SK TECH CO., LTD.

TEST REPORT

Test Report No.:	**SKTRFC-100405-005**		
Applicant:	**MOVON CORPORATION**		
Applicant Address:	6Fl. Hyunjuk Bldg., 140-28, Samsung-dong, Gangnam-Gu, Seoul, 135-090 Korea		
Manufacturer:	**MOVON CORPORATION**		
Manufacturer Address:	6Fl. Hyunjuk Bldg., 140-28, Samsung-dong, Gangnam-Gu, Seoul, 135-090 Korea		
Device Under Test:	**Bluetooth Alarm Band**		
FCC ID:	**TDU-1402010**	**Model Name:**	**MB20**
Brand/Trade Name:	**MOVON**		
Receipt No.:	SKTEU10-0269	**Date of receipt:**	March 12, 2010
Date of Issue:	April 5, 2010		
Location of Testing:	**SK TECH CO., LTD.** #820-2, Wolmoon-ri, Wabu-up, Namyangju-si, Kyunggi-do, 472-905 South Korea		
Test Procedure:	**ANSI C63.4, FCC Public Notice DA 00-705 (March 2000)**		
Test Specification:	**47CFR, Part 15 Rules**		
FCC Equipment Class:	**DSS - Part 15 Spread Spectrum Transmitter**		
Test Result:	**The above-mentioned device has been tested and passed.**		

Tested & Reported by: *Jungtae, Kim*

2010-04-05

Signature *Date*

Approved by: *Jongsoo, Yoon*

2010-04-05

Signature *Date*

Other Aspects:	-
Abbreviations:	**· OK, Pass = passed · Fail = failed · N/A = not applicable**

☞
- **This test report is not permitted to copy partly and entirely without our permission.**
- **This test result is dependent on only equipment to be used.**
- **This test result is based on a single evaluation of submitted samples of the above mentioned.**

>> CONTENTS <<

1. GENERAL

These tests were performed using the test procedure outlined in ANSI C63.4, 2003 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.247. The EUT (Equipment Under Test) has been shown to be capable of compliance with the applicable technical standards.

We attest to the accuracy of data. All measurements reported herein were performed by SK TECH CO., LTD. and were made under Chief Engineer's supervision.
We assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

2. TEST SITE

SK TECH CO., LTD.

2.1 Location

#820-2, Wolmoon-ri, Wabu-up, Namyangju-si, Kyunggi-do, 472-905 South Korea
(FCC Registered Test Site Number: 90752)

This test site is in compliance with ISO/IEC 17025 for general requirements for the competence of testing and calibration laboratories.
This laboratory is recognized as a Conformity Assessment Body (CAB) for CAB's Designation Number: KR0007 by FCC, is accredited by NVLAP for NVLAP Lab. Code: 200220-0.

2.2 List of Test and Measurement Instruments

No.	Description	Manufacturer	Model No.	Serial No.	Calibrated until	Used
1	Spectrum Analyzer	Agilent	E4405B	US40520856	2010.07	
2	EMC Spectrum Analyzer	Agilent	E7405A	US40240203	2011.03	
3	EMI Test Receiver	Rohde&Schwarz	ESIB40	100277	2011.02	⊠
4	EMI Test Receiver	Rohde&Schwarz	ESHS10	862970/019	2010.07	
5	Artificial Mains Network	Rohde&Schwarz	ESH3-Z5	836679/018	2010.07	
6	Pre-amplifier	HP	8447F	3113A05153	2010.07	⊠
7	Pre-amplifier	MITEQ	AFS44	1116321	2010.07	⊠
8	Pre-amplifier	MITEQ	AFS44	1116322	2011.03	⊠
9	Power Meter	Agilent	E4417A	MY45100426	2010.07	⊠
10	Power Meter	Agilent	E4418B	US39402176	2010.07	
11	Power Sensor	Agilent	E9327A	MY44420696	2010.07	⊠
12	Power Sensor	Agilent	8482A	MY41094094	2010.07	
13	Attenuator (10dB)	HP	8491B	38067	2010.07	⊠
14	Attenuator (20dB)	Weinschel	44	AH6967	2010.07	
15	High Pass Filter	Wainwright	WHKX3.0/18G	8	2010.07	⊠
16	VHF Precision Dipole Antenna (TX/RX)	Schwarzbeck	VHAP	1014 / 1015	2010.12	
17	UHF Precision Dipole Antenna (TX/RX)	Schwarzbeck	UHAP	989 / 990	2010.12	
18	Loop Antenna	Schwarzbeck	HFH2-Z2	863048/019	2010.11	⊠
19	TRILOG Broadband Antenna	Schwarzbeck	VULB9168	230	2010.07	⊠
20	TRILOG Broadband Antenna	Schwarzbeck	VULB9168	189	2010.09	
21	Horn Antenna	AH Systems	SAS-200/571	304	N/A	
22	Horn Antenna	EMCO	3115	00040723	2010.03	
23	Horn Antenna	EMCO	3115	00056768	2010.09	⊠
24	Horn Antenna	Schwarzbeck	BBHA9170	BBHA9170318	2010.08	⊠
25	Vector Signal Generator	Agilent	E4438C	MY42080359	2010.07	
26	PSG analog signal generator	Agilent	E8257D-520	MY45141255	2010.07	
27	DC Power Supply	HP	6622A	3448A032223	2010.11	⊠
28	DC Power Supply	HP	6268B	2542A-07856	2010.07	
29	Hygro/Thermo Graph	SATO	PC-5000TRH-II	-	2010.07	⊠

2.3 Test Date

Date of Test: March 18, 2010 ~ April 5, 2010

2.4 Test Environment

See each test item’s description.

3. DESCRIPTION OF THE EQUIPMENT UNDER TEST

The product specification described herein was obtained from the product data sheet or user's manual.

3.1 Rating and Physical Characteristics

Power source	DC 3.7 V Li-ion battery
Transmit Frequency	2402 ~ 2480 MHz (1 MHz step, 79 channels)
X-tal or Oscillator	X-tal: 26 MHz
Antenna Type	Integral (Chip antenna, Gain: 3.32 dBi)
Type of Modulation	FHSS (GFSK)
RF Output power	Under 4 dBm (declared by the applicant)
External Ports	Mini-USB (DC Input for battery charging) AC/DC Adaptor Manufacturer : DongGuan Leader Electronics Model : M5-052100-A1 Input : AC 100-240 V, 50/60 Hz, 0.3A Output : DC 5.0 V, 0.5 A

3.2 Equipment Modifications

None

3.3 Submitted Documents

Block diagram

Schematic diagram

Antenna Specification

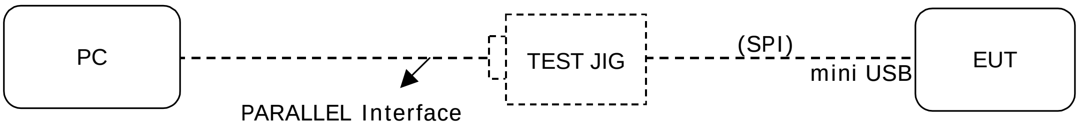
Part List

User manual

4. MEASUREMENT CONDITIONS

4.1 Description of test configuration

The measurements were taken in continuous transmitting mode using the TEST MODE. For controlling the EUT as TEST MODE, the test program and the cable assembly were provided by the applicant.



[System Block Diagram of Test Configuration]

4.2 List of Peripherals

Equipment Type	Manufacturer	Model	S/N
Personal Computer**	SAMSUNG	DM-V50	371F97BA100133V
TEST JIG**	MOVON CORPORATION	-	-

** *For control of the RF module via SPI interface in the EUT. For AC power line connected emission measurements, the EUT was tested as stand-alone equipment without the Notebook PC, setting the EUT to TEST MODE.*
If not otherwise stated, for modulating the transmitter, a pseudo random bit sequence with a pattern type DH5 was used.

4.3 Type of Used Cables

#	START		END		CABLE	
	NAME	I/O PORT	NAME	I/O PORT	Length(m)	Shielded
1	EUT	SPI Interface	TEST JIG	SPI	0.3	NO
2	TEST JIG	Parallel interface	PC	LPT	1.8	YES

4.4 Uncertainty

Measurement Item	Combined Standard Uncertainty U_c	Expanded Uncertainty $U = kU_c$ ($k = 2$)
Conducted RF power	± 1.49 dB	± 2.98 dB
Radiated disturbance	± 2.30 dB	± 4.60 dB
Conducted disturbance	± 1.96 dB	± 3.92 dB

5. TEST AND MEASUREMENTS

Summary of Test Results

Requirement	**CFR 47 Section**	**Report Section**	**Test Result**
Antenna Requirement	15.203, 15.247(b)(4)	5.1	PASS
Maximum Peak Output Power	15.247(b)(1), (4)	5.2	PASS
Carrier Frequency Separation	15.247(a)(1)	5.3	PASS
20dB Channel Bandwidth	15.247(a)(1)	5.3	PASS
Number of Hopping Channels	15.247(a)(iii), 15.247(b)(1)	5.4	PASS
Time of Occupancy (Dwell Time)	15.247(a)(iii)	5.5	PASS
Spurious Emission, Band Edge, and Restricted bands	15.247(d), 15.205(a), 15.209(a)	5.6	PASS
Conducted Emissions	15.207(a)	5.7	PASS
RF Exposure	15.247(i), 1.1307(b)(1)	5.8	PASS

5.1 ANTENNA REQUIREMENT

5.1.1 Regulation

According to §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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

And according to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.1.2 Result: PASS

The transmitter has an integral Chip antenna. The directional gain of the antenna is 3.32 dBi.

5.2 MAXIMUM PEAK OUTPUT POWER

5.2.1 Regulation

According to §15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

According to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.2.2 Test Procedure

1. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
2. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via SPI interface and make sure the spectrum analyzer is operated in its linear range.
3. Set the spectrum analyzer as follows:
   Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
   RBW > the 20 dB bandwidth of the emission being measured
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
4. Measure the highest amplitude appearing on spectral display and record the level to calculate results.
5. Repeat above procedures until all frequencies measured were complete.

5.2.3 Test Results: PASS

Table 1: Measured values of the Maximum Peak Output Power (Conducted)

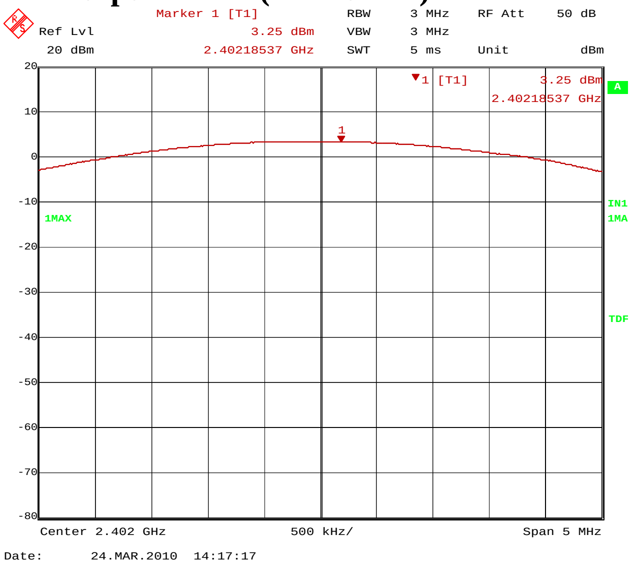
Modulation	Operating Frequency	Resolution Bandwidth	Measured value		Limit
			dBm	W	
Basic (GFSK)	2402 MHz	3 MHz	3.25	0.002 11	1 W (the number of the non-overlapping hopping channels is equal to or greater than 75)
	2441 MHz	3 MHz	3.48	0.002 23	
	2480 MHz	3 MHz	3.19	0.002 08	

NOTE 1. Since the directional gain of the integral antenna declared by the manufacturer (GAIN = 3.32 dBi) does not exceed 6.0 dBi, there was no need to reduce the output power.

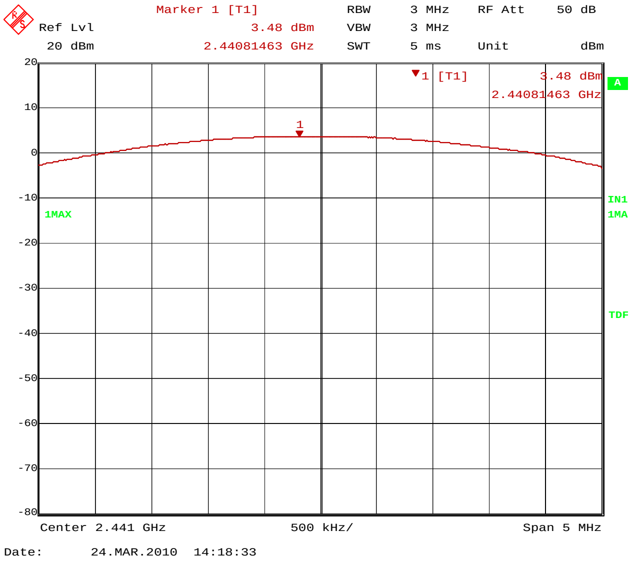
NOTE 2. We took the insertion loss of the cable loss into consideration within the measuring instrument.

Figure 1. Plot of the Maximum Peak Output Power (Conducted)

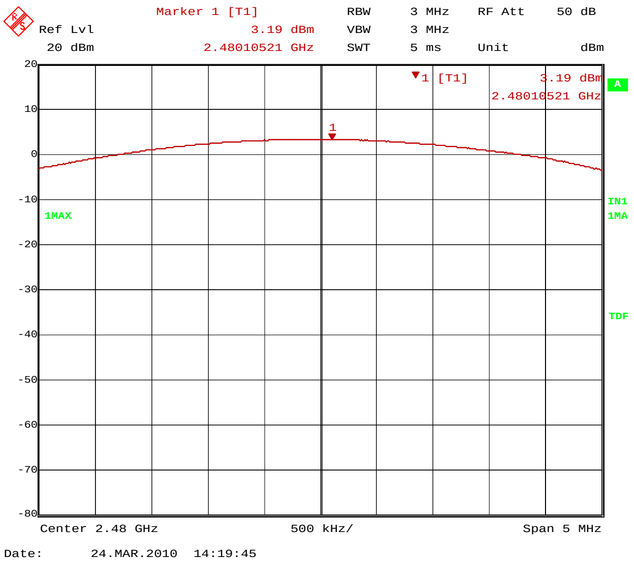
Lowest Channel (2402 MHz)



Middle Channel (2441 MHz)



Highest Channel (2480 MHz)



5.3 CARRIER FREQUENCY SEPARATIONS and 20 dB BANDWIDTH

5.3.1 Regulation

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

5.3.2 Test Procedure

1. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
2. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via SPI interface.
3. Set the spectrum analyzer as follows:

   For measurements of Carrier Frequency Separation
   Span = wide enough to capture the peaks of two adjacent channels
   Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span
   Video (or Average) Bandwidth (VBW) ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold

   For measurements of 20 dB Bandwidth
   Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
   RBW ≥ 1% of the 20 dB bandwidth
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
4. Measure the separation between the peaks of the adjacent channels using the marker-delta function.
5. Repeat above procedures until all frequencies measured were complete.

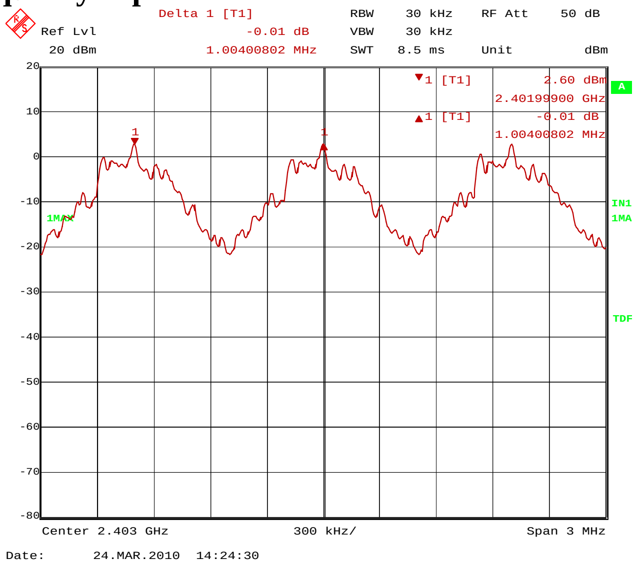
5.3.3 Test Results: PASS

Table 2: Measured values of the Carrier Frequency Separation and 20 dB Bandwidth

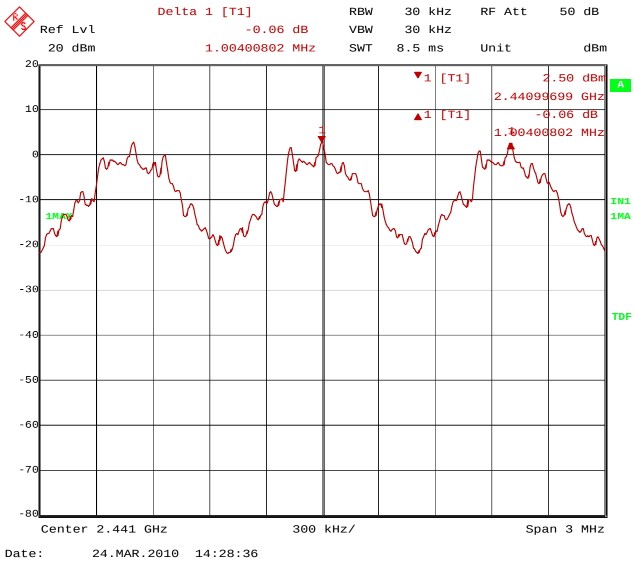
Modulation	Operating Frequency	Frequency Separation	20 dB Bandwidth	LIMIT (Frequency Separation)
Basic (GFSK)	2402 MHz	1004 kHz	938 kHz	≥ 25 kHz or 20 dB bandwidth, whichever is greater
	2441 MHz	1004 kHz	938 kHz	
	2480 MHz	1004 kHz	938 kHz	

Figure 2. Plot of the Carrier Frequency Separation

Lowest Channel (2402 MHz)



Middle Channel (2441 MHz)



Highest Channel (2480 MHz)

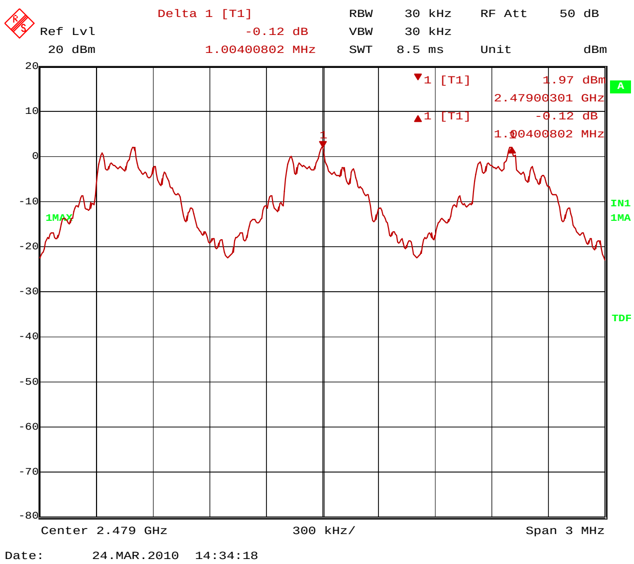
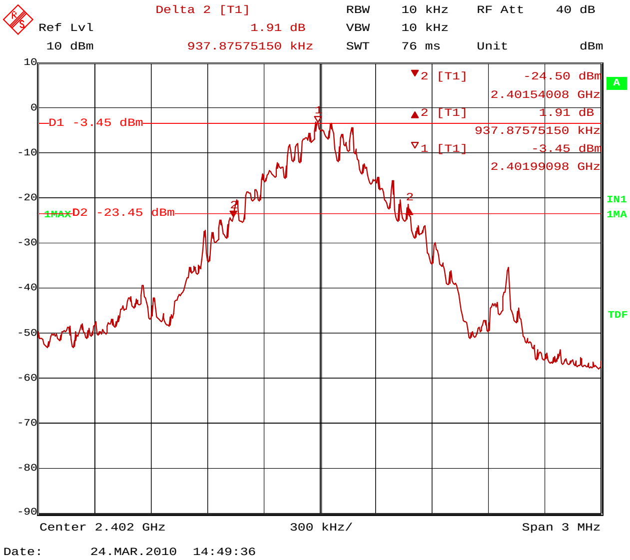
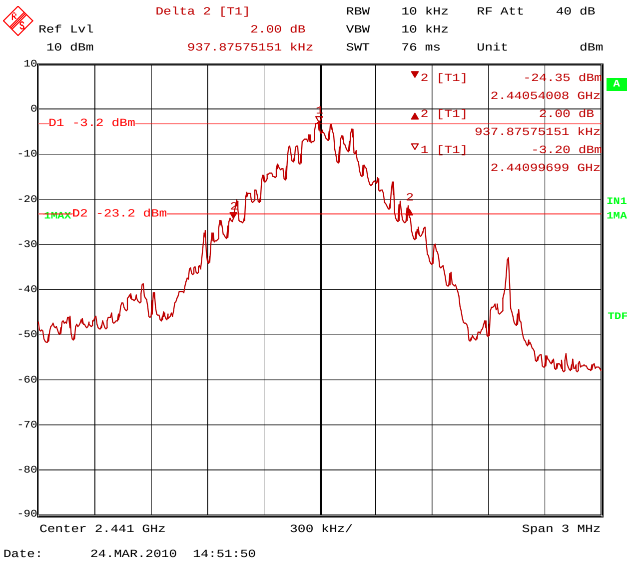


Figure 3. Plot of the 20 dB Channel Bandwidth

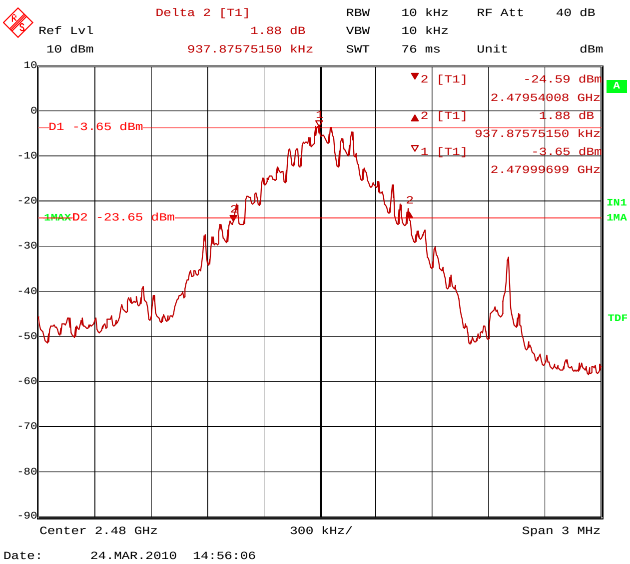
Lowest Channel (2402 MHz)



Middle Channel (2441 MHz)



Highest Channel (2480 MHz)



5.4 NUMBER OF HOPPING CHANNELS

5.4.1 Regulation

According to §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

According to §15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

5.4.2 Test Procedure

1. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
2. Turn on the EUT and set the hopping function enabled by controlling it via SPI interface.
3. Set the spectrum analyzer as follows:
   Span = the frequency band of operation
   RBW ≥ 1% of the span
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
4. Record the number of hopping channels.

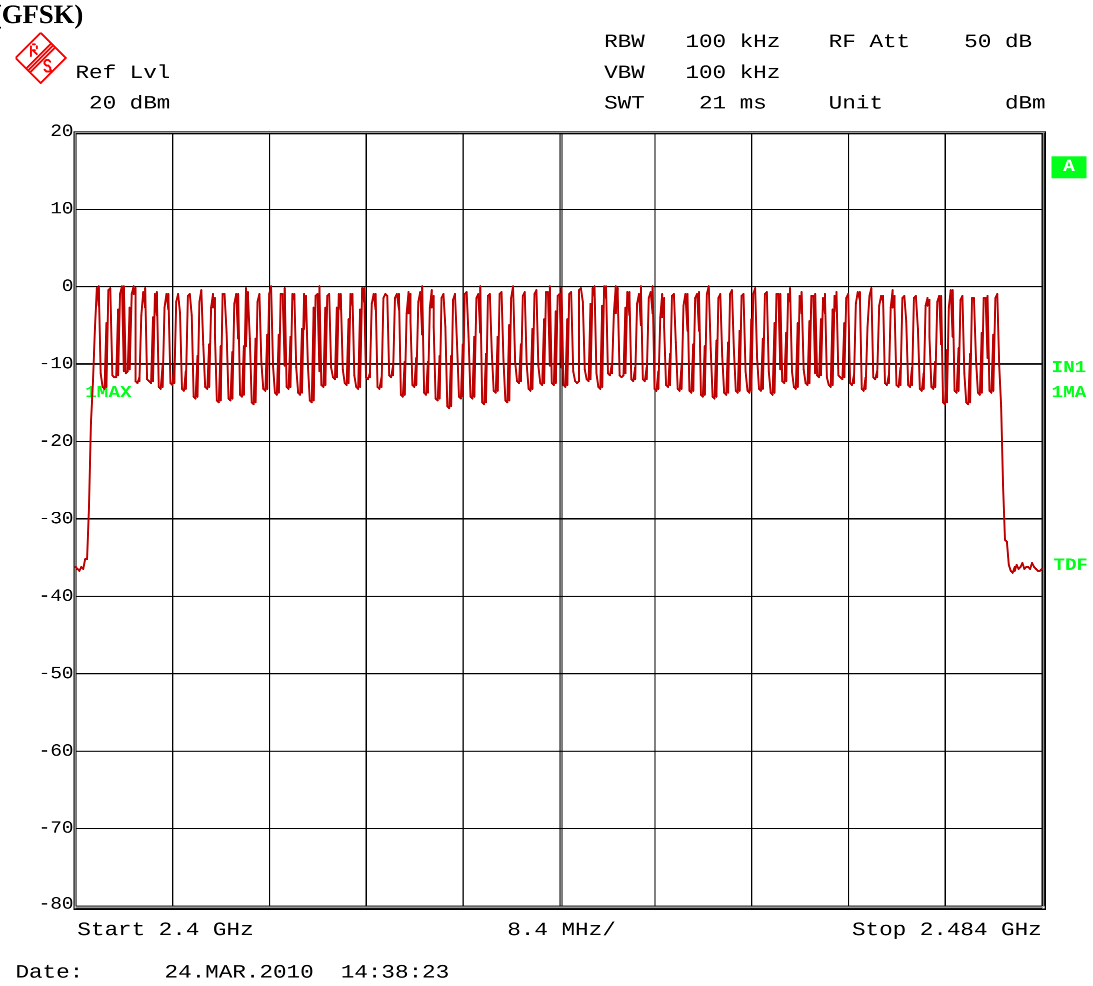
5.4.3 Test Results: PASS

Table 3: Measured values of the Number of Hopping Channels

Modulation	Operating Frequency	Number of hopping channels	LIMIT
Basic (GFSK)	2402 - 2480 MHz	79	≥ 15

Figure 4. Plot of the Number of Hopping Channels

Basic (GFSK)



5.5 TIME OF OCCUPANCY (DWELL TIME)

5.5.1 Regulation

According to §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

5.5.2 Test Procedure

1. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable.
2. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via SPI interface.
3. Set the spectrum analyzer as follows:
   Span = zero span, centered on a hopping channel
   RBW = 1 MHz
   VBW ≥ RBW
   Sweep = as necessary to capture the entire dwell time per hopping channel
   Detector function = peak
   Trace = max hold
4. Measure the dwell time using the marker-delta function.
5. Repeat above procedures until all frequencies measured were complete.
6. Repeat this test for different modes of operation (e.g., data rate, modulation format, etc.), if applicable.

5.5.3 Test Results: PASS

Table 4: Measured values of the Time of Occupancy

Modulation	Operating Frequency	Reading (ms)	Hopping rate (hops/s)	Number of Channels	Actual (seconds)	LIMIT (seconds)
Basic (GFSK)	2402 MHz	2.902	266.667	79	0.31	0.4
	2441 MHz	2.902	266.667	79	0.31	0.4
	2480 MHz	2.902	266.667	79	0.31	0.4

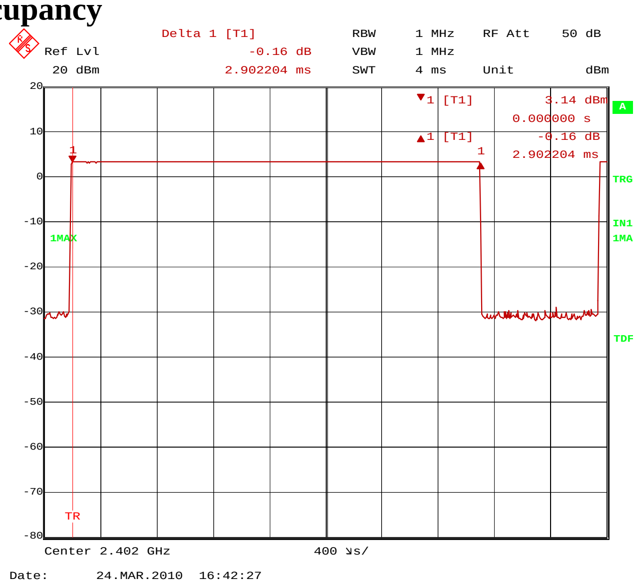
Actual = Reading × (Hopping rate / Number of channels) × Test period

Test period = 0.4 [seconds / channel] × 79 [channel] = 31.6 [seconds]

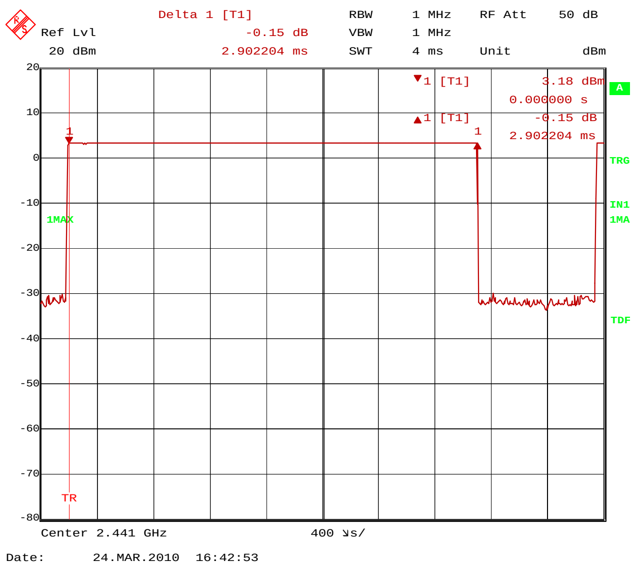
NOTE: The EUT makes worst case 1600 hops per second or 1 time slot has a length of 625μs with 79 channels. The DH5 Packet (GFSK) , needs 5 time slot for transmitting and 1 time slot for receiving. Then the EUT makes worst case 266.667 hops per second with 79 channels.

Figure 5. Plot of the Time of Occupancy

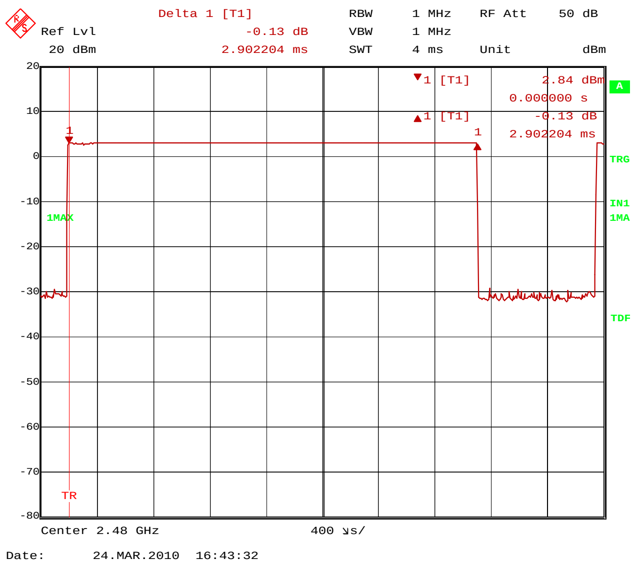
Lowest Channel (2402 MHz)



Middle Channel (2441 MHz)



Highest Channel (2480 MHz)



5.6 SPURIOUS EMISSIONS, BAND EDGE, AND RESTRICTED BANDS

5.6.1 Regulation

According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

According to §15.209(a), for an intentional device, the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency (MHz)	Field strength (μV/m @ 3m)	Field strength (dBμV/m @ 3m)
30–88 88–216 216–960 Above 960	100 150 200 500	40.0 43.5 46.0 54.0

According to §15.109(a), for an unintentional device, except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the above table.

** The emission limits shown in the above table are based on measurement instrumentation employing a CISPR quasi-peak detector and above 1000 MHz are based on the average value of measured emissions.

5.6.2 Test Procedure

<u>1) Band-edge Compliance of RF Conducted Emissions</u>

1. Set the spectrum analyzer as follows:

   Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
   RBW ≥ 1% of the span
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold

2. Allow the trace to stabilize. Set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
3. Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

2) Spurious RF Conducted Emissions:

1. Set the spectrum analyzer as follows:
   - Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
   - RBW = 100 kHz
   - VBW ≥ RBW
   - Sweep = auto
   - Detector function = peak
   - Trace = max hold
2. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.

3) Spurious Radiated Emissions:

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.
2. The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360˚.
3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 30 to 1000 MHz using the TRILOG broadband antenna, and from 1000 MHz to 18000 MHz or to tenth harmonic of the highest fundamental frequency, whichever is higher, using the horn antenna.
4. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
5. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.
6. The EUT is situated in three orthogonal planes (if appropriate)
7. The presence of ambient signals was verified by turning the EUT off. In case an ambient signal was detected, the measurement bandwidth was reduced temporarily and verification was made that an additional adjacent peak did not exist. This ensures that the ambient signal does not hide any emissions from the EUT.
8. If the emission on which a radiated measurement must be made is located at the edge of the authorized band of operation, then the alternative “marker-delta” method may be employed.

4) Marker-Delta Method at the edge of the authorized band of operation:

1. Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function as the above Spurious Radiated Emissions test procedure.
2. Choose a spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the analyzer RBW to 1% of the total span (but never less than 30 kHz) with a video bandwidth equal to or greater than the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not a field strength measurement; it is only a relative measurement to determine the amount by which the emission drops at the band-edge relative to the highest fundamental emission level.
3. Subtract the delta measured in step (2) from the field strengths measured in step (1). The resultant field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge compliance as required by Section 15.205.
4. The above "delta" measurement technique may be used for measuring emissions that are up to two "standard" bandwidths away from the band-edge, where a "standard" bandwidth is the bandwidth specified by C63.4 for the frequency being measured. For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, C63.4 specifies a measurement bandwidth of at least 1 MHz. Therefore you may use the "delta" technique for measuring emissions up to 2 MHz removed from the band-edge. Radiated emissions that are removed by more than two “standard” bandwidths must be measured as the above Spurious Radiated Emissions test procedure.

5.6.3 Test Results: PASS

Band-edge compliance of RF conducted/radiated emissions was shown in the Figure 6 and 7.

Spurious RF conducted emissions were shown in the Figure 8.

Emission plot for the preliminary radiated measurements were shown in the Figure 9.

NOTE: for conducted measurement, we took the insertion loss of the cable loss into consideration within the measuring instrument. And for radiated measurement, the results were calibrated to the field strength within the measuring instrument.

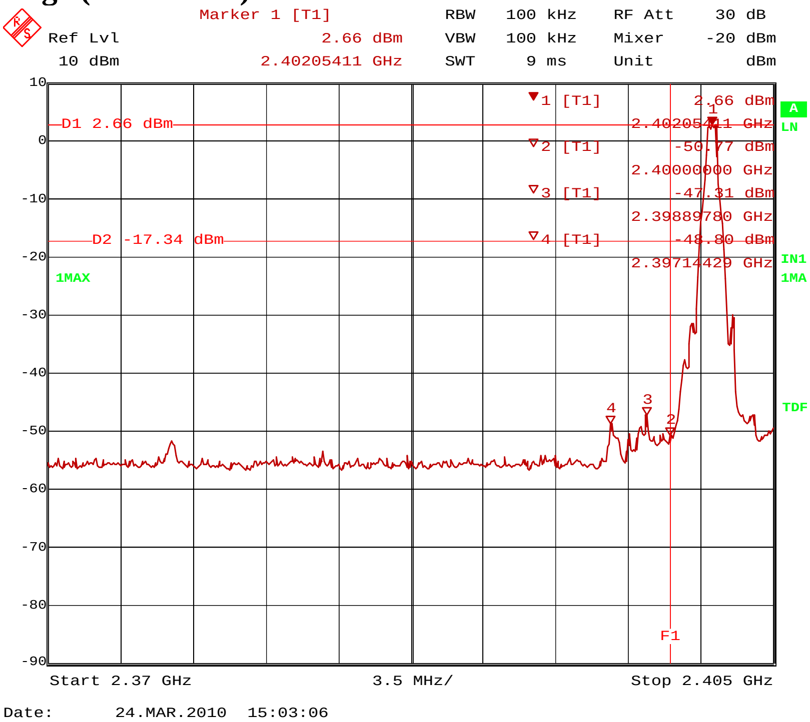
Table 5: Measured values of the Field strength of spurious emission (Radiated)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Antenna Height [m]	Turn Table [degree]	Reading [dB(μV)]	Amp Gain [dB]	ATT [dB]	AF dB(1/m)	CL [dB]	Actual [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Average/Peak/Quasi-peak data, emissions below 30 MHz												
			No Spurious Radiated Emissions Found									
Quasi-peak data, emissions below 1000 MHz												
			No Spurious Radiated Emissions Found									
AVERAGE data, emissions above 1000 MHz												
4804.0	1000	V	1.87	259	---	47.72	0.71	33.20	7.84	---	54.00	---
4804.0	1000	H	1.42	19	50.00	47.72	0.71	33.20	7.84	44.03	54.00	9.97
4882.0	1000	V	1.85	244	---	47.76	0.71	33.31	7.89	---	54.00	---
4882.0	1000	H	1.49	31	47.52	47.76	0.71	33.31	7.89	41.67	54.00	12.33
4960.0	1000	V	1.88	250	---	47.80	0.71	33.42	7.92	---	54.00	---
4960.0	1000	H	1.53	27	45.55	47.80	0.71	33.42	7.92	39.80	54.00	14.20
PEAK data, emissions above 1000 MHz												
4804.0	1000	V	1.87	259	---	47.72	0.71	33.20	7.84	---	74.00	---
4804.0	1000	H	1.42	19	57.23	47.72	0.71	33.20	7.84	51.26	74.00	22.74
4882.0	1000	V	1.58	244	---	47.76	0.71	33.31	7.89	---	74.00	---
4882.0	1000	H	1.49	31	54.75	47.76	0.71	33.31	7.89	48.90	74.00	25.10
4960.0	1000	V	1.88	250	---	47.80	0.71	33.42	7.92	---	74.00	---
4960.0	1000	H	1.53	27	52.87	47.80	0.71	33.42	7.92	47.12	74.00	26.88

Margin (dB) = Limit – Actual
[Actual = Reading – Amp Gain + ATT + AF + CL]
1. H = Horizontal, V = Vertical Polarization
2. ATT = Attenuation (10dB pad and/or Insertion Loss of HPF)
3. AF = Antenna Factor, CL = Cable Loss
Remark "---" means the emission level was too low to be measured or in the noise floor.

Figure 6. Plot of the Band Edge (Conducted)

Lower band-edge
Lowest Channel (2402 MHz)



Upper band-edge
Highest Channel (2480 MHz)

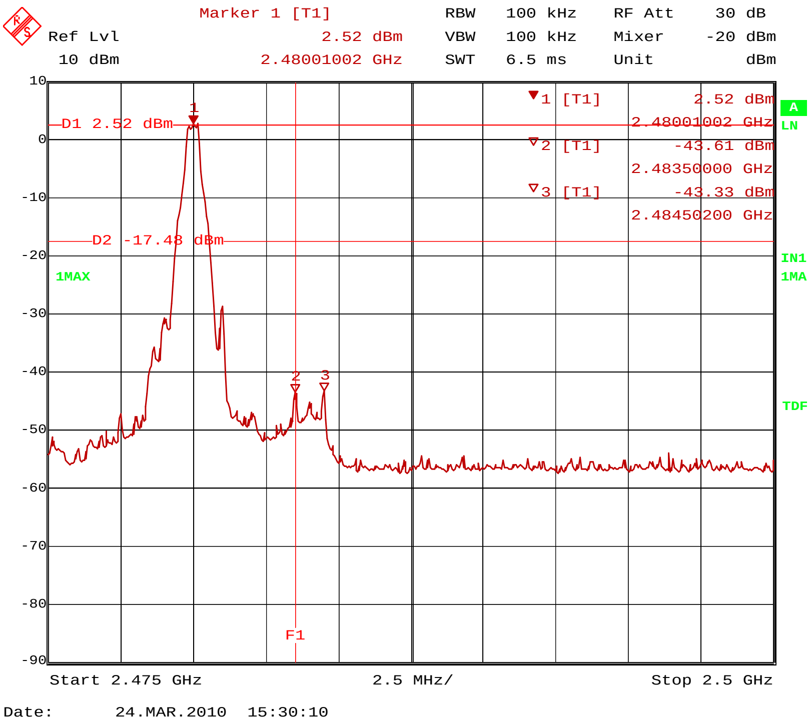
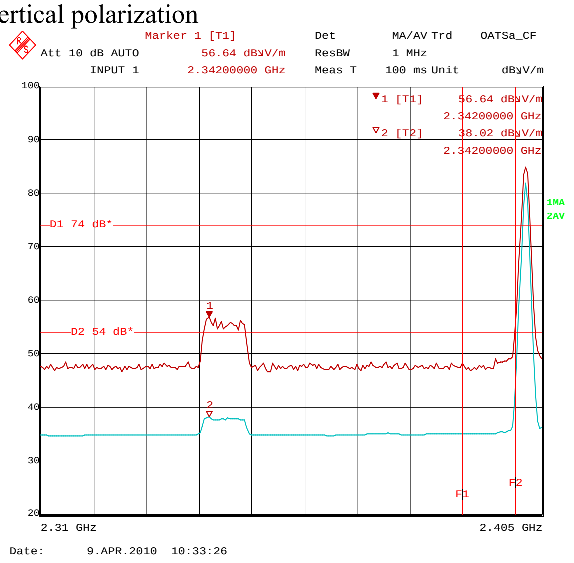
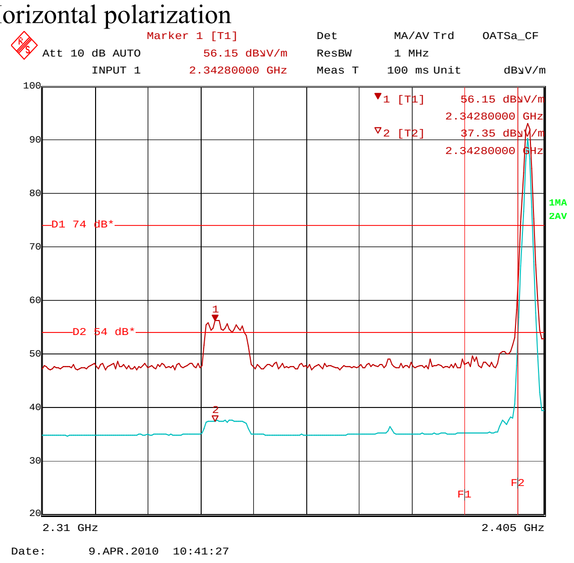


Figure 7. Plot of the Band Edge (Radiated)

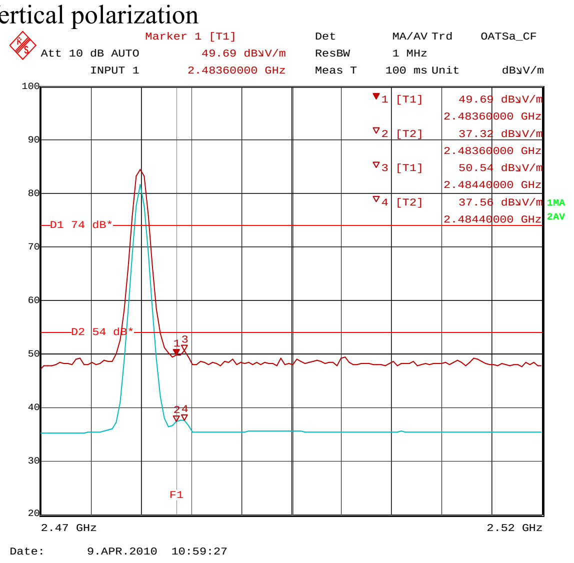
Lowest Channel (operating at 2402 MHz)
Vertical polarization



Lowest Channel (operating at 2402 MHz)
Horizontal polarization



Highest Channel (operating at 2480 MHz)
Vertical polarization



Highest Channel (operating at 2480 MHz)
Horizontal polarization

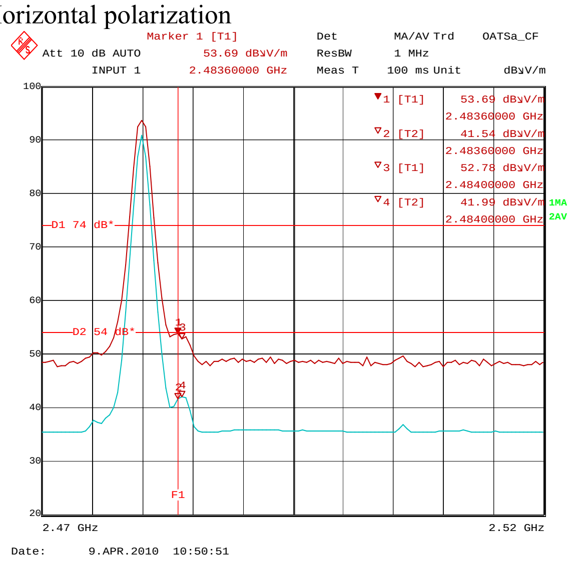
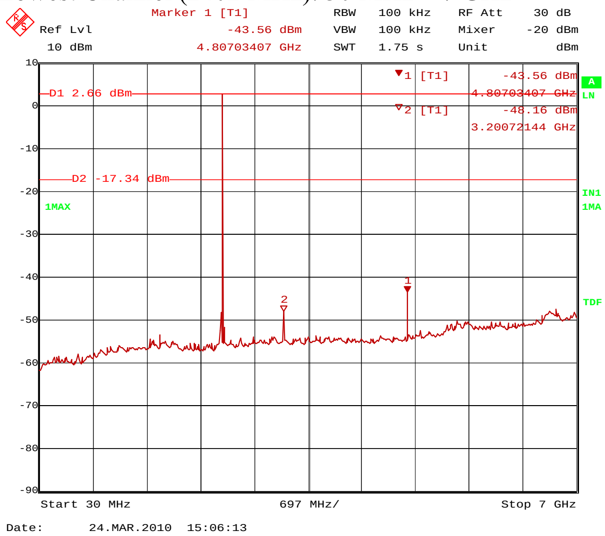
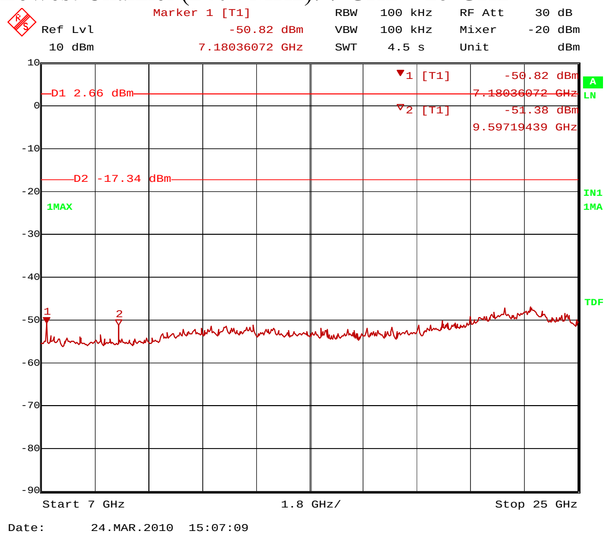


Figure 8. Spurious RF conducted emissions

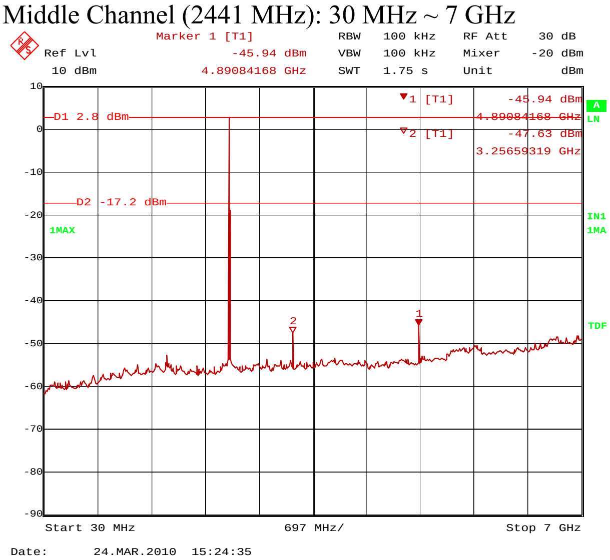
Lowest Channel (2402 MHz): 30 MHz ~ 7 GHz



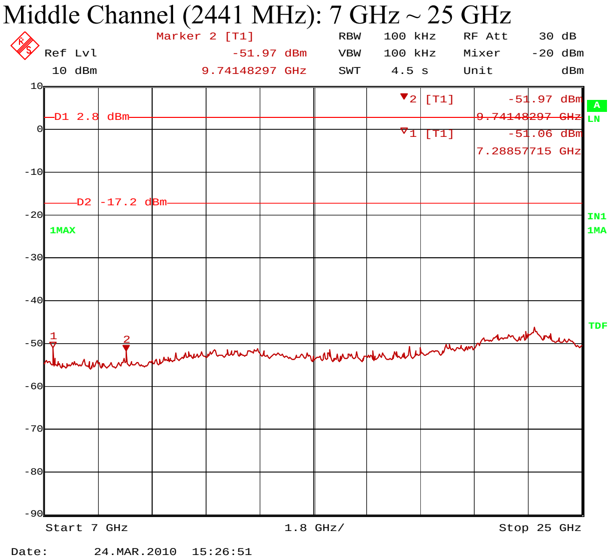
Lowest Channel (2402 MHz): 7 GHz ~ 25 GHz



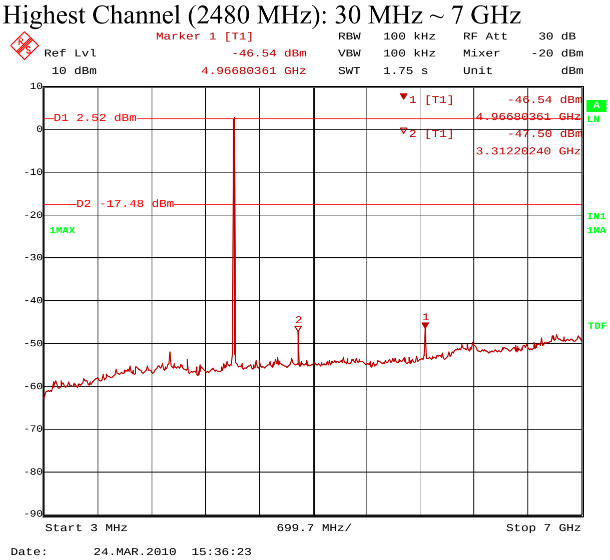
Middle Channel (2441 MHz): 30 MHz ~ 7 GHz



Middle Channel (2441 MHz): 7 GHz ~ 25 GHz



Highest Channel (2480 MHz): 30 MHz ~ 7 GHz



Highest Channel (2480 MHz): 7 GHz ~ 25 GHz

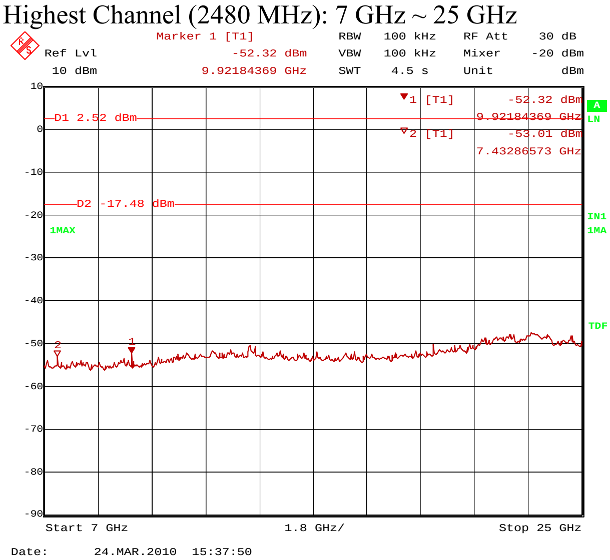
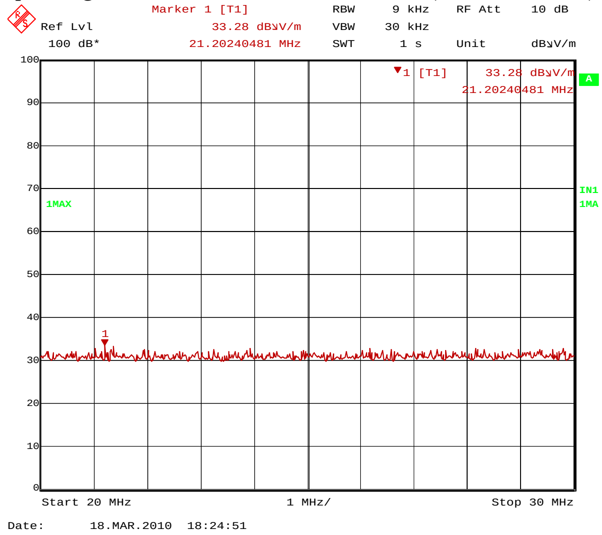
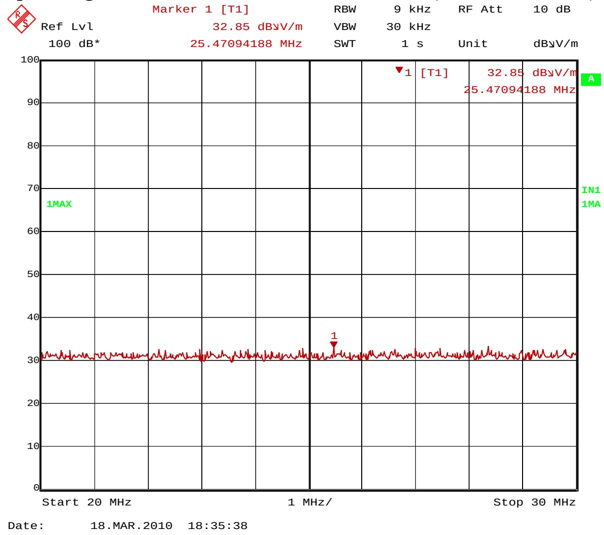


Figure 9. Emission plot for the preliminary radiated measurements

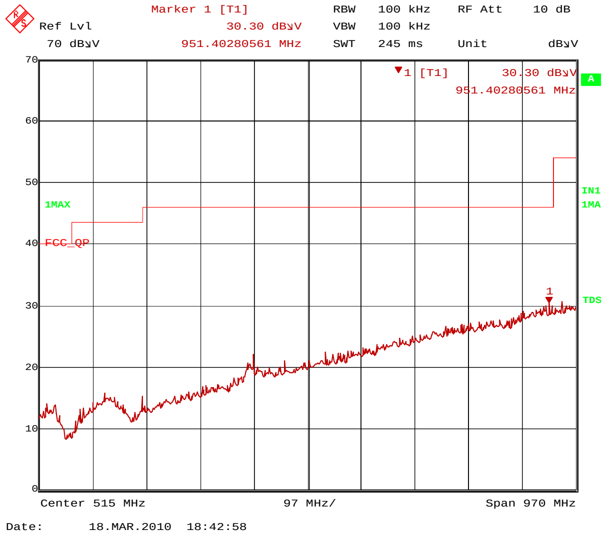
Operating at 2402 MHz: 20 MHz ~ 30 MHz (@ 3-m distance)



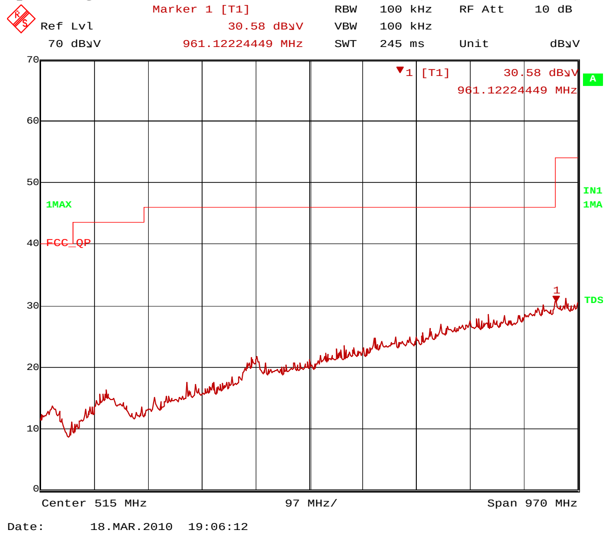
Operating at 2480 MHz: 20 MHz ~ 30 MHz (@ 3-m distance)



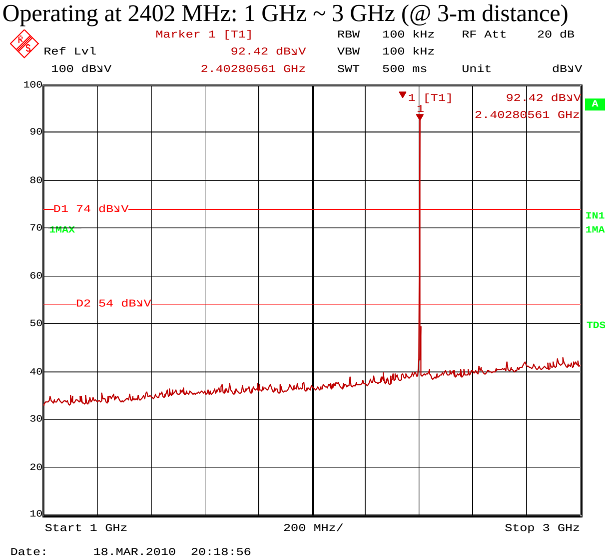
Operating at 2402 MHz: 30 MHz ~ 1 GHz (@ 3-m distance)



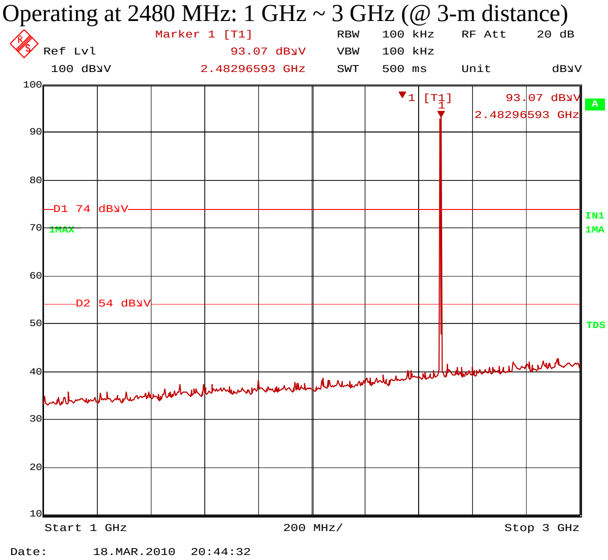
Operating at 2480 MHz: 30 MHz ~ 1 GHz (@ 3-m distance)



Operating at 2402 MHz: 1 GHz ~ 3 GHz (@ 3-m distance)

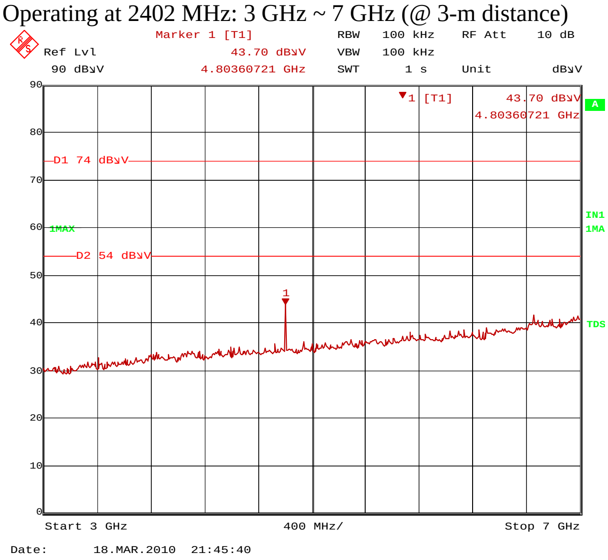


Operating at 2480 MHz: 1 GHz ~ 3 GHz (@ 3-m distance)

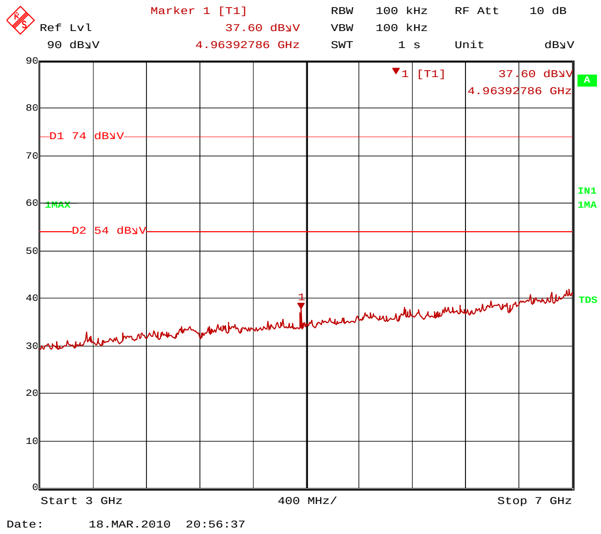


Emission plot for the preliminary radiated measurements (continued)

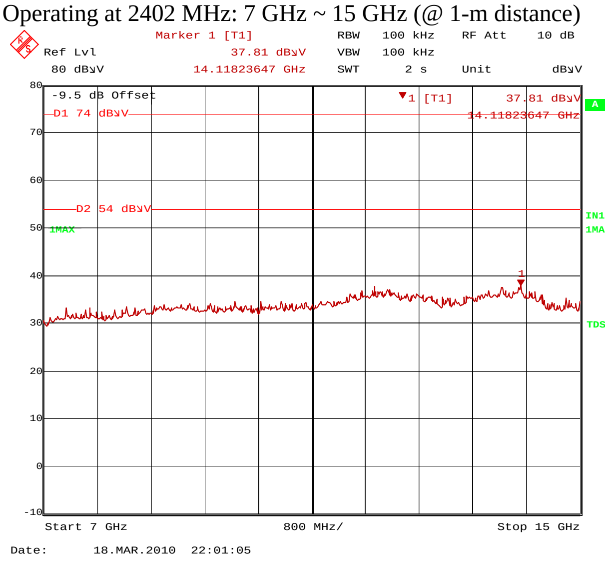
Operating at 2402 MHz: 3 GHz ~ 7 GHz (@ 3-m distance)



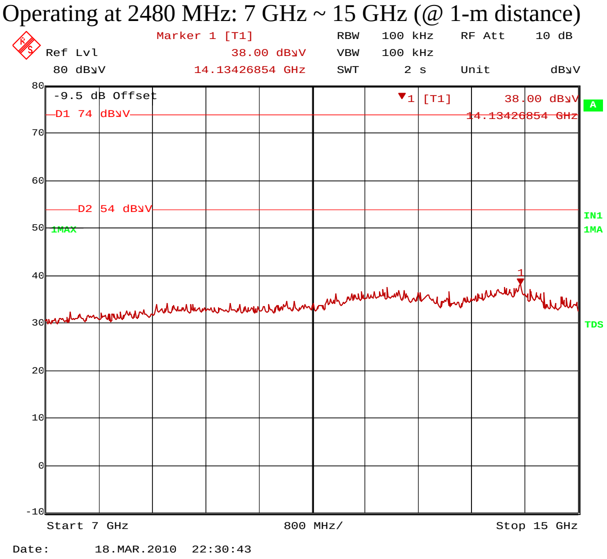
Operating at 2480 MHz: 3 GHz ~ 7 GHz (@ 3-m distance)



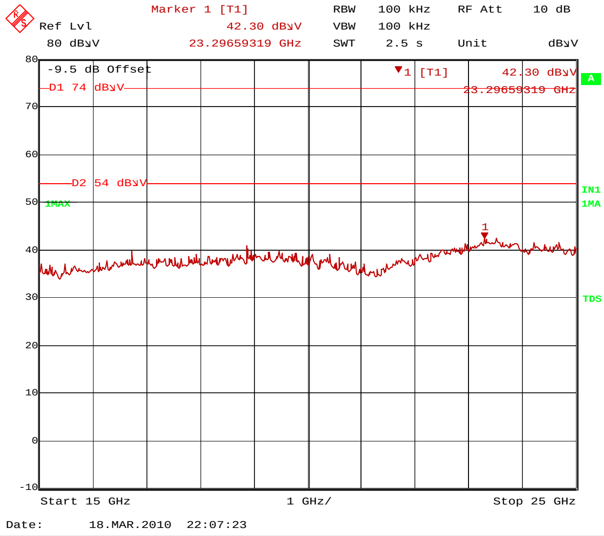
Operating at 2402 MHz: 7 GHz ~ 15 GHz (@ 1-m distance)



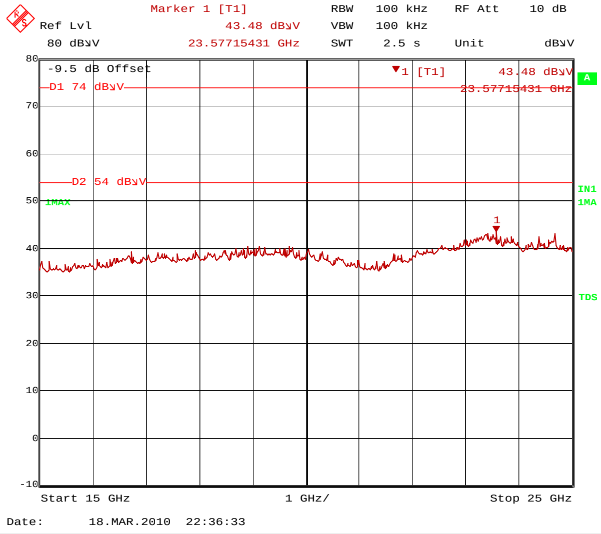
Operating at 2480 MHz: 7 GHz ~ 15 GHz (@ 1-m distance)



Operating at 2402 MHz: 15 GHz ~ 25 GHz (@ 1-m distance)



Operating at 2480 MHz: 15 GHz ~ 25 GHz (@ 1-m distance)



5.7 AC POWER LINE CONDUCTED EMISSIONS

5.7.1 Regulation

According to §15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Qausi-peak	Average
0.15 – 0.5	66 to 56 *	56 to 46 *
0.5 – 5	56	46
5 – 30	60	50

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

5.7.2 Test Procedure

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.
2. Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.
3. Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
5. The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASI-PEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

5.7.3 Test Results: PASS

Table 6: Measured values of the Conducted Emissions

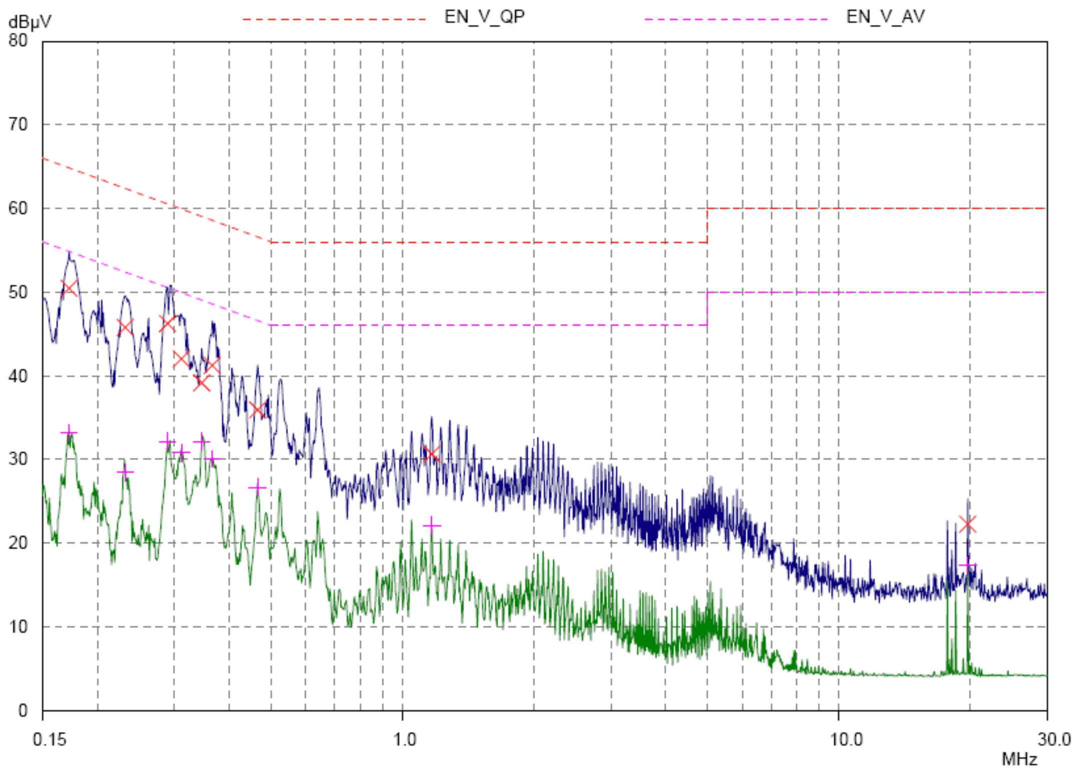
Frequency [MHz]	Reading [dBμV]	L / N	CF [dB]	CL [dB]	Actual [dBμV]	Limit [dBμV]	Margin [dB]
QUASI-PEAK DATA							
0.172	50.62	N	0.34	0.05	51.01	64.84	13.83
0.232	45.76	L	0.28	0.05	46.09	62.39	16.30
0.290	46.30	N	0.29	0.05	46.64	60.53	13.89
0.311	42.00	L	0.28	0.05	42.33	59.93	17.60
0.347	39.12	L	0.28	0.05	39.45	59.04	19.59
0.367	41.22	L	0.28	0.05	41.55	58.57	17.02
0.466	35.90	L	0.28	0.05	36.23	56.58	20.35
1.167	30.62	L	0.26	0.09	30.97	56.00	25.03
19.710	22.24	L	0.75	0.29	23.28	60.00	36.72
AVERAGE DATA							
0.172	33.15	L	0.35	0.05	33.55	54.84	21.29
0.232	28.43	L	0.28	0.05	28.76	52.39	23.63
0.290	32.15	L	0.28	0.05	32.48	50.53	18.05
0.311	30.78	L	0.28	0.05	31.11	49.93	18.82
0.347	32.15	L	0.28	0.05	32.48	49.04	16.56
0.367	30.03	L	0.28	0.05	30.36	48.57	18.21
0.466	26.64	L	0.28	0.05	26.97	46.58	19.61
1.167	22.11	L	0.26	0.09	22.46	46.00	23.54
19.710	17.36	L	0.75	0.29	18.40	50.00	31.60

Margin (dB) = Limit – Actual
[Actual = Reading + CF + CL]
L/N = LINE / NEUTRAL
CF/CL = Correction Factor and Cable Loss

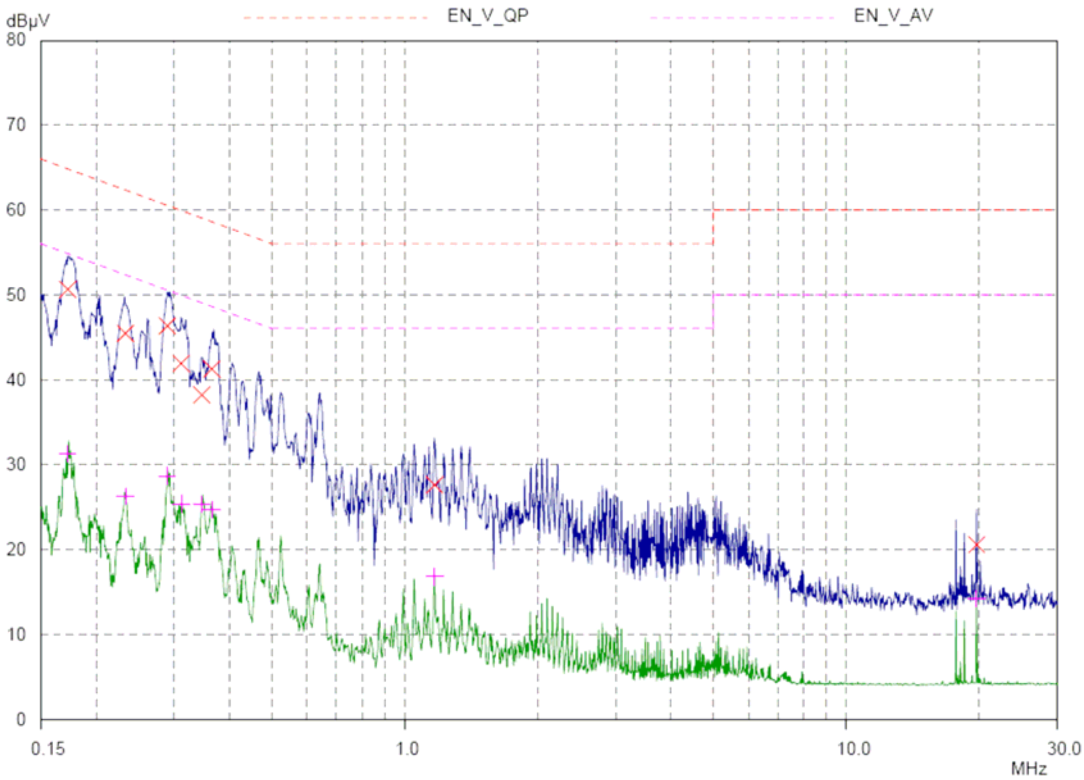
NOTE: The frequency range was scanned from 150 kHz to 30 MHz. All emissions not reported were more than 20 dB below the specified limit.

Figure 10. Plot of the AC Power Line Conducted Emissions

Line – PE (Peak and Average detector used)



Neutral – PE (Peak and Average detector used)



5.8 RF Exposure

5.8.1 Regulation

According to §15.247(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Limits for Maximum Permissive Exposure: RF exposure is calculated.

Frequency Range	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm^2]	Averaging Time [minute]
Limits for General Population/Uncontrolled Exposure				
0.3 ~ 1.34	614	1.63	*(100)	30
1.34 ~ 30	824/f	2.19/f	*(180/f^2)	30
30 ~ 300	27.5	0.073	0.2	30
300 ~ 1500	/	/	f/1500	30
1500 ~ 15000	/	/	1.0	30

f = frequency in MHz, * = Plane-wave equivalent power density

MPE (Maximum Permissive Exposure) Prediction

Predication of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$S = PG/4\pi R^2$

$\left(\Rightarrow R = \sqrt{PG/4\pi S}\right)$

S = power density [mW/cm^2]
P = power input to antenna [mW]
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna [cm]

EUT: Maximum peak output power=2.23 [mW](= 3.48 dBm)& Antenna gain**=2.15 (= 3.32 [dBi])	
100 mW, at 20 cm from an antenna 6 [dBi]	S = PG/4πR² = 100 × 3.98 / (4 × π × 400) = 0.0792 [mW/cm2] < 1.0 [mW/cm2]
2.23 mW, at 20 cm from the antenna 3.32 [dBi]	S = PG/4πR² = 0.0010 [mW/cm^2] < 1.0 [mW/cm^2]
2.23 mW, at 2.5 cm from the antenna 3.32 [dBi]	S = PG/4πR² = 0.0610 [mW/cm^2] < 1.0 [mW/cm^2]

*** For the calculation of the MPE, the antenna gain was assumed as the maximum of 6 dBi.*

5.8.2 RF Exposure Compliance Issue

The EUT is categorically excluded from routine environmental because it operates at very low power level. The equipment is deemed to comply with the SAR or MPE limits without testing due to this very low power level. SAR data was not submitted because the output power of the EUT was below the low thresholds in the July 02 TCB Exclusion List: for portable transmitters,

Low threshold [(60/f_{GHZ} ≈ 25) mW, d < 2.5 cm, (120/f_{GHZ} ≈ 50) mW, d ≥ 2.5 cm], and

High threshold [(900/f_{GHZ} ≈ 370) mW, d < 20 cm], where f_{GHz}: 2.44, d: distance to a person's body