



Electromagnetic Compatibility Test Report

Tests Performed on a Federal Signal Corporation

Transmitter, Model VisiBeam

Radiometrics Document RP-5698A



Product Detail:

FCC ID: **HVVVB**

Equipment type: 433.9 MHz Momentarily operated Transmitter

Test Standards:

US CFR Title 47, Chapter I, FCC Part 15 Subpart C

FCC Part 15 CFR Title 47: 2006

This report concerns: Original Grant for Certification

FCC Part 15.231

Tests Performed For:

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Test Date(s): (Month-Day-Year)

December 19, 2005 and June 7, 2006

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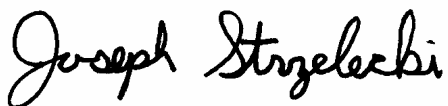
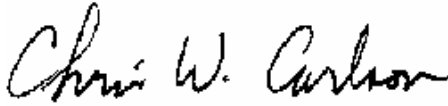
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1 ADMINISTRATIVE DATA

<i>Equipment Under Test:</i> A Federal Signal Corporation, Transmitter Model: VisiBeam Serial Number: N/A This will be referred to as the EUT in this Report	
<i>Date EUT Received at Radiometrics: (Month-Day-Year)</i> October 27, 2005	<i>Test Date(s): (Month-Day-Year)</i> December 19, 2005 thru June 7, 2006
<i>Test Report Written By:</i> Joseph Strzelecki Senior EMC Engineer	<i>Test Witnessed By:</i> Jacek Jozwik Federal Signal Corporation
<i>Radiometrics' Personnel Responsible for Test:</i>  Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	<i>Test Report Approved By</i>  Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a Transmitter, Model VisiBeam, manufactured by Federal Signal Corporation. The detailed test results are presented in a separate section. The following is a summary of the test results.

Emissions Tests Results

Environmental Phenomena	Frequency Range	Basic Standard	Test Result
RF Radiated Emissions	30-4400 MHz	FCC Part 15	Pass
Occupied Bandwidth Test	Fundamental Freq.	FCC Part 15	Pass

2.1 RF Exposure Compliance Requirements

The power output is 2 mW, The EUT meets the FCC requirement for RF exposure. There are no power level adjustments and the antenna is permanently attached. The detailed calculations for RF Exposure are presented in a separate document.

3 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a Transmitter, Model VisiBeam , manufactured by Federal Signal Corporation. The EUT was in good working condition during the tests, with no known defects.

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3.1.1 FCC Section 15.203 Antenna Requirements

The antenna is an Internal PCB Trace Loop Antenna located inside of the Transmitter. It cannot be readily changed by the end user.

3.2 Related Submittals

Federal Signal Corporation is not submitting any other products simultaneously for equipment authorization related to the EUT.

4 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations.

The EUT was tested as a stand-alone device.

Power was supplied with two new AA batteries.

4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

Document	Date	Title
FCC CFR Title 47	2006	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
ANSI C63.4-2003	2003	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

The test procedures used are in accordance with the Industry ANSI document C63.4-2003, "Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The specific procedures are described herein. Radiated testing was performed at an antenna to EUT distance of 3 meters. The antenna was raised and lowered from 1 to 4 meters.

6 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 1999 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois:

Chamber A: Is an anechoic chamber that measures 24' L X 12' W X 12' H. The walls and ceiling are fully lined with ferrite absorber tiles. The floor has a 10' x 10' section of ferrite absorber tiles located in the center. Panashield of Rowayton, Connecticut manufactured the chamber. The enclosure is NAMAS certified.

Chamber B: Is a shielded enclosure that measures 24' L X 12' W X 8' H. Erik A. Lindgren & Associates of Chicago, Illinois manufactured the enclosure.

Chamber C: Is a shielded enclosure that measures 20' L X 10' W X 8' H. Lindgren RF Enclosures Inc. of Addison, Illinois manufactured the enclosure.

Chamber D: Is a fully anechoic chamber that measures 22' L X 10' W X 10' H. The walls, ceiling and floor are fully lined with ferrite absorber tiles. Braden Shielding Systems of Tulsa, Oklahoma manufactured the chamber.

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

Open Area Test Site (OATS): Is located on 8625 Helmar Road in Newark, Illinois, USA and measures 56' L X 24' W X 17' H. The entire open field test site has a metal ground screen. The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as file number IC3124.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

7 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

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8 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification. The results relate only to the EUT listed herein. Any modifications made to the EUT subsequent to the indicated test date will invalidate the data and void this certification.

9 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	12/22/05
AMP-22	Anritsu	Pre-amplifier	MH648A	M23969	0.1-1200MHz	12 Mo.	12/21/05
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	24 Mo.	10/13/04
ANT-44	Impossible Machine	Super Log Antenna	SL-20M2G	1002	20-2000MHz	24 Mo.	12/12/05
PRE-01	Hewlett Packard	Preselector	85685A	2510A00143	20 Hz-2GHz	12 Mo.	01/20/05
REC-07	Anritsu	Spectrum Analyzer	MS2601A	MT53067	0.01-2200MHz	12 Mo.	01/04/05
REC-08	Hewlett Packard	Spectrum Analyzer	8566B	2648A13481 2209A01436	30Hz-22GHz	12 Mo.	06/14/05

Note: All calibrated equipment is subject to periodic checks.

10 TEST SECTIONS

10.1 Radiated RF Emissions

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. Below 1 GHz, when a radiated emission is detected approaching the specification limit, the measurement of the emission is repeated using a tuned dipole antenna with a Roberts Balun.

The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 450 kHz to 30 MHz is 9 or 10 kHz and the bandwidth from 30 MHz to 1000 MHz is 100 or 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists.

From 30 to 1000 MHz an Anritsu Spectrum analyzer and a preamplifier with a 10 dB attenuator connected to the input. The out of band emissions and the ambient emissions were below the level of input overload (80 dBuV).

For tests from 1 to 4.4 GHz, an HP8566A spectrum analyzer was used with a Celeritek uWave amplifier. The fundamental emission, out of band emissions, and the ambient emissions were below the level of input overload (72 dBuV).

Preliminary radiated emission tests were performed inside of an anechoic enclosure. The frequency range from 30 to 4400 MHz was scanned and plotted using the peak detector function. The test antennas were positioned 3 meters from the EUT. The results of the preliminary scans were only used to identify the frequencies being emitted from the EUT and were not used to determine compliance with the test specification. Radiated emission measurements are performed with linearly polarized broadband antennas.

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Final radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. Measurements were performed using the peak or quasi-peak detector function. The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

The device was rotated through three orthogonal axis as per 13.1.4.1 of ANSI C63.4 during the prescans and during final radiated tests.

The entire frequency range from 30 to 4400 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high in the preliminary emission scan. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded.

10.1.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

$$FS = RA + AF + CF - AG + PKA$$

Where: FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

HPF = High pass Filter Loss

PKA = Peak to Average Factor (This is zero for non-average measurements)

The Peak to average factor is used when average measurements are required. It is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is $20 * \log(\text{Duty cycle}/100)$.

10.1.2 Radiated Emissions Test Results

Test Date	December 19, 2006
Test Distance	3 Meters
Specification	FCC Part 15; Subpart B; Class B & RSS-210
Notes	
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; BC = Biconical (ANT-3); LP = Log-Periodic (ANT-6); HN = Horn (ANT-13) P = peak; Q = QP

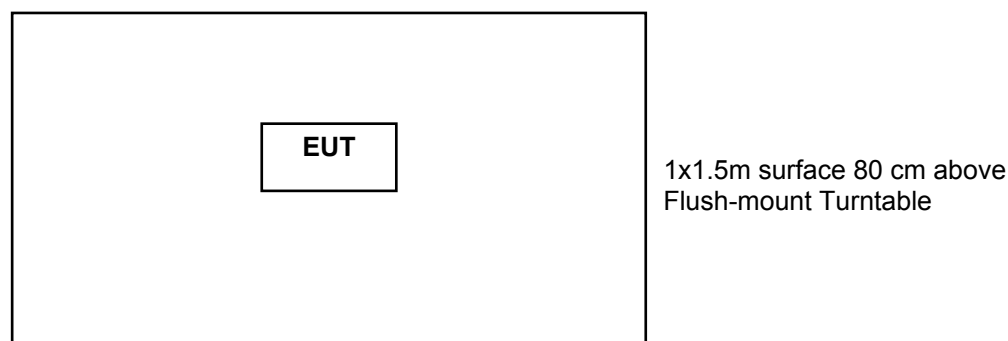
Hrm	Tx Freq	Emission Freq		Max Peak	Peak to Ave	Ave	ANT	Cbl + Amp	Ave Field Strength		Peak Tot	Margin under limit
#	MHz	MHz	Ant. Pol	dBuV	dB	dBuV	Fact.	dB	EUT	Limit	dBuV/m	
1	433.9	433.9	V	80.1	-7.1	73.0	16.4	-14.3	75.1	80.8	82.2	5.7
1	433.9	433.9	H	79.5	-7.1	72.4	16.9	-14.3	75.0	80.8	82.1	5.8
2	433.9	867.8	V	45.5	-7.1	38.4	21.4	-10.9	48.9	60.8	56.0	11.9
2	433.9	867.8	H	40.6	-7.1	33.5	22.5	-10.9	45.1	60.8	52.2	15.7
3	433.9	1301.8	V	61.1	-7.1	54.0	24.8	-27.3	51.5	54.0	58.6	2.5
3	433.9	1301.8	H	53.9	-7.1	46.8	24.8	-27.3	44.3	54.0	51.4	9.7

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4	433.9	1735.7	V	65.9	-7.1	58.8	26.3	-26.8	58.3	60.8	65.4	2.5
4	433.9	1735.7	H	60.7	-7.1	53.6	26.3	-26.8	53.1	60.8	60.2	7.7
5	433.9	2169.6	V	61.0	-7.1	53.9	27.9	-26.7	55.1	60.8	62.2	5.7
5	433.9	2169.6	H	64.5	-7.1	57.4	27.9	-26.7	58.6	60.8	65.7	2.2
6	433.9	2603.5	V	59.2	-7.1	52.1	28.9	-25.8	55.2	60.8	62.3	5.6
6	433.9	2603.5	H	56.9	-7.1	49.8	28.9	-25.8	52.9	60.8	60.0	7.9
7	433.9	3037.4	V	59.6	-7.1	52.5	30.1	-25.2	57.4	60.8	64.5	3.4
7	433.9	3037.4	H	54.8	-7.1	47.7	30.1	-25.2	52.6	60.8	59.7	8.2
8	433.9	3471.4	V	53.1	-7.1	46.0	31.1	-24.6	52.5	60.8	59.6	8.3
8	433.9	3471.4	H	51.7	-7.1	44.6	31.1	-24.6	51.1	60.8	58.2	9.7
9	433.9	3905.3	V	44.9	-7.1	37.8	32.5	-24.3	46.0	54.0	53.1	8.0
9	433.9	3905.3	H	43.7	-7.1	36.6	32.5	-24.3	44.8	54.0	51.9	9.2
10	433.9	4339.2	V	44.6	-7.1	37.5	33.1	-24.1	46.5	54.0	53.6	7.5
10	433.9	4339.2	H	45.4	-7.1	38.3	33.1	-24.1	47.3	54.0	54.4	6.7

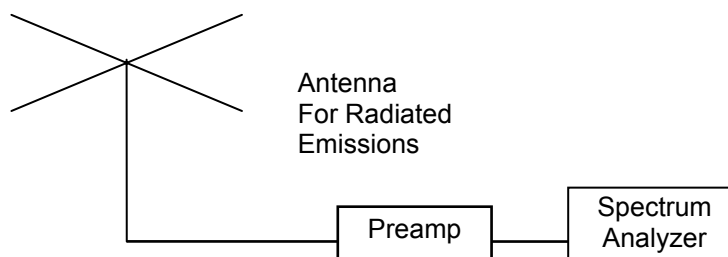
Judgment: Passed by 2.2 dB

Figure 1. Drawing of Radiated Emissions Setup



Notes:

- AC outlet with low-pass filter at the base of the turntable
- Antenna height varied from 1 to 4 meters
- Distance from antenna to tested system is 3 meters
- Not to Scale



10.2 Occupied Bandwidth Data

FCC part 15.231 requires the bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

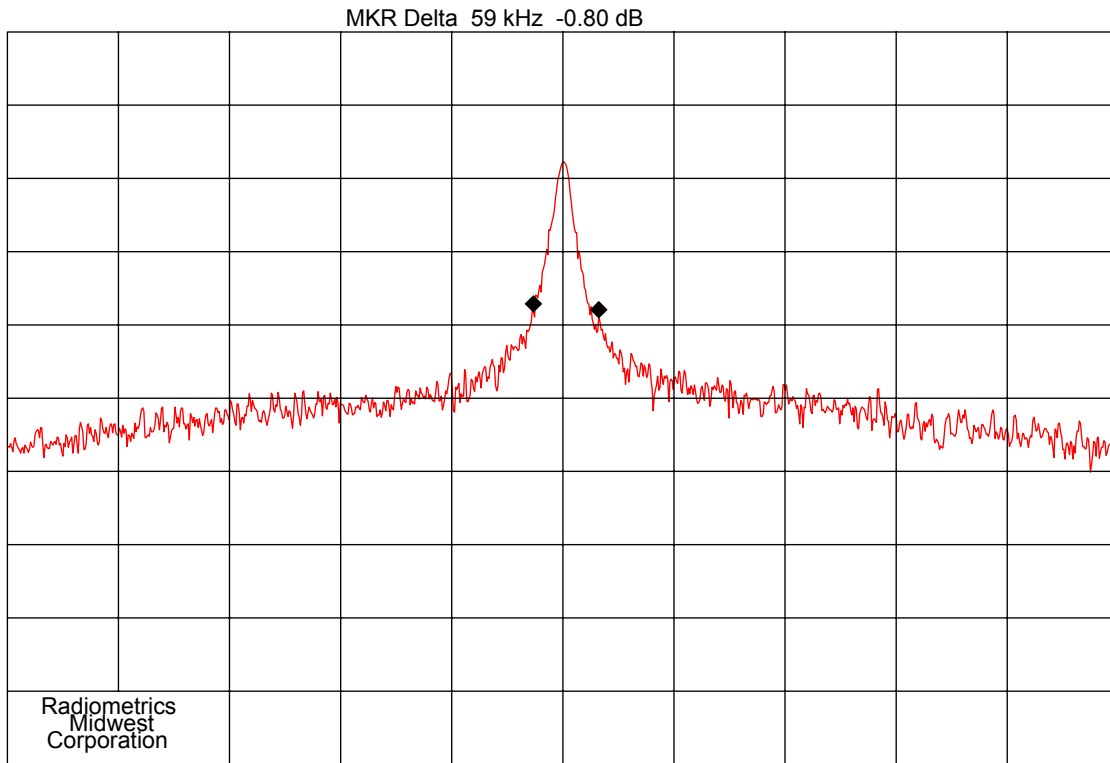
The occupied bandwidth of the RF output was measured using a spectrum analyzer. The bandwidth was measured using the peak detector function and a narrow resolution bandwidth.

A broadband antenna was used to receive the modulated signal. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The spectrum analyzer display was digitized and plotted. A limit was drawn on the plots based on the level of the modulated carrier. The plots of the occupied bandwidth for the EUT are supplied on the following page.

Figure 2. Occupied Bandwidth Plot

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COMPANY : Federal Signal
CENTER 433.93 MHz
RES BW 10 kHz
10 dB/
NOTES : Occupied Bandwidth Test,

ITEM : VisiBeam
REF 0.0 dBm
VBW 30 kHz
TIME : 09:21

DATE : 06-07-2006
SPAN 1.00 MHz
ATTEN 10 dB
SWP 30.0 msec

The 20 dB Occupied Bandwidth is 59 kHz. The FCC requirement is that the bandwidth to be less than 1.085 MHz.

Judgment: pass

10.3 Duty cycle calculation

As required by FCC section 15.35 and RSS-210 section 6.5, the Peak to Average correction factor was calculated.

A transmission message is composed of:

- 1) Preamble: 16 cycles of square wave, T=0.76ms 50% duty
- 2) Header: off time T = 3.76 ms
- 3) Message portion: 67 bits, T= 1.14 ms each 33% duty for logic '1', 66% duty for logic '0'
- 4) Blank Time after a transmission: T= 142.6 ms

Description	On time mS	Off time mS
preamble	5.9	5.9
Header off time	0	3.76
Message	38.4	38.4
Blank after Transmission	0	142.6

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Total on time for most active 100 mS	44.3	
Duty cycle for most active 100 mS	44.3 %	

The maximum total on time for any 100 mSec time period is 44.3 mSec. The peak to average factor is $20 \cdot \log(44.3/100) = -7.1$ dB