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FCC PART 90
450-470 MHz UHF PORTABLE
TEST REPORT

APPLICANT	MIDLAND RADIO CORPORATION
	5900 PARRETTA DRIVE KANSAS CITY MISSOURI 64120 USA
FCC ID	MMABR200
MODEL NUMBER	BR200
PRODUCT DESCRIPTION	PORTABLE UHF TRANSCEIVER
STANDARD APPLIED	CFR 47 Part 90
DATE SAMPLE RECEIVED	8/21/2015
FINAL TEST DATE	9/4/2015
TESTED BY	Tim Royer
APPROVED BY	Cory Leverett
TEST RESULTS	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL

Report Number	Version Number	Description	Issue Date
1739AUT15TestReport	Rev1	Initial Issue	9/10/2015

**THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL
WITHOUT THE WRITTEN APPROVAL OF TIMCO ENGINEERING, INC.**

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GENERAL REMARKS

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Summary

The device under test does:

- ☒ Fulfill the general approval requirements as identified in this test report
☐ Not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025: 2005 requirements.

I attest that the necessary measurements were made, under my supervision, at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669

Authorized Signatory Name:



Tim Royer
Engineering Project Manager

Date: 9/8/2015

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Applicant: MIDLAND RADIO CORPORATION
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GENERAL INFORMATION

EUT Specification

EUT Description	PORTABLE UHF TRANSCEIVER
FCC ID	MMABR200
Model Number	BR200
Operating Frequency	450 – 470 MHz
Test Frequencies	450.25, 460, 469.75 MHz
Type of Emission	11K0F3E
Modulation	FM
EUT Power Source	<input type="checkbox"/> 110–120Vac/50– 60Hz
	<input type="checkbox"/> DC Power 12V
	<input checked="" type="checkbox"/> Battery Operated Exclusively
Test Item	<input type="checkbox"/> Prototype
	<input checked="" type="checkbox"/> Pre-Production
	<input type="checkbox"/> Production
Type of Equipment	<input type="checkbox"/> Fixed
	<input type="checkbox"/> Mobile
	<input checked="" type="checkbox"/> Portable
Test Conditions	The temperature was 26°C with a relative humidity of 50%.
Revision History to the EUT	None
Test Exercise	The EUT was placed in continuous transmit mode.
Applicable Standards	FCC CFR 47 Part 90, ANSI/TIA 603-D:2010, ANSI C63.4-2009
Test Facility	Timco Engineering Inc. 849 NW State Road 45 Newberry, FL 32669 USA.

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TEST REPORT SUMMARY

Rule Part No.	Scope of Work	Status Pass/Fail/NA
Part 2.1033(c)(8) , Part 2.1046(a) , Part 90	RF Power Output	Pass
Part 2.1033(c) (4) Part 2.1047(a)(6)	Modulation Characteristics	Pass
2.1049(c) , 90.210(b) , 90.210 (c) 90.210(d) , 90.210(e)	Emission Mask and Occupied Bandwidths	Pass
2.1051(a)	Antenna Conducted Emissions	Pass
2.1053 , Part 90	Field Strength Spurious Emissions	Pass
Part 2.1055 , Part 90.213	Frequency Stability	Pass
Part 90.214	Transient Frequency Behavior	Pass

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TEST PROCEDURE

Power Line Conducted Interference: The procedure used was ANSI/TIA 603-D: 2010, using a 50uH LISN. Both lines were observed with the EUT transmitting. The bandwidth of the spectrum analyzer was 10 kHz with an appropriate sweep speed.

Bandwidth 20 dB: The measurements were made with the spectrum analyzer's resolution bandwidth (RBW) = 1 MHz and the video bandwidth (VBW) = 3 MHz and the span set as shown on plot.

Power Output: The RF power output was measured at the antenna feed point using a peak power meter.

Antenna Conducted Emissions: The RBW = 100 kHz, VBW = 300 kHz and the span set to 10.0 MHz and the spectrum was scanned from 30 MHz to the 10th harmonic of the fundamental. Above 1 GHz the resolution bandwidth was 1 MHz and the VBW = 3 MHz and the span to 50 MHz.

Radiation Interference: The test procedure used was ANSI/TIA 603-D: 2010, using a Rohde & Schwarz – EMI test receiver. The bandwidth (RBW) of the spectrum receiver was 100 kHz up to 1 GHz and 1 MHz above 1 GHz with an appropriate sweep speed. The VBW above 1 GHz was 3 MHz. The analyzer was calibrated in dB above a microvolt at the output of the antenna.

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RF POWER OUTPUT

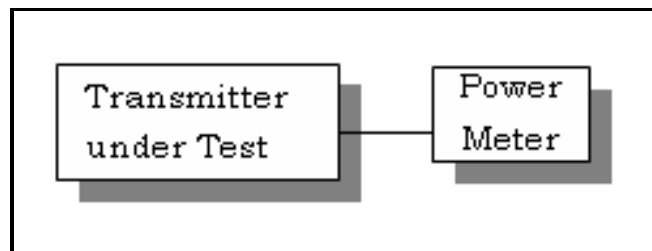
Rule Part No.: Part 2.1046(a), Part 90

Test Requirements: Manufacturer's Specification

Method of Measurement: RF power is measured by using a 50-ohm, resistive wattmeter to the RF output connector. With a nominal battery voltage (if battery operated), or a properly adjusted power supply (if not battery operated), and the transmitter properly adjusted the RF output measures:

For the device with a fixed or integral antenna, the RF power is measured as ERP. The substitution method was used. The RF output measures:

Test Setup Diagram:



Test Data:

OUTPUT POWER:

Tuned Frequency (MHz)	RF POWER	
	dBm	Watts
450.25	32.11	1.626
460.00	31.64	1.459
469.75	31.52	1.419

Part 2.1033 (C) (8) DC Input into the final amplifier

INPUT POWER: (4) (0.790) = 3.16 Watts

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MODULATION CHARACTERISTICS

Rule Part No.: Part 2.1047(a) (b)

Test Requirements:

Method of Measurement:

Part 2.1033(c)

Part 90.209

Part 90.207

Part 2.1033(c) (4) Type of Emission: 11K0F3E

$$B_n = 2M + 2DK$$

$$M = 3000$$

$$D = 2500$$

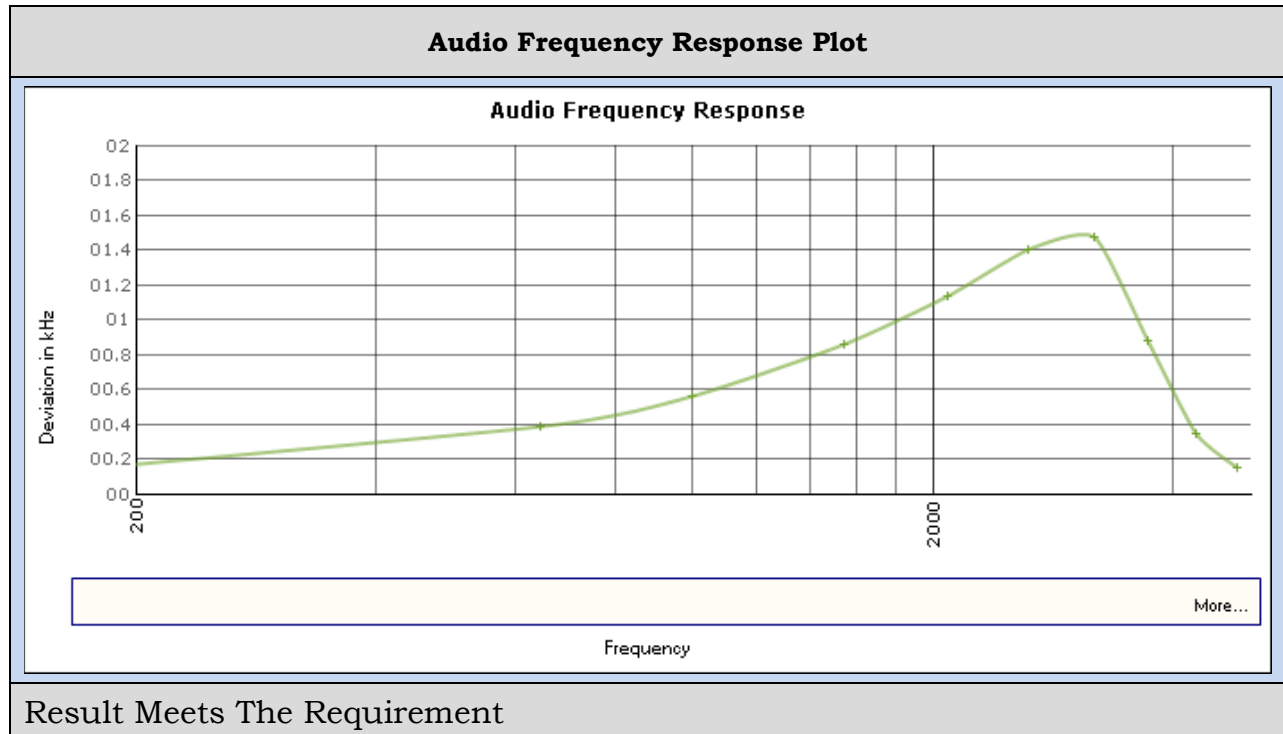
$$K=1$$

$$B_n = 2(3000) + 2(2500) = 11.0k$$

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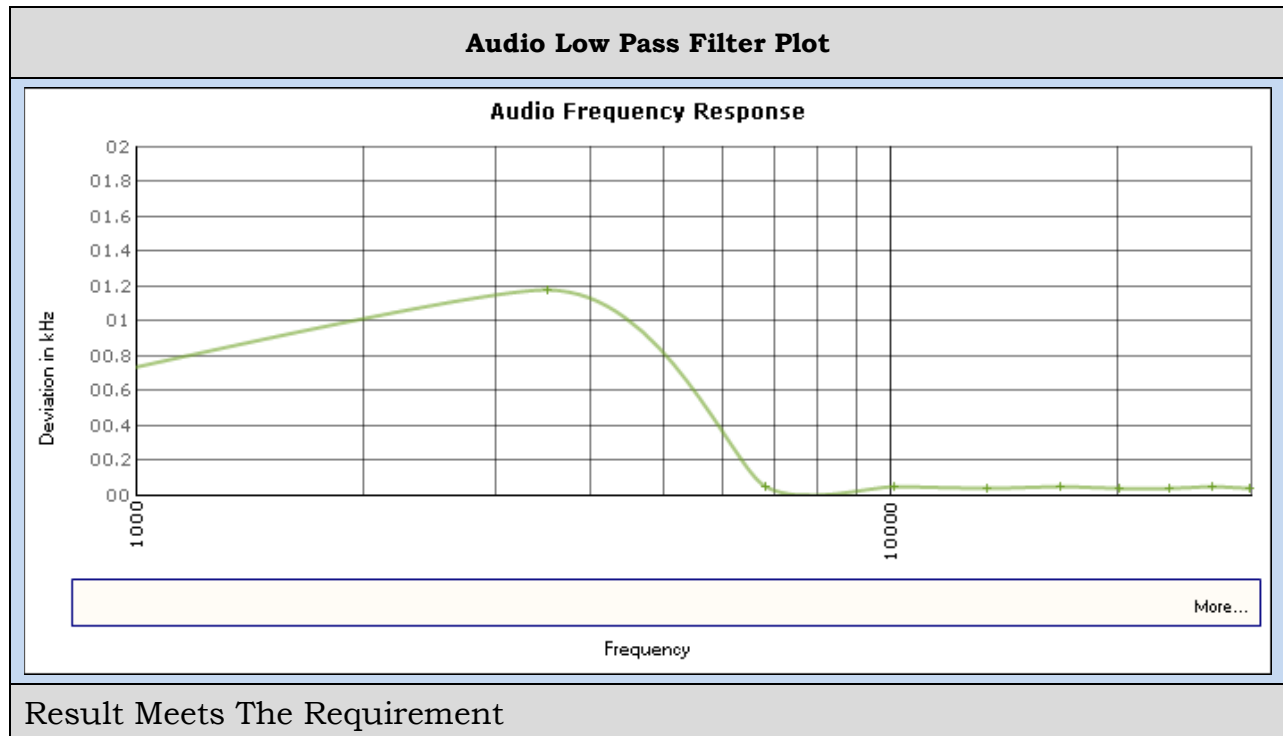
Audio frequency response

The audio frequency response was measured in accordance with ANSI/TIA 603-D: 2010. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 – 5000Hz shall be submitted. The audio frequency response curve is shown below.



VOICE MODULATED COMMUNICATION EQUIPMENT

Part 2.1047(a): For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter or of all the circuitry installed between the modulation limiter and the modulated stage shall be submitted.



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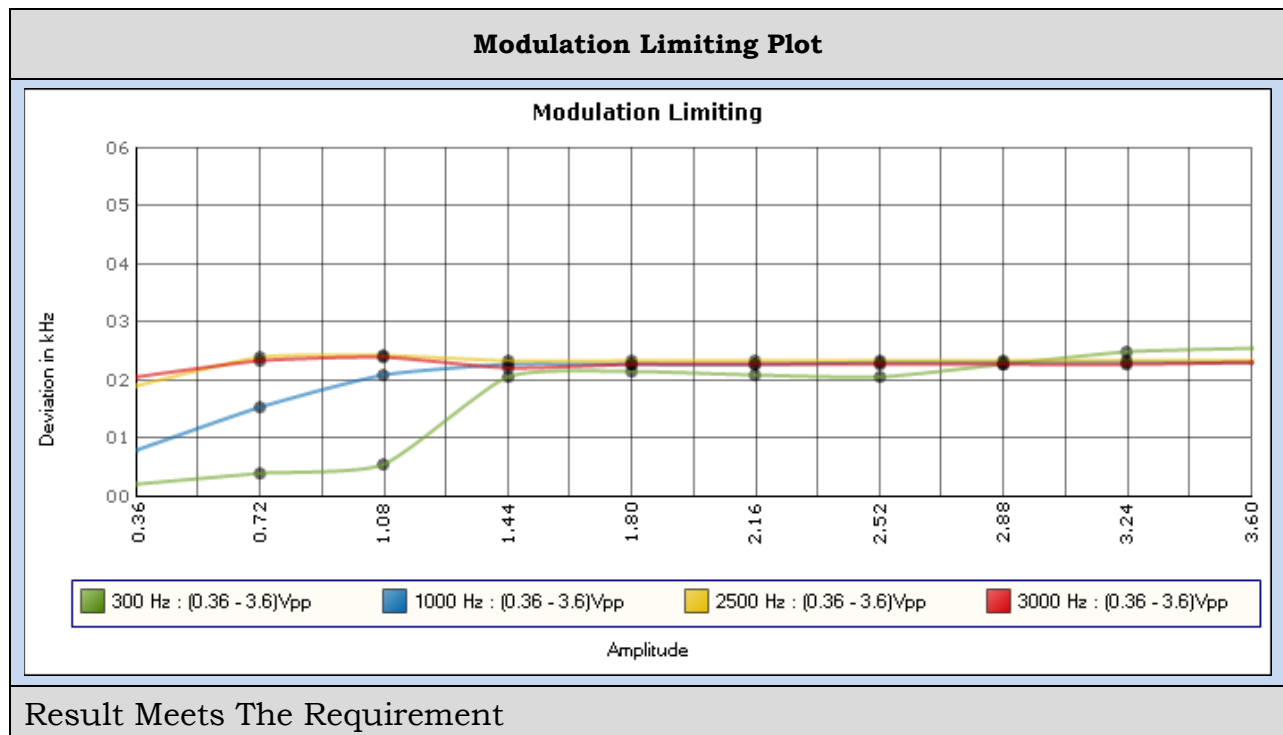
AUDIO INPUT VERSUS MODULATION

Rule Part No.: Part 2.1047(b) & 90

Test Requirements:

Method of Measurement: Modulation cannot exceed 100%, the audio input level needed for a particular percentage of modulation was measured in accordance with ANSI/TIA 603-D: 2010. The audio input curves versus modulation are shown below. Curves are provided for audio input frequencies of 300, 1000, and 3000 Hz.

Test data:



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OCCUPIED BANDWIDTH

Part 2.1049(c) EMISSION BANDWIDTH:

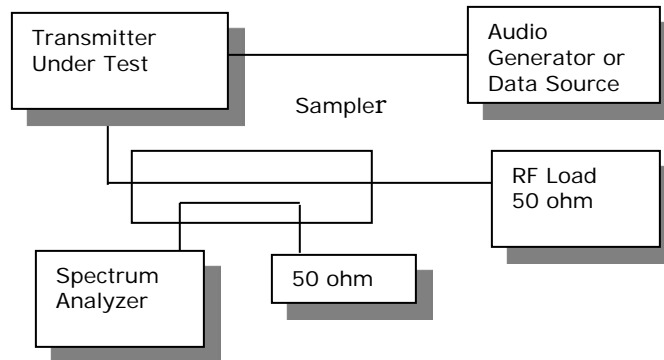
Part 90.210(d) **Emission Mask D - 12.5 kHz channel BW equipment.**

For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

- (1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0 : Zero dB.
- (2) On any frequency from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least $7.27 (f_d - 2.88 \text{ kHz})$ dB.
- (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least $50 + 10\log (P)$ dB or 70 dB, whichever is the lesser attenuation.

Method of Measurement: ANSI/TIA 603-D: 2010

Test Setup Diagram:



Test Data: See the plots below

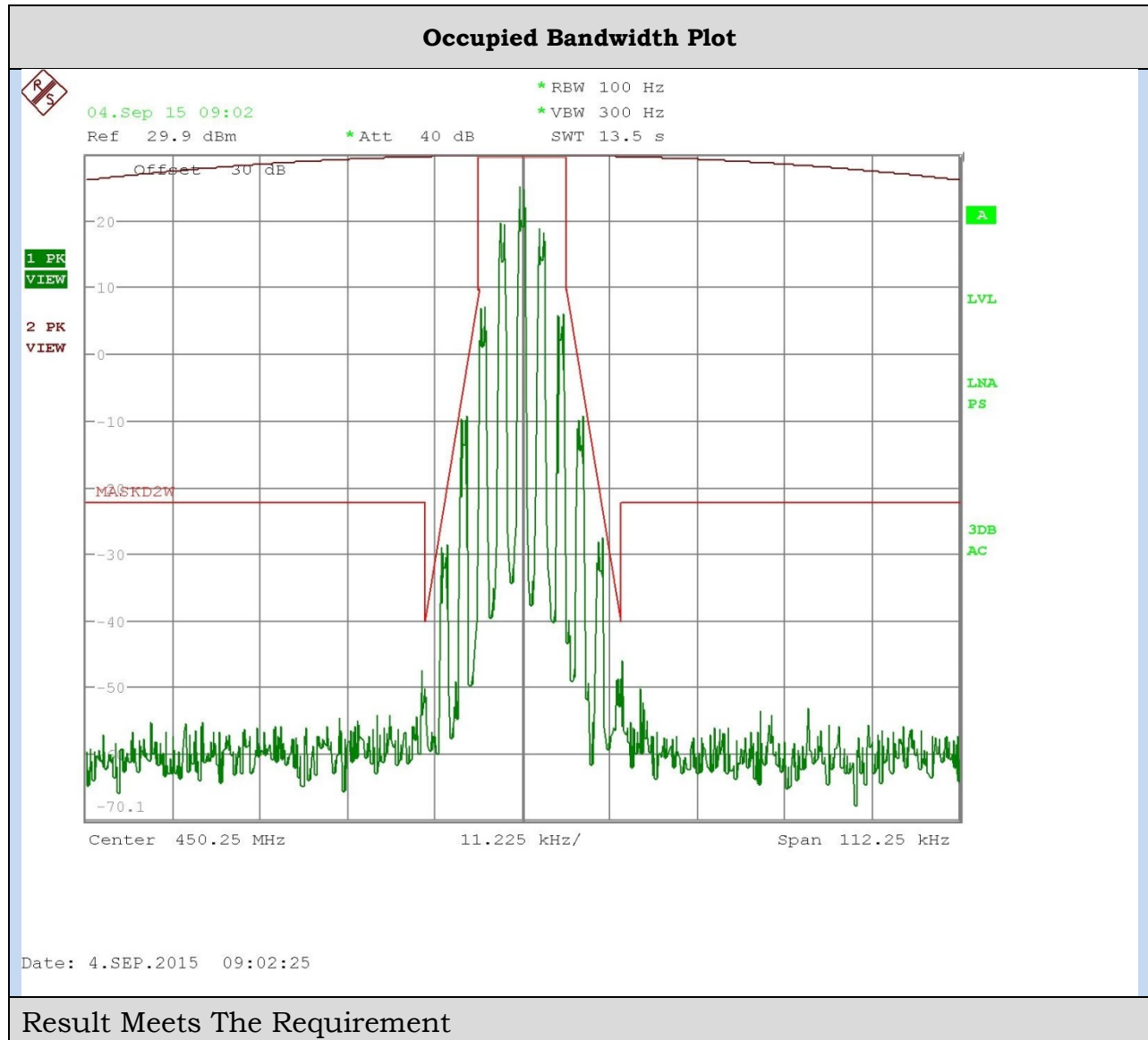
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OCCUPIED BANDWIDTH

TEST DATA: ANALOG 11kOF3E

Part 90.210(D) Emission Mask D – 12.5 kHz Channel Bandwidth -

Low End of Band



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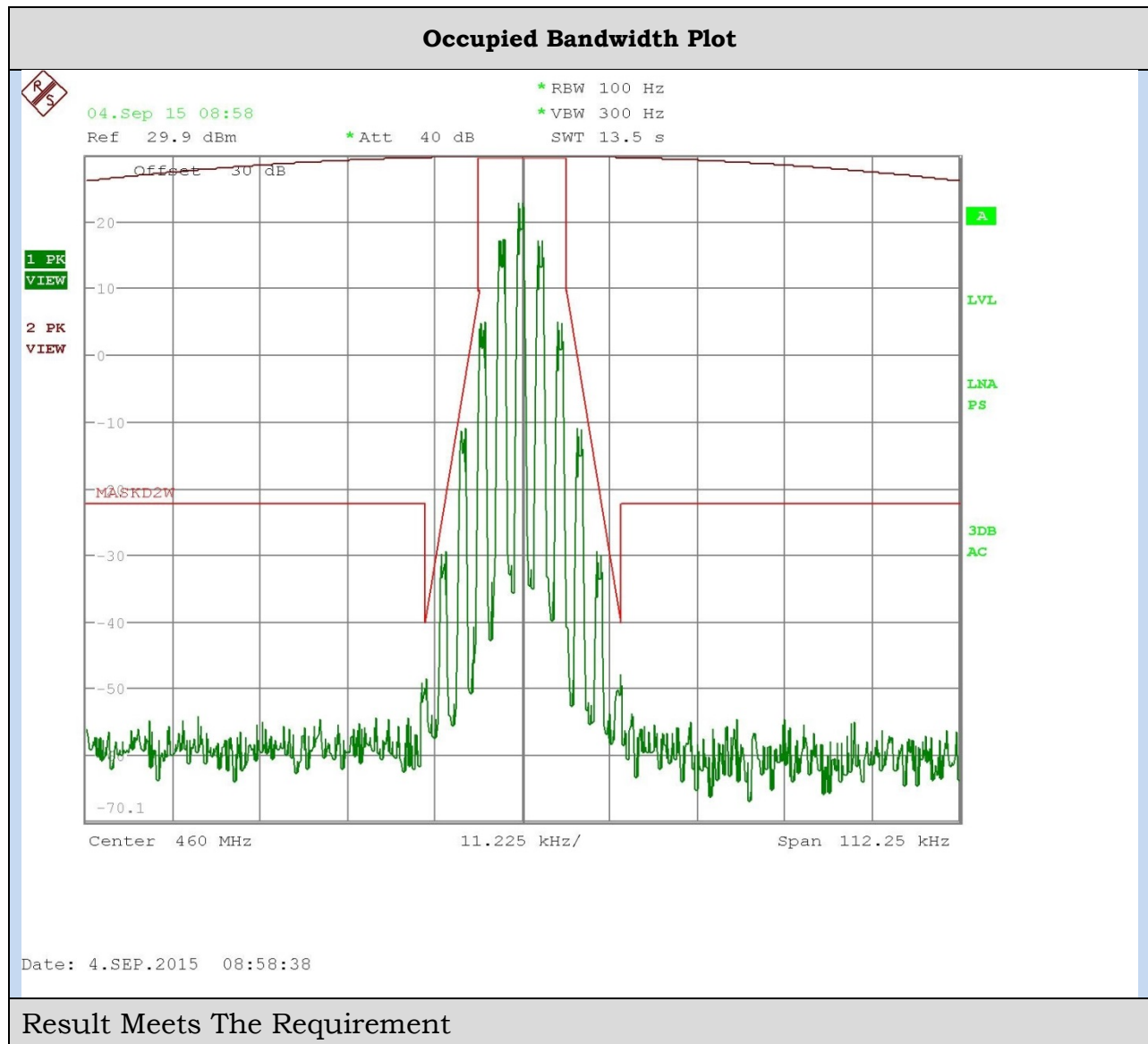
FCC ID: MMABR200

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OCCUPIED BANDWIDTH PLOTS: ANALOG 11k0F3E

Part 90.210(D) Emission Mask D – 12.5 kHz Channel Bandwidth -

Middle of Band



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Applicant: MIDLAND RADIO CORPORATION

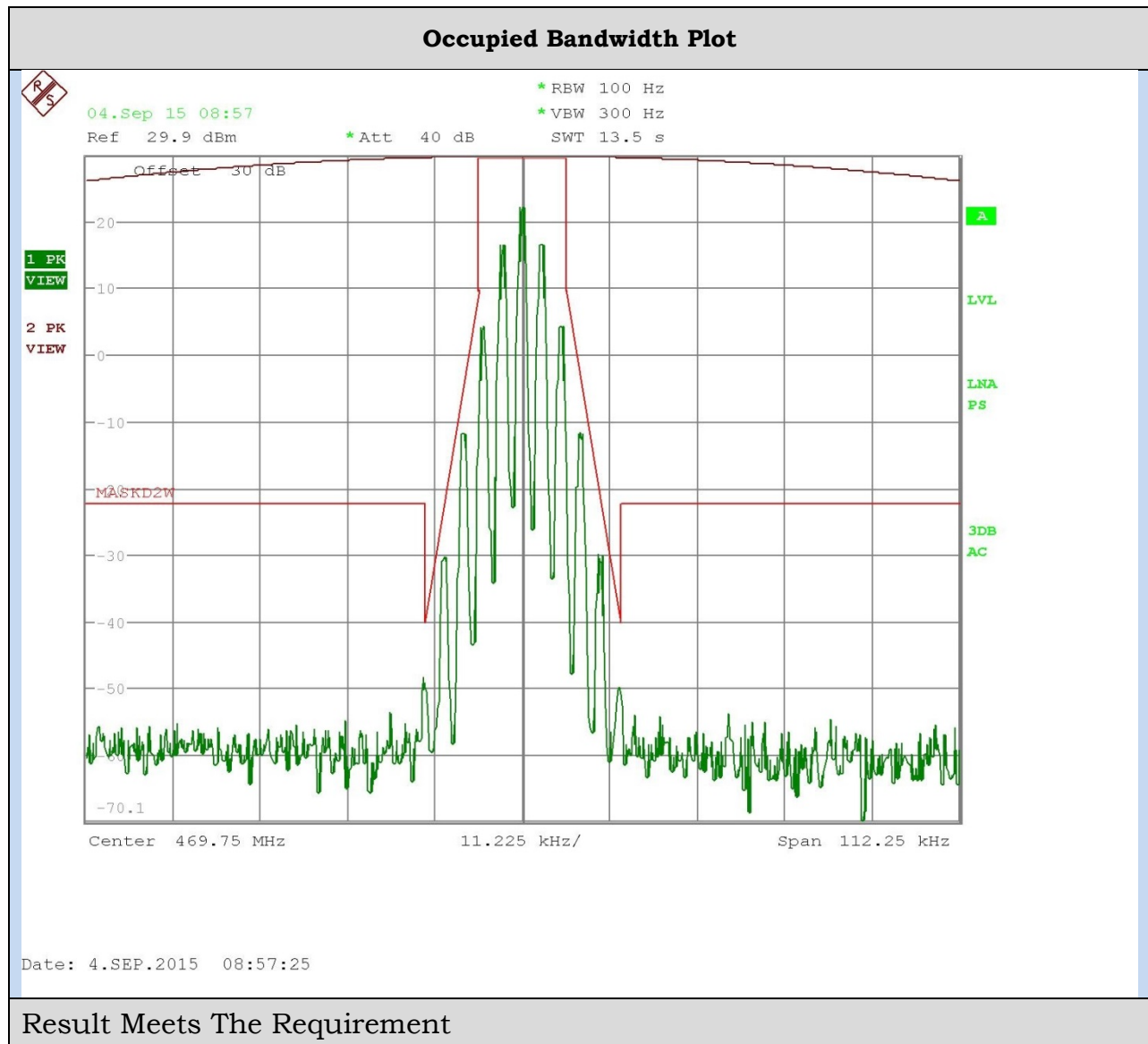
FCC ID: MMABR200

Report: M\MIDLAND_MMA\1739AUT15\1739AUT15TestReport.docx

OCCUPIED BANDWIDTH PLOTS: ANALOG 11k0F3E

Part 90.210(D) Emission Mask D – 12.5 kHz Channel Bandwidth -

High End of Band



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SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

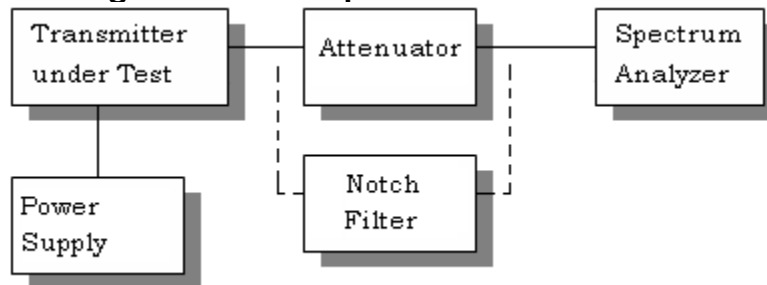
Rule Part No.: Part 2.1051(a)

Requirements:

12.5 kHz Channel Spacing = $50 + 10 \log (OP) = \text{dBc}$

Method of Measurement: The carrier was modulated 100% using a 2500 Hz tone. The spectrum was scanned from the lowest frequency generated to at least the 10th harmonic of the fundamental. The measurements were made in accordance with standard ANSI/TIA 603-D: 2010.

Method of Measuring Conducted Spurious Emissions



Test Data: Low end of Band

	dBm	Watts	dBc Limit
Power Output	32.11	1.626	53
	Frequency	dBc	Margin
	450.25	-	-
	900.5	68.9	15.9
	1350.75	96	43
	1801	93.2	40.2
	2251.25	97.3	44.3
	2701.5	91.8	38.8
	3151.75	99.7	46.7
	3602	89.3	36.3
	4052.25	93	40
	4502.5	92.2	39.2

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SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Test Data: Middle of Band

	dBm	Watts	dBc Limit
Power Output	31.64	1.459	53
	Frequency	dBc	Margin
	460	-	-
	920	67.1	14.1
	1380	96.5	43.5
	1840	94.9	41.9
	2300	106.3	53.3
	2760	86.7	33.7
	3220	96.9	43.9
	3680	86.9	33.9
	4140	100.8	47.8
	4600	93.5	40.5

Test Data: High End of Band

	dBm	Watts	dBc Limit
Power Output	31.52	1.419	52.69
	frequency	dBc	Margin
	469.75	-	-
	939.5	61.7	9.01
	1409.25	95.1	42.41
	1879	94.7	42.01
	2348.75	95.2	42.51
	2818.5	85.7	33.01
	3288.25	95.6	42.91
	3758	90.2	37.51
	4227.75	97.9	45.21
	4697.5	102.1	49.41

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FIELD STRENGTH OF SPURIOUS EMISSIONS

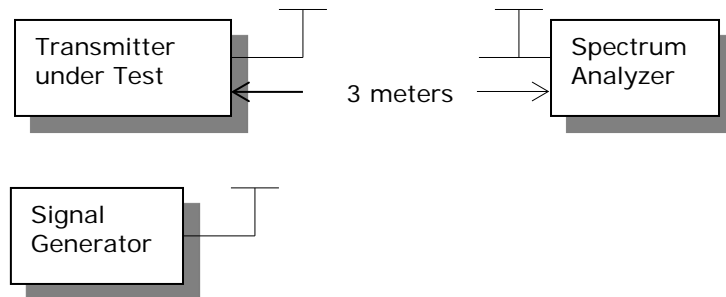
Rule Parts. No.: Part 2.1053

Requirements:

$$12.5\text{kHz Channel Spacing} = 50 + 10\log(\text{OP}) = \text{dBc}$$

METHOD OF MEASUREMENT: The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from 30 MHz to at least the tenth harmonic of the fundamental. This test was conducted per ANSI/TIA 603-D: 2010 using the substitution method. Measurements were made at the test site of **TIMCO ENGINEERING, INC. located at 849 NW State Road 45, Newberry, FL 32669.**

Test Setup Diagram:



Test Data:

Low End of the Band

Emission Frequency (MHz)	Power Mode	ERP Power Output (dBm)	ERP Power Output (Watts)	FCC Requirement dB	Bandwidth - BW - kHz
450.25	Hi	32.12	1.63	52.12	12.50
Emission Frequency (MHz)	Ant. Polarity		Below Carrier (dBc)	Margin	
900.50	H		76.35	23.15	
1,350.75	V		77.94	24.74	
1,801.00	V		80.99	27.79	
2,251.25	H		84.83	31.63	
2,701.50	H		83.88	30.68	
3,151.75	V		78.51	25.31	
3,602.00	V		78.81	25.61	
4,052.25	H		75.65	22.45	
4,502.50	H		80.19	26.99	

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FIELD STRENGTH OF SPURIOUS EMISSIONS

Middle of the Band

Emission Frequency (MHz)	Power Mode	ERP Power Output (dBm)	ERP Power Output (Watts)	FCC Requirement dB	Bandwidth - BW - kHz
460.00	Hi	31.64	1.46	51.64	12.50
Emission Frequency (MHz)	Ant. Polarity		Below Carrier (dBc)	Margin	
920.00	V		83.20	30.00	
1380.00	V		72.26	19.06	
1840.00	V		81.76	28.56	
2300.00	H		85.96	32.76	
2760.00	H		82.52	29.32	
3220.00	H		79.82	26.62	
3680.00	V		78.20	25.00	
4140.00	V		81.48	28.28	
4600.00	H		77.94	24.74	

High End of the Band

Emission Frequency (MHz)	Power Mode	ERP Power Output (dBm)	ERP Power Output (Watts)	FCC Requirement dB	Bandwidth - BW - kHz
469.75	Hi	31.52	1.42	51.52	12.50
Emission Frequency (MHz)	Ant. Polarity		Below Carrier (dBc)	Margin	
939.50	H		58.36	5.66	
1,409.25	V		84.60	31.90	
1,879.00	H		85.20	32.50	
2,348.75	V		85.43	32.73	
2,818.50	H		84.36	31.66	
3,288.25	H		80.39	27.69	
3,758.00	V		75.18	22.48	
4,227.75	V		79.69	26.99	
4,697.50	H		85.05	32.35	

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FREQUENCY STABILITY

Rule Parts. No.: Part 2.1055, Part 90.213

Requirements: Temperature range requirements: -30 to +50° C.
Voltage Variation +, -15%
±2.5 PPM

Method of Measurements: ANSI/TIA 603-D: 2010.

Test Data:

Temperature	Frequency MHz	PPM
25°C (reference)	459.999905	
-30°C	459.999709	-0.426
-20°C	459.999684	-0.480
-10°C	459.999836	-0.150
0°C	459.999810	-0.207
10°C	459.999839	-0.143
20°C	459.999907	0.004
30°C	459.999897	-0.017
40°C	459.999900	-0.011
50°C	459.999899	-0.013
Battery Voltage	Frequency	PPM
-15%	459.999904	-0.002
15%	459.999902	-0.007

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TRANSIENT FREQUENCY BEHAVIOR

Part 90.214 Transient Frequency Behavior

REQUIREMENTS: Transmitters designed to operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain transient frequencies within the maximum transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals ^{1 2}	Maximum frequency difference ³	All equipment	
		150 to 174 MHz	421 to 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels			
t ₁ ⁴	±12.5 kHz	5.0 ms	10.0 ms
t ₂	±6.25 kHz	20.0 ms	25.0 ms
t ₃ ⁴	±12.5 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels			

¹_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

t_1 is the time period immediately following t_{on} .

t_2 is the time period immediately following t_1 .

t_3 is the time period from the instant when the transmitter is turned off until t_{off} .

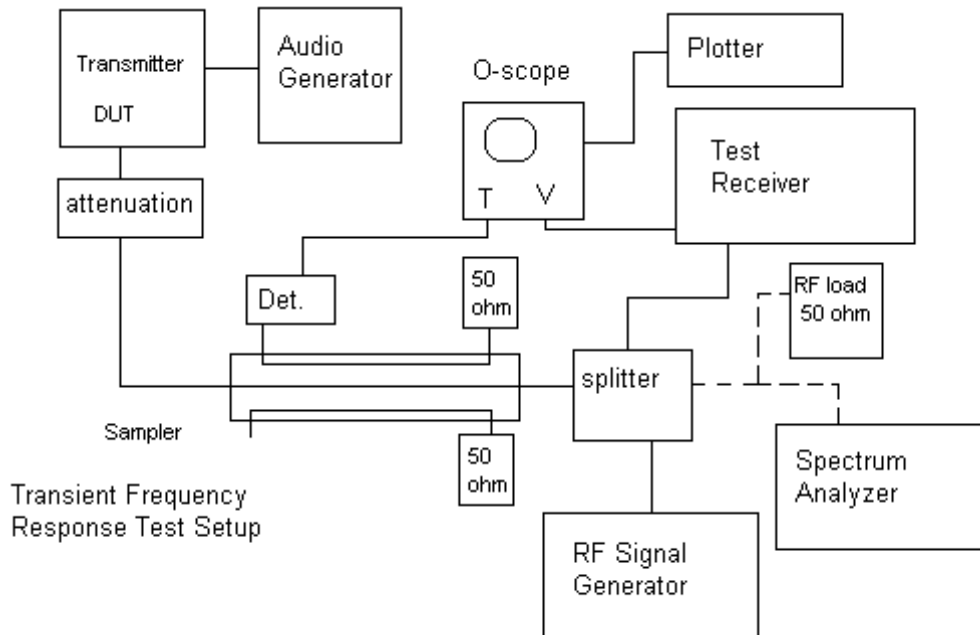
t_{off} is the instant when the 1 kHz test signal starts to rise.

⁴ If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

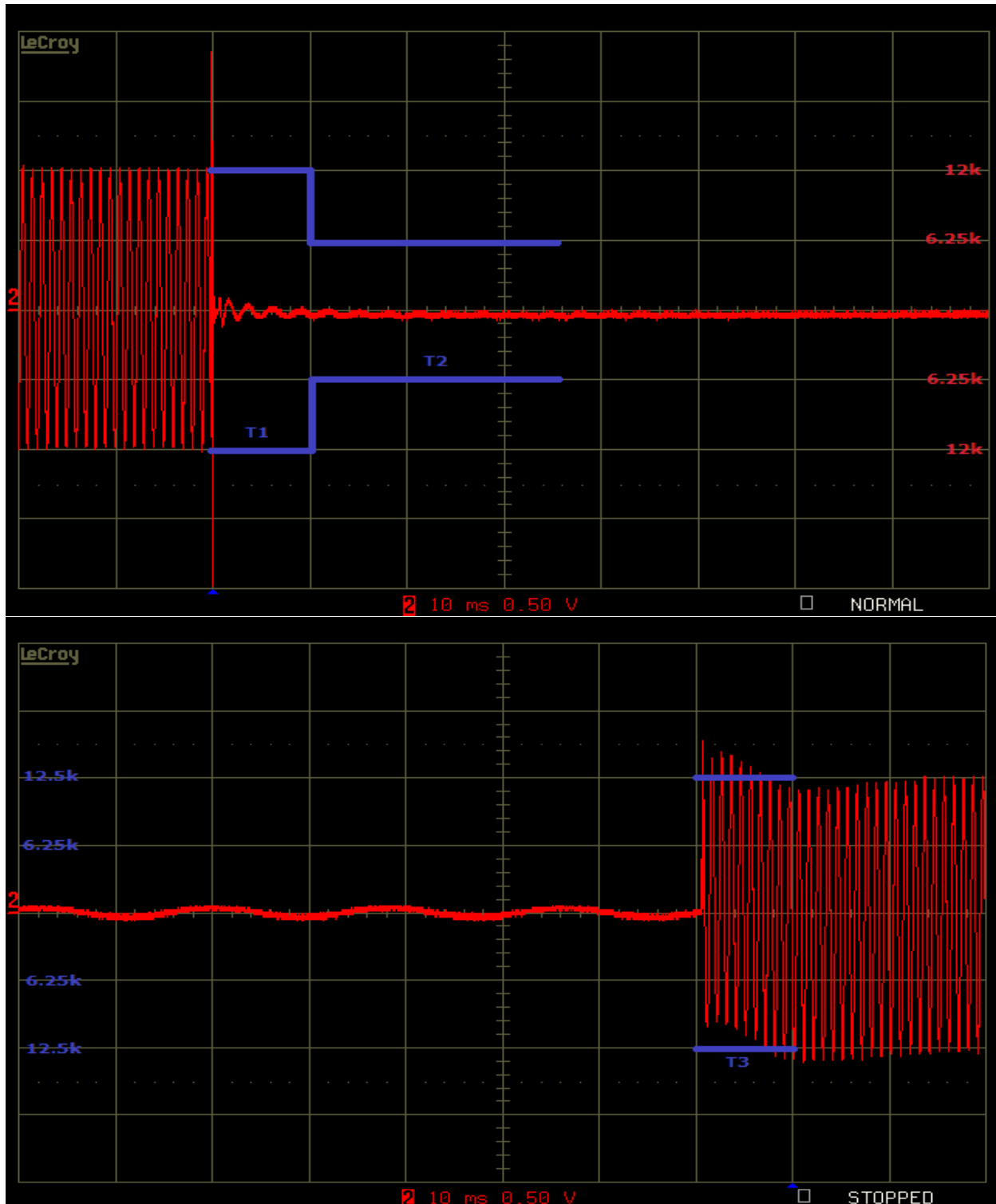
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TEST PROCEEDURE: ANSI/TIA 603-D:2010, the levels were set as follows:

1. Using the variable attenuator the transmitter level was set to 40 dB below the test receivers maximum input level, then the transmitter was turned off.
2. With the transmitter off the signal generator was set 20dB below the level of the transmitter in the above step, this level will be maintained with the signal generator through-out the test.
3. Reduce the attenuation between the transmitter and the RF detector by 30 dB.
4. With the levels set as above, the transient frequency behavior was observed and recorded.



Test Data:



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EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
Antenna: Biconnical Chamber	Eaton Chamber	94455-1	1057	06/14/13	12/14/15
Antenna: Log-Periodic Chamber	Eaton	96005	1243	05/31/13	11/30/15
DC Power Supply	HP	6264B	2032A04119	05/06/13	11/06/15
Temperature Chamber LARGE	Tenney Engineering	TTRC	11717-7	08/19/14	08/19/16
AC Voltmeter	HP	400FL	2213A14728	06/20/13	12/26/15
Digital Multimeter	Fluke	77	43850817	06/11/14	06/11/16
DC Power Supply	HP	6286A	2411A09414	N/A	N/A
Frequency Counter Small Chamber	HP	5385A	3242A07460	07/01/15	07/01/17
3-Meter Semi-Anechoic Chamber	Panashield	N/A	N/A	12/31/13	12/31/15
Ant: Double-Ridged Horn/ETS Horn 1 Ch	ETS-Lindgren Chamber	3117	00035923	06/13/14	06/13/16
Audio Analyzer	HP	8903A	2336A03066	08/30/13	08/30/16
Temperature Chamber Small	Thermotron Corp.	S1.2 Mini Max	25-1420-09	08/20/14	08/20/16
EMI Test Receiver R & S ESIB 40 Screen Room	Rohde & Schwarz	ESIB 40	100274	08/12/14	08/12/16
Software: Field Strength Program	Timco	N/A	Version 4.0	N/A	N/A
Hygro-Thermometer	Extech	445703	0602	06/30/15	06/30/17
Attenuator N 30dB 150W DC-6G	Narda	769-30	10267	06/26/15	06/26/17
EMI Test Receiver R & S ESU 40 Chamber	Rohde & Schwarz	ESU 40	100320	03/11/14	03/11/16
Signal Generator HP 8648C	HP	8648C	3623A02898	08/29/13	11/29/15
Attenuator 30dB 500W	Bird	8325	1761 (#67)	05/18/15	05/18/17

*EMI RECEIVER SOFTWARE VERSION

The receiver firmware used was version 4.43 Service Pack 3

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