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Measured Radio Frequency Emissions
From

Martec Access Products Inc. Transmitter
FCC ID: JCQ-WMTX
IC: 1907A-WMTX

Test Report No. 417124-470
October 28, 2008

For:
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Summary

Tests for compliance with FCC Regulations, CFR 47, Part 15 and with Industry Canada RSS-210/Gen, were performed on a Martec, FCC ID: JCQ-WMTX, IC: 1907A-WMTX. This device under test (DUT) is subject to the rules and regulations as a Transmitter.

In testing completed on October 10, 2008, the DUT tested met the allowed specifications for radiated emissions by 0.3 dB. Conducted emissions are not subject to regulation as the DUT is powered by a 9 VDC battery.

Table of Contents

1. Introduction 3
2. Equipment Used 3
3. Device Under Test 4
   3.1 Description & Block Diagram 4
   3.2 Variants and Samples 4
   3.3 Modes of Operation 4
   3.4 Exemptions 4
   3.5 EMC Relevant Modifications 4
4. Emissions Limits 5
   4.1 Radiated Emissions Limits 5
   4.2 Power Line Conducted Emissions Limits 5
5. Measurement Procedures 6
   5.1 Semi-Anechoic Chamber Radiated Emissions 6
   5.2 Outdoor Radiated Emissions 6
   5.3 Radiated Field Computations 6
   5.4 Indoor Power Line Conducted Emissions 6
   5.5 Supply Voltage Variation 7
6. Test Results 7
   6.1 Radiated Emissions 7
   6.1.1 Correction for Pulse Operation 7
   6.1.2 Emission Spectrum 7
   6.1.3 Emission Bandwidth 7
   6.1.4 Supply Voltage and Supply Voltage Variation 7
   6.2 Conducted Emissions 7

1. Introduction

This Martec Transmitter was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989 as subsequently amended, and with Industry Canada RSS-210/Gen, Issue 7, June 2007. Tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI 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 Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057A-1).

2. Equipment Used

The pertinent test equipment commonly used in our facility for measurements is listed in Table 2.1 below. The middle column identifies the specific equipment used in these tests. The quality system employed at the University of Michigan Radiation Laboratory Willow Run Test Range has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to national standards.

Table 2.1 Test Equipment.

Test Instrument	Used	Manufacturer/Model	Q Number
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E, SN: 3412A01131	HP8593E1
Spectrum Analyzer (9kHz-6.5GHz)	X	Hewlett-Packard 8595E, SN: 3543A01546	JDB8595E
Power Meter		Hewlett-Packard, 432A	HP432A1
Harmonic Mixer (26-40 GHz)		Hewlett-Packard 11970A, SN: 3003A08327	HP11970A1
Harmonic Mixer (40-60 GHz)		Hewlett-Packard 11970U, SN: 2332A00500	HP11970U1
Harmonic Mixer (75-110 GHz)		Hewlett-Packard 11970W, SN: 2521A00179	HP11970W1
Harmonic Mixer (140-220 GHz)		Pacific Millimeter Prod., GMA, SN: 26	PMPGMA1
S-Band Std. Gain Horn		S/A, Model SGH-2.6	SBAND1
C-Band Std. Gain Horn		University of Michigan, NRL design	CBAND1
XN-Band Std. Gain Horn		University of Michigan, NRL design	XNBAND1
X-Band Std. Gain Horn		S/A, Model 12-8.2	XBAND1
X-band horn (8.2- 12.4 GHz)		Narda 640	XBAND2
X-band horn (8.2- 12.4 GHz)		Scientific Atlanta , 12-8.2, SN: 730	XBAND3
K-band horn (18-26.5 GHz)		FXR, Inc., K638KF	KBAND1
Ka-band horn (26.5-40 GHz)		FXR, Inc., U638A	KABAND1
U-band horn (40-60 GHz)		Custom Microwave, HO19	UBAND1
W-band horn(75-110 GHz)		Custom Microwave, HO10	WBAND1
G-band horn (140-220 GHz)		Custom Microwave, HO5R	GBAND1
Bicone Antenna (30-250 MHz)	X	University of Michigan, RLBC-1	LBBIC1
Bicone Antenna (200-1000 MHz)	X	University of Michigan, RLBC-2	HBBIC1
Dipole Antenna Set (30-1000 MHz)	X	University of Michigan, RLDP-1,-2,-3	UMDIP1
Dipole Antenna Set (30-1000 MHz)		EMCO 3121C, SN: 992 (Ref. Antennas)	EMDIP1
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223	EMROD1
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855	EMLOOP1
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan	UMRH1
Amplifier (5-1000 MHz)	X	Avantek, A11-1, A25-1S	AVAMP1
Amplifier (5-4500 MHz)	X	Avantek	AVAMP2
Amplifier (4.5-13 GHz)		Avantek, AFT-12665	AVAMP3
Amplifier (6-16 GHz)		Trek	TRAMP1
Amplifier (16-26 GHz)		Avantek	AVAMP4
LISN Box		University of Michigan	UMLISN1
Signal Generator		Hewlett-Packard 8657B	HPSG1

3. Device Under Test

3.1 Description & Block Diagram

The DUT is a 318 MHz Transmitter designed for remote control applications, and as such it is powered by a 9 VDC source. The device is housed in a plastic case approximately 2 x 3 x 0.75 inches in dimension. The DUT is designed and manufactured by Martec Access Products Inc, 240 Sheffield Street, Mountainside, New Jersey 07092.

Device	[Make], Model	[S/N],P/N	EMC Consideration
DUT	[Martec], MMTC 535T	[Proto 1]	FCC/IC
DUT	[Martec], MMTC 639T	[Proto 1]	FCC/IC
DUT	[Martec], MMTC 733T	[Proto 1]	FCC/IC
DUT	[Martec], MMTC 831T	[Proto 1]	FCC/IC

3.2 Variants and Samples

There are four variants of the device under test. Model 535T is a fully populated model with 3 pushbuttons and two rotary switches. Models 639T and 733T each have one rotary switch with 3 pushbuttons, and model 831T has only 3 pushbuttons. One sample was provided for testing, the fully populated 535T. Measurements were made for the other models by depopulating buttons and switches.

3.3 Modes of Operation

The DUT is capable of only a single operating mode (On-Off Keyed) with different bit combinations sent for each button.

3.4 Exemptions

None.

3.5 EMC Relevant Modifications

No EMI Relevant Modifications were performed by this test laboratory. To measure worst case emissions of the models employing fewer buttons/switches, the test lab removed these components for testing.

4. Emissions Limits

4.1 Radiated Emissions Limits

The DUT tested falls under the category of an Intentional Radiator. The applicable testing frequencies and corresponding emission limits set by both the FCC and IC are given in Tables 4.1 and 4.2 below.

Table 4.1. TX Emission Limits (FCC: 15.231(b), .205(a); IC: RSS-210 2.7 T4).

Frequency (MHz)	Fundamental Ave. E_{lim} (3m) (µV/m)	dB (µV/m)	Spurious** Ave. E_{lim} (3m) (µV/m)	dB (µV/m)
260.0-470.0	3750-12500*		375-1250	
315	6042	75.6	604.2	55.6
433.9	10966	80.8	1096.6	60.8
322-335.4 399.9-410 608-614	Restricted Bands		200	46.0
960-1240/1427(IC) 1300-1427 1435-1626.5 1645.5-1646.5 (IC) 1660-1710 1718.9-1722.2 2200-2300	Restricted Bands		500	54.0

* Linear interpolation, formula: E = -7083 + 41.67*f (MHz)
** Measure up to tenth harmonic; 120 kHz BW up to 1 GHz, 1 MHz BW above 1 GHz

Table 4.2. Spurious Emission Limits (FCC: 15.33, .35, .109/209; IC: RSS-210 2.7, T2)

Freq. (MHz)	E_{lim} (3m) µV/m	E_{lim} dB(µV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-2000	500	54.0

Note: Average readings apply above 1000 MHz (1 MHz BW), Quasi-Peak readings apply to 1000 MHz (120 kHz RBW), PRF of intentional emissions > 20 Hz for QPK to apply.

4.2 Power Line Conducted Emissions Limits

Table 4.3 Emission Limits (FCC:15.107 (CISPR); IC: RSS-Gen, 7.2.2 T2).

Frequency (MHz)	Class A (dBµV) Quasi-peak	Class A (dBµV) Average	Class B (dBµV) Quasi-peak	Class B (dBµV) Average
.150 - 0.50	79	66	66 - 56*	56 - 46*
0.50 - 5	73	60	56	46
5 - 30	73	60	60	50

Notes:
1. The lower limit shall apply at the transition frequency
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15-0.50 MHz:
   *Class B Quasi-peak: dBµV = 50.25 - 19.12*log(f)
   *Class B Average: dBµV = 40.25 - 19.12*log(f)
3. 9 kHz RBW

5. Measurement Procedures

5.1 Semi-Anechoic Chamber Radiated Emissions

To become familiar with the radiated emission behavior of the DUT, the device is first studied and measured in our shielded semi-anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with a turntable, an antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

The DUT is laid on the test table as shown in the included block diagram. A shielded loop antenna is employed when studying emissions from 9 kHz to 30 MHz. Above 30 MHz and below 250 MHz a biconical antenna is employed. Above 250 MHz a ridge or and standard gain horn antennas are used. The spectrum analyzer resolution and video bandwidths are set so as to measure the DUT emission without decreasing the emission bandwidth (EBW) of the device. Emissions are studied for all orientations (3-axes) of the DUT and all test antenna polarizations. In the chamber spectrum and modulation characteristics of the carrier are recorded. This data is presented in subsequent sections.

5.2 Outdoor Radiated Emissions

After measurements are performed indoors, emissions on our outdoor 3-meter Open Area Test Site (OATS) are made. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. Any intentionally radiating elements are placed on the test table flat, on their side, and on their end (3-axes) and worst case emissions are recorded. For devices with intentional emissions below 30 MHz, our shielded loop antenna is used and low frequency field extrapolation to the regulatory limit distance is employed as needed. Emissions between 30 MHz and 1 GHz are measured using tuned dipoles and/or biconical antennas. Care is taken to ensure that the RBW and VBW used meet the regulatory requirements, and that the EBW of the DUT is not reduced. The Photographs included in this report show the DUT on the OATS.

5.3 Radiated Field Computations

To convert the dBm values measured on the spectrum analyzer to dB(μV/m), we use expression

$$E3(dB\mu V/m) = 107 + PR + KA - KG + KE - CF$$

where

where	PR	=	power recorded on spectrum analyzer, dB, measured at 3 m
	KA	=	antenna factor, dB/m
	KG	=	pre-amplifier gain, including cable loss, dB
	KE	=	duty correction factor, dB
	CF	=	distance conversion (employed only if limits are specified at alternate distance), dB

When presenting the data at each frequency, the highest measured emission under all of the possible DUT orientations (3-axes) is given.

5.4 Indoor Power Line Conducted Emissions

When applicable, power line conducted emissions are measured in our semi-anechoic chamber. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration.

The conducted emissions measured with the spectrum analyzer and recorded (in dBμV) from 0-2 MHz and 2-30 MHz for both the ungrounded (Hi) and grounded (Lo) conductors. The spectrum analyzer is set to peak-hold mode in order to record the highest peak throughout the course of functional operation. Only when the emission exceeds or is near the limit are quasi-peak and average detection used.

5.5 Supply Voltage Variation

Measurements of the variation in the fundamental radiated emission were performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value. For battery operated equipment, tests were performed using a new battery, and worst case emissions are re-checked employing a new battery.

6. Test Results

6.1 Radiated Emissions

6.1.1 Correction for Pulse Operation

When the transmitter is activated by manual button press, it can, in the worst case, transmit eighteen 3.90 ms on-bits in a given 100 ms window. See Figure 6.1. Computing the duty factor results in:

$$K_E = (18 \times 3.90 \text{ ms}) / 100 \text{ ms} = 0.702 \text{ or } -3.1 \text{ dB}.$$

6.1.2 Emission Spectrum

The relative DUT emission spectrum is recorded and is shown in Figure 6.2.

6.1.3 Emission Bandwidth

The emission bandwidth of the signal is shown in Figure 6.3. The allowed 99% bandwidth is 0.25% of 318 MHz, or 795 kHz. From the plot we see that the EBW is 65.0 kHz, and the center frequency is 318 MHz.

6.1.4 Supply Voltage and Supply Voltage Variation

The DUT has been designed to be powered by a 9 VDC battery. For this test, relative radiated power was measured at the fundamental as the voltage was varied from 6.0 to 12.0 volts. The emission variation is shown in Figure 6.4.

Batteries:	before testing	V_{oc}	=	9.47 V
	after testing	V_{oc}	=	9.42 V
Ave. current from batteries		I	=	4.2 mA (pulsed)

6.2 Conducted Emissions

These tests do not apply, since the DUT is powered from a 9 VDC battery.

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Table 6.1 Highest Emissions Measured

#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3* dBµV/m	E3lim dBµV/m	Pass dB	Comments
	Radiated Emission - RF										Martec Wall Unit Tx; FCC/IC
1	**Model 535T (most populated)**										
2	318.0	Dip	H	-34.3	Pk	18.7	21.5	66.8	75.8	**9.0**	flat
3	318.0	Dip	V	-38.0	Pk	18.7	21.5	63.1	75.8	12.7	end
4	636.0	Dip	H	-63.9	Pk	24.5	18.4	46.0	55.8	9.8	flat
5	636.0	Dip	V	-64.9	Pk	24.5	18.4	45.0	55.8	10.8	end
6	954.0	Dip	H	-70.5	Pk	28.9	16.5	45.8	55.8	10.0	flat
7	954.0	Dip	V	-71.4	Pk	28.9	16.5	44.9	55.8	10.9	end
8	1272.0	Horn	H	-48.3	Pk	20.7	28.1	48.1	54.0	5.9	flat
9	1590.0	Horn	H	-51.0	Pk	21.5	28.1	46.3	54.0	7.7	side
10	1908.0	Horn	H	-57.7	Pk	22.3	28.1	40.3	55.8	15.5	side
11	2226.0	Horn	H	-57.5	Pk	23.1	27.1	42.4	54.0	11.6	flat
12	2544.0	Horn	H	-54.6	Pk	23.9	27.5	45.7	55.8	10.1	side
13	2862.0	Horn	H	-50.4	Pk	24.9	26.7	51.7	54.0	2.3	side (worst case)
14	3180.0	Horn	H	-51.9	Pk	25.9	25.0	52.9	55.8	2.9	side (worst case)
15	**Model 831T**										
16	2862.0	Horn	H	-49.0	Pk	24.9	26.7	53.1	54.0	0.9	side
17	3180.0	Horn	H	-54.5	Pk	25.9	25.0	50.3	55.8	5.5	side
18	**Model 733T**										
19	2862.0	Horn	H	-48.4	Pk	24.9	26.7	53.7	54.0	**0.3**	side
20	3180.0	Horn	H	-51.5	Pk	25.9	25.0	53.3	55.8	2.5	side
21	**Model 639T**										
22	2862.0	Horn	H	-50.5	Pk	24.9	26.7	51.6	54.0	2.4	side
23	3180.0	Horn	H	-53.3	Pk	25.9	25.0	51.5	55.8	4.3	side
24											
25	* Includes 3.1 dB duty factor										
26											
27											
28											
29											

Digital Radiated Emissions

#	Freq. kHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3 dBµV/m	E3lim dBµV/m	Pass dB	Comments
30											
31	Digital emissions more than 20 dB below FCC/IC Class B Limit.										
32											
33											
34											
35											
36											

Meas.10/08/08; U of Mich.

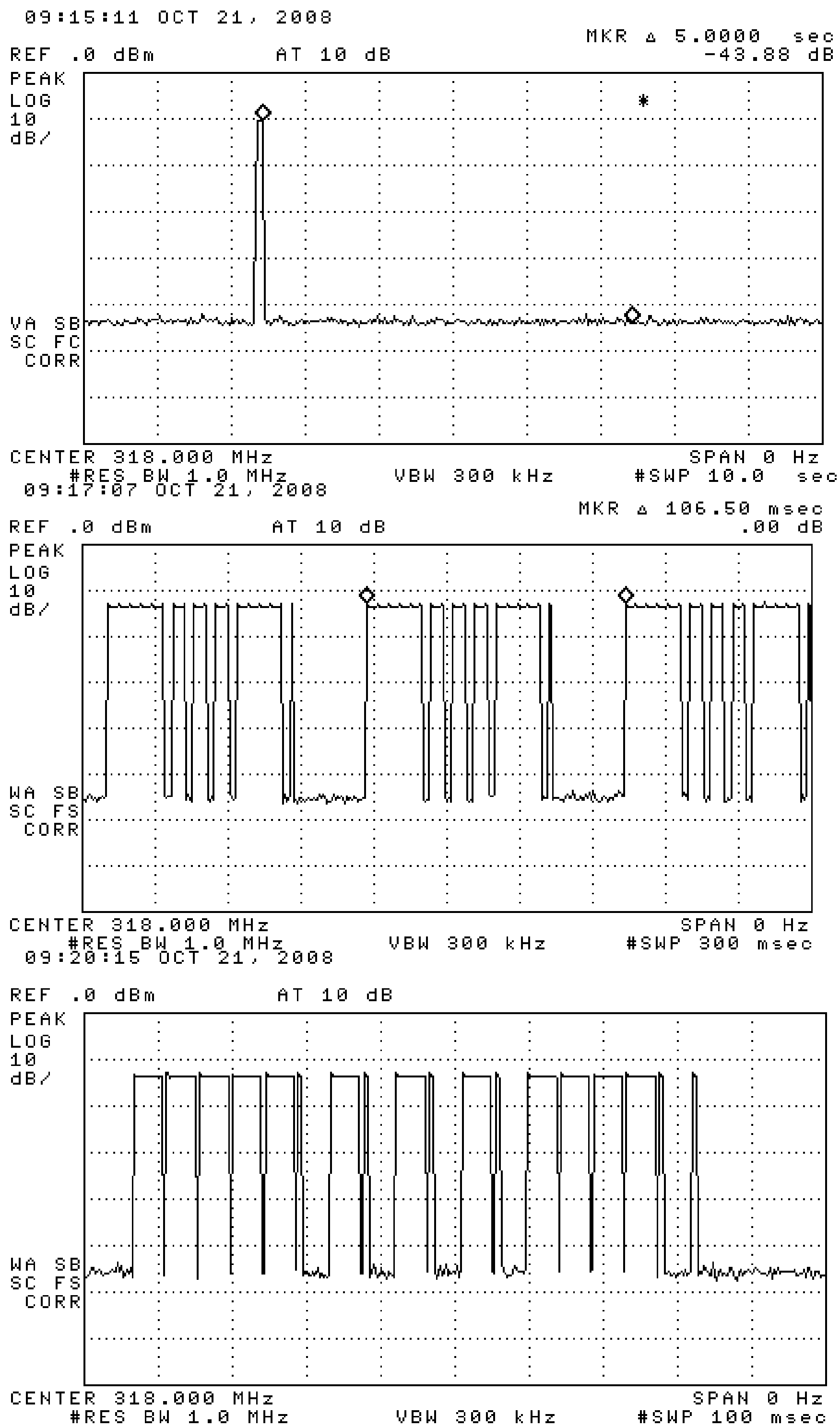

Figure 6.1(a). Transmission modulation characteristics. (top) transmission from button press, (center) maximum re-transmit rate for held button, (bottom) expanded word.

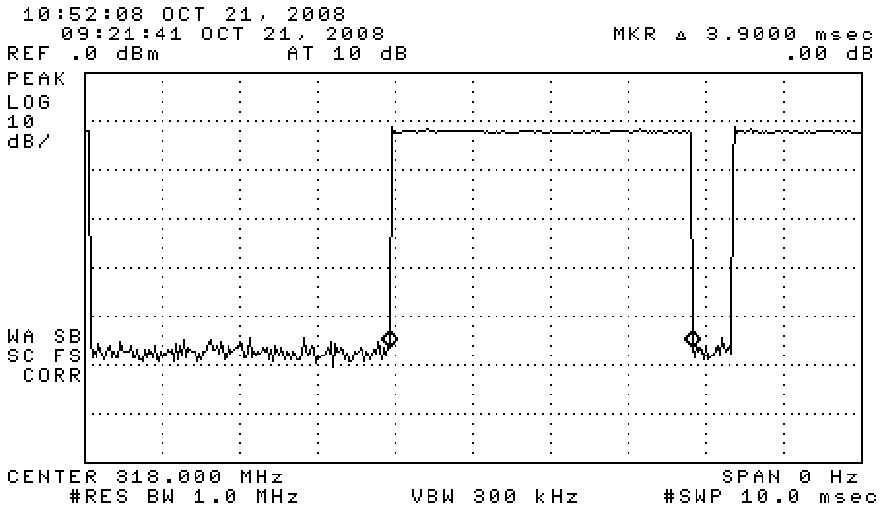

Figure 6.1(b). Transmission modulation characteristics. Single bit.

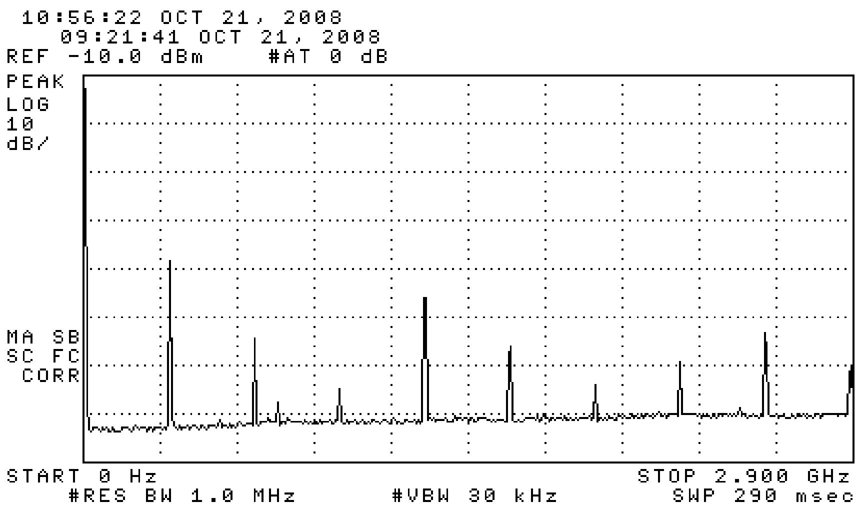

Figure 6.2. Emission spectrum of the DUT (pulsed emission). Amplitudes are only indicative (not calibrated).

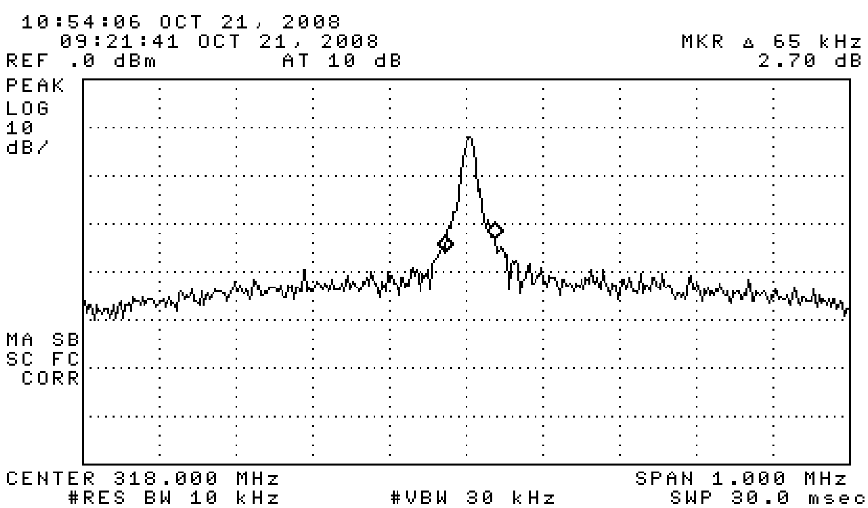

Figure 6.3. Measured emission bandwidth of the DUT (pulsed).

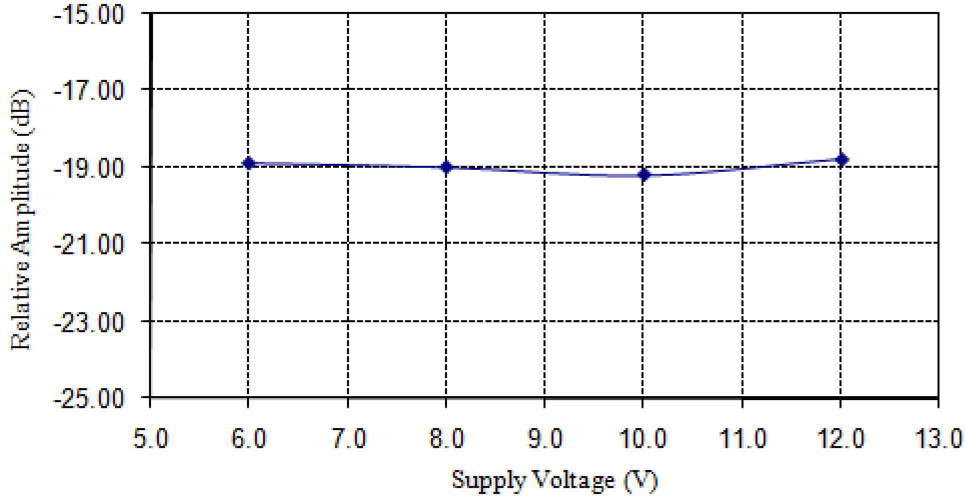

Figure 6.4. Relative emission at fundamental vs. supply voltage (pulsed).

Photograph 6.5. DUT on OATS (one of three axes tested)

Photograph 6.6. Close-up of DUT on OATS (one of three axes tested)