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Testing of

Electromagnetic Emissions

per

USA: CFR Title 47, Part 15.231
Canada: IC RSS-210/GENe

are herein reported for

Delphi Electronics & Safety SFOB,UFOB0,UFOB2

Test Report No.: 417124-20150503-01

Applicant/Provider:
Delphi Electronics & Safety
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Measured by: Dr. Valdis V. Liepa Report Approved by: Dr. Valdis V. Liepa

Report by: Dr. Valdis V. Liepa Report Date of Issue: May 3 , 2015

Results of testing completed on (or before) April 15, 2015 are as follows.

Emissions: The transmitter intentional emissions **COMPLY** with the regulatory limit(s) by no less than 9.6 dB. Transmit chain spurious harmonic emissions **COMPLY** by no less than 5.5 dB. Unintentional spurious emissions from digital circuitry **COMPLY** with radiated emission limit(s) by more than 20 dB.

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1 Test Specifications, General Procedures, and Location

1.1 Test Specification and General Procedures

The ultimate goal of Delphi Electronics & Safety is to demonstrate that the Equipment Under Test (EUT) complies with the Rules and/or Directives below. Detailed in this report are the results of testing the Delphi Electronics & Safety SFOB,UFOB0,UFOB2 for compliance to:

Country/Region	**Rules or Directive**	**Referenced Section(s)**
United States	Code of Federal Regulations	CFR Title 47, Part 15.231
Canada	Industry Canada	IC RSS-210/GENe

Delphi Electronics & Safety has determined that the equipment under test is subject to the rules and directives above at the date of this testing. In conjunction with these rules and directives, the following specifications and procedures are followed herein to demonstrate compliance (in whole or in part) with these regulations.

ANSI C63.4:2009	"Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"
ICES-003; Issue 5 (2012)	"Information Technology Equipment (ITE) Limits and methods of measurement"
Industry Canada	"The Measurement of Occupied Bandwidth"

1.2 Test Location and Equipment Used

Test Location The EUT was fully tested by **The University of Michigan Radiation Laboratory**, 3228 EECS Building, Ann Arbor, Michigan 48109-2122 USA. The Test Facility description and attenuation characteristics are on file with the FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057A-1).

Test Equipment Pertinent test equipment used for measurements at this facility is listed in Table 1. The quality system employed at The University of Michigan Radiation Laboratory has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to the SI through NIST, other recognized national laboratories, accepted fundamental or natural physical constants, ratio type of calibration, or by comparison to consensus standards.

Table 1: The University of Michigan Radiation Laboratory Equipment List

Description	**Manufacturer/Model**	**SN**	**Quality Num.**	**Last Cal By / Date Due**
Spectrum Analyzer	Hewlett Packard / 8593E	3412A01131	HP8593E1	Agilent / Jul-2015
Dipole Set (20-1000 MHz)	UM / RLDP	RLDP-1,-2,-3	UMDIP1	UM / Jul-2015
Ridge-Horn Antenna	Univ. of Michigan / VVL	5	UMRH1	UM / Jul-2015

2 Configuration and Identification of the Equipment Under Test

2.1 Description and Declarations

The EUT is a vehicular Remote Keyless Entry Transmitter. The EUT is approximately 4 x 4 x 1 cm (approx.) in dimension, and is depicted in Figure 1. It is powered by a 3 VDC lithium coin cell battery. This device is a remote keyless entry transmitter used for locking and ignition of a motor cycle. Table 2 outlines provider declared EUT specifications.

Figure 1: Photos of EUT.

Table 2: EUT Declarations.

General Declarations			
Equipment Type:	RKE Transmitter	**Country of Origin:**	USA
Nominal Supply:	3 VDC	**Oper. Temp Range:**	Not Declared
Frequency Range:	433.9 MHz	**Antenna Dimension:**	Not Declared
Antenna Type:	PCB Trace	**Antenna Gain:**	Integral
Number of Channels:	1	**Channel Spacing:**	N/A
Alignment Range:	Not Declared	**Type of Modulation:**	ASK FSK
United States			
FCC ID Number:	L2C0056TR	**Classification:**	DSC
Canada			
IC Number:	3432A-0056TR	**Classification:**	Remote Control Device

2.1.1 EUT Configuration

The EUT is configured for testing as depicted in Figure 2.

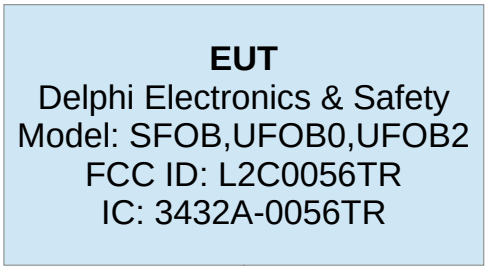

Figure 2: EUT Test Configuration Diagram.

2.1.2 Modes of Operation

The EUT can be activated either automatically by encoded LF interrogation resulting from a button press on the vehicle, or in the case of the two-button variant it can be manually activated by button press. Response to encoded LF (automatic) interrogation is a single FSK transmitted frame. Response to a manual button press is a set of ASK modulated frames.

2.1.3 Variants

There are three variants of the EUT. Model SFOB employs a plastic-only housing and can be activated only by external encoded LF interrogation. Model UFOB0 employs a plastic housing with a snap-in metal trunk key and can be activated only by external encoded LF interrogation. Model UFOB2 employs a plastic housing with a snap-in metal trunk key and two physical button switches populated to the PCB. This model can be activated by external encoded LF interrogation or by manual button press. All three models employ the same electronics and PCB, with UFOB2 as the "fully populated" version with two mechanical SMT switches.

2.1.4 Test Samples

Six samples in total were provided. Three normal samples (one of each variant) and three samples modified for CW transmission. Unmodified samples were also used for photographs.

2.1.5 Functional Exerciser

Normal operating EUT functionality was verified by observation of transmitted signal and by interrogation with a paired LF transmitter.

2.1.6 Modifications Made

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

2.1.7 Production Intent

The EUT appears to be a production ready sample.

2.1.8 Declared Exemptions and Additional Product Notes

None.

3 Emissions

3.1 General Test Procedures

3.1.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are first pre-scanned in our shielded anechoic chamber. Spectrum and modulation characteristics of all emissions are recorded. Instrumentation, including spectrum analyzers and other test equipment as detailed in Section 1.2 are employed. After indoor pre-scans, emission measurements are made on our outdoor 3-meter Open Area Test Site (OATS). If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in relevant test standards are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 3. All intentionally radiating elements that are not fixed-mounted in use are placed on the test table lying flat, on their side, and on their end (3-axes) and the resulting worst case emissions are recorded. If the EUT is fixed-mounted in use, measurements are made with the device oriented in the manner consistent with installation and then emissions are recorded.

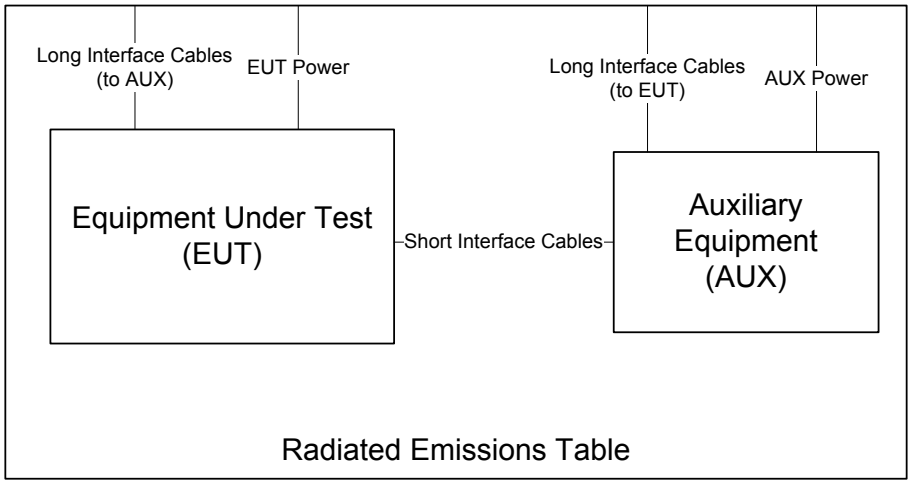

Figure 3: Radiated Emissions Diagram of the EUT.

If the EUT exhibits spurious emissions due to internal receiver circuitry, such emissions are measured with an appropriate carrier signal applied. For devices with intentional emissions below 30 MHz, a shielded loop antenna is used. It is placed at a 1 meter receive height. Emissions between 30 MHz and 1 GHz are measured using tuned dipoles and/or calibrated broadband antennas. For both horizontal and vertical polarizations, the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected. The EUT is then rotated through 360^o in azimuth until the highest emission is detected. The test antenna is then raised and lowered one last time from 1 to 4 m and the worst case value is recorded. Emissions above 1 GHz are characterized using standard gain horn antennas or calibrated broadband ridge-horn antennas on our OATS with a 2.4m x 2.4m square of AN-79 or H-4 absorber placed over the ground screen between the EUT and the test antenna. Care is taken to ensure that test receiver resolution and video bandwidths meet the regulatory requirements, and that the emission bandwidth of the EUT is not reduced. Photographs of the test setup employed are depicted in Figure 4.

Where regulations allow for direct measurement of field strength, power values (dBm) measured on the test receiver / analyzer are converted to dBμV/m at the regulatory distance, using

$$E_{dist} = 107 + P_R + K_A - K_G + K_E - C_F$$

where P_R is the power recorded on spectrum analyzer, in dBm, K_A is the test antenna factor in dB/m, K_G is the combined pre-amplifier gain and cable loss in dB, K_E is duty correction factor (when applicable) in dB, and C_F is a distance conversion (employed only if limits are specified at alternate distance) in dB. This field strength value is then compared with the regulatory limit. If effective isotropic radiated power (EIRP) is computed, it is computed as

$$EIRP(dBm) = E_{3m}(dB\mu V/m) - 95.2.$$

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

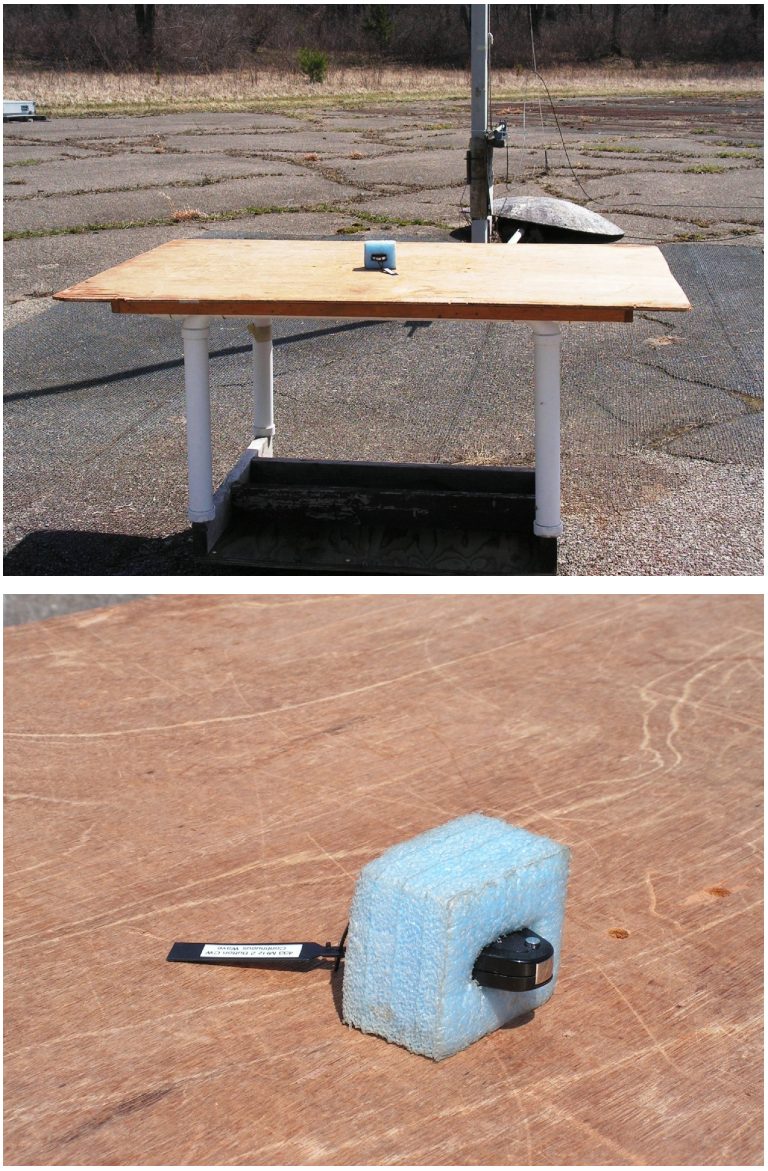

Figure 4: Radiated Emissions Test Setup Photograph(s).

3.1.2 Conducted Emissions Test Setup and Procedures

Battery Power Conducted Spurious The EUT is not subject to measurement of power line conducted emissions as it is powered solely by its internal battery.

3.1.3 Power Supply Variation

Tests at extreme supply voltages are made if required by the the procedures specified in the test standard, and results of this testing are detailed in this report.

In the case the EUT is designed for operation from a battery power source, the extreme test voltages are evaluated over the range specified in the test standard; no less than $\pm 10\%$ of the nominal battery voltage declared by the manufacturer. For all battery operated equipment, worst case intentional and spurious emissions are re-checked employing a new (fully charged) battery.

3.2 Intentional Emissions

3.2.1 Fundamental Emission Pulsed Operation

Test Setup & Procedure The test equipment and facilities were setup in accordance with the standards and procedures listed in Section 1.1. Environmental conditions were set at the appropriate temperature and thermal balance was checked with a thermocouple based probe. Duty cycle is reported for all relevant modes of operation. The test equipment employed includes HP8593E1, UMDIP1.

Measurement Results The details and results of testing the EUT are summarized in Table 3. Plots showing the measurements made to obtain these values are provided in Figure 5.

Table 3: Fundamental Emission Pulsed Operation.

The EUT is capable of two types of transmission. When automatically activated via encoded LF interrogation, the EUT transmits a single FSK frame 25ms in length in response. When manually activated via button press, the EUT will transmit 50.5 ms ASK frames that repeat every 127 ms for as long as the button in depressed. Each frame is Manchester encoded with a 0.135 ms / 0.250 ms duty.

	Duty Cycle Computation	Delphi HD; FCC/IC
1	KE_{ASK} = (50.5 ms x 0.135 ms / 0.250 ms) / 100 ms = 0.273 or -11.3 dB	
2	KE_{FSK} = 25 ms / 100 ms = 0.250 or -12.0 dB	

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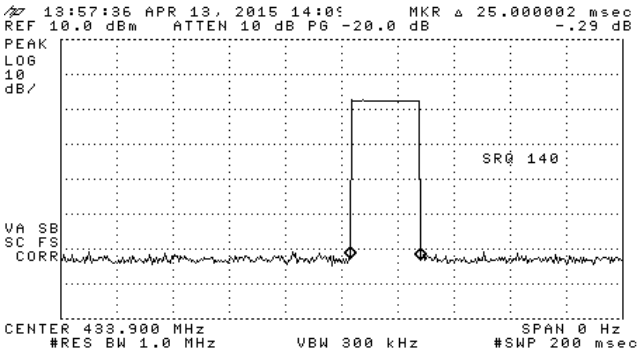

Figure 5(a): Fundamental Emission Pulsed Operation.

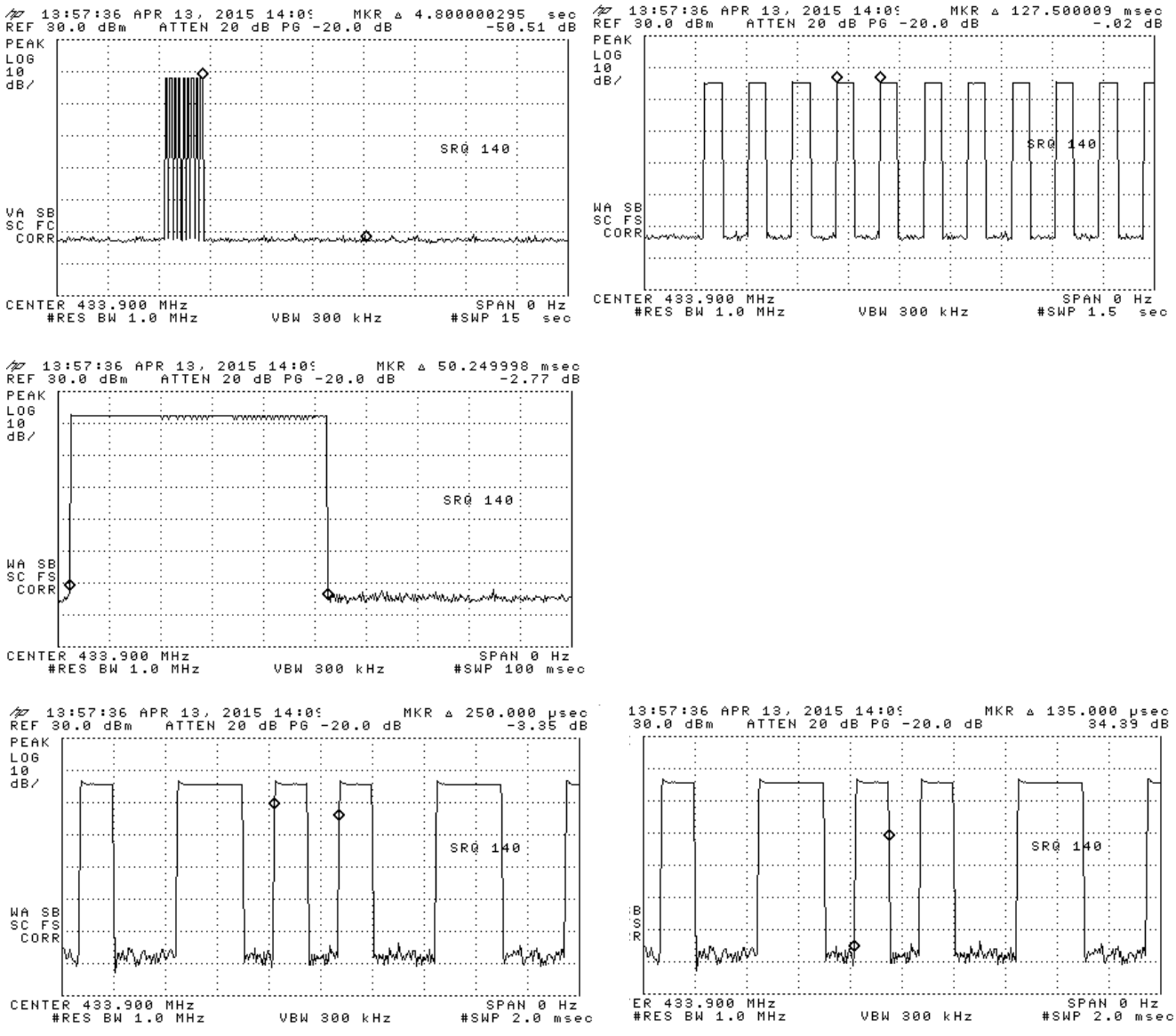

Figure 5(b): Fundamental Emission Pulsed Operation.

3.2.2 Fundamental Emission Bandwidth

Test Setup & Procedure The test equipment and facilities were setup in accordance with the standards and procedures listed in Section 1.1. Environmental conditions were set at the appropriate temperature and thermal balance was checked with a thermocouple based probe. Emission bandwidth (EBW) of the EUT is measured with the device placed in the test mode(s) with the shortest available frame length and minimum frame spacing. The 20 dB EBW is measured as the max-held peak-detected signal when the IF bandwidth is greater than or equal to 1% of the receiver span. For complex modulations other than ASK and FSK, the 99% emission bandwidth per IC test procedures has a different result, and is also reported. The test equipment employed includes HP8593E1, UMDIP1.

Measurement Results The details and results of testing the EUT are summarized in Table 4. Plots showing the measurements made to obtain these values are provided in Figure 6.

Table 4: Fundamental Emission Bandwidth.

The emission bandwidth of the signal is shown in the following Figure. The allowed 99% bandwidth is 0.25% of 433.9 MHz, or 1085 kHz.

Measured Emission Bandwidth							Delphi HD; FCC/IC
#	EBW meas. (kHz)						
1	63.0						

Meas. U of Mich.; 4/11/2015

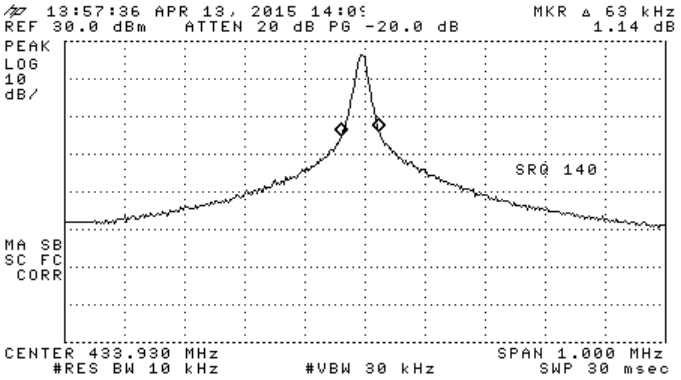

Figure 6: Fundamental Emission Bandwidth.

3.2.3 Fundamental Emission Field Strength

Test Setup & Procedure The test equipment and facilities were setup in accordance with the standards and procedures listed in Section 1.1. Environmental conditions were set at the appropriate temperature and thermal balance was checked with a thermocouple based probe. Fundamental emissions are measured at the regulatory distance on our OATS. The test equipment employed includes HP8593E1, UMDIP1.

Measurement Results The details and results of testing the EUT are summarized in Table 5.

Table 5: Fundamental Emission Field Strength.

Frequency Range	Det	IF Bandwidth	Video Bandwidth
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz
f > 1 000 MHz	Pk	1 MHz	3 MHz
f > 1 000 MHz	Avg	1 MHz	10kHz

Fundamental Radiated Emission											Delphi HD; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3* dBµV/m	E3lim dBµV/m	Pass dB	Comments
1	**MOST POPULATED SAMPLE**										
2	433.9	Dip	H	-28.3	Pk	21.5	20.6	68.3	80.8	12.5	flat Two-button w/key in
3	433.9	Dip	V	-26.9	Pk	21.5	20.6	69.7	80.8	**11.1**	side
4	**VARIANTS/VARIATIONS**										
5	433.9	Dip	V	-26.3	Pk	21.5	20.6	70.3	80.8	10.5	side Two-button w/key out
6	433.9	Dip	V	-26.3	Pk	21.5	20.6	70.3	80.8	10.5	side No-button w/key in
7	433.9	Dip	V	-26.1	Pk	21.5	20.6	70.5	80.8	10.3	side No-button w/key out
8	433.9	Dip	V	-25.4	Pk	21.5	20.6	71.2	80.8	**9.6**	side No-button no/key
9											
10	* Includes					11.3	dB Duty Cycle				
11											

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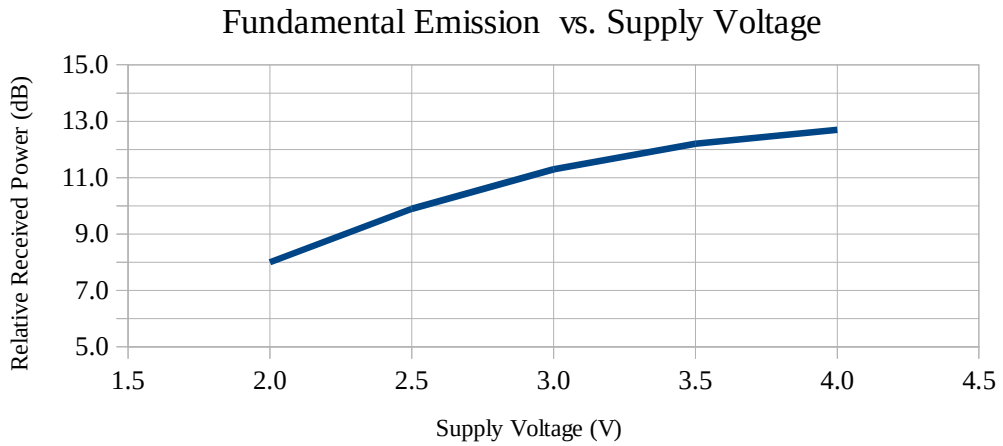

3.3 Unintentional Emissions

3.3.1 Transmit Chain Spurious Emissions

Test Setup & Procedure The test equipment and facilities were setup in accordance with the standards and procedures listed in Section 1.1. Environmental conditions were set at the appropriate temperature and thermal balance was checked with a thermocouple based probe. Spurious radiated emissions measurements are performed to 10 times the highest fundamental operating frequency. The test equipment employed includes HP8593E1, UMDIP1, UMRH1.

Measurement Results The details and results of testing the EUT are summarized in Table 6.

Table 6: Transmit Chain Spurious Emissions.

Frequency Range	Det	IF Bandwidth	Video Bandwidth
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz
f > 1 000 MHz	Pk	1 MHz	3 MHz
f > 1 000 MHz	Avg	1 MHz	10kHz

Spurious Radiated Emissions											Delphi HD; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3* dBµV/m	E3lim dBµV/m	Pass dB	Comments
1	**MOST POPULATED SAMPLE**										
2	867.8	Dip	H	-64.4	Pk	27.8	17.2	41.9	60.8	18.9	flat
3	867.8	Dip	V	-66.1	Pk	27.8	17.2	40.2	60.8	20.6	end
4	1301.8	Horn	H	-53.9	Pk	20.7	28.1	34.4	54.0	19.6	flat
5	1735.7	Horn	H	-54.5	Pk	21.9	28.1	35.0	60.8	25.8	flat
6	2169.6	Horn	H	-56.0	Pk	22.9	26.5	36.1	60.8	24.7	flat
7	2603.5	Horn	H	-45.5	Pk	24.1	25.7	48.6	60.8	12.2	flat
8	3037.4	Horn	H	-55.7	Pk	25.5	23.9	41.5	60.8	19.3	end
9	3471.4	Horn	H	-53.0	Pk	26.8	23.2	46.3	60.8	14.5	end
10	3905.3	Horn	H	-57.3	Pk	28.1	22.4	44.2	54.0	**9.8**	flat
11	4339.2	Horn	H	-67.4	Pk	29.5	16.2	41.5	54.0	12.5	end
12											
13	**VARIANTS/VARIATIONS (AT WORST CASE EMISSION)**										
14	3905.3	Horn	H	-58.9	Pk	28.1	22.4	42.6	54.0	11.4	side Two-button w/key out
15	3905.3	Horn	H	-55.9	Pk	28.1	22.4	45.6	54.0	8.4	side No-button w/key in
16	3905.3	Horn	H	-56.1	Pk	28.1	22.4	45.4	54.0	8.6	side No-button w/key out
17	3905.3	Horn	H	-53.0	Pk	28.1	22.4	48.5	54.0	**5.5**	side No-button no/key
18											
19	* Includes					11.3	dB Duty Cycle.				
20											

Meas. U of Mich.; 4/11/2015