

**EMISSIONS TEST REPORT FOR A LOW POWER TRANSMITTER**

**I. GENERAL INFORMATION**

Requirement: Federal Communications Commissions

Test Requirements: 15.205, 15.207, 15.209, 15.247

Applicant: BreezeCom Ltd.

Product ID: FCC ID: LKT-SUR-24

**II. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)**

The Breezecom FCC ID: LKT-SUR-24 is a frequency hopping spread spectrum (FHSS) transceiver used for WLANs and similar applications. The product uses antenna diversity, a proprietary connector is used on the antenna. Only one antenna transmits at a time, both receive simultaneously.

The following antennas were tested for use with this radio:

No	Antenna description	Breezecom name	MFR name
1	Flat panel patch antenna	UNI-8.5dBi	Huber-Shuner SPA 2400/75/9/0/V 2300-2500MHz
2	Flat panel patch antenna	UNI-7dBi	M/A -Com
3	whip antenna	Omni-3dBi	NA
4	2 x antenna	Omni-6dBi	NA

**III. TEST LOCATION**

All conducted tests and radiated emissions for the 3dBi antenna were performed at:

Compliance Certification Services  
561F Monterey Road  
Morgan Hill, CA 95037

Radiated emissions tests for the patch antennas and 6 dBi omni were performed at

The Standards Institution  
Of Israel  
Industry Division  
Telematics Laboratory

EMC Section

T.N. Cokenias  
EMC Consultant/Agent for Breezecom

15 June 2001

**15.203 Antenna connector requirement**

The EUT's antenna has a unique connector, a keyed bayonet type, that can only be inserted one way into the corresponding slots in the radio. Refer to the attached photographs for details.

**15.204 Antenna description**

No	Antenna description	Breezecom name	MFR name
1	Flat panel patch antenna	UNI-8.5dBi	Huber-Shuner SPA 2400/75/9/0/V 2300-2500MHz
2	Flat panel patch antenna	UNI-7dBi	M/A -Com
3	whip antenna	Omni-3dBi	NA
4	2 x antenna	Omni-6dBi	NA

**15.247(a) Frequency hopping spread spectrum definition**

**Pseudorandom frequency hopping sequence:**

The transmitter cannot coordinate its hopping sequence with the hopping sequence of other transmitters, or vice versa, for the purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters

Each access unit has an individual ID number and there is no link or association between two access units so there is no simultaneous occupancy of individual hopping frequency transmission of two or more access units.

**Equal hopping frequency use:**

The EUT supports 802.11 standard up to the channels defined by the out of band radiation.

For example here are the channels of one hopping sequence each channel is associated to a frequency (channel 2 is 2402MHz, channel 25 is 2425MHz etc.)

According to Table B.1 Hopping sequence Set 1:

2,25,64,10,45,18,73,49,21,63,78,31,61,24,54,65,28,33,4,20,13,38,74,56,71,23,5,39,12,36,68,9,70,77,6,62,29,14,27,16,59,43,76, etc..

There is an implementation in the software of all sequences defined in the standard.

**System receiver input bandwidth and receiver hopping capability:**

The Access unit (base station) defines to all subscriber units the frequency sequence. The protocol is implemented according to 802.11.

The receiver band width is defined by a 440MHz SAW filter of 1MHz bandwidth. The frequency shift is defined by a frequency hop PLL synthesizer that sets the received frequency to a 440MHz IF frequency.

## **TEST DATA and TEST PROCEDURES - CCS Laboratory**

### **Radiated Emissions**

#### **Test Requirement: 15.205**

#### **Measurement Equipment Used:**

HP 8593EM Spectrum Analyzer

HP 8449 Microwave pre-amplifier, 1-26.5 GHz

EMCO 3115 Double Ridged Horn antenna, 1 - 18 GHz

1. The EUT was placed on a wooden table resting on a turntable on the open air test site. The search antenna was placed 3m from the EUT. The EUT antenna was mounted vertically as per normal installation.
2. The turntable was slowly rotated to locate the direction of maximum emission at each emission falling in the restricted bands of 15.205.
3. Radiated emissions were investigated for a LOW channel, a MID channel, and HIGH channel. Emissions were investigated to the 10<sup>th</sup> harmonic.
4. Careful measurements were made at the restricted bands 2310-2390 MHz and 2483.5 – 2500 MHz for the LOW and HIGH channel respectively. The preamplifier was not used for these measurements.
5. Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded in the data listed below.

**Test Results:** Worst case results are presented. Refer to data sheets, attached.

For bandedge measurements, received radiated emissions seemed to overload the spectrum analyzer, even though the frequency of operation (2474 MHz) was over 9 MHz removed from the restricted band, and said emission is only 1 MHz wide at the -20 dB points. In lieu of radiated measurements, radiated emissions levels at the bandedge were calculated from conducted measurements.

The relationship between transmitter power, antenna gain, and field strength at 3m is

$E_{V/m} = (\sqrt{30 \cdot P \cdot G}) / d$  meters (E in volts/m, P in watts, G numeric gain over isotropic)

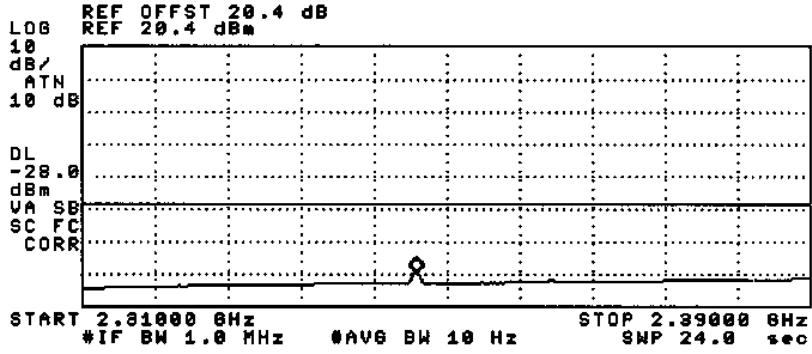
Converting to logarithms and combining terms,

**$E@3m, \text{dBuV/m} = (95.1 + P_{\text{dBm}} + G_{\text{dBi}}) \text{ dBuV/m} = 54 \text{ dBuV/m}$  for 15.205 limits**

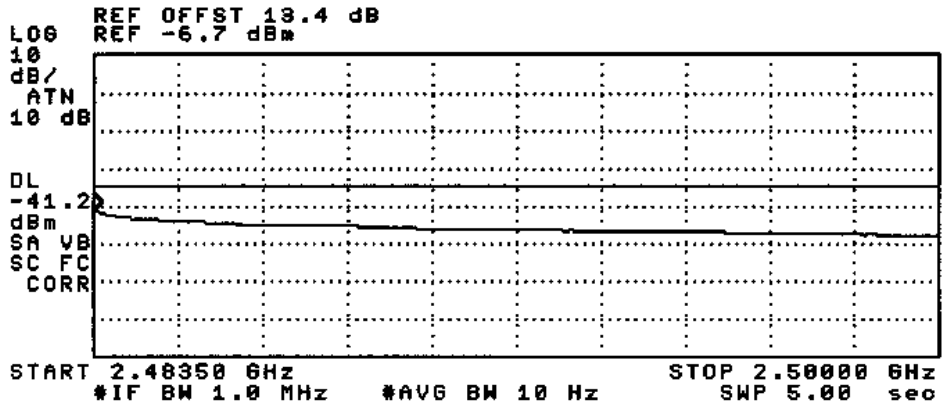
**Maximum conducted reading in restricted band: -48.1 dBm at 2483.5 MHz**  
**Antenna gain = 3 dBi**

**$-48.1 \text{ dBm} + 3 \text{ dBi} + 95.2 = 50.1 \text{ dBuV/m}$  calculated at 3 m.**

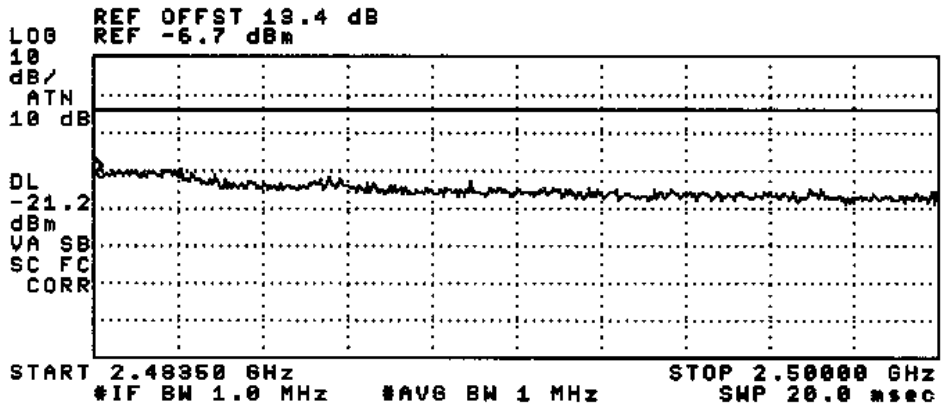
15:49:46 MAR 19, 2001  
BREEZECOM: 15, S/N:01429, CH 2 CONDUCTED  
ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 2.34660 GHz  
-49.13 dBm



15:50:23 MAR 20, 2001  
BREEZECOM; S/N: 01429, HI CH 78 BANDEGE  
ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 2.48350 GHz  
-48.10 dBm



15:51:48 MAR 20, 2001  
BREEZECOM; S/N: 01429, HI CH 78 BANDEGE  
ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 2.48350 GHz  
-38.16 dBm



**COMPLIANCE CERTIFICATION SERVICES, INC.**

Radiated Emissions  
15.205

03/20/01  
Kenwin Corpuz  
A-site (1.0 Meter)

BREEZECOM  
2402 - 2478 MHz FHSS,M/N: SU-R, S/N: 01429

f<sub>o</sub>= 2478 MHz (HIGH)

F(MHz)	READING (dBuV)		AF (dB)	CL (dB)	AMP (dB)	DIST (dB)	HPF (dB)	TOTAL (dBuV/m)		LIMIT (dBuV/m)		MARGIN (dB)	
	Pk	Avg						Pk	Avg	Pk	Avg	Pk	Avg
4956*	43.2	31.6	33.65	5.28	35	9.5	1	38.63	27.03	74	54	-35.37	-26.97
7434V*	47.3	34.8	37.36	6.51	35	9.5	1	47.67	35.17	74	54	-26.33	-18.83
7434H	49.4	39.2	37.36	6.51	35	9.5	1	49.77	39.57	74	54	-24.23	-14.43
9912*	45.6	32.7	38.1	7.7	35	9.5	1	47.9	35	74	54	-26.1	-19
12390*	48.2	35.3	39.29	8.6	35	9.5	1	52.59	39.69	74	54	-21.41	-14.31
14868*	49.5	37.6	40.86	9.9	35	9.5	1	56.76	44.86	74	54	-17.24	-9.14
17346*	51.9	39.3	43.39	11.26	35	9.5	1	63.05	50.45	74	54	-10.95	-3.55
19824*	51.6	39.2	32.11	12.38	35	9.5	1	52.59	40.19	74	54	-21.41	-13.81
22302*	55.3	42.9	32.5	13.42	35	9.5	1	57.72	45.32	74	54	-16.28	-8.68
24780*	55.9	43.2	32.43	14.45	35	9.5	1	59.28	46.58	74	54	-14.72	-7.42

\* Measured noise floor (worse case vertical)

**NOTE: MEASURED HORIZONTAL (H) AND VERTICAL (V)**

**DIST:** Correction to extrapolate reading to 3m specification distance  
1.0M measurement distance= -9.5dB

**AF:** Antenna Factor

**ANTENNA:** EMCO, 3115, S/N:2238 & ARA, MWH-1826/B, S/N:1013

**AMP:** Pre-amp gain

**PRE-AMP:** HP 8449B, S/N:3710A00205

**CL:** Cable loss (17ft)

**HPF:** FSY High pass filter insertion loss (4.57GHz; S/N:003)



**COMPLIANCE CERTIFICATION SERVICES, INC.**

Radiated Emissions  
15.205

03/20/01  
Kerwin Corpuz  
A-site (1.0 Meter)

BREEZECOM  
2402 - 2478 MHz FHSS,M/N: SU-R, S/N: 01429

f<sub>o</sub>= 2441 MHz (MID)

F(MHz)	READING (dBuV)		AF (dB)	CL (dB)	AMP (dB)	DIST (dB)	HPF (dB)	TOTAL (dBuV/m)		LIMIT (dBuV/m)		MARGIN (dB)	
	Pk	Avg						Pk	Avg	Pk	Avg	Pk	Avg
4882*	43.2	31.6	33.65	5.28	35	9.5	1	38.63	27.03	74	54	-35.37	-26.97
7323V	51.6	43.8	37.36	6.51	35	9.5	1	51.97	44.17	74	54	-22.03	-9.83
7323H*	47.3	34.8	37.36	6.51	35	9.5	1	47.67	35.17	74	54	-26.33	-18.83
9764*	45.6	32.7	38.1	7.7	35	9.5	1	47.9	35	74	54	-26.1	-19
12205*	48.2	35.3	39.29	8.6	35	9.5	1	52.59	39.69	74	54	-21.41	-14.31
14646*	49.5	37.6	40.86	9.9	35	9.5	1	56.76	44.86	74	54	-17.24	-9.14
17087*	51.9	39.3	43.39	11.26	35	9.5	1	63.05	50.45	74	54	-10.95	-3.55
19528*	51.6	39.2	32.11	12.38	35	9.5	1	52.59	40.19	74	54	-21.41	-13.81
21969*	55.3	42.9	32.5	13.42	35	9.5	1	57.72	45.32	74	54	-16.28	-8.68
24410*	55.9	43.2	32.43	14.45	35	9.5	1	59.28	46.58	74	54	-14.72	-7.42

\* Measured noise floor (worse case vertical)

**NOTE: MEASURED HORIZONTAL (H) AND VERTICAL (V)**

DIST: Correction to extrapolate reading to 3m specification distance  
1.0M measurement distance= -9.5dB

AF: Antenna Factor

ANTENNA: EMCO, 3115, S/N:2238 & ARA, MWH-1826/B, S/N:1013

AMP: Pre-amp gain

PRE-AMP: HP 8449B, S/N:3710A00205

CL: Cable loss (17ft)

HPF: FSJ High pass filter insertion loss (4.57GHz; S/N:003)

**COMPLIANCE CERTIFICATION SERVICES, INC.**

Radiated Emissions  
15.205

03/20/01  
Kerwin Corpuz  
A-site (1.0 Meter)

BREEZECOM

2402 - 2478 MHz FHSS,M/N: SU-R, S/N: 01429

$f_o$ = 2402 MHz (LOW)

F(MHz)	READING (dBuV)		AF (dB)	CL (dB)	AMP (dB)	DIST (dB)	HPF (dB)	TOTAL (dBuV/m)		LIMIT (dBuV/m)		MARGIN (dB)	
	Pk	Avg						Pk	Avg	Pk	Avg	Pk	Avg
4802*	43.2	31.6	33.65	5.28	35	9.5	1	38.63	27.03	74	54	-35.37	-26.97
7206V	52.5	45.7	37.36	6.51	35	9.5	1	52.87	46.07	74	54	-21.13	-7.93
7206H*	47.3	34.8	37.36	6.51	35	9.5	1	47.67	35.17	74	54	-26.33	-18.83
9608*	45.6	32.7	38.1	7.7	35	9.5	1	47.9	35	74	54	-26.1	-19
12010*	48.2	35.3	39.29	8.6	35	9.5	1	52.59	39.69	74	54	-21.41	-14.31
14412*	49.5	37.6	40.86	9.9	35	9.5	1	56.76	44.86	74	54	-17.24	-9.14
16814*	51.9	39.3	43.39	11.26	35	9.5	1	63.05	50.45	74	54	-10.95	-3.55
19216*	51.6	39.2	32.11	12.38	35	9.5	1	52.59	40.19	74	54	-21.41	-13.81
21618*	55.3	42.9	32.5	13.42	35	9.5	1	57.72	45.32	74	54	-16.28	-8.68
24020*	55.9	43.2	32.43	14.45	35	9.5	1	59.28	46.58	74	54	-14.72	-7.42

\* Measured noise floor (worse case vertical)

**NOTE: MEASURED HORIZONTAL (H) AND VERTICAL (V)**

**DIST:** Correction to extrapolate reading to 3m specification distance

1.0M measurement distance= **-9.5dB**

**AF:** Antenna Factor

**ANTENNA:** EMCO, 3115, S/N:2238 & ARA, MWH-1826/B, S/N:1013

**AMP:** Pre-amp gain

**PRE-AMP:** HP 8449B, S/N:3710A00205

**CL:** Cable loss (17ft)

**HPF:** FSJ High pass filter insertion loss (4.57GHz; S/N:003)

**AC Line Conducted Emissions**  
**Test Requirement: 15.107, 15.207**

**Measurement Equipment Used:**

Rohde & Schwarz EMI Receiver ESHS-20  
Fischer Custom Communication LISN, FCC-LISN-50/250-25-2

**Test Procedure**

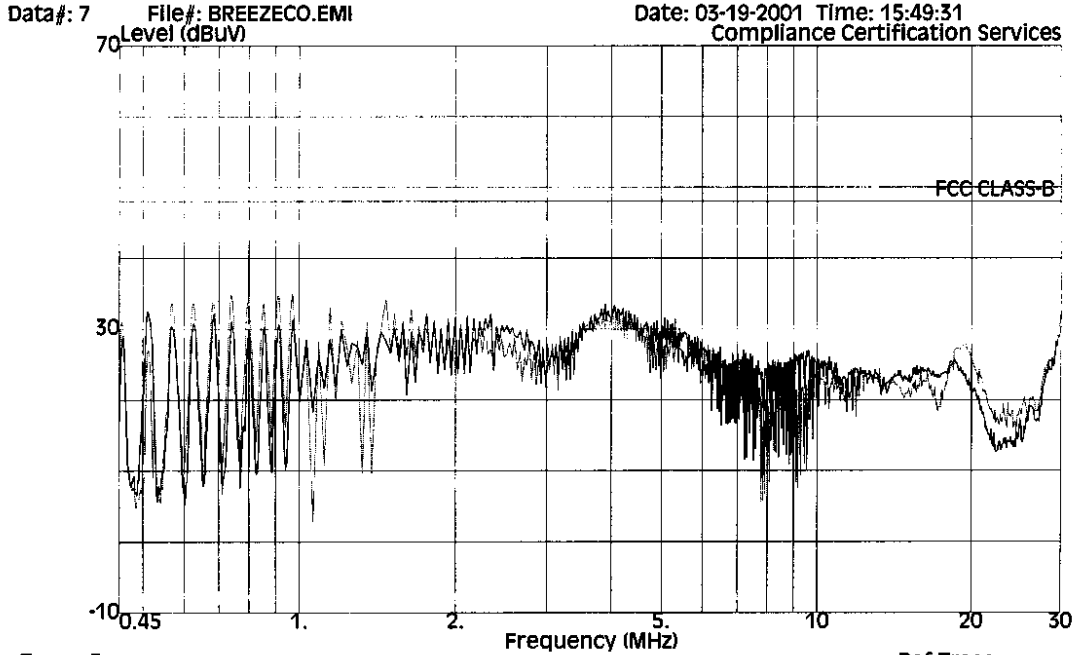
1. The EUT was placed on a wooden table 40 cm from a vertical ground plane and approximately 80 cm above the horizontal ground plane on the floor. The EUT was set to transmit in normally.
2. Line conducted data was recorded for both NEUTRAL and HOT lines.

**Test Results**

PASS. Refer to data sheet below.



561 F Monterey Road, Route 2  
Morgan Hill, CA 95037-9001 USA  
Tel: (408) 463-0885  
Fax: (408) 463-0888



Trace: 3  
Project No. :  
Report No. : 010319LC  
Test Engr : KERWIN CORPUZ  
Company : BREEZECOM  
EUT Description : 2.4 GHz FHSS, S/N:01429  
Model : SU-R  
EUT Config. : EUT with POWER ADAPTOR  
Type of Test : FCC Class B  
Mode of Operation: NORMAL HOPPING  
: Peak: L1(Green), L2(Black)  
: 115Vac, 60HZ

**Minimum 20 dB Bandwidth for FHSS**

**Test Requirement: 15.247**

**Measurement Equipment Used:**

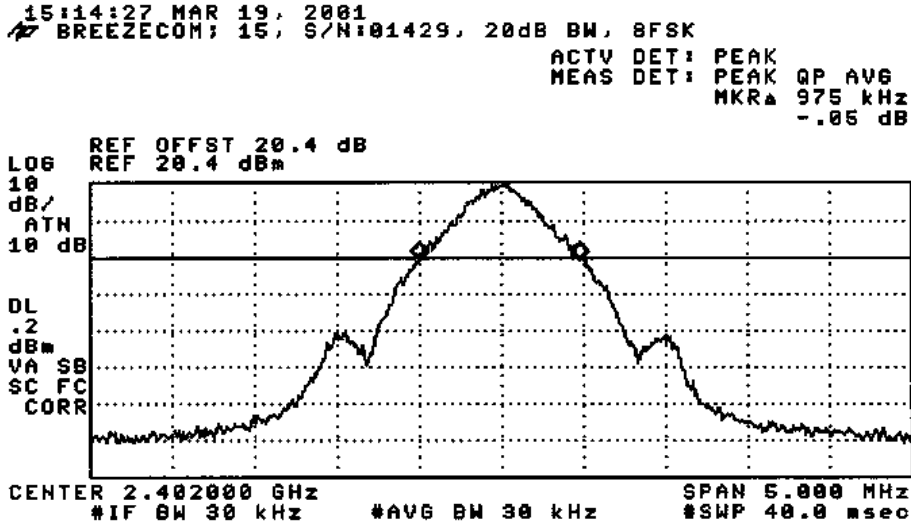
HP 8593EM Spectrum Analyzer  
6' length low loss coaxial cable

**Test Procedures**

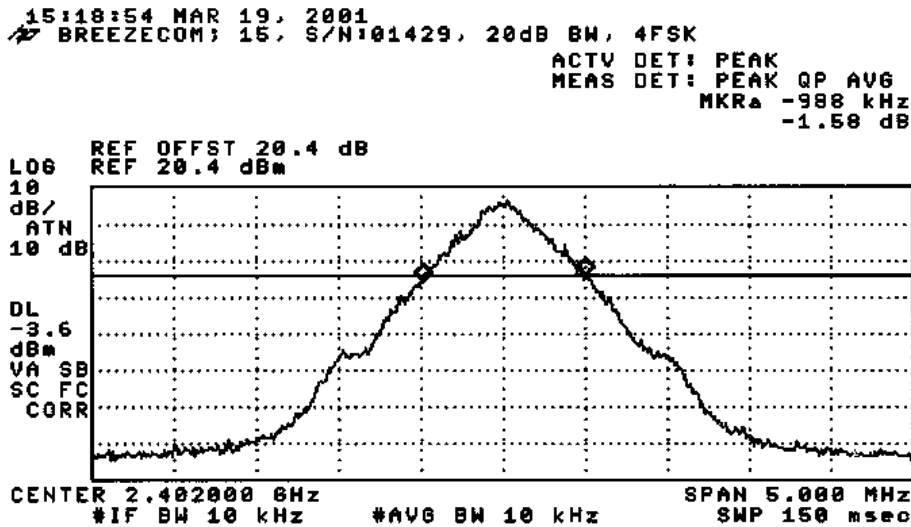
The EUT was configured on a test bench. The EUT's hopping function was stopped, transmission was continuous at 2.400 GHz (LOW channel). While the transmitter broadcast a steady stream of digital data, the analyzer MAX HOLD function was used to capture the envelope of the transmission occupied bandwidth.

**Test Results:** Refer to attached spectrum analyzer charts. Data taken with RES BW of 30 kHz shows 20 dB BW of 988 kHz, below the 1 MHz limit in the Rules.

15.247 Minimum 20 dB FHSS Channel Bandwidth



LO

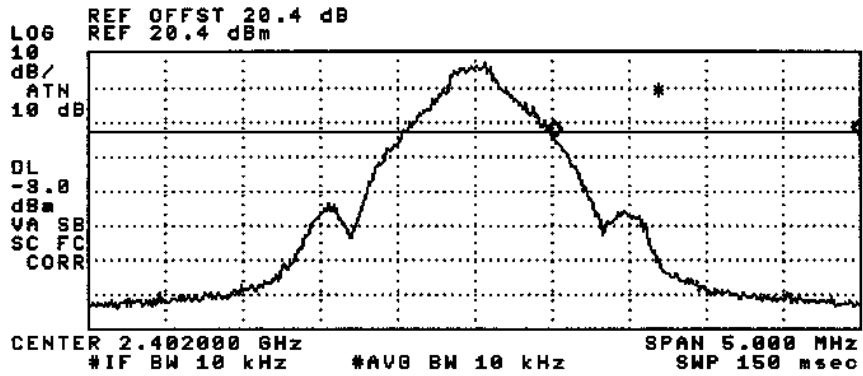


LO

15:23:20 MAR 19, 2001

BREEZECOM; 15, S/N:01429, 20dB BW, FSK

ACTV DET: PEAK  
 MEAS DET: PEAK QP AVG  
 MKRΔ 988 kHz  
 -.44 dB

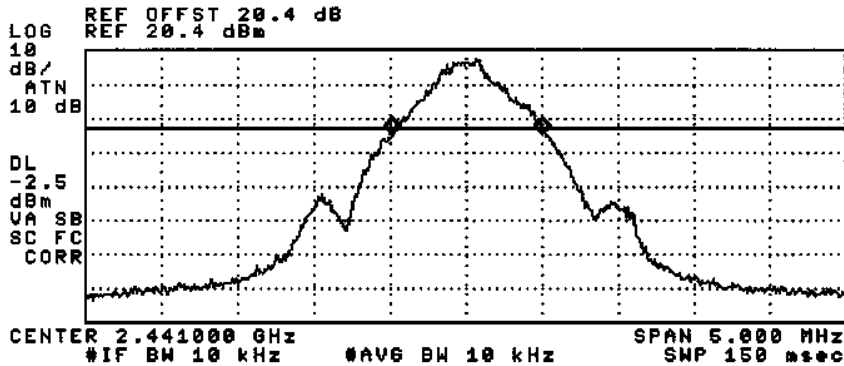


L0

15:30:33 MAR 19, 2001

BREEZECOM; 15, S/N:01429, 20dB BW, GFSK

ACTV DET: PEAK  
 MEAS DET: PEAK QP AVG  
 MKRΔ 988 kHz  
 .09 dB

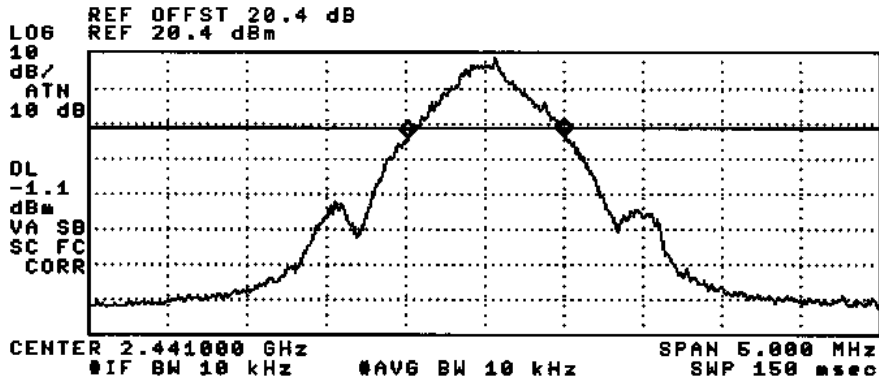


M1D

15:26:14 MAR 19, 2001

BREEZECOM; 15, S/N:01429, 20dB BW, FSK

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKRa -988 kHz  
-.49 dB

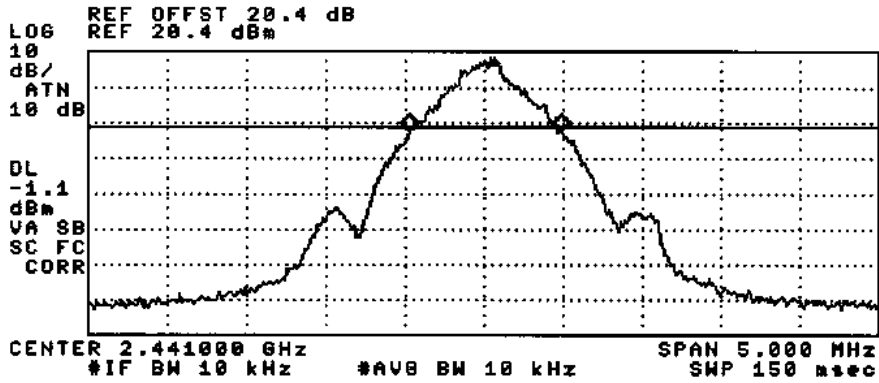


MID

15:27:48 MAR 19, 2001

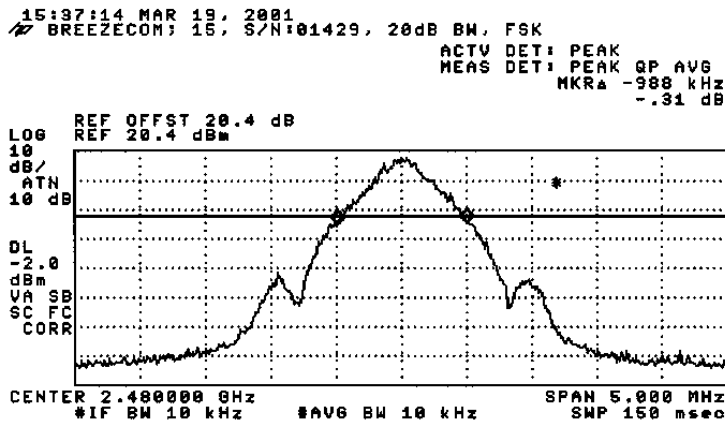
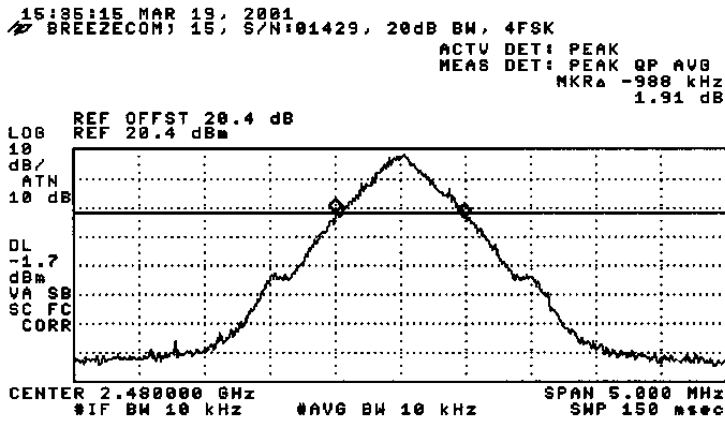
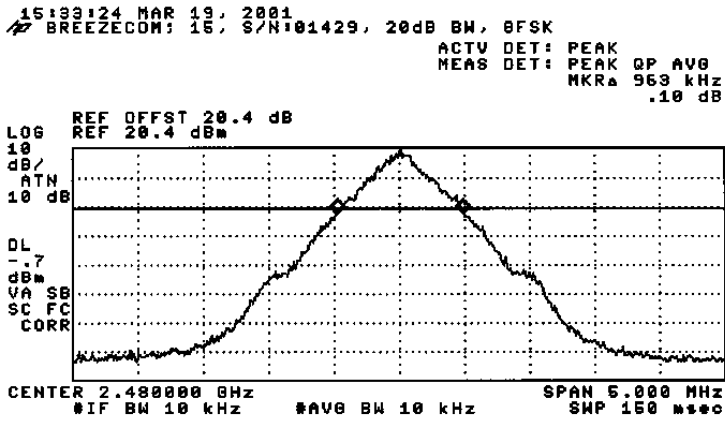
BREEZECOM; 15, S/N:01429, 20dB BW, 4FSK

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKRa -963 kHz  
.08 dB



MID





**RF Power Output**

**Test Requirement: 15.247**

**Measurement Equipment Used:**

HP 8593EM Spectrum Analyzer  
 2 ft length low loss A coaxial RF cable

**Test Procedures**

1. The EUT was configured on a test bench. The cable was connected between the EUT antenna port and the spectrum analyzer input port.

The EUT's hopping function was stopped, transmission was continuous at the LOW channel. While the transmitter broadcast a steady stream of digital data, the analyzer MAX HOLD function was used to capture the envelope of the transmission.

2. The process in (1) was repeated for MID channel and HIGH channel.

**Test Results**

Power level readings converted to dBm are shown below. Refer also to spectrum analyzer graphs. Reference level offset corrects for external attenuation and cable loss.

<b>Channel</b>	<b>Frequency, MHz</b>	<b>Output Power, dBm</b>	<b>Limit, dBm</b>
Low	2402	27.0	30.0
Mid	2445	27.0	30.0
High	2778	27.4	30.0

Maximum output power output is within 1.4 dBm of design typical maximum 26 dBm.

## **Out of Band Measurements**

### **Test Requirement: 15.247**

#### **Measurement Equipment Used:**

HP 8593EM Spectrum Analyzer  
2 ft length low loss A coaxial RF cable

#### **Test Procedure**

1. The EUT was configured on a test bench. The cable was connected between the EUT antenna port and the spectrum analyzer input port.

Spectrum analyzer RES BW was set to 100 kHz. The EUT's hopping function was stopped, transmission was continuous at the LOW channel. While the transmitter broadcast a steady stream of digital data, the analyzer MAX HOLD function was used to capture the envelope of the transmission.

Readings were taken out to 10fo.

2. The process in (1) was repeated for MID channel and HIGH channel.

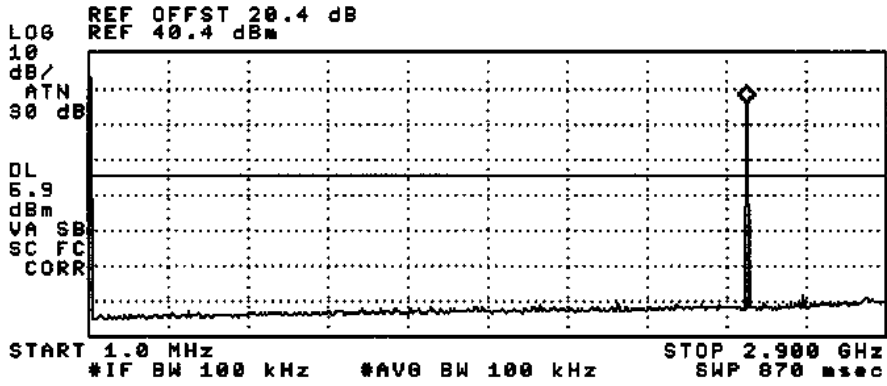
#### **Test Results**

Refer to attached data sheets. Data shows out of band emissions are suppressed well below the -20 dBc minimum required by the Rules.

**15.247 Spurious Emissions, Antenna conducted**

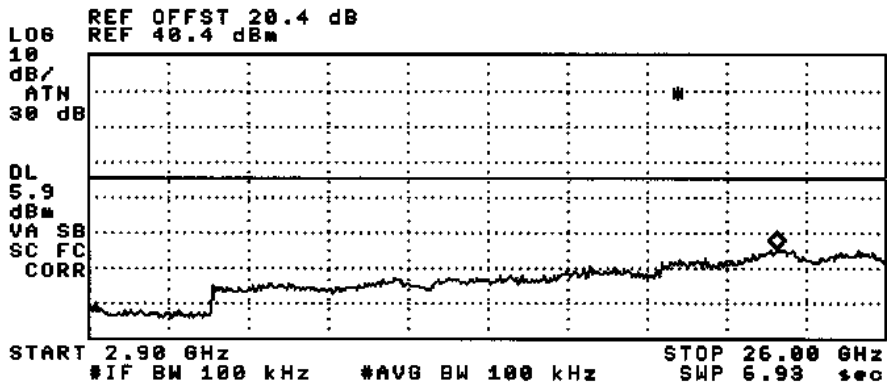
11:07:27 MAR 19, 2001  
BREEZECOM; 15; S/N:01429, CH 1

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 2.999 GHz  
25.96 dBm



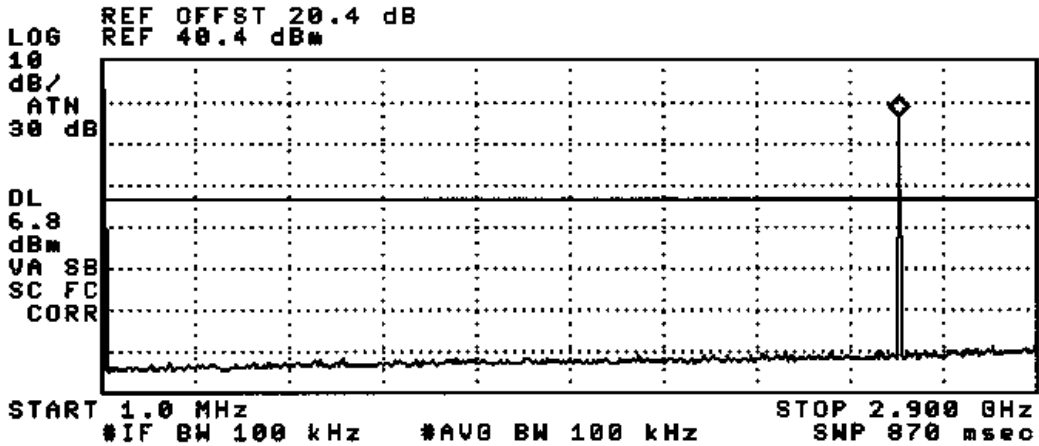
11:08:10 MAR 19, 2001  
BREEZECOM; 15; S/N:01429, CH 1

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 22.82 GHz  
-14.24 dBm



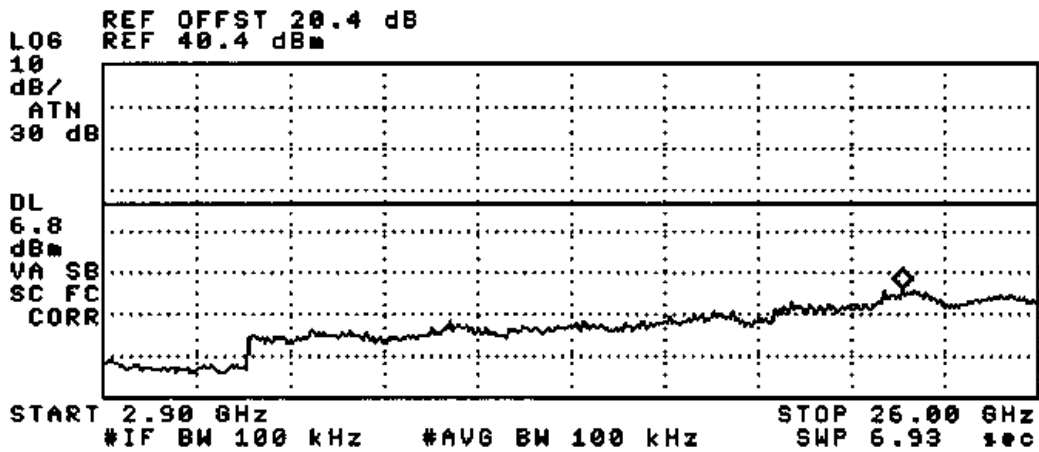
11:16:44 MAR 19, 2001  
BREEZECOM; 15, S/N:01429, CH 82

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 2.472 GHz  
26.79 dBm



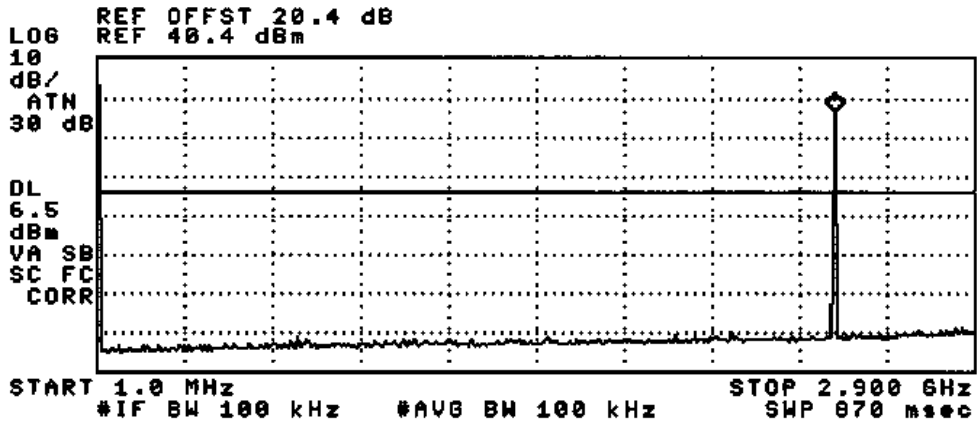
11:17:30 MAR 19, 2001  
BREEZECOM; 15, S/N:01429, CH 82

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 22.65 GHz  
-13.64 dBm



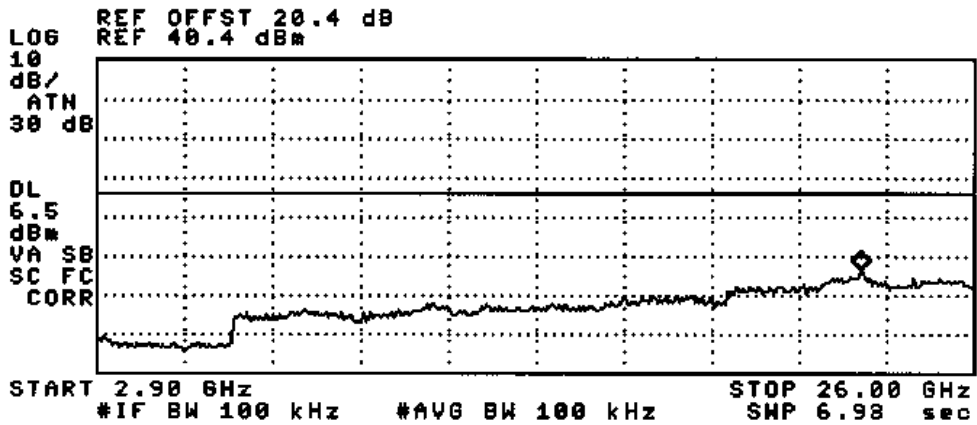
11:14:31 MAR 19, 2001  
BREEZECOM; 15, S/N:01429, CH 41

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 2.486 GHz  
26.52 dBm



11:15:27 MAR 19, 2001  
BREEZECOM; 15, S/N:01429, CH 41

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 23.00 GHz  
-12.09 dBm



**Minimum Number of Hopping Channels**

**Test Requirement: 15.247(a)(1)(ii)**

**Measurement Equipment Used:**

HP 8593EM Spectrum Analyzer  
2 ft length low loss A coaxial RF cable

**Test Procedure**

The EUT was set to transmit in normal hopping mode. The spectrum analyzer was set to MAX HOLD and swept continuously for 5 - 10 minutes so as to capture all the hopping channels.

**Test Results**

A total of 79 hopping channels were counted. This corresponds to design. Refer to attached data sheet.

NOTE: For operation in the United States, channel hopset will be between Ch 2 - Ch 78, in order to meet emissions limits in paragraphs 15.205 and 15.209 at the bandedges.





**Average Time of Channel Occupancy**  
**Test Requirement: 15.247**

**Measurement Equipment Used:**

HP 8593EM Spectrum Analyzer  
2 ft length low loss A coaxial RF cable

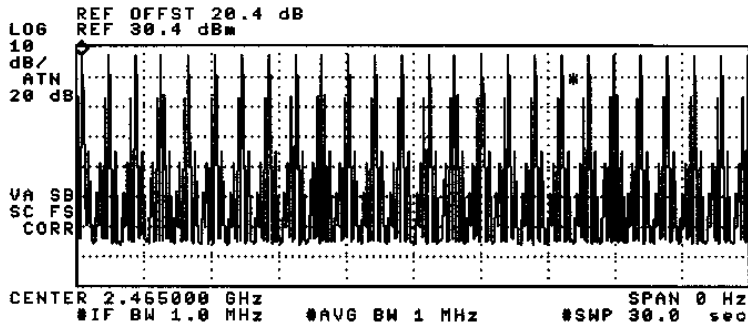
**Test Procedure**

1. The EUT was set to transmit in normal hopping mode.
2. The analyzer was center tuned to 2465 MHz. Analyzer frequency SPAN was set to ZERO SPAN. SWEEP TIME was set to 30 seconds, MAX HOLD function was engaged.
3. A total of 10 different 30 second sweeps were performed and the maximum time of channel occupancy was determined by the maximum number of transmissions detected in any 30 second period, times the duration of each transmission.

**Test Results**

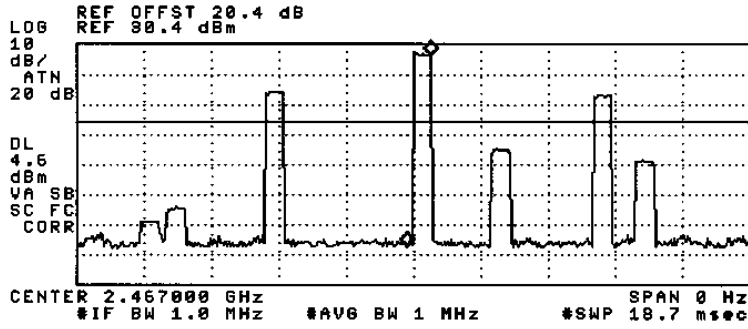
Maximum channel occupancy time was determined to be  $6.8 \text{ msec} \times 26 \text{ hits}/30\text{sec} = 176.8 \text{ msec}$ , well below the 400 msec ( 0.4 sec) maximum allowed. Refer to attached spectrum analyzer charts.

14:38:50 MAR 19, 2001  
 BREEZECOM: 15, S/N:01429, HOPPING CH OCCUPANCY  
 ACTV DET: PEAK  
 MEAS DET: PEAK QP AVG  
 MKR 225.00 msec  
 27.00 dBm



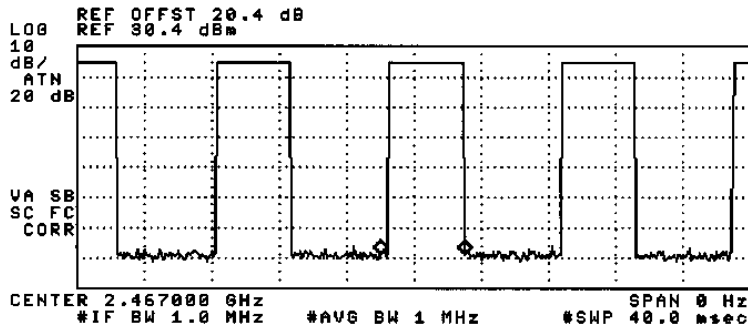
26 hits/30 sec

14:55:02 MAR 19, 2001  
 BREEZECOM: 15, S/N:01429, HOPPING CH OCCUPANCY BEACON  
 ACTV DET: PEAK  
 MEAS DET: PEAK QP AVG  
 MKR 656.00 usec  
 69.42 dB



FSK

14:57:45 MAR 19, 2001  
 BREEZECOM: 15, S/N:01429, HOPPING CH OCCUPANCY TEST M  
 ACTV DET: PEAK  
 MEAS DET: PEAK QP AVG  
 MKR 5.0000 msec  
 .10 dB



8FSK

15:04:36 MAR 19, 2001  
BREEZECOM; 15, S/N101429, HOPPING CH OCCUPANCY TEST M  
ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKRA 6.8000 msec  
1.29 dB

