

REPORT NUMBER 2010

June 2004

RADIO PERFORMANCE MEASUREMENTS

On the TMAB22-H500 Mobile Transceiver

FCC ID: CASTMAH5C

SN: 19007584

In accordance with

FCC 47 CFR Parts 22 and 90

PREPARED BY:	Elizabeth Comery	_____
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REPORT ON :

Type Approval Testing of the TMAB22-H500 (Serial No 19007584)
in accordance with:

FCC CFR 47 Parts 22 & 90

FCC ID: CASTMAH5C

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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TABLE OF CONTENTS

DECLARATION OF CONFORMITY.....	4
ENVIRONMENTAL CONDITIONS	5
NECESSARY BANDWIDTH AND EMISSION DESIGNATORS	5
TEST RESULTS.....	7
TRANSMITTER OUTPUT POWER (CONDUCTED)	7
TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS	8
TRANSMITTER MODULATION LIMITING	10
OCCUPIED BANDWIDTH	13
SPURIOUS EMISSIONS (CONDUCTED).....	22
SPURIOUS EMISSIONS (RADIATED).....	25
<i>Refer EMC Technologies Report 40604.2 dated 10 June 2004.....</i>	<i>25</i>
TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)	26
TRANSMITTER FREQUENCY STABILITY (VOLTAGE)	28
TRANSIENT FREQUENCY BEHAVIOR	29
TEST EQUIPMENT USED.....	34
APPENDIX A	35
TEST SETUP DETAILS.....	35

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: TMAH5C

Product code: TMAB22-H500

Serial Numbers: 19007584

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
$B_n = 6 + 5 \times 1$ =11kHz	

2. Analogue Voice 25kHz Bandwidth

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

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
$B_n = 1.2 + 3 \times 1.2$ =4.8kHz	

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 = $1.2 + 6 \times 1.2$
= 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)	1.1	28.3
Variation from Nominal (%)	10	13.2
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.

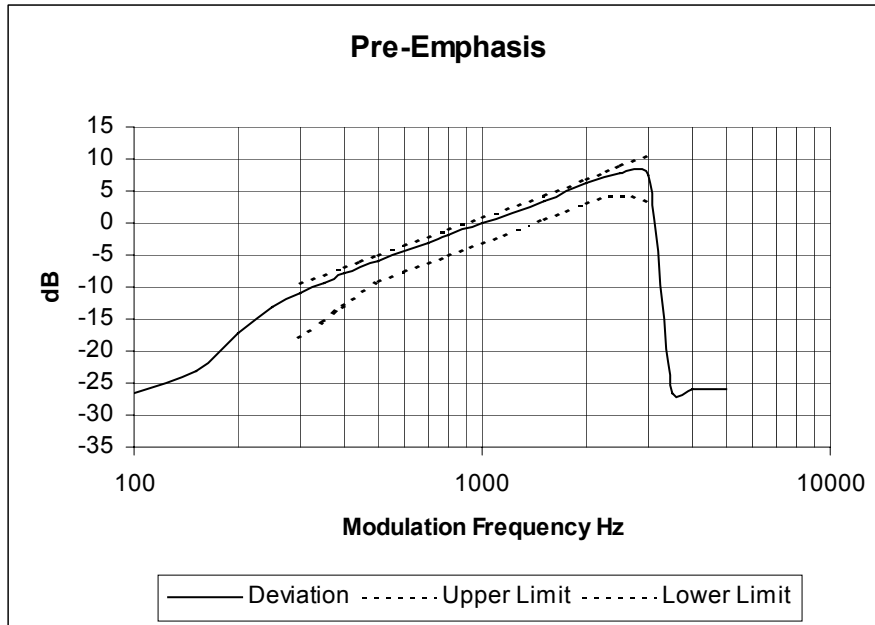
.

LIMIT CLAUSE: TIA/EIA-603B 3.2.6

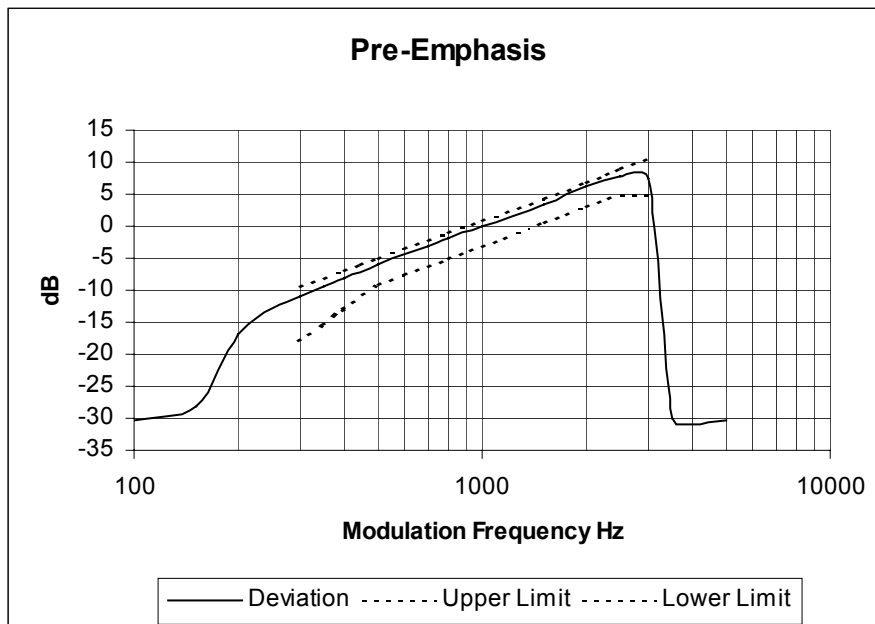
TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS

SPECIFICATION: FCC CFR 2.1047 (a)

Tx FREQUENCY: 425.1 MHz 12.5 kHz Channel Spacing



Tx FREQUENCY: 425.1 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:

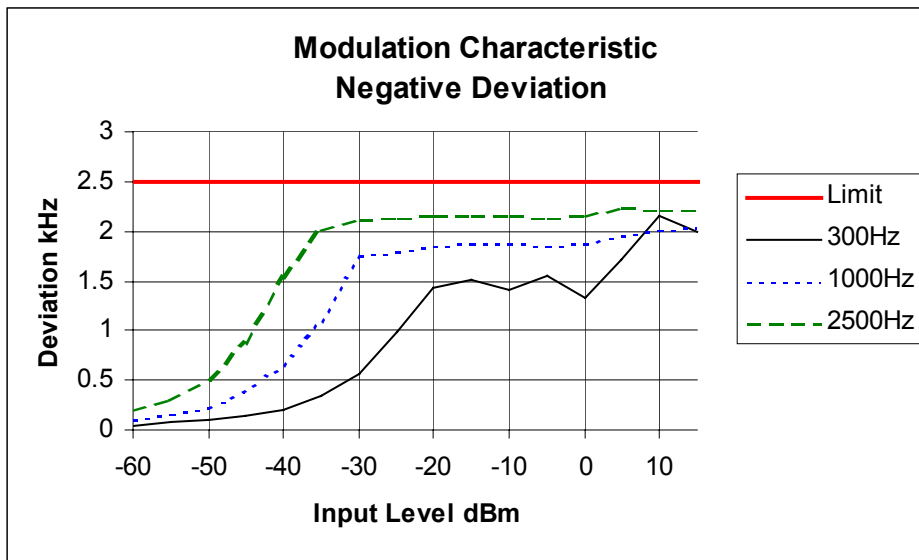
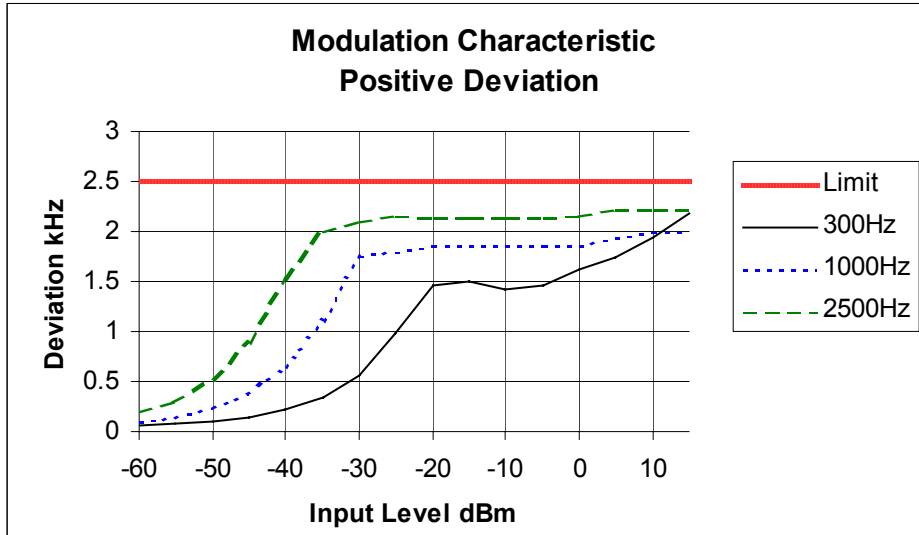
See the plots on the following pages for 12.5 kHz & 25.0 kHz channel spacings.

LIMIT CLAUSE: TIA/EIA-603B 1.3.4.4

TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC CFR 2.1047 (b)

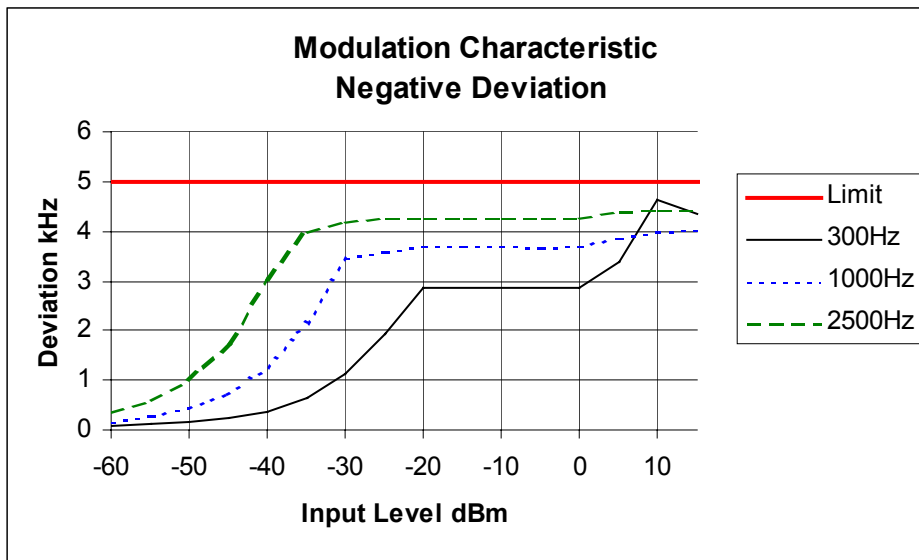
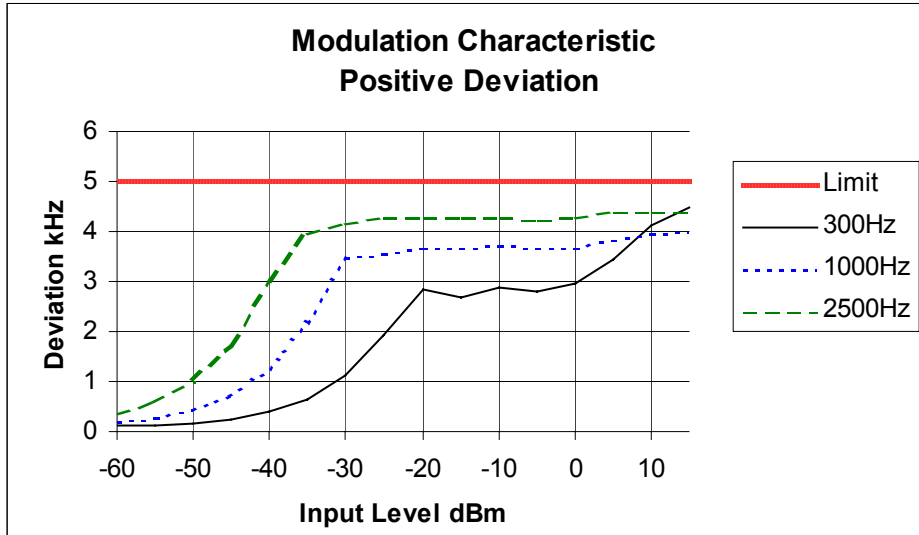
Tx FREQUENCY: 425.1 MHz 12.5 kHz Channel Spacing



TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC CFR 2.1047 (b)

Tx FREQUENCY: 425.1 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

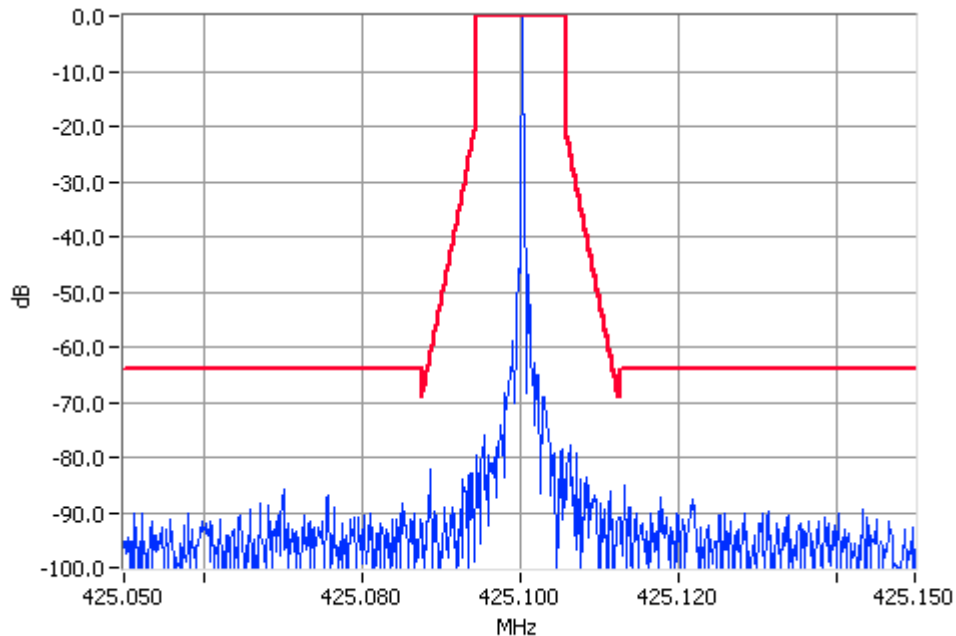
Emission Mask D	12.5 kHz Channel Spacing	Analog; FFSK; THSD
Emission Mask B	25.0 kHz Channel Spacing	Analog;
Emission Mask C	25.0 kHz Channel Spacing	FFSK; THSD

DATA SPEED

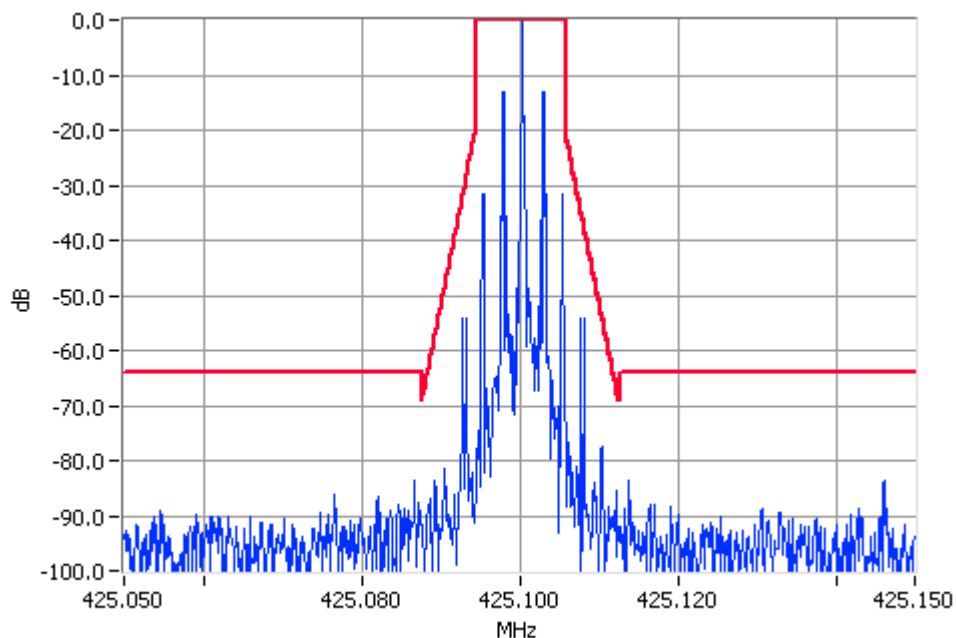
FFSK	1200 bps	12.5 kHz Channel Spacing
FFSK	1200 bps	25.0 kHz Channel Spacing
THSD	12000 bps	12.5 kHz Channel Spacing
THSD	19200 bps	25.0 kHz Channel Spacing

(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:	425.1 MHz 25W	12.5 kHz Channel Spacing

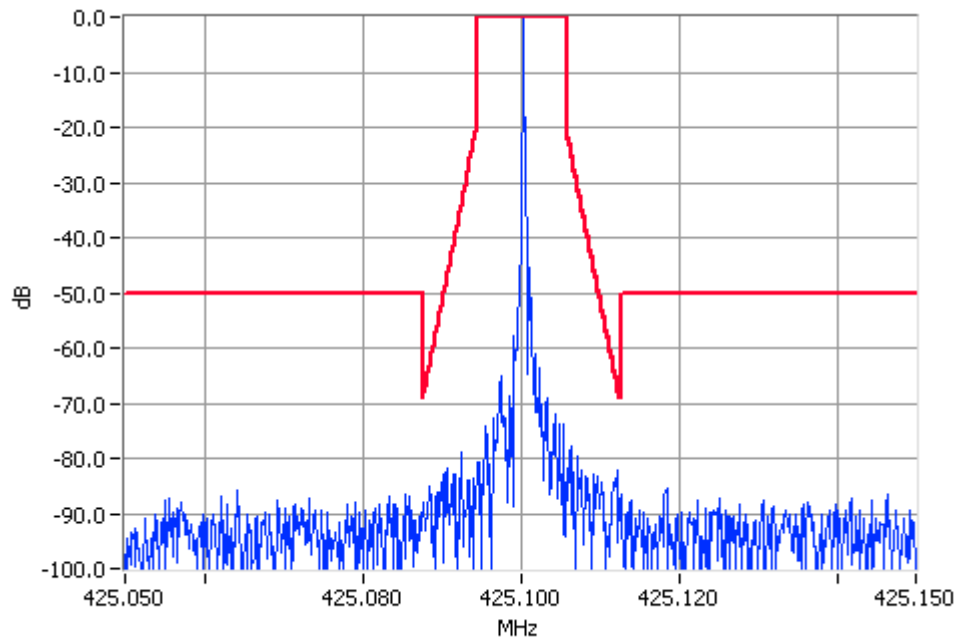


Unmodulated 425.1000MHz Mask D 25W Pass

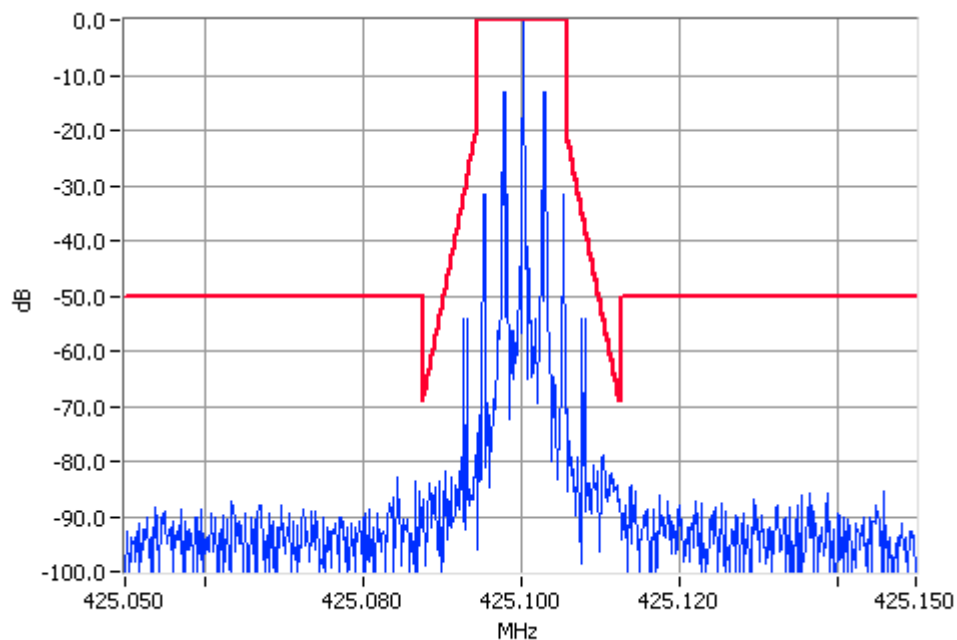


Analogue Modulation 425.1000MHz Mask D 25W Pass

NAME OF TEST:	OCCUPIED BANDWIDTH	VOICE
SPECIFICATION:	FCC CFR 2.1049 (c)	
Tx FREQUENCY:	425.1 MHz 1W	12.5 kHz Channel Spacing

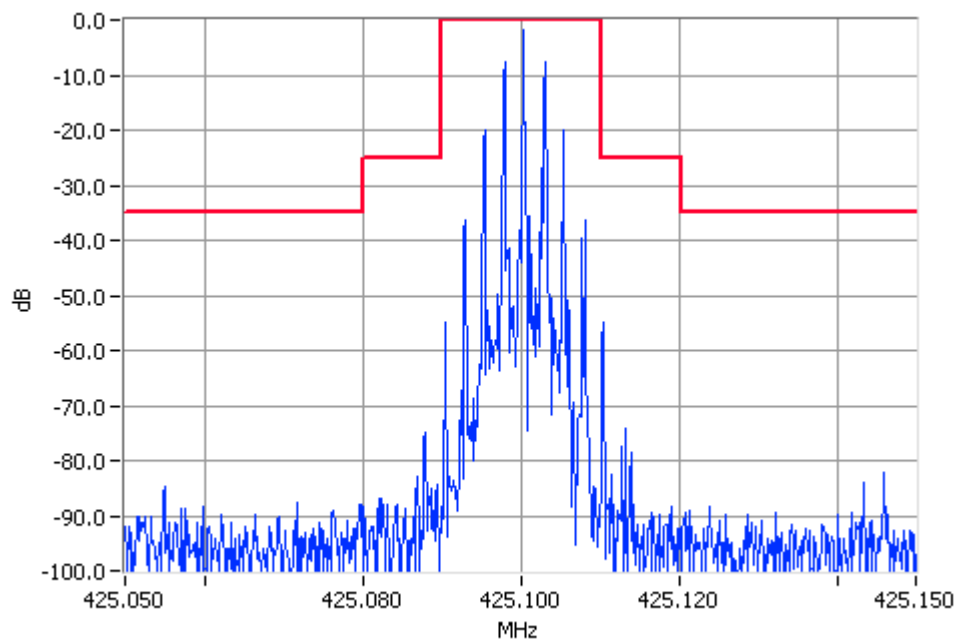
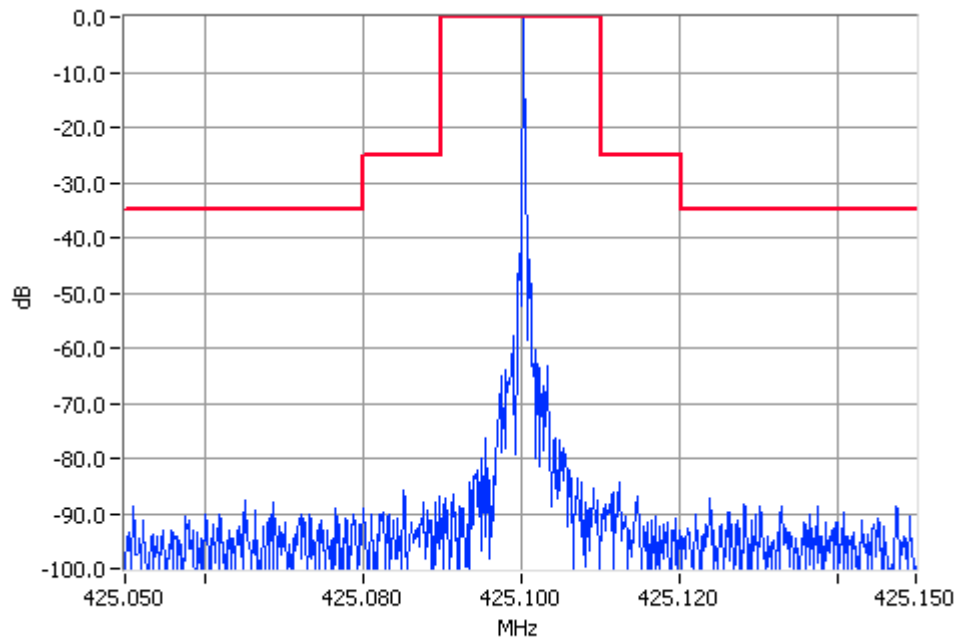


Unmodulated 425.1000MHz Mask D 1W Pass



Analogue Modulation 425.1000MHz Mask D 1W Pass

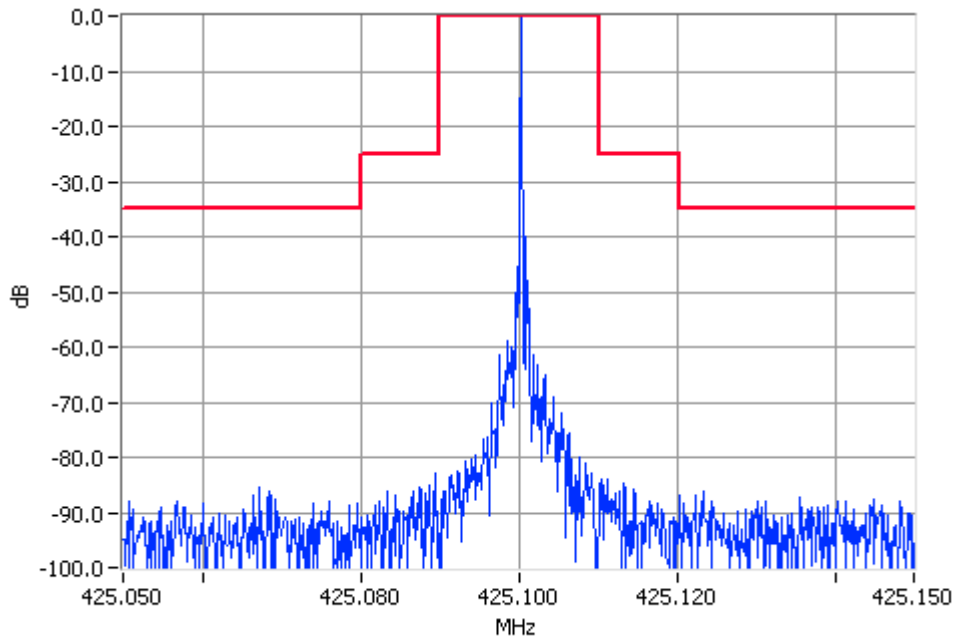
NAME OF TEST: OCCUPIED BANDWIDTH VOICE
SPECIFICATION: FCC CFR 2.1049 (c)
Tx FREQUENCY: 425.1 MHz 25W 25.0 kHz Channel Spacing



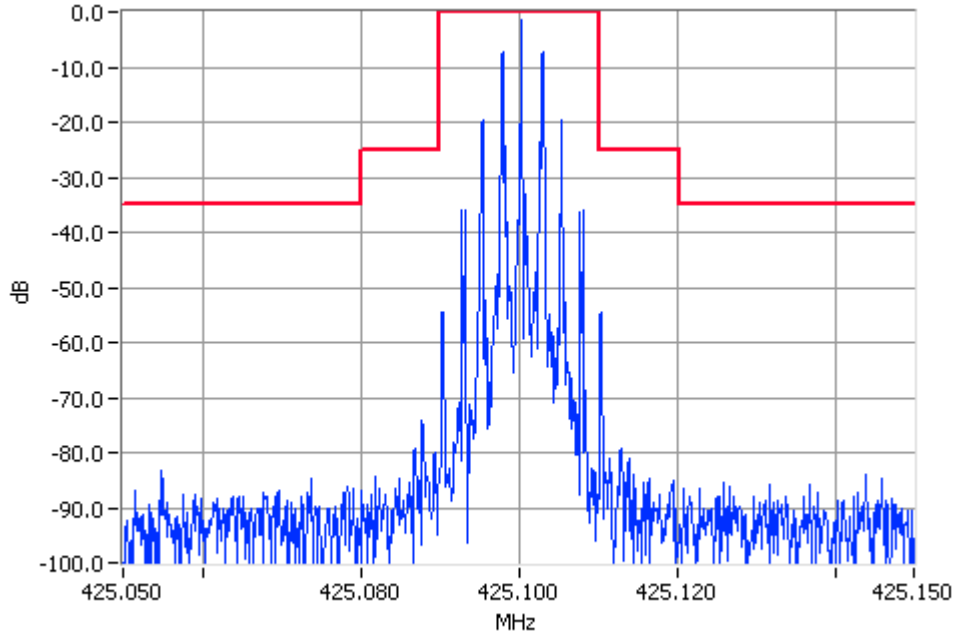
NAME OF TEST: OCCUPIED BANDWIDTH VOICE

SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 425.1 MHz 1W 25.0 kHz Channel Spacing



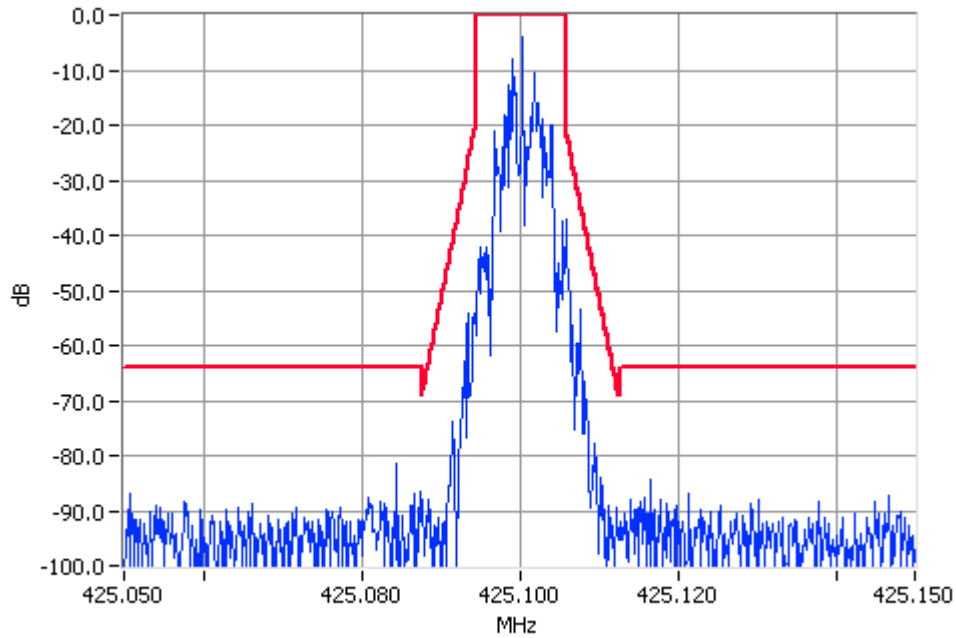
Unmodulated 425.1000MHz Mask B 1W Pass



Analogue Modulation 425.1000MHz Mask B 1W Pass

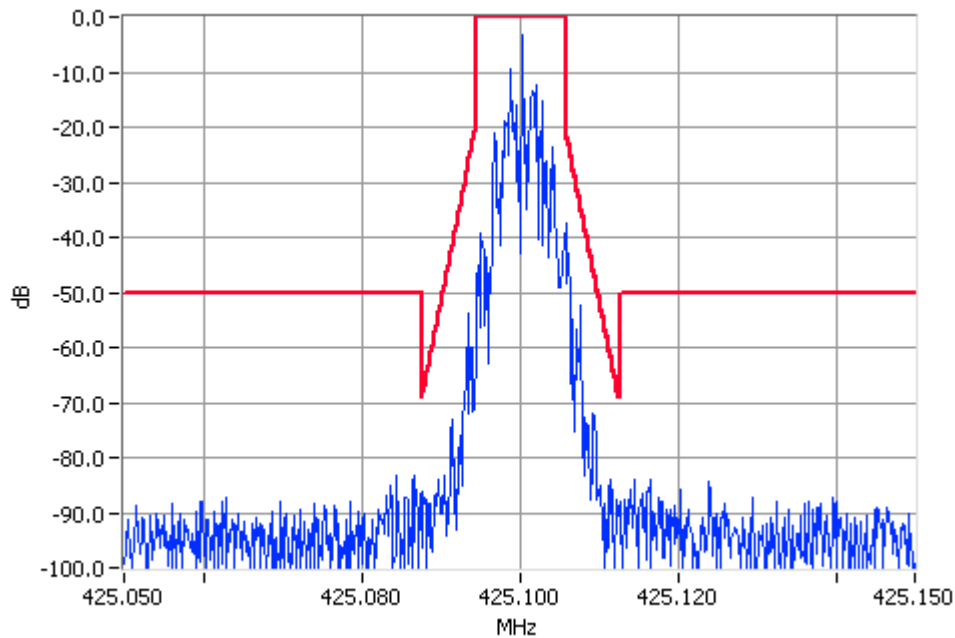
NAME OF TEST: OCCUPIED BANDWIDTH DATA FFSK

SPECIFICATION: FCC CFR 2.1049 (c)
Tx FREQUENCY: 425.1 MHz 25W 12.5 kHz Channel Spacing



Digital Modulation 425.1000MHz Mask D 25W Pass

Tx FREQUENCY: 425.1 MHz 1W 12.5 kHz Channel Spacing

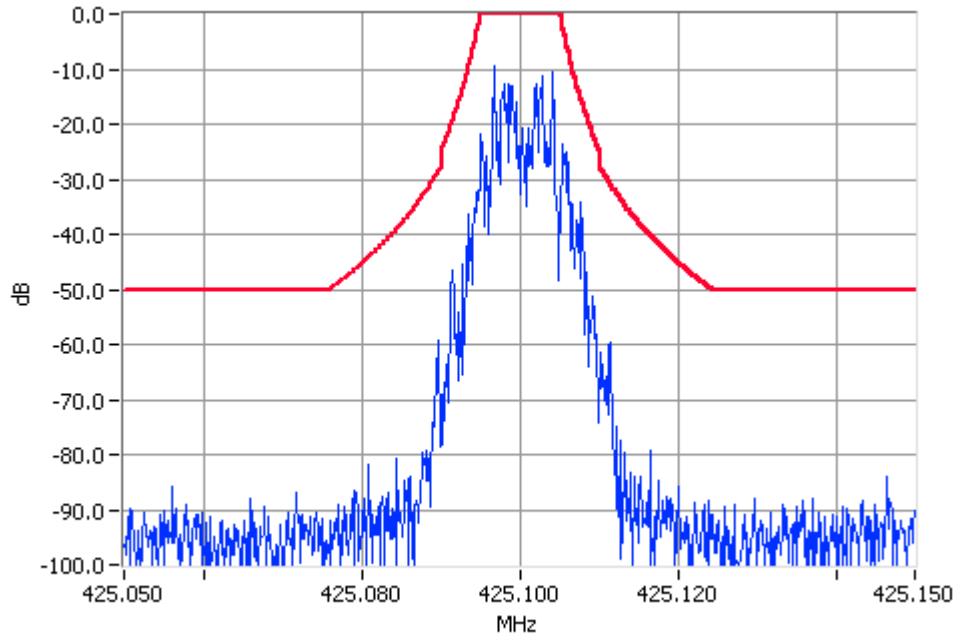


Digital Modulation 425.1000MHz Mask D 1W Pass

NAME OF TEST: OCCUPIED BANDWIDTH DATA FFSK

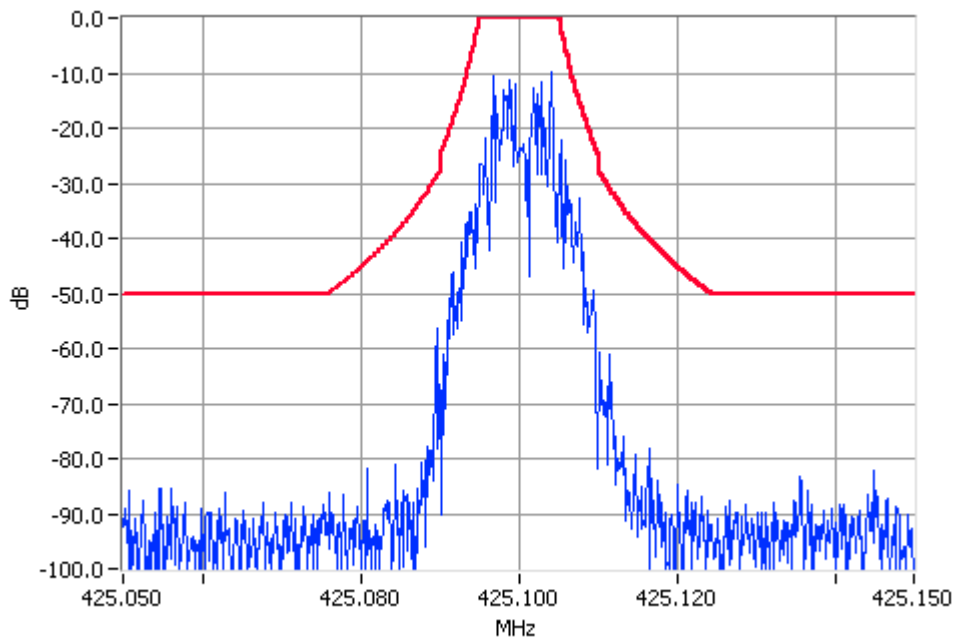
SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 425.1 MHz 25W 25.0 kHz Channel Spacing



Digital Modulation 425.1000MHz Mask C 25W Pass

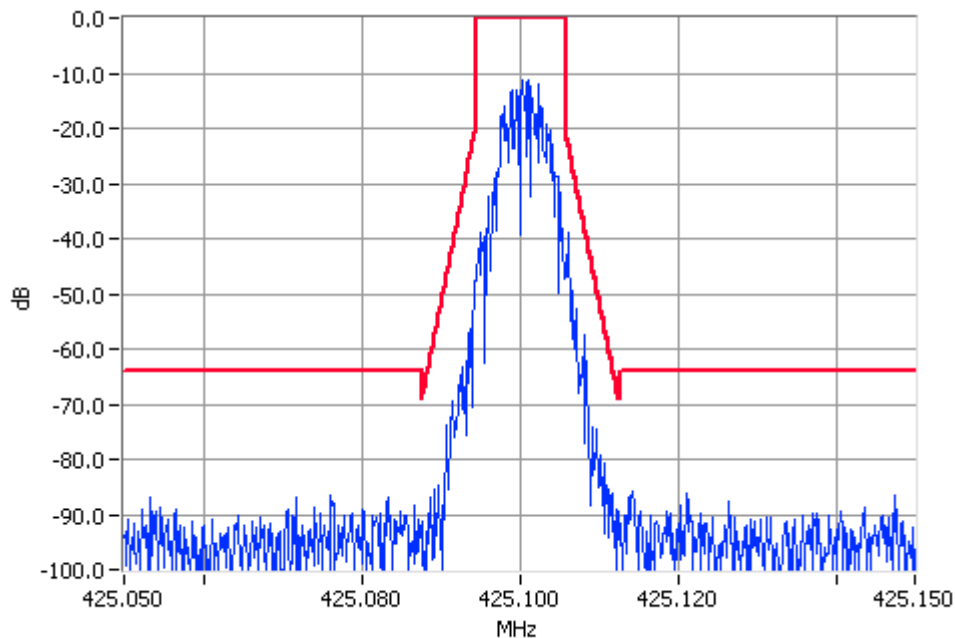
Tx FREQUENCY: 425.1 MHz 1W 25.0 kHz Channel Spacing



Digital Modulation 425.1000MHz Mask C 1W Pass

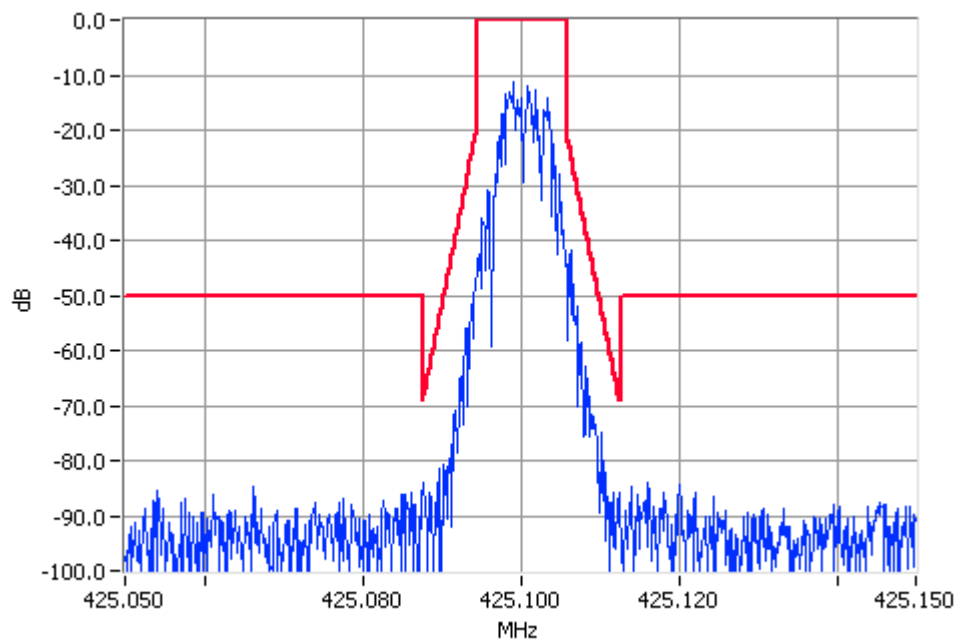
NAME OF TEST: OCCUPIED BANDWIDTH DATA THSD

SPECIFICATION: FCC CFR 2.1049 (c)
Tx FREQUENCY: 425.1 MHz 25W 12.5 kHz Channel Spacing



Digital Modulation 425.1000MHz Mask D 25W Pass

Tx FREQUENCY: 425.1 MHz 1W 12.5 kHz Channel Spacing

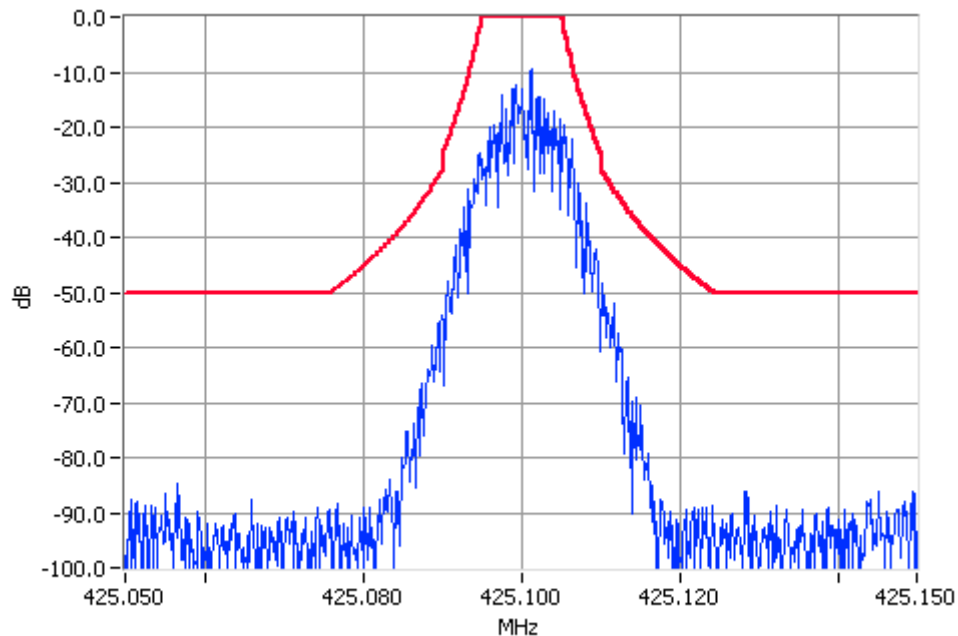


Digital Modulation 425.1000MHz Mask D 1W Pass

NAME OF TEST: OCCUPIED BANDWIDTH DATA THSD

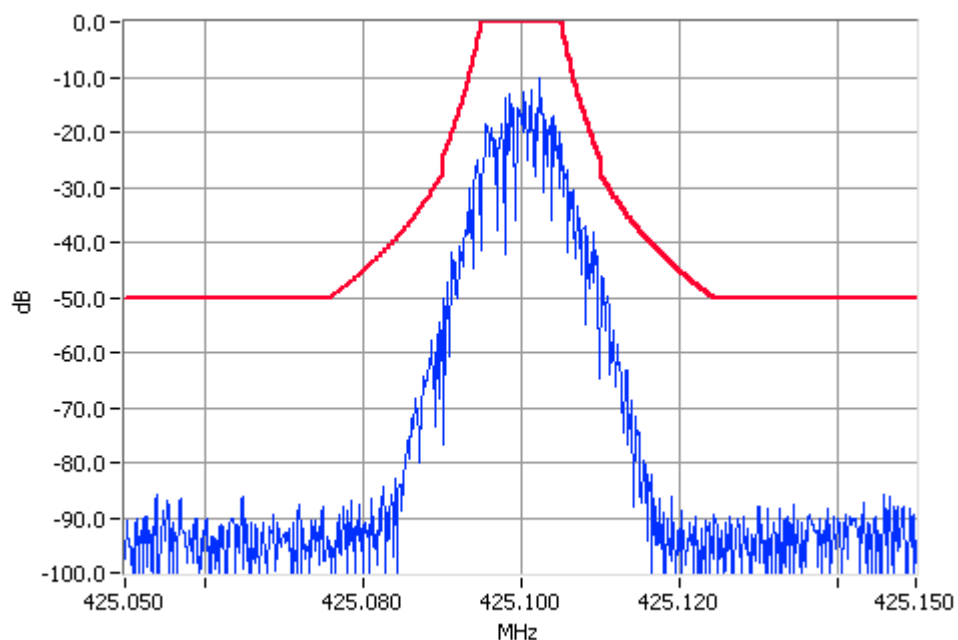
SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 425.1 MHz 25W 25.0 kHz Channel Spacing



Digital Modulation 425.1000MHz Mask C 25W Pass

Tx FREQUENCY: 425.1 MHz 1W 25.0 kHz Channel Spacing



Digital Modulation 425.1000MHz Mask C 1W Pass

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

SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATION: FCC CFR 2.1051

Tx FREQUENCY: 425.1 MHz

12.5 kHz Channel Spacing	425.1 MHz @ 25 W	Emission Mask D
Emission Frequency (MHz)	Level (dBm)	Level (dBc)
425.2287	-38.9	83.4
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 40604.2 dated 10 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

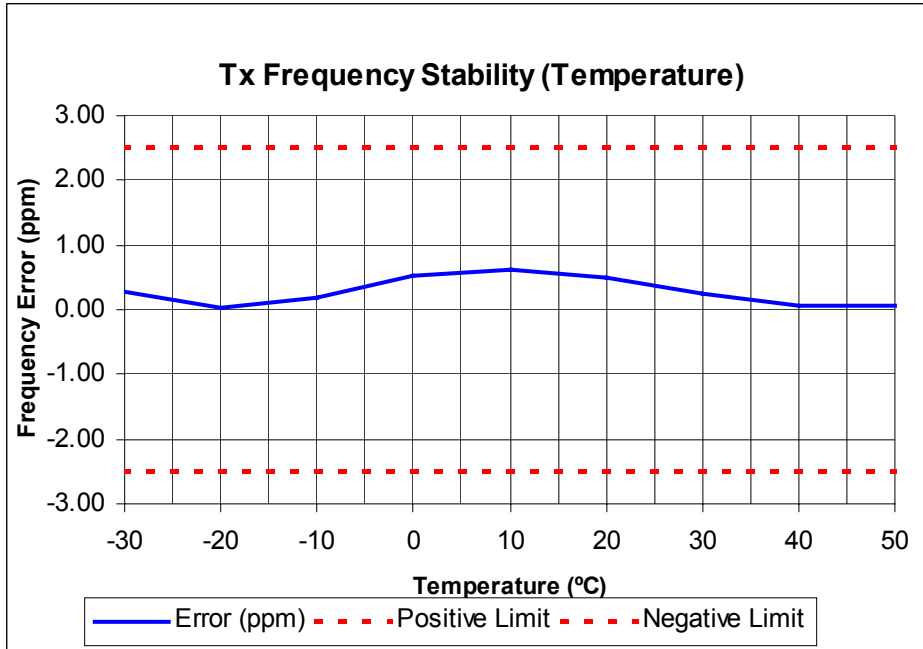
Frequency Range: 421 MHz to 512 MHz

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

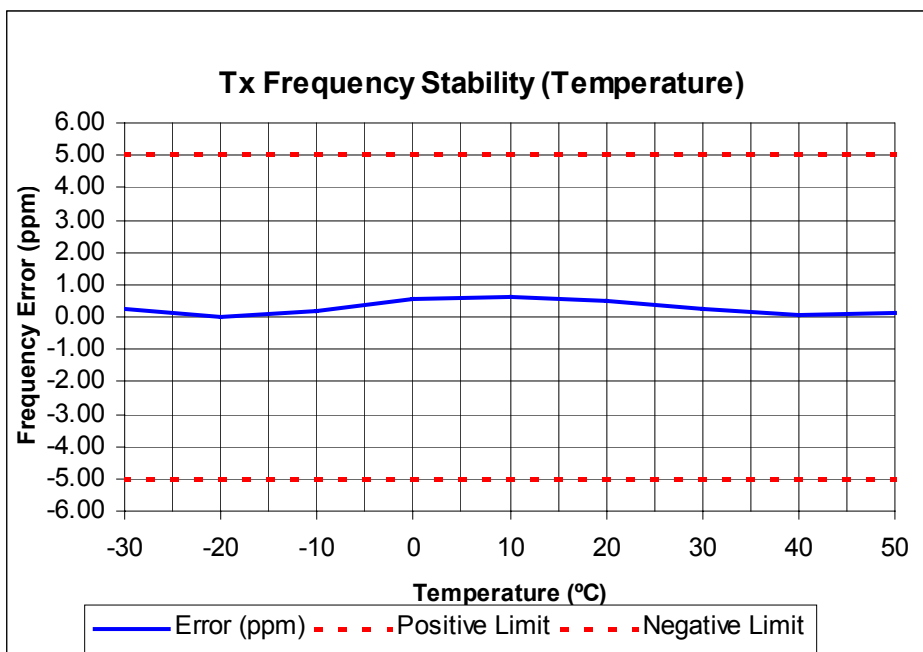
TRANSMITTER FREQUENCY STABILITY (TEMPERATURE)

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

Tx FREQUENCY: 425.1 MHz 25W 12.5 kHz channel Spacing



Tx FREQUENCY: 425.1 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: 421 MHz to 512 MHz

Channel Spacing (kHz)	FREQUENCY ERROR (ppm) @ 425.1 MHz		
	11.7 V DC	13.8 V DC	15.9 V DC
12.5	0.47	0.48	0.44
25.0	0.39	0.35	0.36

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: 425.1 MHz 25 W 12.5 kHz Channel Spacing

FREQUENCY	425.1 MHz @ 25 W Tx	
TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t ₁	0.7	N/A
t ₂	0.4	N/A
t ₃	N/A	0.6
t ₂ → t ₃ ppm	1.6	
ERROR LIMIT (t ₂ → t ₃) ppm	2.5	

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	

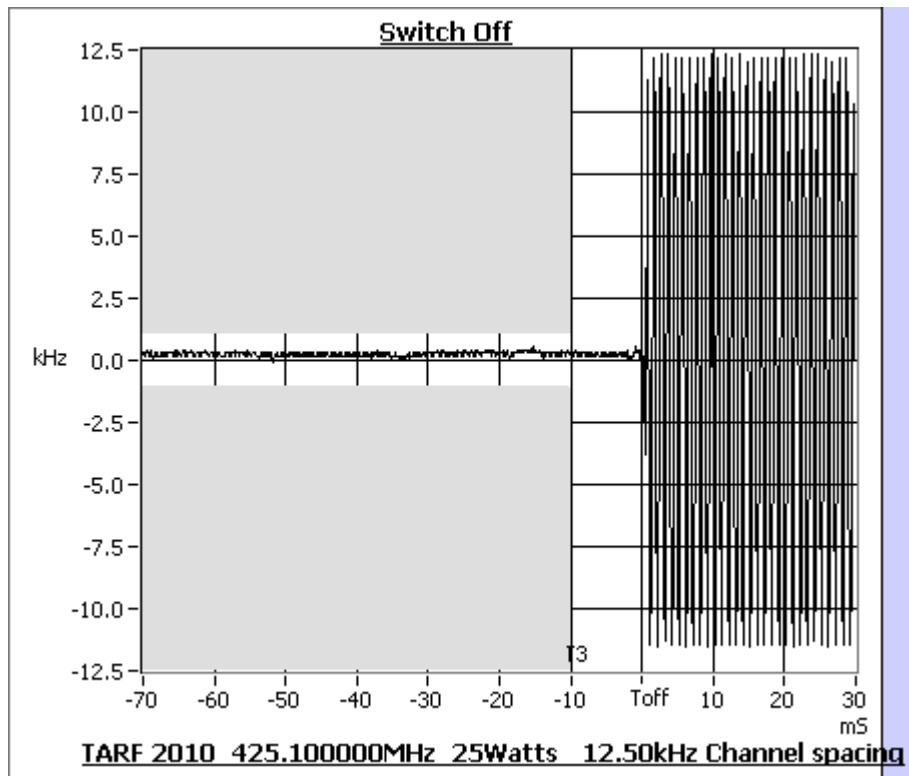
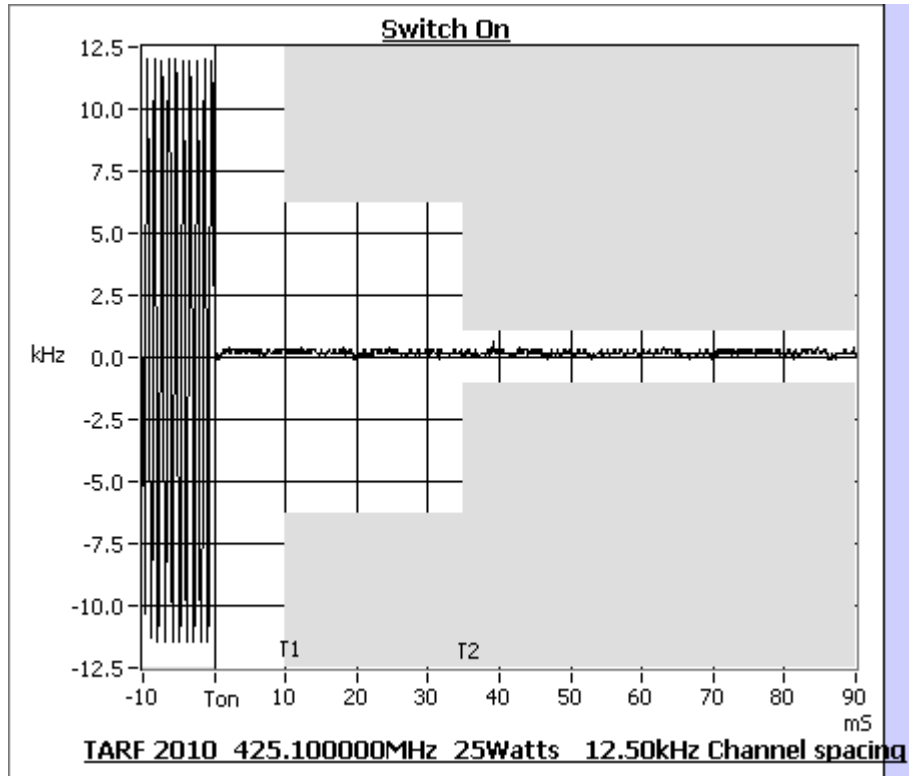
LIMIT:

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: 425.1 MHz 25 W 12.5 kHz Channel Spacing



TRANSIENT FREQUENCY BEHAVIOUR

SPECIFICATION: FCC 47 CFR 90.214

Tx FREQUENCY: 425.1 MHz 25 W 25.0 kHz Channel Spacing

FREQUENCY	425.1 MHz @ 25 W Tx	
TRANSIENT RESPONSE PERIOD	CARRIER PEAK VARIATION FROM NORMAL	
	Key ON (kHz)	Key OFF (kHz)
t_1	0.4	N/A
t_2	0.4	N/A
t_3	N/A	0.4
$t_2 \rightarrow t_3$ ppm	-0.9	
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	

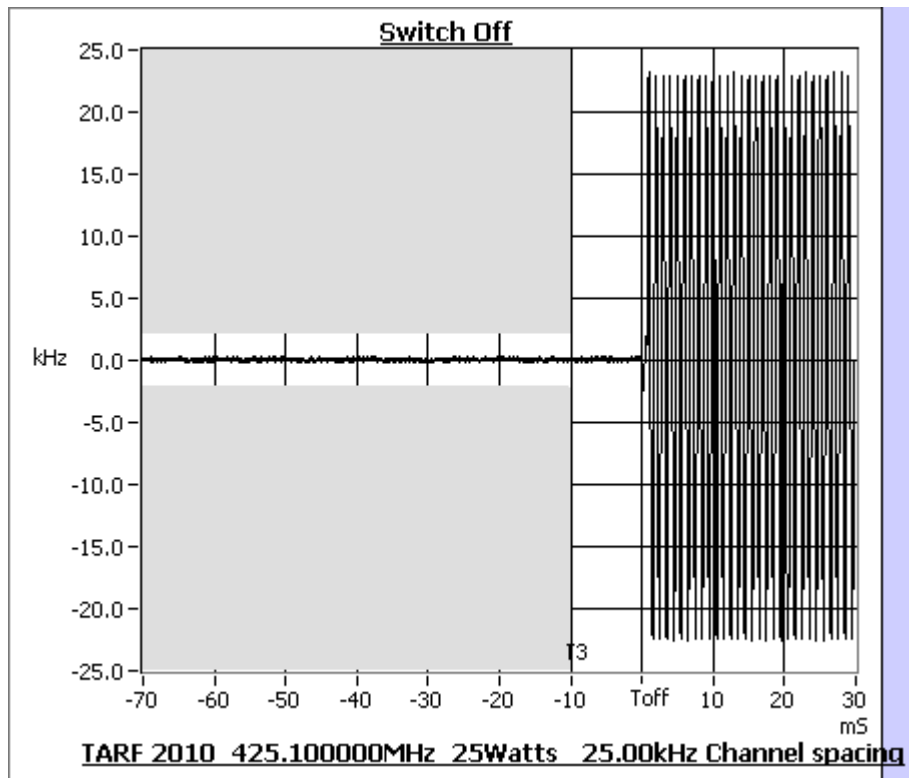
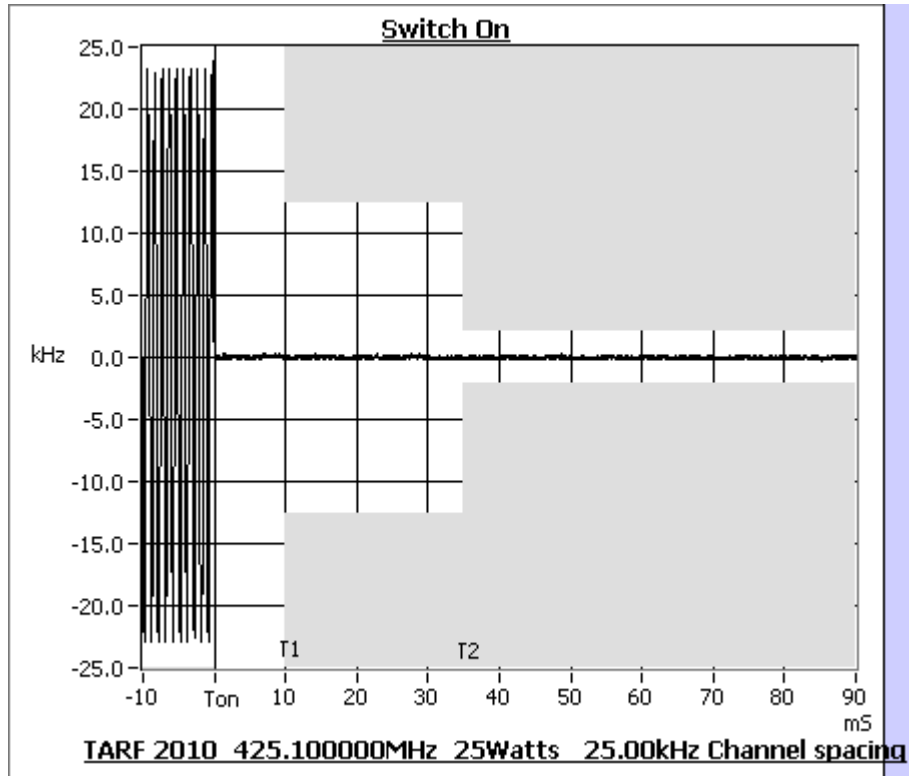
LIMIT:

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: 425.1 MHz 25 W 25.0 kHz Channel Spacing



TEST EQUIPMENT USED

TELTEST LABORATORIES Test Equipment List					
To facilitate inclusion on each page, the Test Equipment used is numbered and listed against the related test in the Report.					
No#	Equipment	Manufacturer	Model No	Serial No#	Tait ID Cal Due
5	Signal Generator	Rohde & Schwarz	SMY01 1062.5502.11	841736/019	E3553 29-Oct-04
21	Power Supply	Rohde & Schwarz	NGS M32/10 192.0810.31	Fnr 434	E3556 14-Jun-05
57	Filter Low Pass	Tait	MHz	N/A	-
62	RF Attenuator 150W	Weinschel	57-10-34	LB590	E3674 09-Jul-04
65	RF Attenuator 50W	Weinschel	24-20-44	AW1266	E3562 26-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
115	Environ. Chamber	Contherm	5400 RHSLT.M		E4051 04-Mar-05
116	Power Head	Hewlett Packard	HP11722A	2716A02037	
117	RF Attenuator	Weinschel	Model 1	BL9950	E4080 On Use
119	RF Attenuator 150W Treva	Weinschel	40-20-23	MF817	E4082 09-Jul-04
120	RF Splitter Combiner	Minicircuits	ZFSC-4-1	-	E4083 On Use

APPENDIX A

TEST SETUP DETAILS

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.

