

REPORT NUMBER 2079

SEPTEMBER 2004

RADIO PERFORMANCE MEASUREMENTS

On the TMAB32-B100 Mobile Transceiver

FCC ID: CASTMAB1E

SN: 19018423

In accordance with

FCC 47 CFR Parts 22 and 90

Report Revision: 2

Issue Date: 8th May 2007

PREPARED BY:

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REPORT ON :

Type Approval Testing of the TMAB32-B100 (Serial No 19018423)
in accordance with:

FCC CFR 47 Parts 22 & 90

FCC ID: CASTMAB1E

PREPARED FOR :

Tait Electronics Ltd
PO Box 1645
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APPROVED :

Hamish Newton

Senior Technician

Date :

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

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TABLE OF CONTENTS

| | |
|---|-----------|
| REVISION HISTORY | 4 |
| DECLARATION OF CONFORMITY | 4 |
| TEST CONDITIONS | 5 |
| NECESSARY BANDWIDTH AND EMISSION DESIGNATORS | 5 |
| TEST RESULTS | 8 |
| TRANSMITTER OUTPUT POWER (CONDUCTED) | 8 |
| TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS | 9 |
| TRANSMITTER MODULATION LIMITING | 11 |
| OCCUPIED BANDWIDTH..... | 13 |
| <i>ANALOGUE VOICE</i> | 14 |
| <i>FFSK</i> | 18 |
| <i>THSD</i> | 22 |
| <i>DIGITAL - 4 Level FSK</i> | 26 |
| SPURIOUS EMISSIONS (CONDUCTED)..... | 30 |
| SPURIOUS EMISSIONS (RADIATED) | 33 |
| TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)..... | 36 |
| TRANSMITTER FREQUENCY STABILITY (VOLTAGE)..... | 38 |
| TRANSIENT FREQUENCY BEHAVIOR | 39 |
| TEST EQUIPMENT USED | 44 |
| APPENDIX A | 45 |
| TEST SETUP DETAILS..... | 45 |

Revision History

| Date | Revision | Comments |
|----------------|----------|---|
| 8-October-2004 | 1 | Initial test report |
| 8-May-2007 | 2 | Change FFSK / THD Emission Designators, and test methods for ED's deleted |

DECLARATION OF CONFORMITY

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

Equipment: Mobile Transceiver
Type: TMAB1E
Product code: TMAB32-B100
Serial Numbers: 19018423
Quantity: 1

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

FCC CFR 47 Parts 22 & 90

Signature: _____

S. A. Crompton
Compliance Laboratory Manager.

Date: _____

4. Fast Frequency Shift Keying (FFSK) 25kHz Bandwidth

Necessary bandwidth

Emission Designator

M = 1.8 kHz

9k60F2D

D = 3 kHz (60% of peak deviation)

F2D represents a FM data transmission with the use of a modulating sub carrier

Bn = 3.6 + 6 x 1.0
= 9.6 kHz

5. Tait High Speed Data (THSD)

THSD uses a 4 level gaussian frequency shift keying (CP-4GFSK) modulation scheme. It can be used when transferring data between two radios. Data is transmitted at a rate of 12000bps for narrow band channels, and 19200bps for wide-band channels.

12.5kHz Bandwidth

Emission Designator

7k70F1D

F1D represents a FM data transmission without the use of a modulating sub carrier

25kHz Bandwidth

Emission Designator

12k7F1D

F1D represents a FM data transmission without the use of a modulating sub carrier

6. Digital Voice /Data (4 – Level FSK) – CFR 47 90.212 (b)

Digital Voice/data transmissions use a 4 level frequency shift keying modulation scheme.

a) Operating in a 12.5 kHz Bandwidth

Digital voice

Emission Designator

8K10F1E

F1E represents a digital FM voice transmission

8K10F7E

F7E represents two or more channels containing quantized or digital voice information

Digital Data

Emission Designator

8K10F1D

F1D represents a digital FM data transmission

8K10F7D

F7D represents two or more channels containing quantized or digital information

b) Operating in a 25 kHz Bandwidth

Digital voice

Emission Designator

10K0F1E

F1E represents a digital FM voice transmission

10K0F7E

F7E represents two or more channels containing quantized or digital voice information

Digital Data

Emission Designator

10K0F1D

F1D represents a digital FM data transmission

10K0F7D

F7D represents two or more channels containing quantized or digital information

7. Digital Voice Encryption (4 – Level FSK) – CFR 47 90.212 (b)

Digital Voice Encryption transmissions use a 4 level frequency shift keying modulation scheme.

b) Operating in a 12.5 kHz Bandwidth

Digital voice

Emission Designator

8K10F1E

F1E represents a digital FM voice transmission

c) Operating in a 25 kHz Bandwidth

Digital voice

Emission Designator

10K0F1E

F1E represents a digital FM voice transmission

Test Results

TRANSMITTER OUTPUT POWER (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1046

GUIDE: TIA/EIA-603B 2.2.1

MEASUREMENT PROCEDURE:

1. Refer Appendix 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: 1 W and 25 W

| 155.1 MHz | 1 W nominal | 25 W nominal |
|------------------------------|-------------|----------------|
| POWER (W) | 1.0 | 24.8 |
| Variation from Nominal (%) | 0.0 | - 0.8 |
| Measurement Uncertainty (dB) | | +0.63 -0.68 |

LIMIT CLAUSE: FCC 47 CFR 90.205

Radio Type: Mobile Transceiver

Frequency Band: 150 MHz ~ 174 MHz

- (o) The output power shall not exceed by more than 20% the manufacturer's rated output power for the particular transmitter.

TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS

SPECIFICATION: FCC 47 CFR 2.1047 (a)

GUIDE: TIA/EIA-603B 2.2.6

MEASUREMENT PROCEDURE:

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

MEASUREMENT RESULTS:

See the plots on the following pages for 12.5 kHz & 25.0 kHz channel spacings.

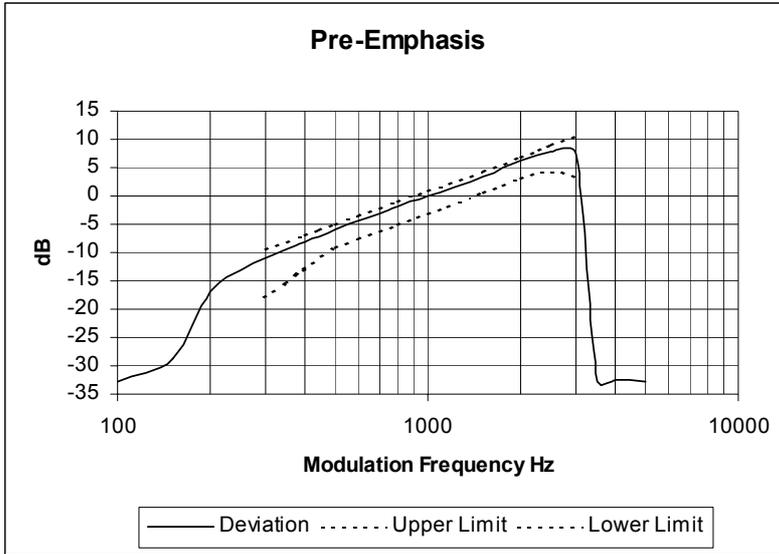
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LIMIT CLAUSE: TIA/EIA-603B 3.2.6

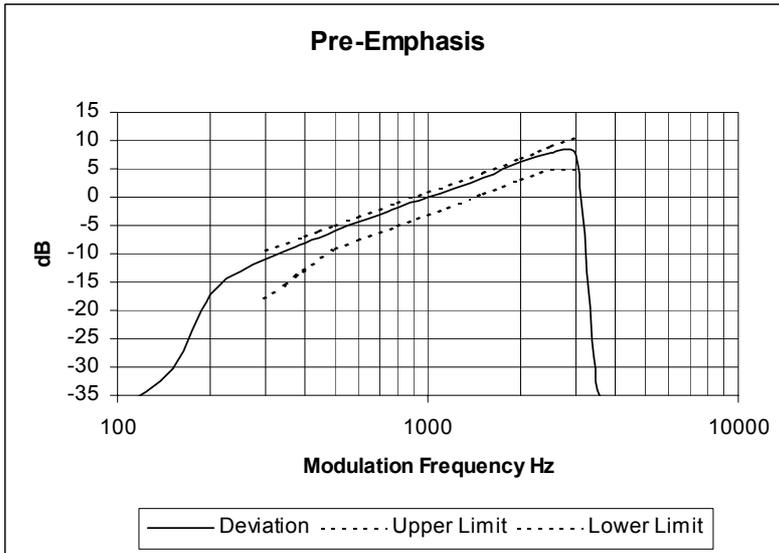
TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS

SPECIFICATION: FCC CFR 2.1047 (a)

Tx FREQUENCY: 155.1 MHz 12.5 kHz Channel Spacing



Tx FREQUENCY: 155.1 MHz 25.0 kHz Channel Spacing



TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC 47 CFR 2.1047 (b)

MEASUREMENT PROCEDURE:

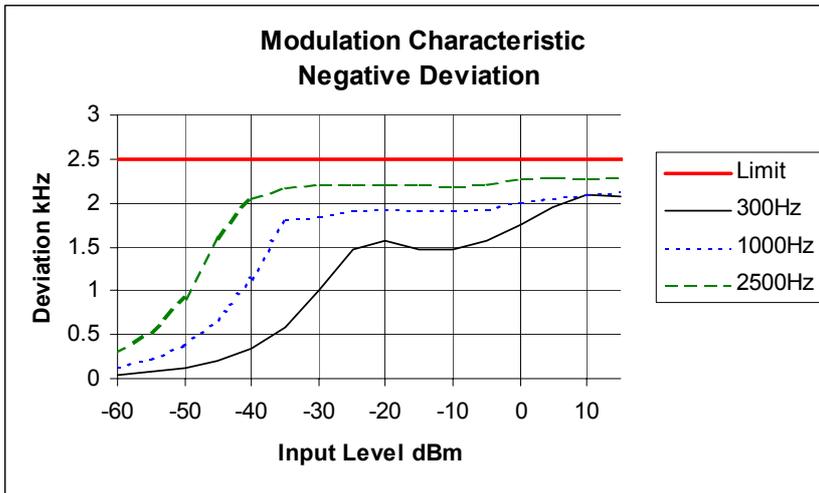
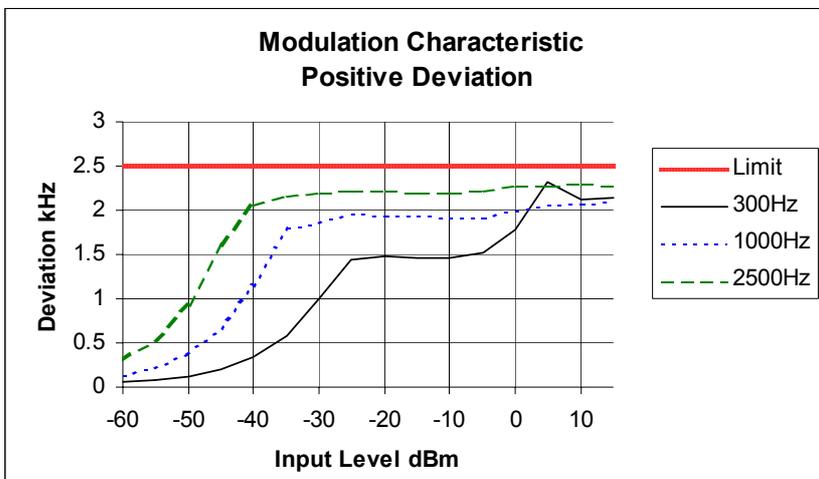
1. Refer Appendix A for Equipment set up.
2. The modulation response was measured at three audio frequencies while varying the input level.
3. Measurements were made for both Positive and Negative Deviation.

MEASUREMENT RESULTS:

See the plots on the following pages for 12.5 kHz & 25.0 kHz channel spacings.

LIMIT CLAUSE: TIA/EIA-603B 1.3.4.4

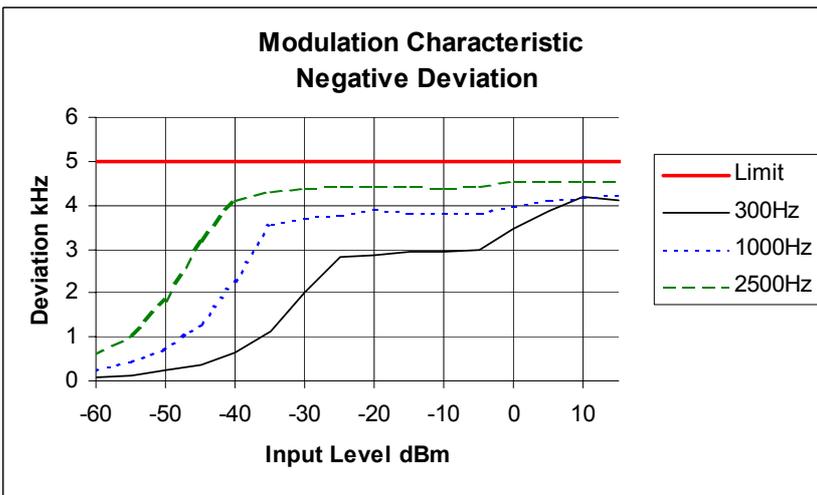
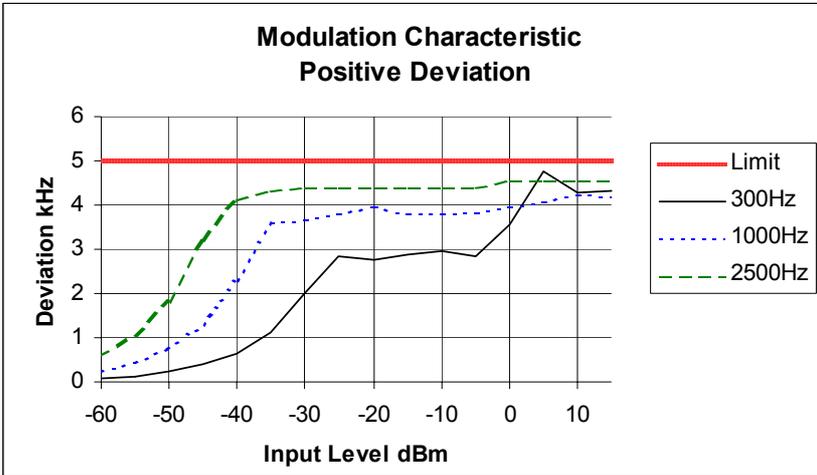
Tx FREQUENCY: 155.1 MHz 12.5 kHz Channel Spacing



TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC CFR 2.1047 (b)

Tx FREQUENCY: 155.1 MHz 25.0 kHz Channel Spacing



OCCUPIED BANDWIDTH

SPECIFICATION: FCC 47 CFR 2.1049 (c)

GUIDE: TIA/EIA-603B 2.2.11 for Analogue
TIA/EIA-102CAAA-A 2.2.5 for Digital

MEASUREMENT PROCEDURE:

1. Refer Appendix A for Equipment Set up.
2. For analogue measurements: The EUT was modulated by a 2500Hz tone at an input level 16dB above a level that produced 50% deviation. The input level was established at the frequency of maximum response of the audio modulating circuit .
For Digital 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 = 100Hz, Video Bandwidth = 1 kHz
Emission Mask B, and C – Resolution bandwidth = 300Hz, Video Bandwidth = 3 kHz

MEASUREMENT RESULTS:

See the plots on the following pages for 12.5 kHz & 25.0 kHz channel spacings.

LIMIT CLAUSE: FCC 47 CFR 90.210

EMISSION MASKS

| | | |
|-----------------|--------------------------|--------------------------------|
| Emission Mask D | 12.5 kHz Channel Spacing | Analog; Digital; FFSK; THSD |
| Emission Mask B | 25.0 kHz Channel Spacing | Analog; |
| Emission Mask C | 25.0 kHz Channel Spacing | Digital; FFSK; THSD |

DATA SPEED

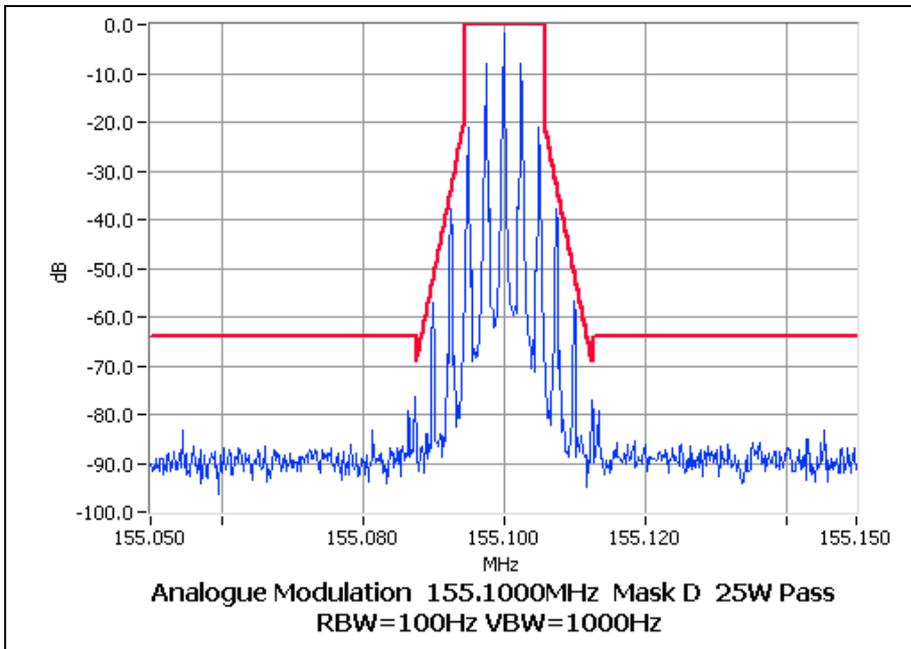
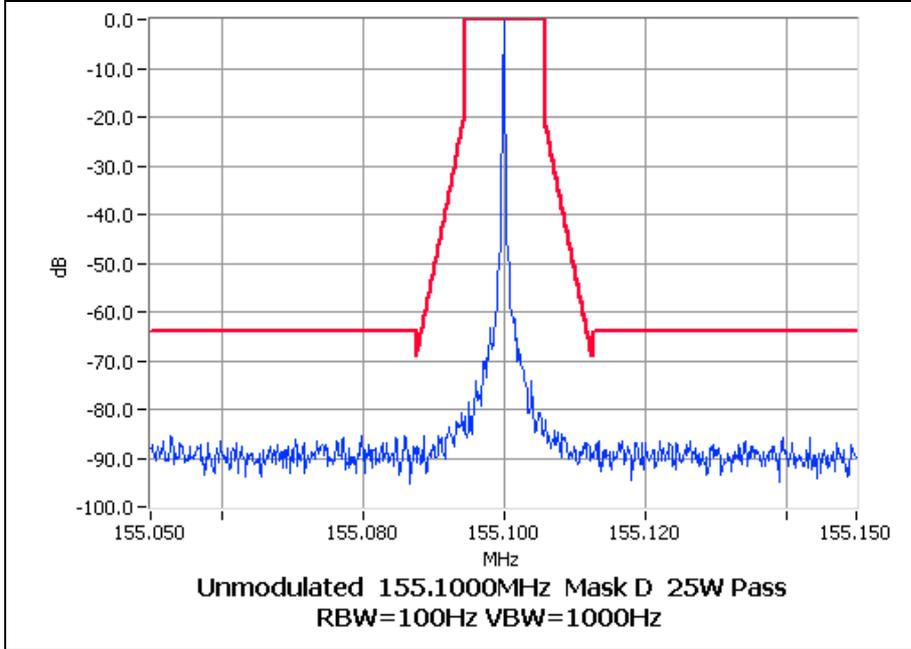
| | |
|------------------|--------------------------|
| Digital 9600 bps | 12.5 kHz Channel Spacing |
| Digital 9600 bps | 25.0 kHz Channel Spacing |
| FFSK 1200 bps | 12.5 kHz Channel Spacing |
| FFSK 1200 bps | 25.0 kHz Channel Spacing |
| THSD 12000 bps | 12.5 kHz Channel Spacing |
| THSD 19200 bps | 25.0 kHz Channel Spacing |

OCCUPIED BANDWIDTH

ANALOGUE VOICE

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 25W 12.5 kHz Channel Spacing

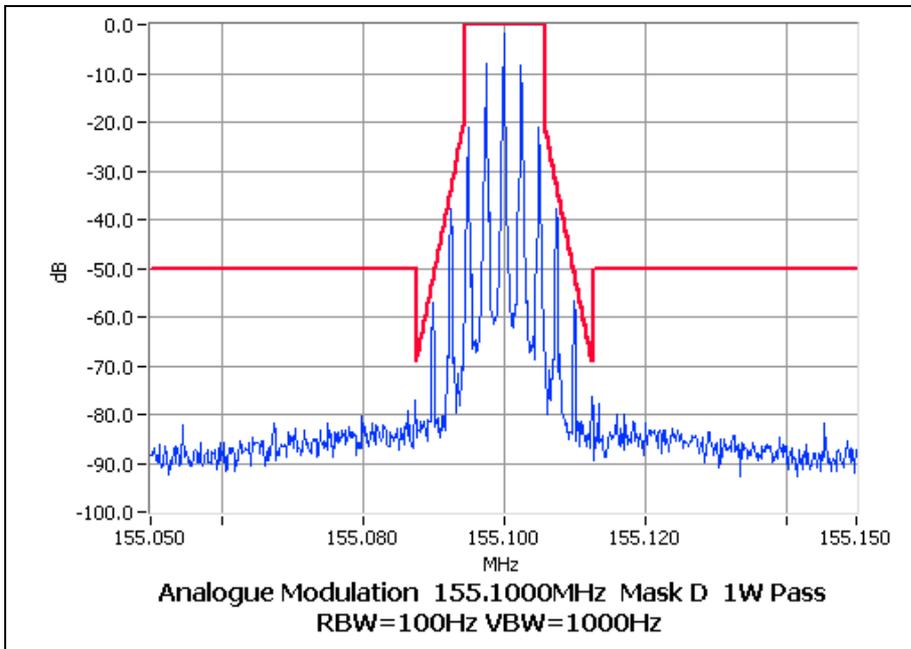
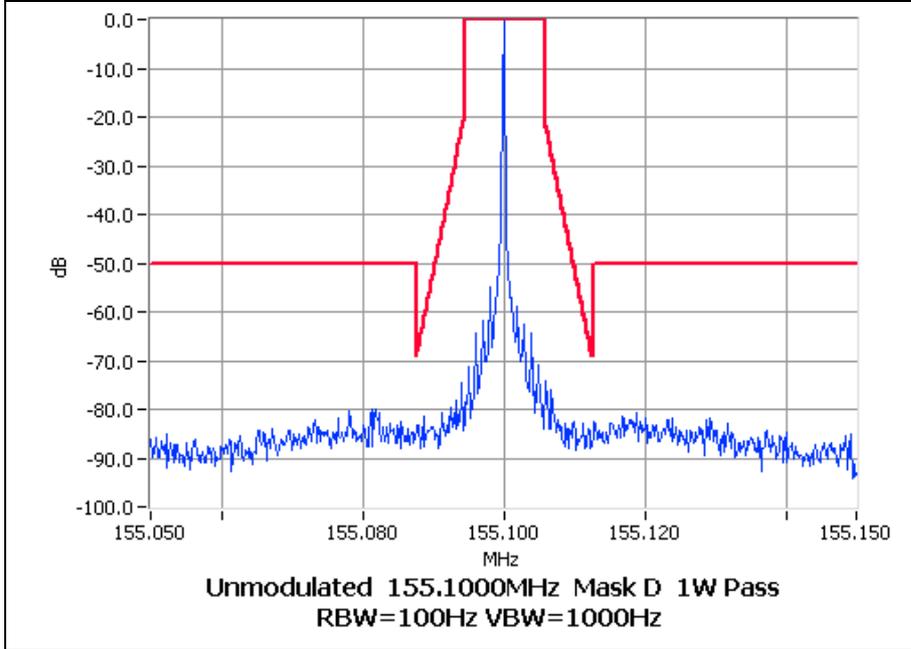


OCCUPIED BANDWIDTH

ANALOGUE VOICE

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 1W 12.5 kHz Channel Spacing

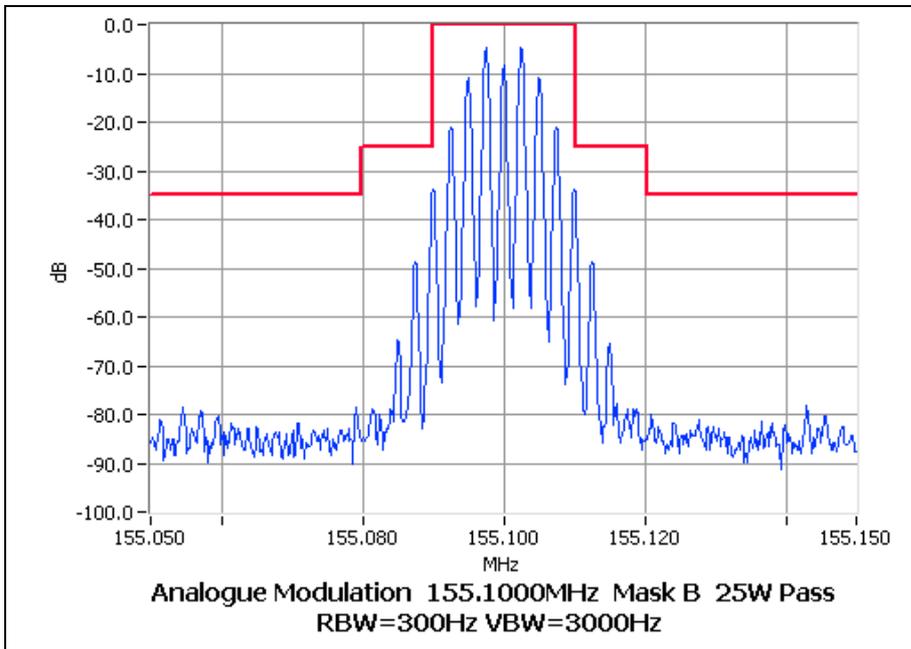
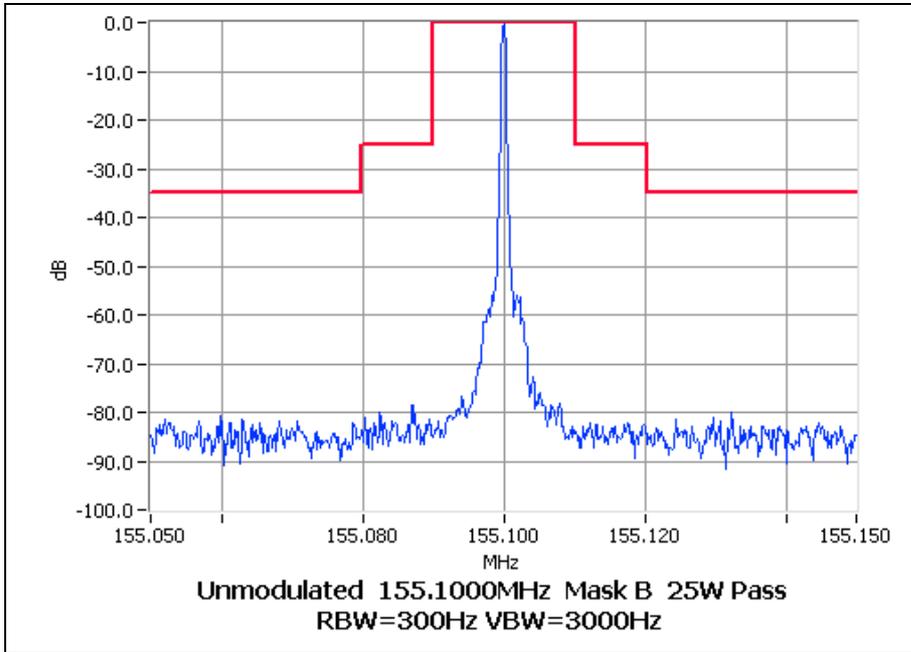


OCCUPIED BANDWIDTH

ANALOGUE VOICE

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 25W 25.0 kHz Channel Spacing

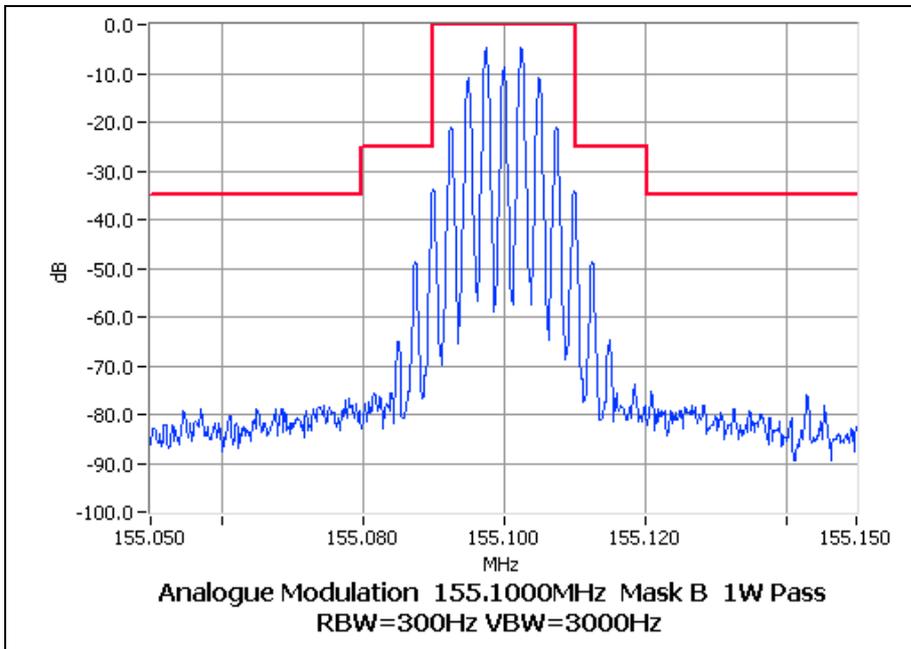
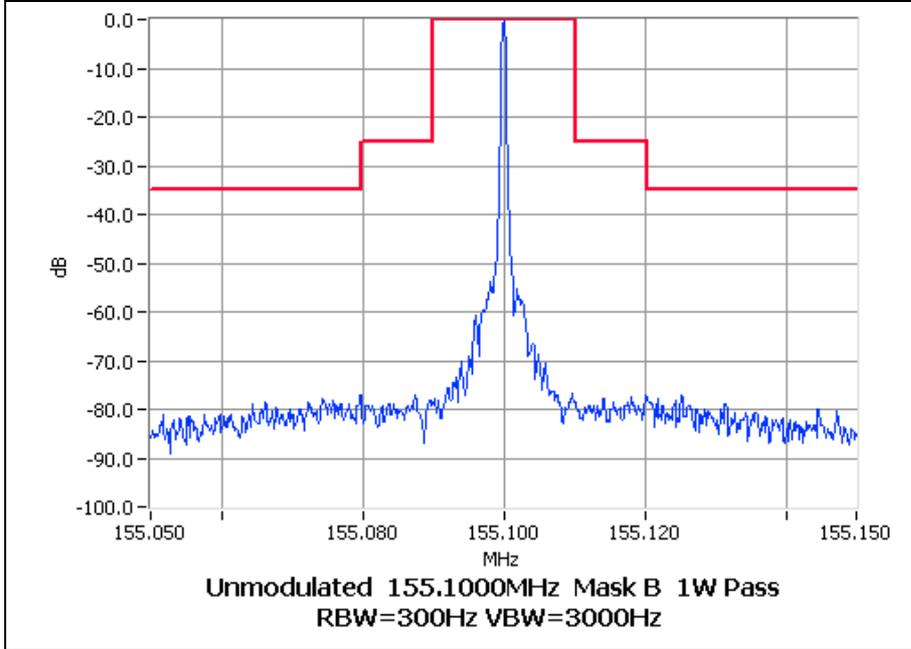


OCCUPIED BANDWIDTH

ANALOGUE VOICE

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 1W 25.0 kHz Channel Spacing

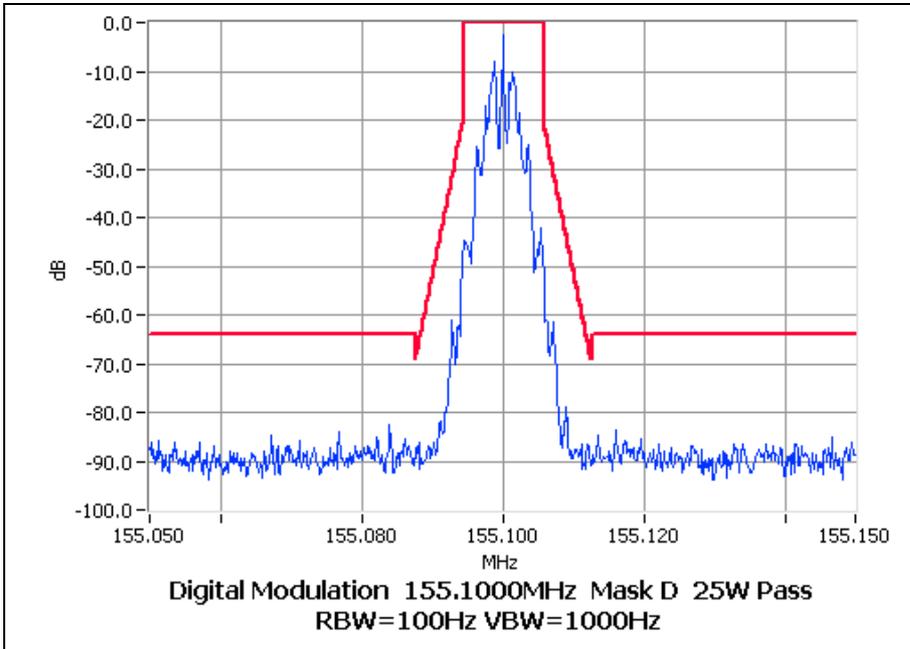
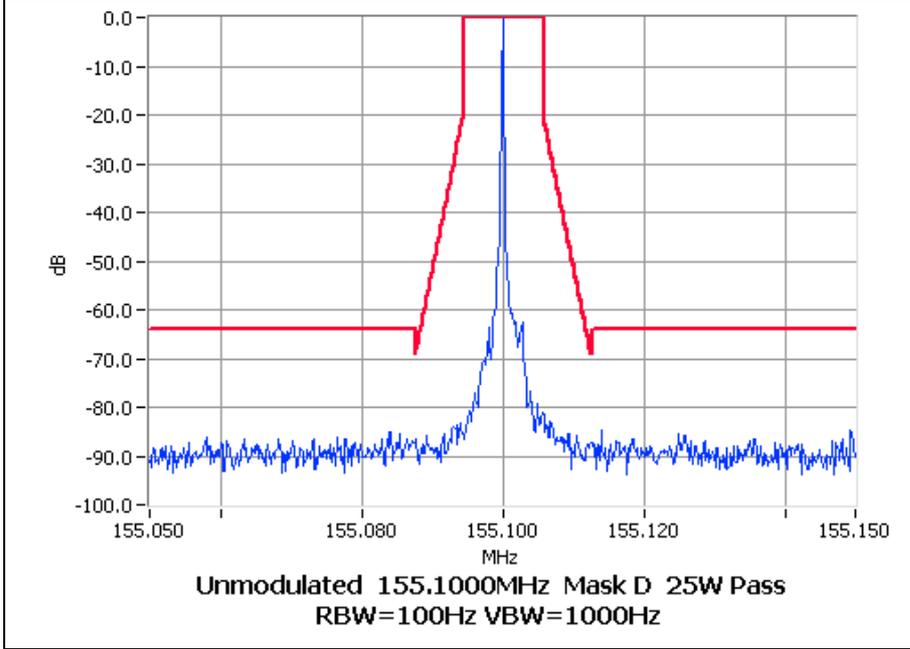


OCCUPIED BANDWIDTH

FFSK

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 25W 12.5 kHz Channel Spacing

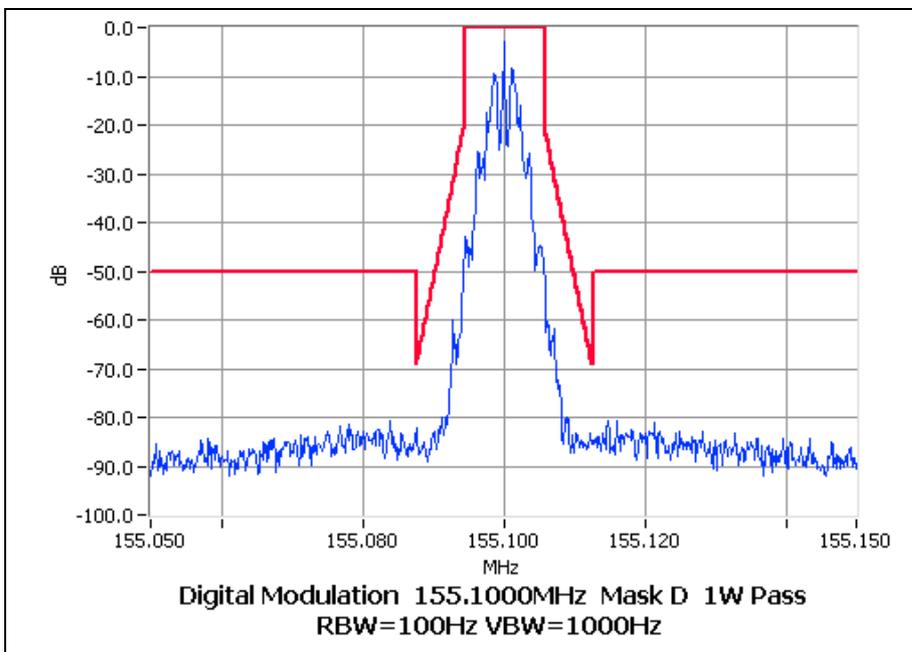
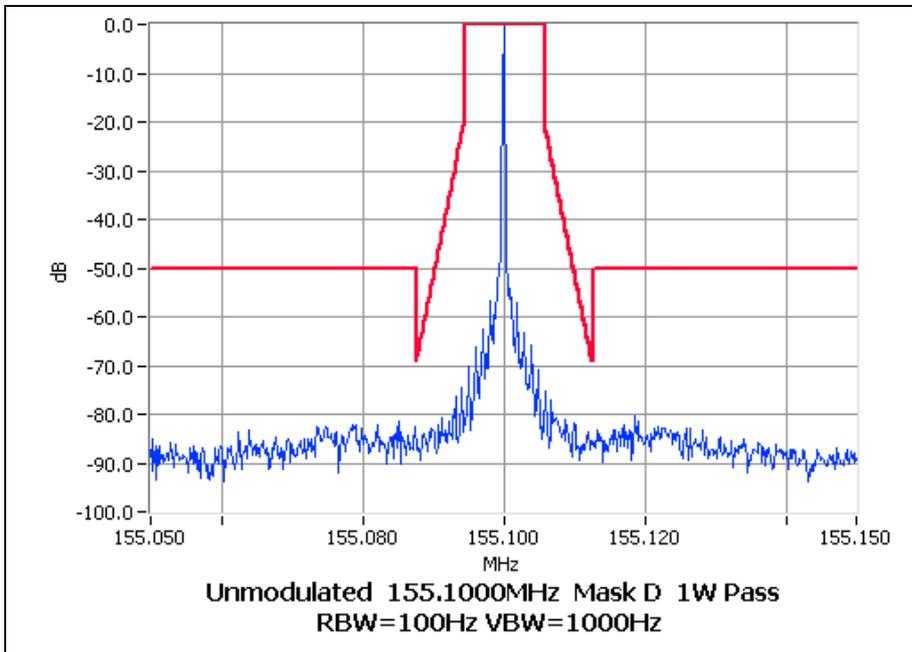


OCCUPIED BANDWIDTH

FFSK

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 1W 12.5 kHz Channel Spacing

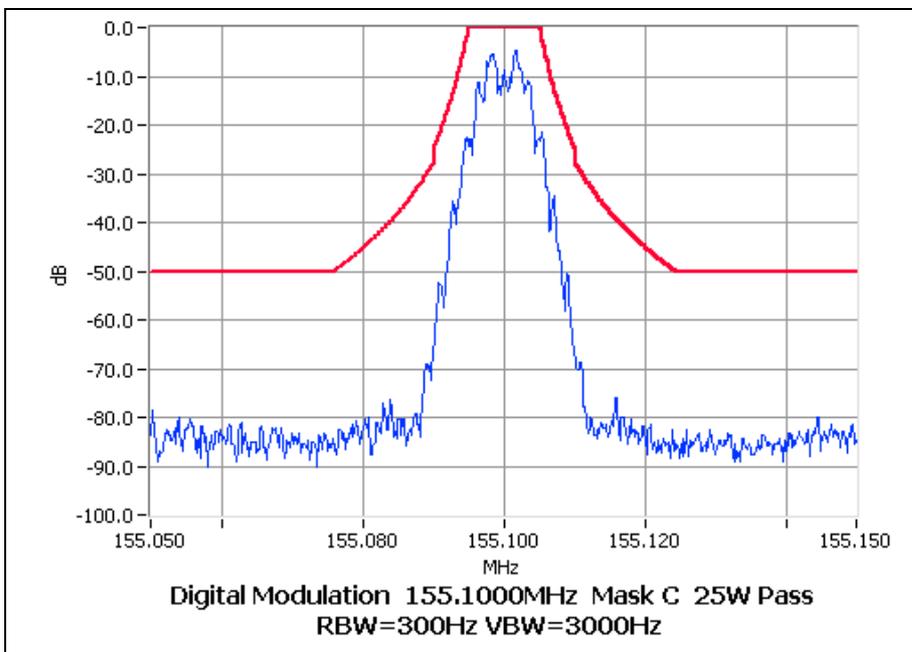
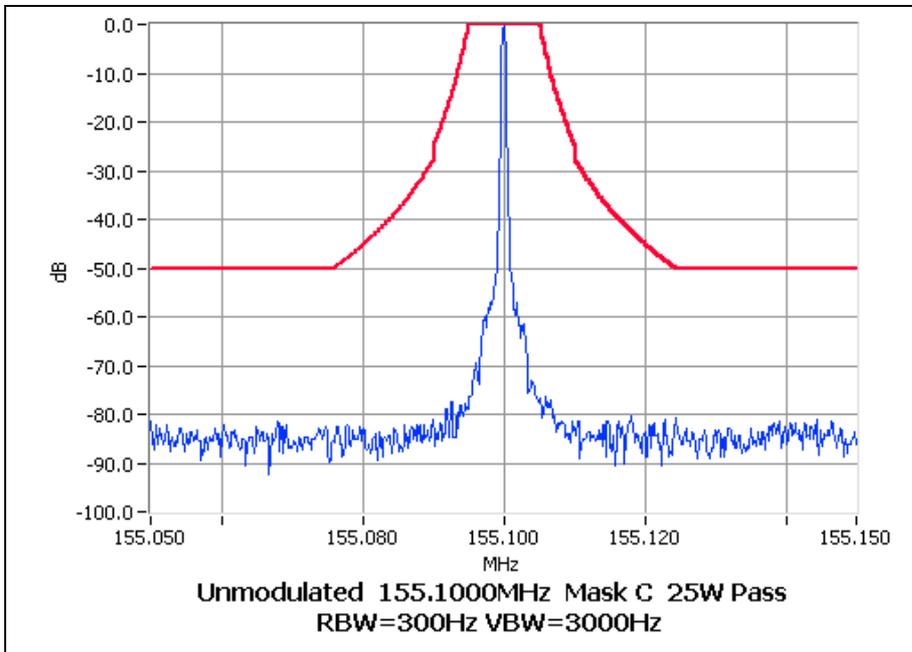


OCCUPIED BANDWIDTH

FFSK

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 25W 25.0 kHz Channel Spacing

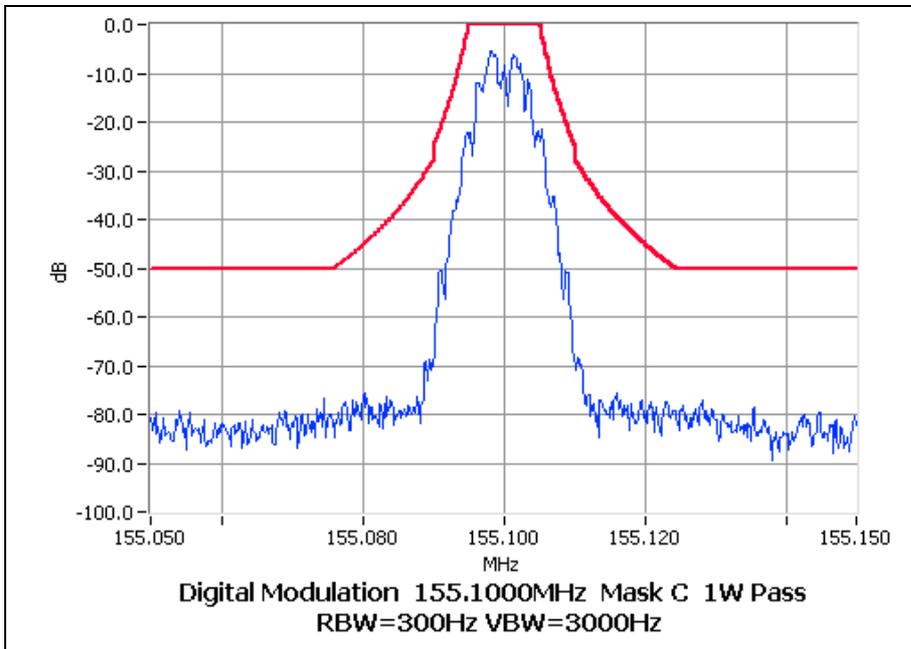
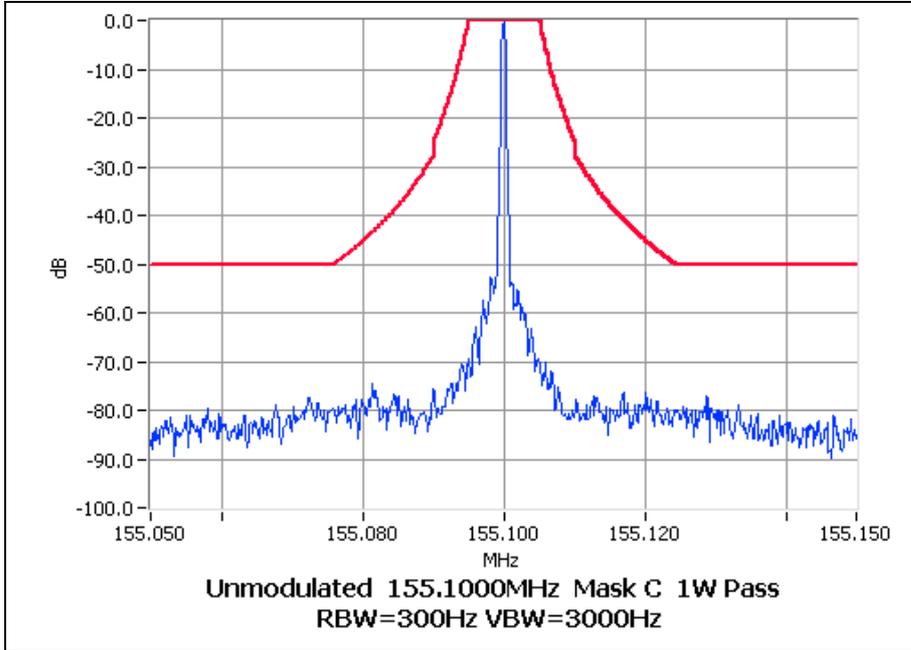


OCCUPIED BANDWIDTH

FFSK

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 1W 25.0 kHz Channel Spacing

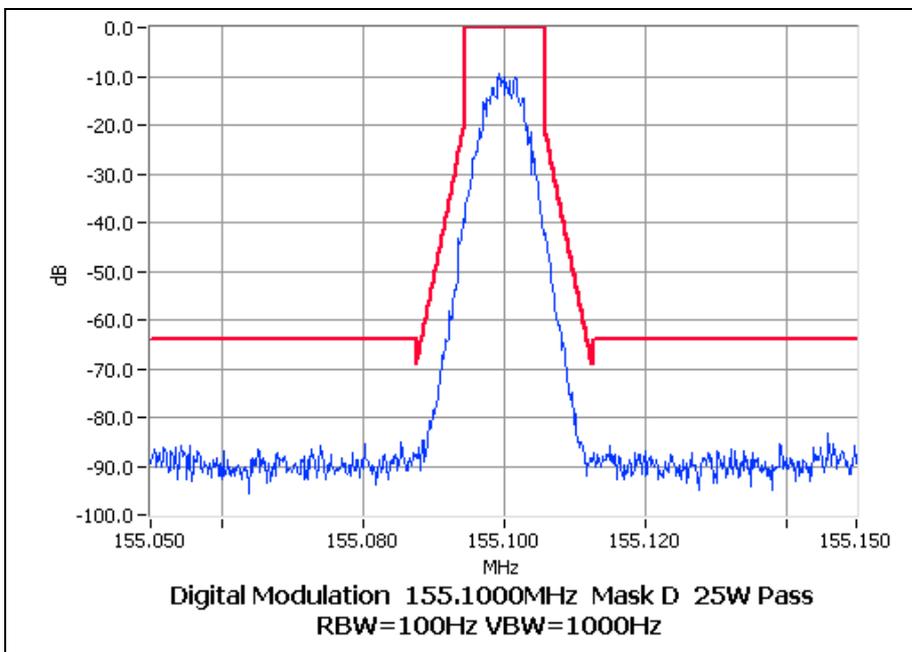
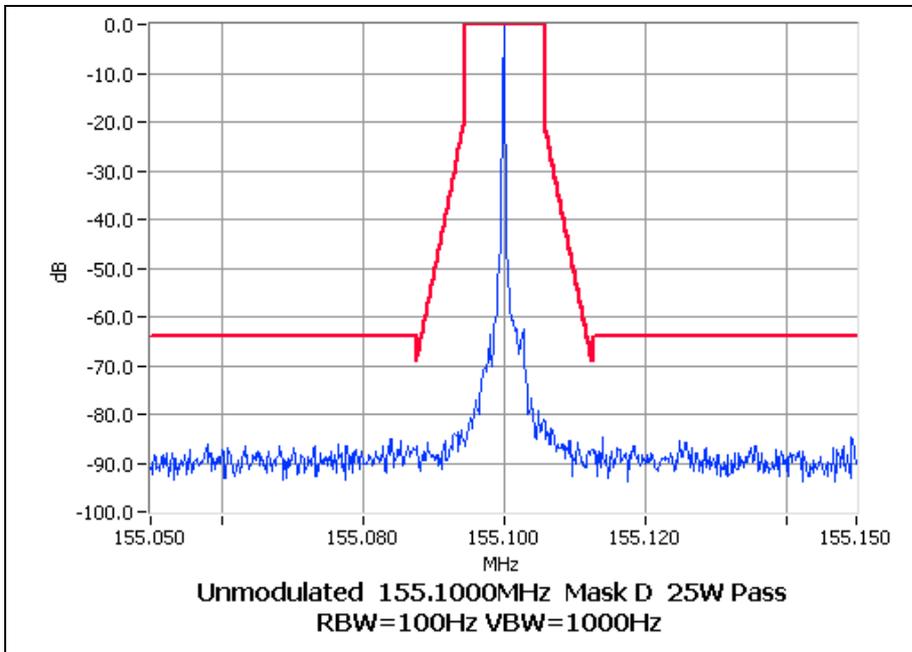


OCCUPIED BANDWIDTH

THSD

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 25W 12.5 kHz Channel Spacing

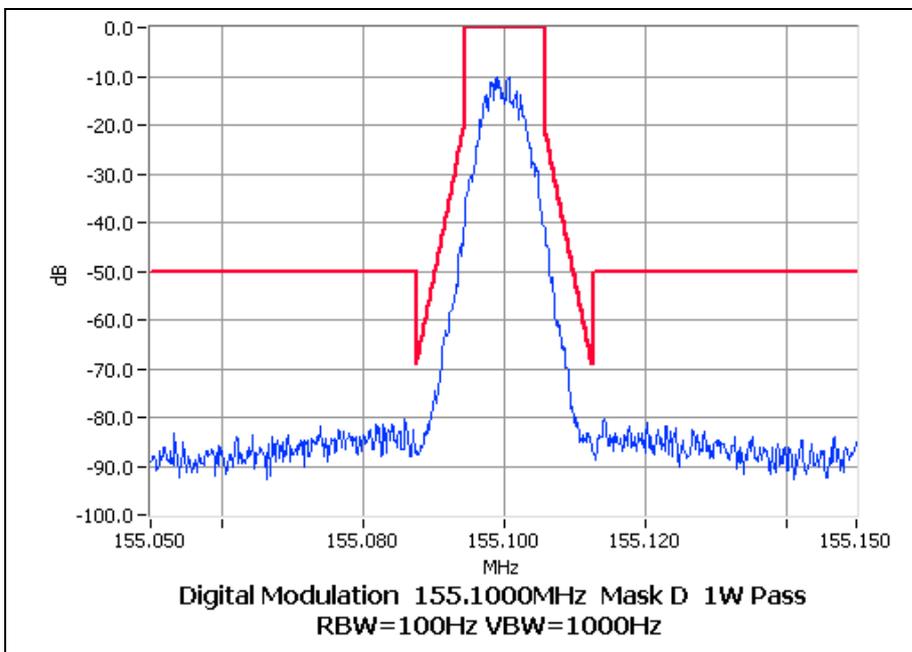
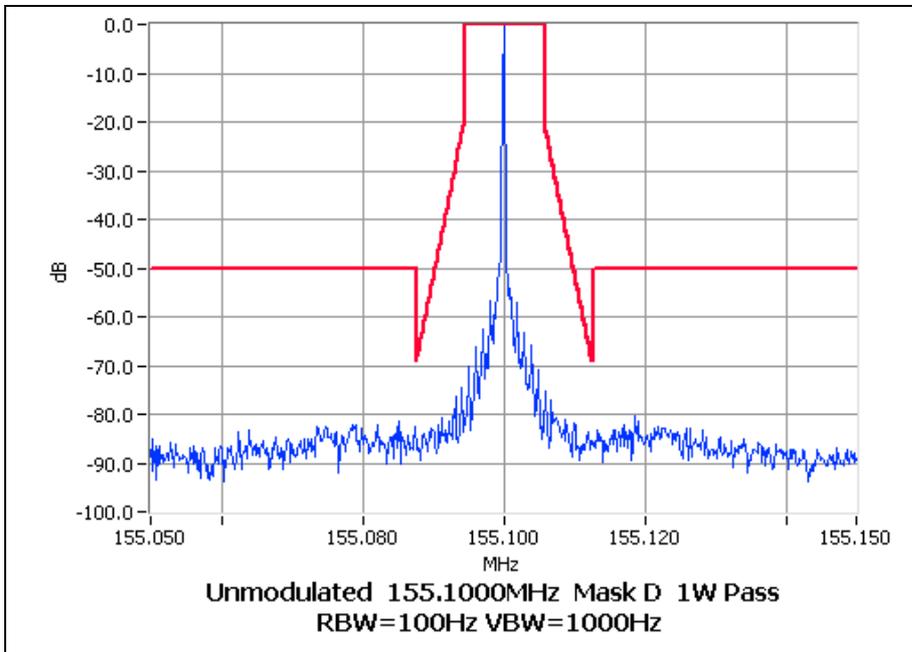


OCCUPIED BANDWIDTH

THSD

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 1W 12.5 kHz Channel Spacing

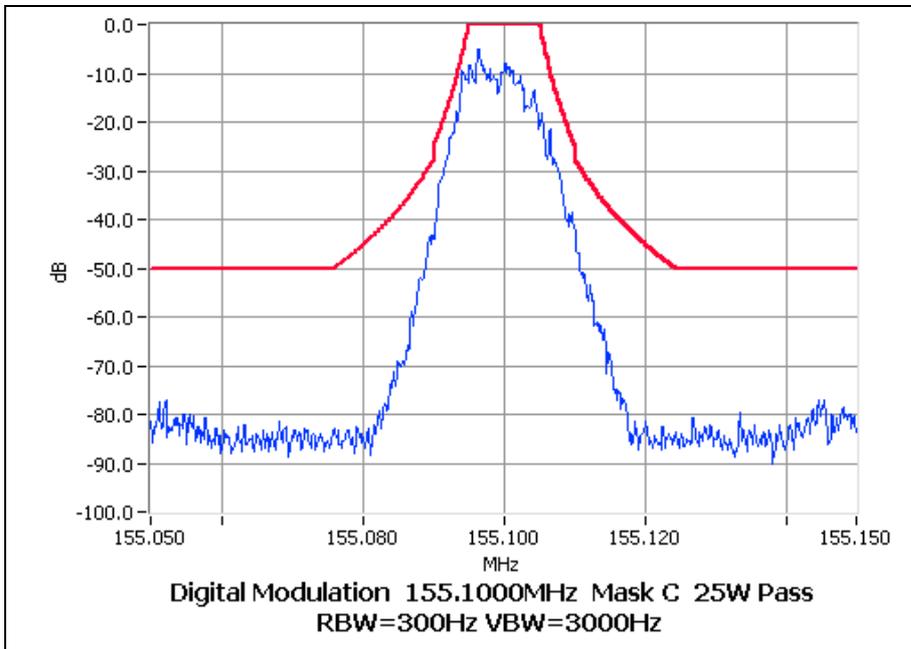
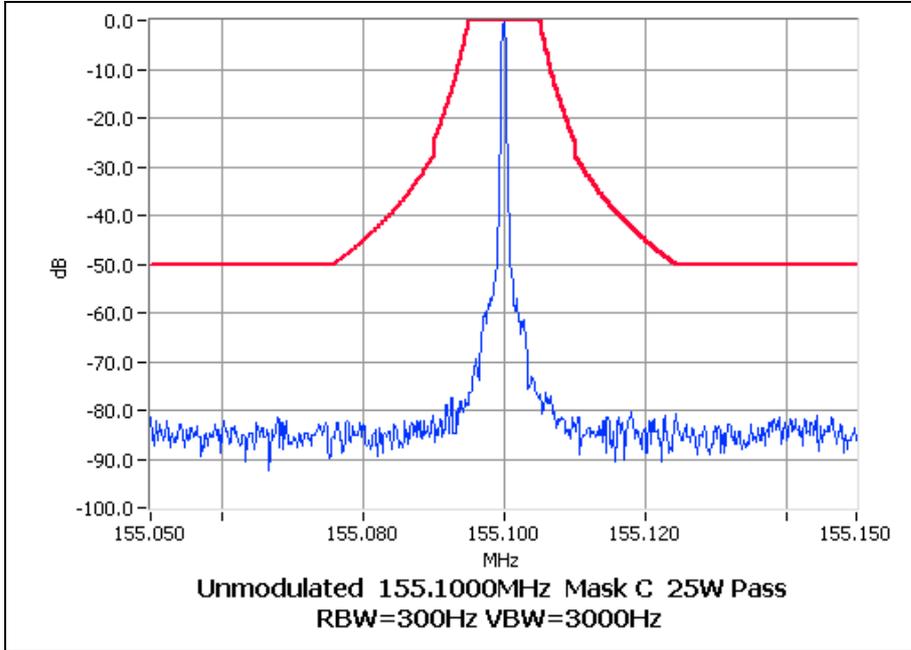


OCCUPIED BANDWIDTH

THSD

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 25W 25.0 kHz Channel Spacing

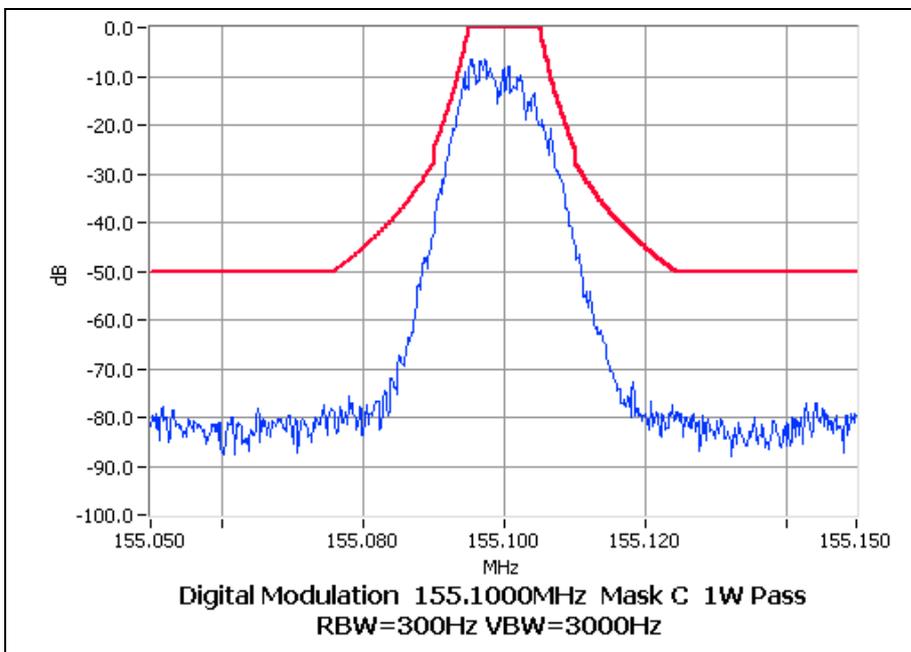
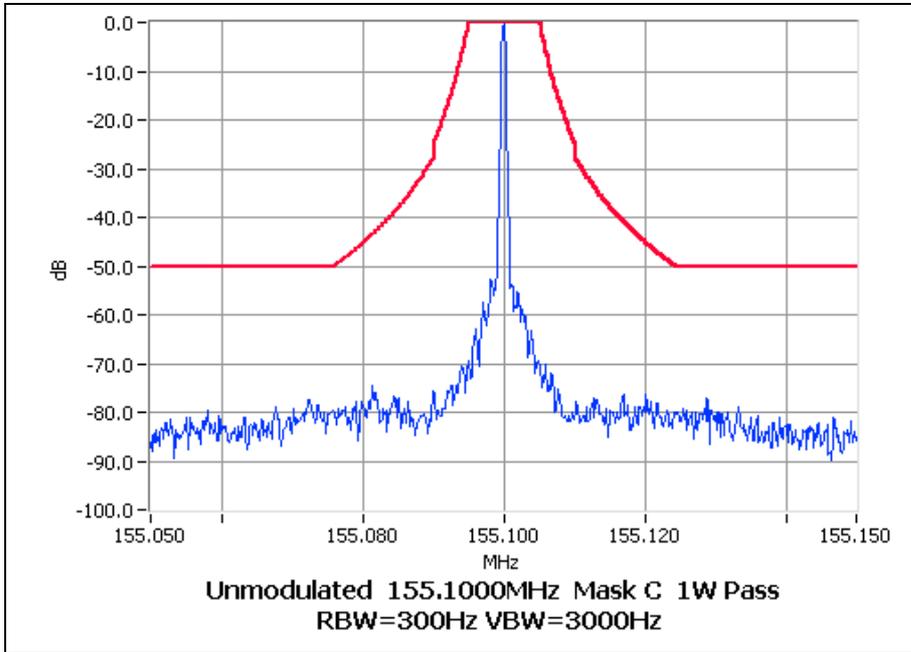


OCCUPIED BANDWIDTH

THSD

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 1W 25.0 kHz Channel Spacing

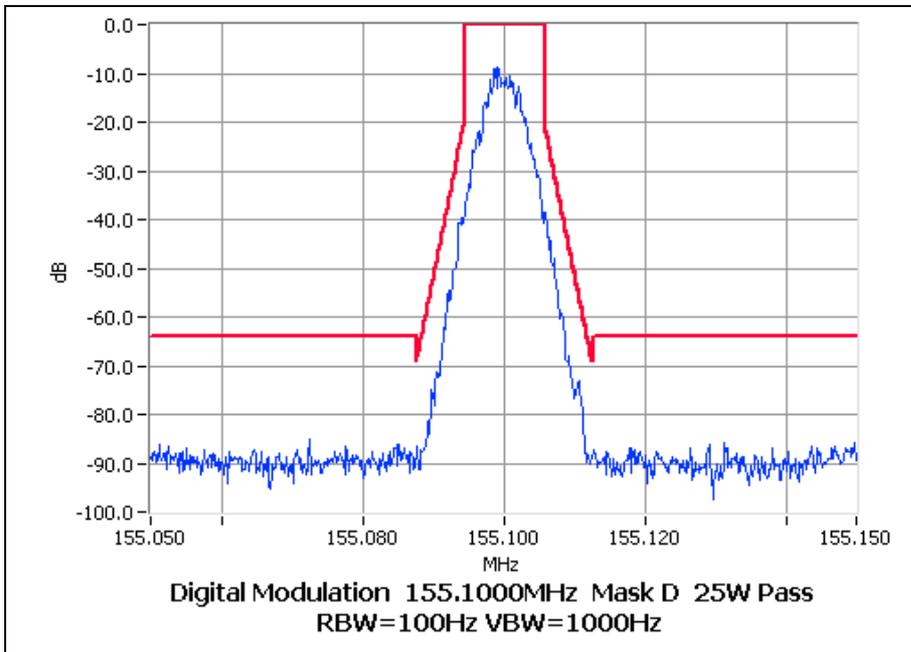
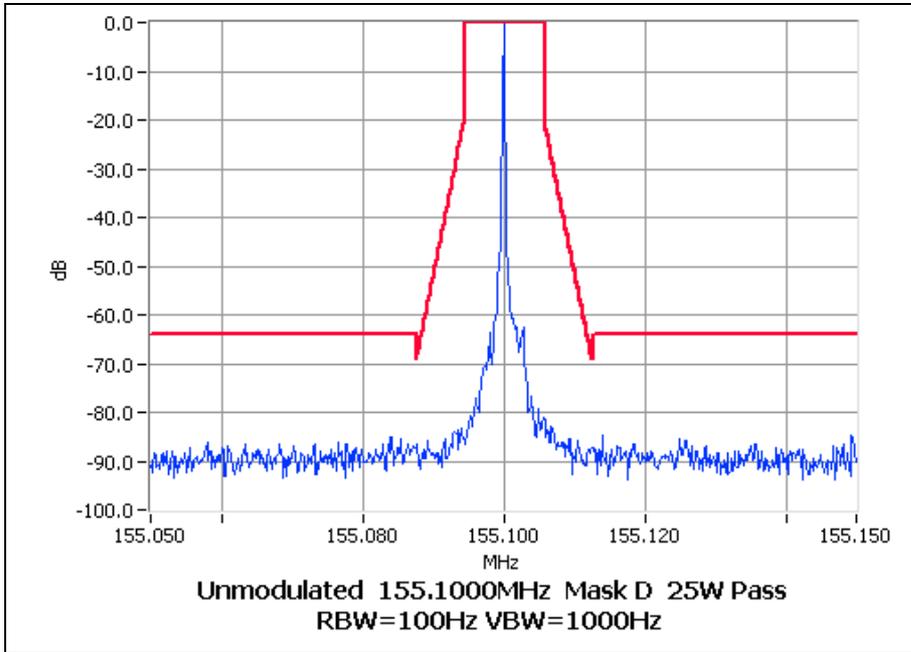


OCCUPIED BANDWIDTH

DIGITAL - 4 Level FSK

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 25W 12.5 kHz Channel Spacing

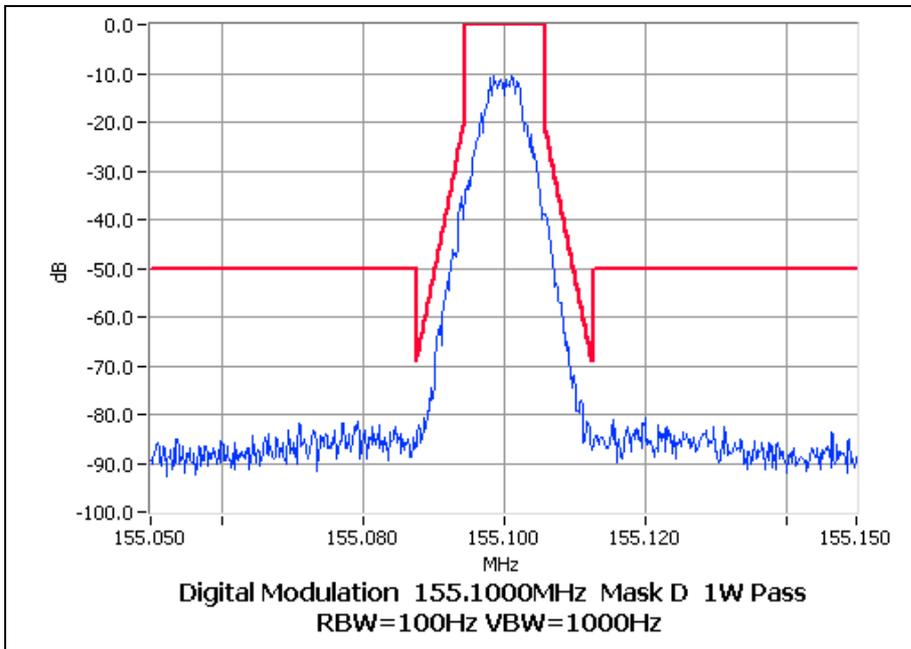
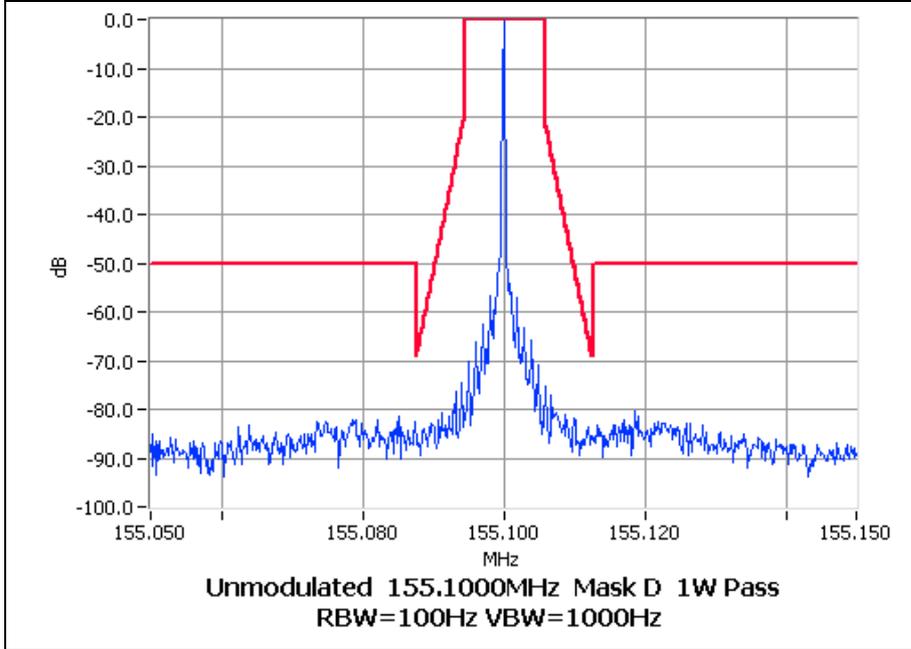


OCCUPIED BANDWIDTH

DIGITAL - 4 Level FSK

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 1W 12.5 kHz Channel Spacing

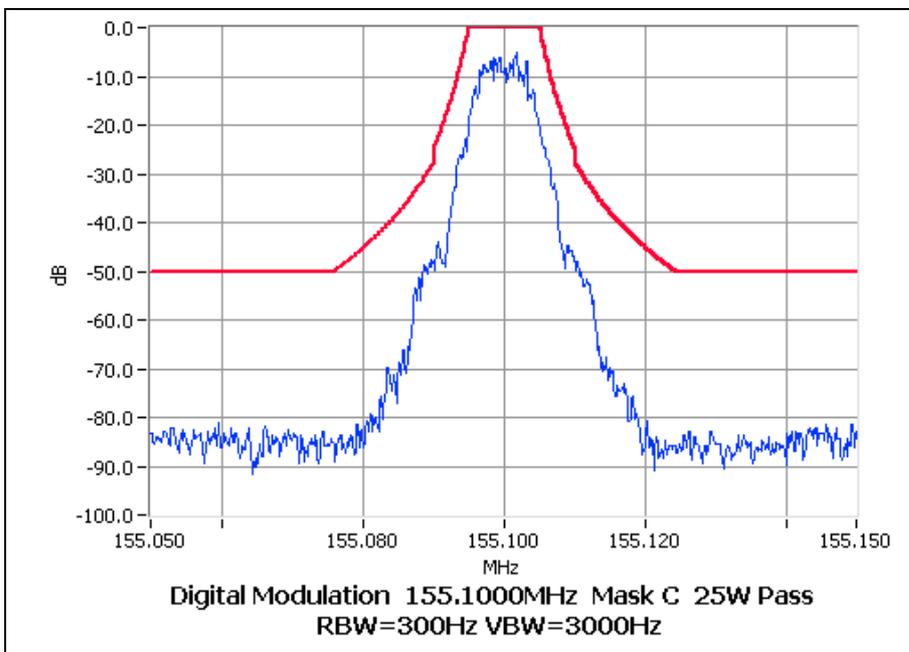
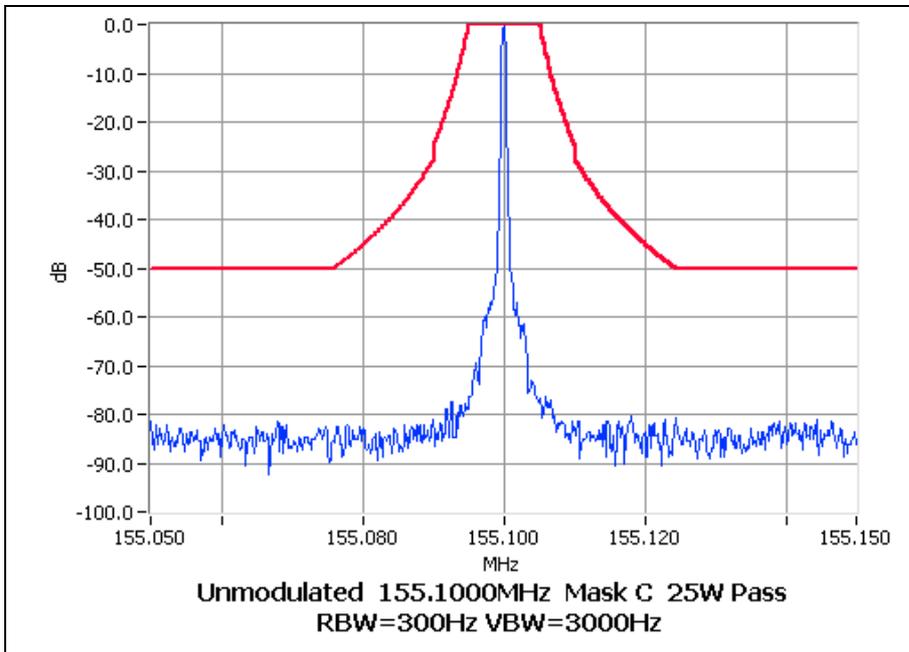


OCCUPIED BANDWIDTH

DIGITAL - 4 Level FSK

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 25W 25.0 kHz Channel Spacing

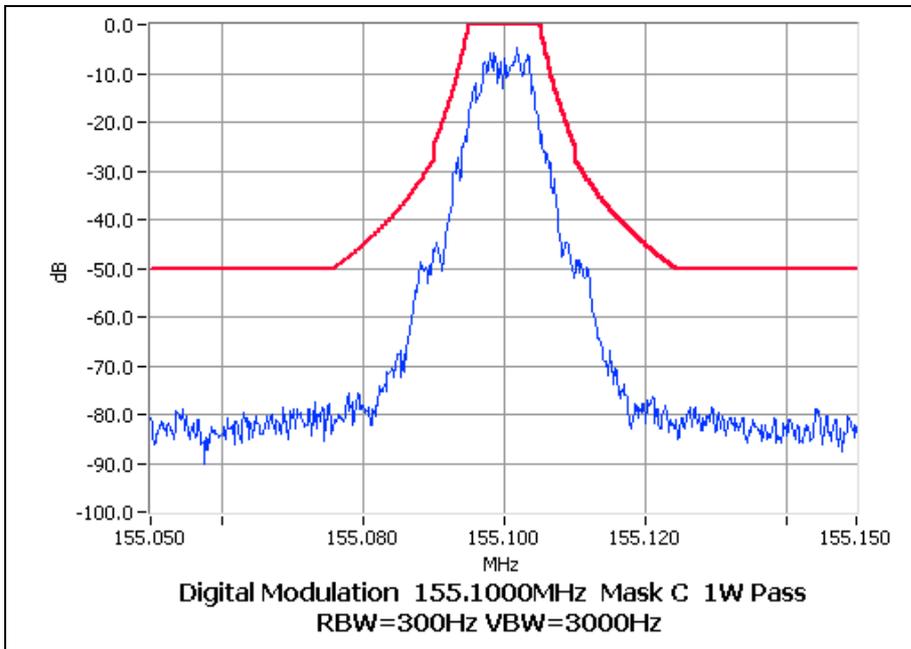
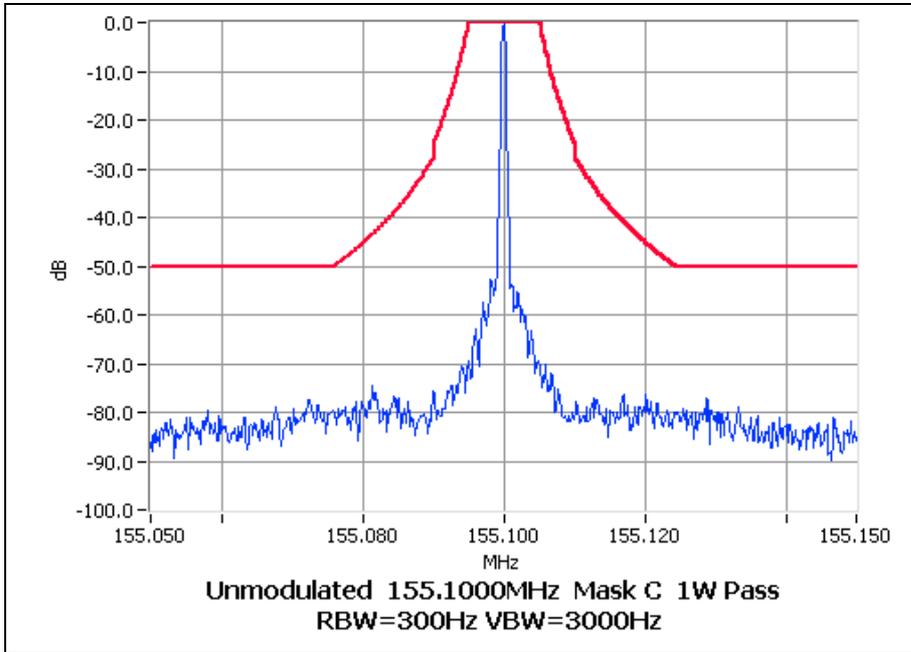


OCCUPIED BANDWIDTH

DIGITAL - 4 Level FSK

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 155.1 MHz 1W 25.0 kHz Channel Spacing



SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1051

GUIDE: TIA/EIA-603B 2.2.13

MEASUREMENT PROCEDURE:

1. Refer Appendix 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: 100kHz to Fc-BW
Fc+BW to 1.8 GHz
3. A Pre-scan is performed with a resolution bandwidth of 1 kHz, and a video bandwidth of 3 kHz. If any emissions are found to be within 20dB of the limit a second measurement is made with the carrier modulated, and a resolution bandwidth of 10 kHz, and a video bandwidth of 30kHz.
4. Spurious emissions which were attenuated more than 20dB below the limit were not recorded.

Formatted: Bullets and Numbering

MEASUREMENT RESULTS:

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

LIMIT CLAUSE: FCC 47 CFR 90.210

SPURIOUS EMISSIONS (RADIATED)

SPECIFICATION: FCC 47 CFR 2.1053

GUIDE: TIA/EIA-603B 2.2.12

MEASUREMENT PROCEDURE:

1. Refer Appendix A for equipment set up.
2. The EUT was placed on a wooden turntable at a distance of three metres from the test antenna. The output terminal was connected to an RF dummy load.
3. The turntable was rotated through 360° to obtain the maximum response of each spurious emission. Valid emissions were determined by switching the EUT on and off.
4. The EUT was 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 (RADIATED)

TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)

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

GUIDE: TIA/EIA-603B 2.2.2

MEASUREMENT PROCEDURE:

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

MEASUREMENT RESULTS:

See the plots on the following pages for 12.5 kHz & 25.0 kHz channel spacings.

LIMIT CLAUSE: FCC 47 CFR 90.213

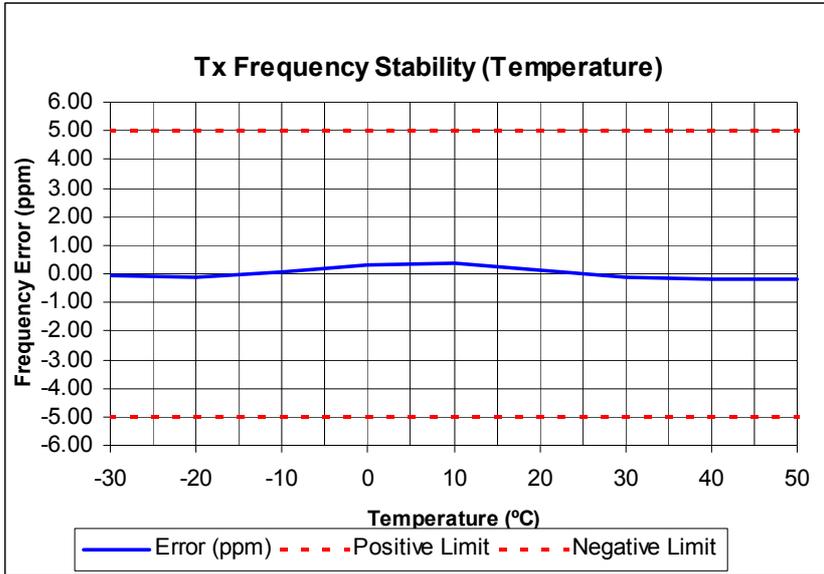
Frequency Range: 136 MHz to 174 MHz

| Channel Spacing (kHz) | Frequency Error (ppm) |
|-----------------------|-----------------------|
| 12.5 | 5.0 |
| 25.0 | 5.0 |

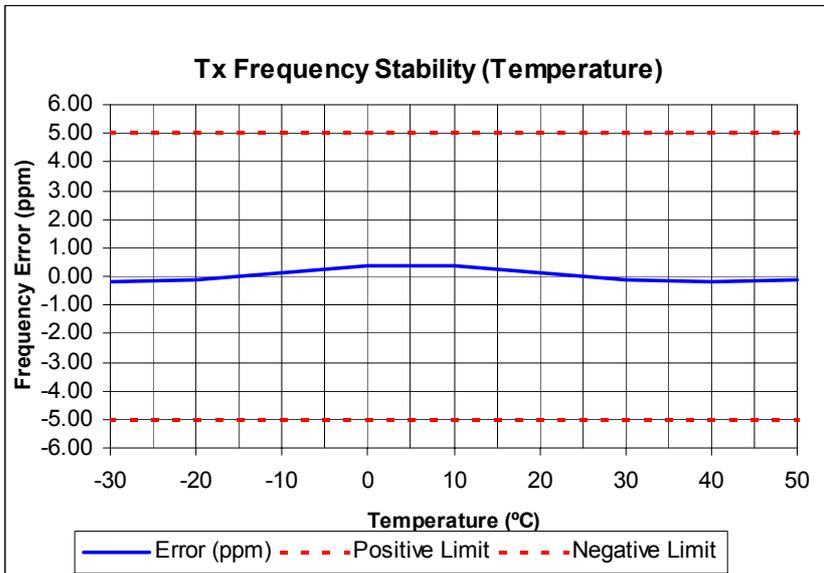
TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)

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

Tx FREQUENCY: 155.1 MHz 25W 12.5 kHz channel Spacing



Tx FREQUENCY: 155.1 MHz 25W 25.0 kHz channel Spacing



TRANSMITTER FREQUENCY STABILITY (VOLTAGE)

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

GUIDE: TIA/EIA-603B 2.2.2

MEASUREMENT PROCEDURE:

1. Refer Appendix 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: Frequency Range: 150 MHz to 174 MHz

| Channel Spacing (kHz) | FREQUENCY ERROR (ppm) @ 155.1 MHz | | |
|-----------------------|-----------------------------------|-----------|-----------|
| | 11.7 V DC | 13.8 V DC | 15.9 V DC |
| 12.5 | 0.01 | 0.02 | -0.01 |
| 25.0 | 0.21 | 0.21 | 0.19 |

LIMIT CLAUSE: FCC 47 CFR 90.213

| Channel Spacing (kHz) | Frequency Error (ppm) |
|-----------------------|-----------------------|
| 12.5 | 5.0 |
| 25.0 | 5.0 |

TRANSIENT FREQUENCY BEHAVIOR

SPECIFICATION: FCC 47 CFR 90.214

GUIDE: TIA/EIA-603B 2.2.19

MEASUREMENT PROCEDURE:

1. Refer Appendix 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 & 25.0 kHz channel spacings.

LIMIT CLAUSE: FCC 47 CFR 90.214

TRANSIENT FREQUENCY BEHAVIOUR

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 155.1 MHz 25 W 12.5 kHz Channel Spacing

| FREQUENCY | 155.1 MHz @ 25 W Tx | |
|--|------------------------------------|---------------|
| TRANSIENT RESPONSE PERIOD | CARRIER PEAK VARIATION FROM NORMAL | |
| | Key ON (kHz) | Key OFF (kHz) |
| t ₁ | 0.8 | N/A |
| t ₂ | 0.4 | N/A |
| t ₃ | N/A | 0.5 |
| t ₂ → t ₃ ppm | 3.3 | |
| ERROR LIMIT (t ₂ → t ₃) ppm | 5.0 | |

| | | |
|---|-----|----|
| Confirm that during periods t ₁ and t ₃ the frequency difference does not exceed the value of one channel separation. | YES | NO |
| | Y | |
| Confirm that during the period t ₂ the frequency difference does not exceed half a channel separation. | YES | NO |
| | Y | |
| Confirm that during the period t ₂ to t ₃ the frequency difference does not exceed the frequency error limit. | YES | NO |
| | Y | |

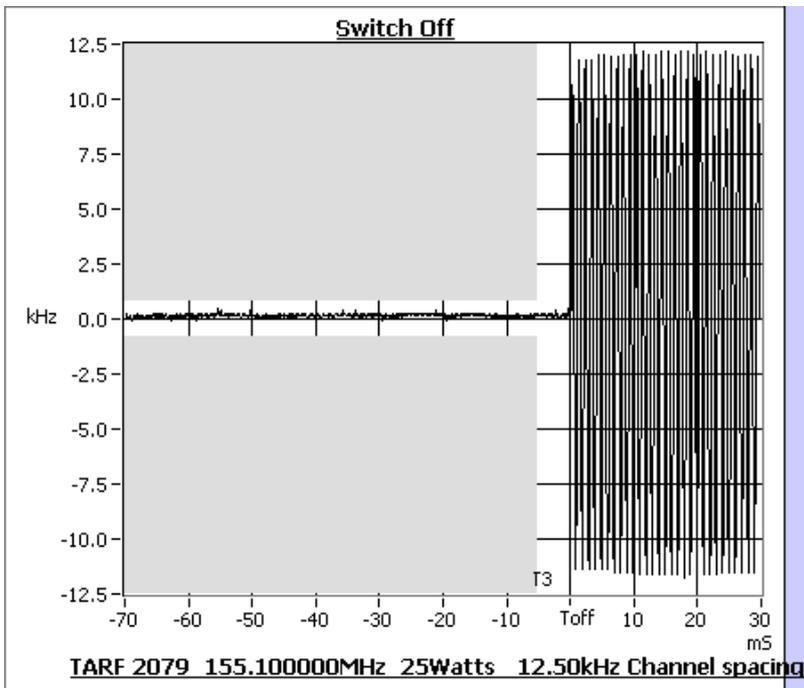
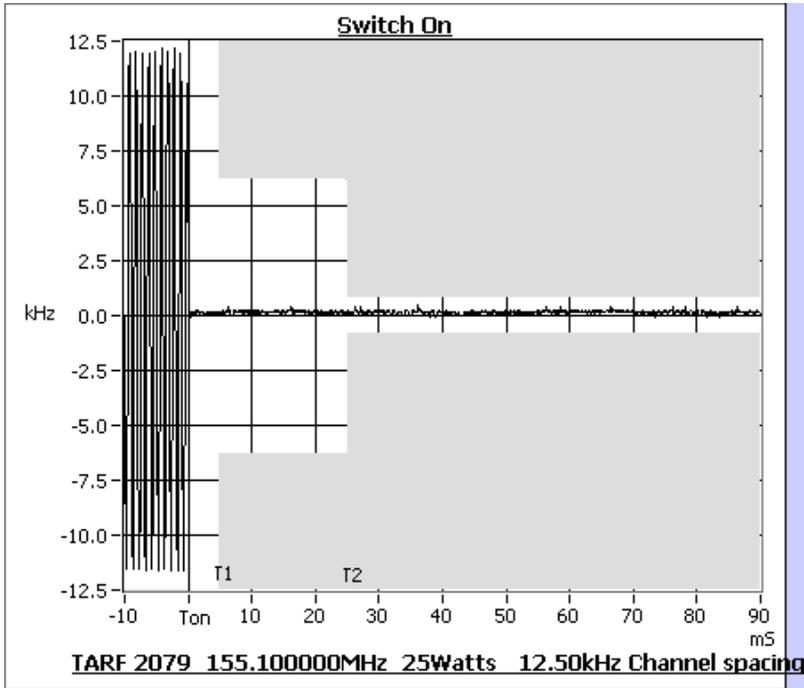
LIMIT:

| TRANSIENT PERIODS | FREQUENCY RANGE 150MHz – 174 MHz | FREQUENCY RANGE 421MHz – 512 MHz |
|---------------------|-------------------------------------|-------------------------------------|
| t ₁ (ms) | 5 ms | 10 ms |
| t ₂ (ms) | 20 ms | 25 ms |
| t ₃ (ms) | 5 ms | 10 ms |

TRANSIENT FREQUENCY BEHAVIOUR

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 155.1 MHz 25 W 12.5 kHz Channel Spacing



TRANSIENT FREQUENCY BEHAVIOUR

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 155.1 MHz 25 W 25.0 kHz Channel Spacing

| FREQUENCY | 155.1 MHz @ 25 W Tx | |
|--|------------------------------------|---------------|
| TRANSIENT RESPONSE PERIOD | CARRIER PEAK VARIATION FROM NORMAL | |
| | Key ON (kHz) | Key OFF (kHz) |
| t ₁ | 2.3 | N/A |
| t ₂ | 0.6 | N/A |
| t ₃ | N/A | 0.3 |
| t ₂ → t ₃ ppm | 3.6 | |
| ERROR LIMIT (t ₂ → t ₃) ppm | 5.0 | |

| | | |
|---|-----|----|
| Confirm that during periods t ₁ and t ₃ the frequency difference does not exceed the value of one channel separation. | YES | NO |
| | Y | |
| Confirm that during the period t ₂ the frequency difference does not exceed half a channel separation. | YES | NO |
| | Y | |
| Confirm that during the period t ₂ to t ₃ the frequency difference does not exceed the frequency error limit. | YES | NO |
| | Y | |

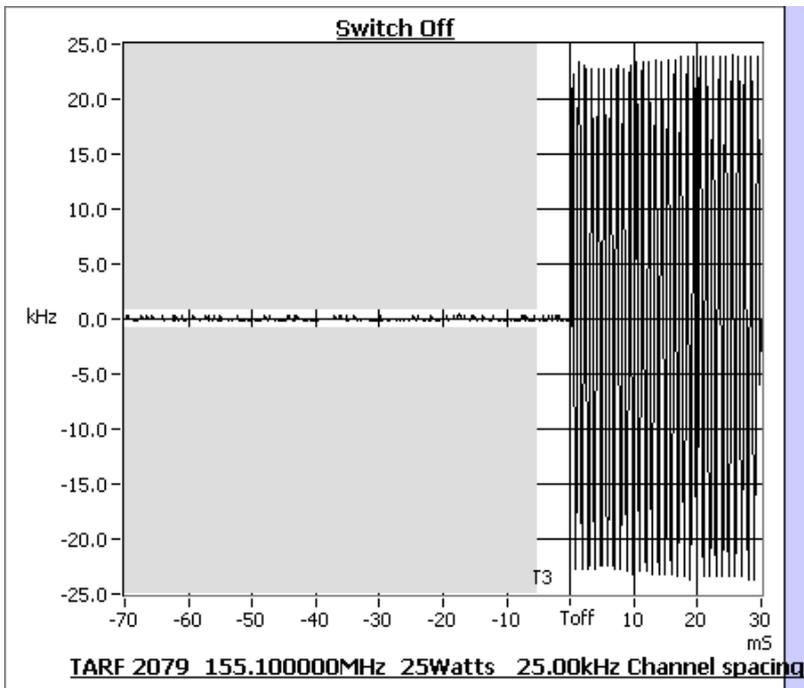
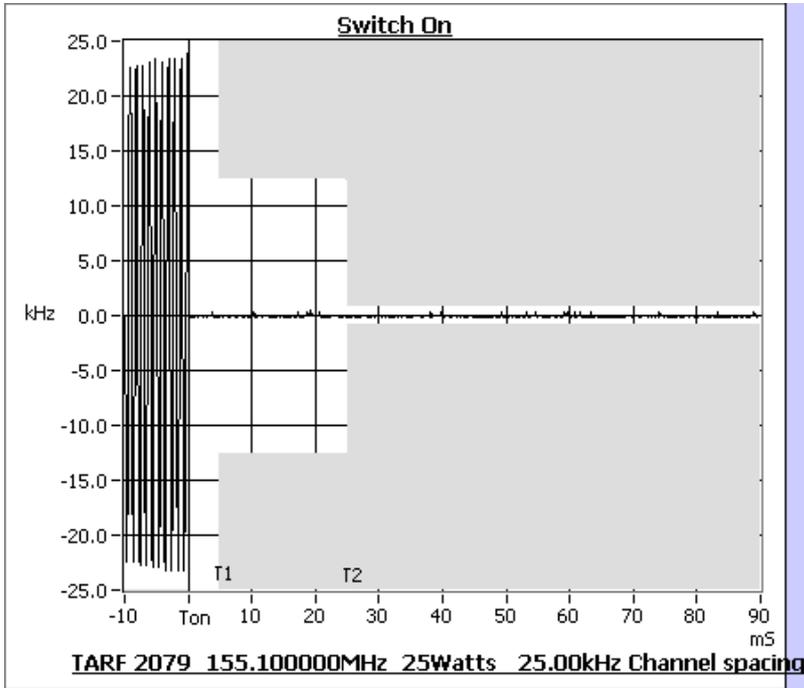
LIMIT:

| TRANSIENT PERIODS | FREQUENCY RANGE 150MHz – 174 MHz | FREQUENCY RANGE 421MHz – 512 MHz |
|---------------------|-------------------------------------|-------------------------------------|
| t ₁ (ms) | 5 ms | 10 ms |
| t ₂ (ms) | 20 ms | 25 ms |
| t ₃ (ms) | 5 ms | 10 ms |

TRANSIENT FREQUENCY BEHAVIOUR

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 155.1 MHz 25 W 25.0 kHz Channel Spacing



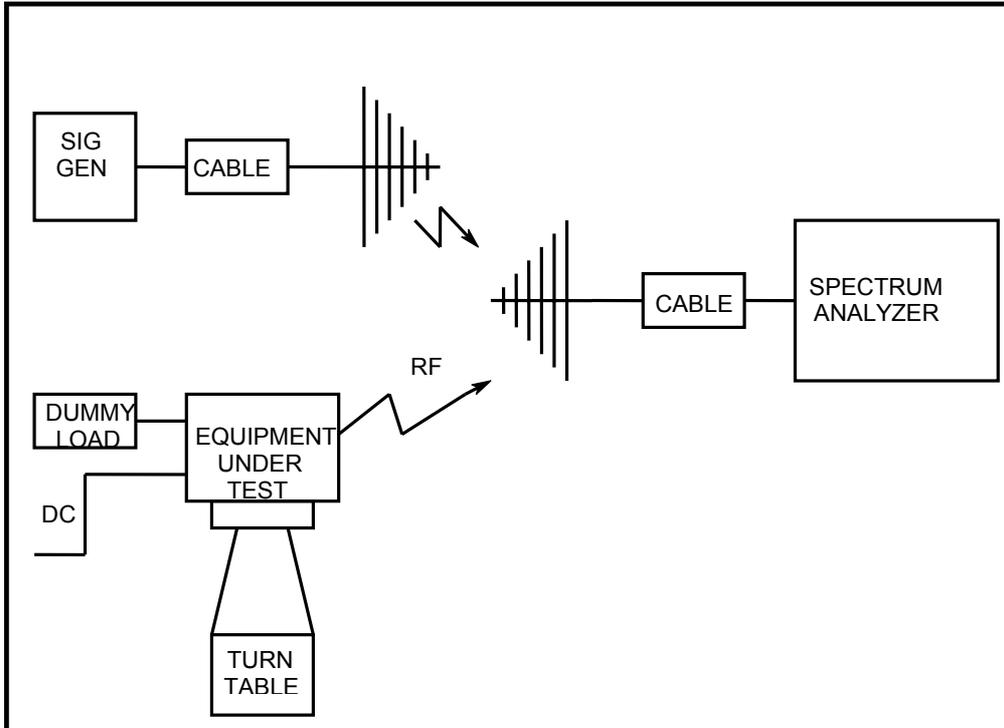
TEST EQUIPMENT USED

| No# | Equipment | Manufacturer | Model No | Serial No# | Tait ID | Cal Due |
|-----|--------------------------|-----------------|-------------------|-------------|---------|-----------|
| 3 | Signal Generator | Agilent | E4422B | GB40050320 | E3788 | 22-Oct-04 |
| 14 | Power Head | Hewlett Packard | HP11722A | 2320A00688 | E3307 | 15-Oct-04 |
| 20 | Power Supply | Hewlett Packard | HP6032A | 2441A-0041Z | E3075 | 15-Oct-04 |
| 22 | Oscilloscope | Tektronics | TDS340 | B013611 | E3585 | 25-Nov-04 |
| 42 | Reference Horn Antenna | Emco | DRG3115 | 9512-4638 | E3560 | 27-Sep-06 |
| 82 | 3m Coax Cable (BLUE) | Suhner | Sucoflex 104A | 25033/4A | E3694 | 30-Oct-04 |
| 84 | 1m Coax Cable (BLUE) | Suhner | Sucoflex 104A | 25005/4A | E3692 | 15-Jul-05 |
| 85 | 1m Coax Cable (BLUE) | Suhner | Sucoflex 104A | 25004/4A | E3691 | 15-Jul-05 |
| 111 | Modulation Analyser | Hewlett Packard | HP8901B (Opt 002) | 3704A05837 | E3786 | 15-Oct-04 |
| 115 | Environ. Chamber | Contherm | 5400 RHLT.M | | E4051 | 04-Mar-05 |
| 118 | RF Attenuator | Weinschel | Model 1 | BL9958 | E4081 | 24-May-05 |
| 119 | RF Attenuator 150W Treva | Weinschel | 40-20-23 | MF817 | E4082 | 17-May-05 |
| 123 | Spectrum Analyser | Agilent | E4445A | MY42510072 | E4139 | 23-Apr-05 |
| 135 | Attenuator | Weinschel | 67-30-33 | BR0531 | | 09-Aug-05 |

APPENDIX A

TEST SETUP DETAILS

Test set up for Radiated Emissions



All other testing is performed using the Teltest Radio **EVAL**uation 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.

