

REPORT NUMBER 2007

MAY 2004

RADIO PERFORMANCE MEASUREMENTS

On the TMAB22-B100 Mobile Transceiver

FCC ID: CASTMAB1C

SN: 19007605

In accordance with

FCC 47 CFR Parts 22 and 90

PREPARED BY:

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REPORT ON :

Type Approval Testing of the TMAB22-B100 (Serial No 19007605)
in accordance with:

FCC CFR 47 Parts 22 & 90

Report No 2007

FCC ID: CASTMAB1C

PREPARED FOR :

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APPROVED :

S. A. Crompton

Compliance Laboratory Manager

Date :

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

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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: TMAB1C

Product code: TMAB22-B100

Serial Numbers: 19007605

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: _____

Environmental Conditions

All testing was performed at the following conditions.

Ambient Temperature 15°C to 30°C
Relative Humidity 20% to 75%

Necessary Bandwidth and Emission Designators

SPECIFICATION: FCC 47 CFR 2.202

The Necessary Bandwidth is the minimum value of the occupied bandwidth sufficient to ensure the transmission of information at the rate and with the quality required for the system employed.

This is calculated using the following formula.

$B_n = 2M + 2DK$ Where: B_n = Necessary Bandwidth
 M = Maximum modulation frequency
 For Data transmission
 $M = B/2$
 Where: B = Modulation rate in Baud
 D = Peak deviation
 K = Constant
 For Analogue transmission this is 1
 For Data transmission this is typically 1.2

1. Analogue Voice 12.5kHz Bandwidth

Necessary bandwidth	Emission Designator
$M = 3\text{kHz}$	11k0F3E
$D = 2.5\text{kHz}$	F3E represents a FM voice transmission
$B_n = 6 + 5 \times 1$	
$= 11\text{kHz}$	

2. Analogue Voice 25kHz Bandwidth

Necessary bandwidth	Emission Designator
$M = 3\text{kHz}$	16k0F3E
$D = 5\text{kHz}$	F3E represents a FM voice transmission
$B_n = 6 + 10 \times 1$	
$= 16\text{kHz}$	

3. Fast Frequency Shift Keying (FFSK) 12.5kHz Bandwidth

Necessary bandwidth	Emission Designator
$M = 0.6$ (Baud rate = 1200)	4k80F2D
$D = 1.5\text{kHz}$ (60% of peak deviation)	F2D represents a FM data transmission with the use of a modulating sub carrier
$B_n = 1.2 + 3 \times 1.2$	
$= 4.8\text{kHz}$	

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

Necessary bandwidth

Emission Designator

M = 0.6 (Baud rate = 1200)

8k40F2D

D = 3kHz (60% of peak deviation)

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

Bn = 1.2 + 6 x 1.2
=8.4kHz

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 conventional radios. Data is transmitted at a rate of 12000bps for narrow band channels, and 19200bps for wide-band channels.

Due to the difficulties in determining the value of k, the necessary bandwidth has been measured using the 99% energy rule.

12.5kHz Bandwidth

99% bandwidth

Emission Designator

7.6 kHz

7k60F1D

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

25kHz Bandwidth

99% bandwidth

Emission Designator

12.7 kHz

12k7F1D

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

Test Results

TRANSMITTER OUTPUT POWER (CONDUCTED)

TEST CONDITIONS: Standard Voltage 13.8 V DC

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

425.1 MHz	1 W nominal	25 W nominal
POWER (W)	1.0	27.2
Variation from Nominal (%)	0.0	+8.8
Measurement Uncertainty (dB)	+0.63 -0.68	

LIMIT CLAUSE: FCC 47 CFR 90.205

Radio Type: Mobile Transceiver

Frequency Band: 421 MHz ~ 512 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

TEST CONDITIONS: Standard Voltage 13.8 V DC

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:

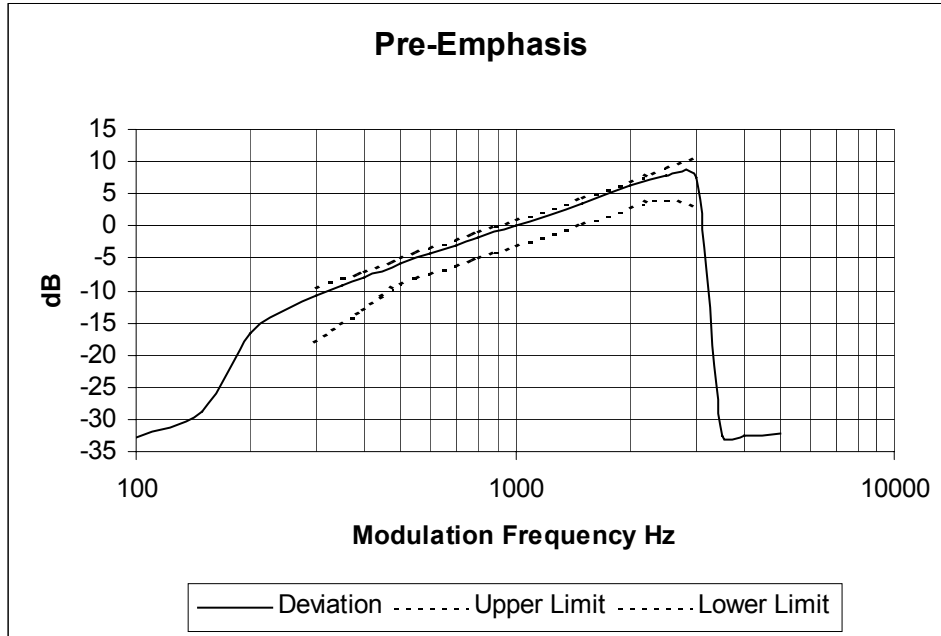
See the plots on the following pages for 12.5 kHz & 25.0 kHz channel spacings.

LIMIT CLAUSE: TIA/EIA-603B 3.2.6

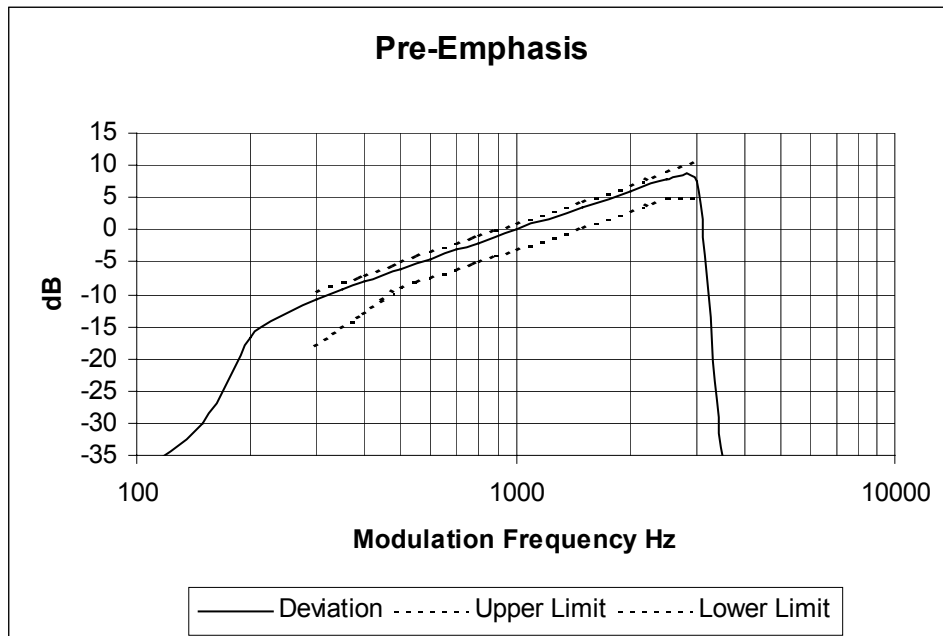
TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS

SPECIFICATION: FCC CFR 2.1047 (a)

Tx FREQUENCY: 155.1 MHz 12.5 kHz Channel Spacing



Tx FREQUENCY: 155.1 MHz 25 kHz Channel Spacing



TRANSMITTER MODULATION LIMITING

TEST CONDITIONS: Standard Voltage 13.8 V DC

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:

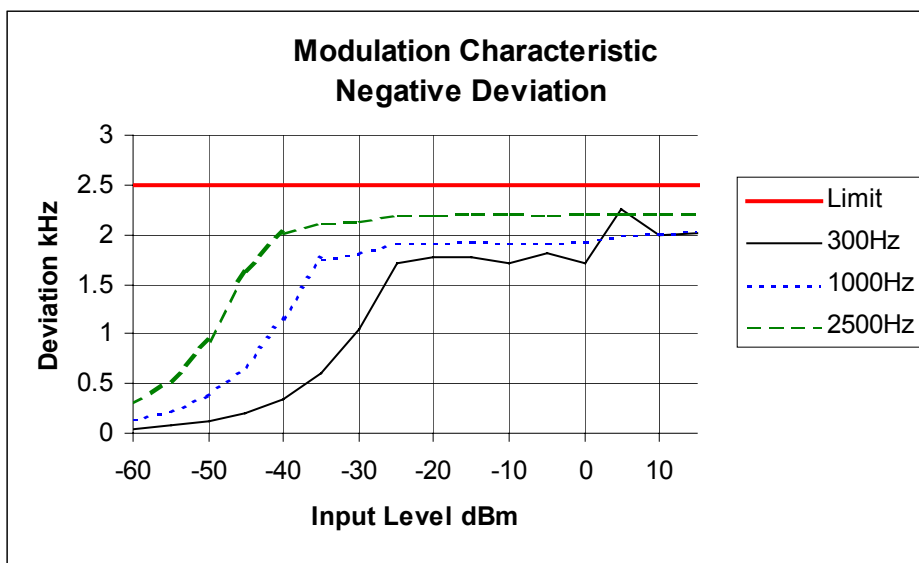
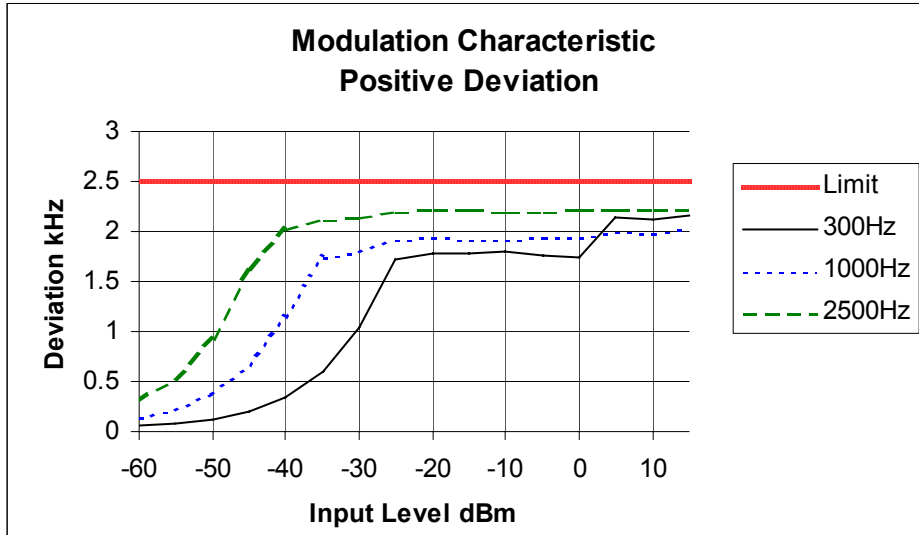
See the plots on the following pages for 12.5 kHz & 25.0 kHz channel spacings.

LIMIT CLAUSE: TIA/EIA-603B 1.3.4.4

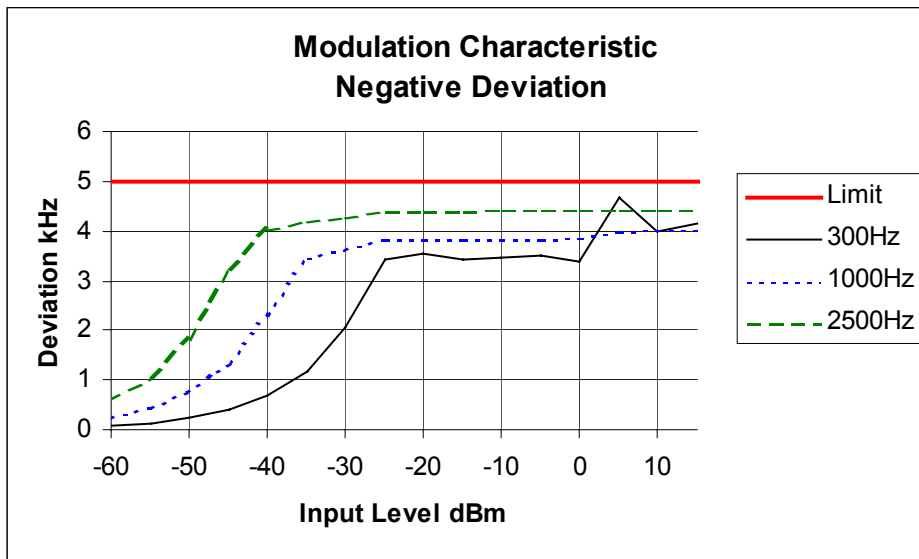
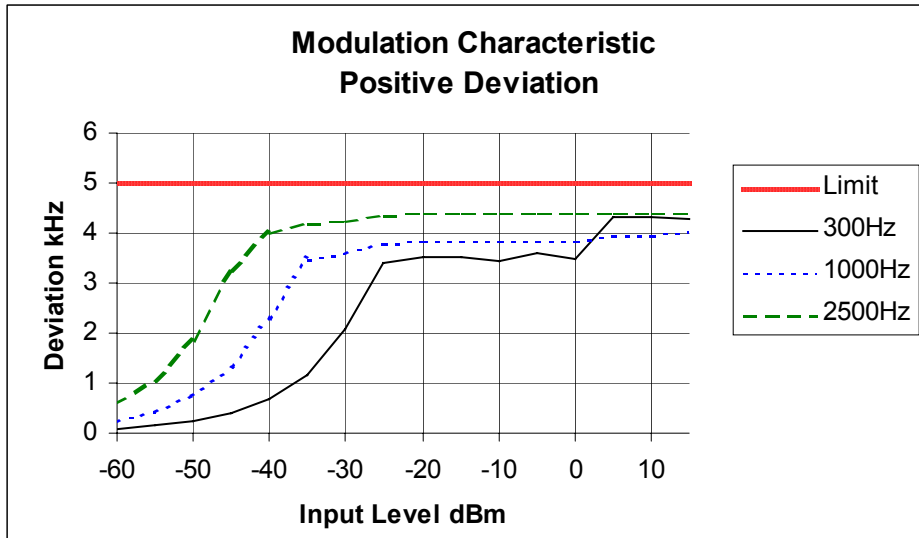
TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC CFR 2.1047 (b)

Tx FREQUENCY: 155.1 MHz 12.5 kHz Channel Spacing



NAME OF TEST: TRANSMITTER MODULATION LIMITING
SPECIFICATION: FCC CFR 2.1047 (b)
Tx FREQUENCY: 155.1 MHz 25.0 kHz Channel Spacing



OCCUPIED BANDWIDTH

TEST CONDITIONS: Standard Voltage 13.8 V DC

SPECIFICATION: FCC 47 CFR 2.1049 (c)

GUIDE: TIA/EIA-603B 2.2.11

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 Data measurements: The EUT was modulated with an internally generated pseudo random bit sequence at the appropriate Baud rates.
3. The Occupied Bandwidth was measured on the Spectrum Analyser, with bandwidth settings as follows.

Emission Mask D – Resolution Bandwidth = 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

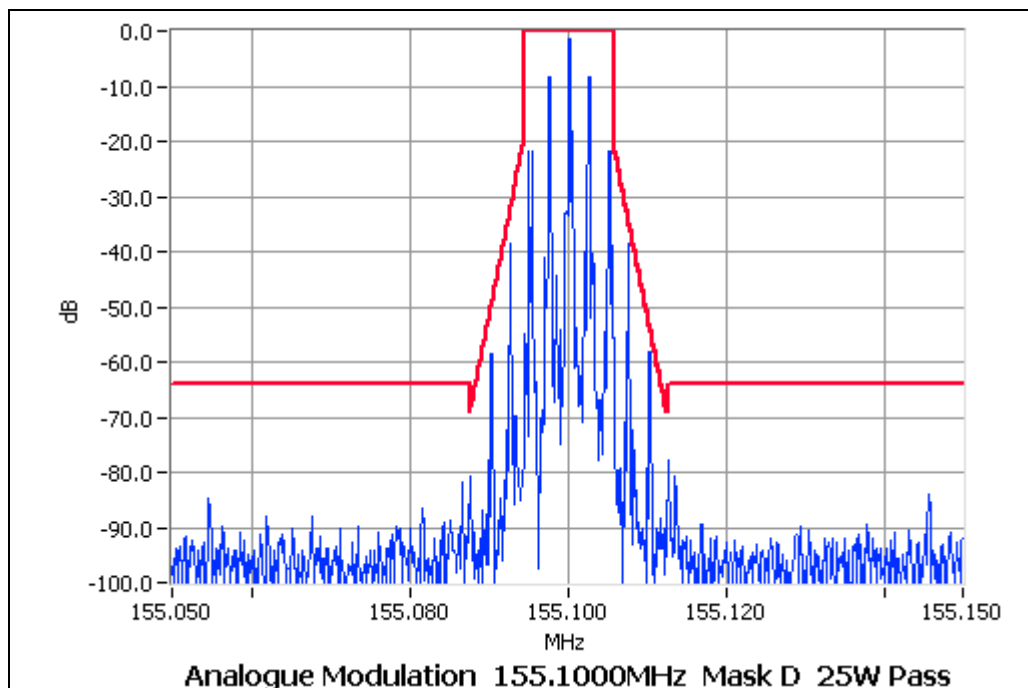
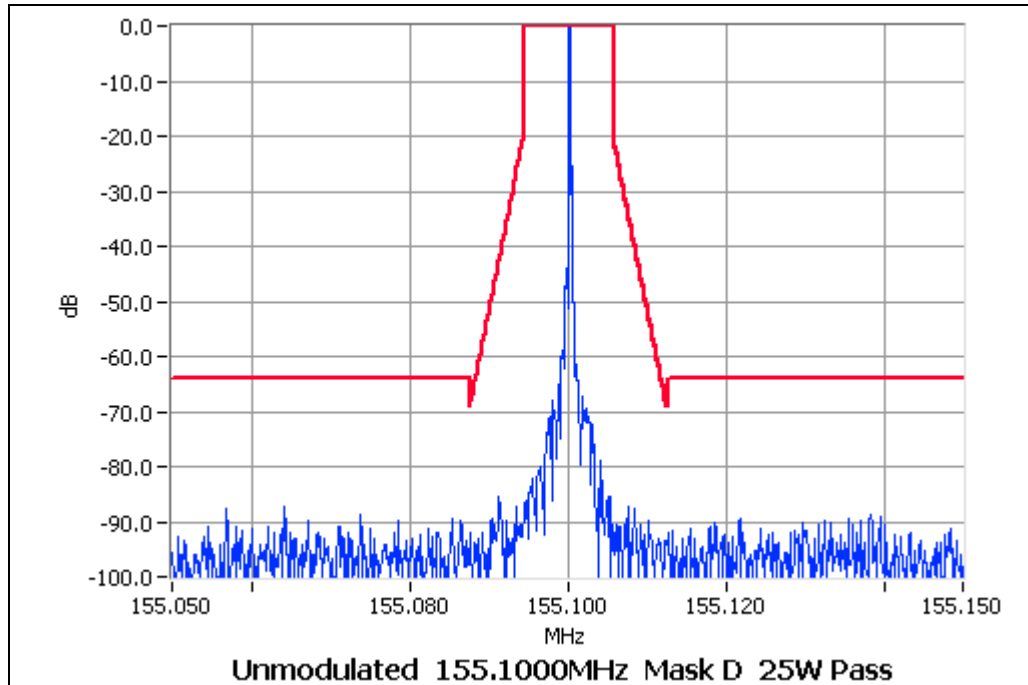
Emission Mask D	12.5 kHz Channel Spacing	Analog; FFSK; THSD
Emission Mask B	25.0 kHz Channel Spacing	Analog;
Emission Mask C	25.0 kHz Channel Spacing	FFSK; THSD

DATA SPEED

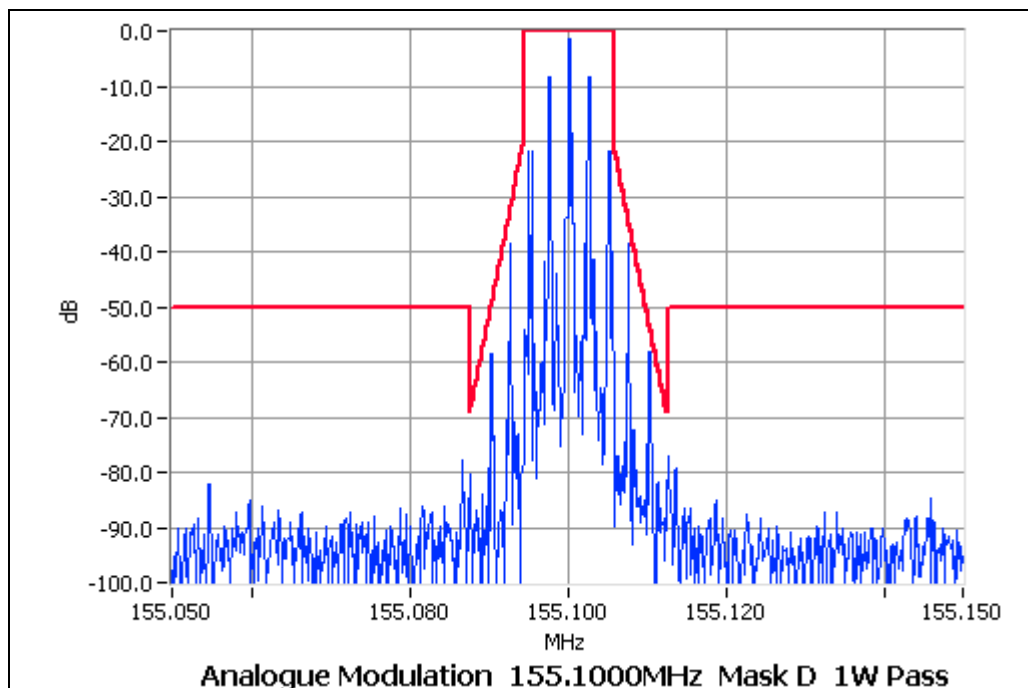
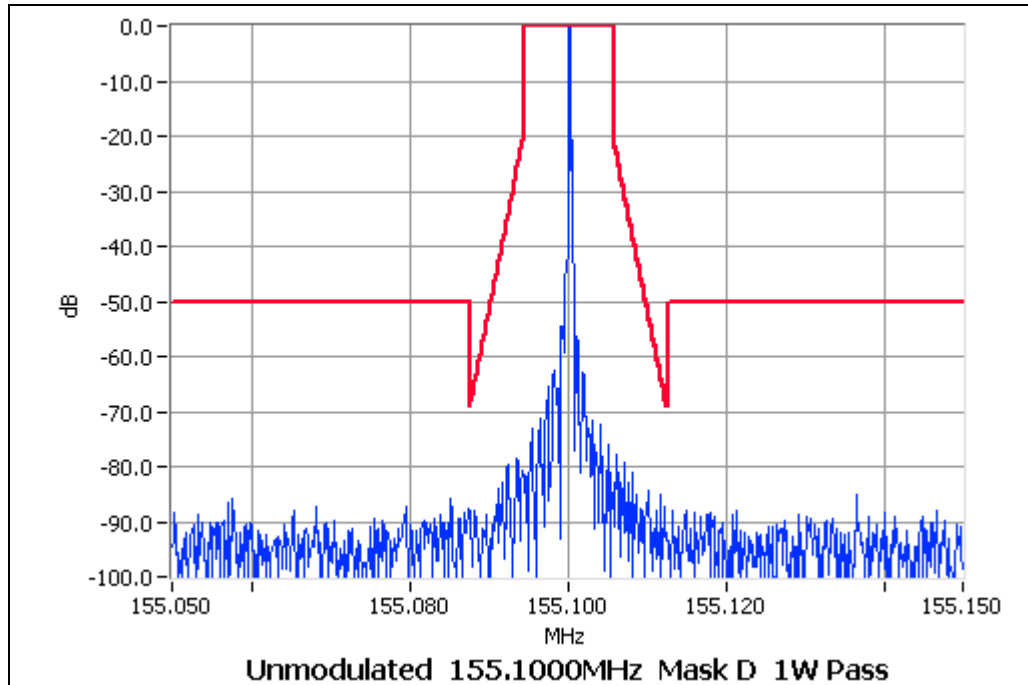
FFSK	1200 bps	12.5 kHz Channel Spacing
FFSK	1200 bps	25.0 kHz Channel Spacing
THSD	12000 bps	12.5 kHz Channel Spacing
THSD	19200 bps	25.0 kHz Channel Spacing

(FFSK is Fast Frequency Shift Keying; THSD is Tait High Speed Data – CP4GFSK)

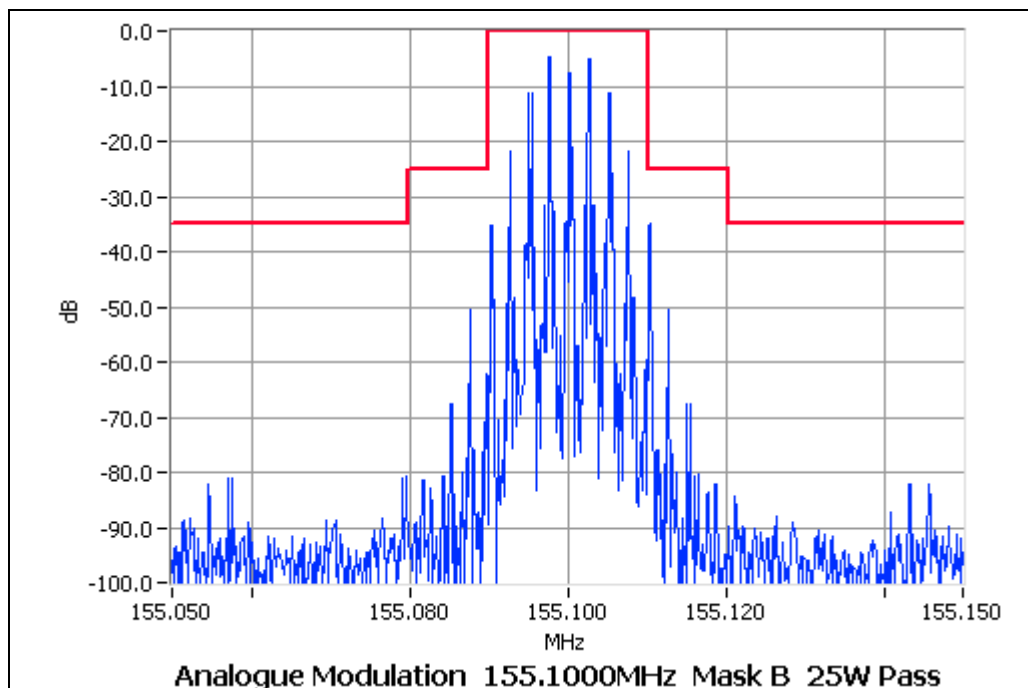
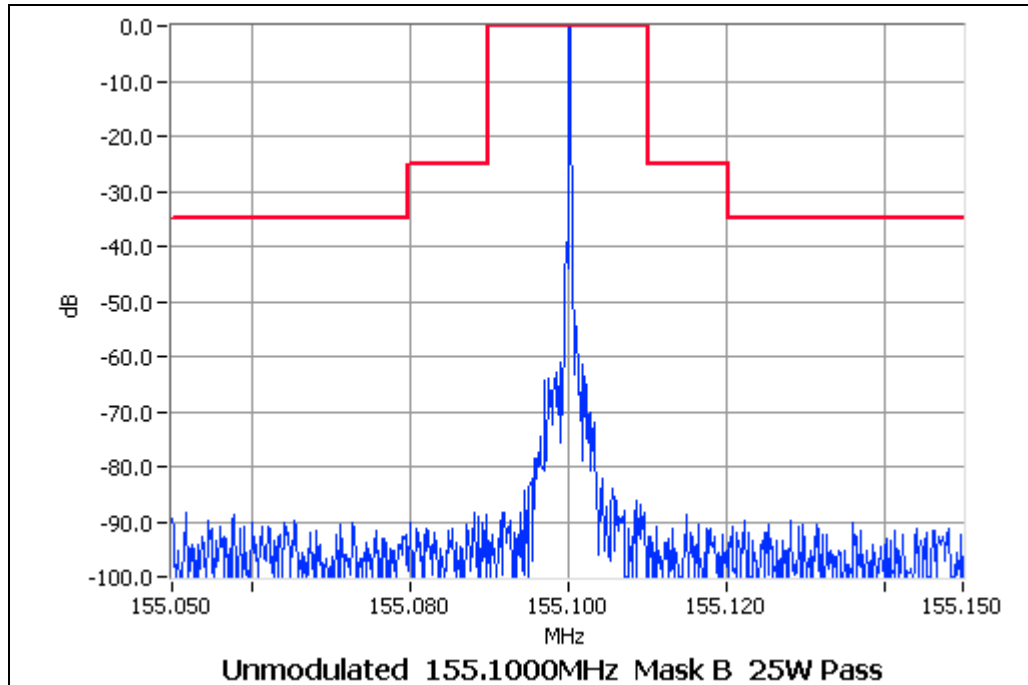
NAME OF TEST:	OCCUPIED BANDWIDTH	VOICE
SPECIFICATION:	FCC CFR 2.1049 (c)	
Tx FREQUENCY:	155.1 MHz	25W
		12.5 kHz Channel Spacing



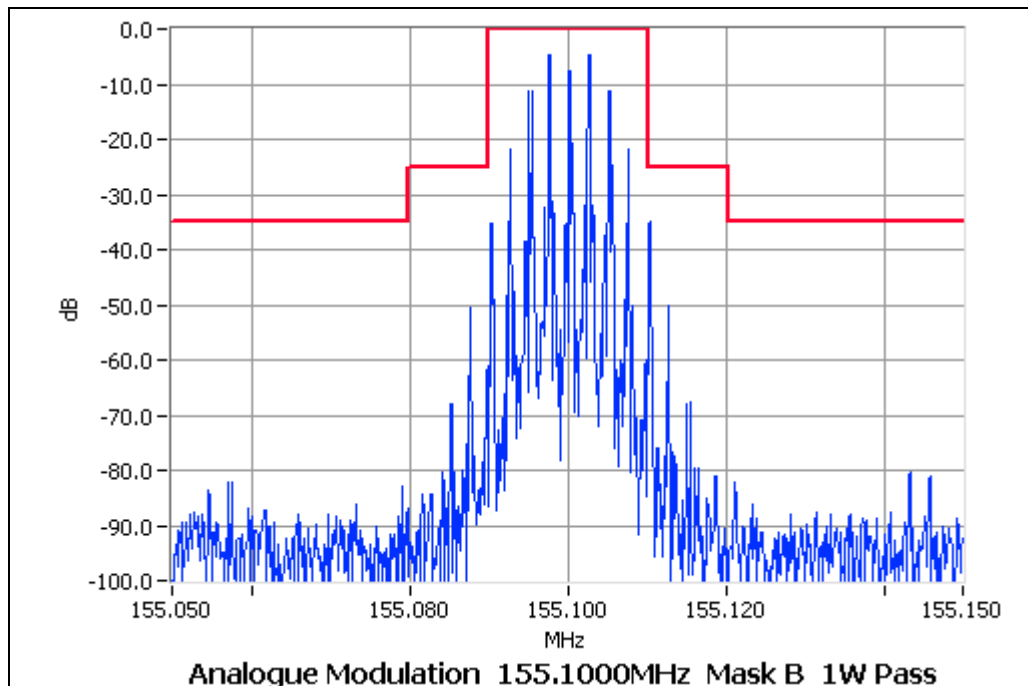
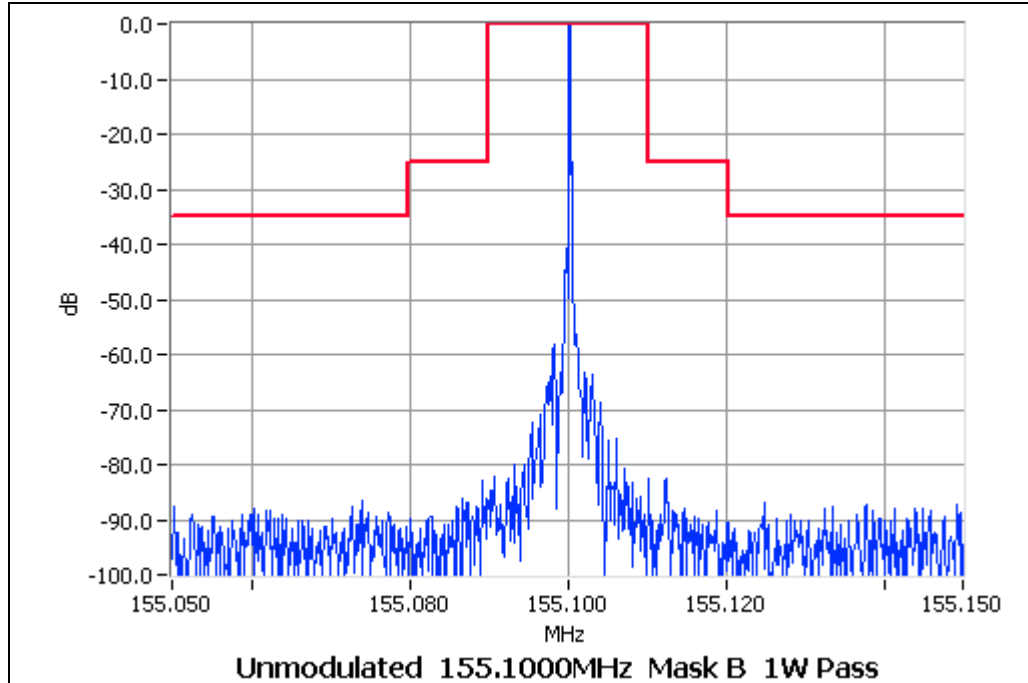
NAME OF TEST:	OCCUPIED BANDWIDTH	VOICE
SPECIFICATION:	FCC CFR 2.1049 (c)	
Tx FREQUENCY:	155.1 MHz	1W
		12.5 kHz Channel Spacing



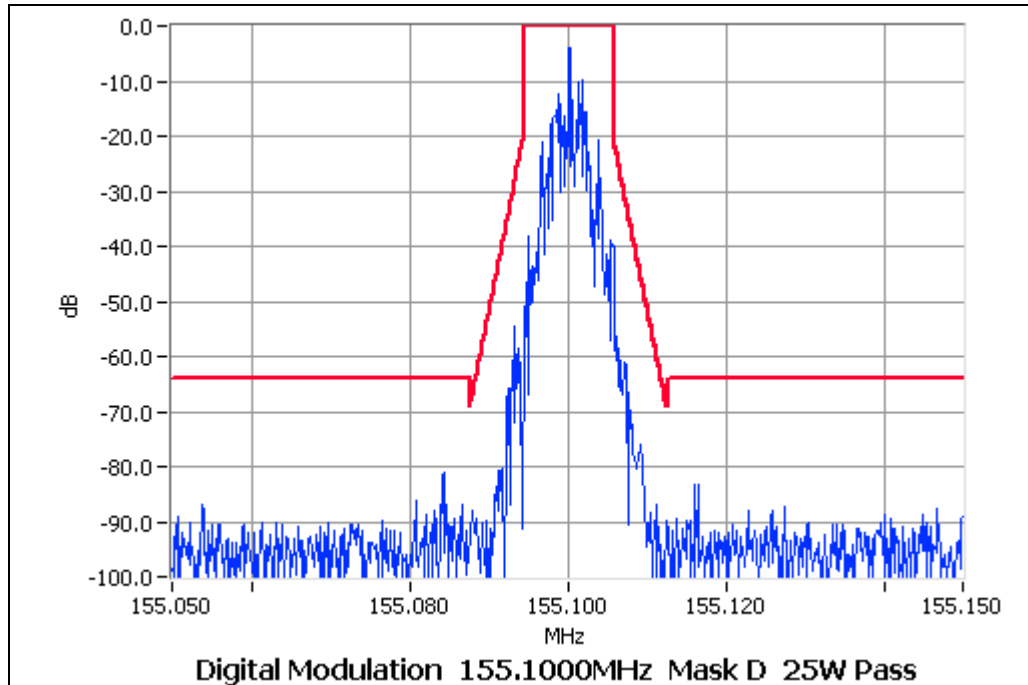
NAME OF TEST:	OCCUPIED BANDWIDTH	VOICE
SPECIFICATION:	FCC CFR 2.1049 (c)	
Tx FREQUENCY:	155.1 MHz	25W
		25.0 kHz Channel Spacing



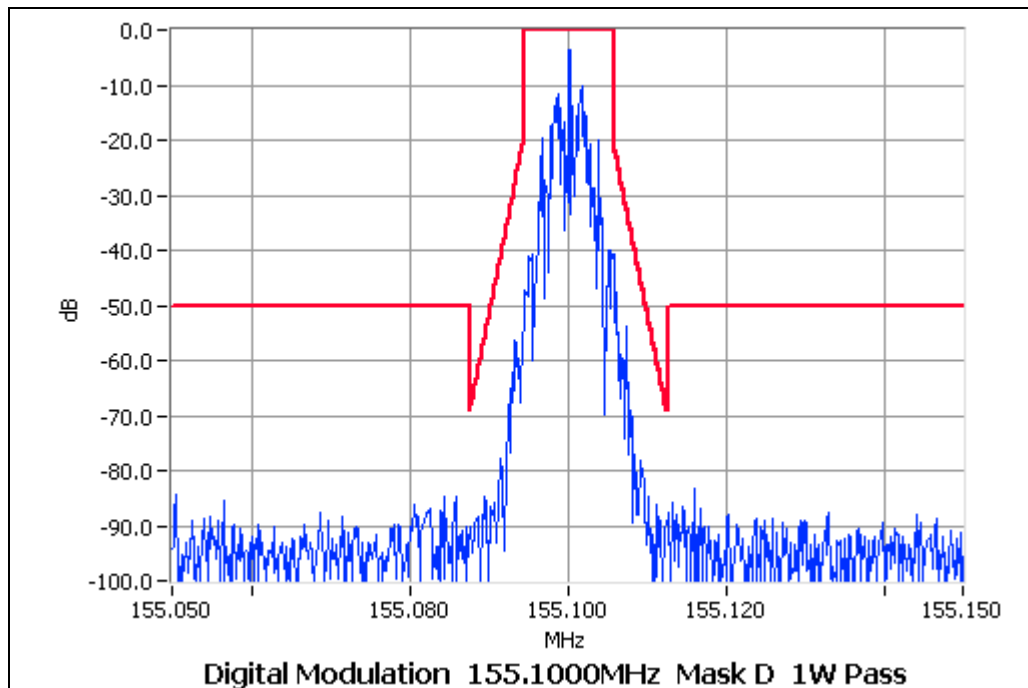
NAME OF TEST:	OCCUPIED BANDWIDTH	VOICE
SPECIFICATION:	FCC CFR 2.1049 (c)	
Tx FREQUENCY:	155.1 MHz 1W	25.0 kHz Channel Spacing



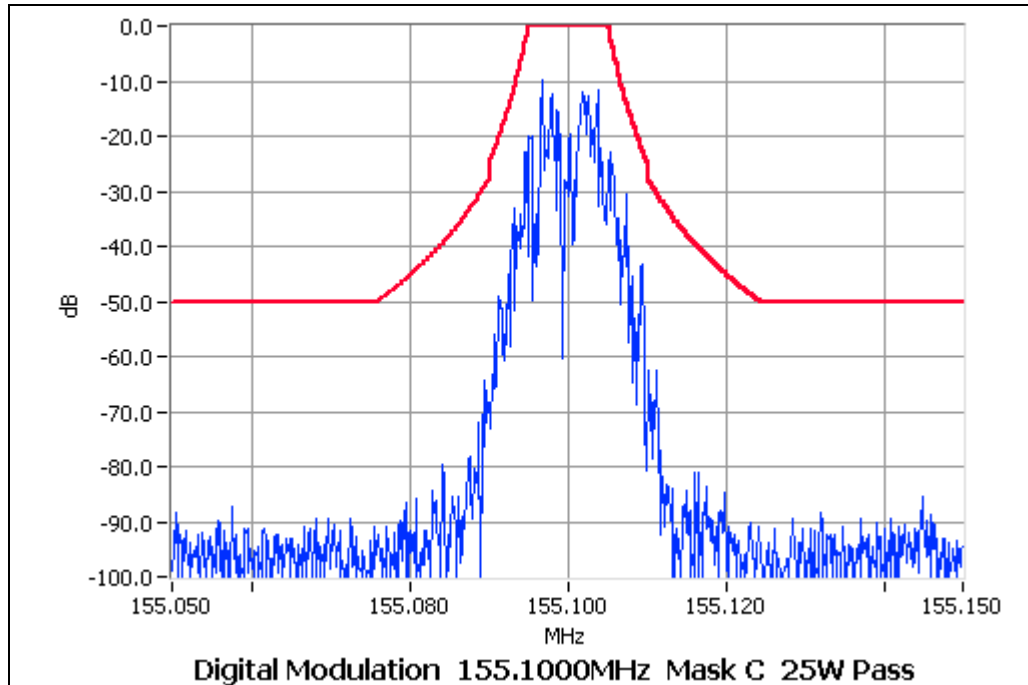
NAME OF TEST:	OCCUPIED BANDWIDTH	DATA	FSK
SPECIFICATION:	FCC CFR 2.1049 (c)		
Tx FREQUENCY:	155.1 MHz	25W	12.5 kHz Channel Spacing



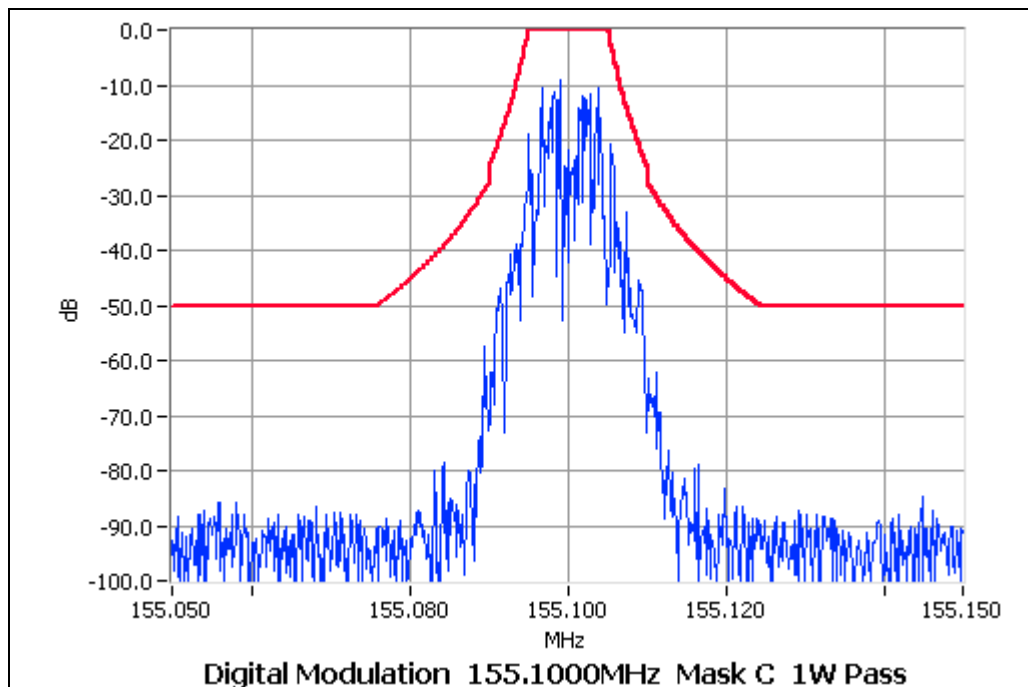
Tx FREQUENCY:	155.1 MHz	1W	12.5 kHz Channel Spacing
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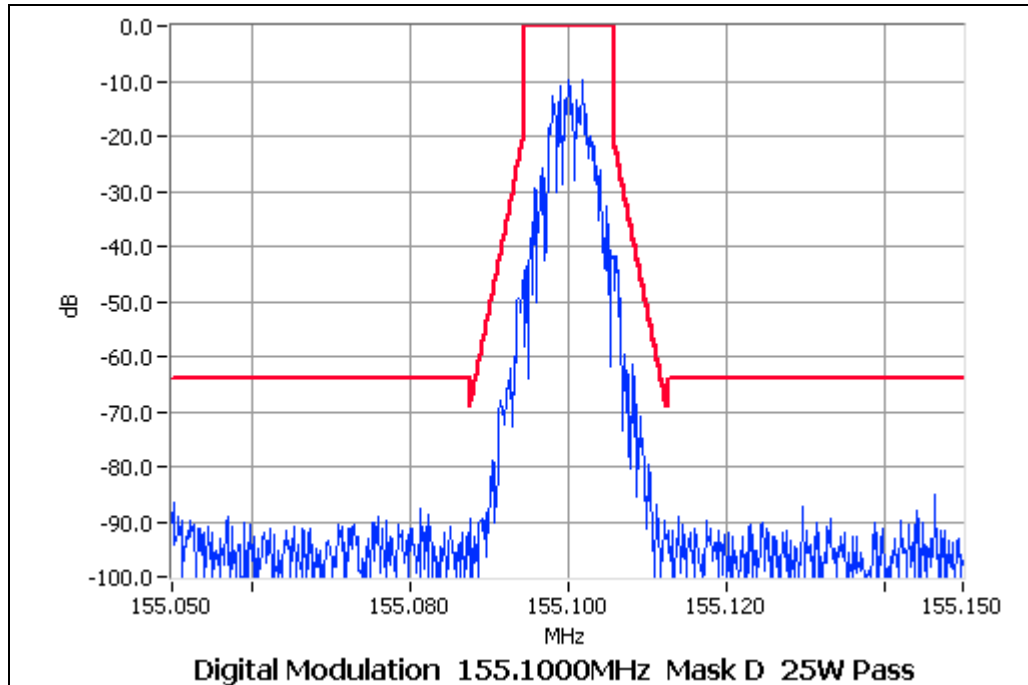
NAME OF TEST: OCCUPIED BANDWIDTH DATA FFSK
SPECIFICATION: FCC CFR 2.1049 (c)
Tx FREQUENCY: 155.1 MHz 25W 25.0 kHz Channel Spacing



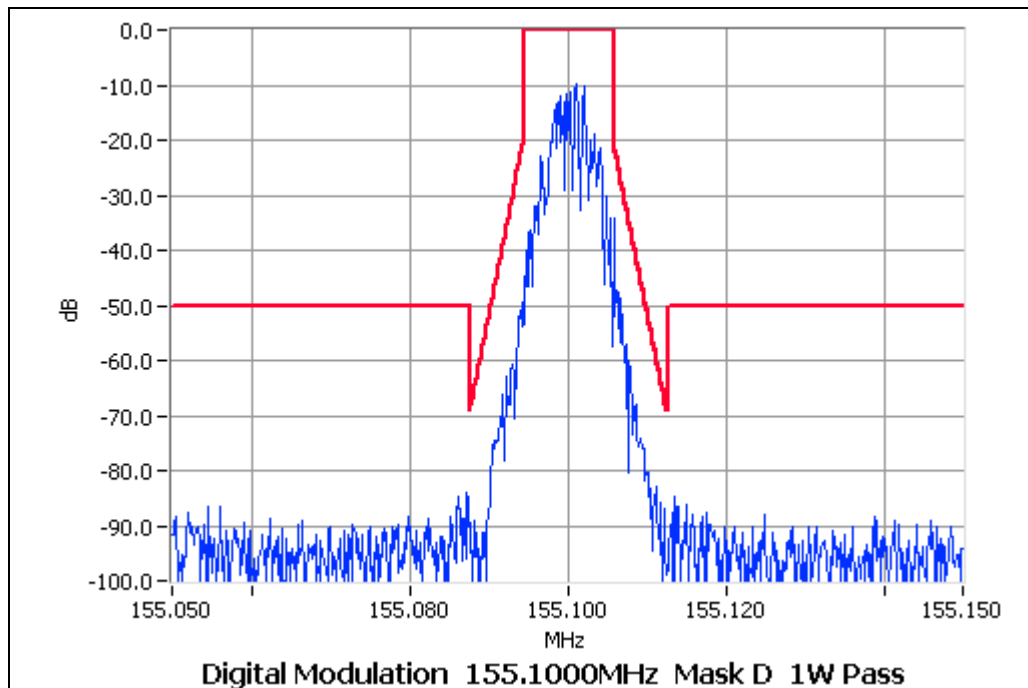
Tx FREQUENCY: 155.1 MHz 1W 25.0 kHz Channel Spacing



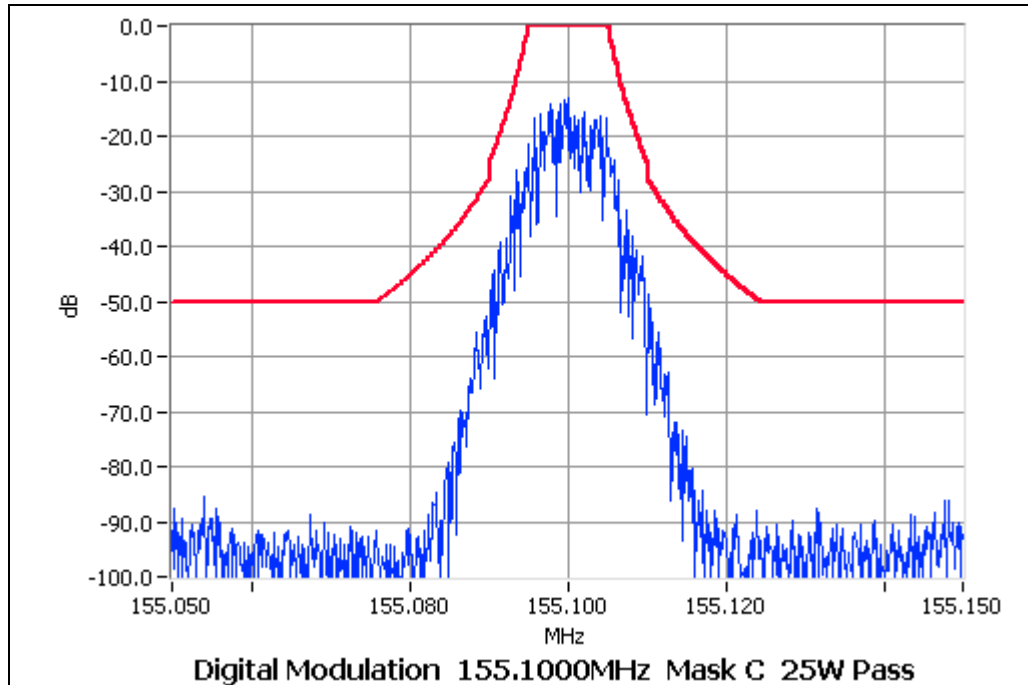
NAME OF TEST:	OCCUPIED BANDWIDTH	DATA	THSD
SPECIFICATION:	FCC CFR 2.1049 (c)		
Tx FREQUENCY:	155.1 MHz	25W	12.5 kHz Channel Spacing



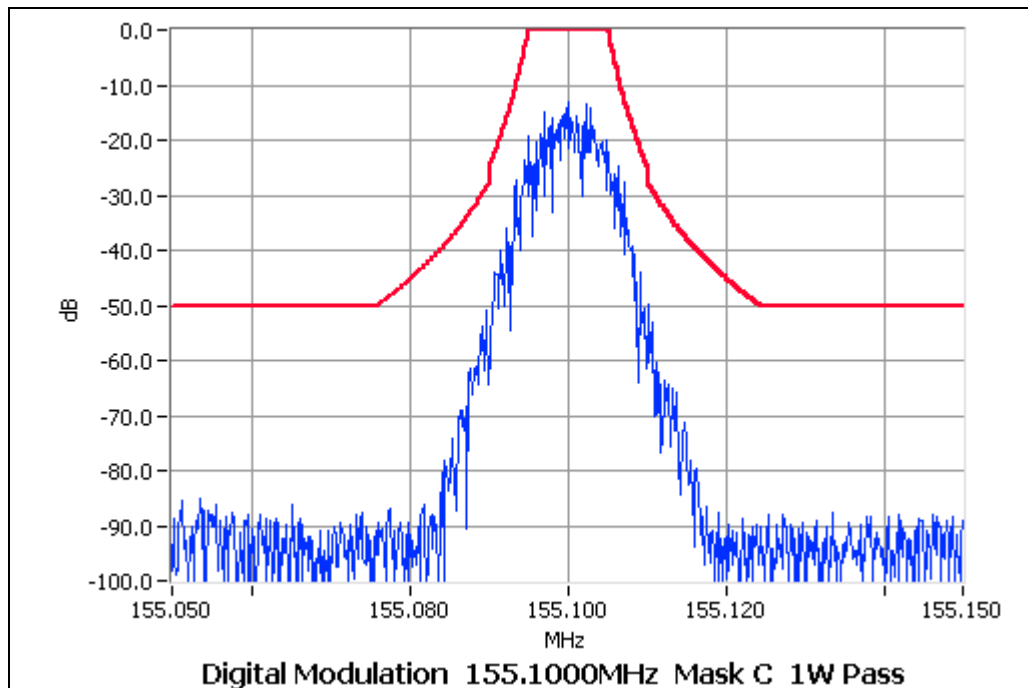
Tx FREQUENCY:	155.1 MHz	1W	12.5 kHz Channel Spacing
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NAME OF TEST:	OCCUPIED BANDWIDTH	DATA	THSD
SPECIFICATION:	FCC CFR 2.1049 (c)		
Tx FREQUENCY:	155.1 MHz	25W	25.0 kHz Channel Spacing



Tx FREQUENCY:	155.1 MHz	1W	25.0 kHz Channel Spacing
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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 4.7 GHz

NAME OF TEST: SPURIOUS EMISSIONS (CONDUCTED)
SPECIFICATION: FCC CFR 2.1051
Tx FREQUENCY: 155.1 MHz

12.5 kHz Channel Spacing	155.1 MHz @ 1 W	Emission Mask D
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
No emissions were detected at a level greater than 20 dB below the limit.		

LIMITS:

Carrier Output Power Watts	Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \log_{10}(P_{\text{Watts}})$	
1 W	-20 dBm	50 dBc
25 W	-20 dBm	64 dBc

NAME OF TEST: SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATION: FCC CFR 2.1051

Tx FREQUENCY: 155.1 MHz

12.5 kHz Channel Spacing	155.1 MHz @ 25 W	Emission Mask D
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
36.548	-37.0	-81.0
No other emissions were detected at a level greater than 20 dB below the limit.		

LIMITS:

Carrier Output Power Watts	Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \log_{10} (P_{\text{Watts}})$	
1 W	-20 dBm	50 dBc
25 W	-20 dBm	64 dBc

SPURIOUS EMISSIONS (RADIATED)

Refer EMC Technologies Report 40534.2 dated 4 June 2004

TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)

TEST CONDITIONS: Standard Voltage 13.8 V DC

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

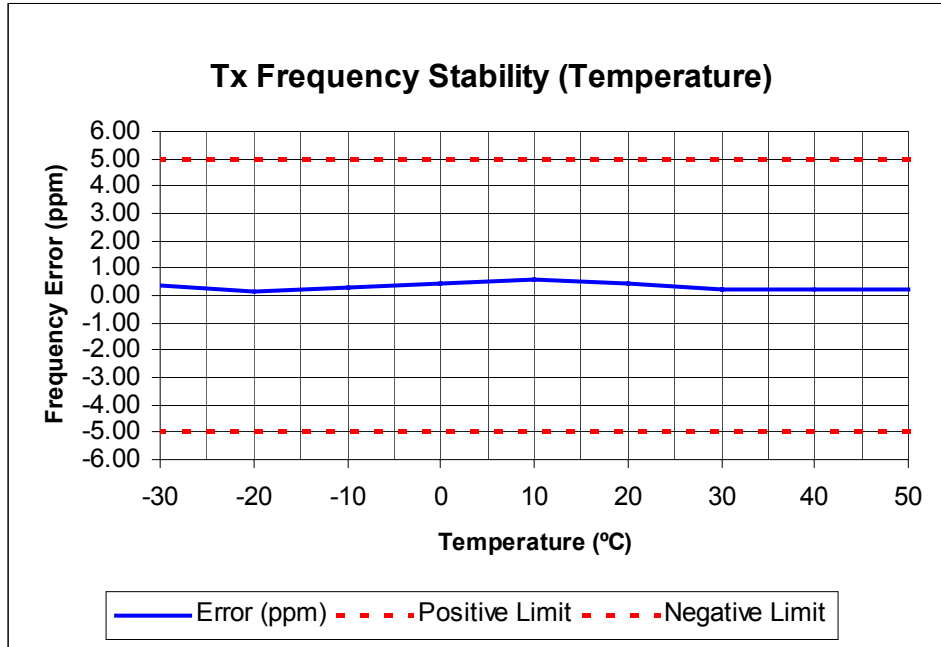
Frequency Range: 421 MHz to 512 MHz

Channel Spacing (kHz)	Frequency Error (ppm)
12.5	2.5
25.0	5.0

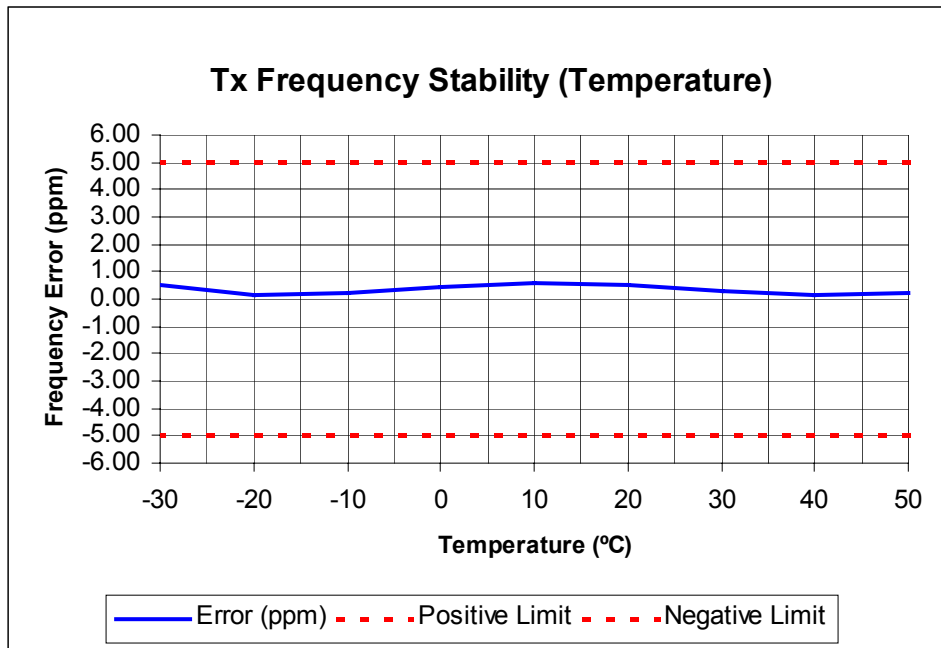
TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)

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)

TEST CONDITIONS: Standard Voltage 13.8 V DC

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

GUIDE: TIA/EIA-603B 2.2.2

MEASUREMENT PROCEDURE:

1. The Equipment Under Test was set up as shown in the following diagram.
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		
	11.73 V DC	13.8 V DC	15.87 V DC
12.5	0.43	0.42	0.41
25.0	0.50	0.50	0.46

LIMIT CLAUSE: FCC 47 CFR 90.213

Channel Spacing (kHz)	Frequency Error (ppm)
12.5	2.5
25.0	5.0

TRANSIENT FREQUENCY BEHAVIOR

TEST CONDITIONS: Standard Voltage 13.8 V DC

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	0.2	N/A
t_2	-0.3	N/A
t_3	N/A	0.2
$t_2 \rightarrow t_3$ ppm	3.8	
ERROR LIMIT ($t_2 \rightarrow t_3$) 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	

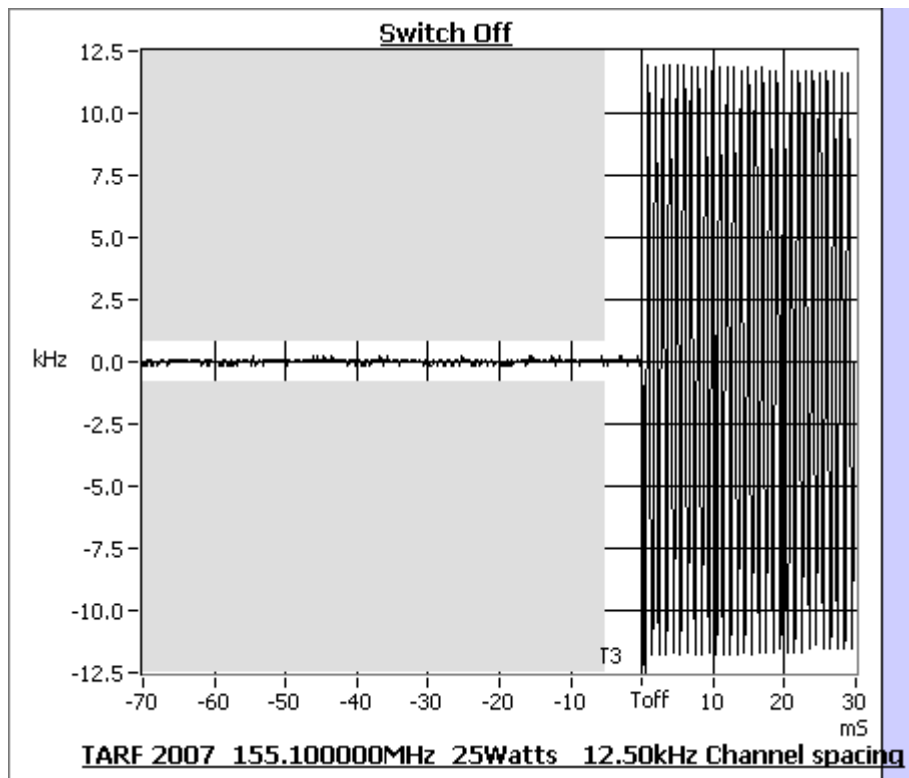
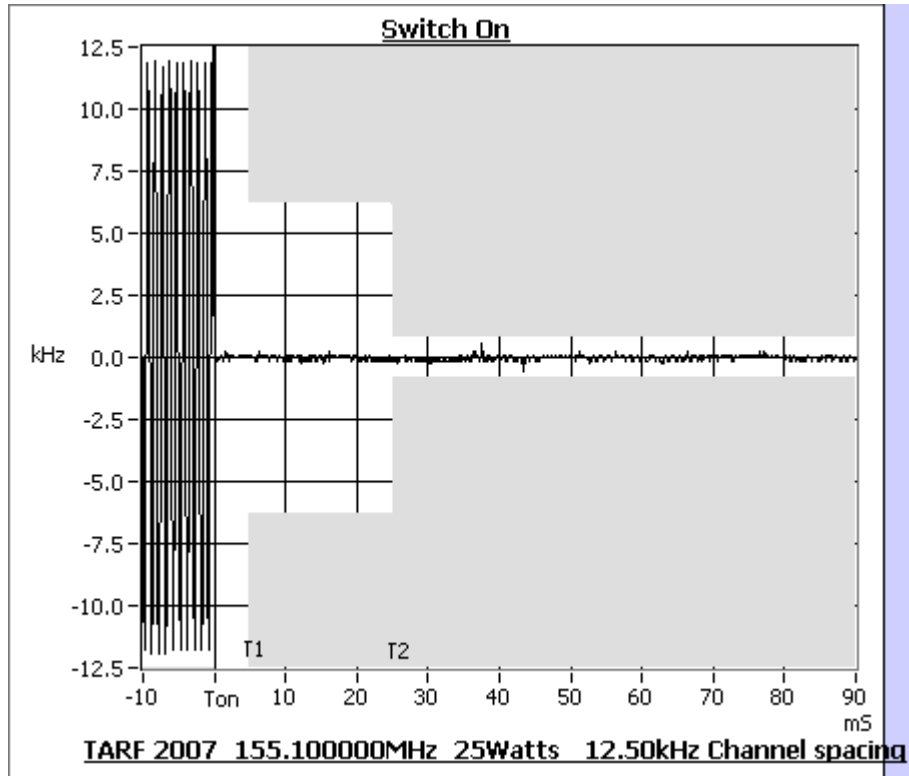
LIMIT:

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	-0.6	N/A
t ₂	0.4	N/A
t ₃	N/A	0.2
t ₂ → t ₃ ppm	2.8	
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	

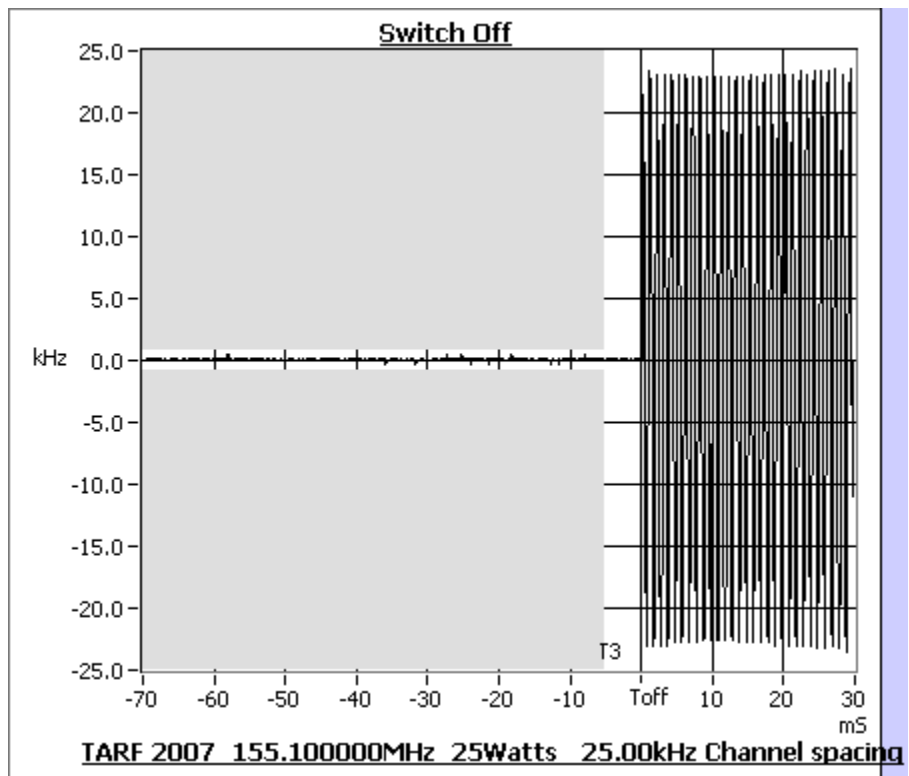
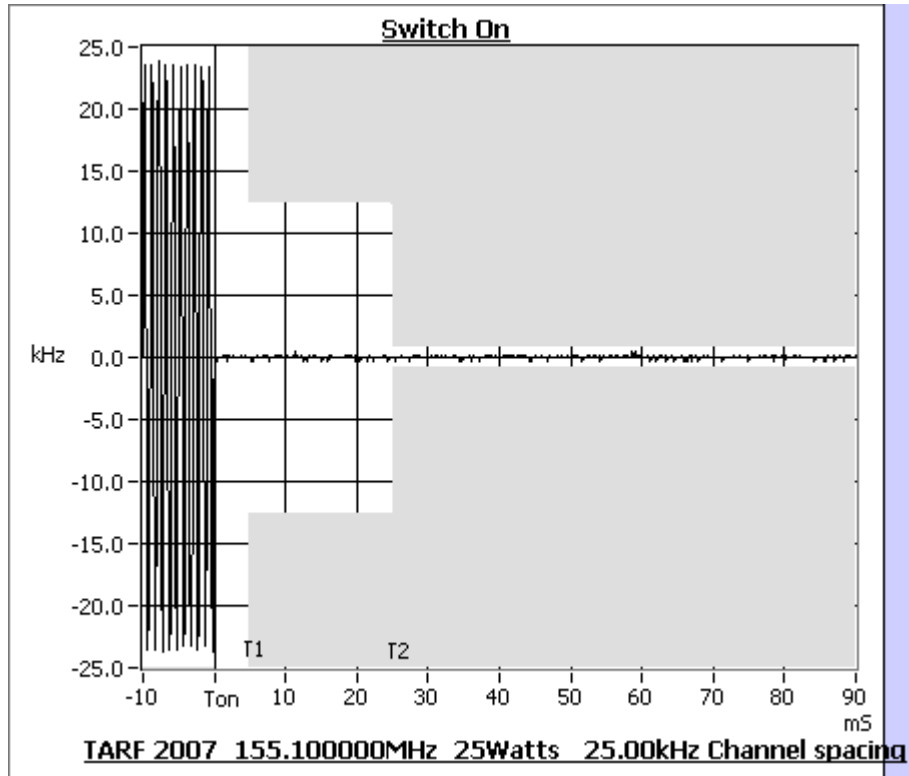
LIMIT:

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
2	Signal Generator	Hewlett Packard	HP8648A	3430U00344	E3579	15-Oct-04
5	Signal Generator	Rohde & Schwarz	SMY01 1062.5502.11	841736/019	E3553	29-Oct-04
12	Modulation Analyser	Rohde & Schwarz	FMA0852.8500.52	842541/001	E3554	18-Jul-04
21	Power Supply	Rohde & Schwarz	NGS M32/10 192.0810.31	Fnr 434	E3556	14-Jun-05
22	Oscilloscope	Tektronics	TDS340	B013611	E3585	25-Nov-04
32	4 Port Combiner	Rohde & Schwarz	DVU4, 3W 201.4018. 03	300.971/28	E3572	28-Aug-04
57	Filter Low Pass	Tait	MHz	N/A	-	On Use
60	RF Attenuator 250W	Weinschel	45-30-34	JW663	E3386	09-Jul-04
62	RF Attenuator 150W	Weinschel	57-10-34	LB590	E3674	09-Jul-04
63	RF Attenuator 150W	Weinschel	40-06-34	KV457	E3561	11-Aug-04
65	RF Attenuator 50W	Weinschel	24-20-44	AW1266	E3562	26-May-04
66	RF Attenuator 25W	Weinschel	33-20-33	BD5871	E3673	09-Jul-04
67	RF Attenuator 150W Treva	Weinschel	40-20-33	CJ405	E3733	29-May-04
83	1m Coax Cable (BLUE)	Suhner	Sucoflex 104A	25006/4A	E3693	11-Aug-04
84	1m Coax Cable (BLUE)	Suhner	Sucoflex 104A	25005/4A	E3692	09-Jul-04
86	1m Coax Cable (BLUE)	Suhner	Sucoflex 104A	25003/4A	E3690	11-Aug-04
87	Audio Analyser	Hewlett Packard	HP8903B	2818A04275	E3710	25-Nov-04
88	Spectrum Analyser	Hewlett Packard	HP8562E	3821A00779	E3715	06-Jan-05
111	Modulation Analyser	Hewlett Packard	HP8901B (Opt 002)	3704A05837	E3786	15-Oct-04
114	Signal Generator	Rohde & Schwarz	SML03 1090.3000.13		E4050	28-Nov-04
115	Environ. Chamber	Contherm	5400 RHSLT.M		E4051	04-Mar-05
116	Power Head	Hewlett Packard	HP11722A	2716A02037		08-Aug-04
117	RF Attenuator	Weinschel	Model 1	BL9950	E4080	On Use
120	RF Splitter Combiner	Minicircuits	ZFSC-4-1	-	E4083	On Use
123	Spectrum Analyser	Agilent	E4445A	MY42510072	E4139	23-Apr-05

APPENDIX A

TEST SETUP DETAILS

Testing is performed using the Teltest Radio **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.

