

Produkte
Products

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<i>Test Report No.:</i>			
Auftraggeber: Mitsubishi Electric Corporation			
<i>Client:</i> 6-5-66, Tebira, Wakayama-shi, Wakayama 640-8686, Japan			
Gegenstand der Prüfung: Remote Controller for Package Air Conditioner			
<i>Test Item:</i>			
Bezeichnung: PAR-CT01MAU-SB		Serien-Nr.: Refer to section 4.3	
<i>Identification:</i>		<i>Serial No.:</i>	
Wareneingangs-Nr.: A000525205-001 to -005		Eingangsdatum: 2017-04-06	
<i>Receipt No.:</i>		<i>Date of Receipt:</i>	
Zustand des Prüfgegenstandes bei Anlieferung: Good			
<i>Condition of Test Item at Delivery:</i>			
Prüfört: TÜV Rheinland Japan Ltd. – Global Technology Assessment Center			
<i>Testing Location:</i> 4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan			
Prüfgrundlage: FCC 47 CFR Part 15, Subpart C, Section 15.247 (October 1, 2015)			
<i>Test Specification:</i> RSS-247 (Issue 1): 2015 RSS-Gen (Issue 4): 2014 ANSI C63.10-2013 KDB Publication No. 558074 D01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (v04)			
Prüfergebnis: Der Prüfgegenstand entspricht oben genannter Prüfgrundlage(n).			
<i>Test Result:</i> The test item passed the test specification(s).			
Prüflaboratorium: TÜV Rheinland Japan Ltd. – Global Technology Assessment Center			
<i>Testing Laboratory:</i> 4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan			
geprüft/ tested by:		kontrolliert/ reviewed by:	
			
2017-05-16 A. Abe / Inspector		2017-05-16 R. Meiranke / Reviewer	
Datum <i>Date</i>	Name/Stellung <i>Name/Position</i>	Unterschrift <i>Signature</i>	Datum <i>Date</i>
		Name/Stellung <i>Name/Position</i>	Unterschrift <i>Signature</i>
Sonstiges / Other Aspects:			
Abkürzungen: P(ass) = entspricht Prüfgrundlage F(ail) = entspricht nicht Prüfgrundlage N/A = nicht anwendbar N/T = nicht getestet		Abbreviations: P(ass) = passed F(ail) = failed N/A = not applicable N/T = not tested	
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.			
<i>This test report relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any safety mark on this or similar products.</i>			

TEST SUMMARY

5.1.1 SUPPLY VOLTAGE REQUIREMENTS

RESULT: PASS

5.1.2 ANTENNA REQUIREMENTS

RESULT: PASS

5.1.3 RESTRICTED BANDS OF OPERATION

RESULT: PASS

5.2.1 CONDUCTED OUTPUT POWER

RESULT: PASS

5.2.2 CONDUCTED SPURIOUS EMISSIONS

RESULT: PASS

5.2.3 PEAK POWER SPECTRAL DENSITY

RESULT: PASS

5.3.1 6dB BANDWIDTH

RESULT: PASS

5.3.2 99% BANDWIDTH

5.3.3 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER

RESULT: PASS

5.4.1 AC POWER LINE CONDUCTED EMISSION OF TRANSMITTER

RESULT: PASS

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1. General Remarks

1.1 Complementary Materials

There is no attachment to this test report.

2. Test Sites

2.1 Test Facilities

TÜV Rheinland Japan Ltd. – Global Technology Assessment Center
4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan

The used test equipment is in accordance with CISPR 16 for measurement of radio interference.

The Federal Communications Commission has reviewed the technical characteristics of the radiated and conducted emission facilities and has found these test sites to be in compliance with the requirements of section 2.948 of the FCC rules. The description of the test facility is listed under FCC registration number 299054.

Innovation, Science and Economic Development Canada has reviewed the technical characteristics of the radiated and conducted emission facilities and has found these test sites to be in compliance with Canadian requirements. The description of the test facility is listed under OATS filing number 3466B-1.

The test facility is accredited by VLAC (member of ILAC) under number VLAC-017 according to ISO/IEC 17025:2005.



TÜV Rheinland Japan Ltd. is accredited by the Federal Communications Commission as a Conformity Assessment Body under Designation Number JP0017 and Test Firm Registration Number 386498.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Serial Number	Equip. ID	Cal. Interval	Cal. Date	Next Cal.
For Antenna Port Conducted Emission							
Receiver	Rohde & Schwarz	ESU 40	100029	RF-0021	1 year	2016-08-31	2017-08-31
For AC Power Line Conducted Emission							
Conducted Emission Measurement Software	Toyo Corporation	EP5/CE	Ver. 5.0.20	RF-0025	1 year	2017-03-31	2018-03-31
Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	1 year	2016-07-30	2017-07-30
LISN	Rohde & Schwarz	ENV216	100276	RF-0016	1 year	2016-05-27	2017-05-27
For Radiated Emission							
Radiated Emission Measurement Soft-ware (below 30MHz)	Toyo Corporation	EP5/ME	Ver. 5.0.10	RF-0172	1 year	2017-03-31	2018-03-31
Radiated Emission Measurement Soft-ware (above 30MHz)	Toyo Corporation	EP7/RE	Ver. 5.0.2	RF-0026	1 year	2017-03-31	2018-03-31
Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	1 year	2016-07-30	2017-07-30
Receiver	Rohde & Schwarz	ESU 40	100029	RF-0021	1 year	2016-08-31	2017-08-31
RF Selector (10m Chamber)	Toyo Corporation	NS4900	0703-182	RF-0029	1 year	2017-03-31	2018-03-31
Loop Antenna with Amplifier, 9kHz-30MHz	Rohde & Schwarz	HFH2-Z2	100139	RF-0048	1 year	2016-06-03	2017-06-03
Trilog Antenna No. 2, 30-1000MHz	Schwarzbeck	VULB 9168	9168-475	RF-0462	1 year	2017-04-04	2018-04-04
5dB Attenuator	Pasternack	PE7047-5	-	RF-0731	1 year	2017-03-01	2018-03-01
Low Noise Preamplifier, 9kHz-1GHz	TSJ	MLA-10K01-B01-35	1370750	RF-0253	1 year	2017-01-18	2018-01-18
Low Pass Filter, DC-1GHz	R&K	LP1000CH 3	12104001	RF-0515	1 year	2017-01-18	2018-01-18
Horn Antenna, 1-8GHz	Schwarzbeck	BBHA 9120 D	1059	RF-0553	1 year	2016-06-03	2017-06-03
Microwave Preamplifier, 1-8GHz	Toyo Corporation	TPA0108-40	0634	RF-0052	1 year	2017-01-25	2018-01-25
Band Reject Filter, 1-8GHz	Nitsuki	NF-49BT	027	RF-0131	1 year	2017-01-26	2018-01-26
Horn Antenna with Preamplifier, 8-18GHz	Toyo Corporation	HAP06-18W	00000025	RF-0065	1 year	2016-06-03	2017-06-03

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Kind of Equipment	Manufacturer	Model Name	Serial Number	Equip. ID	Cal. Interval	Cal. Date	Next Cal.
High Pass Filter, 8-18GHz	Micro-Tronics	HPM50107	006	RF-0334	1 year	2016-07-01	2017-07-01
Horn Antenna with Preamplifier, 18-26.5GHz	Toyo Corporation	HAP18-26N	00000010	RF-0070	1 year	2016-06-03	2017-06-03
Constant Voltage Constant Frequency Stabilizers and Power Accessories							
CVCF (Shielded Room)	NF Corporation	ES2000S	9075612	RF-0210	1 year	2017-03-21	2018-03-21
CVCF Booster (Shielded Room)	NF Corporation	ES2000B	9074403	RF-0211	1 year	2017-03-21	2018-03-21
CVCF (10m Chamber)	NF Corporation	ES2000U	9067307	RF-0212	1 year	2017-03-21	2018-03-21
CVCF Booster (10m Chamber)	NF Corporation	ES2000B	9074408	RF-0213	1 year	2017-03-21	2018-03-21
DC Power Supply	Agilent	E3646A	MY50350007	RF-0412	N/A	N/A	N/A
True RMS Multimeter	Fluke	87V	97680445	RF-0281	1 year	2017-02-02	2018-02-02

Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025:2005 has been confirmed before testing.

2.3 Measurement Uncertainty

Table 2: Emission Measurement Uncertainty

Measurement Type	Frequency	Uncertainty
AC Power Line Conducted Emission	150kHz - 30MHz	±2.0dB
Antenna Port Conducted Emission	20Hz - 40GHz	±1.5dB
Radiated Emission	150kHz - 30MHz	±4.7dB
	30MHz - 1GHz	±4.7dB
	> 1GHz	±4.7dB

3. General Product Information

3.1 Product Function and Intended Use

The EUT (**E**quipment **U**nder **T**est) is a wall mounted type wired remote controller with a BLE (**B**luetooth **L**ow **E**nergy) module. The EUT is intended to be used with thier package Air Conditioner Systems for office, factory, commercial facility etc. A wireless device such as smart phone can remotely access and control an air conditioner via BLE wireless communication.

This module was newly designed by the customer. Therefore, all radio testing was conducted at the final product.

Note:

Minimum separation distance among the EUT and an end user and/or bystanders is expected to be more than 20cm. However, corresponded RF exposure evaluation is performed as portable equipment.

3.2 System Details

Specified output power:	-0.1dBm (conducted peak)
Antenna gain:	+1.6dBi
Antenna type:	Single chip antenna
Antenna mounting type:	Internal (mounted on PCB)
Frequency range:	2402-2480MHz
Number of channels:	40 ($f = 2402\text{MHz} + k \cdot 2\text{MHz}$, where $k=0, 1, \dots, 39$)
Channel spacing:	2MHz
Modulation type:	GFSK

FCC classification:	DTS
IC classification:	Bluetooth Device
Emission designator:	1M06F1D (See section 5.3.2, 99% bandwidth)

Rated voltage:	DC 12.0V
Rated current:	Max. 1.5mA
Protection class:	III

Test voltage:	DC 12.0V
Test voltage and frequency:	AC 120V, 60Hz for Conducted Emission

Duty cycle for radio testing: 100%

3.3 Clock Frequencies

The highest frequency generated or used by the EUT is 32MHz for the digital interface.

3.4 Noise Suppressing Parts

Refer to schematics.

4. Test Set-up and Operation Modes

4.1 Test Methodology

The test methodology used is based on the requirements of 47 CFR Part 15, Sections 15.31, 15.33, 15.35, 15.205, 15.207, 15.209, 15.247 and KDB Publication No. 558074 D01.

The test methods, which have been used, are based on ANSI C63.10 and RSS-Gen. For details, see under each test item.

4.2 Operation Modes

Testing was performed at the lowest operating frequency (2402MHz), at the operating frequency in the middle of the specified frequency band (2442MHz) and at the highest operating frequency (2480MHz).

The basic operation modes used for testing are:

- A. EUT transmits (TX mode), with full power, at lowest channel (2402MHz), a continuous modulated signal streaming with 100% duty cycle.
- B. EUT transmits (TX mode), with full power, at middle channel (2442MHz), a continuous modulated signal streaming with 100% duty cycle.
- C. EUT transmits (TX mode), with full power, at highest channel (2480MHz), a continuous modulated signal streaming with 100% duty cycle.

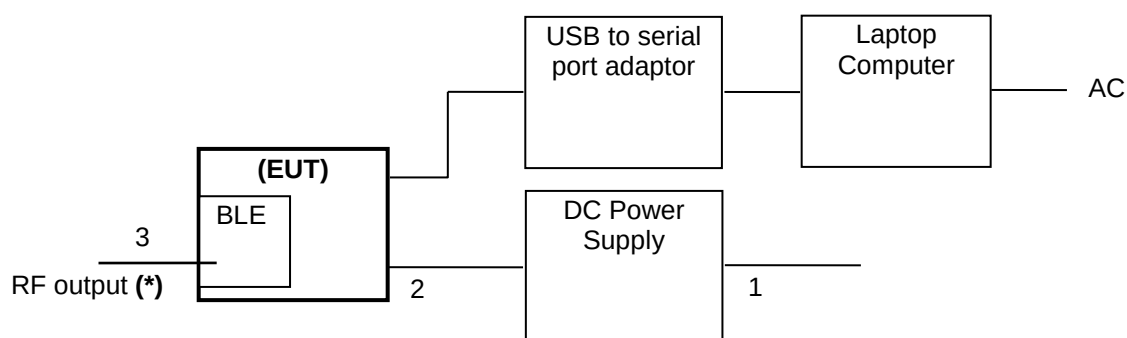
4.3 Physical Configuration for Testing

The test system was configured in a typical fashion (as a customer would normally use it).

The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.10.

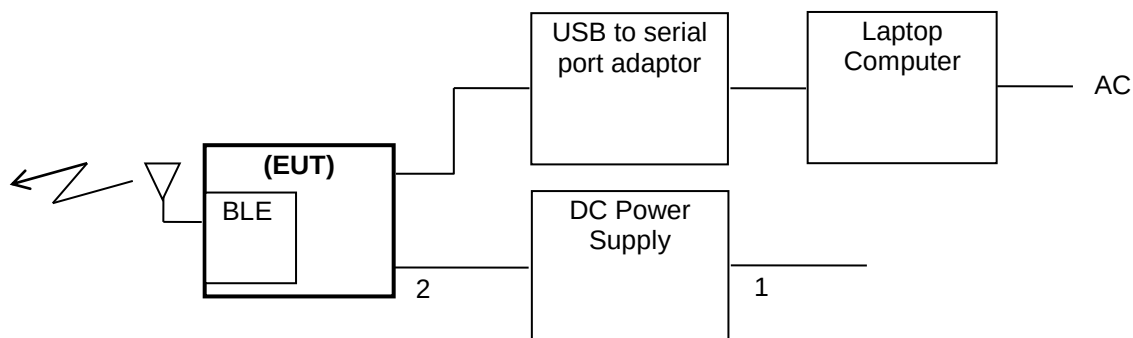
Figure 1: Block Diagram

1) Test Setup of Conducted Radio Testing



Note: A laptop computer and USB to serial adaptor were only used for an initial setup of radio operation. They were disconnected to the EUT during conducted and radiated radio testing.

2) Test Setup of Radiated Radio and Conducted Emission testing



Note: A laptop computer and USB to serial adaptor were only used for an initial setup of radio operation. They were disconnected to the EUT during conducted and radiated radio testing.

Table 3: Interfaces present on the EUT

No.	Interface	Cable Length for Testing, Shielding	Interface Classification
1.	AC Mains for AC/DC Adapter	(Direct plug-in type) (*)	AC Input Power Port
2.	DC Mains for conducted radio	1m, Un-shielded	DC Input Power Port
	DC Mains for radiated radio	2.5m, Un-shielded	
3.	RF Cable (**)	0.3m, Shielded	RF Port

Note:

(*) AC extension cable was used with an AC/DC adapter for AC Power Line Conducted Measurements in section 5.4.

(**) This interface is not user accessible, but for testing purpose only.

Two test samples were available,

- Sample No. 7IBCT17200017 was used for antenna conducted measurements;
- Sample No. 7IBCT17200031 was used for AC power line conducted measurement and for radiated emission measurements.

For antenna conducted measurements, the antenna was replaced by a 50Ω antenna connector.

For more details, refer to section: Photographs of the Test Set-Up.

4.4 Test Software

The EUT was provided by the manufacturer with suitable software to allow operation in all the required modes.

Software used for testing: rBLE_Tool Version 1.12 by Renesas Electronics.

Before starting radio testing, special software mentioned above was running on a laptop computer connected to the EUT through a converter for an initial setting purpose. It was used to enable the test operation modes (mode A, B and C) listed in section 4.2 as appropriate.

4.5 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

1. Product: Laptop Computer
Manufacturer: Dell
Model: Latitude E6230
Rated Voltage: DC 19.5V
Input Current: 4.62A
Protection Class: III
Serial Number: 24352642117
2. Product: AC Adaptor for Laptop Computer
Manufacturer: Dell
Model: LA65NS2-01
Rated Voltage: AC 100-240V
Input Current: 1.6A
Frequency: 50-60Hz
Protection Class: II
Serial Number: CN-06TM1C-72438-374-73A5-A01
3. Product: AC/DC Adaptor (For Conducted Emission)
Manufacturer: UNIFIVE
Model: UU336-1230
Rated Voltage: AC 100-240V
Input Current: 0.79A
Frequency: 50/60Hz
Protection Class: II
Serial Number: G11-0286491
4. Product: USB-TTL Serial Convertor
Manufacturer: FTDI Chip
Model: TTL-232R-3V3
Rated Voltage: DC 5V (USB bus-powered)
Protection Class: III

4.6 Countermeasures to achieve Compliance

No additional measures were employed to achieve compliance.

5. Test Results RADIO

5.1 Technical Requirements

5.1.1 Supply Voltage Requirements

RESULT: **PASS**

Requirements:

FCC 15.31(e)

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Verdict:

The EUT has an internal voltage regulator to supply the RF circuit. Therefore it complies with the supply voltage requirements.

5.1.2 Antenna Requirements

RESULT: **PASS**

Requirements:

FCC 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.

Verdict:

The EUT has one chip antenna inside its enclosure. It is not user accessible. Therefore it complies with the antenna requirements.

5.1.3 Restricted Bands of Operation

RESULT:

PASS

Requirements:

FCC 15.205 and RSS-Gen §8.10

Only spurious emissions are permitted in any of the restricted frequency bands, unless otherwise specified.

Verdict:

The EUT operation frequency range is 2402 - 2480MHz. Therefore only spurious emissions may be found in the restricted bands of operation and the EUT complies with the restricted frequency band requirement.

5.2 Conducted Measurements at Antenna Port

5.2.1 Conducted Output Power

RESULT:

PASS

Date of testing: 2017-04-23

Ambient temperature: 24°C

Relative humidity: 48%

Atmospheric pressure: 1011hPa

Requirements:

FCC 15.247(b)(3) and RSS-247 §5.4(4)

For systems using digital modulation in the 2400-2483.5MHz band, the maximum peak conducted output power is 1W (30dBm).

If transmitting antennas of directional gain greater than 6dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

Test procedure:

KDB Publication No. 558074 D01, section 9.1.1 and RSS-Gen §6.12.

The maximum peak conducted output power was measured at the antenna port with a spectrum analyzer using a peak detector. The resolution bandwidth was set to 1MHz ($\geq$ measured DTS bandwidth in the section 5.3.1) and the video bandwidth was set to 3MHz ($\geq 3 \times$ RBW). The readings of the measurements take into account the loss generated by all the involved cables.

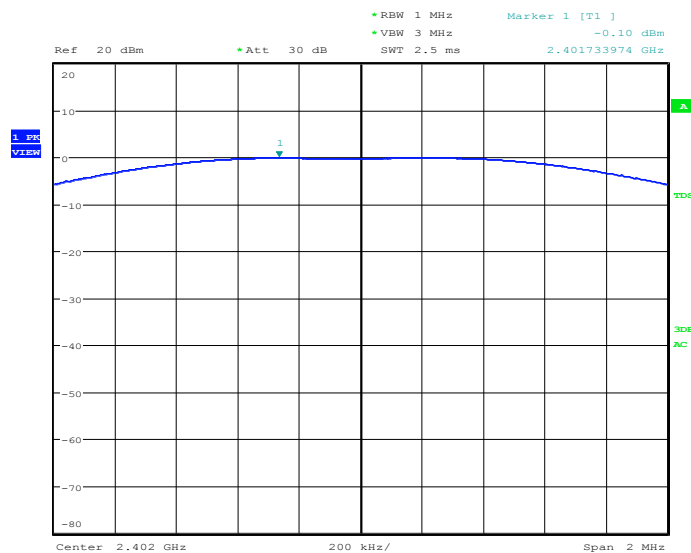
The measurement was performed at GFSK modulation and corresponded data rate of 1Mbps. All the other measurements for the evaluation of the radio properties of the EUT have been performed using this data rate.

Table 4: Conducted Output Power

Operating Frequency [MHz]	Conducted Output Power		Limit [dBm]	Margin [dB]
	[dBm]	[mW]		
2402MHz	-0.10	0.9772	30	30.10
2442MHz	-0.42	0.9078	30	30.42
2480MHz	-0.68	0.8551	30	30.68

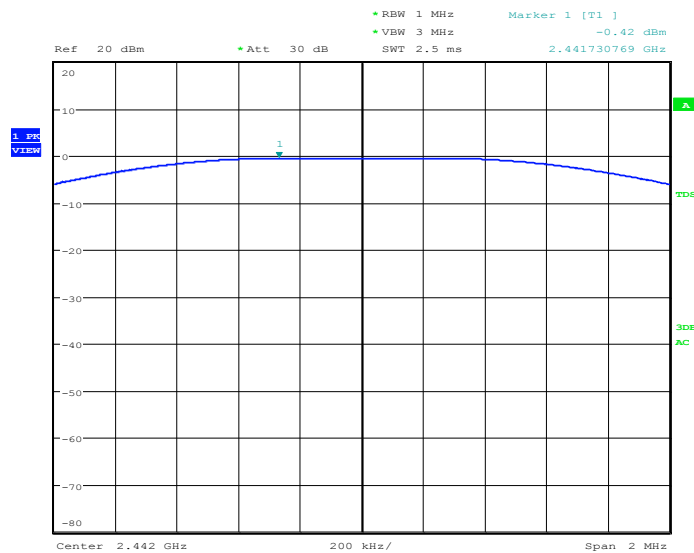
Note: Grey shading area shows the highest output power in this test result.

Figure 2: Conducted Output Power, Mode A (2402MHz)



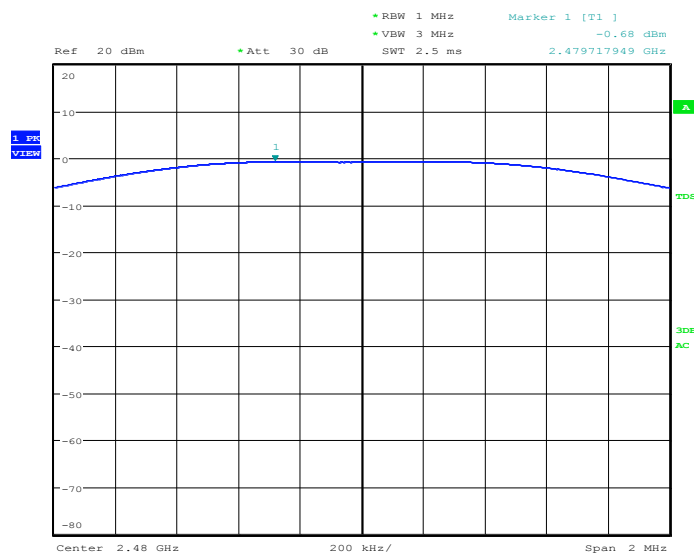
Maximum peak conducted output power, mode A
Date: 23.APR.2017 17:07:51

Figure 3: Conducted Output Power, Mode B (2442MHz)



Maximum peak conducted output power, mode B
Date: 23.APR.2017 17:17:04

Figure 4: Conducted Output Power, Mode C (2480MHz)



Maximum peak conducted output power, mode C
Date: 23.APR.2017 17:24:06

5.2.2 Conducted Spurious Emissions

RESULT:

PASS

Date of testing: 2017-04-23

Ambient temperature: 24°C

Relative humidity: 48%

Atmospheric pressure: 1011hPa

Requirements:

FCC 15.247(d) and RSS-247 §5.5

In any 100kHz bandwidth outside the frequency band in which the intentional radiator is operating, the RF power shall be at least 20dB below that of the maximum in-band 100kHz emission.

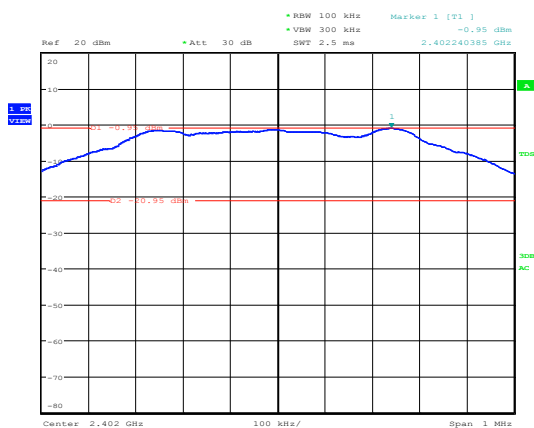
Test procedure:

KDB Publication No. 558074 D01 and RSS-Gen §6.13.

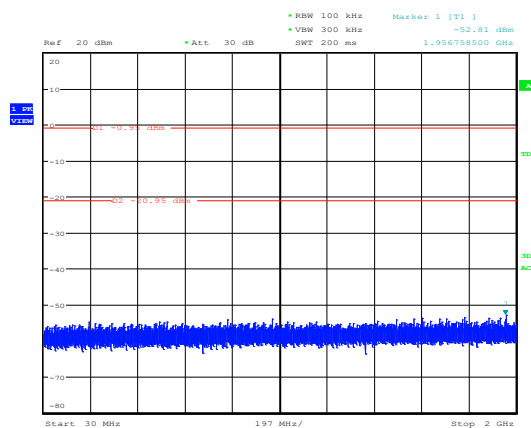
The conducted spurious emissions were measured at the antenna port with a spectrum analyzer using a peak detector. The resolution bandwidth was set to 100kHz and the video bandwidth to 300kHz. Measurements were performed from 30MHz to 25GHz (10th harmonics).

The readings of the measurements take into account the loss generated by all the involved cables.

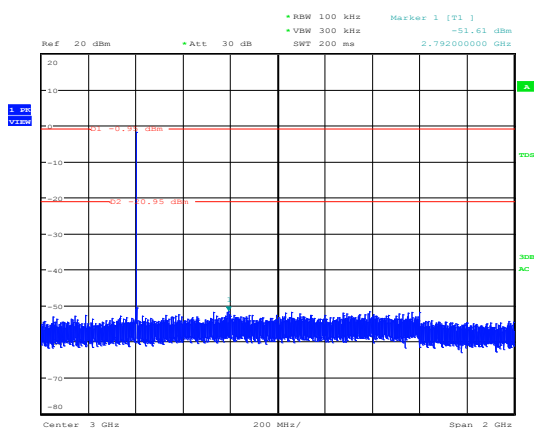
Figure 5: Conducted Spurious Emissions, 30MHz - 10GHz, Mode A (2402MHz)



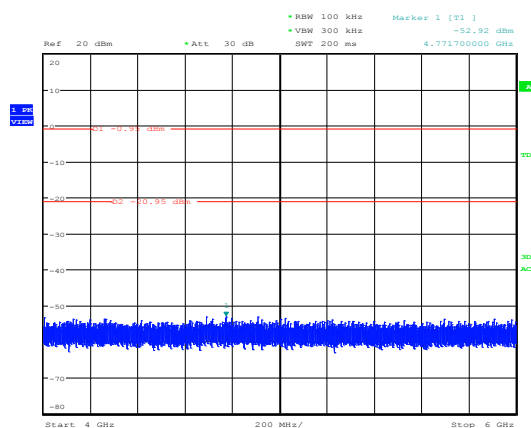
Conducted spurious emissions, mode A
Date: 23.APR.2017 17:09:04



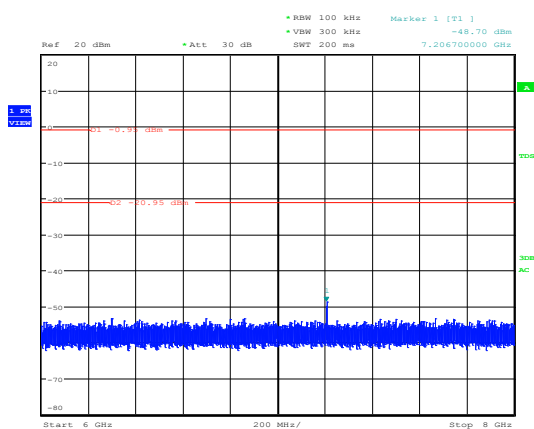
Conducted spurious emissions, mode A
Date: 23.APR.2017 17:09:36



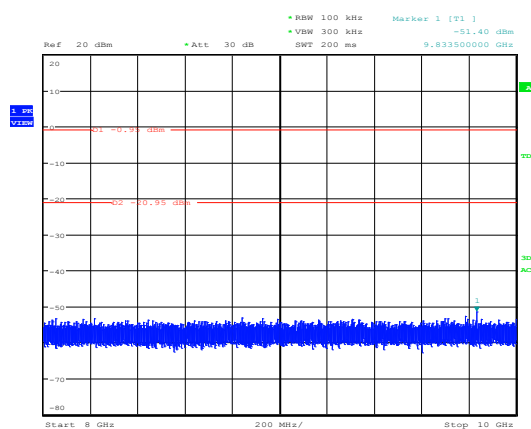
Conducted spurious emissions, mode A
Date: 23.APR.2017 17:10:06



Conducted spurious emissions, mode A
Date: 23.APR.2017 17:10:23

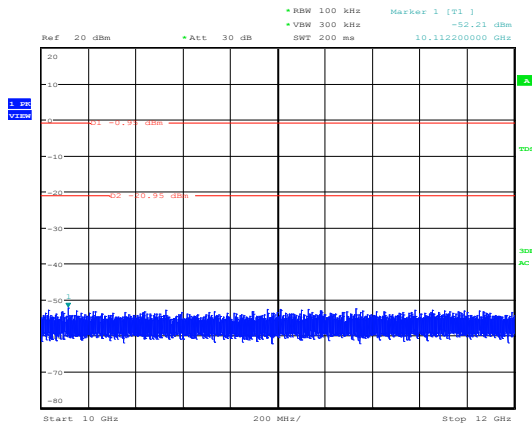


Conducted spurious emissions, mode A
Date: 23.APR.2017 17:10:43

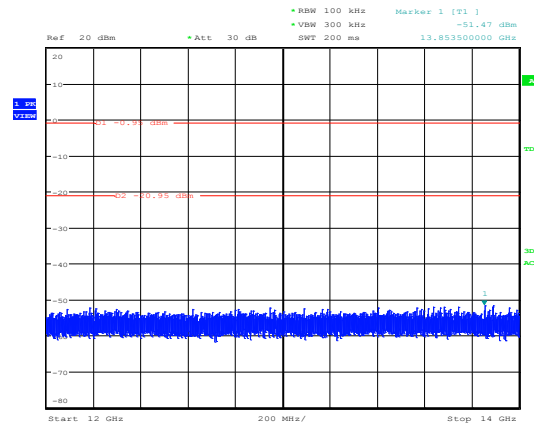


Conducted spurious emissions, mode A
Date: 23.APR.2017 17:11:01

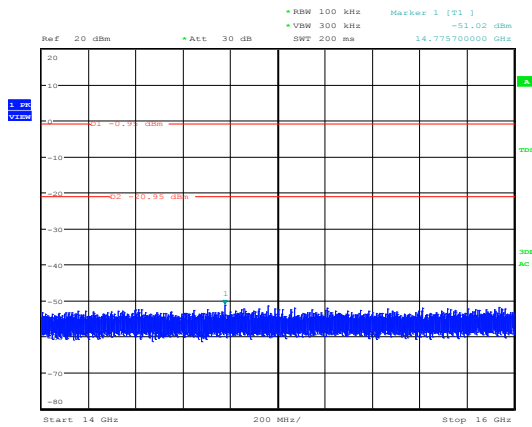
Figure 6: Conducted Spurious Emissions, 10 - 22GHz, Mode A (2402MHz)



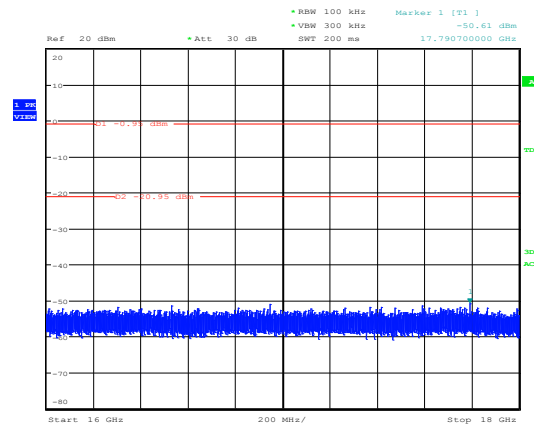
Conducted spurious emissions, mode A
Date: 23.APR.2017 17:11:18



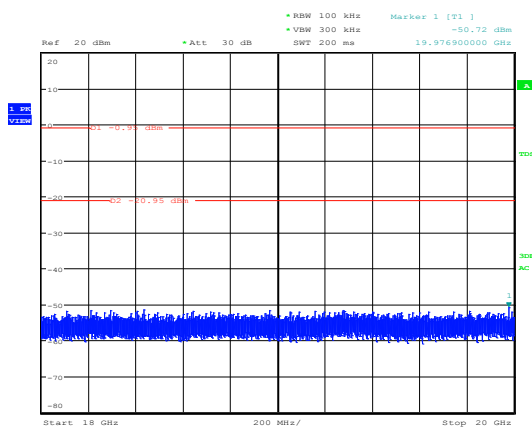
Conducted spurious emissions, mode A
Date: 23.APR.2017 17:11:35



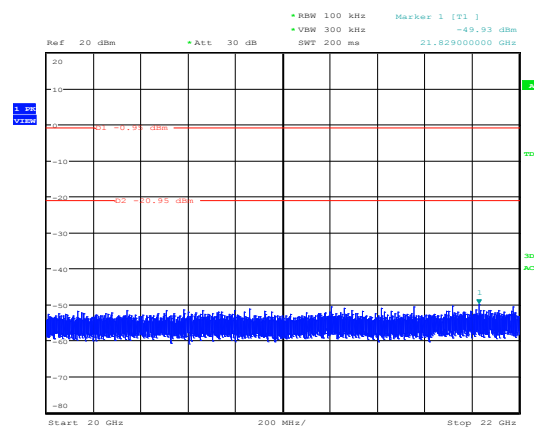
Conducted spurious emissions, mode A
Date: 23.APR.2017 17:11:52



Conducted spurious emissions, mode A
Date: 23.APR.2017 17:12:29

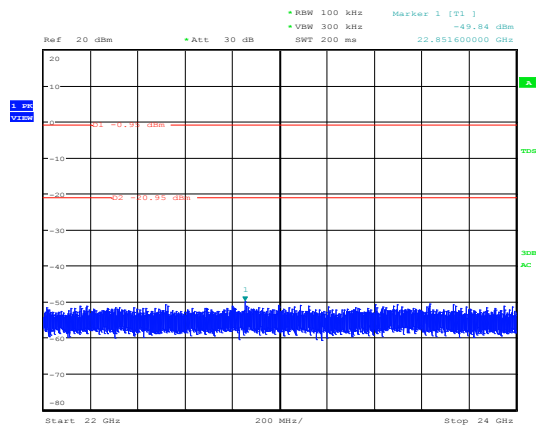


Conducted spurious emissions, mode A
Date: 23.APR.2017 17:12:46

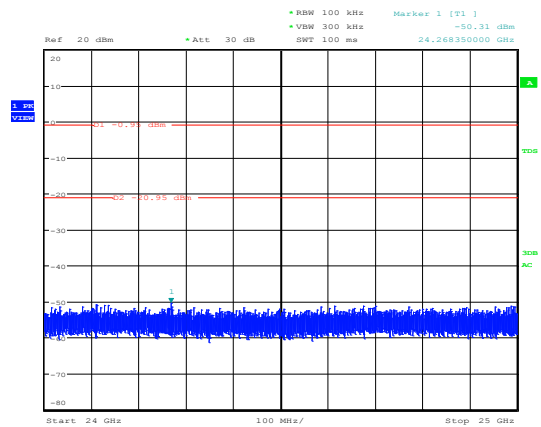


Conducted spurious emissions, mode A
Date: 23.APR.2017 17:13:02

Figure 7: Conducted Spurious Emissions, 22 - 25GHz, Mode A (2402MHz)

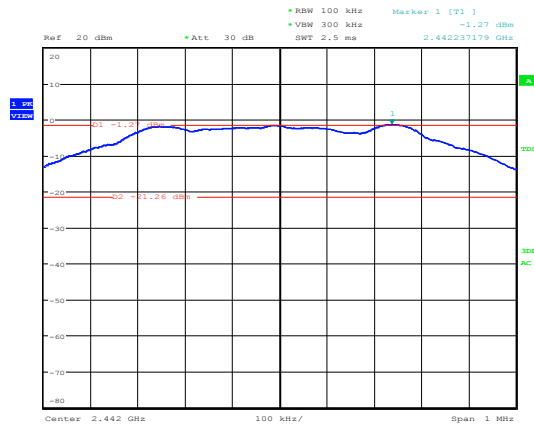


Conducted spurious emissions, mode A
Date: 23.APR.2017 17:13:18

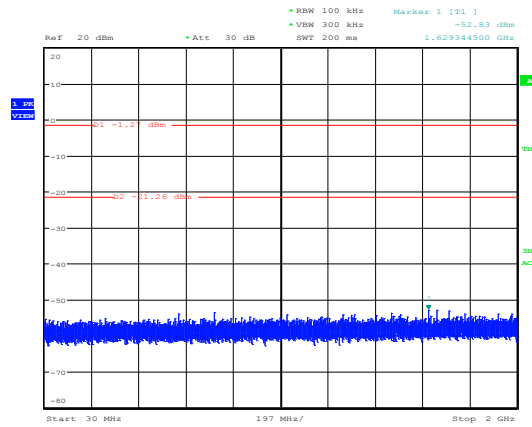


Conducted spurious emissions, mode A
Date: 23.APR.2017 17:14:03

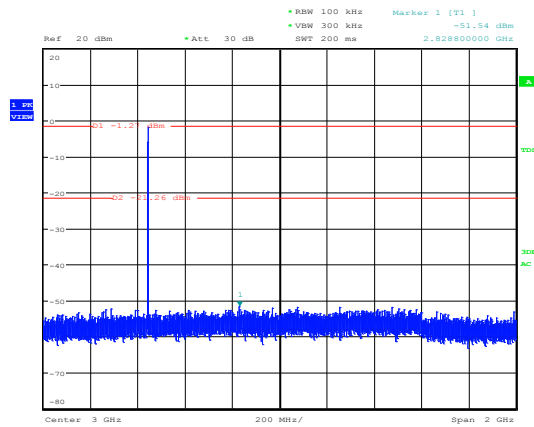
Figure 8: Conducted Spurious Emissions, 30MHz - 10GHz, Mode B (2442MHz)



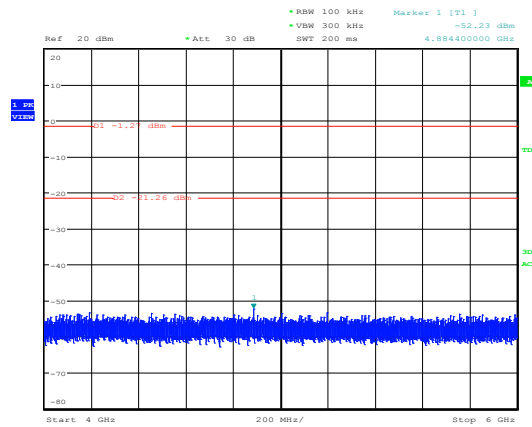
Conducted spurious emissions, mode B
Date: 23.APR.2017 17:18:24



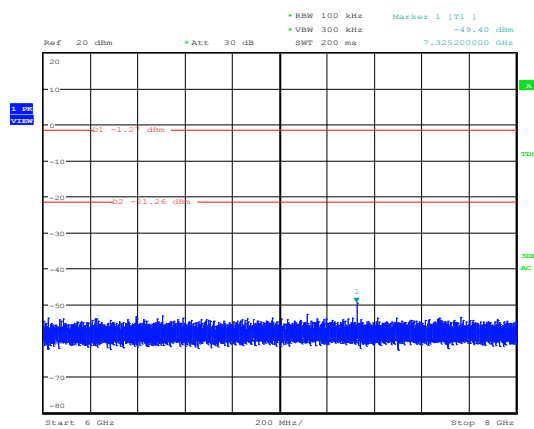
Conducted spurious emissions, mode B
Date: 23.APR.2017 17:18:41



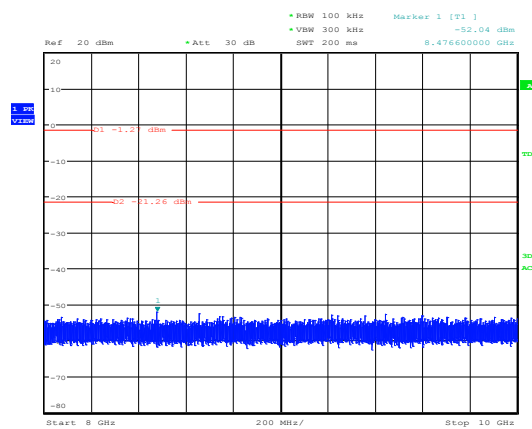
Conducted spurious emissions, mode B
Date: 23.APR.2017 17:19:17



Conducted spurious emissions, mode B
Date: 23.APR.2017 17:19:39

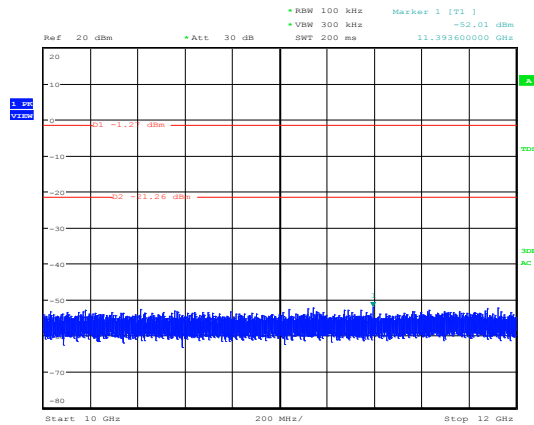


Conducted spurious emissions, mode B
Date: 23.APR.2017 17:20:01

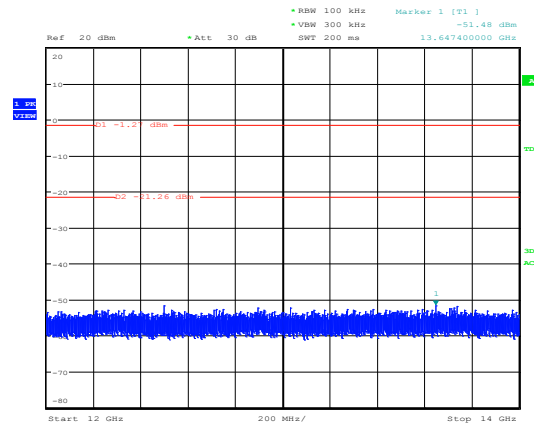


Conducted spurious emissions, mode B
Date: 23.APR.2017 17:20:23

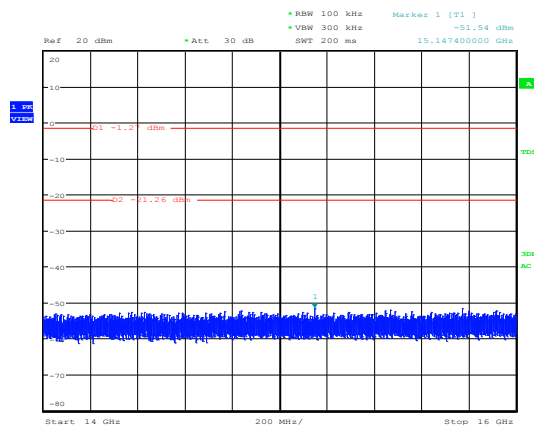
Figure 9: Conducted Spurious Emissions, 10 - 22GHz, Mode B (2442MHz)



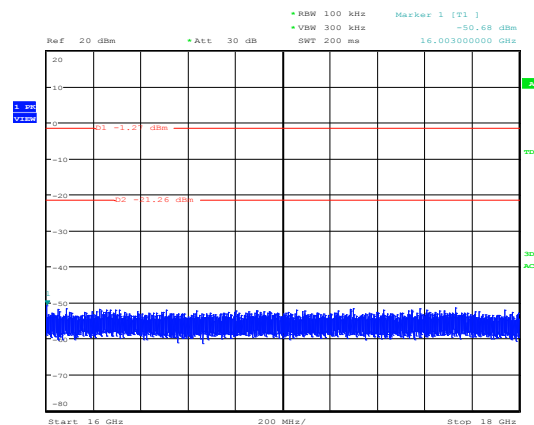
Conducted spurious emissions, mode B
Date: 23.APR.2017 17:20:40



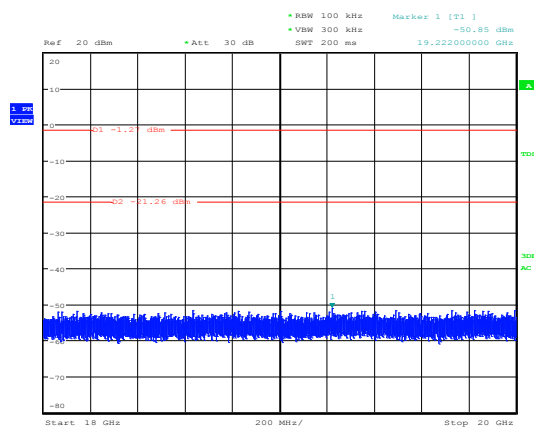
Conducted spurious emissions, mode B
Date: 23.APR.2017 17:21:06



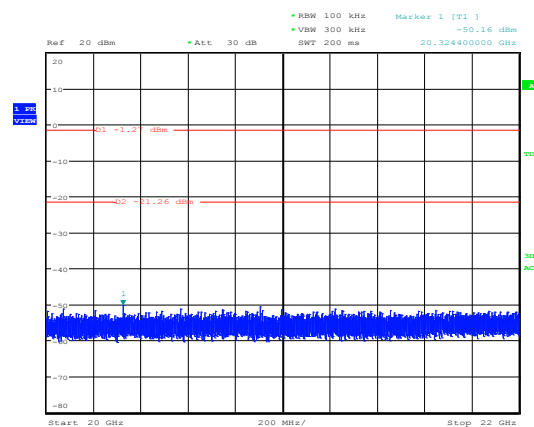
Conducted spurious emissions, mode B
Date: 23.APR.2017 17:21:21



Conducted spurious emissions, mode B
Date: 23.APR.2017 17:21:38

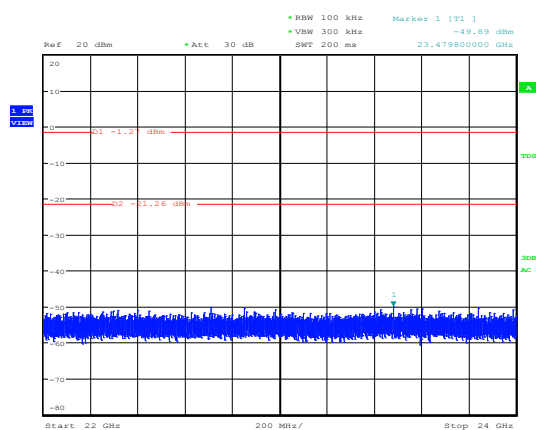


Conducted spurious emissions, mode B
Date: 23.APR.2017 17:21:57

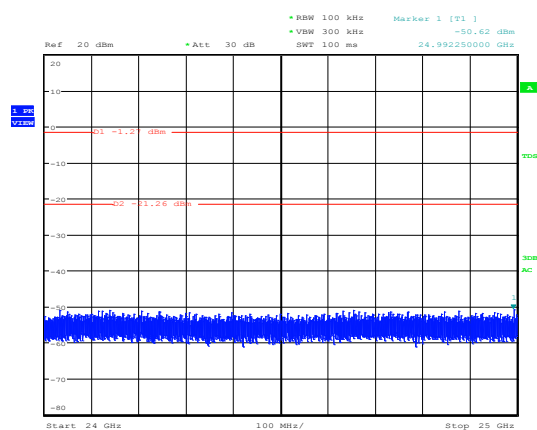


Conducted spurious emissions, mode B
Date: 23.APR.2017 17:22:16

Figure 10: Conducted Spurious Emissions, 22 - 25GHz, Mode B (2442MHz)

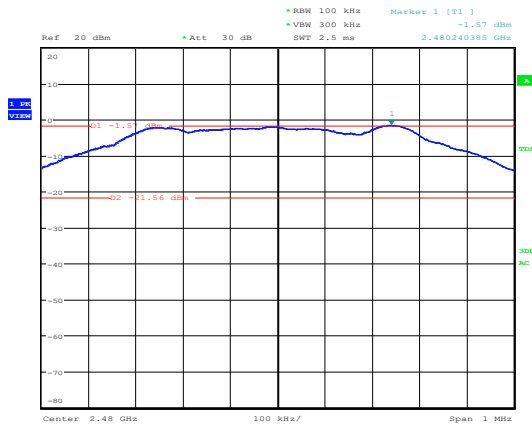


Conducted spurious emissions, mode B
Date: 23.APR.2017 17:22:38

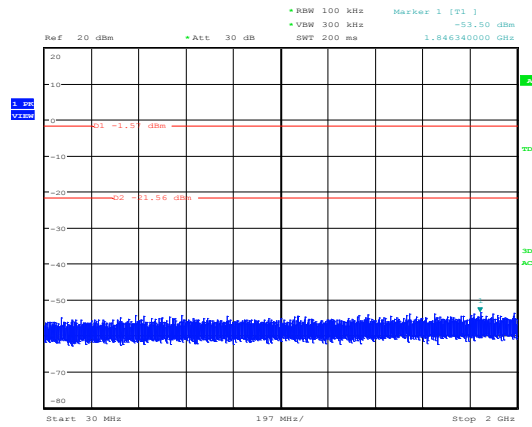


Conducted spurious emissions, mode B
Date: 23.APR.2017 17:22:56

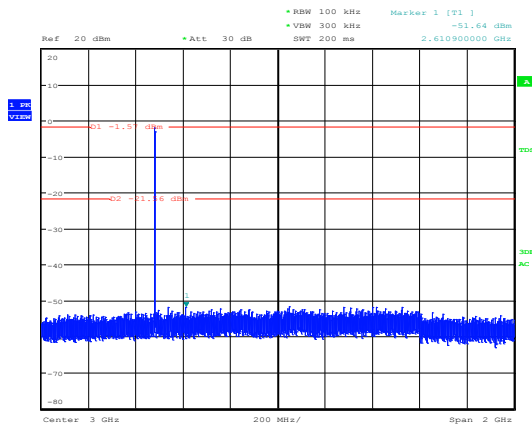
Figure 11: Conducted Spurious Emissions, 30MHz - 10GHz, Mode C (2480MHz)



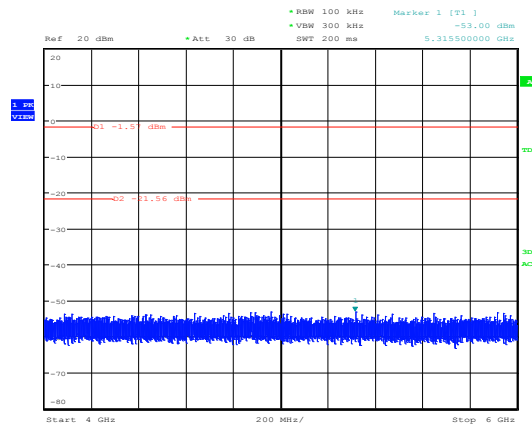
Conducted spurious emissions, mode C
Date: 23.APR.2017 17:28:53



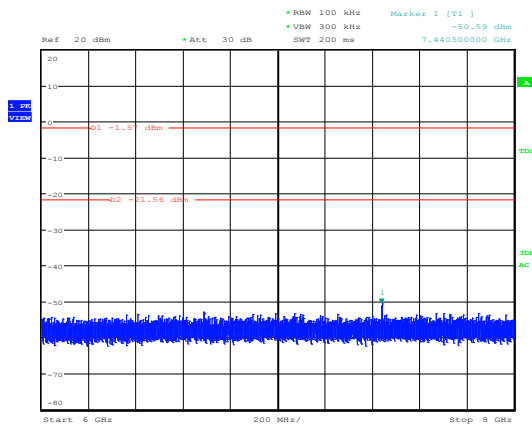
Conducted spurious emissions, mode C
Date: 23.APR.2017 17:29:14



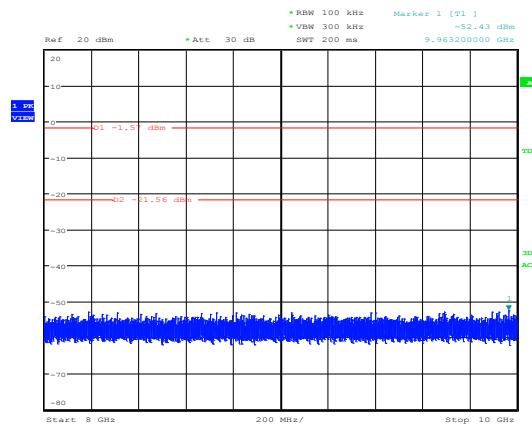
Conducted spurious emissions, mode C
Date: 23.APR.2017 17:29:45



Conducted spurious emissions, mode C
Date: 23.APR.2017 17:30:01

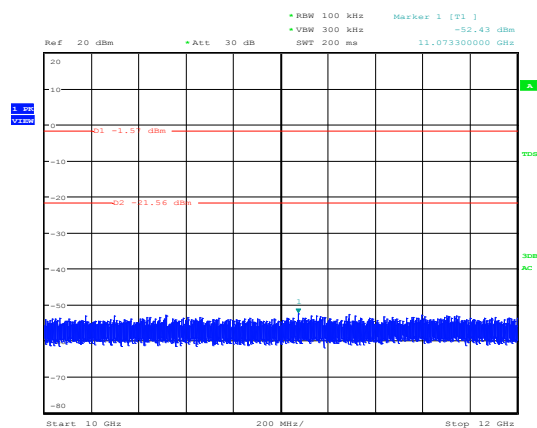


Conducted spurious emissions, mode C
Date: 23.APR.2017 17:30:27

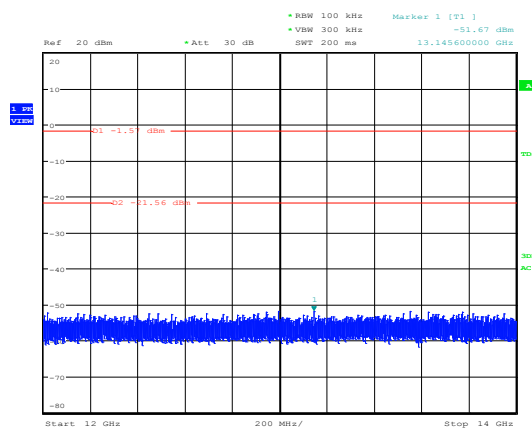


Conducted spurious emissions, mode C
Date: 23.APR.2017 17:30:47

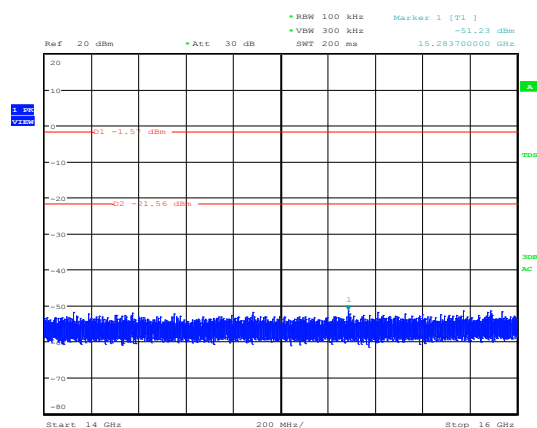
Figure 12: Conducted Spurious Emissions, 10 - 22GHz, Mode C (2480MHz)



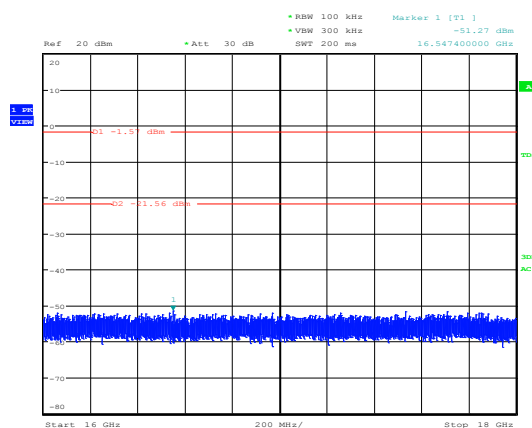
Conducted spurious emissions, mode C
Date: 23.APR.2017 17:31:11



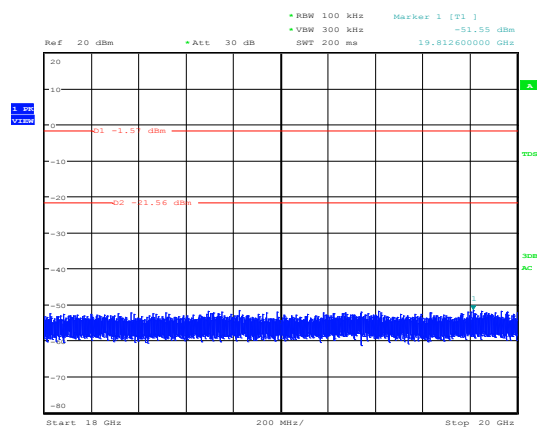
Conducted spurious emissions, mode C
Date: 23.APR.2017 17:31:28



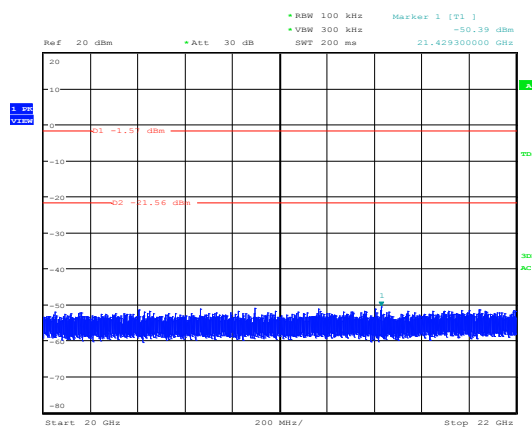
Conducted spurious emissions, mode C
Date: 23.APR.2017 17:31:47



Conducted spurious emissions, mode C
Date: 23.APR.2017 17:32:04

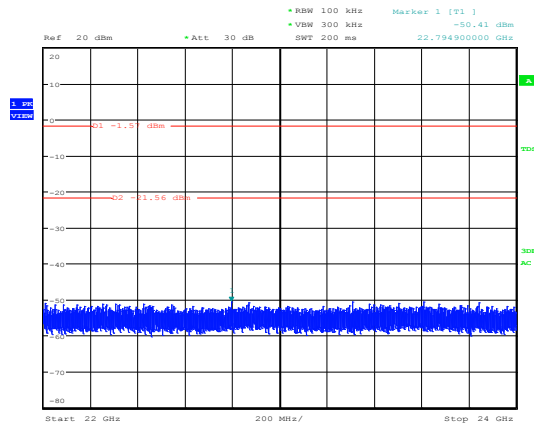


Conducted spurious emissions, mode C
Date: 23.APR.2017 17:32:27

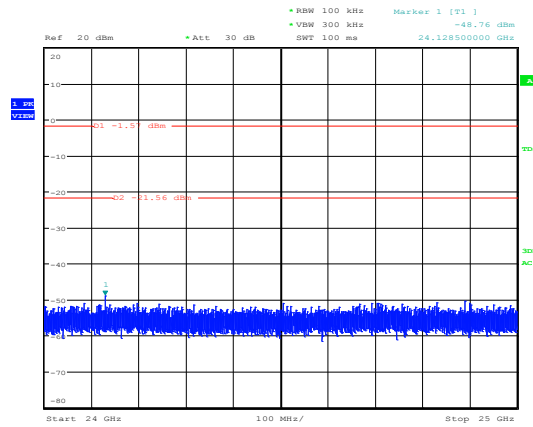


Conducted spurious emissions, mode C
Date: 23.APR.2017 17:32:49

Figure 13: Conducted Spurious Emissions, 22 - 25GHz, Mode C (2480MHz)



Conducted spurious emissions, mode C
Date: 23.APR.2017 17:33:07



Conducted spurious emissions, mode C
Date: 23.APR.2017 17:33:45

5.2.3 Peak Power Spectral Density

RESULT:

PASS

Date of testing: 2017-04-23

Ambient temperature: 24°C

Relative humidity: 48%

Atmospheric pressure: 1011hPa

Requirements:

FCC 15.247(e) and RSS-247 §5.2(2)

For digitally modulated systems, the power spectral density (PSD) conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.

Test procedure:

KDB Publication No. 558074 D01.

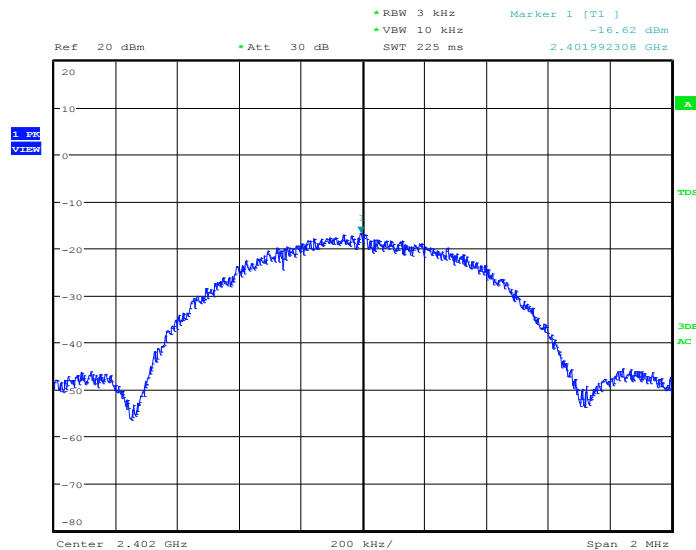
The peak power spectral density was measured at the antenna port with a spectrum analyzer using a peak detector with a resolution bandwidth of 3kHz and a video bandwidth of 10kHz.

The readings of the measurements take into account the loss generated by all the involved cables.

Table 5: Peak Power Spectral Density

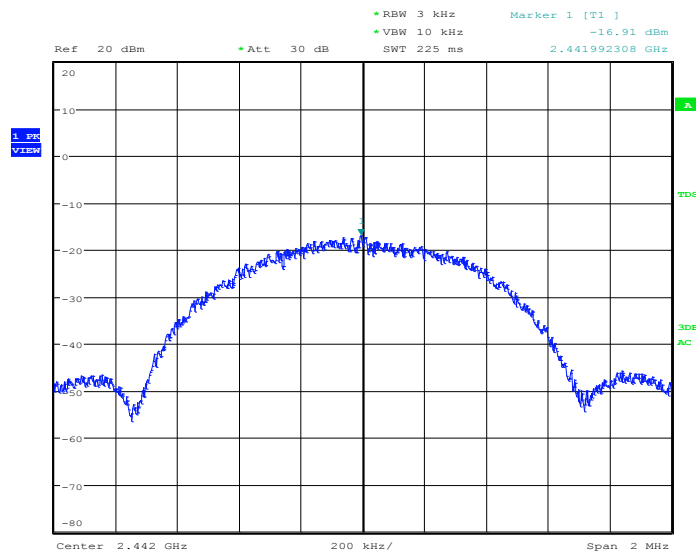
Operating Frequency [MHz]	Max PSD Frequency [MHz]	Max PSD [dBm]	Limit [dBm]	Margin [dB]
2402MHz	2401.992308	-16.62	8	24.62
2442MHz	2441.992308	-16.91	8	24.91
2480MHz	2479.992308	-16.97	8	24.97

Figure 14: Power Spectral Density, Mode A (2402MHz)



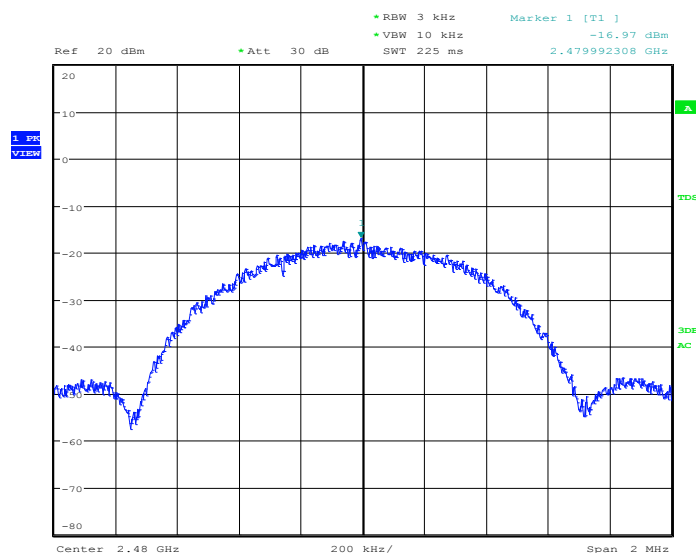
Peak power spectral density, mode A
Date: 23.APR.2017 17:08:35

Figure 15: Power Spectral Density, Mode B (2442MHz)



Peak power spectral density, mode B
Date: 23.APR.2017 17:17:53

Figure 16: Power Spectral Density, Mode C (2480MHz)



Peak power spectral density, mode C
Date: 23.APR.2017 17:28:29

5.3 Radiated Measurements

5.3.1 6dB Bandwidth

RESULT:

PASS

Date of testing: 2017-04-22

Ambient temperature: 25°C

Relative humidity: 58%

Atmospheric pressure: 1003hPa

Requirements:

FCC 15.215(c), 15.247(a)(2) and RSS-247 §5.2(1)

For systems using digital modulation in the 2400-2483.5MHz band, the 6dB bandwidth shall be at least 500kHz. Additionally, for FCC, the 6dB bandwidth shall be contained within the frequency band designated in the rule section under which the equipment is operated.

Test procedure:

KDB Publication No. 558074 D01, section 8.1 and RSS-Gen §6.6.

Since radiated method was applied, the EUT and measurement antenna positions were oriented to produce the highest emission level for each requirement.

The 6dB bandwidth was measured with a spectrum analyzer using a peak detector. The resolution bandwidth was set to 100kHz and the video bandwidth to 300kHz. Markers placed at the lowest and highest intersections of the trace with a 6dBc line were used to calculate the emission bandwidth.

Table 6: 6dB Bandwidth Edge Frequencies

6dB Bandwidth Edge Side	Operating Frequency [MHz]	Edge Frequency [MHz]	Limit [MHz]	Margin [MHz]
Lower freq.	2402MHz	2401.623397	2400	1.623397
Upper freq.	2480MHz	2480.364205	2483.5	3.135795

Table 7: 6dB Bandwidth

Operating Frequency [MHz]	EUT/ Antenna Orientation	6dB Bandwidth [MHz]	Limit [MHz]
2402MHz	V/Z	0.752820512832	0.5
2442MHz	V/Z	0.744256410254	0.5
2480MHz	V/Z	0.737179487175	0.5

Note: Grey shading area shows the widest bandwidth in this test result.

Figure 17: 6dB Bandwidth, Mode A (2402MHz)

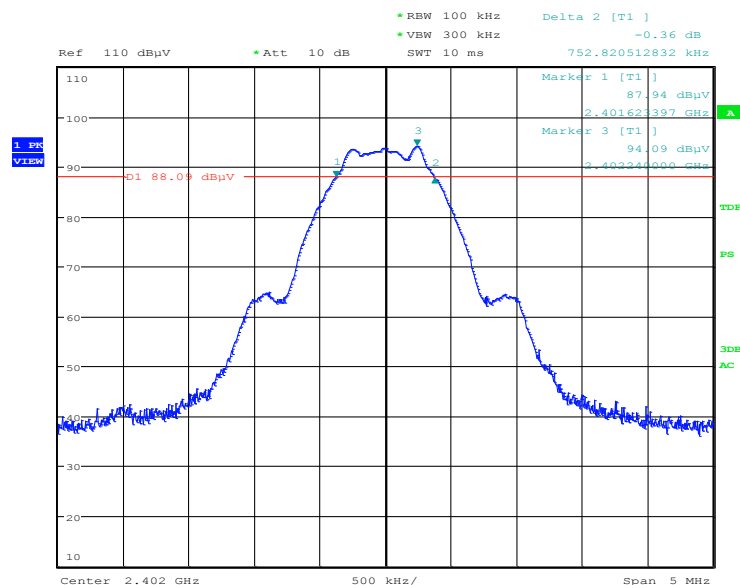
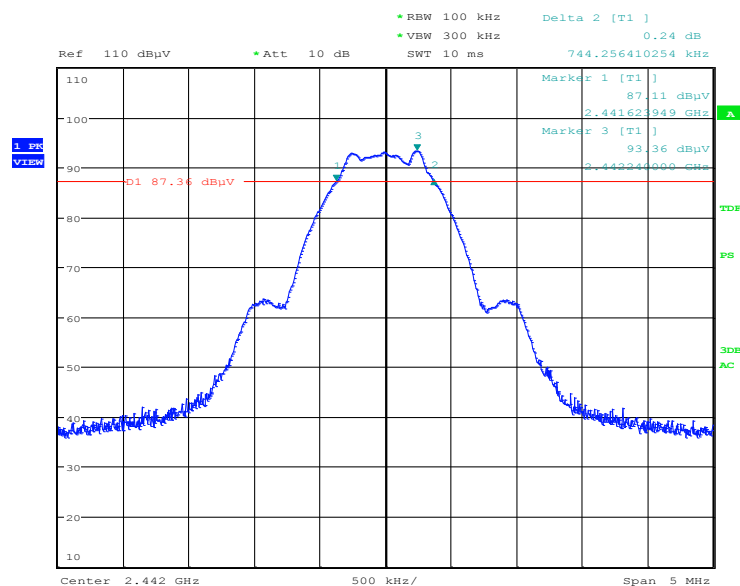
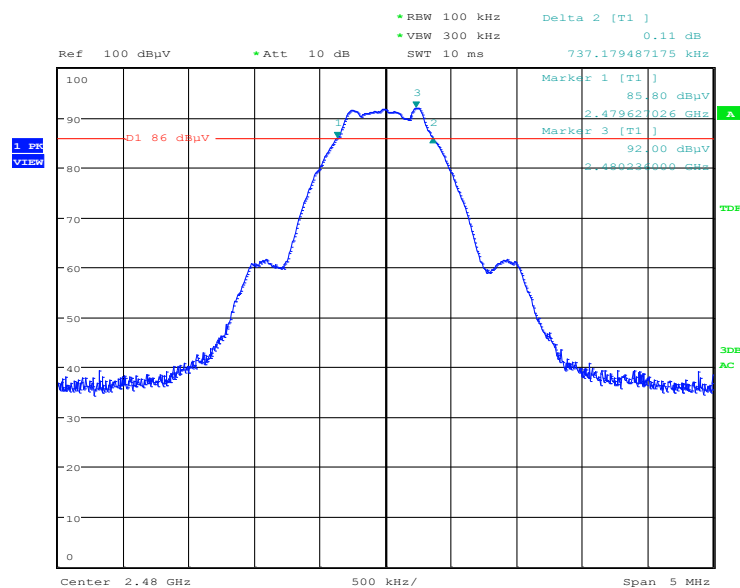


Figure 18: 6dB Bandwidth, Mode B (2442MHz)



Date: 22.APR.2017 16:12:55

Figure 19: 6dB Bandwidth, Mode C (2480MHz)



Date: 22.APR.2017 15:45:04

Note: Frequency of the maker 2 is calculated by the following.
 $2479.627026 + 0.737179 = 2480.364205$ (MHz)

5.3.2 99% Bandwidth

Date of testing: 2017-04-22

Ambient temperature: 25°C

Relative humidity: 58%

Atmospheric pressure: 1003hPa

Requirements:

RSS-Gen §6.6 and 8.11

The 99% bandwidth shall be reported and shall lie entirely outside the restricted bands and the prohibited TV bands of 54-72MHz, 76-88MHz, 174-216MHz, 470-608MHz and 614-806MHz.

Test procedure:

ANSI C63.10 §6.9.3 and RSS-Gen §6.6

Since radiated method was used, the EUT and measurement antenna positions were oriented to produce the highest emission level.

The 99% bandwidth was measured with a spectrum analyzer using a sample detector. The resolution bandwidth was set to in the range of 1% to 5% of the observed occupied bandwidth and video bandwidth was approximately $3 \times \text{RBW}$.

The 99% bandwidth was measured by using the OBW function of the analyzer with a 99% coverage setting.

Table 8: 99% Bandwidth Edge Frequencies

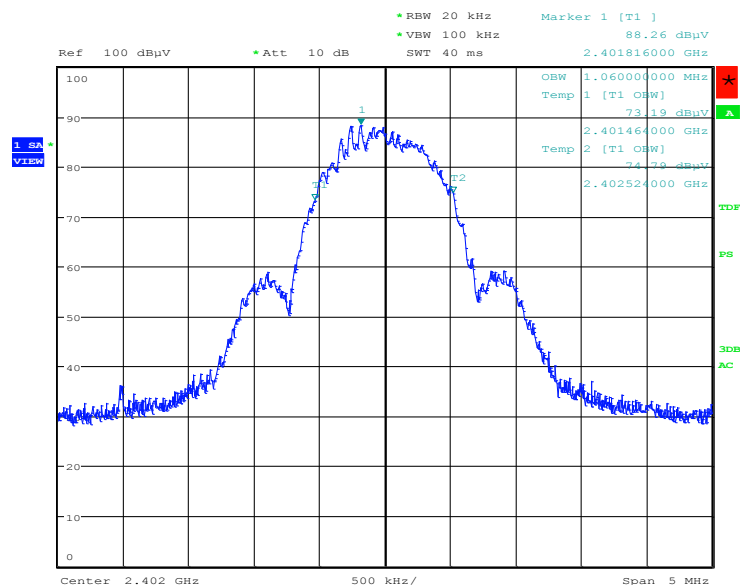
99% Bandwidth Edge Side	Operating Frequency [MHz]	Edge Frequency [MHz]	Limit [MHz]	Margin [MHz]
Lower freq.	2402MHz	2401.464000	2390	11.464
Upper freq.	2480MHz	2480.516000	2655	174.484

Table 9: 99% Bandwidth

Operating Frequency [MHz]	EUT/ Antenna Orientation	99% Bandwidth [MHz]
2402MHz	V / Z	1.060000000
2442MHz	V / Z	1.052000000
2480MHz	V / Z	1.044000000

Note: Grey shading area shows the widest bandwidth in this test result.

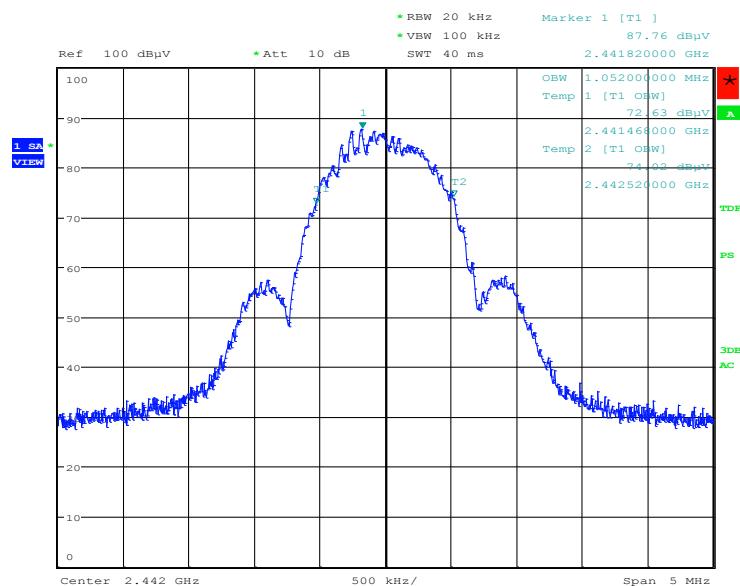
Figure 20: 99% Bandwidth, Mode A (2402MHz)



Date: 22.APR.2017 16:41:51

Note: RBW was set to 1.89% of the observed OBW. $(20 \text{ kHz} / 1060 \text{ kHz}) \times 100 = 1.89 \%$

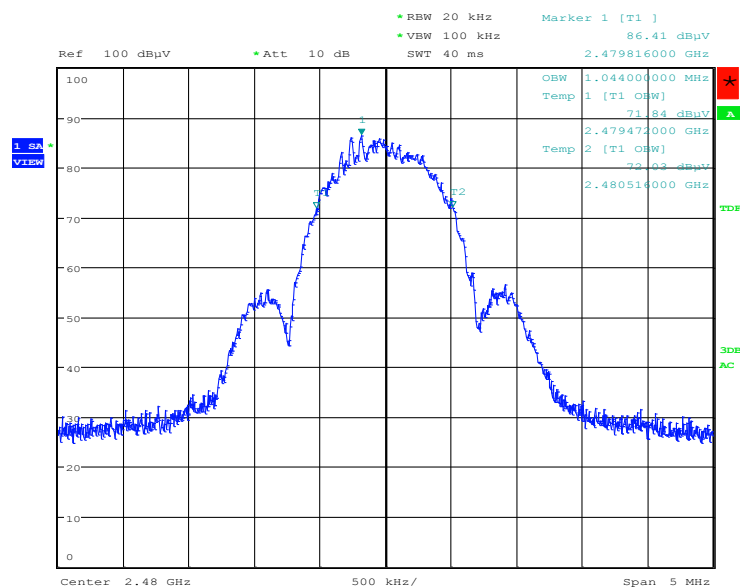
Figure 21: 99% Bandwidth, Mode B (2442MHz)



Date: 22.APR.2017 16:17:13

Note: RBW was set to 1.90% of the observed OBW. $(20 \text{ kHz} / 1052 \text{ kHz}) \times 100 = 1.90 \%$

Figure 22: 99% Bandwidth, Mode C (2480MHz)



Date: 22.APR.2017 15:41:12

Note: RBW was set to 1.92% of the observed OBW. $(20 \text{ kHz} / 1044 \text{ kHz}) \times 100 = 1.92 \%$

5.3.3 Radiated Spurious Emissions of Transmitter

RESULT:

PASS

Date of testing: 2017-04-17, 2017-04-22

Ambient temperature: 25, 25°C

Relative humidity: 58, 58%

Atmospheric pressure: 1009, 1003hPa

Frequency range: 9kHz - 25GHz

Measurement distance: 3m

Kind of test site: Semi Anechoic Chamber

Requirements:

FCC 15.205, FCC 15.209, FCC 15.247(d), RSS-Gen §8.9 and 8.10 and RSS-247 3.1.

Radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a) and RSS-Gen §8.10 (table 6), must comply with the radiated emission limits specified in FCC 15.209(a) and RSS-Gen §8.9 (tables 4 and 5).

Radiated emissions which fall outside the operation frequency band and outside restricted bands shall either meet the limit specified in FCC 15.209(a) and RSS-Gen §8.9 or be attenuated at least 20dB below the power level in the 100kHz bandwidth within the band that contains the highest level of the desired power (the less severe limit applies).

Test procedure:

KDB Publication No. 558074 D01, ANSI C63.10 §6.3, 6.4, 6.5, 6.6, 6.10 and RSS-Gen §6.13 and 8.1

The EUT was placed on a nonconductive turntable. The table height was 0.8m for measurements below 1GHz and 1.5m for measurements above 1GHz. Before final measurements of radiated emissions were performed, the EUT was scanned to determine its emission spectrum profile. The physical arrangement of the test system, the associated cabling and the EUT orientation (X, Y and Z) were varied in order to ensure that maximum emission amplitudes were attained.

The spectrum was examined from 9kHz to the 10th harmonic of the highest fundamental transmitter frequency (25GHz). Final radiated emission measurements were made at 3m distance.

At each frequency where a spurious emission was found, the EUT was rotated 360° in order to determine the emission's maximum level. For frequencies above 30MHz, the antenna was raised and lowered from 1 to 4m and measurements were taken using both horizontal and vertical antenna polarizations.

For emissions between 30MHz and 1GHz, measurements were performed with a test receiver operating in the CISPR quasi-peak detection mode with a 6dB bandwidth set to

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120kHz. For emissions above 1GHz, measurements were performed with a spectrum analyzer using the following settings: for peak field strength: RBW = 1MHz & VBW ≥ 1MHz; for average field strength: RBW = 1MHz & VBW = 10Hz.

Absorbers have been placed on the floor between the EUT and the measuring antenna for testing above 1GHz.

The highest emission amplitudes relative to the appropriate limit were recorded in this report. Emissions other than those mentioned are small or not detectable.

No spurious emission was found in the following ranges, from 9kHz to 30MHz, from 8 to 18GHz and from 18 to 25GHz.

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Table 10: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz)

Frequency [MHz]	EUT / Antenna Orientation	Reading QP [dBμV]	Factor [dB(1/m)]	Level QP [dBμV/m]	Limit [dBμV/m]	Margin QP [dB]	Height [cm]	Angle [°]
134.502	Z/V	41.5	-21.3	20.2	43.5	23.3	105	90
186.857	Z/V	47.6	-22.1	25.5	43.5	18.0	101	299
529.287	Z/V	30.4	-12.7	17.7	46.0	28.3	123	330
823.258	Z/H	30.9	-8.8	22.1	46.0	23.9	273	341

Note: Level QP = Reading QP + Factor

Table 11: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode B (2442MHz)

Freq. [MHz]	EUT / Antenna Orientation	Reading QP [dBμV]	Factor [dB(1/m)]	Level QP [dBμV/m]	Limit [dBμV/m]	Margin QP [dB]	Height [cm]	Angle [°]
144.114	Z/V	41.8	-20.9	20.9	43.5	22.6	101	150
185.242	Z/V	47.7	-22.0	25.7	43.5	17.8	101	86
471.997	Z/V	36.8	-14.2	22.6	46.0	23.4	157	144
900.102	Z/H	31.0	-7.8	23.2	46.0	22.8	100	171

Note: Level QP = Reading QP + Factor

Table 12: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz)

Freq. [MHz]	EUT / Antenna Orientation	Reading QP [dBμV]	Factor [dB(1/m)]	Level QP [dBμV/m]	Limit [dBμV/m]	Margin QP [dB]	Height [cm]	Angle [°]
71.999	Z/V	37.4	-22.8	14.6	40.0	25.4	100	79
144.002	Z/V	44.4	-20.9	23.5	43.5	20.0	100	145
187.596	Z/V	49.2	-22.1	27.1	43.5	16.4	101	281
824.233	Z/V	31.0	-8.9	22.1	46.0	23.9	343	32

Note: Level QP = Reading QP + Factor

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Table 13: Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz)

Freq. [MHz]	EUT / Antenna Orientation	Reading AV [dBμV]	Factor [dB(1/m)]	Level AV [dBμV/m]	Limit [dBμV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1499.940	X/H	39.1	-16.5	22.6	54.0	31.4	200	61
2434.120	X/H	39.7	-14.9	24.8	54.0	29.2	166	19
7390.800	X/H	38.3	-1.8	36.5	54.0	17.5	164	124
8016.188	X/H	38.3	0.0	38.3	54.0	15.7	193	206

Note: Level AV = Reading AV + Factor

Table 14: Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz)

Freq. [MHz]	EUT / Antenna Orientation	Reading PK [dBμV]	Factor [dB(1/m)]	Level PK [dBμV/m]	Limit [dBμV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1499.940	X/H	53.6	-16.5	37.1	74.0	36.9	200	61
2434.120	X/H	54.2	-14.9	39.3	74.0	34.7	166	19
7390.800	X/H	52.6	-1.8	50.8	74.0	23.2	164	124
8016.188	X/H	52.0	0.0	52.0	74.0	22.0	193	206

Note: Level PK = Reading PK + Factor

Table 15: Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2442MHz)

Freq. [MHz]	EUT / Antenna Orientation	Reading AV [dBμV]	Factor [dB(1/m)]	Level AV [dBμV/m]	Limit [dBμV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1398.834	X/H	39.1	-16.4	22.7	54.0	31.3	142	26
3561.337	X/H	40.0	-11.8	28.2	54.0	25.8	160	305
5151.494	X/V	39.3	-7.8	31.5	54.0	22.5	114	223
7266.347	X/V	38.9	-1.8	37.1	54.0	16.9	153	227

Note: Level AV = Reading AV + Factor

Table 16: Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2442MHz)

Freq. [MHz]	EUT / Antenna Orientation	Reading PK [dBμV]	Factor [dB(1/m)]	Level PK [dBμV/m]	Limit [dBμV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1398.834	X/H	53.1	-16.4	36.7	74.0	37.3	142	26
3561.337	X/H	53.8	-11.8	42.1	74.0	31.9	160	305
5151.494	X/V	53.4	-7.8	45.6	74.0	28.4	114	223
7266.347	X/V	53.3	-1.8	51.5	74.0	22.5	153	227

Note: Level PK = Reading PK + Factor

Table 17: Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz)

Freq. [MHz]	EUT / Antenna Orientation	Reading AV [dBμV]	Factor [dB(1/m)]	Level AV [dBμV/m]	Limit [dBμV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1547.766	X/V	39.0	-16.8	22.2	54.0	31.8	100	45
3572.277	X/H	39.9	-11.7	28.2	54.0	25.8	179	123
7390.906	X/V	39.0	-1.8	37.2	54.0	16.8	200	107
7942.682	X/H	38.9	-0.9	38.0	54.0	16.0	100	92

Note: Level AV = Reading AV + Factor

Table 18: Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz)

Freq. [MHz]	EUT / Antenna Orientation	Reading PK [dBμV]	Factor [dB(1/m)]	Level PK [dBμV/m]	Limit [dBμV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1547.766	X/V	53.1	-16.8	36.3	74.0	37.7	100	45
3572.277	X/H	54.1	-11.7	42.4	74.0	31.6	179	123
7390.906	X/V	52.9	-1.8	51.1	74.0	22.9	200	107
7942.682	X/H	52.7	-0.9	51.8	74.0	22.2	100	92

Note: Level PK = Reading PK + Factor

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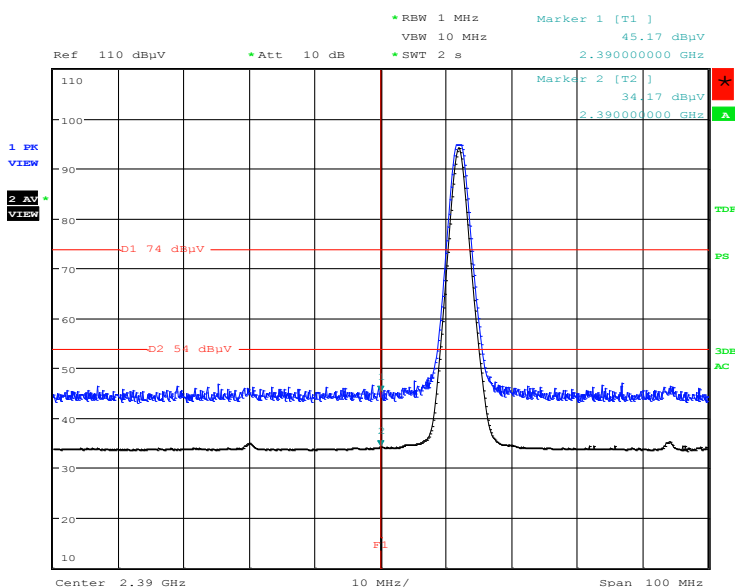
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Table 19: Radiated Emissions at Band Edge, Average and Peak Data, Horizontal and Vertical Antenna Orientations, Modes A (2402MHz) and C (2480MHz)

Operating Frequency [MHz]	EUT / Antenna Orientation	Level AV [dBμV/m]	Level PK [dBμV/m]	Limit AV [dBμV/m]	Limit PK [dBμV/m]	Margin AV [dB]	Margin PK [dB]
2402MHz	Z/V	34.17	45.17	54	74	19.83	28.83
2480MHz	Z/V	47.05	52.26	54	74	6.95	21.74

Notes: All correction factors (antenna, cable, pre-amplifier) are included in the measurement values.
Average limit in dBμV/m is calculated as follows: Average limit = 20 x Log₁₀(500μV/m).
Peak limit in dBμV/m is calculated as follows: Peak limit = Average limit + 20dB.

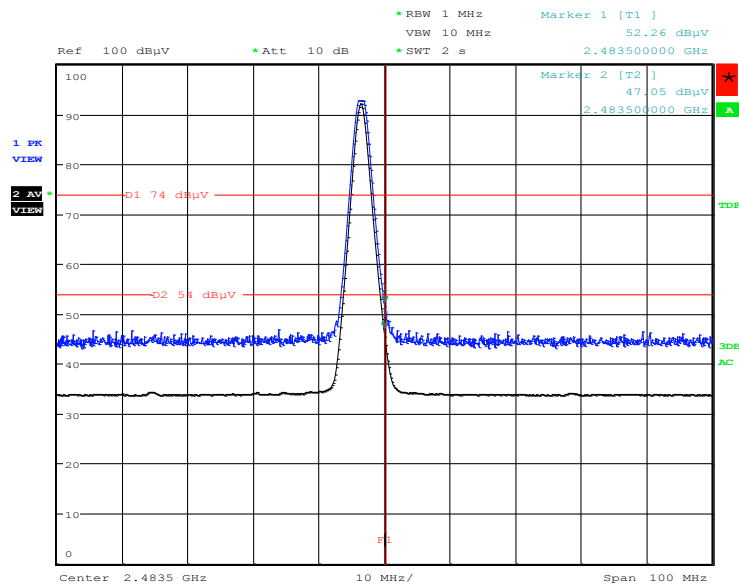
Figure 23: Radiated Emissions at Band Edge, Spectral Diagram, Mode A (2402MHz)



Date: 22.APR.2017 16:33:42

Note: The upper trace shows the peak value and the lower trace shows the average value.

Figure 24: Radiated Emissions at Band Edge, Spectral Diagram, Mode C (2480MHz)



Date: 22.APR.2017 15:55:12

Note: The upper trace shows the peak value and the lower trace shows the average value.

5.4 AC Power Line Conducted Measurements

5.4.1 AC Power Line Conducted Emission of Transmitter

RESULT:

PASS

Date of testing: 2017-04-17

Ambient temperature: 24°C

Relative humidity: 50%

Atmospheric pressure: 1011hPa

Frequency range: 0.15 - 30MHz

Kind of test site: Shielded Room

Requirements:

FCC 15.207 and RSS-Gen §8.8

The AC power line conducted emission on any frequency within the band 150kHz to 30MHz shall not exceed the limits specified in FCC 15.207 and RSS-Gen §8.8 (table 3).

Test procedure:

ANSI C63.10 §6.2 and RSS-Gen §8.1

The EUT was placed on a wooden table raised 80cm above the reference ground plane. A vertical conducting plane of the screened room was located 40cm to the rear of the EUT. One commercial available AC adapter was connected to a Line Impedance Stabilization Network (LISN).

The physical arrangement of the test system and associated cabling was varied to determine the effect on the EUT's emissions in amplitude and frequency in order to ensure that maximum emission amplitudes were attained.

The measurements were performed with a test receiver operating in the CISPR quasi-peak and average detection modes. The receiver's 6dB bandwidth was set to 9kHz.

Disturbances other than those mentioned are small or not detectable.

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Table 20: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L), Mode A (2402MHz)

Freq. [MHz]	Phase	Reading QP [dBµV]	Reading AV [dBµV]	Factor [dB]	Level QP [dBµV]	Level AV [dBµV]	Limit QP [dBµV]	Limit AV [dBµV]	Margin QP [dB]	Margin AV [dB]
0.15431	N	30.0	7.5	9.6	39.6	17.1	65.8	55.8	26.2	38.7
0.17326	N	26.9	6.0	9.7	36.6	15.7	64.8	54.8	28.2	39.1
0.19970	L1	24.2	2.9	9.7	33.9	12.6	63.6	53.6	29.7	41.0
0.24735	N	20.6	3.8	9.7	30.3	13.5	61.8	51.8	31.5	38.3
0.26794	N	20.8	4.3	9.7	30.5	14.0	61.2	51.2	30.7	37.2
0.55839	N	24.2	7.4	9.7	33.9	17.1	56.0	46.0	22.1	28.9
0.84658	L1	20.2	4.6	9.7	29.9	14.3	56.0	46.0	26.1	31.7
13.55501	L1	9.2	-3.1	10.1	19.3	7.0	60.0	50.0	40.7	43.0

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

Table 21: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L), Mode B (2442MHz)

Freq. [MHz]	Phase	Reading QP [dBµV]	Reading AV [dBµV]	Factor [dB]	Level QP [dBµV]	Level AV [dBµV]	Limit QP [dBµV]	Limit AV [dBµV]	Margin QP [dB]	Margin AV [dB]
0.15282	N	29.7	7.0	9.6	39.3	16.6	65.8	55.8	26.5	39.2
0.17236	N	26.8	6.0	9.7	36.5	15.7	64.8	54.8	28.3	39.1
0.18351	L1	26.3	3.3	9.7	36.0	13.0	64.3	54.3	28.3	41.3
0.19989	N	24.5	4.9	9.7	34.2	14.6	63.6	53.6	29.4	39.0
0.25953	L1	19.5	1.9	9.7	29.2	11.6	61.4	51.4	32.2	39.8
0.55545	N	24.0	7.4	9.7	33.7	17.1	56.0	46.0	22.3	28.9
0.85725	L1	20.1	4.3	9.7	29.8	14.0	56.0	46.0	26.2	32.0
13.96735	L1	9.8	-3.0	10.1	19.9	7.1	60.0	50.0	40.1	42.9

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

Table 22: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L), Mode C (2480MHz)

Freq. [MHz]	Phase	Reading QP [dBµV]	Reading AV [dBµV]	Factor [dB]	Level QP [dBµV]	Level AV [dBµV]	Limit QP [dBµV]	Limit AV [dBµV]	Margin QP [dB]	Margin AV [dB]
0.15852	L1	29.8	4.5	9.6	39.4	14.1	65.5	55.5	26.1	41.4
0.18087	L1	26.5	3.4	9.7	36.2	13.1	64.4	54.4	28.2	41.3
0.21269	L1	23.0	3.0	9.7	32.7	12.7	63.1	53.1	30.4	40.4
0.22728	N	21.8	3.7	9.7	31.5	13.4	62.5	52.5	31.0	39.1
0.26580	N	21.3	4.7	9.7	31.0	14.4	61.2	51.2	30.2	36.8
0.55435	L1	24.1	6.4	9.7	33.8	16.1	56.0	46.0	22.2	29.9
4.04300	N	8.6	-2.7	9.9	18.5	7.2	56.0	46.0	37.5	38.8
14.07218	L1	9.7	-2.7	10.1	19.8	7.4	60.0	50.0	40.2	42.6

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

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