

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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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_{AC}

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	11K0F3E
D = 2.5 kHz	F3E represents an FM voice transmission
$B_n = (2 \times 3.0) + (2 \times 2.5) \times 1$ = 11.0 kHz	

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

Necessary bandwidth	Emission Designator
M = 1.8 kHz	7K60F2D
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 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 = 7.6 kHz	Emission Designator 7K60FXW FXW represents FM combination of data and telephony.
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Digital Data 12.5 kHz Channel Spacing – 7K60FXD

99% bandwidth = 7.6 kHz	Emission Designator 7K60FXD FXD represents FM data only
----------------------------	--

TEST RESULTS

TRANSMITTER OUTPUT POWER (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1046
RSS-119 5.4

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 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 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 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.

RSS-119 5.4

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.

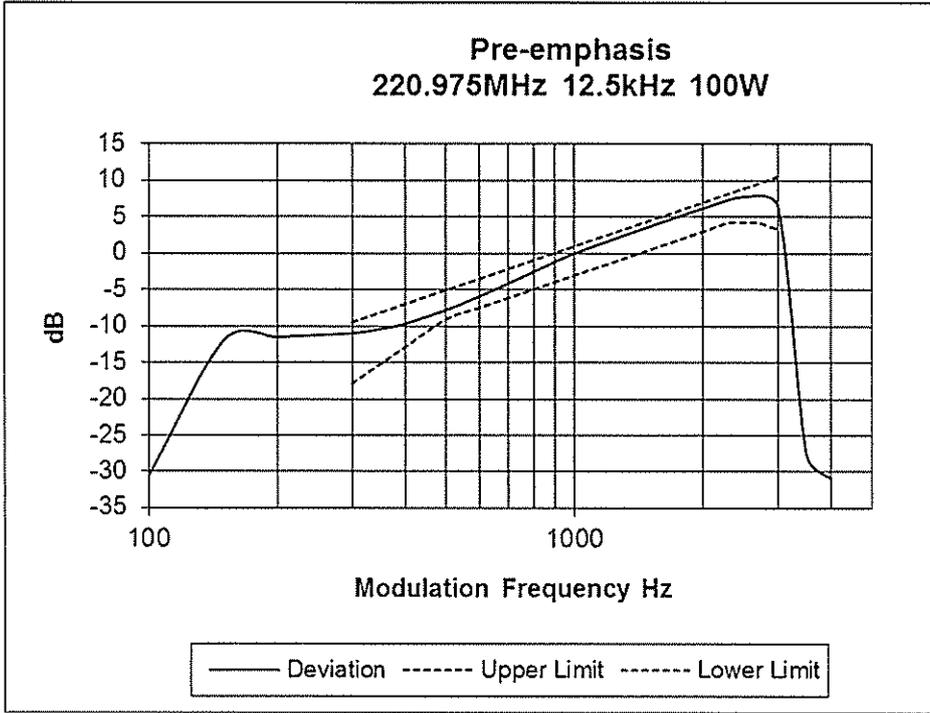
LIMIT CLAUSE: TIA/EIA-603E 3.2.6

Transmitter Audio Frequency Response – Pre-emphasis

SPECIFICATION: FCC CFR 2.1047 (a)

Tx FREQUENCY: 220.975 MHz

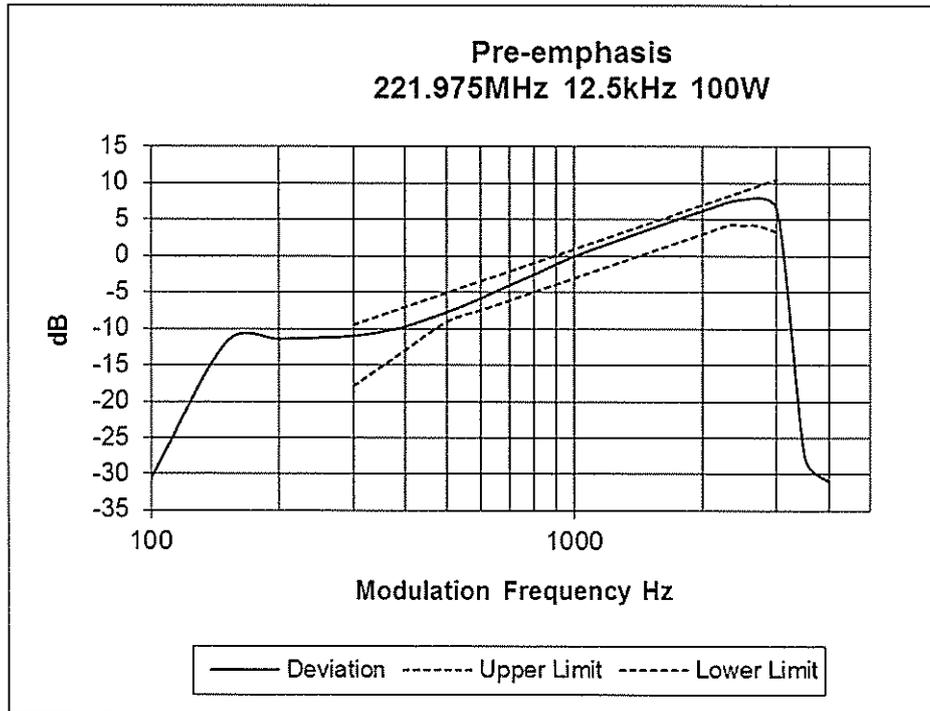
12.5 kHz Channel Spacing



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:

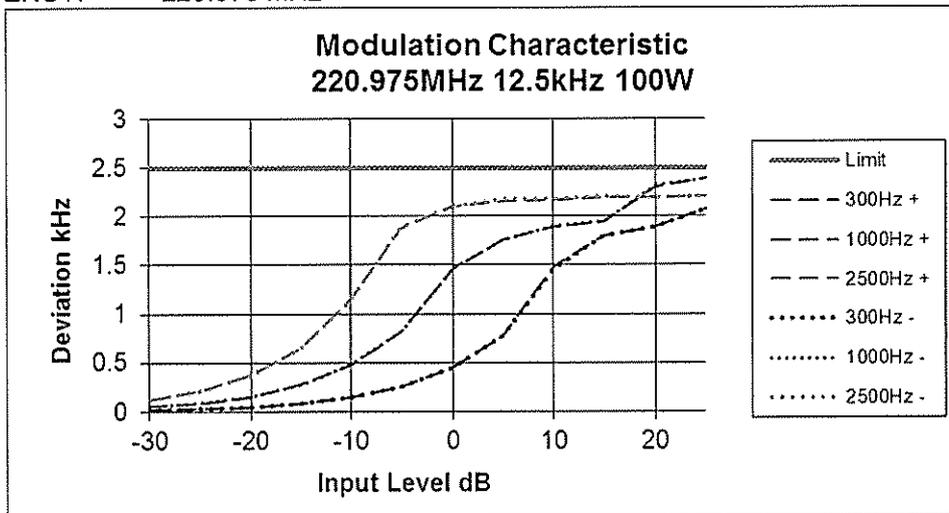
1. Refer Annex A for Equipment set up.
2. The modulation response was measured at three audio frequencies while varying the input level.
3. Measurements were made for both Positive and Negative Deviation.

MEASUREMENT RESULTS:

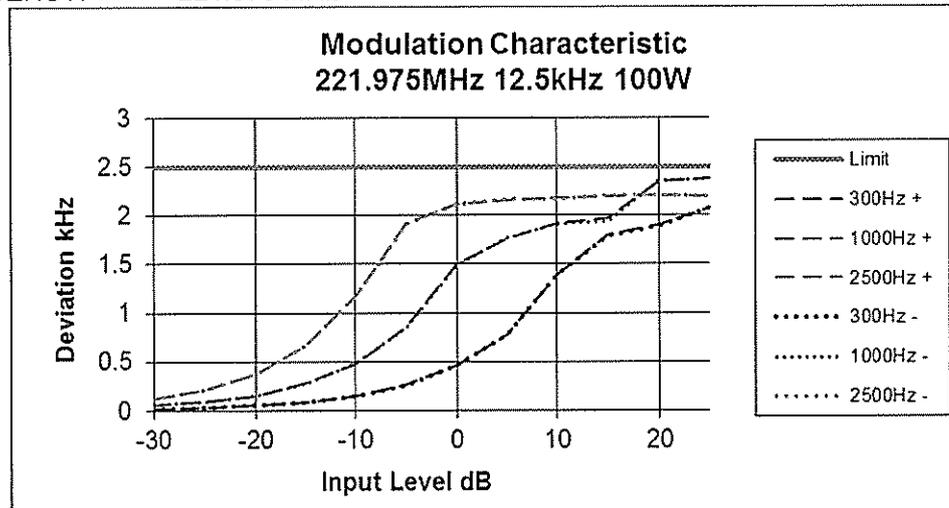
See the plots on the following pages for 12.5 kHz channel spacing.

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) RSS-119 5.5

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 (4 contiguous channels)	F (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 & RSS-119 5.5	F (4 contiguous channels)	F (4 contiguous channels)

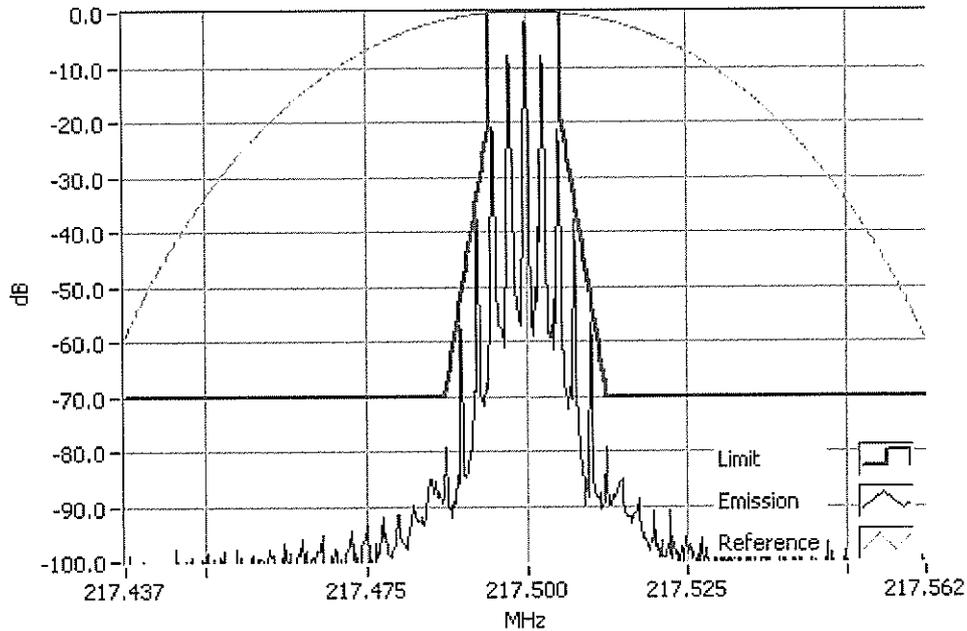
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

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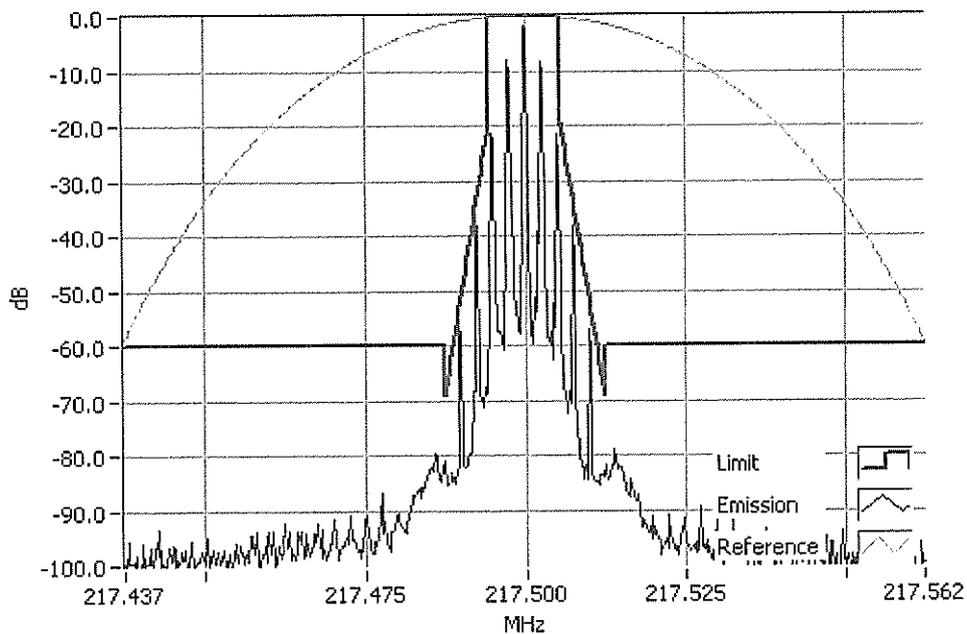
Analog Modulation

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

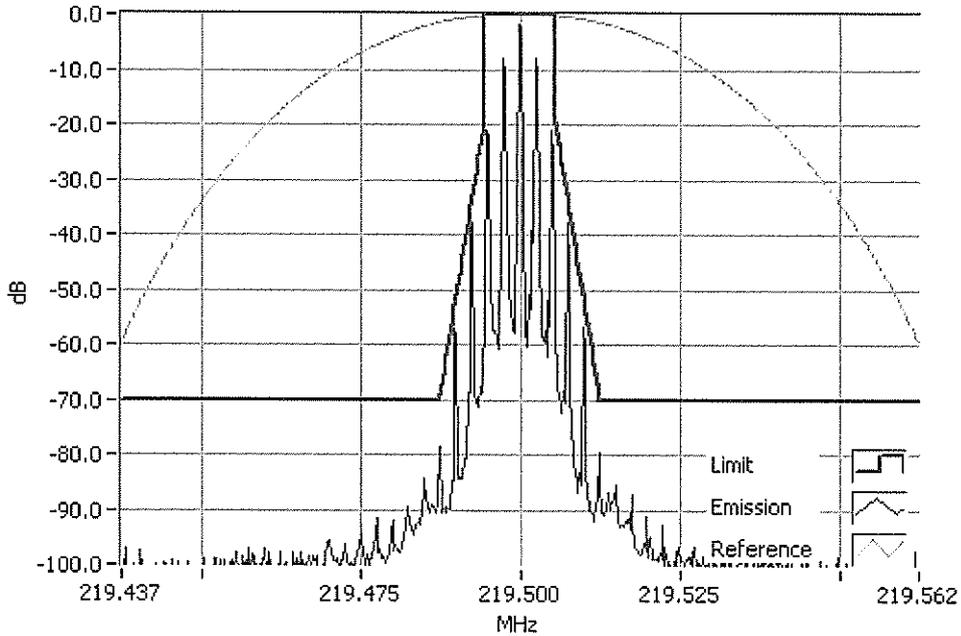
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

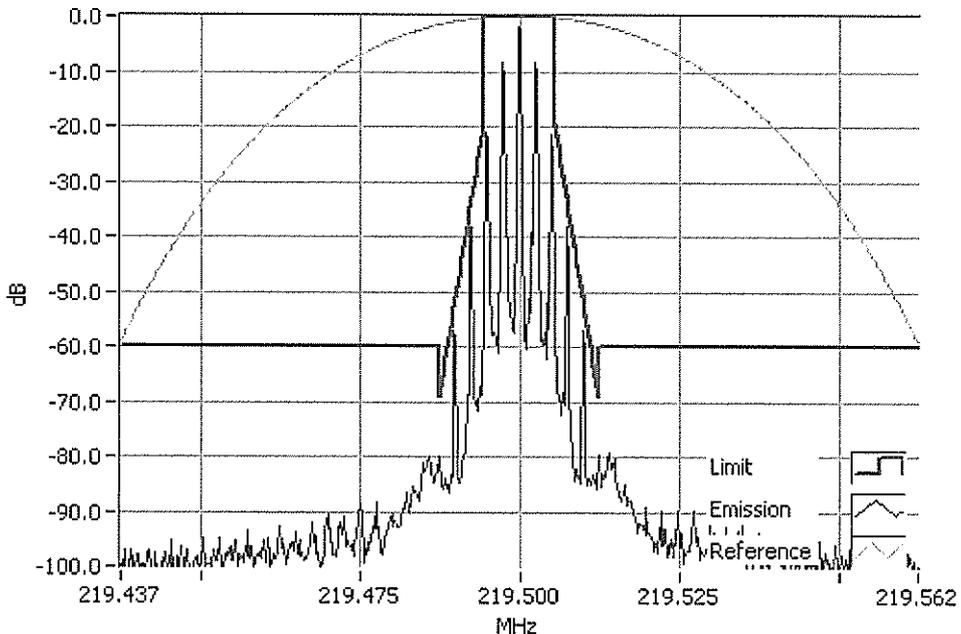
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Analogue Modulation 219.5000MHz Mask D 10W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

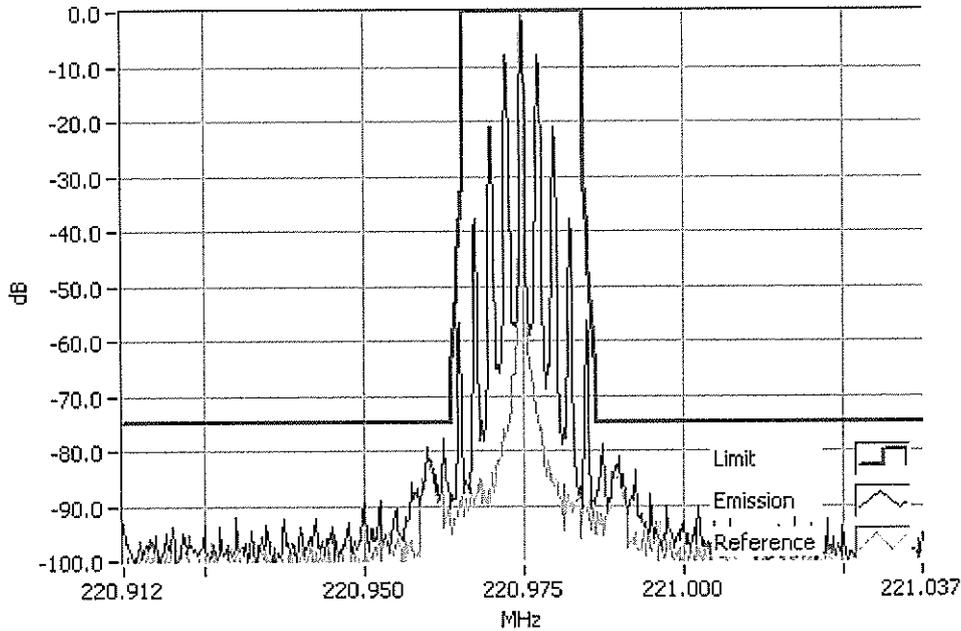
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

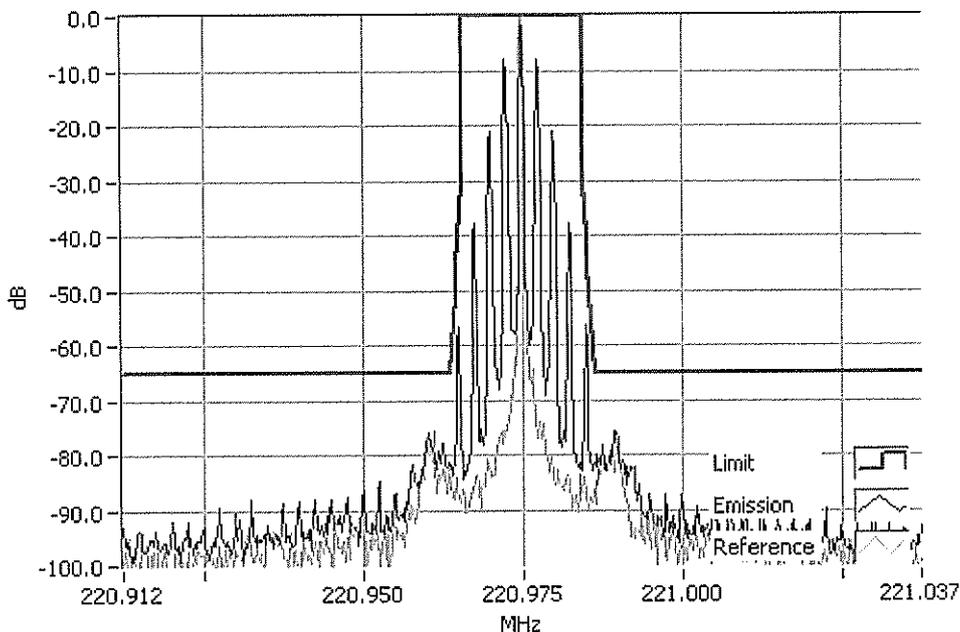
Analog Modulation

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

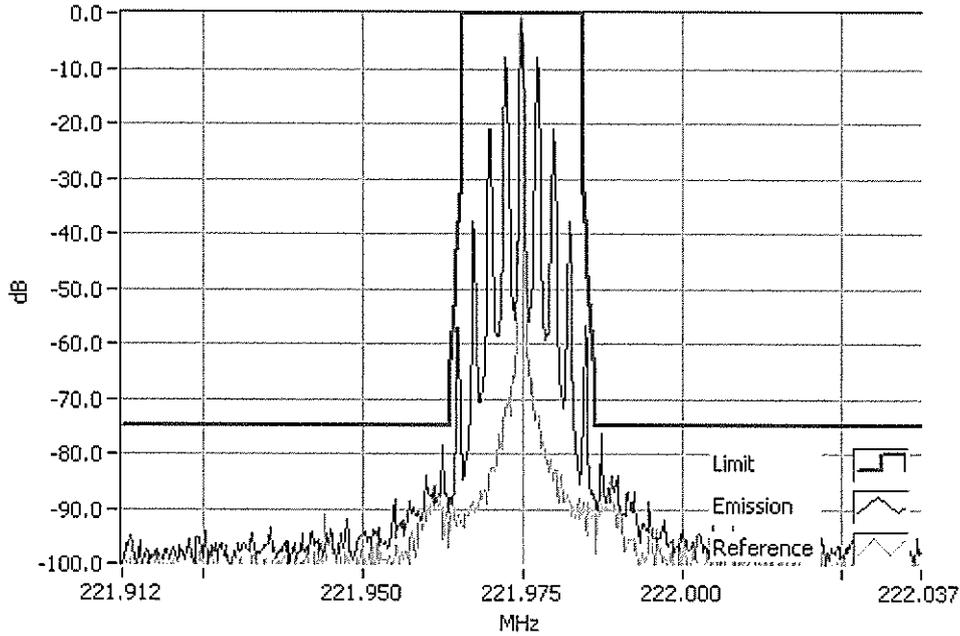
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

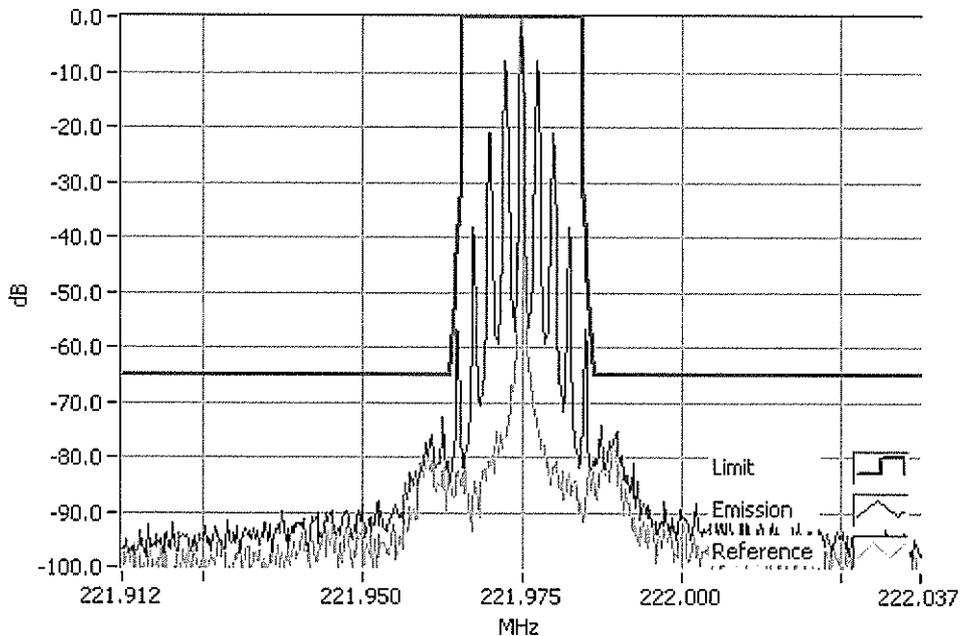
Analog Modulation

Tx FREQUENCY: 221.975 MHz 100 W 12.5 kHz Channel Spacing



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

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

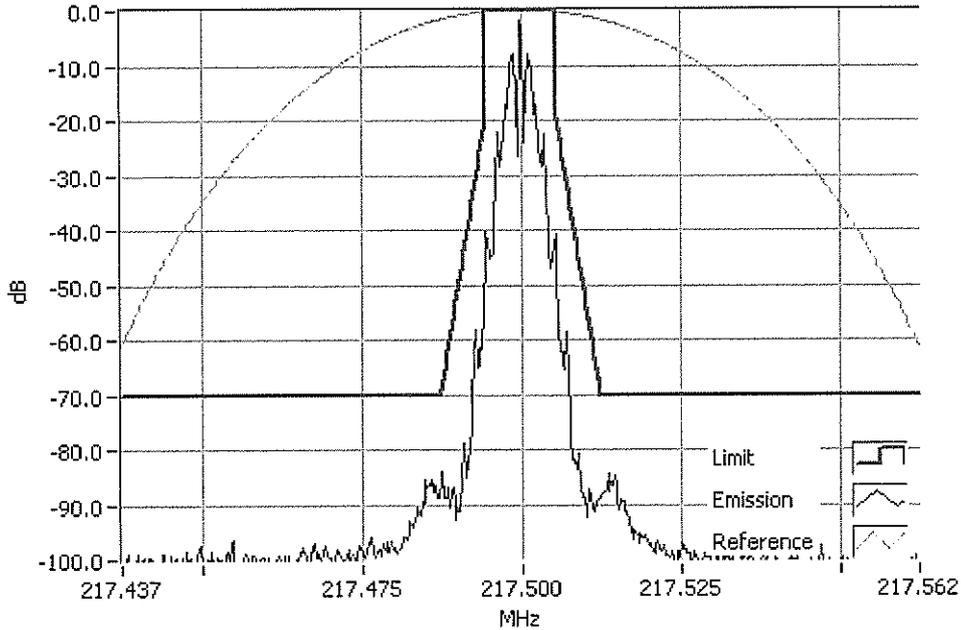
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

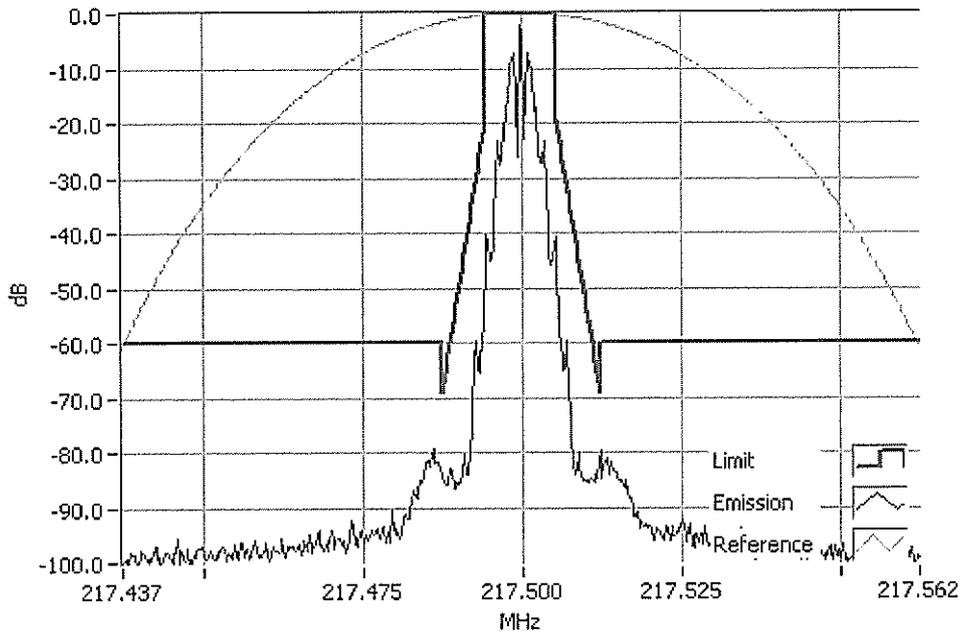
FFSK Modulation

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

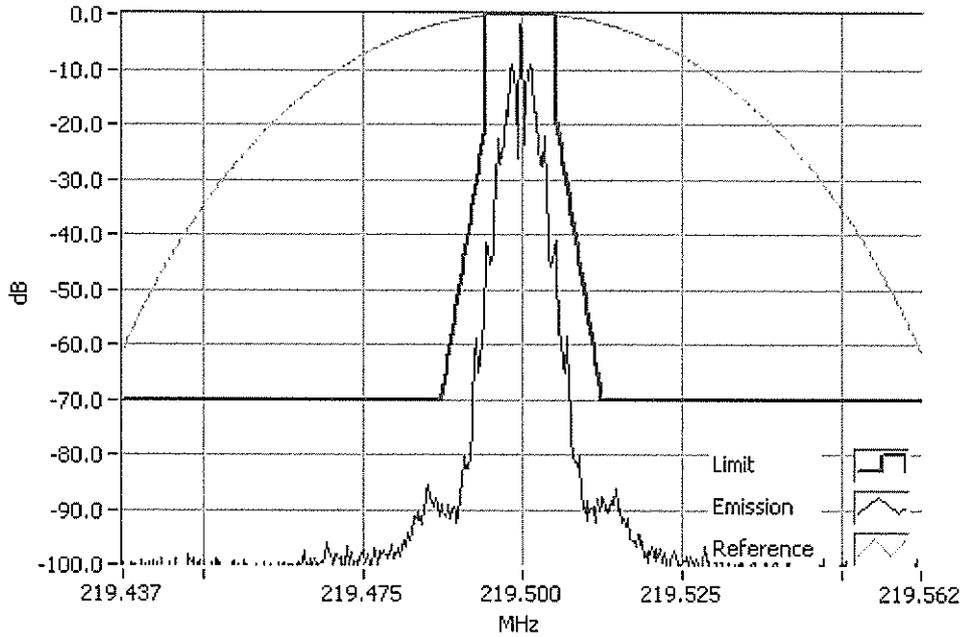
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

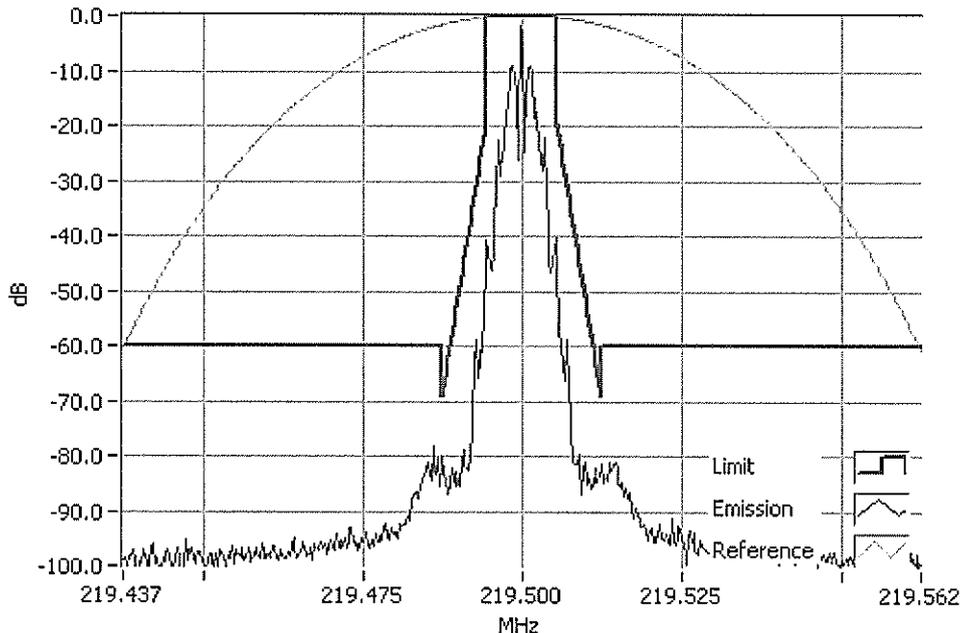
FFSK Modulation

Tx FREQUENCY: 219.5 MHz 100 W 12.5 kHz Channel Spacing



FFSK 1200 219.5000MHz Mask D 100W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 219.5 MHz 10 W 12.5 kHz Channel Spacing



FFSK 1200 219.5000MHz Mask D 10W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

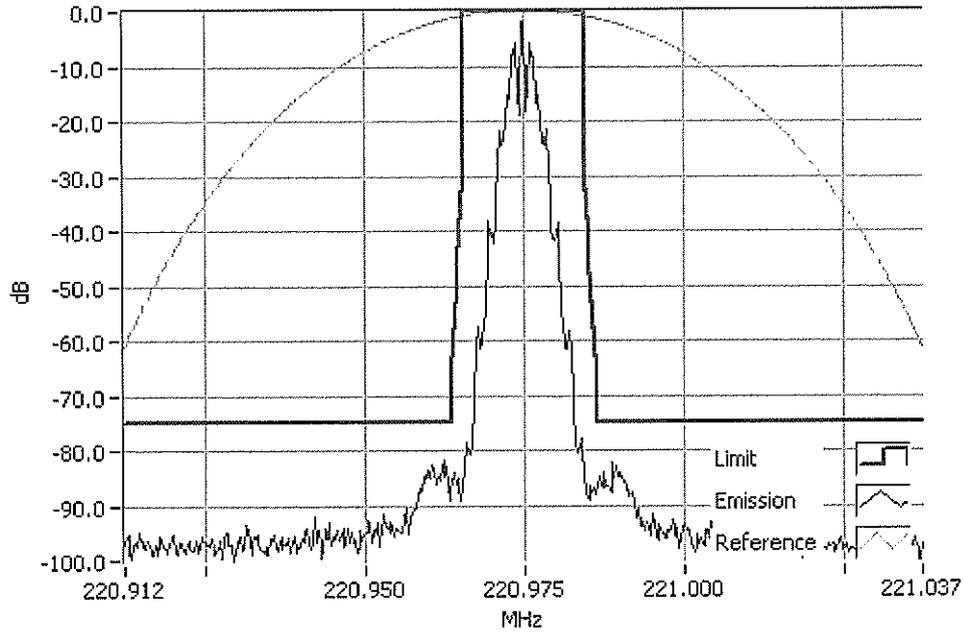
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

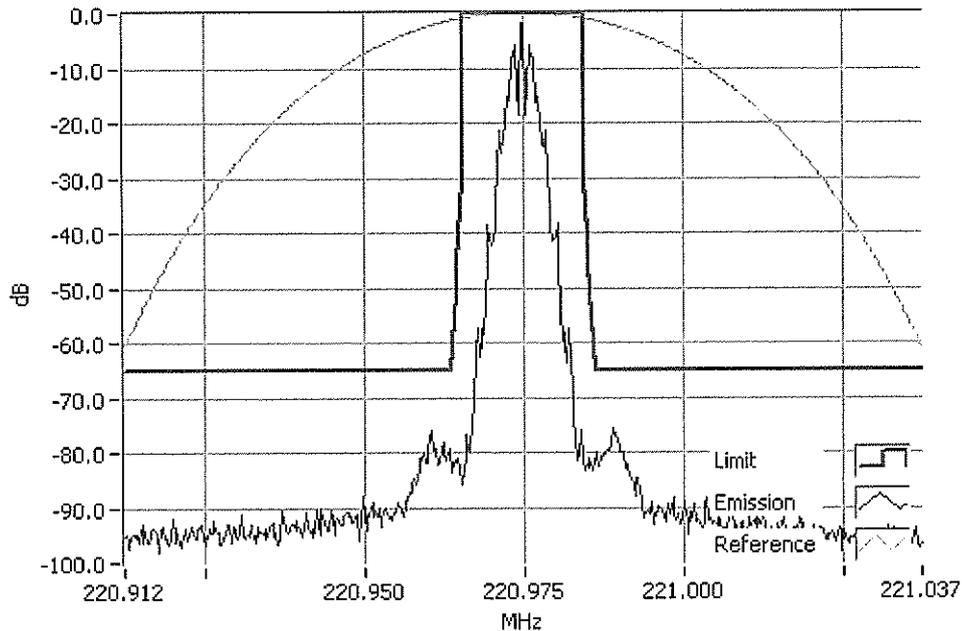
FFSK Modulation

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

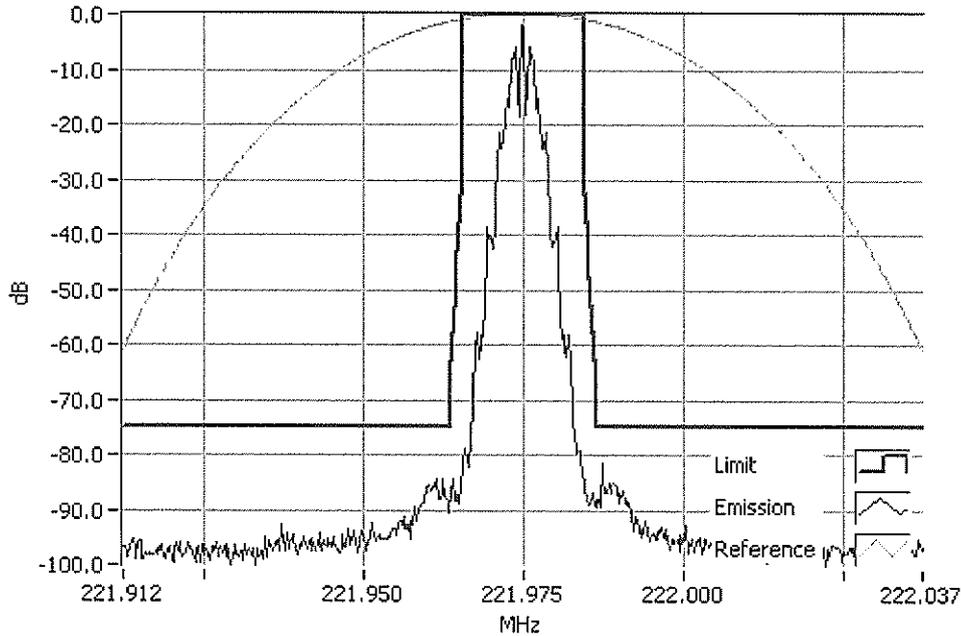
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

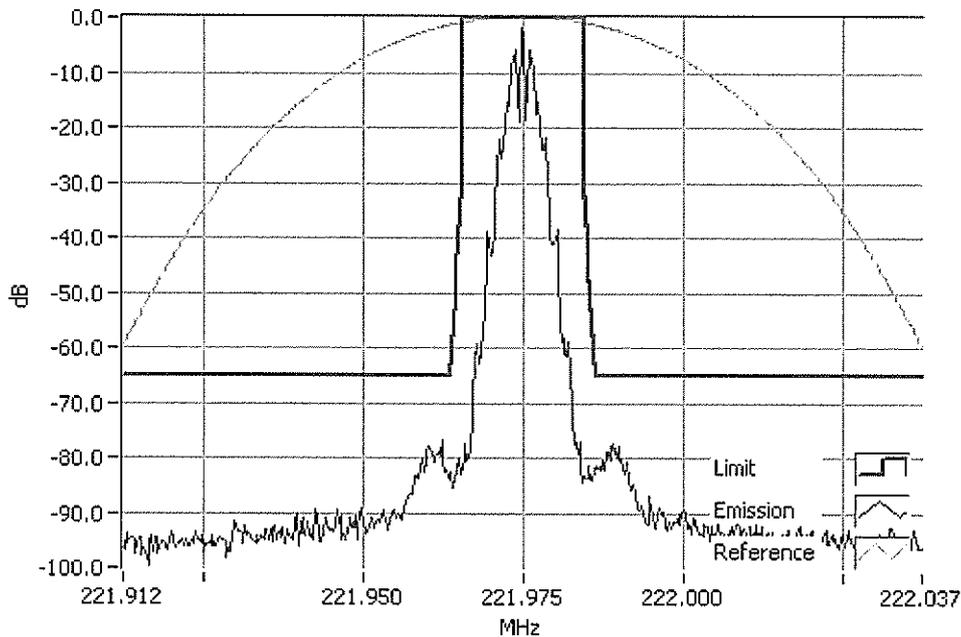
FFSK Modulation

Tx FREQUENCY: 221.975 MHz 100 W 12.5 kHz Channel Spacing



FFSK 1200 221.9750MHz Mask Fx4 100W
RBW=300Hz, VBW=3000Hz, Detector Mode=Peak
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FFSK 1200 221.9750MHz Mask Fx4 10W
RBW=300Hz, VBW=3000Hz, Detector Mode=Peak
Result=Pass

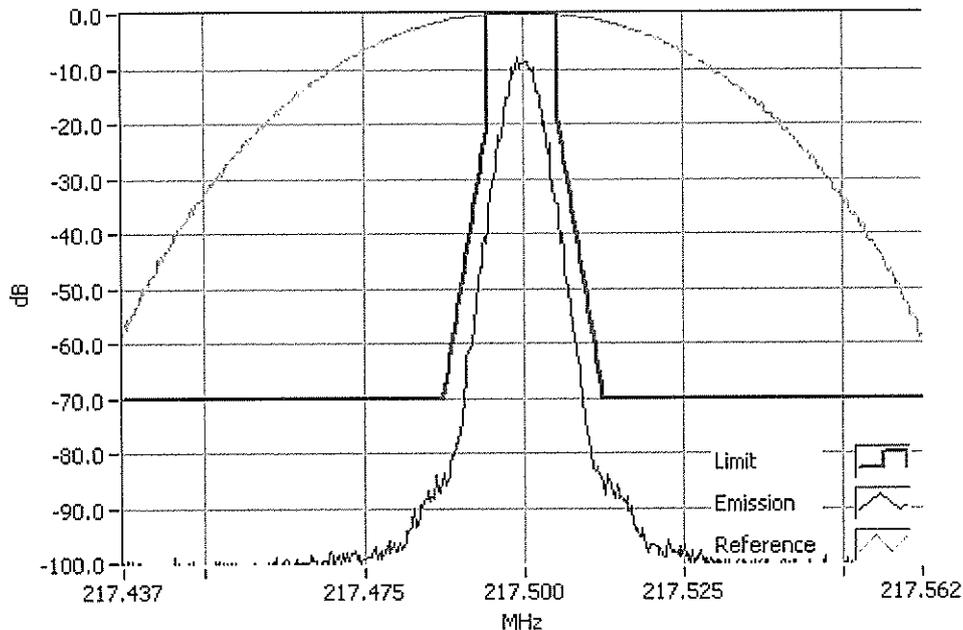
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

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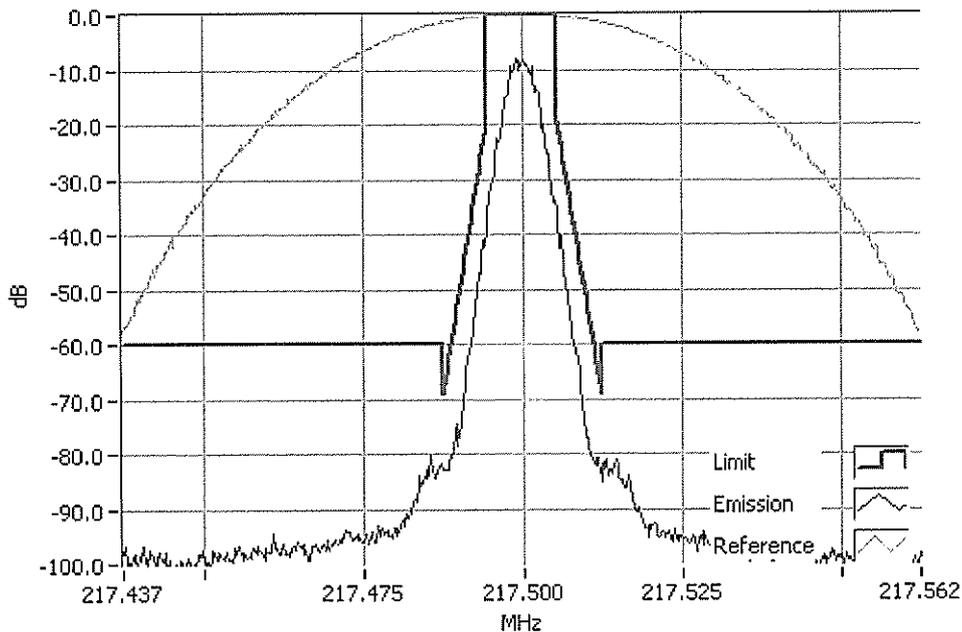
DMR Modulation

Tx FREQUENCY: 217.5 MHz 100 W 12.5 kHz Channel Spacing



DMR 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



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

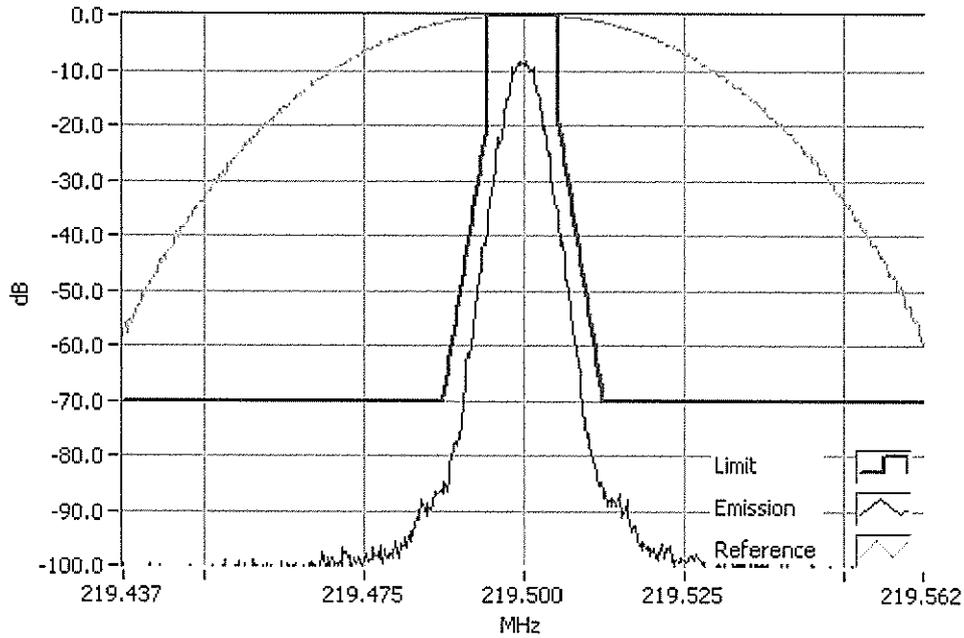
Occupied Bandwidth and Spectrum Masks

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RSS-119 5.5

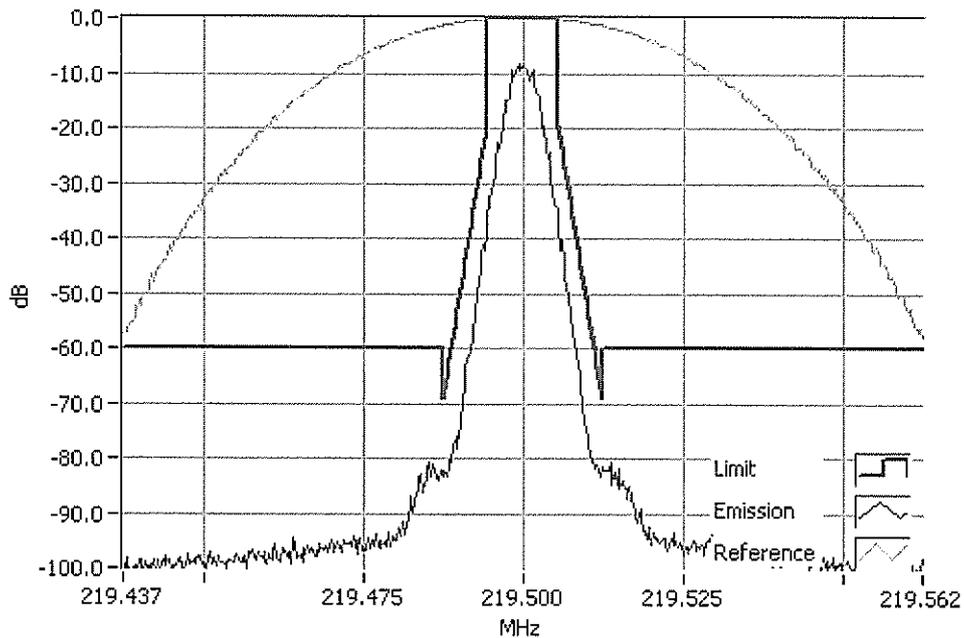
DMR Modulation

Tx FREQUENCY: 219.5 MHz 100 W 12.5 kHz Channel Spacing



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

Tx FREQUENCY: 219.5 MHz 10 W 12.5 kHz Channel Spacing



DMR 219.5000MHz Mask D 10W
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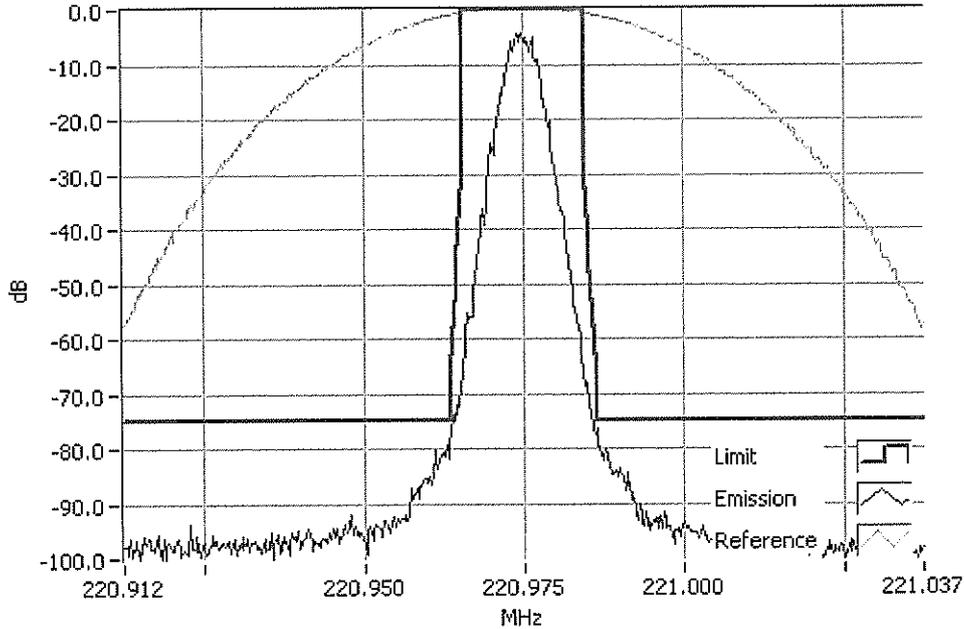
Occupied Bandwidth and Spectrum Masks

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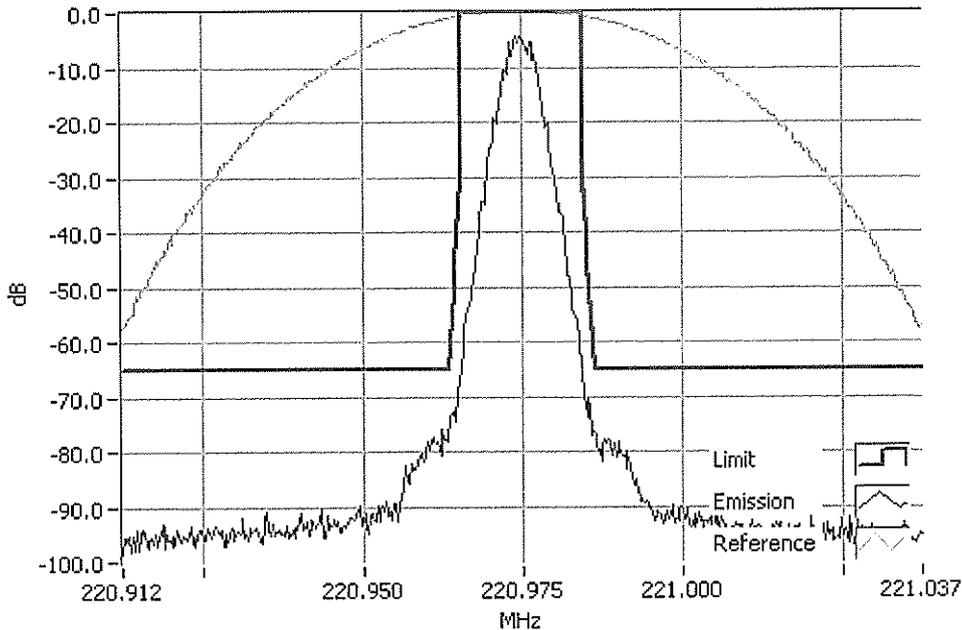
DMR Modulation

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DMR 220.9750MHz Mask Fx4 100W
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DMR 220.9750MHz Mask Fx4 10W
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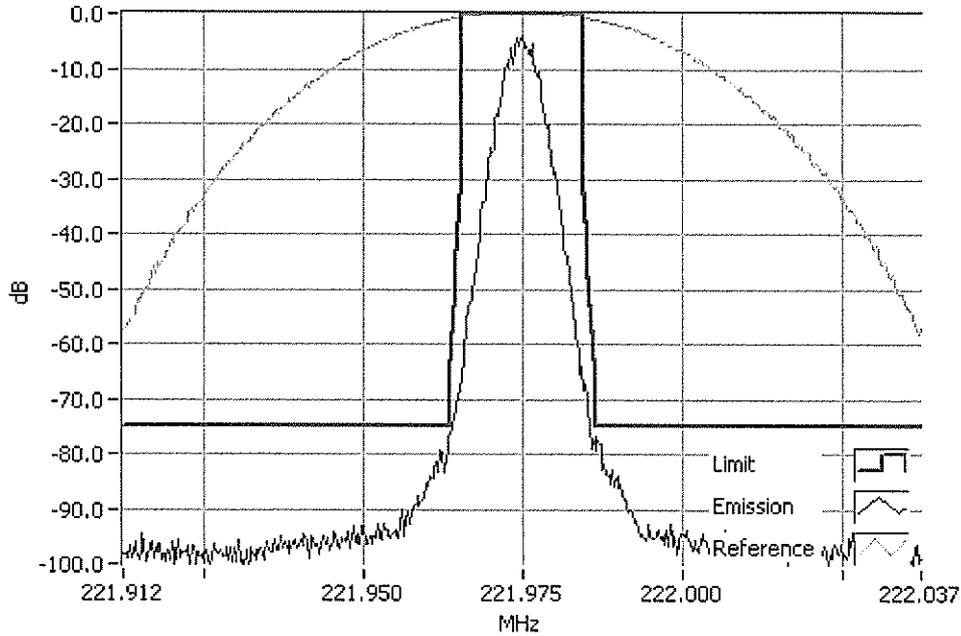
Occupied Bandwidth and Spectrum Masks

SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

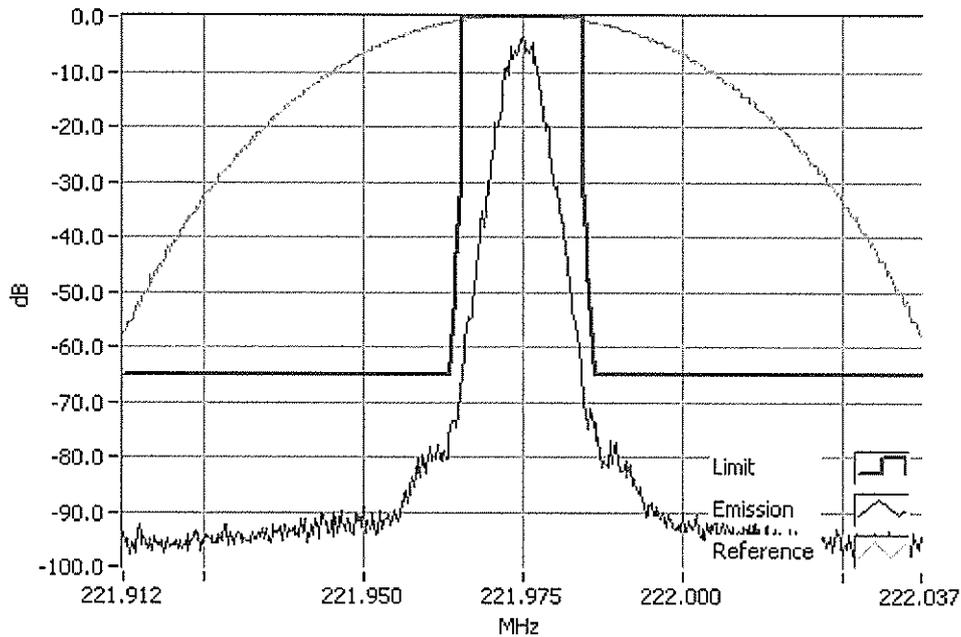
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Result=Pass

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 10th 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.

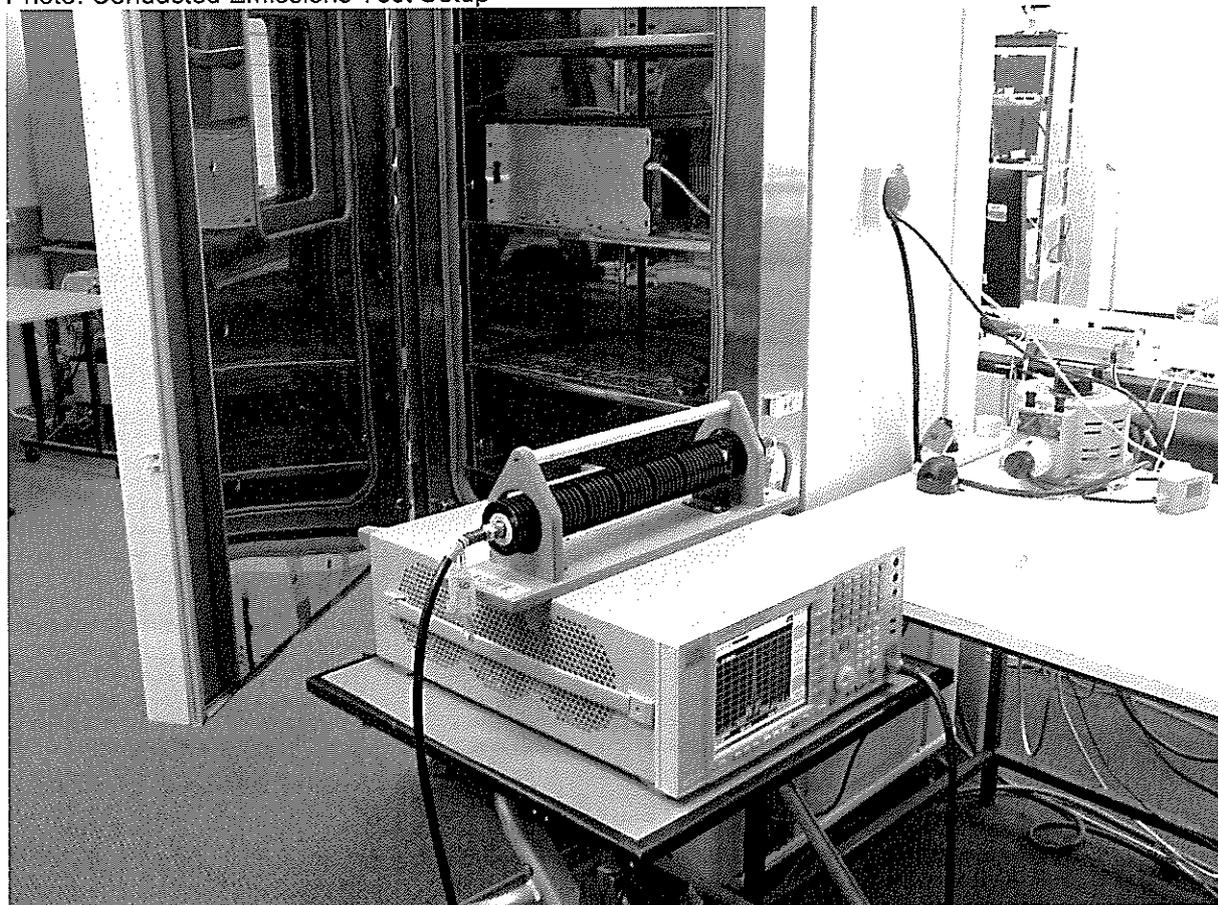
MEASUREMENT RESULTS:

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

LIMIT CLAUSES: FCC 47 CFR 90.210

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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

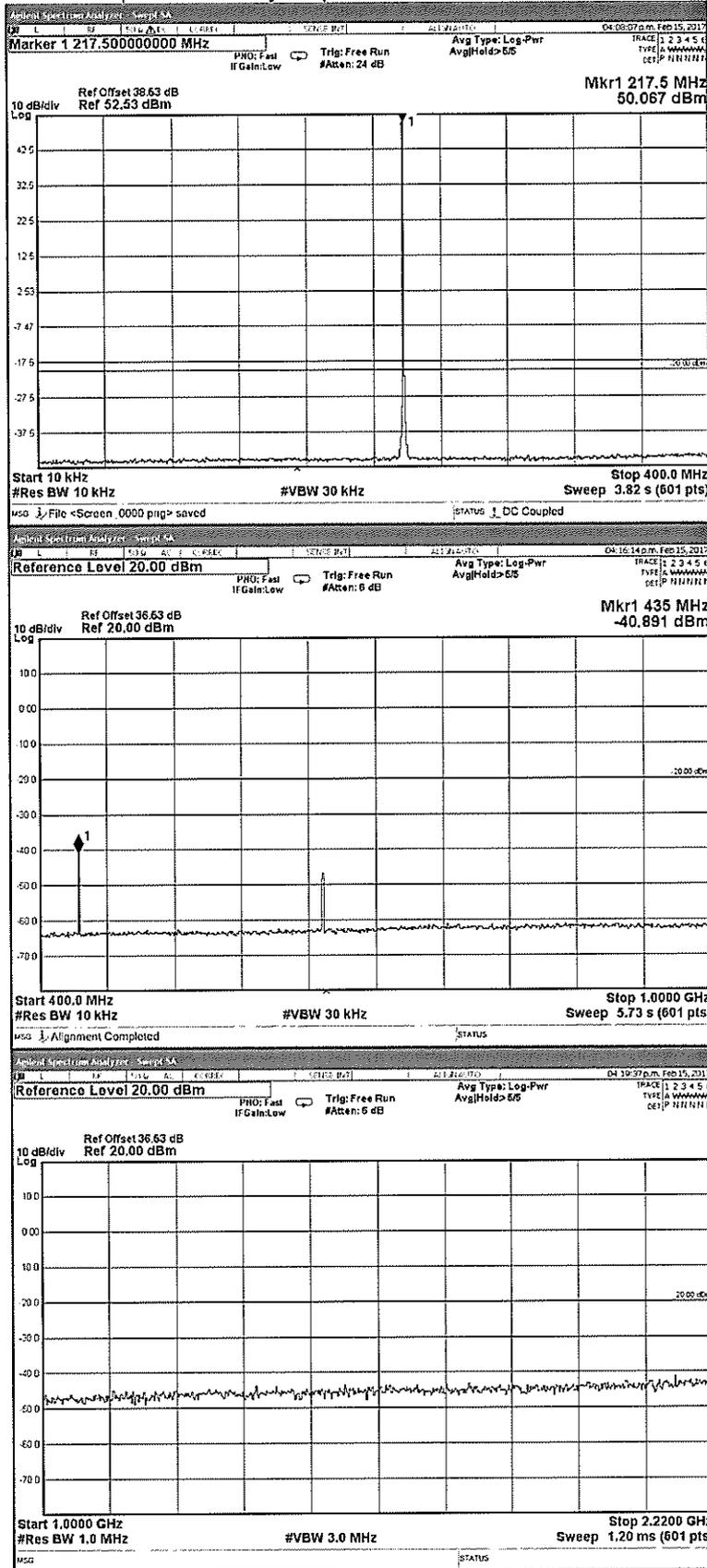
Emission Mask D

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

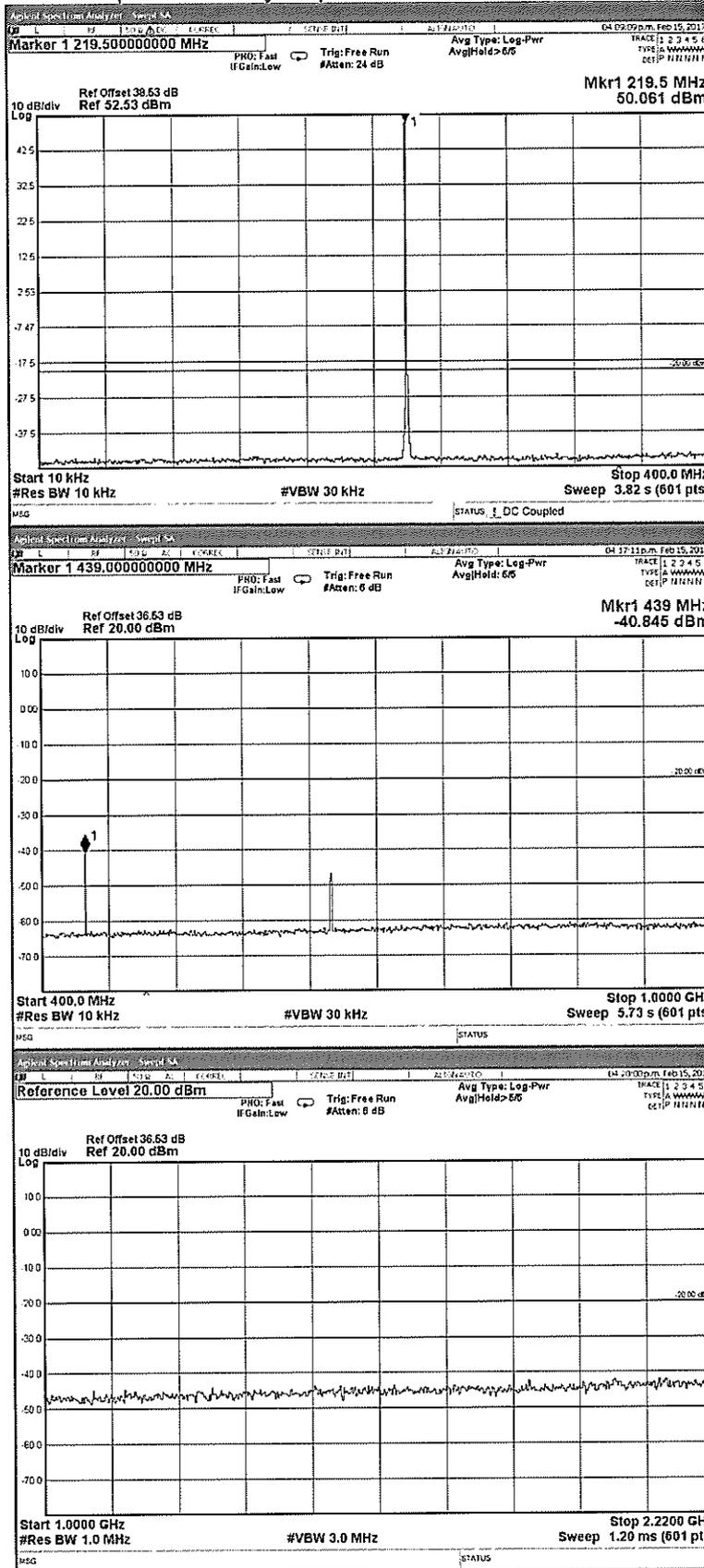
219.5 MHz @ 10 W

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

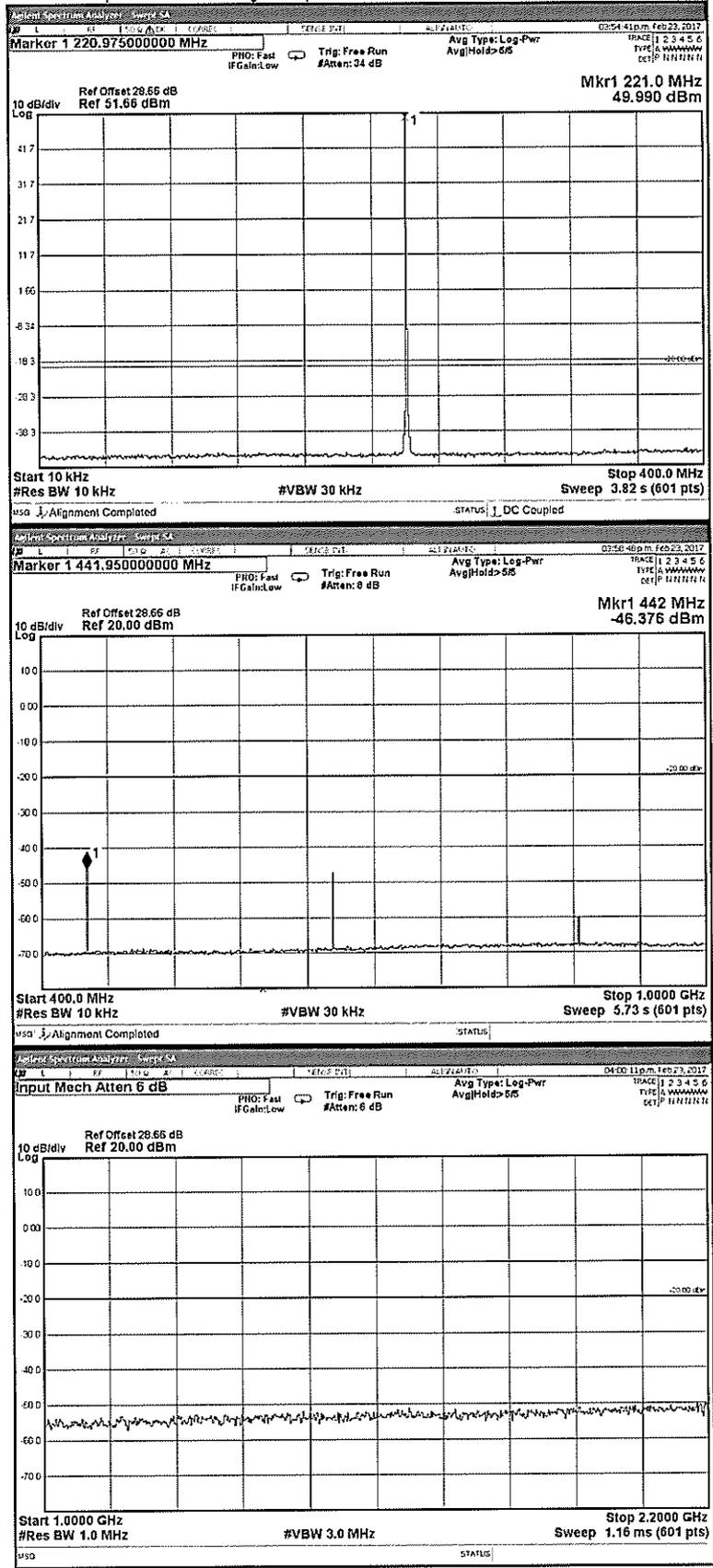
220.975 MHz @ 10 W

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

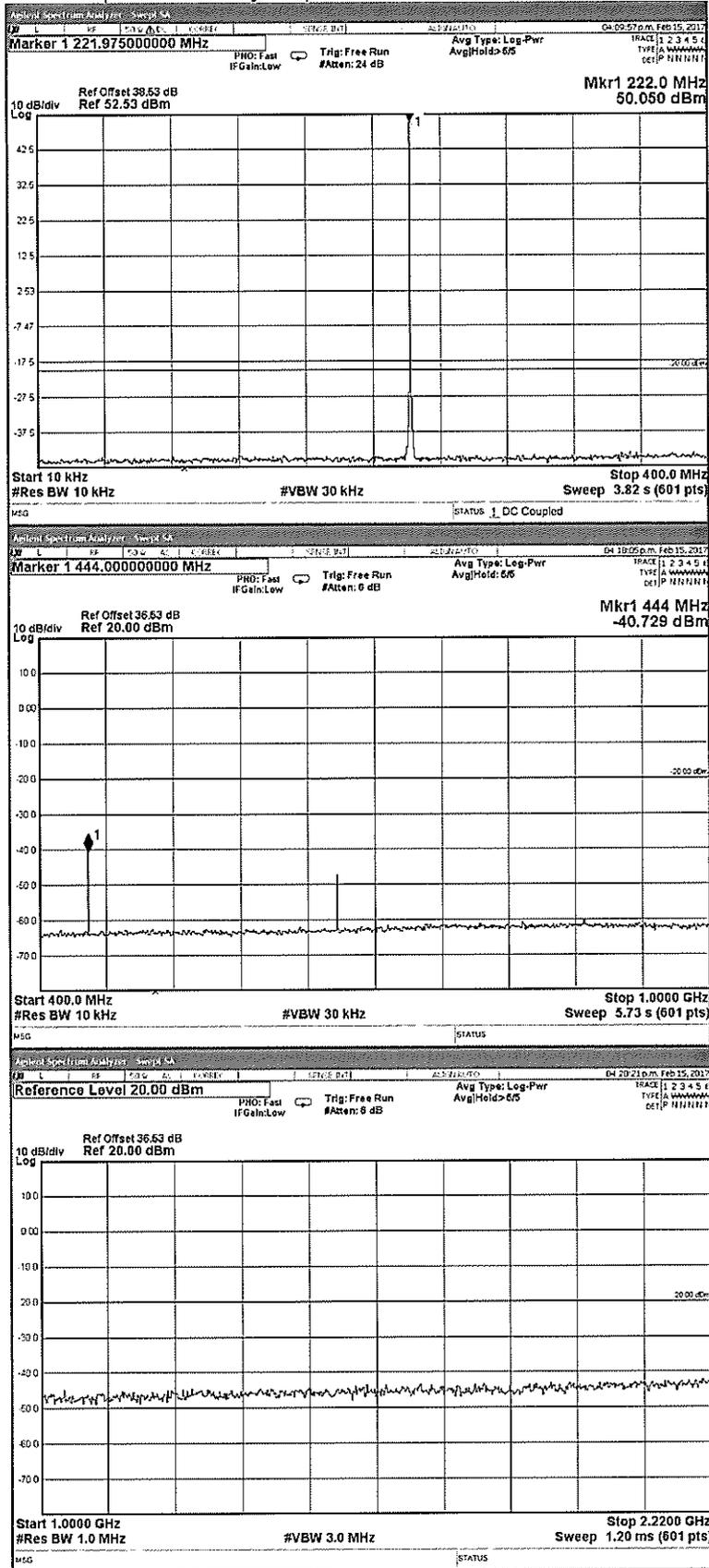
221.975 MHz @ 10 W

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 12.5 kHz Channel Spacing $50 + 10 \text{ Log}_{10} (P_{\text{Watts}})$	
	100 W	-20 dBm
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 6th 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 12.5 kHz Channel Spacing $50 + 10 \text{ Log}_{10} (P_{\text{watts}})$	
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 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°C to $+50^{\circ}\text{C}$ in 10°C increments
3. The frequency error was recorded in parts per million (ppm).

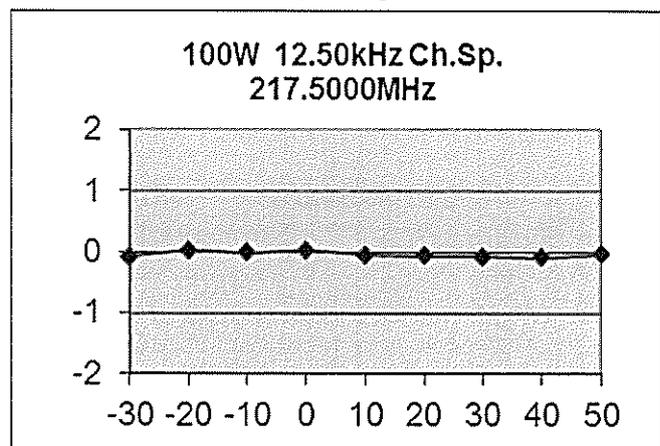
MEASUREMENT RESULTS:

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

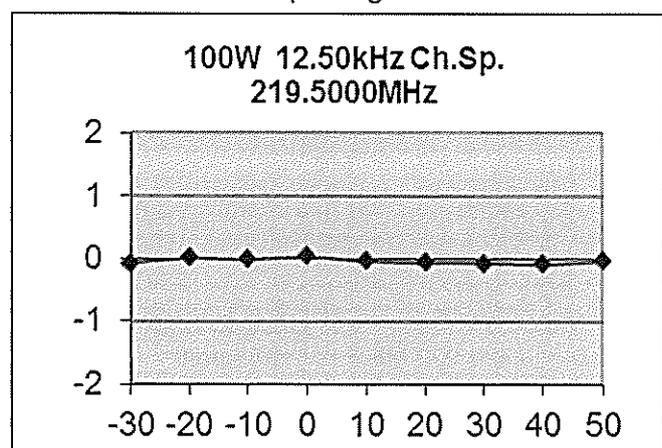
12.5 kHz channel spacing



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

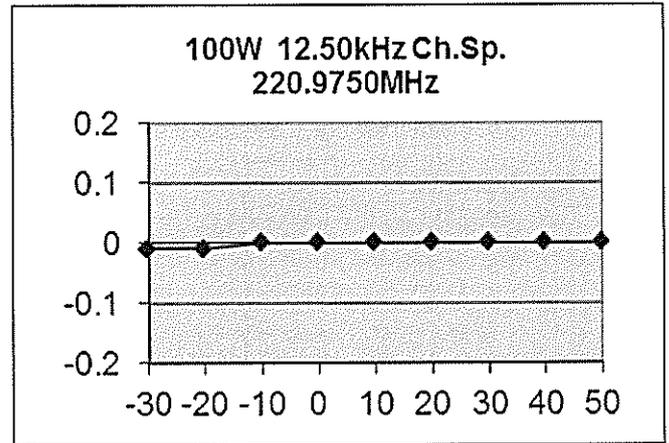


Transmitter Frequency Stability - Temperature

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

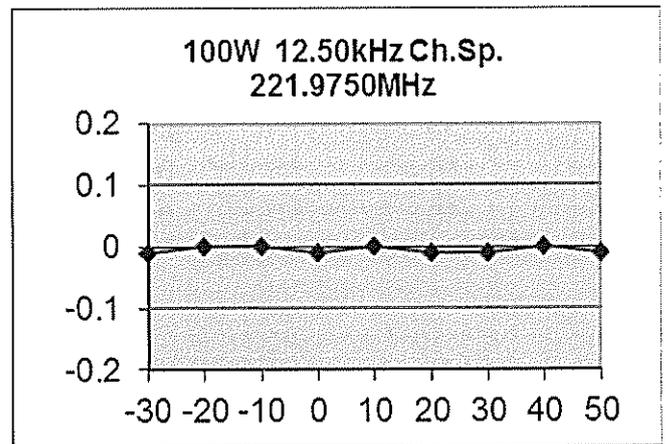


External 10 MHz reference provided to EUT for this test

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:

		RSS-119 5.3
217-218 & 219-220 MHz		1.0 ppm
	FCC Part 90	RSS-119 5.3
220-222 MHz	0.1 ppm	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 _{AC}	-0.11	-0.07	-0.08	-0.05
102 V _{AC}	-0.13	-0.06	-0.07	-0.05
138 V _{AC}	-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

TEST EQUIPMENT LIST

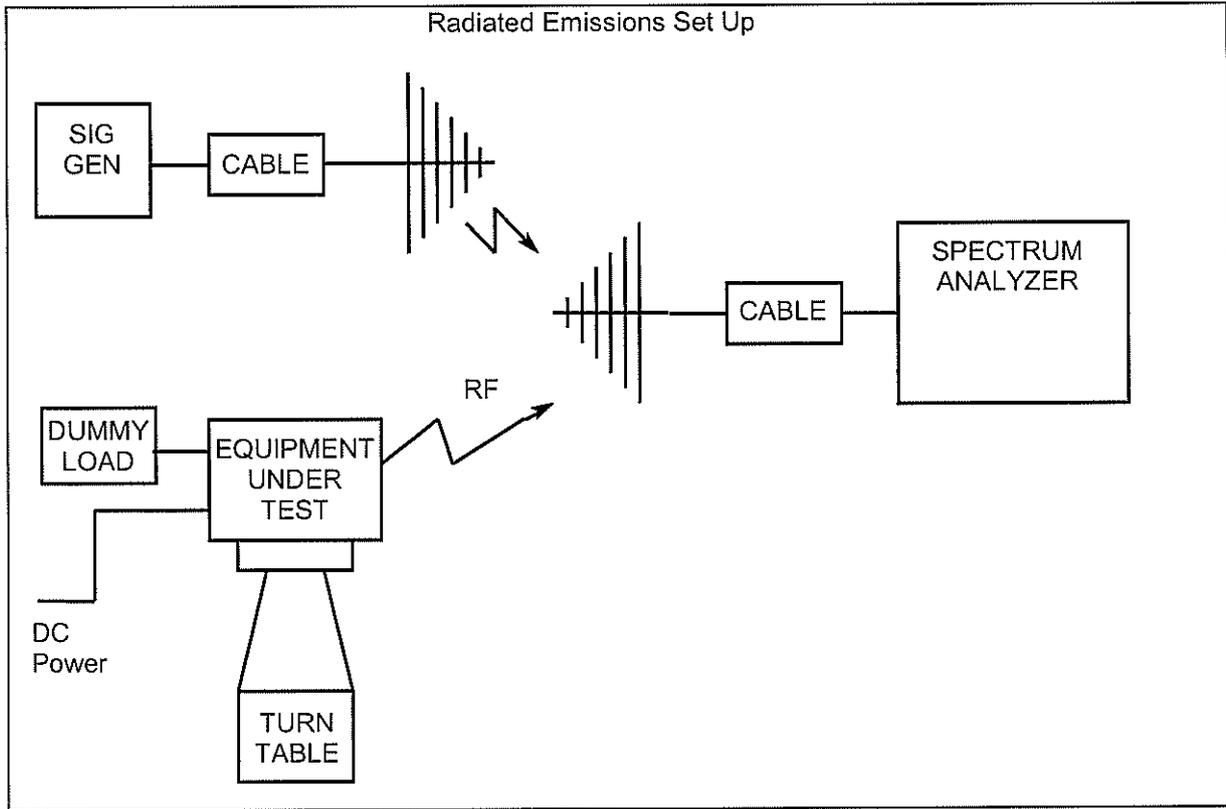
Equipment Type	Information	Manufacturer	Model No	Serial No#	Tait ID	Cal Due
AC Voltmeter		Tait		1		8-Sep-17
Antenna	Reference Dipoles	Emco	3121C DB1	9510-1164	E3559	14-Apr-19
Antenna	18GHz DRG	Emco	DRG3115	9512-4638	E3560	29-Apr-19
Antenna	Log Periodic	Schwarzbeck	VUSLP	9111-219	E4617	
Antenna	Reverb - 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/ Nm/2000	TeltestBlack2	E4623	1-Dec-17
Coax Cable	2m Black	Suhner	RG214HF/Nm/ 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/ Nm/2000	TeltestBlack5	E4850	28-Nov-17
Coax Cable	2m Black	Suhner	RG214HF/Nm/ 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/ Nm/2000	TeltestBlack7	E5004	6-Dec-17
Coax Cable	2m Black	Suhner	RG214HF/Nm/ 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 (Opt 002)	2441A00393	E3073	14-Oct-17
Modulation Analyser	TREVA2	Hewlett Packard	HP8901B (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 EVALuation 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.

