

LABORATORY TEST REPORT

RADIO PERFORMANCE MEASUREMENTS

for the

TBCH0E Base Station Transceiver

Tested in accordance with:

FCC 47 CFR Parts 22, 74 and 90

RSS-119 Issue 11
RSS-Gen Issue 3

Report Revision: 1

Issue Date: 13-November-2013

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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
13-November-2013	1	Initial test report

INTRODUCTION

This report covers the requirements of FCC 47 Parts 22, 74 & 90, and RSS-119 Issue 11 & RSS-Gen Issue 3.

REASON FOR REPORT
The TB9300 100 W Base Station is a new addition to the Tait Ltd product line capable of Digital Mobile Radio (DMR) modulation. DMR supports two voice or data channels in each 12.5 kHz channel.

Modulation Description	Channel Spacing kHz	Data / Speech Channels	Symbol Rate (symbols/sec)	Data Rate (bits / sec)
Digital Mobile Radio 4-Level FSK	12.5	2	4800	9600

Type Approval Testing of the
Serial number TBCH0E
18188544 & 18188546
Frequency range 400 → 440 MHz (H1 Rack) and 440 → 480 MHz (H2 Rack)

in accordance with:
FCC 47 CFR Parts 22, 74 and 90
RSS-119 Issue 11 & RSS-Gen Issue 3

REPORT PREPARED FOR
Tait Communications
PO Box 1645
558 Wairakei Road
Christchurch
New Zealand

DESCRIPTION OF SAMPLE
Manufacturer Tait Limited
Equipment: Base Station Transceiver
Type: TBCH0E
Serial Number(s): 18188544 & 18188546
Quantity: 2

HARDWARE & SOFTWARE

TBCH0D 100W Rack 400 → 440 MHz SN: 18188544

FUNCTIONAL DESCRIPTION	PRODUCT CODE	SERIAL NUMBER	HARDWARE & SOFTWARE	FREQUENCY RANGE
Reciter	T01-01105-KAAA	18187801	FW: dmr-1.20.00.0003 HW: 00.11	400→440 MHz
Power Amplifier	T01-01136-JBAA	18187837	FW: 0314 HW: 00.02	380→520 MHz
PMU	TBA30A0-0100	18187034	FW: 0316 HW: 00.03	N/A
Front Panel	T01-01110-CCAA	18187978	FW: 1.05.00.0001 HW: 00.04	N/A

HARDWARE & SOFTWARE - Continued

TBCH0E 100W Rack 440 → 480 MHz SN: 18188546

FUNCTIONAL DESCRIPTION	PRODUCT CODE	SERIAL NUMBER	HARDWARE & SOFTWARE	FREQUENCY RANGE
Reciter	T01-01105-LAAA	18187285	FW: dmr-1.16.01.0004 HW: 00.00	440→480 MHz
Power Amplifier	T01-01136-JBAA	18187284	FW: 0312 HW: 00.02	380→520 MHz
PMU	TBA30A0-0100	18187448	FW: 0314 HW: 00.03	N/A
Front Panel	T01-01110-CCAA	18187556	FW: 1.04.00.0001 HW: 00.04	N/A

TEST CONDITIONS

All testing was performed between 8-October → 13-November-2013, 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: TBCH0E
Serial Number(s): 18188544 & 18188546
Quantity: 2

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

FCC 47 CFR Parts 22, 74 and 90

RSS-119 Issue 11 & RSS-Gen Issue 3

Signature: _____

Mike James
Technical Manager

Date: _____

MODULATION TYPES, NECESSARY BANDWIDTH & EMISSION DESIGNATORS

MODULATION TYPES:

FXD	Digital Data	4800 symbols/sec	9600 bps
FXW	Digital Voice / Data	4800 symbols/sec	9600 bps

CHANNEL SPACINGS: 12.5 kHz

EMISSION DESIGNATORS:

DMR Digital Data	7K60FXD
DMR Digital Voice / Data	7K60FXW

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

Digital Data 12.5 kHz Channel Spacing – 7K60FXW
99% bandwidth Emission Designator
= 7.6 kHz 7K60FXW
FXW represents FM combination of data and telephony.

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

TBCH0D 100 W Rack

Nominal 100 W	406.2 MHz	418.1 MHz	429.9 MHz
Measured	91.3	88.6	89.2
Variation (%)	-8.7	-11.4	-10.8
Variation (dB)	-0.4	-0.5	-0.5
Nominal 10 W	406.2 MHz	418.1 MHz	429.9 MHz
Measured	9.6	9.5	9.3
Variation (%)	-4.0	-5.3	-6.7
Variation (dB)	-0.2	-0.2	-0.3
Measurement Uncertainty		± 0.6 dB	

Transmitter Output Power (Conducted) - Continued

Manufacturer's Rated Output Power:

Switchable: 100 W and 10 W

TBCH0E 100 W Rack

Nominal 100 W	450.1 MHz	459.9 MHz	469.9 MHz
Measured	92.2	90.3	88.7
Variation (%)	-7.8	-9.7	-11.3
Variation (dB)	-0.4	-0.4	-0.5
Nominal 10 W	450.1 MHz	459.9 MHz	469.9 MHz
Measured	9.2	9.1	9.1
Variation (%)	-8.2	-9.3	-9.3
Variation (dB)	-0.4	-0.4	-0.4
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.

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

TRANSMITTER OCCUPIED BANDWIDTH AND SPECTRUM MASKS

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

GUIDE: TIA-102.CAAA-C 2.2.5

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment Set up.
The EUT was modulated with an internally generated pseudo random bit sequence at the appropriate Baud rates.
2. 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 & 25.0 kHz channel spacings.

LIMIT CLAUSE: FCC 47 CFR 90.210 RSS-119 5.5

EMISSION MASKS

Emission Mask D 12.5 kHz Channel Spacing Digital Voice/Data

DATA SPEED

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

Occupied Bandwidth and Spectrum Masks

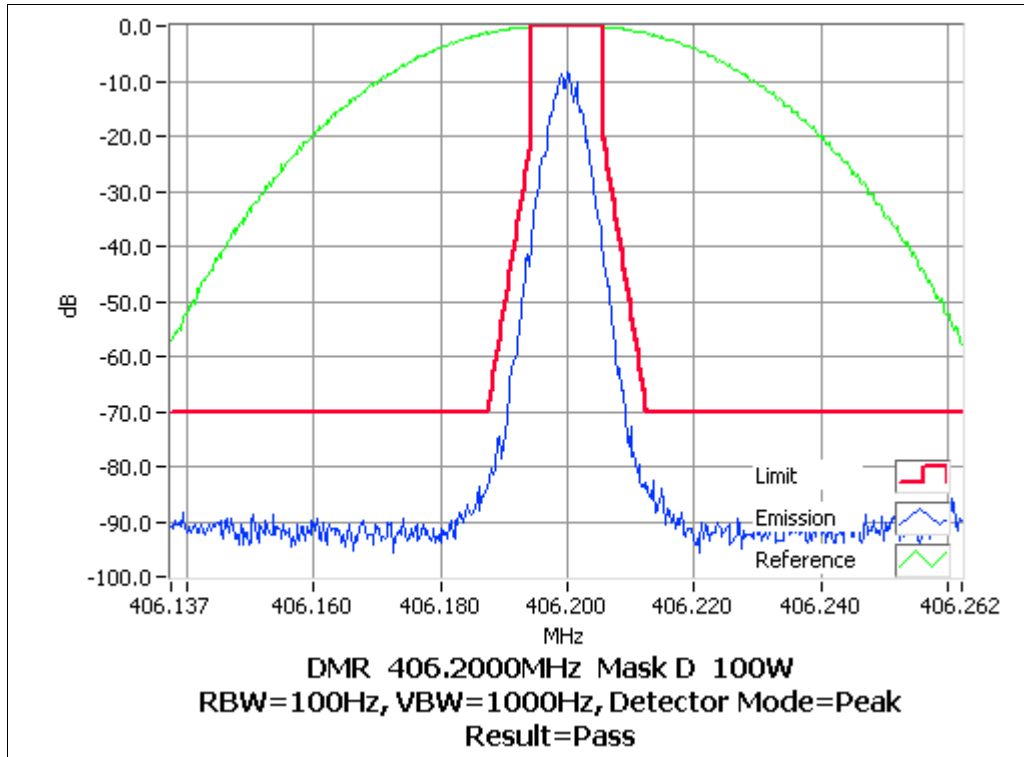
SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

Tx FREQUENCY: 406.2 MHz

100 W

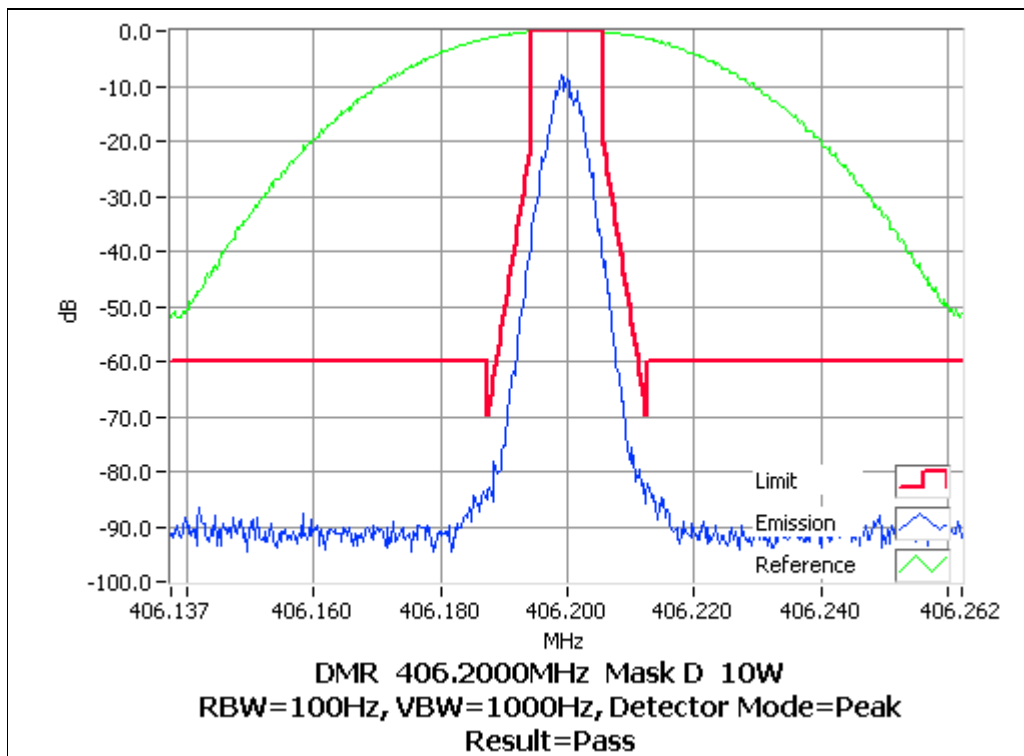
12.5 kHz Channel Spacing



Tx FREQUENCY: 406.2 MHz

10 W

12.5 kHz Channel Spacing



Occupied Bandwidth and Spectrum Masks

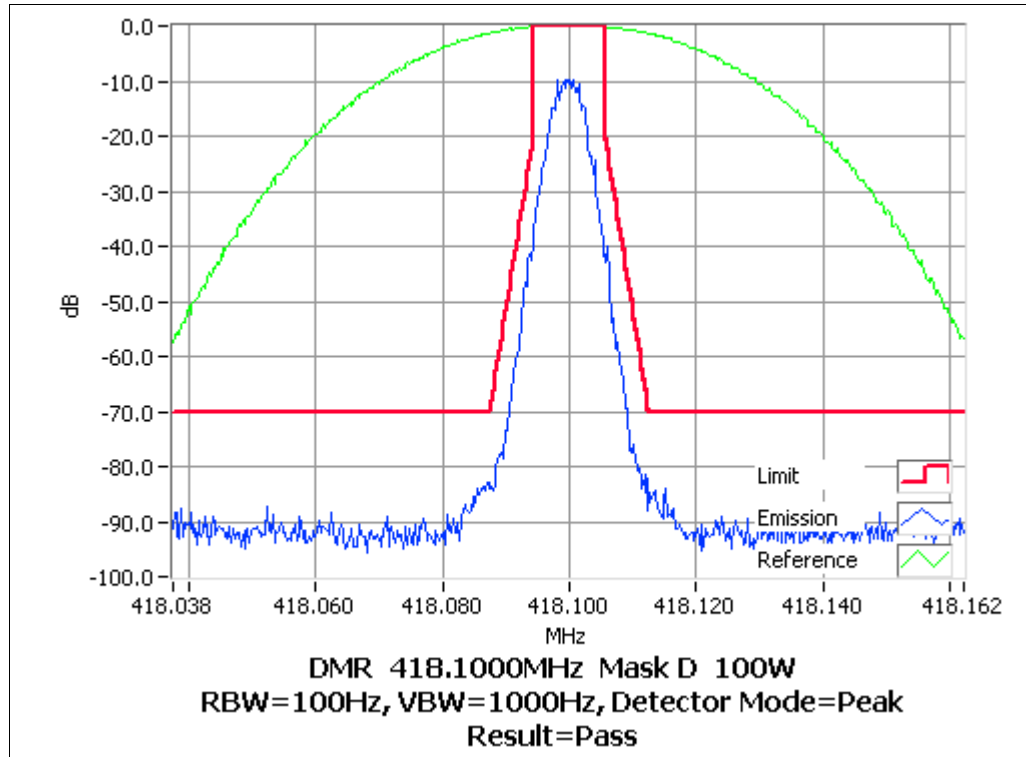
SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

Tx FREQUENCY: 418.1 MHz

100 W

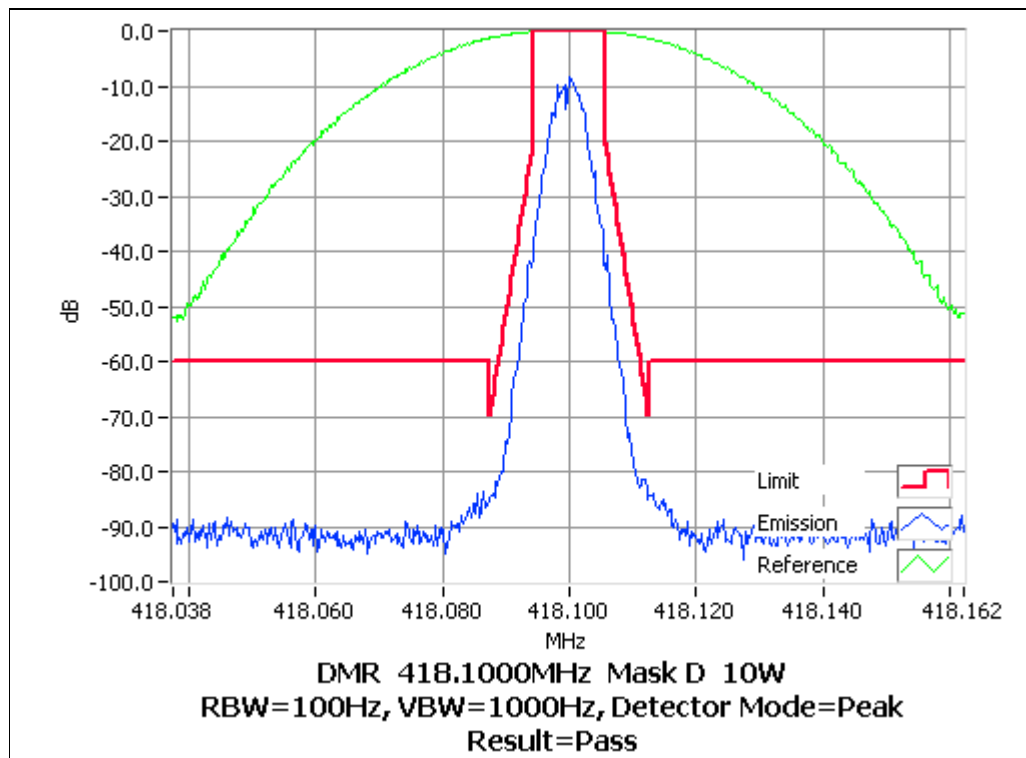
12.5 kHz Channel Spacing



Tx FREQUENCY: 418.1 MHz

10 W

12.5 kHz Channel Spacing



Occupied Bandwidth and Spectrum Masks

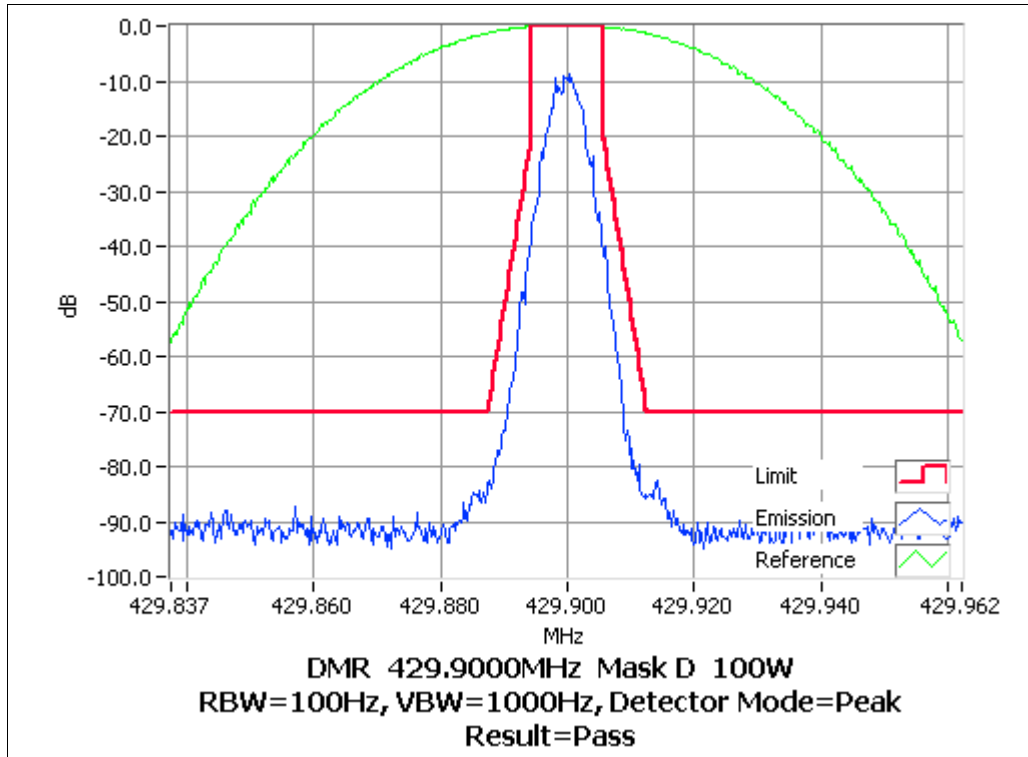
SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

Tx FREQUENCY: 429.9 MHz

100 W

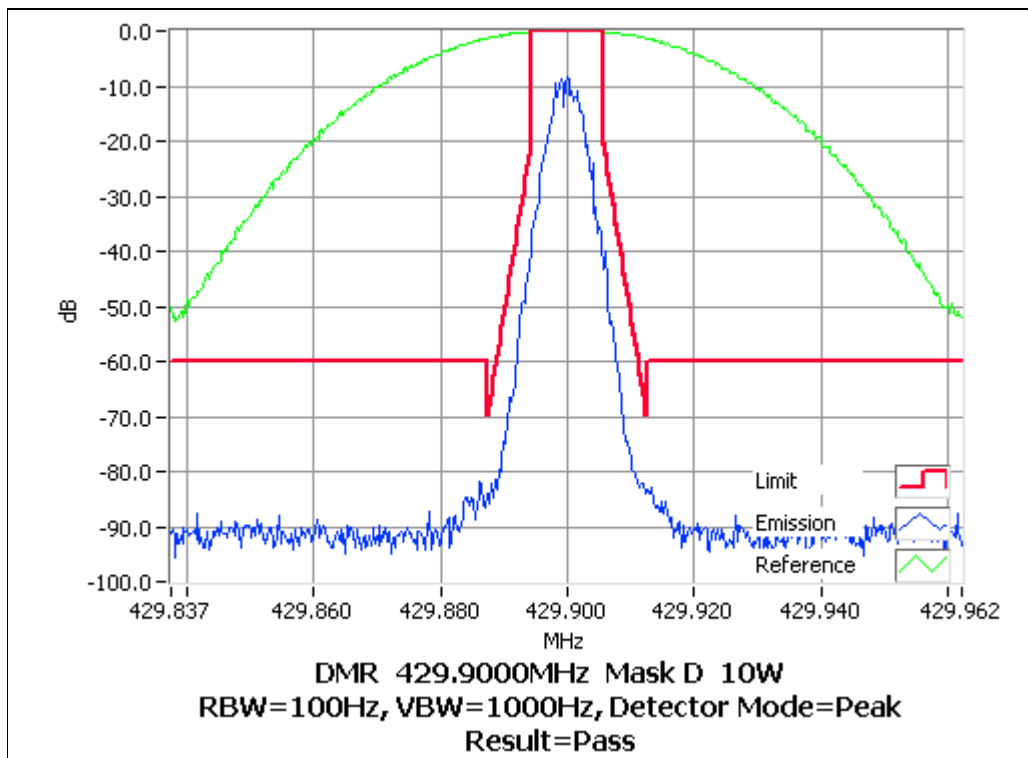
12.5 kHz Channel Spacing



Tx FREQUENCY: 429.9 MHz

10 W

12.5 kHz Channel Spacing



Occupied Bandwidth and Spectrum Masks

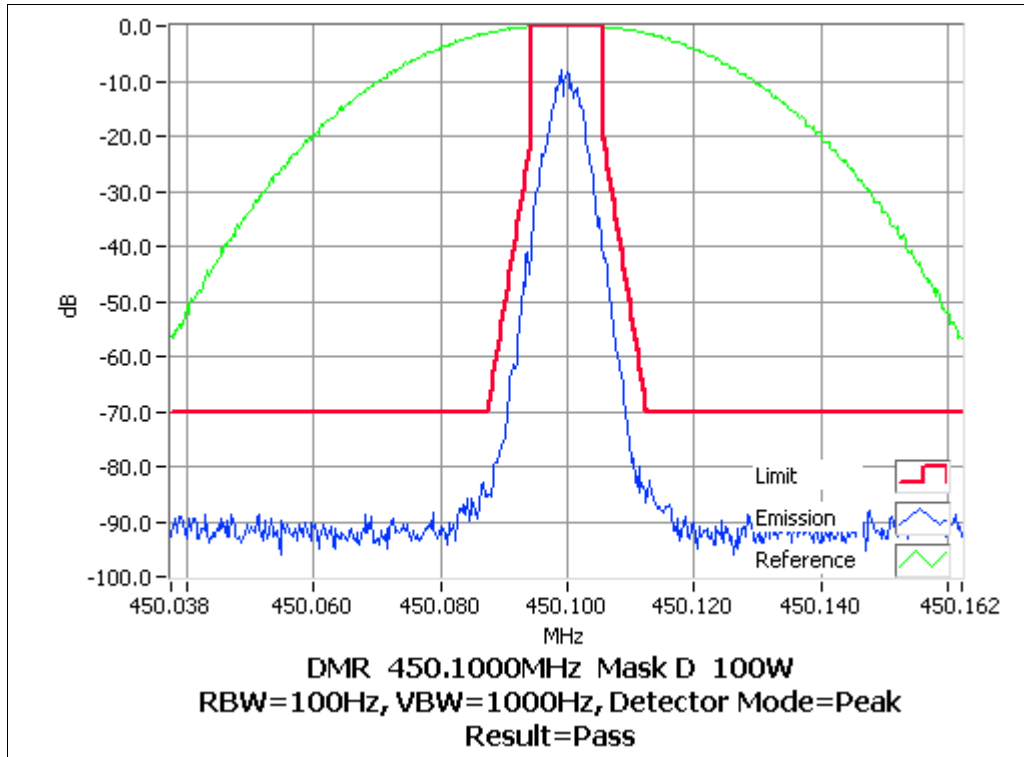
SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

Tx FREQUENCY: 450.1 MHz

100 W

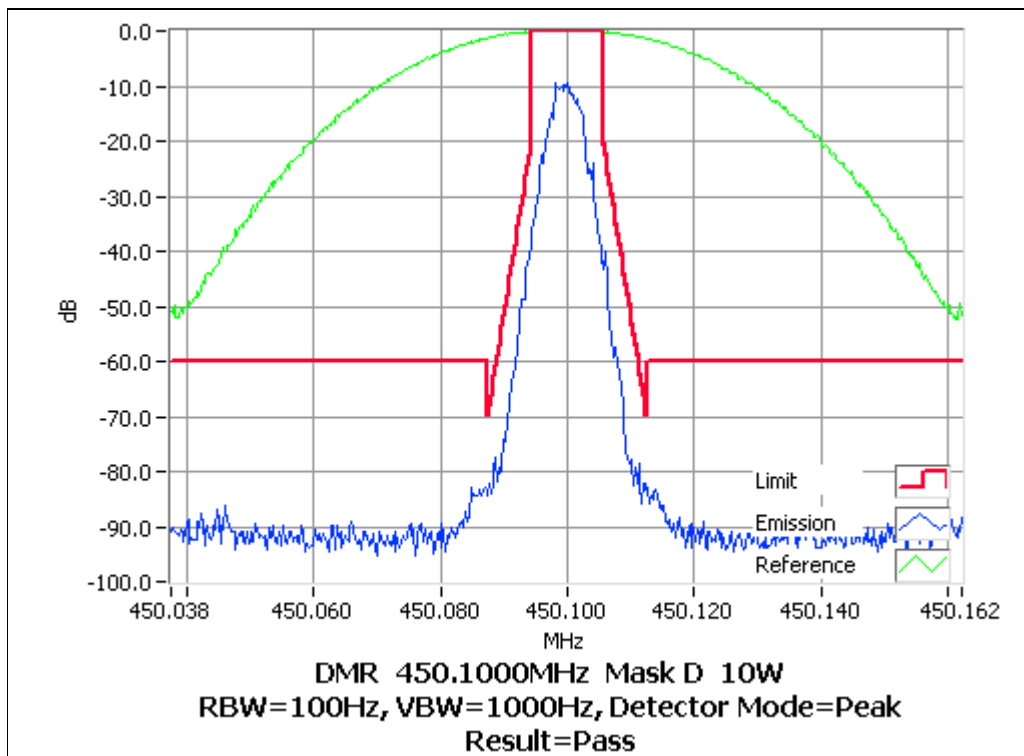
12.5 kHz Channel Spacing



Tx FREQUENCY: 450.1 MHz

10 W

12.5 kHz Channel Spacing



Occupied Bandwidth and Spectrum Masks

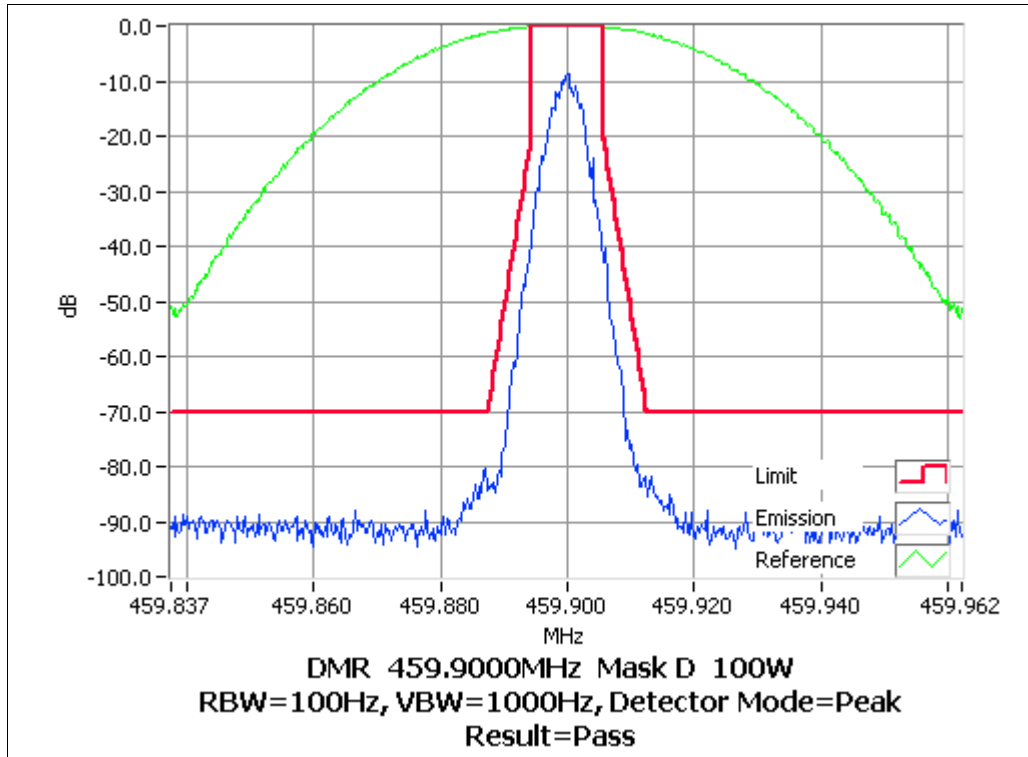
SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

Tx FREQUENCY: 459.9 MHz

100 W

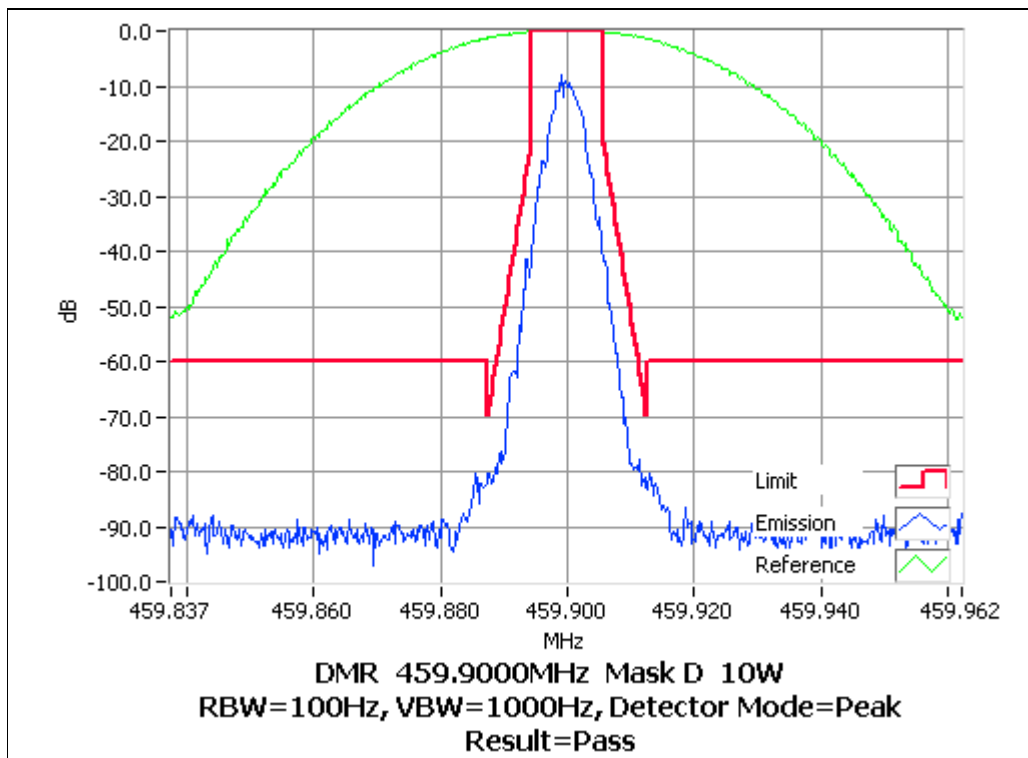
12.5 kHz Channel Spacing



Tx FREQUENCY: 459.9 MHz

10 W

12.5 kHz Channel Spacing



Occupied Bandwidth and Spectrum Masks

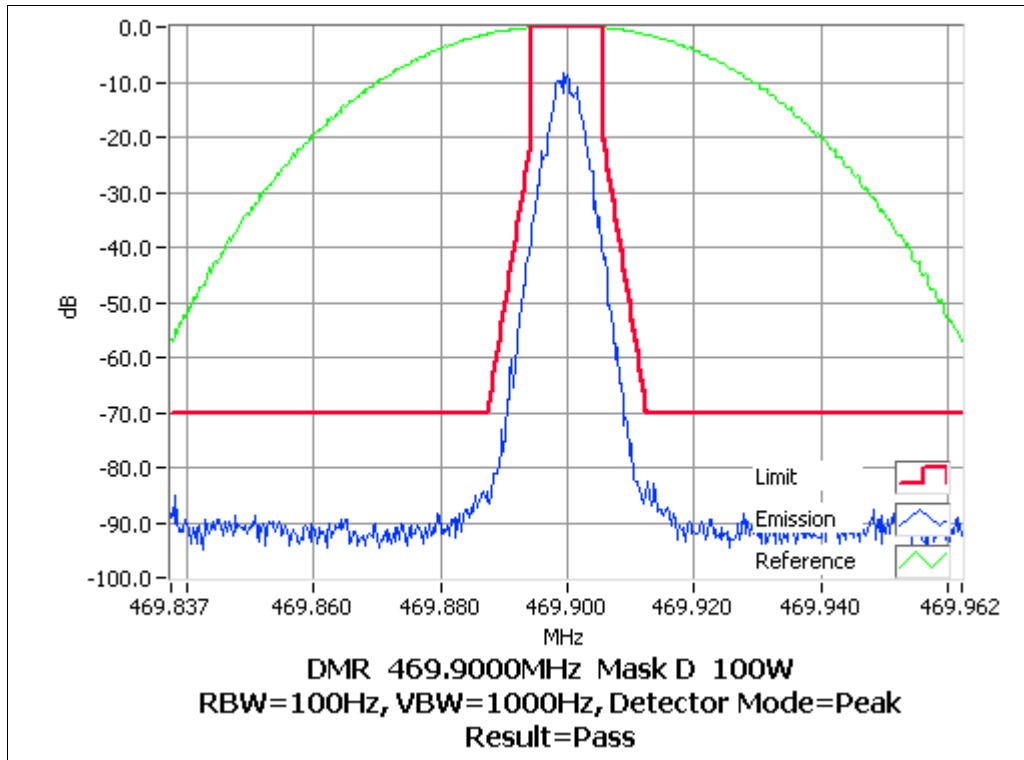
SPECIFICATION: FCC CFR 2.1049 (c)

RSS-119 5.5

Tx FREQUENCY: 469.9 MHz

100 W

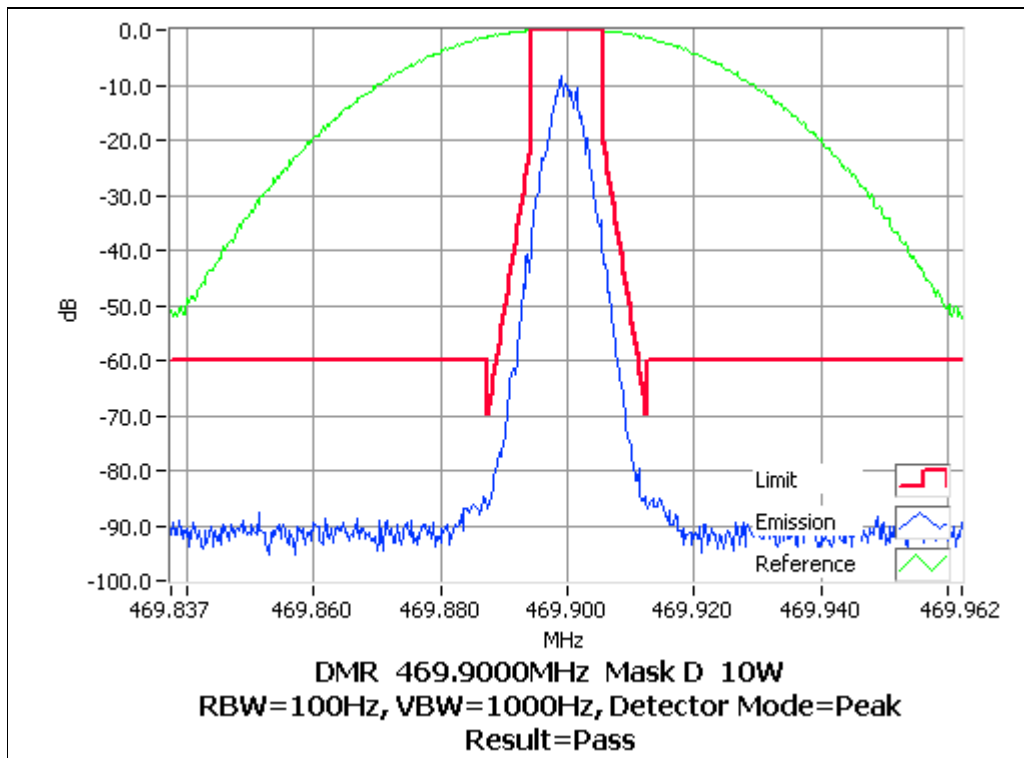
12.5 kHz Channel Spacing



Tx FREQUENCY: 469.9 MHz

10 W

12.5 kHz Channel Spacing



TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATIONS: FCC 47 CFR 2.1051

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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.

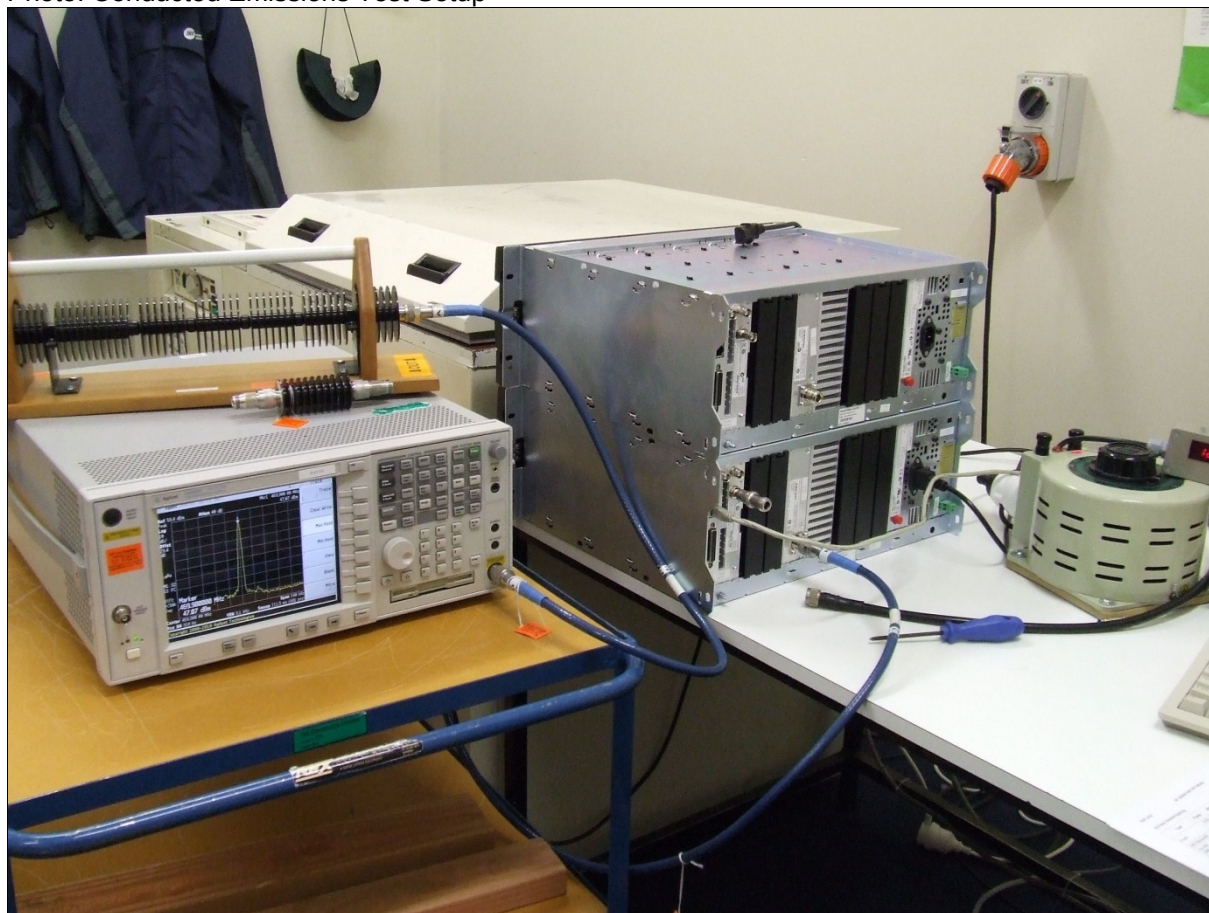
MEASUREMENT RESULTS:

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

LIMIT CLAUSES: FCC 47 CFR 90.210

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Photo: Conducted Emissions Test Setup



Spurious Emissions (Tx Conducted) - Continued

SPECIFICATION: FCC CFR 2.1051

RSS-119 5.8

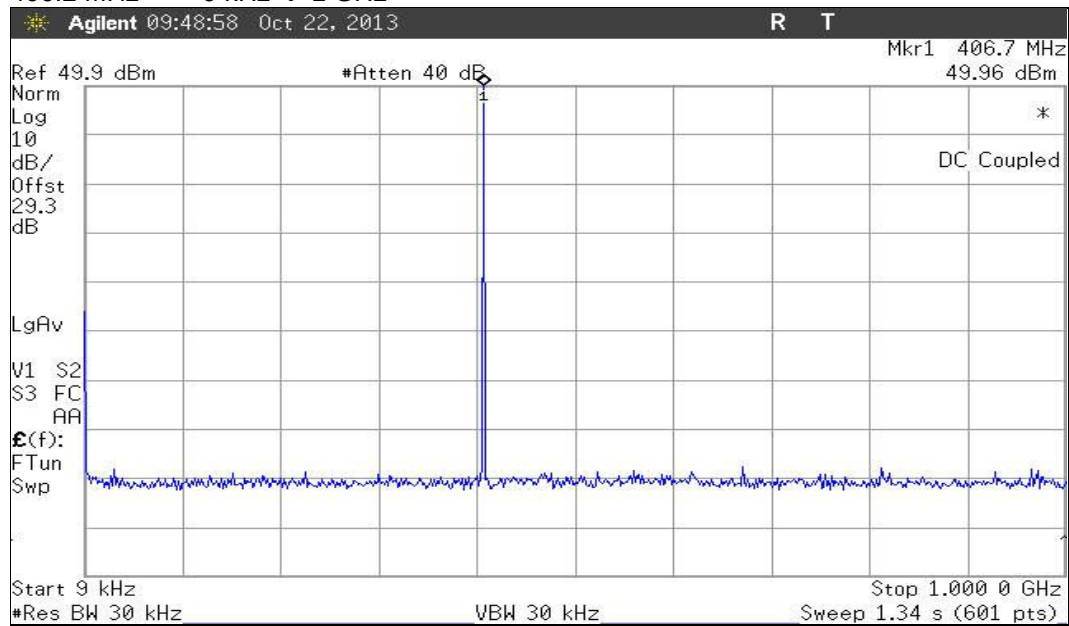
12.5 kHz Channel Spacing 406.2 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
2843.3996	-34.4	-84.4
~	~	~
12.5 kHz Channel Spacing 406.2 MHz @ 10 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
~	~	~
12.5 kHz Channel Spacing 418.1 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
1254.2998	-38.7	-88.7
2926.6996	-35.6	-85.6
12.5 kHz Channel Spacing 418.1 MHz @ 10 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
~	~	~
12.5 kHz Channel Spacing 429.9 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
1289.6998	-39.6	-89.6
2579.3997	-38.7	-88.7
3009.2996	-36.7	-86.7
12.5 kHz Channel Spacing 429.9 MHz @ 10 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.		

Spurious Emissions (Tx Conducted) – Continued

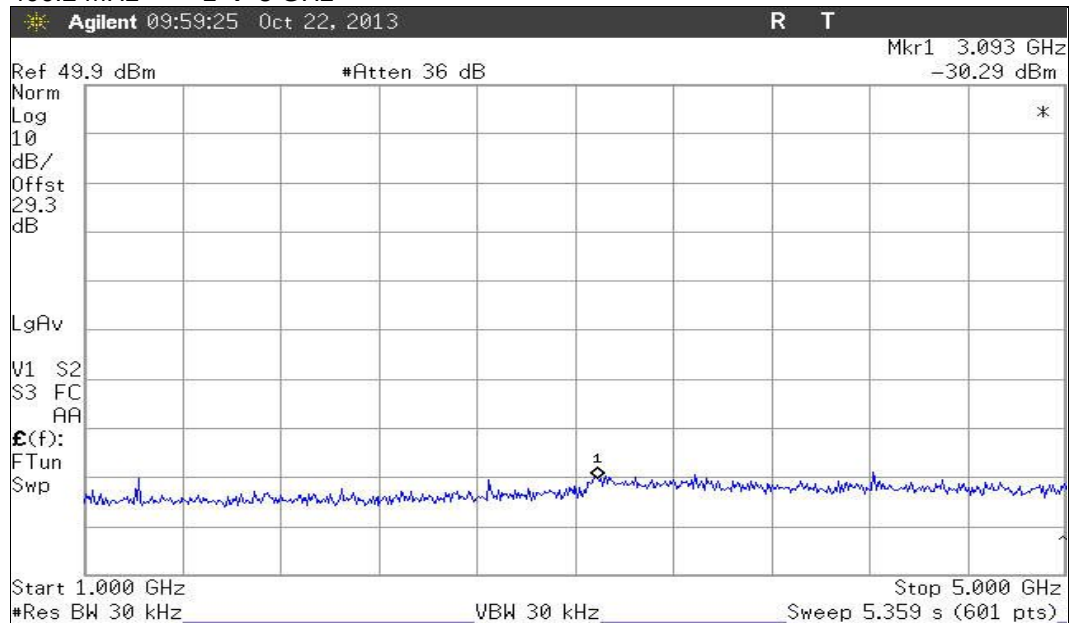
12.5 kHz Channel Spacing 450.1 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
2700.5998	-31.8	-81.8
4050.8997	-36.3	-86.3
12.5 kHz Channel Spacing 450.1 MHz @ 10 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
~	~	~
12.5 kHz Channel Spacing 459.9 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
2759.3998	-31.4	-81.4
~	~	~
12.5 kHz Channel Spacing 459.9 MHz @ 10 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
~	~	~
12.5 kHz Channel Spacing 469.9 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
939.7999	-39.8	-89.8
2819.3998	-32.1	-82.1
12.5 kHz Channel Spacing 469.9 MHz @ 10 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.		

Spurious Emissions (Tx Conducted) – Continued

406.2 MHz 9 kHz → 1 GHz

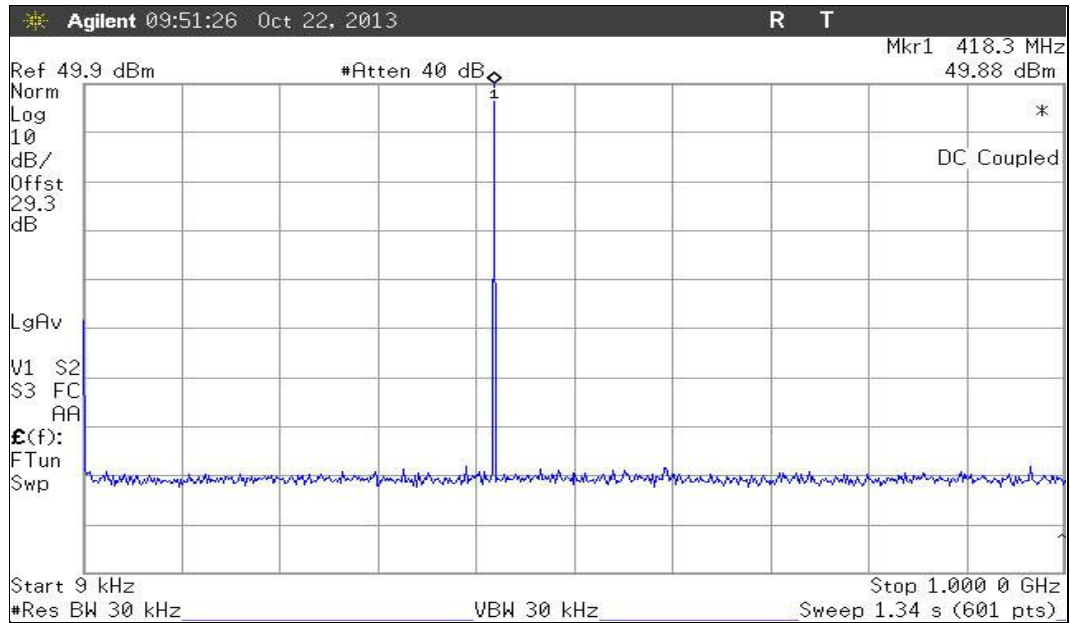


406.2 MHz 1 → 5 GHz

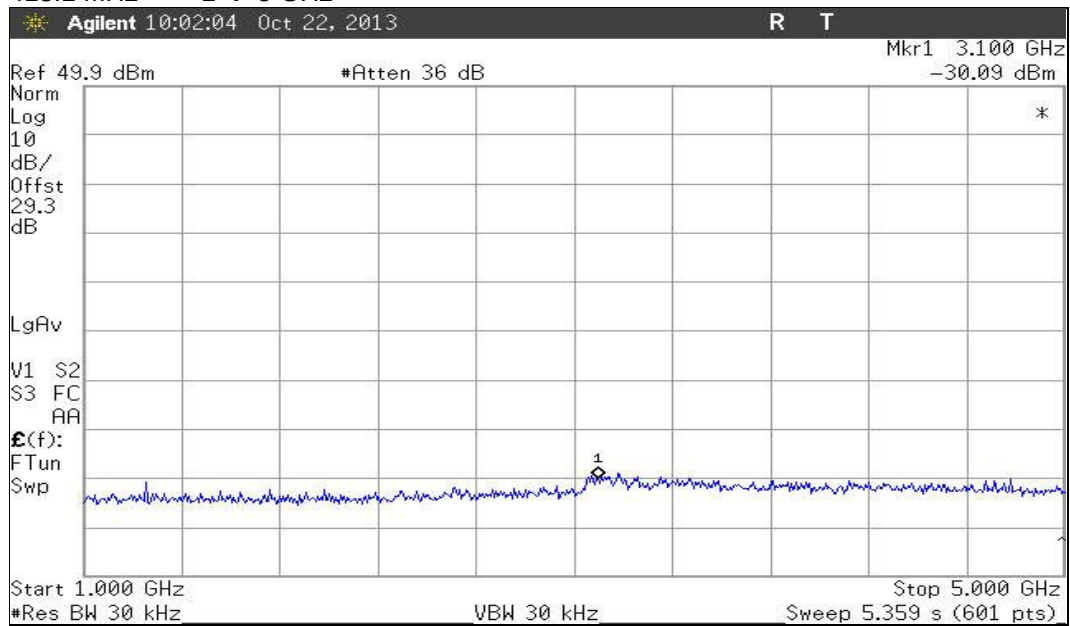


Spurious Emissions (Tx Conducted) – Continued

418.1 MHz 9 kHz → 1 GHz

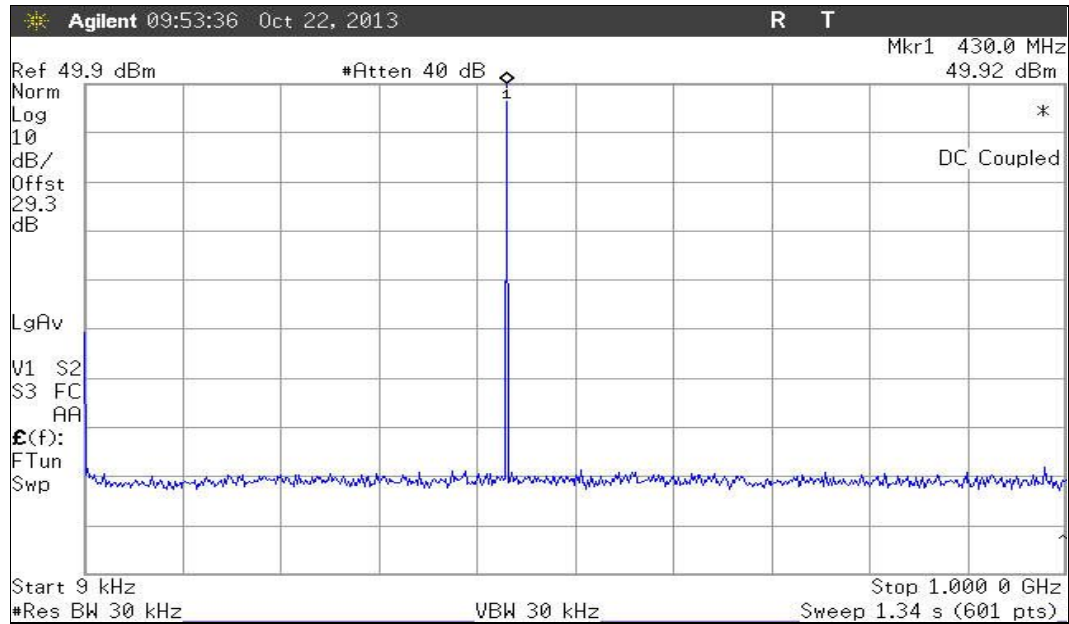


418.1 MHz 1 → 5 GHz

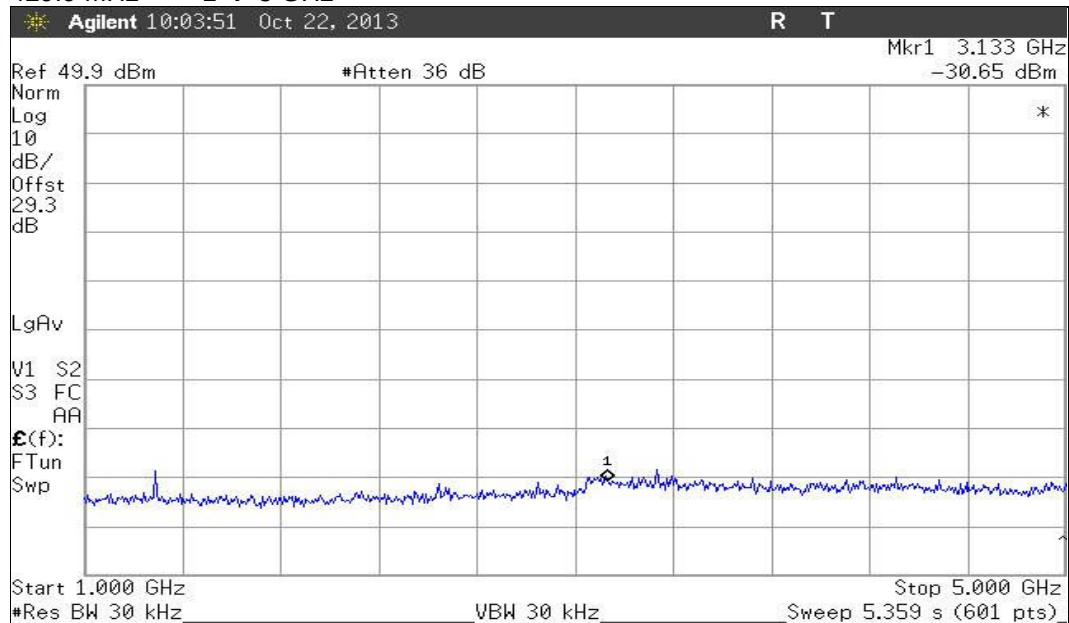


Spurious Emissions (Tx Conducted) – Continued

429.9 MHz 9 kHz → 1 GHz

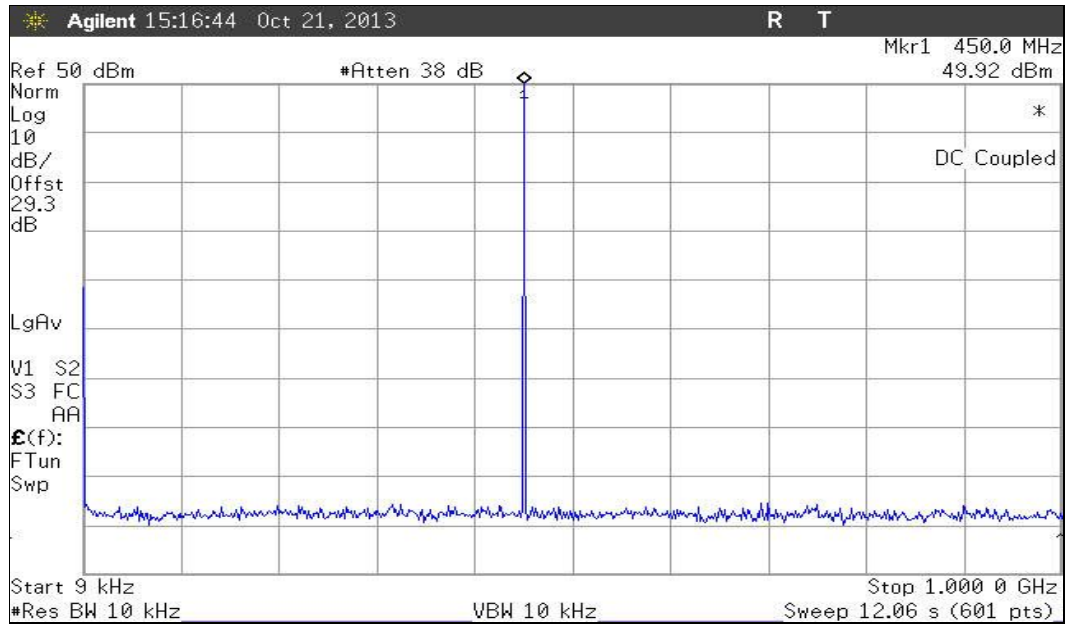


429.9 MHz 1 → 5 GHz

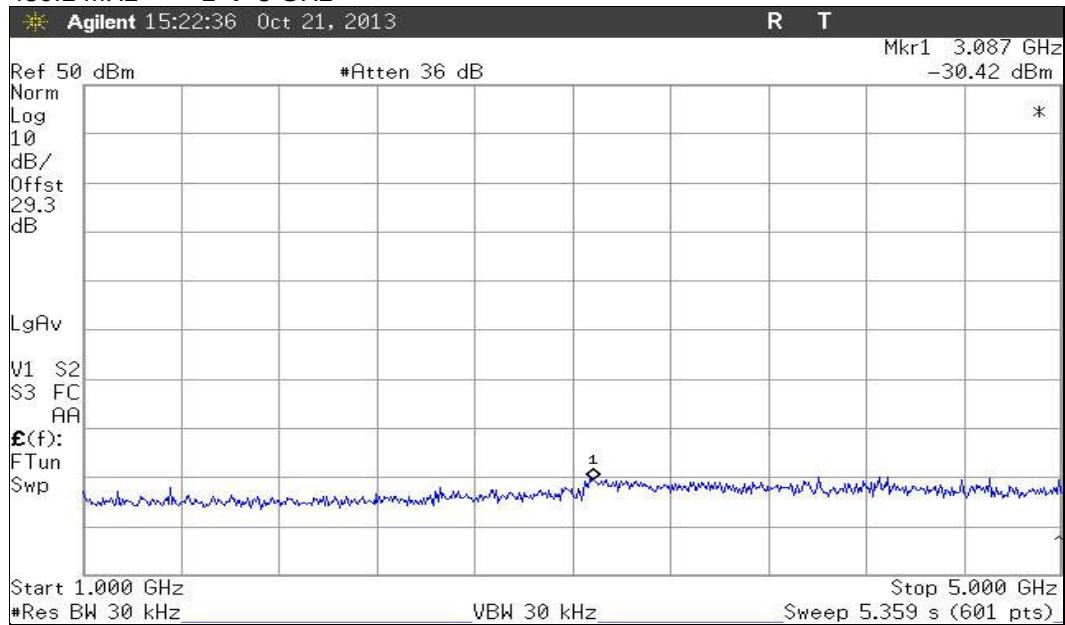


Spurious Emissions (Tx Conducted) – Continued

450.1 MHz 9 kHz → 1 GHz

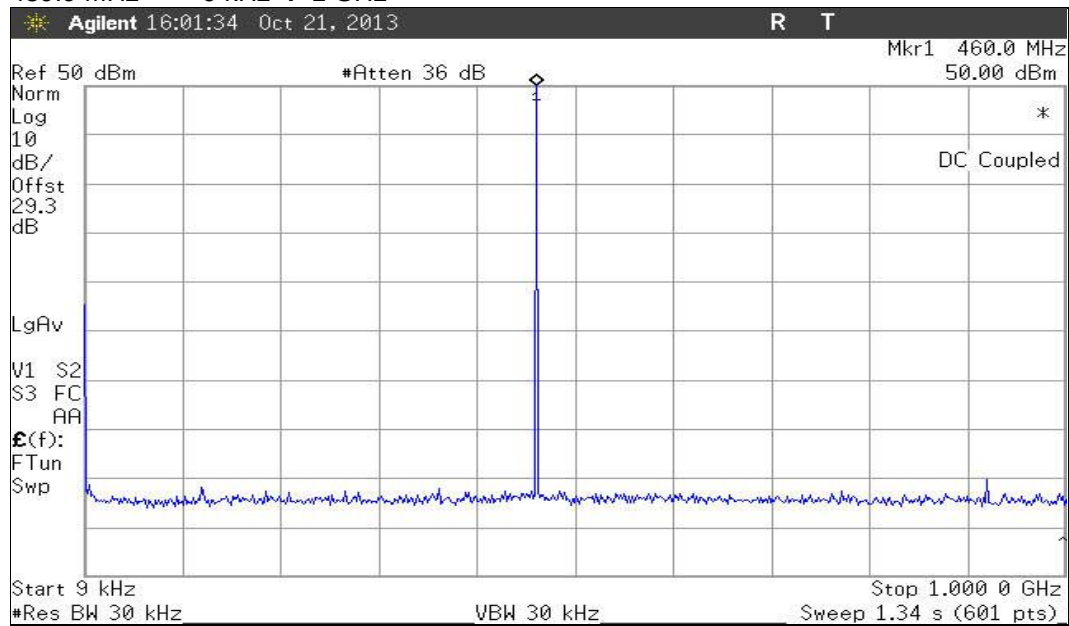


450.1 MHz 1 → 5 GHz

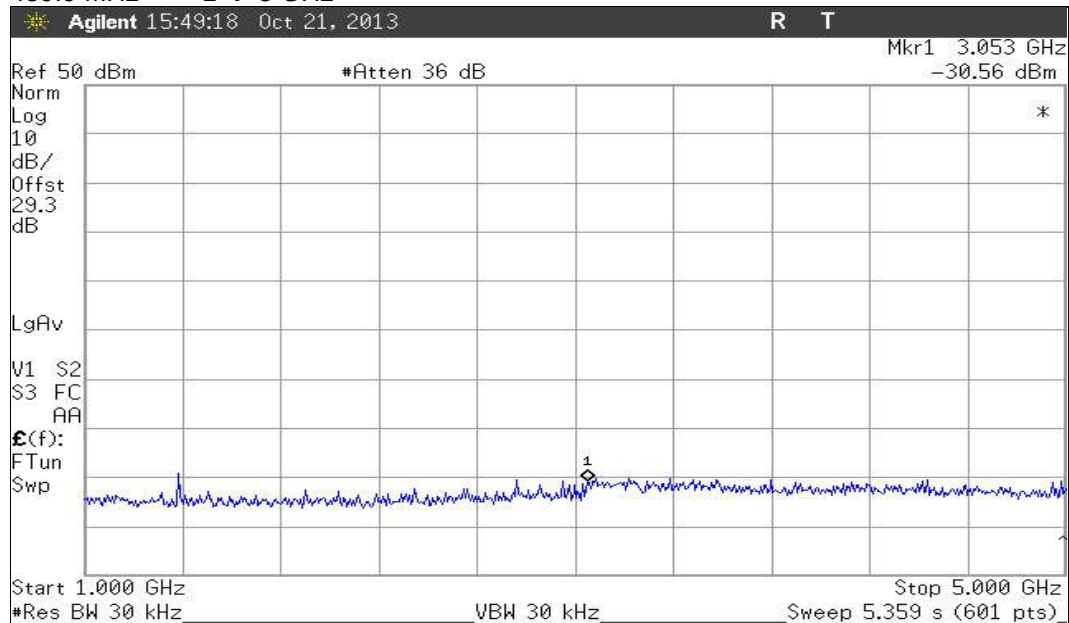


Spurious Emissions (Tx Conducted) – Continued

459.9 MHz 9 kHz → 1 GHz

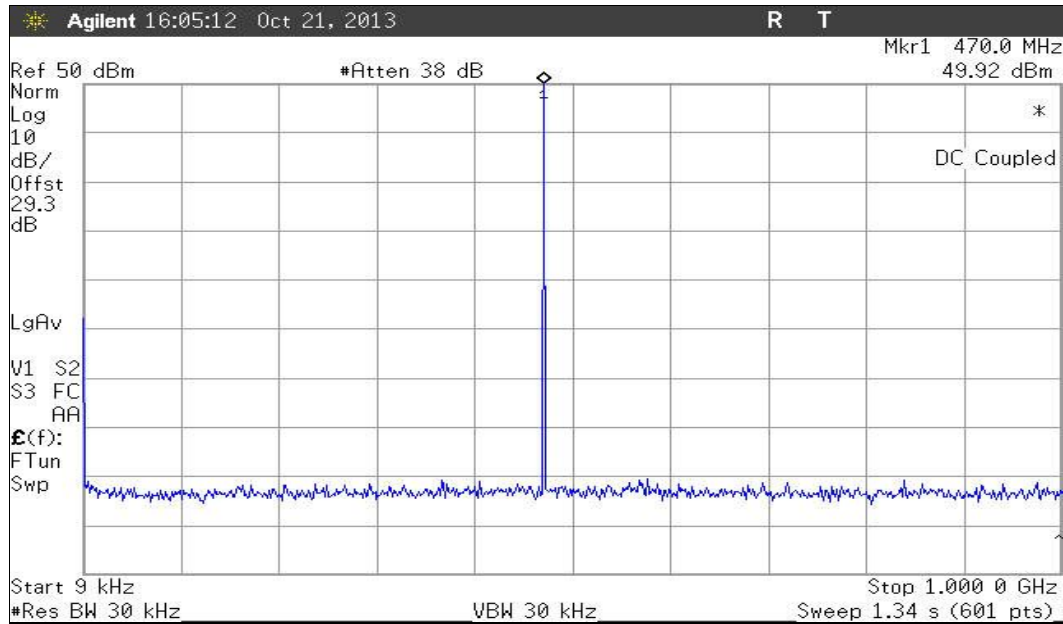


459.9 MHz 1 → 5 GHz

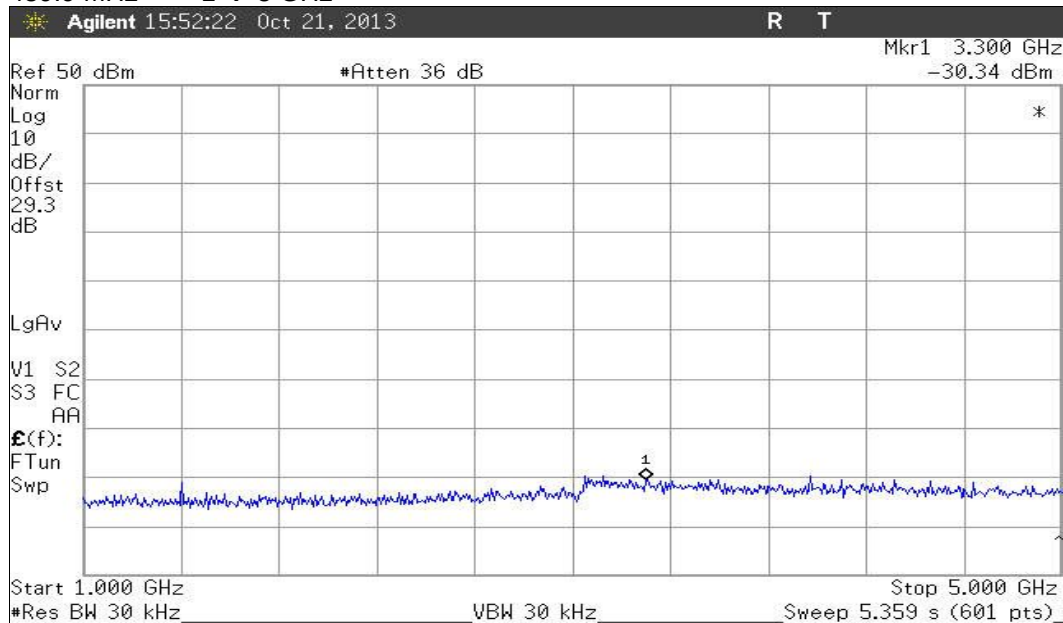


Spurious Emissions (Tx Conducted) – Continued

469.9 MHz 9 kHz → 1 GHz



459.9 MHz 1 → 5 GHz



LIMIT CLAUSES: FCC 47 CFR 90.210

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Carrier Output Power	Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \log_{10}(P_{\text{Watts}})$	
	100 W	10 W
	-20 dBm	-20 dBm
	-70 dBc	-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 1000 MHz. Any emission within 20 dB of the limit is then re-tested on the OATS along with measurements from 1000 MHz to the 10th harmonic of the fundamental frequency.
2. The EUT is placed in the reverberation chamber and emissions are measured from 1000 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 406.2 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
4062.000	-36.38	-86.38
12.5 kHz Channel Spacing 406.2 MHz @ 10 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
12.5 kHz Channel Spacing 418.1 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
12.5 kHz Channel Spacing 418.1 MHz @ 10 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
12.5 kHz Channel Spacing 429.9 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
1289.700	-35.52	-85.52
12.5 kHz Channel Spacing 429.9 MHz @ 10 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.		

Tx Radiated Emissions - Continued

12.5 kHz Channel Spacing 450.1 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
1350.000	-34.58	-84.58
12.5 kHz Channel Spacing 450.1 MHz @ 10 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
12.5 kHz Channel Spacing 459.9 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
12.5 kHz Channel Spacing 459.9 MHz @ 10 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
12.5 kHz Channel Spacing 469.9 MHz @ 100 W Emission Mask D		
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
12.5 kHz Channel Spacing 469.9 MHz @ 10 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.		

LIMIT CLAUSES: FCC CFR 2.1053

Carrier Output Power	Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \log_{10} (P_{\text{Watts}})$	
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

H1 406.2 MHz @ 100 W

Emission Mask D

Harmonics Emission Frequency (MHz)	Level (dBm)	Level (dBc)
812.400	-58.52	-108.52
1218.600	-43.89	-93.89
1624.800	-56.08	-106.08
2031.000	-62.08	-112.08
2437.200	-68.39	-118.39
2843.400	-59.45	-109.45

12.5 kHz Channel Spacing

H2 459.9 MHz @ 100 W

Emission Mask D

Harmonics Emission Frequency (MHz)	Level (dBm)	Level (dBc)
919.800	-63.41	-113.41
1379.700	-45.25	-95.25
1839.600	-50.24	-100.24
2299.500	-68.19	-118.19
2759.400	-46.20	-96.20
3219.300	-60.79	-110.79

Photo: OATS Setup



TRANSIENT FREQUENCY BEHAVIOR

SPECIFICATION: FCC 47 CFR 90.214

RSS-119 5.9

GUIDE: TIA-102.CAAA-C 2.2.18

MEASUREMENT PROCEDURE:

1. Refer Annex A for equipment set up.
2. Measurements and plots were made following the TIA procedure.

MEASUREMENT RESULTS:

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

LIMIT CLAUSES: FCC 47 CFR 90.214

RSS-119 5.9

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

RSS-119 5.9

Tx FREQUENCY: 406.2 MHz

100 W

12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	-1.7	N/A
t2	0.4	N/A
t3	N/A	0.7
t2 → t3 ppm	-1.4	
ERROR LIMIT (t2 → t3) ppm	1.5	

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

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

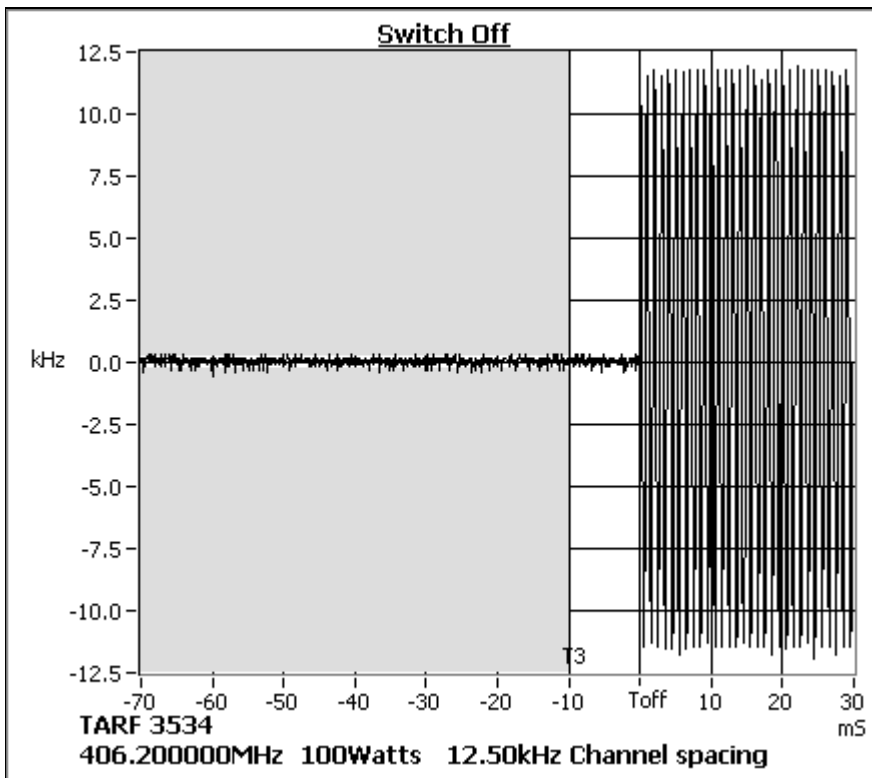
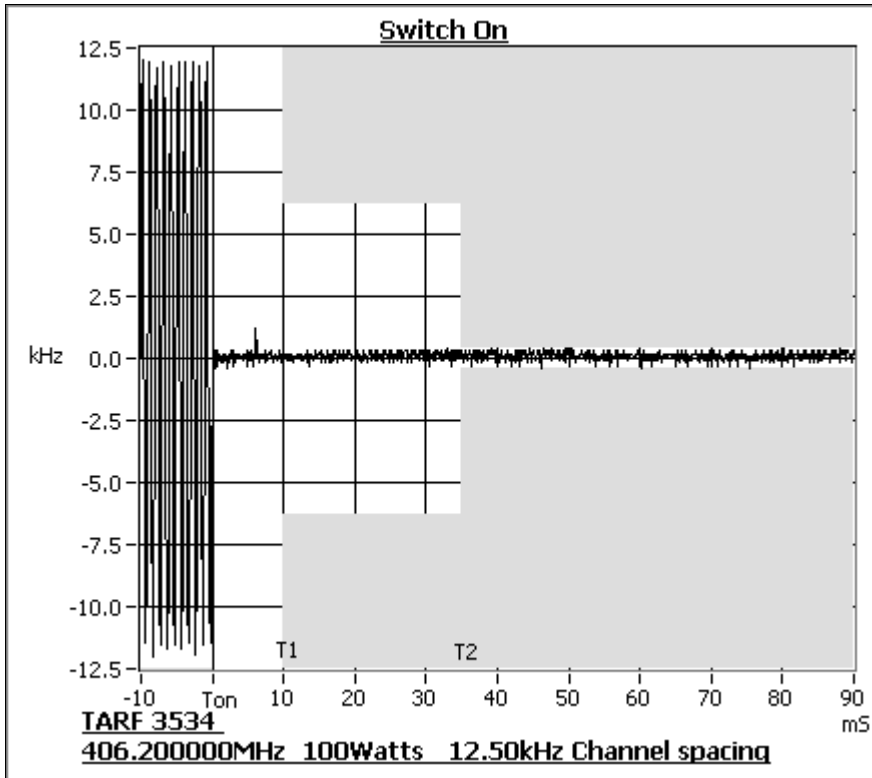
SPECIFICATION: FCC 47 CFR 90.214

RSS-119 5.9

Tx FREQUENCY: 406.2 MHz

100 W

12.5 kHz Channel Spacing



Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 418.1 MHz 100 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	-1.7	N/A
t2	-0.5	N/A
t3	N/A	0.7
t2 → t3 ppm	-1.1	
ERROR LIMIT t2 → t3 (ppm)	1.5	

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

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

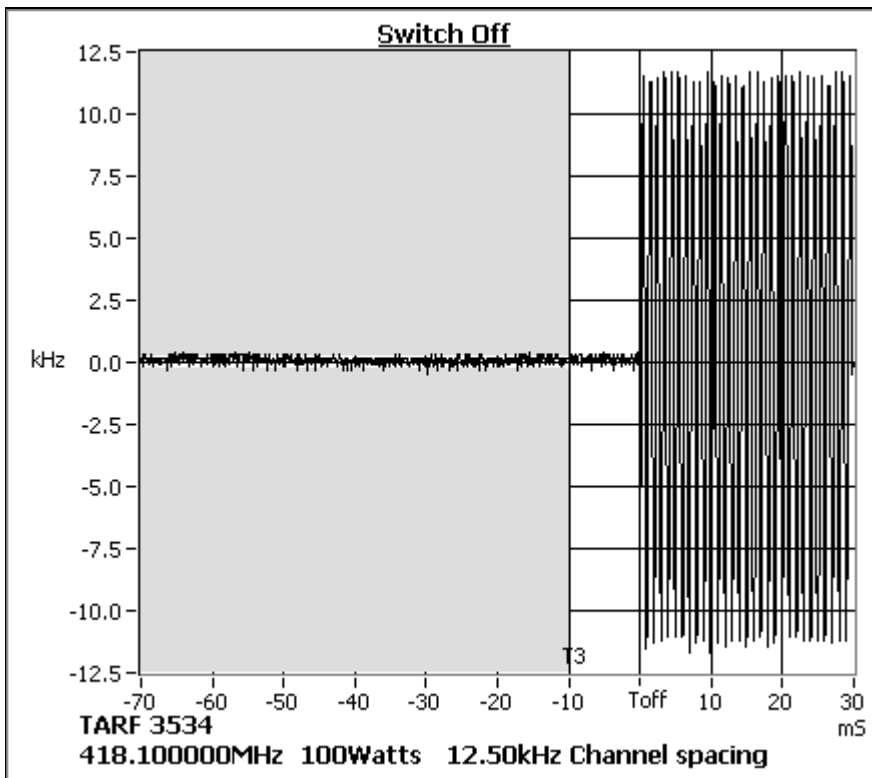
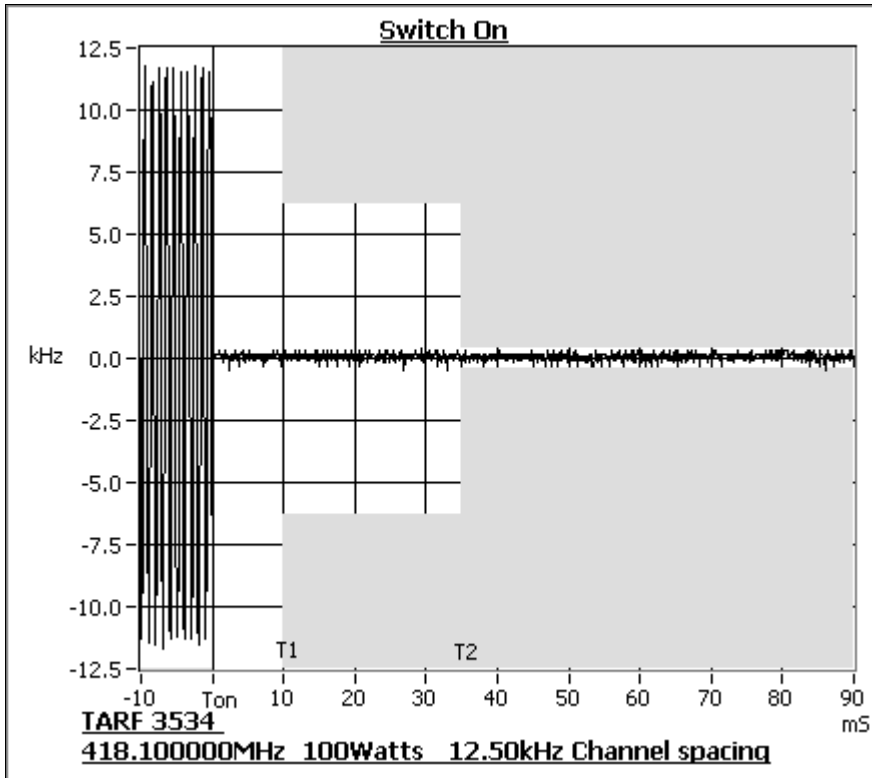
Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz Channels			
TRANSIENT PERIODS	Maximum Frequency Difference	FREQUENCY RANGE	
		138 – 174 MHz	406.1 – 470 MHz
t1 (ms)	± 12.5 kHz	5 ms	10 ms
t2 (ms)	± 6.25 kHz	20 ms	25 ms
t3 (ms)	± 12.5 kHz	5 ms	10 ms

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 Behavior

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 418.1 MHz 100 W 12.5 kHz Channel Spacing



Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 429.9 MHz 100 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	-3.6	N/A
t2	-0.4	N/A
t3	N/A	-0.4
t2 → t3 ppm	-1.2	
ERROR LIMIT t2 → t3 (ppm)	1.5	

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

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,

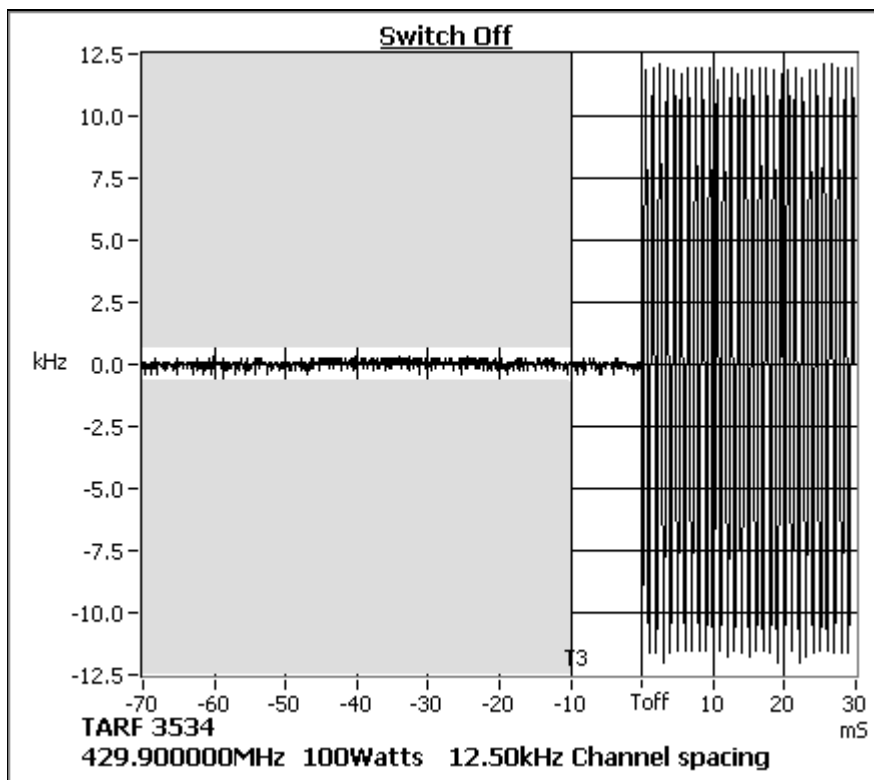
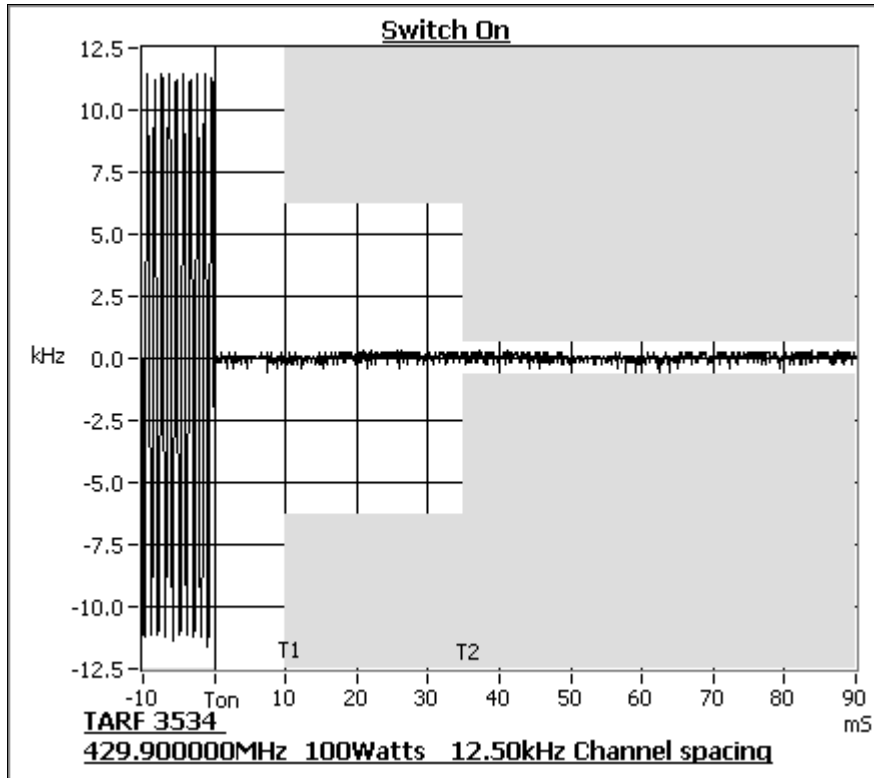
Transient Frequency Behavior

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 429.9 MHz

100 W

12.5 kHz Channel Spacing



Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 450.1 MHz 100 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	1.8	N/A
t2	0.6	N/A
t3	N/A	-0.8
t2 → t3 ppm	-0.7	
ERROR LIMIT t2 → t3 (ppm)	1.5	

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

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

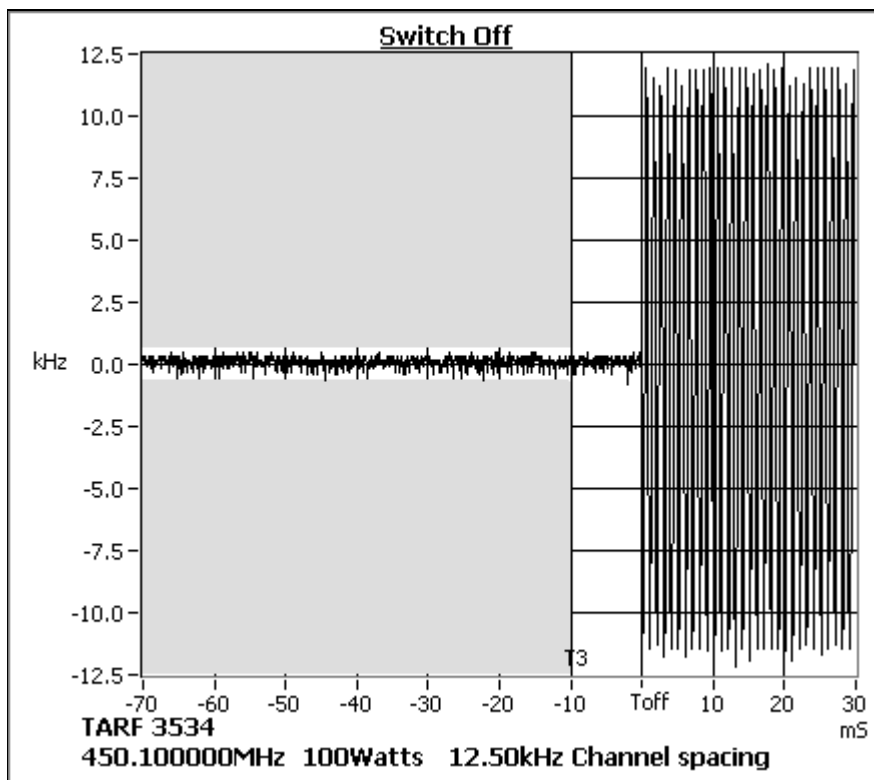
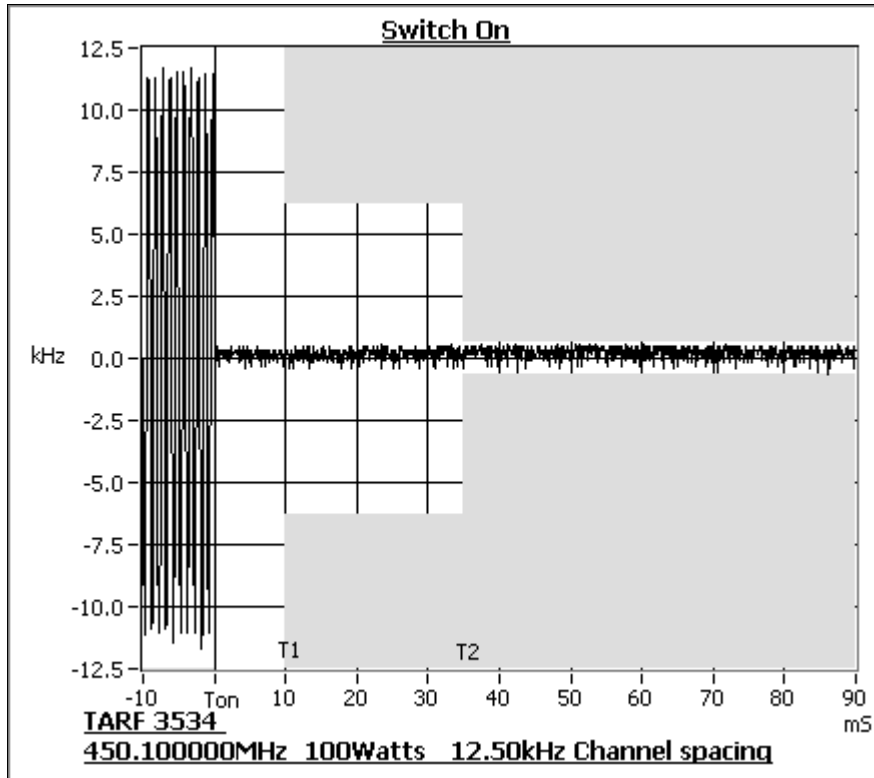
Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz Channels			
TRANSIENT PERIODS	Maximum Frequency Difference	FREQUENCY RANGE	
		138 – 174 MHz	406.1 – 470 MHz
t1 (ms)	± 12.5 kHz	5 ms	10 ms
t2 (ms)	± 6.25 kHz	20 ms	25 ms
t3 (ms)	± 12.5 kHz	5 ms	10 ms

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 Behavior

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 450.1 MHz 100 W 12.5 kHz Channel Spacing



Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 459.9 MHz 100 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	-1.1	N/A
t2	1.0	N/A
t3	N/A	-0.6
t2 → t3 ppm	-0.8	
ERROR LIMIT t2 → t3 (ppm)	1.5	

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

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,

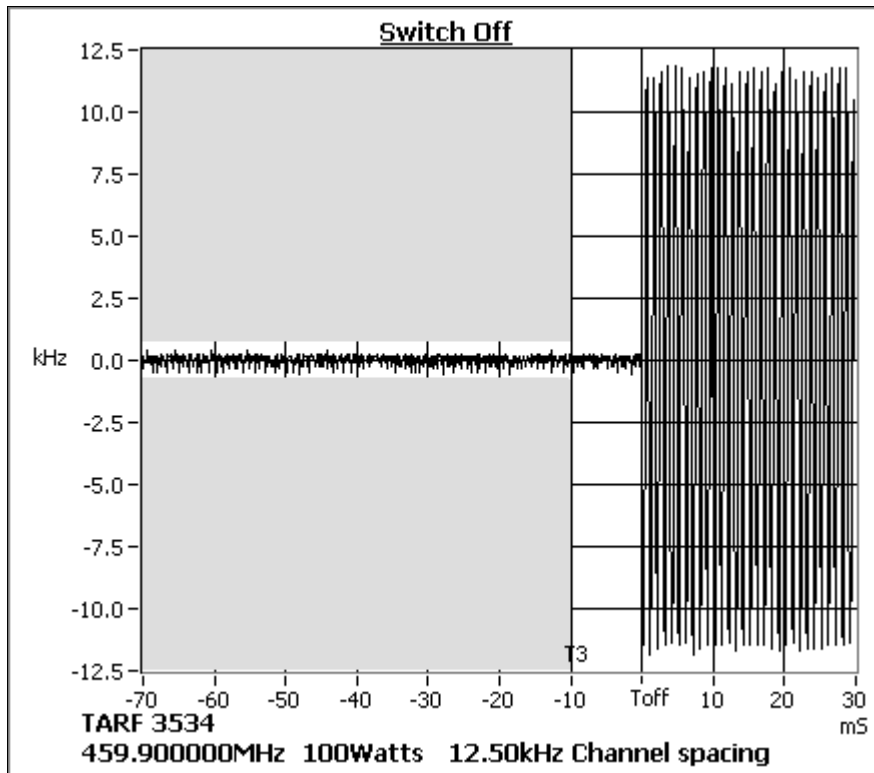
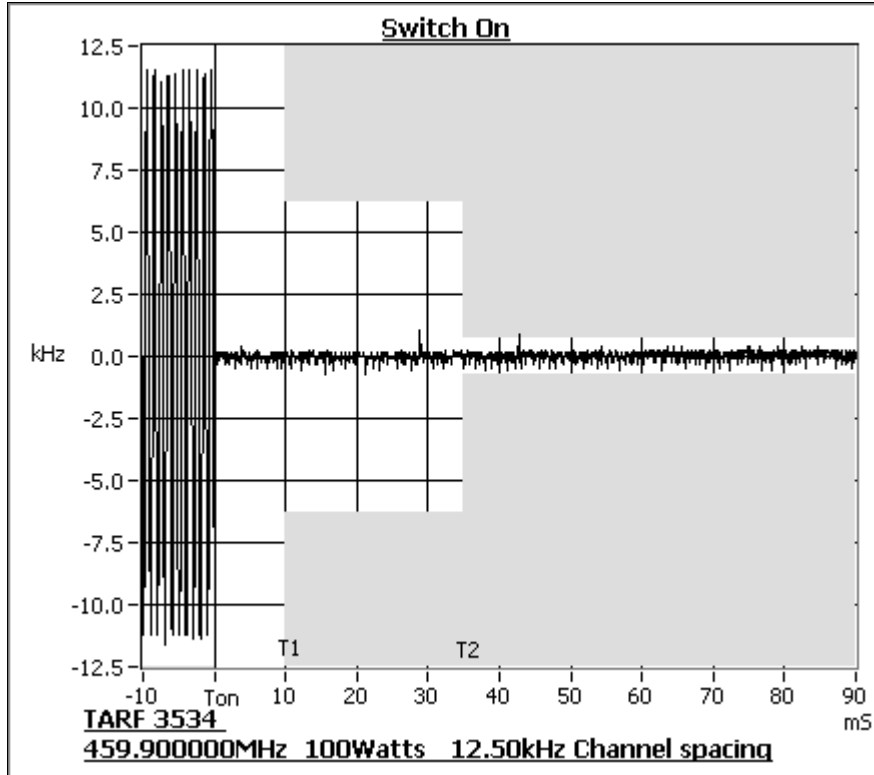
Transient Frequency Behavior

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 459.9 MHz

100 W

12.5 kHz Channel Spacing



Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 469.9 MHz 100 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	1.5	N/A
t2	-0.7	N/A
t3	N/A	0.7
t2 → t3 ppm	-0.6	
ERROR LIMIT t2 → t3 (ppm)	1.5	

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

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,

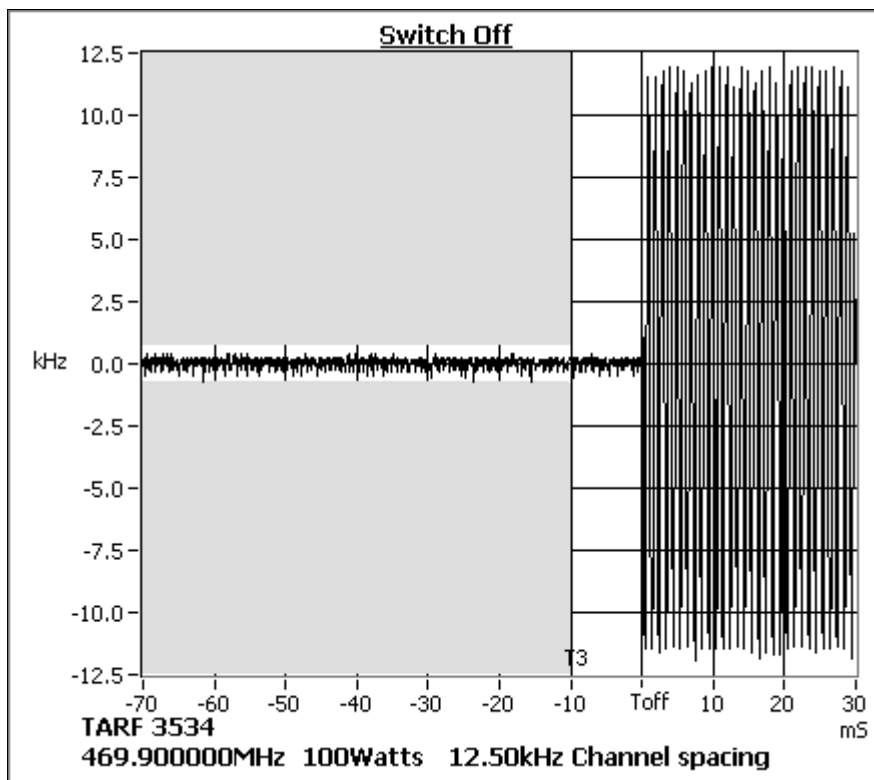
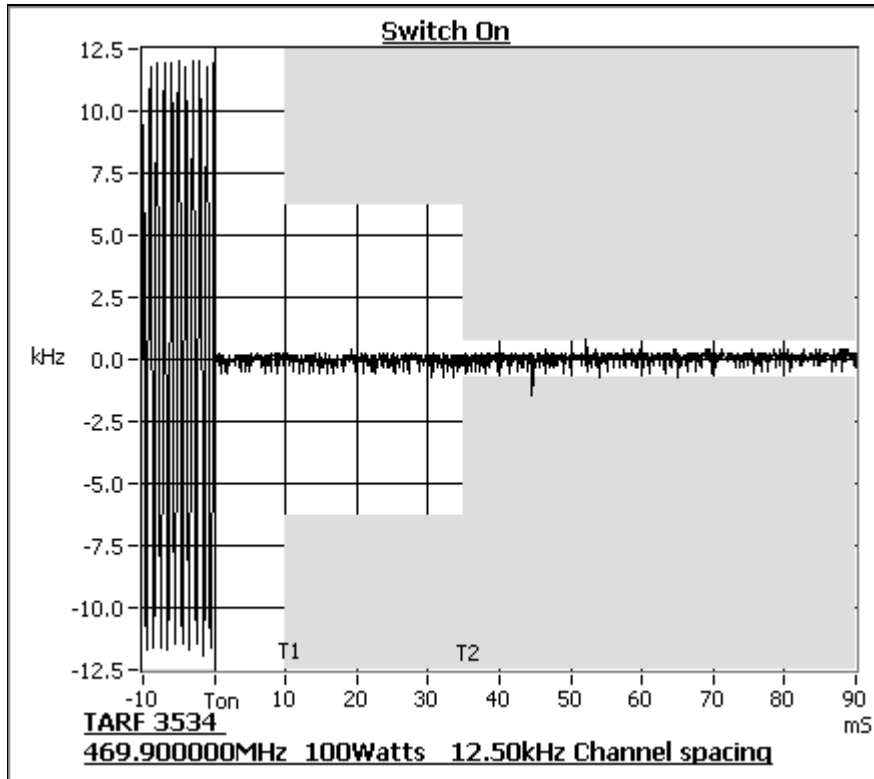
Transient Frequency Behavior

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 469.9 MHz

100 W

12.5 kHz Channel Spacing



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:

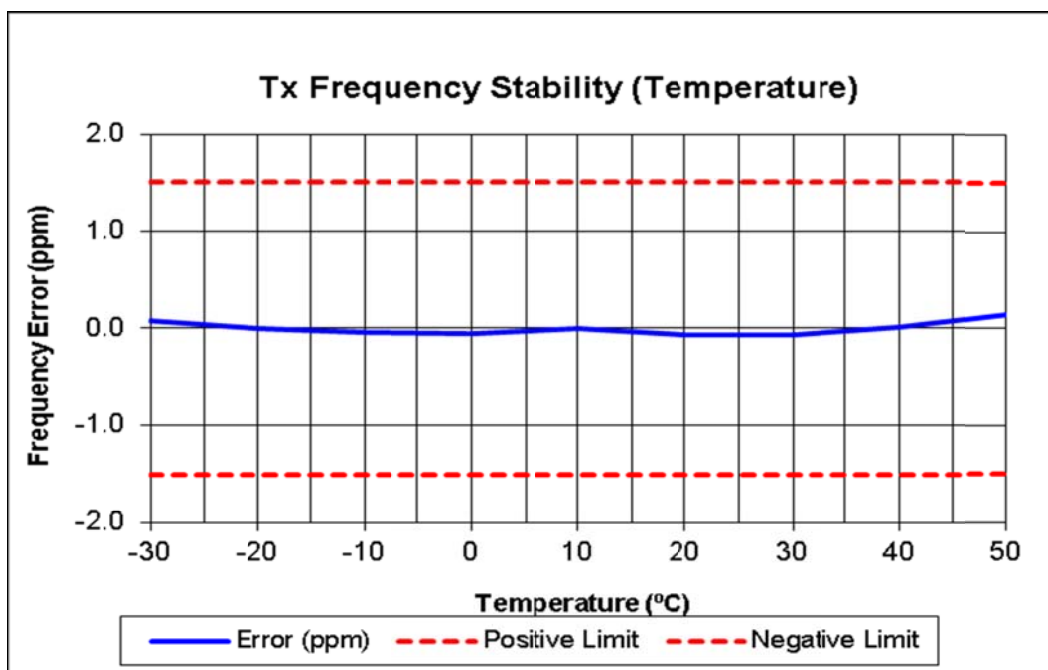
1. Refer Annex A for equipment set up.
2. The EUT was tested for frequency error from -30°C to $+50^{\circ}\text{C}$ in 10°C increments
3. The frequency error was recorded in parts per million (ppm).

MEASUREMENT RESULTS:

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

406.2 MHz

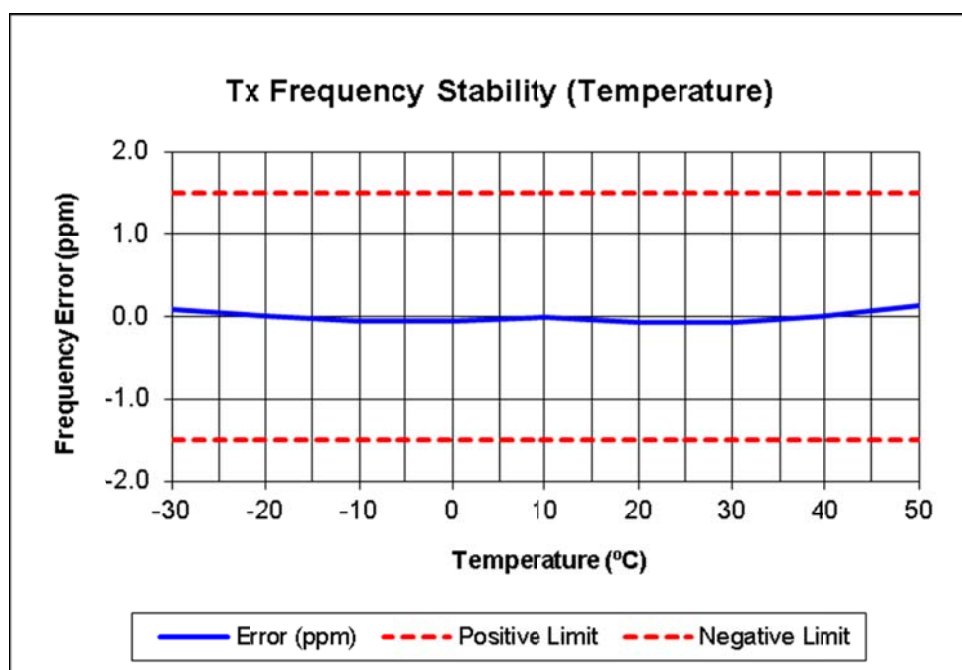
Temperature ($^{\circ}\text{C}$)	Frequency (MHz)	Error (ppm)
50	406.200056	0.1
40	406.200005	0.0
30	406.199970	-0.1
20	406.199972	-0.1
10	406.199999	0.0
0	406.199979	-0.1
-10	406.199984	0.0
-20	406.200001	0.0
-30	406.200033	0.1



Transmitter Frequency Stability - Temperature

418.1 MHz

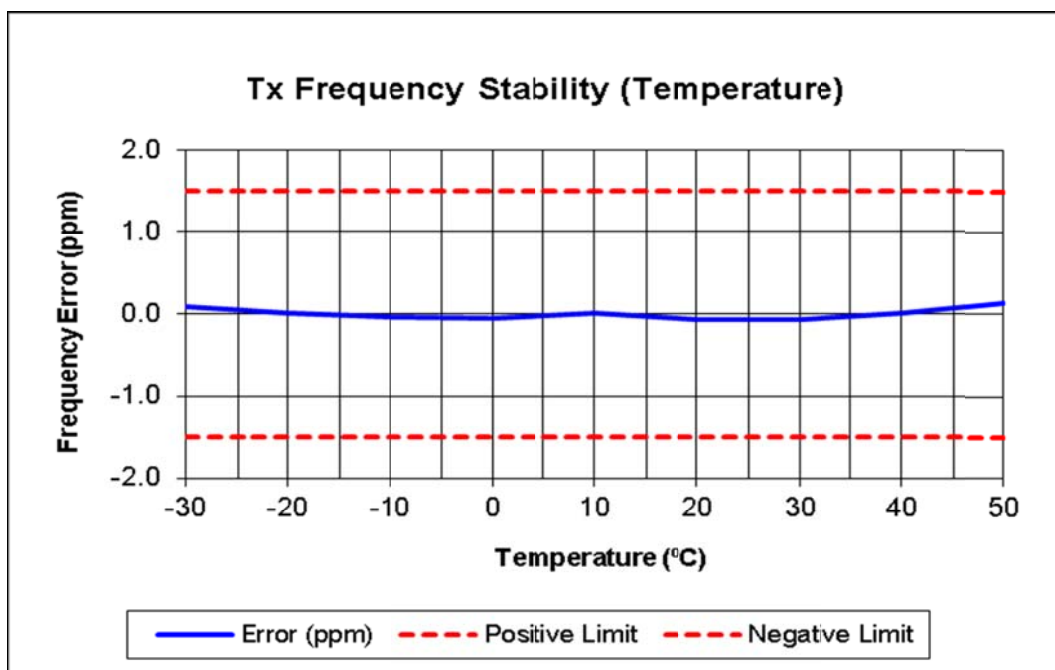
Temperature (°C)	Frequency (MHz)	Error (ppm)
50	418.100060	0.1
40	418.100004	0.0
30	418.099972	-0.1
20	418.099974	-0.1
10	418.100002	0.0
0	418.099978	-0.1
-10	418.099983	0.0
-20	418.100003	0.0
-30	418.100036	0.1



Transmitter Frequency Stability - Temperature

429.9 MHz

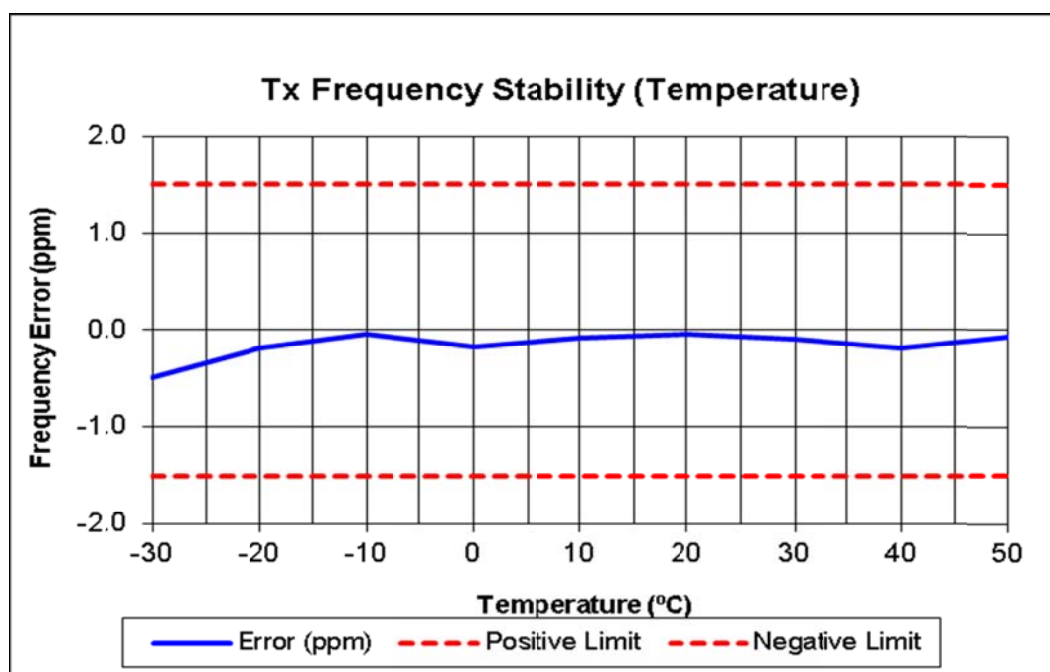
Temperature (°C)	Frequency (MHz)	Error (ppm)
50	429.900062	0.1
40	429.900004	0.0
30	429.899973	-0.1
20	429.899975	-0.1
10	429.900004	0.0
0	429.899980	0.0
-10	429.899985	0.0
-20	429.900003	0.0
-30	429.900038	0.1



Transmitter Frequency Stability - Temperature

450.1 MHz

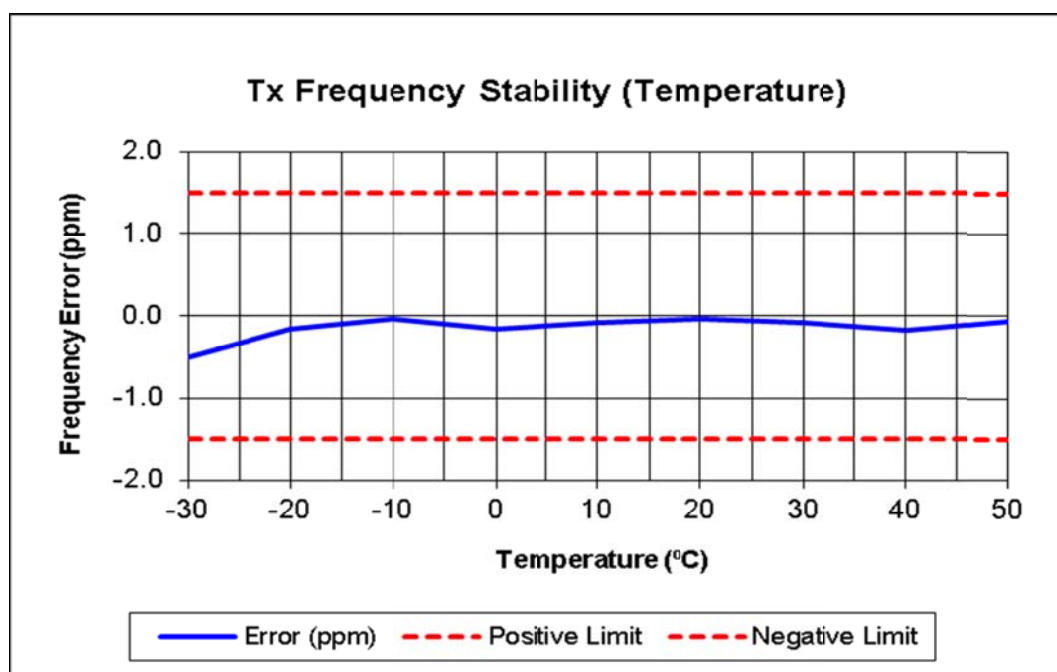
Temperature (°C)	Frequency (MHz)	Error (ppm)
50	450.099967	-0.1
40	450.099918	-0.2
30	450.099958	-0.1
20	450.099984	0.0
10	450.099966	-0.1
0	450.099925	-0.2
-10	450.099979	0.0
-20	450.099918	-0.2
-30	450.099778	-0.5



Transmitter Frequency Stability - Temperature

459.9 MHz

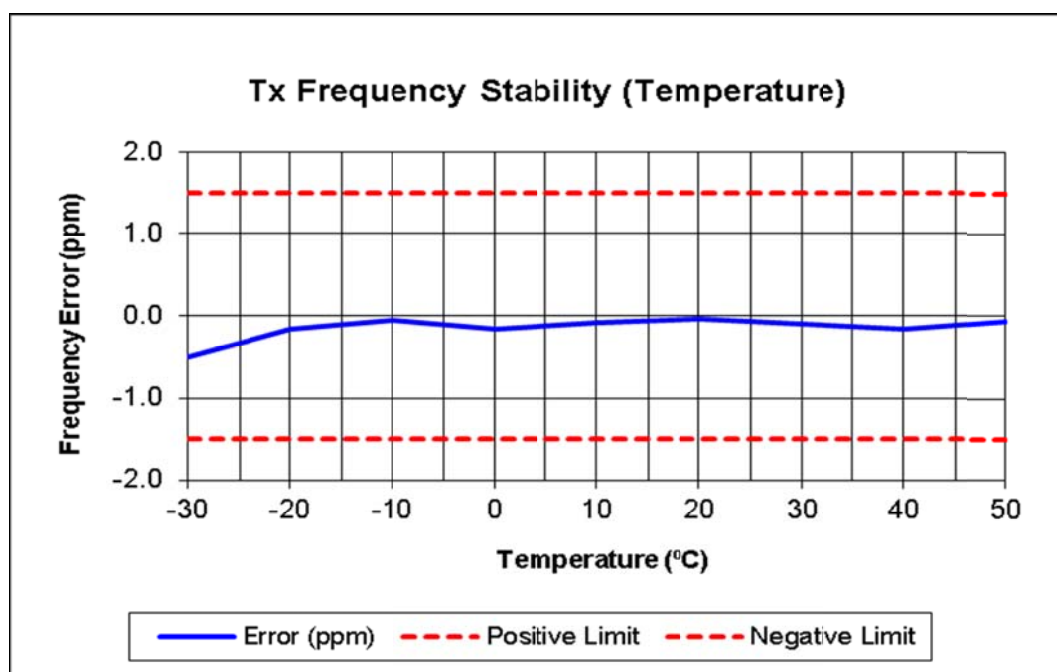
Temperature (°C)	Frequency (MHz)	Error (ppm)
50	459.899970	-0.1
40	459.899921	-0.2
30	459.899961	-0.1
20	459.899984	0.0
10	459.899967	-0.1
0	459.899926	-0.2
-10	459.899982	0.0
-20	459.899931	-0.2
-30	459.899771	-0.5



Transmitter Frequency Stability - Temperature

469.9 MHz

Temperature (°C)	Frequency (MHz)	Error (ppm)
50	469.899968	-0.1
40	469.899924	-0.2
30	469.899957	-0.1
20	469.899986	0.0
10	469.899966	-0.1
0	469.899925	-0.2
-10	469.899980	0.0
-20	469.899925	-0.2
-30	469.899762	-0.5



LIMIT CLAUSES: FCC 47 CFR 90.213

RSS-119 5.3

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

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:

TBCH0D 100 W Rack

Voltage	FREQUENCY ERROR (ppm) for 12.5 kHz		
	406.2 MHz	418.1 MHz	429.9 MHz
120 V _{ac}	0.00	-0.01	-0.03
102 V _{ac}	-0.01	-0.01	-0.02
138 V _{ac}	-0.01	-0.01	-0.03

TBCH0E 100 W Rack

Voltage	FREQUENCY ERROR (ppm) for 12.5 kHz		
	450.1 MHz	459.9 MHz	469.9 MHz
120 V _{ac}	0.00	0.00	-0.01
102 V _{ac}	-0.01	0.00	-0.01
138 V _{ac}	0.00	0.00	0.00

LIMIT CLAUSES: FCC 47 CFR 90.213

RSS-119 5.3

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

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

TBCH0D 100 W Rack		
406.2 MHz Receive (Receiver RF Input Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
418.1 MHz Receive (Receiver RF Input Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
429.9 MHz Receive (Receiver RF Input Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
TBCH0E 100 W Rack		
450.1 MHz Receive (Receiver RF Input Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
459.9 MHz Receive (Receiver RF Input Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
469.9 MHz Receive (Receiver RF 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.

TBCH0D 100 W Rack		
406.2 MHz Transmitter Standby (Transmitter RF Output Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
418.1 MHz Transmitter Standby (Transmitter RF Output Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
429.9 MHz Transmitter Standby (Transmitter RF Output Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
TBCH0E 100 W Rack		
450.1 MHz Transmitter Standby (Transmitter RF Output Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
459.9 MHz Transmitter Standby (Transmitter RF Output Port)		
Emission Frequency (MHz)	Level (nW)	Level (dBm)
~	~	~
469.9 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)

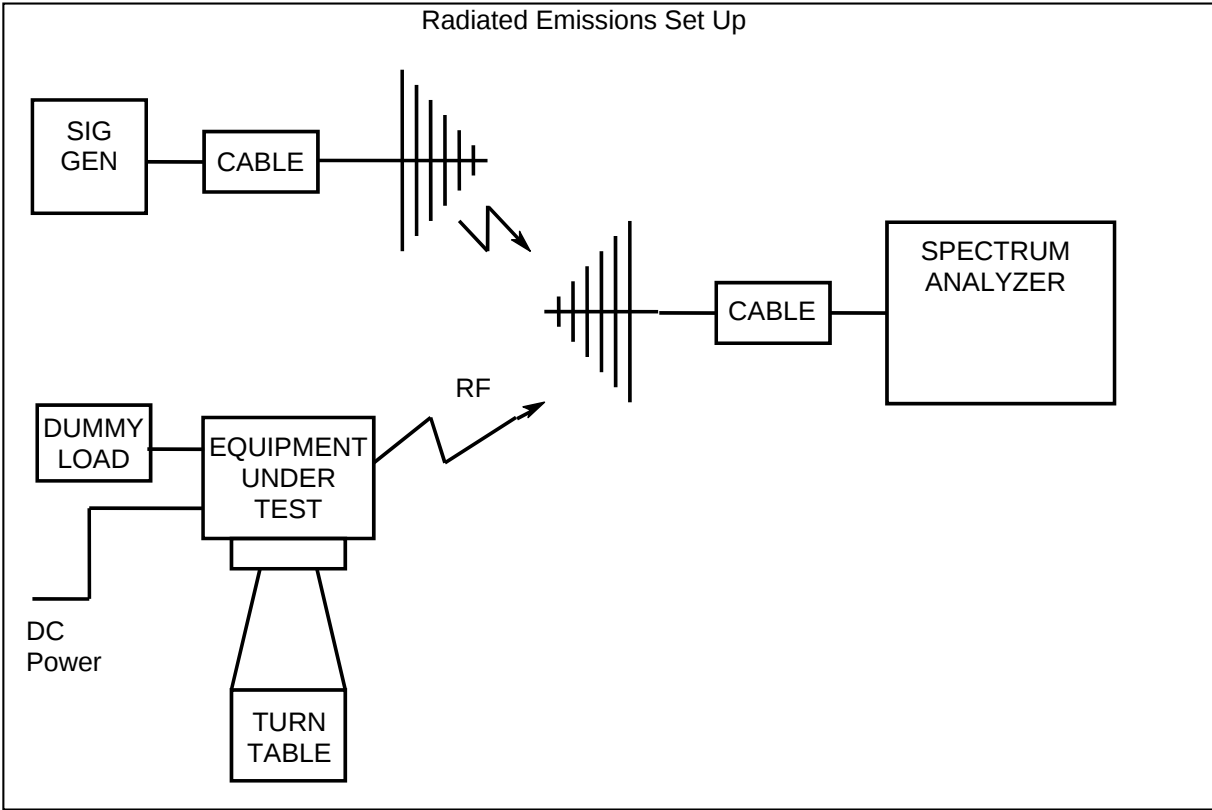
LIMIT	30 → 1000 MHz	2 nW	- 57 dBm
	> 1000 MHz	5 nW	- 53 dBm

TEST EQUIPMENT LIST

No#	Equipment Type	Information	Manufacturer	Model No	Serial No#	Tait ID	Cal Due
9	Modulation Analyser	Includes Audio Analyser	Rohde & Schwarz	FMA0852.8500.52	842541/001	E3554	14-Dec-14
16	Oscilloscope	100MHz Digital	Tektronics	TDS340	B013611	E3585	16-Oct-14
27	Power Supply	AC Variac	Yamabishi	S-260-5	TX-533	E1737	
29	Antenna	Reference Dipoles	Emco	3121C DB1	9510-1164	E3559	30-Jan-16
31	Antenna	18GHz DRG	Emco	DRG3115	9512-4638	E3560	6-Mar-16
32	Antenna	18GHz DRG	Emco	DRG3115	2084	E3076	6-Mar-16
35	RF Chamber	S-LINE TEM CELL	Rohde & Schwarz	1089.9296.02	338232/003	E3636	31-Aug-15
45	RF Attenuator	TREVA1 20dB 150W	Weinschel	40-20-33	QT968	E4842	17-Oct-14
48	RF Attenuator	10dB 50W	Weinschel	24-10-34	AZ0401	E3388	17-Oct-14
49	RF Attenuator	20dB 50W	Weinschel	24-20-44	AW1266	E3562	17-Oct-14
50	RF Attenuator	20dB 25W	Weinschel	33-20-33	BD5871	E3673	18-Oct-14
51	RF Attenuator	TREVA2 20dB 150W	Weinschel	40-20-33	CJ405	E3733	21-Oct-14
52	RF Load	150W	Bird	8166	524	E3625	23-Oct-14
54	RF Load	50W	Weinschel	F1426	AE2490	E3624	18-Oct-14
56	RF Load	2W	MCL	NTRM-50	951215	E3574	18-Dec-13
60	Coax Cable	1m Blue	Suhner	Sucoflex 104A	44610/4A	E4619	16-Oct-14
61	Coax Cable	2m Black	Suhner	RG214HF/Nm/Nm/2000	TeltestBlack2	E4623	15-Oct-14
62	Coax Cable	2m Black	Suhner	RG214HF/Nm/Nm/2000	TeltestBlack3	E4624	15-Oct-14
63	Coax Cable	3m Blue	Suhner	Sucoflex 104A	44611/4A	E4620	16-Oct-14
64	Coax Cable	2m Black	Suhner	RG214HF/Nm/Nm/2000	TeltestBlack4	E4653	15-Oct-14
65	Audio Analyser	TREVA2	Hewlett Packard	HP8903B	2818A04275	E3710	17-Oct-14
66	Spectrum Analyser	13.2GHz	Hewlett Packard	HP8562E	3821A00779	E3715	18-Oct-14
78	Oscilloscope	400MHz	Tektronics	TDS380	B017095	E3782	16-Oct-14
91	Signal Generator	Digital 4GHz	Agilent	E4433B	US38440446	E4147	18-Oct-14
94	Environ. Chamber	Upright	Contherm	5400 RHSLT.M	1416	E4051	2-Aug-15
95	Environ. Chamber	Upright	Contherm	5400 RHSLT.M	1416	E4051	5-Aug-14
97	RF Attenuator	TREVA2 3dB	Weinschel	Model 1	BL9950	E4080	
98	RF Attenuator	TREVA1 3dB	Weinschel	Model 1	BL9958	E4081	
100	RF Combiner	TREVA1	Minicircuits	ZFSC-4-1	-	E4083	
101	RF Combiner	TREVA2	Minicircuits	ZFSC-4-1	-	E4084	
103	Spectrum Analyser	13.2GHz	Agilent	E4445A	MY42510072	E4139	21-Nov-14
106	OATS	NSA	Tait				15-Apr-14
107	Coax Cable	OATS Tower Cable	Intelcom	RG214	OATS1	E4621	13-Oct-14
108	Coax Cable	OATS Turntable Cable	Intelcom	RG215	OATS2	E4622	13-Oct-14
109	OATS	Antenna Tower	Electrometrics	EM-4720-2	112	E4447	
110	OATS	Controller	Electrometrics	EM-4700	119	E4445	
111	OATS	Turntable	Electrometrics	EM-4704A	105	E4446	
115	RF Attenuator	30dB 350W	Weinschel	67-30-33	BR0531	E4280	18-Oct-14
127	Power Meter	TREVA2 Power Head for HP8901	Hewlett Packard	HP11722A	2716A02037	1575	21-Oct-14
128	Antenna	Log Periodic	Schwarzbeck	VUSLP	9111-219	E4147	
133	TREVA 2		Teltest	-	2	-	23-Apr-14
134	Coax Cable	Reverb - 4.5m Multiflex 141	TeltestBlue6	MF 141	TeltestBlue6	E4843	16-Oct-14
135	Coax Cable	Reverb - 2m Multiflex 141	TeltestBlue5	MF 141	TeltestBlue5	E4844	16-Oct-14
136	Coax Cable	Reverb - 2m Multiflex 141	TeltestBlue4	MF 141	TeltestBlue4	E4845	15-Oct-14
137	Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue3	MF 141	TeltestBlue3	E4846	17-Oct-14
138	Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue2	MF 141	TeltestBlue2	E4847	17-Oct-14
139	Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue1	MF 141	TeltestBlue1	E4848	17-Oct-14
145	RF Chamber	Reverb - Stirrer controller for reverb chamber	Teseq	Stirrer Controller	29765.1	E4854	
146	RF Chamber	Reverb - 0.5 - 18GHz Reverberation Chamber	Teseq	RVC XS	29765	E4855	
148	Antenna	Reverb - 1-18GHz DRG	Schwarzbeck	BBHA9120 D	9120D-885	E4857	
149	Antenna	Reverb - 1-18GHz DRG	Schwarzbeck	BBHA9120 D	9120D-884	E4858	
150	RF Amplifier	Pre-amplifier	Agilent	87405C	MY47010688	E4941	18-Oct-14

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 **EVA**luation 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.

