

LABORATORY TEST REPORT

RADIO PERFORMANCE MEASUREMENTS

for the

TPGB1A Handportable Transceiver

Tested in accordance with:

FCC 47 CFR Parts 22 and 90

Report Revision: 1
Issue Date: 26 August 2019

PREPARED BY: L. M. White



Test Technician

CHECKED & APPROVED BY: M. C. James



Laboratory Technical Manager



FCC REGISTRATION: 838288

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

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FCC ID: CASTPGB1A

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Issue Date: 26 August 2019

Report Revision: 1

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REVISION

| Date | Revision | Comments |
|----------------|----------|---------------------|
| 26 August 2019 | 1 | Initial test report |
| | | |

INTRODUCTION

Type approval testing of the TPGB1A, 5 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: TPGB1A
Product Code: T03-00071-BBAA
Serial Number(s): 26202671
Frequency range: 136 → 174 MHz
Transmit Power: 5 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 | TPGB1X-B100_0001 | TPGB1X-B100_0001 |
| Firmware Package | QIP25_TPG.0008 | QIDMR_TPG.0008 |

TEST CONDITIONS

All testing was performed between 21 → 23 August 2019, and under the following conditions:

Ambient temperature: 15°C → 30°C
Relative Humidity: 20% → 75%
Standard Test Voltage 7.5 V_{DC}

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: TPGB1A
Product Code: T03-00071-BBAA
Serial Number(s): 26202671
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: 12 September 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 |
|------------------------------------|----------|
| Analogue 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 Data and Voice P25 phase 2 | 8K10F1W |

CALCULATIONS

Equation: $B_n = 2M + 2Dk$

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

Analogue Voice 12.5 kHz Bandwidth

Necessary bandwidth

M = 3.0 kHz

D = 2.5 kHz

$$B_n = (2 \times 3.0) + (2 \times 2.5) \times 1$$

$$= 11.0 \text{ kHz}$$

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)

$$B_n = (2 \times 1.8) + (2 \times 1.5) \times 1$$

$$= 6.6 \text{ kHz}$$

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)

$$B_n = (2 \times 2.4) + (2 \times 1.5) \times 1$$

$$= 7.8 \text{ kHz}$$

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
= 7.6 kHz

Emission Designator
7K60FXW

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

Digital Data 12.5 kHz Bandwidth DMR

99% bandwidth
= 7.6 kHz

Emission Designator
7K60FXD

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

Digital Voice 12.5 kHz Bandwidth P25 phase 1

99% bandwidth
= 8.1 kHz

Emission Designator
8K10F1E

F1E represents a digital FM voice transmission

Digital Data 12.5 kHz Bandwidth P25 phase 1

99% bandwidth
= 8.1 kHz

Emission Designator
8K10F1D

F1D represents a digital FM data transmission

Digital Data and Voice 12.5 kHz Bandwidth P25 phase 2

99% bandwidth
= 8.1 kHz

Emission Designator
8K10F1W

F1W represents an FM channel with a combination of digital data and voice transmission

TEST RESULTS

TRANSMITTER OUTPUT POWER (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1046

GUIDE: ANSI C63.26 5.2.4.2

MEASUREMENT PROCEDURE:

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

EXAMPLE CALCULATION:

$$\begin{aligned}
 \text{Power in dBm} &= \text{Measured power (dBm)} + \text{attenuator and cable loss (dB)} \\
 \text{Chan 1 power (dBm)} &= 7.2 \text{ dBm} + 30 \text{ dB} \\
 &= 37.2 \text{ dBm} \\
 \text{Power in Watts} &= (10^{(37.2 \text{ dBm})} / 10) / 1000 \\
 &= 5.3 \text{ W}
 \end{aligned}$$

MEASUREMENT RESULTS:

Manufacturer's Rated Output Power:

Switchable: 5 W and 1 W

| Nominal 5 W | Measured | Variation (%) | Variation (dB) |
|-------------------------|----------|---------------|----------------|
| 138.1 MHz | 5.3 | 5.0 | 0.2 |
| 150.85 MHz | 5.4 | 7.7 | 0.3 |
| 156.1 MHz | 5.5 | 9.4 | 0.4 |
| 157.2 MHz | 5.5 | 9.5 | 0.4 |
| 161.9 MHz | 5.4 | 8.7 | 0.4 |
| 162.1 MHz | 5.4 | 8.9 | 0.4 |
| 173.3 MHz | 5.3 | 6.6 | 0.3 |
| Measurement Uncertainty | | ± 0.6 dB | |

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Transmitter Output Power (Conducted) - continued

| Nominal 1 W | Measured | Variation (%) | Variation (dB) |
|-------------------------|----------|---------------|----------------|
| 138.1 MHz | 1.1 | 11.0 | 0.5 |
| 150.85 MHz | 1.2 | 16.5 | 0.7 |
| 156.1 MHz | 1.1 | 14.6 | 0.6 |
| 157.2 MHz | 1.1 | 12.3 | 0.5 |
| 161.9 MHz | 1.1 | 10.4 | 0.4 |
| 162.1 MHz | 1.1 | 10.2 | 0.4 |
| 173.3 MHz | 1.1 | 10.1 | 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.

TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS

SPECIFICATION: FCC 47 CFR 2.1047 (a)

GUIDE: ANSI C63.26 5.3.3.2

MEASUREMENT PROCEDURE:

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

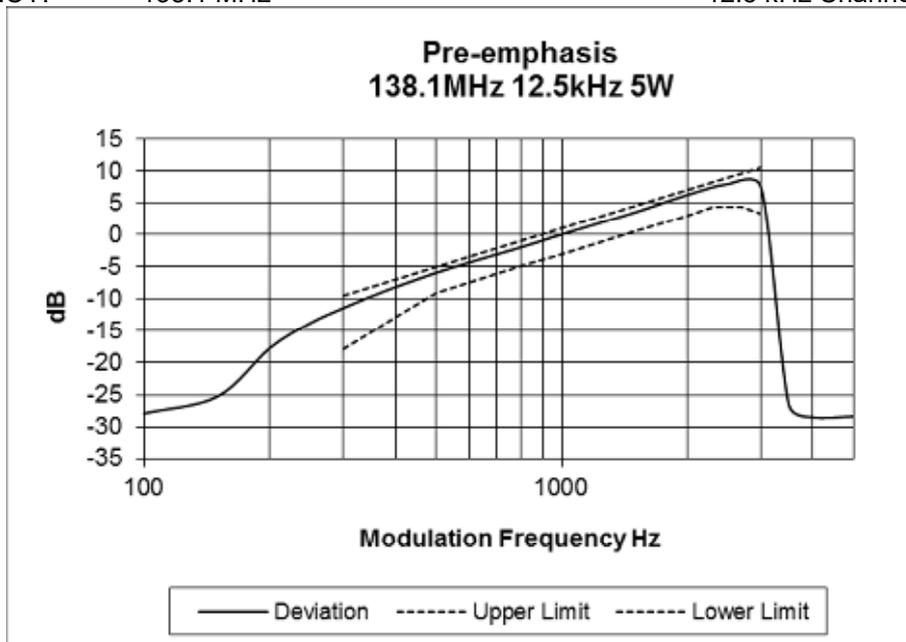
MEASUREMENT RESULTS:

See the plots on the following pages for 12.5 kHz channel spacing tested at 5 W transmit power.

LIMIT CLAUSE: TIA/EIA-603D 3.2.6

MEASUREMENT UNCERTAINTY: $\pm 1.5\%$

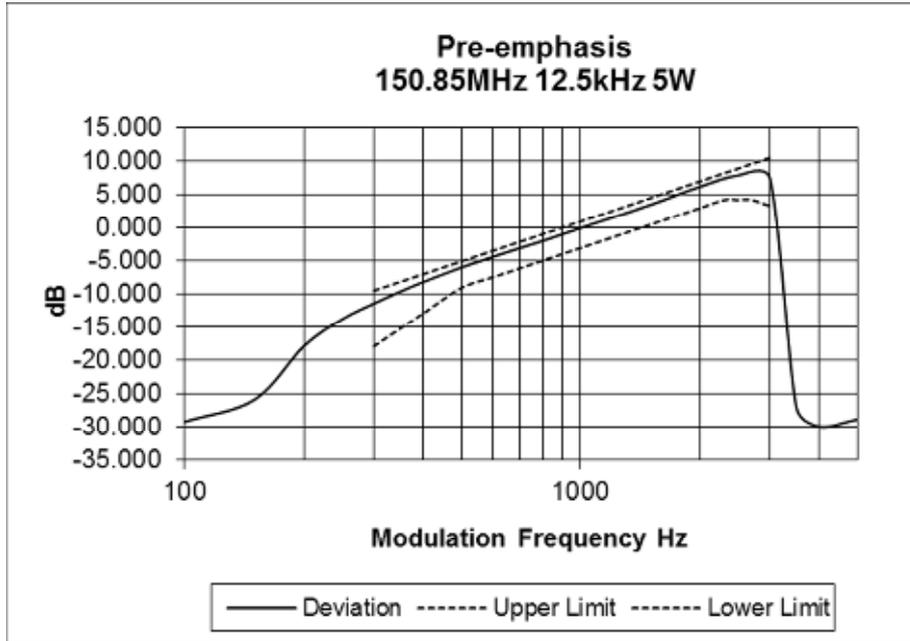
Tx FREQUENCY: 138.1 MHz 12.5 kHz Channel Spacing



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Transmitter Audio Frequency Response – Pre-emphasis

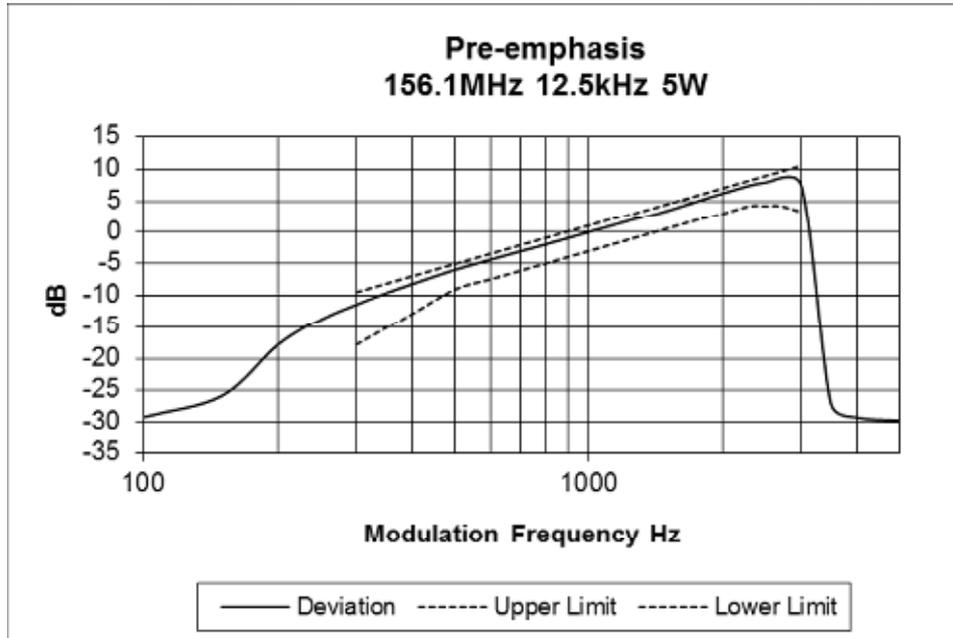
Tx FREQUENCY: 150.85 MHz

12.5 kHz Channel Spacing



Tx FREQUENCY: 156.1 MHz

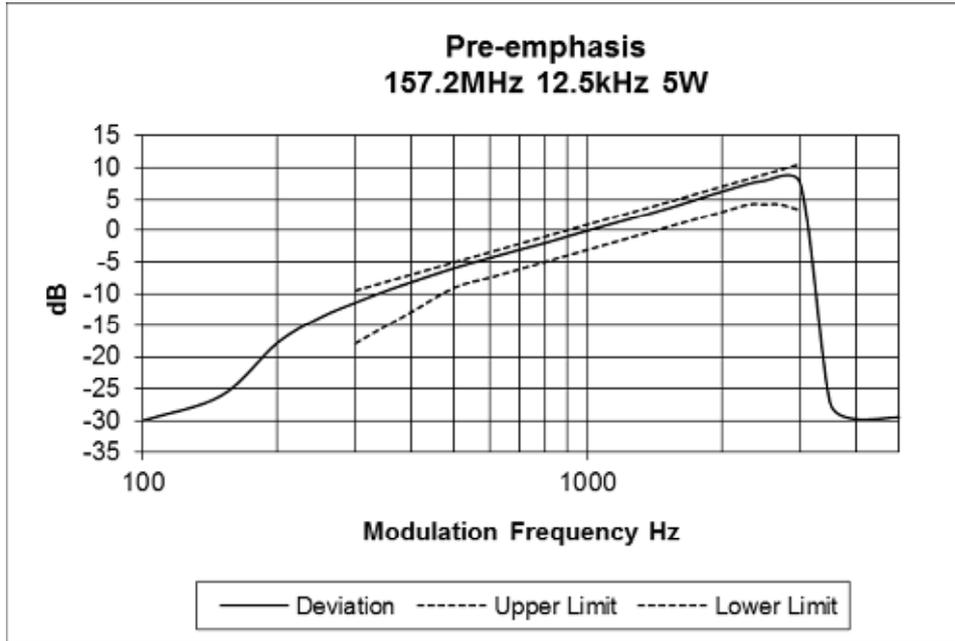
12.5 kHz Channel Spacing



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Transmitter Audio Frequency Response – Pre-emphasis

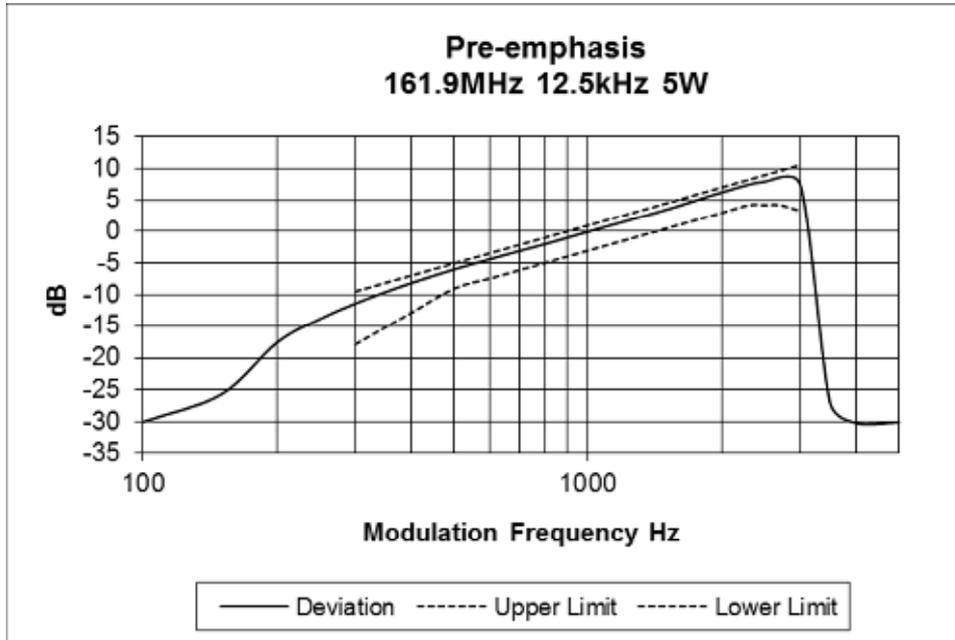
Tx FREQUENCY: 157.2 MHz

12.5 kHz Channel Spacing



Tx FREQUENCY: 161.9 MHz

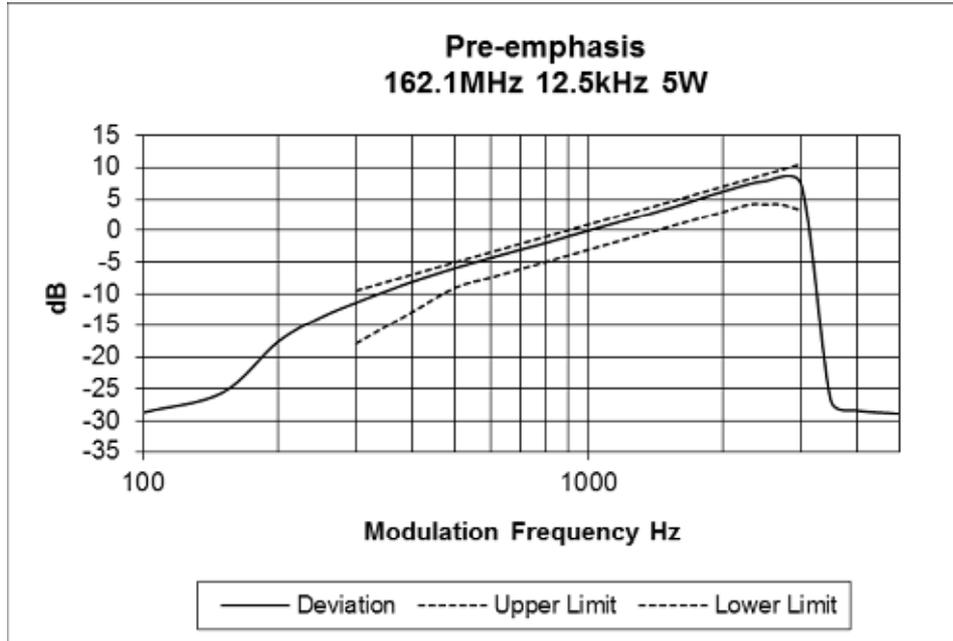
12.5 kHz Channel Spacing



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Transmitter Audio Frequency Response – Pre-emphasis

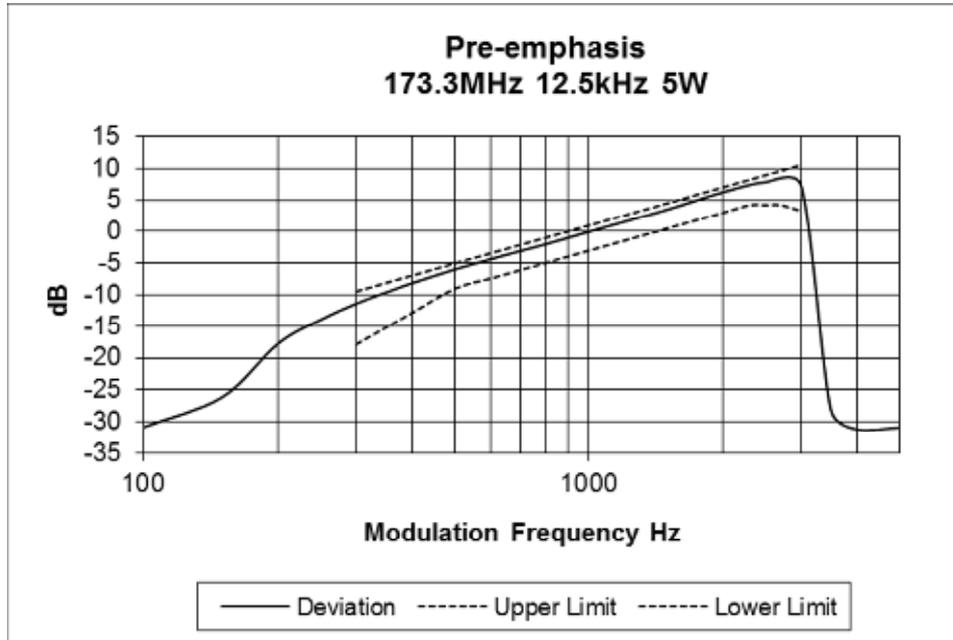
Tx FREQUENCY: 162.1 MHz

12.5 kHz Channel Spacing



Tx FREQUENCY: 173.3 MHz

12.5 kHz Channel Spacing



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TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC 47 CFR 2.1047 (b)

GUIDE: ANSI C63.26 5.3.2

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up.
2. An audio input tone of 1000 Hz was applied with the level set to obtain 60% of maximum deviation. This was used as the 0 dB reference point.
3. The modulation response was measured at four audio frequencies while increasing the input level in 5dB steps.
4. Additionally the level used to measure sideband spectrum (occupied bandwidth) was included in the level sweep.
5. Measurements were made for both Positive and Negative Deviation.

MEASUREMENT RESULTS:

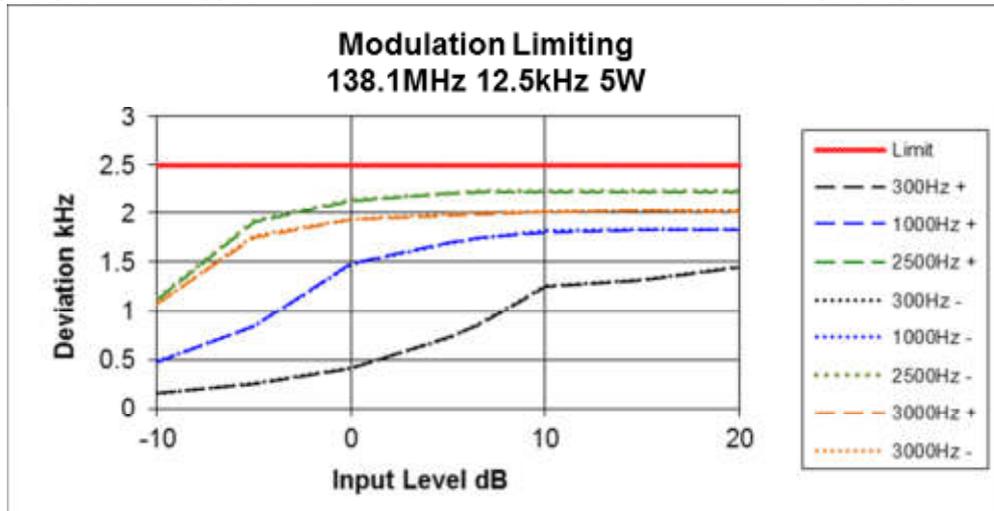
See the plots on the following pages for 12.5 kHz channel spacing.

LIMIT CLAUSE: TIA/EIA-603D 1.3.4.4

MEASUREMENT UNCERTAINTY: $\pm 1.5 \%$

Tx FREQUENCY: 138.1 MHz

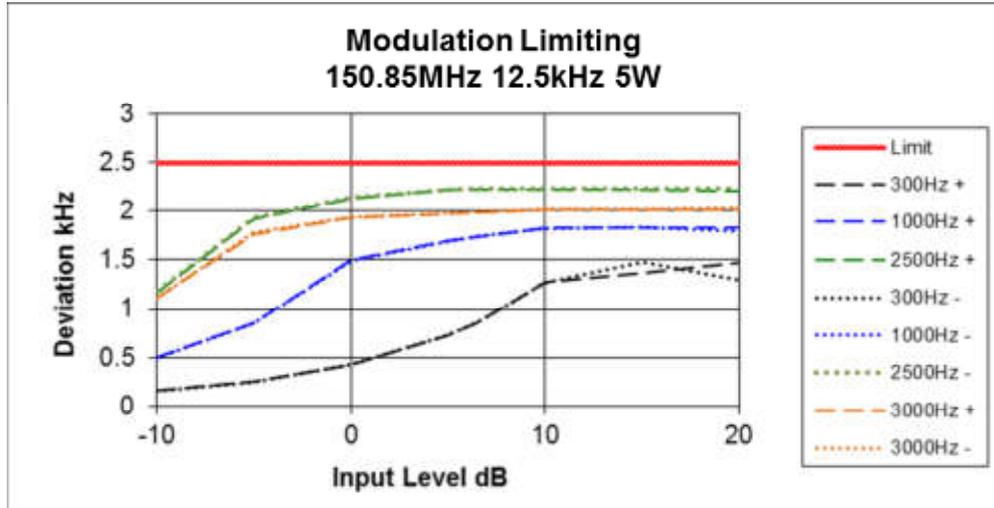
12.5 kHz Channel Spacing



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Transmitter Modulation Limiting

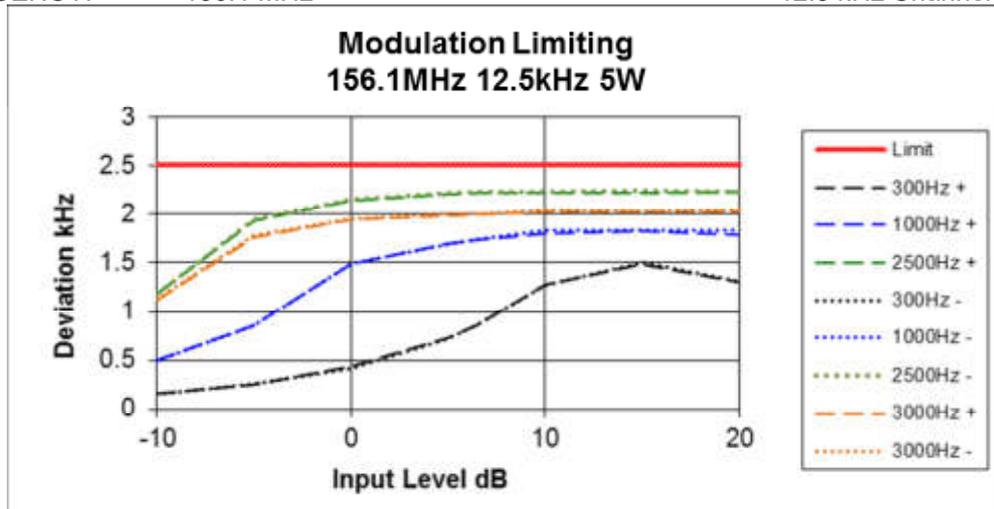
Tx FREQUENCY: 150.85 MHz

12.5 kHz Channel Spacing



Tx FREQUENCY: 156.1 MHz

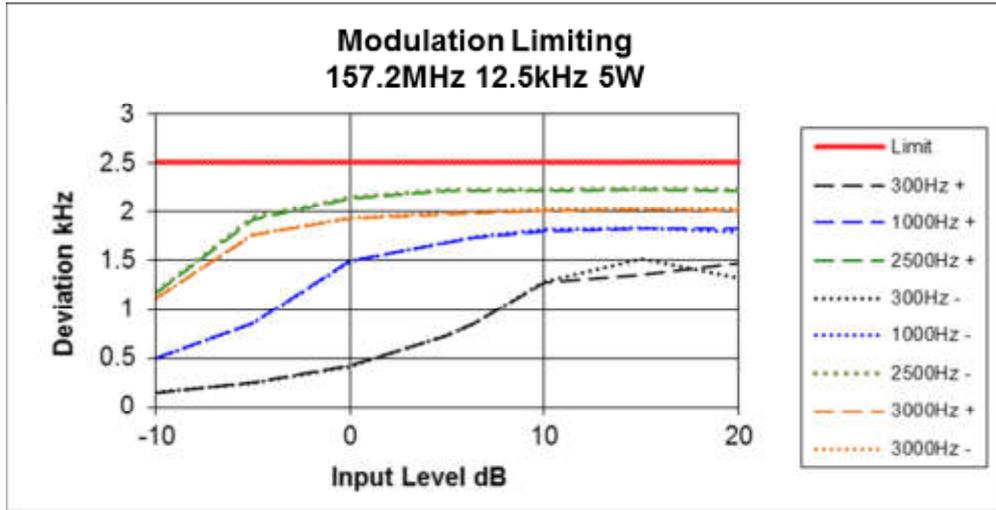
12.5 kHz Channel Spacing



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Transmitter Modulation Limiting

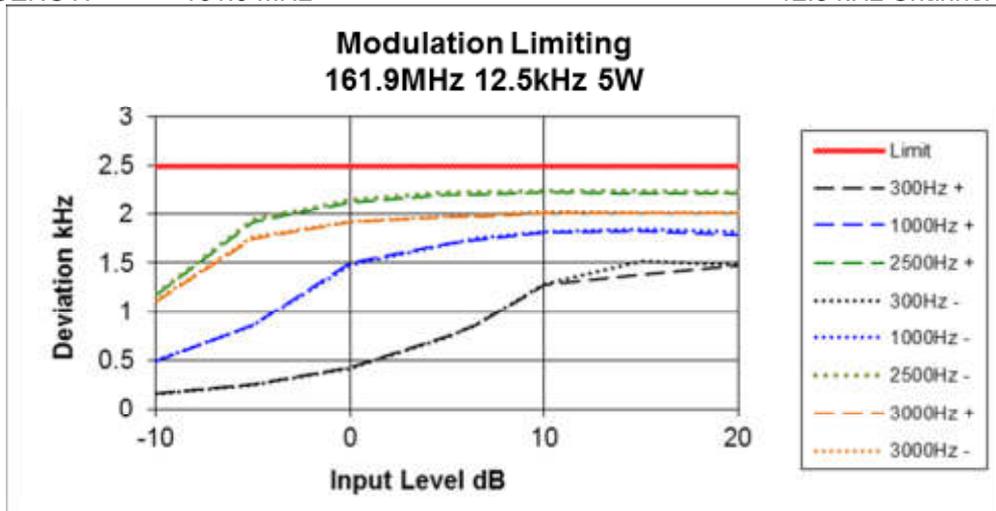
Tx FREQUENCY: 157.2 MHz

12.5 kHz Channel Spacing



Tx FREQUENCY: 161.9 MHz

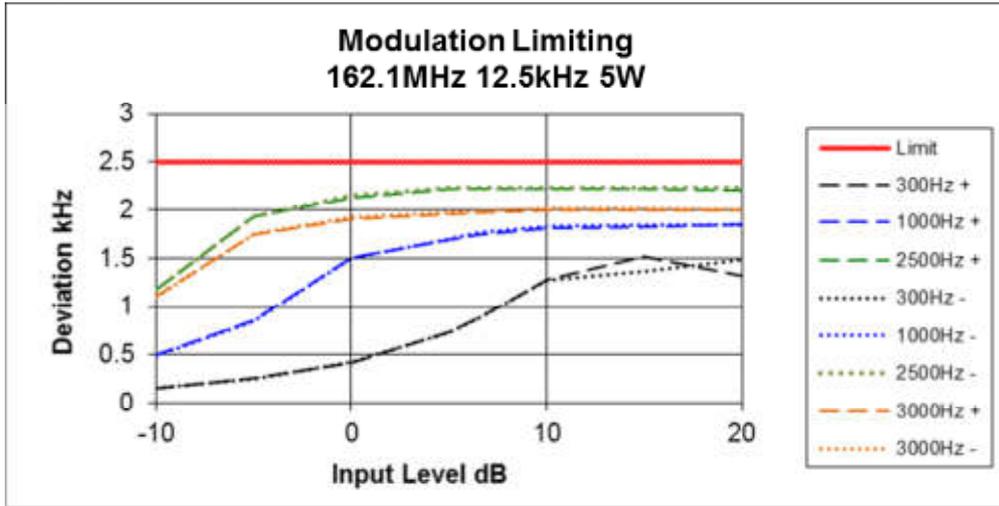
12.5 kHz Channel Spacing



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 Transmitter Modulation Limiting

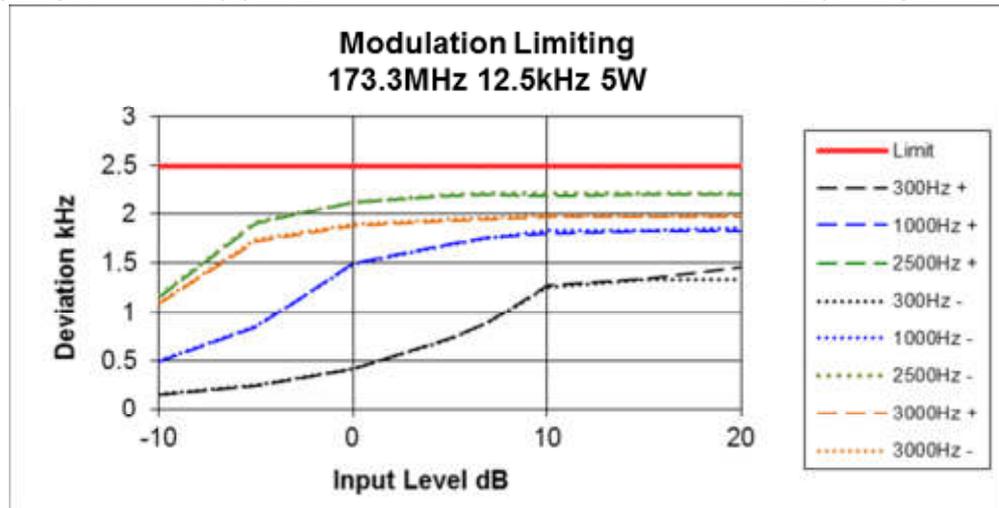
Tx FREQUENCY: 162.1 MHz

12.5 kHz Channel Spacing



Tx FREQUENCY: 173.3 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 (Analogue)
TIA-102.CAAA-C 2.2.5 (Digital)

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment Set up.
2. For Analogue measurements: The EUT was modulated by a 2500 Hz tone at an input level 16 dB above a level that produced 50% deviation. The input level was established at the frequency of maximum response of the audio modulating circuit.
For Data measurements: The EUT was modulated with an internally generated pseudo random bit sequence at the appropriate Baud rates.
3. The Occupied Bandwidth was measured on the Spectrum Analyser, with bandwidth settings as noted on the recorded plots.

MEASUREMENT RESULTS:

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

MEASUREMENT UNCERTAINTY 95% $\pm 0.65\text{dB}$

LIMIT CLAUSE: FCC 47 CFR 90.210

EMISSION MASKS

Emission Mask D 12.5 kHz Channel Spacing Analogue, FFSK, Digital Voice/data

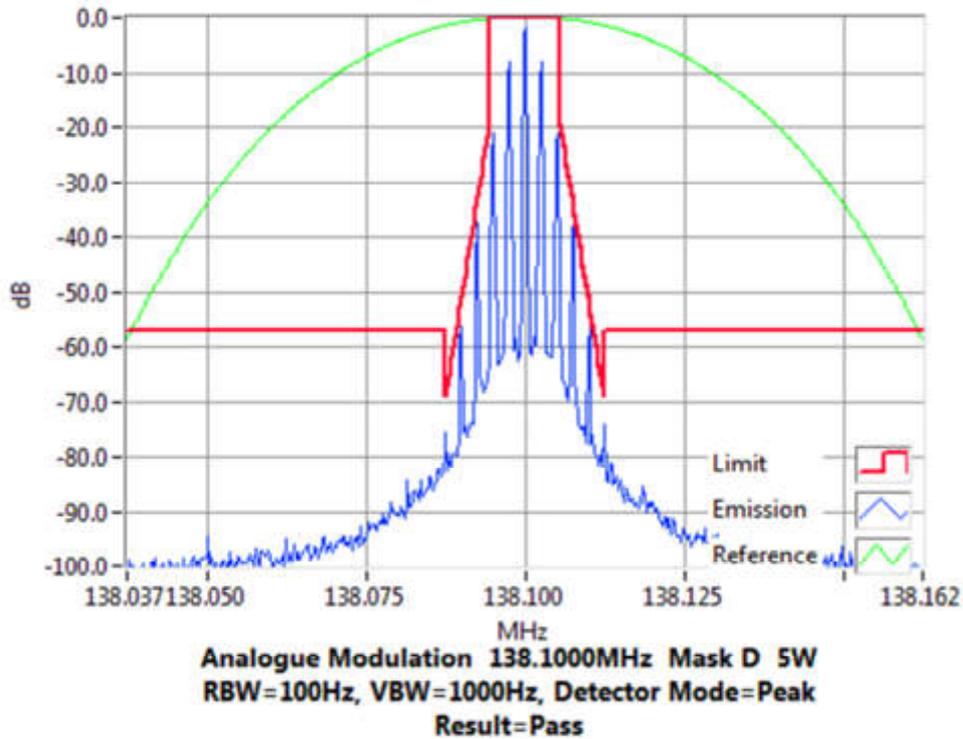
DATA SPEED

Digital Voice/Data 12.5 kHz Channel Spacing 9600 bps & 12000 bps
FFSK 12.5 kHz Channel Spacing 1200 bps & 2400 bps

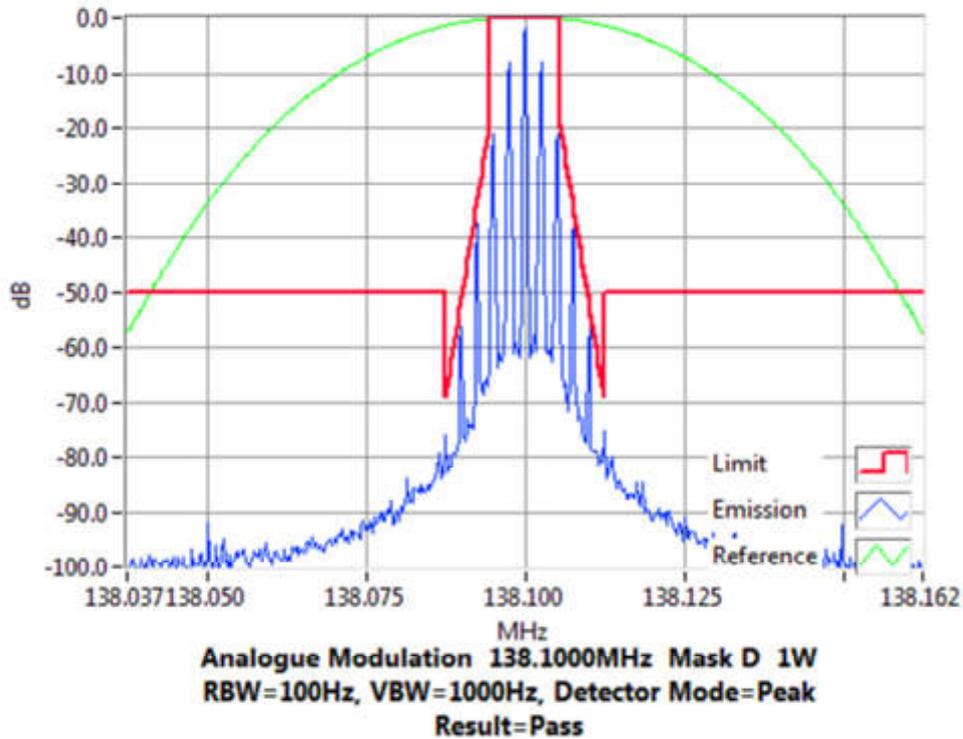
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Occupied Bandwidth and Spectrum Masks

ANALOGUE VOICE

Tx FREQUENCY: 138.1 MHz 5 W 12.5 kHz Channel Spacing



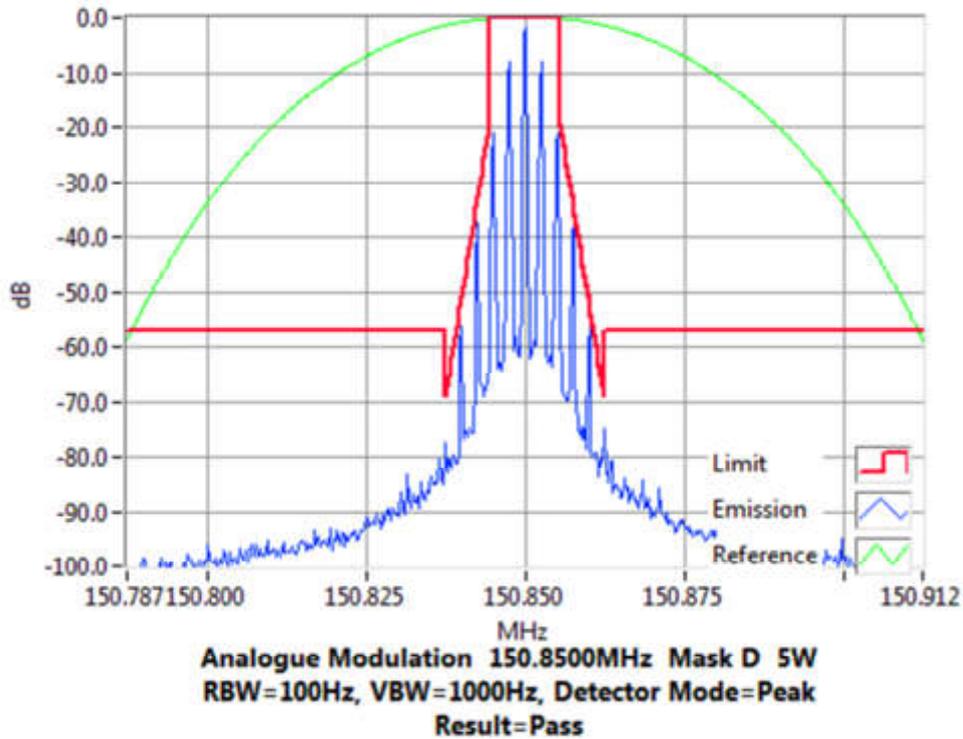
Tx FREQUENCY: 138.1 MHz 1 W 12.5 kHz Channel Spacing



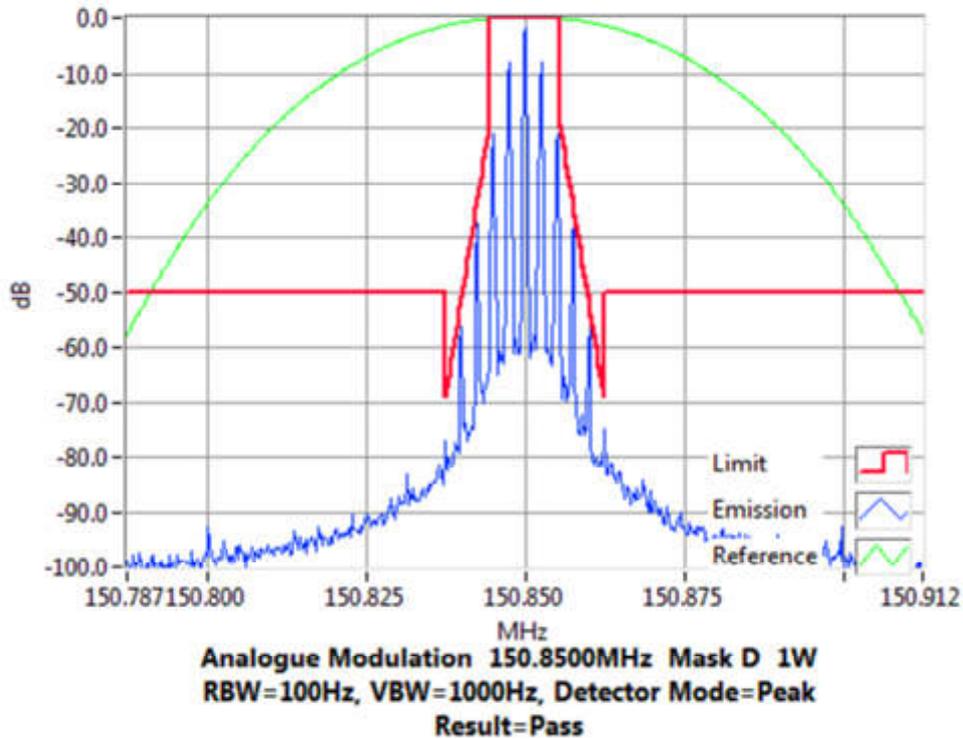
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ANALOGUE VOICE

Tx FREQUENCY: 150.85 MHz 5 W 12.5 kHz Channel Spacing



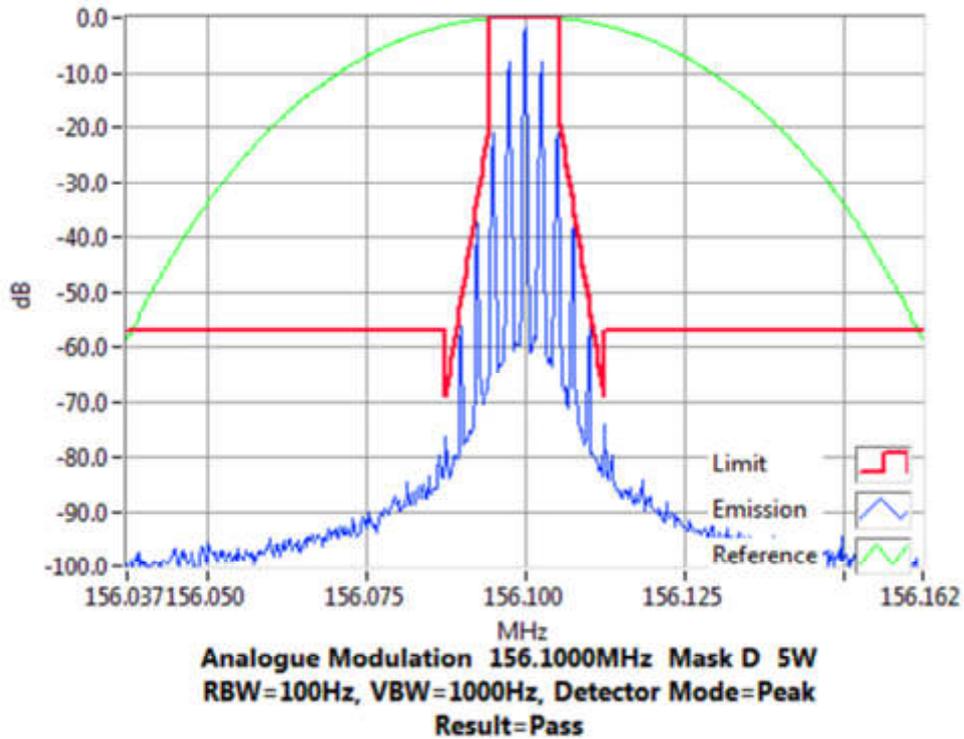
Tx FREQUENCY: 150.85 MHz 1 W 12.5 kHz Channel Spacing



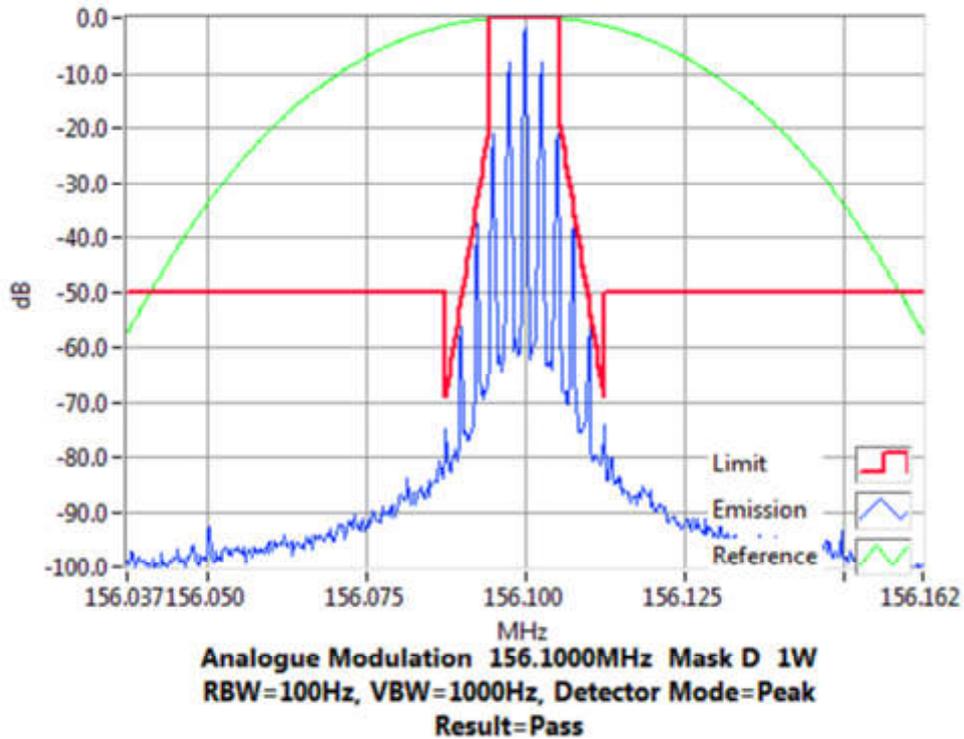
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ANALOGUE VOICE

Tx FREQUENCY: 156.1 MHz 5 W 12.5 kHz Channel Spacing



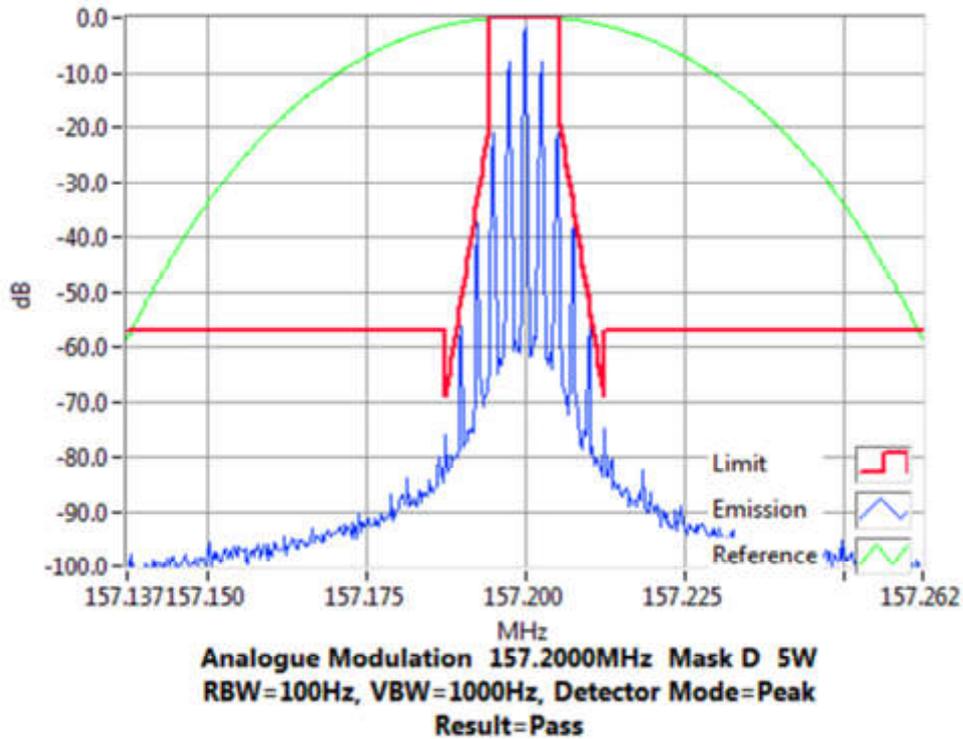
Tx FREQUENCY: 156.1 MHz 1 W 12.5 kHz Channel Spacing



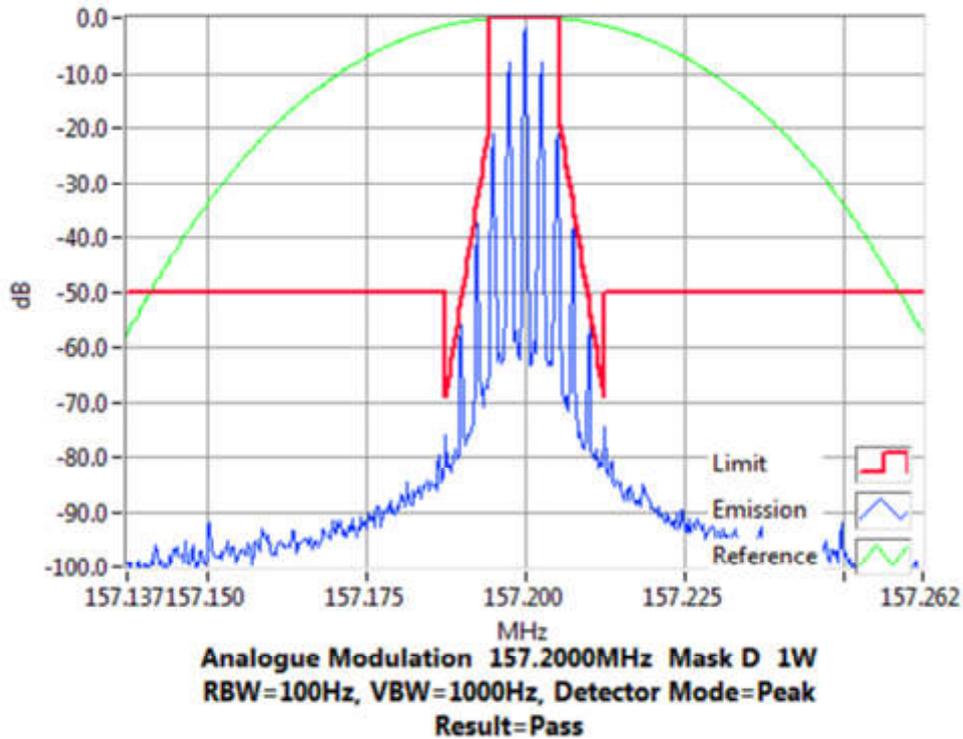
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ANALOGUE VOICE

Tx FREQUENCY: 157.2 MHz 5 W 12.5 kHz Channel Spacing



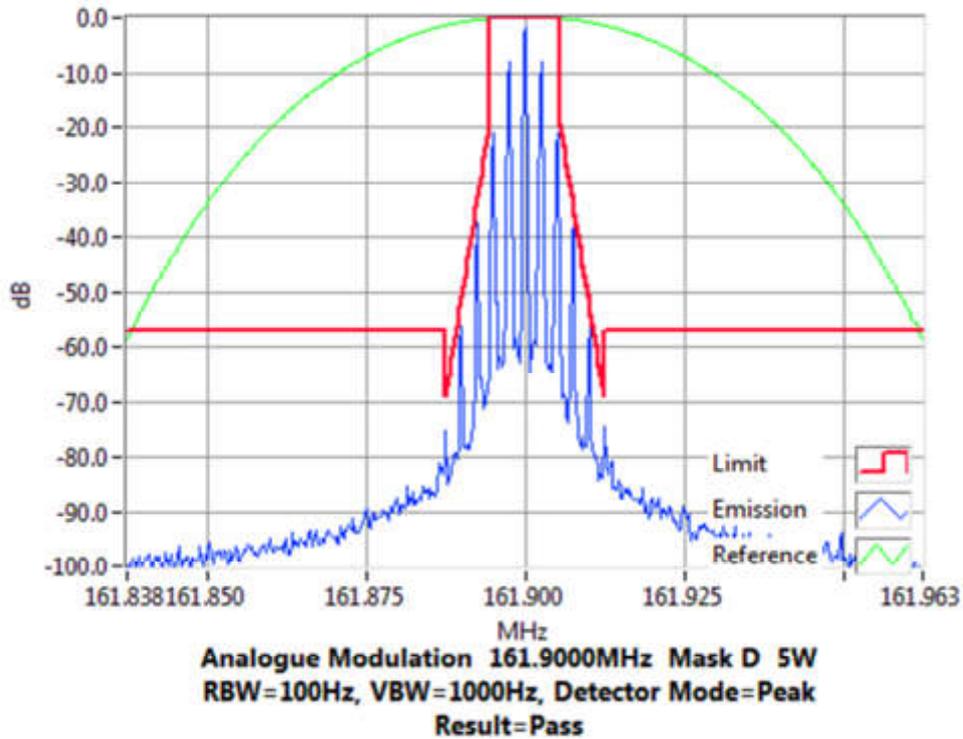
Tx FREQUENCY: 157.2 MHz 1 W 12.5 kHz Channel Spacing



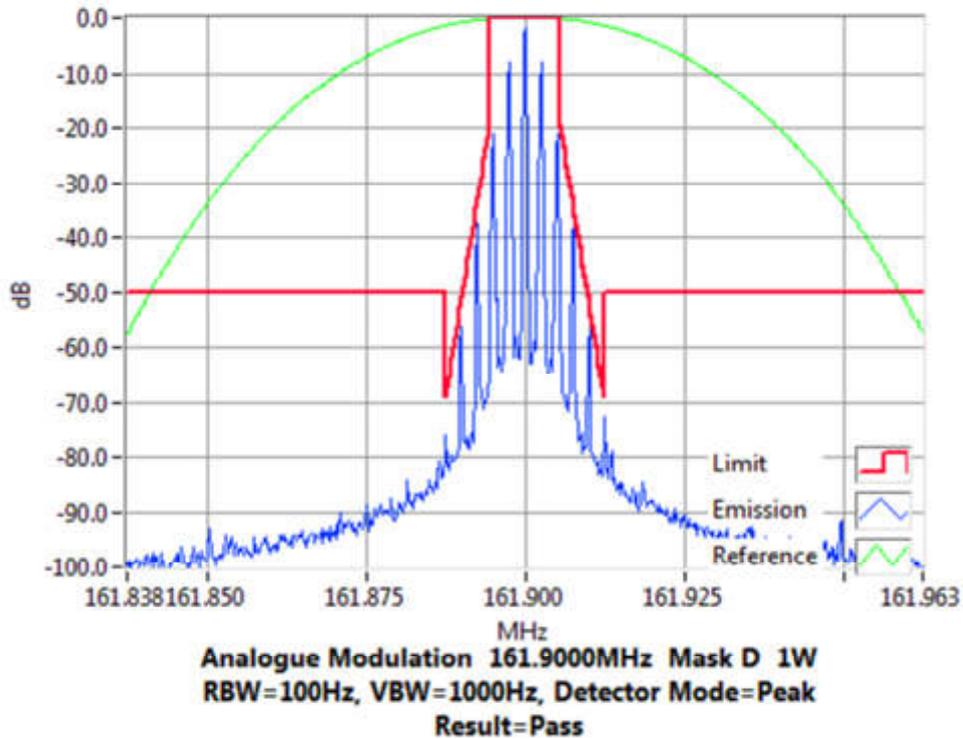
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ANALOGUE VOICE

Tx FREQUENCY: 161.9 MHz 5 W 12.5 kHz Channel Spacing



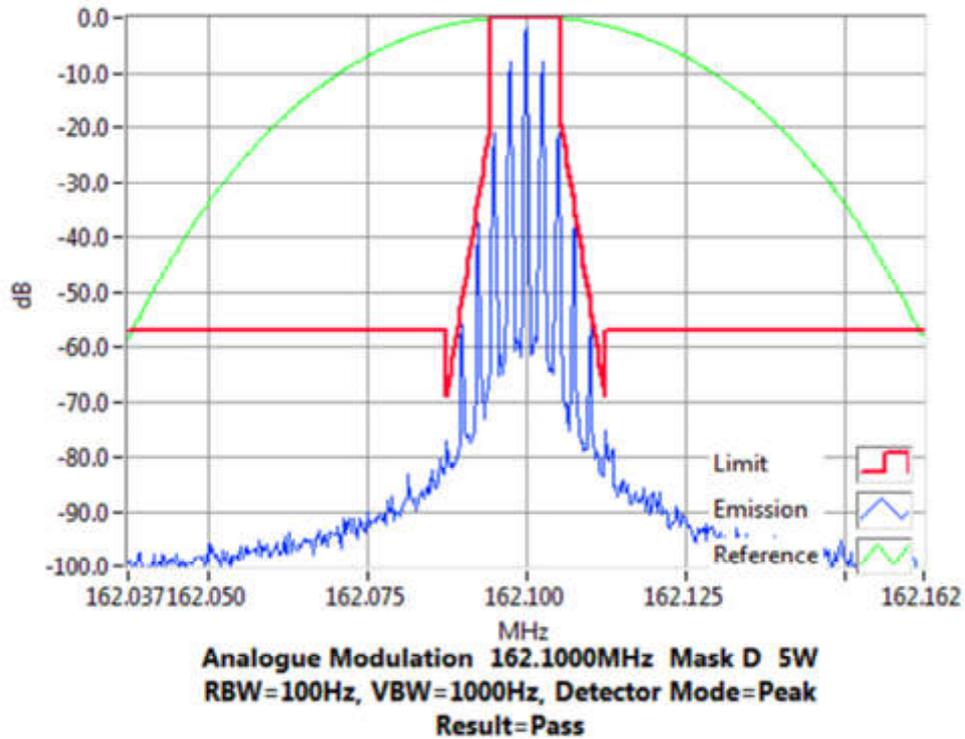
Tx FREQUENCY: 161.9 MHz 1 W 12.5 kHz Channel Spacing



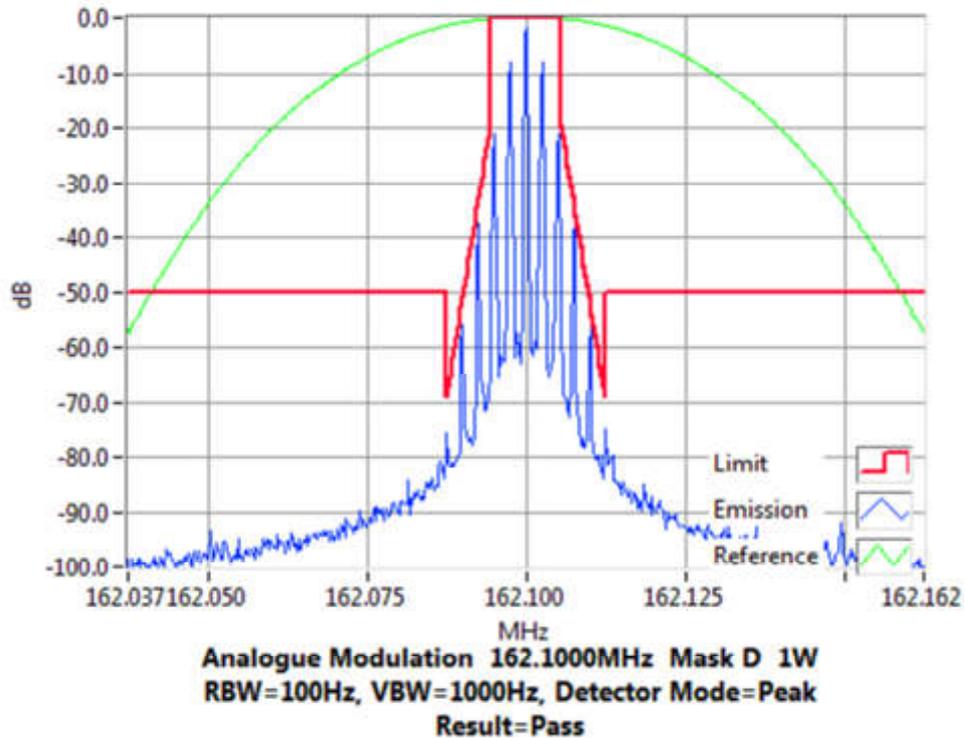
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ANALOGUE VOICE

Tx FREQUENCY: 162.1 MHz 5 W 12.5 kHz Channel Spacing



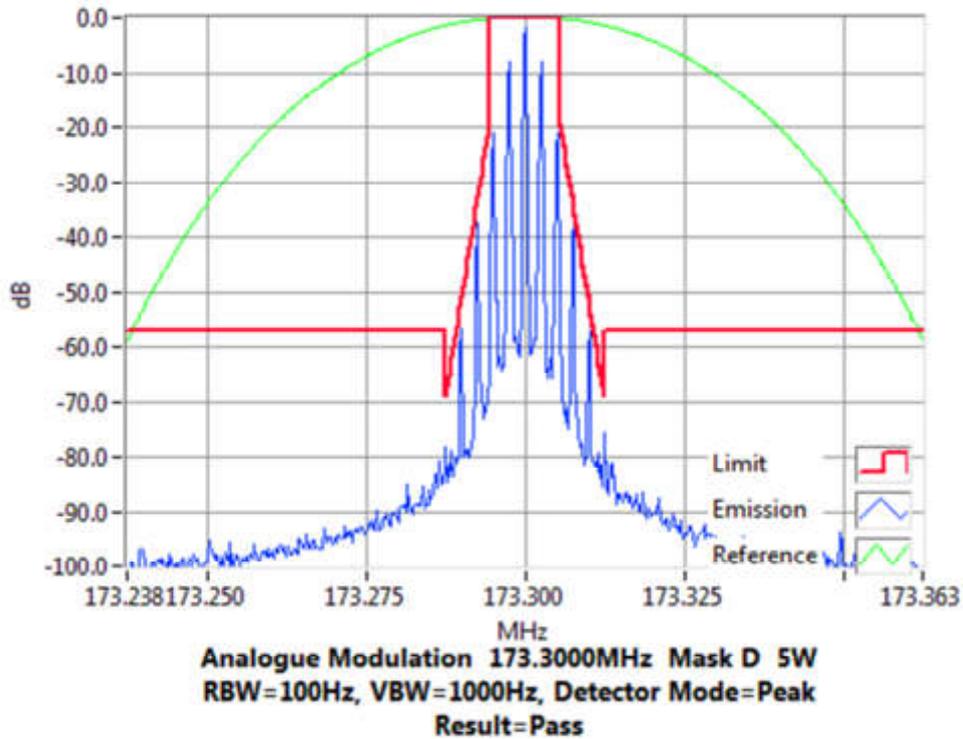
Tx FREQUENCY: 162.1 MHz 1 W 12.5 kHz Channel Spacing



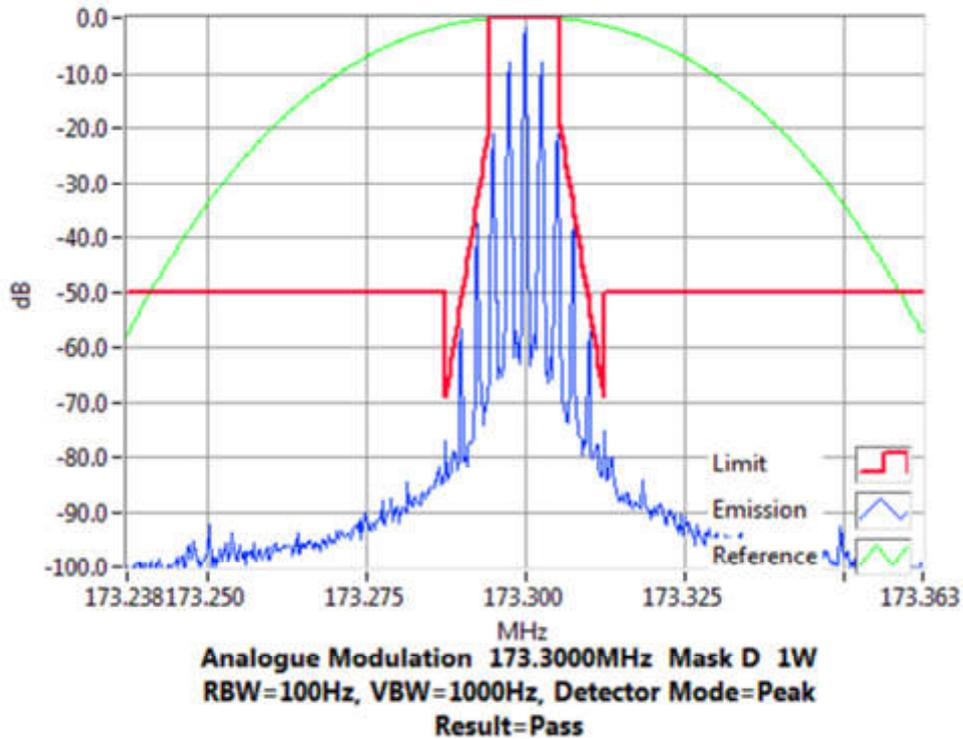
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Occupied Bandwidth and Spectrum Masks

ANALOGUE VOICE

Tx FREQUENCY: 173.3 MHz 5 W 12.5 kHz Channel Spacing



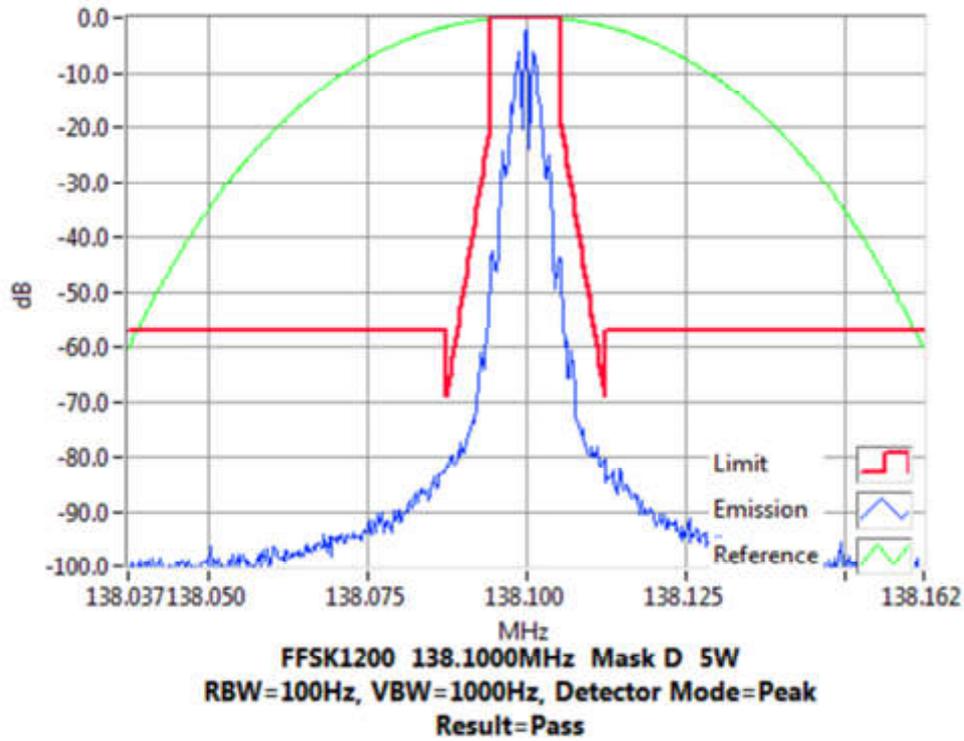
Tx FREQUENCY: 173.3 MHz 1 W 12.5 kHz Channel Spacing



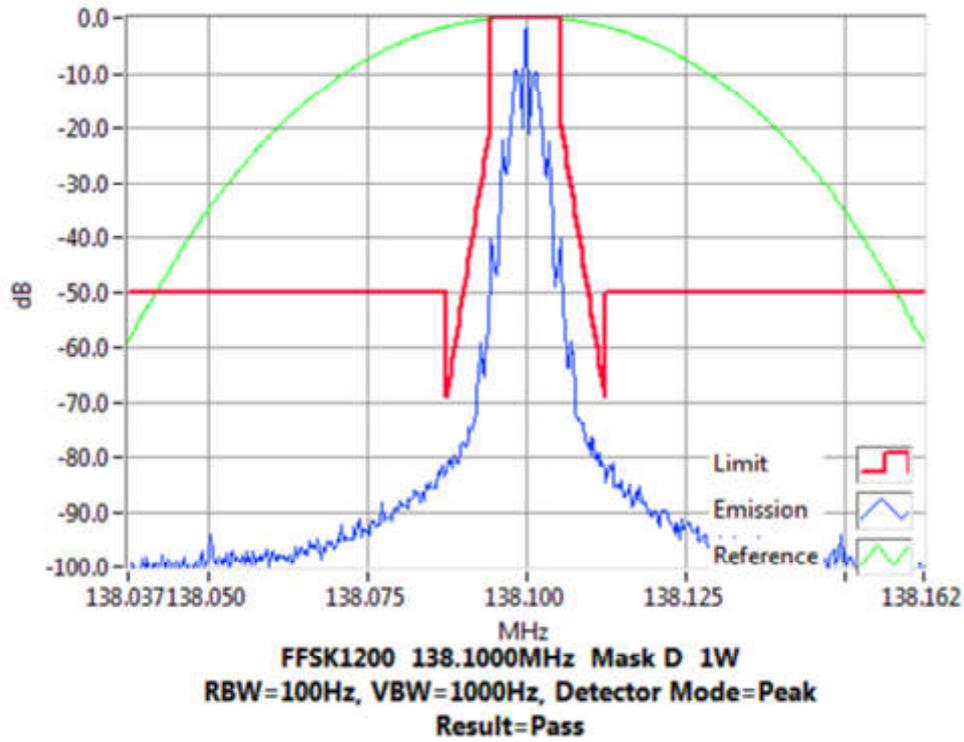
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Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

Tx FREQUENCY: 138.1 MHz 5 W 12.5 kHz Channel Spacing



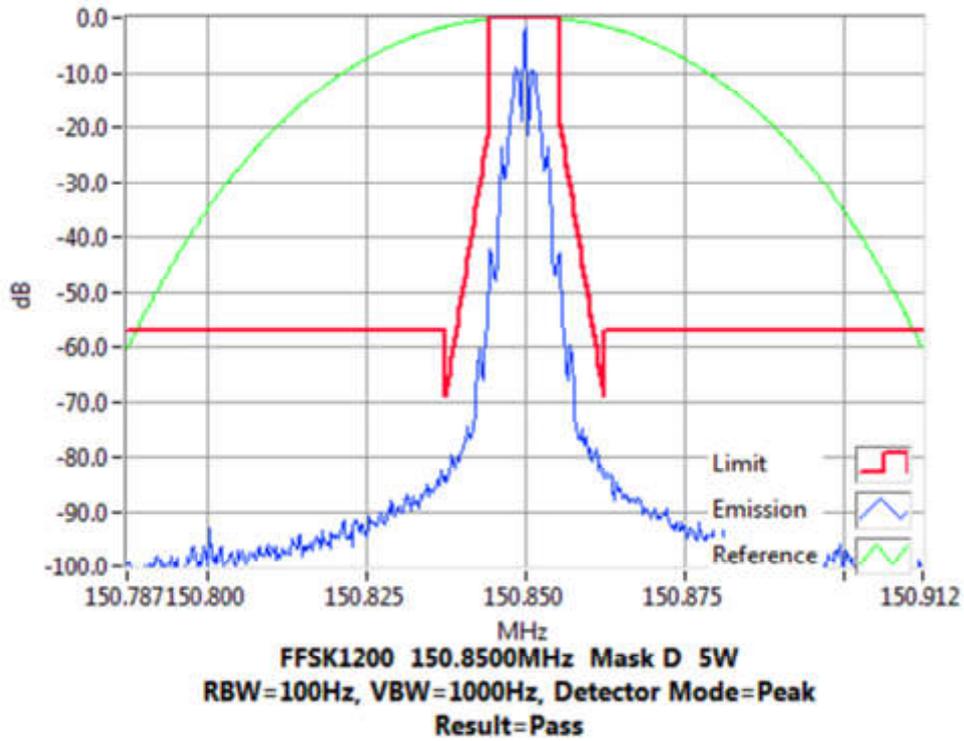
Tx FREQUENCY: 138.1 MHz 1 W 12.5 kHz Channel Spacing



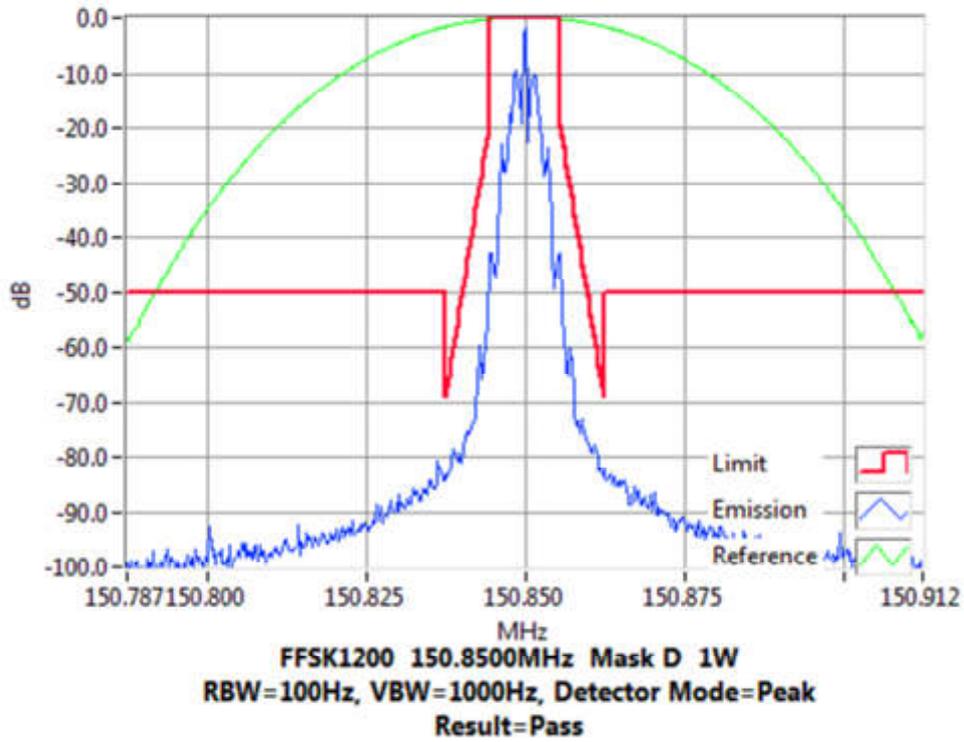
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Tait International Ltd
Report Number 3997
Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

Tx FREQUENCY: 150.85 MHz 5 W 12.5 kHz Channel Spacing



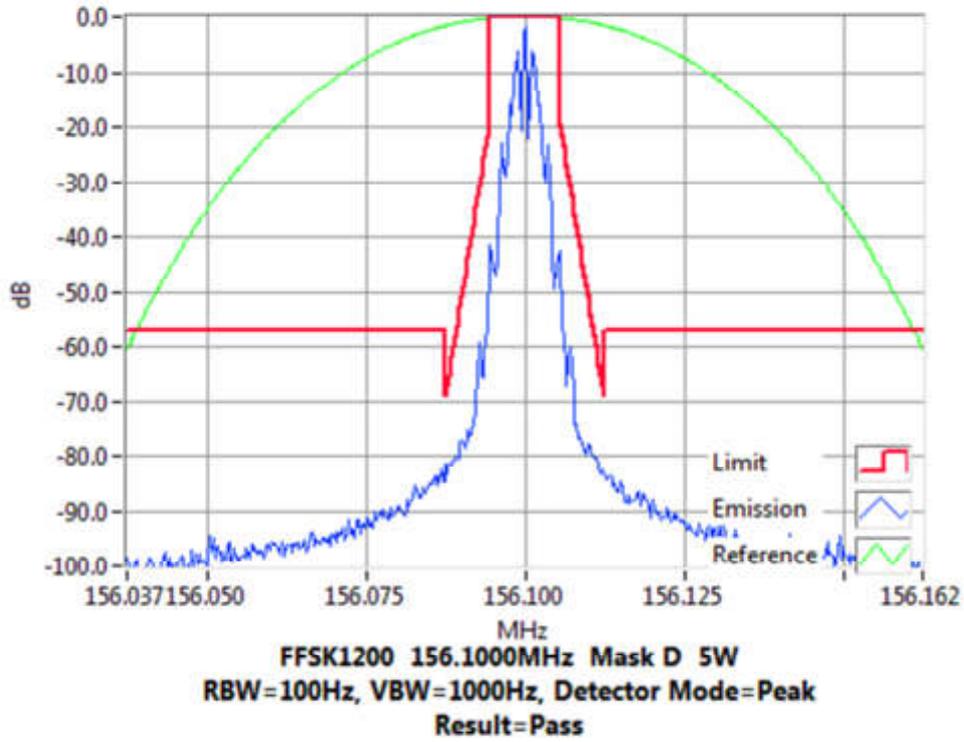
Tx FREQUENCY: 150.85 MHz 1 W 12.5 kHz Channel Spacing



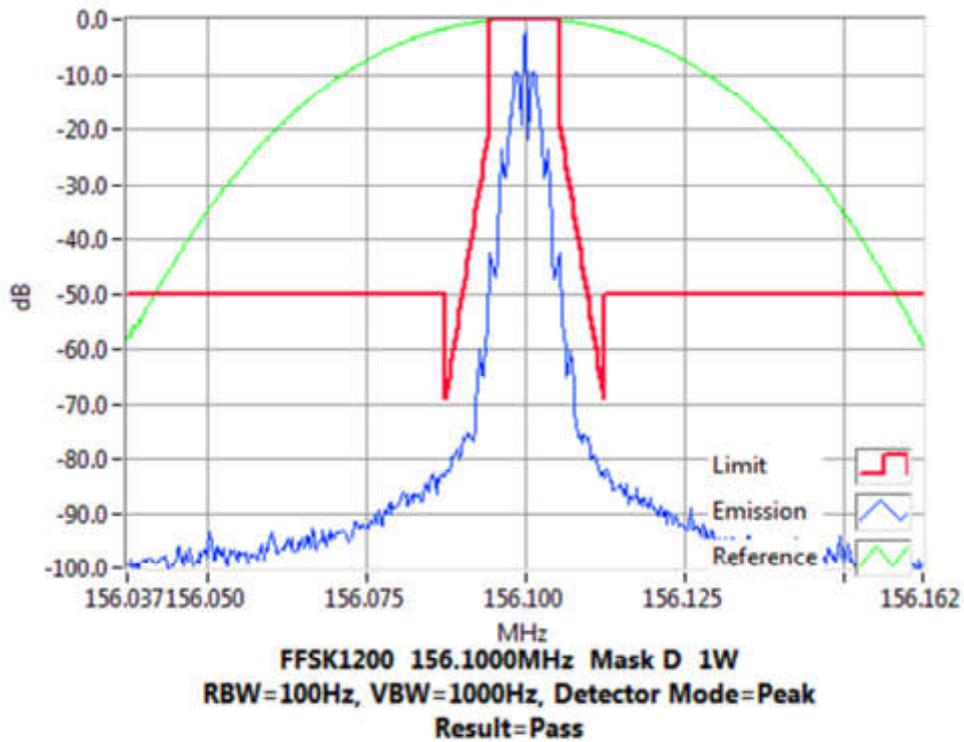
TELTEST Laboratories
Tait International Ltd
Report Number 3997
Occupied Bandwidth and Spectrum Masks

FSK 1200 bps

Tx FREQUENCY: 156.1 MHz 5 W 12.5 kHz Channel Spacing



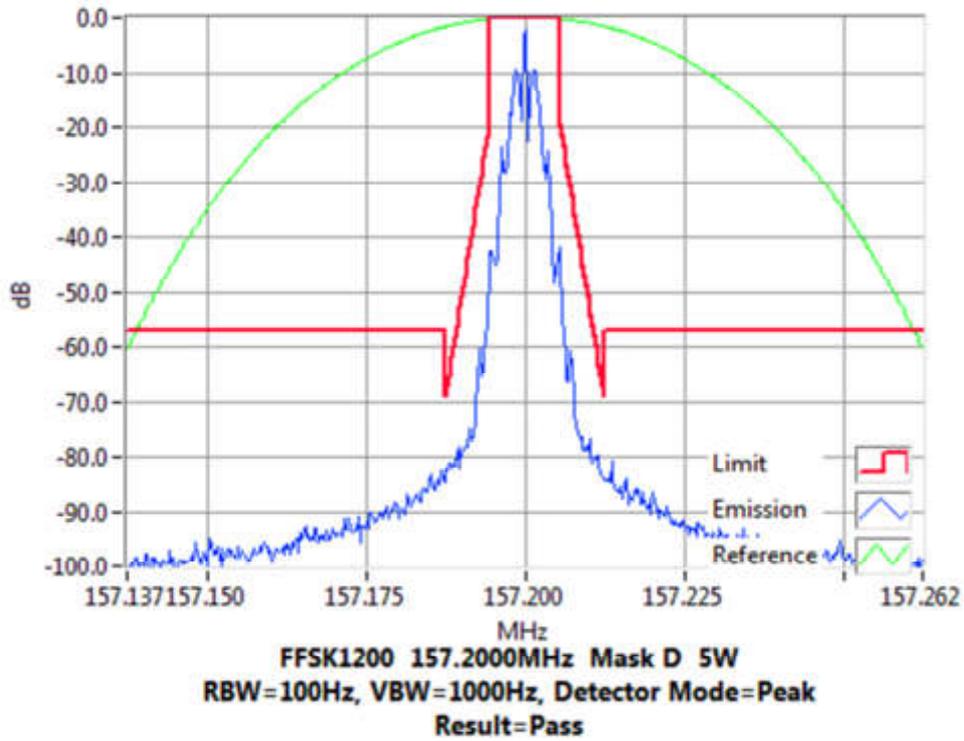
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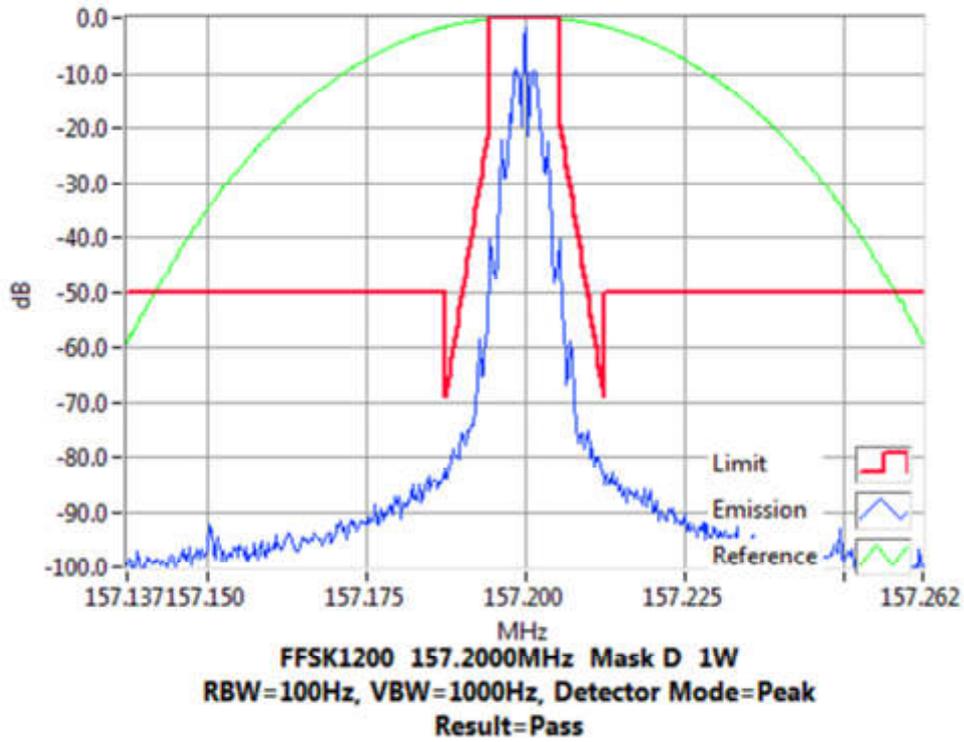
TELTEST Laboratories
Tait International Ltd
Report Number 3997
Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

Tx FREQUENCY: 157.2 MHz 5 W 12.5 kHz Channel Spacing



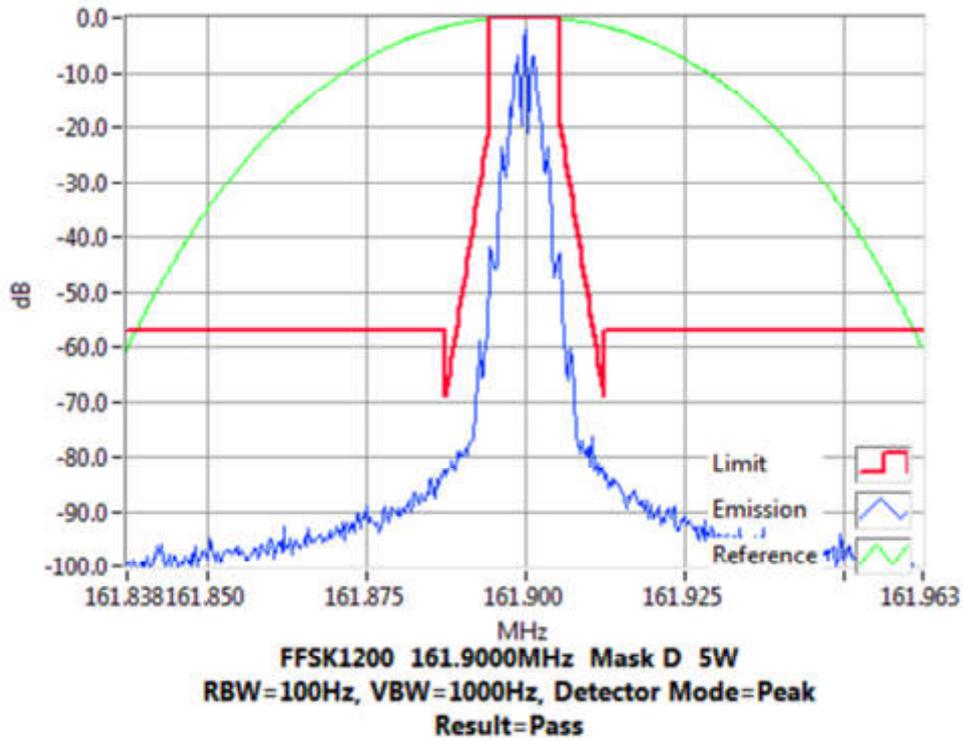
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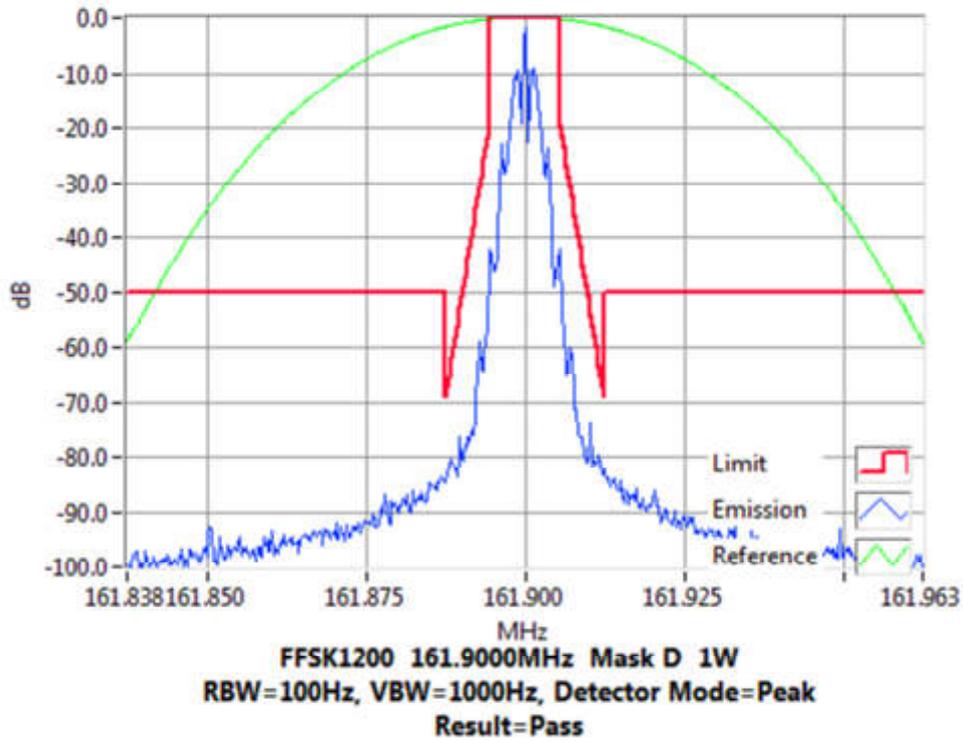
TELTEST Laboratories
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Occupied Bandwidth and Spectrum Masks

FSK 1200 bps

Tx FREQUENCY: 161.9 MHz 5 W 12.5 kHz Channel Spacing



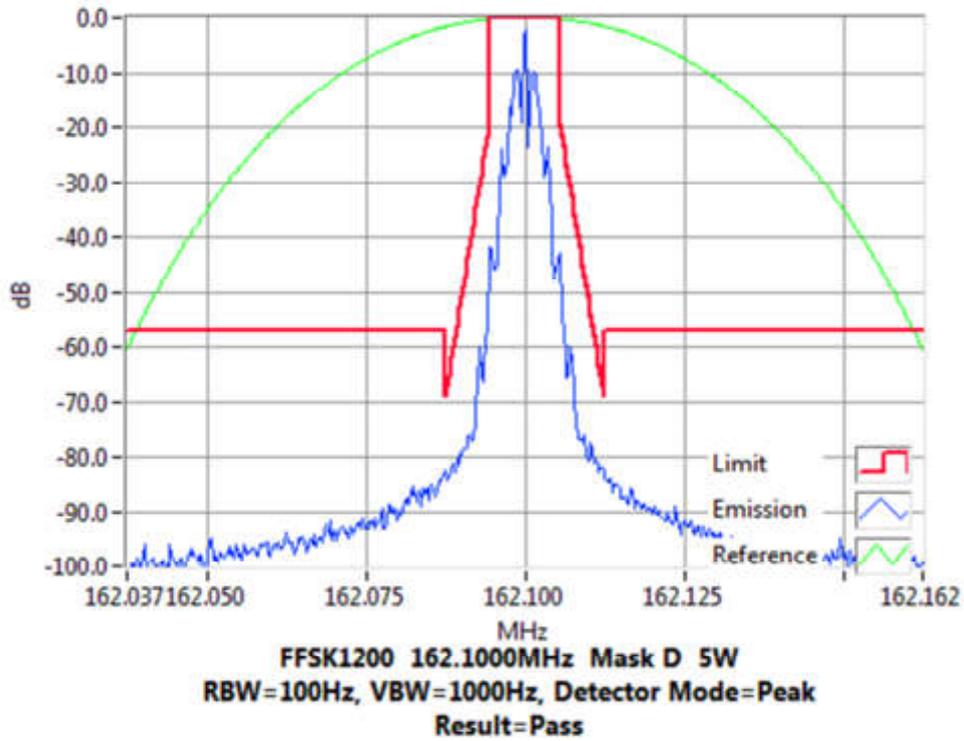
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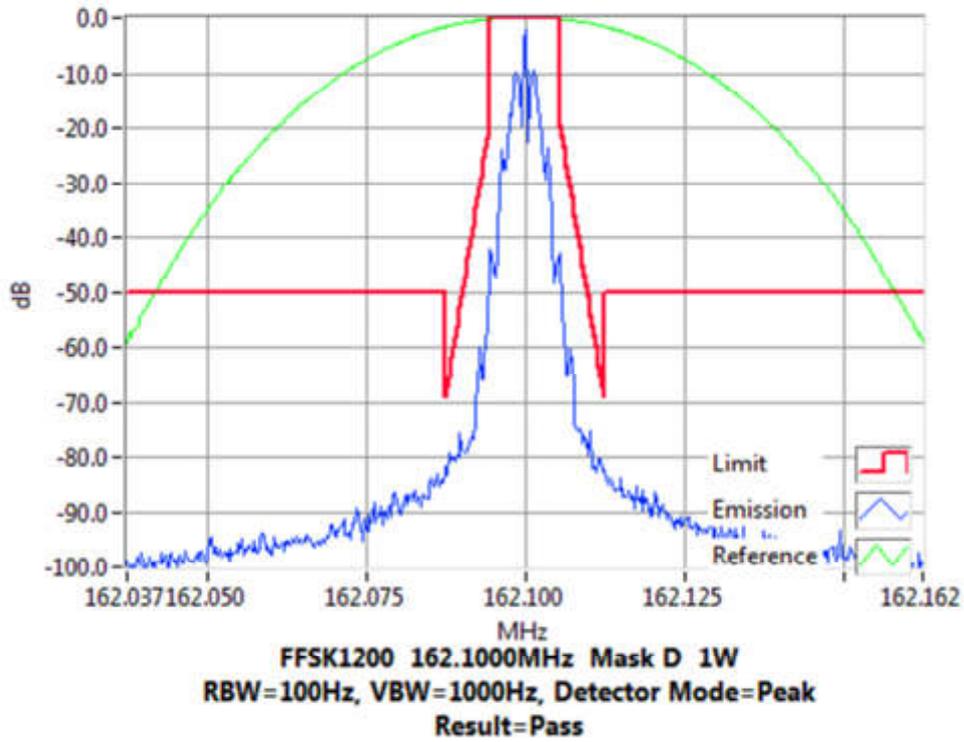
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Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

Tx FREQUENCY: 162.1 MHz 5 W 12.5 kHz Channel Spacing



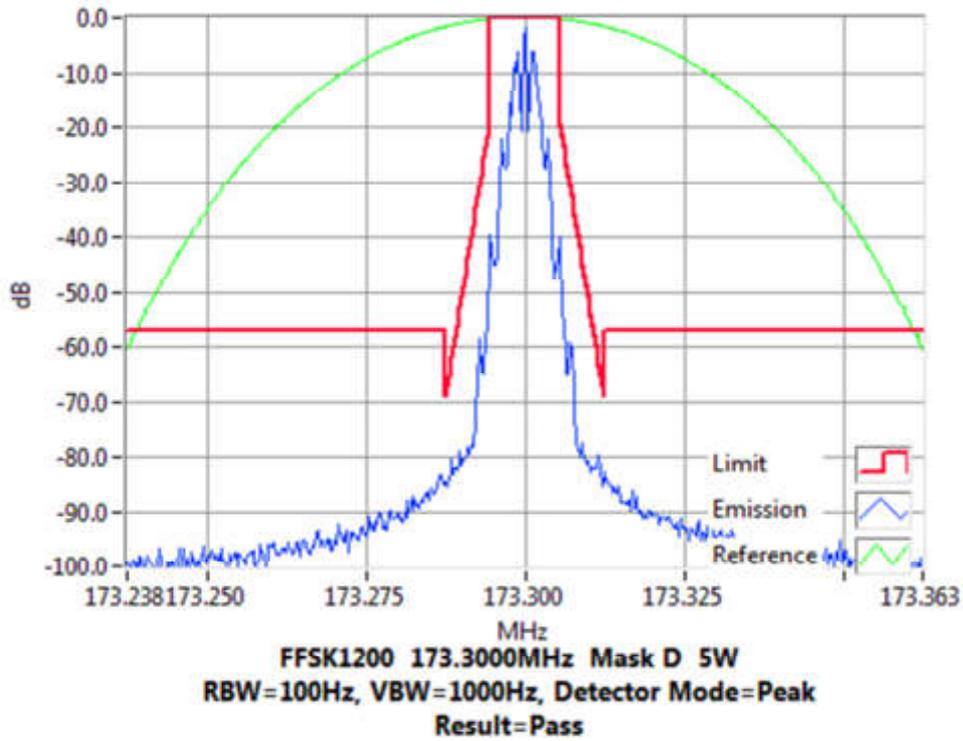
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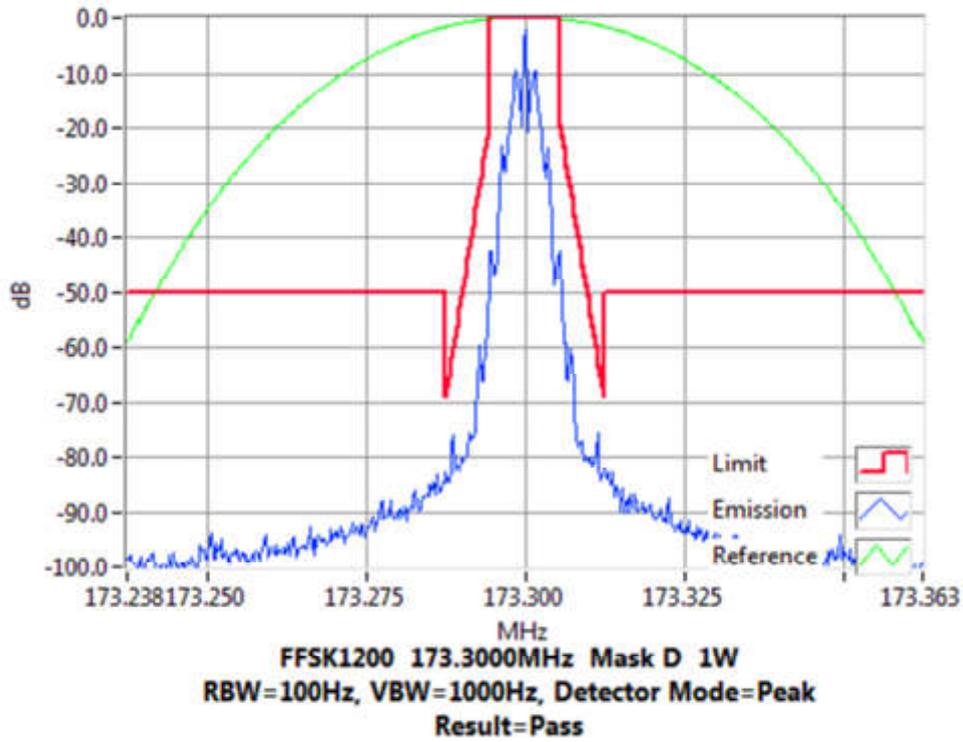
TELTEST Laboratories
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Report Number 3997
Occupied Bandwidth and Spectrum Masks

FFSK 1200 bps

Tx FREQUENCY: 173.3 MHz 5 W 12.5 kHz Channel Spacing



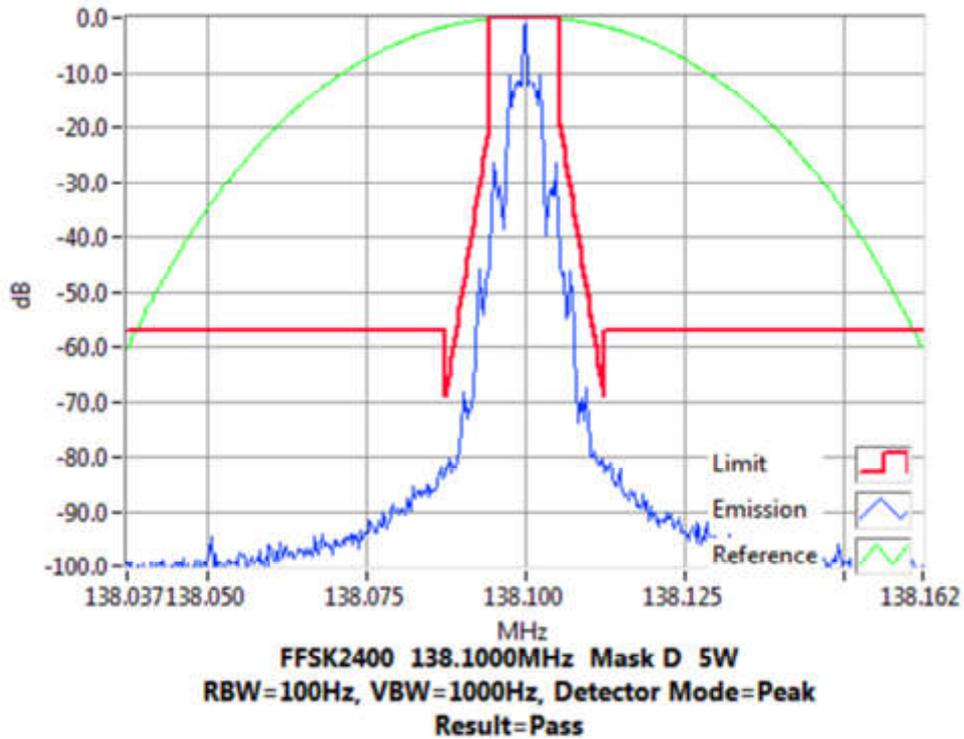
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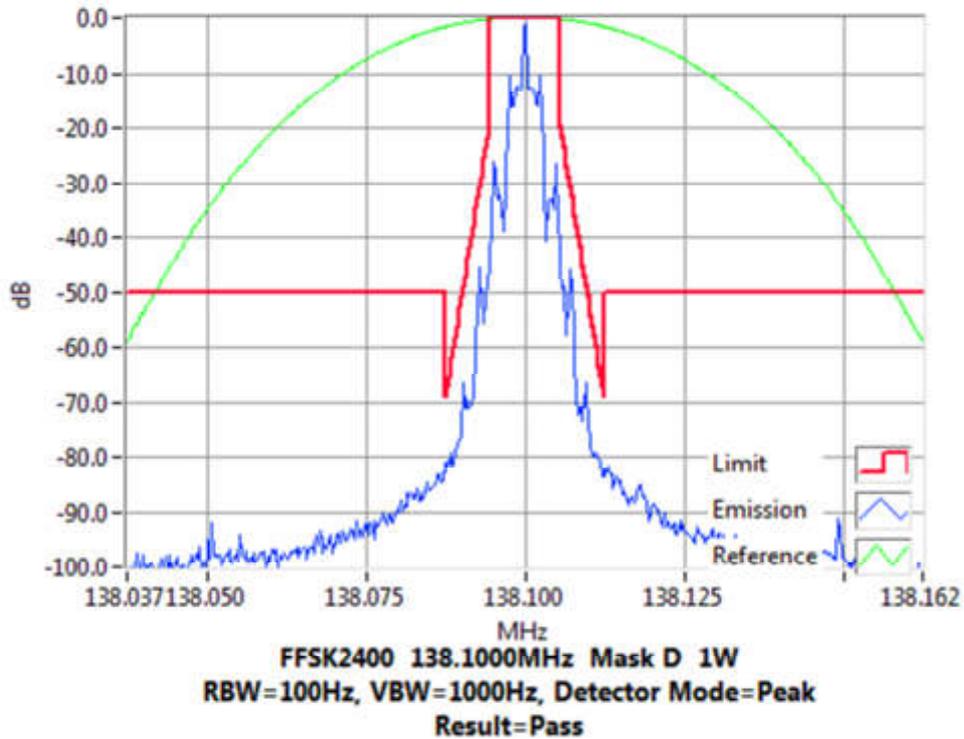
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Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

Tx FREQUENCY: 138.1 MHz 5 W 12.5 kHz Channel Spacing



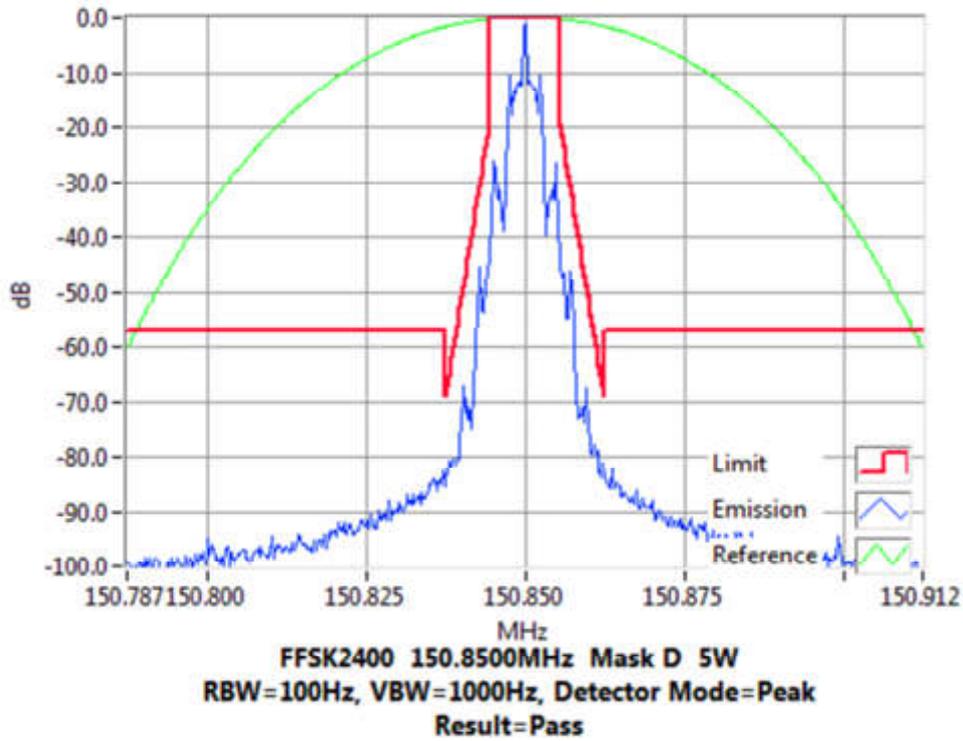
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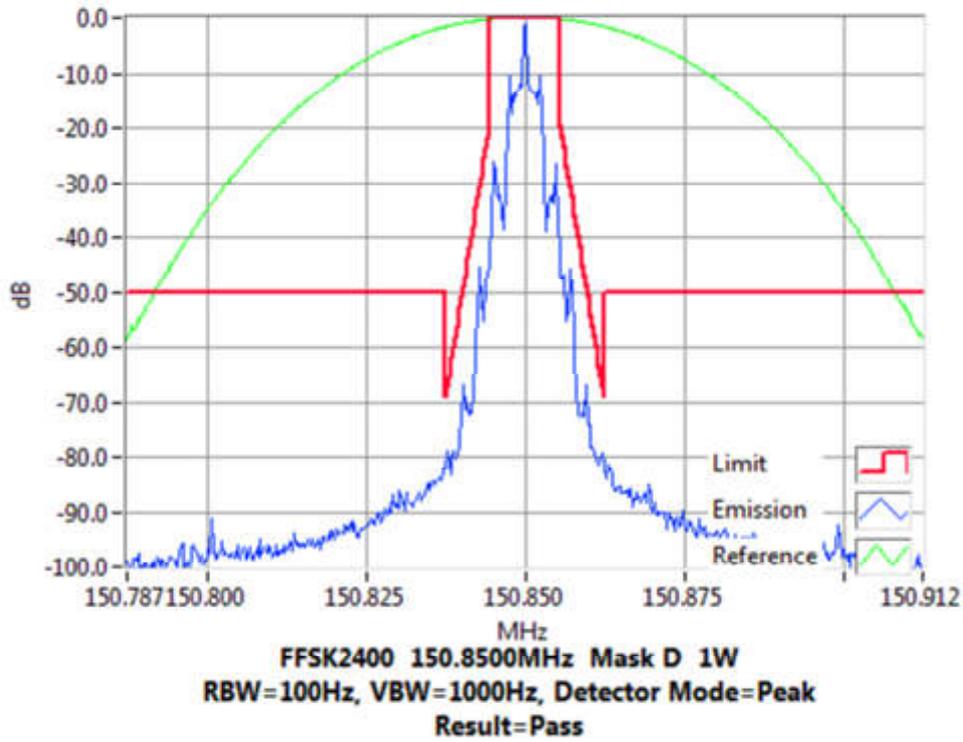
TELTEST Laboratories
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Report Number 3997
Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

Tx FREQUENCY: 150.85 MHz 5 W 12.5 kHz Channel Spacing



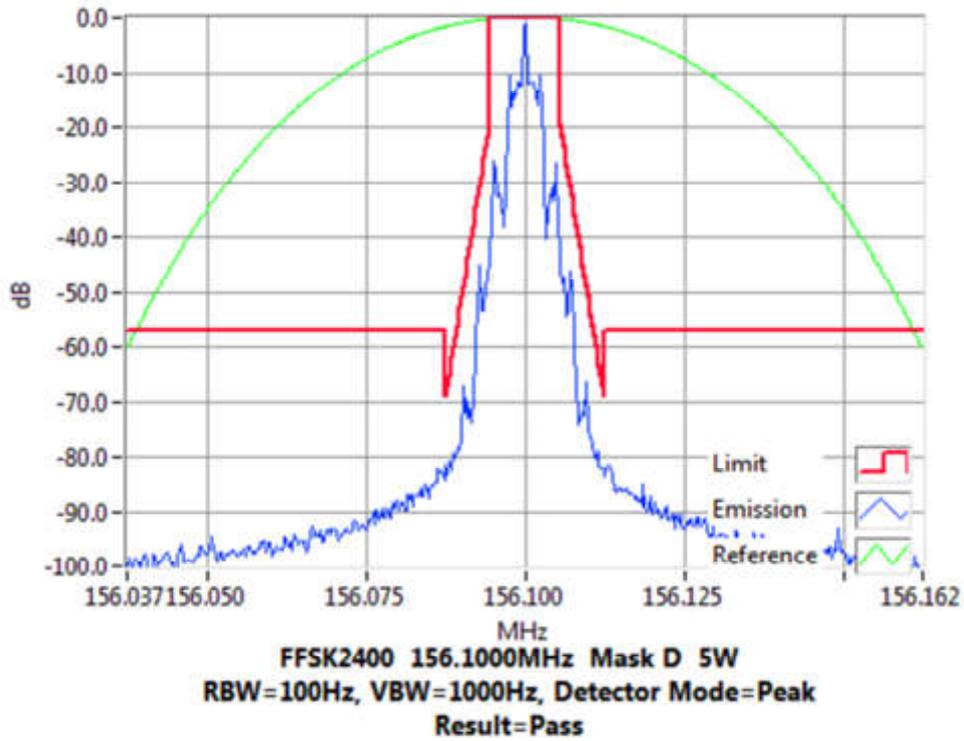
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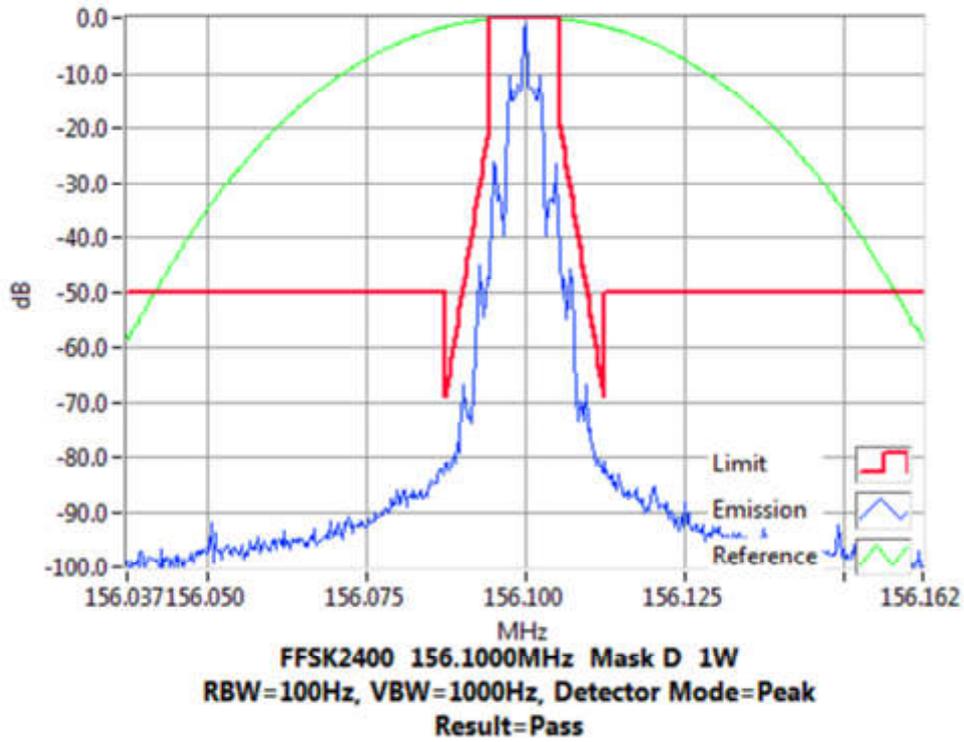
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Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

Tx FREQUENCY: 156.1 MHz 5 W 12.5 kHz Channel Spacing



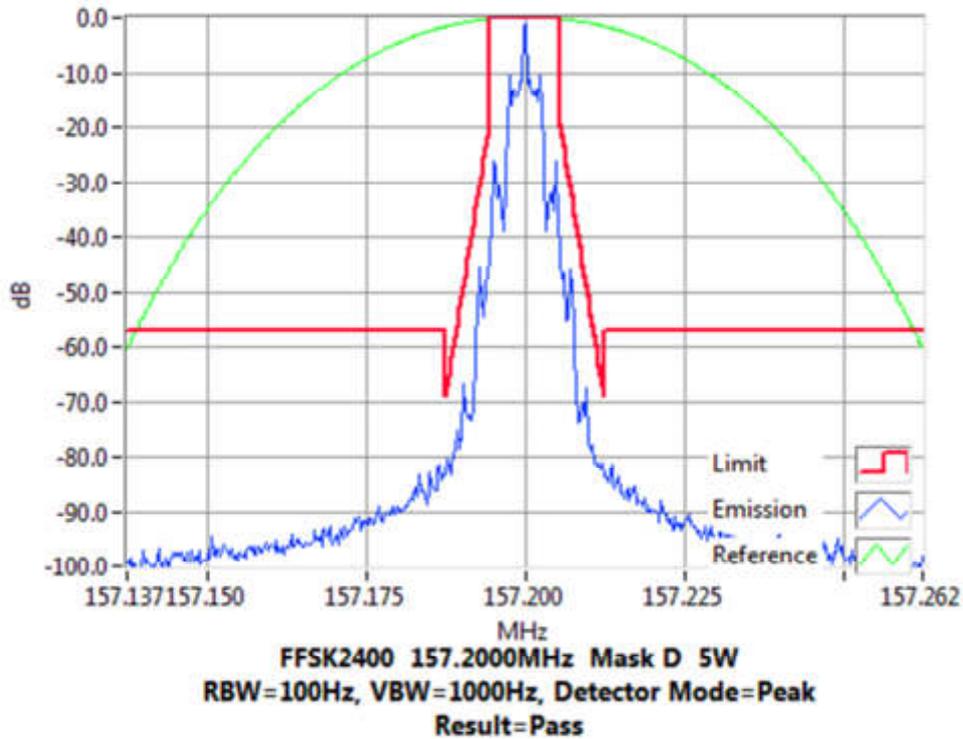
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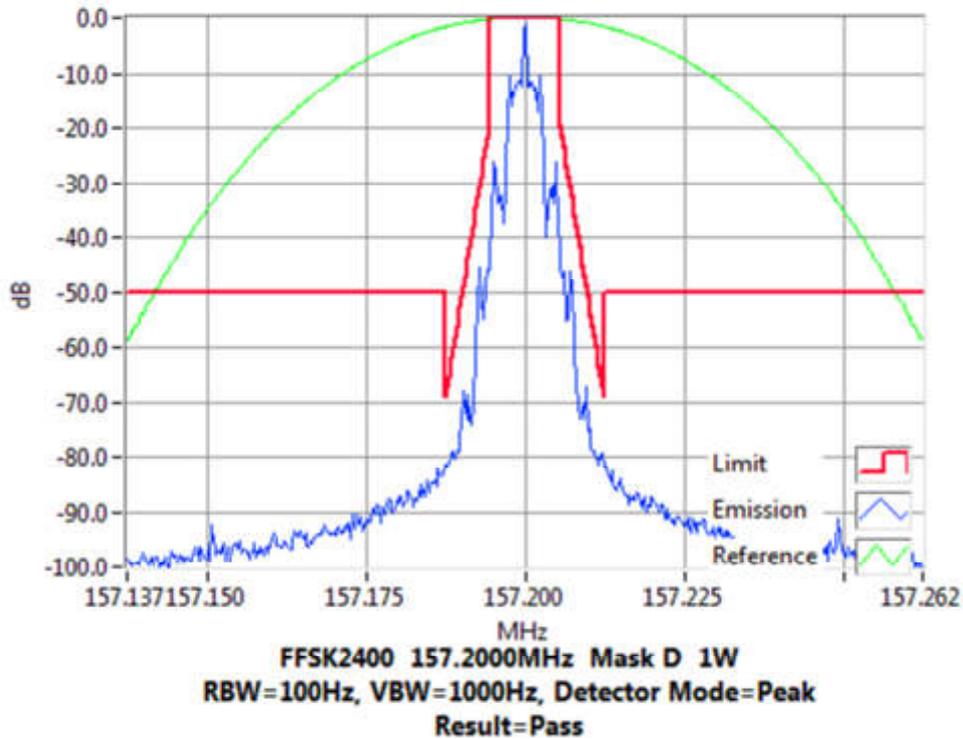
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FFSK 2400 bps

Tx FREQUENCY: 157.2 MHz 5 W 12.5 kHz Channel Spacing



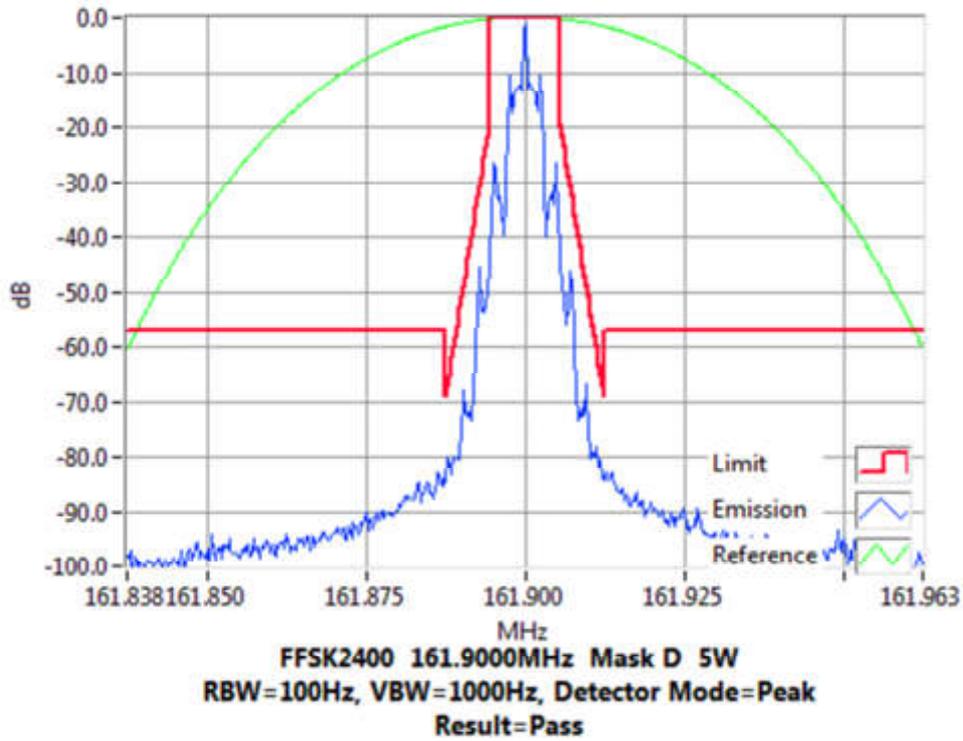
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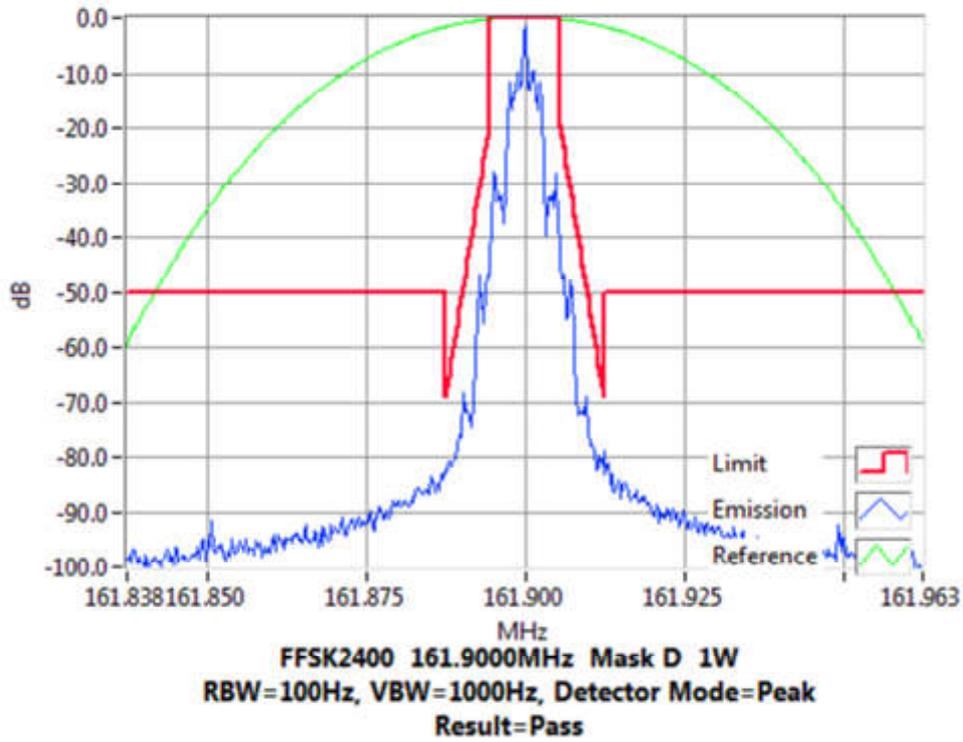
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Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

Tx FREQUENCY: 161.9 MHz 5 W 12.5 kHz Channel Spacing



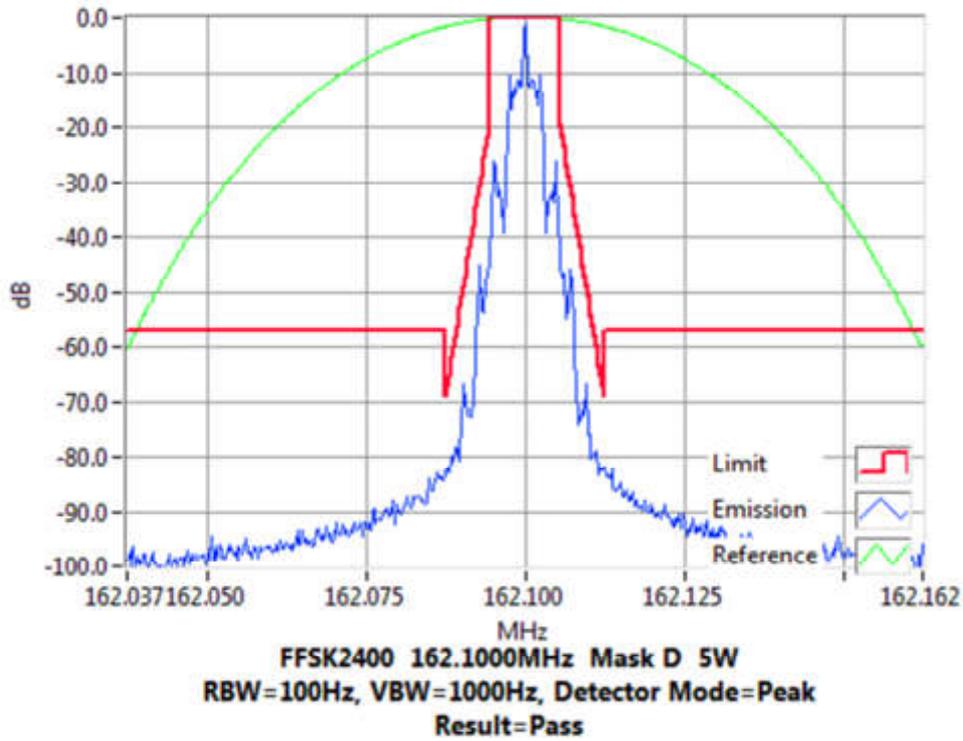
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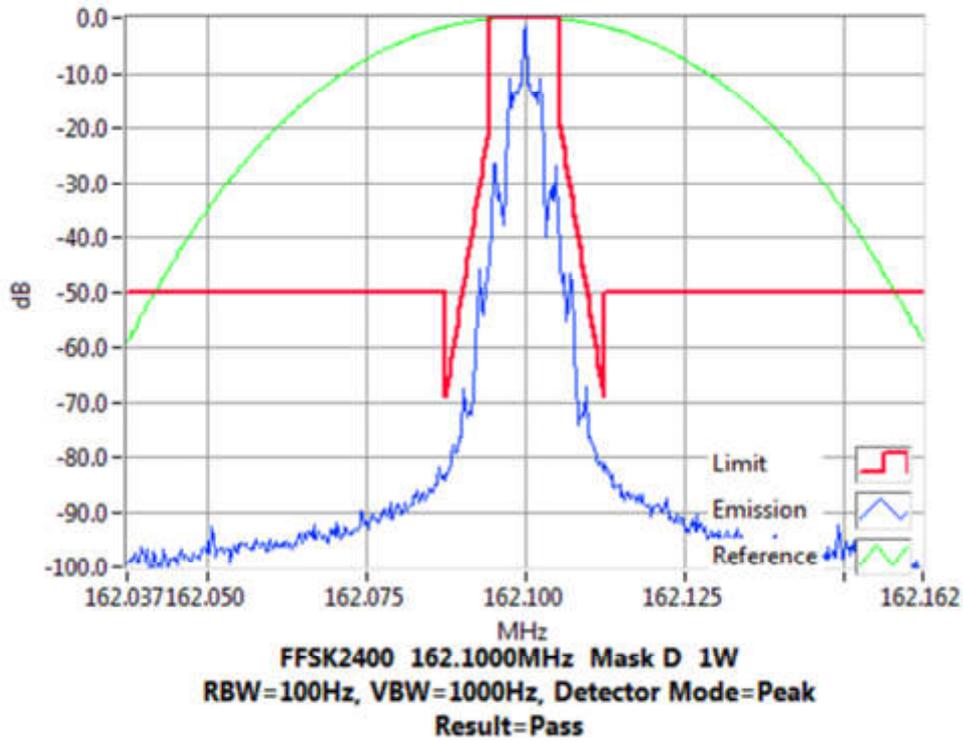
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Occupied Bandwidth and Spectrum Masks

FFSK 2400 bps

Tx FREQUENCY: 162.1 MHz 5 W 12.5 kHz Channel Spacing



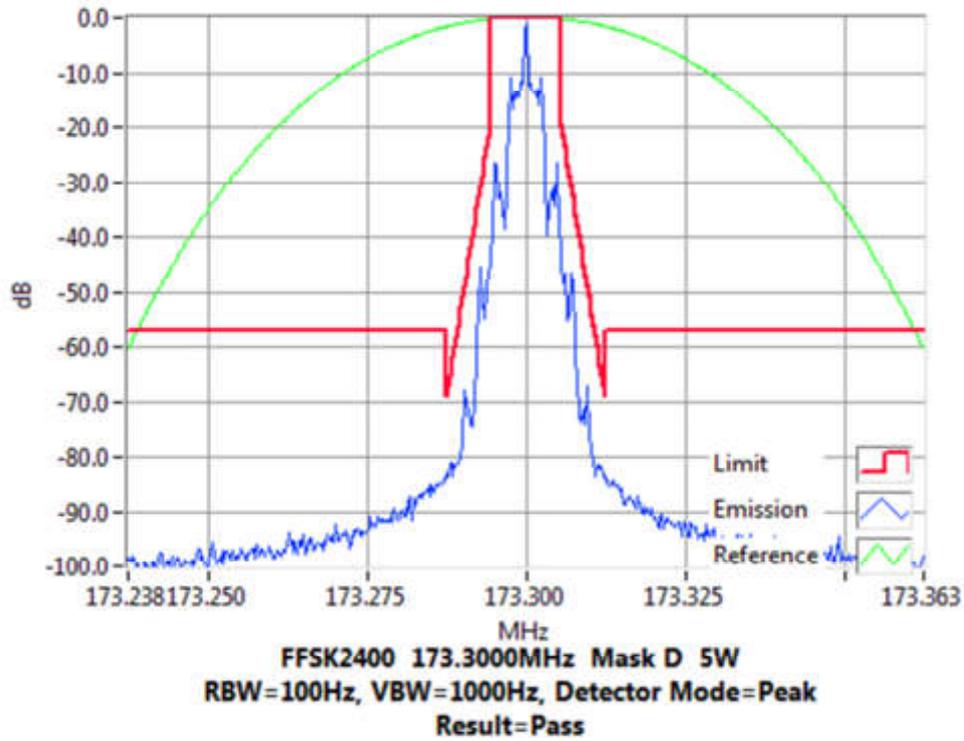
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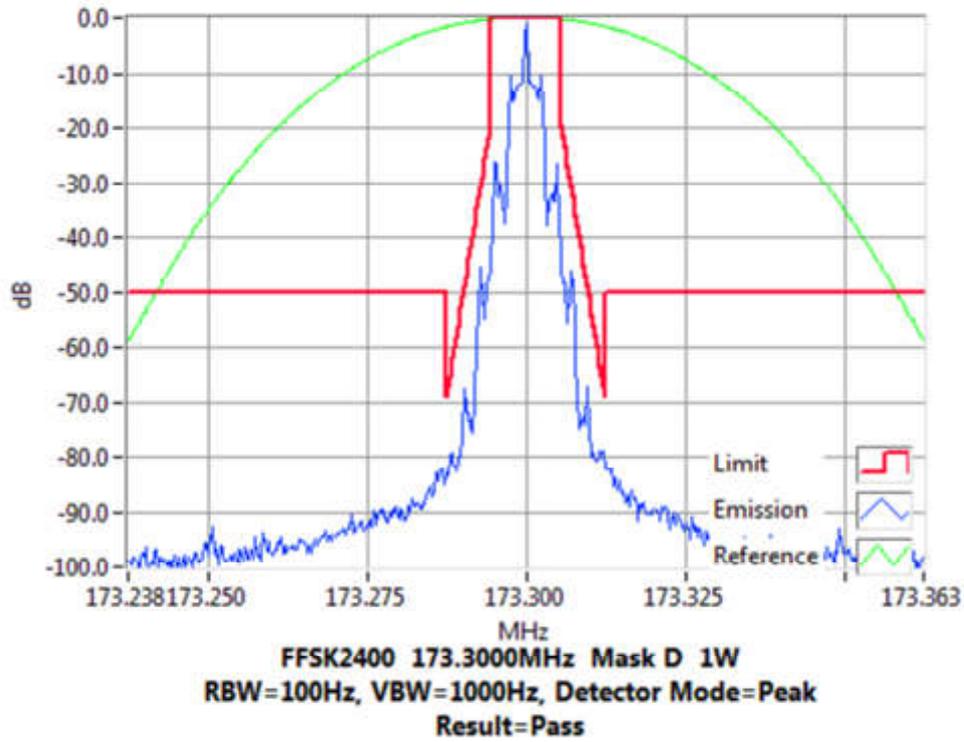
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FFSK 2400 bps

Tx FREQUENCY: 173.3 MHz 5 W 12.5 kHz Channel Spacing



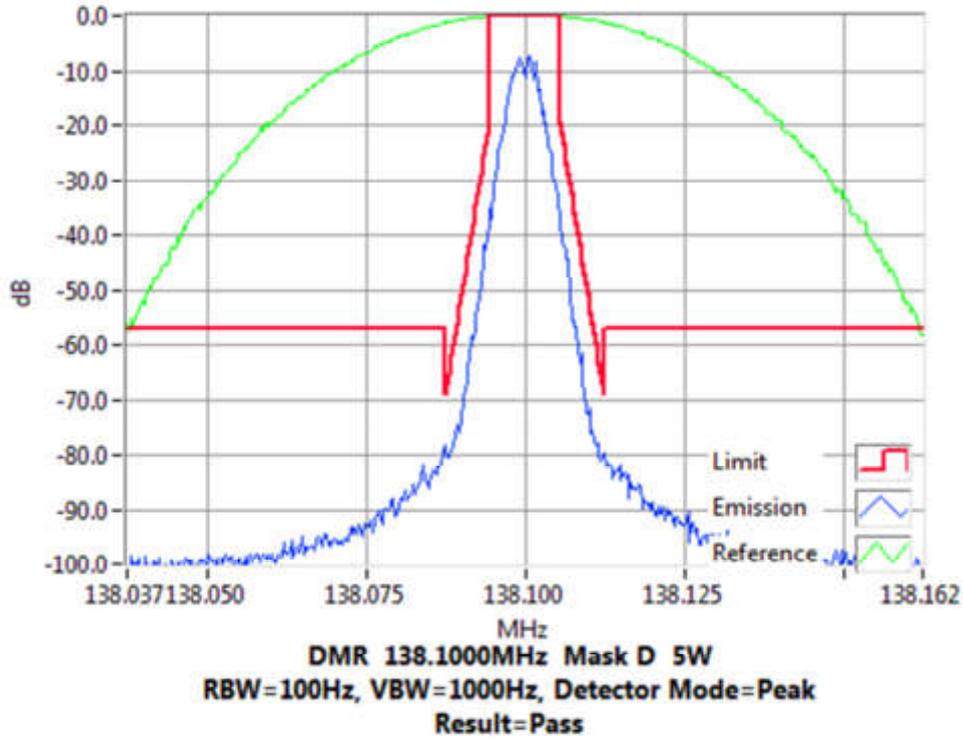
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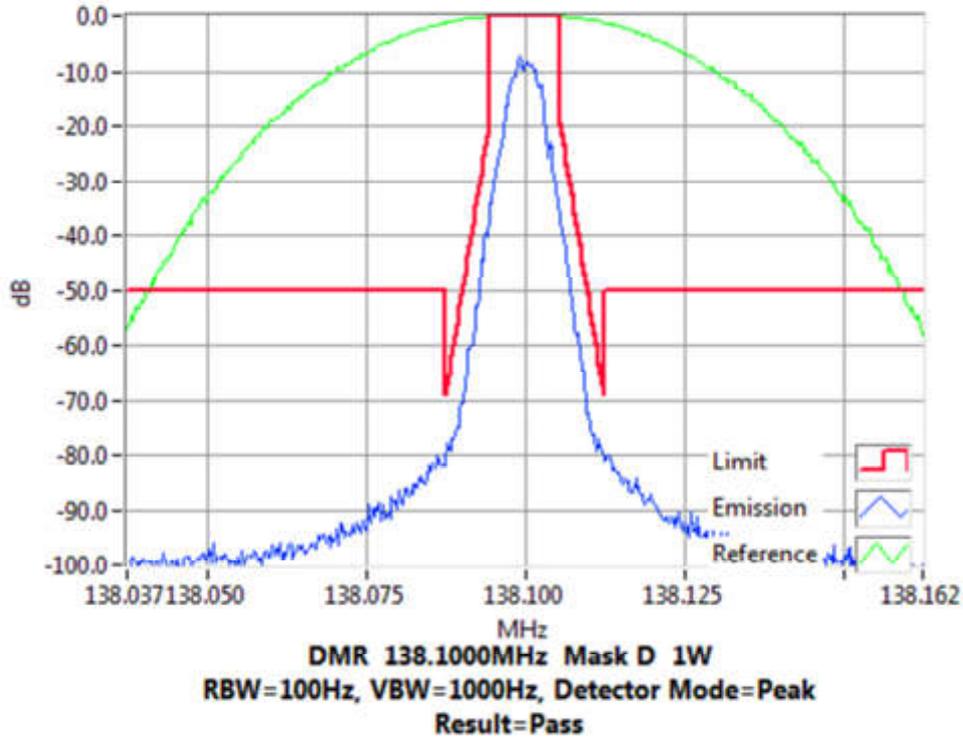
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DMR

Tx FREQUENCY: 138.1 MHz 5 W 12.5 kHz Channel Spacing



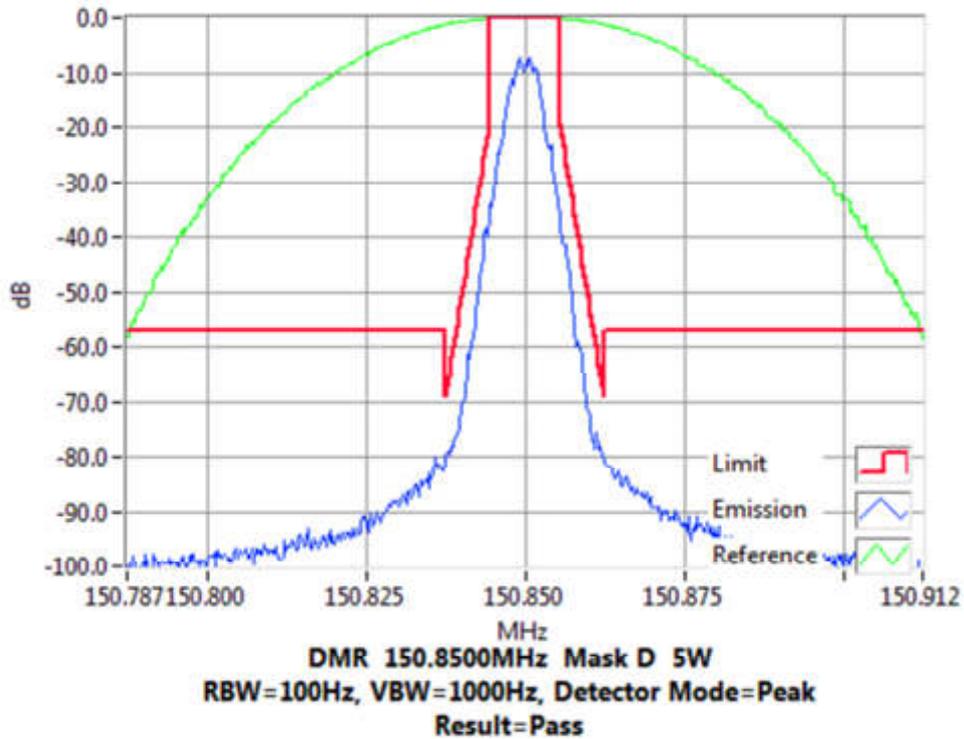
Tx FREQUENCY: 138.1 MHz 1 W 12.5 kHz Channel Spacing



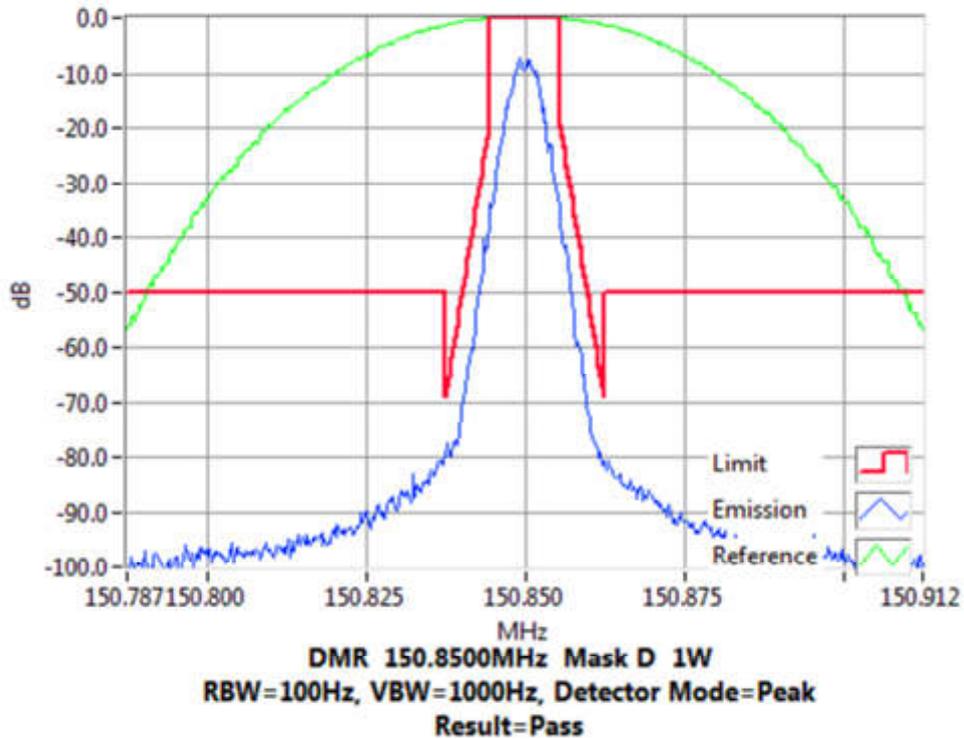
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Occupied Bandwidth and Spectrum Masks

DMR

Tx FREQUENCY: 150.85 MHz 5 W 12.5 kHz Channel Spacing



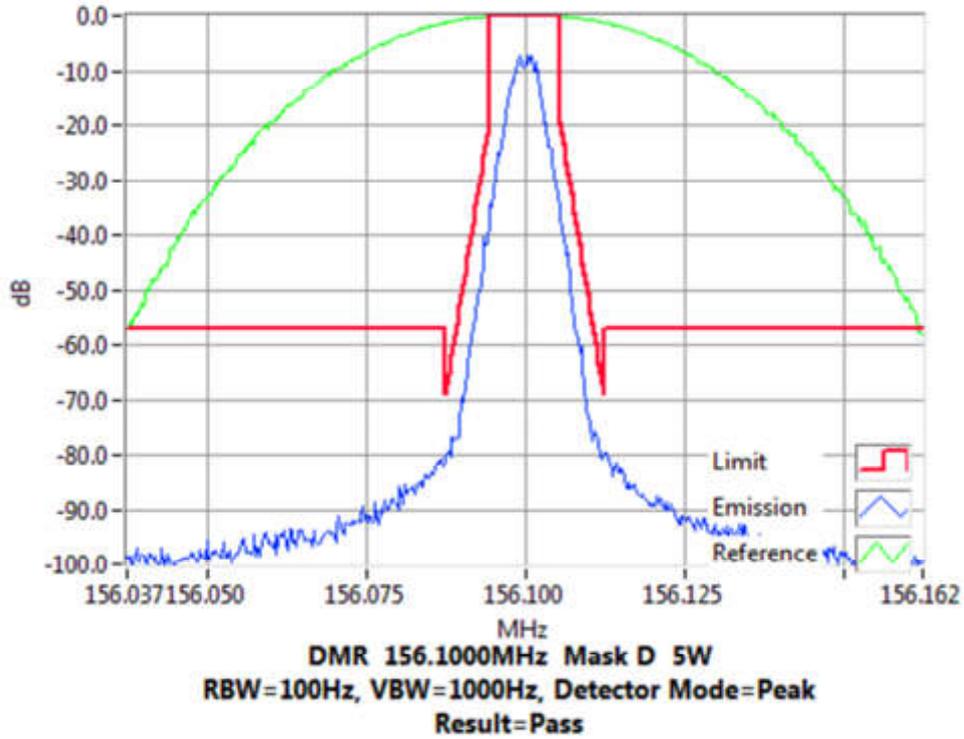
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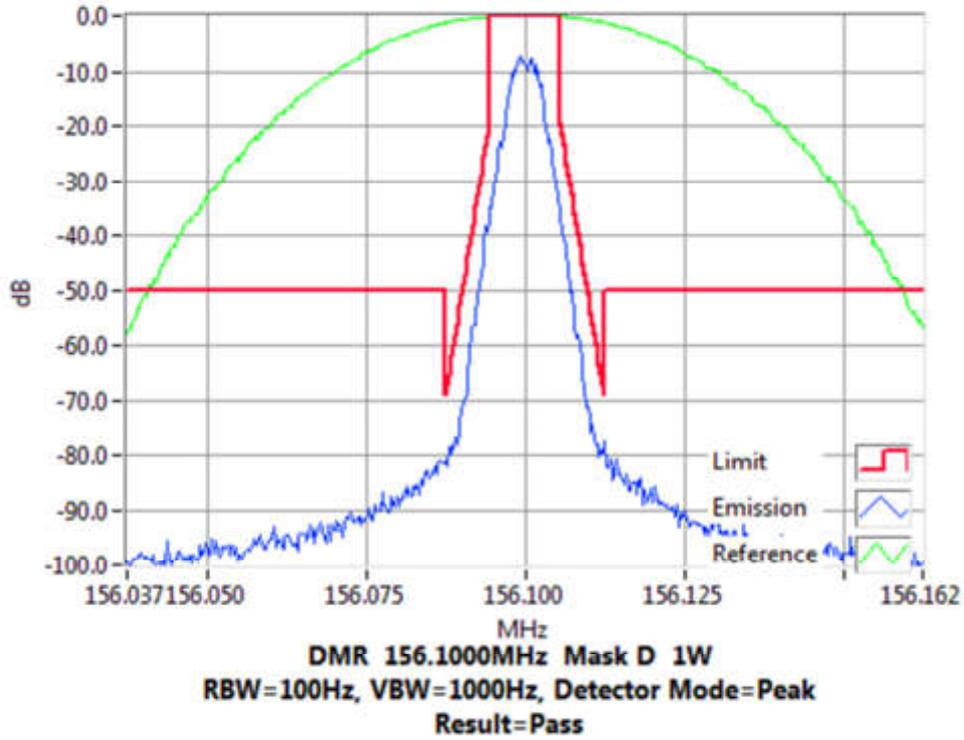
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DMR

Tx FREQUENCY: 156.1 MHz 5 W 12.5 kHz Channel Spacing



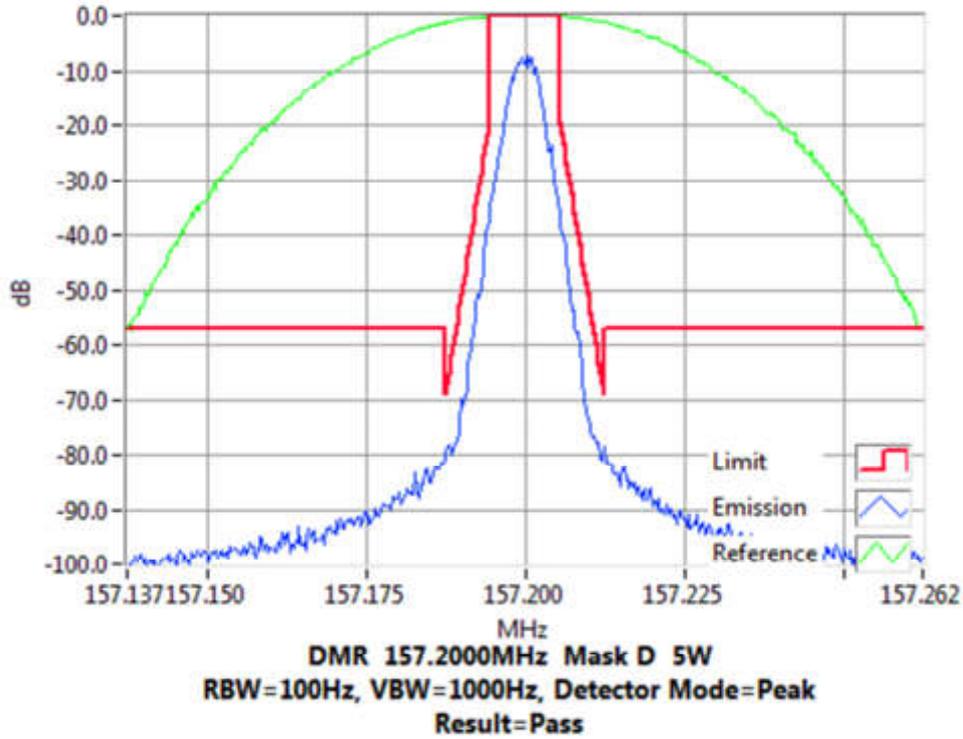
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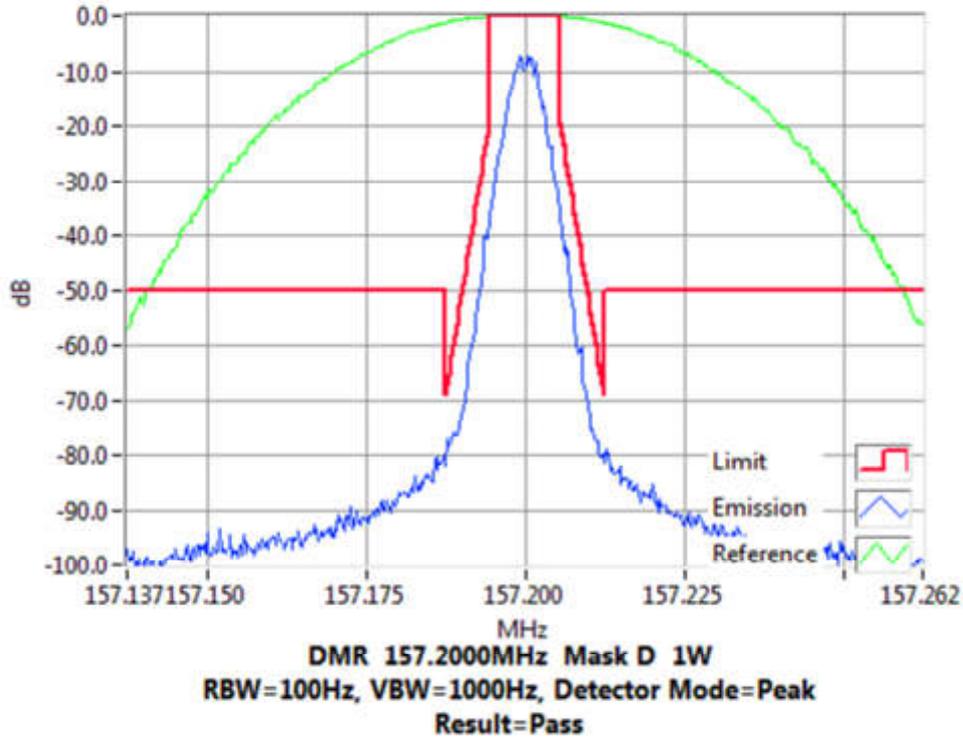
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Occupied Bandwidth and Spectrum Masks

DMR

Tx FREQUENCY: 157.2 MHz 5 W 12.5 kHz Channel Spacing



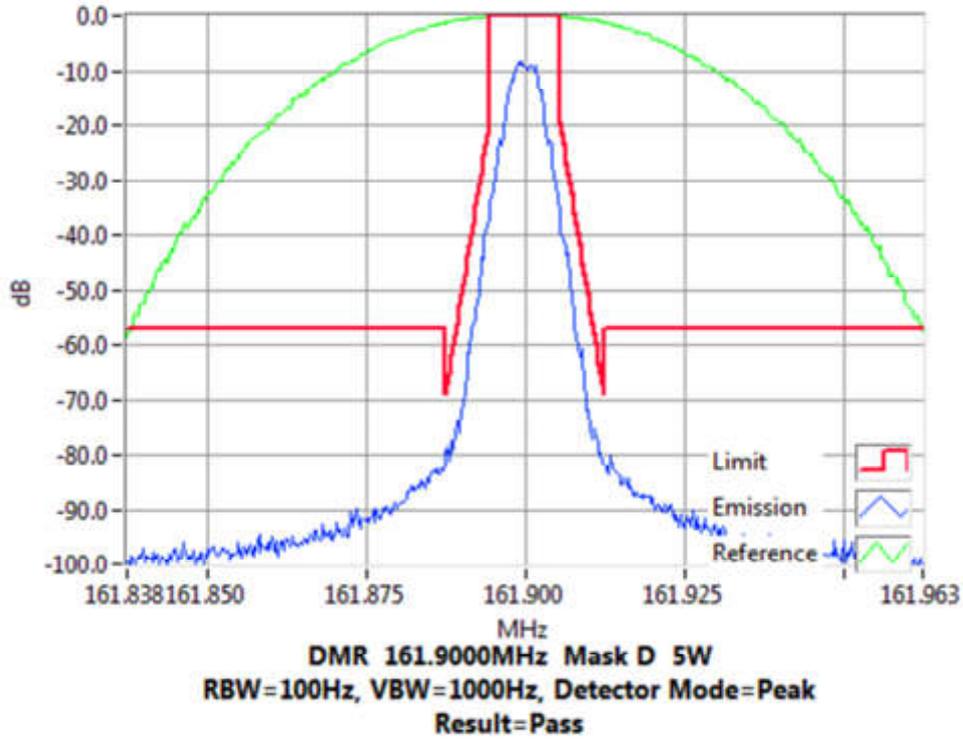
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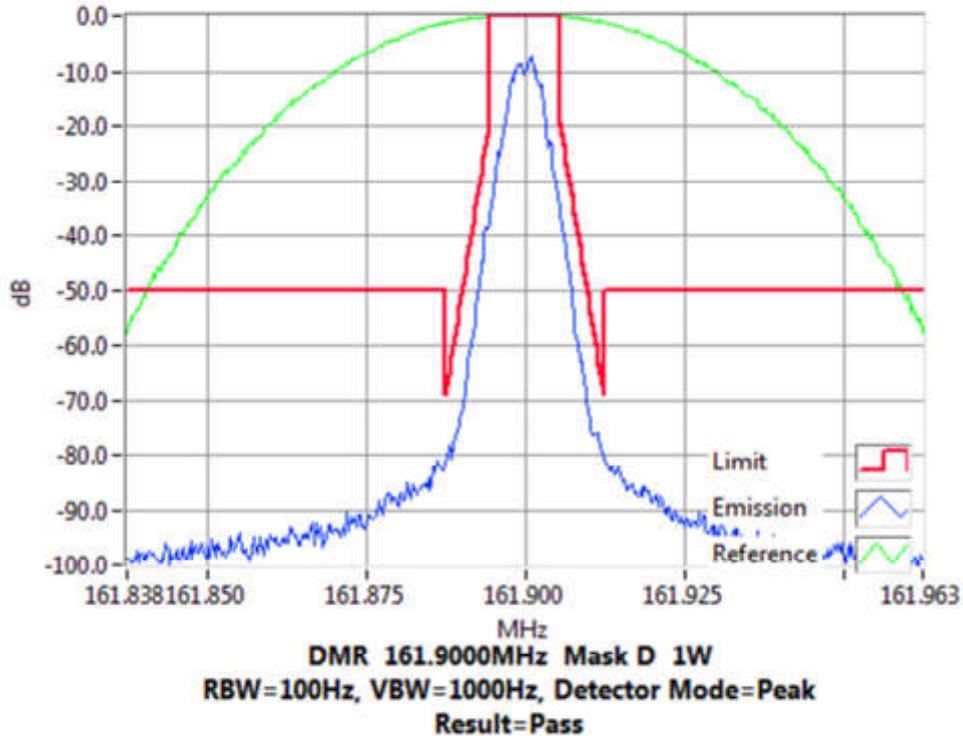
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Occupied Bandwidth and Spectrum Masks

DMR

Tx FREQUENCY: 161.9 MHz 5 W 12.5 kHz Channel Spacing



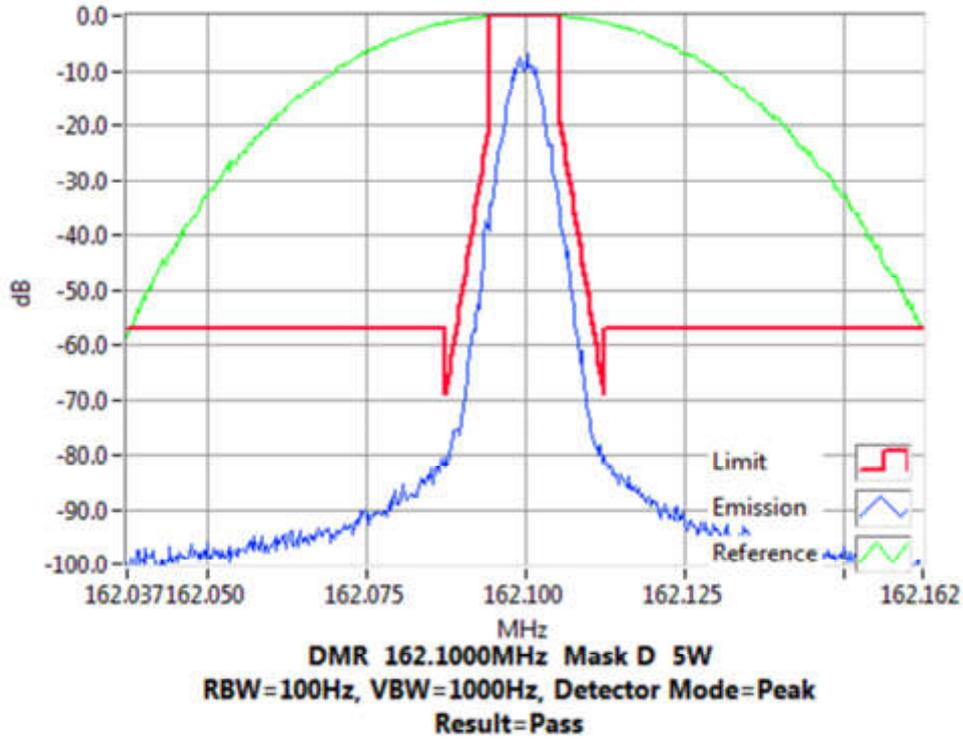
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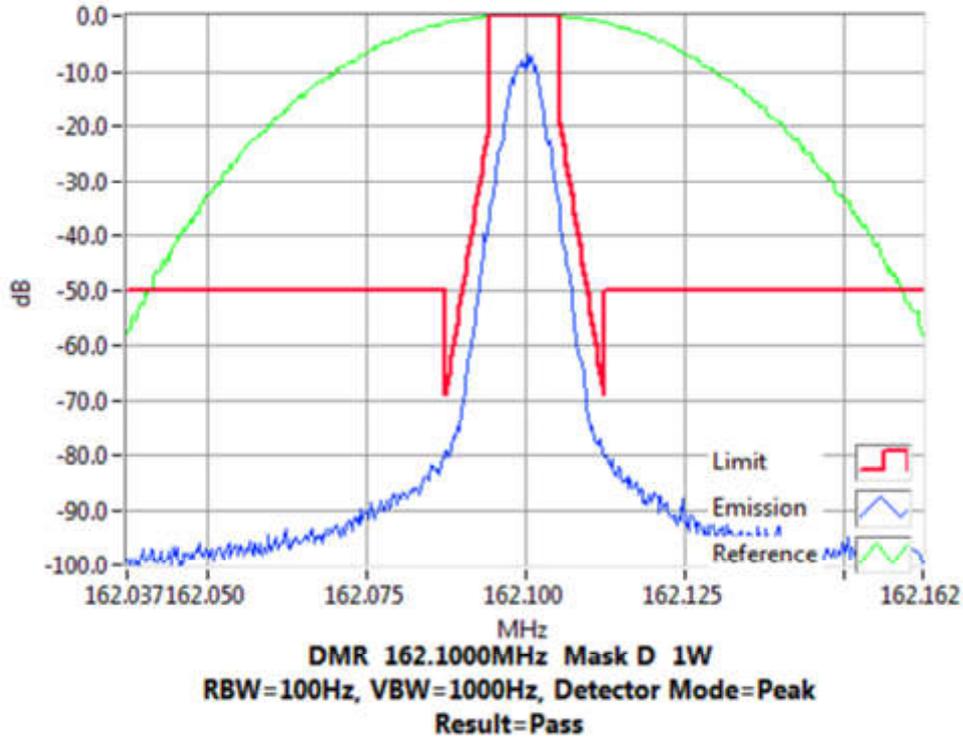
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Occupied Bandwidth and Spectrum Masks

DMR

Tx FREQUENCY: 162.1 MHz 5 W 12.5 kHz Channel Spacing



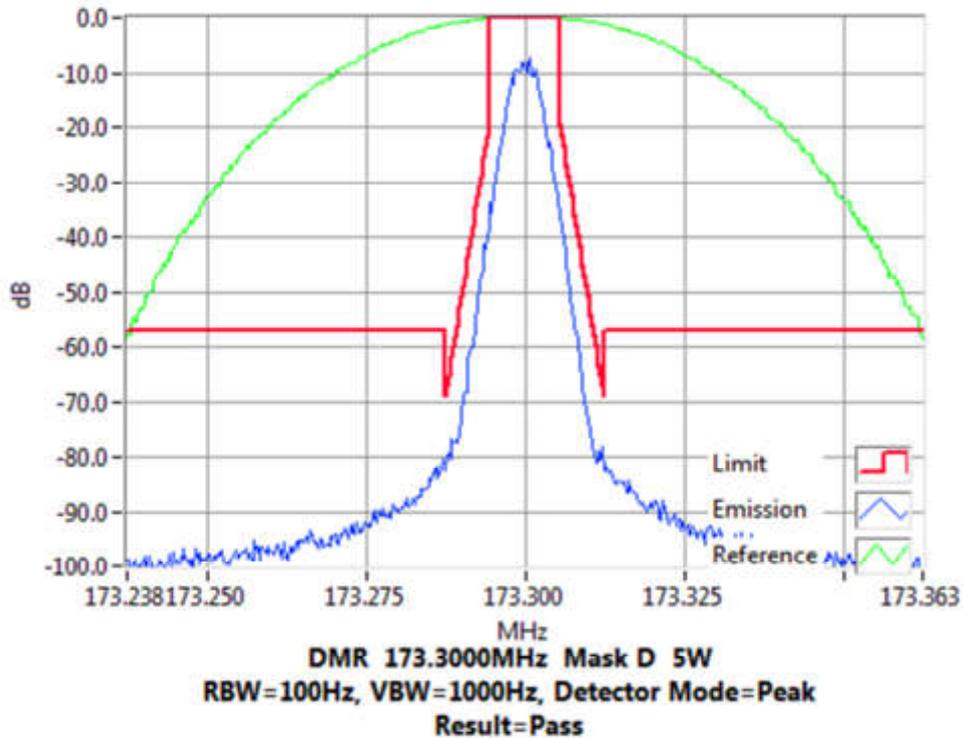
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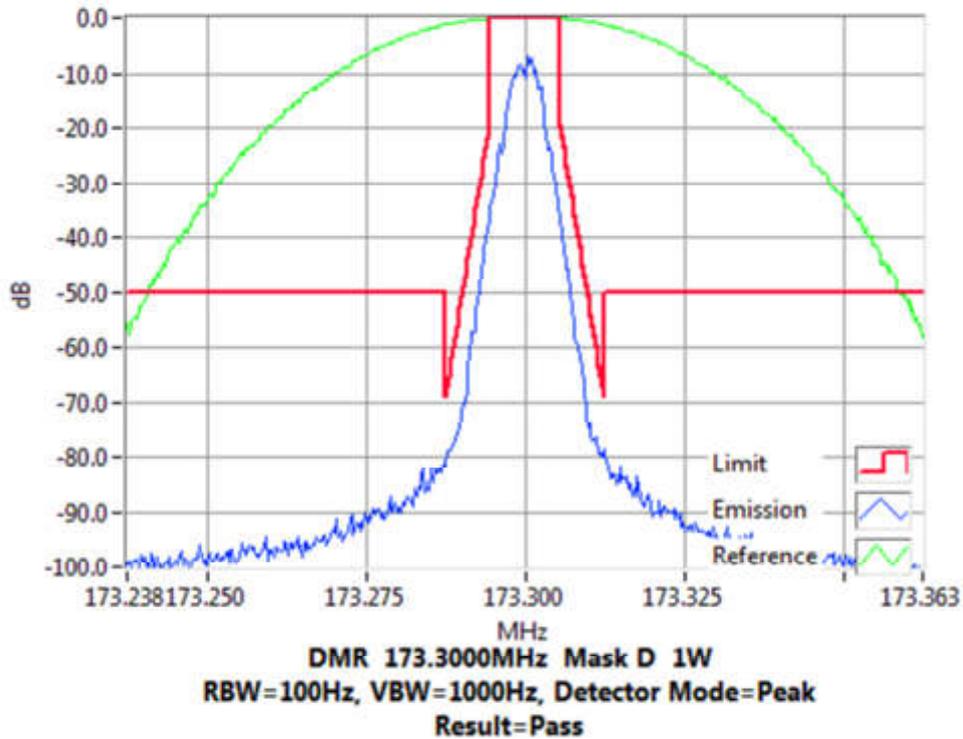
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Occupied Bandwidth and Spectrum Masks

DMR

Tx FREQUENCY: 173.3 MHz 5 W 12.5 kHz Channel Spacing



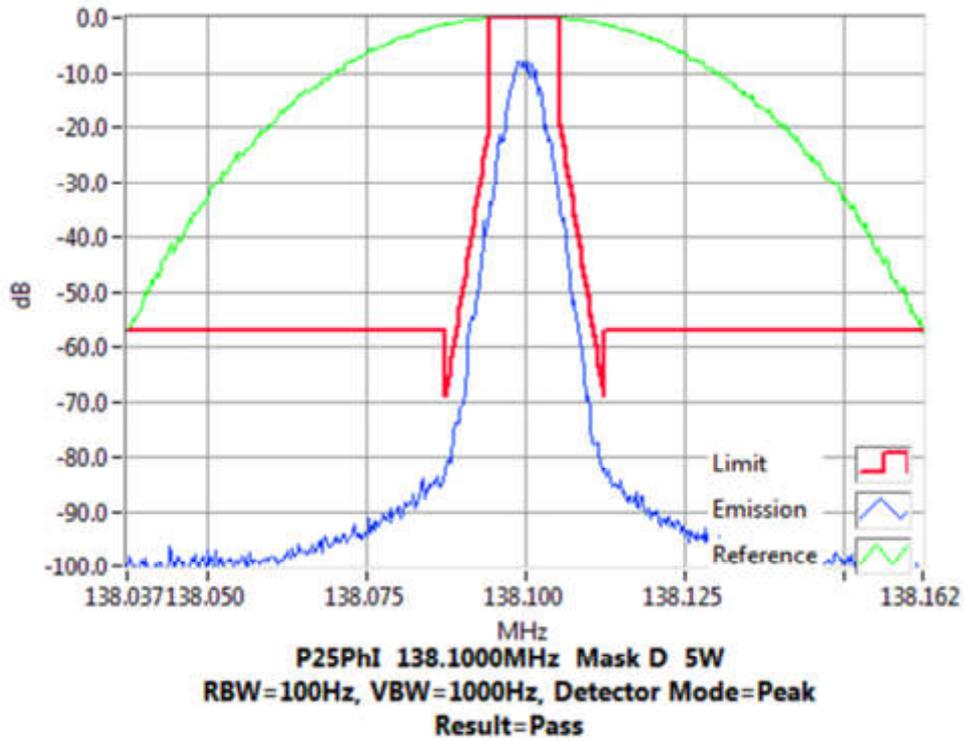
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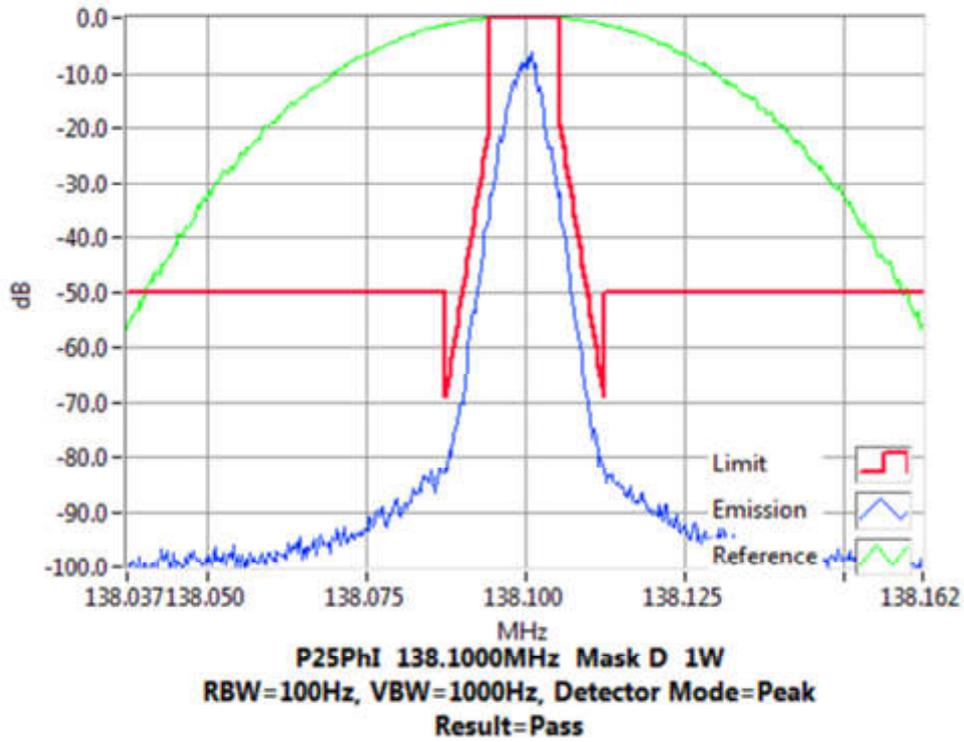
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Occupied Bandwidth and Spectrum Masks

APCO P25 phase-1

Tx FREQUENCY: 138.1 MHz 5 W 12.5 kHz Channel Spacing



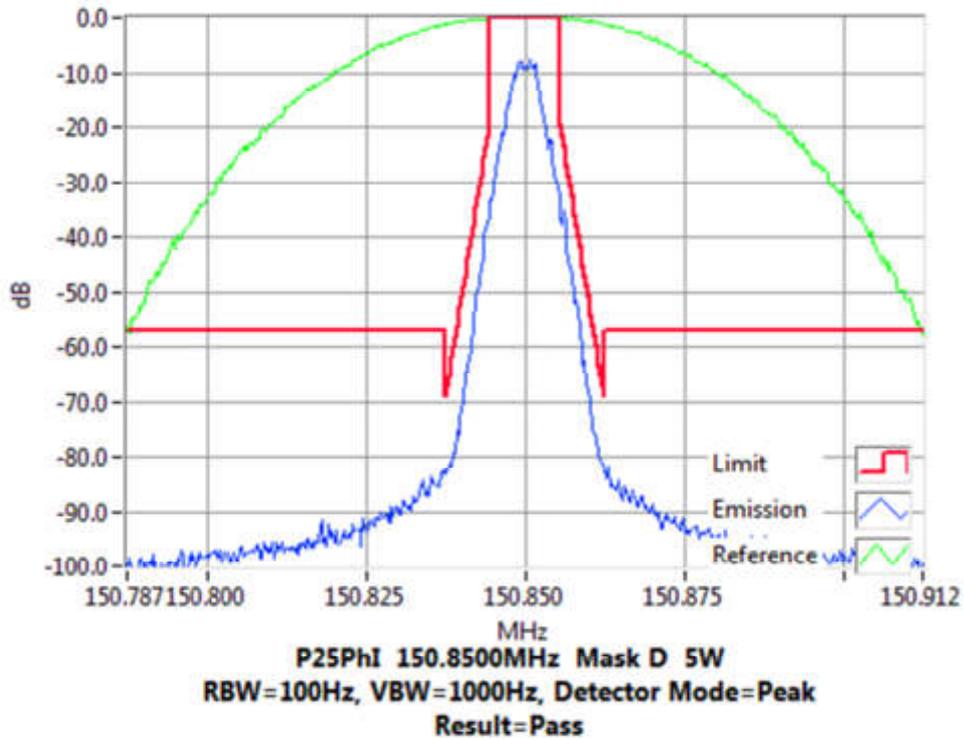
Tx FREQUENCY: 138.1 MHz 1 W 12.5 kHz Channel Spacing



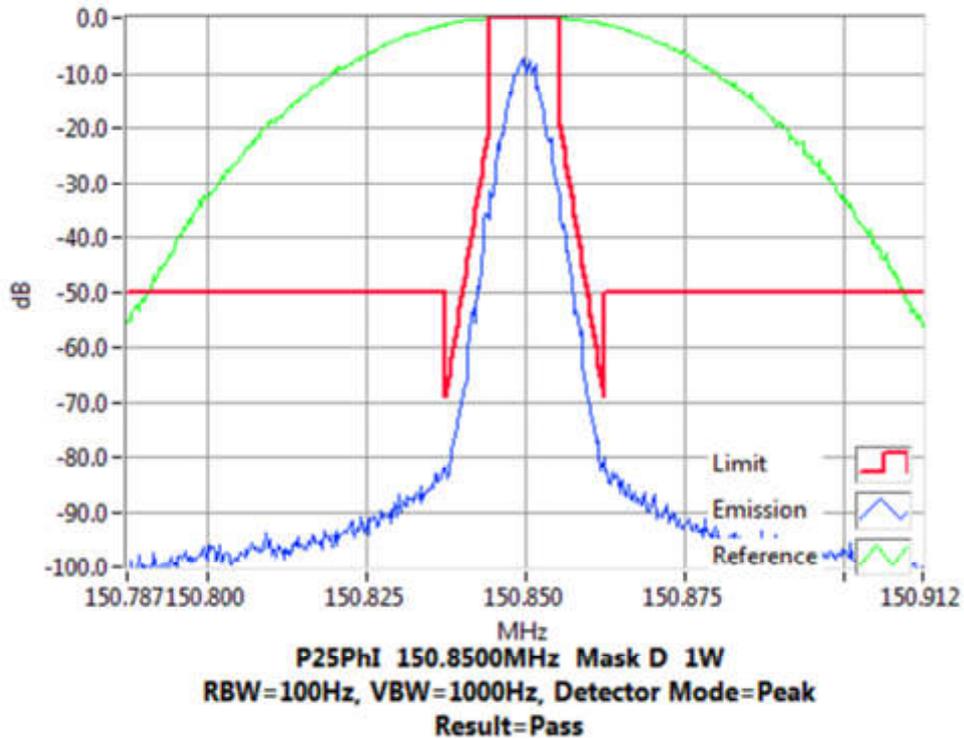
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Occupied Bandwidth and Spectrum Masks

APCO P25 phase-1

Tx FREQUENCY: 150.85 MHz 5 W 12.5 kHz Channel Spacing



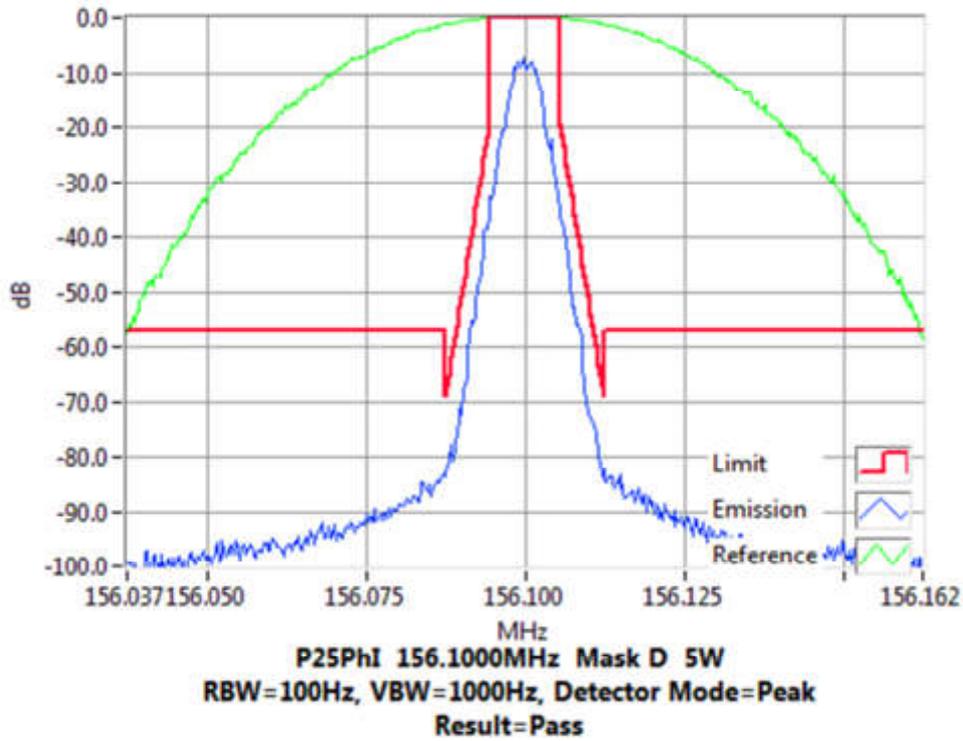
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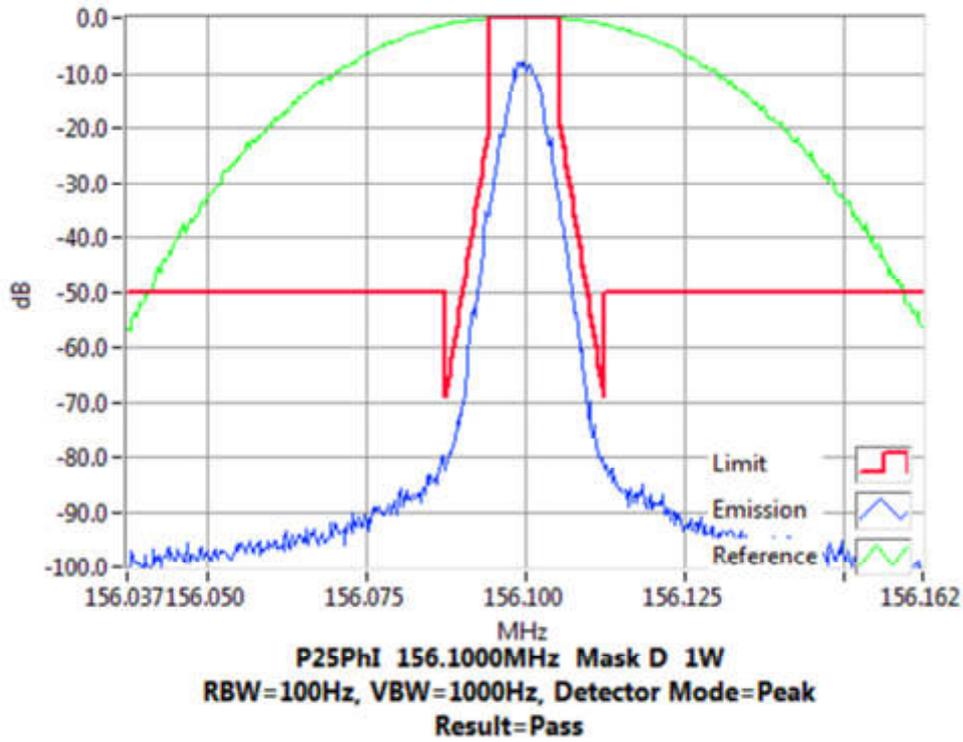
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Occupied Bandwidth and Spectrum Masks

APCO P25 phase-1

Tx FREQUENCY: 156.1 MHz 5 W 12.5 kHz Channel Spacing



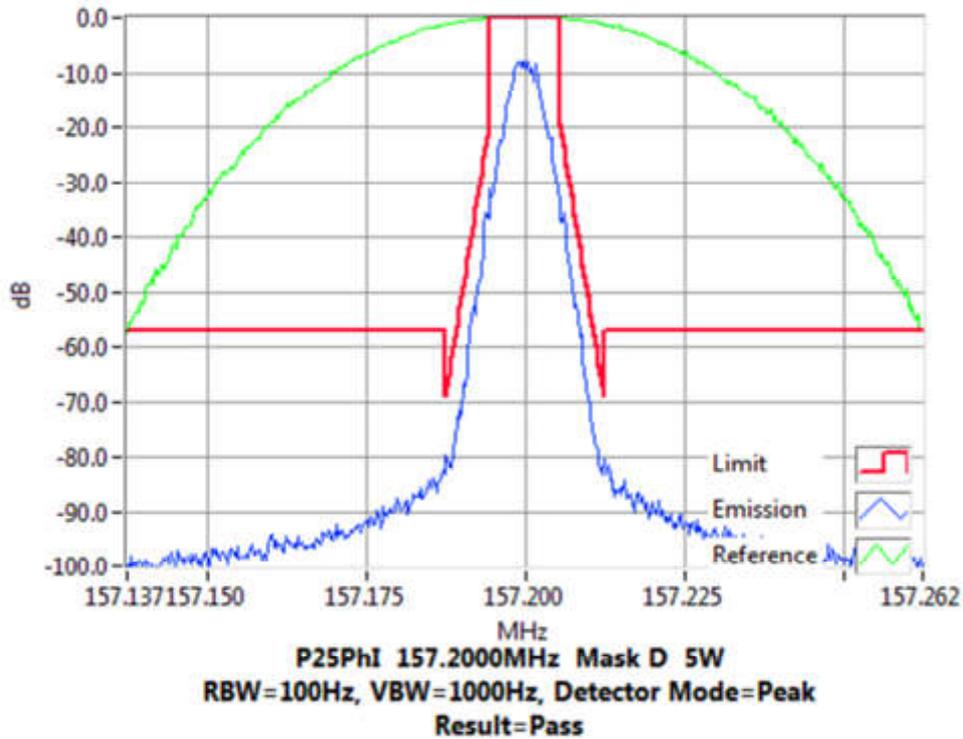
Tx FREQUENCY: 156.1 MHz 1 W 12.5 kHz Channel Spacing



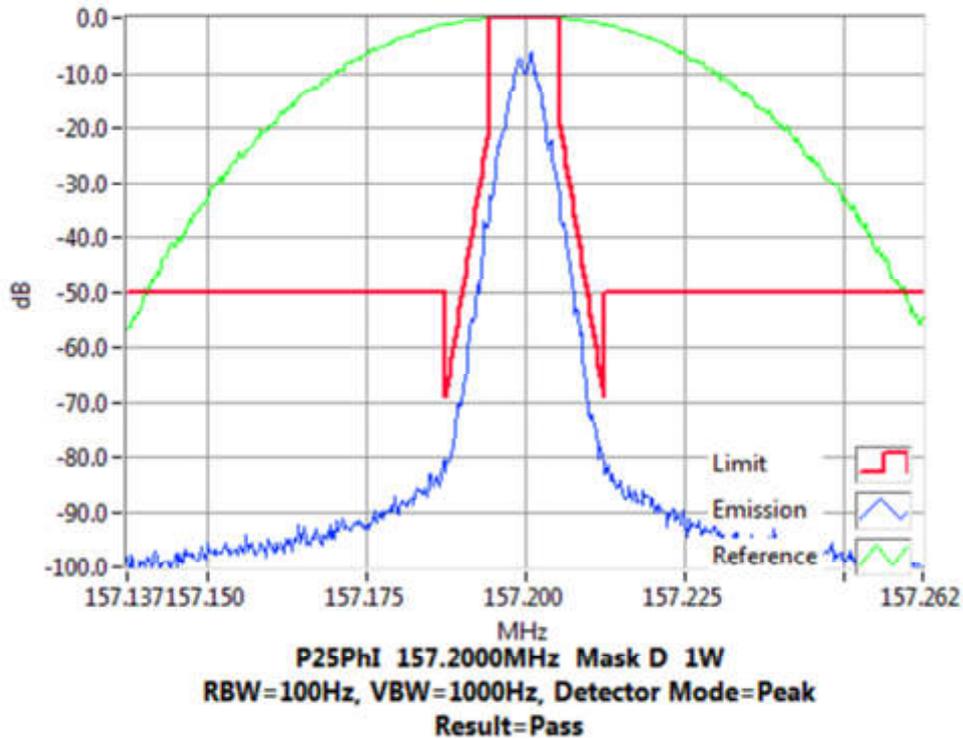
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APCO P25 phase-1

Tx FREQUENCY: 157.2 MHz 5 W 12.5 kHz Channel Spacing



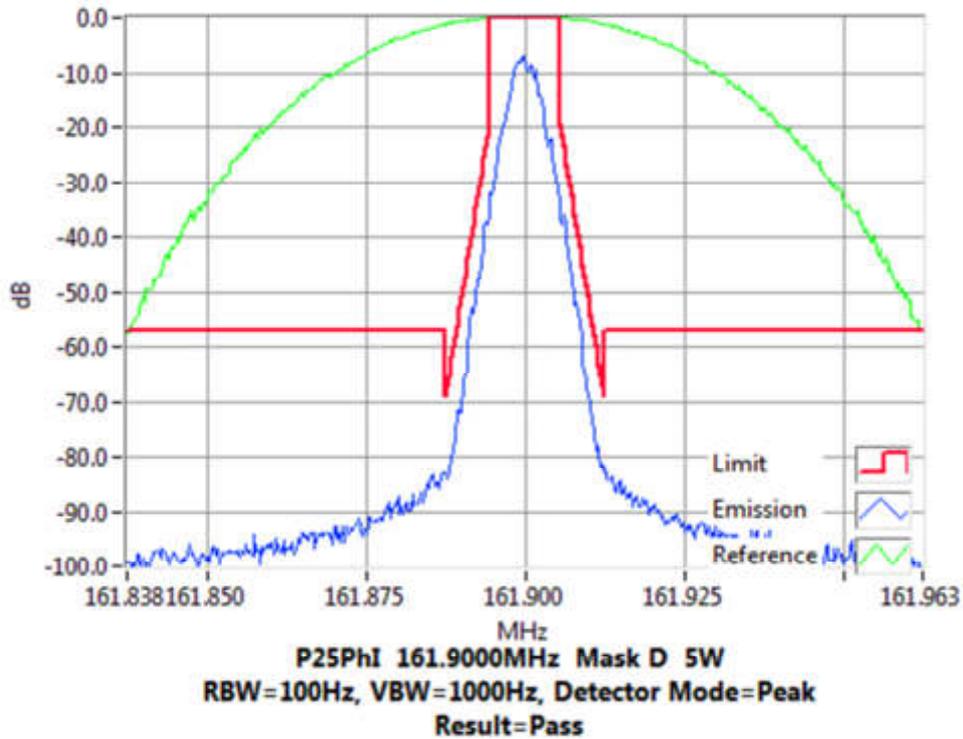
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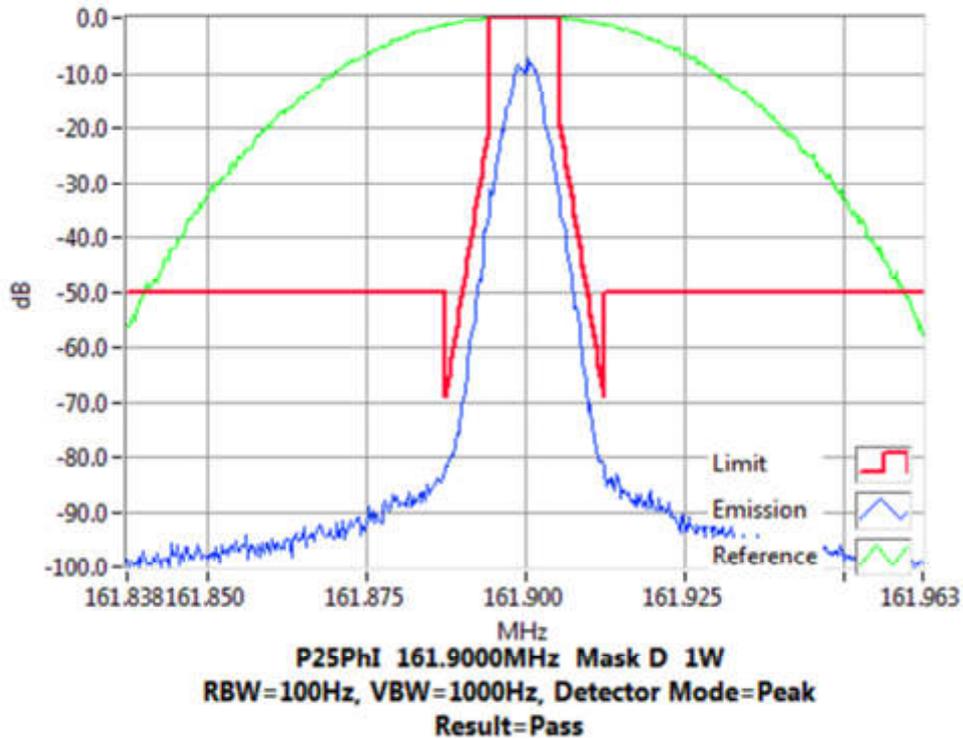
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Occupied Bandwidth and Spectrum Masks

APCO P25 phase-1

Tx FREQUENCY: 161.9 MHz 5 W 12.5 kHz Channel Spacing



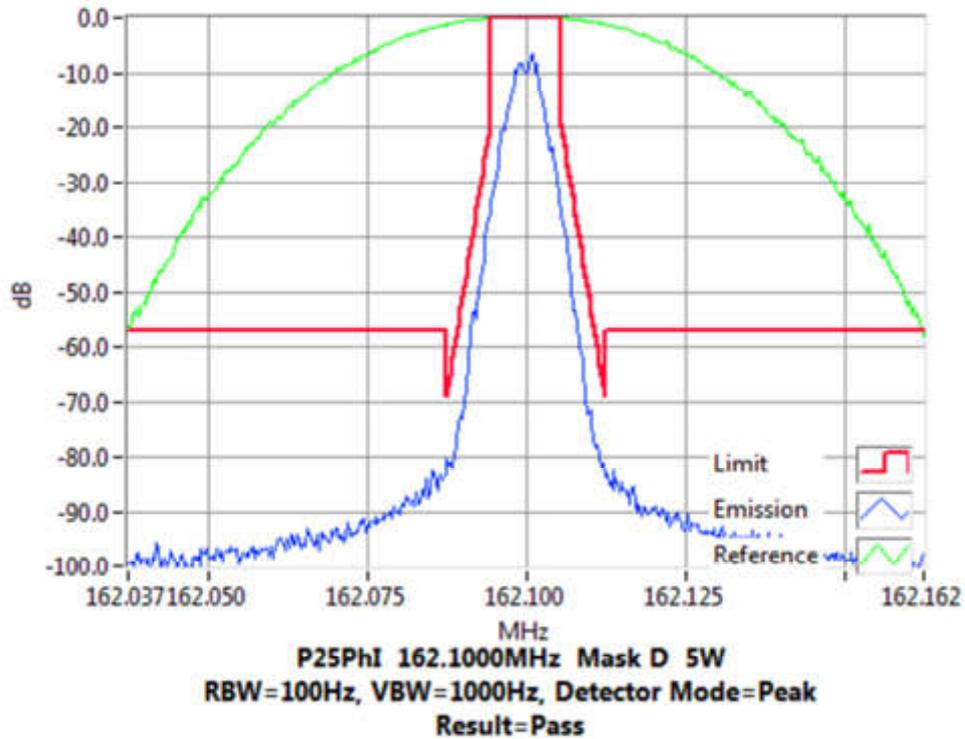
Tx FREQUENCY: 161.9 MHz 1 W 12.5 kHz Channel Spacing



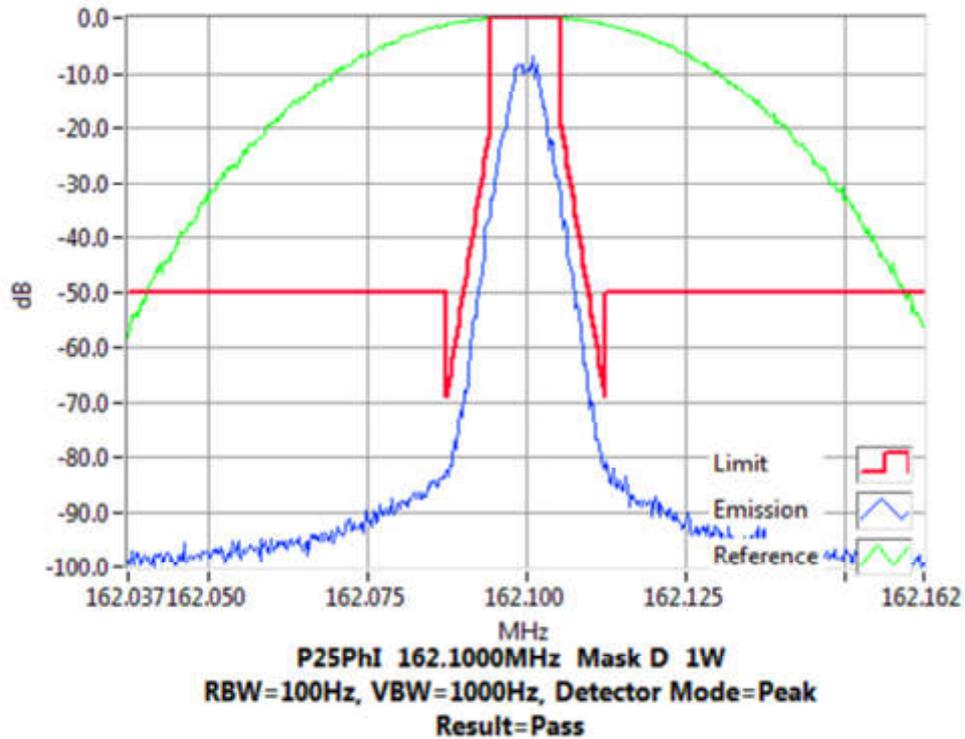
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Occupied Bandwidth and Spectrum Masks

APCO P25 phase-1

Tx FREQUENCY: 162.1 MHz 5 W 12.5 kHz Channel Spacing



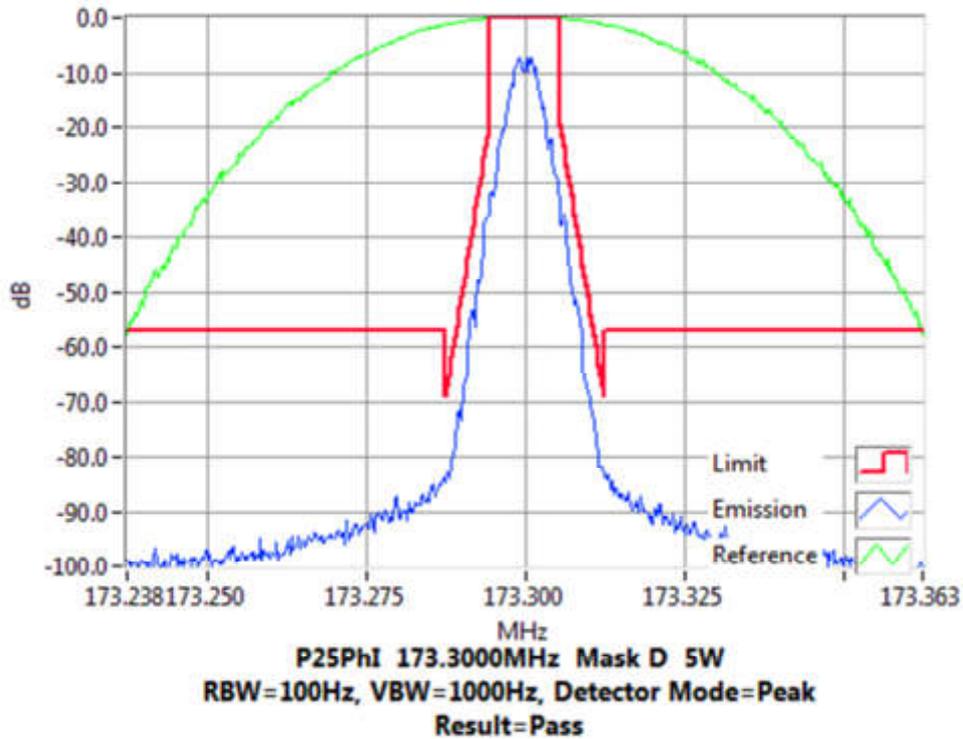
Tx FREQUENCY: 162.1 MHz 1 W 12.5 kHz Channel Spacing



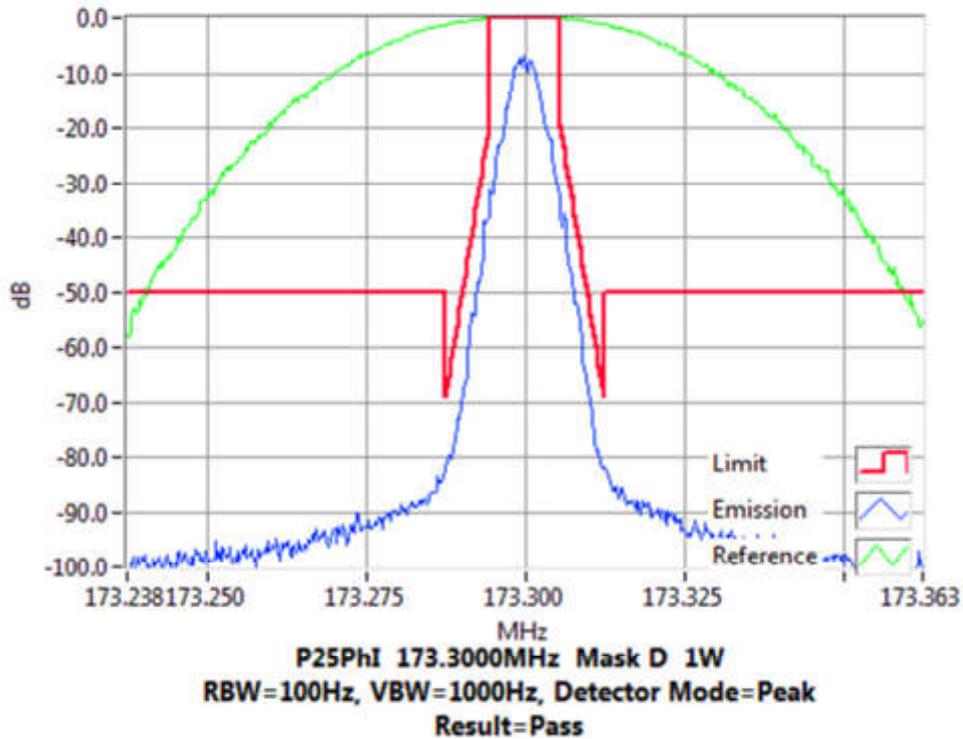
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Occupied Bandwidth and Spectrum Masks

APCO P25 phase-1

Tx FREQUENCY: 173.3 MHz 5 W 12.5 kHz Channel Spacing



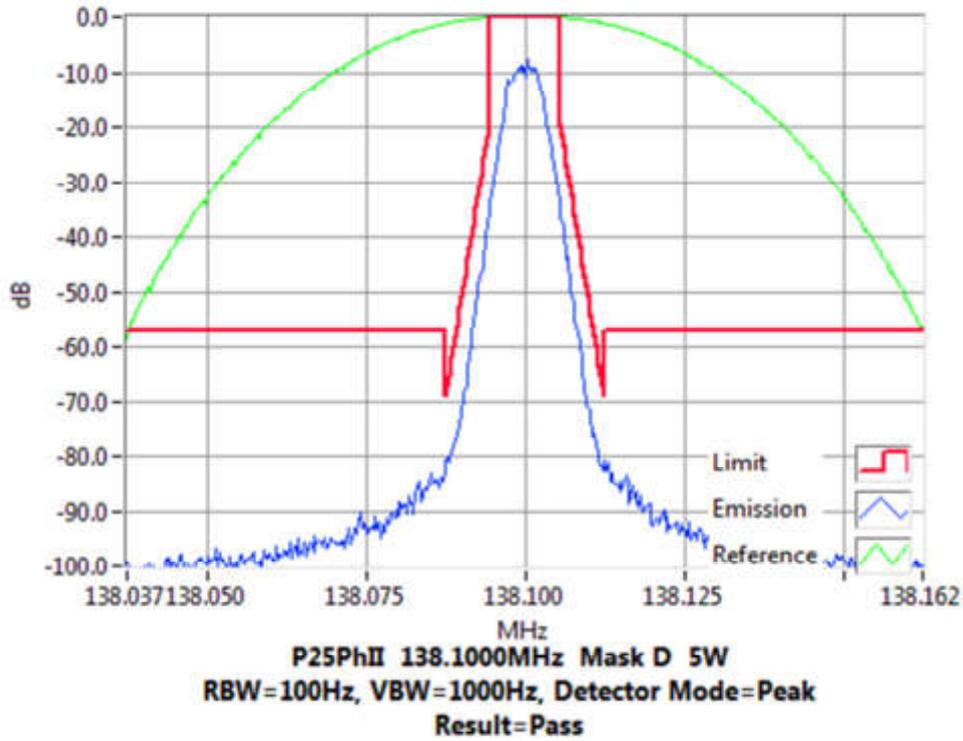
Tx FREQUENCY: 173.3 MHz 1 W 12.5 kHz Channel Spacing



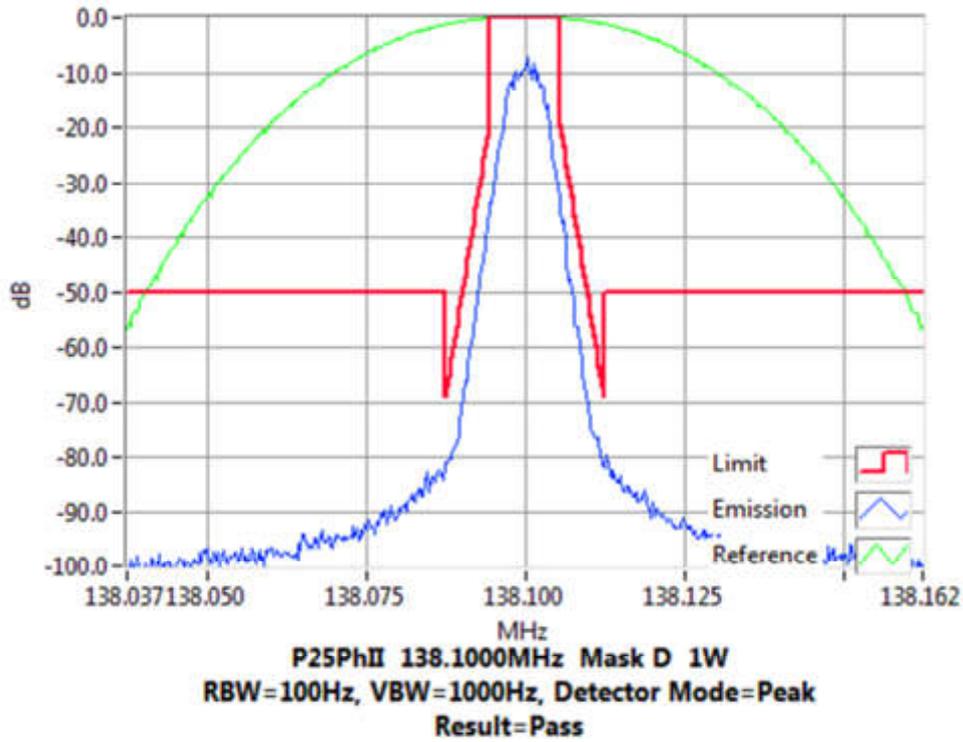
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Occupied Bandwidth and Spectrum Masks

APCO P25 phase-2

Tx FREQUENCY: 138.1 MHz 5 W 12.5 kHz Channel Spacing



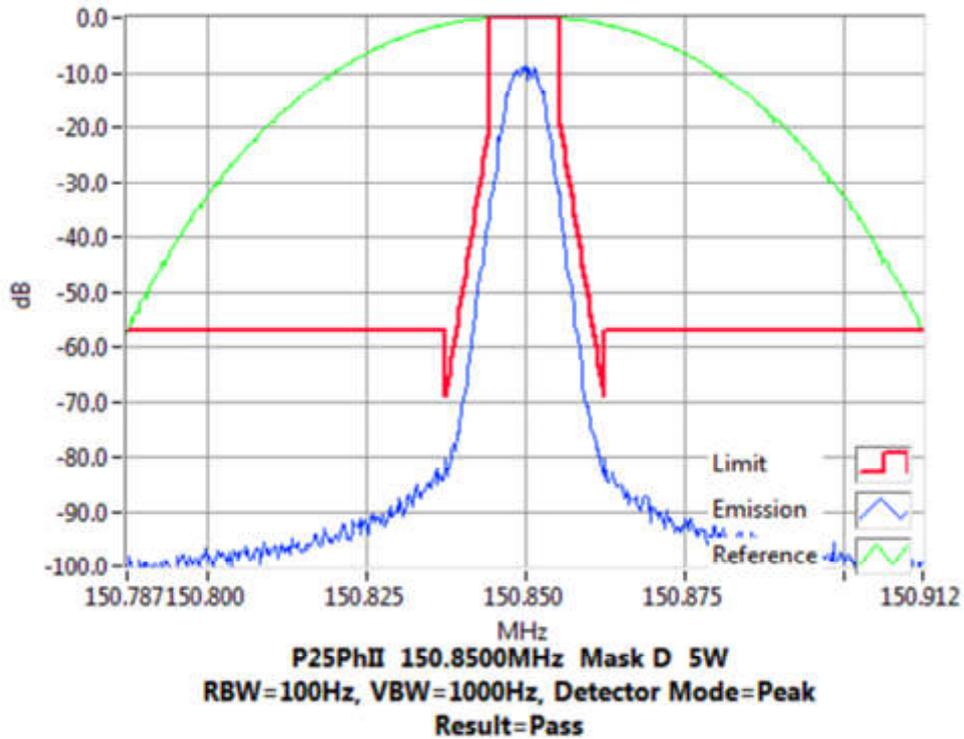
Tx FREQUENCY: 138.1 MHz 1 W 12.5 kHz Channel Spacing



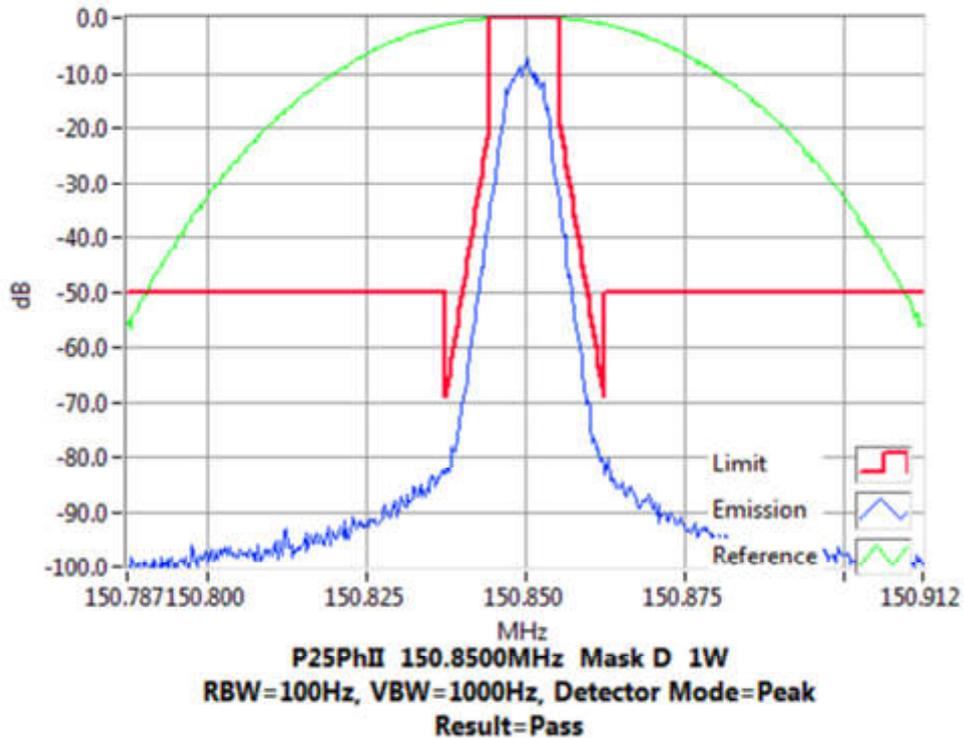
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Occupied Bandwidth and Spectrum Masks

APCO P25 phase-2

Tx FREQUENCY: 150.85 MHz 5 W 12.5 kHz Channel Spacing



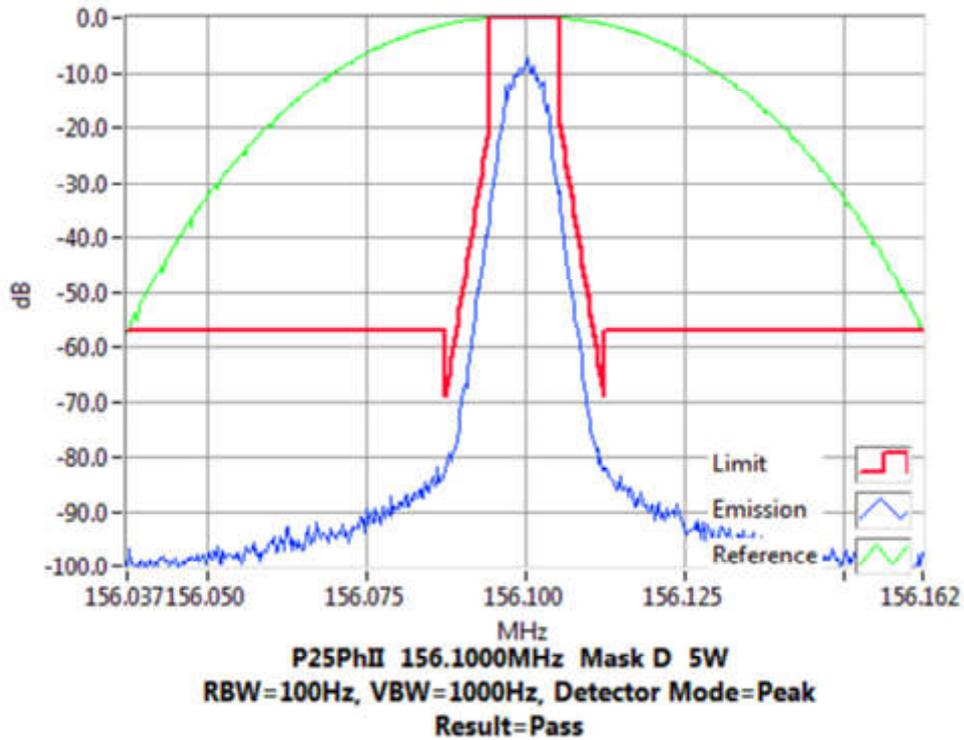
Tx FREQUENCY: 150.85 MHz 1 W 12.5 kHz Channel Spacing



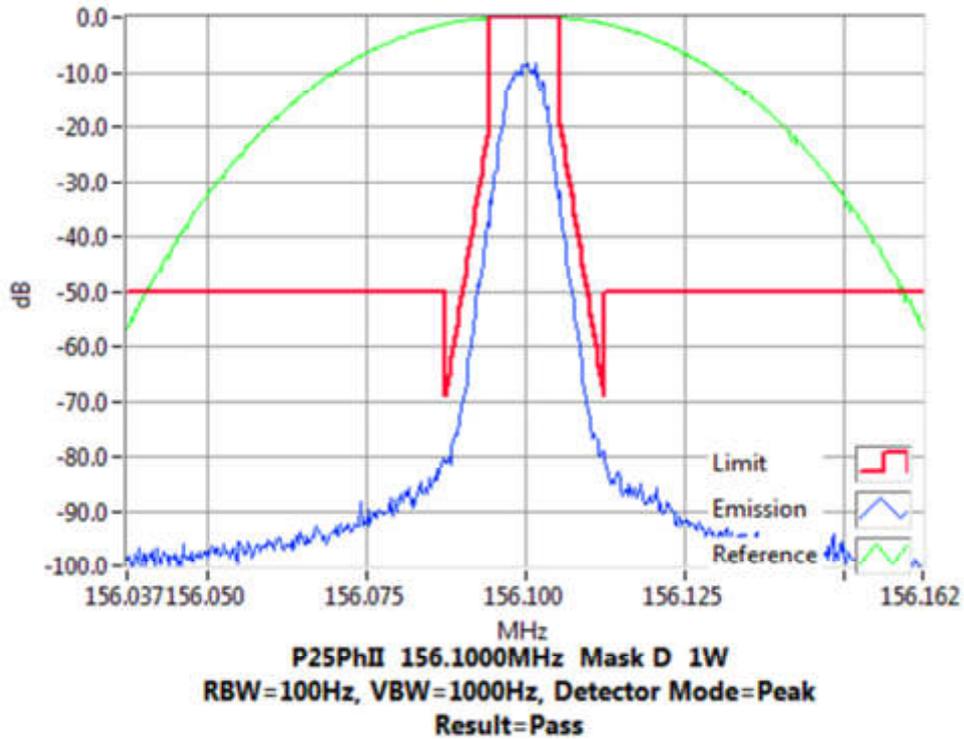
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APCO P25 phase-2

Tx FREQUENCY: 156.1 MHz 5 W 12.5 kHz Channel Spacing



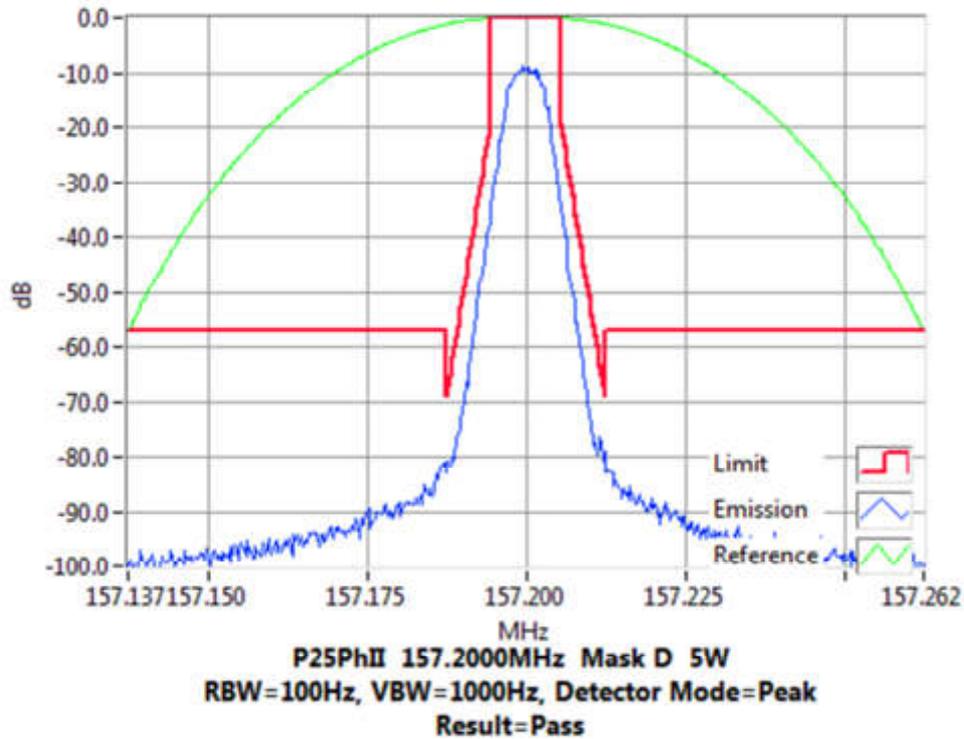
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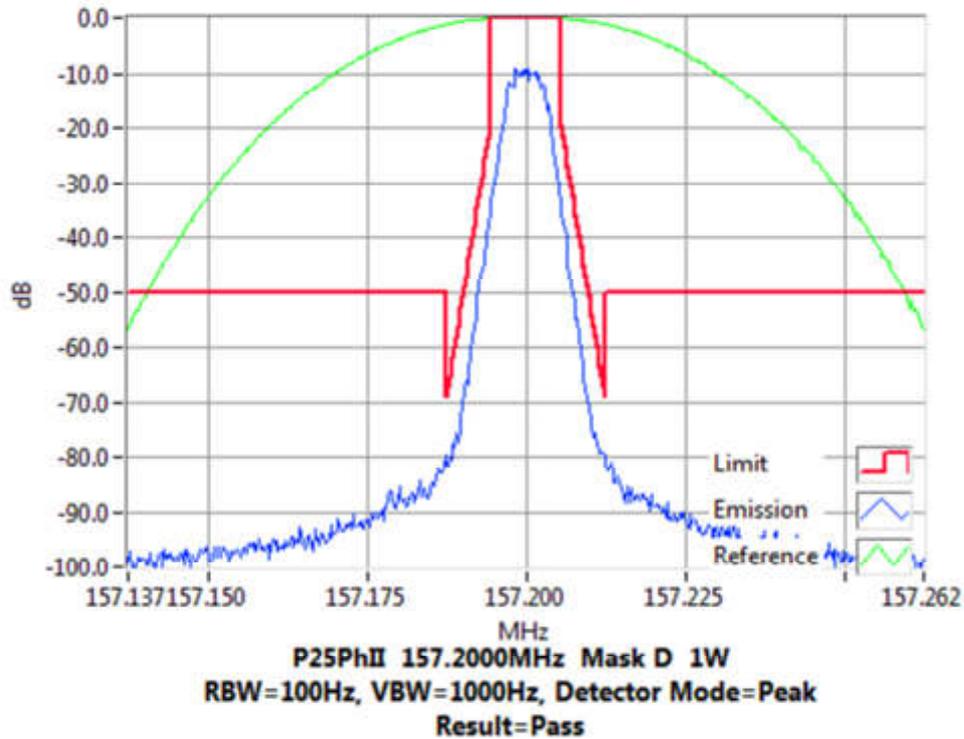
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APCO P25 phase-2

Tx FREQUENCY: 157.2 MHz 5 W 12.5 kHz Channel Spacing



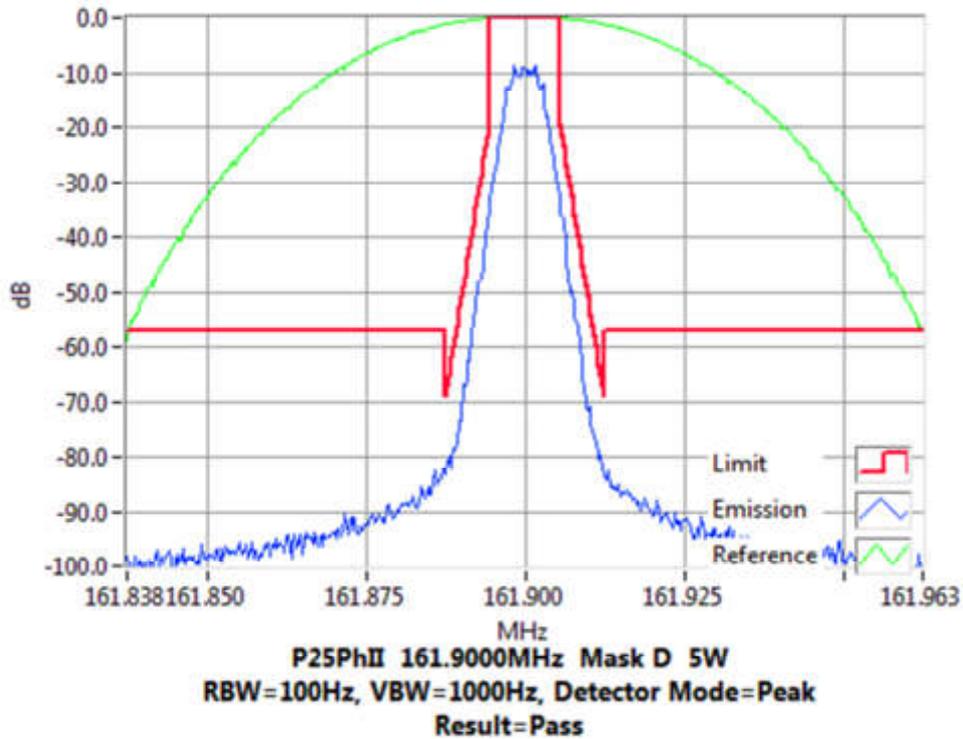
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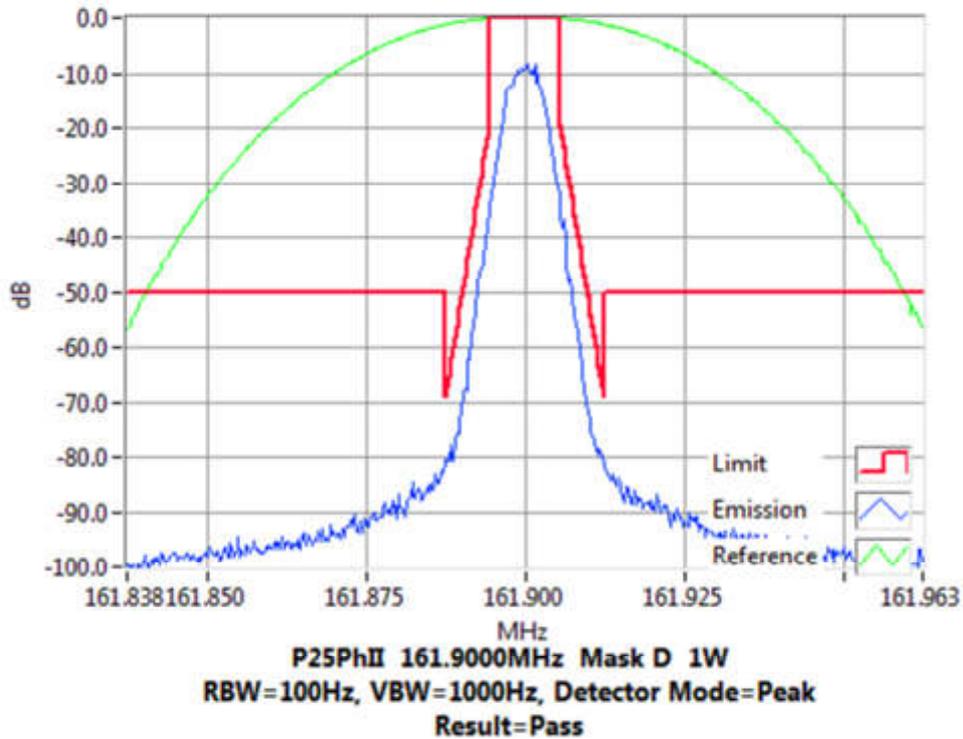
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APCO P25 phase-2

Tx FREQUENCY: 161.9 MHz 5 W 12.5 kHz Channel Spacing



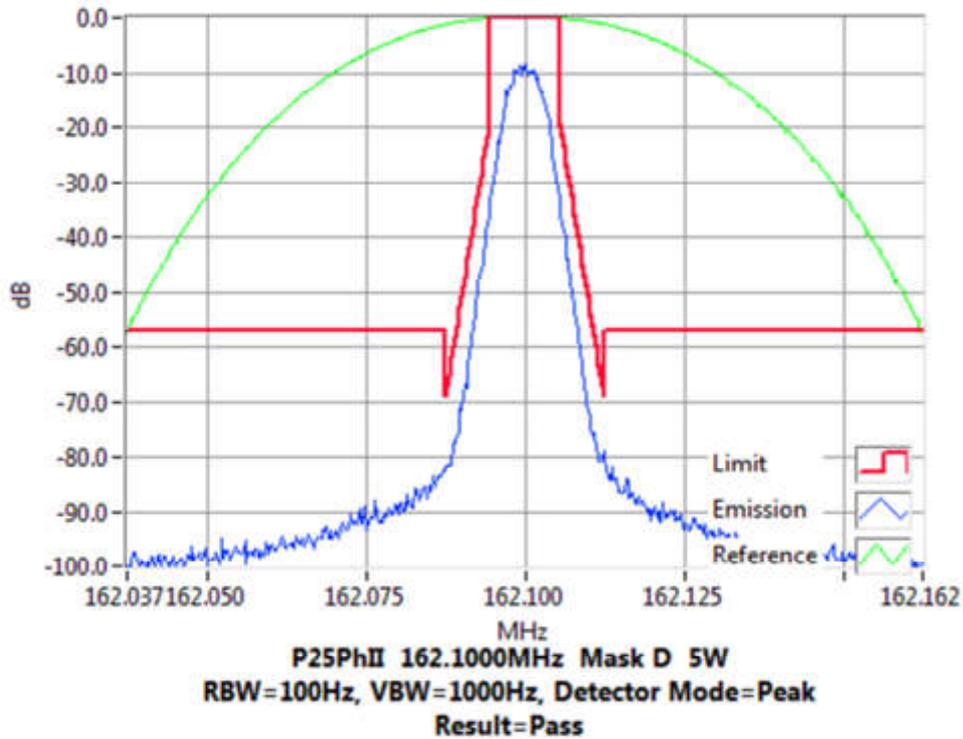
Tx FREQUENCY: 161.9 MHz 1 W 12.5 kHz Channel Spacing



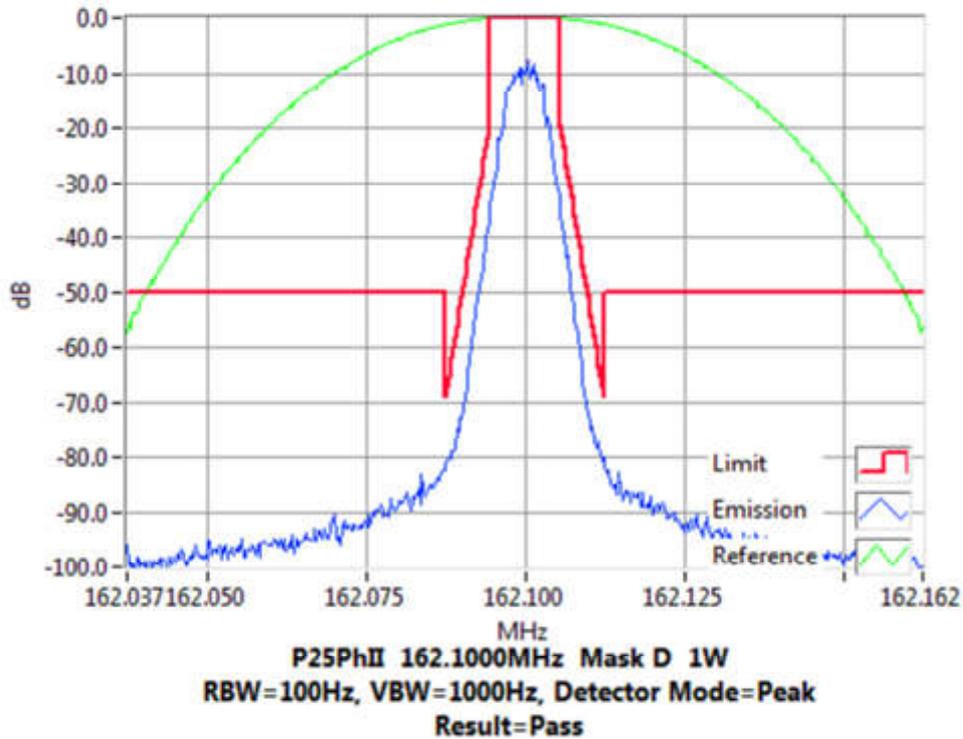
TELTEST Laboratories
Tait International Ltd
Report Number 3997
Occupied Bandwidth and Spectrum Masks

APCO P25 phase-2

Tx FREQUENCY: 162.1 MHz 5 W 12.5 kHz Channel Spacing



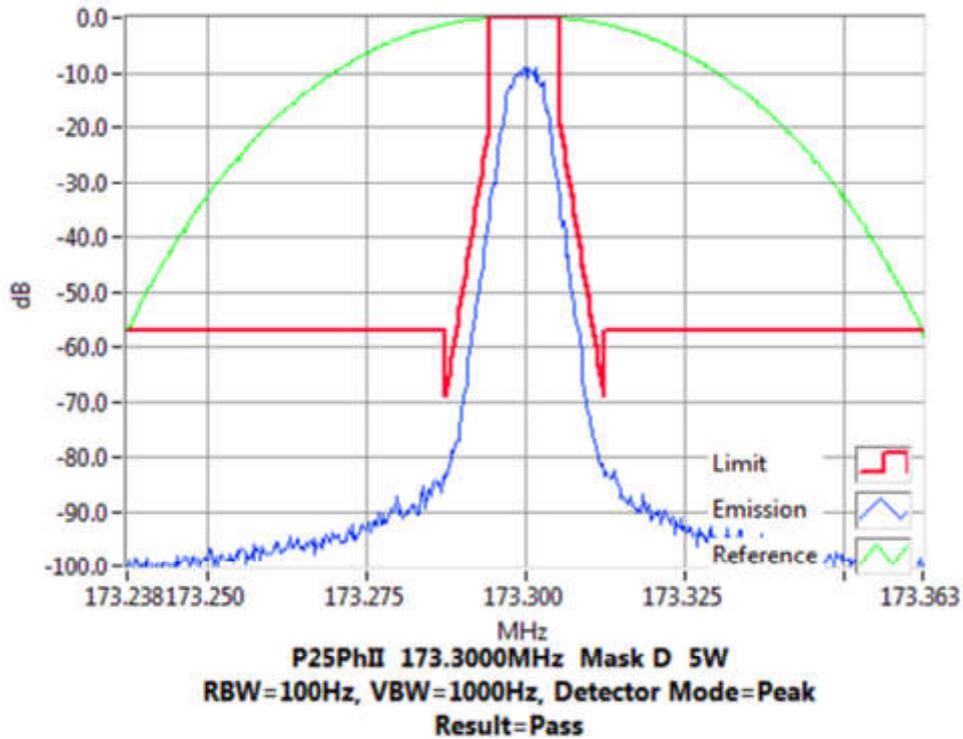
Tx FREQUENCY: 162.1 MHz 1 W 12.5 kHz Channel Spacing



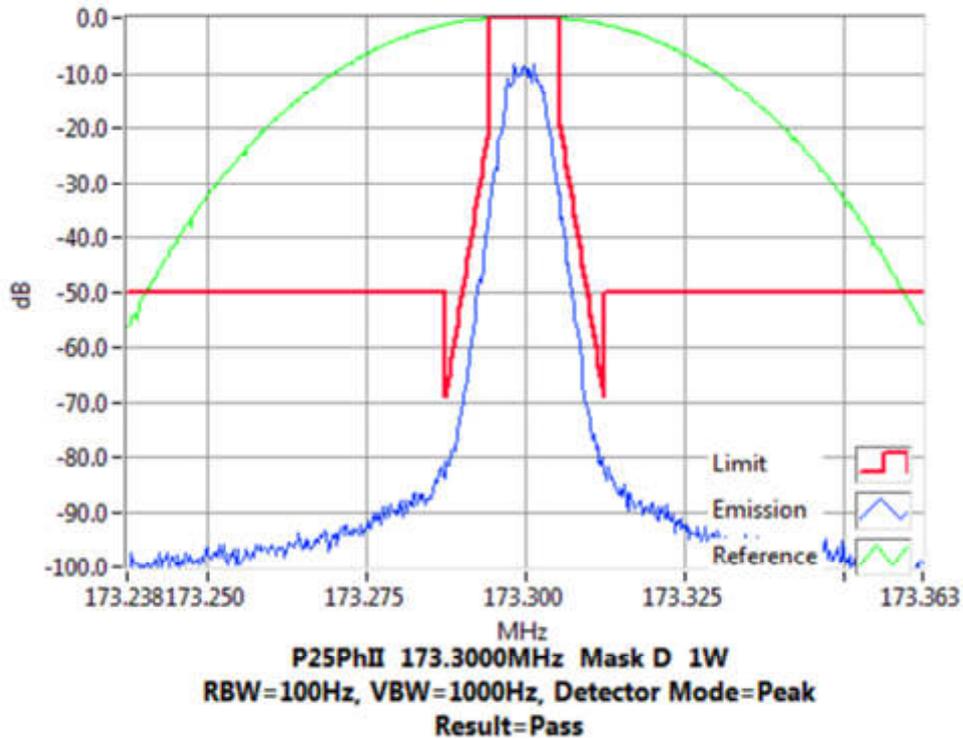
TELTEST Laboratories
Tait International Ltd
Report Number 3997
Occupied Bandwidth and Spectrum Masks

APCO P25 phase-2

Tx FREQUENCY: 173.3 MHz 5 W 12.5 kHz Channel Spacing



Tx FREQUENCY: 173.3 MHz 1 W 12.5 kHz Channel Spacing



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 (2 GHz)
3. The EUT was set to transmit high or low power, modulated with DMR. 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 2 GHz.
4. For each frequency range the spectrum analyser was loaded with the appropriate calibration figures to compensate for the cables, attenuator and filter losses, allowing the emission levels to be read directly with no further calculation.
The calibrations are loaded as an overall reference level offset plus a set of correction factors for the required frequency band.

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

Example of attenuation correction:

| | | |
|------------------------------|-------|----------------------------------|
| 30dB 350W CK9178 | 32.09 | |
| 2m Black4 | 0.36 | |
| 2m Black5 | 0.35 | |
| E3382 135_175MHz HPBRF | 0.96 | |
| Total Attenuation @ 414 M Hz | 33.75 | Sum of component attenuation (a) |
| Amplitude offset | 33.66 | (b) |
| Correction @ 414 MHz | 0.1 | (a-b) |

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

MEASUREMENT RESULTS:

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

LIMIT CLAUSES: FCC 47 CFR 90.210

Photo: Conducted Emissions Test Setup



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Tait International Ltd
Report Number 3997
Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

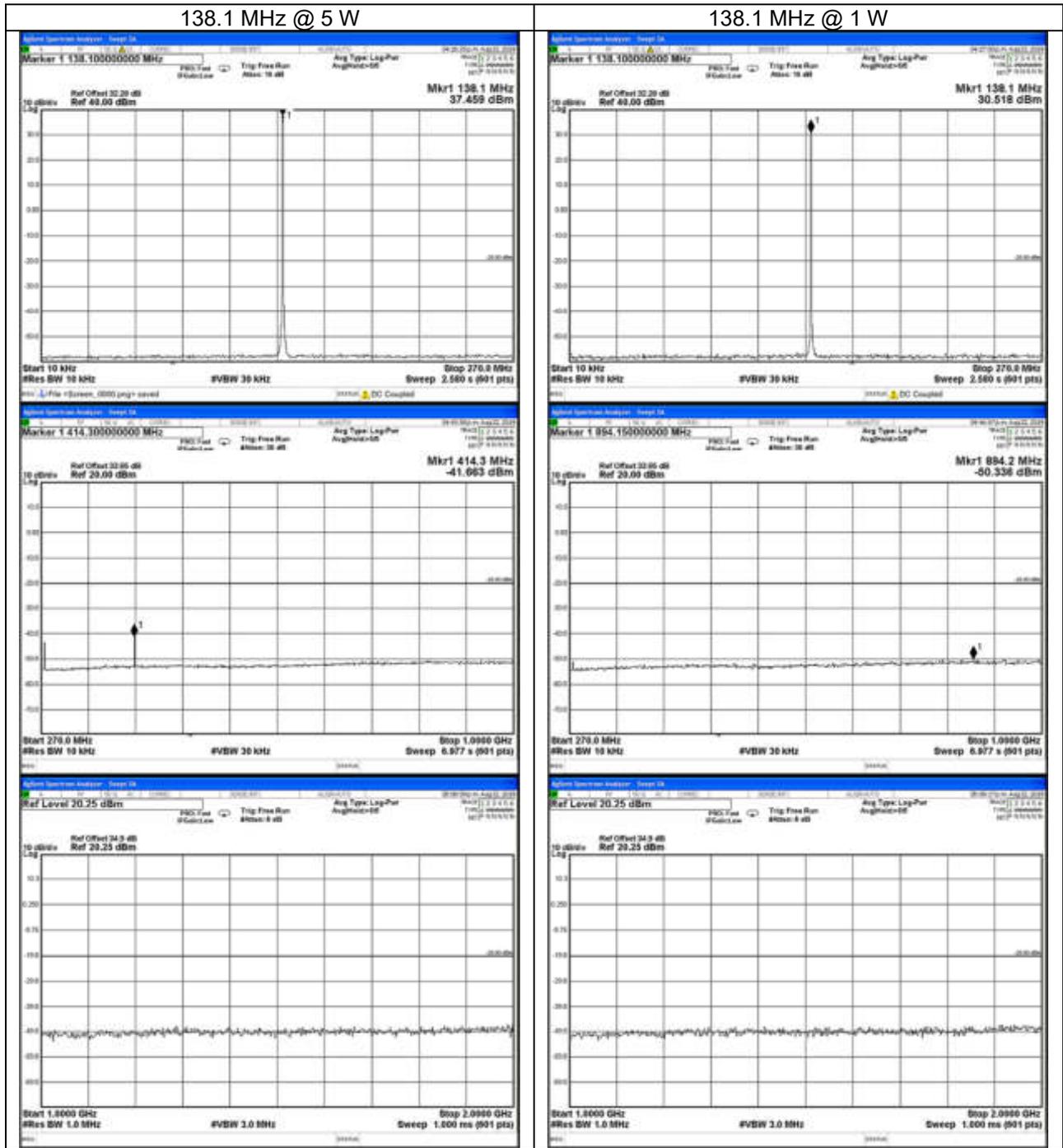
12.5 kHz Channel Spacing 138.1 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 138.1 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. | | |

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 Spurious Emissions (Tx Conducted)



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

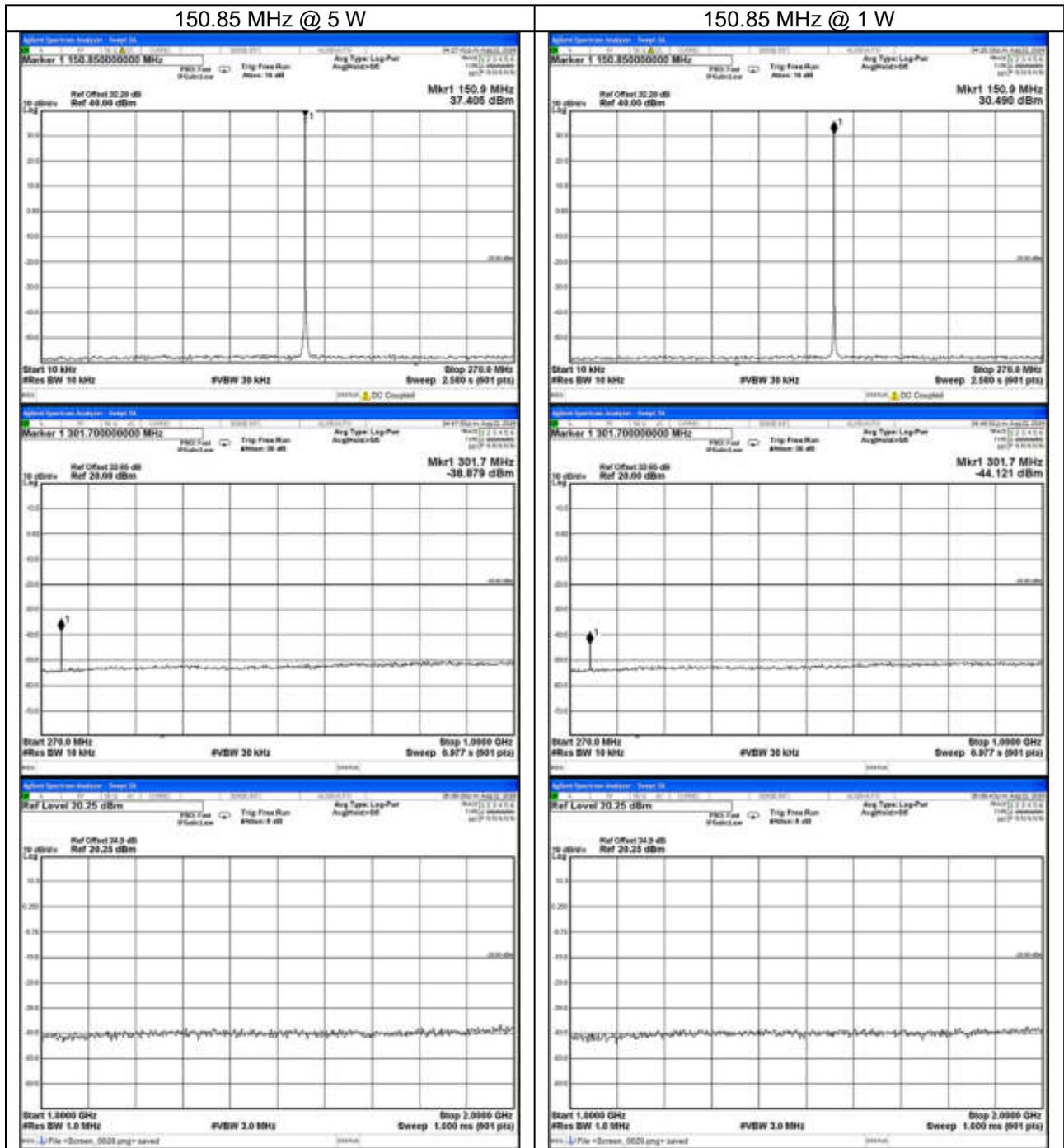
12.5 kHz Channel Spacing 150.85 MHz @ 5 W Emission Mask D

| Emission Frequency (MHz) | Level (dBm) | Level (dBc) |
|--------------------------|-------------|-------------|
| 301.7 | -38.9 | -75.9 |
| ~ | ~ | ~ |

12.5 kHz Channel Spacing 150.85 MHz @ 1 W Emission Mask D

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

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Spurious Emissions (Tx Conducted)



TELTEST Laboratories
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Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

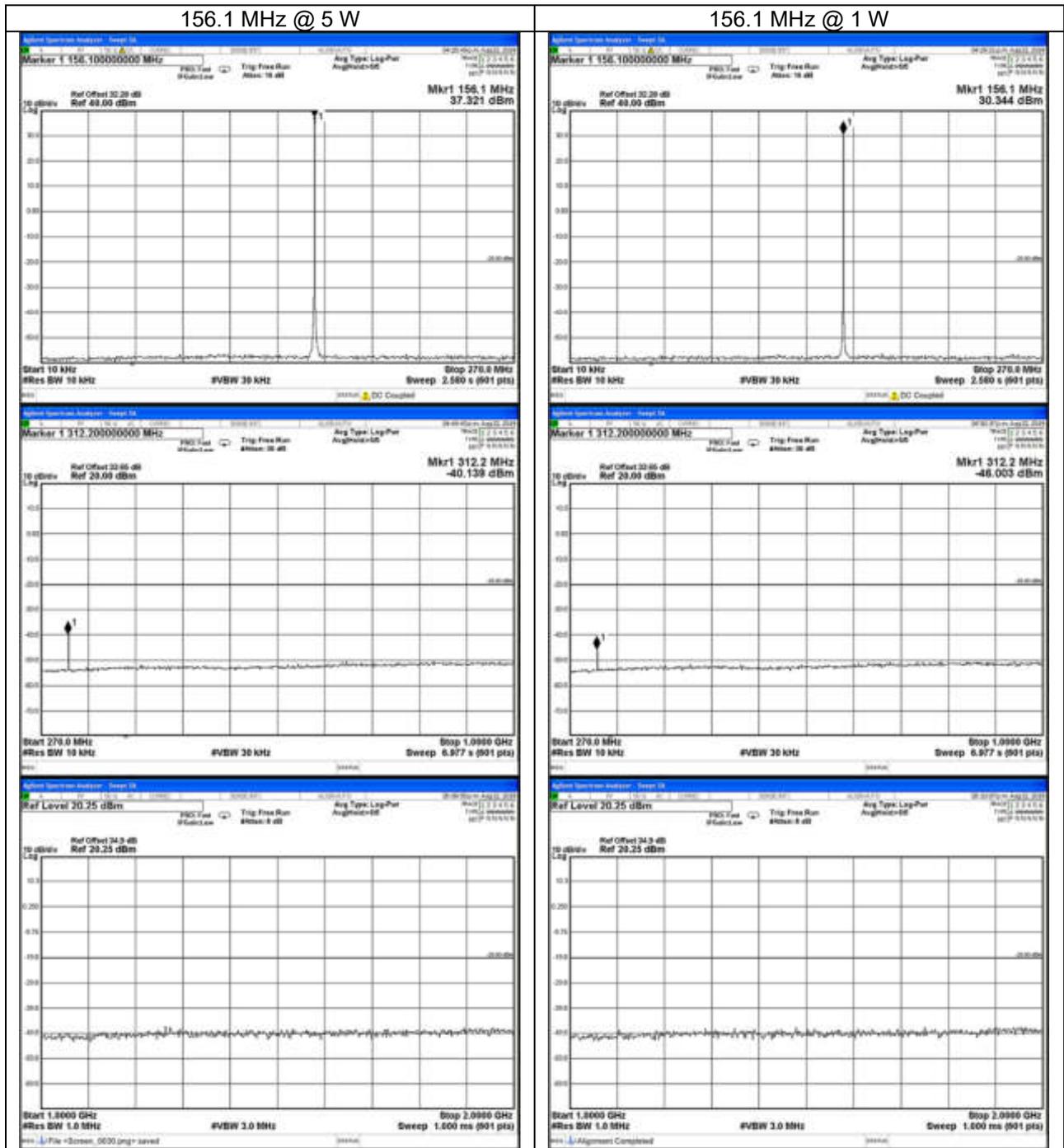
12.5 kHz Channel Spacing 156.1 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 156.1 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. | | |

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 Spurious Emissions (Tx Conducted)



TELTEST Laboratories
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Report Number 3997
Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

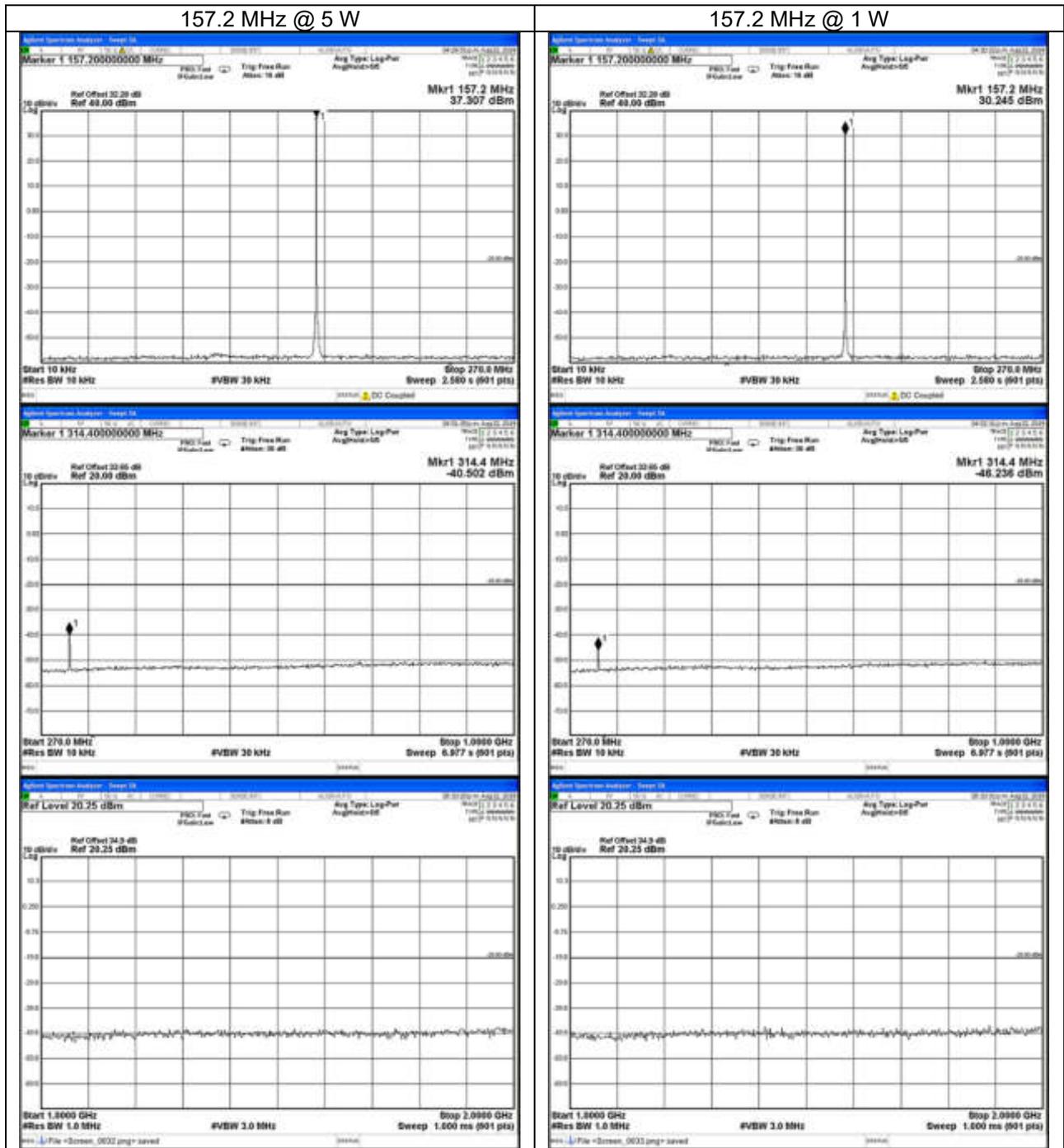
12.5 kHz Channel Spacing 157.2 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 157.2 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. | | |

TELTEST Laboratories
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 Report Number 3997
 Spurious Emissions (Tx Conducted)



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

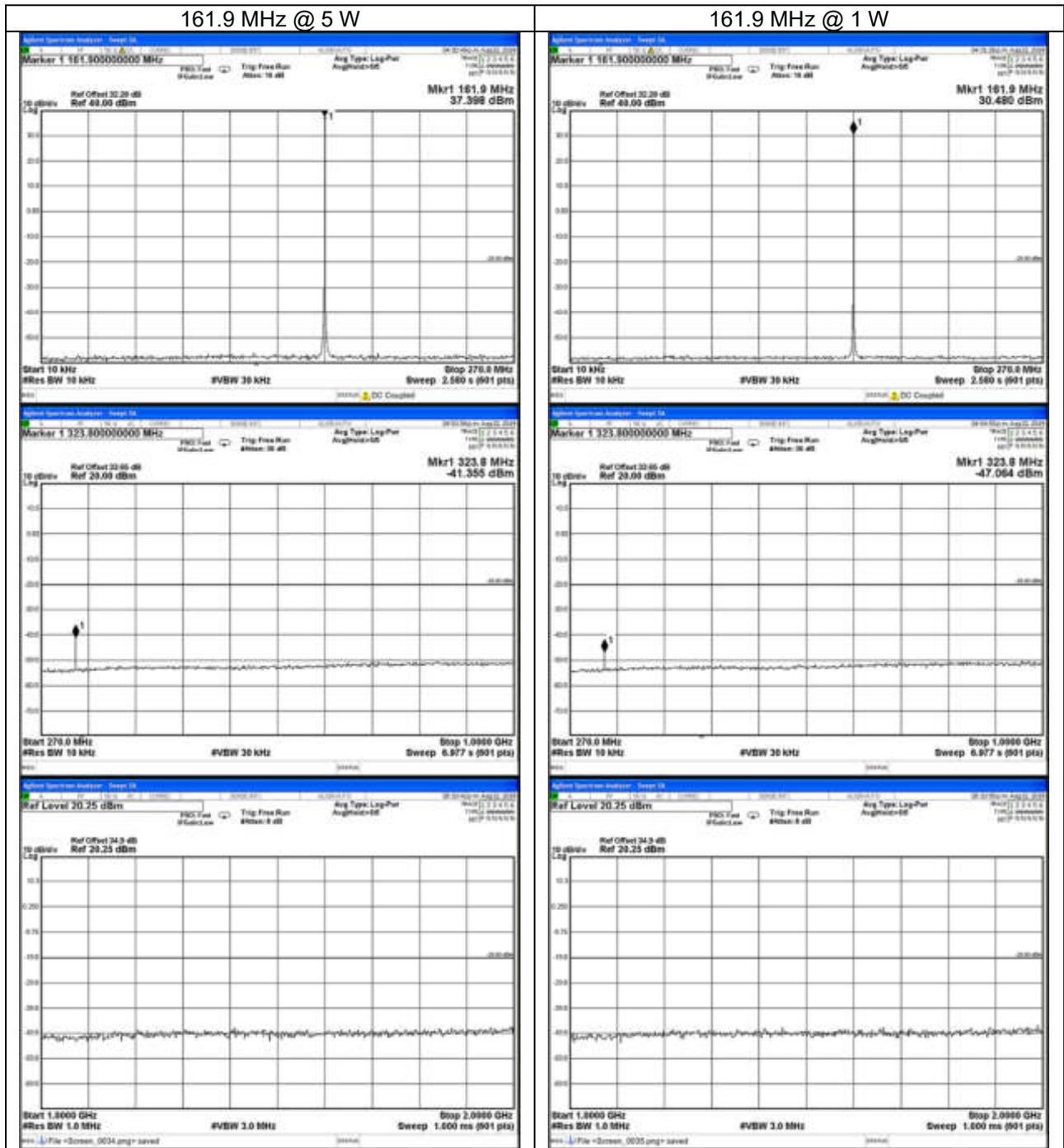
12.5 kHz Channel Spacing 161.9 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 161.9 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. | | |

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 Spurious Emissions (Tx Conducted)



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

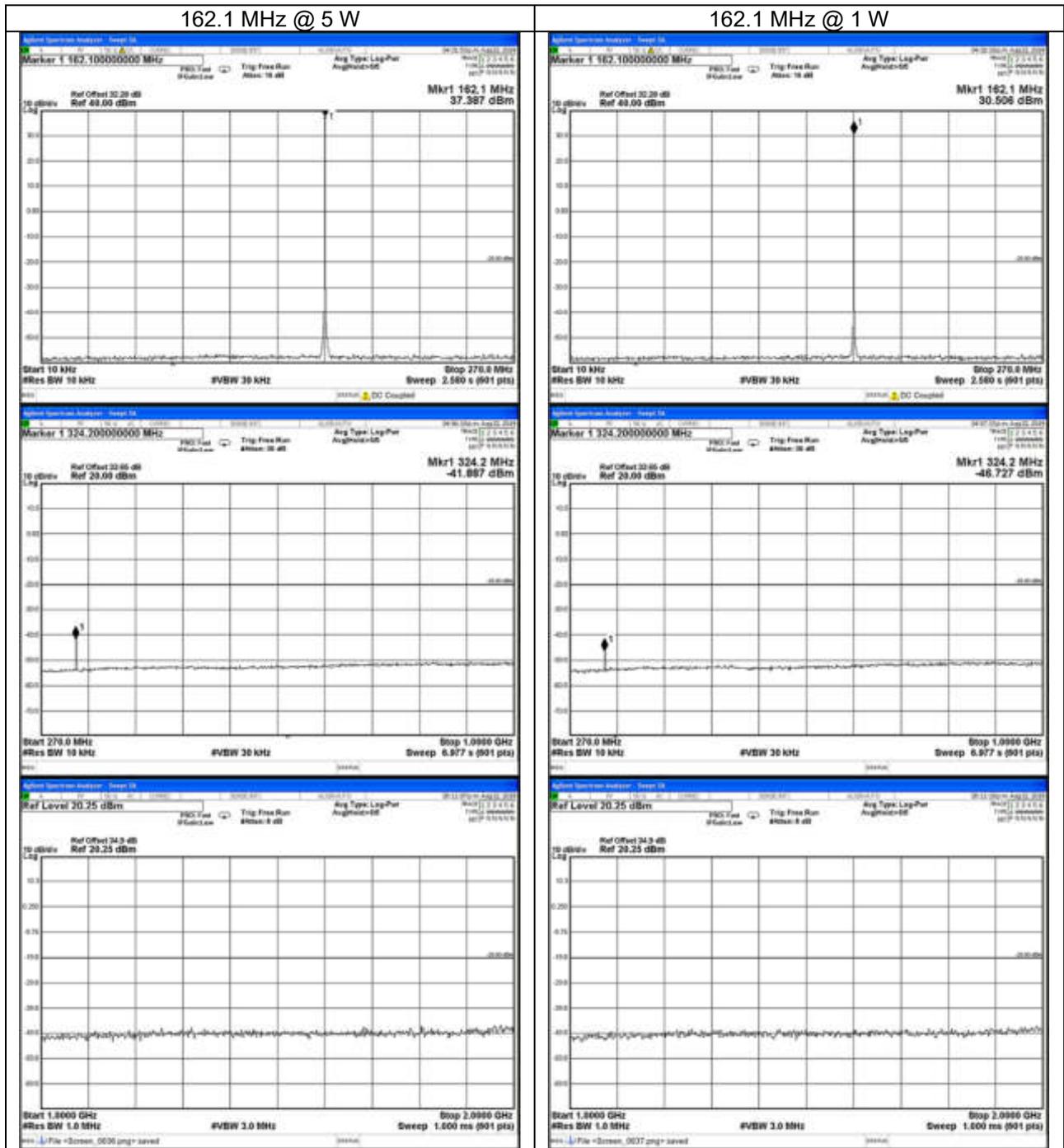
12.5 kHz Channel Spacing 162.1 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 162.1 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. | | |

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Spurious Emissions (Tx Conducted)



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

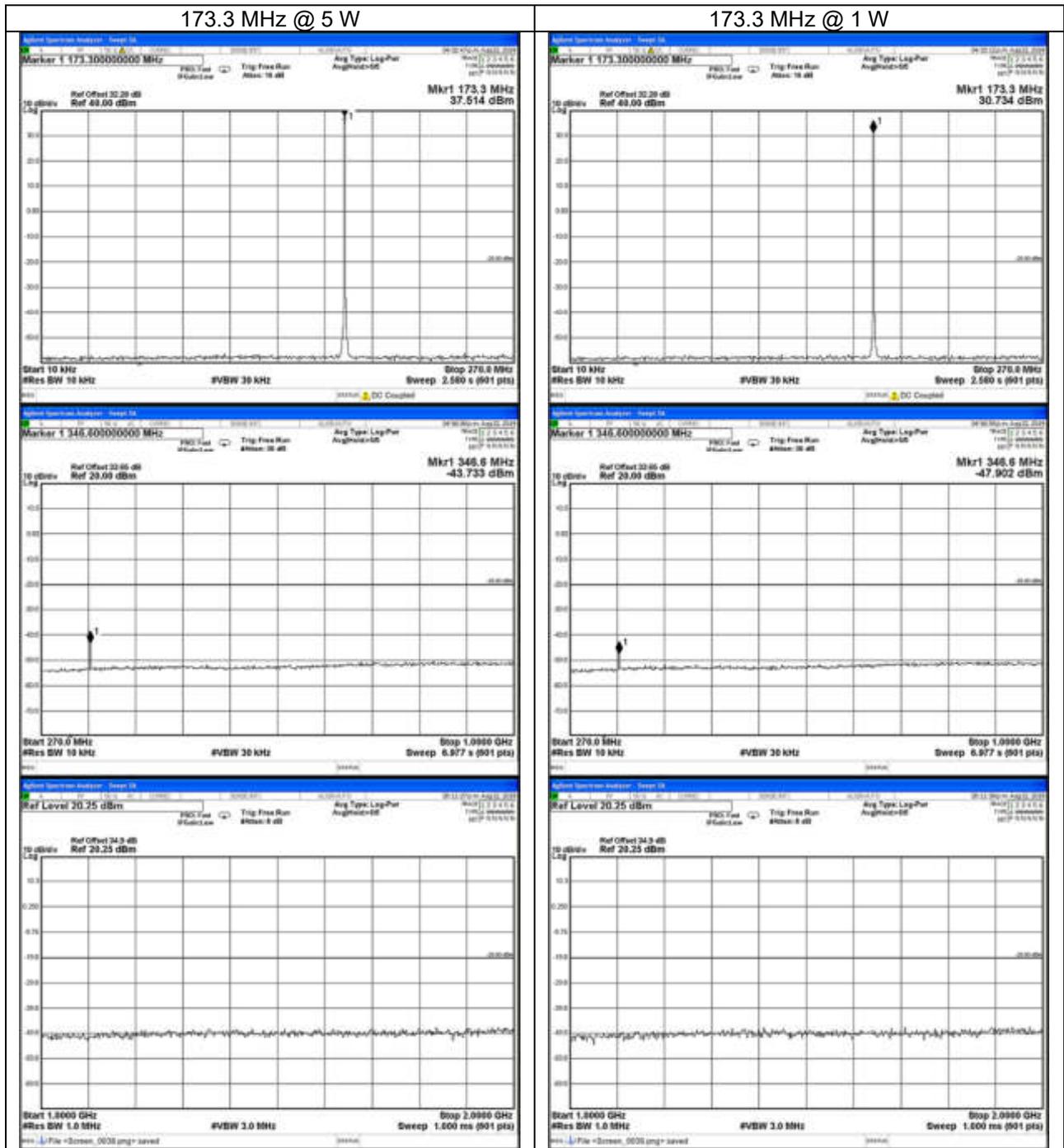
12.5 kHz Channel Spacing 173.3 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 173.3 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. | | |

TELTEST Laboratories
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Report Number 3997
Spurious Emissions (Tx Conducted)



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC 47 CFR 2.1051

LIMITS: FCC 47 CFR 90.210

| Carrier Output Power | Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \text{ Log}_{10} (P_{\text{Watts}})$ | |
|----------------------|--|---------|
| | 5 W | -20 dBm |
| 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° 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

TELTEST Laboratories
Tait International Ltd
Report Number 3997
Spurious Emissions (Tx Radiated) - Continued

SPECIFICATION: FCC 47 CFR 2.1053

12.5 kHz Channel Spacing 138.1 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 138.1 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 150.85 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 150.85 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 156.1 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 156.1 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. | | |

Spurious Emissions (Tx Radiated) - Continued

12.5 kHz Channel Spacing 157.2 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 157.2 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 161.9 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 161.9 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 162.1 MHz @ 5 W Emission Mask D

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

12.5 kHz Channel Spacing 162.1 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. | | |

Spurious Emissions (Tx Radiated) - Continued

12.5 kHz Channel Spacing

173.3 MHz @ 5 W

Emission Mask D

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

12.5 kHz Channel Spacing

173.3 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. | | |

LIMITS: FCC 47 CFR 2.1053

| Carrier Output Power | Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \text{ Log}_{10} (P_{\text{Watts}})$ | |
|----------------------|--|---------|
| 5 W | -20 dBm | -57 dBc |
| 1 W | -20 dBm | -50 dBc |

TELTEST Laboratories
Tait International Ltd
Report Number 3997
Spurious Emissions (Tx Radiated) - Continued

Open Area Test Site Results:

12.5 kHz Channel Spacing

161.9 MHz @ 5 W

Emission Mask D

| Harmonics Emission Frequency (MHz) | Level (dBm) | Level (dBc) |
|------------------------------------|-------------|-------------|
| 323.8 | -63.8 | -100.8 |
| 485.7 | -58.8 | -95.8 |
| 647.6 | -80.0 | -117.0 |
| 809.5 | -81.7 | -118.7 |
| 971.4 | -79.7 | -116.7 |
| 1133.3 | -80.9 | -117.9 |
| 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 |
| 323.8 | -90.14 | -49.56 | -14.03 | -0.49 | 0.26 | -63.83 |
| | | A | B | C | D | E |

Result (E) =

A+B+C+D Result

Photo: OATS Setup



TELTEST Laboratories
Tait International Ltd
Report Number 3997
TRANSIENT FREQUENCY BEHAVIOR

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 CLAUSES: FCC 47 CFR 90.214

TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 138.1 MHz 5 W 12.5 kHz Channel Spacing

| TRANSIENT RESPONSE PERIOD | CARRIER PEAK VARIATION FROM NORMAL | |
|---------------------------|------------------------------------|---------------|
| | Key ON (kHz) | Key OFF (kHz) |
| t1 | 0.6 | N/A |
| t2 | -0.3 | N/A |
| t3 | N/A | 2.1 |

| | | |
|---|-----|--------------------------|
| Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 the frequency difference does not exceed half a channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit. | YES | NO |
| | ✓ | <input type="checkbox"/> |

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

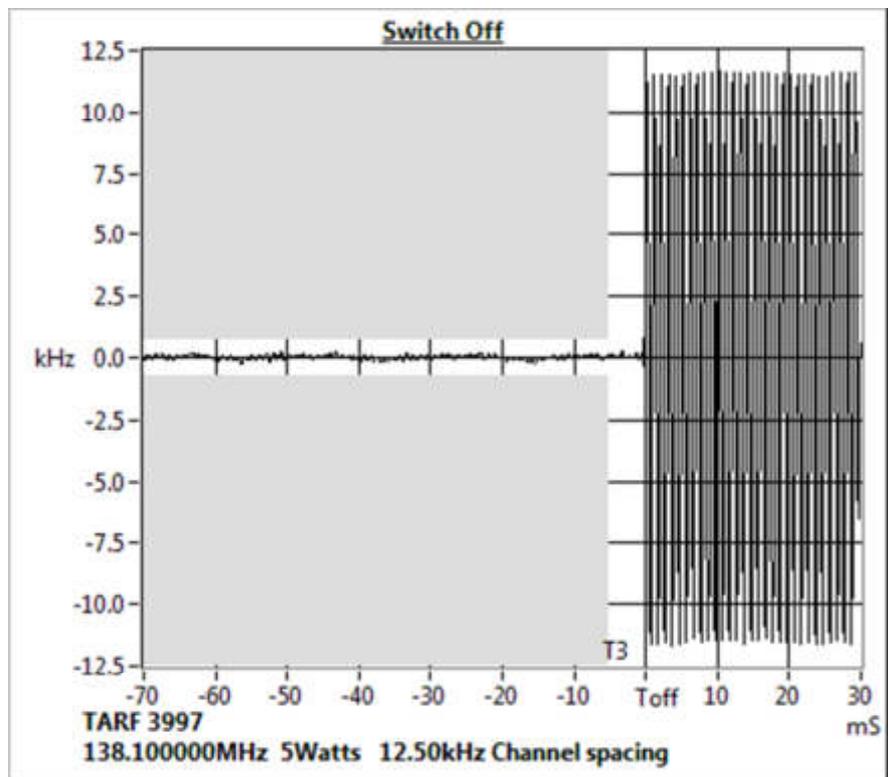
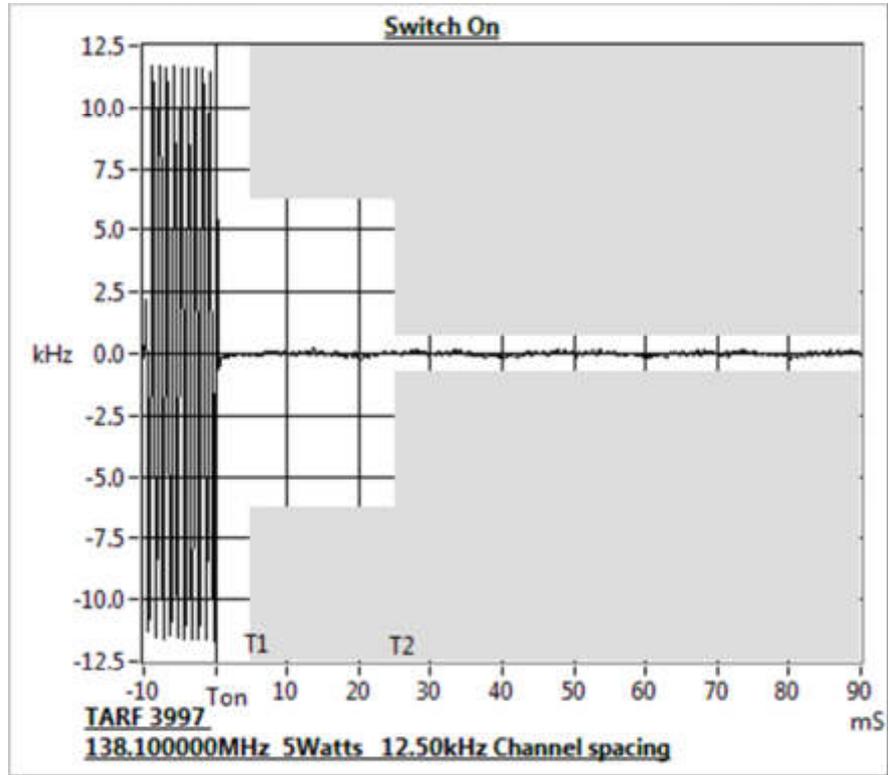
LIMIT: FCC 47 CFR 90.214

| 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 |

TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 138.1 MHz 5 W 12.5 kHz Channel Spacing



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 150.85 MHz 5 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 | -0.1 | N/A |
| t3 | N/A | -5.2 |

| | | |
|---|-----|--------------------------|
| Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 the frequency difference does not exceed half a channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit. | YES | NO |
| | ✓ | <input type="checkbox"/> |

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

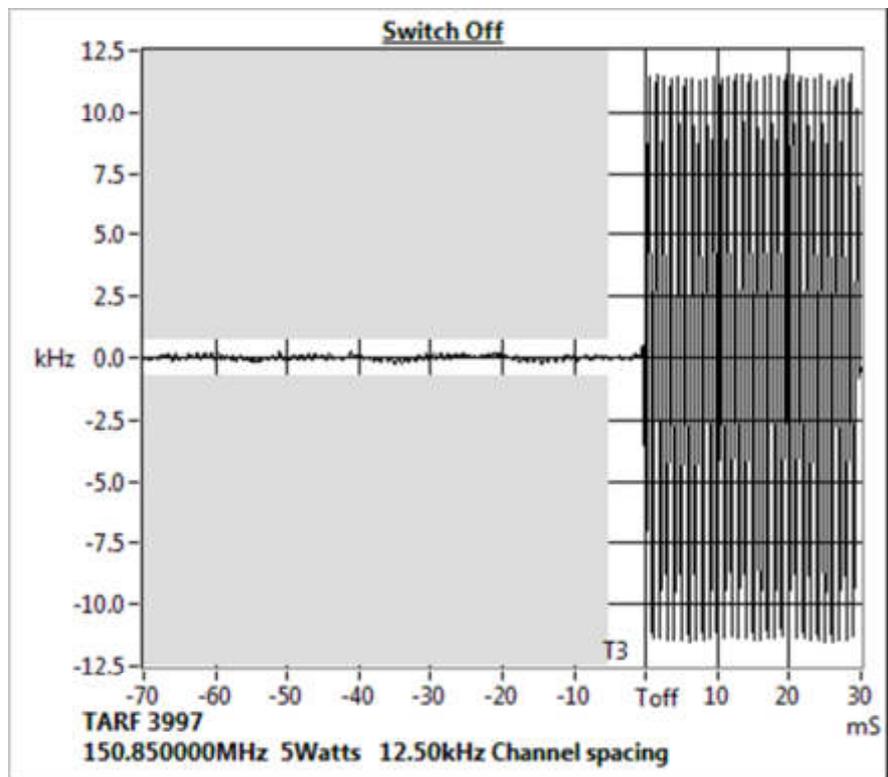
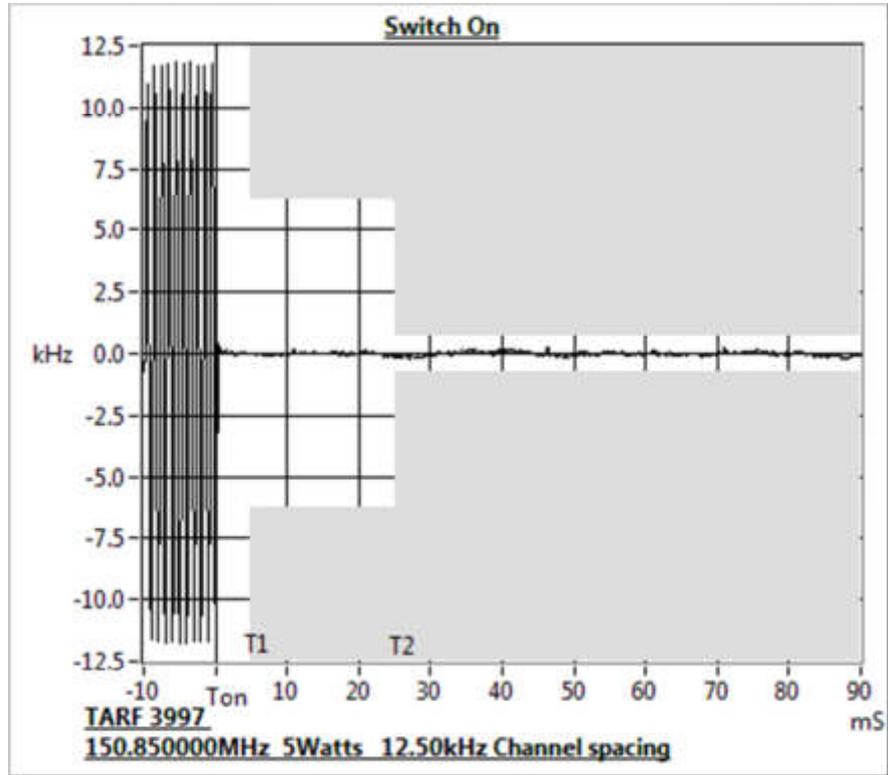
LIMIT: FCC 47 CFR 90.214

| 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 |

TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behavior

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 150.85 MHz 5 W 12.5 kHz Channel Spacing



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 156.1 MHz 5 W 12.5 kHz Channel Spacing

| TRANSIENT RESPONSE PERIOD | CARRIER PEAK VARIATION FROM NORMAL | |
|---------------------------|------------------------------------|---------------|
| | Key ON (kHz) | Key OFF (kHz) |
| t1 | 1.2 | 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 |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 the frequency difference does not exceed half a channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit. | YES | NO |
| | ✓ | <input type="checkbox"/> |

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

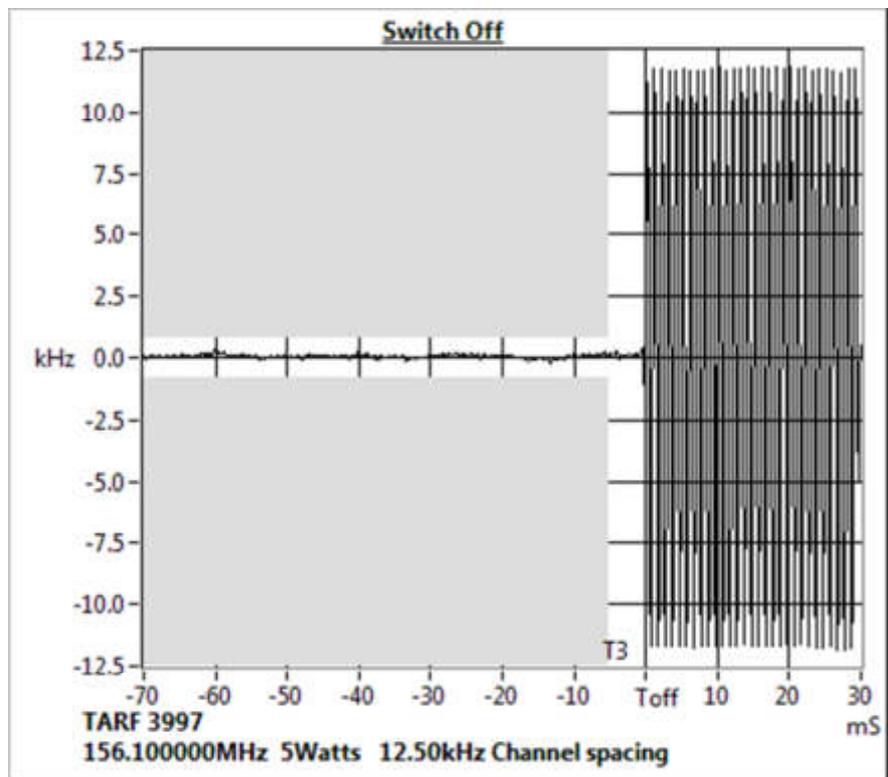
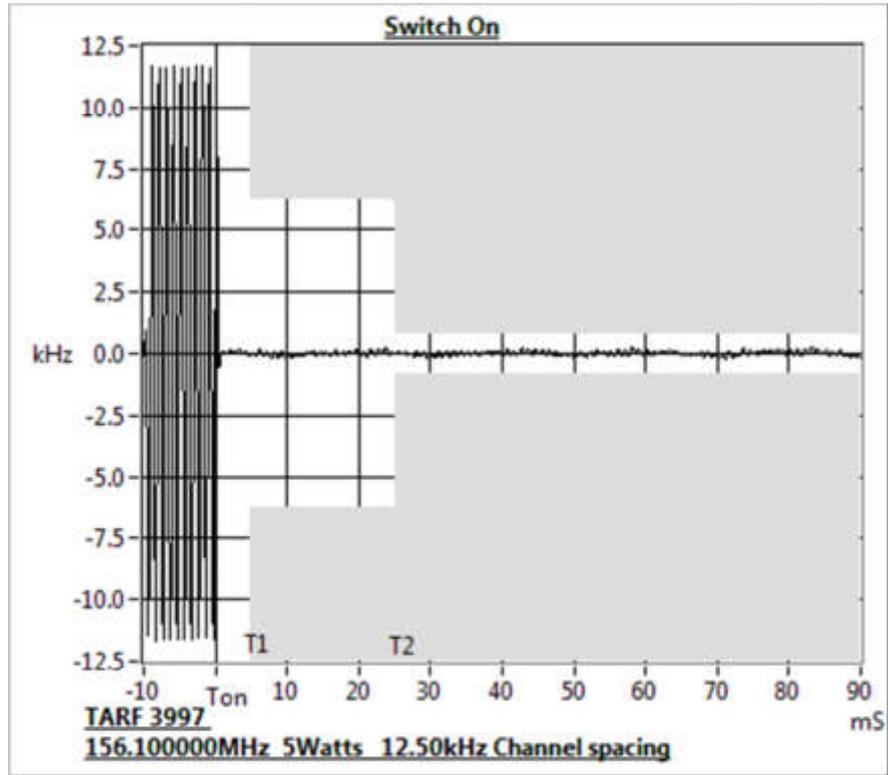
LIMIT: FCC 47 CFR 90.214

| 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 |

TELTEST Laboratories
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Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 156.1 MHz 5 W 12.5 kHz Channel Spacing



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 157.2 MHz 5 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 | 5.7 |

| | | |
|---|-----|--------------------------|
| Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 the frequency difference does not exceed half a channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit. | YES | NO |
| | ✓ | <input type="checkbox"/> |

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

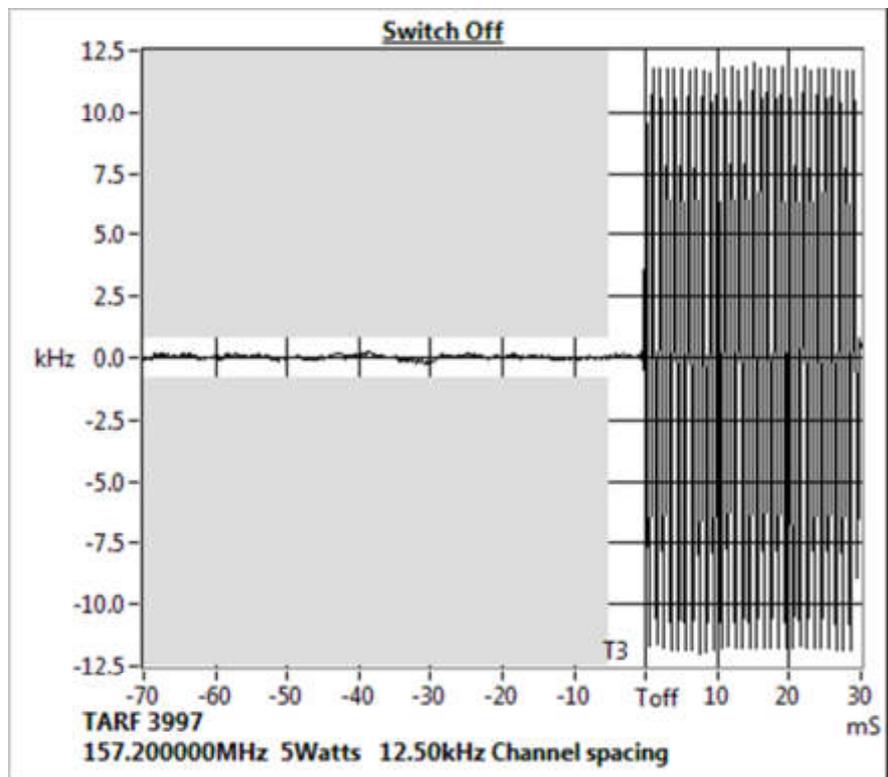
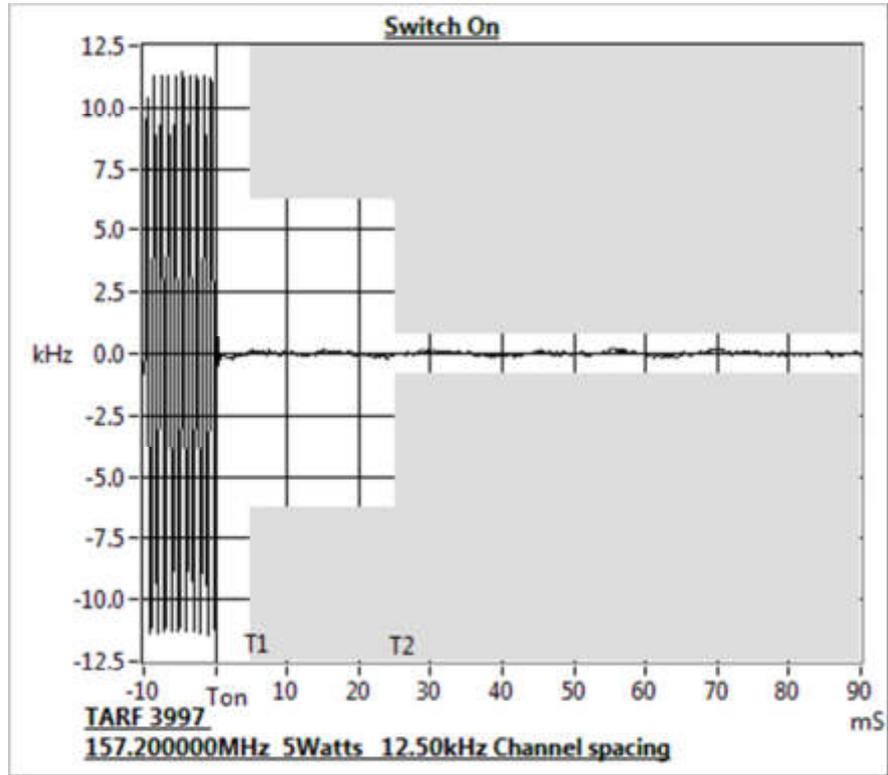
LIMIT: FCC 47 CFR 90.214

| 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 |

TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 157.2 MHz 5 W 12.5 kHz Channel Spacing



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 161.9 MHz 5 W 12.5 kHz Channel Spacing

| TRANSIENT RESPONSE PERIOD | CARRIER PEAK VARIATION FROM NORMAL | |
|---------------------------|------------------------------------|---------------|
| | Key ON (kHz) | Key OFF (kHz) |
| t1 | -1.0 | N/A |
| t2 | -0.2 | N/A |
| t3 | N/A | 2.7 |

| | | |
|---|-----|--------------------------|
| Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 the frequency difference does not exceed half a channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit. | YES | NO |
| | ✓ | <input type="checkbox"/> |

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

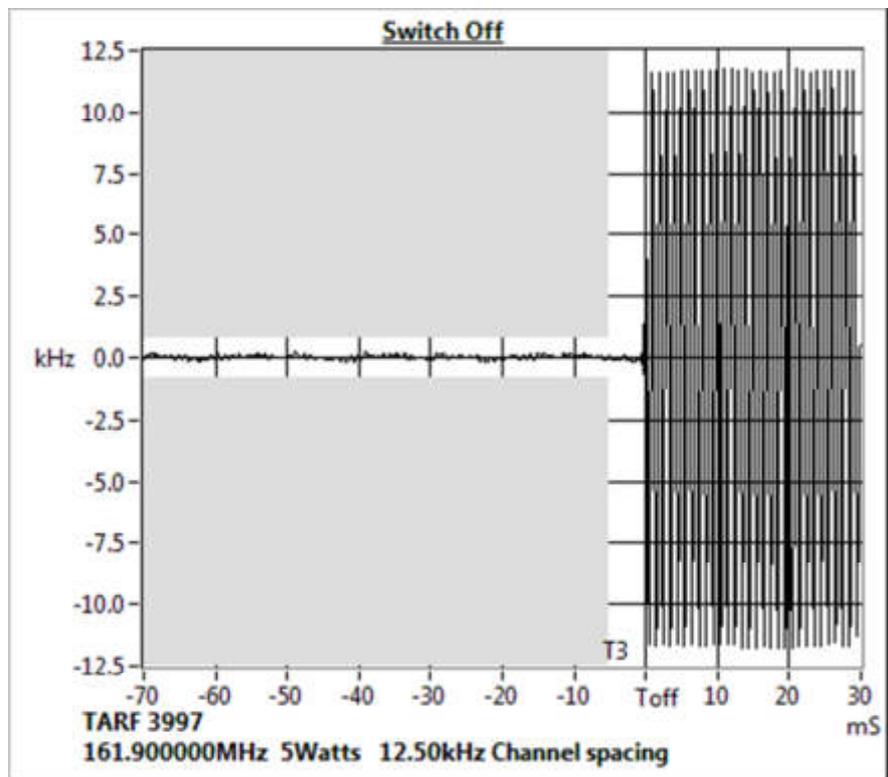
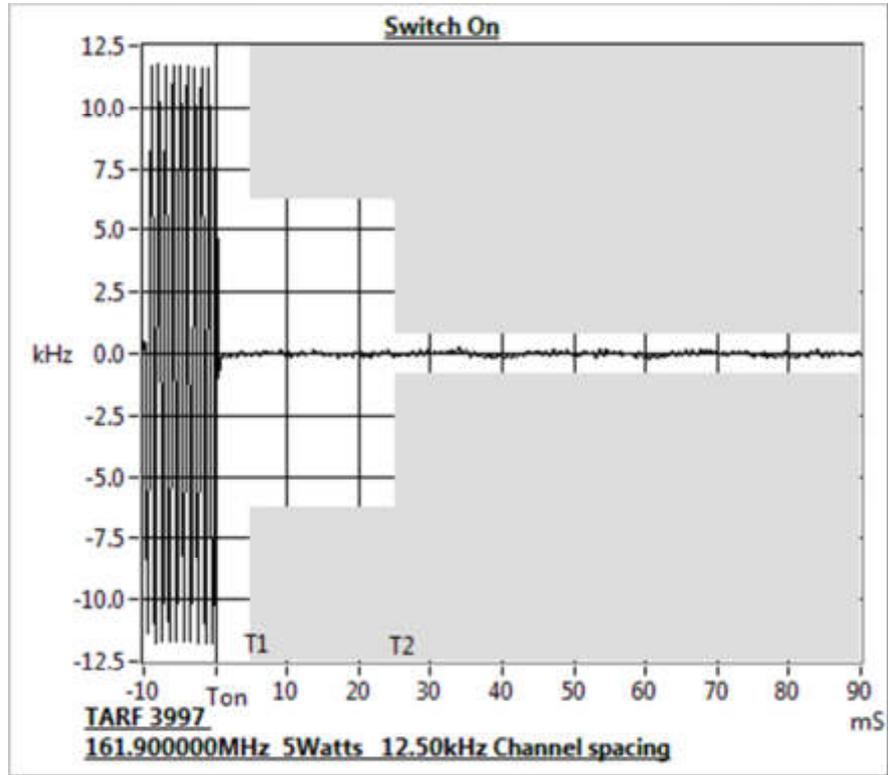
LIMIT: FCC 47 CFR 90.214

| 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 |

TELTEST Laboratories
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Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 161.9 MHz 5 W 12.5 kHz Channel Spacing



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 162.1 MHz 5 W 12.5 kHz Channel Spacing

| TRANSIENT RESPONSE PERIOD | CARRIER PEAK VARIATION FROM NORMAL | |
|---------------------------|------------------------------------|---------------|
| | Key ON (kHz) | Key OFF (kHz) |
| t1 | 1.6 | N/A |
| t2 | 0.2 | N/A |
| t3 | N/A | -1.9 |

| | | |
|---|-----|--------------------------|
| Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 the frequency difference does not exceed half a channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit. | YES | NO |
| | ✓ | <input type="checkbox"/> |

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

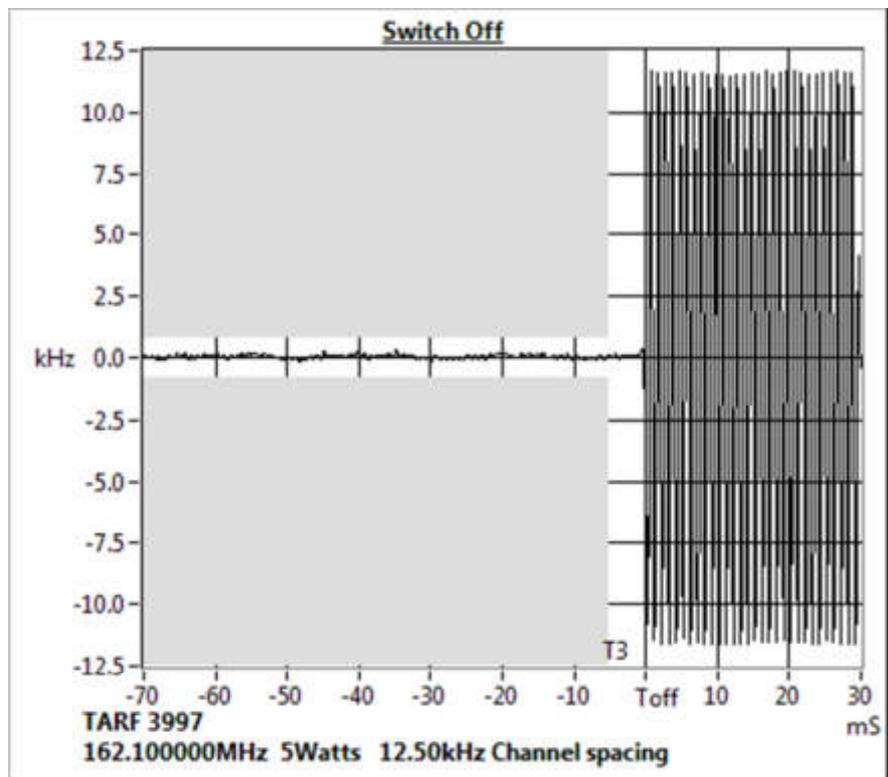
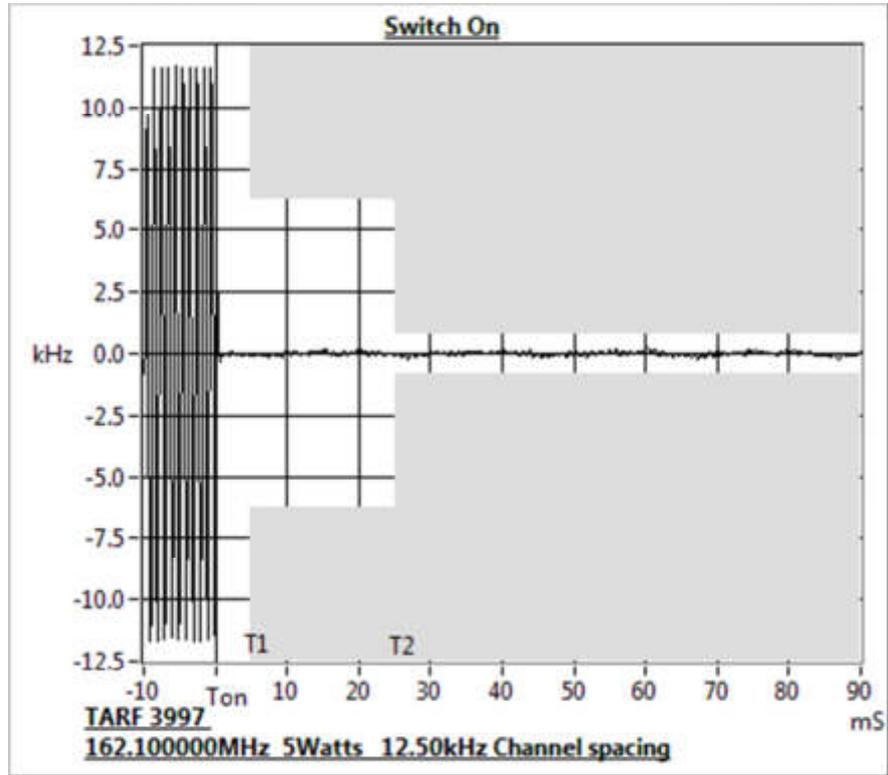
LIMIT: FCC 47 CFR 90.214

| 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 |

TELTEST Laboratories
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Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 162.1 MHz 5 W 12.5 kHz Channel Spacing



TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 173.3 MHz 5 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 | 0.2 | N/A |
| t3 | N/A | 2.3 |

| | | |
|---|-----|--------------------------|
| Confirm that during periods t1 and t3 the frequency difference does not exceed the value of one channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 the frequency difference does not exceed half a channel separation. | YES | NO |
| | ✓ | <input type="checkbox"/> |
| Confirm that during the period t2 to t3 the frequency difference does not exceed the frequency error limit. | YES | NO |
| | ✓ | <input type="checkbox"/> |

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

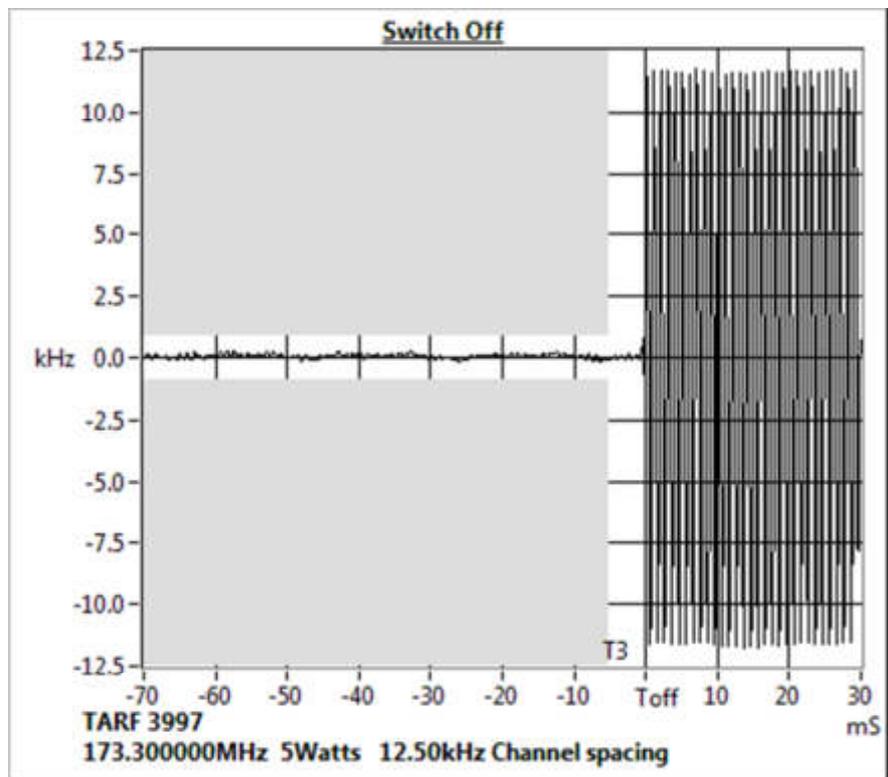
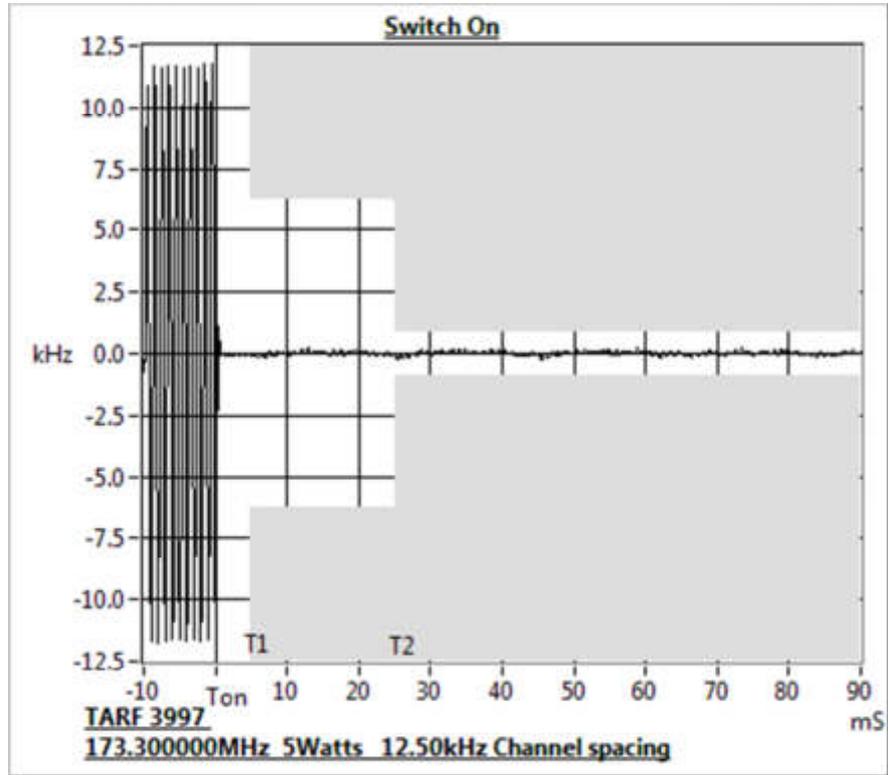
LIMIT: FCC 47 CFR 90.214

| 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 |

TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transient Frequency Behaviour

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 173.3 MHz 5 W 12.5 kHz Channel Spacing



TELTEST Laboratories
Tait International Ltd
Report Number 3997
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:

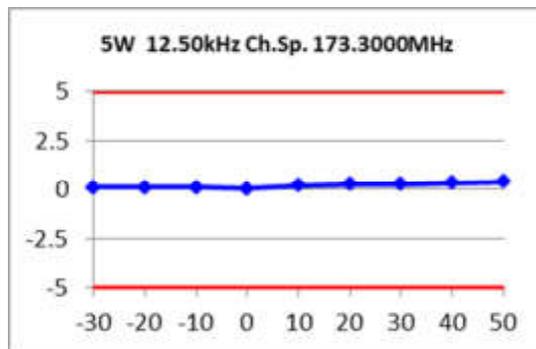
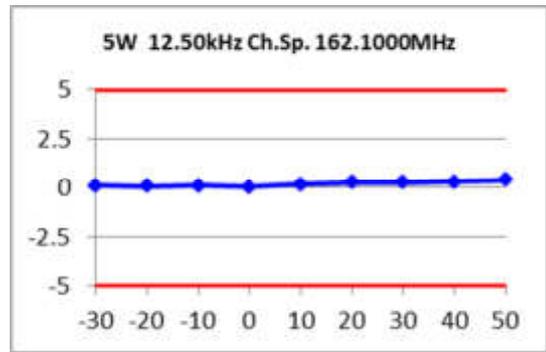
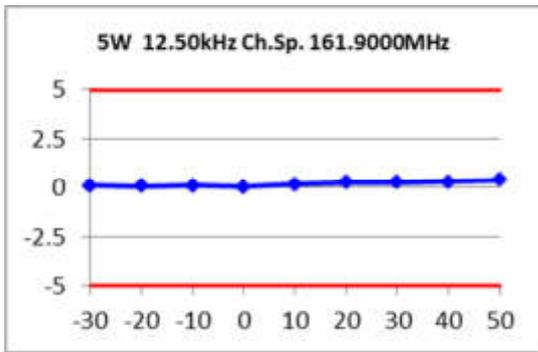
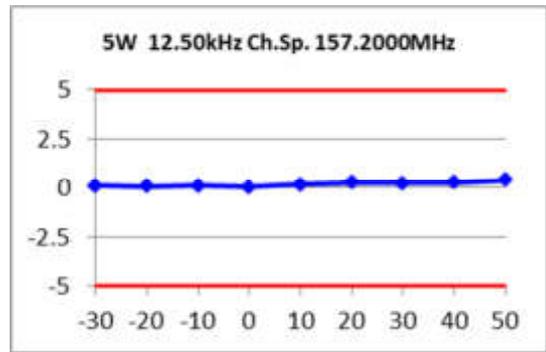
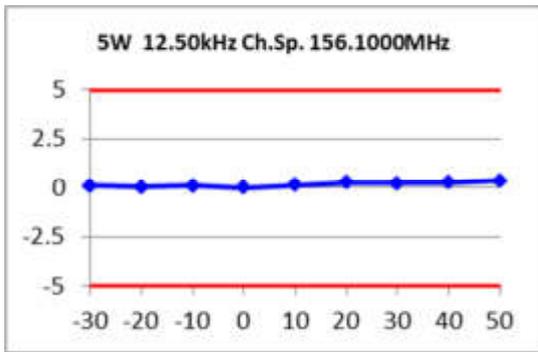
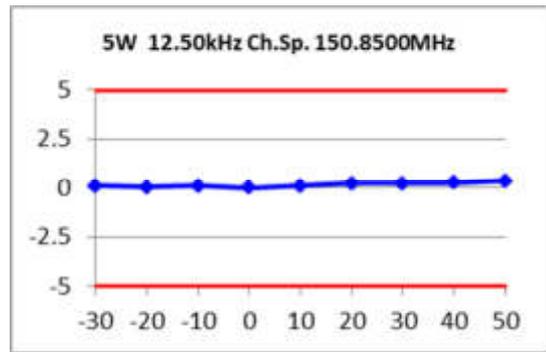
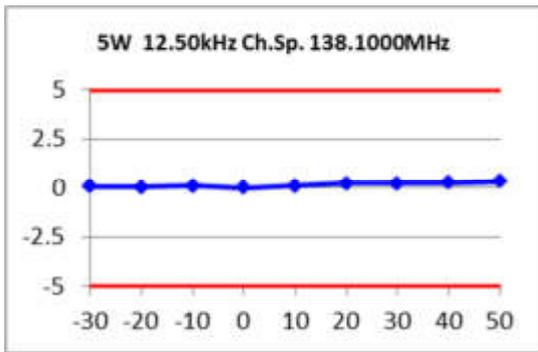
See the plots on the following pages for 12.5 kHz channel spacing.

| Temperature (°C) | Error (ppm) | | | | | | |
|-------------------------|-------------|------------|-----------|------------------------|-----------|-----------|-----------|
| | 138.1 MHz | 150.85 MHz | 156.1 MHz | 157.2 MHz | 161.9 MHz | 162.1 MHz | 173.3 MHz |
| -30 | 0.06 | 0.08 | 0.10 | 0.10 | 0.11 | 0.10 | 0.10 |
| -20 | 0.02 | 0.03 | 0.03 | 0.05 | 0.06 | 0.07 | 0.08 |
| -10 | 0.09 | 0.10 | 0.11 | 0.11 | 0.11 | 0.10 | 0.09 |
| 0 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.03 | 0.03 |
| 10 | 0.09 | 0.10 | 0.13 | 0.15 | 0.15 | 0.17 | 0.18 |
| 20 | 0.23 | 0.23 | 0.25 | 0.26 | 0.27 | 0.26 | 0.27 |
| 30 | 0.23 | 0.23 | 0.24 | 0.24 | 0.25 | 0.25 | 0.25 |
| 40 | 0.25 | 0.26 | 0.26 | 0.27 | 0.30 | 0.30 | 0.31 |
| 50 | 0.33 | 0.34 | 0.37 | 0.38 | 0.39 | 0.39 | 0.40 |
| Measurement Uncertainty | | | | $\pm 7 \times 10^{-8}$ | | | |

LIMIT: FCC 47 CFR 90.213

| Channel Spacing (kHz) | Frequency Error (ppm) |
|-----------------------|-----------------------|
| 12.5 | 5.0 |

TELTEST Laboratories
Tait International Ltd
Report Number 3997
Transmitter Frequency Stability - Temperature



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 nominal battery voltage and battery end point .
3. The frequency error was recorded in parts per million (ppm).

MEASUREMENT RESULTS:

| | FREQUENCY ERROR (ppm) for 12.5 kHz | | |
|-------------------------|------------------------------------|------------------------|---------------------|
| | 7.5 V _{DC} | 6.375 V _{DC} | 7.5 V _{DC} |
| 138.1 MHz | 0.12 | 0.15 | 0.15 |
| 150.85 MHz | 0.16 | 0.17 | 0.19 |
| 156.1 MHz | 0.18 | 0.19 | 0.19 |
| 157.2 MHz | 0.17 | 0.20 | 0.20 |
| 161.9 MHz | 0.20 | 0.19 | 0.22 |
| 162.1 MHz | 0.19 | 0.21 | 0.23 |
| 173.3 MHz | 0.23 | 0.23 | 0.21 |
| Measurement Uncertainty | | $\pm 7 \times 10^{-8}$ | |

LIMIT CLAUSES: FCC 47 CFR 90.213

| Channel Spacing (kHz) | Frequency Error (ppm) |
|-----------------------|-----------------------|
| 12.5 | 5.0 |

TEST EQUIPMENT LIST

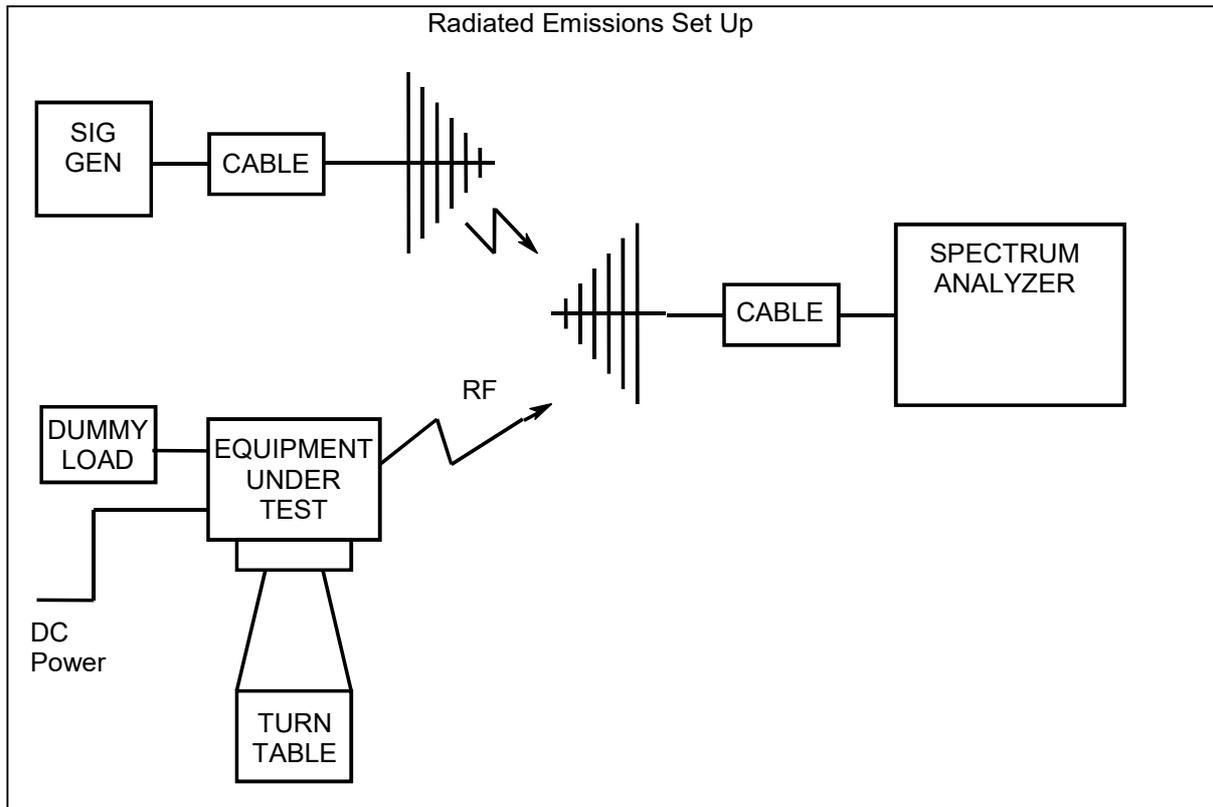
| Equipment Type | Information | Manufacturer | Model No | Serial No# | Tait ID | Cal Due |
|----------------------------|---------------------------------|-----------------|------------------------|---------------|---------|-----------|
| Antenna | Reference Dipoles | Emco | 3121C DB1 | 9510-1164 | 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 | TREVA1 | Hewlett Packard | HP8903A | 2437A04625 | E4986 | 4-Oct-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 | 2m Black | Suhner | RG214HF/Nm/ Nm/2000 | TeltestBlack4 | E4653 | 18-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 | 2m Black | Suhner | RG214HF/Nm/ Nm/2000 | TeltestBlack5 | E4850 | 17-Oct-19 |
| Coax Cable | OATS Turntable Cable 2 | Intelcom | RG215 | OATS3 | E4995 | 14-Nov-19 |
| Coax Cable | 2m Black | Suhner | RG214HF/Nm/ Nm/2000 | TeltestBlack7 | E5004 | 17-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 | 135 to 175MHz | Tait | | N/A | E3382 | 25-Sep-19 |
| Modulation Analyser | TREVA1 | Hewlett Packard | HP8901B (Opt 002) | 2441A00393 | E3073 | 4-Oct-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 | TREVA1 Power Head for HP8901 | Hewlett Packard | HP11722A | 3111A05573 | E7054 | 28-Sep-19 |
| Power Supply | TREVA1 | Agilent | HP6032A | MY41000319 | E4045 | 24-Sep-20 |
| 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 | 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 | TREVA1 3dB | Weinschel | Model 1 | BL9958 | E4081 | 17-Oct-19 |
| RF Attenuator | TREVA 1 20dB 150W | Weinschel | 40-20-23 | MF817 | E4082 | 17-Oct-19 |
| RF Attenuator | 3dB 0.5W | Weinschel | Model 2 | CH6857 | E5012 | 17-Oct-19 |

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| Equipment Type | Information | Manufacturer | Model No | Serial No# | Tait ID | Cal Due |
|----------------------------|--|-----------------|--------------------|------------|---------|-----------|
| RF Chamber | S-LINE TEM CELL | Rohde & Schwarz | 1089.9296.02 | 338232/003 | E3636 | 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 | TREVA1 | Minicircuits | ZFSC-4-1 | - | E4083 | |
| RF Load | 50W | Weinschel | F1426 | BF0487 | E3675 | 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 | TREVA1 Analog 3.2GHz | Agilent | E8663D | MY50420224 | E4908 | 2-Oct-20 |
| 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 1 | | Teltest | - | 1 | - | 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 Teltest **R**adio **E**VALuation 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.

