41039 Boyce Road
Fremont, CA. 94538

510-578-3500 Phone
510-440-9525 Fax

EMC Test Report

Application for FCC Grant of Equipment Authorization
Canada Certification

Innovation, Science and Economic Development Canada
RSS-Gen Issue 5 / RSS-247 Issue 2
FCC Part 15 Subpart C

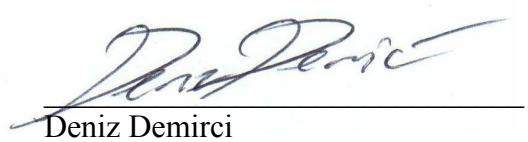
Model: CWD7712

IC CERTIFICATION #:	5683C-CWD7712
FCC ID:	EROCWD7712
APPLICANT:	Crestron Electronics 15 Volvo Drive Rockleigh, NJ 7647
TEST SITE(S):	National Technical Systems 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-4 and 2845B-5
PROJECT NUMBER:	PR093543
REPORT DATE:	September 11, 2019
FINAL TEST DATES:	July 26, 29, and 31 and August 16, 2019
TOTAL NUMBER OF PAGES:	70

ACCREDITED
Testing Cert #0214.26

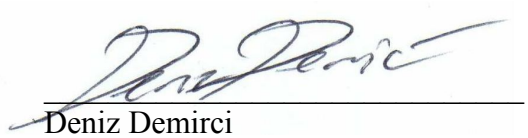
VALIDATING SIGNATORIES

PROGRAM MGR



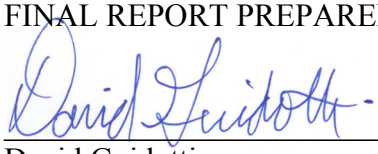
Deniz Demirci
Senior Wireless / EMC Engineer

TECHNICAL REVIEWER:



Deniz Demirci
Senior Wireless / EMC Engineer

FINAL REPORT PREPARER:



David Guidotti
Senior Technical Writer

QUALITY ASSURANCE DELEGATE

Jesse Reel
Quality Assurance

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	September 11, 2019	First release	

TABLE OF CONTENTS

SCOPE

An electromagnetic emissions test has been performed on the Crestron Electronics model CWD7712, pursuant to the following rules:

RSS-Gen Issue 5 " General Requirements for Compliance of Radio Apparatus"
RSS 247 Issue 2 "Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices"
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 National Technical Systems test procedures:

ANSI C63.10-2013
FCC DTS Measurement Guidance KDB558074

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.

National Technical Systems is accredited by the A2LA, certificate number 0214.26, to perform the test(s) listed in this report, except where noted otherwise.

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.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification 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 Crestron Electronics model CWD7712 complied with the requirements of the following regulations:

RSS-Gen Issue 5 " General Requirements for Compliance of Radio Apparatus"
RSS 247 Issue 2 "Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices"
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 Crestron Electronics model CWD7712 and therefore apply only to the tested sample. The sample was selected and prepared by William Wack of Crestron Electronics.

DEVIATIONS FROM THE STANDARDS

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

TEST RESULTS SUMMARY

DIGITAL TRANSMISSION SYSTEMS (2400 – 2483.5MHz)

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.247(a)	RSS 247 5.2	Digital Modulation	Systems uses digital transmission techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)	RSS 247 5.2 (1)	6 dB Bandwidth	1.667 MHz	> 500 kHz	Complies
15.247 (b) (3)	RSS 247 5.4 (4)	Output Power (multipoint systems)	18.4 dBm (0.0692 Watts) EIRP = 0.1 W Note 1	1 Watt, EIRP limited to 4 Watts.	Complies
15.247(e)	RSS 247 5.2 (2)	Power Spectral Density	3.2 dBm/3 kHz	8 dBm/3 kHz	Complies
15.247(d)	RSS 247 5.5	Antenna Port Spurious Emissions	-53.9 dBc	< -20 dBc	Complies
15.247(d) / 15.209	RSS 247 5.5	Radiated Spurious Emissions 9 kHz – 25 GHz	53.1 dBµV/m @ 2483.5 MHz (-0.9 dB)	Refer to the limits section (p20) for restricted bands, all others < -20 dBc	Complies
Note 1: EIRP calculated using antenna gain of 1.6 dBi for the highest EIRP system.					

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Integral PCB trace (Inverted F)	Unique or integral antenna required	Complies
15.407 (b) (6)	RSS-Gen Table 4	AC Conducted Emissions	30.2 dBµV @ 0.448 MHz (-16.7 dB)	Refer to page 19	Complies
15.247 (i) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to MPE calculations in separate exhibit, RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSS-Gen 6.8	User Manual	N/A	Statement for products with detachable antenna	Complies
-	RSS-Gen 8.4	User Manual	Refer to User Manual	Statement for all products	Complies
-	RSP-100 RSS-Gen 6.7	Occupied Bandwidth	2.25 MHz	Information only	N/A

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	± 0.5 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	9 kHz 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 Crestron Electronics model CWD7712 is a ZigBee module. The EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 5 VDC (120 V/ 60 Hz AC-DC power supply)

The sample was received on April 22, 2019 and tested on July 26, 29, and 31 and August 16, 2019. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Creston Electronics	CWD7712	ZigBee Module	13 (radiated sample)	EROCWD7712
Creston Electronics	CWD7712	ZigBee Module	10 (conducted sample)	EROCWD7712
Creston Electronics	NBS12E050120UV	AC/DC power supply	-	-

ANTENNA SYSTEM

The antenna is a PCB trace inverted F with a peak gain of 1.6 dBi

ENCLOSURE

The EUT does not have an enclosure. It measures approximately 4 cm wide by 9 cm deep by 2 cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at NTS Silicon Valley.

SUPPORT EQUIPMENT

No local support equipment was used during testing.

The following equipment was used as remote support equipment for emissions testing:

Company	Model	Description	Serial Number	FCC ID
Dell Latitude	D630	Laptop	-	-
CRESTRON	CEN-GWEXER-PWE	ZigBee Controller	15591818	EROCENGWEXER

Note: The support equipment was used to configure the EUT over the air and it was not communicating with the EUT 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)
DC	AC/DC Power Supply	2 Wire Twisted Pair	Unshielded	5

EUT OPERATION

During emissions testing the EUT was transmitting in a rated RF power and channels required by the tests.

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 6.2 of RSS-GEN, NTS has been recognized as an accredited test laboratory by the Commission and Innovation, Science and Economic Development Canada. A description of the facilities employed for testing is maintained by NTS.

Site	Designation / Registration Numbers		Location
	FCC	Canada	
Chamber 4	US1031	US0027	41039 Boyce Road Fremont, CA 94538-2435
Chamber 5			

ANSI C63.4 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. Results from testing performed in this chamber have been correlated with results from an open area test site. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.10. 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 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4.

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 20 Hz, 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 1000 MHz 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

Software is used to view and convert 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 software used for radiated and conducted emissions measurements is NTS EMI Test Software (rev 2.10)

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a 50 µH Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 µH 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 1 m above the ground plane.

ANSI C63.10 specifies that the test height above ground for table mounted devices shall be 80 cm for testing below 1 GHz and 1.5 m for testing above 1 GHz. 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 as specified in ANSI C63.4. 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 C63.10, 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 cm 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.

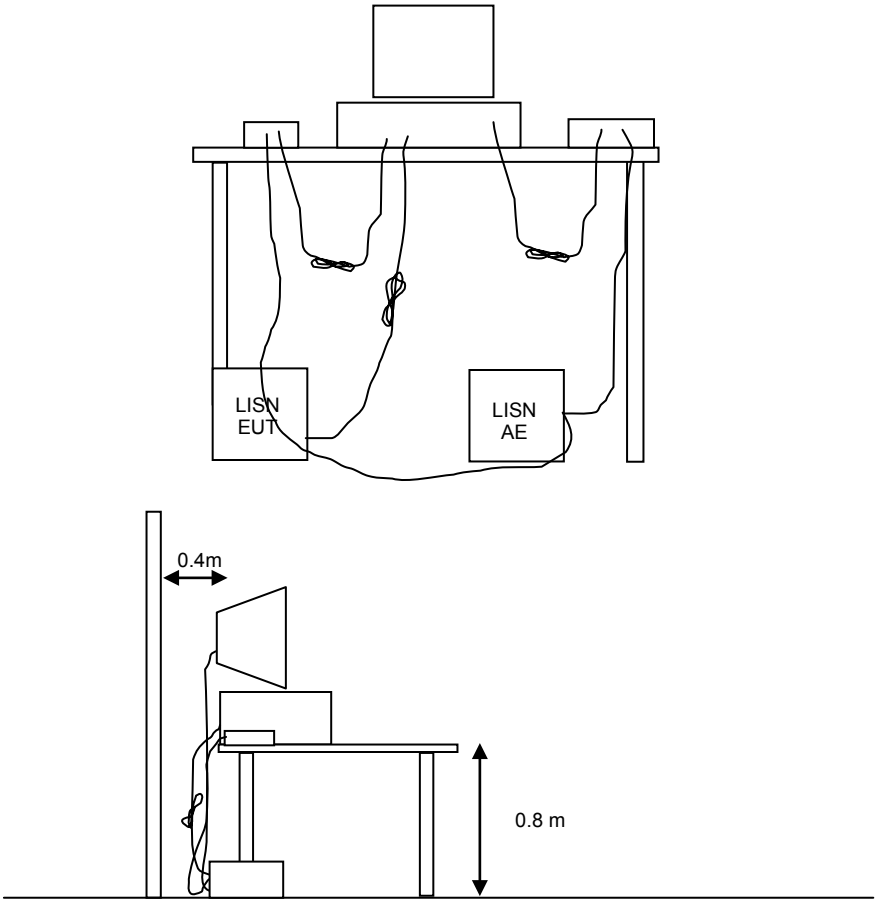


Figure 1 Typical Conducted Emissions Test Configuration

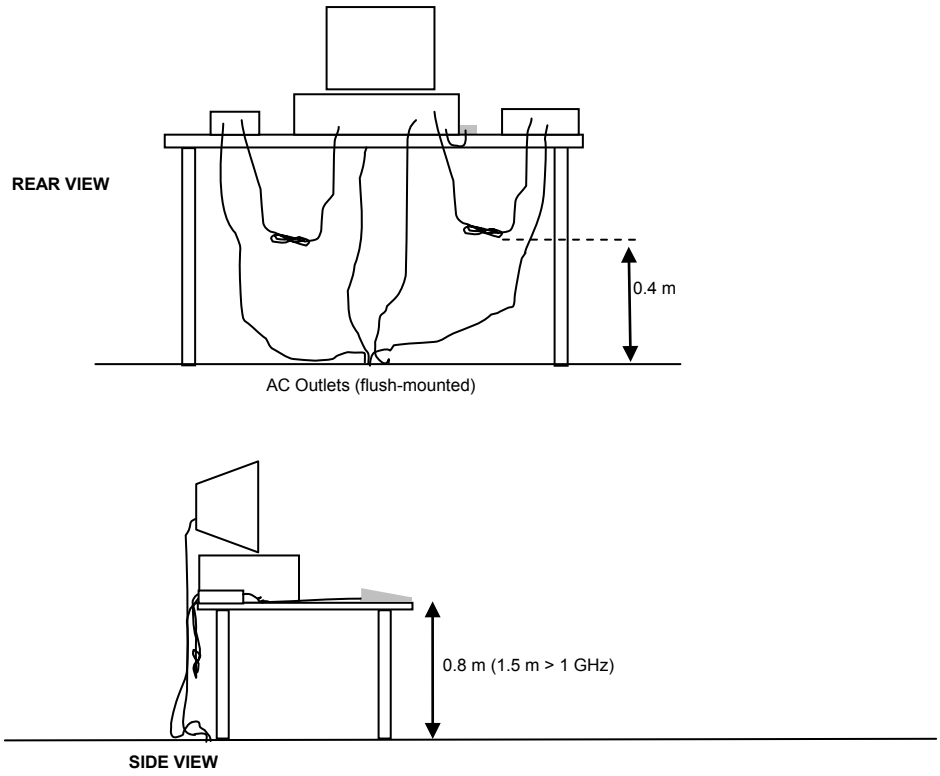
RADIATED EMISSIONS

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.

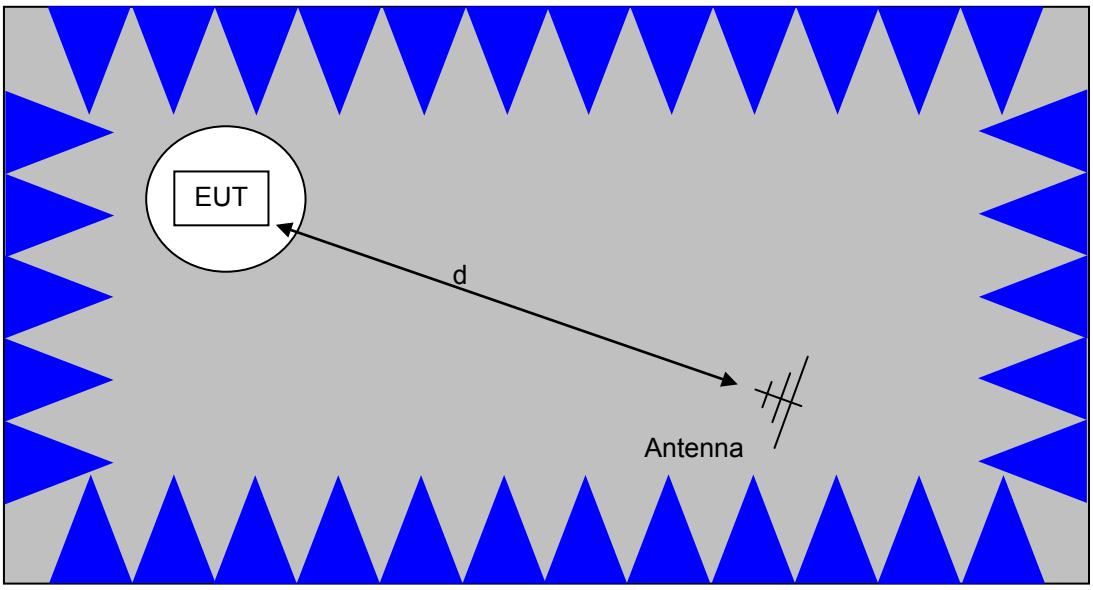
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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 1 m). 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 m.

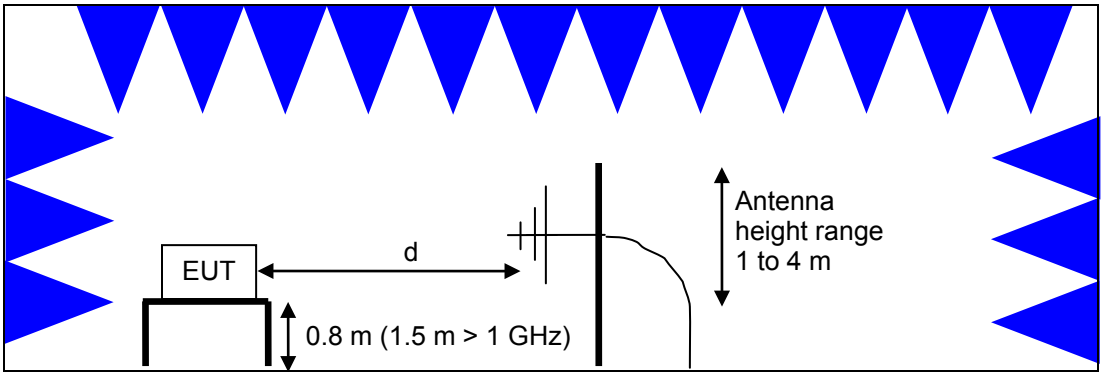


Typical Test Configuration for Radiated Field Strength Measurements



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.

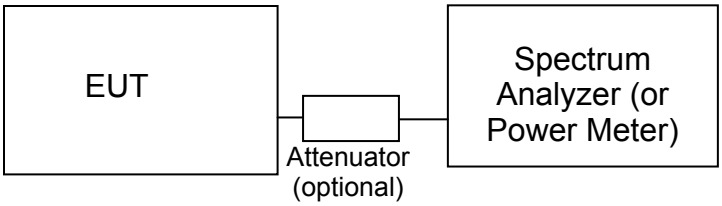
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements of power, bandwidth and power spectral density are performed, where possible, with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.



Test Configuration for Antenna Port Measurements

Measurement bandwidths (video and resolution) are set in accordance with the relevant standards and NTS Silicon Valley's test procedures for the type of radio being tested. When power measurements are made using a resolution bandwidth less than the signal bandwidth the power is calculated by summing the power across the signal bandwidth using either the analyzer channel power function or by capturing the trace data and calculating the power using software. In both cases the summed power is corrected to account for the equivalent noise bandwidth (ENBW) of the resolution bandwidth used.

If power averaging is used (typically for certain digital modulation techniques), the EUT is configured to transmit continuously. Power averaging is performed using either the built-in function of the analyzer or, if the analyzer does not feature power averaging, using external software. In both cases the average power is calculated over a number of sweeps (typically 100). When the EUT cannot be configured to continuously transmit then either the analyzer is configured to perform a gated sweep to ensure that the power is averaged over periods that the device is transmitting or power averaging is disabled and a max-hold feature is used.

If a power meter is used to make output power measurements the sensor head type (peak or average) is stated in the test data table.

BANDWIDTH MEASUREMENTS

The 6 dB, 20 dB, 26 dB and/or 99% signal bandwidth are measured using the bandwidths recommended by ANSI C63.10 and 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 (dBµV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBµV/m). The results are then converted to the linear forms of µV and µV/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:

CONDUCTED EMISSIONS SPECIFICATION LIMITS: FCC 15.207; FCC 15.107(a), RSS GEN

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency (MHz)	Average Limit (dBµV)	Quasi Peak Limit (dBµV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1].

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

[1] The restricted bands are detailed in FCC 15.205 and RSS-Gen Table 7

OUTPUT POWER LIMITS – DIGITAL TRANSMISSION SYSTEMS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Output Power	Power Spectral Density
902 – 928	1 Watt (30 dBm)	8 dBm/3 kHz
2400 – 2483.5	1 Watt (30 dBm)	8 dBm/3 kHz
5725 – 5850	1 Watt (30 dBm)	8 dBm/3 kHz

The maximum permitted output power is reduced by 1 dB for every dB the antenna gain exceeds 6 dBi.

TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

The limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands are those specified in the general limits sections of FCC Part 15 and RSS 210. All other unwanted (spurious) emissions shall be at least 20 dB below the level of the highest in-band signal level (30 dB if the power is measured using the sample detector/power averaging method).

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 dBµV

S = Specification Limit in dBµV

M = Margin to Specification in +/- dB

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 dBµV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBµV/m

L_s = Specification Limit in dBµV/m

M = Margin in dB Relative to Spec

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Radiated Emissions, 9 kHz - 1 GHz, 26-Apr-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1549	5/30/2017	5/30/2019
Hewlett Packard	9KHz-1300MHz pre-amp	8447F	2777	12/20/2018	12/20/2019
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	9482	10/13/2018	10/13/2019
Rhode & Schwarz	Magnetic Loop Antenna, 9 kHz-30 MHz	HFH2-Z2	WC062 457	1/5/2018	1/5/2020
Conducted Emissions - AC Power Ports, 26-Apr-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	LISN, 10 kHz-100 MHz	3825/2	1293	6/19/2018	6/19/2019
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	12/26/2018	12/26/2019
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	9482	10/13/2018	10/13/2019
Radiated Emissions, Band Edge, 29-Apr-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	9/18/2018	9/18/2020
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1538	2/9/2019	2/9/2020
Atenna port measurements, 26-Jul-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
National Technical Systems	NTS Capture Analyzer Software (rev 3.8)	N/A	0		N/A
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1422	2/8/2019	2/8/2020
Agilent Technologies	USB Average Power Sensor	U2001A	2442	1/11/2019	1/11/2020
Agilent Technologies	3 Hz -44 GHz PSA Spectrum Analyzer	E4446A	2796	5/31/2018	5/31/2019
Rohde & Schwarz	Signal generator 100 kHz-12.75 GHz	SMB 100A	3002		N/A
Rohde & Schwarz	Peak Power Sensor 100 uW - 2 Watts use with 20 dB attenuator sn:1031.6959.00 only	NRV-Z32	3225	12/14/2018	12/14/2019
Radiated Emissions, 1,000 - 18,000 MHz, 26-Jul-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz (SA40-Blu)	3115	1386	10/8/2018	10/8/2020
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	12/8/2018	12/8/2019
Micro-Tronics	Band Reject Filter, 2400-2500	BRM50702-02	1683	4/25/2019	4/25/2020

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
	MHz				
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	7/18/2019	7/18/2020
Radiated Emissions, 18,000 - 25,000 MHz, 29-Jul-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	12/8/2018	12/8/2019
HP / Miteq	SA40 B Head HF preAmplifier, 18-40 GHz (w/1393)	TTA1840-45-5P-HG-S	1620	1/9/2019	1/9/2020
A. H. Systems	Blue System Horn, 18-40GHz	SAS-574, p/n: 2581	2159	9/5/2017	8/8/2020
Radiated Emissions, Band edge, 29-Jul-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz (SA40-Blu)	3115	1386	10/8/2018	10/8/2020
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESI 40	2493	3/15/2019	3/15/2020
Radio Antenna Port (Power and Spurious Emissions), 16-Aug-19					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
National Technical Systems	NTS Capture Analyzer Software (rev 3.8)	N/A	0		N/A
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1534	6/18/2019	6/18/2020
Rohde & Schwarz	Peak Power Sensor 100 uW - 2 Watts (w/ 20 dB attenuator)	NRV-Z32	1536	6/28/2019	6/28/2020
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	7/18/2019	7/18/2020

Appendix B Test Data

TL093543-RA Pages 26 – 69

Client:	Crestron Electronics	Job Number:	PR093543
Product	CWD7712	T-Log Number:	TL093543-RA
System Configuration:	-	Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Emissions Standard(s):	FCC 15.247, RSS-247	Class:	B
Immunity Standard(s):	-	Environment:	-

EMC Test Data

For The

Crestron Electronics

Product

CWD7712

Date of Last Test: 8/16/2019

Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

RSS-247 and FCC 15.247 (DTS) Antenna Port Measurements

Power, PSD, Bandwidth and Spurious 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.

Date of Test: 7/31/2019, 8/16/2019
Test Engineer: Deniz Demirci, Mehran Birgani
Test Location: FT Lab #4B

Config. Used: 1
Config Change: None
EUT Voltage: 120 VAC / 60 Hz

General Test Configuration

The EUT was connected to the spectrum analyzer or power meter via a suitable attenuator. All measurements were made on a single chain.

All measurements have been corrected to allow for the external attenuators used.

Ambient Conditions:

Temperature: 21 °C
Rel. Humidity: 39 %

Summary of Results

Run #	Pwr setting	Avg Pwr	Test Performed	Limit	Pass / Fail	Result / Margin
1	19	-	Output Power	15.247(b)	Pass	18.4 dBm
2	19	-	Power spectral Density (PSD)	15.247(d)	Pass	3.2 dBm/3 kHz
3	19	-	Minimum 6 dB Bandwidth	15.247(a)	Pass	1.667 MHz
3	19	-	99% Bandwidth	RSS GEN	-	2.25 MHz
4	19	-	Spurious emissions	15.247(b)	Pass	-53.9 dBc

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:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
ZigBee	-	1.00	Yes	-	0	0	10

Sample Notes

Sample S/N: 10
Driver: -
Antenna: PCB Trace, Inverted F.

Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #1: Output Power

Mode: ZigBee

Power Setting[2]	Frequency (MHz)	Output Power (dBm) [1]	Output Power mW	Antenna Gain (dBi)	Result	EIRP dBm	EIRP W	Output Power (dBm) [3]	Output Power mW
19	2405	18.4	69.2	1.6	Pass	20.0	0.100		
19	2440	18.4	69.2	1.6	Pass	20.0	0.100		
19	2475	18.4	69.2	1.6	Pass	20.0	0.100		
13	2480	12.9	19.5	1.6	Pass	14.5	0.028		

Note 1:	Output power measured using a peak power meter, spurious limit is -20 dBc.
Note 2:	Power setting - the software power setting used during testing, included for reference only.

Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

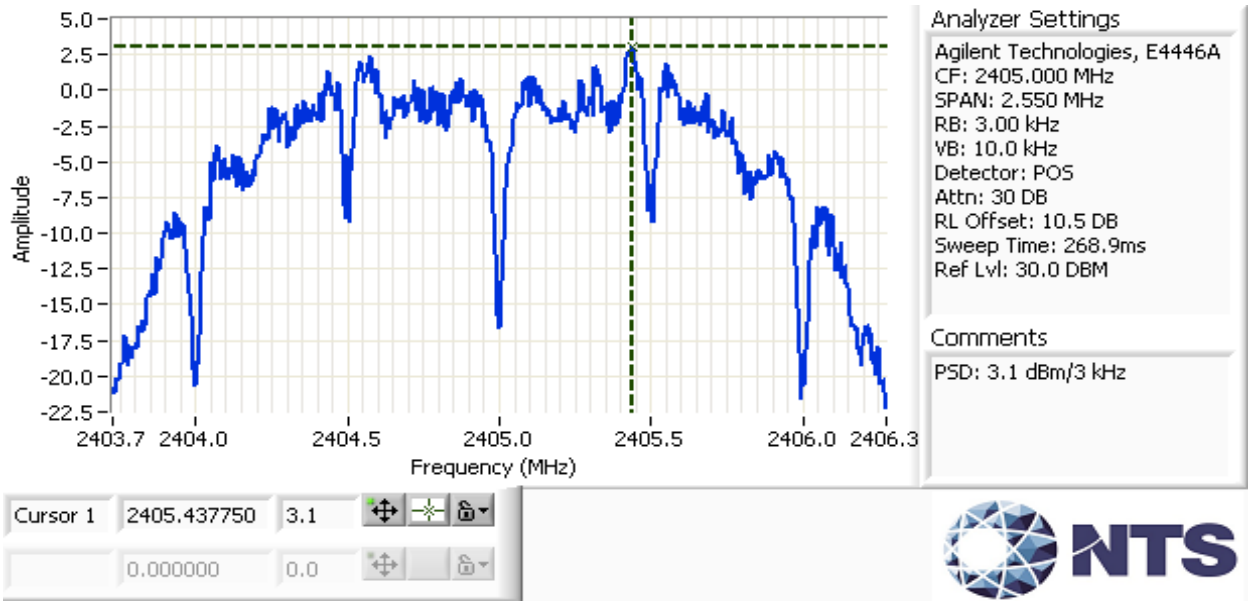
Run #2: Power spectral Density

Mode: ZigBee

Power Setting	Frequency (MHz)	PSD (dBm/3 kHz) Note 1	Limit dBm/3 kHz	Result
19	2405	3.1	8.0	Pass
19	2440	3.2	8.0	Pass
13	2480	-1.5	8.0	Pass

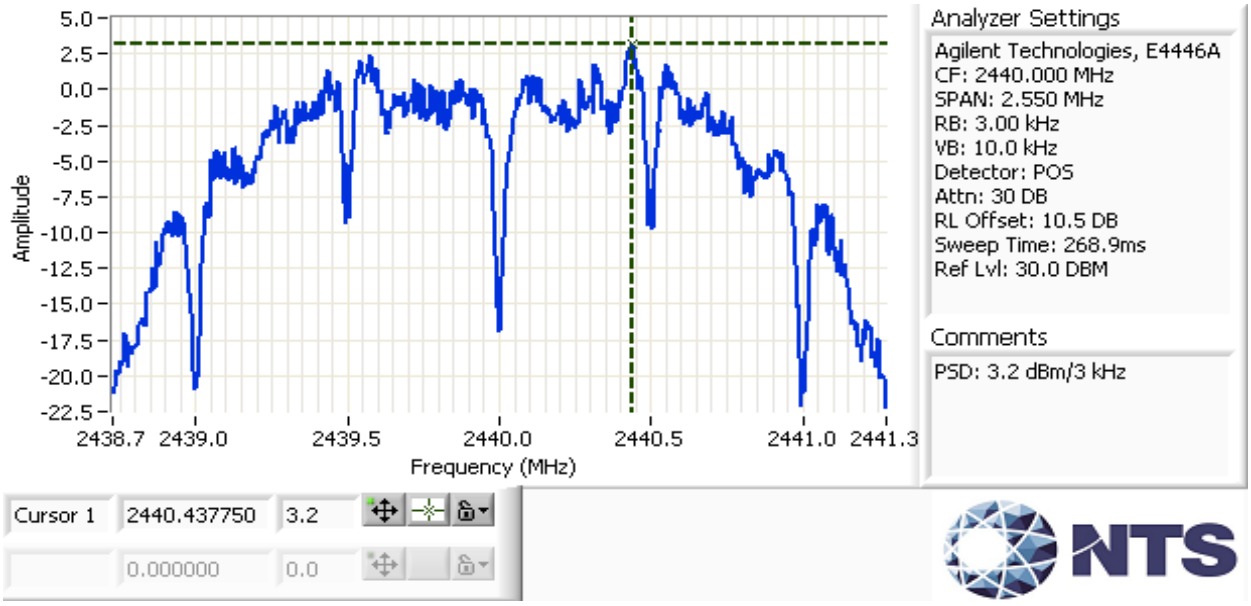
Note 1:	Test performed per method PKSPD, in KDB 558074. Power spectral density measured using: 3 kHz ≤ RBW ≤ 100 kHz, VBW=3*RBW, peak detector, span = 1.5*DTS BW, auto sweep time, max hold.

Plot for low channel

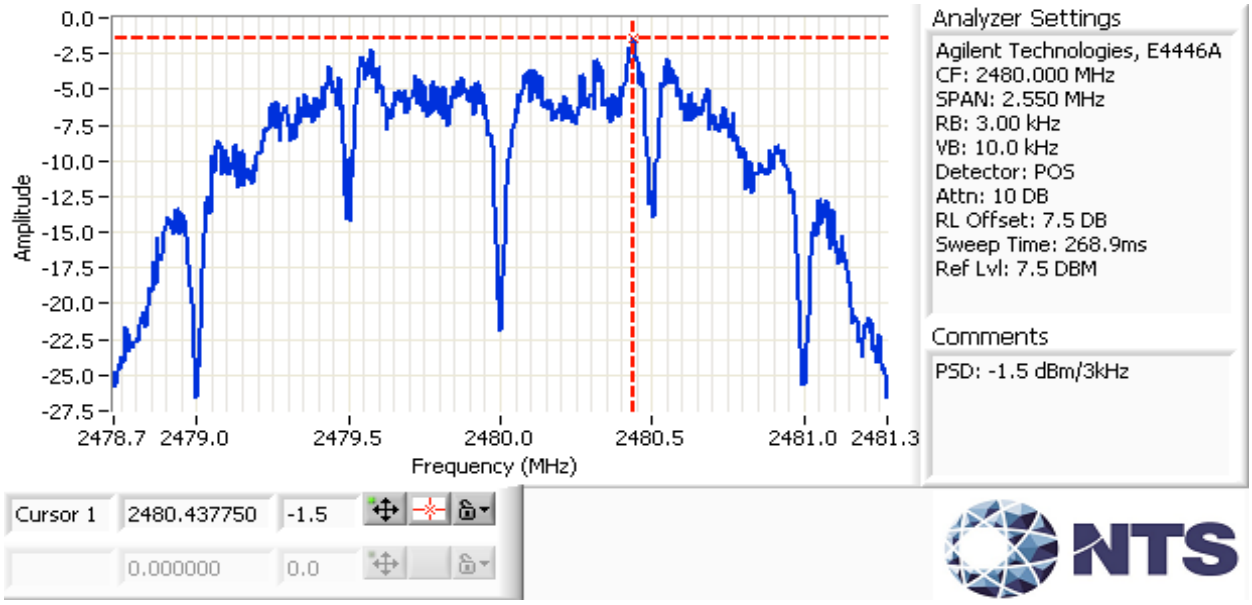


Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Plot for center channel



Plot for high channel



Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #3: Signal Bandwidth

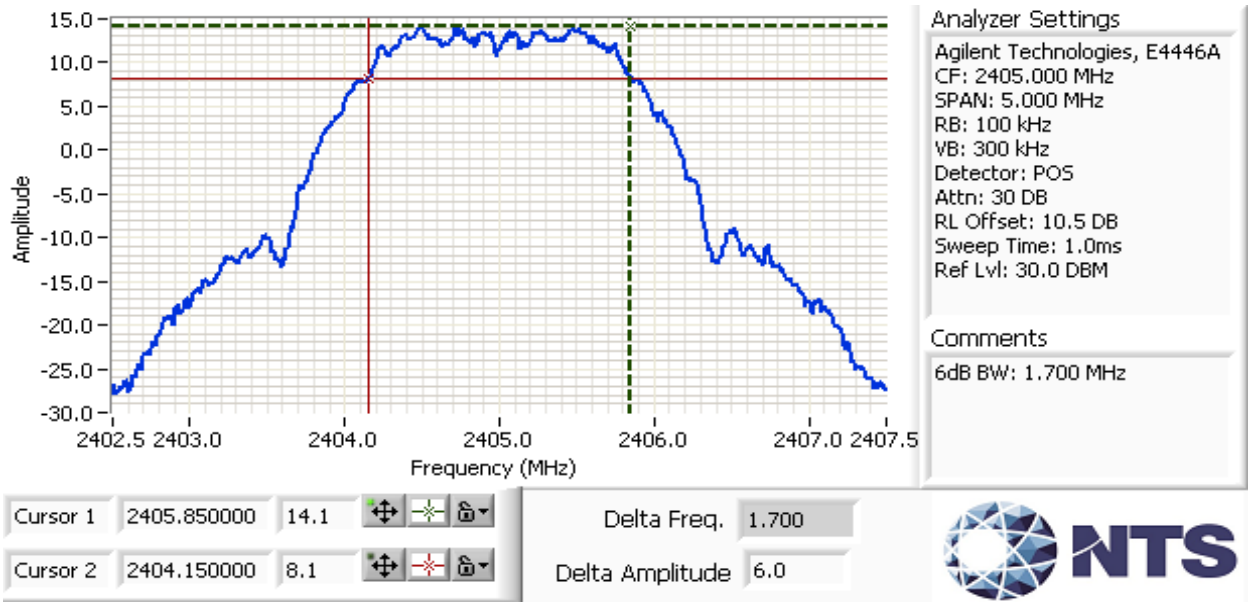
Mode: ZigBee

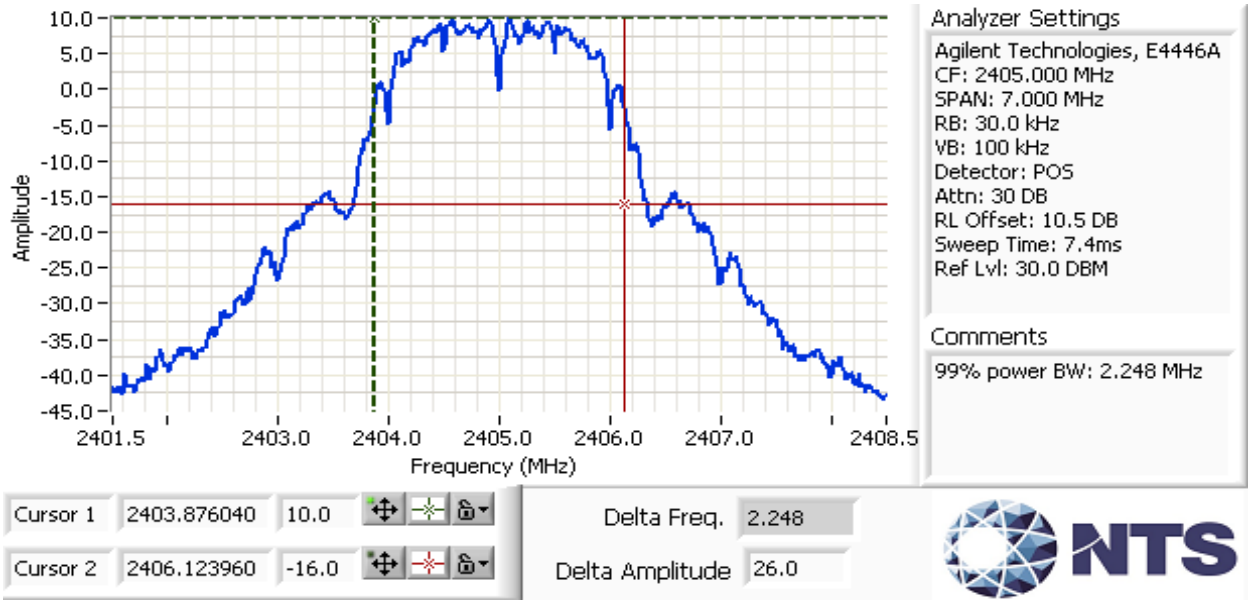
Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		6 dB	99%	6 dB	99%
19	2405	1.700	2.248	100	30
19	2440	1.692	2.248	100	30
13	2480	1.667	2.246	100	30

Note 1:	DTS BW: RBW=100 kHz, VBW ≥ 3*RBW, peak detector, max hold, auto sweep time, Span 2-5 times measured BW. 99% BW: RBW=1-5% of 99%BW, VBW ≥ 3*RBW, peak detector, max hold, auto sweep time. Span 1.5-5 times OBW.

Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

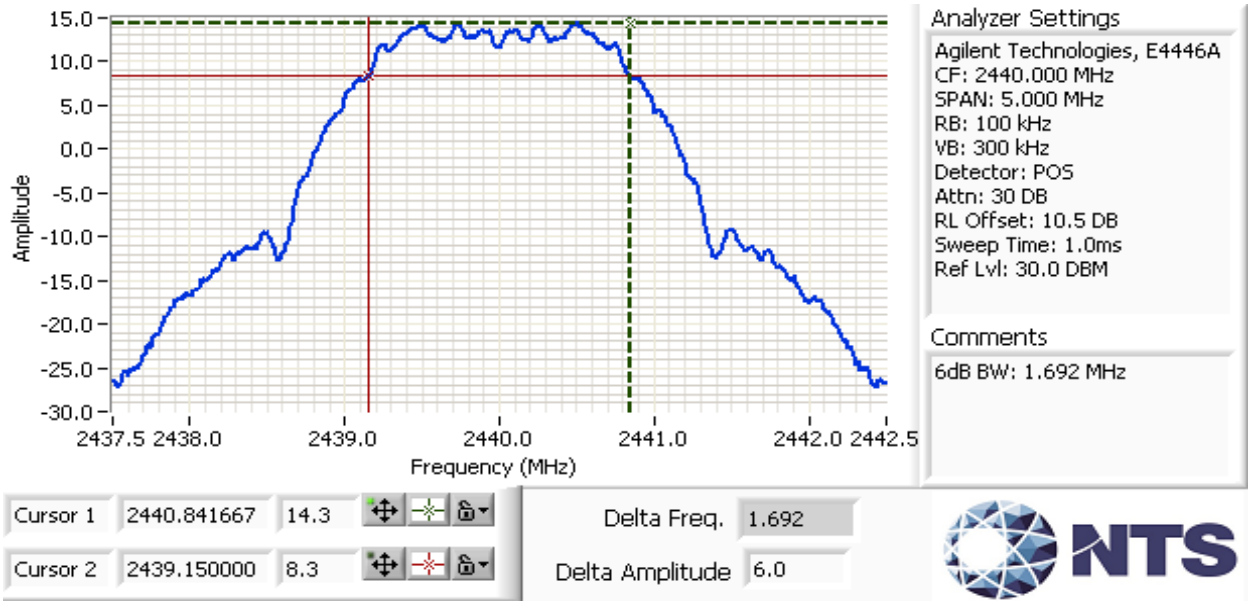
Plot for low channel

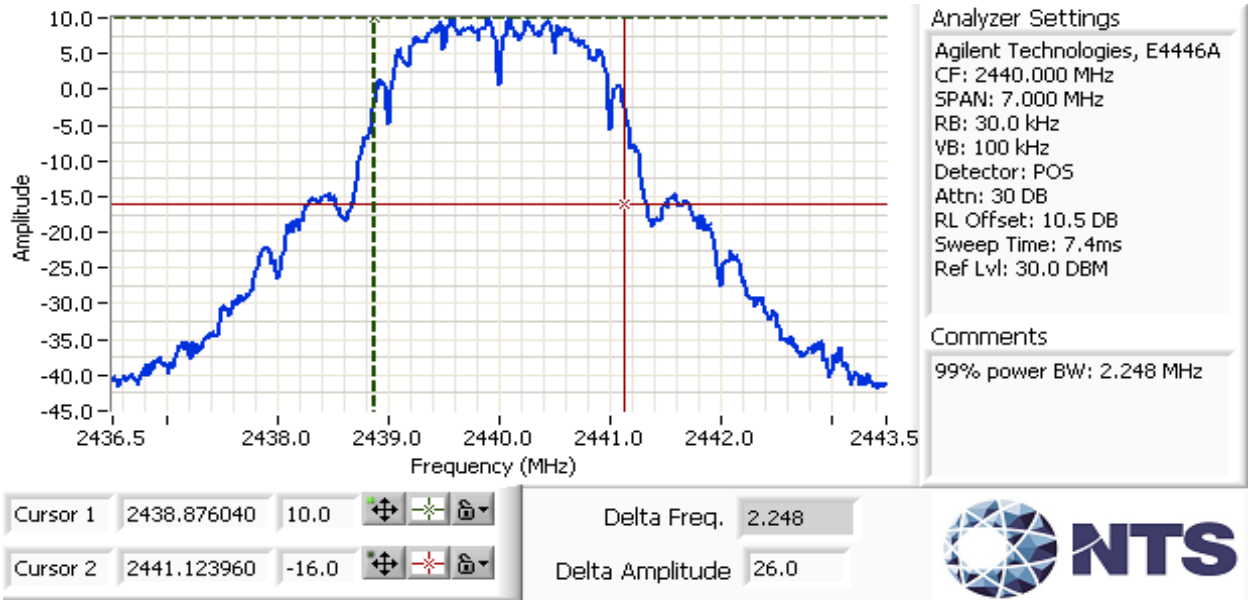




Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

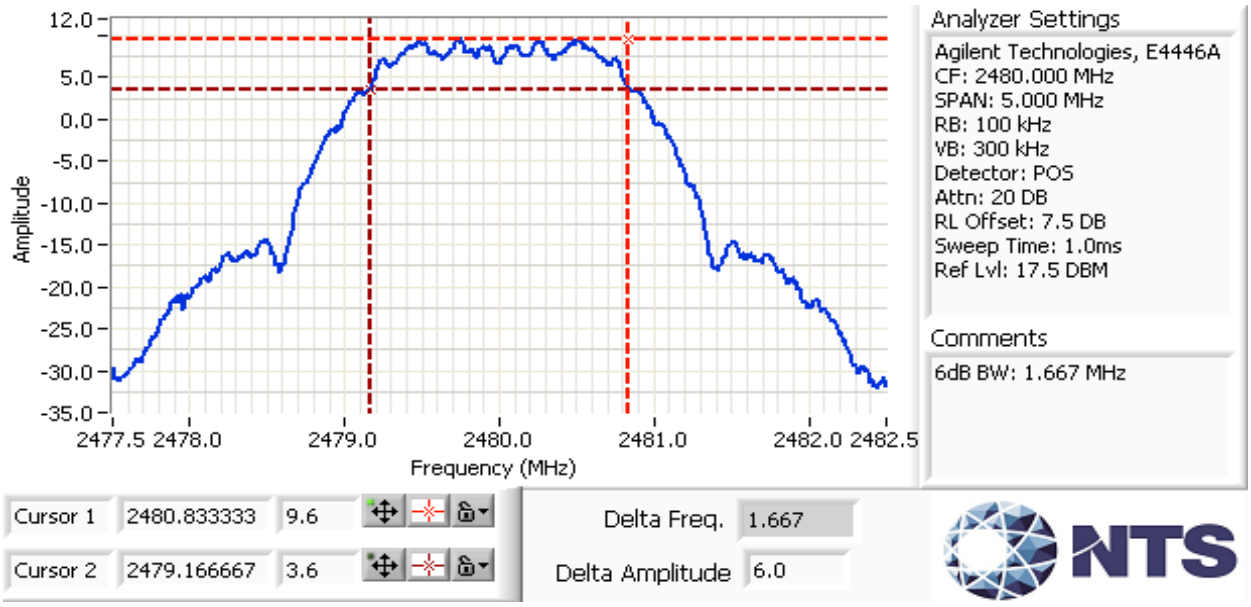
Plot for center channel

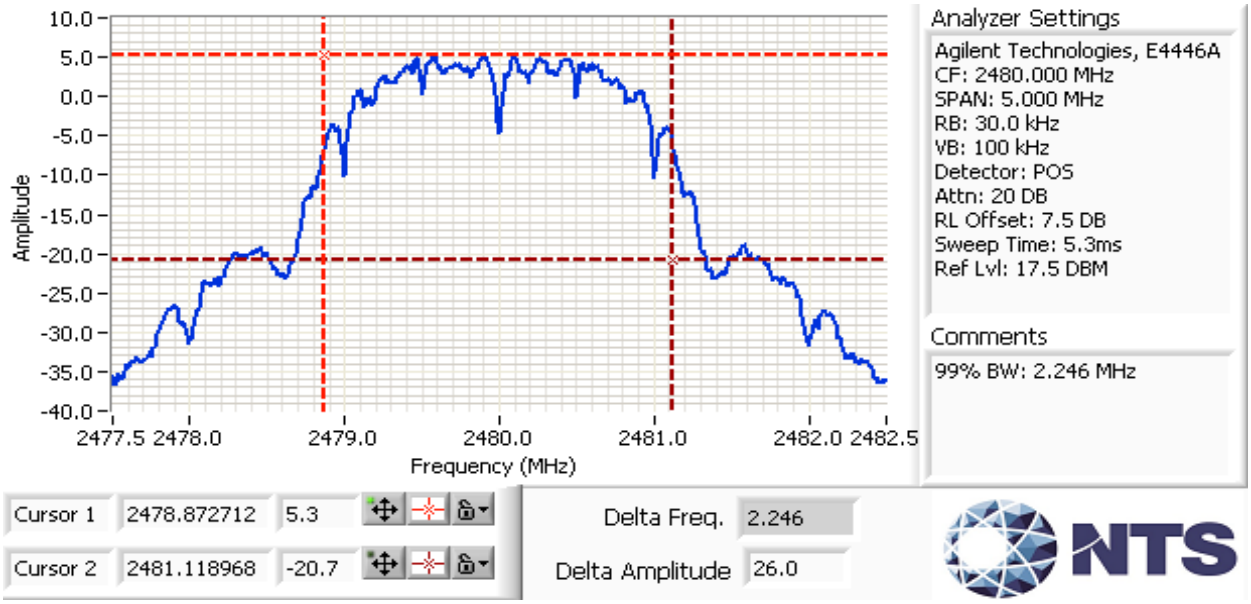




Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Plot for high channel



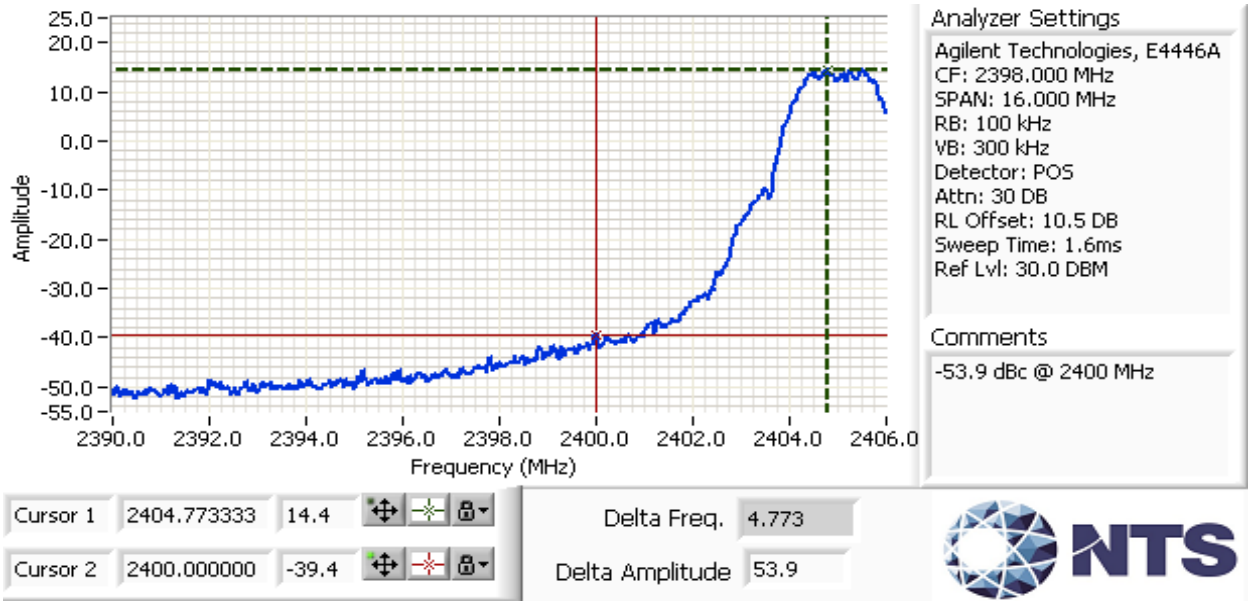


Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #4a: Out of Band Spurious Emissions

Frequency (MHz)	Power Setting	Mode	Limit	Result
2405	19	ZigBee	-20 dBc	-53.9 dBc

Plot for low channel



The plot showing compliance with -20 dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.

Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

RSS-247 and FCC 15.247 (DTS) Radiated Spurious 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 was located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 24 °C
Rel. Humidity: 39 %

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

Run #	Mode	Channel	Target Power	Power Setting	Test Performed	Limit	Result / Margin
1a Flat	ZigBee	11 - 2405 MHz	19	19	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	38.2 dBµV/m @ 2367.2 MHz (-15.8 dB)
1b Side	ZigBee	11 - 2405 MHz	19	19			37.2 dBµV/m @ 2367.3 MHz (-16.8 dB)
1c Upright	ZigBee	11 - 2405 MHz	19	19			37.4 dBµV/m @ 2367.0 MHz (-16.6 dB)
2a Flat	ZigBee	26 - 2480 MHz	19	13	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	53.6 dBµV/m @ 2483.5 MHz (-0.4 dB)
2b Side	ZigBee	26 - 2480 MHz	19	13			52.1 dBµV/m @ 2483.5 MHz (-1.9 dB)
2c Upright	ZigBee	26 - 2480 MHz	19	13			53.1 dBµV/m @ 2483.5 MHz (-0.9 dB)
3a Flat	ZigBee	25 - 2475 MHz	19	19	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	44.1 dBµV/m @ 2483.5 MHz (-9.9 dB)

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.

Sample Notes

Sample S/N: 13
Driver: -
Antenna: Internal PCB Trace, Inverted F.

Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1 MHz, VBW=3 MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has a duty cycle ≥ 98% and was measured using RBW=1 MHz, VBW=10 Hz, peak detector, linear average mode, auto sweep time, max hold.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
ZigBee	-	1.00	Yes	-	0	0	10

Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

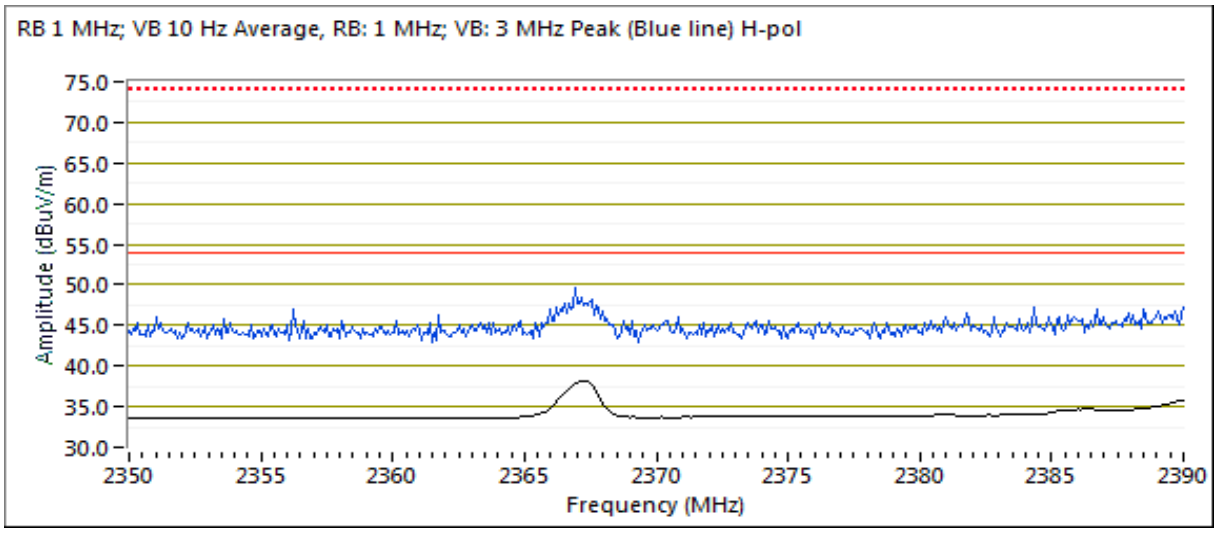
Run #1: Radiated Bandedge Measurements

Date of Test: 7/29/2019 Config. Used: 1
Test Engineer: Deniz Demirci Config Change: None
Test Location: FT Ch #7 EUT Voltage: 120 V / 60 Hz

Channel: 11 - 2405 MHz Mode: ZigBee
Tx Chain: Main Data Rate: -

Run #1a: EUT Flat
Band Edge Signal Field Strength - Direct measurement of field strength

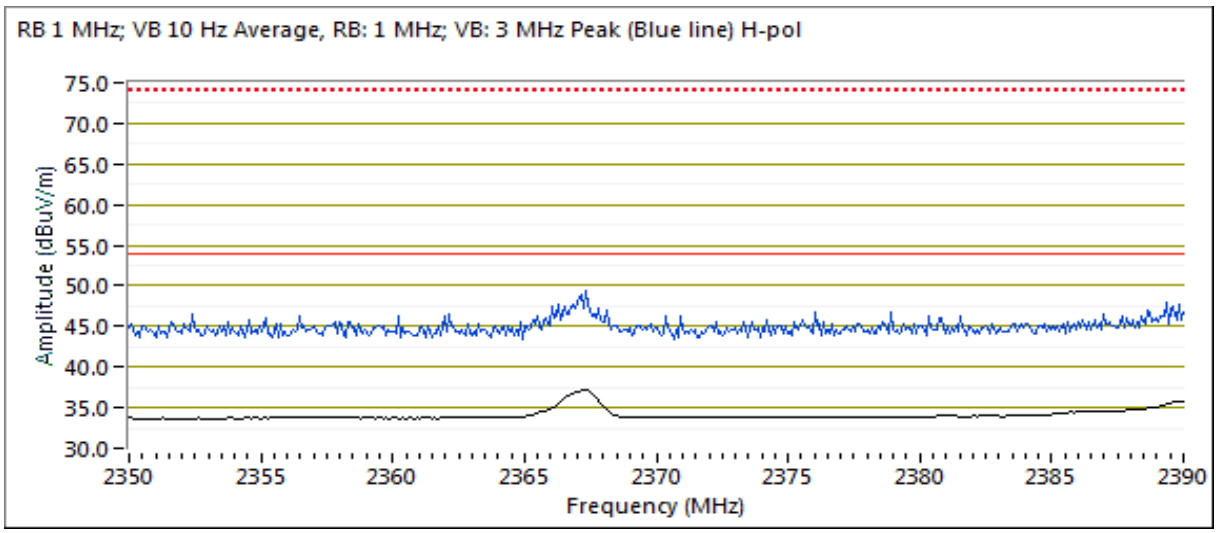
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2367.210	38.2	H	54.0	-15.8	AVG	131	1.7	POS; RB 1 MHz; VB: 10 Hz
2366.990	49.7	H	74.0	-24.3	PK	131	1.7	POS; RB 1 MHz; VB: 3 MHz
2389.990	33.7	V	54.0	-20.3	AVG	263	1.2	POS; RB 1 MHz; VB: 10 Hz
2389.810	47.1	V	74.0	-26.9	PK	263	1.2	POS; RB 1 MHz; VB: 3 MHz

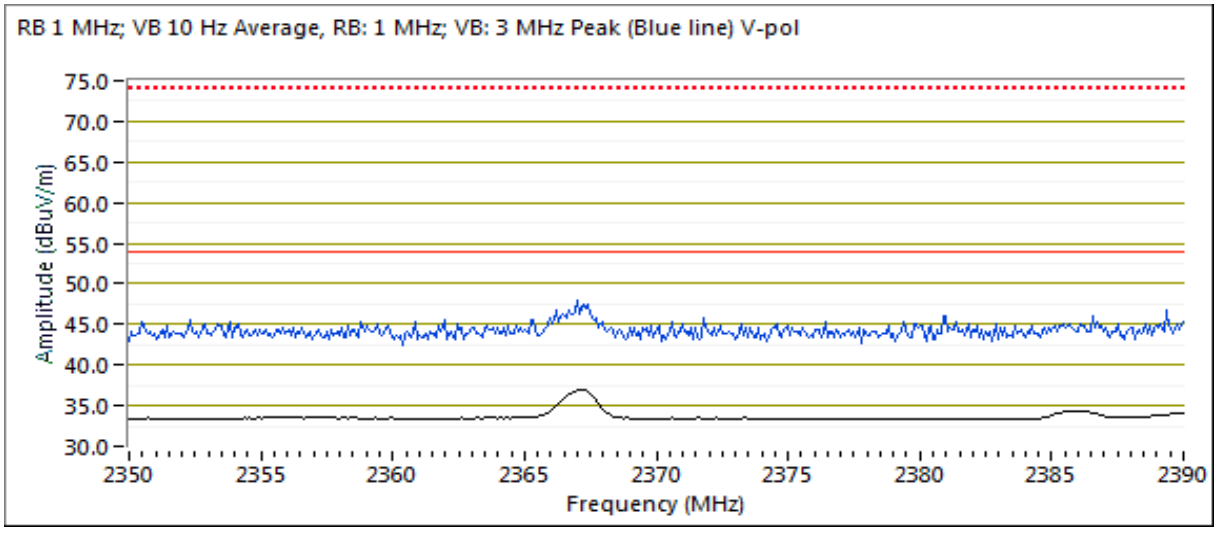


Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #1b: EUT Side
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	
2367.280	37.2	H	54.0	-16.8	AVG	157	1.3	POS; RB 1 MHz; VB: 10 Hz
2367.410	49.0	H	74.0	-25.0	PK	157	1.3	POS; RB 1 MHz; VB: 3 MHz
2367.140	37.0	V	54.0	-17.0	AVG	266	1.7	POS; RB 1 MHz; VB: 10 Hz
2366.940	49.1	V	74.0	-24.9	PK	266	1.7	POS; RB 1 MHz; VB: 3 MHz

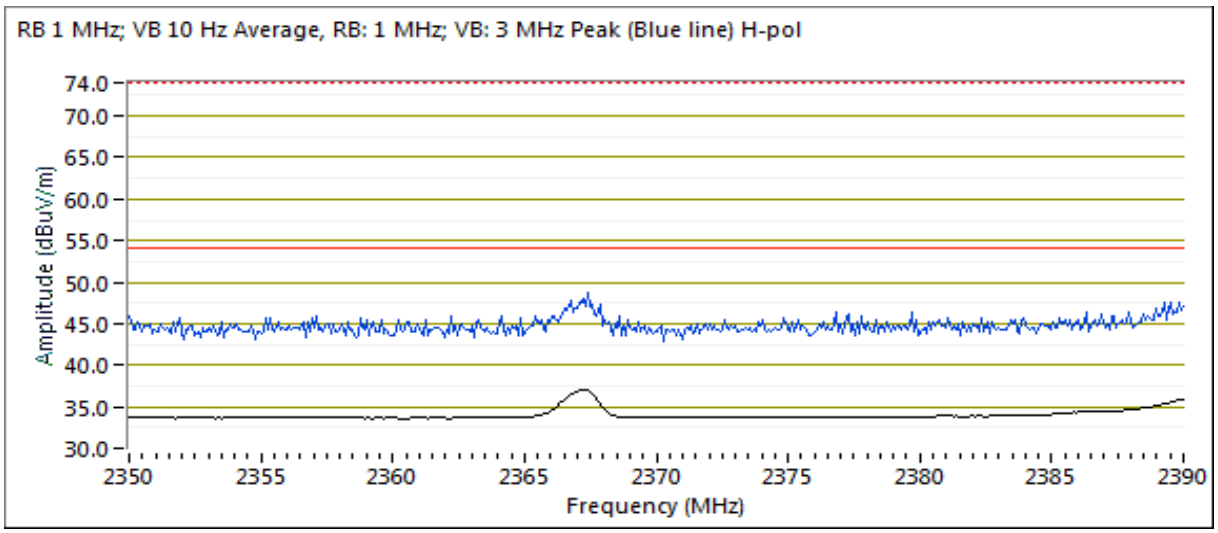


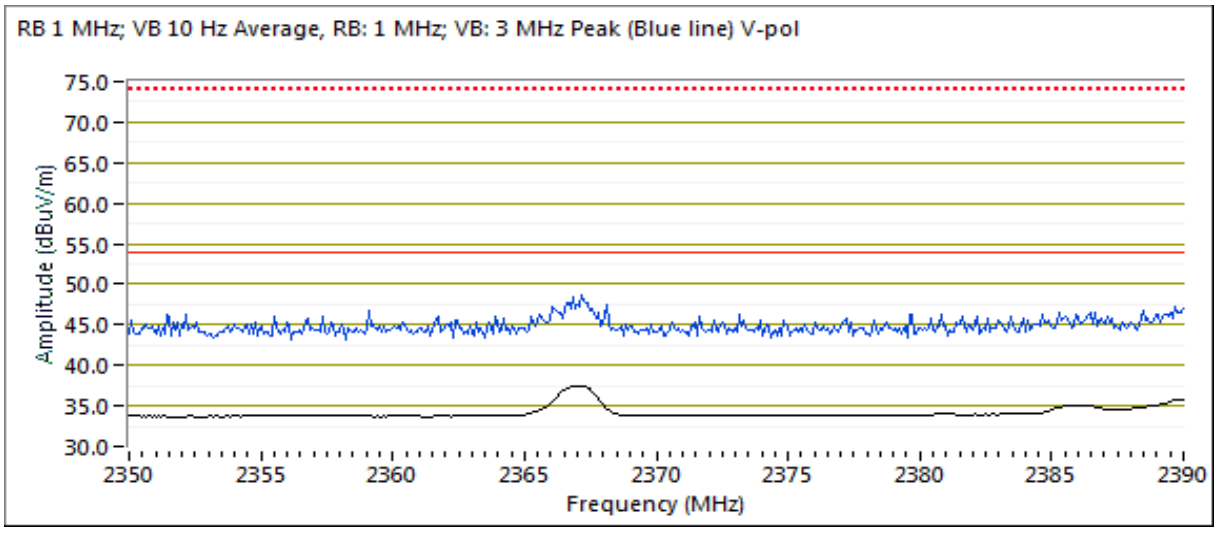


Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #1c: EUT Upright
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	
2367.250	37.1	H	54.0	-16.9	AVG	182	1.0	POS; RB 1 MHz; VB: 10 Hz
2366.650	48.4	H	74.0	-25.6	PK	182	1.0	POS; RB 1 MHz; VB: 3 MHz
2366.990	37.4	V	54.0	-16.6	AVG	215	2.2	POS; RB 1 MHz; VB: 10 Hz
2367.200	50.0	V	74.0	-24.0	PK	215	2.2	POS; RB 1 MHz; VB: 3 MHz





Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

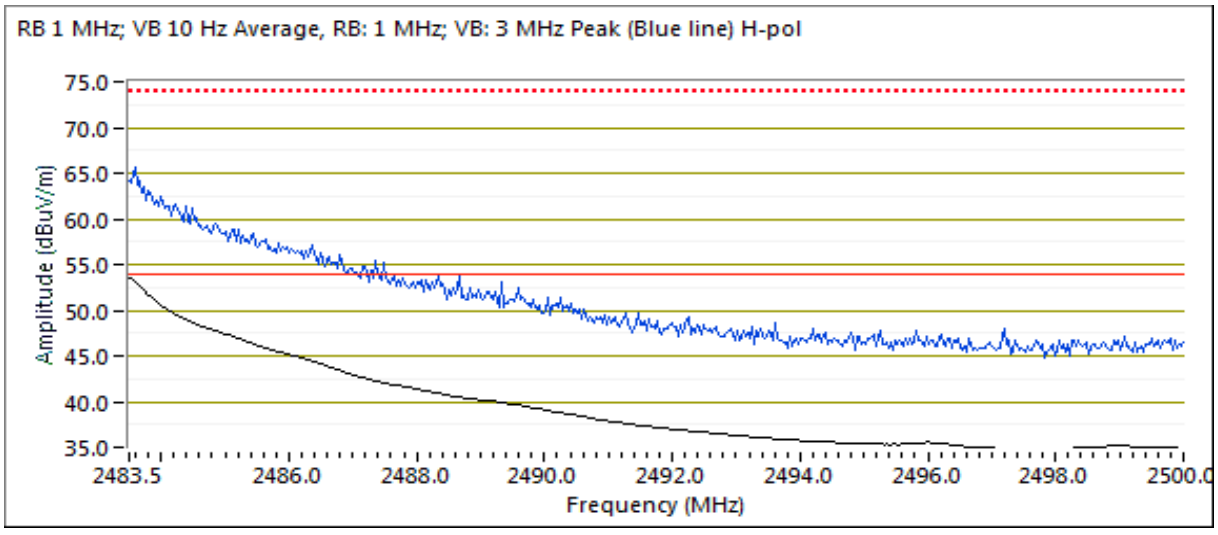
Run #2: Radiated Bandedge Measurements

Date of Test: 7/29/2019 Config. Used: 1
Test Engineer: Deniz Demirci Config Change: None
Test Location: FT Ch #7 EUT Voltage: 120 V / 60 Hz

Channel: 26 - 2480 MHz Mode: ZigBee
Tx Chain: Main Data Rate: -

Run #2a: EUT Flat
Band Edge Signal Field Strength - Direct measurement of field strength

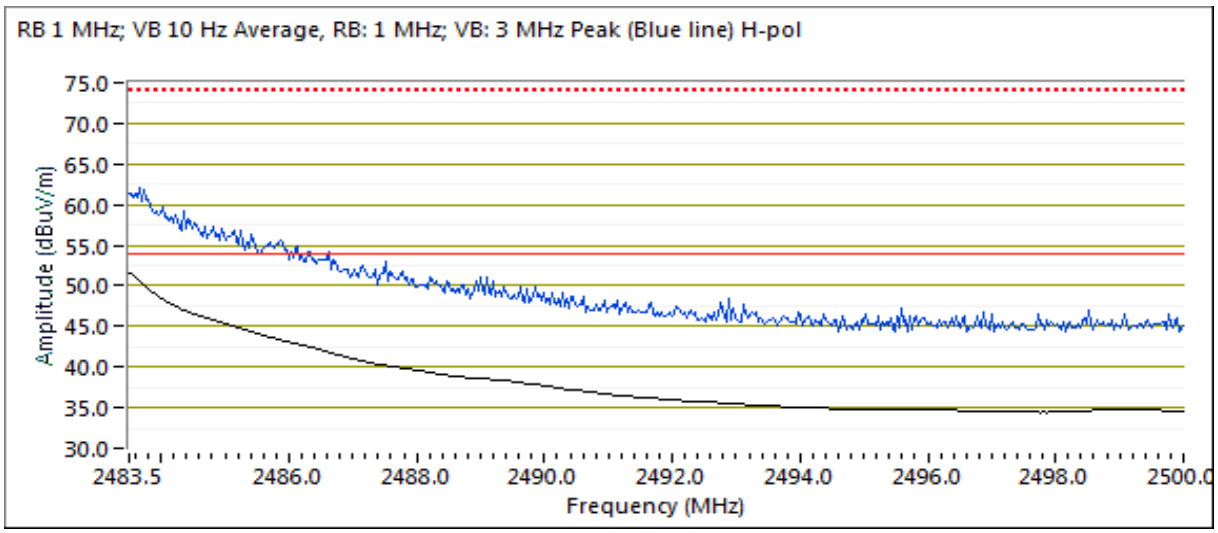
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.510	53.6	H	54.0	-0.4	AVG	322	2.1	POS; RB 1 MHz; VB: 10 Hz
2483.540	62.7	H	74.0	-11.3	PK	322	2.1	POS; RB 1 MHz; VB: 3 MHz
2483.500	43.0	V	54.0	-11.0	AVG	302	1.0	POS; RB 1 MHz; VB: 10 Hz
2483.520	57.0	V	74.0	-17.0	PK	302	1.0	POS; RB 1 MHz; VB: 3 MHz

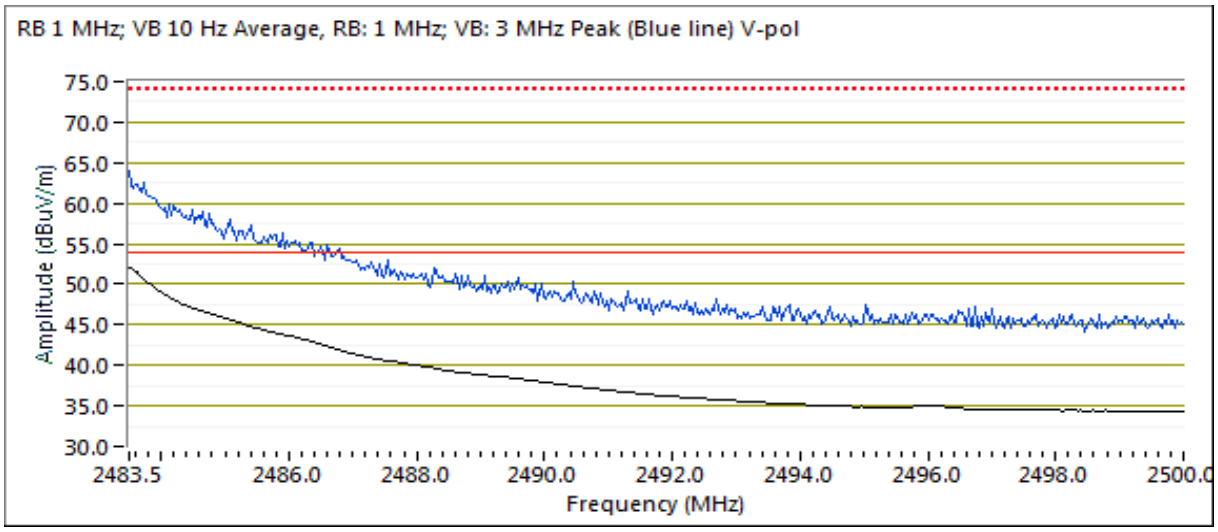


Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #2b: EUT Side
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	52.0	H	54.0	-2.0	AVG	324	2.2	POS; RB 1 MHz; VB: 10 Hz
2483.540	61.7	H	74.0	-12.3	PK	324	2.2	POS; RB 1 MHz; VB: 3 MHz
2483.510	52.1	V	54.0	-1.9	AVG	112	1.9	POS; RB 1 MHz; VB: 10 Hz
2483.500	61.0	V	74.0	-13.0	PK	112	1.9	POS; RB 1 MHz; VB: 3 MHz

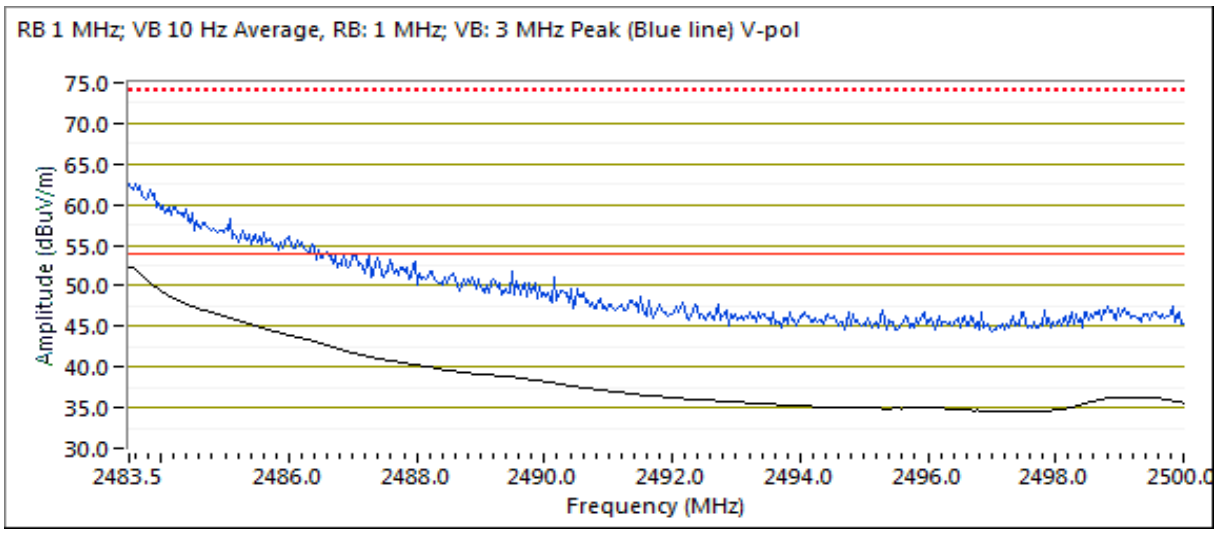


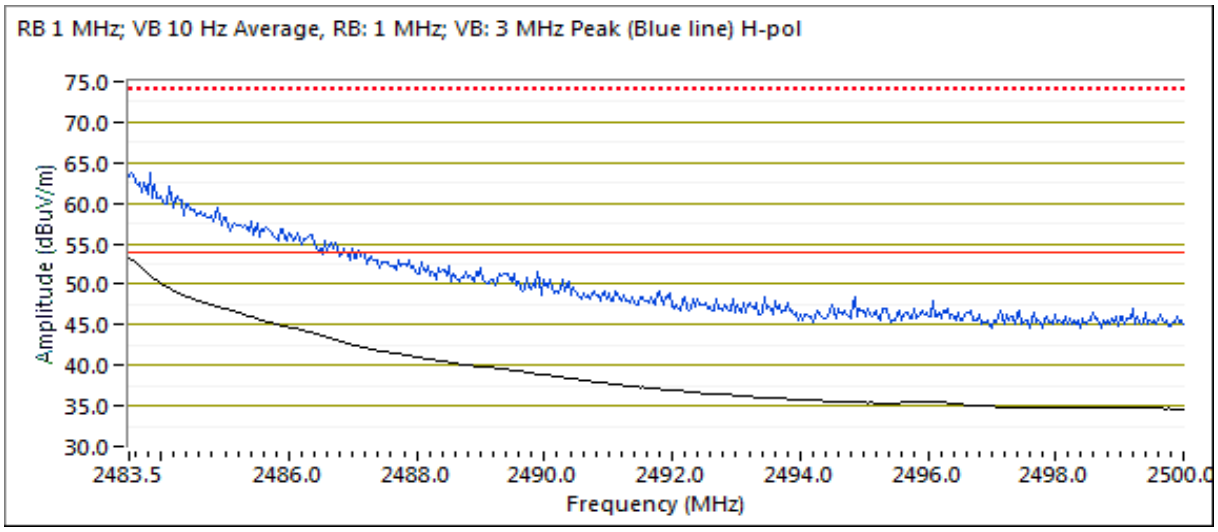


Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #2c: EUT Upright
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	
2483.510	52.3	V	54.0	-1.7	AVG	194	2.1	POS; RB 1 MHz; VB: 10 Hz
2483.500	61.8	V	74.0	-12.2	PK	194	2.1	POS; RB 1 MHz; VB: 3 MHz
2483.510	53.1	H	54.0	-0.9	AVG	165	1.4	POS; RB 1 MHz; VB: 10 Hz
2483.510	62.4	H	74.0	-11.6	PK	165	1.4	POS; RB 1 MHz; VB: 3 MHz





Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

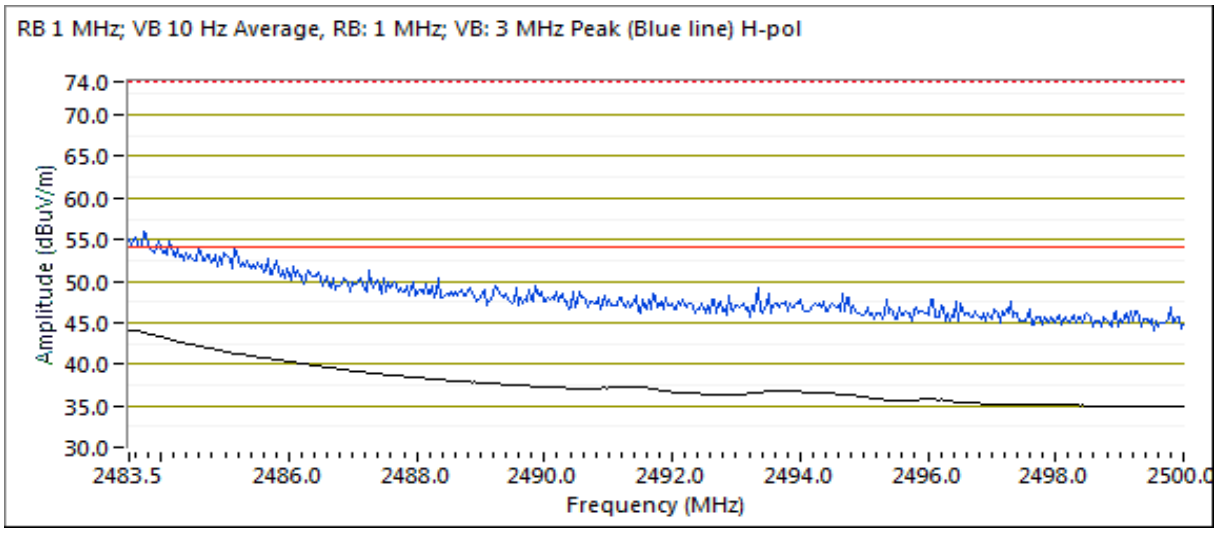
Run #3: Radiated Bandedge Measurements

Date of Test: 7/29/2019 Config. Used: 1
Test Engineer: Deniz Demirci Config Change: None
Test Location: FT Ch #7 EUT Voltage: 120 V / 60 Hz

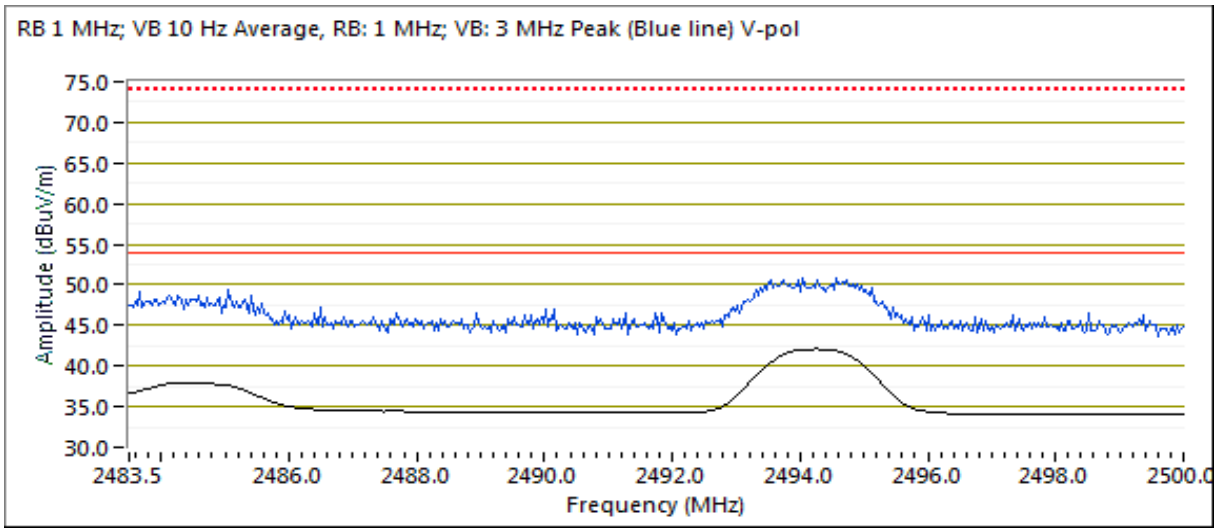
Channel: 25 - 2475 MHz Mode: ZigBee
Tx Chain: Main Data Rate: -

Run #3a: EUT Flat
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	
2483.530	44.1	H	54.0	-9.9	AVG	165	1.8	POS; RB 1 MHz; VB: 10 Hz
2483.520	57.0	H	74.0	-17.0	PK	165	1.8	POS; RB 1 MHz; VB: 3 MHz
2494.240	42.1	V	54.0	-11.9	AVG	296	1.7	POS; RB 1 MHz; VB: 10 Hz
2494.780	51.9	V	74.0	-22.1	PK	296	1.7	POS; RB 1 MHz; VB: 3 MHz



Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A



Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

RSS-247 and FCC 15.247 (DTS) Radiated Spurious 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 was located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 23 °C
Rel. Humidity: 39 %

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

Run #	Mode	Channel	Power Setting	Power Setting	Test Performed	Limit	Result / Margin
Scans on center channel in all three orientations.							
1a Flat	ZigBee	Center 2440 MHz	19	19	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	43.8 dBµV/m @ 4879.0 MHz (-10.2 dB)
1b Side	ZigBee	Center 2440 MHz	19	19	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	45.1 dBµV/m @ 4881.0 MHz (-8.9 dB)
1c Upright	ZigBee	Center 2440 MHz	19	19	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	43.5 dBµV/m @ 4881.0 MHz (-10.5 dB)
Measurements on low and high channels in worst-case orientation.							
2 Side	ZigBee	Low 2405 MHz	19	19	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	42.6 dBµV/m @ 4811.0 MHz (-11.4 dB)
3 Side	ZigBee	High 2480 MHz	19	19	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	45.6 dBµV/m @ 4961.0 MHz (-8.4 dB)

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:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

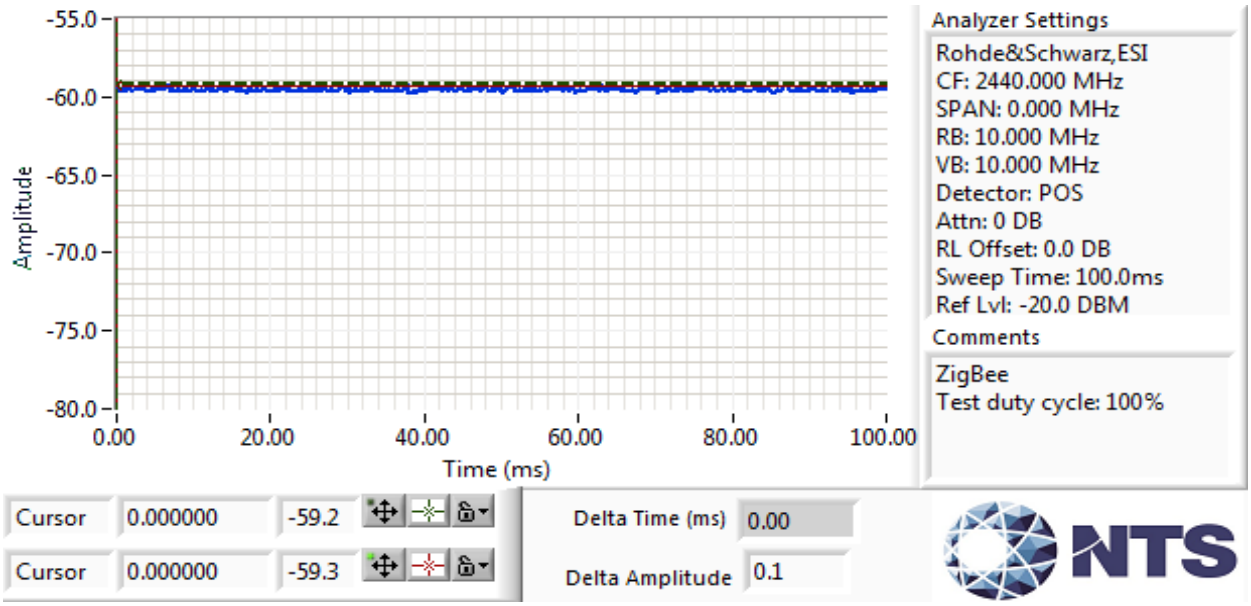
Sample Notes

Sample S/N: 12
Driver: -
Antenna: Internal PCB Trace, Inverted F.

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1 MHz, VBW=3 MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has duty cycle ≥ 98% and was measured using RBW=1 MHz, VBW=10 Hz, peak detector, linear average mode, auto sweep time, max hold.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt C. F.**	Min VBW for FS (Hz)
ZigBee	-	1.00	Yes	-	0	0	10



Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #1: Radiated Spurious Emissions, 1,000 - 25,000 MHz. Operating Mode: ZigBee

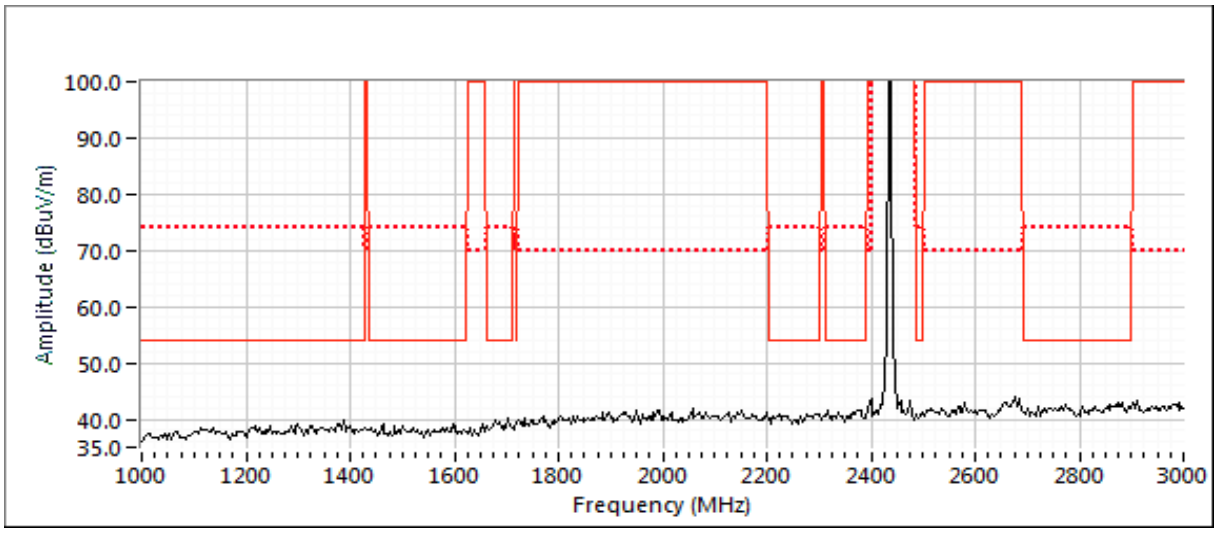
Date of Test: 7/26/2019, 7/29/2019 Config. Used: 1
Test Engineer: Deniz Demirci Config Change: None
Test Location: Chamber #7 EUT Voltage: 120 V/60 Hz

Run #1a: Center Channel (EUT Flat on the table)

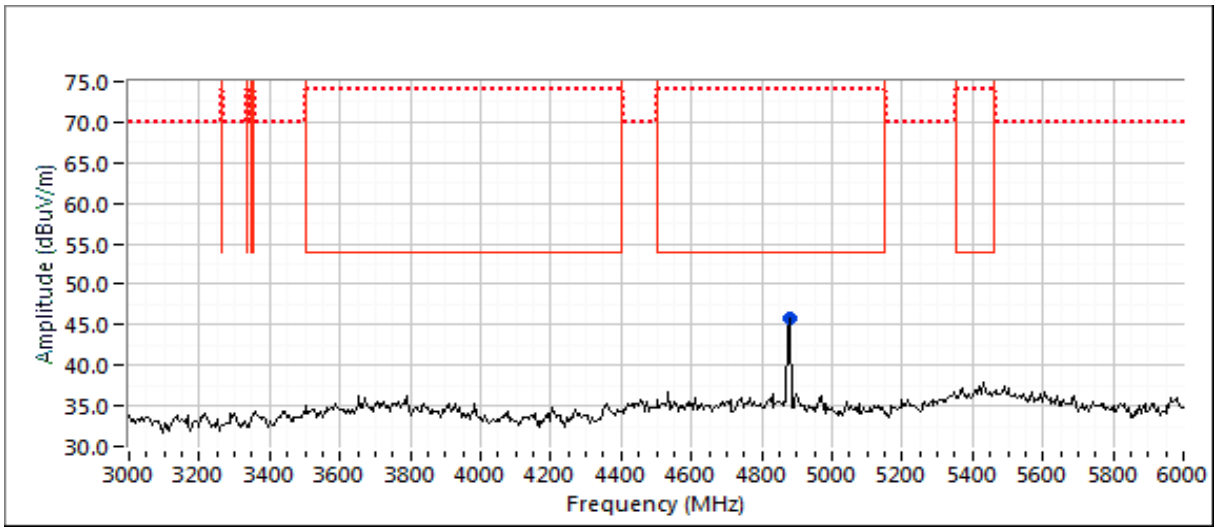
Channel: 2440 MHz Mode: ZigBee
Tx Chain: Main Data Rate: -

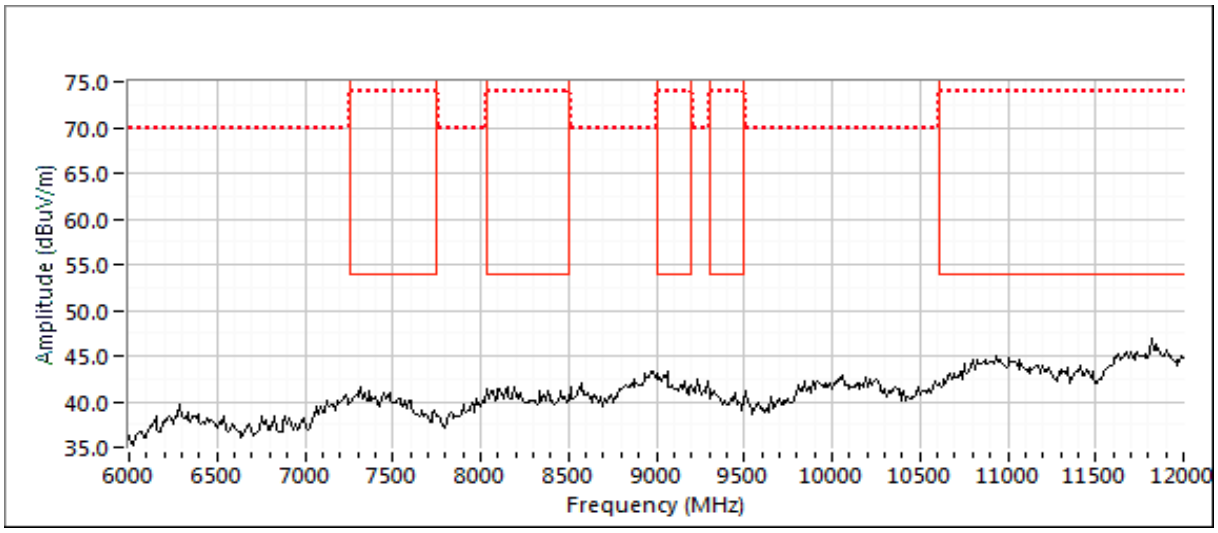
Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2439.950	115.2	H	Carrier	-	PK	47	1.1	RB 2 MHz;VB 3 MHz;Peak
4878.990	43.8	H	54.0	-10.2	AVG	221	2.0	RB 1 MHz;VB 10 Hz;Peak
4878.860	51.7	H	74.0	-22.3	PK	221	2.0	RB 1 MHz;VB 3 MHz;Peak

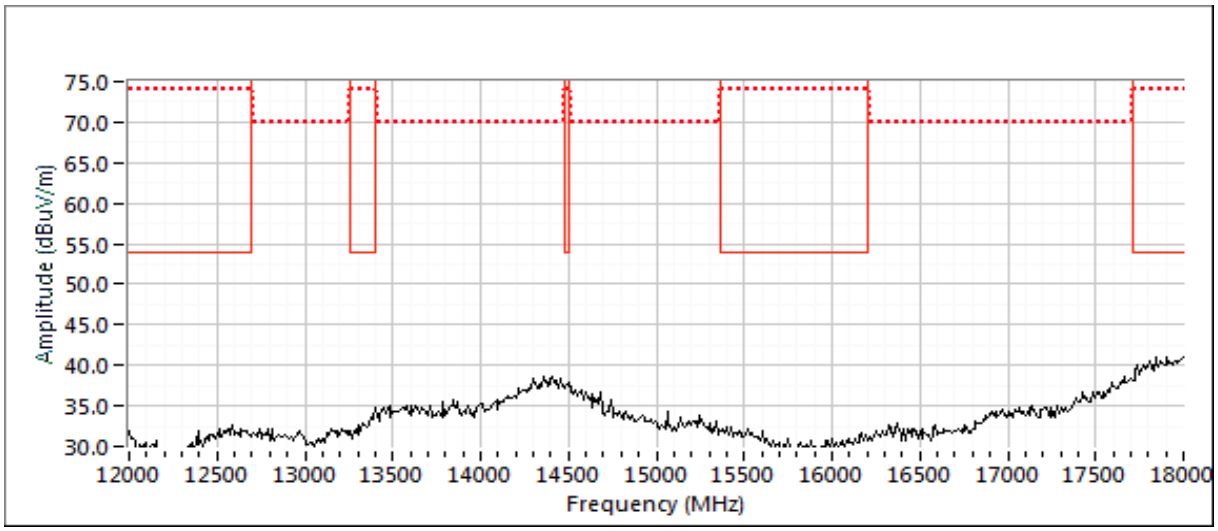


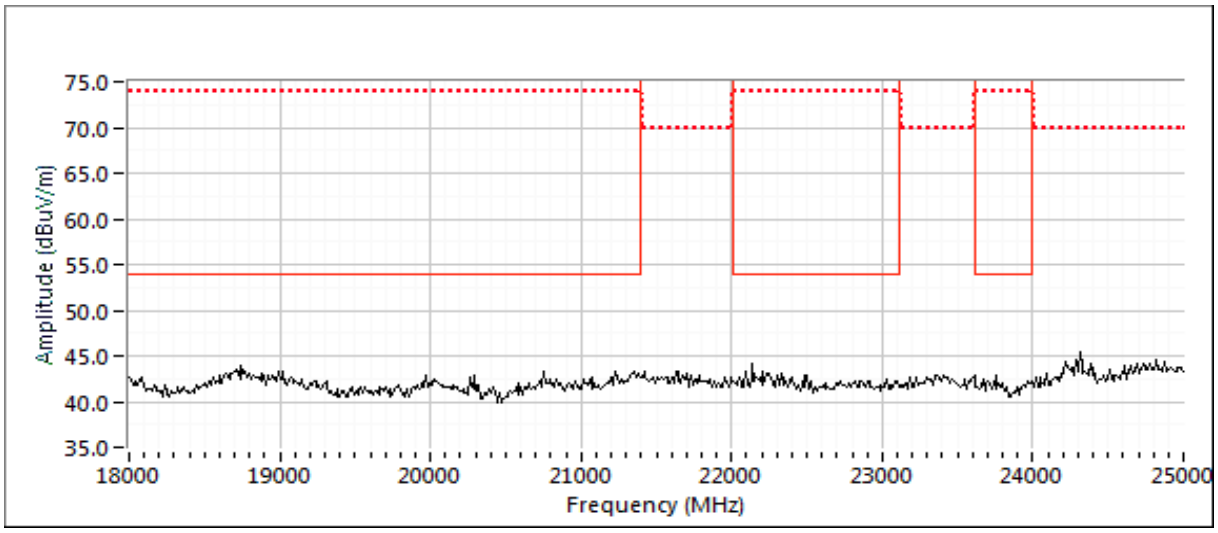
Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





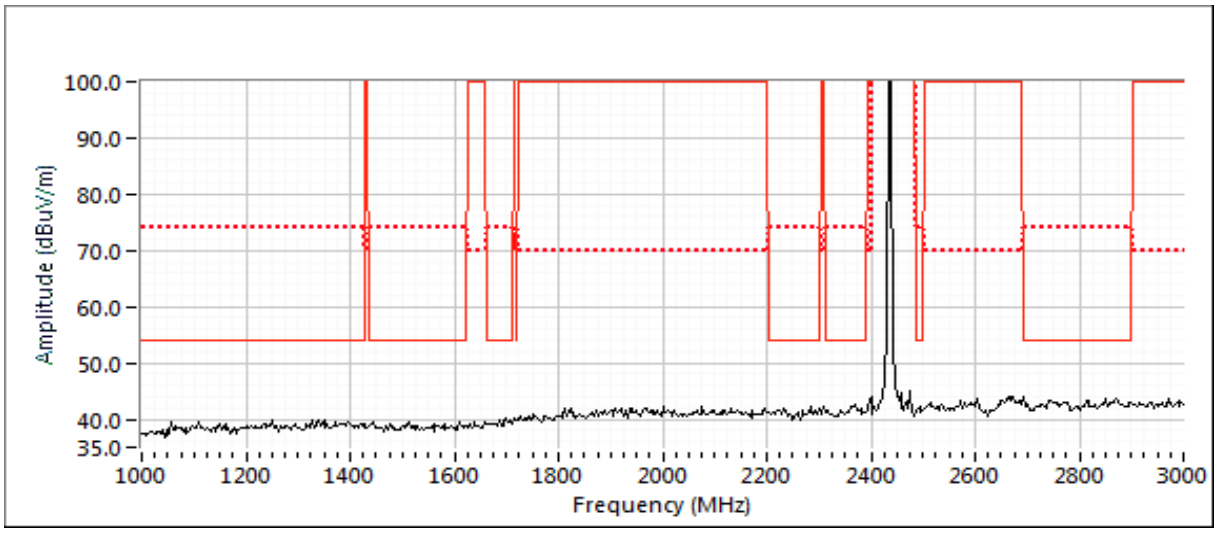
Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #1b: Center Channel (EUT side on the table)

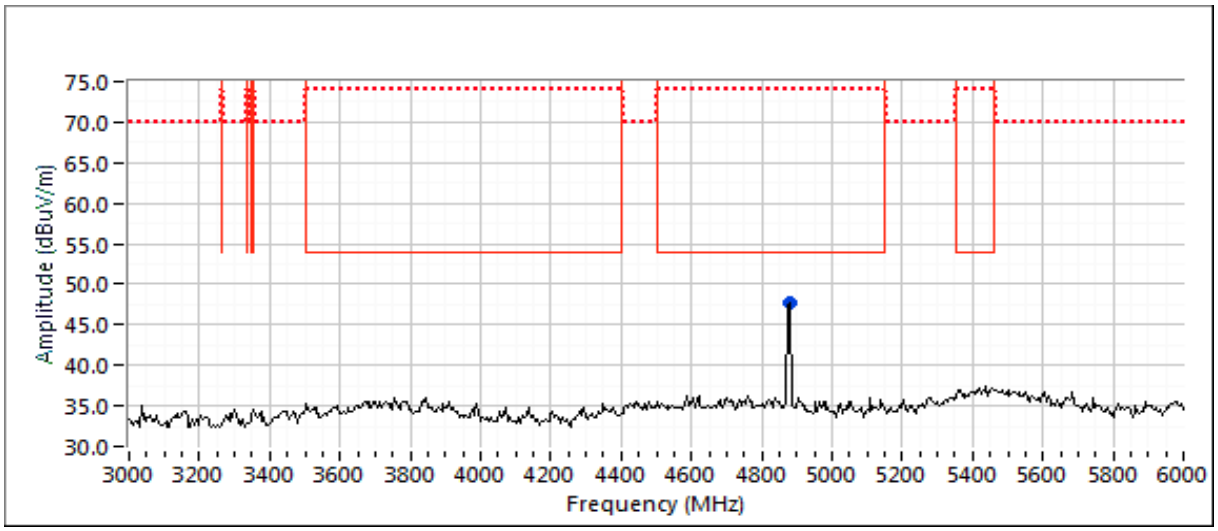
Channel: 2440 MHz Mode: ZigBee
Tx Chain: Main Data Rate: -

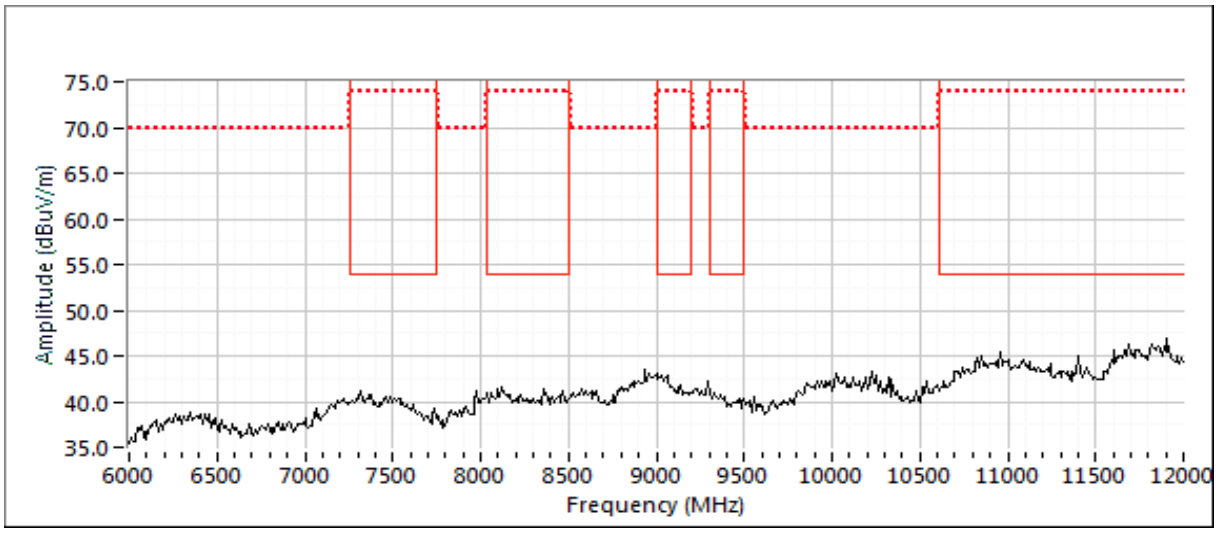
Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2439.980	114.9	H	Carrier	-	PK	34	1.3	RB 2 MHz;VB 3 MHz;Peak
4881.040	45.1	H	54.0	-8.9	AVG	323	2.0	RB 1 MHz;VB 10 Hz;Peak
4881.000	53.1	H	74.0	-20.9	PK	323	2.0	RB 1 MHz;VB 3 MHz;Peak

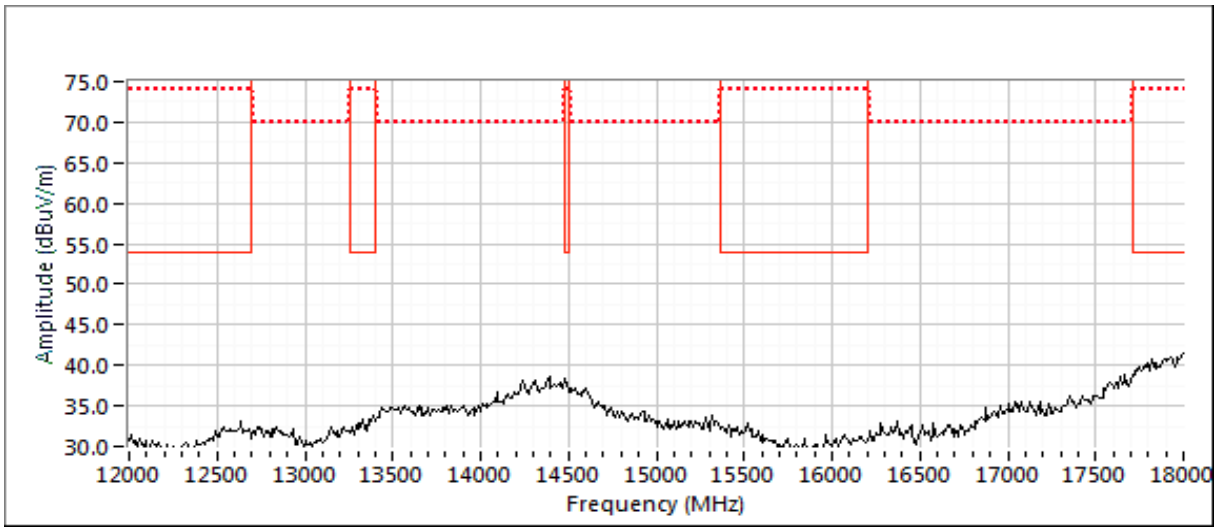


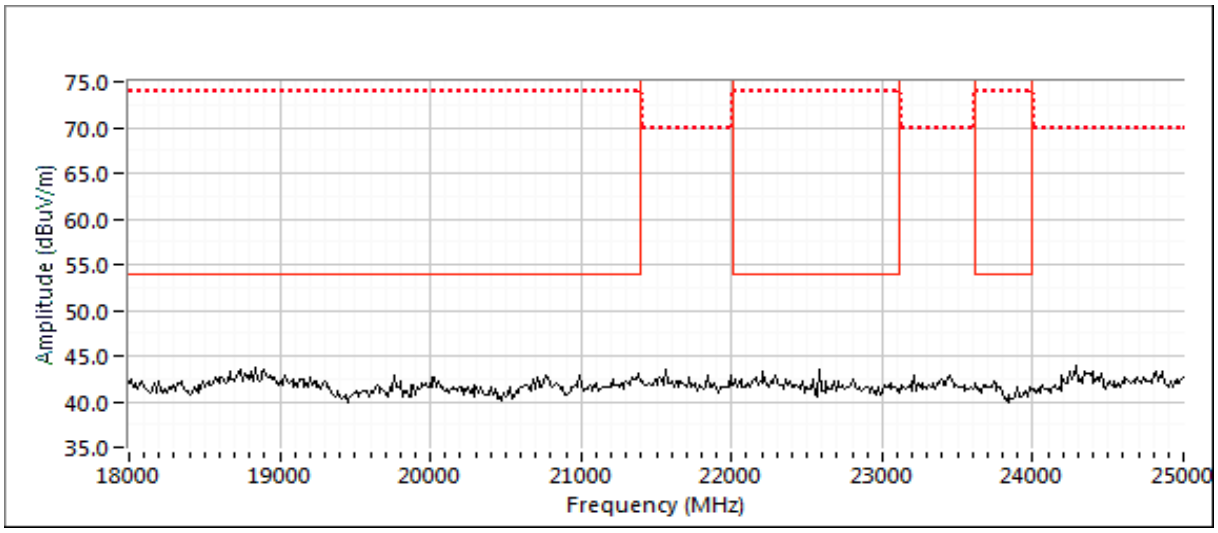
Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





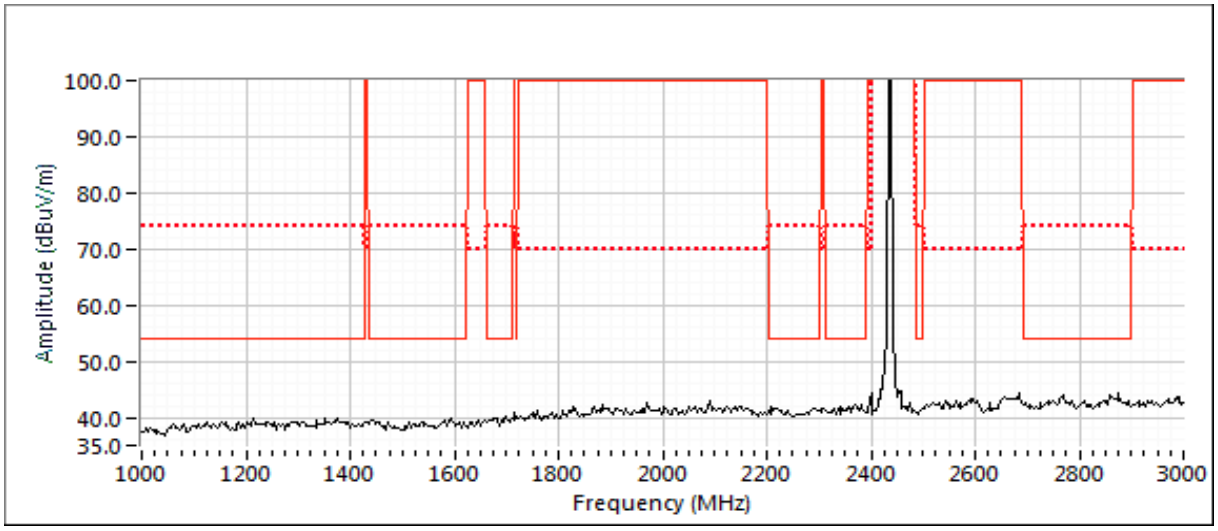
Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #1c: Center Channel (EUT upright on the table)

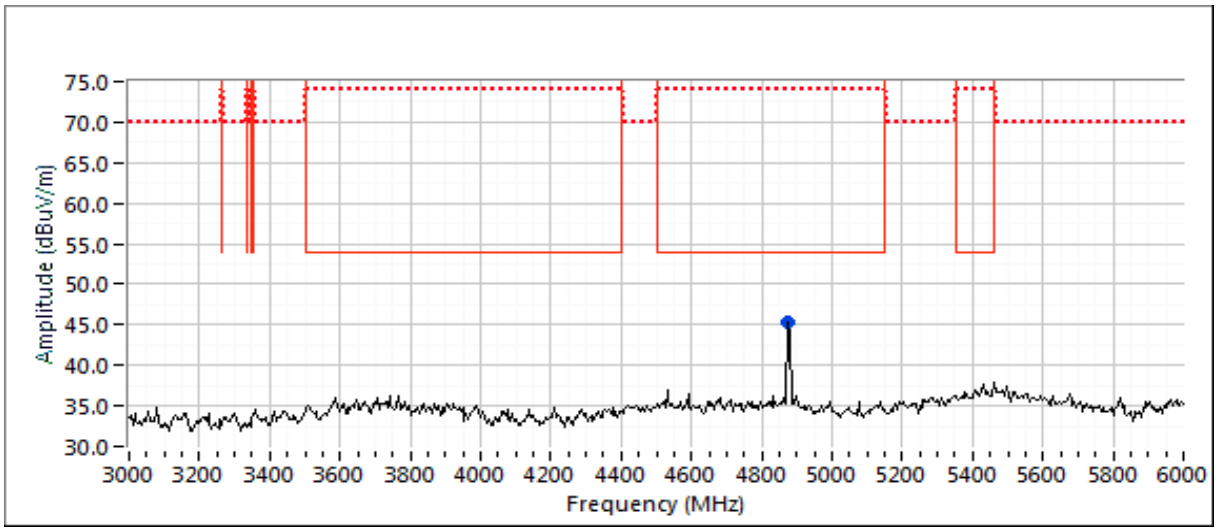
Channel: 2440 MHz Mode: ZigBee
Tx Chain: Main Data Rate: -

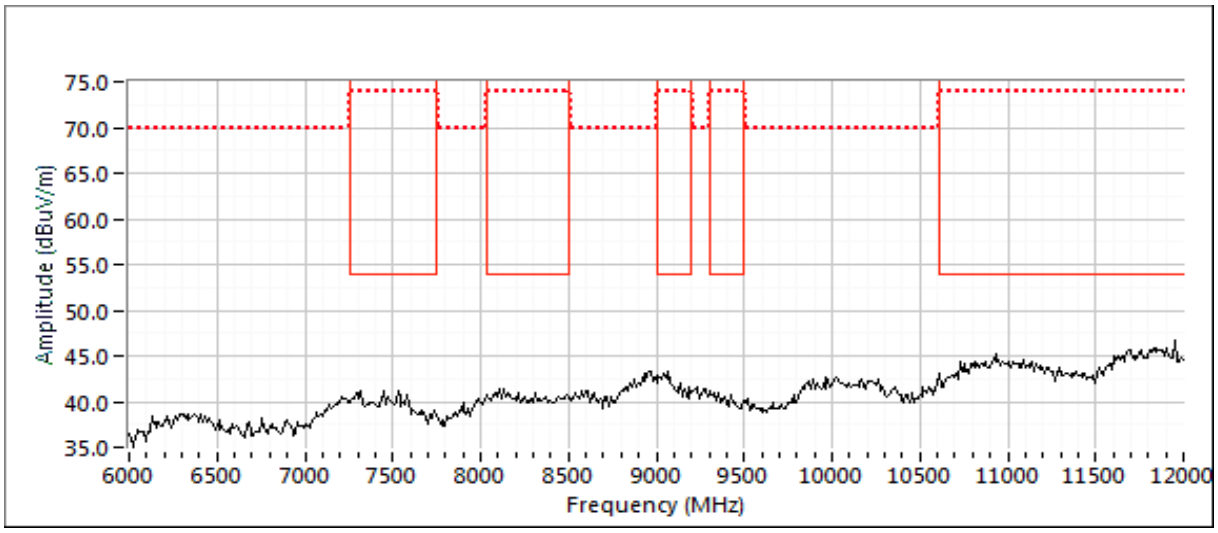
Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2439.680	115.1	H	Carrier	-	PK	150	1.0	RB 2 MHz;VB 3 MHz;Peak
4881.000	43.5	V	54.0	-10.5	AVG	253	1.2	RB 1 MHz;VB 10 Hz;Peak
4881.050	51.2	V	74.0	-22.8	PK	253	1.2	RB 1 MHz;VB 3 MHz;Peak

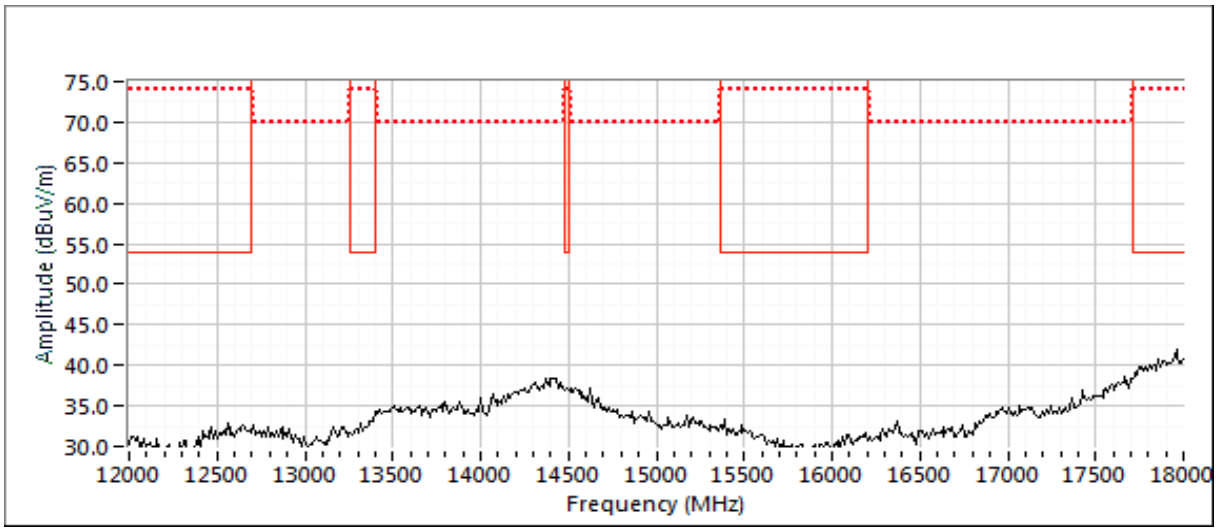


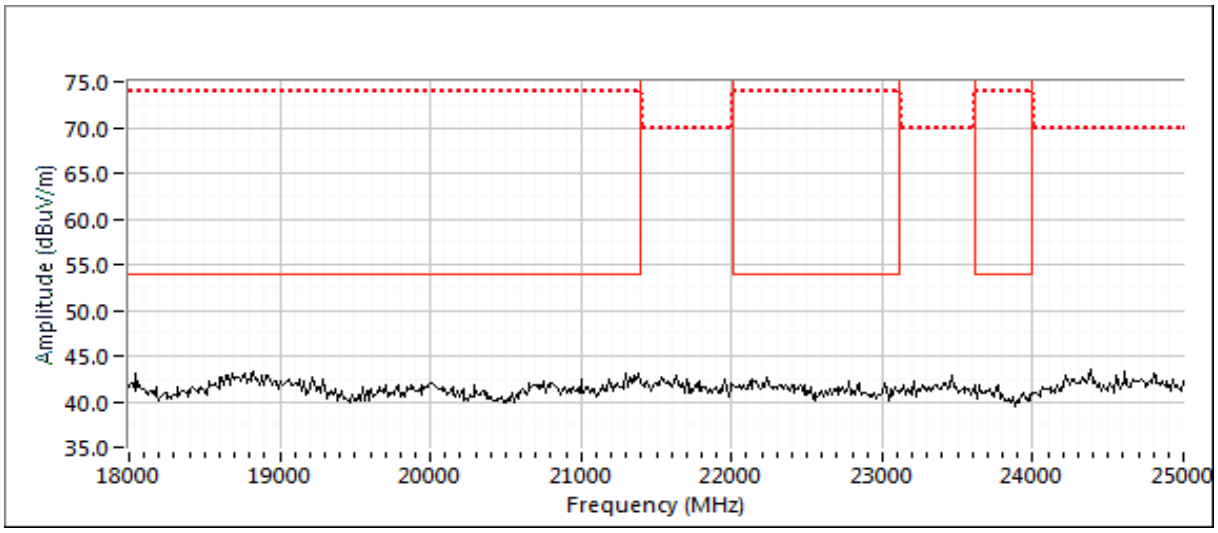
Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #2: Radiated Spurious Emissions, 1,000 - 25,000 MHz. Operating Mode: ZigBee

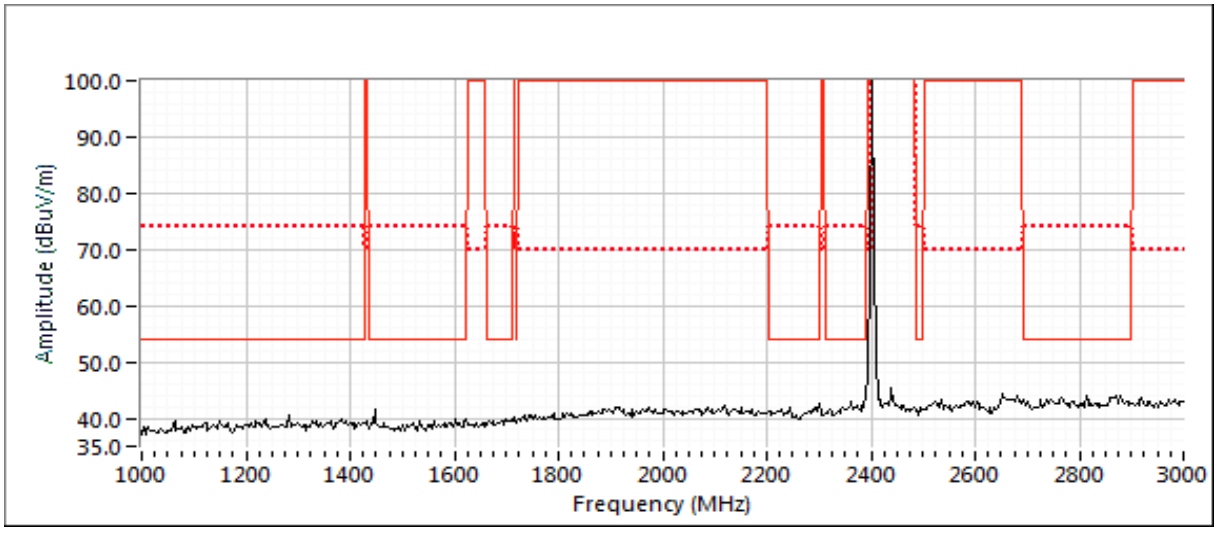
Date of Test: 7/26/2019, 7/29/2019 Config. Used: 1
Test Engineer: Deniz Demirci Config Change: None
Test Location: Chamber #7 EUT Voltage: 120 V/60 Hz

Low Channel

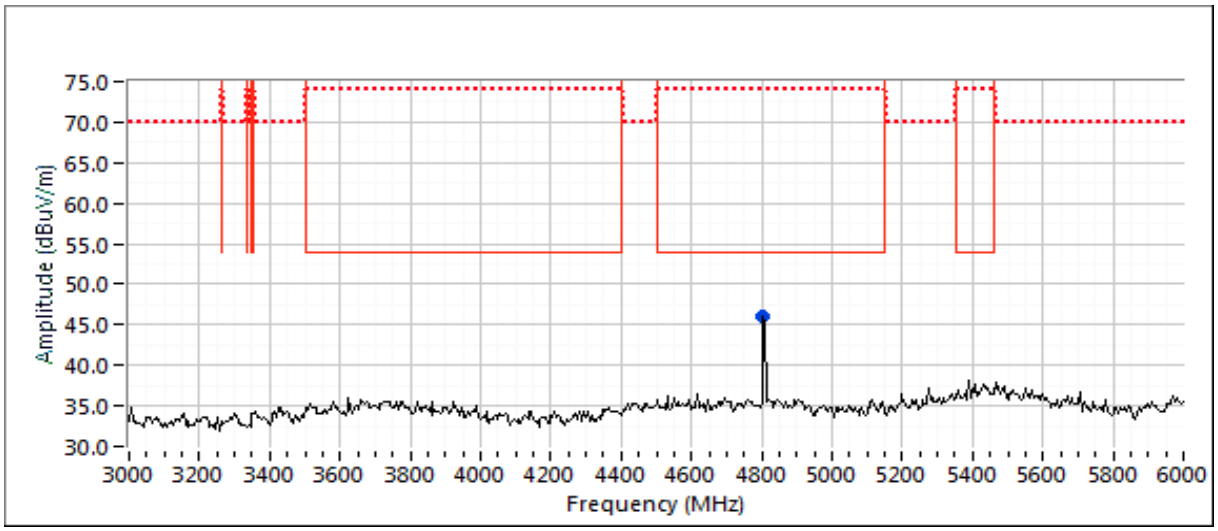
Channel: 2405 MHz Mode: ZigBee
Tx Chain: Main Data Rate: -

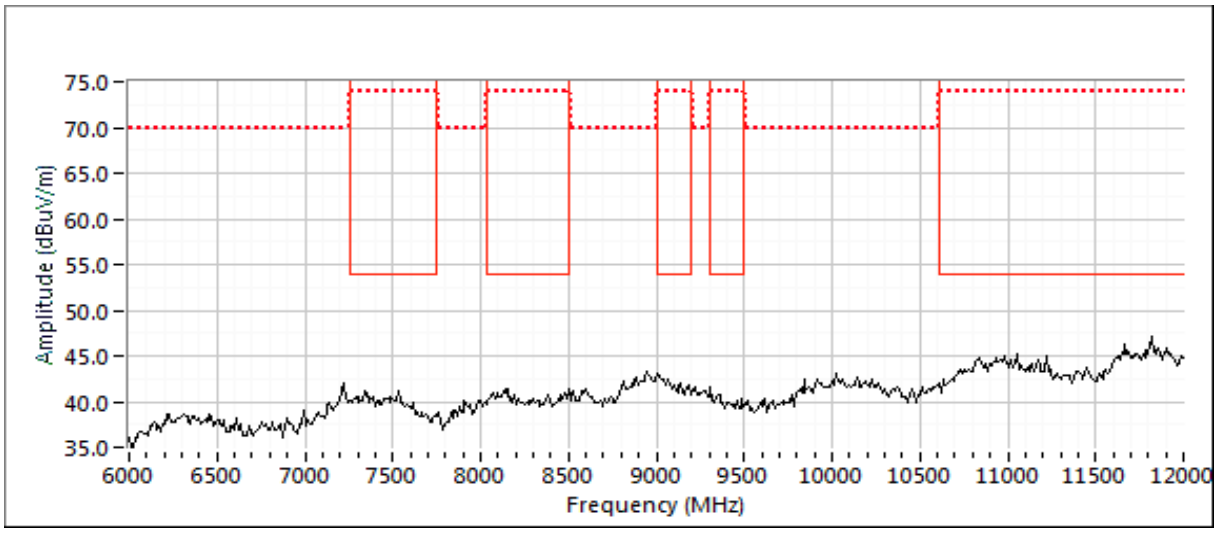
Run #2a: Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2405.600	112.8	H	Carrier	-	PK	325	2.3	POS; RB 2 MHz; VB: 3 MHz
2404.390	111.4	V	Carrier	-	PK	168	1.5	POS; RB 2 MHz; VB: 3 MHz
4810.990	42.6	H	54.0	-11.4	AVG	321	1.4	RB 1 MHz;VB 10 Hz;Peak
4811.080	51.0	H	74.0	-23.0	PK	321	1.4	RB 1 MHz;VB 3 MHz;Peak

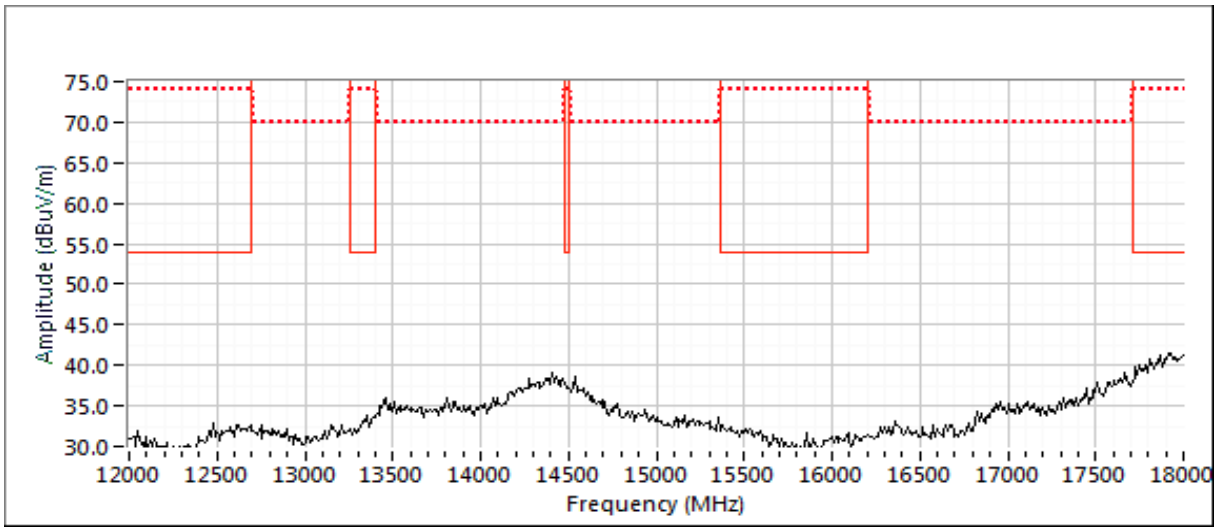


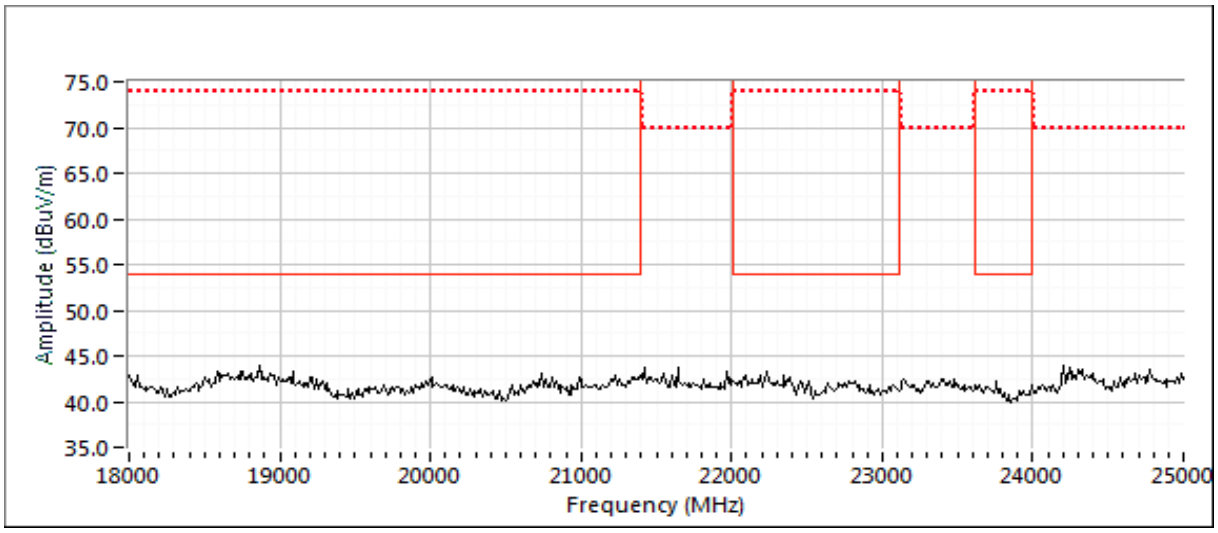
Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A

Run #3: Radiated Spurious Emissions, 1,000 - 25,000 MHz. Operating Mode: ZigBee

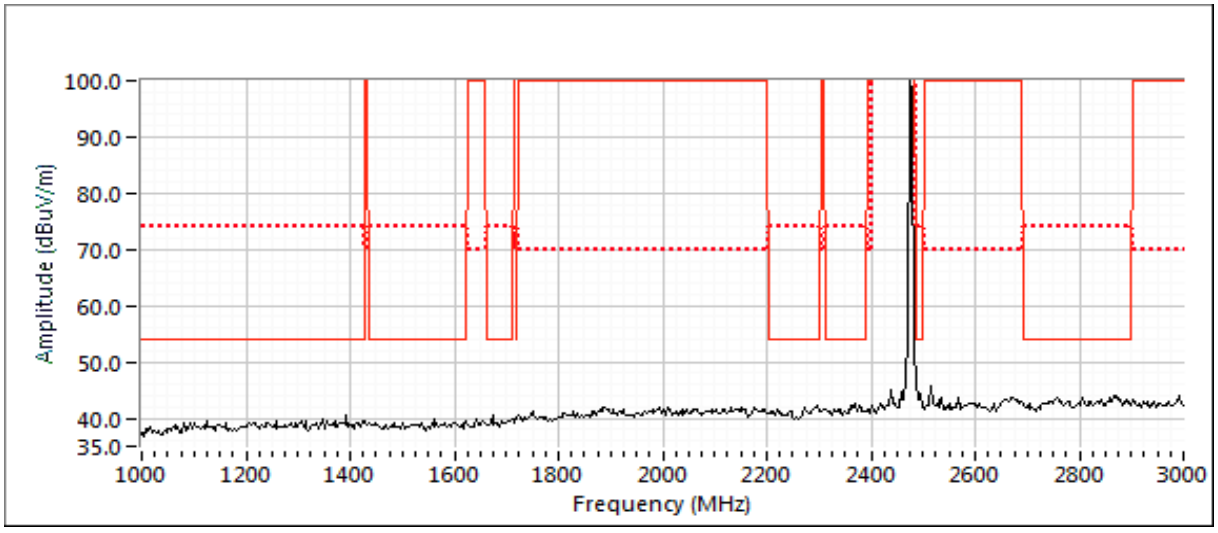
Date of Test: 7/26/2019 Config. Used: 1
Test Engineer: Deniz Demirci Config Change: None
Test Location: Chamber #7 EUT Voltage: 120 V/60 Hz

High Channel

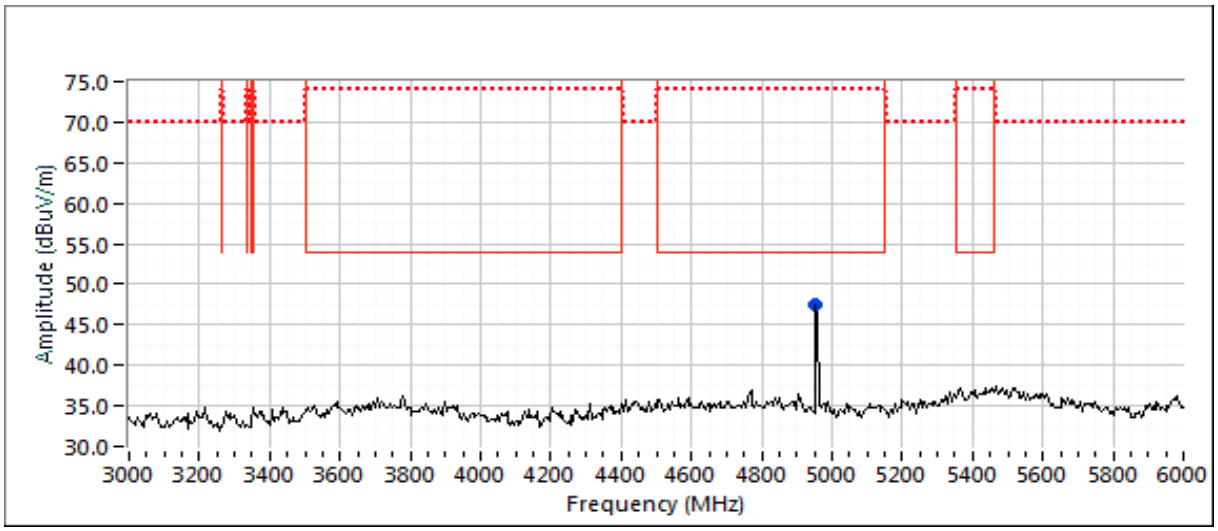
Channel: 2480 Mode: ZigBee
Tx Chain: Main Data Rate: -

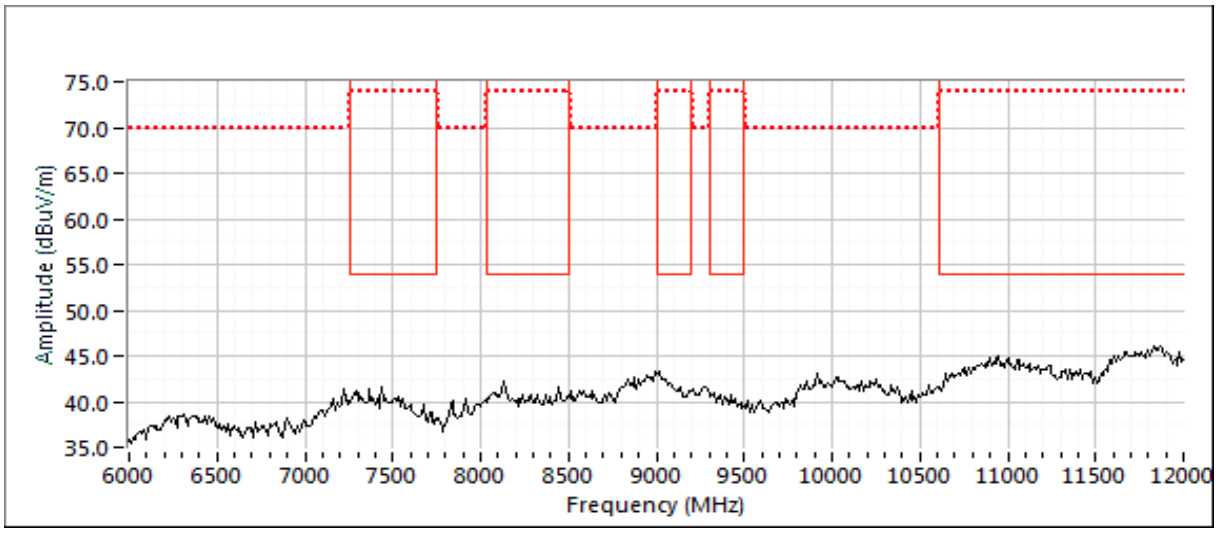
Run #3a: Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2478.720	113.7	H	Carrier	-	PK	321	1.8	POS; RB 10 MHz; VB: 10 MHz
2479.420	112.6	V	Carrier	-	PK	106	1.5	POS; RB 10 MHz; VB: 10 MHz
4960.980	45.6	H	54.0	-8.4	AVG	325	2.0	RB 1 MHz;VB 10 Hz;Peak
4961.060	53.6	H	74.0	-20.4	PK	325	2.0	RB 1 MHz;VB 3 MHz;Peak

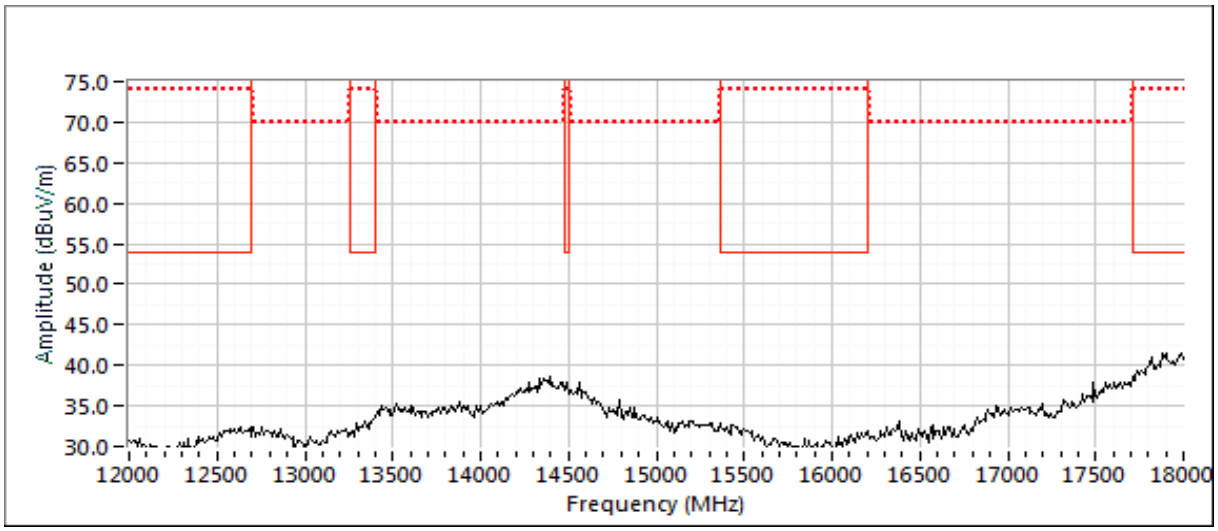


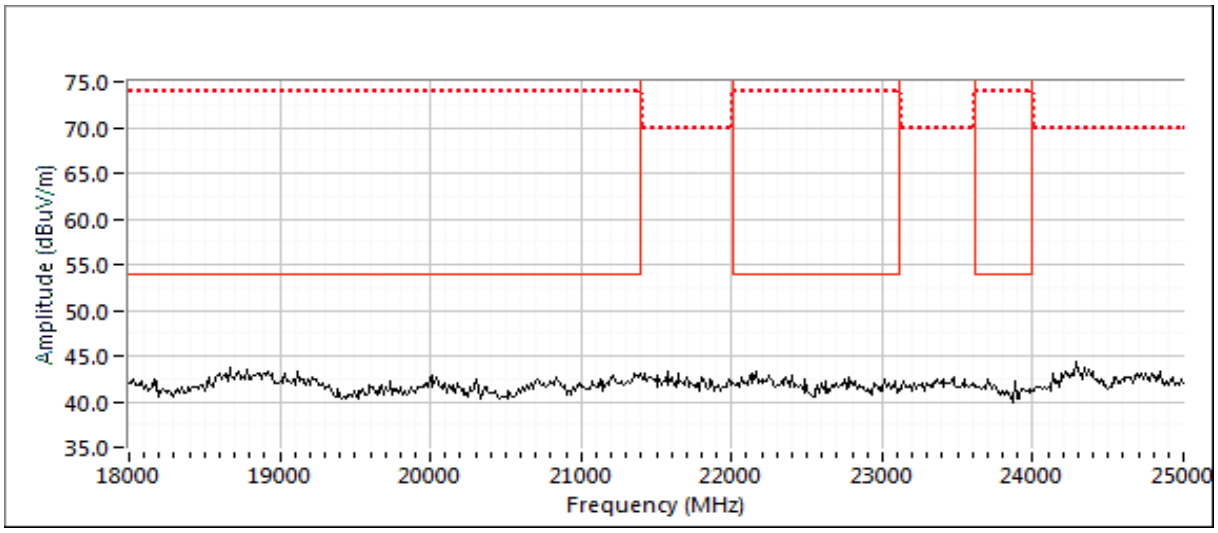
Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





Client:	Crestron Electronics	Job Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Coordinator:	-
Standard:	FCC 15.247, RSS-247	Class:	N/A





Client:	Crestron Electronics	PR Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Engineer:	-
Standard:	FCC 15.247, RSS-247	Class:	B

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.

Date of Test: 7/26/2019
Test Engineer: Deniz Demirci
Test Location: FT Ch #5

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

General Test Configuration

The EUT was located on the turntable for radiated emissions testing.
The test distance and extrapolation factor (if used) are detailed under each run description.
Note, preliminary testing indicates that the emissions were maximized by orientation of the EUT and elevation of the measurement antenna. Maximized testing indicated that the emissions were maximized by orientation of the EUT, elevation of the measurement antenna, and manipulation of the EUT's interface cables.

Ambient Conditions:

Temperature: 26 °C
Rel. Humidity: 39 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	9 KHz - 30 MHz	FCC 15.209	Pass	-9.40 dBµV/m @ 27.996 MHz (-38.9 dB) Noise floor reading.
2	30 MHz- 1 GHz	FCC 15.209	Pass	34.2 dBµV/m @ 151.79 MHz (-9.3 dB)

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.

Sample Notes

Sample S/N: 13
Driver: -
Antenna: Internal PCB Trace, Inverted F.

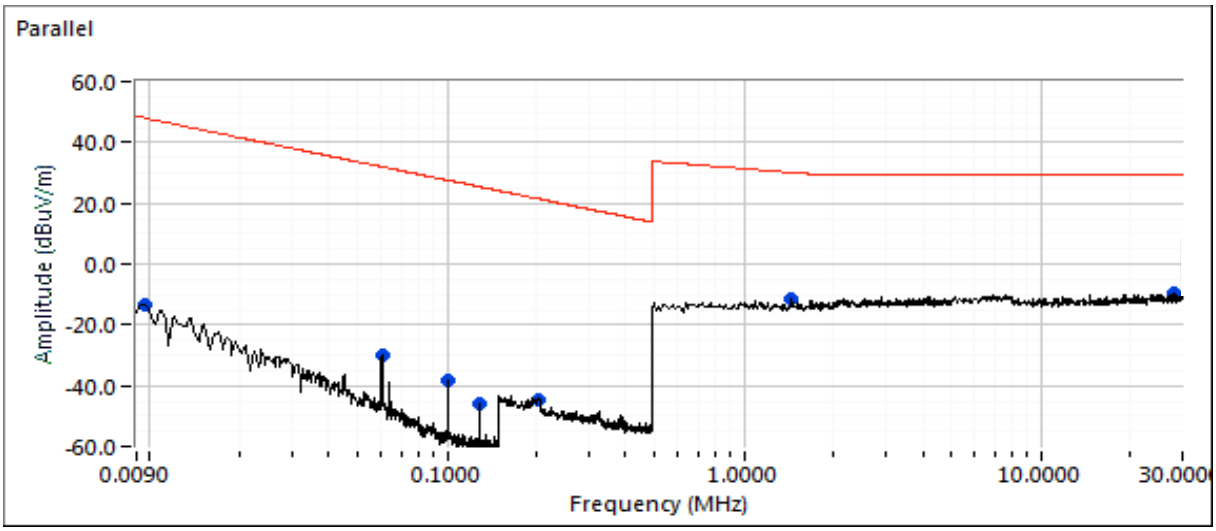
Client:	Crestron Electronics	PR Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Engineer:	-
Standard:	FCC 15.247, RSS-247	Class:	B

Run #1: Radiated Emissions, 9 kHz - 30 MHz, FCC 15.209, Center Channel @ 2440 MHz

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
0.009 - 0.490 MHz	3	300	-80.0
0.490 - 1.705 MHz	3	30	-40.0
1.705 - 30.0 MHz	3	30	-40.0

Note - the extrapolation factor is based on 40log(test distance/limit distance) as permitted by FCC 15.31

EUT side on the table (worst case emission orientation of > 1 GHz measurements.) RX antenna parallel.



Maximized readings (includes manipulation of EUT interface cables)

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
0.010	-13.5	V	48.0	-61.5	Peak	234	1.0	
0.060	-29.7	V	32.0	-61.7	Peak	360	1.0	
0.100	-38.1	V	27.6	-65.7	Peak	360	1.0	
0.128	-46.1	V	25.4	-71.5	Peak	234	1.0	
0.203	-44.4	V	21.4	-65.8	Peak	244	1.0	
1.448	-11.8	V	30.1	-41.9	Peak	14	1.0	
27.996	-9.4	V	29.5	-38.9	Peak	169	1.0	

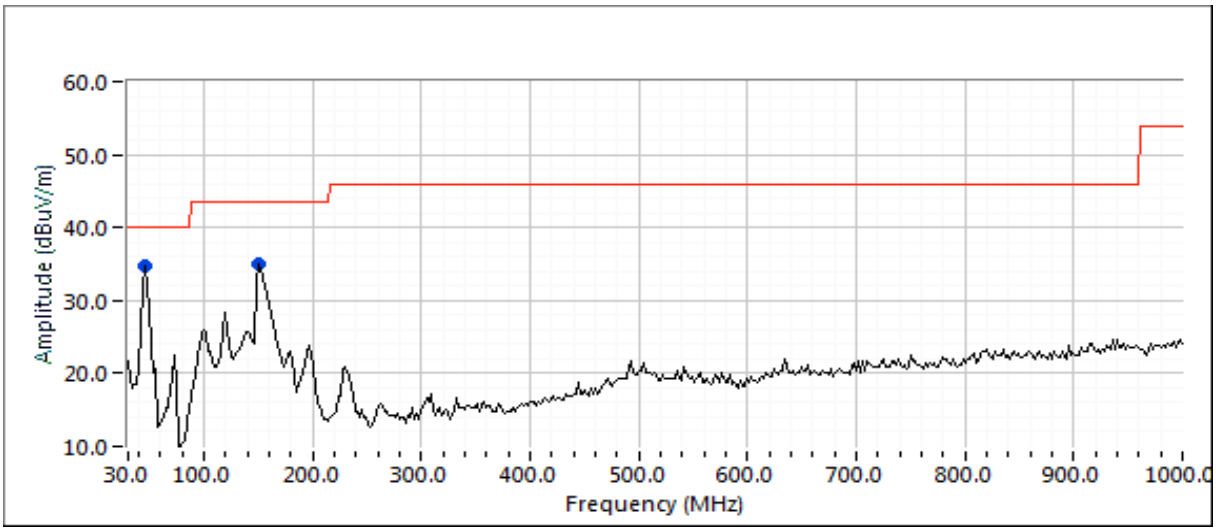
Note 1:	The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, with a peak limit 20 dB above the average limit.

Client:	Crestron Electronics	PR Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Engineer:	-
Standard:	FCC 15.247, RSS-247	Class:	B

Run #2: Radiated Emissions, 30 MHz - 1 GHz, FCC 15.209, Center Channel @ 2440 MHz

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
30 MHz - 1 GHz	3	3	0.0

EUT side on the table, (worst case emission orientation of > 1 GHz measurements.)



Maximized readings (includes manipulation of EUT interface cables)

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
151.785	34.2	V	43.5	-9.3	QP	46	1.0	QP (1.00s)
46.348	29.9	V	40.0	-10.1	QP	328	1.0	QP (1.00s)

Client:	Crestron Electronics	PR Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Engineer:	-
Standard:	FCC 15.247, RSS-247	Class:	B

Conducted Emissions

(NTS Silicon Valley, 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: 7/26/2019
Test Engineer: Deniz Demirci
Test Location: FT Ch #5

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

General Test Configuration

For tabletop equipment, the EUT was located on a table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80 cm from the LISN. No remote support equipment was used.

Ambient Conditions:

Temperature: 26 °C
Rel. Humidity: 39 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power, 120 V/60 Hz	Class B	Pass	30.2 dBµV @ 0.448 MHz (-16.7 dB)

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.

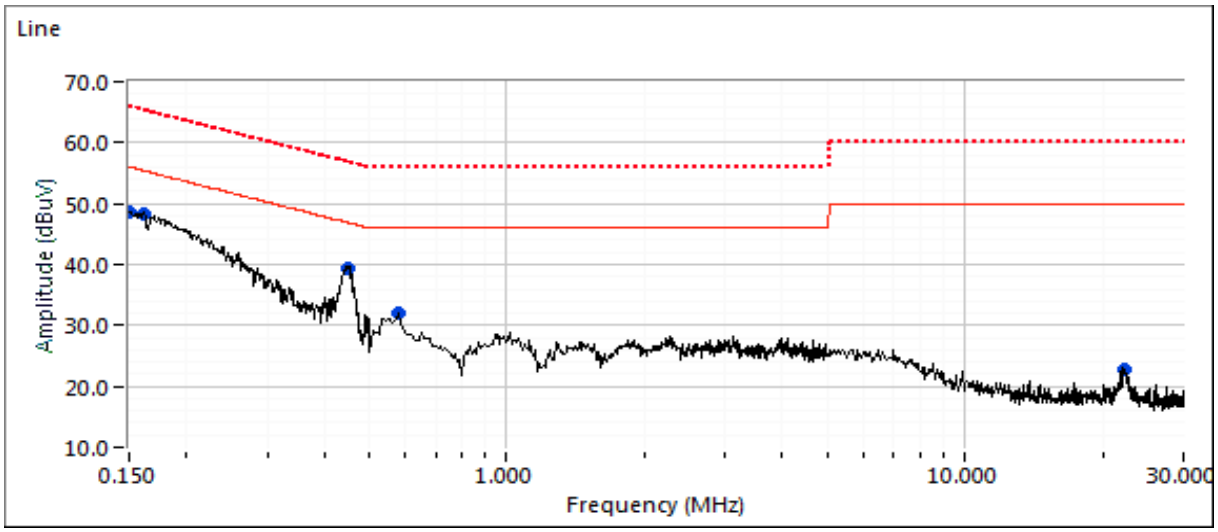
Sample Notes

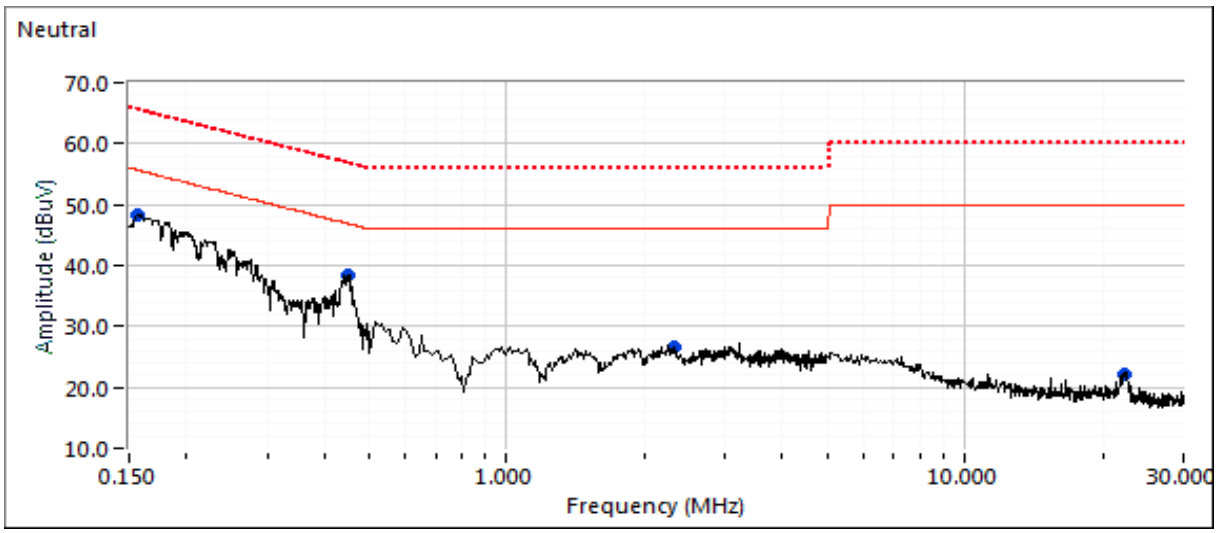
Sample S/N: 13
Driver: -
Antenna: Internal PCB Trace, Inverted F.

Client:	Crestron Electronics	PR Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Engineer:	-
Standard:	FCC 15.247, RSS-247	Class:	B

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

Tx Center Channel @ 2440 MHz





Client:	Crestron Electronics	PR Number:	PR093543
Model:	CWD7712	T-Log Number:	TL093543-RA
		Project Manager:	Christine Krebill
Contact:	William Wack	Project Engineer:	-
Standard:	FCC 15.247, RSS-247	Class:	B

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	
0.151	*48.7*	*Line 1*	*56.0*	*-7.3*	*Peak*	
0.162	*48.4*	*Line 1*	*55.4*	*-7.0*	*Peak*	
0.451	*39.5*	*Line 1*	*46.9*	*-7.4*	*Peak*	
0.581	*32.0*	*Line 1*	*46.0*	*-14.0*	*Peak*	
22.385	*22.9*	*Line 1*	*50.0*	*-27.1*	*Peak*	
0.156	*48.2*	*Neutral*	*55.7*	*-7.5*	*Peak*	
0.452	*38.5*	*Neutral*	*46.8*	*-8.3*	*Peak*	
2.322	*26.7*	*Neutral*	*46.0*	*-19.3*	*Peak*	
22.385	*22.2*	*Neutral*	*50.0*	*-27.8*	*Peak*	

Final quasi-peak and average readings

Frequency	Level	AC	Class B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.448	30.2	Line 1	46.9	-16.7	AVG	AVG (0.10s)
0.451	28.4	Neutral	46.9	-18.5	AVG	AVG (0.10s)
0.448	37.9	Line 1	56.9	-19.0	QP	QP (1.00s)
0.451	35.8	Neutral	56.9	-21.1	QP	QP (1.00s)
0.156	44.0	Neutral	65.7	-21.7	QP	QP (1.00s)
0.151	44.2	Line 1	66.0	-21.8	QP	QP (1.00s)
0.161	42.5	Line 1	65.4	-22.9	QP	QP (1.00s)
0.559	20.2	Line 1	46.0	-25.8	AVG	AVG (0.10s)
0.151	28.0	Line 1	56.0	-28.0	AVG	AVG (0.10s)
0.559	27.7	Line 1	56.0	-28.3	QP	QP (1.00s)
0.161	26.4	Line 1	55.4	-29.0	AVG	AVG (0.10s)
0.156	22.9	Neutral	55.7	-32.8	AVG	AVG (0.10s)
2.345	22.5	Neutral	56.0	-33.5	QP	QP (1.00s)
2.345	11.2	Neutral	46.0	-34.8	AVG	AVG (0.10s)
22.164	11.0	Line 1	50.0	-39.0	AVG	AVG (0.10s)
22.264	10.1	Neutral	50.0	-39.9	AVG	AVG (0.10s)
22.164	16.2	Line 1	60.0	-43.8	QP	QP (1.00s)
22.264	15.5	Neutral	60.0	-44.5	QP	QP (1.00s)

End of Report

This page is intentionally blank and
marks the last page of this test report.