Sierra Innotek

TEST REPORT FOR

VHF Transmitter
Model: C-CAT

Tested To The Following Standard:

FCC Part 90I

Report No.: 96962-7

Date of issue: June 16, 2016

ACCREDITED
Testing Certificates:
803.01, 803.02, 803.05, 803.06

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of EMC testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Sierra Innotek
4391 Cameron Rd.
Cameron Park, CA 95682

Representative: Steve Palmer

REPORT PREPARED BY:

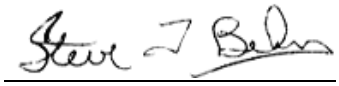
Terri Rayle
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 96962

DATE OF EQUIPMENT RECEIPT: June 8, 2016
DATE(S) OF TESTING: June 8-9, 2016

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the sample equipment tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.



Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa CA 95338

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.02
EMITest Immunity	5.03.02

Site Registration & Accreditation Information

Location	CB #	TAIWAN	CANADA	FCC	JAPAN
Mariposa A	US0103	SL2-IN-E-1147R	3082A-2	90477	A-0136

SUMMARY OF RESULTS

Standard / Specification: FCC Part(s) 2 / 90I

Test Procedure	Description	Modifications	Results
Transmitter Requirements			
2.1046 / 90.205	Power Output	NA	Pass
2.1047	Modulation Limiting	NA	Pass
2.1049 / 90.209(b)(5)	Occupied Bandwidth	NA	Pass
2.1051 / 90.210(d)	Spurious Emission at Antenna Terminal - Conducted	NA	Pass
2.1053 / 90.210(d)	Field Strength of Spurious Radiation	NA	Pass
2.1055 / 90.213	Frequency Stability	NA	Pass
90.210(d)	Emission mask	NA	Pass
90.214	Transient Frequency Behaviour	NA	Pass

NA = Not Applicable

Modifications During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions
No modifications were made to the EUT during testing.

***Modifications listed above must be incorporated into all production units.**

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
None

EQUIPMENT UNDER TEST (EUT)

During testing numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration 1

Equipment Tested:

Device	Manufacturer	Model #	S/N
VHF Transmitter	Sierra Innotek	C-CAT	012345

Support Equipment:

Device	Manufacturer	Model #	S/N
Signal Generator	Tektronic	AFB3022B	C030431

Configuration 2

Equipment Tested:

Device	Manufacturer	Model #	S/N
VHF Transmitter	Sierra Innotek	C-CAT	012345

Support Equipment:

Device	Manufacturer	Model #	S/N
DC Power Supply	HP	6205C	2228A01775

FCC PART(S) 2 / 90I

2.1046 / 90.205(d) RF Power Output

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 5046 Sierra Pines Drive • Mariposa, CA 95338 • (209) 966-5240		
Customer:	**Sierra Innotek**		
Specification:	**47 CFR §90.205 Power Output**		
Work Order #:	**96962**	Date:	6/8/2016
Test Type:	**Conducted Emissions**	Time:	15:39:28
Tested By:	E. Wong	Sequence#:	1
Software:	EMITest 5.03.02		6V DC

Equipment Tested:

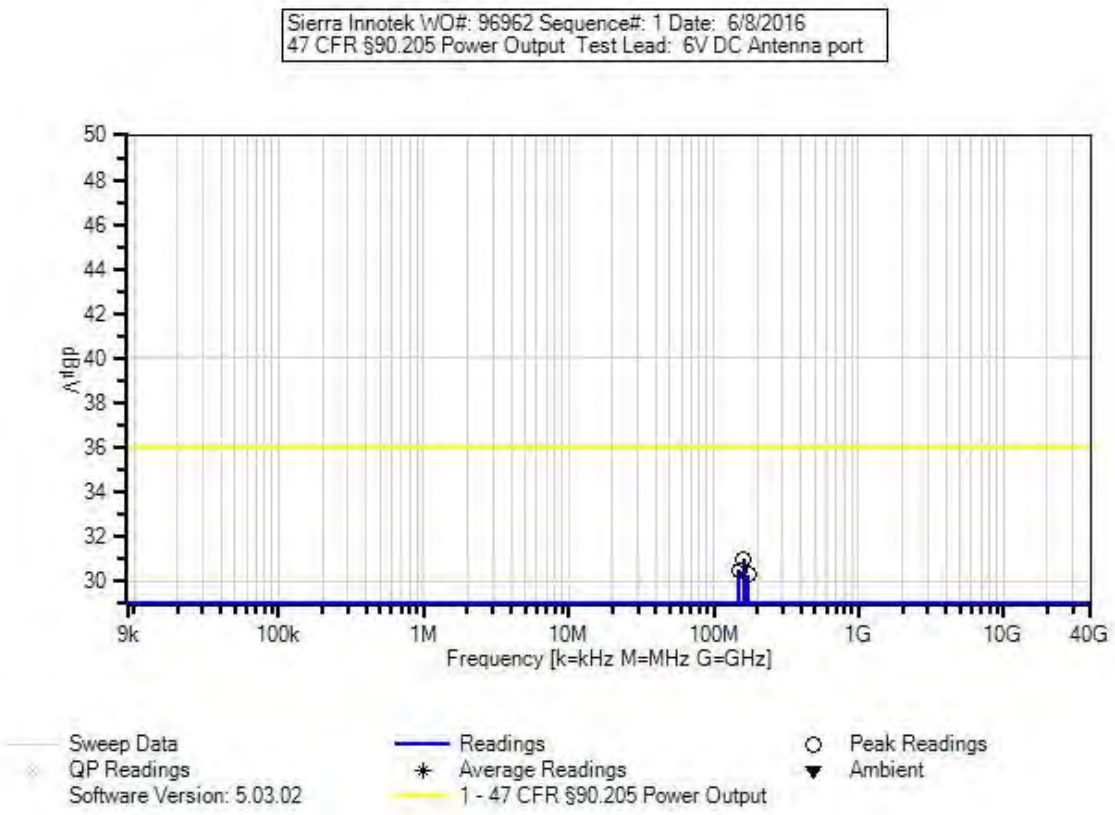
Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The EUT is placed on the test bench. Microphone port is connected to a microphone which is receiving Audio signal via a speaker box. The EUT digitizes the Analog signal and modulates as NBFM Analog Voice. The Audio digitizer has AGC activated, this test was performed with worst case Audio signal at 1kHz. Sig gen set at 7 V p-p
The EUT contains modular approved Bluetooth radio FCCID VPYLBZY for device configuration purposes only and do not transmit simultaneously with the FM signal.
Frequency range: 150-174MHz TX Frequency: 150.002 MHz, 162MHz, 173.390MHz, 12.5 kHz channel bandwidth.
Modulation: NBFM analog voice, Firmware setting = 1W.
4 AAA Fresh batteries were used for this evaluation.
Firmware version: 54
Test environment conditions: Temperature: 25°C, Relative Humidity: 40%, Pressure: 100kPa
RBW=VBW=1MHz
RF characteristic measured at antenna port.
Test method: EIA-TIA 603
Power limit set at 36dBm=2W IAW intended application of the device.
90.20(f)(5) A Police licensee may use, without special authorization from the Commission, any mobile service frequency between 40 and 952 MHz, listed in paragraph (c)(3) of this section, for communications in connection with physical surveillance, stakeouts, raids, and other such activities. Such use shall be on a secondary basis to operations of licensees regularly authorized on the assigned frequencies. The maximum output power that may be used for such communications is 2 watts. Transmitters, operating under this provision of the rules, shall be exempted from the station identification requirements of §90.425. Use of frequencies not designated by a "PP" in the coordinator column of the frequency table in paragraph (c)(3) of this section, is conditional on the approval of the coordinator corresponding to each frequency. Spread spectrum transmitters may be operated on Public Safety Pool frequencies between 37 and 952 MHz, providing that they are certificated by the Commission under the provisions of §2.803 of this chapter and §90.203, and meet the following conditions:



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/17/2015	7/17/2016
T2	AN03430	Attenuator	75A-10-12	11/2/2015	11/2/2017
T3	ANP06554	Cable	32022-29094K-29094K-24TC	12/30/2015	12/30/2017

Measurement Data: Reading listed by margin. Test Lead: Antenna port

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	162.000M	20.9	+0.0	+10.0	+0.1		+0.0	31.0	36.0	-5.0	Anten
									1.2589 Watt FM and CW		
2	150.000M	20.4	+0.0	+10.0	+0.1		+0.0	30.5	36.0	-5.5	Anten
									1.1220Watt, FM and CW		
3	173.390M	20.2	+0.0	+10.0	+0.1		+0.0	30.3	36.0	-5.7	Anten
									1.0715 Watt FM and CW		

Test Setup Photo

2.1047 Modulation Limit

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 5046 Sierra Pines Drive • Mariposa, CA 95338 • (209) 966-5240		
Customer:	**Sierra Innotek**		
Specification:	**47 CFR §2.1047 Modulation characteristics.**		
Work Order #:	**96962**	Date:	6/8/2016
Test Type:	**Conducted Emissions**	Time:	16:00:05
Tested By:	E. Wong	Sequence#:	2
Software:	EMITest 5.03.02		6V DC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The EUT is placed on the test bench. Microphone port is connected to a microphone which is receiving Audio signal via a speaker box. The EUT digitizes the Analog signal and modulates as NBFM Analog Voice. The Audio digitizer has AGC activated.

The EUT contains modular approved Bluetooth radio FCCID VPYLBZY for device configuration purposes only and does not transmit simultaneously with the FM signal.

Frequency range: 150-174MHz
TX Frequency: 162MHz, 12.5 kHz channel bandwidth.
Modulation: NBFM analog voice, Firmware setting = 1W.
Firmware version: 54

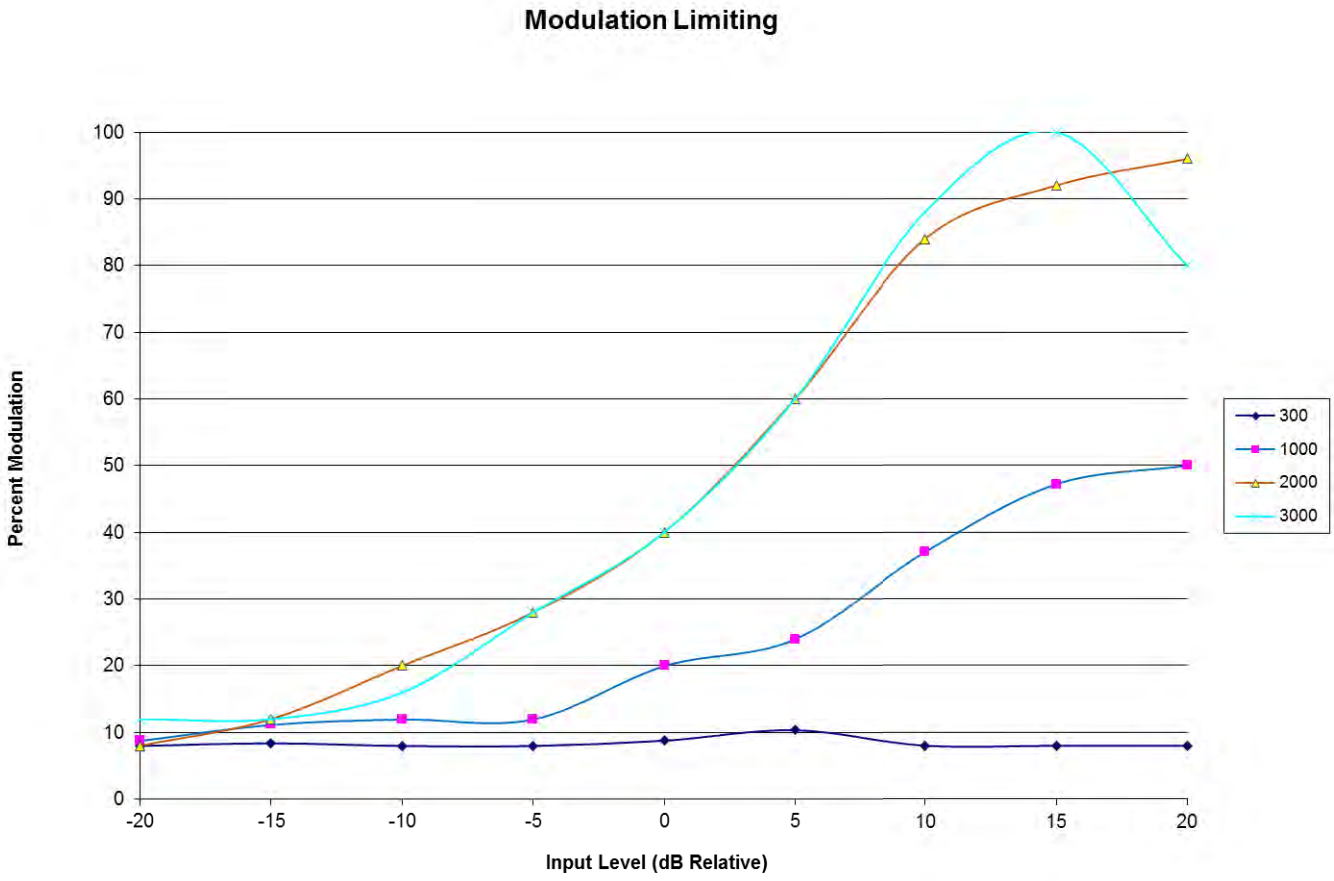
Test environment conditions: Temperature: 25°C, Relative Humidity: 40%, Pressure: 100kPa

RF characteristic measured at antenna port.
Test method: EIA-TIA 603
Frequency range of measurement = Fundamental Frequency

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/17/2015	7/17/2016
T2	AN03430	Attenuator	75A-10-12	11/2/2015	11/2/2017
	00838	Arbitrary Waveform Generator	33120A	1/21/2015	1/21/2017
	02072	RF Characteristics Analyzer	8901A	5/18/2015	5/18/2017
T3	ANP06554	Cable	32022-29094K-29094K-24TC	12/30/2015	12/30/2017

Result


Modulation Limiting
Percent Modulation
100
90
80
70
60
50
40
30
20
10
0
-20
-15
-10
-5
0
5
10
15
20
Input Level (dB Relative)
300
1000
2000
3000

Test Setup Photo

2.1049 / 90.209(b)(5) Occupied Bandwidth

Test Setup / Conditions

Test Location:	CKC Laboratories, Inc. • 5046 Sierra Pines Drive • Mariposa, CA 95338 • (209) 966-5240		
Customer:	**Sierra Innotek**		
Specification:	**47 CFR §90.209 Bandwidth limitations / 2.1049 Occupied bandwidth**		
Work Order #:	**96962**	Date:	6/8/2016
Test Type:	**Conducted Emissions**	Time:	16:00:05
Tested By:	E. Wong	Sequence#:	2
Software:	EMITest 5.03.02		6V DC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The EUT is placed on the test bench. Microphone port is connected to a microphone which is receiving Audio signal via a speaker box. The EUT digitizes the Analog signal and modulates as NBFM Analog Voice. The Audio digitizer has AGC activated, this test was performed with worst case Audio signal at 1kHz. Sig gen set at 7 V p-p

The EUT contains modular approved Bluetooth radio FCCID VPYLBZY for device configuration purposes only and does not transmit simultaneously with the FM signal.

Frequency range: 150-174MHz

TX Frequency: 150.002 MHz, 162MHz, 173.390MHz, 12.5 kHz channel bandwidth.
Modulation: NBFM analog voice, Firmware setting = 1W.
4 AAA Fresh batteries were used for this evaluation.
Firmware version: 54

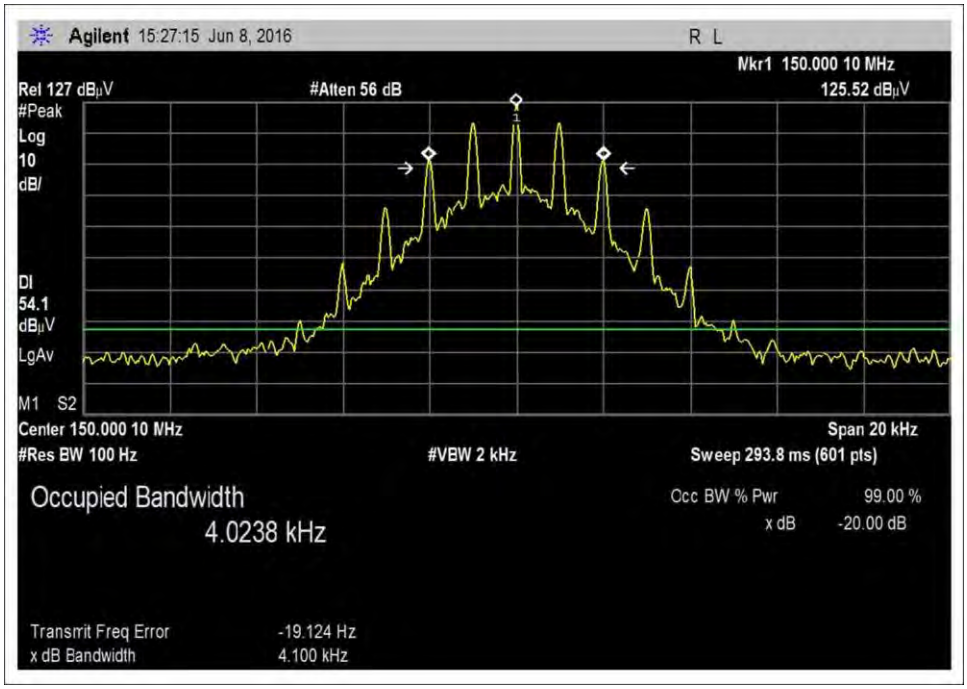
Test environment conditions: Temperature: 25°C, Relative Humidity: 40%, Pressure: 100kPa

RF characteristic measured at antenna port.
Test method: EIA-TIA 603
Frequency range of measurement = Fundamental Frequency

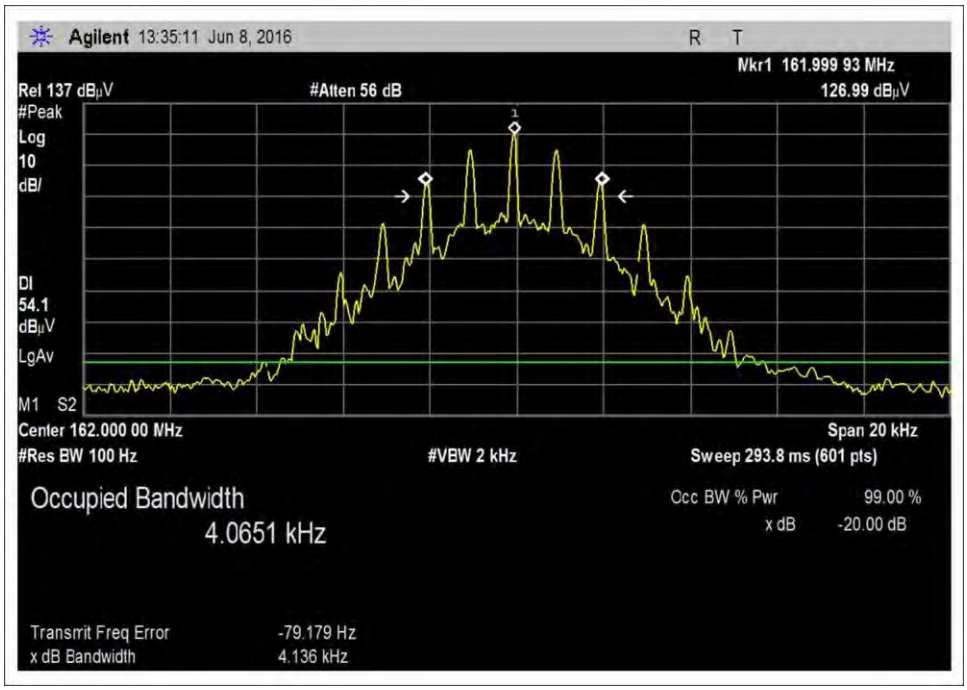
Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/17/2015	7/17/2016
T2	AN03430	Attenuator	75A-10-12	11/2/2015	11/2/2017
T3	ANP06554	Cable	32022-29094K-29094K-24TC	12/30/2015	12/30/2017

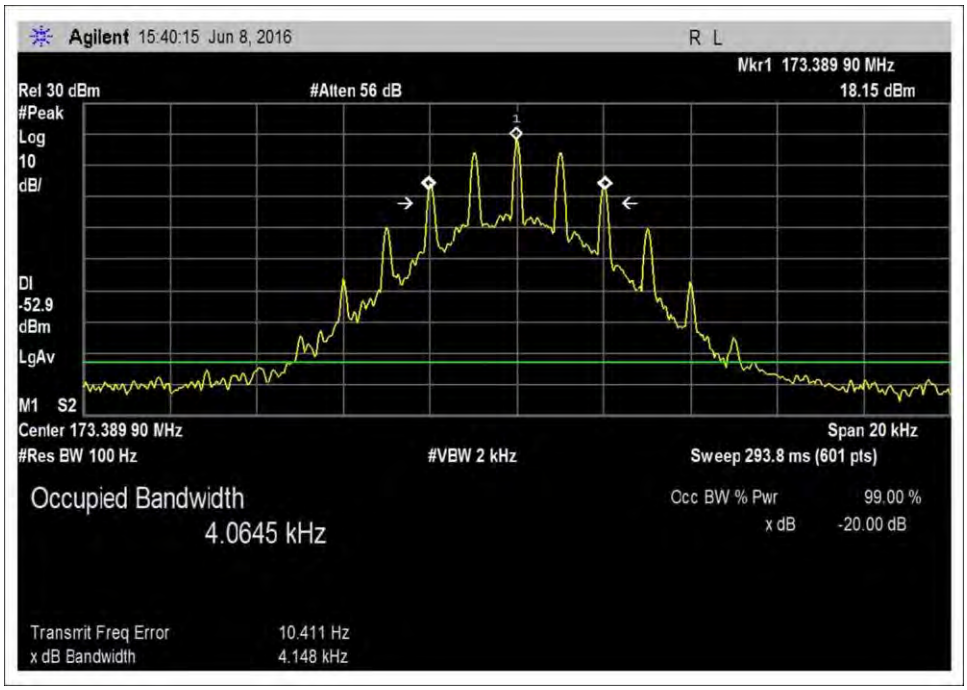
Plots



Low Frequency 150MHz



Middle Frequency 162MHz



High Frequency 174MHz

Test Setup Photo

2.1051 / 90.210(d) Spurious Emissions at Antenna Terminals - Conducted

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 5046 Sierra Pines Drive • Mariposa, CA 95338 • (209) 966-5240		
Customer:	**Sierra Innotek**		
Specification:	**47 CFR §90.210(d) Spurious Emissions**		
Work Order #:	**96962**	Date:	6/8/2016
Test Type:	**Conducted Emissions**	Time:	16:00:05
Tested By:	E. Wong	Sequence#:	2
Software:	EMITest 5.03.02		6V DC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

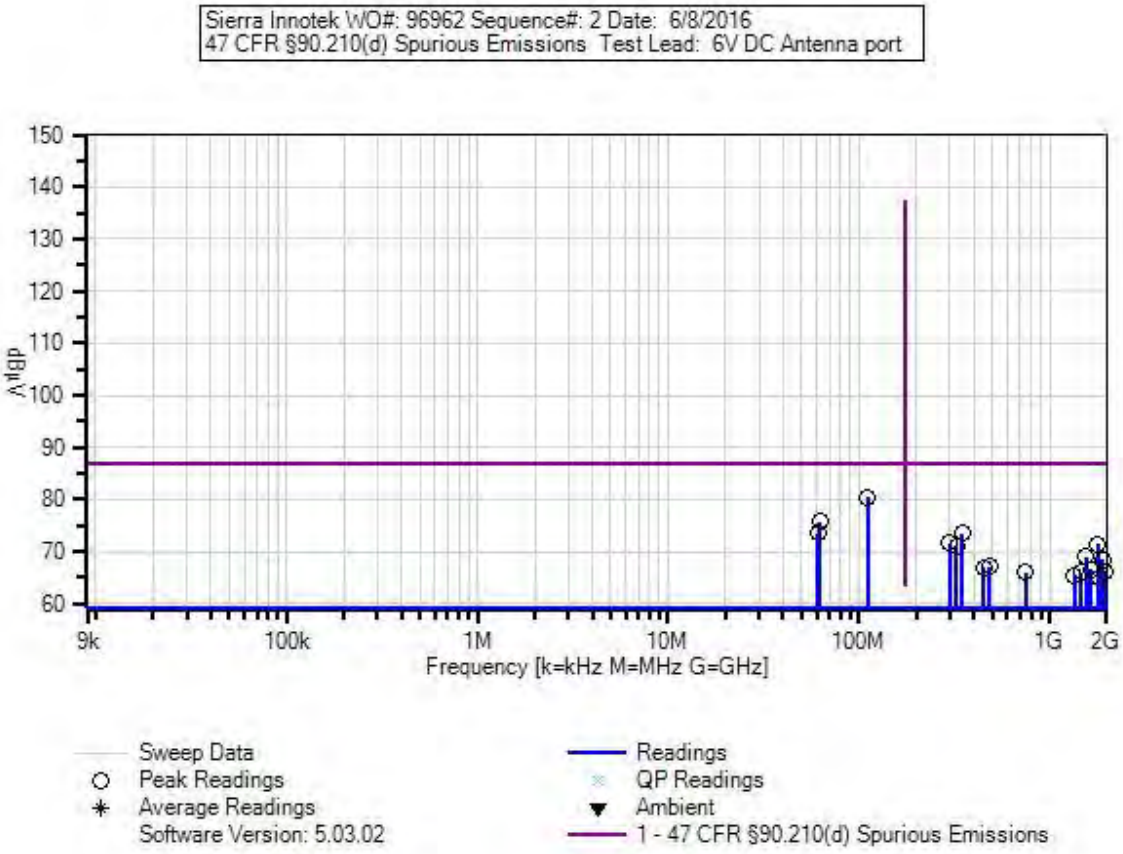
The EUT is placed on the test bench. Microphone port is connected to a microphone which is receiving Audio signal via a speaker box. The EUT digitizes the Analog signal and modulates as NBFM Analog Voice. The Audio digitizer has AGC activated, this test was performed with worst case Audio signal at 1kHz. Sig gen set at 7 V p-p

The EUT contains modular approved Bluetooth radio FCCID VPYLBZY for device configuration purposes only and does not transmit simultaneously with the FM signal.
Frequency range: 150-174MHz
TX Frequency: 150.002 MHz, 162MHz, 173.390MHz, 12.5 kHz channel bandwidth.
Modulation: NBFM analog voice, Firmware setting = 1W.
4 AAA Fresh batteries were used for this evaluation.
Firmware version: 54

Test environment conditions: Temperature: 25°C, Relative Humidity: 40%, Pressure: 100kPa

RF characteristic measured at antenna port.
Test method: EIA-TIA 603

Frequency range of measurement = 9 kHz- 2GHz.
9kH-150kHz;RBW=200Hz,VBW=200Hz;150kHz-30MHz;RBW=9kHz,VBW=9kHz;30MHz-1000 MHz;RBW=120 kHz,VBW=120 kHz,1000 -2000MHz ;RBW=1 MHz,VBW=1 MHz.


Sierra Innotek WO#: 96962 Sequence#: 2 Date: 6/8/2016
47 CFR §90.210(d) Spurious Emissions Test Lead: 6V DC Antenna port
150
140
130
120
110
100
90
80
70
60
dBµV
9k
100k
1M
10M
100M
1G
2G
Frequency [k=kHz M=MHz G=GHz]
Sweep Data
Peak Readings
Average Readings
Software Version: 5.03.02
Readings
QP Readings
Ambient
1 - 47 CFR §90.210(d) Spurious Emissions

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/17/2015	7/17/2016
T2	AN03430	Attenuator	75A-10-12	11/2/2015	11/2/2017
T3	ANP06554	Cable	32022-29094K-29094K-24TC	12/30/2015	12/30/2017

Measurement Data: Reading listed by margin. Test Lead: Antenna port

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	111.300M	70.4	+0.0	+10.0	+0.1		+0.0	80.5	87.0 174MHz	-6.5	Anten
2	62.700M	65.6	+0.0	+10.0	+0.1		+0.0	75.7	87.0 162MHz	-11.3	Anten
3	60.700M	63.4	+0.0	+10.0	+0.1		+0.0	73.5	87.0 150MHz	-13.5	Anten
4	346.300M	63.3	+0.0	+10.0	+0.2		+0.0	73.5	87.0 174MHz	-13.5	Anten
5	300.000M	61.5	+0.0	+10.0	+0.2		+0.0	71.7	87.0 150MHz	-15.3	Anten
6	1782.000M	60.9	+0.0	+10.1	+0.5		+0.0	71.5	87.0 162MHz	-15.5	Anten
7	324.000M	60.9	+0.0	+10.0	+0.2		+0.0	71.1	87.0 162MHz	-15.9	Anten
8	1560.500M	58.5	+0.0	+10.1	+0.4		+0.0	69.0	87.0 174MHz	-18.0	Anten
9	1907.500M	57.8	+0.0	+10.1	+0.5		+0.0	68.4	87.0 174MHz	-18.6	Anten
10	486.000M	56.9	+0.0	+10.0	+0.2		+0.0	67.1	87.0 162MHz	-19.9	Anten
11	450.000M	56.7	+0.0	+10.0	+0.2		+0.0	66.9	87.0 150MHz	-20.1	Anten
12	1650.000M	56.1	+0.0	+10.1	+0.4		+0.0	66.6	87.0 150MHz	-20.4	Anten
13	1950.000M	55.6	+0.0	+10.1	+0.5		+0.0	66.2	87.0 150MHz	-20.8	Anten
14	750.000M	55.7	+0.0	+10.1	+0.3		+0.0	66.1	87.0 150MHz	-20.9	Anten
15	1458.000M	55.6	+0.0	+10.1	+0.4		+0.0	66.1	87.0 162MHz	-20.9	Anten
16	1350.000M	55.0	+0.0	+10.1	+0.4		+0.0	65.5	87.0 150MHz	-21.5	Anten
17	1800.000M	54.4	+0.0	+10.1	+0.5		+0.0	65.0	87.0 150MHz	-22.0	Anten

Limit line for Spurious Conducted Emission

REQUIRED ATTENUATION = 50+10 LOG P DB

Limit line (dBuV) = V_{dBuv} - Attenuation

$$V_{dBuV} = 20 \text{ Log } \frac{V}{1 \text{ x } 10^{-6}}$$

$$= 20\left(\text{Log } V - \text{Log } 1 \text{ x } 10^{-6}\right)$$

$$= 20 \text{ Log } V - 20 \text{ Log} 1 \text{ x } 10^{-6}$$

$$= 20 \text{ Log } V - 20(-6)$$

$$= 20 \text{ Log } V + 120$$

$$\text{Attenuation} = 50 + 10 \text{ Log } P$$

$$= 50 + 10 \text{ Log } \frac{V^2}{R}$$

$$= 50 + 10\left(\text{Log } V^2 - \text{Log } R\right)$$

$$= 50 + 10\left(2 \text{ Log } V - \text{Log } R\right)$$

$$= 50 + 20 \text{ Log } V - 10 \text{ Log } R$$

Limit line = V_{dBuv} - Attenuation

= 20 Log V + 120 – (55 + 20 Log V – 10Log R)

= 20 Log V + 120 – 55 – 20 Log V + 10Log R

= 20 Log V + 120 – 55 – 20 Log V + 10Log R

= 120 – 50 + 10 Log 50 Note : R = 50 Ω

= 120 –50 + 16.897

= 87 dBuV (-20dBm) at any power level

Test Setup Photo

2.1053 / 90.210(d) Field Strength of Spurious Radiation

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 5046 Sierra Pines Drive • Mariposa, CA 95338 • (209) 966-5240		
Customer:	**Sierra Innotek**		
Specification:	**47 CFR §90.210(d) Spurious Emissions**		
Work Order #:	**96962**	Date:	6/9/2016
Test Type:	**Radiated Scan**	Time:	17:04:48
Tested By:	E. Wong	Sequence#:	4
Software:	EMITest 5.03.02		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The EUT is placed on the Styrofoam platform. Microphone port is connected to a microphone which is receiving Audio signal via a speaker box. The EUT digitizes the Analog signal and modulates as NBFM Analog Voice. The Audio digitizer has AGC activated, this test was performed with worst case Audio signal at 1kHz. Sig gen set at 7 V p-p. Antenna port is terminated into 50 ohm load.

The EUT contains modular approved Bluetooth radio FCCID: VPYLBZY used for device configuration purposes only and does not transmit simultaneously with the FM signal.

Frequency range: 150-174MHz

TX Frequency: 150.002 MHz, 162MHz, 173.390MHz, 12.5 kHz channel bandwidth.
Modulation: NBFM analog voice, Firmware setting = 1W.
4 AAA Fresh batteries were used for this evaluation.
Firmware version: 54

FM signal RF : ON
Bluetooth: OFF
Evaluation of intentional radiator.

Frequency range of measurement = 9 kHz- 2GHz.
9kH-150kHz;RBW=200Hz,VBW=200Hz;150kHz-30MHz;RBW=9kHz,VBW=9kHz;30MHz-1000 MHz;RBW=120 kHz,VBW=120 kHz,1000 -2000MHz ;RBW=1 MHz,VBW=1 MHz.

Test environment conditions: Temperature: 25°C, Relative Humidity: 40%, Pressure: 100kPa

Emission profile of the EUT rotated along three orthogonal axes was investigated. Recorded data represent worse case emission.
Test method: EIA-TIA603
Mariposa Site A

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/17/2015	7/17/2016
T2	AN03155	Preamp	83017A	6/30/2015	6/30/2017
T3	AN01273	Horn Antenna	3115	2/3/2015	2/3/2017
T4	ANP05904	Cable	32022-2-29094K-144TC	12/8/2014	12/8/2016
T5	ANP06554	Cable	32022-29094K-29094K-24TC	12/30/2015	12/30/2017
T6	ANP01403	Cable	58758-23	12/8/2014	12/8/2016
T7	AN01993	Biconilog Antenna	CBL6111C	3/11/2016	3/11/2018
T8	ANP05656	Attenuator	PE7004-6	12/22/2015	12/22/2017
T9	ANP06230	Cable	CXTA04A-50	3/3/2016	3/3/2018
T10	ANP04249	Cable	CXTA04A-50	3/3/2016	3/3/2018
T11	ANP06847	Cable	LMR195-FR-6	7/9/2015	7/9/2017
T12	AN00449	Preamp-Top Amp (dB)	8447F	2/18/2016	2/18/2018
T13	ANP06883	Cable	LMR195-FR-3	10/27/2015	10/27/2017
	AN00226	Loop Antenna	6502	4/4/2016	4/4/2018

LIMIT LINE FOR SPURIOUS RADIATED EMISSION

REQUIRED ATTENUATION = 50+10 LOG P (DB)
FOR RADIATED SPURIOUS EMISSION MEASURED AT 3 METER TEST DISTANCE,
Required attenuation = 50+10 Log $P_{t\ at\ 3\ meter}$ dB
Limit line (dBuV) = E_{dBuv} - Attenuation

E_{dBuv} = Measured field strength at 3 meter in dBuV/m

Power Density (Isotropic)

$$P_D = \frac{P_t}{4\pi r^2}$$

P_D = Power Density in Watts /m^2
Pt = Average Transmit Power
r = Test distance

Field Intensity E (V/m)

$$E = \sqrt{P_D \times 377}$$

$$E = \frac{\sqrt{P_t \times 377}}{4\pi r^2}$$

$$E = \sqrt{\frac{P_t \times 30}{r^2}}$$

$$P_t = \left(\frac{E^2 \times r^2}{30} \right)$$

10 Log P_t = 10 Log E^2 (V/m)+ 10 Log r^2 – 10 Log 30
10 Log P_t = 20 Log E (V/m) + 20 Log r – 10 Log 30

At 3 meter, r = 3 m

10 Log P_t = 20 Log E (V/m) + 20 Log 3 – 10 Log 30
10 Log P_t = 20 Log E (V/m) + 9.54 – 14.77
10 Log P_t = 20 Log E (V/m) - 5.23

Since 20 Log E (V/m) = 20 Log E (uV/m) –120

10 Log P_t = 20 Log E (uV/m) - 120 - 5.23
10 Log P_t = 20 Log E (uV/m) –125.23

Limit line (dBuV) at 3 meter = E_{dBuv} – Attenuation

= E_{dBuv} - (50+10 Log $P_{t\ at\ 3\ meter}$)

= E_{dBuv} - 50 - 10 Log $P_{t\ at\ 3\ meter}$

= E_{dBuv} - 50 – (20 Log E (uV/m) –125.23)

= E_{dBuv} - 50 - 20 Log E (uV/m) + 125.23

= E_{dBuv} - 20 Log E (uV/m) + 75.23

Since 20 Log E (uV/m) = E in dBuV/m

= E dBuv - E dBuv + 75.23

Radiated Emission limit 3 meter = 75.23 dBuV at any power level measured in dBuV

Test Data

Operating Frequency(ies):	150-174MHz
Operational Mode(s):	Tx, 1 watt setting
Highest Measured Power:	31 dBm
Measurement Distance:	10 meters

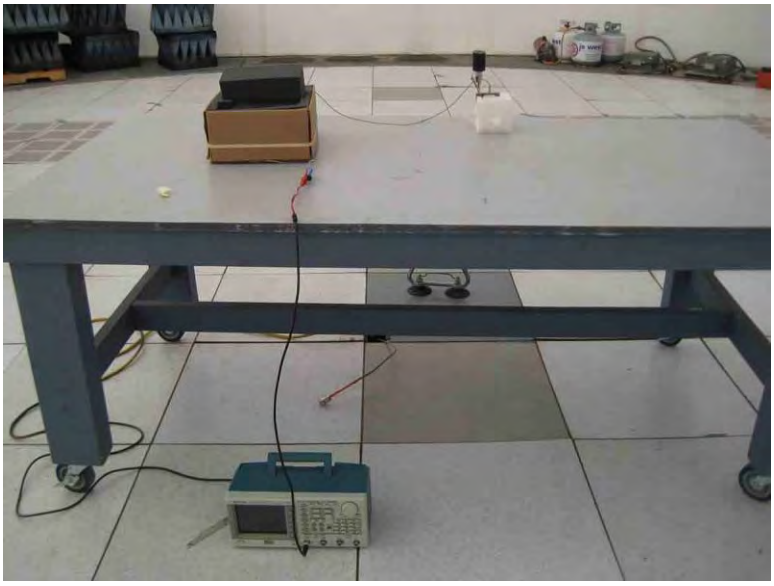
Limit Definition:

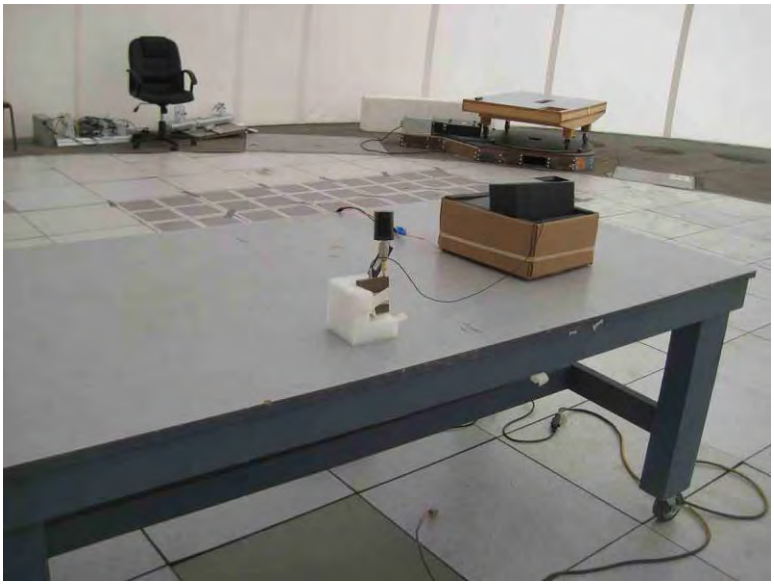
Frequency Range	Limit (dBc)	Limit Calculation
9kHz - 200GHz	60	50+10*LOG(P)

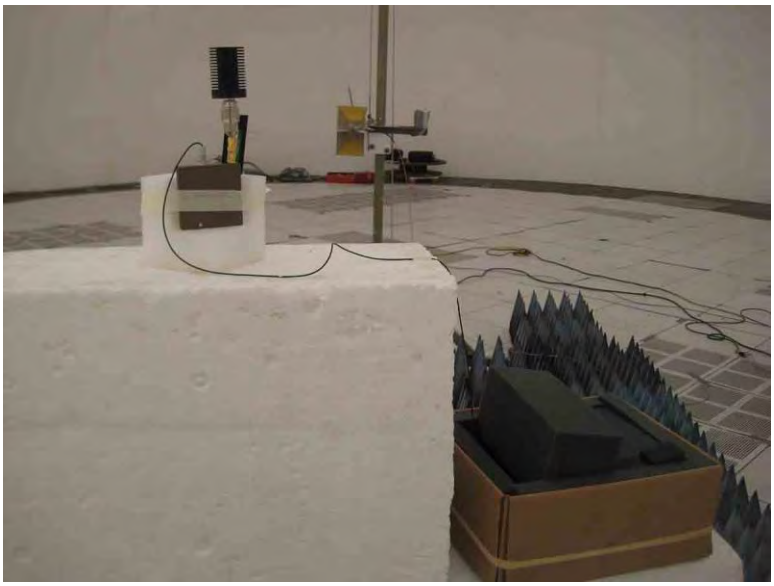
Frequency (MHz)	Reference Level (dBm)	Measured (dBc)	Margin	Antenna Polarity
173.380	-33.3	64.3	-4.3	Horizontal
173.380	-34.8	65.8	-5.8	Horizontal
173.383	-38.3	69.3	-9.3	Horizontal
162.000	-38.9	69.9	-9.9	Horizontal
346.767	-43.5	74.5	-14.5	Horizontal
486.000	-44.1	75.1	-15.1	Horizontal
520.150	-46.1	77.1	-17.1	Horizontal
450.000	-46.9	77.9	-17.9	Horizontal
520.159	-47.1	78.1	-18.1	Vertical
324.000	-47.3	78.3	-18.3	Horizontal
486.000	-49.6	80.6	-20.6	Vertical
324.000	-50.1	81.1	-21.1	Vertical
150.000	-51.2	82.2	-22.2	Horizontal
173.386	-51.8	82.8	-22.8	Vertical
161.983	-52.0	83.0	-23.0	Vertical
346.773	-52.4	83.4	-23.4	Vertical
450.000	-53.9	84.9	-24.9	Vertical
900.000	-54.8	85.8	-25.8	Horizontal
648.000	-55.0	86.0	-26.0	Vertical
300.000	-55.0	86.0	-26.0	Vertical
810.000	-55.5	86.5	-26.5	Horizontal
1213.690	-55.5	86.5	-26.5	Vertical
1213.000	-55.7	86.7	-26.7	Vertical
810.000	-56.0	87.0	-27.0	Vertical

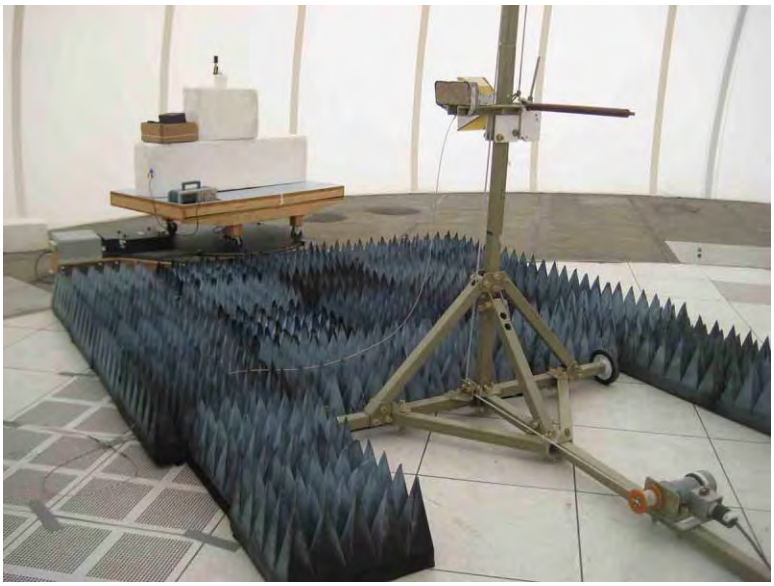
Frequency (MHz)	Reference Level (dBm)	Measured (dBc)	Margin	Antenna Polarity
1213.000	-56.7	87.7	-27.7	Horizontal
1213.000	-56.9	87.9	-27.9	Vertical
300.000	-57.5	88.5	-28.5	Horizontal
150.000	-57.7	88.7	-28.7	Vertical
1215.000	-58.2	89.2	-29.2	Vertical
1783.300	-58.3	89.3	-29.3	Vertical
693.546	-58.5	89.5	-29.5	Vertical
1781.700	-58.9	89.9	-29.9	Vertical
1650.000	-59.0	90.0	-30.0	Vertical
1350.000	-59.7	90.7	-30.7	Vertical
1561.700	-59.8	90.8	-30.8	Vertical
1561.000	-60.5	91.5	-31.5	Horizontal
1908.000	-60.6	91.6	-31.6	Horizontal
1050.000	-60.7	91.7	-31.7	Horizontal
1800.000	-61.4	92.4	-32.4	Horizontal
1350.000	-61.8	92.8	-32.8	Horizontal
1650.000	-62.1	93.1	-33.1	Horizontal
1456.700	-63.7	94.7	-34.7	Vertical
1140.000	-64.5	95.5	-35.5	Horizontal
1456.700	-66.6	97.6	-37.6	Horizontal
308.327	-69.8	100.8	-40.8	Vertical

Test Setup Photos









2.1055 / 90.213 Frequency Stability

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 5046 Sierra Pines Drive • Mariposa, CA 95338 • (209) 966-5240		
Customer:	**Sierra Innotek**		
Specification:	**47 CFR §90.213 / 2.1055 Frequency Stability**		
Work Order #:	**96962**	Date:	6/8/2016
Test Type:	**Conducted Emissions**	Time:	16:00:05
Tested By:	E. Wong	Sequence#:	2
Software:	EMITest 5.03.02		6V DC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 2			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 2			

Test Conditions / Notes:

The EUT is placed in the temperature chamber. Microphone port is connected to a loop back cable to enable transmission of unmodulated signal.

The EUT contains modular approved Bluetooth radio FCCID VPYLBZY for device configuration purposes only and does not transmit simultaneously with the FM signal.

Frequency range: 150-174MHz

TX Frequency: 150.002 MHz, 162MHz, 173.390MHz, 12.5 kHz channel bandwidth.
Modulation: NBFM analog voice, Firmware setting = 1W.
For this evaluation, the battery power is replaced with variable voltage DC power supply
Firmware version: 54

Test environment conditions: Temperature: 25°C, Relative Humidity: 40%, Pressure: 100kPa

RF characteristic measured at antenna port.
Test method: EIA-TIA 603

Frequency range of measurement = Fundamental Frequency

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/17/2015	7/17/2016
T2	AN03430	Attenuator	75A-10-12	11/2/2015	11/2/2017
	01879	Temperature Chamber	S-1.2 Min.	12/5/2014	12/5/2016
	03338	Multimeter	MM570A	1/22/2015	1/2/2017
T3	ANP06554	Cable	32022-29094K-29094K-24TC	12/30/2015	12/30/2017

§90.213 Frequency stability.

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

MINIMUM FREQUENCY STABILITY

[Parts per million (ppm)]

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Below 25	[1][2][3]100	100	200
25-50	20	20	50
72-76	5		50
150-174	[5][11]5	[6]5	[4][6]50
216-220	1.0		1.0
220-222[12]	0.1	1.5	1.5
421-512	[7][11][14]2.5	[8]5	[8]5
806-809	[14]1.0	1.5	1.5
809-824	[14]1.5	2.5	2.5
851-854	1.0	1.5	1.5
854-869	1.5	2.5	2.5
896-901	[14]0.1	1.5	1.5
902-928	2.5	2.5	2.5
902-928[13]	2.5	2.5	2.5
929-930	1.5		
935-940	0.1	1.5	1.5
1427-1435	[9]300	300	300
Above 2450[10]			

[1]Fixed and base stations with over 200 watts transmitter power must have a frequency stability of 50 ppm except for equipment used in the Public Safety Pool where the frequency stability is 100 ppm.

[2]For single sideband operations below 25 MHz, the carrier frequency must be maintained within 50 Hz of the authorized carrier frequency.

[3]Travelers information station transmitters operating from 530-1700 kHz and transmitters exceeding 200 watts peak envelope power used for disaster communications and long distance circuit operations pursuant to §§90.242 and 90.264 must maintain the carrier frequency to within 20 Hz of the authorized frequency.

[4]Stations operating in the 154.45 to 154.49 MHz or the 173.2 to 173.4 MHz bands must have a frequency stability of 5 ppm.

[5]In the 150-174 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

[6]In the 150-174 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth or designed to operate on a frequency specifically designated for itinerant use or designed for low-power operation of two watts or less, must have a frequency stability of 5.0 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 2.0 ppm.

[7]In the 421-512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.

[8]In the 421-512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

[9]Fixed stations with output powers above 120 watts and necessary bandwidth less than 3 kHz must operate with a frequency stability of 100 ppm. Fixed stations with output powers less than 120 watts and using time-division multiplex, must operate with a frequency stability of 500 ppm.

[10]Except for DSRCS equipment in the 5850-5925 MHz band, frequency stability is to be specified in the station authorization. Frequency stability for DSRCS equipment in the 5850-5925 MHz band is specified in subpart M of this part.

[11]Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150-174 MHz band and 2.5 ppm in the 421-512 MHz band.

[12]Mobile units may utilize synchronizing signals from associated base stations to achieve the specified carrier stability.

[13]Fixed non-multilateration transmitters with an authorized bandwidth that is more than 40 kHz from the band edge, intermittently operated hand-held readers, and mobile transponders are not subject to frequency tolerance restrictions.

[14]Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

(b) For the purpose of determining the frequency stability limits, the power of a transmitter is considered to be the maximum rated output power as specified by the manufacturer.

Result:

Frequency Stability

Customer:	Sierra Innotek
WO#:	96962
Date:	10-Jun-16
Test Engineer:	E. Wong
Device Model #:	C-CAT
Operating Voltage:	6 **VDC Battery**
Frequency Limit:	5.00E+00 **ppm**

Temperature Variations

		Channel 1 (MHz)	Dev (ppm)	Channel 2 (MHz)	Dev (ppm)	Channel 3 (MHz)	Dev (ppm)
Channel Frequency:		**149.999866000**		**161.999727000**		**173.389693000**	
Temp (C)	Voltage						
-30	6	149.999893000	-0.180000	161.999757000	-0.185185	173.389753000	-0.346041
-20	6	149.999923000	-0.380000	161.999774000	-0.290124	173.389763000	-0.403715
-10	6	149.999927000	-0.406667	161.999777000	-0.308642	173.389784000	-0.524829
0	6	149.999904000	-0.253334	161.999760000	-0.203704	173.389760000	-0.386413
10	6	149.999897000	-0.206667	161.999744000	-0.104938	173.389737000	-0.253764
20	6	149.999866000	0.000000	161.999727000	0.000000	173.389693000	0.000000
30	6	149.999867000	-0.006667	161.999710000	0.104938	173.389703000	-0.057674
40	6	149.999857000	0.060000	161.999703000	0.148148	173.389694000	-0.005767
50	6	149.999873000	-0.046667	161.999720000	0.043210	173.389720000	-0.155719

Voltage Variations (-15%, *Batt End Point)

Temp (C)	Voltage	Channel 1 (MHz)	Dev. (ppm)	Channel 2 (MHz)	Dev. (ppm)	Channel 3 (MHz)	Dev. (ppm)
20	5.1	149.999860000	0.040000	161.999710	0.104938	173.389707	-0.080743
20	6.0	149.999866000	0.000000	161.999727	0.000000	173.389693	0.000000
20	4.25*	149.999873000	-0.046667	161.999723	0.024691	173.389746	-0.305670

Max Deviation (ppm)		**+**	**0.06000**	+	**0.14815**	+	**0.00000**
Max Deviation (ppm)		**-**	**0.40667**	**-**	**0.30864**	**-**	**0.52483**
			PASS		**PASS**		**PASS**

Test Setup Photos

90.210(d) Emissions Mask

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 5046 Sierra Pines Drive • Mariposa, CA 95338 • (209) 966-5240		
Customer:	**Sierra Innotek**		
Specification:	**47 CFR §90.210 Emission mask D**		
Work Order #:	**96962**	Date:	6/8/2016
Test Type:	**Conducted Emissions**	Time:	16:00:05
Tested By:	E. Wong	Sequence#:	2
Software:	EMITest 5.03.02		6V DC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The EUT is placed on the test bench. Microphone port is connected to a microphone which is receiving Audio signal via a speaker box. The EUT digitizes the Analog signal and modulates as NBFM Analog Voice. The Audio digitizer has AGC activated, this test was performed with worst case Audio signal at 1kHz. Sig gen set at 7 V p-p

The EUT contains modular approved Bluetooth radio FCCID VPYLBZY for device configuration purposes only and does not transmit simultaneously with the FM signal.

Frequency range: 150-174MHz

TX Frequency: 150.002 MHz, 162MHz, 173.390MHz, 12.5 kHz channel bandwidth.
Modulation: NBFM analog voice, Firmware setting = 1W.
4 AAA Fresh batteries were used for this evaluation.
Firmware version: 54

Test environment conditions: Temperature: 25°C, Relative Humidity: 40%, Pressure: 100kPa

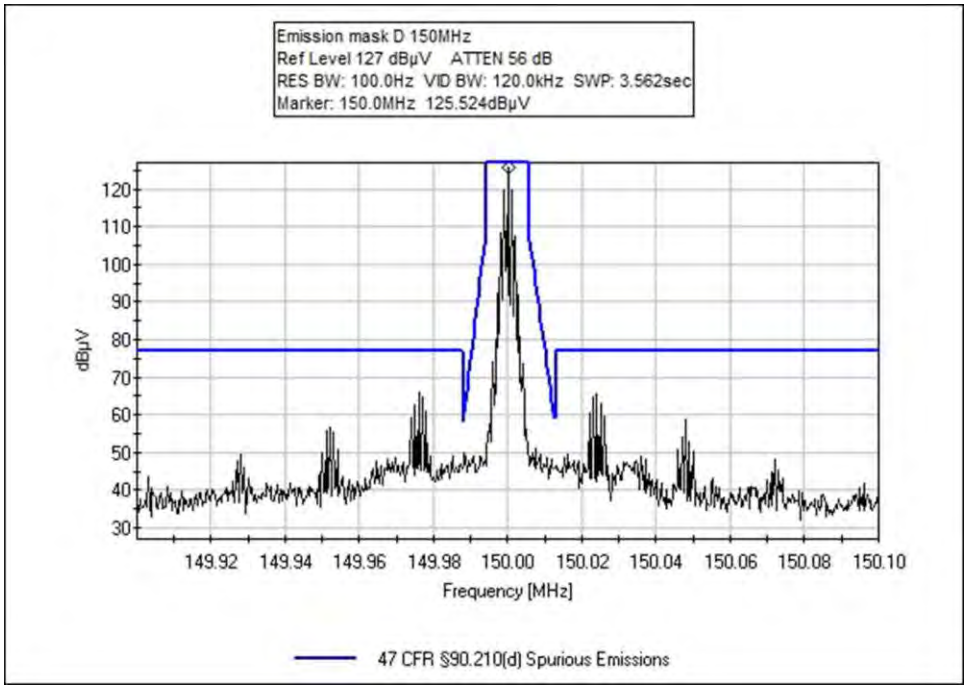
RF characteristic measured at antenna port.
Test method: EIA-TIA 603

Frequency range of measurement = Fundamental Frequency
An extra plot is provided at a wider span to provide improved clarity.

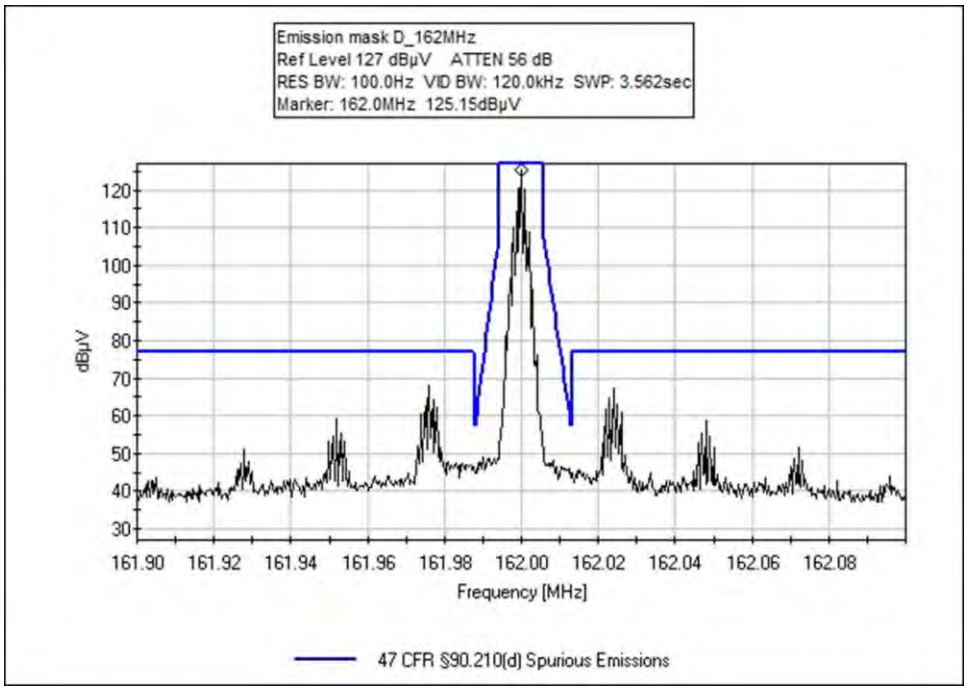
Test Equipment:

ID	Asset #/	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/17/2015	7/17/2016
T2	AN03430	Attenuator	75A-10-12	11/2/2015	11/2/2017
T3	ANP06554	Cable	32022-29094K-29094K-24TC	12/30/2015	12/30/2017

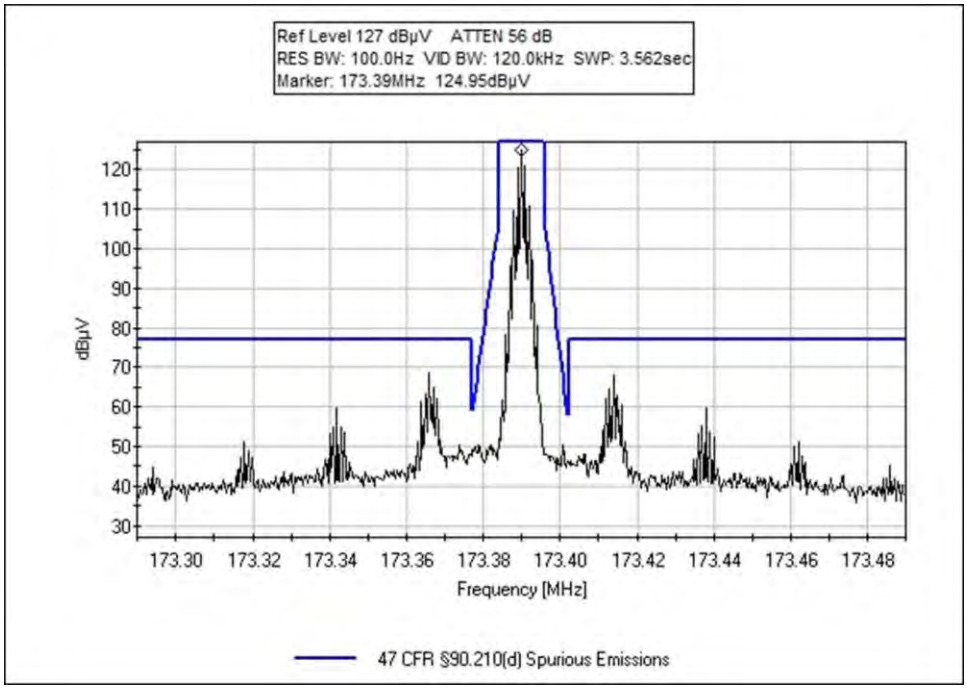
Plots



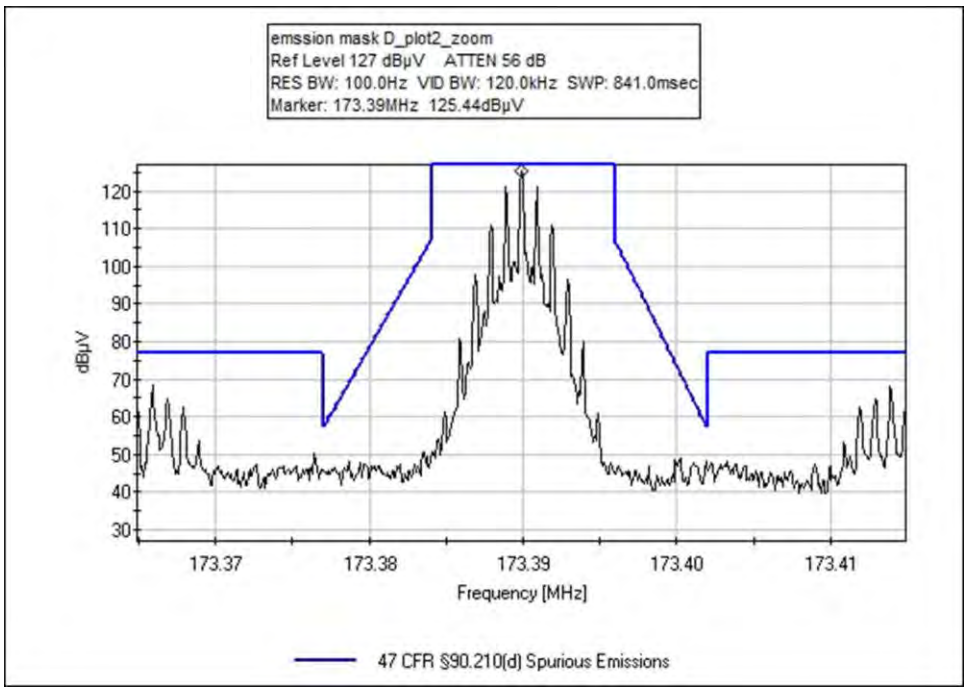
Low Frequency 150MHz



Middle Frequency 162MHz



High Frequency 174MHz



High Frequency 174MHz - zoom

Test Setup Photo

90.214 Transient Frequency Behavior

Test Setup / Conditions

Test Location:	CKC Laboratories, Inc. • 5046 Sierra Pines Drive • Mariposa, CA 95338 • (209) 966-5240		
Customer:	**Sierra Innotek**		
Specification:	**47 CFR §90.214 Transient frequency behavior.**		
Work Order #:	**96962**	Date:	6/8/2016
Test Type:	**Conducted Emissions**	Time:	16:00:05
Tested By:	E. Wong	Sequence#:	2
Software:	EMITest 5.03.02		6V DC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The EUT is placed on the test bench. Microphone port is connected to a microphone which is receiving Audio signal via a speaker box. The EUT digitizes the Analog signal and modulates as NBFM Analog Voice. The Audio digitizer has AGC activated, this test was performed with worst case Audio signal at 1kHz. Sig gen set at 7 V p-p

The EUT contains modular approved Bluetooth radio FCCID VPYLBZY for device configuration purposes only and does not transmit simultaneously with the FM signal.

Frequency range: 150-174MHz

TX Frequency: 162MHz, 12.5 kHz channel bandwidth.
Modulation: NBFM analog voice, Firmware setting = 1W.

Firmware version: 54

Test environment conditions: Temperature: 25°C, Relative Humidity: 40%, Pressure: 100kPa

RF characteristic measured at antenna port.
Test method: EIA-TIA 603

Frequency range of measurement = Fundamental Frequency

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	7/17/2015	7/17/2016
T2	AN03430	Attenuator	75A-10-12	11/2/2015	11/2/2017
	P01313	Splitter, 4-Way	NA	6/8/2016	6/8/2018
	02589	Crystal Detector	8472B	12/1/2015	12/1/2017
	02072	RF Characteristics Analyzer	8901A	5/18/2015	5/18/2017
	03331	Oscilloscope	TDS3052A	8/14/2014	8/14/2016
T3	ANP06554	Cable	32022-29094K-29094K-24TC	12/30/2015	12/30/2017

§90.214 Transient frequency behavior.

Transmitters designed to operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain 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 25 kHz Channels			
t_1[4]	±25.0 kHz	5.0 ms	10.0 ms
t_2	±12.5 kHz	20.0 ms	25.0 ms
t_3[4]	±25.0 kHz	5.0 ms	10.0 ms
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			
t_1[4]	±6.25 kHz	5.0 ms	10.0 ms
t_2	±3.125 kHz	20.0 ms	25.0 ms
t_3[4]	±6.25 kHz	5.0 ms	10.0 ms

[1] t_{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}.

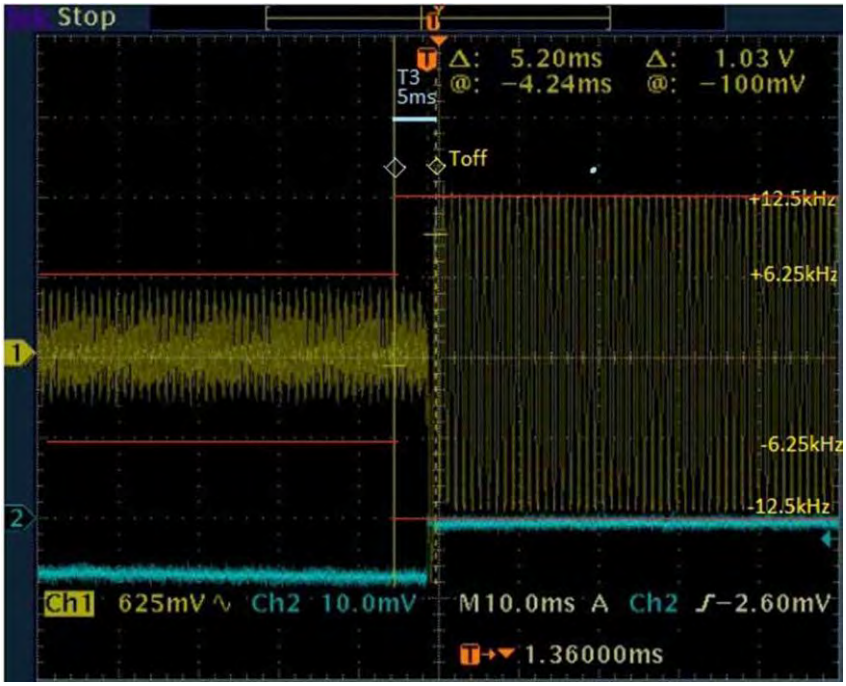
t_2 is the time period immediately following t_1.

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

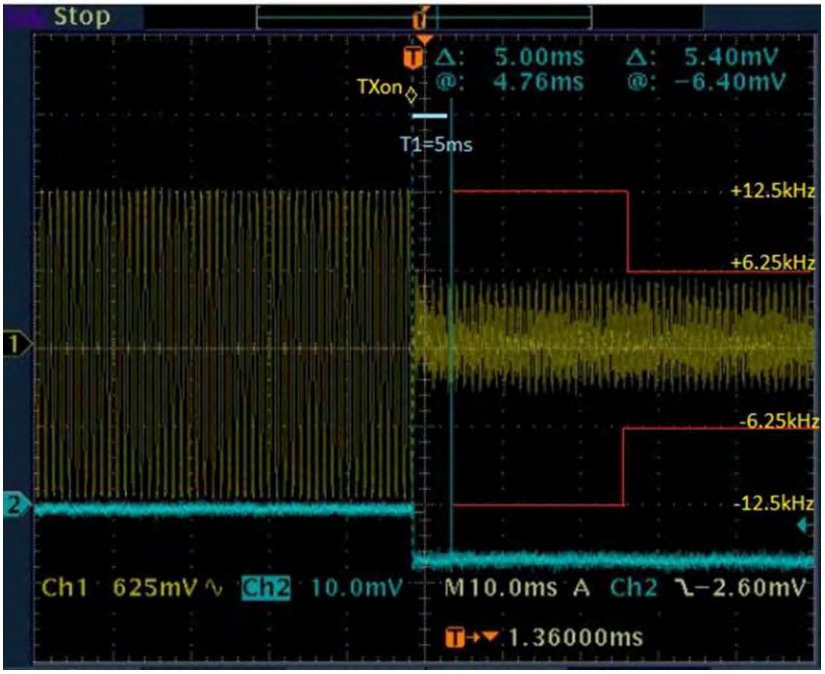
t_{off} is the instant when the 1 kHz test signal starts to rise.

[2] During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in §90.213.

Data



Key Off, 12.5kHz



Key On, 12.5kHz

Test Setup Photo

SUPPLEMENTAL INFORMATION

Measurement Uncertainty

Uncertainty Value	Parameter
4.73 dB	Radiated Emissions
3.34 dB	Mains Conducted Emissions
3.30 dB	Disturbance Power

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2. Compliance is deemed to occur provided measurements are below the specified limits.

Emissions Test Details

TESTING PARAMETERS

Unless otherwise indicated, the following configuration parameters are used for equipment setup: The cables were routed consistent with the typical application by varying the configuration of the test sample. Interface cables were connected to the available ports of the test unit. The effect of varying the position of the cables was investigated to find the configuration that produced maximum emissions. Cables were of the type and length specified in the individual requirements. The length of cable that produced maximum emissions was selected.

The equipment under test (EUT) was set up in a manner that represented its normal use, as shown in the setup photographs. Any special conditions required for the EUT to operate normally are identified in the comments that accompany the emissions tables.

The emissions data was taken with a spectrum analyzer or receiver. Incorporating the applicable correction factors for distance, antenna, cable loss and amplifier gain, the data was reduced as shown in the table below. The corrected data was then compared to the applicable emission limits. Preliminary and final measurements were taken in order to ensure that all emissions from the EUT were found and maximized.

CORRECTION FACTORS

The basic spectrum analyzer reading was converted using correction factors as shown in the highest emissions readings in the tables. For radiated emissions in dBµV/m, the spectrum analyzer reading in dBµV was corrected by using the following formula. This reading was then compared to the applicable specification limit. Individual measurements were compared with the displayed limit value in the margin column. The margin was calculated based on the limit value subtracting the corrected measured value; a negative margin represents a measurement less than the limit while a positive margin represents a measurement exceeding the limit.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB/m)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dBµV/m)

TEST INSTRUMENTATION AND ANALYZER SETTINGS

The test instrumentation and equipment listed were used to collect the emissions data. A spectrum analyzer or receiver was used for all measurements. Unless otherwise specified, the following table shows the measuring equipment bandwidth settings that were used in designated frequency bands. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	9 kHz	150 kHz	200 Hz
RADIATED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	30 MHz	1000 MHz	120 kHz
RADIATED EMISSIONS	1000 MHz	>1 GHz	1 MHz

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

The notes that accompany the measurements contained in the emissions tables indicate the type of detector function used to obtain the given readings. Unless otherwise noted, all readings were made in the "positive peak" detector mode. Whenever a "quasi-peak" or "average" reading was recorded, the measurement was annotated with a "QP" or an "Ave" on the appropriate rows of the data sheets. In cases where quasi-peak or average limits were employed and data exists for multiple measurement types for the same frequency then the peak measurement was retained in the report for reference, however the numbering for the affected row was removed and an arrow or caret ("^") was placed in the far left-hand column indicating that the row above takes precedence for comparison to the limit. The following paragraphs describe in more detail the detector functions and when they were used to obtain the emissions data.

Peak

In this mode, the spectrum analyzer or receiver recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature called "peak hold," the measurement device had the ability to measure intermittent or low duty cycle transient emission peak levels. In this mode the measuring device made a slow scan across the frequency band selected and measured the peak emission value found at each frequency across the band.

Quasi-Peak

Quasi-peak measurements were taken using the quasi-peak detector when the true peak values exceeded or were within 2 dB of a quasi-peak specification limit. Additional QP measurements may have been taken at the discretion of the operator.

Average

Average measurements were taken using the average detector when the true peak values exceeded or were within 2 dB of an average specification limit. Additional average measurements may have been taken at the discretion of the operator. If the specification or test procedure requires trace averaging, then the averaging was performed using 100 samples or as required by the specification. All other average measurements are performed using video bandwidth averaging. To make these measurements, the test engineer reduces the video bandwidth on the measuring device until the modulation of the signal is filtered out. At this point the measuring device is set into the linear mode and the scan time is reduced.