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Amended Test Report

Includes R033109-01-04 and Amendment

Client: **Johnson Outdoors**
1531 Madison Ave.
Mankato, MN 56001

Contact: **Paul Salmon**

Product: **i-Pilot Controller**

FCC ID: **T62-IPCON**
IC ID: **4397A-IPCON**

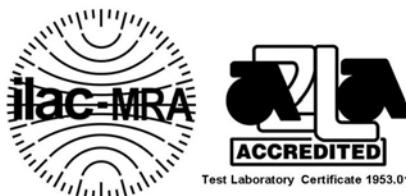
Test Report No: **R033109-01-04A**

APPROVED BY: **Nic Johnson**
Test Engineer

DATE: **5 May 2010**

Total Pages: **41**

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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 AS/NZS 4268	Radiated Emissions	Pass	Meets the requirement of the limit.
15.247(a)(1) RSS-210 Issue 7 AS/NZS 4268	Minimum Bandwidth, Limit Min. 500kHz	Pass	Meets the requirement of the limit.
15.247(b) RSS-210 Issue 7 AS/NZS 4268	Maximum Peak Output Power, Limit: Max. 23.9dBm	Pass	Meets the requirement of the limit.
15.247(c) RSS-210 Issue 7 AS/NZS 4268	Transmitter Radiated Emissions, Limit: Table 15.209	Pass	Meets the requirement of the limit.
15.247(c) RSS-210 Issue 7 AS/NZS 4268	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 7 AS/NZS 4268	Power Spectral Density	Pass	Meets the requirement of the limit.
AS/NZS 4268	Extreme Test Conditions	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 was tested in accordance with the methods of ANSI/IEEE C63.4: 2003 and KDB Publication No. 558074: 2005. 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 receiving antenna was moved from 1m to 4m in both vertical and horizontal positions. The EUT was tested while sitting both vertically and horizontally. The horizontal 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 2500.0MHz to 2483.5MHz band and subsequent harmonics.

AS/NZS 4268:2008:

According to Table 1, Note five of this standard, a compliant test report to part 15.247 of the FCC rules is sufficient to demonstrate compliance. Additional testing was conducted as acquit for the variations of AS/NZS 4268 in Section 4.7 of this report.

1.3 Reason for amendment

Section 4.3.6 was modified so the table for 6dB bandwidth was modified to match the results shown in the screen captures. The table for the 99% occupied bandwidth was modified to show measurements in MHz.

Section 4.2 was modified to show the limits from FCC Part 15.209 for measurements from 30MHz to 1GHz.

Average measurements of harmonics were re-taken using a peak detector and a 1MHz resolution bandwidth/10Hz Video bandwidth as specified in KDB 58807. The new measurements can be seen in Section 4.2

2.0 Description

2.1 Equipment under test

The Equipment Under Test (EUT) was an i-Pilot controller, to be installed in a Terrova, Riptide ST, Riptide SP or Powerdrive V2 motor. The controller will control the direction and speed of the motor based on command it receives from an i-Pilot remote. The EUT also includes a GPS receiver and can control the motor automatically using information provided by the GPS and the user.

EUT Received Date: 28 September 2010

EUT Tested Dates: 29 October, 24 November 2009

23 February 2010

PRODUCT	i-Pilot Controller
POWER SUPPLY	12VDC, 24VDC, 36VDC
MODULATION TYPE	FM
TRANSMISSION PROTOCOL	IEEE 802.15.4
RADIO TECHNOLOGY	Half-duplex RF Link
FREQUENCY RANGE	2.4GHz
MAX OUTPUT POWER	-1.05dBm (0.78mW)
ANTENNA TYPE	Internal Dipole
ASSOCIATED EQUIPMENT	i-Pilot 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 $45 \pm 4\%$

Temperature of $20 \pm 3^\circ$ Celsius

2.3 Description of test modes

The EUT was tested at the frequencies below:

Channel	Frequency
1	2452
2	2457
3	2462

These are the only three frequencies available.

2.4 Applied standards

The EUT uses digital modulation and operates between 2400.0MHz and 2483.5MHz. It has no AC mains connection. 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: 2005

ANSI C63.4:2003

AS/NZS 4268: 2008 (915.500MHz – 926.750MHz only)

Industry Canada RSS-GEN

Industry Canada RSS-220

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. The EUT was tested with a 12VDC lead-acid marine battery.

3.0 Test equipment used

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE
Rohde & Schwarz Test Receiver****	ESI26	100037	16 Sep 2009
EMCO Biconilog Antenna	3142B	1654	6 Feb 2009
EMCO Horn Antenna	3115	6415	6 Feb 2009
EMCO Horn Antenna***	3116	2576	6 Jun 2008
Rohde & Schwarz LISN	ESH3-Z5	100023	10 Feb 2009
Hewlett Packard Power Meter	4378	100307	20 Jan 2009
Hewlett Packard Power Sensor	8481A	2702A63981	20 Jan 2009
Rohde & Schwarz Preamp*	TS-PR18	082001/003	15 Dec 2008
Trilithic High Pass Filter*	6HC330	23042	15 Dec 2008
Mini-circuits High Pass Filter**	VHF-8400+	15542	15 Dec 2008

*Used for radiated measurements above 3GHz

**Used for measurements above 6GHz

***Used for measurements above 18GHz

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 (μ V/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 (dB_uV/m) = 20 * log * Emission level (μ V/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 the horizontal position only as it would be in normal operating condition.

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

4.2.3 Deviations from test standard

No deviation.

4.2.4 Test setup

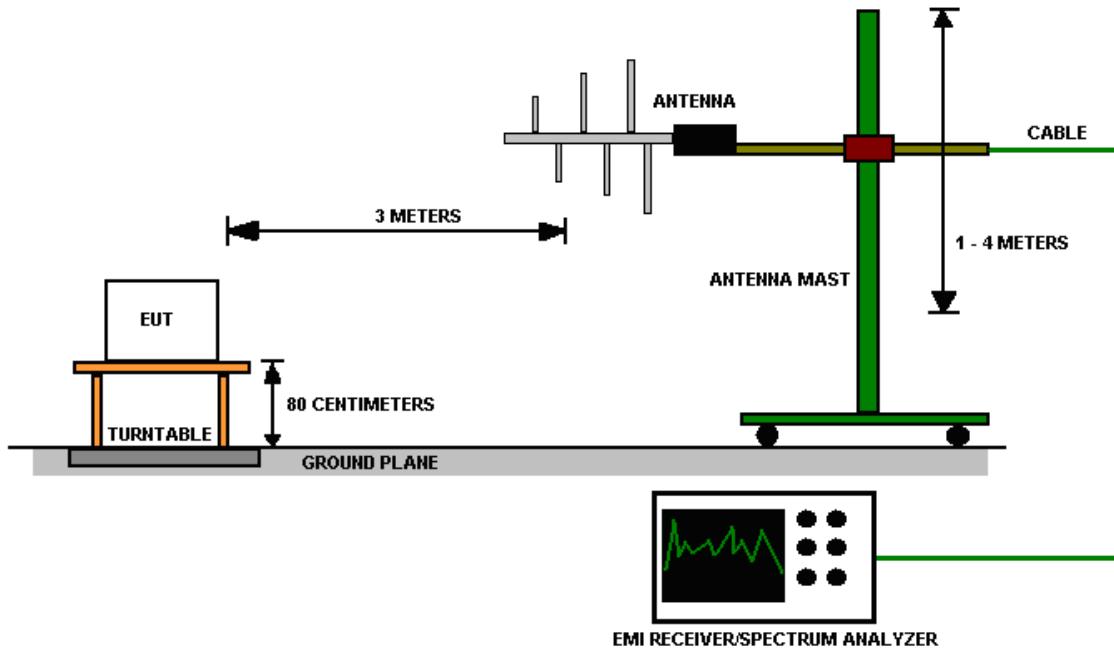


Figure 1 - Radiated Emissions Test Setup

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 a 12.0VDC battery and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range. The EUT was tested installed in a Terrova motor case with an i-Pilot Remote for measurements from 30MHz – 1GHz. For all other measurements the EUT was tested alone in the horizontal position with no plastic case.

4.2.6 Test results

EUT	i-Pilot Controller	MODE	Channel 1
INPUT POWER	12.0VDC	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

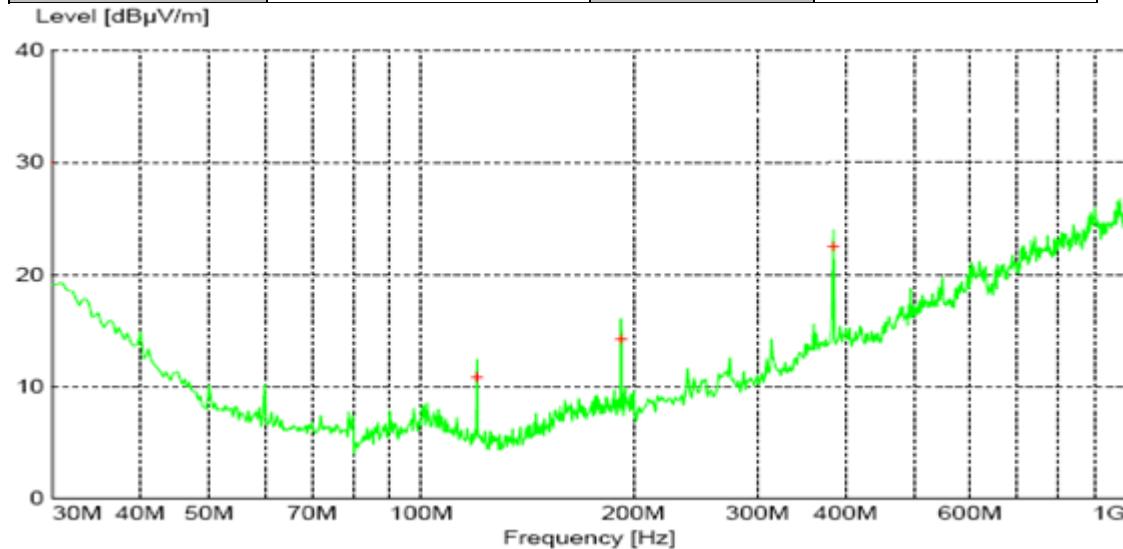


Figure 2 - Radiated Emissions Plot, Channel 1

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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
120.00	10.87	43.50	32.63	115	360	VERT
192.00	14.28	43.50	29.22	100	227	VERT
383.98	22.53	46.00	23.47	210	38	HORI

REMARKS:

1. Emission level (dB μ V/m) = Raw Value (dB μ V) + 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 Controller	MODE	Channel 2
INPUT POWER	12.0VDC	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

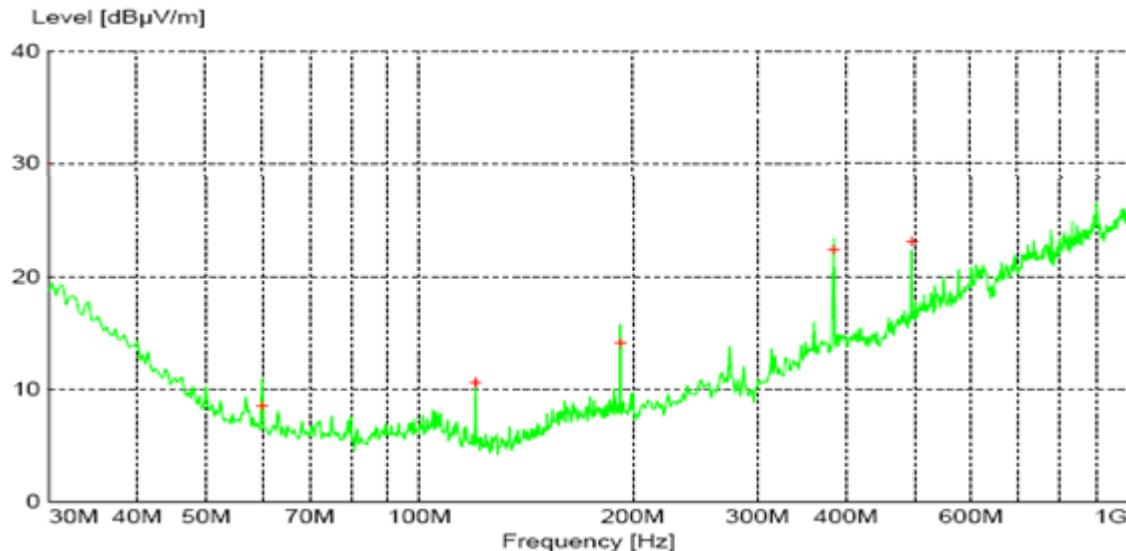


Figure 3 - Radiated Emissions Plot, Channel 2

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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
60.00	8.49	40.00	31.51	325	90	VERT
120.00	10.59	43.50	32.91	101	202	VERT
192.00	14.09	43.50	29.41	98	185	VERT
383.98	22.43	46.00	23.57	178	48	HORI
495.22	23.06	46.00	22.94	99	55	VERT

REMARKS:

1. Emission level (dB μ V/m) = Raw Value (dB μ V) + 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 Controller	MODE	Channel 3
INPUT POWER	12.0VDC	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

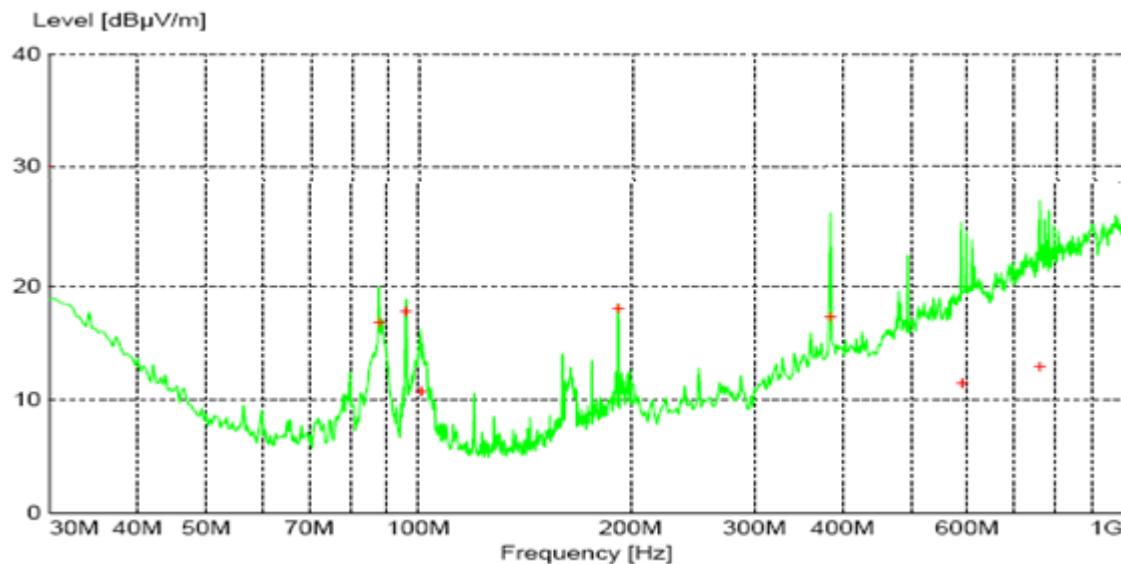


Figure 4- Radiated Emissions Plot, Channel 3

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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
88.02	16.73	43.50	26.77	103	180	VERT
96.00	17.74	43.50	25.76	133	41	VERT
100.86	10.67	43.50	32.83	99	189	VERT
192.00	17.96	43.50	25.54	136	342	VERT
383.98	17.32	46.00	28.68	214	40	HORI
590.44	11.44	46.00	34.56	136	35	HORI
760.36	12.96	46.00	33.04	100	11	HORI

REMARKS:

1. Emission level (dB μ V/m) = Raw Value (dB μ V) + 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.
5. *Radiated limits do not apply within the 2400.0MHz to 2483.5MHz band.
6. ** Radiated emissions outside of the 2400.0MHz to 2483.5MHz band must be at least 20dB below the highest emission

EUT	i-Pilot Controller	MODE	Receive
INPUT POWER	12.0VDC Battery	FREQUENCY RANGE	30MHz – 1GHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

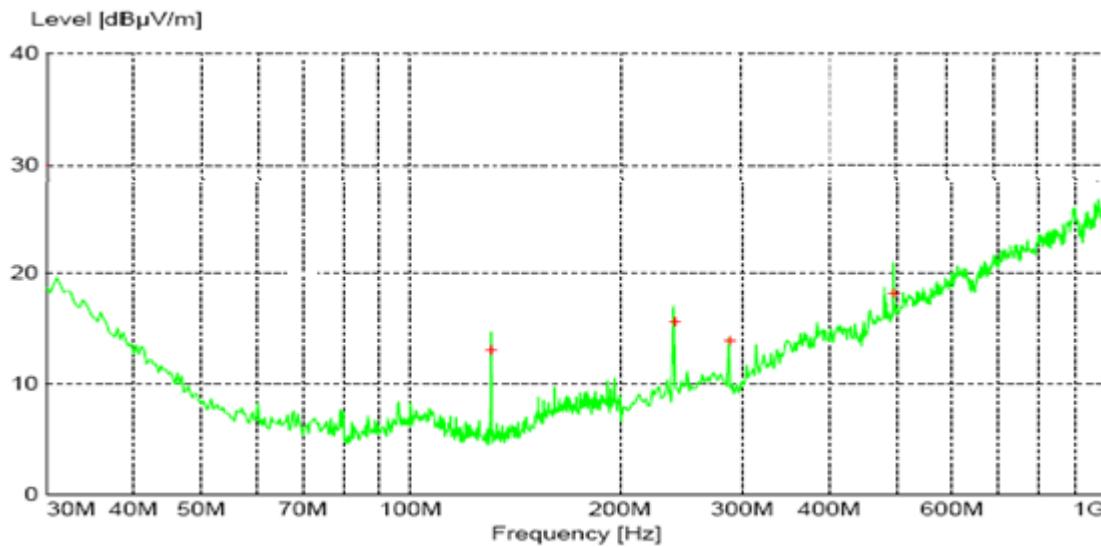


Figure 5 - Radiated Emissions Plot, Receive

Table 4- Radiated Emissions Quasi-peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
130.56	13.05	43.50	30.45	99	192	VERT
240.04	15.61	43.50	27.89	99	138	VERT
287.98	13.83	46.00	32.17	141	114	VERT
495.22	18.16	46.00	27.84	101	0	VERT

REMARKS:

1. Emission level (dB μ V/m) = Raw Value (dB μ V) + 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 Controller	MODE	Channel 1
INPUT POWER	12.0VDC	FREQUENCY RANGE	1GHz – 26GHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

Table 5 - Radiated Emissions Average Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
2451.50	85.74	NA*	NA	188	61	HORI
2454.00	38.38	NA*	NA	302	198	VERT
4909.50	46.45***	53.90		154	12	VERT
4913.00	47.01***	53.90		212	209	HORI

Table 6 - Radiated Emissions Peak Measurements, Channel 1

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
2451.50	85.74	NA	NA	188	61	HORI
2454.00	38.96	NA	NA	302	198	VERT
4909.50	57.23	73.90	16.67	154	12	VERT
4913.00	57.62	73.90	16.28	212	209	HORI

REMARKS:

1. Emission level (dB μ V/m) = Raw Value (dB μ V) + 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.
5. *Radiated limits do not apply within the 2400.0MHz to 2483.5MHz band.
6. ** Radiated emissions outside of the 2400.0MHz to 2483.5MHz band must be at least 20dB below the highest emission
7. ***Measurements taken on 4/29/2010 after receiving TCB feedback.

EUT	i-Pilot Controller	MODE	Channel 2
INPUT POWER	12.0VDC	FREQUENCY RANGE	1GHz – 26GHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

Table 7 - Radiated Emissions Average Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
2456.00	93.20	NA*	NA	101	223	HORI
2456.50	59.51	NA*	NA	98	231	VERT
4904.50	52.02***	53.90	1.88	201	300	VERT
4915.50	48.11***	53.90	5.79	109	28	VERT

Table 8 - Radiated Emissions Peak Measurements, Channel 2

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
2456.00	93.20	NA	NA	101	223	HORI
2456.50	59.00	NA	NA	98	231	VERT
4904.50	56.98	73.90	16.92	201	300	VERT
4915.50	55.45	73.90	18.45	109	28	VERT

REMARKS:

1. Emission level (dB μ V/m) = Raw Value (dB μ V) + 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.
5. *Radiated limits do not apply within the 2400.0MHz to 2483.5MHz band.
6. ** Radiated emissions outside of the 2400.0MHz to 2483.5MHz band must be at least 20dB below the highest emission
7. ***Measurements taken on 4/29/2010 after receiving TCB feedback.

EUT	i-Pilot Controller	MODE	Channel 3
INPUT POWER	12.0VDC	FREQUENCY RANGE	1GHz – 26GHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

Table 9 - Radiated Emissions Average Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
2462.50	95.19	NA*	NA	100	120	VERT
4911.00	46.32***	53.90	7.58	254	349	HORI

Table 10 - Radiated Emissions Peak Measurements, Channel 3

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
2462.50	95.19	NA	NA	100	120	VERT
4911.00	56.99	73.90	16.91	254	349	HORI

REMARKS:

1. Emission level (dB μ V/m) = Raw Value (dB μ V) + 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.
5. *Radiated limits do not apply within the 2400.0MHz to 2483.5MHz band.
6. ** Radiated emissions outside of the 2400.0MHz to 2483.5MHz band must be at least 20dB below the highest emission
7. ***Measurements taken on 4/29/2010 after receiving TCB feedback.

EUT	i-Pilot Controller	MODE	Receive
INPUT POWER	12.0VDC	FREQUENCY RANGE	1GHz – 26GHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

Table 11 - Radiated Emissions Average Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
2452.50	36.23	53.90	17.67	197	54	VERT
4811.50	46.89***	53.90	7.01	100	1	VERT

Table 12 - Radiated Emissions Peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
2452.50	55.37	73.90	18.53	197	54	VERT
4811.50	56.14	73.90	17.76	100	1	VERT

REMARKS:

1. Emission level (dB μ V/m) = Raw Value (dB μ V) + 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.
5. *Radiated limits do not apply within the 2400.0MHz to 2483.5MHz band.
6. ** Radiated emissions outside of the 2400.0MHz to 2483.5MHz band must be at least 20dB below the highest emission

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

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW 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



4.3.5 EUT operating conditions

The EUT was powered by 3.0VDC 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 Controller	MODE	Cont. Transmit
INPUT POWER	12.0VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

CHANNEL	CHANNEL FREQUENCY (MHz)	6dB BW (MHz)	20dB Limit Max (kHz)	RESULT
1	2452	1.573	500.00	PASS
2	2457	1.663	500.00	PASS
3	2462	1.583	500.00	PASS

REMARKS:

None

CHANNEL	CHANNEL FREQUENCY (MHz)	99% Occupied BW (MHz)
1	2452	2.395
2	2457	2.485
3	2462	2.485

REMARKS:

None

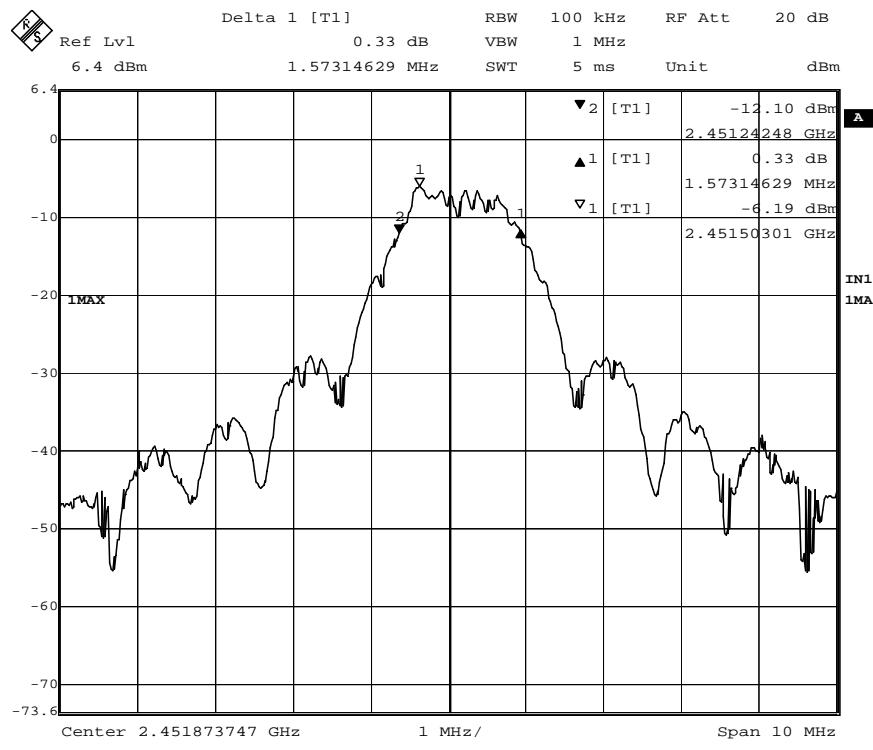


Figure 6 - Channel 1, 6dB Bandwidth

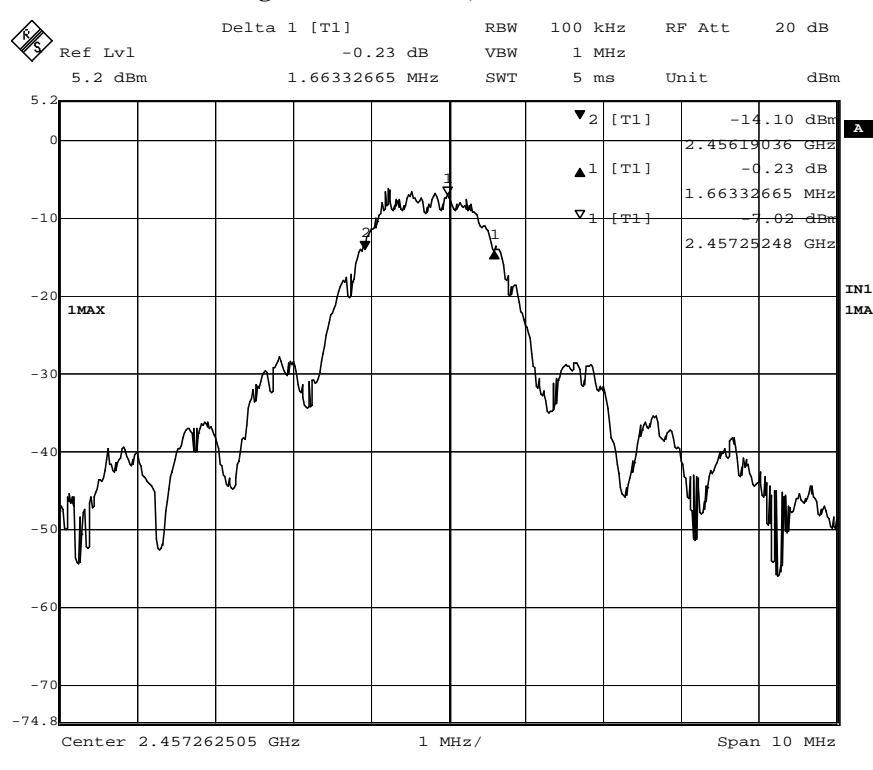


Figure 7 - Channel 2, 6dB Bandwidth

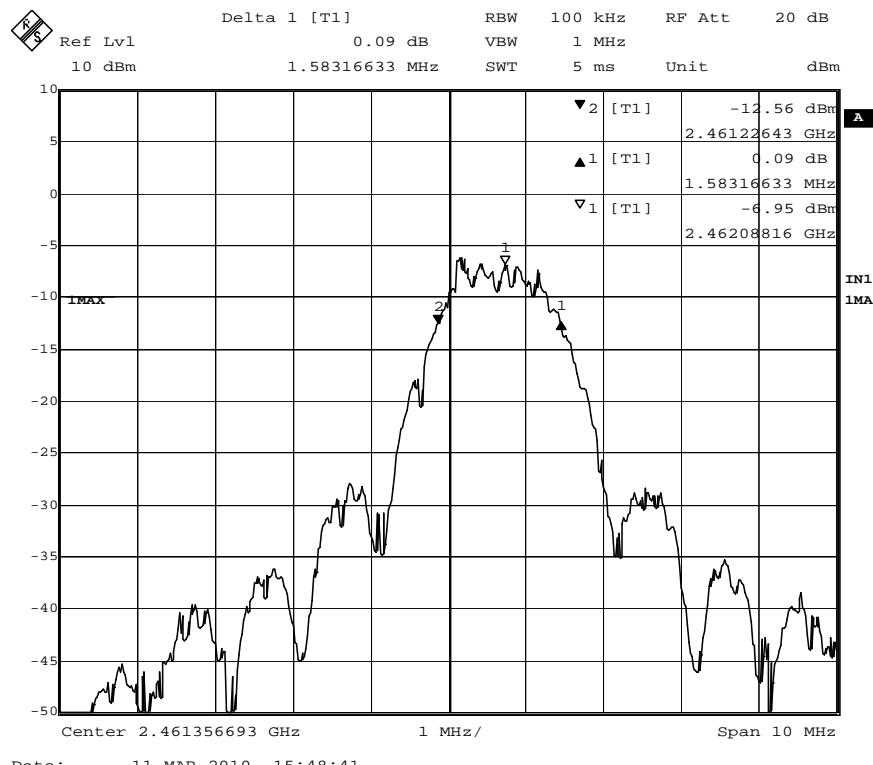


Figure 8 - Channel 3, 6dB Bandwidth

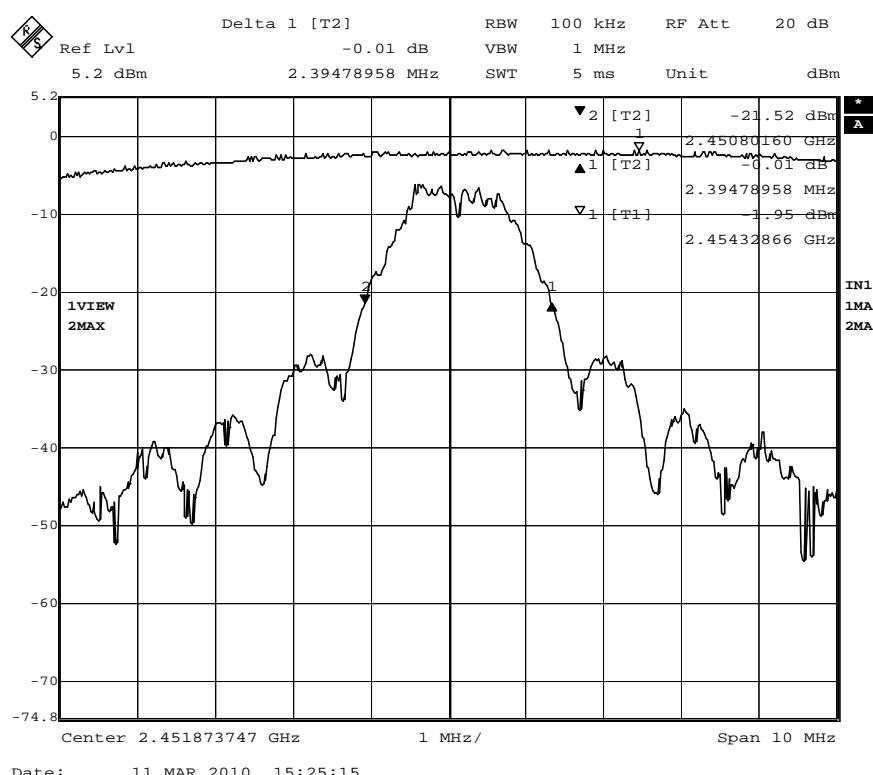


Figure 9 - Channel 1, 99% Occupied Bandwidth

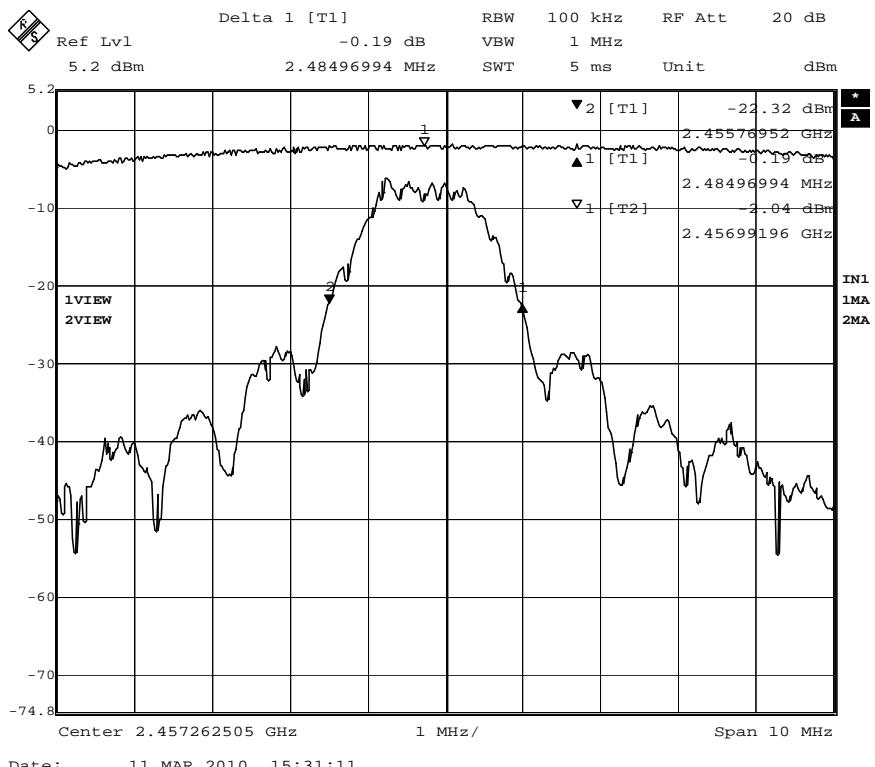


Figure 10 – Channel 2, 99% Occupied Bandwidth

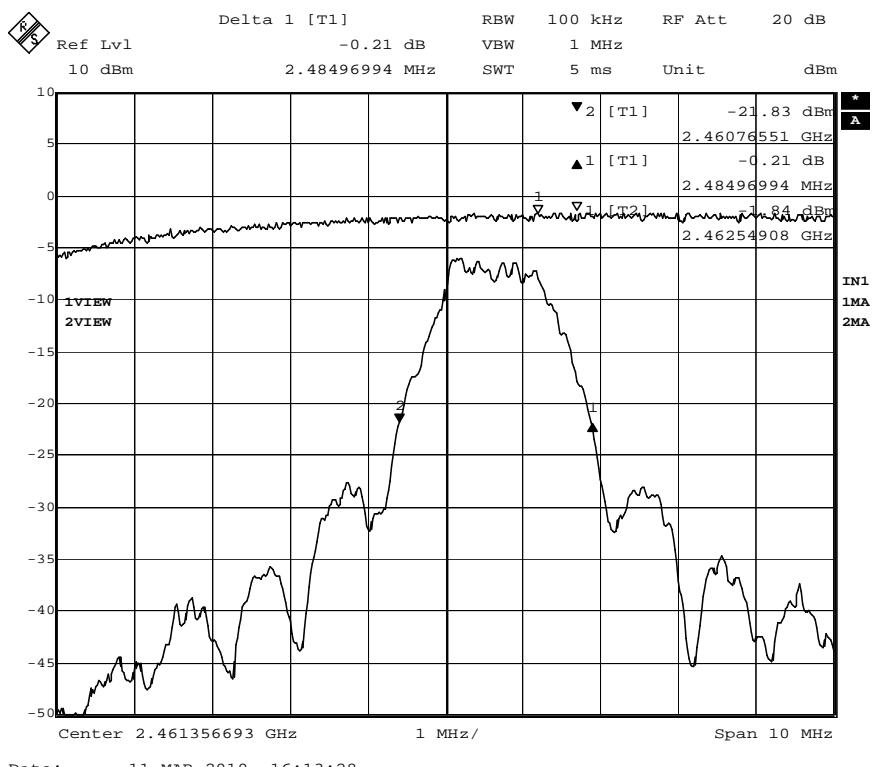


Figure 11 – Channel 3, 99% Occupied Bandwidth

4.4 Maximum peak output power

4.4.1 Limits of power measurements

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

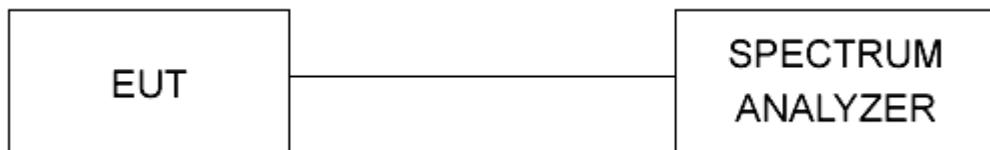
4.4.2 Test procedures

1. The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable.
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



4.4.5 EUT operating conditions

4.4.6 Test results

EUT	i-Pilot Controller	MODE	Cont. Transmit
INPUT POWER	12.0VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	45% ± 5% RH 20 ± 3°C	TECHNICIAN	NJohnson

Maximum peak output power

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK POWER OUTPUT (dBm)	PEAK POWER LIMIT (dBm)	RESULT
1	2452	-1.05	30	PASS
2	2457	-1.22	30	PASS
3	2462	-1.26	30	PASS

REMARKS:

None

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 resolution bandwidth was set to 100kHz and the spectrum analyzer was used to scan from the bandedge to the fundamental frequency with a peak detector. The highest emissions level at 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 3.0VDC battery and set to transmit continuously on the lowest frequency channel and the highest frequency channel.

4.5.6 Test results

EUT	i-Pilot Controller	MODE	Cont. transmst
INPUT POWER	12.0VDC	FREQUENCY RANGE	2400.0MHz - 2483.5MHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

Highest Out of Band Emissions

CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level dBm	Highest in band level dBm	Delta	Limit (dBc)	Result
1	2400.0	-66.41	-6.45	59.96	20.00	PASS
3	2483.5	-57.46	-2.59	54.87	20.00	PASS

NOTE:

EUT was tested as described in section 4.3.

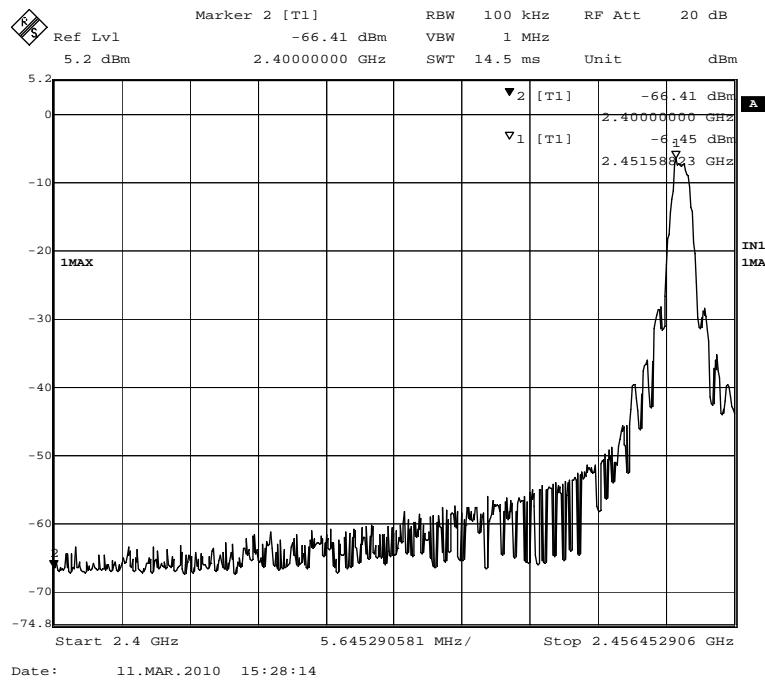


Figure 12 - Lower Bandedge

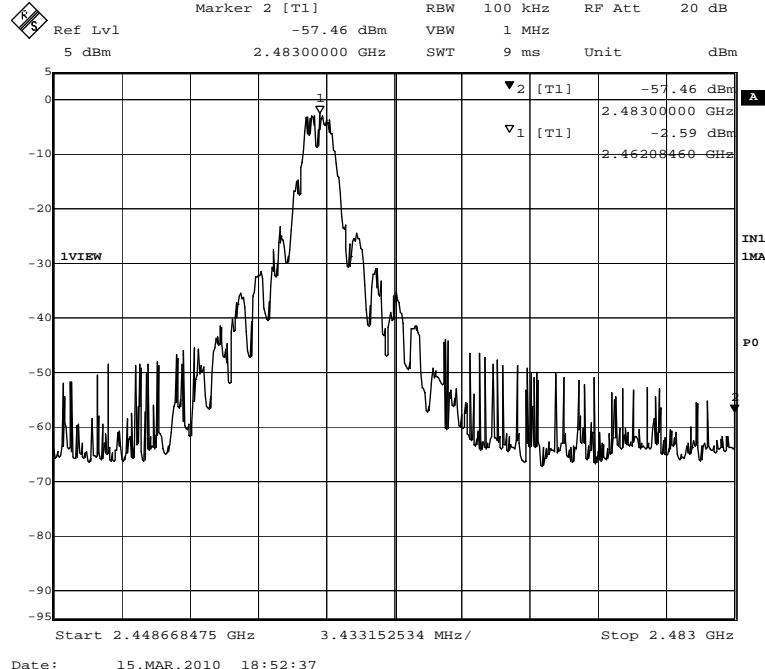


Figure 13 - Higher Bandedge

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

The antenna output of the EUT was connected directly to the spectrum analyzer using a low-loss shielded coaxial cable. 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 by 120VAC/60Hz from the AC mains supply 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 Controller	MODE	Continuous transmit
INPUT POWER	12.0VDC	FREQUENCY RANGE	2400.0MHz – 2483.5MHz
ENVIRONMENTAL CONDITIONS	45% \pm 5% RH 20 \pm 3°C	TECHNICIAN	NJohnson

Power Spectral Density

CHANNEL	CHANNEL FREQUENCY (MHz)	RF POWER LEVEL IN # KHz BW (dBm)	MAXIMUM POWER LIMIT (dBm)	RESULT
1	2452	-18.44	8.00	PASS
2	2457	-15.80	8.00	PASS
3	2662	-16.08	8.00	PASS

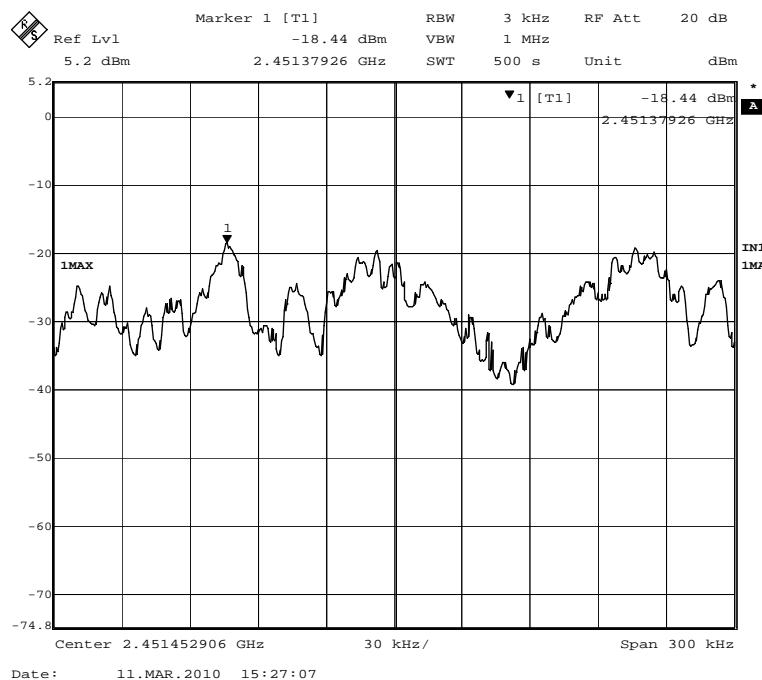


Figure 14 - Channel 1, PSD

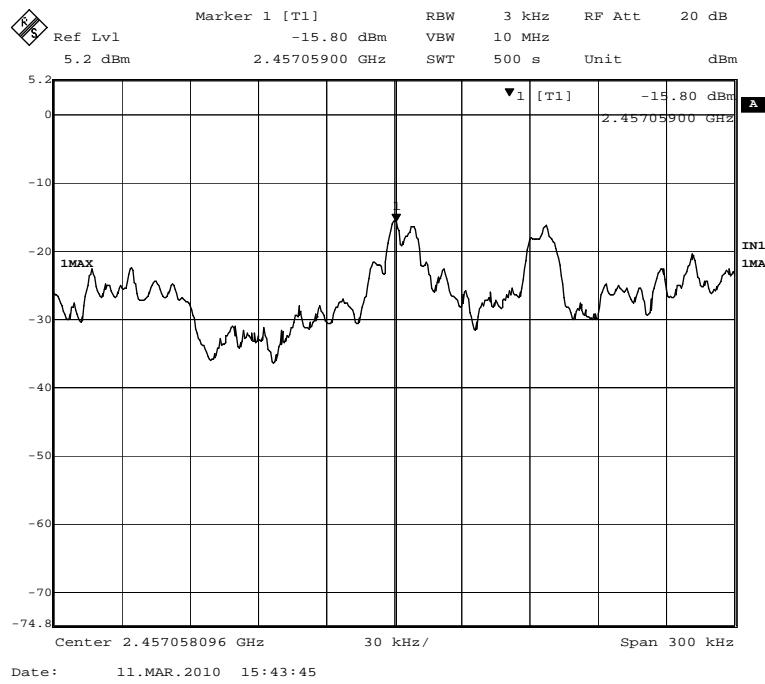


Figure 15 - Channel 2, PSD

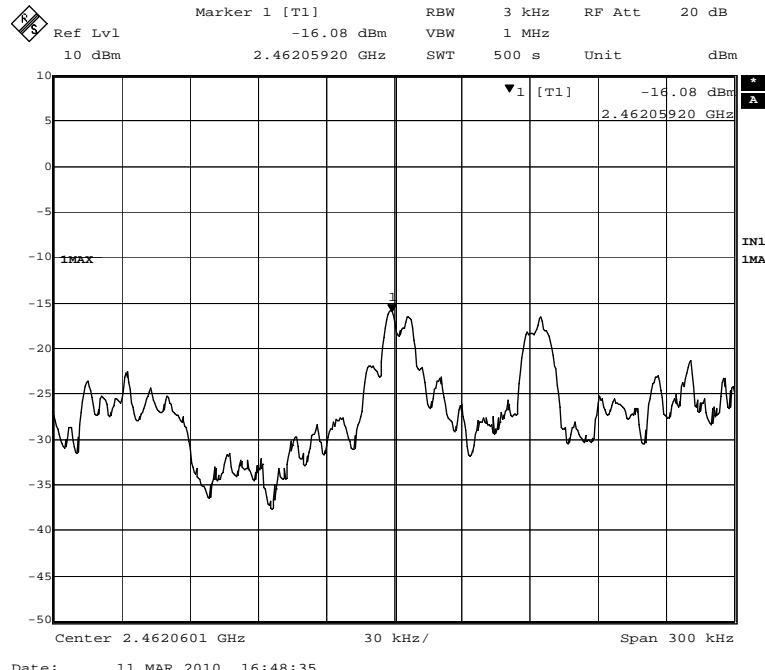


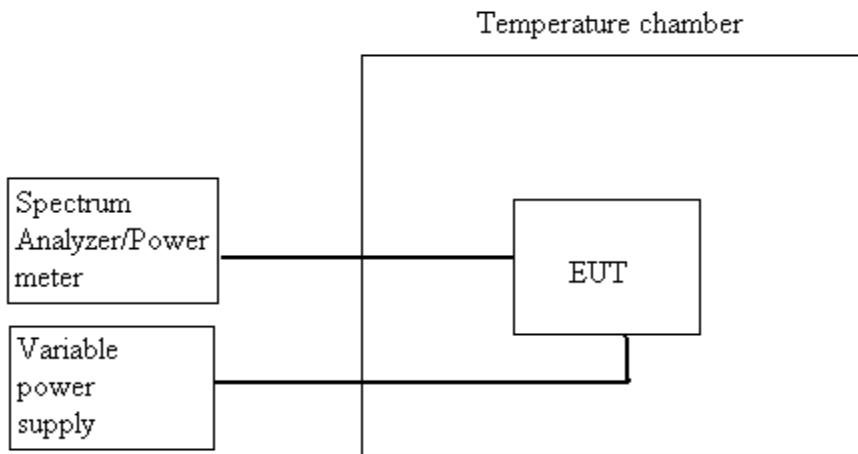
Figure 16 - Channel 3, PSD

4.7 Extreme Test Conditions

AS/NZS 4268:2008 Section 4.3

The frequency range shall lie within the band 2.4GHz to 2.4823GHz.

Test Setup:



Test Procedure:

See the standard for test procedures.

Test Results:

Ambient temperature: 22degC Relative Humidity: 45%

Test conditions		Frequency (MHz)		
		Channel 1 2452.00	Channel 2 2457.00	Channel 3 2462.00
25degC	12.0VAC	2452.10	2456.84	2462.87
0degC	10.8VAC	2452.08	2457.52	2462.03
	39.9VAC	2452.92	2457.98	2462.01
55degC	10.8VAC	2451.70	2457.11	2461.88
	39.9VAC	2452.19	2457.00	2461.50
Measured frequencies		Lowest: 2451.70	Highest: 2462.87	PASS

Appendix A: Test Photos



Figure 17 - Radiated Emissions Test Setup, 1 – 26GHz



Figure 18 - Radiated Emissions Test Setup, 1 – 26GHz



Figure 19 - Radiated Emissions Test Setup, 30MHz - 1GHz



Figure 20 - Radiated Emissions Test Setup, 30MHz - 1GHz

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 dB μ V 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 dB μ V/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

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

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