ITS Intertek Testing Services

Intertek Testing Services NA Inc.
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Acumen, Inc.

Emissions Testing
Performed
on the
Periodic Transmitter
Model: H
FCC Part 15, Subpart C, Section §15.231

Date of Test: September 15, 1998

JOB #J98025340A
KPS/Rbt
ACU5340A.KPS
September 22, 1998
DOT: September 15, 1998
Contact: Mr. George Carrigan

Total No. of Pages Contained in this Report: 29

INTERTEK TESTING SERVICES

TO: Acumen, Inc.
Mr. George Carrigan
FROM: Kouma P. Sinn
DATE: September 15, 1998
JOB #: J98025340A

RE: Emissions Testing Performed On The Periodic Transmitter, Model: H

On September 15, 1998 we tested the Model: H to determine if it was in compliance with the FCC Part 15 requirements, Subpart C, Section §15.231. A prototype version of the sample was received on September 15, 1998 was in good condition. We found that the unit met the Part 15 requirements when tested as received.

Fundamental output power is regulated under The fundamental output power and harmonic emission limits are outlined in paragraph (b) of this section. The device is designed to poll at intervals not greater than once per hour with a transmit duration not exeeding 1 second. The fundamental field strength allowed at a distance of 3 meters was calculated to be 7943 μV/m. Harmonic emission limits at frequencies outside of the forbidden bands of §15.205 must be lower than the limit of 794 μV/m.

Table 1 shows the unit's radiated emissions results. Note that no radiated emissions were detected above the measuring equipment noise floor, which is at least 6 dB below the applicable limit.

No line-conducted emissions were performed as the unit is battery powered.

Harmonic emissions which lie in the forbidden bands of §15.205 are required to meet the General Radiated Emission Limits of §15.209.

The maximum level of the fundamental signal at 349.845 MHz was 2239 μV/m, which is 11 dB below the FCC limit. The worst-case harmonic emission was 25 dB below the FCC limit. Please note that an average factor was applied to the level of the fundamental emission for comparison to the FCC limits. A duty cycle of 27.9% was measured, and the corresponding average factor of 11 dB was determined.

Please note that this calculation and corresponding plots are included in the Average Factor section within this report. Care was taken to avoid pulse desensitization of the measurement equipment. Please see Table 2 for a summary of the emission results.

The maximum occupied bandwidth is determined by the operating frequency. The bandwidth must be less than 0.25% of the operating frequency. For a device operating at 349.845 MHz, the bandwidth limit of 875 kHz applies. The measured bandwidth of this signal was 110 kHz, which is significantly less than the FCC requirement. A bandwidth plot can be shown in the Bandwidth section of the report.

Summary

In summary, this report confirms that the Model: H is compliant with the FCC Part 15, Subpart C, Section §15.231 requirements when production units conform with the initial sample. Please address all questions and comments concerning this report to Andrew J. Bellezza, ITE Engineering Team Leader.

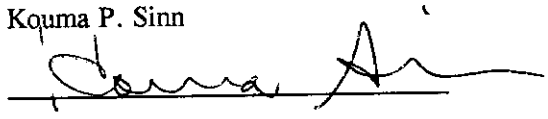
LABORATORY MEASUREMENTS

Pursuant To
Part 15, Subpart C
For
Intentional Radiators

Manufacturer:	Acumen, Inc. 101A Executive Dr., Suite 200 Sterling, VA 20166
Attention:	Mr. George Carrigan
Model Number:	H
Serial Number:	Not Labelled

Certification

I attest to the accuracy of this report:

Engineer:	Kouma P. Sinn
Signature:	
Title:	Compliance Engineer
Date:	9/30/98

Introduction

The following is a description of the test procedure used by Intertek Testing Services in the measurements of transmitters operating under Part 15, Subpart C, General Requirements.

A. **Test Set-Up**: The test set-up and procedures described below are designed to meet the requirements of ANSI C63.4 (1992).

1. The test site is a wooden structure with a groundplane. The site has attenuation characteristics which meet the requirements of ANSI C63.4 (1992). Information on the site has been filed with the FCC as required by Rule §2.948. The address of the site is 593 Massachusetts Avenue, Boxborough, MA 01719.

2. Power to the site is nominal line voltage of 117 V_{AC} and 230 V_{AC}, 60 Hz.

3. The equipment under test (EUT) is placed on a wooden turntable which is four feet in diameter and approximately one meter in height above the groundplane. During the radiated emissions test, the turntable is rotated and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The antenna height and polarization are also varied during the search for maximum signal levels. The height of the antenna is varied from one meter to four meters.

4. Detector function for radiated emissions is in peal or quasi-peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings according to the following formula:

Averaging Factor in dB = 20 LOG (duty cycle)

A. **Test Set Up (cont'd)**

The time period over which the duty cycle is measured is 100 msec. The worst-case (highest percentage on) duty cycle is used and described specifically in the data section. The duty cycle is measured by placing the spectrum analyzer in zero scan (receiver mode) and linear mode at maximum bandwidth (3 MHz at 3 dB down) and viewing the resulting time domain signal output from the analyzer on a Tektronix 465 Oscilloscope. The oscilloscope is used because of its superior time base and triggering facilities. A drawing or photograph of the worst-case duty cycle as detected in this manner is included as an attached page.

5. Antennas used below 1000 MHz was Emco Biconolog Antenna, Roberts B-1000 Biconical Antennas. For measurements between 1000 MHz and 18000 MHz, where required, an Emco Double-Ridge Guide Horn Antenna was used. Alternately, for measurements above 1 GHz, an EMCO M/N 3115 Horn Antenna may have been used.

6. The field strength measuring equipment used included:

Spectrum Analyzer:	Hewlett Packard 8593A
Preamplifier:	CDI P-950
LISN:	Solar Electronics

Additional equipment or comments:

Equipment is calibrated at frequent intervals.

A. **Test Set Up (cont'd)**

7. The frequency range to be scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency, or 40 GHz, whichever is lower. For line-conducted emissions, the range scanned is 450 kHz to 30 MHz.

8. The EUT is warmed up for 15 minutes prior to the test. AC power to the unit is varied from 85% to 115% nominal and variation in the fundamental emission field strength is recorded. If battery powered, a new battery is used.

9. Conducted measurements were made as described in ANSI C63.4 (1992). An IF bandwidth of 10 kHz is used, and peak or quasi-peak detection is employed.

10. The IF bandwidth used for measurement of radiated signal strength was 100 kHz or greater below 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application No. 150-2. A discussion of whether pulse desensitivity is applicable to this unit is included in this report. Above 1000 MHz, a bandwidth of 1 MHz is generally used.

11. Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the forbidden bands and above 1 GHz (where no preamplifier is used), signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, but those measurements taken at a closer distance are so marked.

A. **Test Set Up (cont'd)**

12. For measurements made in the 9 kHz to 30 MHz range, a distance of 30 meters was used unless a good signal-to-noise ratio could not be obtained. In that case, a closer distance was used and that distance is so marked in the data table.

B. This transmitter was found to meet the requirements of Part 15, Subpart C, Section §15.209, General Requirements.

1. The emissions of the transmitter will not exceed the levels defined in §15.209(b).
2. Line-conducted emissions will be below the requirements of Rule §15.207.
3. The device does not operate in any of the restricted bands listed in §15.205(a).

C. **Miscellaneous Information**

1.	**Manufacturer:**	Acumen, Inc.
2.	**Grantee:**	Acumen, Inc.
3.	**Model No.:**	H
4.	**Trade Name:**	Acumen, Inc.
5.	**Serial No.:**	Not Labelled
6.	**Date of Test:**	September 15, 1998
7.	**Frequencies to which device can be tuned:**	None
8.	**Can customer tune device?**	No

9. **Detailed description of operation pursuant to §15.231**

For simplicity of testing, the unit was wired to transmit continuously.

10. **Applicable emissions limits:** §15.209, §15.205, §15.231

11. **Additional Comments:**

The transmitter was configured for testing in a typical fashion (as a customer would normally use it). The device was mounted to a cardboard box, which enabled the engineer to maximize emissions through its placement in the three orthogonal axes.

The device was powered from three new, fully charged 1.5V battery.

The worst case bit sequence was applied during test.

The EUT was mounted on a non-conductive box to allow the engineer to manipulate the EUT in the three orthogonal axes.

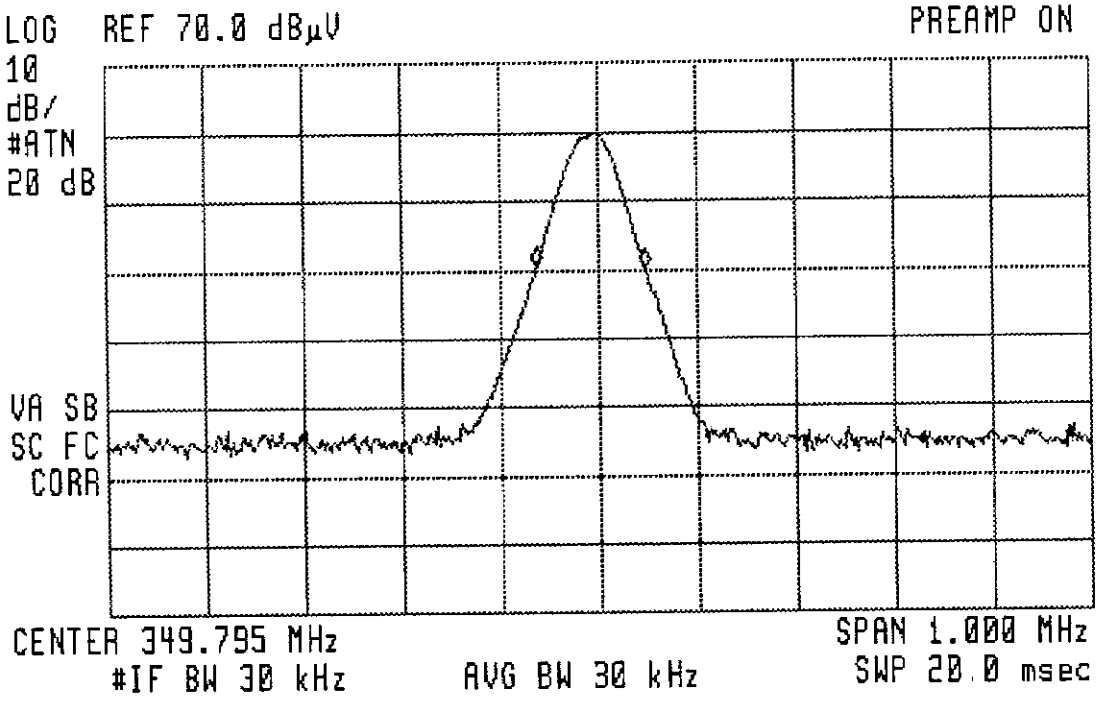
Measurements of Bandwidth

The plot on the following page shows the fundamental emission when modulated with a worst-case bit sequence. From the plot, the bandwidth is observed to be 110 kHz at 20 dBc. The bandwidth limit is 875 kHz. The unit meets the FCC bandwidth requirements. Please note the following:

Frequency:	349.795 MHz
Span:	1 MHz
RBW:	30 kHz
Bandwidth:	110 kHz

08:01:30 SEP 18, 1998

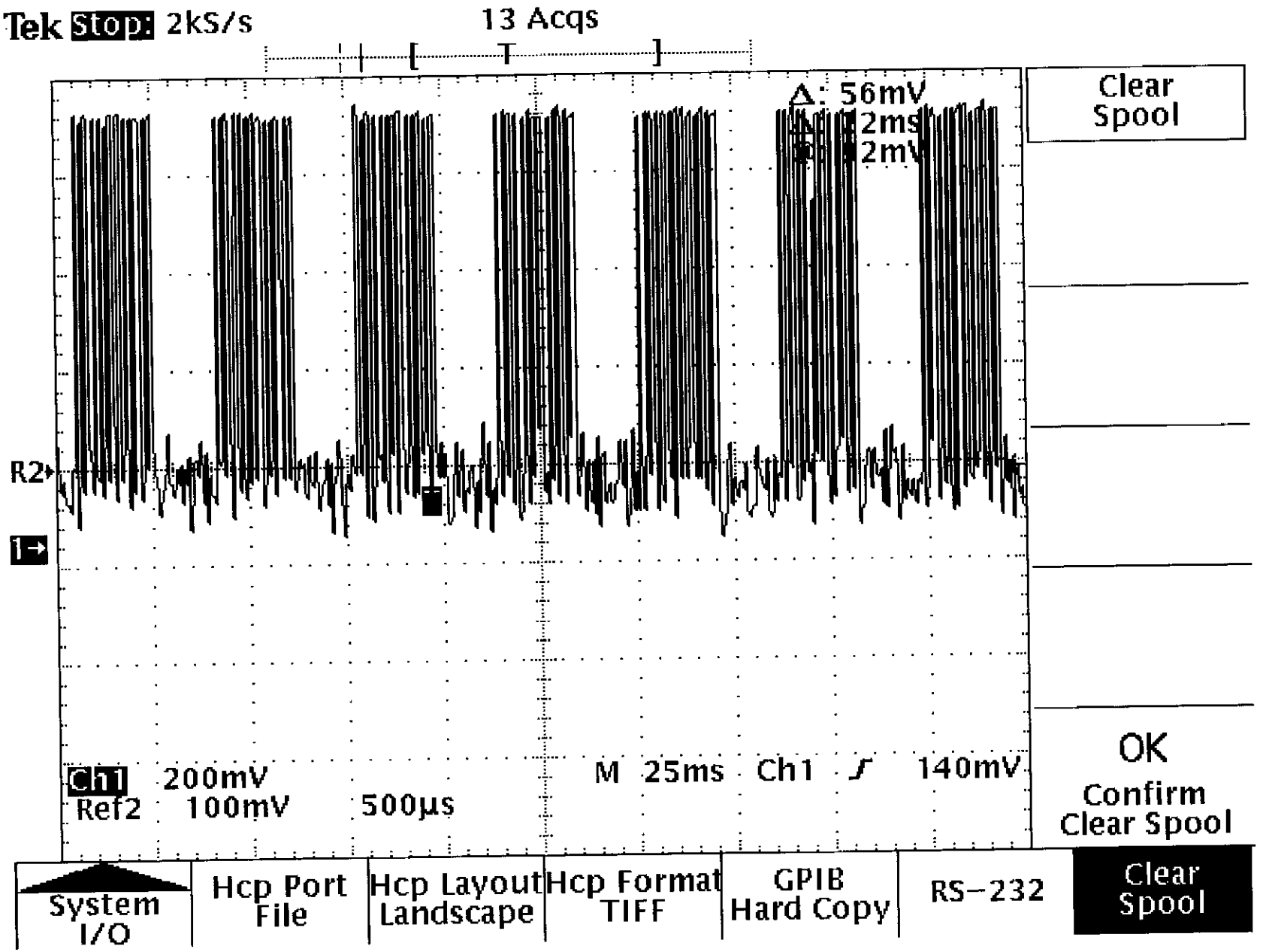
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKRΔ -110 kHz
.26 dB

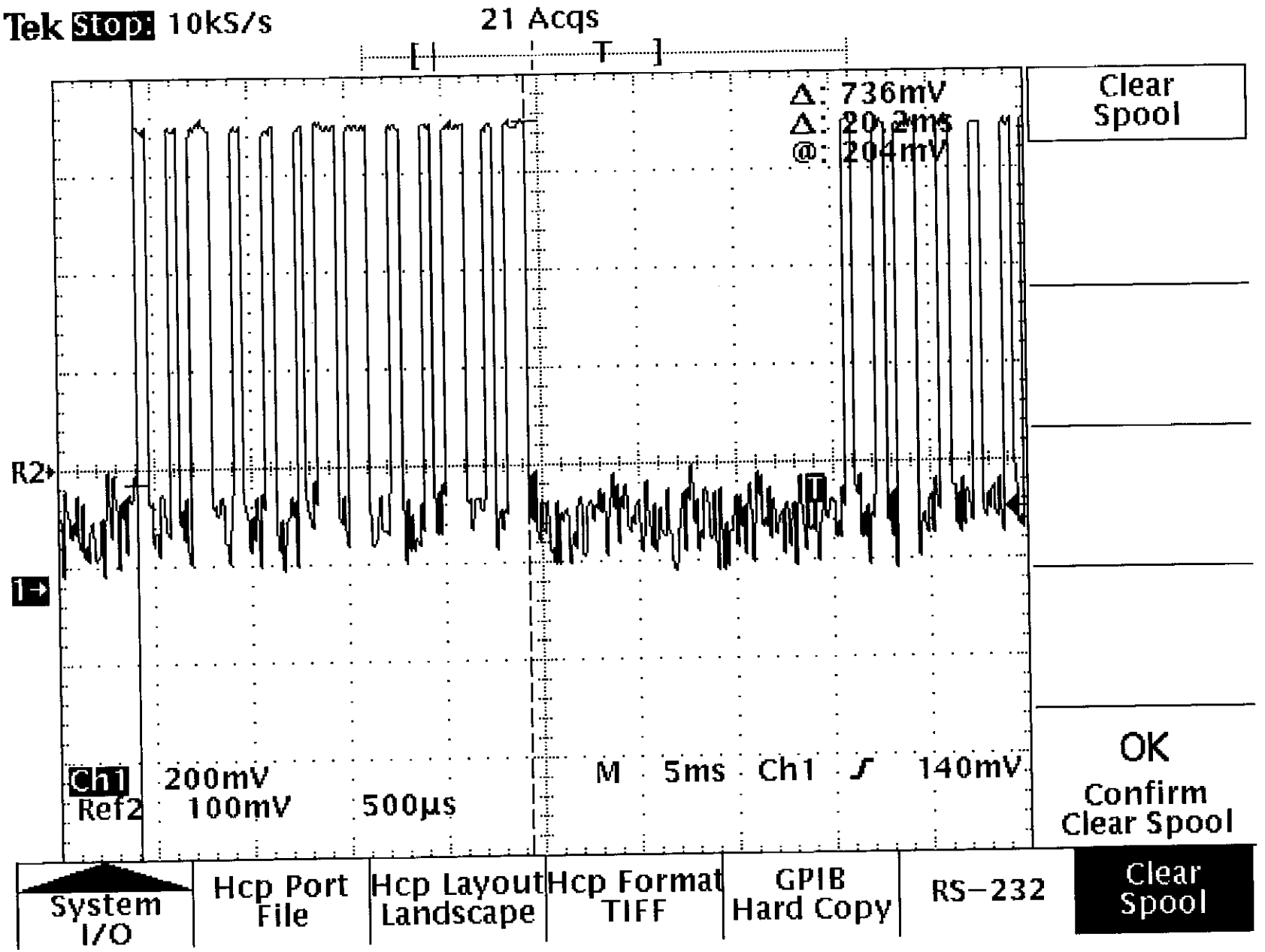


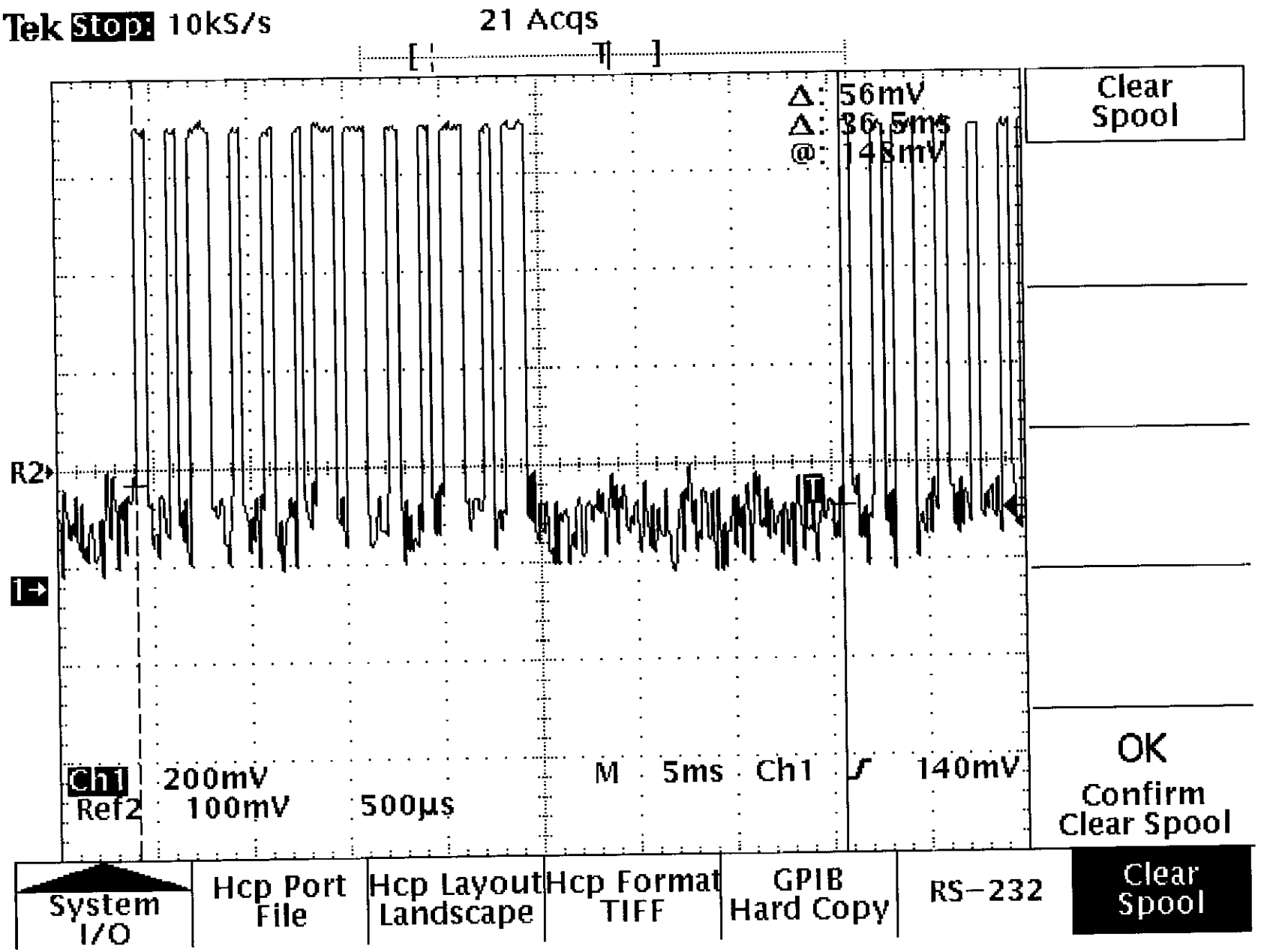
Derivation of Averaging Factor

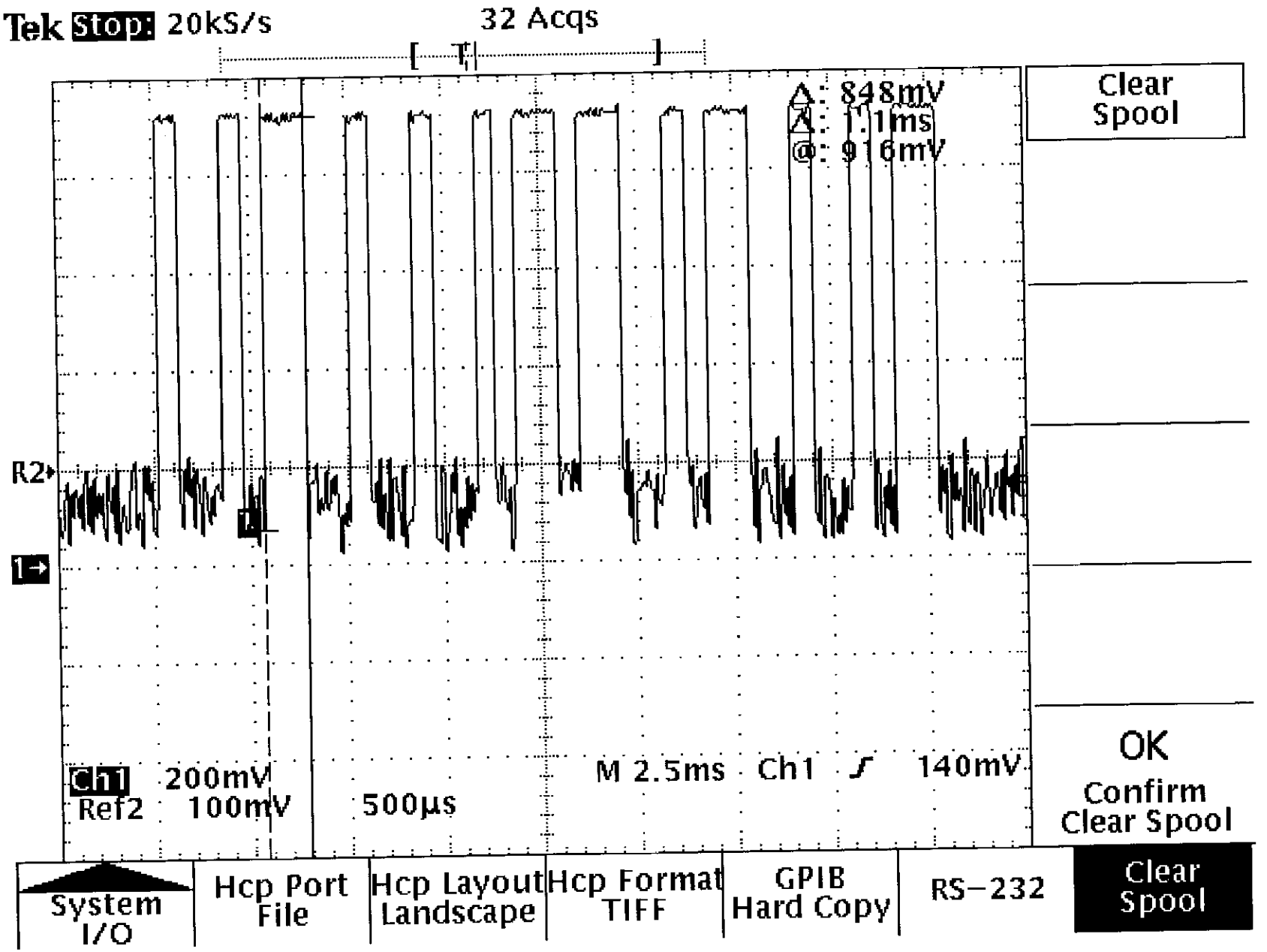
The repetition cycle of the EUT is less/greater than 100 ms. The averaging factor is determined as follows:

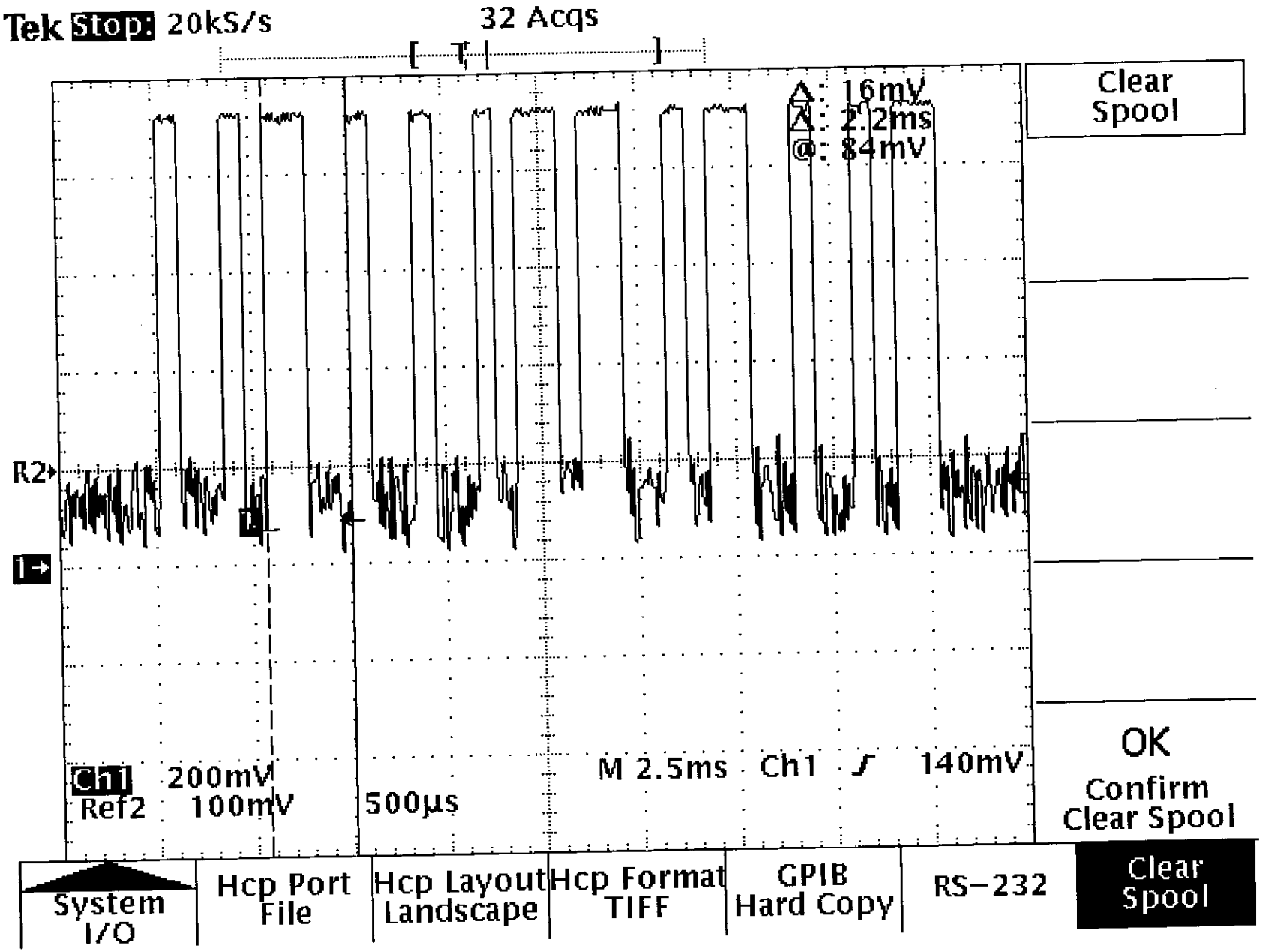
Word Cycle Period:	36.5 msec
Effective Period of Word Ontime:	20.2 msec
Duty Cycle of Word:	55.3%
Period of Single Bit:	2.2 msec
Effective Period of Digital "1":	1.1 msec
Duty cycle of a Digital "1":	50%
Total Duty Cycle:	(.558) (.5) = 27.9%
Average Factor = 20 Log (.553) (.5)=	11 dB


Tek Stop: 2kS/s
13 Acqs
Δ: 56mV
2ms
2mV
Clear Spool
R2
1
Ch1 200mV
Ref2 100mV
500µs
M 25ms Ch1 ∫ 140mV
OK
Confirm Clear Spool
System I/O
Hcp Port File
Hcp Layout Landscape
Hcp Format TIFF
GPIB Hard Copy
RS-232
Clear Spool


Tek Stop: 10kS/s
21 Acqs
Δ: 736mV
Δ: 20.2ms
@: 204mV
Clear Spool
R2
1
Ch1 200mV
Ref2 100mV
500µs
M 5ms Ch1 ∫ 140mV
OK
Confirm Clear Spool
System I/O
Hcp Port File
Hcp Layout Landscape
Hcp Format TIFF
GPIB Hard Copy
RS-232
Clear Spool


Tek Stop: 10kS/s
21 Acqs
Δ: 56mV
Δ: 36.5ms
@: 148mV
Clear Spool
R2
1
Ch1 200mV
Ref2 100mV
500µs
M 5ms Ch1 140mV
OK
Confirm Clear Spool
System I/O
Hcp Port File
Hcp Layout Landscape
Hcp Format TIFF
GPIB Hard Copy
RS-232
Clear Spool


Tek Stop: 20kS/s
32 Acqs
Δ: 848mV
Δ: 1.1ms
@: 916mV
Clear Spool
R2
1
Ch1 200mV
Ref2 100mV
500µs
M 2.5ms Ch1 ∫ 140mV
OK
Confirm Clear Spool
System I/O
Hcp Port File
Hcp Layout Landscape
Hcp Format TIFF
GPIB Hard Copy
RS-232
Clear Spool


Tek Stop: 20kS/s
32 Acqs
Δ: 16mV
Δ: 2.2ms
@: 84mV
Clear Spool
R2
1
Ch1 200mV
Ref2 100mV
500µs
M 2.5ms Ch1 ∫ 140mV
OK
Confirm Clear Spool
System I/O
Hcp Port File
Hcp Layout Landscape
Hcp Format TIFF
GPIB Hard Copy
RS-232
Clear Spool

Configuration Information

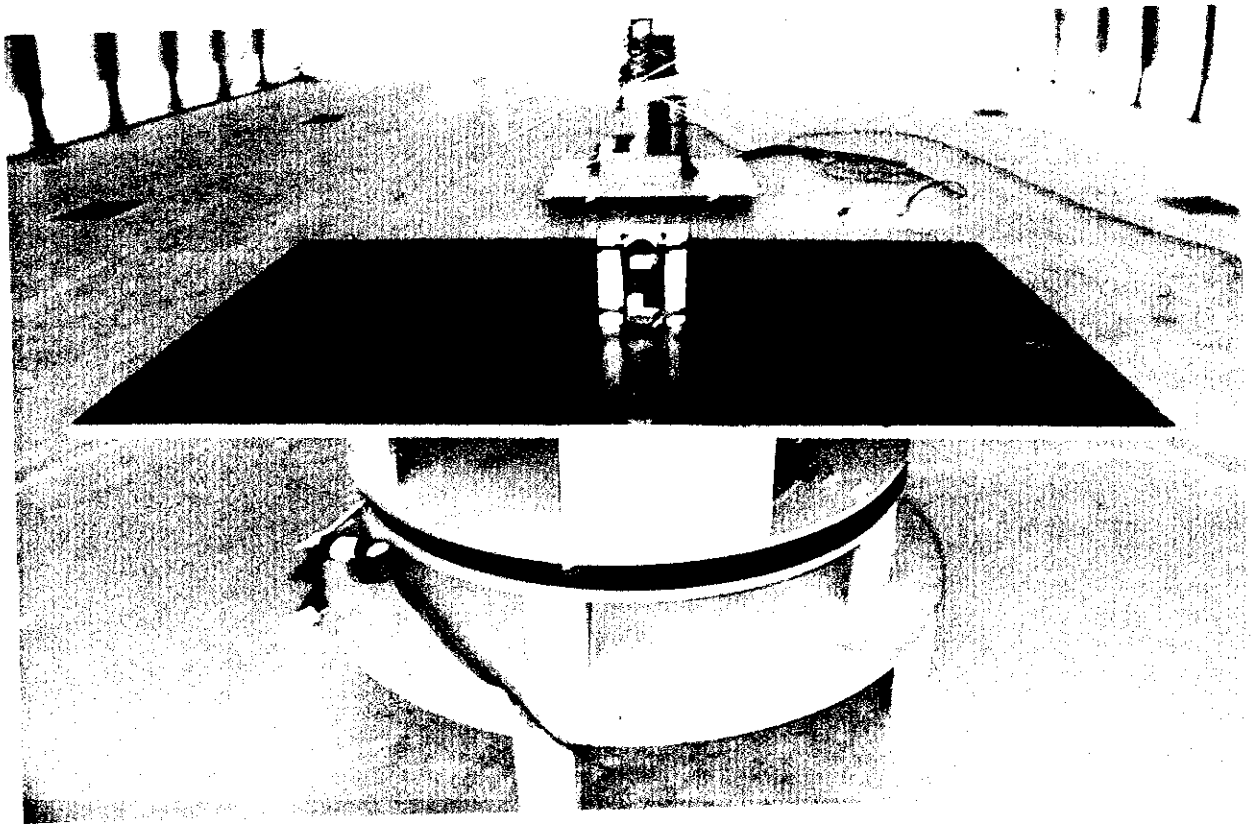
Equipment Under Test:	Periodic Transmitter
Model:	H
Serial No.:	Not Labelled
FCC Identifier:	Not Labelled
Support Equipment:	Standalone

Configuration Photographs

Worst-Case Radiated Emissions

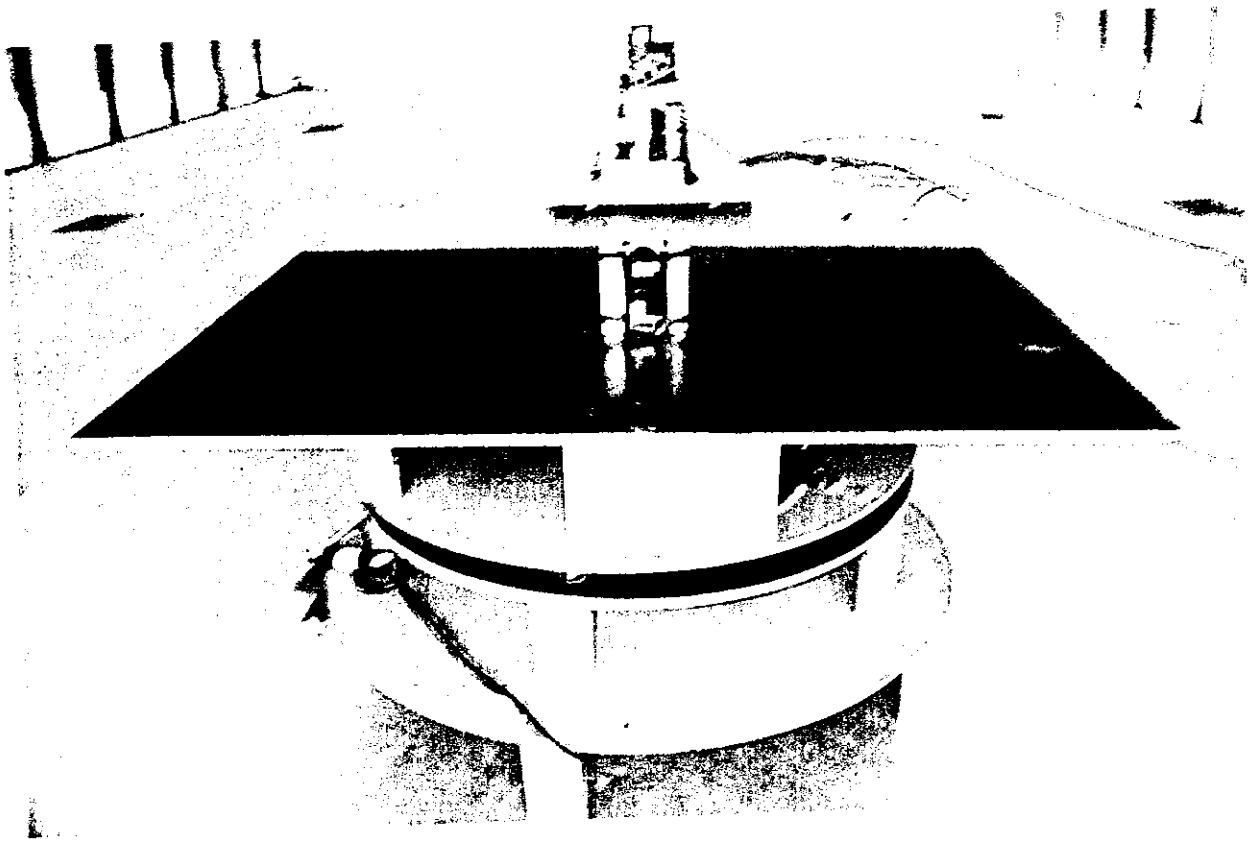
Company:	Acumen, Inc.	Model:	H
Date:	September 15 and 16, 1998	Engineer:	Kouma Sinn
Notes:			

Worst-Case Radiated Emissions Configuration



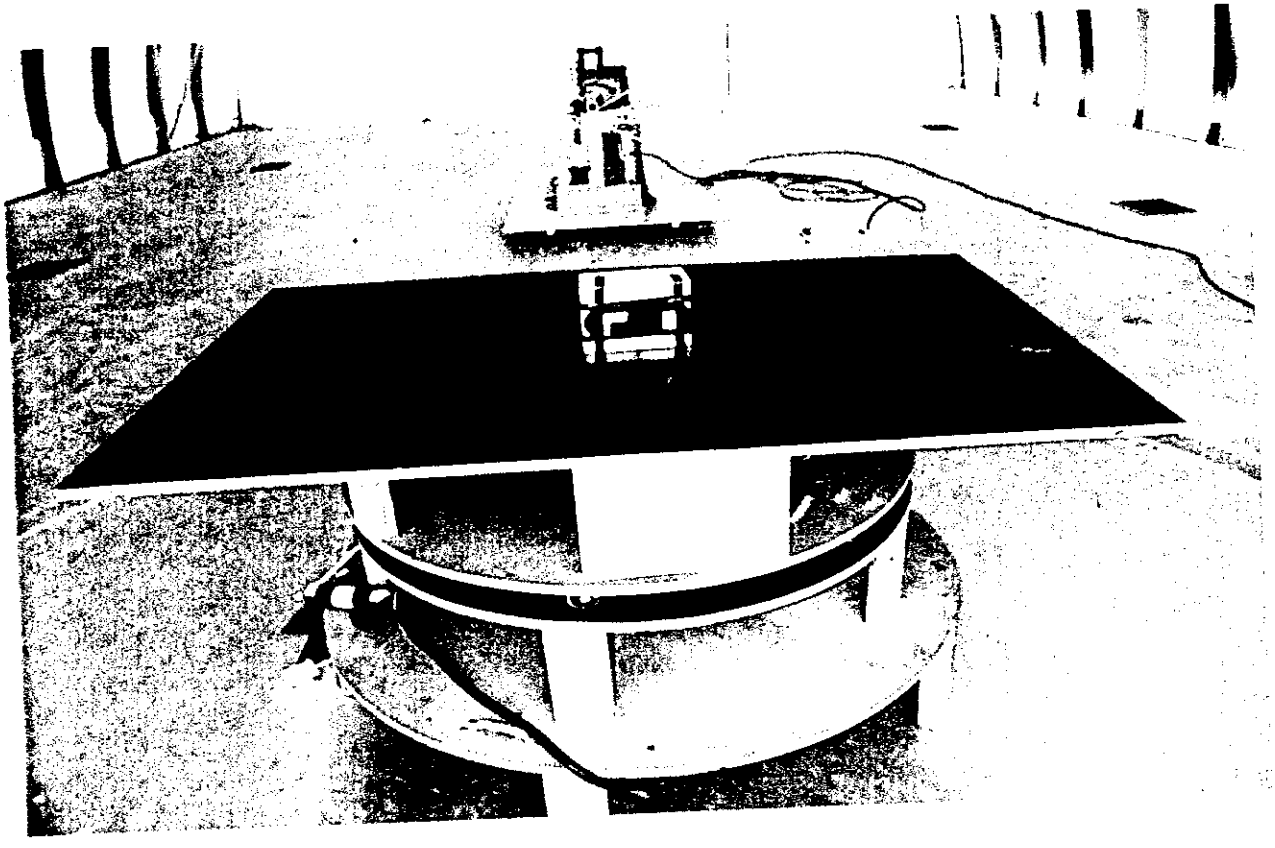
Company:	Acumen, Inc.	Model:	H
Date:	September 15 and 16, 1998	Engineer:	Kouma Sinn
Notes:			

Worst-Case Radiated Emissions Configuration



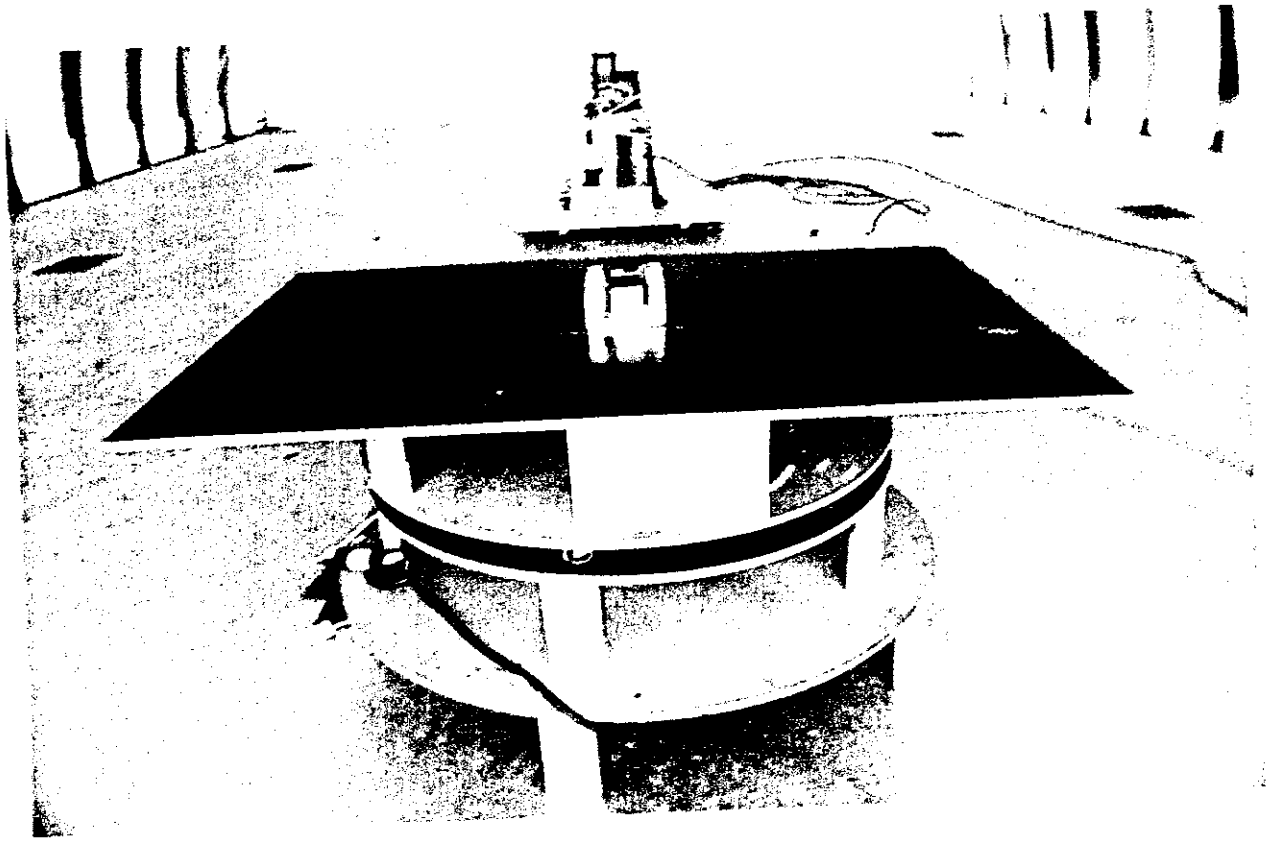
Company:	Acumen, Inc.	Model:	H
Date:	September 15 and 16, 1998	Engineer:	Kouma Sinn
Notes:			

Worst-Case Radiated Emissions Configuration



Company:	Acumen, Inc.	Model:	H
Date:	September 15 and 16, 1998	Engineer:	Kouma Sinn
Notes:			

Worst-Case Radiated Emissions Configuration



The following equipment was used to make measurements for emissions testing (the equipment abbreviation corresponds to a measuring device on the following calibration list):

LISN7

HP3

Emco Horn Antenna, M/N: 3115, S/N: 9610-4980

PRE6

LOG3

SCOPE1

EQUIPMENT LIST TABLE 1					
Abbr	Equipment	Manufacturer	Model	Serial	Cal Due
ANT1	BROADBAND ANTENNA	COMPLIANCE DESIGN	B1000	1649, 1650, 1651	16Jun99
ANT4	BROADBAND ANTENNA	COMPLIANCE DESIGN	B1000	3317, 3245, 3352	16Jun99
ANT5	BROADBAND ANTENNA	COMPLIANCE DESIGN	B1000	1670, 1671, 1672	16Jun99
CLMP1	ABSORBING CLAMP	FISCHER CUSTOM	F-201	122	13Jun99
CLMP2	ABSORBING CLAMP	FISCHER CUSTOM	F-201	297	16Jan99
DIP1	TUNED DIPOLE SET	COMPLIANCE DESIGN	A100	402	30Jan99
DIP2	TUNED DIPOLE SET	COMPLIANCE DESIGN	A100	506	16Jun99
DIP3	TUNED DIPOLE SET	COMPLIANCE DESIGN	A100	3947	23Jan99
HORN1	HORN ANTENNA	EMCO	3115	4632	OUT
HORN2	HORN ANTENNA	EMCO	3115	4675	02Sep98
HORN3	HORN ANTENNA	EMCO	3116	2090	11Feb99
HP1	SPECTRUM ANALYZER	HEWLETT PACKARD	8591	3308A01445	05May99
HP2	SPECTRUM ANALYZER	HEWLETT PACKARD	8591	3346A02319	20Jul99
HP3	SPECTRUM ANALYZER	HEWLETT PACKARD	8593A	3009A00659	30Apr99
LISN1	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	871083	15Jan99
LISN10	LISN	SOLAR ELECTRONICS	9252-50-R-24-BNC	941712	15June99
LISN11	LISN	SOLAR ELECTRONICS	9252-50-R-24-BNC	941713	15June99
LISN12	LISN	SOLAR ELECTRONICS	9252-50-R-24-BNC	941714	15Jun99
LISN13	LISN	SOLAR ELECTRONICS	9252-50-R-24-BNC	955107	15Jan99
LISN14	LISN	SOLAR ELECTRONICS	6338-5-TS-50-N	871131	27Jan99
LISN15	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	865575	3/31/99
LISN2	LISN	SOLAR ELECTRONICS	6338-5-TS-50-N	871132	27Jan99
LISN3	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	8379114	14Jan99
LISN4	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	837929	15Jan99
LISN5	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	934610	15Jun99
LISN6	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	934611	15Jun99
LISN7	LISN	SOLAR ELECTRONICS	8012-50-R-24-BNC	934612	15Jun99
LISN8	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	871047	10Aug99
LISN8	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	871055	10Aug99

EQUIPMENT LIST TABLE 2					
Abbr	Equipment	Manufacturer	Model	Serial	Cal Due
LISN8	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	883147	10Aug99
LISN8	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	883151	10Aug99
LISN9	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	953947	14Jan99
LISN9	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	953948	14Jan99
LISN9	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	953949	14Jan99
LISN9	LISN	SOLAR ELECTRONICS	8028-50-TS-24-BNC	953950	14Jan99
LOG1	BICONOLOG ANTENNA	EMCO	3142	1116	13Jan99
LOG2	BICONOLOG ANTENNA	EMCO	3142	1223	06Dec98
LOG3	BICONOLOG ANTENNA	EMCO	3142	1224	06Dec98
LOG4	BICONOLOG ANTENNA	EMCO	3142	1225	06Dec98
LOOP1	LOOP ANTENNA	EMPIRE DEVICES	LG105	61	17Jan99
LOOP2	LOOP ANTENNA	EMPIRE DEVICES	LP105	905	17Jan99
LOOP3	LOOP ANTENNA	EMCO	6509	9612-1403	OUT
PRB1	LINE PROBE	SOLAR ELECTRONICS	8614-1	932725	15Jun99
PRB2	LINE PROBE	SOLAR ELECTRONICS	8614-1	932731	10Aug99
PRE1	PREAMPLIFIER	COMPLIANCE DESIGN	P950	1648	18May99
PRE2	PREAMPLIFIER	COMPLIANCE DESIGN	P950	5107	18May99
PRE3	PREAMPLIFIER	COMPLIANCE DESIGN	P950	1828	18May99
PRE4	PREAMPLIFIER	COMPLIANCE DESIGN	P950	1844	18May99
PRE5	PREAMPLIFIER	COMPLIANCE DESIGN	P950	PROTO1	18May99
PRE6	PREAMPLIFIER	HEWLETT PACKARD	8447D	1937A03354	18May99
PRE7	PREAMPLIFIER	HEWLETT PACKARD	8447D	2944A08718	18May99
PRE8	PREAMPLIFIER	MITEQ	NSP4000-NF	507145	25Sep98
REC1	RECEIVER	HEWLETT PACKARD	8542	3520A00125	06Nov98
REC1	RF FILTER	HEWLETT PACKARD	85420	3427A00126	06Nov98
REC2	RECEIVER	HEWLETT PACKARD	85422	3625A00188	04Jan99
REC2	RF FILTER	HEWLETT PACKARD	8542	3427A00177	04Jan99
REC3	RECEIVER	HEWLETT PACKARD	8546A	3325A00160	OUT
REC3	RECEIVER	HEWLETT PACKARD	8546A	3330A00158	OUT
SCOPE1	OSCILLOSCOPE	TEKTRONIX	TDS380	B011379	07Oct98
SIG1	SIGNAL GENERATOR	HEWLETT PACKARD	8648B	3537A01040	10Apr99
TEK1	SPECTRUM ANALYZER	TEKTRONIX	2784	B010153	30Apr99

Table:1

Model: H

Company: Acumen, Inc.

Notes: Radiated scan at 3 meters (30-1000 MHz)

FCC Class B Radiated Emissions

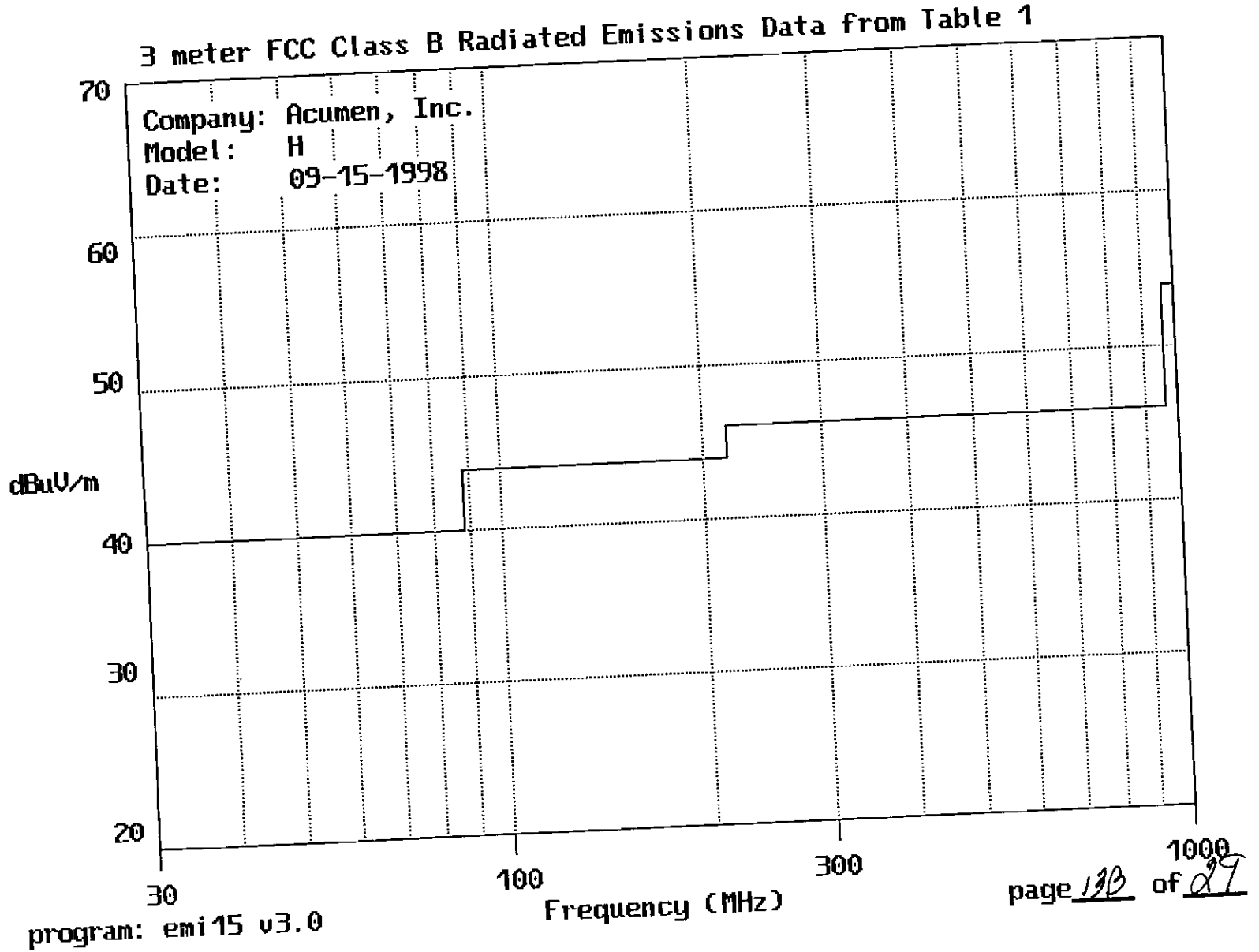
Antenna Polarity	Frequency (MHz)	Reading (dBuV)	Antenna Factor (dB)	Net at 3 meter (dBuV/m)	Class B Limit (dBuV/m)	Margin (dB)

No Radiated emissions were detected above the measuring equipment noise floor, which is at least 6 dB below the applicable limit.

Test Engineer: Kouma Sinn

Test Date: 09-15-1998

program: emi15 v3.0


3 meter FCC Class B Radiated Emissions Data from Table 1
Company: Acumen, Inc.
Model: H
Date: 09-15-1998
70
60
50
40
30
20
dBuV/m
30
100
300
1000
Frequency (MHz)
program: emi15 v3.0

Intertek Testing Services

Boxborough, MA

COMPANY: Acumen, Inc.
MODEL: H

TABLE: 2
Date of Test: 09-16-1998

NOTES:

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)
349.845	58	0	20	0	-11	0	67	2239	7943	-11
699.635	39	0	33	28	-11	0	33	45	794	-25
1049.540	33	0	29	24	-11	0	27	22	500	-27
1399.480	35	10	29	24	-11	0	19	9	500	-35
1748.000	37	10	30	24	-11	0	22	13	794	-36
2099.230	33	10	33	24	-11	0	21	11	794	-37

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

Test Engineer: Kouma Sinn

program: tx15 v3.1