RADIO TEST REPORT

47 CFR FCC PART 15.247
RSS-GEN ISSUE 4
RSS-247 ISSUE 2

Report Number:	CFR- CWD7545-11032016
Test Dates:	10/12, 10/13, 10/24, 10/25, 10/26, 10/27, 10/28, 10/31, 11/01, 11/02 /2016

EWO:	**2264**

Model:	CWD7545

FCC ID:	ERO CWD7545
IC:	5683C- CWD7545

FRN:	0005022819
ADDRESS:	15 Volvo Dr, Rockleigh, NJ 07647

Report Date: 11/3/2016

Test Result:	Pass

Prepared by: Hirayr M. Kudyan Date: 11/3/2016

Hirayr M. Kudyan, PhD, PE, NCE
Senior Compliance Engineer

Reviewed by: Date: 11/10/2016

Gary Freed,
Global Compliance Manager

Table of Contents

Revision History

Revision	Description	Date
00	Initial release	11/03/2016
01	-Replace RSS-247 Issue 1 by RSS-247 Issue 2 on pages 1 and 4 -Correct antenna gain on page 19 to -2.0dBi -Update equipment table on page16 for current Cal. and Cal. Due dates	04/12/2017

1. Reference Standards

Measurements were performed according to the following procedures and standards:

1) ANSI C63.4: 2014
2) FCC Publication, "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under §15.247", June 5, 2014
3) Industry Canada RSS-Gen Issue 4
4) Industry Canada RSS-247 Issue 2
5) Industry Canada ICES-003 Issue 5

All measurements were performed in a 3-meter semi-anechoic chamber and the control room.

1.1 Test Facility

The 3-meter semi-anechoic chamber used to collect conducted and radiated emission data is located at 22 Link Drive, Rockleigh, New Jersey. This test facility has been placed on file with the FCC, Registration Number: 412871, and Industry Canada, Site Number: 5683C-1.

2. System Test Configuration

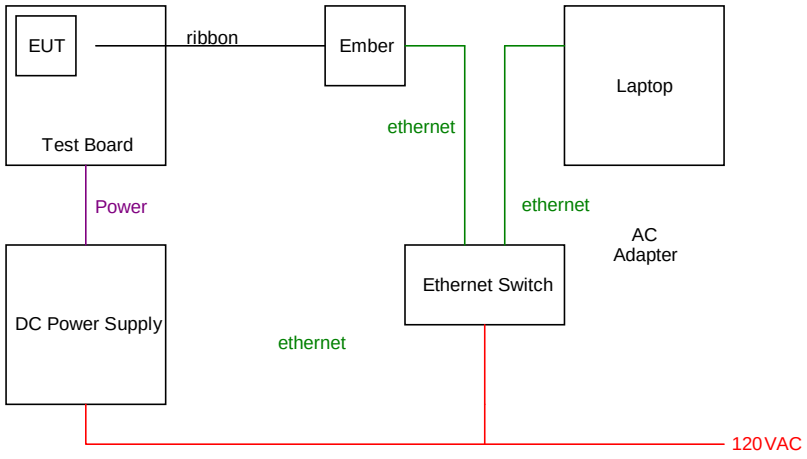
2.1 Product Description

The equipment under test (EUT) is a Zigbee radio module manufactured by Crestron Electronics, Inc.

Model Number: CWD7545

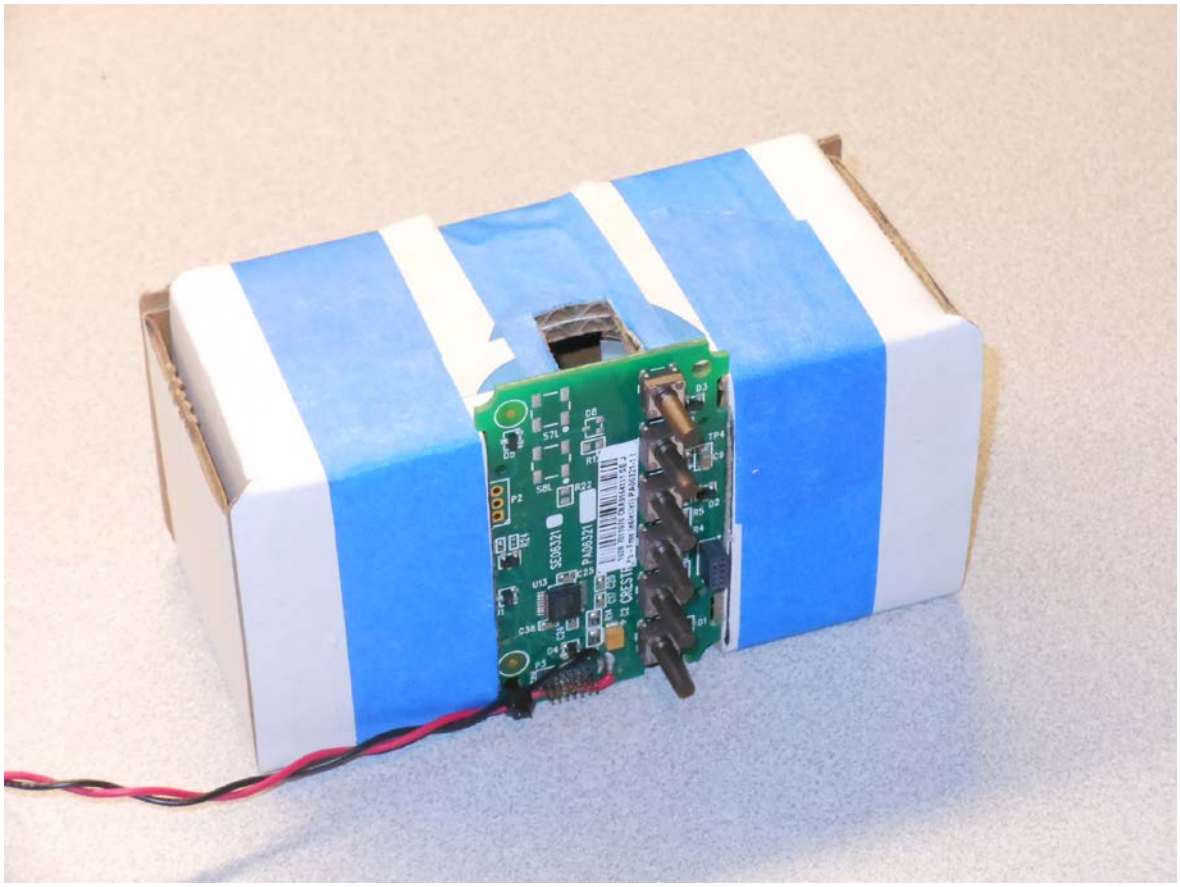
2.2 Block Diagram

Test Setup Block Diagram

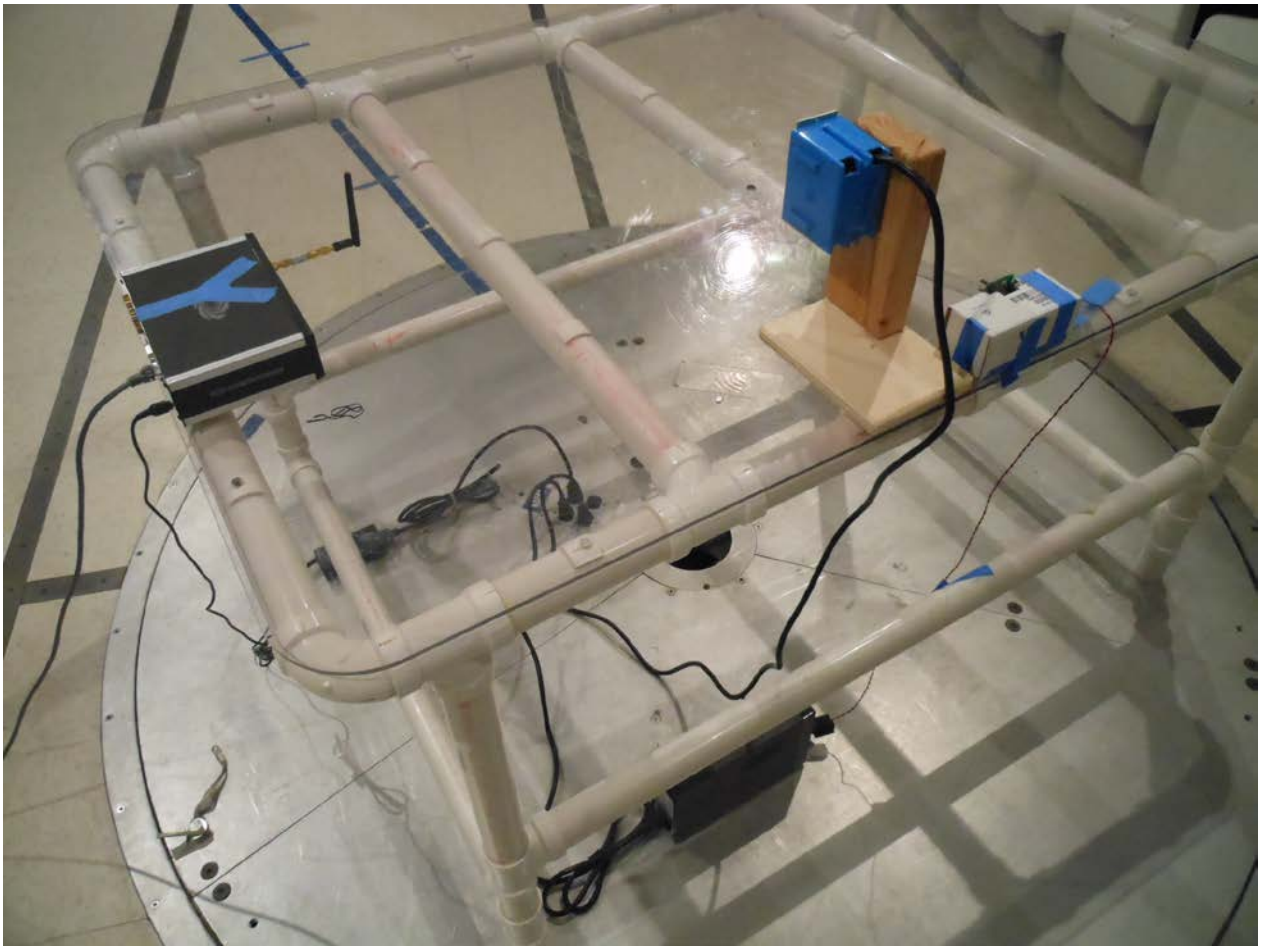


2.3 EUT Setup Justification

The setup was configured for testing in a representative user configuration with nominal interface data activity to imitate EUT functions. For radiated and conducted radio emissions testing, the Ember test interface box was used to control the carrier RF power levels, modulation, frequency and duration generated by the stand-alone EUT module, consisting of the PCB seen below:



For radio Duty-Cycle measurements the "test packet" command was used to have the Crestron INET-CBDEX product deploying the same radio module (as the EUT), broadcast test packets as a "client" node, to a Crestron MC3 gateway (see photo below where the EUT, the INET-CBDEX client and the MC3 gateway appear on the test table in the EMC chamber):

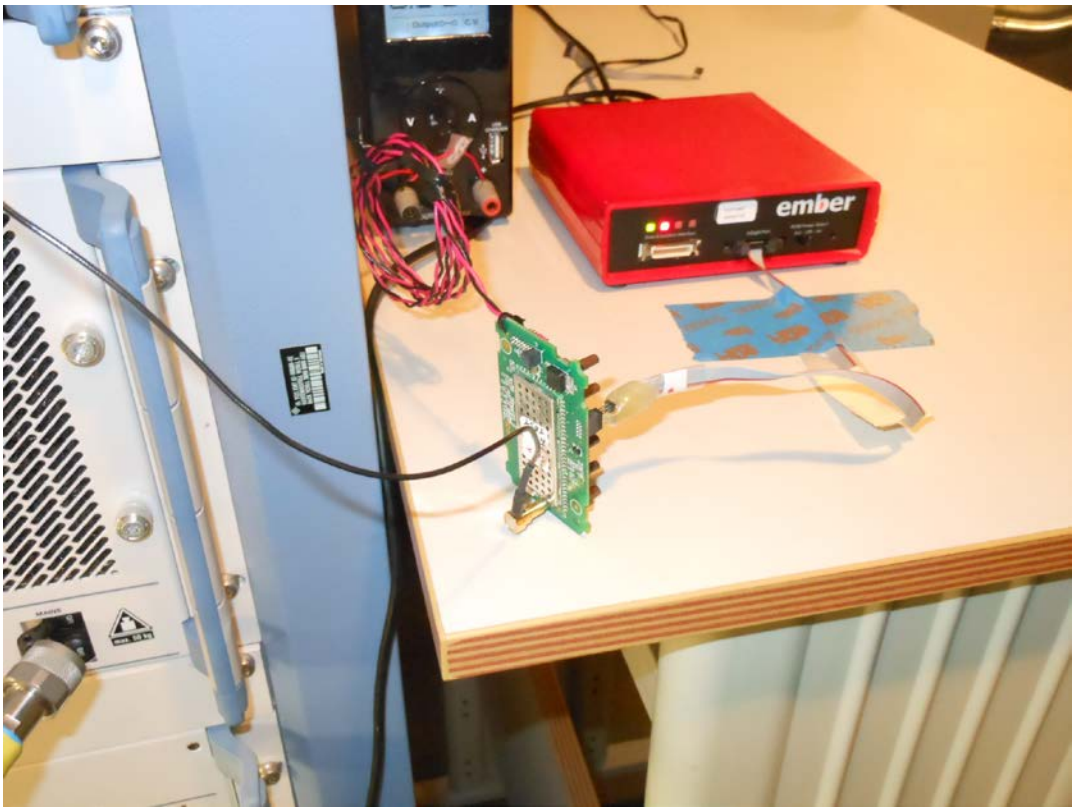


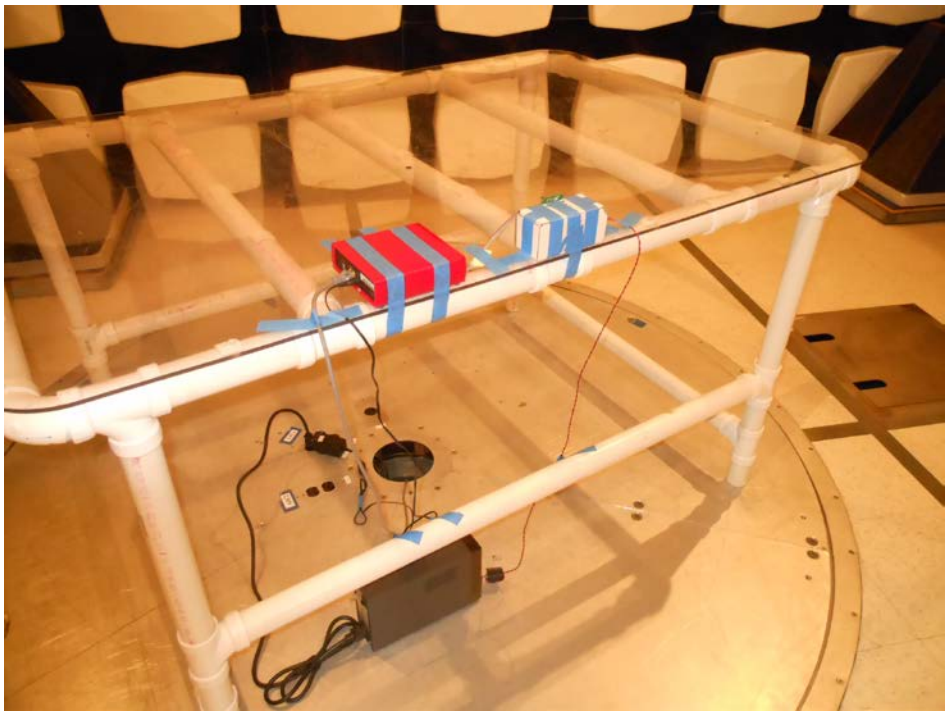
2.4 EUT Exercise Software and Mode(s) of Operation

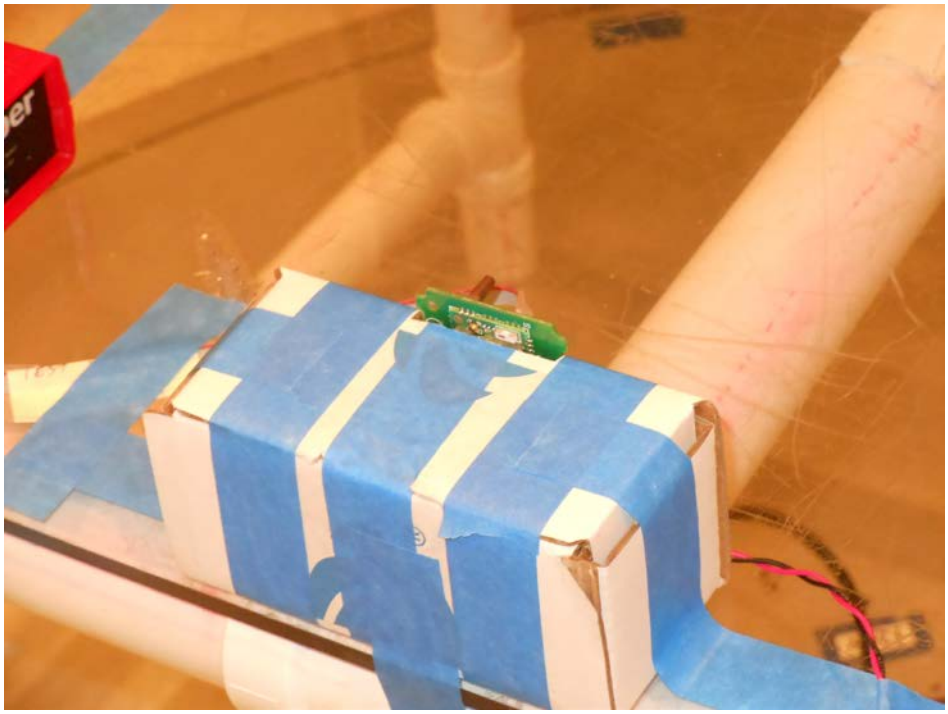
For radio Conducted and Radiated tests, the EUTs were configured to transmit continuously, with pseudorandom carrier modulation, mostly over the following channels:

Channel 11 (2405 MHz)
Channel 18 (2440 MHz)
Channel 24 (2470 MHz)
Channel 25 (2475 MHz)
Channel 26 (2480 MHz)

During radio Conducted and Radiated tests, the EUT was controlled by the Ember Box (red box in photos below), via a LAN connection to the control room PC:







Step-by-step Operating Instructions

Setup Computer:

When the computer is first used, set the DHCP OFF in computer as follows:

- **Start - Control Panel - Network Connections - Local Area Connection**
- Click **Properties**
- Check/highlight **Internet Protocol (TCP/IP)**
- Click **Properties**
- Check **Use the following IP address:**
  - IP address: 172.168.1.2
  - Subnet mask: 255.255.0.0
  - Default gateway: 172.168.1.1
- Click **OK** to exit Internet Protocol (TCP/IP) Properties
- Click **OK** to exit Local Area connection Properties
- Click **OK** to exit Local Area connection Status
- Click **X** to close Network Connections

Setup Test (Red) Box (or, Ember Box):

- Install InSight Desktop (Version: 3.0.131 (Beta) or later), if needed
- Double click **InSight Desktop** icon
- Expand **Default Group (1)**
- Right click **Ember Box (em250)** – **Connect.** The status circle next to the device name should change from grey to green.
- Right click **Ember Box (em250)** – **Load application …**
- Select/browse to **em250- rangetest.hex**
- Click **OK** to upload **em250- rangetest.hex**
- Once the upload is complete, close the upload context menu.

Step-by-step Operating Instruction for radio Conducted and Radiated tests using Ember Box

- Double click **InSight Desktop** icon
- Expand **Default Group (1)**
- Right click **Ember Box (em250)** – **Connect.** The status circle next to the device name should change from grey to green.
- Right click **Ember Box (em250)** – **Launch Console**
- Click **Series 0** tab
- Press **ENTER** until > shows up
- Set maximum power level at decimal level 0, boost mode:
  txpow 0 ('e'xit to e)
  txpowermode 1 1 ('e'xit to e)
- Set channel frequency:
  channel 0B or **channel 12** or **channel 1A** (= decimal channels11 or 18 or 26)
- Transmit only carrier
  txtone ('e'xit to e)
- Transmit constant stream of packets
  txstream ('e'xit to e)
- Set module to only receive
  receive ('e'xit to e)
- Readback the test firmware version by powering up the RF module while the computer is connected.

PA7545 Transmit Power Setup Table

EM358 Power set (dBm)	Power setting command manually- signed hexadecimal	2405 (MHz) output power (dBm)	2440 (MHz) output power (dBm)	2480 (MHz) output power (dBm)
-43	-2b	-13.970	-13.823	-14.137
-26	**-1a**	0.810	1.047	0.820
-20	-14	6.246	6.521	6.361
-17	-11	9.627	9.895	9.764
-14	-e	12.264	12.790	12.950
-12	-c	13.912	14.230	14.192
-11	-b	15.432	15.761	15.741
-9	**-9**	16.810	17.075	17.023
-8	-8	17.855	18.113	17.977
-7	-7	18.672	18.906	18.715
-6	-6	19.402	19.496	19.232
-5	-5	19.939	20.225	20.156
-4	-4	20.737	20.654	20.275
-3	-3	21.295	21.114	20.712

Power setup information

Channel 11 to 24:
Channel 25:
Channel 26:

PA7545 Channel Setup Table

Channel (decimal)	Channel (hexadecimal)	Frequency (MHz)
11	**0B**	**2405**
12	0C	2410
13	0D	2415
14	0E	2420
15	0F	2425
16	10	2430
17	11	2435
18	**12**	**2440**
19	13	2445
20	14	2450
21	15	2455
22	16	2460
23	17	2465
24	18	2470
25	19	2475
26	**1A**	**2480**

Step-by-step Operating Instruction (normal operation for duty cycle measurement):

Setup Control System (MC3):

- Load normal application firmware to MC3
- Double click Crestron **Toolbox**, found from a computer desktop
- Click **Tools – Text Console**, or click the text icon from the tool bar.
- Click pencil icon, located on the bottom of the Text Console screen
- Check **USB**
- Click **OK,** Press ENTER until **MC3>** showing up

Normal Operation for Duty Cycle Measurement:

MC3>rfchannel 11

Channel: 11
Active channel: 17

MC3>rfconfig

EZSP version: 0x04
stack type: 0x02
stack version: 0x4740
stack status: 0x02 EMBER_JOINED_NETWORK

EUI: 00 0d 6f 00 01 d8 68 0b
node type [EMBER_COORDINATOR], short ID [0000], chan [11], power [-8], panId [0xDCC7]
active mode[EMBER_TX_POWER_MODE_BOOST_AND_ALTERNATE], power [-8]
active channel: 11

MC3>Acquire start

acquire started

1. To Acquire the CLW-DIMFLVEX lighting control, do the Quad-Tap & Hold on the power on button
2. After 10 Seconds, activity LEDs are flash once, then let go of the button

MC3>[FAh][B3h] Active 000d6f000aacf4e6 01239875 Y 03 Y CLW-DIMFLVEX-230-P [v1.000.0025, #01239875] [FBh]
[00h][FAh][B3h] Active 000d6f000aacf4e6 01239875 Y 03 Y CLW-DIMFLVEX-230-P [v1.000.0025, #01239875] [FBh]
[00h]

MC3> Acquire Stop

acquire stopped

MC3>[FAh][B1h] Acquire Ended.[FBh]

Client (EUT) sends packets to the control system (MC3).

MC3>**testpacket 0 all 5000 56 0** (ACTIVITY LED turns on, green)
MC3>**testpacket ?**
Trigger test packets by TSID
TESTPACKET [mode] [TSID|ALL] [num packets] [packet length] [delay between packets]
Mode - **0** - client sends packets to gateway; **1** - gateway sends packets to client(s)

TSID - device TSID <########>
ALL - all devices, Num packets - [0 - 65535], Packet length - [0 - 56], Delay between packets - [0 – 65535]

2.5 Cables

Qty	Description	Length (m)	From - To	Shielded/ Unshielded
1	Cat5 (Crossover)	15	Ember Box – LAN switch	Unshielded
1	10-conductor Ribbon Cable	0.25	Ember Box – EUT	Unshielded
1	AWG#18	1	DC Power Supply – EUT	Unshielded

2.6 Special Accessories

No special accessories used.

2.7 Support equipment

No	Description	Manufacturer	Model No	Serial No
1	Computer	Dell	Optiplex 3010	16844225977
2	DC Power Supply	BK Precision	1550	15501107
3	Test (Red) Box	None	Ember	N/A
4	Wireless Gateway	Crestron	MC3	
5		Crestron	INET-CBDEX-P W/O	15347719

2.8 Equipment Modification

There were no modifications installed during compliance measurements.

2.9 Test Equipment

Equipment Type	Frequency Range	Make	Model No.	Serial No.	Cal. Done by	Cal. Date	Cal. Due Date
EMI Receiver	20Hz–40GHz	R&S	ESU40	100076	R & S	10/06/2016	10/06/2017
Bilog Antenna	30MHz–2GHz	Teseq	CBL 6112D	25231	Liberty Labs, Inc	10/13/2016	10/13/2018
Double Ridge Horn Antenna	1GHz–18GHz	ETS-Lindgren	3117	00047560	Liberty Labs, Inc	10/18/2016	10/13/2018
Preamplifier	1GHz–18GHz	R&S	TS-PR18	100044	Liberty Labs, Inc	10/18/2016	10/18/2018
ETS-Lindgren Standard Gain Rectangular Horn Antenna	18GHz–26.5GHz	ETS-Lindgren	3160-09	00078911	Liberty Labs, Inc	10/11/2016	10/11/2018
Preamplifier	18GHz–26.5GHz	R&S	TS-PR26	100030	Liberty Labs, Inc	10/11/2016	10/18/2018
LISN	150KHz-30MHz	R&S	ENV-216	101122	Liberty Labs, Inc.	10/12/2016	10/12/2017

All instruments are calibrated in accordance with the manufacturer's recommendations.
All antennas are calibrated per ANSI C63.5.
All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration system.

3. Test Results

3.1 Compliance Statement

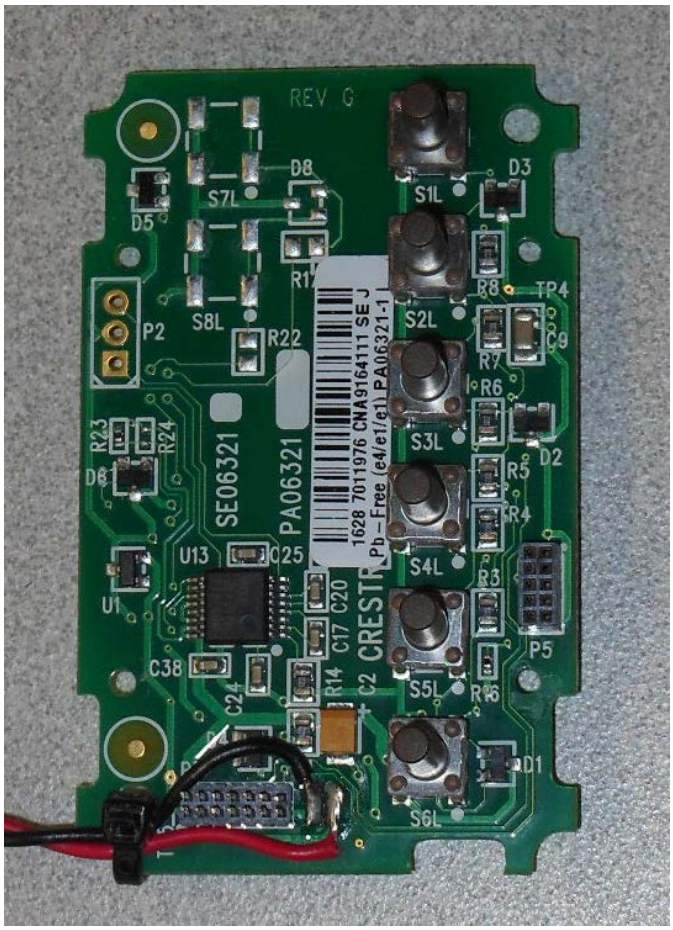
Rule Section		Description	Date of Test (mm/dd/yy)	Test Engineer	Results
FCC	IC				
§15.203	§8.3 of RSS-Gen	Antenna Requirement	-	-	Complies
§15.247(a)(2)	§5.2(1) of RSS-247	6 dB Bandwidth, 500 kHz	10/12/2016	Hirayr M. Kudyan	Complies
N/A	§6.6 of RSS-Gen	99% Occupied Bandwidth	10/12/2016	Hirayr M. Kudyan	(for reporting purpose)
§15.247(b)(3)	§5.4(4) of RSS-247	Power Output, conducted, 1 Watt (30dBm)	10/12/2016 11/1/2016	Hirayr M. Kudyan	Complies
§15.247(d)	§A5.5 of RSS- 247	Band Edge	10/13/2016	Hirayr M. Kudyan	Complies
§15.247(d)	§5.5 of RSS-247	Conducted Spurious Emissions, -20 dBc	10/13/2016	Hirayr M. Kudyan	Complies
§15.247(e)	§5.2(2) of RSS-247	Power Spectral Density (PSD), 8 dBm in any 3 kHz band.	10/13/2016	Hirayr M. Kudyan	Complies
§15.205, §15.209, §15.247(d)	§5.5 of RSS-247; §8.9 of RSS-Gen	Radiated Spurious Emissions	10/12, 10/13, 10/24, 10/27, 10/28, 10/31, 11/1, 11/2 /2016	Hirayr M. Kudyan	Complies*
§15.207	§8.8 of RSS-Gen	Transmitter AC Power Line Conducted Emissions	10/25/2016	Hirayr M. Kudyan	Complies

*See limitation on Channel 26 power level setting to meet Upper Band Edge criteria under Radiated Spurious Emissions.

Note:
The channels selected for test were 11, 18, 24, 25 and 26.

3.2 Antenna Requirements

This EUT uses a 2.4GHz Surface Mount, Above Metal, Low Profile Mini Chip Antenna (Johanson Technology P/N 2450AT42E0100) embedded into its PCB (see photos below).



The antenna chip cannot be replaced externally and is compliant with FCC §15.203, §15.204(b), and §15.204(c).

The Peak Gain of the antenna is -2.0 dBi.

The relevant parts of antenna document are exhibited below for more details:

CRESTRON

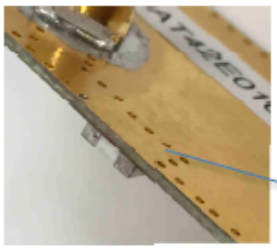
"High Frequency Ceramic Solutions"

2.4 GHz Surface Mount, Above Metal, Low Profile Mini Chip Antenna **P/N 2450AT42E0100**

This antenna must have metal directly underneath on bottom layer in order to function properly

Detail Specification: 1/21/2016 Page 1 of 8

General Specifications	
Part Number	2450AT42E0100
Frequency (MHz)	2400 - 2480
Peak Gain	-2.0 dBi typ. (YZ-V)
Impedance	50Ω
Return Loss	4.5 dB min.
Power Capacity	2W max. (CW)
Q'ty/Reel (pcs)	2,000 pcs
Operating Temp	-40 to +85°C
Storage Temp	-40 to +85°C
Storage Period	18 months max.



Patent Pending

Antenna mounts directly above or below the metal layer of PCB. No antenna clearance required ever again!

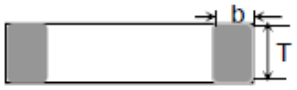
Total average radiated efficiency on PCB feature on "Mounting Considerations 1" (orderable EVB p/n: 2450AT42E0100-EB1SMA) is ~30%

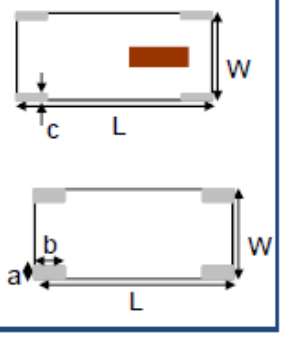
This antenna was designed in mind for small coin cell, wearable, IoT, 2.4 BLE, 802.11, ISM, Zigbee, etc. applications in close-range networks where metal or a battery/display covers the entire length or side of the PCB or encasement must be present directly under the antenna and there's no room for usual/typical antenna metal clearance.

Part Number Explanation				
P/N Suffix	Packing Style	Bulk	Suffix = S	e.g.. 2450AT42E0100S
		T & R	Suffix = E	e.g.. 2450AT42E0100E
	EVB p/n	2450AT42E0100-EB1SMA (comes with 1 female SMA connector)		

Mechanical Specifications

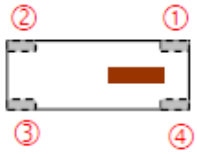
	In	mm
L	0.197 ± 0.008	5.00 ± 0.20
W	0.079 ± 0.008	2.00 ± 0.20
T	0.059 ± 0.008	1.50 ± 0.20
a	0.020 ± 0.008	0.50 ± 0.20
b	0.059 ± 0.008	1.50 ± 0.20
C	0.012 max	0.30 max





Terminal Configuration

1	Feeding Point
2	NC[1]
3	GND
4	GND



[1]Make sure to have Pin 2 soldered to its PCB land pad but **not** connected to GND or input, it must be NC (or floating).

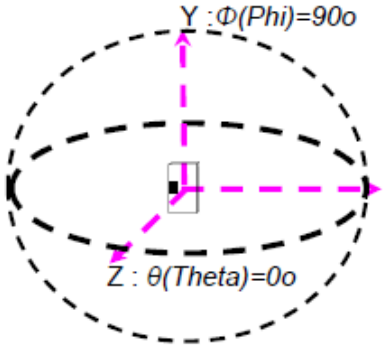
JOHANSON TECHNOLOGY

www.johansontechnology.com

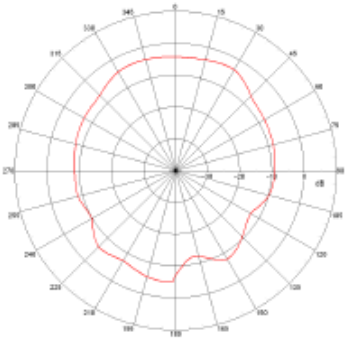
4001 Calle Tecate • Camarillo, CA 93012 • TEL 805.389.1166 FAX 805.389.1821

Ver. 2.2

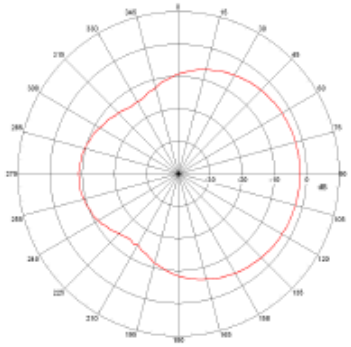
Typical Electrical Characteristics (T=25 °C) Radiation Patterns@2.44GHz



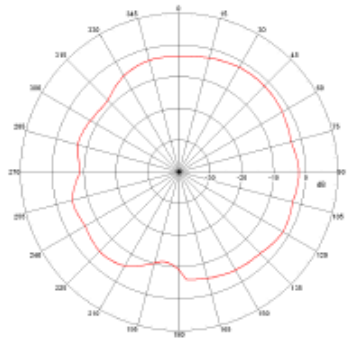
XY-plane @2440MHz
Total



XZ-plane @2440MHz
Total



YZ-plane @2440MHz
Total



JOHANSON TECHNOLOGY
www.johansontechnology.com
4001 Calle Tecate • Camarillo, CA 93012 • TEL 805.389.1166 FAX 805.389.1821

3.3 6 dB bandwidth

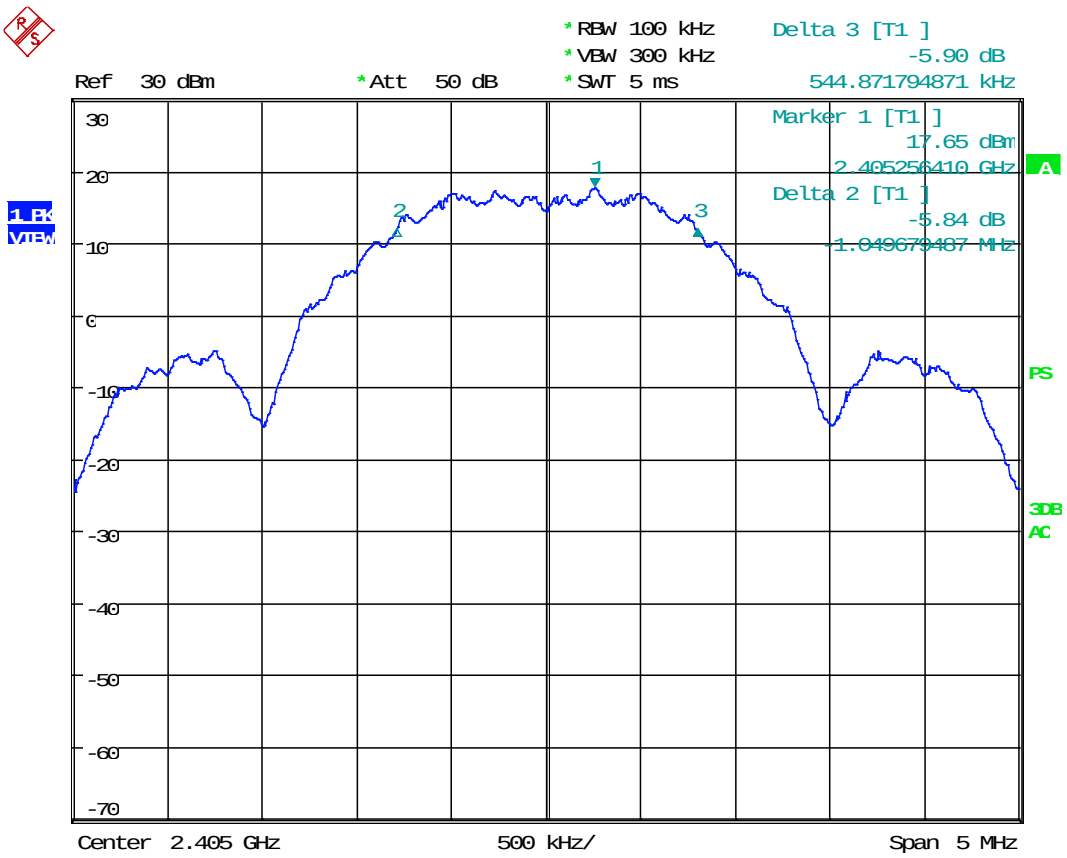
Criterion: The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure: Per 558074 D01 DTS Meas Guidance v03r02 § 8.

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 × RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

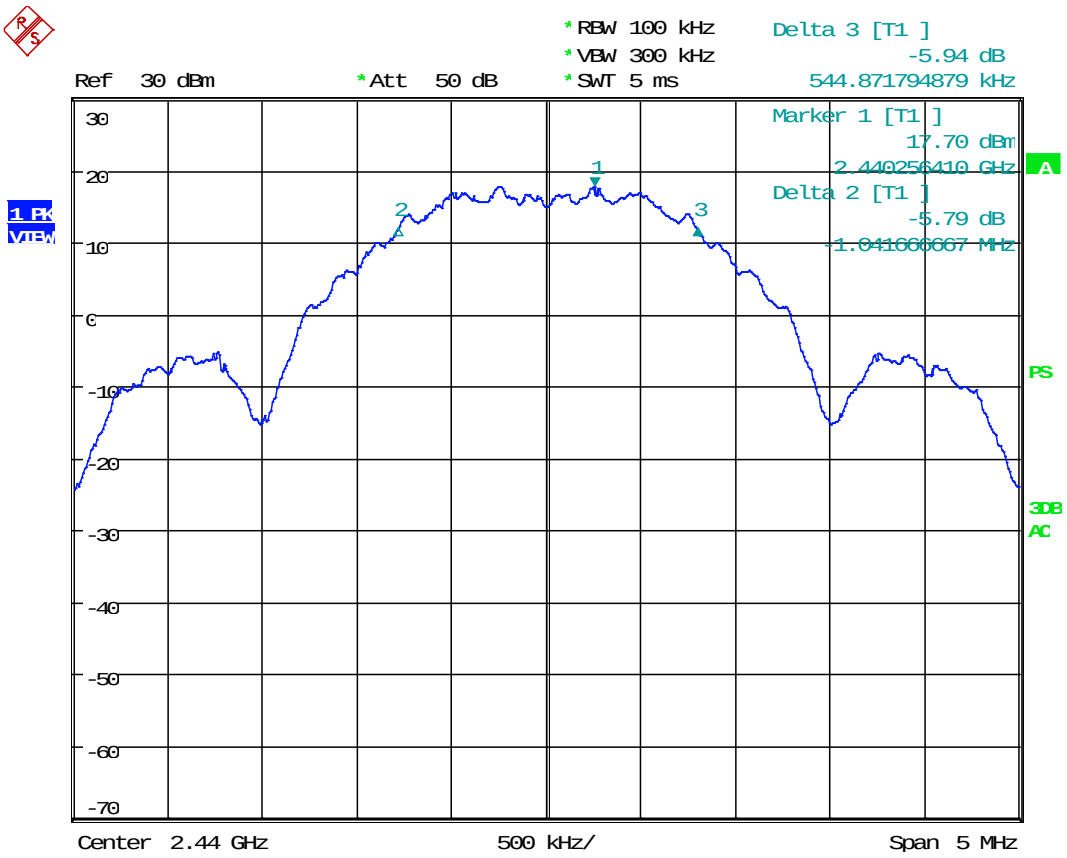
Channel	Frequency(MHz)	6 dB Bandwidth(kHz)
11	2405	1594.6
18	2440	1586.5
26	2480	1594.6

6 dB Bandwidth, Channel 11:

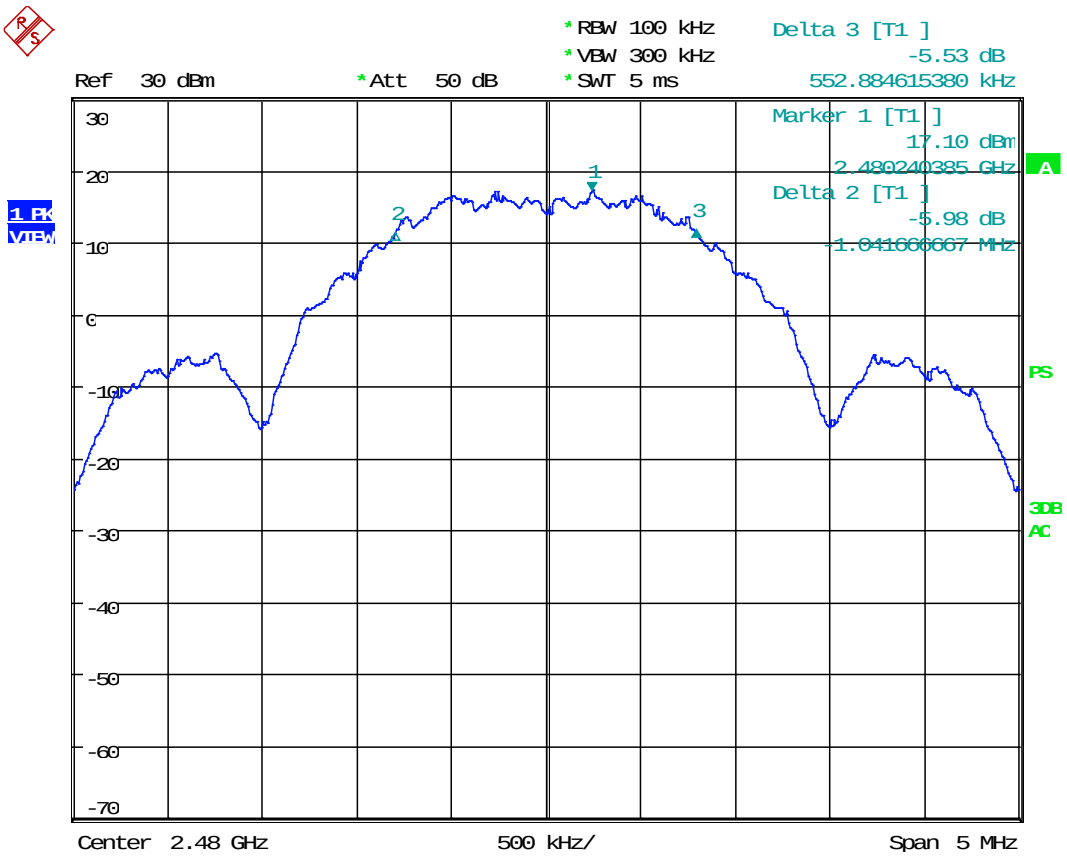


Date: 12.OCT.2016 17:14:09

6 dB Bandwidth, Channel 18:



6 dB Bandwidth, Channel 26:

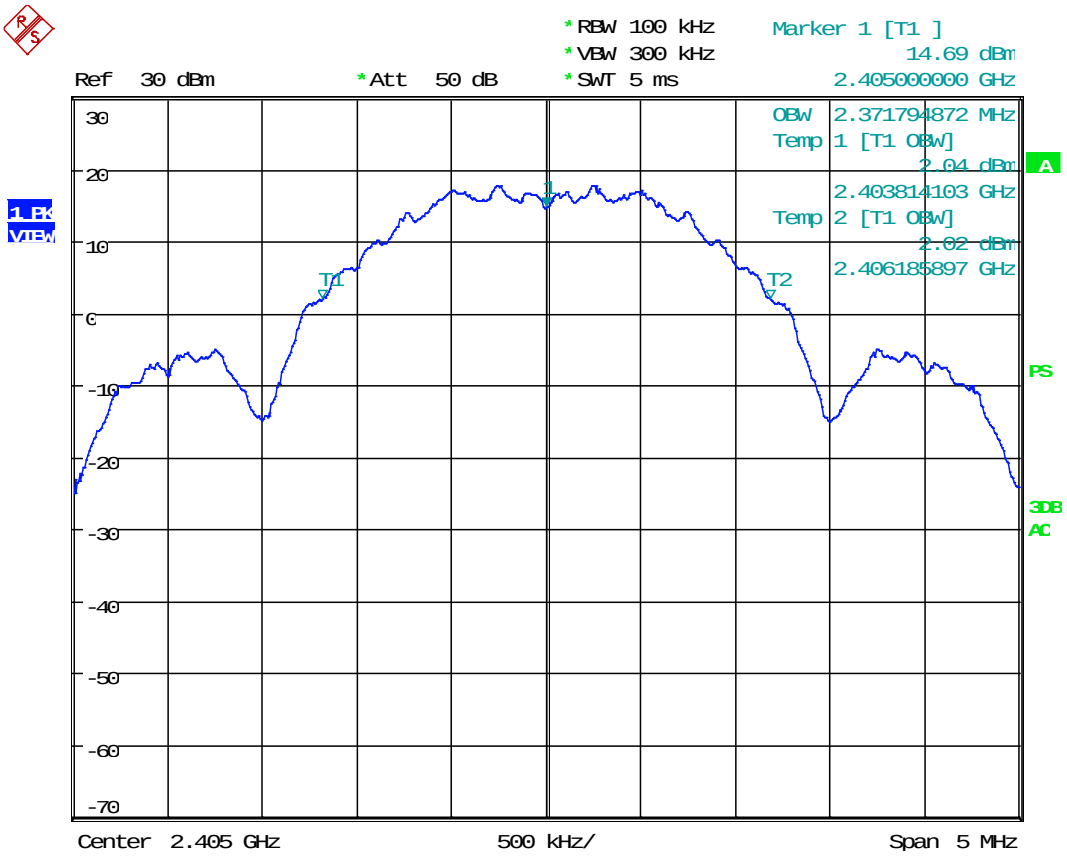


3.2 99% (Occupied Channel) Bandwidth

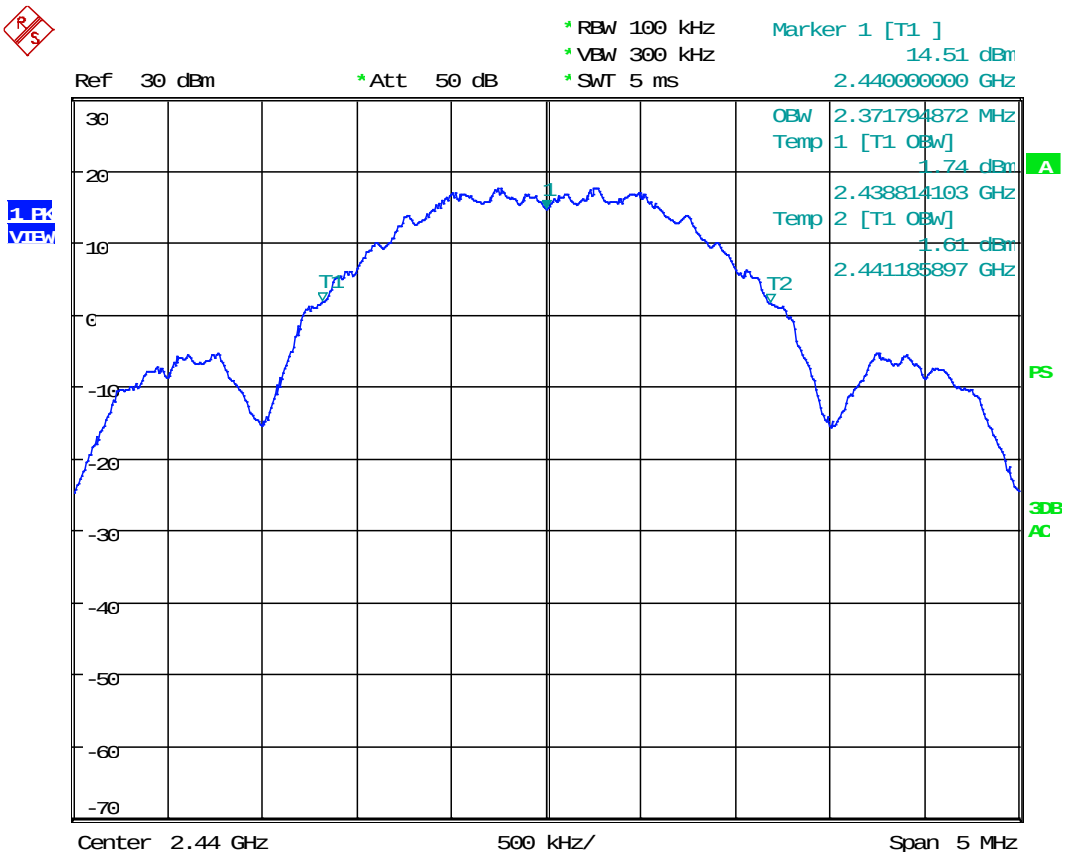
Performance Criterion: The 99% Bandwidth (OBW) of each channel carrier will fall within the 5MHz nominal bandwidth of the corresponding channel.

Channel	Frequency(MHz)	99% Bandwidth(MHz)
11	2405	2.372
18	2440	2.372
26	2480	2.396

99% Bandwidth, Channel 11:

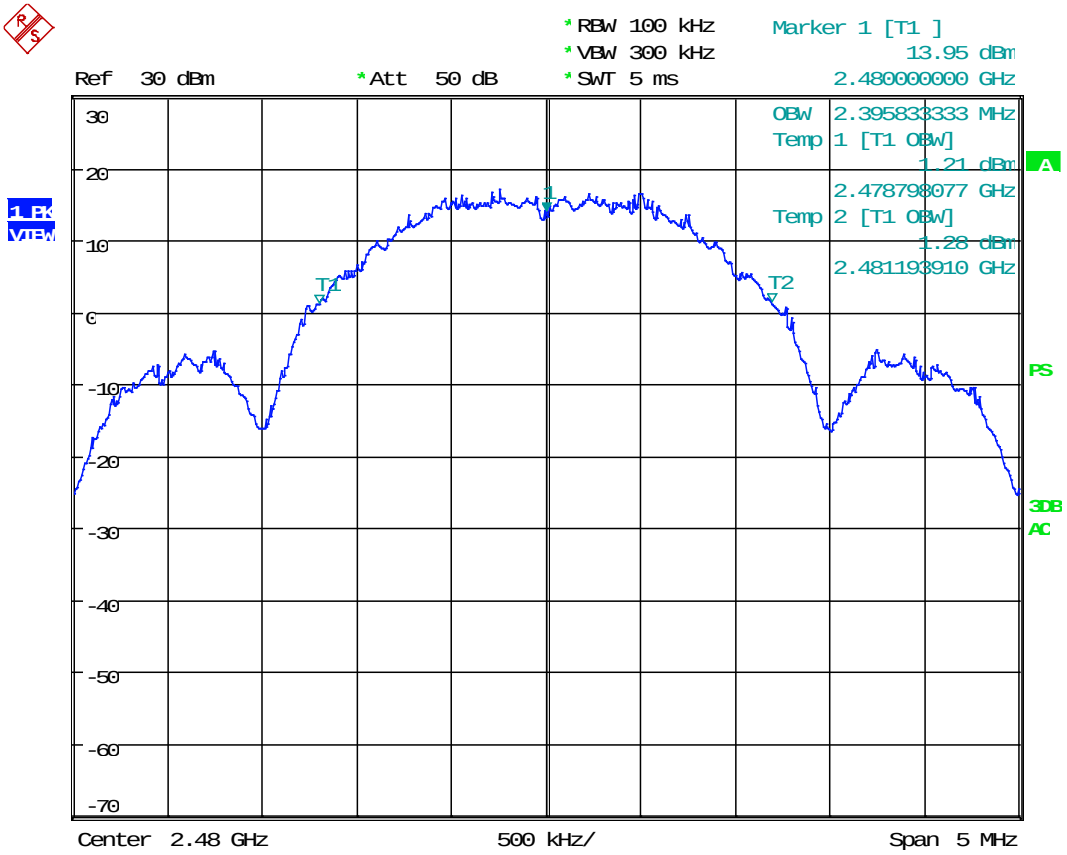


99% Bandwidth, Channel 18:



Date: 12.OCT.2016 17:07:18

99% Bandwidth, Channel 26:



Date: 12.OCT.2016 16:52:14

3.3 Power Output

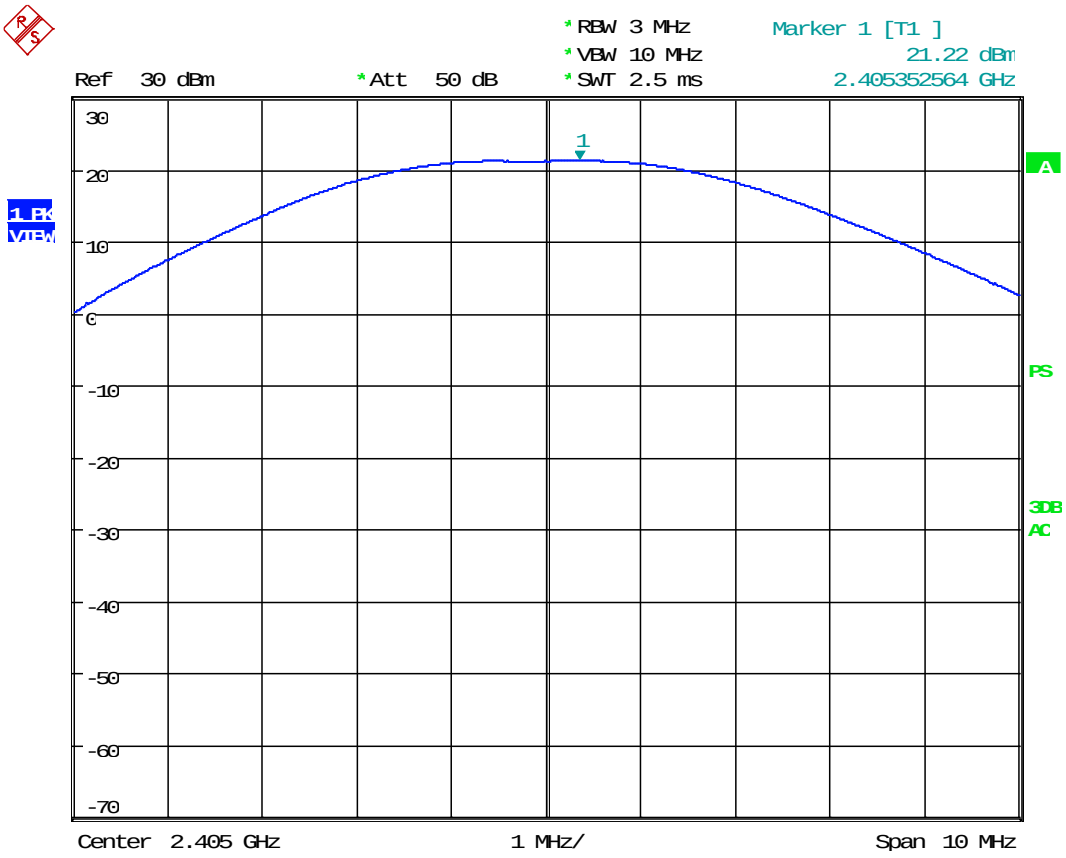
Criterion: The maximum peak conducted output power shall not exceed 1 Watt or 30 dBm

Test Procedure: Per 558074 D01 DTS Meas Guidance v03r02 § 9.1.1

a) Set the RBW ≥ *DTS bandwidth*.
b) Set VBW ≥ 3 × RBW.
c) Set span ≥ 3 x RBW
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

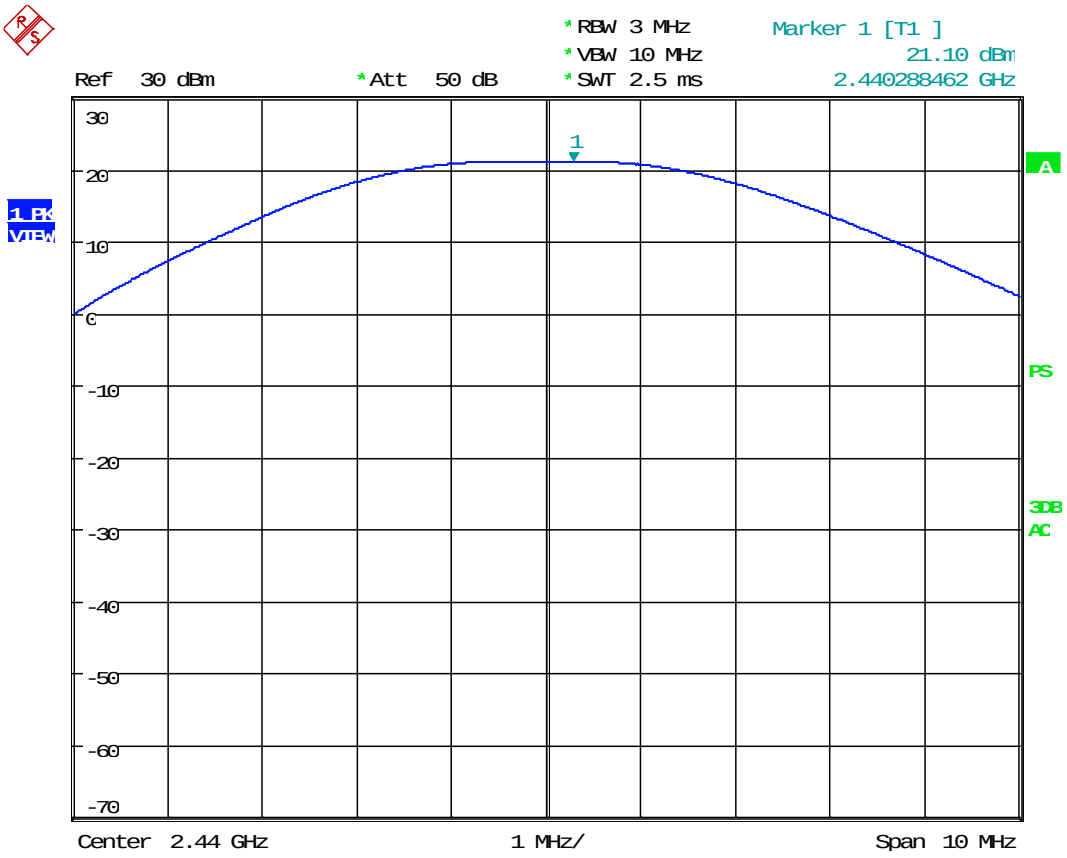
Channel	Frequency(MHz)	Output Power Level Setting Command (decimal)	Measured Power	
			dBm	mW
11	2405	253	21.22	132.43
18	2440	253	21.1	128.82
24	2470	253	20.92	123.59
25	2475	253	20.77	119.40
26	2480	234	5.96	3.94

Power Output, Channel 11:



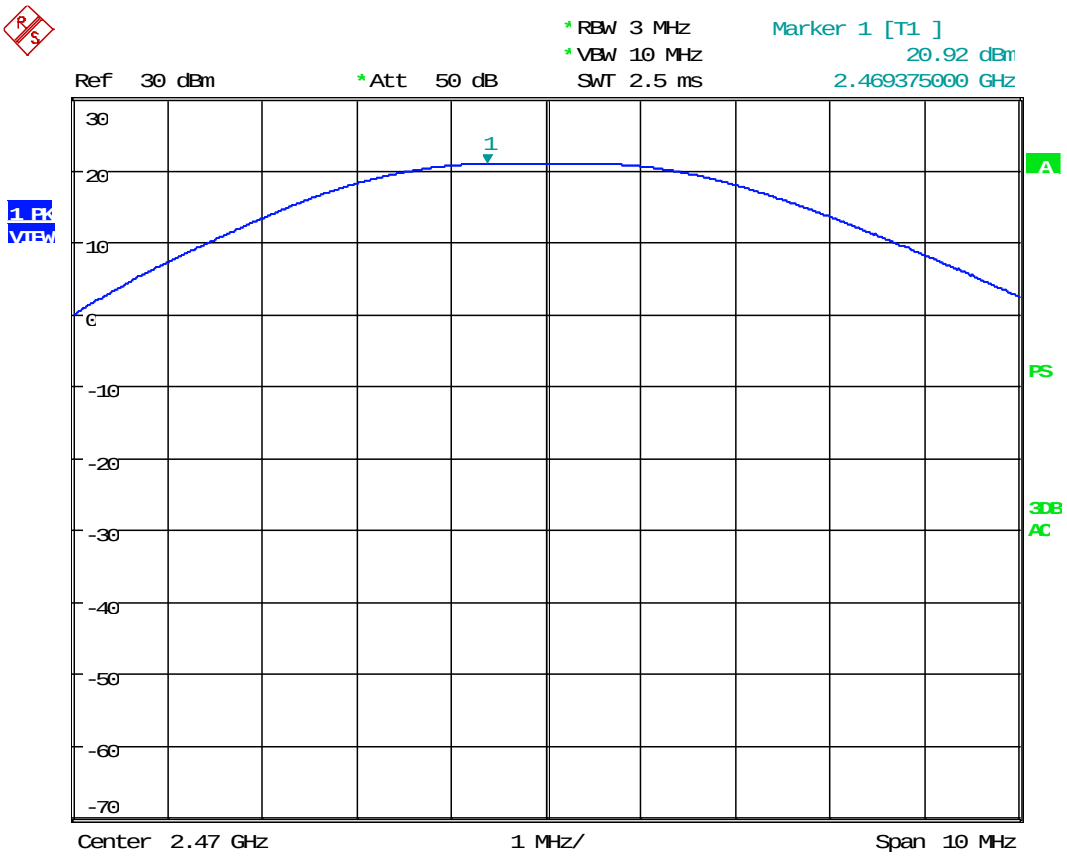
Date: 12.OCT.2016 16:36:21

Power Output, Channel 18:



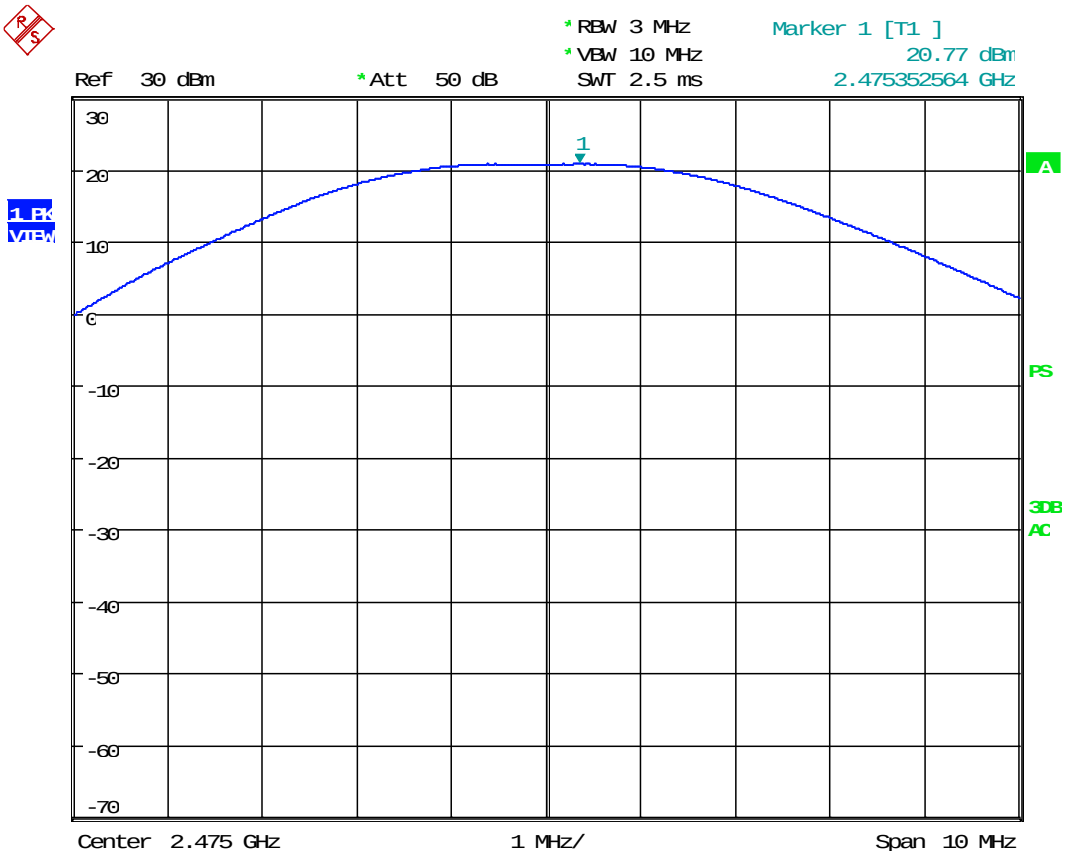
Date: 12.OCT.2016 16:39:32

Power Output, Channel 24:



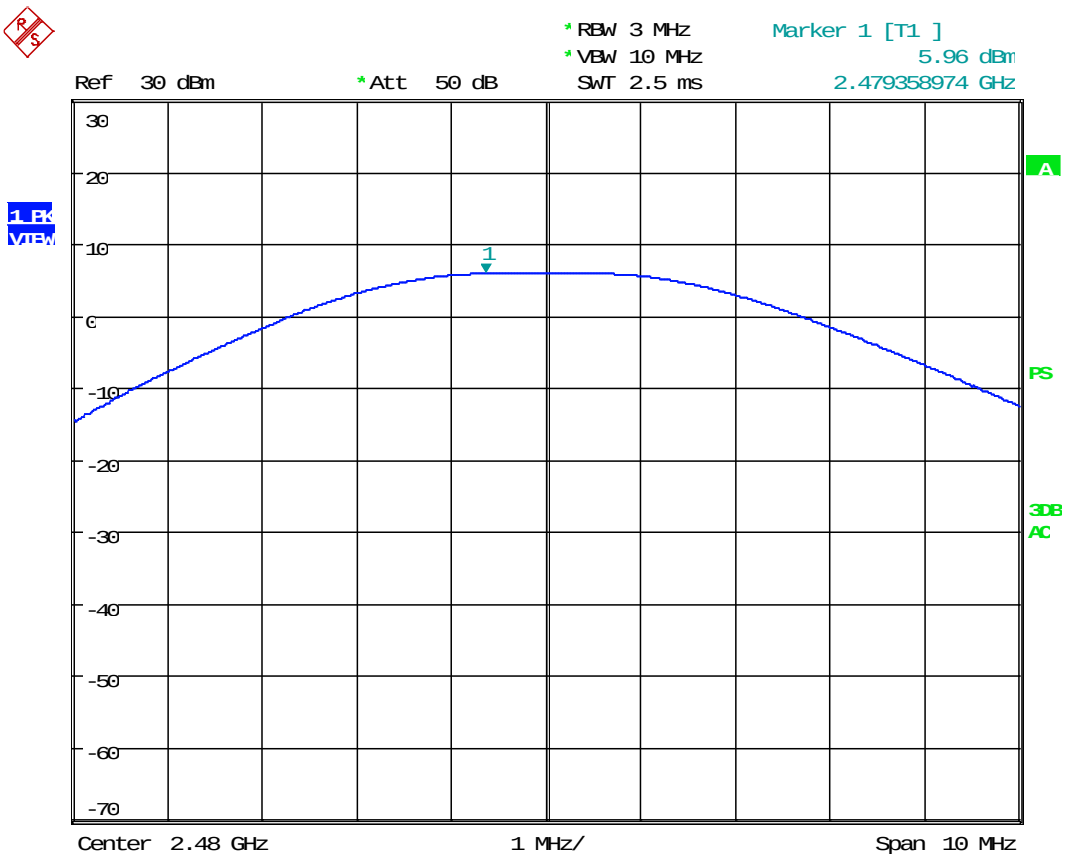
Date: 13.OCT.2016 15:42:41

Power Output, Channel 25:



Date: 13.OCT.2016 15:48:11

Power Output, Channel 26:



Date: 1.NOV.2016 15:37:57

3.4 Band Edge Conducted

Criterion: In any 100 kHz bandwidth outside the frequency band, the RF power shall be at least 20 dB below that in the 100 kHz bandwidth within the band.

Test Procedure: Per 558074 D01 DTS Meas Guidance v03r02 § 11

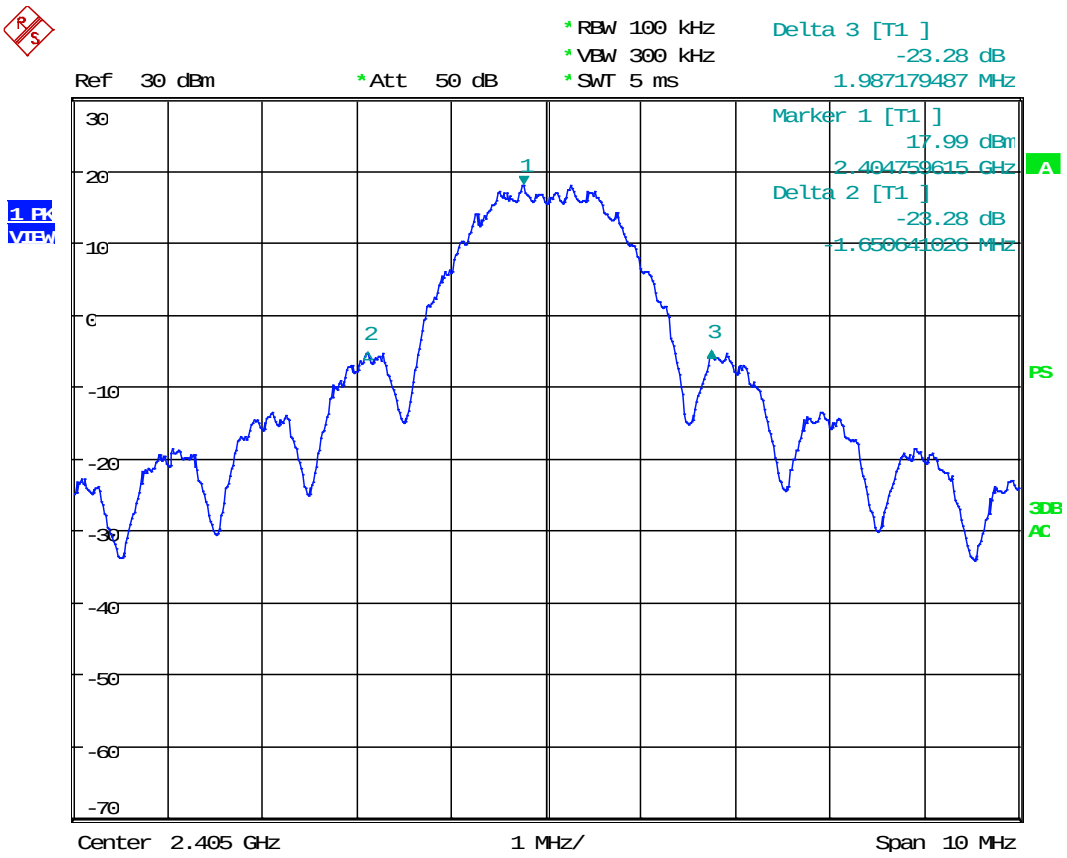
The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

a) If the maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (*i.e.*, 20 dBc).

b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (*i.e.*, 30 dBc).

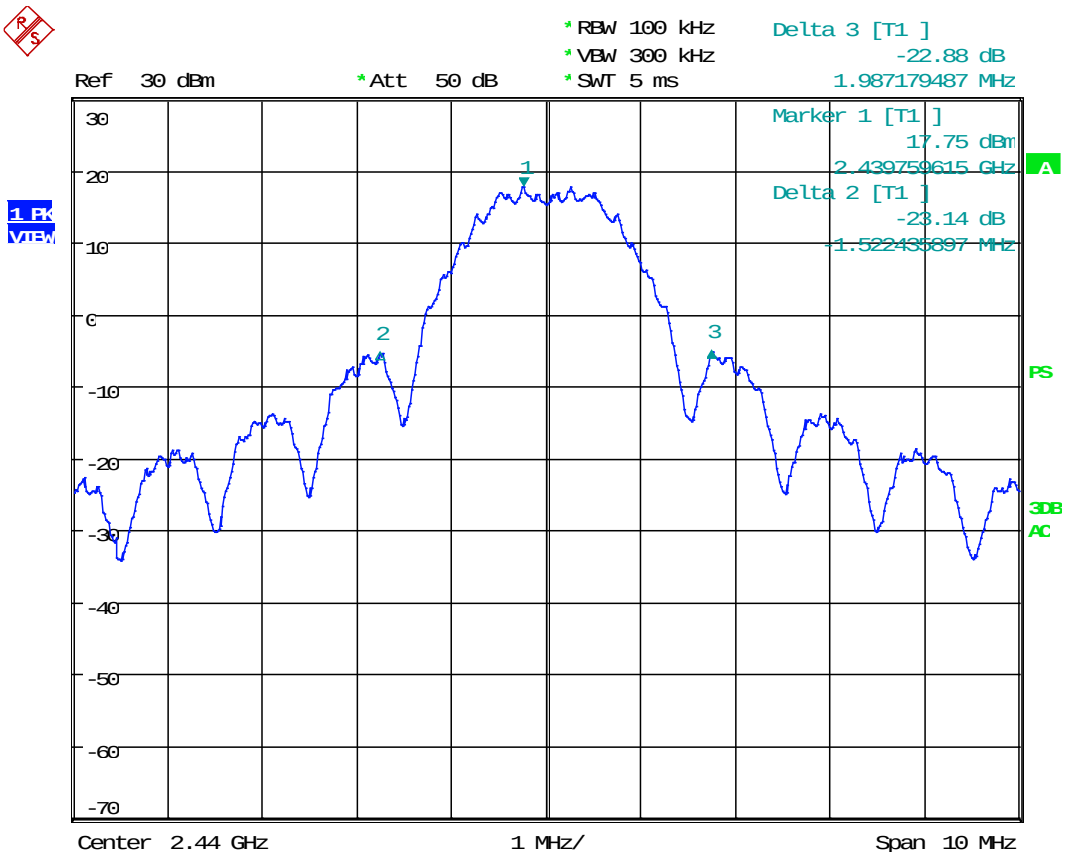
c) In either case, attenuation to levels below the 15.209 general radiated emissions limits is not required.

Band Edge, Channel 11:



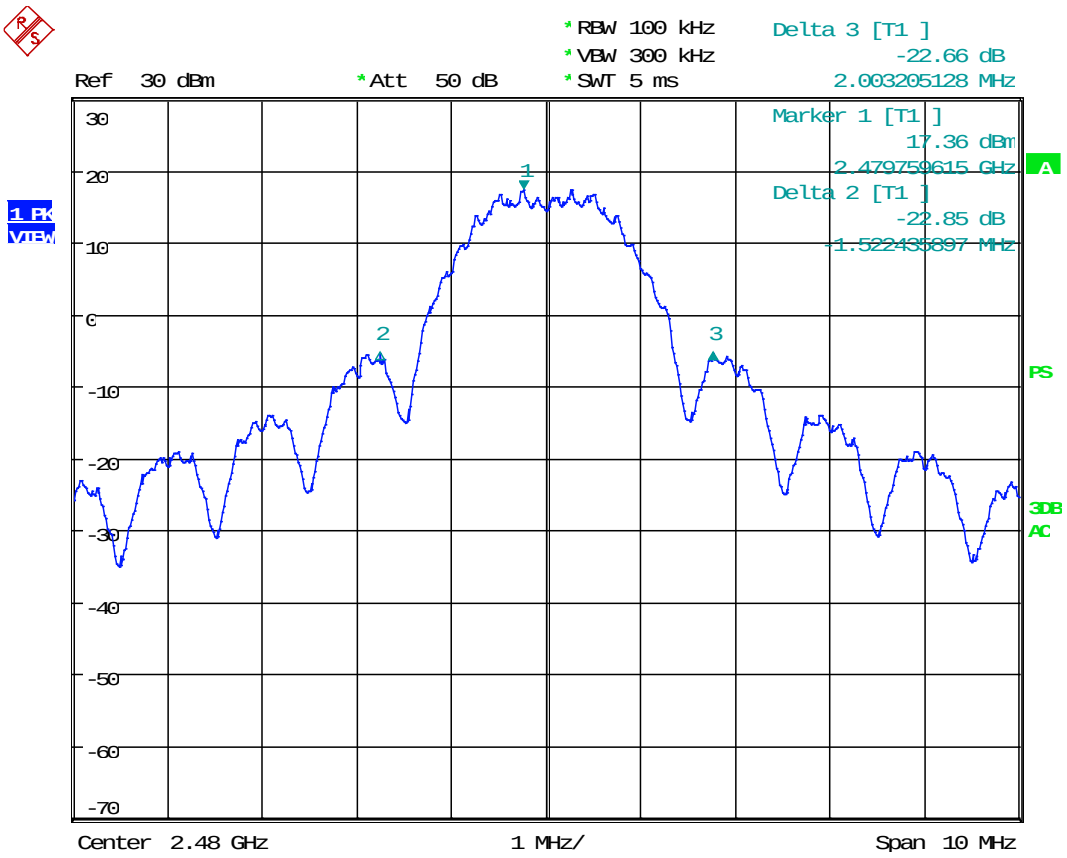
Date: 13.OCT.2016 11:01:00

Band Edge, Channel 18:



Date: 13.OCT.2016 11:06:11

Band Edge, Channel 26:



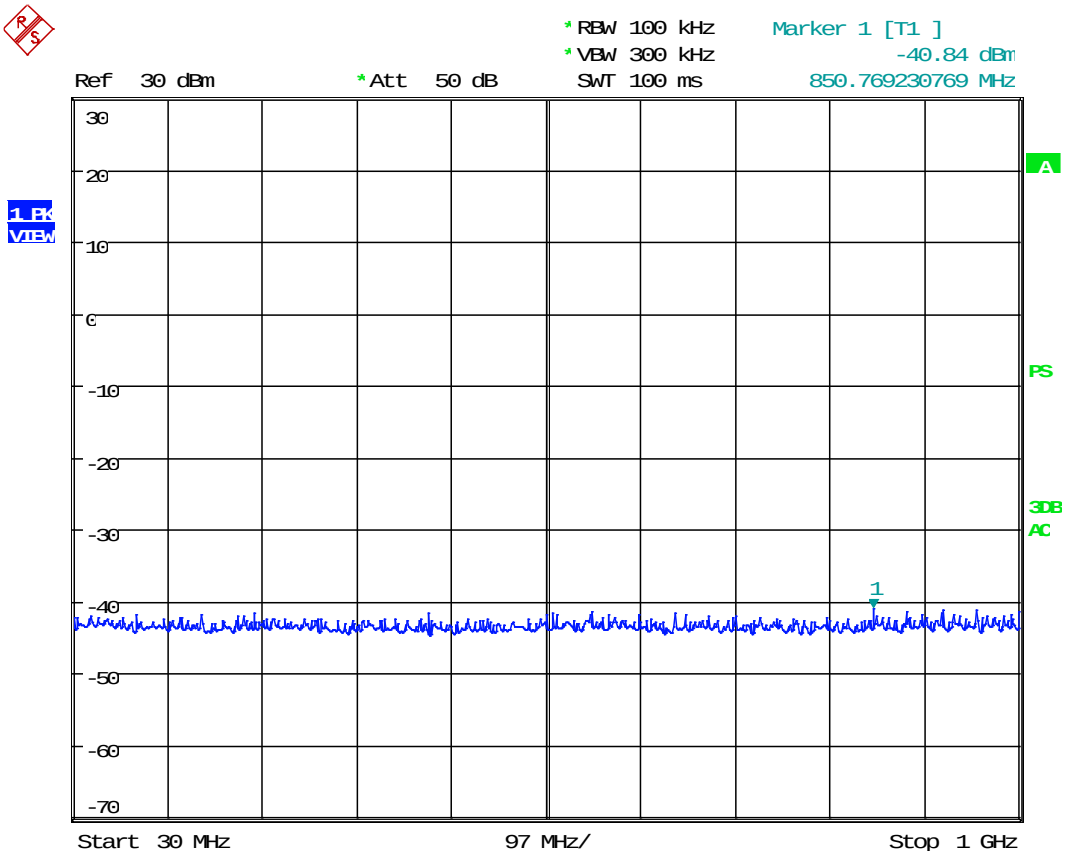
Date: 13.OCT.2016 11:13:40

3.5 Conducted Spurious Emissions

Criterion: In any 100 kHz bandwidth outside the frequency band, the RF power shall be at least 20 dB below that in the 100 kHz bandwidth within the band.

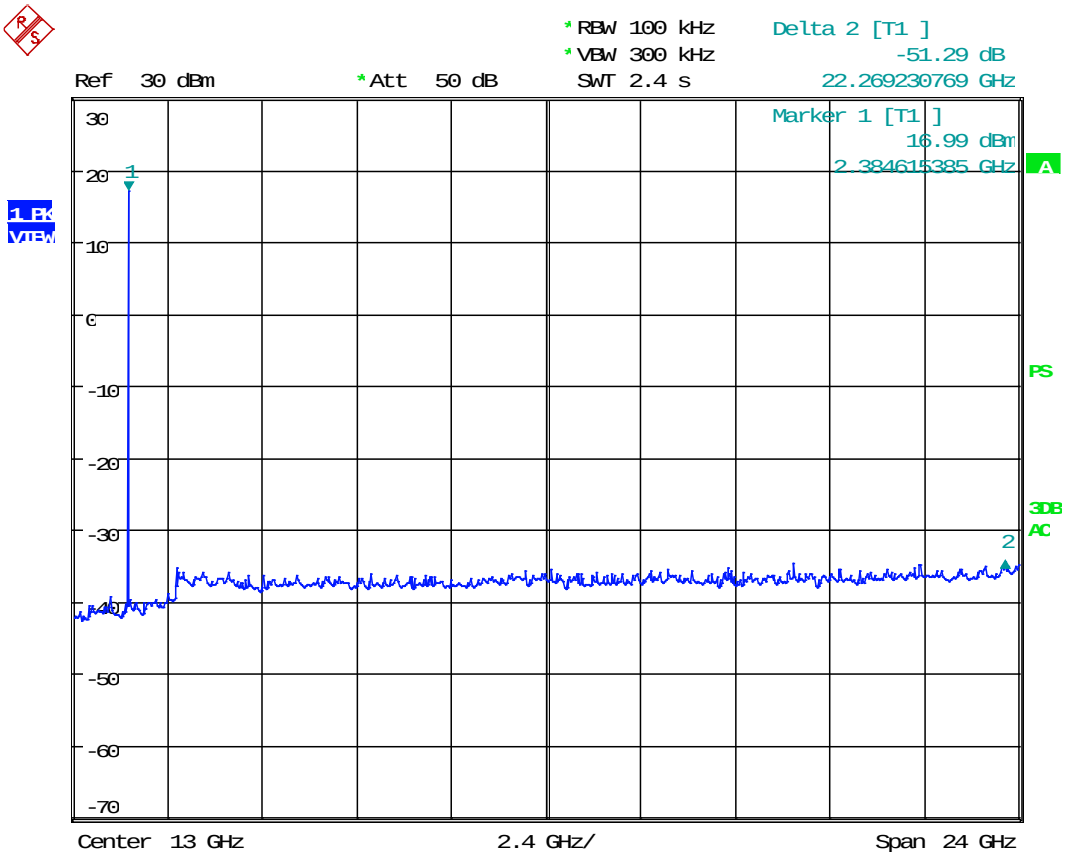
Test Procedure: Per 558074 D01 DTS Meas Guidance v03r02 § 11

Conducted Spurious Emission, 30MHz to 1GHz, Channel 11:



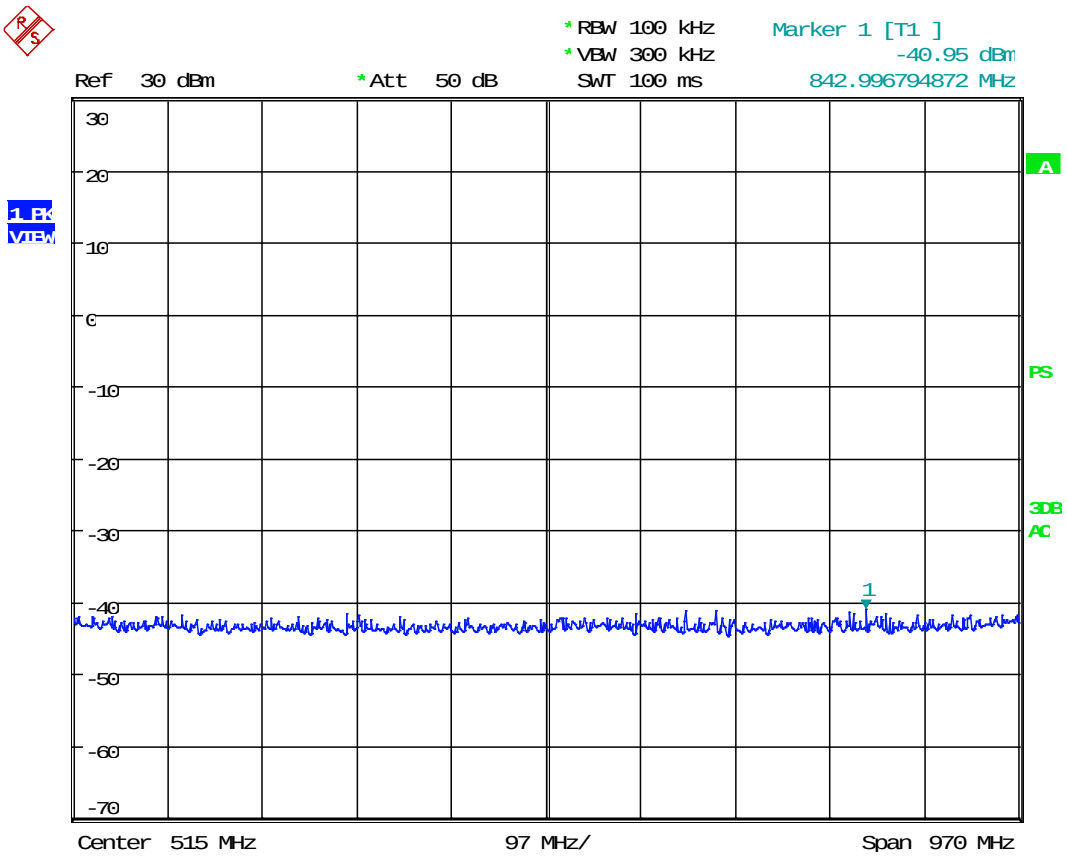
Date: 13.OCT.2016 12:20:24

Conducted Spurious Emission, 1GHz to 25GHz, Channel 11:



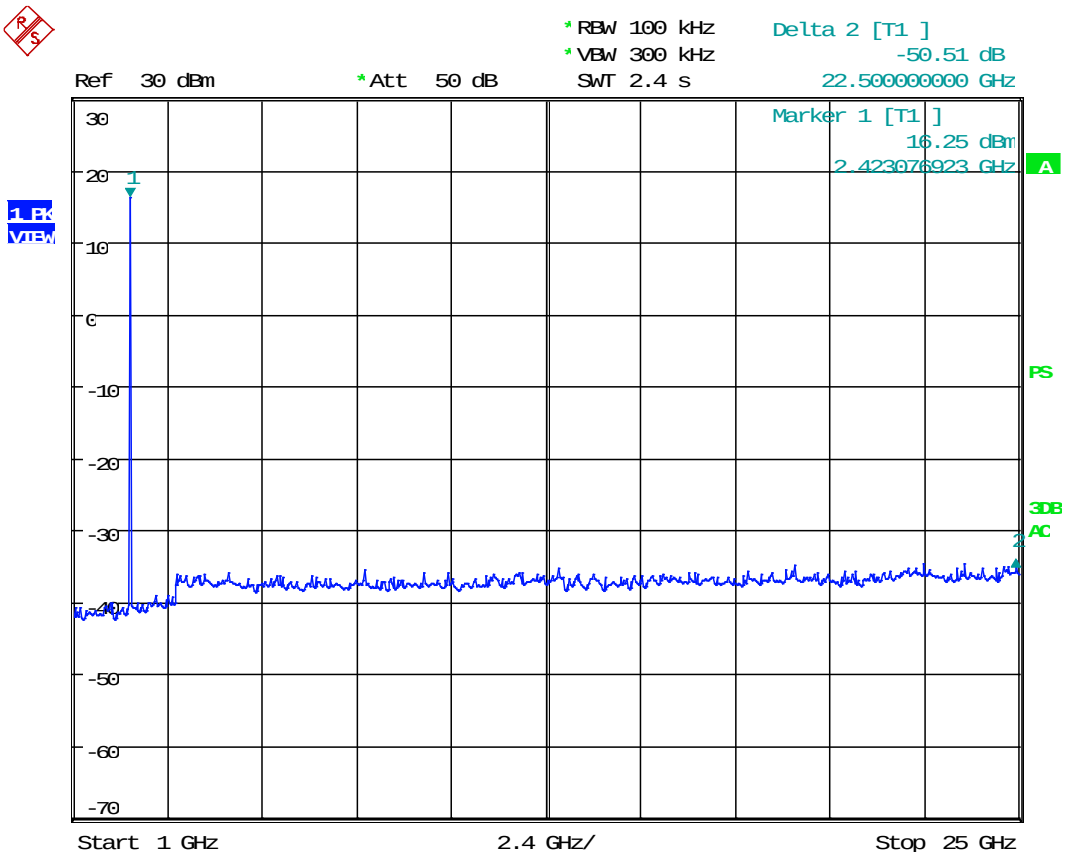
Date: 13.OCT.2016 12:47:28

Conducted Spurious Emission, 30MHz to 1GHz, Channel 18:



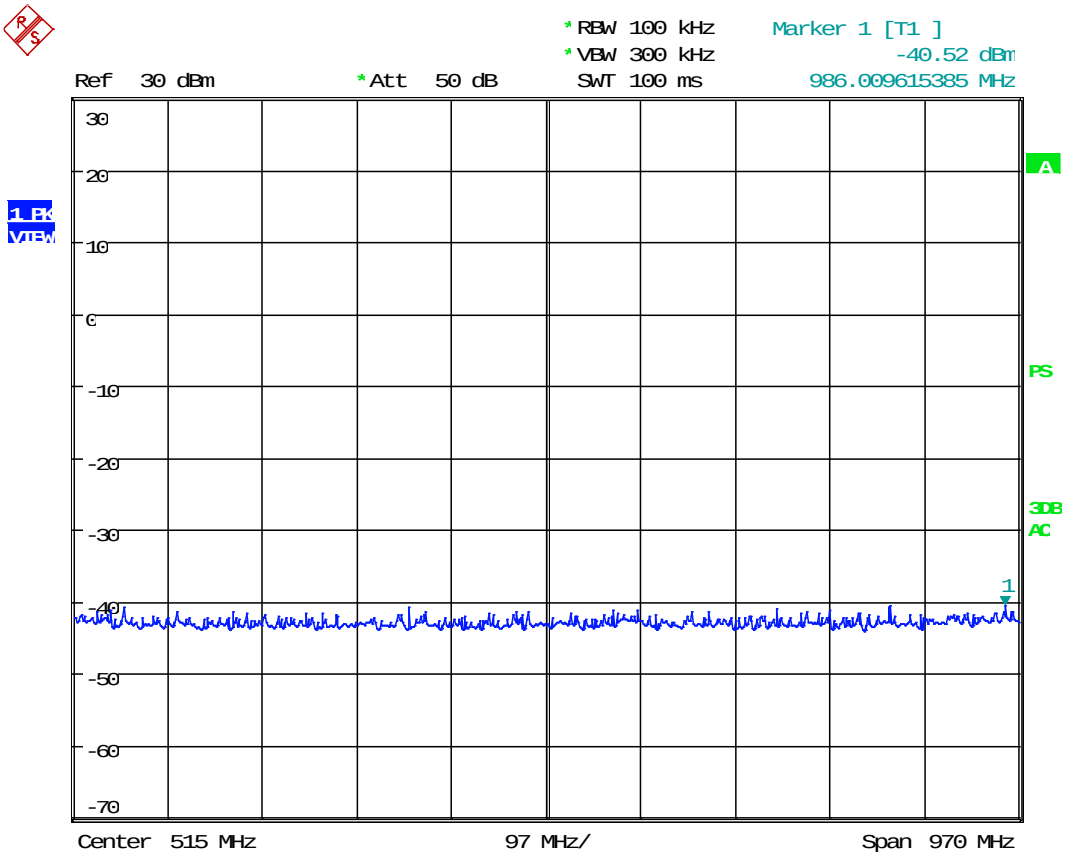
Date: 13.OCT.2016 12:24:59

Conducted Spurious Emission, 1GHz to 25GHz, Channel 18:



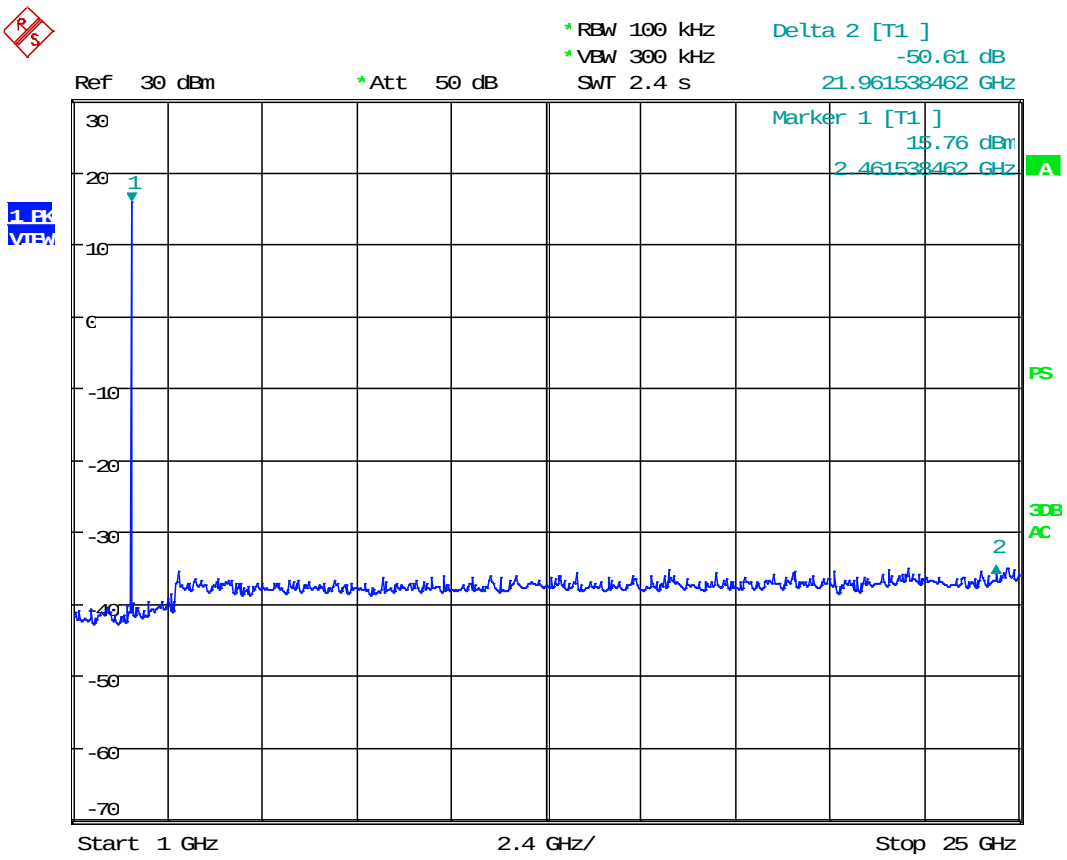
Date: 13.OCT.2016 12:55:40

Conducted Spurious Emission, 30MHz to 1GHz, Channel 26:



Date: 13.OCT.2016 12:28:07

Conducted Spurious Emission, 1GHz to 25GHz, Channel 26:



Date: 13.OCT.2016 12:58:38

3.6 Power Spectral Density

Criterion: The Power Spectral Density shall not be greater than 8dBm in any 3 KHz band.

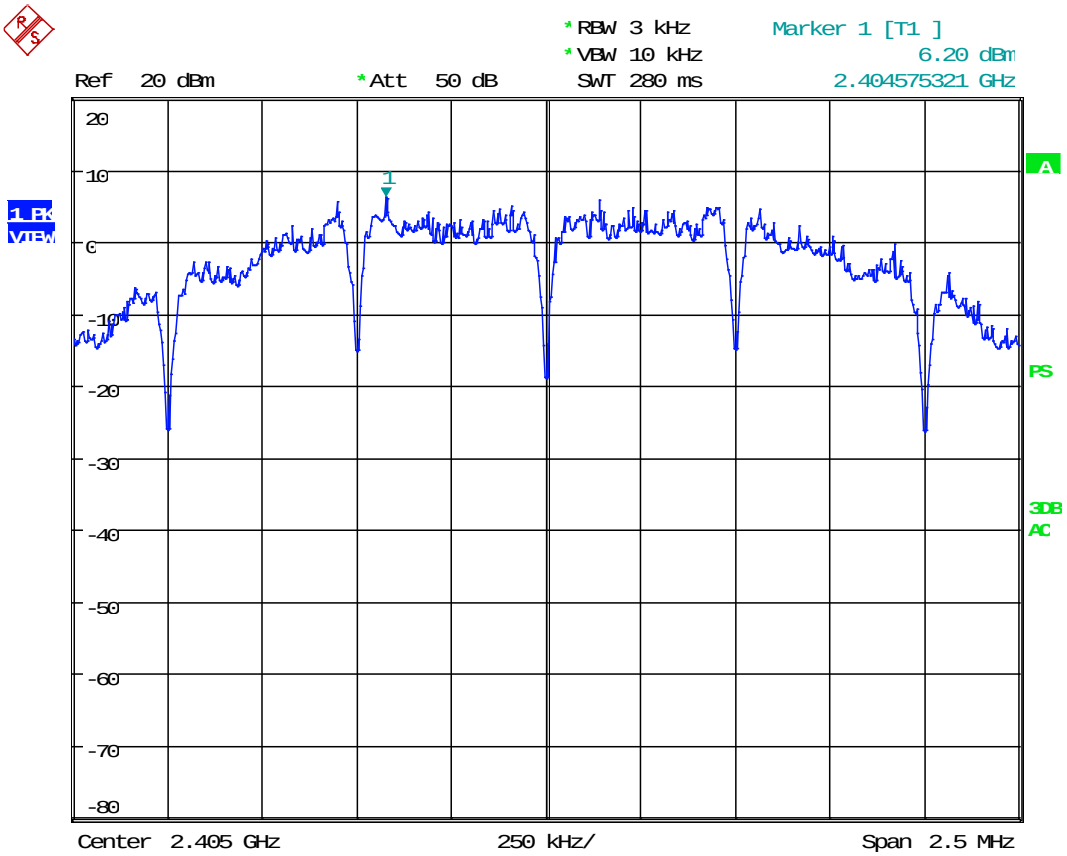
Test Procedure: Per 558074 D01 DTS Meas Guidance v03r02 § 10.2

Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the *DTS bandwidth*.
c) Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 3 × RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

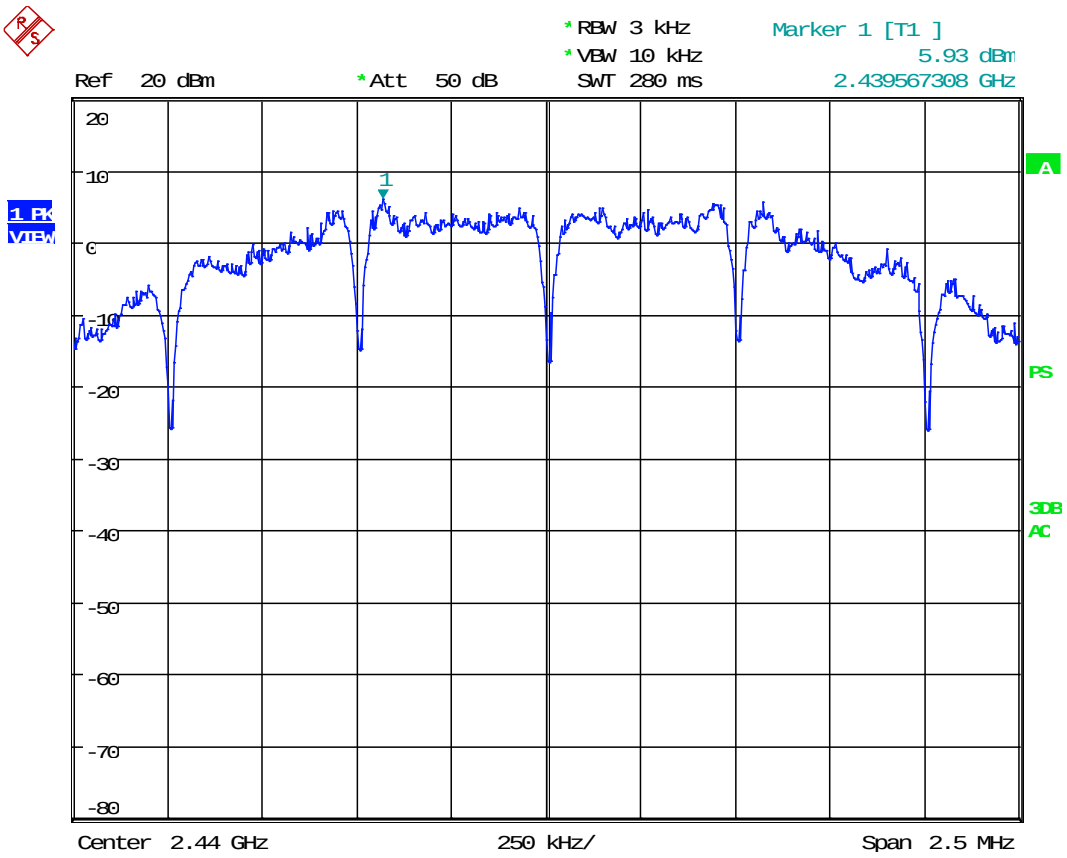
Channel	Frequency(MHz)	Power Spectral Density (dBm)
11	2405	6.2
18	2440	5.93
26	2480	6.64

Power Spectral Density, Channel 11:



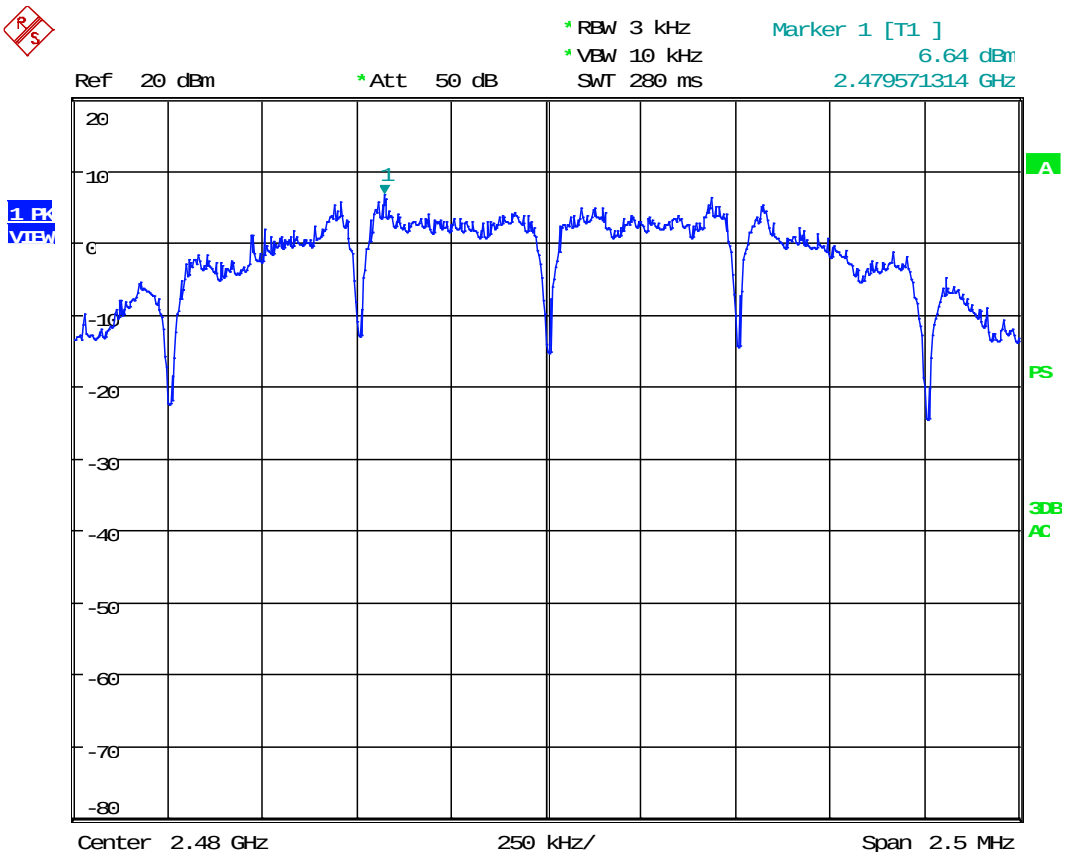
Date: 13.OCT.2016 15:07:12

Power Spectral Density, Channel 18:



Date: 13.OCT.2016 15:14:52

Power Spectral Density, Channel 26:



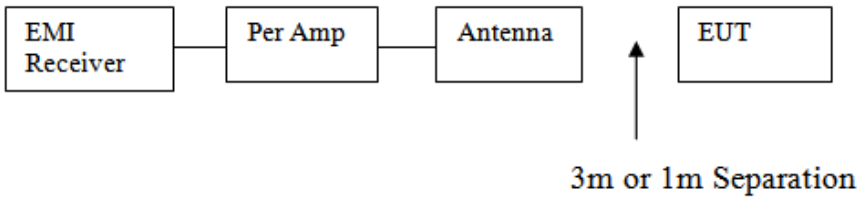
Date: 13.OCT.2016 15:24:08

3.7 Radiated Spurious Emissions

Criterion: Radiated spurious emissions which fall in the restricted bands must comply with the radiated emission limits specified in FCC § 15.209(a) and Table 2 of IC RSS-Gen.

Test Procedure: Per 558074 D01 DTS Meas Guidance v03r02 § 11
Radiated spurious emission was performed from 30 MHz to the tenth harmonics of the carrier. For each scan of radiated emission measurement, the procedures for maximizing emissions were followed. The EUT was rotated and antenna height was varied between 1meter (m) and 4m in order to maximize the observed levels. Measurements in both horizontal and vertical polarities were made and the data was recorded. All radiated emission measurements, up to 18 GHz, were performed at 3m distance between an antenna and the EUT. All radiated emission measurements, above 18 GHz, were performed at 1m distance between an antenna and the EUT.

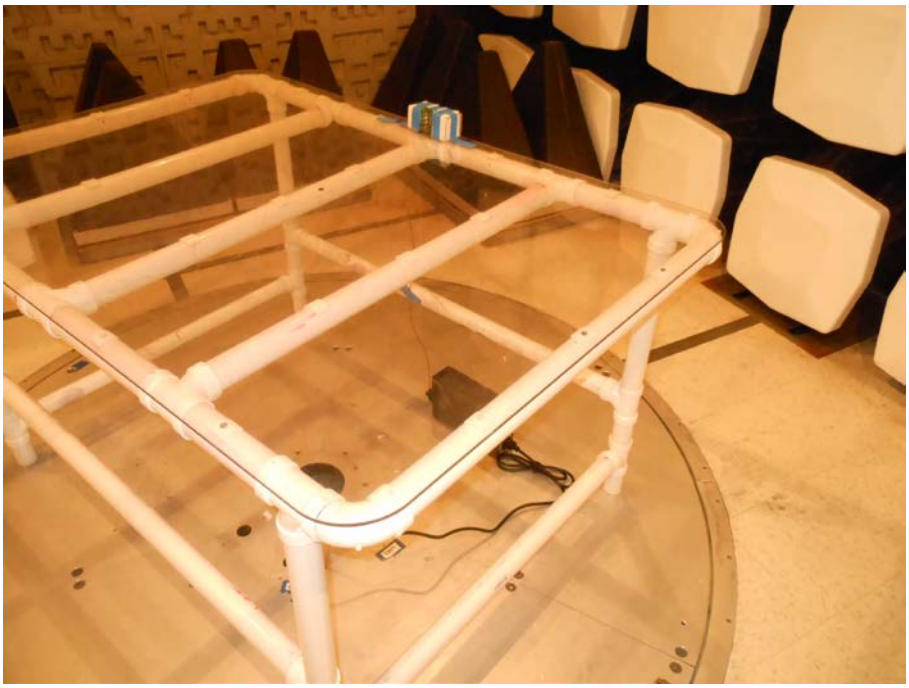
Block Diagram:

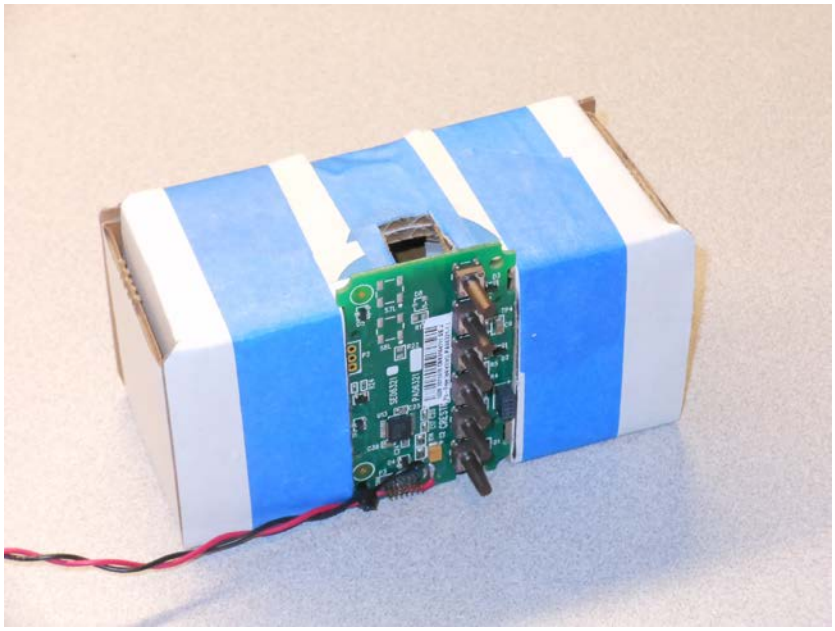


The peak levels of radiated emissions above 1 GHz was measured with a resolution bandwidth (RBW) of 1 MHz and a Video Band Width (VBW) of 3 MHz. Duty Cycle Correction Factor (DCCF) was applied to the Average level readings at UBE, harmonic and LBE frequencies.

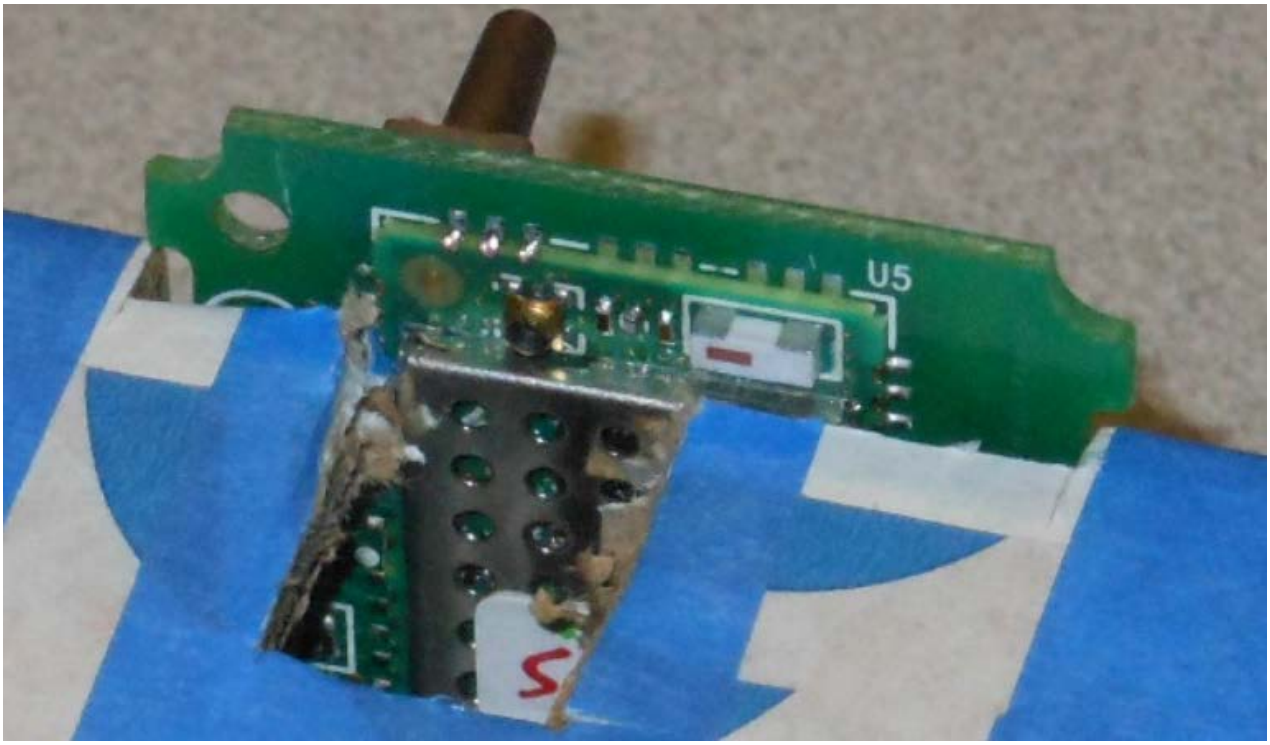
Over the 30MHz to 18GHz frequency range, the EUT was distanced 3 meters from the receive antenna (bilog or double ridge).

For all applications, the EUT is intended to be mounted on a vertical wall surface, with its PCB flat against the plane of the wall.



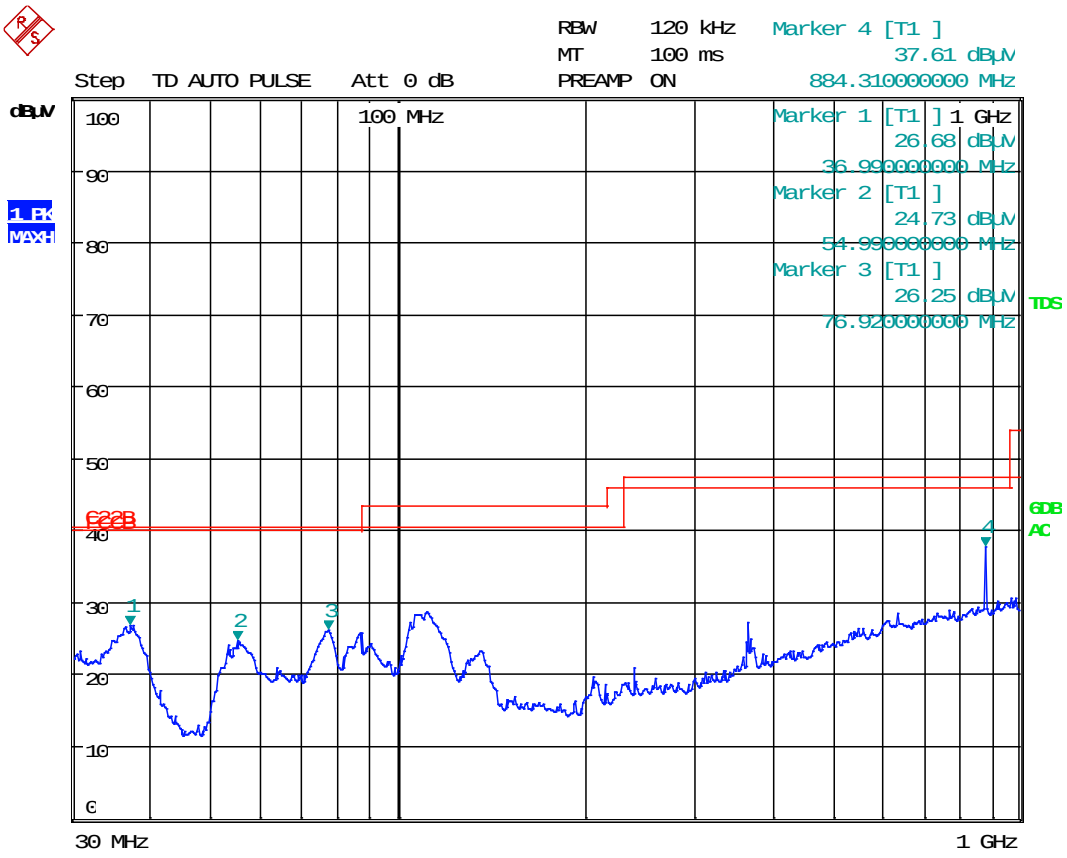


The integral antenna is in the plane of the PCB, near and parallel to its upper edge, and facing the wall, as seen in the close-up photo of the PCB below:



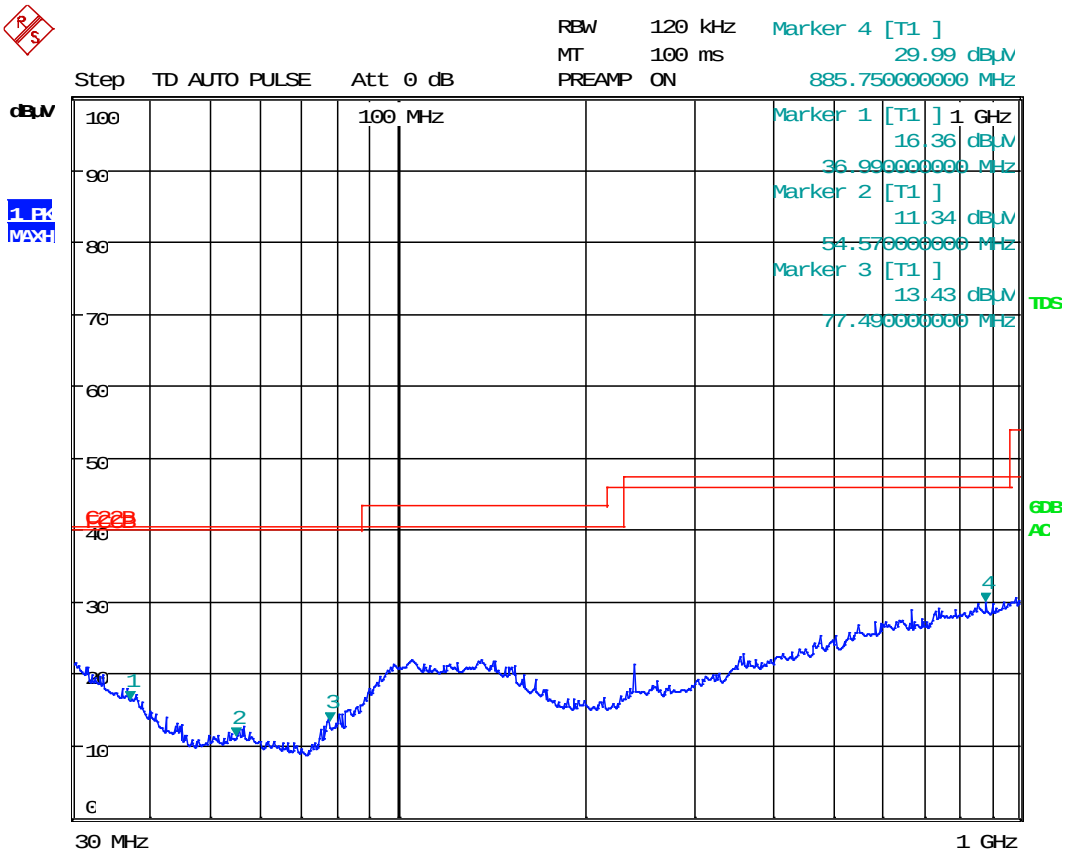
Sample Plots

30MHz-1GHz Vertical:



Date: 24.OCT.2016 15:06:03

30MHz-1GHz Horizontal:



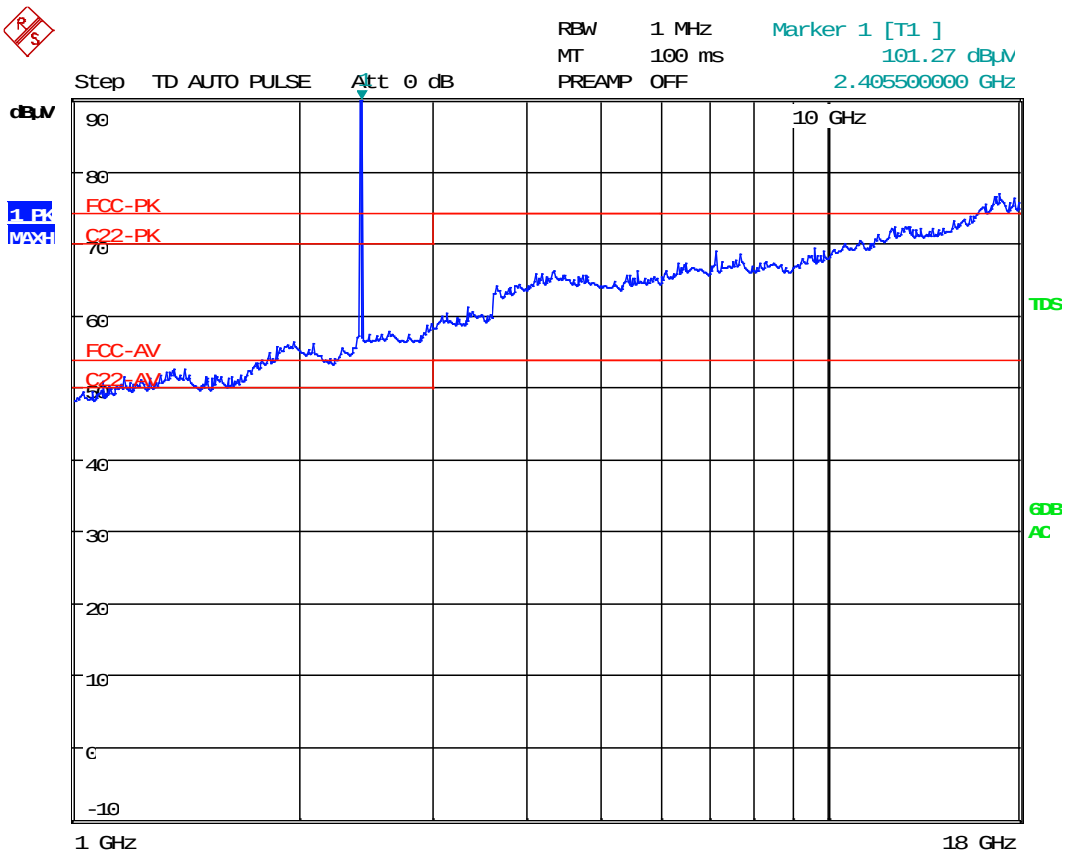
Date: 24.OCT.2016 15:10:01

Radiated Spurious Emissions (30MHz – 1GHz)

Antenna		Turntable Azimuth Angle (degrees)	Frequency (MHz)	Measured Level (dBuV/m)	FCC 15 Class B	
Polarity	Height (cm)				Limit (dBuV/m)	Margin (dB)
v	100	14.9	37.68	21.71	40	18.29
v	106	181	57.96	19.78	40	20.22
v	170	359.9	77.37	23.2	40	16.8
v	118.5	277.3	108.96	23.87	43.5	19.63
v	134.3	338.2	885.75	23.06	46	22.94

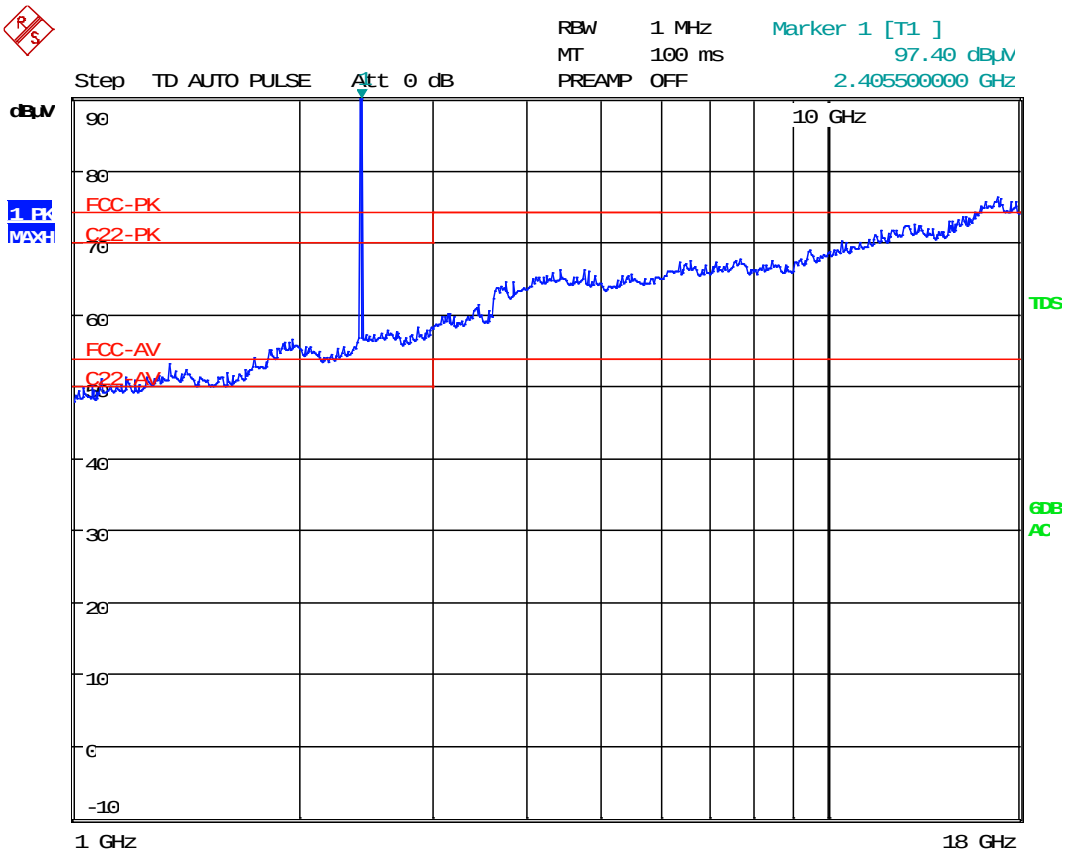
Sample Plots

1GHz-18GHz Vertical: Channel 11



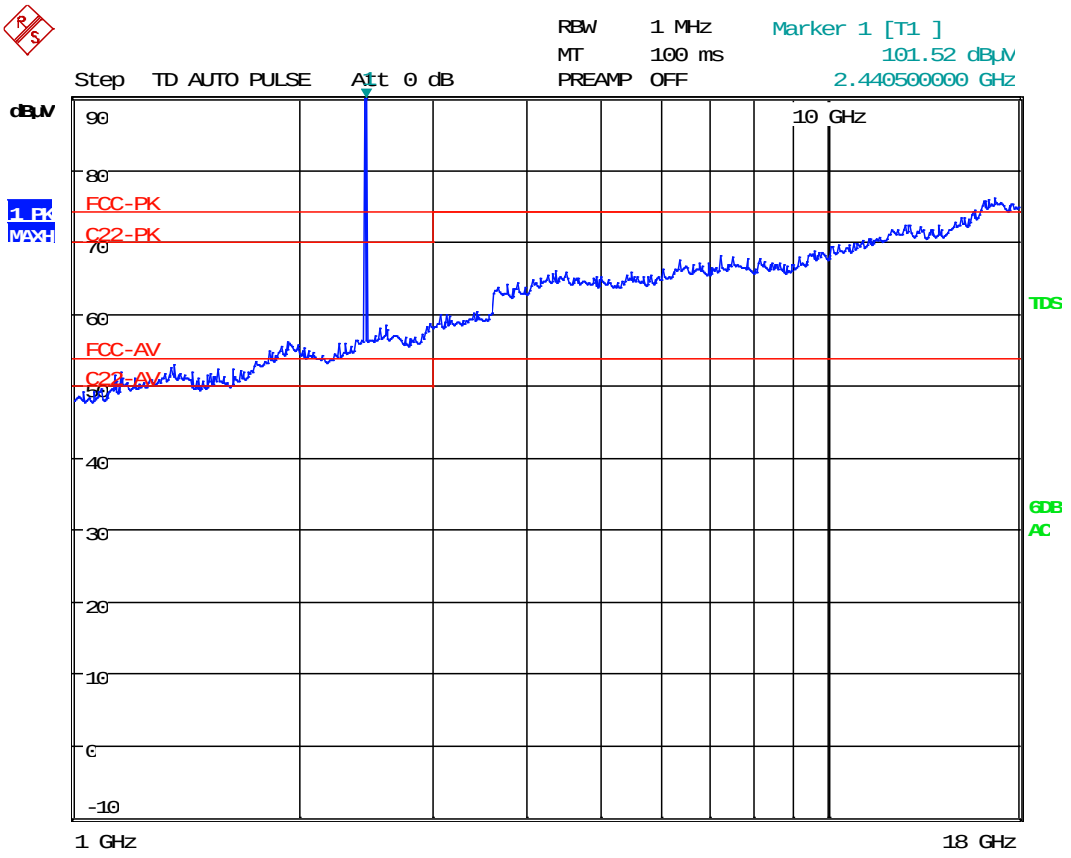
Date: 27.OCT.2016 15:46:25

1GHz-18GHz Horizontal: Channel 11

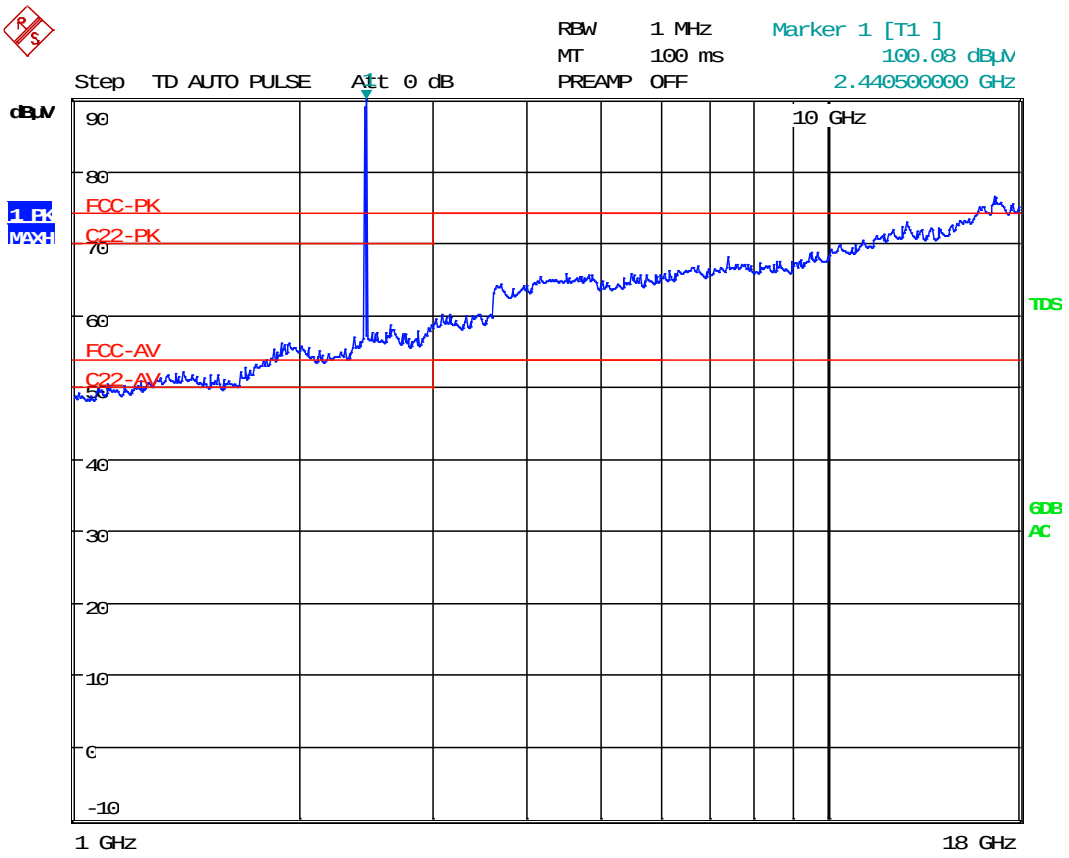


Date: 27.OCT.2016 16:32:43

1GHz-18GHz Vertical: Channel 18

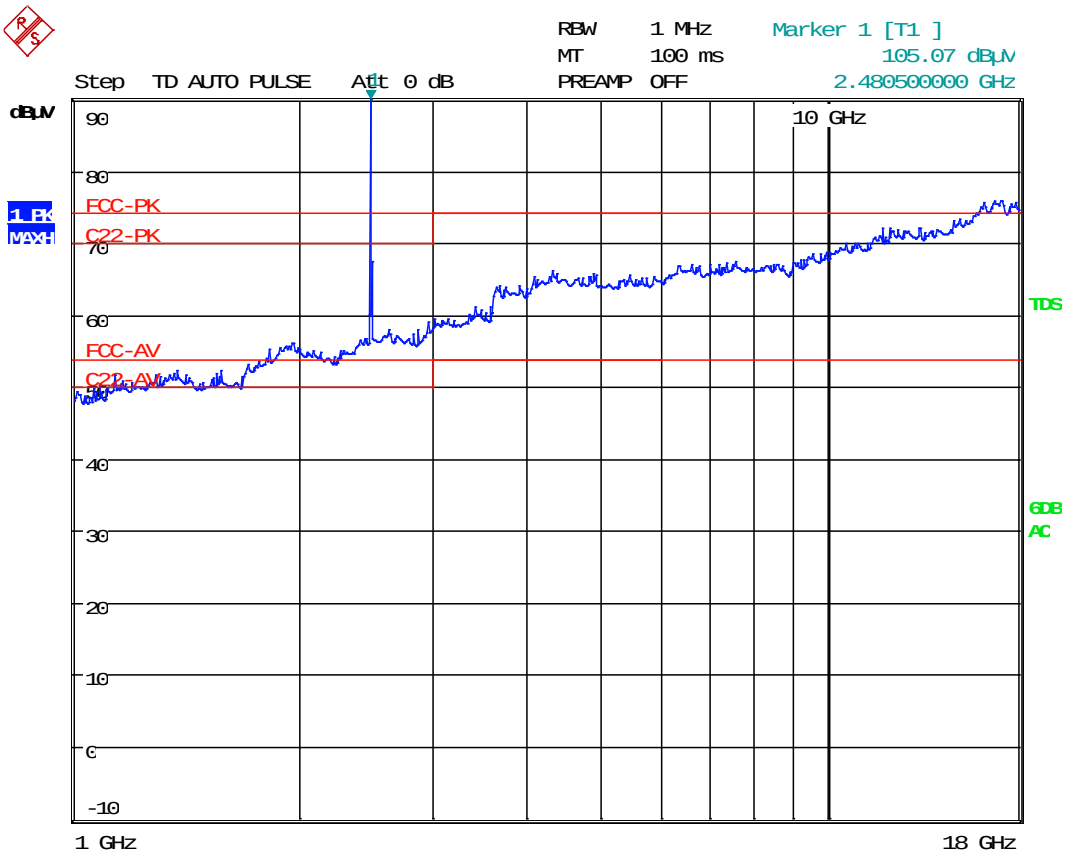


1GHz-18GHz Horizontal: Channel 18



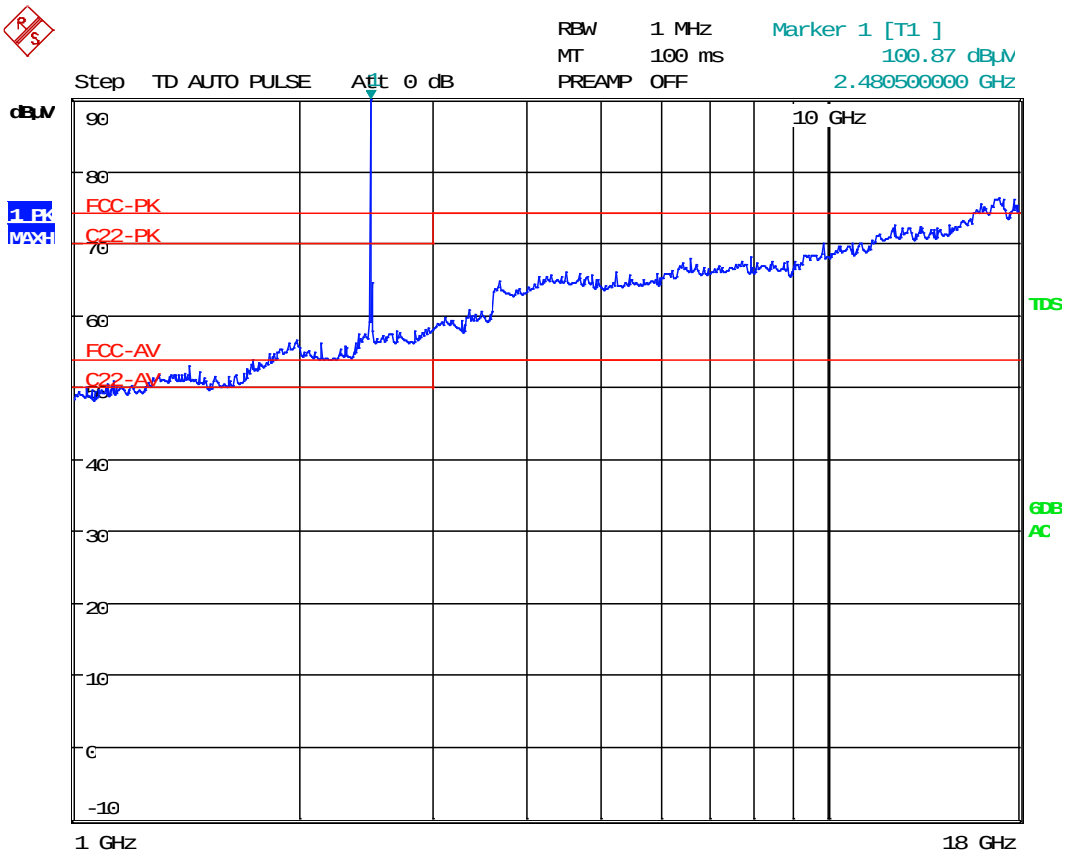
Date: 27.OCT.2016 16:48:31

1GHz-18GHz Vertical: Channel 26



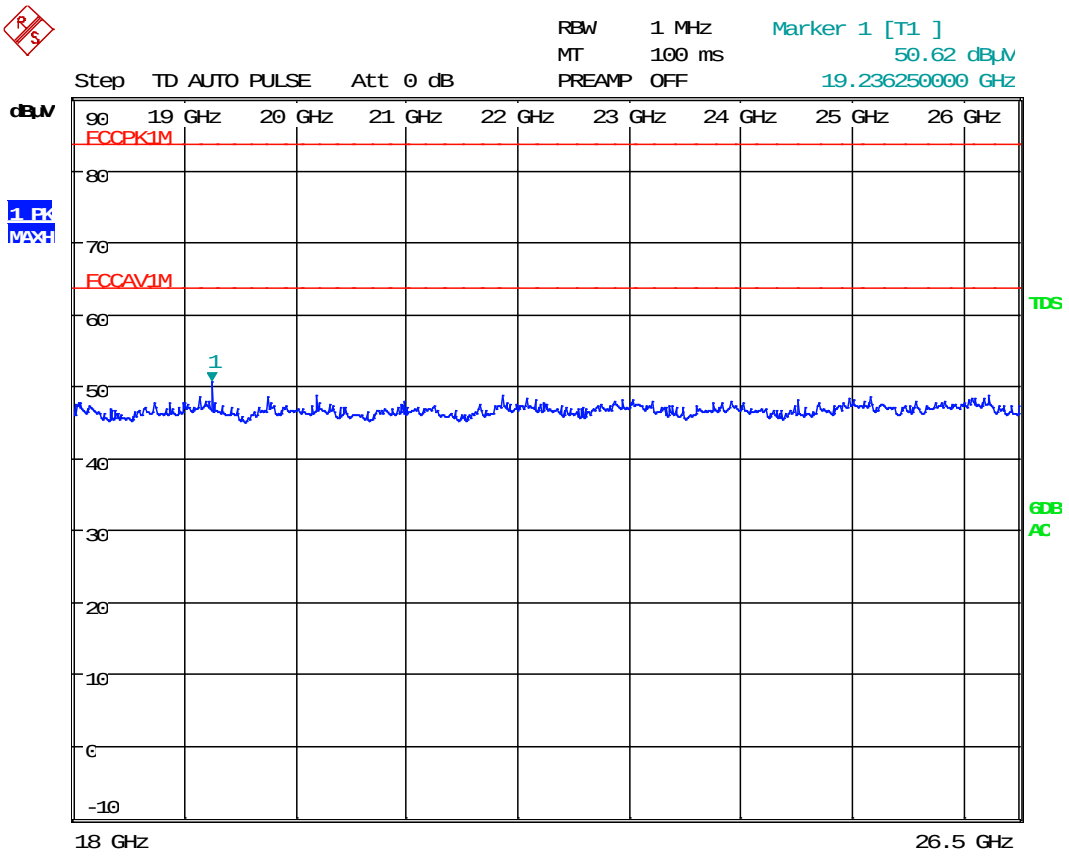
Date: 28.OCT.2016 18:20:52

1GHz-18GHz Horizontal: Channel 26



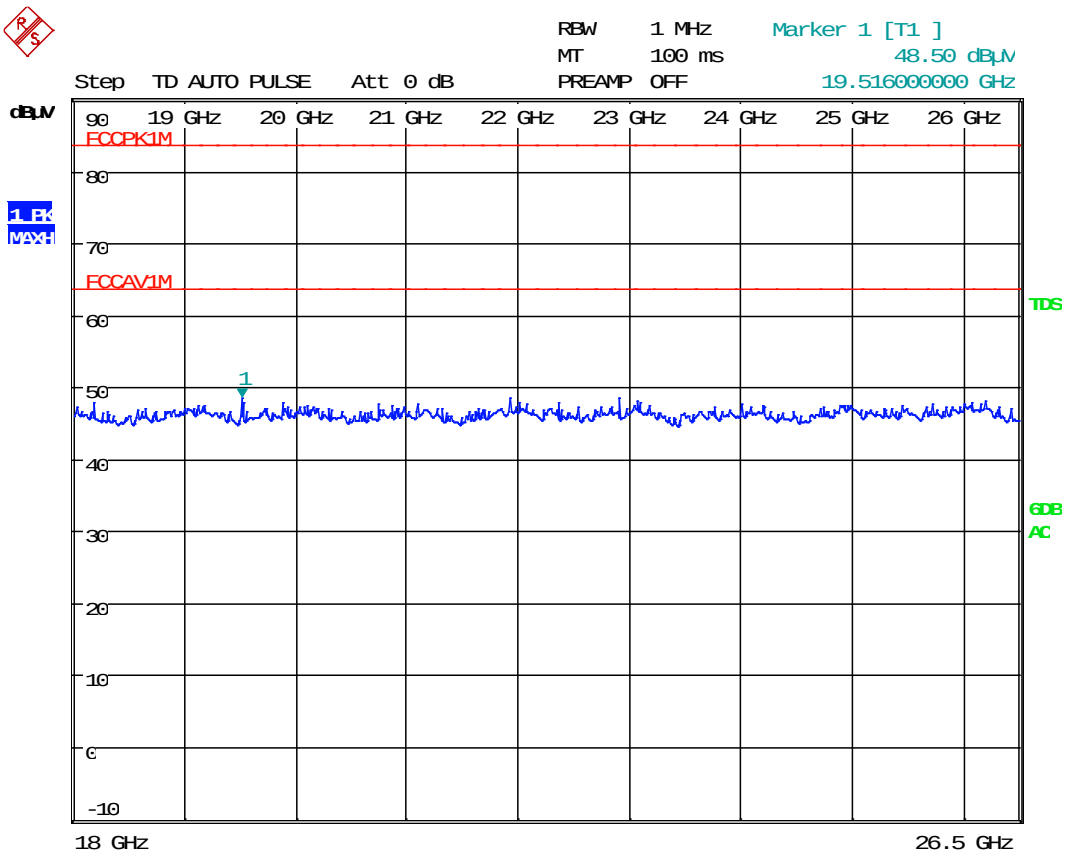
Date: 28.OCT.2016 17:42:51

18GHz - 26GHz Horizontal: Channel 11 (1 Meter)



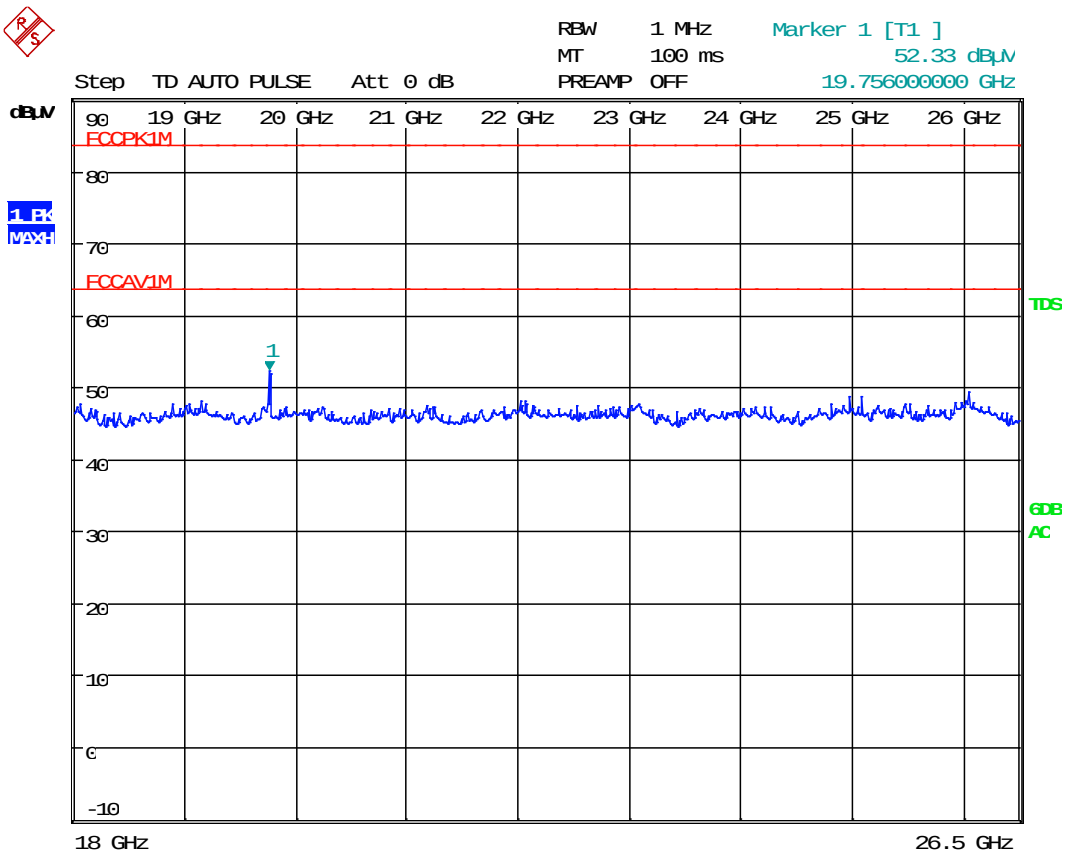
Date: 2.NOV.2016 13:56:45

18GHz - 26GHz Horizontal: Channel 18 (1 Meter)



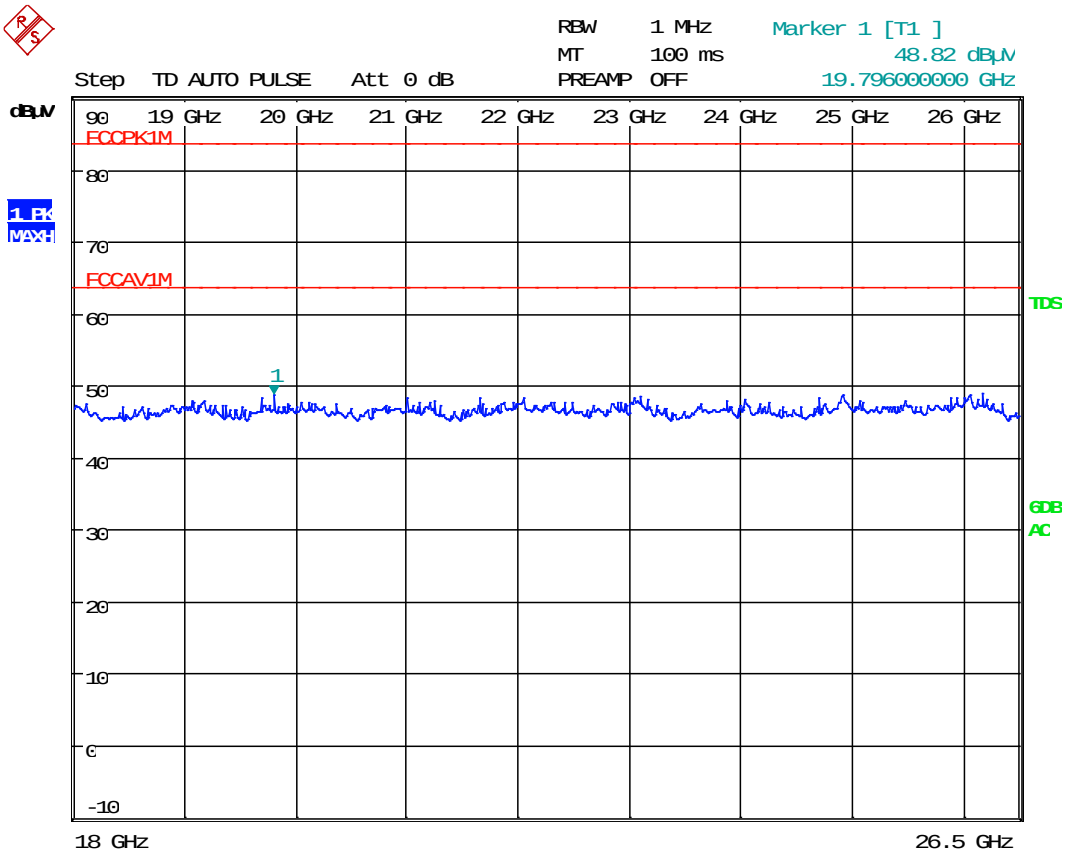
Date: 2.NOV.2016 14:17:36

18GHz - 26GHz Horizontal: Channel 24 (1 Meter)



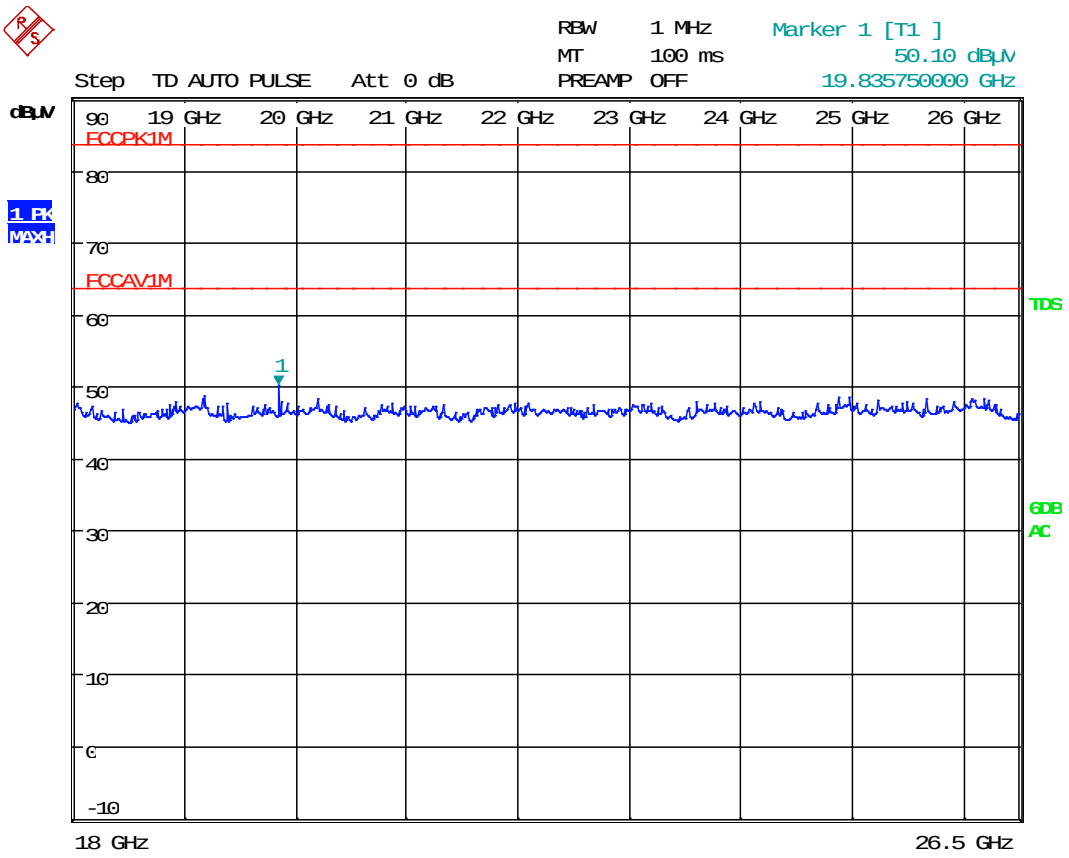
Date: 2.NOV.2016 14:20:54

18GHz - 26GHz Horizontal: Channel 25 (1 Meter



Date: 2.NOV.2016 14:27:10

18GHz - 26GHz Horizontal: Channel 26 (1 Meter)



Date: 2.NOV.2016 14:32:07

Radiated EMI Data (1 – 25GHz)

Ch #	Type	Freq (MHz)	Power Level Setting	Antenna Orient [1]	Antenna Dist (m)	Antenna Height (cm)	TT Azimuth Angle (Deg)	Meas Level (dBuV/m) PK	Meas Level (dBuV/m) AV	DCCF (dB)[2]	Corr Level (dBuV/m) PK	Corr Level (dBuV/m) AV	FCC Limit (dBuV/m) PK	FCC Limit (dBuV/m) AV	FCC Margin (dB) PK	FCC Margin (dB) AV
11	lbe	2390	253	h	3	204	172	60.0	51.1	-12.1	60.0	39.0	74	54	14.0	15.0
	f	2405	253	h	3	204	172	106.6	100.8				n/a	n/a		
	2f	4810	253	h	3	204	172	67.3	57.0	-12.1	67.3	44.9	74	54	6.7	9.1
	3f	7215	253	h	3	204	172	69.3	58.7	-12.1	69.3	46.6	74	54	4.7	7.4
	4f	9620	253	h	3	204	172	70.6	60.0	-12.1	70.6	48.0	74	54	3.4	6.0
18	f	2440	253	h	3	200	183	108.8	102.9				n/a	n/a		
	2f	4880	253	h	3	200	183	67.6	57.0	-12.1	67.6	44.9	74	54	6.4	9.1
	3f	7320	253	h	3	200	183	70.2	58.5	-12.1	70.2	46.4	74	54	3.8	7.6
	4f	9760	253	h	3	200	183	70.5	60.2	-12.1	70.5	48.1	74	54	3.5	5.9
24	f	2470	253	h	3	200	168	108.8	103.1				n/a	n/a		
	ube	2483	253	h	3	200	168	60.9	55.0	-12.1	60.9	42.9	74	54	13.1	11.1
	2f	4940	253	h	3	200	168	67.8	56.9	-12.1	67.8	44.8	74	54	6.2	9.2
	3f	7410	253	h	3	200	168	69.5	58.9	-12.1	69.5	46.8	74	54	4.5	7.2
	4f	9880	253	h	3	200	168	71.6	60.2	-12.1	71.6	48.1	74	54	2.4	5.9
25	f	2475	253	h	3	197	175	109.8	104.2				n/a	n/a		
	ube	2483	253	h	3	197	175	66.1	59.3	-12.1	66.1	47.2	74	54	7.9	6.8
	2f	4950	253	h	3	197	175	67.5	57.1	-12.1	67.5	45.0	74	54	6.6	9.0
	3f	7425	253	h	3	197	175	70.2	58.9	-12.1	70.2	46.8	74	54	3.8	7.2
	4f	9900	253	h	3	197	175	70.6	60.1	-12.1	70.6	48.0	74	54	3.5	6.0
26	f	2480	253	h	3	198	175	109.4	103.8				n/a	n/a		
	ube	2483	234	h	3	198	175	68.2	61.8	-12.1	68.2	49.7	74	54	5.8	4.3
	2f	4960	253	h	3	198	175	68.6	57.8	-12.1	68.6	45.7	74	54	5.4	8.3
	3f	7440	253	h	3	198	175	69.6	60.0	-12.1	69.6	47.9	74	54	4.5	6.1
	4f	9920	253	h	3	198	175	71.5	61.2	-12.1	71.5	49.1	74	54	2.5	4.9

[1] receiver antenna h (horizontal) orientation produced largest levels

[2] Measured DCCF(dB) = -12.1

Sample Calculation of the Electric Field Magnitude

The magnitude of the Electric field, ***E*** is calculated in *dBµV/m* in terms of the measured antenna output voltage and three transducer factors as follows:

$$E\ (dB\mu V/m) = AOV(dB\mu V) + AF(dB/m) + CL(dB) - AG(dB)$$

where,

AOV*(dBµV)* = Antenna Output Voltage in dB(µV),

AF*(dB/m)* = Antenna Factor in dB(1/m),

CL*(dB)* = Cable Loss in dB,

AG*(dB)* = Amplifier Gain in dB

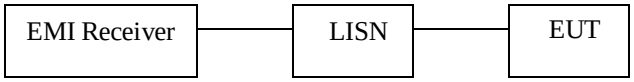
The three transducer factors ***AF***, ***CL*** and ***AG*** are stored in the EMI Receiver, as functions of frequency, over corresponding frequency ranges.

3.8 Transmitter AC Power line Conducted Emissions

Performance Criterion: AC power line conducted emissions shall not exceed the limits specified in FCC § 15.207 and Table 4 of IC RSS-Gen.

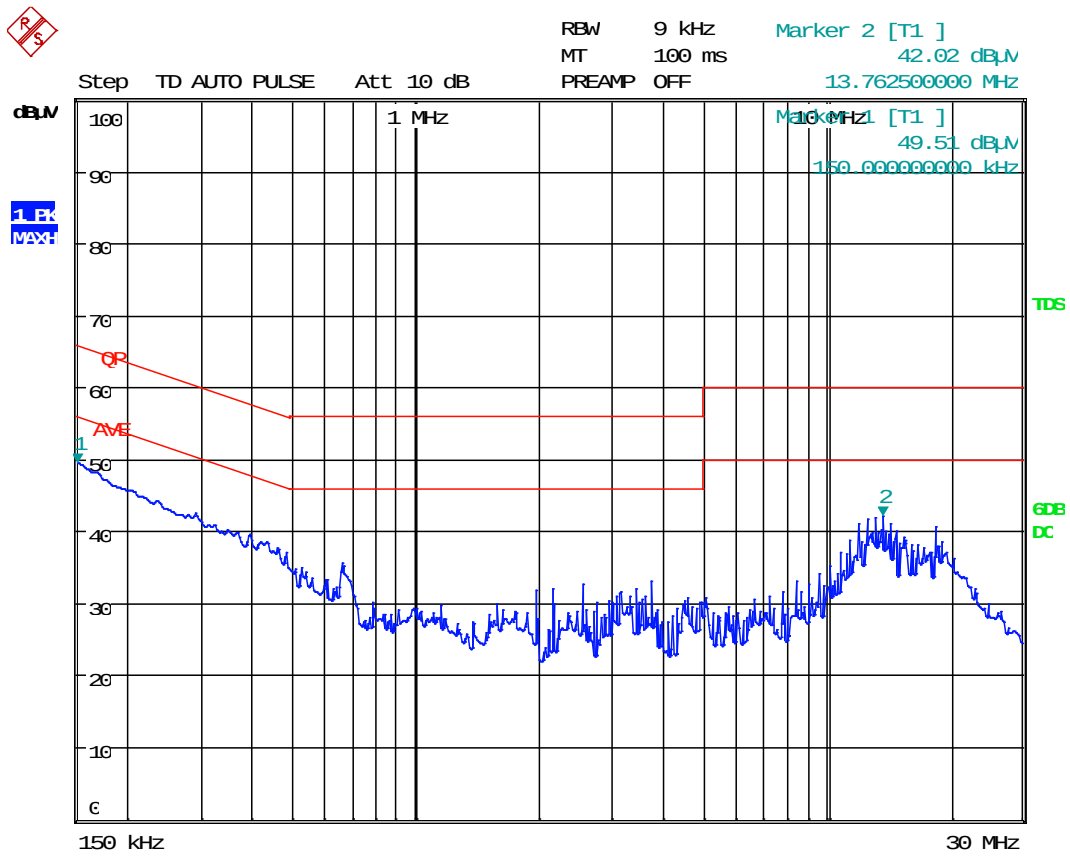
Test Details: AC power line conducted emissions were performed from 150 kHz to 30 MHz and measured with a resolution bandwidth of 9 kHz. EUT was set in the receiving mode. Refers to the following screen captures (using a peak detector) and block diagram

Block Diagram:



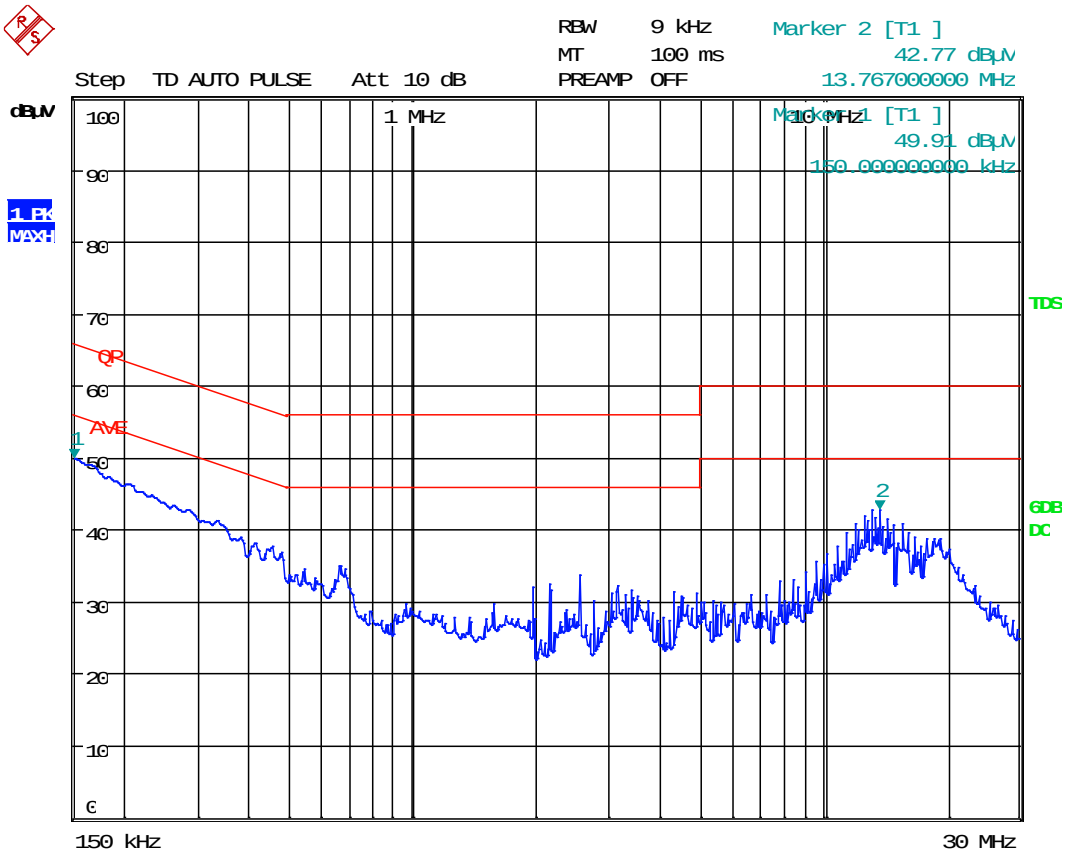
Note: AC side of AC-DC (support power supply) conducted emissions were measured.

Line 1:



Date: 25.OCT.2016 15:23:52

Line 2:

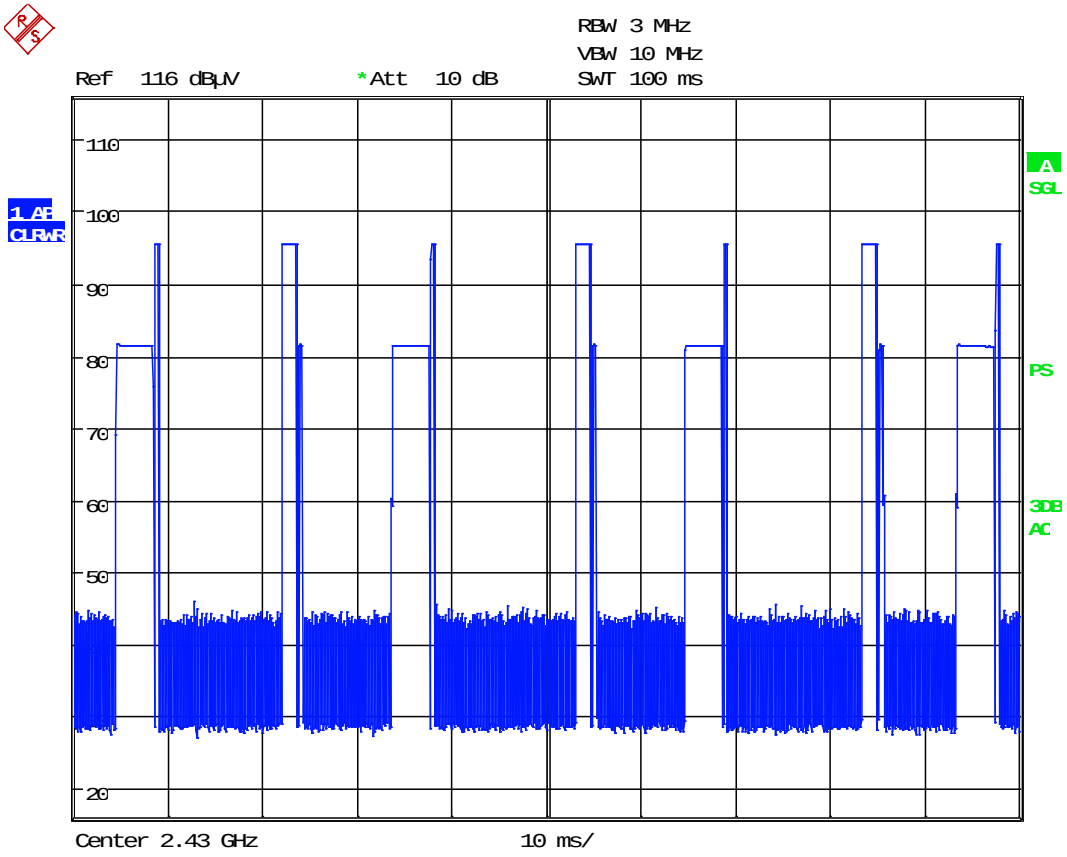


Date: 25.OCT.2016 15:42:34

AC Line Conducted Emissions Data

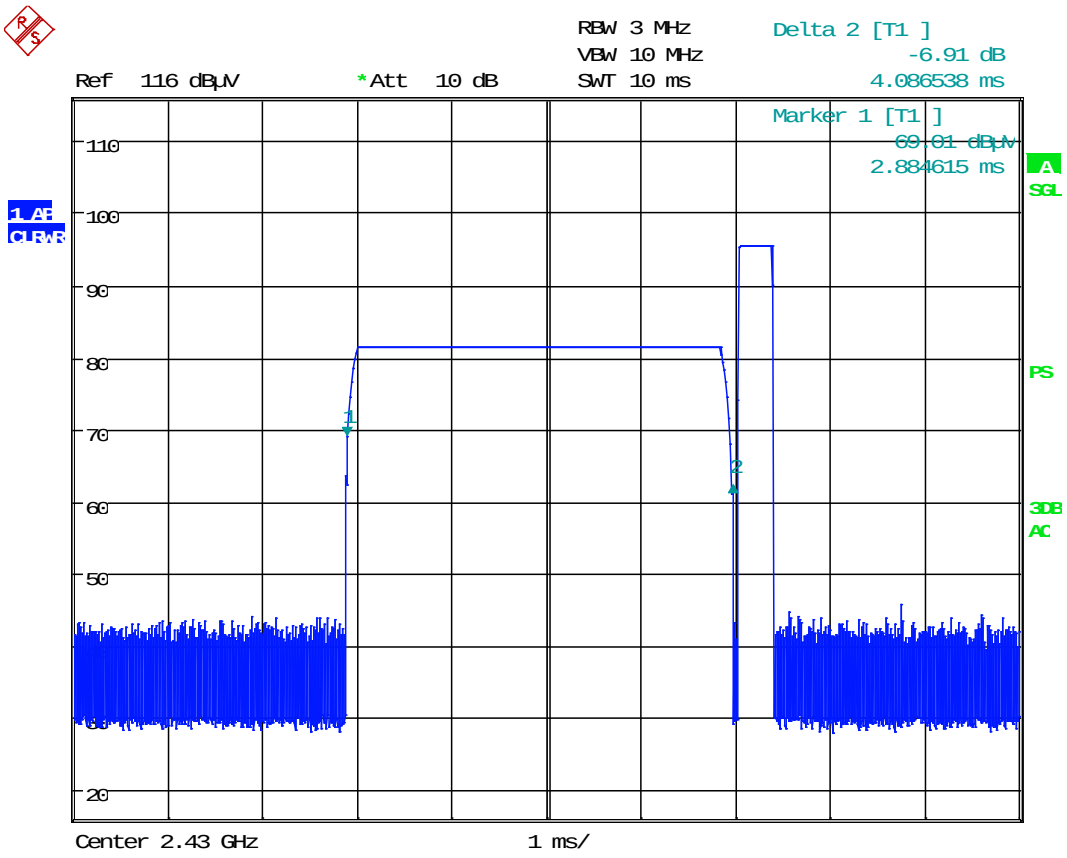
			FCC15 Class B			
Frequency (MHz)	**Measured Level (dBuV)**		**Limits (dBuV)**		**Margins (dB)**	
	QP	**AV**	**QP**	**AV**	**QP**	**AV**
120V/L1						
0.15	43.59	22.76	66.0	56.0	22.4	33.2
13.762	34.89	29.36	60.0	50.0	25.1	20.6
120V/L2						
0.15	43.7	22.74	66.0	56.0	22.3	33.3
13.762	37.63	32.73	60.0	50.0	22.4	17.3

3.9 Duty Cycle Correction Factor (DCCF) Measurement



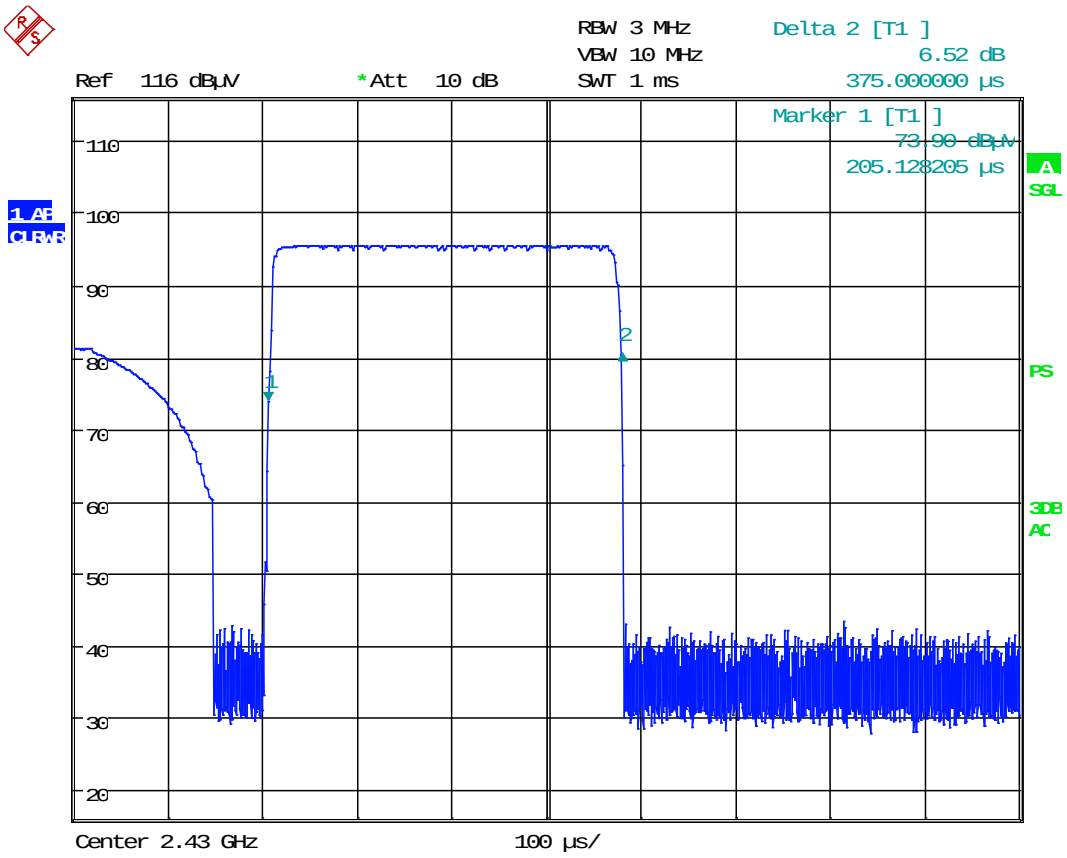
Date: 26.OCT.2016 16:46:44

Pulse1-Sample1



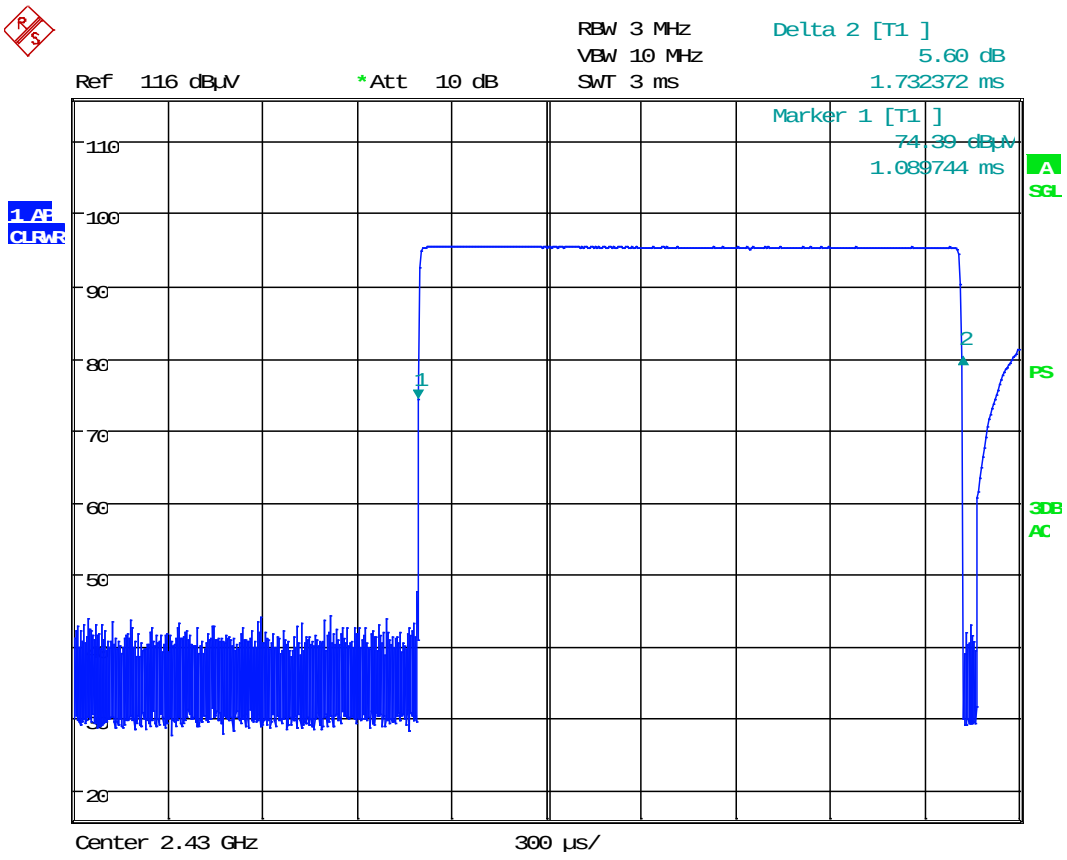
Date: 26.OCT.2016 16:56:47

Pulse 2-Sample1



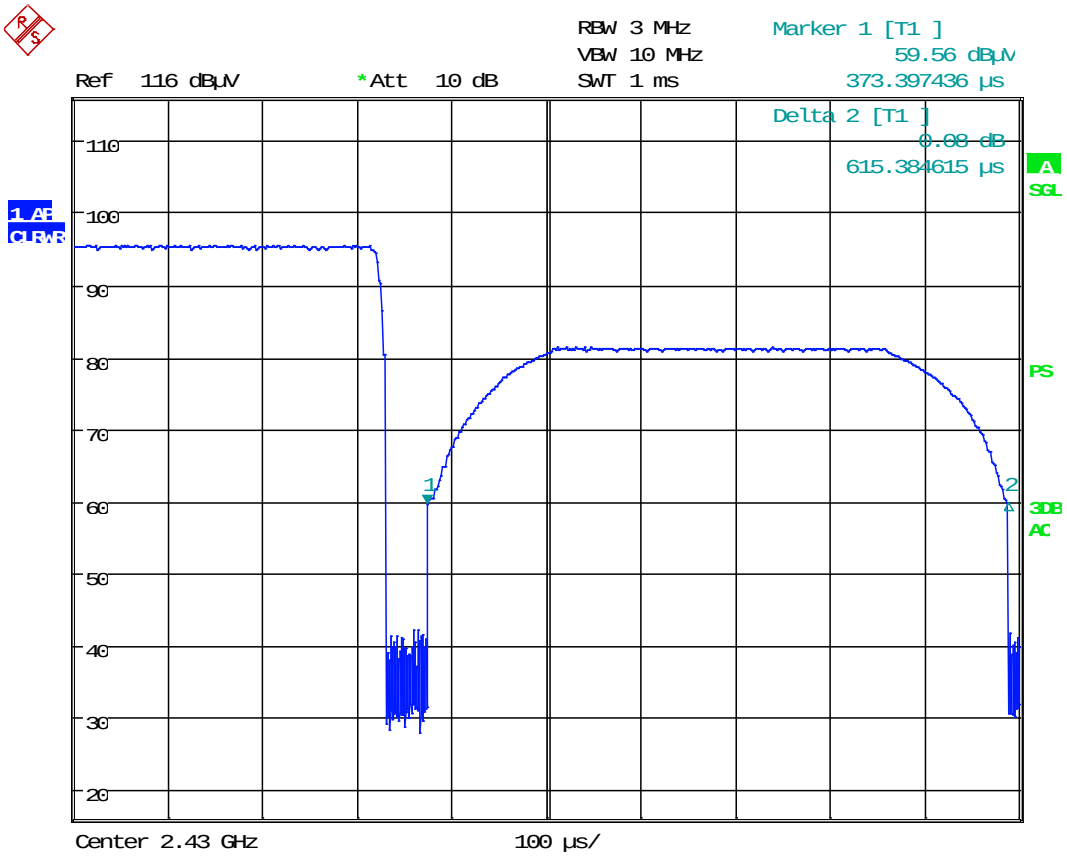
Date: 26.OCT.2016 17:02:58

Pulse 3-Sample1



Date: 26.OCT.2016 17:10:22

Pulse 4-Sample1



Date: 26.OCT.2016 17:15:47

Calculation of the Duty Cycle Correction Factor (DCCF)

The DCCF is defined by the following relationship:

$$DCCF(dB) = 20\ log_{10}(Duty\ Cycle\ over\ a\ 100ms\ interval)$$

Pulses 1 and 2 repeat 4 times over the 100ms interval, whereas pulses 3 and 4 repeat 3 times over the same time interval, as seen in the below table:

samples	p1	p2	p3	p4
s1	4.086538	0.375	1.732372	0.615385
s2	4.102564	0.375	1.727564	0.615385
s3	4.070513	0.375	1.727564	0.615385
s4	4.070513	0.376602564	0	0
sums of each type	16.330128	1.501602564	5.1875	1.846154

sum of ALL pulses	24.86538441
Duty Cycle =	0.248653844
DCCF =	-12.09