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 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001

⇒ RF Preselector: Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated: 17 March 2000, Calibration due Date: 17 March 2001

7.3 Test Procedures

The modulated RF output of the EUT is connected to the RF input port of the RF reselector. The following measurements were made with a RBW = 3 MHz and VBW = 3 MHz.

7.4 Test Results

⇒ Measured maximum Peak Envelope Power for channel 1 was 7.6 dBm.
⇒ Measured maximum Peak Envelope Power for channel 3 was 9.7 dBm.
⇒ Measured maximum Peak Envelope Power for channel 6 was 10.2 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.

1 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 highest gain antenna is the Conifer Model 26T-2400 with 24 dBi gain. The maximum measured power is 10.2 dBm. The EUT's EIRP of 34.2 dBm is less than the 36.0 dBm allowed by the regulation.

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

According to par 1.1307b(1), the EUT does not require an environmental evaluation.

1. This equipment classification is not present within table 1 of part 1.1307 and is not listed in section 1.1307b(2).
2. The EUT categorically exempt from routine environmental evaluation per section 2.1093.

Included are calculations that determine that minimum distance I from the transmitter antenna that will ensure an exposure limit at or below the guidelines given in table 1 of part 1.1310 for the general population. The formula for these calculations are taken from OET Bulletin 65, edition 97-01, August 1997; "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields".

9.3 CALCULATIONS

Per Table 1 of Section 1.1310 the limit for general population exposure at 2.4 GHz is 1.0 mW/cm^2

Per OET Bulletin 65, edition 97-01 the formula for calculating power density is:
$S = P*G/4\pi R^2$
with
Power = 10.2 dBm = 10.5 mW
Gain of Antenna = 24 dBi or a numeric gain of 251
therefore
Solving for R gives a minimum safe distance of 14.4 cm

9.4 CONCLUSION

The EUT user's manual instructs the installer to maintain the at least minimum safe distance.

10. Conducted Spurious Emissions

10.1 Regulation

15.247 I 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 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001

⇒ RF Preselector: Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated: 17 March 2000, Calibration due Date: 17 March 2001

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2521A-00689, Calibrated: 19 November 1999, Calibration due Date: 19 November 2000

10.3 Test Procedures

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

10.4 Test Results

No out of band conducted emissions were detected within 50 dB of the carrier power. Please see plots in the list of attachments.

11. Radiated Spurious Emissions

11.1 Regulation

15.247 I 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 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001

⇒ RF Preselector: Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated: 17 March 2000, Calibration due Date: 17 March 2001

⇒ Quasi Peak Adapter: Hewlett-Packard 85650A, Serial Number 2521A-00689, Calibrated: 19 November 1999, Calibration due Date: 19 November 2000

⇒ Line Impedance Stabilization Network: Rhode & Schwarz ESH2-Z5, Serial Number ACMERS1, Calibrated: 1 September 1999, Calibration due Date: 01 September 2000

⇒ Broadband Biconical Antenna (20 MHz to 200 MHz): EMCO 3110, Serial Number 1115, Calibrated: 28 December 1999, Calibration due Date: 28 December 2000

⇒ Broadband Log Periodic Antenna (200 MHz to 1000 MHz): EMCO 3146, Serial Number 2853, Calibrated: 28 December 1999, Calibration due Date: 28 December 2000

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

⇒ Antenna Mast with Controller: EMCO 1051, Serial Number 9002-1457, No Calibration Required

⇒ Pyramidal Horn Antenna: EMCO 3160-10, Serial Number 9708-1055, Calibration Not Required

⇒ 2 GHz to 10 GHz Low Noise Preamplifier: Milliwave 593-2898, Serial Number 2494, No Calibration Required

⇒ Double Ridge Guide Horn Antenna: EMCO 3115, Serial Number 9807-5534, Calibrated: 30 December 1999, Calibration due Date: 30 December 2000

⇒ 8 – 22GHz Preamplifier: MITEQ AFS4-35LN, Serial Number 484280, Calibrated: 3 January 2000, Calibration Due Date: 3 January 2001

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 – 22000 MHz **15.205 RESTRICTED BANDS ONLY**
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz (30 MHz – 10,000 MHz) 1 MHz (10,000 MHz – 22,000 MHz)
Receive antenna scan height	1 m – 4 m
Receive antenna polarization	Vertical/Horizontal

11.4 Test Results

With Dish Antenna

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)	Comments
1	1069.09	53.9	74.0	-20.1	PK	V	141	285	All Channels
2	1069.15	49.8	54.0	-4.2	AVG	V	141	285	All Channels
3	1135.90	48.1	54.0	-5.9	AVG	V	142	284	All Channels
4	1135.91	52.2	74.0	-21.8	PK	V	142	284	All Channels
5	2387.76	49.7	54.0	-4.3	AVG	V	119	359	Channel 1
6	2388.56	61.7	74.0	-12.3	PK	V	119	359	Channel 1
7	2187.77	60.9	74.0	-13.1	PK	V	107	359	Channel 6
8	2188.02	48.3	54.0	-5.7	AVG	V	107	359	Channel 6
9	1823.91	36.1	54.0	-17.9	AVG	V	123	7	Channel 1
10	1821.01	43.9	74.0	-30.1	PK	V	123	7	Channel 1
11	1871.00	28.3	54.0	-25.7	AVG	V	128	15	Channel 3
12	1871.10	45.1	74.0	-28.9	PK	V	128	15	Channel 3
13	1921.00	35.8	54.0	-18.2	AVG	V	105	5	Channel 6
14	1921.01	46.2	74.0	-27.8	PK	V	118	5	Channel 6

With Omni Antenna

Emission Number	Frequency (MHz)	EUT Emission (dBuV/m)	Spec limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)	Comments
1	1069.09	50.4	74.0	-23.6	PK	V	131	331	All Channels
2	1069.15	46.3	54.0	-7.7	AVG	V	131	331	All Channels
3	1135.90	46.6	54.0	-7.4	AVG	V	114	337	All Channels
4	1135.91	51.7	74.0	-22.3	PK	V	114	337	All Channels
5	2385.37	47.3	74.0	-26.7	PK	V	112	360	Channel1
6	2390.00	34.1	54.0	-19.9	AVG	V	112	360	Channel 1
7	2183.51	51.6	74.0	-22.4	PK	V	146	0	Channel 6
8	2183.52	34.1	54.0	-19.9	AVG	V	146	0	Channel 6

With Yagi Antenna

Emission Number	Frequency (MHz	EUT Emission (dBuV/m)	Spec Limit (dBuV/m)	Delta to the limit dB	Detector Function (Peak, Quasi-Peak)	Polarity (Vertical/ Horizontal)	Antenna Height (cm)	Table Azimuth (deg.)	Comments
1	1069.08	50.8	74.0	-23.2	PK	V	129	324	All Channels
2	1069.15	45.8	54.0	-8.2	AVG	V	129	324	All Channels
3	1135.90	44.8	54.0	-9.2	AVG	V	119	317	All Channels
4	1135.91	50.2	74.0	-23.8	PK	V	119	317	All Channels
5	2388.54	35.6	54.0	-18.4	AVG	V	103	360	Channel 1
6	2388.95	50.3	74.0	-23.7	PK	V	103	360	Channel 1
7	2183.66	52.5	74.0	-21.5	PK	V	100	0	Channel 6
8	2183.68	36.5	54.0	-17.5	AVG	V	100	0	Channel 6

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 2403A06519, Calibrated: 7 January 2000, Calibration due Date: 7 January 2001

⇒ RF Preselector: Hewlett-Packard 85685A, Serial Number 2926A00971, Calibrated: 17 March 2000, Calibration due Date: 17 March 2001

12.3 Test Procedures

The RF output of the EUT is connected to the RF input port of the RF preselector through a 10 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 of channel 1 is –15.9 dBm.
Maximum peak power spectral density of channel 1 is –13.5 dBm.
Maximum peak power spectral density of channel 1 is –13.0 dBm.

Please see plots in the list of attachments.

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

Please see the process gain measurements in the attachments. The process gain of the product exceeds 10 dB.

14. Miscellaneous Comments and Notes

1. None.

15. List of Attachments

1 Conducted Emissions Plots. (2)
2 Conducted Spurious Emissions Plots. (9)
3 Spectral Density Plots. (3)
4 6 dB Bandwidth Plots. (3)
5 Band Edge Plots. (2)
6 Process Gain Testing. (43) +
7 Photos of test set-up. (2)