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Measured Radio Frequency Emissions
From

Delphi 76.7 GHz Radar
FCC ID: L2C0049TR
IC: 3432A-0049TR

Report No. 417124-614
October 29, 2011

For:
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Summary

Testing for compliance with FCC Regulations Part 15, Subpart C, Section 253 and Industry Canada RSS-210 was performed on Delphi 76.7 GHz Radar model L2C0049TR. This device is subject to the Rules and Regulations as a Field Disturbance Device.

In testing completed on October 10, 2011, we determined that the L2C0049TR meets FCC/IC regulations for average power density at 3 meters by 18.4 dB in the worst case. Spurious emissions meet out of band emissions regulations by more than 10.5 dB.

1. Introduction

This Delphi 76.7 GHz Radar 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, December 2010. The tests were performed at the University of Michigan Radiation Laboratory following the procedures described in the FCC MM-Wave Test Procedures. Test site description and attenuation characteristics 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. Test Procedure and 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.

Table 2.1 Test Equipment.

Test Instrument	Eqpt. Used	Manufacturer/Model
Spectrum Analyzer (9kHz-22GHz)		Hewlett-Packard 8593A SN: 3107A01358
Spectrum Analyzer (9kHz-26GHz)		Hewlett-Packard 8593E, SN: 3412A01131
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8563E, SN: 3310A01174
Spectrum Analyzer (9kHz-40GHz)	X	Hewlett-Packard 8564E, SN: 3745A01031
Power Meter		Hewlett-Packard, 432A
Power Meter		Anritsu, ML4803A/MP
Harmonic Mixer (26-40 GHz)	X	Hewlett-Packard 11970A, SN: 3003A08327
Harmonic Mixer (40-60 GHz)	X	Hewlett-Packard 11970U, SN: 2332A00500
Harmonic Mixer (50-90 GHz)	X	Hewlett-Packard 11970V, SN: 2521A00179
Harmonic Mixer (75-110 GHz)	X	Hewlett-Packard 11970W, SN: 2521A00179
Harmonic Mixer (140-220 GHz)	X	Pacific Millimeter Prod., GMA, SN: 26
S-Band Std. Gain Horn		S/A, Model SGH-2.6
C-Band Std. Gain Horn	X	University of Michigan, NRL design
XN-Band Std. Gain Horn	X	University of Michigan, NRL design
X-Band Std. Gain Horn	X	S/A, Model 12-8.2
X-band horn (8.2- 12.4 GHz)		Narda 640
X-band horn (8.2- 12.4 GHz)		Scientific Atlanta , 12-8.2, SN: 730
K-band horn (18-26.5 GHz)		FXR, Inc., K638KF
Ka-band horn (26.5-40 GHz)	X	FXR, Inc., U638A
U-band horn (40-60 GHz)	X	Custom Microwave, HO19
W-band horn(75-110 GHz)	X	Custom Microwave, HO10
G-band horn (140-220 GHz)	X	Custom Microwave, HO5R
Bicone Antenna (30-250 MHz)		University of Michigan, RLBC-1
Bicone Antenna (200-1000 MHz)		University of Michigan, RLBC-2
Dipole Antenna Set (30-1000 MHz)		University of Michigan, RLDP-1,-2,-3
Dipole Antenna Set (30-1000 MHz)		EMCO 2131C, SN: 992
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan
Amplifier (5-1000 MHz)		Avantak, A11-1, A25-1S
Amplifier (5-4500 MHz)	X	Avantak
Amplifier (4.5-13 GHz)	X	Avantek, AFT-12665
Amplifier (6-16 GHz)	X	Trek
Amplifier (16-26 GHz)	X	Avantek
LISN Box		University of Michigan
Signal Generator		Hewlett-Packard 8657B

3. Device Under Test

3.1 Identification

The Device Under Test (DUT) is a 76.7 GHz vehicular radar employing two chirp modulated transmit chains, noted herein as Tx1 and Tx2 with 250 MHz chirp bandwidth. The DUT is 12 x 13 x 3.5 cm in dimension.

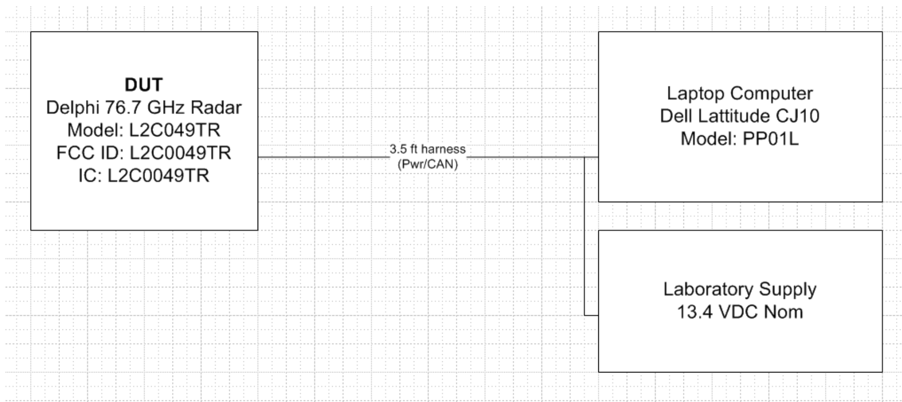


Figure 3.1 Test Configuration Block Diagram

3.2 Variants

There are two electrically identical variants of the radar in question, one for the left hand side of the vehicle and one for the right hand side of the vehicle. No electrical or mechanical differences exist between these two variants.

3.4 Samples

A laptop was provided to setup radar functionality over the CAN bus, directing the radar to operate in both the normal modulated and CW modes. In CW mode the DUT transmits out of the higher-gain Tx1 chain as discussed below. The nominal operating voltage is 13.4 VDC; for testing this was supplied by a laboratory power supply.

3.3 Modes of Operation

The DUT is capable of only one normal modulated mode of operation. When installed on a vehicle, the device operates in this mode when the vehicle is both moving and at rest. The DUT transmits repeated chirps on alternating Tx1 and Tx2 transmit chains. Each transmit chain employs a different antenna radiation pattern. The Tx1 array emits a uniform broadside pattern (normal to the radome) with a manufacturer declared gain of 14dBi, and the Tx2 chain array emits a split-beam end-fire pattern radiating in the direction toward the end of the device with a manufacturer declared gain of 7 dBi. The Tx1 chain transmission repeats with a period of 50 ms, and the Tx2 chain transmission repeats with a 100 ms period. The EUT then receives the returning chirp on a receive array and resolves object locations via digital beam forming.

3.5 EMI/EMC Relevant Modifications

There were no modifications made to the DUT by this laboratory.

4. Emission Limits

4.1 Radiated Emission Limits

The DUT tested falls under the category of an Intentional Radiator, subject to FCC Part 15.253 and Industry Canada RSS-210 / RSS-GEN. The applicable critical testing frequencies with corresponding emission limits are given in Table 4.1. As a digital device this product is exempt because as it is deployed for use only in a motor vehicle.

Table 4.1. Radiated Emission Limits (Ref: FCC: 15.253 / RSS-210)

Frequency (GHz)	Forward Looking	Side Looking	Not Moving
0.030 - 40000	per 15.209	per 15.209	per 15.209
76.0 - 77.0	60 $\mu W/cm^2$	30 $\mu W/cm^2$	200 nW/cm^2
40.0 - 200.0	600 pW/cm^2	300 pW/cm^2	dependent
200.0 - 231.0	1000 pW/cm^2	1000 pW/cm^2	1000 pW/cm^2

5. Test Procedures

5.1 Indoor Measurements

Prior to any measurements, all active components of the test setup were allowed a warm-up for a period of approximately one hour, or as recommended by their manufacturers.

For the tests, the unit was mounted at a 3 or 1 (or even 0.25 m) meter distance, depending on the available signal strength, and rotated through 360 degrees to determine the most intense radiation lobe. Care is taken such that there is no interference from the hand or body. Due to the rigid connection of the receive antenna to the spectrum analyzer in many instances, the DUT is also rotated around its antenna axes to match the polarization of the emission.

5.2 Field Calculation for Radiated Emission Measurements

When the measurement is made at a distance other than 3 m, but is called out at 3 m, the reading is extrapolated to the 3 m distance. This is done using the 20 dB/decade field behavior relation when translating in the far field, and 40 dB/decade relation when translating in the near field. The near-field/far-field criterion, N/F, is based on

$$N/F = 2\ D^2 / \text{wavelength}$$

where D is the maximum dimension of the transmitter or receiver antenna , and the wavelength is that of the measurement frequency. Suppose N/F = 2 m and the measurement is made at 1 m. Here the 40 dB/ decade relation is applied from 1 to 2 m, and a 20 dB/decade relation is applied from 2 to 3 m. In dB, this gives a 15.6 dB adjustment.

To convert the dBm measured and extrapolated to 3 m, the $E_3(dB\mu V/m)$ is computed from

$$E_3(dB\mu V/m) = 107 + Pr + CF + K_a - Kg + K_E$$

Where
- P_r = power recorded on spectrum analyzer, dBm (extrapolated to 3 m distance)
- CF = correction factor to compute peak power value from insufficient Rx bandwidth
- K_a = antenna factor, dB/m
- K_g = pre-amp gain, dB
- K_E = pulse operation correction factor, dB (see 6.1)

For conversion to power densities specified in 15.253, we used

$$EIRP\ (dBm) = S\ (dBm/cm^2) + 10\ Log_{10}(4\ \pi\ R(cm)^2)$$
$$EIRP\ (dBm) = Pr\ (dBuV/m) - 95.2\ dB$$

Thus, at a 3m distance:

$$EIRP\ (dBm) = S\ (dBm/cm^2) + 10\ Log_{10}(4\ \pi\ (300)^2) + 95.2\ dB = S\ (dBm/cm^2) + 155.74\ dB$$

and we note that

$$200\ nW/cm^2 = -37.0\ dBm/cm^2$$
$$1000\ pW/cm^2 = -60.0\ dBm/cm^2$$
$$300\ pW/cm^2 = -65.2\ dBm/cm^2$$

For microwave measurements, either the receive antenna is connected directly to the spectrum analyzer, or it is connected to an external mixer followed by an insignificant length of cable. Hence, no cable loss term is used. The mixer conversion losses are programmed in the spectrum analyzer and are included in the dB values. However, for 125 GHz and up, an external mixer with an external LO and pre-amplifier was used. The mixer conversion loss, IF amp gain and cable losses are included in mixer conversion factor.

6. Test Results

6.1 Correction for Pulse Operation

In the following measurements, the maximum spectrum analyzer RBW of 1 MHz was employed. Peak power measurements were made with the DUT employing CW mode on Tx1 channel. Duty cycle correction is then applied to determine the average power values by examining the worst-case time-domain transmission from the DUT at a single frequency for both transmit chains.

Duty Cycle to Obtain Average Power

When the DUT is operating in normal modulating mode.

Tx chain #1 (Tx1) chirps for 17.6 ms with (single frequency) chirp width of 23.6 us / 250 MHz ~ 1 us in a 28 us chirp period. This modulation repeats with a 50 ms period.

Tx chain #2 (Tx2) chirps for 16.3 ms with (single frequency) chirp width of 23.6 us / 250 MHz ~ 1 us in a 28 us chirp period. This modulation repeats with a 100 ms period.

At the end of each single (Tx1) or paired (Tx1 then Tx2) set of chirp transmissions, the carrier rests in CW at either the lowest, middle, or highest frequency in the 250 MHz chirp bandwidth for approximately 1.6 ms before it is shut-down/attenuated. During this time, it appears to radiate principally through transmit chain Tx1. This "rest" occurs at most twice in any given 100 ms window.

As the Tx1 and Tx2 chain radiation patterns overlap for this radar, the worst case single frequency duty cycle is most easily computed where both chains are assumed to contribute to a common emission along the higher gain Tx1 channel.

$$K_{ETX1} = (2 \times 1.6\ ms + 2 \times (1\ us / 28\ us \times 17.6\ ms))/\ 100\ ms) = 0.044 = -13.5\ dB$$
$$K_{ETX2} = (1\ us / 28\ us \times 16.3\ ms)/\ 100\ ms = 0.006 < -20\ dB$$
$$K_{Eboth} = (2 \times 1.6\ ms + 2\ (1\ us / 28\ us \times 17.6\ ms) + 1\ us / 28\ us * 16.3\ ms)/100\ ms) = 0.050 = \mathbf{-13.0\ dB}$$

6.2 Potential Health Hazard EM Radiation Level

We use two methods to determine health hazard levels and these are obtained (1) by probing the near field and (2) by computing EIRP from measured emission data.

(1) Direct measured radiation level from the unit is determined using a W-band Standard Gain horn fed directly into the spectrum analyzer via the harmonic mixer. The analyzer is set to RBW=1 MHz, VBW=3 MHz. The physical aperture of the horn antenna is 1.869 x 2.461cm (A = 4.60 cm^2). Its effective aperture (Aeff) at 76.5 GHz is 2.23 cm^2, based on a Gain of 22.6 dB. For the subject DUT, the near-field region was probed, rotating the DUT on all axis and polarizations and moving the DUT closer and closer to the

radome. Maximum received power was detected at the center in front of the Tx1 array. The maximum average reading at the radome was

$$P_{cw} = Pr + K_E = -7.1 \text{ dBm} - 13.0 \text{ dB} = -20.1 \text{ dBm} = 0.010 \text{ mW}$$

Hence the worst case power density of the device at its radome is

$$S_{meas}\ (\text{mW/cm}^2) = P_{cw}\ /Aeff = 0.010 \text{ mW}/\ 2.23 \text{ cm}^2 = 0.004 \text{ mW/cm}^2$$

and meets the FCC Part 1.1307, 1.1310, 2.1091, and 2.0193 requirements.

(2) The worst case power density at a given separation distance can be calculated following FCC OET Bulletin 65 as follows, where S is power density,

$Scalc_{cw}$ (3m) = -55.3 dBm/cm^2 (avg. from Table 6.1)
$EIRP_{cw}$ = Scalc (3m) x 4π (300 cm)^2 = -55.3 + 60.5 = 5.2 dBm = 3.3 mW
ERP_{cw} = EIRP – 2.15 = 5.2 – 2.15 = 3.05 dBm = 2.02 mW

S_{calc} (mW/cm^2) = EIRP(mW)/(4π R(cm)^2).

The DUT will be mounted in the bumper of an automobile, with a minimum separation of 1 cm between the radome and the exterior surface of the vehicle. Following the formulation for power density at a distance given the radar's EIRP is

S_{calc} (mW/cm^2) = 3.3 mW /(4π 1cm ^{2}) = 0.262 mW/ cm^2.

Which is an overestimated value that also demonstrates compliance with FCC Part 1.1307, 1.1310, 2.1091, and 2.0193 requirements when the DUT is mounted in the motor vehicle.

6.3 Effect of Supply Voltage Variation

The DUT is designed to operate on 13.4 VDC, originating from a vehicular 12-volt system. The relative radiated emissions and frequency were recorded at the CW mode "fundamental" (76.7 GHz) as the supply voltage was varied from 6 to 18 VDC. Figure 6.2 shows the emission power variation.

6.4 Effect of Temperature Variation on Fundamental Frequency

The DUT was cooled to –20 C and its temperature was slowly increased to +55 C, during which time the fundamental emission was monitored. Measurements of band-edge frequencies were taken every 10 C. Figure 6.3 shows the emission center frequency as a function of temperature.

6.5 Sample Field Computations

<u>FUNDAMENTAL</u>

Refer to: (a) Table 6.2 (f > 40 GHz); line 3
(c) Table 4.1; limit; (200 nW//cm^2)

To compute the power density we use:

$P3_{avg}$ dB(mW/ cm^2) = 107 + Pr(3m) + Ka - Kg + K_E – 155.74
= 107 – 38.9.0 + 45.3 – 0 – 13.0 – 155.4
= -55.3 dBm/cm^2

The limit is 200 nW/cm^2 = -37.0 dBm/cm^2

SPURIOUS
Here we present computation for the reference signal emission at 4.8 GHz.
Refer to: (a) Table 6.1 (f < 40 GHz); line 3
(c) Table 4.1; 15.209 limit; 54 dB(μV/m)

To compute received power at 3 m from that measured at 1 m, with a N/F transition at 1.49 m we use:

$$Pr(3m) = Pr(1m) - 40 \times Log10(1.49\ m / 1.0\ m) - 20 \times Log10(3\ m / 1.49\ m)$$

and field strength at 3 meters is:

$$\begin{aligned} E3\ dB(\mu V/m) &= 107 + Pr(3m) + Ka - Kg + Ke \\ &= 107 - 67.0 + 24.7 - 37.5 + 0 \\ &= 27.2\ dB(\mu V/m) \end{aligned}$$

The limit is 54.0 dB(μV/m).

Table 6.1 Highest Emissions Measured (f<40 GHz)

RF/Microwave Radiated Emissions

Delphi 49TR

#	Freq. GHz	Ant. Used	Ant. D,cm	Meas. dist, m	Pr dBm	N/F m	Pr(3m) dBm	Ka dB/m	Kg dB	E3 dBµV/m	E3lim dBµV/m	Pass dB	Comments (Notes)
1	2 to 4.5	R-Horn	15.00	1.00	-69.5	0.30	-79.0	26.0	26.5	27.5	54.0	26.5	Noise, Pk (1,3,4,5,7)
2	4.5 to 6	C-horn	21.6	1.00	-71.9	1.40	-84.4	24.7	37.5	9.8	54.0	44.2	Noise, Pk (1,3,4,5)
3	4.80	C-horn	21.6	1.00	-54.0	1.49	-67.0	24.7	37.5	27.2	54.0	**26.8**	VCO / 16, Pk (5)
4	6 to 8.6	XN-horn	28.9	1.00	-63.7	3.34	-82.8	25.3	37.0	12.5	54.0	41.5	Noise, Pk (1,3,4,5)
5	8.6to13	X-horn	19.4	3.00	-61.0	2.16	-61.0	28.5	37.0	37.5	54.0	16.5	Noise, Pk (1,3,4,5)
6	9.60	X-horn	19.4	3.00	-56.0	2.41	-56.0	29.5	37.0	43.5	54.0	**10.5**	VCO / 8, Pk. (8)
7	13to18	Ku-horn	15.2	0.25	-60.4	2.00	-100.1	29.3	17.0	19.2	54.0	34.8	Noise, Pk (1,3,4,5)
9	18to26	K-horn	12.0	0.25	-55.2	1.73	-93.6	33.2	0.0	46.6	54.0	7.4	Noise, Pk (1,3,4,5)
10	26to40	Ka-horn	12.0	0.20	-64.3	2.50	-109.7	36.0	0.0	33.3	54.0	20.7	Noise, Pk (1,3,4,5)
11													
12	NOTES:												
13	(1) When measured at stated distance from the DUT, no signal was detected.												
14	(2) Mixer conversion loss is programmed in the spectrum analyzer and automatically adjusts the readings.												
15	(3) When extrapolating to 3 m, use 40 dB/dec to far-field distance (or 3m, if 3m < N/F) and then 20 dB/dec to 3 meters.												
16	(4) For Ave. measurement a VBW >= 1% RBW was used; RBW was always 1 MHz.												
17	(5) DUT max. antenna size, D = 8.0 cm < test horn antenna dims.												
18	(6) Extermal mixer, LO, and 36.5 dB IF amp were used												
19	(7) For ridge-horn (R-Horn) use aperture dimension of one half wavelength, all horn aperatures > 8cm DUT aperature.												
20	(8) At 9.60 GHz, Peak to Average ratiowas not applied in demonstrating compliance. (Measured with DUT in CW)												
21													
22													

Digital Radiated Emissions*

#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used			Ka dB/m	Kg dB	E3 dBµV/m	E3lim dBµV/m	Pass dB	Comments
23													
24													
25													
26													
27													
28													
29													
30													
31	* For devices used in transportation vehicles, digital emissions are exempt from regulations per FCC 15.103(a) and ICES-003e												

Conducted Emissions*

#	Freq. MHz	Line Side	Det. Used	Vtest dBµV	Vlim dBµV	Pass dB							Comments
32													
33													
34	* Not applicable - DUT is powered by motor vehicle system.												

Meas. 8/1/11-10/15/11; U of Mich.

Table 6.2 Highest Emissions Measured (f>40 GHz)

RF/Microwave Radiated Emissions — Delphi 49TR

#	Freq. GHz	Ant. Used	Ant. D,cm	Meas. dist, m	Pr dBm	N/F m	Pr(3m) dBm	Ka dB/m	Kg dB	E3 dBm/cm2	E3lim dBm/cm2	Pass dB	Comments (Notes)
1	40-76	U-horn	8.0	0.20	-75.8	1.71	-117.9	41.0	0.0	-125.7	-65.2	60.5	Noise, pk. meas. (1-5)
2	76.56	W-horn	8.0	3.00	-39.1	3.27	-39.1	45.3	0.0	-42.5	-17.0	25.5	Signal chirped (pk) meas (2-6,8)
3	76.56	W-horn	8.0	3.00	-39.1	3.27	-39.1	45.3	0.0	-55.5	-37.0	18.5	Signal Avg. (2-7)
4	76.70	W-horn	8.0	3.00	-38.9	3.27	-38.9	45.3	0.0	-42.3	-17.0	25.3	Signal CW pk. meas (2-6)
5	76.70	W-horn	8.0	3.00	-38.9	3.27	-38.9	45.3	0.0	-55.3	-37.0	**18.3**	Signal Avg. (2-7)
6	76.84	W-horn	8.0	3.00	-39.9	3.28	-39.9	45.3	0.0	-43.3	-17.0	26.3	Signal chirped (pk) meas (2-6,8)
7	76.84	W-horn	8.0	3.00	-39.9	3.28	-39.9	45.3	0.0	-56.3	-37.0	19.3	Signal Avg. (2-7)
8	77-110.	W-horn	8.0	0.25	-47.9	3.29	-91.1	46.4	0.0	-93.4	-65.2	28.2	Noise, pk. meas.(1-5)
9	153.12	G-horn	8.0	0.25	-55.2	6.52	-98.4	51.3	0.0	-95.8	-65.2	30.6	Signal, pk. meas. (2-6)
10	229.68	G-horn	8.0	0.25	-77.1	9.78	-120.3	54.0	0.0	-115.0	-60.0	55.0	Noise, pk. meas. (1-6)
11	to 231	G-horn	8.0	0.25	-77.1	9.78	-120.3	54.0	0.0	-115.0	-60.0	55.0	Noise, pk. meas. (1-6)
12	NOTES:												
13	(1) When measured at 0.25 cm from the DUT, no signal was detected anywhere, even at the radome.												
14	(2) Mixer conversion loss is programmed in the spectrum analyzer and automatically adjusts the readings.												
15	(3) When extrapolating to 3 m, use 40 dB/dec to far-field distance (or 3m, if 3m < N/F) and then 20 dB/dec to 3 meters.												
16	(4) For Ave. measurement a VBW >= 1% RBW was used; RBW was always 1 MHz.												
17	(5) DUT max. antenna size, D = 8.0 cm > All test horn aperatures.												
18	(6) Extermal mixer, LO, and 36.5 dB IF amp were used												
19	(7) Average Power Limits Apply. Duty of -13.0 dB applied to peak CW number (see section 6.1 of test report)												
20	(8) Peak fundamental emission at ends of band could only be measured in chirp mode, DUT cw mode is only avaliable at middle of band.												
21													

RF Health Hazard - Fundamental

#	Freq. GHz	Ant. Used	Ant. D,cm	Meas. dist, m	Pr dBm	N/F m	Pr(3m) dBm	Ka dB/m	Kg dB	E3 dBm/cm2	EIRP dBm	S (1cm) mW/cm^2	Comments (Notes)
22	76.4	W-horn	8.0	3.00	-38.9	3.26	-38.9	45.3	0.0	-42.3	18.2	5.25	Peak
23	76.4	W-horn	8.0	3.00	-38.9	3.26	-38.9	45.3	0.0	-55.3	5.2	**0.26**	Average
24													

RF Health Hazard - Spurious

#	Freq. GHz	Ant. Used	Ant. D,cm	Meas. dist, m	Pr dBm	N/F m	Pr(3m) dBm	Ka dB/m	Kg dB	E3 dBμV/m	EIRP dBm	S (1cm) mW/cm^2	Comments (Notes)
25	4.80	C-horn	21.6	1.00	-54.0	0.15	-63.5	24.7	37.5	30.7	-64.5	0.000000	Peak
26	9.60	X-horn	19.4	3.00	-56.0	2.41	-56.0	29.5	37.0	43.5	-51.7	**0.000001**	Peak
27													
28													
29													
30													
31													
32													

Meas. 8/1/11-10/15/11; U of Mich.

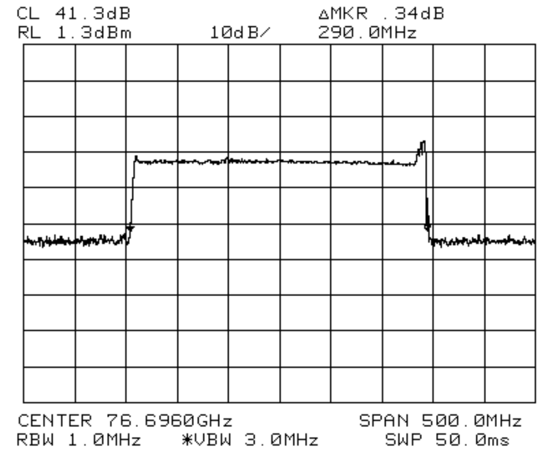


Fig. 6.1(a) Emission Spectrum + Emission Bandwidth (Tx1 + Tx2 along boresight)

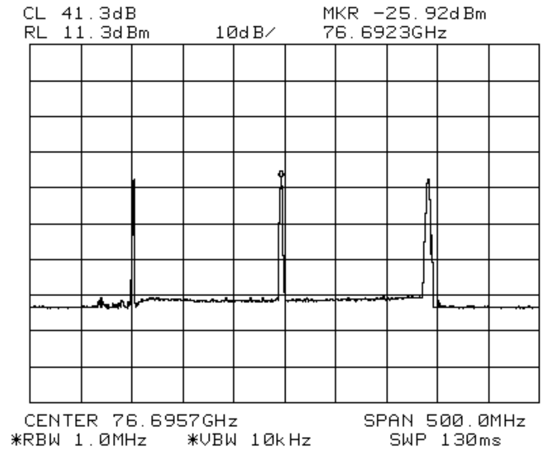


Fig. 6.1(b) Average Emissions dominate at Low, Mid, High

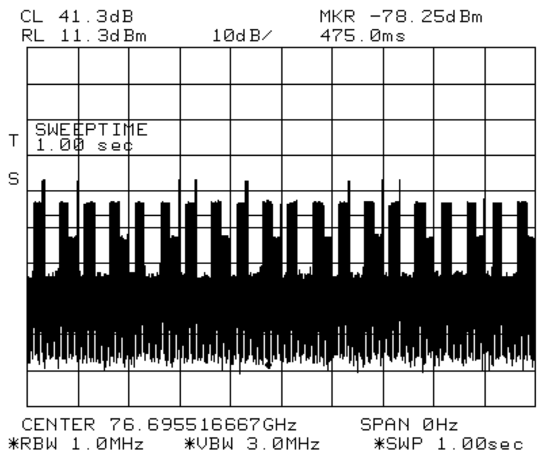


Fig. 6.1(c) Center Frequency Time Domain Chirp

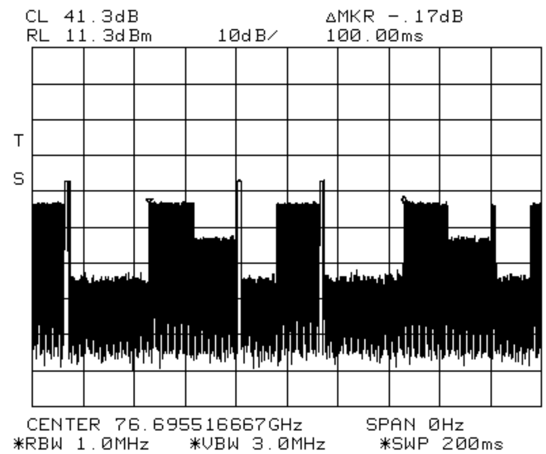


Fig. 6.1(d) Repeated Chirp Sequence for Tx1 and Tx2 Chains

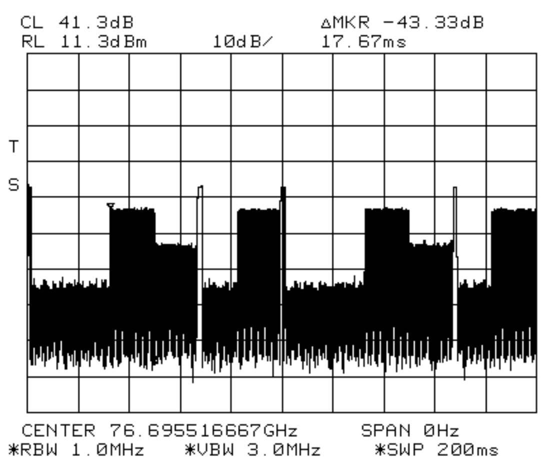


Fig. 6.1(e) Tx1 Chain Chirp duration measured (17.7 ms).

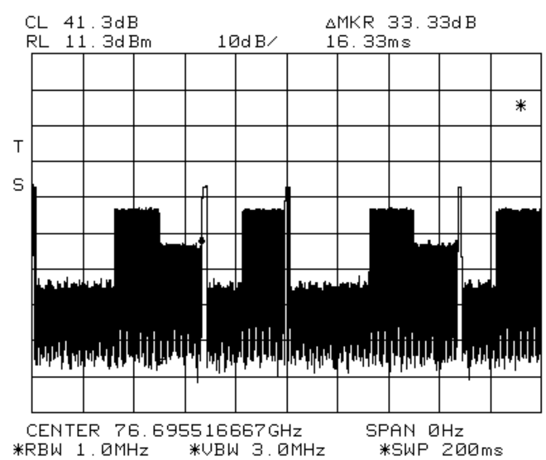


Fig. 6.1(f) Tx2 Chain Chirp duration measured (16.3 ms)

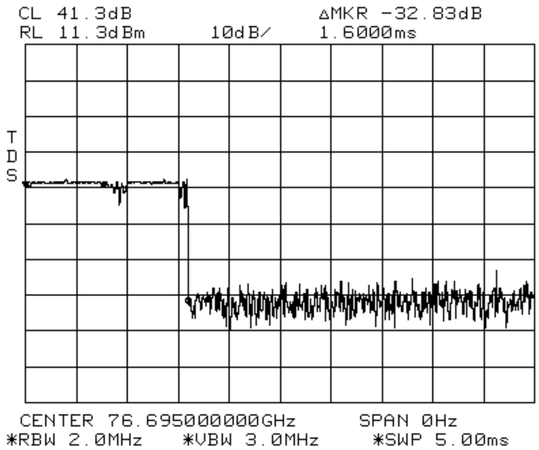


Fig. 6.1(g) CW “rest” emission measured (1.600 ms)

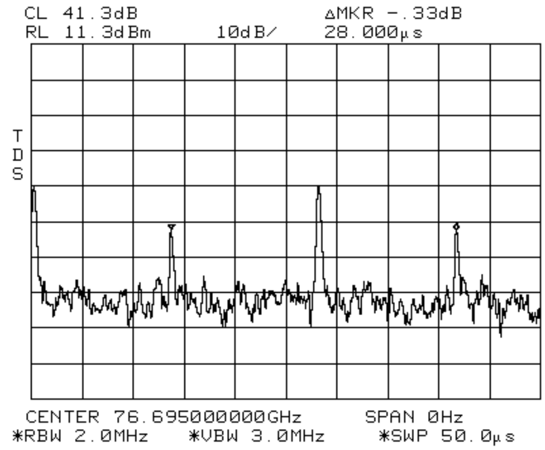


Fig. 6.1(h) Single frequency chirp period (same for Tx1&2 chains)

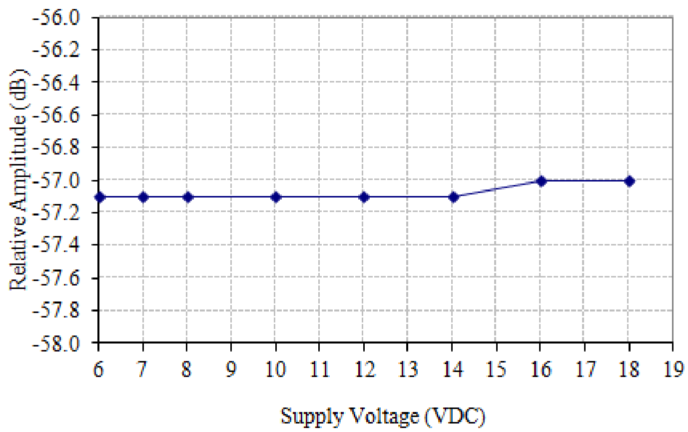


Fig. 6.2 Relative amplitude vs. supply voltage.

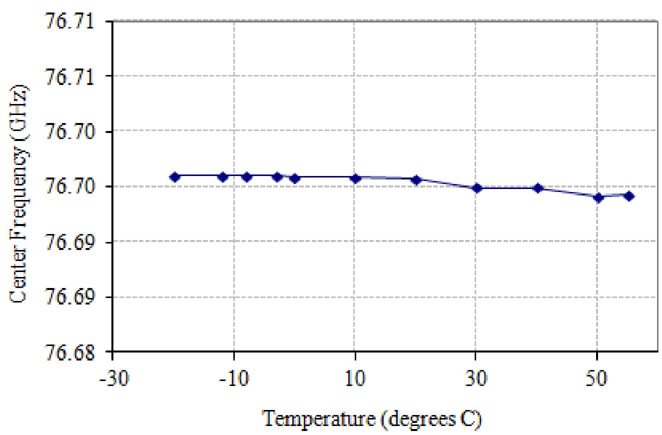
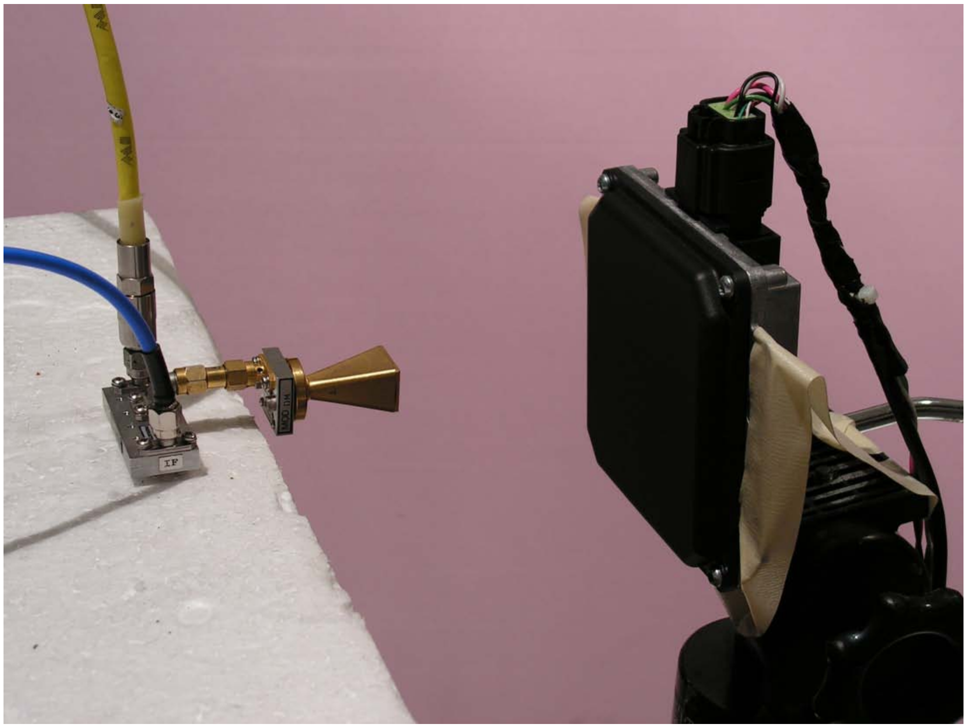
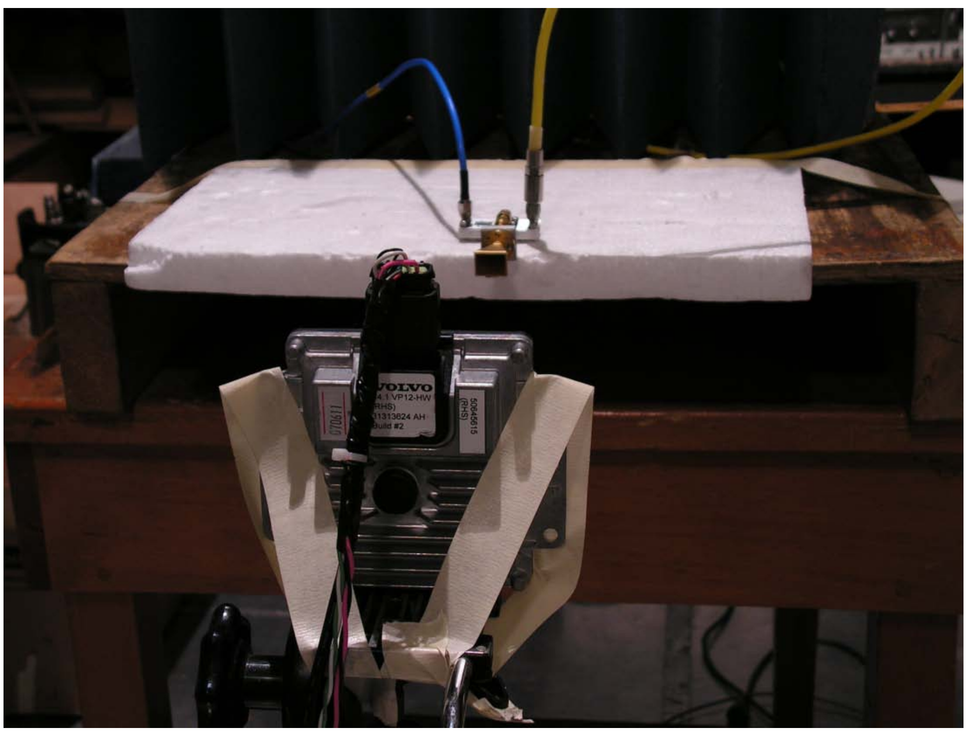


Fig. 6.3 Relative CW frequency vs. supply voltage.



High Frequency DUT test setup (one of three axes tested)



High Frequency DUT test setup (one of three axes tested)