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REPORT OF MEASUREMENTS
PART 15C - INTENTIONAL RADIATOR

DEVICE:	1 CHANNEL 2.4 GHz 1 CHANNEL DIRECT SEQUENCE SPREAD SPECTRUM TRANSCEIVER
MODEL:	2010ET
MANUFACTURER:	SPECTRUM WIRELESS, INC.
ADDRESS:	2600 DENALI STREET SUITE 420 ANCHORAGE AK 99503

THE DATA CONTAINED IN THIS REPORT WAS
COLLECTED ON 7 & 10 JULY 1998 AND COMPILED BY:

PAUL G. SLAVENS
CHIEF EMC ENGINEER

WORK ORDER: 30003

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1. General

1.1 Purpose

The purpose of this report is to show compliance to the FCC regulations for spread spectrum unlicensed devices operating under section 15.247 of the Code of Federal Regulations title 47.

The device tested was already certified under FCC ID # AX2JX4000. The grantee wishes to have the device "re-certified" with the three new antennas listed in section 8 of this report.

1.2 Manufacturer

Company Name:	Spectrum Wireless, Inc.
Contact:	Jay Blucher
Street Address:	2600 Denali Street Suite 420
City/State/Zip:	Anchorage AK 99503
Telephone:	907 272-1066
Fax:	907 272-1075
E-mail:	info@spectrumwireless.net
Web:	www.spectrumwireless.net

1.3 Test location

Company:	Acme Testing Inc.
Street Address:	2002 Valley Highway
Mailing Address:	PO Box 3
City/State/Zip:	Acme WA 98220-0003
Laboratory:	Test Site 2
Telephone:	888 226-3837
Fax:	360 595-2722
E-mail:	acmetest@acmetesting.com
Web:	www.acmetesting.com

1.4 Test Personnel

Paul G. Slavens

2. Test Results Summary

Summary of Test Results
2010ET 1 Channel 2.4 GHz Spread Spectrum Transceiver

Requirement	CFR Section	Test Result
Radiated Spurs < 15.209	15.205(b)	Maximum F.S. = 37.4 dBuV/m
Conducted Emissions < 48.0 dBuV	15.207	Max Conducted Emission 45.2 dBuV
6 dB BW > 500 kHz	15.247(a2)	6 dB BW = 25 MHz
Max Output Power < 1 W	15.247(a2b)	Max Power = 25 mW
Conducted Spurious >-20 dBc	15.247(a2c)	Spurious > -40 dBc
Power Density < 8dBm in 3 kHz	15.247(a2d)	Power Density = -7.7 dBm in 3 kHz
Process Gain > 10 dB	15.247(a2e)	Process Gain > 10 dB

The signed original of this report, supplied to the client, represents the only "official" copy. Retention of any additional copies (electronic or non-electronic media) is at Acme Testing's discretion to meet internal requirements only. The client has made the determination that EUT Condition, Characterization, and Mode of Operation are representative of production units, and meet the requirements of the specifications referenced herein.

The measurements contained in this report were made in accordance with the referenced standards and all applicable Public Notices received prior to the date of testing. Acme Testing assumes responsibility only for the accuracy and completeness of this data as it pertains to the sample tested.

Paul G. Slavens
Chief EMC Engineer

Date of Issuance

3. Description of Equipment and Peripherals

3.1 Equipment Under Test (EUT)

Device:	1 Channel 2.4 GHz Spread Spectrum Transceiver
Model Number:	2010ET
Serial Number:	00606F0C0191
FCC ID:	NX92010ET
Power:	120V/60Hz
Grounding:	Local
Antenna Distance:	3 meters

3.2 Published Equipment Specifications

3.2.1 General

Frequency Range	:	2400-2483.5 MHz ISM band
Carrier Frequency	**:**	**2436.07 MHz**
Type of Emission	:	Direct Sequence Spread Spectrum
Chip Modulation	:	BPSK, 32 Mcps
Data Rate	*:*	*10 Mbps*
Processing Gain	:	12dB (Nominal)
Communication Method	:	Half Duplex
Channel Access Method	:	SS-p-CSMA[1]
Type of Interface	:	MAU (driven by AUI)
Datalink Interface	:	IEEE802.3 or Ethernet II MAC
Network Addressing	:	derived from attached NIC
RF MAC Protocol	*:*	*Radio encapsulation of IEEE802.3 or Ethernet II MAC frame.*
Network Topology	*:*	*Peer to peer*
Power Requirement	*:*	*6.2V dc, 1.2A*

3.2.2 Radio

Transmit Power	*:*	*14 dBm (typical)*
Sensitivity	*:*	*-85 dBm (typical)*[2]
Antenna	*:*	*Installed Internal Antenna*[3] *and External Antenna (SMA male)*

[1] Spread Spectrum p-persistent CSMA

[2] Input power at which the throughput without re-transmission degrades to 75% of typical throughput.

[3] Depends on model.

3.2.3 Configurable Parameters

AUI Busy Collision on/off, SQE Test on/off, Ignore CRC on/off, FEC Sequence, p-CSMA wait time, Numbers of Re-transmission, Address Checking on/off, Security Channel, Duplicate Filter on/off, Search Code, (Antenna Diversity), (Antenna Selection), RF Address, Upload Address, ACK time-out
Note: parameters put in parentheses depends on model.

3.2.4 Dimensions

148(W) × 210(D) × 75(H) (mm), excluding projections

3.2.5 Environmental

Operating Temperature Range : 0°C ~ +40°C
Storage Temperature Range : -20°C ~ +60°C

3.3 EUT Peripherals

Device	Manufacturer	Model Number	FCC ID	Serial Number
Laptop Computer	Compaq Computer Corp.	2940	D.O.C.	V343BQH2D382
LAN PC Card	3COM	3C589C	DF63C589C	6CLIAB8BOO
Media Converter	Allied Telesyn Int.	AT-MC12T	None	S37K7272B

3.4 Description of Interface Cables

***EUT/Media converter/LAN PC Card**

Shielded	Unshielded	Flat	Round	Length	Ferrite
NO	YES	NO	YES	2 m	NO

EUT/Antenna

Shielded	Unshielded	Flat	Round	Length	Ferrite
YES	NO	NO	YES	2 m	NO

* Media Converter attaches directly to EUT.

ARRANGEMENT OF INTERFACE CABLES: All interface cables were positioned for worst case maximum emissions within the manner assumed to be a typical operation condition (please reference photographs).

3.5 Mode of Operation During Tests

EUT was exercised with manufacture's test software program "traffic". EUT was constantly transmitting during testing. EUT was tested at only one frequency as it is a one channel device.

3.6 Modifications Required for Compliance

The EUT required the following modifications during testing to bring the product into compliance:
1. None.

4. Antenna requirement

4.1 Regulation

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 the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

4.2 Result

The intentional radiator uses a standard SMA connector, however the intentional radiator is only installed by professionals and therefore not applicable to this requirement.

5. Conducted Emissions Tests

Test Requirement: FCC CFR47, Part 15C

Test Procedure: ANSI C63.4:1992

5.1 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Line Impedance Stabilization Network: EMCO 3825/2, Serial Number 9002-1601, Calibrated: 8 August 1997, Calibration due Date: 8 August 1998

5.2 Purpose

The purpose of this test is to evaluate the level of conducted noise the EUT imposes on the AC mains.

5.3 Test Procedures

For tabletop equipment, the EUT is placed on a 1 meter by 1.5 meters wide and 0.8 meter high nonconductive table that is placed above the groundplane. Floor standing equipment is placed directly on the groundplane. Any supplemental grounding mechanisms are connected, if appropriate. The EUT is connected to its associated peripherals, with any excess I/O cabling bundled to approximately 1 meter. The EUT is connected to a dedicated LISN and all peripherals are connected to a second separate LISN circuit. The LISNs are bonded to the groundplane.

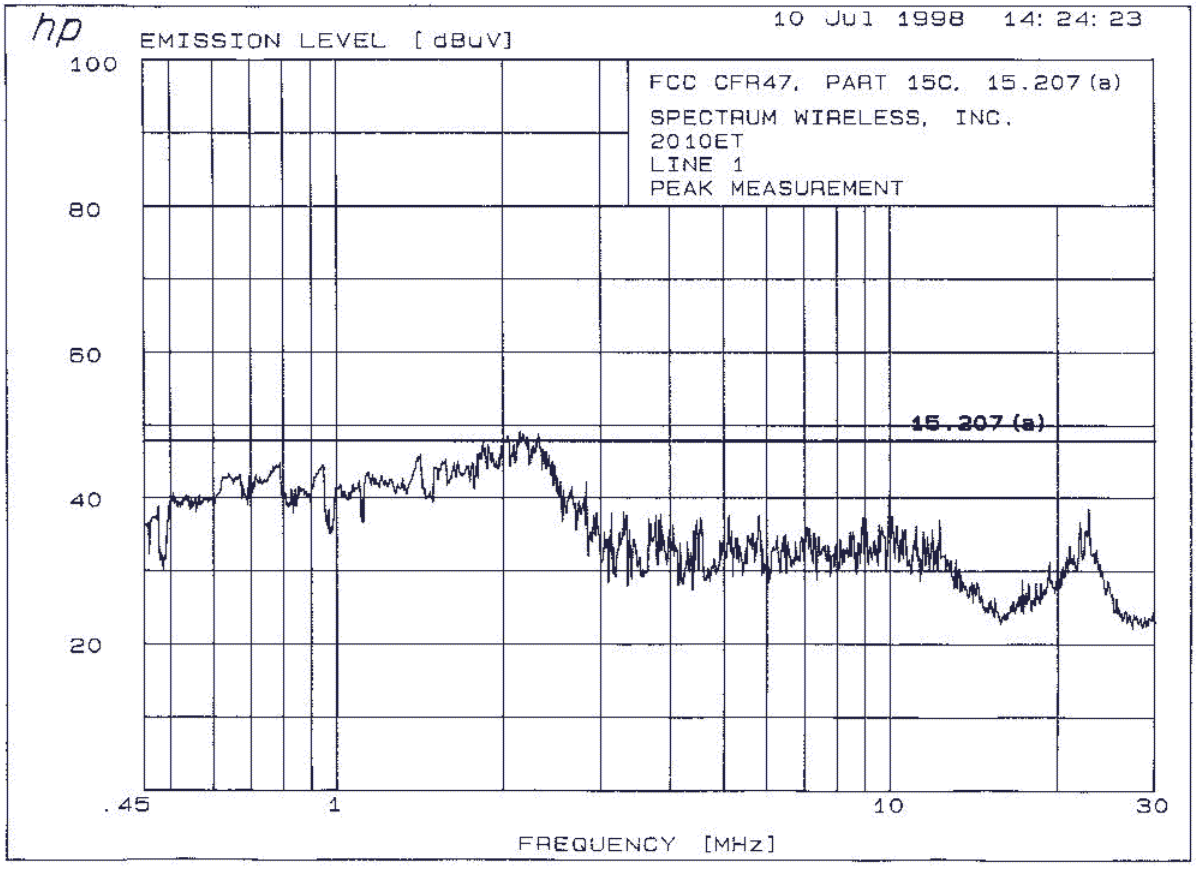
Preview tests are performed to determine the "worst case" mode of operation. With the EUT operating in "worst case" mode, final conducted measurements are taken. Conducted measurements are made on each current carrying conductor with respect to ground.

Conducted Emissions Test Characteristics	
Frequency range	0.45 MHz - 30.0 MHz
Test instrumentation resolution bandwidth	9 kHz
Lines Tested	Line 1/Line 2

5.4 Test Results

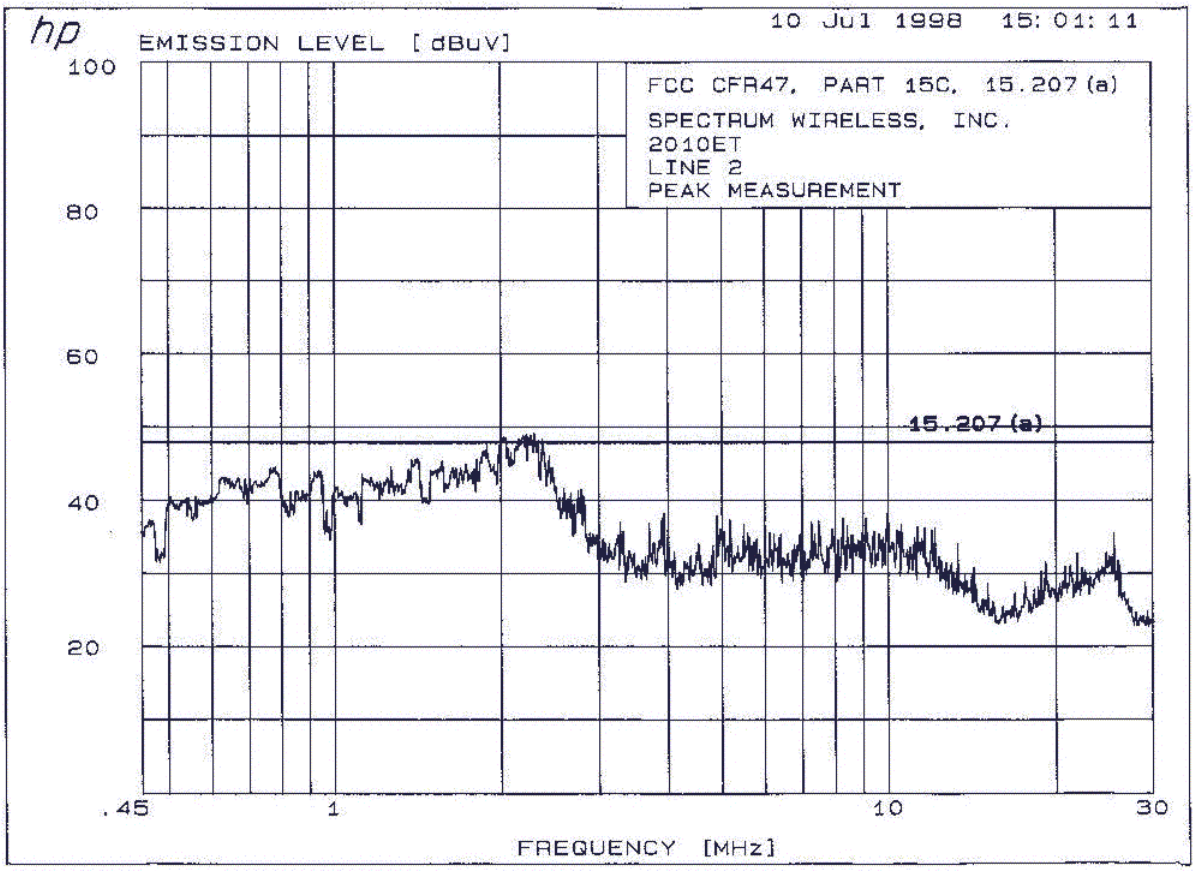
LINE 1
PEAK

PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	0.6401	43.2
2	0.7929	44.7
3	0.9456	44.4
4	1.1	42.3
5	1.421	45.9
6	1.578	45.3
7	1.659	45.0
8	1.797	45.9
9	1.843	47.5
10	1.882	47.4
11	2.046	48.5
12	2.152	49.1
13	2.321	48.9
14	2.482	44.6
15	2.827	42.1



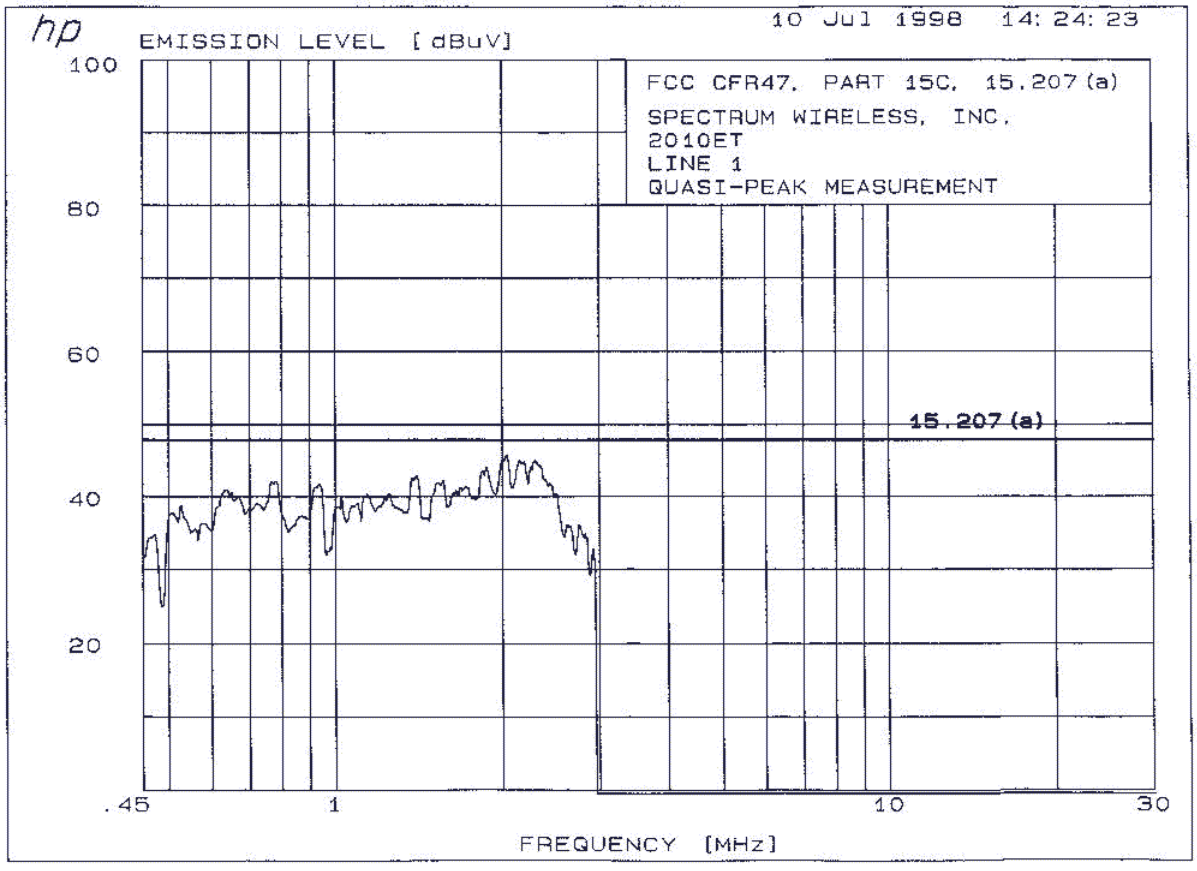
LINE 2
PEAK

PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	0.6295	43.1
2	0.7829	44.5
3	0.9377	44.0
4	1.123	43.6
5	1.268	44.6
6	1.379	45.6
7	1.571	45.4
8	1.73	44.9
9	1.89	47.5
10	2.029	48.6
11	2.225	48.9
12	2.301	49.1
13	2.38	48.4
14	2.451	46.0



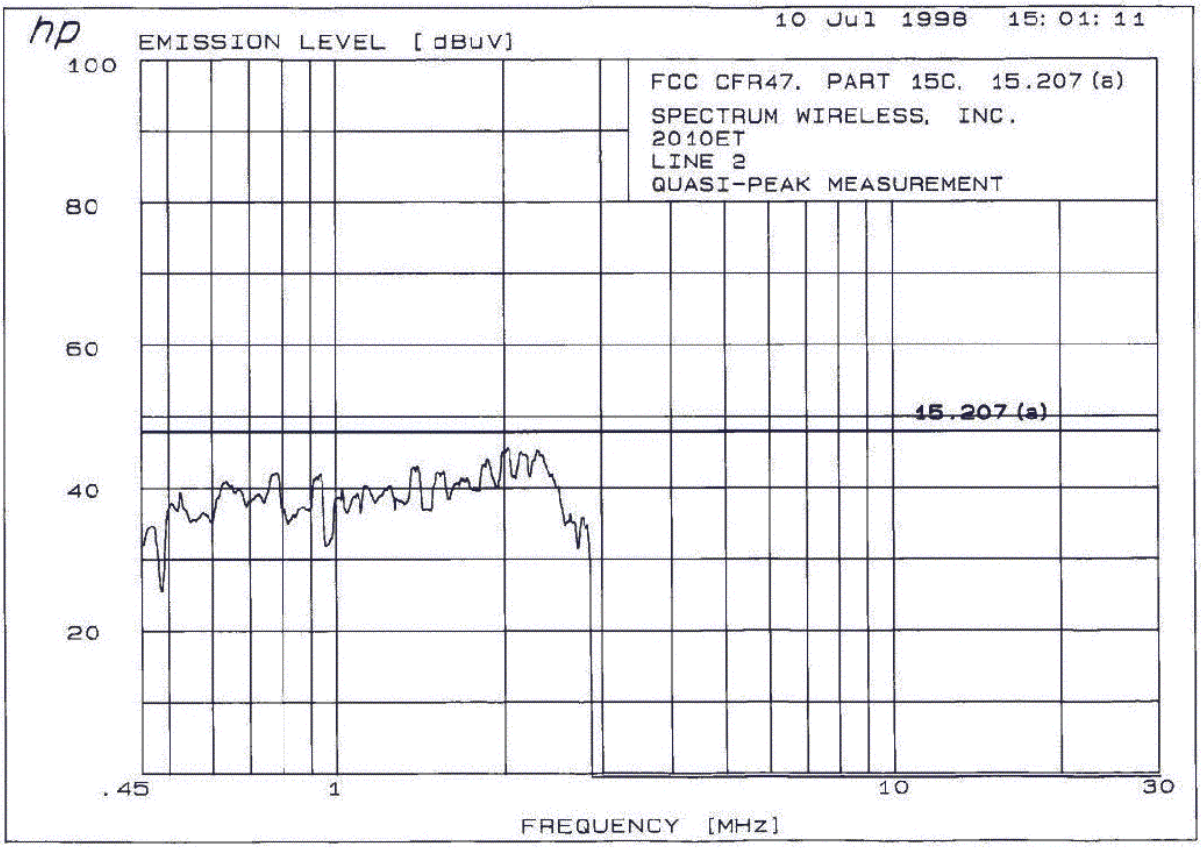
LINE 1
QUASI PEAK

PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	0.7797	42.1
2	1.403	42.9
3	1.564	42.2
4	1.874	44.1
5	2.038	45.7
6	2.152	45.1
7	2.301	45.1



LINE 2
QUASI PEAK

PEAK #	FREQ. (MHz)	AMPL (dBuV)
1	1.409	43.0
2	1.564	42.3
3	1.866	43.9
4	2.029	45.5
5	2.152	45.0
6	2.292	45.2



6. 6 dB Bandwidth

6.1 Regulation

15.247(a2) For direct sequence systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

6.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

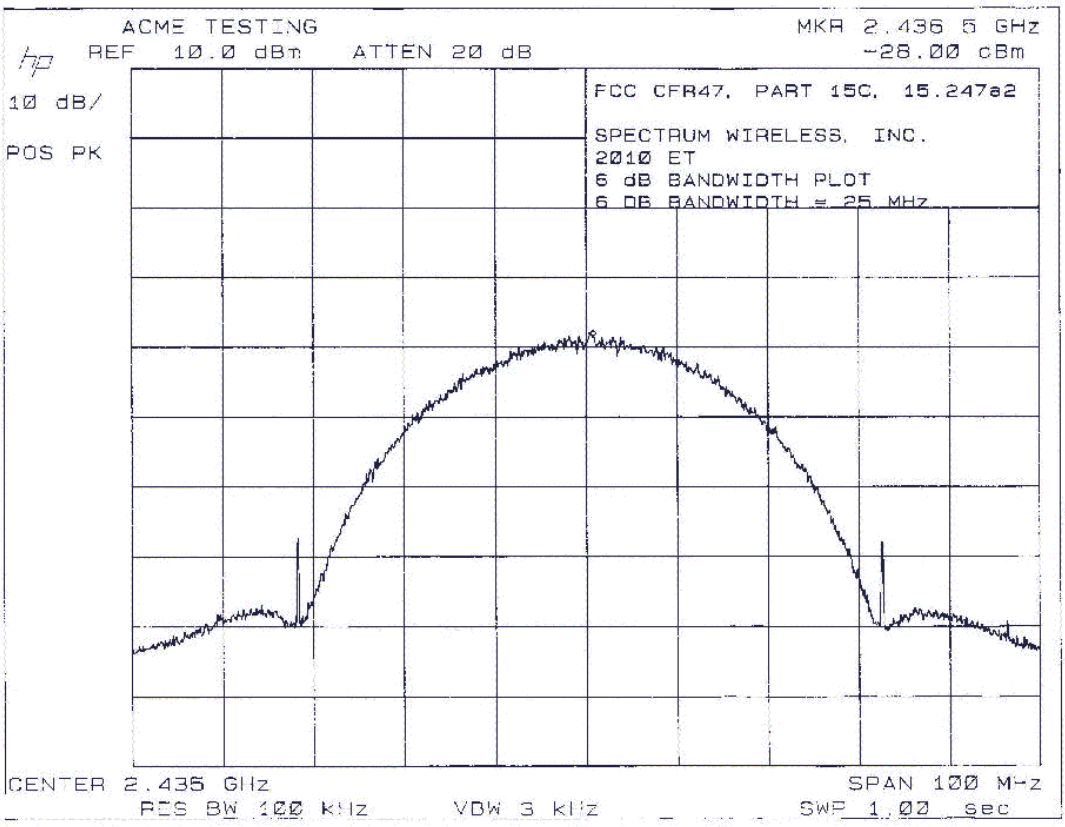
⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

6.3 Test Procedures

The RF output of the EUT is connected to the RF input port of the RF preselector through a 20 dB pad. The following measurements were made with a RBW = 100 kHz and VBW = 3KHz.

6.4 Test Results

The 6 dB bandwidth is 25 MHz.



7. Power Output

7.1 Regulation

15.247(b1) The maximum peak output power of the intentional radiator shall not exceed the following: For frequency hopping systems operating in the 2400-2483.5 MHz or 5725-5850 MHz band and for all direct sequence systems: 1 watt.

7.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

7.3 Test Procedures

The RF output of the EUT is connected to the RF input port of the RF preselector through a 20 dB pad. The following measurements were made with a RBW = 3 MHz and VBW = 3 MHz.

7.4 Test Results

Measured maximum Peak Envelope Power was 12.6 dBm. Manufacturer's published nominal power is 14 dBm.

.

8. Antenna gain requirements

8.1 Regulation

15.247(b3) Except as shown below, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the above stated values by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(i) Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(ii) 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.

(iii) Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

8.2 Result

The EUT can be supplied with three antennas:

1. A 15.9 dBi Yagi (Cushcraft Model # PC24115N)
2. A 15.4 dBi Omni (Comet Model # GP-24)
3. A 24.0 dBi Parabolic (Conifer Model # 26T-2400)

The maximum allowed ERP => 30 dBm (peak power) + 6 dBi (max antenna gain) = 36 dBm (EIRP).

For the EUT => 14 dBm (peak power) + 24 dBi (max antenna gain) – 2 dB (cable loss*) = 36 dBm (EIRP).

* The system is professionally installed and therefore the 2 dB cable loss is guaranteed by the professional installer.

9. Radio Frequency exposure

9.1 Regulation

15.247(b4) 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. *See* §1.1307(b)(1) of this Chapter.

9.2 Result

The intentional radiator operates at a maximum of 4 W EIRP with an external antenna that is normally mounted on a rooftop. According to table 1 of Supplement C to OET Bulletin, 65 no special instructions or warnings are necessary to ensure compliance.

10. Conducted Spurious Emissions

10.1 Regulation

15.247 (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

10.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

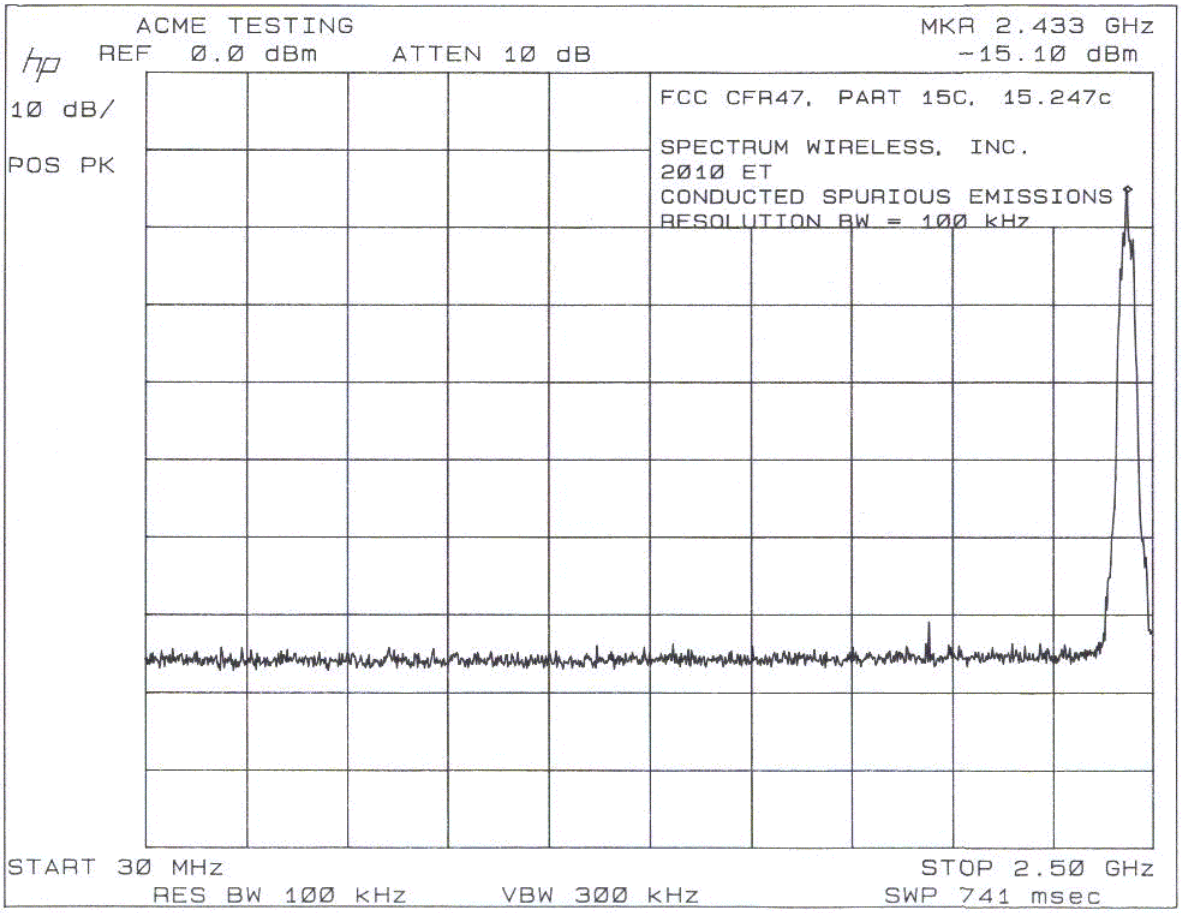
⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

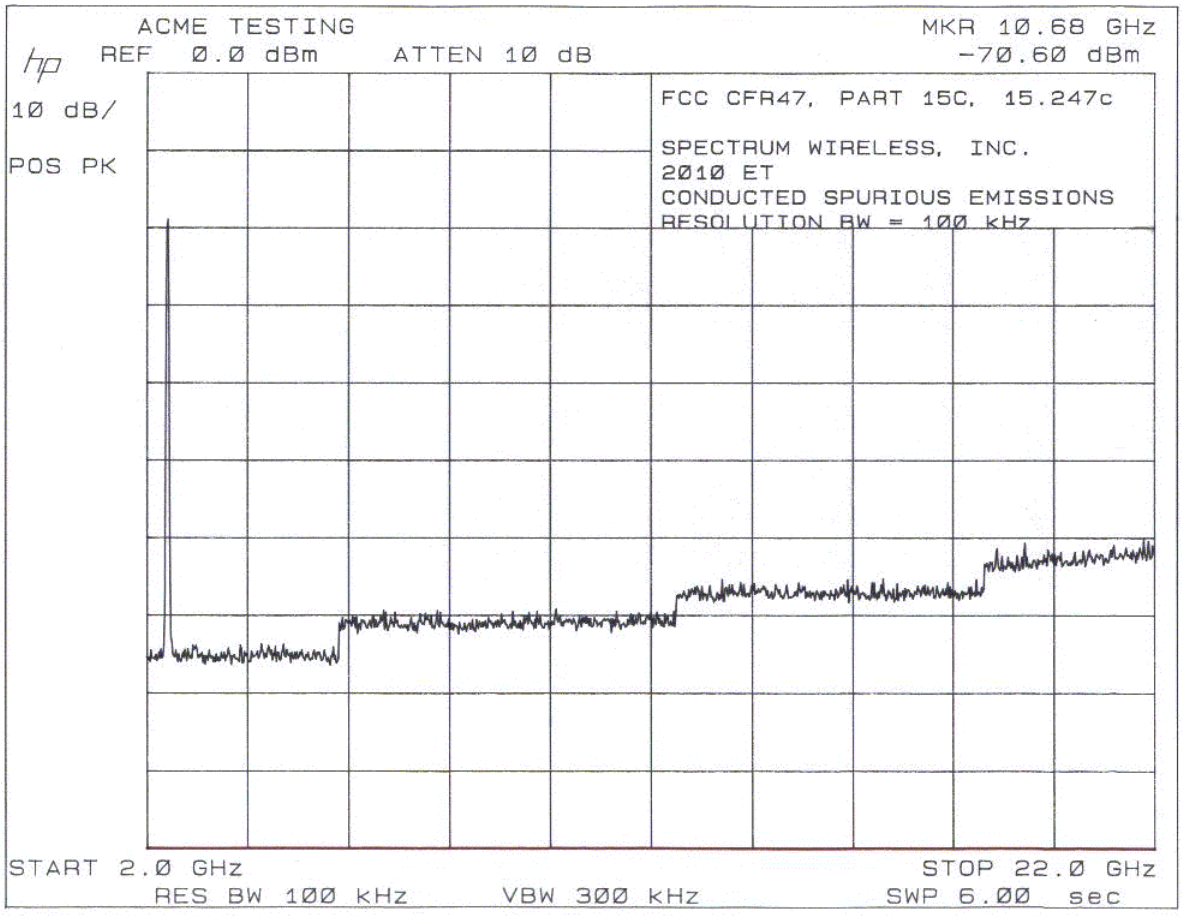
10.3 Test Procedures

The RF output of the EUT is connected to the RF input port of the RF preselector through a 20 dB pad. The following measurements were made with a RBW = 100 kHz and VBW = 300 kHz.

10.4 Test Results



(Results continued on next page)


ACME TESTING
MKR 10.68 GHz
REF 0.0 dBm
ATTEN 10 dB
-70.60 dBm
10 dB/
POS PK
FCC CFR47, PART 15C, 15.247c
SPECTRUM WIRELESS, INC.
2010 ET
CONDUCTED SPURIOUS EMISSIONS
RESOLUTION BW = 100 kHz
START 2.0 GHz
STOP 22.0 GHz
RES BW 100 kHz
VBW 300 kHz
SWP 6.00 sec

11. Radiated Spurious Emissions

11.1 Regulation

15.247 (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

11.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ Line Impedance Stabilization Network: EMCO 3825/2, Serial Number 9002-1601, Calibrated: 8 August 1997, Calibration due Date: 8 August 1998

⇒ Broadband Biconical Antenna (20 MHz to 200 MHz): EMCO 3110, Serial Number 1115, Calibrated: 1 July 1998, Calibration due Date: 1 July 1999

⇒ Broadband Log Periodic Antenna (200 MHz to 1000 MHz): EMCO 3146, Serial Number 2853, Calibrated: 1 July 1998, Calibration due Date: 1 July 1999

⇒ EUT Turntable Position Controller: EMCO 1061-3M 9003-1441, No Calibration Required

⇒ Antenna Mast: EMCO 1051 9002-1457, No Calibration Required

⇒ 2 GHz to 10 GHz Low Noise Preamplifier: Milliwave 593-2898, Serial Number 2494, Calibrated: 19 July 1997, Calibration due Date: 19 July 1998

11.3 Test Procedures

For tabletop equipment, the EUT is placed on a 1 meter by 1.5 meters wide and 0.8 meter high nonconductive table that sits on a flush mounted metal turntable. Floor standing equipment is placed directly on the flush mounted metal turntable. The EUT is connected to its associated peripherals with any excess I/O cabling bundled to approximately 1 meter.

Preview tests are performed to determine the "worst case" mode of operation. With the EUT operating in "worst case" mode, emissions from the unit are maximized by adjusting the polarization and height of the receive antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz - 24000 MHz **15.205 RESTRICTED BANDS ONLY**
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz (30 MHz - 1000 MHz) 1 MHz (1000 MHz - 24000 MHz)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/Horizontal

11.4 Test Results

PRODUCT EMISSIONS

No	EMISSION FREQUENCY MHz	SPEC LIMIT dBuV/m	MEASUREMENTS ABS	dLIM dB	MODE	POL	SITE HGT cm	AZM deg	CORR FACTOR dB
1	239.963	46.0	36.3	-9.7	PK	V	110	30	13 8
2	249.995	46.0	37.4	-8.6	PK	V	108	3	14.4
3	256.010	46.0	33.9	-12.1	PK	V	107	49	14.6
4	259.990	46.0	35.2	-10.8	PK	V	108	9	14.8
5	270.040	46.0	37.4	-8.6	PK	V	110	26	15.3
6	279.962	46.0	33.9	-12.2	PK	V	108	20	15.9

12. Peak Power Spectral Density

12.1 Regulation

For direct sequence 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.

12.2 Test Equipment

⇒ Spectrum Analyzer: Hewlett-Packard 8566B, Serial Number 2410A-00168, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

⇒ RF Preselector: Hewlett-Packard 85685, Serial Number 2648A-00519, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

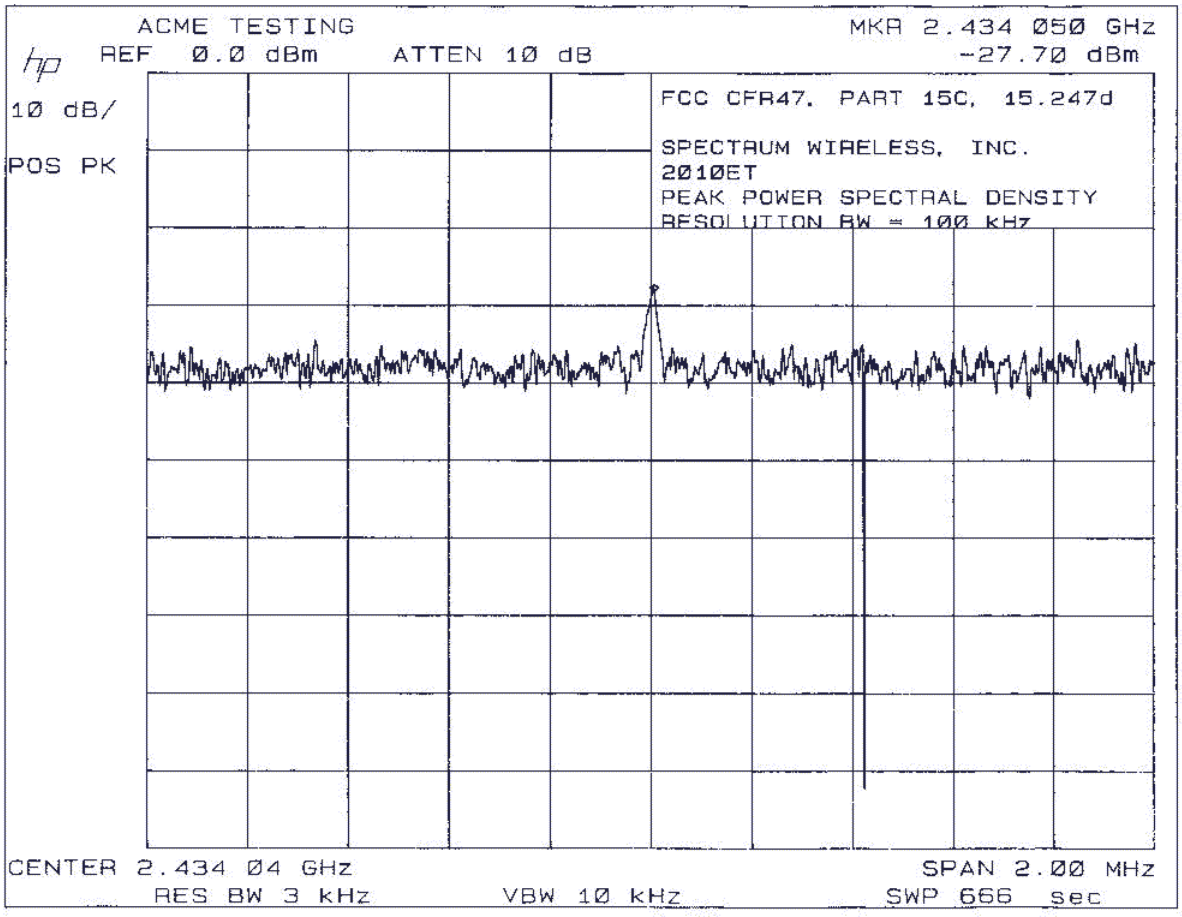
⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2043A-00327, Calibrated: 31 December 1997, Calibration due Date: 31 December 1998

12.3 Test Procedures

The RF output of the EUT is connected to the RF input port of the RF preselector through a 20 dB pad. The following measurements were made with a RBW = 3 kHz, VBW = 10 kHz and Sweep Time = 666 seconds.

12.4 Test Results

Maximum peak power spectral density is –7.7 dBm. Please note that in the "title block" of the below graph the line "resolution BW = 100 kHz" is incorrect.



13. Process gain requirements

13.1 Regulation

The processing gain of a direct sequence system shall be at least 10 dB. The processing gain represents the improvement to the received signal-to-noise ratio, after filtering to the information bandwidth, from the spreading/despreading function. The processing gain may be determined using one of the following methods:

(1) As measured at the demodulated output of the receiver: the ratio in dB of the signal-to-noise ratio with the system spreading code turned off to the signal-to-noise ratio with the system spreading code turned on.

(2) As measured using the CW jamming margin method: a signal generator is stepped in 50 kHz increments across the passband of the system, recording at each point the generator level required to produce the recommended Bit Error Rate (BER). This level is the jammer level. The output power of the intentional radiator is measured at the same point. The jammer to signal ratio (J/S) is then calculated, discarding the worst 20% of the J/S data points. The lowest remaining J/S ratio is used to calculate the processing gain as follows: Gp = (S/N)o + Mj + Lsys, where Gp = processing gain of the system, (S/N)o = signal-to-noise ratio required for the chosen BER, Mj = J/S ratio, and Lsys = system losses. Note that total losses in a system, including intentional radiator and receiver, should be assumed to be no more than 2 dB.

13.2 Result

The original designers of the product performed the process gain measurement. The process gain of the product exceeds 10 dB. Please refer to the attached PDF document for complete test procedures and test results.

14. Miscellaneous Comments and Notes

1. None.