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Measured Radio Frequency Emissions
From

Continental Automotive Systems US Inc. Transceiver
FCC ID: M3NA2C31243300
IC: 7812A-A2C31243300

Test Report No. 417124-627
April 16, 2012

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 Continental, FCC ID: M3NA2C31243300, IC: 7812A-A2C31243300. This device under test (DUT) is subject to the rules and regulations as a Transceiver.

In testing completed on January 25, 2012, the DUT tested met the allowed specifications for radiated emissions by 1.0 dB. Band edge spurious is demonstrated to be more than 50 dB down from the peak in-band emission. AC Power line conducted emissions are not subject to regulation as the DUT is powered by a 3 VDC battery.

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1. Introduction

This Continental transceiver 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 8. 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	X	S/A, Model SGH-2.6	SBAND1
C-Band Std. Gain Horn	X	University of Michigan, NRL design	CBAND1
XN-Band Std. Gain Horn	X	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)	X	Scientific Atlanta , 12-8.2, SN: 730	XBAND3
K-band horn (18-26.5 GHz)	X	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)	X	Avantek, AFT-12665	AVAMP3
Amplifier (6-16 GHz)		Trek	TRAMP1
Amplifier (16-26 GHz)	X	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 902 MHz Transceiver designed for automotive/vehicular remote keyless entry applications, and as such it is powered by a 3 VDC lithium battery source. The device is housed in a plastic case approximately 2.5 x 1 x inches in dimension. The DUT is designed and manufactured by Continental Automotive Systems US Inc., 2400 Executive Hills Drive, Auburn Hills Michigan 48326-2980.

Device	[Make], Model	[S/N],P/N	EMC Consideration
DUT	[Continental]	A2C31243300	15.249 / RSS-210
DUT	[Continental]	A2C31244600	15.249 / RSS-210

3.2 Variants & Samples

There are two electrically identical variants of the DUT, model A2C31243300 employing a Ford logo, and model A2C31244600 employing a Lincoln logo. Normal operating, receive only, and CW modified samples of both variants were provided for testing.

3.3 Modes of Operation

The DUT operates on two channels (frequencies), CH1 at 903.425MHz and CH2 at 902.375MHz. Upon manual button press the DUT transmits two FSK frames at CH1, then two FSK frames at CH2, then a final pair of frames at CH1. Upon encoded 125 kHz LF interrogation of the DUTs LF coil, the DUT transmits only two frames at one frequency, CH1. The DUT’s UHF receiver is set to receive at the same frequency that was last transmitted (e.g. after each frame it listens for a response from the vehicle).

3.4 Exemptions

None.

3.5 EMC Relevant Modifications

No EMI Relevant Modifications were performed by this test laboratory.

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: 15.249; IC: RSS-210e A2.9).

Frequency (MHz)	Field Strength of Fundamental (mV/m)	Field Strength of Harmonics (µV/m)
902.0 – 928.0	50	500
2400 - 2483.5	50	500
5725.0 – 5875.0	50	500
24000.0 – 24250.0	250	2500

1) Field strength limits are specified at a distance of 3 meters.
2) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209 (Class B), whichever is the lesser attenuation.
3) Peak field strength of any emission above 1GHz shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. (15.35)

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.

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)		Class B (dBµV)	
	Quasi-peak	Average	Quasi-peak	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 and/or photographs. 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 intentional carriers are recorded. Receiver spurious emissions are measured with an appropriate carrier signal applied. Associated test 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, when applicable. 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 each configuration the DUT is rotated 360 degrees about its azimuth and the receive antenna is raised and lowered between 1 and 4 meters to maximize radiated emissions from the device. Receiver spurious emissions are measured with an appropriate carrier signal applied. For devices with intentional emissions below 30 MHz, our shielded loop antenna at a 1 meter receive height is used. 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 Test Setup.

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 PR = power recorded on spectrum analyzer, dBm, 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 Peak to Quasi-peak and Average Ratio

Below 1 GHz, the peak measured data is employed to demonstrate compliance with the Quasi-peak regulations. However, when the transmitter is activated (either by button press or LF interrogation), it can, in the worst case, transmit one 52.5 ms frame within any given 100 ms window at both frequencies employed. The following duty factor is thus computed for application to emissions above 1 GHz. See Figure 6.1.

$$K_E = 52.5 \text{ ms} / 100 \text{ ms} = 0.525 \text{ or } -5.6 \text{ dB}.$$

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. Therein the 99% bandwidth measured to be 70kHz in both CH1 and CH2.

6.1.4 Supply Voltage and Supply Voltage Variation

The DUT has been designed to be powered by a 3 VDC battery. For this test, relative radiated power was measured at the fundamental as the voltage was varied from 2.0 to 4.0 volts. The emission variation is shown in Figure 6.4.

Batteries:	before testing	V_{oc} =	3.28 V
	after testing	V_{oc} =	3.03 V
Ave. current from batteries		I =	15.3 mA (cw)

6.2 Conducted Emissions

These tests do not apply, since the DUT is powered from a 3 VDC battery.

Table 6.1 Worst Case Radiated Emissions

	Radiated Emissions										›rd PEPS MY13; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr. (PK) dBm	Det. Used	Ka dB/m	Kg dB	E3* dBμV/m	E3lim dBμV/m	Pass dB	Comments
1	**PN: A2C31243300 (Ford Logo), CH1**										
2	903.4	Dip	H	-24.5	Pk	28.3	18.0	92.8	94.0	1.2	flat
3	903.4	Dip	V	-25.2	Pk	28.3	18.0	92.1	94.0	1.9	end
4	1806.8	Horn RG	H/V	-43.1	Pk	22.1	28.0	52.4	54.0	1.6	flat
5	2710.2	Horn RG	H/V	-59.1	Pk	24.7	25.9	41.1	54.0	12.9	side
6	3613.6	Horn RG	H/V	-54.0	Pk	27.4	23.9	50.8	54.0	3.2	side
7	4517.0	Horn C	H/V	-63.1	Pk	24.5	33.0	29.8	54.0	24.2	max all
8	5420.4	Horn C	H/V	-41.9	Pk	24.7	38.0	46.2	54.0	7.8	max all
9	6323.8	Horn XN	H/V	-45.4	Pk	24.4	38.0	42.4	54.0	11.6	max all
10	7227.2	Horn XN	H/V	-49.7	Pk	25.1	36.8	40.0	54.0	14.0	max all
11	8130.6	Horn X	H/V	-50.1	Pk	27.0	36.8	41.5	54.0	12.5	max all
12	9034.0	Horn X	H/V	-57.7	Pk	27.5	36.8	34.4	54.0	19.6	max all
13	**PN: A2C31243300 (Ford Logo), CH2**										
14	902.4	Dip	H	-24.3	Pk	28.3	18.0	93.0	94.0	**1.0**	flat
15	902.4	Dip	V	-25.1	Pk	28.3	18.0	92.2	94.0	1.8	end
16	1804.8	Horn RG	H/V	-42.5	Pk	22.1	28.0	53.0	54.0	**1.0**	flat
17	2707.2	Horn RG	H/V	-58.5	Pk	24.7	25.9	41.7	54.0	12.3	side
18	3609.6	Horn RG	H/V	-54.6	Pk	27.3	23.9	50.2	54.0	3.8	side
19	4512.0	Horn C	H/V	-62.6	Pk	24.5	33.0	30.4	54.0	23.6	max all
20	5414.4	Horn C	H/V	-42.1	Pk	24.7	38.0	46.0	54.0	8.0	max all
21	6316.8	Horn XN	H/V	-40.1	Pk	24.4	38.0	47.7	54.0	6.3	max all
22	7219.2	Horn XN	H/V	-46.2	Pk	25.1	36.8	43.5	54.0	10.5	max all
23	8121.6	Horn X	H/V	-50.2	Pk	27.0	36.8	41.4	54.0	12.6	max all
24	9024.0	Horn X	H/V	-56.3	Pk	27.5	36.8	35.8	54.0	18.2	max all
25											
26	**PN: A2C31244600 (Lincoln Logo), CH1 & CH2 worst case**										
27	903.4	Dip	V	-24.1	Pk	28.3	18.0	93.2	94.0	1.2	flat
28	902.4	Dip	V	-24.4	Pk	28.3	18.0	92.9	94.0	1.1	flat
29	* No duty has been applied to the fundamental emission, Pk. Measurement complies with QPk limit.										
30	*A duty cycle of 5.6 dB has been applied to emissions above 1 GHz to show compliance with the average limits.										
	Digital/Spurious/Receiver 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
31	902.7	SBic	H,V	-83.0	QP	29.3	18.0	35.3	46.0	10.7	Rx. LO, noise
32	903.7	SBic	H,V	-82.9	QP	29.3	18.0	35.4	46.0	**10.6**	Rx. LO, noise
33	1805.4	Horn RG	H,V	-79.8	Ave	22.1	28.0	21.3	54.0	32.7	2 x Rx. LO, both, noise
34	2708.1	Horn RG	H,V	-80.6	Ave	24.7	25.9	25.2	54.0	28.8	3 x Rx. LO, both, noise
35	3610.8	Horn RG	H,V	-81.9	Ave	27.3	23.9	28.5	54.0	25.5	4 x Rx. LO, both, noise
36	4518.5	Horn C	H/V	-71.3	Ave	24.5	33.1	27.2	54.0	26.8	5 x Rx. LO, both, noise
37	All digital emissions are noise measurements, more than 20 dB below Class B limits.										

Meas. 1/25,3/27/2012; U of Mich.

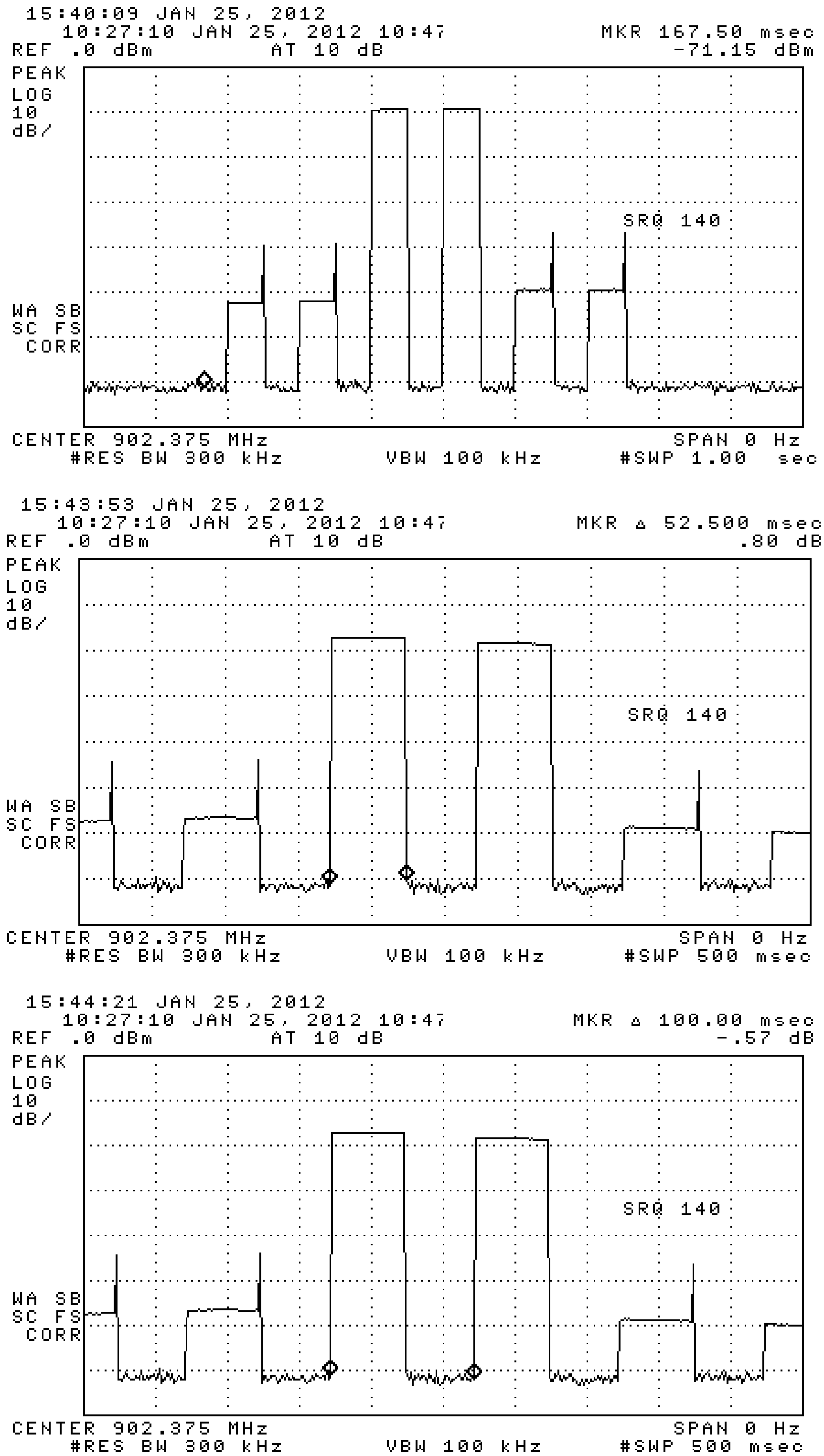
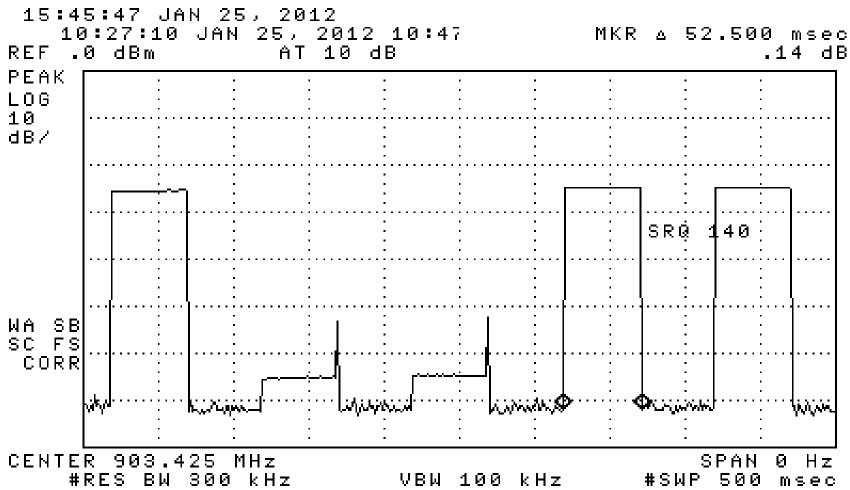


Figure 6.1(a). Transmission modulation characteristics.

(top) complete transmission, (center) frame length in CH2, (bottom) frame period on CH2.



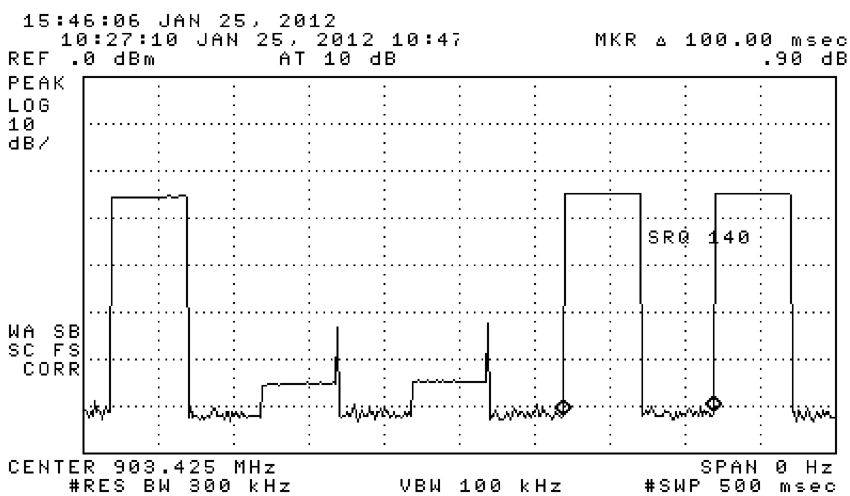


Figure 6.1(b). Transmission modulation characteristics.

(top) frame length in CH1, (bottom) frame period in CH1.

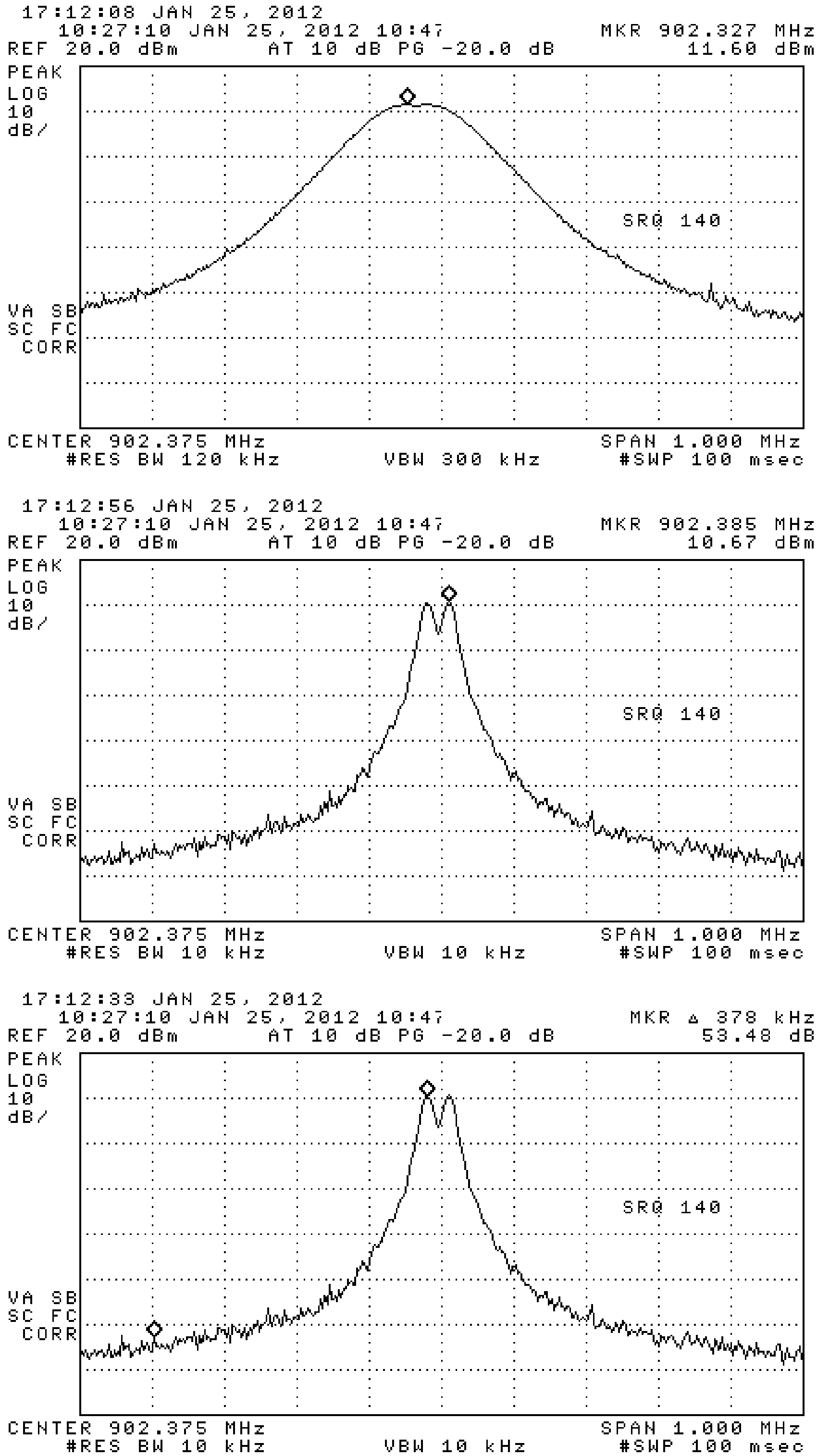


Figure 6.2. Band Edge Measurement (pulsed emission). (top) Peak Measurement in 120 kHz IFBW, (middle) Peak Measurement in 10 kHz IFBW, (bottom) Delta-Measurement in 10 kHz IFBW.

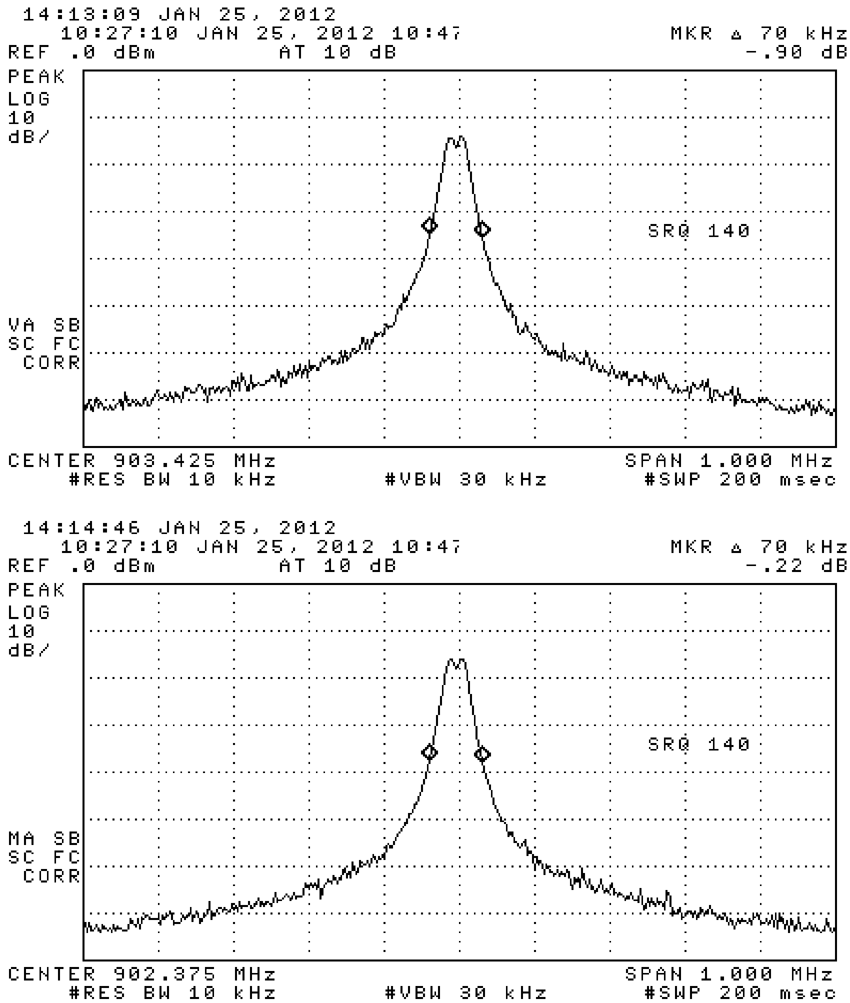


Figure 6.3. Measured emission bandwidth of the DUT. (top) CH1, (bottom) CH2

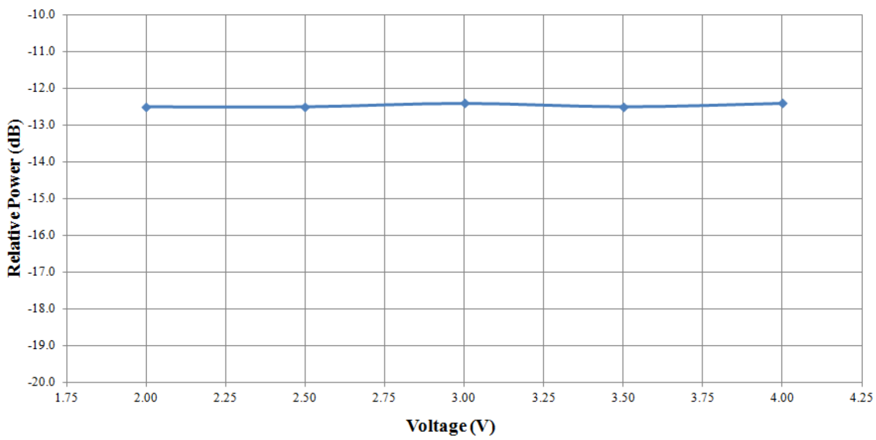


Figure 6.4. Relative emission at fundamental vs. supply voltage (pulsed).

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

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