Test Report

Prepared for: BK Technologies, Inc

Model: BKR-5000

Description: VHF Transceiver

Project #: p24a0005

Test Results: Pass

FCC ID: K95BKR5000-2

To

FCC Part 90

Date of Issue: November 17, 2024

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**
Prepared By:	**Compliance Testing, LLC** **Mesa, AZ 85204** **(480) 926-3100 phone / (480) 926-3598 fax** **www.compliancetesting.com** **ANAB Cert#: AT-2901** **FCC Site Reg. #US2901** **ISED Site Reg. #2044A-2**

Reviewed / Authorized By:

Greg Corbin

Project Test Engineer

Test Result Summary

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

Statements of conformity are reported as:

- Pass - the measured value is below the acceptance limit, *acceptance limit = test limit*.
- Fail - the measured value is above the acceptance limit, *acceptance limit = test limit*.

References/Methods	Description
ANSI C63.4-2014	Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz.
ANSI C63.10:2020	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Ansi C63.26:2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
996369 D04 Module Integration Guide v02	Modular Transmitter Integration Guide Guidance For Host Product Manufacturers
ISO/IEC 17025:2017	General requirements for the Competence of Testing and Calibrations Laboratories

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	November 17, 2024	Greg Corbin	Original Document

Table of Contents

Table of Annexes

EUT Description

Model Tested:	BKR5000-T3BS-1
Serial:	1017250112440262
Description:	VHF Portable Transceiver with BT module
Additional Information:	The manufacturer rated power is 1 – 6 watts. The transmitter contains a BT pre-certified module with singular module approval. The BT tests are limited to /host Integration. Contains BT Module: BT Module FCC ID: Z64-2564N BT Module ISED ID: 451I-2564N
Receipt of Sample(s):	**October 23, 2024**
EUT Condition:	**Visual Damage** No **State of Development** Production/Production Equivalent

Model (HVIN)	Front Display	Keypad	Case Color	Channel Switch	w/Bluetooth
BKR5000 (base number)	Yes	Yes	Black or Yellow	Continuous or w/Stop	Yes or No
BKR5000-T3BS-1	Yes	Yes	Black	w/Stop	Yes
BKR5000-T3YS-1	Yes	Yes	Yellow	w/Stop	Yes
BKR5000-T3YS-0	Yes	Yes	Yellow	w/Stop	No
BKR5000-T3BC-1	Yes	Yes	Black	Continuous	Yes
BKR5000-T3YC-1	Yes	Yes	Yellow	Continuous	Yes
BKR5000-T2BS-1	Yes	No	Black	w/Stop	Yes
BKR5000-T2YS-1	Yes	No	Yellow	w/Stop	Yes

Table 1 – Frequency Range, Modulation Type and Emission Designators

Frequency Range (MHz)	Modulation and Emission Designators		
FCC	**FM_12.5kHz**	**P25 Phase1 C4FM**	**P25 Phase 2 TDMA**
136 – 174	11K0F3E	8K10F1E 8K10F1D	8K10F1W

Table 2 –Test Frequencies

Test Frequencies (MHz)
138.035
150.075
162.000 (ISED only)
173.965

EUT Photo

ANAB

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. 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.

FCC Site Reg. #349717

IC Site Reg. #2044A-2

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.

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)**
21 - 25	21.4 – 31.5	960.3 – 979.4

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

EUT Operation during Tests

For all tests the EUT was set to the high power setting.
Modulations used for testing were 12.5 kHz FM, C4FM and TDMA.
Power was supplied either by battery and/or the battery eliminator.
The manufacturer declared the nominal voltage when using the battery eliminator is 7.8 vdc.

Host Integration tests:
See separate Host Integration test report_p24a0005_Host Integration_ Rev 1.0.

	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	BKR0111	N/A
1	Audio Interface Test Jig	BK	BKR0608A	N/A
1	Antenna	BK	BKRVHFGPS	N/A

	Cables: N/A

	Modifications: none

Carrier Output Power (Conducted)

Engineer: John Michalowicz

Test Date: 10/30/2024

Measurement Procedure

The Equipment Under Test (EUT) was connected to a spectrum analyzer through a 30 dB Power attenuator.

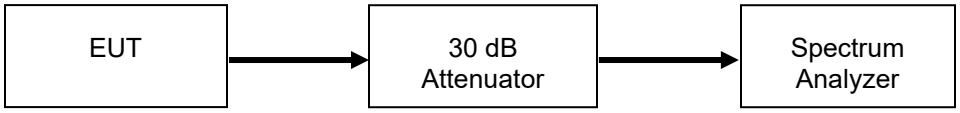
All cable and attenuator losses were input into the spectrum analyzer as a reference level offset to ensure accurate readings were obtained.

Detector = Peak, max hold

RBW = 100 kHz

VBW = 300 kHz

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)

Transmitter Peak Output Power

Tuned Frequency	Output Power	Output Power	Result
MHz	(dBm)	(watts)	
138.035	37.62	5.781	Pass
150.075	37.53	5.662	Pass
173.965	37.43	5.534	Pass

Conducted Spurious Emissions

Engineer: Greg Corbin

Test Date: 11/21/2024

Test Procedure

The EUT was connected directly to a spectrum analyzer though a 30 dB power attenuator to verify that the EUT met the requirements for spurious emissions.

The frequency range from 30 – 2000 MHz was observed and plotted.

The spurious emissions were measured with the EUT operating in CW and C4FM modes.

With the RBW set to 100 kHz and the detector set to Peak max hold, the worst case emission was recorded.

The highest signal on the graphs, noted with marker 1, is the fundamental emission and is exempt from the spurious emission limit.

Detector = Peak, max hold

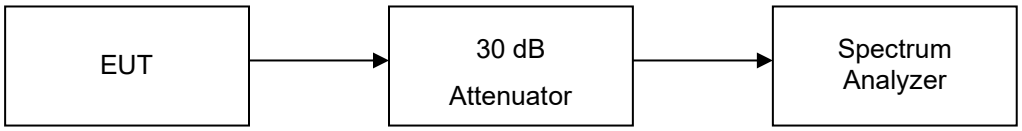
RBW = 100 kHz

VBW = 300 kHz

The following formula was used for calculating the limits:

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

Test Setup



Conducted Spurious Emissions Summary Test Table

Tuned Frequency (MHz)	LMR Mode of operation	Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Specification Limit (dBm)	Result
138.035	CW	276.04	-36.8	-20	Pass
150.075	CW	300.09	-33.6	-20	Pass
173.965	CW	167.33	-35.1	-20	Pass
138.035	C4FM	276.04	-35.4	-20	Pass
150.075	C4FM	300.09	-33.1	-20	Pass
173.965	C4FM	166.13	-35.0	-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: 11/22/2024

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 highest spurious signal from 30 MHz to 2 GHz was recorded in the test summary table.

For 30 – 1000 MHz, the highest signal on the graphs, noted with marker 1, is the fundamental emission and is exempt from the spurious emission limit.

For 1 – 2 GHz, a 1 GHz highpass filter was used at the receive antenna output.

RBW = 100 kHz from 30 – 1000 MHz,

RBW = 1 MHz from 1 – 2 GHz

VBW = 3 x RBW

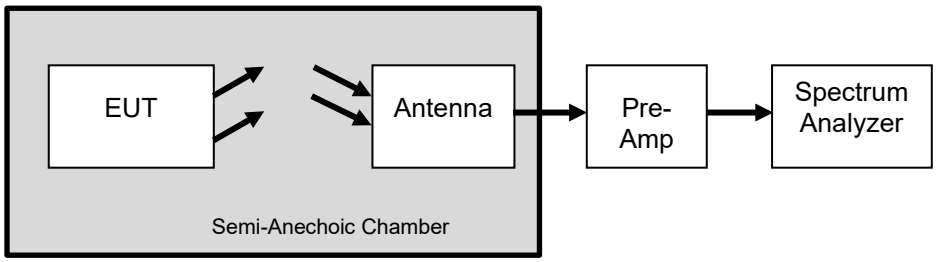
Detector = peak max hold

The following formula was used for calculating the limits:

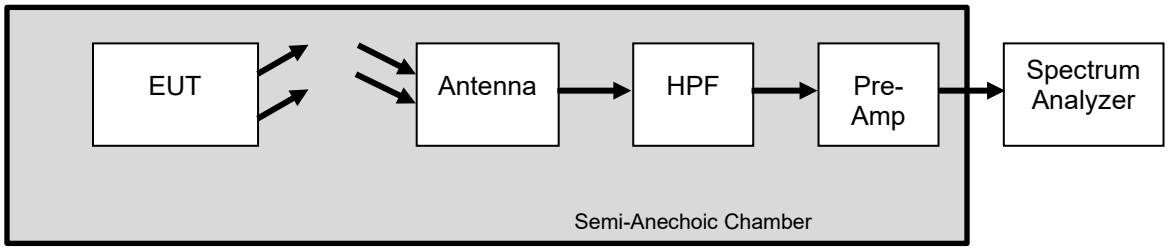
The radiated spurious limit = P1 – (50+ 10Log(P2)) = -20dBm

Test Setup

30 – 1000 MHz



1 – 2 GHz



Spurious Emissions Test Results

Tuned Frequency (MHz)	Frequency Range (MHz)	LMR mode of operation.	Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Specification Limit (dBm)	Result
138.035	30 - 1000	CW	276.11	-38.7	-20	Pass
138.035	30 - 1000	C4FM	828.20	-39.5	-20	Pass
150.075	30 - 1000	CW	964.11	-40.6	-20	Pass
150.075	30 - 1000	C4FM	997.19	-40.3	-20	Pass
173.965	30 - 1000	CW	944.51	-40.2	-20	Pass
173.965	30 - 1000	C4FM	347.9	-37.4	-20	Pass
138.035	1000 - 2000	CW	1656.27	-52.0	-20	Pass
138.035	1000 - 2000	C4FM	1111.91	-43.7	-20	Pass
150.075	1000 - 2000	CW	1650.87	-53.0	-20	Pass
150.075	1000 - 2000	C4FM	1650.77	-52.9	-20	Pass
173.965	1000 - 2000	CW	1217.82	-51.9	-20	Pass
173.965	1000 - 2000	C4FM	1217.62	-51.4	-20	Pass

Annex B Radiated Spurious Emission

Refer to Annex B for Radiated Spurious Emission plots

Emission Masks (Occupied Bandwidth)

Engineer: John Michalowicz

Test Date: 10/31/2024

Measurement Procedure

The EUT was connected directly to a spectrum analyzer to verify that the EUT meets the required emissions mask.

For WB and NB FM, 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.

For C4FM and TDMA the internal P25 modulated signals were used as required.

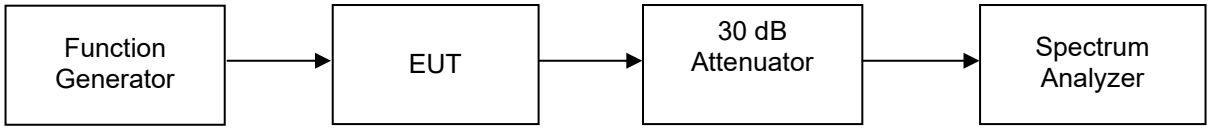
For WB FM, the emission mask B was used.

For NB FM, C4FM, and TDMA, emission mask D was used.

For emission masks the mask limits were input to the spectrum analyzer.

For Occupied Bandwidth, the occupied bandwidth tool built into the spectrum analyzer was used.

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: 11/11/2024

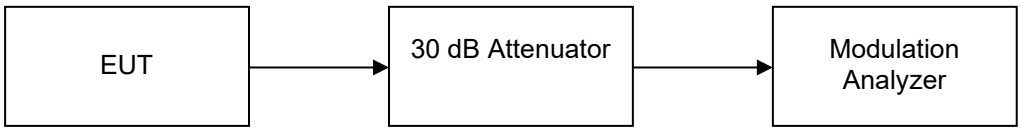
Measurement Procedure

The EUT was connected directly to a modulation analyzer through a 30 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

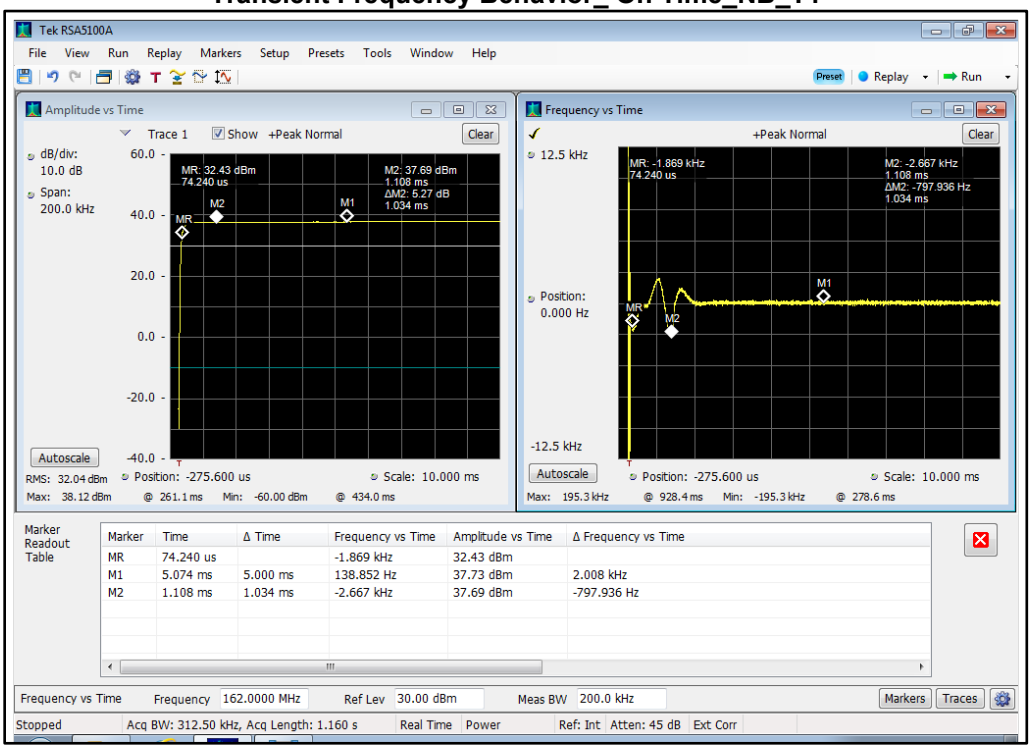


Transient Frequency Behavior Summary Table

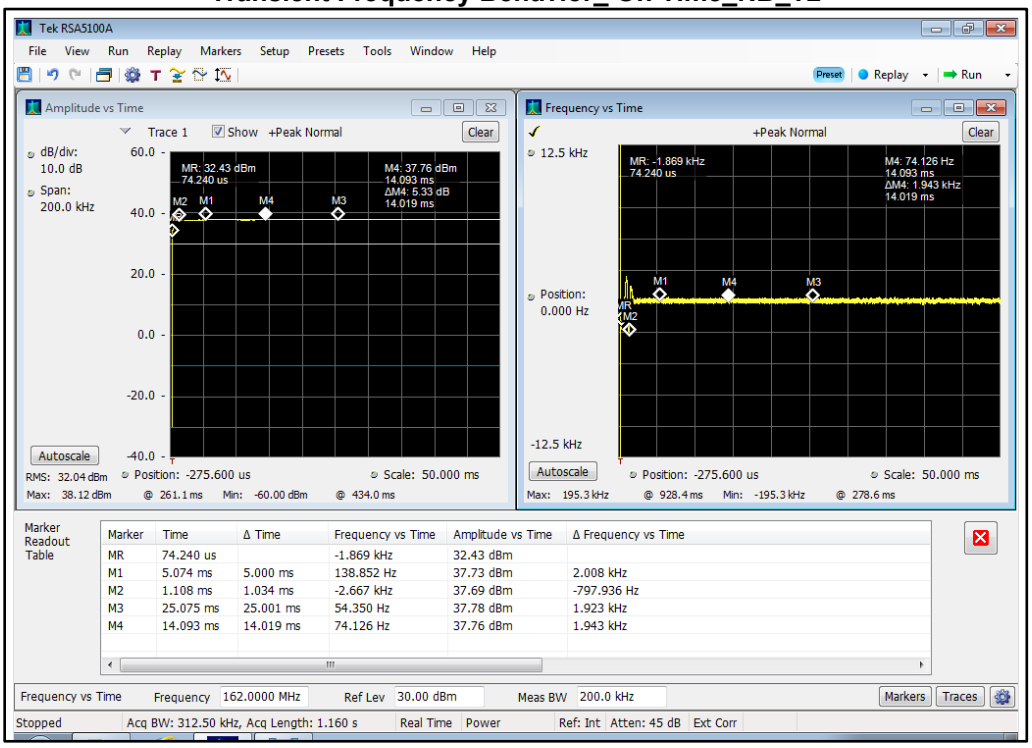
12.5 kHz CH spacing -				
	time - referenced from t_{on}	Measured value	Limit	Margin
	(ms)	(kHz)	(kHz)	(kHz)
t_1	5	-1.108	12.5	-11.392
t_2	20	1.943	6.5	4.557
t_3	5	153.865**	12.5	141.365**

**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.

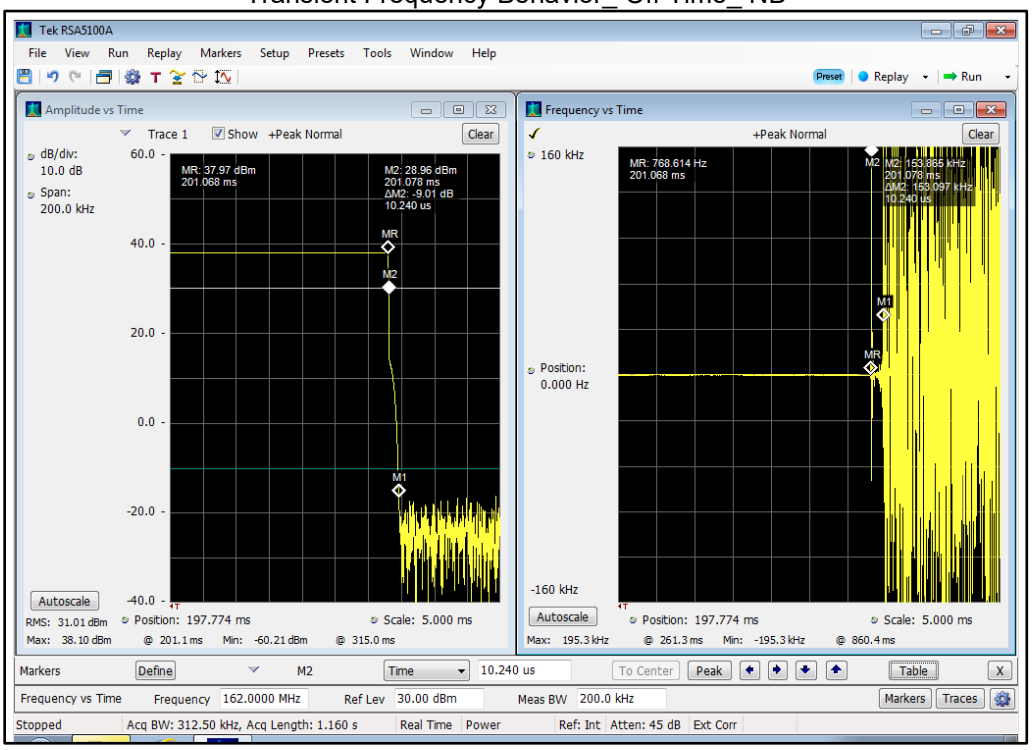
Transient Frequency Behavior_ On Time_NB_T1



Transient Frequency Behavior_ On Time_NB_T2



Transient Frequency Behavior_ Off Time_ NB



Audio Low Pass Filter (Voice Input)

Engineer: Greg Corbin

Test Date: 11/12/2024

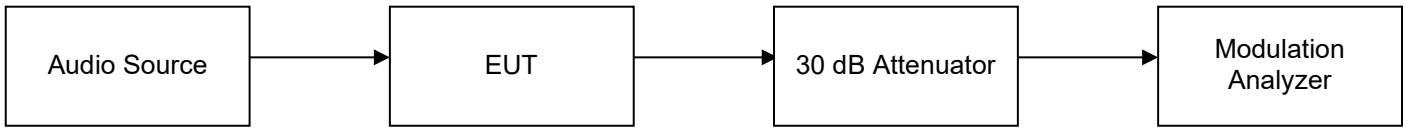
Measurement Procedure

The EUT was connected directly to a modulation analyzer through an attenuator.

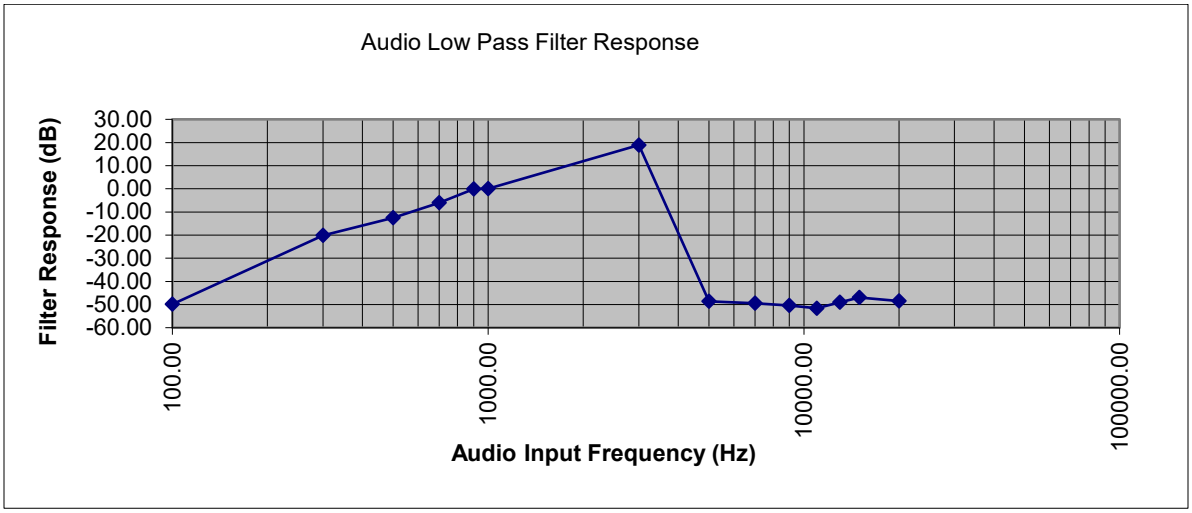
The audio source was tuned across the required audio frequency range and the audio low pass filter response was measured and plotted.

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: 11/12/2024

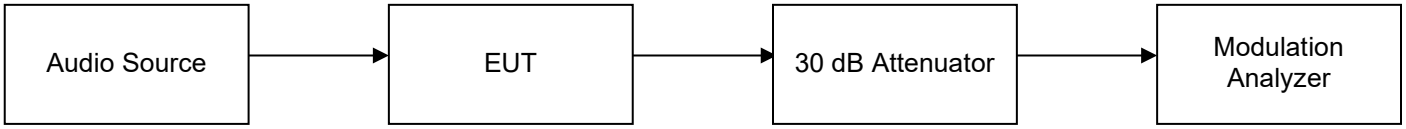
Measurement Procedure

The EUT was connected directly to a modulation analyzer through an attenuator.

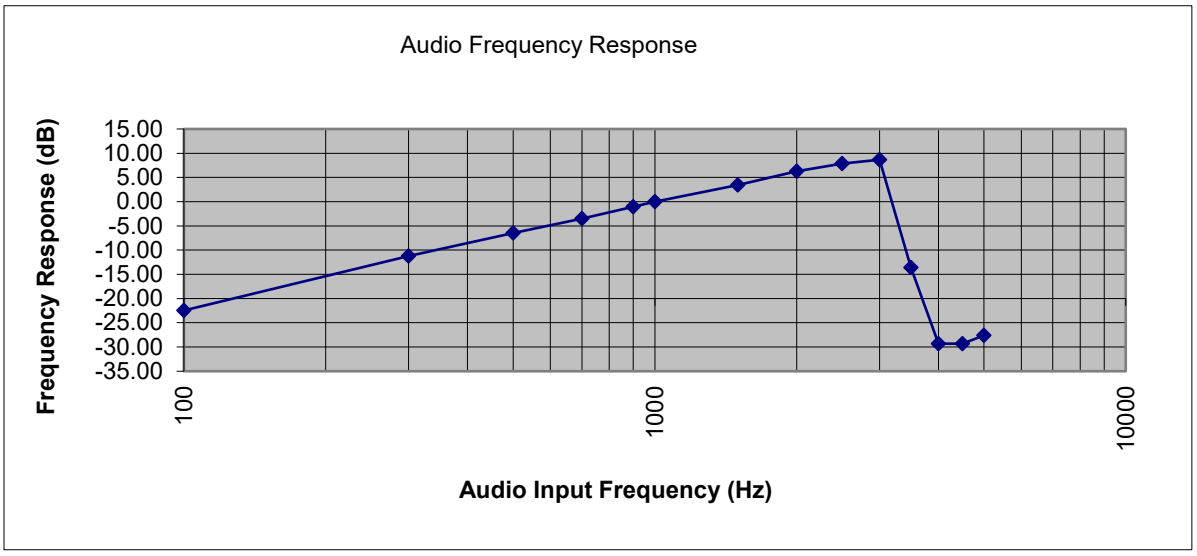
The audio source was tuned across the required audio frequency range and the audio frequency response was measured and plotted.

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: 11/12/2024

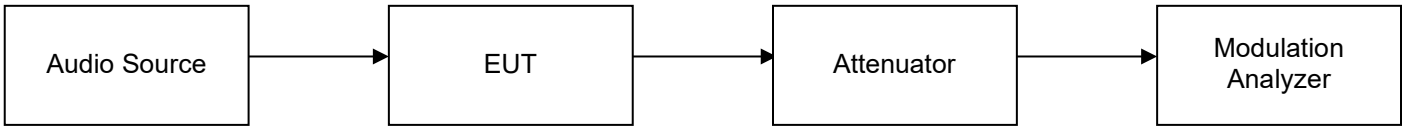
Measurement Procedure

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.

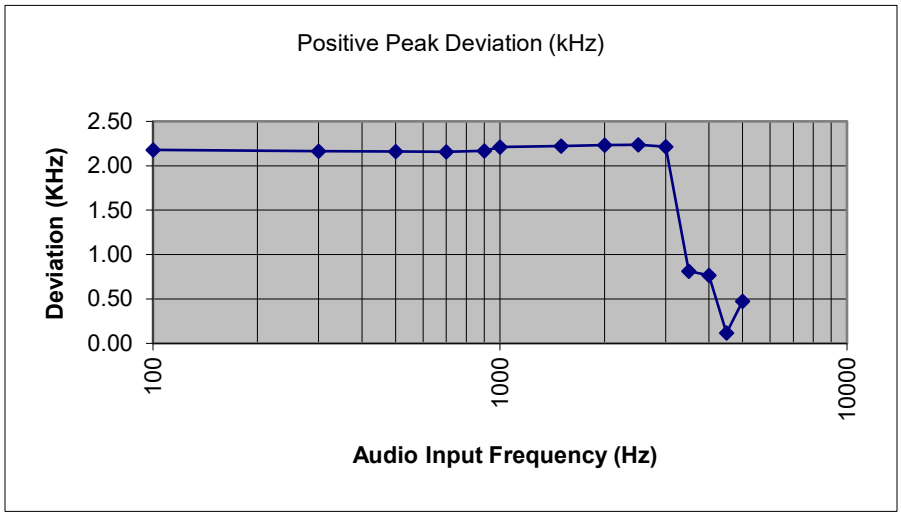
The modulation analyzer is a real time spectrum analyzer with integrated demodulation, audio measurement capabilities, and timing analysis.

Test Setup

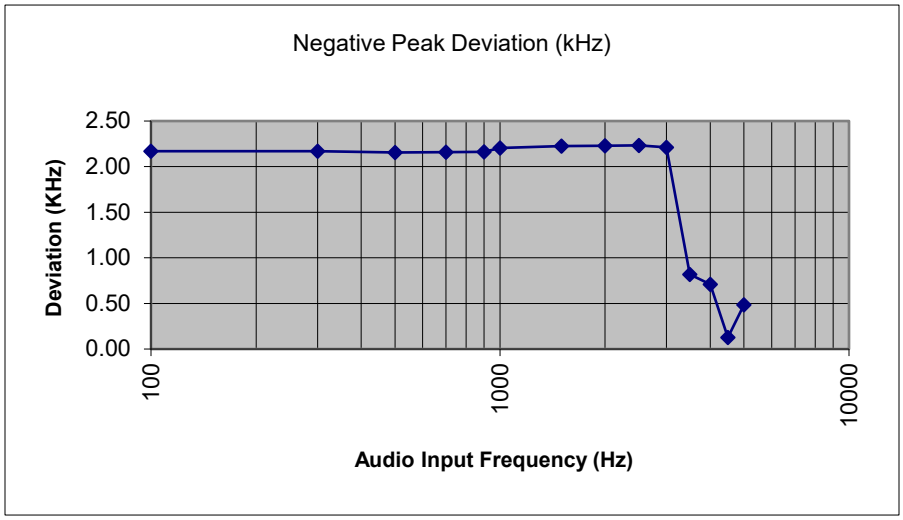


Modulation Limiting Test Results

Positive Peak Deviation



Negative Peak Deviation



Frequency Stability (Temperature Variation)

Engineer: Greg Corbin

Test Date: 11/13/2024

Measurement Procedure

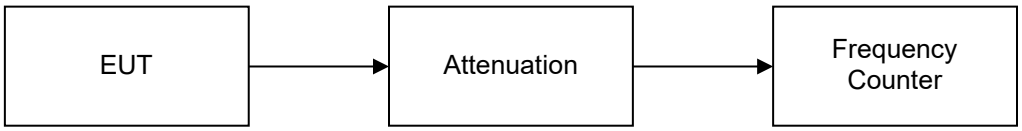
The EUT was placed in an environmental test chamber and the RF output was connected directly to a spectrum analyzer. The temperature was varied from -30°C to 50°C in 10°C increments.

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.

The manufacturer declared the nominal voltage when using the battery eliminator is 7.8 vdc.

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	162.000072	162.000324	161.999676	-0.000252	0.000396
162	-20	2	162.000003	162.000324	161.999676	-0.000321	0.000327
162	-10	2	161.999997	162.000324	161.999676	-0.000327	0.000321
162	0	2	161.999982	162.000324	161.999676	-0.000342	0.000306
162	10	2	161.999985	162.000324	161.999676	-0.000339	0.000309
162	20	2	162.000021	162.000324	161.999676	-0.000303	0.000345
162	30	2	162.000072	162.000324	161.999676	-0.000252	0.000396
162	40	2	162.000098	162.000324	161.999676	-0.000226	0.000422
162	50	2	162.000090	162.000324	161.999676	-0.000234	0.000414

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	6.63	162.000050	162.000324	161.999676	-0.000274	0.000374
162	2	7.80	162.000021	162.000324	161.999676	-0.000303	0.000345
162	2	8.97	162.000030	162.000324	161.999676	-0.000294	0.000354

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 (U_{lab}) for Compliance Testing is listed in the table below.

Measurement	U_{lab}
Radio Frequency	± 3.3 x 10^{-8}
RF Power, conducted	± 1.5 dB
RF Power Density, conducted	± 1.0 dB
Conducted Emissions	± 1.8 dB
Radiated Emissions 9kHz-30MHz	± 3.6 dB
Radiated Emissions 30MHz-1000MHz	± 4.25 dB
Radiated Emissions – 1GHz-18GHz	± 4.5 dB
Temperature	± 1.5 deg C
Humidity	± 4.3 %
DC voltage	± 0.20 VDC
AC Voltage	± 1.2 VAC

The reported expanded uncertainty +/- U_{lab}(dB) has been estimated at a 95% confidence level (k=2)

U_{lab} is less than or equal to U_{ETSI} therefore

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit
- Non-Compliance is deemed to occur if any measured disturbance exceeds the disturbance limit

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Function Generator	HP	33120A	i00118	Verified on: 11/12/24	
High Pass Filter (3.4GHz)	Trilithic	4HX3400-3-XX	i00177	Verified on: 10/30/24	
Horn Antenna (1-18GHz)	ARA	DRG-118/A	i00271	8/9/24	8/9/26
Temperature Chamber	Tenney	Tenney II Benchmaster	i00287	N/A	N/A
Data Logger	Fluke	Hydra Data Bucket	i00343	6/19/2024	6/19/2025
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	2/7/23	2/7/25
Spectrum Analyzer	Textronix	RSA5126A	i00424	6/25/2024	6/25/2025
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	7/13/2023	7/13/2026
Highpass Filter (1 GHz)	K&L	7IH40-980/T6000-O/O	i00432	Verified on: 10/30/24	
PSA Spectrum Analyzer	Agilent	E4445A	i00471	1/5/2024	1/5/2025
Voltmeter	Fluke	179	i00488	6/19/2024	6/19/2025
Network Analyzer (50MHz-40GHz)	Hewlett Packard	8722D	i00521	12/18/23	12/18/24
44GHz EMI receiver	Keysight	N9038A	i00552	3/1/2024	3/1/2025
Attenuator, 30 dB, 50 w	Mini-Circuits	BW-N30W50+	I00459	Verified on: 10/30/24	
Power Supply	Agilent	E3615A	I00568	Verified on: 11/13/24	
Temp./humidity/pressure monitor (Main Lab)	Omega Engineering	iBTHX-W-5	i00686	1/25/24	1/25/25
Preamplifier	Eravant	SBB-0115034019-2F2F-E3	i00722	Verified on: 2/7/24	
Preamplifier	COM-Power	PAM-103	i00734	Verified on: 6/27/24	

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