FCC / IC Test Report

FOR:
CalAmp Wireless Networks Corp.

Model Name:
VLU11B / VLU11

Product Description:
Lojack vehicle recovery system

FCC ID: APV-VLU11B / APV-VLU11
IC ID: 5483C-VLU11B / 5483C-VLU11

Applied Rules and Standards:
47 CFR: Part 90

REPORT #: EMC_CALAM_086_19001_FCC_90

DATE: 2019-05-10

A2LA Accredited

IC recognized # 3462B-2

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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Part 90 of Title 47 of the Code of Federal Regulations.

On-time measurement for FSK modulation is covered by Declaration from Customer.

Deviation of test procedure was ascertained for the Transient Frequency Behavior test.

Company	Description	Model #
CalAmp Wireless Networks Corp.	Lojack vehicle recovery system	VLU11VMAB / VLU11VMA

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2019-05-10	Compliance	Cindy Li (EMC Lab Manager)	Cindy Li Digitally signed by Cindy Li DN: cn=Cindy Li, o=Cetecom Inc., ou=EMC, email=cindy.li@cetecom.com, c=US Date: 2019.05.10 17:12:22 -07'00'

Responsible for the Report:

Date	Section	Name	Signature
2019-05-10	Compliance	Chin Ming Lui (Associate EMC Engineer)	Chin Ming Lui Digitally signed by: Chin Ming Lui DN: CN = Chin Ming Lui email = ChinMing.Lui@cetecom.com C = US O = CETECOM Date: 2019.05.10 16:05:16 -07'00'

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
EMC Lab Manager:	Cindy Li
Responsible Project Leader:	Cathy Palacios

2.2 Identification of the Client

Applicant's Name:	CalAmp Wireless Networks Corp.
Street Address:	2177 Salk Ave, Suite 200
City/Zip Code:	Carlsbad, CA 92008
Country:	USA

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as Client
Manufacturers Address:	
City/Zip Code	
Country	

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	VLU11VMAB (for BTLE populated unit) VLU11VMA (for BTLE depopulated unit)
HW Version :	REV 1
SW Version :	11.00.01
FCC-ID:	APV-VLU11B / APV-VLU11
IC-ID:	5483C-VLU11B / 5483C-VLU11
HVIN:	11.00.01
PMN:	VLU11B / VLU11
Product Description:	Lojack vehicle recovery system
Frequency Range / number of channels:	173.075 MHz
Type(s) of Modulation:	FSK
Modes of Operation:	VHF Freq Proprietary Tech
Antenna Information as declared:	No antenna gain specified
Max. Peak Effective Radiated Power (ERP):	ERP: 24.222 dBm
Power Supply/ Rated Operating Voltage Range:	Battery / Vmin: 7 VDC/ Vnom: 12-24 VDC / Vmax: 32 VDC
Operating Temperature Range:	-20 ºC to 60 ºC
Other Radios included in the device:	❖ LTE • Module name: UBLOX - SARA R410M • Model number: SARA-R410M-52B • FCC ID: XPY2AGQN4NNN • IC ID: 8595A-2AGQN4NNN • Frequency Band of Operation: ▪ FDD LTE 2 ▪ FDD LTE 4 ▪ FDD LTE 5

	▪ FDD LTE 12 ▪ FDD LTE 13 • Main Antenna: ▪ Type: Custom ▪ Location: Internal ▪ Gain: 2.58 dBi ❖ <u>BTLE</u> • Module: Designed by CalAmp Wireless Networks based on Texas Instruments Chip CC2640 • Main Antenna: ▪ Type: Chip ▪ Location: Internal ▪ Gain: 5.36 dBi ▪ Frequency: 2.4 GHz ❖ <u>GPS</u> • Chip based, no module • Antenna location: Internal
Sample Revision:	☐Prototype Unit; ☐ Production Unit; ■ Pre-Production

3.2 EUT Sample details

EUT #	IMEI Number	HW Version	SW Version	Notes/Comments
1	357812093409834	REV 1	11.00.01	Conducted and Radiated Measurements

3.3 Support Equipment

SE #	Type	Model	Manufacturer	Serial Number
1	DC Power Supply	E3634A	Agilent	MY53290018
2	DC Power Supply	1672	BK PRECISION	1672002260611085

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1+ SE#1	The EUT operates in VHF. The EUT is capable of transmitting an FSK modulated signal.
2	EUT#1+ SE#2	The EUT operates in VHF. The EUT is capable of transmitting an FSK modulated signal.

3.5 Mode of Operation

The EUT can be configured into modulation type FSK, and will transmit on a radio (RF) carrier frequency of 173.075 MHz. Vehicles with the system installed send a 200 millisecond (ms) chirp every fifteen seconds on this frequency when activated.

4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 90 of Title 47 of the Code of Federal Regulations.

Testing procedures are based on ANSI C63.26 – "American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Devices", by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§2.1046, §2.1053, §90.20(e)(6) & §90.210	RF Output Power and Spurious Emissions	Nominal	FSK	■	☐	☐	Complies
§2.1049 & §90.20(e)(6)	Occupied Bandwidth	Nominal	FSK	■	☐	☐	Complies
§2.1055 & §90.213	Transmitter Frequency Stability	Nominal & Extreme	FSK Note 4	■	☐	☐	Complies
§2.1055 & §90.214	Transient Frequency Behavior	Nominal	FSK	■	☐	☐	Complies
§90.210	Transmitter Emissions Mask	Nominal	FSK	■	☐	☐	Complies
§90.20(e)(6)	On-Time	Nominal	FSK	■	☐	☐	Complies Note 3

Note 1: NA= Not Applicable; NP= Not Performed.
Note 2: EUT is powered by 12VDC battery
Note 3: On-Time measurement for FSK modulation covered by Declaration from Customer
Note 4: Test performed with FSK modulated signal due to unavailability of a carrier wave (CW) signal

6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=1.

Radiated measurement

9 kHz to 30 MHz	±2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	±2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	±2.3 dB (Horn Antenna)

Conducted measurement

150 kHz to 30 MHz	±0.7 dB (LISN)
RF conducted measurement	±0.5 dB

According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: http://physics.nist.gov/cuu/Uncertainty/typeb.html. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3 dB to the limit.

6.1 Environmental Conditions During Testing:

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25° C
- Relative humidity: 40-60%

6.2 Dates of Testing:

02/27/2019 – 03/27/2019

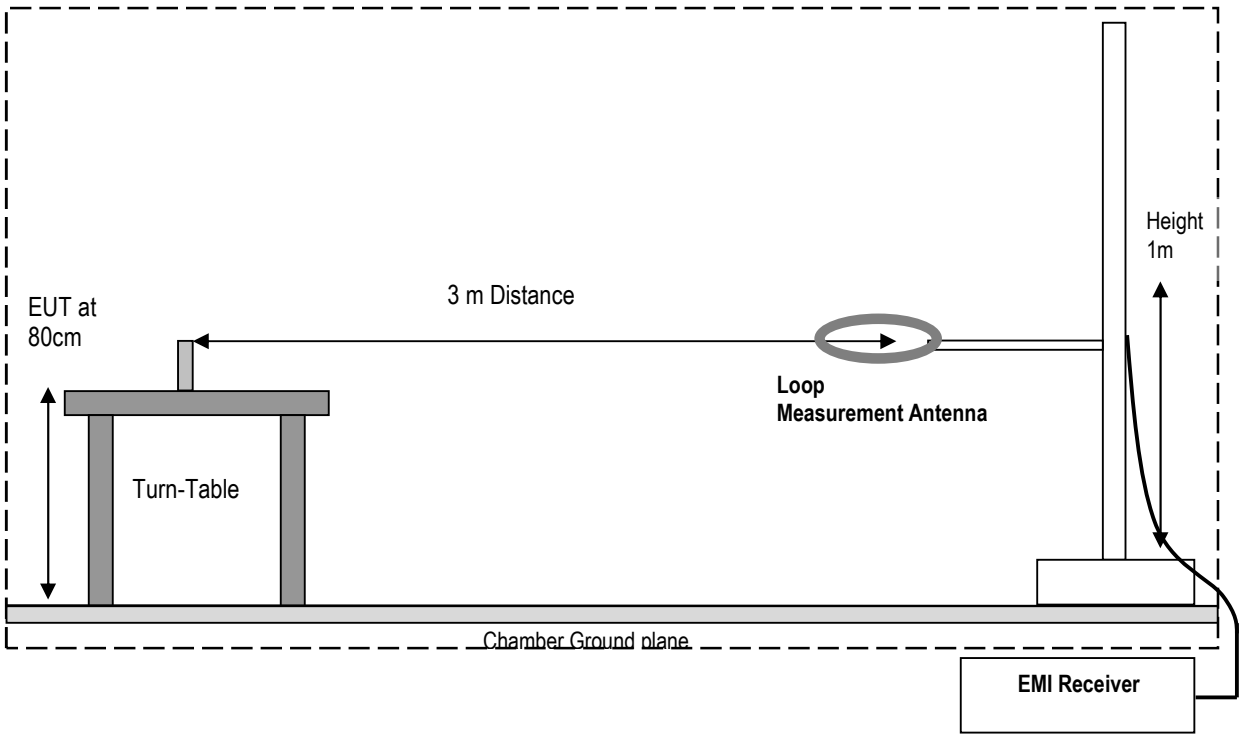
7 Measurement Procedures

7.1 Radiated Measurement

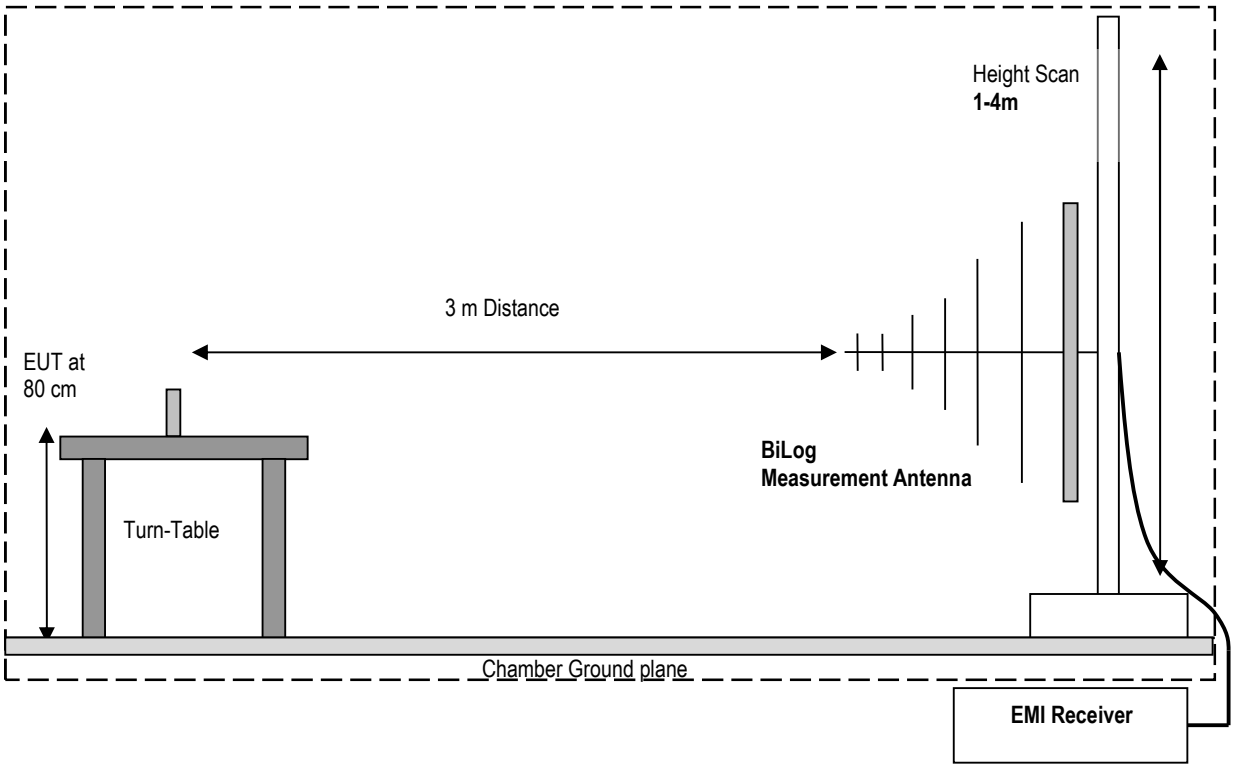
The radiated measurement is performed according to ANSI C63.26 (2015)

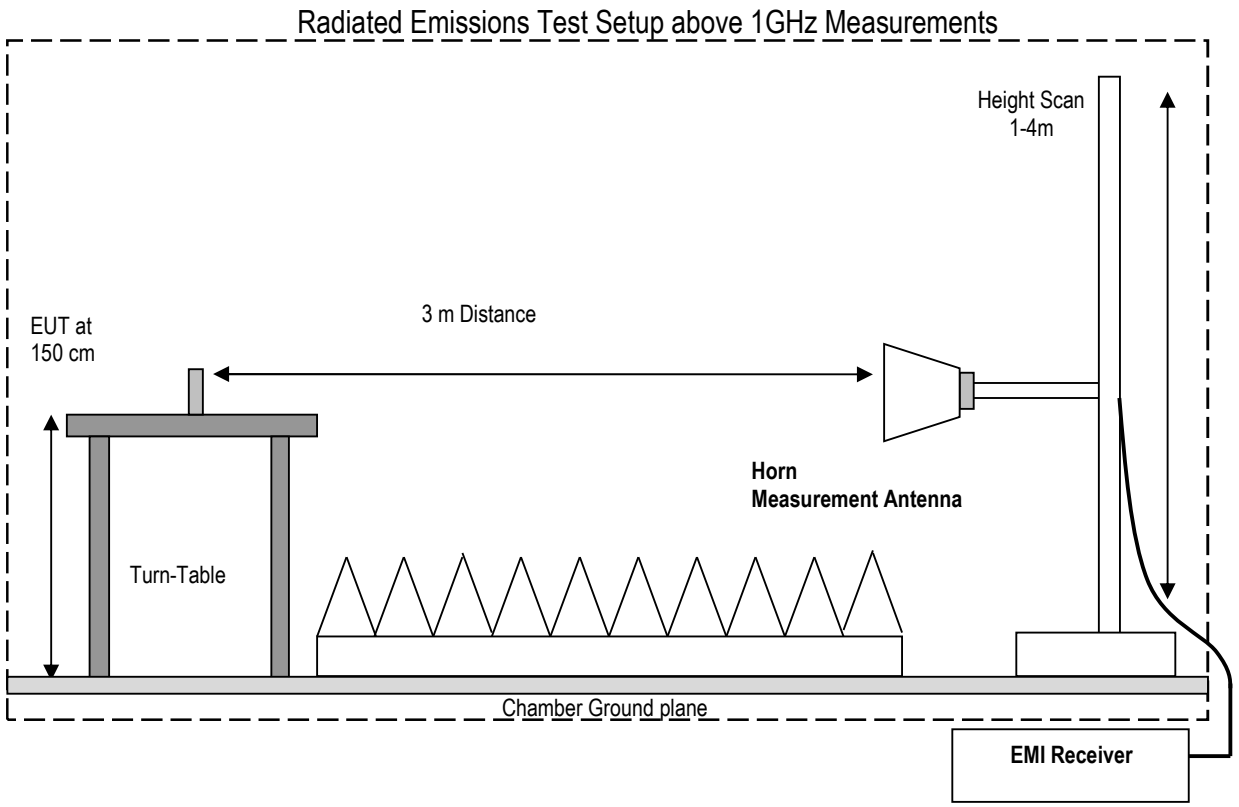
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.

Radiated Emissions Test Setup below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements





7.1.1 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

1. Measured reading in dBµV
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

FS (dBµV/m) = Measured Value on SA (dBµV)- Cable Loss (dB)+ Antenna Factor (dB/m)

Example:

Frequency (MHz)	Measured SA (dBµV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBµV/m)
1000	80.5	3.5	14	98.0

7.2 RF Conducted Measurement Procedure

Testing procedures are based on ANSI C63.26 – "American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Devices", by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

- Connect the equipment as shown in the above diagram.
- Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
- Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.
- Calculate the conducted power by taking into account attenuation of the cable and the attenuator

8 Test Result Data

8.1 RF Output Power and Radiated Transmitter Spurious Emissions

8.1.1 Measurement according to ANSI C63.26 (2015)

Refer to Section 5.5.4 Radiated measurement using the field strength method of ANSI C63.26 (2015) for test procedure.

Spectrum Analyzer Settings:

- Frequency = 9 KHz – 30 MHz
- RBW = 9 KHz
- Detector: Peak

- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW= 120 KHz (<1GHz)

- Frequency > 1 GHz
- Detector = Peak / Average
- RBW = 1 MHz

- Radiated spurious emissions shall be measured using the appropriate parameters and test requirements.
- For testing at distance other than the specified in the standard, the limit conversion is calculated by using 40 dB/decade extrapolation factor as follow: Conversion factor (CF) = 40 log (D/d) = 40 log (300m / 3m) = 80dB

8.1.2 Limits:

RF Output Power:
According to FCC §90.20(e)(6):

(iii) Mobile transmitters operating on this frequency with emissions authorized in a maximum bandwidth of 12.5 kHz are limited to 5.0 watts power output. Mobile transmitters operating on this frequency with emissions authorized in a maximum bandwidth of 20 kHz are limited to 2.5 watts power output.

Spurious Emissions:
According to FCC §90.210:

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (o) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating under this part.

Applicable Emission Masks

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25[1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174[2]	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512[2 5]	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854[6]	B	H
809-824/854-869[35]	B, D	D, G.
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M
5850-5925[4]		
All other bands	B	C

(c) *Emission Mask C.* For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (f_d/5) dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (f_d^2/11) dB or 50 dB, whichever is the lesser attenuation;

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

(4) In the 1427-1432 MHz band, licensees are encouraged to take all reasonable steps to ensure that unwanted emissions power does not exceed the following levels in the 1400-1427 MHz band:

(i) For stations of point-to-point systems in the fixed service: −45 dBW/27 MHz.

(ii) For stations in the mobile service: −60 dBW/27 MHz.

8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	FSK continuous fixed channel	12 VDC

8.1.4 Measurement result:

RF Output Power:

Plot #	Channel	RF Output Power (dBm)	Limit	Result
1	173.075 MHz	24.222	5.0 W / 36.99 dBm	Pass

Spurious Emissions:

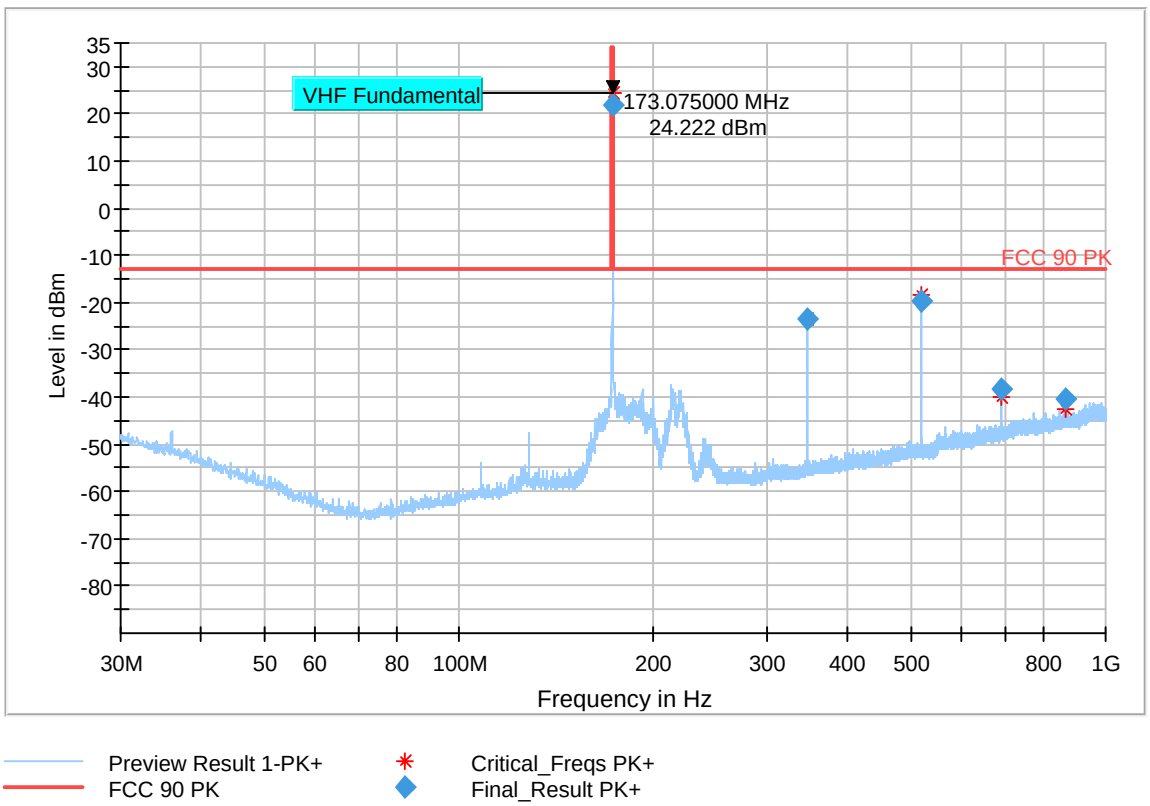
Plot #	Channel	Scan Frequency	Limit	Result
1-2	173.075 MHz	30 MHz – 3 GHz	-13 dBm	Pass

8.1.5 Measurement Plots:

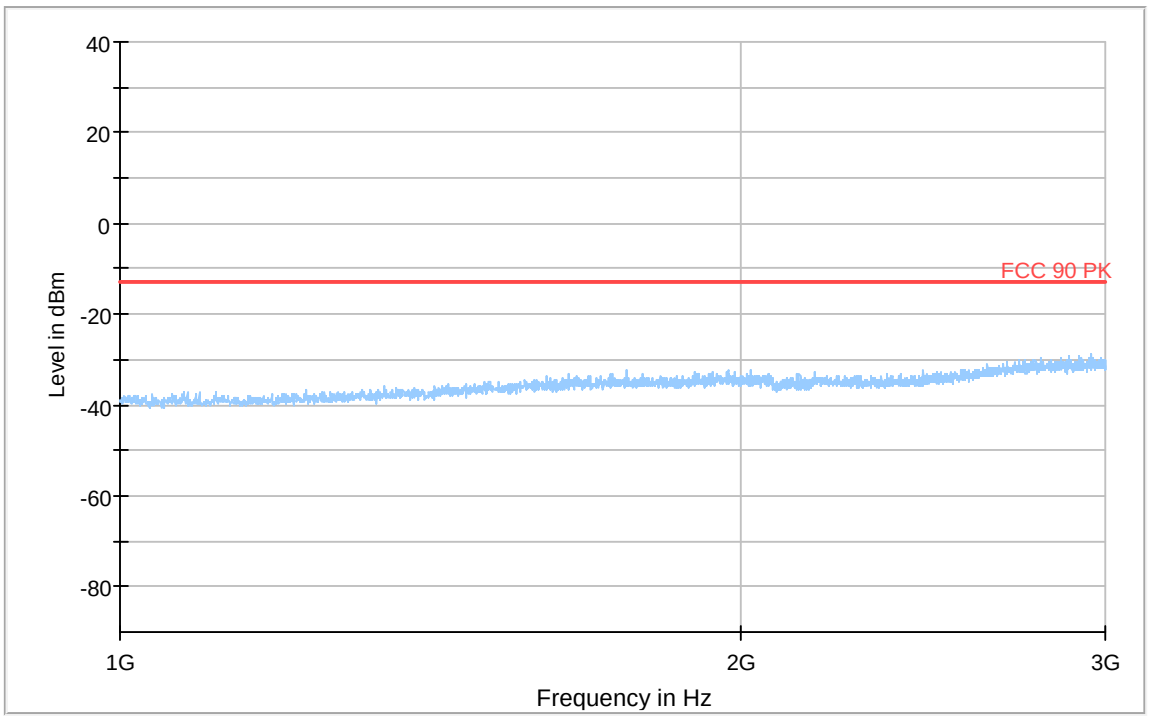
Plot #1 Radiated Emissions: 30 MHz – 1GHz

Modulation: FSK | **Channel: 173.075 MHz**

Frequency (MHz)	MaxPeak (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
173.029	21.79	34.00	12.21	10000.0	100.0	350.0	V	171.0	-83	12:05:06 PM - 3/7/2019
346.156	-23.34	-13.00	10.34	10000.0	100.0	100.0	H	30.0	-79	11:51:37 AM - 3/7/2019
519.185	-19.76	-13.00	6.76	10000.0	100.0	312.0	V	203.0	-75	12:01:45 PM - 3/7/2019
692.280	-38.27	-13.00	25.27	10000.0	100.0	255.0	V	184.0	-71	11:58:16 AM - 3/7/2019
865.371	-40.23	-13.00	27.23	10000.0	100.0	105.0	H	134.0	-69	11:54:33 AM - 3/7/2019



Plot #2 Radiated Emissions: 1-3 GHz	
Modulation: FSK	**Channel: 173.075 MHz**



8.2 Occupied Bandwidth

8.2.1 Measurement according to FCC §2.1049 & FCC §90.20(e)(6) and ANSI C63.26

Refer to Section 5.4.4 Occupied bandwidth – Power bandwidth (99%) measurement procedure of ANSI C63.26 for test procedure.

Spectrum Analyzer settings:

- Set RBW = 1% to 5% of anticipated OBW
- Set the video bandwidth (VBW) ≥ 3 x RBW
- Detector = Peak
- Trace mode = Max hold
- Sweep = Auto couple
- Allow the trace to stabilize
- Filter: FFT

8.2.2 Limits:

According to FCC §90.20(e)(6):

(ii) Any type of emission may be used within a maximum authorized bandwidth of 12.5 kHz, except that stations that operate as part of a stolen vehicle recovery system that was authorized and in operation prior to May 27, 2005 may operate with a maximum authorized bandwidth of 20 kHz until May 27, 2019.

8.2.3 Test conditions and setup:

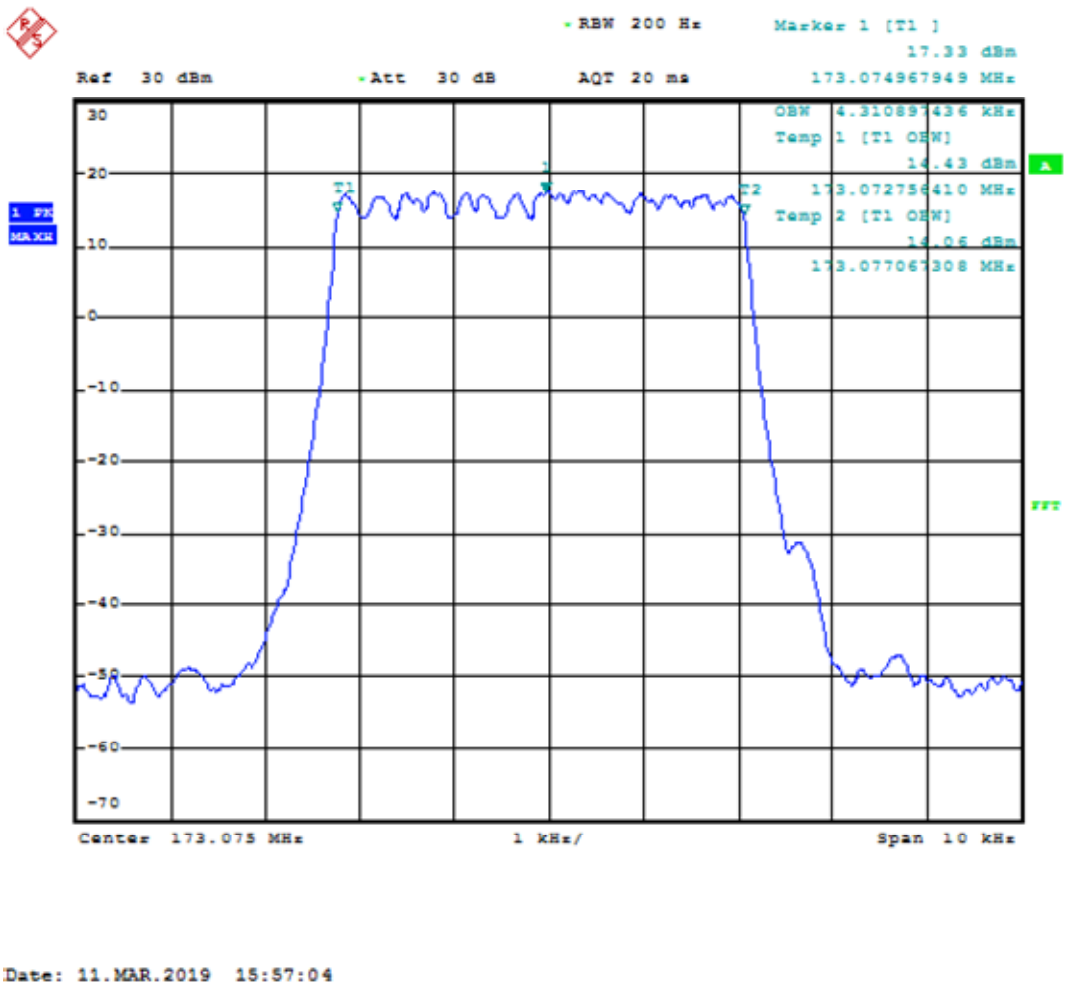
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	FSK continuous fixed channel	12 VDC

8.2.4 Measurement result:

Plot #	Frequency (MHz)	99% Occupied Bandwidth (KHz)	Limit (KHz)	Result
3	173.075	4.3109	< 12.5	Pass

8.2.5 Measurement Plots:

Plot #3		
Channel: 173.075 MHz	**Mode: FSK**	**99% OBW**



8.3 Frequency Stability

8.3.1 Measurement according to FCC §2.1055, §90.213, and ANSI C63.26 (2015)

Refer to FCC §2.1055:

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

8.3.2 Limits:

According to FCC §90.213, measurements of the EUT were made with an applicable limit of 5 ppm:

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]			

[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.

8.3.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	FSK continuous fixed channel	12 VDC, +/- 15% of 12VDC

8.3.4 Results:

Temperature Variation:

Temperature (°C)	Frequency (MHz)	Deviation (KHz)	Deviation (ppm)	Limit (ppm)
-20	173.075048	0.048	0.2773	+/- 5
-10	173.074879	-0.121	-0.6991	+/- 5
0	173.074927	-0.073	-0.4218	+/- 5
10	173.074795	-0.205	-1.1845	+/- 5
20	173.075004	0.004	0.0231	+/- 5
30	173.074927	-0.073	-0.4218	+/- 5
40	173.074823	-0.177	-1.0227	+/- 5
50	173.075056	0.056	0.3236	+/- 5
60	173.074895	-0.105	-0.6067	+/- 5

Note 5: EUT could not be configured to CW signal, so test was performed using FSK modulation. The peak value of the power envelop was measured. Measurements of -10dBc relative from the peak value were taken for both positive (f1) and negative (f2) frequency increments. The center frequency would then be calculated as $\frac{f1+f2}{2}$. Temperature was varied from -20°C to 60°C during the test according to manufacturer specifications. The deviation of the measured frequency from the actual frequency would then be calculated from ppm = $\frac{\text{Measured Frequency} - \text{Actual Frequency}}{\text{Actual Frequency}} \times 1{,}000{,}000$.

Supply Voltage Variation:

Voltage Variation	Voltage (Volts DC)	Frequency (MHz)	Deviation (KHz)	Deviation (ppm)	Limit (ppm)
-15%	10.2	173.074919	-0.081	-0.4680	+/- 5
-10%	10.8	173.075024	0.024	0.1387	+/- 5
-5%	11.4	173.074887	-0.113	-0.6529	+/- 5
0%	12	173.075004	0.004	0.0231	+/- 5
+5%	12.6	173.074919	-0.081	-0.4680	+/- 5
+10%	13.2	173.075024	0.024	0.1387	+/- 5
+15%	13.8	173.074927	-0.073	-0.4218	+/- 5

Note 6: EUT could not be configured to CW signal, so test was performed using FSK modulation. The peak value of the power envelop was measured. Measurements of -10dBc relative from the peak value were taken for both positive (f1) and negative (f2) frequency increments. The center frequency would then be calculated as $\frac{f1+f2}{2}$. Testing was performed at 20°C and using an external DC power supply to set nominal voltage to 12 VDC as well as varying voltage +/- 15% from nominal voltage. The deviation of the measured frequency from the actual frequency would then be calculated from ppm =
$$\frac{\text{Measured Frequency} - \text{Actual Frequency}}{\text{Actual Frequency}} \times 1{,}000{,}000.$$

8.4 Emission Mask

8.4.1 Measurement according to FCC §90.210 and ANSI C63.26

Refer to Section 5.7.3 Out-of-band unwanted emissions measurements of ANSI C63.26 for test procedure.

8.4.2 Limits

According to FCC §90.210, Emission Mask C was applicable:

Applicable Emission Masks

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25[1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174[2]	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512[2 5]	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854[6]	B	H
809-824/854-869[35]	B, D	D, G.
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M
5850-5925[4]		
All other bands	B	C

[2]Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask B or C, as applicable. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.

(c) *Emission Mask C.* For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (f_d/5) dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (f_d^2/11) dB or 50 dB, whichever is the lesser attenuation;

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

8.4.3 Test conditions and setup:

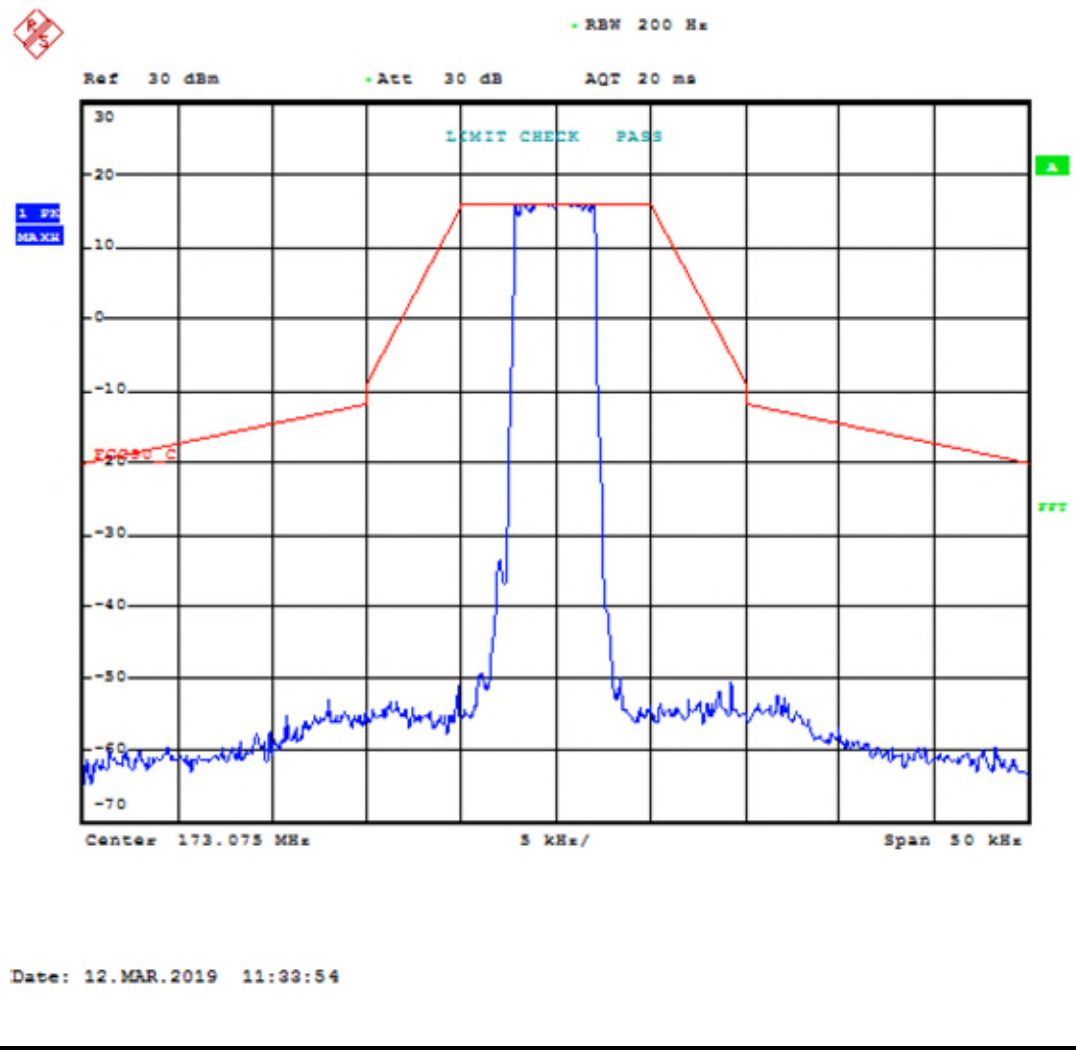
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	FSK continuous fixed channel	12 VDC

8.4.4 Measurement result:

Plot #	Frequency (MHz)	Limit	Result
4	173.075	Emission Mask C	Pass

8.4.5 Measurement Plots:

Plot #4		
Channel: 173.075 MHz	**Mode: FSK**	**Emission Mask C**



8.5 On-Time

8.5.1 Measurement according to FCC §90.20(e)(6)

Spectrum Analyzer settings:

- Detector = Peak
- Trace mode = Clear Write
- Sweep Time = 1 s

8.5.2 Limits

According to FCC §90.20(e)(6):

(e) *Additional frequencies available.* In addition to the frequencies shown in the frequency table of this section, the following frequencies are available in this service. (See also §90.253.)

(6) The frequency 173.075 MHz is available for stolen vehicle recovery systems on a shared basis with Federal stations in the fixed and mobile services.

(v) Transmissions from mobiles shall be limited to 400 milliseconds for every 10 seconds, except when a vehicle is being tracked actively transmissions are limited to 400 milliseconds for every second. Alternatively, transmissions from mobiles shall be limited to 7200 milliseconds for every 300 seconds with a maximum of six such messages in any 30 minute period.

Since the transmitter of EUT is set being tracked actively, the limitation of 400 milliseconds for every second applies.

8.5.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	FSK continuous fixed channel	12 VDC

8.5.4 Measurement result:

Plot #	Modulation	Frequency (MHz)	On Time (ms)	Limit (ms)	Result
5	FSK	173.075	See Note 7	< 400	See Note 7

Note 7: Measurement covered by Declaration from Customer

8.5.5 Measurement Plots:

Plot #5 On-Time measurement for FSK modulation

This measurement will be covered by Declaration from Customer.

8.6 Transient Frequency Behavior

8.6.1 Measurement according to FCC §2.1055, FCC §90.214, and ANSI C63.26

Test procedure was deviated from Section 6.5.2.2 Transient frequency behavior of ANSI C63.26. The measurement was made with an oscilloscope using the TDSJIT3 jitter analysis function. Frequency stability limit of 5 ppm was applicable to this test as stated in FCC §90.213. The mode set on oscilloscope was Time Trend of Clock Period. A frequency mixer was used to demodulate the signal.

8.6.2 Limits:

According to FCC §90.214, 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.

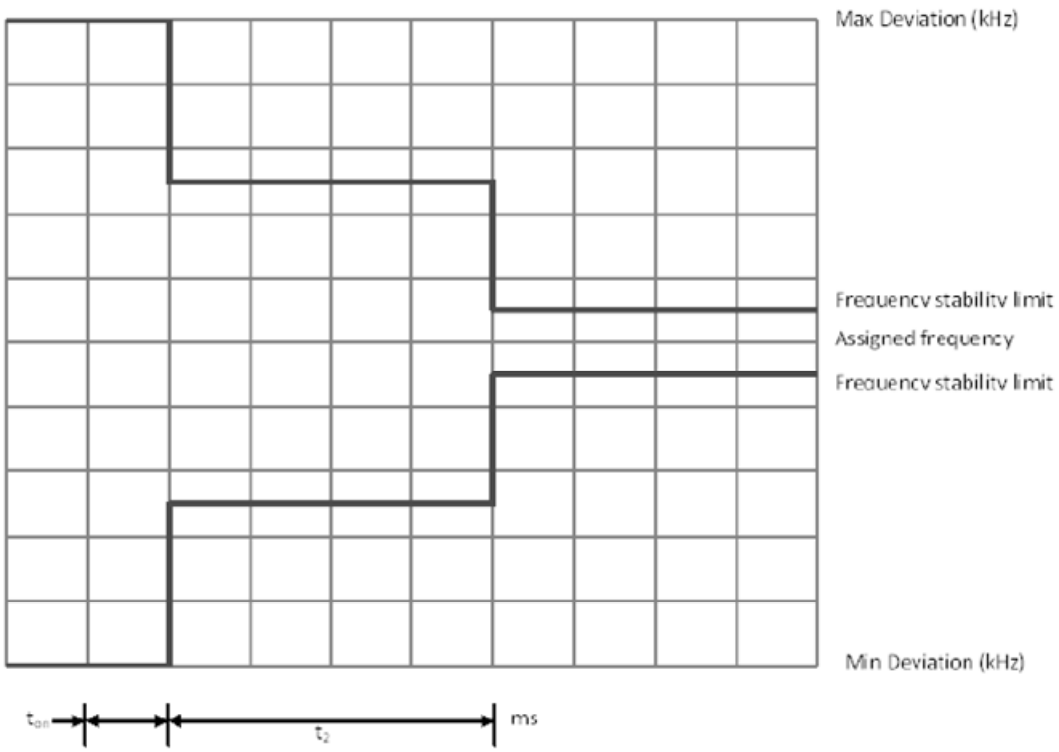
[2] During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in §90.213.

[3] Difference between the actual transmitter frequency and the assigned transmitter frequency.

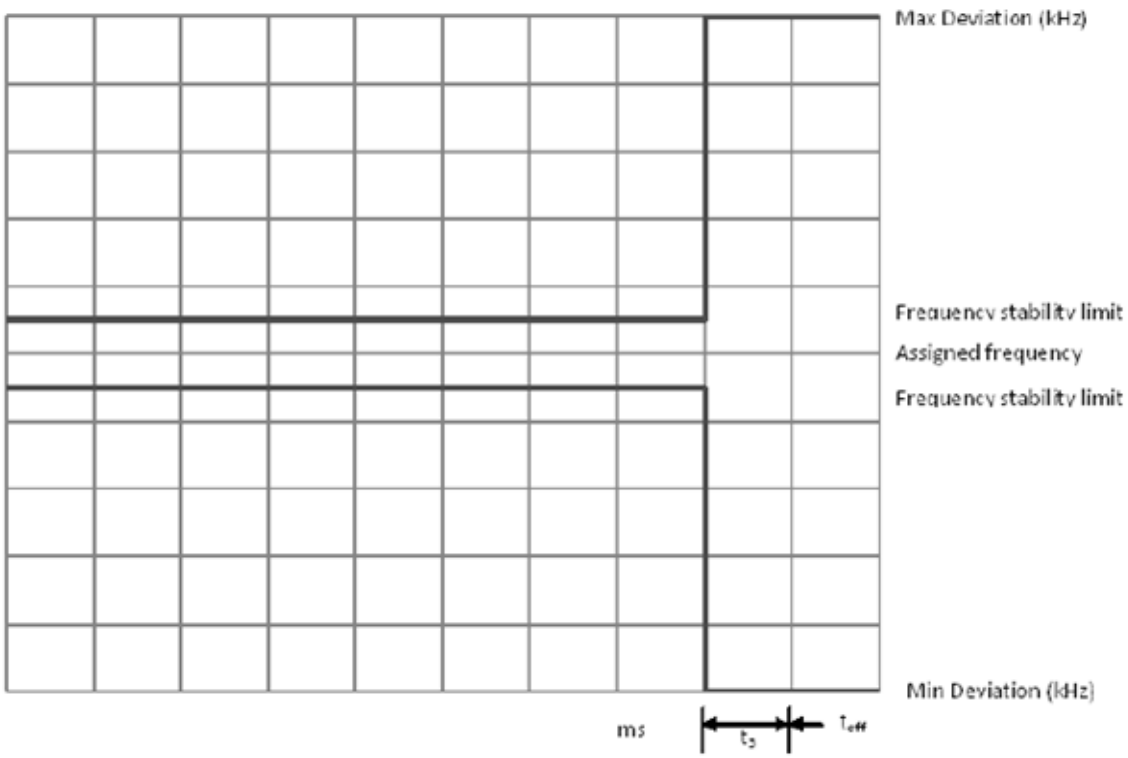
[4] If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

According to Section 6.5.2.2 of ANSI C63.26, the following figures show the transient frequency response in switch on and switch off conditions:

Transient Frequency Response – Switch On Condition



Transient Frequency Response – Switch Off Condition



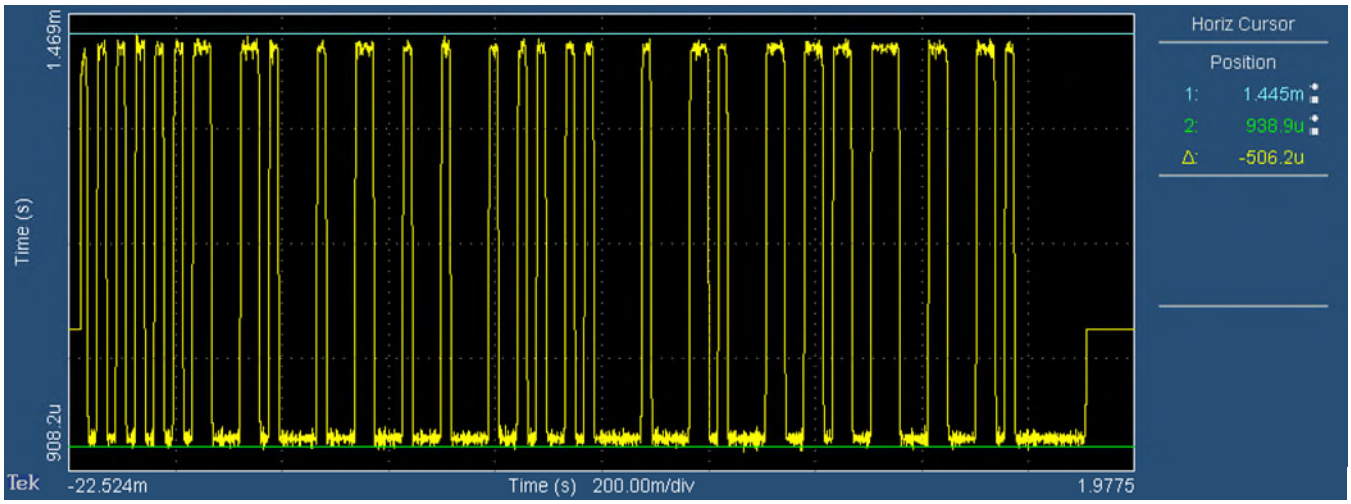
8.6.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	FSK continuous fixed channel	12 VDC

8.6.4 Measurement result:

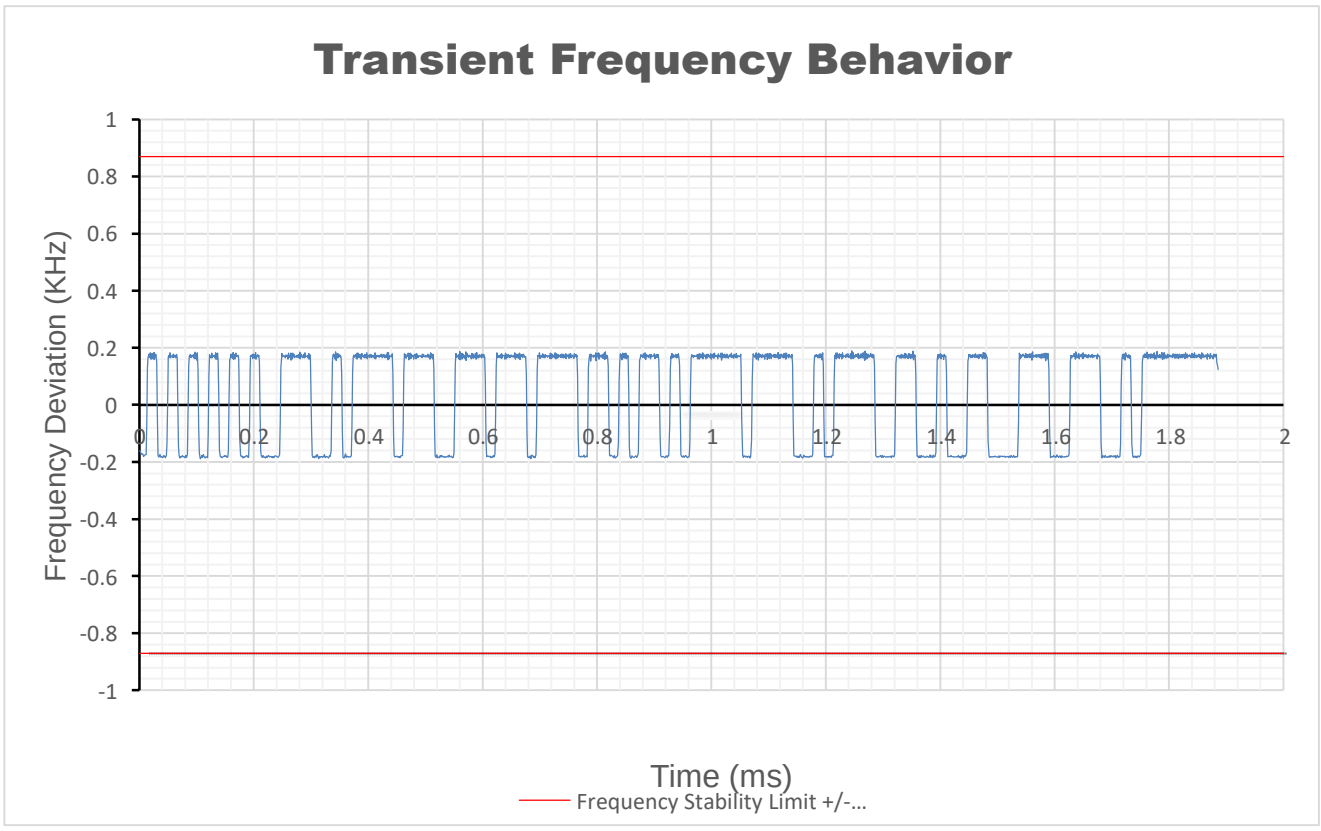
Plot #	Modulation	Frequency (MHz)	Limit	Result
6	FSK	173.075	< 0.87 KHz	Pass

Oscilloscope Jitter Analysis:



8.6.5 Measurement Plots:

Plot #6	
Channel: 173.075 MHz	**Mode: FSK**



9 Test setup photos

Setup photos are included in supporting file name: "EMC_CALAM_086_19001_FCC_90_Setup_Photos.pdf"

10 Test Equipment And Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
BILOG ANTENNA	TESEO	CBL 6141B	41106	3 YEARS	11/01/2017
HORN ANTENNA	ETS.LINDGREN	3115	00035114	3 YEARS	07/31/2017
SIGNAL ANALYZER	R&S	FSU26	200065	2 YEARS	07/03/2017
SIGNAL ANALYZER	R&S	FSV 40	101022	3 YEARS	07/05/2017
DIGITAL BAROMETER	VWR	35519-055	91119547	2 YEARS	06/20/2017
THERMOMETER HUMIDITY MONITOR	CONTROL COMPANY	36934-164	191871994	2 YEARS	01/10/2019
OSCILLOSCOPE	TEKTRONIX	DPO 7254	B044030	1 YEAR	03/28/2018
SIGNAL GENERATOR	AGILENT	E4433B	ESG 2	N/A	N/A
FREQUENCY MIXER	WATKINS JOHNSON	M2AC	0120259433	N/A	N/A
DC Power Supply	BK PRECISION	1672	16720022606 11085	N/A	N/A
DC Power Supply	AGILENT	E3634A	MY53290018	N/A	N/A
TEMPERATURE HUMIDITY CHAMBER	TESTEQUITY	123H	N/A	N/A	N/A

Note: Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels. Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.

11 Revision History

Date	Report Name	Changes to report	Report prepared by
2019-05-10	EMC_CALAM_086_19001_FCC_90	Initial version	Chin Ming Lui