FCC Part 15 Subpart E Test Report
for
Wireless Bypass
on the
Cable Access Radio CPE
Model: DL-5801C24

FCC ID: PPS-DL-5801C24

Date of Report: December 4, 2001

Project #: 3015156
Date of Test: June 11, 2001 – June 19, 2001, November 28, 2001 – November 29, 2001

Lab Code 100270-0

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1.0 Summary of Tests

Wireless Bypass, Model: DL-5801C24
FCC ID: PPS-DL-5801C24

TEST	REFERENCE	RESULTS
Output power	15.407 (a)	Pass
26 dB Bandwidth*	15.407 (a)	For calculation only
Power Density	15.407 (a) (5)	Pass
The ratio of the peak excursion of the modulation envelope to the peak transmit power	15.407 (a) (6)	Pass
Out of Band Antenna Conducted Emission	15.407 (b)	Pass
Radiated Emission in Restricted Bands	15.205	Pass
AC Conducted Emission	15.207	Pass
Radiated Emission from Digital Module	15.209	Pass
Radiated Emission from Receiver	15.209	Pass
Radiation Exposure Requirement	1.1310	Pass
Frequency Stability	15.407(g)	Pass
Antenna Requirement	15.203	Pass, Professional Install

Test Engineer: _____ Date: _____
Nicholas Abbondante

Staff Engineer: _____ Date: _____
Michael F. Murphy

2.0 General Description

2.1 Product Description

The EUT Model No.: DL-5801C24 is an intentional transmitter used for wireless point-to-point and point-to-multipoint communications operating in the frequency range: 5.725-5.825 GHz.

A pre-production version of the sample was received on June 11, 2001 and on November 28, 2001 in good condition.

Overview of the Cable Access Radio CPE

Applicant	Wireless Bypass, Inc.
Trade Name & Model No.	Cable Access Radio CPE, Model: DL-5801C24
FCC Identifier	PPS-DL-5801C24
Use of Product	Point-to-point fixed and point-to-multipoint wireless interconnect
Type of Transmission	256 QAM, 64 QAM
Maximum RF Output (dBm) *	10.97 dBm
Frequency Range (MHz)	5.725 – 5.825 GHz
Number of Channel(s)	3
Antenna(s) & Gain, dBi	Point-to-Point: Flat Panel Antenna, 23 dBi Parabolic Antenna, 28, 34.6, and 37.6 dBi Point-to-Multipoint: Flat Panel Antenna, 12, 15, 16, 18 and 23 dBi
Antenna Requirement	[ ] The EUT uses a permanently connected antenna. [ ] The antenna is affixed to the EUT using a unique connector which allows for replacement of a broken antenna, but DOES NOT use a standard antenna jack or electrical connector. [x] The EUT requires professional installation (attach supporting documentation if using this option).
Manufacturer name & address	Wireless Bypass, Inc. 43 Northwestern Drive Salem, MA, 03079

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

2.2 Related Submittal(s)/Grants

Cable Access Radio HUB
Model: DL-5800H24
FCC ID: PPS-DL-5800H24

2.3 Test Methodology

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

2.4 Test Facility

Site 2C and 3C are 3m and 10m sheltered EMI measurement ranges located in a light commercial environment in Boxborough, Massachusetts. They meet the technical requirements of ANSI C63.4-1992 and CISPR 22:1993/EN 55022:1994 for radiated and conducted emission measurements. The shelter structure is entirely fiberglass and plastic, with outside dimensions of 33 ft x 57 ft. The structure resembles a quonset hut with a center ceiling height of 16.5 ft.

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

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

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

AC mains power is brought to the equipment under test through a power line filter, to remove ambient conducted noise. 50 Hz (240 VAC single phase), 60 Hz power (120 VAC single phase, 208 VAC three phase), and 60 Hz (480 VAC three phase) are available. Conducted emission measurements are performed with a Line Impedance Stabilization Network (LISN) or Artificial Mains Network (AMN) bonded to the ground reference plane. A removable vertical groundplane (2 meter X 2 meter area) is used for line-conducted measurements for table top equipment. The vertical groundplane is electrically connected to the reference groundplane.

3.0 System Test Configuration

3.1 Support Equipment, Cables, and Antenna List

Description:	Model #:	Serial #:	FCC ID:
Toshiba Cable Modem	DAZ8813F	5105740987-54	N7ZDAZ8813
Dell Computer	MMP	95B71	N/L
Microsoft Mouse	91289	02231747	C3KKMP3
Samsung Keyboard	SK-1688	C0010069512	GYUR84SK
Samsung Monitor	Syncmaster 710s	HCCJB02206Y	N/L
3Com Cable Modem	3CR29220	HAZHA8BDF8	N/L
3Com Cable Modem	3CR29220	HAZHA8BDCO	N/L
RIC Monitor	X-554M	CZC000405074	HSUTRLX-554
Samtron Monitor	SC-528UXL	A9439024501	CSYSC-528UX
3Com Hub	3C16592A	0100/7D9F042259	HED3C16593A
Riverdelta CMTS	BSR1000	0110A0006	N/L
WIN Computer	WNP-II233-128-18.2	WN9710-3754	N/L
Compaq Computer	5BW130	1X06DTY8120A	N/L
Compaq Mouse	334584-007	334584-007	JNZ201213
Microsoft Mouse	02695686	02695686	C3KKMP1
Compaq Keyboard	SDM454OUL	B354ABUOAJHPPO	N/L
NMB Keyboard	RT2348TW	C0281497	AQ6-MTN71BZ15DIP
Cable Access Radio Hub	DL-5800H24	ENG2	PPS-DL-5800H24

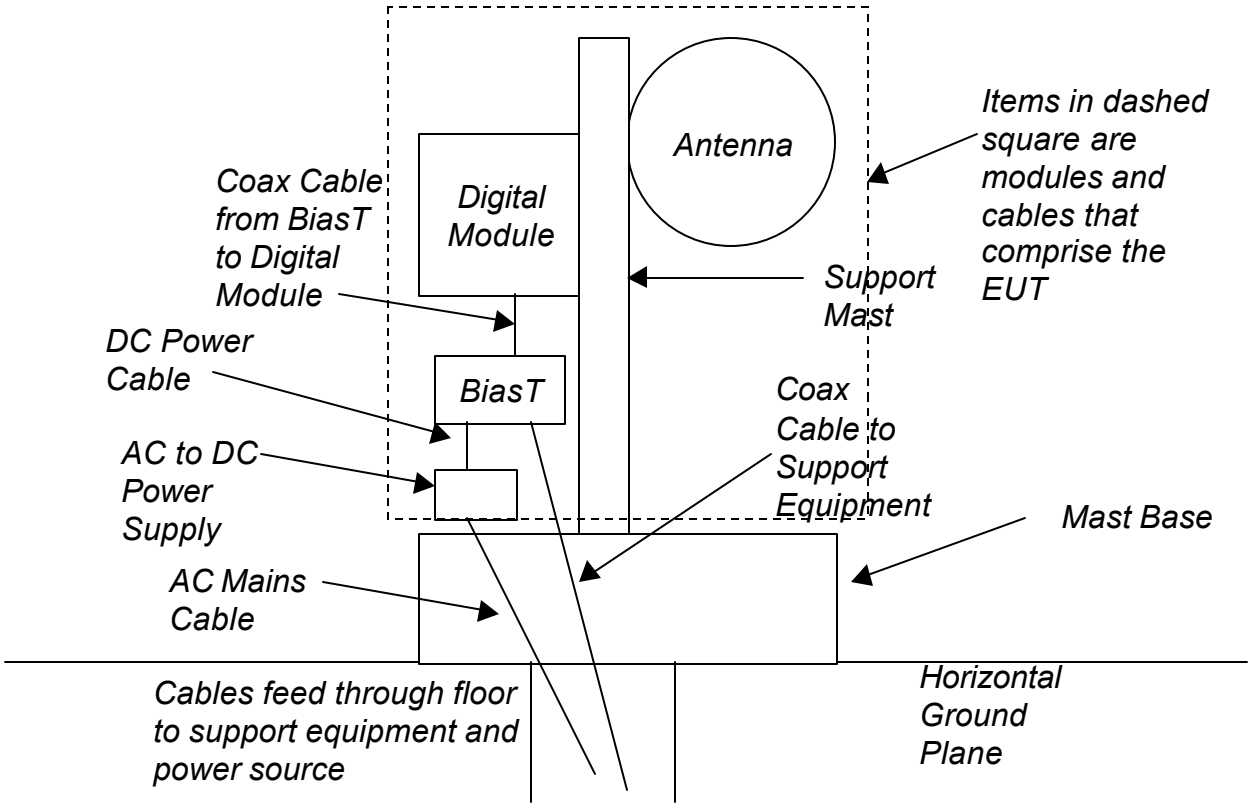
Cables:

Description:	Shield:	Connector:	Length:	Quantity:
AC Mains	None	Plastic	2	1
Coaxial	Coaxial	Full 360° Metal	3	1

Antennas:

Description	Usage	Model No.
Cushcraft Flat Panel Antenna 12 dBi	Point-to-Multipoint	S57212AMP10SMF
Telex Flat Panel Antenna 15 dBi	Point-to-Multipoint	5840AA
Radiowaves Flat Panel Antenna 16 dBi	Point-to-Multipoint	SEC-5H-16-90
Gabriel Flat Panel Antenna 18 dBi	Point-to Multipoint	DFPD 5-52
Gabriel Flat Panel Antenna 23 dBi	Point-to-Multipoint, Point-to-Point	DFPD 1-52
Radiowaves 2’ Parabolic Antenna 28 dBi	Point-to-Point	SP2-5.8
Radiowaves 4’ Parabolic Antenna 34.6 dBi	Point-to-Point	SP4-5.8
Radiowaves 6’ Parabolic Antenna 37.6 dBi	Point-to-Point	SP6-5.8

3.2 Block Diagram of Test Setup



3.3 Justification

For emission testing, the Equipment Under Test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). During testing, all cables were manipulated to produce worst case emissions.

The EUT is wired to transmit full power.

The signal is maximized through 360 degree rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

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

All support equipment was remotely located. The EUT was placed in the center of the turntable.

3.4 Software Exercise Program

The EUT exercise program used during testing was designed to exercise the various system components in a manner similar to a typical use. Data was transmitted through the system in order to activate the transmitter circuitry. The receiver circuitry was connected to the transmitted signal to activate receiver circuitry. Care was taken to ensure proper power supply voltages during testing.

3.5 Mode of operation during test

100% time transmitting signal on all channels.

3.6 Modifications required for Compliance

The following modifications were installed during compliance testing in order to bring the product into compliance (Please note that this list does not include changes made specifically by Wireless Bypass prior to compliance testing):

A prescan was performed to determine if the EUT had any spurious emissions. Due to the results of this scan, the following modifications were required:

1) Conductive gasket (Manufacturer: TennRich P/N:FBC0402) was placed between the access panel and the chassis of the EUT with paint removed for better conductive contact.

2) A minimum of 20’ of coaxial cable must separate the BiasT Module of the EUT from the Digital Module.

3.7 Additions, deviations and exclusions from standards

No additions, deviations or exclusion have been made from standard.

4.0 Measurement Results

4.1 Conducted Output Power at Antenna Terminal
FCC Rule 15.407(a)

Requirement:

For fixed point-to-point U-NII devices operating in 5.725-5.825 GHz band, the peak transmit power shall not exceed the lesser of 1 W (30 dBm) or 17 dBm + 10Log(B), where B is the 26 dB emission bandwidth in MHz (for antenna gain up to 6 dBi).

Procedure:

The antenna port of the EUT was connected to the input of a spectrum analyzer with 3 MHz resolution bandwidth and 7 MHz video bandwidth. Power was read directly from the analyzer and cable loss was added to the reading to obtain power at the EUT antenna terminal.

Result:

Frequency, MHz	Output Power, mW	Output Power, dBm	Limit, dBm	Maximum allowed antenna gain, dBi
Low Channel: 5727.25	10.5	10.2	21.9	17.7(p-mp), 34.7(p-p)
Mid Channel: 5733.00	12.5	11.0	22.0	17.0(p-mp), 34.0(p-p)
High Channel: 5740.00	11.8	10.7	22.0	17.3(p-mp), 34.3(p-p)

Note:

1. The EUT Output Power was set to maximum to produce the worse case test result.
2. When a higher gain antenna is used, the Output Power will be reduced further by a 1:1 ratio equal to the amount by which the antenna gain exceeds the allowed antenna gain for point to multipoint use and for point to point use.
3. (p-mp) refers to “Point to Multipoint” operation, while (p-p) refers to “Point to Point” operation.

4.2 26 dB Bandwidth
FCC Rule 15.407(a) (for calculation only)

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer Res BW was set to 100 kHz. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. A PEAK output reading was taken, a DISPLAY line was drawn 26 dB lower than PEAK level. The 26 dB bandwidth was determined from where the channel output spectrum intersected the display line.

Frequency, MHz	26 dB Bandwidth, MHz
5727.25	3.07
5733.00	3.16
5740.00	3.18

Refer to the following plots for 26 dB bandwidth:

Plot 1a: Low Channel 26 dB Bandwidth
Plot 1b: Mid Channel 26 dB Bandwidth
Plot 1c: High Channel 26 dB Bandwidth

4.3 Power Density

Requirement:

For fixed point-to-point U-NII devices operating in 5.725-5.825 GHz band peak power spectral density shall not exceed 17 dBm in any 1 MHz band (for antenna gain up to 6 dBi for point to multipoint operation and gain up to 23 dBi for point to point operation). This gives an effective EIRP limit of 23.0 dBm for point to multipoint operation and 40 dBm for point to point operation.

Procedure:

Antenna output of the EUT was coupled directly to spectrum analyzer; an external attenuator and cable were used; the losses are 30 dB for the attenuator and 6.1 dB for the cable.

The spectrum analyzer Resolution Bandwidth was set to 1 MHz and Video Bandwidth was set to 3 MHz. The START and STOP frequencies were set to the band edges of the maximum output passband. The spectrum analyzer was set to video average, 100 sweeps were used. Maximum peak-power spectral density reading was recorded.

Result (includes losses through the measurement system):

Frequency MHz	Power Density dBm	EIRP Limit dBm	Maximum Allowed Antenna Gain dBi
5727.25	6.7	23.0(p-mp), 40(p-p)	16.3 (p-mp), 33.3 (p-p)
5733.00	8.4	23.0(p-mp), 40(p-p)	14.6 (p-mp), 31.6 (p-p)
5740.00	7.2	23.0(p-mp), 40(p-p)	15.8 (p-mp), 32.8 (p-p)

Refer to the following plots for power density data:

Plot 2a: Low Channel Power Density
Plot 2b: Mid Channel Power Density
Plot 2c: High Channel Power Density

Note:
1. (p-mp) refers to “Point to Multipoint” operation, while (p-p) refers to “Point to Point” operation.
2. When an antenna is used with gain higher than that specified as allowable for either point to point or point to multipoint operation, the output power shall be reduced by the amount in dB that the antenna gain exceeds the allowed antenna gain.

4.4 The ratio of the peak excursion of the modulation envelope to the peak power
FCC Rule 15.407(a)(6)

Requirement:

The ratio of the peak excursion of the modulation envelope to the peak transmit power shall not exceed 13 dB.

Procedure:

Spectrum Analyzer was connected to the output of the EUT. The Resolution Bandwidth was set to 1 MHz. Two plots were made in each band: with the Video Bandwidth set to 3 MHz and with the Video Bandwidth set to 30 kHz. The difference between spectrum analyzer readings indicates the ratio of the peak excursion of the modulation envelope to the peak transmit power.

Test Result:

See attached plots 3.a1, 3.a2, 3.b1, 3.b2, 3.c1 and 3.c2 for the ratio of the peak excursion of the modulation envelope to the peak power. The maximum Ratio is 5.0 dB.

4.5 Out-of-Band Emissions
FCC Rule 15.407(b)

Requirement:

For transmitters operating in the 5.725-5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of –17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of –27 dBm/MHz.

The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

Note that this gives a spurious emission limit of 80 dBuV for out of band emissions, which far exceeds the limits set forth in 15.209. Therefore the limits of 15.209 were applied to any radiated emissions below 1 GHz.

Procedure:

For radiated spurious measurements, the spectrum analyzer was connected to an antenna set that spanned the range from 30 MHz to 40 GHz. The EUT was connected to the highest and lowest gain antenna of each type marketed with the EUT. For frequencies above 1 GHz, the Resolution Bandwidth was set to 1 MHz, and average measurements were performed. For frequencies below 1 GHz, the Resolution Bandwidth was set 100 kHz, and quasi-peak measurements were performed. Several plots were made in the frequency range from 30 MHz to 40 GHz. For band edge measurements, the spectrum analyzer was connected directly to the EUT antenna port via a 30 dB attenuator and a cable with 6.1 dB of loss at the transmit frequency range.

Result:

Note that all emissions detected above 1 GHz were determined to be ambient (by interrupting power to the EUT and observation that the emissions still persisted) with exception to the fundamental transmit frequency, which is measured elsewhere in this report. Also note that the marker resolution of the analyzer lead to inaccuracy in the frequency value of the fundamental emission. These values are not being measured. Photos are provided.

Refer to the following plots and data tables for spurious radiated emissions data:
Plot 4.a1 – 4.a8 and Table A: 2’ Parabolic 28 dBi Gain (Point-Point)
Plot 4.b1 – 4.b8 and Table B: 6’ Parabolic 37.6 dBi Gain (Point-Point)
Plot 4.c1 – 4.c8 and Table C: Flat Panel 23 dBi Gain (Point-Point)
Plot 4.d1 – 4.d8 and Table D: Flat Panel 23 dBi Gain (Point-Multipoint)
Plot 4.e1 – 4.e8 and Table E: Flat Panel 12 dBi Gain (Point-Multipoint)

Refer to the following plots for antenna conducted band edge measurements:
Plot 4.f1 – 4.f2: Low Channel Band Edge Measurements, 5727.25 MHz.
Plot 4.g1 – 4.g2: Mid Channel Band Edge Measurements, 5733.00 MHz.
Plot 4.h1 – 4.h2: High Channel Band Edge Measurements, 5740.00 MHz

Refer to plots 4.j1 – 4.j8 for antenna port conducted emissions plots. No spurious emissions were observed.

The EUT was scanned for spurious emissions while connected to the highest and lowest gain antennas of each type that is marketed with the EUT. Band edge measurements were taken by directly connecting the spectrum analyzer to the EUT antenna port.

Operating frequency	Frequency, MHz	Conducted Level, dBm	EIRP Limit, dBm/MHz
5727.25 MHz	5725	-17.4 from plot 4.f1	-17.0
	5825	-31.6 from plot 4.f2	-17.0

Operating frequency	Frequency, MHz	Conducted Level, dBm	Limit, dBm/MHz
5733.00 MHz	5725	-26.2 from plot 4.g1	-17.0
	5825	-45.3 from plot 4.g2	-17.0

Operating frequency	Frequency, MHz	Conducted Level, dBm	Limit, dBm/MHz
5740.00 MHz	5724	-32.0 from plot 4.g1	-17.0
	5826	-35.7 from plot 4.g2	-17.0

Intertek Testing Services

Radiated Emissions / Interference

Table: A

Company: Wireless Bypass
Model: DL-5800C
Job No.: J20046196
Date: 06/15/01
Standard: FCC15
Class: A Group: None
Notes: Radiowaves 2' parabolic on CPE

Tested by: Nicholas Abbondante
Location: Site 1C
Detector: HP 8546A
Antenna: LOG1
PreAmp: 0
Cable(s): 1C, 3 METER, PRIMARY
Distance: 3 meters

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	39.510	20.0	12.7	0.7	0.0	0.0	33.4	40.0	-6.6
V	48.000	21.2	9.4	0.9	0.0	0.0	31.4	40.0	-8.6
V	69.250	21.2	6.6	0.8	0.0	0.0	28.7	40.0	-11.3
V	74.000	22.2	6.4	0.9	0.0	0.0	29.5	40.0	-10.5
V	109.000	12.1	7.3	1.3	0.0	0.0	20.6	43.5	-22.9
V	117.600	18.3	6.8	1.3	0.0	0.0	26.4	43.5	-17.1
V	135.800	16.7	7.1	1.4	0.0	0.0	25.3	43.5	-18.2

Intertek Testing Services

Radiated Emissions / Interference

Table: B

Company:	Wireless Bypass	Tested by:	Nicholas Abbondante
Model:	DL-5800C	Location:	Site 1C
Job No.:	J20046196	Detector:	HP 8546A
Date:	06/14/01	Antenna:	LOG1
Standard:	FCC15	PreAmp:	0
Class:	A Group: None	Cable(s):	1C, 3 METER, PRIMARY
Notes:	Radiowaves 6' Parabolic on CPE	Distance:	3 meters

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	40.120	20.8	12.4	0.7	0.0	0.0	33.9	40.0	-6.1
V	43.520	20.0	11.1	0.8	0.0	0.0	31.8	40.0	-8.2
V	74.540	23.5	6.4	0.9	0.0	0.0	30.8	40.0	-9.2
V	108.800	19.5	7.3	1.3	0.0	0.0	28.0	43.5	-15.5
V	118.300	17.3	6.8	1.3	0.0	0.0	25.4	43.5	-18.1
V	133.700	17.5	7.0	1.4	0.0	0.0	25.9	43.5	-17.6

Intertek Testing Services

Radiated Emissions / Interference

Table: C

Company:	Wireless Bypass	Tested by:	Nicholas Abbondante
Model:	DL-5800C	Location:	Site 1C
Job No.:	J20046196	Detector:	HP 8546A
Date:	06/15/01	Antenna:	LOG1
Standard:	FCC15	PreAmp:	0
Class:	A Group: None	Cable(s):	1C, 3 METER, PRIMARY
Notes:	Gabriel Flat panel on CPE p-p	Distance:	3 meters

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	43.520	19.5	11.1	0.8	0.0	0.0	31.3	40.0	-8.7
V	45.680	19.8	10.2	0.8	0.0	0.0	30.9	40.0	-9.1
V	74.630	21.8	6.4	0.9	0.0	0.0	29.1	40.0	-10.9
V	86.070	19.6	6.8	1.2	0.0	0.0	27.6	40.0	-12.4
V	108.800	20.2	7.3	1.3	0.0	0.0	28.7	43.5	-14.8
V	121.800	17.1	6.7	1.3	0.0	0.0	25.1	43.5	-18.4
V	135.800	16.5	7.1	1.4	0.0	0.0	25.1	43.5	-18.4

Intertek Testing Services

Radiated Emissions / Interference

Table: D

Company:	Wireless Bypass	Tested by:	Nicholas Abbondante
Model:	DL-5800C	Location:	Site 1C
Job No.:	J20046196	Detector:	HP 8546A
Date:	06/14/01	Antenna:	LOG1
Standard:	FCC15	PreAmp:	0
Class:	A Group: None	Cable(s):	1C, 3 METER, PRIMARY
Notes:	Gabriel Flat Panel Antenna on CPE p-mp	Distance:	3 meters

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	40.340	20.8	12.3	0.7	0.0	0.0	33.8	40.0	-6.2
V	46.390	16.9	10.0	0.8	0.0	0.0	27.7	40.0	-12.3
V	74.560	18.6	6.4	0.9	0.0	0.0	25.9	40.0	-14.1
V	108.800	21.5	7.3	1.3	0.0	0.0	30.0	43.5	-13.5
V	117.600	18.0	6.8	1.3	0.0	0.0	26.1	43.5	-17.4
V	132.300	15.4	6.9	1.4	0.0	0.0	23.7	43.5	-19.8

Intertek Testing Services

Radiated Emissions / Interference

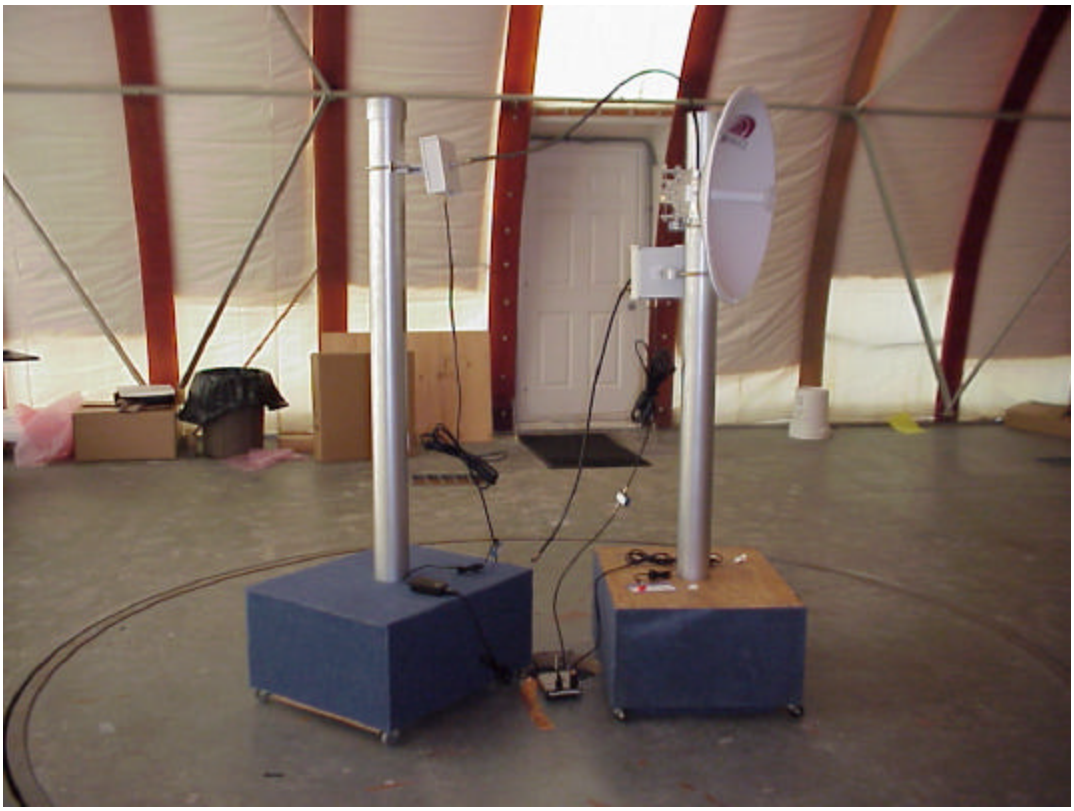
Table: E

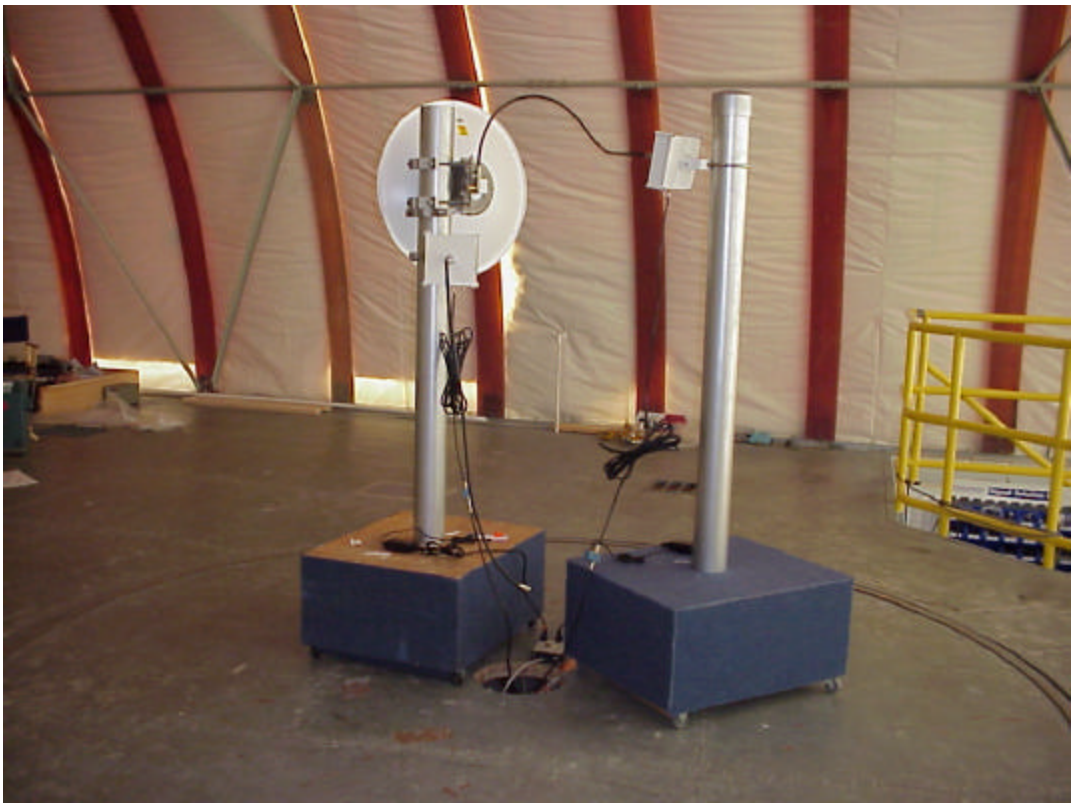
Company:	Wireless Bypass	Tested by:	Nicholas Abbondante
Model:	DL-5800C	Location:	Site 1C
Job No.:	J20046196	Detector:	HP 8546A
Date:	06/14/01	Antenna:	LOG1
Standard:	FCC15	PreAmp:	0
Class:	A Group: None	Cable(s):	1C, 3 METER, PRIMARY
Notes:	Cushcraft patch antenna on CPE	Distance:	3 meters

Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB
V	40.340	22.1	12.3	0.7	0.0	0.0	35.1	40.0	-4.9
V	51.020	21.1	8.5	0.9	0.0	0.0	30.5	40.0	-9.5
V	73.970	19.1	6.4	0.9	0.0	0.0	26.4	40.0	-13.6
V	108.800	20.1	7.3	1.3	0.0	0.0	28.6	43.5	-14.9
V	137.700	17.3	7.3	1.4	0.0	0.0	26.0	43.5	-17.5
V	154.900	12.7	8.6	1.5	0.0	0.0	22.8	43.5	-20.7

Configuration Photograph

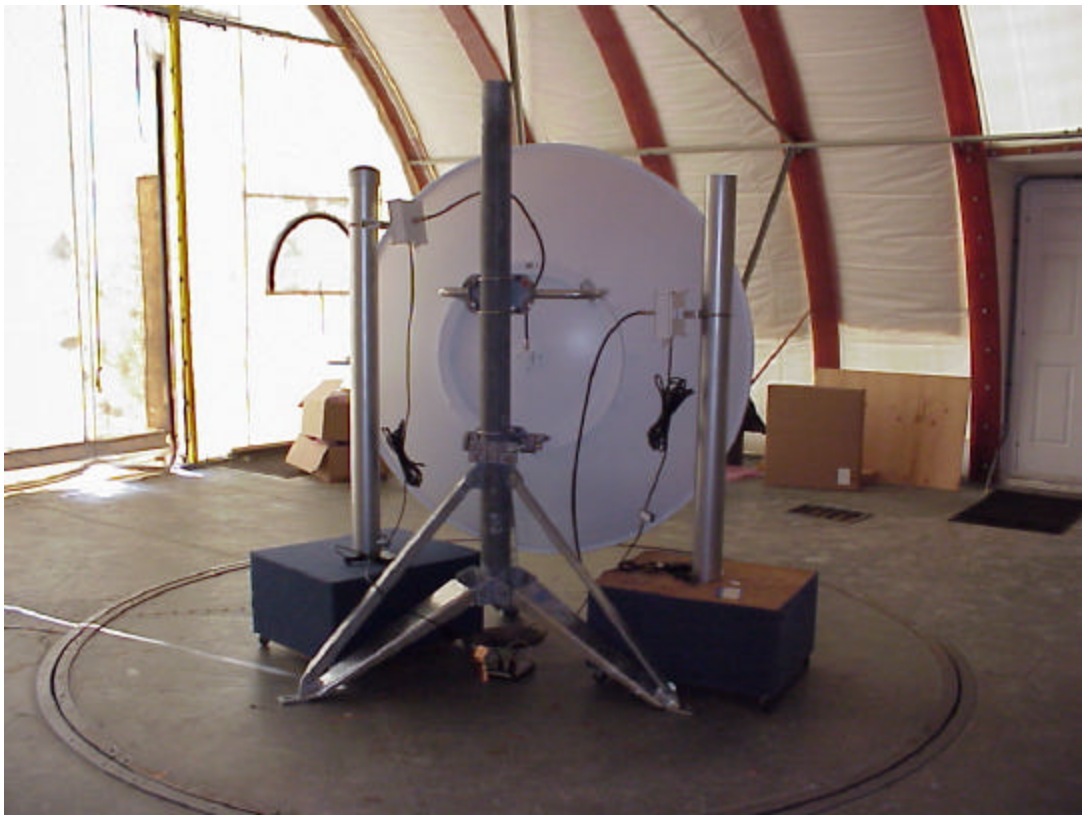
2' Parabolic Point-to-Point 28 dBi Gain





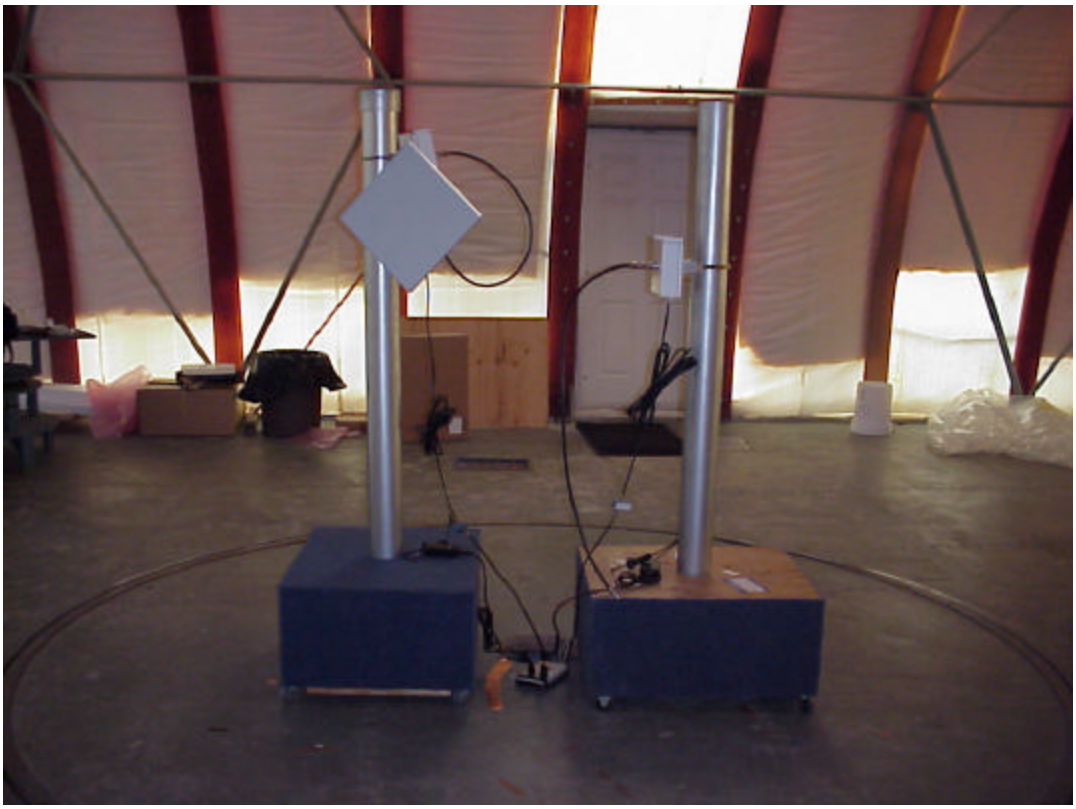
Configuration Photograph (Continued)

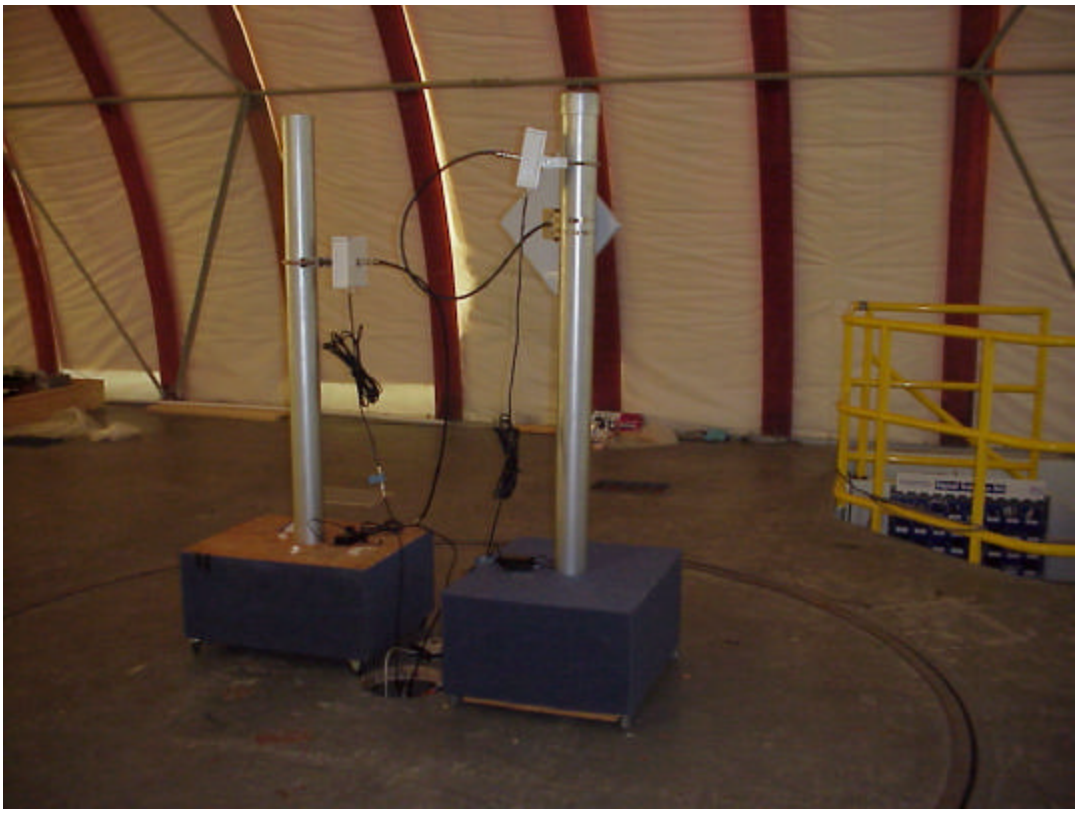
6' Parabolic Point-to-Point 37.6 dBi Gain



Configuration Photograph (Continued)

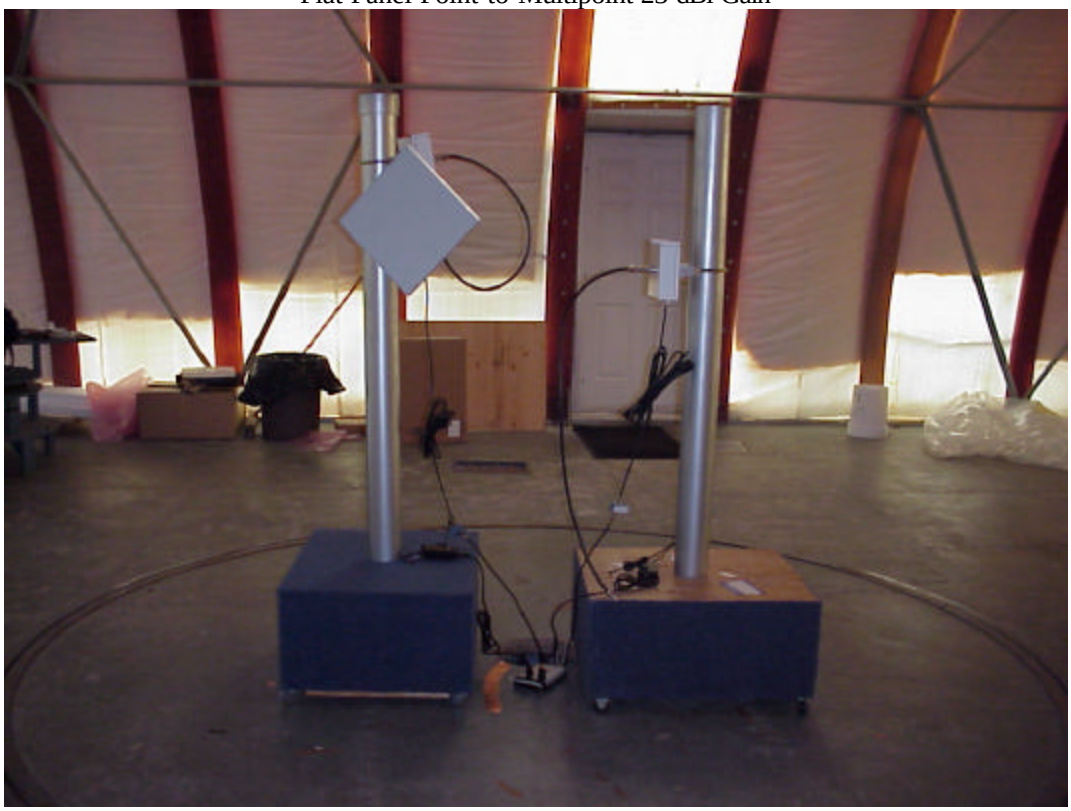
Flat Panel Point-to-Point 23 dBi Gain

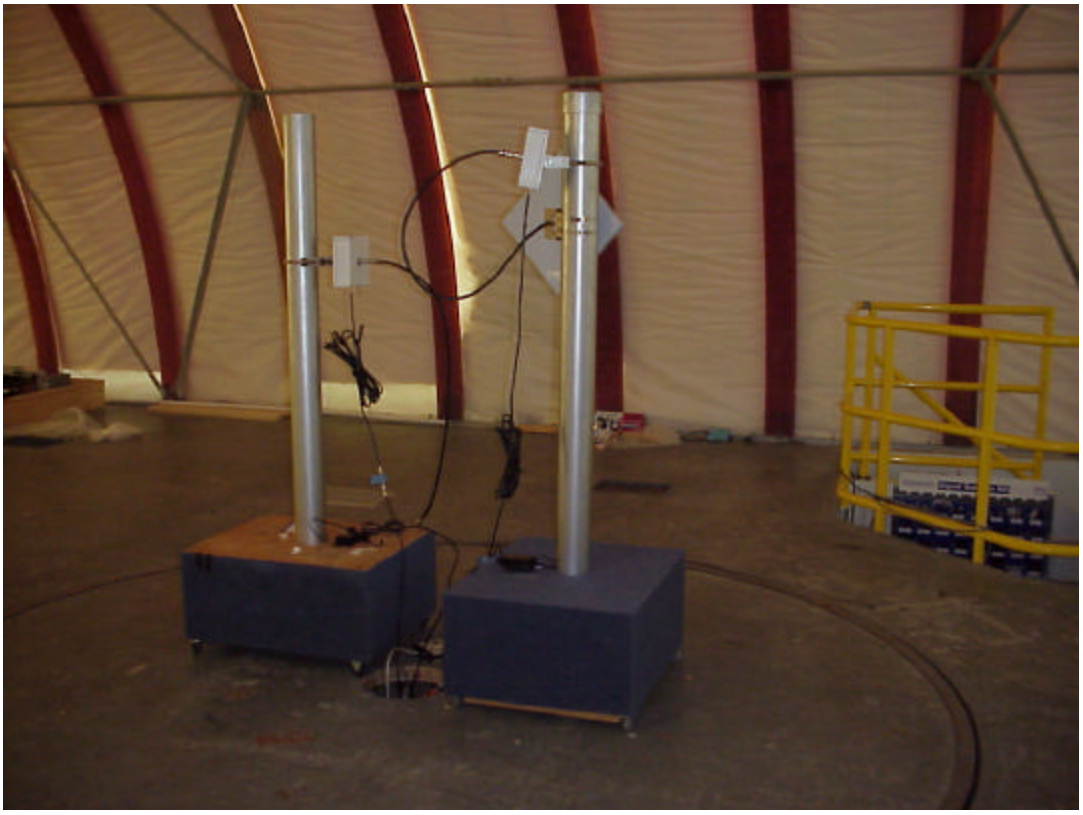




Configuration Photograph (Continued)

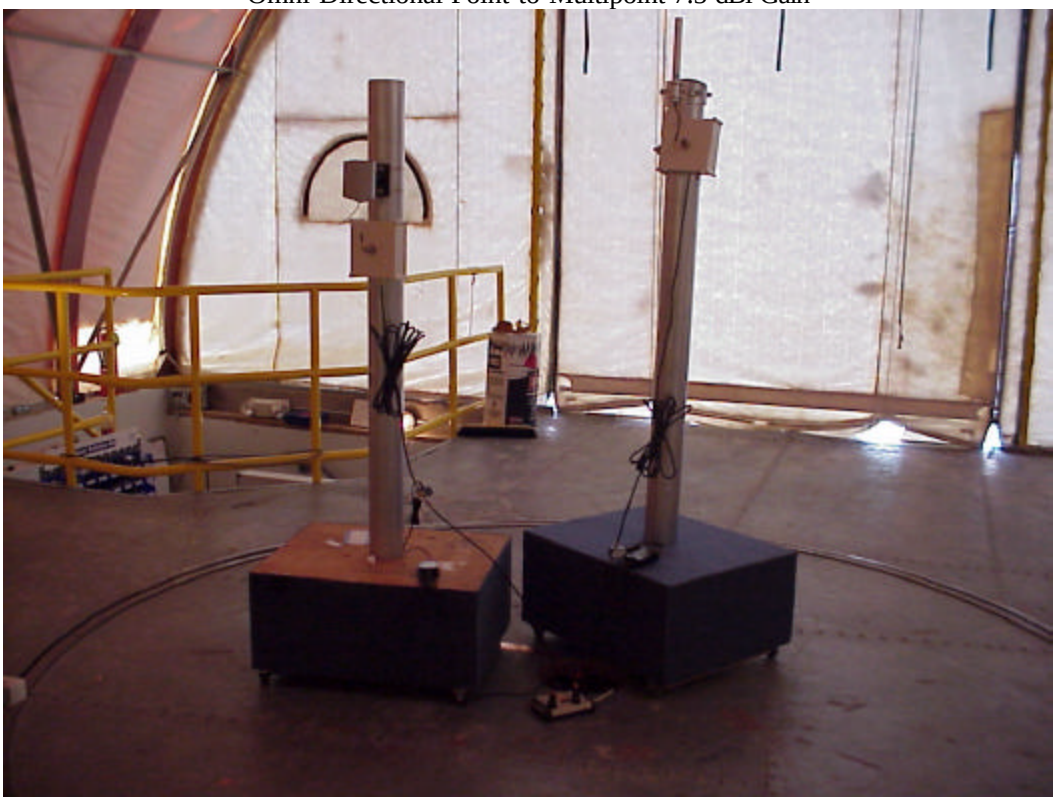
Flat Panel Point-to-Multipoint 23 dBi Gain

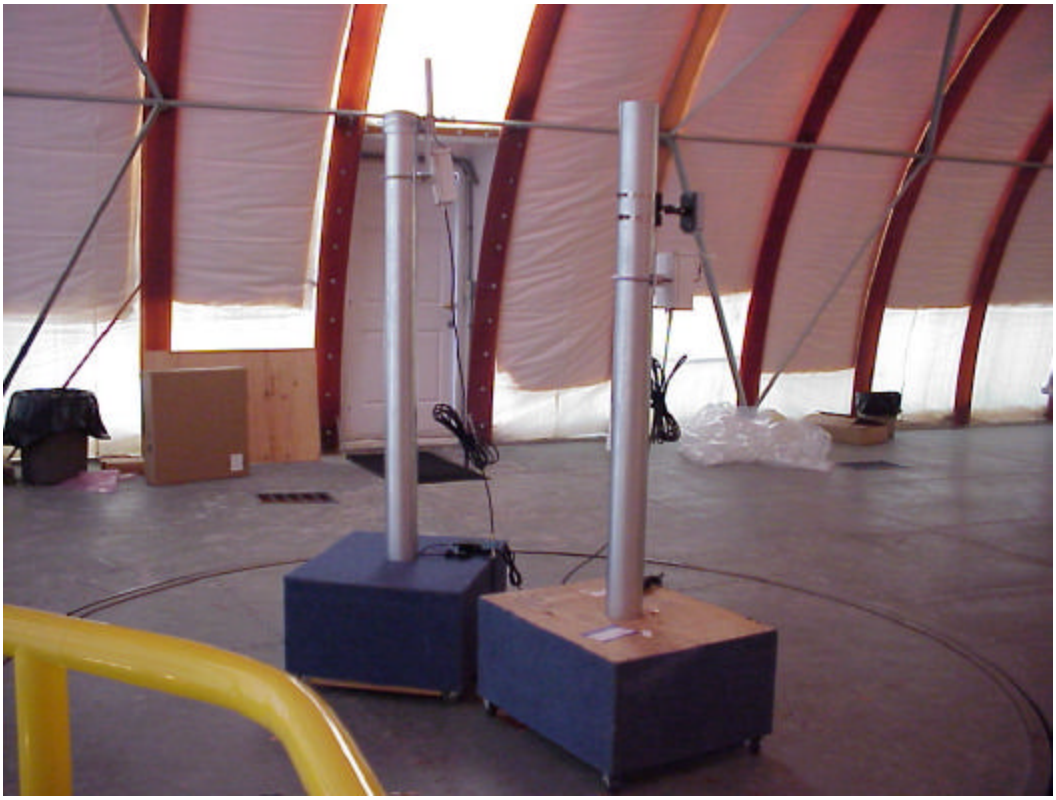




Configuration Photograph (Continued)

Omni-Directional Point-to-Multipoint 7.5 dBi Gain





4.6 Transmitter Radiated Emissions in Restricted Bands
FCC Rule 15.205

Radiated emission measurements were performed from 30 MHz to 40,000 MHz. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz - for frequencies above 1000 MHz.

If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst case emissions. The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

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

A sample calculation is included. All measurements were performed with quasi-peak detection unless otherwise specified. Emissions within the restricted bands are subject to the limits set forth in 15.209. No emissions were detected above 1 GHz. Refer to section 4.5 for data.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

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

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

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

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

RA = 52.0 dBµV AF = 7.4 dB
RR = 23.0 dBµV CF = 1.6 dB
LF = 9.0 dB AG = 29.0 dB
FS = RR + LF FS = 23 + 9 = 32 dBµV/m
Level in µV/m = Common Antilogarithm [(32 dBµV/m)/20] = 39.8 µV/m

4.8 AC Line Conducted Emission
FCC Rule 15.207

4.8.1 Line Conducted Emission Limits

Conducted Emissions Limits, Section 15.107(a)

Frequency (MHz)	Class B (uV)	Class B (dBuV)
0.45 - 1.705	250	48
1.705 to 30.000	250	48

Note: Three sets of units are commonly used for EMI measurement, decibels below one milliwatt (-dBm), decibels above a microvolt (dBmV), and microvolts (mV). To convert between them, use the following formulas: 20 LOG_{10}(mV) = dBmV, dBm = dBmV-107.

Test Result

See Table F.
The EUT passed the test

Intertek Testing Services

Conducted Emissions / Interference

Table: F

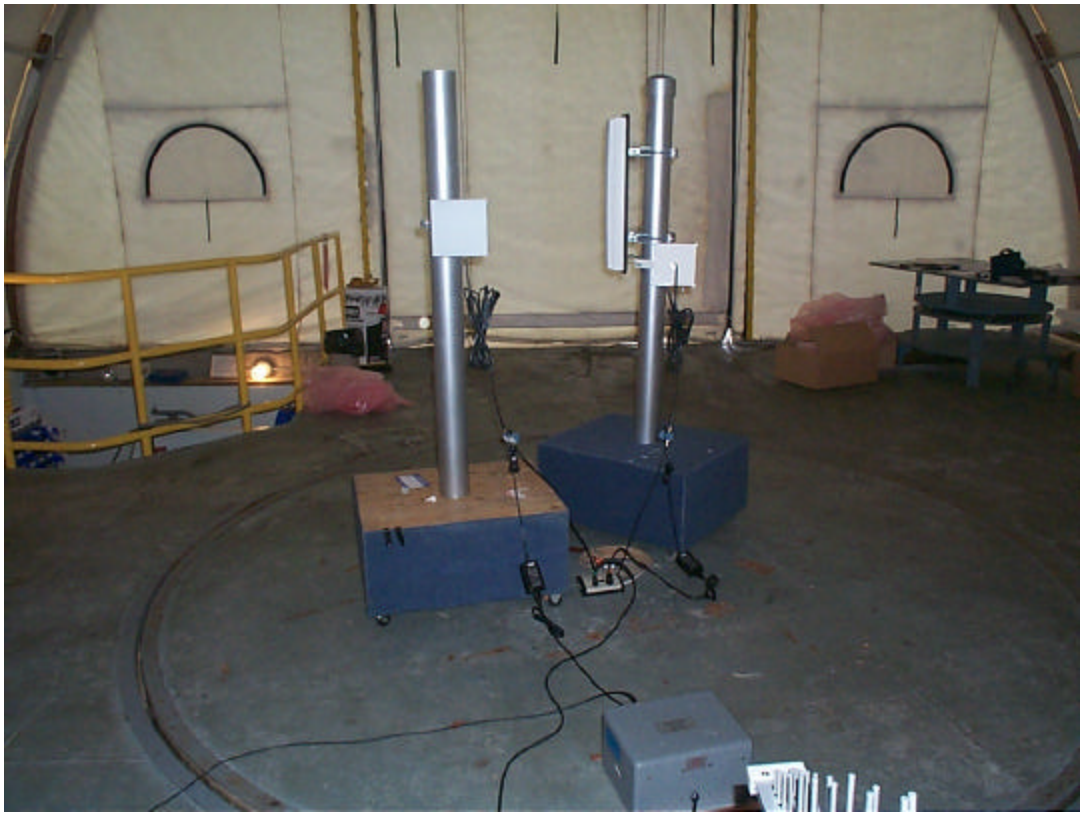
Company: Wireless Bypass
Model: DL-5800C
Job No.: J20046196
Date: 06/12/01
Standard: FCC15E
Class: A Group: None
Notes:
System Loss: Includes the Cable and LISN loss.

Tested by: Nicholas Abbondante
Location: Site 1C
Detector: Agilent E7405A
Cable(s): 1C, CBL11(
Limiter: no

Frequency MHz	Reading Side A dB	Reading Side B dB	Attenuator Factor dB	System Loss dB	Quasi-Peak Net dB(uV)	Quasi-Peak Limit dB(uV)	Quasi-Peak Margin dB
0.633	2.3	4.5	20.0	1.3	25.8	48.0	-22.2
0.949	4.1	6.3	20.0	0.5	26.8	48.0	-21.2
2.741	4.6	8.2	20.0	0.4	28.6	48.0	-19.4
5.905	12.1	12.2	20.0	0.6	32.8	48.0	-15.2
10.960	14.2	15.9	20.0	0.6	36.5	48.0	-11.5
16.230	17.9	18.8	20.0	0.8	39.6	48.0	-8.4
19.180	19.3	20.1	20.0	0.9	41.0	48.0	-7.0
22.760	18.9	19.6	20.0	1.0	40.6	48.0	-7.4

Configuration Photograph

Line-conducted emissions, CPE



4.9 Radiated Emissions from Digital Section
FCC Rule 15.109

Test was performed as described in the section 4.6.

The digital section was scanned at the same time as the entire system. Test data can be found in section 4.5. The limits are equivalent to the limits of 15.209.

4.10 Radiated Emissions from Receiver Section
FCC Ref: 15.109, 15.111

The receiver was scanned at the same time as the entire system and according to the procedure set forth in section 4.6. The limits are equivalent to those set forth in 15.209. Test data can be found in section 4.5.

4.11 Transmitter Duty Cycle Calculation / Measurements
FCC Rule 15.35(b), (c)

The EUT antenna output port was connected to the input of the spectrum analyzer. The analyzer center frequency was set to EUT RF channel carrier. The SWEEP function on the analyzer was set to ZERO SPAN. The transmitter ON time was determined from the resultant time-amplitude display:

Duty cycle = Maximum ON time in 100 msec/100

Duty cycle correction, dB = 20 * log (DC)

	See attached spectrum analyzer chart(s) for transmitter timing
	See transmitter timing diagram provided by manufacturer
X	Not applicable.

4.12 Frequency Stability
FCC Rule 15.407(g)

The EUT antenna output was connected directly to the input of the spectrum analyzer via a 30 dB attenuation pad and a high frequency cable with 6.1 dB of loss. Measurements were made from the 26dBc bandwidth point, or lower, of the fundamental frequency to the nearest band edge for both the high and low band edges. The frequency margin between these two points was then compared with the worst case frequency stability for the oscillators used. It was found that the frequency margin was much greater than the possible frequency deviation of the fundamental, so the EUT passes.

Refer to Exhibit A for a discussion of the worst case frequency stability of the EUT. Refer to the following plots for supporting data:

Plot 5.a1-5.a2: Frequency Stability Margin Low Channel
Plot 5.b1-5.b2: Frequency Stability Margin Mid Channel
Plot 5.c1-5.c2: Frequency Stability Margin High Channel

5.0 List of Test Equipment

Equipment	Manufacturer	Model	Serial #	Cal. Due
Spectrum Analyzer	Agilent	E7405A	US40240205	11/02/02*
Spectrum Analyzer	Tektronix	2784	B010153	12/13/01*
EMI Receiver Set W/RF Filter	Hewlett Packard	85462A	3325A00160	12/28/01
Plotter, Digital Pen	Hewlett Packard	7470A	2308A23938	#*
Cable, SMA-SMA <18GHz	Sucoflex	104PE	CBLSHF203	2/21/02*
Attenuator, 30 dB	Weinschel Corp.	23-30-34	AR6008	8/14/01
High Frequency Horn Antenna	EMCO	3116	9310-2222	2/04/02
Horn Antenna	EMCO	3115	9610-4980	11/01/01
Antenna	EMCO	3142	9701-1116	7/18/01
MW Cable (DC-40GHz) 24”	Astrolab	32029-2-2909K-24TC	CBL049	8/17/01
MW Cable (DC-40GHz) 48”	Astrolab	32029-2-2909K-48TC	CBL050	8/17/01
Cable, BNC/BNC	Alpha	RG58B/U	CBL110E	9/10/01
LISN, 50uH, .01-50MHz, 24A	Solar Electronics	9252-50-R-24-BNC	941712	5/02/02
Attenuator, 20 dB	Mini Circuits	20 dB, 50 Ohm	DS25A	8/14/01
Peak Power Meter	Hewlett Packard	8900D	3607U00673	8/08/02*
Peak Power Sensor	Hewlett Packard	84811A	3318A05091	8/08/02*

Calibration is not required *Used in November testing