COMPLIANCE TESTING

OF

STRIKE SENSOR

TRANSMITTER

- TEST REPORT 301245

Tests performed on:
7/25th/2001, 8/8th and 10th/2001

Prepared for:

Sensortronics Industries
120 West Main Street
Campbellsport, WI 53010
(U.S.A)

Table of Contents

DESCRIPTION OF MEASUREMENT FACILITIES

Site on File with the FCC

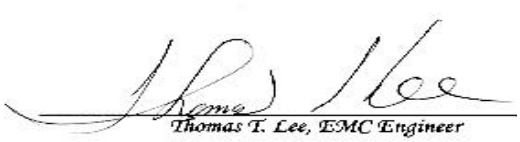
ID Number: 31040/SIT

1300F2

" The site referenced above has been found to comply with the test site criteria found in ANSI C63.4-1992 and 47CFR Section 2.948."

SIGNATURE PAGE

Tests Performed and Prepared By:



August/ 22nd/01

Approved By:

August/ 22nd/01

Kenneth L. Boston, EMC Lab Manager — Date

PE #31926
Registered Professional Engineer
(State of Wisconsin)

THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

L.S. COMPLIANCE, INC.
Cedarburg, WI

for technical competence in the field of

Electrical (EMC) Testing

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC Guide 25-1990 "General Requirements for the Competence of Calibration and Testing Laboratories" (equivalent to relevant requirements of the ISO 9000 series of standards) and any additional program requirements in the identified field of testing.

Presented this 30th day of December, 1998.

SEAL

President
For the Accreditation Council
Certificate Number 1255.01
Valid to January 31, 2001

For tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical (EMC) Scope of Accreditation

1.4 SUMMARY OF TEST REPORT

MANUFACTURER:	Sensortronics Industries
MODEL:	Strike Sensor
SERIAL:	LSR-002
DESCRIPTION:	Low Power Periodic Transmitter
FREQUENCY RANGE:	Transmitter; 433.92MHz

The Strike Sensor transmitter device was found to MEET the radiated emission specification of Title 47 CFR FCC, Part 15, subpart C. for an intentional radiator.

1.5 INTRODUCTION

On July 25th, 2001, August 8th, and 10th, 2001, a series of radiated emissions tests were performed on one sample model of the Strike Sensor transmitter, a small handheld sensor unit, which is designed to transmit a coded signal used in a wireless application. These tests were performed using the test procedures outlined in ANSI C63.4-2000 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.231b for a periodic transmitter. These tests were performed by Thomas T. Lee, of L. S. Compliance, Inc. and witnessed by Kenneth Boston, PE, of L.S.Compliance, Inc.

1.6 PURPOSE

The above mentioned tests were performed in order to determine the compliance of the Strike Sensor transmitter with limits contained in various provisions of Title 47 CFR, FCC Part 15, including:

15.109	15.231b
15.205	15.231c
15.209	

All radiated emissions tests were performed to measure the emissions in the frequency bands described by the above sections, and to determine whether said emissions are below the limits established by the above sections. These tests were performed in accordance with the procedure described in the American National Standard for methods of measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2000). Another document used as reference for the EMI receiver specification was the International Special Committee on Radio Interference (CISPR) number 16-1 (1993).

1.7 RADIATED EMISSIONS TEST SETUP

The test sample was operated within the 3 meter Semi-Anechoic, FCC listed chamber located at L.S. Compliance in Cedarburg, WI. The sample was placed on an 80cm high wooden pedestal, which was centered on the flush-mounted 2m diameter metal turntable. The test sample was operated on its own [new] internal battery. The battery voltage at the beginning of the tests was measured to be 9 volts. The test sample was configured to run in a continuous transmit mode during the 15.231c and 15.231b measurements.

Please refer to Section 1.11 for pictures of the test setup.

1.8 RADIATED EMISSION TEST PROCEDURE

The fundamental and spurious (harmonic) emissions of the transmitter was tested for compliance to Title 47 CFR, FCC Part 15.231b limits for periodic devices. For the calculations used to determine the limits applicable for the test sample (at their respective operating frequencies) refer to Appendix A. These limits are expressed in decibels (dB) above 1 microvolt per meter (μV/m). The sample was tested from the lowest frequency generated by the transmitter (without going below 9 kHz) to the 10th harmonic of the fundamental frequency generated by the device. The appropriate limits were also observed when the fundamental or spurious signals were located within any of the restricted bands as described in Part 15.205a. These frequencies, and their associated limits, are referenced in Section 1.10. The sample was placed on a nonconductive (wooden) pedestal in the 3 Meter chamber and the antenna mast was placed such that the antenna was 3m from the test object. A biconical antenna or tuned dipole was used to measure emissions from 30 to 300 MHz, a log periodic or tuned dipole was used to measure emissions from 300 to 1000 MHz, and a double ridged waveguide horn was used to measure emissions above 1 GHz. The test object was programmed to operate in continuous transmit, and the resultant signals were maximized by rotating the turntable 360 degrees, and by raising and lowering the antenna between 1 and 4 meters. The test object was also given several different orientations to determine the maximum signal levels, using both horizontal and vertical antenna polarities.

No significant emissions were found aside from the transmitter fundamental and several harmonics. The unit was scanned for emissions while in continuous transmit, over the range 30 to 4500 MHz to establish compliance with Part 15.209 and 15.231.

In addition to measuring the levels of radiated emissions, the occupied bandwidth of the transmitter was measured. In accordance with FCC Part 15.231c, the 20dB bandwidth of the transmitted signal should be within a window of 0.25% of the center carrier frequency. The calculation for this bandwidth can be found in Appendix A, which for this product is 1.085MHz. The resolution bandwidth was set either to 120 kHz or to the closest available filter setting on the HP8546A EMI system that corresponded to 5% of the allowable bandwidth determined in the calculation mentioned above, without going below the resolution bandwidth of 10kHz, as dictated in ANSI C63.4-1992 section 13.1.7.

The sample was activated to transmit in a continuous mode and was placed on a pedestal within the 3 meter semi-anechoic chamber. The transmitted signal was received on a log periodic antenna and fed to the HP8546A EMI System, where the fundamental frequency was displayed, and a plot of the occupied bandwidth was produced. These plots are included in Appendix C.

From the data supplied; and an indicated –20dBc bandwidth of 58.8 kHz at worst case, it can be seen that the test sample does indeed **MEET** the bandwidth requirement established by FCC Part 15.231(c).

1.9 TEST EQUIPMENT UTILIZED FOR RADIATED EMISSIONS TEST

A list of the test equipment and antennas used for the tests can be found in Section 1.13, which includes the calibration information as well as the equipment description. All equipment is calibrated and used according to the user manuals supplied by the manufacturer. All antenna calibrations were performed at a N.I.S.T traceable site, and the resultant correction factors were entered into the Hewlett Packard 8546A EMI receiver software database. The connecting cables used were also measured for loss using a calibrated signal generator and the HP 8546A EMI receiver. The resulting loss factors were entered into the HP 8546A database. This allowed for automatic changes in the antenna correction factor, as well as cable loss or other corrections, to be added to the EMI receiver display while taking measurements. Thus, the resulting data taken from the HP 8546A is an actual reading and can be entered into the database as a corrected meter reading. When a reading is taken using the peak detector, a duty cycle correction factor can be applied for conversion to an average reading. This operation can be used when measuring periodic data transmission, under FCC part 15.231b, and Part 15.35c. The calculation for deriving this duty factor can be found in Appendix A. The resulting average reading was then compared to the appropriate limit in order to determine compliance. The HP 8546A EMI receiver was operated with a bandwidth of 120 kHz when receiving signals below 1 GHz, and with a bandwidth of 1 MHz when receiving signals above 1 GHz, in accordance with CISPR 16. Both the peak and Quasi-peak detector functions were used.

1.10 CONDUCTED EMISSION MEASUREMENTS

This product was operated on its own internal battery power, as opposed to using a power cord, therefore, it was not necessary to perform a test for conducted emissions.

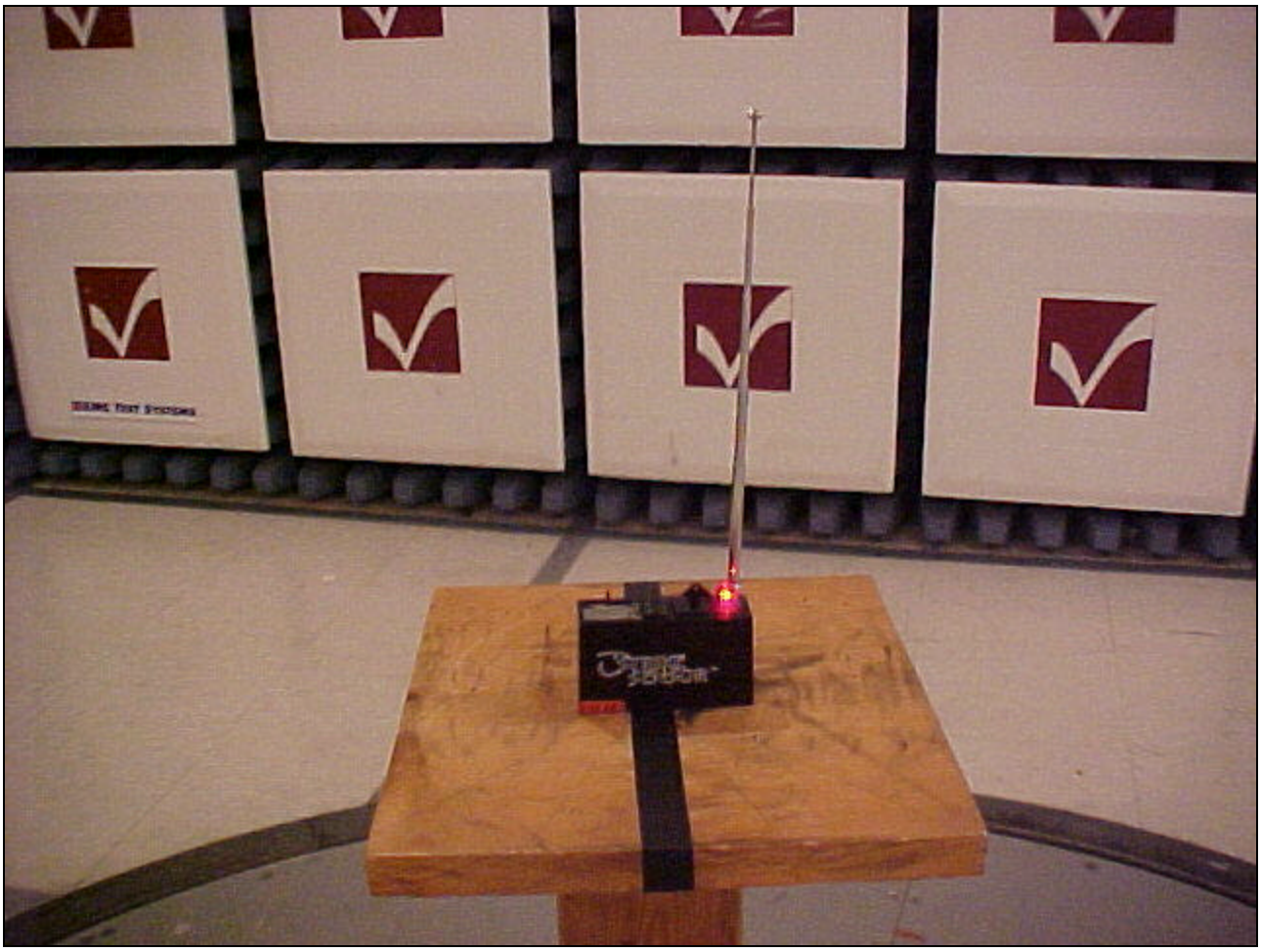
Manufacturer: Sensortronics Industries
Model: Strike Sensor
Serial Number(s): LSR-002

1.11 - Restricted Bands affecting this product

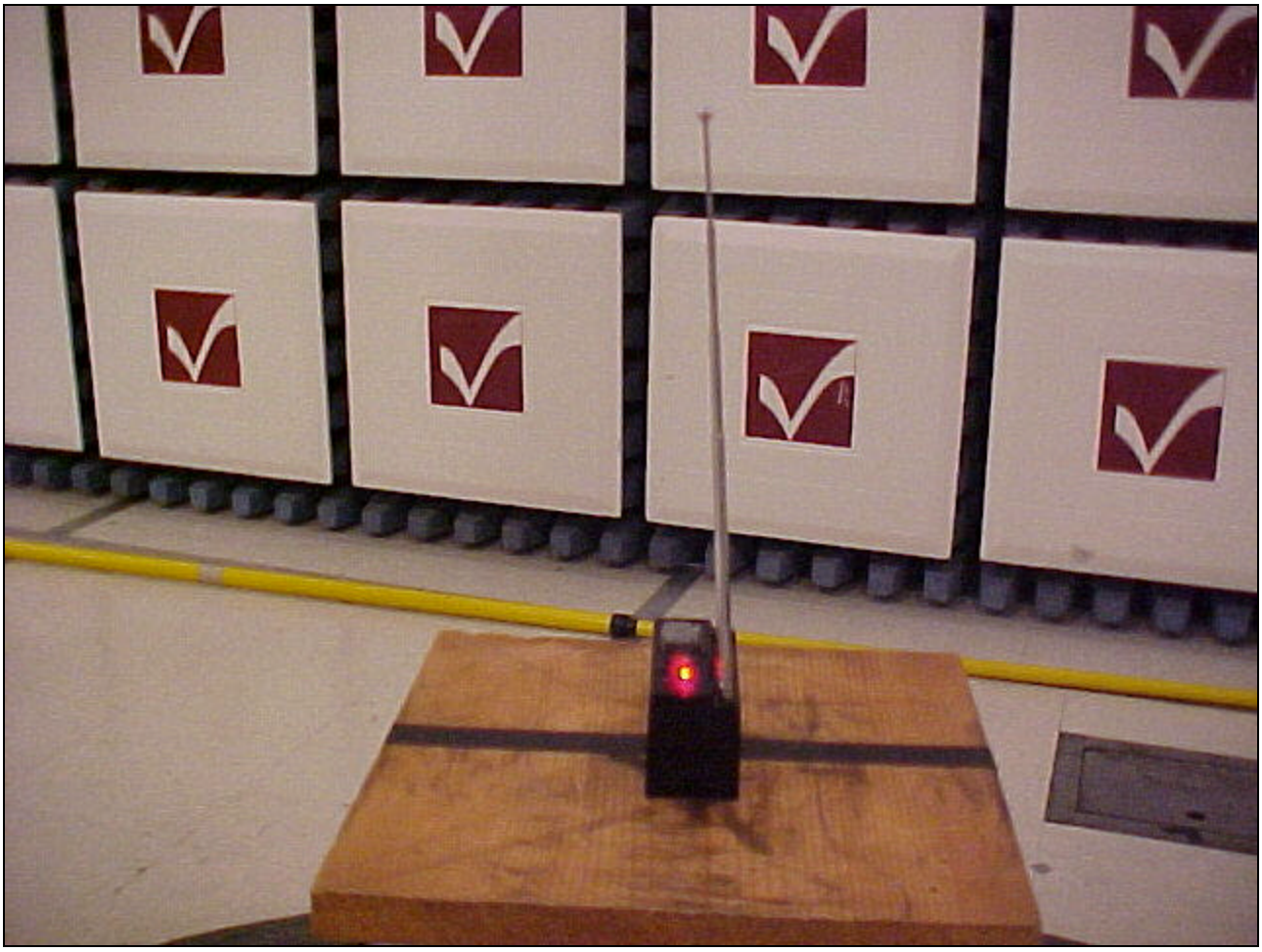
3 Meter limits

Frequency (MHz)	Limit (μV)	Limit (dB/μV/m)
37.5-38.25	100	40.0
73.74.6	100	40.0
74.8-75.2	100	40.0
108-121.94	150	43.5
123-138	150	43.5
149.9-150.05	150	43.5
156.52-156.53	150	43.5
156.7-156.9	150	43.5
162-167.17	150	43.5
167.72-173.2	150	43.5
240-285	200	46.0
322-335.4	200	46.0
399.9-410	200	46.0
608-614	200	46.0
960-1240	500	54.0
1300-1427	500	54.0
1435-1626.5	500	54.0
1645.5-1646.5	500	54.0
1660-1710	500	54.0
1718.8-1722.2	500	54.0
2200-2300	500	54.0
2310-2390	500	54.0
2483.5-2500	500	54.0
2655-2900	500	54.0
3260-3267	500	54.0
3332-3339	500	54.0
3345.8-3358	500	54.0
3600-4400	500	54.0

1.12 – Photos taken during testing



Front view of the Strike Sensor transmitter device during the radiated emissions tests. This view shows the orientation of the product where the maximum signal levels were present in the vertical antenna polarity.



Rear view of the Strike Sensor transmitter device during the radiated emissions tests. This view shows the orientation of the product where the maximum signal levels were present in the vertical antenna polarity.

1.13 SUMMARY OF RESULTS AND CONCLUSIONS

Based on the procedures outlined in this report, and the test results included in appendices B and C, it can be determined that the model Strike Sensor transmitter device does **MEET** the emission requirements of Title 47 CFR, FCC Part 15 Subpart C for an intentional radiator. Radiated emissions of the 433.9MHz fundamental were found to be within 4dB of the limit, and could be found to be over the limit if these samples, or others were to be tested by another regulatory agency.

The enclosed test results pertain to the sample of the test item listed, and only for the tests performed on the data sheets. Any subsequent modification or changes to the test item could invalidate the data contained herein, and could therefore invalidate the findings of this report.

1.14 - Test Equipment

Asset #	Manufacturer	Model #	Serial #	Description	Due Date
FF666012	EMCO	93146	9701-4855	Log Periodic Antenna	8/21/01
AA960005	EMCO	3110B	9601/2280	Biconical Antenna	9/28/01
AA960007	EMCO	3115	99111-4198	Double Ridged Guide/Horn Antenna	9/18/01
EE960004	EMCO	2090	9607-1164	Mast/Ttable Controller	LO
EE960013	HP	8546A	3617A00320	Receiver RF Section W/Display and RF filter section	11/1/01
EE960014	HP	85460A	3448A00296	Receiver RF Section Preselector	11/1/01
Cable	LSC	Cable	11	3meter helix	12/7/01
Cable	LSC	Cable	38	1meter RG214	12/7/01
Cable	LSC	Cable	50	10meter RG214	12/7/01

APPENDIX A:

SAMPLE CALCULATIONS

Manufacturer: Sensortronics
Model: Strike Sensor Transmitter
Serial Number(s): LSR-002

Calculation of Radiated Emissions limits for FCC Part 15.231(b) (260-470 MHz)

FIELD STRENGTH OF FUNDAMENTAL FREQUENCIES:

The calculation involves a linear interpolation of 3750 to 12500 µV/m over 260-470 MHz,
Where field strength of the fundamental frequency (f_0) when, $260 \leq f_0 \leq 470$ MHz, can be found by: $3750.0+41.667(f_0-260)$, where f_0 is in MHz.

FIELD STRENGTH OF SPURIOUS/HARMONIC FREQUENCIES:

The calculation involves a linear interpolation of 375 to 1250 µV/m over 260 to 470 MHz,
Where field strength of the harmonic frequencies ($2f_0$, $3f_0$..), when $260 \leq f_0 \leq 470$ MHz, can be found by: $375.0+4.1667(f_0-260)$, where f_0 is in MHz.

- Where f_0 = 434 MHz
  Fundamental: $3750+41.667(433.92-260) = 10996.72$ µV/m
  Harmonic: $375+4.1667(433.92-260) = 1099.56$ µV/m

Frequency (MHz)	Fundamental limit (mV/m)	Fundamental limit (dB mV/m)	Harmonic limit (mV/m)	Harmonic limit (dB mV/m)
433.92	10996.72	80.8	1099.56	60.82

Manufacturer: Sensortronics
Model: Strike Sensor Transmitter
Serial Number(s): LSR-002

Duty Cycle Correction Factor Calculation

The Strike Sensor Transmitter uses a Holtek "HT12E" encoder scheme. For a graphical presentation of the data bursts being transmitted from the transmitter, refer to Figures 1-3 below for the amount of time that the transmitter is active. Figures provided below show the "on" time of the transmitter that occurs when a key is held down continuously over a 100ms (worst case) period. The Holtek "HT12E" encoder has 1 start bit plus 8 address bits plus 4 data bits, total of 13 bits. Figure 1 below shows the graphical presentation of one full transmit packet of a nominal length of 13ms. The Guard time is nominally 12ms and "zero" bit high time is measured at 0.34ms as depicted in Figure 2. The "one" bit high time is shown in Figure 3 at 0.68ms. Similarly, the "zero" bit low time is also measured at 0.68ms, and the "one" bit low time is 0.34ms. While activated, and using the Holtek code of the maximum possible duration, the total On-time is 7.48ms, for 1 packet. (For this product, the start bit is always zero, and the data bits are always binary 1000; the address bits can vary). When the total On-time is computed over a 100ms window, according to FCC Part 15.35(c), where the pulse duration exceeds 100ms, a total of 29.92ms is measured as shown in the equation below.
To determine the relaxation factor, we need to compute the total "On" time of the transmitter. The total "On" time is the sum of the start bit plus 8 address bits plus 4 data bits equals a total of 13 bits, which is then multiplied by four to allow for 4 packets sent in a 100ms window. This results in a relaxation factor of 10.48dB, which is under the allowable cap of 20 dB, as stated in FCC Part 15.35(b).

$[0.340+(8x0.680) + (0.680 + 3x0.340)] = 7.48ms$ (one Packet)

$=29.92ms$ (four packets)

$=29.9\%$ for a duty cycle correction factor

Therefore the Relaxation Factor is: $= 20*\log(0.2992)$

$= -10.5$ dB

Figure1: HT12E Transmit Packet

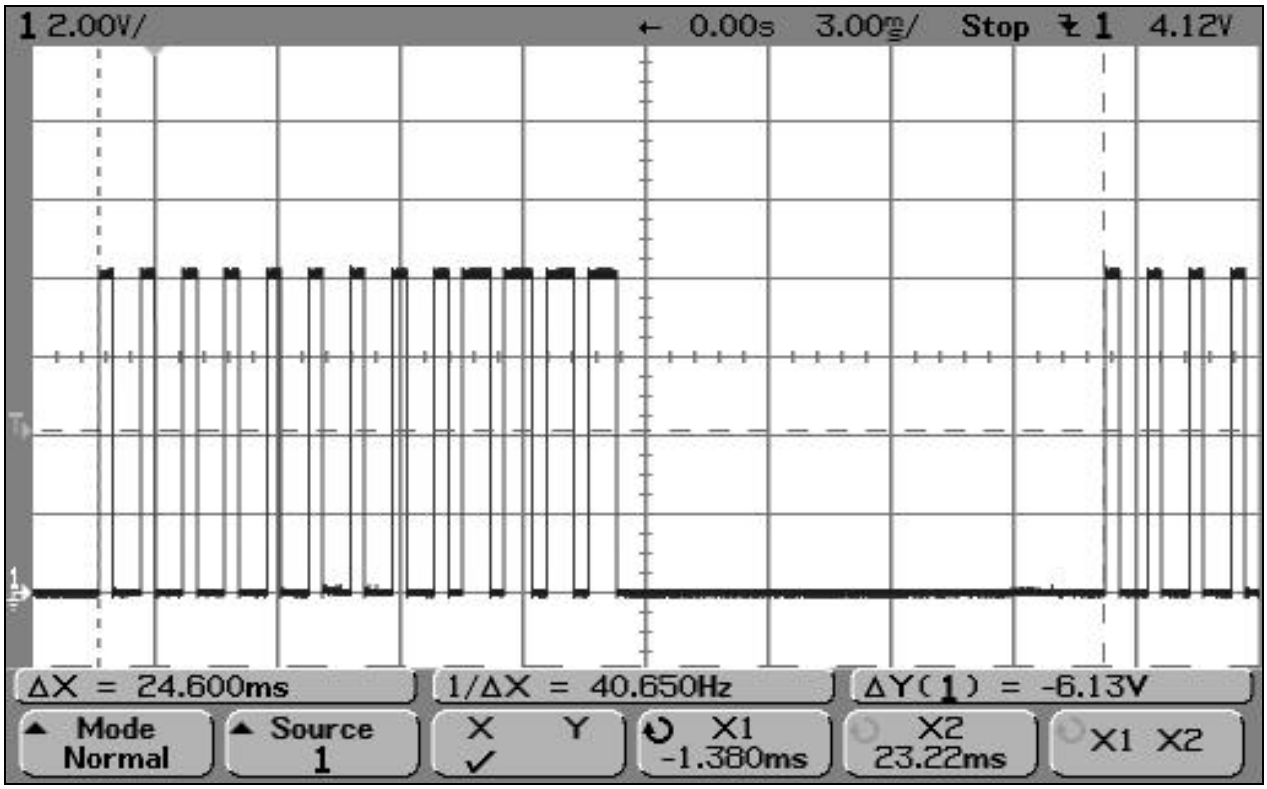


Figure2: HT12E Zero bit high time

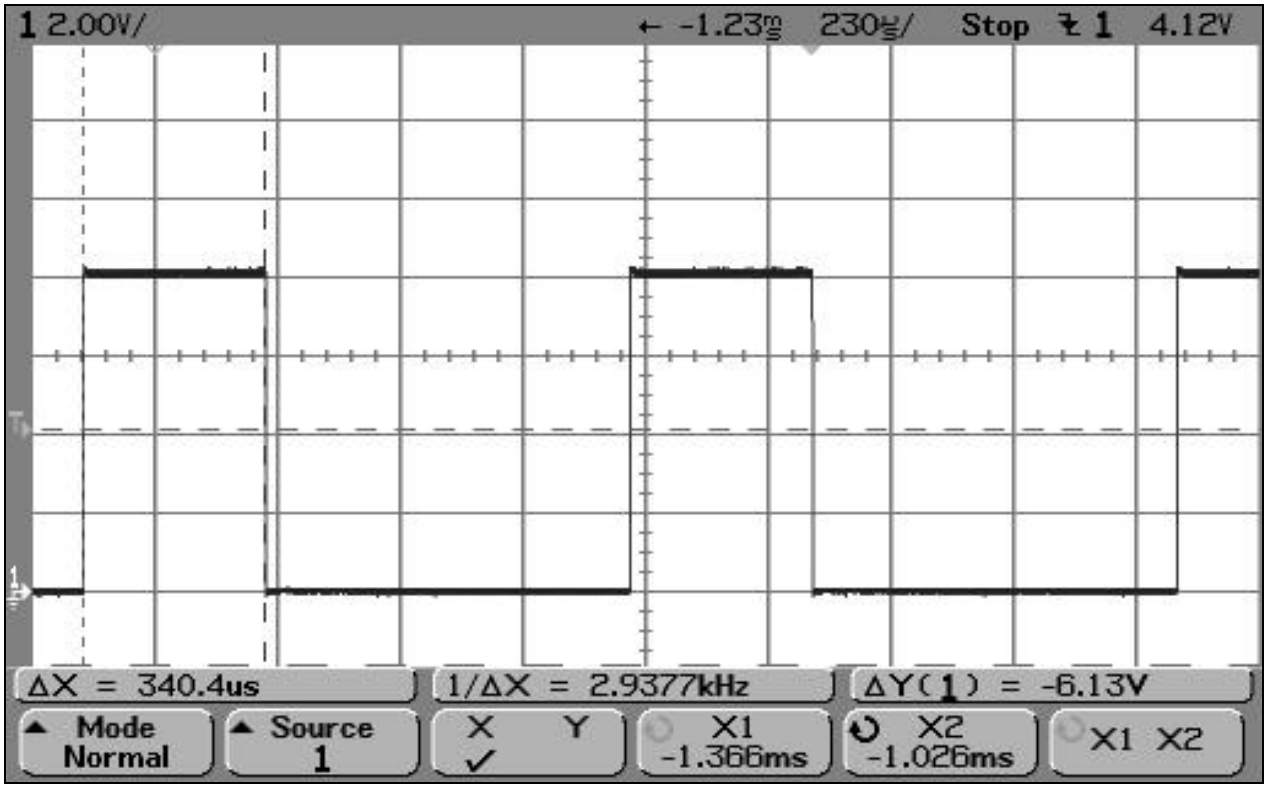
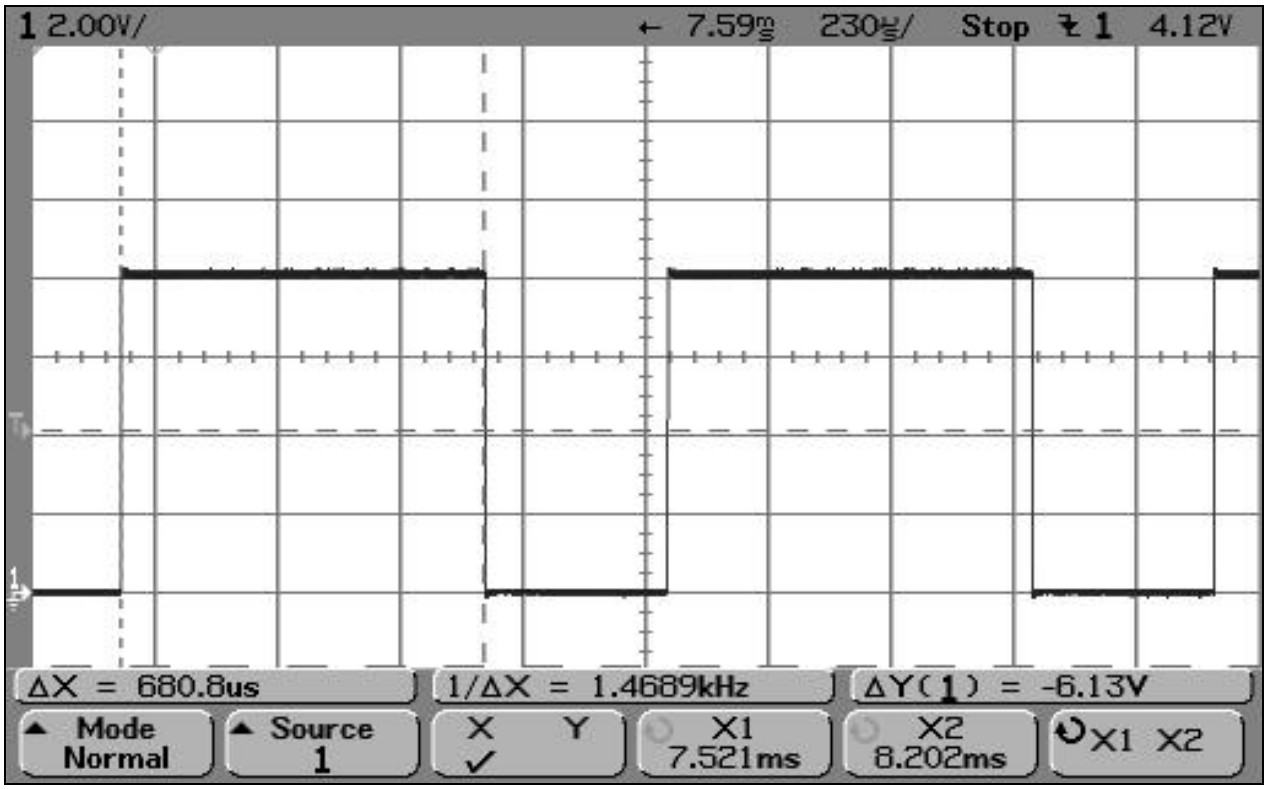


Figure3: One bit high time



Manufacturer: Sensortronics
Model: Strike Sensor Transmitter
Serial Number(s): LSR-002

Occupied Bandwidth Calculations

FCC Part 15.231(c) states that the bandwidth of the periodic device shall be no wider than 0.25% of the center frequency for devices operating between 70 and 900 MHz. Said bandwidth is determined at the **-20 dB** reference to peak carrier points.

For 433.92 MHz, the 20 dB bandwidth is *0.0025 X 433.92=1.085 MHz*

Refer to Appendix C for the set of graphs that show the actual occupied bandwidth of the test sample.

APPENDIX B:

DATA CHARTS

Measurement of Electromagnetic Radiated Emission within 3 Meter FCC Listed Chamber

Frequency Range inspected: 30 to 4500 MHz

Date of Test:	7/25th/2001, 8/8th and 10th/2001	Manufacturer:	Sensortronics
Location:	L.S. Compliance, Inc.	Model No.:	Strike Sensor
	W66 N220 Commerce Court		
	Cedarburg, WI 53012		
Specifications:	Title 47CFR, FCC Part 15.231b	Serial No.:	Pre-production
Distance:	3 meters in the Semi-anechoic Chamber	Configuration:	Active, continuous burst
Equipment:	HP 8546A EMI Receiver	Detector(s) Used:	Peak
	EMCO 3115 Double Ridged Waveguide		
	EMCO 3146A Log Periodic		

The following table depicts the level of significant fundamental and harmonic emissions found:

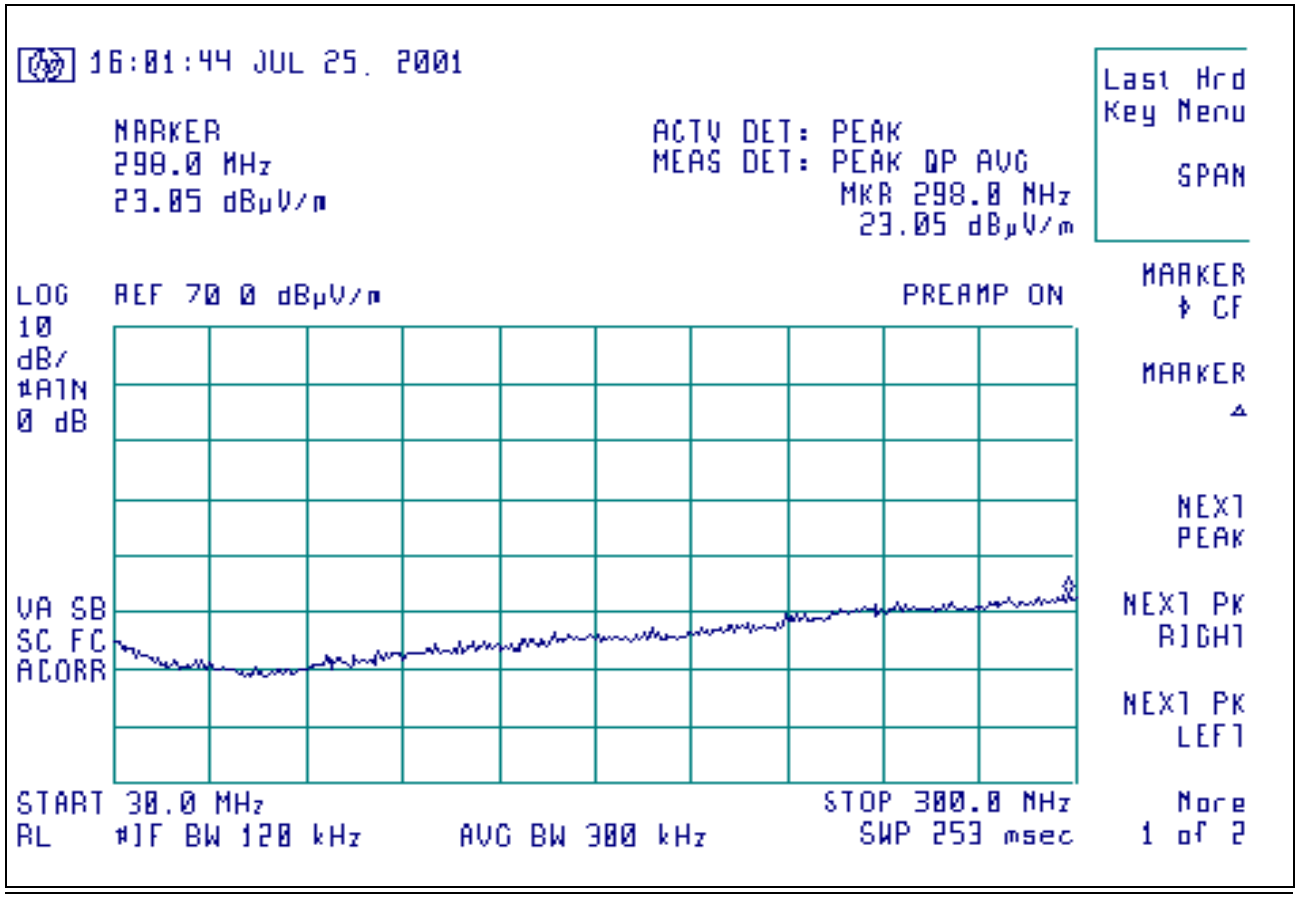
Higher order harmonics were found to be below the noise floor of the receiving system:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0- 360)	EMI Meter Reading (dBuV/m)	Duty Cycle Correction (dB)	Corrected Reading (dBuV/m)	15.231b Limit (dBuV/m)	Margin (dB)
433.92	H	3	229	76.7	10.5	66.2	80.8	14.6
433.92	V	1	252	90.7	10.5	80.2	80.8	0.6
868	V	1	20	57.1	10.5	46.6	60.8	14.2
1302	H	1.1	195	39	10.5	28.5	54	25.5
1736	V	1.05	270	35.5	10.5	25	60.8	35.8
2170	V	1	75	38.4	10.5	27.9	60.8	32.9

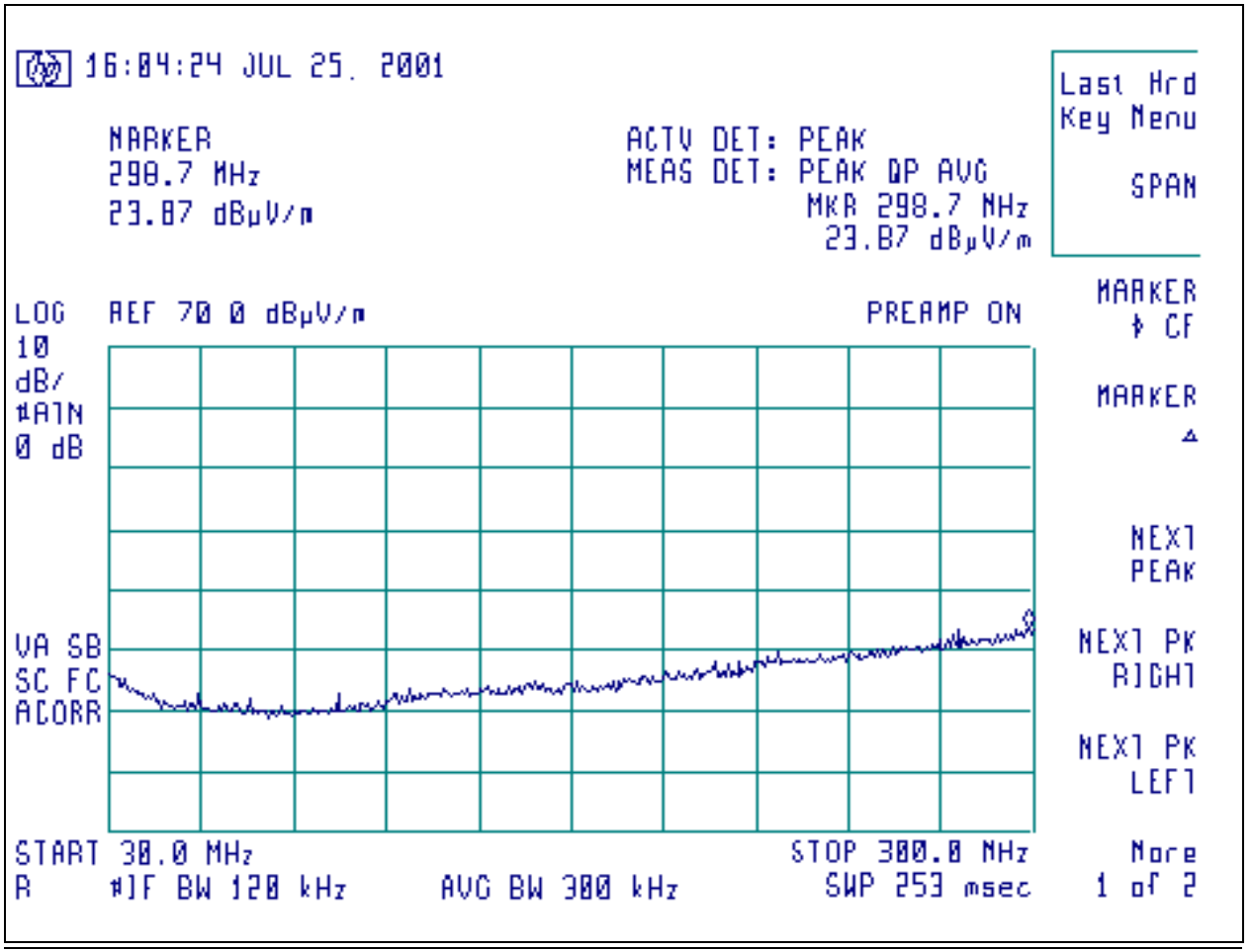
APPENDIX C:

GRAPHS

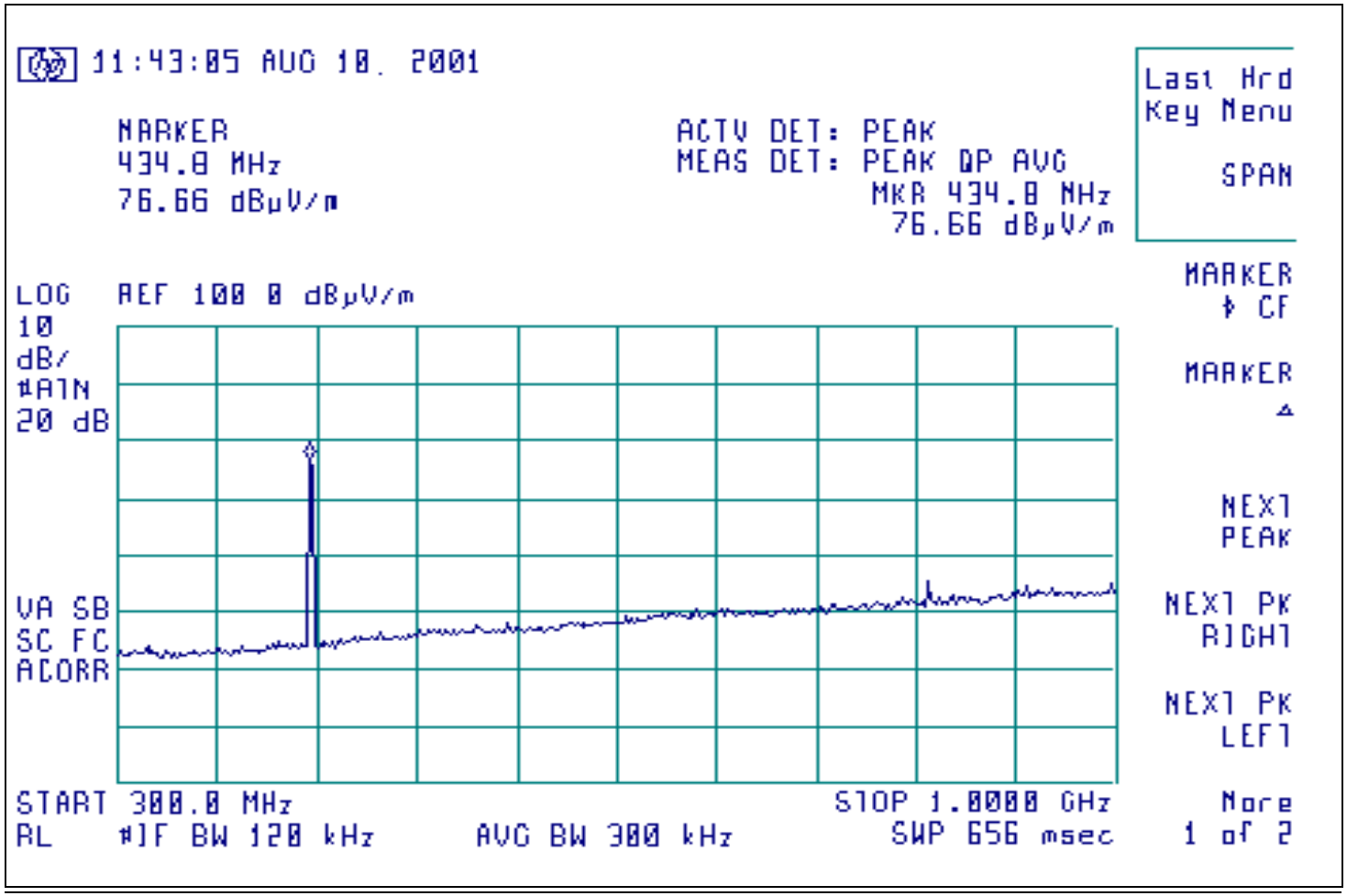
433MHz Strike Sensor **Transmitter, emissions 30-300 MHz, Vertical polarity**



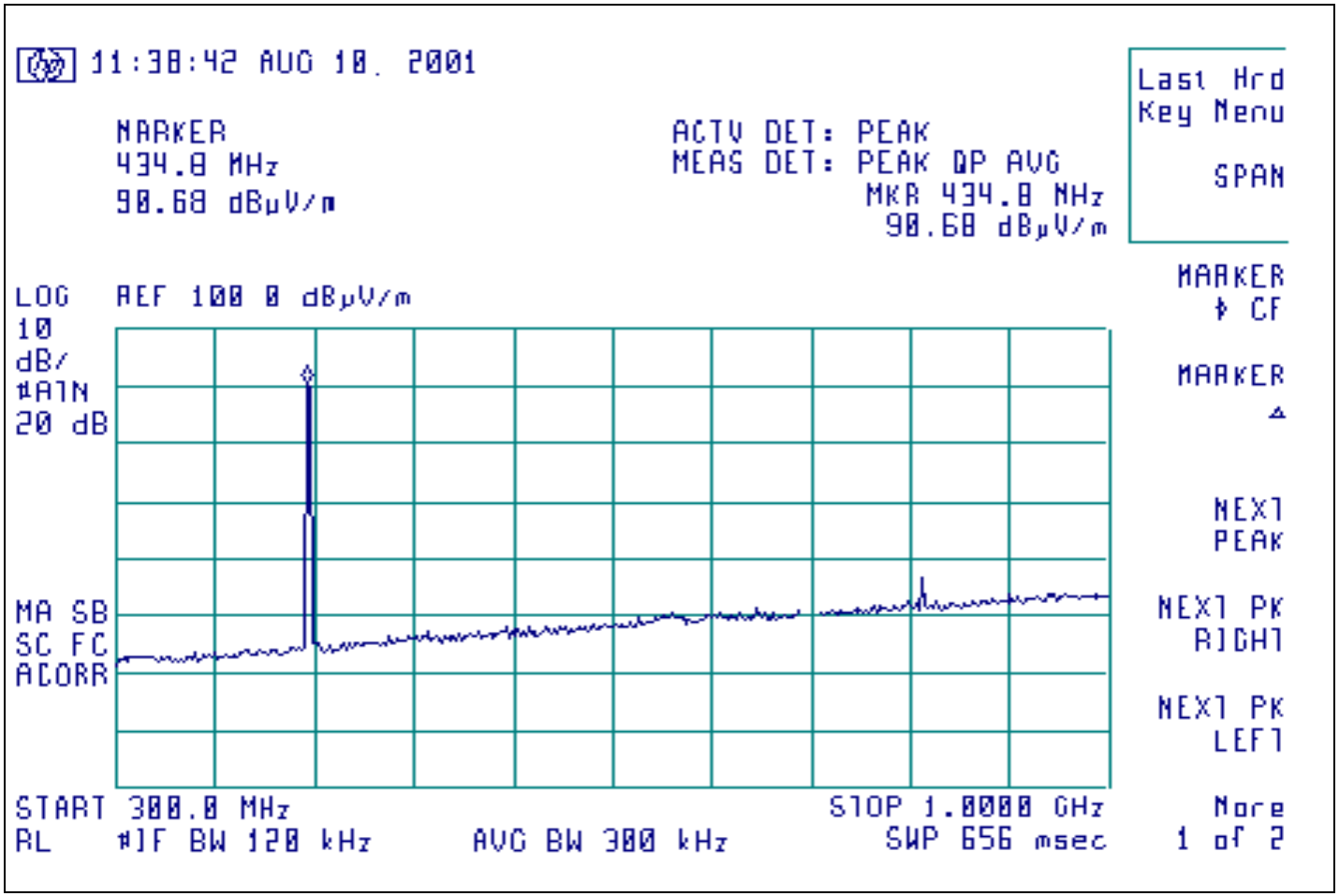
433MHz Strike Sensor **Transmitter, emissions 30-300 MHz, horizontal polarity**



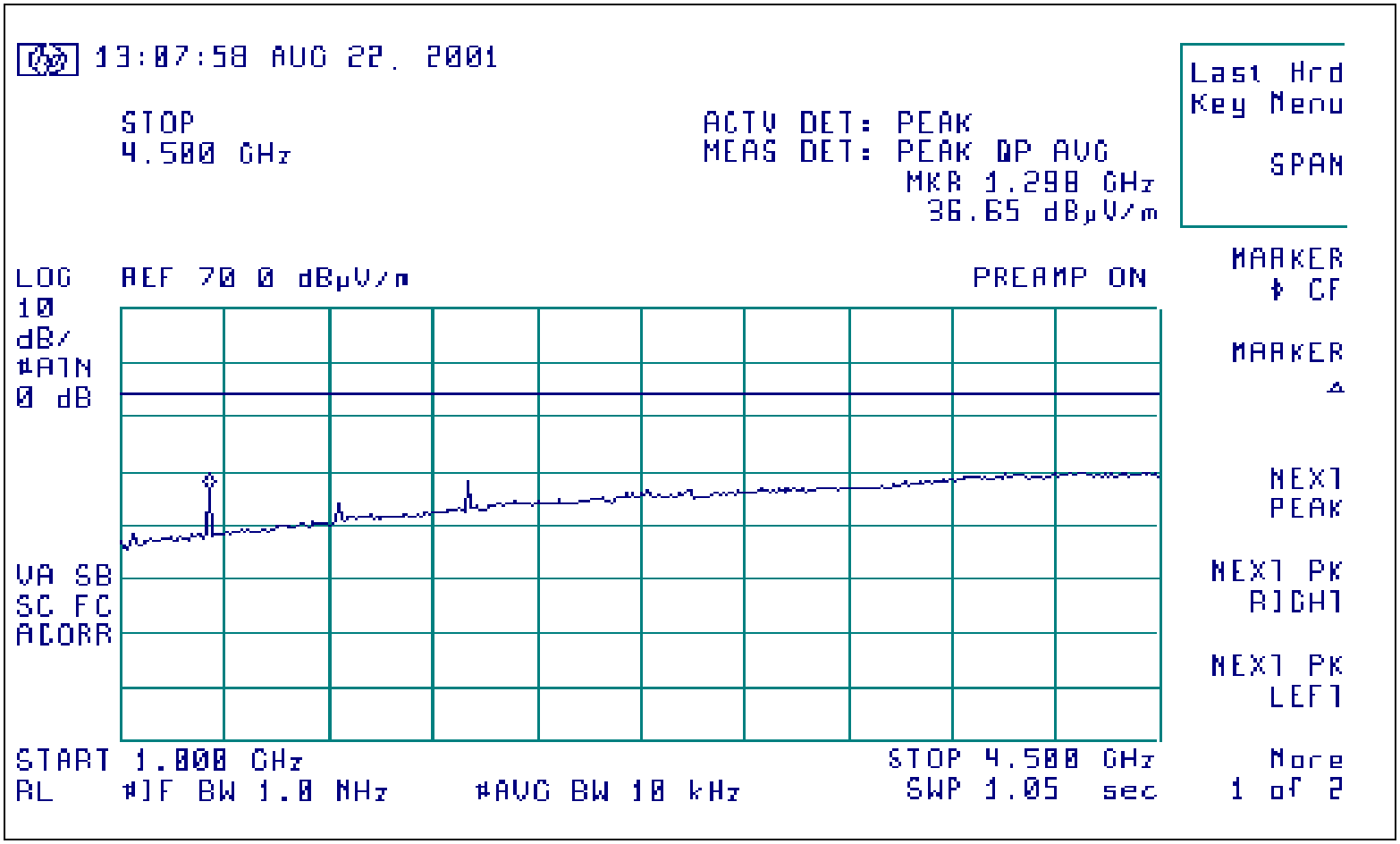
433MHz Strike Sensor **Transmitter, emissions 300 MHz- 1 GHz, horizontal polarity**



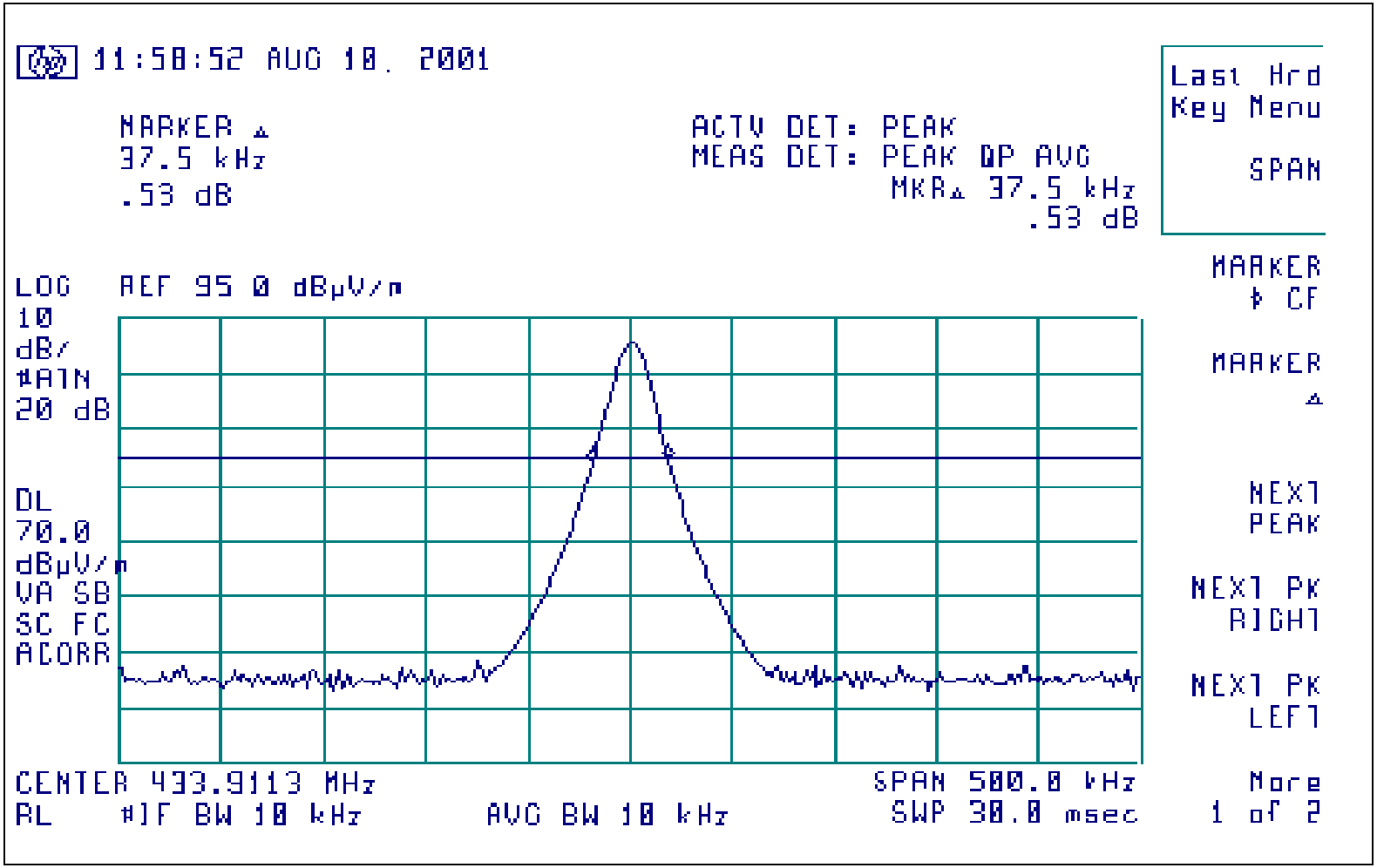
433MHz Strike Sensor Transmitter, emissions 300 MHz-1 GHz, vertical polarity



433MHz Strike Sensor Transmitter, vertical above 1 GHz



433 MHz Strike Sensor Transmitter, Vertical Polarity occupied bandwidth



433MHz Strike Sensor Transmitter, Horizontal occupied bandwidth