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Amended Test Report

Includes NCEE Labs report R20120224-21-03C and its amendment in full

Client:	**Johnson Outdoors** **1531 Madison Ave.** **Mankato, MN 56001**
Product:	**i-Pilot Link System Controller**
FCC ID:	**T62-IPCON20**
IC ID:	**4397A-IPCON20**
Test Report No:	**R20120224-21-03D**
Approved By:	**Nic S. Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
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Test Laboratory Certificate 1953.01

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1.0 Summary of test results

1.1 Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARDS: FCC Part 15, Subpart C Industry Canada RSS-Gen, RSS-210 Issue 7 AS/NZS 4268:2008			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
15.203 RSS-Gen	Unique Antenna Requirement	Pass	Permanently attached antenna
15.207 RSS-Gen	Conducted Emissions	NA	No connection to AC mains network
15.209 RSS-Gen	Radiated Emissions	Pass	Meets the requirement of the limit.
15.247(a)(1) RSS-210 Issue 8	Minimum Bandwidth, Limit Min. 500kHz	Pass	Meets the requirement of the limit.
15.247(b) RSS-210 Issue 8	Maximum Peak Output Power, Limit: Max. 23.9dBm	Pass	Meets the requirement of the limit.
15.247(c) RSS-210 Issue 8	Transmitter Radiated Emissions, Limit: Table 15.209	Pass	Meets the requirement of the limit.
15.247(c) RSS-210 Issue 8	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass	Meets the requirement of the limit.
15.247(a) RSS-210 Issue 8	Power Spectral Density	Pass	Meets the requirement of the limit.

1.2 Test Methods

1.2.1 Radiated Emissions

Compliance to 47 CFR Parts 15.209 and 15.247 and Industry Canada RSS 210, Issue 8 was tested in accordance with the methods of ANSI/IEEE C63.4: 2003 and KDB Publication No. 558074: 2012. Several configurations were examined and the results presented represent a worst-case scenario. The EUT was placed on a wooden table approximately 80cm high and centered on a 4m diameter turntable. The table was rotated to find the angles of maximum emissions and the height of the receiving antenna above the ground plane was moved from 1m to 4m in both vertical and horizontal positions. The EUT was tested while sitting both vertically and horizontally. The vertical configuration produced the highest emissions, and that position was used for all radiated testing. All measurements were taken at a distance of 3m from the EUT for Part 15.209 intentional radiator measurements, and 3m for 15.247 measurements of the fundamental frequency in the 2400.0MHz to 2483.5MHz band and subsequent harmonics.

1.3 Reason for amendment

A) Added calibration due dates to test equipment list

B) In response to TCB comments, the power in Section 2 was corrected. The 6dB bandwidth was measured with a 50kHz RBW. An average factor was calculated based off of calculated duty cycle. PSD measurements were also corrected as EIRP values.

C) In response to TCB comments, the bandwidth measurement procedure was modified. Duty cycle correction was modified to be over a 100ms period. Section 4.4.6 was modified to explain how EIRP calculations were made.

D) EIRP measurements in Section 4.4 were made with 10MHz RBW.

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was controller used to install into a trolling motor to allow control form an i-Pilot remote using the i-Pilot Link System.

EUT Received Date: 10 September 2012
EUT Tested Dates: 10 September 2012 – 19 October 2012
4 December 2012 – 6dB bandwidth measurements
10 December 2012 – Measurements in section 4.4

PRODUCT	iPilot Link system Controller
MODEL NUMBER	2994086 Rev 5
POWER SUPPLY	12VDC
MODULATION TYPE	FM
RADIO TECHNOLOGY	Half-duplex RF Link
FREQUENCY RANGE	2.4GHz
MAX OUTPUT POWER (EIRP)	20.10 dBm (102.36 mW)
ANTENNA TYPE	Internal Dipole
ASSOCIATED EQUIPMENT	i-Pilot Link System Remote

NOTE:
1. For more detailed features description, please refer to the manufacturer's specifications or User's Manual.

2.2 Laboratory description

All testing was performed at the NCEE Lincoln facility. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of 40 ± 4%
Temperature of 22 ± 3° Celsius

2.3 Description of test modes

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency
1	2437
2	2441
3	2447

These are the only three frequencies possible.

2.4 Applied standards

The EUT uses digital modulation and operates in the band between 2400.0MHz and 2483.5MHz. There are no provisions for connection to the AC mains. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.247)
FCC Part 15, Subpart C (15.209)
KDB Publication No. 558074: 2012
Industry Canada RSS-GEN
Industry Canada RSS-210

All test items have been performed and recorded as per the above.

2.5 Description of support units

None

2.6 Configuration of system under test

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on Channel 1, 2 or 3.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Rohde & Schwarz Test Receiver	ES17	100007	7/19/2012	7/19/2013
Rohde & Schwarz Test Receiver**	ES126	100037	9/27/ 2011*****	10/27/2012*****
EMCO Biconilog Antenna*	3142B	1654	1/6/2012	1/6/2013
EMCO Horn Antenna**	3115	6415	1/12/2011	1/12/2013
EMCO Horn Antenna***	3116	2576	6/14/2011	6/14/2013
Rohde & Schwarz Preamp*	TS-PR18	082001/003	12/15/2011****	12/15/2012****
Trilithic High Pass Filter*	6HC330	23042	12/15/2011****	12/15/2012****

*Used for radiated measurements above 3GHz
**Used for measurements above 6GHz
***Used for measurements above 18GHz
****Internal Characterization
*****Extended Calibration

4.0 Detailed results

4.1 Unique antenna requirement

4.1.1 Standard applicable

For intentional device, according to FCC 47 CFR Section 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.

4.1.2 Antenna description

The antenna is permanently attached and internal to the EUT and not replaceable.

4.2 Radiated emissions

4.2.1 Limits for radiated emissions measurements

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

4.2.2 Test procedures

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The EUT was measured in both the horizontal and vertical orientation. It was found that the vertical position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, The video bandwidth was 1MHz for peak measurements and 10Hz for average measurements. A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

4.2.3 Deviations from test standard

No deviation.

4.2.4 Test setup

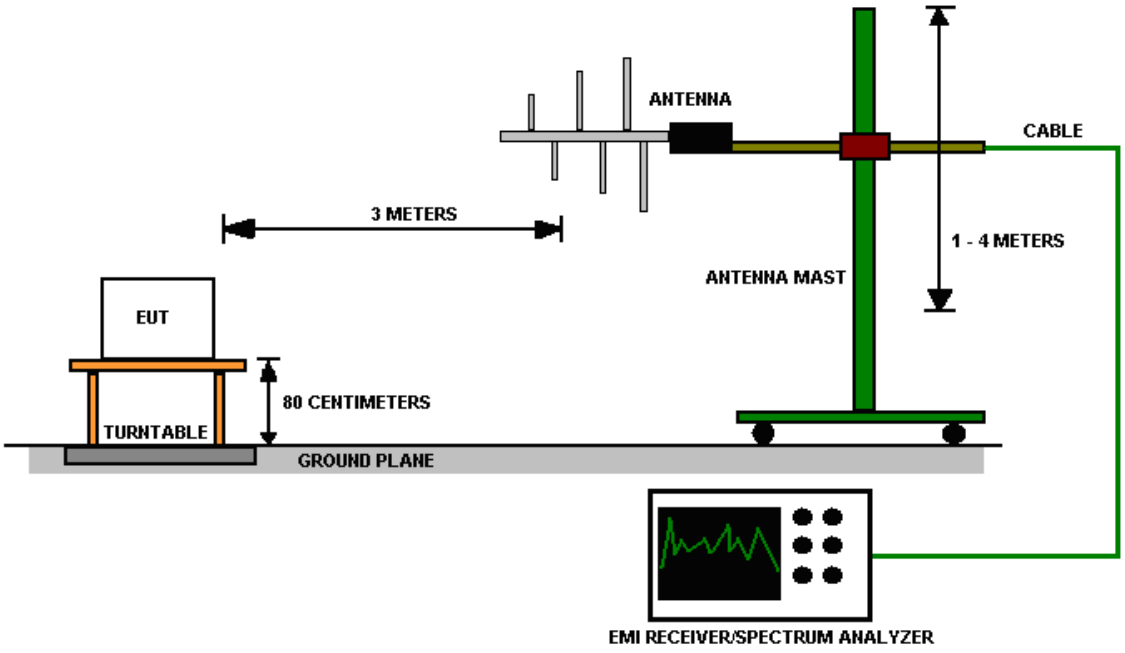

Figure 1 - Radiated Emissions Test Setup

For the actual test configuration, please refer to Appendix A for photographs of the test configuration.

4.2.5 EUT operating conditions

The EUT was powered by 12VDC and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range. For measurements the EUT was tested alone in the horizontal position.

4.2.6 Test results

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Channel 1
INPUT POWER	12VDC	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

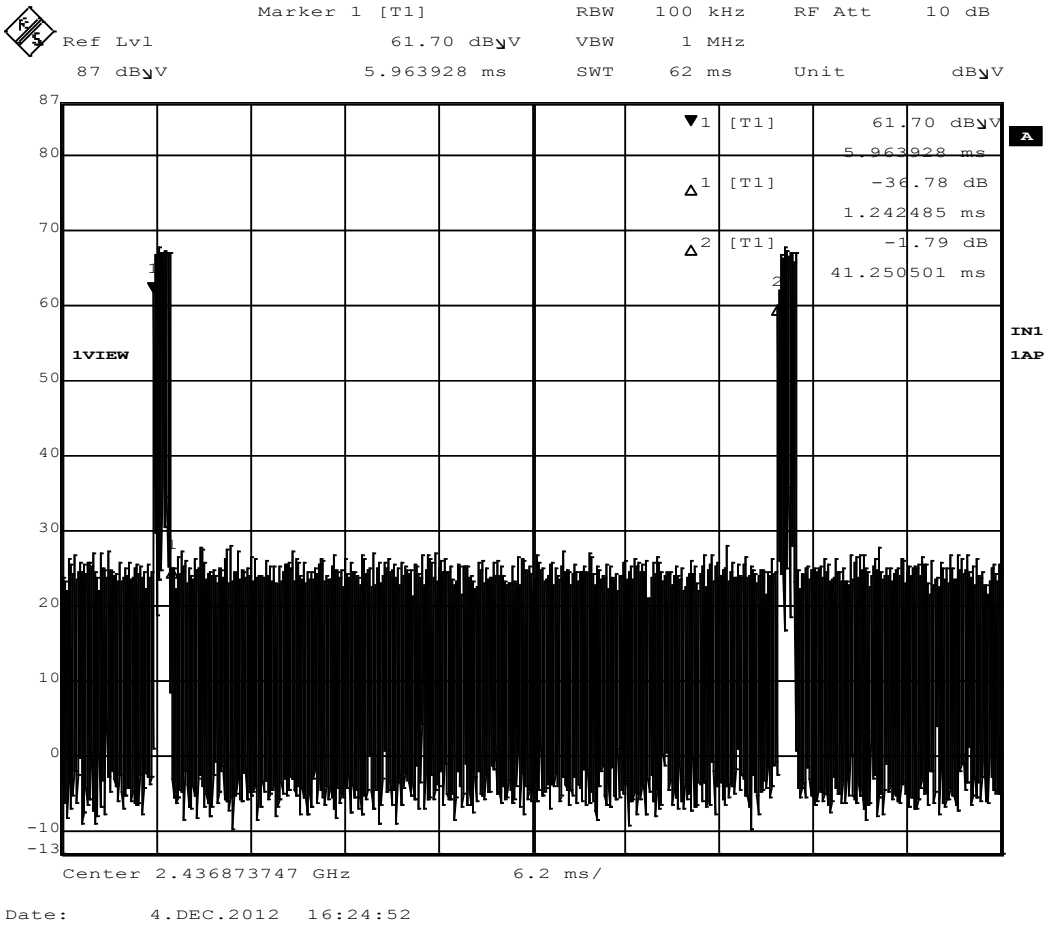

Figure 2 - Transmitter duty cycle

Averaging Factor Calculation;

Period = 41.25 ms
Pulse duration = 1.24 ms
Maximum duty cycle over 100ms period =(3 x 1.24ms) / 100ms = 0.037

Averaging Factor (AF) = 20log(Duty cycle) = -28.59 dB
Maximum allowed duty cycle allowed is -20 dB per FCC Part 15.31(c)

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Receive
INPUT POWER	12VDC	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

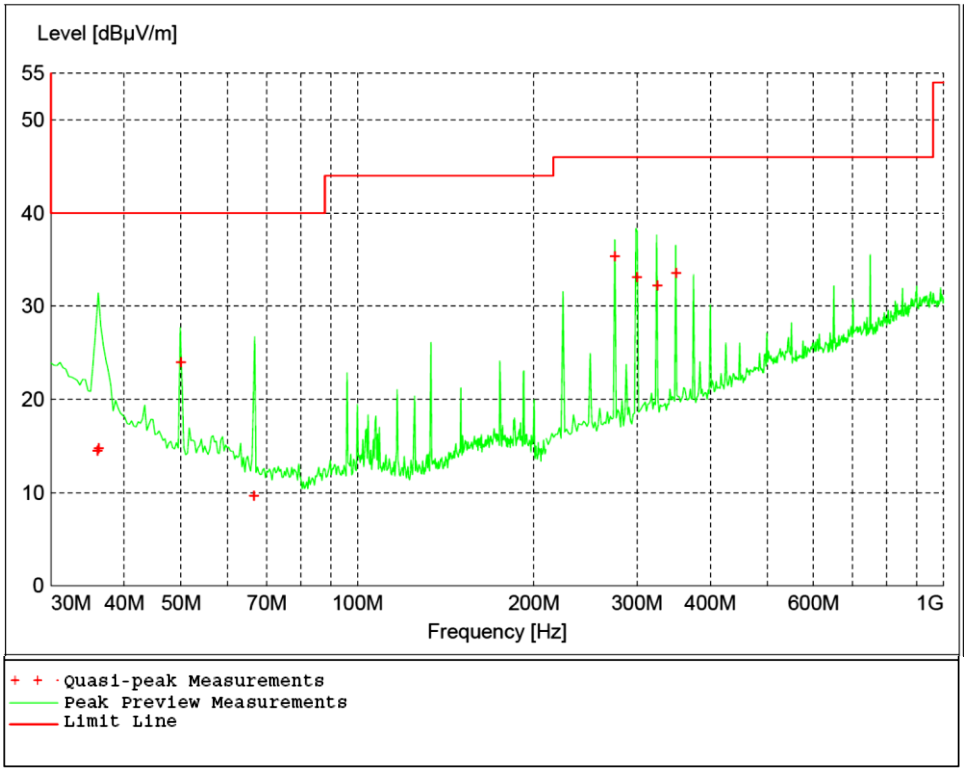

Figure 3 - Radiated Emissions Plot, Receive

Table 1 - Radiated Emissions Quasi-peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
36.000000	14.46	40.00	25.50	102	239	VERT
36.180000	14.70	40.00	25.30	98	288	VERT
49.980000	23.95	40.00	16.00	101	48	VERT
66.540000	9.62	40.00	30.40	115	175	VERT
274.980000	35.29	46.00	10.70	99	358	VERT
300.000000	33.09	46.00	12.90	98	291	HORI
324.960000	32.15	46.00	13.80	101	51	HORI
349.980000	33.53	46.00	12.50	101	267	HORI

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Channel 1
INPUT POWER	12VDC	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

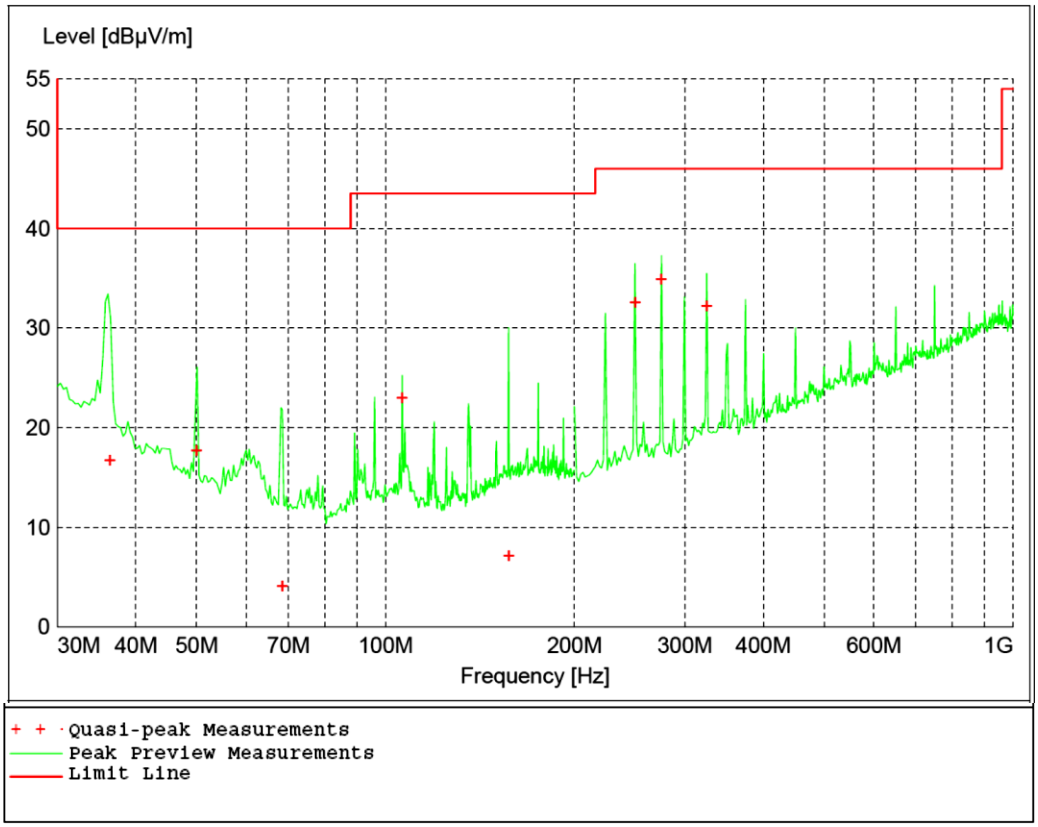

Figure 4 - Radiated Emissions Plot, Channel 1

Table 2 - Radiated Emissions Quasi-peak Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
36.360000	16.71	40.00	23.30	102	360	VERT
49.980000	17.68	40.00	22.30	355	194	VERT
68.520000	4.06	40.00	35.90	222	205	VERT
106.260000	22.98	43.50	20.50	240	78	VERT
157.080000	7.13	43.50	36.40	308	359	HORI
250.020000	32.50	46.00	13.50	101	332	VERT
274.980000	34.89	46.00	11.10	98	63	HORI
325.020000	32.17	46.00	13.80	111	234	HORI

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Channel 2
INPUT POWER	12VDC	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

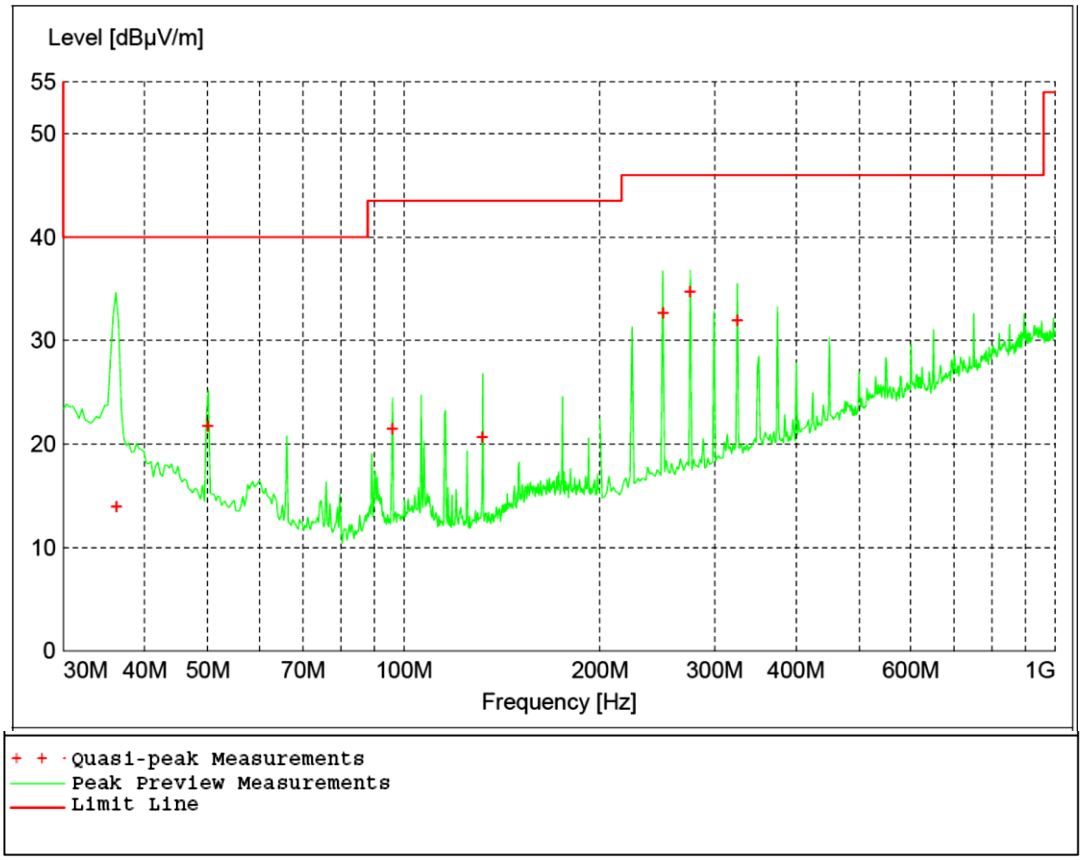

Figure 5 - Radiated Emissions Plot, Channel 2

Table 3 - Radiated Emissions Quasi-peak Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
36.180000	13.89	40.00	26.10	382	5	VERT
49.980000	21.73	40.00	18.30	99	204	VERT
96.000000	21.42	43.50	22.10	123	0	VERT
131.940000	20.60	43.50	22.90	194	347	HORI
249.960000	32.63	46.00	13.40	100	337	VERT
274.980000	34.63	46.00	11.40	99	63	HORI
325.020000	31.93	46.00	14.10	101	247	HORI

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Channel 3
INPUT POWER	12VDC	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

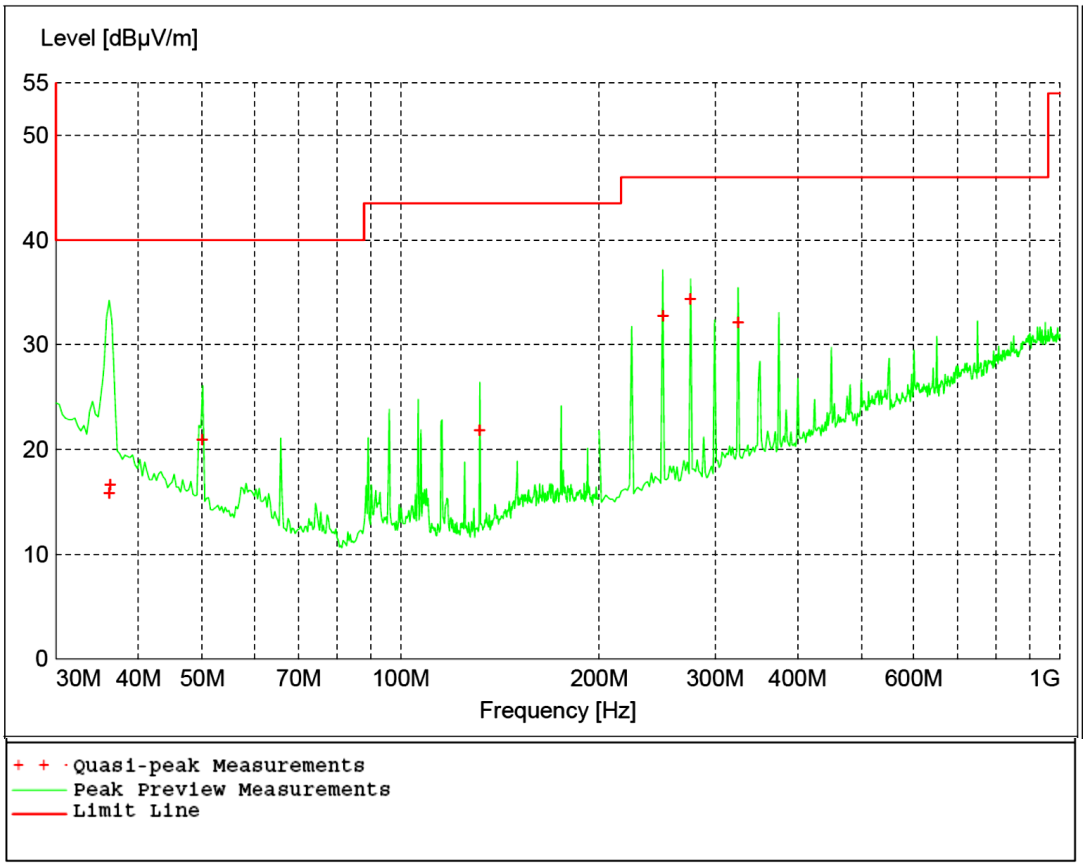

Figure 6 - Radiated Emissions Plot, Channel 3

Table 4 - Radiated Emissions Quasi-peak Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
36.120000	15.81	40.00	24.20	140	8	VERT
36.240000	16.59	40.00	23.40	99	360	VERT
49.980000	20.93	40.00	19.10	106	311	VERT
131.760000	21.75	43.50	21.80	344	353	HORI
250.020000	32.67	46.00	13.30	100	337	VERT
274.980000	34.32	46.00	11.70	102	63	HORI
324.960000	32.09	46.00	13.90	114	251	HORI

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Receive
INPUT POWER	12VDC	FREQUENCY RANGE	1GHz – 26GHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

Table 5 - Radiated Emissions Average Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2381.500000	33.36	54.00	20.60	140	338	VERT
2411.500000	33.80	54.00	20.20	197	333	VERT

Table 6 - Radiated Emissions Peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2381.500000	54.59	54.00	-0.60	140	338	VERT
2411.500000	62.97	54.00	-9.00	197	333	VERT

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Channel 1
INPUT POWER	12VDC	FREQUENCY RANGE	1GHz – 26GHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

Table 7 - Radiated Emissions Average Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2437.500000	93.53*	NA	NA	196	226	VERT
6160.000000	43.72*	54.00	10.28	99	157	VERT

Table 8 - Radiated Emissions Peak Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2437.500000	113.53	NA	NA	196	226	VERT
6160.000000	63.72	74.00	10.28	99	157	VERT

*Note: An averaging factor of 20dB was applied from the duty cycle measurement in Figure 2.

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
highest emission
5. Measurements at the fundamental frequency were done with a peak detector only.
6. *NA Field strength limits do not apply at the fundamental frequency.

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Channel 2
INPUT POWER	12VDC	FREQUENCY RANGE	1GHz – 26GHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

Table 9 - Radiated Emissions Average Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2441.500000	94.82*	NA	NA	166	210	VERT
6194.000000	43.27*	54.00	10.73	128	185	HORI

Table 10 - Radiated Emissions Peak Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2441.500000	114.82	NA	NA	166	210	VERT
6194.000000	63.27	74.00	10.73	128	185	HORI

*Note: An averaging factor of 20dB was applied from the duty cycle measurement in Figure 2.

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
highest emission
5. Measurements at the fundamental frequency were done with a peak detector only.
6. *NA Field strength limits do not apply at the fundamental frequency.

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Channel 3
INPUT POWER	12VDC	FREQUENCY RANGE	1GHz – 26GHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

Table 11 - Radiated Emissions Average Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2447.500000	82.99	NA	NA	200	212	VERT
6154.000000	43.87	54.00	10.13	210	360	VERT

Table 12 - Radiated Emissions Peak Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2447.500000	112.99	NA	NA	200	212	VERT
6154.000000	63.87	74.00	10.13	210	360	VERT

*Note: An averaging factor of 20dB was applied from the duty cycle measurement in Figure 2.

REMARKS:
1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
highest emission
5. Measurements at the fundamental frequency were done with a peak detector only.
6. *NA Field strength limits do not apply at the fundamental frequency.

4.3 Bandwidth

4.3.1 Limits of bandwidth measurements

The 6dB bandwidth of the signal must be greater than 0.500MHz.

4.3.2 Test procedures

All measurements were taken at a distance of 3m from the EUT. The bandwidth of the fundamental frequency was measured by spectrum analyzer with a resolution bandwidth of 1-5% of the signal bandwidth. and 1 MHz VBW. The 6 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 6dB.

The 99% occupied is defined as the bandwidth at which 99% of the signal power is found. This corresponds to 20dB down from the maximum power level. The maximum power was measured with the largest resolution bandwidth possible (10MHz) and this value was recorded. The signal was then captured with a 100kHz resolution bandwidth and the frequencies where the measurements were 20dB below the maximum power were marked. The bandwidth between these frequencies was recorded as the 99% occupied bandwidth.

4.3.3 Deviations from test standard

No deviation.

4.3.4 Test setup

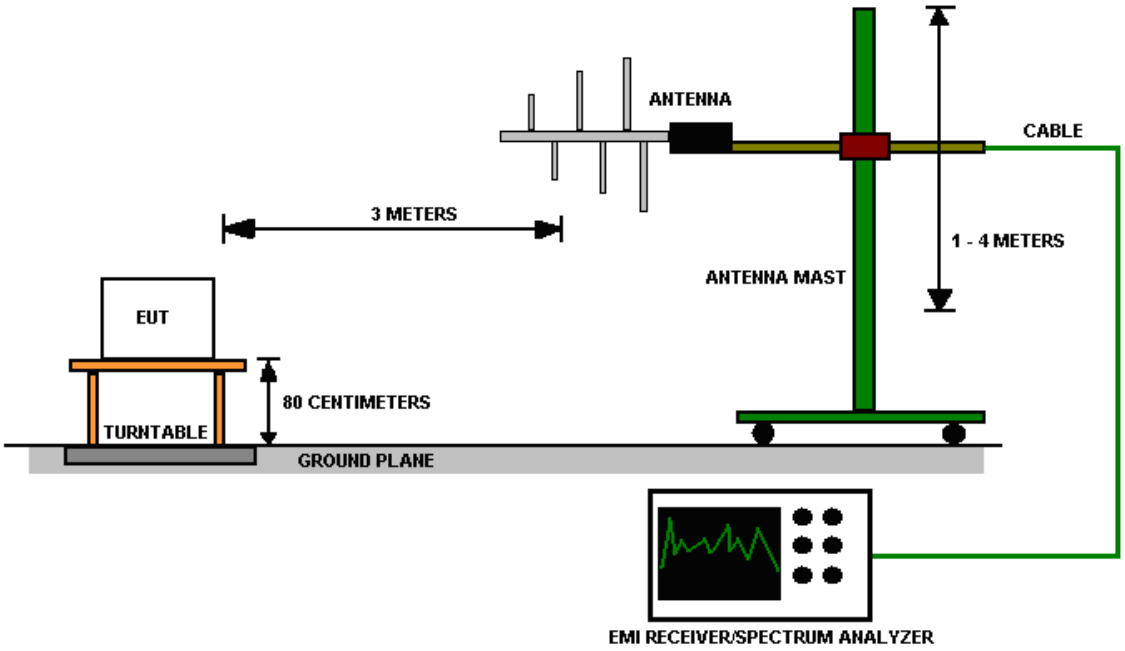

Figure 7 - Bandwidth Measurements Test Setup

4.3.5 EUT operating conditions

The EUT was powered by 12VDC and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.3.6 Test results

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Cont. Transmit
INPUT POWER	12VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

CHANNEL	CHANNEL FREQUENCY (MHz)	6dB BW (kHz)	6dB Limit Min (kHz)	RESULT
1	2437	1323	500.00	PASS
2	2441	1423	500.00	PASS
3	2447	1443	500.00	PASS

REMARKS:
None

CHANNEL	CHANNEL FREQUENCY (MHz)	99% Occupied BW (MHz)
1	2436	2505
2	2441	2725
3	2443	2585

REMARKS:
None

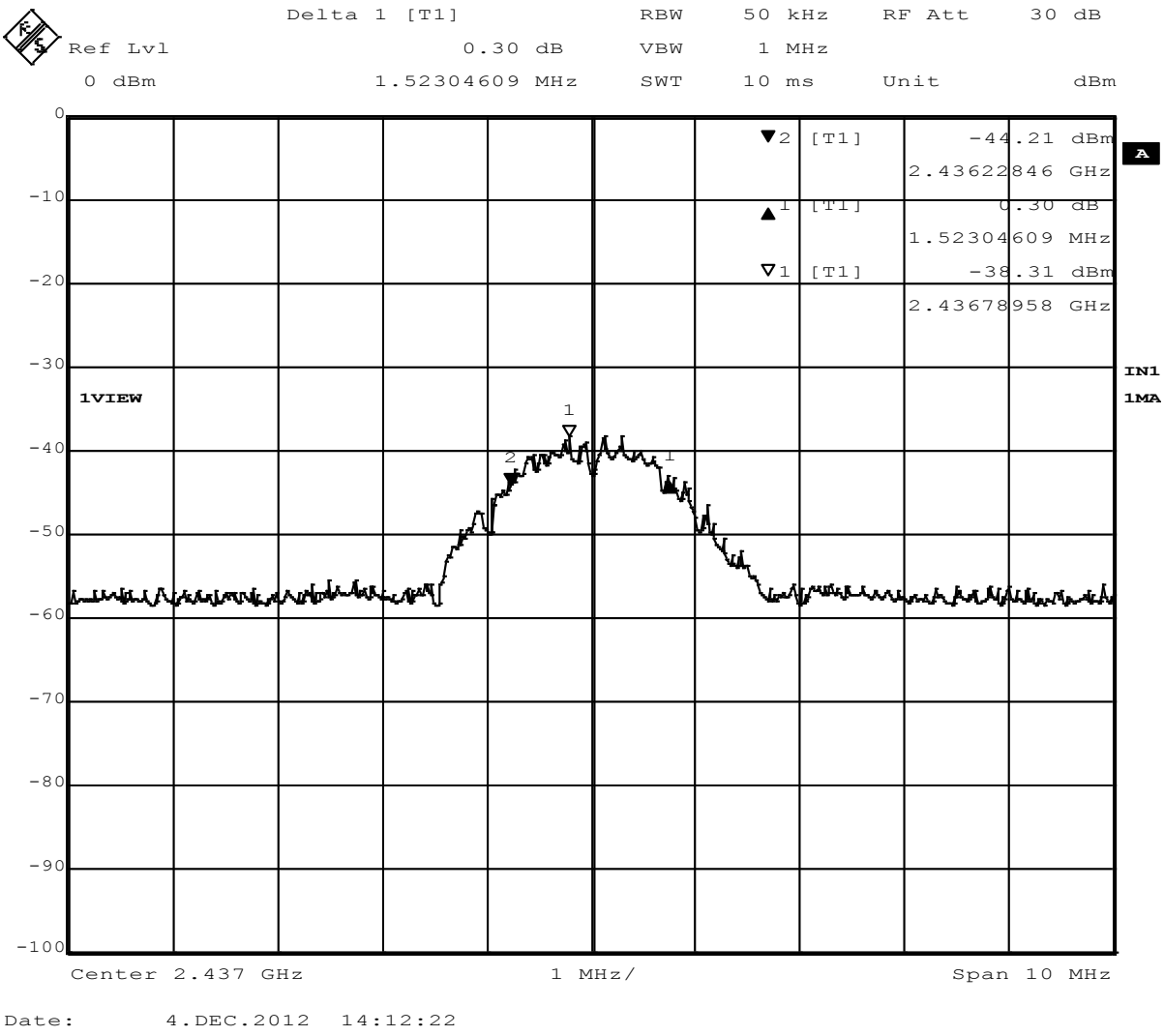

Figure 8 - 6dB Bandwidth, Low Channel

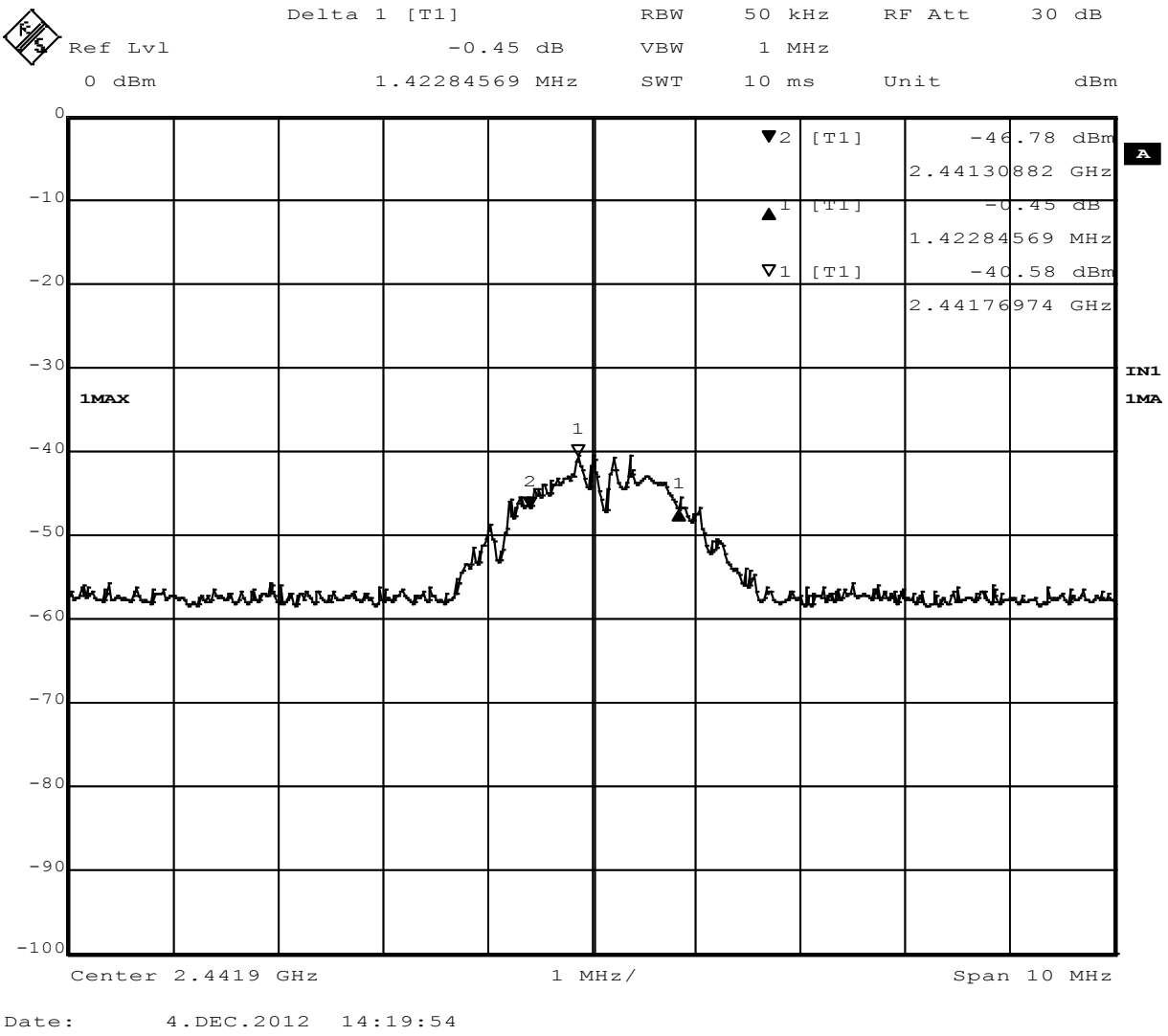

Figure 9 - 6dB Bandwidth, Middle Channel

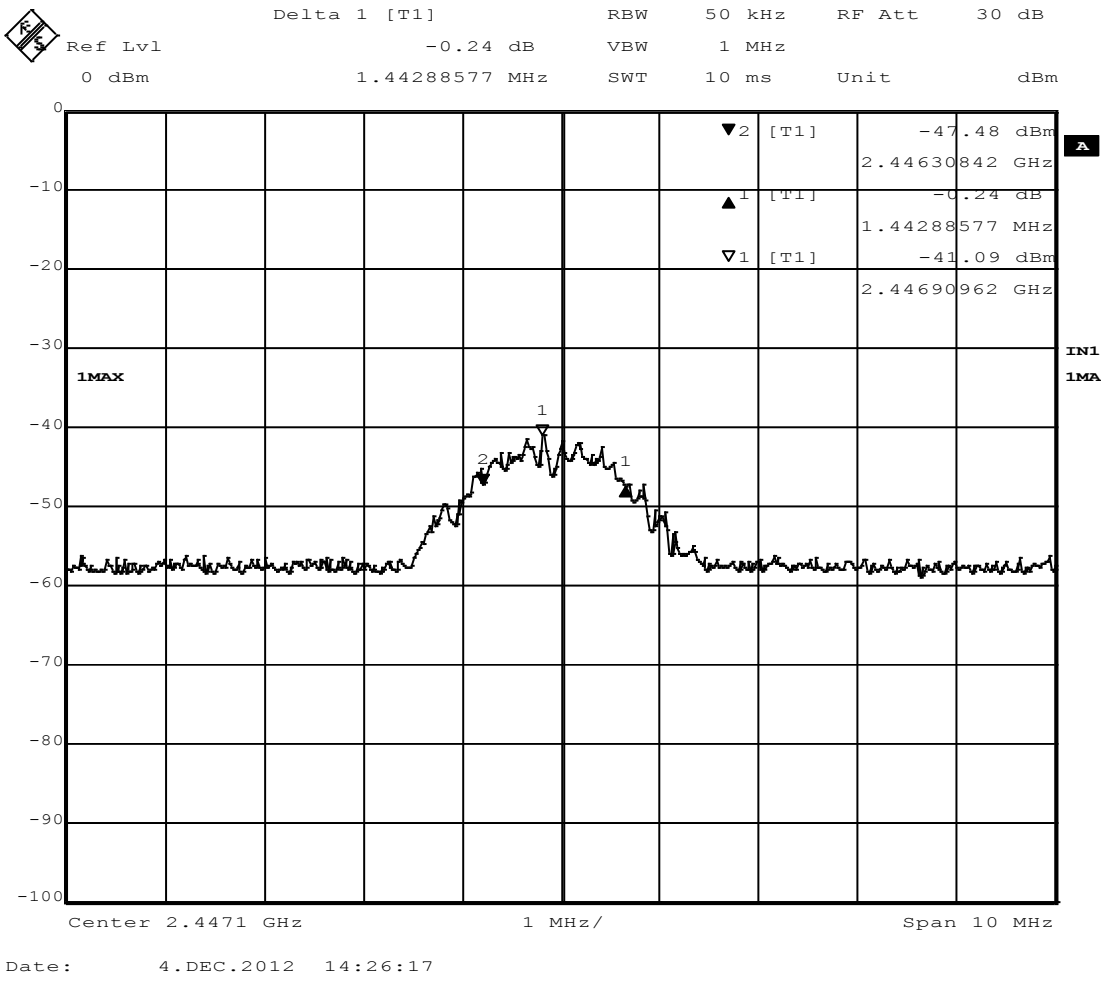

Figure 10 - 6dB Bandwidth, High Channel

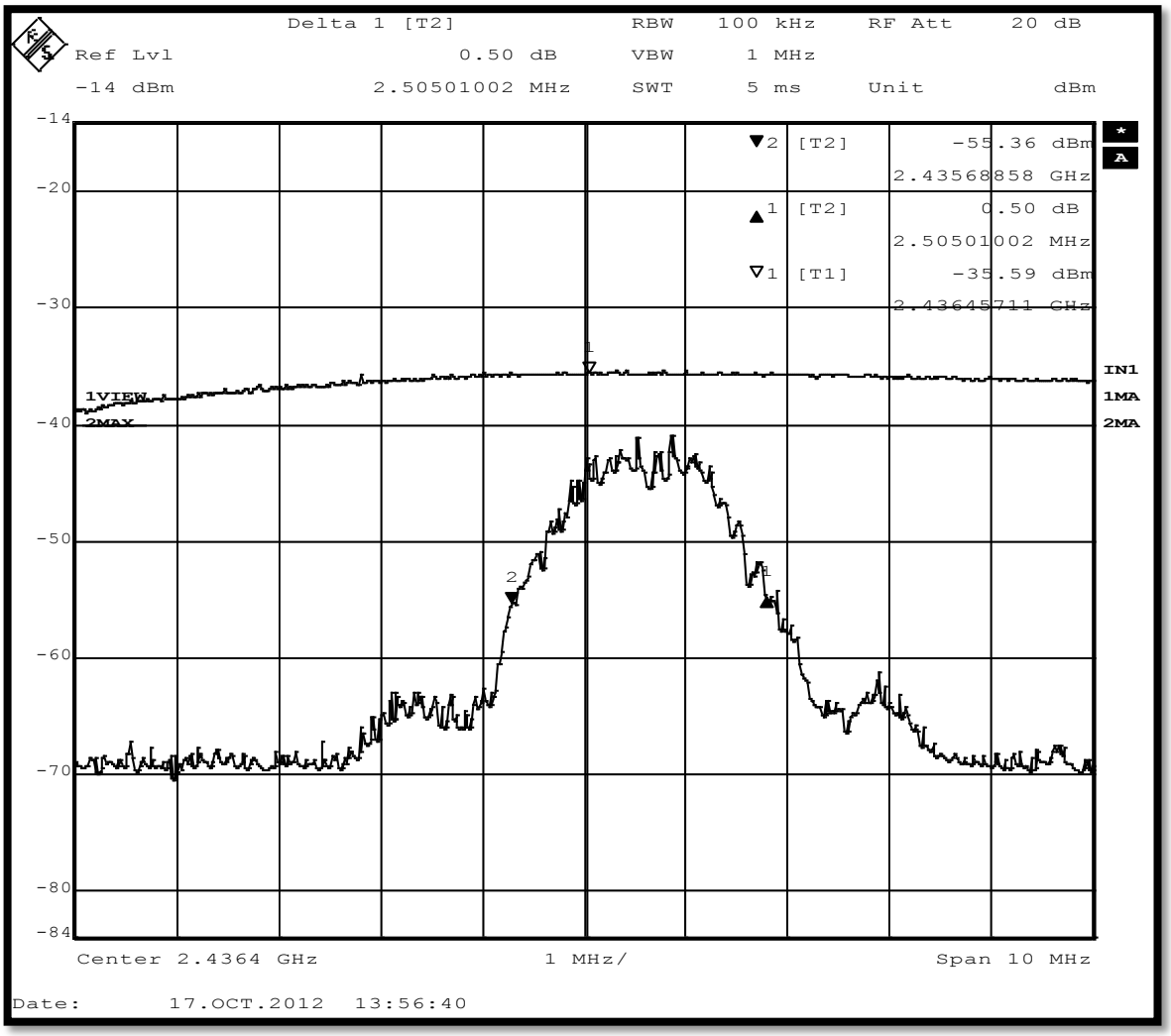

Figure 11 - 99% Occupied Bandwidth, Low Channel

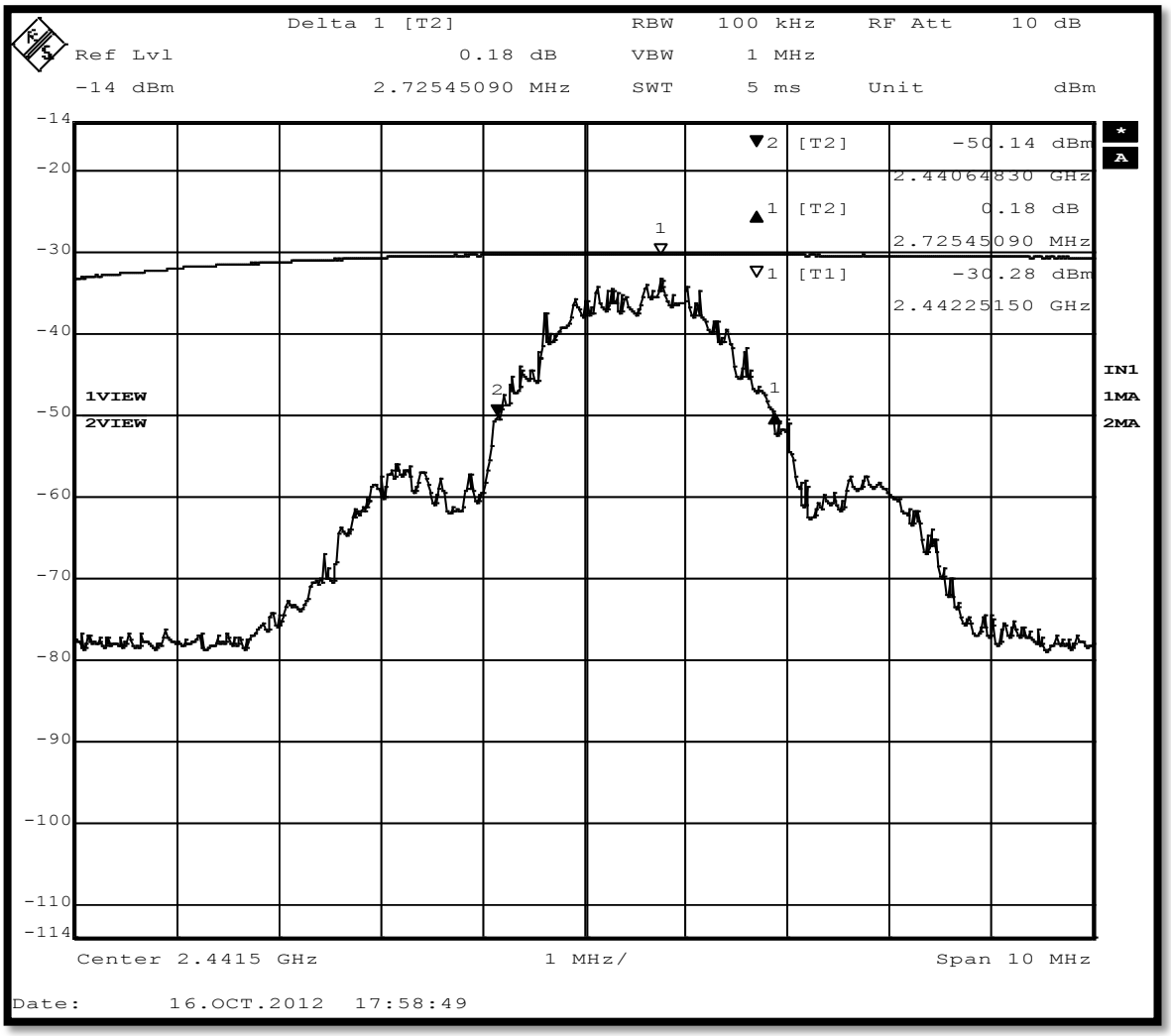

Figure 12 - 99% Occupied Bandwidth, Mid Channel

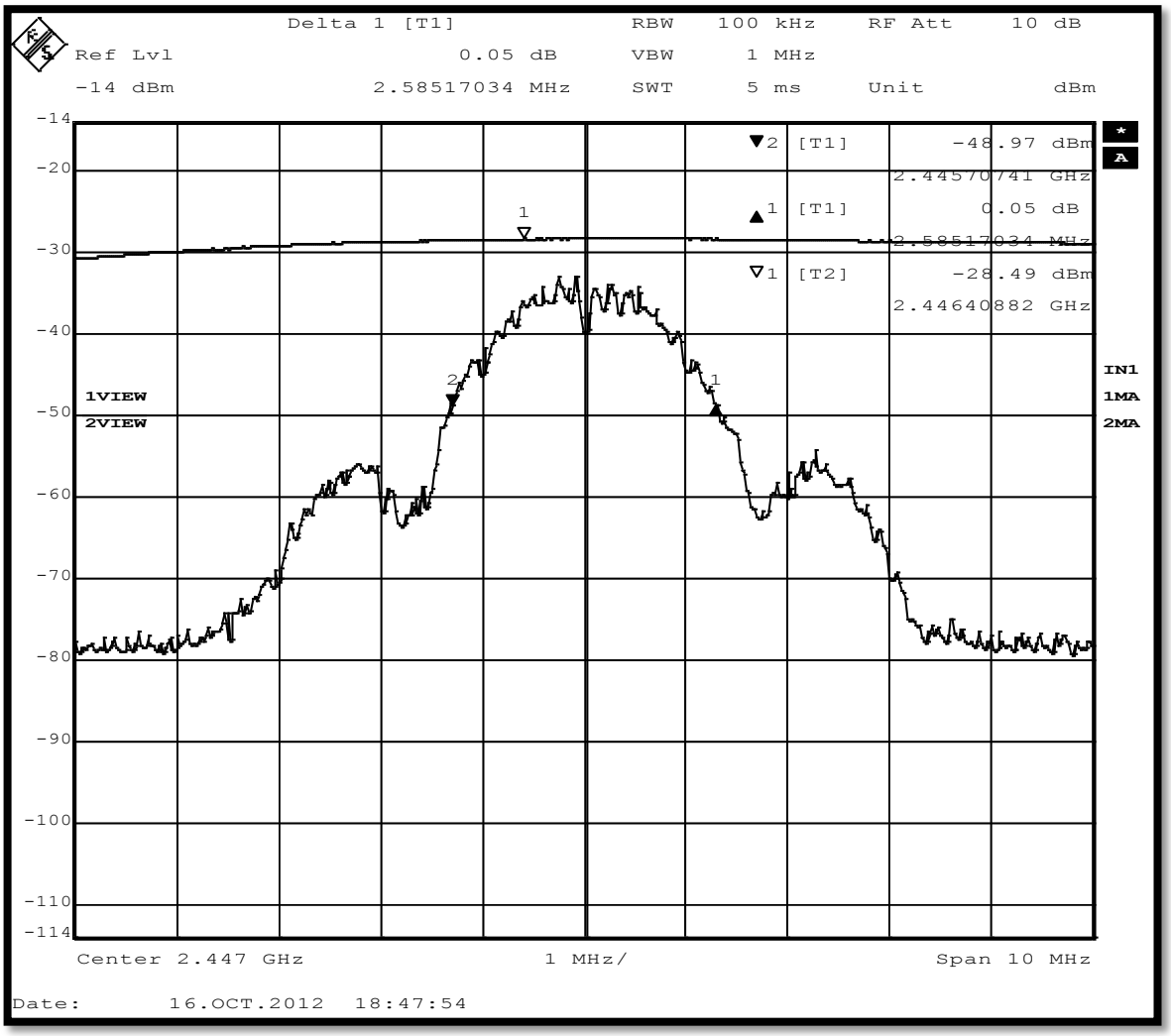

Figure 13 - 99% Occupied Bandwidth, High Channel

4.4 Maximum peak output power

4.4.1 Limits of power measurements

The maximum peak output power allowed is 30dBm (1000mW).

4.4.2 Test procedures

1. All measurements were taken at a distance of 3m from the EUT. The orientation of the EUT was maximized before making the measurement.

2. The resolution bandwidth was set to 10MHz and the video bandwidth was set to 10MHz to capture the maximum amount of signal. The analyzer used a peak detector in max hold mode. This represented the maximum output power.

4.4.3 Deviations from test standard

No deviation.

4.4.4 Test setup

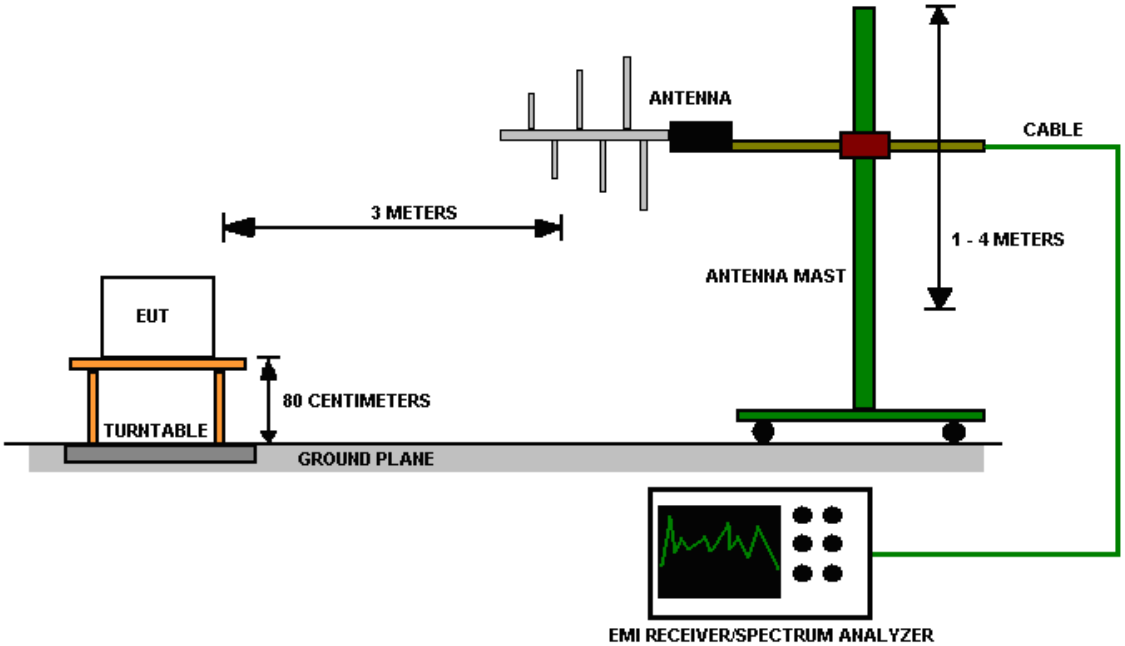

Figure 14 - Power Measurements Test Setup

4.4.5 EUT operating conditions

The EUT was powered by 12VDC and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

4.4.6 Test results

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Cont. Transmit
INPUT POWER	12VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

Maximum peak output power

CHANNEL	CHANNEL FREQUENCY (MHz)	FIELD STREGNTH AT 3m (dBµV/m)	EIRP PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	2437	115.33	20.10	30	PASS
2	2441	114.86	19.63	30	PASS
3	2447	114.81	19.58	30	PASS

Peak output measurements are calculated as EIRP values from the maximized 3m field strength measurements. These measurements were with a 10MHz resolution bandwidth so as to measure the power over the entire bandwidth. All measurements shown in Figures 15 – 17 include correction factors.

These values were added to the values measured with a 10MHz resolution bandwidth in Section 4.3 to calculate the3m field stregnth values in the above table.

Example for 2441 MHz;

Field strength at 3m = 115.33dBµV/m = 10^(115.83/20) / 10^6 = 0.62 V/m

EIRP = (0.62 V/m * 3 meters)^2 / (30 * 1) = 115.32 mW

115.32 mW = 10*log(115.32 mW) dBm = 20.10 dBm

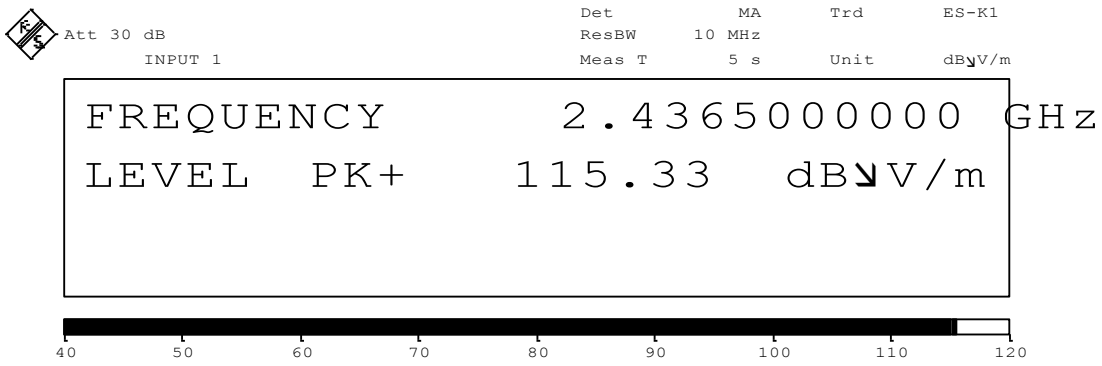

Figure 15 - 3m field strength, Channel 1

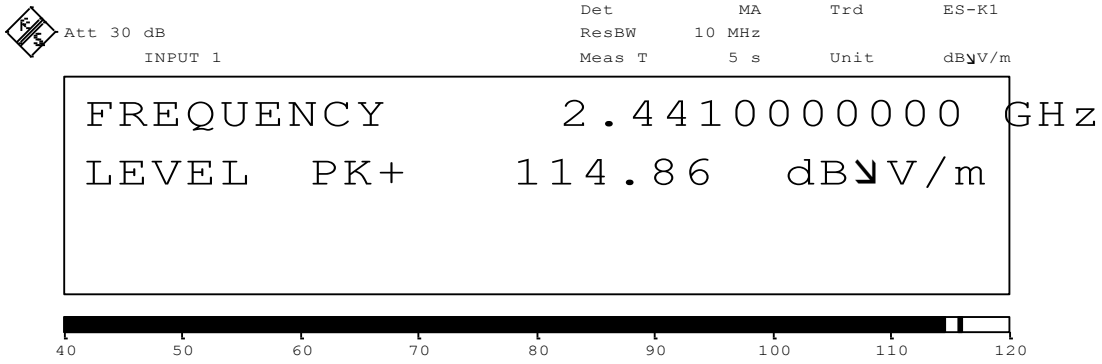

Figure 16 - 3m field strength, Channel 2

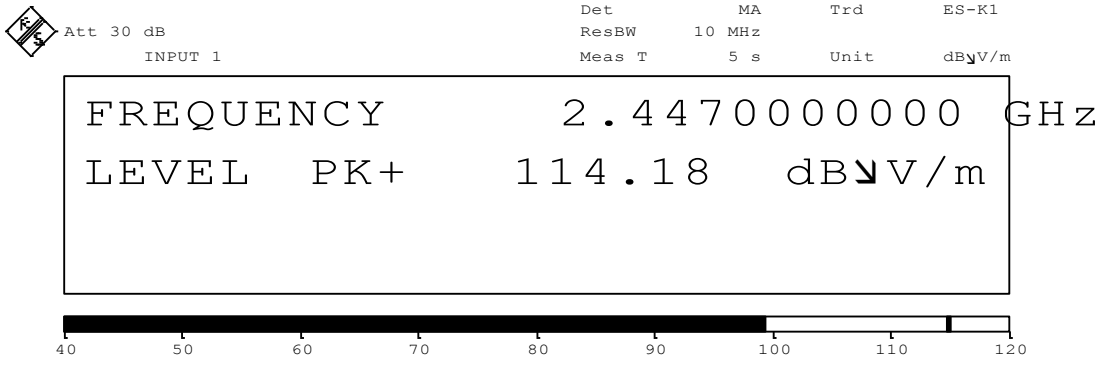

Figure 17 - 3m field strength, Channel 3

4.5 Bandedges

4.5.1 Limits of bandedge measurements

For emissions outside of the allowed band of operation (2400.0MHz – 2483.5MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

4.5.2 Test procedures

The EUT was tested in the same method as described in section *4.3 - Bandwidth*. The EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 120kHz and the EMI receiver was used to scan from the bandedge to the fundamental frequency with a quasi-peak detector. The highest emissions level beyond the bandedge was measured and recorded. If the out of band emissions do not fall within a restricted band from 15.205, then it is required that the out of band emission be 20dB below that of the fundamental emission level. If the out of band emission falls with a restricted band from 15.205, then it is required that the emission be below the limits from 15.209.

4.5.3 Deviations from test standard

No deviation.

4.5.4 Test setup

See Section 4.4

4.5.5 EUT operating conditions

The EUT was powered by an internal 12VDC and set to transmit continuously on the lowest frequency channel and the highest frequency channel.

4.5.6 Test results

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Cont. tranmsit
INPUT POWER	12VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

Highest Out of Band Emissions

CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level dBm	Fundamental Level (dBm)	Delta	Min (dBc)	Result
1	2400.0	-110.27	-43.33	66.94	59.63	PASS
3	2483.5	-102.91	-41.92	64.12	50.09	PASS

*Minimum delta = [highest fundamental peak field strength from Section 4.2] – [Part 15.209 radiated emissions limit.]

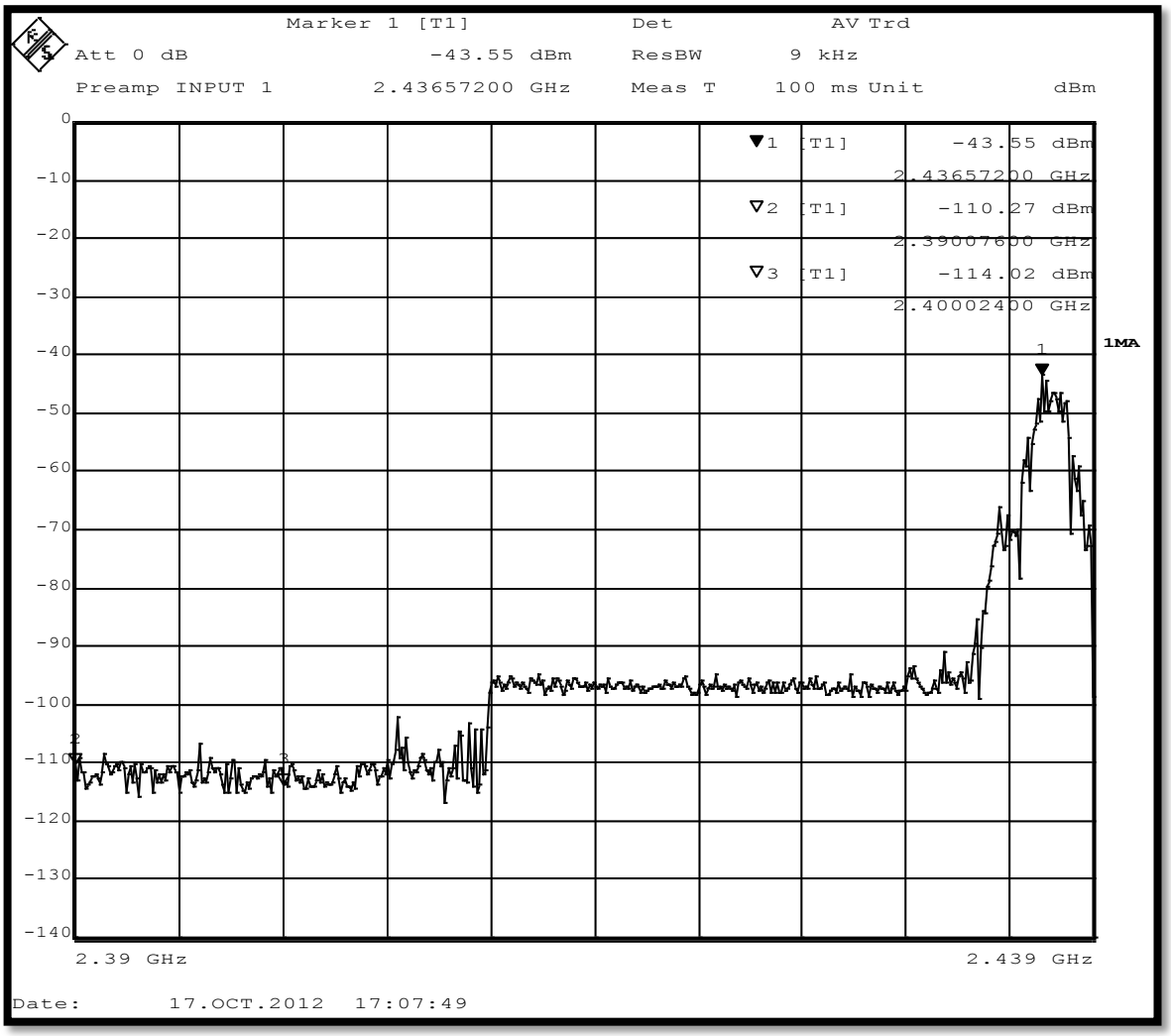

Figure 18 - Band-edge Measurement, Low Channel

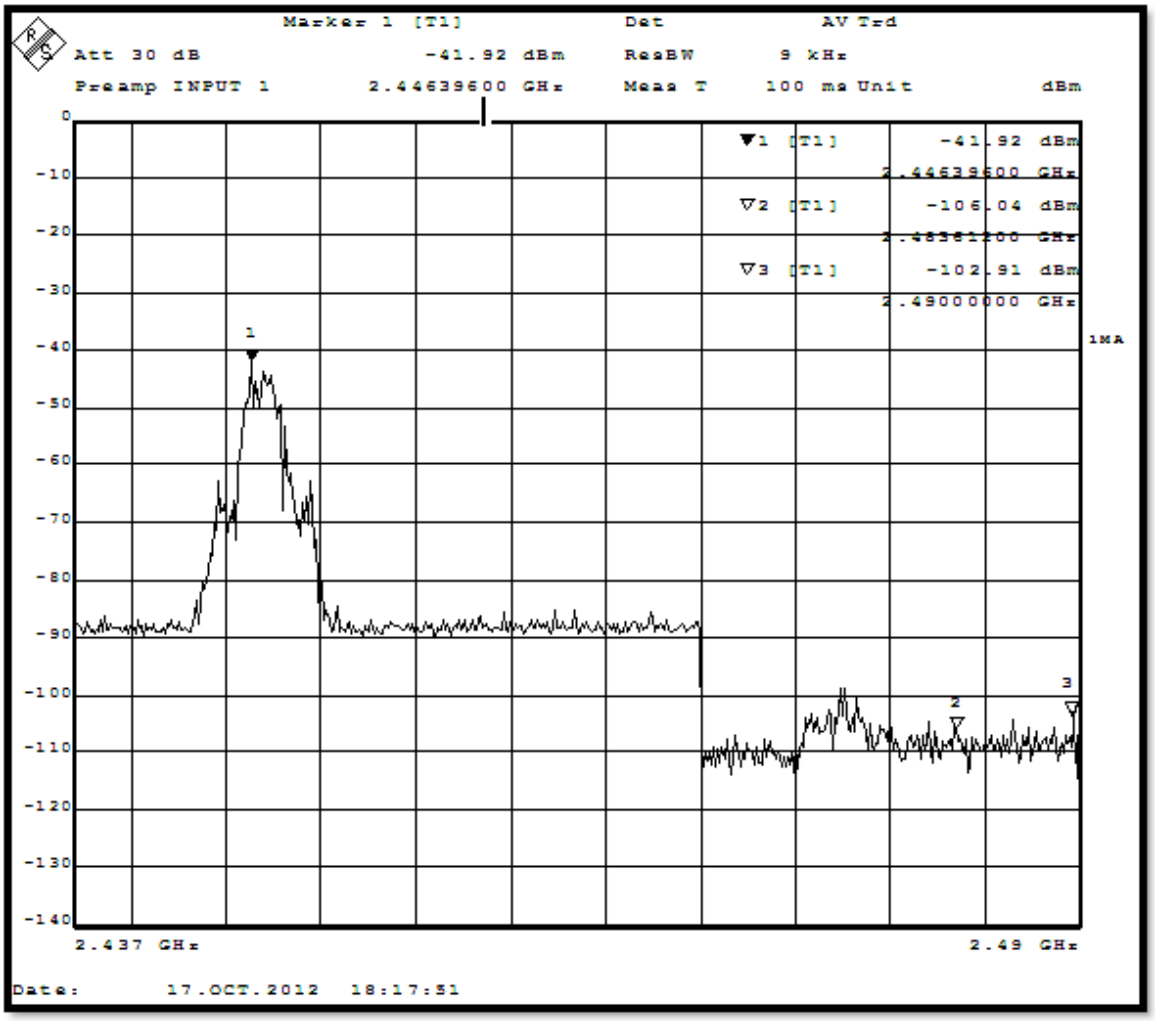

Figure 19 - Band-edge Measurement, High Channel

4.6 Power Spectral Density

4.6.1 Power spectral density measurements

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

4.6.2 Test procedures

All measurements were taken at a distance of 3m from the EUT. The spectrum analyzer was set to 3 kHz RBW and 30 kHz VBW, the sweep time was 500s. The power spectral density was measured and recorded at the frequency with the highest emission. The sweep time is allowed to be longer than span/3KHz for a full response of the mixer in the spectrum analyzer.

4.6.3 Deviations from test standard

No deviation.

4.6.4 Test setup

See section 4.3

4.6.5 EUT operating conditions

The EUT was powered 12VDC and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

EUT	I-PILOT SYSTEM CONTROLLER	MODE	Continuous transmit
INPUT POWER	12VDC	FREQUENCY RANGE	2400.0MHz – 2483.5MHz
ENVIRONMENTAL CONDITIONS	40% ± 5% RH 22 ± 3ºC	TECHNICIAN	KVepuri

Power Spectral Density

CHANNEL	CHANNEL FREQUENCY (MHz)	RF POWER (EIRP) LEVEL IN # KHz BW (dBm)	MAXIMUM POWER LIMIT (dBm)	RESULT
1	2436	-5.03	8.00	PASS
2	2441	2.02	8.00	PASS
3	2447	2.59	8.00	PASS

Values are corrected from the following plots by an antenna factor of 28.4 dB and a cable factor of 6.6 dB. RF power is listed as EIRP, calculated from 3m field strength.

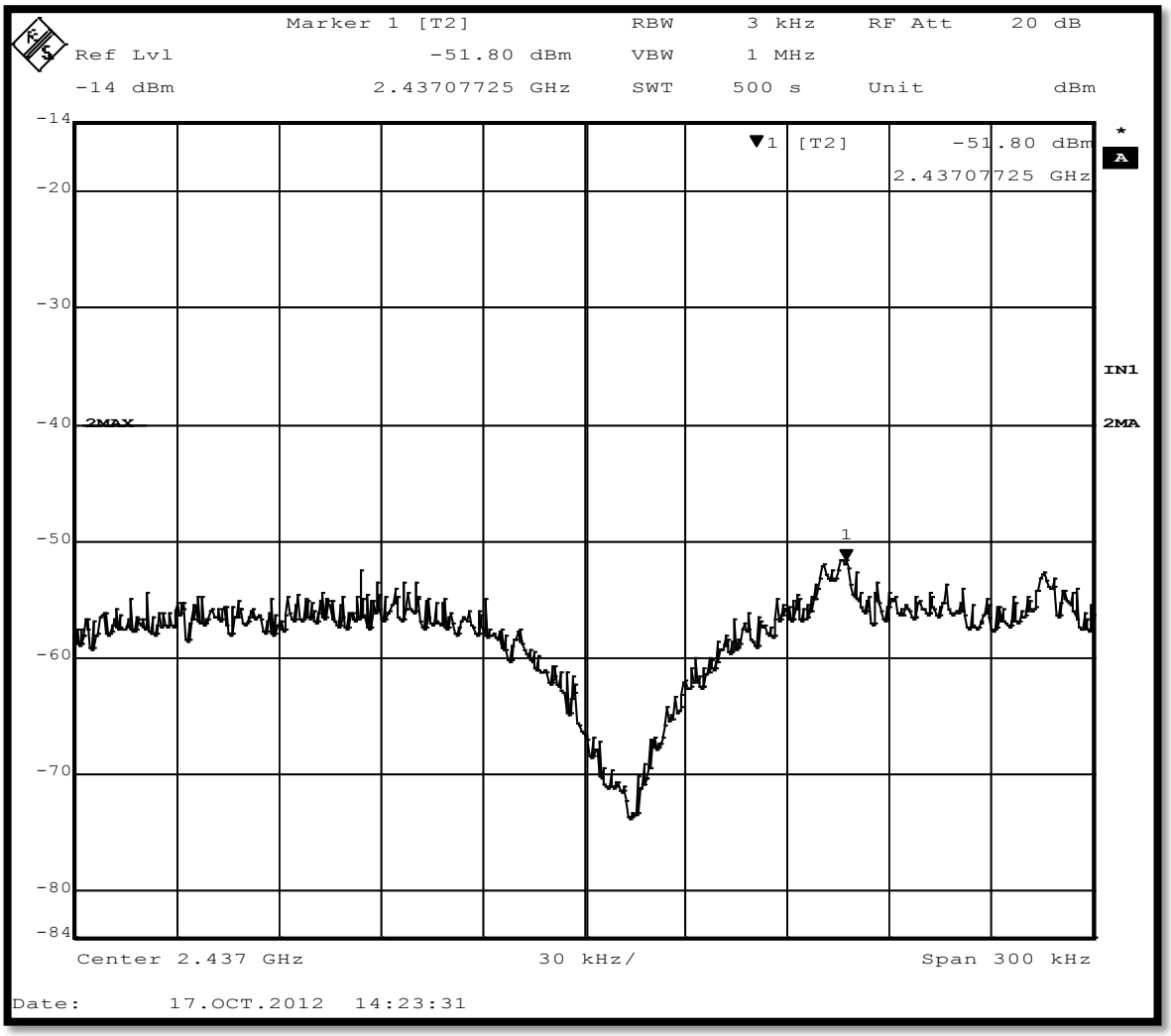

Figure 20 - Power Spectral Density Measurement, Low Channel

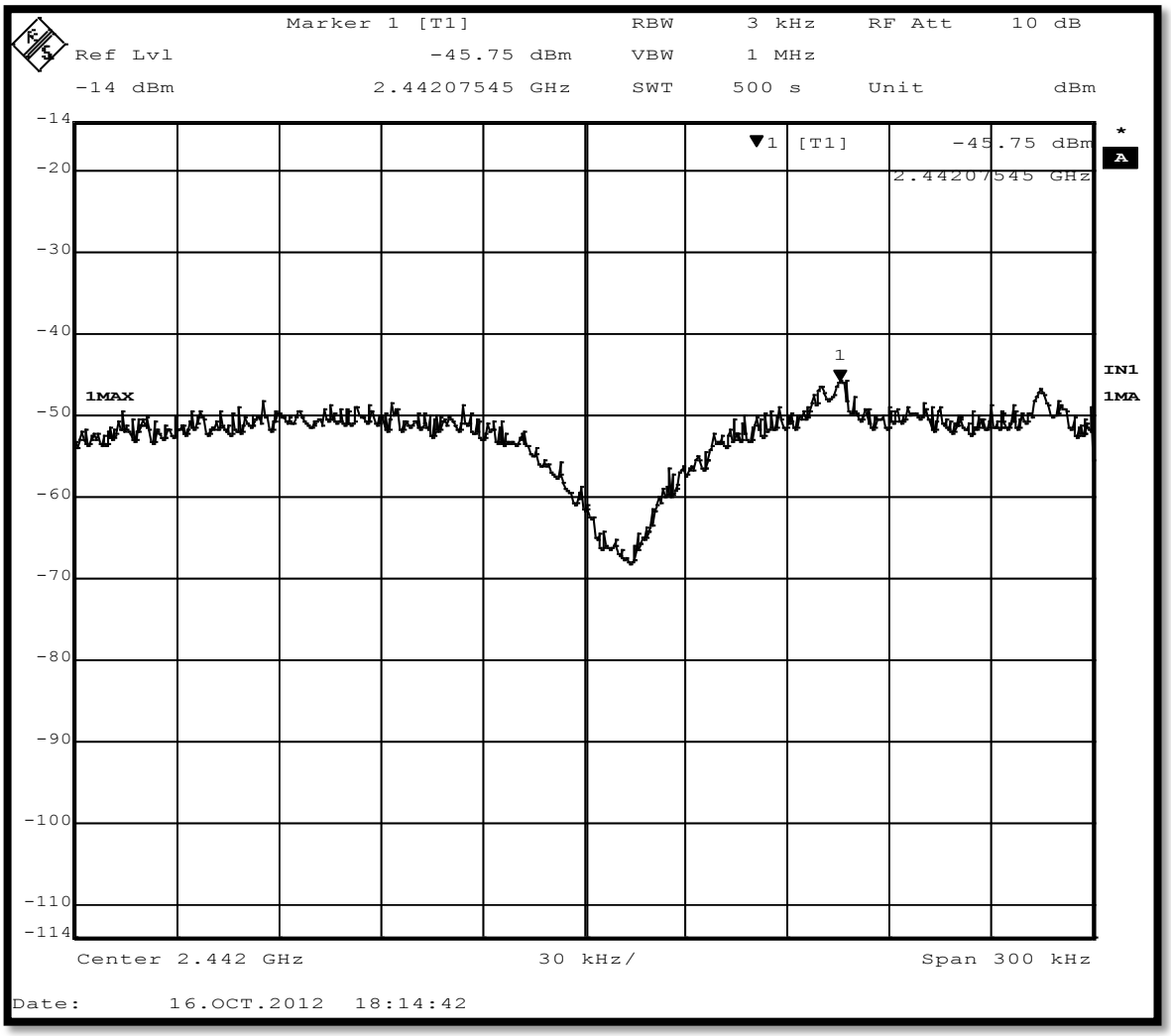

Figure 21 - Power Spectral Density Measurement, Mid Channel

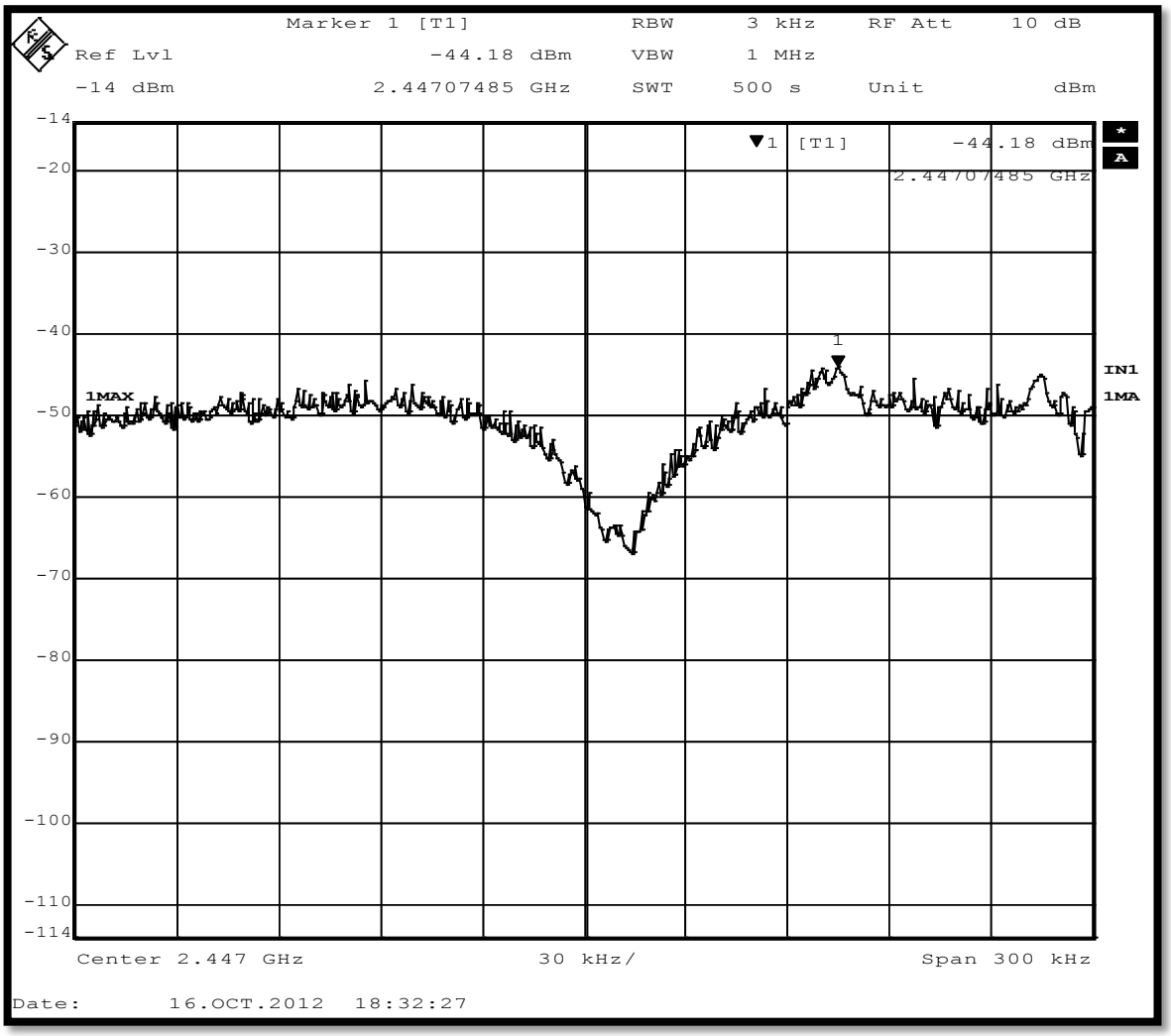

Figure 22 - Power Spectral Density Measurement, High Channel

Appendix A: Test Photos

Figure 23 - Test Setup

Figure 24 - Test Setup

Appendix B: Sample Calculation

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Stregnth (V/m) x antenna distance (m)]^2 / [30 x Gain (numeric)]

Power (watts) = 10^[Power (dBm)/10] x 1000

Field Strength (dBµV/m) = Field Stregth (dBm) = 107 (for 50Ω measurement systems)

Field Stregnth (V/m) = 10^[Field Stregnth (dBµV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator

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