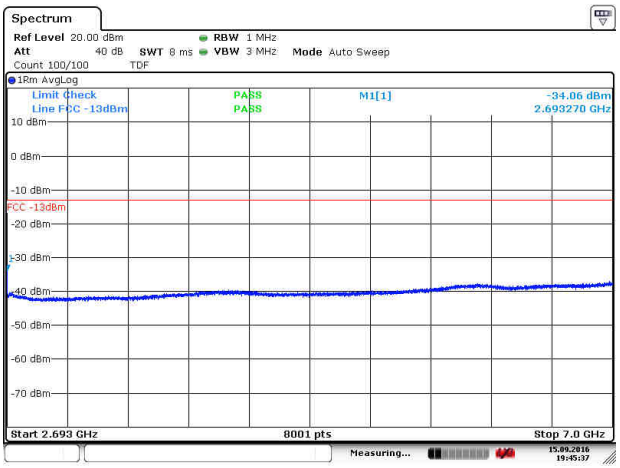

2600 MHz below band edge



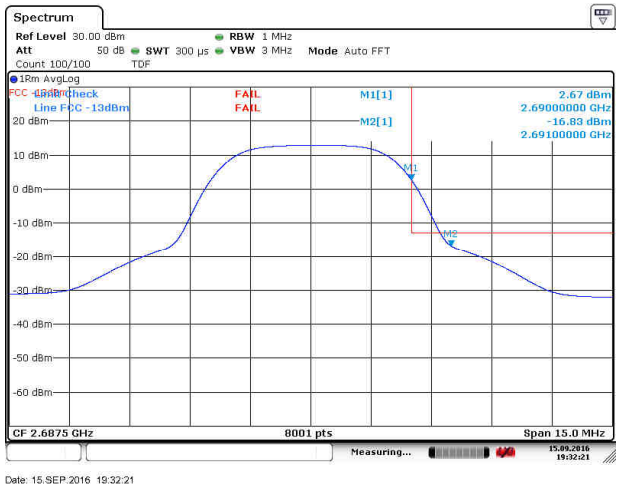

2600 MHz above band edge



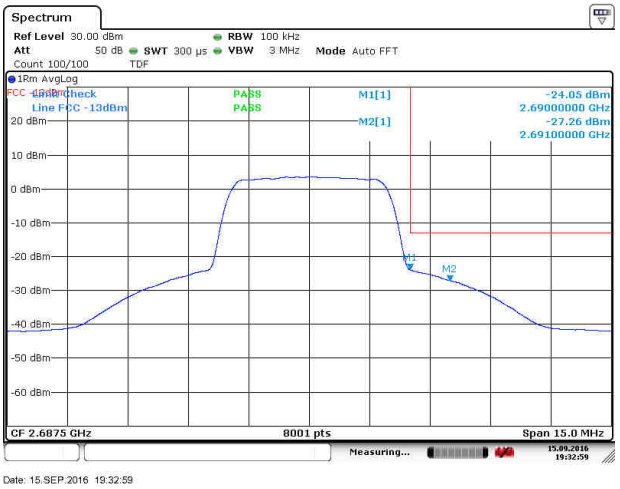

2687.5 below band edge




2687.5 above "band edge + 3MHz"



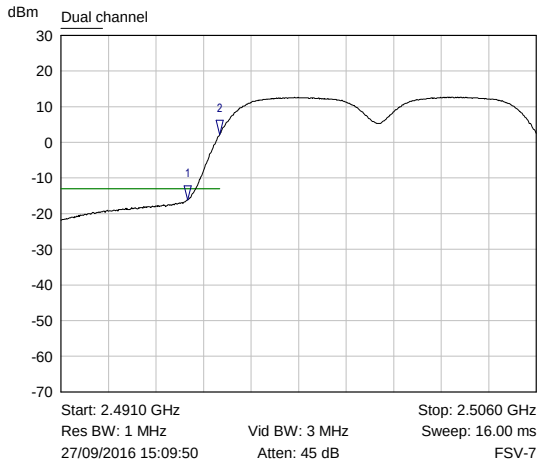

2687.5 MHz band edge (1MHz RBW)




2687.5 MHz band edge (100 kHz RBW)

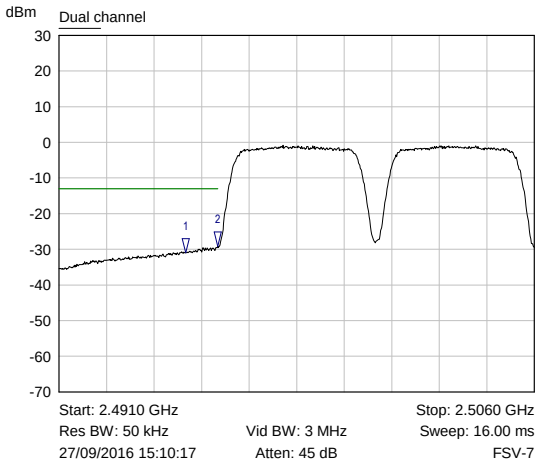
**Figure 16: CSE and band edge 2496 - 2690 MHz Band**

## 16.2.2 Dual Channel: AWGN



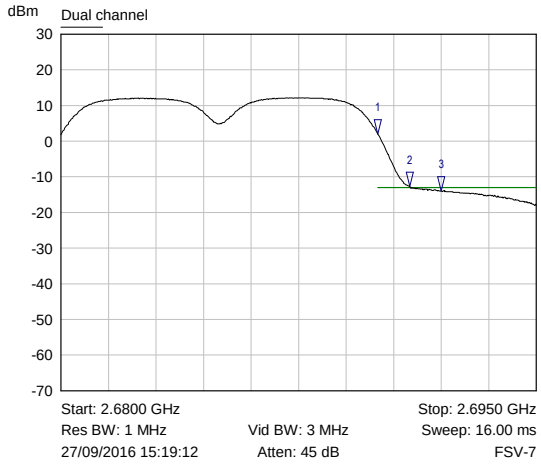

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Dual channel | 2.4950 GHz | -3.19 dBm | Relative to limit |
| 2 ▽ | Dual channel | 2.4960 GHz | 15.14 dBm | Relative to limit |

Lower band edge: 1 MHz RBW



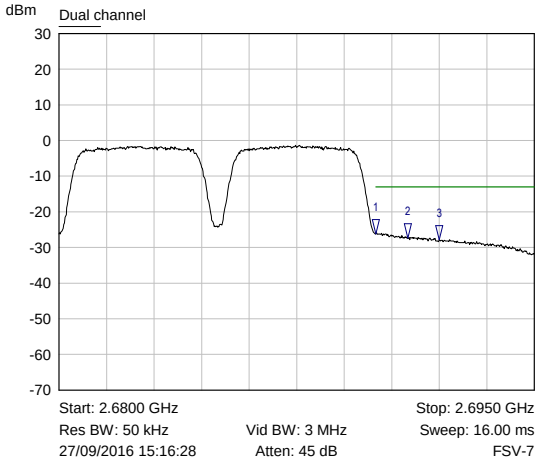

| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Dual channel | 2.4950 GHz | -17.97 dBm | Relative to limit |
| 2 ▽ | Dual channel | 2.4960 GHz | -16.24 dBm | Relative to limit |

Lower band edge: 50kHz RBW for adjacent 1 MHz band




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Dual channel | 2.6900 GHz | 14.98 dBm | Relative to limit |
| 2 ▽ | Dual channel | 2.6910 GHz | 0.36 dBm | Relative to limit |
| 3 ▽ | Dual channel | 2.6920 GHz | -1.00 dBm | Relative to limit |

Upper band edge: 1 MHz RBW




| Mkr | Trace | X-Axis | Value | Notes |
|---|---|---|---|---|
| 1 ▽ | Dual channel | 2.6900 GHz | -13.12 dBm | Relative to limit |
| 2 ▽ | Dual channel | 2.6910 GHz | -14.27 dBm | Relative to limit |
| 3 ▽ | Dual channel | 2.6920 GHz | -14.90 dBm | Relative to limit |

Dual channel

| Measurement Parameter | Value |
|---|---|
| Channel bandwidth | 5.00 MHz |
| Channel spacing | 4.00 MHz |
| On- channel power | 16.49 dBm |
| Adjacent channel power (channel -1) | 10.47 dBm |
| Adjacent channel power (channel +1) | -14.85 dBm |

Upper band edge: 50kHz RBW for adjacent 1 MHz band

**Figure 17: CSE and band edge 2496 - 2690 MHz Band dual channel**

# 17 Radiated Spurious Emissions testing

## *17.1 Test method*

Pre-scan measurements were performed with a spectrum analyser, using a peak detector and max hold.

Measurement bandwidths for pre-scan emissions were 100 kHz RBW for frequencies below 1 GHz and 1 MHz for frequencies above 1 GHz.

Measurement bandwidths for final emissions measurements by substitution were 1 MHz except for 1 MHz band immediately adjacent to band edge.

All measurements below 18 GHz were performed at 3m distance and emissions above 18 GHz were measured at 1m.

The cabinet radiation was performed while transmit antenna port was terminated with a 50Ω load.

Initial pre-scan measurements were performed against a field strength limit determined by

$E = EIRP - 20\log D + 104.8$

Where pre-scans showed any emissions of note, final measurement was made using substitution method, with results presented in sections 17.3 and 17.5.

## 17.2 Pre-scans for single channel operation

Emissions were investigated with device transmitting on bottom, middle and top channels.

Worst case pre-scans are shown below:

### 17.2.1 2180 – 2200 MHz RSE

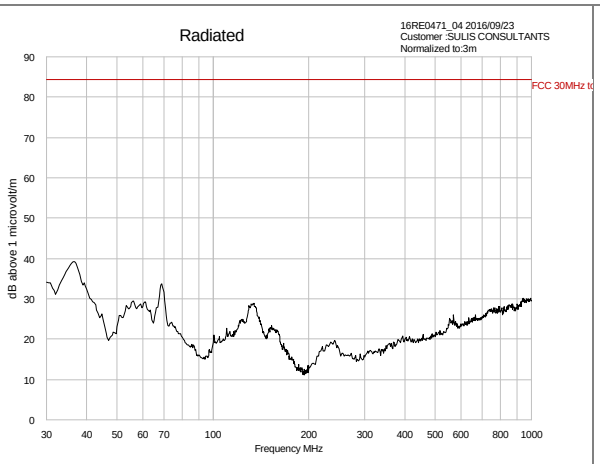
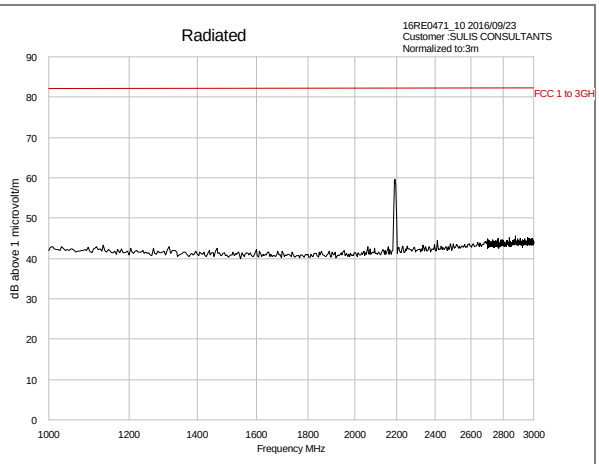
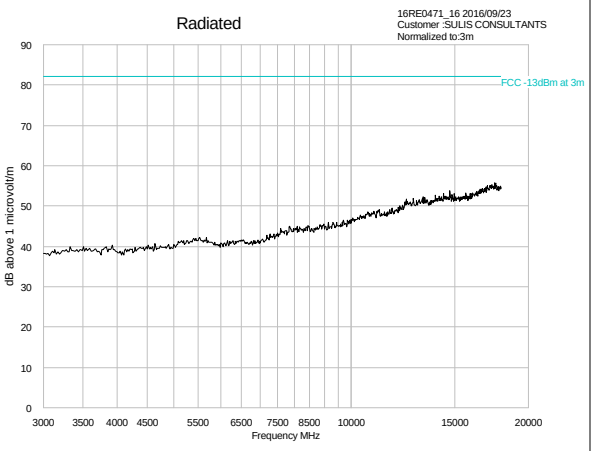
<table>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>30 – 1000 MHz</td><td>1 – 3 GHz</td></tr>
<tr><td> 
</td><td>No emissions of note</td></tr>
<tr><td>3 – 18 GHz</td><td>18 – 27 GHz</td></tr>
</table>

**Figure 18: RSE pre-scans: 2180-2200 MHz band operation**

## 17.2.2 2345 - 2360 MHz RSE

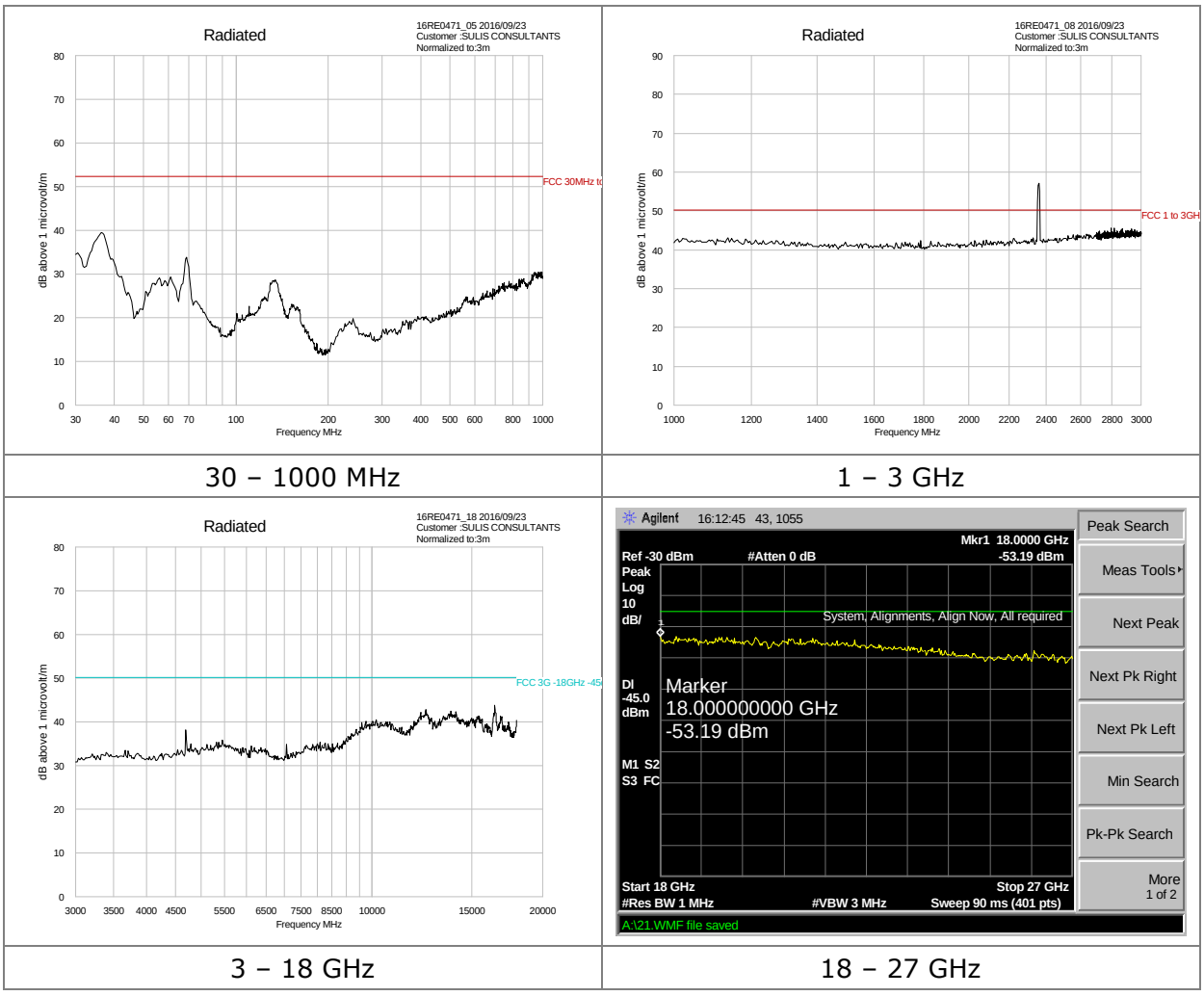
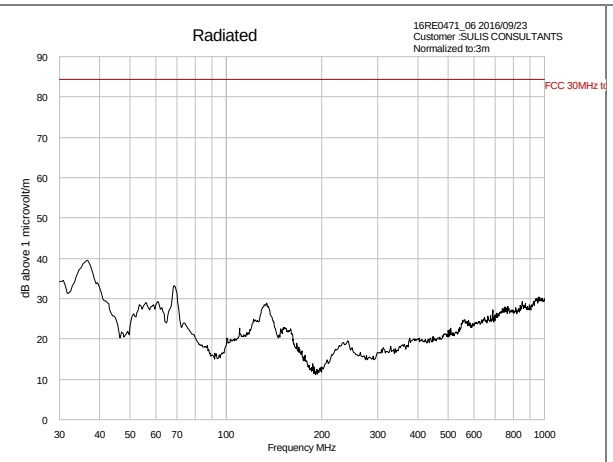
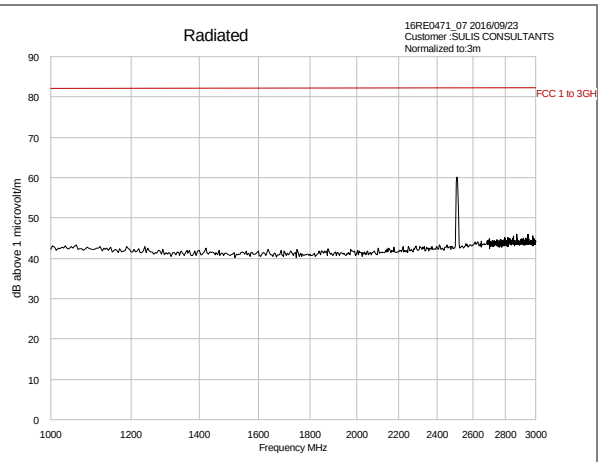



**Figure 19: RSE pre-scans: 2345 - 2360 MHz band operation**

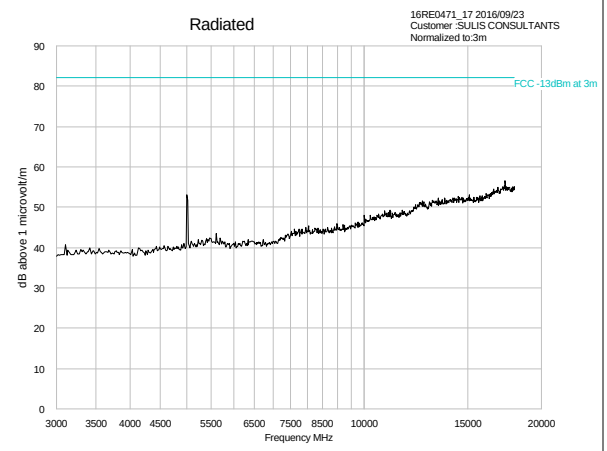
### *17.2.3 2496 - 2690 MHz RSE*




30 – 1000 MHz




1 – 3 GHz




3 – 18 GHz

No emissions of note

18 – 27 GHz

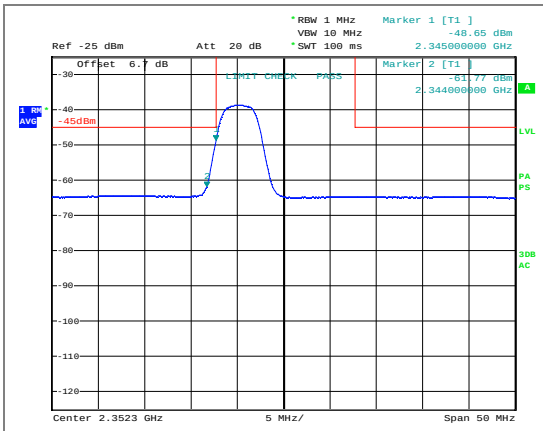
**Figure 20: RSE pre-scans: 2496 - 2690 MHz band operation**

## 17.3 Final measurements for single channel operation

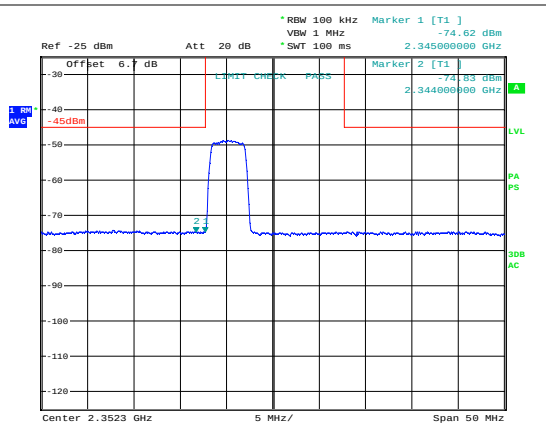
The only emissions of note were in the 2345-2360 MHz band where the limit line is more stringent.

Measurements were made using RMS detector and trace averaging.

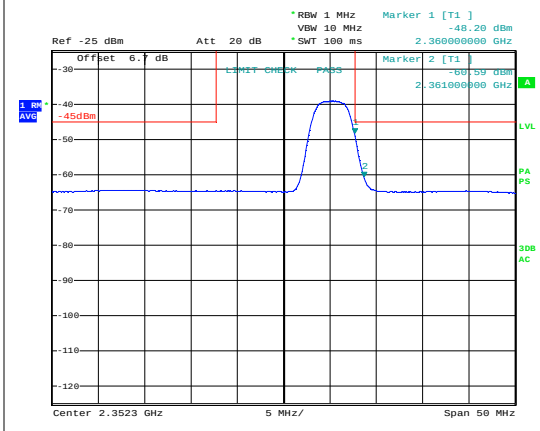
| Band-edge Frequency (MHz) | Frequency being measured | Measurement bandwidth | Emission level (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|---|
| 2345.0 | Band edge – 1MHz | 1 MHz | -61.8 | -45.0 | Pass |
| 2345.0 | Band edge | 100 kHz | -74.6 | -45.0 | Pass |
| 2360.0 | Band edge + 1MHz | 1 MHz | -60.6 | -45.0 | Pass |
| 2360.0 | Band edge | 100 kHz | -74.6 | -45.0 | Pass |



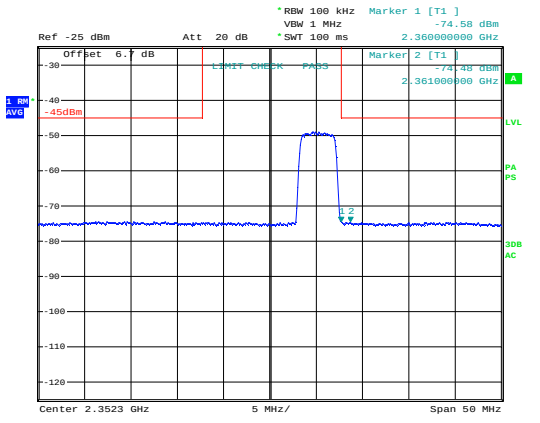

2347.5 MHz band edge




2347.5 MHz band edge, lower RBW




2357.5 MHz band edge




2357.5 MHz band edge, lower RBW

**Figure 21: RSE final measurements**

## 17.4 Pre-scans for dual channel operation

Emissions were investigated with device transmitting in two modes:

- Bottom and adjacent channels.
- Top and adjacent channels

Worst case pre-scans are shown below

### 17.4.1 2180 – 2200 MHz RSE – dual channel

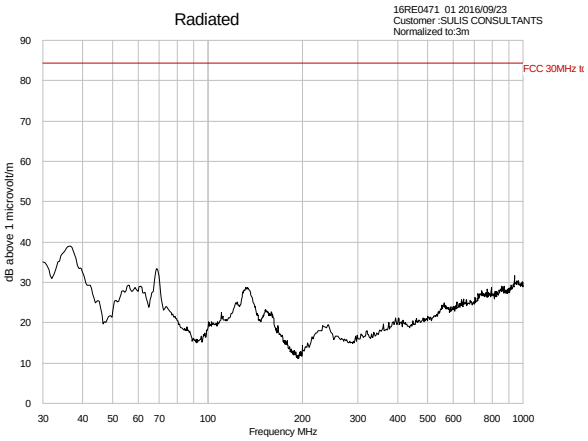
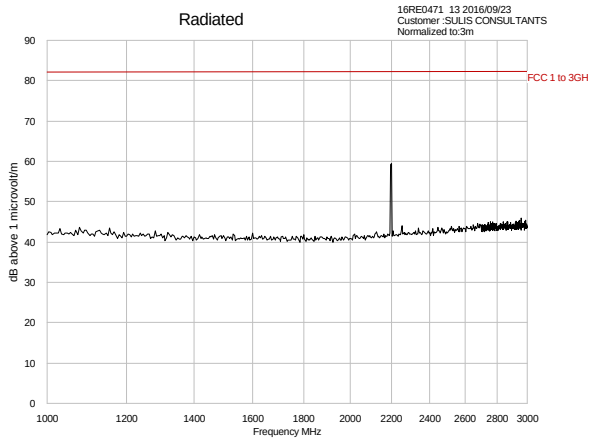
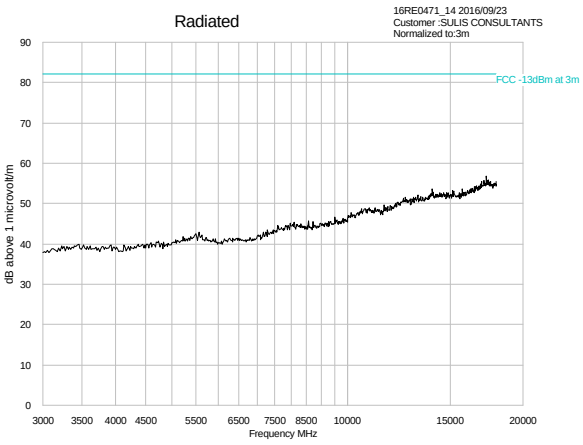
<table>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>30 – 1000 MHz</td><td>1 – 3 GHz</td></tr>
<tr><td> 
</td><td>No emissions of note</td></tr>
<tr><td>3 – 18 GHz</td><td>18 – 27 GHz</td></tr>
</table>

**Figure 22: RSE pre-scans: 2180-2200 MHz band operation – dual channel**

## 17.4.2 2345 - 2360 MHz RSE – dual channel

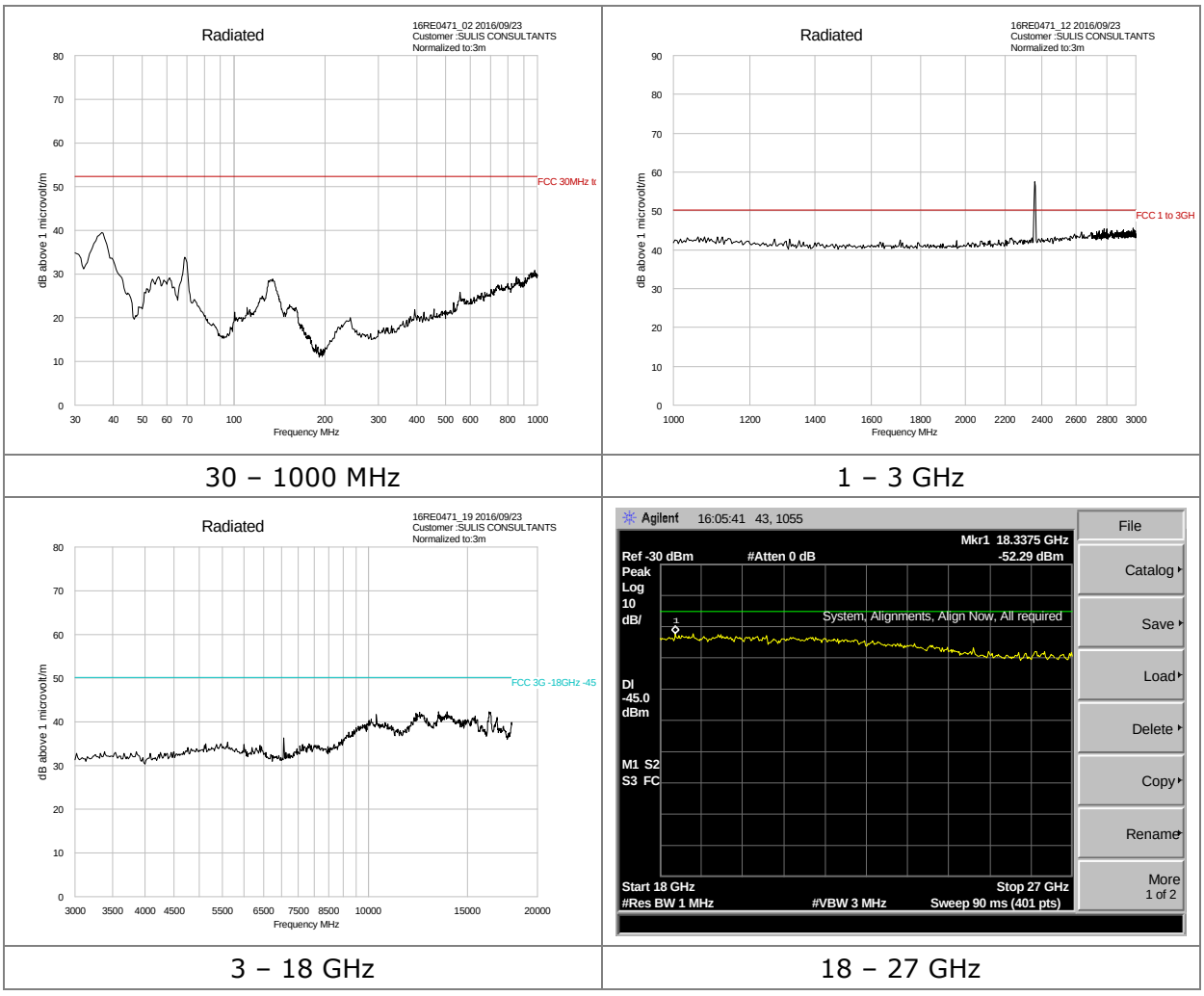



**Figure 23: RSE pre-scans: 2345 - 2360 MHz band operation – dual channel**

### *17.4.3 2496 - 2690 MHz RSE – dual channel*

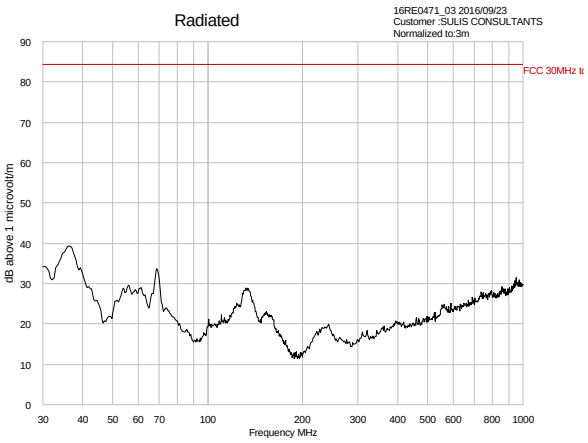
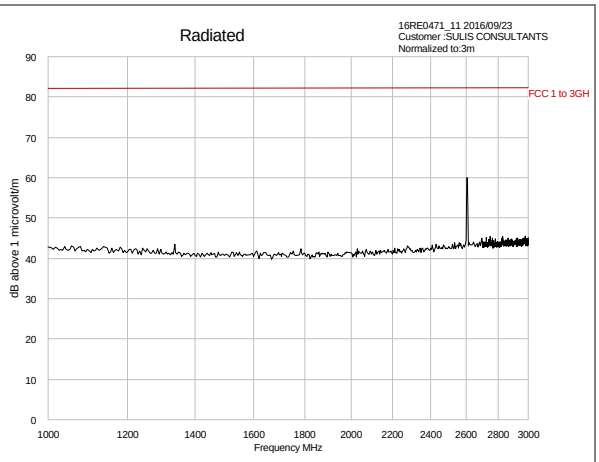
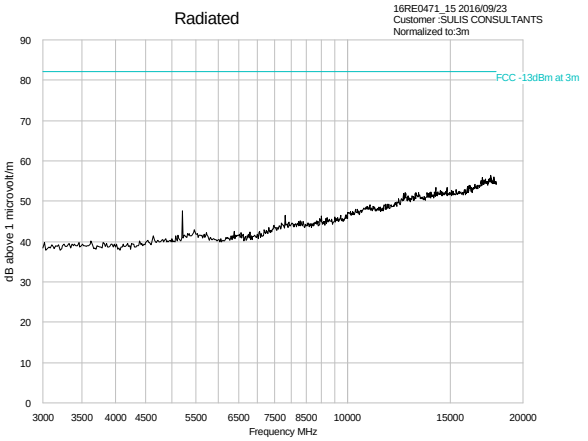
<table>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>30 – 1000 MHz</td><td>1 – 3 GHz</td></tr>
<tr><td> 
</td><td>No emissions of note</td></tr>
<tr><td>3 – 18 GHz</td><td>18 – 27 GHz</td></tr>
</table>

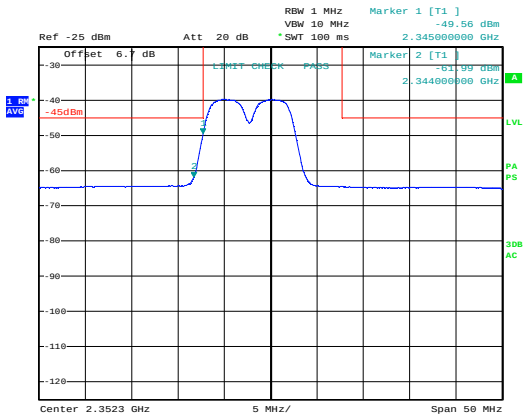
**Figure 24: RSE pre-scans: 2496 - 2690 MHz band operation – dual channel**

## 17.5 Final measurements for dual channel operation

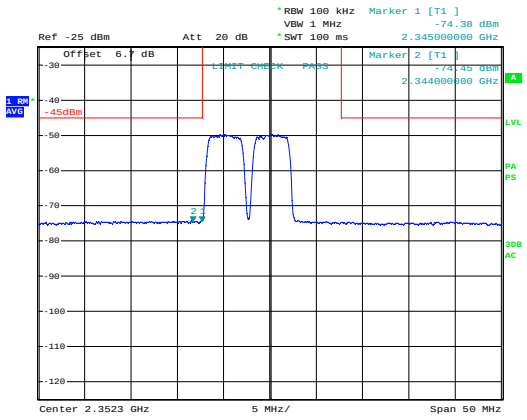
The only emissions of note were in the 2345-2360 MHz band where the limit line is more stringent.

Measurements were made using RMS detector and trace averaging.

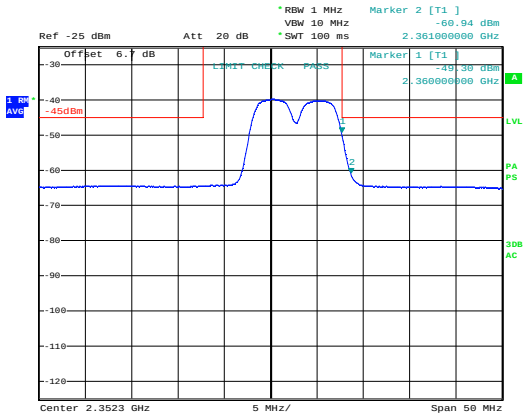
| Band-edge Frequency (MHz) | Frequency being measured | Measurement bandwidth | Emission level (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|---|
| 2345.0 | Band edge – 1MHz | 1 MHz | -62.0 | -45.0 | Pass |
| 2345.0 | Band edge | 100 kHz | -74.4 | -45.0 | Pass |
| 2360.0 | Band edge + 1MHz | 1 MHz | -60.9 | -45.0 | Pass |
| 2360.0 | Band edge | 100 kHz | -74.0 | -45.0 | Pass |



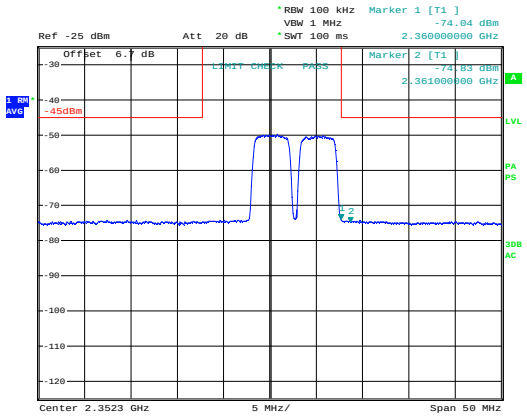

2347.5 MHz band edge




2347.5 MHz band edge, lower RBW




2357.5 MHz band edge




2357.5 MHz band edge, lower RBW

**Figure 25: RSE final measurements – dual channel**

# 18 Test equipment

| Description | Manufacturer | Model | Serial Number | Calibration |
|---|---|---|---|---|
| Signal Analyser | Rohde & Schwarz | FSV 7 | Zinwave 000073 | R&S 20-516458 Due 14 Nov 16 |
| Signal Generator | Rohde & Schwarz | SMBV100A | Microlease asset 45440 | Ref: 45440 Due 19 Nov 15 |
| Cable | Utiflex | BUA01G | FA210A0009M30309 | ABEX UK. Ref: green bua01g Due 08 Oct 17 |
| Spectrum analyser (9kHz-26.5GHz) | HP | 8593EM | 3536A00137 | HEMC Cal due 17/12/2016 |
| Signal Generator | Rohde & Schwarz | SMJ100A | 100156 | Verified as part of system test |
| Signal Generator | Agilent | E4432B | G83934071A | |
| Attenuator | Mini-circuits | VAT 10 | 3 0433 | |
| Cable (input) | Mini-circuits | CBL-1M-SMNM+ | 120274 | |
| Cable (input) | Mini-circuits | CBL-1M-SMNM+ | 120295 | |
| 2-way splitter (input) | Mini-circuits | ZN2PD2-63-S+ | UU21401232 | |
| **RSE testing at Hursley EMC Services Ltd. All calibration maintained under UKAS ISO17025 accreditation no 1874** | | | | |
| Pre-amplifier (30-1000MHz) | HP | 8447D | 1937A02341 | HEMC Cal due 14/09/2017 |
| Pre-amplifier (1.0-26.5GHz) | HP | 8449B | 3008A01394 | HEMC Cal due 25/08/2017 |
| Pink 30M-2G Antenna | CHASE | CBL 6141 | 4013 | HEMC Cal due 01/10/2018 |
| 1-10GHz Horn | Schwarzbeck | BBHA 9120 571 | 571 | HEMC Cal due 24/02/2019 |
| Horn antenna (2-18GHz) | Q-par Angus | WBH218HN | 5367 | HEMC Cal due 22/06/2019 |
| 18 to 40GHz Horn | Q-par Angus | WBH18-40k | 10300 | HEMC Cal due Internal |
| 7GHz Receiver | Rohde & Schwarz | ESCI7 | 1.167E+09 | HEMC Cal due 20/05/2017 |
| Spectrum analyser (9kHz-26.5GHz) | HP | 8593EM | 3536A00137 | HEMC Cal due 17/12/2016 |
| Synthesized sweeper | HP | 8341B | 2819A1509 | HEMC Cal due 14/10/2017 |
| Spectrum Analyser | Agilent | E4407B | MY44220967 | HEMC Cal due 30/11/20116 |

**Table 7: Test Equipment**