WASHINGTON LABORATORIES, LTD.
7560 Lindbergh Drive • Gaithersburg, Maryland 20879 • (301) 417-0220 • Fax (301) 417-9069 • (800) 839-1649
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FCC CERTIFICATION REPORT

for

O'Neill Connectivities, Inc.

809 North Bethlehem Pike
Bldg. C Unit 6
Spring House, PA 19477

FCC ID: LT4LAWNIIPO

October 8, 1998

WLL PROJECT #: 4691X

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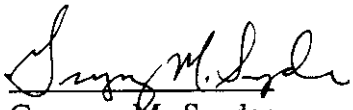
STATEMENT OF QUALIFICATIONS

for

Gregory M. Snyder

Washington Laboratories, Ltd.

I hold a Bachelor of Science in Electronics Engineering Technology and have over nine years of EMI testing experience. I am qualified to perform EMC testing to the methods described in this test report. The measurements taken within this report are accurate within my ability to perform the tests and within the tolerance of the measuring instrumentation.

By: 
Gregory M. Snyder
Compliance Engineer

Date: October 8, 1998

OCI

Chief, Authorization Branch
Federal Communications Commission
7453 Oakland Mills Road
Columbia, MD 21046

Re: Letter of Agency

This letter is to serve notice that Washington Laboratories, Ltd. is hereby authorized to act on our behalf in connection with the Application for Equipment Authorization attached herewith.

We certify that we are not subject to denial of federal benefits, that includes FCC benefits, pursuant to Section 5301 of the Anti-Drug Abuse ACT of 1988, U.S.C. 862. Further, no party, as defined in 47 CFR 1.2002(b), to the application is subject to denial of federal benefits, that includes FCC benefits.

Signed,

Wen T. Lin

Wen T. Lin
President

O'Neill Connectivities, Inc.
2445 Maryland Road,
Willow Grove, PA 19090

Phone: 215-830-1200
Fax:215-830-1207

FCC CERTIFICATION REPORT

for

O'Neill Connectivities, Inc.

FCC ID: LT4LAWNIIPO

1.0 Introduction

This report has been prepared on behalf of O'Neill Connectivities, Inc. to support the attached Application for Equipment Authorization. The test and application are submitted for an Intentional Radiator under Section 15.247 of the FCC Rules and Regulations. The Equipment Under Test was an O'Neill Connectivities, Inc. Direct Sequence Spread Spectrum Transmitter Module.

All measurements herein were performed according to the 1992 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and field Strength Instrumentation. Calibration checks are made periodically to verify proper performance of the measuring instrumentation.

All measurements are performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP as an independent test laboratory.

The results of this test report relate only to the item tested. This report shall not be used to claim product endorsement by NVLAP or any agency of the US Government.

The results of this test report relate only to the item tested. The measurement uncertainty of the data contained herein is ±2.3 dB. Refer to Appendix A for Statement of Measurement Uncertainty.

1.1 Summary

The O'Neill Connectivities, Inc. Direct Sequence Spread Spectrum Transmitter Module complies with the limits for an Intentional Radiator under Section 15.247.

2.0 Description of Equipment Under Test (EUT)

The O'Neill Connectivities, Inc. Direct Sequence Spread Spectrum Transmitter Module is a low power spread spectrum transceiver module that is part of a wireless RS-232 modem (FCC Class A verified device). The module interfaces with a digital section via a 14-pin header located on the underside of the module. Power to the module is provided via an external AC to DC wall mount transformer which connects to the digital board. Filtered DC power is then supplied to the transmitter module through pins on the 14-pin header connector. The transmitter has three different frequency channels between 907.475-921.10 MHz. The transmitter module also contains a 6" RF cable with a reverse one-of-a-kind "N" type RF connector for the transmit/receive antenna. The digital board contains a 9-pin D-sub connector for RS-232 interface.

The unit will be used with one of the following antennas:

Omni-directional Monopole

Cushcraft; M/N: S8960B, Unity gain
Maxrad; M/N: Z368, 7 dB gain
Maxrad; M/N: Z367, 5 dB gain
Maxrad; M/N: Z369, 3 dB gain

2.1 On-board Oscillators

The O'Neill Connectivities, Inc. Direct Sequence Spread Spectrum Transmitter Module contains a 9.8304 MHz oscillator contained on the digital interface board.

3.0 Test Configuration

To complete the test configuration required by the FCC, the transmitter module was connected to the digital board and was tested in three orthogonal planes since the unit may be mounted in various manners when incorporated into a final product. The unit was tested with three different transmit channels, Channel 1 (907.475 MHz), Channel 2 (915.5 MHz), and Channel 3 (921.8 Mhz). The antenna used during testing was a Maxrad M/N: Z368 omni-directional monopole. The unit was also connected to a certified computer system and the system was configured with external peripherals that also have been certified to comply with the limits for Class A digital devices.

3.1 Testing Algorithm

The transmitter was powered on and constantly transmitting. Worst case emissions are recorded in the data tables.

3.2 Conducted Emissions Testing

The EUT was placed on an 80 cm high 1 x 1.5 m non-conductive table. Power to the transmitter module was provided through a Solar Corporation 50 Ω/50 μH Line Impedance Stabilization Network bonded to a 3 x 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power was supplied to the peripherals through a second LISN. The peripherals were placed on the table in accordance with ANSI C63.4-1992. Power, data cables, and antenna were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 450 kHz to 30 MHz was measured. The detector function was set to quasi-peak or peak, as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth.

Table 1

FCC CLASS A CONDUCTED EMISSIONS DATA -SITE 1

CLIENT: O'Neill Connectivities, Inc.
FCC ID: LT4LAWNIIPO
DATE: September 11, 1998
CLK SPEED(S): 9.83 MHz
BY: Greg Snyder
JOB #: 4691X

LINE 1 - NEUTRAL

FREQ MHz	VOLTAGE (PEAK) dBuV	VOLTAGE uV	FCC LIMIT uV	MARGIN dB
9.83	36.8	69.2	3000	-32.7
10.00	41.4	117.5	3000	-28.1
19.66	36.4	66.1	3000	-33.1
25.76	34.8	55.0	3000	-34.7
27.57	32.4	41.7	3000	-37.1
29.49	53.1	451.9	3000	-16.4

LINE 2 - PHASE

FREQ MHz	VOLTAGE (PEAK) dBuV	VOLTAGE uV	FCC LIMIT uV	MARGIN dB
9.83	37.6	75.9	3000	-31.9
10.00	41.3	116.1	3000	-28.2
19.70	37.8	77.6	3000	-31.7
25.77	36.4	66.1	3000	-33.1
27.30	41.2	114.8	3000	-28.3
29.49	56.1	638.3	3000	-13.4

3.3 Radiated Emissions Testing

The EUT was initially tested indoors at a distance of 3 meters to determine its emissions profile. The EUT was then placed on a 80 cm high 1 x 1.5 meters non-conductive motorized turntable for radiated testing on a 3 meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Biconical, log periodic, and horn broadband antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-1992. Antenna and cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier or preselector, to the input of the spectrum analyzer. The detector function was set to quasi-peak for frequencies below 1000 MHz and average and peak for frequencies above 1000 MHz. For frequencies below 1000 MHz, the measurement bandwidth on the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth. For frequencies above 1000 MHz, the resolution bandwidth on the spectrum analyzer system was set to 1 MHz and the video bandwidth on the spectrum analyzer system was set to 1 MHz for peak measurements and 10 Hz for average measurements.

3.3.1 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are grouped into a composite antenna factor (AFc) and are supplied in the AFc column of the data table. The AFc in dB/m is algebraically added to the Spectrum Analyzer Voltage in dbμV to obtain the Radiated Electric Field in dBμV/m. This level is then compared with the FCC limit.

Example:

Spectrum Analyzer Voltage: VdBμV

Composite Antenna Factor: AFcdB/m

Electric Field: $EdB\mu V/m = VdB\mu V + AFcdB/m$

To convert to linear units: $E\mu V/m = \text{antilog}\ (EdB\mu V/m/20)$

Data is recorded in Tables 2-4.

Table 2

FCC 15.247(c) 3M RADIATED EMISSIONS DATA - SITE 1

CLIENT: O'Neill
MODEL: Tx Module
DATE: 8/21/98
BY: Greg Snyder
JOB #: 4691X
CONFIGURATION: Channel 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (QP) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
37.86	V	90.0	1	13.4	17.8	31.2	36.2	100.0	-8.8
73.30	V	0.0	1	18.8	7.4	26.2	20.4	100.0	-13.8
74.93	V	90.0	1	19.6	7.7	27.3	23.1	100.0	-12.7
168.60	V	0.0	1	10.5	10.8	21.3	11.6	150.0	-22.2
329.33	V	0.0	1	7.7	16.4	24.1	16.1	200.0	-21.9
403.06	V	0.0	1	15.9	17.8	33.7	48.7	200.0	-12.3
961.56	V	180.0	1	13.4	25.6	39.0	89.3	500.0	-15.0

FCC 15.247(c) 3M RADIATED EMISSIONS DATA ABOVE 1 GHz - SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (Avg) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2724.00	V	180.0	1	42.3	-7.0	35.3	58.2	500.0	-18.7
3628.00	V	180.0	1	38.3	-6.5	31.8	38.9	500.0	-22.2
4537.00	V	180.0	1	37.4	-3.8	33.6	47.9	500.0	-20.4
5444.00	V	180.0	1	36.9	-1.5	35.4	58.9	500.0	-18.6
2724.00	H	180.0	1	43.5	-7.0	36.5	66.8	500.0	-17.5

FCC 15.247(c) 3M PEAK RADIATED EMISSIONS DATA ABOVE 1 GHz- SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (Peak) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2724.00	V	180.0	1	48.7	-7.0	41.7	121.6	5000.0	-32.3
3628.00	V	180.0	1	45.7	-6.5	39.2	91.2	5000.0	-34.8
4537.00	V	180.0	1	45.0	-3.8	41.2	114.8	5000.0	-32.8
5444.00	V	180.0	1	44.2	-1.5	42.7	136.5	5000.0	-31.3
2724.00	H	180.0	1	52.8	-7.0	45.8	195.0	5000.0	-28.2
3628.00	H	180.0	1	44.9	-6.5	38.4	83.2	5000.0	-35.6
4537.00	H	180.0	1	43.8	-3.8	40.0	100.0	5000.0	-34.0
5444.00	H	180.0	1	43.8	-1.5	42.3	130.3	5000.0	-31.7

Table 3

FCC 15.247(c) 3M RADIATED EMISSIONS DATA - SITE 1

CLIENT: O'Neill
MODEL: Tx Module
DATE: 8/21/98
BY: Greg Snyder
JOB #: 4691X
CONFIGURATION: Channel 2

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (QP) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
251.00	H	225.0	2.5	10.5	13.5	24.0	15.9	200.0	-22.0
961.56	H	337.5	2.5	19.5	25.6	45.1	180.3	500.0	-8.9

FCC 15.247(c) 3M RADIATED EMISSIONS DATA ABOVE 1 GHz - SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (Avg) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2745.00	V	337.5	2.5	43.7	-7.0	36.7	68.4	500.0	-17.3
3660.00	V	337.5	2.5	37.6	-6.5	31.1	35.9	500.0	-22.9
4587.00	V	337.5	2.5	38.3	-3.8	34.5	53.1	500.0	-19.5
5488.00	V	337.5	2.5	37.8	-1.5	36.3	65.3	500.0	-17.7
2745.00	H	337.5	2.5	46.7	-7.0	39.7	96.6	500.0	-14.3

FCC 15.247(c) 3M PEAK RADIATED EMISSIONS DATA ABOVE 1 GHz- SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (Peak) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2745.00	V	337.5	2.5	50.0	-7.0	43.0	141.3	5000.0	-31.0
3660.00	V	337.5	2.5	44.7	-6.5	38.2	81.3	5000.0	-35.8
4587.00	V	337.5	2.5	44.7	-3.8	40.9	110.9	5000.0	-33.1
5488.00	V	337.5	2.5	44.3	-1.5	42.8	138.0	5000.0	-31.2
2745.00	H	337.5	2.5	54.2	-7.0	47.2	229.1	5000.0	-26.8
3660.00	H	337.5	2.5	44.2	-6.5	37.7	76.7	5000.0	-36.3
4587.00	H	337.5	2.5	44.5	-3.8	40.7	108.4	5000.0	-33.3
5488.00	H	337.5	2.5	44.5	-1.5	43.0	141.3	5000.0	-31.0

Table 4

FCC 15.247(c) 3M RADIATED EMISSIONS DATA - SITE 1

CLIENT: O'Neill
MODEL: Tx Module
DATE: 8/21/98
BY: Greg Snyder
JOB #: 4691X
CONFIGURATION: Channel 3

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (QP) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
37.86	V	90.0	1	11.5	17.8	29.3	29.1	100.0	-10.7
73.30	V	0.0	1	18.8	7.4	26.2	20.4	100.0	-13.8
74.93	V	90.0	1	19.6	7.7	27.3	23.1	100.0	-12.7
168.60	V	0.0	1	10.5	10.8	21.3	11.6	150.0	-22.2
265.40	V	0.0	1	24.8	14.2	39.0	88.9	200.0	-7.0
285.11	V	0.0	1	25.3	15.8	41.1	113.8	200.0	-4.9
975.24	V	180.0	1	17.7	26.1	43.8	155.1	500.0	-10.2

FCC 15.247(c) 3M RADIATED EMISSIONS DATA ABOVE 1 GHz - SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (Avg) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2763.00	V	180.0	1	45.6	-7.0	38.6	85.1	500.0	-15.4
3686.00	V	180.0	1	38.5	-6.5	32.0	39.8	500.0	-22.0
4605.00	V	180.0	1	37.0	-3.8	33.2	45.7	500.0	-20.8
5527.00	V	180.0	1	36.8	-1.5	35.3	58.2	500.0	-18.7
2763.00	H	180.0	1	47.2	-7.0	40.2	102.3	500.0	-13.8

FCC 15.247(c) 3M PEAK RADIATED EMISSIONS DATA ABOVE 1 GHz- SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (Peak) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2763.00	V	180.0	1	57.5	-7.0	50.5	335.0	5000.0	-23.5
3686.00	V	180.0	1	45.0	-6.5	38.5	84.1	5000.0	-35.5
4605.00	V	180.0	1	44.2	-3.8	40.4	104.7	5000.0	-33.6
5527.00	V	180.0	1	36.8	-1.5	35.3	58.2	5000.0	-38.7
2763.00	H	180.0	1	56.2	-7.0	49.2	288.4	5000.0	-24.8
3686.00	H	180.0	1	45.0	-6.5	38.5	84.1	5000.0	-35.5
4605.00	H	180.0	1	44.5	-3.8	40.7	108.4	5000.0	-33.3
5527.00	H	180.0	1	44.3	-1.5	42.8	138.0	5000.0	-31.2

3.4 RF Antenna Conducted Emissions Testing

The EUT antenna was removed and connected directly into the spectrum analyzer input with a short length of coaxial cable. The analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 1 MHz. The emissions were scanned up to the tenth harmonic of the carrier. At each frequency an external attenuator or filter was used to confirm that the transmitter input was not overloading the spectrum analyzer input.

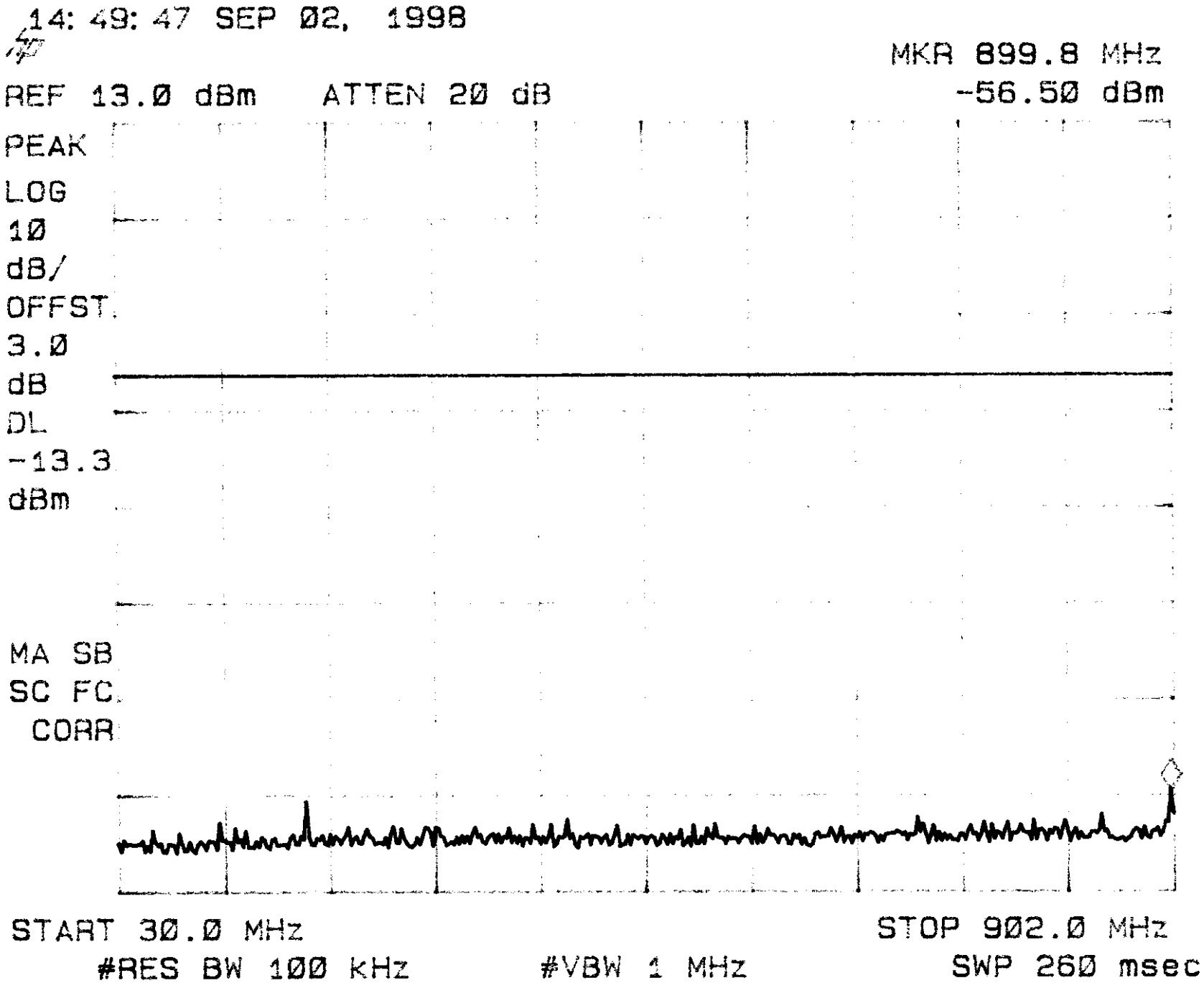
Data, followed by spectrum analyzer plots, is recorded in Table 8.

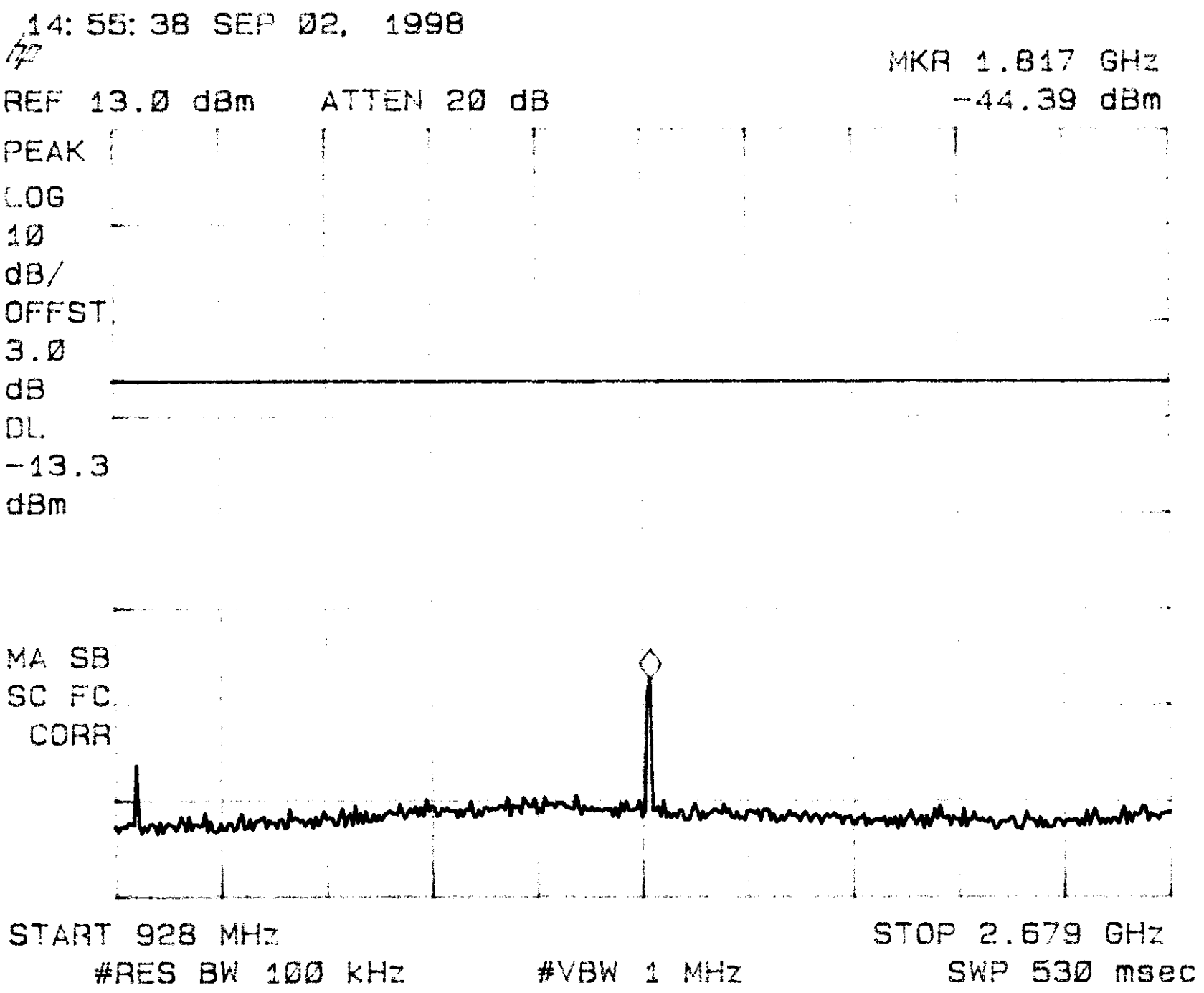
Table 8

FCC 15.247 RF ANTENNA CONDUCTED EMISSIONS DATA

CLIENT: O'Neill Communications, Inc.
DATE: 9/2/98
FCC ID: LT4LAWNIIPO
BY: Greg Snyder
JOB #: 4691X
CONFIGURATION: Channel 1

FREQ MHz	LEVEL (PEAK) dBm	LIMIT dBm	MARGIN dB
907.192	6.7	N/A	N/A
899.8	-55.1	-13.3	-41.8
963.0	-54.0	-13.3	-40.7
1820	-44.4	-13.3	-31.1
2730	-52.2	-13.3	-38.9
5120	-55.2	-13.3	-41.9
5440	-54.1	-13.3	-40.8


14: 49: 47 SEP 02, 1998
MKR 899.8 MHz
REF 13.0 dBm
ATTEN 20 dB
-56.50 dBm
PEAK
LOG
10
dB/
OFFST
3.0
dB
DL
-13.3
dBm
MA SB
SC FC
CORR
START 30.0 MHz
STOP 902.0 MHz
#RES BW 100 kHz
#VBW 1 MHz
SWP 260 msec


14: 55: 38 SEP 02, 1998
MKR 1.817 GHz
REF 13.0 dBm
ATTEN 20 dB
-44.39 dBm
PEAK
LOG
10
dB/
OFFST
3.0
dB
DL
-13.3
dBm
MA SB
SC FC
CORR
START 928 MHz
STOP 2.679 GHz
#RES BW 100 kHz
#VBW 1 MHz
SWP 530 msec

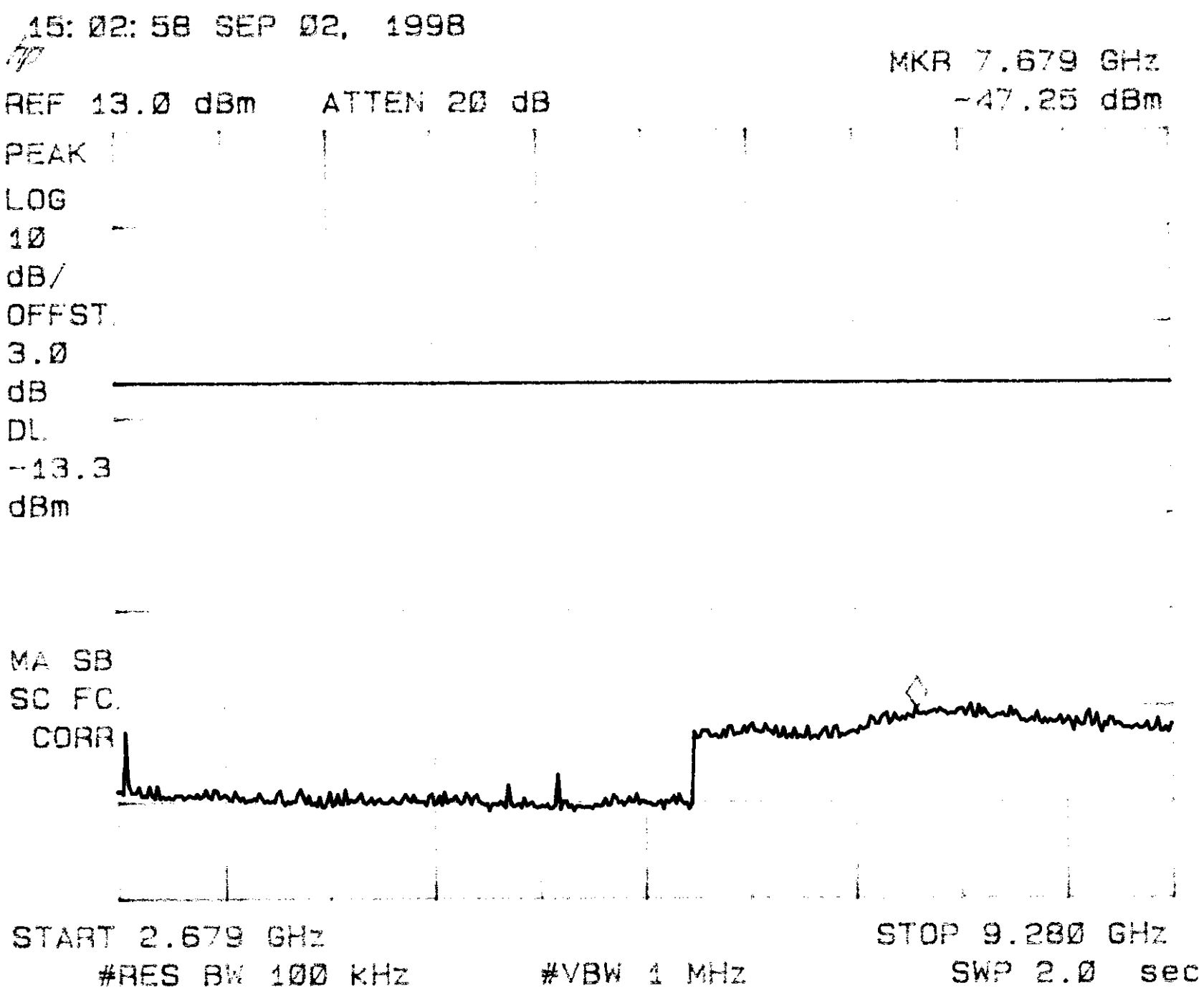
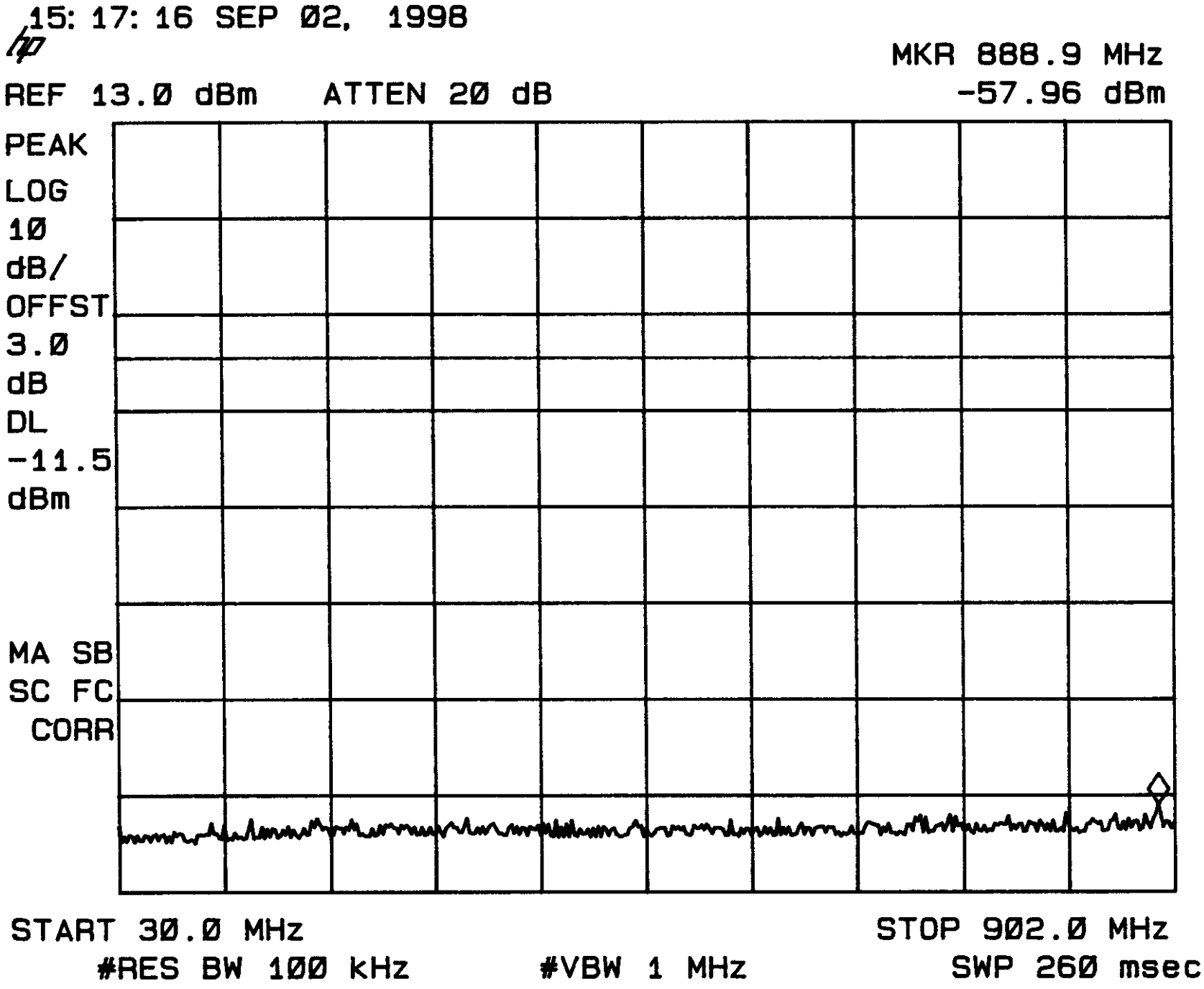

15: 02: 58 SEP 02, 1998
MKR 7.679 GHz
REF 13.0 dBm
ATTEN 20 dB
-47.25 dBm
PEAK
LOG
10
dB/
OFFST
3.0
dB
DL
-13.3
dBm
MA SB
SC FC
CORR
START 2.679 GHz
STOP 9.280 GHz
#RES BW 100 kHz
#VBW 1 MHz
SWP 2.0 sec

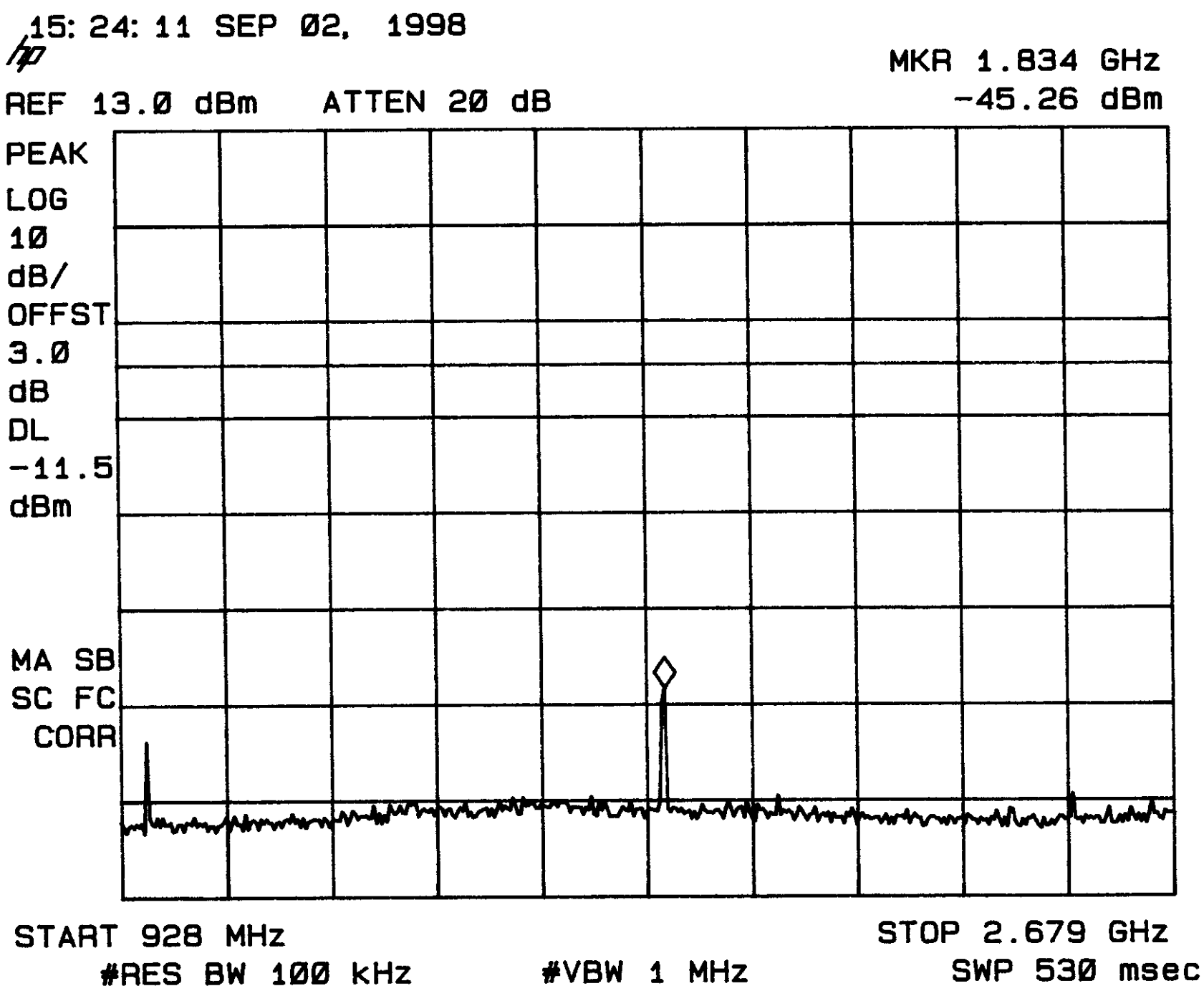
Table 9

FCC 15.247 RF ANTENNA CONDUCTED EMISSIONS DATA

CLIENT: O'Neill Communications, Inc.
DATE: 9/2/98
FCC ID: LT4LAWNIIPO
BY: Greg Snyder
JOB #: 4691X
CONFIGURATION: Channel 2

FREQ MHz	LEVEL (PEAK) dBm	LIMIT dBm	MARGIN dB
915.5	8.5	N/A	N/A
888.9	-58.0	-11.5	-46.5
972	-52.3	-11.5	-40.8
1834	-45.3	-11.5	-33.8
2750	-51.5	-11.5	-40.0
3665.5	-57.2	-11.5	-45.7
5480	-56.5	-11.5	-45.0


15: 17: 16 SEP 02, 1998
MKR 888.9 MHz
REF 13.0 dBm
ATTEN 20 dB
-57.96 dBm
PEAK
LOG
10
dB/
OFFST
3.0
dB
DL
-11.5
dBm
MA SB
SC FC
CORR
START 30.0 MHz
STOP 902.0 MHz
#RES BW 100 kHz
#VBW 1 MHz
SWP 260 msec


15: 24: 11 SEP 02, 1998
MKR 1.834 GHz
-45.26 dBm
REF 13.0 dBm
ATTEN 20 dB
PEAK
LOG
10
dB/
OFFST
3.0
dB
DL
-11.5
dBm
MA SB
SC FC
CORR
START 928 MHz
#RES BW 100 kHz
#VBW 1 MHz
STOP 2.679 GHz
SWP 530 msec

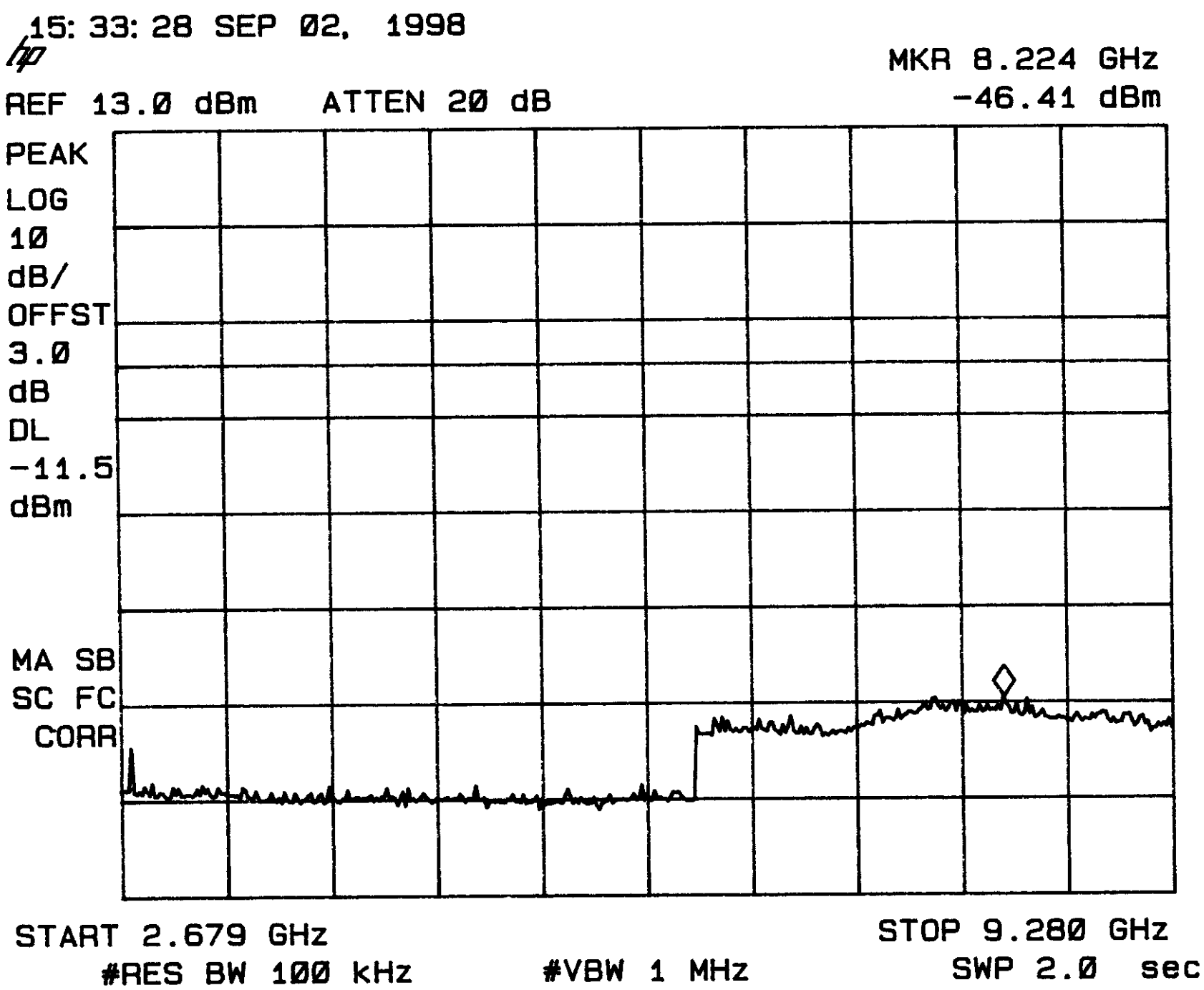
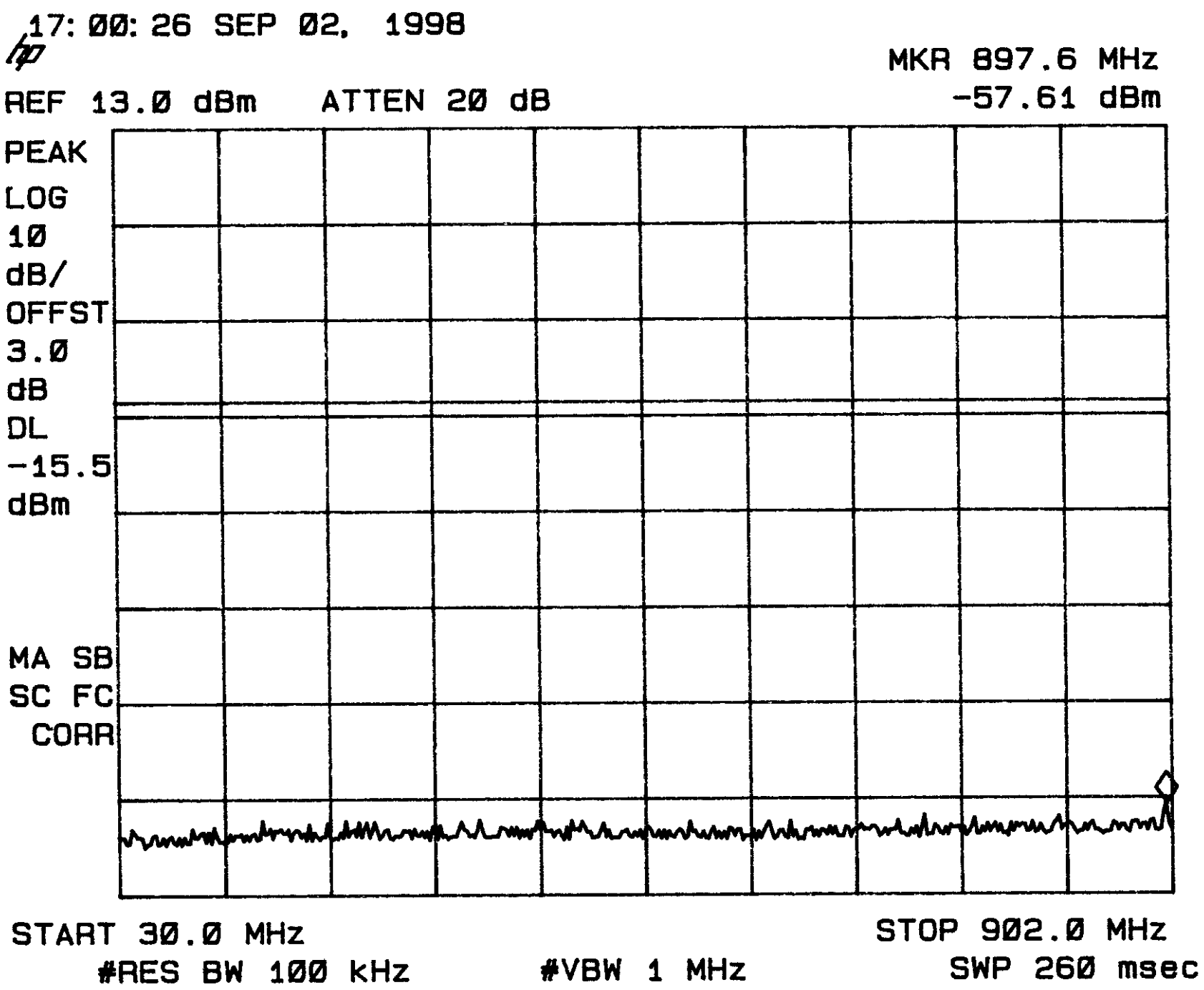

15: 33: 28 SEP 02, 1998
MKR 8.224 GHz
-46.41 dBm
REF 13.0 dBm
ATTEN 20 dB
PEAK
LOG
10
dB/
OFFST
3.0
dB
DL
-11.5
dBm
MA SB
SC FC
CORR
START 2.679 GHz
#RES BW 100 kHz
#VBW 1 MHz
STOP 9.280 GHz
SWP 2.0 sec

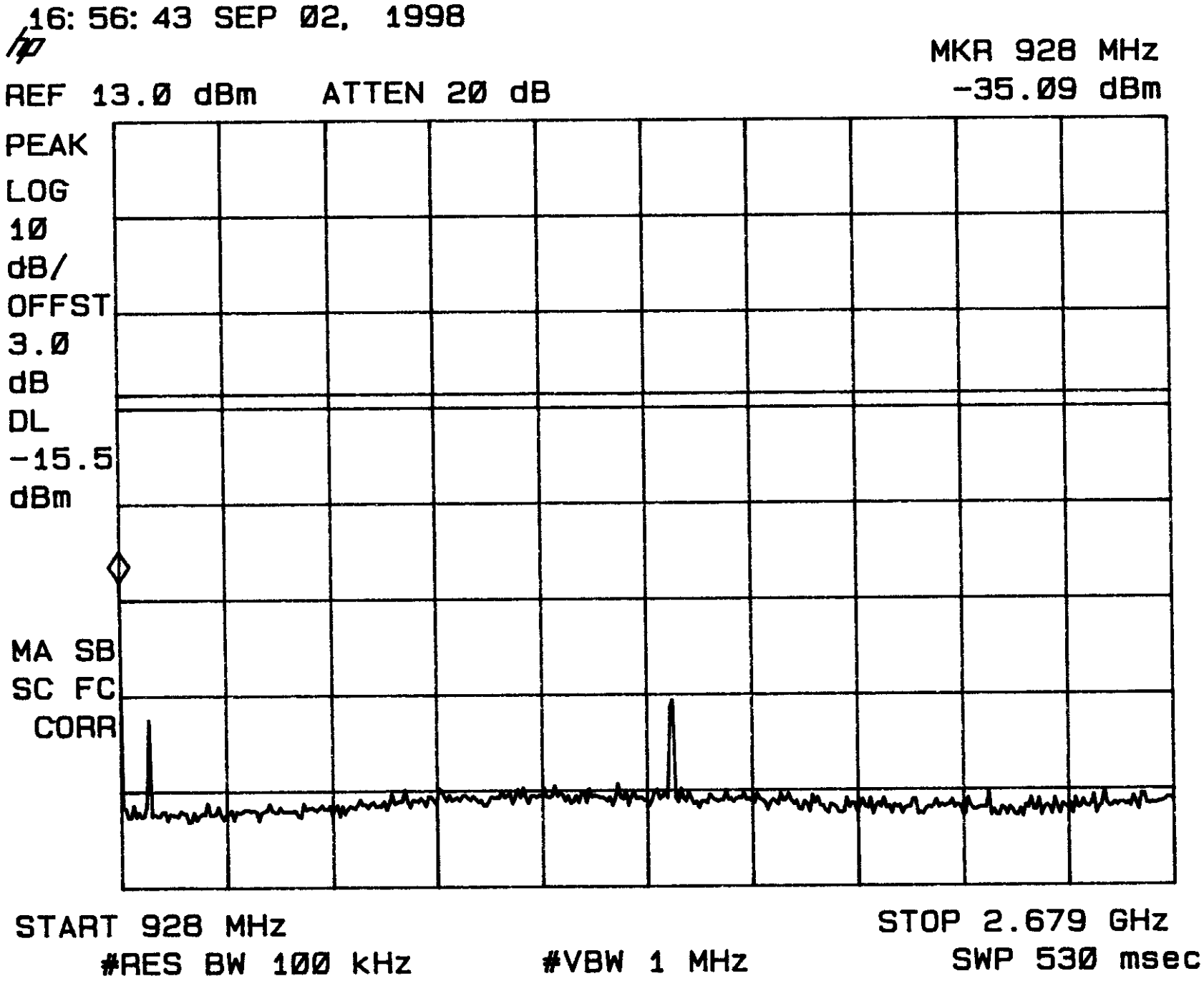
Table 10

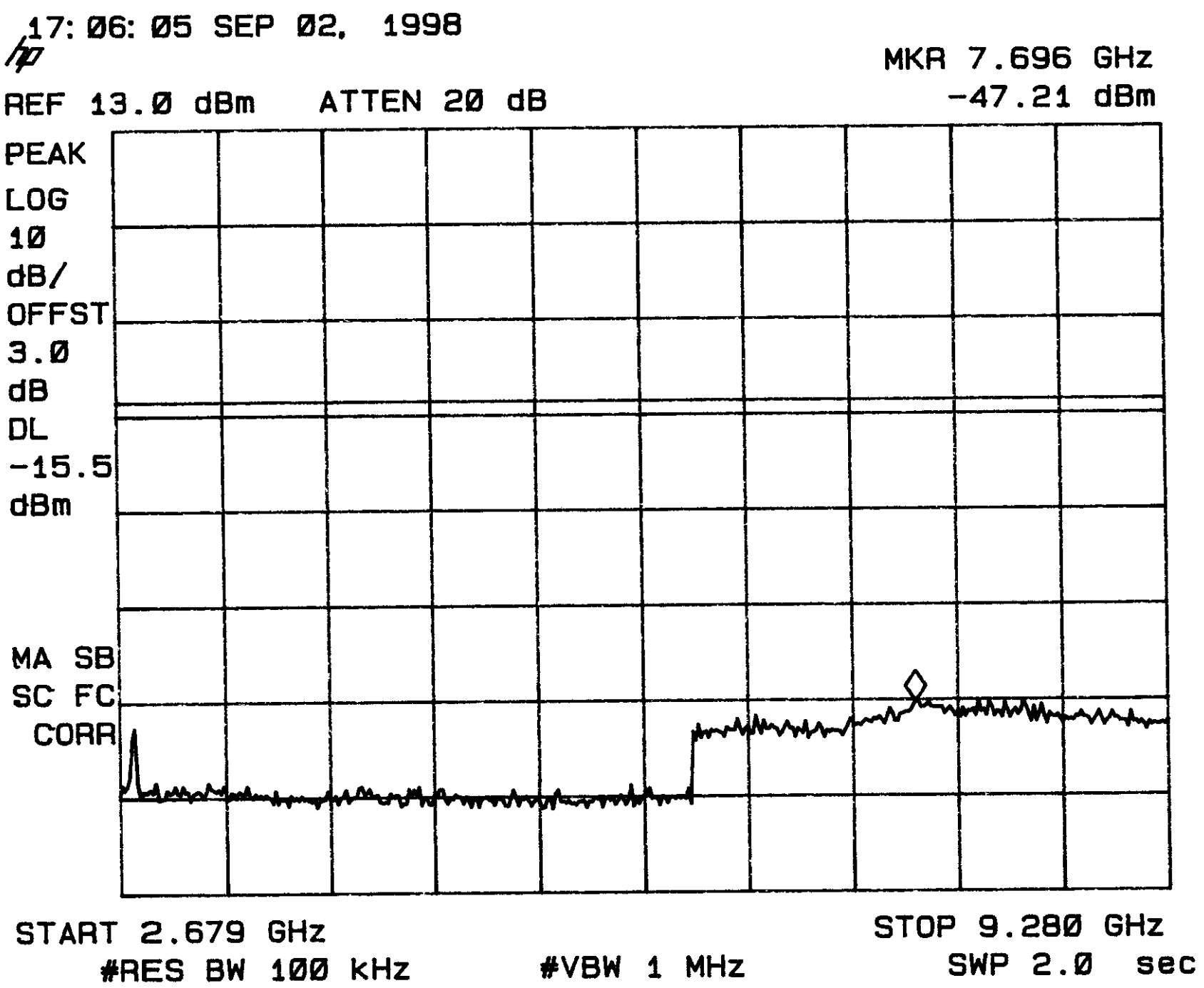
FCC 15.247 RF ANTENNA CONDUCTED EMISSIONS DATA

CLIENT: O'Neill Communications, Inc.
DATE: 9/2/98
FCC ID: LT4LAWNIIPO
BY: Greg Snyder
JOB #: 4691X
CONFIGURATION: Channel 3

FREQ MHz	LEVEL (PEAK) dBm	LIMIT dBm	MARGIN dB
921.8	4.5	N/A	N/A
897.6	-57.2	-15.5	-41.7
928.0	-35.1	-15.5	-19.6
976.0	-49.7	-15.5	-34.2
1847	-48.5	-15.5	-33.0
2780	-50.7	-15.5	-35.2
7700	-47.2	-15.5	-31.7


17: 00: 26 SEP 02, 1998
MKR 897.6 MHz
REF 13.0 dBm
ATTEN 20 dB
-57.61 dBm
PEAK
LOG
10
dB/
OFFST
3.0
dB
DL
-15.5
dBm
MA SB
SC FC
CORR
START 30.0 MHz
STOP 902.0 MHz
#RES BW 100 kHz
#VBW 1 MHz
SWP 260 msec


16: 56: 43 SEP 02, 1998
MKR 928 MHz
-35.09 dBm
REF 13.0 dBm
ATTEN 20 dB
PEAK
LOG
10
dB/
OFFST
3.0
dB
DL
-15.5
dBm
MA SB
SC FC
CORR
START 928 MHz
#RES BW 100 kHz
#VBW 1 MHz
STOP 2.679 GHz
SWP 530 msec


17: 06: 05 SEP 02, 1998
MKR 7.696 GHz
-47.21 dBm
REF 13.0 dBm
ATTEN 20 dB
PEAK
LOG
10
dB/
OFFST
3.0
dB
DL
-15.5
dBm
MA SB
SC FC
CORR
START 2.679 GHz
#RES BW 100 kHz
#VBW 1 MHz
STOP 9.280 GHz
SWP 2.0 sec

3.5 Transmitted Power Density Testing

The EUT antenna was removed and connected directly into the spectrum analyzer input with a short length of coaxial cable. The highest peak of the carrier was centered on the analyzer display. The analyzer resolution bandwidth was set to 3 kHz, the video bandwidth was set to 10 kHz, the sweep time was set to 100 seconds, and the span was set to 300 kHz. An external attenuator or filter was used to confirm that the transmitter input was not overloading the spectrum analyzer input. The highest level was measured in dBm and compared to the FCC limit.

Spectrum analyzer plots of the power density are located in Exhibit 1. The measured transmitter power density was 4.87 dBm for Channel 1, 4.98 dBm for Channel 2, and 3.42 dBm for Channel 3.

3.6 Carrier Bandwidth Testing

The EUT antenna was removed and connected directly into the spectrum analyzer input with a short length of coaxial cable. The analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 1 MHz. The highest peak of the carrier was centered on the analyzer display. An external attenuator or filter was used to confirm that the transmitter input was not overloading the spectrum analyzer input. The 6 dB bandwidth of the modulated carrier was measured and compared to the FCC limit.

Spectrum analyzer plots of the bandwidths are located in Exhibit 2. The measured 6 dB bandwidth was 1.025 MHz for Channel 1, 0.9 MHz for Channel 2, and 0.887 MHz for Channel 3.

3.7 Power Output Testing

The EUT antenna was removed and connected directly into the spectrum analyzer input with a short length of coaxial cable. The analyzer resolution and video bandwidths were set to 5 MHz and 3 MHz respectively (greater than the 6 dB bandwidth). The highest peak of the carrier was centered on the analyzer display. An external attenuator or filter was used to confirm that the transmitter input was not overloading the spectrum analyzer input. The peak power in dBm was measured and compared to the FCC limit.

The measured peak power was 13.68 dBm, or 23.33 mW, for Channel 1, 13.63 dBm, or 23.07 mW, for Channel 2, and 12.97 dBm, or 19.82 mW, for Channel 3.

3.8 Radio Frequency Radiation Exposure

Based on the above data, the worst case RF output power of the unit occurs at Channel 1, 907.475 MHz. According to Section 1.1310 of the FCC rules, the uncontrolled RF exposure limit for this frequency range is $f_{MHz}/1500$. At 907.192 MHz, the limit would be 0.605 mW/cm^2. This unit will be used with different antennas. The gain of the antennas will range from unity up to 7 dBi. To comply with the exposure limits for this section, humans must not be too close to the transmit antenna. These distances were calculated as follows:

$$S = (PG)/(4\pi R^2)$$

Where,
S = Power Density
P = Output Power at the Antenna Terminals
G = Gain of Transmit Antenna (linear gain)
R = Distance from Transmitting Antenna

For this device, the calculation is as follows:
S = FCC Limit = 0.605 mW/cm^2
P = Output Power = 23.33 mW
G = Worst Case Gain = 7 dBi = INVLOG(7/10) = 5.01

Therefore,
$0.605 = (23.33)(5.01)/(4\pi R^2)$

$R = ((23.33)(5.01)/(4\pi)(0.605))^{1/2}$

R = 3.92 cm

For this device with a unity gain antenna, the calculation is as follows:
S = FCC Limit = 0.605 mW/cm^2
P = Output Power = 23.33 mW
G = 0 dBi = INVLOG(0/10) = 1

Therefore,
$0.605 = (23.33(1.0)/(4\pi R^2)$

$R = ((23.33)(1.0)/(4\pi)(0.605))^{1/2}$

R = 1.75 cm

A warning statement has been placed in the manual to caution the user about the RF exposure limitations of the unit. According to the manufacturer, the high gain omni-directional antennas are always used outdoors and due to the "normal" means of mounting the antenna, humans would not be within 4 cm of the antenna. The smaller unity gain antennas may be used indoors. These antennas are manufactured with a 1 cm guard around the antenna. Therefore, the manual cautions the user not to touch or be within 0.75 cm of the antenna.

Table 11

System Under Test

FCC ID: LT4LAWNIIPO

EUT:	O'Neill Connectivities, Inc. Direct Sequence Spread Spectrum Transmitter Module; FCC ID: LT4LAWNIIPO
Personal Computer:	IBM PS; M/N: 30286; S/N: N/A; FCC ID: AN09SAS30286
Keyboard:	IBM; M/N: M; P/N: 1391401; FCC ID: 1501738
Printer:	Hayes Smartmodem; M/N: 231AA; S/N: A10431083133; FCC ID: BFJ9D93108US

Table 12

Interface Cables Used

One meter bundled/shielded interface cables were used for connection of EUT digital board to the Host PC and for connection of the other peripherals to the Host PC.

All devices used during testing of the O'Neill Connectivities, Inc. Direct Sequence Spread Spectrum Transmitter Module were powered via non-shielded power cords.

Table 13

Measurement Equipment Used

The following equipment is used to perform measurements:

Hewlett-Packard Spectrum Analyzer: HP 8568B

Hewlett-Packard Quasi-Peak Adapter: HP 85650A

Hewlett-Packard Preselector: HP 85685A

Antenna Research Associates, Inc. Biconical Log Periodic Antenna: LPB-2520 (Site 1)

Solar 50 Ω/50 µH Line Impedance Stabilization Network: 8012-50-R-24-BNC

Solar 50 Ω/50 µH Line Impedance Stabilization Network: 8028-50-TS-24-BNC

AH Systems, Inc. Portable Antenna Mast: AMS-4 (Site 1)

AH Systems, Inc. Motorized Turntable (Site 1)

RG-214 semi-rigid coaxial cable

RG-223 double-shielded coaxial cable

Appendix A

Statement of Measurement Uncertainty

For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

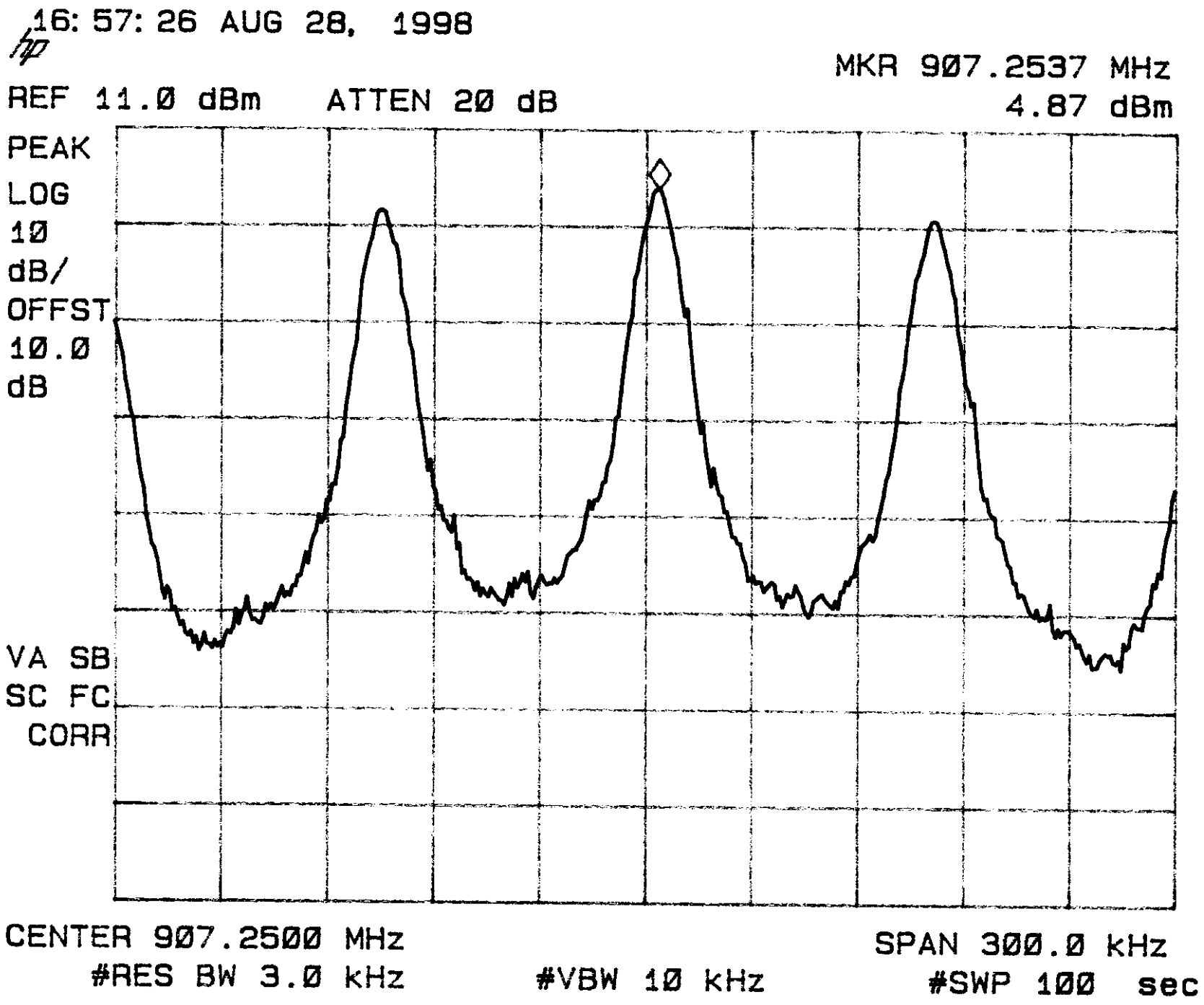
$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

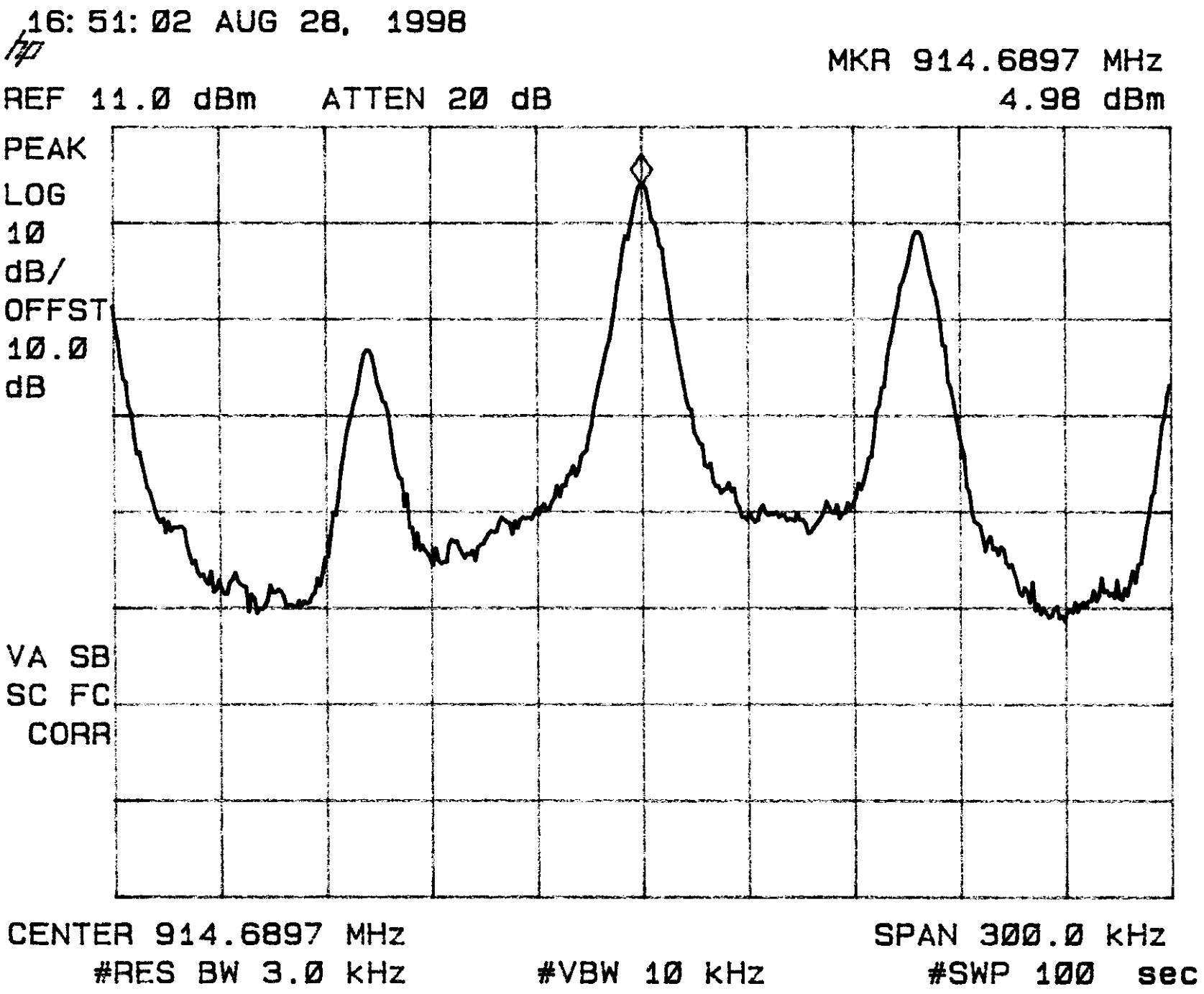
where:
A = Antenna calibration uncertainty, in dB = 2 dB
B = Spectrum Analyzer uncertainty, in dB = 1 dB
C = Site uncertainty, in dB = 4 dB
n = number of factors in uncertainty calculation = 3

$$\text{Thus, Total Uncertainty} = 0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3 \text{ dB}$$

EXHIBIT 1

POWER DENSITY PLOTS


16: 57: 26 AUG 28, 1998
MKR 907.2537 MHz
REF 11.0 dBm
ATTEN 20 dB
4.87 dBm
PEAK
LOG
10
dB/
OFFST
10.0
dB
VA SB
SC FC
CORR
CENTER 907.2500 MHz
#RES BW 3.0 kHz
#VBW 10 kHz
SPAN 300.0 kHz
#SWP 100 sec


16: 51: 02 AUG 28, 1998
MKR 914.6897 MHz
REF 11.0 dBm
ATTEN 20 dB
4.98 dBm
PEAK
LOG
10
dB/
OFFST
10.0
dB
VA SB
SC FC
CORR
CENTER 914.6897 MHz
SPAN 300.0 kHz
#RES BW 3.0 kHz
#VBW 10 kHz
#SWP 100 sec

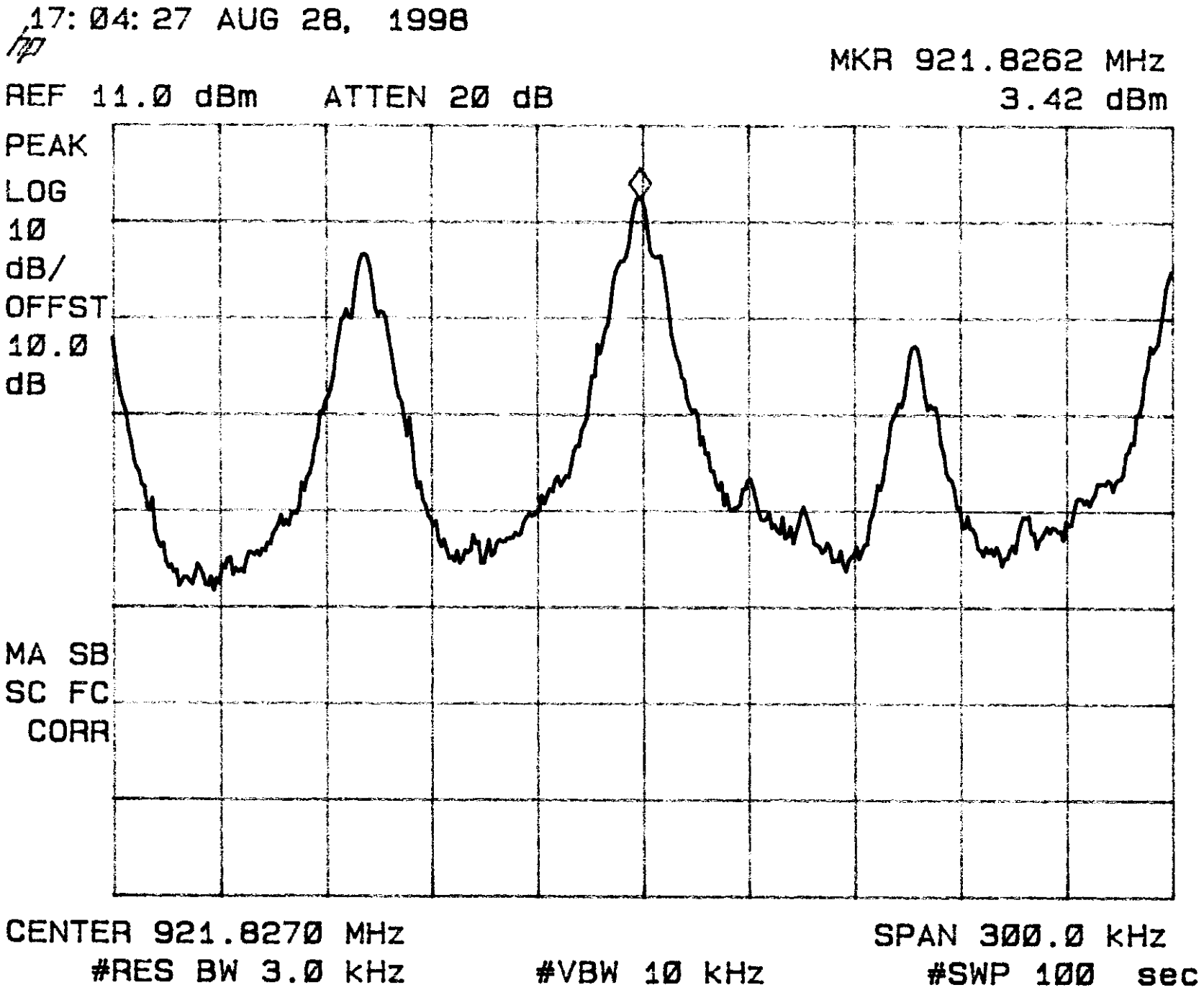
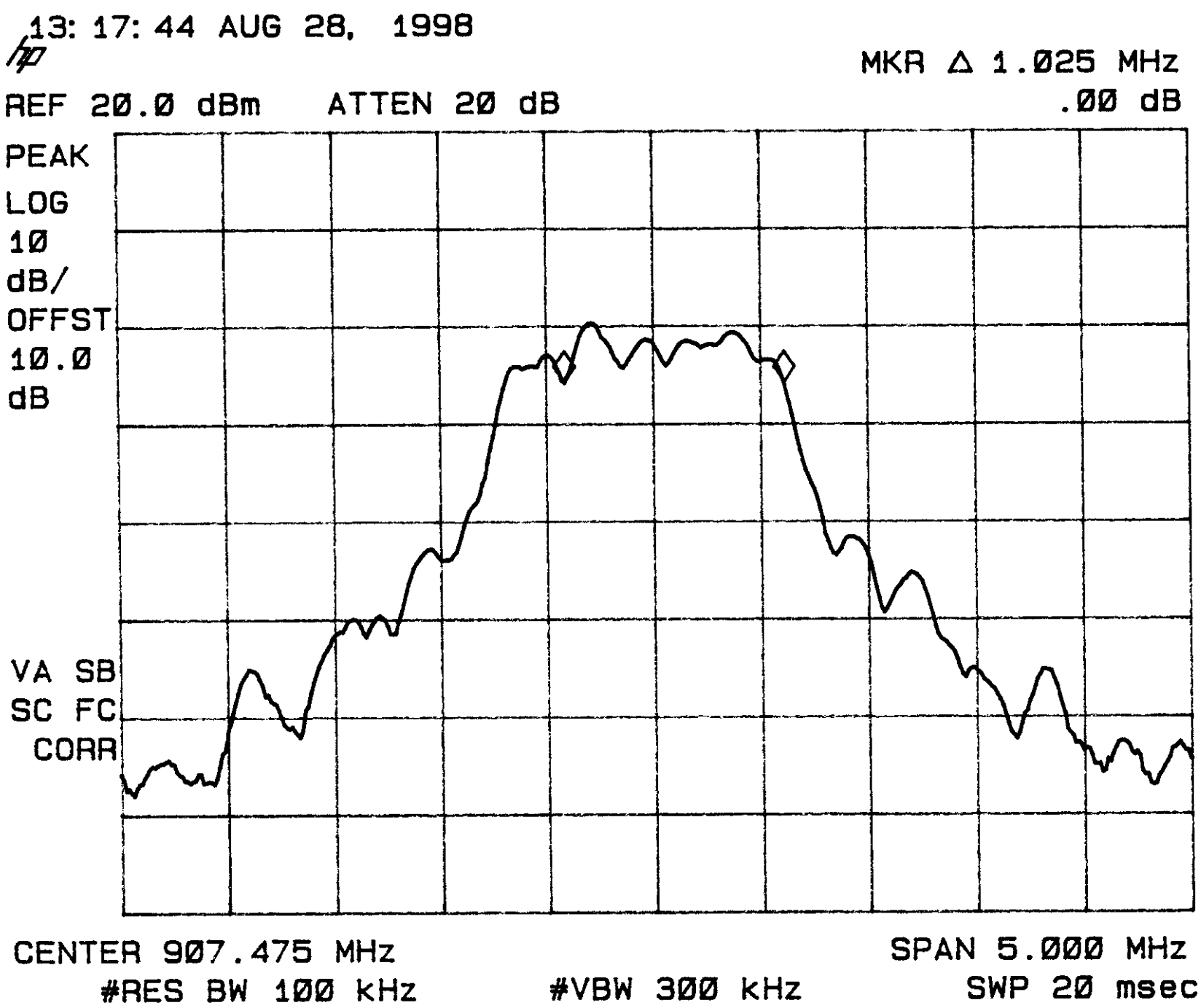
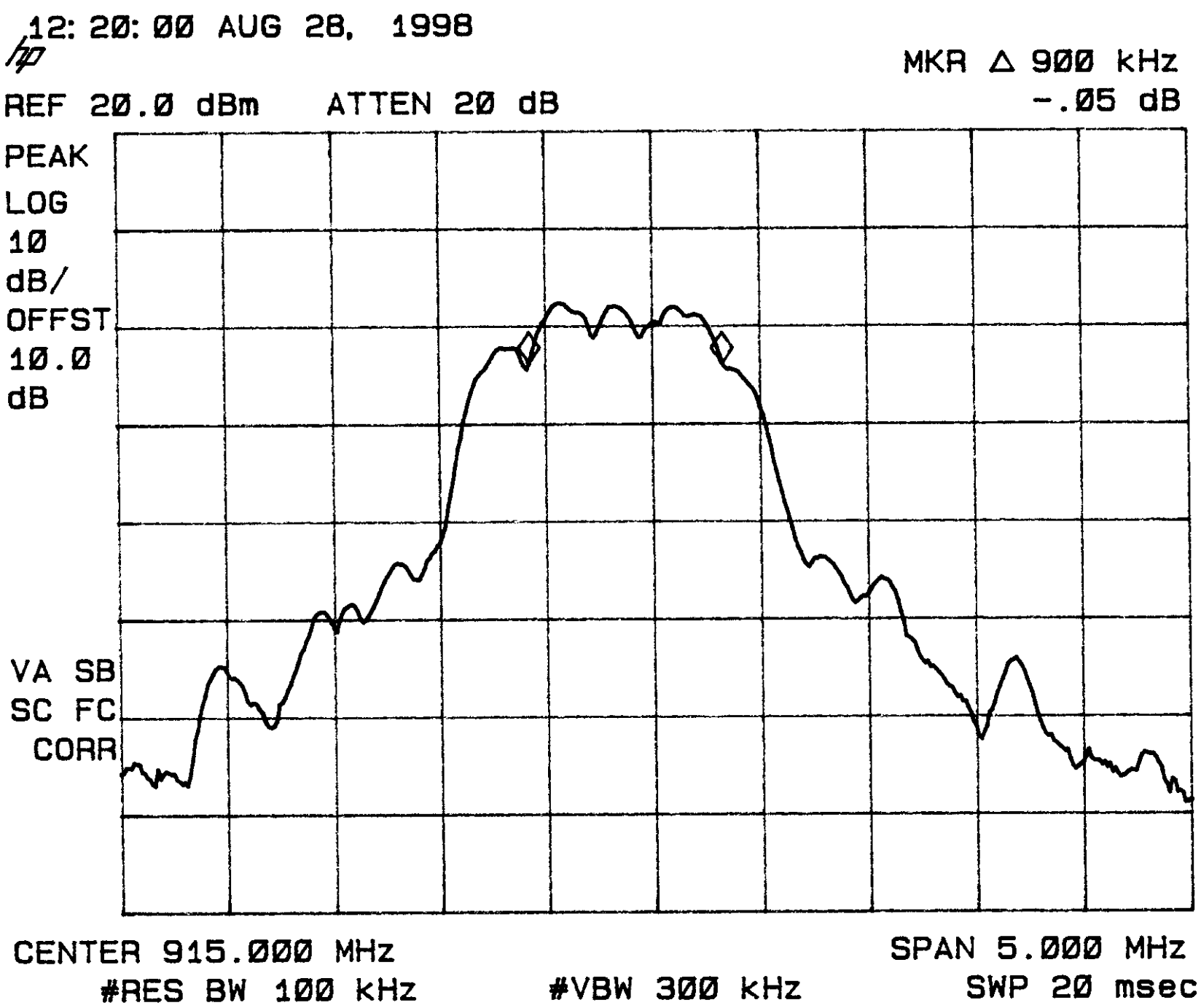

17: 04: 27 AUG 28, 1998
MKR 921.8262 MHz
REF 11.0 dBm
ATTEN 20 dB
3.42 dBm
PEAK
LOG
10
dB/
OFFST
10.0
dB
MA SB
SC FC
CORR
CENTER 921.8270 MHz
SPAN 300.0 kHz
#RES BW 3.0 kHz
#VBW 10 kHz
#SWP 100 sec

EXHIBIT 2

CARRIER BANDWIDTH PLOTS


13: 17: 44 AUG 28, 1998
MKR Δ 1.025 MHz
REF 20.0 dBm
ATTEN 20 dB
.00 dB
PEAK
LOG
10
dB/
OFFST
10.0
dB
VA SB
SC FC
CORR
CENTER 907.475 MHz
SPAN 5.000 MHz
#RES BW 100 kHz
#VBW 300 kHz
SWP 20 msec


12: 20: 00 AUG 28, 1998
MKR Δ 900 kHz
REF 20.0 dBm
ATTEN 20 dB
-.05 dB
PEAK
LOG
10
dB/
OFFST
10.0
dB
VA SB
SC FC
CORR
CENTER 915.000 MHz
SPAN 5.000 MHz
#RES BW 100 kHz
#VBW 300 kHz
SWP 20 msec

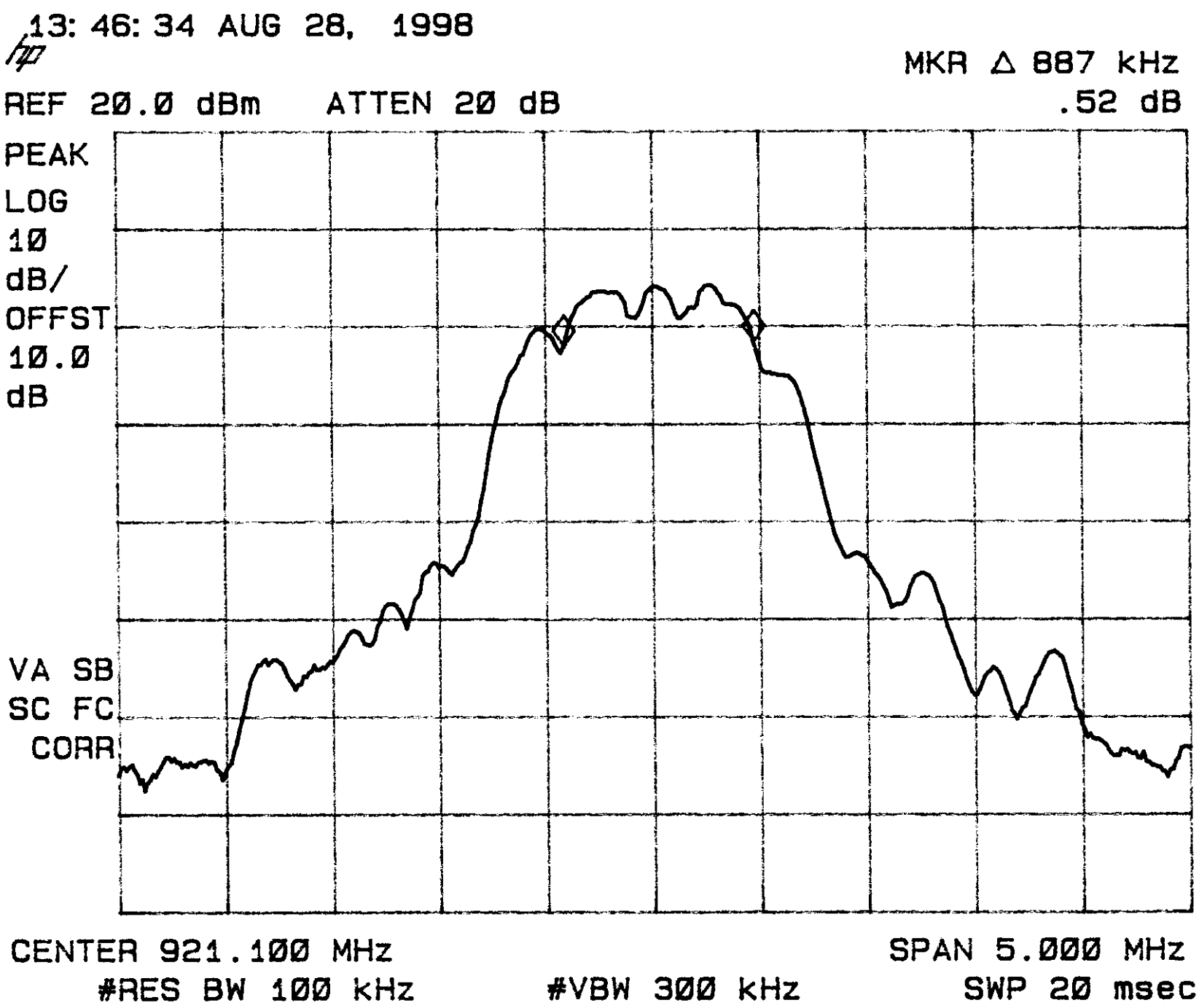

13: 46: 34 AUG 28, 1998
MKR Δ 887 kHz
REF 20.0 dBm
ATTEN 20 dB
.52 dB
PEAK
LOG
10
dB/
OFFST
10.0
dB
VA SB
SC FC
CORR
CENTER 921.100 MHz
SPAN 5.000 MHz
#RES BW 100 kHz
#VBW 300 kHz
SWP 20 msec

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TABLE 2

FCC 15.247(c) 3 METER RADIATED EMISSIONS DATA-SITE 1

CLIENT: O'Neill Connectivities
MODEL: Tx with Yagi Antenna (Cushcraft PC9013N)
DATE: 12/11/98
CLK SPEED(S): clock
BY: Herb Meadows
JOB #: 4785X

CONFIGURATION:
Channel 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (QP) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
108.14	H	180.0	4	24.6	11.6	36.2	64.4	150.0	-7.3
127.81	H	0.0	4	19.2	11.4	30.6	33.9	150.0	-12.9
167.15	H	180.0	4	21.2	11.0	32.2	40.7	150.0	-11.3
245.72	H	45.0	4	16.0	13.4	29.4	29.6	200.0	-16.6
265.47	H	45.0	4	18.0	14.2	32.2	40.6	200.0	-13.8
324.39	H	45.0	3	14.2	16.4	30.6	33.9	200.0	-15.4
403.01	H	225.0	2.5	10.0	17.8	27.8	24.7	200.0	-18.2
968.90	H	270.0	1.5	12.1	25.9	38.0	79.3	500.0	-16.0
108.15	V	270.0	1	25.1	11.6	36.7	68.2	150.0	-6.8
137.70	V	270.0	1	22.7	10.2	32.9	44.4	150.0	-10.6
167.15	V	180.0	1	23.0	11.0	34.0	50.1	150.0	-9.5
245.72	V	225.0	1	18.6	13.4	32.0	39.9	200.0	-14.0
255.62	V	45.0	1	27.2	13.6	40.8	109.9	200.0	-5.2
265.47	V	180.0	1	18.7	14.2	32.9	44.1	200.0	-13.1
324.39	V	315.0	1	15.0	16.4	31.4	37.1	200.0	-14.6
403.01	V	270.0	1	11.3	17.8	29.1	28.7	200.0	-16.9
968.90	V	180.0	1	11.3	25.9	37.2	72.3	500.0	-16.8

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Channel 1

FCC 15.247© 3M RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (AVG) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2724.00	V	180.0	1	42.3	-2.2	40.1	101.3	500.0	-13.9
3628.00	V	180.0	1	40.0	-1.6	38.4	83.2	500.0	-15.6
4537.00	V	180.0	1	35.5	-0.4	35.1	56.9	500.0	-18.9
5444.00	V	180.0	1	32.4	1.3	33.7	48.7	500.0	-20.2
2724.00	H	180.0	1	37.6	-2.2	35.4	59.0	500.0	-18.6
3628.00	H	180.0	1	40.5	-1.6	38.9	88.1	500.0	-15.1
4537.00	H	180.0	1	36.0	-0.4	35.6	60.3	500.0	-18.4

FCC 15.247© 3M PEAK RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (PEAK) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2724.00	V	180.0	1	55.1	-2.2	52.9	442.1	5000.0	-21.1
3628.00	V	180.0	1	52.4	-1.6	50.8	346.7	5000.0	-23.2
4537.00	V	180.0	1	48.3	-0.4	47.9	248.4	5000.0	-26.1
5444.00	V	180.0	1	45.8	1.3	47.1	227.6	5000.0	-26.8
2724.00	H	180.0	1	52.3	-2.2	50.1	320.3	5000.0	-23.9
3628.00	H	180.0	1	53.7	-1.6	52.1	402.7	5000.0	-21.9
4537.00	H	180.0	1	48.9	-0.4	48.5	266.2	5000.0	-25.5
5444.00	H	180.0	1	46.3	1.3	47.6	241.1	5000.0	-26.3

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TABLE 2

FCC 15.247(c) 3 METER RADIATED EMISSIONS DATA-SITE 1

CLIENT: O'Neill Connectivities
MODEL: Tx with Yagi Antenna (Cushcraft PC9013N)
DATE: 12/11/98
CLK SPEED(S): clock
BY: Herb Meadows
JOB #: 4785X

CONFIGURATION:
Channel 2

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (QP) dBuV	APc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
108.14	H	180.0	4	22.5	11.6	34.1	50.6	150.0	-9.4
127.81	H	0.0	4	18.6	11.4	30.0	31.7	150.0	-13.5
167.15	H	180.0	4	20.6	11.0	31.6	38.0	150.0	-11.9
265.47	H	45.0	4	17.8	14.2	32.0	39.7	200.0	-14.0
324.39	H	45.0	3	15.3	16.4	31.7	38.4	200.0	-14.3
403.01	H	225.0	2.5	9.8	17.8	27.6	24.1	200.0	-18.4
968.90	H	270.0	1.5	11.9	25.9	37.8	77.5	500.0	-16.2
108.15	V	270.0	1	24.3	11.6	35.9	62.2	150.0	-7.6
137.70	V	270.0	1	21.8	10.2	32.0	40.0	150.0	-11.5
255.62	V	45.0	1	25.3	13.6	38.9	88.3	200.0	-7.1
324.39	V	315.0	1	14.0	16.4	30.4	33.1	200.0	-15.6
403.01	V	270.0	1	12.8	17.8	30.6	34.1	200.0	-15.4
968.90	V	180.0	1	15.3	25.9	41.2	114.6	500.0	-12.8

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Channel 2

FCC 15.247© 3M RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (AVG) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2745.00	V	180.0	1	44.5	-2.1	42.4	131.2	500.0	-11.6
3660.00	V	180.0	1	39.2	-1.6	37.6	75.9	500.0	-16.4
4587.00	V	180.0	1	35.3	-0.3	35.0	56.3	500.0	-19.0
5488.00	V	180.0	1	32.6	1.4	34.0	50.2	500.0	-20.0
2745.00	H	180.0	1	42.7	-2.1	40.6	106.6	500.0	-13.4
3660.00	H	180.0	1	40.9	-1.6	39.3	92.3	500.0	-14.7
4587.00	H	180.0	1	35.7	-0.3	35.4	58.9	500.0	-18.6

FCC 15.247© 3M PEAK RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (PEAK) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2745.00	V	180.0	1	56.8	-2.1	54.7	540.5	5000.0	-19.3
3660.00	V	180.0	1	52.1	-1.6	50.5	335.0	5000.0	-23.5
4587.00	V	180.0	1	48.3	-0.3	48.0	251.4	5000.0	-26.0
5488.00	V	180.0	1	47.5	1.4	48.9	279.3	5000.0	-25.1
2745.00	H	180.0	1	54.7	-2.1	52.6	424.4	5000.0	-21.4
3660.00	H	180.0	1	52.8	-1.6	51.2	363.1	5000.0	-22.8
4587.00	H	180.0	1	47.6	-0.3	47.3	232.0	5000.0	-26.7
5572.00	H	180.0	1	45.5	1.6	47.1	225.6	5000.0	-26.9

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TABLE 2

FCC 15.247(c) 3 METER RADIATED EMISSIONS DATA-SITE 1

CLIENT: O'Neill Connectivities
MODEL: Tx with Yagi Antenna (Cushcraft PC9013N)
DATE: 12/11/98
CLK SPEED(S): clock
BY: Herb Meadows
JOB #: 4785X

CONFIGURATION:
Channel 3

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (QP) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
108.14	H	180.0	4	22.6	11.6	34.2	51.1	150.0	-9.5
167.15	H	180.0	4	18.6	11.0	29.6	30.2	150.0	-13.4
324.39	H	45.0	3	15.8	16.4	32.2	40.7	200.0	-13.8
968.90	H	270.0	1.5	12.8	25.9	38.7	85.9	500.0	-15.3
108.15	V	270.0	1	24.7	11.6	36.3	65.1	150.0	-7.2
255.62	V	45.0	1	25.4	13.6	39.0	88.9	200.0	-7.0
324.39	V	315.0	1	14.9	16.4	31.3	36.7	200.0	-14.7
968.90	V	180.0	1	16.0	25.9	41.9	124.2	500.0	-12.1

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Channel 3

FCC 15.247© 3M RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (AVG) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2763.00	V	180.0	1	48.2	-2.1	46.1	201.7	500.0	-7.9
3686.00	V	180.0	1	37.7	-1.6	36.1	63.8	500.0	-17.9
4625.00	V	180.0	1	35.1	-0.2	34.9	55.5	500.0	-19.1
5527.00	V	180.0	1	32.3	1.5	33.8	48.9	500.0	-20.2
2763.00	H	180.0	1	43.3	-2.1	41.2	114.7	500.0	-12.8
3686.00	H	180.0	1	40.4	-1.6	38.8	87.1	500.0	-15.2
4625.00	H	180.0	1	35.5	-0.2	35.3	58.1	500.0	-18.7
5527.00	H	180.0	1	32.2	1.5	33.7	48.4	500.0	-20.3

FCC 15.247© 3M PEAK RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (PEAK) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2763.00	V	180.0	1	59.5	-2.1	57.4	740.9	5000.0	-16.6
3686.00	V	180.0	1	50.5	-1.6	48.9	278.6	5000.0	-25.1
4625.00	V	180.0	1	47.9	-0.2	47.7	242.3	5000.0	-26.3
5527.00	V	180.0	1	45.4	1.5	46.9	221.0	5000.0	-27.1
2763.00	H	180.0	1	55.6	-2.1	53.5	472.9	5000.0	-20.5
3686.00	H	180.0	1	52.5	-1.6	50.9	350.8	5000.0	-23.1
4625.00	H	180.0	1	44.3	-0.2	44.1	160.1	5000.0	-29.9
5527.00	H	180.0	1	45.1	1.5	46.6	213.5	5000.0	-27.4

3.8 Radio Frequency Radiation Exposure

Based on the above data, the worst case RF output power of the unit occurs at Channel 1, 907.475 MHz. According to Section 1.1310 of the FCC rules, the uncontrolled RF exposure limit for this frequency range is $f_{MHz}/1500$. At 907.192 MHz, the limit would be 0.605 mW/cm^2. This unit will be used with different antennas. The gain of the antennas will range from unity up to 13 dBi. To comply with the exposure limits for this section, humans must not be too close to the transmit antenna. These distances were calculated as follows:

$S = (PG)/(4\Pi R^2)$

Where,
S = Power Density
P = Output Power at the Antenna Terminals
G = Gain of Transmit Antenna (linear gain)
R = Distance from Transmitting Antenna

For this device, the calculation is as follows:
S = FCC Limit = 0.605 mW/cm^2
P = Output Power = 23.33 mW
G = Worst Case Gain = 13 dBi = INVLOG(13/10) = 20

Therefore,
$0.605 = (23.33)(20)/(4\Pi R^2)$

$R = ((23.33)(20)/(4\Pi(0.605))^{1/2}$

R = 7.38 cm

For this device with a unity gain antenna, the calculation is as follows:
S = FCC Limit = 0.605 mW/cm^2
P = Output Power = 23.33 mW
G = 0 dBi = INVLOG(0/10) = 1

Therefore,
$0.605 = (23.33(1.0)/(4\Pi R^2)$

$R = ((23.33)(1.0)/(4\Pi)(0.605))^{1/2}$

R = 1.75 cm

A warning statement has been placed in the manual to caution the user about the RF exposure limitations of the unit. According to the manufacturer, the high gain omni-directional antennas are always used outdoors and due to the "normal" means of mounting the antenna, humans would not be within 7.5 cm of the antenna. The smaller unity gain antennas may be used indoors. These antennas are manufactured with a 1cm guard around the antenna. Therefore, the manual cautions the user not to touch or be within 0.75 cm of the antenna.

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TABLE 2

FCC 15.247(c) 3 METER RADIATED EMISSIONS DATA-SITE 1

CLIENT: O'Neill Connectivities
MODEL: Tx with Yagi Antenna (Cushcraft PC9013N)
DATE: 12/11/98
CLK SPEED(S): clock
BY: Herb Meadows
JOB #: 4785X

CONFIGURATION:
Channel 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (QP) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
108.14	H	180.0	4	24.6	11.6	36.2	64.4	150.0	-7.3
127.81	H	0.0	4	19.2	11.4	30.6	33.9	150.0	-12.9
167.15	H	180.0	4	21.2	11.0	32.2	40.7	150.0	-11.3
245.72	H	45.0	4	16.0	13.4	29.4	29.6	200.0	-16.6
265.47	H	45.0	4	18.0	14.2	32.2	40.6	200.0	-13.8
324.39	H	45.0	3	14.2	16.4	30.6	33.9	200.0	-15.4
403.01	H	225.0	2.5	10.0	17.8	27.8	24.7	200.0	-18.2
968.90	H	270.0	1.5	12.1	25.9	38.0	79.3	500.0	-16.0
108.15	V	270.0	1	25.1	11.6	36.7	68.2	150.0	-6.8
137.70	V	270.0	1	22.7	10.2	32.9	44.4	150.0	-10.6
167.15	V	180.0	1	23.0	11.0	34.0	50.1	150.0	-9.5
245.72	V	225.0	1	18.6	13.4	32.0	39.9	200.0	-14.0
255.62	V	45.0	1	27.2	13.6	40.8	109.9	200.0	-5.2
265.47	V	180.0	1	18.7	14.2	32.9	44.1	200.0	-13.1
324.39	V	315.0	1	15.0	16.4	31.4	37.1	200.0	-14.6
403.01	V	270.0	1	11.3	17.8	29.1	28.7	200.0	-16.9
968.90	V	180.0	1	11.3	25.9	37.2	72.3	500.0	-16.8

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Channel 1

FCC 15.247© 3M RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (AVG) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2724.00	V	180.0	1	42.3	-2.2	40.1	101.3	500.0	-13.9
3628.00	V	180.0	1	40.0	-1.6	38.4	83.2	500.0	-15.6
4537.00	V	180.0	1	35.5	-0.4	35.1	56.9	500.0	-18.9
5444.00	V	180.0	1	32.4	1.3	33.7	48.7	500.0	-20.2
2724.00	H	180.0	1	37.6	-2.2	35.4	59.0	500.0	-18.6
3628.00	H	180.0	1	40.5	-1.6	38.9	88.1	500.0	-15.1
4537.00	H	180.0	1	36.0	-0.4	35.6	60.3	500.0	-18.4

FCC 15.247© 3M PEAK RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (PEAK) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2724.00	V	180.0	1	55.1	-2.2	52.9	442.1	5000.0	-21.1
3628.00	V	180.0	1	52.4	-1.6	50.8	346.7	5000.0	-23.2
4537.00	V	180.0	1	48.3	-0.4	47.9	248.4	5000.0	-26.1
5444.00	V	180.0	1	45.8	1.3	47.1	227.6	5000.0	-26.8
2724.00	H	180.0	1	52.3	-2.2	50.1	320.3	5000.0	-23.9
3628.00	H	180.0	1	53.7	-1.6	52.1	402.7	5000.0	-21.9
4537.00	H	180.0	1	48.9	-0.4	48.5	266.2	5000.0	-25.5
5444.00	H	180.0	1	46.3	1.3	47.6	241.1	5000.0	-26.3

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TABLE 2

FCC 15.247(c) 3 METER RADIATED EMISSIONS DATA-SITE 1

CLIENT: O'Neill Connectivities
MODEL: Tx with Yagi Antenna (Cushcraft PC9013N)
DATE: 12/11/98
CLK SPEED(S): clock
BY: Herb Meadows
JOB #: 4785X

CONFIGURATION:
Channel 2

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (QP) dBuV	APc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
108.14	H	180.0	4	22.5	11.6	34.1	50.6	150.0	-9.4
127.81	H	0.0	4	18.6	11.4	30.0	31.7	150.0	-13.5
167.15	H	180.0	4	20.6	11.0	31.6	38.0	150.0	-11.9
265.47	H	45.0	4	17.8	14.2	32.0	39.7	200.0	-14.0
324.39	H	45.0	3	15.3	16.4	31.7	38.4	200.0	-14.3
403.01	H	225.0	2.5	9.8	17.8	27.6	24.1	200.0	-18.4
968.90	H	270.0	1.5	11.9	25.9	37.8	77.5	500.0	-16.2
108.15	V	270.0	1	24.3	11.6	35.9	62.2	150.0	-7.6
137.70	V	270.0	1	21.8	10.2	32.0	40.0	150.0	-11.5
255.62	V	45.0	1	25.3	13.6	38.9	88.3	200.0	-7.1
324.39	V	315.0	1	14.0	16.4	30.4	33.1	200.0	-15.6
403.01	V	270.0	1	12.8	17.8	30.6	34.1	200.0	-15.4
968.90	V	180.0	1	15.3	25.9	41.2	114.6	500.0	-12.8

Channel 2

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FCC 15.247© 3M RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (AVG) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2745.00	V	180.0	1	44.5	-2.1	42.4	131.2	500.0	-11.6
3660.00	V	180.0	1	39.2	-1.6	37.6	75.9	500.0	-16.4
4587.00	V	180.0	1	35.3	-0.3	35.0	56.3	500.0	-19.0
5488.00	V	180.0	1	32.6	1.4	34.0	50.2	500.0	-20.0
2745.00	H	180.0	1	42.7	-2.1	40.6	106.6	500.0	-13.4
3660.00	H	180.0	1	40.9	-1.6	39.3	92.3	500.0	-14.7
4587.00	H	180.0	1	35.7	-0.3	35.4	58.9	500.0	-18.6

FCC 15.247© 3M PEAK RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (PEAK) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2745.00	V	180.0	1	56.8	-2.1	54.7	540.5	5000.0	-19.3
3660.00	V	180.0	1	52.1	-1.6	50.5	335.0	5000.0	-23.5
4587.00	V	180.0	1	48.3	-0.3	48.0	251.4	5000.0	-26.0
5488.00	V	180.0	1	47.5	1.4	48.9	279.3	5000.0	-25.1
2745.00	H	180.0	1	54.7	-2.1	52.6	424.4	5000.0	-21.4
3660.00	H	180.0	1	52.8	-1.6	51.2	363.1	5000.0	-22.8
4587.00	H	180.0	1	47.6	-0.3	47.3	232.0	5000.0	-26.7
5572.00	H	180.0	1	45.5	1.6	47.1	225.6	5000.0	-26.9

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TABLE 2

FCC 15.247(c) 3 METER RADIATED EMISSIONS DATA-SITE 1

CLIENT: O'Neill Connectivities
MODEL: Tx with Yagi Antenna (Cushcraft PC9013N)
DATE: 12/11/98
CLK SPEED(S): clock
BY: Herb Meadows
JOB #: 4785X

CONFIGURATION:
Channel 3

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (QP) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
108.14	H	180.0	4	22.6	11.6	34.2	51.1	150.0	-9.3
167.15	H	180.0	4	18.6	11.0	29.6	30.2	150.0	-13.9
324.39	H	45.0	3	15.8	16.4	32.2	40.7	200.0	-13.8
968.90	H	270.0	1.5	12.8	25.9	38.7	85.9	500.0	-15.3
108.15	V	270.0	1	24.7	11.6	36.3	65.1	150.0	-7.2
255.62	V	45.0	1	25.4	13.6	39.0	88.9	200.0	-7.0
324.39	V	315.0	1	14.9	16.4	31.3	36.7	200.0	-14.7
968.90	V	180.0	1	16.0	25.9	41.9	124.2	500.0	-12.1

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channel 3

FCC 15.247© 3M RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (AVG) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2763.00	V	180.0	1	48.2	-2.1	46.1	201.7	500.0	-7.9
3686.00	V	180.0	1	37.7	-1.6	36.1	63.8	500.0	-17.9
4625.00	V	180.0	1	35.1	-0.2	34.9	55.5	500.0	-19.1
5527.00	V	180.0	1	32.3	1.5	33.8	48.9	500.0	-20.2
2763.00	H	180.0	1	43.3	-2.1	41.2	114.7	500.0	-12.8
3686.00	H	180.0	1	40.4	-1.6	38.8	87.1	500.0	-15.2
4625.00	H	180.0	1	35.5	-0.2	35.3	58.1	500.0	-18.7
5527.00	H	180.0	1	32.2	1.5	33.7	48.4	500.0	-20.3

FCC 15.247© 3M PEAK RADIATED EMISSIONS DATA ABOVE 1 GHz-SITE 1

FREQ MHz	POL H/V	Azimuth Degree	Ant Ht m	SA LVL (PEAK) dBuV	AFc dB/m	E-FLD dBuV/m	E-FLD uV/m	LIMIT uV/m	MRGN dB
2763.00	V	180.0	1	59.5	-2.1	57.4	740.9	5000.0	-16.6
3686.00	V	180.0	1	50.5	-1.6	48.9	278.6	5000.0	-25.1
4625.00	V	180.0	1	47.9	-0.2	47.7	242.3	5000.0	-26.3
5527.00	V	180.0	1	45.4	1.5	46.9	221.0	5000.0	-27.1
2763.00	H	180.0	1	55.6	-2.1	53.5	472.9	5000.0	-20.5
3686.00	H	180.0	1	52.5	-1.6	50.9	350.8	5000.0	-23.1
4625.00	H	180.0	1	44.3	-0.2	44.1	160.1	5000.0	-29.9
5527.00	H	180.0	1	45.1	1.5	46.6	213.5	5000.0	-27.4

3.8 Radio Frequency Radiation Exposure

Based on the above data, the worst case RF output power of the unit occurs at Channel 1, 907.475 MHz. According to Section 1.1310 of the FCC rules, the uncontrolled RF exposure limit for this frequency range is $f_{MHz}/1500$. At 907.192 MHz, the limit would be 0.605 mW/cm^2. This unit will be used with different antennas. The gain of the antennas will range from unity up to 13 dBi. To comply with the exposure limits for this section, humans must not be too close to the transmit antenna. These distances were calculated as follows:

$S = (PG)/(4\Pi R^2)$

Where,
S = Power Density
P = Output Power at the Antenna Terminals
G = Gain of Transmit Antenna (linear gain)
R = Distance from Transmitting Antenna

For this device, the calculation is as follows:
S = FCC Limit = 0.605 mW/cm^2
P = Output Power = 23.33 mW
G = Worst Case Gain = 13 dBi = INVLOG(13/10) = 20

Therefore,
$0.605 = (23.33)(20)/(4\Pi R^2)$

$R = ((23.33)(20)/(4\Pi)(0.605))^{1/2}$

R = 7.38 cm

For this device with a unity gain antenna, the calculation is as follows:
S = FCC Limit = 0.605 mW/cm^2
P = Output Power = 23.33 mW
G = 0 dBi = INVLOG(0/10) = 1

Therefore,
$0.605 = (23.33(1.0)/(4\Pi R^2)$

$R = ((23.33)(1.0)/(4\Pi)(0.605))^{1/2}$

R = 1.75 cm

A warning statement has been placed in the manual to caution the user about the RF exposure limitations of the unit. According to the manufacturer, the high gain omni-directional antennas are always used outdoors and due to the "normal" means of mounting the antenna, humans would not be within 7.5 cm of the antenna. The smaller unity gain antennas may be used indoors. These antennas are manufactured with a 1cm guard around the antenna. Therefore, the manual cautions the user not to touch or be within 0.75 cm of the antenna.

EXHIBIT 8

PROCESSING GAIN

5. Frequency synthesizer

The receiver local oscillator stays on all the time. It not only provides the LO drive to the receiver mixer, it also beats with the transmitter VCO to generate a low frequency oscillation signal to be used to synthesize the transmitter frequency. The beating mechanism provides a low frequency version of the transmitter frequency without using a divider which will adversely slow down the response time of the phase lock loop. As a result, the keyup time of the transmitter is normally below 300 usec.

6. Packet engine

LAWNIIP use a Zilog 84C15 processor to build the packet for the transmitter and valid the packet for the receiver. The packet protocol follows the industry standard of AX.25 with some minor modifications. The standard packet has 256 bytes of data and 21 bytes of overhead and some pre-amble for the receiver to synchronize. A 9.8304 Mhz crystal is used as the system clock. The baud rate over the air is a constant speed of 76.8 Kbaud. The maximum serial port baud rate is 38.4 Kbaud. LAWNIIP utilizes the CSMA/CD technology to prevent packet collision.

7. ASIC

The OCI-100 ASIC contains the synthesizers for the receiver and transmitter PLL's and the spreading and dispreading for the chips. Each data bit is spreaded into 16 data chips for the transmitter. As for the despreading, a state machine is used to detect, acquire and lock the local chips to the incoming chips. The ASIC can detect and lock the incoming chips in less than 50 usec.

8. Battery Backup

A lithium battery is used to keep the containss of the RAM alive when the unit is powered off.. To protect the RAM from being disturbed during abnormal operating conditions, a Maxim 691 chip is used to monitor the power line and protect the Chip Enable line of the RAM.

9. Power Supply

A low dropoff voltage regulator is used to provide a clean 5 Volt to the whole system. The recommended power supply voltage input is 8V DC.

10. LED Display

The status of the LAWNIIP is shown through the four LEDs that indicates the condition of power, traffic, transmitter and link connection. These four LEDs provide an easy way for system debugging.

11. Processing Gain

Since the LAWNIIP used post-IF despreading technique for chip despreading, the processing gain of the despreader can only be measured indirectly by measuring the jamming margin. According to the

Dixon's book " Spread Spectrum Systems", the processing gain can be calculated as follows,

PG = JM +S/N + SL

where PG is the processing gain, JM is the jamming margin, S/N is the required S/N and SL is the system loss.

The test equipment setup for measuring the jamming margin is show as the attached figure. A LAWNIIP with the transmitter locked on and placed inside a completely sealed tin can is used as the test signal. This test signal is then combined with the jamming signal from a signal generator to become the composite test signal which is then splitted into two signals, one for the Unit Under Test (UUT) and the other is sent to the spectrum analyzer for monitoring.

The test signal level used for the testing is fixed to -32 dbm to simulate the pass loss for about 50 feet indoors. The jamming signal's level and frequency are adjustable. During the test, the jamming signal's level at each test frequency will be increased until the error rate of the UUT exceeds the minimum requirement of 10^{-4}. The level difference between the test signal and the jamming signal for causing 10^{-4} error rate is the desired jamming margin at that frequency.

The frequency of the jamming signal has to cover the whole -6db bandwidth of the spectrum with 50 Khz steps. Since the LAWNIIP's -6 db spectrum bandwidth is 2.6 Mhz, there are 53 frequencies to be measured. The Channel 2 (center at 914.8Mhz) of the LAWNIIP is used as the test channel and the jamming frequency starts at 913.5 Mhz and stops at 916.1 Mhz.

The jamming margin of each of the test frequency is shown as follows,

Frequency(Mhz)	Jamming Margin(dB)	
913.5	+0.2	
913.55	-0.2	
913.6	-2.0	
913.65	-2.4	
913.7	-0.9	
913.75	-1.3	
913.8	-2.0	
913.85	-1.4	
913.9	-1.2	
913.95	-2.0	
914	-2.9	(#5)
914.05	-2.5	(#10)
914.1	-4.0	(#1)
914.15	-3.2	(#3)
914.2	-2.9	(#4)
914.25	-2.4	
914.3	-3.3	(#2)
914.35	-2.8	(#8)
914.4	-2.2	
914.45	-1.2	

914.5	-0.2	
914.55	-0.5	
914.6	-0.9	
914.65	-1.0	
914.7	-1.0	
914.75	-1.2	
914.8	-1.2	
914.85	-1.2	
914.9	-1.3	
914.95	-1.4	
915.	-1.9	
915.05	-1.6	
915.1	-2.0	
915.15	-2.4	
915.2	-2.1	
915.25	-2.8	(#7)
915.3	-2.0	
915.35	-2.9	(#6)
915.4	-1.8	
915.45	-2.0	
915.5	-1.0	
915.55	-1.7	
915.6	-1.1	
915.65	-2.6	(#9)
915.7	-1.9	
915.75	-1.9	
915.8	-1.8	
915.85	-0.8	
915.9	-0.2	
915.95	+0.5	
916	+0.6	
916.05	-0.9	
916.1	-0.9	

Since 80% of the test frequencies have a jamming margin better than -2.5 db, the jamming margin of the LAWNIIP is measured as -2.5 db.

Since the LAWNIIP uses the FSK demodulator that requires 13 db S/N for an error rate of 10^{-4} and consider a moderate system loss of 2 db, the processing gain of the LAWNIIP is calculated as

PG = -2.5 +13 +2 = 12.4 db