FCC Part 15 Subpart C, Section 15.255 Test Report
for
SierraCom
on the
Fiber Connection™ 60GHz Microwave Radio
Model No.: 3260-0000
Serial No.: 11-3264-0000-2 & 12-3264-0000-1
FCC ID: PWL3260

Date of Report: November 9, 2001

Project #: 3004764
Dates of Test: September 4, 5, 6, 17-21, 2001
October 3, 4, 19, 2001

Lab Code 100270-0

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The results contained in this report were derived from measurements performed on the identified test samples. Any implied performance of other samples on this report is dependent on the representative of the samples tested.

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1.0 Summary of Tests

This report is designed to show compliance with FCC Part 15 Subpart C, Section 15.255. The test procedures described in American National Standards Institute C63.4:1992 at frequencies below 40GHz and Section 15.255 (40 – 200GHz) were employed. A description of the product and operating configurations, the various provisions of the rules, the methods for determining compliance and a detailed summary of the results are included within this test report.

Measurements were made to determine compliance with FCC Part 15.255 as follows:

- 1.1310 to verify compliance with radiation exposure limits
- 15.255(b) to determine peak power density
- 15.255(c) to determine power density above 40GHz compared with a limit of 90pW/cm^2
- 15.255(d) to verify that only spurious signals are present in the 59 – 59.05GHz band
- 15.255(e) to determine maximum power transmitted in the range of 59-64GHz. The limit is based on the 6dB bandwidth of the intentional signal
- 15.255(f) to verify compliance with frequency stability limits

Radios under test were:

s/n 11-3264-0000-2
s/n 12-3264-0000-1

Summary of tests

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Radiation Exposure Requirement	1.1310	Pass	10
Antenna Requirement	15.203	Pass, Professional Install	5
AC Conducted Emission	15.207	Pass	11
Peak Power Density	15.255 (b) (1)	Pass	16
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Power Density outside band	15.255 (c)(1)	Pass	21
Radiated Emission From Digital Module Below 40GHz	15.255 (c)(2) and 15.209	Pass	18
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Spurious Emission 59.0 – 59.05GHz	15.255 (d)	Pass	24
6 dB Bandwidth*	15.255 (e) (1)	Pass	24
Peak Power	15.255 (e) (2)	Pass	25
Frequency Stability	15.255(f)	Pass	26

2.0 General Description

2.1 Product Description

The EUT Model No.: 3260-0000 is an intentional transmitter used for wireless point-to-point communications operating in the frequency range: 59GHz-64GHz. The Fiber Connection™ Radio Product is designed to carry Synchronous based (SONET:OC-3 or OC-12) data traffic. The radio uses Binary Phase Shift Keying (BPSK) modulation scheme to carry traffic of 155 Mb/sec or 622 Mb/sec. It is designed to support a variety of short-range applications (distances up to one km) and to operate in environments where frequency congestion is problematic. The signal absorption by oxygen gas (O_2) and the use of the narrow beam-width antennas allow for frequency re-use factor to one, thereby eliminating the need for costly frequency coordinations.

A pre-production version of the sample was received on September 4, 2001 in good condition.

Overview of the Fiber Connection™ Microwave Radio

Applicant	SierraCom
Trade Name & Model No.	Fiber Connection™ 60 GHz Microwave Radio
FCC Identifier	Not Available
Type of Transmission	Synchronous based (SONET: OC-3 or OC-12) data traffic
Maximum RF Output (dBm) *	+10
Frequency Range (GHz)	59GHz-64GHz
Number of Channel(s)	2 Channels (Lowband and Highband)
Antenna(s) & Gain, dBi	41- Parabolic
Antenna Requirement	[ ] The EUT uses a permanently connected antenna. [✓] The antenna is affixed to the EUT using a unique connector which allows for replacement of a broken antenna, but DOES NOT use a standard antenna jack or electrical connector. [✓] The EUT requires professional installation (attach supporting documentation if using this option).
Manufacturer name & address	SierraCom 99 South Street Hopkinton, MA 01748

* The total output power depends on the gain of the antenna used.

2.2 Test Methodology

Both AC mains line-conducted and radiated emissions measurements were performed according to the procedures in ANSI C63.4 (1992). Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the Tables in this Application. All other measurements were made in accordance with the procedures in part 2 of CFR 47.

2.3 Test Facility

Site 1C (Top Site) is a 3m and 10m sheltered emissions measurement range located in a light commercial environment in Boxborough, Massachusetts. It meets the technical requirements of ANSI C63.4-1992 and CISPR 22:1993/EN 55022:1994 for radiated and conducted emission measurements. The shelter structure is entirely fiberglass and plastic, with outside dimensions of 33 ft x 57 ft. The structure resembles a quonset hut with a center ceiling height of 16.5 ft.

The testing floor is covered by a galvanized sheet metal ground plane that is earth-grounded via copper rods around the perimeter of the site. The joints between individual metal sheets are bridged with a 2 inch wide metal strips to provide low RF impedance contact throughout. The sheets are screwed in place with stainless steel, round-head screws every three inches. Site illumination and HVAC are provided from beneath the ground reference plane through flush entry ports, the port covers are electrically bonded to the ground plane.

A flush metal turntable with 12 ft. diameter and 5000 lb. load capacity is provided for floor-standing equipment. A wooden table 80 cm high is used for table-top equipment. The turntable is electrically connected to the ground plane with three copper straps. The straps are connected to the turntable at the center of it with ground braid. The copper strap is directly connected to the ground plane at the edges of the turntable. The turntable is located on the south end of the structure and the antennas are mounted 3 and 10 meters away to the north. The antenna mast is a non-conductive with remote control of antenna height and polarization. The antenna height is adjustable from 1 to 4 meters.

All final radiated emission measurements are performed with the testing personnel and measurement equipment located below the ground reference plane. The site has a full basement underneath the turntable where support equipment may be remotely located. Operation of the antenna, turntable and equipment under test is controlled by remote controls that manipulate the antenna height and polarization and with a turntable control. Test personnel are located below the ellipse when measurements are performed, however the site maintains the ability of having personnel manipulate cables while monitoring test equipment. Ambient radiated emissions are 6 dB or more below the relevant FCC emission limits.

AC mains power is brought to the equipment under test through a power line filter, to remove ambient conducted noise. 50 Hz (240 VAC single phase), 60 Hz power (120 VAC single phase, 208 VAC three phase), and 60 Hz (480 VAC three phase) are available.

3.0 System Test Configuration

3.1 Support Equipment, Cables, and Antenna List

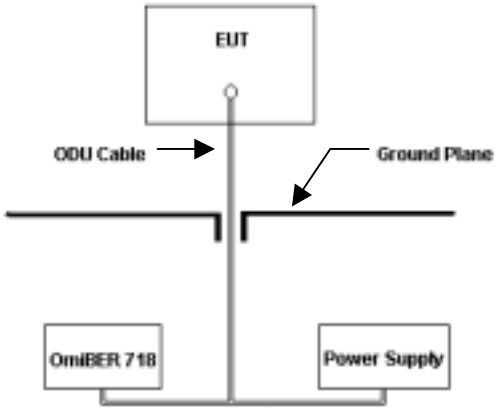
Description:	Model #:	Serial #:	FCC ID:
BERT Generator (OmiBER 718)	37718A	GB00001661	Not Applicable
Variable 48VDC Power Supply	6303D	PS-243	Not Applicable

Cables:

Description:	Shield:	Connector:	Length (Meters):	Quantity:
AC Mains	None	Plastic	2	1
ODU interface *	Foil	Plastic	15	1

*The ODU-IDU cable is constructed of multiple category 5 twisted pairs having a characteristic impedance of 100ohms ±15%, #16 gauge wire for the power and chassis ground and the single mode optic fibers for OC-3 or OC-12 signals. The bundled pairs are wrapped in a foil shield with internal drain wire and covered with a wire braid and insulating jacket. The maximum recommended cable length is 150m.

3.2 Block Diagram of Test Setup



3.3 Justification

For emission testing, the Equipment Under Test (EUT) was configured for testing in a typical fashion (as a customer would normally use it), powered by 48Vdc through the ODU/IDU cable. Random data was sent from the OmniBer to the EUT via fiber optic cables through the ODU/IDU cable. (With the direct connection to the OmniBer, the IDU was not required for this test.) The EUT is wired to transmit full power. All support equipment was remotely located. The EUT was placed in the center of the turntable.

During testing, all cables were manipulated to produce worst case emissions. The signal is maximized through 360 degree rotation of the EUT and variation of the antenna height and polarization. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

Requirements of power density are based on measurements made with an antenna to EUT distance of 3m. At this distance the receive antenna is in the near field of the transmitter according to the formulae in FCC OET Bulletin 65 (OET65). (A discussion of the calculation of power density in the near field and in the transition region is presented in Appendix A.) Thus the power density can not be determined from the measured electric field based on Z_0. Manual positioning of the EUT and receive antenna was performed to maximize fundamental emissions.

3.4 Software Exercise Program

Random data was generated in the OmniBer and used as input to the EUT.

3.5 Mode of operation during test

Care was taken to ensure proper power supply voltages during testing. The EUT was set to transmit continuously in either OC3 (low band) or OC12 (high band) format.

3.6 Modifications required for Compliance

No modifications were made by Intertek Testing Services during compliance testing (Please note that this does not include changes made specifically by SierraCom prior to compliance testing).

Measurement Results

4.1 Radiation Exposure (1.1310)

Requirement

The limits for maximum permissible exposure (MPE) are presented in Table 1 of 47 CFR 1.1310. In the frequency range of 1500 – 100,000 MHz the MPE is 5mW/cm^2 averaged over 6 minutes for occupational exposure, and 1mW/cm^2 averaged over 30 minutes for uncontrolled exposure.

Procedure

Maximum permissible exposure was calculated using the equations (1, 11-17) of FCC Bulletin OET-65

Results

The power density calculated at multiple distances complies with the requirements of Section 1.1310. The detailed analysis is contained in Appendix A. Results are summarized below

Distance from antenna	result	Limit (uncontrolled)
Surface of antenna	0.038mW/cm^2	1mW/cm^2
Near field (<439cm)	0.014mW/cm^2	1mW/cm^2
Far field (>10.55m)	4.65µW/cm^2	1mW/cm^2

4.2 Antenna Requirement (15.203)

Requirement

Intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used.

Procedure

The product documentation is reviewed to determine compliance

Result

The EUT is required to be installed only by a professional. No access to the antenna is possible by other than the professional installer.

4.3 AC Line Conducted Emission (15.207)

Requirement

For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the power line at any frequency within the band of 450kHz – 30MHz shall not exceed 250µV.

Procedure

Conducted emission measurements are performed in accordance with ANSI C63.4-1992. A Line Impedance Stabilization Network (LISN) or Artificial Mains Network (AMN) is placed in the mains power line of the EUT. It is then bonded to the ground reference plane. A removable vertical ground plane (2 meter X 2 meter area) is used for line-conducted measurements for table top equipment. The vertical ground plane is electrically connected to the reference ground plane.

The voltages conducted back onto the power line is measured using a spectrum analyzer connected to the measurement port of the LISN.

Conducted Emission Sample Calculation

Measurements on the spectrum analyzer are in units of dBm. As this is referenced to a 50ohm input, the corresponding voltage in dBµV is determined as:

$dB\mu V = dBm + 107 + \text{cable loss}$
$dB\mu V = 20*\log_{10}(\mu V)$
$\mu V = \text{antilog}(dB\mu V/20)$

This calculated result is then compared to the limit. (Cable loss at these frequencies is negligible.)

Conducted Emissions Limits, Section 15.107(a)

Frequency (MHz)	Class B (µV)	Class B (dBµV)
0.45 - 1.705	250	48
1.705 to 30.000	250	48

Test Result

The EUT complies with the requirement of 15.207. Table 1 presents the results for s/n 12 (OC3 – low band). Table 2 presents the results for s/n 11 (OC12 – high band).

Conducted emission/Interference

Table 1: s/n 12 OC3 - low band

Company:	Sierracom		Tested by:	Kouma Sinn	
Model:	3260-0000		Location:	Site 1C	
Serial No.:	12		EMI Receiver:	HP 8546A	
Project No.:	3004764		Detector:	Quasi-peak/Average	
Date:	09/07/01		System Loss:	LISN Calibration + 10 meter RG58	
Standard:	FCC Part 15.255		Limiter:	no	
Class:	None	Group: None	Supply Voltage:	120VAC, 60 Hz	
LISN:	LISN10	20 dB Pad: DS12	Test Frequency:	150kHz to 30MHz	
Notes:	Operation mode - OC3, Lowband Radio				
System Loss:	Includes the Cable and LISN loss.				

	Reading	Reading	Attenuator	System	Quasi-Peak			
Frequency	Side A	Side B	Factor	Loss	Net	Limit	Margin	
MHz	dB(uV)	dB(uV)	dB	dB	dB(uV)	dB(uV)	dB	
0.512	21.9	19.4	10.0	2.0	33.9	48.0	-14.1	
0.623	13.4	11.9	10.0	2.0	25.4	48.0	-22.6	
3.330	1.6	-1.0	10.0	2.0	13.6	48.0	-34.4	
4.856	2.6	-1.0	10.0	2.0	14.6	48.0	-33.4	
15.190	-2.7	-2.7	10.0	2.0	9.3	48.0	-38.7	NF
29.000	-3.0	-3.0	10.0	2.0	9.0	48.0	-39.0	NF

	Reading	Reading	Attenuator	System	Average			
Frequency	Side A	Side B	Factor	Loss	Net	Limit	Margin	
MHz	dB(uV)	dB(uV)	dB	dB	dB(uV)	dB(uV)	dB	
0.512	-4.8	-6.7	10.0	2.0	7.2	no limit	Not applicable	
0.623	-8.3	-8.5	10.0	2.0	3.7	no limit	Not applicable	
3.330	-5.1	-7.3	10.0	2.0	6.9	no limit	Not applicable	
4.856	-6.2	-7.7	10.0	2.0	5.8	no limit	Not applicable	
15.190	-9.4	-9.4	10.0	2.0	2.6	no limit	Not applicable	NF
29.000	-9.4	-9.4	10.0	2.0	2.6	no limit	Not applicable	NF

Conducted Emissions / Interference

Table 2: s/n11 OC12 - high band

Company:	Sierracom		Tested by:	Kouma Sinn	
Model:	3260-0000		Location:	Site 1C	
Serial No.:	11		EMI Receiver:	HP 8546A	
Project No.:	3004764		Detector:	Quasi-peak/Average	
Date:	09/07/01		System Loss:	LISN Calibration + 10 meter RG58	
Standard:	FCC Part 15.255		Limiter:	no	
Class:	None	Group: None	Supply Voltage:	120VAC, 60 Hz	
LISN:	LISN10	20 dB Pad: DS12	Test Frequency:	150kHz to 30MHz	
Notes:	Operation mode - OC12, Highband Radio				
System Loss:	Includes the Cable and LISN loss.				

NF - Noise floor readings

	Reading	Reading	Attenuator	System	Quasi-Peak			
Frequency	Side A	Side B	Factor	Loss	Net	Limit	Margin	
MHz	dB(uV)	dB(uV)	dB	dB	dB(uV)	dB(uV)	dB	
0.512	21.9	19.4	10.0	2.0	33.9	48.0	-14.1	
0.623	13.4	11.9	10.0	2.0	25.4	48.0	-22.6	
3.330	1.6	-1.0	10.0	2.0	13.6	48.0	-34.4	
4.856	2.6	-1.0	10.0	2.0	14.6	48.0	-33.4	
15.190	-2.7	-2.7	10.0	2.0	9.3	48.0	-38.7	NF
29.000	-3.0	-3.0	10.0	2.0	9.0	48.0	-39.0	NF

	Reading	Reading	Attenuator	System	Average			
Frequency	Side A	Side B	Factor	Loss	Net	Limit	Margin	
MHz	dB(uV)	dB(uV)	dB	dB	dB(uV)	dB(uV)	dB	
0.512	-4.8	-6.7	10.0	2.0	7.2	no limit	not applicable	
0.623	-8.3	-8.5	10.0	2.0	3.7	no limit	not applicable	
3.330	-5.1	-7.3	10.0	2.0	6.9	no limit	not applicable	
4.856	-6.2	-7.7	10.0	2.0	5.8	no limit	not applicable	
15.190	-9.4	-9.4	10.0	2.0	2.6	no limit	not applicable	NF
29.000	-9.4	-9.4	10.0	2.0	2.6	no limit	not applicable	NF

Configuration Photograph

Configuration Photograph (Continued)

4.4 Peak Power Density (15.255(b)(1))

Requirement:

The peak power density of any emission from the radiating structure shall not exceed 18 $\mu W/cm^2$ at a distance of 3 meters.

Procedure:

Electric field measurements were made at multiple antenna to EUT distances. Initial data was taken at the specified measurement distance of 3m. Additional measurements in the frequency range of 59 – 64GHz were made at distances of 6m and 12m. The intent of multiple test distances was to validate the power densities measured in the far field, transition region and near field. A data acquisition program (TILE) was used to obtain data from a Tektronix 2784 spectrum analyzer (SA). The program acquired 1000 points of data for each SA sweep. The SA made measurements with resolution bandwidth (RBW) of 10MHz and video bandwidth (VBW) of 7MHz (maximum for SA). Power density using the far field equation was determined for each data point (frequency).

The data was then analyzed using Excel. A piecewise sum of the values was calculated. This was considered to be representative of peak power density. The frequency span was set to 5GHz (59-64GHz) resulting in a difference between each frequency sample of 5MHz. With the RBW set to 10MHz, this represents a possible over-sampling of the data of a factor of two. With the RBW representing a 6dB bandwidth, this effect is mitigated, but still presents conservative results.

Result:

As the spectrum analyzer measurement has a finite noise floor, the frequencies determined by levels approximately 2dB above the average noise floor were used as the low and high frequency bounds (61.5 – 63.8GHz for s/n 11; 59.0 – 61.3GHz for s/n 12) of the summation.

Near field (3m) power density with modulation on was calculated as described above. Measurements were then made with modulation off. As an example, for s/n 11, with no modulation, the 3m measurement showed a relative (assume far field conditions in the near field) power density of 9.09$\mu W/cm^2$ When modulated the relative power density was 9.13$\mu W/cm^2$. This confirmed that the total transmitted power was approximately the same in either case.

Data taken at multiple distances showed that the measurements taken at three meters were not useable for direct calculation of power density because they were in the near field. Final data was measured at 12m (past the far-field boundary) and scaled to a 3m requirement distance. Using equation 19 of Appendix A, the scaling factor at 60.25GHz (s/n 12) is 4.7dB. At 62.75GHz, the factor is 4.3dB.

The power density measured at 12m was 1.3$\mu W/cm^2$ for s/n 11, calculated as described above. Using the scaling factors above , the predicted 3m field was 3.2$\mu W/cm^2$. As shown in the plots of Appendix C, the 12m field of s/n 12 was consistently ~2dB higher than that of s/n 11. Using the distance scaling factor, this results in a 3m power density of 5.6 $\mu W/cm^2$ Both radios are thus shown to comply with the 18 $\mu W/cm^2$ requirement of 15.255(b).

Radio	Measured 12m Power Density	Distance Correction factor	3m Limit (peak)	3m Corrected Power Density
S/n 11-3264-0000-2	1.2µW/cm^2	4.3dB	18µW/cm^2	3.22µW/cm^2
S/n 12-3264-0000-1	1.9 µW/cm^2	4.3dB	18µW/cm^2	5.6µW/cm^2

4.5 Average Power Density (15.255(b)(1))

Requirement:

The average power density of any emission from the radiating structure shall not exceed 9µW/cm^2 at a distance of 3 meters.

Procedure:

The procedures are the same as those for Peak Power Density (section 4.4).

Result:

The average power density is dependent on the EUT duty cycle discussed in 15.35(c) (DC = On time/100ms) The EUT operates at a duty cycle of 100%. There is, therefore, no averaging that can be considered. The measured peak power density is compared to the average limit.

Radio	Measured 12m Power Density	Distance Correction factor	3m Limit (average)	3m Corrected Power Density
S/n 11-3264-0000-2	1.2µW/cm^2	4.3dB	9µW/cm^2	3.22µW/cm^2
S/n 12-3264-0000-1	1.9 µW/cm^2	4.3dB	9µW/cm^2	5.6µW/cm^2

4.6 Spurious emissions outside 59 – 64GHz band (15.255(c)(1))

Requirement

All emissions outside the frequency band 59 – 64GHz shall be limited to spurious emissions.

Procedure

Determination of emissions outside of the specified band are made based on data taken in sections 4.4, 4.8, 4.9 herein.

Results

For either radio (low band; high band) only spurious emissions exist outside the specified band of 59 – 64GHz.

4.7 Radiated emissions from digital module below 40GHz (15.255(c)(2))

Requirement:

All radiated spurious emissions below 40GHz shall not exceed the general limits in 15.209 as specified in 15.255(c)(2).

30 – 88 MHz	40 dBμV/m
88 – 216	44
216 – 960	46
960 – 40,000	54

Procedure:

Measurements are made according to the procedures of ANSI C63.4-1992. The radiated spurious emissions were measured at 3 meters with modulation turned on. Measurements at 6m and 12m were not necessary because the requirement is electric field (not power density) at a fixed distance. The spectrum analyzer's resolution bandwidth was set to 120kHz for frequency below 1000MHz and 1MHz for frequency above 1000MHz up to 40GHz.

The EUT was placed on an 80cm high platform on a turntable. The EUT was configured and operated as described in Section 3 herein. The turntable was rotated, and the measurement antenna was adjusted from 1 to 4m to maximize all emissions.

Sample 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
where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows:

FS = RR + LF
where FS = Field Strength in dBμV/m
RR = RA - AG in dBμV
LF = CF + AF in dB

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV AF = 7.4 dB

RR = 23.0 dBµV CF = 1.6 dB
LF = 9.0 dB AG = 29.0 dB
FS = RR + LF FS = 23 + 9 = 32 dBµV/m
Level in µV/m = Common Antilogarithm [(32 dBµV/m)/20] = 39.8 µV/m

Result:

The EUT complies with the requirement of 15.209. Table 1 presents the results for s/n 12 (OC3 – lowband). Table 2 presents the results for s/n 11 (OC12 – highband).

Radiated Emission/Interference

Table 1: s/n 12 OC3 - low band

		Company:	SierraCom			Tested by:	Vathana Ven			
		Model:	3260-0000			Location:	Site 1C			
		Serial:	12			Spectrum Analyzer:	HP 8546A/Tektronix			
		Job No.:	3004764			Detector:	Quasi/Average			
		Date:	09/05/01			Antenna:	LOG1/HORN1/EMCO3116			
		Standard:	FCC15			PreAmp:	PRE8 Frequency above 1GHz			
		Class:	B	Group:	None	Cable(s):	1C, 1MPRIME_MAR01	0		
		Notes:	30 Mhz-40 Ghz			Distance:	3	meters		

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
H	680.000	17.2	20.2	4.7	0.0	0.0	42.1	46.0	-3.9
H	600.000	14.4	19.8	4.3	0.0	0.0	38.5	46.0	-7.5
H	440.000	6.0	17.1	3.7	0.0	0.0	26.7	46.0	-19.3
V	120.000	12.0	6.8	1.8	0.0	0.0	20.6	43.5	-22.9
H	183.700	12.6	9.5	2.2	0.0	0.0	24.4	43.5	-19.1
H	199.400	23.7	10.8	2.3	0.0	0.0	36.8	43.5	-6.7
H	209.900	20.7	11.4	2.4	0.0	0.0	34.4	43.5	-9.1
H	257.300	13.3	13.0	2.6	0.0	0.0	28.9	46.0	-17.1
H	320.000	16.9	14.4	3.0	0.0	0.0	34.2	46.0	-11.8
H	400.000	8.0	15.6	3.4	0.0	0.0	27.0	46.0	-19.0
H	720.000	10.0	20.6	4.9	0.0	0.0	35.5	46.0	-10.5

Radiated Emissions / Interference

Table 2: s/n 11 OC12 - high band

Company:	SierraCom				Tested by:	Vathana Ven			
Model:	3260-0000				Location:	Site 1C			
Project No.:	3004764				Detector:	HP 8546A			
Serial No.:	11								
Date:	09/04/01				Antenna:	LOG1 8-7-01 V3			
Standard:	FCC15				PreAmp:	None			
Class:	B	Group:	None		Cable(s):	1C, 3MPRIME_MAR01	0		
Notes:	30 Mhz-40Ghz				Distance:	3	meters		

Abbreviations: nb - narrow band, bb - broadband, pk - peak measurement

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
Unit Operating Condition: OC12 mode , Modulating , High band unit, 62.75 Ghz									
H	680.000	17.2	20.2	3.3	0.0	0.0	40.7	46.0	-5.3
H	600.000	14.4	19.8	3.2	0.0	0.0	37.4	46.0	-8.6
H	440.000	6.0	17.1	2.9	0.0	0.0	26.0	46.0	-20.0
V	120.000	9.0	6.8	1.3	0.0	0.0	17.1	43.5	-26.4
V	183.700	9.0	9.5	1.7	0.0	0.0	20.2	43.5	-23.3
H	199.400	24.1	10.8	1.8	0.0	0.0	36.6	43.5	-6.9
H	209.900	22.5	11.4	1.8	0.0	0.0	35.7	43.5	-7.8
H	257.300	13.0	13.0	2.1	0.0	0.0	28.2	46.0	-17.8
H	320.000	16.9	14.4	2.3	0.0	0.0	33.6	46.0	-12.5
H	400.000	8.0	15.6	2.9	0.0	0.0	26.5	46.0	-19.5
H	720.000	10.0	20.6	3.5	0.0	0.0	34.1	46.0	-11.9

Test equipment used from 1 Ghz to 40 Ghz:

PRE8, Horn 1, EMCO Horn 3116, Tektronic Spectrum Analyzer

4.8 Radiated emissions between 40GHz and 200GHz (15.255(c)(3))

Requirement:

Any radiated emissions between 40GHz and 200GHz shall not exceed 90 pW/cm^2 at a distance of 3 meters.

Procedure:

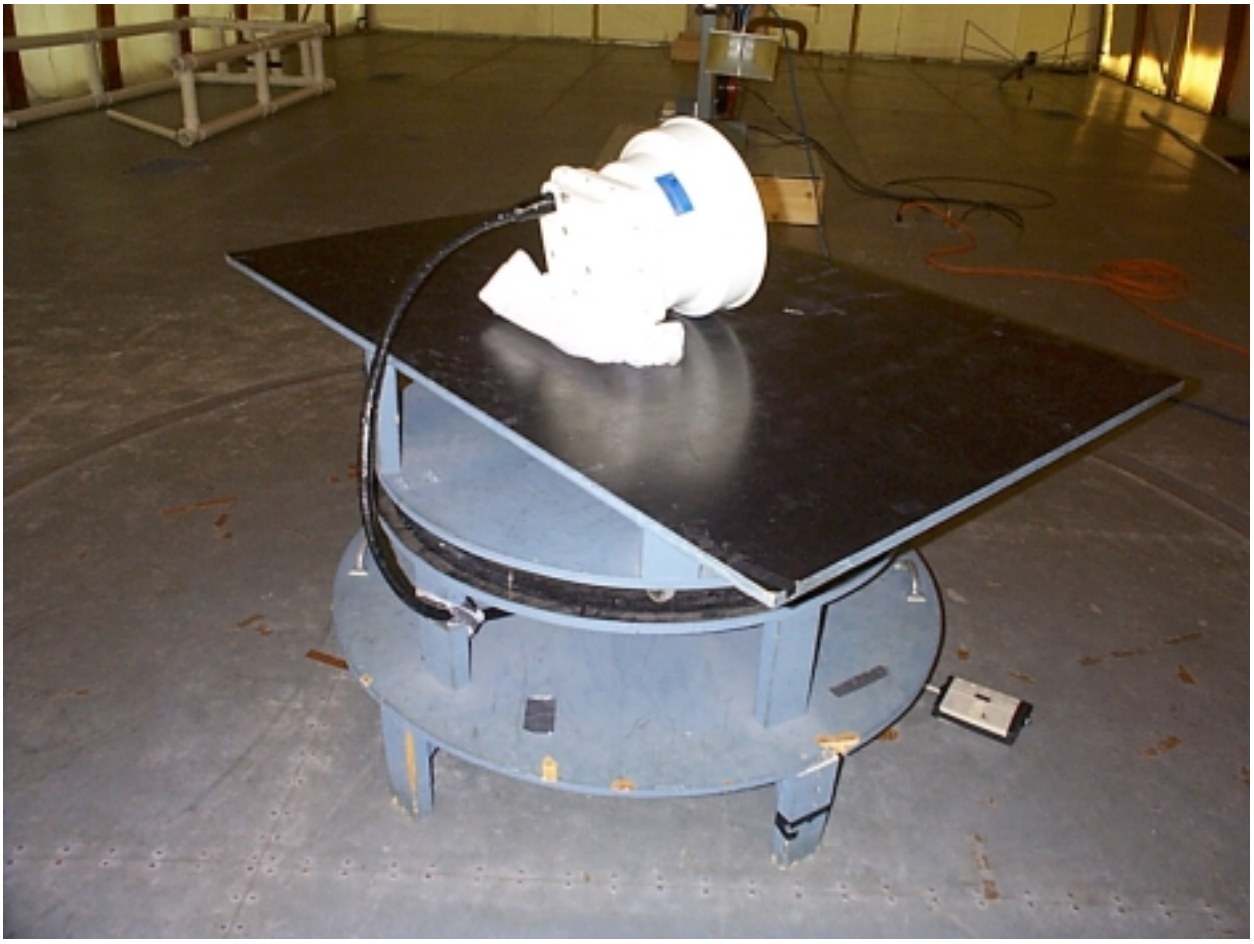
Electric field measurements were made at multiple antenna to EUT distances. Data above 40GHz was taken at the specified measurement distance of 3m. A data acquisition program (TILE) was used to obtain data from a Tektronix 2784 spectrum analyzer (SA). The program acquired 1000 points of data for each SA sweep. The SA made measurements with resolution bandwidth (RBW) of 10MHz and video bandwidth (VBW) of 7MHz (maximum for SA). The data was then analyzed using Excel.

Result:

There were no spurious E-field emissions detected > 40 GHz for either radio. Therefore no power density calculations or multiple measurement distances were necessary. Both radios comply with the requirement for spurious emissions less than 9pW/cm^2.

Configuration Photograph

Configuration Photograph (Continued)



4.9 Emissions inside 59.0 – 59.05GHz band (15.255(d))

Requirement

Any emissions contained within the frequency band 59.0 – 59.05GHz shall be limited to spurious emissions.

Procedure

Determination of emissions in the specified band are made based on data taken in sections 4.6.

Results

Neither radio (low band; high band) has intentional signals exist within the band of 59.0 – 59.05GHz. as shown in plots contained in Appendix C.

4.10 6 dB Bandwidth (15.255(e)(1))

Requirement

The limit for peak transmitter is dependent on the 6dB bandwidth of the intentional signal. Transmitters with a bandwidth of more than 100MHz are permitted up to 500mW. This section determines the applicable bandwidth.

Procedure

The signal was measured at 3 meters away from the EUT. The analyzer bandwidth was set to 300kHz. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. A peak reading of the modulated signal was taken and plotted.

The 6dB bandwidth of the transmitter is determined based on the plots shown in Appendix C. The bandwidth was found by determining the frequencies above and below the frequency of the peak modulated signal that are 6dB below the peak.

Results

The 6dB bandwidth of both radios was at least 100MHz.

S/n 11	760MHz
S/n 12	560MHz

4.11 Peak output power (15.255 (e)(2))

Requirement:

The total peak transmit power shall not exceed the 500mW. For transmitters with an emission bandwidth of less than 100MHz must limit their peak transmitter output power to the product of 500mW times their emission bandwidth divided by 100MHz. The 6 dB emission bandwidth as determined in 4.10 was greater than 100MHz.

Procedure:

Power density measurements were made as described in 4.4. The power densities calculated at 3m were then used to determine transmitted power. As the data are in the near field, equation 13 of OET 65 was used. ($S_{nf} = 16\eta P/D^2$) OET 65 defines the efficiency (η) of a circular aperture antenna as $\eta=(G\lambda^2/4\pi)/(\pi D^2/4)$. This gives a conservative estimate of the transmitter power. The specified antenna gain is 41dBi

Result:

The peak output power from either radio was well within the limit of 500mW.

Radio	efficiency	S_{nf} ($\mu W/cm^2$)	Limit (mW)	Peak Power Output (mW)
S/n 11-3264-0000-2	**0.35**	**3.22**	**500**	**1.63**
S/n 12-3264-0000-1	**0.32**	**5.6**	**500**	**3.19**

Note:
1. The EUT Output Power during operation was set to maximum to produce the worse case test results.

4.12 Frequency Stability (15.255(f))

Requirement

Fundamental emissions must be contained within the frequency band of 59 – 64GHz over the temperature range of –20°C to 50°C with and input voltage of 85% to 115% of the rated input.

Procedure

The EUT antenna output was connected to the input of the spectrum analyzer via an external mixer and a high frequency cable with 1.5 dB of loss. Measurements were made at room temperature and from -20°C to 50°C with an increment of 10 degree. The DC supply voltage was varied at 85% and 115% of the operating voltage. The deviation of the fundamental frequency was monitored with the spectrum analyzer.

Result

The table below shows the frequency stability test result for s/n 12. Both s/n 11 and s/n 12 utilize the same housing, power supplies, and digital section. The RF section is the same with the exception of the reference oscillator. Both are from the same manufacturer with tolerance specified as +/- 2MHz for each. The 3x and 2x multipliers used to get the final output frequency are the same.

The frequency stability of s/n 12 and s/n 11 demonstrates compliance with the requirement for operation in the 59 – 64GHz frequency range.

Frequency (GHz)	Voltage (DC)	Temperature (°C)	Pass/Fail
60.25925	48.00	-20	Pass
60.25925	40.80	-20	Pass
60.25925	55.20	-20	Pass
60.25811	48.00	-10	Pass
60.25811	40.80	-10	Pass
60.25810	55.20	-10	Pass
60.25700	48.00	0	Pass
60.25700	40.80	0	Pass
60.25700	55.20	0	Pass
60.25591	48.00	10	Pass
60.25591	40.80	10	Pass
60.25591	55.20	10	Pass
60.25458	48.00	20	Pass
60.25459	40.80	20	Pass
60.25461	55.20	20	Pass
60.25401	48.00	30	Pass
60.25402	40.80	30	Pass
60.25400	55.20	30	Pass
60.25268	48.00	40	Pass
60.25268	40.80	40	Pass
60.25268	55.20	40	Pass
60.25132	48.00	50	Pass
60.25132	40.80	50	Pass
60.25132	55.20	50	Pass

List of Test Equipment

Equipment	Manufacturer	Model	Serial #	Cal. Due
Spectrum Analyzer	Agilent	E7405A	US40240205	11/28/01
Spectrum Analyzer	Tektronix	2784	B010153	12/13/01
EMI Receiver Set W/RF Filter	Hewlett Packard	85462A	3325A00160	12/28/01
Spectrum Analyzer	Hewlett Packard	8564EC		
Mixer	Millitech	MHB-15-R00W0 8203	019	None
Mixer	Millitech	MSH-05-8FDCSN 8807	017	None
Mixer	Millitech	MHB-06-R00WN 8807	022	None
Mixer	Millitech	MHB-22-R00W0 8203	013	None
Mixer	Millitech	MHB-10-R00W0 8203	015	None
High Frequency Horn Antenna	EMCO	3116	2090	06/07/02
Horn Antenna	EMCO	3115	9512-4632	10/09/01
MW Cable (DC-40GHz) 48”	Astrolab	32029-2-2909K-48TC	CBL050	08/23/02
Sucoflex Cable	Huber + Suhner, Inc.	None	CBLSHF1030	02/21/02
Cable, BNC/BNC	Alpha	RG58B/U	CBL110E	9/10/01
LISN, 50uH, .01-50MHz, 24A	Solar Electronics	9252-50-R-24-BNC	941712	5/02/02
Attenuator, 10 dB	Mini Circuits			

Appendix A – Microwave power density measurement for transmitters with high-gain antenna

Appendix B – Evaluation of compliance with FCC guidelines for human exposure

<<HumanExposure.pdf>>

Appendix C – Spectrum analyzer plots

The following plots represent the emissions of the radios in the frequency range of 40 – 200GHz. They are organized first by serial number. For each s/n there is a set of general plots in each mixer band.

In those areas where a signal apparently exists, other 'narrower' plots are presented showing the 'ID' trace. At those frequencies where the ID trace does not have a corresponding signal (not necessarily the same amplitude), the original plot represents an image frequency and not a real signal.

Finally, the last group includes a plot for the frequency range of 59 – 64GHz. Also in this group are plots which give details of the intentional signal at multiple distances and resolution bandwidths. The plots are repeated with the modulation ON and OFF.

Serial Number 11

List of plots

Freq (GHz)	RBW (MHz)	VBW (MHz)	Distance (m)	Modulation
40 - 50	3	7	3	
50 - 75	3	7	3	
75 - 110	3	7	3	
110 - 170	3	7	3	
170 - 200	3	7	3	
*******				
50 - 60	3	7	3	
65 - 75	3	7	3	
75 - 85	3	7	3	
85 - 95	3	7	3	
95 - 105	3	7	3	
105 - 110	3	7	3	
*******				
59 - 64	10	7	3	
60.25 – 65.25	10	7	3	ON
60.25 – 65.25	10	7	3	OFF
61.77 – 63.77	0.3	0.001	3	ON
61.77 – 63.77	0.3	0.001	3	OFF
60.25 – 65.25	10	7	6	ON
60.25 – 65.25	10	7	6	OFF
61.77 – 63.77	0.3	0.001	6	ON
61.77 – 63.77	0.3	0.001	6	OFF
60.25 – 65.25	10	7	12	ON
60.25 – 65.25	10	7	12	OFF
61.77 – 63.77	0.3	0.001	12	ON
61.77 – 63.77	0.3	0.001	12	OFF

<<plots_sn11.pdf>>

Serial Number 12

List of Plots

Freq (GHz)	RBW (MHz)	VBW (MHz)	Distance (m)	Modulation
40 - 50	3	7	3	ON
50 - 75	3	7	3	ON
75 - 110	3	7	3	ON
110 - 170	3	7	3	ON
170 - 200	3	7	3	ON
*******				
40 – 45	10	7	3	ON
45 - 47	10	7	3	ON
47 – 49	10	7	3	ON
50 – 56.8	10	7	3	ON
50.15 – 52.15	10	7	3	ON
56 – 62	10	7	3	ON
62 - 70	10	7	3	ON
70 – 75	10	7	3	ON
75 – 85	10	7	3	ON
78.172 – 80.172	10	7	3	ON
85 – 95	10	7	3	ON
95 – 105	10	7	3	ON
105 - 110	10	7	3	ON
*******				
59 - 64	10	7	3	ON
59.265 – 61.265	10	7	3	ON
57.755 – 62.755	10	7	6	OFF
57.755 – 62.755	10	7	6	ON
59.255 – 61.255	0.3	0.001	6	ON
59.255 – 61.255	0.3	0.001	6	OFF
57.75 – 62.75	10	7	12	ON
57.75 – 62.75	10	7	12	OFF
57.75 – 62.75	0.3	0.001	12	ON
57.75 – 62.75	0.3	0.001	12	OFF

<<plots_sn12.pdf>>