



**Elkhart Brass Mfg. Co., Inc.
FCC Part 15, Certification Application
PTSS2003 Spread Spectrum Transceiver Module**

February 10, 2003

MEASUREMENT/TECHNICAL REPORT

COMPANY NAME: **Elkhart Brass Mfg. Co., Inc.**

MODEL: **PTSS2003 Spread Spectrum Transceiver Module**

FCC ID: **QT8PTSS2003**

DATE: **February 10, 2003**

This report concerns (check one): Original grant X
Class II change _____

Equipment type: **Spread Spectrum Transceiver**

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes _____ No X

If yes, defer until: _____
date

N.A. agrees to notify the Commission by N.A.
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

United States Technologies, Inc.
3505 Francis Circle
Alpharetta, GA 30004

Phone Number: (770) 740-0717
Fax Number: (770) 740-1508

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GENERAL INFORMATION

GENERAL INFORMATION

1.1 Product Description

The Equipment Under test is the Elkhart Brass Mfg. Co., Inc., Model PTSS2003 Spread Spectrum Transceiver Module. The EUT is a Modular frequency hopping spread spectrum data transceiver that operates in the 902 – 928 MHz frequency band. The manufacturer is requesting a modular approval for this device as shown on the following page. The modulation used is binary frequency shift keying with a deviation of 100 kHz. The RF data rate is 76.8 kbps.



ELKHART BRASS MFG. CO., INC.

1302 WEST BEARDSLEY AVENUE • P.O. BOX 1127 • ELKHART IN 46515 • (574) 295-8330 • FAX (574) 293-9914

Re: modular transmitter approval

Gentlemen:

Public Notice DA00-1407 regarding Part 15 unlicensed modular transmitters requires that the following information be addressed.

The transmitter module is a complete RF transmitter containing its own reference oscillator.

The connections available on the module are for power, data and antenna. Below please find information, addressing each paragraph from DA00-1407, requested about the unit.

- 1.) The unit has its own RF shield to prevent coupling between the RF circuitry of the module and any wires or circuits in the device into which the module is installed. Please see the included photographs.
- 2.) The unit buffers all input signals through its digital logic.
- 3.) The unit has power regulation incorporated in the circuitry to ensure continued compliance regardless of the design of the power supplying circuitry.
- 4.) The unit utilizes a Hirose H.FL connector and stated for use with approved antennas only. This fulfills the requirements of 15.203.
- 5.) The module was tested in a stand-alone configuration. The module complies with part 15 emissions limits regardless of the device into which it is eventually installed.
- 6.) The module has the FCC ID number permanently affixed and information supplied to the end user regarding label placement on the outside of the device into which the module is contained. This information is clearly defined in the user manual.
- 7.) The unit complies with part 15.247 as stated in the user manual. Adequate instructions are supplied with the unit to explain the requirements.
- 8.) The unit complies with the RF exposure requirements as stated in 2.1091, 2.1093, and part 15.

Should you require any further information, please contact the undersigned.
Thank you for your consideration in this matter.

1.2 Related Submittal(s)/Grant(s)

The EUT will be used with part of a system to send/receive data. The transceiver presented in this report will be used with other like transmitters

The EUT is subject to the following authorizations:

- a) Certification as a transceiver
- b) Verification as a receiver and digital device

The information contained in this report is presented for the certification & verification authorization(s) for the EUT.

SECTION 2

TESTS AND MEASUREMENTS

TEST AND MEASUREMENTS

2.1 Configuration of Tested System

The sample was tested per ANSI C63.4, Methods of Measurement from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (1992). Conducted and radiated emissions data were taken with the test receiver or spectrum analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was off throughout the evaluation process. Interconnecting cables were manipulated as necessary to maximize emissions. Interconnecting cables were manipulated as necessary to maximize emissions. A block diagram of the tested system is shown in Figure 1. Test configuration photographs for spurious and fundamental emissions are shown in Figure 2.

The sample used for testing was received by U.S. Technologies on January 2, 2003 in good condition.

2.2 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and submitted to the FCC, and accepted in their letter marked 31040/SIT. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number IC2982.

2.3 Test Equipment

Table 2 describes test equipment used to evaluate this product.

2.4 Modifications

No modifications were made by US Tech, to bring the EUT into compliance with FCC Part 15, Limits for the transmitter portion of the EUT or the Class B Digital Device Requirements.

FIGURE 1a

TEST CONFIGURATION (Radiated Emissions)

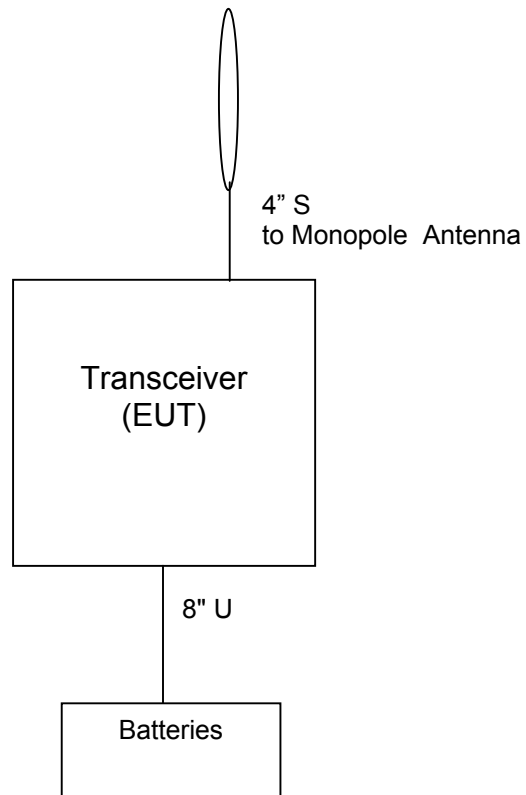
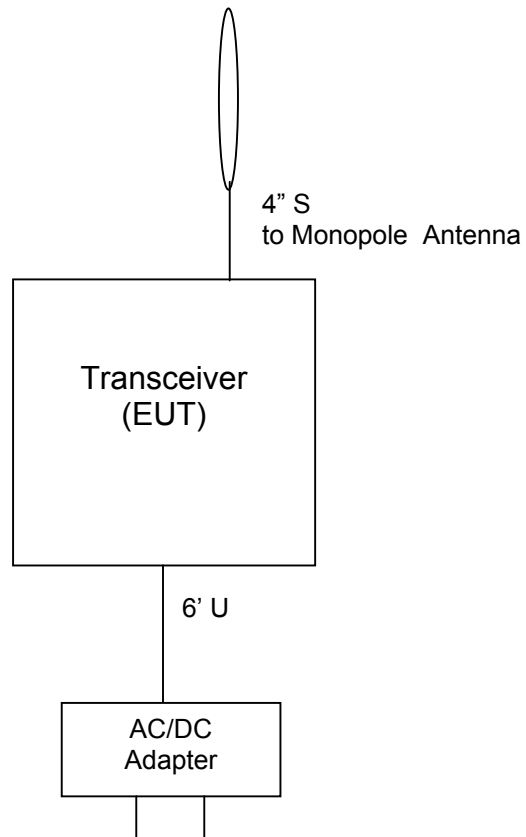


FIGURE 1b
TEST CONFIGURATION (Conducted Emissions)



Test Date: January 15, 2003
UST Project: 03-0020
Customer: Elkhart Brass Mfg. Co., Inc.
Model: PTSS2003 Spread Spectrum Transceiver Module

FIGURE 2a

Photograph(s) for Spurious and Fundamental Emissions

Test photographs were
found to be corrupted
and could not be
provided

Test Date: January 15, 2003
UST Project: 03-0020
Customer: Elkhart Brass Mfg. Co., Inc.
Model: PTSS2003 Spread Spectrum Transceiver Module

FIGURE 2b

Photograph(s) for Conducted Emissions



TABLE 1a**EUT and Peripherals (Radiated Emissions)**

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
Transceiver Module Elkhart Brass Mfg. Co., Inc. (EUT)	PTSS2003	15101, 15102	QT8PTSS2003 (Pending)	4" S to Monopole Antenna
Monopole Antenna Linx	ANT-915-CW-QW	None	N/A	
Battery	None	None	N/A	8" U

TABLE 1b**EUT and Peripherals (Conducted Emissions)**

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
Transceiver Module Elkhart Brass Mfg. Co., Inc. (EUT)	PTSS2003	15101, 15102	QT8PTSS2003 (Pending)	4" S to Monopole Antenna
Monopole Antenna Linx	ANT-915-CW- QW	None	N/A	
AC/DC Adapter	AC-E344A	97J I4	N/A	6' U

TABLE 2
TEST INSTRUMENTS

TYPE	MANUFACTURER	MODEL	SN.
SPECTRUM ANALYZER	HEWLETT-PACKARD	8593E	3205A00124
SPECTRUM ANALYZER	HEWLETT-PACKARD	8558B	2332A09900
S A DISPLAY	HEWLETT-PACKARD	853A	2404A02387
RF PREAMP	HEWLETT-PACKARD	8447D	1937A03355
RF PREAMP	HEWLETT-PACKARD	8449B	3008A00480
HORN ANTENNA	EMCO	3115	3723
BICONICAL ANTENNA	EMCO	3110	9307-1431
LOG PERIODIC ANTENNA	EMCO	3146	9110-3600
BILOG	CHASE	CBL6112A	2238
LISN	SOLAR ELE.	8028	910494
LISN	SOLAR ELE.	8028	910495

2.6 Antenna Description (Paragraph 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

The Elkhart Brass Mfg. Co., Inc. Model PTSS2003 Spread Spectrum Transceiver Module incorporates a Hirose H.FL connector and will be used with approved antennas only. This device will currently be used with the following antenna:

- 1 . Linx ANT-915-CW-QW, Vertical $\frac{1}{4}$ Wave Monopole, Gain 0 dBi, Reverse polarity SMA connector.

2.7 Peak power within the band 902 - 928 MHz per FCC Section 15.247(b)

Peak power within the band 902 - 928 MHz has been measured with a spectrum analyzer by connecting the spectrum analyzer directly via a short cable to the antenna output terminals or across the antenna leads on the PCB as specified by the manufacturer. The spectrum analyzer was set for a $50\ \Omega$ impedance with the VBW \geq RBW 6 dB bandwidth. The results of the measurements are given in Table 3 and Figure 3a through Figure 3c.

The EUT did not incorporate any antennas of directional gain greater than 6 dBi, therefore the output power has not been reduced as required by 15.247(b)(3).

TABLE 3
PEAK POWER OUTPUT

Test Date: January 28, 2003
UST Project: 03-0020
Customer: Elkhart Brass Mfg. Co., Inc.
Model: PTSS2003 Spread Spectrum Transceiver Module

Frequency of Fundamental (MHz)	Measurement (dBm)*	Measurement (Watt)*	FCC Limit* (Watt)
904.0	22.78	189.7	1.0
915.0	23.67	232.8	1.0
928.0	21.82	152.1	1.0

*Note: For 902-928 MHz frequency hopping spread spectrum devices, the FCC Limit is 1 Watt for systems employing at least 50 hopping channels and 0.25 Watts for systems employing less than 50 hopping channels, but at least 25 hopping channels

* Measurement includes 0.23 dB cable loss

Tester
Signature: David P. Blethen **Name:** David Blethen

Figure 3a.
Peak Power per FCC Section 15.247(b) (Low)

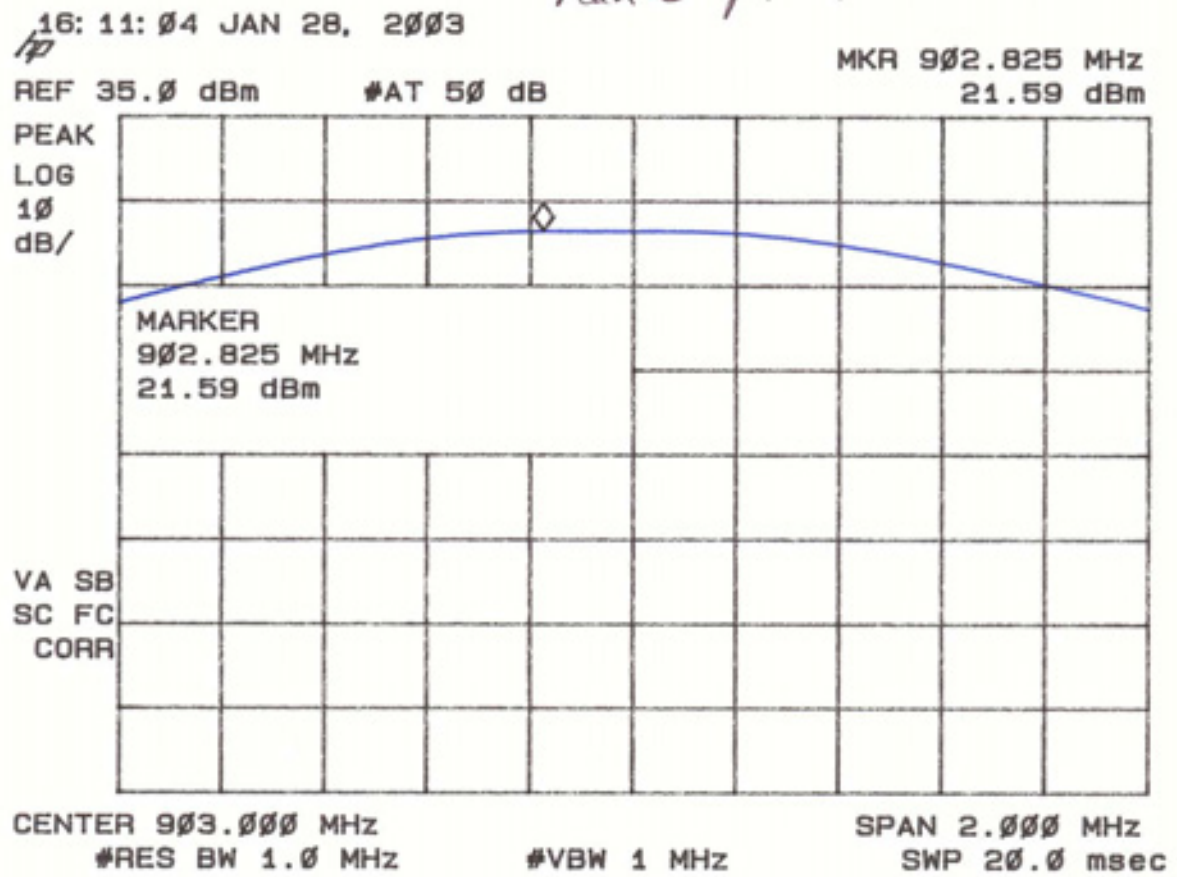


Figure 3b.
Peak Power per FCC Section 15.247(b) (Mid)

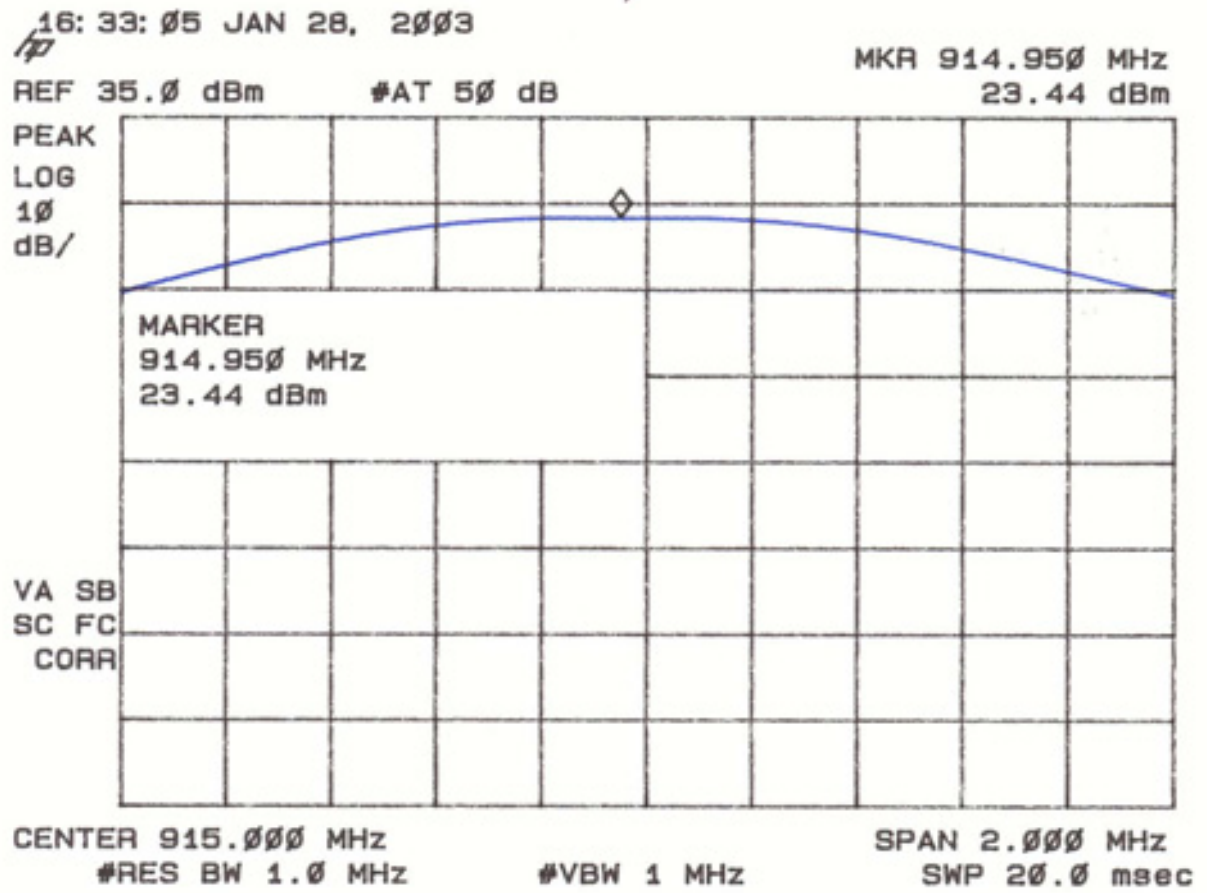
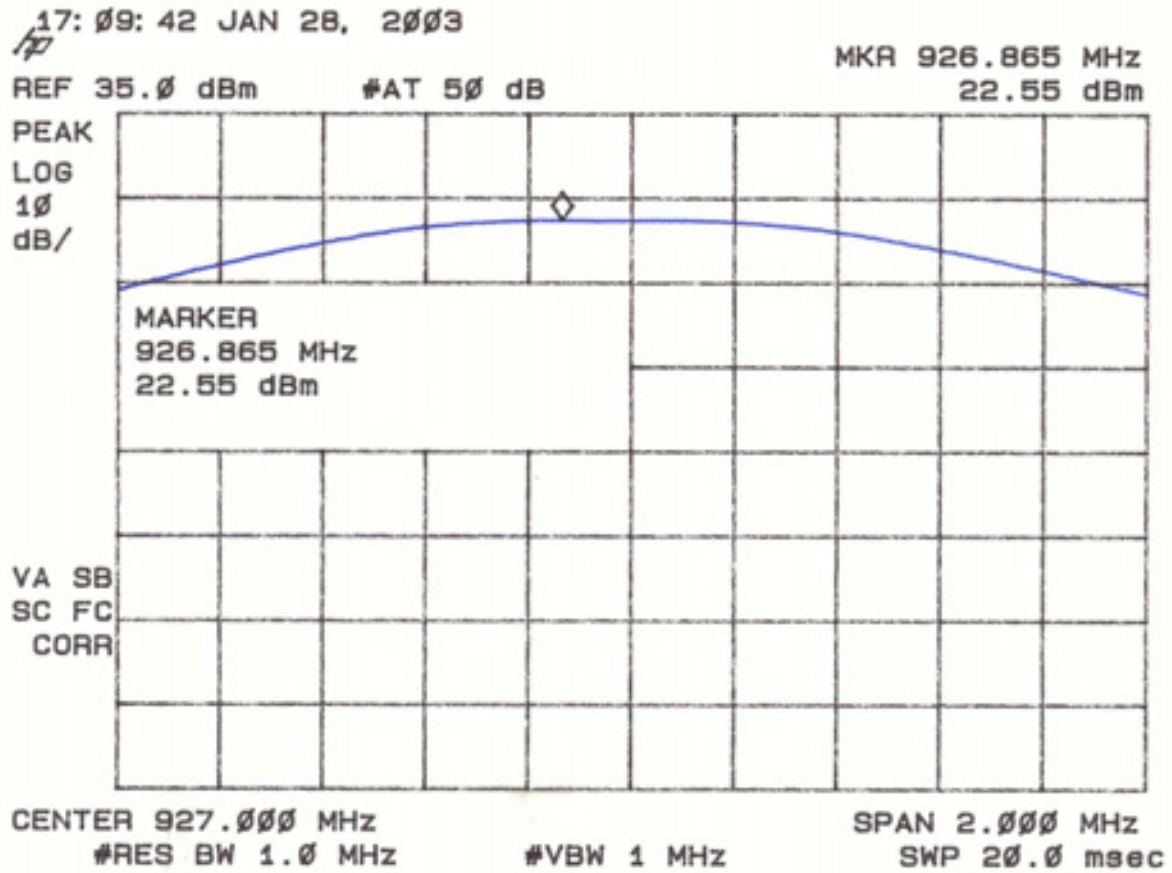


Figure 3c.
Peak Power per FCC Section 15.247(b) (High)



2.8 Antenna Conducted Spurious Emission in the Frequency Range 30 - 10000 MHz (FCC Section 15.247(c))

Spurious emissions in the frequency range 30 - 10000 have been measured with a spectrum analyzer by connecting the spectrum analyzer directly via a short cable to the antenna output terminals or across the antenna leads on the PCB as specified by the manufacturer. The spectrum analyzer was set for a $50\ \Omega$ impedance with the RBW = 100 kHz & VBW > RBW. All spurious emissions were measured to be greater than 20 dB down from the fundamental. The results of conducted spurious emissions are given in Figure 4a through Figure 4l.

Figure 4a
Antenna Conducted Spurious Emissions 15.247(c) Low

NOTE: Due to large span used,
frequency appears off. Actual Frequency
of the fundamental is 903.0 MHz.

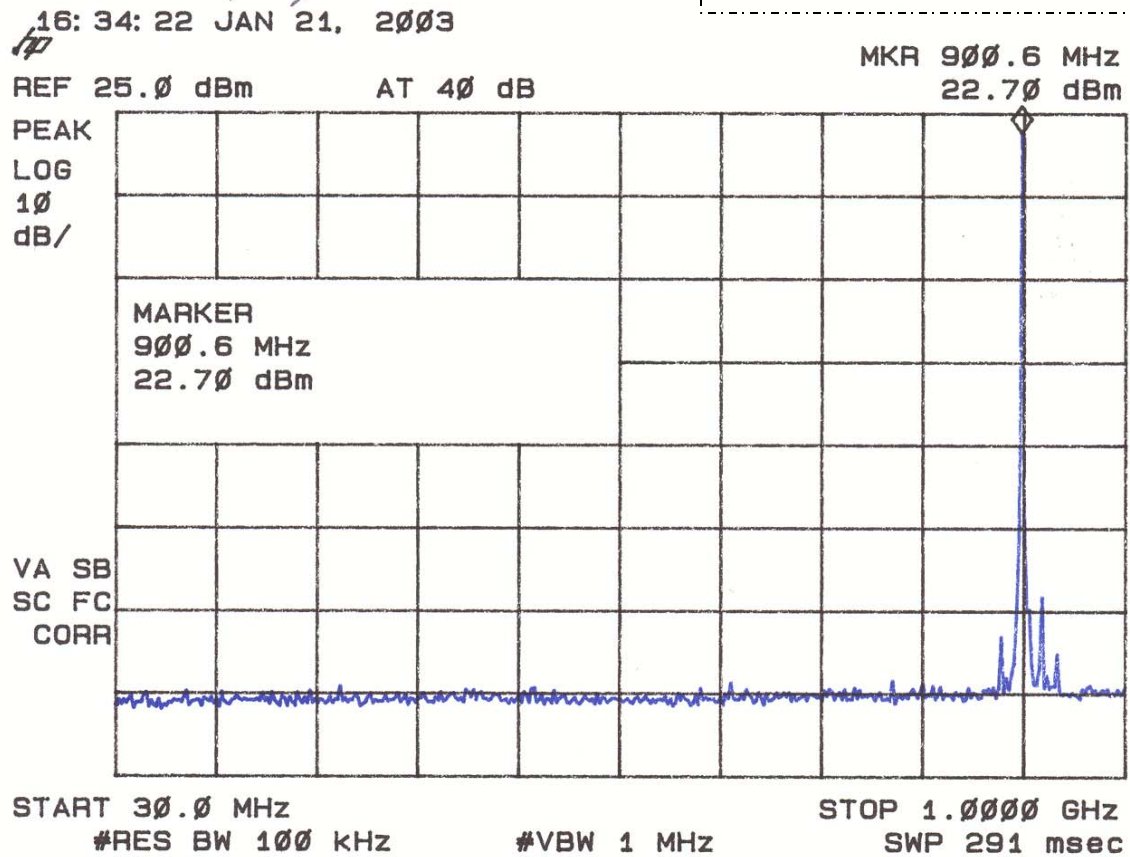


Figure 4b
Antenna Conducted Spurious Emissions 5.247(c) Low

NOTE: Due to large span used,
frequency appears off. Actual Frequency
of the fundamental is 903.0 MHz.

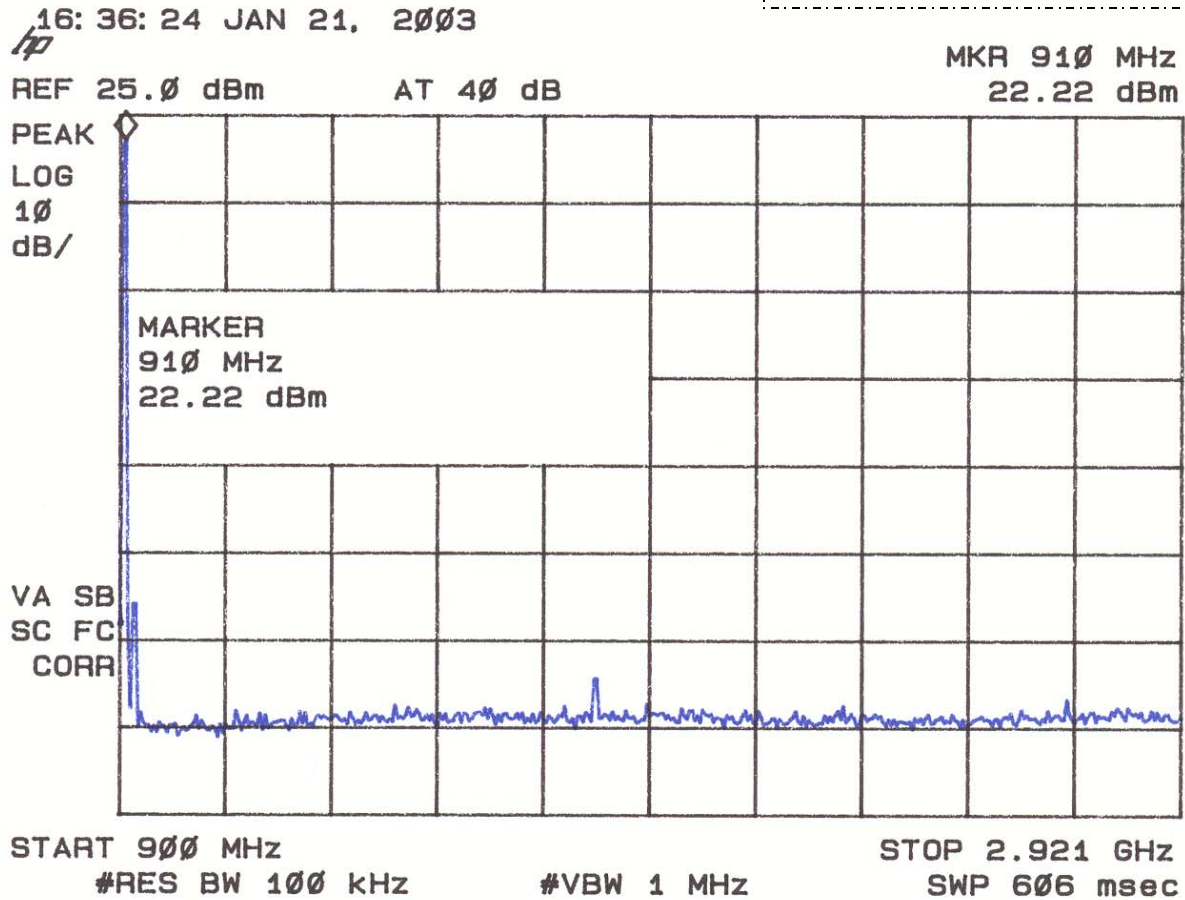


Figure 4c
Antenna Conducted Spurious Emissions 15.247(c) Low

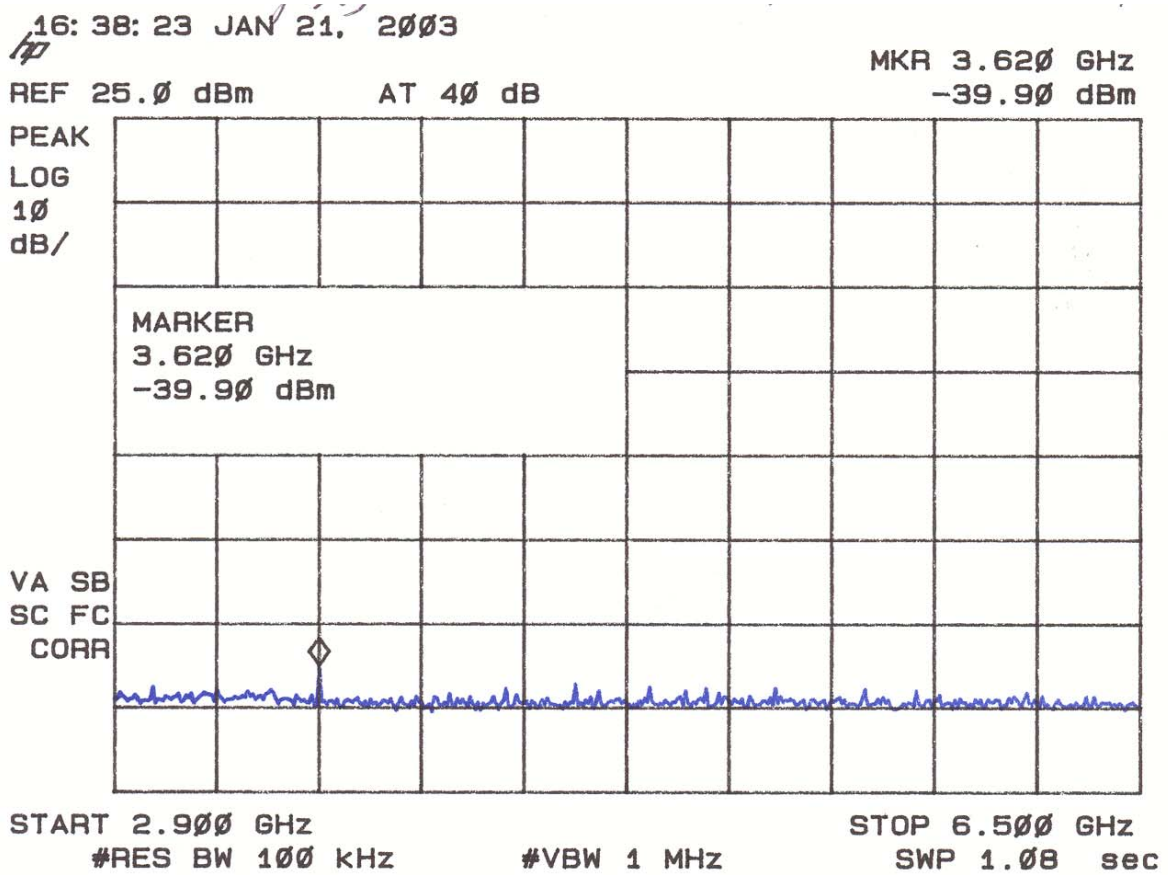


Figure 4d
Antenna Conducted Spurious Emissions 15.247(c) Low

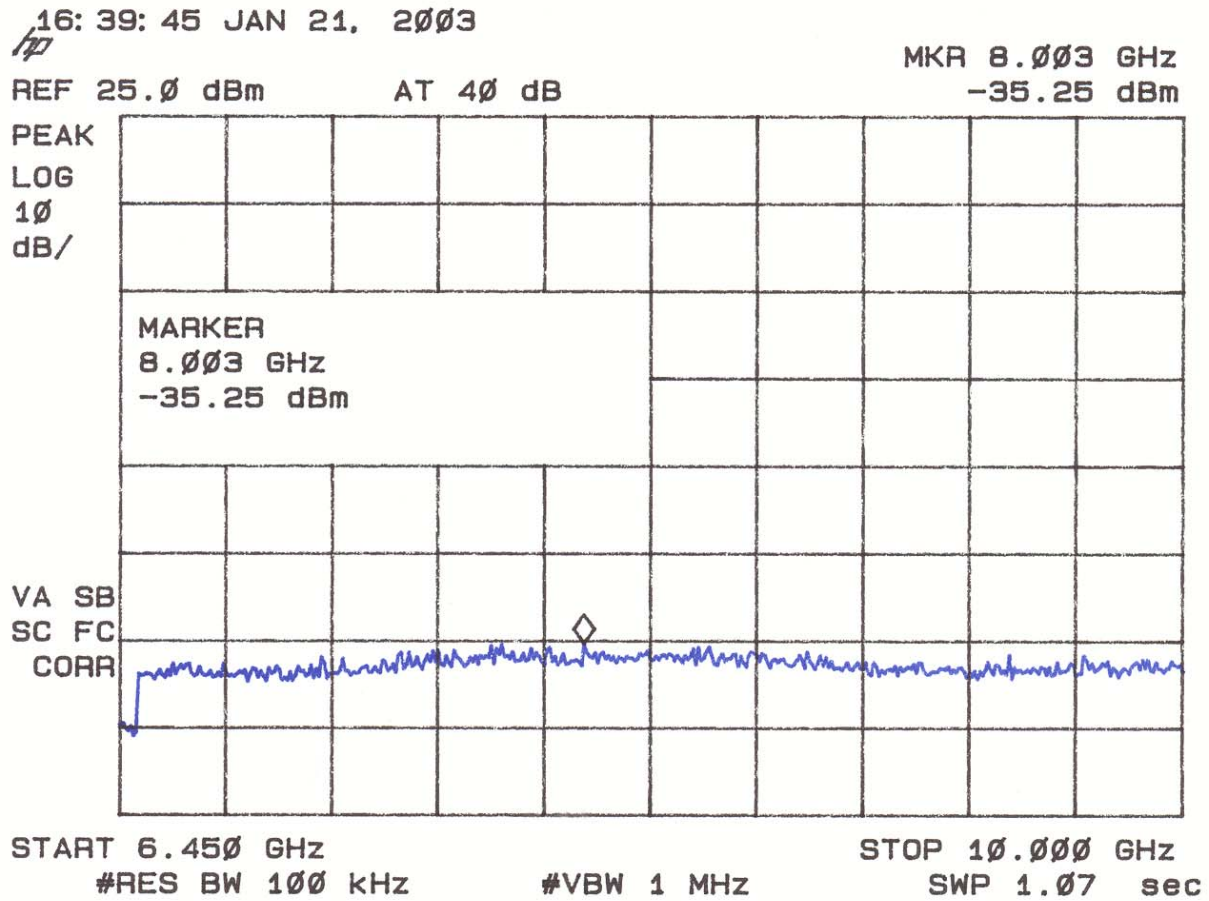


Figure 4e
Antenna Conducted Spurious Emissions 15.247(c) Mid

NOTE: Due to large span used,
frequency appears off. Actual Frequency
of the fundamental is 915.0 MHz.

17:14:07 JAN 21, 2003

~~17~~

REF 25.0 dBm

AT 40 dB

MR 912.7 MHz

21.09 dBm

PEAK

LOG

10

dB/

MARKER

912.7 MHz

21.09 dBm

VA SB

SC FC

CORR

START 30.0 MHz

#RES BW 100 kHz

#VBW 1 MHz

STOP 1.0000 GHz

SWP 291 msec

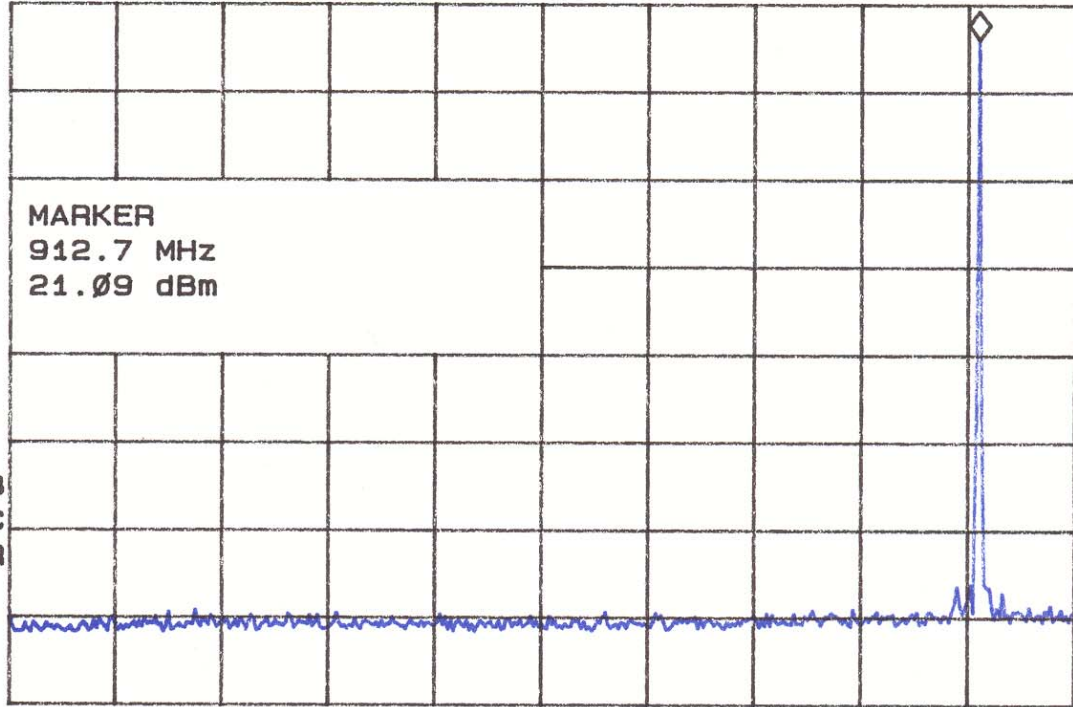


Figure 4f
Antenna Conducted Spurious Emissions 15.247(c) Mid

NOTE: Due to large span used,
frequency appears off. Actual Frequency
of the fundamental is 915.0 MHz.

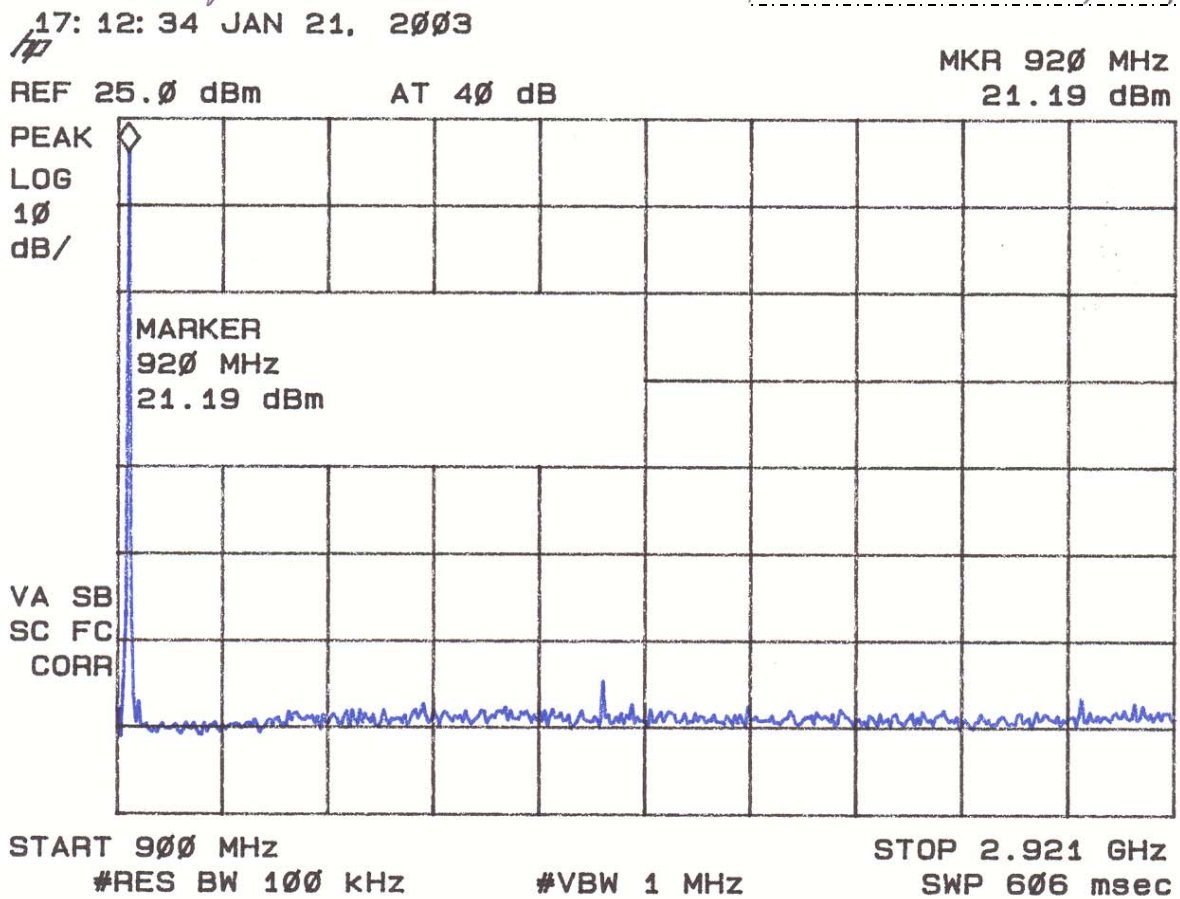


Figure 4g
Antenna Conducted Spurious Emissions 15.247(c) Mid

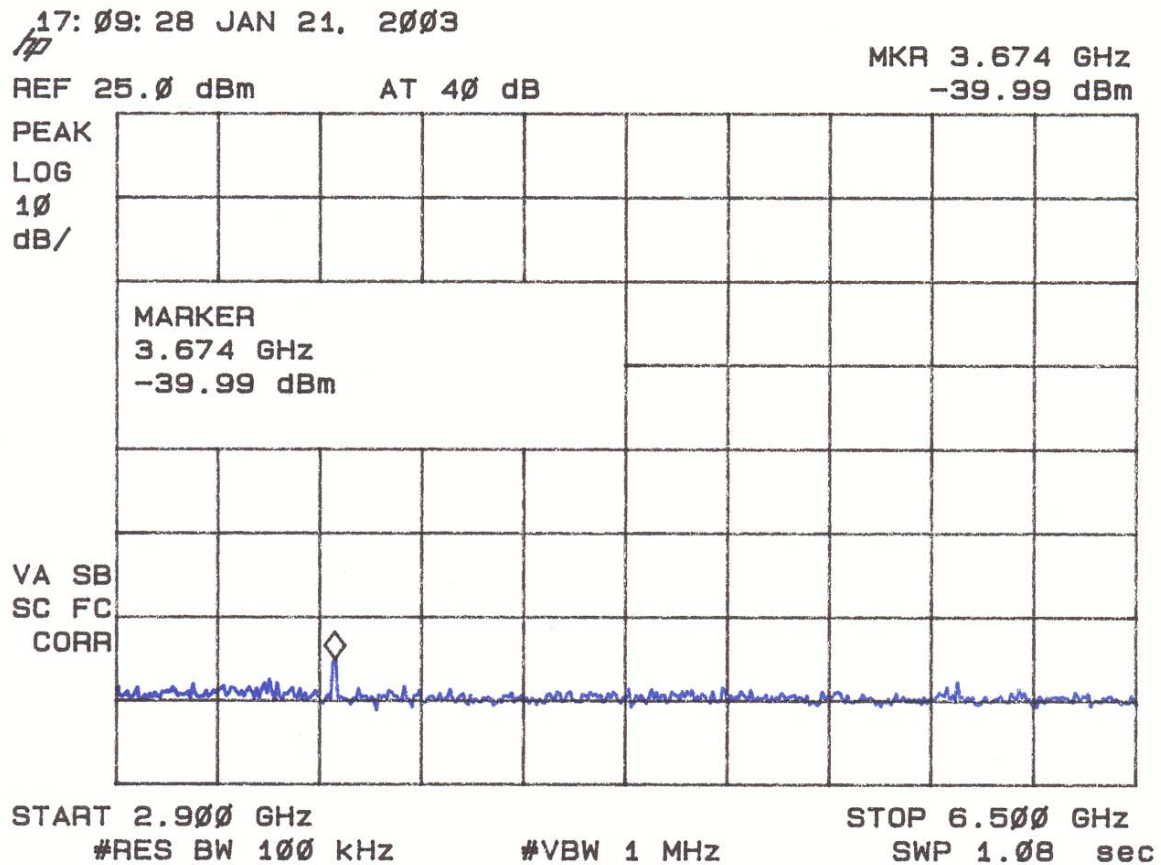


Figure 4h
Antenna Conducted Spurious Emissions 15.247(c) Mid

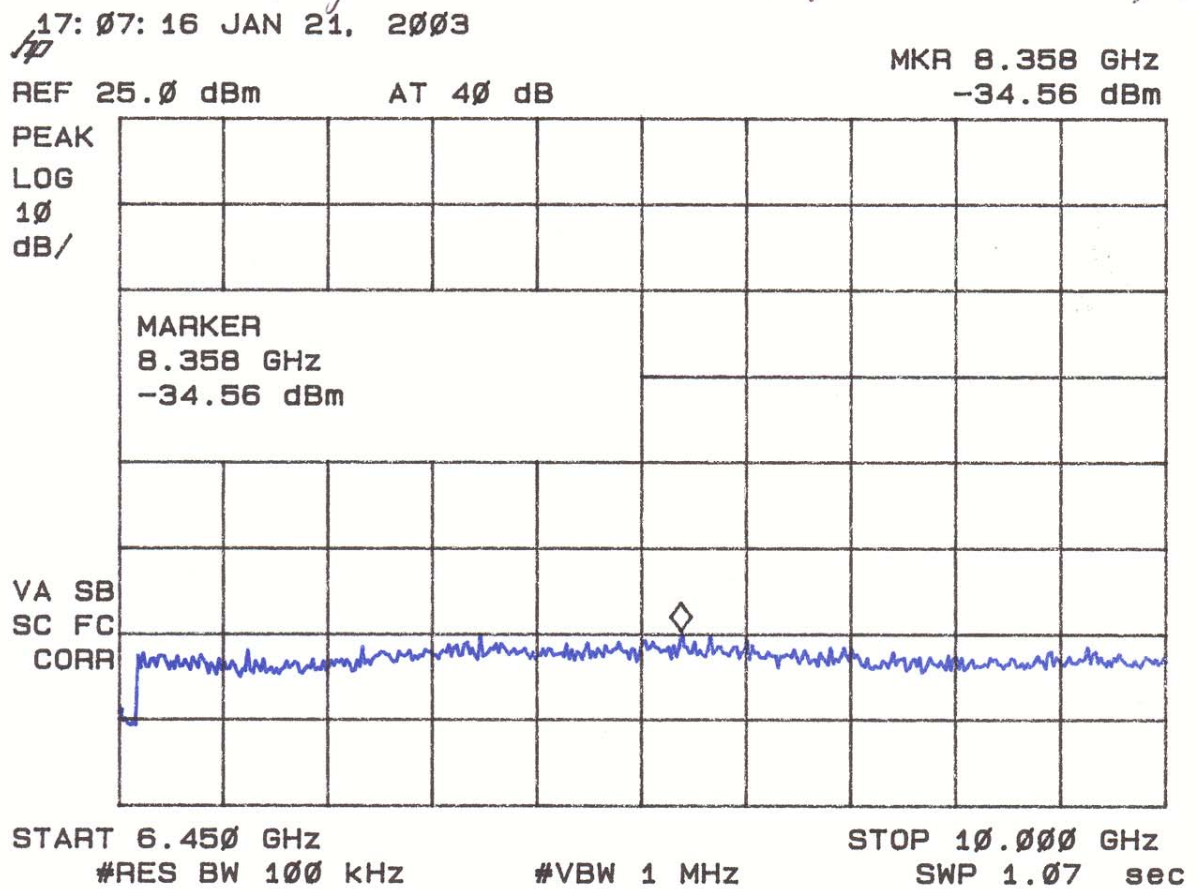


Figure 4i
Antenna Conducted Spurious Emissions 15.247(c) High

NOTE: Due to large span used,
frequency appears off. Actual Frequency
of the fundamental is 927.0 MHz.

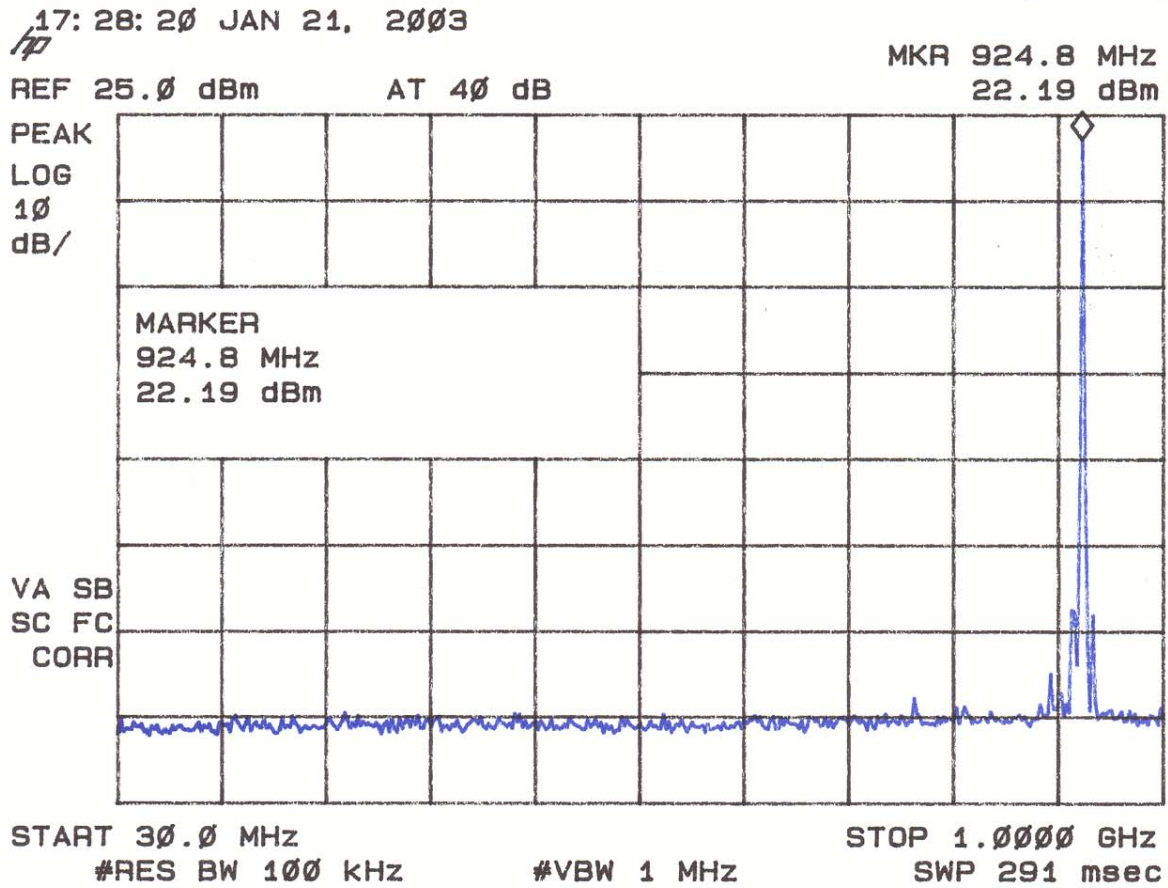


Figure 4j
Antenna Conducted Spurious Emissions 15.247(c) High

NOTE: Due to large span used,
frequency appears off. Actual Frequency
of the fundamental is 927.0 MHz.

17: 29: 49 JAN 21, 2003

17

REF 25.0 dBm

AT 40 dB

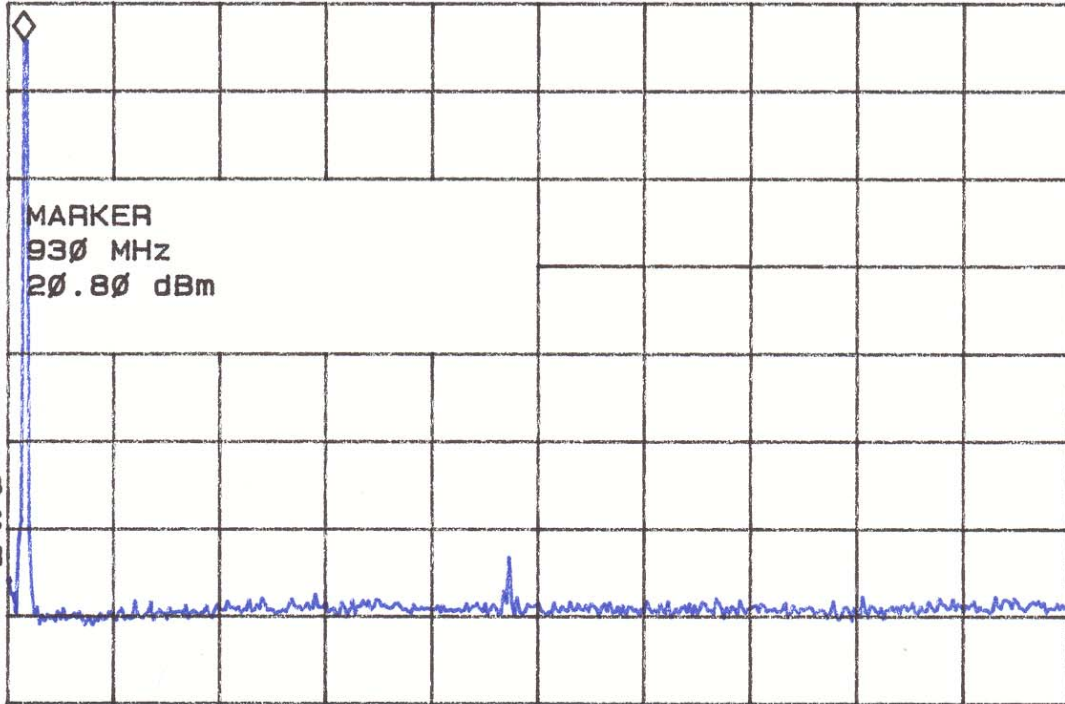
MKR 930 MHz

20.80 dBm

PEAK
LOG
10
dB/

MARKER
930 MHz
20.80 dBm

VA SB
SC FC
CORR



START 900 MHz

#RES BW 100 kHz

#VBW 1 MHz

STOP 2.921 GHz

SWP 606 msec

Figure 4k
Antenna Conducted Spurious Emissions 15.247(c) High

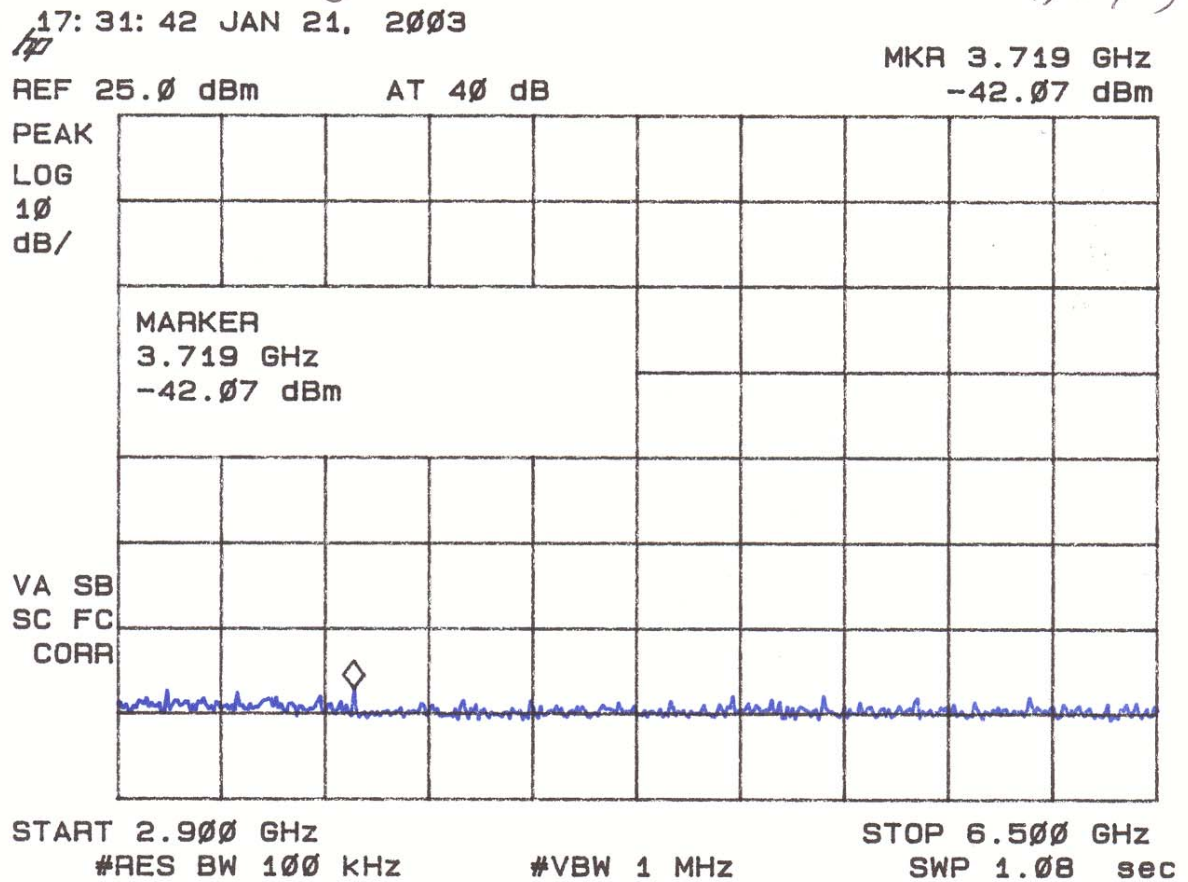
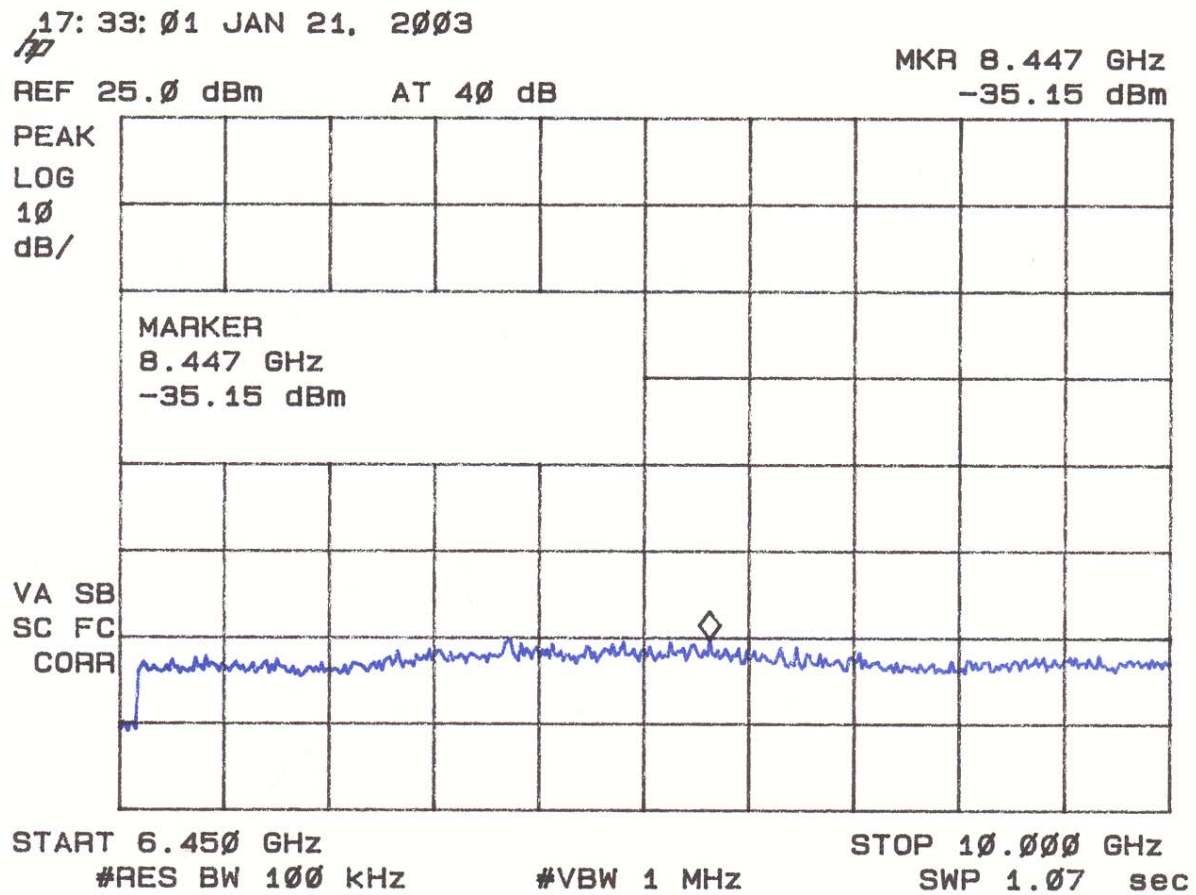


Figure 4l
Antenna Conducted Spurious Emissions 15.247(c) High



2.9 Peak Radiated Spurious Emission in the Frequency Range 30 -10000 MHz (FCC Section 15.247(c))

The EUT was hop-stopped and when possible placed into a continuous transmit mode of operation. A preliminary scan was performed on the EUT to determine frequencies that were caused by the transmitter portion of the product. Significant emissions that fell within restricted bands were then measured on an OAT's site. Radiated measurements below 1 GHz were tested with a RBW = 120 kHz. Radiated measurements above 1 GHz were measured using a RBW = VBW = 1 MHz. The results of peak radiated spurious emissions falling within restricted bands are given in Table 4a (low), Table 4b, (mid), Table 4c (high).

TABLE 4a PEAK RADIATED SPURIOUS EMISSIONS (Low)

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) @3m	FCC Limits (uV/m) @3m
1.80603	-12.10	34.6	28.5	3.0	31.3 dBd*	> 20 dBd
2.70938	-52.04	34.2	30.7	3.8	585.2	5000.0
3.61235	-56.62	33.8	33.1	4.9	536.8	5000.0
4.51448	-51.55	33.4	33.7	5.6	1161.3	5000.0

TABLE 4b PEAK RADIATED SPURIOUS EMISSIONS (Mid)

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) @3m	FCC Limits (uV/m) @3m
1.82975	-7.98	34.5	28.6	3.0	26.3 dBd*	> 20 dBd
2.74468	-43.29	34.2	30.8	3.8	1620.9	5000.0
3.69548	-53.65	33.8	33.3	5.0	789.7	5000.0
4.5745	-52.96	33.4	33.9	5.6	1010.8	5000.0

TABLE 4c PEAK RADIATED SPURIOUS EMISSIONS (High)

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) @3m	FCC Limits (uV/m) @3m
1.2834	-23.04	35.2	26.4	2.8	44.9 dBd*	> 20 dBd
1.85375	-11.58	34.5	28.8	3.0	30.1 dBd*	> 20 dBd
2.78075	-53.32	34.1	30.8	3.9	516.8	5000.0
3.70795	-53.61	33.7	33.4	5.0	798.6	5000.0
4.63557	-48.56	33.4	34.1	5.6	1718.1	5000.0

*Note: results relative to radiated fundamental results

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) = Antilog ((-52.04 - 34.2 + 30.7 + 3.8 + 107)/20) = 585.2

CONVERSION FROM dBm TO dBuV = 107 dB

Tester

Signature: David P. Blethen **Name:** David Blethen

2.10 Average Spurious Emission in the Frequency Range 30 - 10000 MHz (FCC Section 15.247(c))

The results of average radiated spurious emissions falling within restricted bands are given in Table 5a (low), Table 5b, (mid), Table 5c (high). Measurements were made with a RBW = 1 MHz, VBW = 10 Hz.

TABLE 5a AVERAGE RADIATED SPURIOUS EMISSIONS (Low)

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) @3m	FCC Limits (uV/m) @3m
2.70938	-69.70	34.2	30.7	3.8	76.6	500.0
3.61235	-70.73	33.8	33.1	4.9	105.8	500.0
4.51448	-68.65	33.4	33.7	5.6	162.2	500.0

TABLE 5b AVERAGE RADIATED SPURIOUS EMISSIONS (Mid)

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) @3m	FCC Limits (uV/m) @3m
1.82975	-19.75	34.5	28.6	3.0	16544.6	500.0
2.74468	-62.00	34.2	30.8	3.8	188.0	500.0
3.69548	-69.30	33.8	33.3	5.0	130.3	500.0
4.5745	-61.73	33.4	33.9	5.6	368.3	500.0

TABLE 5c AVERAGE RADIATED SPURIOUS EMISSIONS (High)

Freq. (GHz)	Test Data* (dBm) @3m	Amp. Gain (dB)	Antenna Factor (dB)	Cable Loss (dB)	Results (uV/m) @3m	FCC Limits (uV/m) @3m
2.78075	-65.79	34.1	30.8	3.9	123.0	500.0
3.70795	-66.51	33.7	33.4	5.0	180.9	500.0
4.63557	-61.57	33.4	34.1	5.6	384.2	500.0

* = Data adjusted by + 1dB for high pass filter and $20 \log (0.40) = 8.0 + 1.0 = 9.0$

** = Instrumentation ground floor.

SAMPLE CALCULATION:

RESULTS (uV/m @ 3m) =

$$\text{Antilog } ((-69.7 - 34.2 + 30.7 + 3.8 + 107)/20) = 76.6$$

CONVERSION FROM dBm TO dBuV = 107 dB

Tester

Signature: David Blethen **Name:** David Blethen

2.11 20 dB Bandwidth per FCC Section 15.247(a)(1)(i)

The minimum requirement is given in Figure 5a through 5c. The spectrum analyzer was set for a 50 Ω impedance with the RBW = approximately 1/100 of the manufacturers claimed RBW & VBW > RBW. The channel separation is shown in Figure 5d.

TABLE 6
20 dB Bandwidth

Test Date: January 29, 2003
UST Project: 03-0020
Customer: Elkhart Brass Mfg. Co., Inc.
Model: PTSS2003 Spread Spectrum Transceiver Module

Frequency (MHz)	20 dB Bandwidth (kHz)
903.0	350.0
915.0	338.0
927.0	413.0

Results: The EUT is considered to have a 20 dB bandwidth that is > than 250 kHz and does not exceed the maximum of 500 kHz.

(Measured Channel Separation)

Frequency of Channel Separation (kHz)	Minimum FCC Limit (kHz)
465	413.0 20 dB bandwidth

Note: The minimum channel separation limit is 25 kHz or the 20 dB bandwidth, whichever is greater

Tester
Signature: David P. Blethen **Name:** David Blethen

Figure 5a.
20 dB Bandwidth per FCC Section 15.247(a)(1)(i) (low)

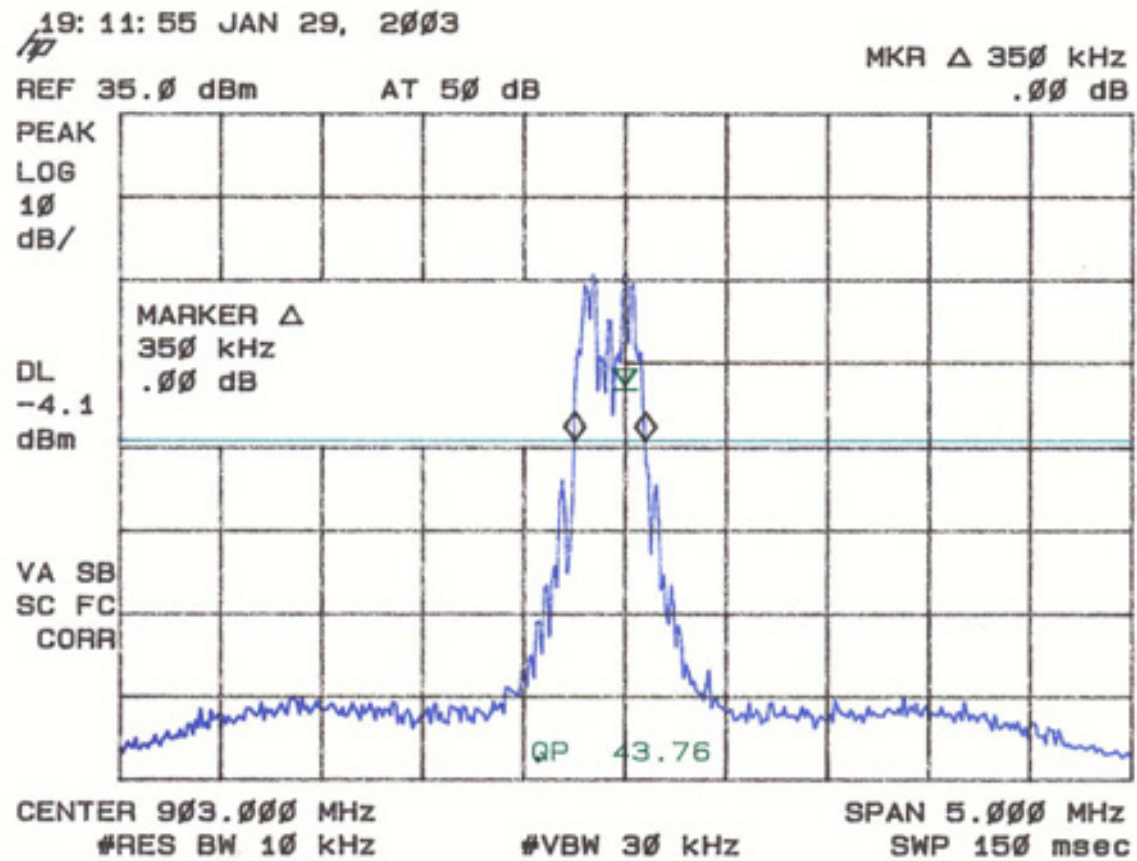


Figure 5b.
20 dB Bandwidth per FCC Section 15.247(a)(1)(i) (Mid)

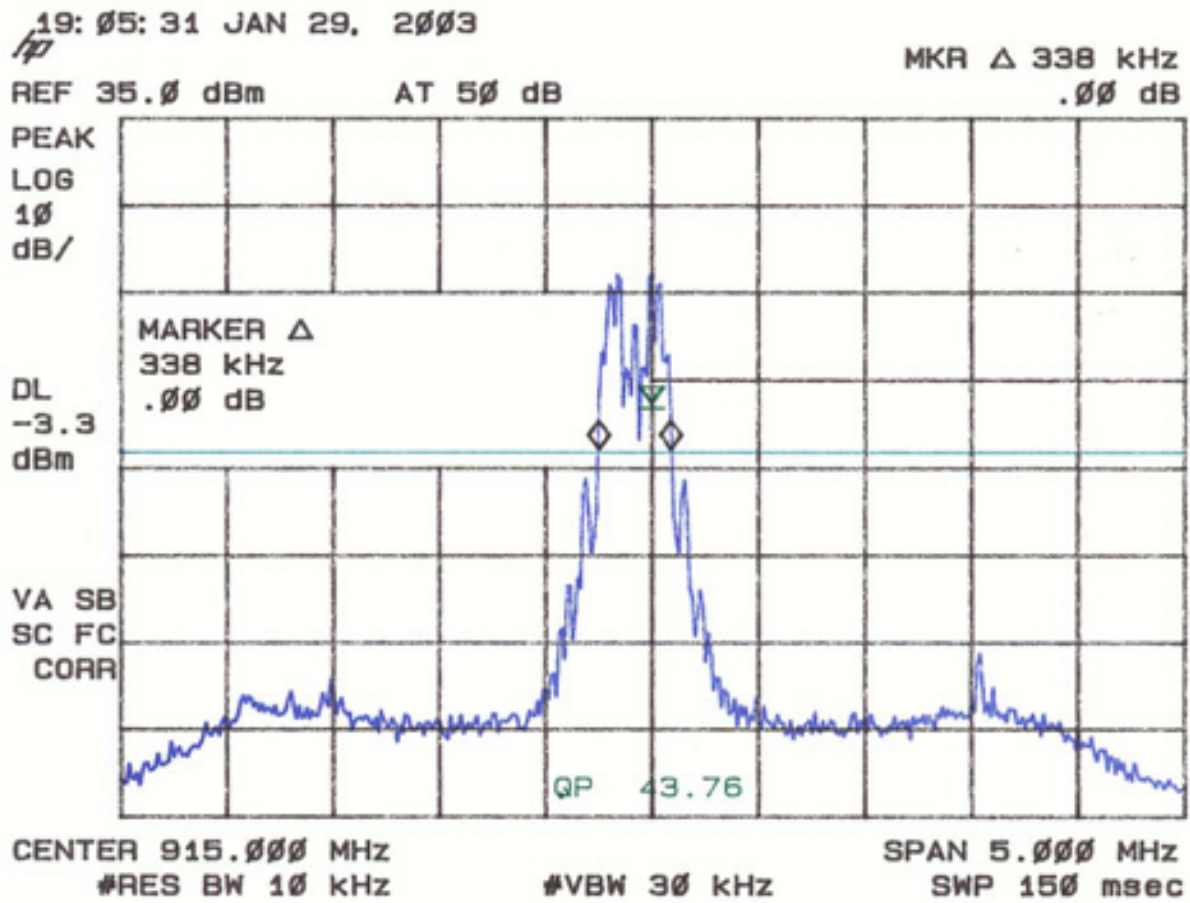


Figure 5c.
20 dB Bandwidth per FCC Section 15.247(a)(1)(i) (High)

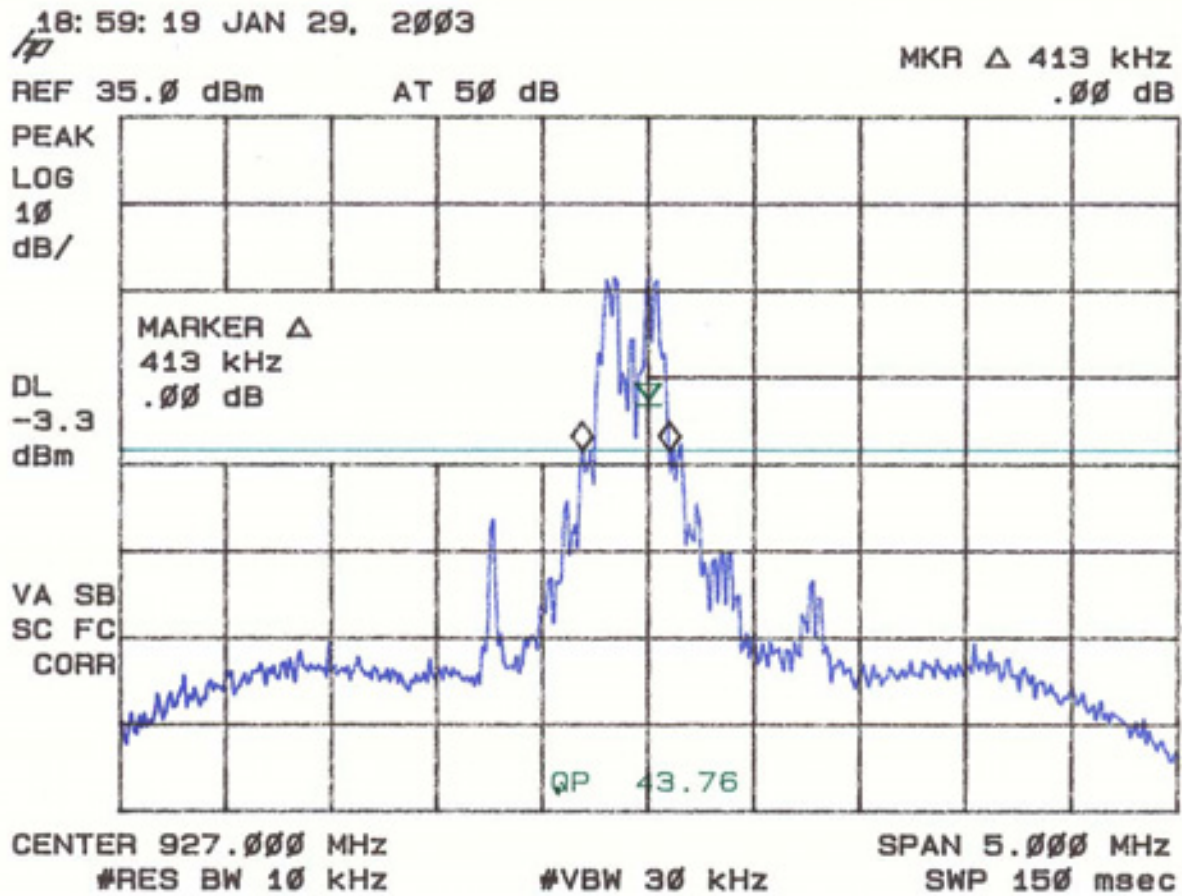
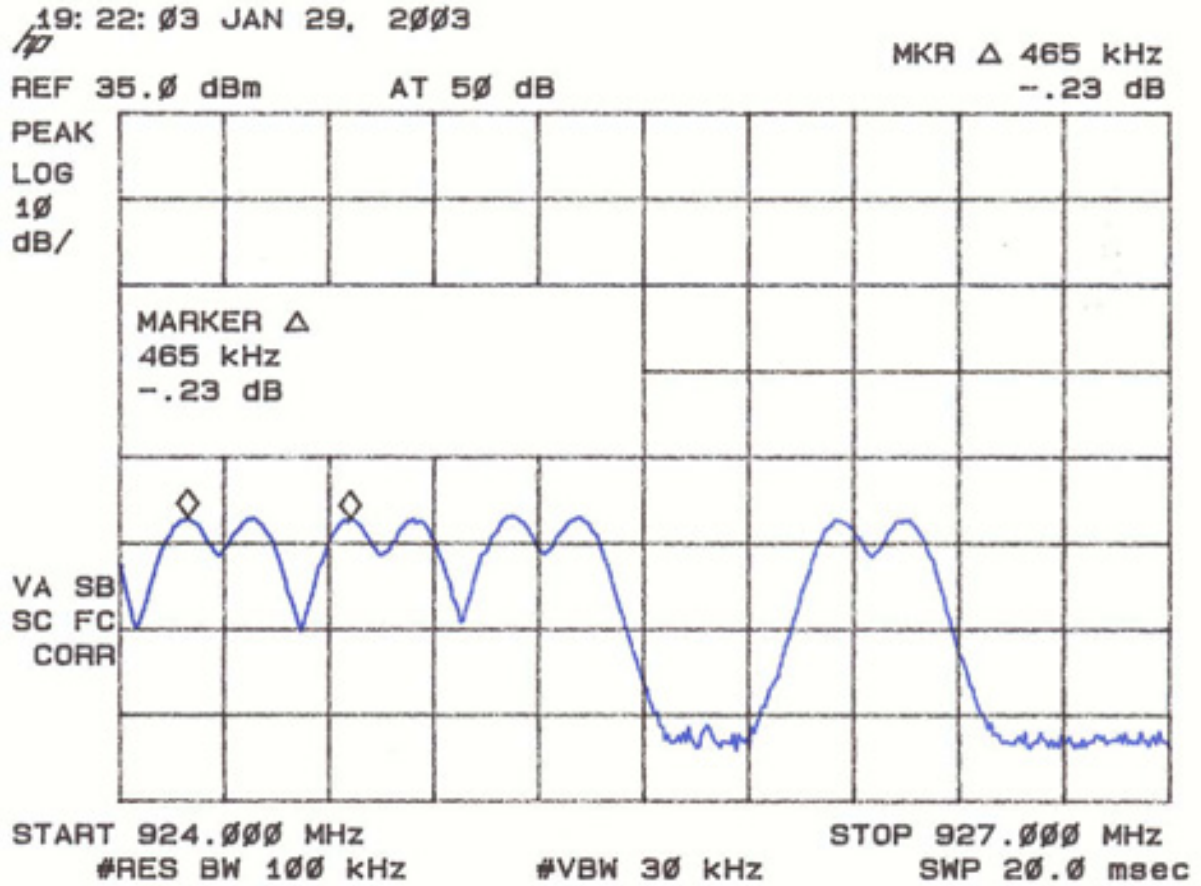


Figure 5d.
Channel Separation per FCC Section 15.247(a)(1)



2.12 Number of Hopping Channels FCC Section 15.247(a)(1)(i)

The transmitter was placed into a typical frequency hopping mode of operation. The 902-928 MHz band was centered on the screen and the RBW and VBW chosen such that the individual channels could be discerned.

Table 7
Number of Hopping Channels

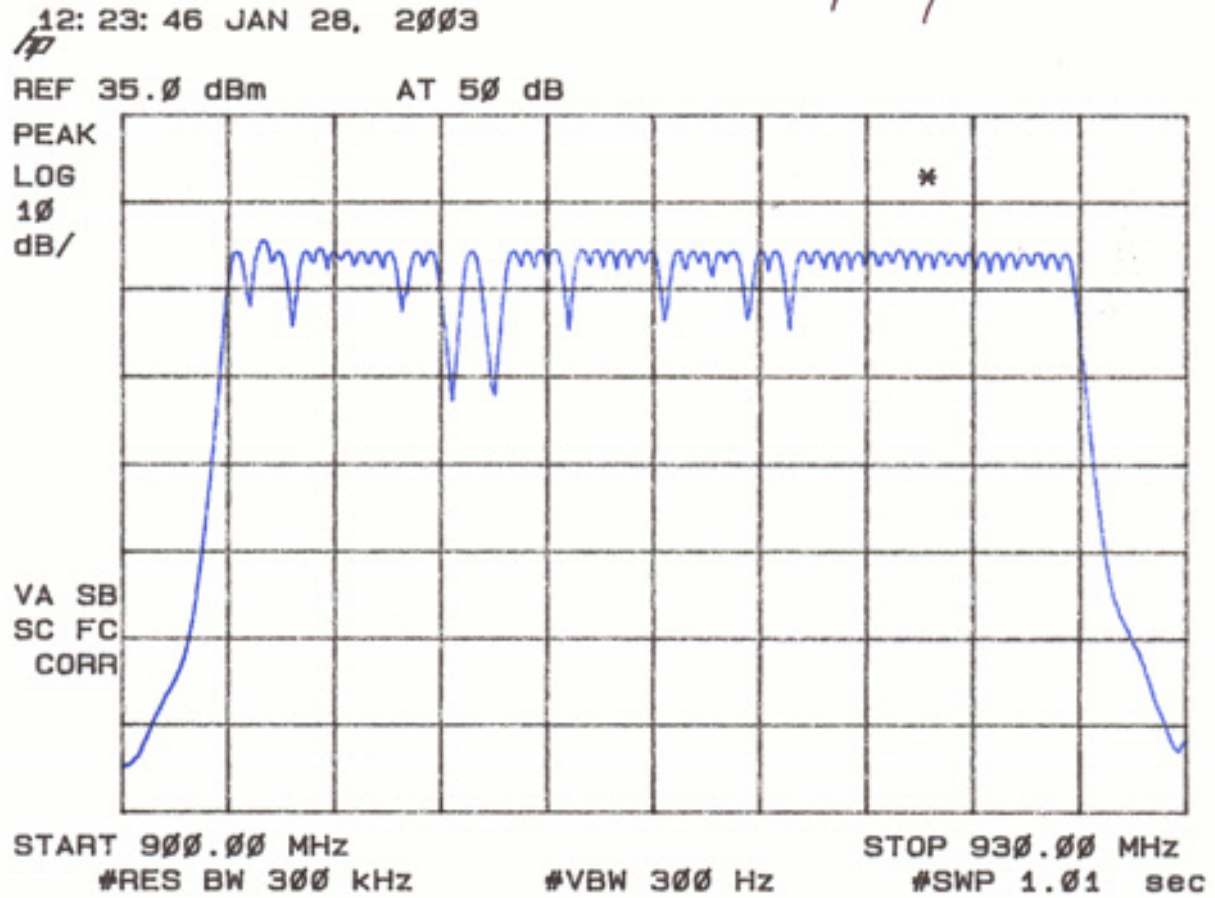
Test Date: January 28, 2003
UST Project: 03-0020
Customer: Elkhart Brass Mfg. Co., Inc.
Model: PTSS2003 Spread Spectrum Transceiver Module

Number of Hopping Frequencies Measured	FCC Limit (Minimum Number of Channels)
50	25

Note: If the 20 dB bandwidth is < 250 kHz, the FCC limit is \geq to 50 channels. If the 20 dB bandwidth is \geq 250 kHz the FCC limit is \geq 25 channels.

Tester
Signature: David P. Blethen **Name:** David Blethen

Figure 6.
Number of Hopping Channels



2.13 Average Time of Occupancy per Channel FCC Section 15.247(a)(1)(i)

The transmitter was placed into a typical frequency hopping mode of operation. Characteristics of the time of occupancy were measured as given in Table 8 and Figure 9.

Table 8
Average Time Of Occupancy Per Channel

Test Date: January 28, 2003
UST Project: 03-0020
Customer: Elkhart Brass Mfg. Co., Inc.
Model: PTSS2003 Spread Spectrum Transceiver Module

Measured Average Time of Occupancy per Channel During 10 Seconds Period (seconds)	FCC Limit (seconds per 10 seconds of time)
0.116	0.4

Note: The data for this test was provided from the manufacturer since a special test mode was necessary that could not be performed with the other tests.

Figure 7a
Average Time of Occupancy per Channel FCC Section 15.247(a)(1)(i)

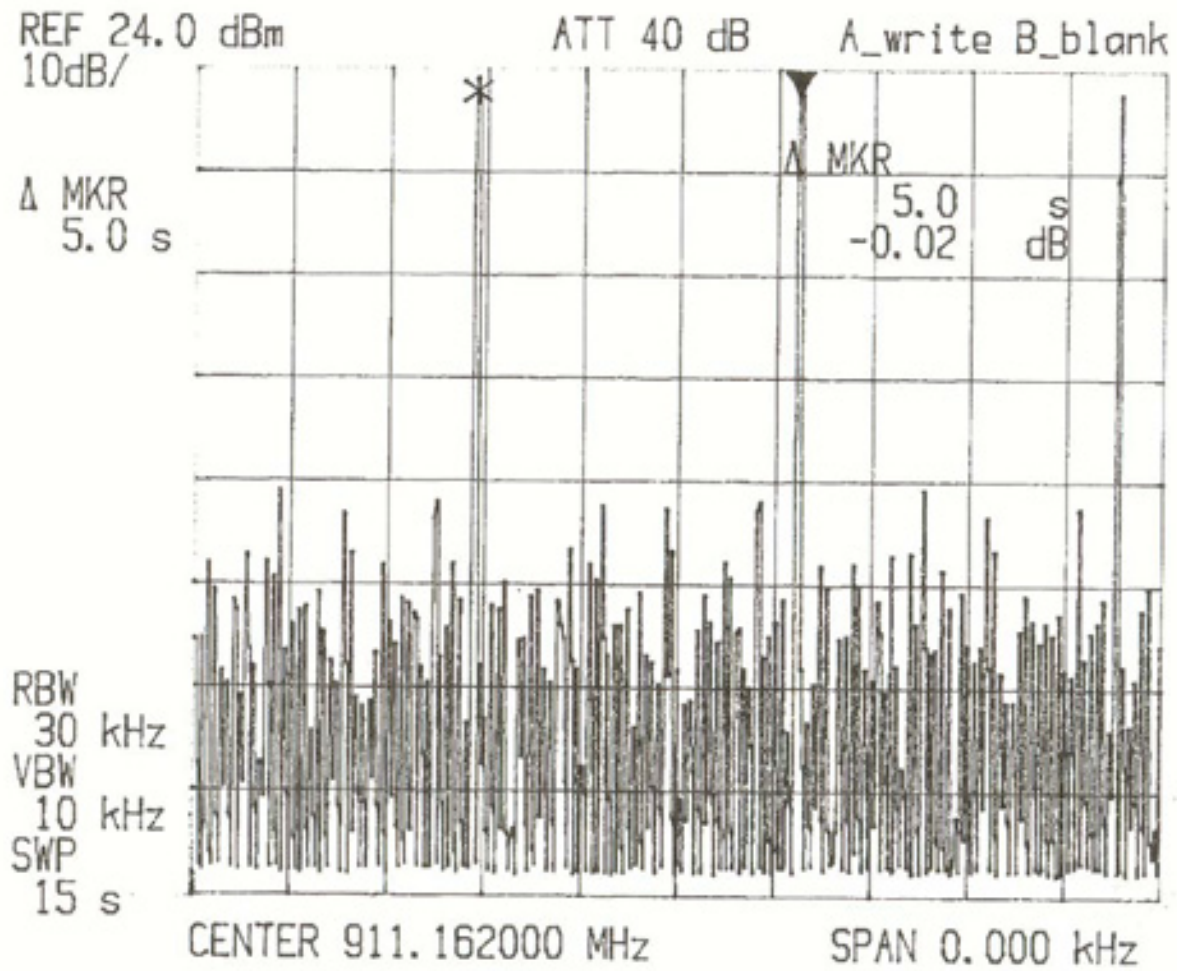


Figure 7b
Average Time of Occupancy per Channel FCC Section 15.247(a)(1)(i)

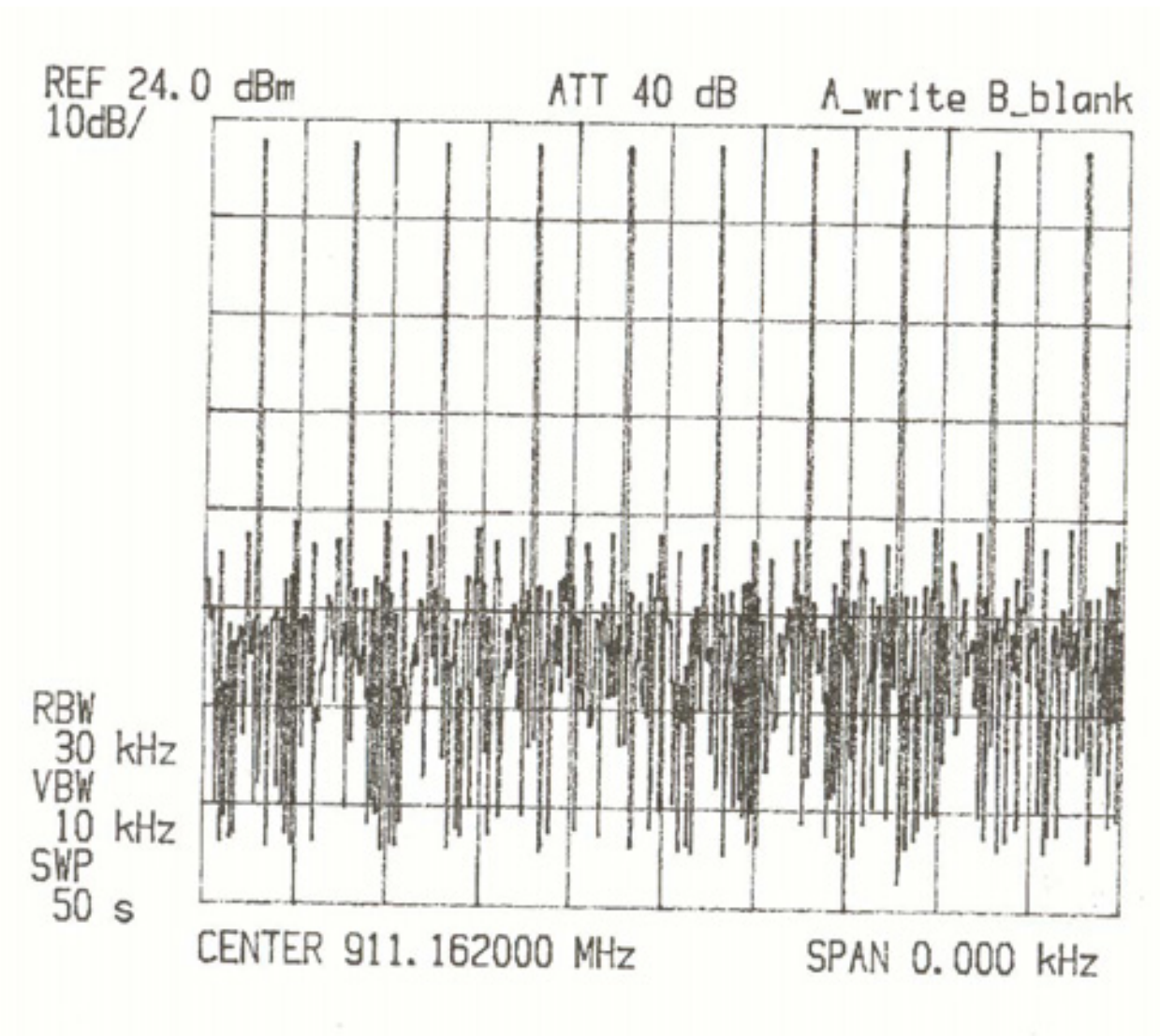
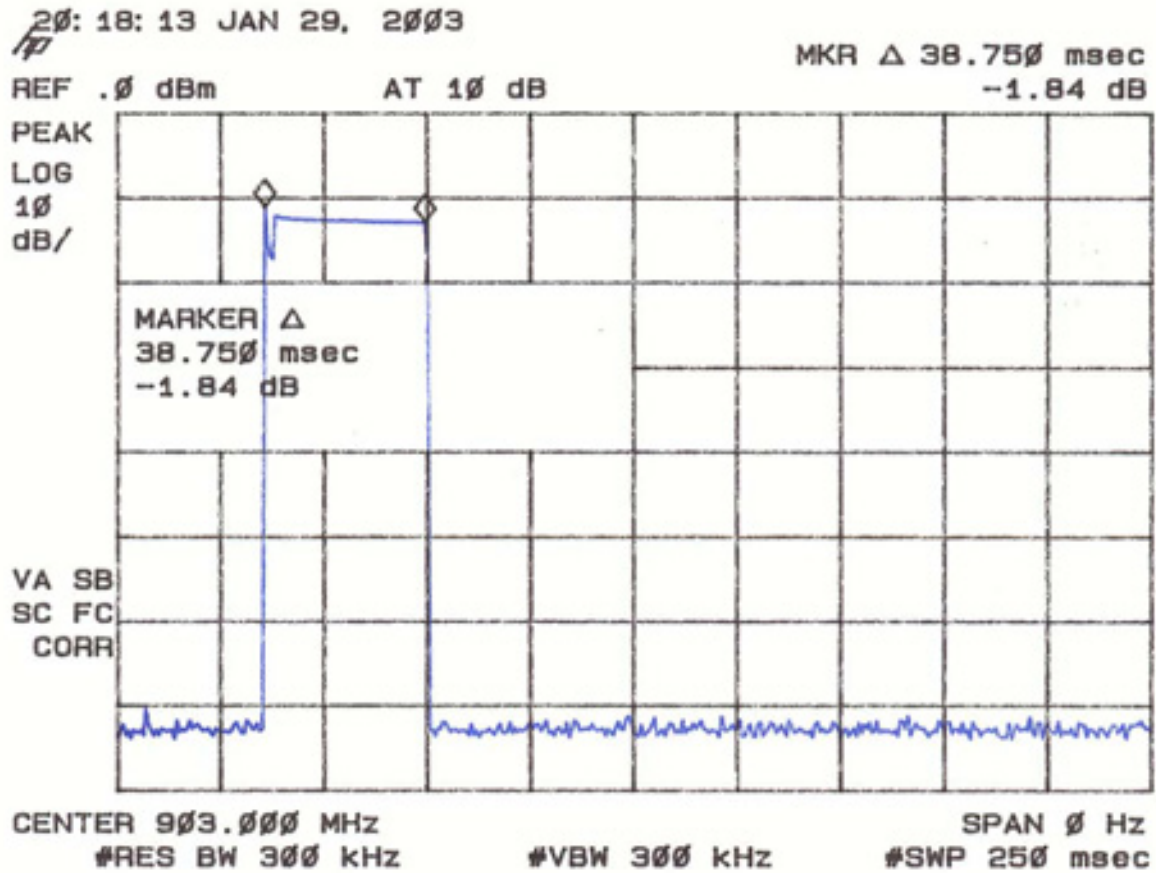


Figure 7c
Average Time of Occupancy per Channel FCC Section 15.247(a)(1)(i)

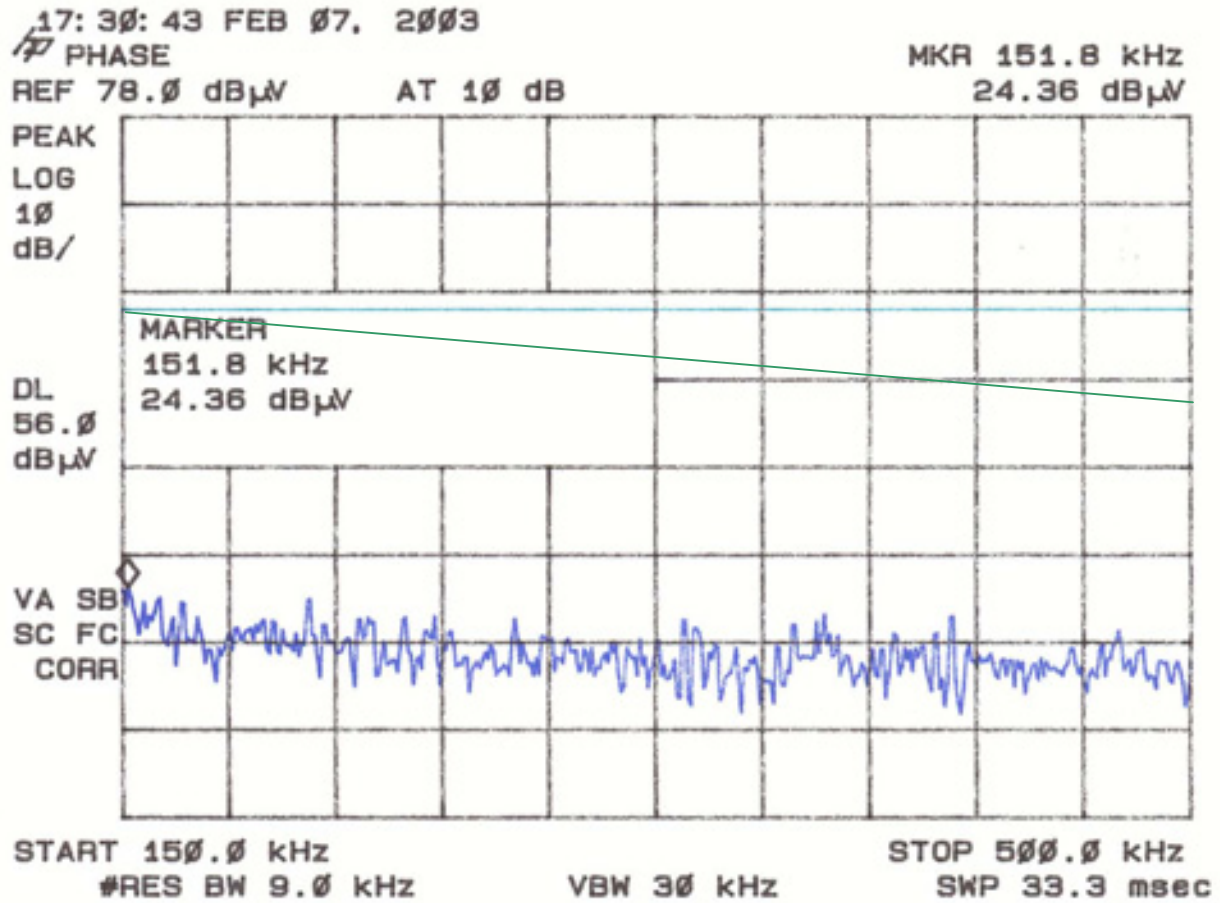


2.14 Power Line Conducted Emissions for Transmitter FCC Section 15.207 and 15.107

The conducted voltage measurements have been carried out in accordance with FCC Section 15.207/15.107, with a spectrum analyzer connected to a LISN and the EUT placed into a continuous mode of transmit. The results are given on the following pages. Since there is little difference between low, middle and high channels and transmit/receive, only one set of data has been provided.

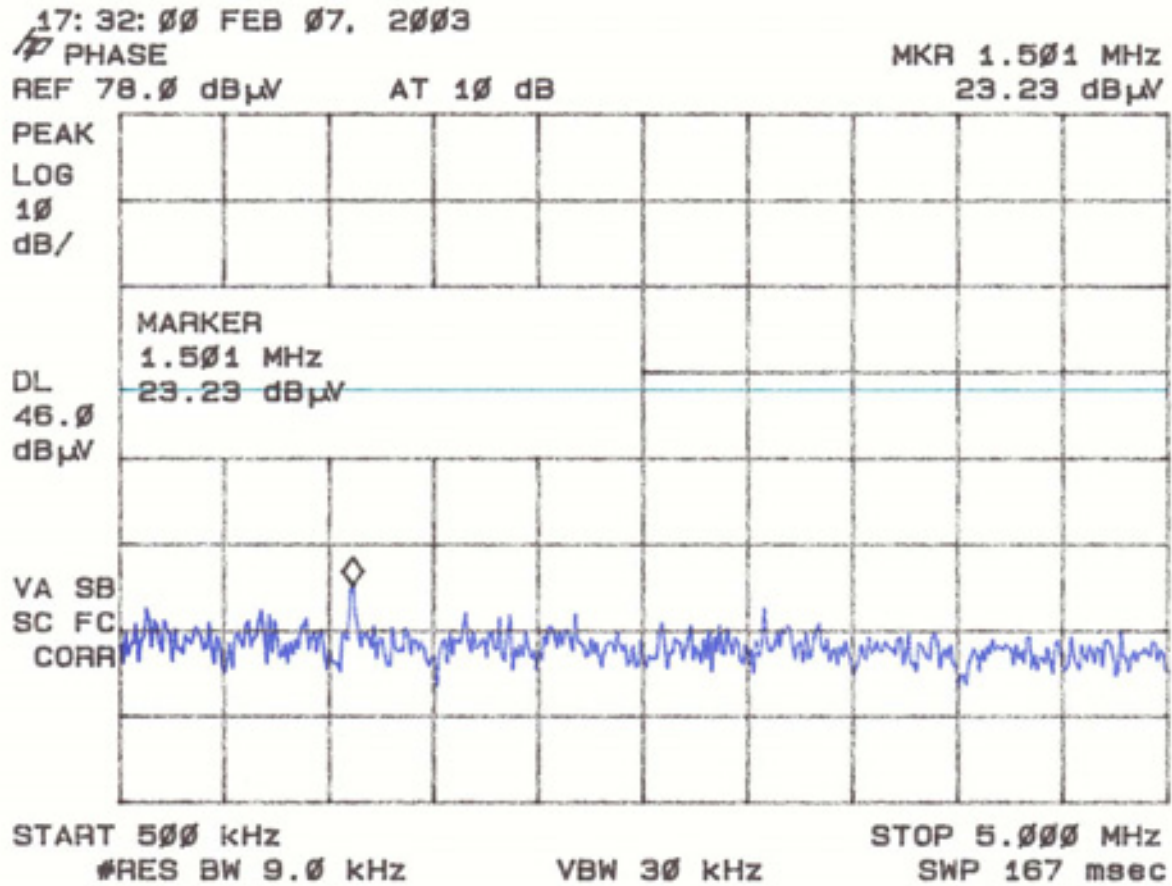
CONDUCTED EMISSIONS

Plot A



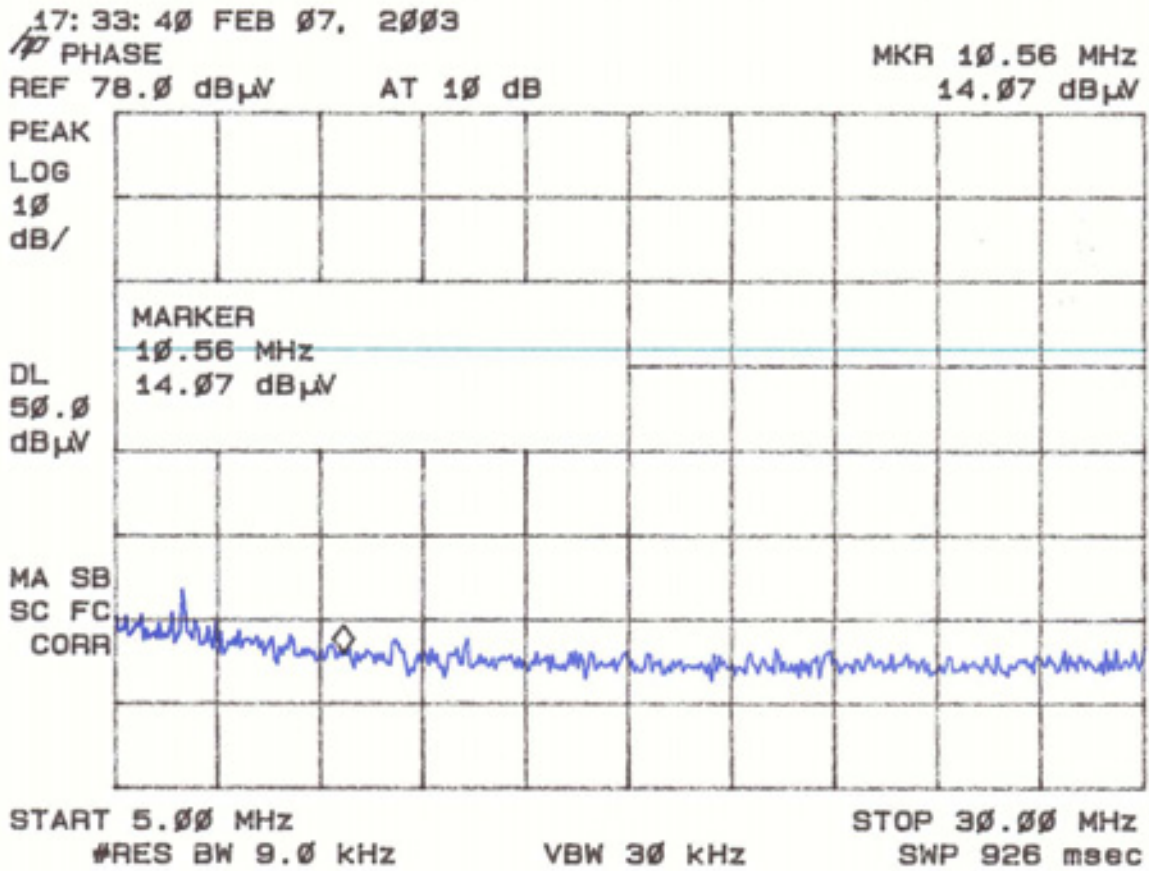
CONDUCTED EMISSIONS

Plot B



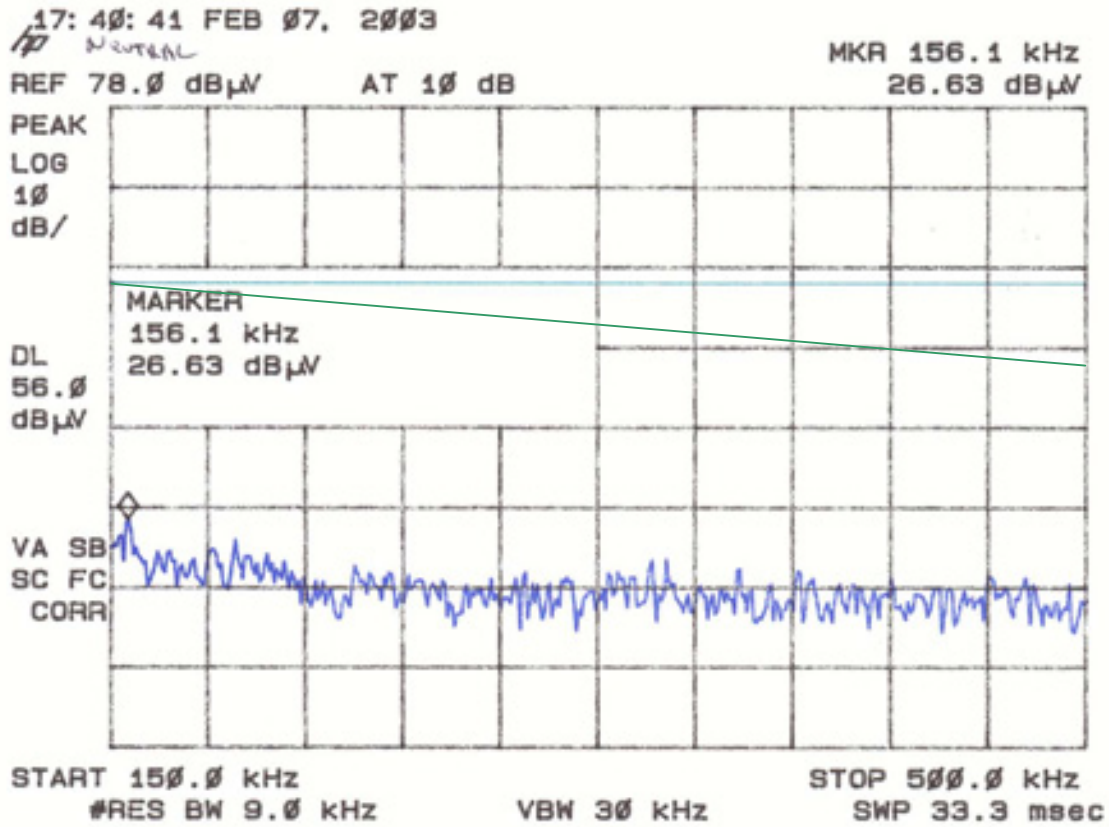
CONDUCTED EMISSIONS

Plot C



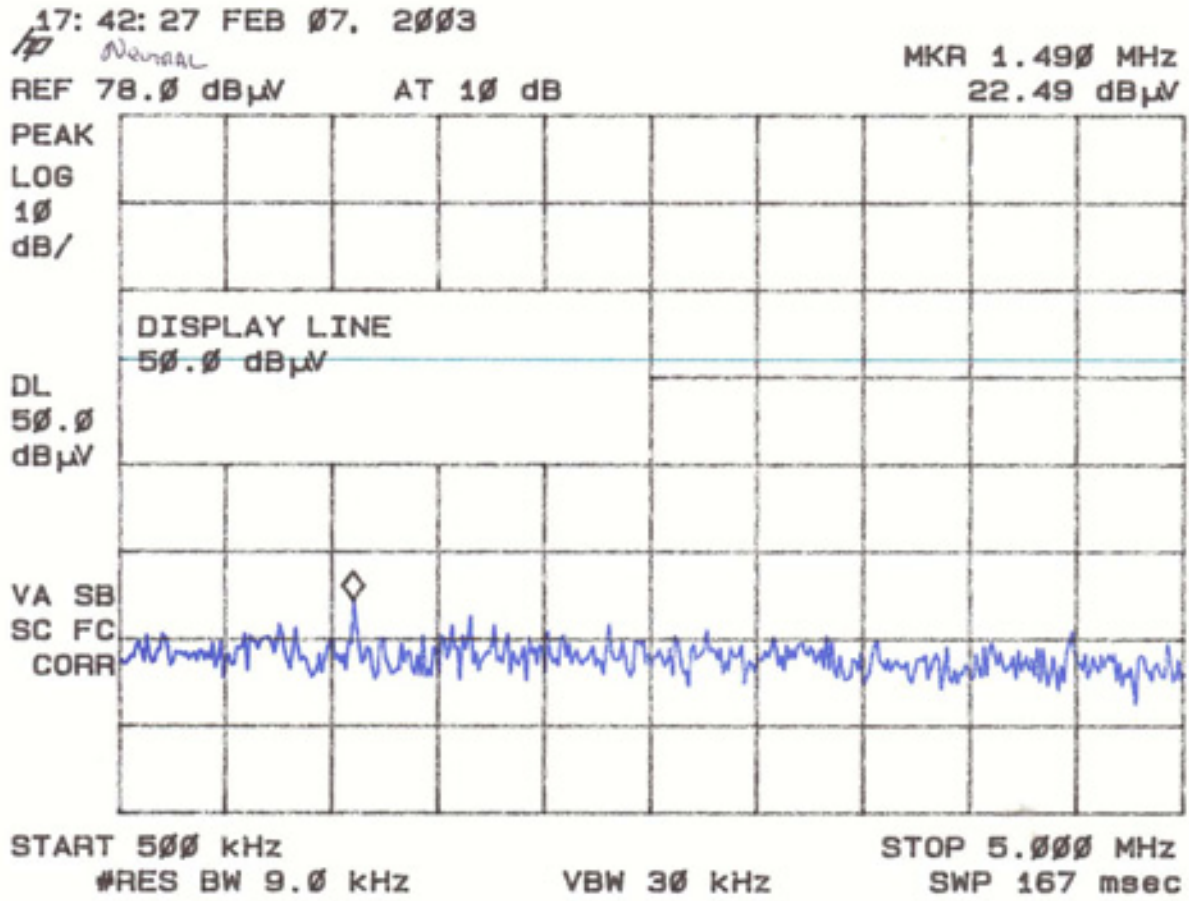
CONDUCTED EMISSIONS

Plot D



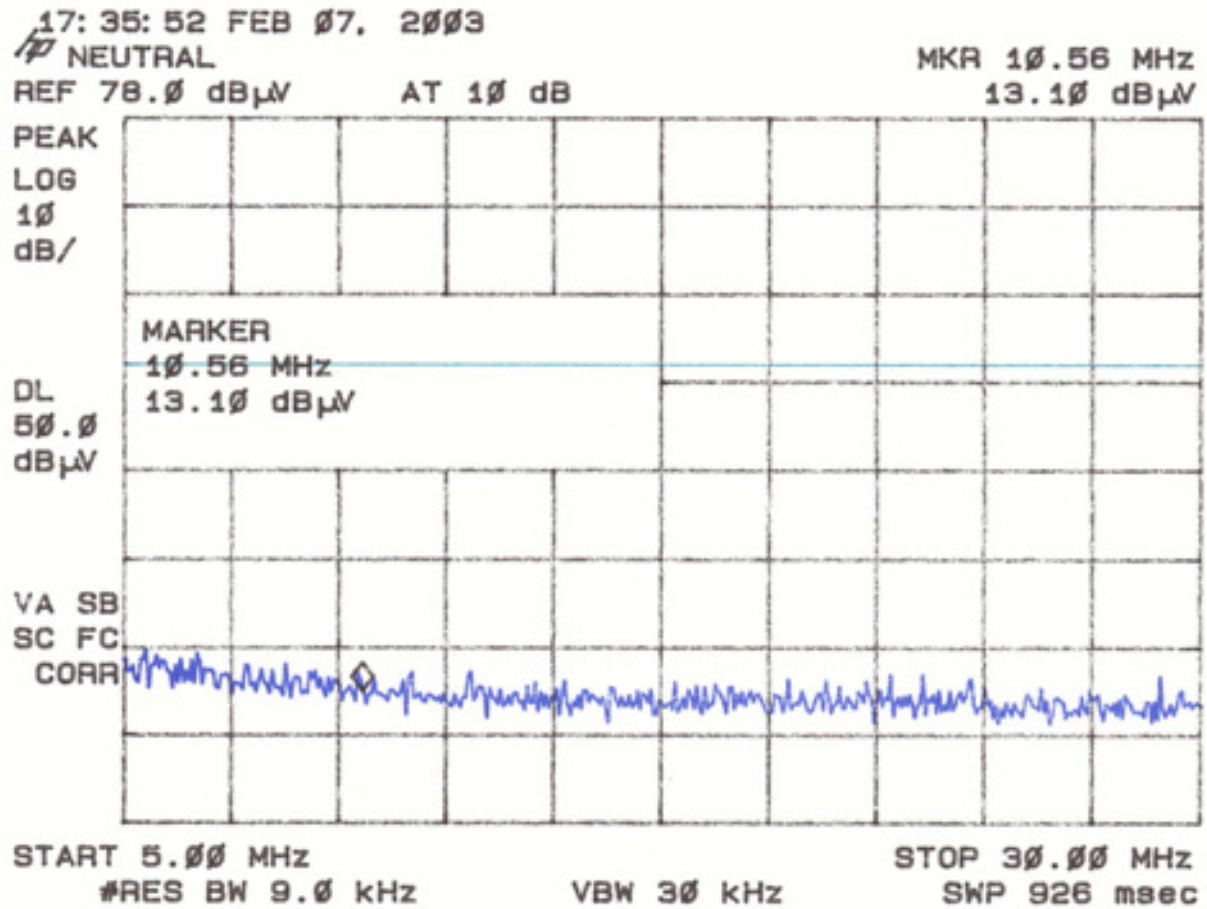
CONDUCTED EMISSIONS

Plot E



CONDUCTED EMISSIONS

Plot F



2.15 Radiated Emissions (47 CFR 15.109a)

Radiated emissions were evaluated from 30 to 5000 MHz. Measurements were made with the analyzer's bandwidth set to 120 kHz measurements made less than 1 GHz and 1 MHz for measurements made 1 GHz and higher. Results for less than 1 GHz are shown in Table 9a. Measurements made over 1 GHz results are shown in Table 9b.

**TABLE 9A
RADIATED EMISSIONS DATA**

CLASS B

Test Date: January 15, 2003
UST Project: 03-0020
Customer: Elkhart Brass Mfg. Co., Inc.
Model: PTSS2003 Spread Spectrum Transceiver Module

Frequency (MHz)	Receiver Reading (dBm) @3m	Correction Factor (dB)	Corrected Reading (uV/m)	FCC Limit (uV/m) @3m
NO EMISSIONS DETECTED WITHIN 10 dB OF THE FCC LIMIT				

Tester
Signature: David P. Blethen

Name: David Blethen

**TABLE 9B
RADIATED EMISSIONS DATA**

CLASS B

Test Date: January 15, 2003
UST Project: 03-0020
Customer: Elkhart Brass Mfg. Co., Inc.
Model: PTSS2003 Spread Spectrum Transceiver Module

Measurements >1GHz

Frequency (MHz)	Receiver Reading (dBm) @3m	Correction Factor (dB)	Corrected Reading (uV/m)	FCC Limit (uV/m) @3m
NO EMISSIONS DETECTED WITHIN 10 dB OF THE FCC LIMIT				

Tested By David P. Blethen **Name:** David Blethen
Signature: