

 ESTECH Co., Ltd. Rm 1015, World Venture Center II, 426-5 Gasan-dong, Guncheon-gu, Seoul, 158-803, Korea	  		Electromagnetic Interference Test Report

Test Report for FCC

FCC ID:R6M-24GHZDSM

Report Number		ESTF151212-002		
Applicant	Company name	Precision RC Electronics Inc.		
	Address	12 Brinkerhoff Terrace Palisades Park NJ 07650 USA		
	Telephone	201-221-6766		
Product	Product name	REMOCON RH PCB A'SSY		
	Model No.	2.4GHZ-DSM	Manufacturer	Precision RC Electronics Inc.
	Serial No.	None	Country of origin	KOREA
Test date	16-Dec-12		Date of issue	24-Dec-12
Testing location	ESTECH Co., Ltd. 97-1 Hoiuk-Ri Majang-Myon, Icheon-city, KyungKi-Do, Korea			
Standard	FCC PART 15 (2010) , ANSI C 63.4 2003			
Measurement facility registration number		915135		
Tested by	Senior Engineer J.H. Kim		(Signature)	
Reviewed by	Engineering Manager J.M.Yang		(Signature)	
Abbreviation	OK, Pass = Passed, Fail = Failed, N/A = not applicable			
* Note - This test report is not permitted to copy partly without our permission - This test result is dependent on only equipment to be used - This test result based on a single evaluation of one sample of the above mentioned				

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1. Laboratory Information

1.1 General

This EUT (Equipment Under Test) has been shown to be capable of compliance with the applicable technical standards and is tested in accordance with the measurement procedures as indicated in this report.

ESTECH Lab attests to accuracy of test data. All measurement reported herein were performed by ESTECH Co., Ltd.

ESTECH Lab assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

1.2 Test Lab.

Corporation Name : ESTECH Co. Ltd

Head Office : Rm 1015, World Venture Center II, 426-5, Gasan-dong, Geumcheon-gu, Seoul, Korea
(Safety & Telecom. Test Lab)

EMC Test Lab : 97-1 Hoiuk-Ri Majang-Myon, Icheon-city, KyungKi-Do, Korea

1.3 Official Qualification(s)

KCC : Granted Accreditation from Ministry of Information & Communication for EMC, Safety and Telecommunication

KOLAS : Accredited Lab By Korea Laboratory Accreditation Schema base on CENELEC requirements

FCC : Filed Laboratory at Federal Communications Commission

VCCI : Granted Accreditation from Voluntary Control Council for Interference from ITE

2. Description of EUT

2.1 Summary of Equipment Under Test

Product Name	: REMOCON RH PCB A'SSY
Model Number	: 2.4GHZ-DSM
Modulation Type	: ZigBee(DSSS)
Transfer Rate	: up to 250 kbps
Number of Channel	: 15
Channel Spacing	: 5 MHz
Serial Number	: NONE
Manufacturer	: Precision RC Electronics Inc.
Country of origin	: KOREA
Rating	: 4.5 Vd.c.(battery power)
X-tal list	: 32 MHz
Receipt Date	: 2012-12-11

2.2 General descriptions of EUT

This device fully compatible with the DSSS standard to provide a wireless data rate of 250kbps. For the detailed features, please refer to the manufacturer's specifications or User's Manual.

3. Test Standards

Test Standard : FCC PART 15 (2010)

This Standard sets out the regulations under which an intentional, unintentional, or incidental radiator may be operated without an individual license. It also contains the technical specifications, administrative requirements and other conditions relating to the marketing of Part 15 devices.

Test Method : ANSI C 63.4 (2003)

This standard sets forth uniform methods of measurement of radio-frequency (RF) signals and noise emitted from both unintentional and intentional emitters of RF energy in the frequency range 9 kHz to 40 GHz. Methods for the measurement of radiated and AC power-line conducted radio noise are covered and may be applied to any such equipment unless otherwise specified by individual equipment requirements. These methods cover measurement of certain devices that deliberately radiate energy, such as intentional emitters, but does not cover licensed transmitters. This standard is not intended for certification/approval of avionic equipment or for industrial, scientific, and medical (ISM) equipment. These methods apply to the measurement of individual units or systems comprised of multiple units.

Summary of Test Results

Applied Standard : 47 CFR Part 15, Subpart C				
Standard	Test Type	Result	Remark	Limit
15.207	AC Power Conducted Emission	N/A	Meet the requirement	
15.209	Radiated Emission	Pass	Meet the requirement	
15.247(a)(2)	Spectrum Bandwidth of a DSSS System	Pass	Meet the requirement	Min. 500 kHz
15.247(b)	Maximum Peak output power	Pass	Meet the requirement	Max. 30 dBm
15.247(c)	Transmitter Radiated Emission	Pass	Meet the requirement	Table 15.209
15.247(d)	Power Spectral Density	Pass	Meet the requirement	Max. 8 dBm
15.247(c)	Band Edge Measurement	Pass	Meet the requirement	20 dB less

4. Measurement Condition

4.1 EUT Operation(ZigBee)

a. Channel

Ch.	Frequency	Ch.	Frequency
12	2410 MHz	20	2450 MHz
13	2415 MHz	21	2455 MHz
14	2420 MHz	22	2460 MHz
15	2425 MHz	23	2465 MHz
16	2430 MHz	24	2470 MHz
17	2435 MHz	25	2475 MHz
18	2440 MHz	26	2480 MHz
19	2445 MHz		

b. Measurement Channel : ZigBee: Low(2410 MHz), Middle(2445 MHz),High(2480 MHz)

c. Test Mode : Continuous Output, DSSS

d. Test rate : the worst case of rate 250 kbps



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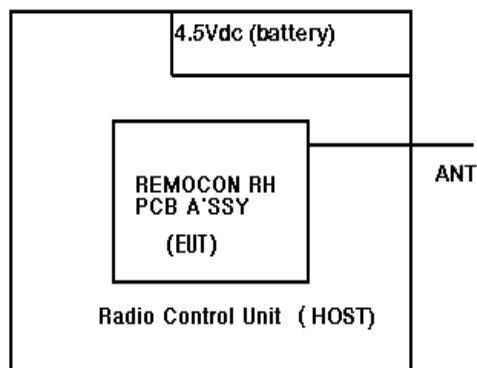


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4.2 EUT Operation.

- * The EUT was in the following operation mode during all testing
- * The operational conditions of the EUT was determined by the manufacturer according to the typical use of the EUT with respect to the expected highest level of emission
- * The EUT under transmission/receiving condition continuously at specific channel frequency.

4.3 Configuration and Peripherals



4.4 EUT and Support equipment

Equipment Name	Model Name	S/N	Manufacturer	Remark (FCC ID)
REMOCON RH PCB A'SSY	2.4GHZ-DSM	NONE	Precision RC Electronics Inc.	EUT
Radio Control Unit	CREST CRE 5700	NONE	Precision RC Electronics Inc.	Host for EUT

4.5 Cable Connecting

Start Equipment		End Equipment		Cable Standard		Remark
Name	I/O port	Name	I/O port	Length	Shielded	
REMOCON RH PCB A'SSY	Connector	Radio Control Unit	Connector	0	Unshielded	

5. 6 dB Bandwidth Measurement

5.1 Test procedure

The transmitter output was connected to the spectrum analyzer. The bandwidth of the fundamental frequency was measured by spectrum analyzer. The 6 dB bandwidth is defined as the bandwidth at 6 dB below from peak power point. The minimum of 6 dB bandwidth measurement is 0.5 MHz.

5.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

- . RBW= 30 kHz
- . VBW= 300 kHz
- . Span= 10 MHz
- . Sweep= suitable duration based on the EUT specification.

6dB Bandwidth Test Instruments

Description	Model	Serial Number	Cal. Due Date
Spectrum Analyzer	E4407B	US42041281	2013-08-17
RF Cable	Length: 20 cm	—	
—Spectrum Analyzer <=> EUT	Loss: 1.0 dB	—	

5.3 Measurement results

EUT	REMOCON RH PCB A'SSY	MODEL	2.4GHZ-DSM
MODE	DSSS	ENVIRONMENTAL CONDITION	24 °C, 44 % R.H.
INPUT POWER	4.5 V d.c.(battery)		

CHANNEL	Channel Frequency (MHz)	Bandwidth at 6dB below(MHz)	Minimum Limit (MHz)	PASS/FAIL
12	2410	1.69	0.5	PASS
19	2445	1.55	0.5	PASS
26	2480	1.54	0.5	PASS



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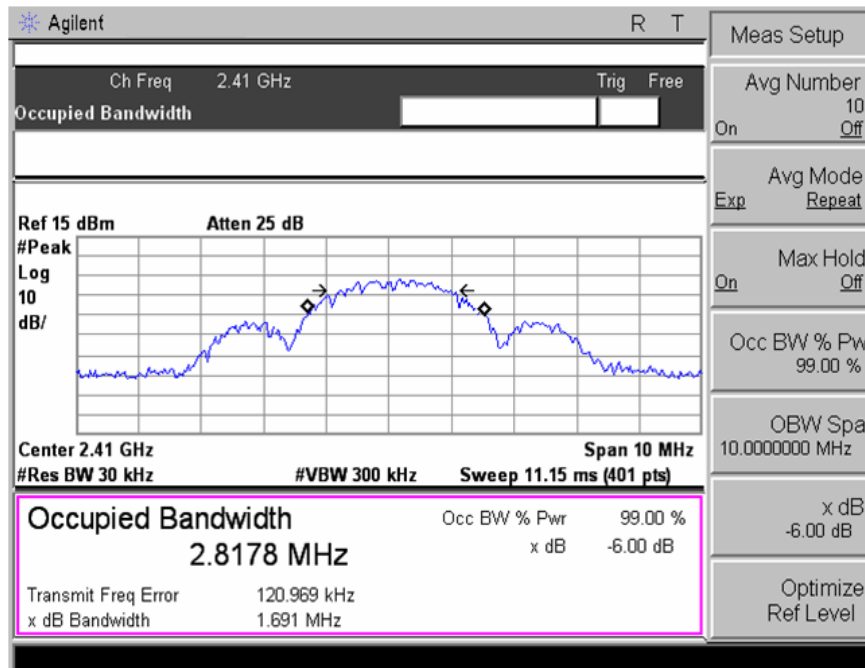
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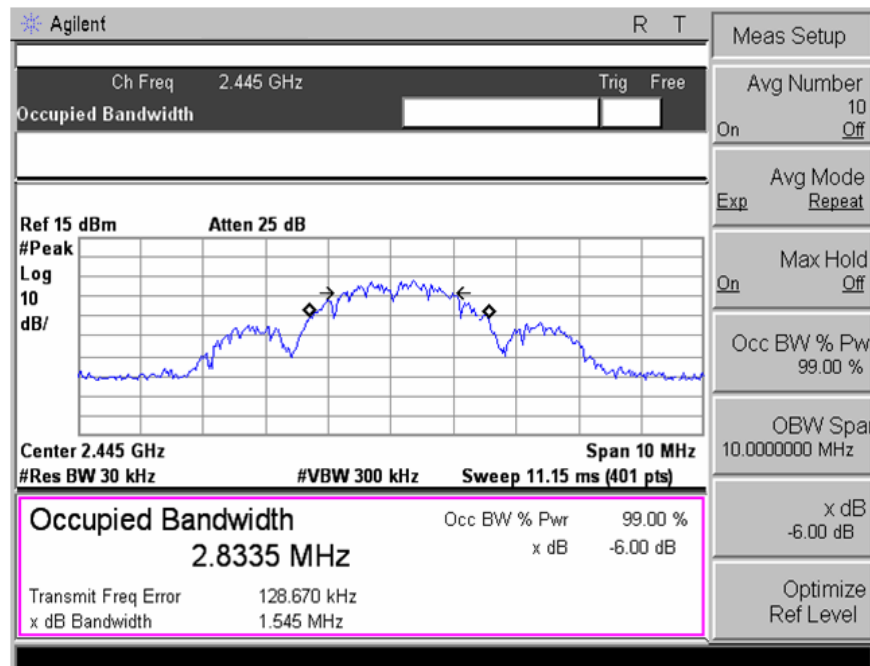
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5.4 Trace data

12 ch



19 ch





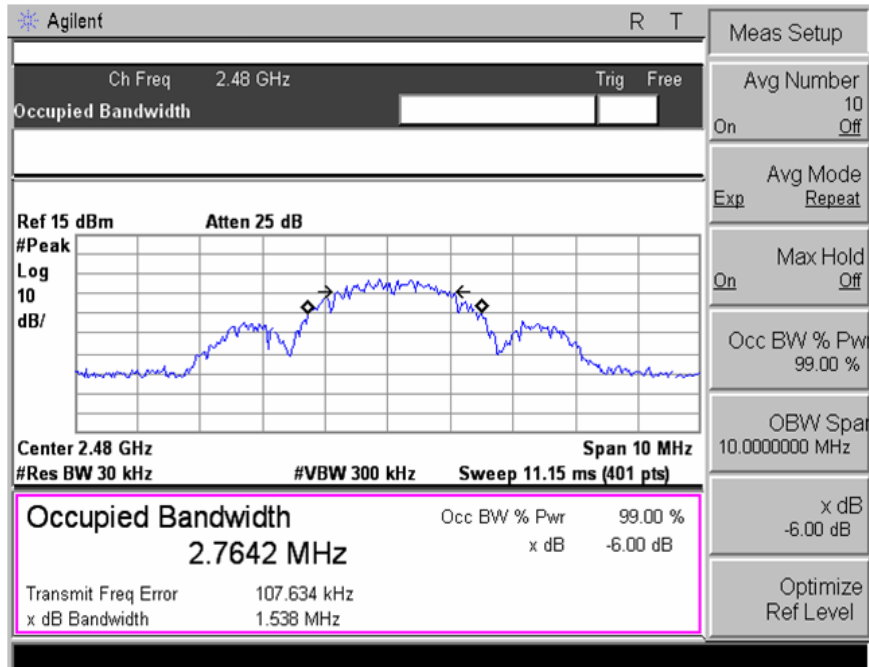
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6. MAXIMUM PEAK OUTPUT POWER

6.1 Test procedure

The transmitter antenna terminal is connected to the input of a RF power sensor. Measurement is made while EUT is operating in transmission mode at the appropriate center frequency. The maximum peak output power measurement is 30 dBm.

Maximum Peak Output Power Test Instruments

Description	Model	Serial Number	Cal. Due Date
Power Meter	EPM-442A	GB37170438	2013-01-26
Power Sensor	8481A	3318A96476	2013-01-26
RF Cable:	Length: 20 cm	—	
Spectrum Analyzer <=> EUT	Loss: 1.0 dB	—	

6.2 Measurement results

EUT	REMOCON RH PCB A'SSY	MODEL	2.4GHZ-DSM
MODE	DSSS	ENVIRONMENTAL CONDITION	24 °C, 43 % R.H.
INPUT POWER	4.5 V d.c.(battery)		

CHANNEL	Channel Frequency (MHz)	Peak Power Output(dBm)		Limit[1W] (dBm)	PASS/FAIL
		(dBm)	(W)		
12	2410	2.6	0.002	30.0	PASS
19	2445	2.3	0.002	30.0	PASS
26	2480	1.5	0.001	30.0	PASS

7. Transmitter power spectral density

7.1 Test procedure

The peak power density was measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency. The maximum of power spectral density measurement is 8 dBm.

7.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

- . RBW= 3 kHz
- . VBW= 30 kHz
- . Span= 1.5 MHz
- . Sweep= 500 seconds (It is allowed to be longer than span/3 kHz.)

The peak power density Test Instruments

Description	Model	Serial Number	Cal. Due Date
Spectrum Analyzer	E4407B	US42041281	2013-08-17
RF Cable	Length: 20 cm	—	
Spectrum Analyzer <=> EUT	Loss: 1.2 dB	—	

7.3 Measurement results

EUT	REMOCON RH PCB A'SSY	MODEL	2.4GHZ-DSM	
MODE	DSSS	ENVIRONMENTAL CONDITION	23 °C, 43 % R.H.	
INPUT POWER	4.5 V d.c.(battery)			
CHANNEL	Channel Frequency (MHz)	RF Power Spectral Density (dBm)	Maximum Limit (dBm)	PASS/FAIL
12	2410	-8.91	8.0	PASS
19	2445	-9.61	8.0	PASS
26	2480	-10.14	8.0	PASS



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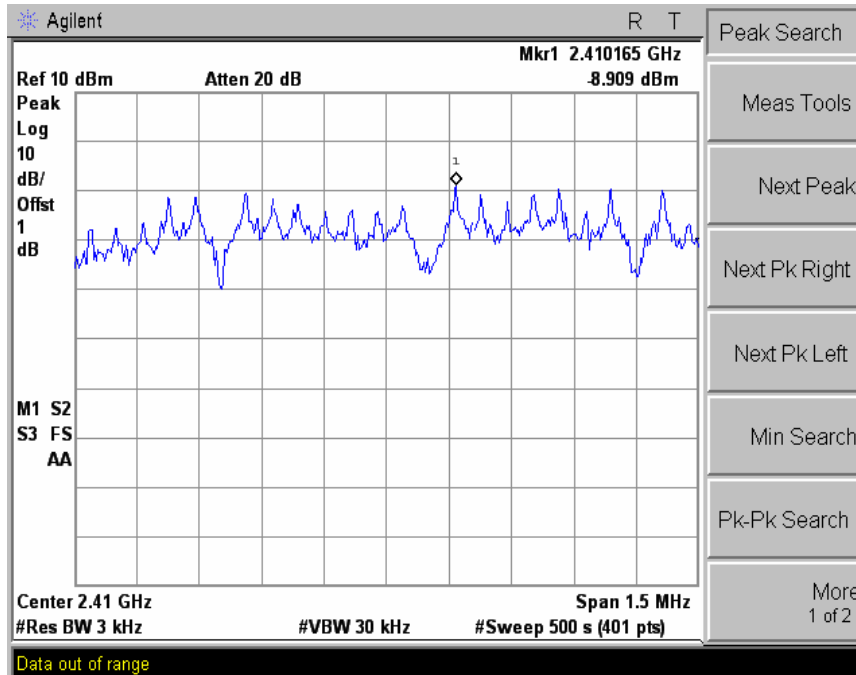
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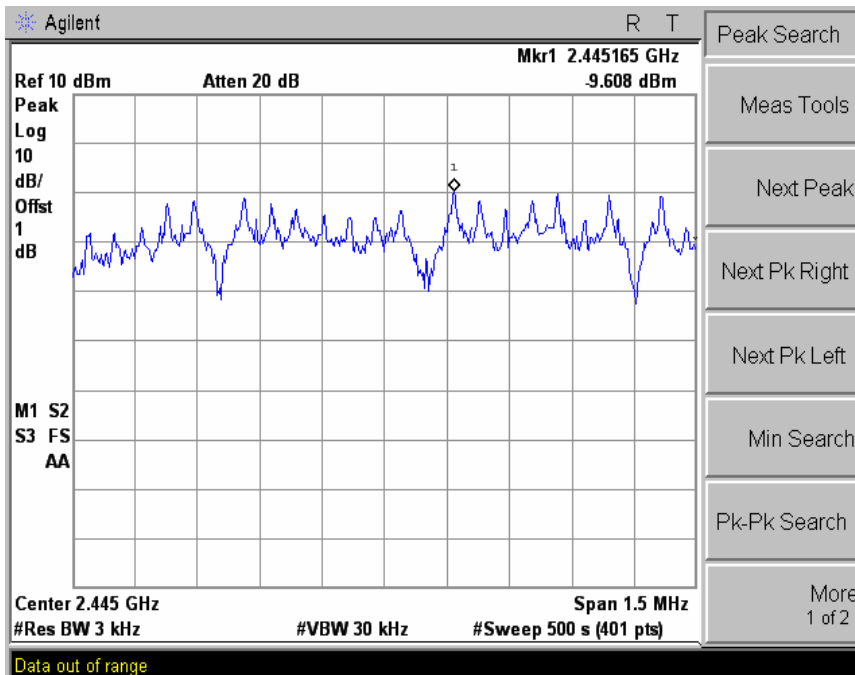
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7.4 Trace data

12 ch



19 ch





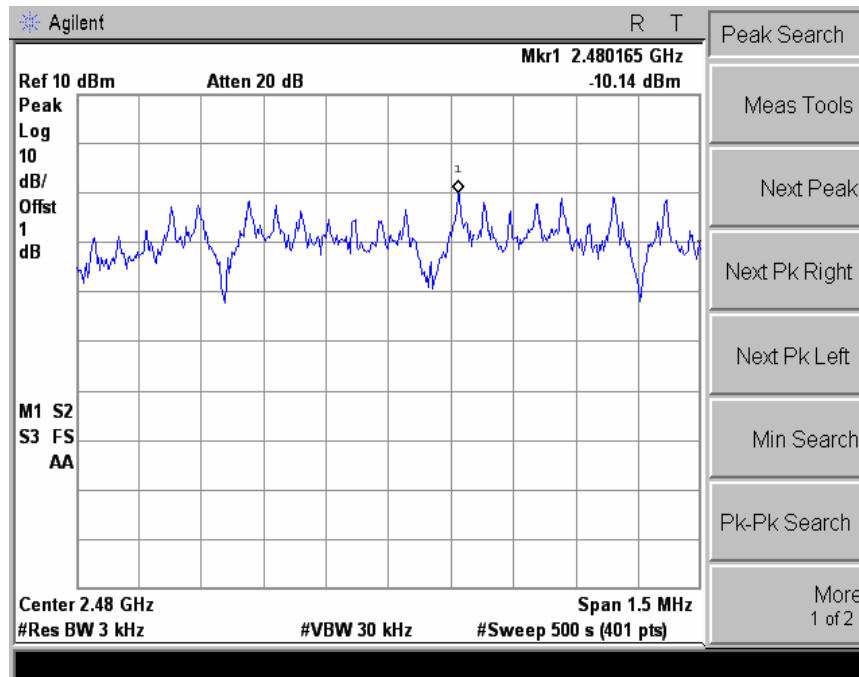
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8. band-edge and out of band emissions.

8.1 Test procedure

The radio frequency power at 20 dB down from the highest inband power level is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency. The band edge&out of band emission shall be at least 20 dB below of the highest inband power level.

8.2 Test instruments and measurement setup

The spectrum analyzer is set to as following.

- . RBW= 100 kHz
- . VBW= 100 kHz
- . Span= suitable frequency span
- . Sweep= suitable duration based on the EUT specification.

Band Edge&Out of Emission Test Instruments

Description	Model	Serial Number	Cal. Due Date
Spectrum Analyzer	E4407B	US42041281	2013-08-17
RF Cable	Length: 20 cm		—
Spectrum Analyzer <=> EUT	Loss: 1.0 dB		—

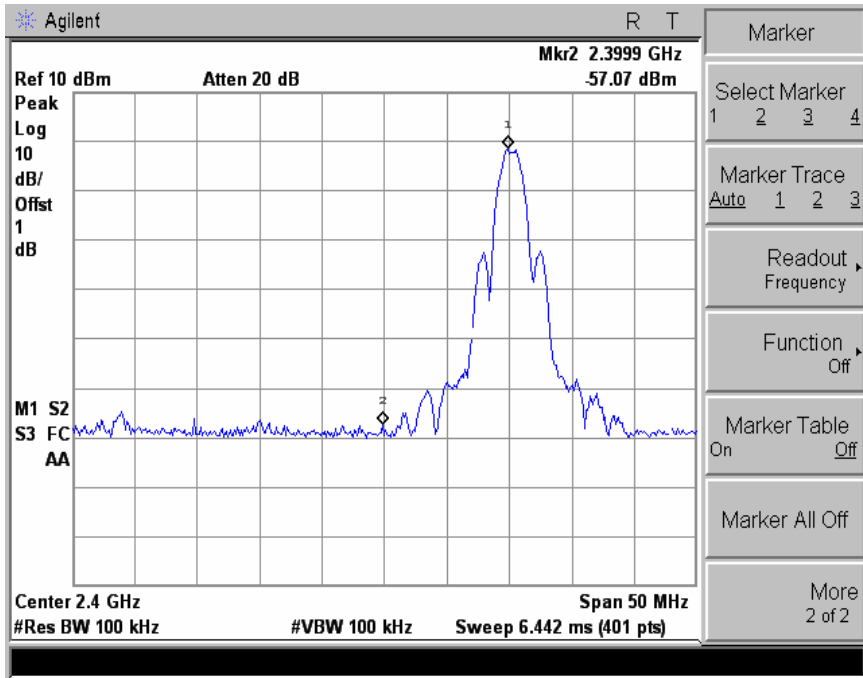
8.3 Measurement results of band-edge & out of emission

EUT	REMOCON RH PCB A'SSY	MODEL	2.4GHZ-DSM
MODE	DSSS	ENVIRONMENTAL CONDITION	23 °C , 43 % R.H.
INPUT POWER	4.5 V d.c.(battery)		

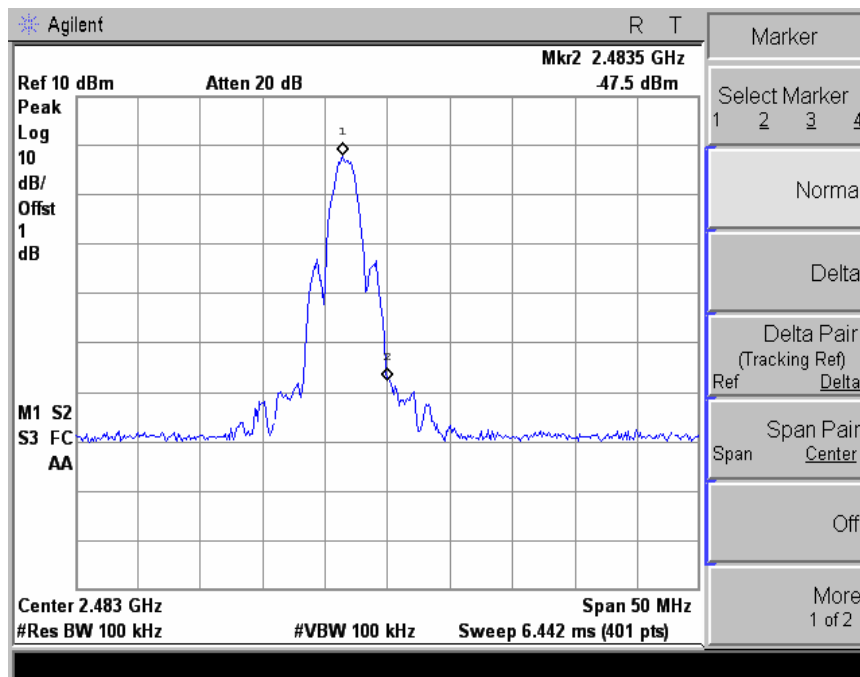
CHANNEL	Channel Frequency (MHz)	Measurement Frequency (MHz)	Peak Level at 20dB below(dBm)	Limit (MHz)
12	2410	2400.0	-57.07	Below 20dB from peak power level to band edge
26	2480	2483.8	-47.50	Below 20dB from peak power level to band edge

8.4 Trace data of band-edge & Out of Emission

12 ch



26 ch





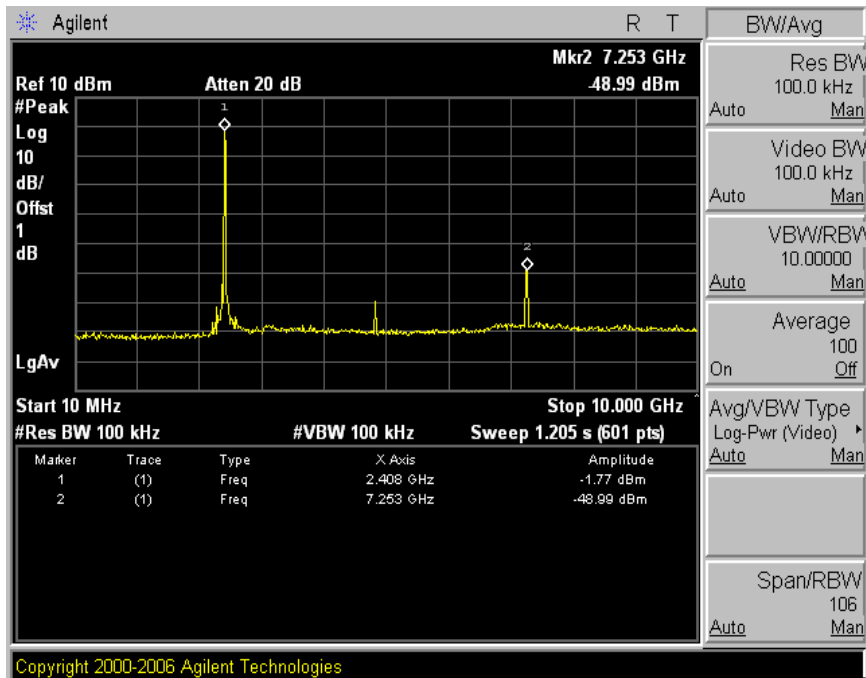
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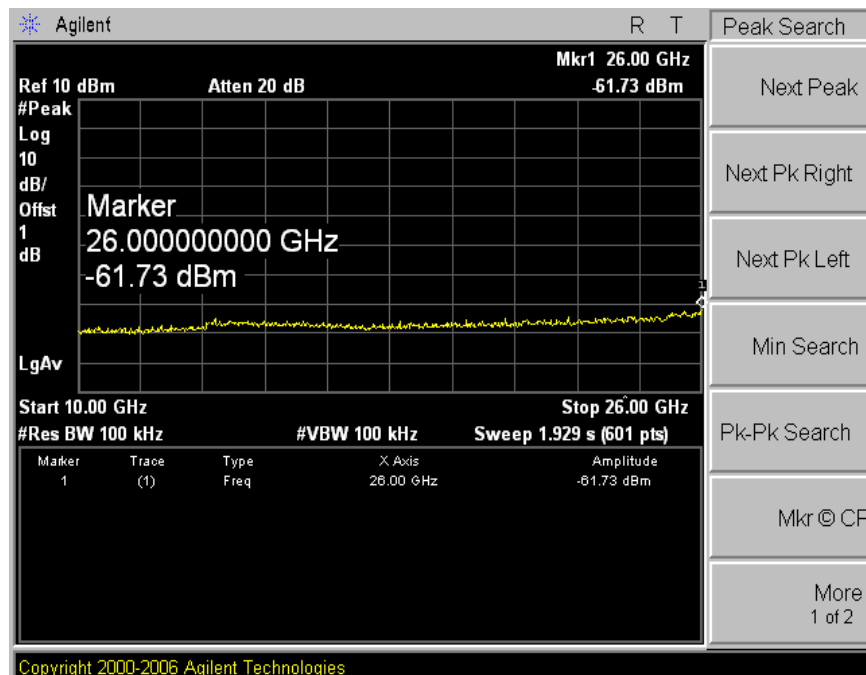


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12 ch



12 ch





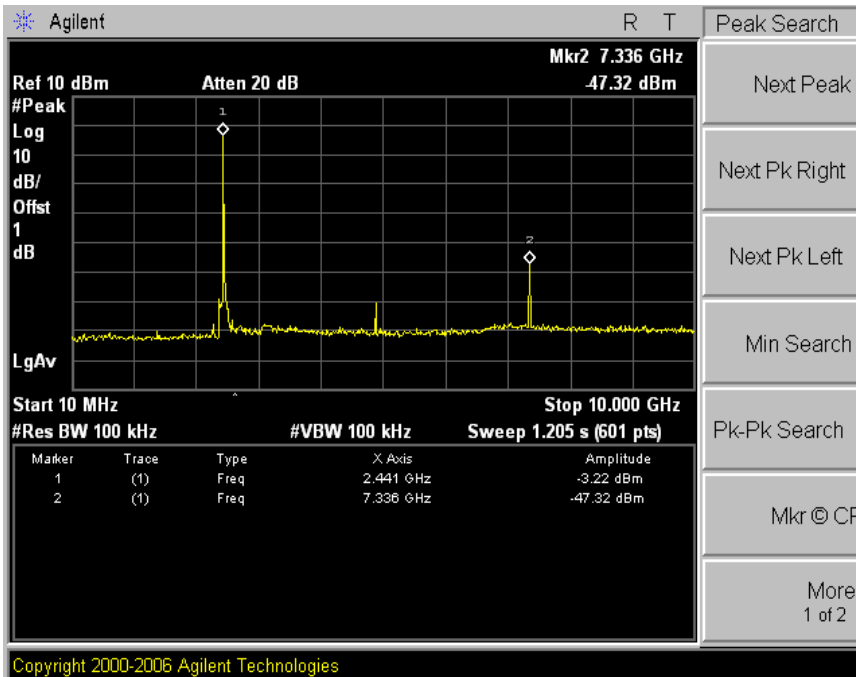
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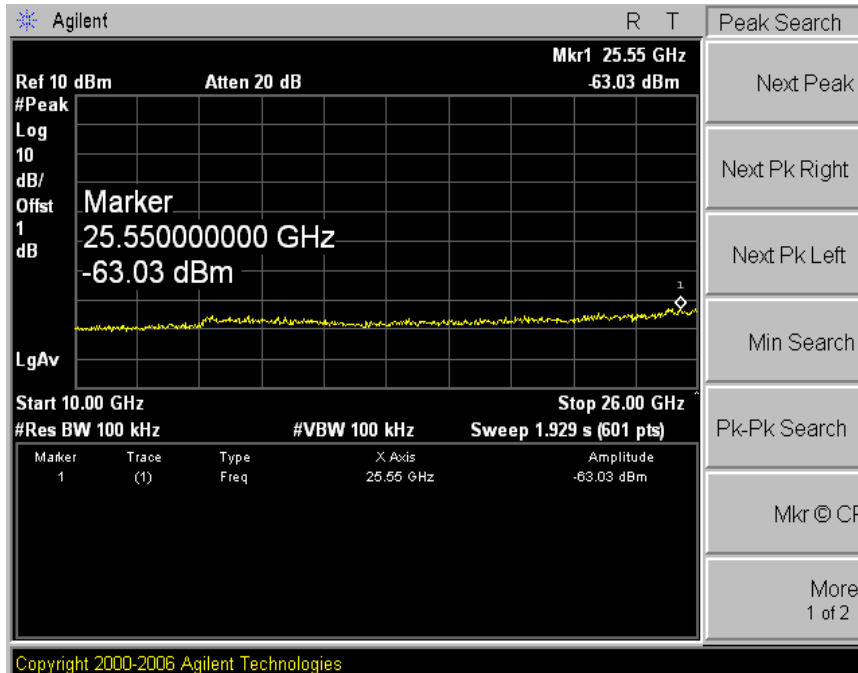


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19 ch



19 ch





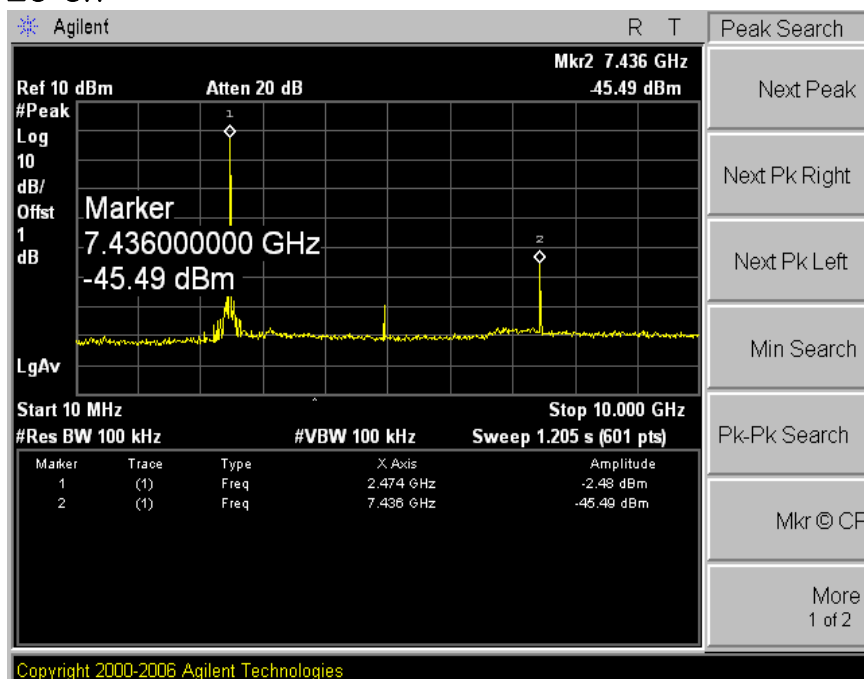
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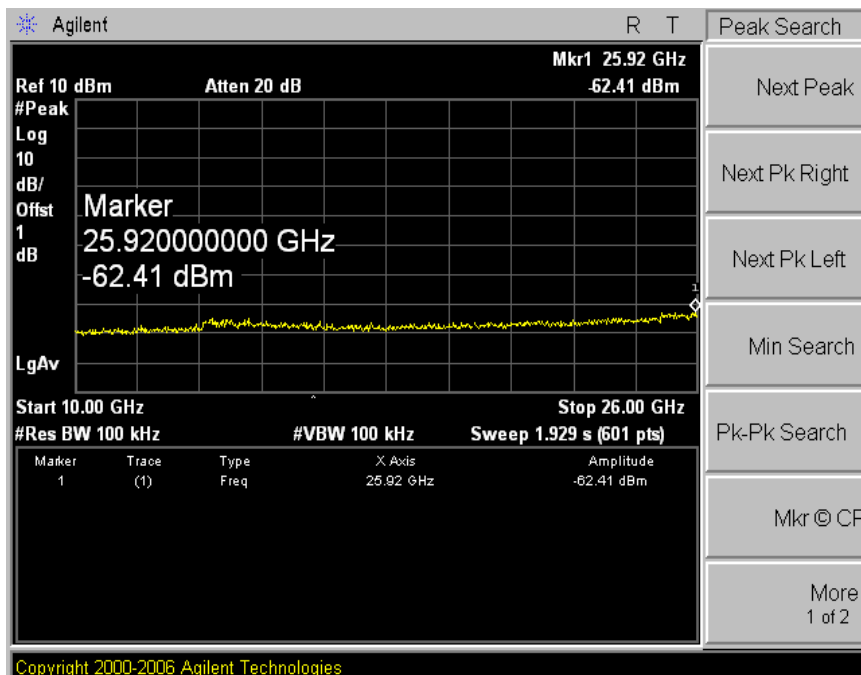


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26 ch



9. Measurement of radiated disturbance

Above 30 MHz Electric Field strength was measured in accordance with FCC PART 15 (2010). The test setup was made according to ANSI C 63.4 (2003) on an open test site, which allows a 3 m distance measurement. The EUT was placed in the center of wooden turntable. The height of this table was 0.8 m. The measurement was conducted with both horizontal and vertical antenna polarization. The turntable has fully rotated. For further description of the configuration refer to the picture of the test setup.

9.1 Measurement equipments

Equipment Name	Type	Manufacturer	Serial No.	Next Calibration date
TEST Receiver	ESCI7	ROHDE & SCHWARZ	1166.5950.07	28-Mar-13
Logbicon Antenna	VULB 9168	SCHWARZBECK	237	20-Jan-13
Turn Table	DT3000-2t	Innco System GmbH	N/A	-
Antenna Mast	MA4000-EP	Innco System GmbH	N/A	-
Antenna Master & Turn table controller	CO2000-P	Innco System GmbH	CO2000/641 /28051111/L	-
TEST Receiver	ESPI7	ROHDE & SCHWARZ	100185	25-Jan-13
PREAMPLIFIER	8449B	AGILENT	3008A00595	25-Jan-13
Horn Antenna	BBHA9120D	SCHWARZBECK	352	15-May-13
Pyramidal Horn Antenna	3160-09	ETS-LINDGREN	102642	22-Oct-13
Turn Table	DT1500-S	Innco System GmbH	N/A	-
Spectrum Analyzer	R3273	ADVANTEST	110600592	26-Jan-13
Antenna Mast	MA4000-EP	Innco System GmbH	N/A	-
Antenna Master & Turn table controller	CO2000-P	Innco System GmbH	CO2000/642 /28051111/L	-

9.2 Environmental Condition

Test Place : 10 m Semi-anechoic chamber

Below 1 GHz

Temperature (°C) : 23 °C

Humidity (% R.H.) : 49 % R.H.

Test Place : 3 m Semi-anechoic chamber(3 m)

Above 1 GHz

Temperature (°C) : 22 °C

Humidity (% R.H.) : 49 % R.H.

9.3 Test data (Below 1 GHz)

Test Date : 16-Dec-12

Measurement Distance : 3 m

Frequency (MHz)	Reading (dB μ V)	Position (V/H)	Height (m)	Correction Factor		Result Value(Quasi-peak)		
				Ant Factor (dB)	Cable (dB)	Limit (dB μ V/m)	Result (dB μ V/m)	Margin (dB)
48.00	4.89	V	1.0	12.65	1.06	40.00	18.60	21.40
72.00	5.12	H	2.1	10.67	1.24	40.00	17.03	22.97
75.30	6.33	V	1.0	10.07	1.31	40.00	17.70	22.30
81.10	10.46	V	1.0	9.04	1.40	40.00	20.90	19.10
100.00	7.96	H	1.6	8.10	1.60	43.50	17.66	25.84
215.10	6.68	V	1.0	9.72	2.20	43.50	18.60	24.90
608.00	4.64	V	1.0	19.83	3.80	46.00	28.27	17.73
672.00	5.92	V	1.0	20.39	4.00	46.00	30.31	15.69
Remark	H : Horizontal, V : Vertical *Checked in all 3 axis and the maximum measured data were reported. *Result Value = Reading + Antenna + Cable loss *Correction Factor = Ant Factor + Cable *The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection							

9.3-1 Test data (CH 12)

Test Date : 16-Dec-12

Measurement Distance : 3 m

Frequency (MHz)	Reading (dB μ V)	Position (V/H)	Height (m)	Correction Factor		Result Value		
				Ant Factor (dB)	Cable (dB)	Limit (dB μ V/m)	Result (dB μ V/m)	Margin (dB)
Peak(RBW:1 MHz VBW:1 MHz)								
2389.20	23.30	H	1.0	26.69	5.00	74.00	54.99	19.01
2410.00	51.63	H	1.0	26.76	5.00	OB	83.39	–
4820.00	50.17	H	1.0	31.39	–22.75	74.00	58.81	15.19
2389.20	24.16	V	1.0	26.69	5.00	74.00	55.85	18.15
2410.00	45.24	V	1.0	26.76	5.00	OB	77.00	–
4820.00	50.87	V	1.0	31.39	–22.75	74.00	59.51	14.49
Average(RBW:1 MHz VBW:100 Hz)								
2389.20	11.12	H	1.0	26.69	5.00	54.00	42.81	11.19
2410.00	40.67	H	1.0	26.76	5.00	OB	72.43	–
4820.00	40.82	H	1.0	31.39	–22.75	54.00	49.46	4.54
2389.20	11.10	V	1.0	26.69	5.00	54.00	42.79	11.21
2410.00	36.63	V	1.0	26.76	5.00	OB	68.39	–
4820.00	42.84	V	1.0	31.39	–22.75	54.00	51.48	2.52
Remark	H : Horizontal, V : Vertical *Reading = receiver reading + Amplifier Gain *CL = Cable Loss–Amplifier Gain *The resolution bandwidth and video bandwidth of spectrum analyzer is 1 MHz And 100 Hz for average detection at frequency above 1 GHz. *TEST MODE : ZigBee–CH12(2410 MHz) *The TX signal isn't detected from 3th harmonics. *OB = Operating band *Checked in all 3 axis and the maximum measured data were reported.							

9.3-2 Test data (CH 19)

Test Date : 16-Dec-12

Measurement Distance : 3 m

Frequency (MHz)	Reading (dB μ V)	Position (V/H)	Height (m)	Correction Factor		Result Value		
				Ant Factor (dB)	Cable (dB)	Limit (dB μ V/m)	Result (dB μ V/m)	Margin (dB)
Peak(RBW:1 MHz VBW:1 MHz)								
2445.00	50.97	H	1.0	26.86	5.00	OB	82.83	–
4890.00	50.12	H	1.0	31.51	–22.49	74.00	59.14	14.86
2445.00	44.96	V	1.0	26.86	5.00	OB	76.82	–
4890.00	50.91	V	1.0	31.51	–22.49	74.00	59.93	14.07
Average(RBW:1 MHz VBW:100 Hz)								
2445.00	40.17	H	1.0	26.86	5.00	OB	72.03	–
4890.00	40.62	H	1.0	31.51	–22.49	54.00	49.64	4.36
2445.00	35.18	V	1.0	26.86	5.00	OB	67.04	–
4890.00	42.18	V	1.0	31.51	–22.49	54.00	51.20	2.80
Remark	H : Horizontal, V : Vertical *Reading = receiver reading + Amplifier Gain *CL = Cable Loss–Amplifier Gain *The resolution bandwidth and video bandwidth of spectrum analyzer is 1 MHz And 100 Hz for average detection at frequency above 1 GHz. *TEST MODE : ZigBee–CH19(2445 MHz) *The TX signal isn't detected from 3th harmonics. *OB = Operating band *Checked in all 3 axis and the maximum measured data were reported.							

9.3-3 Test data (CH 26)

Test Date : 16-Dec-12

Measurement Distance : 3 m

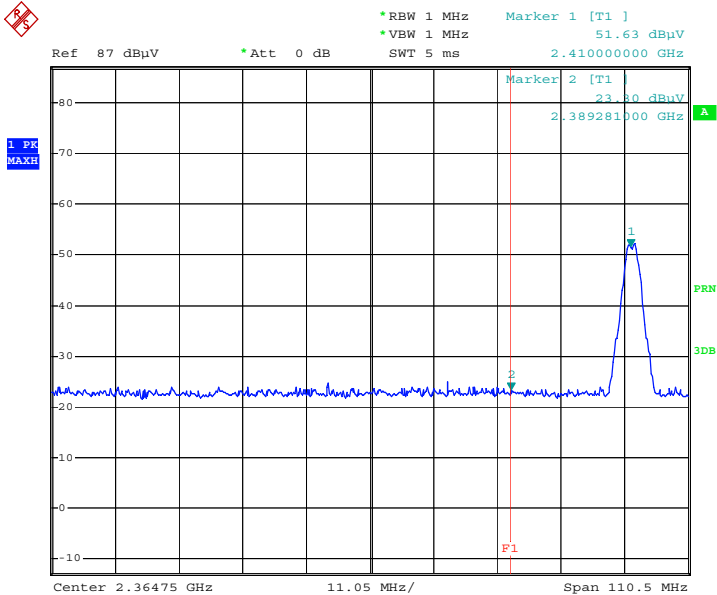
Frequency (MHz)	Reading (dB μ V)	Position (V/H)	Height (m)	Correction Factor		Result Value		
				Ant Factor (dB)	Cable (dB)	Limit (dB μ V/m)	Result (dB μ V/m)	Margin (dB)
Peak(RBW:1 MHz VBW:1 MHz)								
2480.00	50.75	H	1.0	26.97	5.00	OB	82.72	–
2483.60	27.13	H	1.0	26.98	5.00	74.00	59.11	14.89
4960.00	49.17	H	1.0	31.63	–22.25	74.00	58.55	15.45
2480.00	43.65	V	1.0	26.97	5.00	OB	75.62	–
2483.60	22.68	V	1.0	26.98	5.00	74.00	54.66	19.34
4960.00	49.98	V	1.0	31.63	–22.25	74.00	59.36	14.64
Average(RBW:1 MHz VBW:100 Hz)								
2480.00	39.35	H	1.0	26.97	5.00	OB	71.32	–
2483.60	14.45	H	1.0	26.98	5.00	54.00	46.43	7.57
4960.00	39.98	H	1.0	31.63	–22.25	54.00	49.36	4.64
2480.00	34.92	V	1.0	26.97	5.00	OB	66.89	–
2483.60	12.51	V	1.0	26.98	5.00	54.00	44.49	9.51
4960.00	42.66	V	1.0	31.63	–22.25	54.00	52.04	1.96
Remark	H : Horizontal, V : Vertical *Reading = receiver reading + Amplifier Gain *CL = Cable Loss–Amplifier Gain *The resolution bandwidth and video bandwidth of spectrum analyzer is 1 MHz And 10 Hz for average detection at frequency above 1 GHz. *TEST MODE : ZigBee–CH 26(2480 MHz) *The TX signal isn't detected from 3th harmonics. *OB = Operating band *Checked in all 3 axis and the maximum measured data were reported.							

9.3-4 Restricted Band Edges

Band Edges(CH Low)

Detector mode:Peak

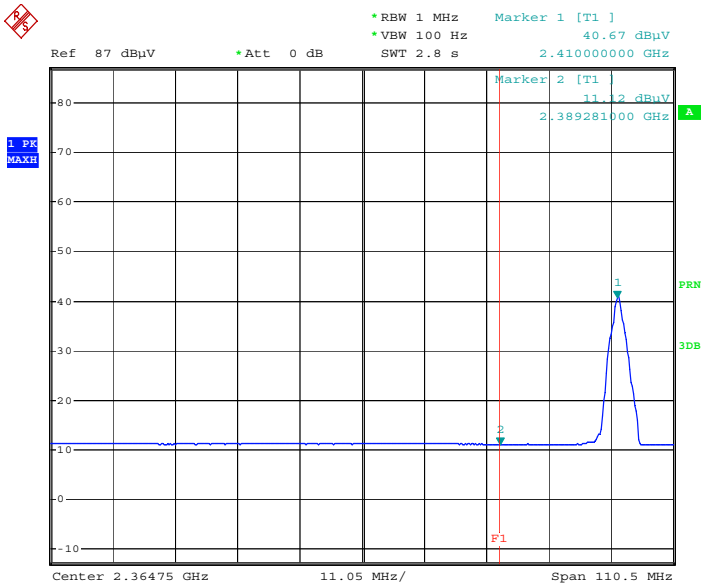
Polarity:Horizontal



Comment: CREST CRE 5700 TX PK 2410 HOR

Detector mode:Average

Polarity:Horizontal



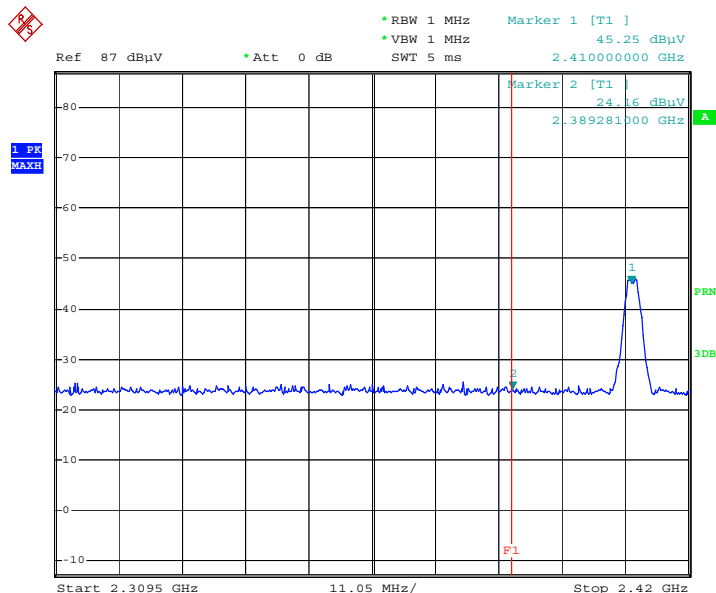
Comment: CREST CRE 5700 TX AV 2410 HOR

Electromagnetic Interference Test Report

Band Edges(CH Low)

Detector mode:Peak

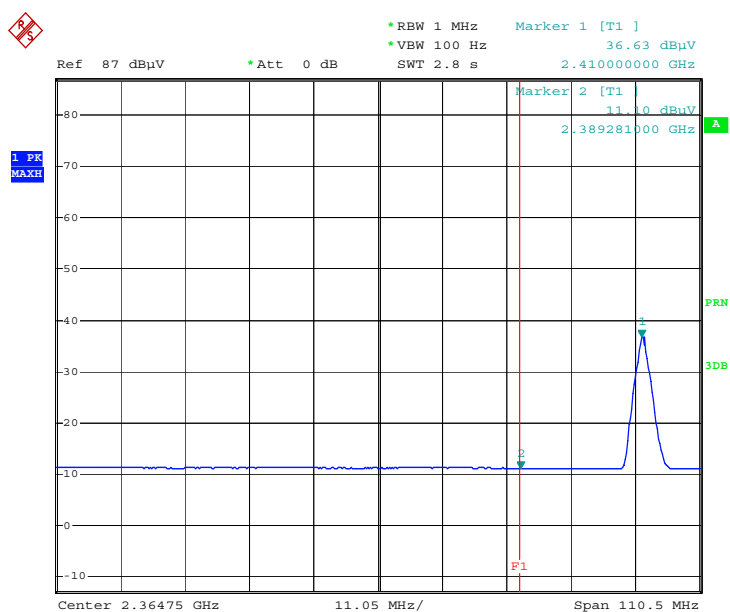
Polarity:Vertical



Comment: CREST CRE 5700 TX PK 2410 VER

Detector mode:Average

Polarity:Vertical

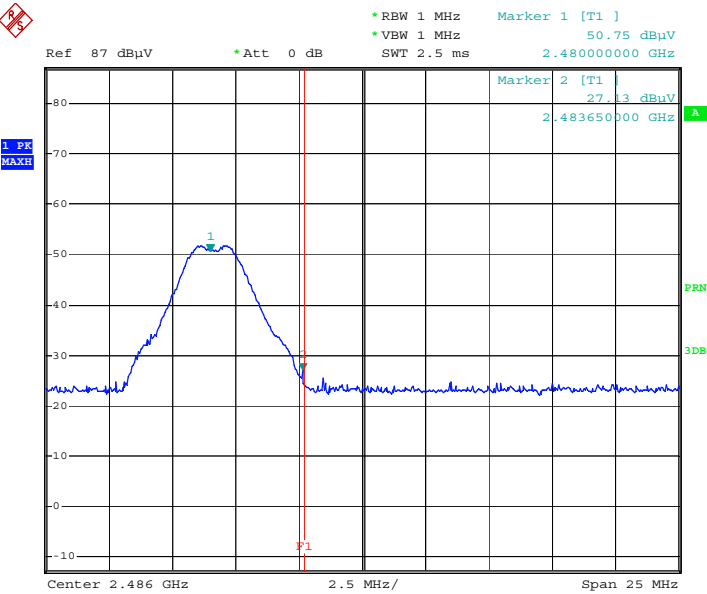


Comment: CREST CRE 5700 TX AV 2410 VER

Band Edges(CH High)

Detector mode:Peak

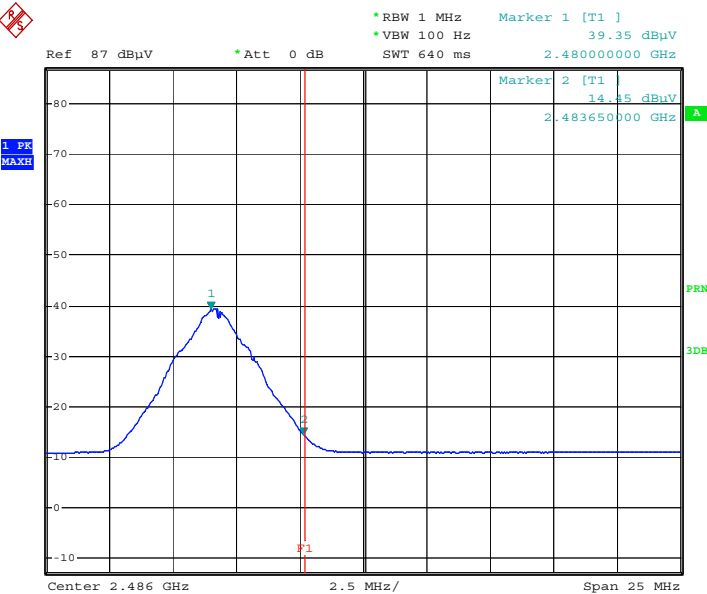
Polarity:Horizontal



Comment: CREST CRE 5700 TX PK 2480 HOR

Detector mode:Average

Polarity:Horizontal

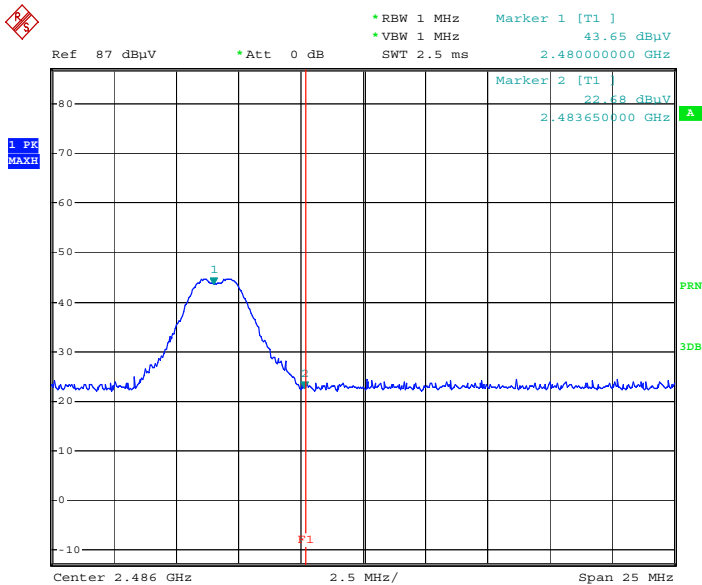


Comment: CREST CRE 5700 TX AV 2480 HOR

Band Edges(CH High)

Detector mode:Peak

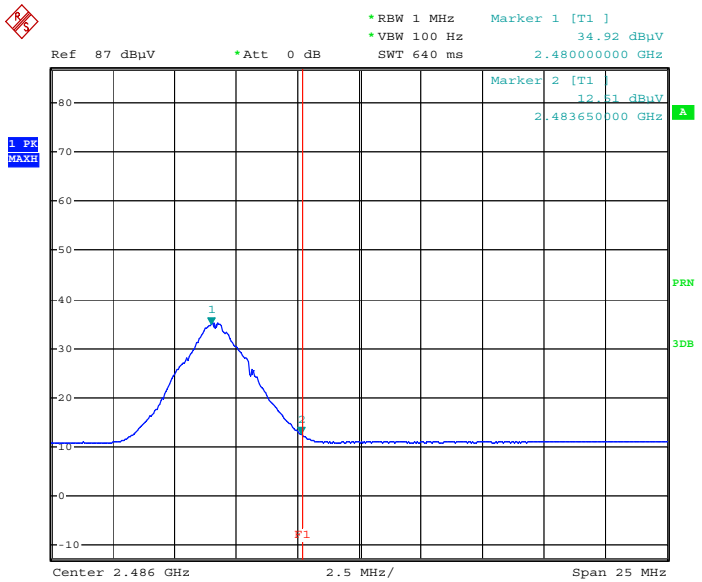
Polarity:Vertical



Comment: CREST CRE 5700 TX PK 2480 VER

Detector mode:Average

Polarity:Vertical



Comment: CREST CRE 5700 TX AV 2480 VER

10. Measurement of conducted disturbance

The continuous disturbance voltage of AC Mains in the frequency from 0.15 MHz to 30 MHz was measured in accordance to FCC PART 15 (2010). The test setup was made according to ANSI C 63.4 (2003) in a shielded room. The EUT was placed on a non-conductive table at least 0.8 m above the ground plan. A grounded vertical reference plane was positioned in a distance of 0.4 m from the EUT. The distance from the EUT to other metal surfaces was at least 0.8 m. The EUT was only earthen by its power cord through the line impedance stabilizing network. The power cord has been bundled to a length of 1.0 m. The test receiver with Quasi Peak detector complies with CISPR 16.

10.1 Measurement equipments

Equipment Name	Type	Manufacturer	Serial No.	Next Calibration date
TEST Receiver	ESHS 30	Rohde & Schwarz	828765/002	14-Dec-13
LISN	ENV 216	Rohde & Schwarz	101231	19-Sep-13
LISN	ESH3-Z5	Rohde & Schwarz	838979/010	26-Jan-13
Pulse Limiter	ESH3Z2	Rohde & Schwarz	NONE	25-Jan-13

10.2 Environmental Condition

Test Place : Shield Room

Temperature (°C) : °C

Humidity (%) : %

10.3 Test data-N/A

Test Date :

Frequency (MHz)	Correction Factor		Line (H/N)	Quasi-peak Value			Average Value		
	Lisn (dB)	Cable (dB)		Limit (dB μ V)	Reading (dB μ V)	Result (dB μ V)	Limit (dB μ V)	Reading (dB μ V)	Result (dB)
Remark	H : Hot Line, N : Neutral Line *Correction Factor = Lisn + Cable *Result = Correction Factor + Reading								