TELTEST Laboratories
Tait International Ltd
Report Number 4308a

LABORATORY TEST REPORT

RADIO PERFORMANCE MEASUREMENTS

for the

TBDHHF Transportable Transceiver

Tested in accordance with:

FCC 47 CFR Parts 22 and 90

RSS-119 Issue 12
RSS-Gen Issue 5

Report Revision:	2	
Issue Date:	03 May 2024	
PREPARED BY:	J. J. Aro	Test Technician
CHECKED & APPROVED BY:	M. C. James	Laboratory Technical Manager

ACCREDITED
TESTING LABORATORY
№ 9, 577

FCC Registration: 838288
ISED Registration: 737A

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

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TABLE OF CONTENTS

REVISION HISTORY 3
INTRODUCTION 4
TEST REQUIREMENTS AND RESULT SUMMARY 5
STATEMENT OF COMPLIANCE 6
CHANNEL TABLE 7
MODULATION TYPES, NECESSARY BANDWIDTH & EMISSION DESIGNATORS 8
TEST RESULTS 9
TRANSMITTER OUTPUT POWER (CONDUCTED) 9
TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS 10
TRANSMITTER MODULATION LIMITING 13
TRANSMITTER OCCUPIED (99%) BANDWIDTH 16
TRANSMITTER SPECTRUM MASKS 19
TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED) 28
TRANSMITTER SPURIOUS EMISSIONS (RADIATED) 36
TRANSIENT FREQUENCY BEHAVIOUR 40
TRANSMITTER FREQUENCY STABILITY - TEMPERATURE 49
TRANSMITTER FREQUENCY STABILITY - VOLTAGE 51
RECEIVER SPURIOUS EMISSIONS (CONDUCTED) 52
TEST EQUIPMENT LIST 57
ANNEX A – TEST SETUP DETAILS 59

REVISION HISTORY

Date	Revision	Comments
04 April 2024	1	Initial test report
03 May 2024	2	Added harmonics measurement results and test setup photos

INTRODUCTION

Type approval testing of the TBDHHF, 15W, Transportable transceiver in order to demonstrate compliance with FCC 47 Parts 22 & 90, and RSS-119 Issue 12 & RSS-Gen Issue 5.

REPORT PREPARED FOR
Tait International Ltd
245 Wooldridge Road
Harewood
Christchurch 8051
New Zealand

DESCRIPTION OF SAMPLE

Manufacturer:	Tait International Limited
Equipment:	Transportable Transceiver
Type:	TBDHHF
Product Code:	TB7306-HHL0
Serial Number(s):	18411988
Frequency range:	378 → 420 MHz
Transmit Power:	15 W

HARDWARE & SOFTWARE
Quantity: 1

Module	Product Code	Serial Number	Firmware Version	Hardware Version
Reciter	T01-01403-JBAA	18412105	p25-3.55.00.0009	06.03
Power Amplifier	T01-01405-JCAA	18412352	NA	00.01

TEST CONDITIONS
All testing was performed between 21 March 2024 → 02 May 2024, and under the following conditions:

Ambient temperature:	15°C → 30°C
Relative Humidity:	20% → 75%
Standard Test Voltage	13.8 V_{DC}

TEST REQUIREMENTS AND RESULT SUMMARY

Specification Versions: RSS-119 issue 12, RSS Gen issue 5, ANSI C63.26-2015, TIA-603-E

ISED Specification	FCC Specification	Test Name	Test Methods	Result
RSS-119 5.4	FCC 47 CFR 2.1046	Transmitter Output Power (Conducted)	ANSI C63.26 5.2.4.2	P
No specification	FCC 47 CFR 2.1047 (a)	Transmitter Audio Frequency Response – Pre-emphasis	ANSI C63.26 5.3.3.2	P
No specification	FCC 47 CFR 2.1047 (b)	Transmitter Modulation Limiting	ANSI C63.26 5.3.2	P
RSS-119 5.5	FCC 47 CFR 2.1049 (c)	Transmitter Occupied (99%) Bandwidth	ANSI C63.26 5.4.4	P
RSS-119 5.5	FCC 47 CFR 90.210	Transmitter Spectrum Masks	ANSI C63.26.5.7.3	P
RSS-119 5.8.9	FCC 47 CFR 90.543	Adjacent Channel Power Ratio	TIA-603-E 2.2.14 TIA-102.CAAA-E 2.2.8	N/A 2
RSS-119 5.8	FCC 47 CFR 2.1051	Transmitter Spurious Emissions (Conducted)	ANSI C63.26 5.7	P
RSS-119 5.8	FCC 47 CFR 2.1053	Transmitter Spurious Emissions (Radiated)	TIA-603-E 2.2.12	P
No specification	FCC CFR 90.543	Transmitter Radiated Emissions in the GNSS Band	TIA-603-E 2.2.12	N/A 2
RSS-119 5.8.9.2 rad	No specification	Transmitter Conducted Emissions in the GNSS Band	ANSI C63.26 6.5.2.7.4	N/A 2
RSS-119 5.9	FCC 47 CFR 90.214	Transient Frequency Behaviour	ANSI C63.26 6.5.2.2	P
RSS-119 5.3	FCC 47 CFR 2.1055, FCC 47 CFR 90.213	Transmitter Frequency Stability - Temperature	ANSI C63.26 5.6.4	P
RSS-119 5.3	FCC 47 CFR 2.1055 (d) (1), FCC 47 CFR 90.213	Transmitter Frequency Stability - Voltage	ANSI C63.26 5.6.5	P
RSS-Gen 7.4	FCC 47CFR 15.111	Receiver Spurious Emissions (Conducted)	TIA-603-E 2.1.2	P

Test Case Result Definitions	
No test Performed	N
Test does not apply to the test object	N/A
Test object meets requirements	P (Pass)
Test object does not meet requirements	F (Fail)
Test object is not conclusive	I (Inconclusive)

Comments:
N/A 1: Only required where the EUT is capable of Analogue modulation
N/A 2: Only required where the EUT transmits in the 768-776 or 798-806 MHz band (ISED), or 769-775 or 799-805 MHz band (FCC).
N/A 3: Only required where the EUT transmits in the 138-174 or 406.1-512 MHz band

STATEMENT OF COMPLIANCE

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

Equipment:	Transportable Transceiver
Type:	TBDHHF
Product Code:	TB7306-HHL0
Serial Number(s):	18411988
Quantity:	1

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

FCC 47 CFR Parts 22 and 90

RSS-119 Issue 12 & RSS-Gen Issue 5

for the parameters tested in this report.

Signature: _____

M. C. James
Laboratory Technical Manager

Date: 6 May 2024

The results obtained in this test report pertain only to the item(s) tested. Teltest does not make any claims of compliance for samples or variants that were not tested.

95% measurement uncertainties are stated in this report but are not applied in the assessment of results.

CHANNEL TABLE

Label	Channel Number	Receive Frequency (MHz)	Transmit Frequency (MHz)	Amplifier Power (W)	Output Power (W)	Channel Spacing (kHz)
CH1 H	1	406.150	406.125	20	15	12.5
CH1 L	2	406.150	406.125	3	2	12.5
CH2 H	3	413.050	413.025	20	15	12.5
CH2 L	4	413.050	413.025	3	2	12.5
CH3 H	5	419.950	419.975	20	15	12.5
CH3 L	6	419.950	419.975	3	2	12.5
CH4 H	7	388.750	378.250	21	15	12.5
CH4 L	8	388.750	378.250	3	2	12.5

Note: To achieve the rated 15W transmission power at the output port, the internal power amplifier was adjusted to a higher power level, as indicated in the above table.

MODULATION TYPES, NECESSARY BANDWIDTH & EMISSION DESIGNATORS

MODULATION TYPES:

F3E	Analogue Frequency Modulation (FM)	
F1E	P25 phase 1 Digital Voice	9600 bps
F1D	P25 phase 1 Digital Data	9600 bps

CHANNEL SPACINGS: 12.5 kHz

EMISSION DESIGNATORS:

	12.5 kHz
Analogue FM	11K0F3E
Digital Voice P25 phase 1	8K10F1E
Digital Data P25 phase 1	8K10F1D

CALCULATIONS:

Equation: Bn = 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 Bandwidth

Necessary bandwidth
M = 3.0 kHz
D = 2.5 kHz
Bn = (2x3.0) + (2x2.5) x 1
= 11.0 kHz

Emission Designator
11K0F3E
F3E represents an FM voice transmission

APCO P25 Phase 1: Digital Voice 12.5 kHz Channel Spacing

99% bandwidth
= 8.1 kHz

Emission Designator
8K10F1E
F1E represents a digital FM voice transmission

APCO P25 Phase 1: Digital Data 12.5 kHz Channel Spacing

99% bandwidth
= 8.1 kHz

Emission Designator
8K10F1D
F1D represents a digital FM data transmission

TEST RESULTS

TRANSMITTER OUTPUT POWER (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1046 RSS-119 5.4

GUIDE: ANSI C63.26 5.2.4.2

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.

EXAMPLE CALCULATION:

Example calculation

Power in dBm =	Measured power (dBm) + attenuator and cable loss (dB)
Chan 1 power (dBm) =	10.89 dBm +30.79 dB
=	41.68dBm
Power in Watts =	(10^(41.68dBm)/10)/1000
=	14.7W

MEASUREMENT UNCERTAINTY: ± 0.6dB

MEASUREMENT RESULTS:

Manufacturer's Rated Output Power: Switchable: 15 W and 2 W

Nominal 15 W	406.125 MHz	413.025 MHz	419.975 MHz	378.250 MHz
Measured	14.7	15.7	14.9	15.1
Variation (%)	-1.7	4.5	-0.6	1.0
Variation (dB)	-0.1	0.2	0.0	0.0

Nominal 2 W	406.125 MHz	413.025 MHz	419.975 MHz	378.250 MHz
Measured	2.2	2.2	2.2	2.2
Variation (%)	8.8	12.5	11.3	11.2
Variation (dB)	0.4	0.5	0.5	0.5

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: ANSI C63.26 5.3.3.2

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.

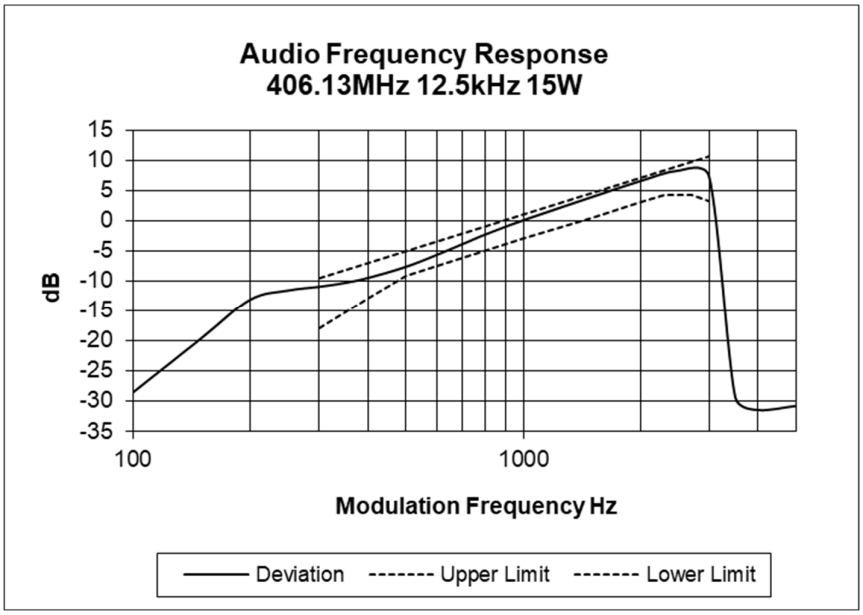
4. The response in dB relative to 1000 Hz was measured.

MEASUREMENT RESULTS:
See the plots on the following pages for 12.5 kHz channel spacings tested at 15 W transmit power.

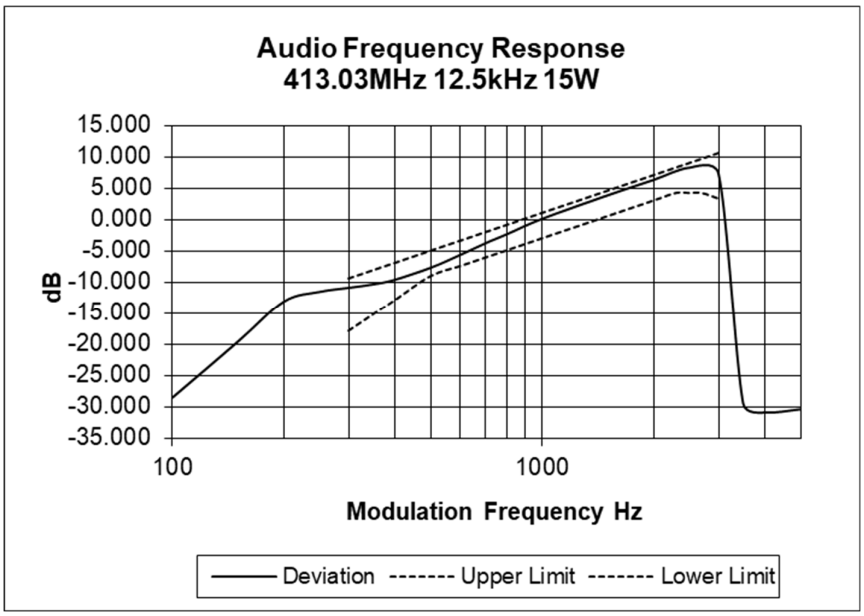
MEASUREMENT UNCERTAINTY: ± 1.5 %

Transmitter Audio Frequency Response – Pre-emphasis

Tx FREQUENCY: 406.125 MHz 12.5 kHz Channel Spacing

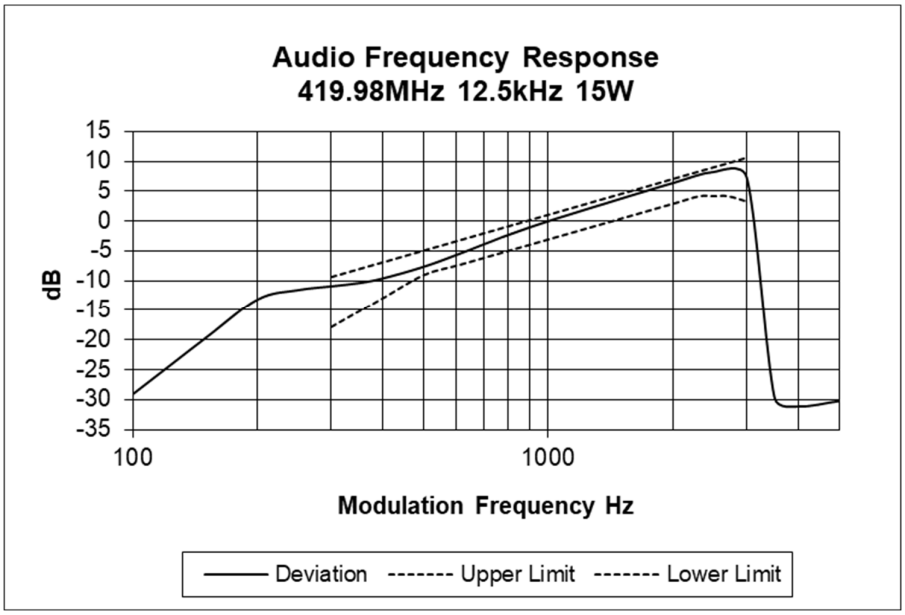


Tx FREQUENCY: 413.025 MHz 12.5 kHz Channel Spacing

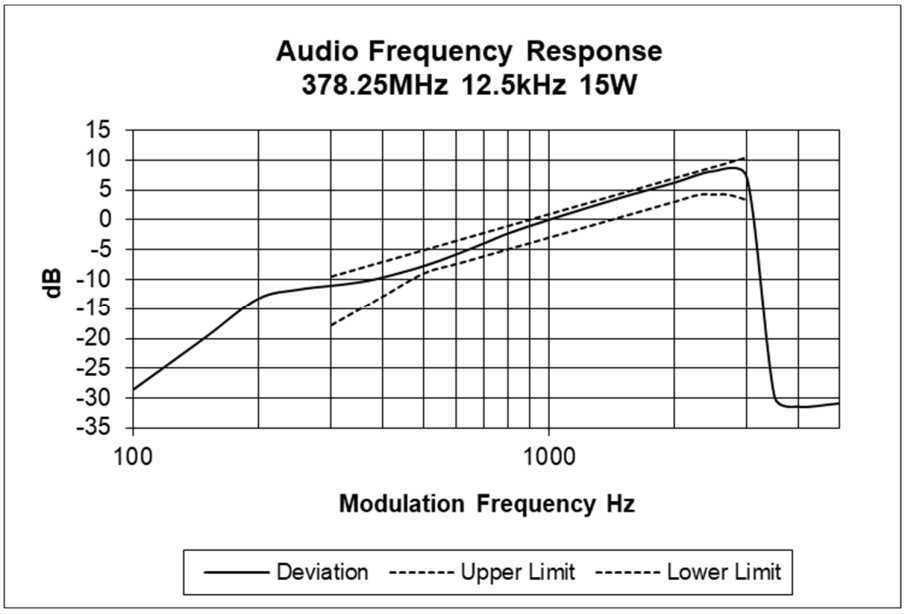


Transmitter Audio Frequency Response – Pre-emphasis

Tx FREQUENCY: 419.975 MHz 12.5 kHz Channel Spacing



Tx FREQUENCY: 378.250 MHz 12.5 kHz Channel Spacing



TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC 47 CFR 2.1047 (b)

GUIDE: ANSI C63.26 5.3.2

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.

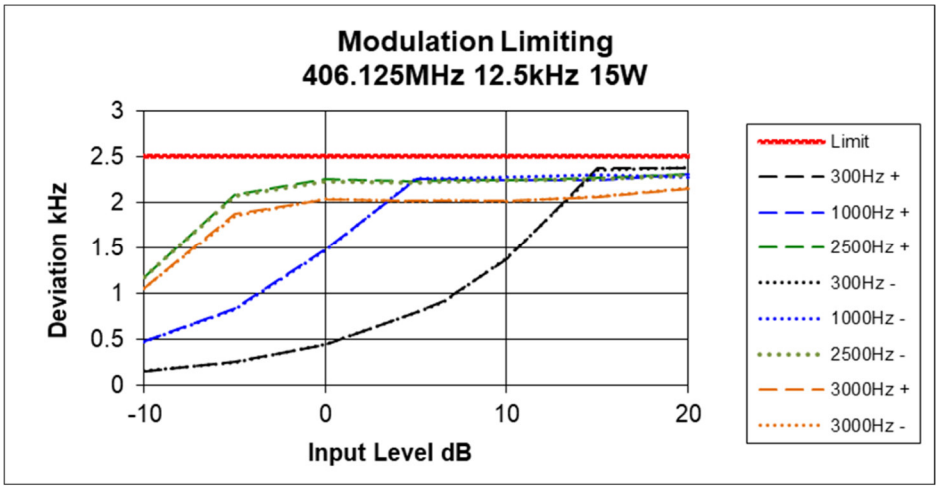
3. Measurements were made for both Positive and Negative Deviation.

MEASUREMENT RESULTS:
See the plots on the following pages for 12.5 kHz channel spacings.

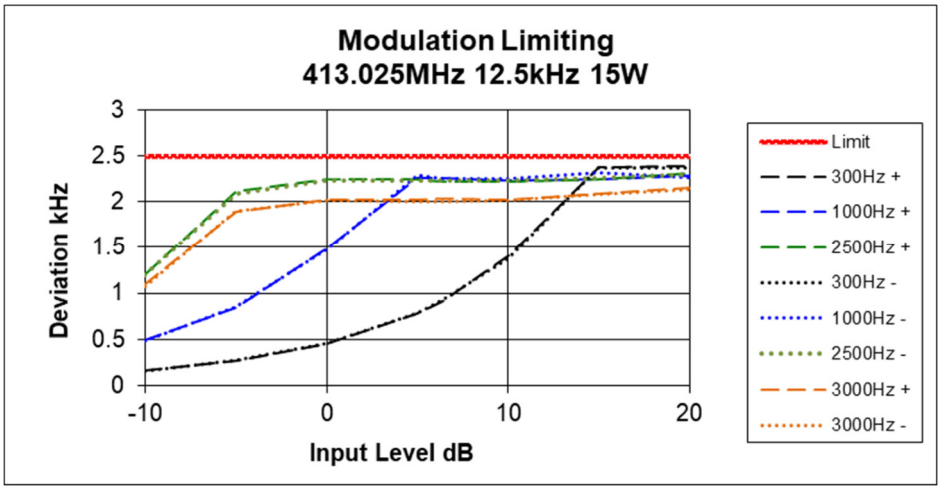
MEASUREMENT UNCERTAINTY: ± 1.5 %

Transmitter Modulation Limiting

Tx FREQUENCY: 406.125 MHz 12.5 kHz Channel Spacing

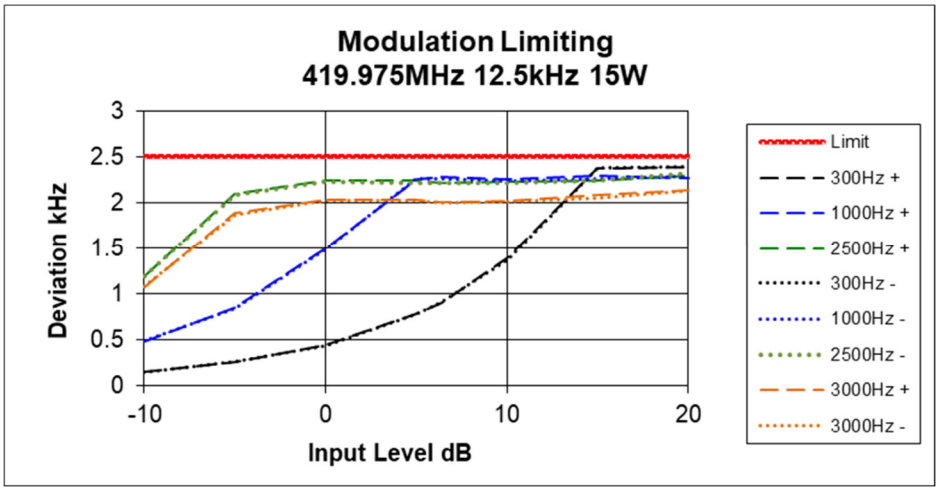


Tx FREQUENCY: 413.025 MHz 12.5 kHz Channel Spacing

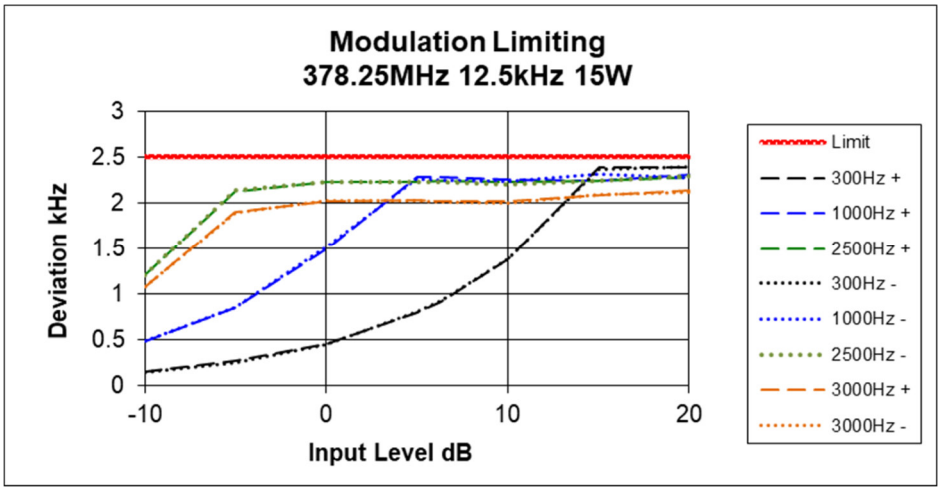


Transmitter Modulation Limiting

Tx FREQUENCY: 419.975 MHz 12.5 kHz Channel Spacing



Tx FREQUENCY: 378.250 MHz 12.5 kHz Channel Spacing



TRANSMITTER OCCUPIED (99%) BANDWIDTH

SPECIFICATION: FCC 47 CFR 2.1046
RSS-119 5.5

GUIDE: ANSI C63.26 5.4.4

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment Set up.

2. For analogue measurements: The EUT was modulated by a 2500 Hz tone at an input level 16 dB above a level that produced 50% deviation. The input level was established at the frequency of maximum response of the audio modulating circuit.

   For Data measurements: 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.
   Resolution Bandwidth = 100 Hz, Video Bandwidth = 300 Hz

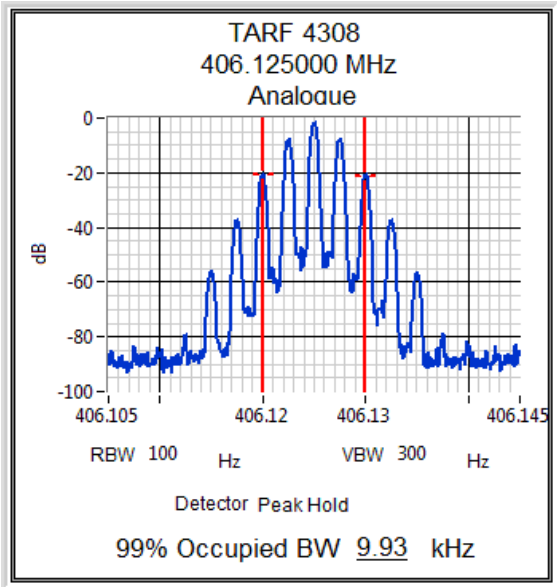
MEASUREMENT RESULTS:

		Bandwidths (kHz)	
Channel Frequency (MHz)	Channel Spacing (kHz)	Analogue	APCO P25 Phase I
406.125 MHz	12.5	9.93	7.80
413.025 MHz	12.5	9.93	7.93
419.975 MHz	12.5	9.93	8.00
378.250 MHz	12.5	9.93	7.87
Limit Authorized Bandwidth 47 CFR 90.209 RSS 119 5.5		11.25	11.25
Necessary BW used in emission designator		11.0	8.1
Result		Pass	Pass

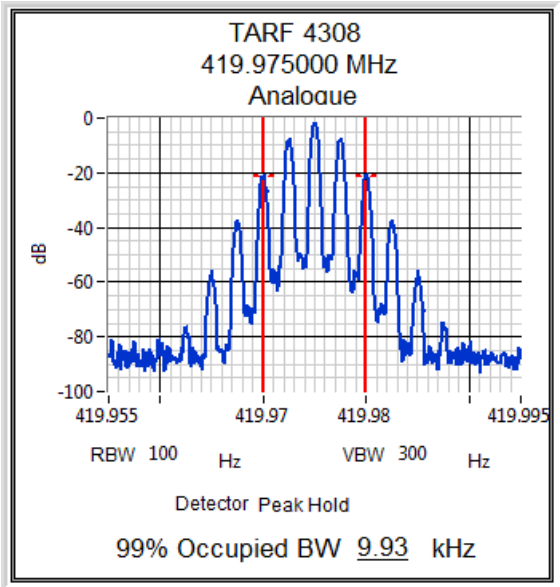
Transmitter Occupied (99%) Bandwidth - Analogue

Channel 1 – 4 15 W Tx Power 12.5 kHz Channel Spacing

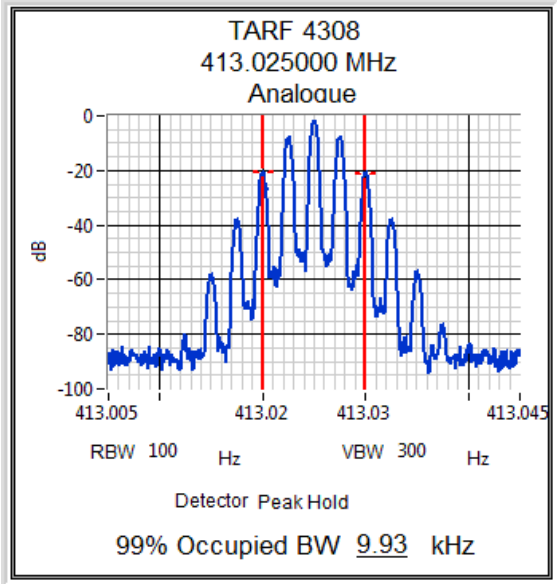
Tx Frequency: 406.125 MHz



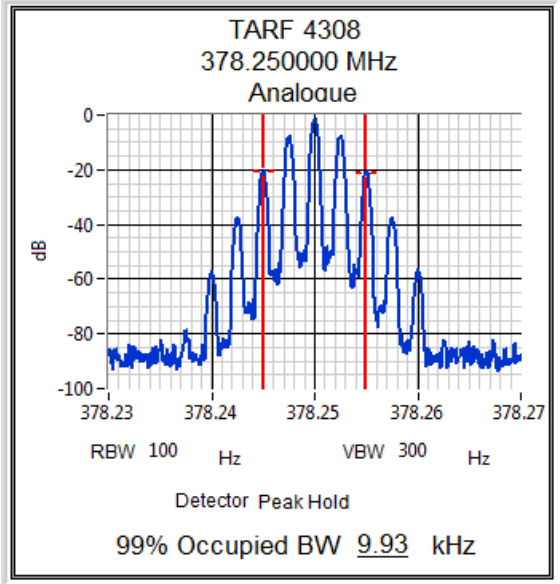
Tx Frequency: 419.975 MHz



Tx Frequency: 413.025 MHz



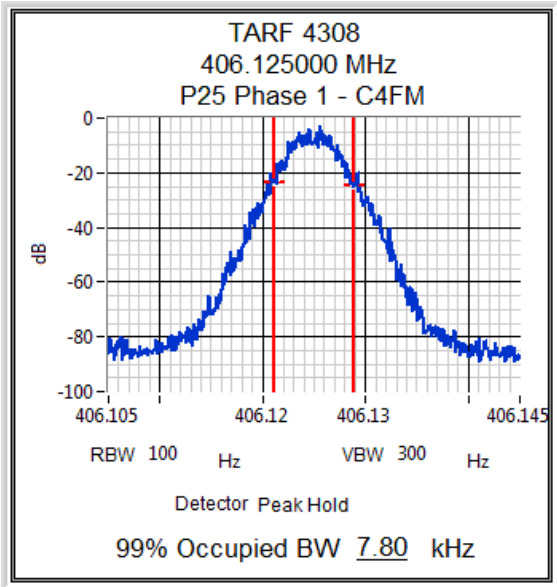
Tx Frequency: 378.250 MHz



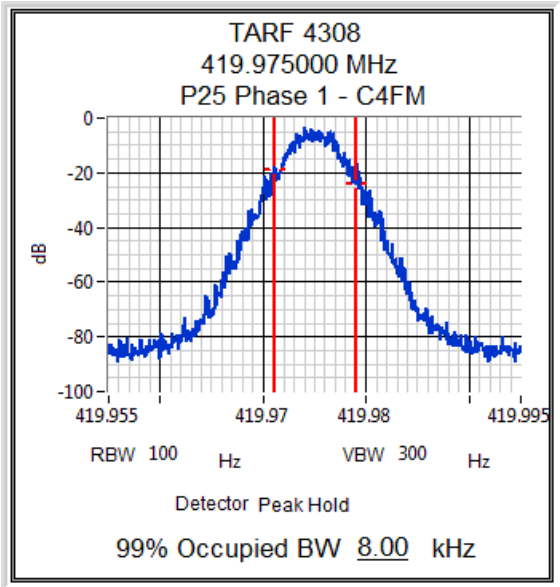
Transmitter Occupied (99%) Bandwidth – P25 Phase 1 C4FM

Channel 1 – 4 15 W Tx Power 12.5 kHz Channel Spacing

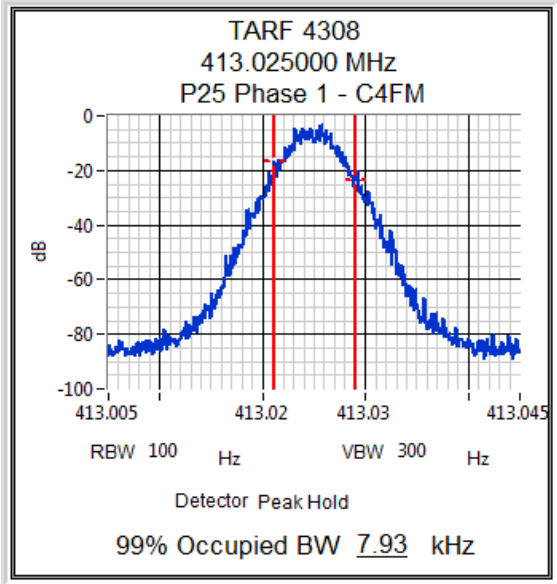
Tx Frequency: 406.125 MHz



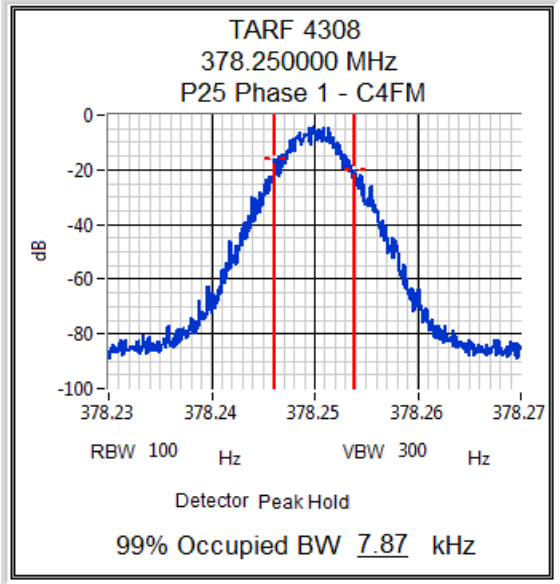
Tx Frequency: 419.975 MHz



Tx Frequency: 413.025 MHz



Tx Frequency: 378.250 MHz



TRANSMITTER SPECTRUM MASKS

SPECIFICATION: FCC 47 CFR 2.1049 (c) RSS-119 5.5

GUIDE: ANSI C63.26.5.7.3

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment Set up.

2. For analogue measurements: The EUT was modulated by a 2500 Hz tone at an input level 16 dB above a level that produced 50% deviation. The input level was established at the frequency of maximum response of the audio modulating circuit.

   For Data measurements: 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

MEASUREMENT RESULTS:
See the plots on the following pages for 12.5 kHz channel spacings at 15W and 2W transmit power.

MEASUREMENT UNCERTAINTY: ±0.65dB

EMISSION MASKS

Emission Mask D	12.5 kHz Channel Spacing	Analogue and Digital Voice/Data

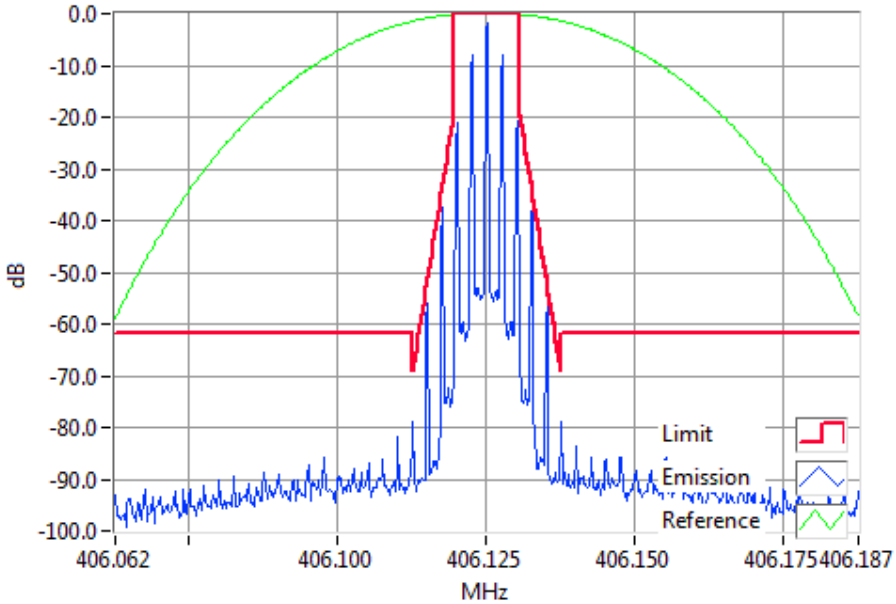
DATA SPEED

Digital Voice/Data	12.5 kHz Channel Spacing	9600 bps

Transmitter Spectrum Masks - Analogue

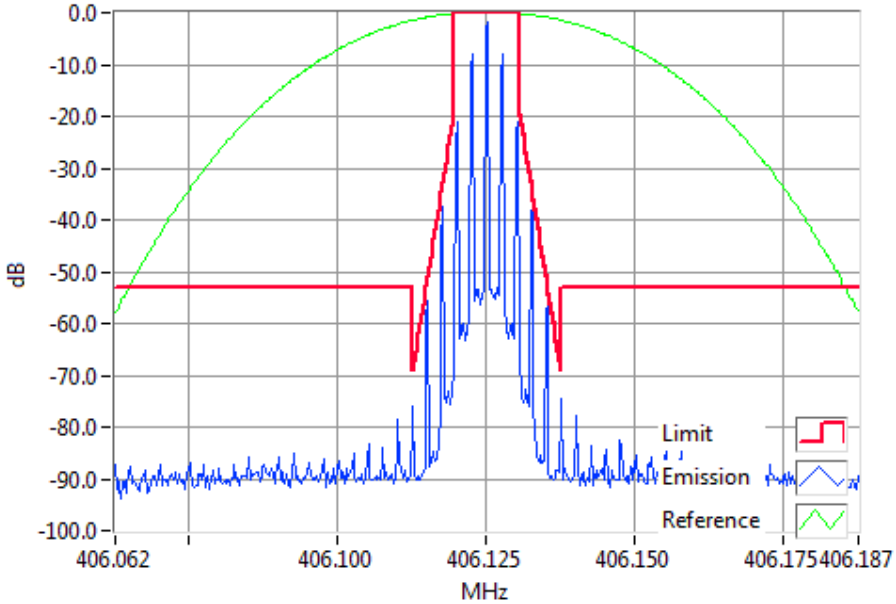
SPECIFICATION: FCC 47 CFR 2.1049 (c) RSS-119 5.5

Tx FREQUENCY: 406.125 MHz 15 W 12.5 kHz Channel Spacing



Analogue Modulation 406.1250MHz Mask D 15W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 406.125 MHz 2 W 12.5 kHz Channel Spacing

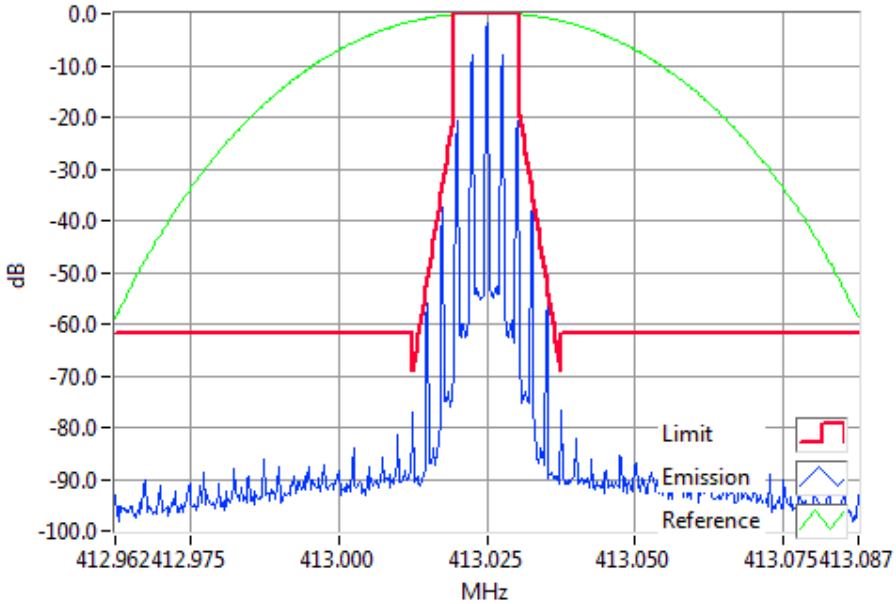


Analogue Modulation 406.1250MHz Mask D 2W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Transmitter Spectrum Masks - Analogue

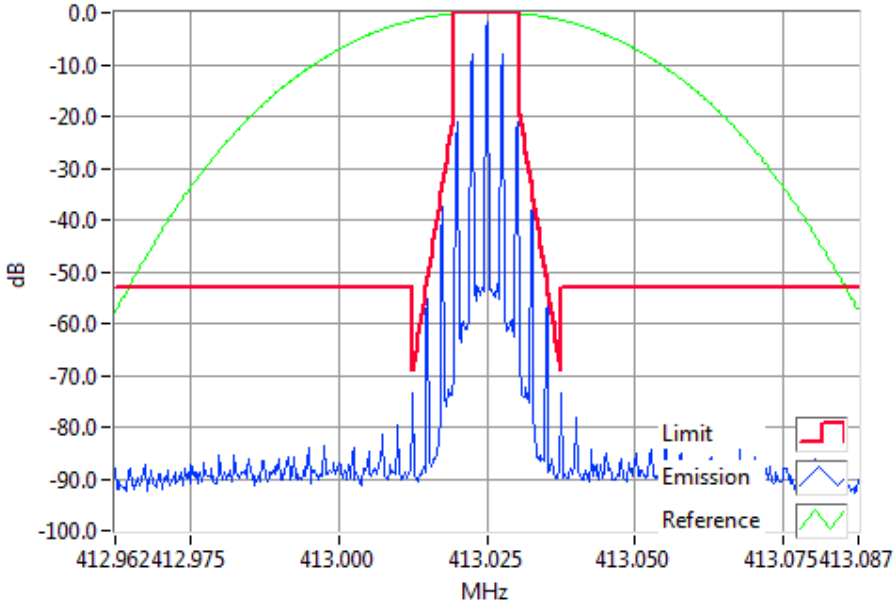
SPECIFICATION: FCC 47 CFR 2.1049 (c) RSS-119 5.5

Tx FREQUENCY: 413.025 MHz 15 W 12.5 kHz Channel Spacing



Analogue Modulation 413.0250MHz Mask D 15W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 413.025 MHz 2 W 12.5 kHz Channel Spacing

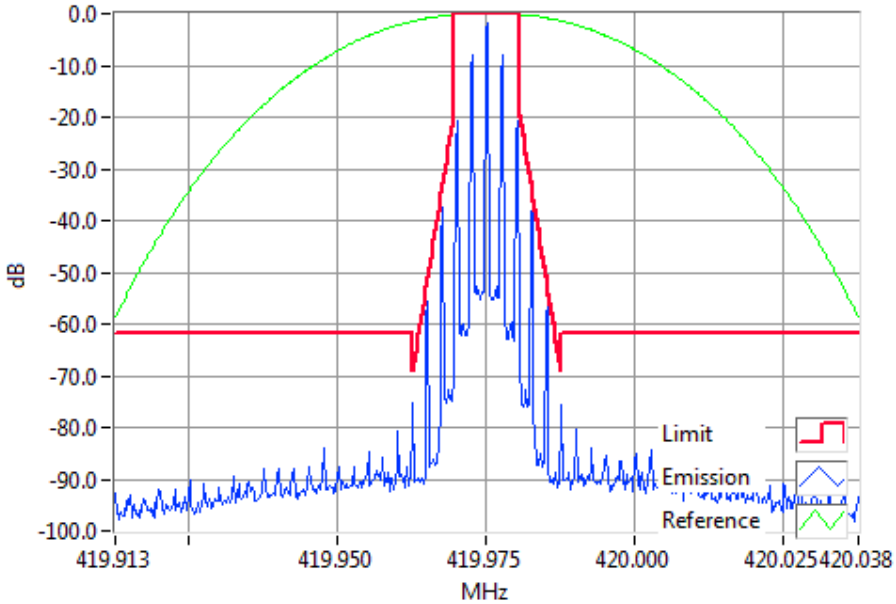


Analogue Modulation 413.0250MHz Mask D 2W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Transmitter Spectrum Masks - Analogue

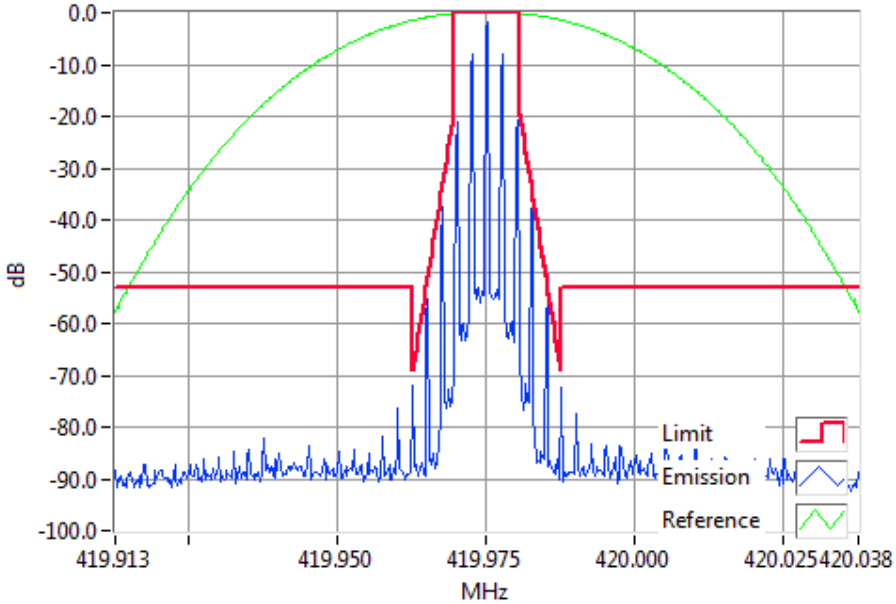
SPECIFICATION: FCC 47 CFR 2.1049 (c) RSS-119 5.5

Tx FREQUENCY: 419.975 MHz 15 W 12.5 kHz Channel Spacing



Analogue Modulation 419.9750MHz Mask D 15W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 419.975 MHz 2 W 12.5 kHz Channel Spacing

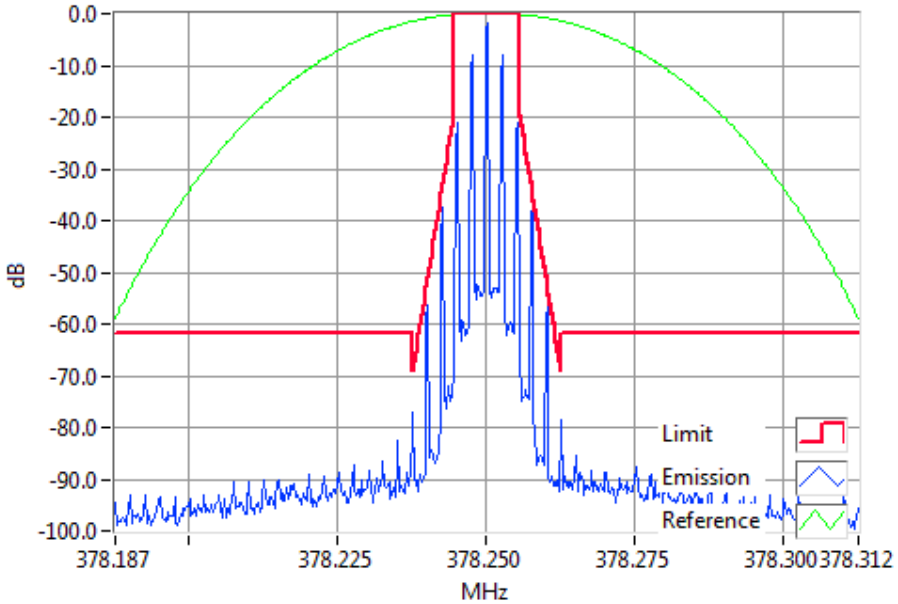


Analogue Modulation 419.9750MHz Mask D 2W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Transmitter Spectrum Masks - Analogue

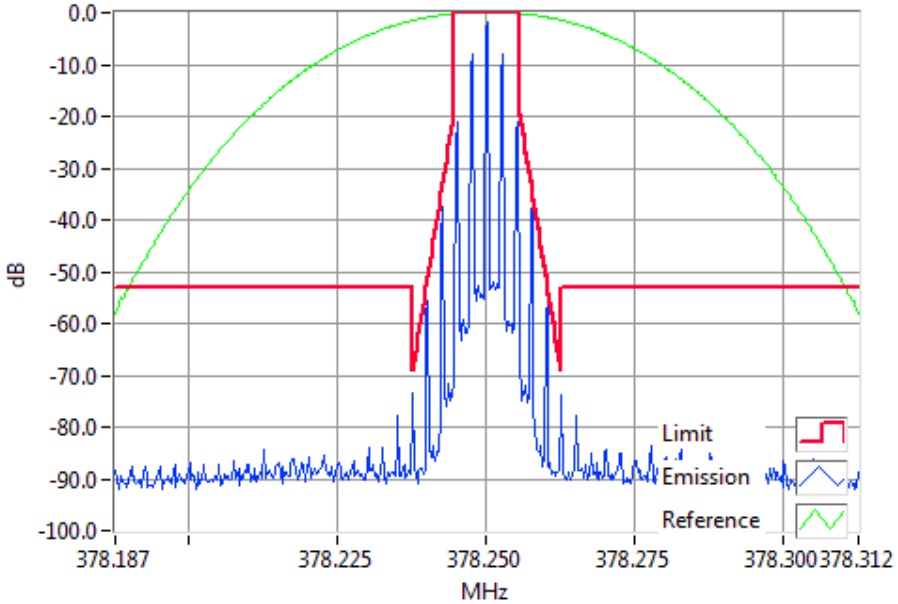
SPECIFICATION: FCC 47 CFR 2.1049 (c) RSS-119 5.5

Tx FREQUENCY: 378.250 MHz 15 W 12.5 kHz Channel Spacing



Analogue Modulation 378.2500MHz Mask D 15W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 378.250 MHz 2 W 12.5 kHz Channel Spacing

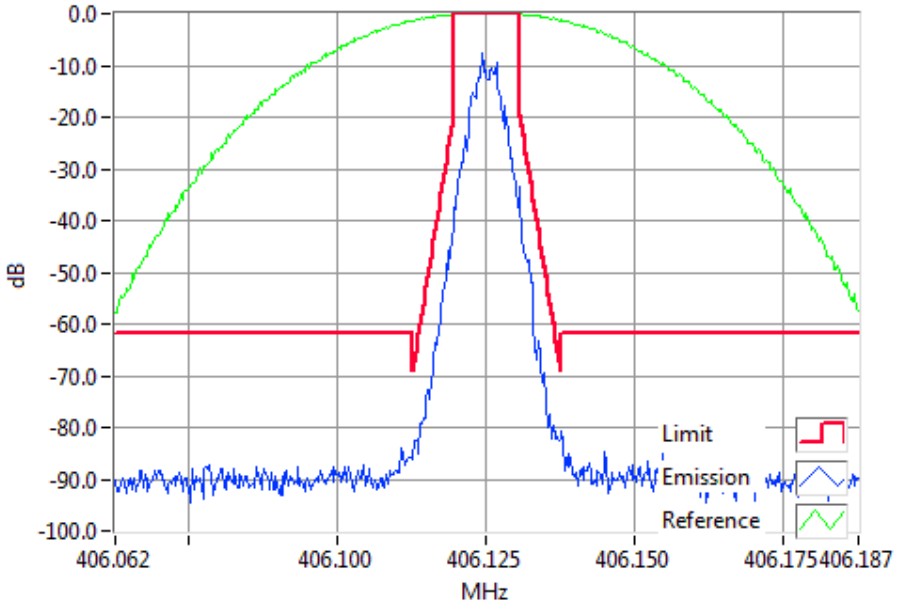


Analogue Modulation 378.2500MHz Mask D 2W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Transmitter Spectrum Masks – P25 Phase 1 C4FM

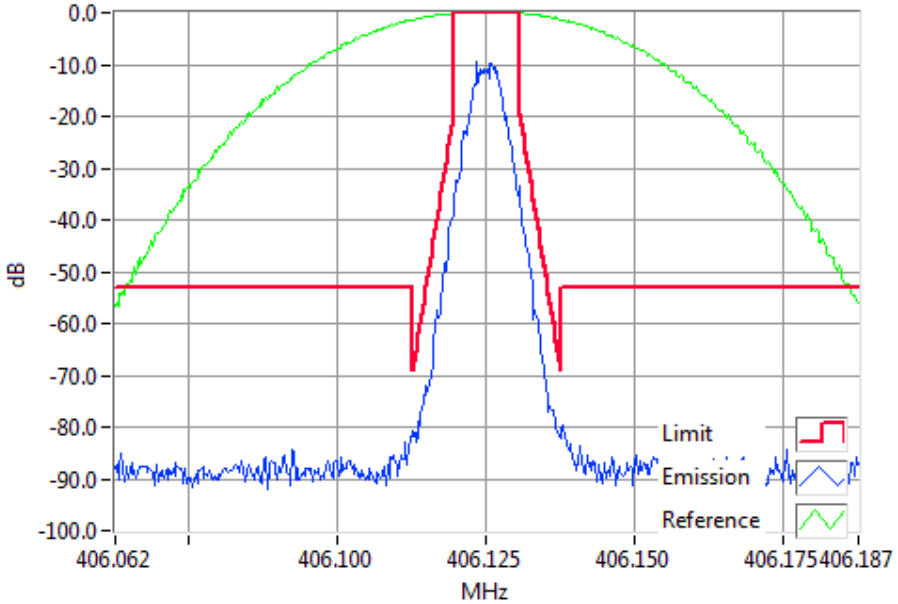
SPECIFICATION: FCC 47 CFR 2.1049 (c) RSS-119 5.5

Tx FREQUENCY: 406.125 MHz 15 W 12.5 kHz Channel Spacing



P25 Phase 1 - C4FM 406.1250MHz Mask D 15W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 406.125 MHz 2 W 12.5 kHz Channel Spacing

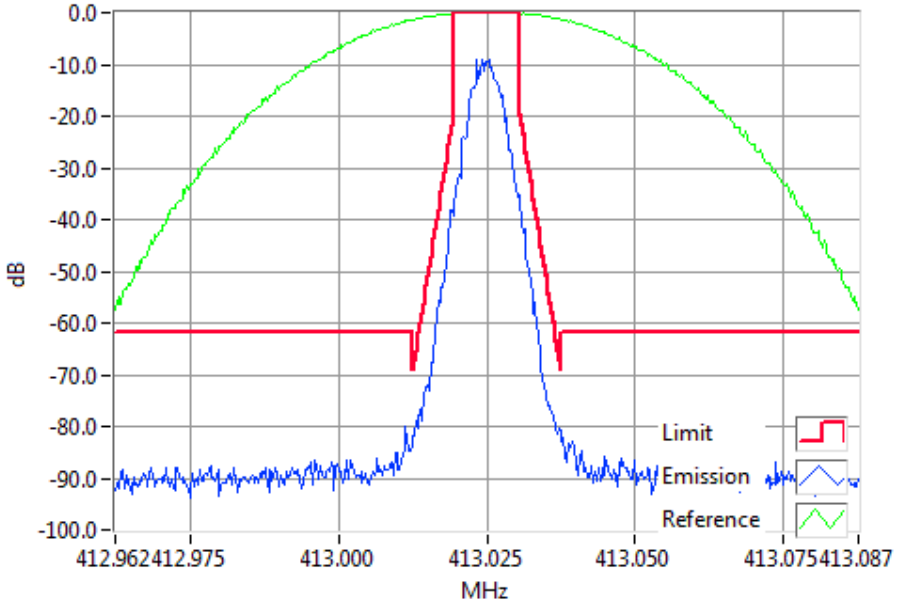


P25 Phase 1 - C4FM 406.1250MHz Mask D 2W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Transmitter Spectrum Masks – P25 Phase 1 C4FM

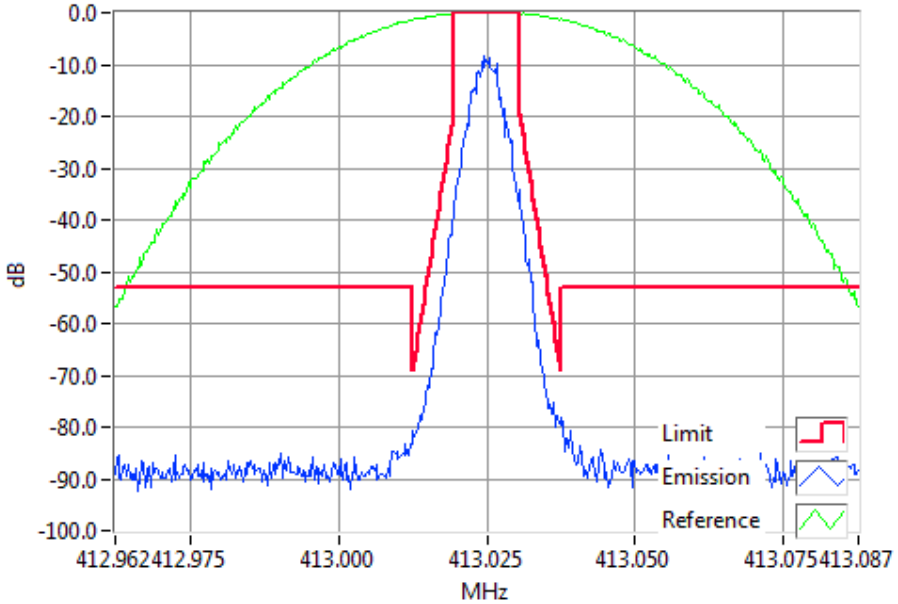
SPECIFICATION: FCC 47 CFR 2.1049 (c) RSS-119 5.5

Tx FREQUENCY: 413.025 MHz 15 W 12.5 kHz Channel Spacing



P25 Phase 1 - C4FM 413.0250MHz Mask D 15W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 413.025 MHz 2 W 12.5 kHz Channel Spacing

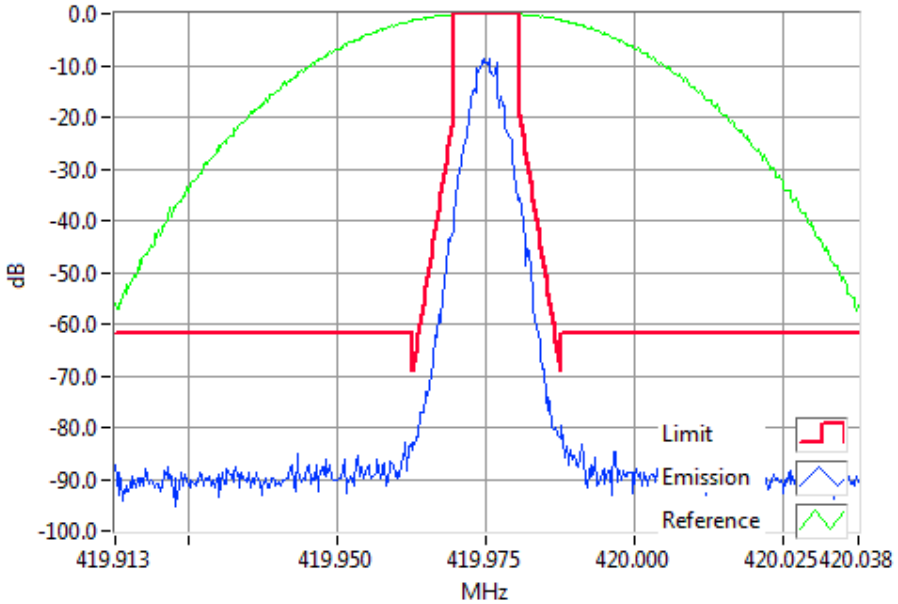


P25 Phase 1 - C4FM 413.0250MHz Mask D 2W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Transmitter Spectrum Masks – P25 Phase 1 C4FM

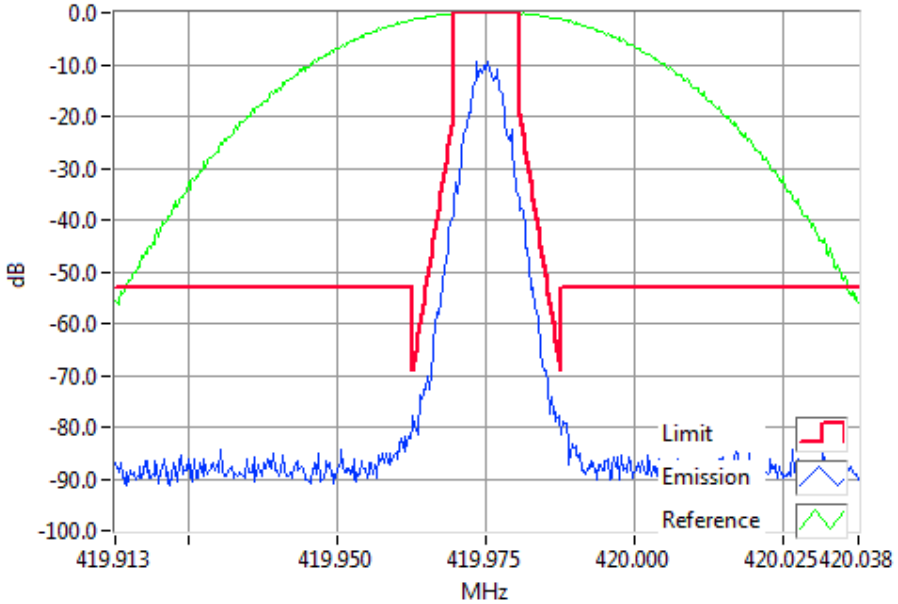
SPECIFICATION: FCC 47 CFR 2.1049 (c) RSS-119 5.5

Tx FREQUENCY: 419.975 MHz 15 W 12.5 kHz Channel Spacing



P25 Phase 1 - C4FM 419.9750MHz Mask D 15W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 419.975 MHz 2 W 12.5 kHz Channel Spacing

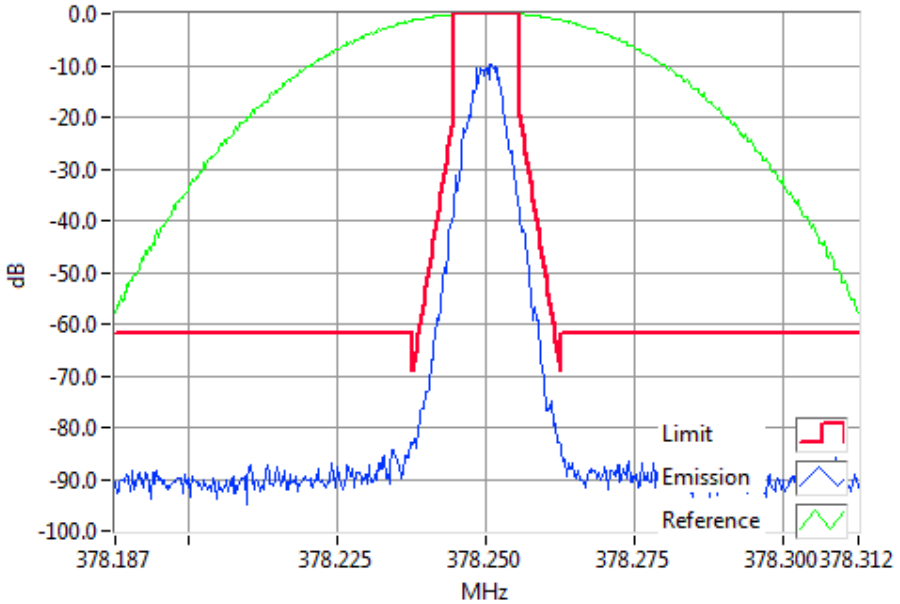


P25 Phase 1 - C4FM 419.9750MHz Mask D 2W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Transmitter Spectrum Masks – P25 Phase 1 C4FM

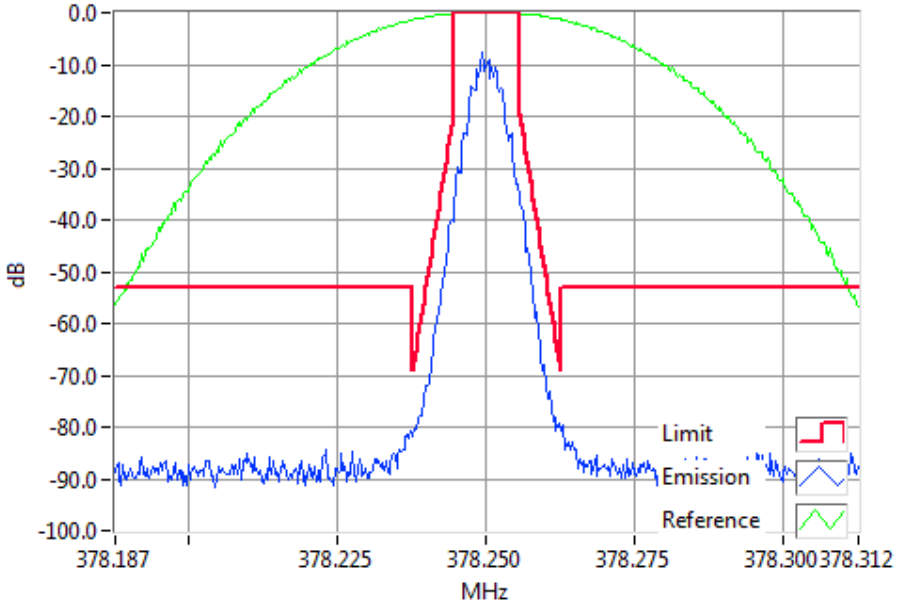
SPECIFICATION: FCC 47 CFR 2.1049 (c) RSS-119 5.5

Tx FREQUENCY: 378.250 MHz 15 W 12.5 kHz Channel Spacing



P25 Phase 1 - C4FM 378.2500MHz Mask D 15W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 378.250 MHz 2 W 12.5 kHz Channel Spacing



P25 Phase 1 - C4FM 378.2500MHz Mask D 2W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATIONS: FCC 47 CFR 2.1051 RSS-119 5.8

GUIDE: ANSI C63.26 5.7

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: 9 kHz to Fc-BW
   Fc + BW to 10Fc (4.2 GHz)
3. The EUT was set to transmit high or low power. A scan is performed with a resolution bandwidth of 100 kHz and a video bandwidth of 300 kHz for frequencies up to 1 GHz, and a resolution bandwidth of 1 MHz and a video bandwidth of 3 MHz for frequencies above 1 GHz.
4. For frequencies close to the carrier the spectrum was measured using a resolution bandwidth of 1kHz, the results were then integrated to give measurements for 100kHz bandwidth.
5. A band notch high-pass filter was used to reject carrier frequencies from 400MHz to 520MHz.
6. For each frequency range the spectrum analyser was loaded with the appropriate calibration figures to compensate for the cables, attenuator, and filter losses, allowing the emission levels to be read directly with no further calculation.
7. The results of the various sweeps were combined programmatically to give charts for frequencies near the carrier, up to 1GHz and above 1GHz.

   The calibrations are loaded as an overall reference level offset plus a set of correction factors for the required frequency band.

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

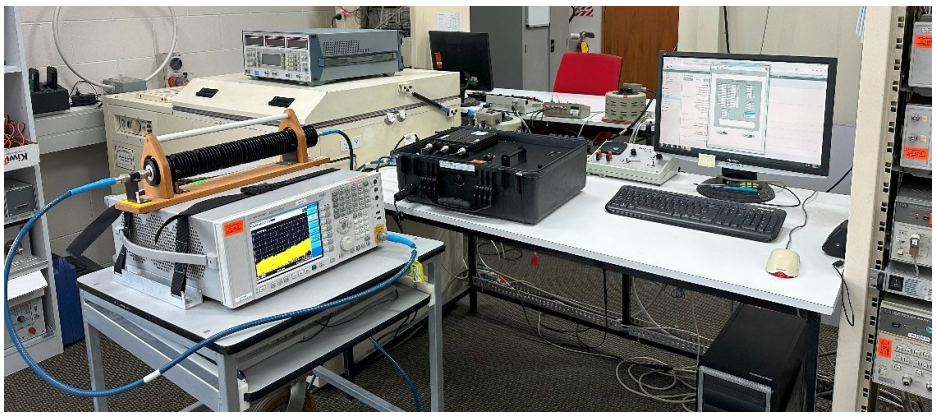
Example of attenuation correction: (dB)

10 dB attenuator E3674	9.50 dB	
1.5 M blue cable E5028	0.28 dB	
Total Attenuation @ 500 MHz	9.78	Sum of component attenuation (a)
Amplitude offset	10.00	(b)
Correction @ 500 MHz	-0.22	(a-b)

MEASUREMENT UNCERTAINTY: ≤12.75 GHz ± 3.0 dB

MEASUREMENT RESULTS:
See the tables and plots on the following pages for 12.5 kHz channel spacing at 15W and 2W transmit power.

Photo: Conducted Emissions Test Setup



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051 RSS-119 5.8

12.5 kHz Channel Spacing 406.125 MHz @ 15 W Emission Mask D

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

12.5 kHz Channel Spacing 406.125 MHz @ 2 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.		

12.5 kHz Channel Spacing 413.025 MHz @ 15 W Emission Mask D

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

12.5 kHz Channel Spacing 413.025 MHz @ 2 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)

SPECIFICATION: FCC 47 CFR 2.1051 RSS-119 5.8

12.5 kHz Channel Spacing 419.975 MHz @ 15 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
2119.224515	-38.4	-80.16
~	~	~

12.5 kHz Channel Spacing 419.975 MHz @ 2 W Emission Mask D

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

12.5 kHz Channel Spacing 378.250 MHz @ 15 W Emission Mask D

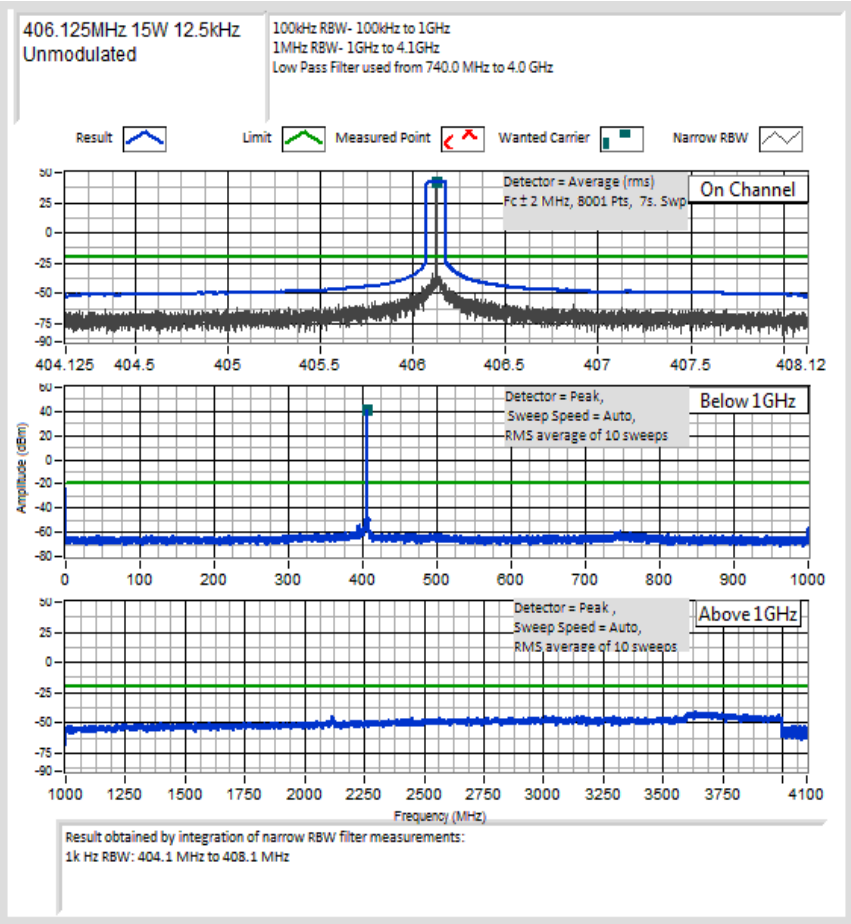
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~

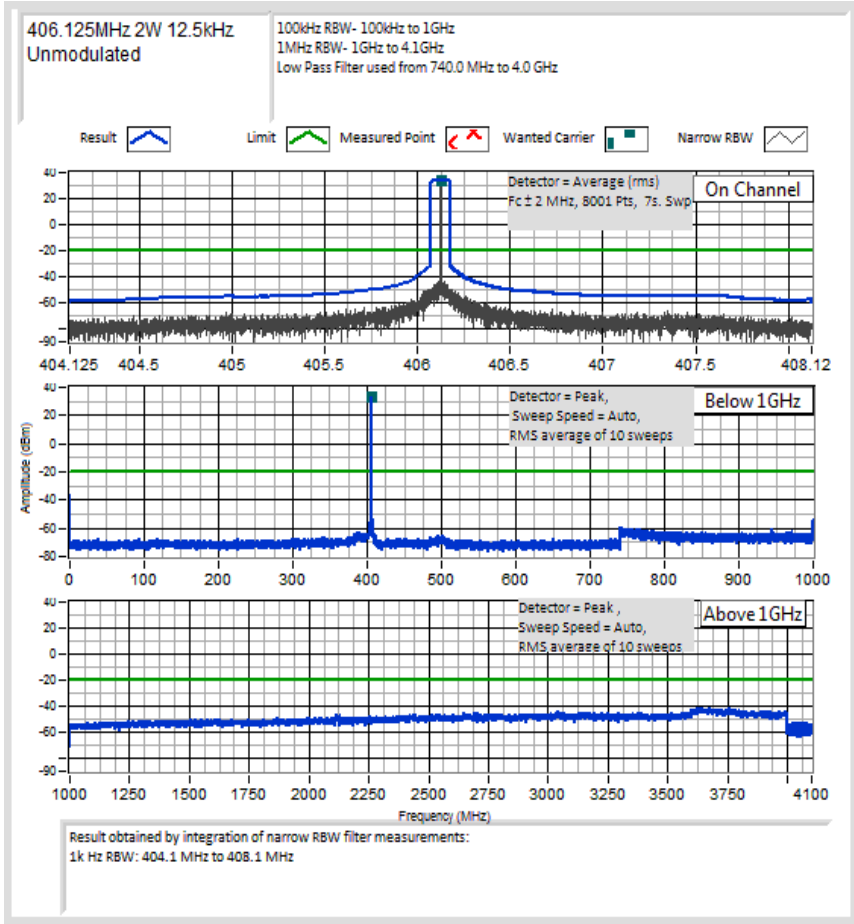
12.5 kHz Channel Spacing 378.250 MHz @ 2 W Emission Mask D

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

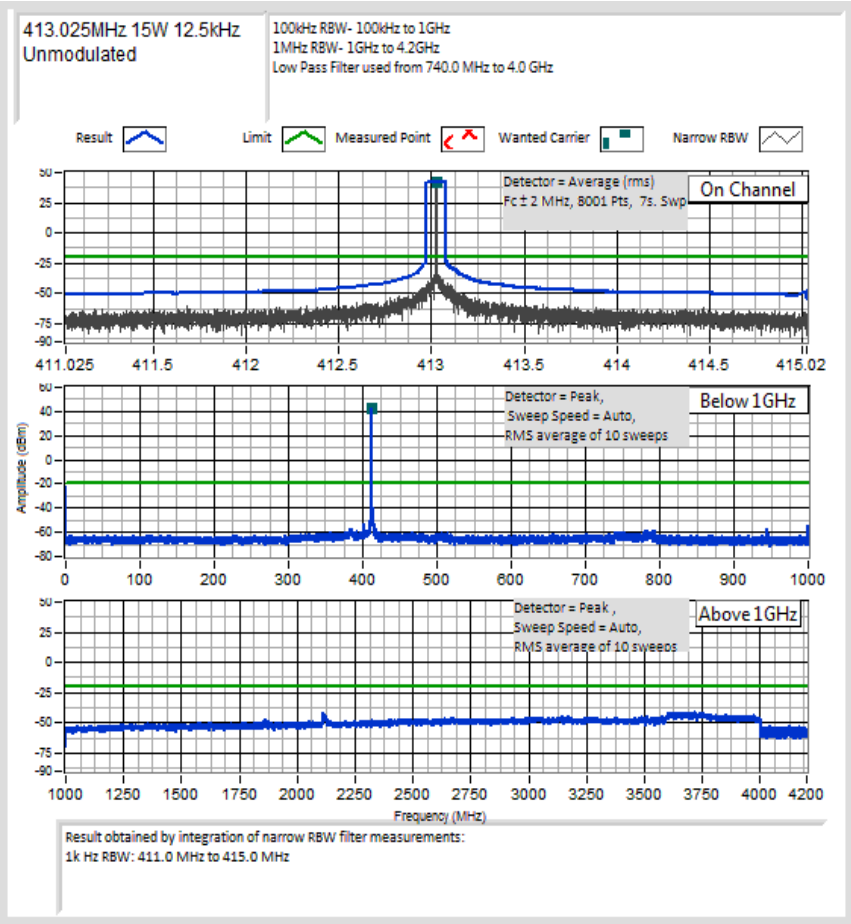
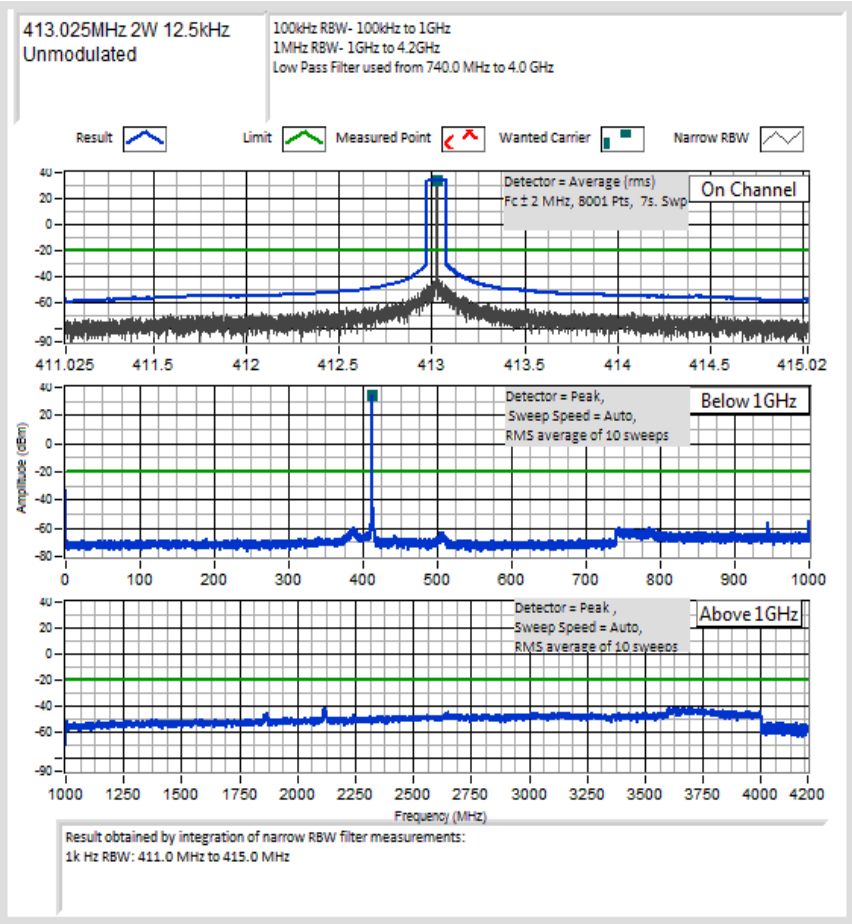
Spurious Emissions (Tx Conducted)

406.125 MHz	
15 W	2 W

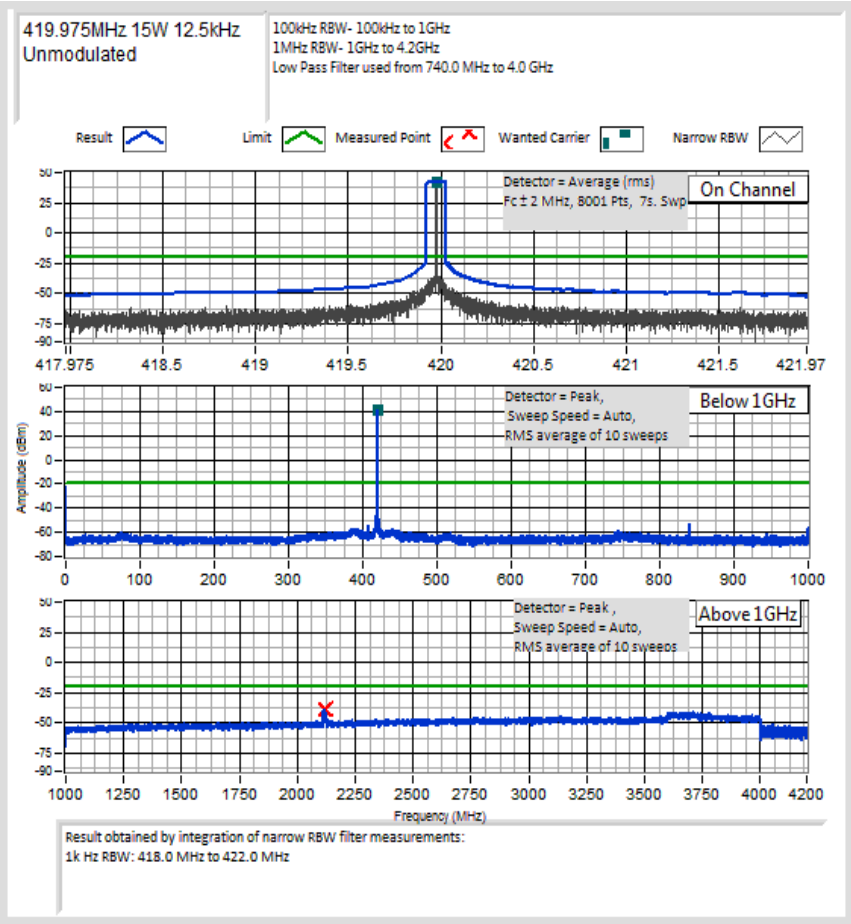
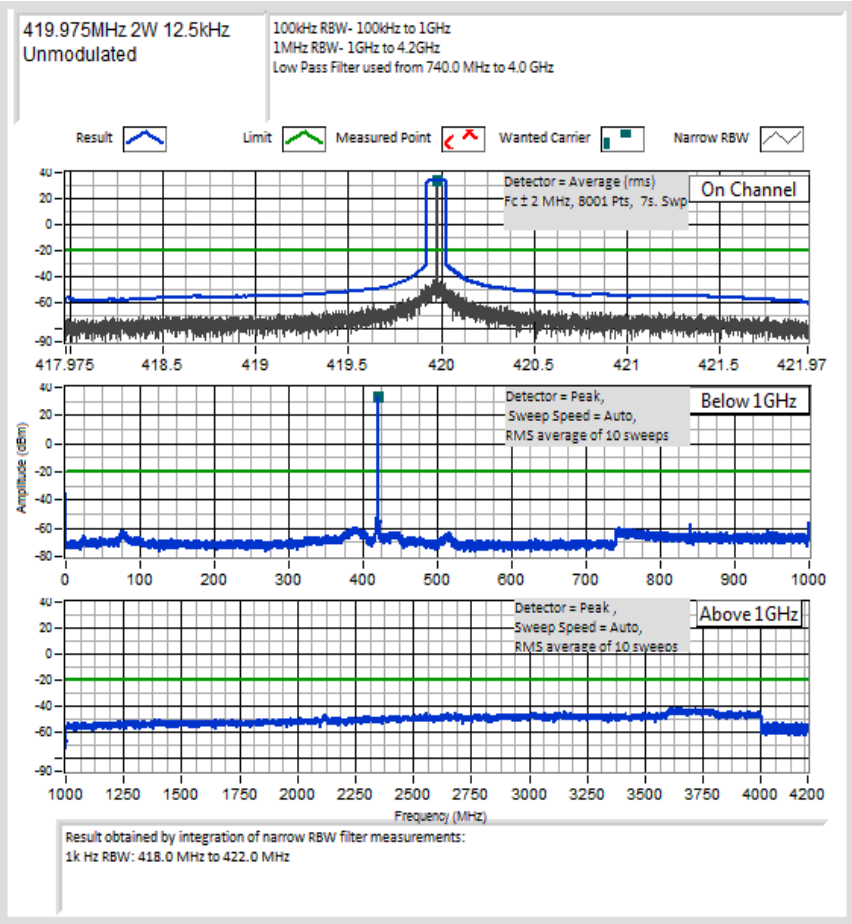




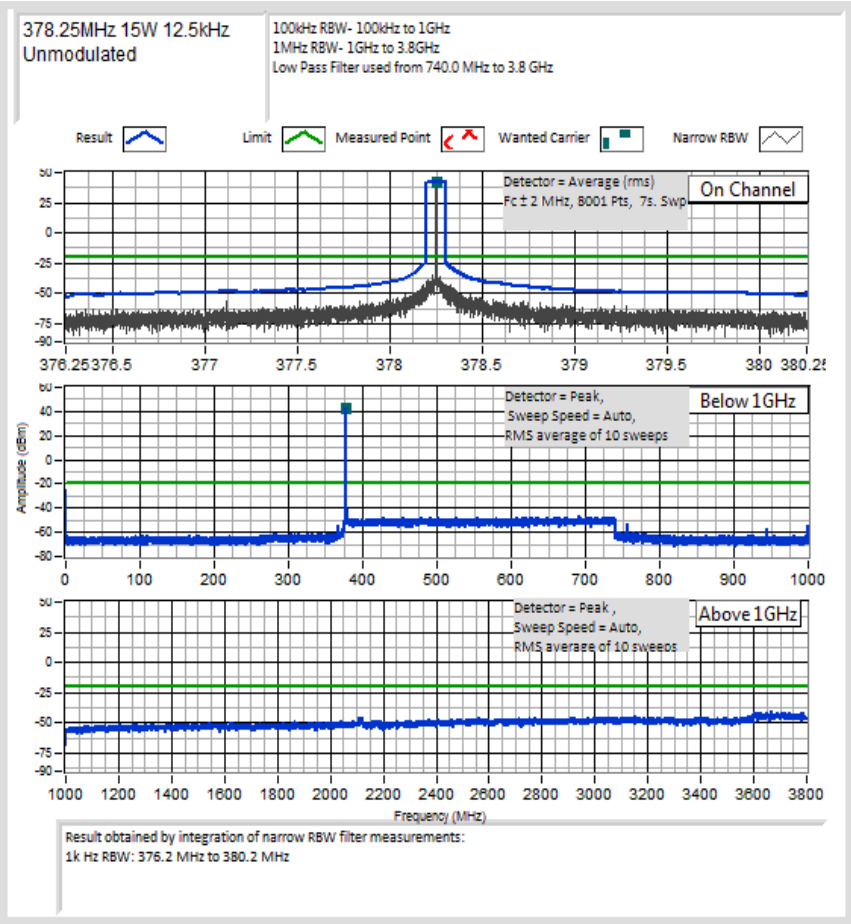
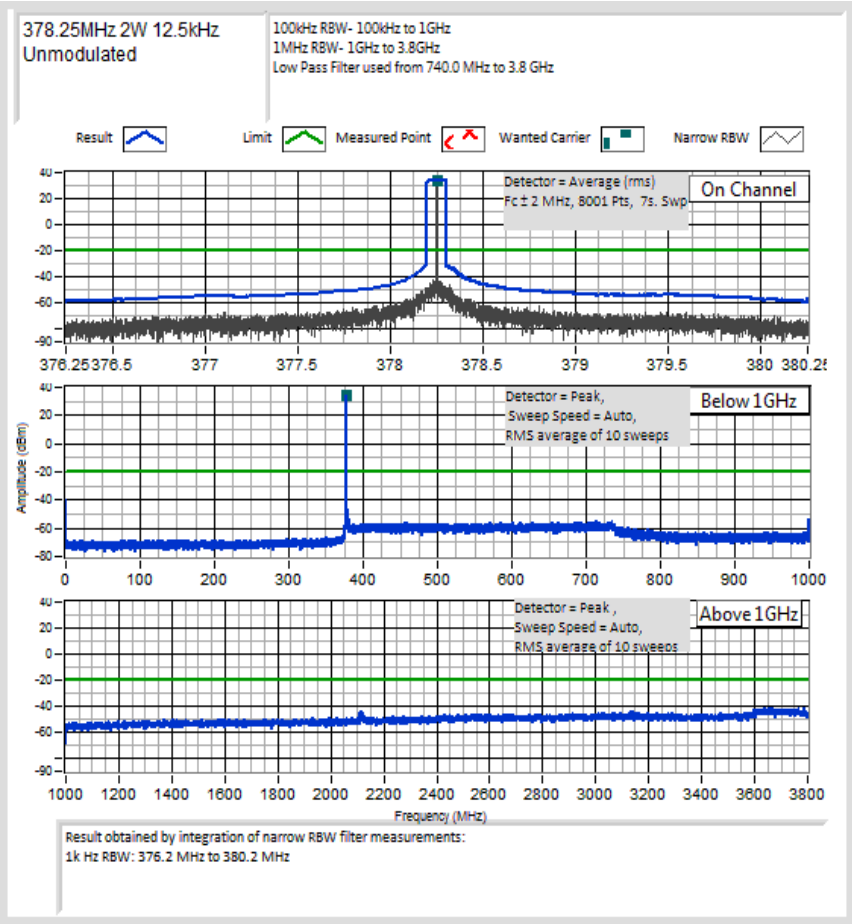
Spurious Emissions (Tx Conducted)

413.025 MHz	
15 W	2 W
	

Spurious Emissions (Tx Conducted)

419.975 MHz	
15 W	2 W
	

Spurious Emissions (Tx Conducted)

378.250 MHz	
15 W	2 W
	

Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 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 $50 + 10 \text{ Log}_{10} (P_{Watts})$	
15 W	-20 dBm	-61.8 dBc
2 W	-20 dBm	-53.0 dBc

TRANSMITTER SPURIOUS EMISSIONS (RADIATED)

SPECIFICATION: FCC 47 CFR 2.1053

GUIDE: TIA/EIA-603E 2.2.12

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 (10 x Fc). 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 UNCERTAINTY: ≤12.75 GHz ± 4.6 dB

MEASUREMENT RESULTS:
See the tables on the following pages

Spurious Emissions (Tx Radiated)

SPECIFICATION: FCC 47 CFR 2.1053

12.5 kHz Channel Spacing 406.125 MHz @ 15 W Emission Mask D

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

12.5 kHz Channel Spacing 406.125 MHz @ 2 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.		

12.5 kHz Channel Spacing 413.025 MHz @ 15 W Emission Mask D

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

12.5 kHz Channel Spacing 413.025 MHz @ 2 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 Radiated)

SPECIFICATION: FCC 47 CFR 2.1053

12.5 kHz Channel Spacing 419.975 MHz @ 15 W Emission Mask D

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

12.5 kHz Channel Spacing 419.975 MHz @ 2 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.		

12.5 kHz Channel Spacing 378.250 MHz @ 15 W Emission Mask D

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

12.5 kHz Channel Spacing 378.250 MHz @ 2 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.		

LIMITS: FCC 47 CFR 2.1053

Carrier Output Power	Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \text{ Log}_{10} (P_{Watts})$	
15 W	-20 dBm	-61.8 dBc
2 W	-20 dBm	-53.0 dBc

Tx Radiated Emissions - Continued

Open Area Test Site Results:

12.5 kHz Channel Spacing 413.025 MHz @ 15 W Emission Mask D

Harmonics Emission Frequency (MHz)	Level (dBm)	Level (dBc)
826.050	-57.87	-99.63
1239.075	-55.43	-97.19
1652.100	-68.64	-110.40
2065.125	No emissions detected	
2478.150	No emissions detected	
2891.175	No emissions detected	
Measurement Uncertainty	± 4.6 dB	

Sample Calculation	Measurement				Result	
	Reference	Substitution				
Emission Frequency (MHz)	Reference Level (dBm)	Sig-gen Level	Cable and Attenuator Gain	Antenna Gain (dBd)	dBm	nW
826.050	-89.5	-40.9	-15.93	-1.04	-57.87	1.6
		A	B	C	D	

Result (D) = A+B+C

Photo: OATS Setup

TRANSIENT FREQUENCY BEHAVIOUR

SPECIFICATION: FCC 47 CFR 90.214 RSS-119 5.9

GUIDE: ANSI C63.26 6.5.2.2

MEASUREMENT PROCEDURE:
1. Refer Annex A for equipment set up.
2. Measurements and plots were made following the TIA/EIA procedure.

MEASUREMENT UNCERTAINTY: 130Hz

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

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214 RSS-119 5.9

Tx FREQUENCY: 406.125 MHz 15 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	-0.4	N/A
t2	0.7	N/A
t3	N/A	-0.4

	YES	NO
Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation.	☑	☐
Confirm that during the period t2 the frequency difference does not exceed half a channel separation.	☑	☐
Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit.	☑	☐

LIMIT: FCC 47 CFR 90.214

TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

LIMIT: RSS-119 5.9

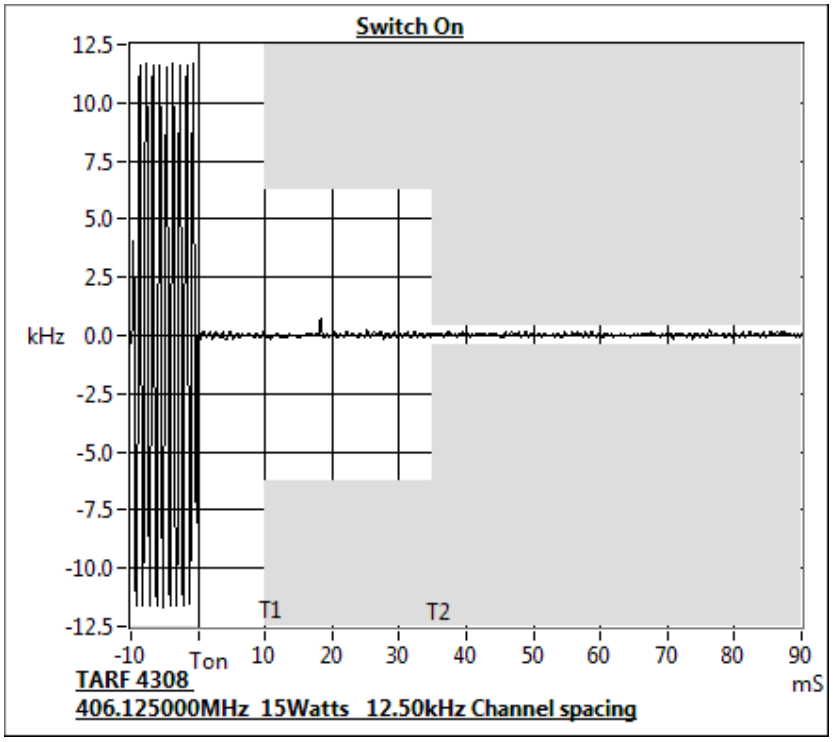
Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz Channels			
TRANSIENT PERIODS	Maximum Frequency Difference	FREQUENCY RANGE	
		138 – 174 MHz	406.1 – 470 MHz
t1 (ms)	± 12.5 kHz	5 ms	10 ms
t2 (ms)	± 6.25 kHz	20 ms	25 ms
t3 (ms)	± 12.5 kHz	5 ms	10 ms

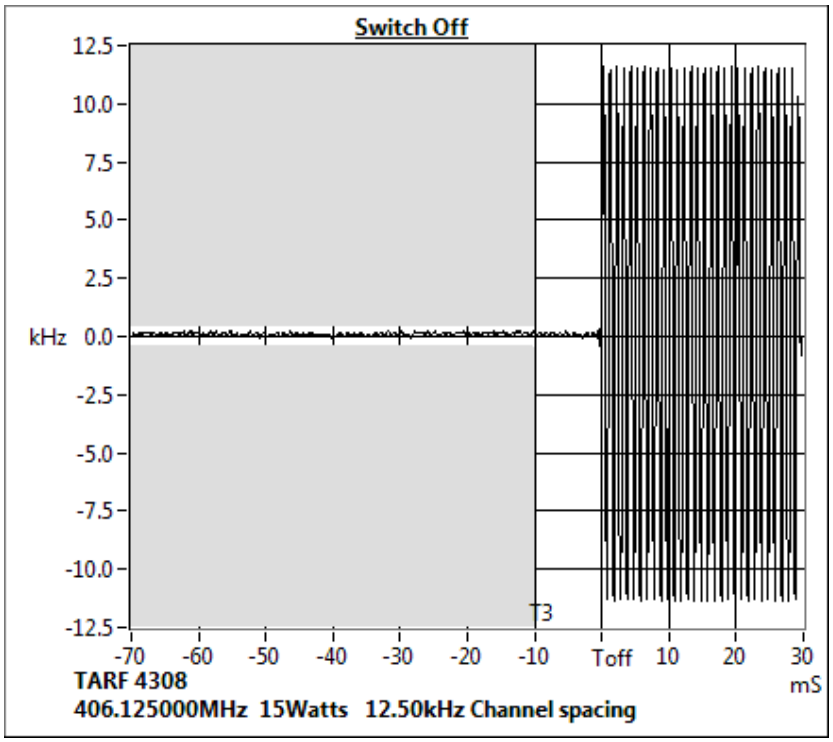
Note: RSS-119 5.9 - If the transmitter carrier output power rating is 6 Watts or less, the frequency difference during the time periods t1 and t3 may exceed the maximum frequency difference for these time periods.

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214 RSS-119 5.9

Tx FREQUENCY: 406.125 MHz 15 W 12.5 kHz Channel Spacing





Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 413.025 MHz 15 W 25.0 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	-0.2	N/A
t2	0.2	N/A
t3	N/A	-1.2

	YES	NO
Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation.	☑	☐
Confirm that during the period t2 the frequency difference does not exceed half a channel separation.	☑	☐
Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit.	☑	☐

LIMIT: FCC 47 CFR 90.214

TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

LIMIT: RSS-119 5.9

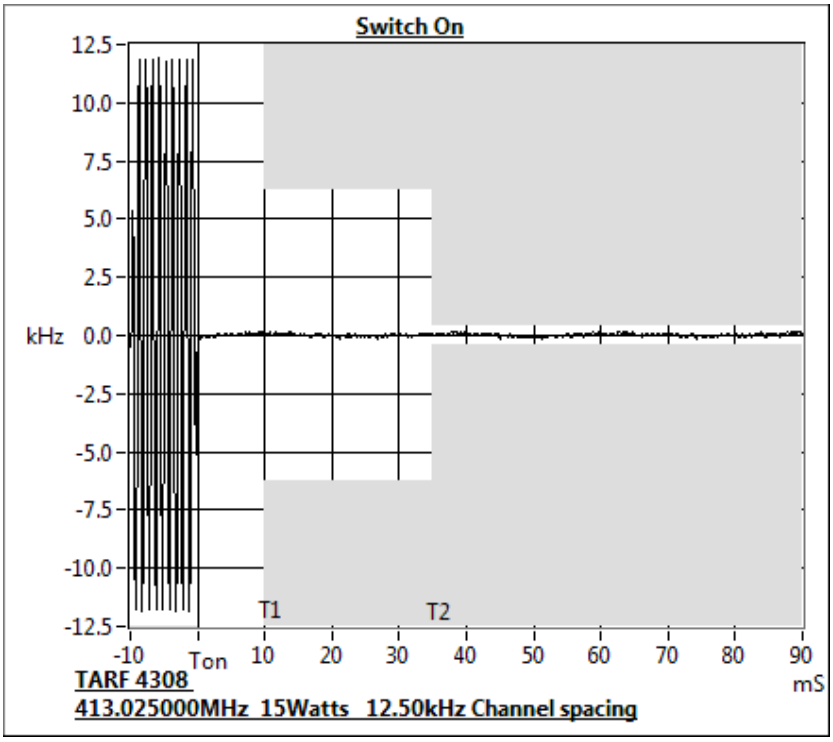
Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz Channels			
TRANSIENT PERIODS	Maximum Frequency Difference	FREQUENCY RANGE	
		138 – 174 MHz	406.1 – 470 MHz
t1 (ms)	± 12.5 kHz	5 ms	10 ms
t2 (ms)	± 6.25 kHz	20 ms	25 ms
t3 (ms)	± 12.5 kHz	5 ms	10 ms

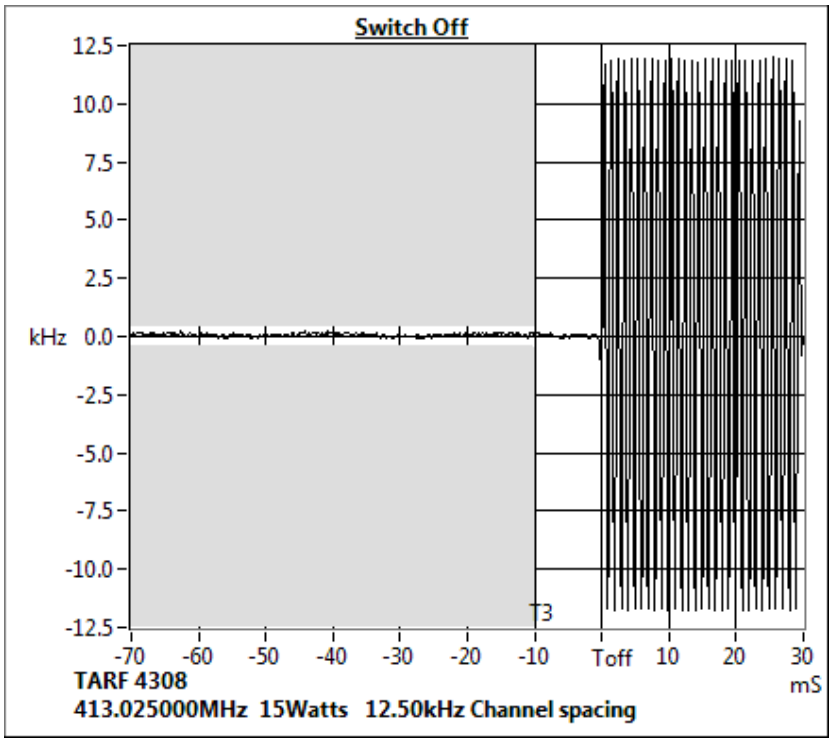
Note: RSS-119 5.9 - If the transmitter carrier output power rating is 6 Watts or less, the frequency difference during the time periods t1 and t3 may exceed the maximum frequency difference for these time periods,

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 413.025 MHz 15 W 25.0 kHz Channel Spacing





Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214 RSS-119 5.9

Tx FREQUENCY: 419.975 MHz 15 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	-0.9	N/A
t2	0.2	N/A
t3	N/A	-0.7

	YES	NO
Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation.	☑	☐
Confirm that during the period t2 the frequency difference does not exceed half a channel separation.	☑	☐
Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit.	☑	☐

LIMIT: FCC 47 CFR 90.214

TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

LIMIT: RSS-119 5.9

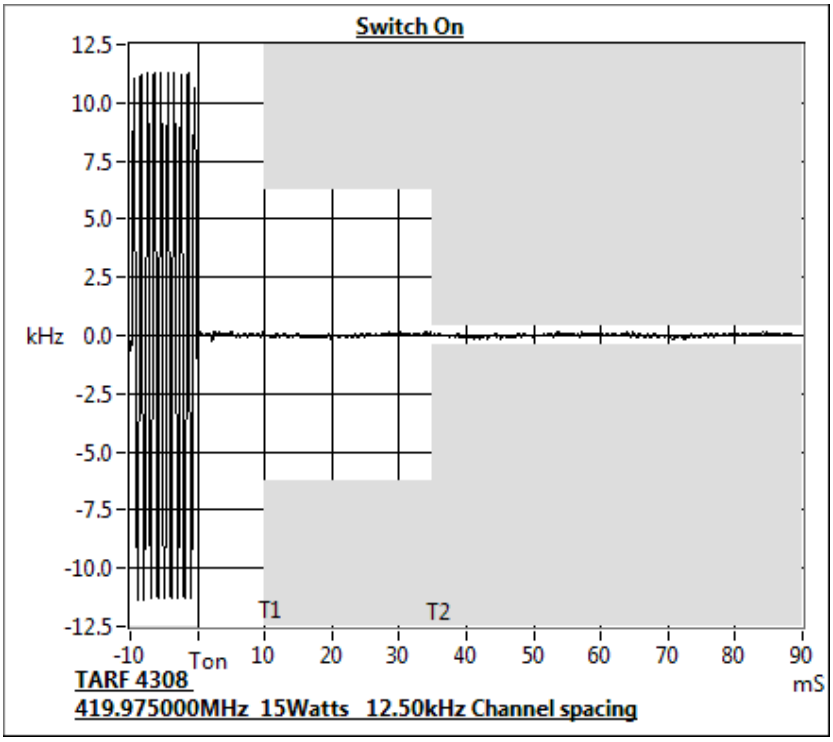
Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz Channels			
TRANSIENT PERIODS	Maximum Frequency Difference	FREQUENCY RANGE	
		138 – 174 MHz	406.1 – 470 MHz
t1 (ms)	± 12.5 kHz	5 ms	10 ms
t2 (ms)	± 6.25 kHz	20 ms	25 ms
t3 (ms)	± 12.5 kHz	5 ms	10 ms

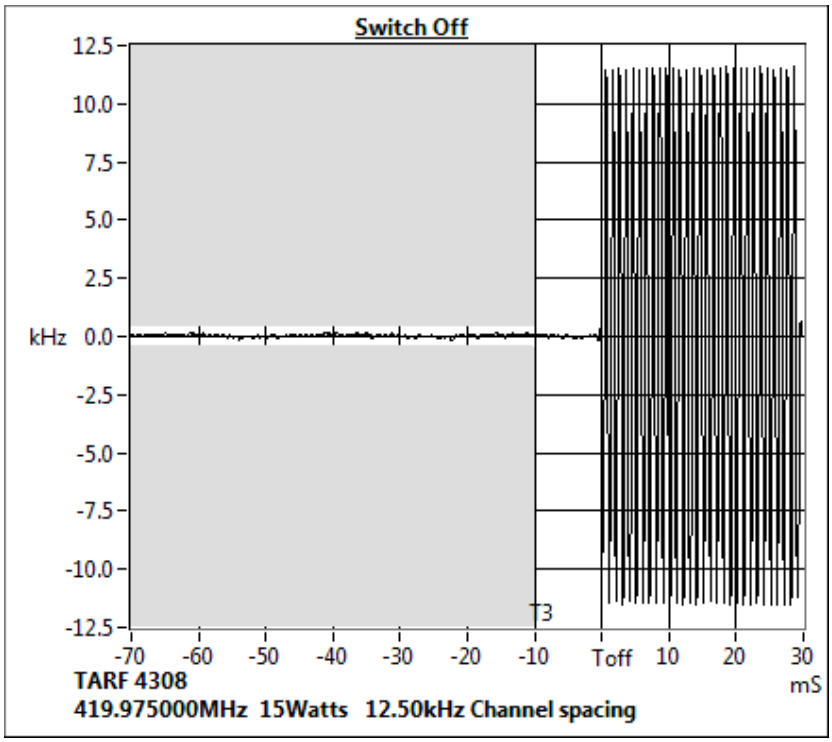
Note: RSS-119 5.9 - If the transmitter carrier output power rating is 6 Watts or less, the frequency difference during the time periods t1 and t3 may exceed the maximum frequency difference for these time periods.

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214 RSS-119 5.9

Tx FREQUENCY: 419.975 MHz 15 W 12.5 kHz Channel Spacing





Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 378.250 MHz 15 W 25.0 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	0.9	N/A
t2	-0.5	N/A
t3	N/A	-1.2

	YES	NO
Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation.	☑	☐
Confirm that during the period t2 the frequency difference does not exceed half a channel separation.	☑	☐
Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit.	☑	☐

LIMIT: FCC 47 CFR 90.214

TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

LIMIT: RSS-119 5.9

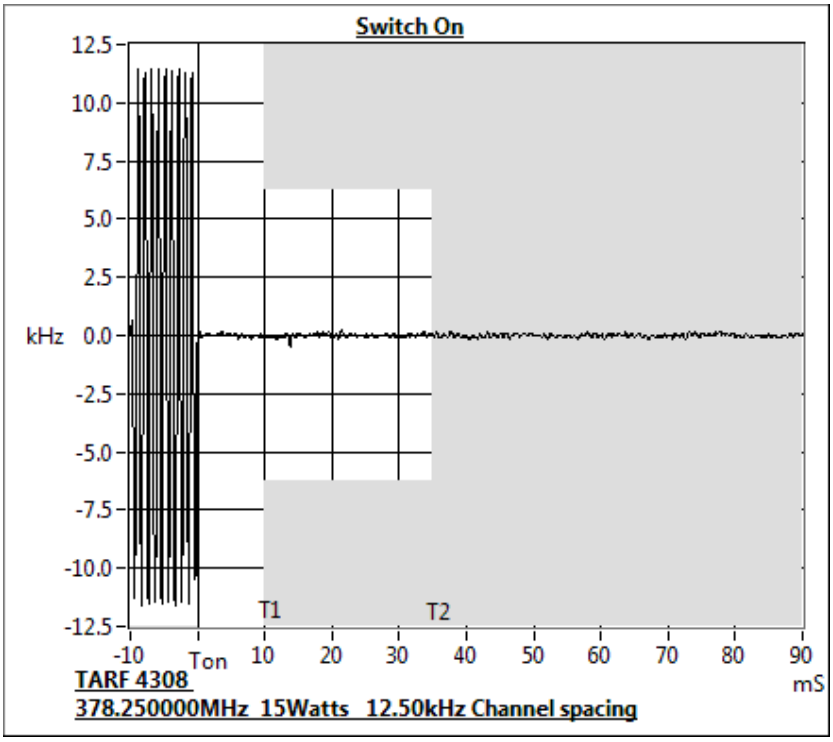
Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz Channels			
TRANSIENT PERIODS	Maximum Frequency Difference	FREQUENCY RANGE	
		138 – 174 MHz	406.1 – 470 MHz
t1 (ms)	± 12.5 kHz	5 ms	10 ms
t2 (ms)	± 6.25 kHz	20 ms	25 ms
t3 (ms)	± 12.5 kHz	5 ms	10 ms

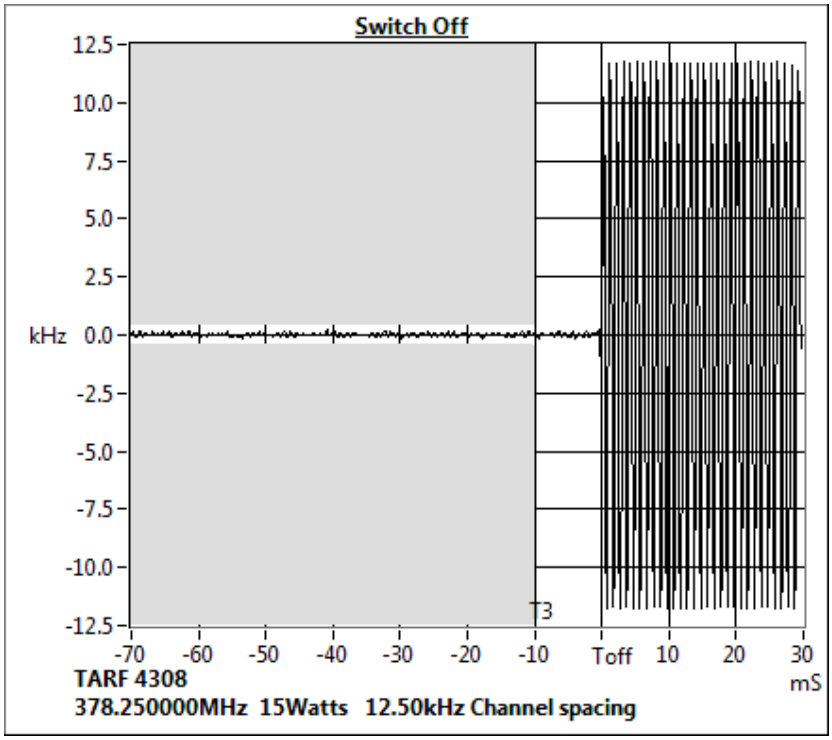
Note: RSS-119 5.9 - If the transmitter carrier output power rating is 6 Watts or less, the frequency difference during the time periods t1 and t3 may exceed the maximum frequency difference for these time periods,

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 378.250 MHz 15 W 25.0 kHz Channel Spacing





TRANSMITTER FREQUENCY STABILITY - TEMPERATURE

SPECIFICATION: FCC 47 CFR 2.1055 (a) (1) RSS-119 5.3

GUIDE: ANSI C63.26 5.6.4

MEASUREMENT PROCEDURE:
1. Refer Annex A for equipment set up.

2. The EUT was tested for frequency error from –30° C to +50° C in 10° C increments.

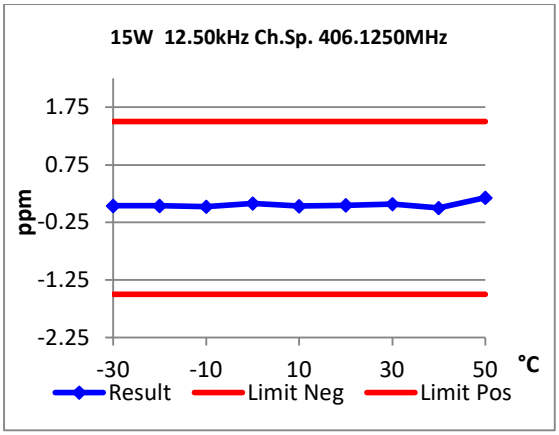
3. The frequency error was recorded in parts per million (ppm).

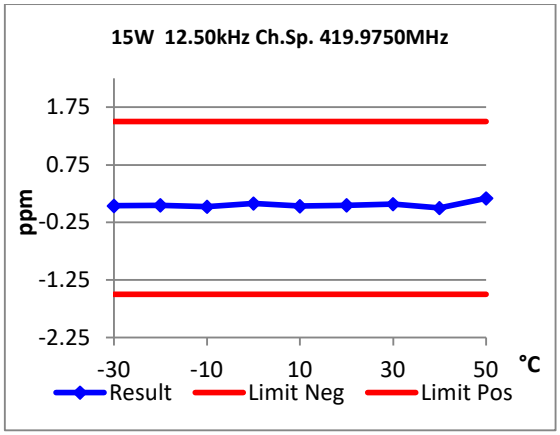
MEASUREMENT UNCERTAINTY: ± 0.05ppm

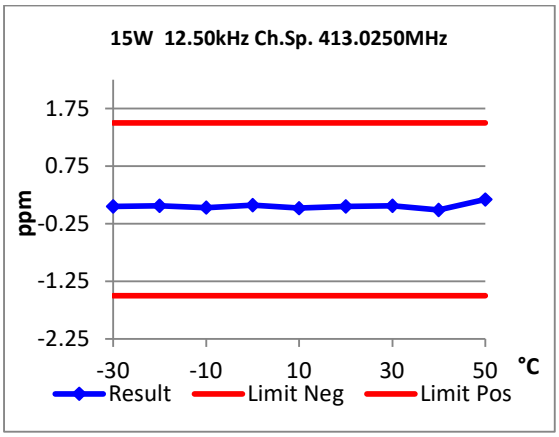
MEASUREMENT RESULTS:
See the plots on the following pages for 12.5 kHz channel spacing.

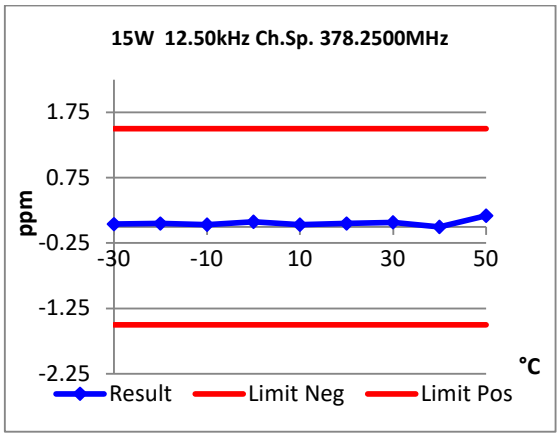
	Error (ppm)			
Temperature (ºC)	406.125 MHz	413.025 MHz	419.975 MHz	378.250 MHz
-30	0.04	0.05	0.04	0.04
-20	0.04	0.06	0.05	0.05
-10	0.02	0.03	0.02	0.03
0	0.08	0.07	0.08	0.08
10	0.03	0.02	0.03	0.03
20	0.05	0.05	0.05	0.05
30	0.07	0.06	0.07	0.07
40	0.00	-0.01	0.00	0.00
50	0.18	0.17	0.17	0.17

Transmitter Frequency Stability - Temperature









LIMIT: FCC 47 CFR 90.213 RSS-119 5.3

Channel Spacing (kHz)	Frequency Error (ppm)
12.5	1.5
25.0	1.5

TRANSMITTER FREQUENCY STABILITY - VOLTAGE

SPECIFICATION: FCC 47 CFR 2.1055, FCC 47 CFR 90.213 RSS-119 5.3

GUIDE: ANSI C63.26 5.6.5

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 UNCERTAINTY: ± 0.05ppm

MEASUREMENT RESULTS:

	FREQUENCY ERROR (ppm) for 12.5 kHz		
	13.8 V_{DC}	11.73 V_{DC}	15.87 V_{DC}
406.125 MHz	0.09	0.09	0.09
413.025 MHz	0.09	0.08	0.09
419.975 MHz	0.09	0.09	0.09
378.250 MHz	0.09	0.09	0.09

LIMIT CLAUSES: FCC 47 CFR 90.213 RSS-119 5.3

Channel Spacing (kHz)	Frequency Error (ppm)
12.5	1.0
25.0	1.0

RECEIVER SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATION: FCC 47CFR 15.111 RSS-Gen 7.4

GUIDE: TIA-603-E 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 highest tunable frequency.

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

4. A scan is performed with a resolution bandwidth of 100 kHz and a video bandwidth of 300 kHz for frequencies up to 1 GHz, and a resolution bandwidth of 1 MHz and a video bandwidth of 3 MHz for frequencies above 1 GHz

5. For each frequency range the spectrum analyser was loaded with the appropriate calibration figures to compensate for the cables and attenuator losses allowing the emission levels to be read directly with no further calculation.
   The calibrations are loaded as an overall reference level offset plus a set of correction factors for the required frequency band.

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

Example of attenuation correction: (dB)

10 dB attenuator E3674	9.50 dB	
1.5 M blue cable E5028	0.28 dB	
Total Attenuation @ 500 MHz	9.78	Sum of component attenuation (a)
Amplitude offset	10.00	(b)
Correction @ 500 MHz	-0.22	(a-b)

MEASUREMENT UNCERTAINTY: ± 2.8dB

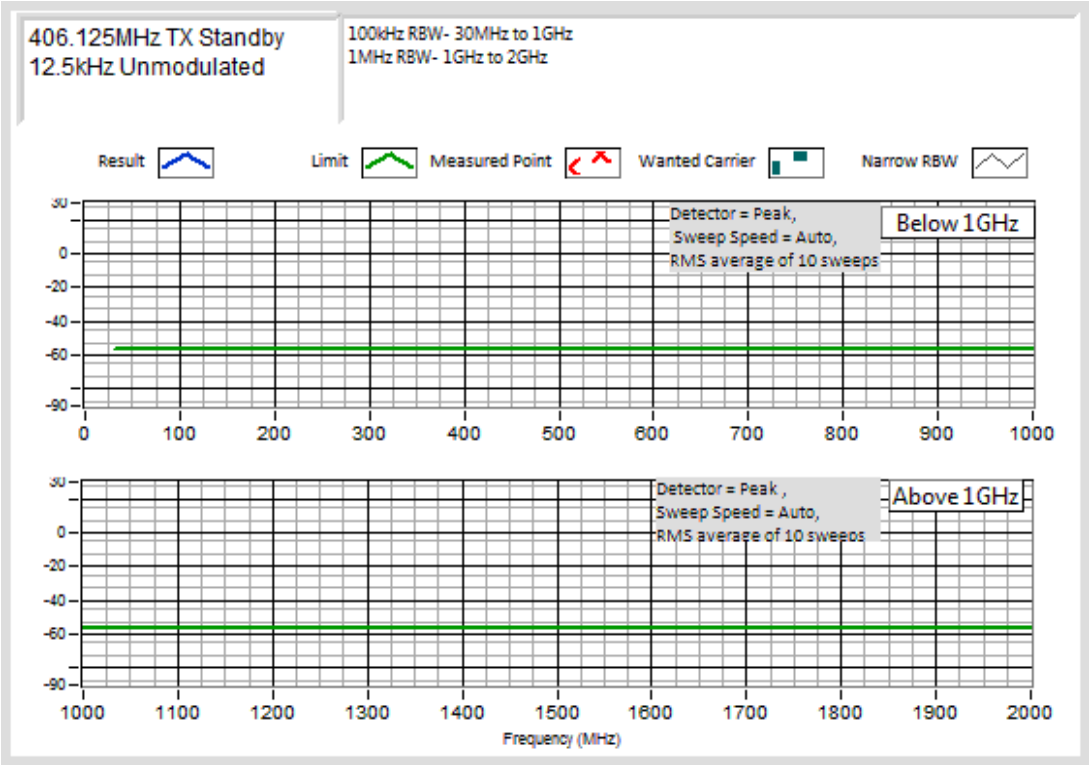
LIMIT CLAUSE: RSS-Gen 7.4

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

Receiver Spurious Emissions (Conducted) – Continued

406.125 MHz Tx Standby / Receive		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
No emissions were detected within 20 dB of Limit.		

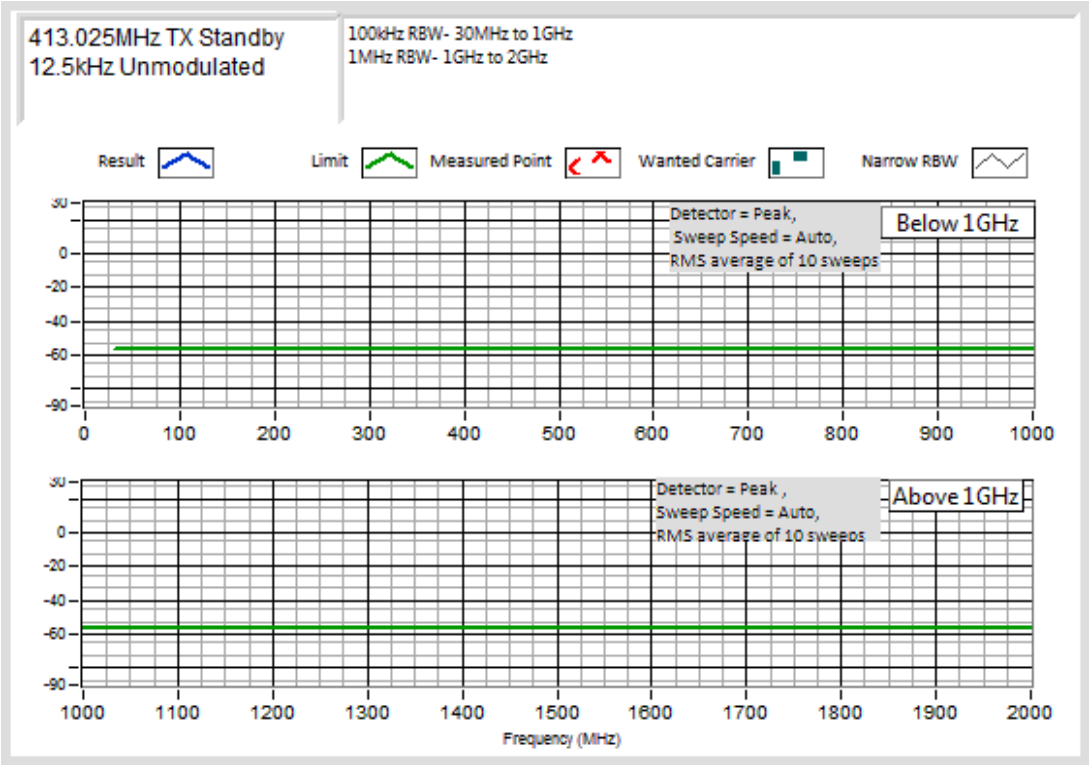
406.125 MHz Tx Standby / Receive



Receiver Spurious Emissions (Conducted) – Continued

413.025 MHz Tx Standby / Receive		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
No emissions were detected within 20 dB of Limit.		

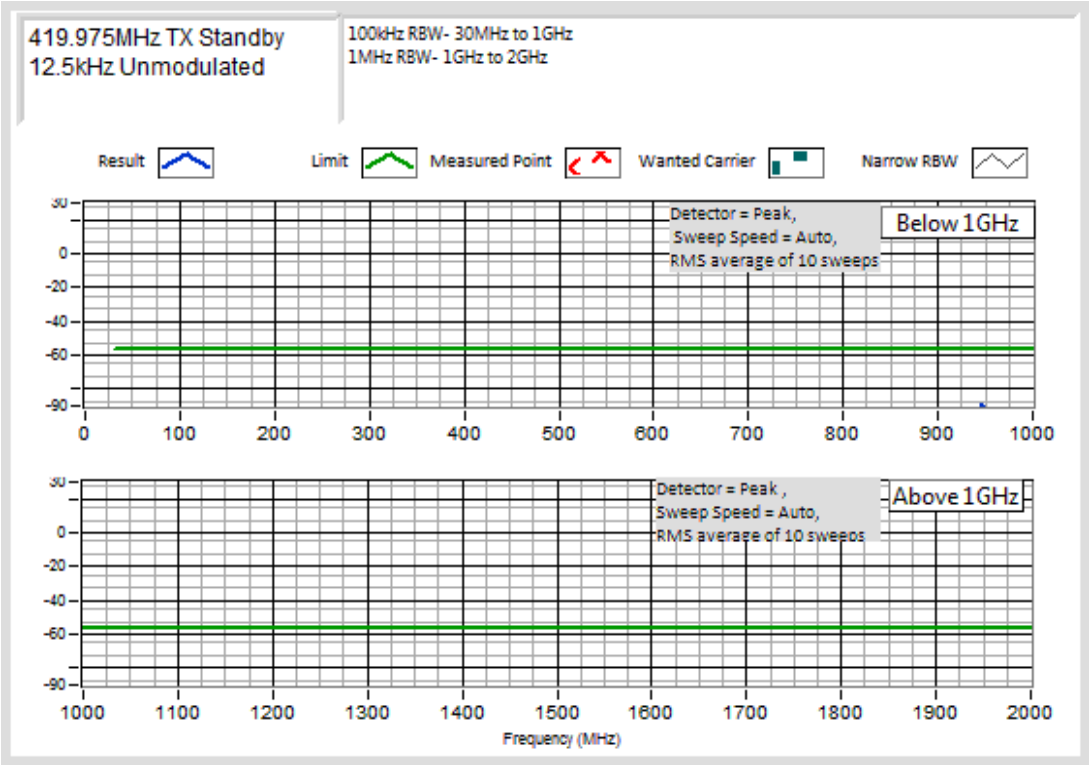
413.025 MHz Tx Standby / Receive



Receiver Spurious Emissions (Conducted) – Continued

419.975 MHz Tx Standby / Receive		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
No emissions were detected within 20 dB of Limit.		

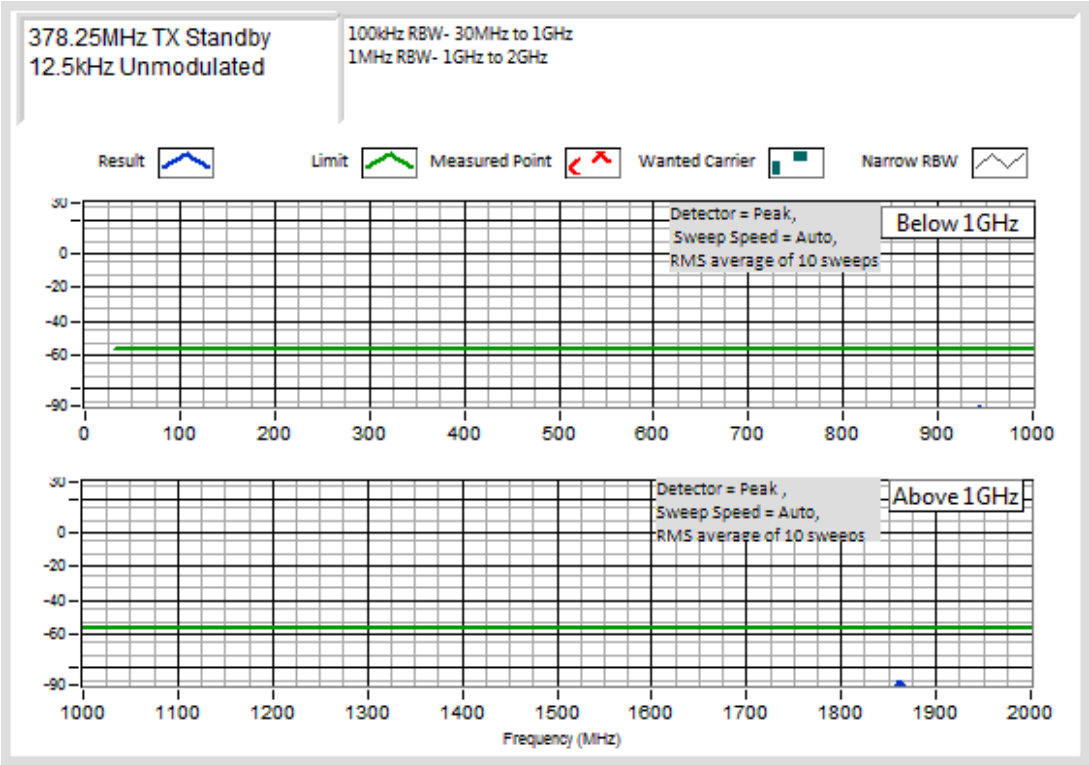
419.975 MHz Tx Standby / Receive



Receiver Spurious Emissions (Conducted) – Continued

378.250 MHz Tx Standby / Receive		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
No emissions were detected within 20 dB of Limit.		

378.250 MHz Tx Standby / Receive



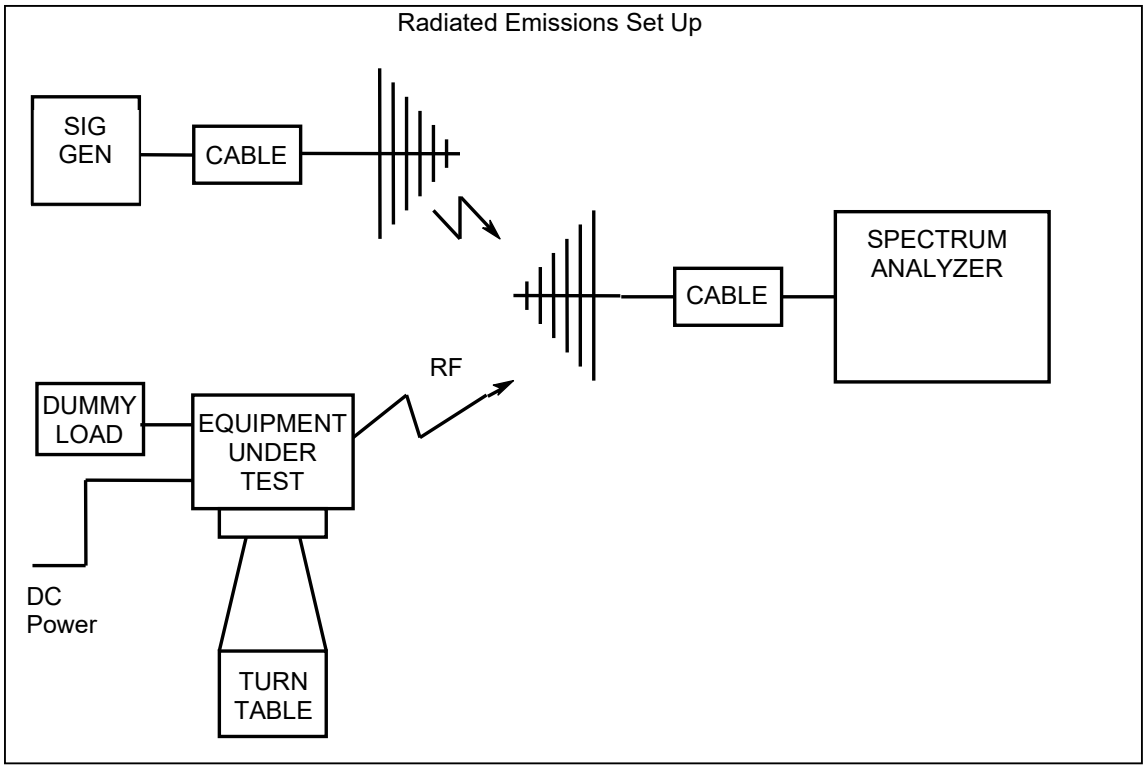
TEST EQUIPMENT LIST

Equipment Type	Information	Manufacturer	Model No	Serial No#	Tait ID	Cal Due
Antenna	18GHz DRG	Emco	DRG3115	2084	E3076	12-Jul-24
Antenna	Reference Dipoles	Emco	3121C DB1	9510-1164	E3559	29-May-24
Antenna	18GHz DRG	Emco	DRG3115	9512-4638	E3560	
Antenna	Log Periodic	Schwarzbeck	VUSLP	9111-219	E4617	
Coax Cable	OATS Turntable Cable 1	Intelcom	RG214	OATS1	E4621	08-Oct-24
Coax Cable	OATS Tower Cable	Intelcom	RG214	OATS2	E4622	08-Oct-24
Coax Cable	OATS Turntable Cable 2	Intelcom	RG215	OATS3	E4995	08-Oct-24
RF Attenuator	10dB 50W	Weinschel	24-10-34	AZ0401	E3388	08-Oct-24
Signal Generator	Analog 3.2GHz	Hewlett Packard	HP8648C	3443U00543	E3558	08-Oct-24
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	TREVA2	Hewlett Packard	HP8903B	2818A04275	E3710	11-Oct-24
Audio Analyser	TREVA1	Hewlett Packard	HP8903A	2437A04625	E4986	04-Oct-24
Coax Cable	Reverb - 4.5m Multiflex 141	TeltestBlue6	MF 141	TeltestBlue6	E4843	08-Oct-24
Coax Cable	Reverb - 2m Multiflex 141	TeltestBlue5	MF 141	TeltestBlue5	E4844	08-Oct-24
Coax Cable	Reverb - 2m Multiflex 141	TeltestBlue4	MF 141	TeltestBlue4	E4845	08-Oct-24
Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue3	MF 141	TeltestBlue3	E4846	08-Oct-24
Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue2	MF 141	TeltestBlue2	E4847	08-Oct-24
Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue1	MF 141	TeltestBlue1	E4848	08-Oct-24
Coax Cable	Conducted Disturbance Cable	Tait	RG223/U	EMC1	E5026	08-Oct-24
Filter High Pass/ Notch	400 to 520MHz	Tait		N/A	E3384	07-Jun-24
LISN	50Ω/50µH+5Ω	Schwarzbeck	NSLK 8117	7	E5016	06-Oct-24
Modulation Analyser	TREVA2	Hewlett Packard	HP8901B (Opt 002)	2441A00393	E3073	11-Oct-24
Modulation Analyser	TREVA1	Hewlett Packard	HP8901B (Opt 002)	3704A05837	E3786	04-Oct-24
Multimeter		Fluke	77	35069359	E3237	11-Oct-24
Power Meter	TREVA2 Power Head for HP8901	Hewlett Packard	HP11722A	2716A02037	1575	10-Oct-24
Power Meter	TREVA1 Power Head for HP8901	Hewlett Packard	HP11722A	3111A05573	E7054	08-Oct-24
Power Supply	AC Variac	Yamabishi	S-260-5	TX-533	E1737	
Power Supply		Rohde & Schwarz	NGS M32/10 192.0810.31	Fnr 434	E3556	02-May-24
Power Supply	60V/50A/1000W	Hewlett Packard	HP6012B	2524A00616	E3712	05-Oct-25
Power Supply	TREVA 1 60V/25A	Agilent	N5767A	US23D6941R	E11372	03-Oct-24
Power Supply	TREVA2 60V/25A	Agilent	N5767A	US09F4901H	E4656	09-Oct-25
Power Supply	40V/38A	Agilent	N5766A	US09E4663L	E4719	11-Oct-25
RF Amplifier	+21.7 dB 1GHz	Tait	ZFL-1000LN	E3660	E3360	15-Aug-24
RF Amplifier	Pre-amplifier	Agilent	87405C	MY47010688	E4941	16-Oct-24
RF Attenuator	30+3dB 350W	Weinschel	67-30-33 & BW-N3W5+	CK9178	E5023	08-Oct-24
RF Attenuator	TREVA2 3dB	Weinschel	Model 1	BL9950	E4080	08-Oct-24
RF Attenuator	TREVA1 3dB	Weinschel	Model 1	BL9958	E4081	08-Oct-24
RF Attenuator	TREVA1 20dB 150W	Weinschel	40-20-23	MF817	E4082	08-Oct-24

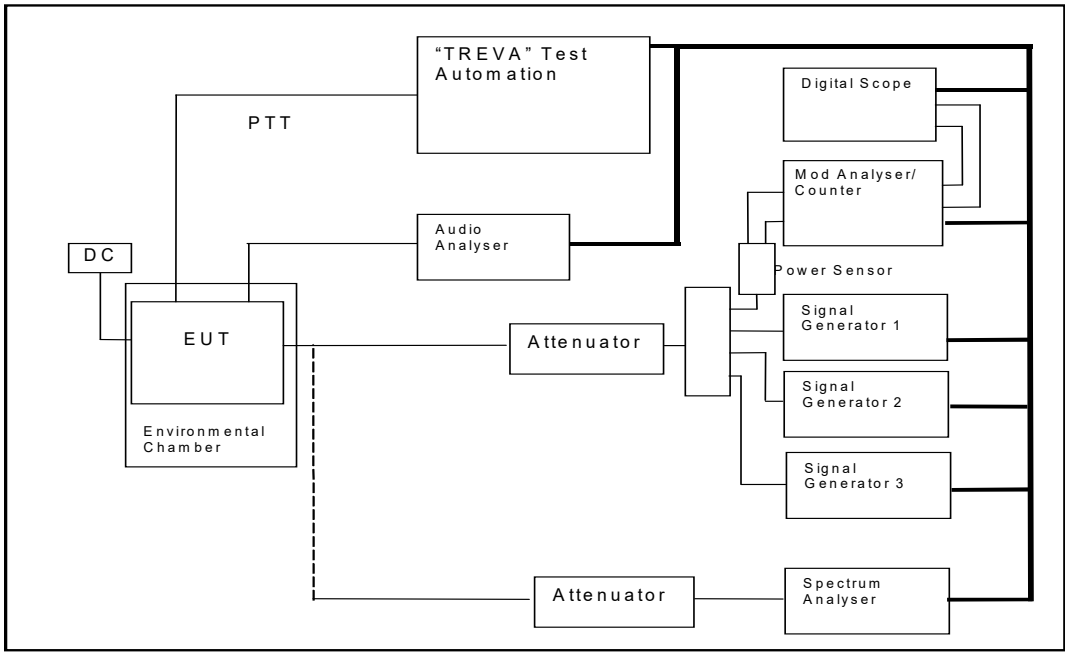
Equipment Type	Information	Manufacturer	Model No	Serial No#	Tait ID	Cal Due
RF Chamber	S-LINE TEM CELL	Rohde & Schwarz	1089.9296.02	338232/003	E3636	07-May-25
RF Chamber	Reverb - Stirrer controller for reverb chamber	Teseq	Stirrer Controller	29765.1	E4854	
RF Chamber	Reverb - 0.5 - 18GHz Reverberation 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	08-Oct-24
Spectrum Analyser	13.2GHz	Agilent	PSA E4445A	MY42510072	E4139	18-Oct-24
Spectrum Analyser	26.5GHz	Agilent	PXA N9030A	MY49432161	E4907	02-Mar-25
Temp & Humidity datalogger		Hobo	U21-011	10134275	E4980	07-Aug-24
TREVA 1		Teltest	-	1	-	23-Oct-24
TREVA 2		Teltest	-	2	-	23-Oct-24
Testware	Base Station Network Audio Generator		December 2017	-	-	
Testware	Conducted Emissions		March 2018	-	-	
Testware	Frequency Vs Temperature		April 2018	-	-	
Testware	Occupied Bandwidth		TTEL_OCCBW 2.00.01	-	-	
Testware	Reverb Emissions		TTEL_REVEMIS 2.00.03	-	-	
Testware	Sideband Spectrum		February 2017	-	-	
Testware	S-Line Radiated Emissions		TTEL_SLINERADEM 2.00.01	-	-	
Testware	TREVA		TTEL_TREVA 2.00.00	-	-	

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

ANNEX A – TEST SETUP DETAILS



All other testing is performed using the **T**eltest **R**adio **EVA**luation system (TREVA), which is configured as shown below. The Spectrum Analyser is connected to the EUT via the attenuator network for Occupied Bandwidth, Spectrum Masks, and Conducted Emissions testing.



END OF REPORT