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Amended Test Report

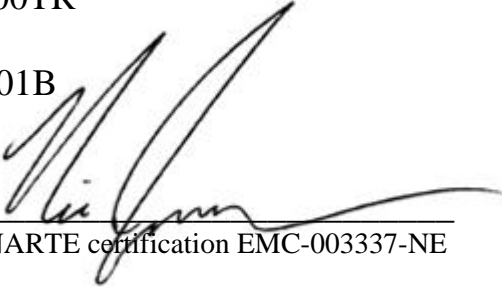
Company: Hetric International
3905 NW 36th St.
Oklahoma City, OK 73112

Contact: Dave Cameron

Product: CS2400TR

FCC ID: LW9-CS2400TR
IC: 2119B-CS2400TR

Test Report No: R041211-01-01B

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Test Engineer, iNARTE certification EMC-003337-NE

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1.0 Summary of test results*1.1 Test Results*

The EUT has been tested according to the following specifications:

APPLIED STANDARDS: FCC Part 15, Subpart C			
Standard Section	Test Type and Limit	Result	Remark
15.203 RSS-Gen	Unique Antenna Requirement	Pass	Required to be contained within enclosure.
15.207 RSS-Gen	Conducted Emissions	NA	The EUT was powered by a battery.
15.209 RSS-Gen	Radiated Emissions	Pass	Meets the requirement of the limit.
15.247(a)(2) RSS-210 Issue 8	Minimum Bandwidth, Limit: Min. 500kHz	Pass	Meets the requirement of the limit.
15.247(b) RSS-210 Issue 8	Maximum Peak Output Power, Limit: Max. 30dBm	Pass	Meets the requirement of the limit.
15.247(c) RSS-210 Issue 8	Transmitter Radiated Emissions, Limit: Table 15.209	Pass	Meets the requirement of the limit.
15.247(d) RSS-210 Issue 8	Power Spectral Density, Limit: Max. 8dBm	Pass	Meets the requirement of the limit.
15.247(c) RSS-210 Issue 8	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass	Meets the requirement of the limit.

1.2 *Test Methods*

1.2.1 *Conducted Emissions*

Conducted emissions measurements were made according to ANSI/IEEE C63.4: 2003 and compared to the limits as found in 47 CFR Part 15.207.

1.2.2 *Radiated Emissions*

Compliance to 47 CFR Parts 15.209 and 15.247 was tested in accordance with the methods of ANSI/IEEE C63.4: 2003. Several configurations were examined and the results presented represent a worst-case scenario. The EUT was placed on a wooden table approximately 80cm high and centered on a 4m diameter turntable. The table was rotated to find the angles of maximum emissions and the receiving antenna was moved from 1m to 4m in both vertical and horizontal positions. The EUT was tested in two orientations in order to test all 3 orthogonal axis (The use of the turntable tests two axis in one position). All measurements were taken at a distance of 3m from the EUT for Part 15.209 intentional radiator measurements, and 3m for 15.247 measurements of the fundamental frequency.

1.3 *Reason for amendment*

Amendment A:

The band edge measurements were tested again in accordance with KDB 913951. The description of the radiated emissions test was modified to state that all 3 orthogonal axis of the EUT were tested (See Section 1.2.2 and 4.2.2). 0.25dB was added to the conducted output power measurements to account for cable loss.

Amendment B:

The data from 2483.5MHz to 2500.0MHz was included in section 4.2 to show that emissions were below the FCC Part 15.209 limits in the restricted band.

2.0 Description**2.1 Equipment under test**

The Equipment Under Test (EUT) was a CS2400TR wireless transceiver module from Hetric International.

EUT Received Date: 24 May 2011

EUT Tested Date: 24 June 2011, 7 July 2011

MODEL	CS2400TR
MODULATION TYPE	DSSS
FREQUENCY RANGE	2400-2483.5MHz
NUMBER OF CHANNELS	16
MAXIMUM OUTPUT POWER	6.64dBm
ANTENNA TYPE	Whip antenna
SERIAL NUMBER OF TEST UNIT	NCEE TEST 1 (assigned)
POWER INPUT	6VDC

NOTE:

1. For more detailed features description, please refer to the manufacturer's specifications or User's Manual.

2.2 Laboratory description

All testing was performed at the NCEE Lincoln facility, which is a FCC and IC registered lab. This site has been fully described in previously submitted reports. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of $45 \pm 4\%$

Temperature of $20 \pm 3^\circ$ Celsius

2.3 *Description of test modes*

Channel	Frequency
0	2405MHz
7	2440MHz
15	2480MHz

2.4 *Applied standards*

The EUT is a digital transmission device operating between 2400 MHz and 2483.5 MHz. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.247 and 15.209)
ANSI/IEEE C63.4: 2003
Industry Canada, RSS 210, Issue 7, Category I Equipment
KDB Publication No. 558074: 2005

All test items have been performed and recorded as per the above standards.

2.5 *Description of support units*

None

2.6 *Configuration of system under test*

The EUT was supplied with 6VDC from a battery. The EUT was modified by the manufacturer to include a selector switch to select between channels 1, 7 and 15 transmitting continuously. The selector switch was for testing purposes only and is not included in the EUT in its standard configuration.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE
Rohde & Schwarz Test Receiver	ESI26	100037	9/2/2010
EMCO Biconilog Antenna	3142B	1654	1/14/2011
EMCO Horn Antenna	3115	6415	1/12/2011
EMCO Horn Antenna	3116	2576	6/14/2011*
Rohde & Schwarz LISN	ESH3-Z5	100023	1/14/2011
Rohde & Schwarz Preamp	TS-PR18	082001/003	12/15/2010**
Trilithic High Pass Filter	6HC330	23042	12/15/2010**

*Calibrated after testing was complete. Transducer factors did not deviate beyond 0.25dB.

**Internally characterized.

4.0 Detailed results

4.1 *Unique antenna requirement*

4.1.1 *Standard applicable*

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

4.1.2 *Antenna description*

The antenna supplied with the EUT is a whip antenna with a standard SMA connection. The device falls under a limited modular approval, where the manufacturer maintains full control over the installation of the EUT, which is required to be inside of an enclosure that requires the use of a tool to open and gain access to the antenna. Under these conditions the antenna is considered internal to the device and meets the requirement.

4.2 *Radiated emissions*

4.2.1 *Limits for radiated emissions measurements*

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (µV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (uV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. *Radiated limits according to 15.209 do not apply within the 2400MHz to 2483.5MHz band for transmitters.
- 6.**For frequencies not in a restricted band as specified in 15.205, spurious emissions shall be at least 20dB less than the field strength at the fundamental frequency.

4.2.2 *Test procedures*

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. For measurements from 30MHz to 1GHz, the test distance was 10m

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement. The EUT was tested in two orientations in order to test all 3 orthogonal axis (The use of the turntable tests two axis in one position). The EUT was tested in both flat (horizontal) and upright (vertical) orientation, with respect to the circuit board. The flat/vertical position was found to produce the highest emissions, so it was used for all measurements. Where measurements were within 4dB of the margin, the EUT was retested in both orientations to find the highest emissions.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one, using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz for peak and average detectors at frequencies above 1GHz.

4.2.3 Deviations from test standard

No deviation.

4.2.4 Test setup

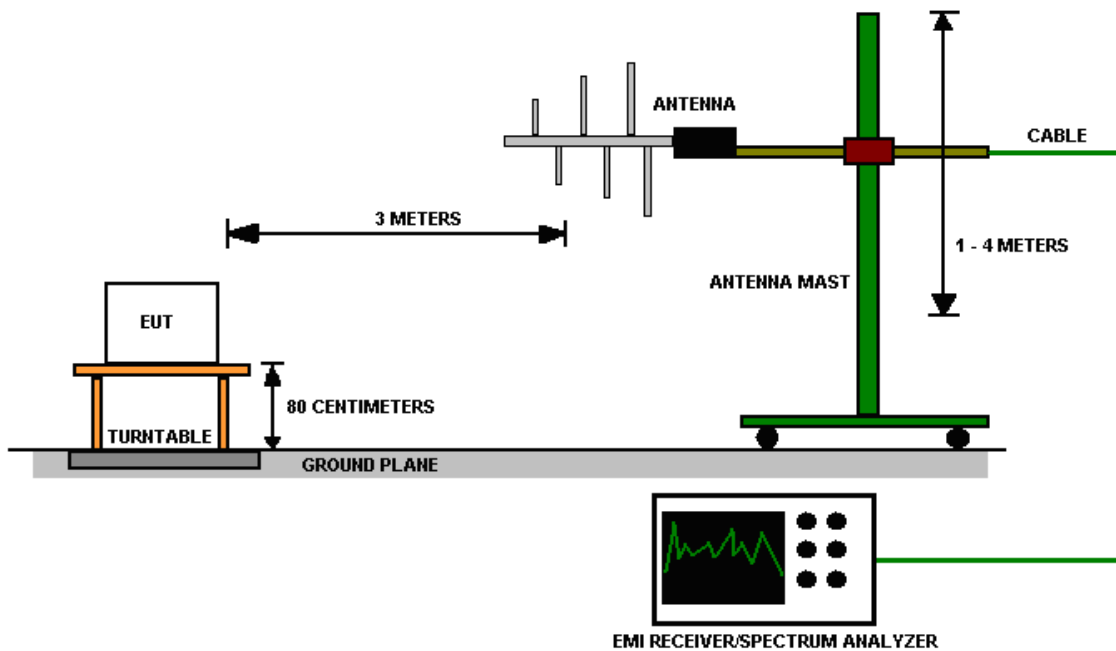


Figure 1 - Radiated Emissions Test Setup

For the actual test configuration, please refer to Appendix A for photographs of the test configuration.

4.2.5 EUT operating conditions

The EUT was supplied with 6VDC from a battery. The EUT was modified by the manufacturer to include a selector switch to select between channels 1, 7 and 15 transmitting continuously. The selector switch was for testing purposes only and is not included in the EUT in its standard configuration.

4.2.6 Test results

EUT	CS2400TR	Model	CS2400TR
MODE	Transmit, Ch 0	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	120VAC/60Hz	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C	TECHNICIAN	NJohnson

Quasi-peak Measurements, Channel 0

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	Cm	deg	
30.6600	21.44	40.00	18.56	211	357	HORI
95.8200	16.80	43.52	26.72	329	48	HORI
191.7000	32.96	43.52	10.56	136	332	HORI
287.5200	24.50	43.52	19.02	99	297	HORI
479.2200	26.09	43.52	17.43	200	183	HORI
958.3800	31.68	43.52	11.84	100	67	HORI

*Unrestricted bands. Emissions are required to be at least 20dB below the fundamental carrier according to FCC Part 15.247.

**Fundamental Frequency. Field strength limits do not apply.

Average Measurements, Channel 0

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	Cm	deg	
2405.5000	98.88	NA**	NA**	128	258	VERT
4811.0000	38.18	54.00	15.80	106	332	VERT
7217.0000	50.52	54.00	3.50	101	158	VERT

Peak Measurements, Channel 0

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
2405.50	100.84	NA**	NA**	128	258	VERT
4811.00	43.96	74.00	30.00	106	332	VERT
7217.00	54.18	74.00	19.80	101	158	VERT

*Unrestricted bands. Emissions are required to be at least 20dB below the fundamental carrier according to FCC Part 15.247.

**Fundamental Frequency. Field strength limits do not apply.

EUT	CS2400TR	Model	CS2400TR
MODE	Transmit, Ch 7	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	120VAC/60Hz	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C	TECHNICIAN	NJohnson

Quasi-peak Measurements, Channel 7

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
30.7800	13.93	40.00	26.07	248	254	VERT
36.1800	11.12	40.00	28.88	298	140	VERT
106.2600	18.51	40.00	21.49	400	360	VERT
175.8600	8.66	40.00	31.34	399	184	VERT
191.7000	27.08	40.00	12.92	143	62	VERT
549.2400	37.81	43.52	5.71	123	206	VERT
692.2800	34.9	43.52	8.62	339	263	VERT
868.3200	38.39	43.52	5.13	134	33	VERT

Average Measurements, Channel 7

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	Cm	deg	
2445.5000	91.89	NA**	NA**	98	262	VERT
4891.0000	41.88	54.00	12.12	101	339	VERT
7337.0000	52.20	54.00	1.80	115	279	VERT

Peak Measurements, Channel 7

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
2445.5000	95.90	NA**	NA**	98	262	VERT
4891.0000	44.08	74.00	29.90	101	339	VERT
7337.0000	55.92	74.00	18.10	115	279	VERT

*Unrestricted bands. Emissions are required to be at least 20dB below the fundamental carrier according to FCC Part 15.247.

**Fundamental Frequency. Field strength limits do not apply.

EUT	CS2400TR	Model	CS2400TR
MODE	Transmit, Ch 15	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	120VAC/60Hz	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C	TECHNICIAN	NJohnson

Quasi-peak Measurements, Channel 15

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
35.7000	11.31	40.00	28.69	101	144	VERT
191.6400	28.58	43.52	14.94	101	62	VERT
549.2400	26.55	46.02	19.47	192	153	VERT
868.3200	39.76	46.02	6.26	358	314	VERT

Average Measurements, Channel 15

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	Cm	deg	
2480.5000	91.22	NA**	NA**	98	245	VERT
4961.0000	39.08	54.00	14.90	178	20	VERT
7442.0000	48.31	54.00	5.70	98	195	VERT

Peak Measurements, Channel 15

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
2480.5000	93.50	NA**	NA**	98	245	VERT
4961.0000	44.58	74.00	29.40	178	20	VERT
7442.0000	54.93	74.00	19.10	98	195	VERT

*Unrestricted bands. Emissions are required to be at least 20dB below the fundamental carrier according to FCC Part 15.247.

**Fundamental Frequency. Field strength limits do not apply.

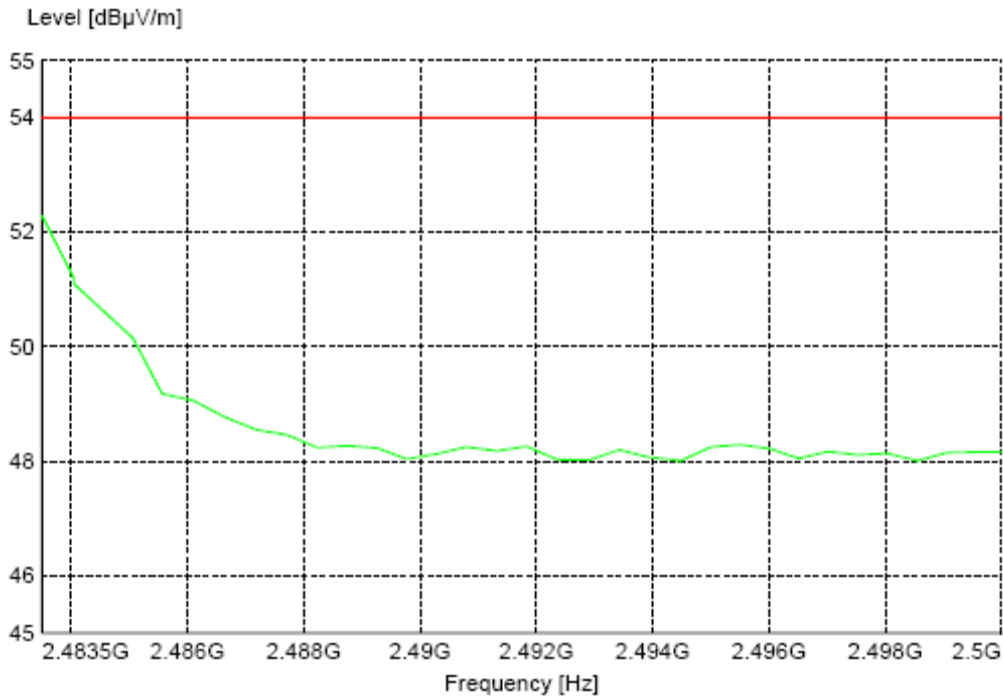


Figure 2 - 2483.5-2500MHz Peak Scan

Radiated Emissions Peak Measurements, 2483.5 - 2500MHz

Highest ten measurements

Frequency	Level	Limit	Margin
MHz	dBµV/m	dBµV/m	dB
2483.5033	52.28	54.00	1.72
2484.0448	51.20	54.00	2.8
2484.0448	51.10	54.00	2.9
2485.0641	50.15	54.00	3.85
2485.5661	49.18	54.00	4.82
2486.1008	49.06	54.00	4.94
2486.6461	48.77	54.00	5.23
2487.1881	48.55	54.00	5.45
2488.2336	48.24	54.00	5.76
2488.7635	48.27	54.00	5.73

All measurements taken 1m height and 245deg angle, where the highest emissions were found. The antenna polarization was vertical.

Peak measurements were found to be compliant with the average limits.

EUT	CS2400TR	Model	CS2400TR
MODE	Receive, Ch. 0	FREQUENCY RANGE	30MHz – 1GHz
INPUT POWER (SYSTEM)	6VDC (battery)	ORIENTATION	Vertical/Horizontal
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C	TECHNICIAN	NJohnson

Quasi-peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
35.4600	11.45	40.00	28.55	109	140	VERT
35.8200	11.39	40.00	28.61	175	140	VERT
191.7000	26.22	43.52	17.30	103	208	VERT
827.5800	24.72	43.52	18.80	359	163	VERT
827.8200	24.96	43.52	18.56	281	0	VERT
929.7600	30.68	43.52	12.84	358	260	VERT

Average Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
2396.5000	19.38	54.00	34.62	121	134	VERT
4795.0000	24.94	54.00	29.10	350	158	VERT
7189.5000	31.70	54.00	22.30	99	328	HORI
9584.0000	34.74	54.00	19.30	399	267	VERT

Peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
2396.5000	32.82	74.00	41.18	121	134	VERT
4795.0000	38.46	74.00	35.50	350	158	VERT
7189.5000	45.42	74.00	28.60	99	328	HORI
9584.0000	48.36	74.00	25.60	399	267	VERT

*Unrestricted bands. Emissions are required to be at least 20dB below the fundamental carrier according to FCC Part 15.247.

**Fundamental Frequency. Field strength limits do not apply.

4.3 *Conducted AC Mains Emissions*

4.3.1 *Limits for conducted emissions measurements*

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

- NOTE:**
1. The lower limit shall apply at the transition frequencies.
 2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.
 3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

4.3.2 *Test Procedures*

- a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument. The resolution bandwidth used for measurements was 9 kHz.
- b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
- c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits could not be reported

4.3.3 *Deviation from the test standard*

No deviation

4.3.4 Test setup

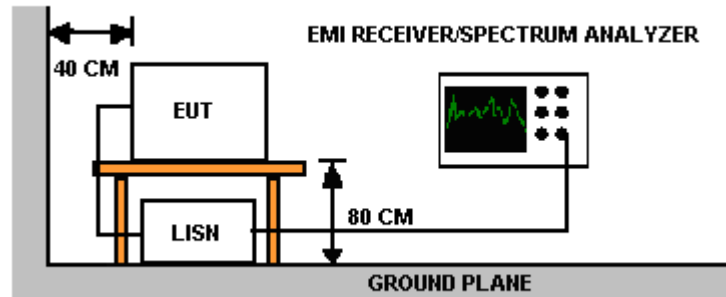


Figure 3 - Conducted Emissions Test Setup

For actual test configuration, see photographs in Appendix A

4.3.5 EUT operating conditions

The EUT was supplied with 120VAC/60Hz directly to pins 1 (neutral) and 2 (line) of the 24-pin connector. The EUT firmware was modified by the manufacturer to transmit or receive continuously on channel 0, 7 or 15.

4.3.6 Test Results

EUT	AC16R	Model	RX_MFS-AC16R_CPU
MODE	Transmit, Ch 0	FREQUENCY RANGE	150kHz – 30MHz
INPUT POWER (SYSTEM)	120VAC/60	PHASE	Line, Neutral
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C	TECHNICIAN	NJohnson

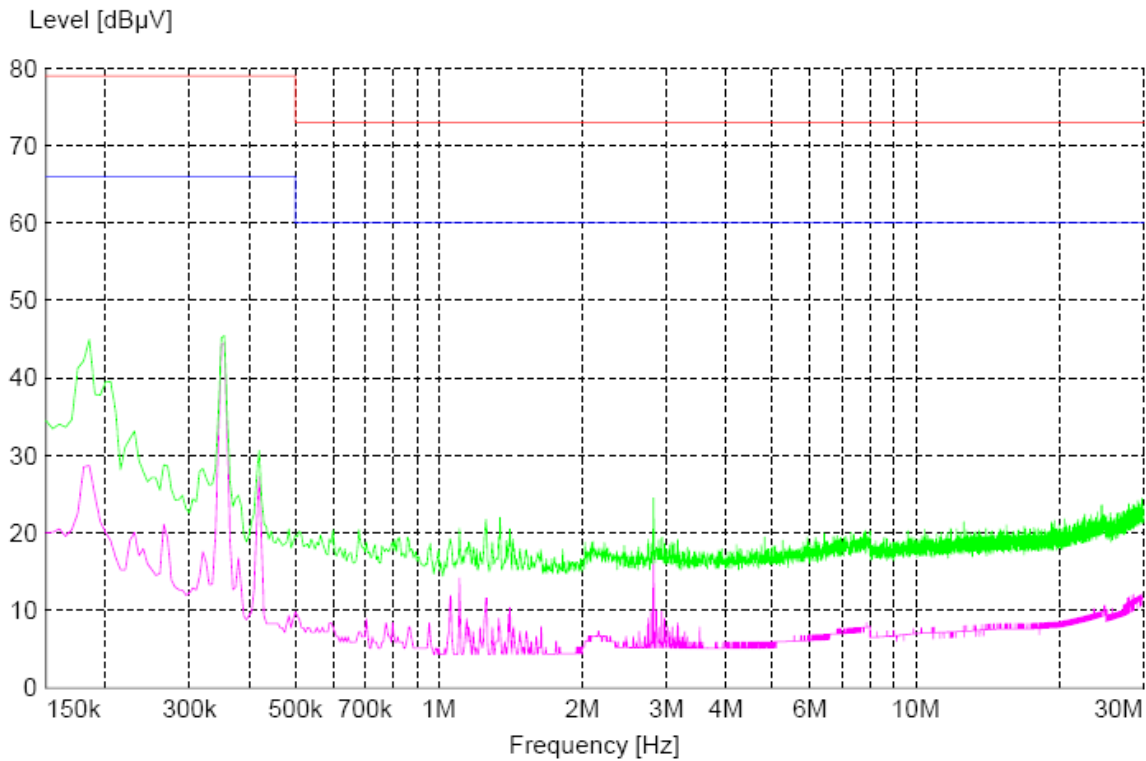


Figure 4 - Conducted Emissions Plot

REMARKS:

1. Q.P. measurements are in green, average measurements are in magenta.
2. All emission levels were very low against the limit.

4.4 *Bandwidth*

4.4.1 *Limits of bandwidth measurements*

The 6dB bandwidth of the signal must be greater than 0.50MHz

4.4.2 *Test procedures*

The transmitter output was connected to the spectrum analyzer directly. The bandwidth of the fundamental frequency was measured by the spectrum analyzer with 100 kHz RBW and 100 kHz VBW. The 6 dB bandwidth is defined as the bandwidth of the signal at a point 6dB below the peak measured value.

The 99% occupied is defined as the bandwidth at which 99% of the signal power is found. This corresponds to 20dB down from the maximum power level. The maximum power was measured with the largest resolution bandwidth possible (10MHz) and this value was recorded (can be seen on the plots for reference). The signal was then captured with a 100kHz resolution bandwidth and the frequencies where the measurements were 20dB below the maximum power were marked. The bandwidth between these frequencies was recorded as the 99% occupied bandwidth.

4.4.3 *Deviations from test standard*

No deviation.

4.4.4 *Test setup*



4.4.5 *EUT operating conditions*

The EUT was supplied with 6VDC from a battery. The EUT was modified by the manufacturer to include a selector switch to select between channels 1, 7 and 15 transmitting continuously. The selector switch was for testing purposes only and is not included in the EUT in its standard configuration.

4.4.6 Test results

EUT	CS2400TR	Model	CS2400TR
INPUT POWER (SYSTEM)	120VAC/60Hz	ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C
TECHNICIAN	NJohnson	MODE	Continuous Transmit

CHANNEL	CHANNEL FREQUENCY (MHz)	6dB BW (kHz)	6dB MINIMUM LIMIT (kHz)	99% Occupied BW (kHz)	RESULT
0	2405	1543.09	500.00	2505.01	PASS
7	2440	1643.28	500.00	2524.05	PASS
15	2480	1713.42	500.00	2585.17	PASS

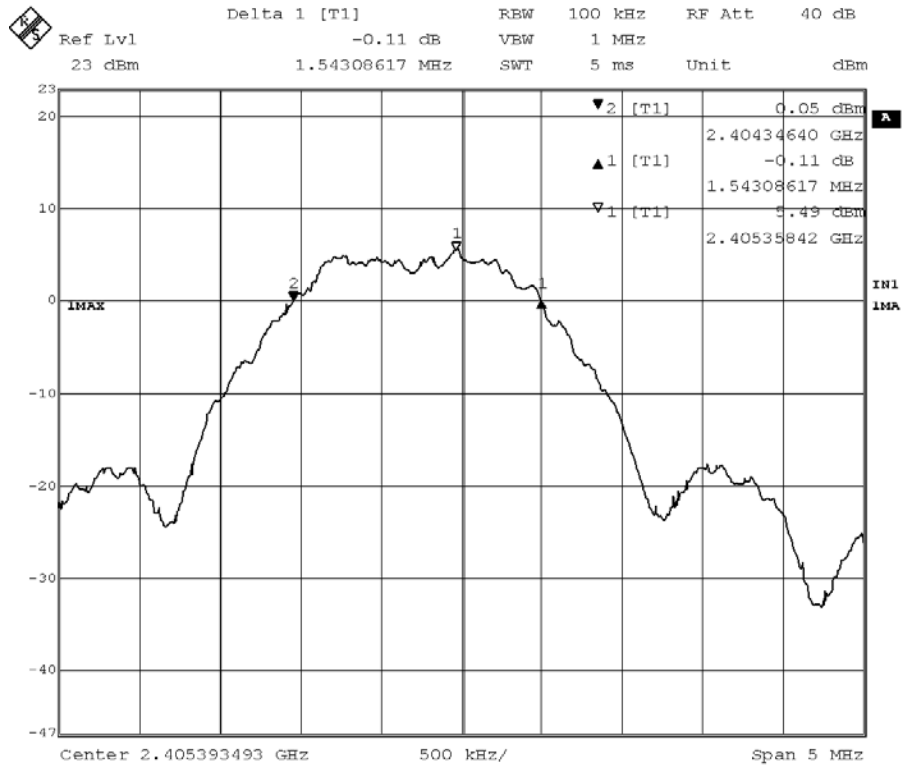


Figure 5 - 6dB Bandwidth, Channel 1

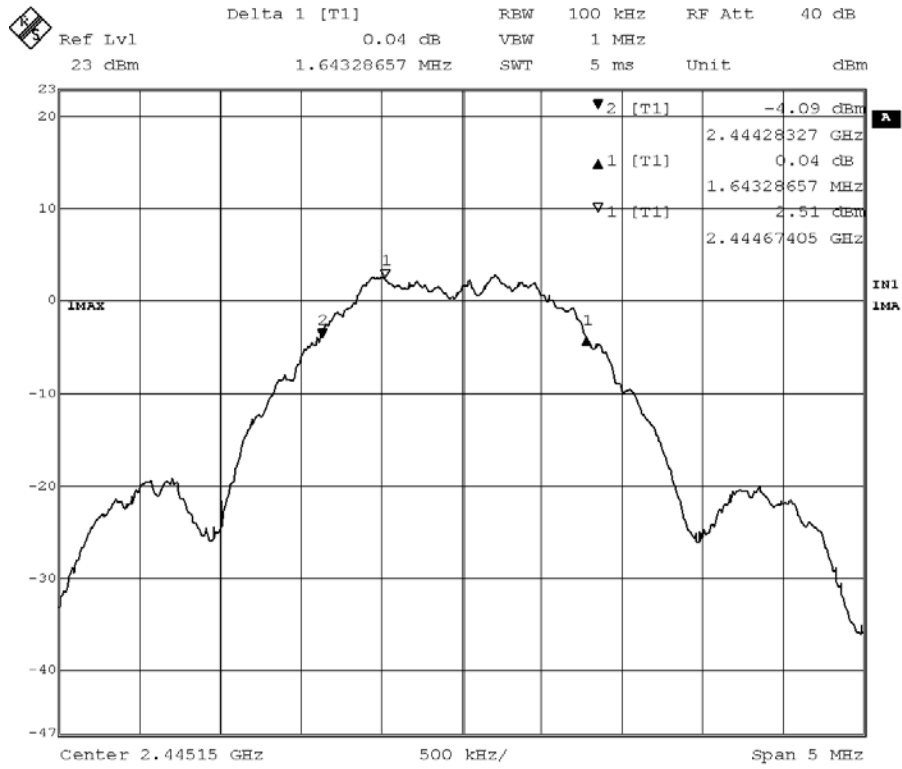


Figure 6 - 6dB Bandwidth, Channel 7

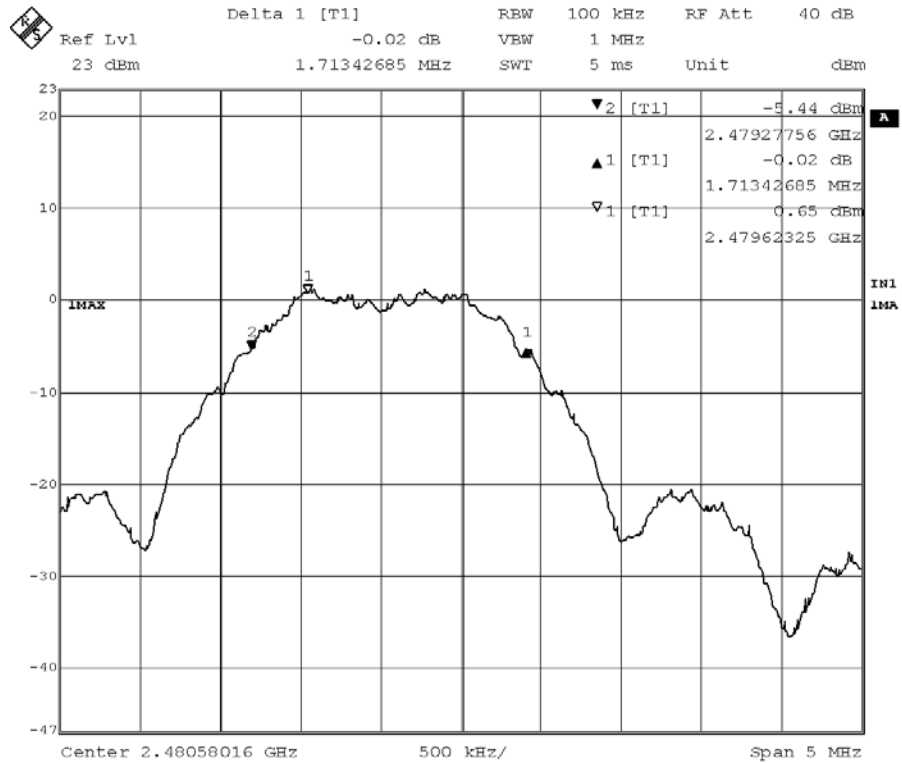


Figure 7 - 6dB Bandwidth, Channel 15

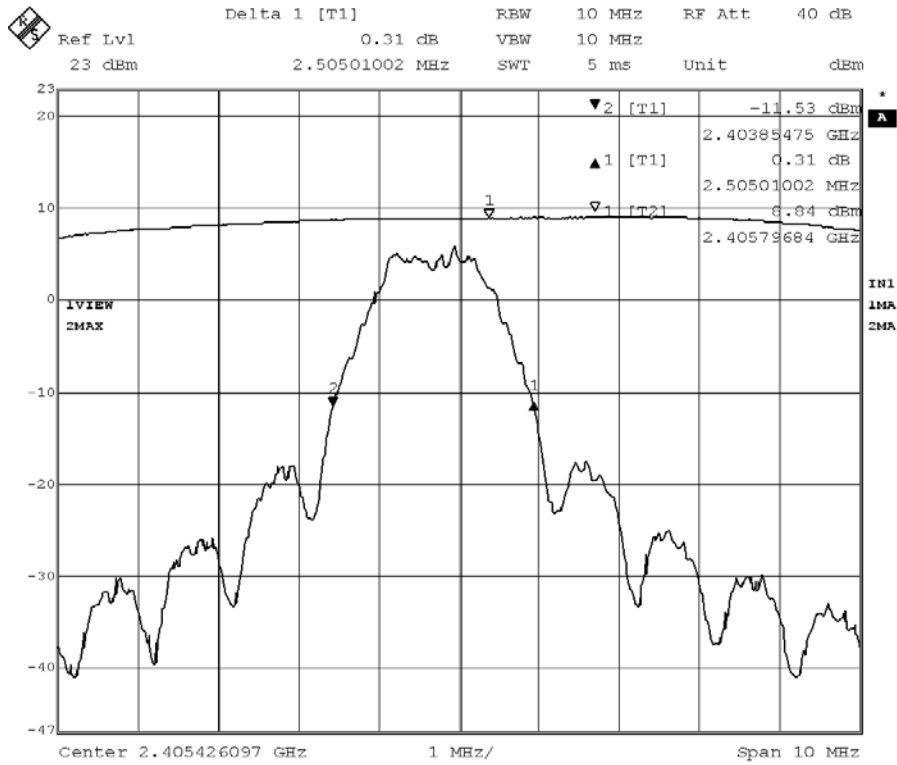


Figure 8 – 99% Occupied Bandwidth, Channel 1

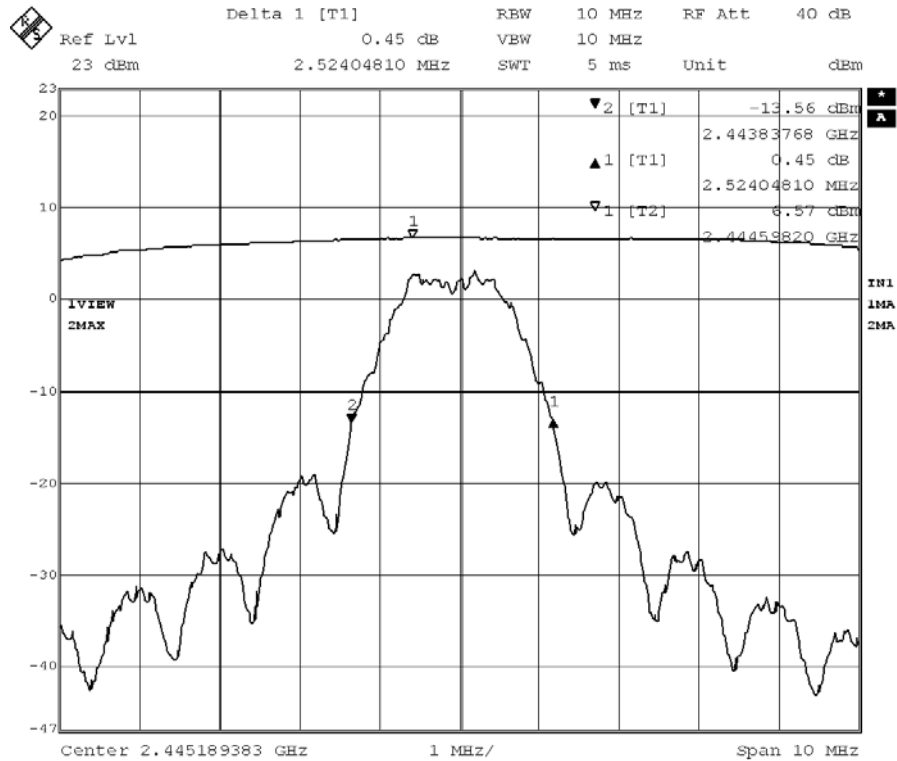


Figure 9 - 99% Occupied Bandwidth, Channel 7

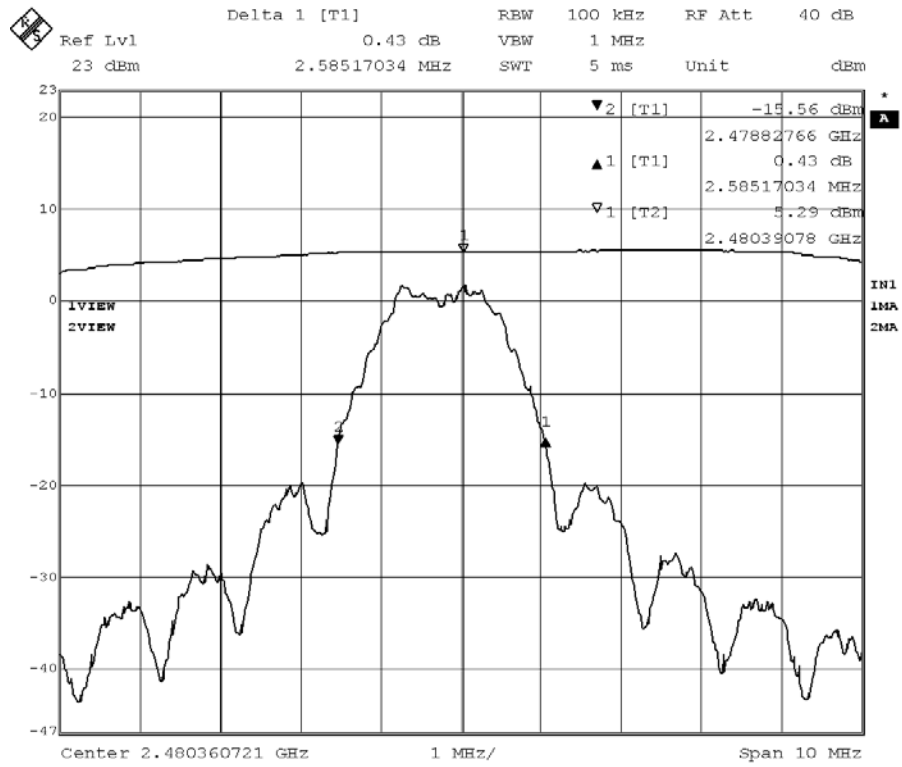


Figure 10 - 99% Occupied Bandwidth, Channel 15

4.5 *Maximum peak output power*

4.5.1 *Limits of power measurements*

The maximum peak output power allowed is 30dBm.

4.5.2 *Test procedures*

The resolution bandwidth was set to 10MHz and the video bandwidth was set to 10MHz to capture the maximum amount of signal. The analyzer used a peak detector in max hold mode. This represented the maximum output power.

4.5.3 *Deviations from test standard*

No deviation.

4.5.4 *Test setup*

Measurements were taken from section 4.3 from the 99% occupied bandwidth measurements

4.5.5 *EUT operating conditions*

The EUT was supplied with 6VDC from a battery. The EUT was modified by the manufacturer to include a selector switch to select between channels 1, 7 and 15 transmitting continuously. The selector switch was for testing purposes only and is not included in the EUT in its standard configuration.

4.4.6 Test results

Maximum peak output power

EUT	CS2400TR	Model	CS2400TR
INPUT POWER (SYSTEM)	6VDC (battery)	ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C
TECHNICIAN	NJohnson	MODE	Continuous transmit

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
0	2405	9.09	30	PASS
7	2440	6.82	30	PASS
15	2480	5.54	30	PASS

All measurements were taken from the 99% occupied bandwidth measurements from Section 4.4. 0.25dB was added to account for the cable used to connect to the spectrum analyzer.

4.6 *Power spectral density (PSD)*

4.6.1 *Limits of PSD measurements*

The maximum power spectral density allowed is 8dBm.

4.6.2 *Test procedures*

The transmitter output was connected directly to the spectrum analyzer. the bandwidth of the fundamental frequency was measured with the spectrum analyzer using 3 kHz RBW and 30 kHz VBW, the sweep time was 500s. The power spectral density was measured and recorded at the frequency with the highest emission. The sweep time is allowed to be longer than span/3KHz for a full response of the mixer in the spectrum analyzer.

4.6.3 *Deviations from test standard*

No deviation.

4.6.4 *Test setup*



4.6.5 *EUT operating conditions*

The EUT was supplied with 6VDC from a battery. The EUT was modified by the manufacturer to include a selector switch to select between channels 1, 7 and 15 transmitting continuously. The selector switch was for testing purposes only and is not included in the EUT in its standard configuration.

4.6.6 Test results

Power Spectral Density

EUT	CS2400TR	Model	CS2400TR
INPUT POWER (SYSTEM)	6VDC (battery)	ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C
TECHNICIAN	NJohnson	MODE	Continuous transmit

CHANNEL	CHANNEL FREQUENCY (MHz)	RF POWER LEVEL IN # KHz BW (dBm)	MAXIMUM POWER LIMIT (dBm)	RESULT
0	2405	-4.95	8.0	PASS
7	2440	-8.28	8.0	PASS
15	2480	-10.22	8.0	PASS

0.25dB was added to account for the cable used to connect to the spectrum analyzer.

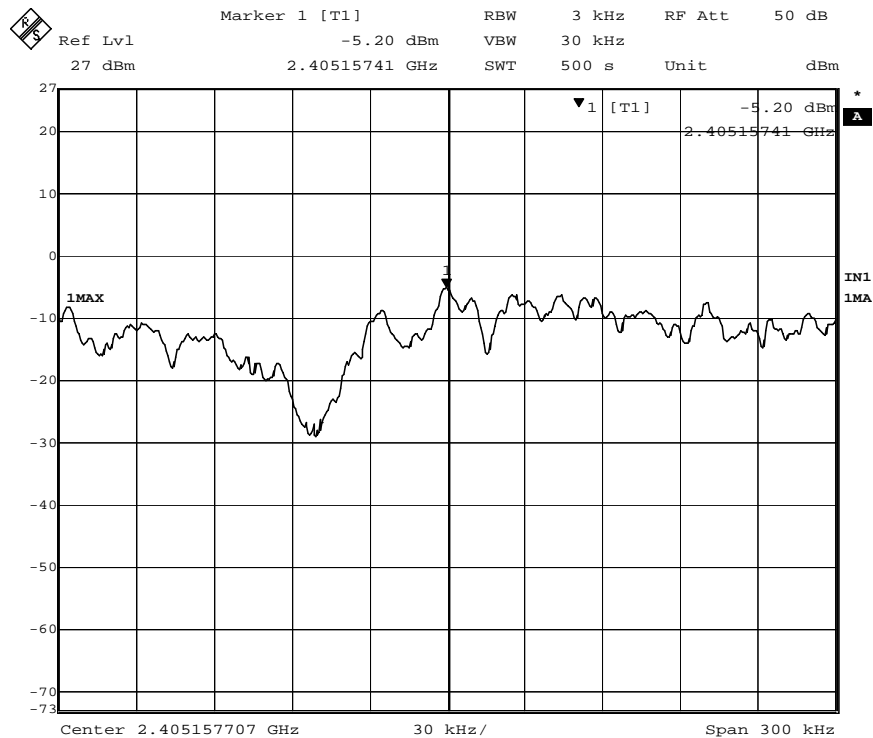


Figure 11 - Power Spectral Density Measurement, Channel 0

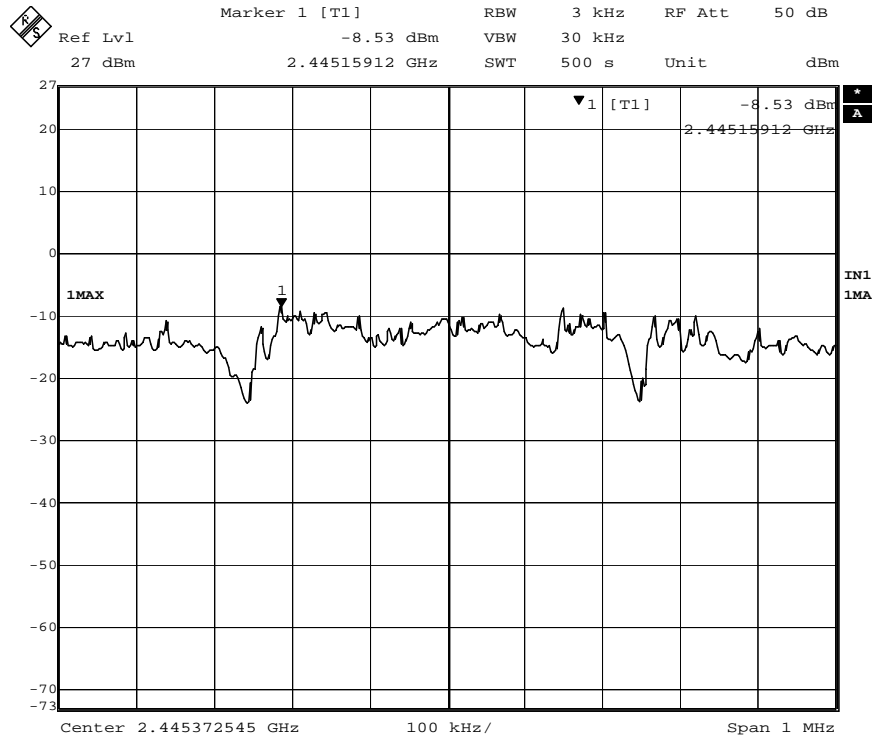


Figure 12 - Power Spectral Density Measurement, Channel 7

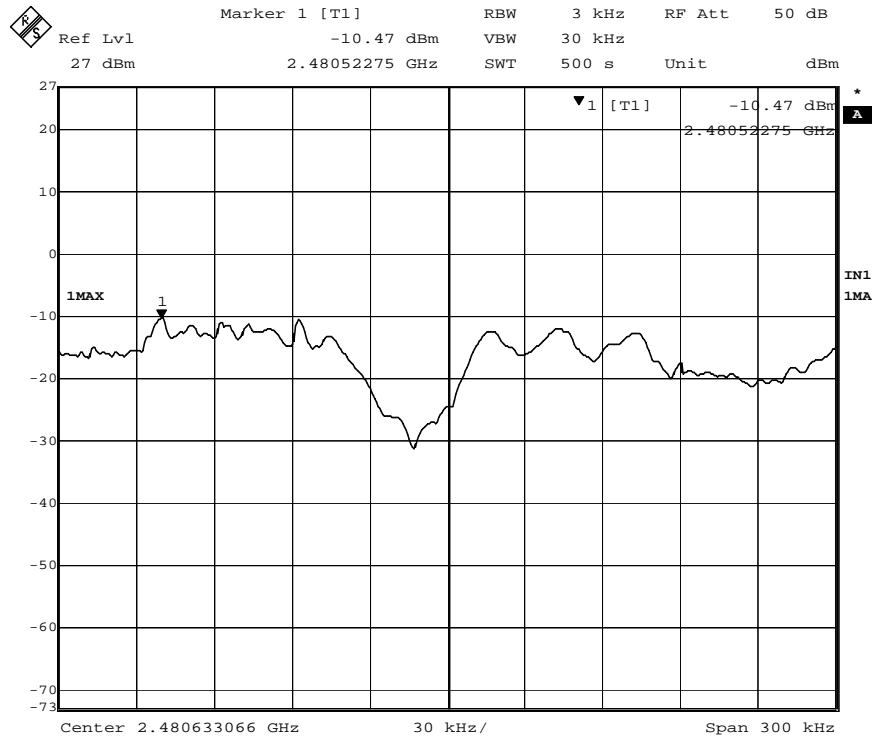


Figure 13 - Power Spectral Density Measurement, Channel 15

4.7 *Bandedges*

4.7.1 *Limits of bandedge measurements*

For emissions outside of the allowed band of operation (2400MHz – 2483.5MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

4.7.2 *Test procedures*

The transmitter output was connected directly to the spectrum analyzer. the bandwidth of the fundamental frequency was measured with the spectrum analyzer using 100 kHz RBW and 1 MHz VBW.

For measurements at the 2853.5MHz band, the measurements were done using the methods described in section 4.4. The turntable and mast were set to the position where the maximum signal was discovered. Because some of the fundamental signal was captured using a 1MHz resolution bandwidth, measurements were made with a 30kHz resolution bandwidth and the delta between the peak and band edge measurement were subtracted from the peak measured with the 1MHz bandwidth. This was also done with the average measurements. These values were compared with the limits from FCC Part 15.209 to determine compliance.

4.7.3 *Deviations from test standard*

No deviation.

4.7.4 *Test setup*



4.7.5 EUT operating conditions

The EUT was supplied with 6VDC from a battery. The EUT was modified by the manufacturer to include a selector switch to select between channels 1, 7 and 15 transmitting continuously. The selector switch was for testing purposes only and is not included in the EUT in its standard configuration.

4.7.6 Test results

EUT	CS2400TR	Model	CS2400TR
INPUT POWER (SYSTEM)	6VDC (battery)	ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C
TECHNICIAN	NJohnson	MODE	Continuous transmit

Highest Out of Band Emissions

CHANNEL	Bandedge/Measurement Frequency (MHz)	Level (dBm)	Fund. Level	Result
0	2400.01	-34.88	5.79	40.67dB (min. 20dB)
15	2483.04	-28.49	1.06	29.50dB (min. 20dB)

NOTE: Plots do not include cable loss. The limits are relative, so cable loss was not included as it is the same at both frequencies. Measurements were made on at the highest point within 1 MHz of the band edge according to FCC Part 15.205.

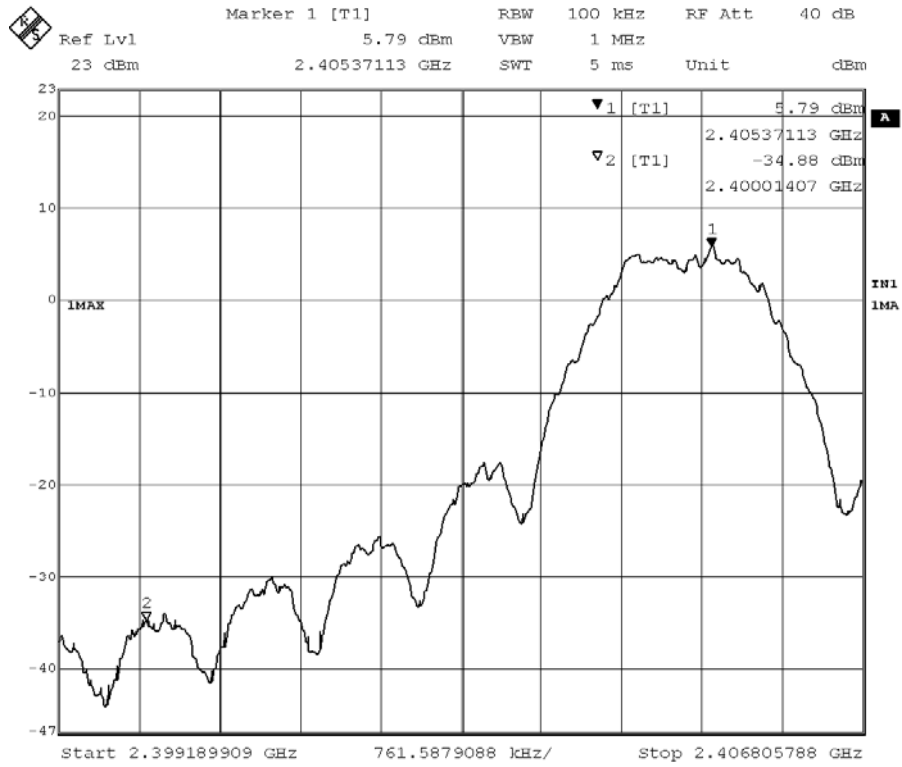


Figure 14 - Band Edge Measurement, Channel 0

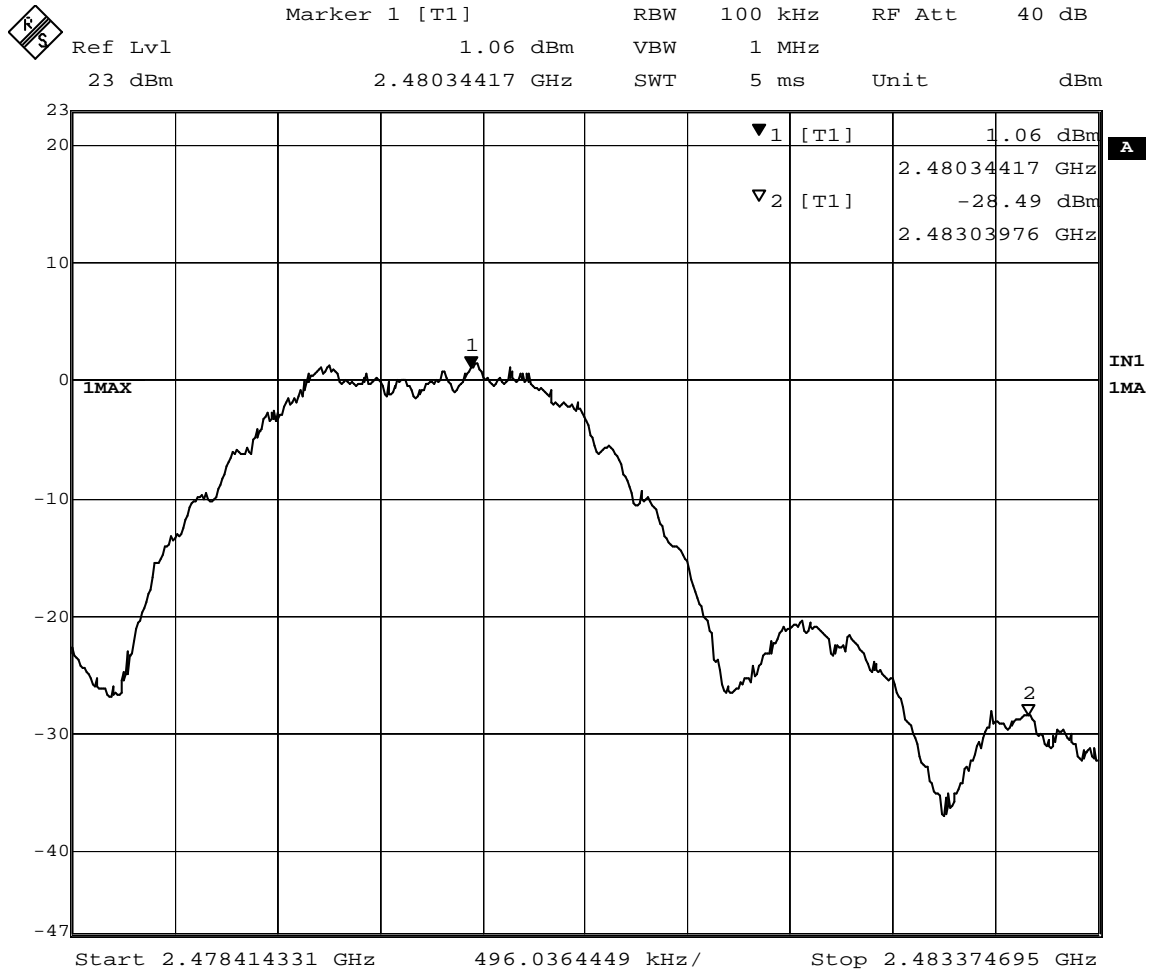


Figure 15 - Band Edge Measurement, Channel 15

The above measurements were made using the methods described in section 4.4

Band edge measurements are worst-case within 500kHz of the bandedge

Appendix A: Test Photos

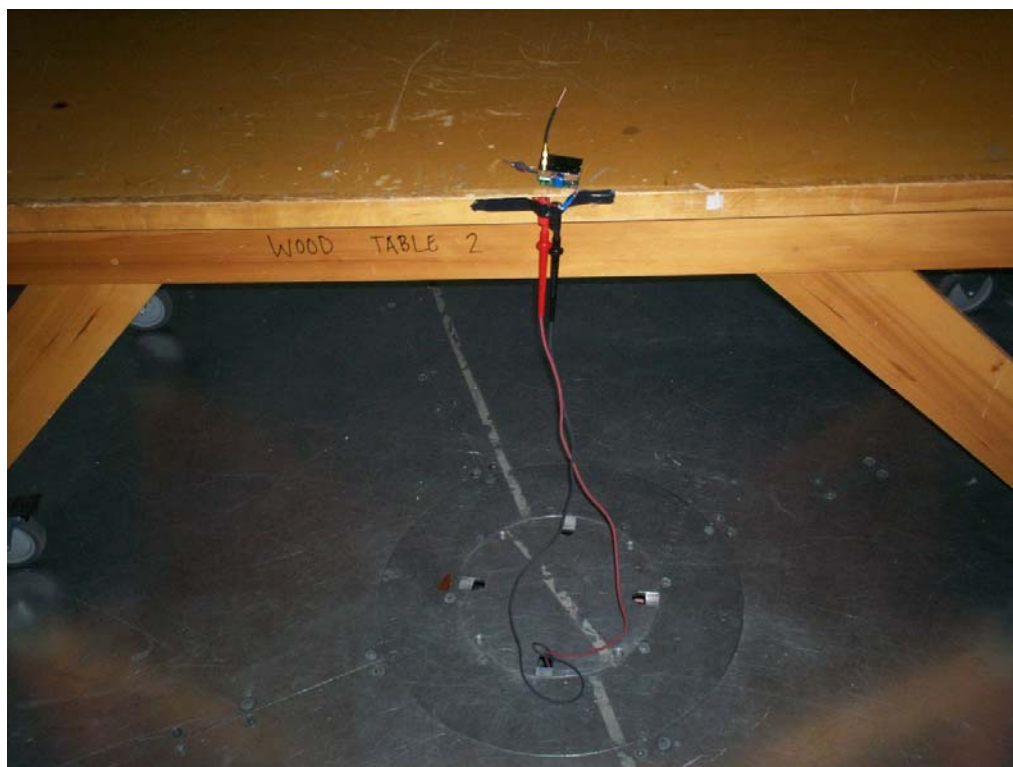


Figure 16 - Radiated Emissions Test Setup

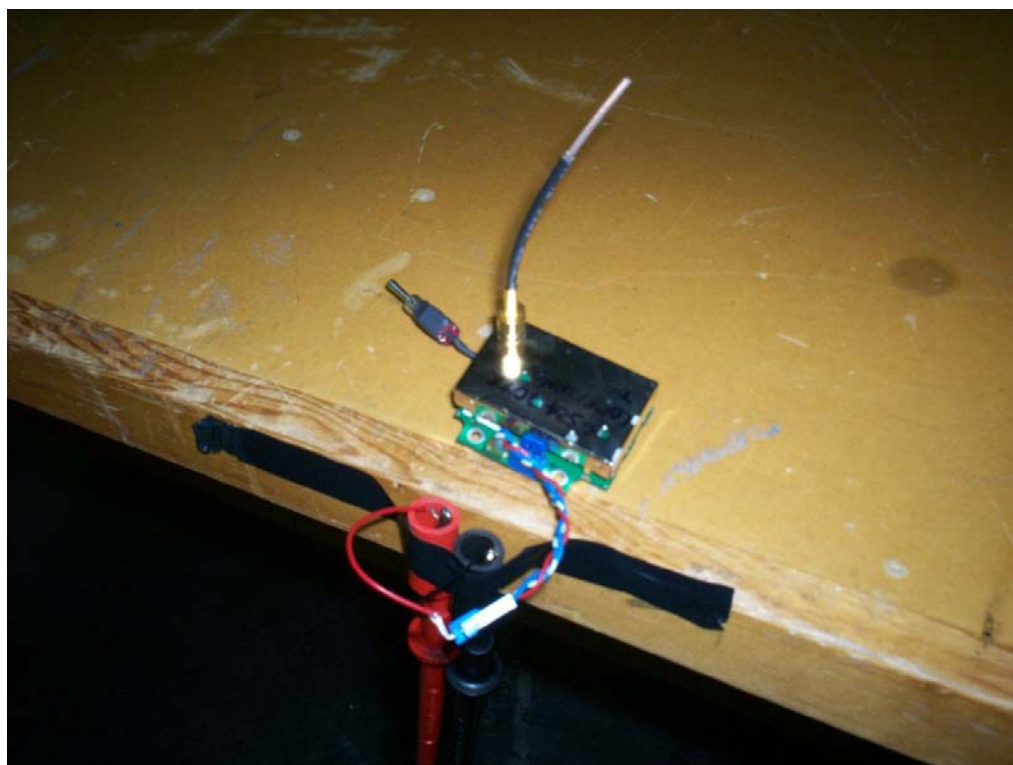


Figure 17 - Radiated Emissions Test Setup

Appendix B: Sample Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF - (-CF + AG) + AV$$

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dB μ V is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dB μ V/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm} [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

AV is calculated by the taking the $20 \cdot \log(T_{\text{on}}/100)$ where T_{on} is the maximum transmission time in any 100ms window.

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