

Electromagnetic Compatibility
Certification Test Report
FCC 15.231

for

Model: TX-434-5B
S/N: 001

Client: Scotia Technologies, Inc.

This Report Contains 21 pages.

Deviations: None

Person responsible for the content of this report: Craig R. Seelig

Date of Report: 16 DEC 99

This Report must not be used to claim product endorsement by NVLAP or any agency of the U.S. government.

Radiated and Conducted Emissions test data only, is included within the scope of *analab's* NVLAP accreditation.

Report Identification No. SCOTIA1.DOC



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EUT

Date of Receipt:

30 November 99

Description

The EUT is a “Key Chain” transmitter designed to operate under the provisions of section 15.231 of the FCC rules as a intentional radiator. The EUT radiates a control signal used to operate a remote switch. 433.92 MHz is the design operating frequency.

Transmit functions are controlled by the HCS301 encoder IC manufactured by Microchip Technology, Inc. Blank alternate code word allows transmission of every fourth code word. Five function buttons are provided which determine the specific code word transmitted. In production units the HCS301 IC will be programmed with a time out timer limiting the maximum transmit period. The Transmitting Antenna is a printed circuit board loop. Multiple code word transmissions will continue as long as a function button is depressed but with a maximum duration set by the time-out-timer.

Condition

Pre-Production Sample.

Cabling

None

Battery

GP-23 (12 V)

Peripherals

None

Modifications¹

A 50 pF capacitor that was in-parallel with L2 was removed. An additional 18 nH inductor (designated as L3) was installed (on the push-button side of the PCB) in-series with L2. These modifications reduced spurious emissions.

¹ No warranty is expressed or implied as to the suitability of this modification other than reduction of the EUT's radiated harmonics.

PCB Views



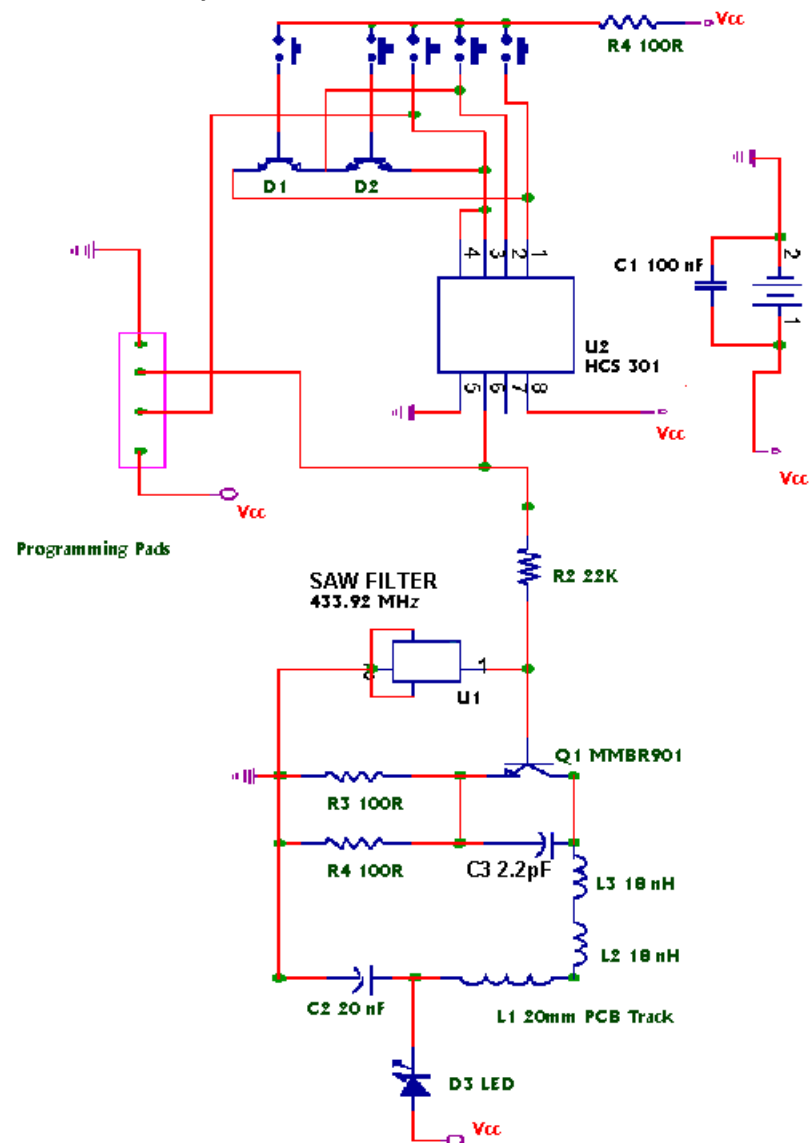
SCOTIA

TX-434-5B

13 DEC 99



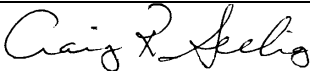
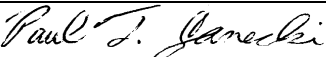
Schematic Diagram



Summary

Place of Test:	Client:
Analab, LLC P.O. Box 34 Spring Hill Road Sterling, PA 18463	Jim Speers Scotia Technologies Canada, Inc. 8850-60 Ave Edmonton, Alberta T6E 6A6 Canada
EUT: TX-434-5B	S/N: 001

Standard Number	Description	Limit	Date Test Performed
FCC Part 15.231	Fundamental Emission 433.495 MHz	Average @ 3 m, 10,965 uV/m	13 DEC 99
FCC Part 15.231	Spurious Radiated Emissions, 0.433-4.5 GHz	Average @ 3 m, 1097 uV/m	13 DEC 99
FCC Part 15.205	Spurious Radiated Emissions, Restricted Bands 0.433-4.5 GHz	Average @ 3 m, 500uV/m	13 DEC 99
FCC Part 15.23	Occupied Bandwidth	1.08 MHz	13 DEC 99

Fundamental Emission, 433.495 MHz	Result: The EUT met FCC part 15. Maximum radiated emissions were 437µV/m "Average" @ 3m which is below the allowed limit.
Spurious Emissions, .030 - 4.4 GHz	Result: The EUT met FCC part 15.205 and 15.231 limits for spurious emissions. Worst case spurious emissions were 86 µV/m "Average".
Bandwidth	Result: Occupied bandwidth (at -20 dB points) was measured to be 328 KHz. The EUT met FCC 15.231 limits.
Tested By:	Craig R. Seelig
Signature, Date	 16 Dec 99
Checked By:	Paul Janecki
Signature Date	 16 Dec 99

Facilities

A description of Analab's 3 and 10-meter test facilities is on file with the FCC. File number 31040/SIT 1300F2.

NVLAP accredited, Lab Code 200260-0

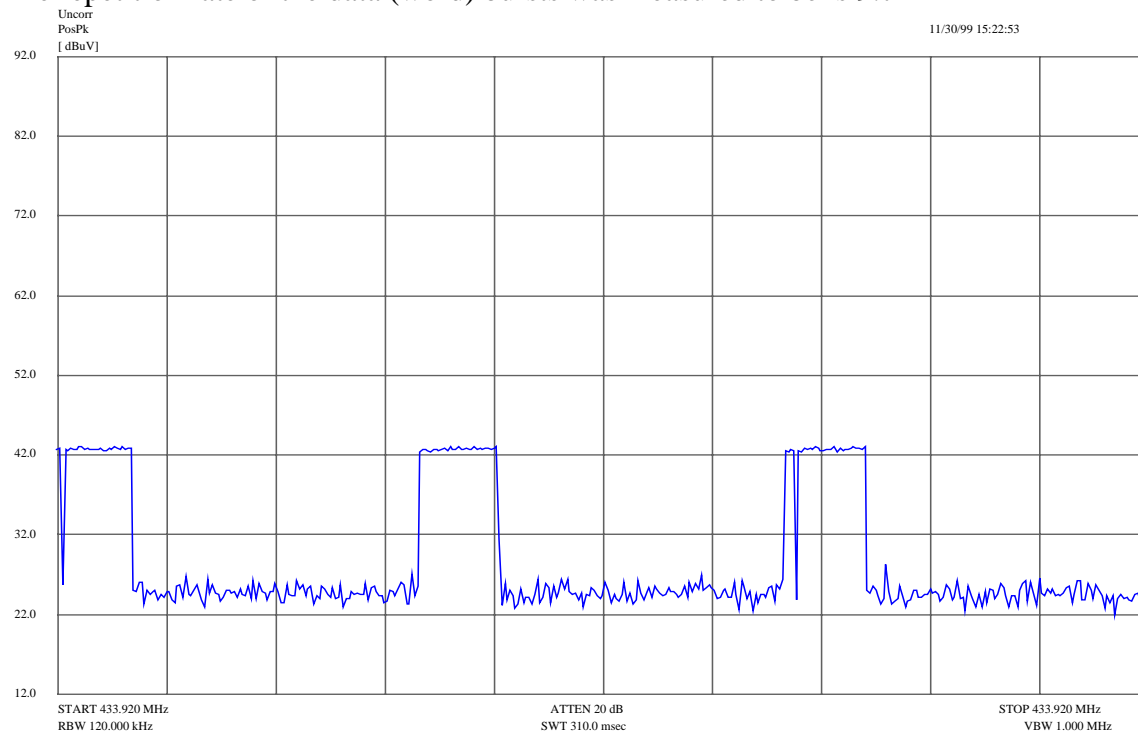
EUT Emissions Characteristics

Fundamental Frequency

The fundamental frequency was measured to be 433.495 MHz

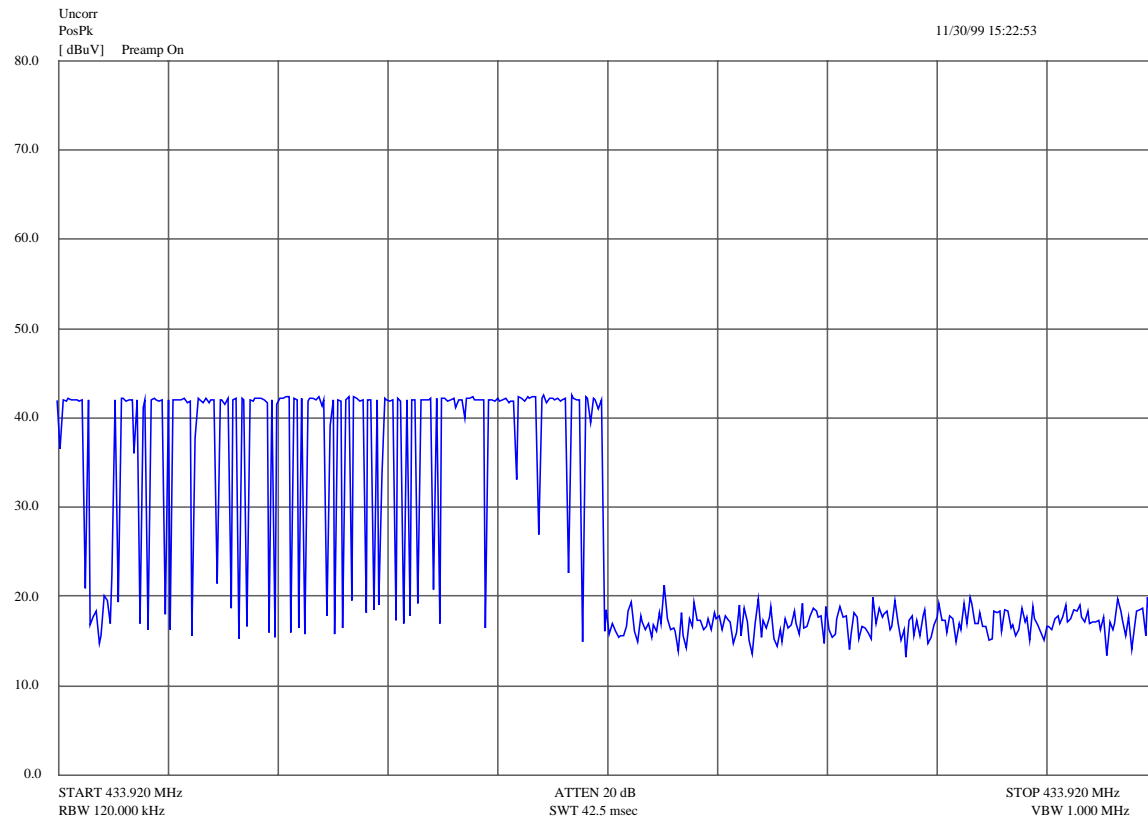
Burst Repetition Rate

The repetition rate of the data (word) bursts was measured to be 9.7 Hz



Burst Duration

Word Burst Duration was measured to be 21.25 mS



Field Strength Measurements

Test Procedure

C63.4 test methods were followed.

Traceability

Traceability of measurements is assured by virtue of the fact that the measurement equipment is in calibration.

Uncertainty of Measurements

Expanded² uncertainty, for a measurement made below 1,000 MHz on the OATS (Open Area Test Site) is calculated to be 4.0 dBμV/m. Expanded uncertainty for a measurement made above 1 GHz is calculated to be 3.4 dBμV/m.

Test Equipment

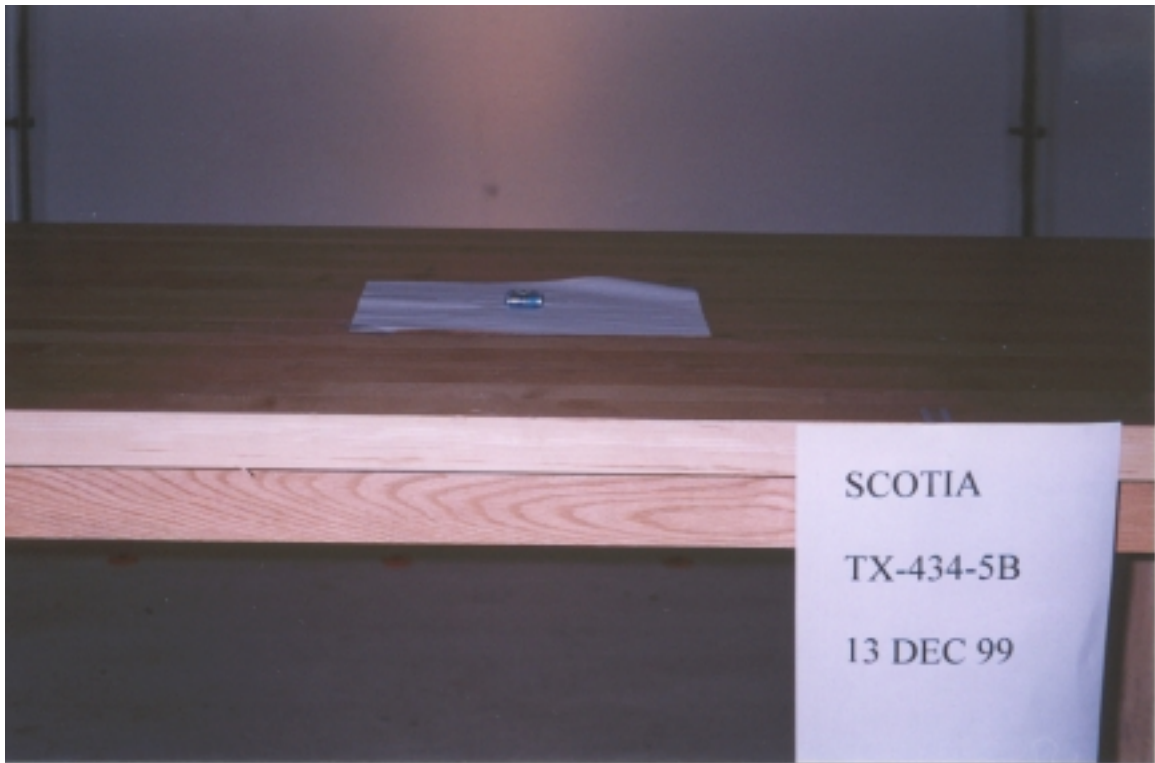
<u>Description</u>	<u>Mfg.</u>	<u>Model #</u>	<u>S/N</u>
EMI Receiver ³ 9 KHz-6.5 GHz	H.P.	85462A	3325A00116
RF Filter ⁴ Bi-Conical Ant. 30-300 MHz	H.P. EMCO	85460A 3110B	3330A00124 9603-2390
Log-Periodic Ant. 200-1100 MHz	EMCO	3146	9606-4565
Double Ridge Guide Horn Antenna	A. H. Systems	SAS-200/571	253
Ant. Mast Non-metallic work table .8m high 3 Meter Open Area Test Site	EMCO Analab	2070-5	9604-1964
Emissions Measurements Software	H.P.	H.P. 85876 B	US36031188

² 95% Confidence

³ CISPR 16 compliant

⁴ CISPR 16 compliant

Test Setup



Ambient Conditions

Below 1 GHz

Temp, 20° C; RH, 30%; Barometric Pressure, 958 mBar

Above 1 GHz

Temp, 23°C; RH, 21%; Barometric Pressure, 956 mBar

EUT Mode of Operation

As tested the EUT was programmed for continuous operation. The EUT will be marketed with the 30 second time-out-timer enabled. During the maximization process a wire was connected across one of the EUT's function keys. For final measurements this wire was removed and a function key was manually depressed using a non-metallic prod. Enabling of any of the five function keys produced the same peak RF emissions from the EUT.

Maximization

Below 1 GHz

A jumper was soldered across a function key on the PCB. Maximization was performed on the OATS. The EUT was placed on a 80 cm high wooden table which was located on a 1.5 m turntable. Evaluation of the EUT's field radiation pattern was made by HP EMI measurements software model HP85876B. 3 different orthogonal modes were scanned to determine what orientation of the EUT produced maximum field strength at the receiving antenna. The height of the measuring antenna was varied from 1 to 4 meters. Vertical and horizontal antenna polarities were used. This process was repeated for fundamental and spurious emissions up to 1,000 MHz.

Above 1 GHz

The EUT was fastened with plastic tape to an indexed piece of Mylar, which was placed, on an 80-cm high wooden table. A 3-meter distance from the EUT and receiving antenna was established. Evaluation of the EUT's field radiation pattern was manually made in 3 different orthogonal modes to determine what orientation produced maximum field strength at the receiving antenna. At all frequencies above the third harmonic, the distance between the antenna and the EUT was reduced because of the low level of emissions. This above configuration was used for identification of harmonic/spurious frequencies. The height of the measuring antenna was varied in conjunction with EUT orientation to produce maximum emissions at the receiving antenna.

Measurement Detector

Because the pulse repetition rate was less than 20 mS, peak detection was used using a 100 mS window. The EMI receiver was configured to provide a 100 mS window as follows:

Sweep time: 100 mS

IF Bandwidth: Frequencies Below 1 GHz, 120 KHz; Frequencies Above 1 GHz, 1 MHz

Average Bandwidth: 300 KHz

Span: 0 Hz

The EMI receiver's Span was gradually reduced to zero while adjusting center frequency to keep the EUT's maximum signal in center of display. Final measurements were made by direct reading of "Maximum Peak Hold" amplitude with peak detection.

Limits

Limits established by §15.231(b) of the FCC rules were applied. Linear interpolation for fundamental frequency of 433.495 MHz was calculated using the formula:

$$\frac{F - F_1}{dB - dB_1} = \frac{F_2 - F_1}{dB_2 - dB_1}$$
. Thus an "Average" limit of 10,965 $\mu\text{V/m}$ @ 3 meters is derived. (80.8 dB $\mu\text{V/m}$ @ 3 meters.)

For any spurious emissions, falling within the "Restricted Bands" identified in section 15.205 of the rules, a limit of 53.98 dB (500 μV) was applied. All other spurious emissions were checked against a limit -20 dB below the limit of the fundamental or 1,096 $\mu\text{V/m}$ (60.8 dB $\mu\text{V/m}$).

Calculation of “Average” Emissions

Because the period of the transmitter emissions is less than 100 mS, measurements were made using the Peak detection. Average emissions were computed by multiplying the peak amplitude of the pulses by the duty factor. The duty factor was calculated by addition of the total “on time” of the pulses during one period divided by the period. The total “on time” was calculated for a worst case scenario. “On” times were based upon Microchip’s design notes for the HCS301 encryption IC. A detailed description follows:

Each bit period or “On” time element is 100 uS.

Each “Burst” consists of the following:

Segment Description	Elapsed Time	Maximum Number of “On” Periods	RF Pulse “On” Times
23 Bit Preamble	2.3 mS	12 Pulses	1.2 mS
10 Bit Header	1.0 mS	0 Pulses	0.0 mS
66 Bit Word	19.8 mS	132 Pulses	13.2 mS
39 Bit Guard Period	3.9	0 Pulses	0.0
Total	27 mS		14.4 mS

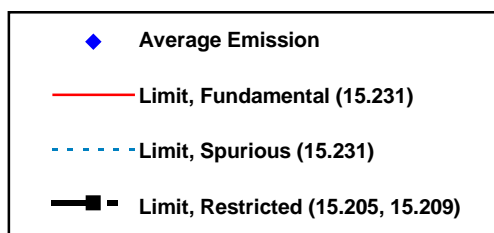
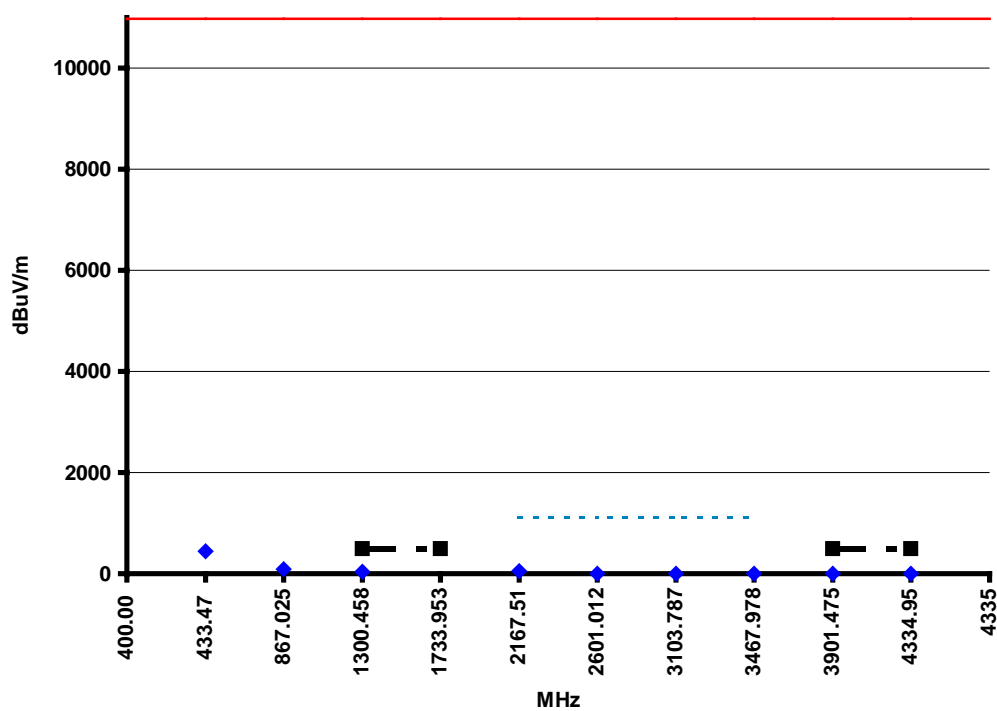
$12 + 132 = 144$ 100 uS bits = 14.4 mS total (worst case) RF “On” time in any 100 mS period.

Therefore, the Average emission is equal to 14.4% of peak measurement.

Configuration of EUT for Final Measurements

A distance of 3 meters between the measuring antenna and the EUT was confirmed. A fresh GP-23 12V battery was installed. For each frequency measured, the EUT orthogonal mode was set to produce maximum field strength. (These orthogonal modes were derived from the previous maximization procedure.)

Test Results



Frequency	Cor. Peak +	Receiver Noise Floor	Cor. Peak	Duty Factor	Avg‡	Angle	Hgt	Tot. Cor.	Ant Pol	EUT Axis	Avg Lmt	Del Lim Avg†
(MHz)	(dBuV/m)	(dBuV)	(uV/m)		(uV/m)	(deg)	(cm)	(dBuV/ m)			(uV/m)	(uV/m)
433.495	69.62		3,026.9	0.144	437	80	100	19.3	H	H	10,965	-10,529
867.025	55.48		594	0.144	86	270	100	25.9	H	H	1,096	-1,010
1300.458*	49.71		306	0.144	44.1	80	148	24.5	H	H	500	-456
1733.980		19.03	**	0.144		170	130	25.4	H	H	1,096	≥ -1096
2167.510	50.34		329	0.144	47.4	0	130	28.6	H	H	1,096	-1,049
2601.012		20.03	**	0.144		45	130	29.6	H	H	1,096	≥ -1,094
3034.296		19.65	**	0.144		0	100	30.6			1,096	≥ -1049
3467.978		19.01	**	0.144		0	100	31.3			1,096	≥ -1,049
3901.475*		19.11	**	0.144		0	100	32.2			500	≥ -447
4334.950*		18.92	**	0.144		0	100	33.5			500	≥ -440

* Restricted Band §15.205(b) applies, Average Limit 500 µV/m

** Emissions @ 3 meters less than EMI Receiver noise-floor

+ FS = RA + AF + CF

‡ (FS_{uV/m}) x 0.144)

† [Average Limit - ((FS_{uV/m}) x 0.144)]

(FS, Field Strength dBµV/m; RA, Receiver Amplitude; AF, Receiving Ant. Factor; CF, Cable Attn. Factor)

Determination

The emissions of the EUT are compliant with the limits specified in §15.205(b); §15.231(b)(2), (d) of the FCC rules. Fundamental emissions were well below the maximum permitted. Spurious and harmonic emissions were below the specified limits. The amplitude of spurious and harmonic emissions were all below that measured for the fundamental emission.

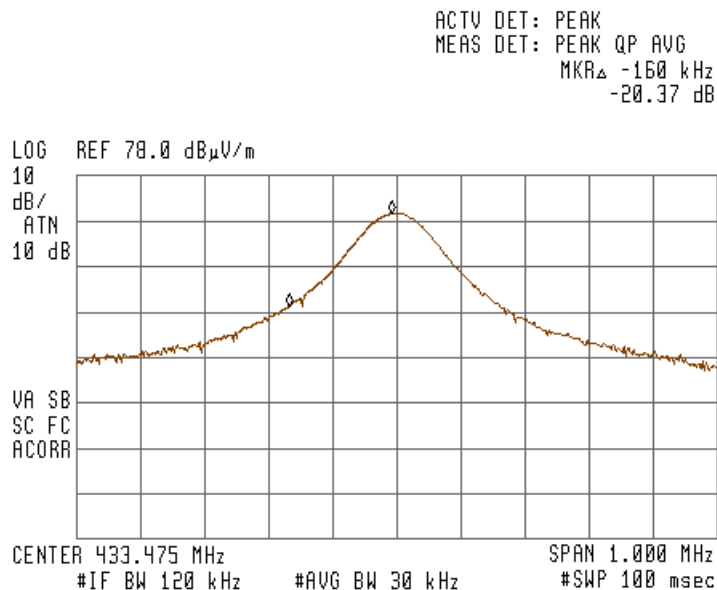
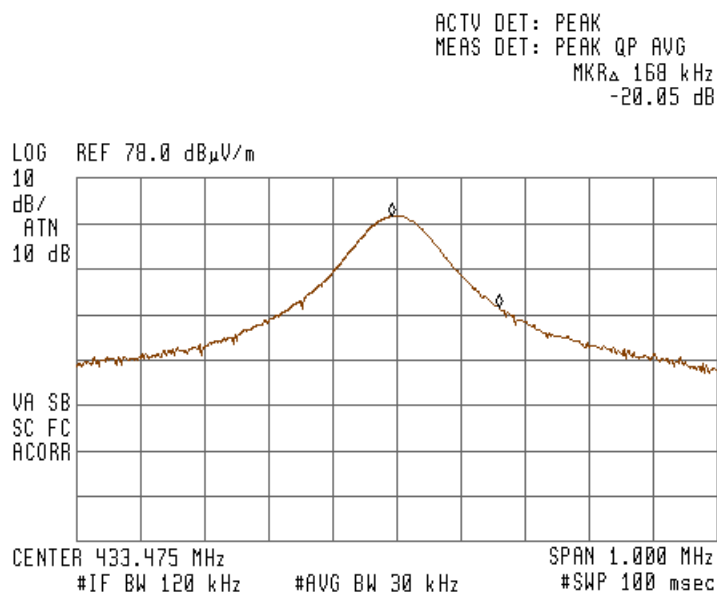
Occupied Bandwidth

Limits

Limits are established by §15.231(c). The maximum allowed for an operating frequency of 433.495 MHz is 1.08 MHz. (0.25% x 433.475 MHz.)

Test Results

The -20 dB, occupied bandwidth, was measured to be 328 KHz.



Determination

The bandwidth of the fundamental emission is compliant with the limits specified in §15.231(c) of the FCC rules.

Calibration Data

Mfg.	DESCRIPTION	MODEL	S/N	LAST CAL.	CAL. DUE
A.H. Systems	Dual Ridge Horn Antenna	SAS-200/571	253	29 JUN 99	29 JUN 00
EMCO	BICONICAL Ant. 30-300 MHz	3100B	9603-2390	12 NOV 99	12 NOV 00
EMCO	Log-Periodic Ant. 200-1100 MHz	3146	9606-4565	9 NOV 99	9 NOV 00
H.P.	EMI Receiver 9kHz-6.5 GHz	85462A	3325A00116	19 OCT 99	19 OCT 00
H.P.	RF Filter	85460A	3330A00124	19 OCT 99	19 OCT 00
H.P.	500 MHz Oscilloscope	546168	US36050920	26 JUL 99	26 JUL 00
Analab	OATS Cable			14 SEP 99	14 SEP 00
Analab	3 m OATS			25 MAY 99	
Analab	Horn Ant. Cable			7 DEC 99	7 DEC 00
HP	Precision Volt Ohm Meter	HP8505A	4075019	30 JUN 99	30 JUN 00