SK TECH CO., LTD. *Page 1 of 26*

TEST REPORT

Test Report No.:	**SKTRFC-110331-007**		
Applicant:	**KYUNGWOO SYSTECH INC.**		
Applicant Address:	#401, Daeryung Post Tower 5, Gasan-dong, Geumcheon-gu, Seoul, 153-702, Korea		
Manufacturer:	**KYUNGWOO SYSTECH INC.**		
Manufacturer Address:	#401, Daeryung Post Tower 5, Gasan-dong, Geumcheon-gu, Seoul, 153-702, Korea		
Device Under Test:	**SMART KEY READER**		
FCC ID:	**ZE8-A230**	**Model Name:**	**A230**
Brand/Trade Name:	**KYUNGWOO**		
Receipt No.:	SKTEU11-0288	**Date of receipt:**	March 17, 2011
Date of Issue:	March 31, 2011		
Location of Testing:	**SK TECH CO., LTD.** #820-2, Wolmoon-ri, Wabu-up, Namyangju-si, Kyunggi-do, 472-905 South Korea		
Test Procedure:	**ANSI C63.4-2003**		
Test Specification:	**47CFR, FCC Part 15 Rules**		
FCC Equipment Class:	**DTS - Part 15 Digital Transmission System**		
Test Result:	The above-mentioned device has been tested and passed.		

Tested & Reported by: *Jungtae Kim*

March 31, 2011

Signature *Date*

Approved by: *Jongsoo Yoon*

March 31, 2011

Signature *Date*

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

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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: 938639)
(OPEN AREA TEST SITE INDUSTRY CANADA NUMBER: IC 5429A)

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	2012.03	
2	Spectrum Analyzer	Agilent	E4440A	MY46186322	2011.05	☒
3	EMC Spectrum Analyzer	Agilent	E7405A	US40240203	2012.03	☒
4	EMI Test Receiver	Rohde&Schwarz	ESPI7	101206	2011.07	☒
5	EMI Test Receiver	Rohde&Schwarz	ESIB40	100277	2012.03	
6	EMI Test Receiver	Rohde&Schwarz	ESHS10	862970/019	2011.07	
7	Artificial Mains Network	Rohde&Schwarz	ESH3-Z5	836679/018	2011.07	
8	Pre-amplifier	HP	8447F	3113A05153	2011.07	☒
9	Pre-amplifier	MITEQ	AFS44	1116321	2011.12	
10	Pre-amplifier	MITEQ	AFS44	1116322	2011.07	☒
11	Power Meter	Agilent	E4417A	MY45100426	2011.07	
12	Power Meter	Agilent	E4418B	US39402176	2011.07	
13	Power Sensor	Agilent	E9327A	MY44420696	2011.07	
14	Power Sensor	Agilent	8482A	MY41094094	2011.07	
15	Attenuator (10dB)	HP	8491B	38067	2011.07	☒
16	Attenuator (20dB)	Weinschel	44	AH6967	2011.07	
17	High Pass Filter	Wainwright	WHKX3.0/18G	8	2011.07	☒
18	VHF Precision Dipole Antenna (TX/RX)	Schwarzbeck	VHAP	1014 / 1015	2011.05	
19	UHF Precision Dipole Antenna (TX/RX)	Schwarzbeck	UHAP	989 / 990	2011.05	
20	Loop Antenna	Schwarzbeck	HFH2-Z2	863048/019	2011.11	☒
21	TRILOG Broadband Antenna	Schwarzbeck	VULB9168	230	2011.07	☒
22	TRILOG Broadband Antenna	Schwarzbeck	VULB9168	189	2011.05	
23	Horn Antenna	AH Systems	SAS-200/571	304	N/A	
24	Horn Antenna	EMCO	3115	00040723	2011.04	
25	Horn Antenna	EMCO	3115	00056768	2011.10	☒
26	Horn Antenna	Schwarzbeck	BBHA9170	BBHA9170318	2013.09	☒
27	Vector Signal Generator	Agilent	E4438C	MY42080359	2011.08	
28	PSG analog signal generator	Agilent	E8257D-520	MY45141255	2011.07	
29	DC Power Supply	HP	6622A	3448A032223	2011.08	☒
30	DC Power Supply	HP	6268B	2542A-07856	2011.07	
31	Temperature/Humidity Chamber	All Three	ATM-50M	20030425	2012.03	
32	Hygro/Thermo Graph	SATO	PC-5000TRH-II	-	2011.07	☒

2.3 Test Date

Date of Test: March 21, 2011 ~ March 30, 2011

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 12 V or 24 V (from the battery in a vehicle)	
Local Oscillator or X-Tal	8 MHz, 16 MHz, and 32 MHz	
Transmit Frequency	2405 MHz to 2480 MHz (16 CH)	125 kHz RFID *
Antenna Type	Integral chip antenna	Integral loop coil antenna
Type of Modulation	OQPSK	ASK
RF Output power	3.05 dBm (measured conducted RF power)	92.37 dBμV/m(PEAK) (measured @ 3m)
External Ports **	- DC INPUT for the lead-acid battery input terminal - CAN for the communication with Cluster, MCU, or ECU in a vehicle.	

** The test report for the 125 kHz RFID was issued with other test report number.*

*** The test report for the compliance with FCC Part 15B as a digital device was issued with other test report number.*

3.2 Equipment Modifications

None

3.3 Submitted Documents

Block diagram

Schematic diagram

Antenna Specification

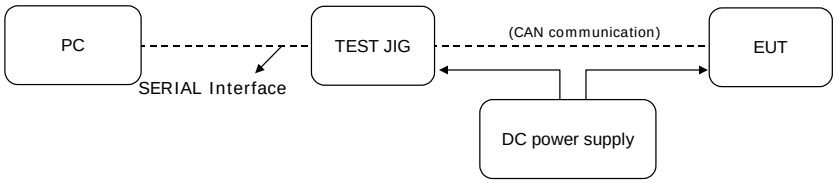
Part List

User manual

4. MEASUREMENT CONDITIONS

4.1 Description of test configuration

The measurements were taken in continuous transmitting mode provided by the applicant.



[System Block Diagram of Test Configuration]

4.2 List of Peripherals

Equipment Type	Manufacturer	Model	S/N
Notebook PC **	DELL	INSPIRION	14791079949
Adaptor (for Notebook PC)	DELL	LA65NS0-00	CN-0DF263-71615-6BT-81A8
TEST JIG	KYUNGWOO SYSTECH INC	-	-

** *For the control of the RF module with TEST JIG. For the radiated spurious emission measurements, the measurements were performed without PC after setting the radio module to TEST MODE.*

4.3 Type of Used Cables

#	START		END		CABLE	
	NAME	I/O PORT	NAME	I/O PORT	LENGTH(m)	SHIELDED
1	EUT	CONNECTOR	TESE JIG	CONNECTOR	-	-
2	TEST JIG	UART	Notebook PC	USB	0.4	-
2	Notebook PC	DC Input	Adaptor	DC Output	1.5	NO
3	Adaptor	AC Input	AC mains	-	0.8	NO

4.4 Uncertainty

Measurement Item	Combined Standard Uncertainty *Uc*	Expanded Uncertainty $U = k \times Uc$ ($k = 1.96$)
Conducted RF power	± 0.71 dB	± 1.40 dB
Radiated disturbance	± 2.30 dB	± 4.51 dB
Conducted disturbance	± 1.96 dB	± 3.84 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
6dB Bandwidth	15.247(a)(2)	5.2	PASS
Maximum Peak Output Power	15.247(b)(3), (4)	5.3	PASS
Spurious Emission, Band Edge, and Restricted bands	15.247(d), 15.205(a), 15.209(a)	5.4	PASS
Peak Power Spectral Density	15.247(e)	5.5	PASS
AC power line Conducted emissions	15.207(a)	-	N/A**
RF Exposure	15.247(i), 1.1307(b)(1)	5.6	PASS

** The product is powered from a DC 12 V or 24 V lead-acid battery in a vehicle

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 the integral chip antenna. The directional gain of the antenna is 3.0 dBi.

5.2 6 dB BANDWIDTH

5.2.1 Regulation

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

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.
2. Set the spectrum analyzer as follows:
   RBW = 100 kHz, VBW ≥ RBW
   Span >> RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold
3. Mark the peak frequency and -6dB (upper and lower) frequency.
4. Set the RBW to as close to 1% of the selected span as is possible without being below 1%.
5. Set the DETECTOR to sample where practical. [REMARK: the function of the PEAK HOLD was used]
6. Measure the 99% occupied bandwidth.
7. Repeat until all the rest channels are investigated.

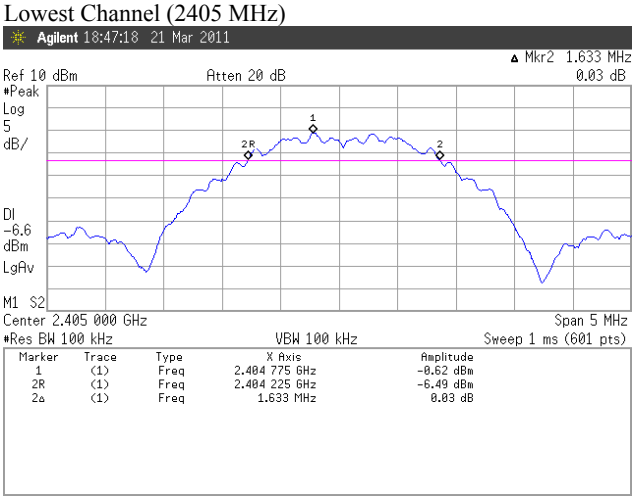
5.2.3 Test Results: PASS

Table 1: Measured values of the 6dB Bandwidth

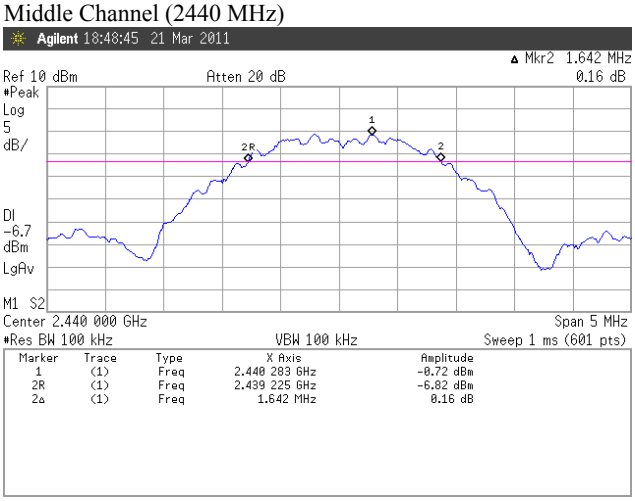
Operating frequency	Occupied Bandwidth (99%)	6dB Bandwidth	Limit
2405 MHz	2.7331 MHz	1.633 MHz	≥ 500 kHz
2440 MHz	2.7634 MHz	1.642 MHz	≥ 500 kHz
2480 MHz	2.7622 MHz	1.633 MHz	≥ 500 kHz

Figure 1. Plot of the 6dB Bandwidth

Lowest Channel (2405 MHz)



Middle Channel (2440 MHz)



Highest Channel (2480 MHz)

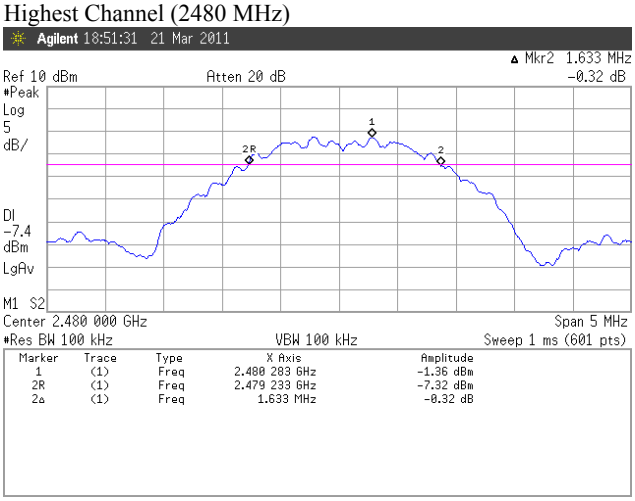
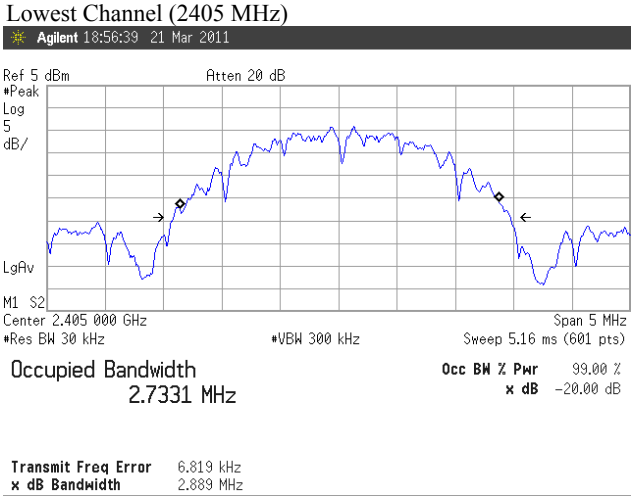
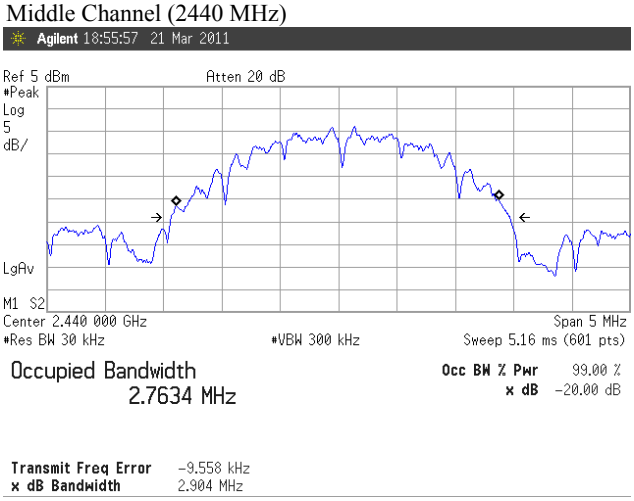


Figure 2. Plot of the Occupied Bandwidth (99%)

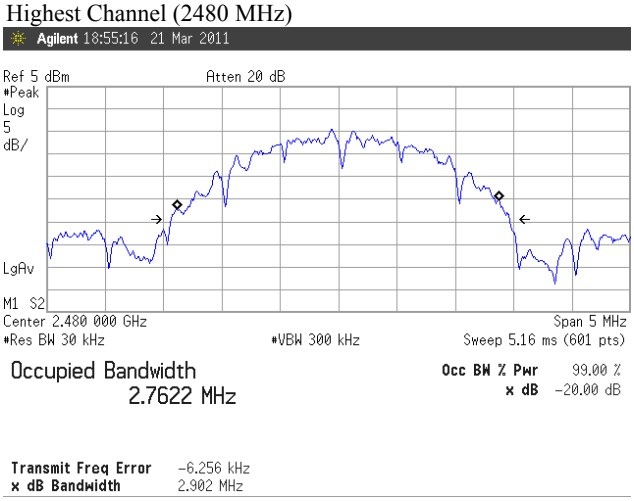
Lowest Channel (2405 MHz)



Middle Channel (2440 MHz)



Highest Channel (2480 MHz)



5.3 MAXIMUM PEAK OUTPUT POWER

5.3.1 Regulation

According to §15.247(b)(3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

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.

5.3.2 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 UART 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 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.

5.3.3 Test Results: PASS

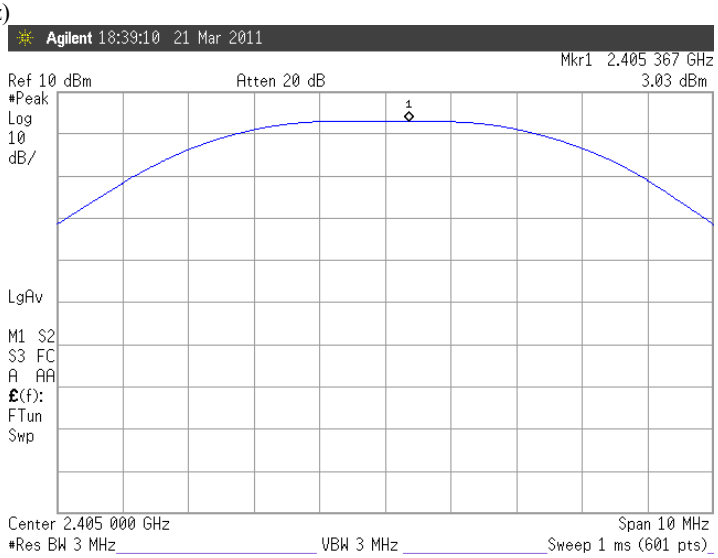
Table 2: Measured values of the Maximum Peak Conducted Output Power

Operating frequency	PEAK POWER		Limit
	[dBm]	[W]	
2405 MHz	3.03	0.002 01	1 W
2440 MHz	3.05	0.002 02	1 W
2480 MHz	2.41	0.001 74	1 W

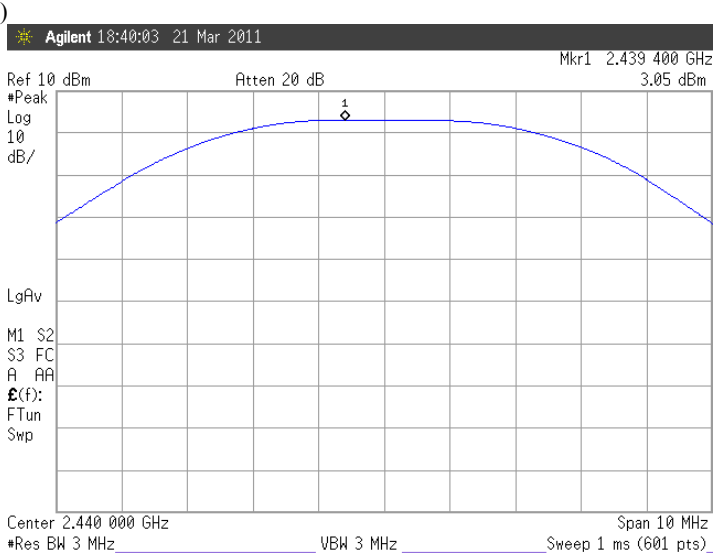
NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

Figure 3. Plot of the Maximum Peak Conducted Output Power

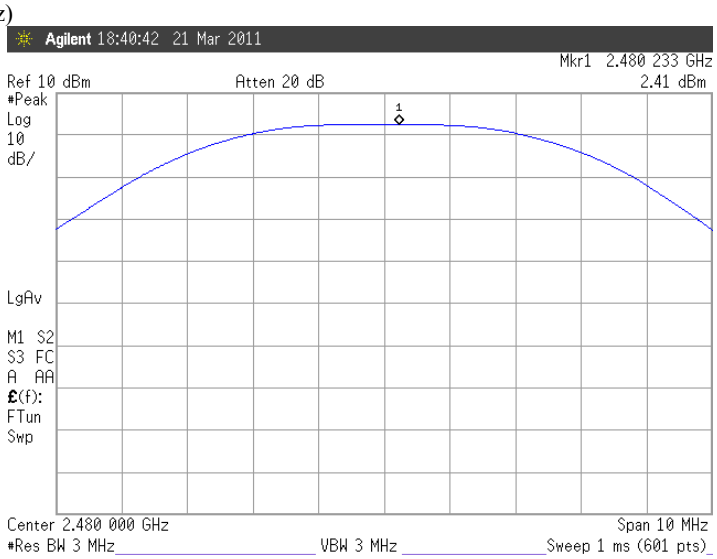
Lowest Channel (2405 MHz)



Middle Channel (2440 MHz)



Highest Channel (2480 MHz)



5.4 SPURIOUS EMISSIONS, BAND EDGE, AND RESTRICTED BANDS

5.4.1 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	100	40.0
88–216	150	43.5
216–960	200	46.0
Above 960	500	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.

5.4.2 Test Procedure

1) Band-edge Compliance of RF Conducted Emissions

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 for above 30 MHz, and at 3 meter distance for below 30 MHz.
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 using the loop antenna below 30 MHz, from 30 to 1000 MHz using the Trilog broadband antenna, and from 1 GHz to tenth harmonic of the highest fundamental frequency 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.

5.4.3 Test Results: PASS

Band-edge compliance of RF conducted/radiated emissions was shown in the Figure 4 and 5.
Spurious RF conducted emissions were shown in the Figure 6.
Emission plot for the preliminary radiated measurements were shown in the Figure 7.

NOTE 1: 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 3 contains the correction factors at the operating frequencies such as antenna factor, cable loss, etc.

NOTE 2: The preliminary radiated measurements were performed in the anechoic chamber in order to find the frequency, which falls in the restricted bands as defined in Section 15.205, and the results for the final measurements were indicated in the Table 3.

Table 3: Measured values of the Field strength of spurious emission (Radiated)

BELOW 1 GHz

Frequency	Receiver Bandwidth	Pol.	Antenna Height	Turn Table	Reading	Amp Gain	ATT	AF	CL	Actual	Limit	Margin
[MHz]	[kHz]	[V/H]	[m]	[degree]	[dB(μV)]	[dB]	[dB]	dB(1/m)	[dB]	[dB(μV/m)]	[dB(μV/m)]	[dB]
Average/Peak/Quasi-peak data, emissions below 30 MHz												
Quasi-peak data, emissions below 1000 MHz												
151.30	120	H	1.58	240	45.00	28.03	-	12.95	1.21	31.13	43.50	12.37
151.30	120	V	1.00	0	42.11	28.03	-	12.95	1.21	28.24	43.50	15.26
416.00	120	H	1.39	175	42.59	28.34	-	14.20	2.00	30.45	46.00	15.55
416.00	120	V	1.05	295	45.88	28.34	-	14.20	2.00	33.74	46.00	12.26
431.98	120	H	1.20	303	48.97	28.44	-	14.51	2.04	37.08	46.00	8.92
431.98	120	V	1.05	77	48.02	28.44	-	14.51	2.04	36.13	46.00	9.87

No Spurious Radiated Emissions Found

Margin (dB) = Limit – Actual
[Actual = Reading – Amp Gain + Attenuator + AF + CL]
1. H = Horizontal, V = Vertical Polarization
2. ATT = Attenuation (10dB pad and/or Insertion Loss of HPF), AF/CL = Antenna Factor and Cable Loss
NOTE: All emissions not reported were more than 20 dB below the specified limit or in the noise floor.

Table 3: Measured values of the Field strength of spurious emission (Radiated) *(continued)*

ABOVE 1 GHz

Frequency	Receiver Bandwidth	Pol.	Antenna Height	Turn Table	Reading	Amp Gain	ATT	AF	CL	Actual	Limit	Margin
[MHz]	[kHz]	[V/H]	[m]	[degree]	[dB(μV)]	[dB]	[dB]	dB(1/m)	[dB]	[dB(μV/m)]	[dB(μV/m)]	[dB]
AVERAGE data, emissions above 1000 MHz												
2405.53	1000	H	1.31	181	92.18	48.18	10.26	27.98	5.04	87.28	Not Applicable	
2405.53	1000	V	1.27	104	89.05	48.18	10.26	27.98	5.04	84.15		
2356.80	1000	H	1.31	181	43.75	48.17	10.26	27.82	4.98	38.64	54.00	15.36
2358.80	1000	V	1.27	104	44.84	48.17	10.26	27.83	4.98	39.74	54.00	14.26
4810.00	1000	H	1.72	191	47.36	48.26	1.18	32.76	7.29	40.33	54.00	13.67
4810.00	1000	V	1.90	120	43.01	48.26	1.18	32.76	7.29	35.98	54.00	18.02
2440.53	1000	H	1.36	182	92.19	48.19	10.26	28.09	5.09	87.44	Not Applicable	
2440.53	1000	V	1.29	109	88.93	48.19	10.26	28.09	5.09	84.18		
4880.00	1000	H	1.70	196	47.00	48.28	1.17	32.77	7.35	40.01	54.00	13.99
4880.00	1000	V	1.69	122	42.88	48.28	1.17	32.77	7.35	35.89	54.00	18.11
2480.53	1000	H	1.30	180	92.11	48.20	10.27	28.22	5.12	87.52	Not Applicable	
2480.53	1000	V	1.22	101	87.70	48.20	10.27	28.22	5.12	83.11		
2483.60	1000	H	1.30	180	53.95	48.20	10.27	28.23	5.13	49.38	54.00	4.62**
2483.60	1000	V	1.22	101	49.67	48.20	10.27	28.23	5.13	45.10	54.00	8.90
4960.00	1000	H	1.68	189	47.26	48.29	1.16	32.78	7.43	40.34	54.00	13.66
4960.00	1000	V	1.48	118	43.28	48.29	1.16	32.78	7.43	36.36	54.00	17.64

Margin (dB) = Limit – Actual

[Actual = Reading – Amp Gain + Attenuator + AF + CL]

1. H = Horizontal, V = Vertical Polarization
2. ATT = Attenuation (10dB pad and/or Insertion Loss of HPF), AF/CL = Antenna Factor and Cable Loss

***: The measured result is within the test standard limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliance based on the 95 % level of confidence. However, the result indicates that compliance is more probable than non-compliance.*

Table 3: Measured values of the Field strength of spurious emission (Radiated) *(continued)*

ABOVE 1 GHz

Frequency	Receiver Bandwidth	Pol.	Antenna Height	Turn Table	Reading	Amp Gain	ATT	AF	CL	Actual	Limit	Margin
[MHz]	[kHz]	[V/H]	[m]	[degree]	[dB(μV)]	[dB]	[dB]	dB(1/m)	[dB]	[dB(μV/m)]	[dB(μV/m)]	[dB]
PEAK data, emissions above 1000 MHz												
2405.53	1000	H	1.31	181	98.30	48.18	10.26	27.98	5.04	93.40	Not Applicable	
2405.53	1000	V	1.27	104	95.15	48.18	10.26	27.98	5.04	90.25		
2356.80	1000	H	1.31	181	60.30	48.17	10.26	27.82	4.98	55.19	74.00	18.81
2358.80	1000	V	1.27	104	62.10	48.17	10.26	27.83	4.98	57.00	74.00	17.00
4810.00	1000	H	1.72	191	53.02	48.26	1.18	32.76	7.29	45.99	74.00	28.01
4810.00	1000	V	1.90	120	48.31	48.26	1.18	32.76	7.29	41.28	74.00	32.72
2440.53	1000	H	1.36	182	98.08	48.19	10.26	28.09	5.09	93.33	Not Applicable	
2440.53	1000	V	1.29	109	94.81	48.19	10.26	28.09	5.09	90.06		
4880.00	1000	H	1.70	196	52.84	48.28	1.17	32.77	7.35	45.85	74.00	28.15
4880.00	1000	V	1.69	122	47.56	48.28	1.17	32.77	7.35	40.57	74.00	33.43
2480.53	1000	H	1.30	180	98.25	48.20	10.27	28.22	5.12	93.66	Not Applicable	
2480.53	1000	V	1.22	101	93.02	48.20	10.27	28.22	5.12	88.43		
2483.60	1000	H	1.30	180	63.90	48.20	10.27	28.23	5.13	59.33	74.00	14.67
2483.60	1000	V	1.22	101	61.15	48.20	10.27	28.23	5.13	56.58	74.00	17.42
4960.00	1000	H	1.68	189	52.19	48.29	1.16	32.78	7.43	45.27	74.00	28.73
4960.00	1000	V	1.48	118	48.60	48.29	1.16	32.78	7.43	41.68	74.00	32.32

Margin (dB) = Limit – Actual

[Actual = Reading – Amp Gain + Attenuator + AF + CL]

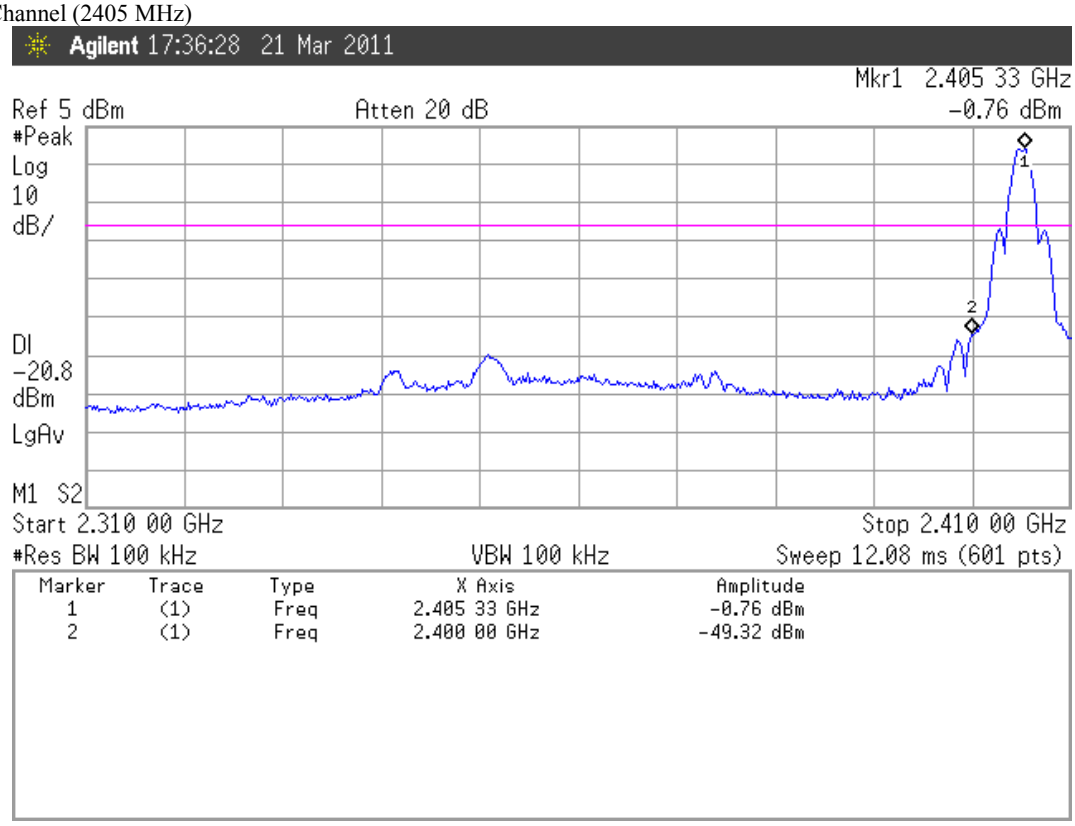
1. H = Horizontal, V = Vertical Polarization

2. ATT = Attenuation (10dB pad and/or Insertion Loss of HPF), AF/CL = Antenna Factor and Cable Loss

NOTE: All emissions not reported were more than 20 dB below the specified limit or in the noise floor.

Figure 4. Plot of the Band Edge (Conducted)

Lowest Channel (2405 MHz)



Highest Channel (2480 MHz)

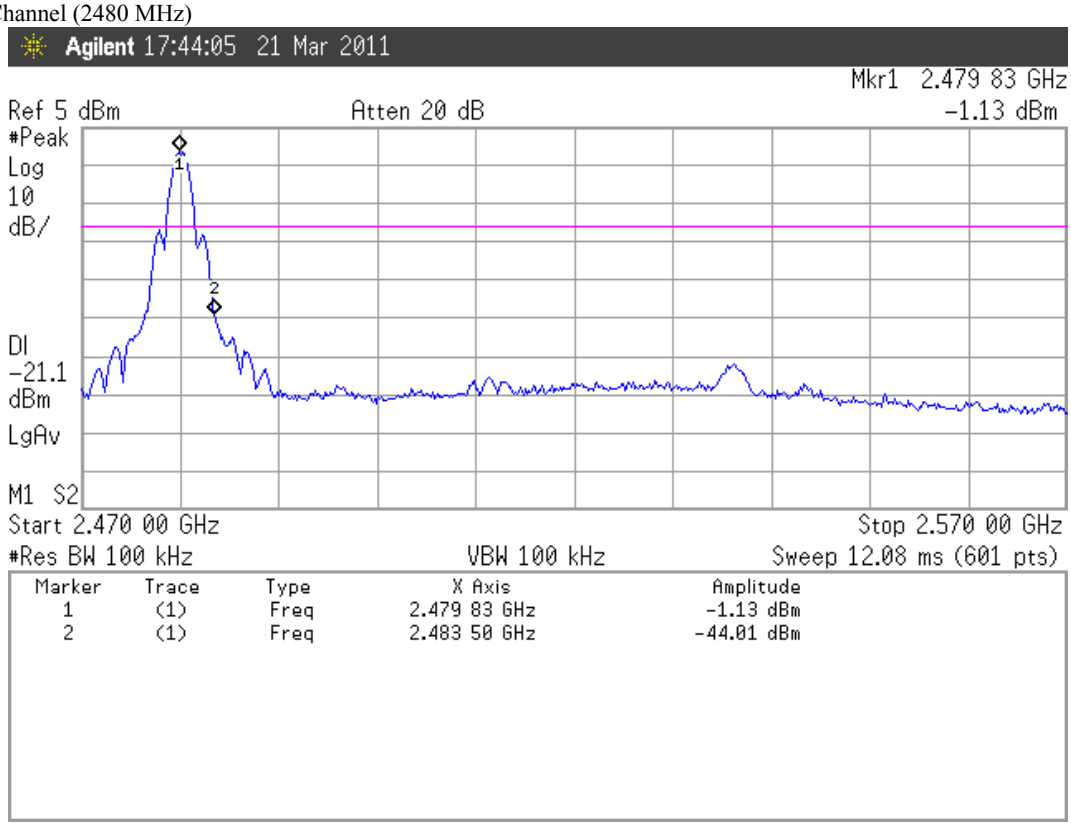
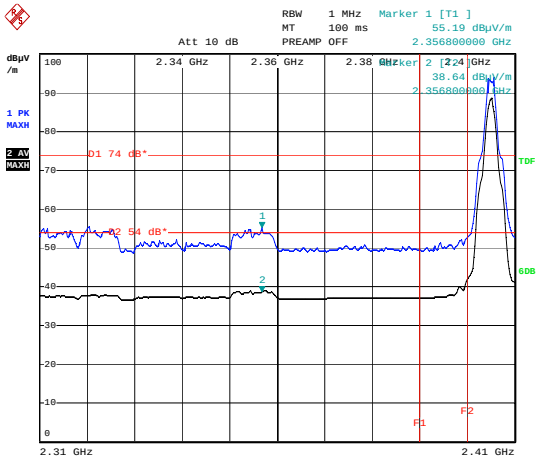


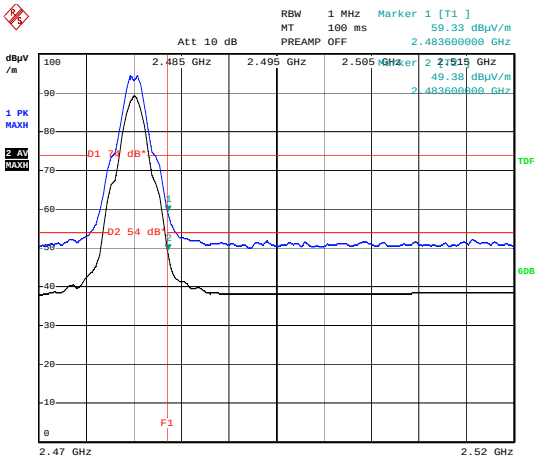
Figure 5. Plot of the Band Edge (Radiated)

Lowest Channel (2405 MHz)
Horizontal



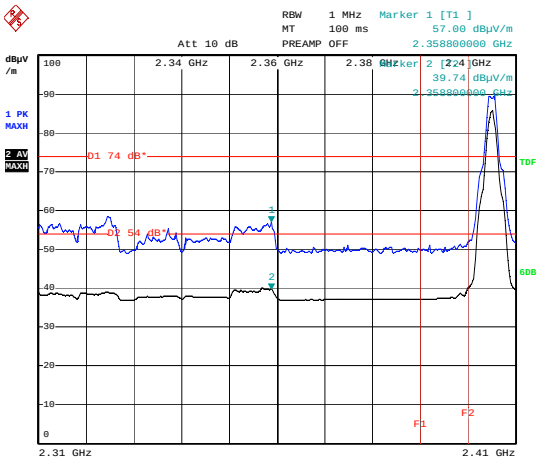
Date: 30.MAR.2011 16:18:07

Highest Channel (2480 MHz)
Horizontal



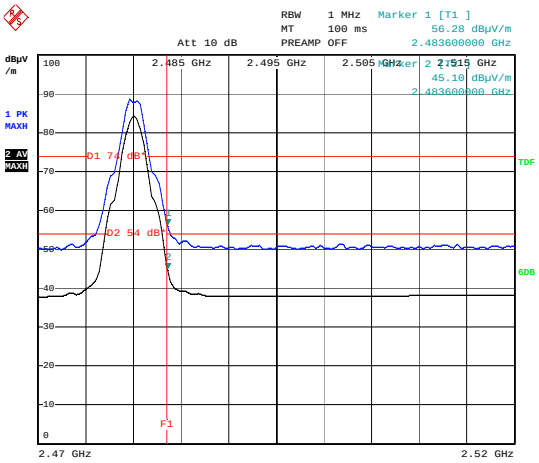
Date: 30.MAR.2011 15:53:06

Lowest Channel (2405 MHz)
Vertical



Date: 30.MAR.2011 16:11:53

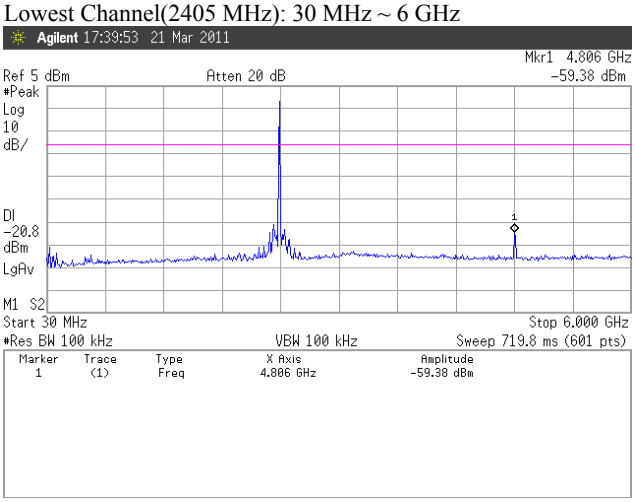
Highest Channel (2480 MHz)
Vertical



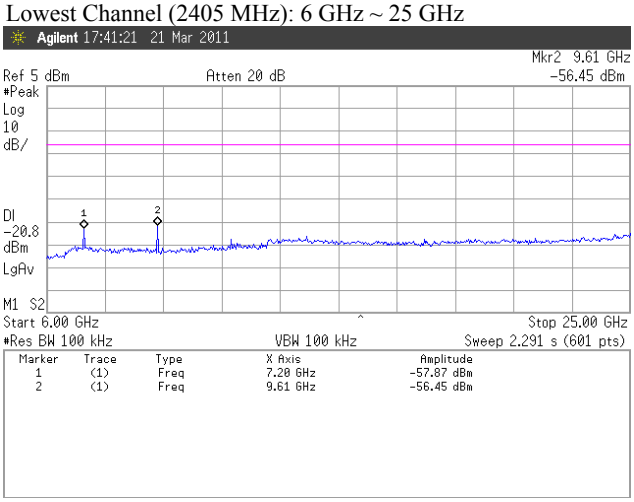
Date: 30.MAR.2011 15:59:37

Figure 6. Spurious RF conducted emissions

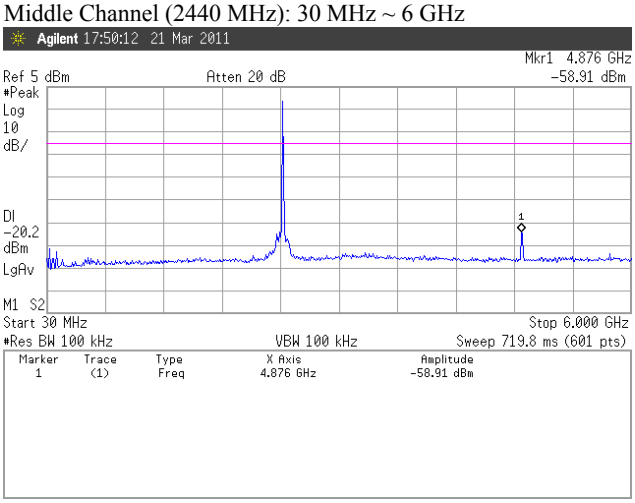
Lowest Channel(2405 MHz): 30 MHz ~ 6 GHz



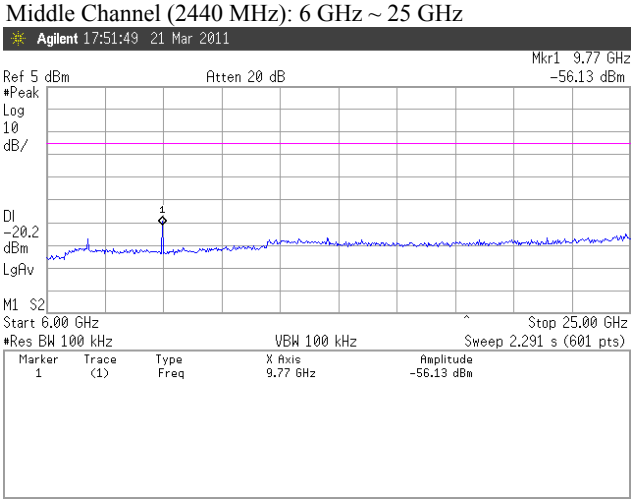
Lowest Channel (2405 MHz): 6 GHz ~ 25 GHz



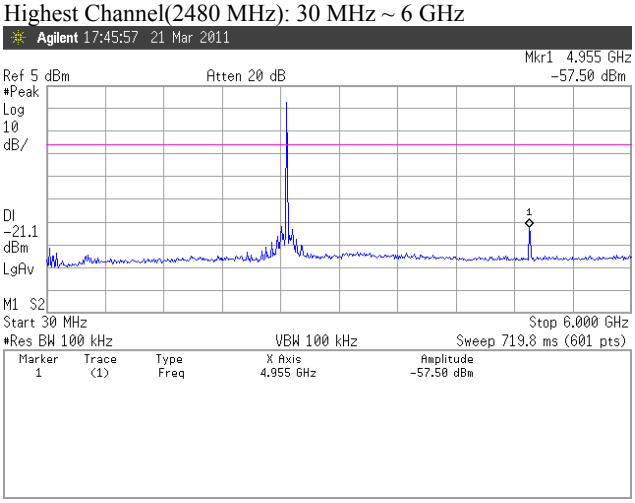
Middle Channel (2440 MHz): 30 MHz ~ 6 GHz



Middle Channel (2440 MHz): 6 GHz ~ 25 GHz



Highest Channel(2480 MHz): 30 MHz ~ 6 GHz



Highest Channel(2480 MHz): 6 GHz ~ 25 GHz

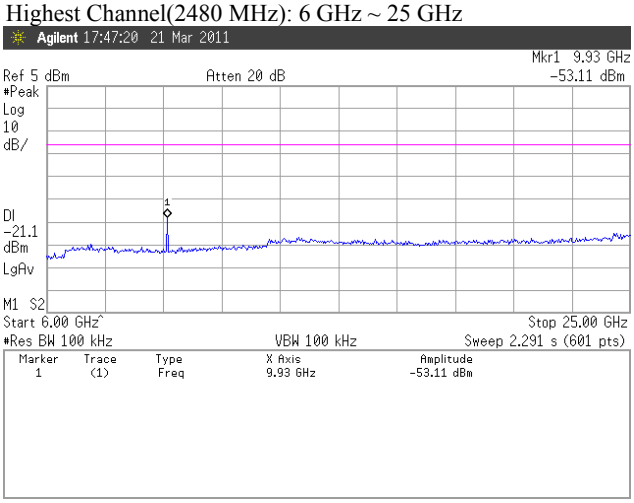
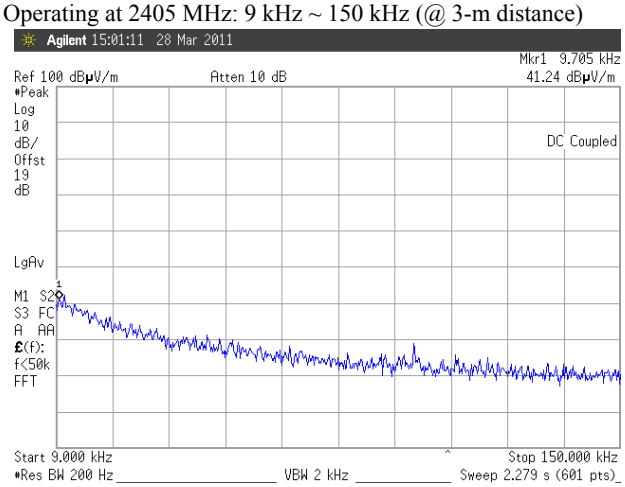
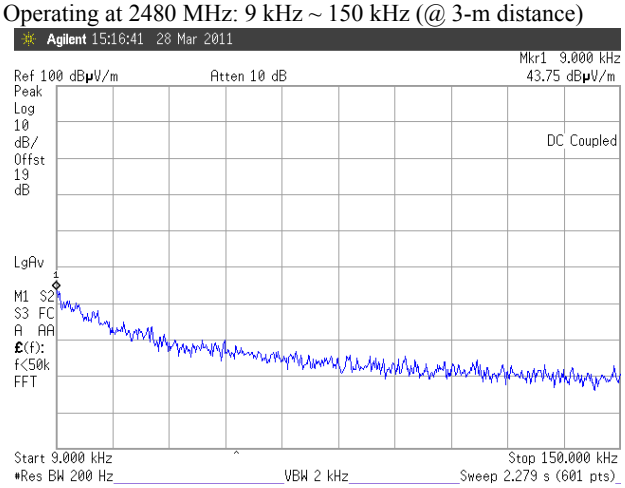


Figure 7. Emission plot for the preliminary radiated measurements

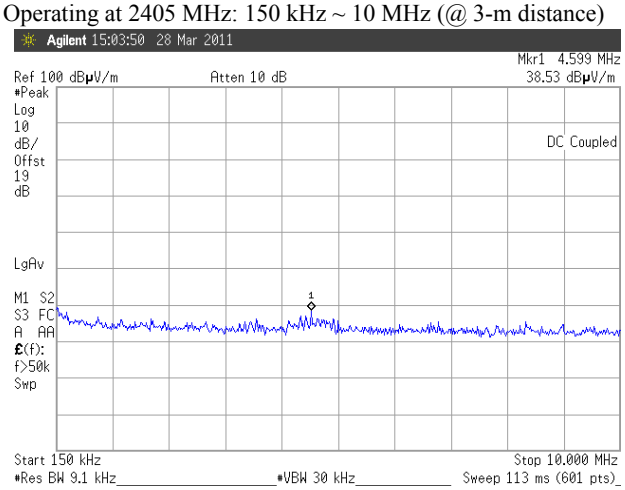
Operating at 2405 MHz: 9 kHz ~ 150 kHz (@ 3-m distance)



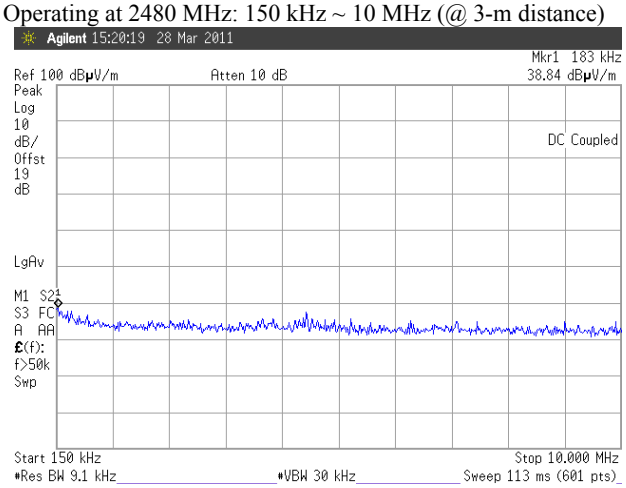
Operating at 2480 MHz: 9 kHz ~ 150 kHz (@ 3-m distance)



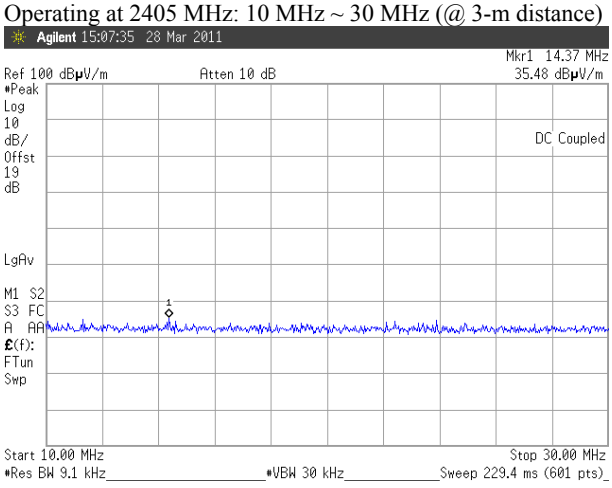
Operating at 2405 MHz: 150 kHz ~ 10 MHz (@ 3-m distance)



Operating at 2480 MHz: 150 kHz ~ 10 MHz (@ 3-m distance)



Operating at 2405 MHz: 10 MHz ~ 30 MHz (@ 3-m distance)



Operating at 2480 MHz: 10 MHz ~ 30 MHz (@ 3-m distance)

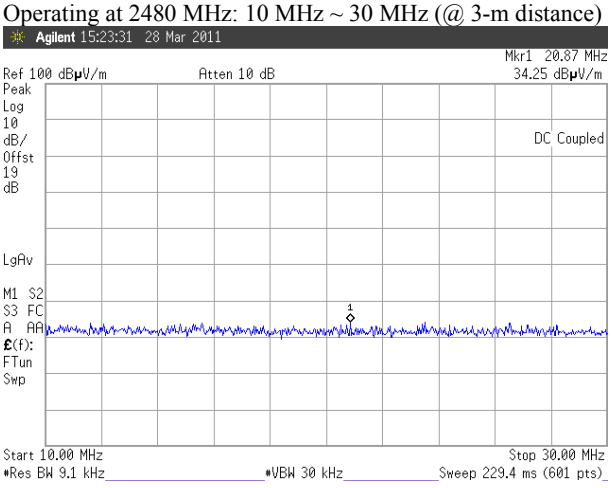
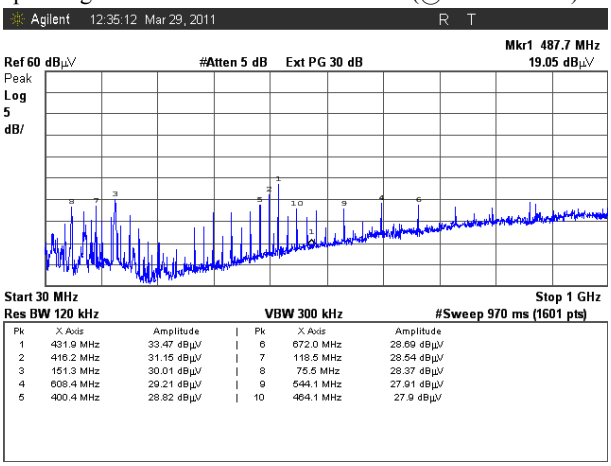
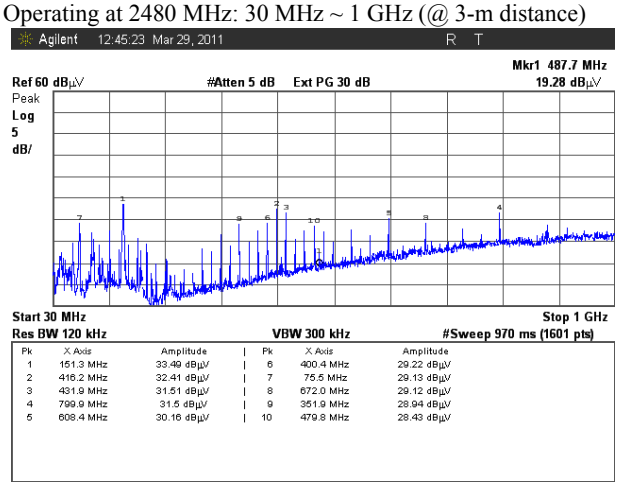


Figure 7. Emission plot for the preliminary radiated measurements

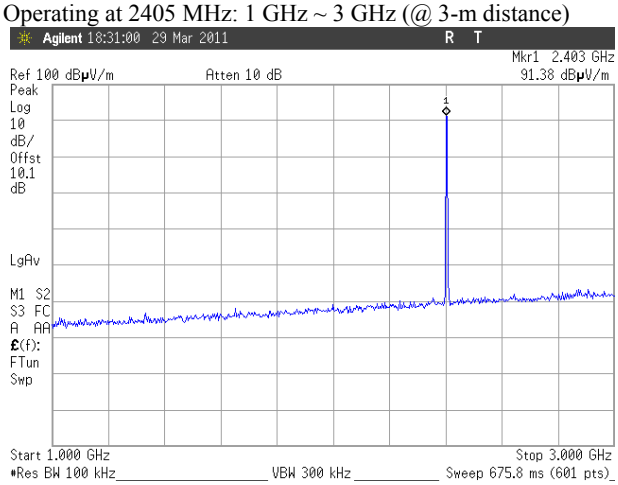
Operating at 2405 MHz: 30 MHz ~ 1 GHz (@ 3-m distance)



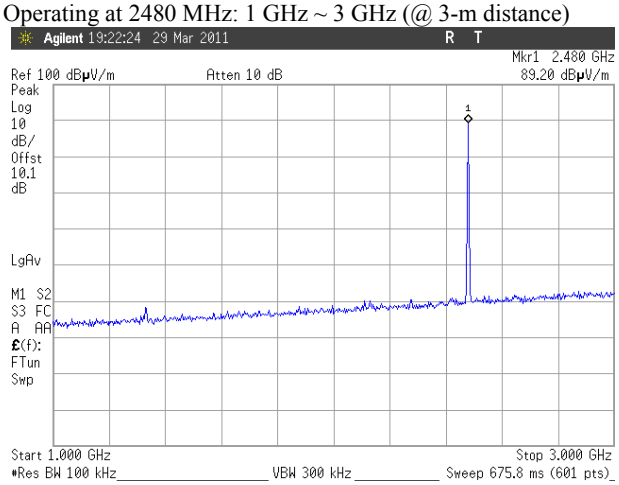
Operating at 2480 MHz: 30 MHz ~ 1 GHz (@ 3-m distance)



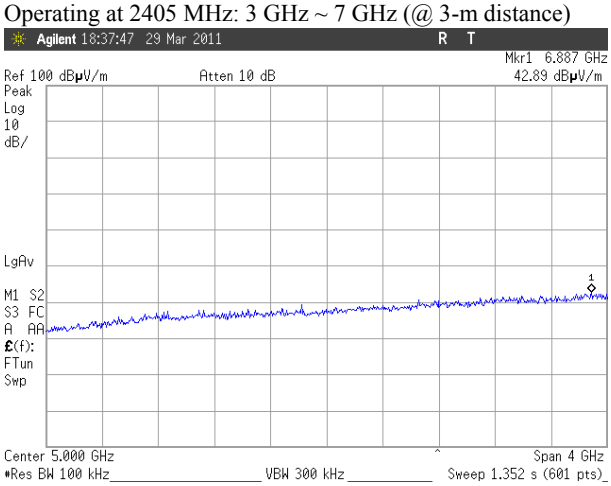
Operating at 2405 MHz: 1 GHz ~ 3 GHz (@ 3-m distance)



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



Operating at 2405 MHz: 3 GHz ~ 7 GHz (@ 3-m distance)



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

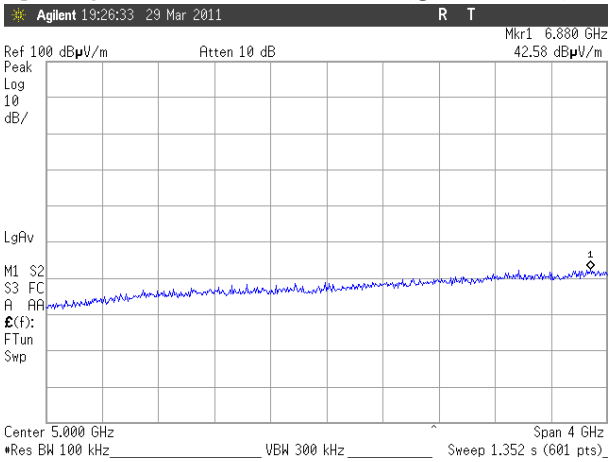
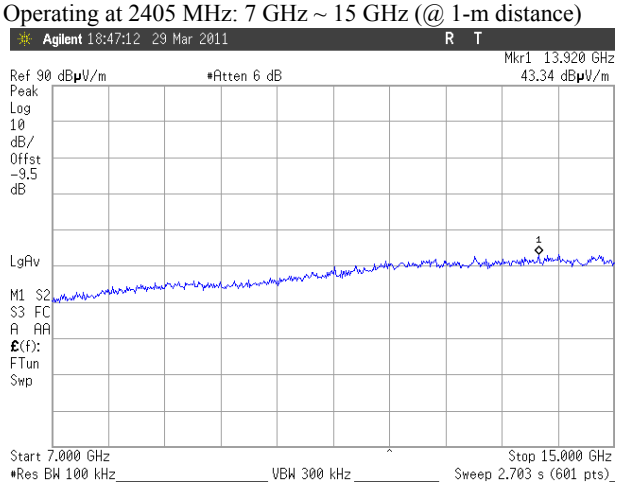
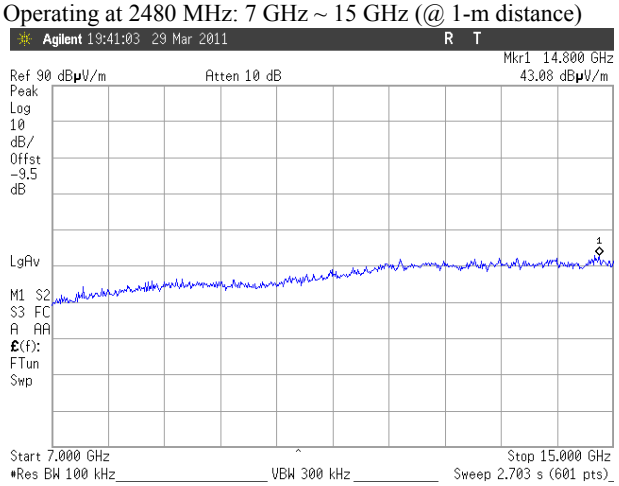


Figure 7. Emission plot for the preliminary radiated measurements

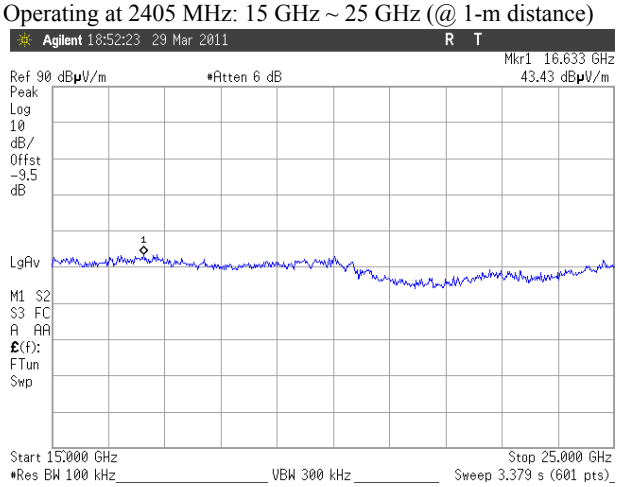
Operating at 2405 MHz: 7 GHz ~ 15 GHz (@ 1-m distance)



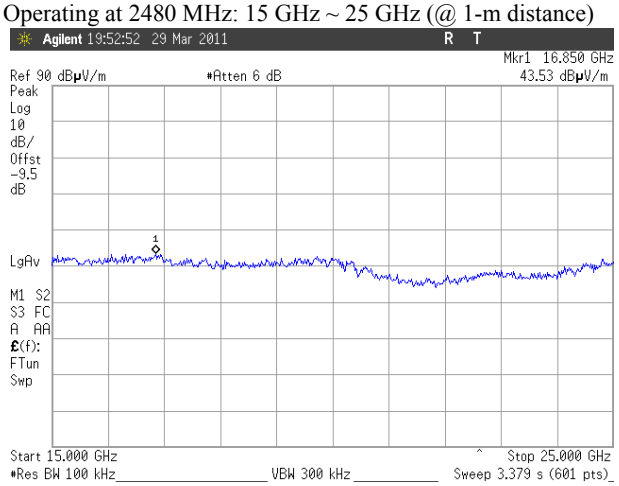
Operating at 2480 MHz: 7 GHz ~ 15 GHz (@ 1-m distance)



Operating at 2405 MHz: 15 GHz ~ 25 GHz (@ 1-m distance)



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



5.5 PEAK POWER SPECTRAL DENSITY

5.5.1 Regulation

According to §15.247(e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.5.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and locate and zoom in on emission peak(s) within the passband.
4. Set the spectrum analyzer as follows:
   RBW = 3 kHz, VBW ≥ RBW
   Span = 1.5 MHz
   Sweep = 500 seconds
   Detector function = peak
   Trace = max hold
5. Measure the highest amplitude appearing on spectral display and record the level to calculate results.

5.5.3 Test Results: PASS

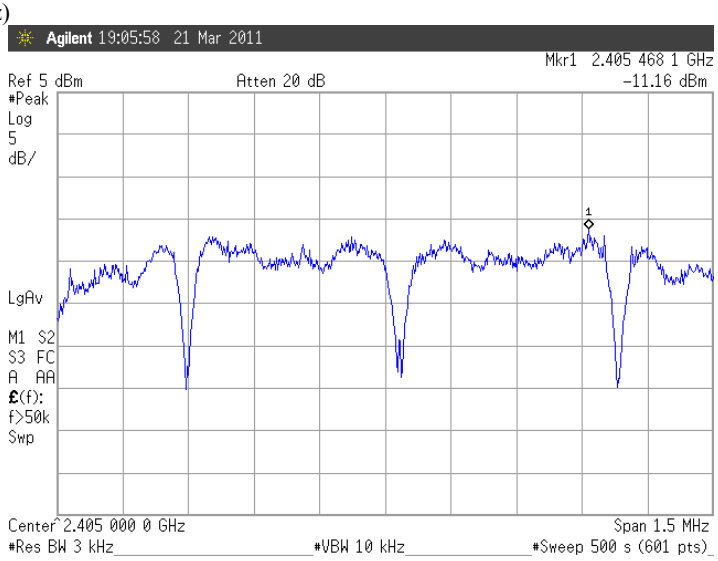
Table 4: Measured values of the Peak Power Spectral Density (Conducted)

Operating frequency	Measured Value (PPSD)	Limit
2405 MHz	-11.16 dBm	8.0 dBm
2440 MHz	-11.79 dBm	8.0 dBm
2480 MHz	-12.35 dBm	8.0 dBm

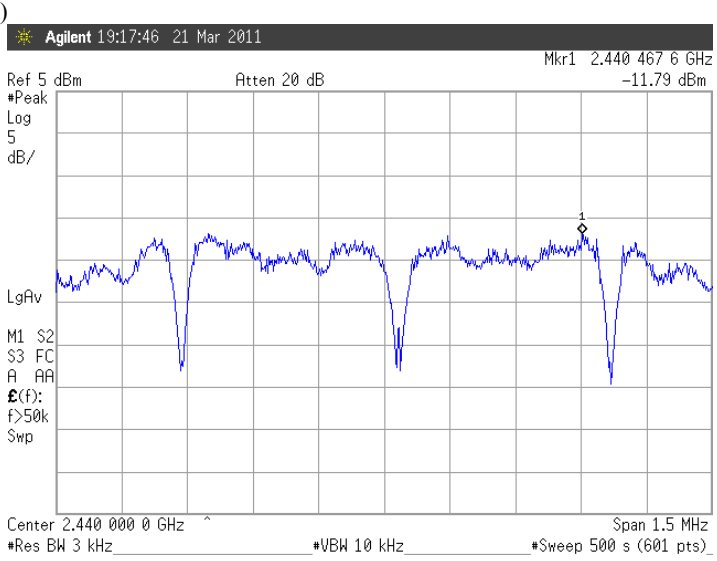
NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

Figure 8. Plot of the Peak Power Spectral Density

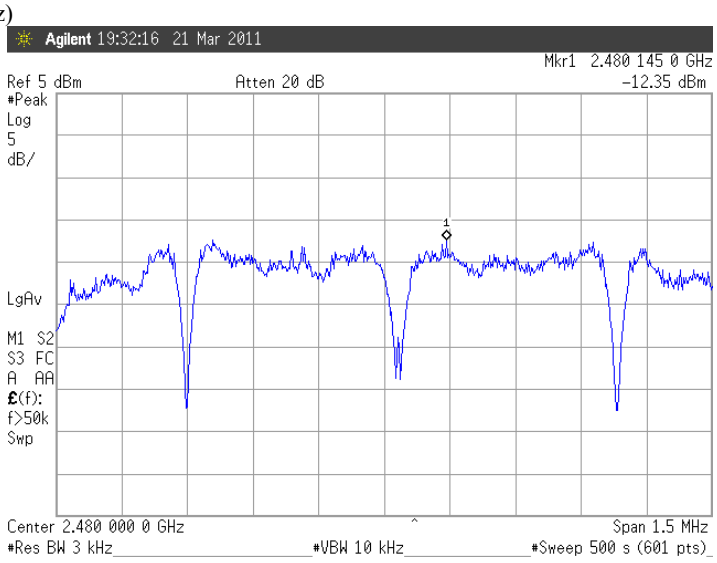
Lowest Channel (2405 MHz)



Middle Channel (2440 MHz)



Highest Channel (2480 MHz)



5.6 RF Exposure

5.6.1 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

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

$\left(\Rightarrow R = \sqrt{PG/4\pi S}\right)$ R = distance to the center of radiation of the antenna [cm]

EUT: Maximum peak output power = 2.02 [mW](= 3.05 dBm) & Antenna gain =2.00 (= 3.0 [dBi])	
100 mW, at 20 cm from an antenna 6 [dBi]	S = PG/4πR² = 100 × 3.98 / (4 × π × 400) = 0.0792 [mW/cm^2] < 1.0 [mW/cm^2]
2.02 mW, at 20 cm from the antenna 3.0 [dBi]	S = PG/4πR² = 0.0008 [mW/cm^2] < 1.0 [mW/cm^2]
2.02 mW, at 2.5 cm from the antenna 3.0 [dBi]	S = PG/4πR² = 0.0513 [mW/cm^2]

5.6.2 RF Exposure Compliance Issue

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

REMARK: The (source based) average RF power output is below 20 mW, and the EUT is categorically excluded from the RF exposure(SAR) requirements.