MEASUREMENT/TECHNICAL REPORT

ERS International Inc. - Model: SN-ACATR-00
FCC ID:NGTSNACATRAA
September 1998

This report concerns (check one:) Original Grant____ Class II Change_X_

Equipment Type:__Electronic Shelf-Label System Transmitter__(example: computer, printer, modem, etc.)

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? Yes___ No_X_

If yes, defer until: ____________
date

Company Name agrees to notify the Commission by: ____________
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Transition Rules Request per 15.37? Yes___ No_X_

If no, assumed Part 15, Subpart B for unintentional radiator - the new 47 CFR [10-1-96 Edition] provision.

Report prepared by:

Michael J. Peters
Intertek Testing Services NA Inc.
70 Codman Hill Road
Boxborough, MA 01719
Phone: 978-263-2662
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EXHIBIT 1

GENERAL DESCRIPTION

1.0 General Description

1.1 Product Description and List of Changes

The ShelfNet is a wireless electronic shelf-label system consisting of ERS ShelfServer software and EasyShelf hardware. This system is intended to operate in an in-door environment.

Please see the attached from ERS International, Inc.

Electronic Retailing Systems International

ERS International, Inc.
330 Codman Hill Road
Boxborough, MA 01719-1739
978.264.2800
FAX: 978.264.2801

To: Federal Communication Commission
Equipment Authorization Division, Applications Processing Branch
7435 Oakland Mills Road, Columbia, MD 21046
From: Kim Peck ERS International
Subject: Application referencing FCC ID:NGTSNACATRAA
Date: 11 September 1998

Gentlemen,
Recently changes were implemented in the ERS ShelfNet system ACA Model No. SN- ACATR-00, and FCC identifier "NGTSNACATRAA". These changes effected the schematic diagram, the manufacturing bill of material, the assembly instructions, and the circuit board lithography.

Reasons for Changes
The original design did not consistently achieve the desired output power, without excessive individual tuning. In addition, the output power was not level across the frequency range. This was due in part, to a set of cascaded output filters, which were placed between the final power amplifier and the antenna system. A large impedance mismatch at the antenna system, and interactions between the cascaded filters, combined to create an unacceptable level of filter ripple. The final output amplifier did not enjoy an optimum impedance match, and was slightly over driven, causing incorrect input impedance and output harmonic levels.

List of Changes
1. The unequal power splitter, which feeds the two patch antennas in each antenna array, has been re-designed to improve the impedance match. Great care has been taken to maintain the phase and power relationships between the two antenna elements.

2. The filter BPF2 has been replaced by a low pass microstrip, type filter (LP1). The two filters were originally 3 pole, dielectric type, band-pass filters. Because the dielectric type filters, have higher loss compared to the low pass microstrip type, this change resulted in a slightly higher output power, closer to the original design value, as well as improved margins in the harmonic spectrum.

3. The final power amplifier's impedance matching has been slightly improved and an input attenuator pad was included (R43, R44, and R48) in order to reduce the drive level to a more optimum level, while improving stability and reducing input reflections. The amplifier bias voltage was also adjusted (R56 from 330 to 510 ohms).

4. C22 has been changed from 1000 pf to .022 uF. The purpose of this change is to reduce the switching speed of the OOK modulator. This significantly reduces the signal bandwidth, during modulation.

5. A voltage regulator (Q7) has been eliminated and it's load assigned to another regulator (Q3). Q5 and R3 have been added to the switching circuit that enables the regulator, in order to eliminate transitory problems at the moment when power is applied.

6. A length of copper tape has been added at the board edge. This material will wrap from the bottom to the top of the board, with the board edge approximately centered in the width of the tape. The length will be approximately centered in the mounting hole adjacent to Q3. The tape will be formed into the circumference of the mounting hole. This will eliminate a small but undesirable radiation from the early stages of the transmitter.

Electronic Retailing Systems International

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7. Several "vias", which are used to connect various layers of the circuit board, have been changed from the standard type, to a "blind" type. The standard via is a plated hole, which is drilled completely through all layers from the top to the bottom of the circuit board. The blind via is a plated hole drilled only in certain layers of the circuit board. The purpose of this change is to close certain holes on the "bottom" of the circuit board (the side opposite from the shields), so that they cannot radiate undesired signals.

The schematic has been re-drawn in 3 pages rather than 2 for clarity. Some schematic changes have been made to correct omissions, and are not design changes. Printed structures, such as the antenna power splitter have always been present on the circuit board but not adequately represented on the schematic.

As always, I am prepared to provide any clarifications or answer any questions the FCC may have.

Kim Peck
Senior RF engineer
ERS International

1.2 Related Submittal(s) Grants

This is a single Class II Permissive Change for the Frequency Hopping Spread Spectrum Transmitter.

1.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.4 (1992). All measurements were performed in Open Area Test Sites. Preliminary scans were performed in the Open Area Test Sites only to determine worst case modes. For each scan, the procedure for maximizing emissions in Appendices D and E were followed. All Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.

1.4 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located at 70 Codman Hill Road, Boxborough, Massachusetts. The 1C site was used. This test facility has been fully described in a report submitted to your office, and found to be in compliance with the 47 CFR 2.948 requirements. Please reference the site filing number: 31040/SIT 1300F2, dated September 4, 1998. Each test site is accredited by the NVLAP program.

EXHIBIT 2

SYSTEM TEST CONFIGURATION

2.0 System Test Configuration

2.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.4 (1992).

The arrangement of the cables dangling from the rear of the table was varied to the extent possible to produce the maximum emissions.

For maximizing emissions, the system was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data reported in Exhibit 3.0.

The unit was operated standalone and placed in the center of the turntable.

All transmitter measurements were made with hop stopped on three frequencies: a high, middle and low.

Measurements were performed with and without the electronic Shelf Label (ESL) in the field. The worst-case readings are recorded which were with the ESL.

At frequencies above the transmit frequency, the receiving antenna was brought in to a closer distance to determine a better noise floor margin comparison to the emissions limit. The measurement distance is reflected in the tables by the application of an appropriate distance factor.

2.2 EUT Exercising Software

The EUT exercise program used during radiated and conducted testing was designed to exercise the various system components in a manner similar to a typical use. A synthetic packet is used without a need for having a destination. The unit was programmed to operate on three frequencies of 2408, 2440 and 2470 MHz.

2.3 Equipment Modification

A list of changes made to the product since original grant of equipment authorization is included in Exhibit 1 of this application.

Any modifications installed previous to testing by ERS International Inc. will be incorporated in each production model sold/leased in the United States.

Confirmed by:

Michael J. Peters
Staff Engineer, Emissions
Intertek Testing Services NA Inc.
Agent for ERS International Inc.

Michael J. Peters ______ Signature

9/16/98 ______ Date

2.4 Support Equipment List and Description

The FCC ID's for all equipment, plus descriptions of all cables used in the tested system (included inserted cards, which have grants) are:

ALL SUPPORT EQUIPMENT REMOTELY LOCATED

Notebook Computer Laptop
M/N: 6200AT
S/N: N6SD72421Z216
FCC ID: L4PK6000T200

ERS Electronic Shelf Label
M/N: SN-EILDN-00
S/N: X7fc9e2f7
FCC ID: Not Labelled

Acculan Hub
M/N: Not Labelled
S/N: Not Labelled
FCC ID: Not Applicable

ERS Microcell Controller
M/N: SN-MCC24-00
S/N: 00-A0-E9-00-01-42
FCC ID: Not Labelled

Cables:
(1) RG58 Cable (10m)
(1) Ethernet (2m, unshielded, plastic hood) - remotely located
(1) RJ45 Cable (15m, unshielded) - remotely located
(1) AC Adapter Cable (2m) - remotely located

EXHIBIT 3

EMISSION RESULTS

3.0 **Emission Results**

Data is included of the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs, data tables and graphical representations of the emissions are included.

3.1 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/m
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 dBμ/V/m)/20] = 39.8 μV/m

3.2 Radiated Emission Configuration

Worst-Case Radiated Emissions and Photographs

FCC Part 15 Subpart C Section §15.247

Table #	Test	Frequency (MHZ)	Margin (dB)	Next Highest Margin (dB)	Detector	RBW
	Transmitting at 2408 MHZ					
1	Radiated	343.6	-19	-20	Average*	1 MHz*
	Transmitting at 2440 MHZ					
2	Radiated	4879.0	-6	-11	Average*	1 MHz*
	Transmitting at 2470 MHZ					
3	Radiated	7410	-10	-19	Average*	1 MHz*

Notes:
An average factor of 4 dB was determined and applied to the readings prior comparing to the limit. Because of this, no peak emission is greater than 4.9 dB of the average.

Radiated emissions measurements were performed from 30 MHz to the 10 harmonic of the highest transmit frequency which is 24,700 MHz.

* Below 1000 MHz a quasi-peak detector was used and no average factor was applied. Below 1000 MHz a RBW of 120 Khz was used.

TEST PERSONNEL:

Tester Signature

Kouma Sinn, Compliance Engineer
Typed/Printed Name

9/16/98
Date

Intertek Testing Services

Boxborough, MA

COMPANY: Electronic Retail Sales
MODEL: SN-ACATR-00

TABLE: 1
Date of Test: September 11, 1998

NOTES: Transmit Frequency is 2408 MHz

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
332.900	9	0	17	0	0	0	26	20	200	-20
343.600	10	0	17	0	0	0	27	22	200	-19
494.400	-2	0	23	0	0	0	21	11	200	-25
4816.000	26	10	42	24	-4	0	30	32	500	-24
7223.000	37	10	48	24	-4	0	47	224	1.8E+05	-58
9638.000	32	10	52	21	-4	0	49	282	1.8E+05	-56

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

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COMPANY: Electronic Retail Sales
MODEL: SN-ACATR-00

TABLE: 2
Date of Test: September 10,1998

NOTES: Transmit Frequency is 2440 MHz

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
332.900	9	0	17	0	0	0	26	20	200	-20
343.600	10	0	17	0	0	0	27	22	200	-19
494.400	-2	0	23	0	0	0	21	11	200	-25
4879.000	35	0	41	24	-4	0	48	251	500	-6
7320.000	34	10	47	24	-4	0	43	141	500	-11
9760.000	32	10	52	21	-4	0	49	282	2.8E+05	-60

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

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Intertek Testing Services

Boxborough, MA

COMPANY: Electronic Retail Sales
MODEL: SN-ACATR-00

TABLE: 3
Date of Test: September 10, 1998

NOTES: Transmit Frequency is 2470 MHz

Radiated Emissions

Frequency (MHz)	Reading (dBuV)	Distance Factor (dB)	Antenna Factor (dB)	Pre-Amp Gain (dB)	Averaging Factor (dB)	Pulse Desensitization (dB)	Field Strength @ 3 m (dBuV/m)	Field Strength @ 3 m (uV/m)	Limits @ 3 m (uV/m)	Margin (dB)
332.900	9	0	17	0	0	0	26	20	200	-20
343.600	10	0	17	0	0	0	27	22	200	-19
494.400	-2	0	23	0	0	0	21	11	200	-25
4940.000	39	20	42	24	-4	0	33	45	500	-21
7410.000	42	20	49	23	-4	0	44	158	500	-10
9880.000	35	20	53	21	-4	0	43	141	2.0E+05	-63
12350.000	26	20	52	21	-4	0	33	45	500	-21

No other harmonic or spurious emissions were detected at a test distance of 0.3 meter.

Test Engineer: Kouma Sinn

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3.3 Line Conducted Configuration and Photos

Worst-Case Line-Conducted Emissions and Photographs

FCC Part 15 Subpart C Section §15.247

FCC Part 15 Subpart C Section §15.207						
5	Line-Conducted	12.30	-8	-11	Quasi-Peak	Pass

TEST PERSONNEL:

Tester Signature

Kouma Sinn, Compliance Engineer
Typed/Printed Name

9/16/98
Date

Intertek Testing Services

70 Codman Hill Road Boxborough, MA

Table:5

Company: Electronic Retail System   Model: SN-ACATR-00

Notes: Line-conducted scan

47 CFR SECTION 15.207 Conducted Emissions

Frequency (MHz)	Reading Side A (dBuV)	Reading Side B (dBuV)	Class B Limit (dBuV)	Margin (dB)
8.698	21	21	48	-27
11.73	33	34	48	-14
12.30	37	40	48	-8
12.81	37	35	48	-11
16.37	29	29	48	-19
21.61	27	26	48	-21
29.02	33	31	48	-15

Test Engineer: Kouma Sinn   Test Date: 09-11-1998

program: emi15 v3.0

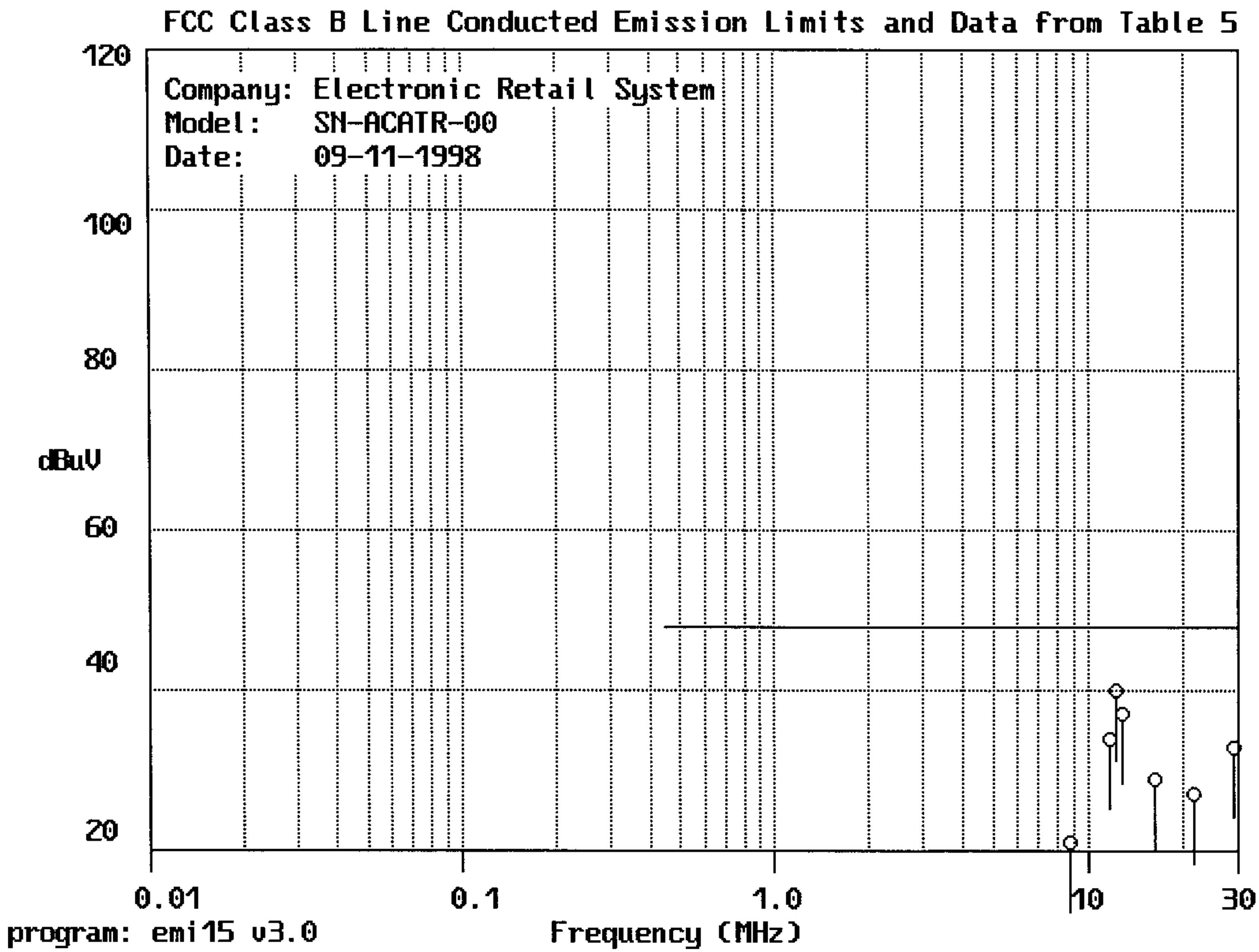

FCC Class B Line Conducted Emission Limits and Data from Table 5
Company: Electronic Retail System
Model: SN-ACATR-00
Date: 09-11-1998
120
100
80
dBuV
60
40
20
0.01
0.1
1.0
10
30
program: emi15 v3.0
Frequency (MHz)

EXHIBIT 4

TECHNICAL SPECIFICATIONS

4.0 Technical Specifications

An updated schematics diagram is attached.

Figure 4.1 Transmitter Schematic Diagram

EXHIBIT 5

MISCELLANEOUS INFORMATION

5.0 Miscellaneous Information

This miscellaneous information includes details of the measurements of output power, channel spacing, number of hopping frequency, measured bandwidth, and calculation of factors such as pulse desensitization and average factor.

5.1 Measurements of Output Power

Measurements Of Output Power

Frequency (MHZ)	Distance (Meters)	Net Reading (dBuv)	Calculated Power (Watts)	Calculated Power (dBm)	Rated Power (dBm)	Limit (Watts)
2407.93	3	125	0.212	23.3	28.5	1.0
2439.85	3	129	0.533	27.3	28.5	1.0
2469.90	3	126	0.267	24.3	28.5	1.0

Output power was measured by measuring the field strength at a low, middle and high transmit frequency. Because there are no RF output ports, the field strength is converted to power using the following formula:

$P = (E * d)^2 / (30 * G)$

P - Power in watts
E - Field Strength in Volts/meter
d - measurement distance in meters
G - numeric gain of the transmit antenna.

For the worst-case field strength the power is calculated as follows:

$P = ((10^{(129/20)} / 1,000,000) * 3)^2 / (30 * 4.47) = 0.533$ watts.

NOTES:
The gain of the transmit antenna is 6.5 dBi, which numerically is expressed as 4.47.
The output power is expressed as peak measurements, without an averaging factor applied.
The resolution bandwidth of the measurement receiver is 1 MHz during power measurements.
Thre video bandwidth of the measurements receiver is 300 Khz during power measurements.

5.2 Channel Spacing

The channel spacing was measured to be 1.000 MHz. The requirement is the separation must be at least the 20 dBc bandwidth of the channel. The 20 dBc bandwidth is 145 Khz. See Plot 5.

5.3 Number of Hopping Frequency

The minimum number of hopping frequencys is 75. The 2400 - 2483.5 MHz bandwidth indicates there is exactly 75 hopping channels. See Plot 4.

5.4 Measured Bandwidth

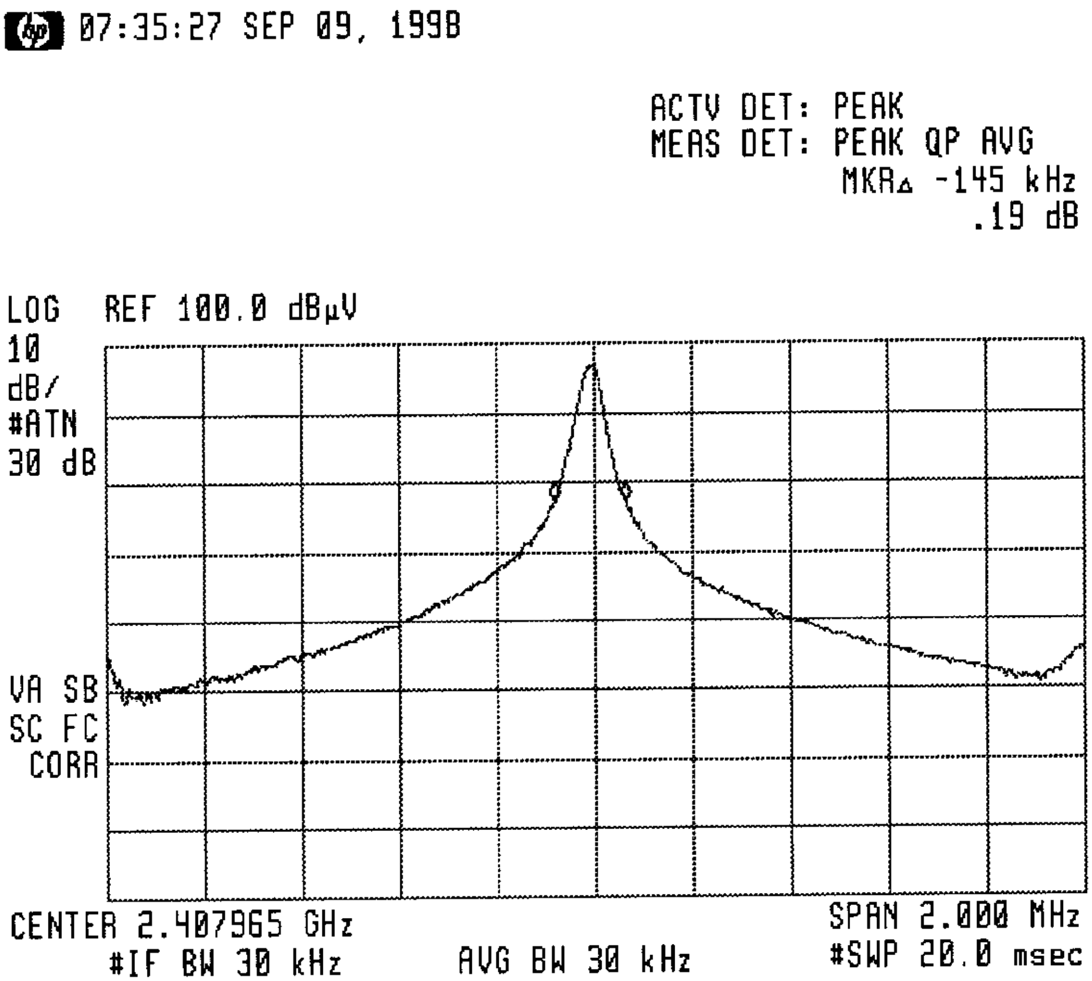
The plots on the following page shows the fundamental emission when modulated with a worst-case bit sequence.

Measurement Of Bandwidth - See Attached Plots 1, 2, 3 and 4

Frequency (MHZ)	Span (MHZ)	RBW (kHz)	Bandwidth (kHz)	Limit (kHz)	Pass/Fail
2400-2483.5	10,836.5	120	74,520	N/A	Pass
2407.97	2.00	30.00	145.00	1000	Pass
2440.00	2.00	30.00	145.00	1000	Pass
2469.96	2.00	30.00	150.00	1000	Pass

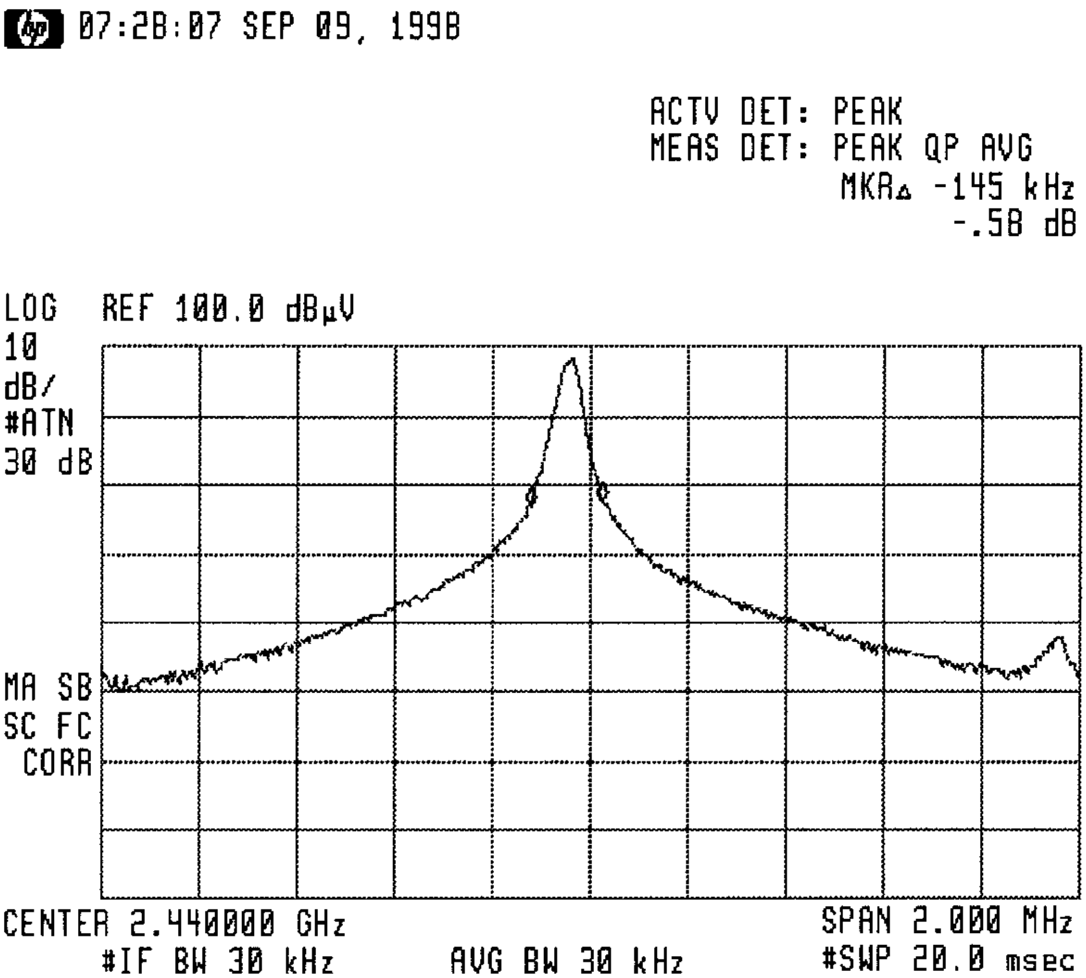
ERS MODEL: ACA Bandwidth Plot

Plot 1



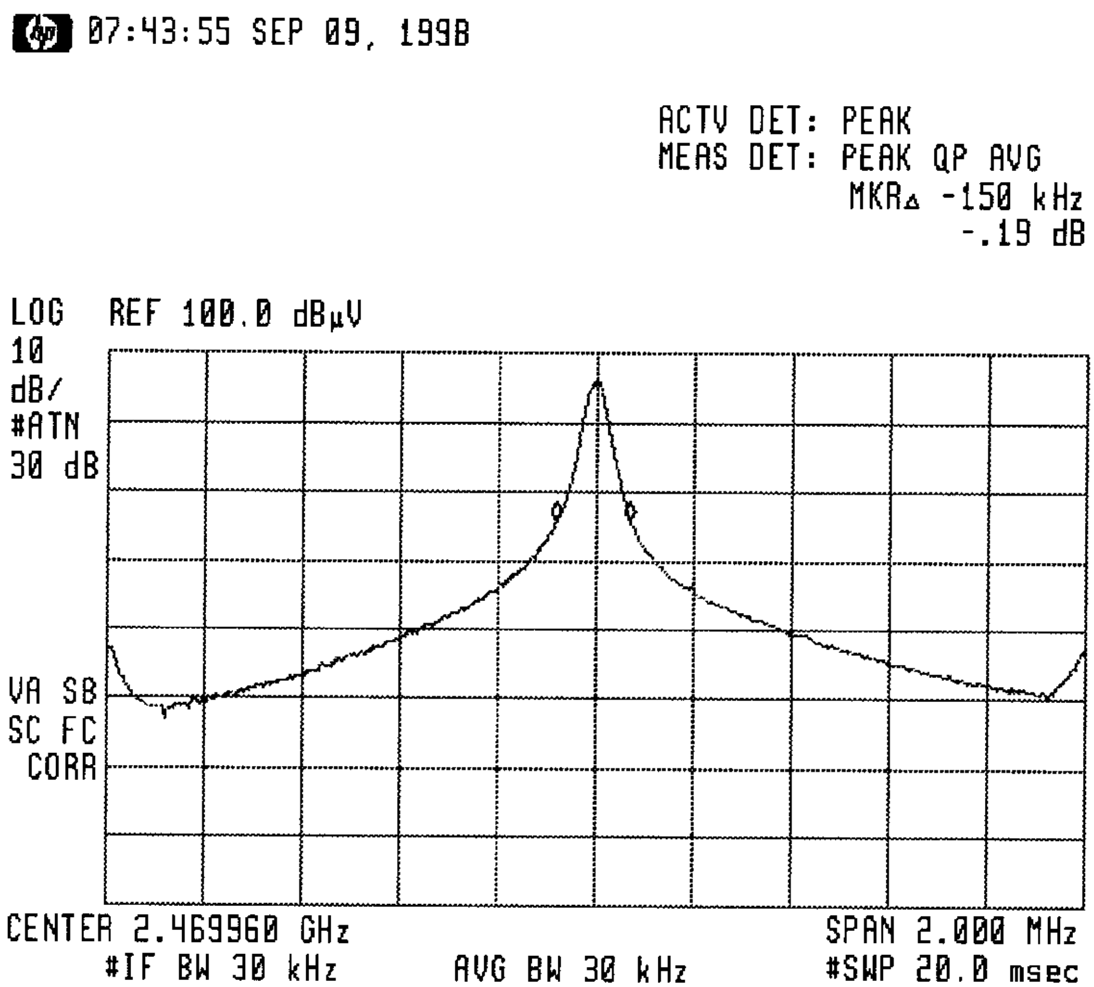
ERS MODEL: ACA Bandwidth Plot

Plot 2



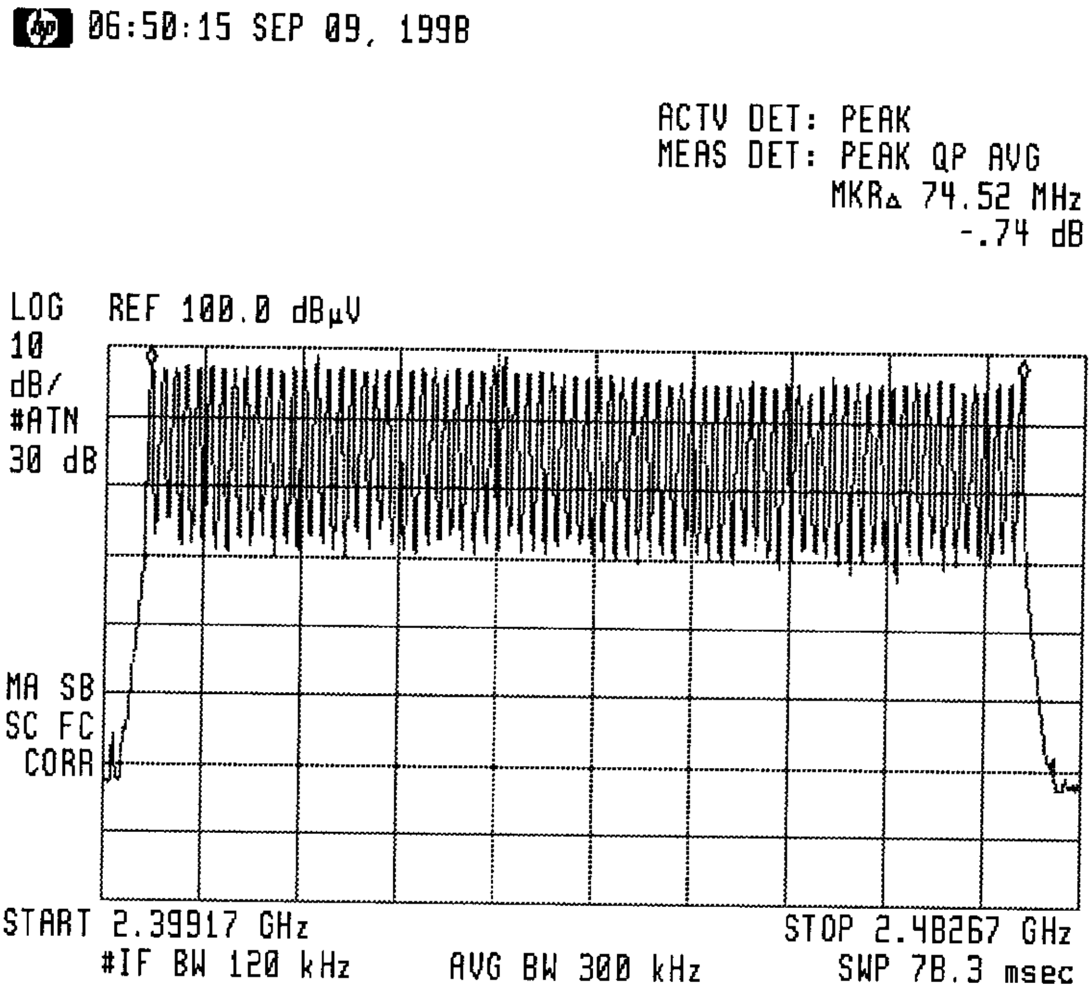
ERS MODEL: ACA Bandwidth Plot

Plot 3



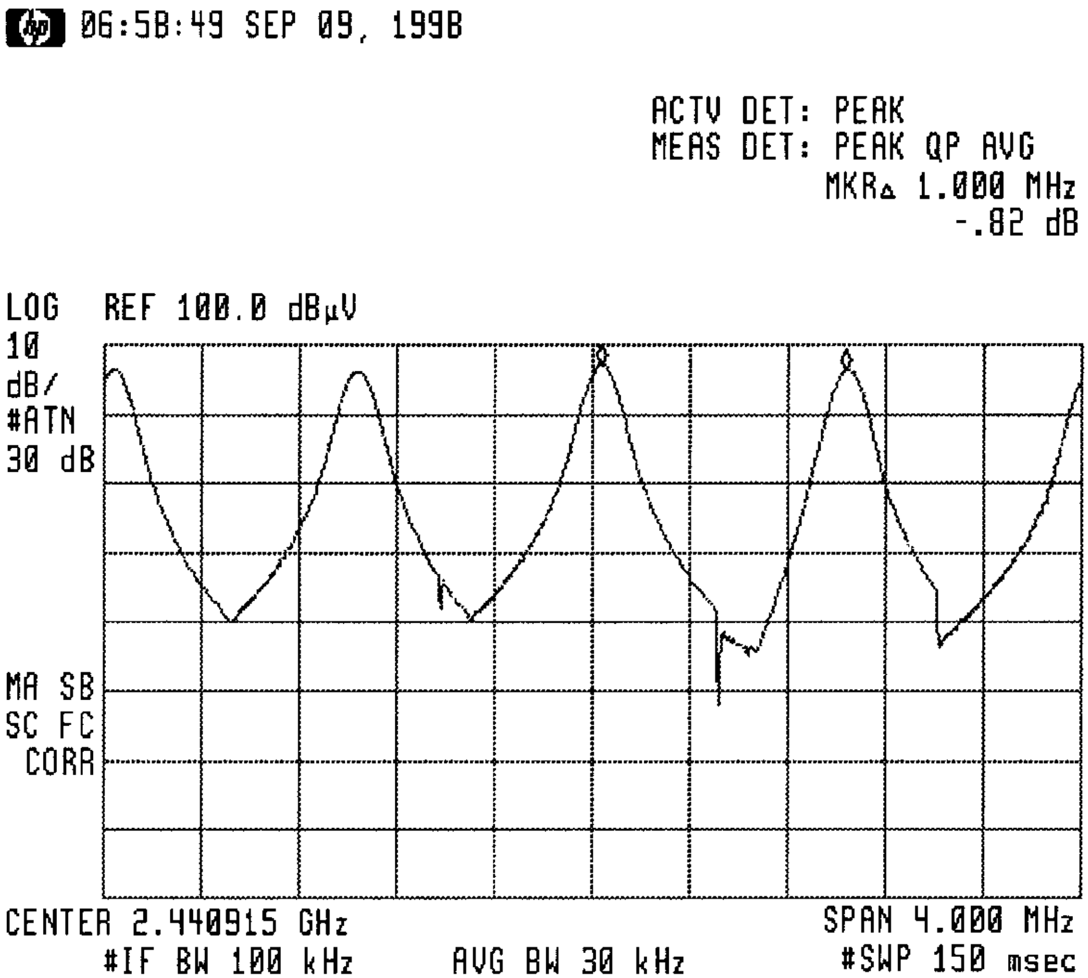
ERS MODEL: ACA Bandwidth and Number of Hopping Frequencies

Plot 4



ERS MODEL: ACA Channel Separation

Plot 5



5.6 Calculation of Average Factor

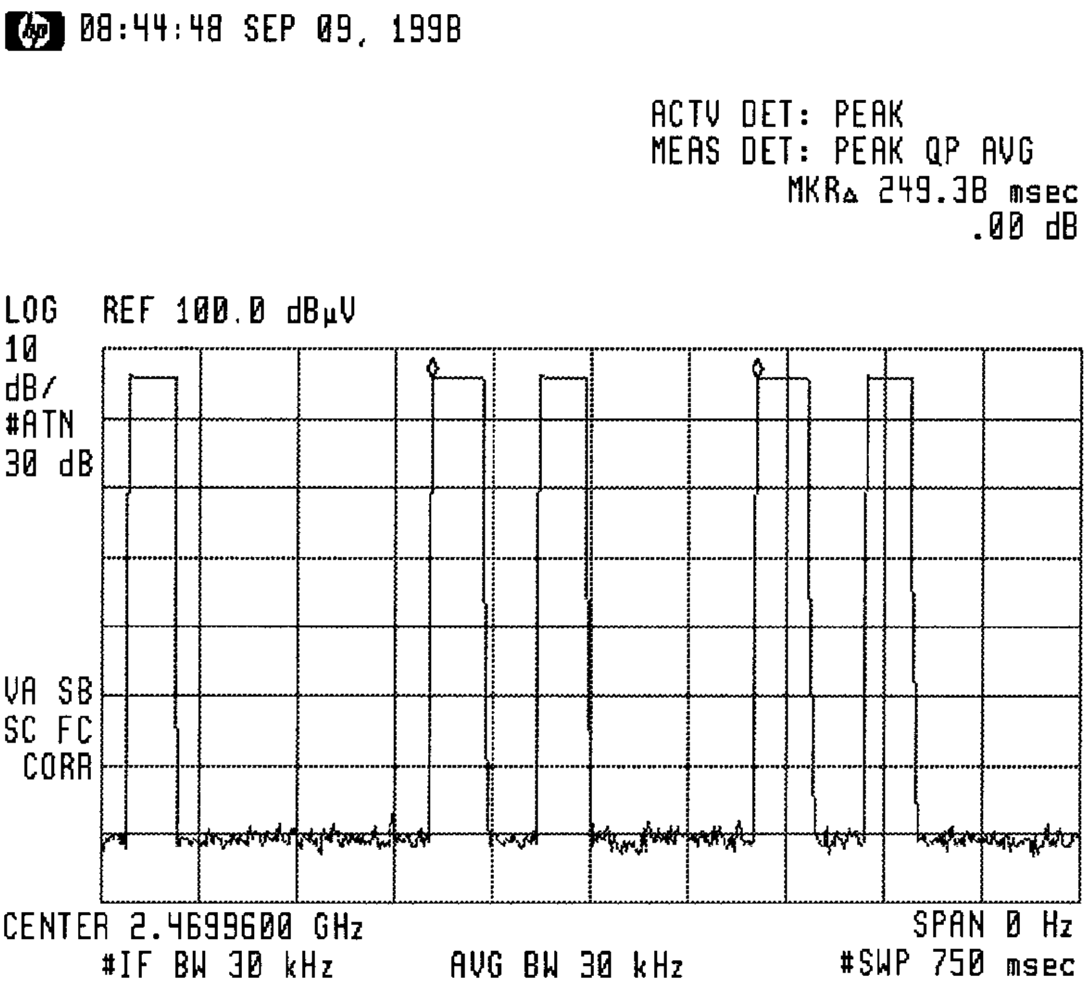
The repetition cycle of the EUT is greater than 100 ms. The averaging factor is determined as follows:

Word Cycle:	100 msec
Effective Period of Word:	56.9 msec
Duty Cycle of Word:	=56.9%
Duty Cycle of a Digital "1":	=100%
Total Duty Cycle: 0.569 * 1.0	=56.9%
Average Factor = 20 Log [0.569] = duty cycle	-4.9 dB

See plots 6, 7, 8 and 9 for measurements used to determine average factor.

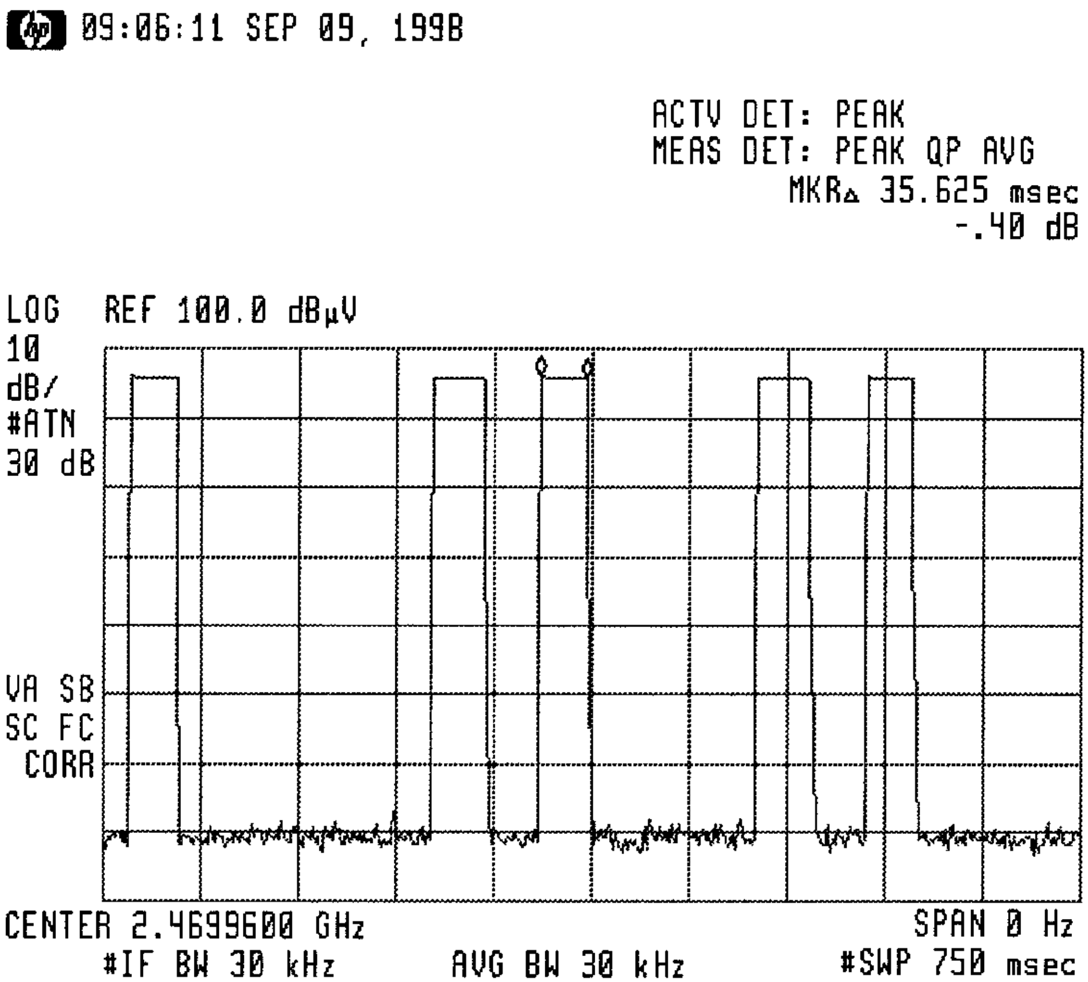
ERS MODEL: ACA Duty Cycle: Measurement of a Word Period

Plot 6

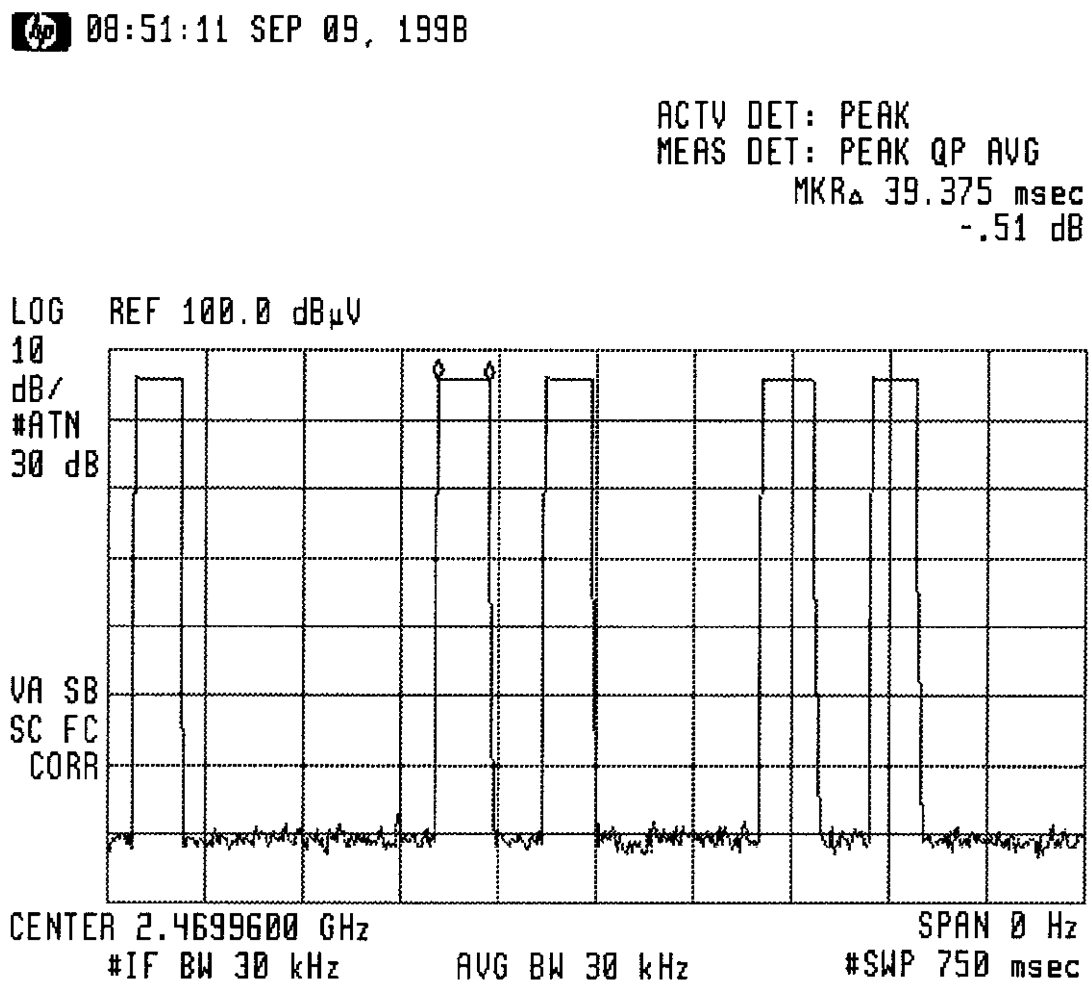


ERS MODEL: ACA Duty Cycle Plots - Duration of a Word

Plot 7



ERS MODEL: ACA Duty Cycle Plot - Duration of a Word
Plot 8



ERS MODEL: ACA Duty Cycle Plot - Time to next cycle.
Plot 9