TEST REPORT

Equipment Tested:

Utility Meter Transceiver
Model 40WN
Serial Number 101011

Itron Test Facility
2401 North State Street
Waseca, Minnesota 56093

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1. TEST SUMMARY

Test Report No.:	W990216
Company:	Itron, Inc.
Requester:	Klaus Bender
Phone:	(509) 891-3323
Test Date(s):	February 9, 10 & 12, 1999
Equipment Under Test:	Utility Meter Transceiver
General Test Summary:	The 40WN ERT® transmitter was tested for compliance to FCC Part 15.249 requirements for an intentional radiator. The receiver was tested for compliance to FCC Part 15.109.
Original Grant or Permissive Change:	Class II Permissive Change
Certification Status:	The 40WN ERT transmitter has been verified as being compliant with the FCC Part 15.249 requirements for an intentional radiator. The receiver has been verified as being compliant with the FCC Part 15.109 requirements for receivers.
Modifications Necessary for Compliance:	None. See Section 2. For EUT description.

Tested By: Robert A. Sleen

Report Written By: Robert A. Sleen

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2. PRODUCT DESCRIPTION AND TEST OBJECTIVE

The EUT is an utility meter transceiver and is used in conjunction with a host meter to measure water consumption. The EUT transmits consumption data if the receiver detects a wake-up tone. (See Sections 6 and 7 for test set-up description). The 40WN ERT® has a wide band receiver centered at 955 MHz. The actual fundamental receiver frequency is set at the time of manufacture. The unit also has a frequency-hopping transmitter that operates over a maximum 6 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 and to determine if the EUT receiver meets the radiated emission levels established by FCC Part 15.109 for unintentional radiators. The EUT was tested at an antenna to EUT horizontal 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 and accepted in a letter dated June 12, 1996 (Ref.: 31040/SIT 1300F2).

4. EUT SUPPORT EQUIPMENT USED:

Test Equipment	Model	Manufacturer	Serial. No.	Radiated or Conducted EMI	Cal. Due
RF Signal Generator	8656A	Hewlett Packard	2341A05541	R & C	N/A
Function Generator	171	Wavetek	M6230187	R & C	N/A
Double Ridged Guide Antenna	3115	EMCO	9508-4550	R & C	N/A

5. EUT SYSTEM DESCRIPTION:

The EUT was physically configured similar to a typical user configuration. The EUT was placed in the center of the test table 80 cm above the ground plane.
There were no associated components or accessories on the table during the radiated emissions tests.

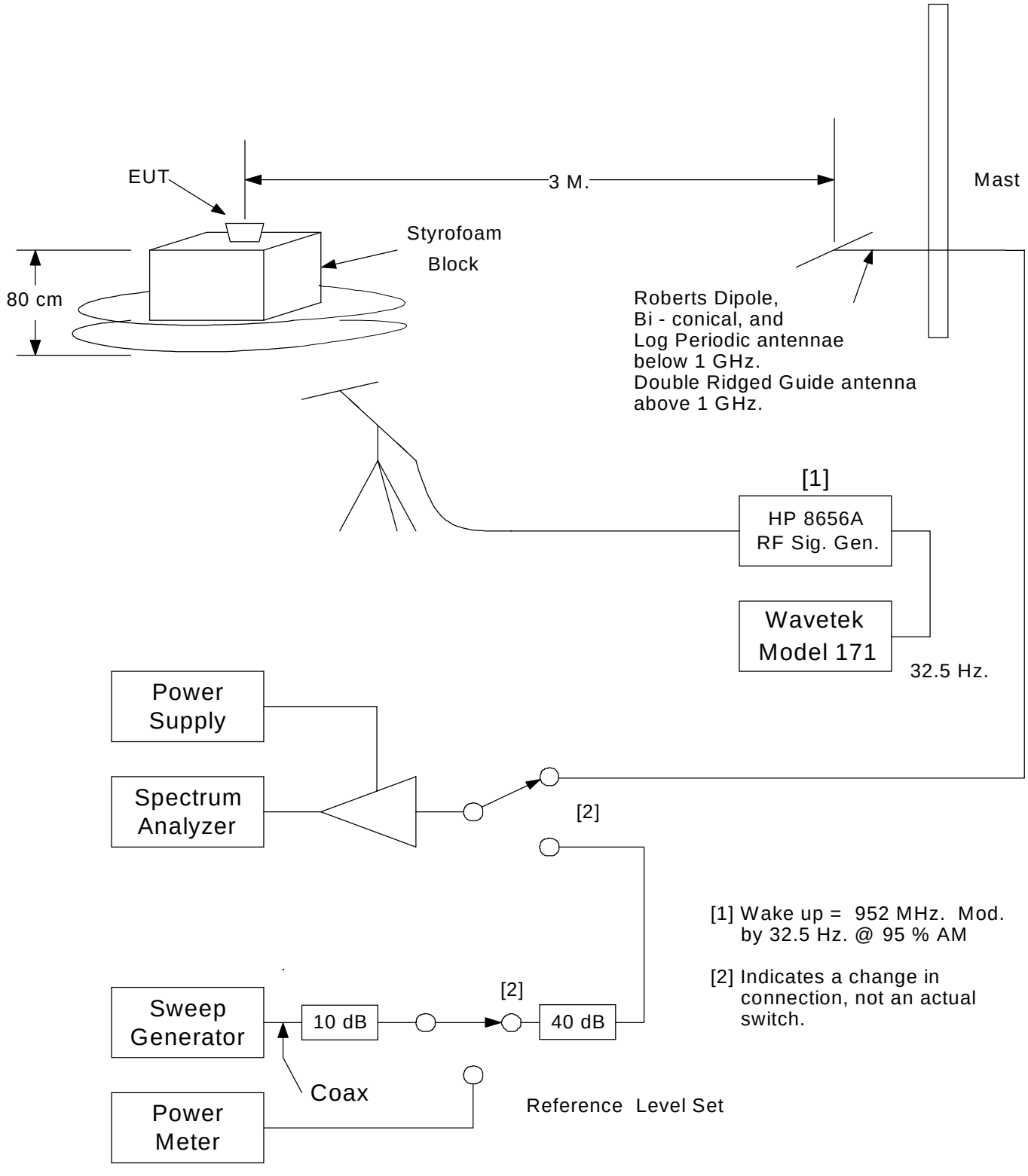
6. OPERATING MODE OF EUT, SOFTWARE/FIRMWARE ETC. :

The EUT was operationally configured to a special test mode. This special test mode causes the ERT® to transmit consecutive messages, thus allowing peaks of transmitter radiation to be more easily found as antenna heights and turntable azimuth are varied.
The hopping bandwidth of the transmitter is in the range of 1.5 to 6.0 MHz including manufacturing and component variability.
See Attachment B for message detail.

The receiver was under normal operation (a 0.25 usec. maximum wide on-time pulse occurring at a 512 Hz rate).

See the test set-up diagram in Section 7 and the photograph in Attachment E.

7. TEST SET-UP DIAGRAM:



8. TEST AND MEASUREMENT EQUIPMENT DETAIL:

Test Equipment	Model	Manufacturer	Serial Number	Radiated or Conducted EMI	Cal Due
Spectrum Analyzer Display Section	141T	Hewlett-Packard	1337A-06987	R	02/99
RF Section	8555A	Hewlett-Packard	1724A08025	R	02/99
IF Section	8552A	Hewlett-Packard	1952A17821	R	02/99
Spectrum Analyzer	8593E	Hewlett-Packard	3543A02032	R	04/99
Sweep Generator	8350B	Hewlett-Packard	2722A08843	R & C	05/99
RF Plug-In	83592A	Hewlett-Packard	2252A00787	R & C	05/99
Power Meter	437B	Hewlett-Packard	3125U16900	R & C	03/99
Power Meter Sensor	8481D	Hewlett-Packard	331BA11513	R & C	03/99
Amplifier < 5 GHz	ZHL - 1042J	Mini-Circuits	H110894-008	R	N/A
Amplifier > 5 GHz	JCA010-415	JCA	103	R	N/A
Power Supply	6284A	Hewlett-Packard	2320A02135	R	04/00
Antenna - Dipole	Roberts	Compliance Design	3038	R	06/99
Antenna - Double Ridged Guide	3115	EMCO	9205-3878	R	03/99
Antenna - Log periodic	3146	EMCO	9203-3358	R	03/99
Antenna - Bi-conical	3108	EMCO	9203-2455	R	10/99

9. AMBIENT CONDITIONS DURING TEST:

Date	Temp (°F)	Humidity (% RH)
02/09/99	55	50
02/10/99	55	50
02/12/99	52	25

10. DISTRIBUTION LIST: Klaus Bender
Archive

11. REFERENCES: ANSI C63.4-1992

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12. DESCRIPTION OF TEST PROCEDURE

12.1 Radiated Emissions (Transmitter and Receiver)

These tests measure the transmitter radiated emissions and the receiver 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 and Log Periodic antennae. A Double Ridged Guide antenna was used from 1 GHz to the product's tenth harmonic of the transmitter (9.1519 GHz) and 5 GHz on the receiver. 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 for the transmitter and 1 MHz for the receiver. The receiver harmonics were also checked with the spectrum analyzer at the following settings: Resolution Bandwidth = 1 MHz; Video Bandwidth = 10 Hz and Span = 0 Hz. The emissions were measured with 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.

13. RESULTS

13.1 Radiated Emissions (Transmitter and Receiver)

Final emission levels are expressed in dBuV/m. This level is determined by converting the reading from the spectrum analyzer or power meter to dBuV 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 quasi-peak with the exception of the transmitter fundamental. The transmitter fundamental is expressed in peak level as it is below the quasi-peak limit. Transmitter final levels of frequencies above 1 GHz are peak average with a 20 dB relaxation allowed for duty cycle.

Refer to Attachment B for duty cycle calculation.
Refer to Attachment D for pulse desensitization of the spectrum analyzer calculations.

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13.1.1 Transmitter Radiated Emissions

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

STANDARD: **Part 15.33 (a)(1)** Frequency range of the radiated measurements:

Tenth harmonic of the highest fundamental frequency.

Part 15.249

Field Strength of Fundamental Frequency: 50,000 uV/m (94 dBuV/m)
Field Strength of Harmonic Radiation: 500 uV/m (54 dBuV/m)

Field Strength of Spurious Radiation:

Part 15.249(c):
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 general radiation limits in 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	Field Strength	Field Strength
(MHz)	(uV/m)	(dBuV/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 FCC Part 15.249 for intentional radiators. The EUT was tested from 30 MHz to the transmitter's 10^{th} harmonic (9.1519 GHz). No EUT transmitter emissions other than the fundamental at 915.19 MHz were detected in the range from 30 MHz to 1 GHz.

The transmitter fundamental (915.19 MHz) was measured to be 93.4 dBuV/m peak. This is 0.6 dB below the quasi-peak limits established by Part 15.249. The worst case harmonic radiated emission was determined to be 72.3 dBuV/m peak. The limit established by Part 15.249 and Part 15.35 (b) is 74 dBuV/m (conversion of instantaneous peak power to average power allows an additional 20 dB relaxation). The result is a margin of 1.7 dB.

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

TEST DATA: Refer to Attachment A for detailed test results
Refer to Attachment C for Part 15.31 (m); Measurement of Relative Field Intensity at the High and Low Frequencies of the EUT.

13.1.2 Receiver Radiated Emissions

RULE: **Part 15.109: Radiated Emission Limits**

STANDARD: **Part 15.33 (b)(1)**
The upper frequency of measurement range: 5000 MHz.

Part 15.109 (a)
The field strength of radiated emissions from unintentional radiators at a distance of three meters shall not exceed the following values:

Frequency of Emission (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

TEST RESULTS: The EUT receiver radiated emissions met the levels established by FCC Part 15.109 (a) requirements for receivers.
The EUT was tested from 30 MHz to 5000 MHz.

The receiver fundamental (948 MHz) was determined to be 44.5 dBuV/m quasi-peak. The limit established by Part 15.109 (a) is 46 dBuV/m. No EUT receiver emissions other than the fundamental at 948 MHz were detected in the range from 30 MHz to 1 GHz.

The receiver second harmonic was determined to be 50.8 dBuV/m.

Duty cycle calculation for Pulsed RF per FCC Part 15.35 (b) is addressed in Attachment B.

TEST DATA: Refer to Attachment A for detailed test results

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ATTACHMENT A

EUT: Encoder/Receiver/Transmitter
Model : 40WN
Serial No.: 101011

FCC Part 15.249
Radiated Emissions-Transmitter
Test Dates: February 9 & 10, 1999
Engineer: Robert A. Sleen

Freq. MHz	Ant. Pos.	Level dBm	[1]	Level dBuV	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
915.19	V	**-37.9**	P	**69.1**	22.8	1.6	**93.4**	94		94	0.6
915.19	H	**-42.2**	P	**64.8**	22.8	1.6	**89.2**	94		94	4.8
1830.4	V	**-68.2**	P	**38.8**	28.1	2.1	**68.9**	54	-20	74	5.1
1830.4	H	**-64.8**	P	**42.2**	28.1	2.1	**72.3**	54	-20	74	1.7
2745.6	V	**-69.2**	P	**37.8**	30.7	2.9	**71.3**	54	-20	74	2.7
2745.6	H	**-70.0**	P	**37.0**	30.7	2.9	**70.5**	54	-20	74	3.5
3660.8	V	**-81.4**	P	**25.6**	32.9	3.3	**61.8**	54	-20	74	12.2
3660.8	H	**-74.0**	P	**33.1**	32.9	3.3	**69.3**	54	-20	74	4.8
4576.0	V	**-77.4**	P	**29.6**	34.5	4.1	**68.2**	54	-20	74	5.8
4576.0	H	**-78.9**	P	**28.1**	34.5	4.1	**66.8**	54	-20	74	7.3
5491.1	V	**-88.1**	P	**18.9**	36.0	4.8	**59.7**	54	-20	74	14.4
5491.1	H	**-87.6**	P	**19.4**	36.0	4.8	**60.2**	54	-20	74	13.9
6406.3	V	**-94.0**	P	**13.0**	36.6	5.5	**55.1**	54	-20	74	18.9
6406.3	H	**-91.9**	P	**15.1**	36.6	5.5	**57.1**	54	-20	74	16.9
7321.5	V	**-92.1**	P	**14.9**	38.0	6.2	**59.2**	54	-20	74	14.9
7321.5	H	**-91.3**	P	**15.7**	38.0	6.2	**60.0**	54	-20	74	14.1
8236.7	V	-95.9	NF	11.1	38.8	6.4	*56.3*	54	-20	74	
8236.7	H	-95.9	NF	11.1	38.8	6.4	*56.4*	54	-20	74	
9151.9	V	-95.1	NF	12.0	39.8	8.0	*59.7*	54	-20	74	
9151.9	H	-95.0	NF	12.0	39.8	8.0	*59.8*	54	-20	74	

Notes:
[1] QP = Quasi-peak, P = Peak, NF = Noise Floor of the Spectrum Analyzer
[2] The Spectrum Analyzer settings are as follows:
Fundamental - Resolution Bandwidth = 120 kHz; Video Bandwidth = 300 kHz; Span = 10 MHZ.
Harmonics - Resolution Bandwidth = 1 MHz; Video Bandwidth = 3 MHz; Span = 50 MHZ.
[3] "Corrected Level" numbers in bold are RF signal levels.
"Corrected Level" numbers in italics are noise floor and as such indicate that there is no RF signal at that level. 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 have been equal to.
[4] The "Final Limit", in the case of the harmonics, represents 20 dB above the average limit in FCC Part 15.249 Refer to Attachment B (Part 15.35 (b)).

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ATTACHMENT A cont.

EUT: Encoder/Receiver/Transmitter
Model : 40WN
Serial No.: 101011

FCC Part 15.109
Radiated Emissions-Receiver
Test Dates: February 10 & 12, 1999
Engineer: Robert A. Sleen

Freq. MHz	Ant. Pos.	Level dBm	[1]	Level dBuV	Ant. Factor dB	Cable Loss dB	[2] **Final Level dBuV/m**	[3] Final Limit dBuV/m	Margin dB
948	V		QP	**19.4**	23.4	1.7	**44.5**	46	1.5
948	H		QP	**10.9**	23.4	1.7	**36.0**	46	10.0
1896.0	V	**-94.0**	P	**13.1**	28.4	2.2	**43.6**	74	30.4
1896.0	H	**-87.1**	P	**19.9**	28.4	2.2	**50.5**	74	23.5
2844.0	V	-95.7	NF	11.3	31.1	3.1	*45.5*	74	
2844.0	H	-95.7	NF	11.3	31.1	3.1	*45.5*	74	
3792.0	V	-96.9	NF	10.1	33.0	3.5	*46.6*	74	
3792.0	H	-96.8	NF	10.2	33.0	3.5	*46.7*	74	
4740.0	V	-98.0	NF	9.0	34.9	4.5	*48.4*	74	
4740.0	H	-97.8	NF	9.2	34.9	4.5	*48.6*	74	

Notes:
[1] QP = Quasi-peak, P = Peak, NF = Noise Floor of the Spectrum Analyzer
[2] The Spectrum Analyzer settings are as follows:
Fundamental - Resolution Bandwidth = 120 kHz; Video Bandwidth = 300 kHz; Span = 10 MHZ.
Harmonics - Resolution Bandwidth = 1 MHz; Video Bandwidth = 3 MHz; Span = 50 MHZ.
"Final Level" numbers in bold are RF signal levels.
"Final Level" numbers in italics are noise floor and as such indicate that there is no RF signal at that level.
The "Antenna Correction Factor" and the "Cable Loss" have been factored in with the noise floor levels in order to demonstrate what the "Final Level" of an RF signal at the noise floor level would have been equal to.

[3] The "Final Limit", in the case of the harmonics, represents 20 dB above the average limit in FCC Part 15.109. Refer to Attachment B (Part 15.35 (b)).
PDSA (Pulse Desensitization of the Spectrum Analyzer) was not factored in when the level measured represented either the noise floor or a harmonic. PDSA of the harmonics at a Resolution Bandwidth of 1MHz is equal to 6.9 dB. - See Attachment D.

ATTACHMENT A cont.

EUT: Encoder/Receiver/Transmitter
Model : 40WN
Serial No.: 101011

FCC Part 15.109
Radiated Emissions-Receiver
Test Dates: February 12, 1999
Engineer: Robert A. Sleen

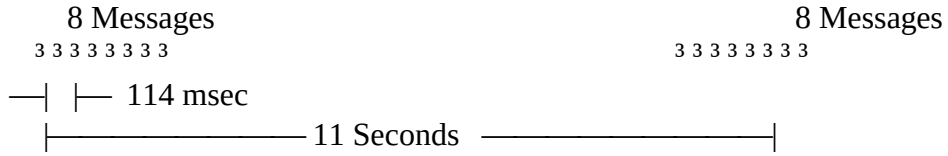
Freq. MHz	Ant. Pos.	Level dBm	[1]	Level dBuV	Ant. Factor dB	Cable Loss dB	[3] Final Level dBuV/m	Limit dBuV/m
1896.0	V	-109.4	NF	-2.4	28.4	2.2	*28.2*	54
1896.0	H	-109.0	NF	-2.0	28.4	2.2	*28.6*	54
2844.0	V	-110.7	NF	-3.7	31.1	3.1	*30.5*	54
2844.0	H	-110.9	NF	-3.9	31.1	3.1	*30.3*	54
3792.0	V	-110.7	NF	-3.7	33.0	3.5	*32.8*	54
3792.0	H	-110.6	NF	-3.6	33.0	3.5	*32.9*	54
4740.0	V	-108.4	NF	-1.4	34.9	4.5	*38.0*	54
4740.0	H	-108.4	NF	-1.4	34.9	4.5	*38.0*	54

NOTES:
[1] QP = Quasi-peak, P = Peak, NF = Noise Floor of the Spectrum Analyzer
[2] The Spectrum Analyzer settings are as follows:
Resolution Bandwidth = 1 MHz; Video Bandwidth = 10 Hz; Span = 0 HZ.
[3] "Final Level" numbers in bold are RF signal levels.
"Final Level" numbers in italics are noise floor and as such indicate that there is no RF signal at that level. The "Antenna Correction Factor" and the "Cable Loss" have been factored in with the noise floor levels in order to demonstrate what the "Final Level" of an RF signal at the noise floor level would have been equal to.

ATTACHMENT B

Conversion from Instantaneous Peak Power to Average Power
40WN ERT®

The ERT Unit Transmits a sequence of eight Manchester Encoded Messages in a ten second Period. Each of the messages are 5.86 msec long. Each message is broadcast on a different frequency within the Transmit Band.



Zooming in on a message length;

Where bit rate is: 16.384 Kbits/Second.

During the transmission of eight 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

During the receive mode, the Receiver Duty Cycle can be computed.

% Duty Cycle Receive = (0.25 μsec.) (512 Hz) (100 %)
% Duty Cycle Receive = .0128 %

Expressing the correction factor for Duty Cycle in dB:

dB Duty Cycle Receive = 20 Log ($1.28 * 10^{-4}$)
dB Duty Cycle Receive = - 77.8 dB

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ATTACHMENT C

Part 15.31(m)

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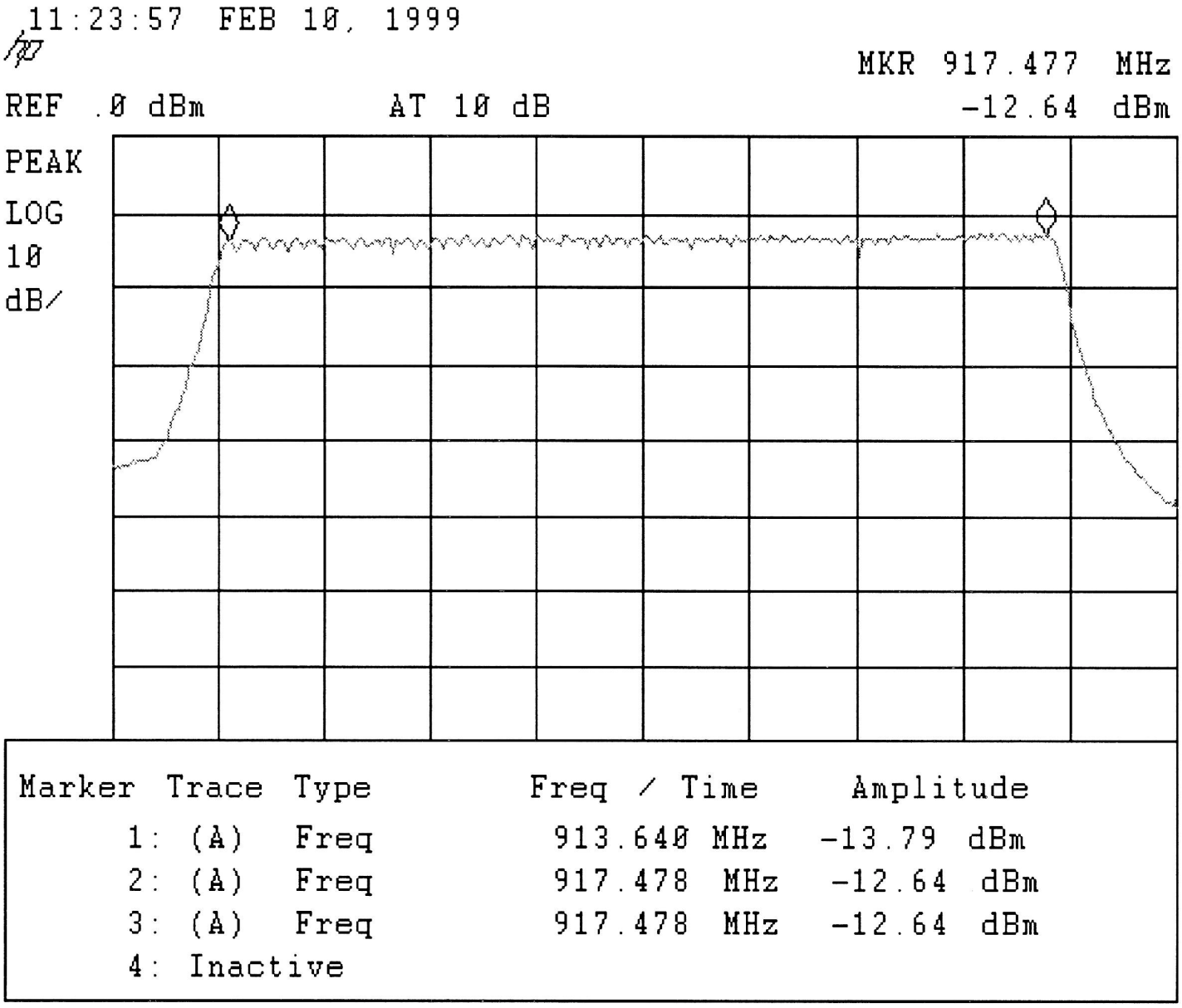
Measurement of Relative Field Intensity at the High and Low Frequencies of the EUT.



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ATTACHMENT D

Pulse Desensitization of the Spectrum Analyzer

Pulse Desensitization of the Spectrum Analyzer is the rise time delay inherently imposed by the resolution bandwidth setting of the spectrum analyzer. The resulting attenuation of narrow pulse signals necessitates that a compensating factor be applied to the levels on the spectrum analyzer when peak levels are being measured.

This does not apply to Quasi-peak measurements.

Reference: Application Note 150-2 "Spectrum Analysis of Pulsed RF", Hewlett Packard, November 1971

Example:

PDSA = 20 log (Pulse width x 1.5 x Spectrum Analyzer Resolution Bandwidth)
PDSA = 20 log (.15 x 10^{-6} x 1.5 x 1 x 10^{6})
PDSA = -12.96 dB

Pulse Desensitization of the Spectrum Analyzer

RF Pulse Width (nsec.)	Spectrum Analyzer Resolution Bandwidth			
	100 kHz	300 kHz	1 MHz	3 MHz
	Desensitization			
	(dB)	(dB)	(dB)	(dB)
500	-22.5	-13.0	-2.5	
450	-23.4	-13.9	-3.4	
400	-24.4	-14.9	-4.4	
350	-25.6	-16.1	-5.6	
300	-26.9	-17.4	-6.9	
250	-28.5	-19.0	-8.5	
225	-29.4	-19.9	-9.4	
200	-30.5	-20.9	-10.5	-0.9
175	-31.6	-22.1	-11.6	-2.1
150	-33.0	-23.4	-13.0	-3.4
125	-34.5	-25.0	-14.5	-5.0
100	-36.5	-26.9	-16.5	-6.9
75	-39.0	-29.4	-19.0	-9.4
50	-42.5	-33.0	-22.5	-13.0

ATTACHMENT E

Photograph (Test Setup)