Compliance Testing, LLC
Previously Flom Test Lab
EMI, EMC, RF Testing Experts Since 1963

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Test Report

Prepared for: BK Technologies, Inc

Model: BKR-5000

Description: VHF Transceiver

FCC ID: K95BKR5000-V
ISED ID: 2116A-BKR5000-V

To

FCC Part 90

ISED RSS-119 issue 12, (May 2015)

Date of Issue: March 9, 2020

On the behalf of the applicant:	**BK Technologies, Inc** **7100 Technology Drive** **Melbourne, FL 32904**
Attention of:	**Brian Jones, Vice President of Engineering** **Ph: (321) 984-1414** **E-Mail: Bjones@BKTechnologies.com**

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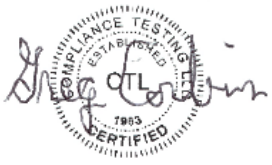

Greg Corbin
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	March 9, 2020	Greg Corbin	Original Document
2.0	April 2, 2020	Greg Corbin	Added test data for TDMA modulation to OCC BW, Emission Mask, Conducted Spurious. Marked 162 MHz for ISED only Added necessary BW calculations for digital modulations.

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ILAC / A2LA

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to http://www.compliancetesting.com/labscope.html for current scope of accreditation.

Testing Certificate Number: **2152.01**

FCC Site Reg. #349717

IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A

The Applicant has been cautioned as to the following:

15.21: **Information to the User**

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a): **Special Accessories**

Equipment marketed to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer, without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Test and Measurement Data

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, Volume II, Part 2, Subpart J, Sections 2.947, 2.1033(c), 2.1041, 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, ANSI C63.26-2015, FCC Part 90, RSS-119 and RSS-GEN.

Standard Test Conditions and Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing.

In accordance with ANSI/TIA 603C, and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Environmental Conditions		
Temp (ºC)	**Humidity (%)**	**Pressure (mbar)**
20.8 – 25.1	35.7 – 41.6	967.5 – 977.8

Measurement results, unless otherwise noted, are worst-case measurements.

EUT Description
Model: BKR-5000
Description: VHF Transceiver
Release: 7.5.8.22
Software: 5.8.20
DSP: 5.8.6
BSP: 5.8.12
Serial Number: P3 033 (conducted and radiated tests), P3 034 (Frequency Stability)

Additional Information:
The EUT is a portable VHF Transceiver operating from 136 – 174 MHz.
The manufacturer rated power is 1 – 6 watts.

EUT Operation during Tests

For output power the EUT was tested at the low and high power settings.
For the remaining tests the EUT was set to the high power setting.
Modulations used for testing were narrowband (12.5 kHz) and C4FM.
Power was supplied by battery and/or battery eliminator at 7.2 vdc.

Table 1 – Frequency Range, Modulation Type and Emission Designators

Frequency Range (MHz)		Modulation and Emission Designators			
FCC	IC	FM_12.5kHz	FM_25 kHz	P25 Phase1 C4FM	P25 Phase 2 TDMA
136 – 174	138 - 174	11K0F3E	N/A	8K10F1E 8K10F1D	8K10F1W

Table 2 –Test Frequencies

Test Frequencies (MHz)	FCC / IC Frequency
138.035	FCC, IC
150.075	FCC, IC
162	ISED Only
173.965	FCC, IC

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Li-ion Battery	BK	BKR0101	N/A
1	Battery Charger	BK	BKR0300	N/A
1	AC Adapter for Power Supply	BK	ATS012T-W120U LPS	N/A
1	Battery Eliminator	BK	N/A	N/A
1	Audio Interface Test Jig	BK	N/A	N/A
1	Antenna	BK	BKR810GPS	N/A

Cables: N/A

Modifications: none

Test Result Summary

Specification		Test Name	Pass, Fail, N/A	Comments
FCC	ISED			
90.205 2.1046	RSS-119_5.4	Carrier Output Power (Conducted)	Pass	
90.210 2.1051	RSS-119_5.8.9.2	Unwanted Emissions (Transmitter Conducted)	Pass	
90.210 2.1053	RSS-119_5.8.9.2	Field Strength of Spurious Radiation	Pass	
90.210, 2.1049	RSS-119_5.5	Emission Masks (Occupied Bandwidth)	Pass	
2.1047	N/A	Audio Low Pass Filter (Voice Input)	Pass	
2.1047	N/A	Audio Frequency Response	Pass	
2.1047(a)	N/A	Modulation Limiting	Pass	
90.213	RSS-119_5.3	Frequency Stability (Temperature Variation)	Pass	
90.213	RSS-119_5.3	Frequency Stability (Voltage Variation)	Pass	
90.214	RSS-119_5.9	Transient Frequency Behavior	Pass	
2.202	N/A	Necessary Bandwidth Calculation	Pass	

Carrier Output Power (Conducted)

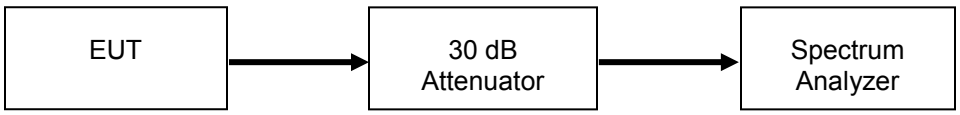
Engineer: Greg Corbin

Test Date: 3/4/2020

Measurement Procedure

The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 30 dB Power attenuator. All cable and attenuator losses were input into the spectrum analyzer as a reference level offset to ensure accurate readings were obtained.

Test Setup



Manufacturer Rated Power = 6 watts (37.782 dBm)
ISED RSS-119 Output Power Limit = ± 1 dB of manufacturer rated power.
FCC Output Power Limit = 7.2 w (20% of manufacturer rated power)

High Power Transmitter Peak Output Power

Tuned Frequency	Output Power	Output Power	Result
MHz	(dBm)	(watts)	
138.035	37.46	5.572	Pass
150.075	37.22	5.272	Pass
162 (ISED only)	37.3	5.370	Pass
173.965	37.35	5.433	Pass

Low Power Transmitter Peak Output Power

Tuned Frequency	Output Power	Output Power	Result
MHz	(dBm)	(watts)	
138.035	30.83	1.211	Pass
150.075	29.57	0.906	Pass
162 (ISED only)	29.53	0.897	Pass
173.965	29.45	0.881	Pass

Conducted Spurious Emissions

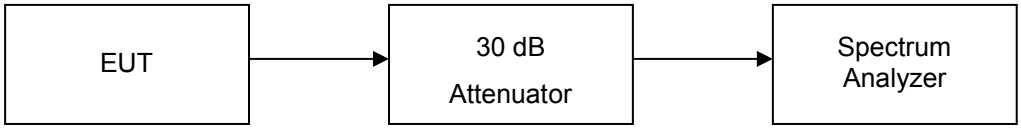
Engineer: Greg Corbin

Test Date: 3/5/2020

Test Procedure

The EUT was connected directly to a spectrum analyzer to verify that the EUT met the requirements for spurious emissions. The resolution bandwidth set for 100 kHz below 1 GHz and 1 MHz above 1 GHz. The reference level was adjusted to ensure the system had sufficient dynamic range to measure spurious emissions. The frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was observed and plotted.

Test Setup



High Power Conducted Spurious Emissions Summary Test Table

Tuned Frequency (MHz)	Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Specification Limit (dBm)	Result
138.035	503	-31.3	-20	Pass
150.075	890	-30.5	-20	Pass
162 (ISED only)	1773	-31.3	-20	Pass
173.965	747	-30.8	-20	Pass

Annex A Conducted Spurious Emissions

Refer to Annex A for Conducted Spurious Emission plots

Field Strength of Spurious Radiation
Engineer: Greg Corbin
Test Date: 3/5/2020

Test Procedure

The EUT was tested in a semi-anechoic chamber with the turntable set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360 degrees with the antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure that the signal levels were maximized. All cable and antenna correction factors were input into the spectrum analyzer ensuring an accurate measurement in ERP/EIRP with the resultant power in dBm.

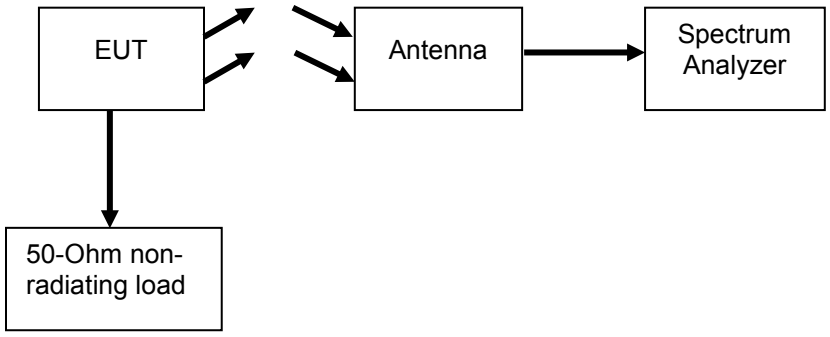
The EUT was set to transmit at maximum power with the RF output terminated with 50 ohms.

The RBW was set to 100 kHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz.
The VBW was set to 3 times the RBW.

The following formula was used for calculating the limits:

The radiated spurious limit = P1 – (50+ 10Log(P2)) = -20dBm

Test Setup



Test Results

Tuned Frequency (MHz)	Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Specification Limit (dBm)	Result
138.035	277.4	-37.9	-20	Pass
150.075	299.9	-45.1	-20	Pass
162 (ISED only)	324.2	-45.4	-20	Pass
173.965	348.5	-46.8	-20	Pass

Annex B Radiated Spurious Emission

Refer to Annex B for Radiated Spurious Emission plots

Emission Masks (Occupied Bandwidth)

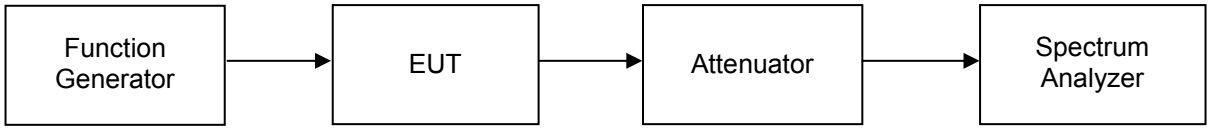
Engineer: Greg Corbin

Test Date: 3/4/2020

Measurement Procedure

The EUT was connected directly to a spectrum analyzer to verify that the EUT meets the required emissions mask. A reference level plot is provided to verify that the peak power was established prior to testing the mask
The transmitter was modulated with a 2.5 kHz tone at a level 16 dB higher than that required to produce 50% of the maximum frequency deviation.

Test Setup



Annex C Occupied Bandwidth

Refer to Annex C for Occupied Bandwidth plots.

Annex D Emission Mask

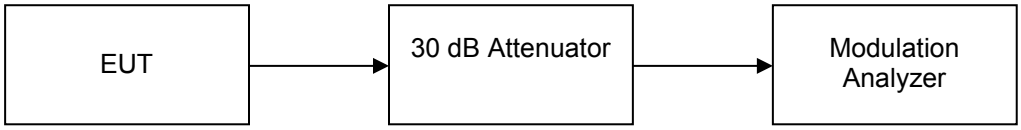
Refer to Annex D for Emission Mask plots.

Transient Frequency Behavior
Engineer: Greg Corbin
Test Date: 3/6/2020

Measurement Procedure

The EUT was connected directly to a modulation analyzer through a 40 dB attenuator to verify that the EUT meets the required Transient Frequency Behavior response per the specification. The modulation analyzer is a real time spectrum analyzer with integrated demodulation, audio measurement capabilities, and timing analysis.
The turn on and turn off transient timing was measured and recorded.

Test Setup

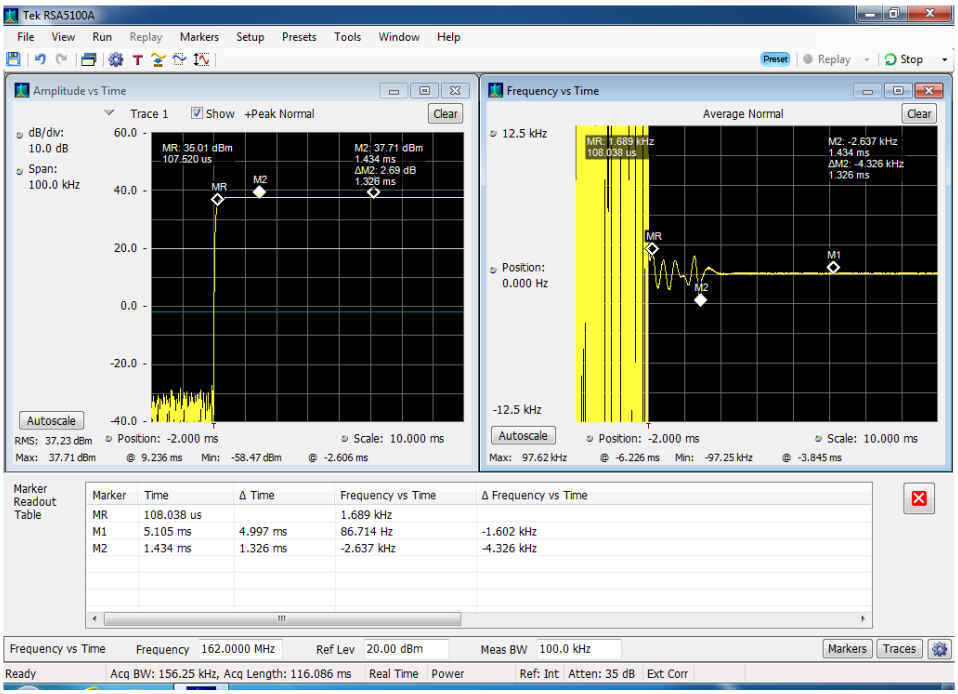


Transient Frequency Behaviour Summary Table

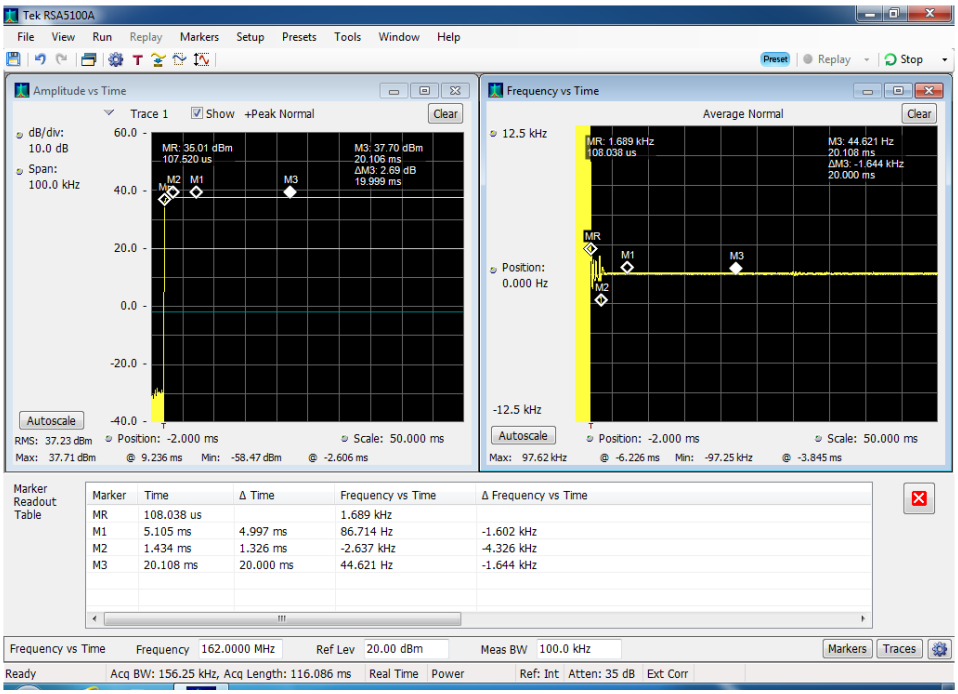
12.5 kHz CH spacing - VHF - 162 MHz				
154.6 MHz	time - referenced from t_{on}	Measured value	Limit	Margin
	(ms)	(kHz)	(kHz)	(kHz)
t_1	5	-2.637	± 12.5	15.137
t_2	20	0.086	± 6.5	6.164
t_3	5	63.172**	± 12.5	-50.672

**Per 90.214 (note 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.

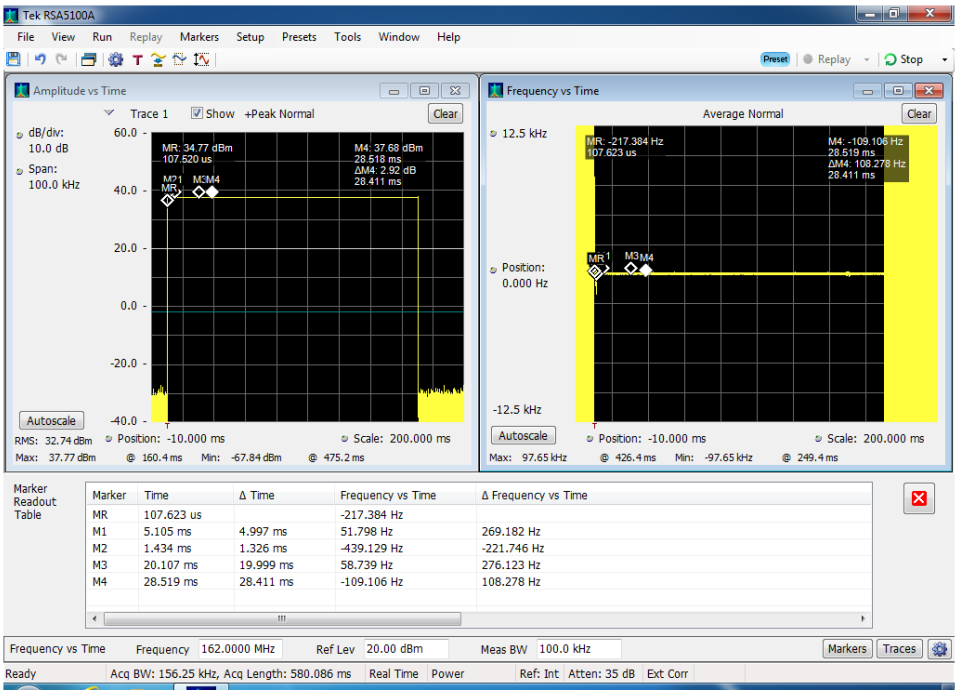
Transient Frequency Behavior_ On Time_NB_T1



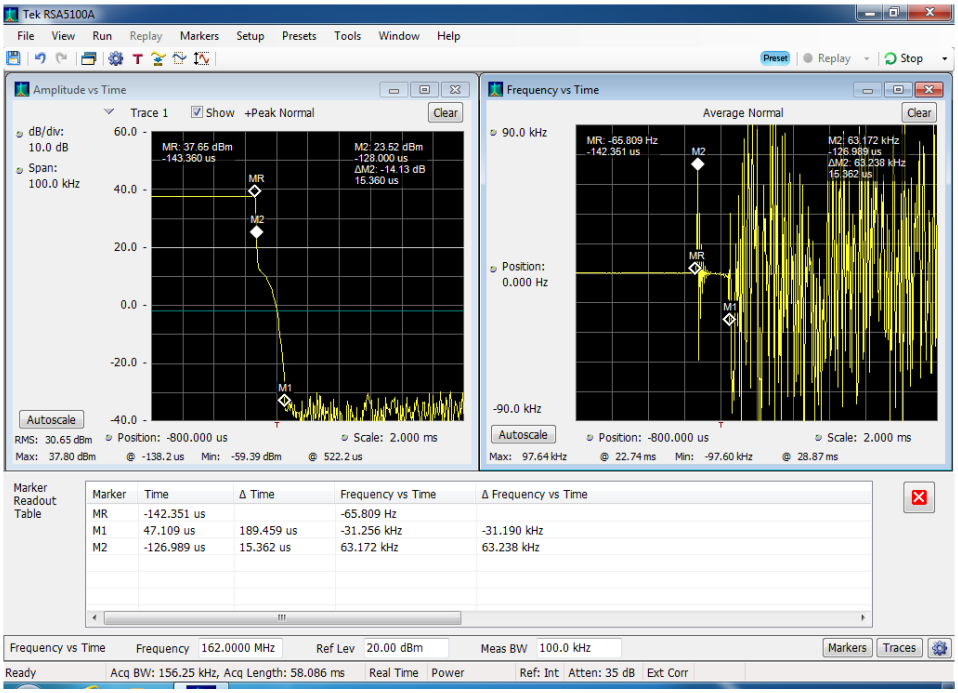
Transient Frequency Behavior_ On Time_NB_T2



Transient Frequency Behavior_ On Time_NB_T2 to T3



Transient Frequency Behavior_ Off Time_ NB



Audio Low Pass Filter (Voice Input)

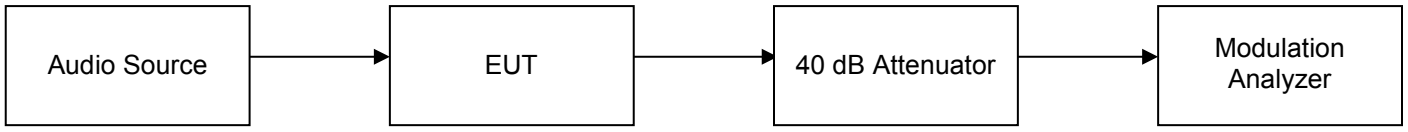
Engineer: Greg Corbin

Test Date: 3/6/2020

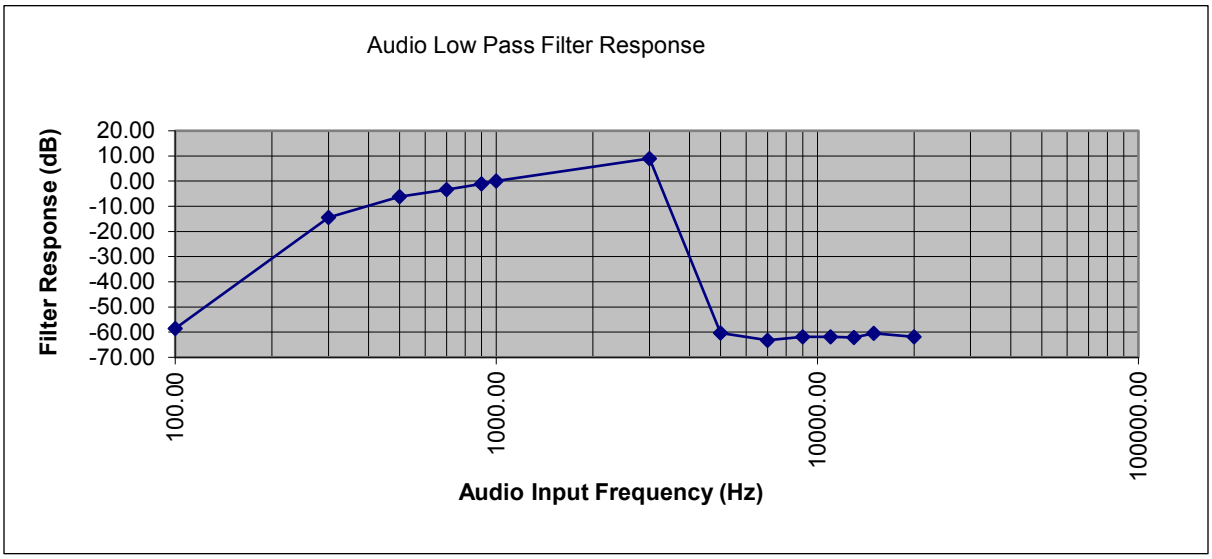
Measurement Procedure

The EUT was connected directly to a modulation analyzer through an attenuator. The audio source was tuned across the required audio frequency range and the audio low pass filter response was measured and plotted. The modulation analyzer is a real time spectrum analyzer with integrated demodulation, audio measurement capabilities, and timing analysis.

Test Setup



Audio Low Pass Filter Test Results



Audio Frequency Response

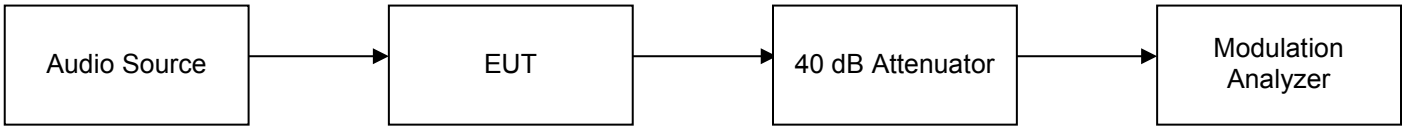
Engineer: Greg Corbin

Test Date: 3/6/2020

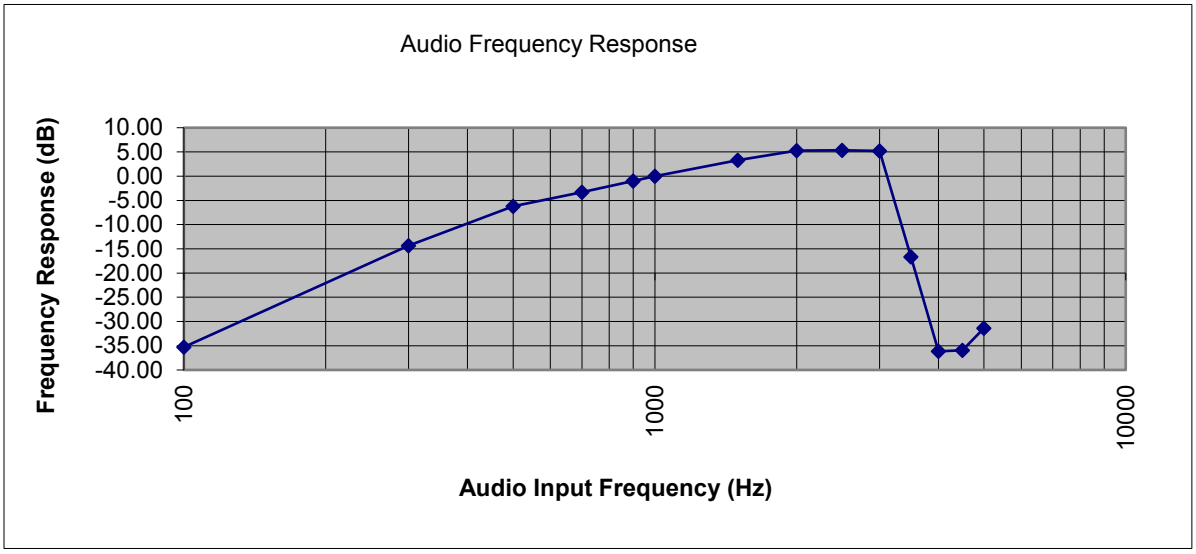
Measurement Procedure

The EUT was connected directly to a modulation analyzer through an attenuator. The audio source was tuned across the required audio frequency range and the audio frequency response was measured and plotted. The modulation analyzer is a real time spectrum analyzer with integrated demodulation, audio measurement capabilities, and timing analysis.

Test Setup



Audio Frequency Response Test Results

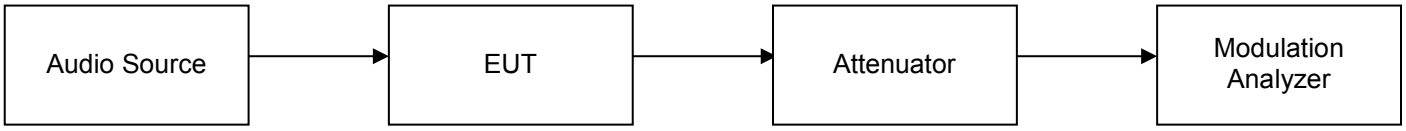


Modulation Limiting
Engineer: Greg Corbin
Test Date: 3/6/2020

Measurement Procedure

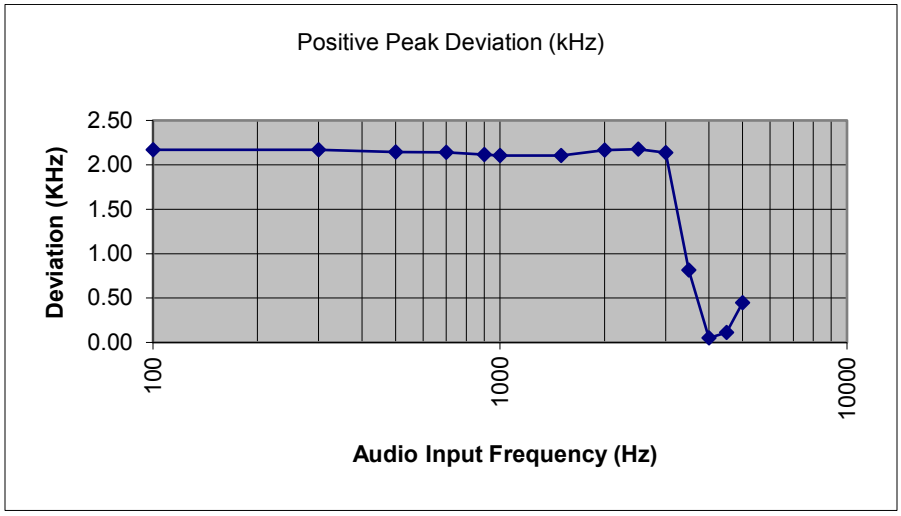
The EUT was connected directly to a modulation analyzer through an attenuator. The audio source was tuned across the required audio frequency range and the modulation limiting response was measured and plotted. The modulation analyzer is a real time spectrum analyzer with integrated demodulation, audio measurement capabilities, and timing analysis.

Test Setup

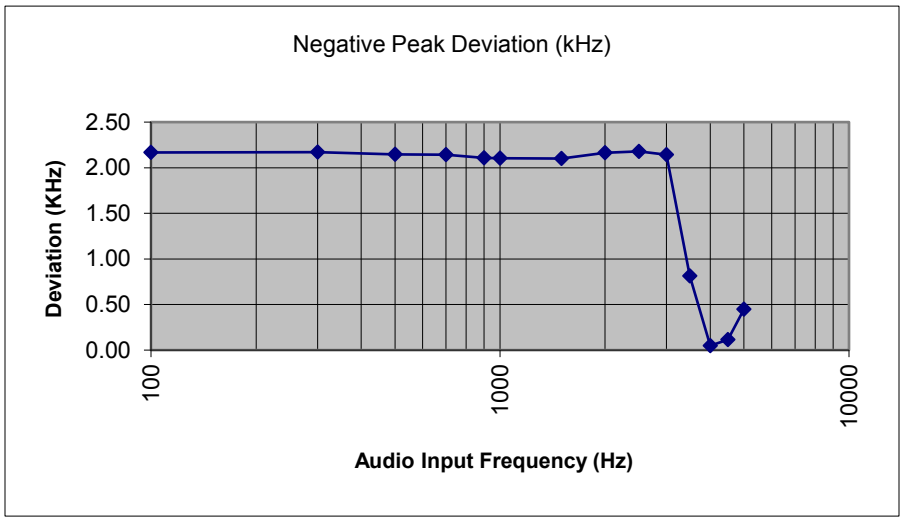


Modulation Limiting Test Results

Positive Peak Deviation



Negative Peak Deviation



Frequency Stability (Temperature Variation)

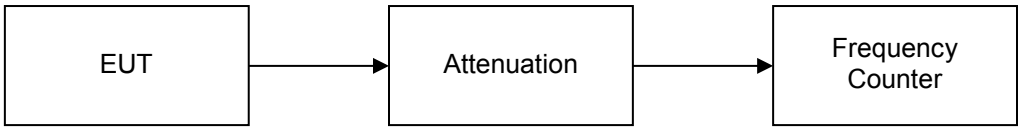
Engineer: Greg Corbin

Test Date:

Measurement Procedure

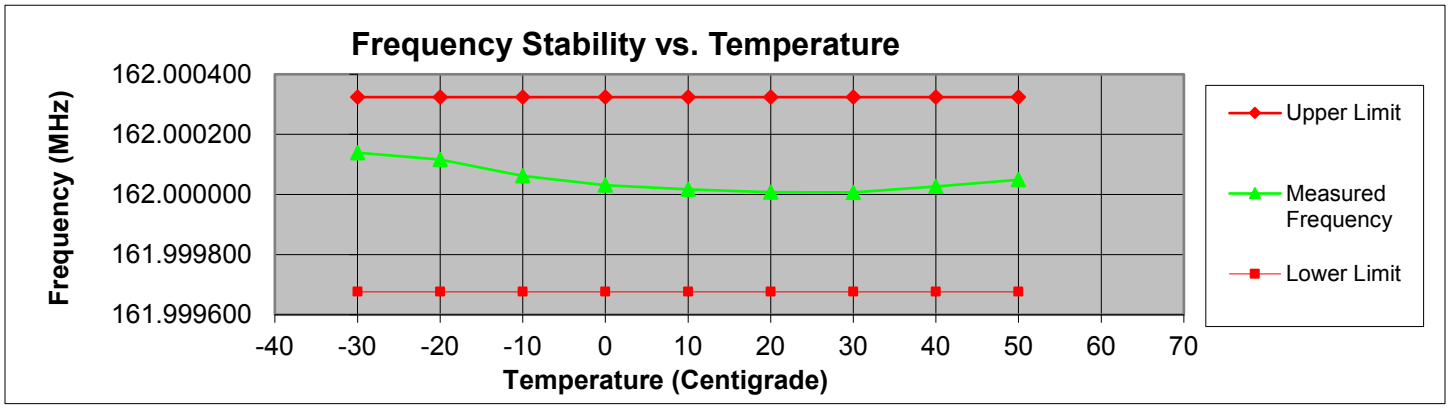
The EUT was placed in an environmental test chamber and the RF output was connected directly to a spectrum analyzer. The temperature was varied from -30°C to 50°C in 10°C increments. After a sufficient time for temperature stabilization the RF output frequency was measured. At 20°C the power supply voltage to the EUT was varied from 85% to 115% of the nominal value and the RF output was measured.

Measurement Setup



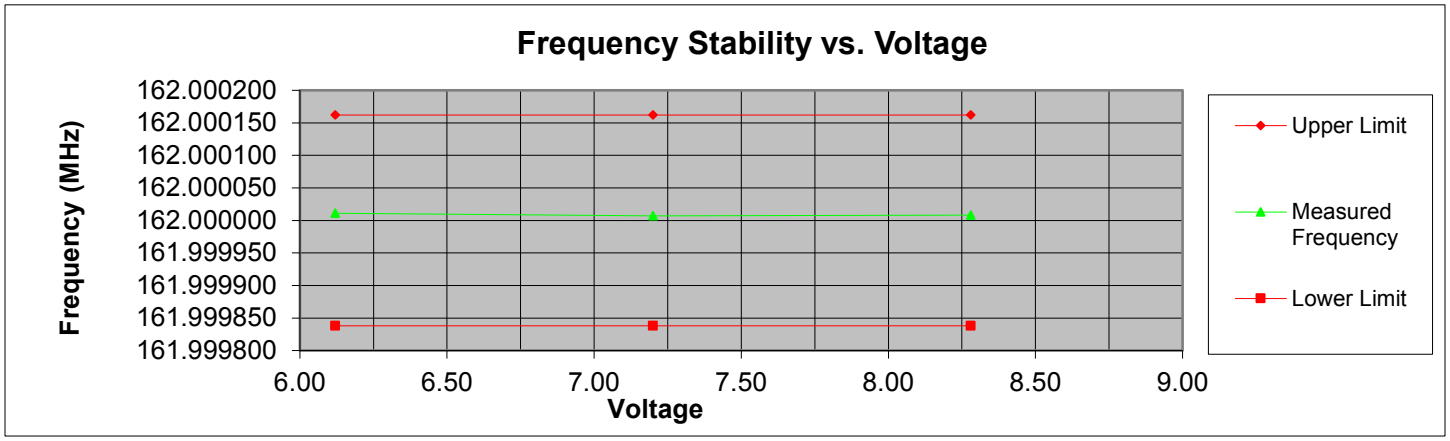
Frequency Stability vs Temperature

Tuned Frequency (MHz)	Temperature (deg C)	Tolerance (PPM)	Measured Frequency (MHz)	Upper Limit (MHz)	Lower Limit (MHz)	Upper Margin (MHz)	Lower Margin (MHz)
162	-30	2	162.000139	162.000139	162.000139	-0.000185	0.000463
162	-20	2	162.000116	162.000116	162.000116	-0.000208	0.000440
162	-10	2	162.000062	162.000062	162.000062	-0.000262	0.000386
162	0	2	162.000031	162.000031	162.000031	-0.000293	0.000355
162	10	2	162.000017	162.000017	162.000017	-0.000307	0.000341
162	20	2	162.000008	162.000008	162.000008	-0.000316	0.000332
162	30	2	162.000007	162.000007	162.000007	-0.000317	0.000331
162	40	2	162.000027	162.000027	162.000027	-0.000297	0.000351
162	50	2	162.000049	162.000049	162.000049	-0.000275	0.000373



Frequency Stability vs Voltage

Tuned Frequency (MHz)	Tolerance (PPM)	Voltage (PPM)	Measured Frequency (MHz)	Upper Limit (MHz)	Lower Limit (MHz)	Upper Margin (MHz)	Lower Margin (MHz)
162	2	6.12	162.000011	162.000162	161.999838	-0.000151	0.000173
162	2	7.20	162.000007	162.000162	161.999838	-0.000155	0.000169
162	2	8.28	162.000008	162.000162	161.999838	-0.000154	0.000170



Necessary Bandwidth Calculations
Engineer:
Test Date:

Modulation = 11K0F3E		
Necessary Bandwidth Calculation:		
Maximum Modulation (M), kHz	=	3
Maximum Deviation (D), kHz	=	2.5
Constant Factor (K)	=	1
Necessary Bandwidth (B_N), kHz	=	(2xM)+(2xDxK)
	=	11.0

Modulation = 8K30F1E, 8K30F1D, 8K30F7W	
(4 level FSK, 9600 bps, 12.5 kHz channel BW)	
Necessary Bandwidth Calculation:	
Data Rate (R) Kbps =	9.6
Maximum Deviation (D), kHz =	3.2
Signaling States =	4
Constant Factor (K) =	0.516
Necessary Bandwidth (B_N), kHz =	($R/\log_2 S$)+2DK
=	8.10

Measurement Uncertainty

Measurement Uncertainty for Compliance Testing is listed in the table below.

The reported expanded uncertainty has been estimated at a 95% confidence level (k=2)

Measurement Type	Expanded Uncertainty
Conducted Emissions, AC Powerline	± 3.28 dB
Radiated Emissions_30 – 1000 MHz	± 4.82 dB
Radiated Emissions_1 – 18 GHz	± 5.73 dB
Frequency Error	± 22 Hz
Conducted RF Power	± 0.98 dB
Conducted Spurious Emission	± 2.49 dB
AC Voltage	± 2.3 %
DC Voltage	± 0.12 %
Temperature	± 1.0 deg C
Humidity	± 4.32 %

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Bi-Log Antenna	Chase	CBL6111C	i00267	3/8/18	3/8/20
Horn Antenna	ARA	DRG-118/A	i00271	6/16/18	6/16/20
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	7/10/19	7/10/20
Temperature Chamber	Tenney	Tenney II Benchmaster	i00287	N/A	N/A
Data Logger	Fluke	Hydra Data Bucket	i00343	5/15/19	5/15/20
Vector Signal Generator	Agilent	E4438C	i00348	4/1/19	4/1/20
EMI Analyzer	Agilent	E7405A	i00379	1/21/20	1/21/21
Spectrum Analyzer	Textronix	RSA5126A	i00424	7/17/19	7/17/20
PSA Spectrum Analyzer	Agilent	E4445A	i00471	12/11/19	12/11/20
Voltmeter	Fluke	179	i00488	4/24/19	4/24/20
Preamplifier	Miteq	AFS44 00101 400 23-10P-44	i00509	N/A	N/A

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT