TEST REPORT

Equipment Tested:

Utility Meter Transmitter
Model 51ESS
Serial Number 45940676

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Itron Test Facility
2401 North State Street
Waseca, Minnesota 56093

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1. TEST SUMMARY

Test Report No.:	W020123
Company:	Itron, Inc.
Test Date(s):	September 27, 28, and 29, 2002
Equipment Under Test:	Utility Meter Transmitter
General Test Summary:	The 51ESS transmitter was tested for compliance to FCC Part 15.249 requirements for an intentional radiator.
Original Grant or Permissive Change:	Class II permissive change
Certification Status:	The 51ESS transmitter has been verified as being compliant with FCC Part 15.249 requirements for an intentional radiator.
Modifications Necessary for Compliance:	None. See Section 2. For EUT description.

Tested By: Drew Rosenberg

Report Written By: Drew Rosenberg

2. PRODUCT DESCRIPTION AND TEST OBJECTIVE

The EUT consists of a utility meter transmitter (51ESS) interfaced to an Invensys sensor board as encoder to measure electrical consumption. The 51ESS transmits the consumption data collected from the sensor board. See Sections 6 and 7 for test set-up description. The 51ESS has a frequency-hopping transmitter that operates over a maximum 4 MHz. bandwidth in the 910 - 920 MHz band (the actual fundamental frequency is set at the time of manufacture). The objective of this test is to determine if the EUT transmitter meets the radiated emission levels established by FCC Part 15.249 for intentional radiators. The EUT was tested at an antenna to EUT distance of 3 meters according to ANSI C63.4-1992.

3. TEST FACILITY

The tests were performed at the test facility of Itron, Inc. located at 2401 North State Street, Waseca, Minnesota 56093. This site is fully described in a document submitted to the FCC accepted per letter dated June 4, 1999 (Ref.: Registration Number: 90716).

4. EUT SUPPORT EQUIPMENT USED:

Test Equipment	Model	Manufacturer	Serial. No.	Cal. Due
Spectrum Analyzer Display Section	141T	Hewlett Packard	1337A06309	N/A
RF Section	8555A	Hewlett Packard	1724A07744	N/A
IF Section	8552B	Hewlett Packard	1952A17996	N/A
Dipole Antenna	Roberts	Compliance Design	7341	N/A

5. EUT SYSTEM DESCRIPTION:

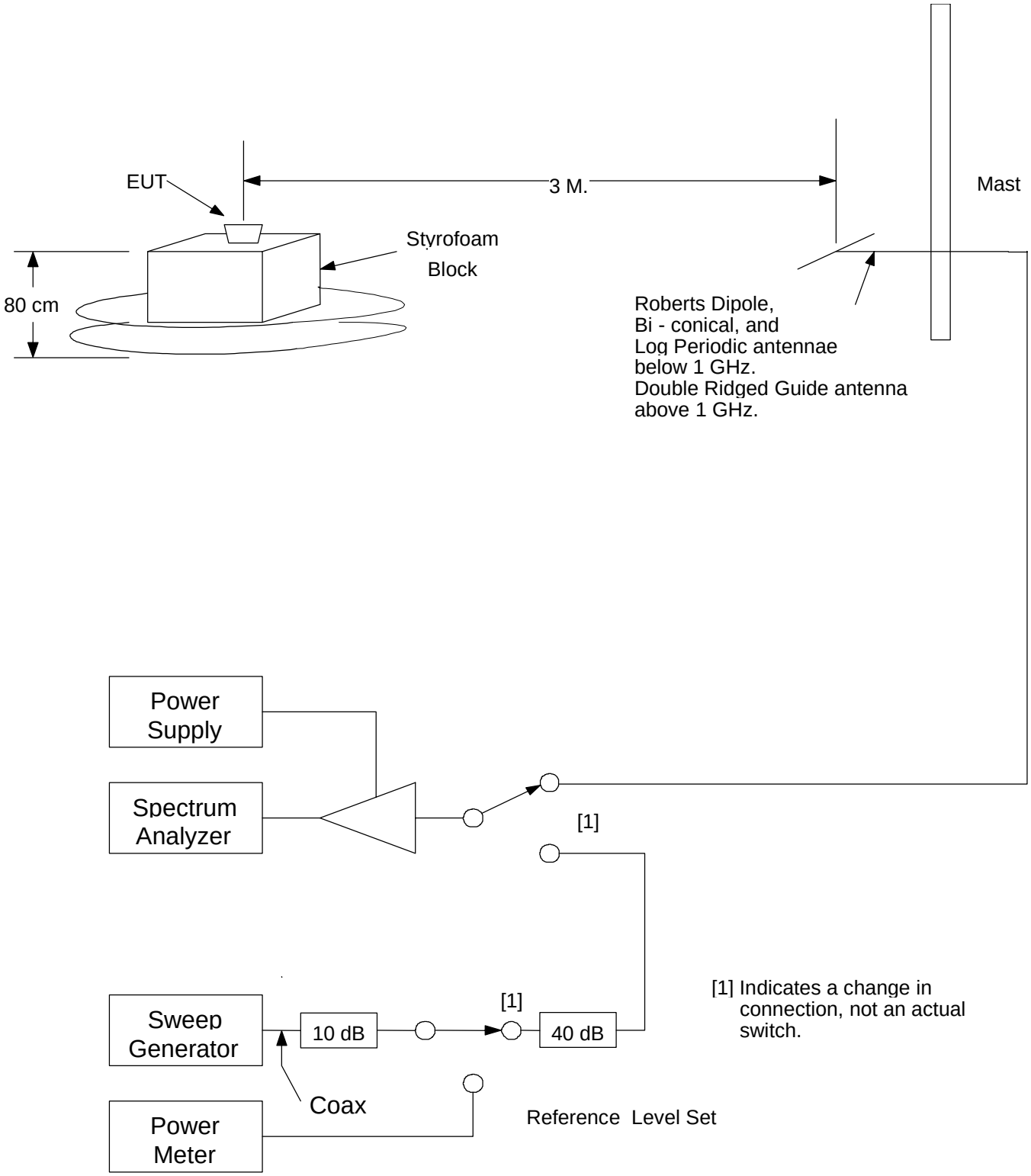
The EUT was physically configured similar to a typical user configuration. The 51ESS was interfaced to an Invensys sensor board in its meter housing. The assembly was placed in the center of the test table 80 cm above the ground plane. There were no other associated components or accessories on the table during the radiated emissions tests.

6. OPERATING MODE OF EUT, SOFTWARE/FIRMWARE ETC. :

During testing, the EUT was operationally configured to a special test mode. This special test mode causes the 51ESS to transmit more messages consecutively, thus allowing peaks of transmitter radiation to be more easily found as antenna height and turntable azimuth are varied.
The hopping bandwidth of the transmitter is around 2.5 to 3.5 MHz including manufacturing and component variability.
See Attachment B for message detail.

See the test set-up diagram in Section 7 and the photo in Attachment F.

7. TEST SET-UP DIAGRAM:



8. TEST AND MEASUREMENT EQUIPMENT DETAIL:

Test Equipment	Model	Manufacturer	Serial Number	Cal Due
Spectrum Analyzer Display Section	141T	Hewlett-Packard	1615A-11287	N/A
RF Section	8555A	Hewlett-Packard	1528A-05430	N/A
IF Section	8552B	Hewlett-Packard	1736A13353	N/A
Spectrum Analyzer	8593E	Hewlett-Packard	3543A02032	08/03
Synthesized Signal Generator	8673D	Hewlett-Packard	3123A01161	10/02
Power Meter	437B	Hewlett-Packard	3125U11553	10/02
Power Meter Sensor	8481D	Hewlett-Packard	331BA08626	10/02
Amplifier < 5 GHz	ZHL - 1042J	Mini-Circuits	H110894-008	N/A
Amplifier > 5 GHz	JCA010-415	JCA	103	N/A
Power Supply	6201B	Hewlett-Packard	1145A03611	12/02
LISN	3825-2	EMCO	9605-2535	01/03
Antenna - Dipole	Roberts	Compliance Design	4106	08/03
Antenna - Double Ridged Guide	3115	EMCO	9205-3878	04/03
Antenna - Log periodic	3146	EMCO	9203-3358	01/03
Antenna - Bi-conical	3108	EMCO	9203-2455	10/02

9. AMBIENT CONDITIONS DURING TEST:

Date	Temp (°F)	Humidity (% RH)
9/27/02	64	41
9/28/02	65	55
9/29/02	63	87

10. DISTRIBUTION LIST: Archive

11. REFERENCES: ANSI C63.4-1992

12. DESCRIPTION OF TEST PROCEDURE

12.1 Radiated Emissions (Transmitter)

These tests measure the transmitter radiated emissions using a spectrum analyzer and receiving antenna. During testing the EUT was placed on a non-conducting support, 80 cm above the ground plane. The RF spectrum was scanned from 30 MHz to 1000 MHz using the Bi-conical, Log Periodic and Dipole antennae. A Double Ridged Guide antenna was used from 1 GHz to the transmitter's 10^{th} harmonic at 9170. Levels below 1 GHz were measured with the spectrum analyzer resolution bandwidth at 120 kHz and levels at or above 1 GHz were measured with the spectrum analyzer resolution bandwidth at 1 MHz. The emissions were measured in vertical and horizontal antenna polarizations. The antenna height was varied from 1-4 meters and the EUT was rotated from 0-360°. Maximum emissions were recorded. The antenna to EUT test distance was 3 meters horizontally. An analog spectrum analyzer was used as an aid in locating the maximum radiation emission as the EUT orientation and antenna position were varied. The level was determined on the HP8593E by means of signal substitution. Testing was performed according to the procedures in ANSI C63.4-1992.
See Attachment F; Test Setup Photographs.

12.2 CONDUCTED EMISSIONS

This test determines the power line conducted emission using a LISN (Line Impedance Stabilization Network) and a spectrum analyzer. The EUT was placed on a non-conducting tabletop 80 cm above the conductive ground plane of the test site. The LISN was grounded to the conductive ground plane by means of a copper strap. A 9 kHz resolution bandwidth was used during the conducted emissions testing. The response due to the ambient electromagnetic conditions (without the EUT being energized) was plotted and the frequencies involved were determined. This was done in order to differentiate between the responses caused by ambient electromagnetic signals and the true EUT generated conducted emissions. The outputs of both ports of the LISN were plotted.

13. RESULTS

13.1 Radiated Emissions (Transmitter)

Final emission levels are expressed in dBµV/m. This level is determined by converting the reading from the spectrum analyzer or power meter to dBµV and adding the antenna correction factor (dB) and cable loss (dB) to it. The amplifier gain is accounted for when the spectrum analyzer display is calibrated. Antenna and cable loss factors are included in the tabular results contained in Attachment A. All levels below 1 GHz are peak. The transmitter fundamental is expressed in peak level as it is hopping in frequency and can not be measured quasi-peak. Transmitter harmonic final levels above 1 GHz are peak average with a 13 dB relaxation allowed for duty cycle.

Refer to Attachment B for duty cycle calculation.

13.1.1 Transmitter Radiated Emissions

RULE: **Part 15.249:** Emission of RF Energy - Transmitter

STANDARD: **Part 15.249**

The field strengths shall not exceed the following:

Fundamental (MHz)	Fundamental (μV/m)	Fundamental (dBμV/m)	Harmonic (μV/m)	Harmonic (dBμV/m)
902 - 928	50,000	94	500	54

Part 15.249 (c): Field Strength of Spurious Radiation
The emissions radiated outside the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the limits in Part 15.209, whichever is the lesser attenuation.

Part 15.209
Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency of Emission (MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)
30 – 88	100	40
88 – 216	150	43.5
216 – 960	200	46
Above 960	500	54

TEST RESULTS:

The EUT transmitter radiated emissions met the requirements established by Part 15.249 for intentional radiators. The EUT was tested from 30 MHz to the transmitter's 10th harmonic (9.17 GHz). Emissions in the 30 MHz to 1 GHz that had less than 20 dB margin in respect to the limit were recorded.

The transmitter fundamental (917 MHz) was measured to be 92.9 dBμV/m peak. This is 1.1 dB below the quasi-peak limits established by Part 15.249.
The worst case harmonic radiated emission was determined to be 66.9 dBμV/m peak. The limit established by Part 15.249 is 54 dBμV/m with a relaxation of 13 dB (67 dBμV/m).

In compliance with Part 15.35 (b) - Pulsed Operation, conversion of instantaneous peak power to average power is addressed in Attachment B.

TEST DATA: Refer to Attachment A for detailed test results

13.1.2 Bandwidth of Emission

RULE:	**Part 15.231 (c) Bandwidth of Emission**
STANDARD:	**Part 15.231 (c), Part 15.31 (m)** The 20 dB bandwidth of devices operating above 900 MHz shall be no wider than 0.5% of the center frequency. 918.05 MHz * 0.005 = 4.59 MHz
TEST RESULTS:	Meets standard. The occupied bandwidth of the transmitted signal was determined to be 205 kHz. Refer to Attachment C for Part 15.231 (c); Bandwidth Plot.
TEST DATA:	Refer to Attachment D for Part 15.31 (m); Measurement of Relative Field Intensity at the High and Low Frequencies of the EUT.

13.2 Conducted Emissions

RULE:	**Part 15.107 (a), Part 15.207 (a)**
STANDARD:	**Part 15.107 (a), Part 15.207 (a)** For equipment that is connected to the public utility power line, the frequencies in the band 450 kHz to 30 MHz as measured between each power line and ground at the power terminal shall not exceed 250 microvolts (48 dBμV).
TEST RESULTS:	When the EUT active results were compared with the ambient response results, there were no detectable conducted signals produced by the EUT.
TEST DATA:	Refer to Attachment E for FCC Part 15.107; Power line Conducted Emissions Plots

Results contained in this report apply to test sample only

Itron

ATTACHMENT A

EUT: Utility Meter Transmitter
Model: 51ESS
Serial No: 45940676

Part 15.249
Radiated Emissions-Transmitter
Test Dates: 9/27-28/02
Engineer: Drew Rosenberg

Freq. MHz	Ant. Pos.	Level dBm	[1]	Level dBuV	Amplifier Gain dB	Ant. Factor dB	Cable Loss dB	[2] [3] Corrected Level dBuV/m	Limit dBuV/m	Duty Cycle Factor dB	[4] Final Limit dBuV/m	Margin dB
917	V	**-**	QP	59.3	0.0	28.6	1.6	89.54	94		94	4.4
917	H	**-52.7**	P	54.4	0.0	28.6	1.64	84.59	94		94	9.4
1834	V	**-56.0**	P	51.0	29.5	28.45	1.68	51.63	54	13	67	15.4
1834	H	**-51.9**	P	55.1	29.5	28.45	1.68	55.73	54	13	67	11.3
2743	V	**-39.8**	P	67.2	42.2	31.24	3.02	59.26	54	13	67	7.7
2743	H	**-39.1**	P	67.9	42.2	31.24	3.02	59.96	54	13	67	7.0
3657	V	**-44.2**	P	62.8	43.4	33.68	3.54	56.62	54	13	67	10.4
3657	H	**-42.2**	P	64.8	43.4	33.68	3.54	58.62	54	13	67	8.4
4572	V	**-43.5**	P	63.5	43.8	34.87	4.16	58.73	54	13	67	8.3
4572	H	**-42.0**	P	65.0	43.8	34.87	4.16	60.23	54	13	67	6.8
5483	V	**-66.4**	NF	40.6	43.6	36.3	4.5	37.80	54	13	67	29.2
5483	H	**-50.0**	P	57.0	43.6	36.3	4.5	54.20	54	13	67	12.8
6397	V	**-48.9**	P	58.1	43.4	36.9	4.5	56.10	54	13	67	10.9
6397	H	**-68.6**	NF	38.4	43.4	36.9	4.5	36.40	54	13	67	30.6
7336	V	**-76.4**	NF	30.6	41.9	38.2	6.3	33.20	54	13	67	33.8
7336	H	**-76.4**	NF	30.6	41.9	38.2	6.3	33.20	54	13	67	33.8
8253	V	**-66.9**	NF	40.1	41.9	39.3	6.7	44.20	54	13	67	22.8
8253	H	**-66.9**	NF	40.1	41.9	39.3	6.7	44.20	54	13	67	22.8
9170	V	**-59.2**	NF	47.8	41.8	40.3	7.3	53.60	54	13	67	13.4
9170	H	**-59.2**	NF	47.8	41.8	40.3	7.3	53.60	54	13	67	13.4

NOTES:
[1] QP = QUASI-PEAK, P = PEAK, NF = NOISE FLOOR OF THE SPECTRUM ANALYZER
[2] THE SPECTRUM ANALYZER SETTINGS ARE AS FOLLOWS:
FUNDAMENTAL - RESOLUTION BW = 120 KHZ; VIDEO BW = 300 KHZ; SPAN = 10 MHZ.
HARMONICS - RESOLUTION BW = 1 MHZ; VIDEO BW = 1 MHZ; SPAN = 50 MHZ.
[3] "CORRECTED LEVEL" NUMBERS IN BOLD ARE RF SIGNAL LEVELS, NUMBERS IN ITALICS ARE NOISE FLOOR LEVELS (NO RF SIGNAL) THE "ANTENNA CORRECTION FACTOR" AND THE "CABLE LOSS" HAVE BEEN FACTORED IN WITH THE NOISE FLOOR LEVELS IN ORDER TO DEMONSTRATE WHAT THE "CORRECTED LEVEL" OF AN RF SIGNAL AT THE NOISE FLOOR LEVEL WOULD BE.
[4] THE "FINAL LIMIT", IN THE CASE OF THE HARMONICS, REPRESENTS 20 DB ABOVE THE AVERAGE LIMIT IN FCC PART 15.249
[5] NEGATIVE MARGINS REFLECT BEYOND LIMIT LEVELS.
[6] THE ANTENNAS USED WERE AS FOLLOWS:
FUNDAMENTAL: ROBERTS DIPOLE – ASSET NUMBER 12261
HARMONICS: DOUBLE RIDGED GUIDE EMCO 3115 – ASSET NUMBER 16256
[7] LEVELS AS READ ON THE HP 8594E SPECTRUM ANALYZER AND CORRECTED FOR AMPLIFIER GAIN WHERE APPLICABLE.

Itron

ATTACHMENT A

Serial No: 45940676 **Engineer:** **Drew Rosenberg**

Freq. MHz	Ant. Pos.	Level dBm	[1]	Level dBuV/m	Amplifier Gain dB	Ant. Factor dB	Cable Loss dB	[2] [3] Corrected Level dBuV/m	Limit dBuV/m	Margin dB
136	V	**-55.0**	P	52.0	29.3	12.08	0.58	35.36	43.5	-8.1
139.6	V	**-60.4**	P	46.7	29.35	12.19	0.59	30.08	43.5	-13.4
146.7	V	**-61.6**	P	45.4	29.34	12.40	0.61	29.11	43.5	-14.4
153.93	V	**-60.4**	P	46.6	29.39	12.54	0.62	30.36	43.5	-13.1
264.9	H	**-67.3**	P	39.7	29.57	17.60	0.83	28.53	46.0	-17.5
266.69	H	**-71.6**	P	35.4	29.57	17.63	0.84	24.27	46.0	-21.7
268.48	H	**-72.5**	P	34.5	29.57	17.67	0.84	23.41	46.0	-22.6
297.1	H	**-68.0**	P	39.0	29.62	18.83	0.89	29.11	46.0	-16.9
302.49	H	**-67.0**	P	40.1	29.65	14.15	0.89	25.44	46.0	-20.6
309.65	H	**-65.0**	P	42.0	29.7	14.29	0.91	27.50	46.0	-18.5
309.65	V	**-69.0**	P	38.0	29.7	14.29	0.91	23.50	46.0	-22.5
315.01	H	**-66.4**	P	40.6	29.73	14.40	0.91	26.21	46.0	-19.8
316.8	H	**-64.9**	P	42.1	29.73	14.44	0.92	27.75	46.0	-18.2
316.8	V	**-71.2**	P	35.8	29.81	14.44	0.92	21.35	46.0	-24.6
352.6	H	**-69.0**	P	38.0	29.81	14.97	0.97	24.15	46.0	-21.9
354.4	H	**-69.7**	NF	37.3	29.81	15.02	0.98	23.50	46.0	-22.5
377.68	V	**-72.7**	P	34.3	29.79	15.66	1.01	21.18	54.0	-32.8

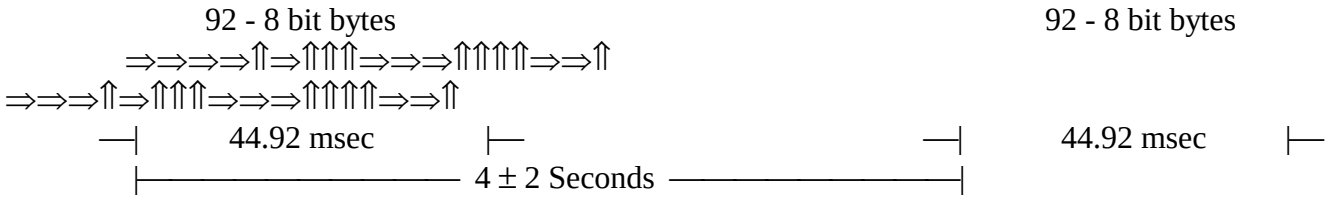
NOTES:
[1] QP = QUASI-PEAK, P = PEAK, NF = NOISE FLOOR OF THE SPECTRUM ANALYZER
[2] THE SPECTRUM ANALYZER SETTINGS ARE AS FOLLOWS:
30 TO 1000MHZ – RESOLUTUION BW = 120KHZ, VIDEO BW = 300KHZ, SPAN = 10MHZ
[3] "CORRECTED LEVEL" NUMBERS IN BOLD ARE RF SIGNAL LEVELS, NUMBERS IN ITALICS ARE NOISE FLOOR LEVELS (NO RF SIGNAL) THE "ANTENNA CORRECTION FACTOR" AND THE "CABLE LOSS" HAVE BEEN FACTORED IN WITH THE NOISE FLOOR LEVELS IN ORDER TO DEMONSTRATE WHAT THE "CORRECTED LEVEL" OF AN RF SIGNAL AT THE NOISE FLOOR LEVEL WOULD BE.
[4] THE "FINAL LIMIT", IN THE CASE OF THE HARMONICS, REPRESENTS 20 DB ABOVE THE AVERAGE LIMIT IN FCC PART 15.249
[5] NEGATIVE MARGINS REFLECT BEYOND LIMIT LEVELS.
[6] THE ANTENNAS USED WERE AS FOLLOWS:
30 TO BELOW 300MHZ – BICONICAL EMCO 3108: ASSET NUMBER 16230
300 TO 1000MHZ – LOG PERIODIC EMCO 3146: ASSET NUMBER 16248
[7] LEVELS AS READ ON THE HP 8594E SPECTRUM ANALYZER AND CORRECTED FOR AMPLIFIER GAIN WHERE APPLICABLE.

ATTACHMENT B

Part 15.35 (b) - Pulsed Operation
Conversion from Instantaneous Peak Power to Average Power
51ESS

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.

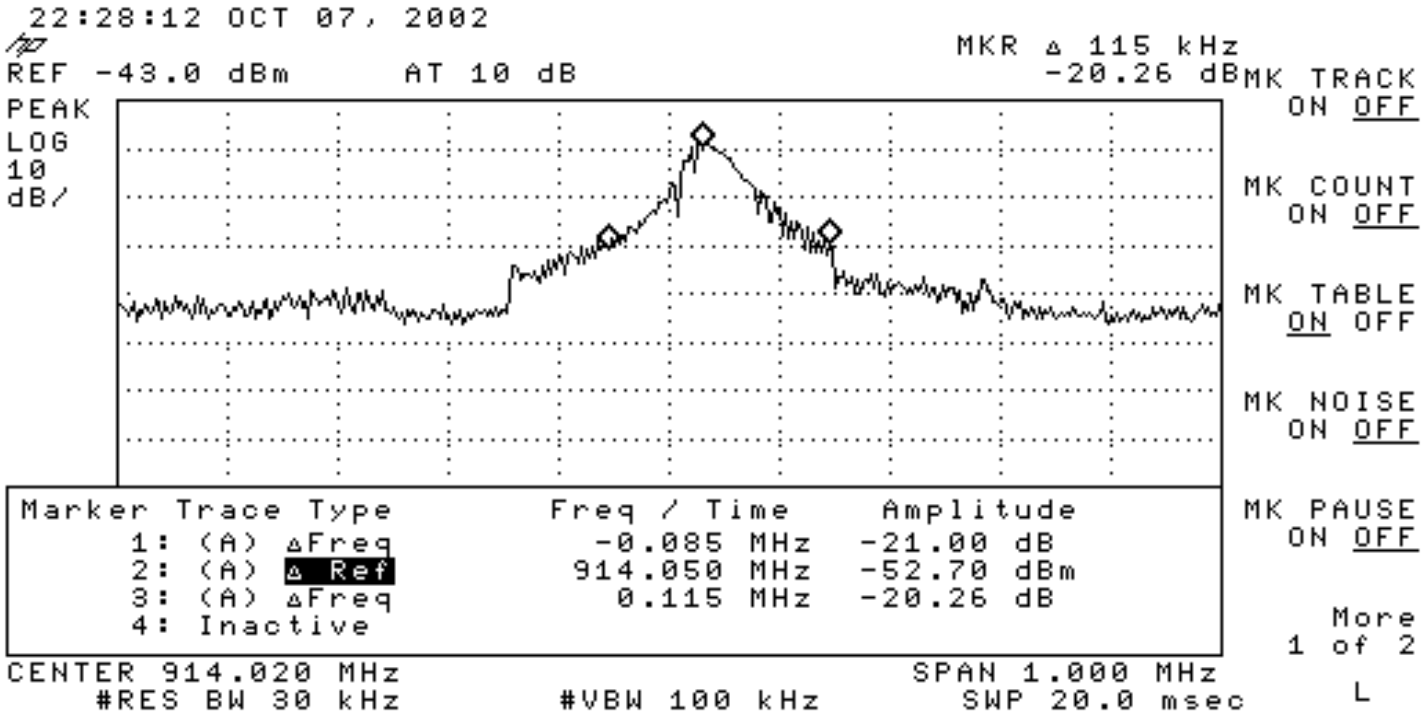
Expressing the correction factor for Duty Cycle in dB:

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 Part 15.35 (b) is 20 dB.

ATTACHMENT C

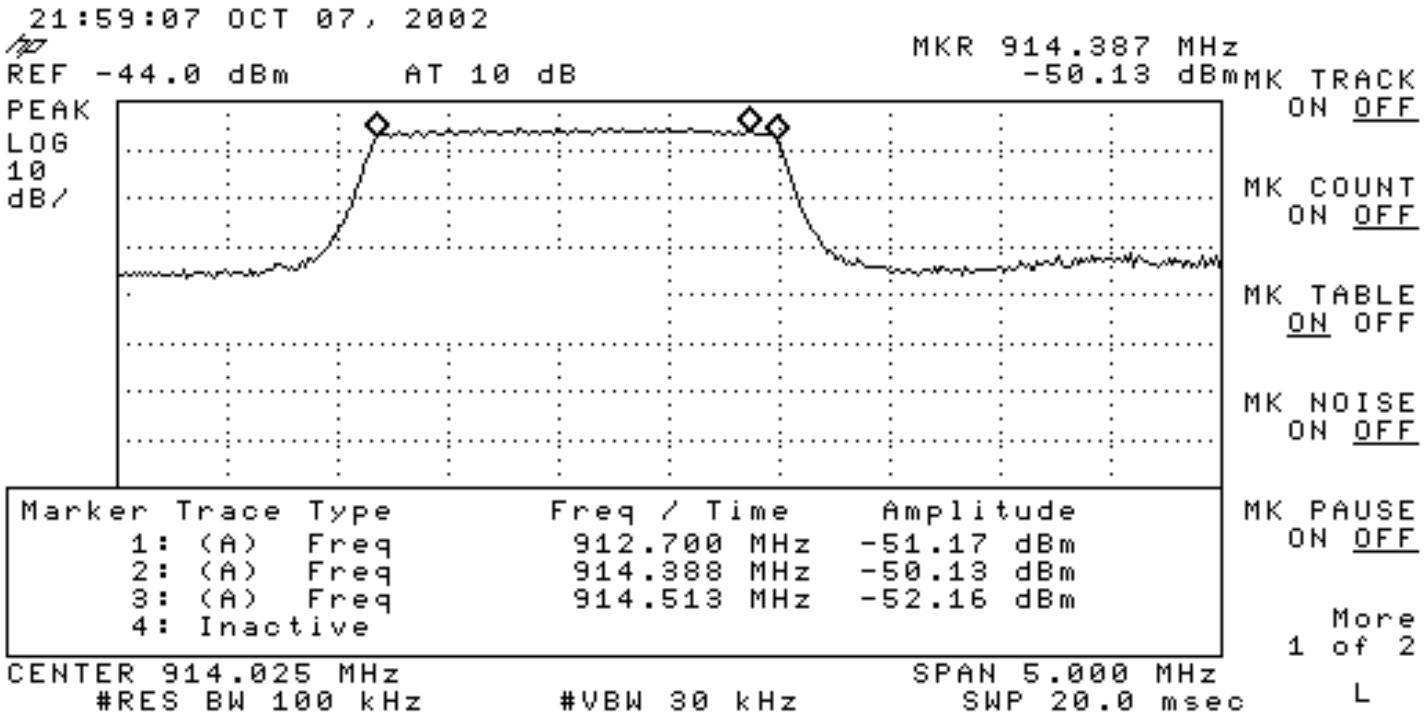
Part 15.231 (c) Bandwidth of Emission
Bandwidth Plot



ATTACHMENT D

Part 15.31(m)

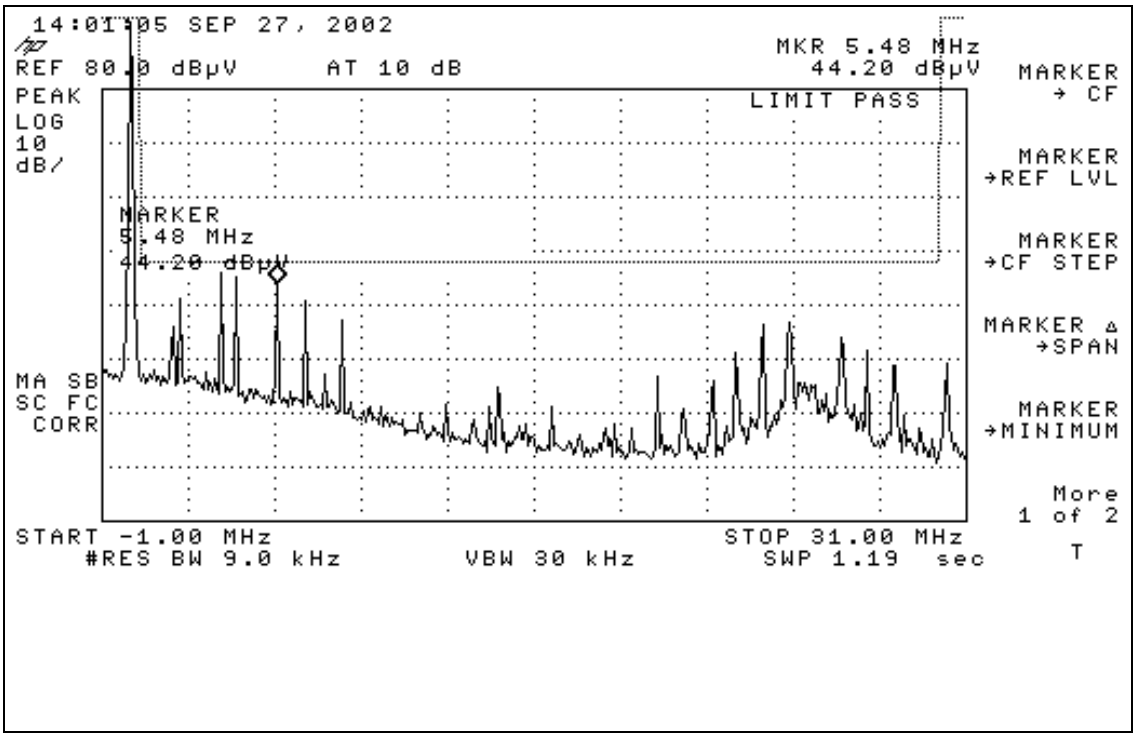
Measurement of Relative Field Intensity at the High and Low Frequencies of the EUT



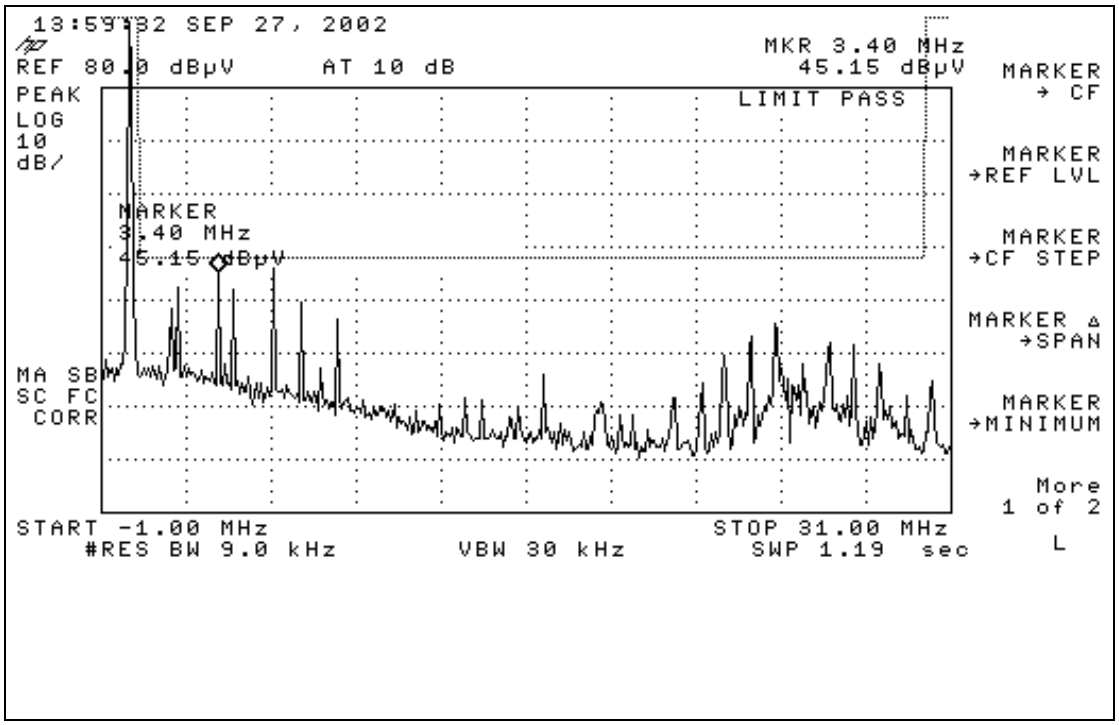
ATTACHMENT E

Part 15.107 Power line Conducted Emissions

Plots



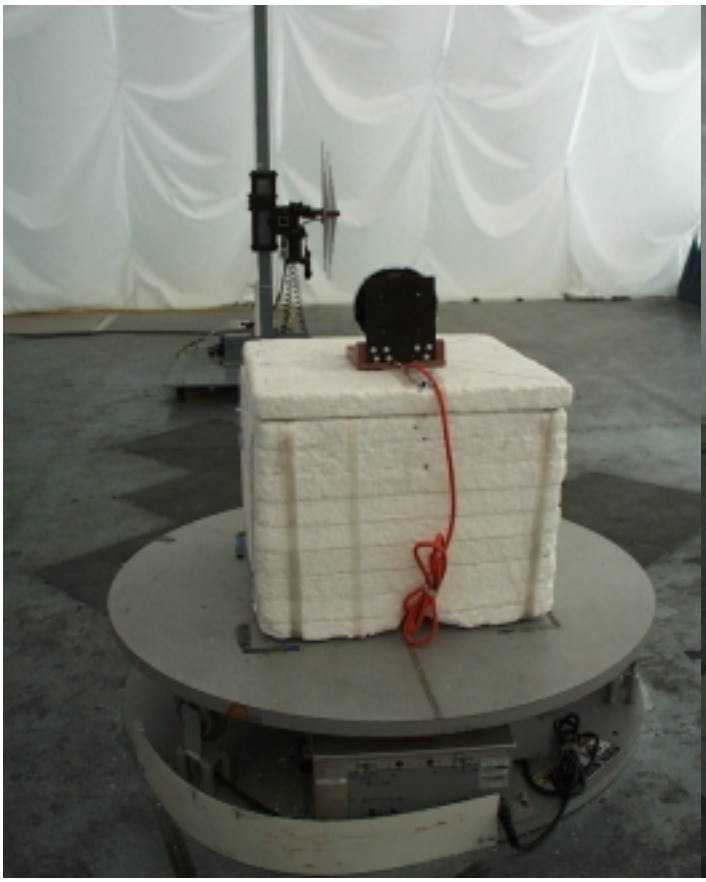
L1

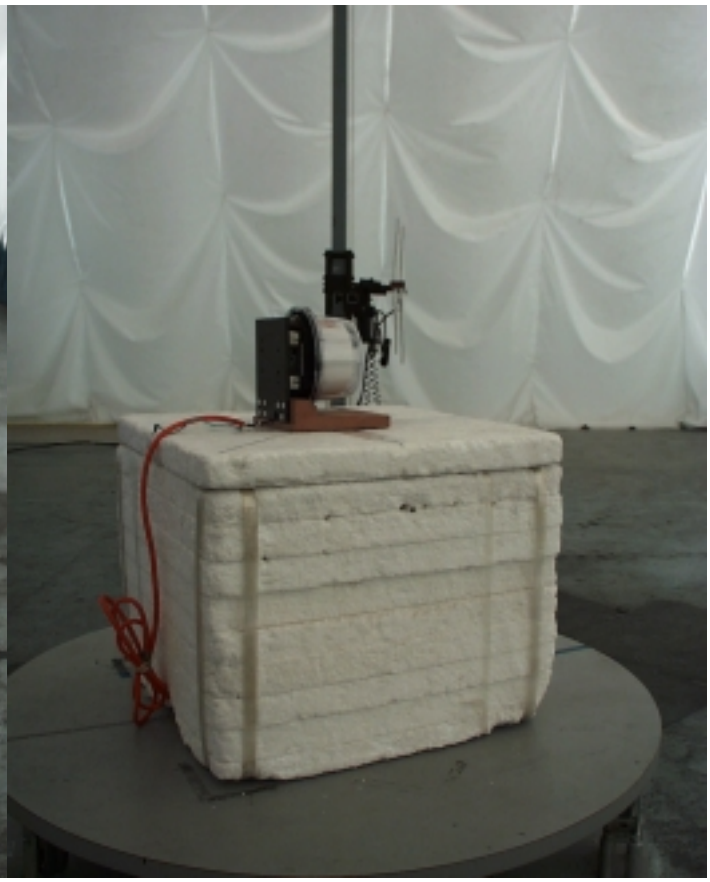


L2

ATTACHMENT F

Photographs (Test Setup)

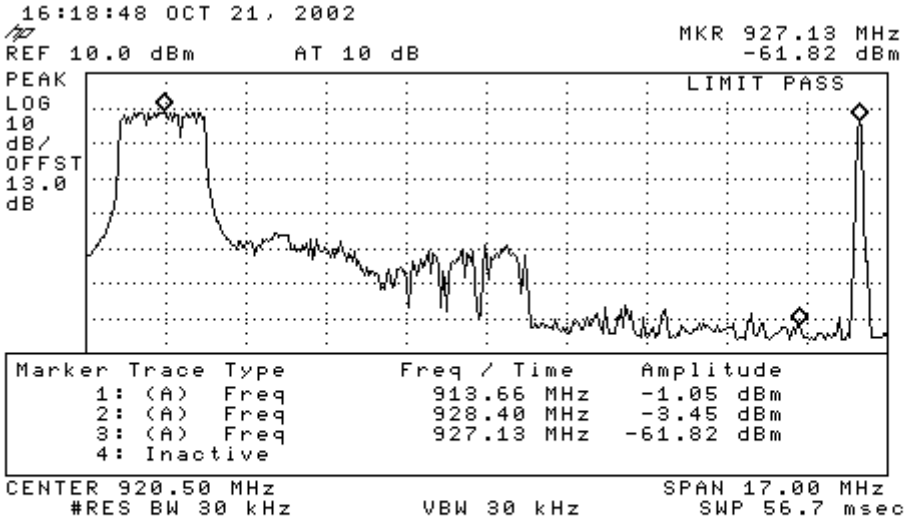




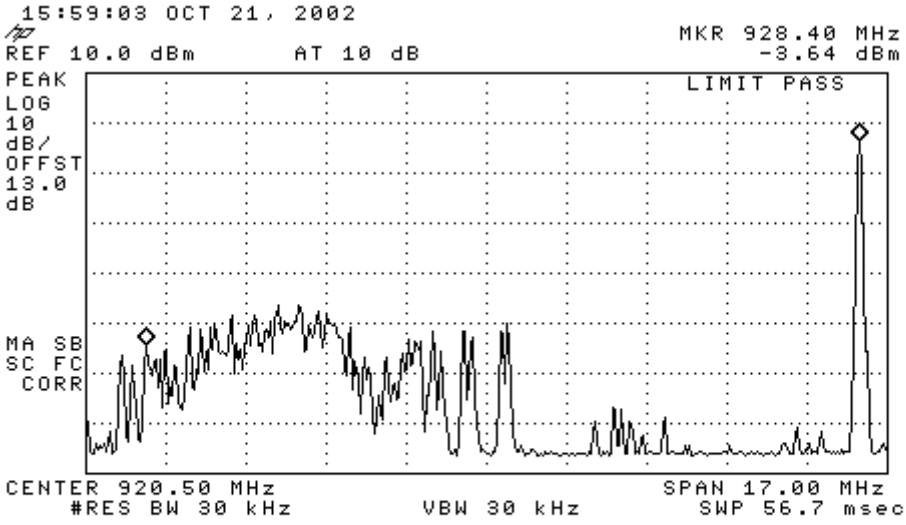
ATTACHMENT G

Part 15.249(c) Band Edge Plots

Band Edge High side



High Side Device off



ATTACHMENT G (continued)

Part 15.249(c) Band Edge Plots

Band Edge Low Side