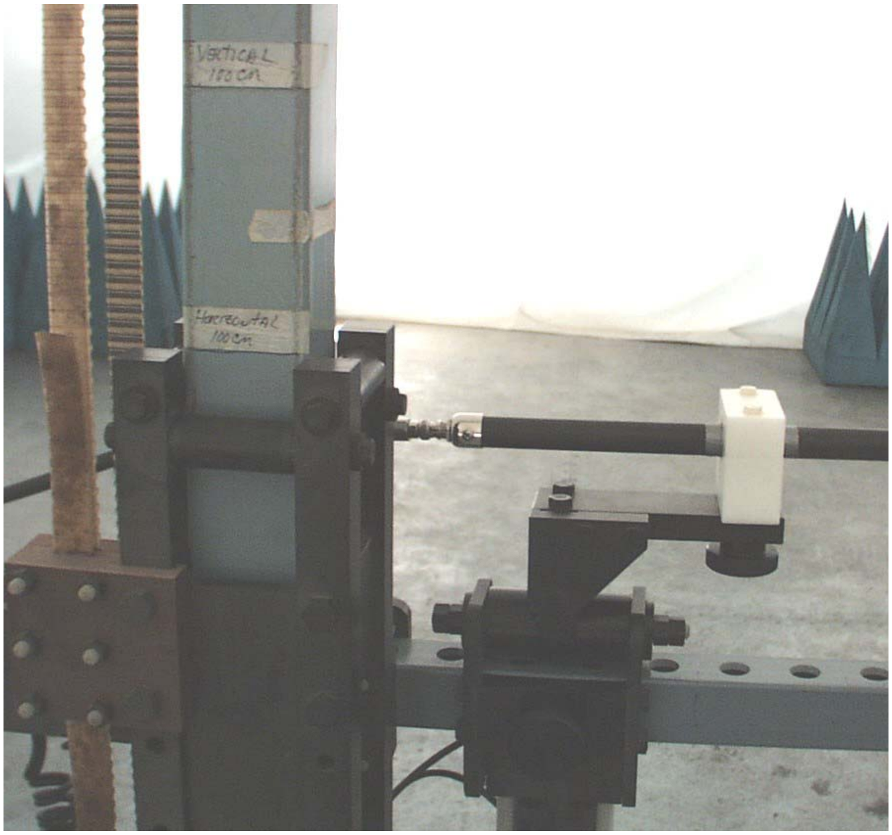


Photo 17
Horizontal Antenna Polarization – Antenna at 100 cm; Display Indicates 100 cm

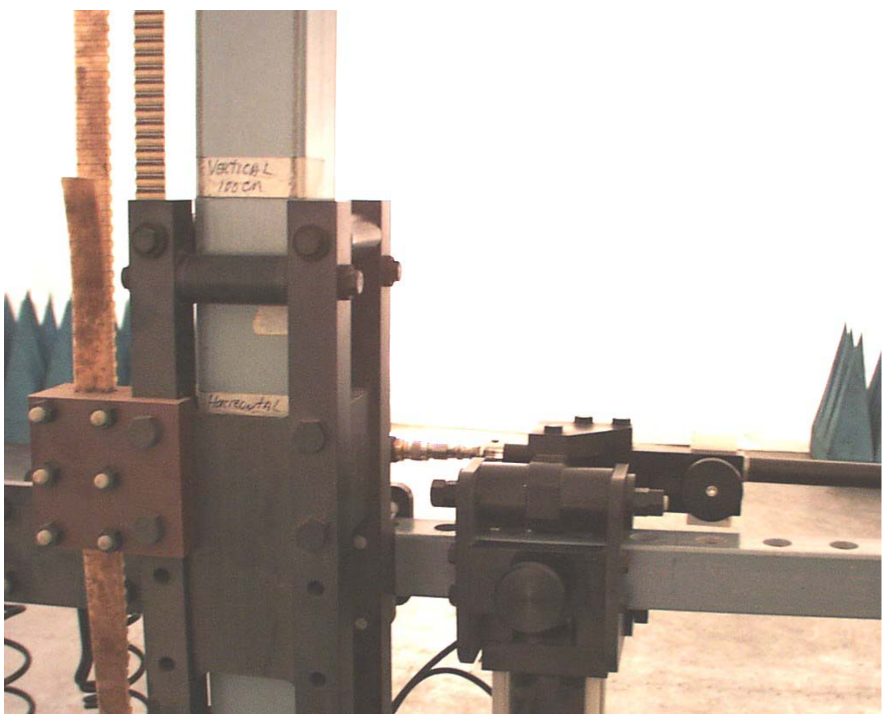


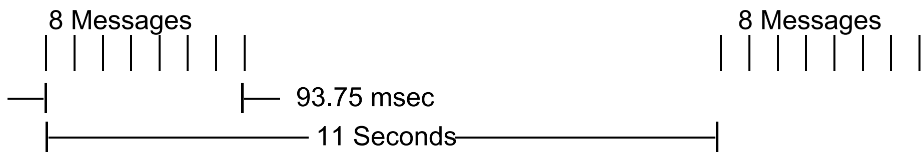
Photo 18
Vertical Antenna Polarization – Antenna at 100 cm; Display Indicates 115 cm

Photo 19
Antenna Mast in Holder / Cradle

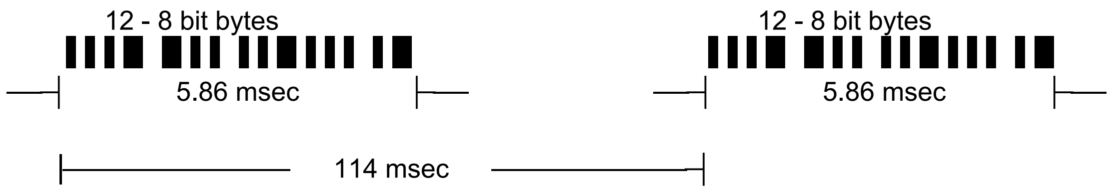
Appendix C
FCC Part 15.35 (b) and Industry Canada RSS-210 Issue 4; Section 6.5 - Pulsed Operation Conversion from Instantaneous Peak Power to Average Power

Standard Consumption Message (SCM)

The ERT Unit transmits a sequence of eight Manchester Encoded Messages in a ten-second period. Each of the messages is 12 bytes (96 bits) long. Each message is broadcast on a different frequency within the Transmit Band.



Zooming in on a message length:



Bit rate is: 16.384 kbits/Second.
Message Period is: 96/16.384 kbits/sec = 5.86 msec

During the transmission of messages, the Transmit Duty Cycle can be computed.

% Duty Cycle Transmit = (96 bits) (1/16.384 kbits/Sec) (.5) (100%) / (100 msec)
% Duty Cycle Transmit = 2.93 %

Note: The .5 factor is a result of Manchester Encoded Data.

Expressing the correction factor for Duty Cycle in dB:

dB Duty Cycle Transmit = 20 Log (Duty Cycle)
dB Duty Cycle Transmit = 20 Log (0.0293)
dB Duty Cycle Transmit = -30.7 dB

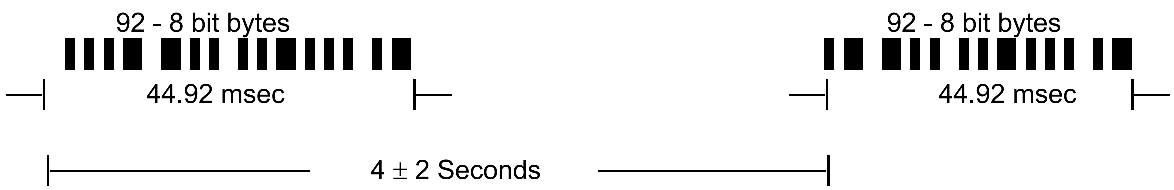
The maximum relaxation allowed per FCC Part 15.35 (b) and Industry Canada RSS-210 Issue 4; Section 6.5 is 20 dB

FCC Part 15.35 (b) and Industry Canada RSS-210 Issue 4; Section 6.5 - Pulsed Operation Conversion from Instantaneous Peak Power to Average Power

Interval Data Message (IDM)

The Unit Transmits Manchester Encoded Messages separated by a two to six second period of time. Each of the messages is 92 bytes (736 bits) long. Each message is broadcast on a different frequency within the Transmit Band.

Zooming in on a message length:



Bit rate is: 16.384 Kbits/Second.
Message Period is: 736/16.384 Kbits/sec = 44.92 msec

During the transmission of messages, the Transmit Duty Cycle can be computed.

% Duty Cycle Transmit = (736 bits) (1/16.384 Kbits/Sec) (.5) (100%) / (100 msec)

% Duty Cycle Transmit =22.46 %

Note: The .5 factor is a result of Manchester Encoded Data.

Expressing the correction factor for Duty Cycle in dB:

dB Duty Cycle Transmit = 20 Log (Duty Cycle)
dB Duty Cycle Transmit = 20 Log (.2246)
dB Duty Cycle Transmit = -12.97 dB

The maximum relaxation allowed per FCC Part 15.35 (b) and Industry Canada RSS-210 Issue 4; Section 6.5 is 20 dB.

Appendix D

Ambient Temperatures

	Instrument Room	Dome Area	Notes
WINTER	72 – 75 Degrees	55 Degrees Max. / 50 Degrees Min.	
SUMMER	72 – 75 Degrees	85 Degrees Max.	[1]

Notes:
[1] Early spring conditions, with a cold floor and humid air combination, may cause moisture to condense on the metallic floor. This can be dangerous, causing a slippery floor, and can be destructive to the metal ground plane causing corrosion at the joints.
Depending on the outdoor temperature relative to the dome interior temperature, either increase the temperature setting to activate the furnace or decrease the temperature setting to activate the air conditioner until the condition is rectified.

Appendix E

Terms List

DUT: Device Under Test

FCC: The Federal Communications Commission is an independent United States government agency responsible for regulating interstate and international communications by radio, television, wire, satellite and cable.
FCC Web site: http://www.fcc.gov/aboutus.html
These rules and regulations are compiled in the Code of Federal Regulations (CFR).
Path to the CFR: http://www.fcc.gov/mb/audio/bickel/47CFRrule.html
FCC Rules and Regulations Site: http://wireless.fcc.gov/rules.html

IC: Industry of Canada – the Canadian department responsible for Radio Spectrum Management in Canada.
IC Web site: http://strategis.ic.gc.ca/sc_mrksv/spectrum/engdoc/spect1.html
Path to Radio Standards Procedures:http://strategis.ic.gc.ca/SSG/RadioStandardsProcedures

Path to Radio Standards Specifications: http://strategis.ic.gc.ca/SSG/RadioStandardsSpecifications
Path to Spectrum Management and Telecommunications site:
http://strategis.ic.gc.ca/SSG/sf01347e.html#Standards

V: Abbreviation for volts.

μV/m: Field Strength (microvolts per meter)

dB: decibel **--** A dimensionless measure of the ratio of two powers or voltages, equal to 10 times the logarithm to the base 10 of the ratio of two powers or 20 times the logarithm to the base 10 of the ratio of two voltages.

dBμV: The level of a voltage, expressed in dB, in respect to one microvolt.

dBμV/m: The level of field strength in respect to one microvolt per meter field strength.

dBm: The level of a power in respect to one milliwatt.

Fundamental Frequency: The frequency of intentional radiation over which the information is transmitted.

Harmonic: An integer multiple of the fundamental – unintentional radiation.

Appendix F

Conversions

The signal levels encountered in compliance testing are generally power levels expressed in dBm. The regulatory compliance limits are expressed as Field Strength in mV/m (millivolts per meter), µV/m (microvolts per meter) and dBµV/m (dB microvolts per meter). The conversion to arrive at the desired term follows.
Assume the following:
The level is determined to be -44 dBm at the output of the coax from the measuring antenna.
The coax loss at the frequency of operation is 1.55 dB.
The Antenna Factor (AF) is 28.6 dB/m.
What is the Field Strength that the measuring antenna is immersed in?

First let us convert from dBm to dBµV.
At 0 dBm the power is 1 mW. What voltage, expressed in µV and dBµV, does 1 mW in a 50 Ohm system represent?

$E=(PxR)^{1/2}$

$E=(1x10\text{-}3 \times 50)^{1/2}$

E=0.2236 V or 223606.8 µV

What level does this represent in dBµV?

dBµV = 20 log (223606.8 µV / 1µV)
= 107 dB
Therefore 0 dBm = 107 dBµV

From these results we see that to convert from a power level in dBm to a voltage level expressed in dBµV we add 107 to the dBm level.
Therefore in the example above the level at the output of the coax, - 44 dBm, is equal to -44 +107 or 63 dBµV.
The level at the output of the antenna (input to the coax) is 63 dBµV + 1.55 dB (coax loss) = 64.55 dBµV.
The Field Strength which the antenna is immersed in is 64.55 dBµV + 28.6 dB/m (AF) = 93.15 dBµV/m.

To determine the field strength (µV/m) equivalent, for FCC / IC regulatory reporting, find the Anti-log of 93.15 dBµV/m
$10^{(93.15/20)}$ = 45446.5 µV/m.

Conversely to convert from µV/m to dBµV/m:
dBµV/m = 20 Log (xx µV/m / 1 µV/m)

Appendix G

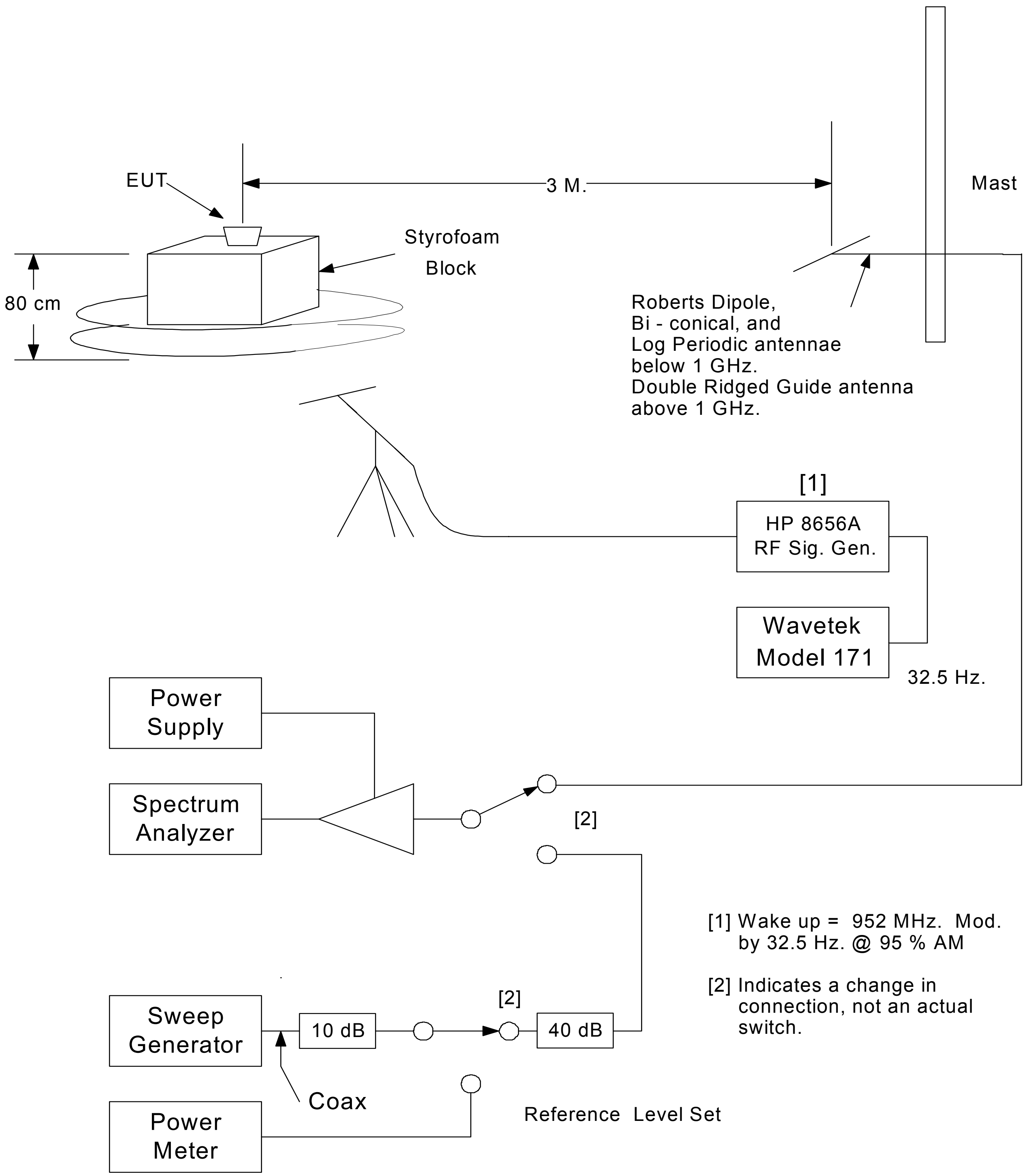
Programming ERTs Prior to Testing

To facilitate testing it is recommended that the ERTs be programmed for maximum transmissions and a decreased delay between transmission bursts.
Using a ReadOne Pro with a 'HAL Personality" enter the following information via the keyboard. To scroll down or up use the ↓ ↑ keys respectively. To page to the next display use the ENTER key on the side.
NOTE: The ReadOne Pro must be configured to allow programming of the following parameters.

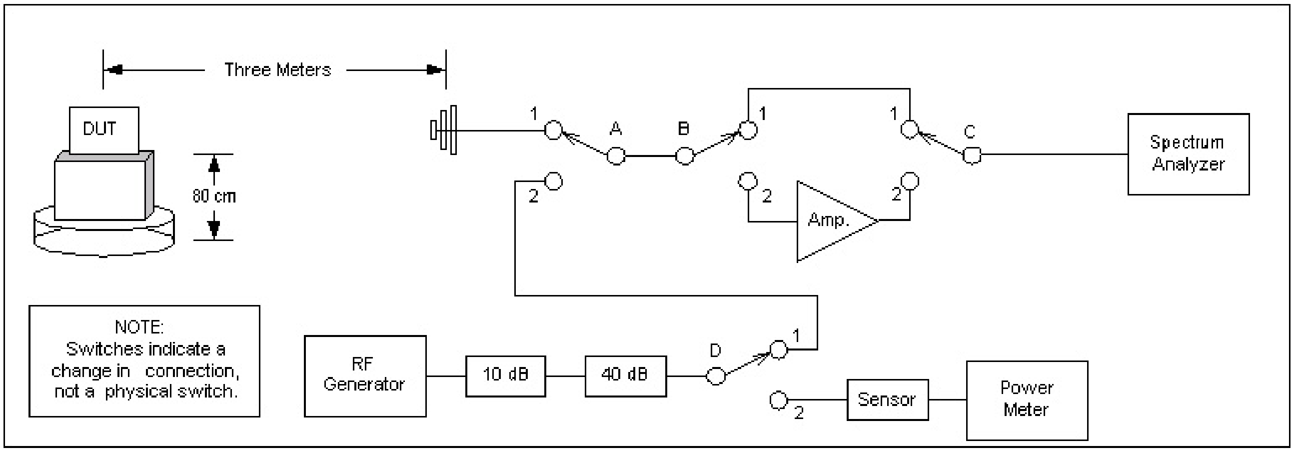
PICK OPTION:	2: PROGRAM ERT	
PROGRAM ERT		
ERT ..	(ERT Serial Number)	
TYPE ..	40G ERT	ENTER
RDG ...	0	
TONE	7	
RATE	3	
ROLLOVER	3	ENTER
PCOMP..	10000	
BURST	15	
WAKE_DLY ...	2	
TILT DEBZ ...	2	ENTER
LOCK TYPE	0	
UTIL ID ...	0	ENTER

Appendix H

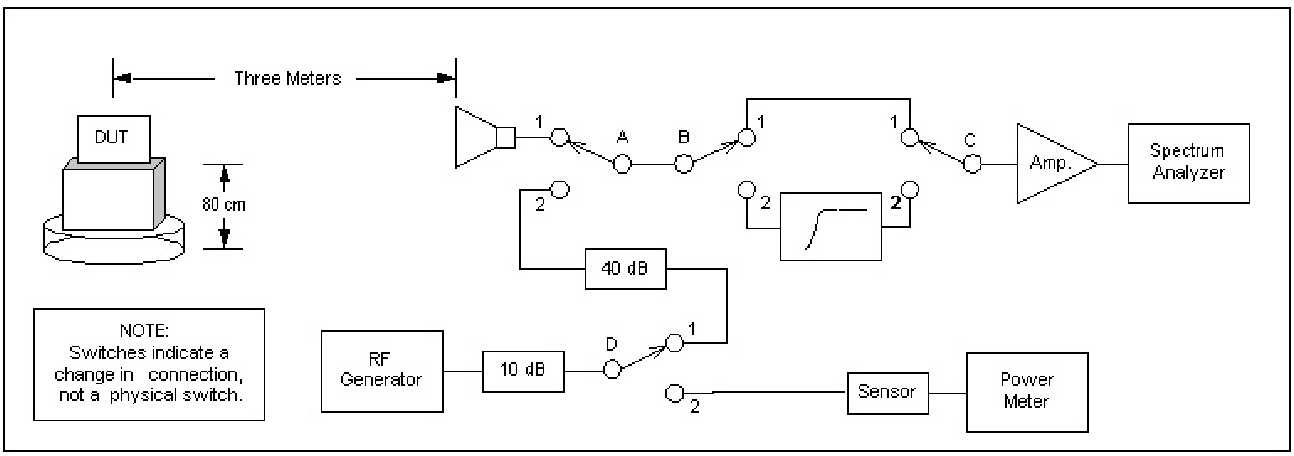
Test Setups



Setup 1



Setup 2



Setup 3

Appendix I

Procedure for establishing a -50 dBm Reference Level on the 141T Spectrum Analyzer

Suggested Equipment:

RF Power Meter:	HP 437B	Power Meter
	HP 8481D	Power Sensor
RF Generator:	HP 8673D	RF Synthesized Generator
Spectrum Analyzer:	HP 141T	Main Frame
	HP 8555A	RF Section
	HP 8552B	IF Section
Pre-Amplifier:	Mini-Circuits	ZHL-1042J; S/N H110094-008
	JCA Technology; JCA010-415; S/N 103	
Precision Attenuators:	10 dB and 40 dB	

PROCEDURE:

CAUTION: The Power Sensor is operational over the range of –70 dBm to – 20 dBm. Ensure that the power to be measured is not greater than the maximum allowed (-20dBm). Also during calibration, the 30 dB attenuator must be in position as the reference level is 0 dBm.

Ensure that the test equipment used is calibrated per Appendix A.
Setup the Power Meter as follows:
Ensure that the 50 MHz 30 dB attenuator is connected to the “Reference Port”.
Connect the Power Sensor to the 30 dB attenuator.
Set "dBm/W" to display dBm.
Press "**ZERO**" and wait until the indication that the zeroing process is done (the word “ZEROING” is no longer displayed).
CAUTION: DO NOT PRESS "**REF**" UNTIL THE ZEROING PROCESS IS DONE!
Press "**SHIFT**" then "**CAL**" – the display indicates "**REF CF**" and **%** is displayed.
Using the arrows (←→ & ↑↓) set the reference CF to that indicated on the HP 8481D Sensor.
Press "**ENTER**"–"**CAL**" will be displayed until the calibration is completed.
Press "**SHIFT**" & "**PWR REF**"– approximately - 30.00 dBm should be displayed.
Press "**SHIFT**" & "**PWR REF**" to turn off the reference.
Connect the Power Sensor through a Female-to-Female N Adapter to the Reference Source (output of the 10 dB and 40 dB attenuators connected via a coax to the Signal Generator HP 8673D).
Set the Signal Generator output to 0 dBm at the frequency of interest.
Adjust the level of the Signal Generator to give -50 dBm indication on the Power Meter.
Store the settings on the Generator in a numerical location corresponding to the harmonic integer.
Disconnect the Power Meter.
With the Pre-Amplifier connected to the Spectrum Analyzer connect the output of the 40 dB attenuator to the Pre-Amplifier input. Setup the Spectrum Analyzer per Appendix N.
Adjust the spectrum analyzer input attenuation to display the -50-dBm level at the second line from the top of the display (-10 dB line).
NOTE: When setting a reference on the spectrum analyzer display, using a CW source and then monitoring ERT transmissions, it will be noted that the trace width or thickness is never the same, as the CW source. As a result using the edge of the trace as the reference will give erroneous results. To overcome this set the reference trace on the spectrum analyzer such that the center of the trace peak is centered on the reference line (cut the trace). The center of the width of the trace is a consistent reference regardless of the intensity. This practice will lessen the chance for error when interpreting the display.
Disconnect the reference source.

Appendix J

HP 8593E Self Calibration

Connect cable HP 10502A between CAL OUT and INPUT 50 Ω ports.
Press:
CAL
CAL FREQ & AMPTD

After about five minutes gives the message:
CAL ALL: done Press CAL STORE to Save

Press:
CAL STORE

Connect HP cable 10502A between 100 MHz COMB OUT and INPUT 50 Ω ports.
Press:
CAL YTF
After about five minutes two tables are displayed.
Press: CAL STORE
Message: CAL: STORED
Press: PRESET

Appendix K

Data Entry Sheet

Tested by:			Date:		Tested for:			Date:	
	Temp:		Humidity:			Temp:		Humidity:	
EUT model number									
Serial number:					Serial number:				
Frequency measured:					Frequency measured:				
Antenna used:					Antenna used:				
ACF (dB):					ACF (dB):				
Cable loss factor (dB):					Cable loss factor (dB):				
Limit (dBm):					Limit (dBm):				
Azimuth	vert meas	Ant height	horz meas	Ant height	Azimuth	vert meas	Ant height	horz meas	Ant height
0					0				
10					10				
20					20				
30					30				
40					40				
50					50				
60					60				
70					70				
80					80				
90					90				
100					100				
110					110				
120					120				
130					130				
140					140				
150					150				
160					160				
170					170				
180					180				
190					190				
200					200				
210					210				
220					220				
230					230				
240					240				
250					250				
260					260				
270					270				
280					280				
290					290				
300					300				
310					310				
320					320				
330					330				
340					340				
350					350				
Results:	Antenna	Table		Final	Results:	Antenna	Table		Final
	Position	Asimuth	Level	Level		Position	Asimuth	Level	Level
	(cm)	(Degrees)	(dBm)	(dBm)		(cm)	(Degrees)	(dBm)	(dBm)
V					V				
H					H				

Appendix L

Procedure for Determining the Transmit-Band Center

- Connect the wakeup antenna coax to the RF signal generator.
  Recall 02 - Adjust the Spectrum Analyzer display to horizontally center the 915 MHz reference.
- Recall 08 - Allow the ERT to transmit a sufficient number of times (4 to 5 times of fifteen transmissions) to cover all transmit steps.
- Determine the upper and lower band edges using signal substitution (Recall 01 and 03).
  Store the upper and the lower Band Edge frequency settings on the RF signal generator in "01" and "03" locations respectively
- Adjust the frequency of the generator to the apparent lowest and highest transmissions. Note the lowest and the highest frequencies, add and divide by two. This is the band center for the fundamental. Calculate the band-center frequency for each of the harmonics as required. Harmonics are integer multiples of the fundamental – the second harmonic is 2 times the fundamental, the third harmonic is 3 times the fundamental, etc.

Appendix M

Three Meter Site Limits

Emission	Frequency (MHz)	FCC Part	IC RSS-210 Issue 4, Section:	mV/m	µV/m	dBµV/m	Notes
Transmit Fundamental	910 - 920	15.249	6.2.2(m2)	50	50,000	94	[1]
Transmit Harmonics	Up to 10^{th} Harmonic	15.249	6.2.2(m2)	0.5	500	54	[2]
Receiver Fundamental	Approx. 952 - 953	15.109	7.1	0.2	200	46	[3] [4]
Receiver Harmonics	Up to 5^{th} Harmonic	15.109	7.1	0.5	500	54	[4][5]
	30-88	15.109 & 15.209	6.2.2(m2) & 7.1		100	40	[6]
	88-216	15.109 & 15.209	6.2.2(m2) & 7.1		150	43.5	[6]
	216-960	15.109 & 15.209	6.2.2(m2) & 7.1		200	46	[6]
	Above 960	15.109 & 15.209	6.2.2(m2) & 7.1 [7]		500	54	[6] [7]

Notes:
The field strength levels are those measured on the three-meter site. The device is 80 cm above the ground-plane. The device is rotated and the measuring antenna height is varied between 1-4 meters.

[1] Quasi-peak is to be used. However per FCC Part 15.35 (a), peak readings can be submitted. Peak readings are typically used as it is difficult to acquire a quasi-peak reading on our hopping transmitter.

[2] Per FCC Part 15.35 (b) an additional relaxation of the requirements is allowed due to the time averaging of the signal over a 100 msec. period. This makes the final limit on transmit harmonics of an SCM transmitter equal to 5000 µV/m or 74 dBµV/m. See Appendix C.
The amount of relaxation is dependant on the message length. The ERT End Points have two message scenarios: SCM and IDM. An SCM (Standard Consumption Message: 5.86 msec. duration) allows a 20 dB relaxation of the harmonic limit and an IDM (Interval Data Message: 44.92 msec. duration) allows a 13 dB relaxation. See Appendix B.

[3] The receiver fundamental is measured quasi-peak.

[4] Verbal communication was received from Joe Dichoso of the FCC on 01/16/1998. The message was as follows:
“In regard to the receiver (the super-regenerative receiver) during testing, the receiver should be cohered with the CW signal during testing and you’d measure it that way And again don’t take the duty cycle correction factor and the pulse de-sensitivity factor - just keep the CW on. The CW should be at the operating frequency and have it continuously transmitting while you’re making the measurements on the receiver.”

[5] Per verbal communication to Gary Larson from Greg Czumak of the FCC on 02/23/1999, the receiver harmonics are measured with the following spectrum analyzer settings: Resolution Bandwidth = 1 MHz; Video Bandwidth = 10 Hz; and Span = 0 Hz.

[6] The levels of emissions between the frequencies of 30 MHz and 1000 MHz are measured quasi-peak.

[7] Industry Canada RSS-210 Issue 4, Section 7.1 at receiver harmonic frequencies greater than 1600 MHz the requirement is 1000 µV/m or 60 dBµV/m.

Appendix N

Spectrum Analyzer Settings

Preset the spectrum analyzer as follows:
Display: NON STORAGE [CONV] switch depressed.
Adjust BASELINE CLIPPER to display grass.

CENTER FREQUENCY	915 MHz
BANDWIDTH	100 kHz
SCAN WIDTH	1 MHz PER DIVISON
Set INPUT ATTENUATION switch to	10 dB
SCAN TIME	0.1 MILLISECONDS PER DIVISON
Set the 2 dB/10 dB/LINEAR switch to	10 dB LOG
Set the LOG REF LEVEL to about	-10 dB
VIDEO FILTER	OFF
SCANMODE	INT
SCAN TRIGGER	AUTO
TUNING STABILIZER	OFF

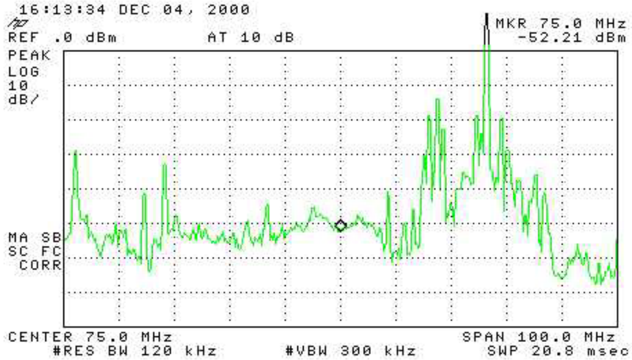
Adjust the BASELINE CLIPPER to just blank the grass on bottom of the display.
Adjust FOCUS and INTENSITY.
Depress [STD] STORAGE and increase the PERSISTANCE Control to maximum.
Depress [ERASE] to clear the display
Coax connections:

Connect the wakeup coax to the RF signal generator.
Connect the coax from the antenna to the RF input of the amplifier or the spectrum analyzer.

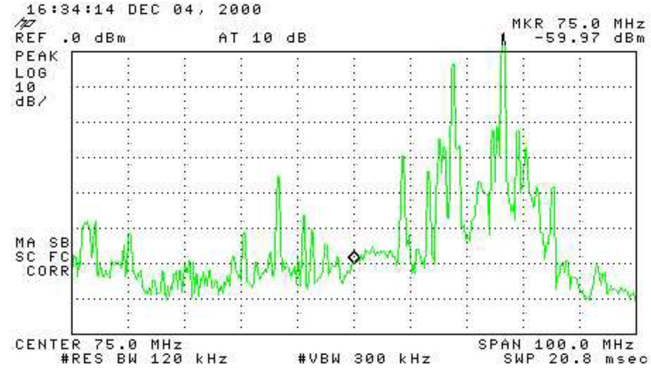
Appendix O

Examples of Ambient Signals in the 30 MHz to 1000 MHz Range at the OATS

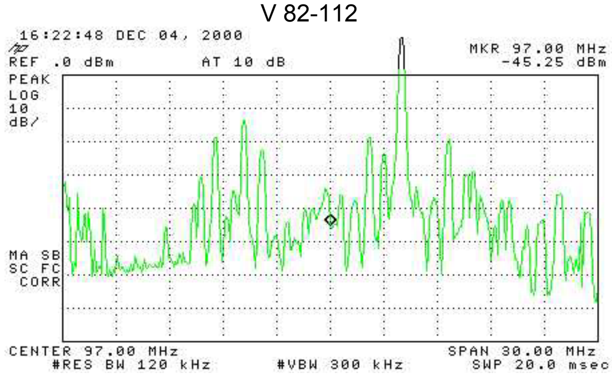
V 25-125



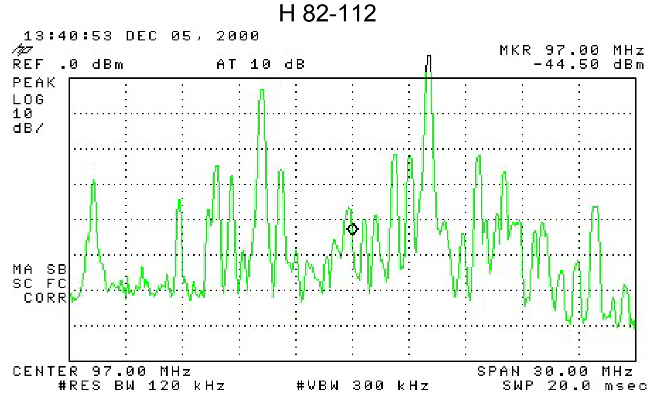
H 25-125



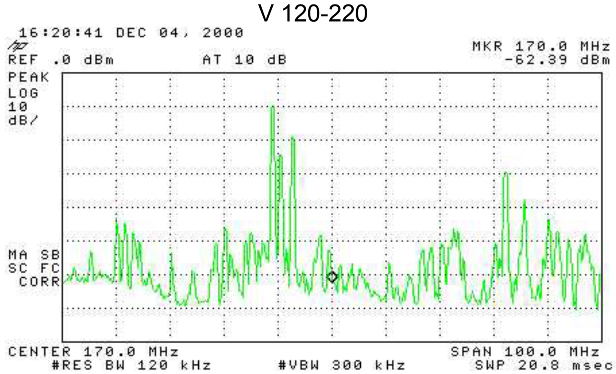
V 82-112



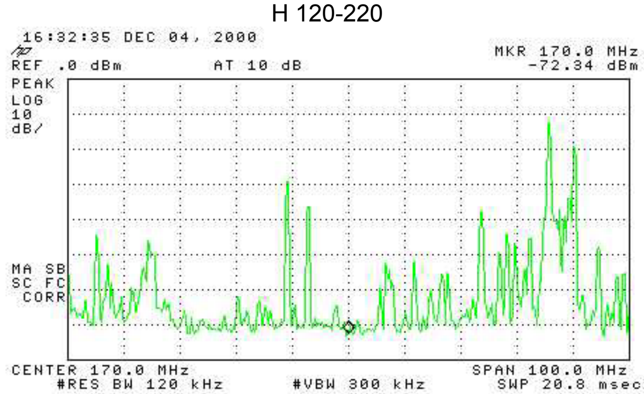
H 82-112



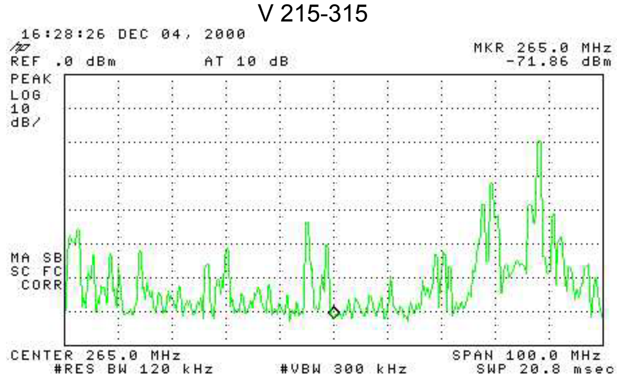
V 120-220



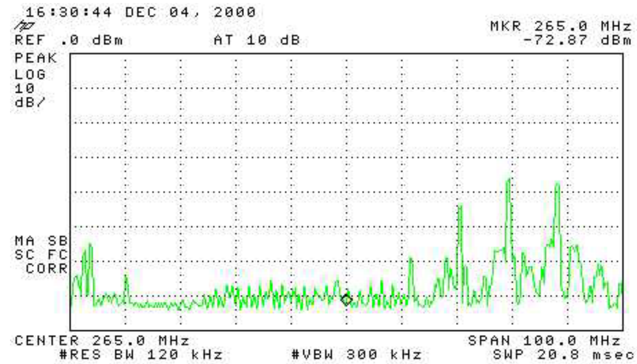
H 120-220



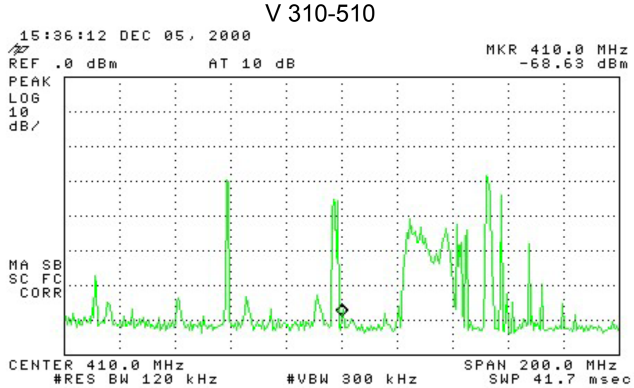
V 215-315



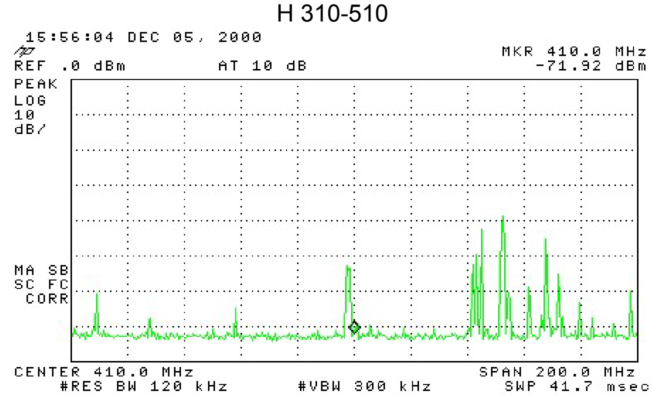
H 215-315



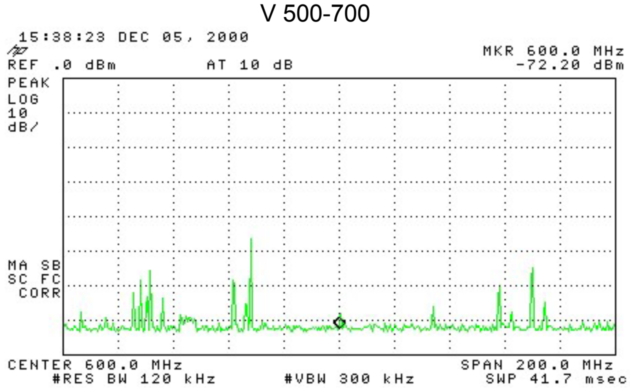
V 310-510



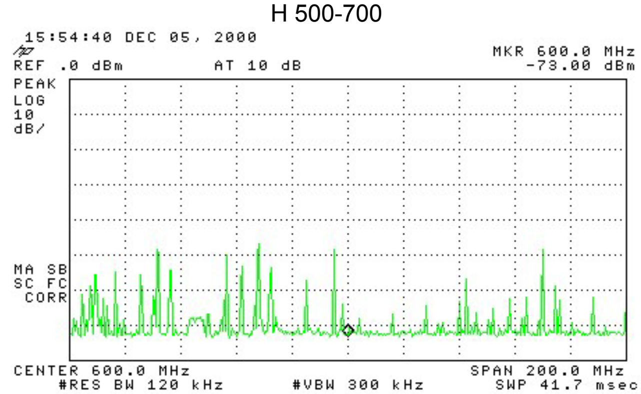
H 310-510



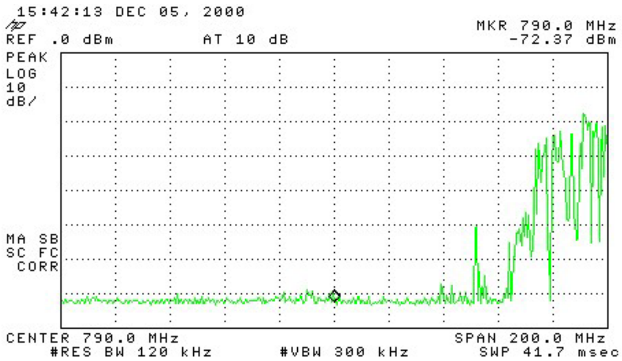
V 500-700



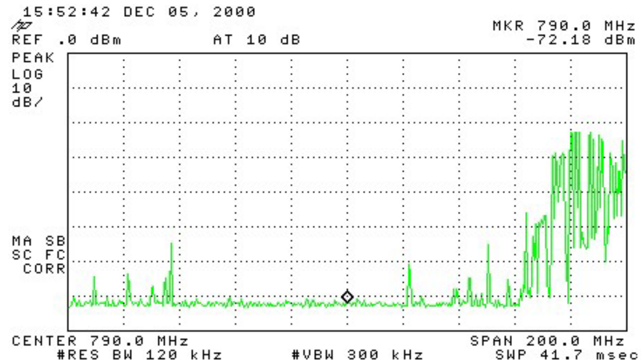
H 500-700



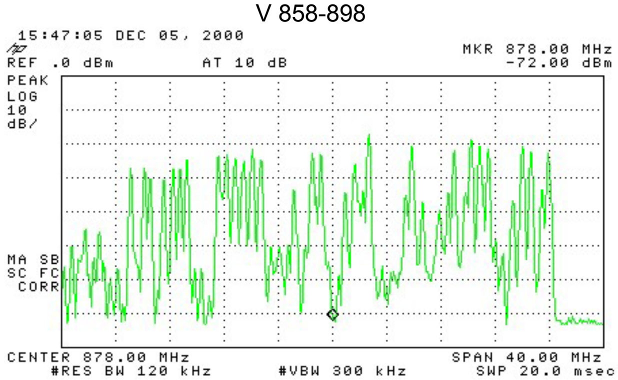
V 690-890



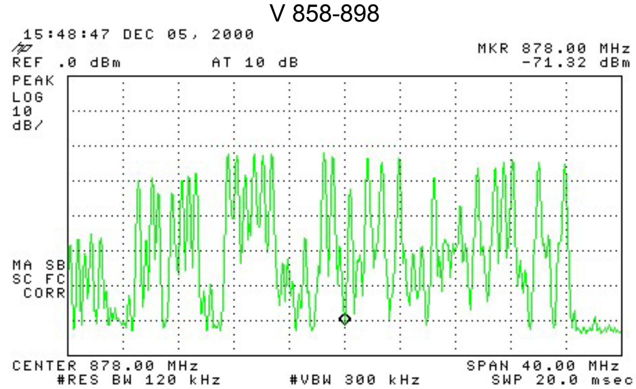
V 690-890



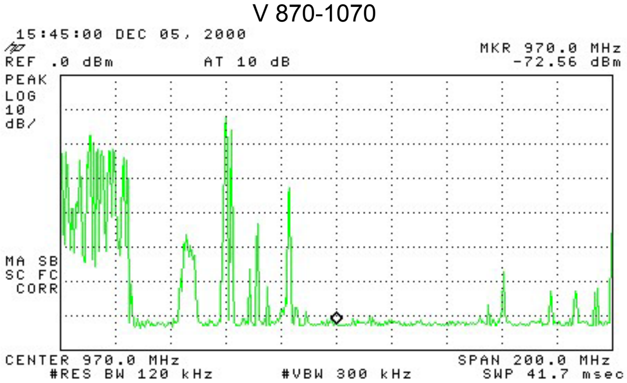
V 858-898



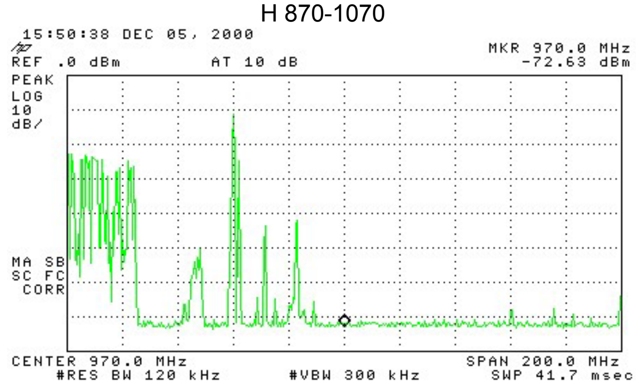
V 858-898



V 870-1070



H 870-1070



Appendix P

Form: Spurious Search Below 1GHz

Spurious Search Below 1 GHz

Device Under Test: ____________
Serial Number: ____________

Date:

Temp:

Humidity:

30 MHz to 300 MHz

Biconical Antenna:

Search at 10 MHz/div. (100 MHz span)

Frequency (MHz)	60	140	220	300
Search vertical 115 thru 400 cm with the table at 0 degrees.				
Search horizontal 100 thru 400 cm with the table at 0 degrees.				

Search at 10 MHz/div. (100 MHz span)

Frequency (MHz)	60	140	220	300
Search 0 thru 360 degrees with ant. vertical at 140 cm.				
Search 0 thru 360 degrees with ant. horizontal at 125 cm.				

300 MHz to 1000 MHz

Log Periodic Antenna

Search at 20 MHz/div. (200 MHz span)

Frequency (MHz)	350	500	650	800	950
Search vertical 115 thru 400 cm with the table at 0 degrees.					
Search horizontal 100 thru 400 cm with the table at 0 degrees.					

Search at 20 MHz/div. (200 MHz span)

Frequency (MHz)	350	500	650	800	950
Search 0 thru 360 degrees with ant. vertical at 140 cm.					
Search 0 thru 360 degrees with ant. horizontal at 125 cm.					

CAUTION:
Use analog spectrum analyzer to enable the capture of all transmissions.
The regions with high numbers of ambient signals will likely require search at a much narrower span.

NOTES:

1 ____________

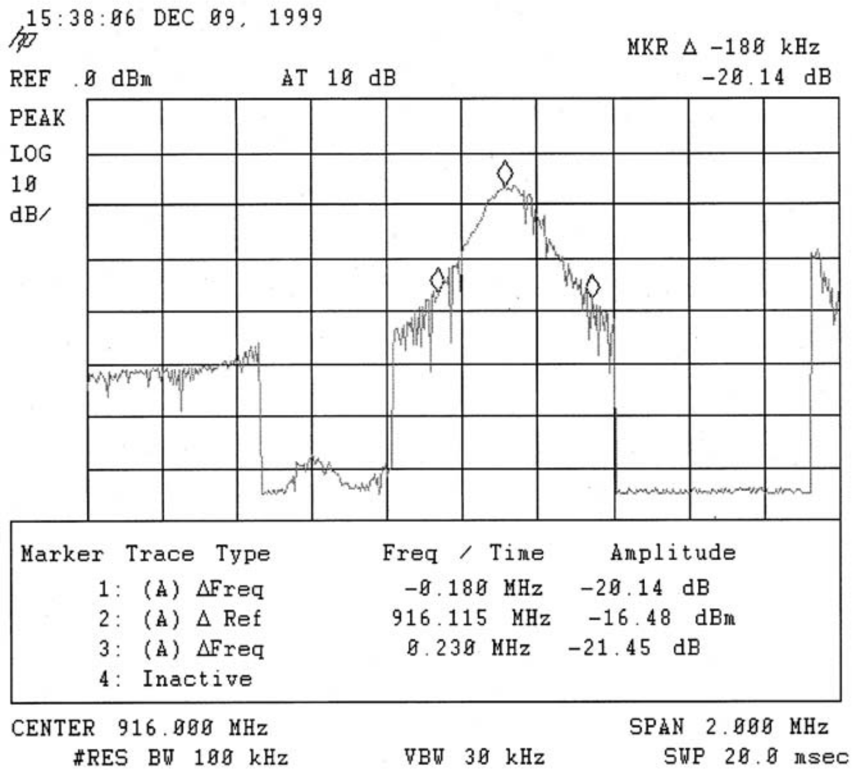
2 ____________

3 ____________

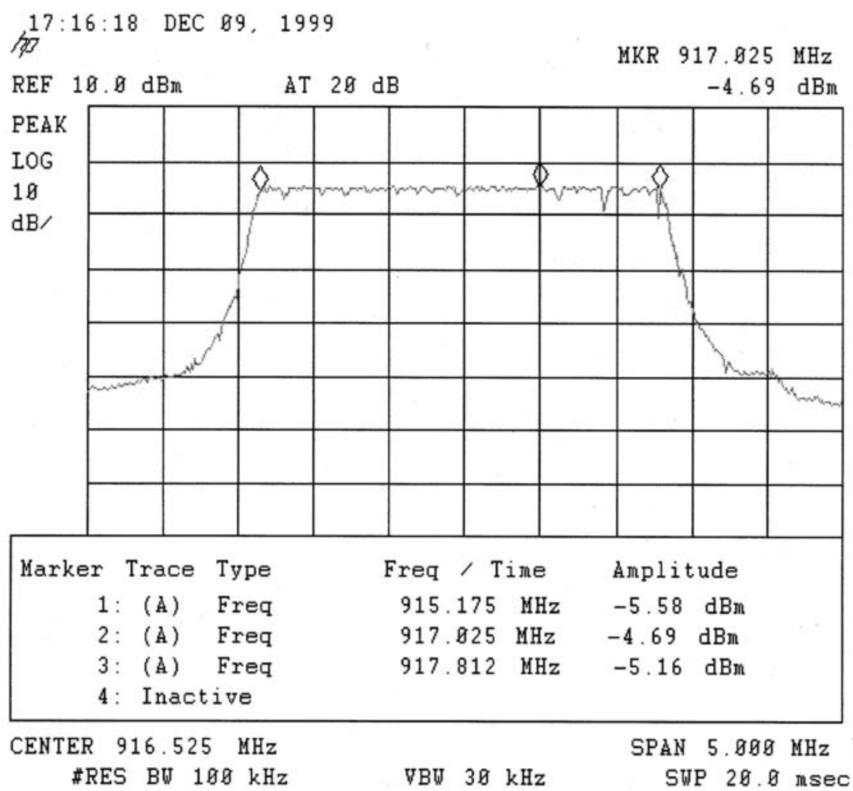
4 ____________

Appendix Q

Transmit Displays



Plot 1 – Bandwidth of Emissions: FCC 15.231 (c)



Plot 2 – Relative Field Intensity: FCC 15.31 (m)

Appendix R

Equipment List for Power Line Conducted Emissions Testing

Description	Manufacturer	Model	Serial Number	Itron Asset Number
Spectrum Analyzer	H.P.	8593E	3543A02032	6965
LISN	EMCO	3825-2	9605-2535	8921
LISN	EMCO	3825-2	9508-2436	6552
Multimeter	Fluke	8012A	2685277	3058
Computer				
BenchLink Software	Agilent	HP4444A		
Custom Vertical Wall				

Appendix S

FCC Part 15.107 Conducted limits

(a) Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

Appendix T

Erection of Vertical Wall and Test Setup

Photo 1

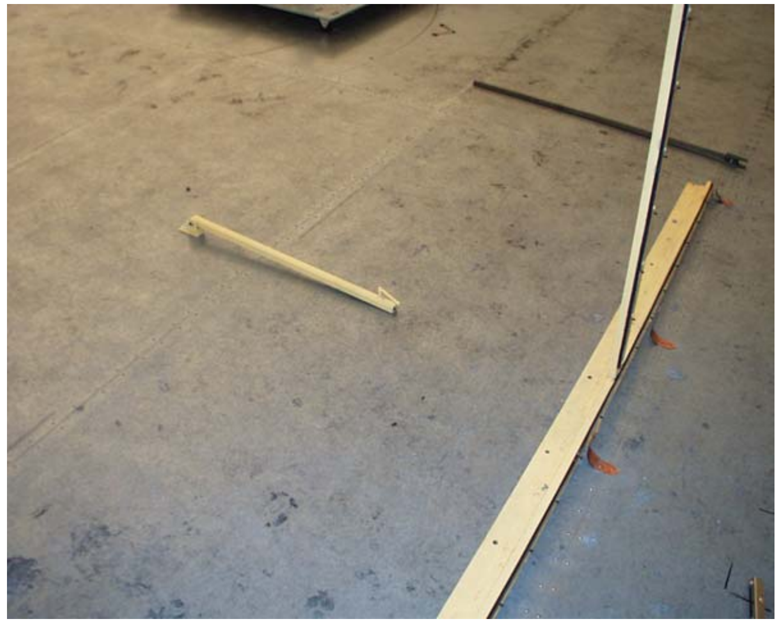


Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Appendix U

Pre-setup of the HP8593E to Measure Power Line Conducted Emissions

PRESET	
FREQUENCY	
START FREQ	-1 MHz
STOP FREQ	31 MHz
BW	9 KHz
VBW AUTO MAN	30 KHz
AMPLITUDE	
More 1 of 2	
Amptd Units	
dBµV	
AMPLITUDE	
REF LVL	80 dB

DISPLAY
Limit Lines

Then:

- For Limit Lines for Quasi-peak limit: RECALL LIMIT, 7, ENTER
- For Limit Lines Average limit: RECALL LIMIT, 4, ENTER
- To restore limit lines Quasi-peak / Average continue below.

NOTE: In steps three through seven, for select amplitude, use the first underlined number for creating a Quasi-peak mask and the second underlined number for creating an Average mask.

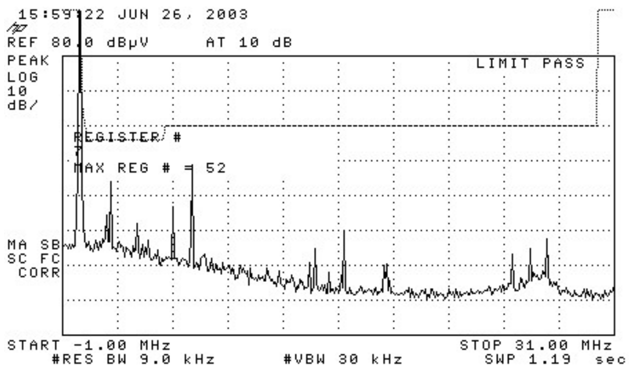
Edit Limit—Check LIMITS FRQ TIME; (FRQ *should be displayed*)
Edit Upper

1	SELECT FREQ SELECT AMPLITUD POINT	-1 MHz 107 dB
2	SELECT FREQ SELECT AMPLITUD FLAT	150 kHz 107 dB
3	SELECT FREQ SELECT AMPLITUD SLOPE	150 kHz 66 / 56 dB
4	SELECT FREQ SELECT AMPLITUD FLAT	500 kHz 56 / 46 dB
5	SELECT FREQ SELECT AMPLITUD FLAT	5 MHz 56 / 46 dB
6	SELECT FREQ SELECT AMPLITUD FLAT	5 MHz 60 / 50 dB
7	SELECT FREQ SELECT AMPLITUD FLAT	30 MHz 60 / 50 dB
8	SELECT FREQ SELECT AMPLITUD FLAT	30 MHz 107 dB
9	SELECT FREQ SELECT AMPLITUD POINT	31 MHz 107 dB
10	More 1 of 2 EDIT DONE	
11	LMT TEST ON OFF (restores the limit line)	
12	SAVE LIMIT (Enter Number) ENTER	

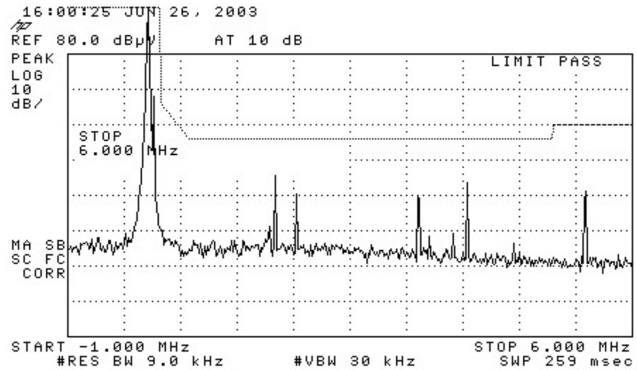
Refer to Appendix V: 'Display of Ambient Levels - DUT Not Connected' and note the plot 'Results of Manually Setting up the Limit Line for the Average Mask'.

Appendix V

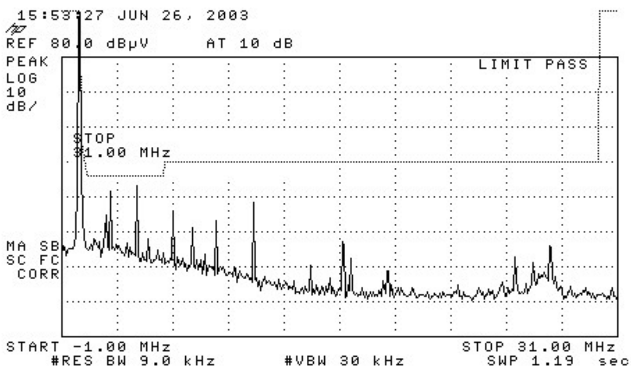
Display of Ambient Levels - DUT Not Connected



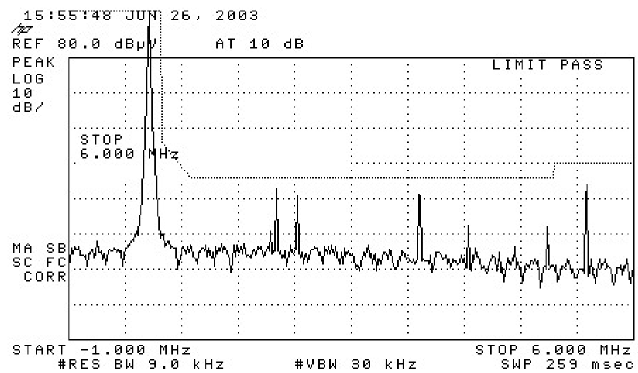
Quasi-peak Mask - Ambient Conditions



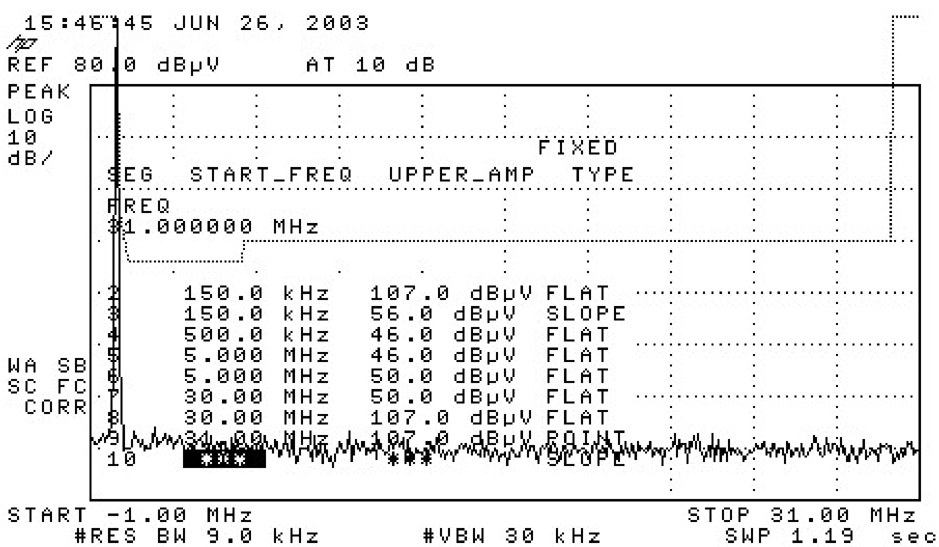
Quasi-peak Mask - Ambient Conditions - Close in



Average Mask - Ambient Conditions



Average Mask - Ambient Conditions – Close in



Results of Manually Setting up the Limit Line for the Average Mask