EMC Test Report
Application for Grant of Equipment Authorization
FCC Part 15 Subpart C

Model: 2.4GHz Transceiver Module for Ctrax CT Series

FCC ID:	Z2CCTRAX
APPLICANT:	Contact Controls 982 Main Street Suite 4, PMB 118 Fishkill, NY 12524
TEST SITE(S):	Elliott Laboratories 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-3; 2845B-5
REPORT DATE:	December 21, 2011
FINAL TEST DATES:	August 11, 12 and 31, September 1 and October 21, 2011
TOTAL NUMBER OF PAGES:	38

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A2LA ACCREDITED
Testing Cert #2016.01

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	12-21-2011	First release	

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SCOPE

An electromagnetic emissions test has been performed on the Contact Controls model 2.4GHz Transceiver Module for Ctrax CT Series, pursuant to the following rules:

FCC Part 15 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in Elliott Laboratories test procedures:

ANSI C63.4:2003

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer's declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of Contact Controls model 2.4GHz Transceiver Module for Ctrax CT Series complied with the requirements of the following regulations:

FCC Part 15 Subpart C

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

The test results recorded herein are based on a single type test of Contact Controls model 2.4GHz Transceiver Module for Ctrax CT Series and therefore apply only to the tested sample. The sample was selected and prepared by Chris Wichman of Contact Controls.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

DEVICES OPERATING IN THE 902 – 928 / 2400 – 2483.5 / 5725 – 5850 MHz BANDS PER 15.249

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.249 (a)	RSS 210 A2.9 (1)	Fundamental Signal Strength	9.44mV/m @ 3m	50mV/m @ 3m	Complies
15.249 (a) / 15.209	RSS 210 A2.9 (1) & Table 2	Radiated Spurious Emissions, 30 - 25000 MHz	51.4dBµV/m (417uV/m) @ 7322.5MHz (-2.6dB)	Harmonics 500uV/m @ 3m or general limits (see page 16)	Complies

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	The antenna is a trace antenna integral to the module	Unique or integral antenna required	Complies
15.207	RSS GEN Table 2	AC Conducted Emissions	4.90dBµV @ 2.141MHz (-41.1dB)	Refer to page	Complies
15.109	RSS GEN 7.2.3 Table 1	Receiver spurious emissions	50.3dBµV/m @ 2793.0MHz (-3.7dB)	Refer to page 17	Complies

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF power, conducted (power meter)	dBm	25 to 7000 MHz	± 0.52 dB
RF power, conducted (Spectrum analyzer)	dBm	25 to 7000 MHz	± 0.7 dB
Conducted emission of transmitter	dBm	25 to 26500 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 26500 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 26500 MHz	± 2.5 dB
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dBµV	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Contact Controls model 2.4GHz Transceiver Module for Ctrax CT Series is designed for use in the Contact Controls wireless electrical energy power meters.

The CT-6000 is a device that tracks electrical energy (known as a Kilowatt meter) for tracking or billing purposes and is read by means of a wireless device.

The sample was received on August 11, 2011 and tested on August 11, 12 and 31, September 1 and October 21, 2011. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Contact Controls	2.4GHz Transceiver Module	2.4GHz Transceiver	N/A	Z2CCTRAX

OTHER EUT DETAILS

During testing, the EUT was mounted to the CT-6000.

ANTENNA SYSTEM

The antenna is a PCB trace antenna (1 dBi) located on the module.

ENCLOSURE

The EUT has no enclosure. It is designed to be installed within the enclosure of a host computer.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at Elliott.

SUPPORT EQUIPMENT

No support equipment was used during testing.

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
AC Power	AC Mains	2wire	Unshielded	1.5

EUT OPERATION

During emissions testing the EUT was RF transmitting a modulated signal at the maximum output power.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission and with industry Canada.

Site	Registration Numbers		Location
	FCC	Canada	
Chamber 3	769238	2845B-3	41039 Boyce Road Fremont, CA 94538-2435
Chamber 5	211948	2845B-5	

ANSI C63.4:2003 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4:2003.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4:2003. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4:2003 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4:2003.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements. If the repetition frequency of the signal being measured is below 20Hz, peak measurements are made in lieu of Quasi-Peak measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1m above the ground plane.

ANSI C63.4:2003 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4:2003, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

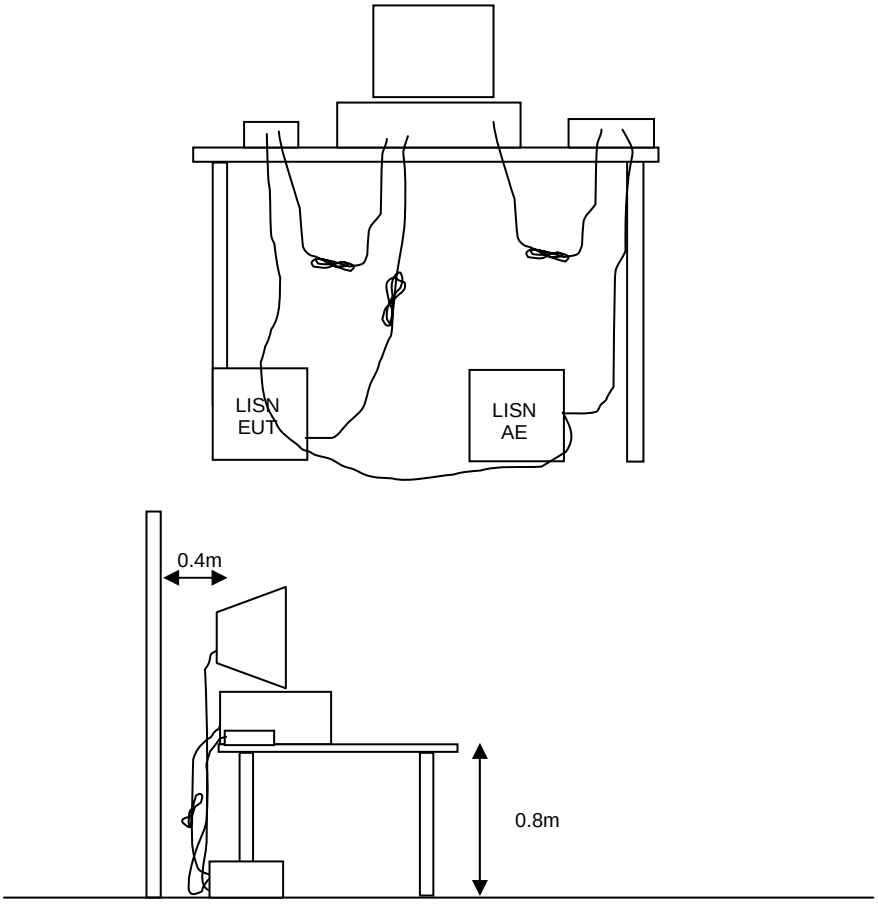


Figure 1 Typical Conducted Emissions Test Configuration

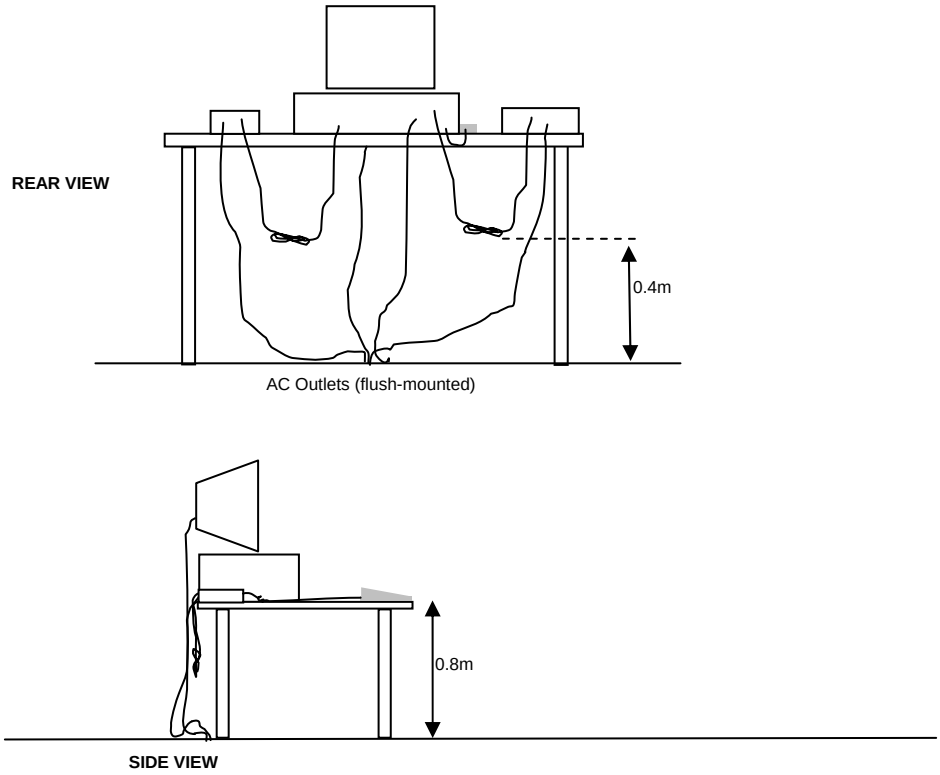
RADIATED EMISSIONS

A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

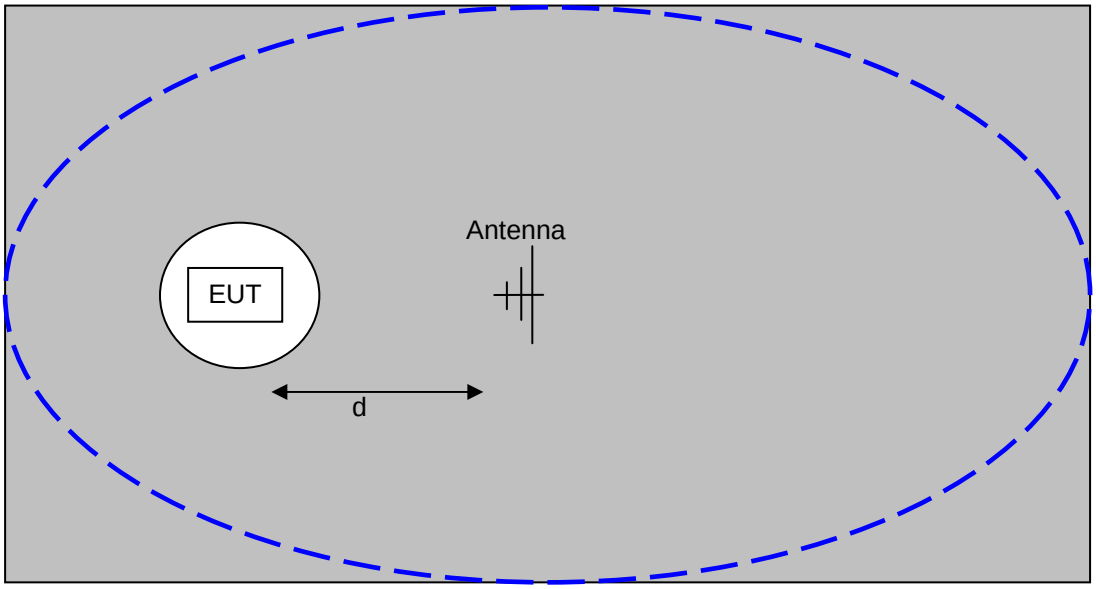
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain.

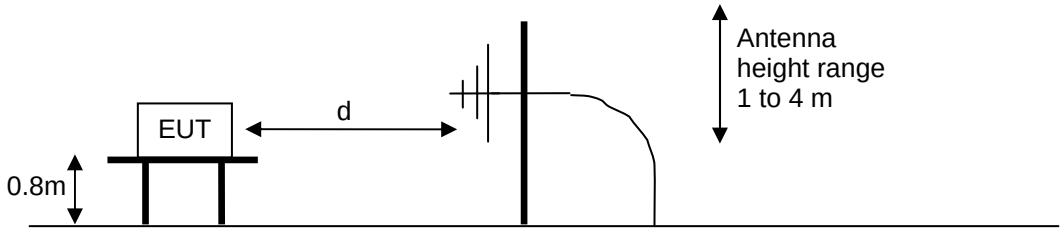
When testing above 18 GHz, the receive antenna is located at 1meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.



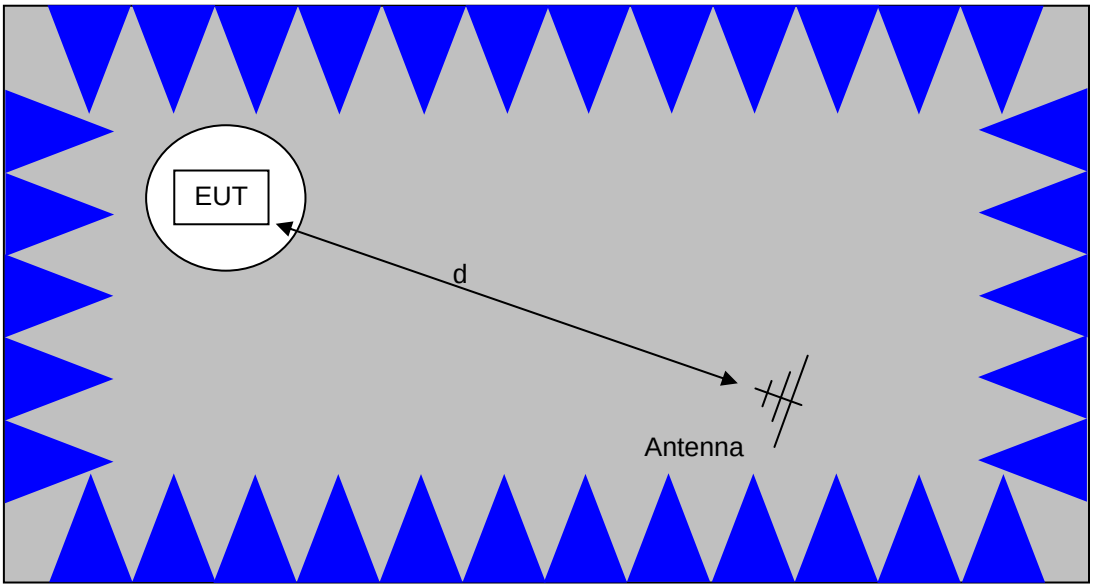
Typical Test Configuration for Radiated Field Strength Measurements



The ground plane extends beyond the ellipse defined in CISPR 16 / CISPR 22 / ANSI C63.4 and is large enough to accommodate test distances (d) of 3m and 10m. Refer to the test data tables for the actual measurement distance.

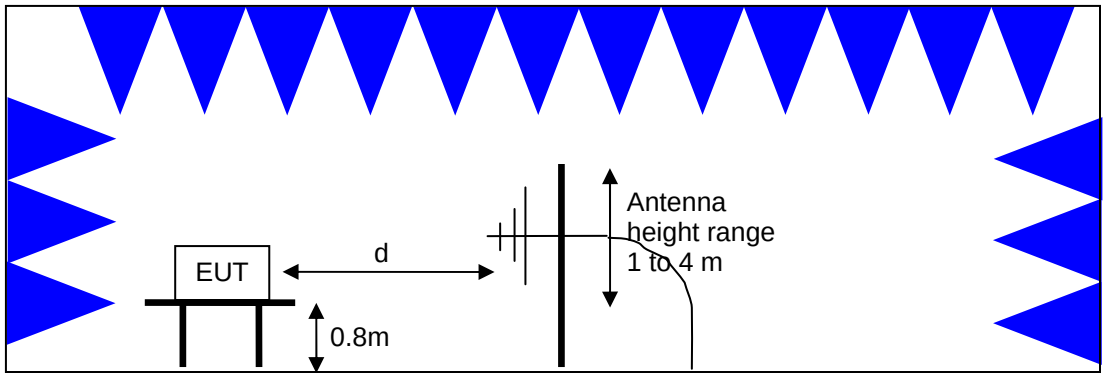


Test Configuration for Radiated Field Strength Measurements
OATS- Plan and Side Views



The anechoic materials on the walls and ceiling ensure compliance with the normalized site attenuation requirements of CISPR 16 / CISPR 22 / ANSI C63.4 for an alternate test site at the measurement distances used.

Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



Test Configuration for Radiated Field Strength Measurements
Semi-Anechoic Chamber, Plan and Side Views

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS GEN.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1] (with the exception of transmitters operating under FCC Part 15 Subpart D and RSS 210 Annex 9), the limits for all emissions from a low power device operating under the general rules of RSS 310 (tables 3 and 4), RSS 210 (table 2) and FCC Part 15 Subpart C section 15.209.

Frequency Range (MHz)	Limit (uV/m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100 @ 3m	40 @ 3m
88 to 216	150 @ 3m	43.5 @ 3m
216 to 960	200 @ 3m	46.0 @ 3m
Above 960	500 @ 3m	54.0 @ 3m

[1] The restricted bands are detailed in FCC 15.203, RSS 210 Table 1 and RSS 310 Table 2

RECEIVER RADIATED SPURIOUS EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from receivers as detailed in FCC Part 15.109, RSS 210 Table 2, RSS GEN Table 1 and RSS 310 Table 3. Note that receivers operating outside of the frequency range 30 MHz – 960 MHz are exempt from the requirements of 15.109.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

RADIATEDFUNDAMENTAL & SPURIOUS EMISSIONS SPECIFICATION LIMITS – 15.249 and RSS 210 A2.9

The table below shows the limits for the fundamental emission and for its harmonics. Harmonics that that fall in restricted bands[2] and all other spurious emissions are subject to the general limits of RSS 210 and FCC Part 15 Subpart C.

Frequency Range (MHz)	Limit for Fundamental @ 3m	Limit for Harmonics @ 3m
902 – 928	50,000 uV/m 94dBuV/m	500 uV/m 54dBuV/m
2400 – 2483.5	50,000 uV/m 94dBuV/m	500 uV/m 54dBuV/m
5725 - 5850	50,000 uV/m 94dBuV/m	500 uV/m 54dBuV/m

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

[2] The restricted bands are detailed in FCC 15.203, RSS 210 Table 1 and RSS 310 Table 2

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor, when used for electric field measurements above 30MHz, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS - FIELD STRENGTH TO EIRP CONVERSION

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp), or where a field strength measurement of output power is made in lieu of a direct measurement, the following formula is used to convert between eirp and field strength at a distance of d (meters) from the equipment under test:

$$E = \frac{1000000 \sqrt{30 P}}{d} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For a measurement at 3m the conversion from a logarithmic value for field strength (dBuV/m) to an eirp power (dBm) is -95.3dB.

Appendix A Test Equipment Calibration Data

Conducted Emissions - AC Power Ports, 12-Aug-11

Manufacturer	Description	Model	Asset #	Cal Due
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	13-Apr-12
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2197	29-Dec-11
Com-Power Corp.	Preamplifier, 30-1000 MHz	PAM-103	2380	13-Apr-12

Radiated Emissions, 30 - 1,000 MHz, 12-Aug-11

Manufacturer	Description	Model	Asset #	Cal Due
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	4/13/2012
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2197	12/29/2011
Com-Power Corp.	Preamplifier, 30-1000 MHz	PAM-103	2380	4/13/2012

Conducted Emissions - AC Power Ports, 12-Aug-11

Manufacturer	Description	Model	Asset #	Cal Due
EMCO	LISN, 10 kHz-100 MHz, 25A	3825/2	1292	3/1/2012
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	4/21/2012
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	4/13/2012

Radiated Emissions, 1,000 - 6,500 MHz, 31-Aug-11

Manufacturer	Description	Model	Asset #	Cal Due
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	8/2/2012
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	2/23/2012
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	2415	7/28/2012

Appendix B Test Data

T84184 Pages 22 – 37

Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		-
Emissions Standard(s):	15.249	Class:	-
Immunity Standard(s):	-	Environment:	-

EMC Test Data

For The

Contact Controls

Model

CT-6000

Date of Last Test: 8/31/2011

Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	-

Conducted Emissions

(Elliott Laboratories Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 8/12/2011
Test Engineer: Joseph Cadigal
Test Location: Fremont Chamber #3

Config. Used: 1
Config Change: none
EUT Voltage: 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN. A second LISN was used for all local support equipment. Remote support equipment was located outside of the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

Ambient Conditions:

Temperature: 20-25 °C
Rel. Humidity: 35-45 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power,120V/60Hz	Class B	Pass	4.90dBµV @ 2.141MHz (-41.1dB)

Modifications Made During Testing

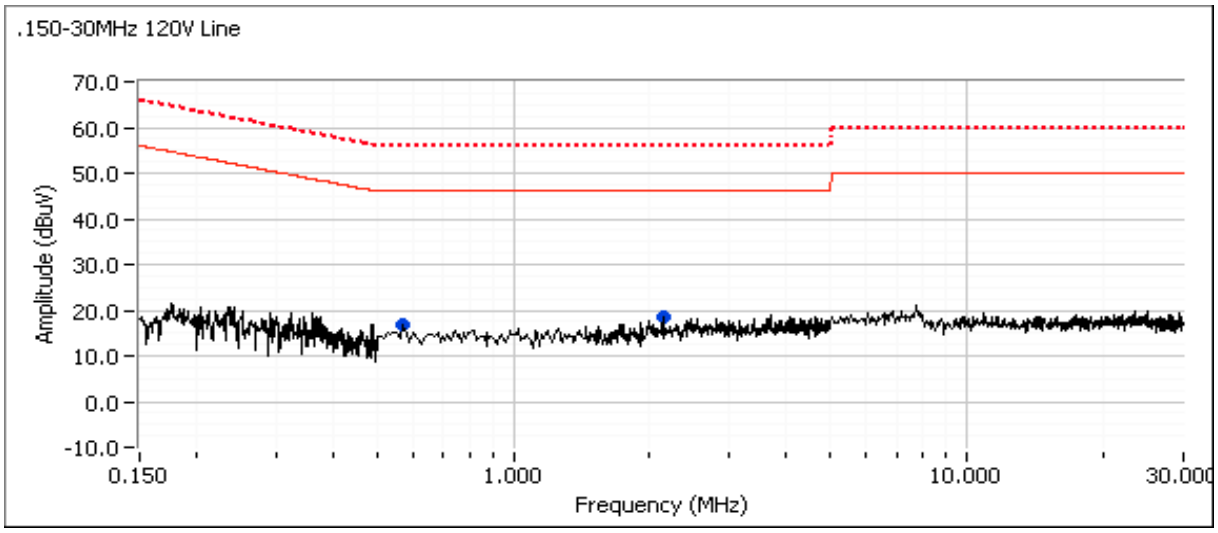
No modifications were made to the EUT during testing

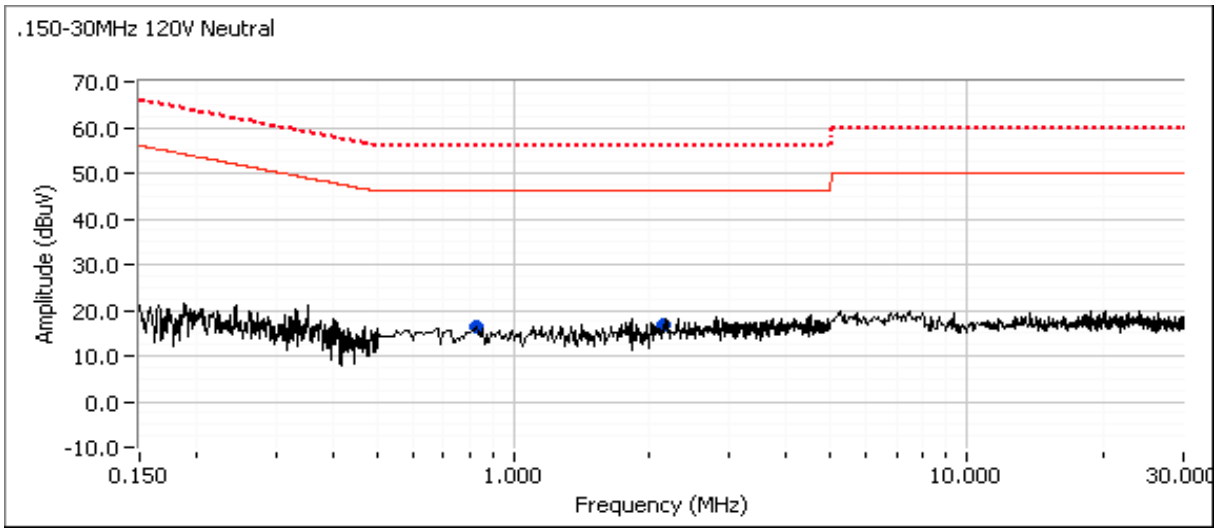
Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	-

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz





Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	-

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	AC	Class B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.570	17.0	Line 1	46.0	-29.0	Peak	
2.139	18.5	Line 1	46.0	-27.5	Peak	
2.141	17.0	Neutral	46.0	-29.0	Peak	
0.821	16.5	Neutral	46.0	-29.5	Peak	

Final quasi-peak and average readings

Frequency	Level	AC	Class B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
2.141	4.9	Neutral	46.0	-41.1	AVG	AVG (0.10s)
2.139	4.8	Line 1	46.0	-41.2	AVG	AVG (0.10s)
0.570	4.5	Line 1	46.0	-41.5	AVG	AVG (0.10s)
0.821	4.2	Neutral	46.0	-41.8	AVG	AVG (0.10s)
2.139	9.1	Line 1	56.0	-46.9	QP	QP (1.00s)
2.141	9.1	Neutral	56.0	-46.9	QP	QP (1.00s)
0.570	9.0	Line 1	56.0	-47.0	QP	QP (1.00s)
0.821	8.5	Neutral	56.0	-47.5	QP	QP (1.00s)

Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

RSS 210 and FCC 15.249 Radiated Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

Ambient Conditions:

Temperature: 20-25 °C

Rel. Humidity: 35-45 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Channel	Channel	Power Setting	Measured Power	Test Performed	Limit	Result / Margin
1	Low	2402	-20 dBm		Fundamental Field Strength	FCC Part 15.249	73.6dBµV/m @ 2401.8MHz (-20.4dB)
			-20 dBm		Restricted Band Edge (2400 MHz)	FCC Part 15.209	42.6dBµV/m @ 2383.6MHz (-11.4dB)
2	High	2482	-20 dBm		Fundamental Field Strength	FCC Part 15.249	77.3dBµV/m @ 2481.8MHz (-16.7dB)
			-20 dBm		Restricted Band Edge (2483.5 MHz)	FCC Part 15.209	48.8dBµV/m @ 2483.5MHz (-5.2dB)
3	Middle	2441	-20 dBm		Fundamental Field Strength	FCC Part 15.249	79.5dBµV/m @ 2440.8MHz (-14.5dB)
4	Low, Middle, High	2402, 2441, 2482	-20 dBm		99% BW	N/A - Informative Only	599kHz

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

Run #1: Radiated Spurious Emissions, Fundamental and Bandedge

Date of Test: 9/1/2011 Test Location: FT Chamber #5

Test Engineer: Mehran Birgani

Run #1: Low Channel @ 2402 MHz with -20dBm power setting

Fundamental Signal Field Strength: Peak and average values measured in 1 MHz.

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
2401.840	73.6	H	94.0	-20.4	AVG	175	1.0	RB 1 MHz;VB 10 Hz;Pk
2401.760	74.4	H	114.0	-39.6	PK	175	1.0	RB 1 MHz;VB 3 MHz;Pk
2401.770	69.7	V	94.0	-24.3	AVG	79	1.3	RB 1 MHz;VB 10 Hz;Pk
2401.730	70.2	V	114.0	-43.8	PK	79	1.3	RB 1 MHz;VB 3 MHz;Pk

2390 MHz Band Edge Signal Radiated Field Strength - Marker Delta

	H	V	
Fundamental emission level @ 3m in 1MHz RBW:	74.4	70.2	Peak Measurement (RB=VB=1MHz)
Fundamental emission level @ 3m in 1MHz RBW:	73.6	69.7	Average Measurement (RB=1MHz, VB=10Hz)

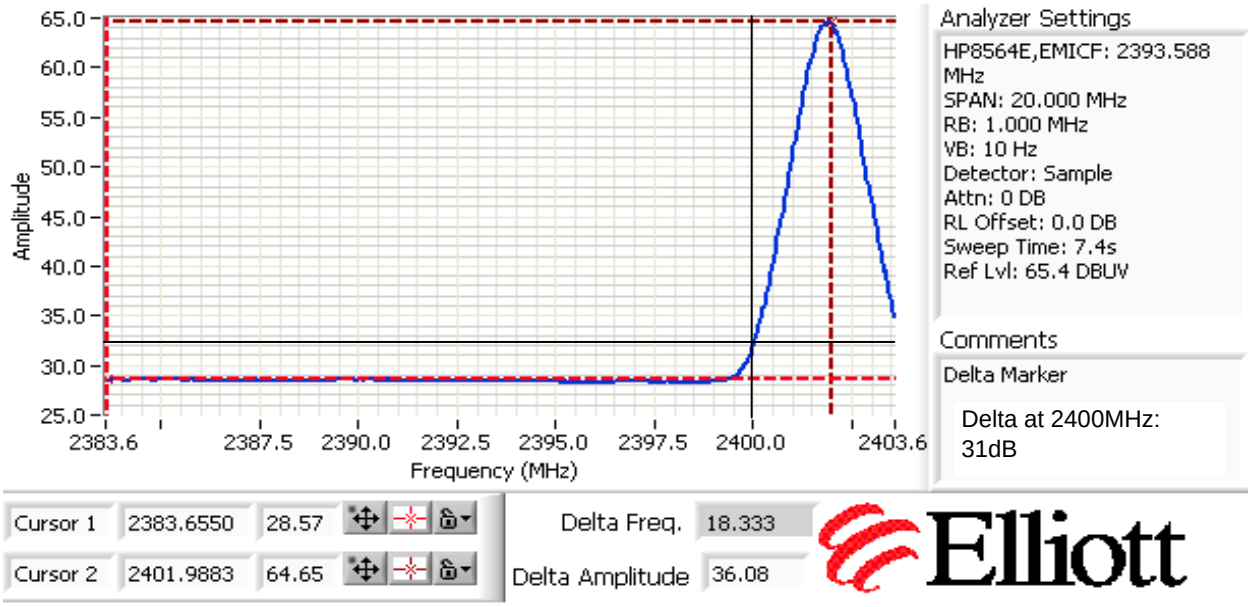
Delta Marker - 30kHz	*dB*	<- this can only be used if band edge signal is highest within 2MHz of band edge.
Calculated Band-Edge Measurement (Peak):	74.4 dBuV/m	
Calculated Band-Edge Measurement (Avg):	73.6 dBuV/m	
Delta Marker - 1MHz/1MHz:	*23.0 dB*	
Delta Marker - 1MHz/10Hz:	31.0 *dB*	
Calculated Band-Edge Measurement (Peak):	51.4 dBuV/m	Using 1MHz delta value
Calculated Band-Edge Measurement (Avg):	42.6 dBuV/m	Using 1MHz delta value

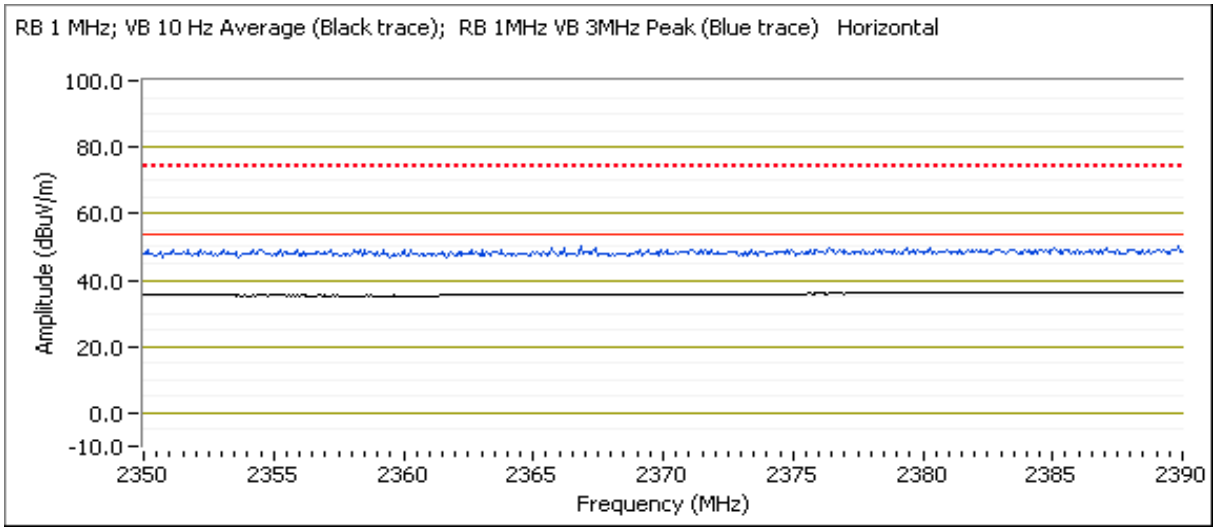
Margin	Level	Limit	Detector
-11.4	42.6	54	Avg
-22.6	51.4	74	Pk

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
2400.000	42.6	-	54.0	-11.4	Avg	-	-	Using 1MHz delta value

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
2383.600	42.6	H	54.0	-11.4	AVG	180	1.0	RB 1 MHz;VB 10 Hz;Pk
2386.330	51.4	H	74.0	-22.6	PK	180	1.0	RB 1 MHz;VB 3 MHz;Pk

Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A





Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

Run #2: High Channel @ 2482 MHz

Fundamental Signal Field Strength: Peak and average values measured in 1 MHz.

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
2481.820	77.3	H	94.0	-16.7	AVG	186	1.0	RB 1 MHz;VB 10 Hz;Pk
2481.710	77.7	H	114.0	-36.3	PK	186	1.0	RB 1 MHz;VB 3 MHz;Pk
2481.620	71.6	V	94.0	-22.4	AVG	77	1.0	RB 1 MHz;VB 10 Hz;Pk
2481.760	72.4	V	114.0	-41.6	PK	77	1.0	RB 1 MHz;VB 3 MHz;Pk

2483.5 MHz Band Edge Signal Radiated Field Strength - Marker Delta

	H	V	
Fundamental emission level @ 3m in 1MHz RBW:	77.7	72.4	Peak Measurement (RB=VB=1MHz)
Fundamental emission level @ 3m in 1MHz RBW:	77.3	71.6	Average Measurement (RB=1MHz, VB=10Hz)
Delta Marker - 30kHz	*dB*		<- this can only be used if band edge signal is highest within 2MHz of band edge.
Calculated Band-Edge Measurement (Peak):	77.7 dBuV/m		
Calculated Band-Edge Measurement (Avg):	77.3 dBuV/m		

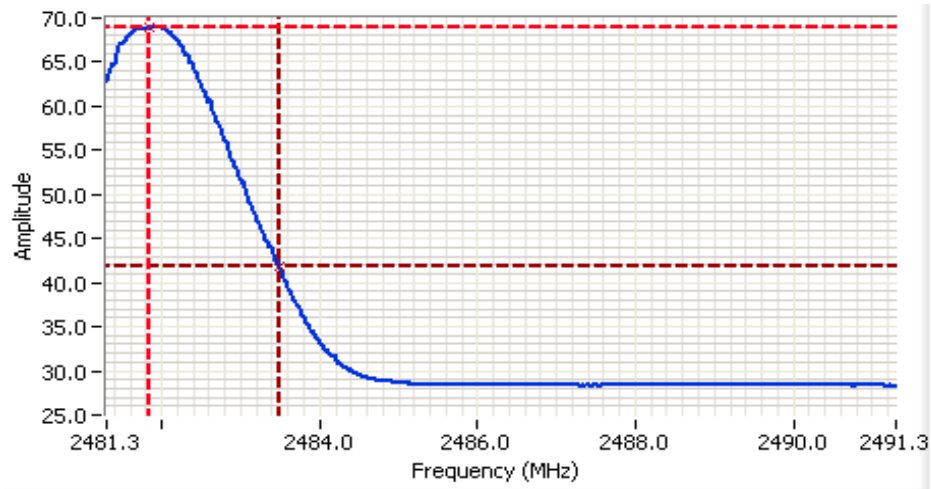
		Margin	Level	Limit	Detector
Delta Marker - 1MHz/3MHz:	*20.7 dB*	-3.8	50.2	54	Avg
Delta Marker - 1MHz/10Hz:	27.1 *dB*	-17.0	57.0	74	Pk
Calculated Band-Edge Measurement (Peak):	57.0 dBuV/m	Using 1MHz delta value			
Calculated Band-Edge Measurement (Avg):	50.2 dBuV/m	Using 1MHz delta value			

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
2485.453	50.2	H	54.0	-3.8	AVG	187	1.0	Using 1MHz delta value

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.500	48.8	H	54.0	-5.2	AVG	180	1.0	RB 1 MHz;VB 10 Hz;Pk
2483.530	53.3	H	74.0	-20.7	PK	180	1.0	RB 1 MHz;VB 3 MHz;Pk

Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A



Analyzer Settings

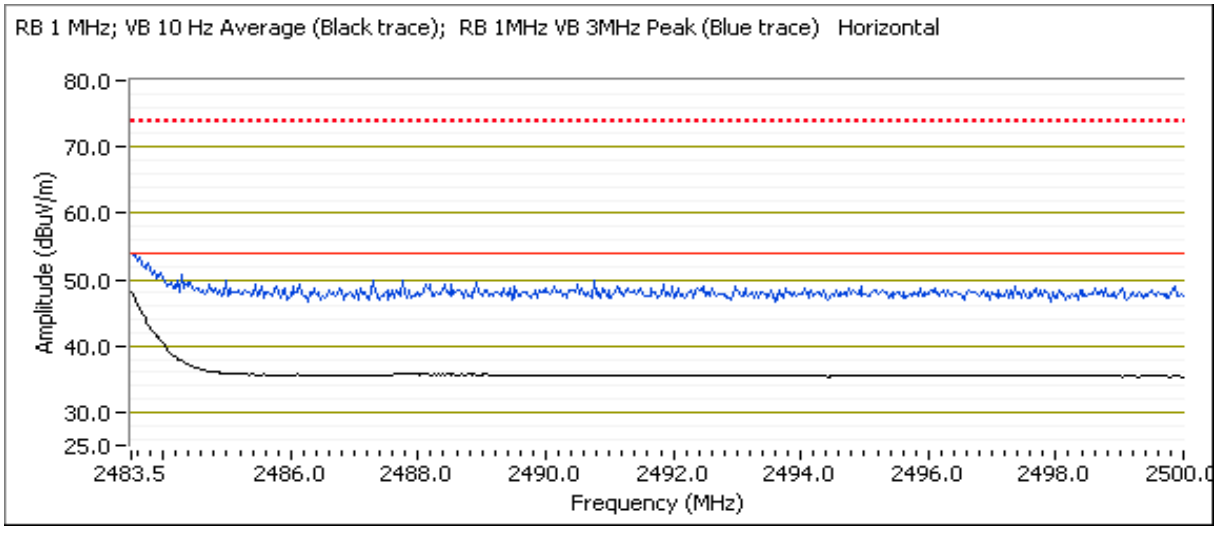
HP8564E,EMICF: 2486.300 MHz
SPAN: 10.000 MHz
RB: 1.000 MHz
VB: 10 Hz
Detector: Sample
Attn: 0 DB
RL Offset: 0.0 DB
Sweep Time: 5.0s
Ref Lvl: 74.9 DBUV

Comments

Delta Marker

Cursor 1	2481.8501	68.98	Delta Freq.	1.650
Cursor 2	2483.5000	41.90	Delta Amplitude	27.08

Elliott



Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

Run #3: Radiated Spurious Emissions, Fundamental and Bandedge
Mid Channel @ 2441 MHz with -20dBm power setting

Date of Test: 10/21/2011 Test Location: FT#3
Test Engineer: Mark Hill

Fundamental Signal Field Strength: Peak and average values measured in 1 MHz.

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
2440.750	79.5	H	94.0	-14.5	AVG	172	1.0	RB 1 MHz;VB 10 Hz;Pk
2441.050	79.9	H	114.0	-34.1	PK	172	1.0	RB 1 MHz;VB 3 MHz;Pk
2440.850	68.4	V	94.0	-25.6	AVG	184	1.0	RB 1 MHz;VB 10 Hz;Pk
2440.920	69.9	V	114.0	-44.1	PK	184	1.0	RB 1 MHz;VB 3 MHz;Pk

Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

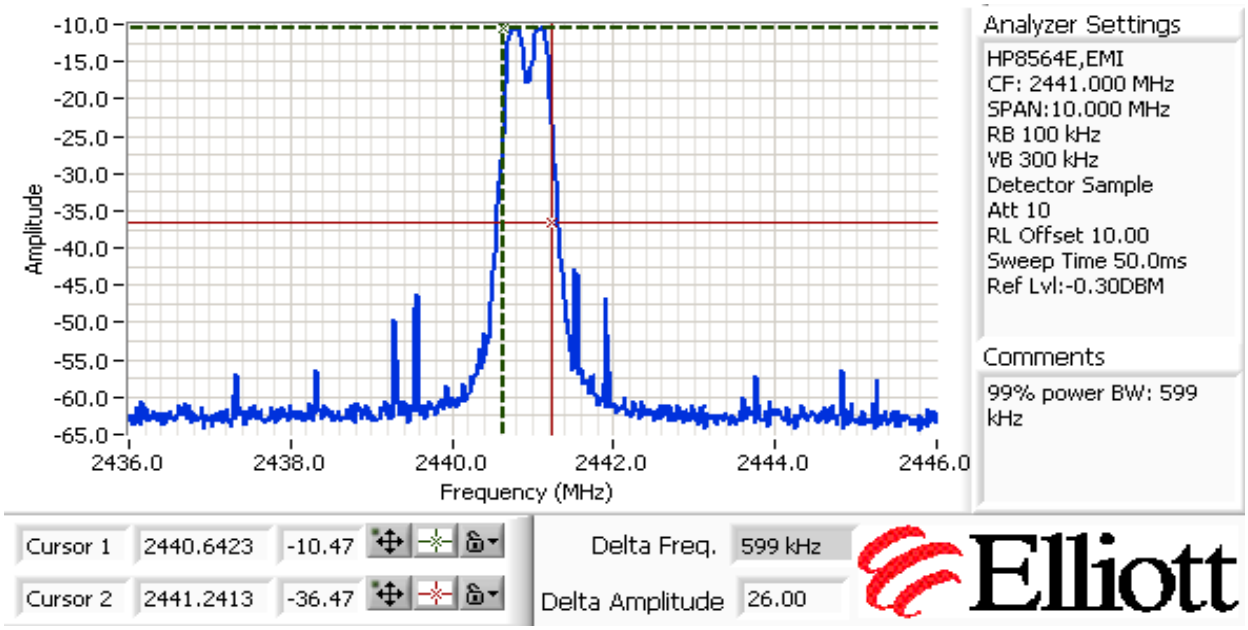
Run #4: Signal Bandwidth

Date of Test: 10/21/2011 Test Location: FT#3

Test Engineer: Mark Hill

Power Setting	Frequency (MHz)	Resolution Bandwidth	Bandwidth (MHz)	
			6dB	99%
-20	2402	100kHz	-	0.566
-20	2441	100kHz	-	0.599
-20	2482	100kHz	-	0.566

Note 1:	99% bandwidth measured in accordance with RSS GEN, with RB > 1% of the span and VB > 3xRB



Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

RSS 210 and FCC 15.249 Radiated Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

Ambient Conditions:

Temperature: 20-25 °C
Rel. Humidity: 35-45 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Channel	Channel	Power Setting	Measured Power	Test Performed	Limit	Result / Margin
1a	Low	2402	-20 dBm		Radiated Emissions 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	48.3dBµV/m @ 7206.1MHz (-5.7dB)
1b	Center	2441	-20 dBm		Radiated Emissions 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	51.4dBµV/m @ 7322.5MHz (-2.6dB)
1c	High	2482	-20 dBm		Radiated Emissions 1 - 26 GHz	FCC Part 15.209 / 15.247(c)	47.7dBµV/m @ 7445.0MHz (-6.3dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Notes:

No transmitter spurious emissions below 1GHz were observed.
Initial testing was performed with the EUT transmitting at a power level that exceeded the final output power level.

Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

Run #1: Radiated Spurious Emissions, 30 - 25,000 MHz.

Date of Test: 8/11/2011 Test Location: FT Chamber #5

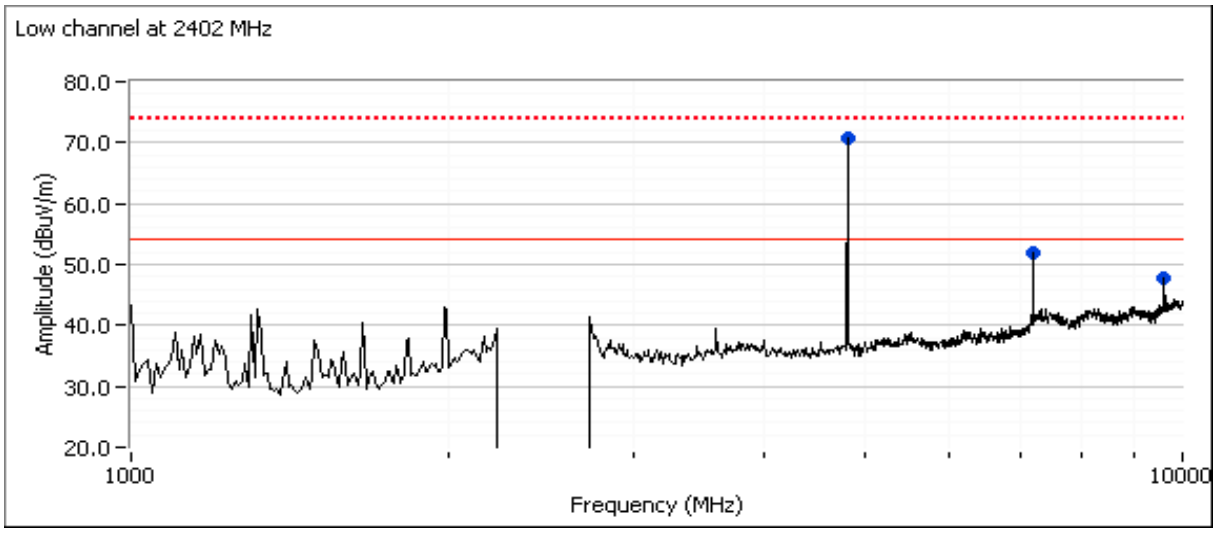
Test Engineer: Mehran Birgani/ Joseph Cadigal

Run #1a: Low Channel @ 2402 MHz with -5dBm power setting

Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7206.120	48.3	V	54.0	-5.7	AVG	53	1.7	RB 1 MHz;VB 10 Hz;Pk
4804.060	40.6	H	54.0	-13.4	AVG	303	1.3	setting = -20dBm
9614.330	37.1	H	54.0	-16.9	AVG	226	1.3	RB 1 MHz;VB 10 Hz;Pk
7206.110	52.4	V	74.0	-21.6	PK	53	1.7	RB 1 MHz;VB 3 MHz;Pk
9612.990	48.8	H	74.0	-25.2	PK	226	1.3	RB 1 MHz;VB 3 MHz;Pk
4803.480	45.9	H	74.0	-28.1	PK	303	1.3	setting = -20dBm

Note 1:	For emissions in restricted bands, the limit of 15.209 was used.

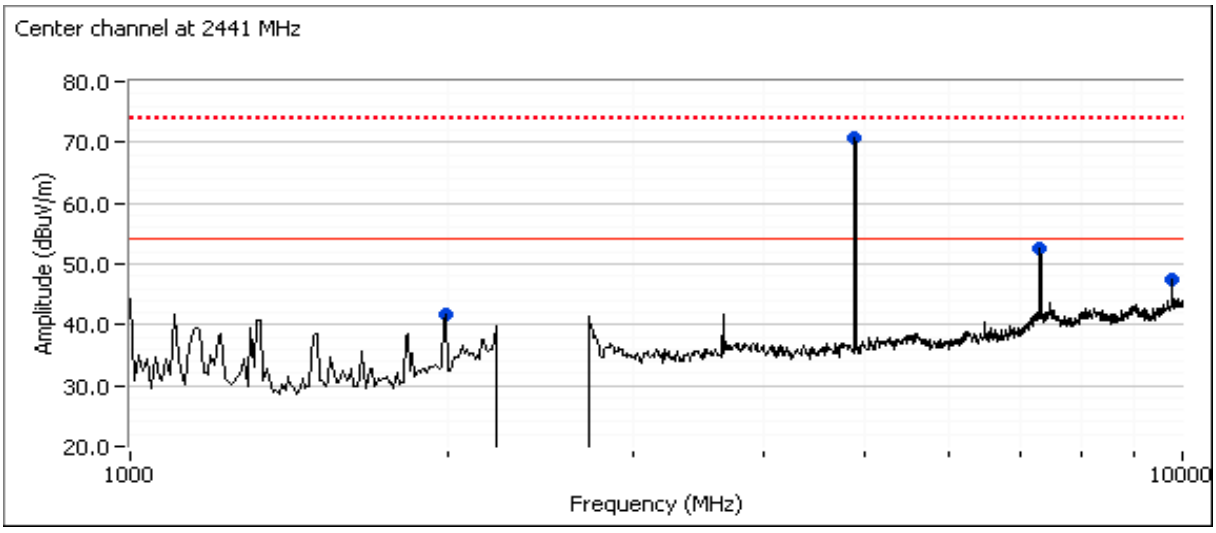


Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

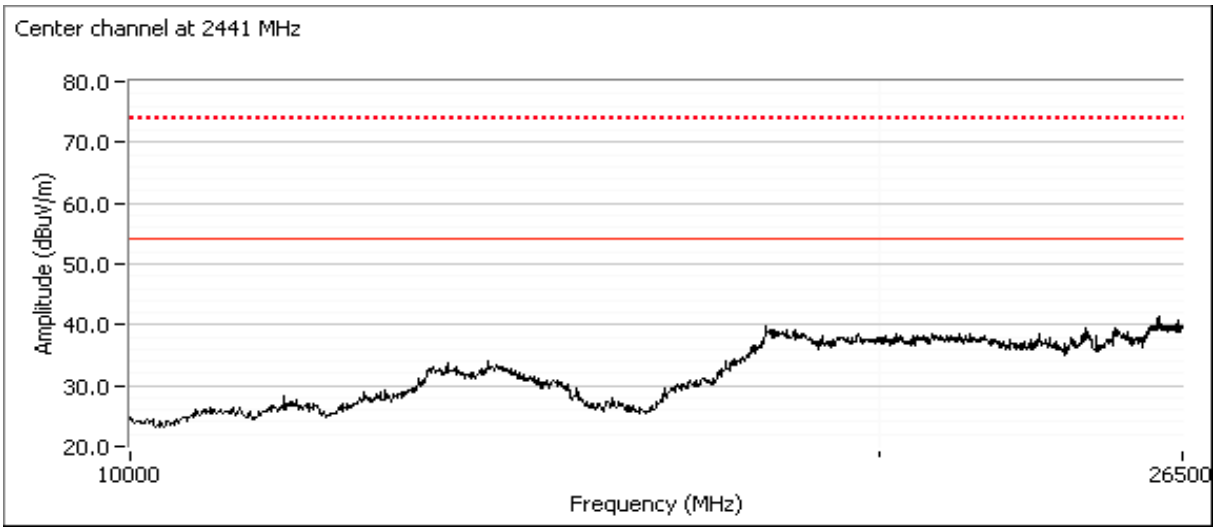
Run #1b: Center Channel @ 2441 MHz
Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7322.480	51.4	V	54.0	-2.6	AVG	58	2.0	RB 1 MHz;VB 10 Hz;Pk
4881.690	38.7	H	54.0	-15.3	AVG	295	1.0	setting = -20dBm
9766.800	37.9	H	54.0	-16.1	AVG	213	1.3	RB 1 MHz;VB 10 Hz;Pk
7322.300	54.9	V	74.0	-19.1	PK	58	2.0	RB 1 MHz;VB 3 MHz;Pk
1993.260	31.7	H	54.0	-22.3	AVG	154	1.3	RB 1 MHz;VB 10 Hz;Pk
9769.540	48.6	H	74.0	-25.4	PK	213	1.3	RB 1 MHz;VB 3 MHz;Pk
1993.310	46.3	H	74.0	-27.7	PK	154	1.3	RB 1 MHz;VB 3 MHz;Pk
4881.420	45.4	H	74.0	-28.6	PK	295	1.0	setting = -20dBm

Note 1:	For emissions in restricted bands, the limit of 15.209 was used.



Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

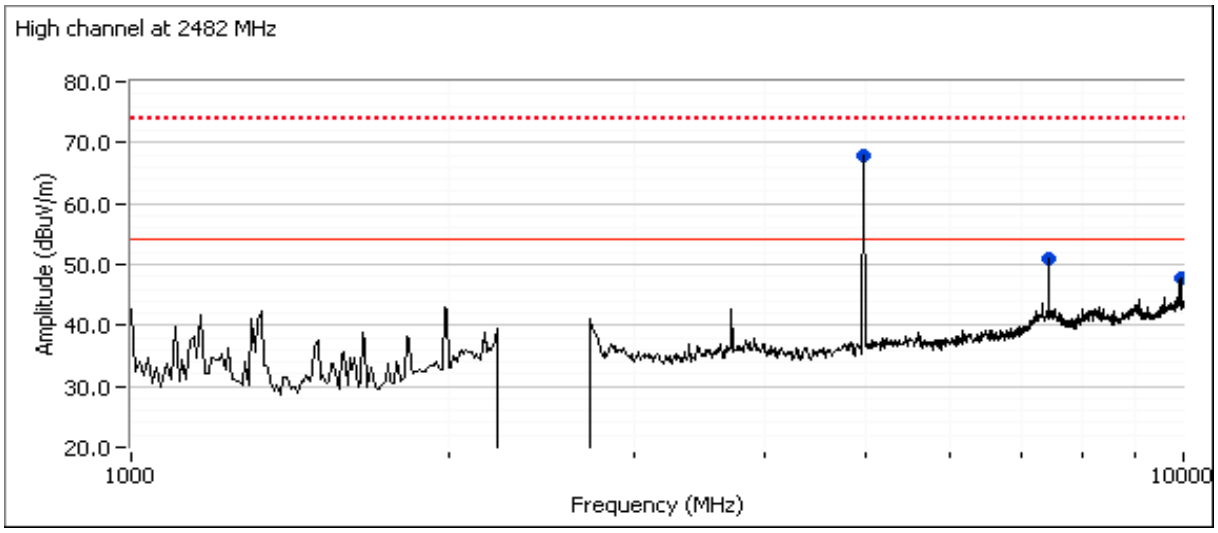


Client:	Contact Controls	Job Number:	J82419
Model:	CT-6000	T-Log Number:	J84184
		Account Manager:	Christine Krebill
Contact:	Chris Wichman		
Standard:	15.249	Class:	N/A

Run #1c: High Channel @ 2482 MHz
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7445.040	47.7	H	54.0	-6.3	AVG	263	1.3	RB 1 MHz;VB 10 Hz;Pk
4964.020	44.2	V	54.0	-9.8	AVG	55	2.0	setting = -20dBm
9938.880	37.4	H	54.0	-16.6	AVG	226	1.6	RB 1 MHz;VB 10 Hz;Pk
7445.970	52.9	H	74.0	-21.1	PK	263	1.3	RB 1 MHz;VB 3 MHz;Pk
9939.000	49.4	H	74.0	-24.6	PK	226	1.6	RB 1 MHz;VB 3 MHz;Pk
4964.190	48.2	V	74.0	-25.8	PK	55	2.0	setting = -20dBm

Note 1:	For emissions in restricted bands, the limit of 15.209 was used.



End of Report

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