TELTEST Laboratories
Tait International Ltd
Report Number 4007

LABORATORY TEST REPORT

RADIO PERFORMANCE MEASUREMENTS

for the

TPDH7C Handportable Transceiver

Tested in accordance with:

FCC 47 CFR Parts 22 and 90

Report Revision:	1	
Issue Date:	7 August 2019	
PREPARED BY:	L. M. White	Test Technician
CHECKED & APPROVED BY:	M. C. James	Laboratory Technical Manager

FCC REGISTRATION: 838288

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TABLE OF CONTENTS

REVISION

Date	Revision	Comments
7 August 2019	1	Initial test report

INTRODUCTION

Type approval testing of the TPDH7C, 4 Watt, Handportable transceiver in order to demonstrate compliance with FCC 47 Parts 22 & 90. This radio supports analogue, digital FFSK, Digital Mobile Radio (DMR), APCO P25 phase-1 and APCO P25 phase-2 modulations.

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

DESCRIPTION OF SAMPLE

Manufacturer	Tait International Limited
Equipment:	Handportable Transceiver
Type:	TPDH7C
Product Code:	T03-00068-HCAZ
Serial Number(s):	26111477
Frequency range	450 → 520 MHz
Transmit Power	4 W

Modulation		Channel Spacing	Speech Channels	Symbol Rate (symbols/sec)	Data Rate (bps)
Analogue FM		12.5 kHz	1	-	-
FFSK	Fast Frequency Shift Keying	12.5 kHz	-	1200	1200
		12.5 kHz	-	2400	2400
Digital Mobile Radio (DMR)	4 Level FSK (2 slot TDMA) (ETSI TS102 361-1)	12.5 kHz	2	4800	9600
APCO P25 Phase 1	C4FM (TIA 102)	12.5 kHz	1	4800	9600
APCO P25 Phase 2	H-CPM (2 slot TDMA) (TIA 102)	12.5 kHz	2	6000	12000

HARDWARE & SOFTWARE
Quantity: 1

	Analogue, FFSK and P25 tests	DMR tests
Hardware ID	TPDB3X-H700_0001	TPDB3X-H700_0001
Boot Code	QPD3B_S00_3.05.07.0001	QPD3B_S00_3.05.07.0001
DSP	QPD3A_A02_2.15.01.0012	QPD3A_E00_2.22.02.0042
Radio Application	QPD3F_A00_2.15.01.0012	QPD3F_E00_2.22.02.0042
Firmware Package	QI94P_A02_2.15.01.0012	QI93P_E00_2.22.02.0042
FPGA Image	QPD3G_S00_1.12.18.0001	QPD3G_S00_1.12.18.0001

TEST CONDITIONS
All testing was performed between 25 → 30 July 2019, and under the following conditions:
Ambient temperature: 15°C → 30°C
Relative Humidity: 20% → 75%
Standard Test Voltage 7.5 V_{DC}

Except the Open Area Test Site (OATS) radiated emissions test, where the temperature was 12.1 °C and the relative humidity was 75%.

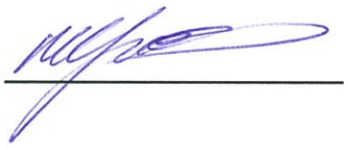
STATEMENT OF COMPLIANCE

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

Equipment:	Handportable Transceiver
Type:	TPDH7C
Product Code:	T03-00068-HCAZ
Serial Number(s):	26111477
Quantity:	1

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

FCC 47 CFR Parts 22 and 90

Signature: 

M. C. James
Laboratory Technical Manager

Date: 19 August 2019

MODULATION TYPES, NECESSARY BANDWIDTH & EMISSION DESIGNATORS

MODULATION TYPES:

F3E	Analogue Frequency Modulation (FM)	
F2D	FFSK	1200 bps and 2400 bps
FXW	DMR Digital Voice	9600 bps
FXD	DMR Digital Data	9600 bps
F1E, F7E	P25 phase 1 Digital Voice	9600 bps
F1D, F7D	P25 phase 1 Digital Data	9600 bps
F1W	P25 phase 2 Digital Voice / Data	12000 bps

CHANNEL SPACING: 12.5 kHz

EMISSION DESIGNATORS:

	12.5 kHz
Analog FM	11K0F3E
FFSK Data 1200 bps	6K60F2D
FFSK Data 2400 bps	7K80F2D
Digital Voice DMR	7K60FXW
Digital Data DMR	7K60FXD
Digital Voice P25 phase 1	8K10F1E
Digital Data P25 phase 1	8K10F1D
Digital Voice P25 phase 2	8K10F1W
Digital Data P25 phase 2	8K10F1W

CALCULATIONS

Equation: Bn = 2M + 2Dk
(M is highest modulating frequency; D is peak allowable deviation; k is a constant of 1 for FM)

Analog 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

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

Necessary bandwidth
M = 1.8 kHz
D = 1.5 kHz (60% of peak deviation)
Bn = (2 x 1.8) + (2 x 1.5) x 1
= 6.6 kHz

Emission Designator
6K60F2D
F2D represents a FM data transmission with the use of a modulating sub carrier

Fast Frequency Shift Keying (FFSK – 2400 bps) 12.5 kHz Bandwidth

Necessary bandwidth
M = 2.4 kHz
D = 1.5 kHz (60% of peak deviation)
Bn = (2 x 2.4) + (2 x 1.5) x 1
= 7.8 kHz

Emission Designator
7K80F2D
F2D represents a FM data transmission with the use of a modulating sub carrier

Emission Designators – Continued

Digital Voice 12.5 kHz Bandwidth DMR

99% bandwidth	Emission Designator
= 7.6 kHz	**7K60FXW**

FXW represents a FM Time Division Multiple Access (TDMA) combination of data and telephony

Digital Data 12.5 kHz Bandwidth DMR

99% bandwidth	Emission Designator
= 7.6 kHz	**7K60FXD**

FXD represents FM Time Division Multiple Access (TDMA) data only

Digital Voice 12.5 kHz Bandwidth P25 phase 1

99% bandwidth	Emission Designator
= 8.1 kHz	**8K10F1E**
	F1E represents a digital FM voice transmission

Digital Data 12.5 kHz Bandwidth P25 phase 1

99% bandwidth	Emission Designator
= 8.1 kHz	**8K10F1D**
	F1D represents an digital FM data transmission

Digital Voice 12.5 kHz Bandwidth P25 phase 2

99% bandwidth	Emission Designator
= 8.1 kHz	**8K10F1W**
	F1W represents a single FM telephony channel

Digital Data 12.5 kHz Bandwidth P25 phase 2

99% bandwidth	Emission Designator
= 8.1 kHz	**8K10F1W**
	F1W represents digital FM data transmission

TEST RESULTS

TRANSMITTER OUTPUT POWER (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1046

GUIDE: TIA/EIA-603D 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: 4 W and 1 W

Nominal 4 W	450.125 MHz	454.5 MHz	459.9 MHz	465.1 MHz	469.9 MHz	511.9 MHz
Measured	3.9	3.9	4.0	4.0	4.0	4.0
Variation (%)	-2.9	-1.7	-0.3	0.2	0.1	-0.9
Nominal 1 W	450.125 MHz	454.5 MHz	459.9 MHz	465.1 MHz	469.9 MHz	511.9 MHz
Measured	1.0	1.0	1.0	1.0	1.0	1.0
Variation (%)	-2.4	-3.2	-1.6	-1.9	-1.4	-3.8
Measurement Uncertainty			± 0.6 dB			

LIMIT CLAUSE:

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.

TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS

SPECIFICATION: FCC 47 CFR 2.1047 (a)

GUIDE: TIA/EIA-603D 2.2.6

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

MEASUREMENT RESULTS:
See the plots on the following pages for 12.5 kHz channel spacing tested at 4 W transmit power.

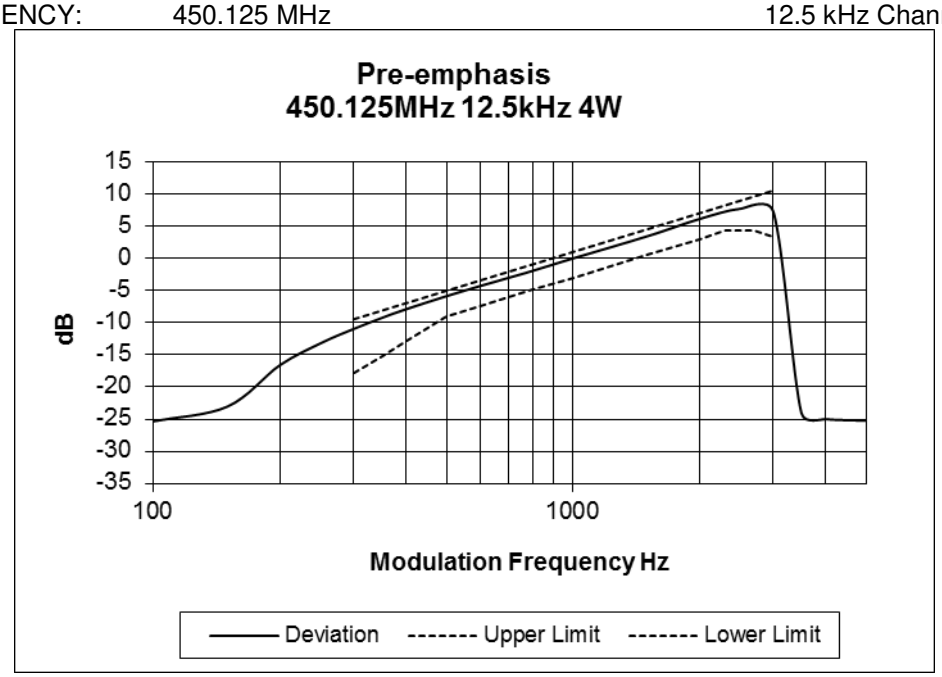
LIMIT CLAUSE: TIA/EIA-603D 3.2.6

MEASUREMENT UNCERTAINTY: ± 1.5 %

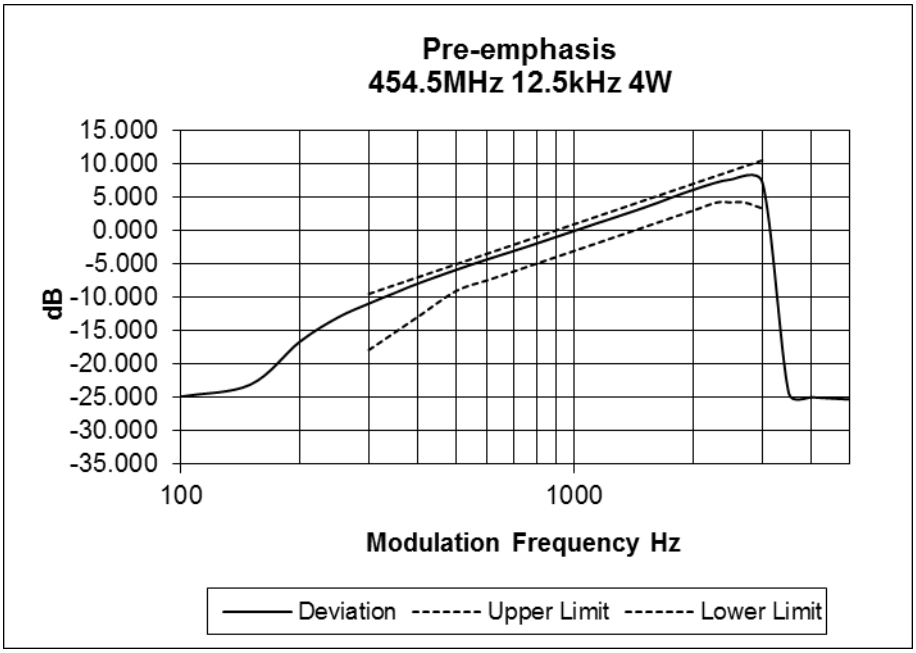
Transmitter Audio Frequency Response – Pre-emphasis

SPECIFICATION: FCC 47 CFR 2.1047 (a)

Tx FREQUENCY: 450.125 MHz 12.5 kHz Channel Spacing



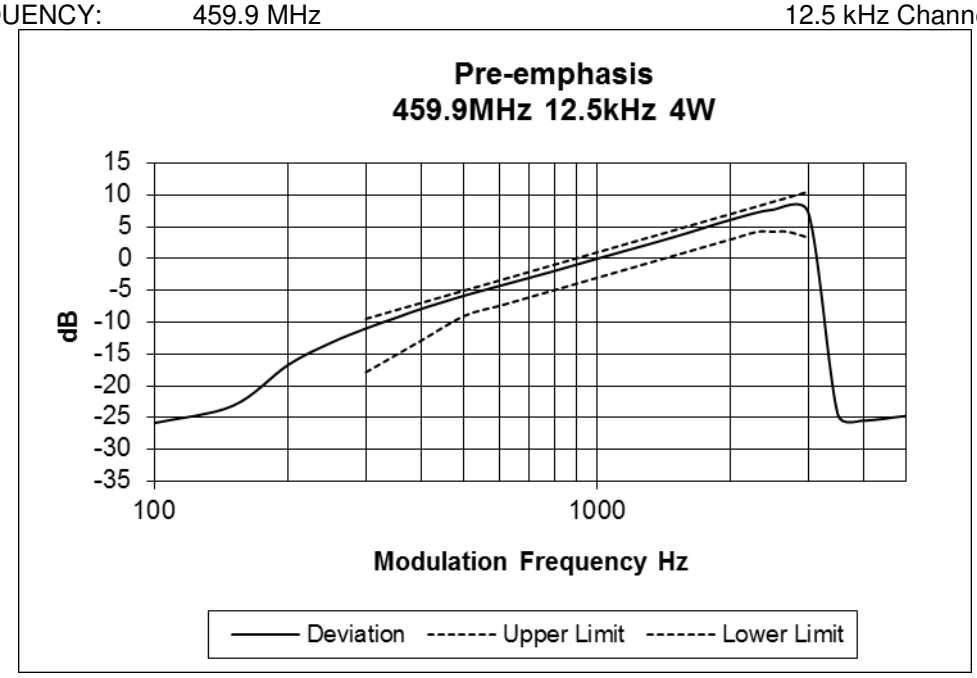
Tx FREQUENCY: 454.5 MHz 12.5 kHz Channel Spacing



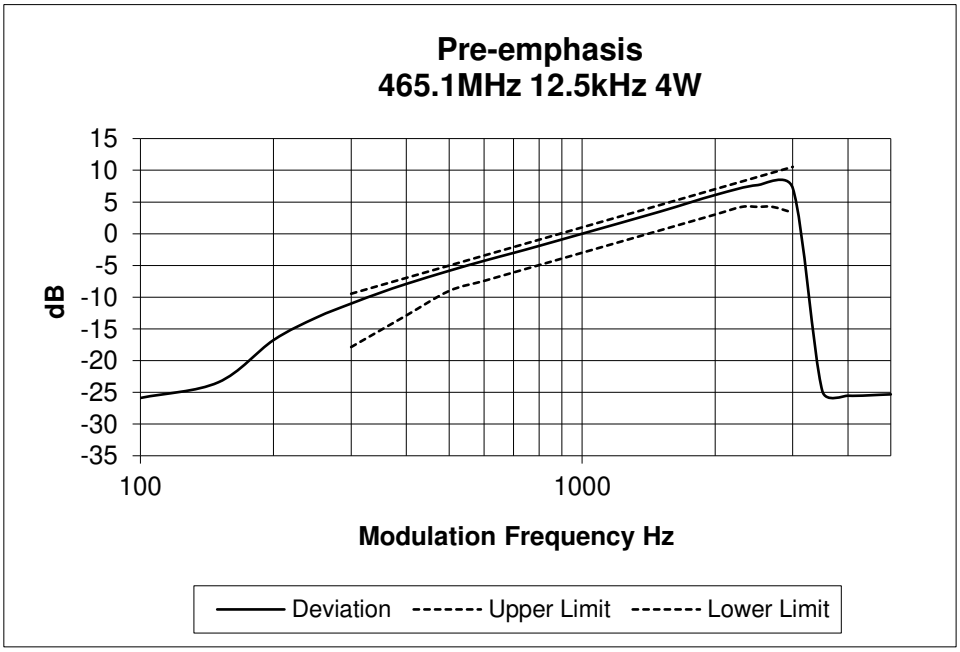
Transmitter Audio Frequency Response – Pre-emphasis

SPECIFICATION: FCC 47 CFR 2.1047 (a)

Tx FREQUENCY: 459.9 MHz 12.5 kHz Channel Spacing



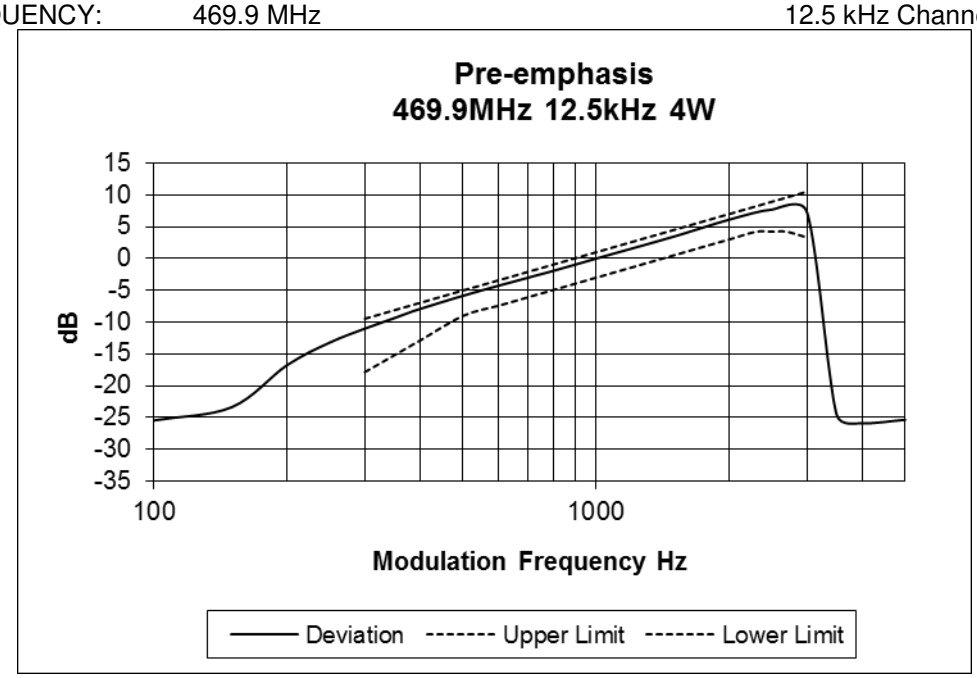
Tx FREQUENCY: 465.1 MHz 12.5 kHz Channel Spacing



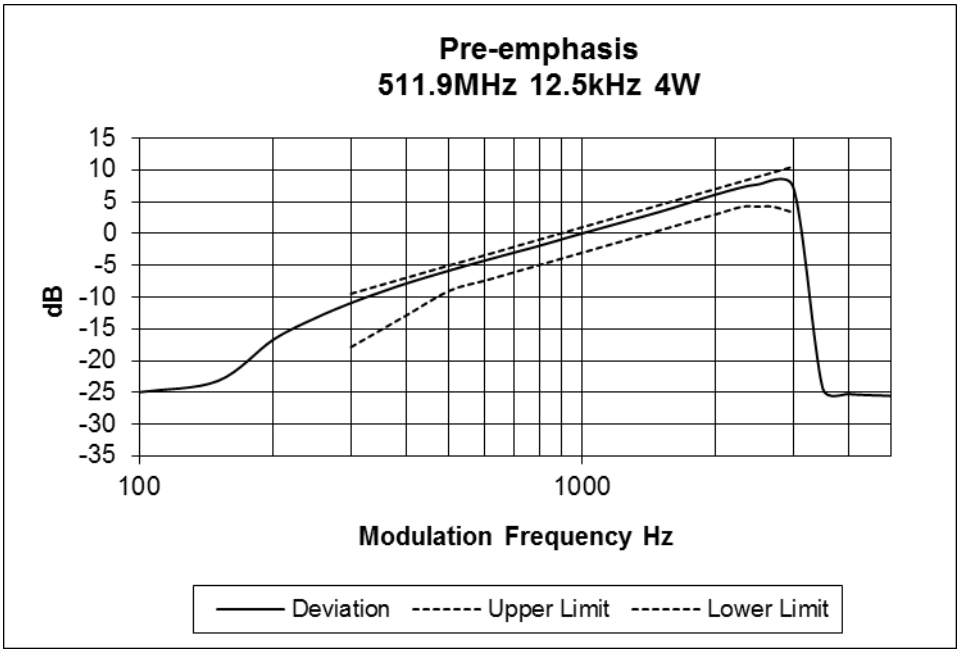
Transmitter Audio Frequency Response – Pre-emphasis

SPECIFICATION: FCC 47 CFR 2.1047 (a)

Tx FREQUENCY: 469.9 MHz 12.5 kHz Channel Spacing



Tx FREQUENCY: 511.9 MHz 12.5 kHz Channel Spacing



TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC 47 CFR 2.1047 (b)

GUIDE: TIA/EIA-603D 2.2.3

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

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

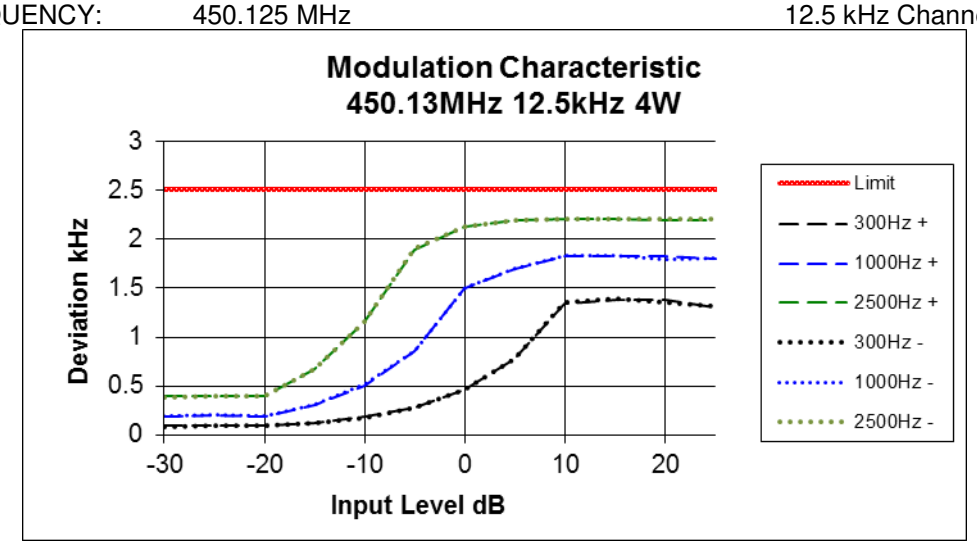
LIMIT CLAUSE: TIA/EIA-603D 1.3.4.4

MEASUREMENT UNCERTAINTY: ± 1.5 %

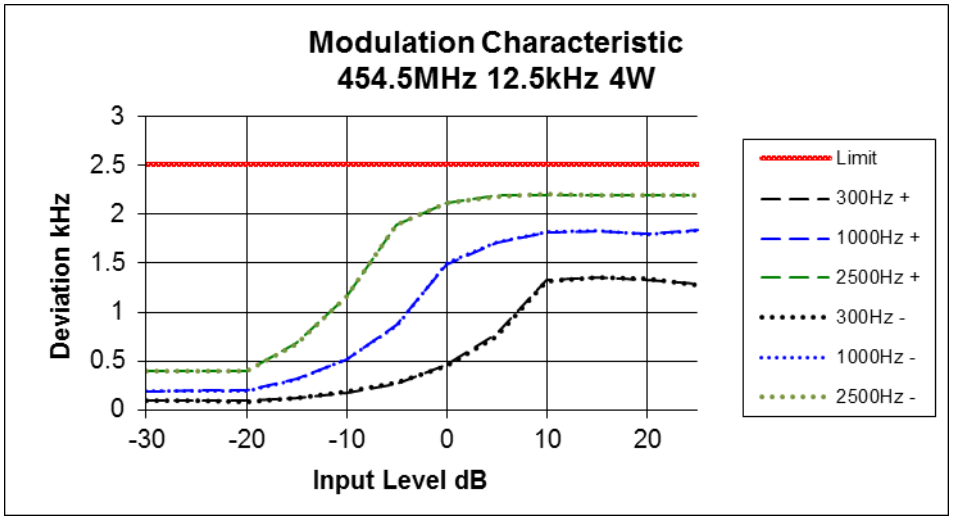
Transmitter Modulation Limiting

SPECIFICATION: FCC 47 CFR 2.1047 (b)

Tx FREQUENCY: 450.125 MHz 12.5 kHz Channel Spacing



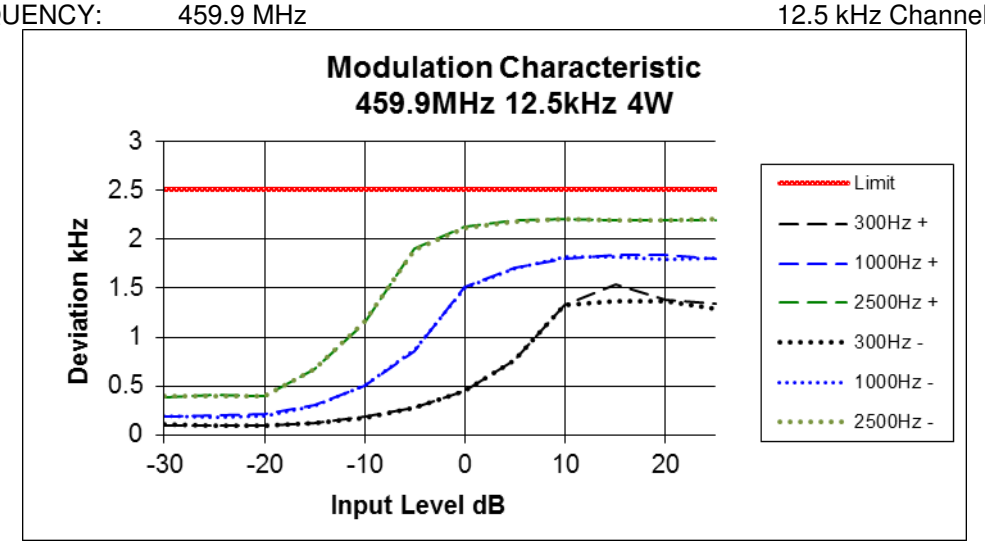
Tx FREQUENCY: 454.5 MHz 12.5 kHz Channel Spacing



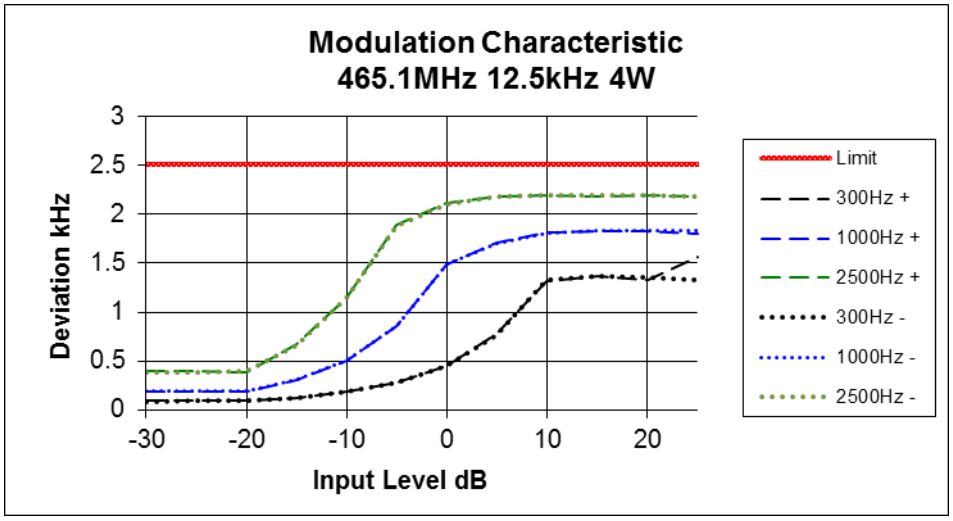
Transmitter Modulation Limiting

SPECIFICATION: FCC 47 CFR 2.1047 (b)

Tx FREQUENCY: 459.9 MHz 12.5 kHz Channel Spacing



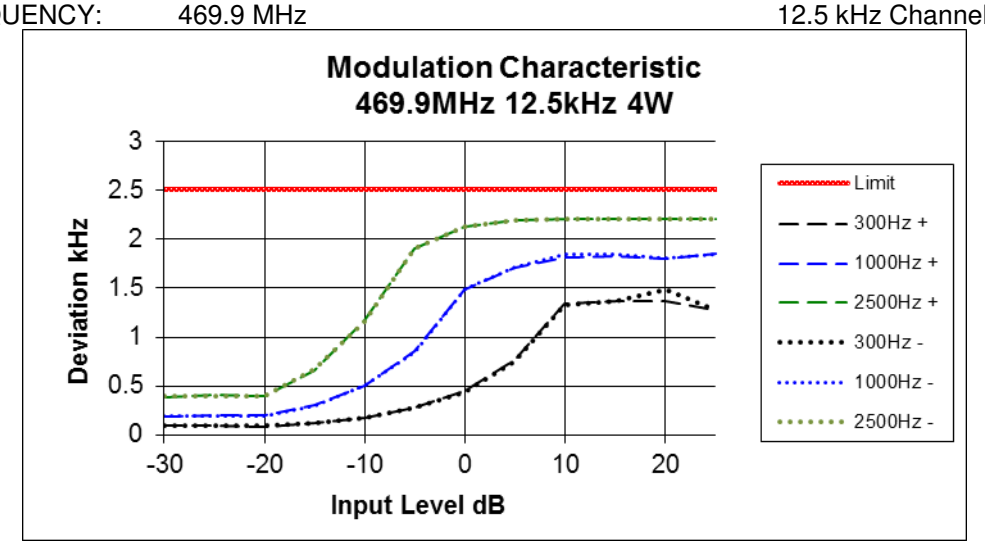
Tx FREQUENCY: 465.1 MHz 12.5 kHz Channel Spacing



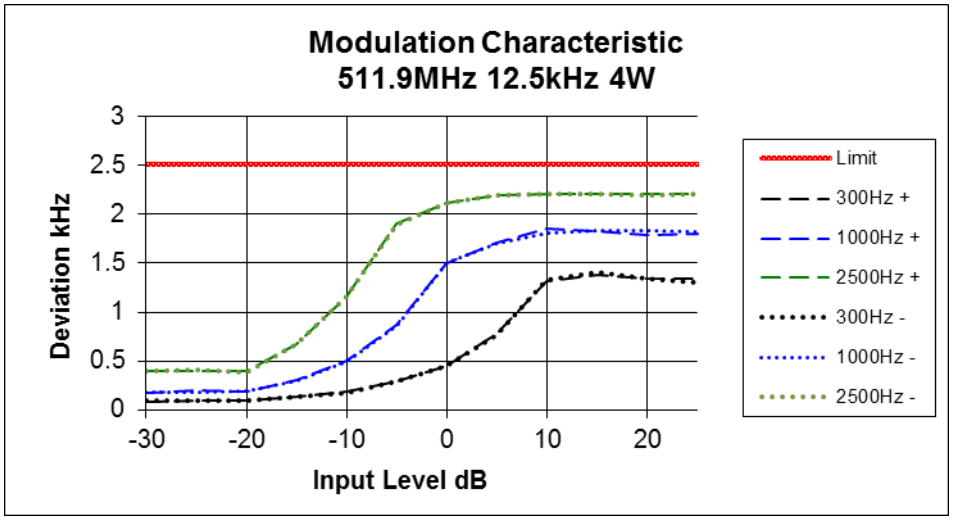
Transmitter Modulation Limiting

SPECIFICATION: FCC 47 CFR 2.1047 (b)

Tx FREQUENCY: 469.9 MHz 12.5 kHz Channel Spacing



Tx FREQUENCY: 511.9 MHz 12.5 kHz Channel Spacing



TRANSMITTER OCCUPIED BANDWIDTH AND SPECTRUM MASKS

SPECIFICATION: FCC 47 CFR 2.1049 (c)

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

MEASUREMENT PROCEDURE:
1. Refer Annex A for Equipment Set up.
2. For analog 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 spacing.

MEASUREMENT UNCERTAINTY 95% ±0.65dB

LIMIT CLAUSE: FCC 47 CFR 90.210

EMISSION MASKS

Emission Mask D	12.5 kHz Channel Spacing	Analog, FFSK, Digital Voice/Data

DATA SPEED

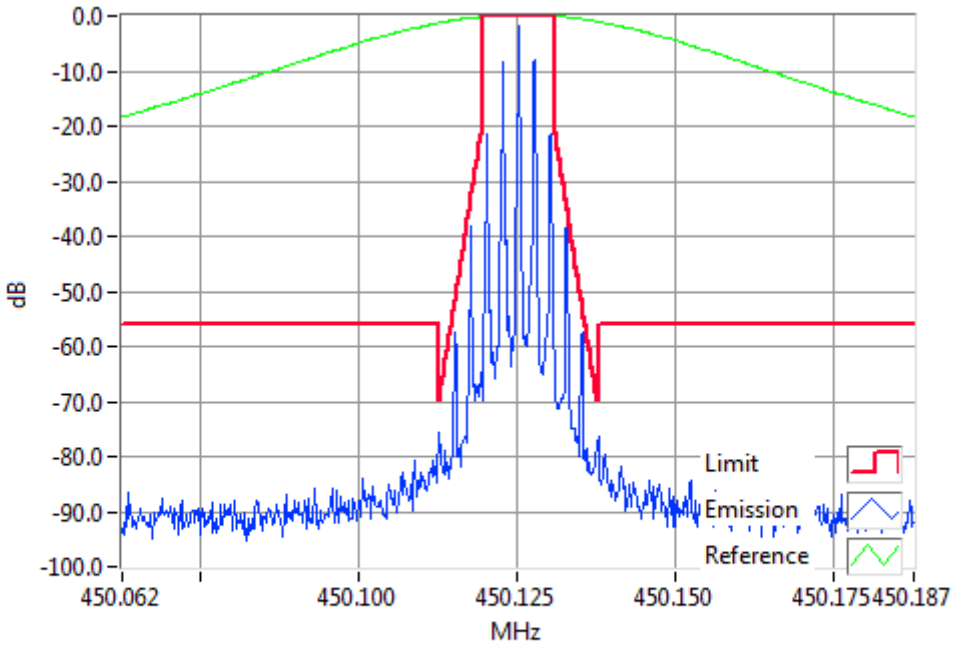
Digital Voice/Data	12.5 kHz Channel Spacing	9600 bps
FFSK	12.5 kHz Channel Spacing	1200 bps & 2400 bps

Occupied Bandwidth and Spectrum Masks

ANALOG VOICE

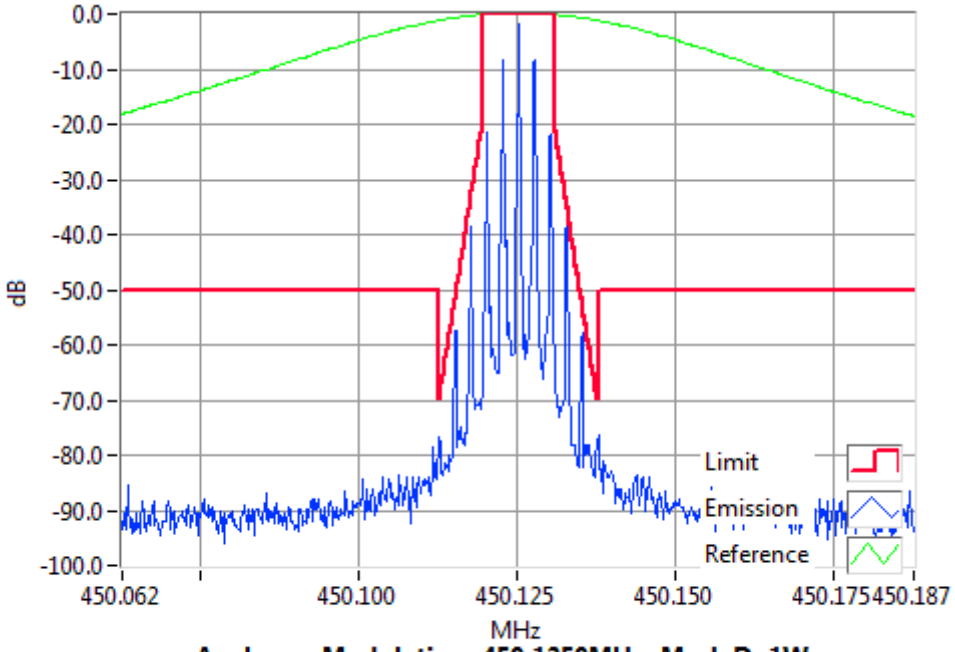
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 450.125 MHz 4 W 12.5 kHz Channel Spacing



Analogue Modulation 450.1250MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 450.125 MHz 1 W 12.5 kHz Channel Spacing



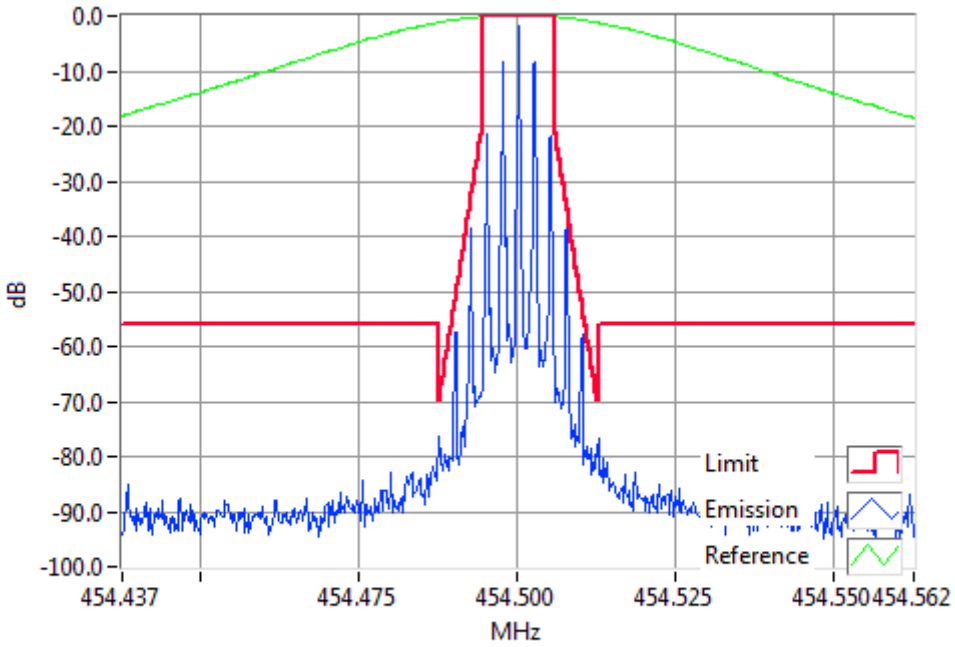
Analogue Modulation 450.1250MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

ANALOG VOICE

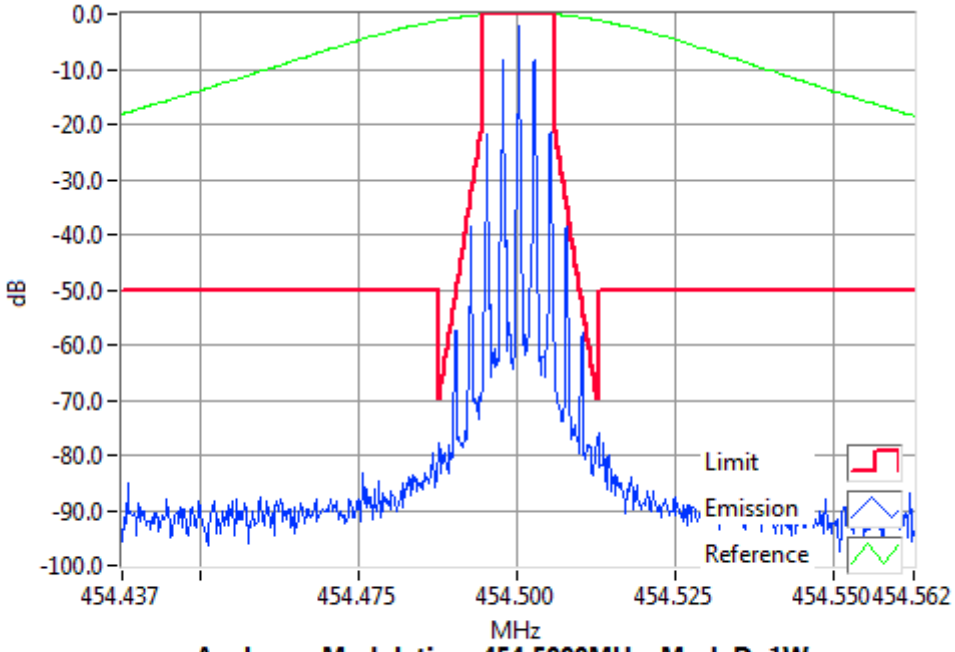
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 454.5 MHz 4 W 12.5 kHz Channel Spacing



Analogue Modulation 454.5000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 454.5 MHz 1 W 12.5 kHz Channel Spacing



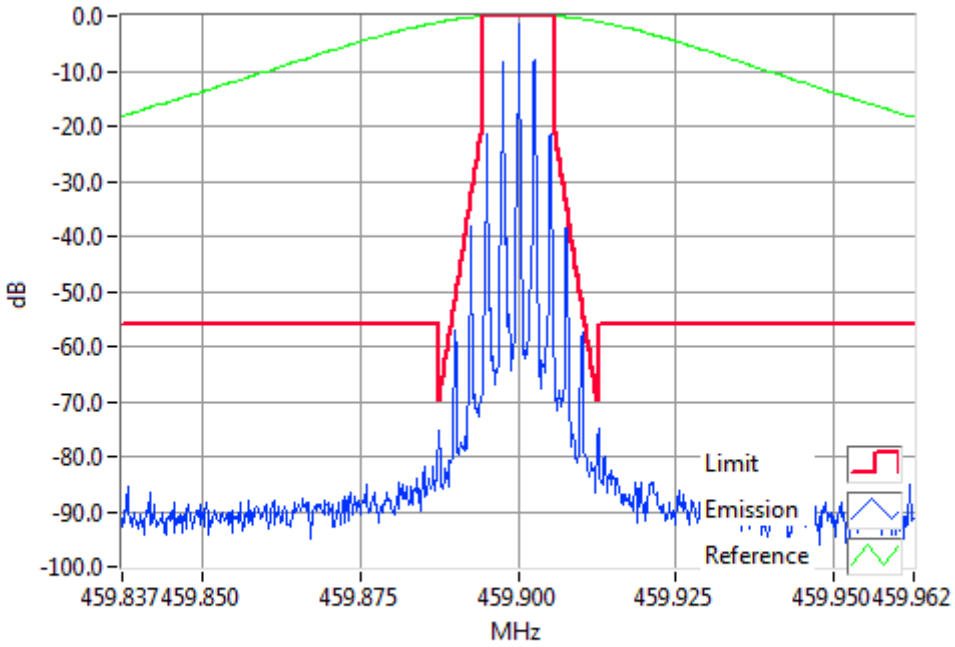
Analogue Modulation 454.5000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

ANALOG VOICE

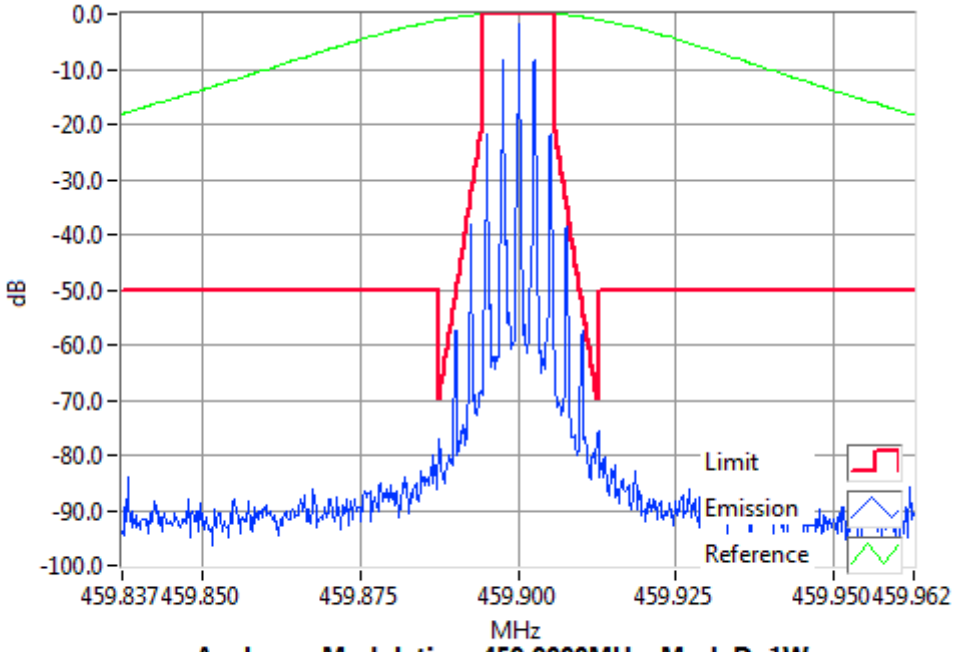
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 459.9 MHz 4 W 12.5 kHz Channel Spacing



Analogue Modulation 459.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 459.9 MHz 1 W 12.5 kHz Channel Spacing



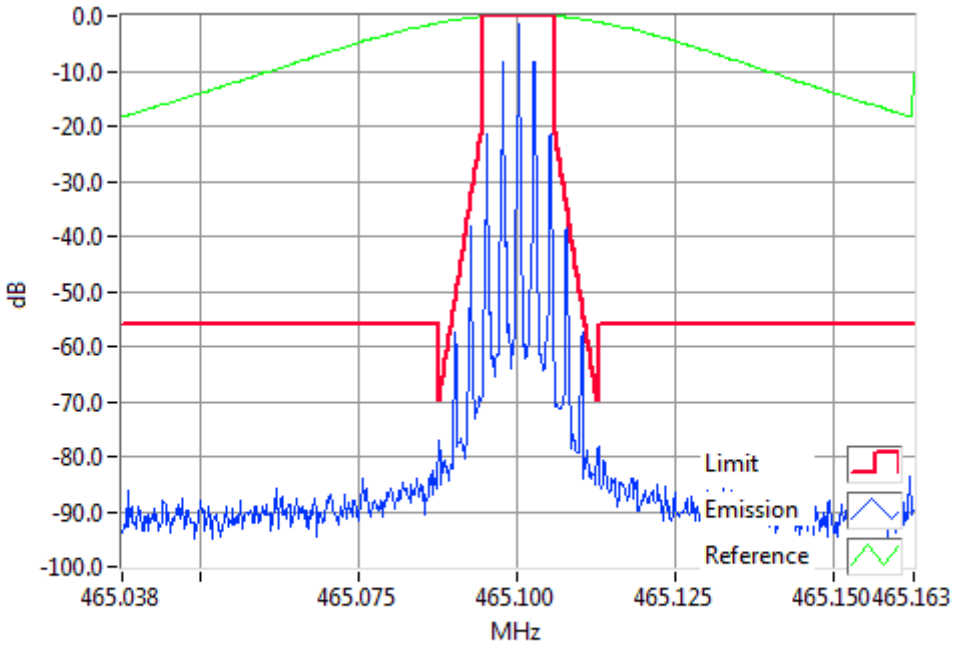
Analogue Modulation 459.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

ANALOG VOICE

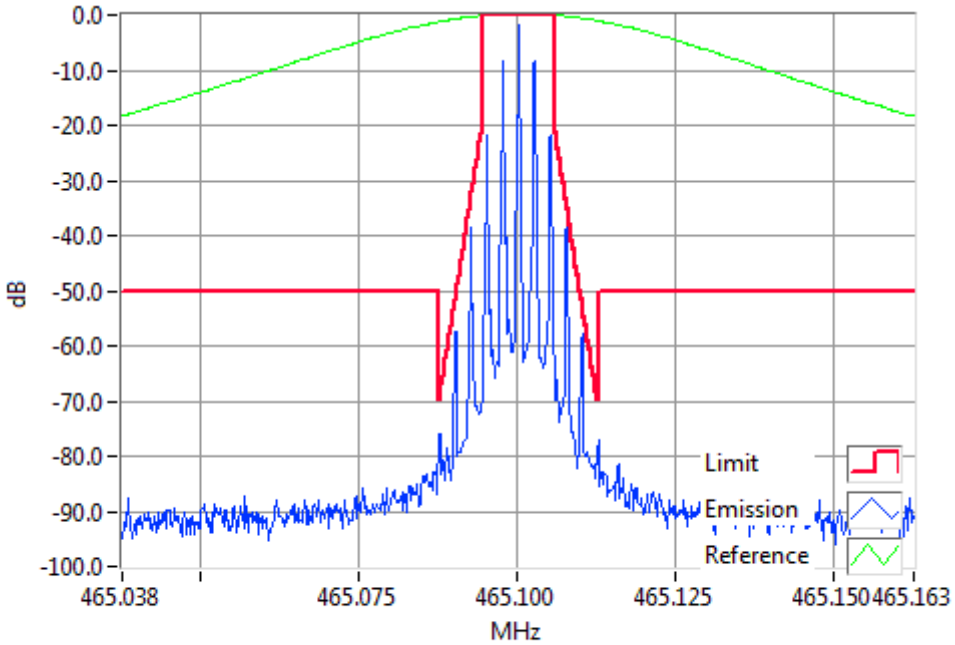
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 465.1 MHz 4 W 12.5 kHz Channel Spacing



Analogue Modulation 465.1000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 465.1 MHz 1 W 12.5 kHz Channel Spacing



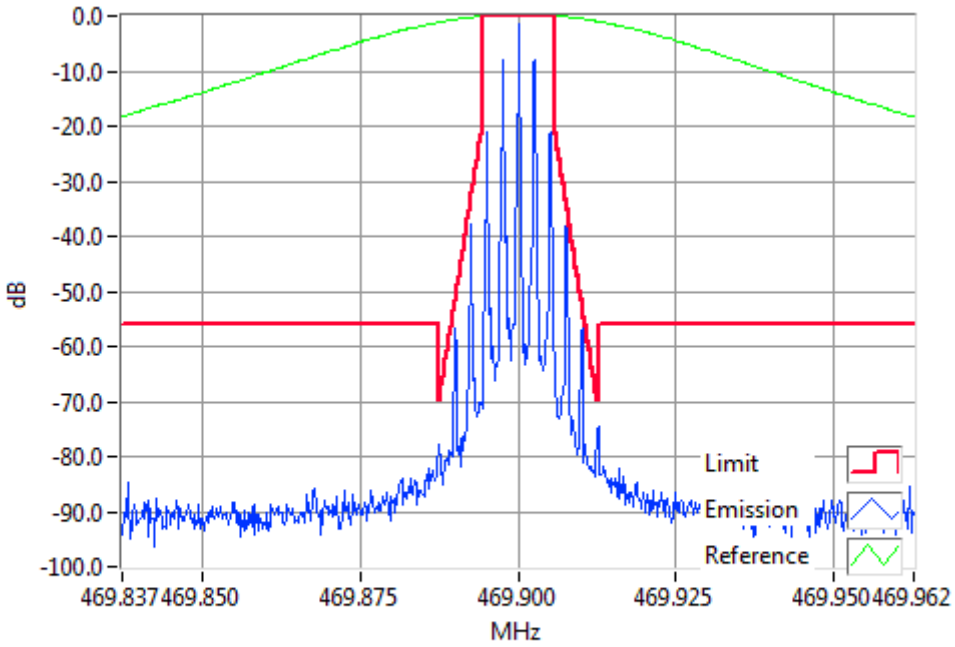
Analogue Modulation 465.1000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

ANALOG VOICE

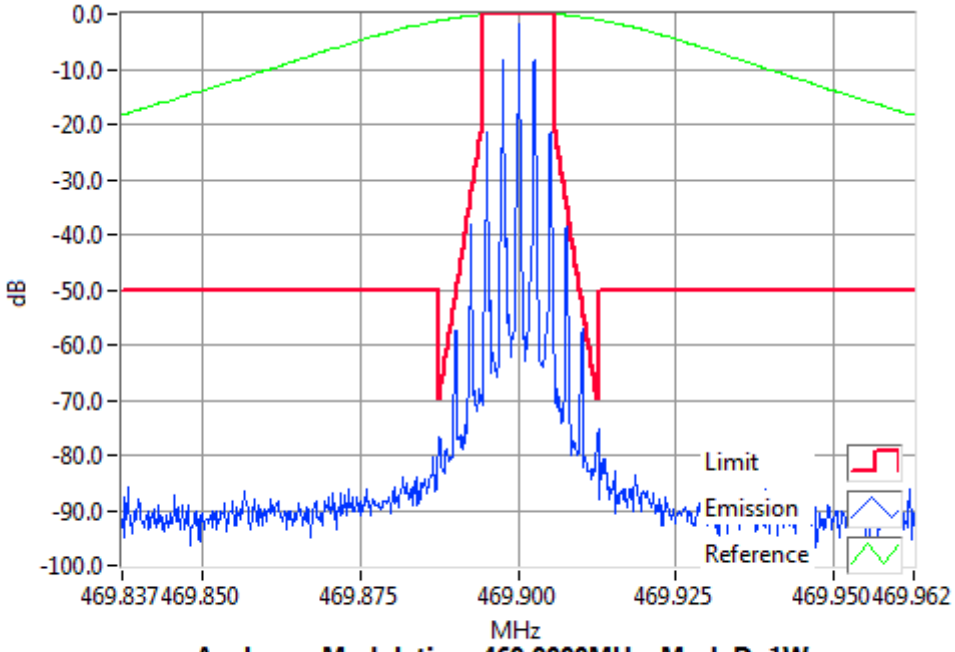
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 469.9 MHz 4 W 12.5 kHz Channel Spacing



Analogue Modulation 469.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 469.9 MHz 1 W 12.5 kHz Channel Spacing



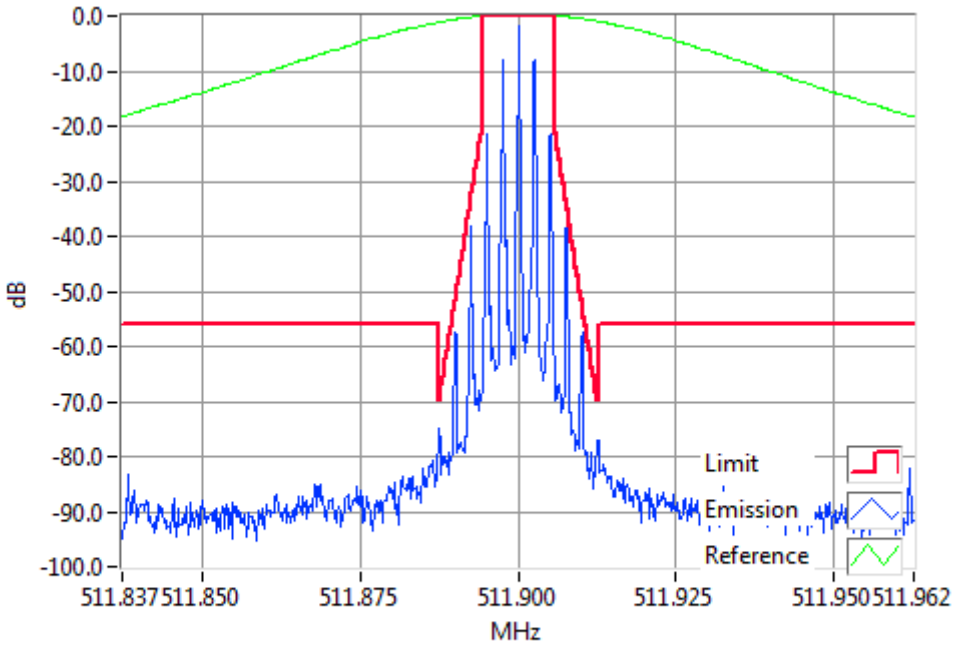
Analogue Modulation 469.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

ANALOG VOICE

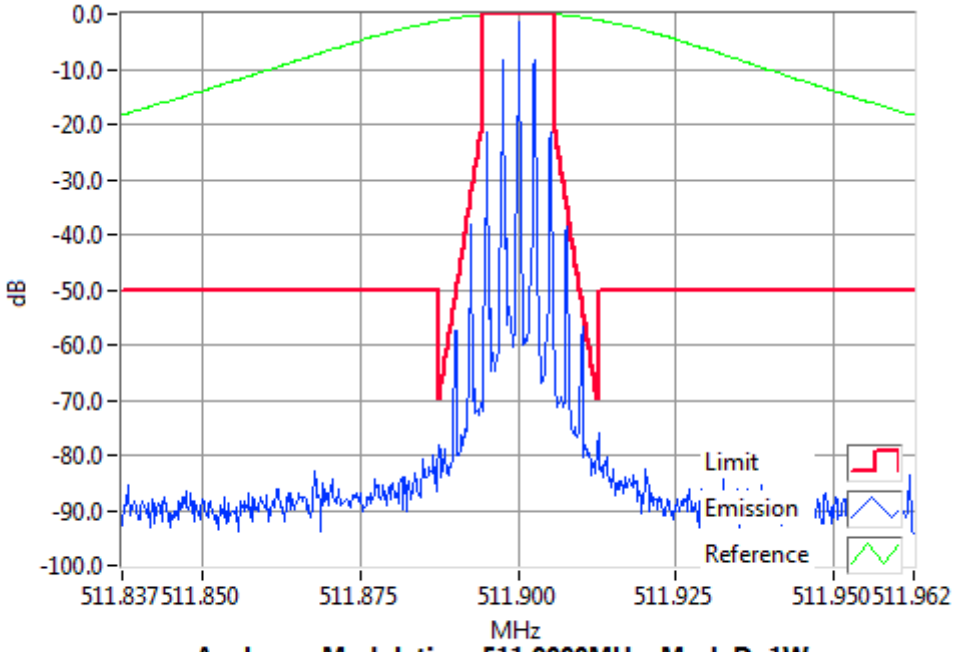
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 511.9 MHz 4 W 12.5 kHz Channel Spacing



Analogue Modulation 511.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 511.9 MHz 1 W 12.5 kHz Channel Spacing



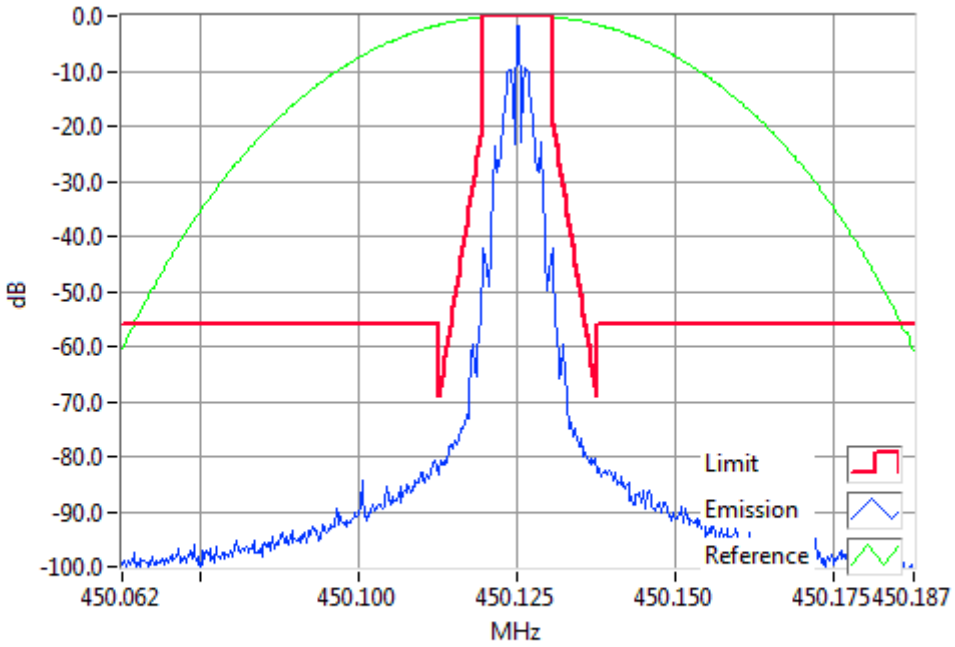
Analogue Modulation 511.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

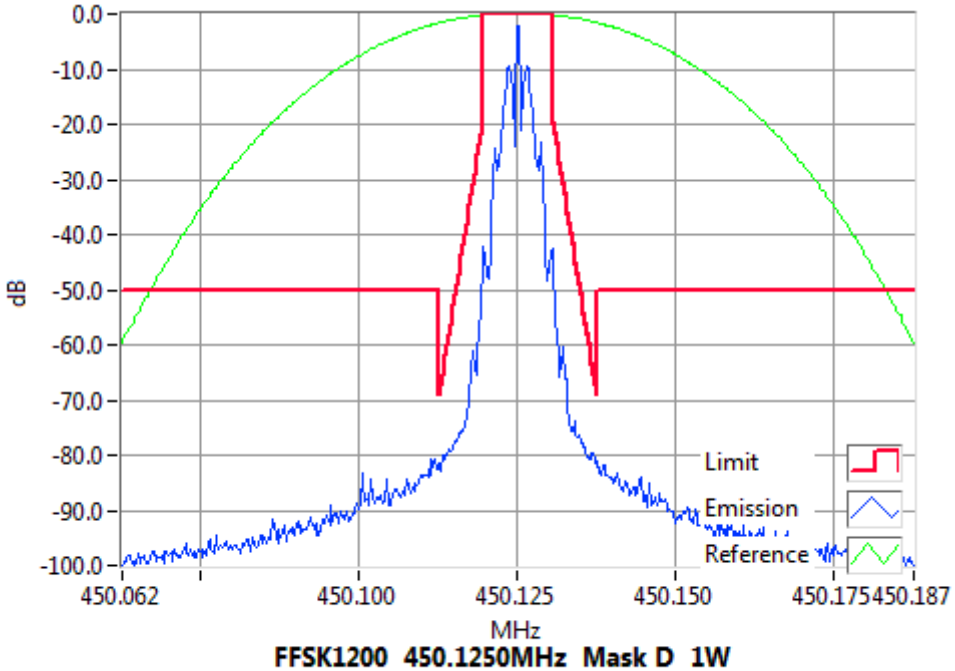
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 450.125 MHz 4 W 12.5 kHz Channel Spacing



FFSK1200 450.1250MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 450.125 MHz 1 W 12.5 kHz Channel Spacing



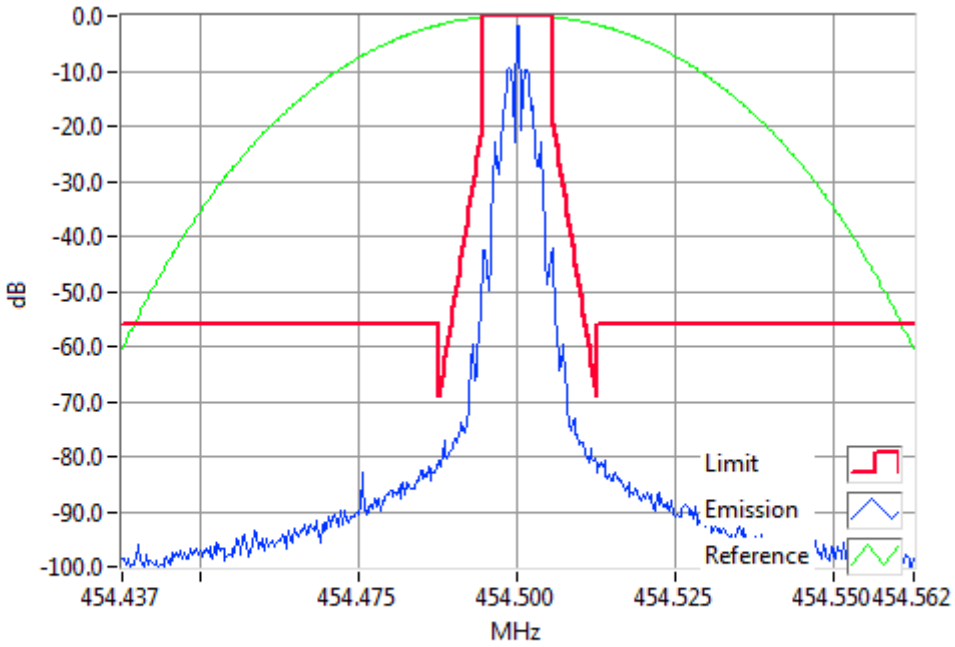
FFSK1200 450.1250MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

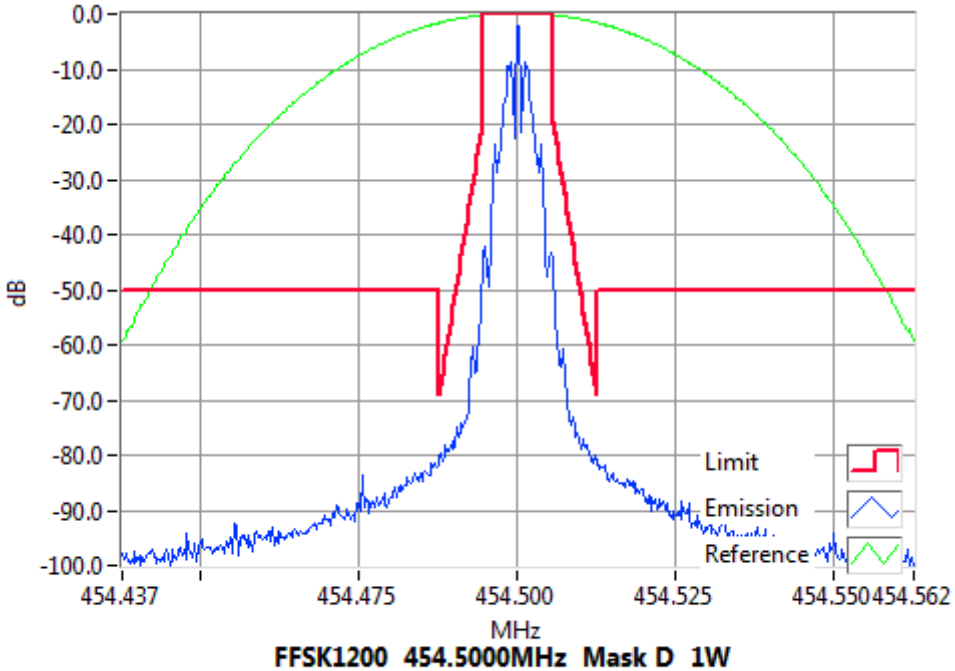
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 454.5 MHz 4 W 12.5 kHz Channel Spacing



FFSK1200 454.5000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 454.5 MHz 1 W 12.5 kHz Channel Spacing



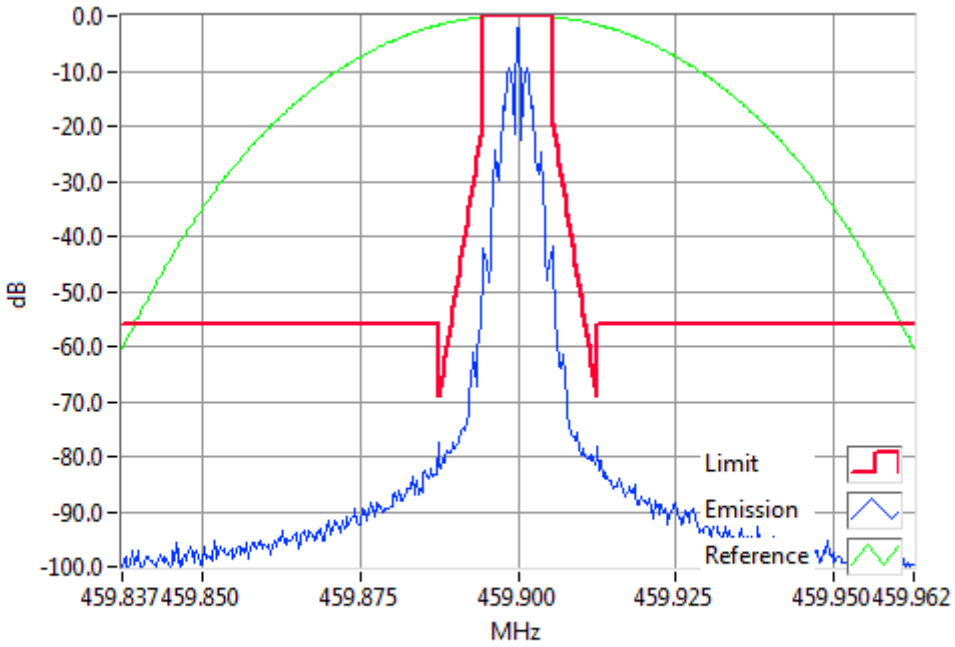
FFSK1200 454.5000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

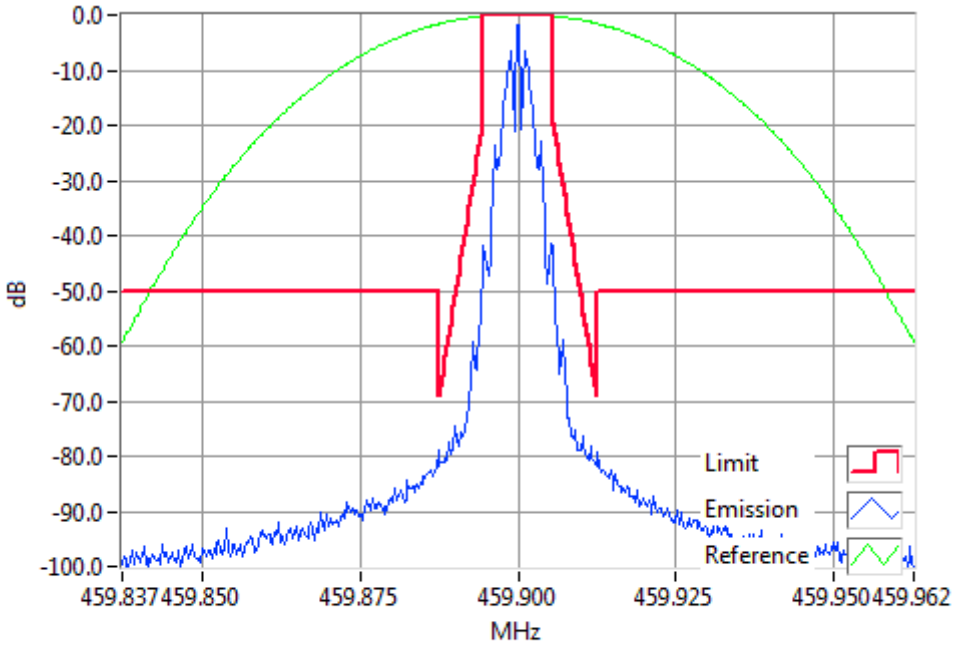
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 459.9 MHz 4 W 12.5 kHz Channel Spacing



FFSK1200 459.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 459.9 MHz 1 W 12.5 kHz Channel Spacing



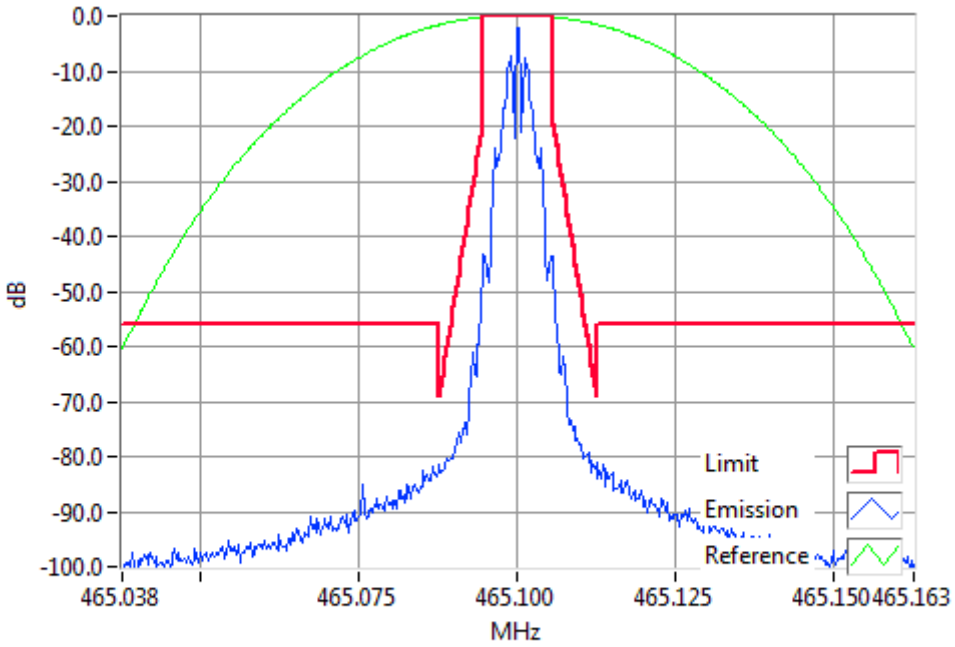
FFSK1200 459.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

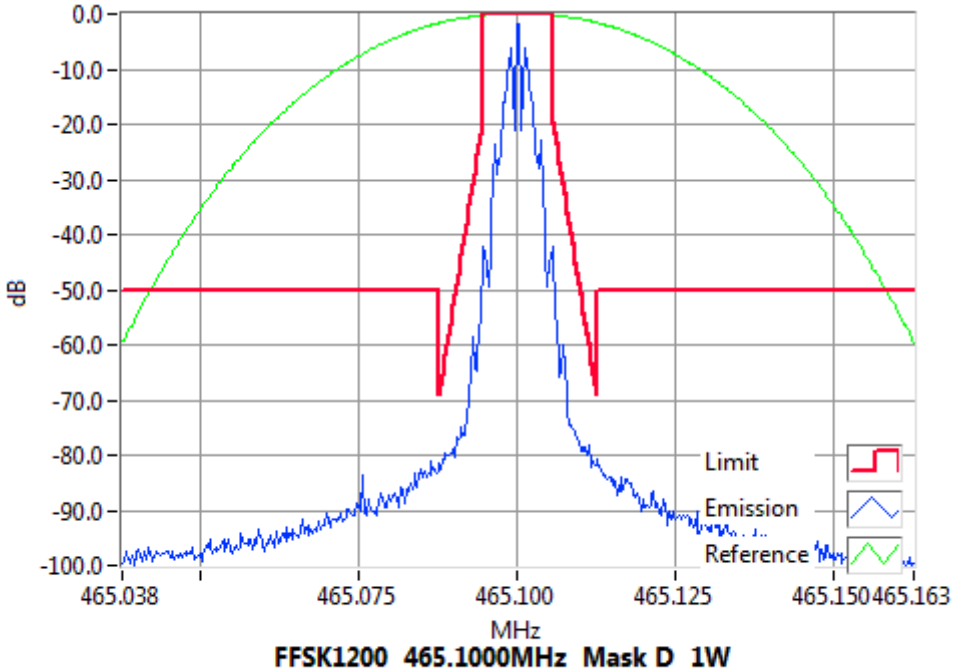
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 465.1 MHz 4 W 12.5 kHz Channel Spacing



FFSK1200 465.1000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 465.1 MHz 1 W 12.5 kHz Channel Spacing



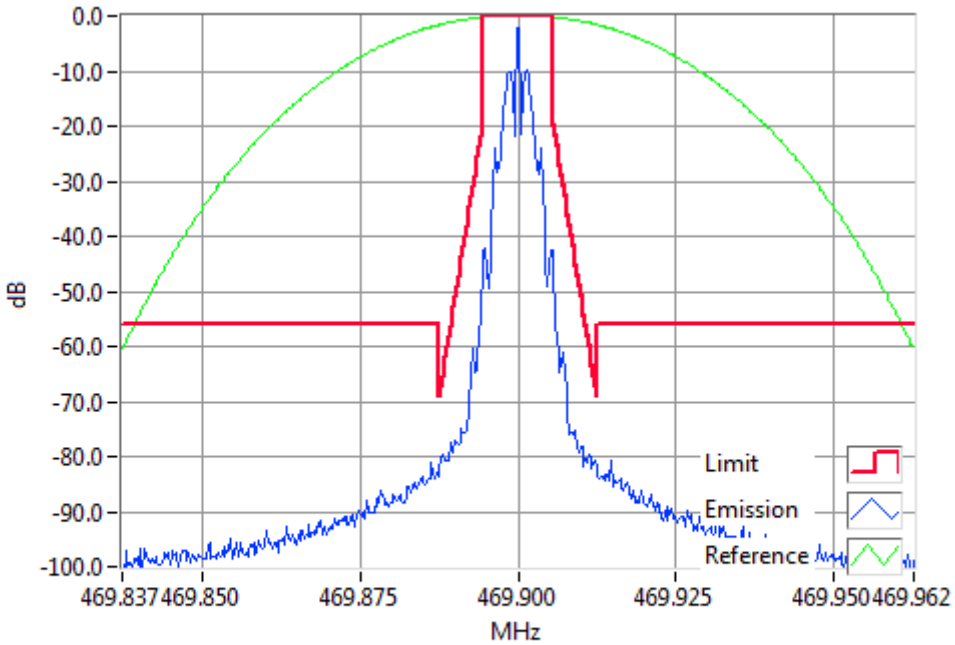
FFSK1200 465.1000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

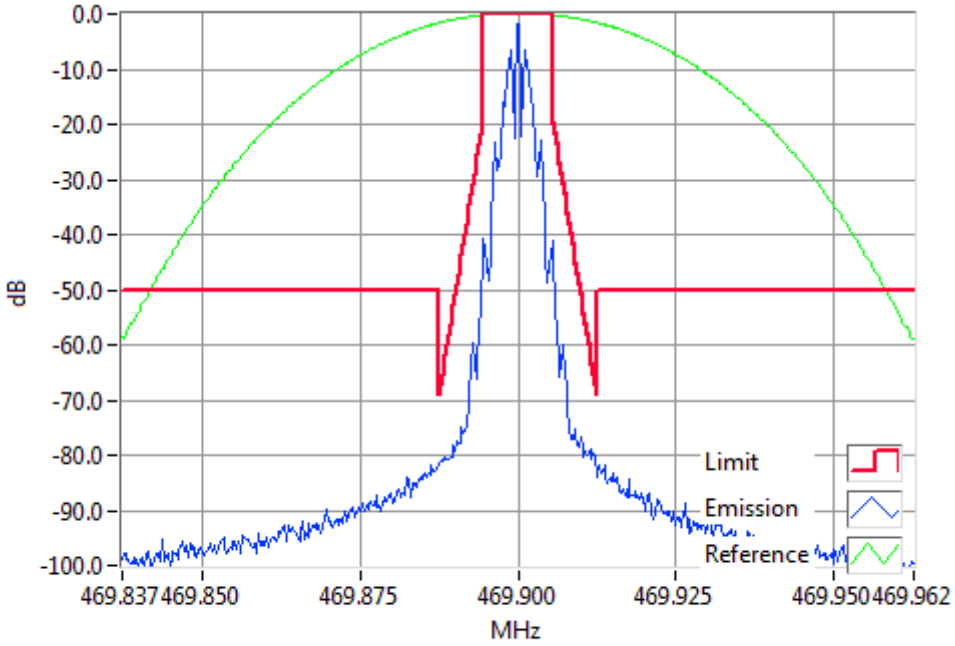
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 469.9 MHz 4 W 12.5 kHz Channel Spacing



FFSK1200 469.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 469.9 MHz 1 W 12.5 kHz Channel Spacing



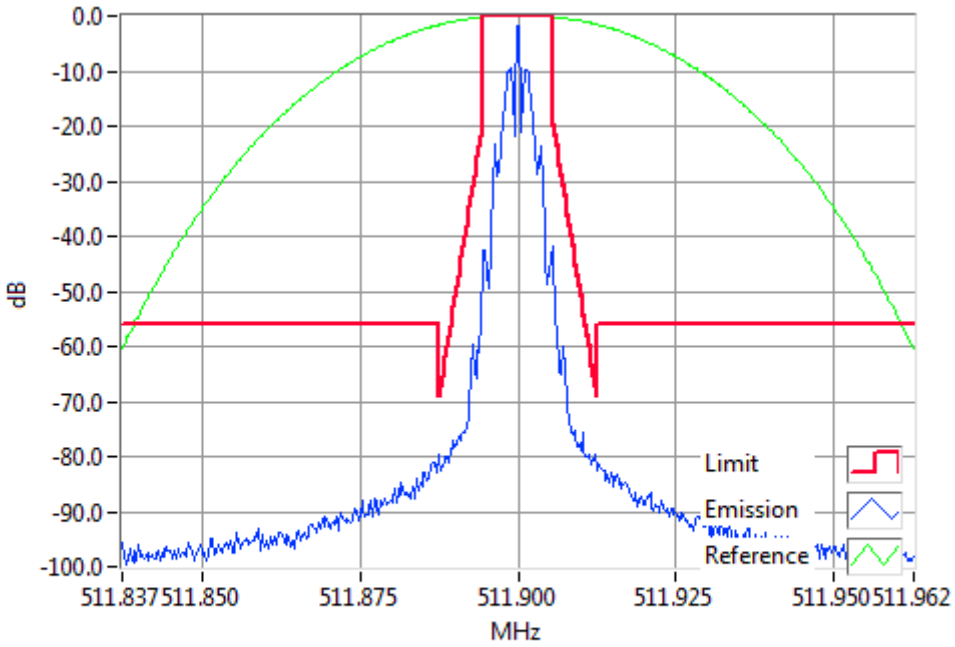
FFSK1200 469.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

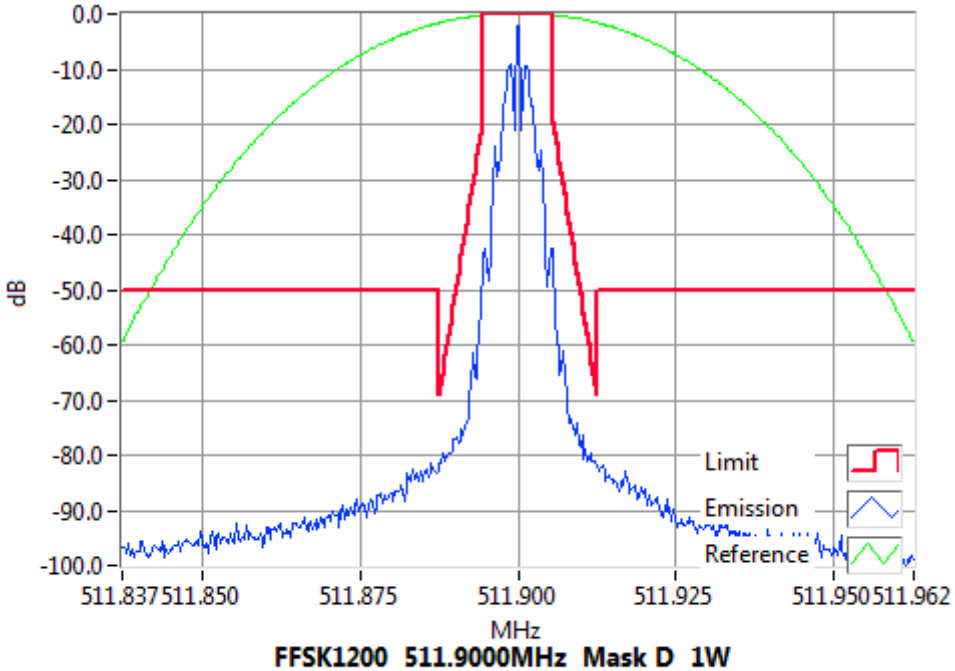
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 511.9 MHz 4 W 12.5 kHz Channel Spacing



FFSK1200 511.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 511.9 MHz 1 W 12.5 kHz Channel Spacing



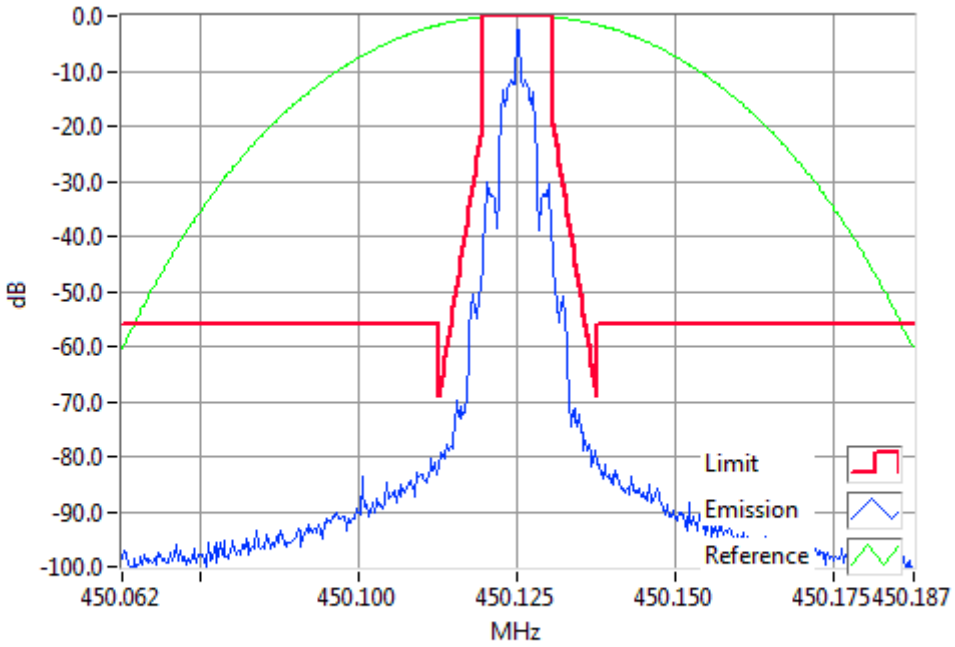
FFSK1200 511.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

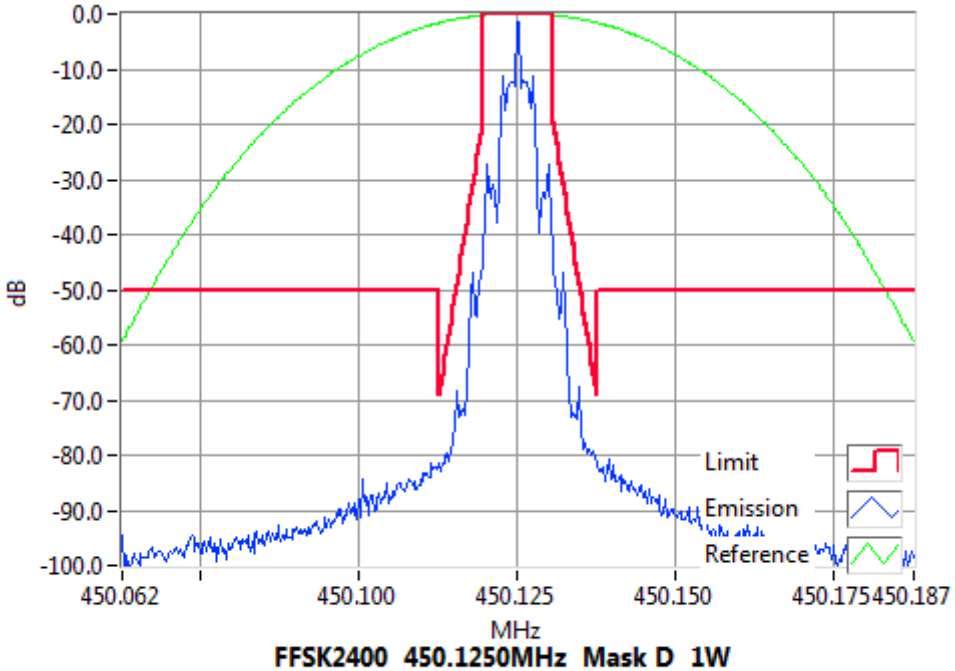
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 450.125 MHz 4 W 12.5 kHz Channel Spacing



FFSK2400 450.1250MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 450.125 MHz 1 W 12.5 kHz Channel Spacing



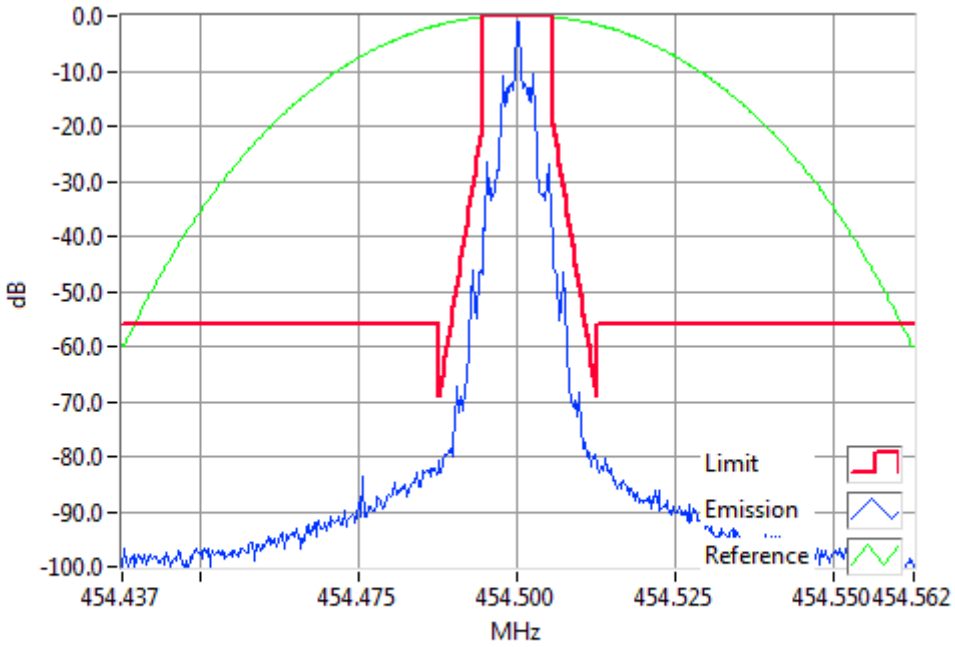
FFSK2400 450.1250MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

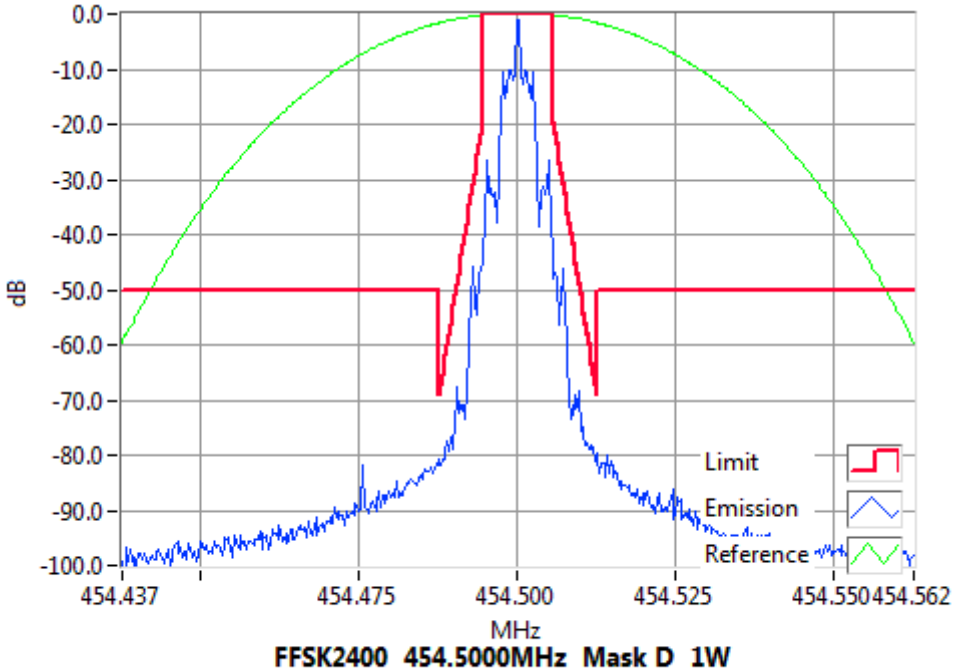
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 454.5 MHz 4 W 12.5 kHz Channel Spacing



FFSK2400 454.5000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 454.5 MHz 1 W 12.5 kHz Channel Spacing



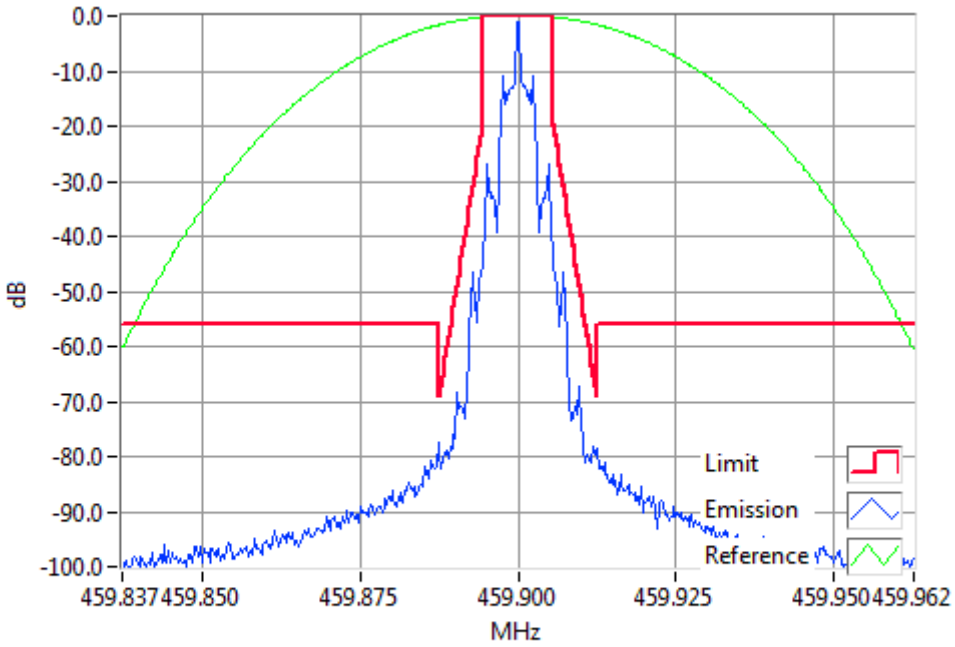
FFSK2400 454.5000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

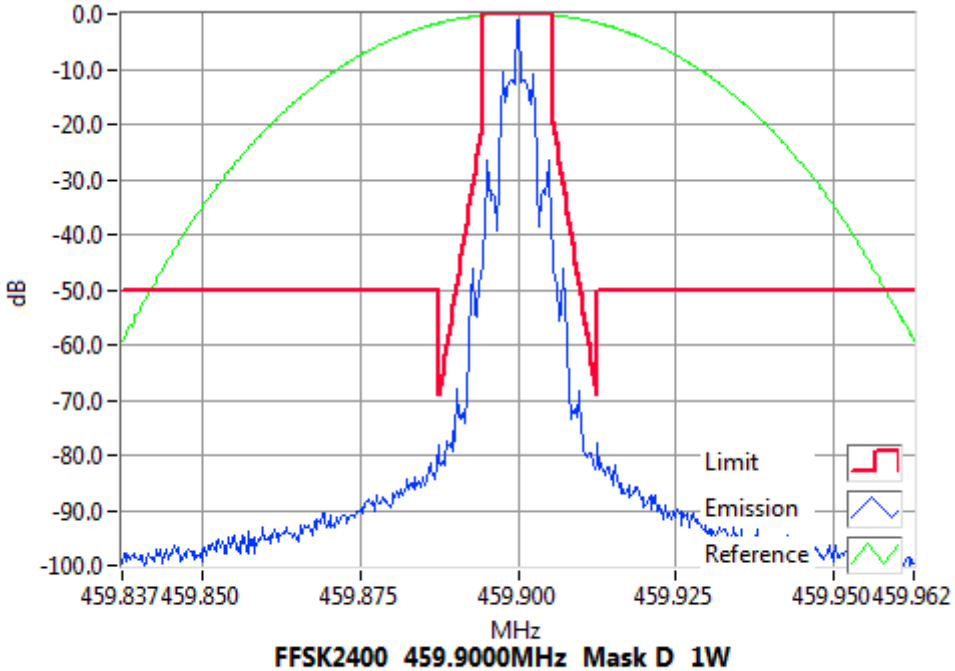
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 459.9 MHz 4 W 12.5 kHz Channel Spacing



FFSK2400 459.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 459.9 MHz 1 W 12.5 kHz Channel Spacing



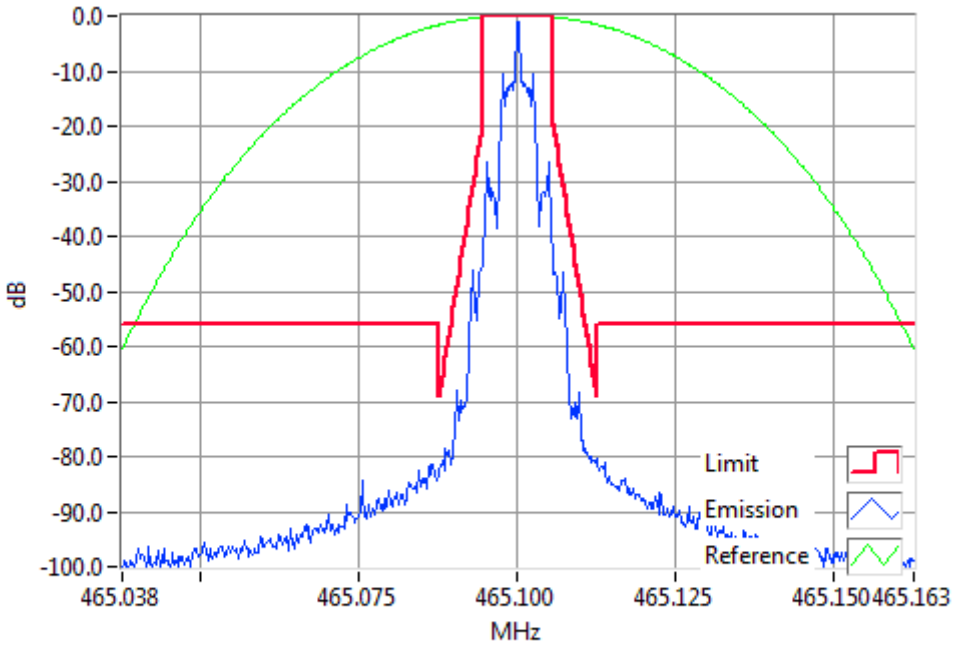
FFSK2400 459.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

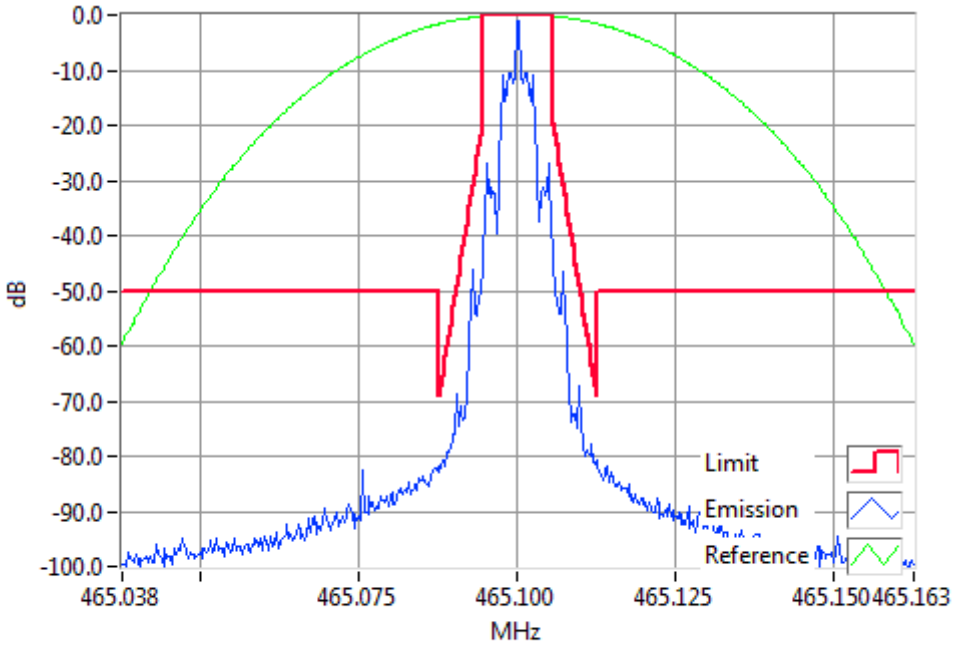
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 465.1 MHz 4 W 12.5 kHz Channel Spacing



FFSK2400 465.1000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 465.1 MHz 1 W 12.5 kHz Channel Spacing



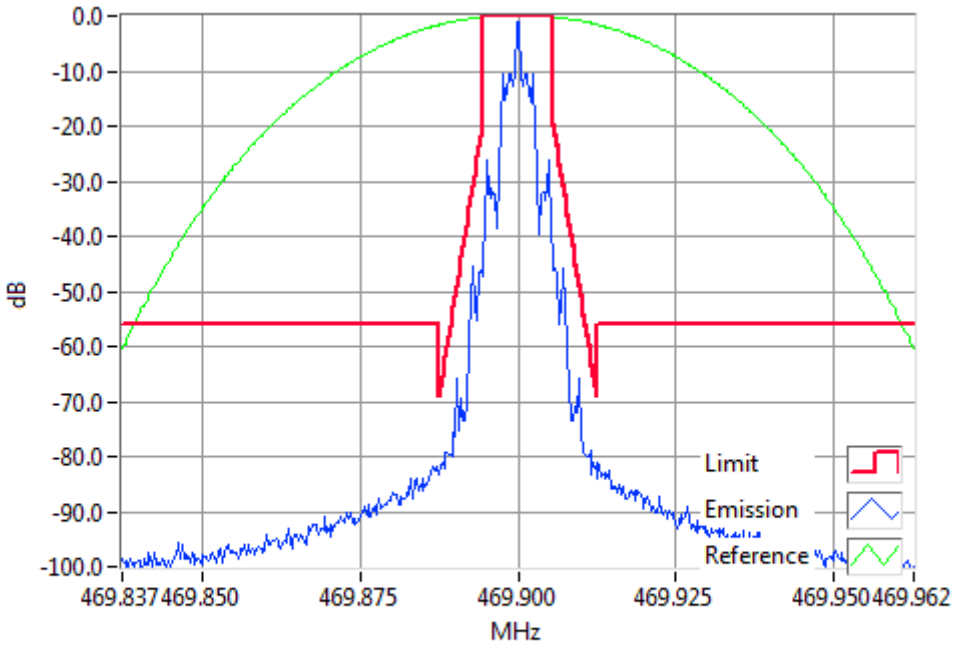
FFSK2400 465.1000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

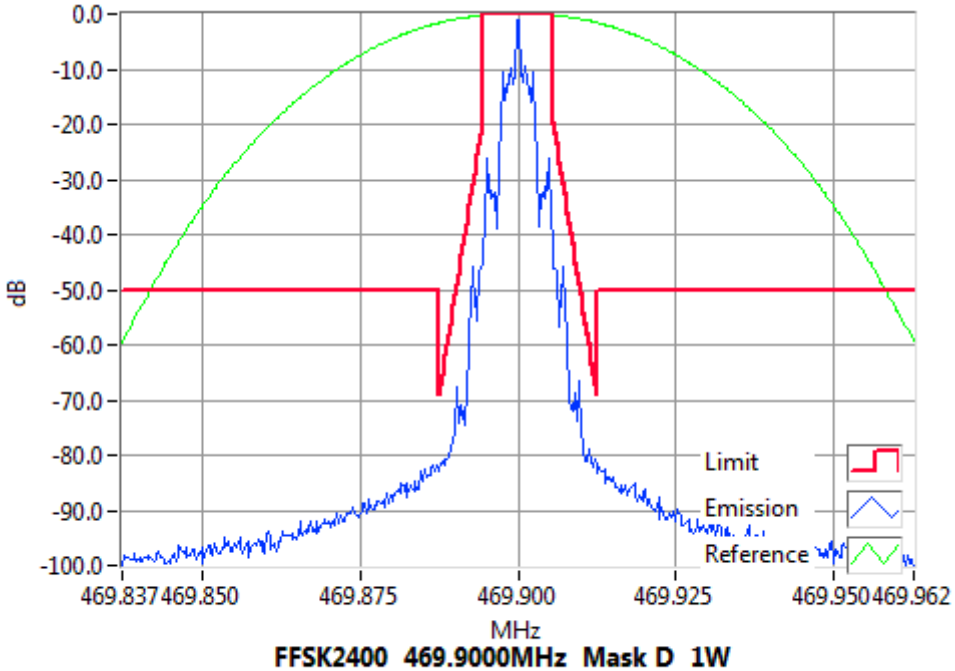
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 469.9 MHz 4 W 12.5 kHz Channel Spacing



FFSK2400 469.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 469.9 MHz 1 W 12.5 kHz Channel Spacing



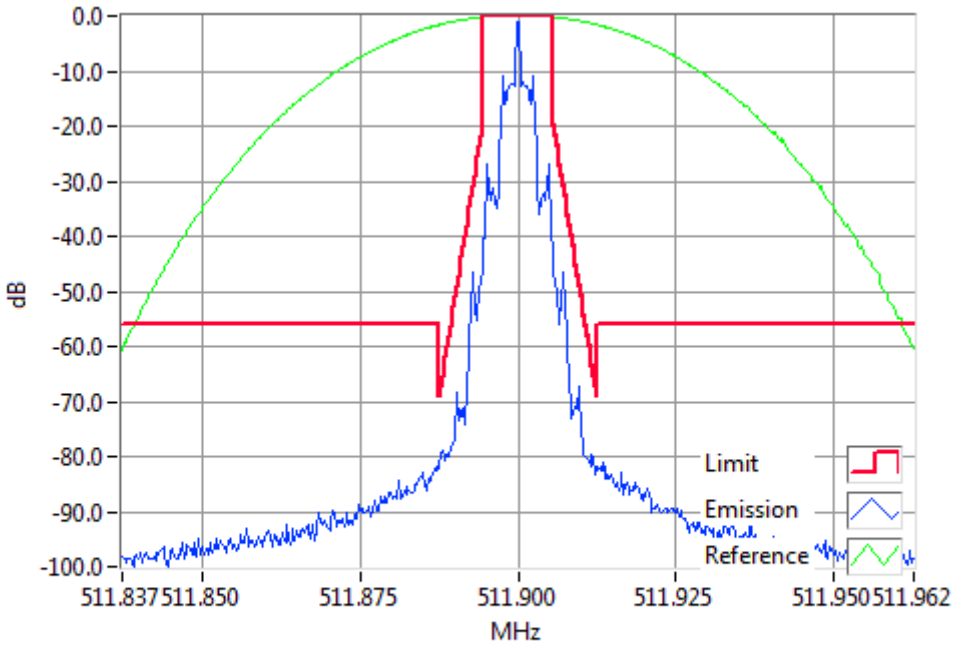
FFSK2400 469.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

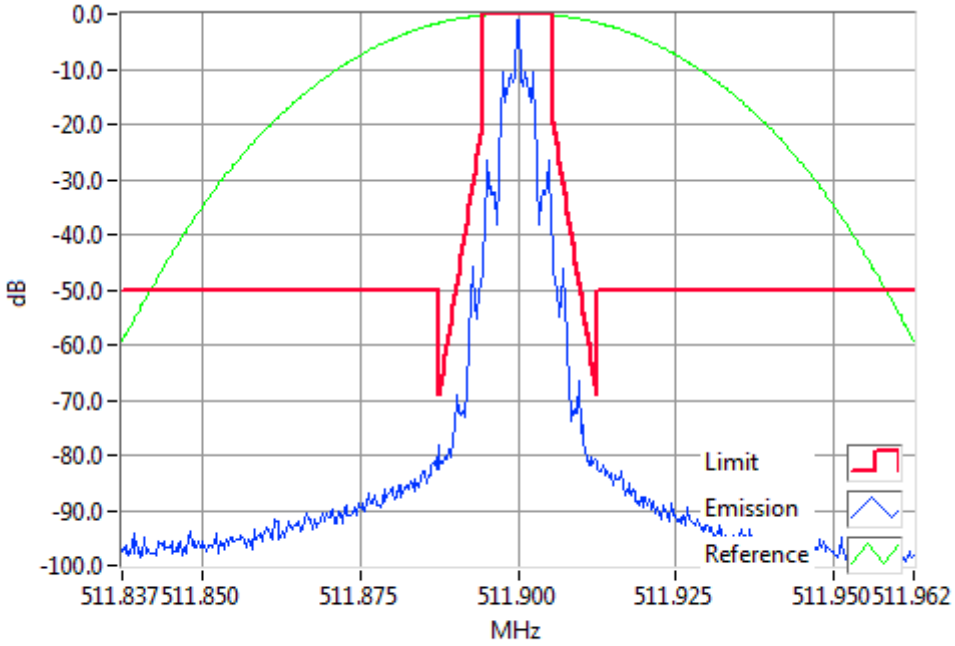
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 511.9 MHz 4 W 12.5 kHz Channel Spacing



FFSK2400 511.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 511.9 MHz 1 W 12.5 kHz Channel Spacing



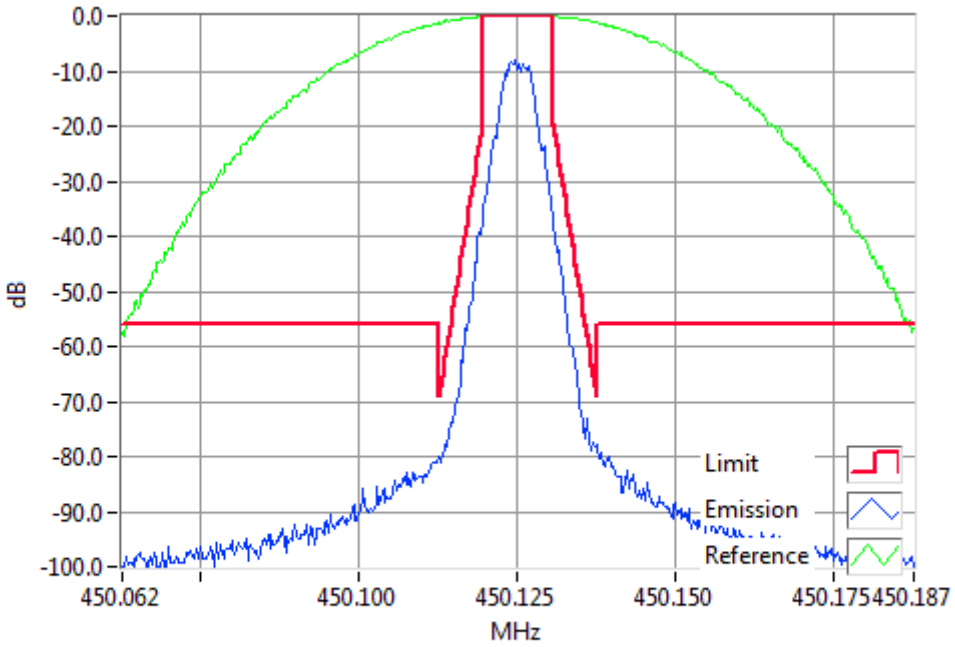
FFSK2400 511.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

DMR

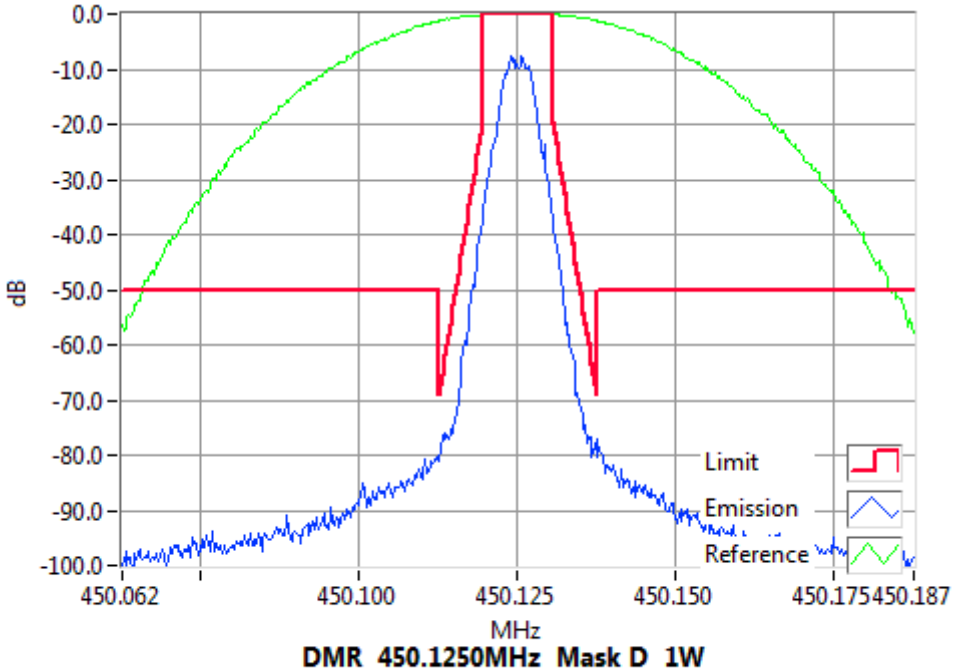
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 450.125 MHz 4 W 12.5 kHz Channel Spacing



DMR 450.1250MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 450.125 MHz 1 W 12.5 kHz Channel Spacing



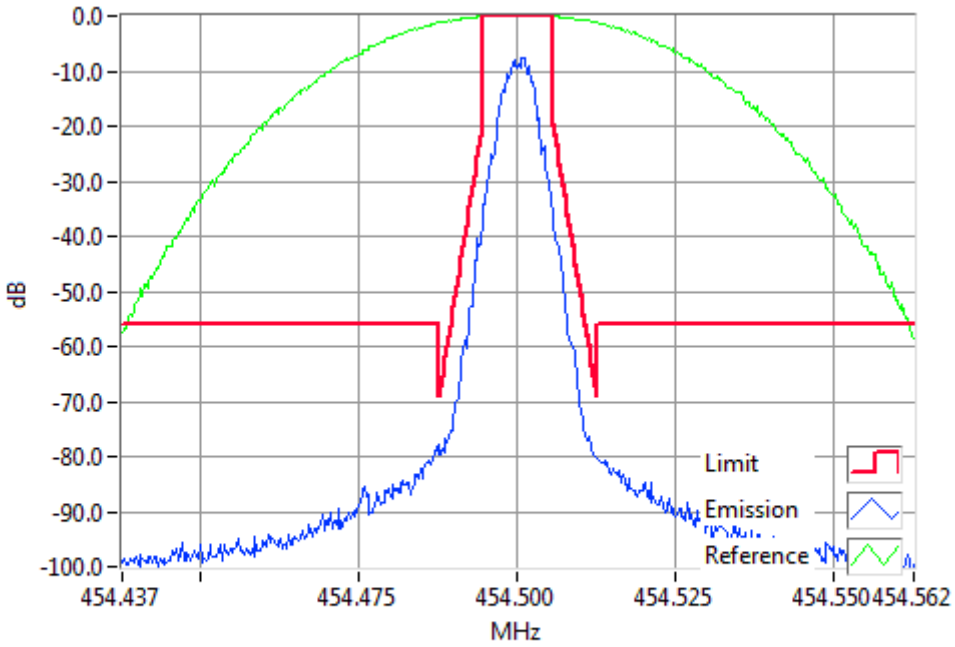
DMR 450.1250MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

DMR

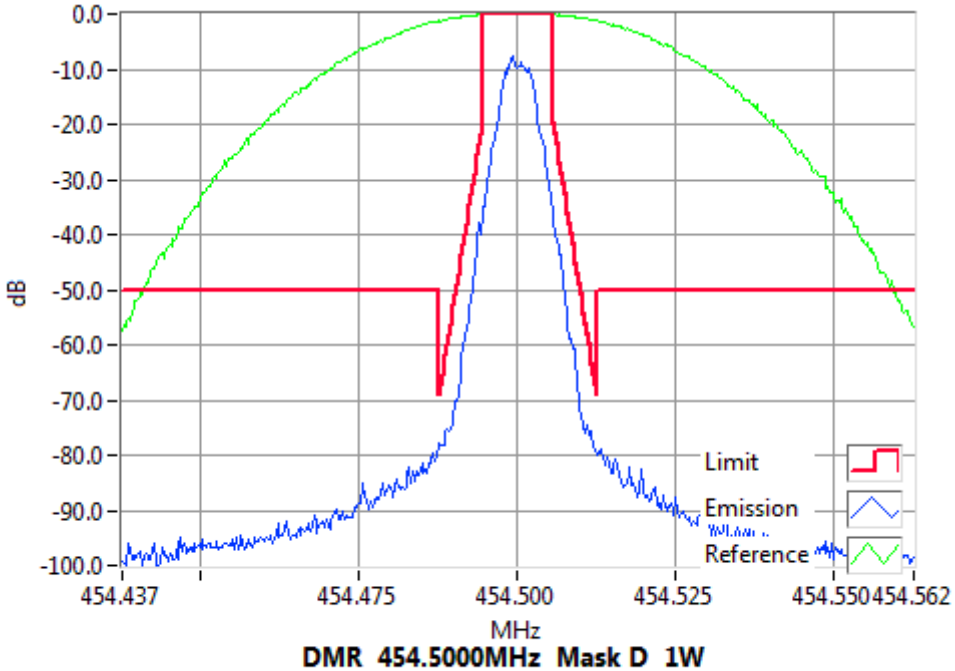
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 454.5 MHz 4 W 12.5 kHz Channel Spacing



DMR 454.5000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 454.5 MHz 1 W 12.5 kHz Channel Spacing



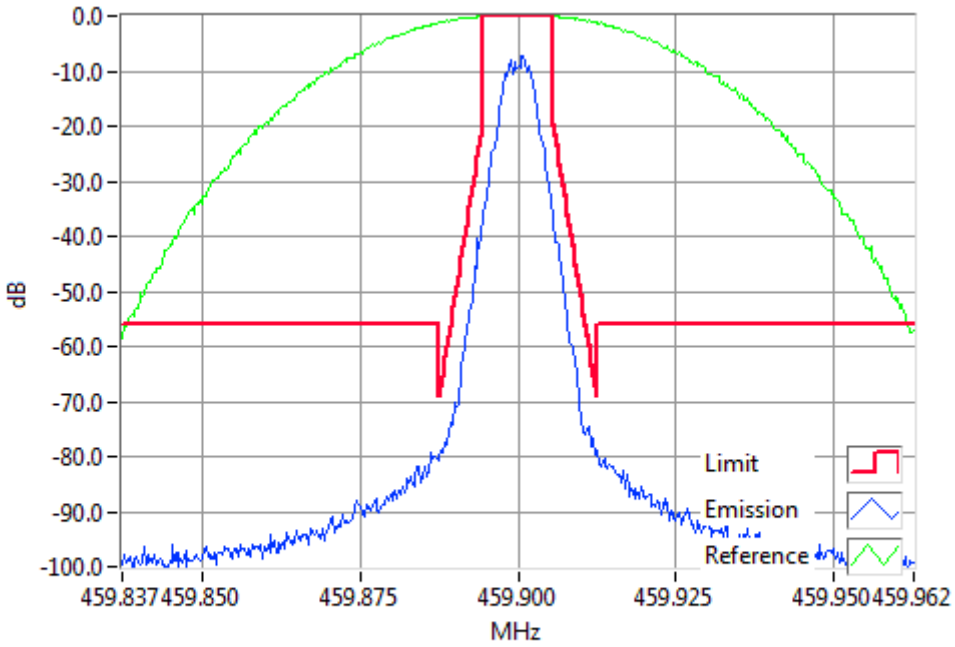
DMR 454.5000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

DMR

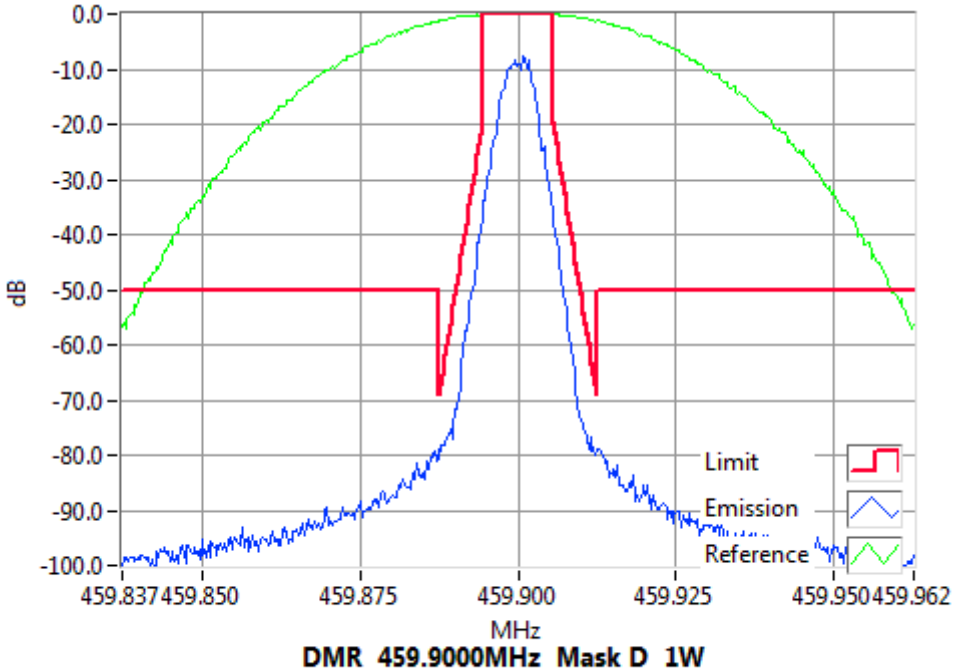
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 459.9 MHz 4 W 12.5 kHz Channel Spacing



DMR 459.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 459.9 MHz 1 W 12.5 kHz Channel Spacing



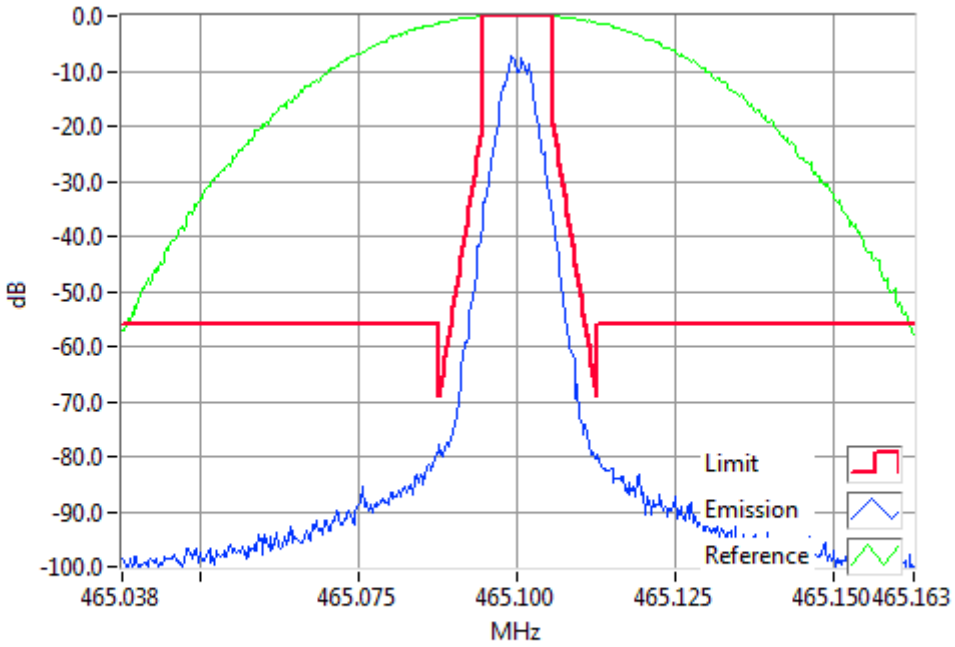
DMR 459.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

DMR

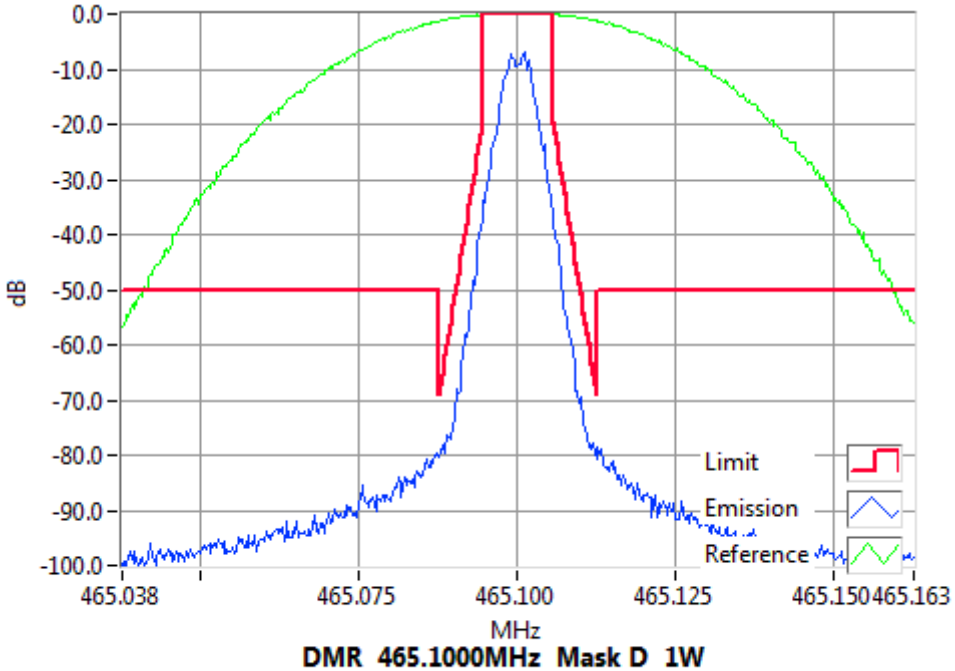
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 465.1 MHz 4 W 12.5 kHz Channel Spacing



DMR 465.1000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 465.1 MHz 1 W 12.5 kHz Channel Spacing



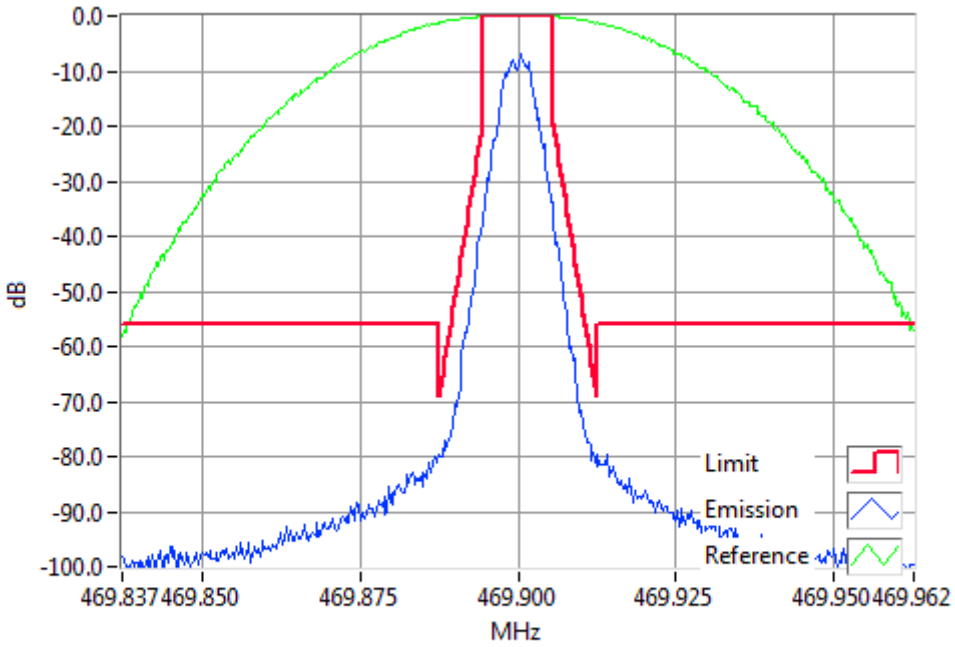
DMR 465.1000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

DMR

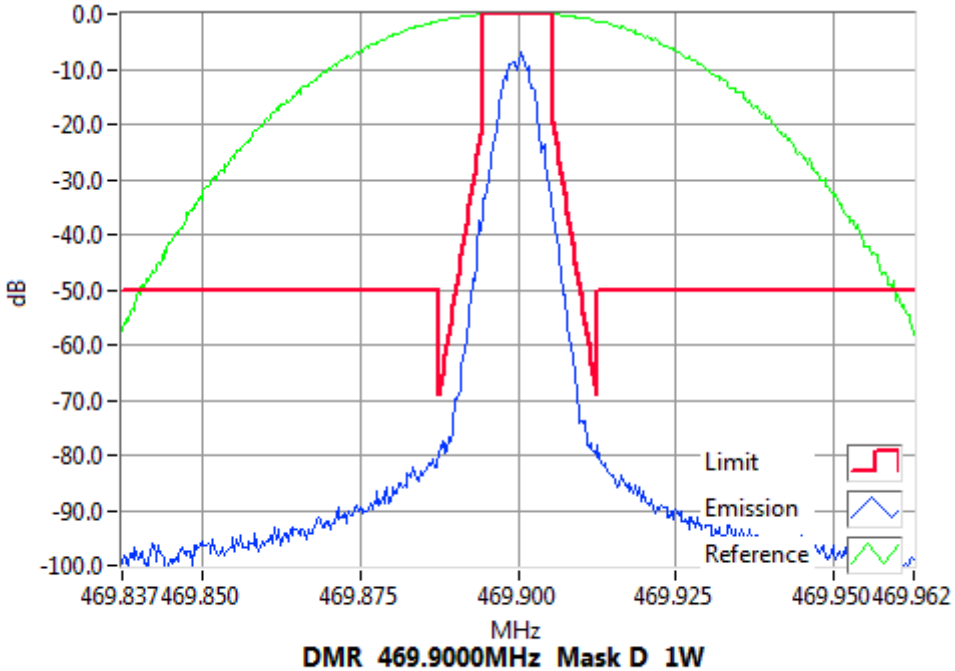
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 469.9 MHz 4 W 12.5 kHz Channel Spacing



DMR 469.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 469.9 MHz 1 W 12.5 kHz Channel Spacing



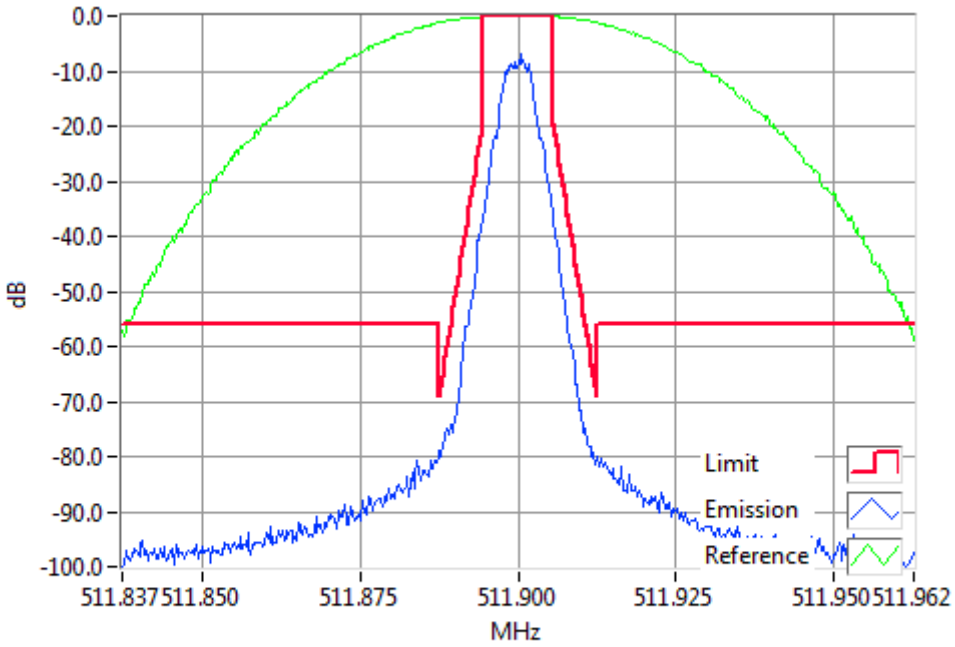
DMR 469.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

DMR

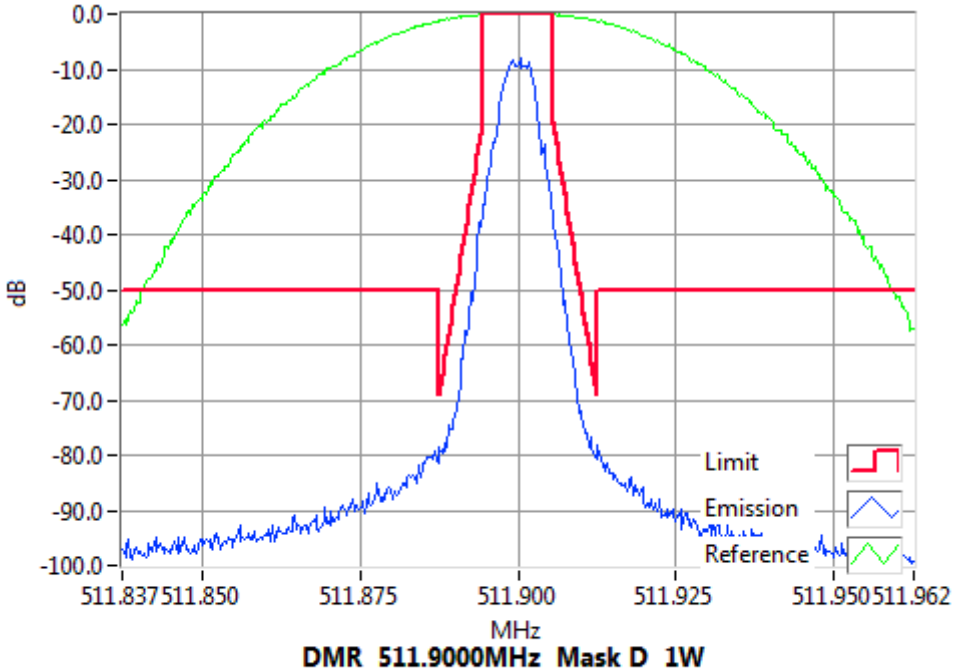
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 511.9 MHz 4 W 12.5 kHz Channel Spacing



DMR 511.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 511.9 MHz 1 W 12.5 kHz Channel Spacing



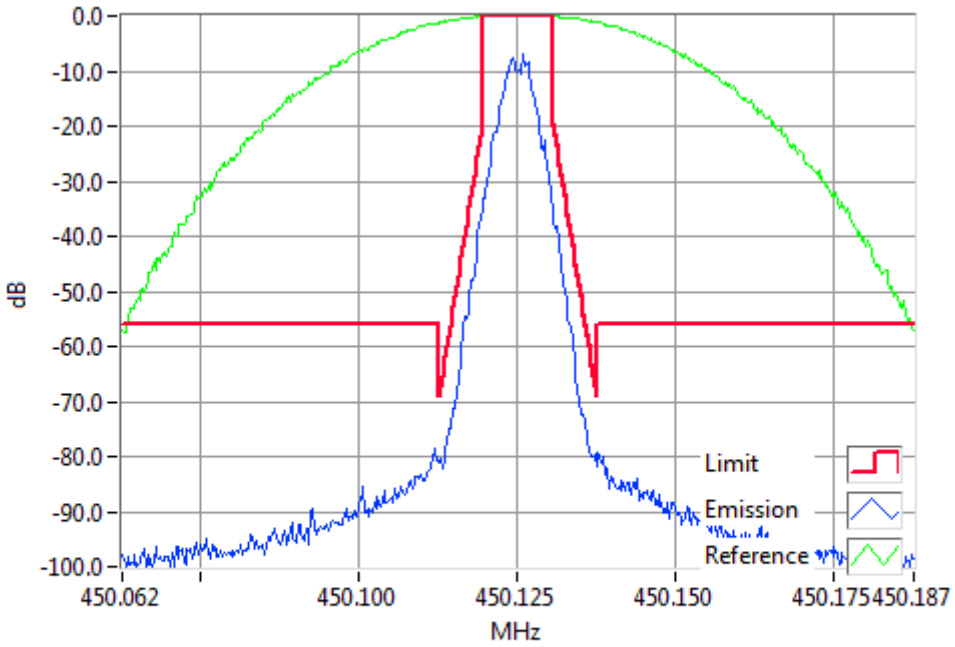
DMR 511.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase I

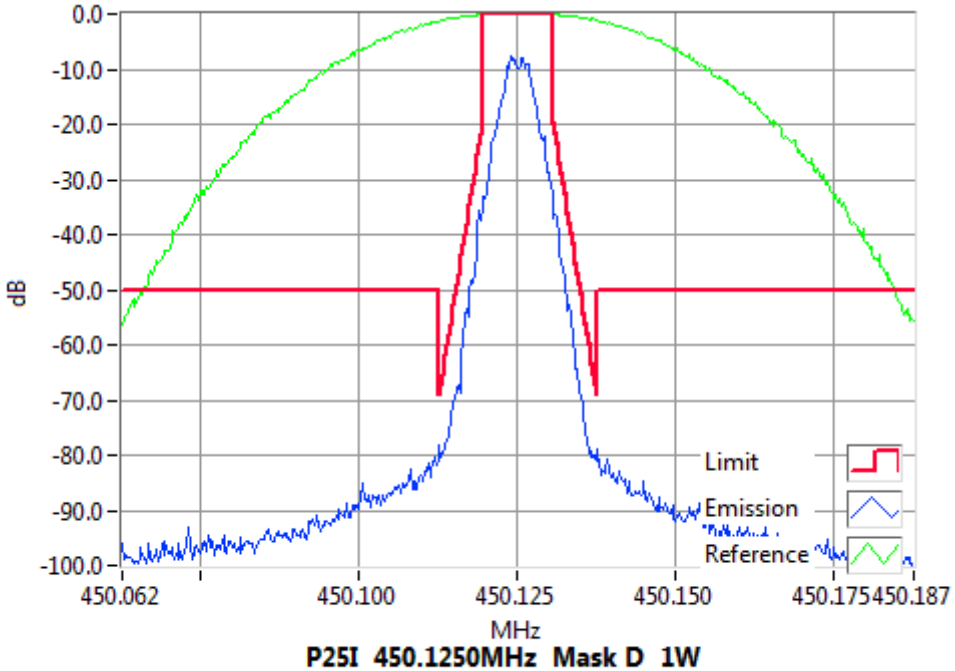
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 450.125 MHz 4 W 12.5 kHz Channel Spacing



P25I 450.1250MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 450.125 MHz 1 W 12.5 kHz Channel Spacing



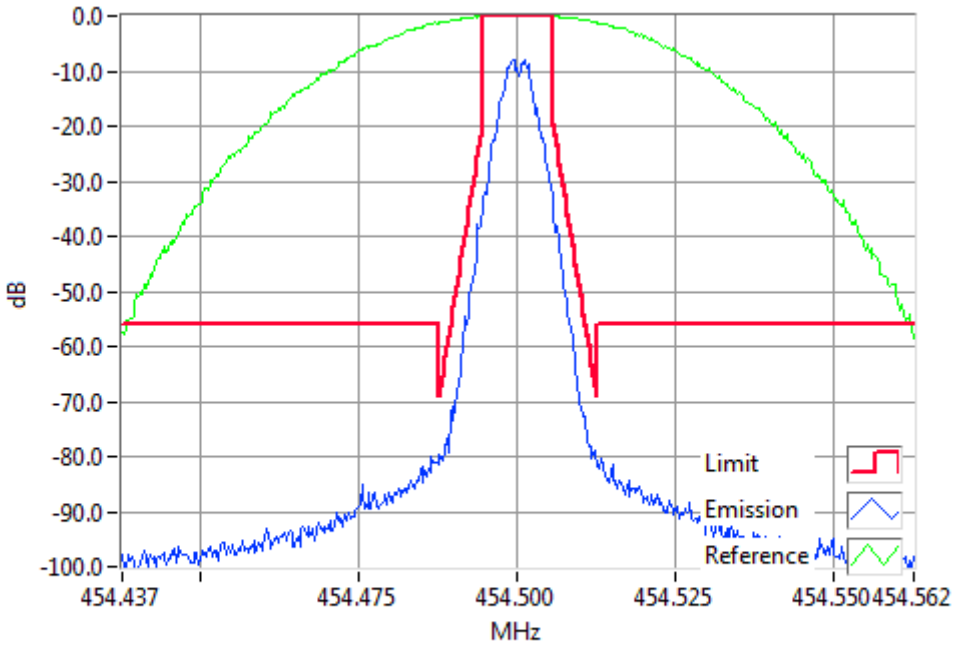
P25I 450.1250MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase I

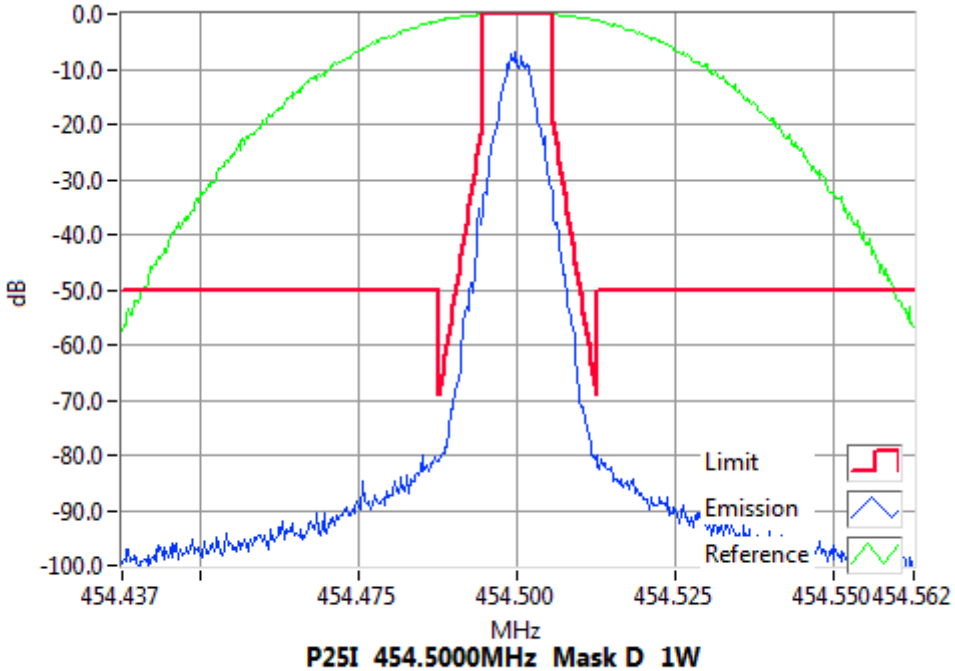
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 454.5 MHz 4 W 12.5 kHz Channel Spacing



P25I 454.5000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 454.5 MHz 1 W 12.5 kHz Channel Spacing



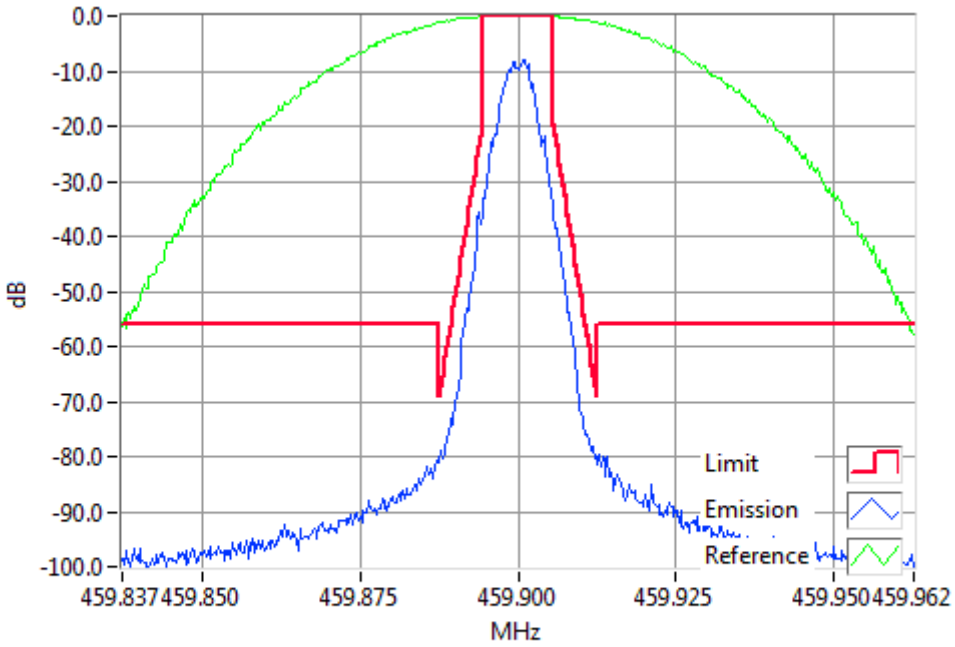
P25I 454.5000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase I

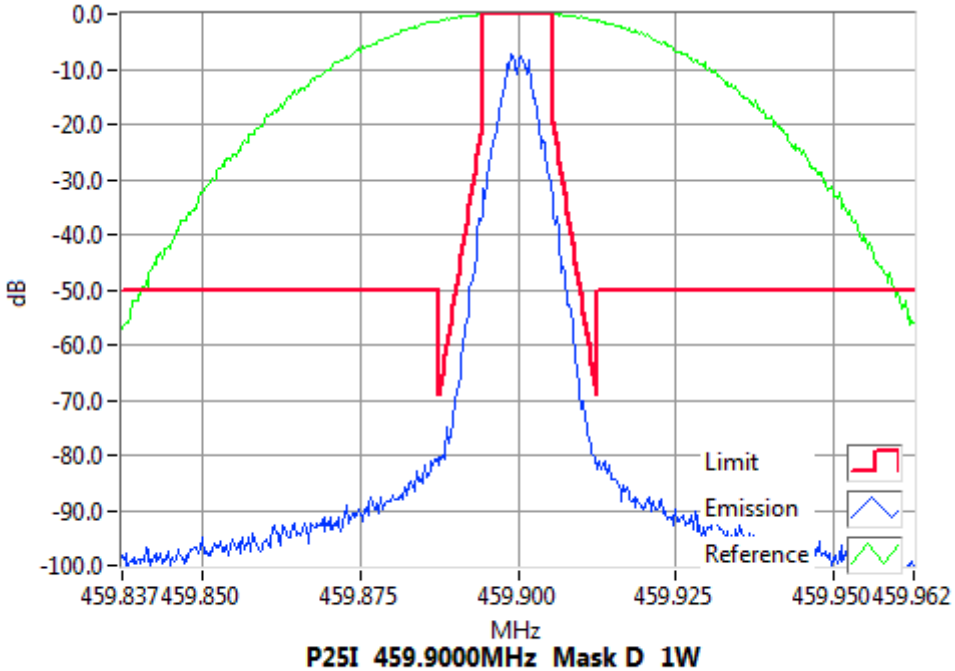
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 459.9 MHz 4 W 12.5 kHz Channel Spacing



P25I 459.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 459.9 MHz 1 W 12.5 kHz Channel Spacing



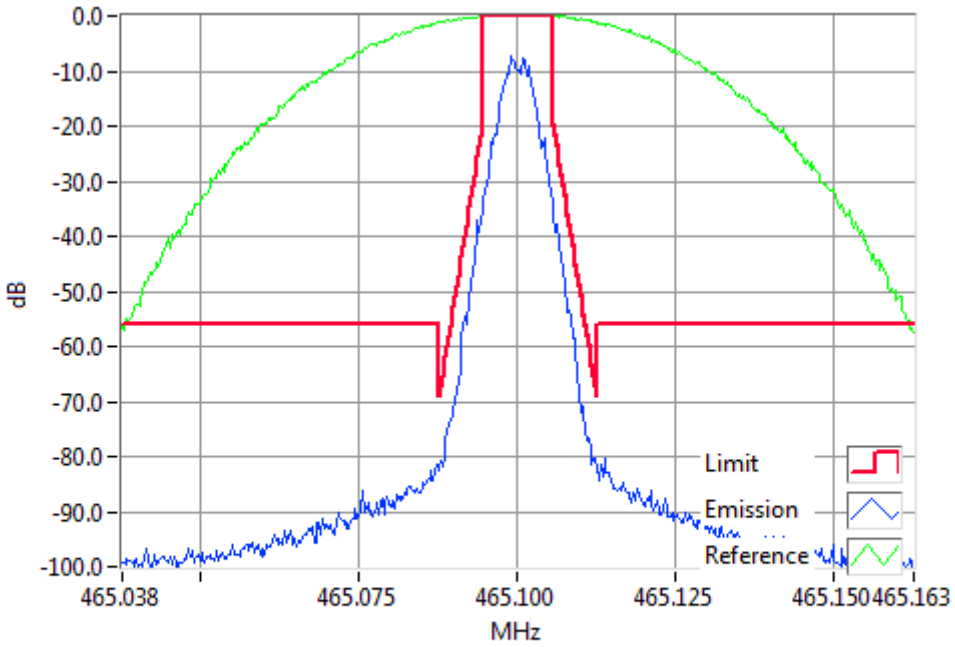
P25I 459.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase I

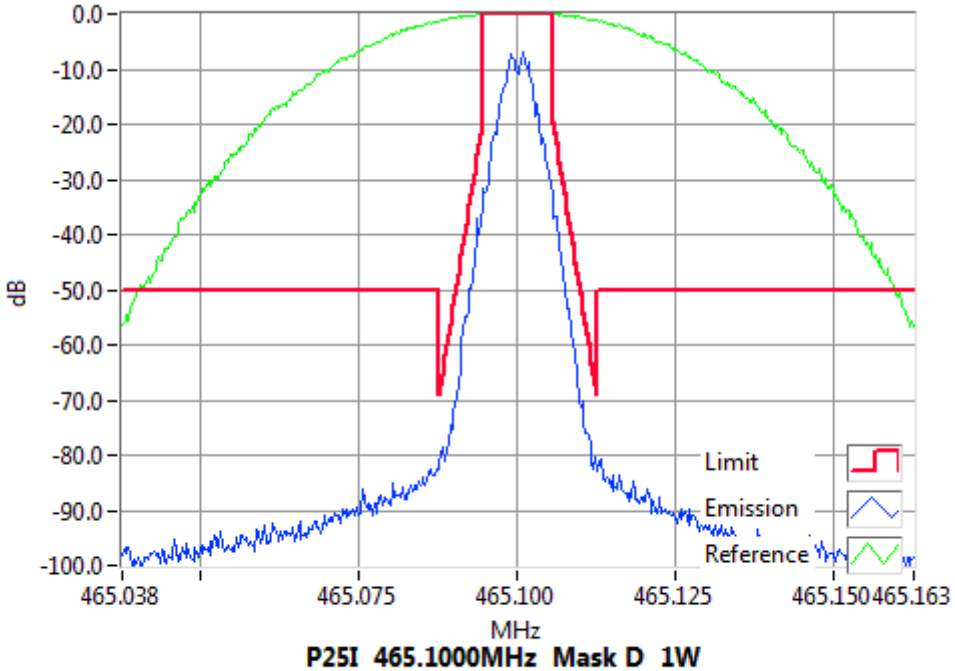
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 465.1 MHz 4 W 12.5 kHz Channel Spacing



P25I 465.1000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 465.1 MHz 1 W 12.5 kHz Channel Spacing



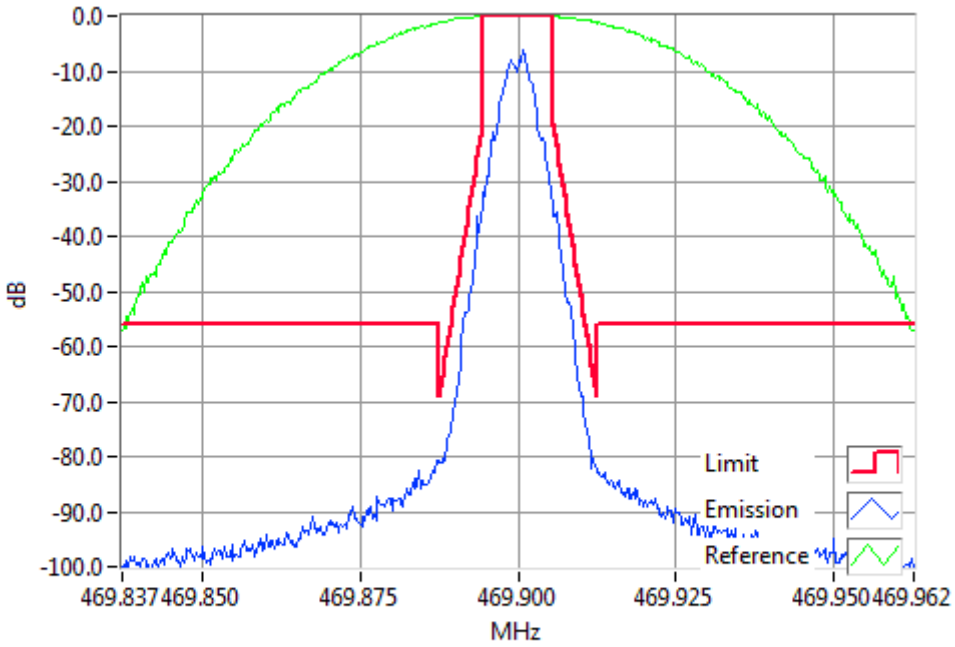
P25I 465.1000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase I

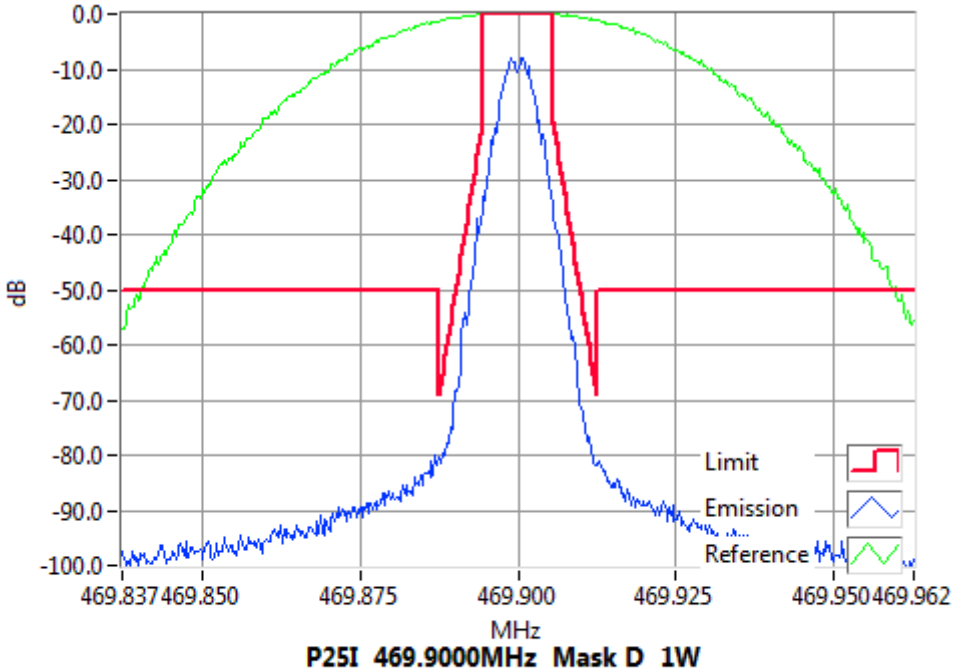
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 469.9 MHz 4 W 12.5 kHz Channel Spacing



P25I 469.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 469.9 MHz 1 W 12.5 kHz Channel Spacing



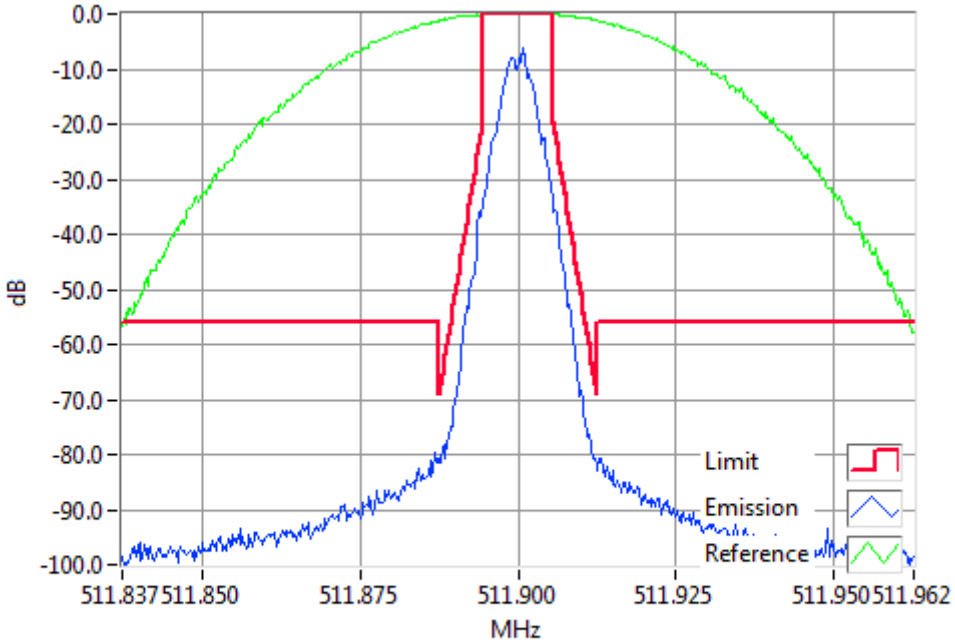
P25I 469.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase I

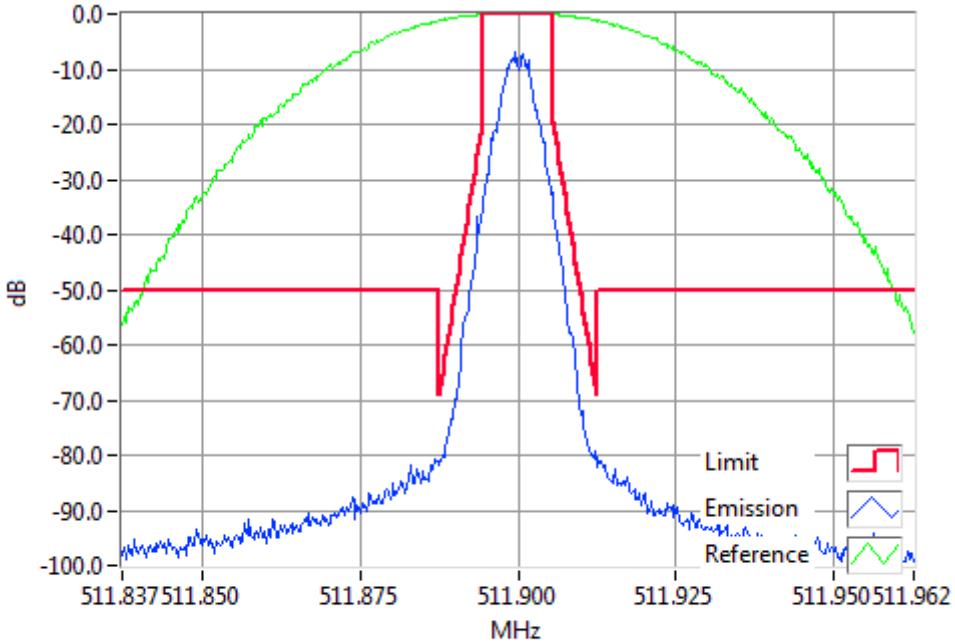
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 511.9 MHz 4 W 12.5 kHz Channel Spacing



P25I 511.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 511.9 MHz 1 W 12.5 kHz Channel Spacing



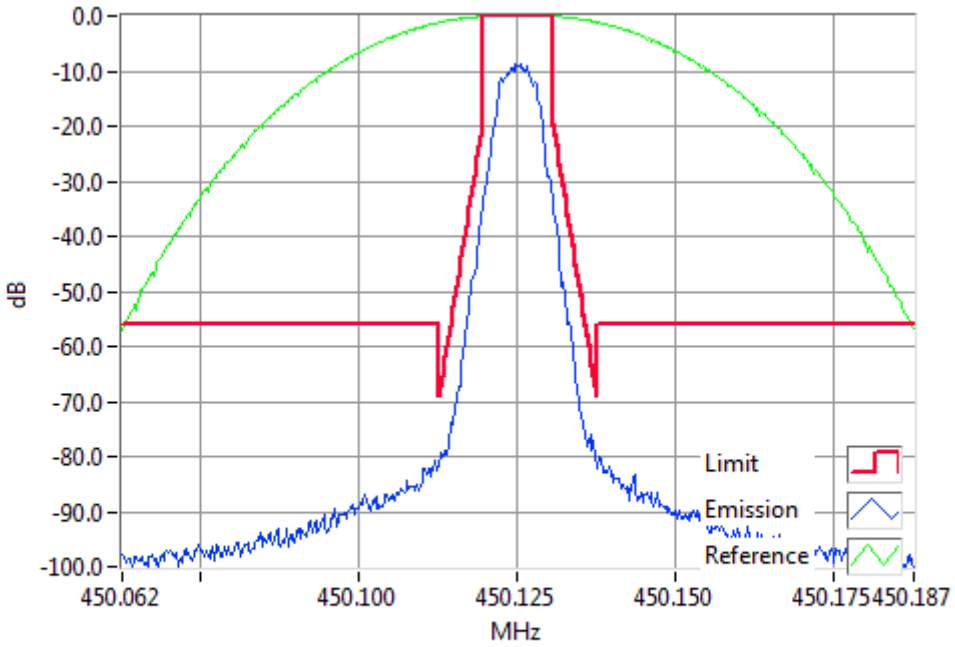
P25I 511.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase II

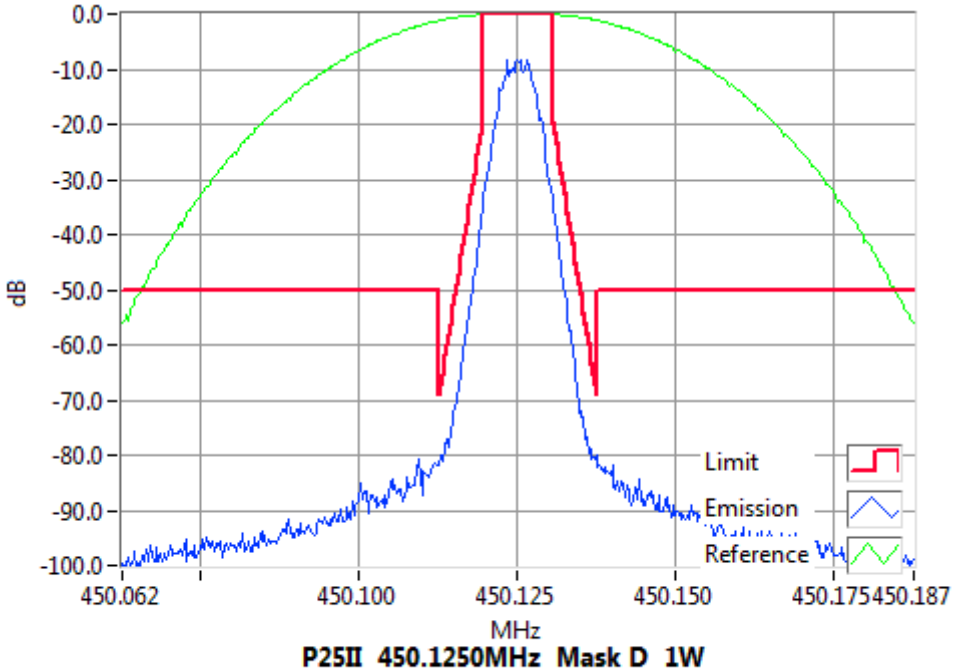
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 450.125 MHz 4 W 12.5 kHz Channel Spacing



P25II 450.1250MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 450.125 MHz 1 W 12.5 kHz Channel Spacing



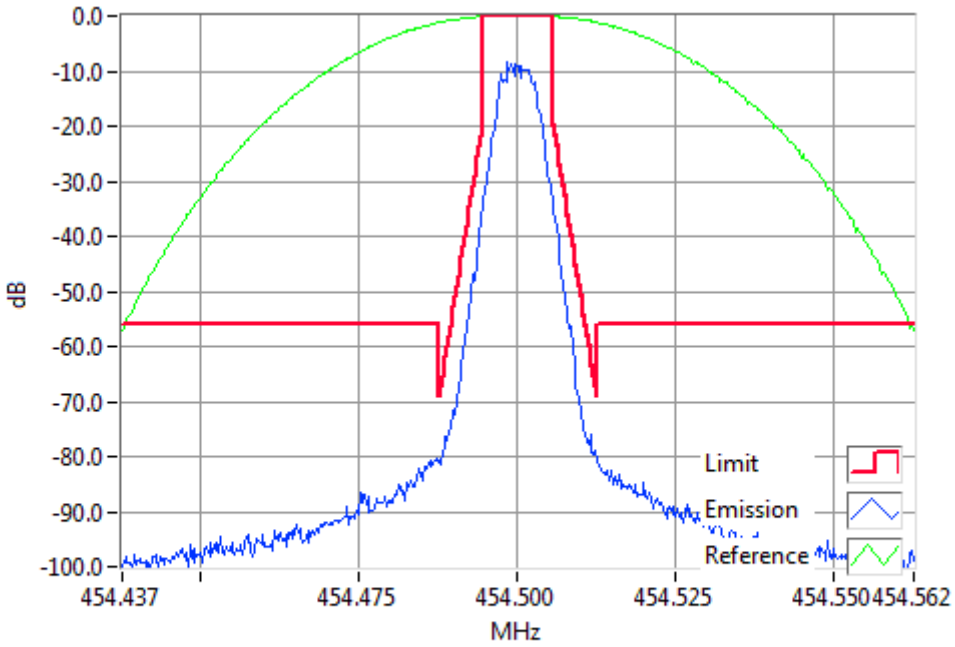
P25II 450.1250MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase II

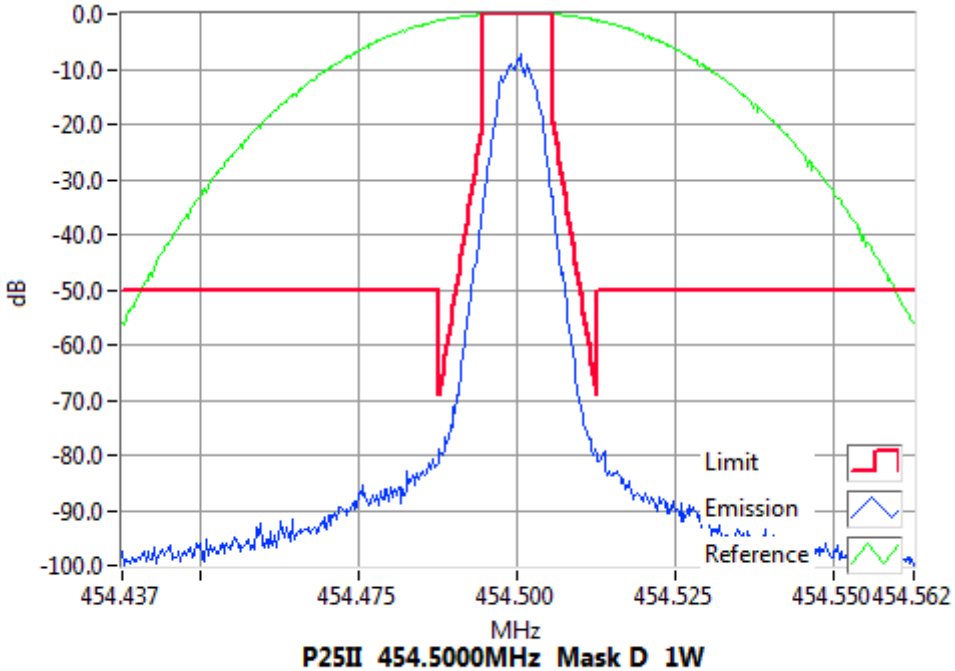
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 454.5 MHz 4 W 12.5 kHz Channel Spacing



P25II 454.5000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 454.5 MHz 1 W 12.5 kHz Channel Spacing



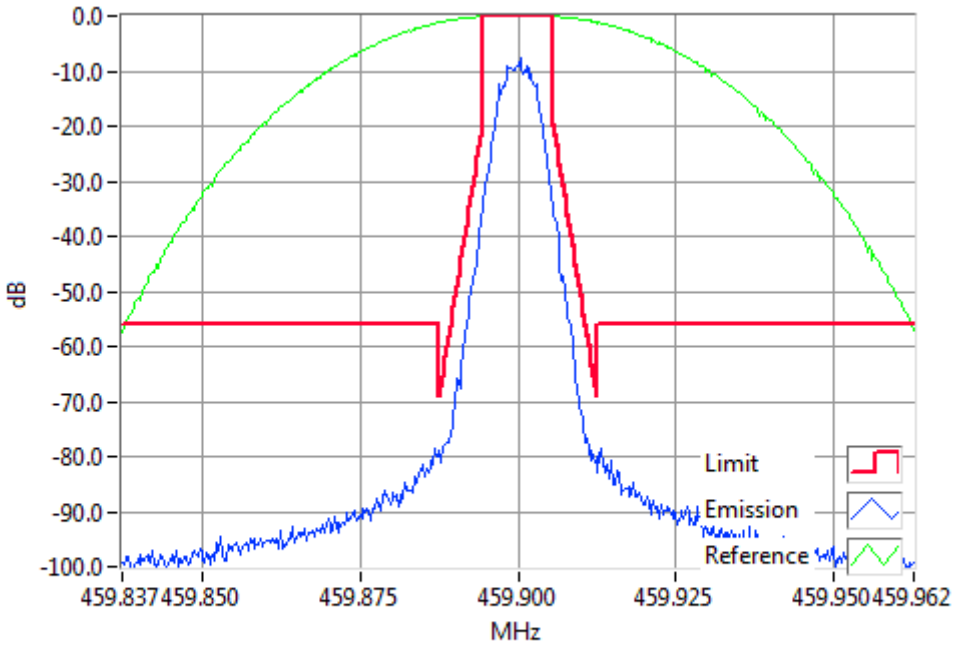
P25II 454.5000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase II

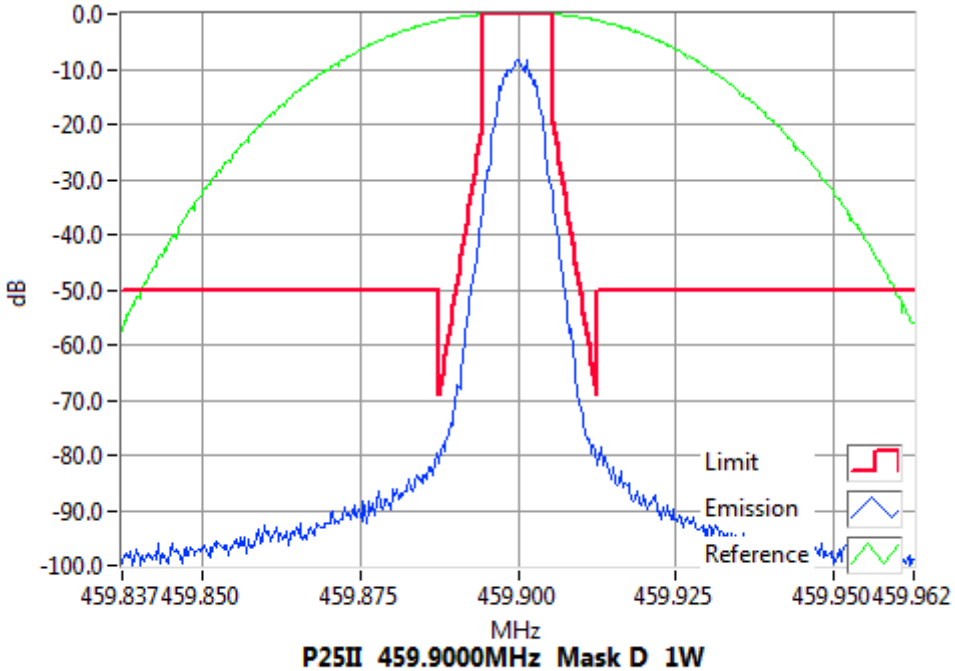
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 459.9 MHz 4 W 12.5 kHz Channel Spacing



P25II 459.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 459.9 MHz 1 W 12.5 kHz Channel Spacing



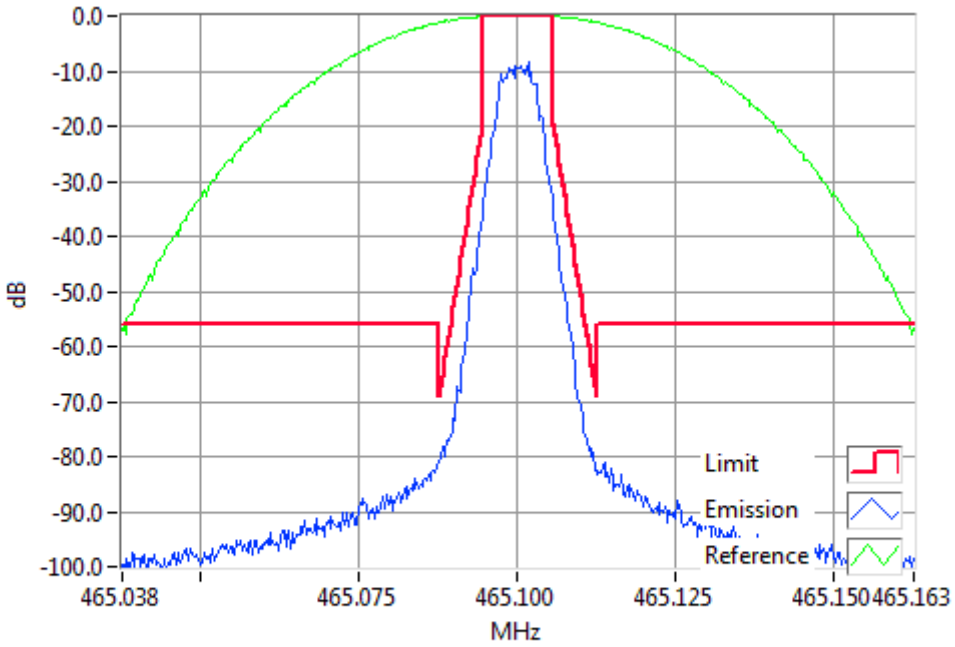
P25II 459.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase II

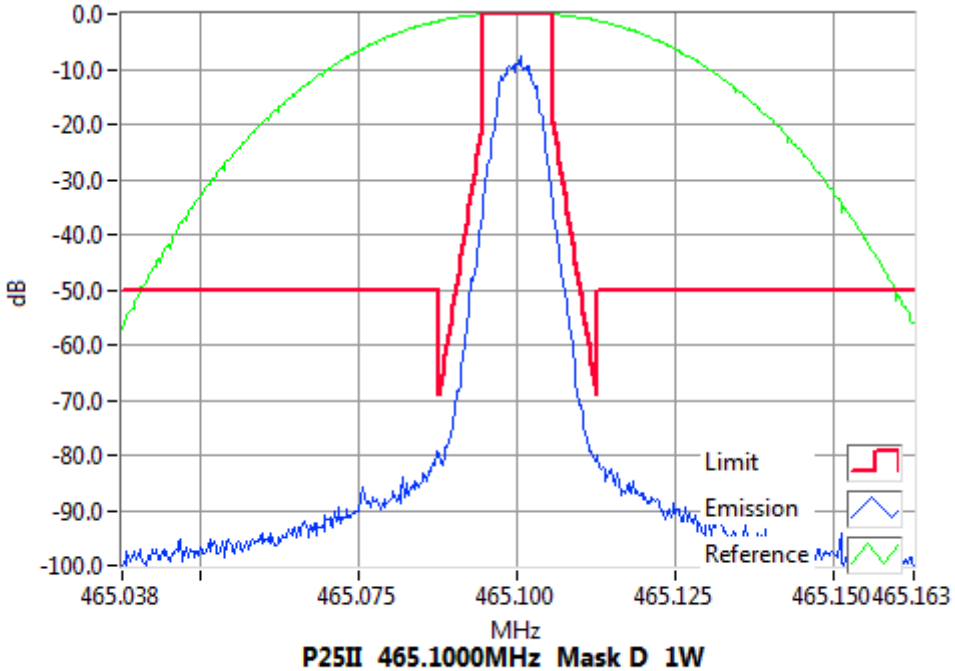
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 465.1 MHz 4 W 12.5 kHz Channel Spacing



P25II 465.1000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 465.1 MHz 1 W 12.5 kHz Channel Spacing



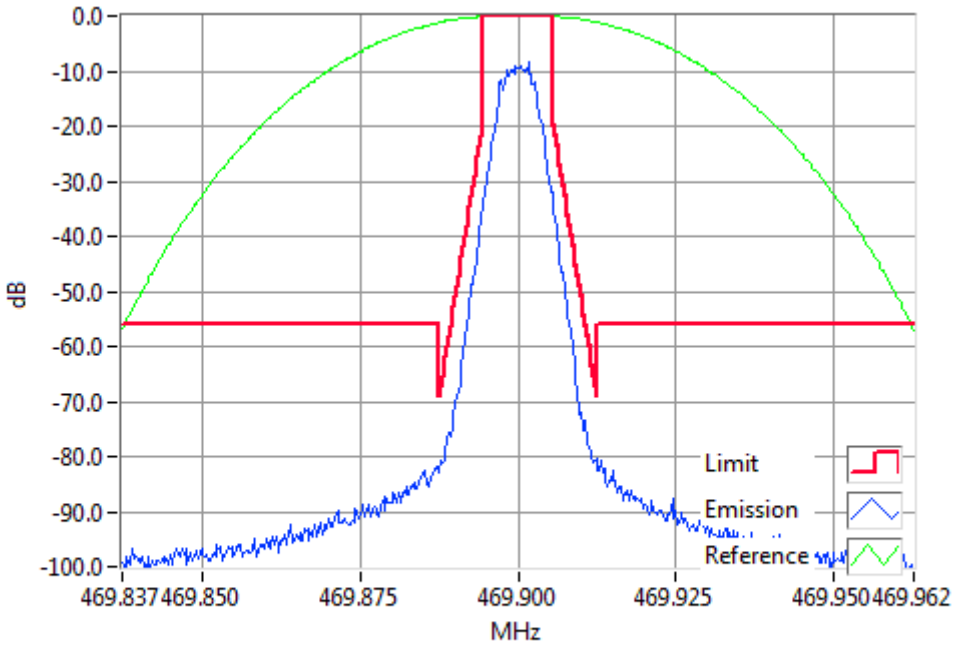
P25II 465.1000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase II

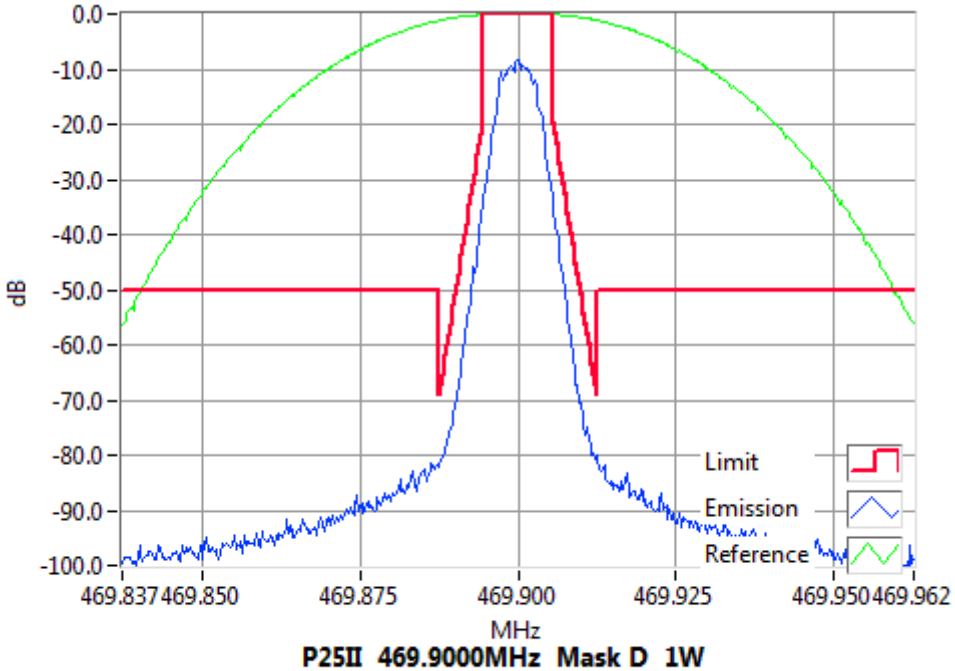
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 469.9 MHz 4 W 12.5 kHz Channel Spacing



P25II 469.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 469.9 MHz 1 W 12.5 kHz Channel Spacing



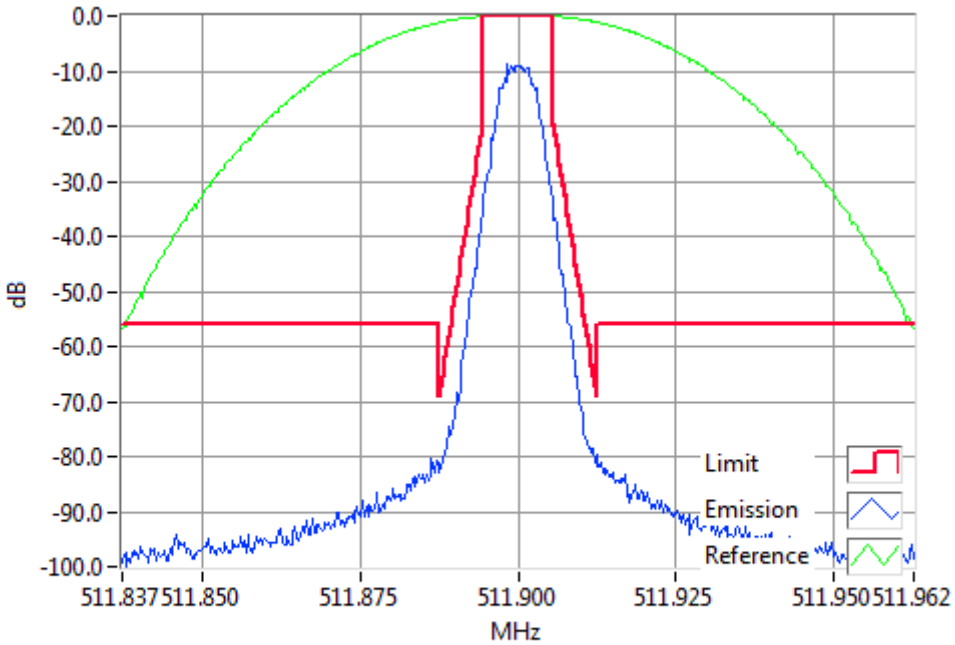
P25II 469.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase II

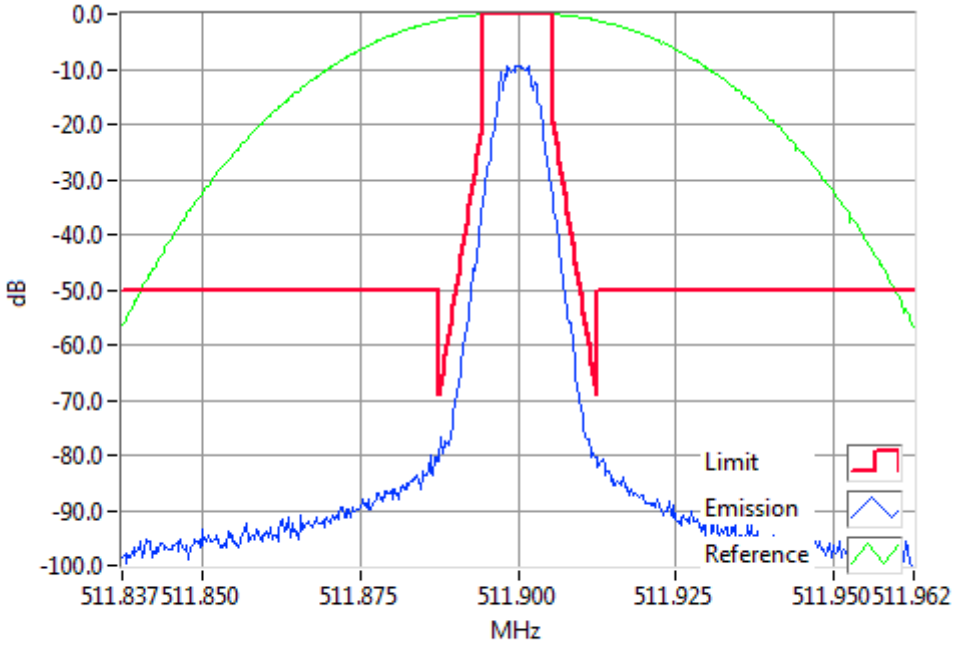
SPECIFICATION: FCC 47 CFR 2.1049 (c)

Tx FREQUENCY: 511.9 MHz 4 W 12.5 kHz Channel Spacing



P25II 511.9000MHz Mask D 4W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 511.9 MHz 1 W 12.5 kHz Channel Spacing



P25II 511.9000MHz Mask D 1W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATIONS: FCC 47 CFR 2.1051

GUIDE: TIA/EIA-603D 2.2.13

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 (5.15 GHz)
3. The EUT was set to transmit high or low power, modulated with P25 Phase 1 (C4FM). A scan is performed with a resolution bandwidth of 10 kHz and a video bandwidth of 30 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. A filter was used for frequencies just below the second harmonic to 4 GHz.
4. The spectrum analyser was loaded with the appropriate calibration figures to compensate for the cables, attenuator and filter losses.

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

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

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

LIMIT CLAUSE: FCC 47 CFR 90.210

Photo: Conducted Emissions Test Setup

Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

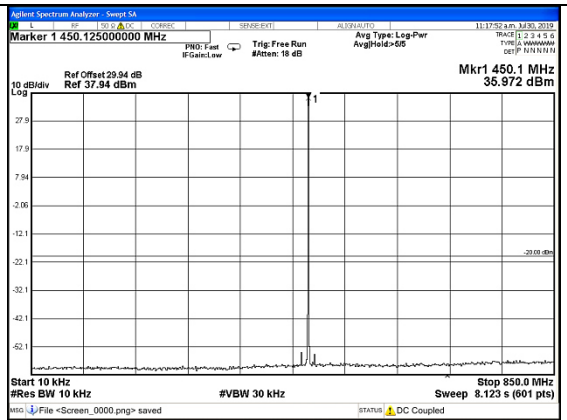
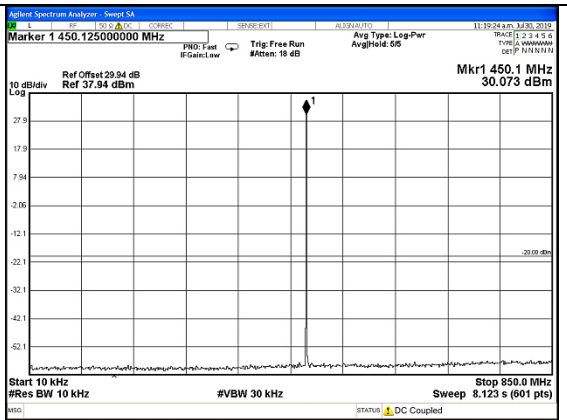
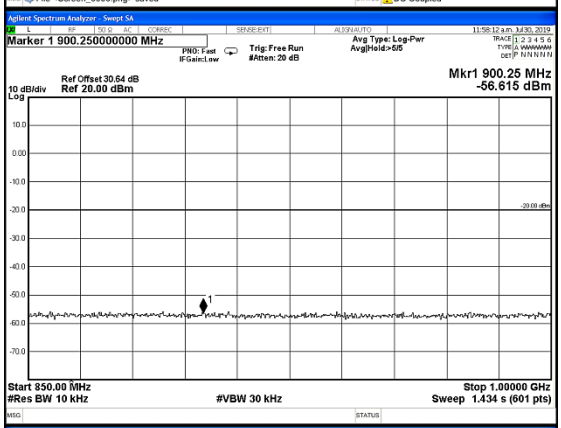
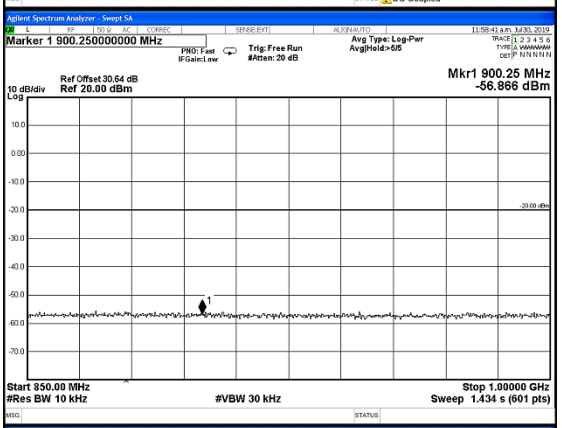
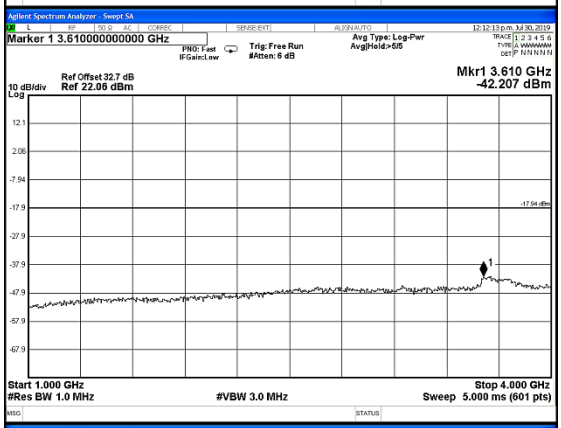
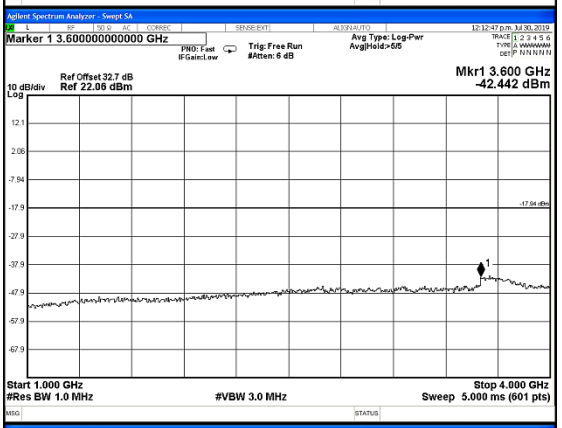
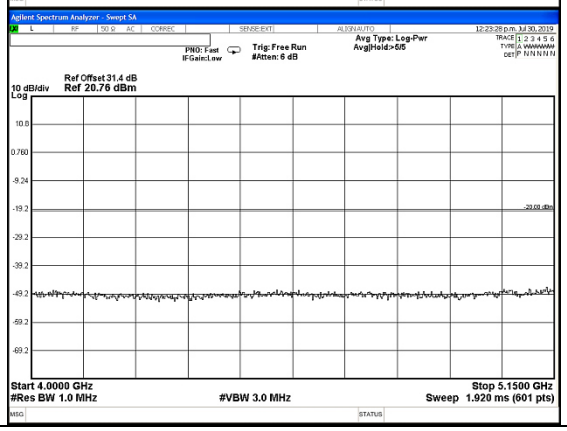
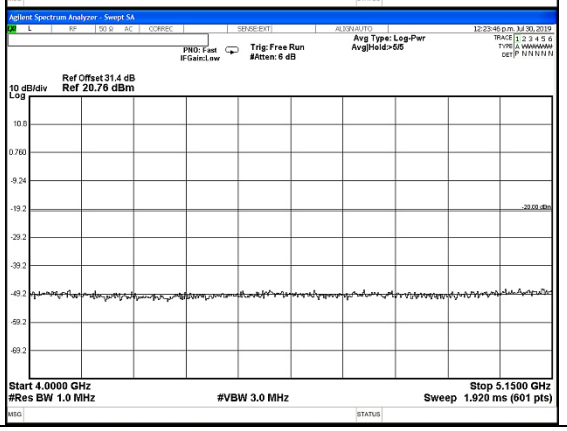
12.5 kHz Channel Spacing 450.125 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 450.125 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty:	≤12.75 GHz ± 3.0 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

Spurious Emissions (Tx Conducted)

450.125 MHz 4 watts	450.125 MHz 1 watts
	
	
	
	

Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

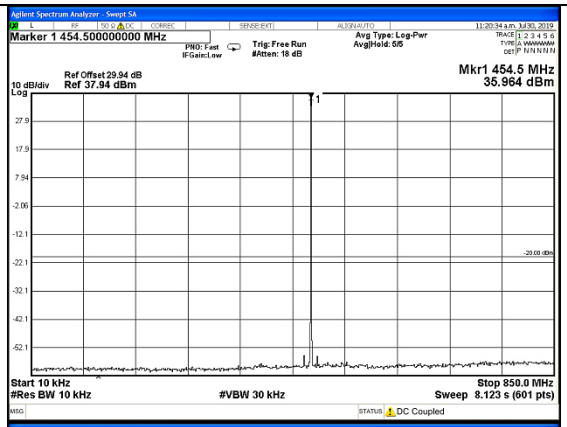
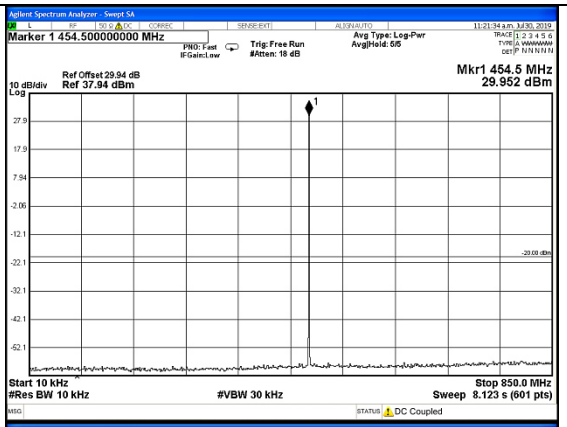
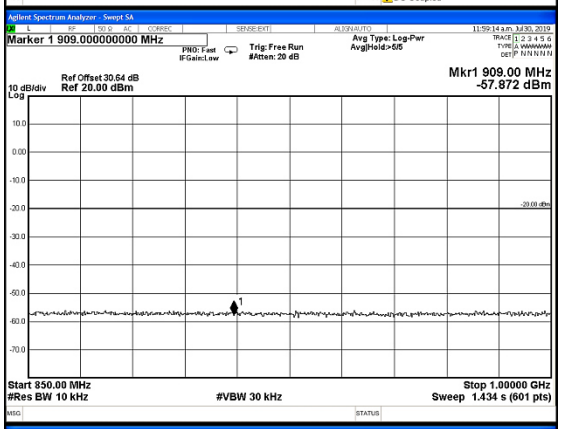
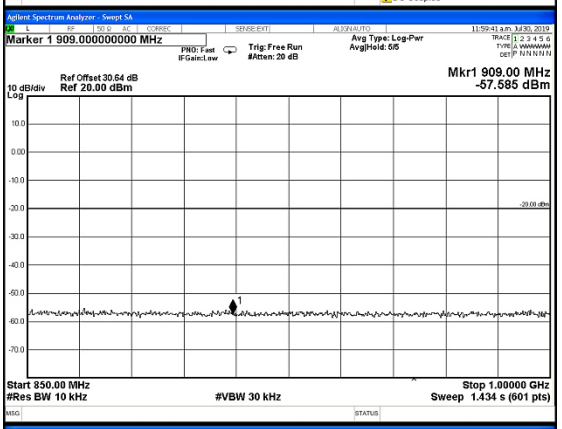
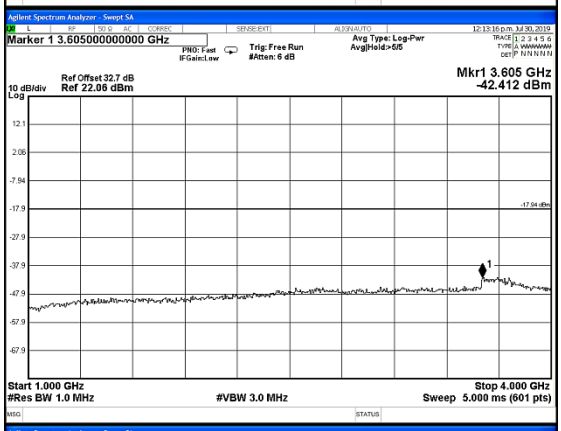
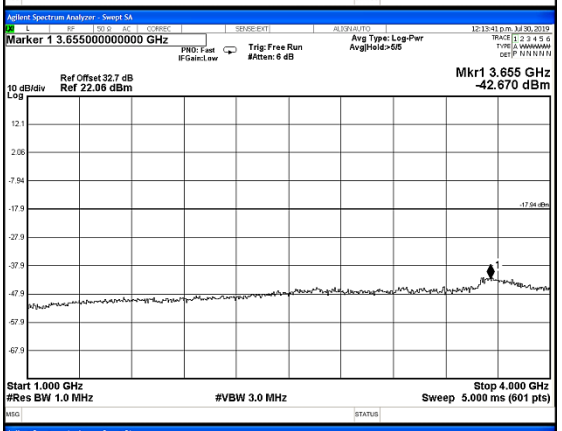
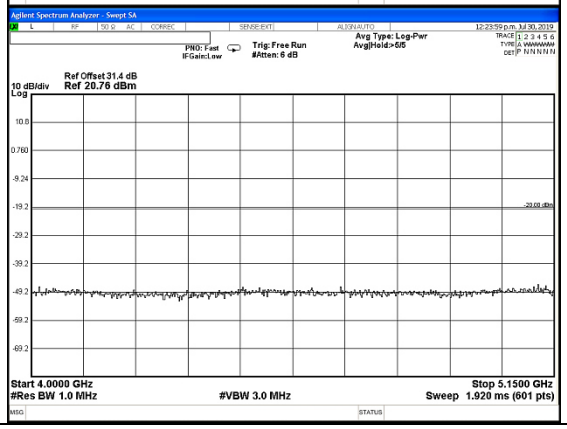
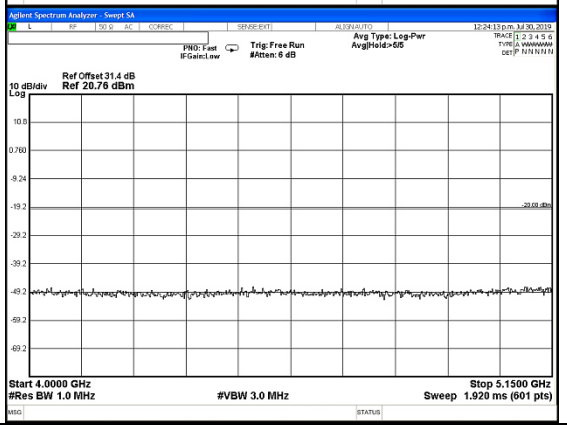
12.5 kHz Channel Spacing 454.5 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 454.5 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty:	≤12.75 GHz ± 3.0 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

Spurious Emissions (Tx Conducted)

454.5 MHz 4 watts	454.5 MHz 1 watts
	
	
	
	

Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

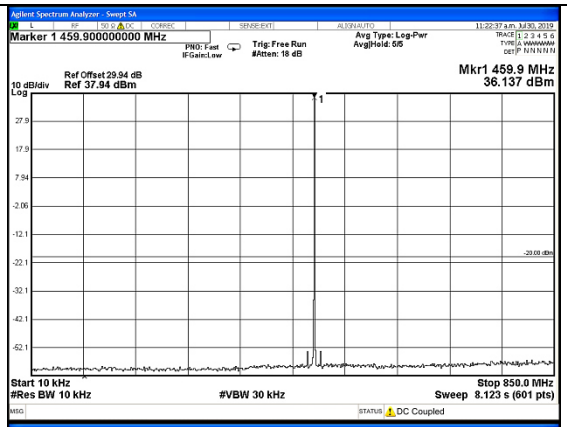
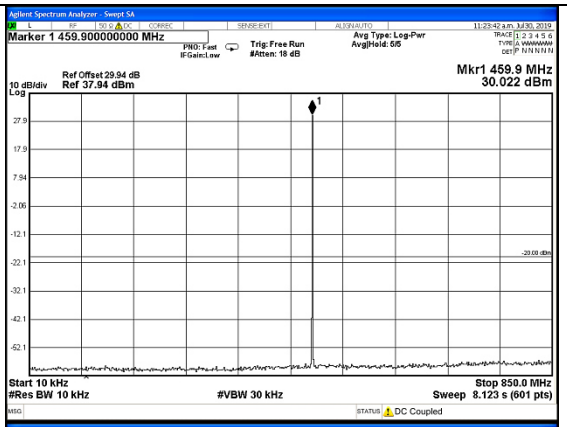
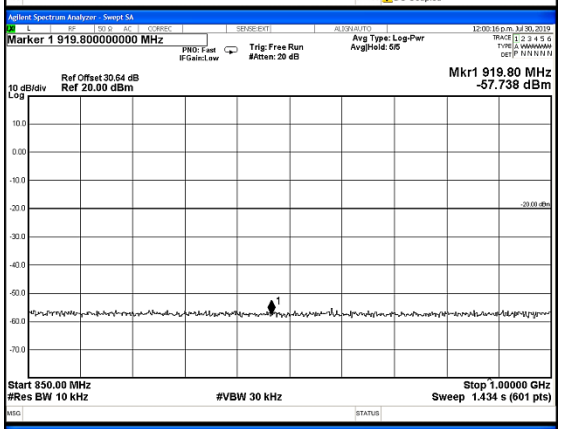
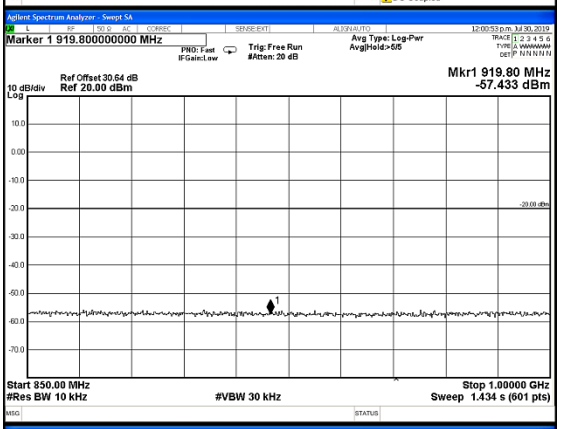
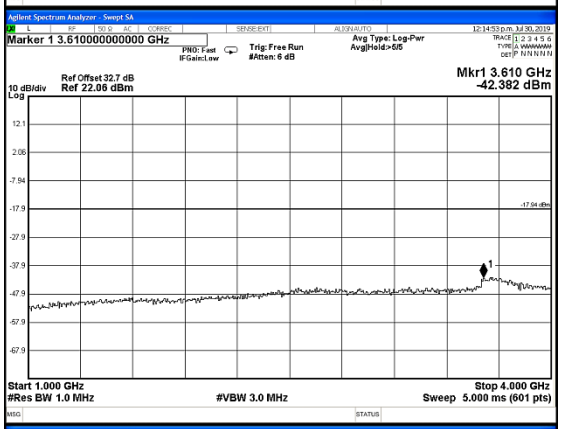
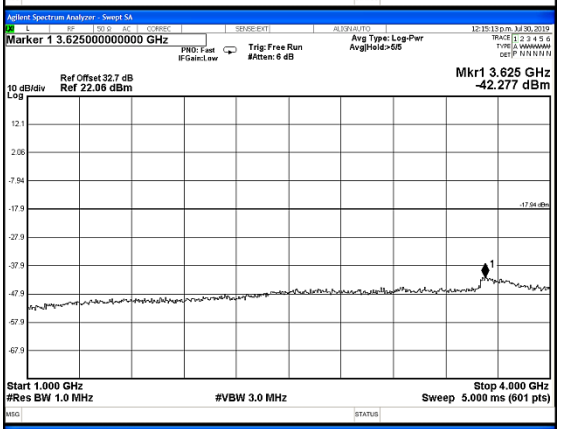
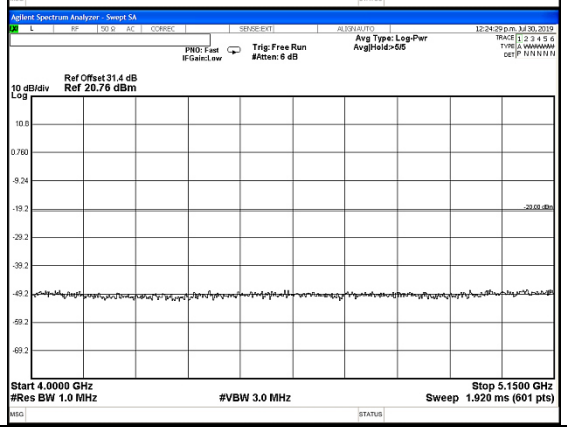
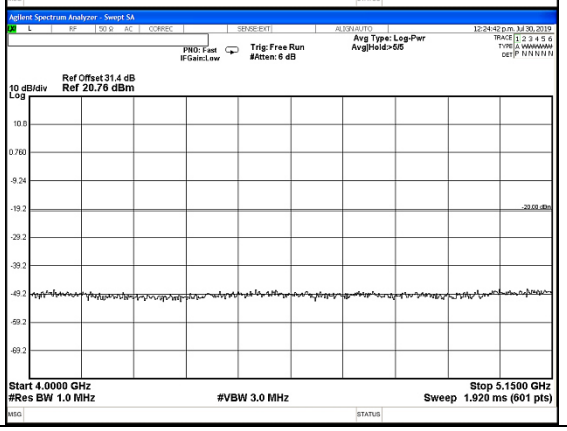
12.5 kHz Channel Spacing 459.9 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 459.9 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty:	≤12.75 GHz ± 3.0 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

Spurious Emissions (Tx Conducted)

459.9 MHz 4 watts	459.9 MHz 1 watts
	
	
	
	

Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

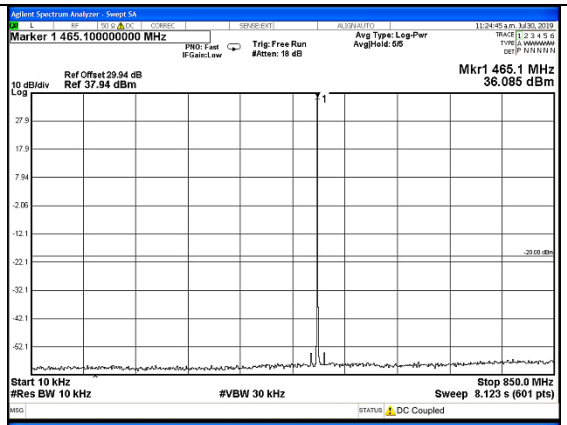
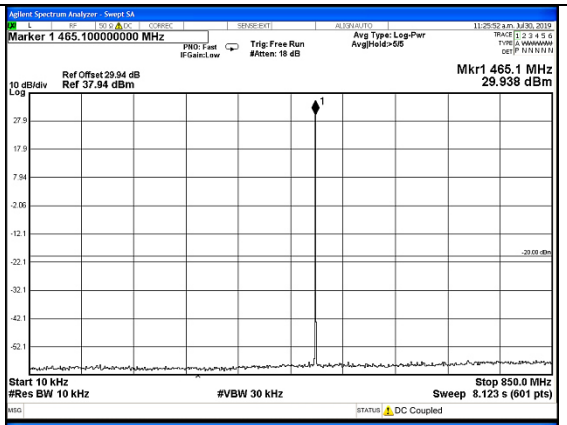
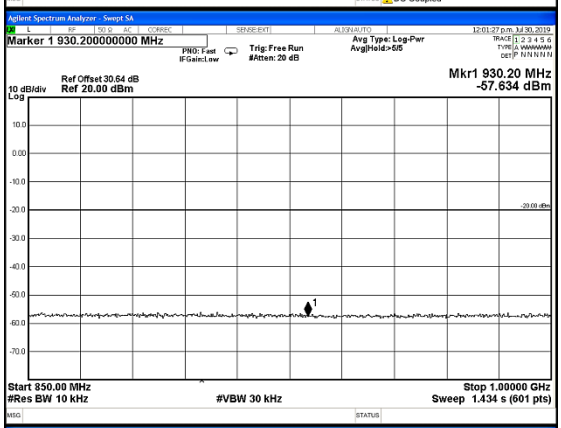
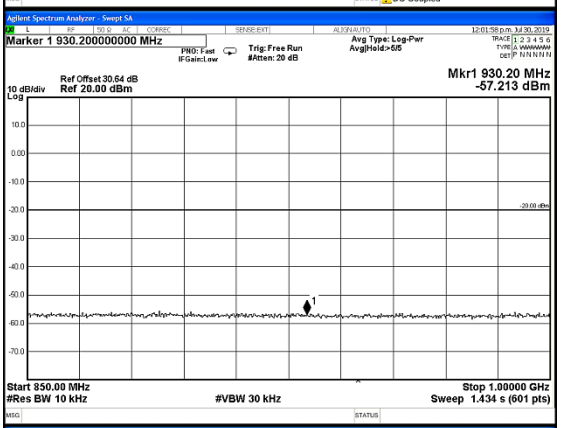
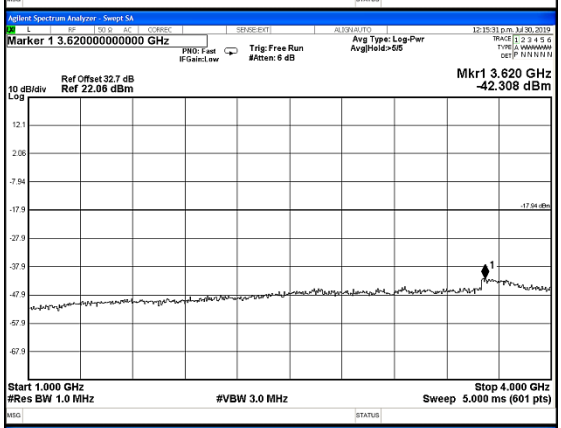
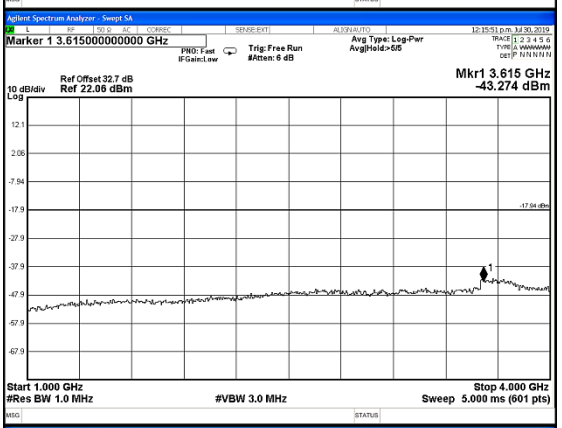
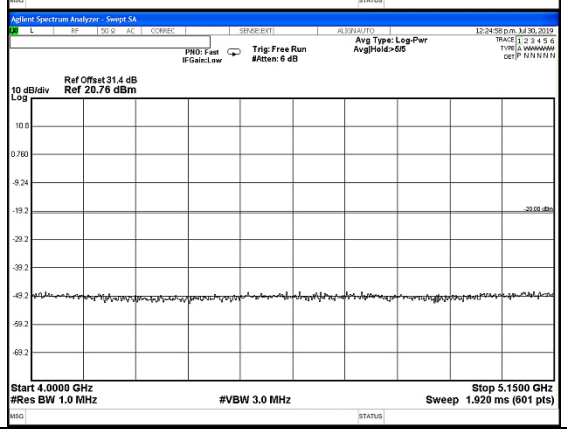
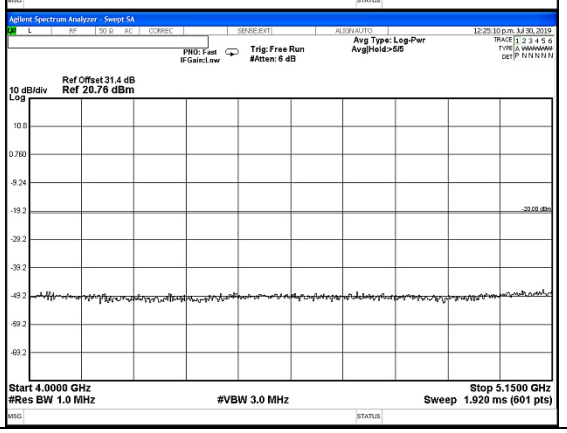
12.5 kHz Channel Spacing 465.1 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 465.1 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty:	≤12.75 GHz ± 3.0 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

Spurious Emissions (Tx Conducted)

465.1 MHz 4 watts	465.1 MHz 1 watts
	
	
	
	

Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

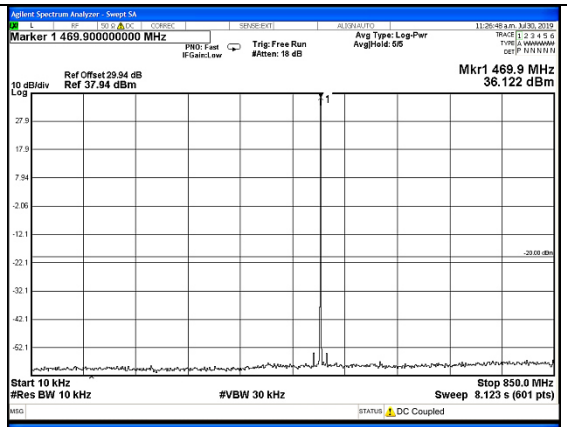
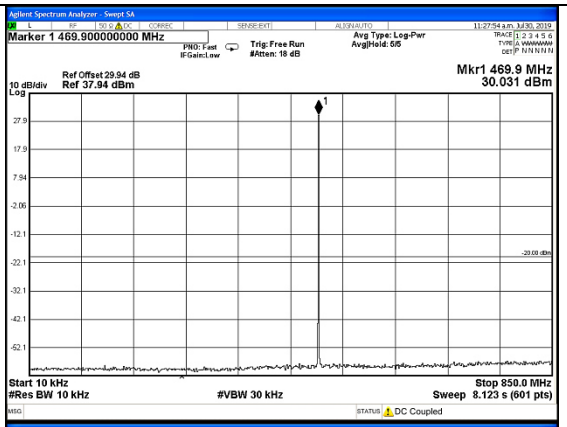
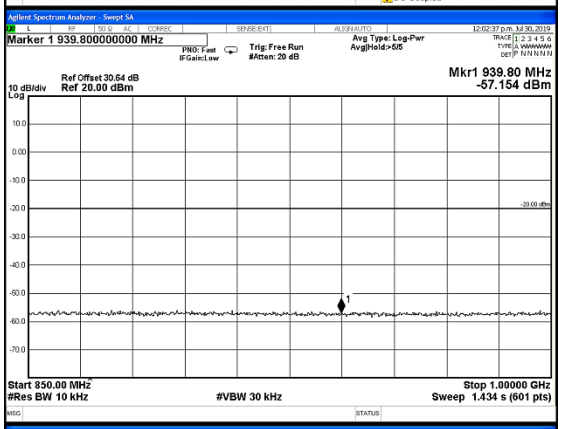
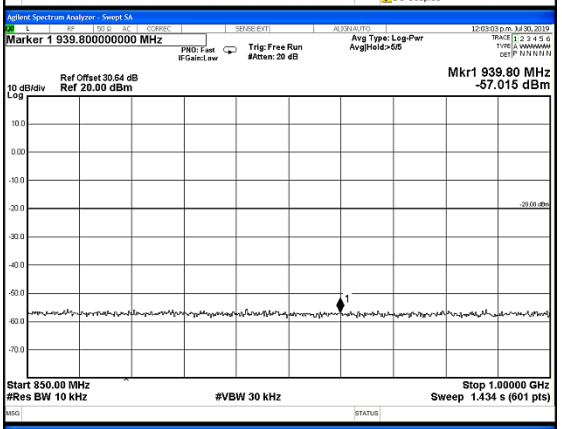
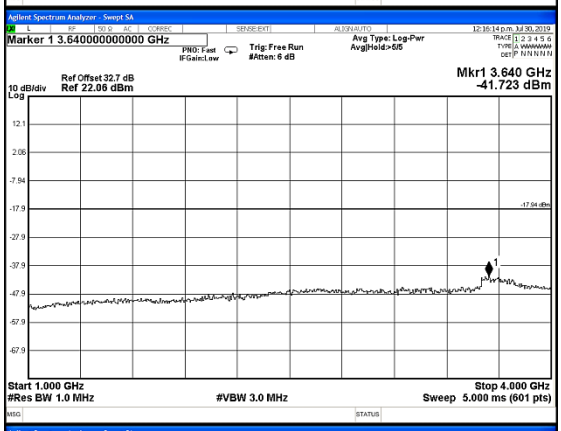
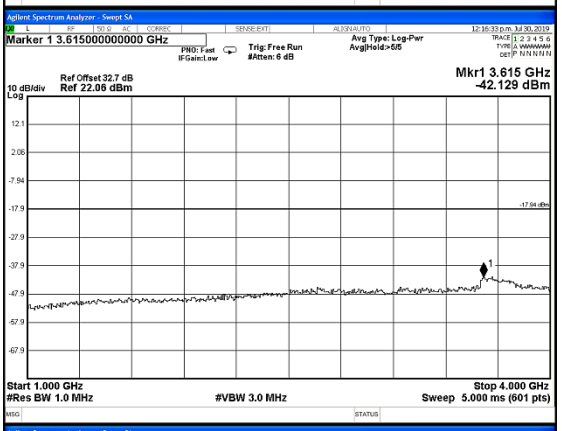
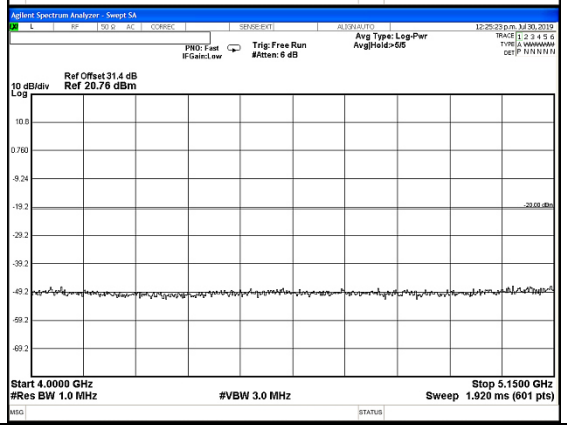
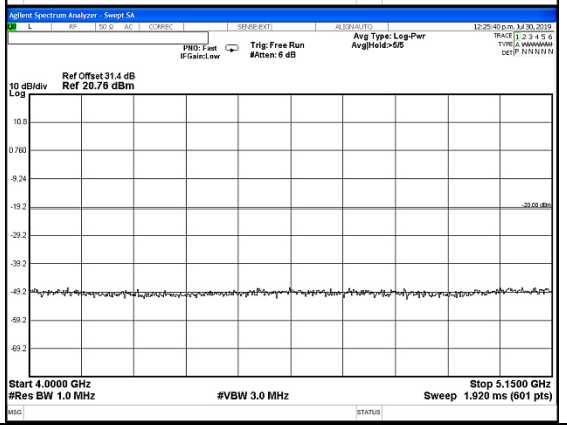
12.5 kHz Channel Spacing 469.9 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 469.9 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty:	≤12.75 GHz ± 3.0 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

Spurious Emissions (Tx Conducted)

469.9 MHz 4 watts	469.9 MHz 1 watts
	
	
	
	

Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

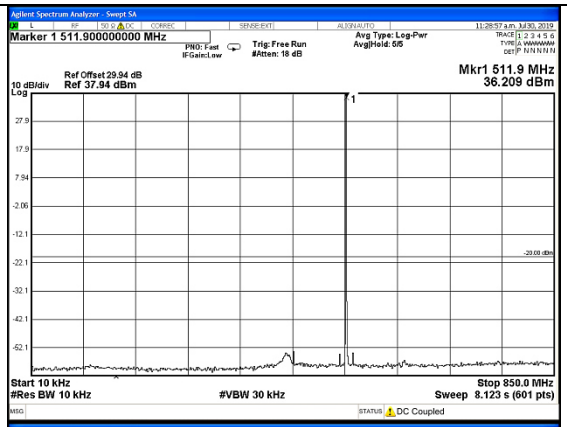
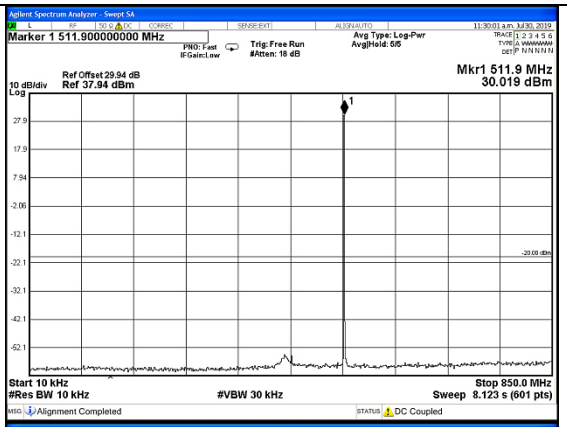
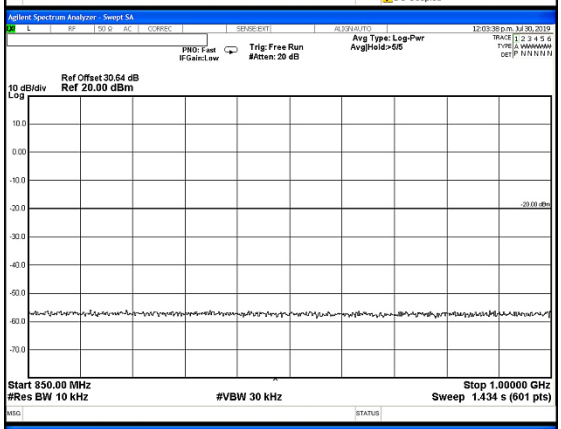
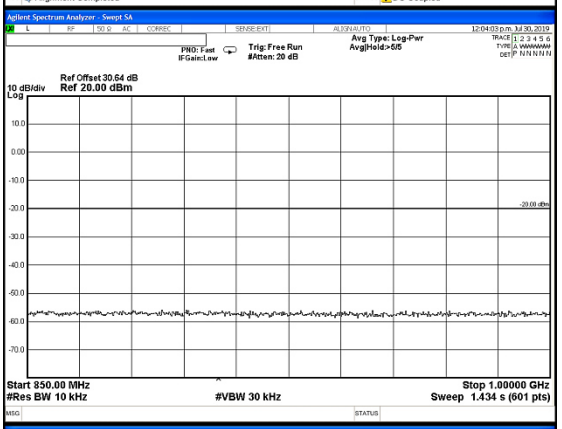
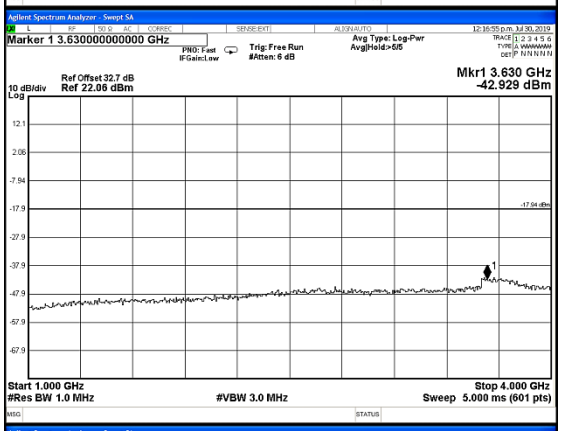
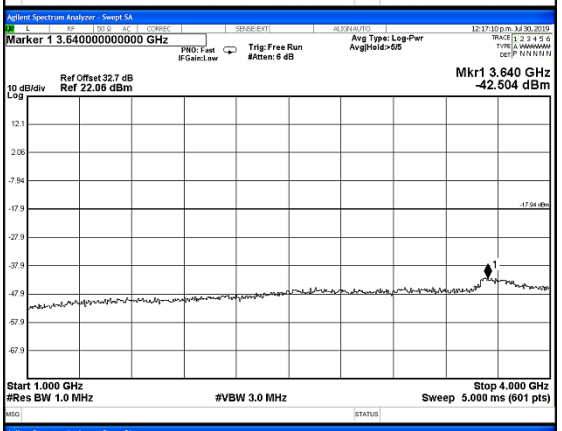
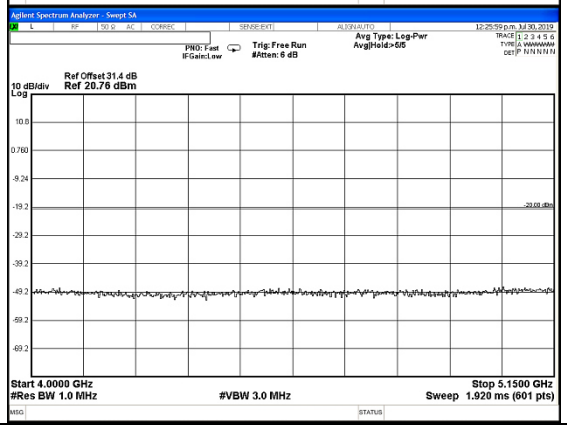
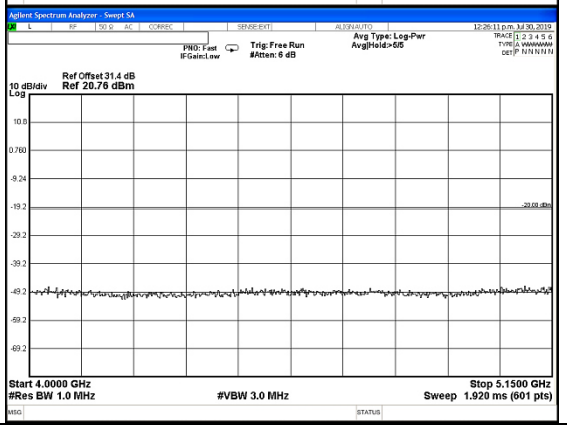
12.5 kHz Channel Spacing 511.9 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 511.9 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty:	≤12.75 GHz ± 3.0 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

Spurious Emissions (Tx Conducted)

511.9 MHz 4 watts	511.9 MHz 1 watts
	
	
	
	

Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

LIMIT CLAUSE: FCC 47 CFR 90.210

Carrier Output Power	Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \text{ Log}_{10} (P_{Watts})$	
4 W	-20 dBm	-56 dBc
1 W	-20 dBm	-50 dBc

TRANSMITTER SPURIOUS EMISSIONS (RADIATED)

SPECIFICATION: FCC 47 CFR 2.1053

GUIDE: TIA/EIA-603D 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. 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^{o} 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 47 CFR 2.1053

12.5 kHz Channel Spacing 450.125 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 450.125 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty	± 4.6 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

12.5 kHz Channel Spacing 454.5 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 454.5 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty	± 4.6 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

12.5 kHz Channel Spacing 459.9 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 459.9 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty	± 4.6 dB	
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 465.1 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 465.1 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty	± 4.6 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

12.5 kHz Channel Spacing 469.9 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 469.9 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty	± 4.6 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

12.5 kHz Channel Spacing 511.9 MHz @ 4 W Emission Mask D

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

12.5 kHz Channel Spacing 511.9 MHz @ 1 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty	± 4.6 dB	
No emissions were detected at a level greater than 20 dB below the limit.		

LIMIT CLAUSE: FCC 47 CFR 2.1053

Carrier Output Power	Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \text{ Log}_{10} (P_{Watts})$	
4 W	-20 dBm	-56 dBc
1 W	-20 dBm	-50 dBc

Tx Radiated Emissions - Continued

Open Area Test Site Results:

12.5 kHz Channel Spacing | 469.9 MHz @ 4 W | Emission Mask D

Harmonics Emission Frequency (MHz)	Level (dBm)	Level (dBc)
939.8	-51.97	-87.97
1409.7	-53.16	-89.16
1879.6	-69.44	-105.44
2349.5	-74.33	-110.33
2819.4	-69.36	-105.36
3289.3	-67.45	-103.45
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)	Path and Boresight corrections	dBm	nW
939.8	-85.22	-32.94	-17.23	-0.89	-0.90	-51.97	6.35
		A	B	C	D	E	

Result (E) = A+B+C+D

Photo: OATS Setup

TRANSIENT FREQUENCY BEHAVIOUR

SPECIFICATION: FCC 47 CFR 90.214

GUIDE: TIA/EIA-603D 2.2.19

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

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

LIMIT CLAUSE: FCC 47 CFR 90.214

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 450.125 MHz 4 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	-0.3	N/A
t3	N/A	-1.0

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

Measurement Uncertainty: Frequency ± 130 Hz; Time ± 0.2%

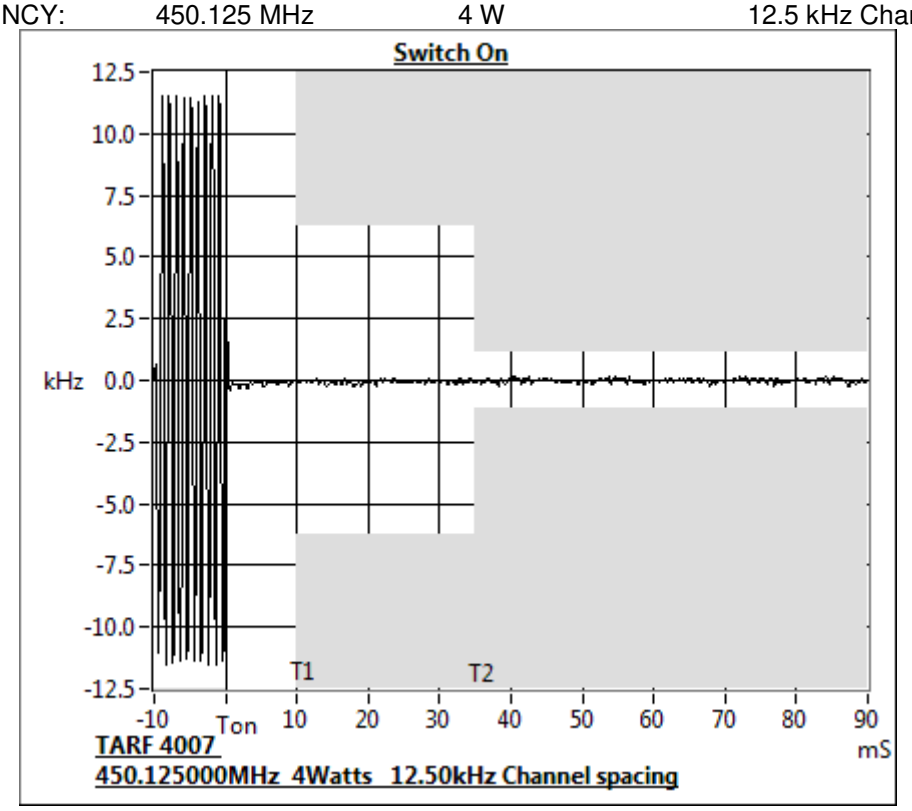
LIMIT: FCC 47 CFR 90.214

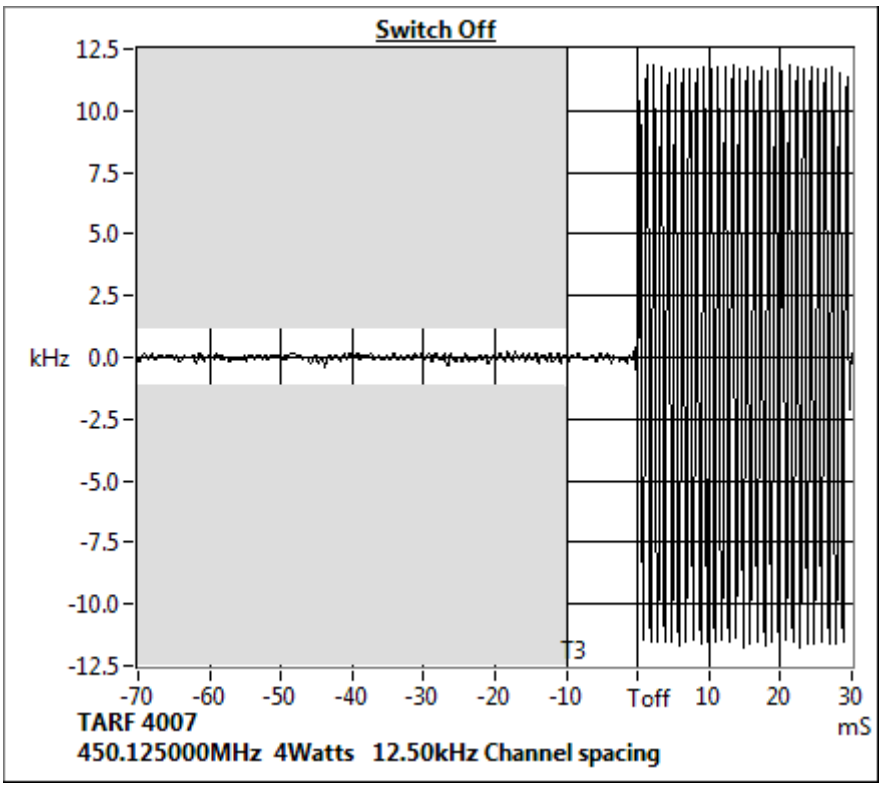
TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 450.125 MHz 4 W 12.5 kHz Channel Spacing





Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 454.5 MHz 4 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	-0.2	N/A
t3	N/A	-0.7

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

Measurement Uncertainty: Frequency ± 130 Hz; Time ± 0.2%

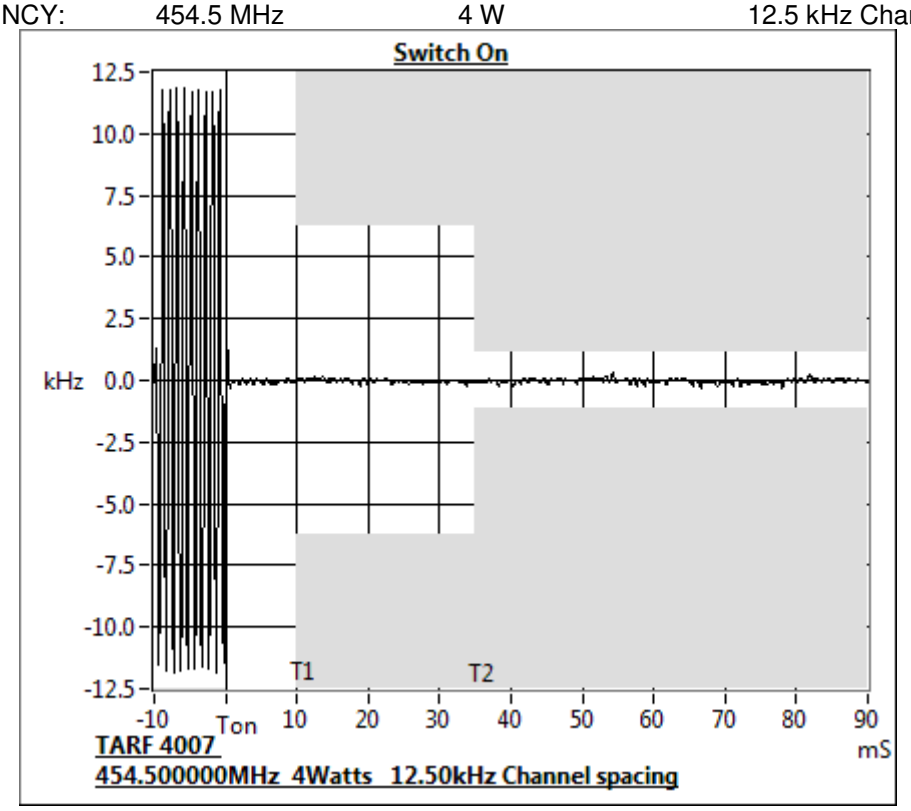
LIMIT: FCC 47 CFR 90.214

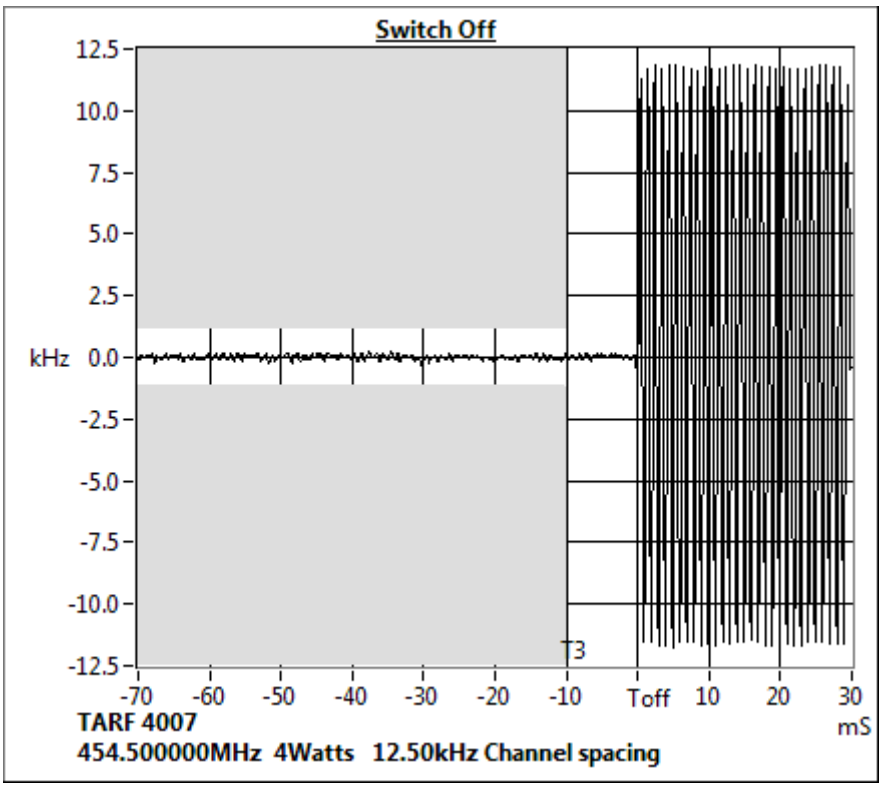
TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 454.5 MHz 4 W 12.5 kHz Channel Spacing





Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 459.9 MHz 4 W 12.5 kHz Channel Spacing

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

	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.	YES	NO
	☒	☐
Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit.	YES	NO
	☒	☐

Measurement Uncertainty: Frequency ± 130 Hz; Time ± 0.2%

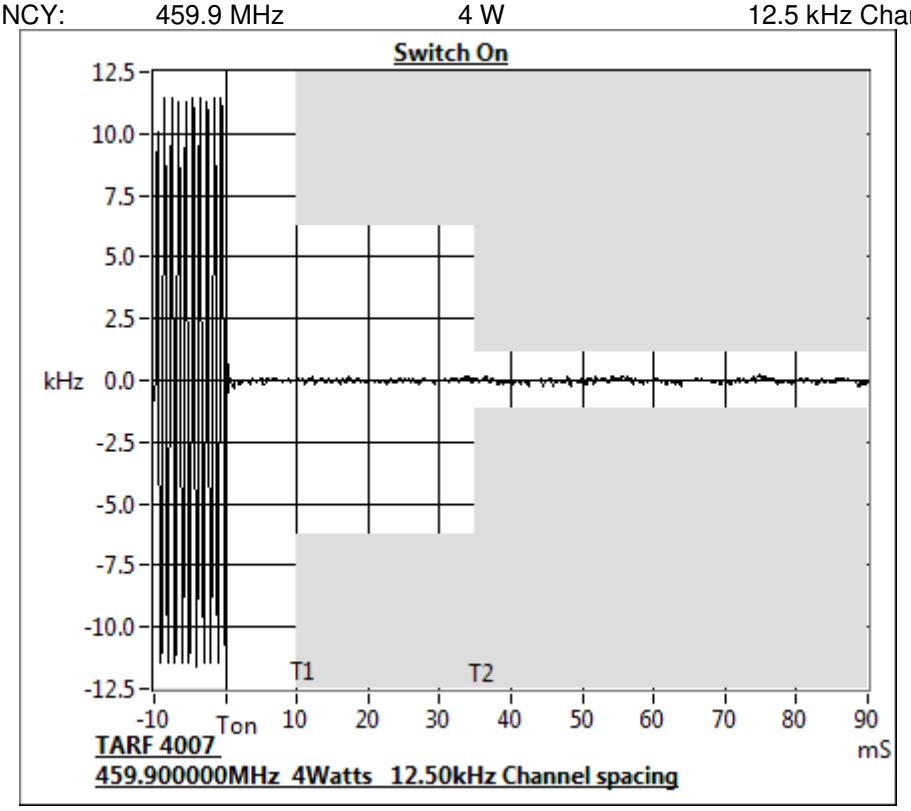
LIMIT: FCC 47 CFR 90.214

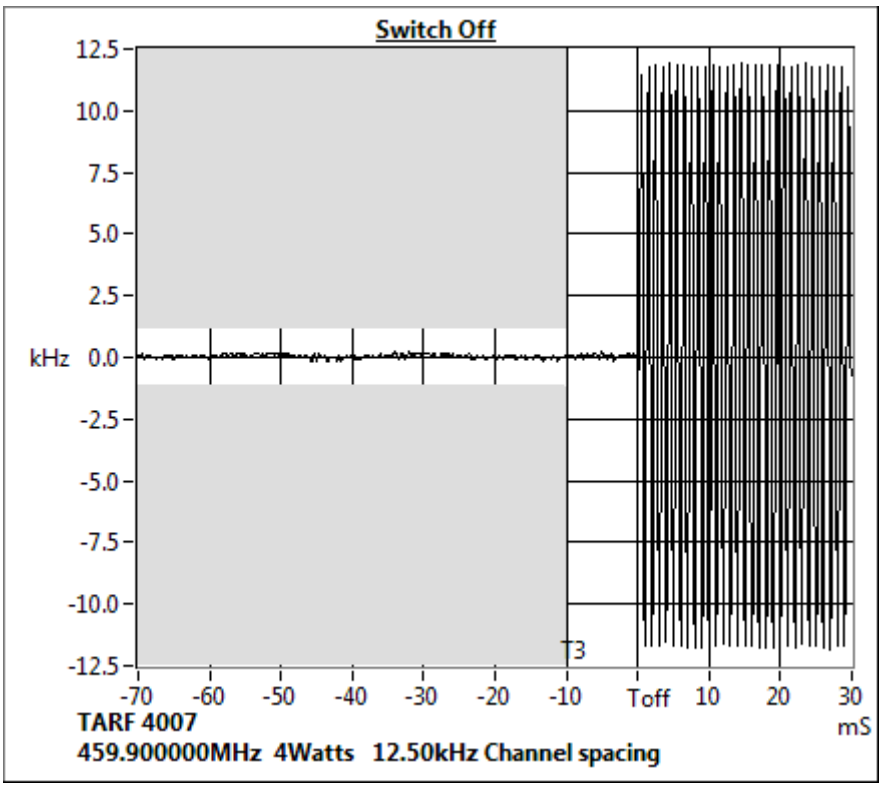
TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 459.9 MHz 4 W 12.5 kHz Channel Spacing





Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 465.1 MHz 4 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	0.7	N/A
t2	-0.2	N/A
t3	N/A	-1.1

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

Measurement Uncertainty: Frequency ± 130 Hz; Time ± 0.2%

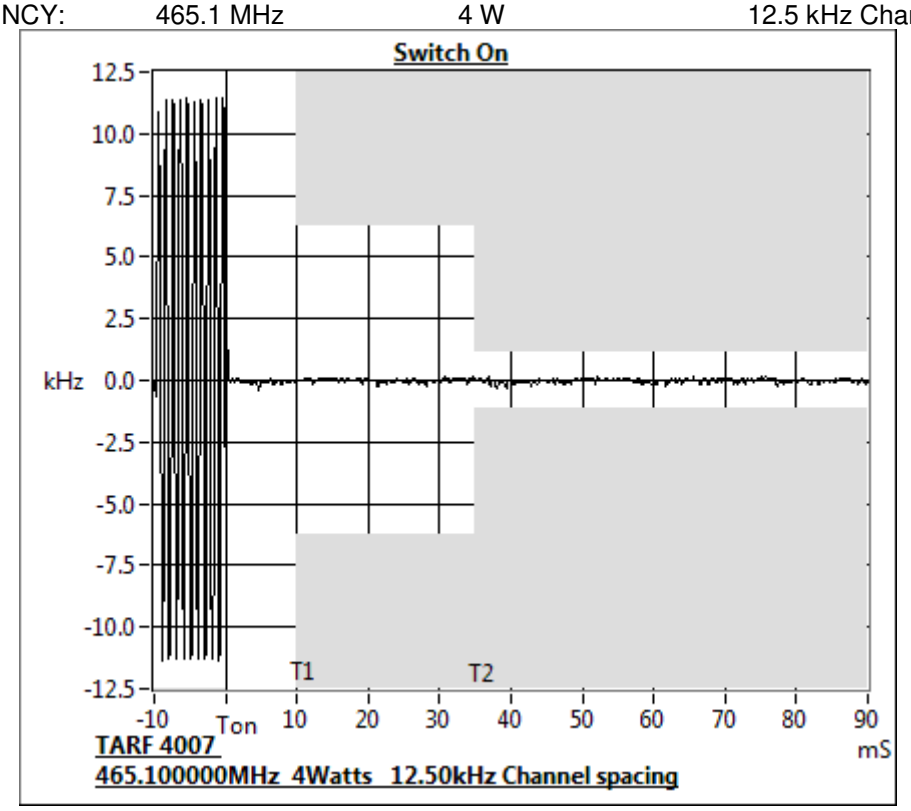
LIMIT: FCC 47 CFR 90.214

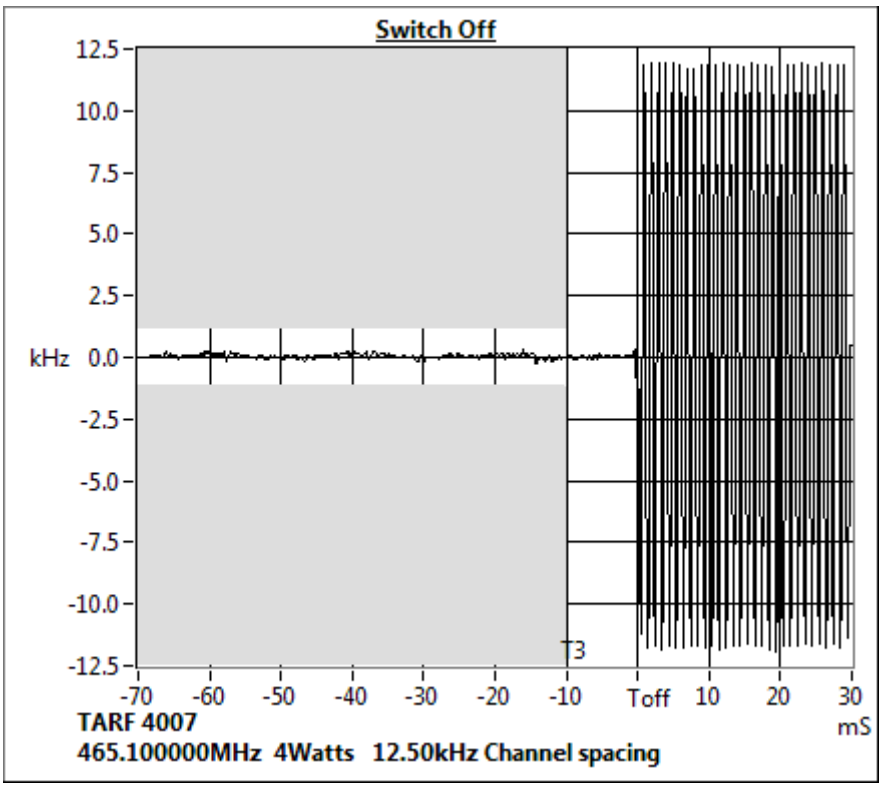
TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 465.1 MHz 4 W 12.5 kHz Channel Spacing





Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 469.9 MHz 4 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	0.8	N/A
t2	-0.3	N/A
t3	N/A	0.7

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

Measurement Uncertainty: Frequency ± 130 Hz; Time ± 0.2%

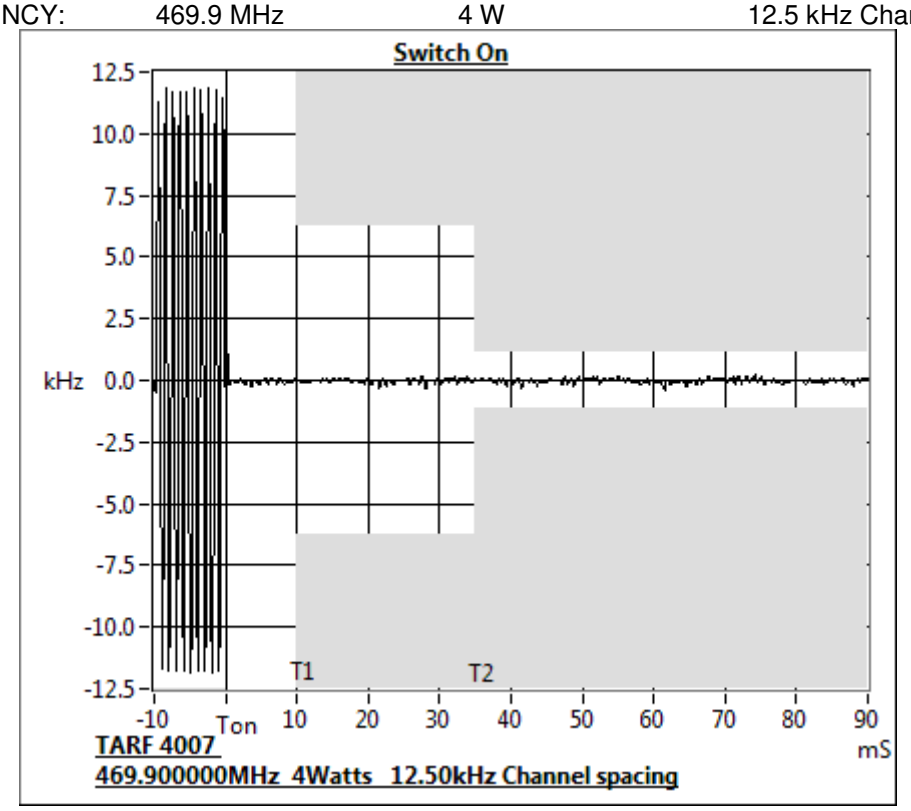
LIMIT: FCC 47 CFR 90.214

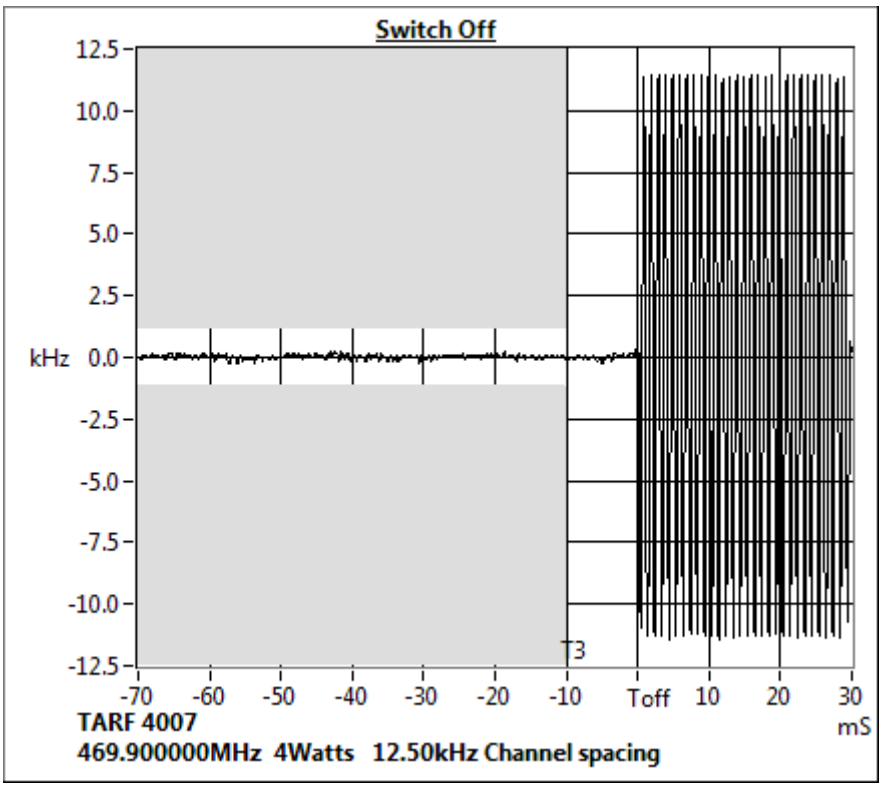
TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 469.9 MHz 4 W 12.5 kHz Channel Spacing





Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 511.9 MHz 4 W 12.5 kHz Channel Spacing

TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t1	0.5	N/A
t2	0.2	N/A
t3	N/A	-1.5

	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.	YES	NO
	☒	☐
Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit.	YES	NO
	☒	☐

Measurement Uncertainty: Frequency ± 130 Hz; Time ± 0.2%

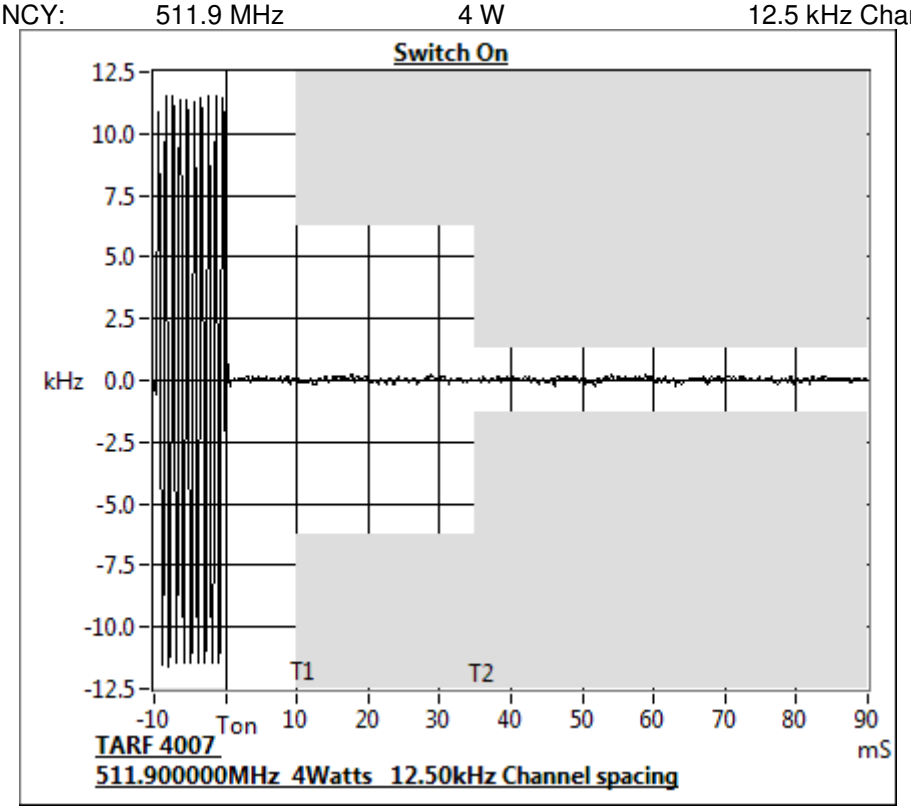
LIMIT: FCC 47 CFR 90.214

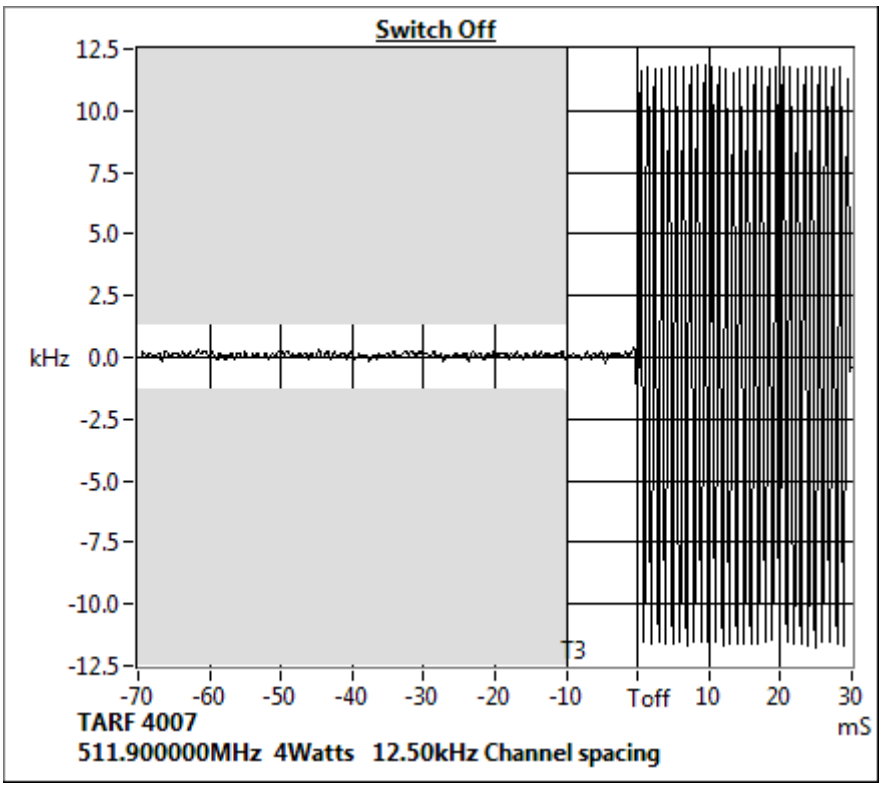
TRANSIENT PERIODS	FREQUENCY RANGE	
	150 MHz – 174 MHz	421 MHz – 512 MHz
t1 (ms)	5 ms	10 ms
t2 (ms)	20 ms	25 ms
t3 (ms)	5 ms	10 ms

Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 511.9 MHz 4 W 12.5 kHz Channel Spacing





TRANSMITTER FREQUENCY STABILITY - TEMPERATURE

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

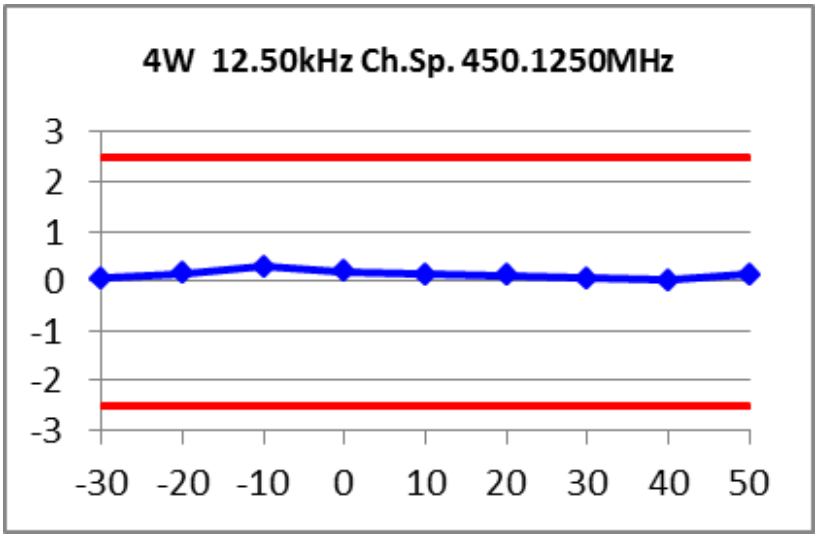
GUIDE: TIA/EIA-603D 2.2.2

MEASUREMENT PROCEDURE:
1. Refer Annex A for equipment set up.
2. The EUT was tested for frequency error from –30° C to +50° 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.

450.125 MHz

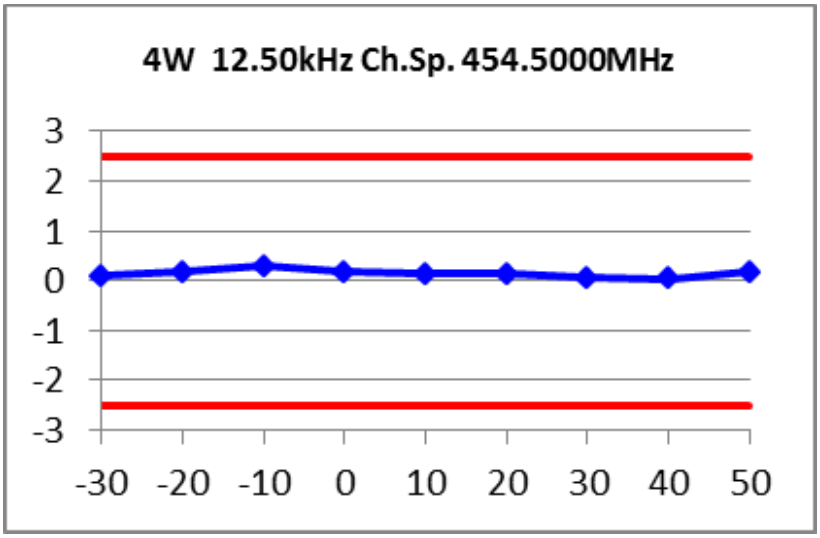
Temperature (ºC)	Frequency (Hz)	Error (ppm)
-30	27	0.06
-20	73	0.16
-10	134	0.30
0	85	0.19
10	57	0.13
20	56	0.12
30	25	0.06
40	7	0.02
50	64	0.14
Measurement Uncertainty	± 7 x 10^{-8}	



Transmitter Frequency Stability - Temperature

454.5 MHz

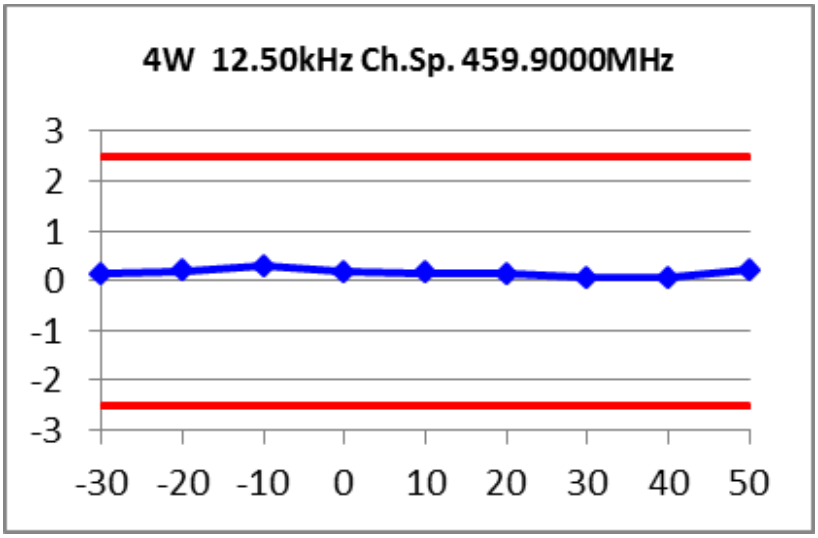
Temperature (ºC)	Frequency (Hz)	Error (ppm)
-30	46	0.10
-20	78	0.17
-10	133	0.29
0	82	0.18
10	63	0.14
20	60	0.13
30	24	0.05
40	14	0.03
50	76	0.17
Measurement Uncertainty	± 7 x 10^{-8}	



Transmitter Frequency Stability - Temperature

459.9 MHz

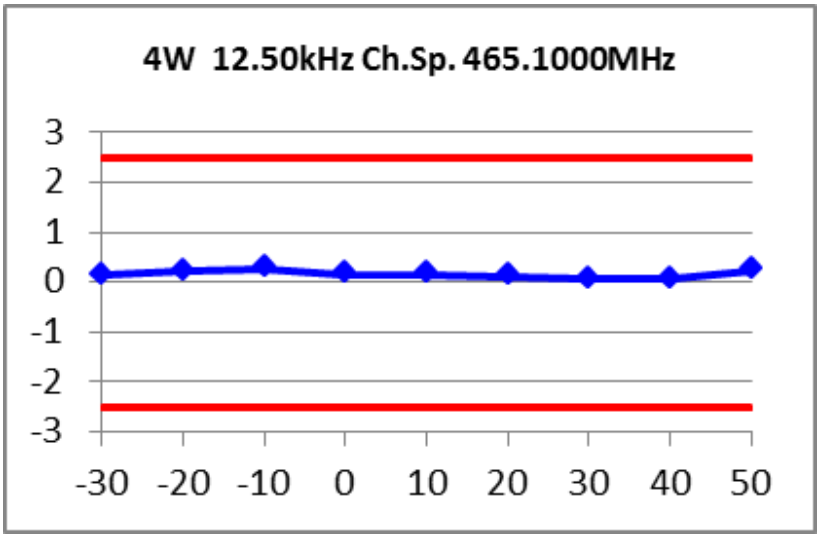
Temperature (ºC)	Frequency (Hz)	Error (ppm)
-30	59	0.13
-20	92	0.20
-10	132	0.29
0	78	0.17
10	68	0.15
20	60	0.13
30	24	0.05
40	23	0.05
50	99	0.22
Measurement Uncertainty	± 7 x 10^{-8}	



Transmitter Frequency Stability - Temperature

465.1 MHz

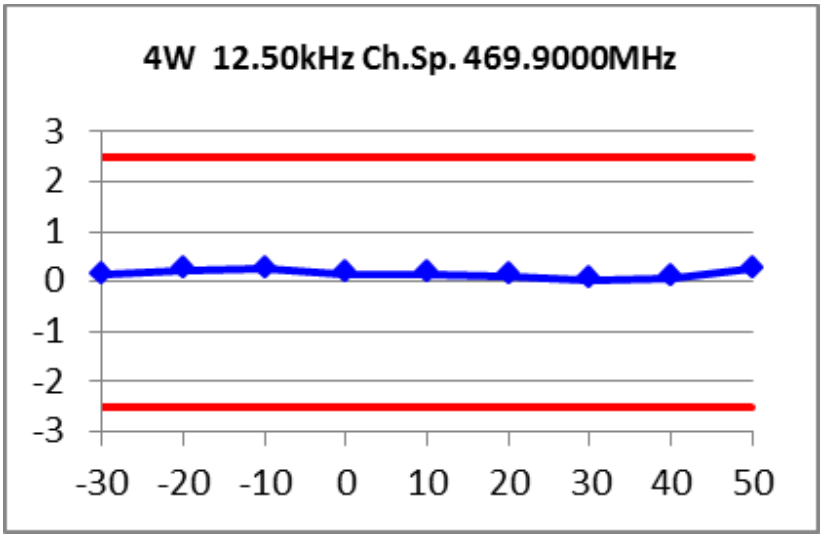
Temperature (ºC)	Frequency (Hz)	Error (ppm)
-30	67	0.14
-20	100	0.22
-10	128	0.28
0	76	0.16
10	72	0.15
20	58	0.12
30	24	0.05
40	30	0.06
50	111	0.24
Measurement Uncertainty	± 7 x 10^{-8}	



Transmitter Frequency Stability - Temperature

469.9 MHz

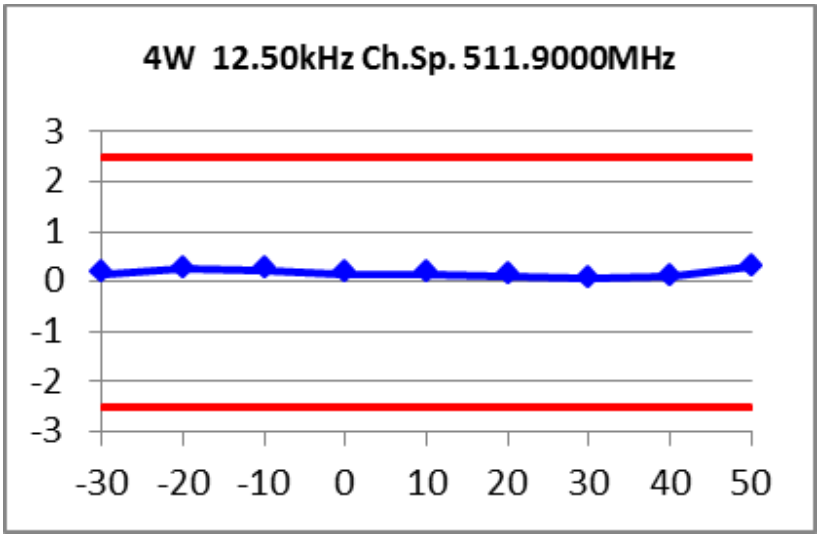
Temperature (ºC)	Frequency (Hz)	Error (ppm)
-30	67	0.14
-20	107	0.23
-10	119	0.25
0	74	0.16
10	71	0.15
20	55	0.12
30	20	0.04
40	36	0.08
50	122	0.26
Measurement Uncertainty	$\pm 7 \times 10^{-8}$	



Transmitter Frequency Stability - Temperature

511.9 MHz

Temperature (ºC)	Frequency (Hz)	Error (ppm)
-30	77	0.15
-20	129	0.25
-10	125	0.24
0	78	0.15
10	79	0.15
20	59	0.12
30	24	0.05
40	49	0.10
50	147	0.29
Measurement Uncertainty	± 7 x 10^{-8}	



Transmitter Frequency Stability - Temperature

LIMIT CLAUSE: FCC 47 CFR 90.213

Channel Spacing (kHz)	Frequency Error (ppm)
12.5	2.5

TRANSMITTER FREQUENCY STABILITY - VOLTAGE

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

GUIDE: TIA/EIA-603D 2.2.2

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

MEASUREMENT RESULTS:

Voltage	FREQUENCY ERROR (ppm) for 12.5 kHz channel spacing					
	450.125 MHz	454.5 MHz	459.9 MHz	465.1 MHz	469.9 MHz	511.9 MHz
7.5 V_{DC}	-0.01	0.07	0.12	0.15	0.16	0.18
6.375 V_{DC}	-0.02	0.05	0.08	0.11	0.13	0.14
7.5 V_{DC}	-0.03	0.02	0.06	0.09	0.10	0.11
Measurement Uncertainty				$\pm 7 \times 10^{-8}$		

LIMIT CLAUSE: FCC 47 CFR 90.213

Channel Spacing (kHz)	Frequency Error (ppm)
12.5	2.5

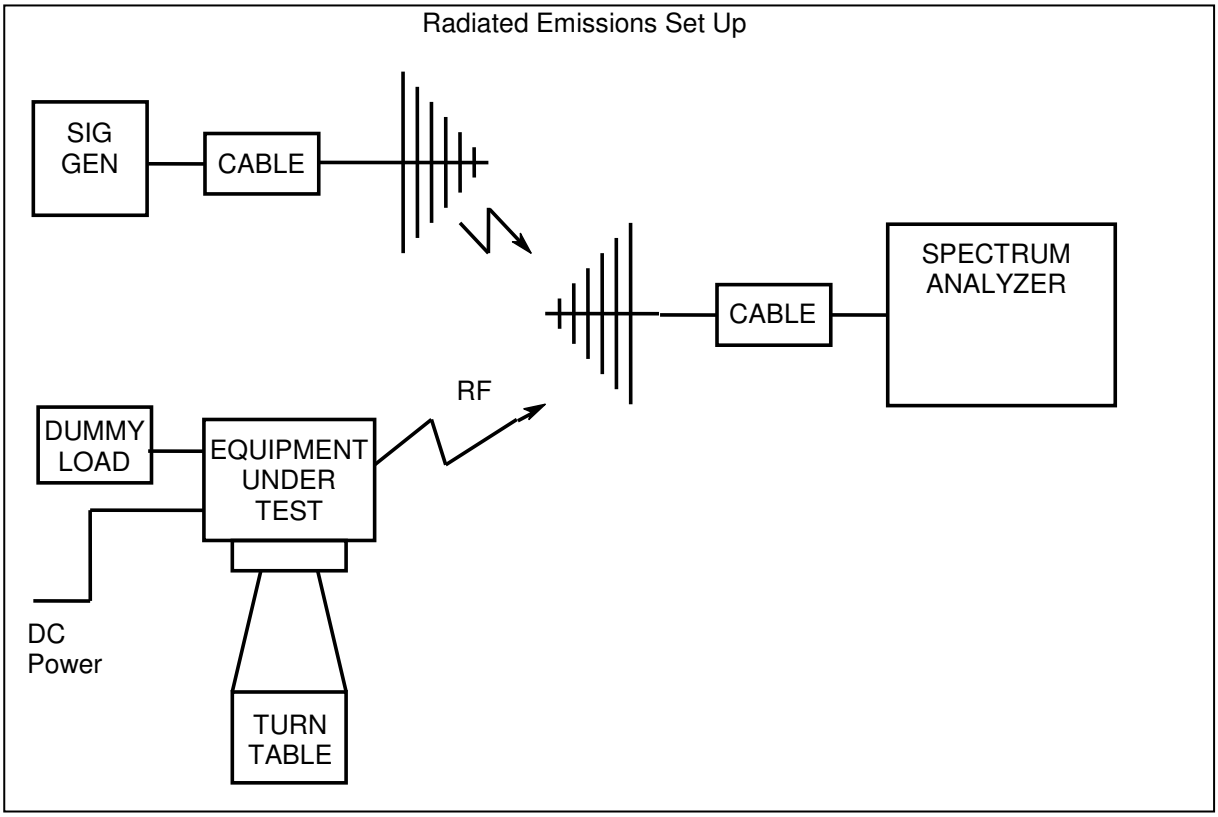
TEST EQUIPMENT LIST

Equipment Type	Information	Manufacturer	Model No	Serial No#	Tait ID	Cal Due
Antenna	18GHz DRG	Emco	DRG3115	2084	E3076	
Antenna	Reference Dipoles	Emco	3121C DB1	9510-1164	E3559	14-May-22
Antenna	18GHz DRG	Emco	DRG3115	9512-4638	E3560	15-May-20
Antenna	Log Periodic	Schwarzbeck	VUSLP	9111-219	E4617	
Antenna	Reverb - 1-18GHz DRG	Schwarzbeck	BBHA 9120 D	9120D-885	E4857	
Antenna	Reverb - 1-18GHz DRG	Schwarzbeck	BBHA 9120 D	9120D-884	E4858	
Audio Analyser	TREVA2	Hewlett Packard	HP8903B	2818A04275	E3710	28-Sep-19
Coax Cable	OATS Turntable Cable 1	Intelcom	RG214	OATS1	E4621	15-Nov-19
Coax Cable	OATS Tower Cable	Intelcom	RG214	OATS2	E4622	14-Nov-19
Coax Cable	2m Black	Suhner	RG214HF/Nm/ Nm/2000	TeltestBlack2	E4623	17-Oct-19
Coax Cable	2m Black	Suhner	RG214HF/Nm/ Nm/2000	TeltestBlack3	E4624	17-Oct-19
Coax Cable	Reverb - 4.5m Multiflex 141	TeltestBlue6	MF 141	TeltestBlue6	E4843	18-Oct-19
Coax Cable	Reverb - 2m Multiflex 141	TeltestBlue5	MF 141	TeltestBlue5	E4844	18-Oct-19
Coax Cable	Reverb - 2m Multiflex 141	TeltestBlue4	MF 141	TeltestBlue4	E4845	18-Oct-19
Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue3	MF 141	TeltestBlue3	E4846	18-Oct-19
Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue2	MF 141	TeltestBlue2	E4847	18-Oct-19
Coax Cable	Reverb - 1m Multiflex 141	TeltestBlue1	MF 141	TeltestBlue1	E4848	18-Oct-19
Coax Cable	OATS Turntable Cable 2	Intelcom	RG215	OATS3	E4995	14-Nov-19
Coax Cable	2.5m Blue	Suhner	Sucoflex 104A	33449/4PEA	E4997	19-Oct-19
Coax Cable	2m Black	Suhner	RG214HF/Nm/ Nm/2000	TeltestBlack8	E5005	17-Oct-19
Coax Cable	3m Blue	Suhner	Sucoflex 126EA	503429/126EA	E5015	19-Oct-19
Environ. Chamber	Upright	Contherm	5400 RHSLT.M	1416	E4051	7-Aug-23
Environ. Chamber	Upright	Contherm	5400 RHSLT.M	1416	E4051	15-May-20
Filter High Pass/ Notch	400 to 520MHz	Tait		N/A	E3384	25-Sep-19
Modulation Analyser	TREVA2	Hewlett Packard	HP8901B (Opt 002)	3704A05837	E3786	28-Sep-19
OATS	Controller	Electrometrics	EM-4700	119	E4445	
OATS	Turntable	Electrometrics	EM-4704A	105	E4446	
OATS	Antenna Tower	Electrometrics	EM-4720-2	112	E4447	
OATS	NSA	Tait				18-Jun-20
Oscilloscope	400MHz	Tektronics	TDS380	B017095	E3782	29-Sep-19
Power Meter	TREVA2 Power Head for HP8901	Hewlett Packard	HP11722A	2716A02037	1575	28-Sep-19
Power Supply	60V/50A/1000W	Hewlett Packard	HP6012B	2524A00616	E3712	30-Sep-19
Power Supply	TREVA2 60V/25A	Agilent	N5767A	US09F4901H	E4656	7-Oct-19
Power Supply	40V/38A	Agilent	N5766A	US09E4663L	E4719	26-Sep-19
RF Amplifier	+21.7 dB 1GHz	Tait	ZFL-1000LN	E3660	E3360	30-Apr-20
RF Amplifier	Pre-amplifier	Agilent	87405C	MY47010688	E4941	2-Oct-19
RF Attenuator	10dB 50W	Weinschel	24-10-34	AZ0401	E3388	17-Oct-19
RF Attenuator	20dB 25W	Weinschel	33-20-33	BD5871	E3673	18-Oct-19

Equipment Type	Information	Manufacturer	Model No	Serial No#	Tait ID	Cal Due
RF Attenuator	TREVA2 20dB 150W	Weinschel	40-20-33	CJ405	E3733	17-Oct-19
RF Attenuator	33dB 350W	Weinschel	67-30-33 & BW-N3W5+	CK9178	E5023	15-Jul-20
RF Attenuator	10dB 50W	Weinschel	24-10-34	BC3293	E4364	17-Oct-19
RF Attenuator	TREVA2 3dB	Weinschel	Model 1	BL9950	E4080	17-Oct-19
RF Chamber	S-LINE TEM CELL	Rohde & Schwarz	1089.9296.02	338232/003	E3636	12-Sep-20
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	TREVA2	Minicircuits	ZFSC-4-1	-	E4084	
RF Load	50W	Weinschel	F1426	AE2490	E3624	18-Oct-19
Signal Generator	Analog 3.2GHz	Hewlett Packard	HP8648C	3443U00543	E3558	2-Oct-19
Signal Generator	Analog 4GHz	Agilent	E4422B	GB40050320	E3788	27-Sep-19
Signal Generator	TREVA2 Analog 3.3GHz	Rohde & Schwarz	SML03 1090.3000.13	100597	E4050	29-Sep-19
Signal Generator	Digital 3GHz	Agilent	E4438C	MY49070242	E4657	9-Oct-19
Spectrum Analyser	13.2GHz	Hewlett Packard	HP8562E	3821A00779	E3715	26-Sep-19
Spectrum Analyser	13.2GHz	Agilent	E4445A	MY42510072	E4139	19-Jul-20
Spectrum Analyser	26.5GHz	Agilent	PXA N9030A	MY49432161	E4907	27-Oct-20
Temp & Humidity datalogger		Hobo	U21-011	10134275	E4980	5-May-20
TREVA 2		Teltest	-	2	-	5-Nov-19
Testware	Frequency Vs Temperature		April 2018	-	-	
Testware	Occupied Bandwidth		July 2019	-	-	
Testware	Radiated Emissions		April 2018	-	-	
Testware	Reverb Emissions		May 2019	-	-	
Testware	Sideband Spectrum		February 2017	-	-	
Testware	S-Line Radiated Emissions		April 2018	-	-	
Testware	TREVA		7 February 2019	-	-	
Testware	Spec An Correction Loader		June 2019	-	-	

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 **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 Conducted Emissions testing, and Occupied Bandwidth.