



MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313

April 3, 2006

InterSense Inc.
36 Crosby Drive, Suite 150
Bedford, MA 01730

Dear Mike Harrington,

Enclosed is the EMC test report for compliance testing of the InterSense Inc., Wireless InertiaCube3 as tested to the requirements of Title 47 of the CFR, Part 15 Subpart C, §15.247 for Intentional Radiators.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Marie Confroy
Documentation Department

Reference: (\\InterSense Inc.\\ Wireless InertiaCube3 \\ EMC18931-FCC247)

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DOC-EMC702 2/26/2004



The Nation's First Licensed Nationally Recognized Testing Laboratory





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914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313

Electromagnetic Compatibility Test Report

For the

**InterSense Inc.
Wireless InertiaCube3**

**Tested in Accordance with
Title 47 of the CFR
FCC Part 15 Subpart C**

MET Report: 18931-FCC247

April 3, 2006

Prepared For:

**InterSense Inc.
36 Crosby Drive, Suite 150
Bedford, MA 01730**

Prepared By:
MET Laboratories, Inc.
914 West Patapsco Avenue
Baltimore, MD 21230



InterSense, Inc.
Wireless InertiaCube3

CFR Title 47, Part 15 Subpart C

Electromagnetic Compatibility Test Report

For the

**InterSense Inc.
Wireless InertiaCube3**

**Tested in Accordance with
Title 47 of the CFR
FCC Part 15 Subpart C**

Len Knight
Test Engineer, Electromagnetic Compatibility Lab

Marie Confroy
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 15, §15.247 of the FCC Rules under normal use and maintenance.

Kevin Mehaffey
Manager, Electromagnetic Compatibility Lab



InterSense, Inc.
Wireless InertiaCube3

CFR Title 47, Part 15 Subpart C

Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	April 3, 2006	Initial Issue.
1	April 17, 2006	Equipment Code change to DTS.
2	April 17, 2006	Band Edge Plots updated.



List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
d	Measurement Distance
dB	Deci Bels
dBμV	Deci-Bels above one micro Volt
dBμV/m	Deci-Bels above one micro Volt per meter
DC	Direct Current
DCF	Distance Correction Factor
E	Electric Field
EUT	Equipment Under Test
f	Frequency
FCC	Federal Communications Commission
H	Magnetic Field
GHz	Giga Hertz
Hz	Hertz
ICES	Interference-Causing Equipment Standard
kHz	kilohertz
kPa	kilopascal
kV	kilo Volt
LISN	Line Impedance Stabilization Network
MHz	MegaHertz
μH	micro Henry
μF	micro Farad
μs	micro seconds
RF	Radio Frequency
RMS	Root-Mean-Square



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1.0 Introduction

1.1 Overview

MET Laboratories, Inc. was contracted by InterSense Inc. to perform testing on the Wireless InertiaCube3, under InterSense Inc. purchase order number 34299.

This document describes the test setups, test methods, required test equipment, and the test limits used to perform compliance testing of Wireless InertiaCube3. All applicable tests were performed in accordance with Title 47 of the CFR, FCC Part 15 Subpart C.

Type of Submission/Rule:	Part 15.247 Original Filing	
Model(s) Tested:	Wireless InertiaCube3	
	Primary Power:	9 VDC Battery
EUT Specifications:	FCC ID:	TK5-IMUW301
	Equipment Code:	DTS
	RF Power Output:	0.297 mW
	Equipment Frequency Range:	2404.6 – 2480.4
Analysis:	The results obtained relate only to the item(s) tested.	
Evaluated by:	Len Knight	
Report Date:	April 3, 2006	

1.2 Test site

All testing was performed at MET Laboratories, Inc., 914 West Patapsco Avenue, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a semi-anechoic chamber. In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories. In accordance with §2.948(d), MET Laboratories has been accredited by the National Voluntary Laboratory Accreditation Program (Lab Code: 100273-0).



1.3 Testing Summary

Paragraph	Name of Test	Compliance
Part 15, Subpart C, §15.209	Radiated Emissions	Compliant
Part 15, Subpart C, §15.247 (a)	Occupied Bandwidth	Compliant
Part 15, Subpart C, §15.247(b)	Output Power	Compliant
Part 15, Subpart C, §15.247(i)	RF Exposure	Compliant
Part 15, Subpart C, §15.247(c)	Band Edge Emissions	Compliant
Part 15, Subpart C, §15.247(d)	Spectral Power Density	Compliant
Part 15, Subpart C, §15.203	Antenna Requirements	Compliant
Part 15, Subpart C, §15.247	Spurious Conducted Emissions	Compliant
Part 15, Subpart C, §15.247	Spurious Radiated Emissions	Compliant

Table 1. Testing Summary



2.0 Equipment Configuration

2.1 Description of EUT

The Equipment Under Test (EUT), is the Wireless InertiaCube3. The Wireless InertiaCube3 (IC3) is a part of an Inertial Measurement Unit (IMU). The Inertial Measurement Units (IMUs) contain sensors that measure rotation, acceleration and magnetic fields to compute the orientation (yaw, pitch and roll) of the Wireless IC3 sensor. They are used in many different applications including simulation and training, virtual reality systems and for system control feedback.

The base station (Wireless IC3 Receiver) can be connected to a PC through either a serial port or a USB connection. In the serial case, the power must be supplied through a separate power supply. In the USB case power is provided through the USB connection. The USB base station can support 1 to 4 wireless IC3s, but the serial base station can only support one wireless IC3. The wireless IC3s only connection is a battery input.

The wireless link is based on Chipcon 2420 reference design with a PCB antenna. They support the low level communication protocol for the Zigbee standard. It uses DSS in the 2.4 to 2.48 GHz range. 16 channels can be selected at 5Mhz spacing. No frequency hopping is implemented. The upper level stack of the Zigbee standard is not supported.

2.2 Equipment Configuration

Name / Description	Model Number	Serial Number
Wireless IC3	100-IMU0W-B301	I3W-0512126-A
Wireless IC3 – Conducted Testing Only	100-IMU0W-B301	I3W-0512107-A

Table 2. Equipment Configuration

2.3 Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	Serial Number
A	Laptop	Dell	Inspiron 7000	8522946BY13377A
B	Laptop Power Supply	Dell	000124BC Rev A01	17971-8CA-5CMD
C	Wireless IC3 Receiver – USB	Intersense	100-IC3UW-RX16	RUW-0511295-B

Table 3. Support Equipment



2.4 Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description / Reason for no cable	Qty.	Length (m)	Shielded?
1	DC Power for IC3	2 conductor 26 ga.	1	0.4	no
2	USB connection for Base Station	4 conductor USB	1	3.0	yes
3	AC Power for Laptop Power Supply	2 conductor 18 ga.	1	1.8	no

Table 4. Ports and Cabling

2.5 Mode Of Operation

The Wireless IC3 Receiver was connected to a test laptop. The Wireless IC3 was connected to a nine volt battery. Both devices were close enough in physical proximity to allow wireless communication.

A test program called FCC_Wireless_IC3.exe was supplied to initiate communication between the Wireless IC3 and the Wireless IC3 Receiver. When initiated, the program instructs the Wireless IC3 Receiver to find up to 4 devices and then collect data in the normal operating mode and display it for use during testing.

A test program called DeviceTool was also supplied. This program allows the user to pair remote IC3s with base receivers and change the channel on which the devices operate.

A third program called FCC_Direct.exe was supplied which allowed the Wireless IC3 to be put into a continuous transmit mode independent of the Wireless IC3 Receiver. The program also allowed the user to change transmit channels.

For the purposes of testing, only one Wireless IC3 communicated with one Wireless IC3 Receiver at any given time.

2.6 Modifications to EUT

No modifications were made to the EUT.

2.7 Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to InterSense Inc. upon completion of testing.

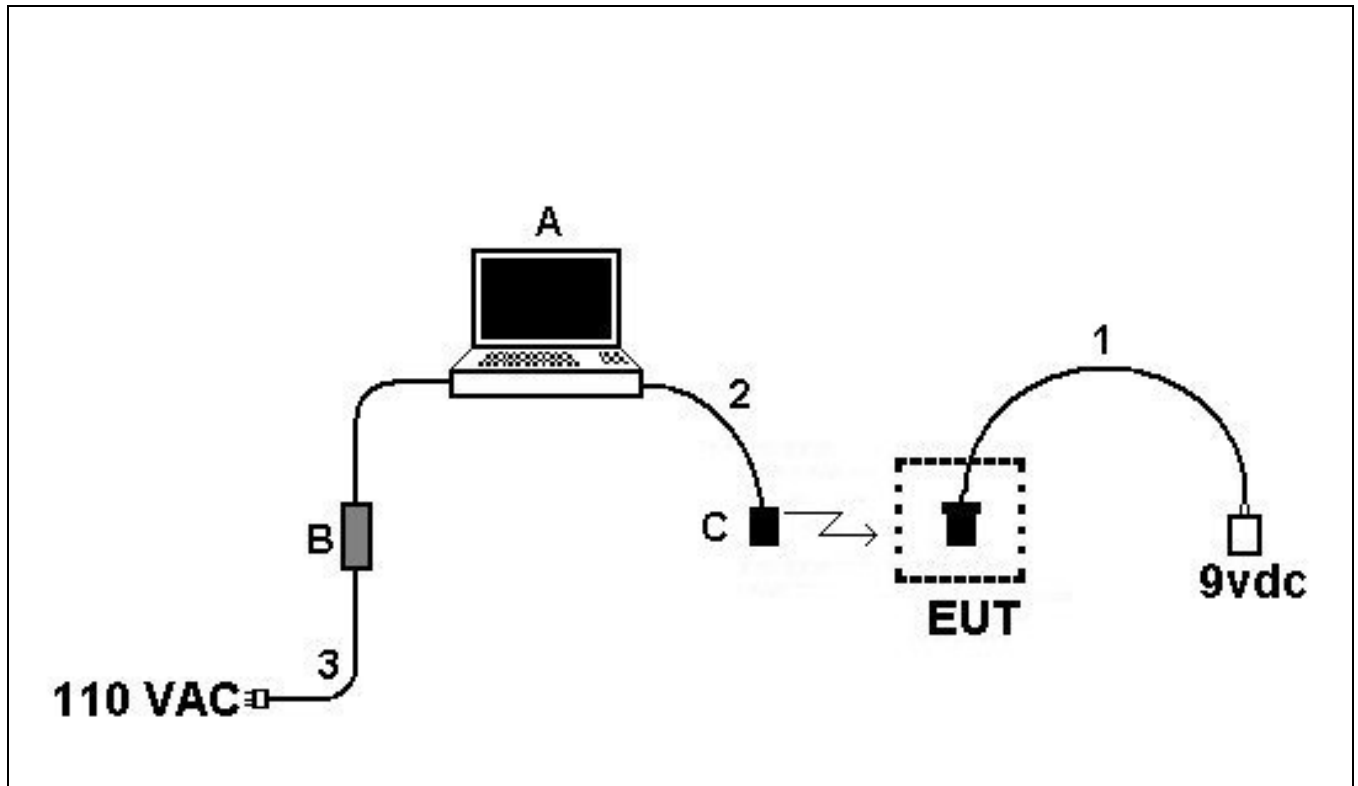


Figure 1. Block Diagram of Test Configuration



3.0 Electromagnetic Compatibility Test Data

3.1 Spurious Radiated Emissions

Test Requirement(s): § 15.205 (a): Except as shown in paragraph (d) of **15.205 Restricted bands of operation**, only spurious emissions are permitted in any of the frequency bands specified in Table 5:

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Note
13.36–13.41.			
Note: Above 38.6			

Table 5. Restricted Bands of Operation from FCC Part 15, § 15.205

§ 15.205 (b): (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§ 15.35 (b): ...When average radiated emission measurements are specified in this part, including emission measurements below 1000 MHz, there also is a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function,



corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules...

Frequency (MHz)	Field Strength (Microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F (kHz)	300
0.490 – 1.705	24000/F (kHz)	30
1.705 – 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.		

Table 6. Radiated Emissions Limits from § 15.209 (a)

Test Procedure: The EUT was configured with the control software to communicate in a normal mode of operation. Measurements were made with a ridge guide horn antenna at a distance of 1 meter. Cable loss has been accounted for in the raw measurement. The frequency range of interest was that indicative to spurious emissions associated with the intentional radiator section of the EUT.

Test Results: The EUT was found compliant with the requirements of this section.

Test Engineer(s): Len Knight and Dusmantha Tennakoon

Test Date(s): 01/18/2006



Radiated Emissions Limits Test Results, 15.209 (a) – Peak

FREQ. (GHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuv)	Antenna Correction Factor (dB) (+)	System Gain (dB) (-)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuv)	Limit (dBuv)	Margin (dB)
4.799685	0	V	1.00	33.66	33.58	27.30	9.54	30.40	74.00	-43.60
4.800300	0	V	1.00	34.59	33.48	27.30	9.54	31.23	74.00	-42.77
4.800725	0	V	1.00	32.90	33.48	27.30	9.54	29.54	74.00	-44.46
4.803905	225	H	1.00	39.81	33.59	27.30	9.54	36.56	74.00	-37.44
4.805910	0	V	1.00	42.52	33.60	27.31	9.54	39.27	74.00	-34.73
4.805930	225	H	1.00	48.94	33.50	27.31	9.54	45.59	74.00	-28.41
4.808930	225	H	1.00	56.18	33.60	27.31	9.54	52.93	74.00	-21.07
4.808960	0	V	1.00	54.31	33.60	27.31	9.54	51.06	74.00	-22.94
4.809930	225	H	1.00	53.50	33.51	27.31	9.54	50.16	74.00	-23.84
4.810910	225	H	1.00	54.19	33.61	27.31	9.54	50.95	74.00	-23.05
4.810910	0	V	1.00	53.38	33.51	27.31	9.54	50.04	74.00	-23.96

Table 7. Radiated Emissions Test Results – Peak

Note: The EUT was tested at 1 m. The data has been corrected for comparison with the 3 m limit using the formula: $20\log(1\text{ m}/3\text{ m})$ as expressed in the 'Distance Correction' column.



Radiated Emissions Limits Test Results, 15.209 (a) - Average

FREQ. (GHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuv)	Antenna Correction Factor (dB) (+)	System Gain (dB) (-)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuv)	Limit (dBuv)	Margin (dB)
4.799685	0	V	1.00	18.40	33.58	27.30	9.54	15.14	54.00	-38.86
4.800300	0	V	1.00	18.81	33.48	27.30	9.54	15.45	54.00	-38.55
4.800725	0	V	1.00	17.60	33.48	27.30	9.54	14.24	54.00	-39.76
4.803905	225	H	1.00	14.61	33.59	27.30	9.54	11.36	54.00	-42.64
4.805910	0	V	1.00	32.10	33.60	27.31	9.54	28.85	54.00	-25.15
4.805930	225	H	1.00	48.94	33.50	27.31	9.54	45.59	54.00	-8.41
4.808930	225	H	1.00	37.07	33.60	27.31	9.54	33.82	54.00	-20.18
4.808960	0	V	1.00	34.04	33.60	27.31	9.54	30.79	54.00	-23.21
4.809930	225	H	1.00	33.24	33.51	27.31	9.54	29.90	54.00	-24.10
4.810910	225	H	1.00	34.96	33.61	27.31	9.54	31.72	54.00	-22.28
4.810910	0	V	1.00	35.76	33.51	27.31	9.54	32.42	54.00	-21.58

Table 8. Radiated Emissions Test Results - Average

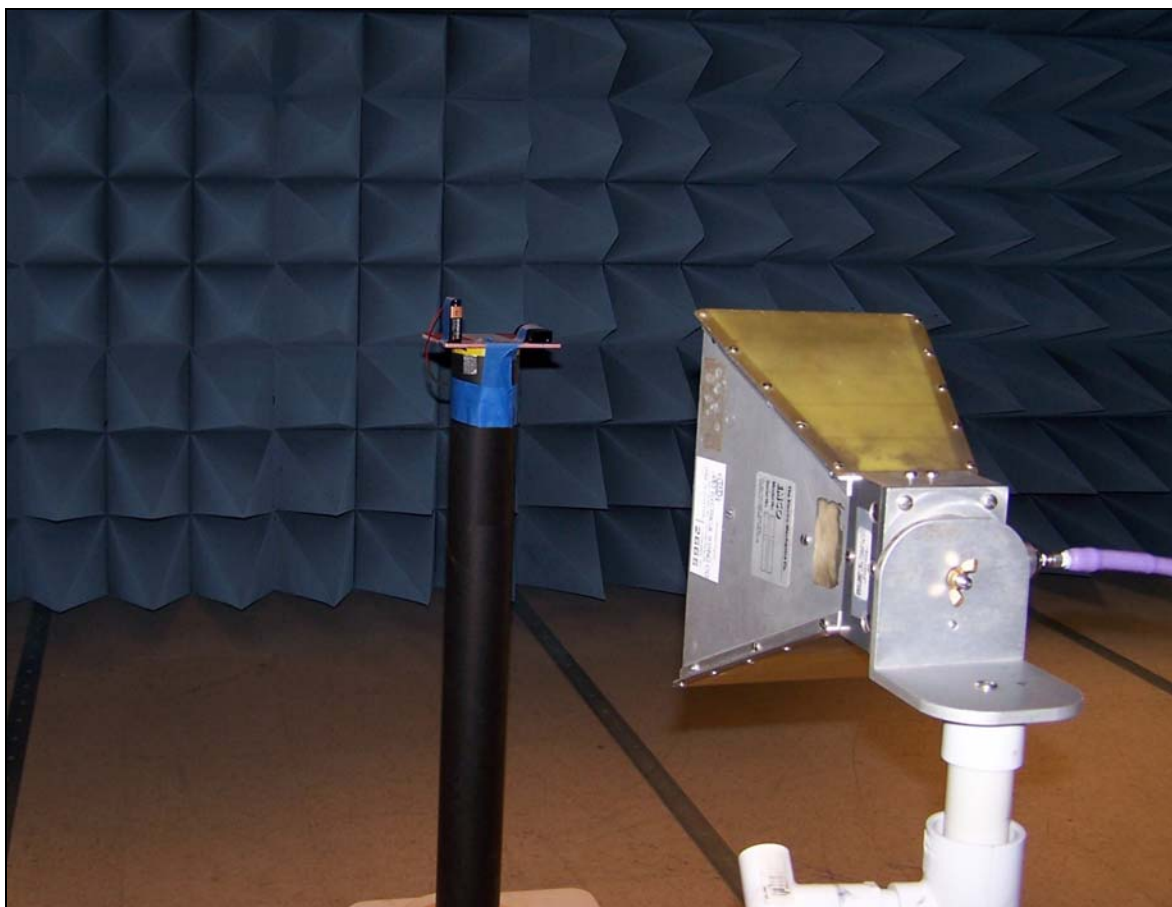
Note: The EUT was tested at 1 m. The data has been corrected for comparison with the 3 m limit using the formula: $20\log(1\text{ m}/3\text{ m})$ as expressed in the 'Distance Correction' column.



InterSense, Inc.
Wireless InertiaCube3

Electromagnetic Compatibility
Emission Criteria
CFR Title 47, Part 15 Subpart C

Radiated Emissions – Test Setup



Photograph 1. Radiated Emissions Test Setup



3.2 Bandwidth Requirements

Test Requirements: § 15.247(a): Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

§ 15.247(a) (2): Systems using digital modulation techniques may operate in the 902 - -928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure: The EUT's transmitter output was connected directly to the spectrum analyzer. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW of 100 kHz and a VBW > RBW. The 6 dB bandwidth was measured and recorded.

Test Results: The EUT was found compliant with the requirements of this section.

Channel	Occupied 6dB bandwidth (kHz)
0	1700
7	1667
15	1675

Test Engineer(s): Len Knight

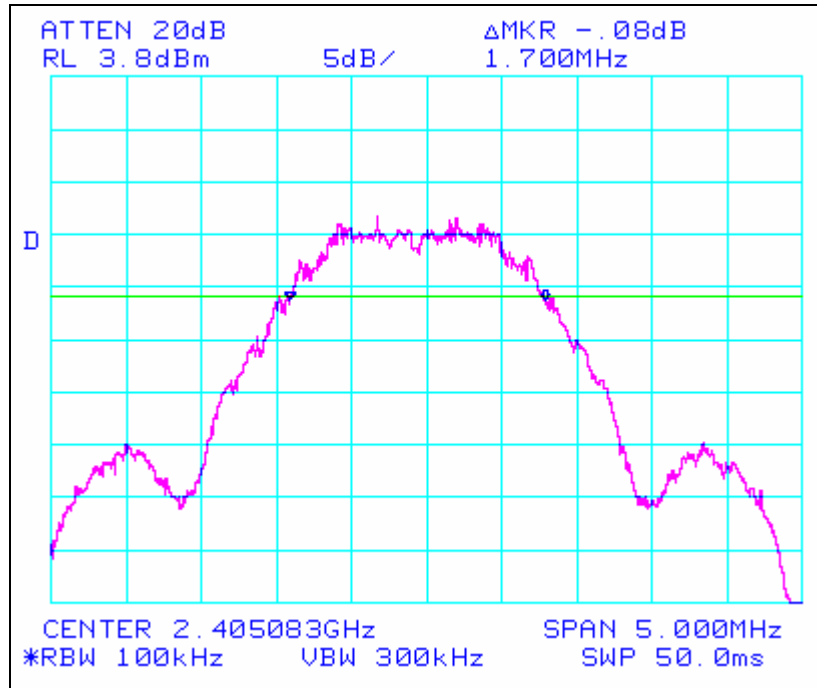
Test Date(s): 12/29/2006



InterSense, Inc.
Wireless InertiaCube3

Electromagnetic Compatibility
Emission Criteria
CFR Title 47, Part 15 Subpart C

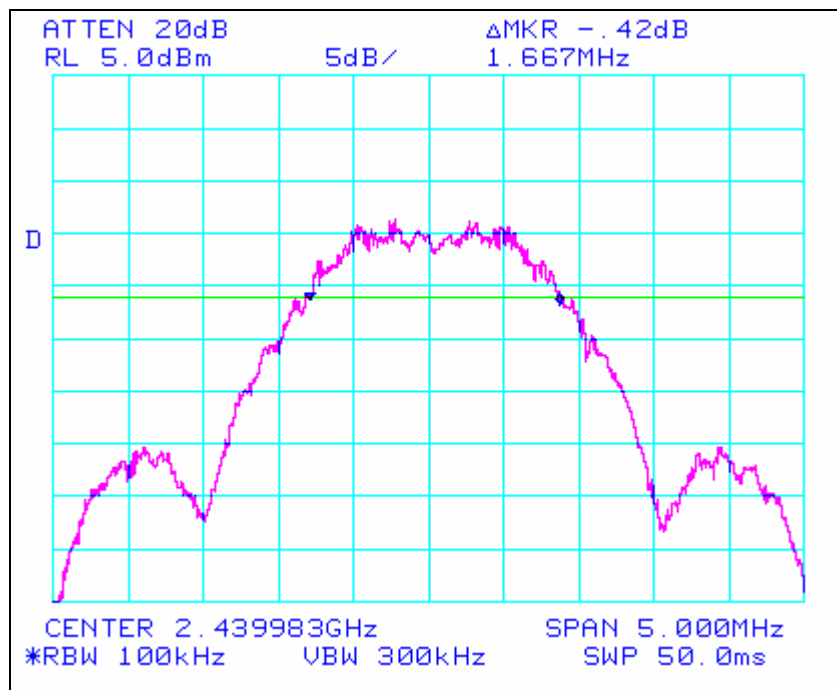
Bandwidth Requirements – Test Results



Plot 1. Occupied Bandwidth – Channel 0



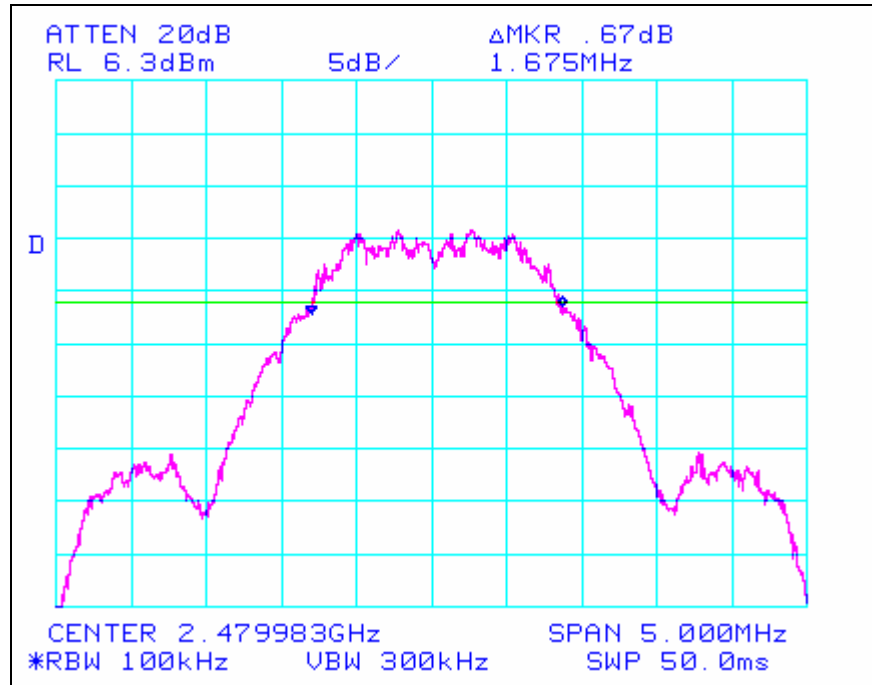
Bandwidth Requirements – Test Results



Plot 2. Occupied Bandwidth – Channel 7



Bandwidth Requirements – Test Results



Plot 3. Occupied Bandwidth – Channel 15



3.4 Peak Output Power

Test Requirements: §15.247(b): The maximum peak output power of the intentional radiator shall not exceed the following:

§15.247(b) (3): For systems using digital modulation in the 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz bands: 1 Watt.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Test Procedure: The transmitter output of the EUT was connected to the spectrum analyzer through an attenuator. The power was set to the maximum output; low, mid, and high channels were measured.

Peak Output Power = 0.297 mW

The peak output power was determined from the plots on the following page(s).

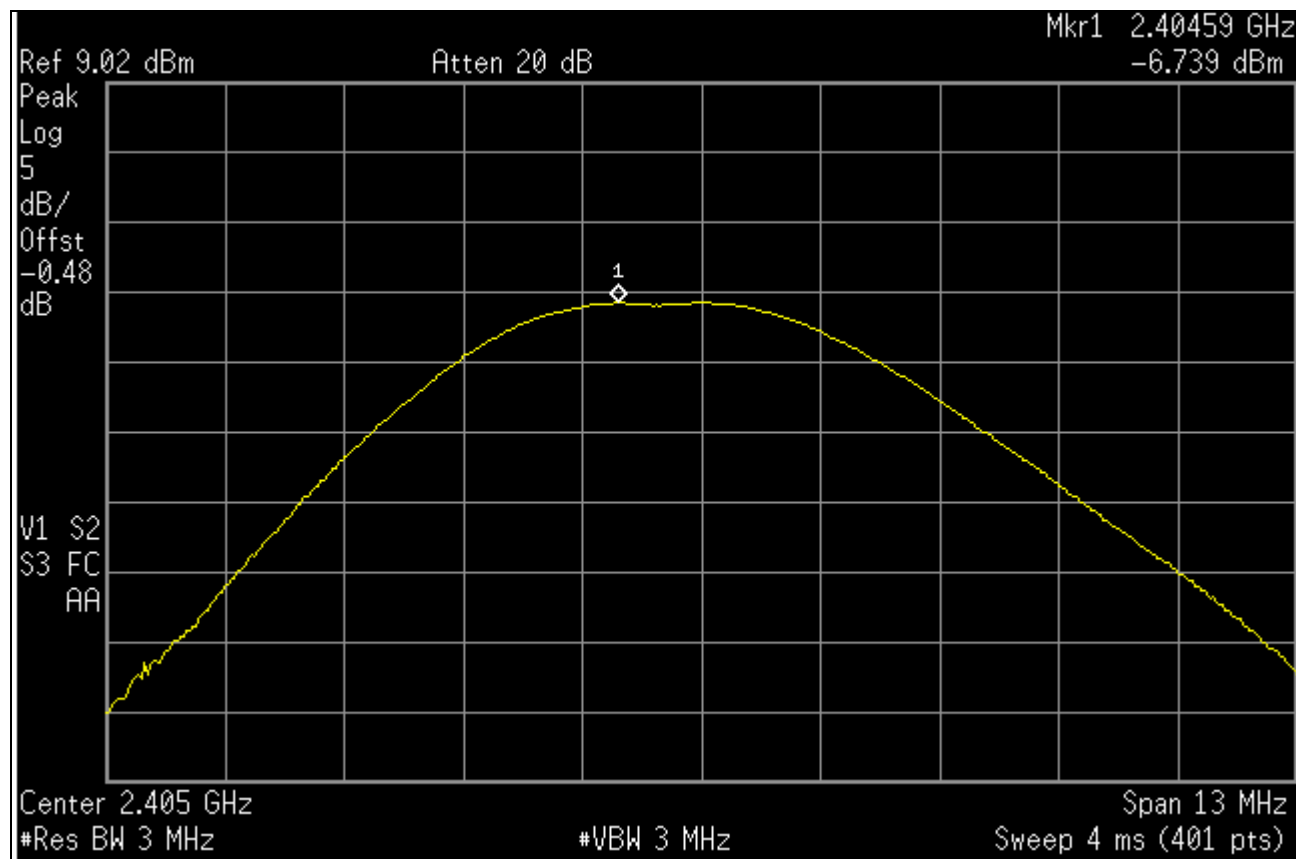
Test Results The EUT was found compliant with the requirements of this section.

Test Engineer: Len Knight

Test Date: 12/28/2006



Peak Output Power – Test Results



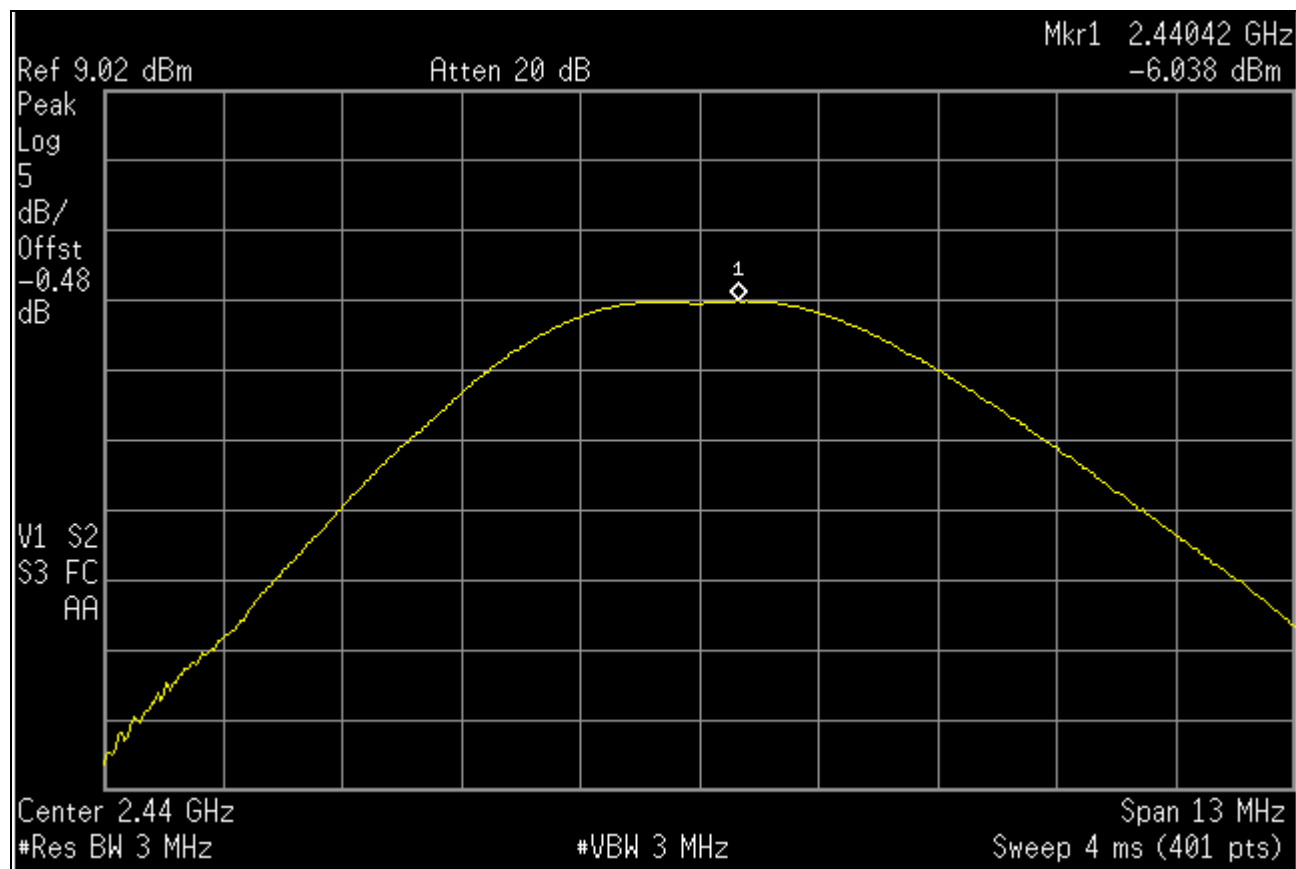
Plot 4. Output Power – Channel 0

$$\text{Output Power} = \text{Measured} + \text{Cable Loss}$$

Cable Loss was factored into Spectrum Analyzer



Peak Output Power – Test Results



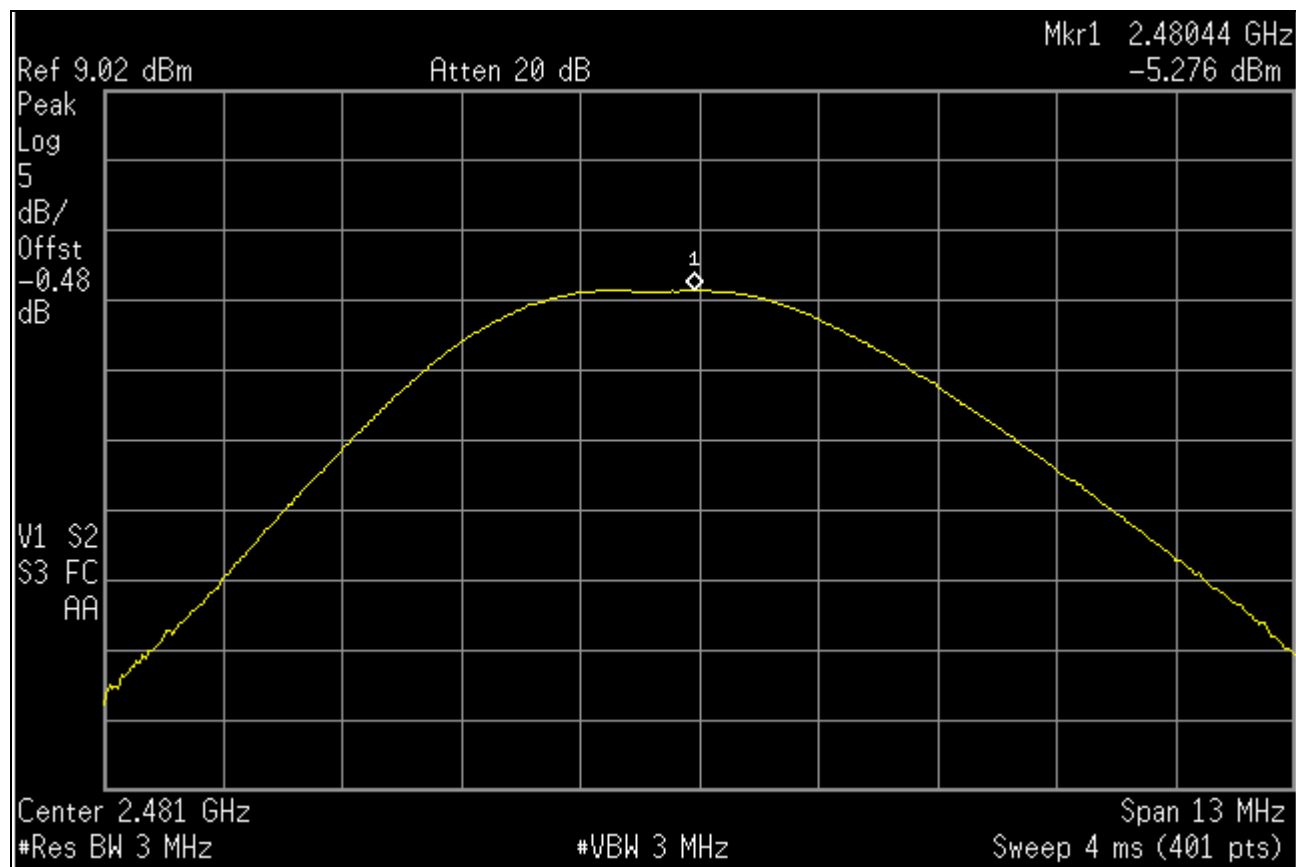
Plot 5. Output Power – Channel 7

$$\text{Output Power} = \text{Measured} + \text{Cable Loss}$$

Cable Loss was factored into Spectrum Analyzer



Peak Output Power – Test Results



Plot 6. Output Power – Channel 15

$$\text{Output Power} = \text{Measured} + \text{Cable Loss}$$

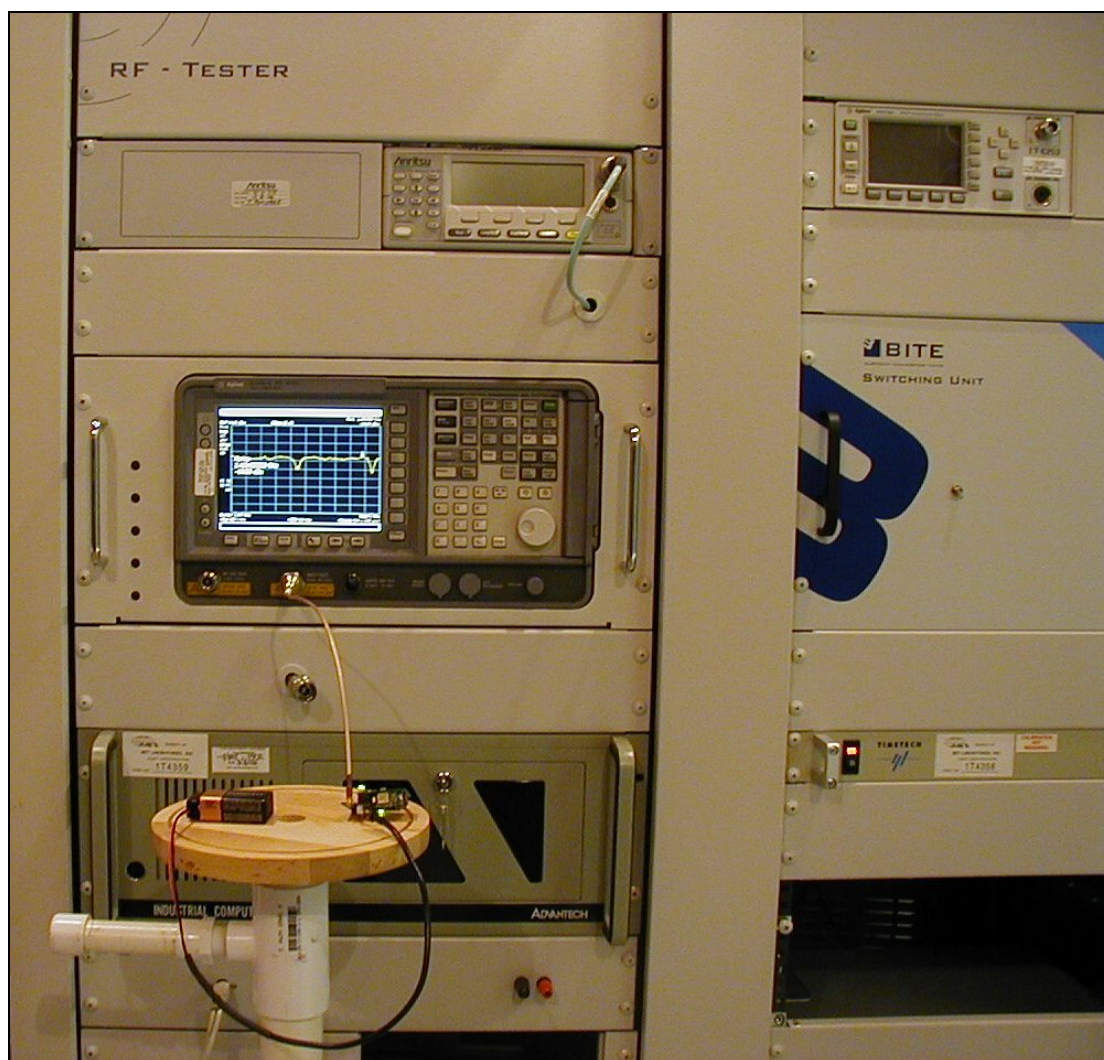
Cable Loss was factored into Spectrum Analyzer



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Peak Output Power – Test Setup



Photograph 2. Peak Output Power Test Setup



3.5 RF Exposure

RF Exposure Requirements - § 15.247 (b) (5): Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Limits: §1.1310: As specified in this section, the Maximum Permissible Exposure (MPE Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Section 1.1307 (b), except in the case of portable devices which shall be evaluated according to the provisions of Section 2.1903 of this chapter.

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
30-300	61.4	0.163	1.0	6
300-1,500	--	--	F/300	6
1,500-100,000	--	--	5	6
(B) Limits for General Population/Uncontrolled Exposure				
30-300	27.5	0.073	0.2	30
300-1,500	--	--	F/1,500	30
1,500-100,000	--	--	1.0	30

Table 9. Limits for Maximum Permissible Exposure

Note: F=Frequency in MHz



Test Results: MPE Limit Calculation:

EUT's lowest frequency channel @ 2400 MHz;
Limit for Uncontrolled exposure: 1 mW/cm²

Equation from page 18 of OET 65, Edition 97-01:

$$S = PG / 4\pi R^2$$

where,

S = Power Density mW/m²

P = Power Input to antenna mili Watts

G = Numeric Antenna Gain

R = Distance to the center of radiation of the antenna (20 cm for Mobile minimum distance)

$$\text{Antenna Numeric Gain} = 10^{\text{dBi}/10}$$

$$\text{Power at antenna port} = 0.297 \text{ mW}$$

$$\text{Antenna Gain} = 5 \text{ dBi}$$

$$\text{Numeric antenna gain} = 10^{5/10} = 3.16$$

$$S = (0.297)(3.16) / 4(3.1416)(20)^2$$

$$S = 0.000187 \text{ mW/cm}^2$$

Therefore, EUT meets the Uncontrolled Exposure limit.

Test Engineer: Len Knight

Test Date: 03/27/2006



3.6 Band Edge Emissions

Test Requirement(s): § 15.205 (a): Except as shown in paragraph (d) of 15.205 Restricted bands of operation, only spurious emissions are permitted in any of the frequency bands specified in Table 10:

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Note
13.36–13.41.			
Note : Above 38.6			

Table 10. Restricted Bands of Operation from FCC Part 15, § 15.205

Test Procedure: The EUT was set up at maximum power, first on Channel Ø, then on Channel 15. It was verified that the first channel and the last channel were within the band 2400 – 2483.5 MHz. The Marker-Delta method was used for making these measurements.

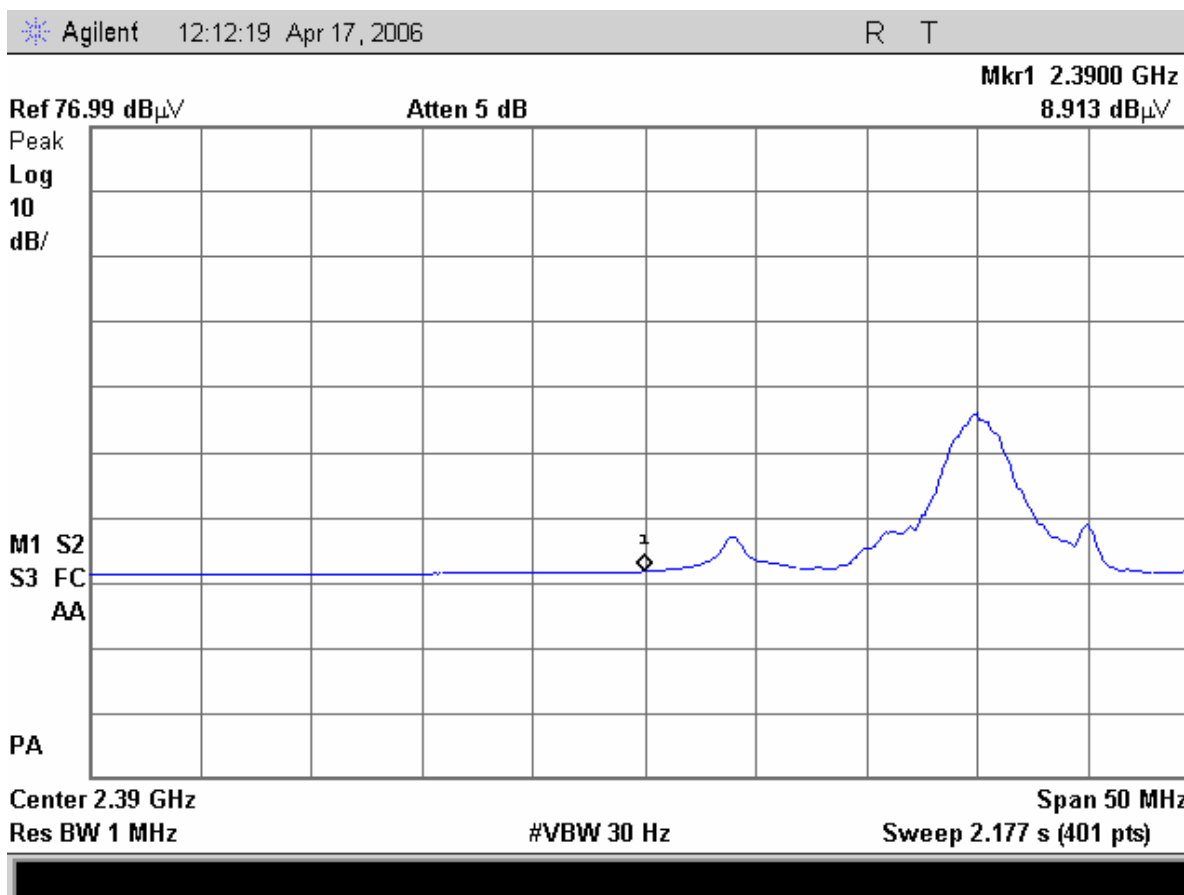
Test Results: The EUT was found compliant with the requirements of this section.

Test Engineer: Dusmantha Tennakoon

Test Date: 01/19/2006



Band Edge Emissions – Test Results



Plot 7. Band Edge Emissions Channel 0

The measured value of 8.913 dBuV is at 1m

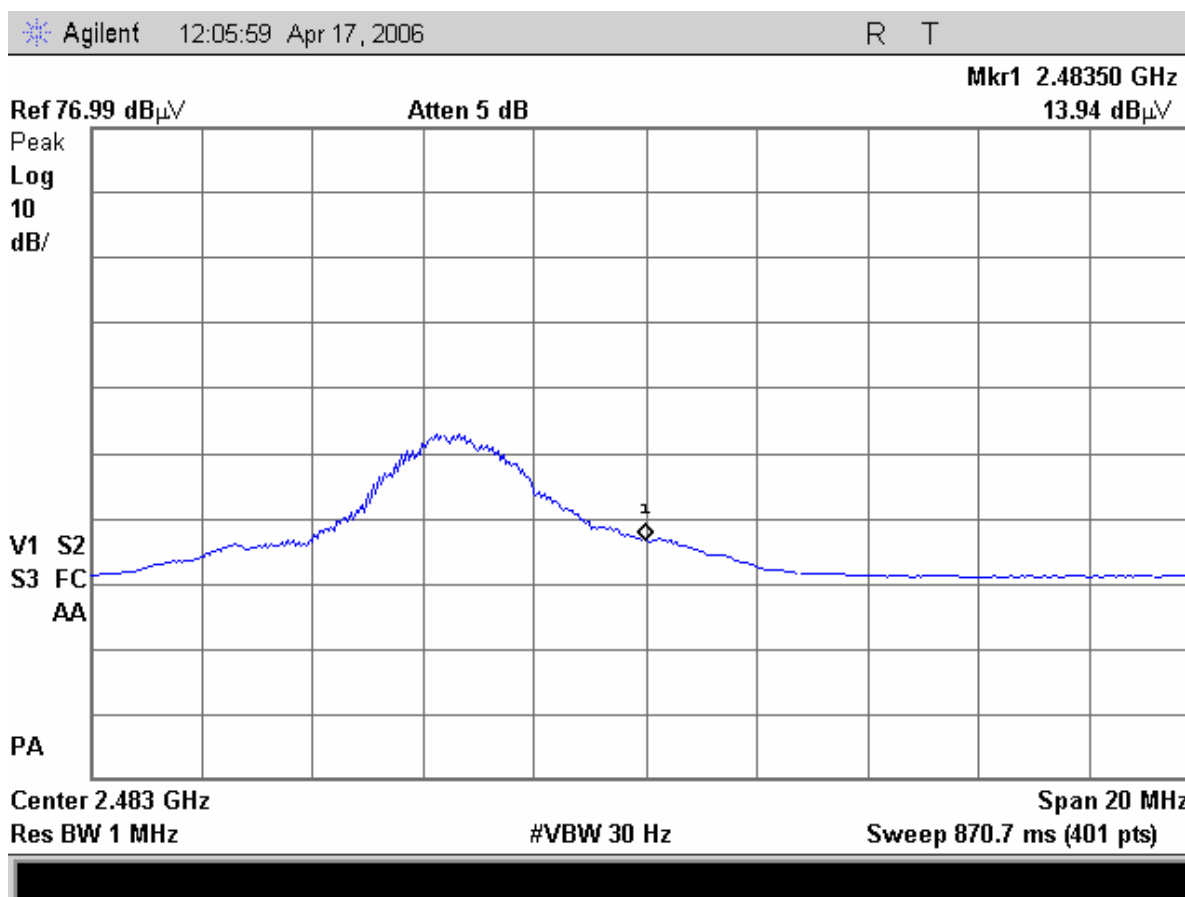
The average power @ 2.39 GHz adjusted for 3m =measured+ACF+cable loss - 9.54 dB

$$= 8.913 + 28.89 + 2.4 - 9.54$$

$$= 30.7 \text{ dBuV}$$



Band Edge Emissions – Test Results



Plot 8. Band Edge Emissions Channel 15

The measured value of 13.94 dBuV is at 1m

The average power @ 2.4835 GHz adjusted for 3m =measured+ACF+cable loss - 9.54 dB

$$= 13.94 + 28.89 + 2.4 - 9.54$$

$$= 35.7 \text{ dBuV}$$



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Band Edge Emissions – Test Setup



Photograph 3. Band Edge Emissions Test Setup



3.7 Spectral Power Density

Test Requirements: §15.247(d): For digitally modulated systems, the peak 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.

Test Procedure: The transmitter output was connected to the spectrum analyzer through an attenuator.

$$RBW = 3\text{kHz}, VBW > RBW$$

$$\text{Sweep} = \text{Span}/3\text{kHz}$$

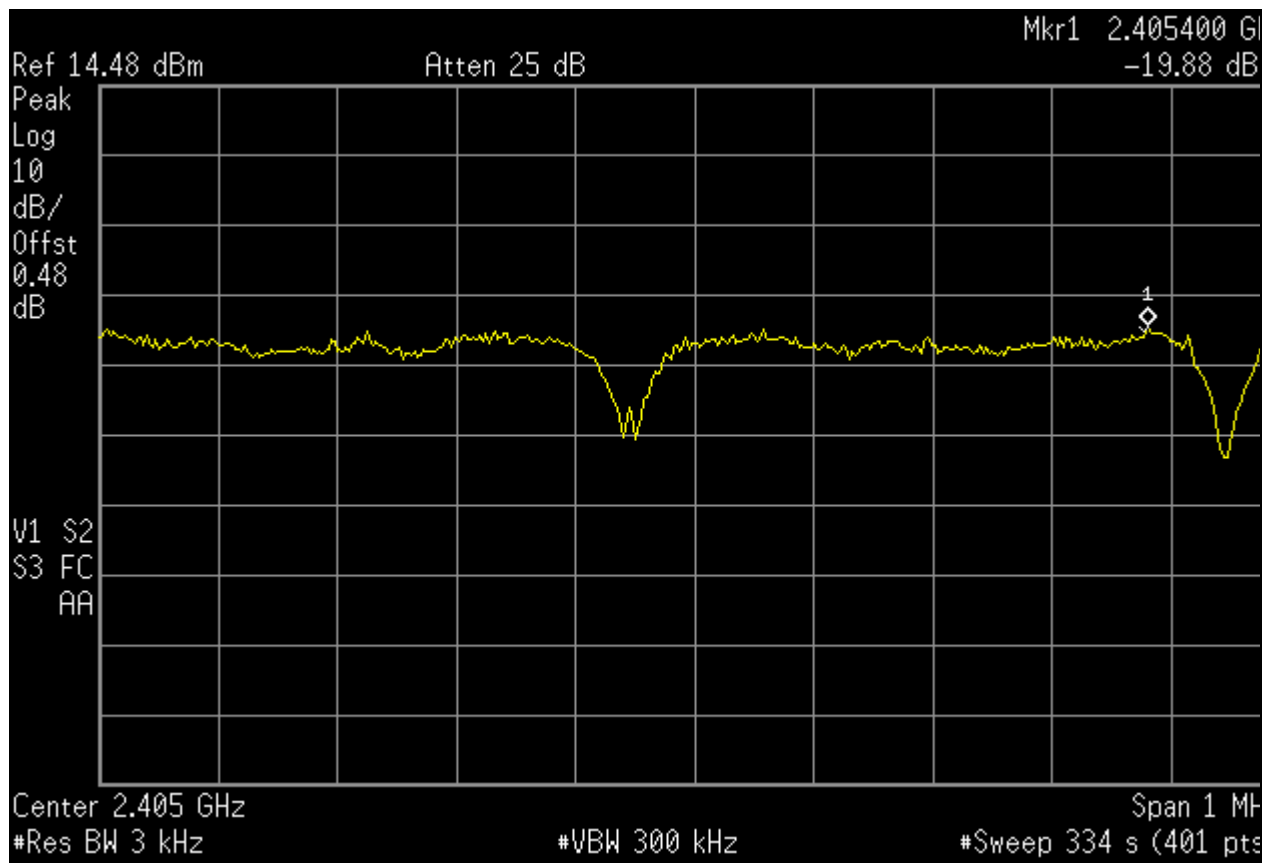
Test Results: The EUT was found compliant with the requirements of this section.

Test Engineer: Len Knight

Test Date: 01/04/2006



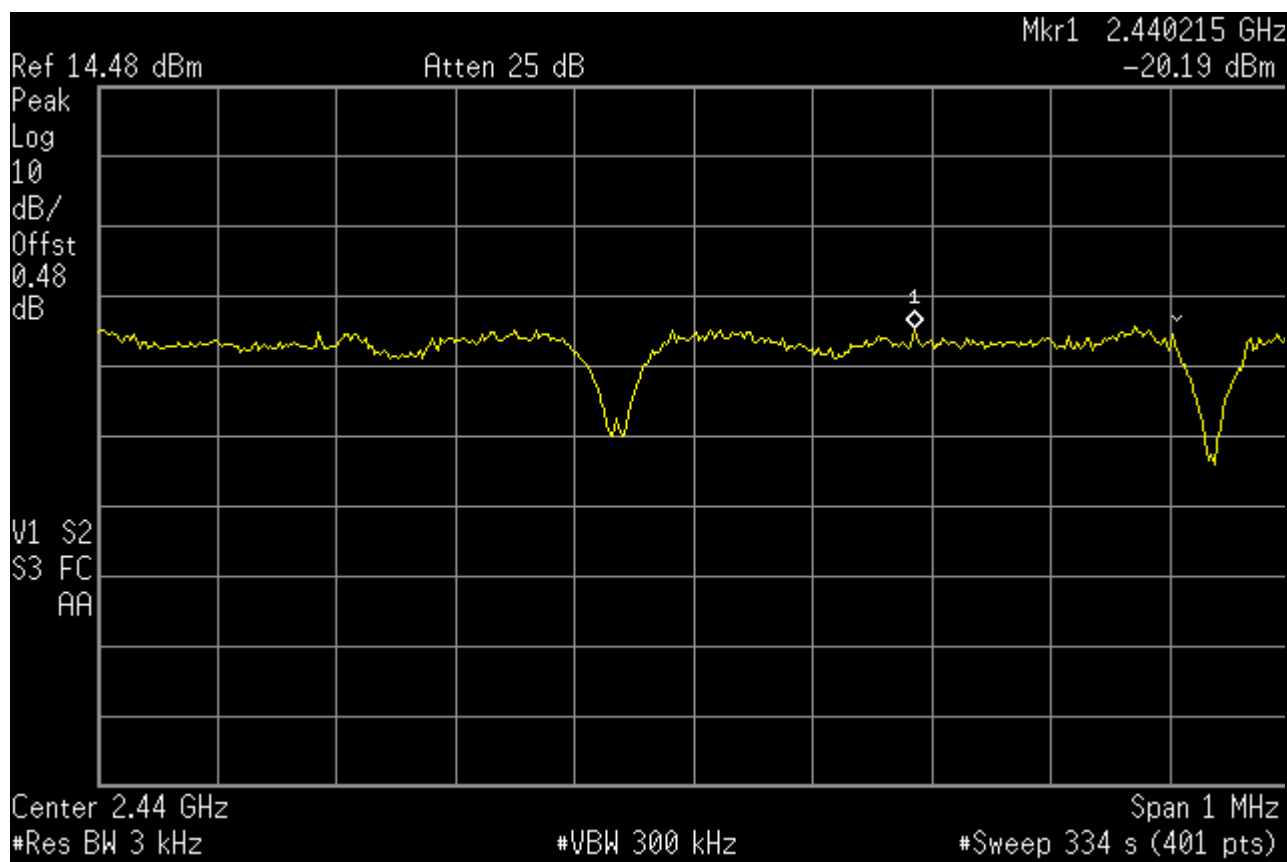
Spectral Power Density Test Results



Plot 9. Spectral Power Density – Channel 0



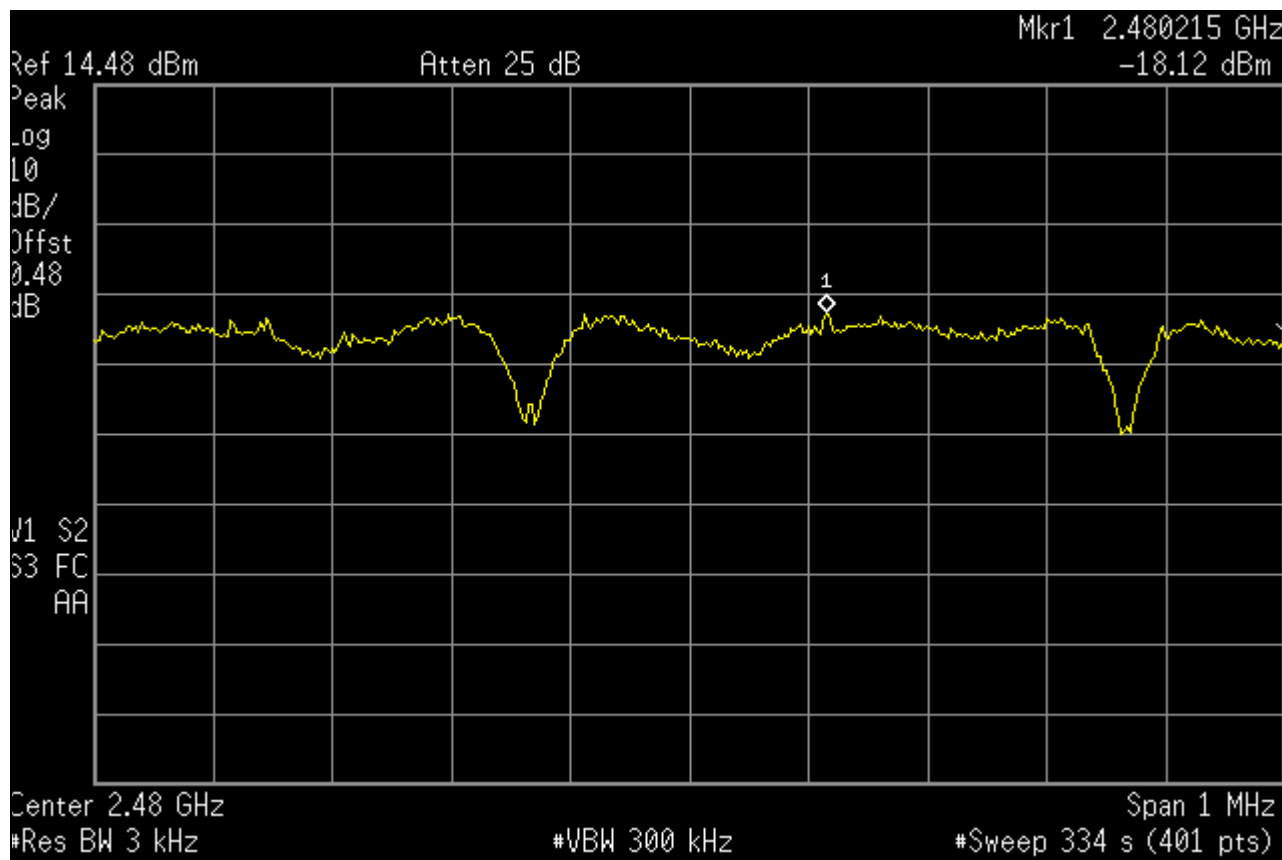
Spectral Power Density Test Results



Plot 10. Spectral Power Density – Channel 7



Spectral Power Density Test Results



Plot 11. Spectral Power Density – Channel 15



3.8 Antenna Requirements

Test Requirement: § 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

- a.) Antenna be permanently attached to the unit.
- b.) Antenna must use a unique type of connector to attach to the EUT.
- c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Test Results: The EUT was found compliant to the requirements of this section. The EUT as tested meets the criteria of this rule by virtue of having a permanently attached integral antenna.

Type of Antenna: PCB etched Inverted F-type

Gain of Antenna: 5 dBi

Test Engineer(s): Len Knight

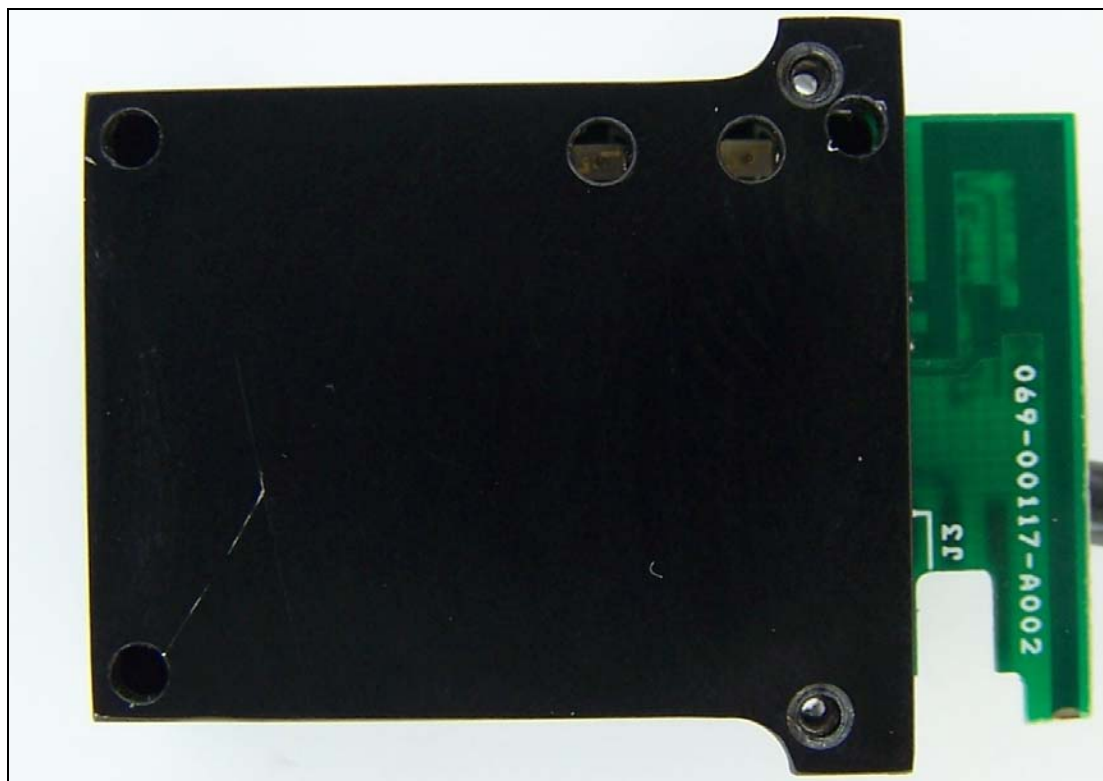
Test Date(s): 01/31/2006



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Antenna Requirements



Photograph 4. Antenna



3.9 Spurious Conducted Emissions

Test Requirements: §15.247(c): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

Test Procedure: The EUT was configured with the control software to transmit at maximum power. The transmit output was connected to the analyzer through an attenuator. $RBW = 100 \text{ kHz}$, $VBW \geq RBW$.

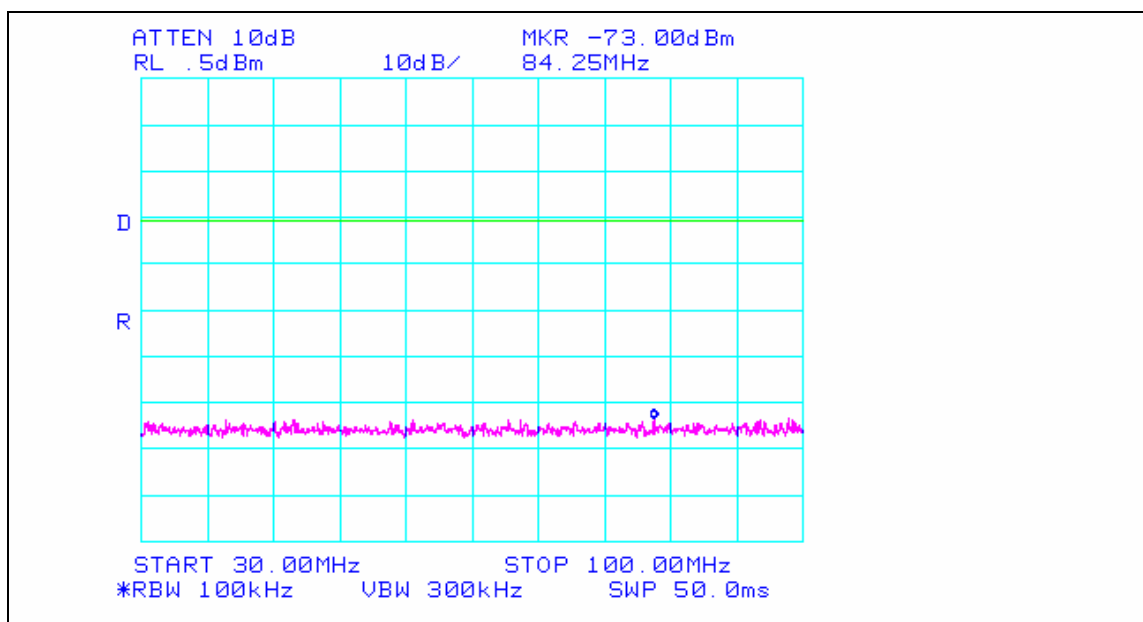
Test Results: The EUT was found compliant with the requirements of this section.

Test Engineer: Len Knight

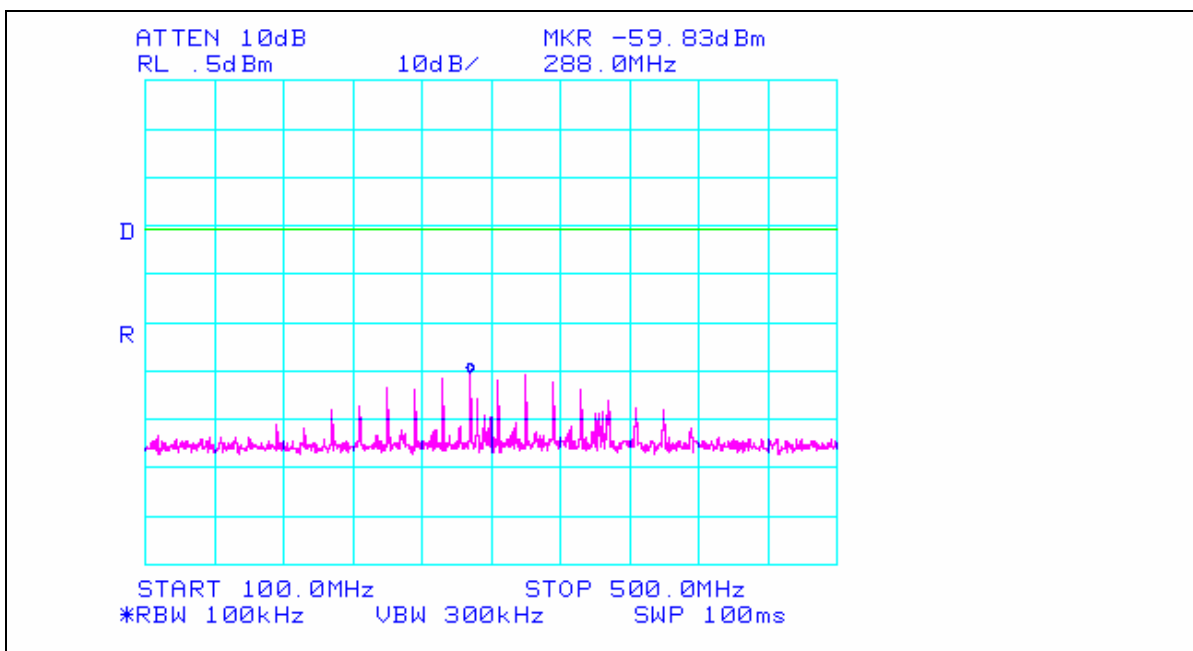
Test Date: 12/29/2005



Spurious Conducted Emissions – Test Results



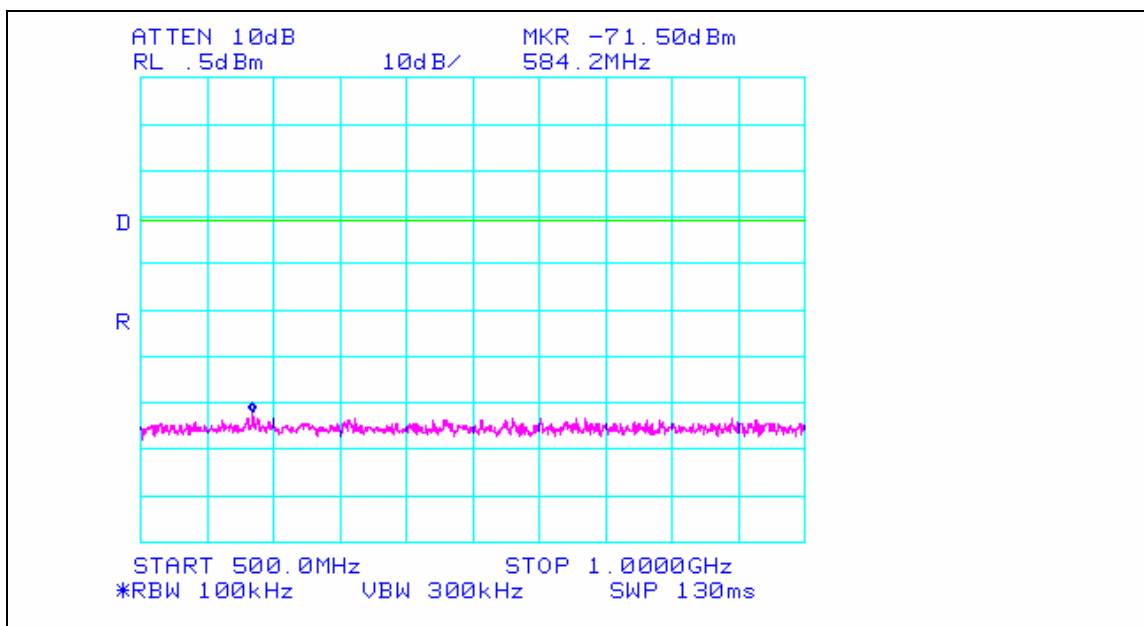
Plot 12. Spurious Conducted Emission – Channel 0 – 30 MHz to 100 MHz*



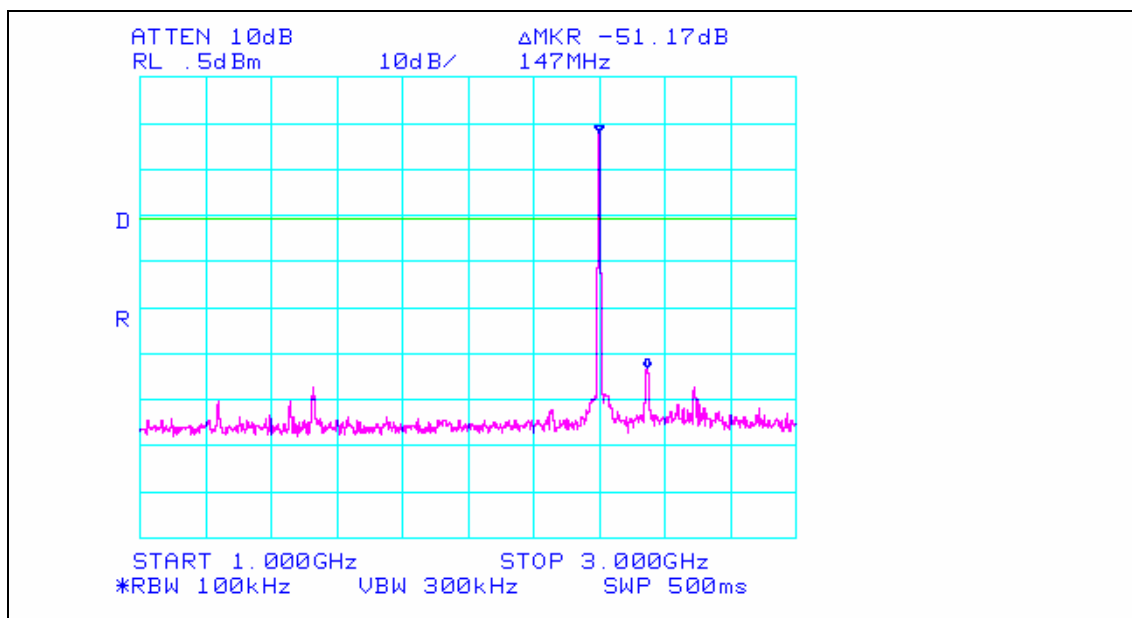
Plot 13. Spurious Conducted Emission – Channel 0 – 100 MHz to 500 MHz*



Spurious Conducted Emissions – Test Results



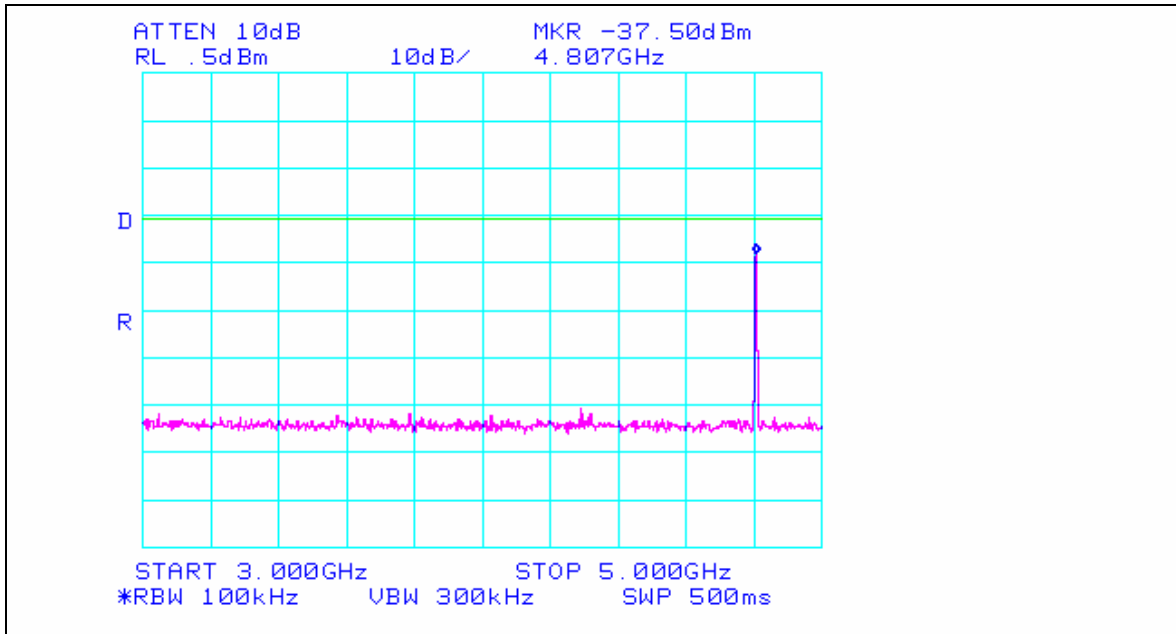
Plot 14. Spurious Conducted Emission – Channel 0 – 500 MHz to 1 GHz*



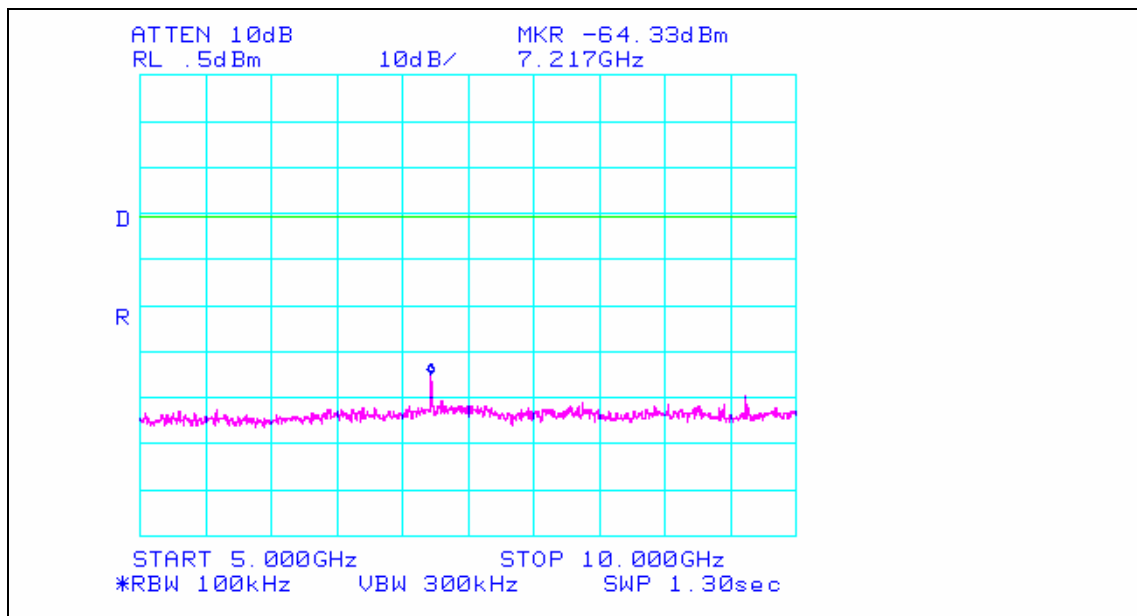
Plot 15. Spurious Conducted Emission – Channel 0 – 1 GHz to 3 GHz



Spurious Conducted Emissions – Test Results



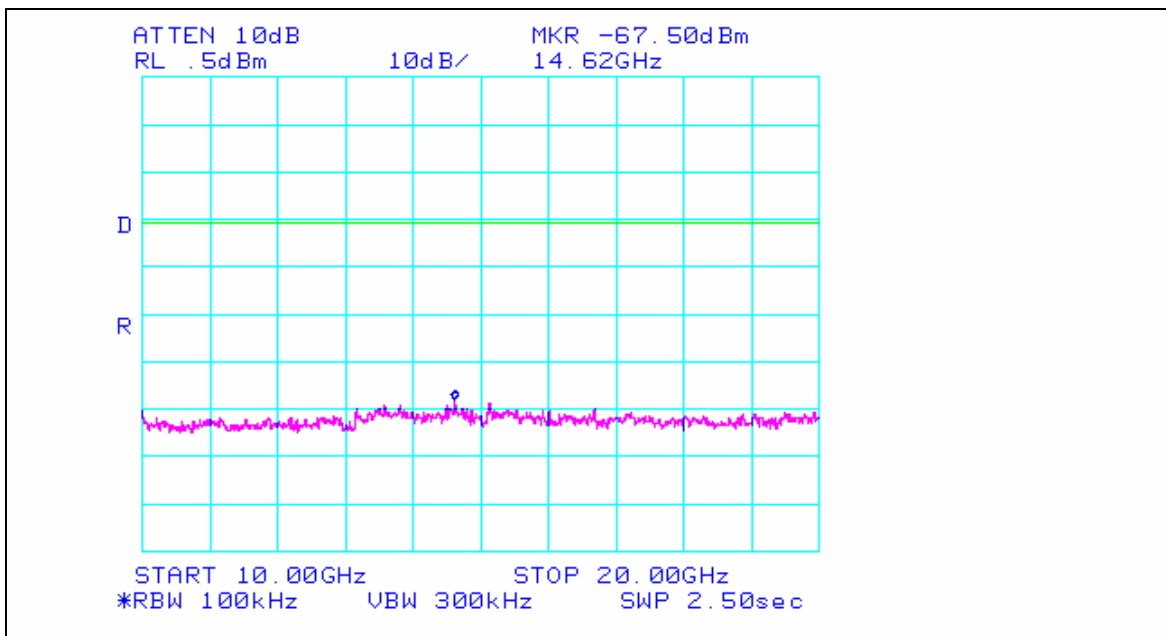
Plot 16. Spurious Conducted Emission – Channel 0 – 3 GHz to 5 GHz*



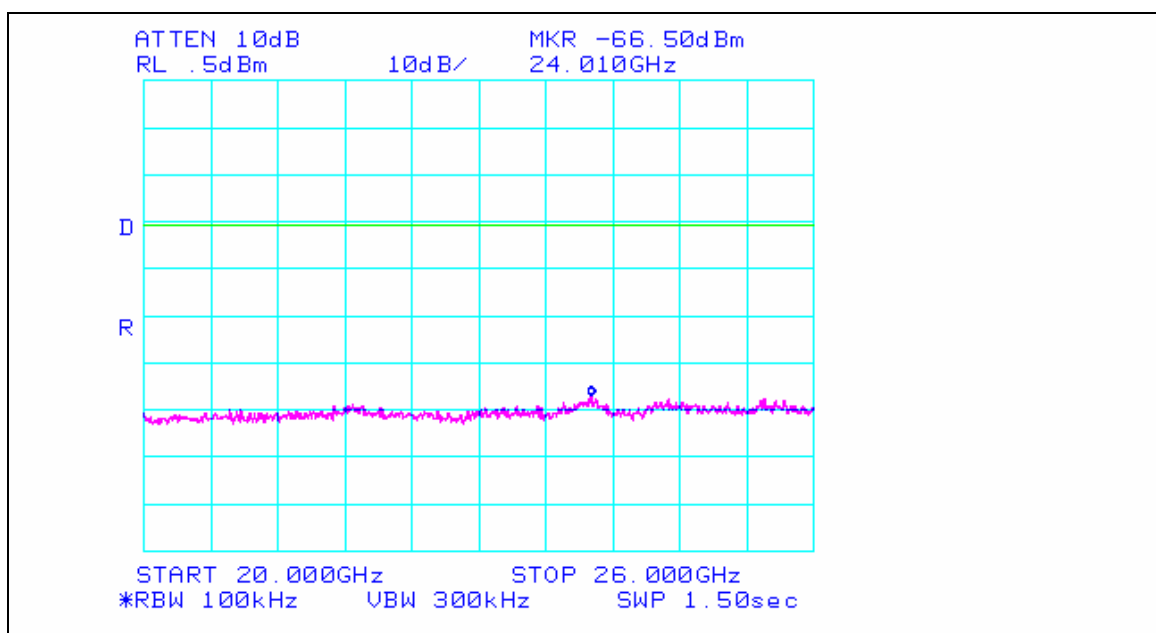
Plot 17. Spurious Conducted Emission – Channel 0 – 5 GHz to 10 GHz*



Spurious Conducted Emissions – Test Results



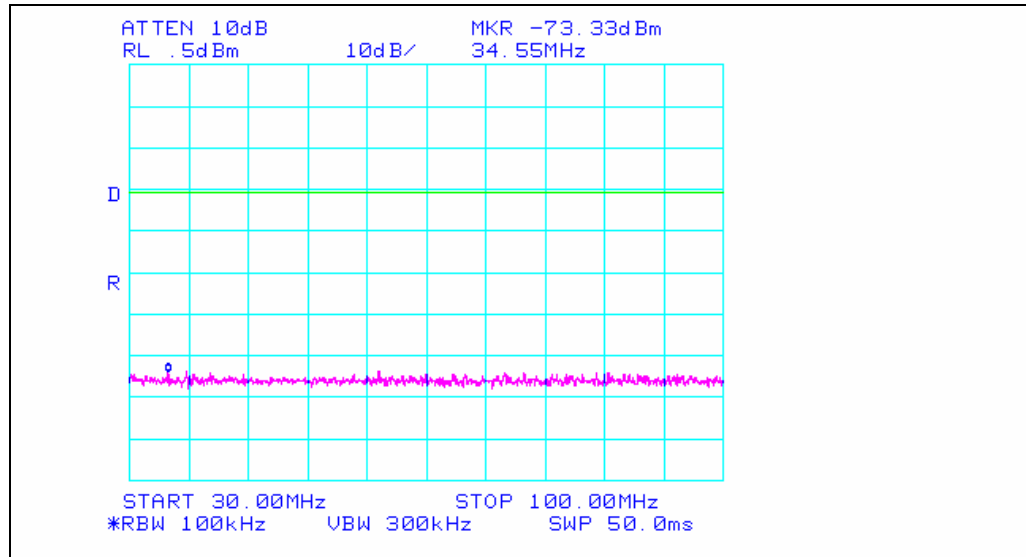
Plot 18. Spurious Conducted Emission – Channel 0 – 10 GHz to 20 GHz*



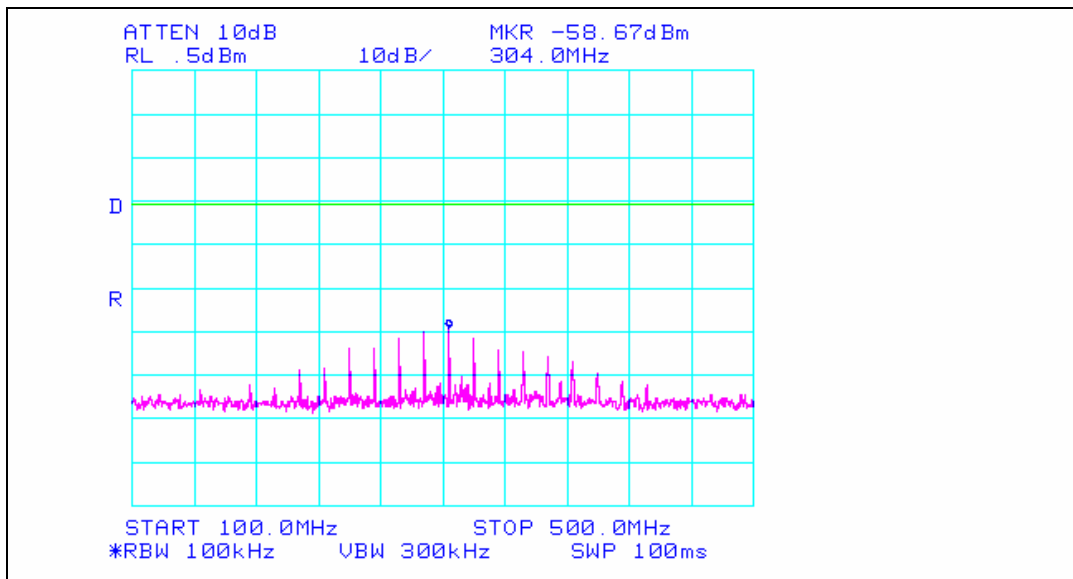
Plot 19. Spurious Conducted Emission – Channel 0 – 20 GHz to 26 GHz*



Spurious Conducted Emissions – Test Results



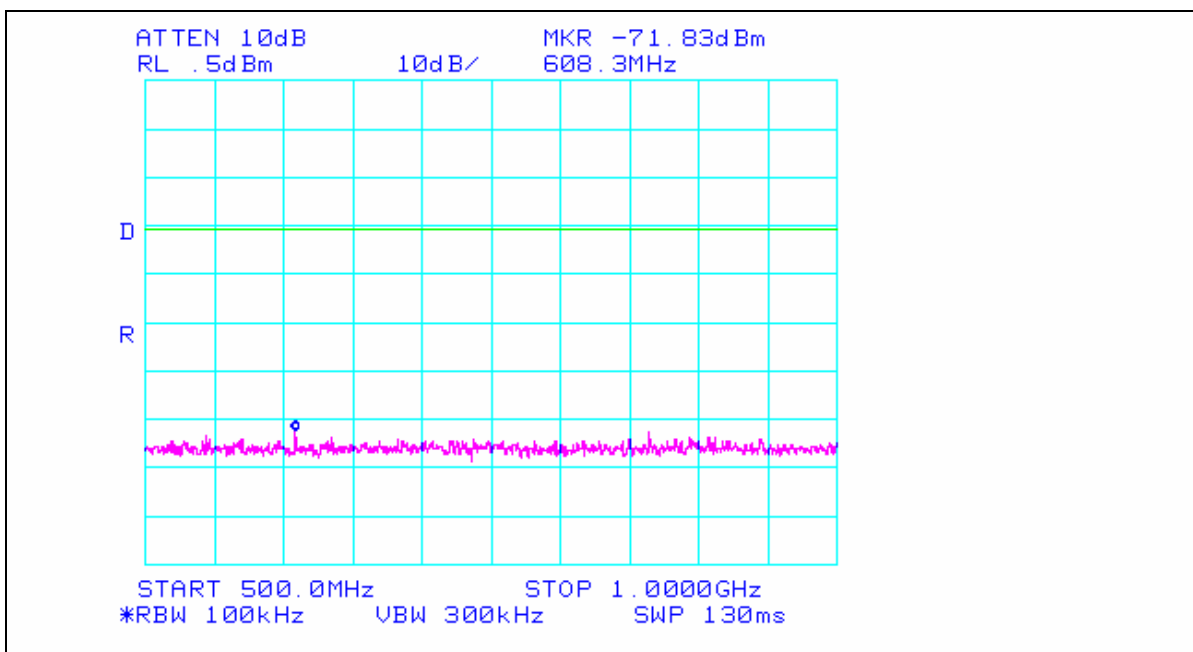
Plot 20. Spurious Conducted Emission – Channel 7 – 30 MHz to 100 MHz*



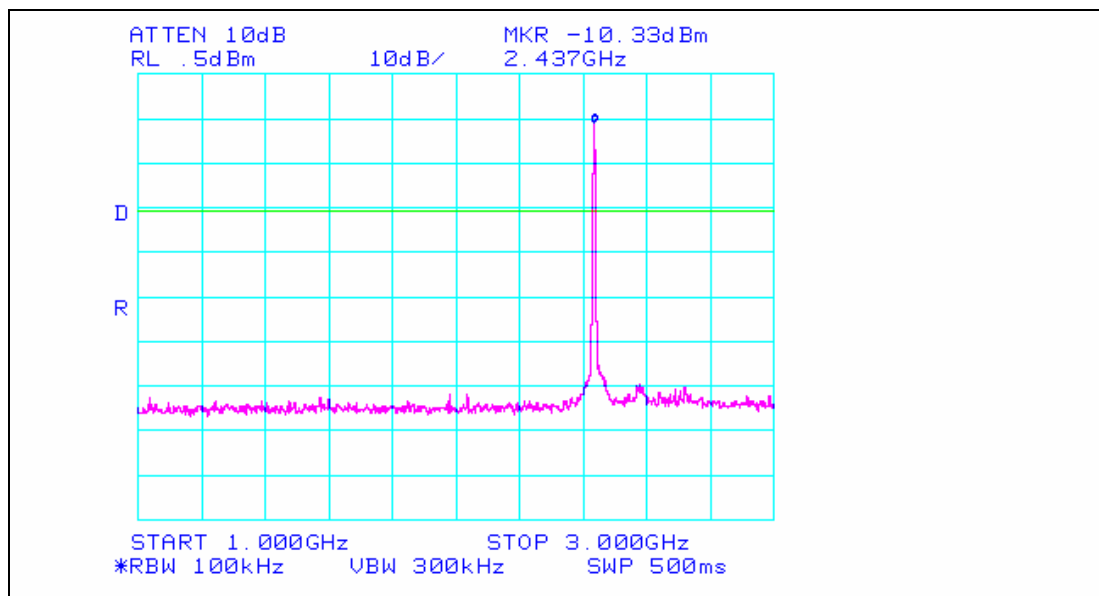
Plot 21. Spurious Conducted Emission – Channel 7 – 100 MHz to 500 MHz*



Spurious Conducted Emissions – Test Results



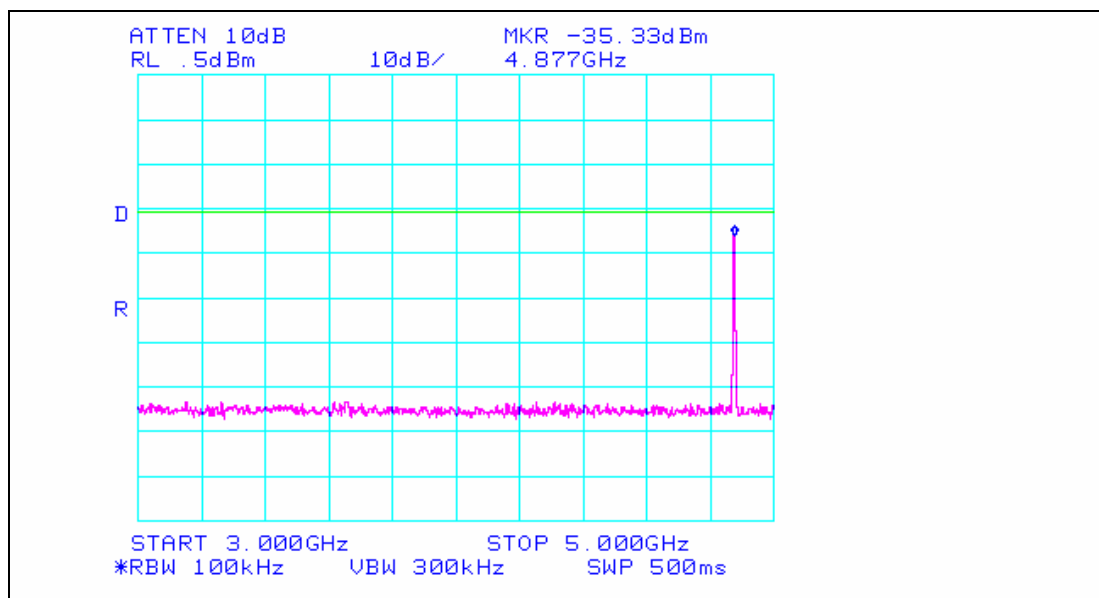
Plot 22. Spurious Conducted Emission – Channel 7 – 500 MHz to 1 GHz*



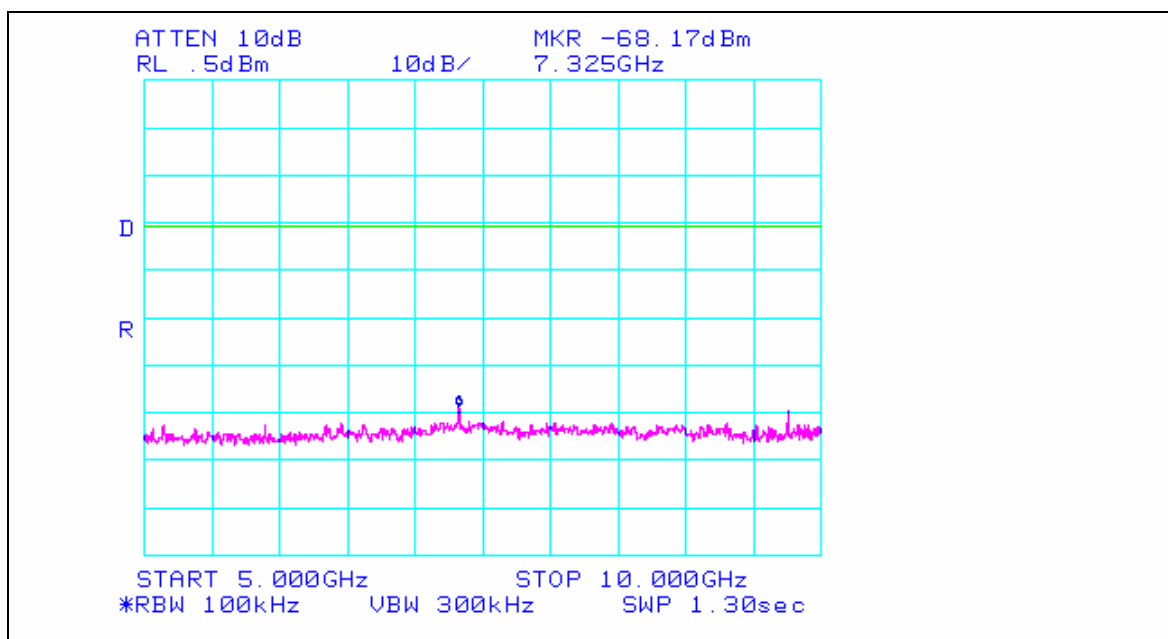
Plot 23. Spurious Conducted Emission – Channel 7 – 1 GHz to 3 GHz*



Spurious Conducted Emissions – Test Results



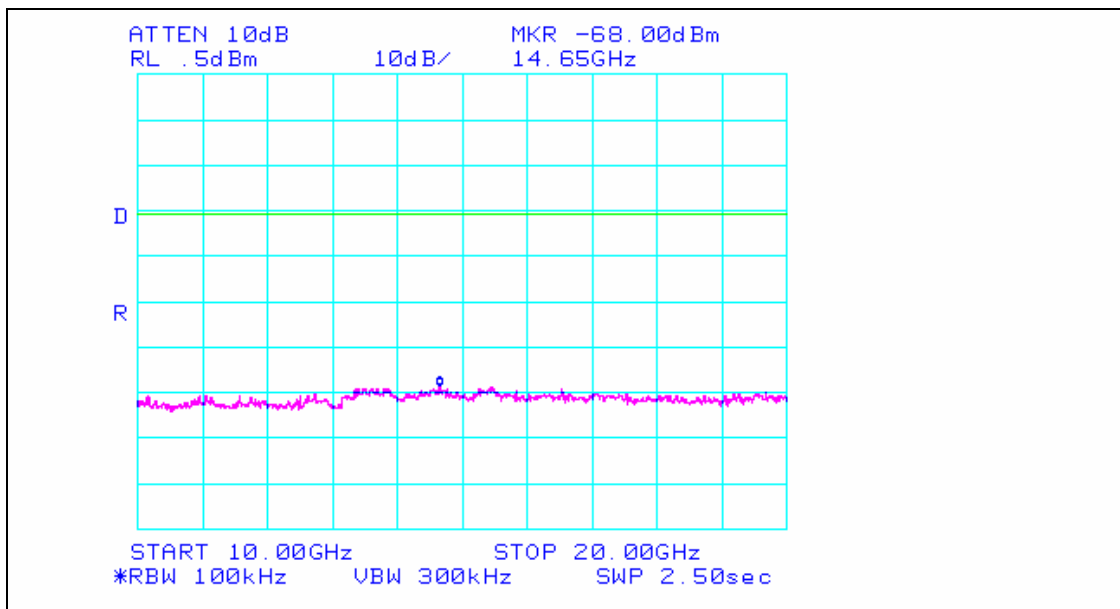
Plot 24. Spurious Conducted Emission – Channel 7 – 3 GHz to 5 GHz*



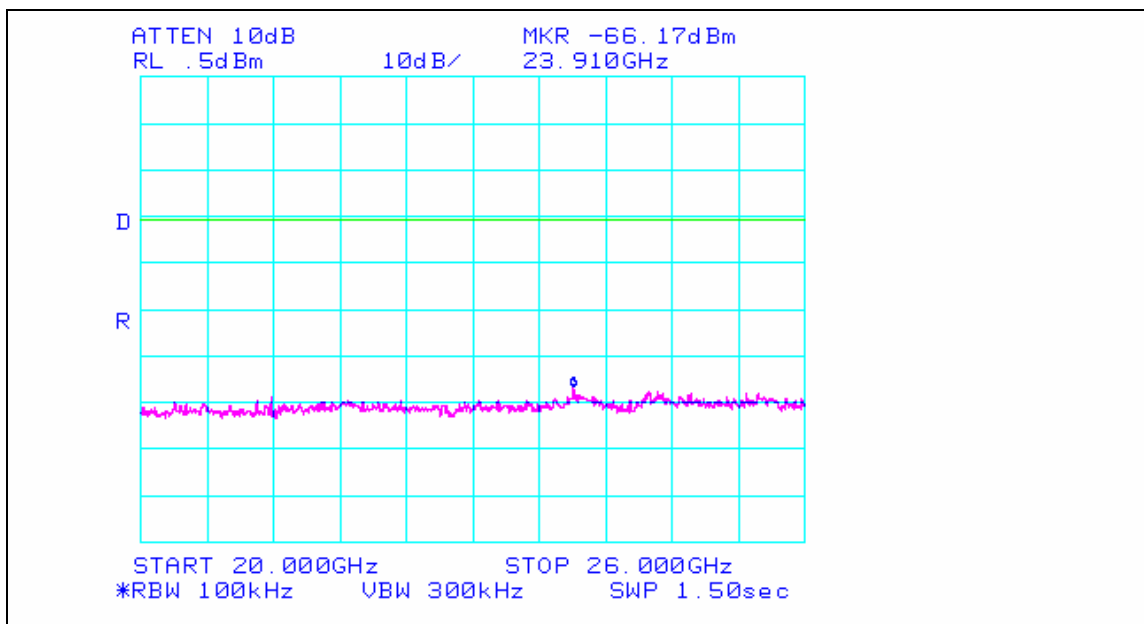
Plot 25. Spurious Conducted Emission – Channel 7 – 5 GHz to 10 GHz*



Spurious Conducted Emissions – Test Results



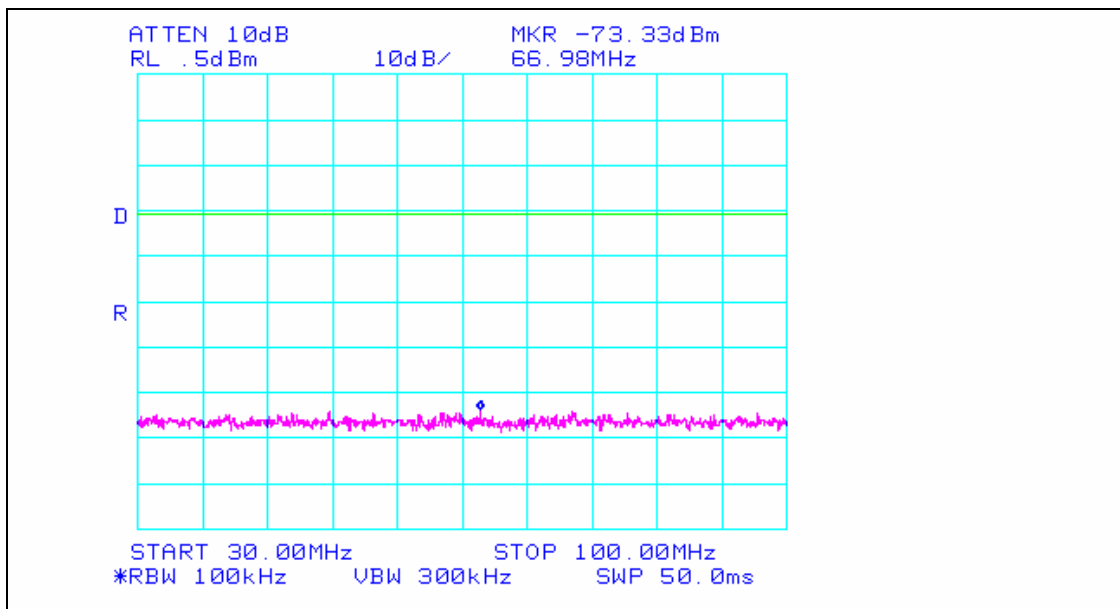
Plot 26. Spurious Conducted Emission – Channel 7 – 10 GHz to 20 GHz*



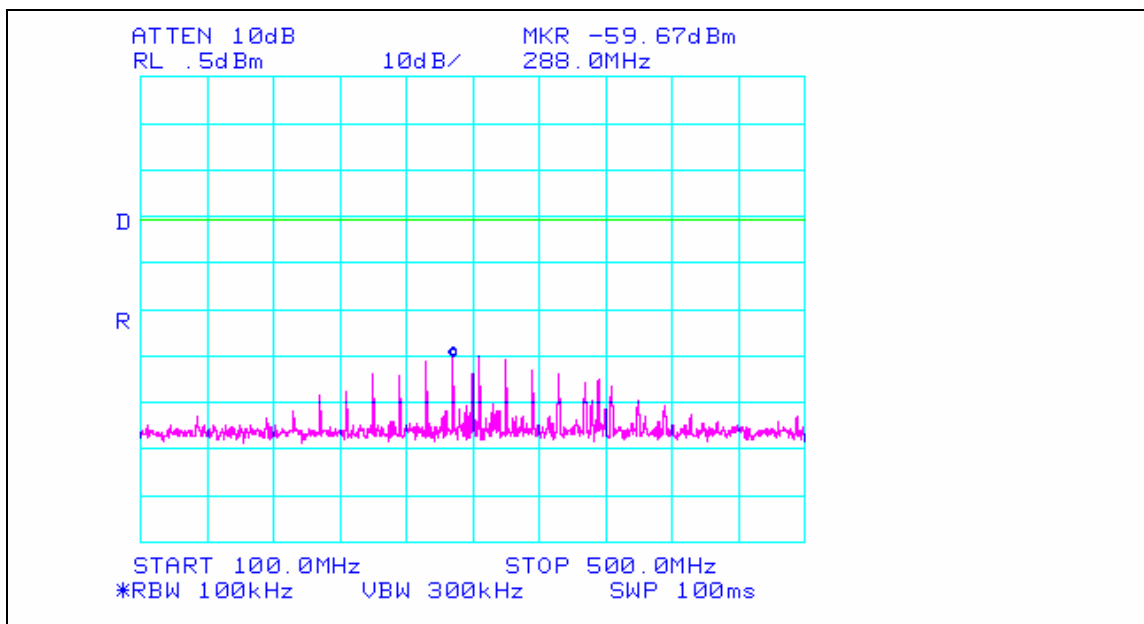
Plot 27. Spurious Conducted Emission – Channel 7 – 20 GHz to 26 GHz*



Spurious Conducted Emissions – Test Results



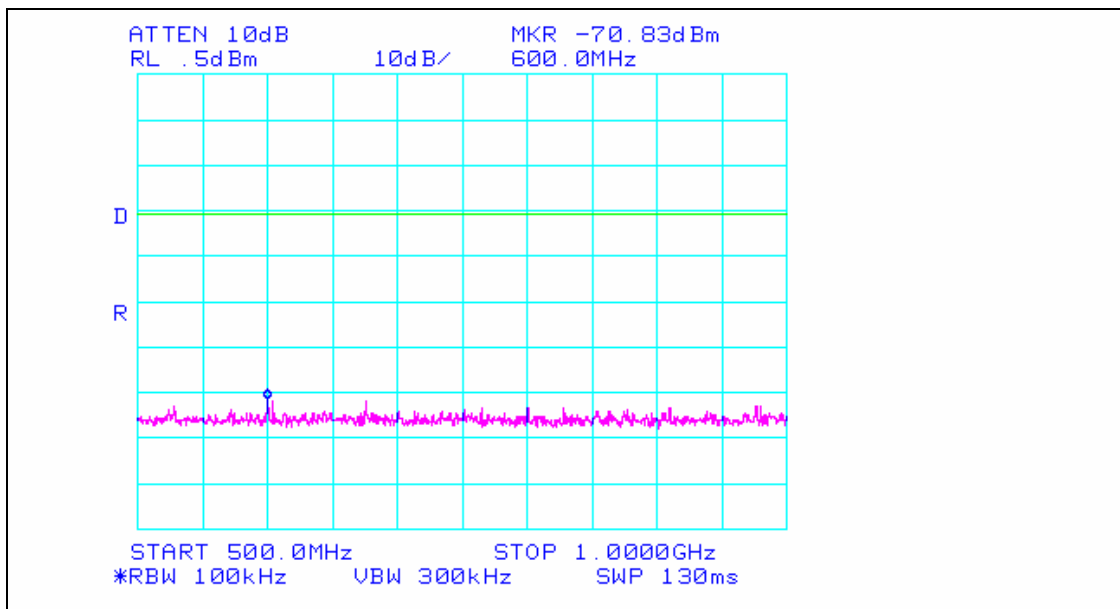
Plot 28. Spurious Conducted Emission – Channel 15 – 30 MHz to 100 MHz*



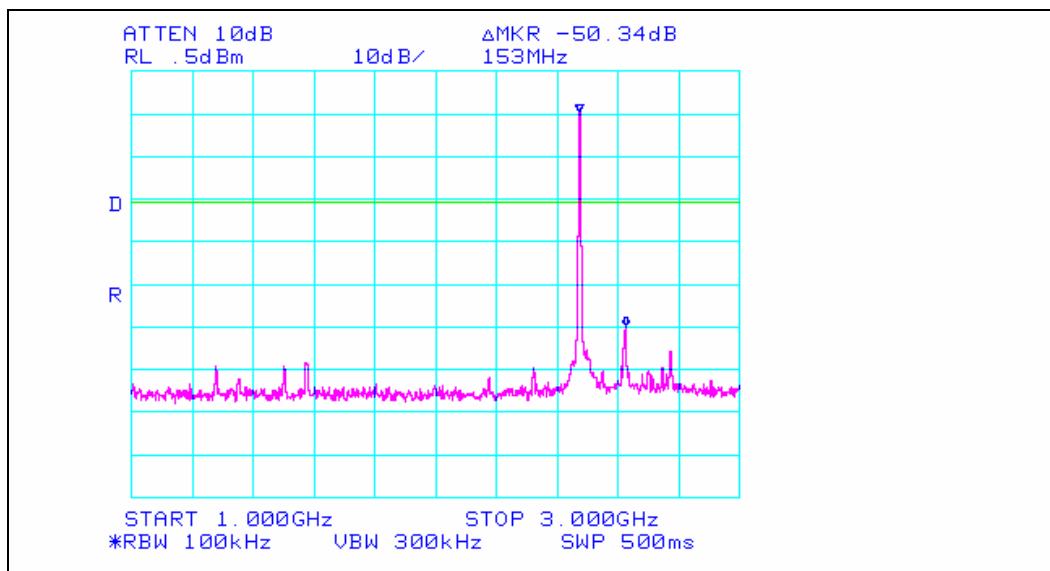
Plot 29. Spurious Conducted Emission – Channel 15 – 100 MHz to 500 MHz*



Spurious Conducted Emissions – Test Results



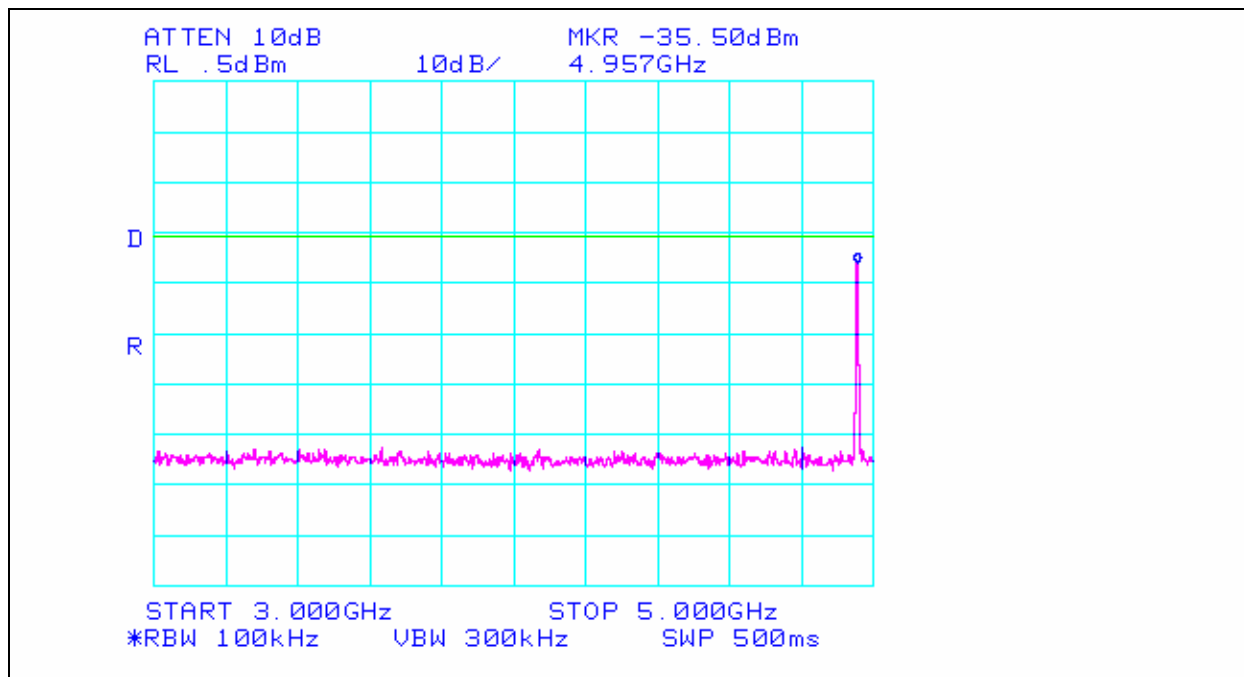
Plot 30. Spurious Conducted Emission – Channel 15 – 500 MHz to 1 GHz*



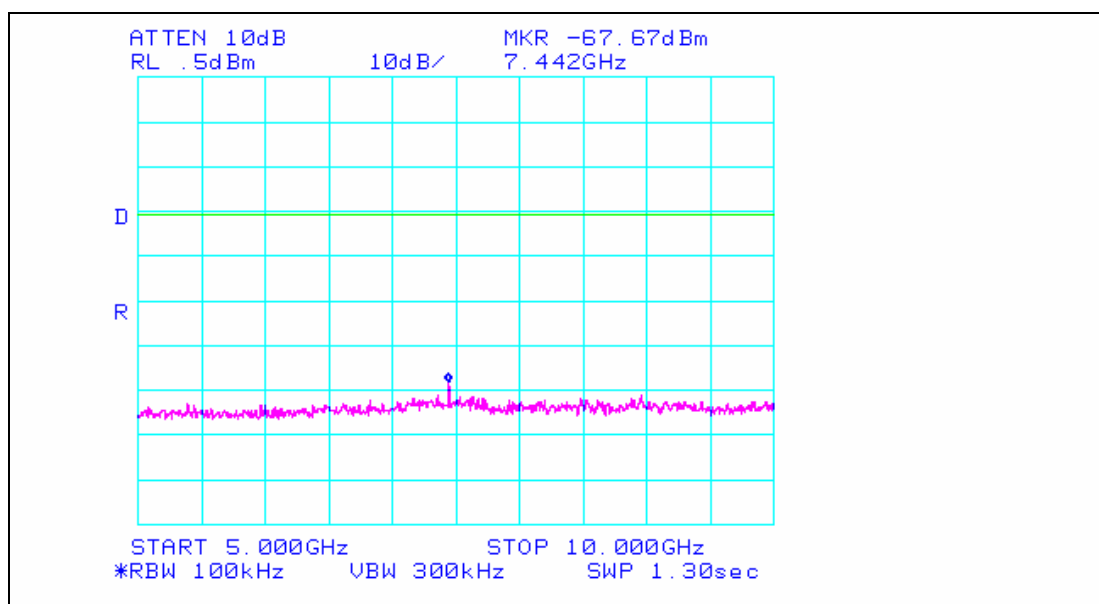
Plot 31. Spurious Conducted Emission – Channel 15 – 1 GHz to 3 GHz*



Spurious Conducted Emissions – Test Results



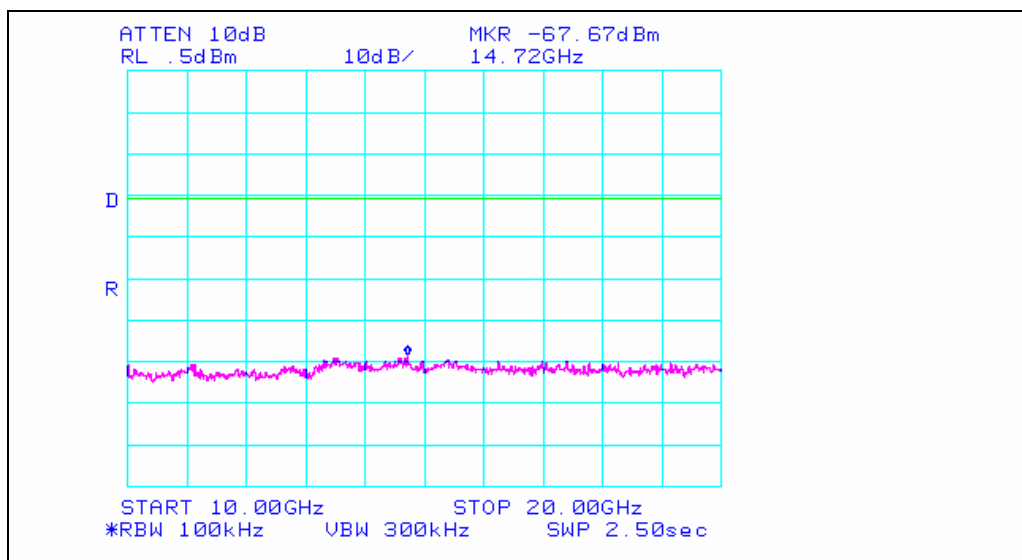
Plot 32. Spurious Conducted Emission – Channel 15 – 3 GHz to 5 GHz*



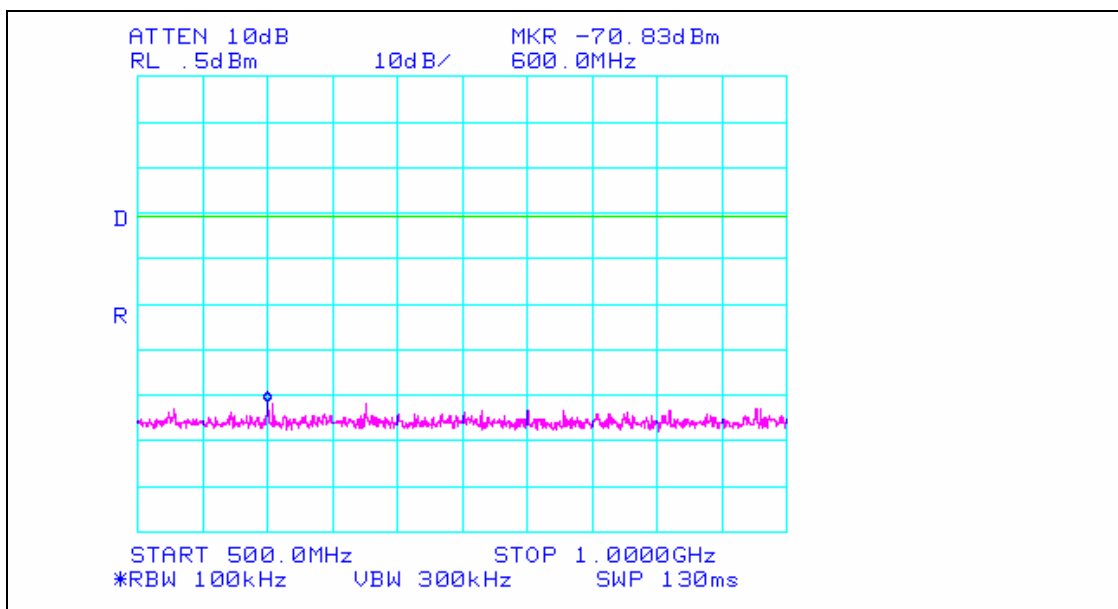
Plot 33. Spurious Conducted Emission – Channel 15 – 5 GHz to 10 GHz*



Spurious Conducted Emissions – Test Results



Plot 34. Spurious Conducted Emission – Channel 15 – 10 GHz to 20 GHz*



Plot 35. Spurious Conducted Emission – Channel 0 – 20 GHz to 26 GHz*

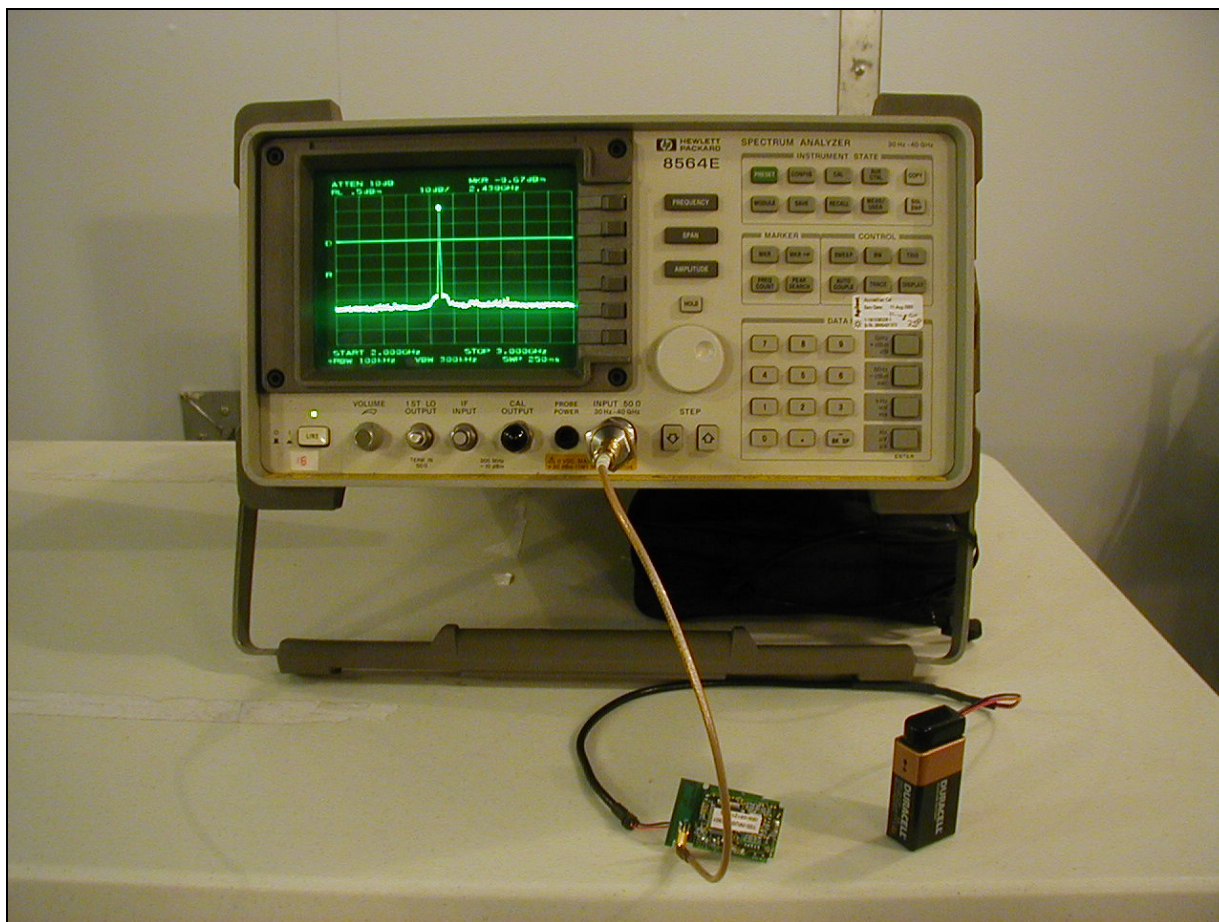
* NOTE: All measurements were peak conducted.



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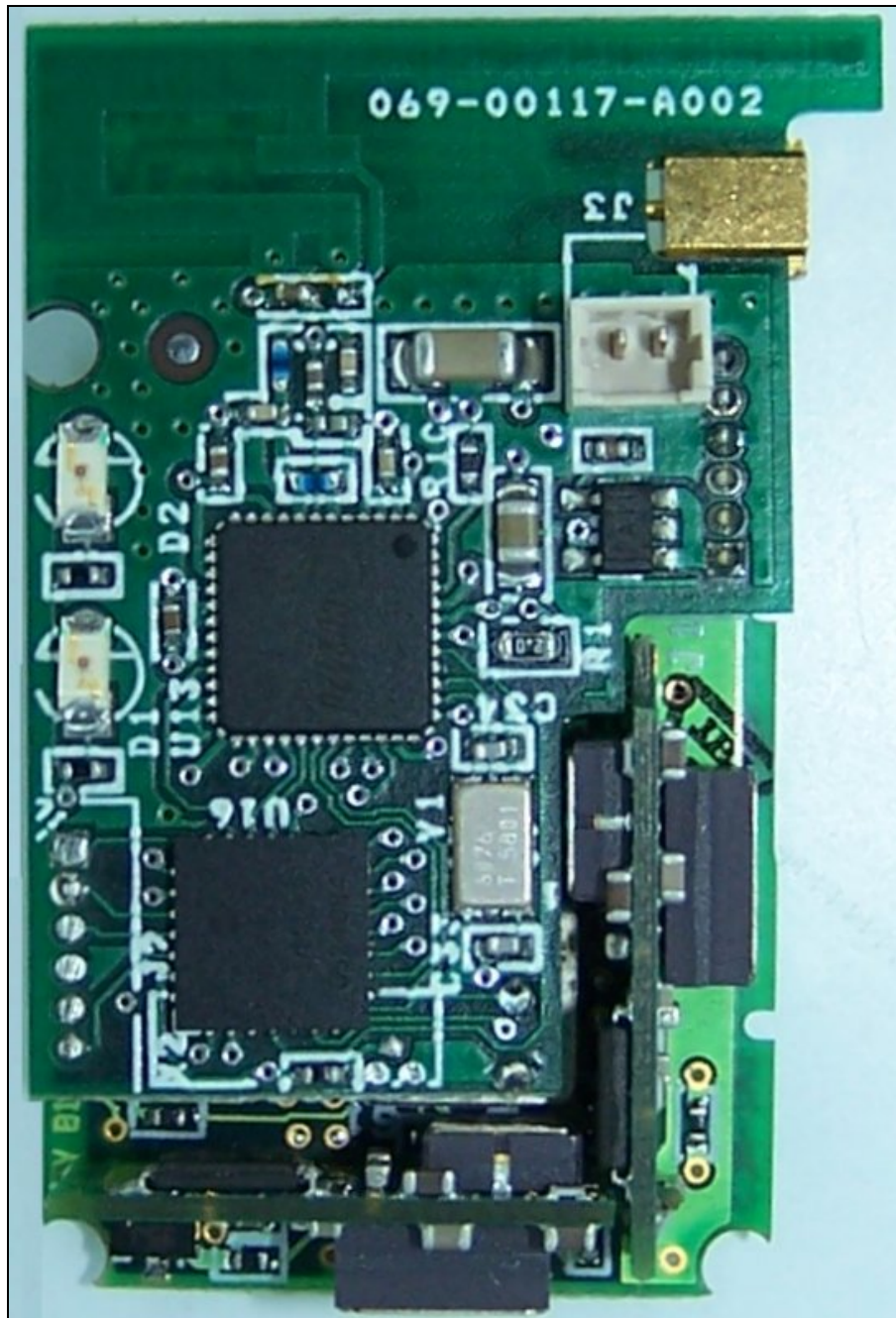
Spurious Conducted Emissions – Test Results



Photograph 5. Spurious Conducted Emissions Test Setup



4.0 Additional Photographs

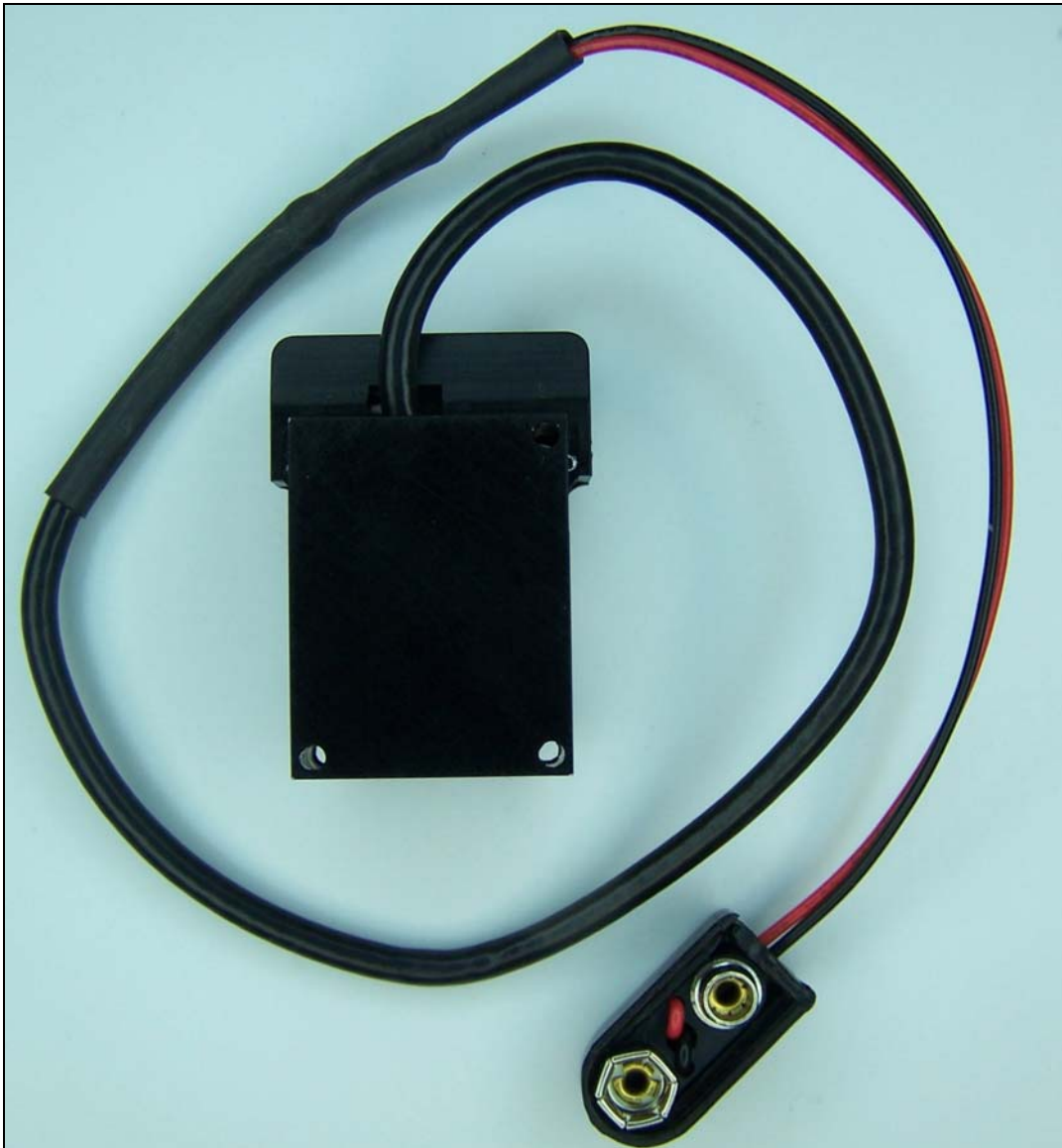


Photograph 6. Sample Used for Conducted Testing



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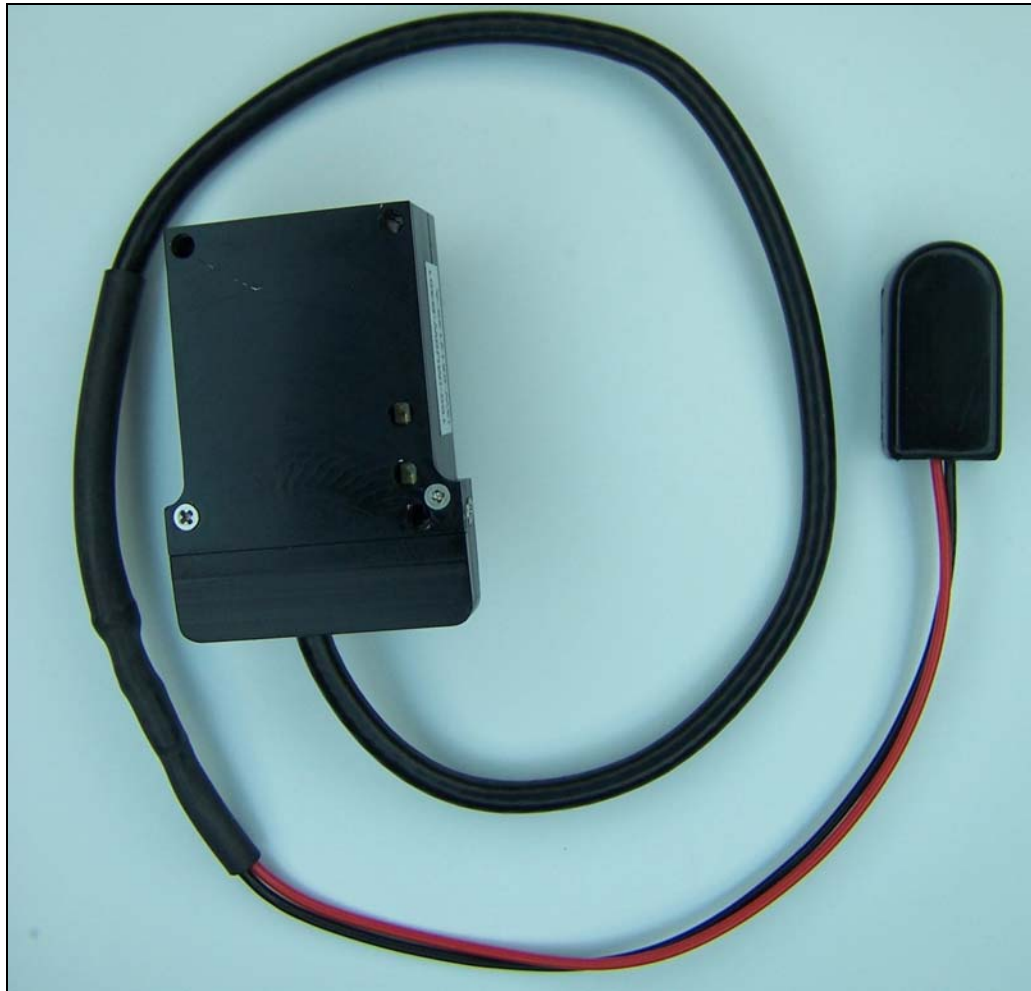


Photograph 7. Top View of IC3 Unit



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Photograph 8. Bottom View of IC3 Unit



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Photograph 9. Internal Photograph 1



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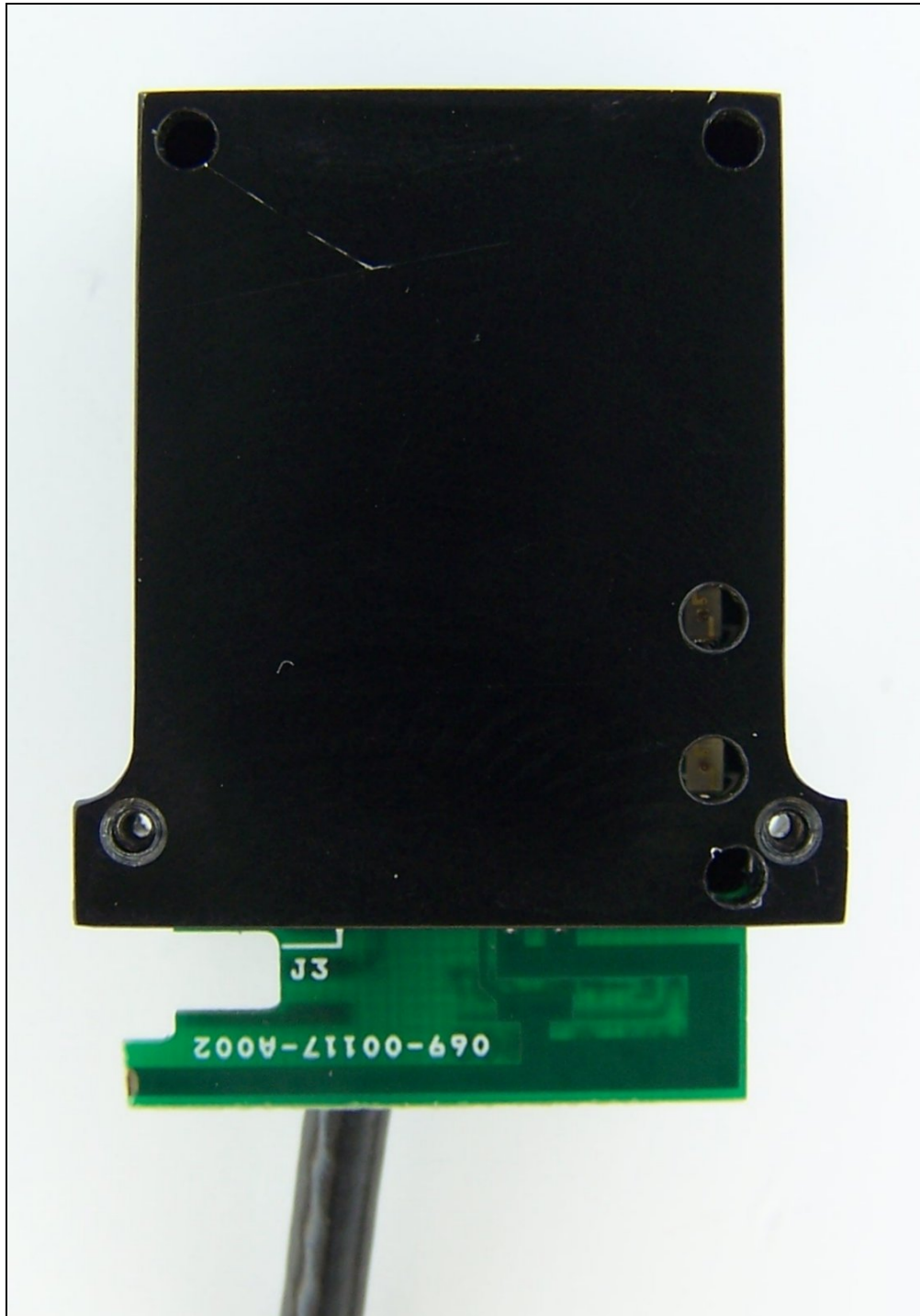


Photograph 10. Internal Photograph 2



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Photograph 11. Internal Photograph 3



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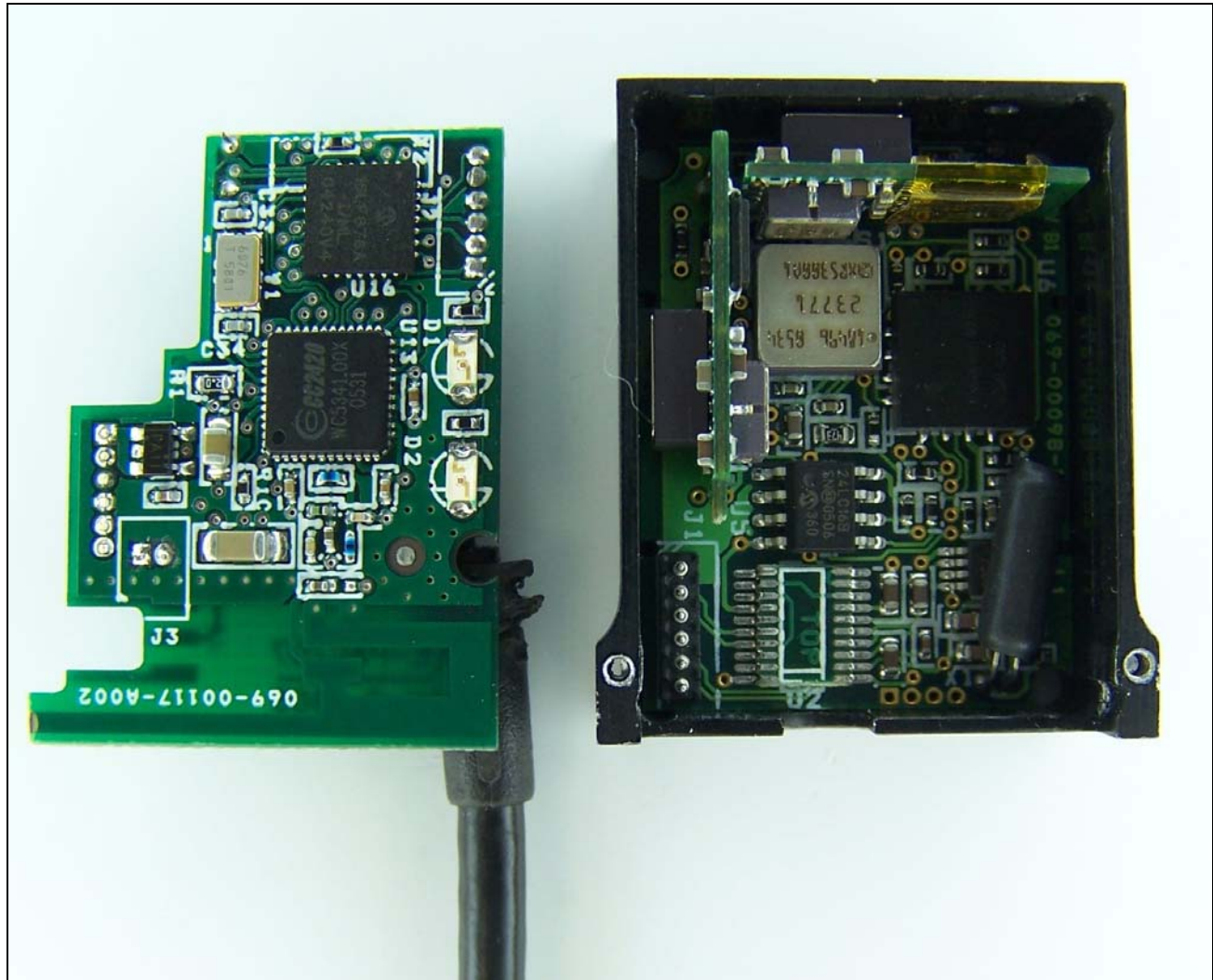


Photograph 12. Internal Photograph 4



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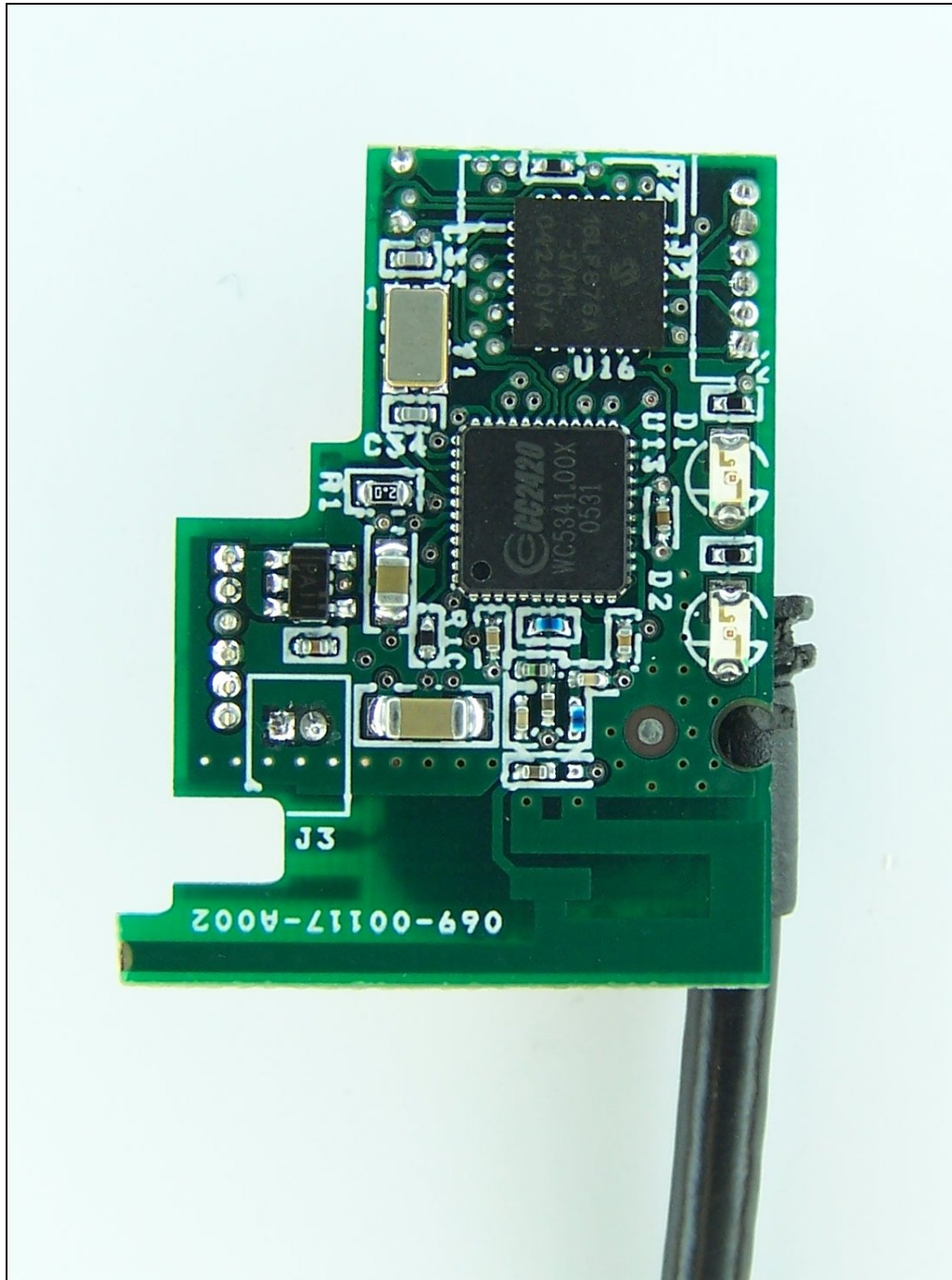


Photograph 13. Internal Photograph 5



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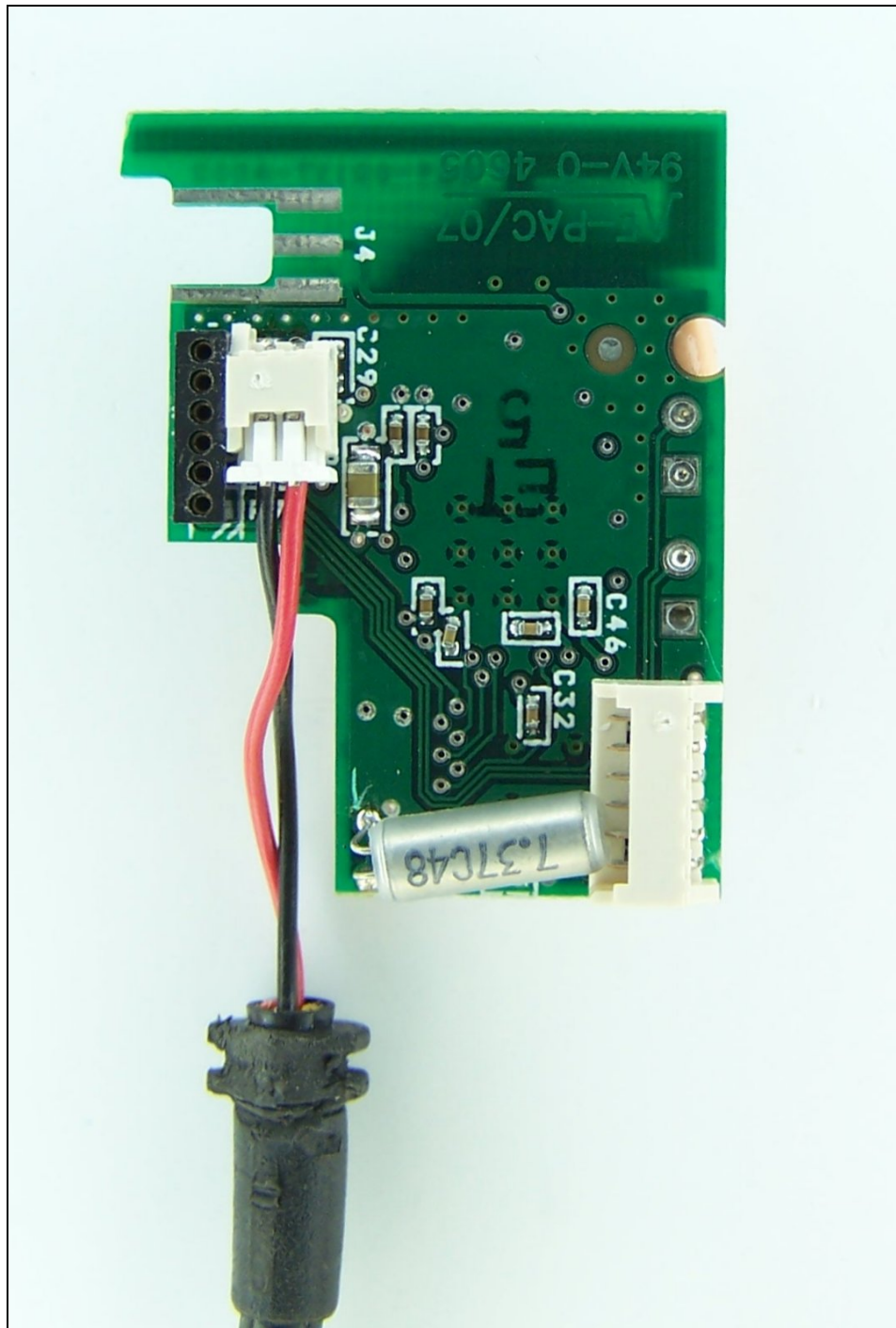


Photograph 14. Internal Photograph 6



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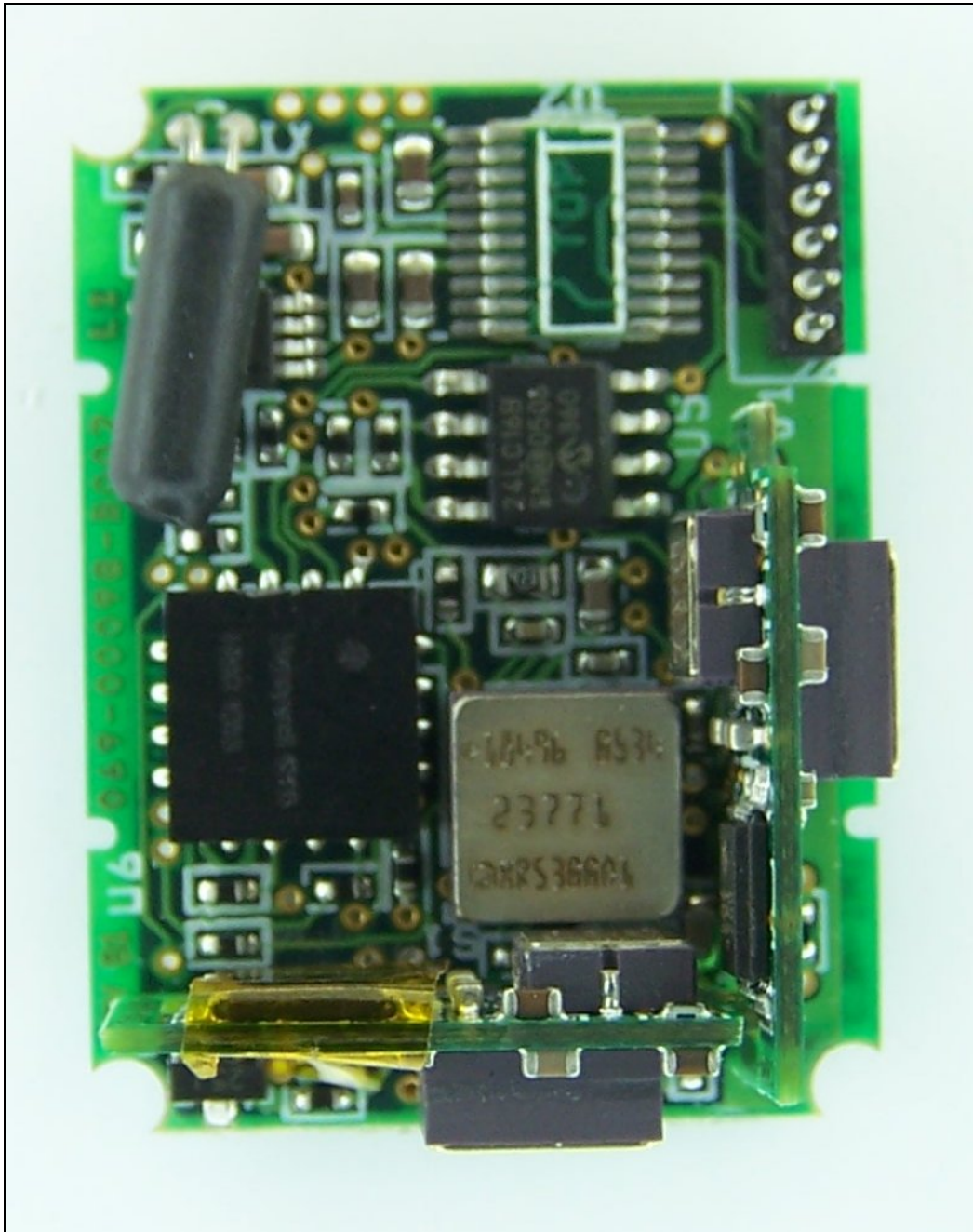


Photograph 15. Internal Photograph 7



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Photograph 16. Internal Photograph 8



Photograph 17. Internal Photograph 9

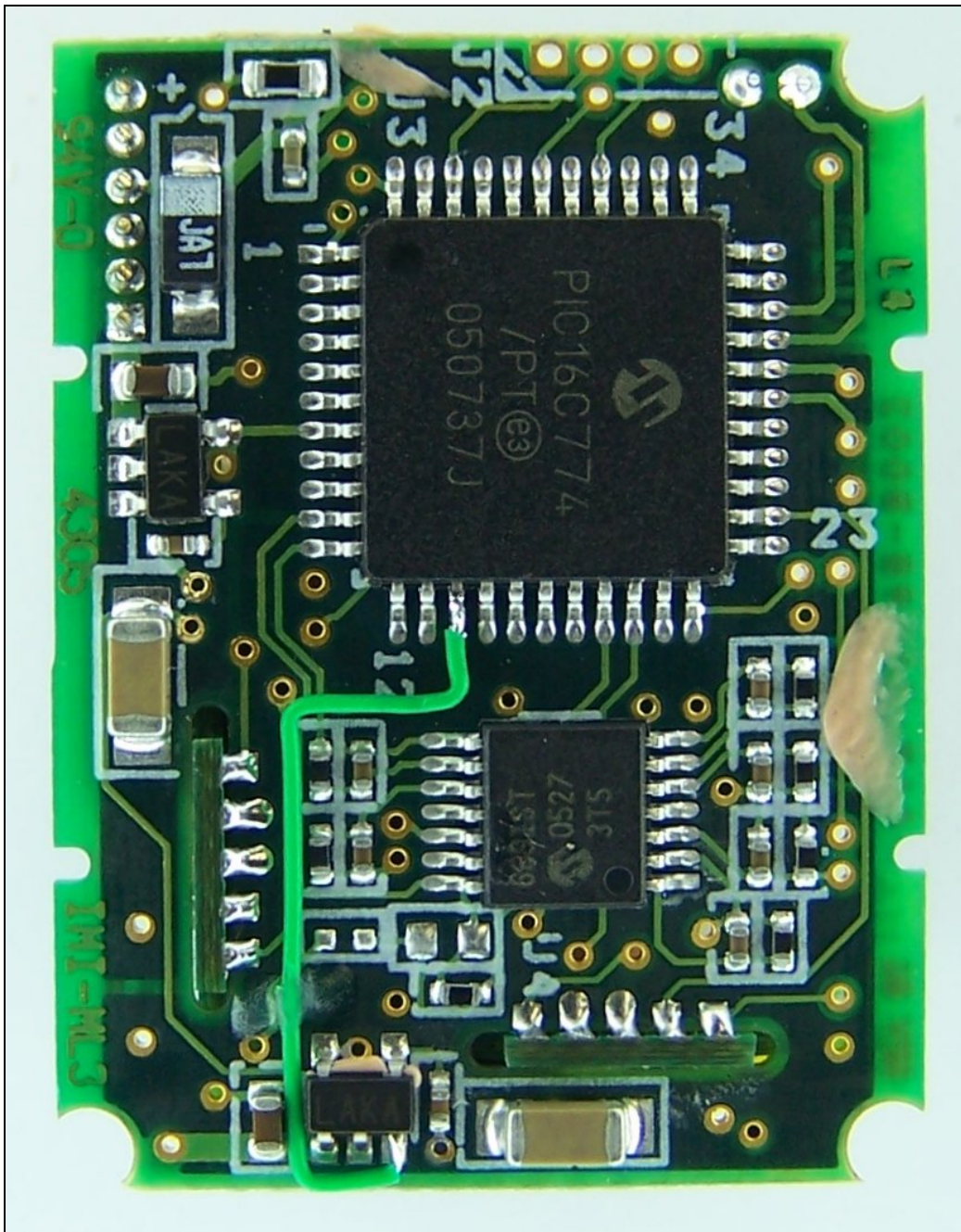


Photograph 18. Internal Photograph 10



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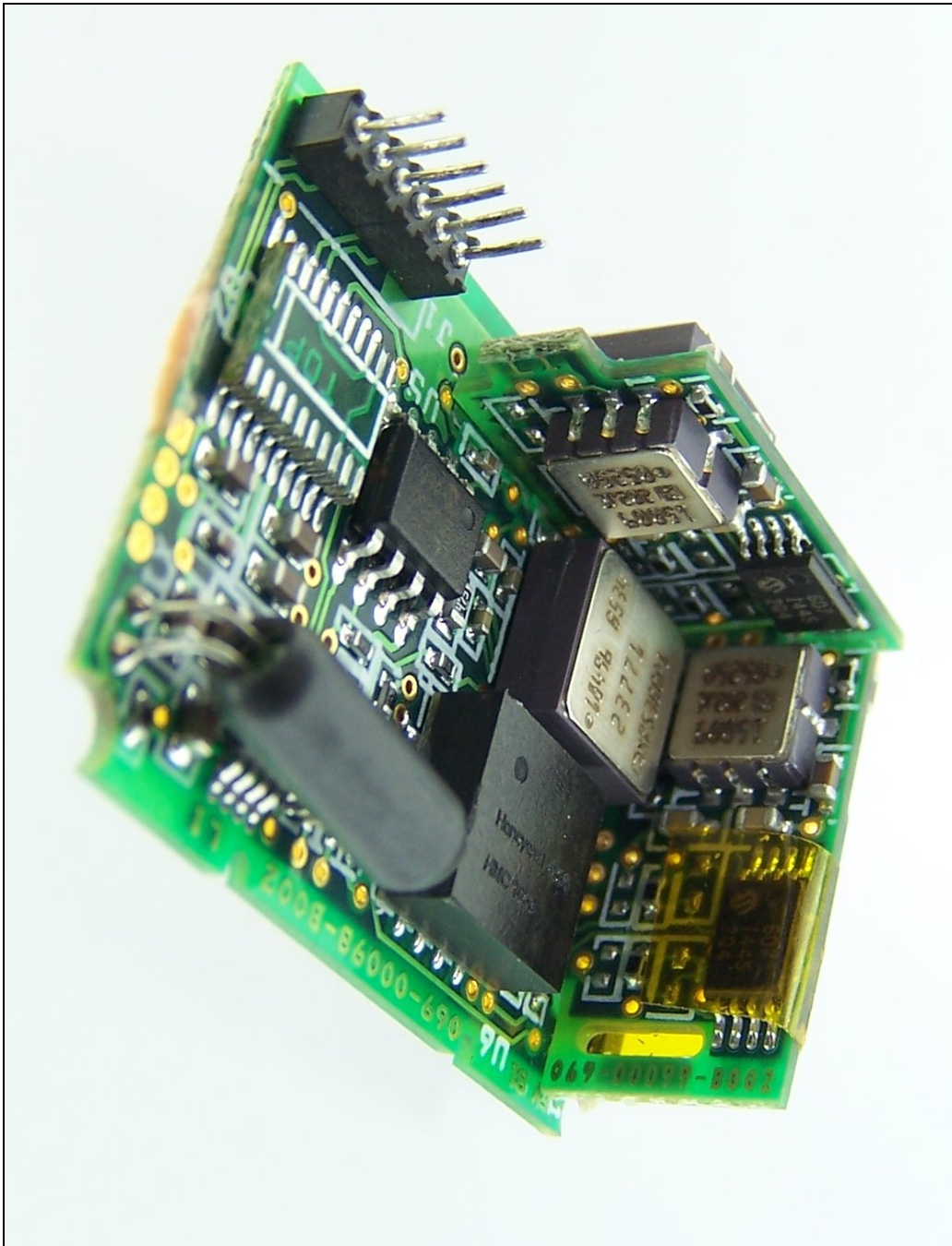


Photograph 19. Internal Photograph 11



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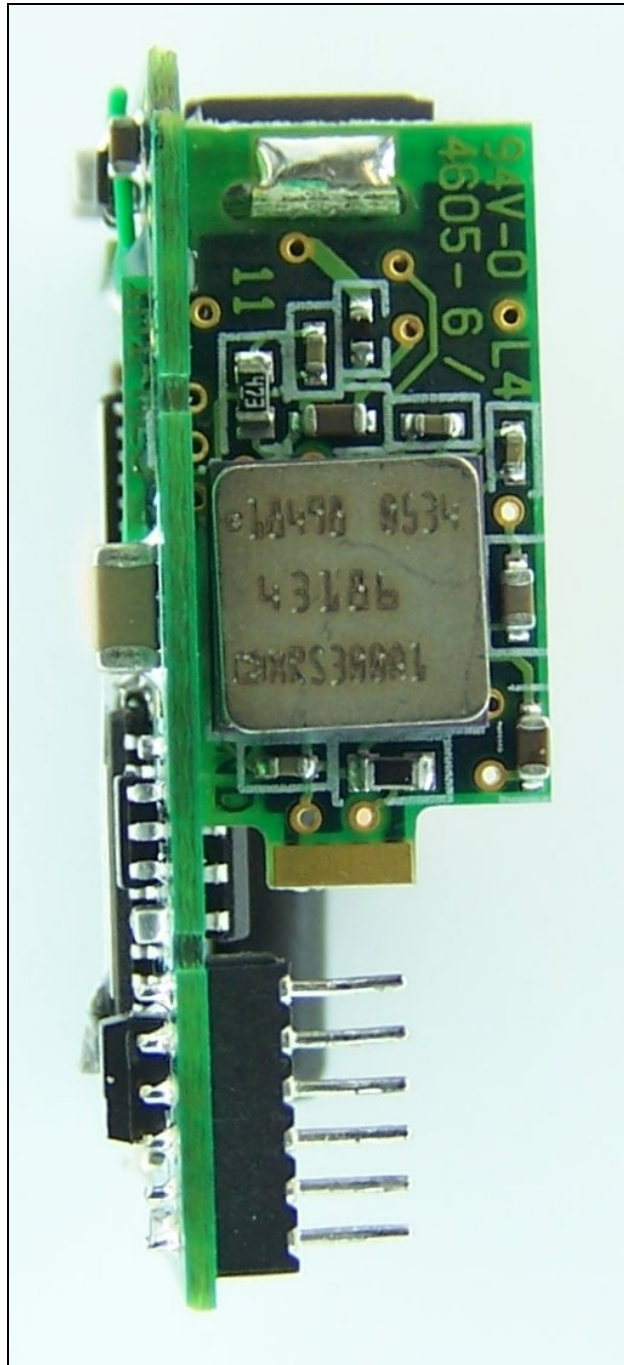


Photograph 20. Internal Photograph 12



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Photograph 21. Internal Photograph 13



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Photograph 22. Internal Photograph 14



5.0 Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ANSI/NCSL Z540-1-1994 and ANSI/ISO/IEC 17025:2000.

Test Name: Spurious Radiated Emissions				Test Date(s): 01/18/2006	
MET Asset #	Nomenclature	Manufacturer	Model	Last Cal Date	Cal Due Date
1T2511	ANTENNA; HORN	EMCO	3115	06/28/2005	06/28/2006
1T4442	PRE-AMPLIFIER; MICROWAVE	Miteq	AFS42-01001800-30-10P	SEE NOTE	
1T4351	SPECTRUM ANALYZER	AGILENT	E7405A	10/04/2005	10/04/2006
1T4503	SHIELDED ROOM	UNIVERSAL SHIELDING CORP	N/A	04/30/2005	04/30/2006
Test Name: Band Edge Emissions				Test Date(s): 02/09/2006	
MET Asset #	Nomenclature	Manufacturer	Model	Last Cal Date	Cal Due Date
1T2511	ANTENNA; HORN	EMCO	3115	06/28/2005	06/28/2006
1T4351	SPECTRUM ANALYZER	AGILENT	E7405A	10/4/2005	10/4/2006
1T4503	SHIELDED ROOM	UNIVERSAL SHIELDING	N/A	4/30/2005	4/30/2006
Test Name: Conducted Measurements				Test Date(s): 02/08/2006 and 02/10/2006	
MET Asset #	Nomenclature	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4316	SPECTRUM ANALYZER	HEWLETT PACKARD	8564E	8/11/2005	8/11/2006
1T4351	EMC ANALYZER	AGILENT	E7405	10/4/2005	10/4/2006
1T4503	SHIELDED ROOM	UNIVERSAL SHIELDING CORP.	NONE LISTED	4/30/2005	4/30/2006

Note: Functionally verified test equipment is verified using calibrated instrumentation at the time of testing.



6.0 Compliance Information

6.1 Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
 - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
 - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.



- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
- (i) *Compliance testing;*
 - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
 - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.



The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.¹ *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

¹ In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart C (of Part 15), which deals with intentional radiators.



§ 2.948 Description of measurement facilities.

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
 - (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
 - (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
 - (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
 - (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.



6.2 Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) *In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:*

- (1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

- (2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

- (3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

- (4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.
- (5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.



§ 15.27 Special Accessories.

(a) Equipment marketed to a consumer must be capable of complying with the necessary regulations in the configuration in which the cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer, without additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in §2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

§ 15.105 Information to the user.

- (a) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.