

# LABORATORY TEST REPORT

## RADIO PERFORMANCE MEASUREMENTS

for the

TBCC0E Base Station Transceiver

Tested in accordance with:

FCC 47 CFR part 90

RSS-119 Issue 12  
RSS-Gen Issue 4

Report Revision: 1  
Issue Date: 3 March 2017

PREPARED BY: L. M. White

  
Test Technician

CHECKED & APPROVED BY: M. C. James

  
Laboratory Technical Manager



OATS FCC LISTING REGISTRATION: 837095  
OATS IC LISTING REGISTRATION: SITE# 737A-1

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation.

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TELTEST Laboratories (A Division of Tait Communications)  
PO Box 1645, 558 Wairakei Road, Christchurch, New Zealand.

Telephone: 64 3 358 3399  
FAX: 64 3 359 4632

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## REVISION

| Date         | Revision | Comments            |
|--------------|----------|---------------------|
| 3 March 2017 | 1        | Initial test report |
|              |          |                     |

## INTRODUCTION

Type approval testing of the TBCC0E, 100 Watt, Base Station transceiver in order to demonstrate compliance with FCC 47 Part 90, and RSS-119 Issue 12 & RSS-Gen Issue 4. This radio supports analogue, digital FFSK and Digital Mobile Radio (DMR) modulations.

Type Approval Testing of the TBCC0E  
Frequency range 216 → 225 MHz

in accordance with:

FCC 47 CFR Part 90  
RSS-119 Issue 12 & RSS-Gen Issue 4

### REPORT PREPARED FOR

Tait Ltd  
245 Wooldridge Road  
Harewood  
Christchurch 8051  
New Zealand

### DESCRIPTION OF SAMPLE

Manufacturer Tait Limited  
Equipment: Base Station Transceiver  
Type: TBCC0E  
Quantity: 1

| Modulation                 |                                              | Channel Spacing | Speech Channels | Symbol Rate (symbols/sec) | Data Rate (bps) |
|----------------------------|----------------------------------------------|-----------------|-----------------|---------------------------|-----------------|
| Analogue FM                |                                              | 12.5 kHz        | 1               | -                         | -               |
| FFSK                       | Fast Frequency Shift Keying                  | 12.5 kHz        | -               | 1200                      | 1200            |
| Digital Mobile Radio (DMR) | 4 Level FSK (2 slot TDMA) (ETSI TS102 361-1) | 12.5 kHz        | 2               | 4800                      | 9600            |

### HARDWARE & SOFTWARE

| Module      | Product Code   | Serial Number | Firmware         | Hardware |
|-------------|----------------|---------------|------------------|----------|
| Front Panel | T01-01110-CCAA | 18181404      | 1.09.00.0002     | 00.04    |
| Reciter     | T01-01105-FACA | 18253013      | dmr-2.25.00.0003 | 1.00     |
| PA          | T01-01136-EBAA | 18252708      | 0314             | 1.00     |
| PMU         | TBA30A0-0100   | 18181802      | 0316             | 0.03     |

### TEST CONDITIONS

All testing was performed between 13 February → 3 March 2017, and under the following conditions:

Ambient temperature: 15°C → 30°C  
Relative Humidity: 20% → 75%  
Standard Test Voltage 120 V<sub>AC</sub>

## STATEMENT OF COMPLIANCE

We, TELTEST LABORATORIES of 558 Wairakei Road, Christchurch, New Zealand, declare under our sole responsibility that the product:

Equipment: Base Station Transceiver  
Type: TBCC0E  
Quantity: 1

| Module      | Product Code   | Serial Number | Firmware         | Hardware |
|-------------|----------------|---------------|------------------|----------|
| Front Panel | T01-01110-CCAA | 18181404      | 1.09.00.0002     | 00.04    |
| Reciter     | T01-01105-FACA | 18253013      | dmr-2.25.00.0003 | 1.00     |
| PA          | T01-01136-EBAA | 18252708      | 0314             | 1.00     |
| PMU         | TBA30A0-0100   | 18181802      | 0316             | 0.03     |

to which this declaration relates, is in conformity with the following standards:

FCC 47 CFR Part 90

RSS-119 Issue 12 & RSS-Gen Issue 4

Signature:



Mike James  
Technical Manager

Date:

7 March 2017

## MODULATION TYPES, NECESSARY BANDWIDTH & EMISSION DESIGNATORS

### MODULATION TYPES:

|     |                             |                  |          |
|-----|-----------------------------|------------------|----------|
| F3E | FM Analogue Voice           | -                | -        |
| F2D | Fast Frequency Shift Keying | 1200 symbols/sec | 1200 bps |
| FXD | Digital Data                | 4800 symbols/sec | 9600 bps |
| FXW | Digital Voice / Data        | 4800 symbols/sec | 9600 bps |

CHANNEL SPACINGS: 12.5 kHz

### EMISSION DESIGNATORS:

|                          |         |
|--------------------------|---------|
| Analogue Voice           | 11K0F3E |
| FFSK                     | 7K60F2D |
| DMR Digital Voice / Data | 7K60FXW |
| DMR Digital Data         | 7K60FXD |

Equation:  $B_n = 2M + 2Dk$

(M is highest modulating frequency; D is peak allowable deviation; k is a constant of 1 for FM)

#### Analogue Voice 12.5 kHz Channel Spacing

|                                                                       |                                         |
|-----------------------------------------------------------------------|-----------------------------------------|
| Necessary bandwidth                                                   | Emission Designator                     |
| M = 3.0 kHz                                                           | <b>11K0F3E</b>                          |
| D = 2.5 kHz                                                           | F3E represents an FM voice transmission |
| $B_n = (2 \times 3.0) + (2 \times 2.5) \times 1$ $= 11.0 \text{ kHz}$ |                                         |

#### Fast Frequency Shift Keying (FFSK – 1200 bps) 12.5 kHz Channel Spacing

|                                                                      |                                                                                |
|----------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Necessary bandwidth                                                  | Emission Designator                                                            |
| M = 1.8 kHz                                                          | <b>7K60F2D</b>                                                                 |
| D = 2.0 kHz                                                          | F2D represents a FM data transmission with the use of a modulating sub carrier |
| $B_n = (2 \times 1.8) + (2 \times 2.0) \times 1$ $= 7.6 \text{ kHz}$ |                                                                                |

Digital Mobile Radio (DMR)      4 level FSK (as per ETSI TS 102 361-1)  
4800 symbols/sec 9600 bps

#### Digital Data 12.5 kHz Channel Spacing – 7K60FXW

|               |                                                      |
|---------------|------------------------------------------------------|
| 99% bandwidth | Emission Designator                                  |
| = 7.6 kHz     | <b>7K60FXW</b>                                       |
|               | FXW represents FM combination of data and telephony. |

#### Digital Data 12.5 kHz Channel Spacing – 7K60FXD

|               |                             |
|---------------|-----------------------------|
| 99% bandwidth | Emission Designator         |
| = 7.6 kHz     | <b>7K60FXD</b>              |
|               | FXD represents FM data only |

## TEST RESULTS

### TRANSMITTER OUTPUT POWER (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1046  
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GUIDE: TIA-102.CAAA-C 2.2.1

#### MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up.
2. The coaxial attenuator has an impedance of 50 Ohms.
3. The unmodulated output power was measured with an RF Power meter.

#### MEASUREMENT RESULTS:

Manufacturer's Rated Output Power:

Switchable: 100 W and 10 W

| Nominal<br>100 W           | 217.5 MHz | 219.5 MHz | 220.975 MHz | 221.975 MHz |
|----------------------------|-----------|-----------|-------------|-------------|
| Measured                   | 107.1     | 108.0     | 105.4       | 109.1       |
| Variation (%)              | 7.1       | 8.0       | 5.4         | 9.1         |
| Variation (dB)             | 0.3       | 0.3       | 0.2         | 0.4         |
|                            |           |           |             |             |
| Nominal<br>10 W            | 217.5 MHz | 219.5 MHz | 220.975 MHz | 221.975 MHz |
| Measured                   | 10.6      | 10.7      | 10.6        | 10.8        |
| Variation (%)              | 6.2       | 7.1       | 6.0         | 8.1         |
| Variation (dB)             | 0.3       | 0.3       | 0.3         | 0.3         |
| Measurement<br>Uncertainty | ± 0.6 dB  |           |             |             |

#### LIMIT CLAUSES:

FCC 47 CFR 90.205 (s)

The output power shall not exceed by more than 20%... the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

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The output power shall be within ±1.0 dB of the manufacturer's rated power.

## TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS

SPECIFICATION: FCC 47 CFR 2.1047 (a)

GUIDE: TIA/EIA-603E 2.2.6

### MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up.
2. An audio input tone of 1000 Hz was applied with the level set to obtain 20% of maximum deviation. This was used as the 0 dB reference point.
3. The AF was varied while the audio level was held constant.
4. The response in dB relative to 1000 Hz was measured.

### MEASUREMENT RESULTS:

See the plots on the following pages for 12.5 kHz channel spacing tested at 100 W transmit power.

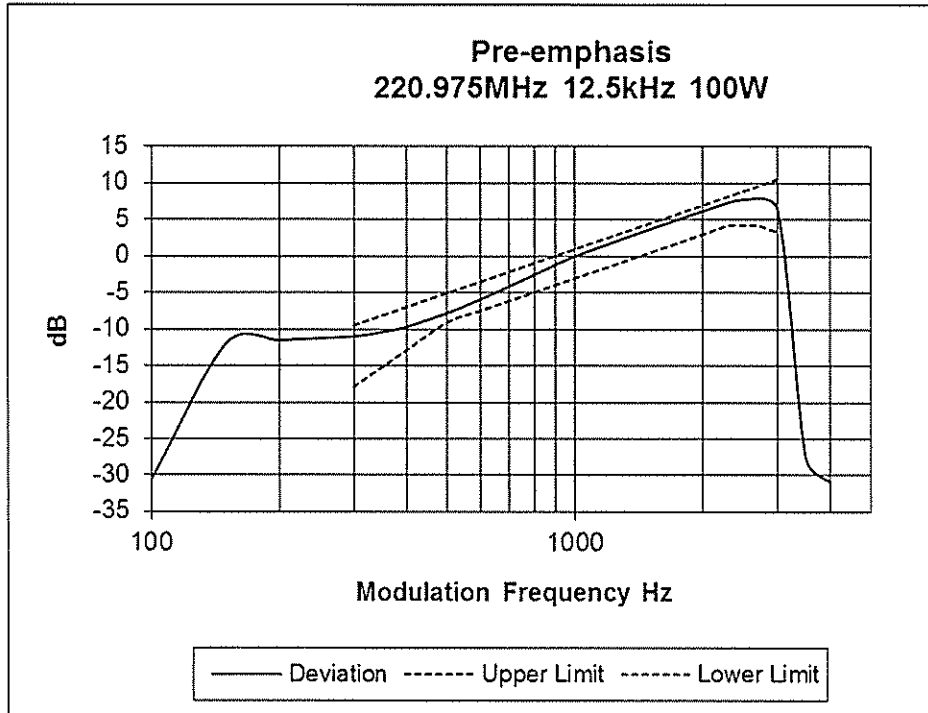
LIMIT CLAUSE: TIA/EIA-603E 3.2.6

### Transmitter Audio Frequency Response – Pre-emphasis

SPECIFICATION: FCC CFR 2.1047 (a)

Tx FREQUENCY: 220.975 MHz

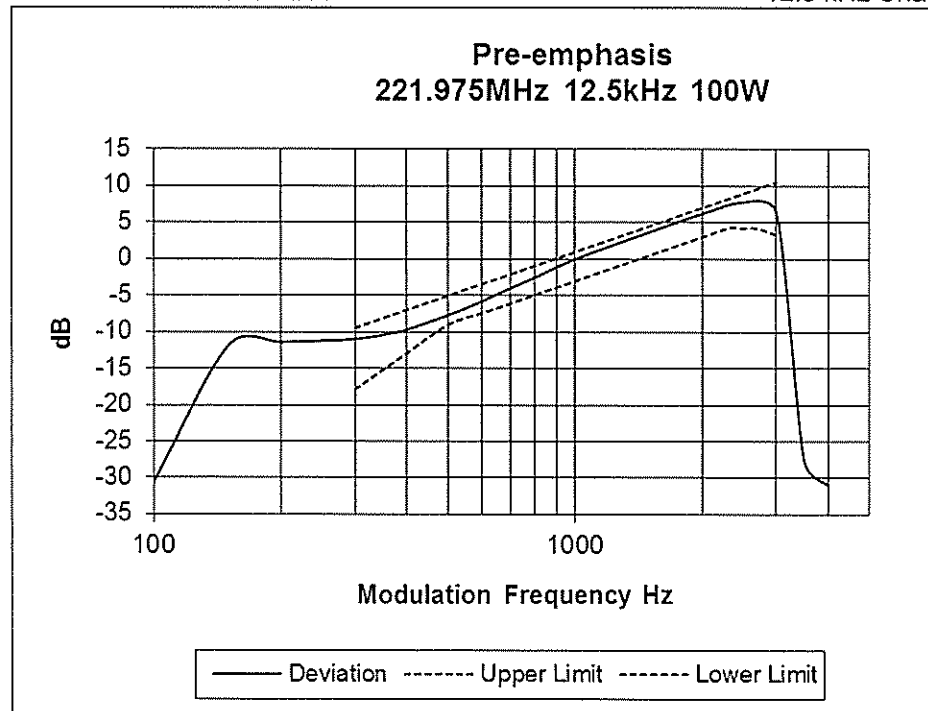
12.5 kHz Channel Spacing



SPECIFICATION: FCC CFR 2.1047 (a)

Tx FREQUENCY: 221.975 MHz

12.5 kHz Channel Spacing



## TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC 47 CFR 2.1047 (b)

GUIDE: TIA/EIA-603E 2.2.3

### MEASUREMENT PROCEDURE:

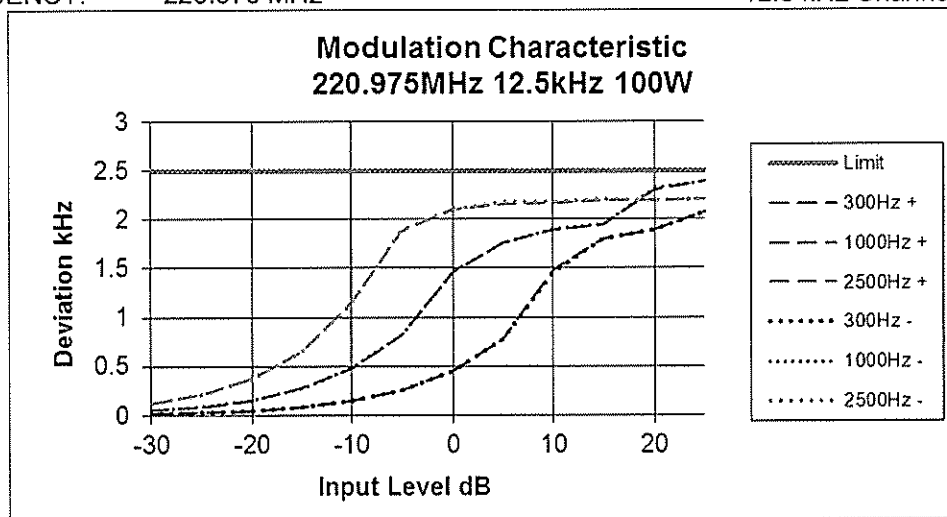
1. Refer Annex A for Equipment set up.
2. The modulation response was measured at three audio frequencies while varying the input level.
3. Measurements were made for both Positive and Negative Deviation.

### MEASUREMENT RESULTS:

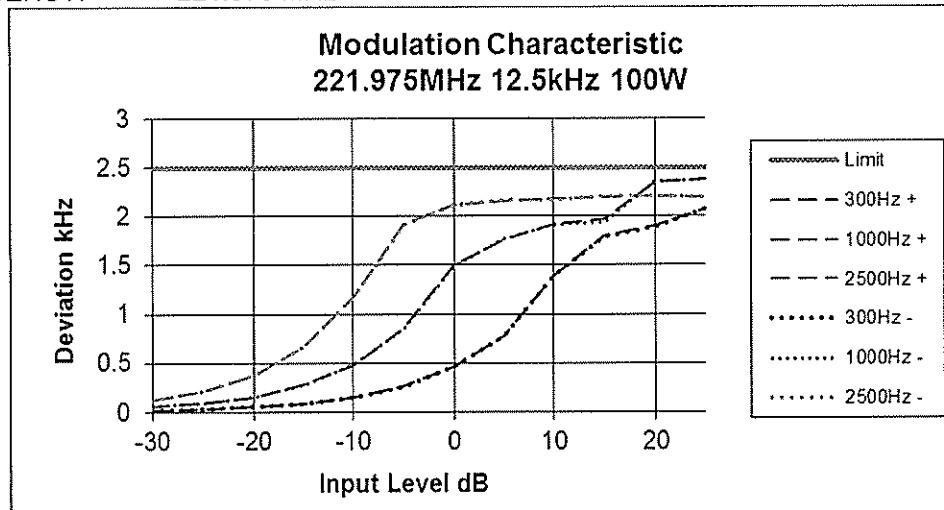
See the plots on the following pages for 12.5 kHz channel spacing.

LIMIT CLAUSE: TIA/EIA-603E 1.3.4.4

Tx FREQUENCY: 220.975 MHz 12.5 kHz Channel Spacing



Tx FREQUENCY: 221.975 MHz 12.5 kHz Channel Spacing



## TRANSMITTER OCCUPIED BANDWIDTH AND SPECTRUM MASKS

SPECIFICATION: FCC 47 CFR 2.1049 (c)

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GUIDE: TIA/EIA-603E 2.2.11 (Analog)  
TIA-102.CAAA-C 2.2.5 (Digital)

### MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment Set up.
2. Analog: The EUT was modulated with an externally generated 2.5 kHz audio signal at a level 16 dB above 50% of the maximum rated deviation.  
FFSK and DMR: The EUT was modulated with an internally generated pseudo random bit sequence at the appropriate Baud rates.
3. The Occupied Bandwidth was measured on the Spectrum Analyser, with bandwidth settings as follows.  
Emission Mask D – Resolution Bandwidth = 100 Hz, Video Bandwidth = 1 kHz  
Emission Mask F (4 contiguous channels) – Resolution Bandwidth = 300 Hz, Video Bandwidth = 3 kHz  
Emission Mask 80.211 (f) – Resolution Bandwidth = 100 Hz, Video Bandwidth = 1 kHz

### MEASUREMENT RESULTS:

See the plots on the following pages for 12.5 kHz channel spacing.

LIMIT CLAUSE: FCC 47 CFR 80.211 & 90.210 RSS-119 5.5

### DATA SPEED

Digital Voice/Data 12.5 kHz Channel Spacing 9600 bps (DMR)  
1200 bps (FFSK)

### EMISSION MASKS

| Transmit Frequency | FCC Part | Analog Mask                  | FFSK & DMR Mask              |
|--------------------|----------|------------------------------|------------------------------|
| 220-222            | 90       | F<br>(4 contiguous channels) | F<br>(4 contiguous channels) |

| Transmit Frequency | IC Document               | Analog Mask                  | FFSK & DMR Mask              |
|--------------------|---------------------------|------------------------------|------------------------------|
| 217-218 & 219-220  | RSS-119 5.5               | D                            | D                            |
| 220-222            | SRSP-512 &<br>RSS-119 5.5 | F<br>(4 contiguous channels) | F<br>(4 contiguous channels) |

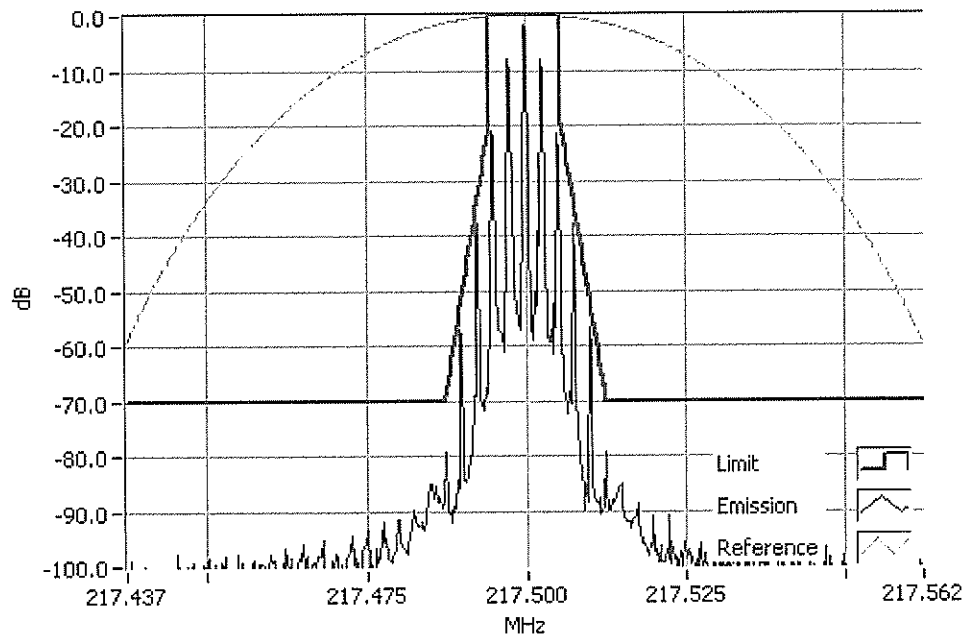
## Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

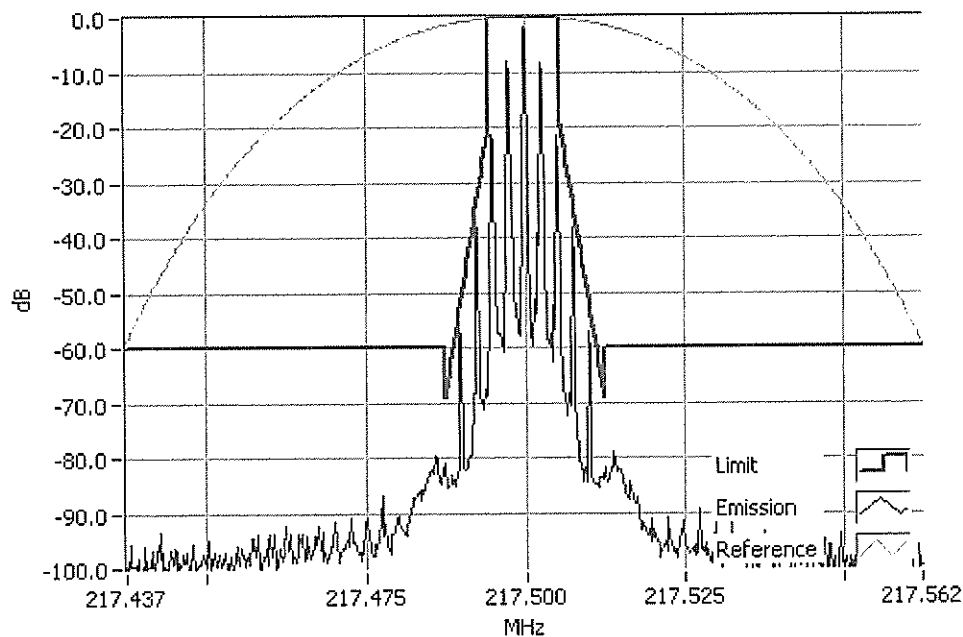
Analog Modulation

Tx FREQUENCY: 217.5 MHz 100 W 12.5 kHz Channel Spacing



Analogue Modulation 217.5000MHz Mask D 100W  
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak  
Result=Pass

Tx FREQUENCY: 217.5 MHz 10 W 12.5 kHz Channel Spacing



Analogue Modulation 217.5000MHz Mask D 10W  
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak  
Result=Pass

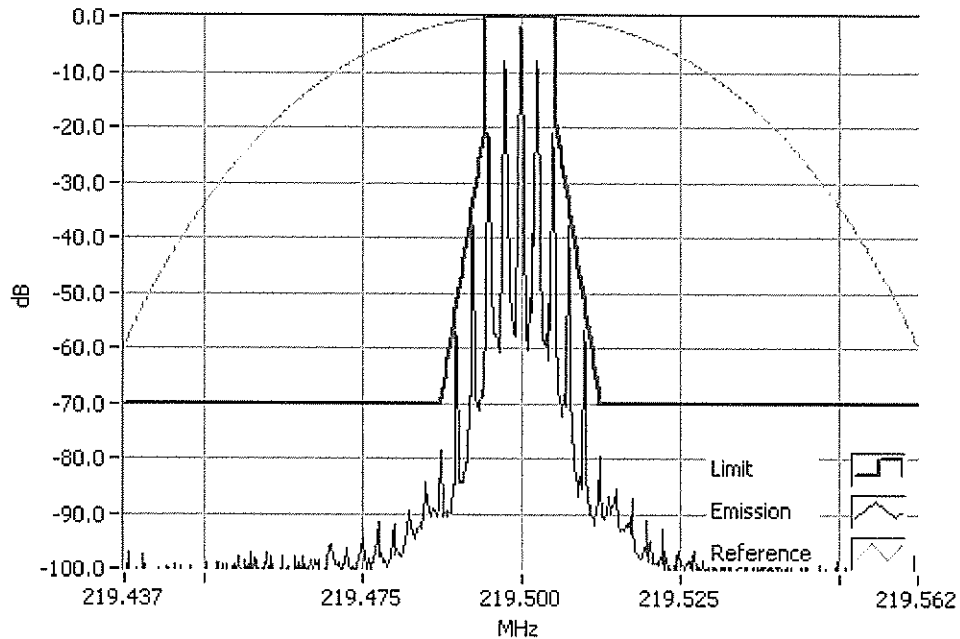
## Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

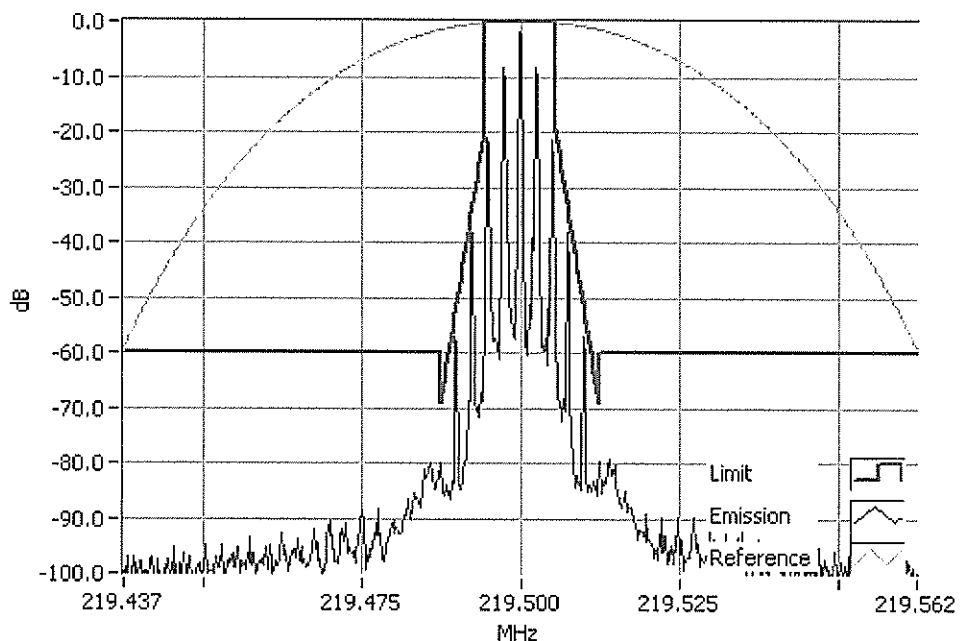
Analog Modulation

Tx FREQUENCY: 219.5 MHz 100 W 12.5 kHz Channel Spacing



Analogue Modulation 219.5000MHz Mask D 100W  
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak  
Result=Pass

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Analogue Modulation 219.5000MHz Mask D 10W  
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak  
Result=Pass

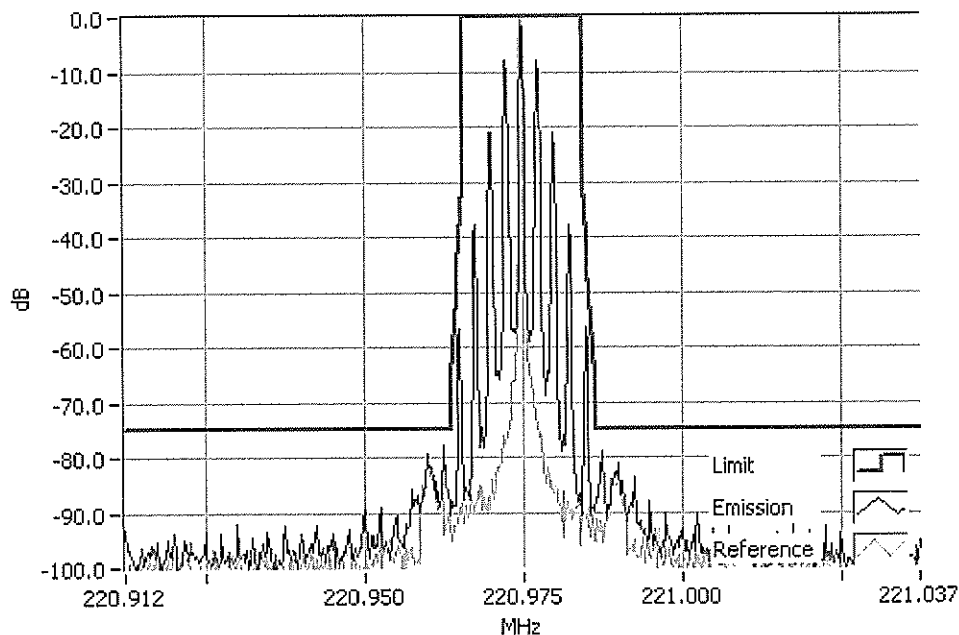
## Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

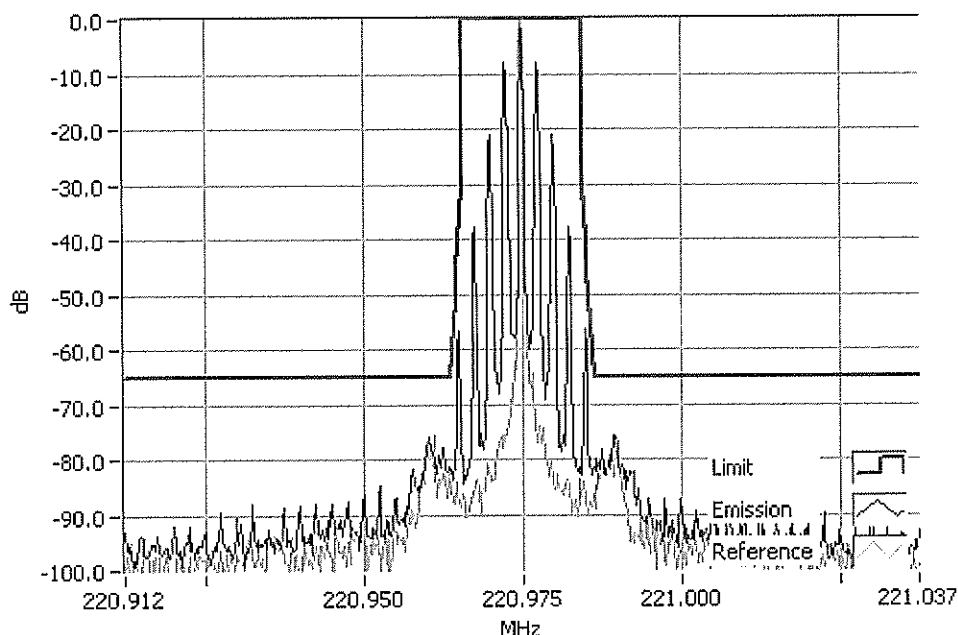
Analog Modulation

Tx FREQUENCY: 220.975 MHz 100 W 12.5 kHz Channel Spacing



Analogue Modulation 220.9750MHz Mask Fx4 100W  
RBW=300Hz, VBW=3000Hz, Detector Mode=Peak  
Result=Pass

Tx FREQUENCY: 220.975 MHz 10 W 12.5 kHz Channel Spacing



Analogue Modulation 220.9750MHz Mask Fx4 10W  
RBW=300Hz, VBW=3000Hz, Detector Mode=Peak  
Result=Pass

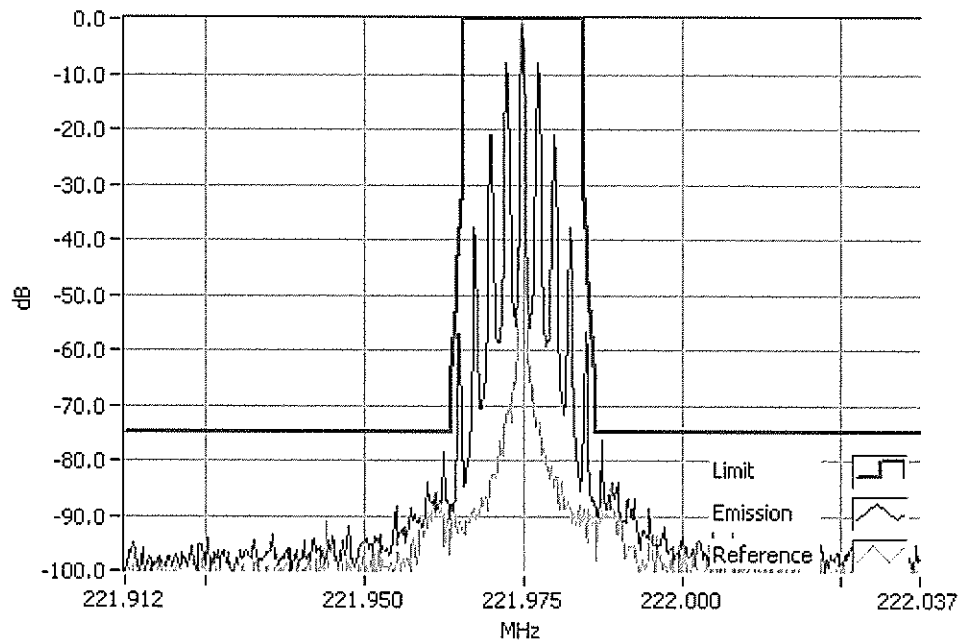
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SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

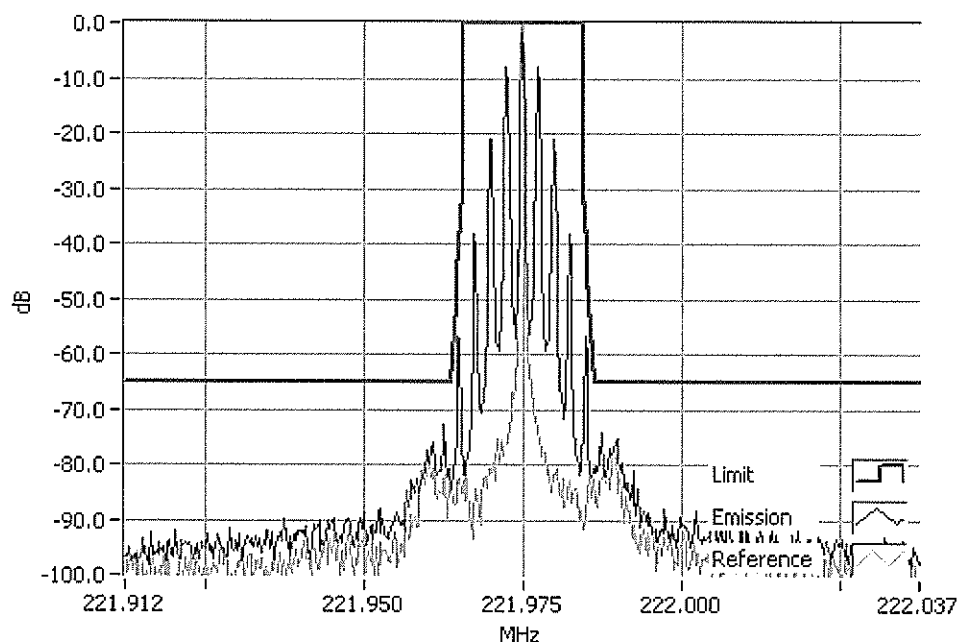
Analog Modulation

Tx FREQUENCY: 221.975 MHz 100 W 12.5 kHz Channel Spacing



Analogue Modulation 221.9750MHz Mask Fx4 100W  
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Tx FREQUENCY: 221.975 MHz 10 W 12.5 kHz Channel Spacing



Analogue Modulation 221.9750MHz Mask Fx4 10W  
RBW=300Hz, VBW=3000Hz, Detector Mode=Peak  
Result=Pass

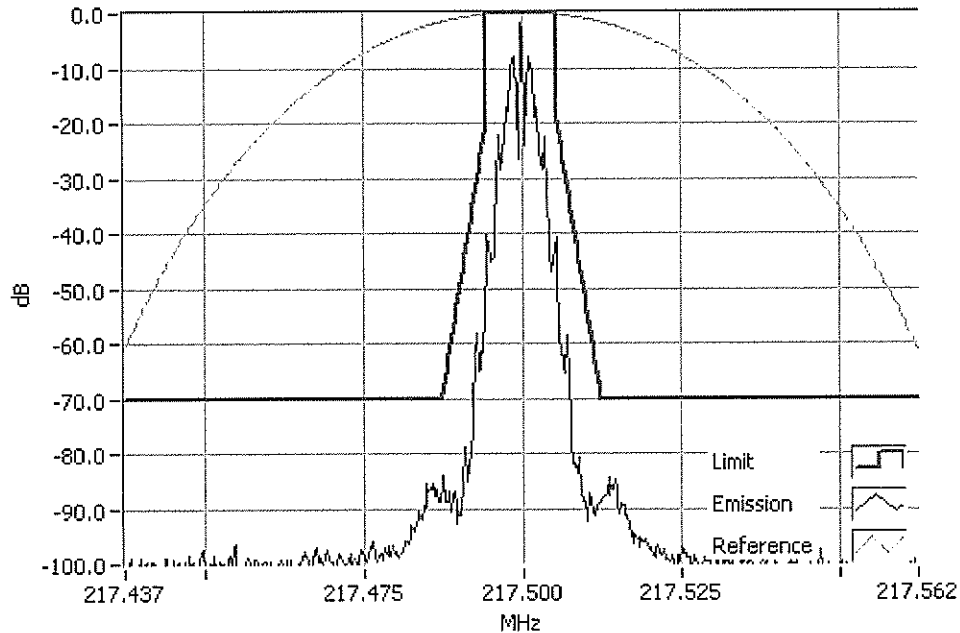
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SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

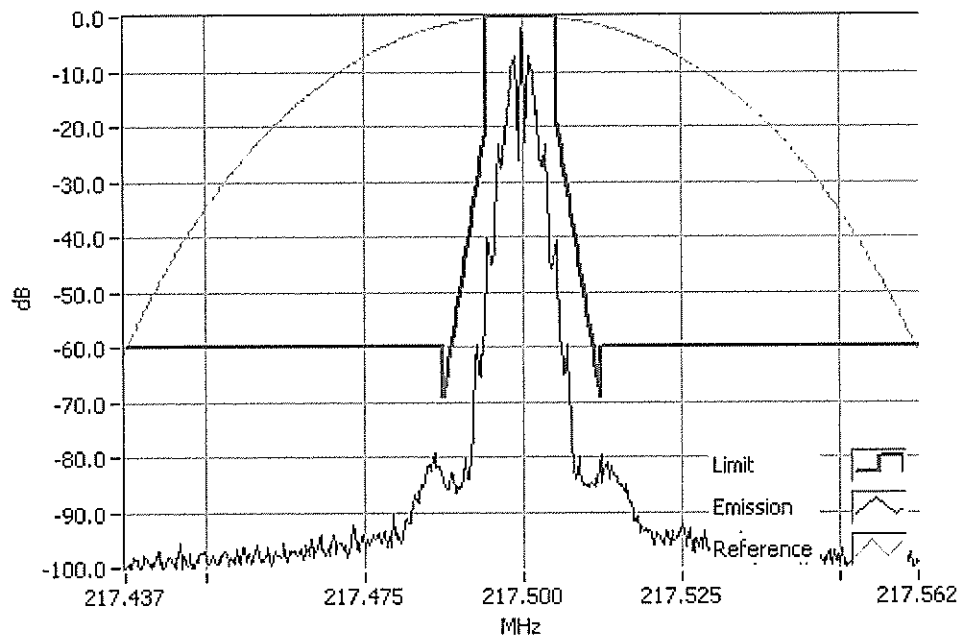
FFSK Modulation

Tx FREQUENCY: 217.5 MHz 100 W 12.5 kHz Channel Spacing



FFSK 1200 217.5000MHz Mask D 100W  
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak  
Result=Pass

Tx FREQUENCY: 217.5 MHz 10 W 12.5 kHz Channel Spacing



FFSK 1200 217.5000MHz Mask D 10W  
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak  
Result=Pass

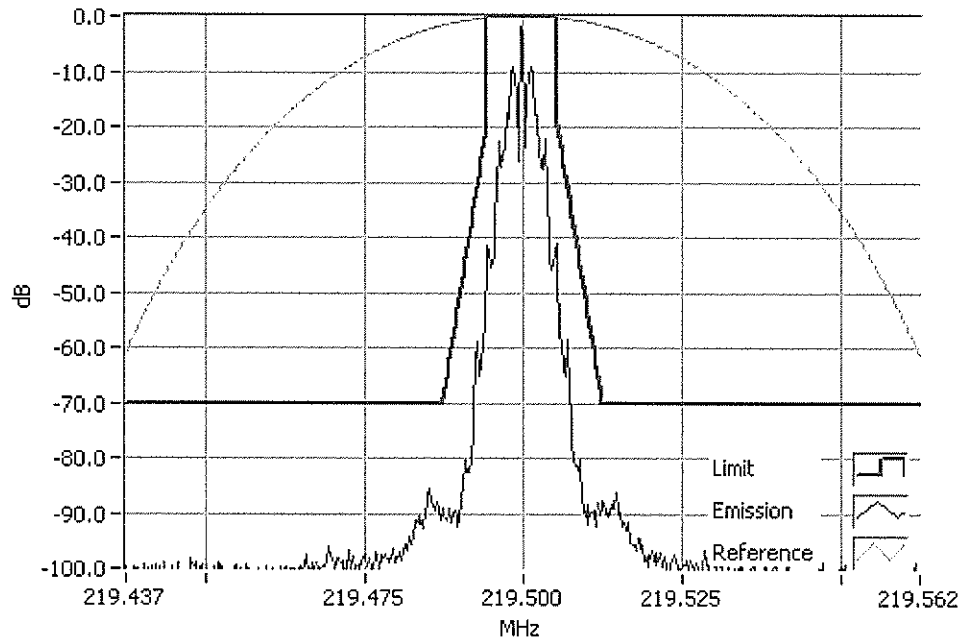
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RSS-119 5.5

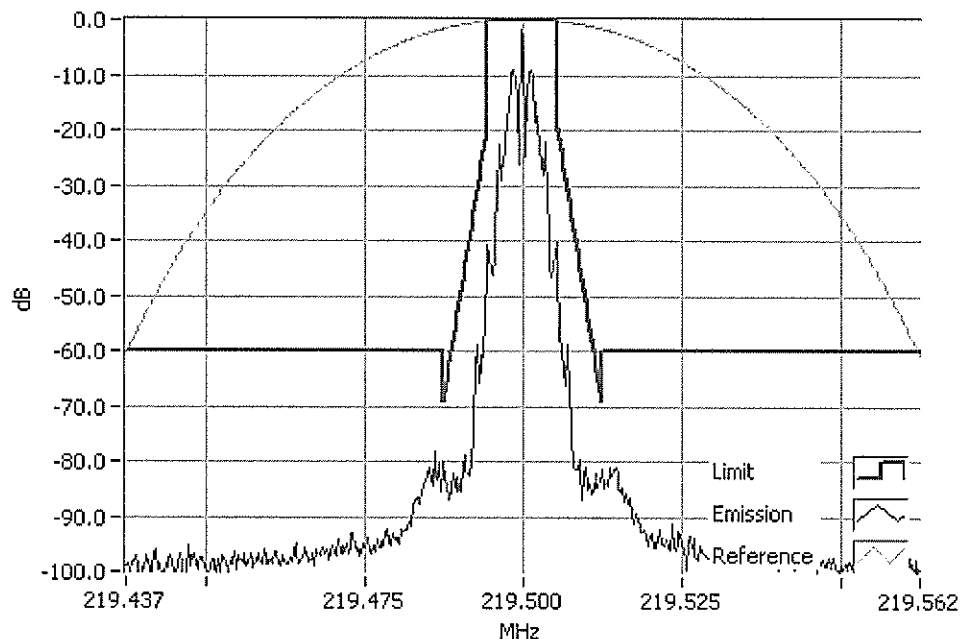
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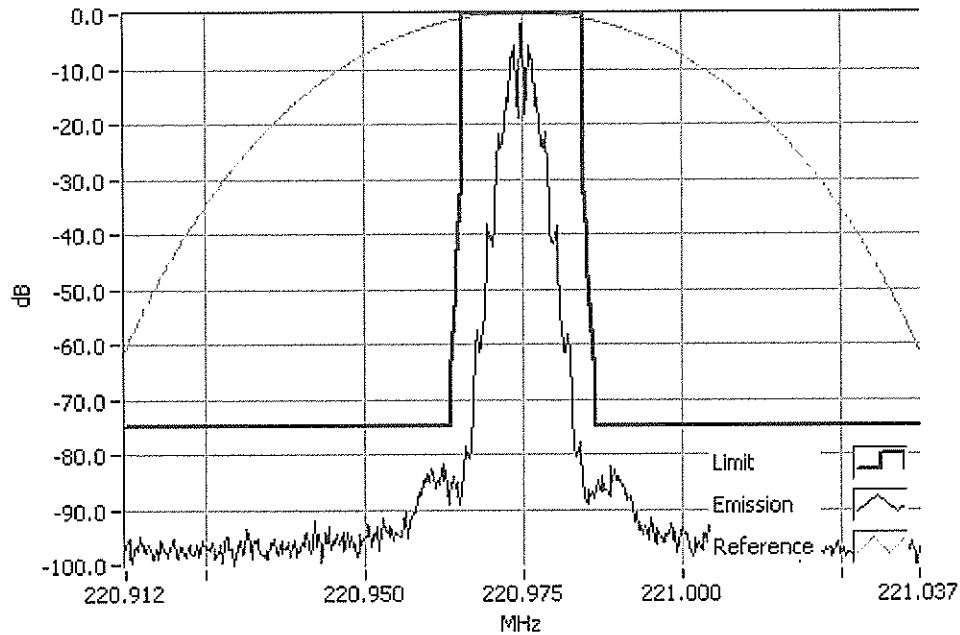
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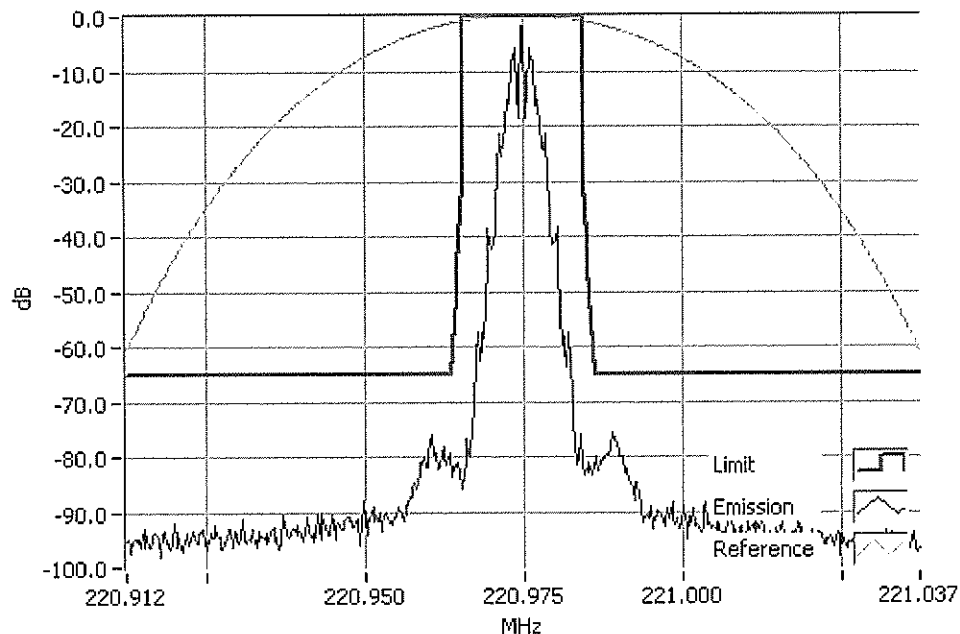
FFSK Modulation

Tx FREQUENCY: 220.975 MHz 100 W 12.5 kHz Channel Spacing



FFSK 1200 220.9750MHz Mask Fx4 100W  
RBW=300Hz, VBW=3000Hz, Detector Mode=Peak  
Result=Pass

Tx FREQUENCY: 220.975 MHz 10 W 12.5 kHz Channel Spacing



FFSK 1200 220.9750MHz Mask Fx4 10W  
RBW=300Hz, VBW=3000Hz, Detector Mode=Peak  
Result=Pass

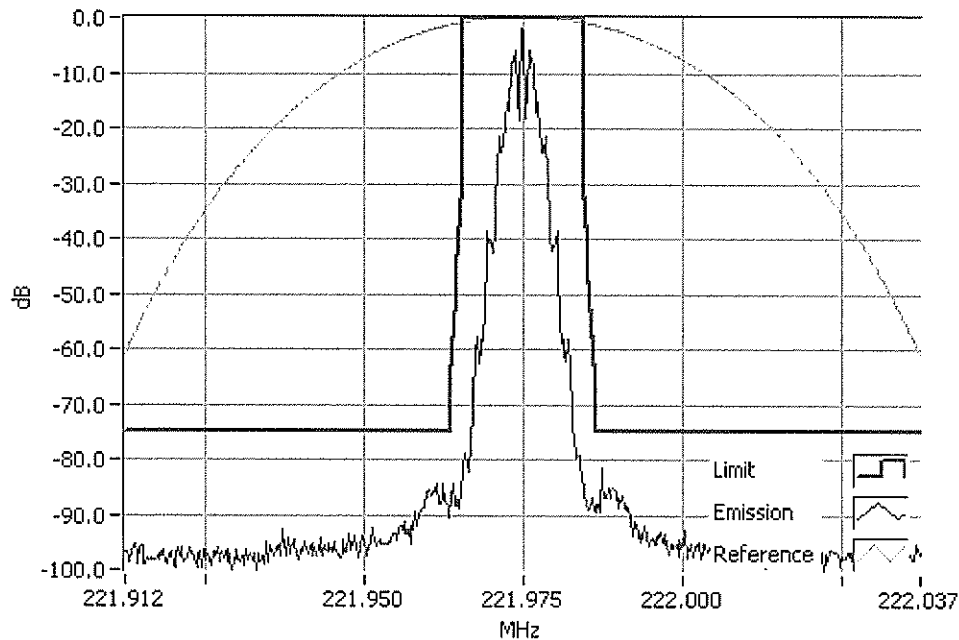
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SPECIFICATION: FCC CFR 2.1049 (c)

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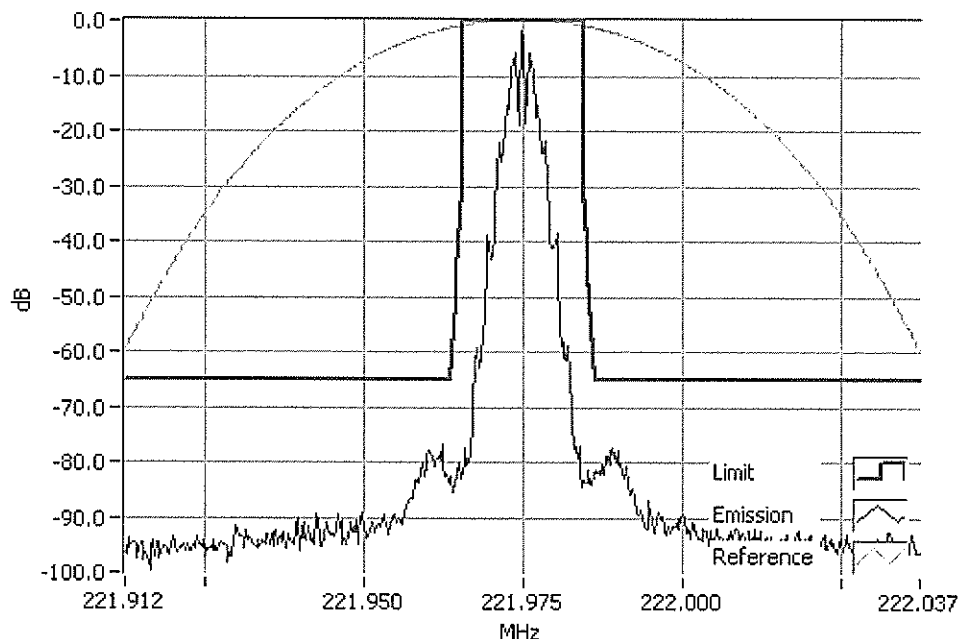
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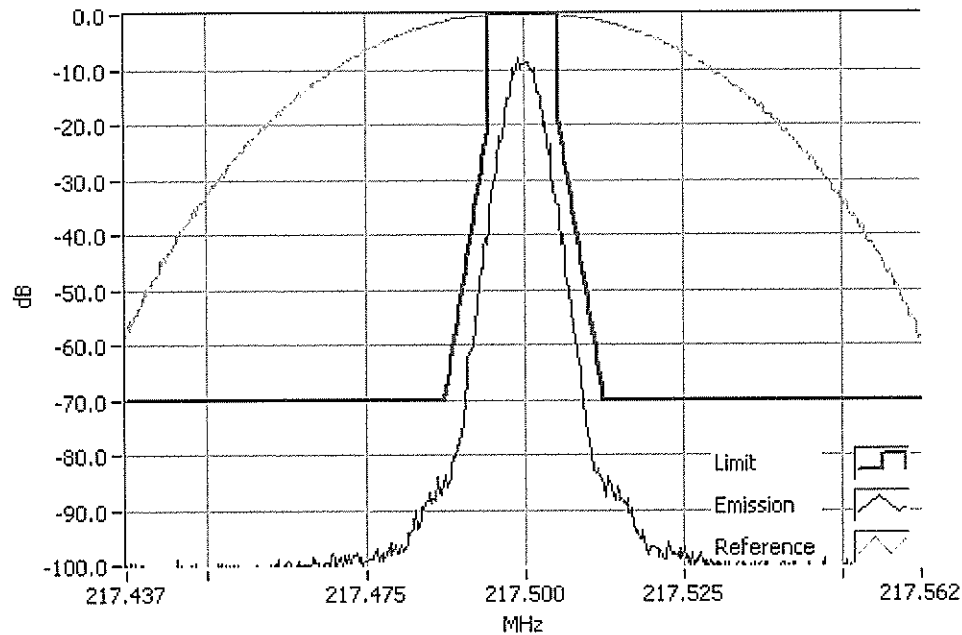
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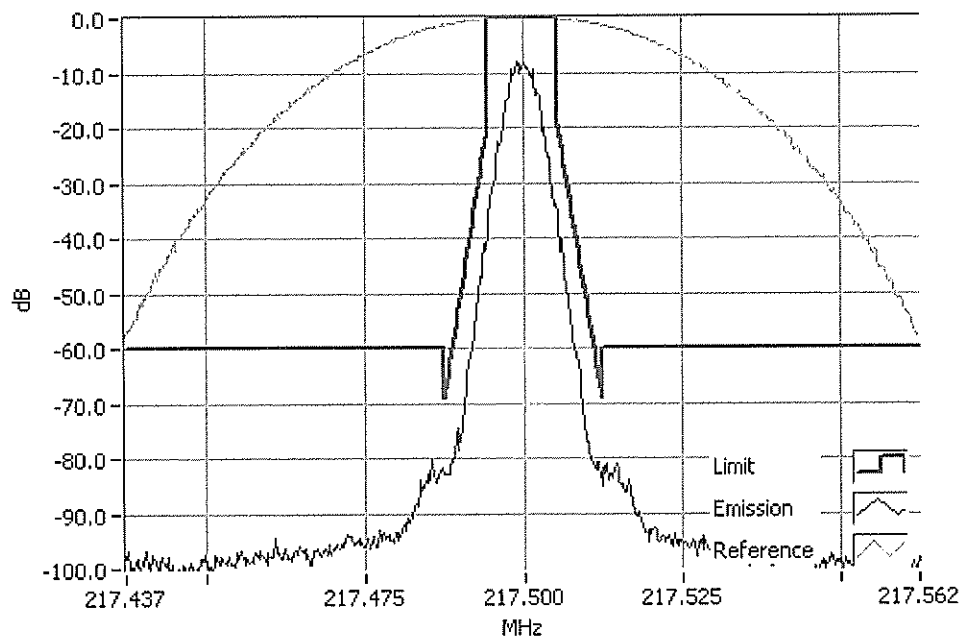
DMR Modulation

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DMR 217.5000MHz Mask D 100W  
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak  
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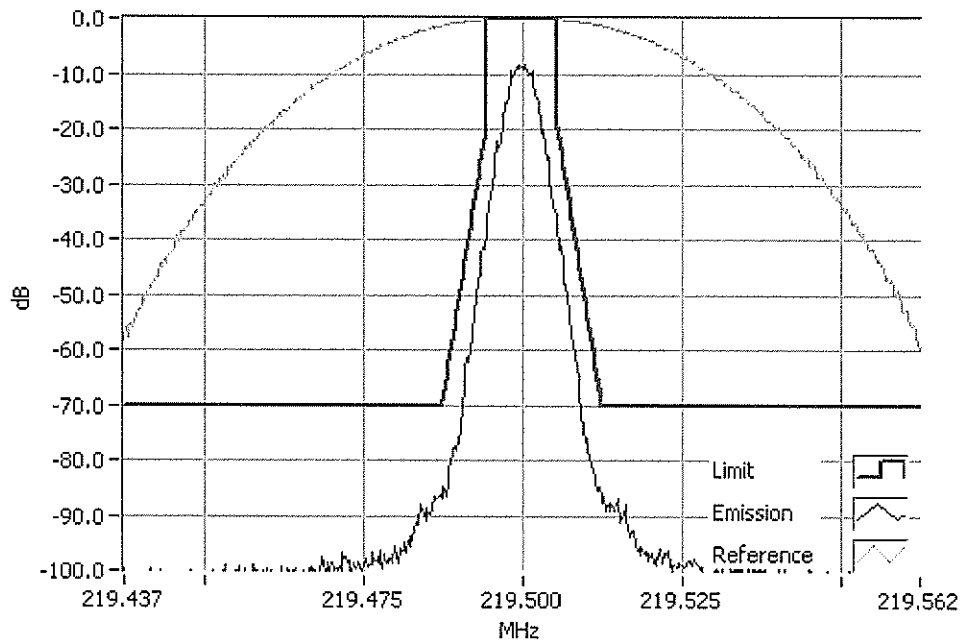
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SPECIFICATION: FCC CFR 2.1049 (c)

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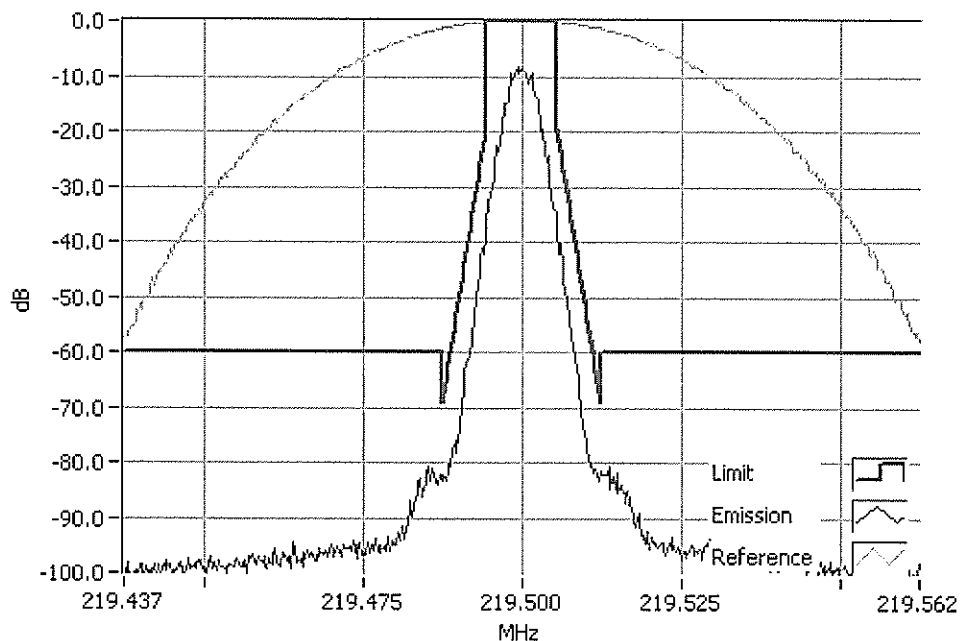
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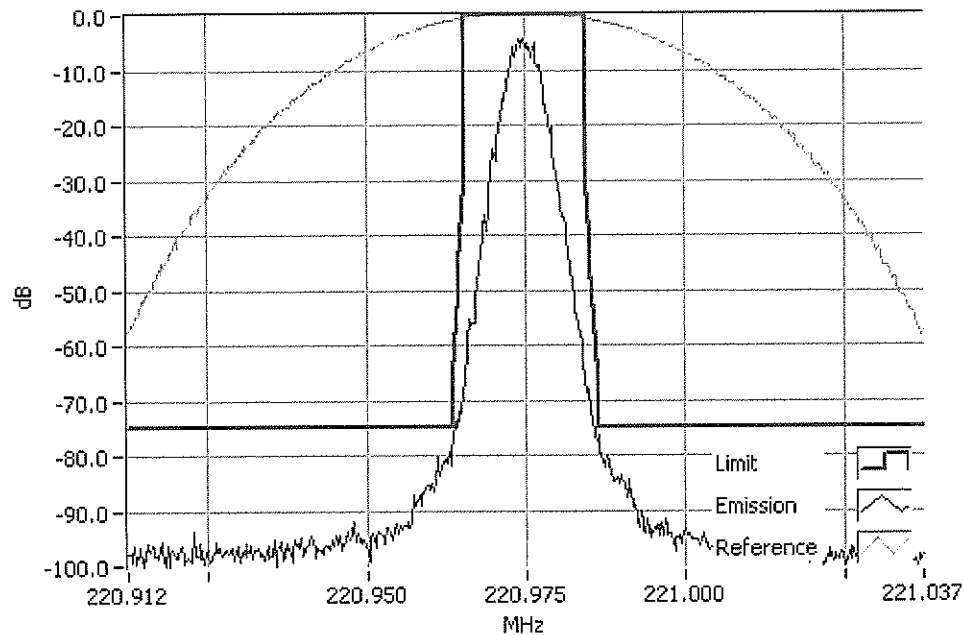
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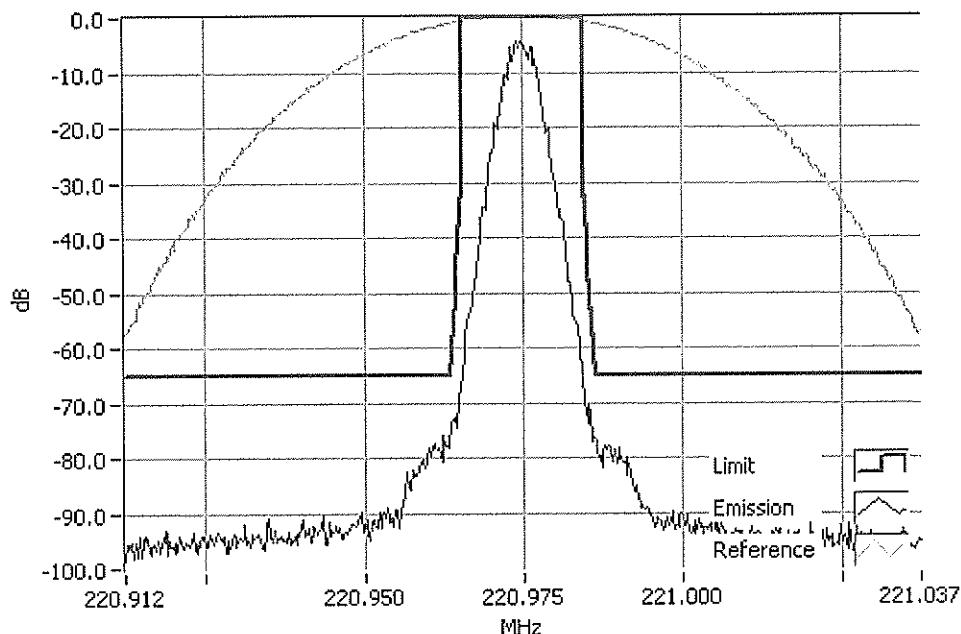
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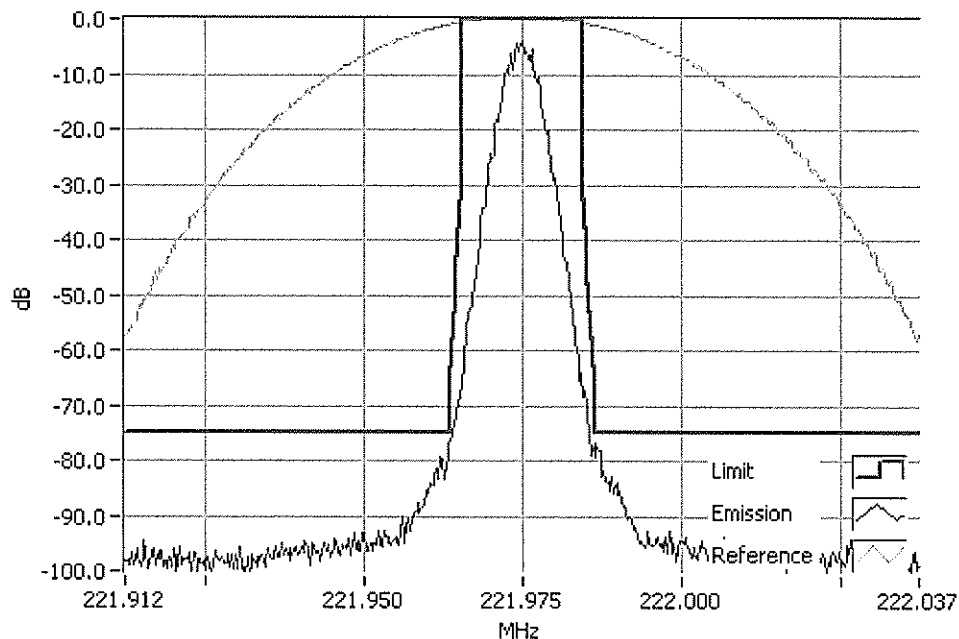
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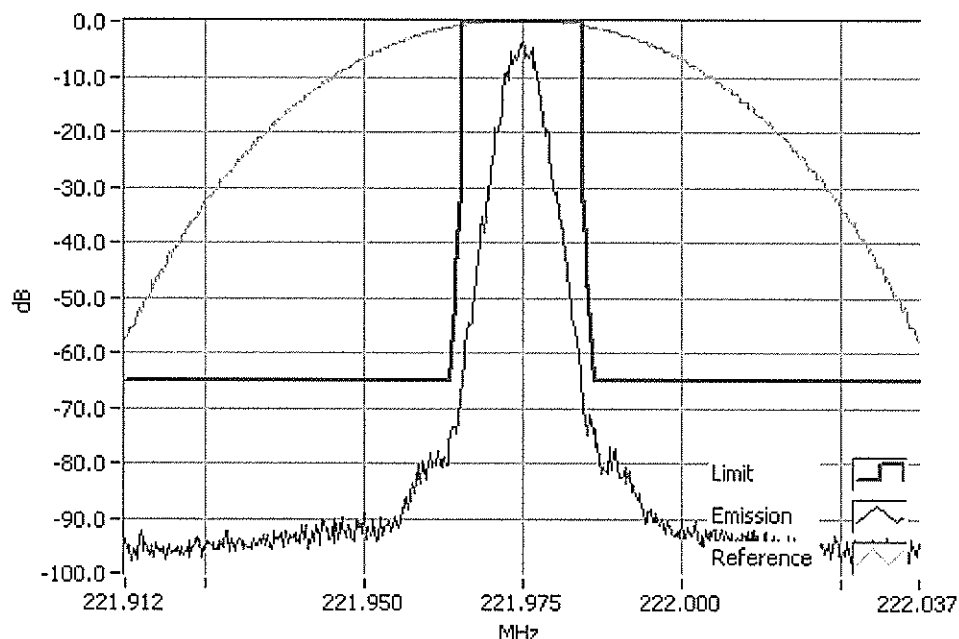
DMR Modulation

Tx FREQUENCY: 221.975 MHz 100 W 12.5 kHz Channel Spacing



DMR 221.9750MHz Mask Fx4 100W  
RBW=300Hz, VBW=3000Hz, Detector Mode=Peak  
Result=Pass

Tx FREQUENCY: 221.975 MHz 10 W 12.5 kHz Channel Spacing



DMR 221.9750MHz Mask Fx4 10W  
RBW=300Hz, VBW=3000Hz, Detector Mode=Peak  
Result=Pass

## TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATIONS: FCC 47 CFR 2.1051

RSS-119 5.8

GUIDE: TIA-102.CAAA-C 2.2.7

### MEASUREMENT PROCEDURE:

1. Refer Annex A for equipment set up.
2. The frequency range examined was from the lowest frequency generated within the EUT, to a frequency higher than the 10<sup>th</sup> Harmonic: 100 kHz to Fc-BW  
Fc+ BW to 10Fc GHz
3. A Pre-scan is performed with a resolution bandwidth of 1 kHz, and a video bandwidth of 3 kHz. If any emissions are found to be within 20 dB of the limit a second measurement is made with the carrier modulated, and a resolution bandwidth of 10 kHz, and a video bandwidth of 30 kHz.

Spurious emissions which were attenuated by more than 20 dB below the limit were not recorded.

A photograph of the test set-up is included below.

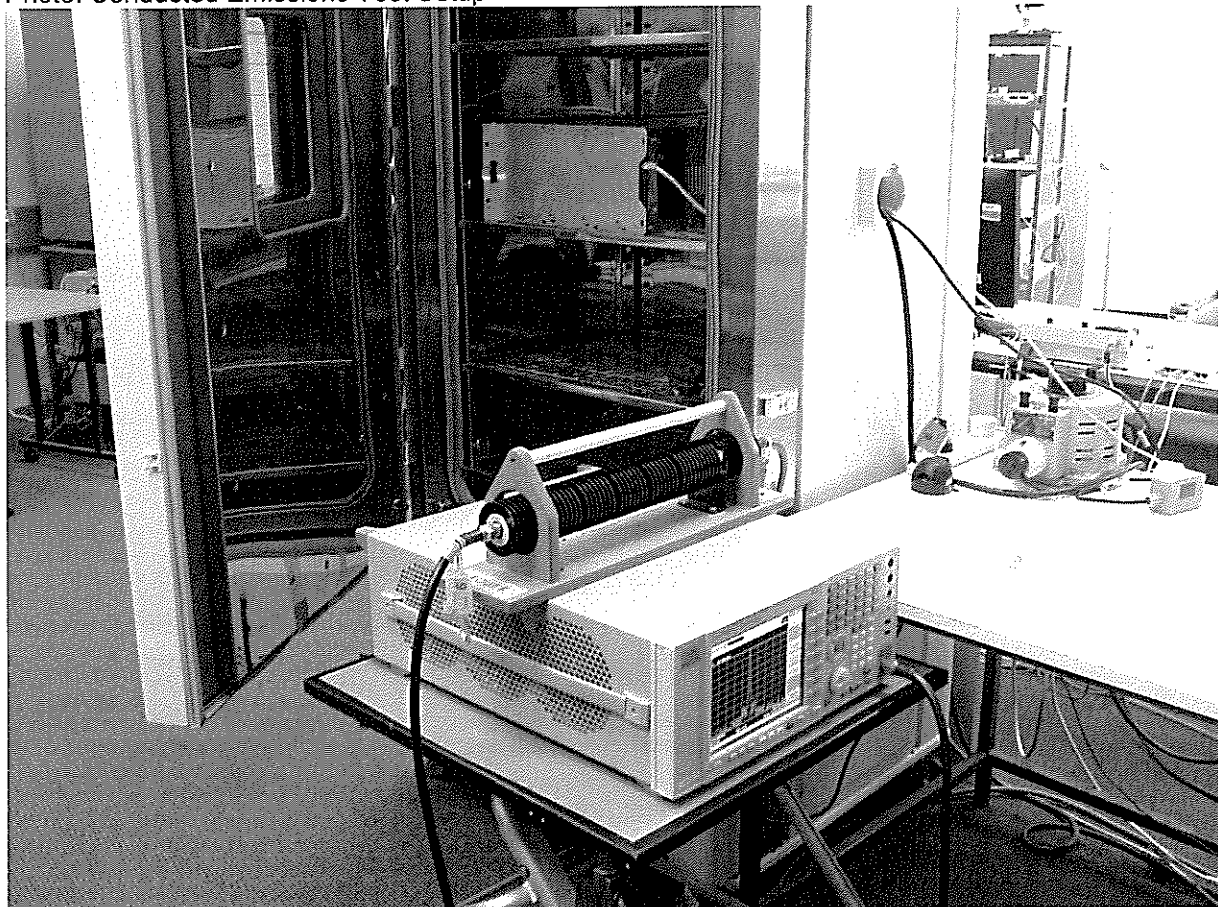
### MEASUREMENT RESULTS:

See the tables and plots on the following pages for 12.5 kHz channel spacing.

LIMIT CLAUSES: FCC 47 CFR 90.210

RSS-119 5.8

Photo: Conducted Emissions Test Setup



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC CFR 2.1051

RSS-119 5.8

Tx FREQUENCY: 217.5 MHz

12.5 kHz Channel Spacing

217.5 MHz @ 100 W

Emission Mask D

| Emission Frequency (MHz) | Level (dBm) | Level (dBc) |
|--------------------------|-------------|-------------|
| ~                        | ~           | ~           |

12.5 kHz Channel Spacing

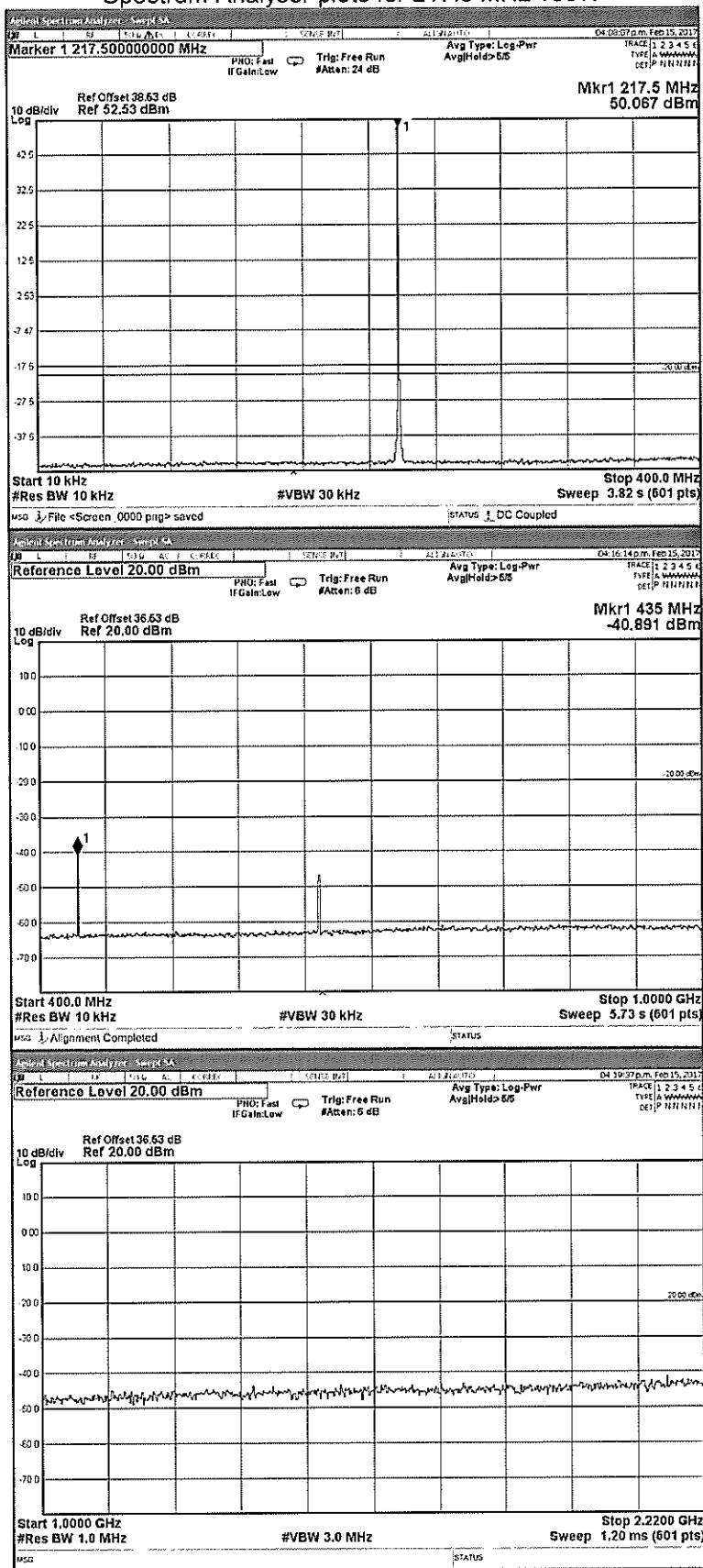
217.5 MHz @ 10 W

Emission Mask D

| Emission Frequency (MHz)                                                  | Level (dBm) | Level (dBc) |
|---------------------------------------------------------------------------|-------------|-------------|
| ~                                                                         | ~           | ~           |
| No emissions were detected at a level greater than 20 dB below the limit. |             |             |

# Spurious Emissions (Tx Conducted)

Spectrum Analyser plots for 217.5 MHz 100W



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC CFR 2.1051

RSS-119 5.8

12.5 kHz Channel Spacing

219.5 MHz @ 100 W

Emission Mask D

| Emission Frequency (MHz) | Level (dBm) | Level (dBc) |
|--------------------------|-------------|-------------|
| ~                        | ~           | ~           |

12.5 kHz Channel Spacing

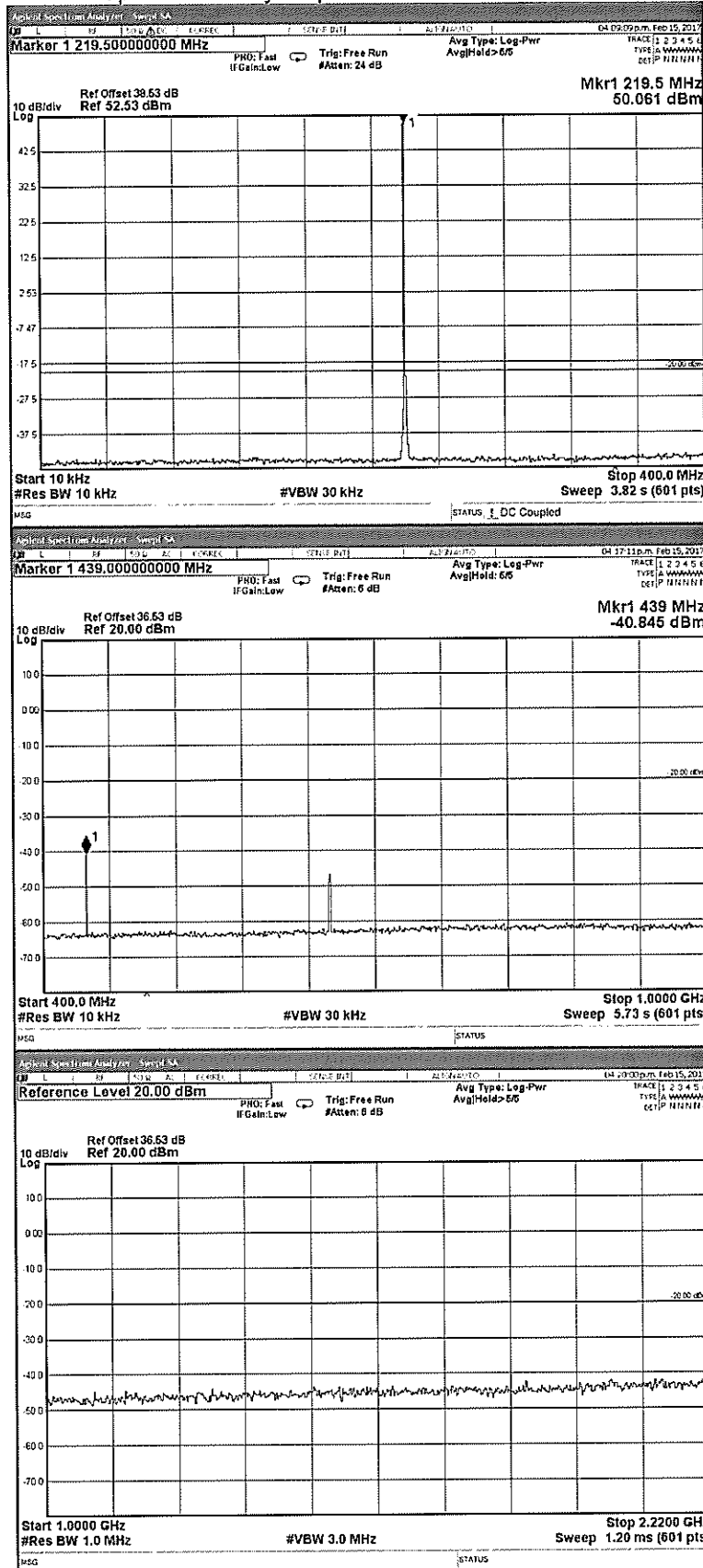
219.5 MHz @ 10 W

Emission Mask D

| Emission Frequency (MHz)                                                  | Level (dBm) | Level (dBc) |
|---------------------------------------------------------------------------|-------------|-------------|
| ~                                                                         | ~           | ~           |
| No emissions were detected at a level greater than 20 dB below the limit. |             |             |

# Spurious Emissions (Tx Conducted)

## Spectrum Analyser plots for 219.5 MHz 100 W



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC CFR 2.1051

RSS-119 5.8

12.5 kHz Channel Spacing

220.975 MHz @ 100 W

Emission Mask Fx4

| Emission Frequency (MHz) | Level (dBm) | Level (dBc) |
|--------------------------|-------------|-------------|
| ~                        | ~           | ~           |

12.5 kHz Channel Spacing

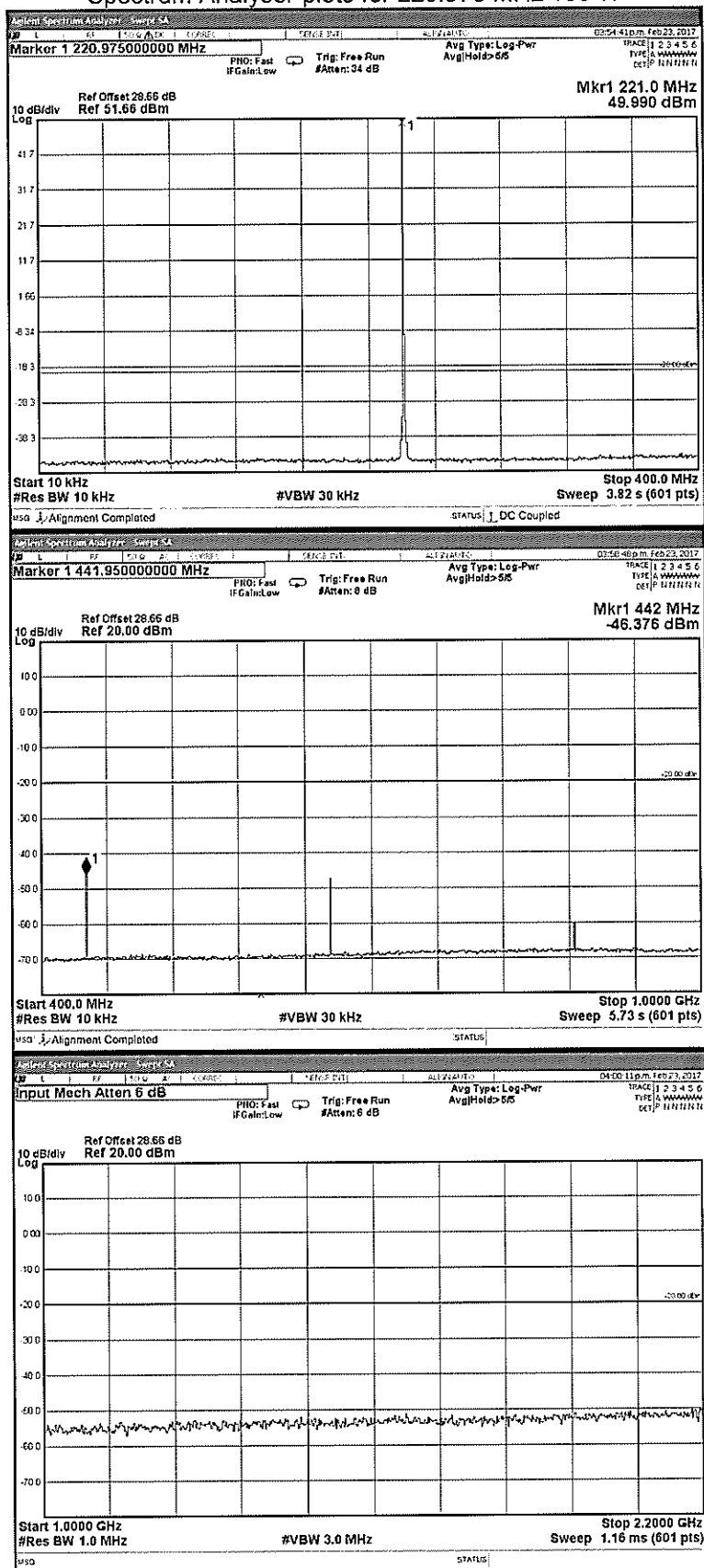
220.975 MHz @ 10 W

Emission Mask Fx4

| Emission Frequency (MHz)                                                  | Level (dBm) | Level (dBc) |
|---------------------------------------------------------------------------|-------------|-------------|
| ~                                                                         | ~           | ~           |
| No emissions were detected at a level greater than 20 dB below the limit. |             |             |

# Spurious Emissions (Tx Conducted)

Spectrum Analyser plots for 220.975 MHz 100 W



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC CFR 2.1051

RSS-119 5.8

12.5 kHz Channel Spacing

221.975 MHz @ 100 W

Emission Mask Fx4

| Emission Frequency (MHz) | Level (dBm) | Level (dBc) |
|--------------------------|-------------|-------------|
| ~                        | ~           | ~           |

12.5 kHz Channel Spacing

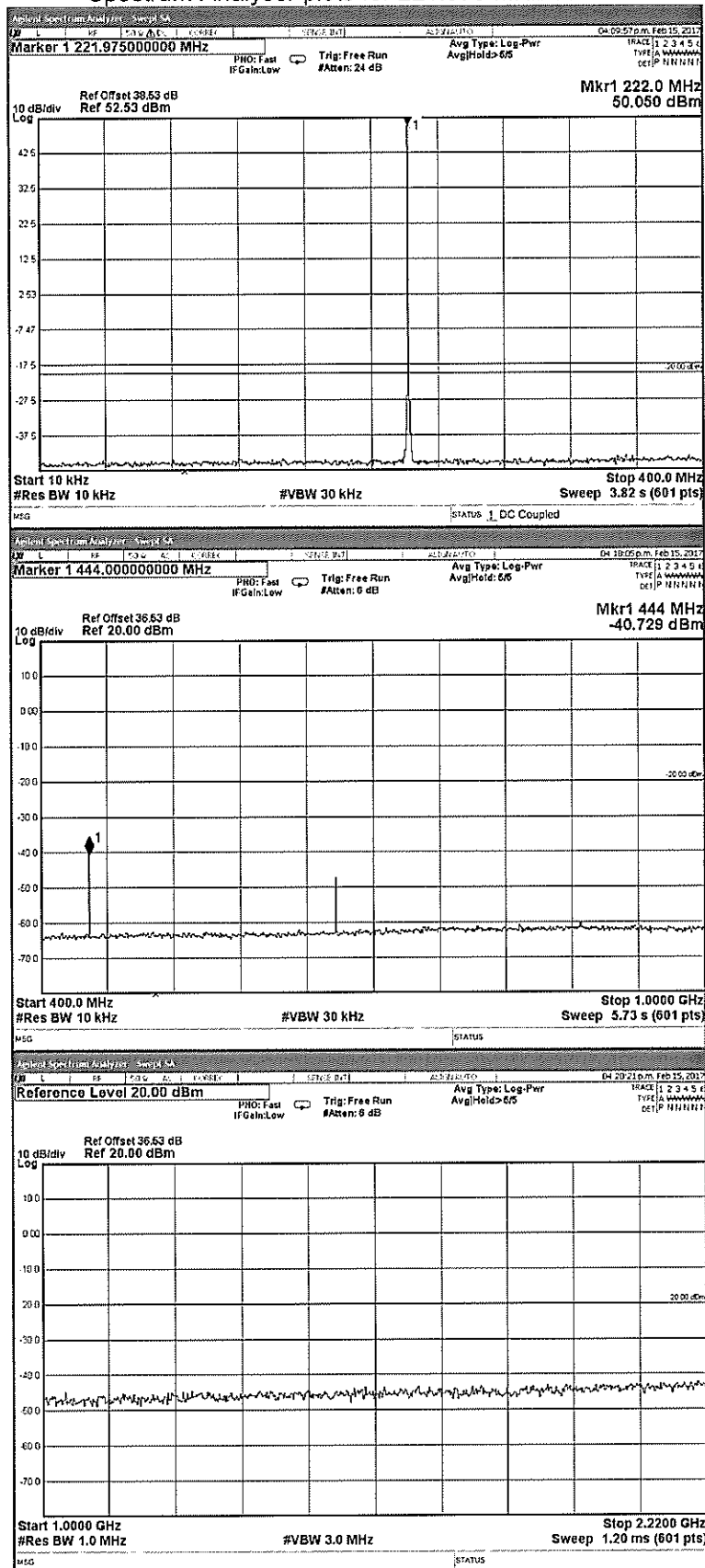
221.975 MHz @ 10 W

Emission Mask Fx4

| Emission Frequency (MHz)                                                  | Level (dBm) | Level (dBc) |
|---------------------------------------------------------------------------|-------------|-------------|
| ~                                                                         | ~           | ~           |
| No emissions were detected at a level greater than 20 dB below the limit. |             |             |

# Spurious Emissions (Tx Conducted)

Spectrum Analyser plots for 221.975 MHz 100 W



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC CFR 2.1051 RSS-119 5.8

LIMITS: FCC 47 CFR 90.210 RSS-119 5.8

| Carrier Output Power | Emission Mask D<br>12.5 kHz Channel Spacing<br>$50 + 10 \log_{10} (P_{\text{Watts}})$ |         |
|----------------------|---------------------------------------------------------------------------------------|---------|
|                      | -20 dBm                                                                               | -70 dBc |
| 100 W                | -20 dBm                                                                               | -70 dBc |
| 10 W                 | -20 dBm                                                                               | -60 dBc |

## TRANSMITTER SPURIOUS EMISSIONS (RADIATED)

SPECIFICATION: FCC 47 CFR 2.1053

GUIDE: TIA-102.CAAA-C 2.2.6

### MEASUREMENT PROCEDURE:

#### Initial Scan:

1. The EUT is placed in the S-Line TEM cell and emissions are measured from 30 MHz to 800 MHz. Any emission within 20 dB of the limit is then re-tested on the OATS.
2. The EUT is placed in the reverberation chamber and emissions are measured from 800 MHz to the upper frequency required. Any emission within 20 dB of the limit is then re-tested on the OATS.
3. The harmonics emissions up to the 6<sup>th</sup> harmonic of the fundamental frequency are measured on the OATS

#### OATS Measurement:

1. The EUT is placed on a wooden turntable at a distance of three metres from the test antenna. The output terminal is connected to an RF dummy load.
2. The test antenna is raised from 1 m to 4 m to obtain a maximum reading; the turntable is then rotated through 360° to obtain the maximum response of each spurious emission. Valid emissions are determined by switching the EUT on and off.
3. The EUT is then replaced by a signal generator and substitution antenna to make measurements by the substitution method.

### MEASUREMENT RESULTS:

See the tables on the following pages

LIMIT CLAUSE: FCC 47 CFR 90.210

## Spurious Emissions (Tx Radiated)

SPECIFICATION: FCC CFR 2.1053

12.5 kHz Channel Spacing      220.975 MHz @ 100 W      Emission Mask Fx4

| Emission Frequency (MHz) | Level (dBm) | Level (dBc) |
|--------------------------|-------------|-------------|
| ~                        | ~           | ~           |
|                          |             |             |

12.5 kHz Channel Spacing      220.975 MHz @ 10 W      Emission Mask Fx4

| Emission Frequency (MHz)                                                  | Level (dBm) | Level (dBc) |
|---------------------------------------------------------------------------|-------------|-------------|
| ~                                                                         | ~           | ~           |
|                                                                           |             |             |
| No emissions were detected at a level greater than 20 dB below the limit. |             |             |

12.5 kHz Channel Spacing      221.975 MHz @ 100 W      Emission Mask Fx4

| Emission Frequency (MHz) | Level (dBm) | Level (dBc) |
|--------------------------|-------------|-------------|
| ~                        | ~           | ~           |
|                          |             |             |

12.5 kHz Channel Spacing      221.975 MHz @ 10 W      Emission Mask Fx4

| Emission Frequency (MHz)                                                  | Level (dBm) | Level (dBc) |
|---------------------------------------------------------------------------|-------------|-------------|
| ~                                                                         | ~           | ~           |
|                                                                           |             |             |
| No emissions were detected at a level greater than 20 dB below the limit. |             |             |

LIMITS: FCC CFR 2.1053

| Carrier Output Power | Emission Mask D & Fx4<br>12.5 kHz Channel Spacing<br>$50 + 10 \log_{10}(P_{\text{watts}})$ |         |
|----------------------|--------------------------------------------------------------------------------------------|---------|
| 100 W                | -20 dBm                                                                                    | -70 dBc |
| 10 W                 | -20 dBm                                                                                    | -60 dBc |

Tx Radiated Emissions - Continued

Open Area Test Site Results:

12.5 kHz Channel Spacing

221.975 MHz @ 100 W

Emission Mask Fx4

| Harmonics<br>Emission Frequency (MHz) | Level (dBm) | Level (dBc) |
|---------------------------------------|-------------|-------------|
| 443.950                               | -76.20      | -126.20     |
| 665.925                               | -68.03      | -118.03     |
| 887.900                               | -70.60      | -120.60     |
| 1109.875                              | -74.33      | -124.33     |
| 1331.850                              | -64.27      | -114.27     |
| 1553.825                              | -73.98      | -123.98     |

Photo: OATS Setup



## TRANSMITTER FREQUENCY STABILITY - TEMPERATURE

SPECIFICATION: FCC 47 CFR 2.1055 (a) (1)

RSS-119 5.3

GUIDE: TIA-102.CAAA-C 2.2.2

### MEASUREMENT PROCEDURE:

1. Refer Annex A for equipment set up.
2. The EUT was tested for frequency error from  $-30^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$  in  $10^{\circ}\text{C}$  increments
3. The frequency error was recorded in parts per million (ppm).

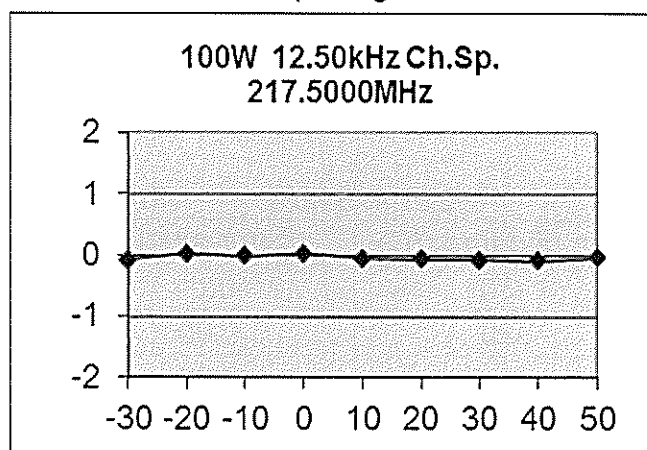
### MEASUREMENT RESULTS:

See the plots on the following pages for 12.5 kHz channel spacing.

217.5 MHz 100 W

| Temperature ( $^{\circ}\text{C}$ ) | Error (ppm) |
|------------------------------------|-------------|
| -30                                | -0.08       |
| -20                                | 0.02        |
| -10                                | -0.02       |
| 0                                  | 0.03        |
| 10                                 | -0.05       |
| 20                                 | -0.07       |
| 30                                 | -0.08       |
| 40                                 | -0.09       |
| 50                                 | -0.04       |

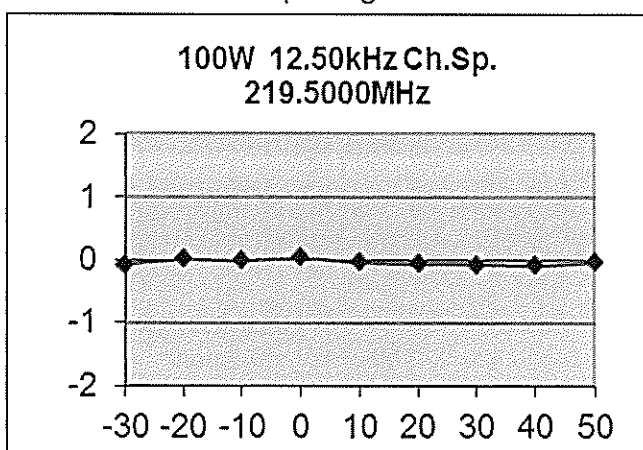
12.5 kHz channel spacing



219.5 MHz 100 W

| Temperature ( $^{\circ}\text{C}$ ) | Error (ppm) |
|------------------------------------|-------------|
| -30                                | -0.08       |
| -20                                | 0.01        |
| -10                                | -0.01       |
| 0                                  | 0.04        |
| 10                                 | -0.04       |
| 20                                 | -0.06       |
| 30                                 | -0.08       |
| 40                                 | -0.09       |
| 50                                 | -0.04       |

12.5 kHz channel spacing

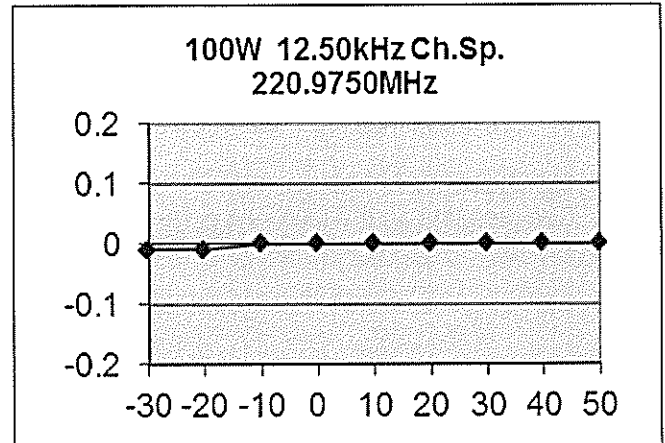


## Transmitter Frequency Stability - Temperature

220.975 MHz 100 W

| Temperature (°C) | Error (ppm) |
|------------------|-------------|
| -30              | -0.01       |
| -20              | -0.01       |
| -10              | 0.00        |
| 0                | 0.00        |
| 10               | 0.00        |
| 20               | 0.00        |
| 30               | 0.00        |
| 40               | 0.00        |
| 50               | 0.00        |

12.5 kHz channel spacing

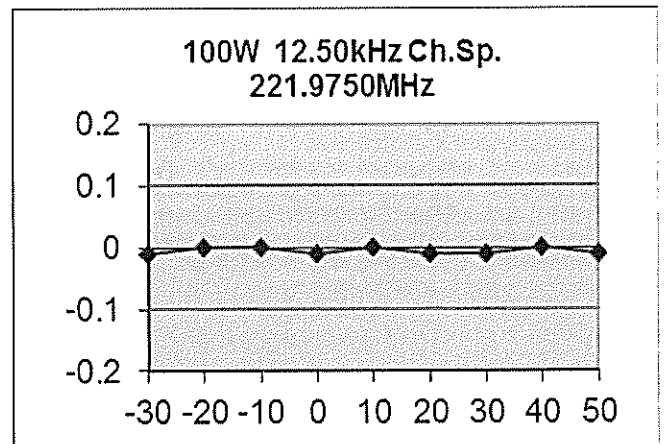


External 10 MHz reference provided to EUT for this test

221.975 MHz 100 W

| Temperature (°C) | Error (ppm) |
|------------------|-------------|
| -30              | -0.01       |
| -20              | 0.00        |
| -10              | 0.00        |
| 0                | -0.01       |
| 10               | 0.00        |
| 20               | -0.01       |
| 30               | -0.01       |
| 40               | 0.00        |
| 50               | -0.01       |

12.5 kHz channel spacing



External 10 MHz reference provided to EUT for this test

LIMIT:

|             |             |
|-------------|-------------|
|             | FCC Part 90 |
| 220-222 MHz | 0.1 ppm     |

|                       |             |
|-----------------------|-------------|
|                       | RSS-119 5.3 |
| 217-218 & 219-220 MHz | 1.0 ppm     |

|             |             |
|-------------|-------------|
|             | RSS-119 5.3 |
| 220-222 MHz | 0.1 ppm     |

## TRANSMITTER FREQUENCY STABILITY - VOLTAGE

SPECIFICATION: FCC 47 CFR 2.1055 (d) (1)

RSS-119 5.3

GUIDE: TIA-102.CAAA-C 2.2.2

### MEASUREMENT PROCEDURE:

1. Refer Annex A for equipment set up.
2. The EUT was tested for frequency error at an input voltage to the radio of 85% to 115%.
3. The frequency error was recorded in parts per million (ppm).

### MEASUREMENT RESULTS:

| Voltage                   | FREQUENCY ERROR (ppm) for 12.5 kHz |           |             |             |
|---------------------------|------------------------------------|-----------|-------------|-------------|
|                           | 217.5 MHz                          | 219.5 MHz | 220.975 MHz | 221.975 MHz |
| 120 V <sub>AC</sub>       | -0.11                              | -0.07     | -0.08       | -0.05       |
| 102 V <sub>AC</sub>       | -0.13                              | -0.06     | -0.07       | -0.05       |
| 138 V <sub>AC</sub>       | -0.13                              | -0.06     | -0.07       | -0.05       |
| Maximum Freq. Error (ppm) | -0.13                              | -0.07     | -0.08       | -0.05       |

### LIMIT:

|             |             |                       |             |
|-------------|-------------|-----------------------|-------------|
|             |             |                       | RSS-119 5.3 |
|             |             | 217-218 & 219-220 MHz | 1.0 ppm     |
|             | FCC Part 90 |                       |             |
| 220-222 MHz | 0.1 ppm     |                       |             |
|             |             |                       | RSS-119 5.3 |
|             |             | 220-222 MHz           | 0.1 ppm     |

## RECEIVER SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATION: RSS-119 5.11

GUIDE: TIA-102.CAAA-C 2.1.2

### MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up diagram.
2. The frequency range examined was from 30 MHz to 3 times the highest tunable frequency.
3. Spurious emissions which were attenuated more than 20 dB below the limit were not recorded.

| 217.5 MHz Receive (Receiver Input Port)           |            |             |
|---------------------------------------------------|------------|-------------|
| Emission Frequency (MHz)                          | Level (nW) | Level (dBm) |
| ~                                                 | ~          | ~           |
| No emissions were detected within 20 dB of Limit. |            |             |

| 219.5 MHz Receive (Receiver Input Port)           |            |             |
|---------------------------------------------------|------------|-------------|
| Emission Frequency (MHz)                          | Level (nW) | Level (dBm) |
| ~                                                 | ~          | ~           |
| No emissions were detected within 20 dB of Limit. |            |             |

| 220.975 MHz Receive (Receiver Input Port)         |            |             |
|---------------------------------------------------|------------|-------------|
| Emission Frequency (MHz)                          | Level (nW) | Level (dBm) |
| ~                                                 | ~          | ~           |
| No emissions were detected within 20 dB of Limit. |            |             |

| 221.975 MHz Receive (Receiver Input Port)         |            |             |
|---------------------------------------------------|------------|-------------|
| Emission Frequency (MHz)                          | Level (nW) | Level (dBm) |
| ~                                                 | ~          | ~           |
| No emissions were detected within 20 dB of Limit. |            |             |

LIMIT CLAUSE: RSS-Gen 6(b)

| LIMIT | 30 → 1000 MHz | 2 nW | - 57 dBm |
|-------|---------------|------|----------|
|       | > 1000 MHz    | 5 nW | - 53 dBm |

## TRANSMITTER STANDBY SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATION: RSS-119 5.11

GUIDE: TIA-102.CAAA-C 2.1.2

### MEASUREMENT PROCEDURE:

4. Refer Annex A for Equipment set up diagram.
5. The frequency range examined was from 30 MHz to 3 times highest tunable frequency.
6. Spurious emissions which were attenuated more than 20 dB below the limit were not recorded.

| 217.5 MHz Transmitter Standby (Transmitter RF Output Port) |            |             |
|------------------------------------------------------------|------------|-------------|
| Emission Frequency (MHz)                                   | Level (nW) | Level (dBm) |
| ~                                                          | ~          | ~           |
| No emissions were detected within 20 dB of Limit.          |            |             |

| 219.5 MHz Transmitter Standby (Transmitter RF Output Port) |            |             |
|------------------------------------------------------------|------------|-------------|
| Emission Frequency (MHz)                                   | Level (nW) | Level (dBm) |
| ~                                                          | ~          | ~           |
| No emissions were detected within 20 dB of Limit.          |            |             |

| 220.975 MHz Transmitter Standby (Transmitter RF Output Port) |            |             |
|--------------------------------------------------------------|------------|-------------|
| Emission Frequency (MHz)                                     | Level (nW) | Level (dBm) |
| ~                                                            | ~          | ~           |
| No emissions were detected within 20 dB of Limit.            |            |             |

| 221.975 MHz Transmitter Standby (Transmitter RF Output Port) |            |             |
|--------------------------------------------------------------|------------|-------------|
| Emission Frequency (MHz)                                     | Level (nW) | Level (dBm) |
| ~                                                            | ~          | ~           |
| No emissions were detected within 20 dB of Limit.            |            |             |

LIMIT CLAUSE: RSS-Gen 6(b)

| LIMIT | 30 → 1000 MHz | 2 nW | - 57 dBm |
|-------|---------------|------|----------|
|       | > 1000 MHz    | 5 nW | - 53 dBm |

## TEST EQUIPMENT LIST

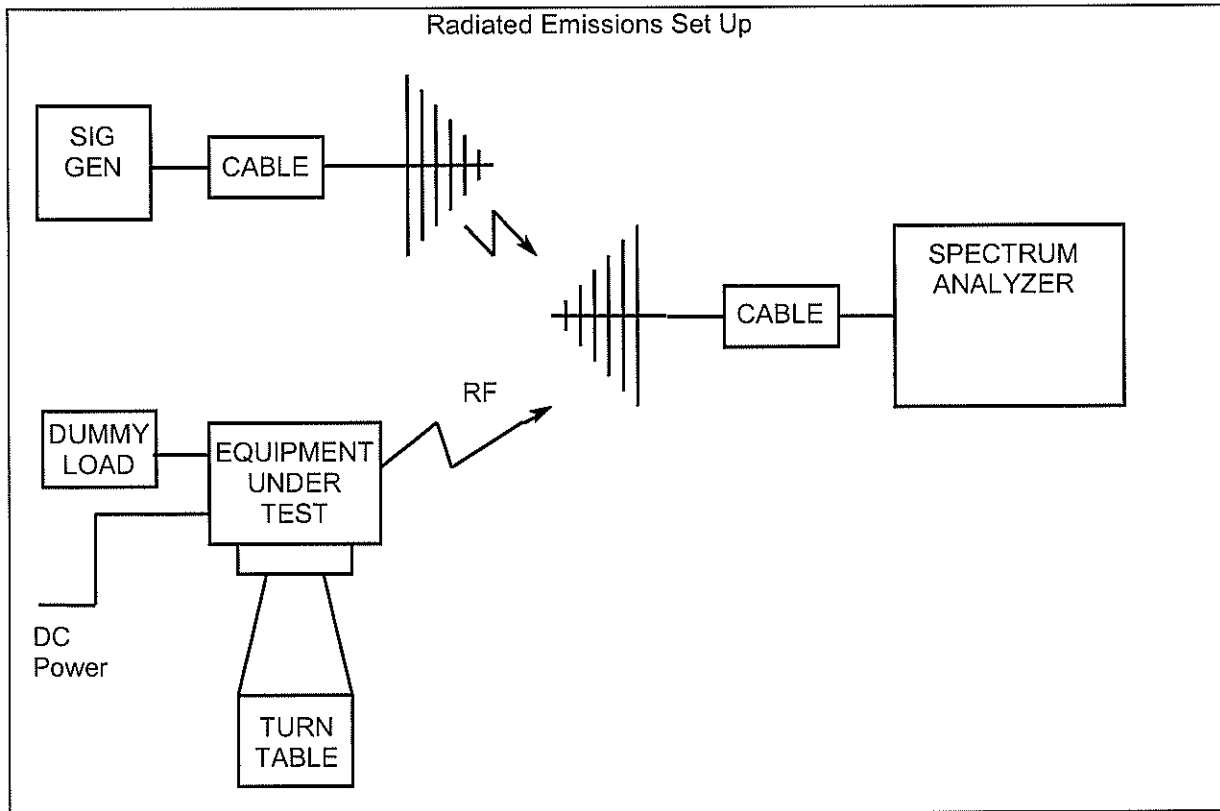
| Equipment Type      | Information                  | Manufacturer    | Model No               | Serial No#    | Tait ID | Cal Due   |
|---------------------|------------------------------|-----------------|------------------------|---------------|---------|-----------|
| AC Voltmeter        |                              | Tait            |                        | 1             |         | 8-Sep-17  |
| Antenna             | Reference Dipoles            | Emco            | 3121C DB1              | 9510-1164     | E3559   | 14-Apr-19 |
| Antenna             | 18GHz DRG                    | Emco            | DRG3115                | 9512-4638     | E3560   | 29-Apr-19 |
| Antenna             | Log Periodic                 | Schwarzbeck     | VUSLP                  | 9111-219      | E4617   |           |
| Antenna             | Reverb - 1-18GHz DRG         | Schwarzbeck     | BBHA 9120 D            | 9120D-885     | E4857   |           |
| Antenna             | Reverb - 1-18GHz DRG         | Schwarzbeck     | BBHA 9120 D            | 9120D-884     | E4858   |           |
| Audio Analyser      | TREVA1                       | Hewlett Packard | HP8903A                | 2437A04625    | E4986   | 13-Oct-17 |
| Audio Analyser      | TREVA2                       | Hewlett Packard | HP8903B                | 2818A04275    | E3710   | 11-Oct-17 |
| Coax Cable          | 2m Black                     | Suhner          | RG214HF/Nm/<br>Nm/2000 | TeltestBlack2 | E4623   | 1-Dec-17  |
| Coax Cable          | 2m Black                     | Suhner          | RG214HF/Nm/<br>Nm/2000 | TeltestBlack3 | E4624   | 28-Nov-17 |
| Coax Cable          | OATS Turntable Cable 1       | Intelcom        | RG214                  | OATS1         | E4621   | 8-Dec-17  |
| Coax Cable          | OATS Tower Cable             | Intelcom        | RG214                  | OATS2         | E4622   | 8-Dec-17  |
| Coax Cable          | 2m Black                     | Suhner          | RG214HF/Nm/<br>Nm/2000 | TeltestBlack5 | E4850   | 28-Nov-17 |
| Coax Cable          | 2m Black                     | Suhner          | RG214HF/Nm/<br>Nm/2000 | TeltestBlack6 | E4849   | 28-Nov-17 |
| Coax Cable          | Reverb - 4.5m Multiflex 141  | TeltestBlue6    | MF 141                 | TeltestBlue6  | E4843   | 6-Dec-17  |
| Coax Cable          | Reverb - 2m Multiflex 141    | TeltestBlue4    | MF 141                 | TeltestBlue4  | E4845   | 6-Dec-17  |
| Coax Cable          | Reverb - 1m Multiflex 141    | TeltestBlue3    | MF 141                 | TeltestBlue3  | E4846   | 6-Dec-17  |
| Coax Cable          | Reverb - 1m Multiflex 141    | TeltestBlue2    | MF 141                 | TeltestBlue2  | E4847   | 6-Dec-17  |
| Coax Cable          | OATS Turntable Cable 2       | Intelcom        | RG215                  | OATS3         | E4995   | 2-Dec-17  |
| Coax Cable          | 2m Black                     | Suhner          | RG214HF/Nm/<br>Nm/2000 | TeltestBlack7 | E5004   | 6-Dec-17  |
| Coax Cable          | 2m Black                     | Suhner          | RG214HF/Nm/<br>Nm/2000 | TeltestBlack8 | E5005   | 6-Dec-17  |
| Environ. Chamber    | Upright                      | Contherm        | 5400 RHSLT.M           | 1416          | E4051   | 1-Aug-17  |
| Environ. Chamber    | Chest                        | Contherm        | Chest                  | E3397         | E3397   | 12-Dec-17 |
| Modulation Analyser | TREVA1                       | Hewlett Packard | HP8901B<br>(Opt 002)   | 2441A00393    | E3073   | 14-Oct-17 |
| Modulation Analyser | TREVA2                       | Hewlett Packard | HP8901B<br>(Opt 002)   | 3704A05837    | E3786   | 11-Oct-17 |
| Multimeter          |                              | Fluke           | 77                     | 35069359      | E3237   | 10-Oct-17 |
| OATS                | NSA                          | Tait            |                        |               |         | 20-Apr-17 |
| OATS                | Antenna Tower                | Electrometrics  | EM-4720-2              | 112           | E4447   |           |
| OATS                | Controller                   | Electrometrics  | EM-4700                | 119           | E4445   |           |
| OATS                | Turntable                    | Electrometrics  | EM-4704A               | 105           | E4446   |           |
| OATS                | FCC Listing Registration     |                 |                        | 837095        |         | 8-May-19  |
| Power Meter         | TREVA1 Power Head for HP8901 | Hewlett Packard | HP11722A               | 3111A05573    | E7054   | 13-Oct-17 |
| Power Meter         | TREVA2 Power Head for HP8901 | Hewlett Packard | HP11722A               | 2716A02037    | 1575    | 11-Oct-17 |
| Power Supply        | AC Variac                    | Yamabishi       | S-260-5                | TX-533        | E1737   |           |
| RF Amplifier        | +21.7 dB 1GHz                | Tait            | ZFL-1000LN             | E3660         | E3360   |           |
| RF Amplifier        | Pre-amplifier                | Agilent         | 87405C                 | MY47010688    | E4941   | 15-Oct-17 |
| RF Attenuator       | 10dB 50W                     | Weinschel       | 24-10-34               | AZ0401        | E3388   | 2-Dec-17  |

TELTEST Laboratories  
Tait Ltd  
Report Number 3812b

| <i>Equipment Type</i>      | <i>Information</i>                             | <i>Manufacturer</i> | <i>Model No</i>    | <i>Serial No#</i> | <i>Tait ID</i> | <i>Cal Due</i> |
|----------------------------|------------------------------------------------|---------------------|--------------------|-------------------|----------------|----------------|
| RF Attenuator              | 30dB 350W                                      | Weinschel           | 67-30-33           | BR0531            | E4280          | 28-Nov-17      |
| RF Attenuator              | 10dB 50W                                       | Weinschel           | 24-10-34           | BC3293            | E4364          | 28-Nov-17      |
| RF Attenuator              | TREVA1 3dB                                     | Weinschel           | Model 1            | BL9958            | E4081          | 30-Nov-17      |
| RF Attenuator              | TREVA2 3dB                                     | Weinschel           | Model 1            | BL9950            | E4080          | 28-Nov-17      |
| RF Attenuator              | TREVA 1 20dB 150W                              | Weinschel           | 40-20-23           | MF817             | E4082          | 28-Nov-17      |
| RF Attenuator              | TREVA2 20dB 150W                               | Weinschel           | 40-20-33           | CJ405             | E3733          | 28-Nov-17      |
| RF Chamber                 | S-LINE TEM CELL                                | Rohde & Schwarz     | 1089.9296.02       | 338232/003        | E3636          |                |
| RF Chamber                 | Reverb - Stirrer controller for reverb chamber | Teseq               | Stirrer Controller | 29765.1           | E4854          |                |
| RF Chamber                 | Reverb - 0.5 - 18GHz Reverberation Chamber     | Teseq               | RVC XS             | 29765             | E4855          |                |
| RF Combiner                | TREVA1                                         | Minicircuits        | ZFSC-4-1           | -                 | E4083          |                |
| RF Combiner                | TREVA2                                         | Minicircuits        | ZFSC-4-1           | -                 | E4084          |                |
| RF Load                    | 150W                                           | Bird                | 8166               | 524               | E3625          | 29-Nov-17      |
| Signal Generator           | Analog 4GHz                                    | Agilent             | E4422B             | GB40050320        | E3788          | 15-Oct-17      |
| Signal Generator           | TREVA1 Analog 3.2GHz                           | Agilent             | E8663D             | MY50420224        | E4908          | 20-Oct-18      |
| Signal Generator           | TREVA2 Analog 3.3GHz                           | Rohde & Schwarz     | SML03 1090.3000.13 | 100597            | E4050          | 13-Oct-17      |
| Signal Generator           | Digital 4GHz                                   | Agilent             | E4437B             | US39260389        | E4764          | 19-Aug-17      |
| Spectrum Analyser          | 26.5GHz                                        | Agilent             | PXA N9030A         | MY49432161        | E4907          | 18-Oct-18      |
| Spectrum Analyser          | 13.2GHz                                        | Hewlett Packard     | HP8562E            | 3821A00779        | E3715          | 13-Oct-17      |
| Spectrum Analyser          | 13.2GHz                                        | Agilent             | E4445A             | MY42510072        | E4139          | 15-Oct-18      |
| Temp & Humidity datalogger |                                                | Hobo                | U21-011            | 10134275          | E4980          | 4-Dec-17       |

NOTE: Items without calibration dates are calibrated immediately before use, or set using calibrated instruments.

## ANNEX A – TEST SETUP DETAILS



All other testing is performed using the Teltest Radio **EVAL**uation system (TREVA), which is configured as shown below. The Spectrum Analyser is connected to the EUT via the attenuator network for Conducted Emissions testing, and Occupied Bandwidth.

