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Testing of

# Electromagnetic Emissions

per

**USA: CFR Title 47, Part 15.253**
**Canada: IC RSS-210/GENe**

are herein reported for

# Delphi Electronics & Safety L2C0059TR

Test Report No.: 20150905-RPTWAC010010Ar0


Applicant/Provider:
Delphi Electronics & Safety
One Corporate Center, Kokomo Indiana 46904-9005 USA
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Measured by: Dr. Joseph Brunett, EMC-002790-NE

Report Approved by: Dr. Joseph Brunett, EMC-002790-NE

Report by: Dr. Joseph Brunett, EMC-002790-NE

Report Date of Issue: September 5, 2015

**Results of testing completed on (or before) August 30, 2015 are as follows.**

**Emissions:** The transmitter intentional emissions **COMPLY** with the regulatory limit(s) by no less than 37.2 dB. Transmit chain spurious harmonic emissions **COMPLY** by no less than 22.3 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 L2C0059TR for compliance to:

| **Country/Region** | **Rules or Directive** | **Referenced Section(s)** |
|---|---|---|
| United States | Code of Federal Regulations | CFR Title 47, Part 15.253 |
| 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 (USA) | "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" |
| KDB 200443 D02 MMW | "FCC/TCB Council Millimeter Wave Test Procedures" |
| ANSI C63.4:2014 (CAN) | "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" |
| Industry Canada | "The Measurement of Occupied Bandwidth" |

### 1.2 Test Location and Equipment Used

**Test Location** The EUT was fully tested by **Willow Run Test Labs, LLC**, 8501 Beck Road, Building 2227, Belleville, Michigan 48111 USA. The Test Facility description and attenuation characteristics are on file with the FCC Laboratory, Columbia, Maryland (FCC Reg. No: 688478) and with Industry Canada, Ottawa, ON (File Ref. No: IC 8719A-1).

**Test Equipment** Pertinent test equipment used for measurements at this facility is listed in Table 1. The quality system employed at Willow Run Test Labs, LLC 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: Willow Run Test Labs, LLC Equipment List

| Description | Manufacturer/Model | SN | Quality Num. | Last Cal By / Date Due |
|---|---|---|---|---|
| Spectrum Analyzer | Rhode-Schwarz / FSV30 | 101660 | RSFSV30001 | RS / Apr-2016 |
| Quad Ridge Horn | ETS Lind. / 3164-04 | 00066988 | HRNQR316401 | Lib. Labs / Apr-2016 |
| XN-Band Horn | JEF / NRL Std. | 001 | HRNXN001 | WRTL / Jul-2016 |
| X-Band Horn | JEF / NRL Std. | 001 | HRNX001 | WRTL / Jul-2016 |
| KU-Band Horn | JEF / NRL Std. | 001 | HRNKU001 | WRTL / Jul-2016 |
| K-Band Horn | JEF / NRL Std. | 001 | HRNK001 | WRTL / Jul-2016 |
| Ka-Band Horn | JEF / NRL Std. | 001 | HRNKA001 | WRTL / Jul-2016 |
| U-Band Horn | Cust. Micro. / HO19R | - | HRNV001 | UM / Jul-2016 |
| V-Band Horn | Cust. Micro. / HO15R | - | HRNV001 | UM / Jul-2016 |
| W-Band Horn | Cust. Micro. / HO10R | - | HRNW001 | UM / Jul-2016 |
| Harmonic Mixer | Hewlett Packard / 11970K | 3003A08327 | MIX26TO4001 | Agilent / Jan-2016 |
| Harmonic Mixer | Hewlett Packard / 11970U | 2332A00500 | MIX40TO6001 | Agilent / Jan-2016 |
| Harmonic Mixer | Pacific mmWave / VM | 291 | MIX50TO7501 | PMP / Mar-2016 |
| Harmonic Mixer | Hewlett Packard / 11970W | 2521A00179 | MIX75TO11001 | Agilent / Jan-2016 |
| Harmonic Mixer | Pacific mmWave / GMA | 26 | MIX110TO22001 | PMP / Mar-2016 |

# 2 Configuration and Identification of the Equipment Under Test

## 2.1 Description and Declarations

The EUT is an automotive radar. The EUT is approximately 10 x 6 x 1 cm (approx.) in dimension, and is depicted in Figure 1. It is powered by a 13.4 VDC vehicle power system. In use, this device is permanently affixed in a motor vehicle. Table 2 outlines provider declared EUT specifications.

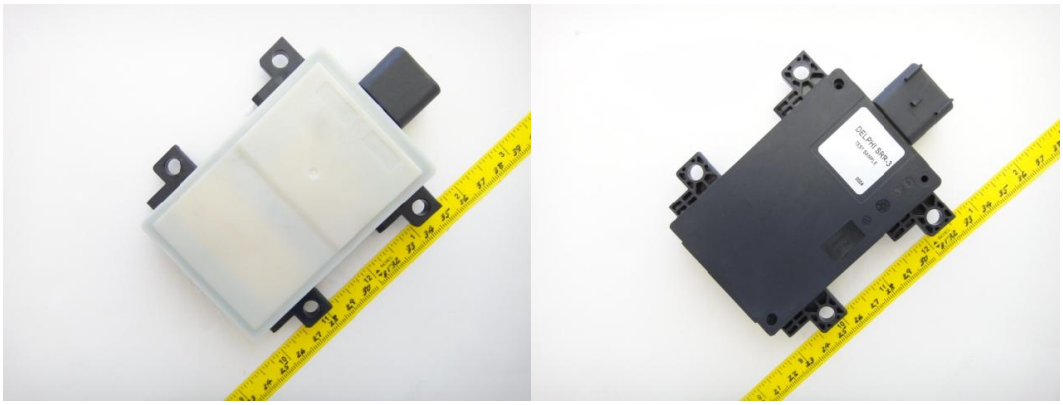

Figure 1: Photos of EUT.

Table 2: EUT Declarations.

| **General Declarations** | | | |
|---|---|---|---|
| **Equipment Type:** | Radar | **Country of Origin:** | Not Declared |
| **Nominal Supply:** | 13.4 VDC | **Oper. Temp Range:** | $-40^{o}$C to $+85^{o}$C |
| **Frequency Range:** | 76.003 to 76.973 GHz | **Antenna Dimension:** | Integral |
| **Antenna Type:** | integral patch arrays | **Antenna Gain:** | 14 dBi (declared) |
| **Number of Channels:** | more than two | **Channel Spacing:** | Not Declared |
| **Alignment Range:** | Not Declared | **Type of Modulation:** | FMCW |
| | | | |
| **United States** | | | |
| **FCC ID Number:** | L2C0059TR | **Classification:** | FDS |
| | | | |
| **Canada** | | | |
| **IC Number:** | 3432A-0059TR | **Classification:** | Radar, Vehicular Device |

### 2.1.1 EUT Configuration

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

### 2.1.2 Modes of Operation

The manufacturer considers the modes of operation of this product to be of a proprietary nature. Please reference the confidential Modes of Operation exhibit for complete details.

### 2.1.3 Variants

There is only a single variant of the EUT, as tested.

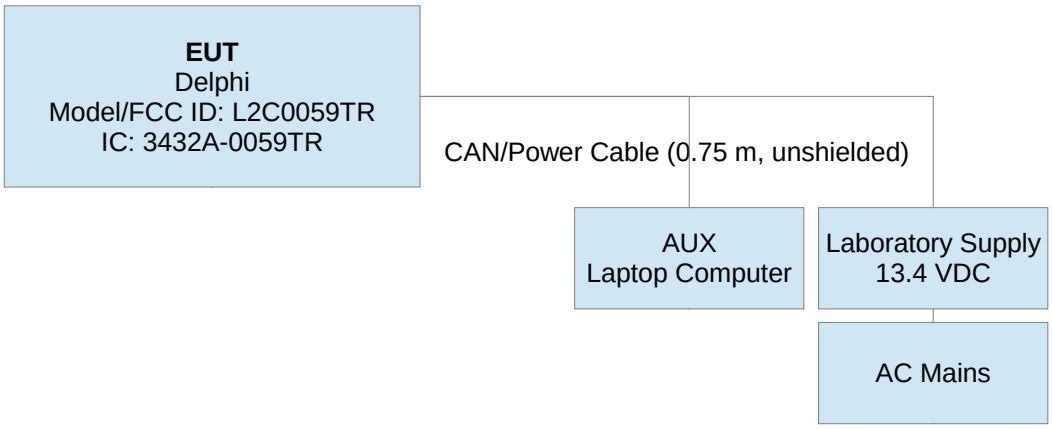


Figure 2: EUT Test Configuration Diagram.

### 2.1.4 Test Samples

Three samples were provided; two normal operating (modulating) devices capable of re-programming via an axillary computer into each of the different modulations employed, and into each channel of operation, as well as CW transmission at select frequencies. One further sample was provided, unsealed, for photos.

### 2.1.5 Functional Exerciser

Normal operating EUT functionality was verified by observation of transmitted signal.

### 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

The EUT is permanently installed in a transportation vehicle. As such, digital emissions are exempt from US and Canadian digital emissions regulations (per FCC 15.103(a) and IC correspondence on ICES-003). However, data is presented here demonstrating digital emissions comply with 15.109 on bequest of the applicant. In the mm-wave band, narrow pulses arise as the FMCW signal chirps past the receiver tuned frequency. To avoid amplitude measurement error due to Pulse Desensitization, we measure peak emissions only when the radar is either placed into CW mode or when the signal Dwells at a single frequency for an extended period of time. In computation of duty cycle for the FMCW chirp modulation, pulse desensitization may cause the measurement receiver with a narrow IFBW to report wider than actual pulse widths, and thus greater on-time and lower duty cycle based on the calculation method. Duty cycle in the FMCW mode is a worst-case computation, applied to a properly measured peak emission.

# 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.

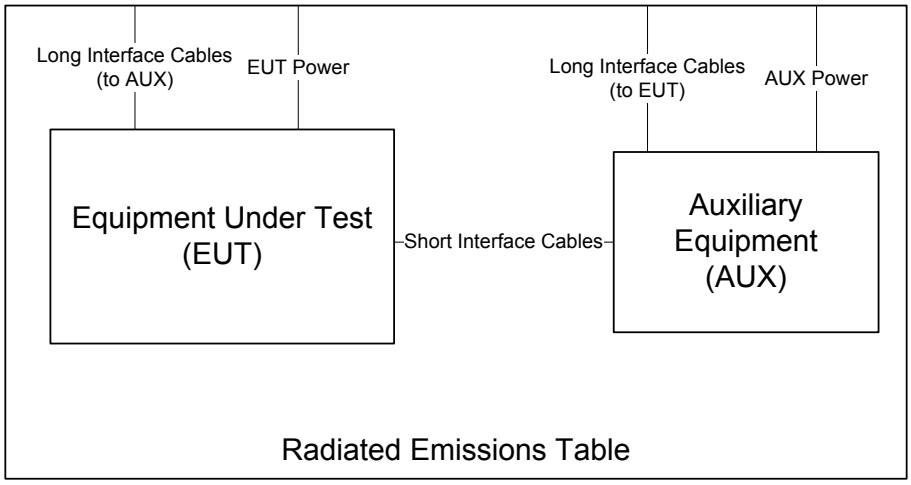


Figure 3: Radiated Emissions Diagram of the EUT.

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 dB$\mu$V/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.

Where regulations call for substitution method measurements, the EUT is replaced by a substitution if field strength measurements indicate the emission is close to the regulatory limit. This antenna is co-polarized with the test antenna and tuned (when necessary) to the emission frequency, after which the test antenna height is again optimized. The substitution antenna signal level is then adjusted such that its emission is equal to the level measured from the EUT. The signal level applied to the substitution antenna is then recorded. Effective isotropic radiated power (EIRP) and effective radiated power (ERP) in dBm are formulated from

$$EIRP = P_T - G_A = ERP + 2.16, \tag{1}$$

where $P_T$ is the power applied to substitution antenna in dBm, including correction for cable loss, and $G_A$ is the substitution antenna gain, in dBi.

When microwave measurements are made at a range different than the regulatory distance or made at close-range to improve receiver sensitivity, the reading is corrected back to the regulatory distance. This is done using a 20 dB/decade far-field behavior relation and a 40 dB/decade near-field relation, as outlined in the FCCs mm-wave measurement procedures. The near-field/far-field boundary (N/F) is computed based on

$$N/F = 2D^2/\lambda$$

where $D$ is the maximum dimension of the transmitter or receiver antenna , and $\lambda$ is the wavelength at the measurement frequency. For example, suppose $N/F = 2$ m, but the measurement is made at 1 m. Here, the 40 dB/decade relation would be applied from 1 to 2 m, and the 20 dB/decade relation would be applied from 2 to 3 m. In dB, this gives a 15.6 dB adjustment. Typically, 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. In this case, no cable loss term is used and mixer conversion losses are programmed in the spectrum analyzer to be included in the recorded dB values.

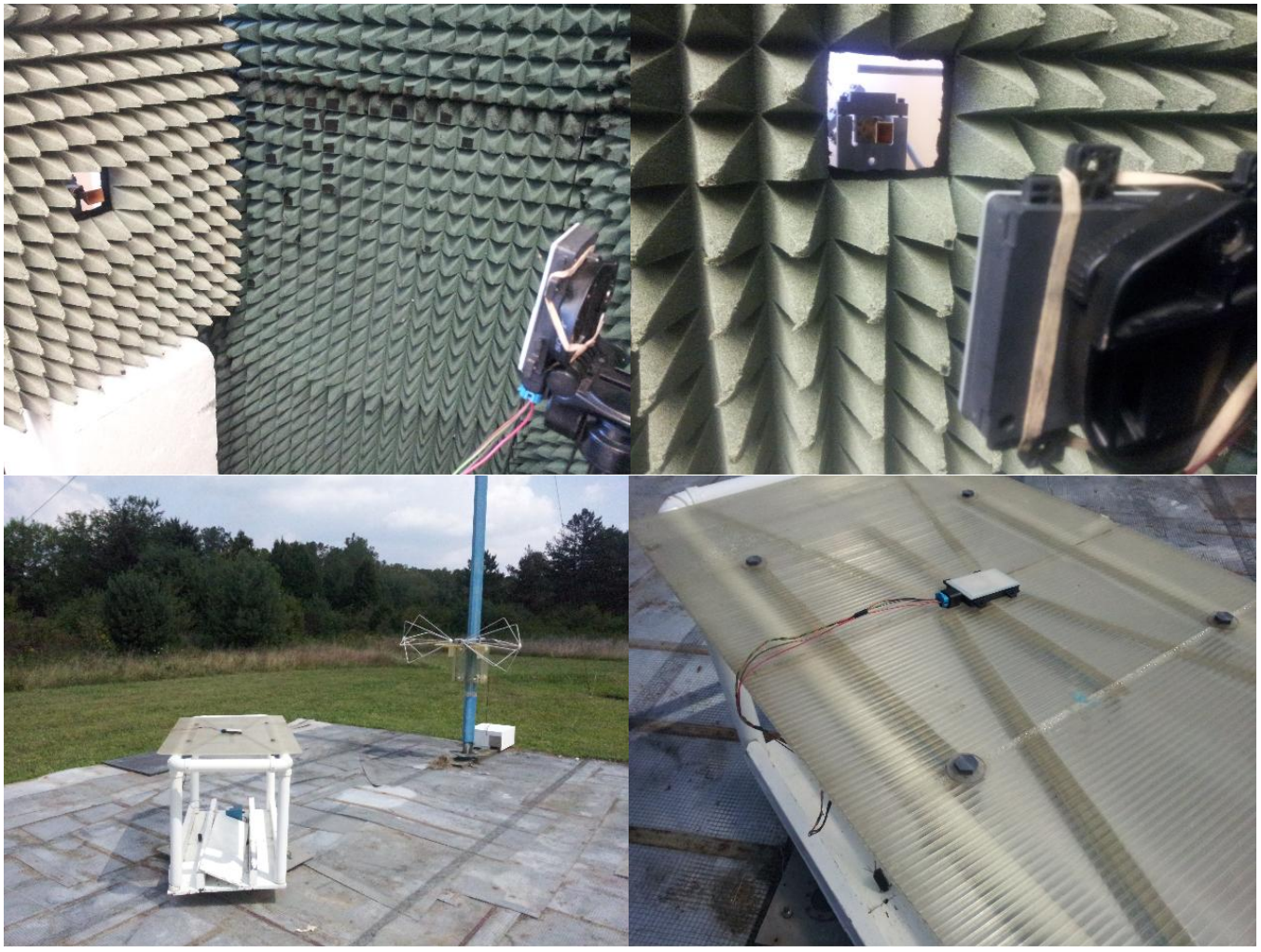

Figure 4: Radiated Emissions Test Setup Photograph(s).

### 3.1.2 Conducted Emissions Test Setup and Procedures

**Vehicle Power Conducted Spurious** The EUT is not subject to power line conducted emissions regulations as it is powered solely by the vehicle power system for use in said motor vehicle.

### 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.

### 3.1.4 Thermal Variation

Tests at extreme temperatures are made if required by the procedures specified in the test standard, and results of this testing are detailed in this report. The provider has declared that the EUT is designed for operation over the temperature range $-40^o$C to $+85^o$C. Before any temperature measurements are made, the equipment is allowed to reach a thermal balance in the test chamber, temperature and humidity are recorded, and thermal balance is verified via a thermocouple based probe.

## 3.2 Intentional Emissions

### 3.2.1 Fundamental Emission Pulsed Operation

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

Table 3: Pulsed Emission Characteristics (Duty Cycle).

| Frequency Range | Det | IFBW | VBW |
|---|---|---|---|
| f > 1 000 MHz | Pk | 1 MHz | 3 MHz |

**Test Date:** 12-Aug-15
**Test Engineer:** Joseph Brunett
**EUT** Delphi SRR3 77GHz
**Meas. Distance:** 30 cm

**Pulsed Operation / Duty Cycle**

| Transmit Mode | Voltage (V) | Test Frequency[1] (GHz) | Total Cycle Time (ms) | Non-FMCW On-Time[2] (ms) | FMCW On-Time[2] (ms) | Exposure Duty Factor[3] (dB) | FMCW Period (ms) | 99% OBW (MHz) | Dwell/MHz/Chirp[4] (ms) | Chirps / On-Time[5] (#) | Max On-Time/Cycle[6] (ms) | Spread Duty[7] (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LR FMCW (subfigure (a)) | 13.4 | 76.202 | 51.2 | 1.190 | 14.49 | **-5.1** | 0.033 | 201.5 | 0.00016 | 442 | 1.262 | **-16.1** |
| MR FMCW (subfigure (b)) | 13.4 | 76.350 | 49.9 | 1.190 | 14.41 | **-5.4** | 0.033 | 353.2 | 0.00009 | 439 | 1.231 | **-16.1** |
| SR FMCW (subfigure (c)) | 13.4 | 76.453 | 50.1 | 1.195 | 14.53 | **-5.4** | 0.033 | 410.7 | 0.00008 | 445 | 1.230 | **-16.1** |

(1) LR, MR, SR Chirp Duty is worst-case at highest emission detected due to longest dwell time at these frequencies.
(2) Total On-Time = 1.19 ms dwell + 14.49ms FMCW chirp
(3) Exposure Duty Correction = 10*Log(Total On-Time/Total Cycle-Time);
(4) Dwell / MHz / Chirp is the CW time spent in any given 1MHz window within the channel during a single chirp = FMCW Period / 99% OBW
(5) Chirps / On-Time = FMCW On-Time / FMCW Period
(6) Max On-Time / Cycle = Non-FMCW Time + Chirps / On-Time x Dwell / MHz / Chirp
(7) Spread Duty = 10*log10(Max On-Time/Cycle / Total Cycle Time) = 10*log10(1.262ms/51.2ms) = -16.1
Equipment Used: RSFSV30001, MIX75TO10001, HRNW01

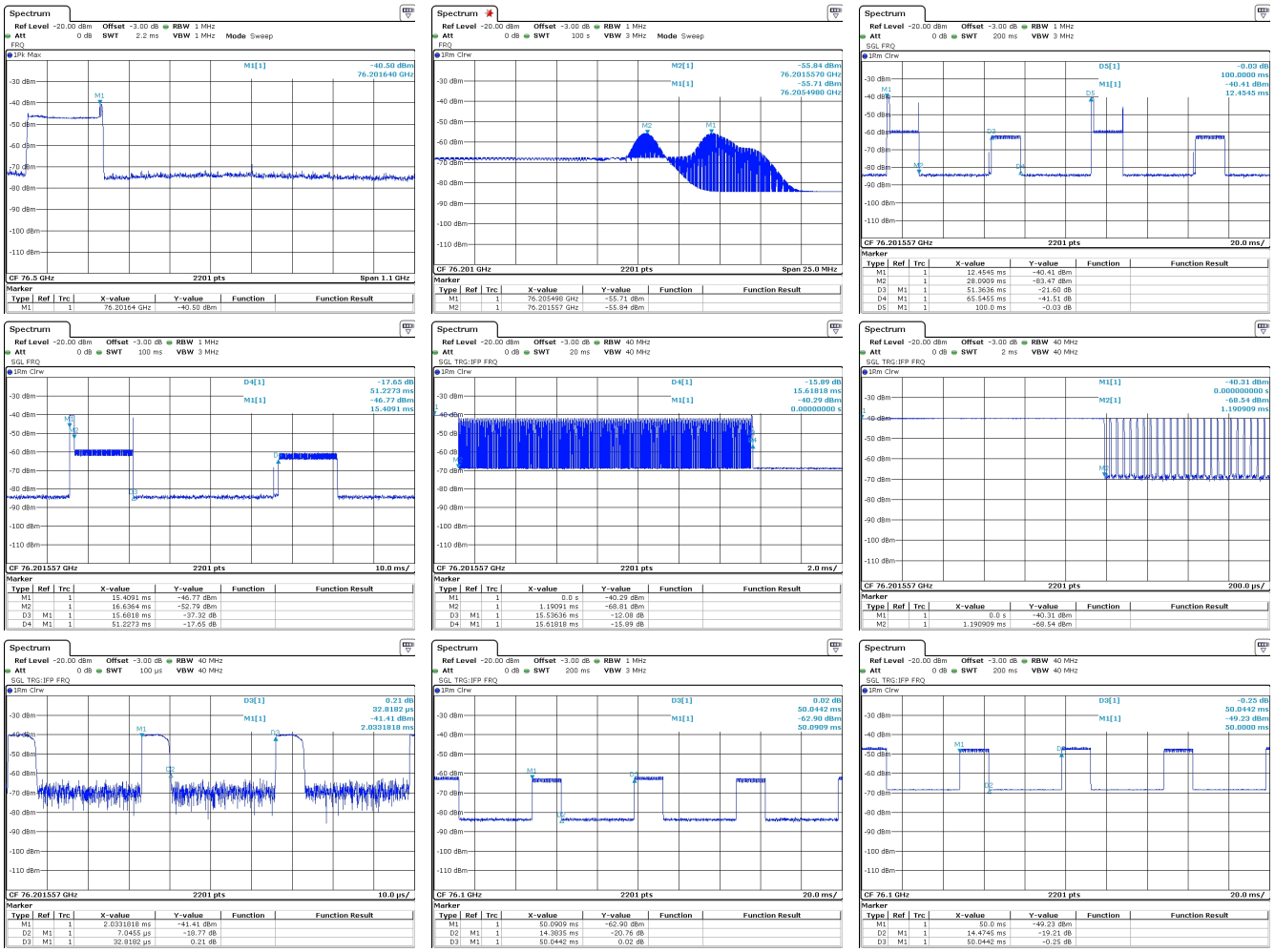

Figure 5(a): Pulsed Emission Characteristics (Duty Cycle).

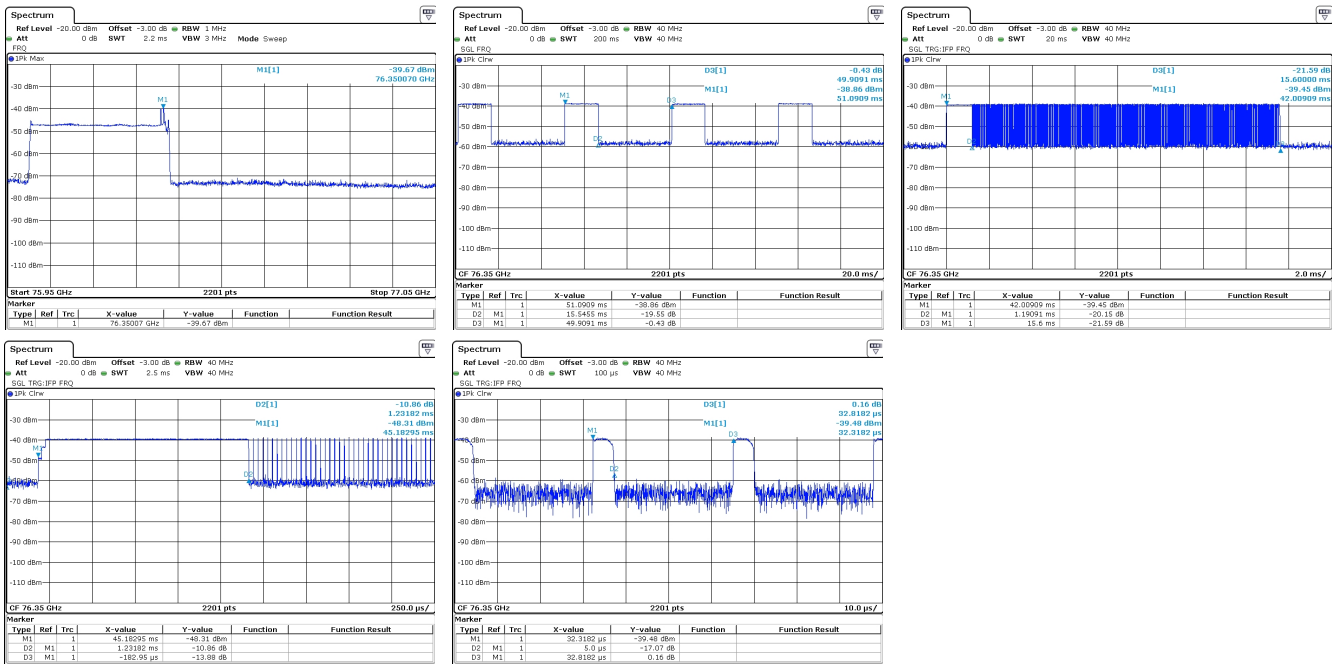

Figure 5(b): Pulsed Emission Characteristics (Duty Cycle).

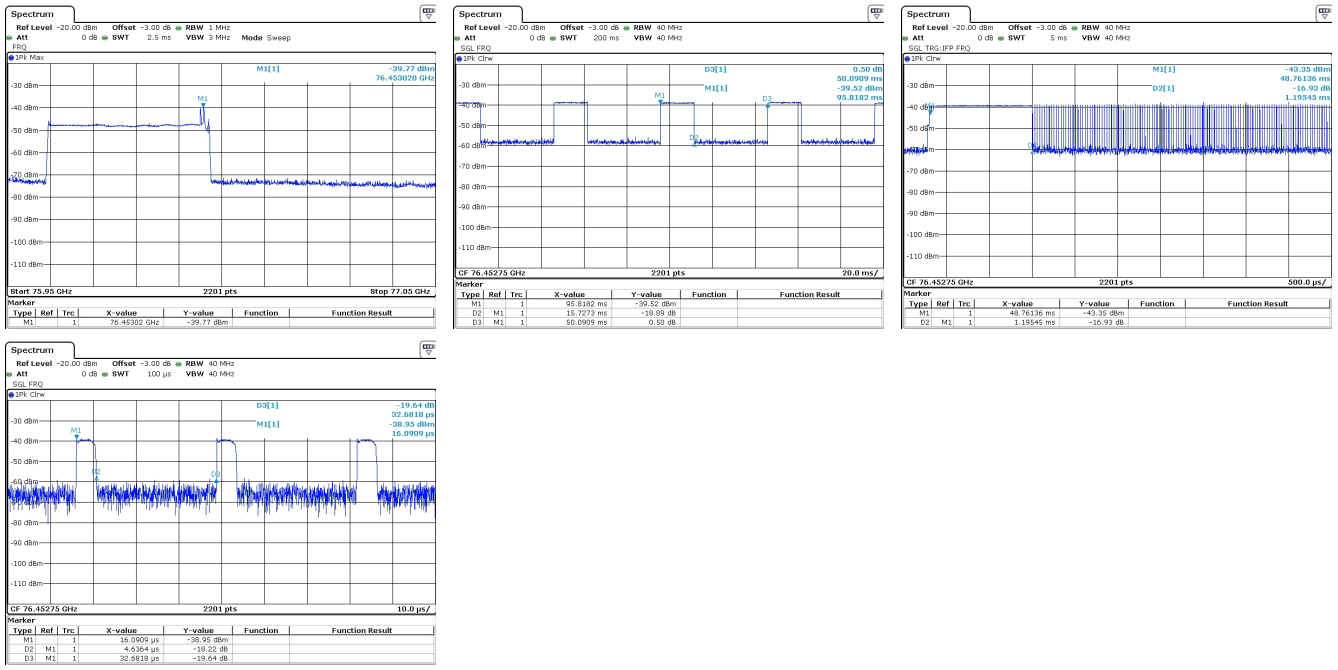

Figure 5(c): Pulsed Emission Characteristics (Duty Cycle).

### 3.2.2 Fundamental Emission Bandwidth

Emission bandwidth (EBW) of the EUT is measured with the device placed in the worst case test mode. Radiated emissions are recorded following the test procedures listed in Section 1.1. The 26 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 separately reported.The results of EBW testing are summarized in Table 4. Plots showing measurements employed to obtain the emission bandwidth reported are provided in Figure 6.

Table 4: Intentional Emission Bandwidth.

| **Frequency Range** | **Det** | **IFBW** | **VBW** | **Span** | | |
|---|---|---|---|---|---|---|
| Freq > 1 GHz | Pk | 1 MHz | 3 MHz | 1200 MHz | **Test Date:** | 24-Aug-15 |
| | | | | | **Test Engineer:** | Joseph Brunett |
| | | | | | **EUT:** | Delphi SRR3 77GHz |
| | | | | | **Meas. Distance:** | 10 cm |

| **Occupied Bandwidth** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Transmit Mode | Channel | Temperature ( C ) | Voltage (V) | fL (MHz) | fL Limit (MHz) | fH (MHz) | fH Limit (MHz) | 26dB OBW (MHz) | 99% OBW (MHz) | Notes/Pass/Fail |
| LR | Low | 85.0 | 15.4 | 76002.9 | 76000.0 | 76211.8 | 77000.0 | 208.9 | 203.2 | |
| | Low | -40.0 | 11.4 | 76005.4 | 76000.0 | 76214.4 | 77000.0 | 208.9 | 204.8 | |
| | Mid | 20.0 | 13.4 | 76398.5 | 76000.0 | 76614.2 | 77000.0 | 215.7 | 208.5 | |
| | High | 85.0 | 15.4 | 76748.5 | 76000.0 | 76955.7 | 77000.0 | 207.2 | 201.5 | |
| | High | -40.0 | 11.4 | 76750.3 | 76000.0 | 76957.5 | 77000.0 | 207.2 | 202.3 | |
| MR | Low | 85.0 | 15.4 | 76003.9 | 76000.0 | 76368.0 | 77000.0 | 364.2 | 356.4 | |
| | Low | -40.0 | 11.4 | 76004.3 | 76000.0 | 76367.5 | 77000.0 | 363.2 | 356.1 | |
| | Mid | 20.0 | 13.4 | 76313.8 | 76000.0 | 76675.5 | 77000.0 | 361.7 | 353.4 | |
| | High | 85.0 | 15.4 | 76613.2 | 76000.0 | 76973.2 | 77000.0 | 359.9 | 353.2 | |
| | High | -40.0 | 11.4 | 76614.7 | 76000.0 | 76970.7 | 77000.0 | 356.0 | 353.9 | |
| SR | Low | 85.0 | 15.4 | 76049.6 | 76000.0 | 76474.2 | 77000.0 | 424.6 | 416.2 | |
| | Low | -40.0 | 11.4 | 76050.3 | 76000.0 | 76473.3 | 77000.0 | 423.0 | 416.1 | |
| | Mid | 20.0 | 13.4 | 76299.1 | 76000.0 | 76720.5 | 77000.0 | 421.4 | 412.2 | |
| | High | 85.0 | 15.4 | 76549.3 | 76000.0 | 76967.4 | 77000.0 | 418.1 | 410.7 | |
| | High | -40.0 | 11.4 | 76548.2 | 76000.0 | 76965.2 | 77000.0 | 417.0 | 411.2 | |
| | | | **$fL_{MIN}$** | **76002.9** | **$fH_{MAX}$** | **76973.2** | **$OBW_{MAX}$** | **424.6** | **416.2** | Pass |

Equipment Used: RSFSV30001, MIX75TO10001, HRNW01

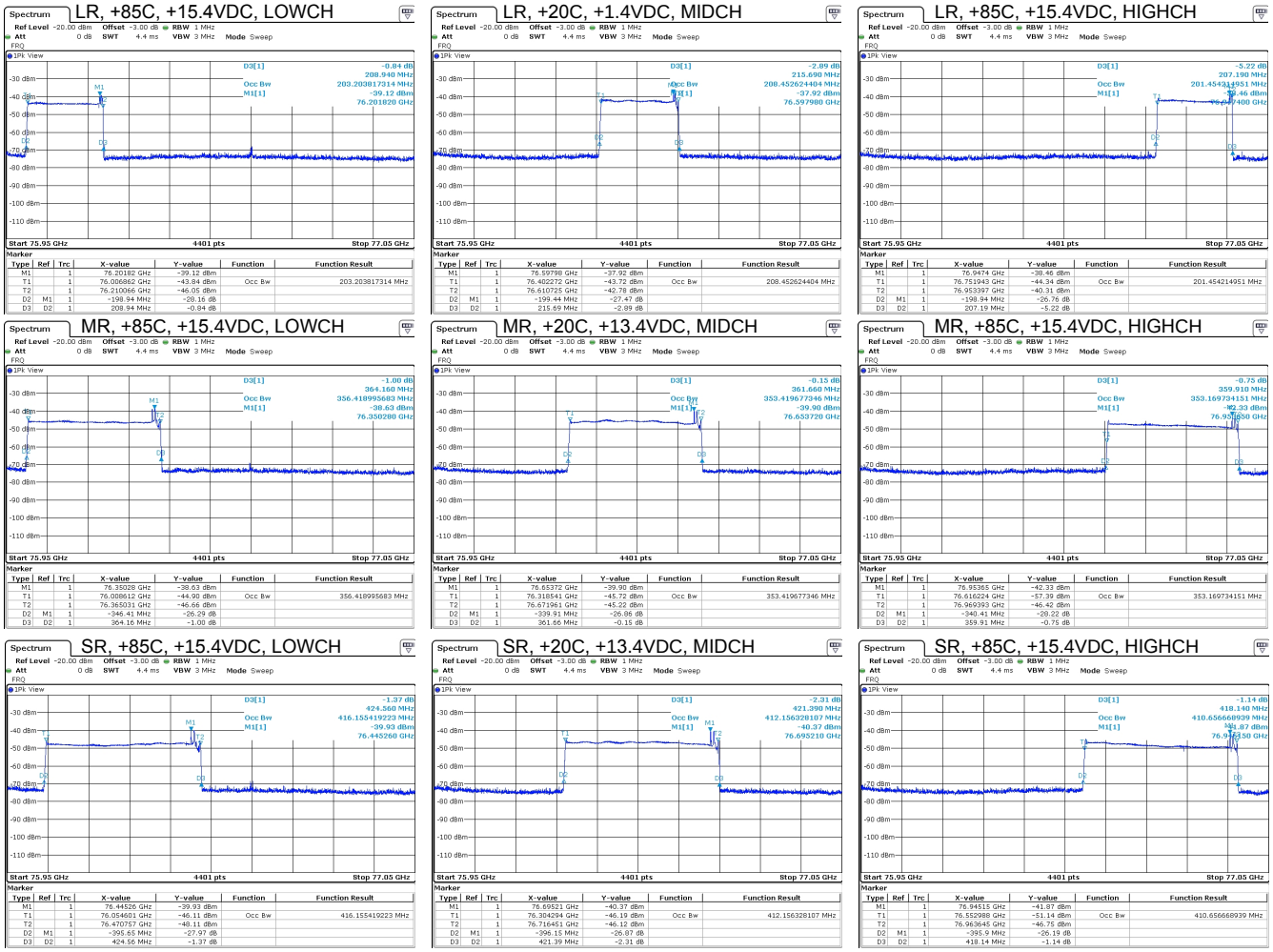


Figure 6: Intentional Emission Bandwidth.

### 3.2.3 Fundamental Emission

Following the test procedures listed in Section 1.1, radiated emissions measurements are made on the EUT for both Horizontal and Vertical polarized fields. Table 5 details the results of these measurements.

Table 5: Fundamental Radiated 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 | RMS (Avg) | 1 MHz | 3 MHz |

| | |
|---|---|
| **Test Date:** | 24-Aug-15 |
| **Test Engineer:** | Joseph Brunett |
| **EUT:** | Delphi SRR3 77GHz |
| **Mode:** | CW |
| **Meas. Distance:** | See Table. |

| | Env. | | Frequency Band | | Antenna + Cable | | | | | Rx. Power | | Range Correction[2] | | | | E3-Field | | EIRP[3] | | S3[5] | | S3 Limit | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temp. | Volt. | Start | Stop | Type | Pol. | Dim.[4] | Ka | Kg | Pk | Avg[1] | MR | DR | N/F | CF | Pk | Avg | Pk | Avg | Pk | Avg | Pk | Avg | Pass By | |
| # | ( C ) | (V) | MHz | MHz | | H/V | cm | dB/m | dB | dBm | | m | m | m | dB | dBuV/m | | dBm | | dBm/cm2 | | dBm/cm2 | | dB | Comments |
| 1 | 20 | 13.4 | 76005.0 | 76005.0 | Horn W | H/V | 3.0 | 45.3 | -16.0 | -42.3 | -58.4 | 0.6 | 3.0 | 0.5 | -14.0 | 112.0 | 95.9 | **16.8** | 0.7 | -43.7 | -59.8 | -5.5 | -10.6 | 38.2 | CW |
| 2 | 20 | 13.4 | 76500.0 | 76500.0 | Horn W | H/V | 3.0 | 45.3 | -16.0 | -41.3 | -57.4 | 0.6 | 3.0 | 0.5 | -14.0 | 113.0 | 96.9 | **17.8** | 1.7 | -42.7 | -58.8 | -5.5 | -10.6 | **37.2** | CW |
| 3 | 20 | 13.4 | 76995.0 | 76995.0 | Horn W | H/V | 3.0 | 45.3 | -16.0 | -45.2 | -61.3 | 0.6 | 3.0 | 0.5 | -14.0 | 109.1 | 93.0 | **13.9** | -2.2 | -46.6 | -62.7 | -5.5 | -10.6 | 41.1 | CW |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | |

(1) Avg. is computed from the Peak measurement via the worst-case Spread Duty Cycle detailed in the Duty Cycle section of this test report.

(2) CF is computed assuming a 40 dB/decade Near-Field Decay Rate and a 20 dB/Decade Far-field Decay Rate. DR is Regulatory Range Distance. MR is Measurement Distance. N/F is near-far boundary.

(3) EIRP is computed from field strength at 3 meter distance. If emission is within 6 dB of regulatory limit, then substitution method measurement is employed to determine exact EIRP.

(4) Dimension of antenna is taken to be the larger of the test antenna and the DUT antenna; DUT antenna is 3cm in dimension.

(5) Spacial Power Density S @ 3m (dBm/cm^2) = EIRP (dBm) – 10*log10(4*pi*((300cm)^2)) = EIRP (dBm) – 60.5 dB

Equipment Used: RSFSV30001, MIX75TO10001, HRNW01

### 3.2.4 Exposure and Potential Health Hazard

To demonstrate compliance with with regulations that place limitations on human electromagnetic field exposure for both the general public and for workers, we measured localized field strength in close proximity to the EUT. These levels are compared with limits placed by the directives and recommendations detailed in Section 1.1. Table 6 details the results of these computations.

Table 6: Electromagnetic Field Exposure.

| | Level | Units | | |
|---|---|---|---|---|
| | | | **Test Date:** | 24-Aug-15 |
| | | | **Test Engineer:** | Joseph Brunett |
| **MPE Field Strength Limit** | 61 | V/m | **EUT Mode:** | CW |
| **MPE Power Density Limit** | 1.0 | mW/cm2 | **Meas. Distance:** | 3m |

| Freq. MHz | Temp ºC | EIRP (Pk) dBm | Exposure Duty dB | EIRP (Avg) dBm | EUT Ant. Dim. cm | Far-field Distance m | S = 1mW/cm2 Dist.* cm | S @ 20 cm Distance mW/cm2 | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 76005 | 20 | 16.8 | -5.1 | 11.7 | 3.00 | 0.46 | 1.0 | 0.003 | CW |
| 76500 | 20 | 17.8 | -5.1 | 12.7 | 3.00 | 0.46 | 1.0 | 0.004 | CW |
| 76995 | 20 | 13.9 | -5.1 | 8.8 | 3.00 | 0.46 | 0.8 | 0.002 | CW |
| | | | | | | | | | |
| | | | | | | | | | |

S @ 20cm = EIRP – 10*log10( 4 * PI * 20^2)

S = 1mW/cm2 Distance = sqrt(30*(EIRP(Avg)/1000))/ 61 *100

S = 1mW/cm2 Distance is an overestimated value(when less than the DUT far field distance, and demonstrates compliance with FCC Part 1.1307, 1.1310, 2.1091, and 2.0193 requirements when the DUT is mounted into the motor vehicle.

## 3.3 Unintentional Emissions

### 3.3.1 Transmit Chain Spurious Emissions

The results for the measurement of transmit chain spurious emissions at the nominal voltage and temperature are provided in Table 7.

Table 7: Transmit Chain Spurious Emissions.

| Frequency Range | Det | IF Bandwidth | Video Bandwidth | | |
|---|---|---|---|---|---|
| 25 MHz ≤ f ≤ 1 000 MHz | Pk/QPk | 120 kHz | 300 kHz | **Test Date:** | 08/24/15 |
| f > 1 000 MHz | Pk | 1 MHz | 3 MHz | **Test Engineer:** | Joseph Brunett |
| f > 1 000 MHz | Avg (RMS) | 1 MHz | 3 MHz | **EUT:** | Delphi SRR3 77GHz |
| | | | | **Mode:** | Modulated |
| | | | | **Meas. Distance:** | See Table. |

**FREQ < 40 GHZ (Digital Emissions)**

| | Env. | | Frequency Band | | Antenna + Cable*** | | | | | Rx. Power | | Range Correction* | | | | E-Field @ DR | | EIRP* | | S @ DR | | E-Field Limit | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temp. | Volt. | Start | Stop | Quality | Pol. | Dim. | Ka | Kg | Pk | Avg | MR | DR | N/F | CF | Pk | Avg | Pk | Avg | Pk | Avg | Pk | Avg | Pass By | |
| # | ( C ) | (V) | MHz | MHz | Number | H/V | cm | dB/m | dB | dBm | | m | m | m | dB | dBuV/m | | dBm | | dBm/cm2 | | dBuV/m | | dB | Comments |
| 1 | 20 | 13.4 | 1000 | 3000 | HRNQR316401 | H/V | | 24.1 | -0.2 | -95.3 | -104.6 | 3.0 | 3.0 | | | 36.0 | 26.7 | | | | | 74.0 | 54.0 | 27.3 | noise |
| 1 | 20 | 13.4 | 3000 | 6000 | HRNQR316401 | H/V | | 36.4 | -0.3 | -90.2 | -103.5 | 3.0 | 3.0 | | | 53.5 | 40.2 | | | | | 74.0 | 54.0 | 13.8 | background |
| 2 | 20 | 13.4 | 6000 | 8400 | HRNXN001 | H/V | 25.0 | 27.1 | -0.6 | -99.8 | | 3.0 | 3.0 | 3.5 | 0.0 | 34.9 | 34.9 | | | | | 74.0 | 54.0 | 19.1 | noise |
| 3 | 20 | 13.4 | 8400 | 12500 | HRNX001 | H/V | 19.4 | 32.0 | -0.8 | -101.3 | | 3.0 | 3.0 | 3.1 | 0.0 | 38.5 | 38.5 | | | | | 74.0 | 54.0 | 15.5 | noise |
| 4 | 20 | 13.4 | 12500 | 18000 | HRNKU001 | H/V | 15.2 | 35.4 | -1.1 | -100.9 | | 3.0 | 3.0 | 2.8 | 0.0 | 42.6 | 42.6 | | | | | 74.0 | 54.0 | **11.4** | background |
| 5 | 20 | 13.4 | 18000 | 26500 | HRNK001 | H/V | 10.2 | 33.7 | -1.6 | -99.4 | | 0.3 | 3.0 | 1.8 | -35.7 | 7.1 | 7.1 | | | | | 74.0 | 54.0 | 46.9 | noise |
| 6 | 20 | 13.4 | 26500 | 40000 | HRNKA001 | H/V | 9.2 | 37.2 | 0.0 | -90.7 | | 0.3 | 3.0 | 2.3 | -37.5 | 16.0 | 16.0 | | | | | 74.0 | 54.0 | 38.0 | noise |

**FREQ >= 40 GHZ**

| | Env. | | Frequency Band | | Antenna + Cable*** | | | | | Rx. Power | | Range Correction* | | | | E-Field @ DR | | EIRP* | | S @ DR | | S Limit | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Temp. | Volt. | Start | Stop | Quality | Pol. | Dim. | Ka | Kg | Pk | Avg | MR | DR | N/F | CF | Pk | Avg | Pk | Avg | Pk | Avg | Pk | Avg | Pass By | |
| # | ( C ) | (V) | GHz | GHz | Number | H/V | cm | dB/m | dB | dBm | | m | m | m | dB | dBuV/m | | dBm | | dBm/cm2 | | dBm/cm2 | | dB | Comments |
| 7 | 20 | 13.4 | 40.0 | 60.0 | HRNU001 | H/V | 6.3 | 39.1 | 0.0 | -63.0 | | 0.30 | 3.0 | 1.6 | -34.5 | 48.6 | | -46.6 | | -107.1 | | | -62.2 | 44.9 | LMH LR+MR+SR Channels (max all) |
| 8 | 20 | 13.4 | 50.0 | 75.0 | HRNV001 | H/V | 4.0 | 40.1 | 0.0 | -64.9 | | 0.30 | 3.0 | 0.8 | -28.5 | 53.7 | | -41.5 | | -102.1 | | | -62.2 | 39.8 | LMH LR+MR+SR Channels (max all) |
| 9 | 20 | 13.4 | 75.0 | 76.0 | HRNW001 | H/V | 3.0 | 45.3 | 0.0 | -65.0 | -74.6 | 0.30 | 3.0 | 0.5 | -23.6 | 63.7 | 54.1 | -31.5 | -41.1 | -92.1 | -101.6 | | -62.2 | 29.9 | LR LowCH (low band edge) |
| 10 | 20 | 13.4 | 75.0 | 76.0 | HRNW001 | H/V | 3.0 | 45.3 | 0.0 | -65.2 | -75.1 | 0.30 | 3.0 | 0.5 | -23.6 | 63.5 | 53.6 | -31.7 | -41.6 | -92.3 | -102.1 | | -62.2 | 30.1 | MR LowCH (low band edge) |
| 11 | 20 | 13.4 | 75.0 | 76.0 | HRNW001 | H/V | 3.0 | 45.3 | 0.0 | -63.9 | -73.2 | 0.30 | 3.0 | 0.5 | -23.6 | 64.8 | 55.4 | -30.4 | -39.8 | -91.0 | -100.3 | | -62.2 | 28.8 | SR LowCH (low band edge) |
| 12 | 20 | 13.4 | 77.0 | 110.0 | HRNW001 | H/V | 3.0 | 46.4 | 0.0 | -61.1 | -70.7 | 0.30 | 3.0 | 0.7 | -26.8 | 65.5 | 55.9 | -29.7 | -39.3 | -90.3 | -99.9 | | -62.2 | 28.1 | LR LowCH (high band edge) |
| 13 | 20 | 13.4 | 77.0 | 110.0 | HRNW001 | H/V | 3.0 | 46.4 | 0.0 | -61.2 | -71.0 | 0.30 | 3.0 | 0.7 | -26.8 | 65.4 | 55.6 | -29.8 | -39.6 | -90.4 | -100.1 | | -62.2 | 28.2 | MR LowCH (high band edge) |
| 14 | 20 | 13.4 | 77.0 | 110.0 | HRNW001 | H/V | 3.0 | 46.4 | 0.0 | -62.4 | -72.1 | 0.30 | 3.0 | 0.7 | -26.8 | 64.2 | 54.4 | -31.0 | -40.8 | -91.6 | -101.3 | | -62.2 | 29.4 | SR LowCH (high band edge) |
| 15 | 20 | 13.4 | 75.0 | 76.0 | HRNW001 | H/V | 3.0 | 45.3 | 0.0 | -65.0 | -74.9 | 0.30 | 3.0 | 0.5 | -23.6 | 63.7 | 53.8 | -31.5 | -41.4 | -92.1 | -101.9 | | -62.2 | 29.9 | LR HighCH (low band edge) |
| 16 | 20 | 13.4 | 75.0 | 76.0 | HRNW001 | H/V | 3.0 | 45.3 | 0.0 | -65.2 | -75.0 | 0.30 | 3.0 | 0.5 | -23.6 | 63.5 | 53.6 | -31.7 | -41.6 | -92.3 | -102.1 | | -62.2 | 30.1 | MR HighCH (low band edge) |
| 17 | 20 | 13.4 | 75.0 | 76.0 | HRNW001 | H/V | 3.0 | 45.3 | 0.0 | -63.9 | -73.2 | 0.30 | 3.0 | 0.5 | -23.6 | 64.8 | 55.4 | -30.4 | -39.8 | -91.0 | -100.3 | | -62.2 | 28.8 | SR HighCH (low band edge) |
| 18 | 20 | 13.4 | 77.0 | 110.0 | HRNW001 | H/V | 3.0 | 46.4 | 0.0 | -60.9 | -70.0 | 0.30 | 3.0 | 0.7 | -26.8 | 65.7 | 56.5 | -29.5 | -38.7 | -90.1 | -99.2 | | -62.2 | 27.9 | LR HighCH (high band edge) |
| 19 | 20 | 13.4 | 77.0 | 110.0 | HRNW001 | H/V | 3.0 | 46.4 | 0.0 | -60.9 | -70.3 | 0.30 | 3.0 | 0.7 | -26.8 | 65.7 | 56.3 | -29.5 | -38.9 | -90.1 | -99.4 | | -62.2 | 27.9 | MR HighCH (high band edge) |
| 20 | 20 | 13.4 | 77.0 | 110.0 | HRNW001 | H/V | 3.0 | 46.4 | 0.0 | -62.4 | -71.8 | 0.30 | 3.0 | 0.7 | -26.8 | 64.2 | 54.8 | -31.0 | -40.4 | -91.6 | -101.0 | | -62.2 | 29.4 | SR HighCH (high band edge) |
| 21 | 20 | 13.4 | 110.0 | 140.0 | HRNG001 | H/V | 3.0 | 54.0 | 0.0 | -60.8 | -70.8 | 0.30 | 3.0 | 0.8 | -28.9 | 71.3 | 61.3 | -23.9 | -33.9 | -84.5 | -94.5 | | -62.2 | 22.3 | LMH LR+MR+SR Channels (max all) |
| 22 | 20 | 13.4 | 140.0 | 200.0 | HRNG001 | H/V | 3.0 | 54.0 | 0.0 | -61.7 | -71.3 | 0.30 | 3.0 | 1.2 | -32.0 | 67.3 | 57.7 | -27.9 | -37.5 | -88.5 | -98.1 | | -62.2 | **26.3** | LMH LR+MR+SR Channels (max all) |
| 23 | 20 | 13.4 | 200.0 | 231.0 | HRNG001 | H/V | 3.0 | 54.0 | 0.0 | -61.9 | -71.4 | 0.30 | 3.0 | 1.4 | -33.3 | 65.8 | 56.3 | -29.4 | -38.9 | -89.9 | -99.4 | | -60.0 | 29.9 | LMH LR+MR+SR Channels (max all) |
| 24 | | | | | | | | | | | | | | | | | | | | | | | | | |

* CF is computed assuming a 40 dB/decade Near-Field Decay Rate and a 20 dB/Decade Far-field Decay Rate. DR is Regulatory Range Distance. MR is Measurement Distance.

** EIRP is computed from field strength at 3 meter distance. If emission is within 6 dB of regulatory limit, then substitution method measurement is employed to determine exact EIRP.

*** Dimension of antenna is taken to be larger of the test antenna and the DUT antenna; DUT antenna is 3cm in dimension.

Equipment Used: RSFSV30001, MIX26TO4001, MIX40TO60OW, MIX50TO7501, MIX75TO10001, ASSORTED ANTENNAS LISTED ABOVE

### 3.3.2 Radiated Digital Spurious

The results for the measurement of digital spurious emissions (emissions arising from digital circuitry) at the nominal voltage and temperature are provided in Table 8. Radiation from digital components has been measured to 4 GHz, or to five times the maximum digital component operating frequency, whichever is greater.

Table 8: Radiated Digital Spurious Emissions.

| Frequency Range | Det | IF Bandwidth | Video Bandwidth | | |
|---|---|---|---|---|---|
| 25 MHz ≤ f ≤ 1 000 MHz | Pk/QPk | 120 kHz | 300 kHz | **Test Date:** | 24-Aug-15 |
| f > 1 000 MHz | Pk | 1 MHz | 3 MHz | **Test Engineer:** | Joseph Brunett |
| f > 1 000 MHz | Avg (RMS) | 1 MHz | 3 MHz | **EUT:** | Delphi SRR3 77GHz |
| | | | | **Mode:** | Active |
| | | | | **Meas. Distance:** | 3 meters |

**Digital Spurious Emissions** FCC/IC + CE(CISPR)

| # | Test Freq. MHz | Antenna Quality Number | Test Pol. | Pr (Pwr Rx.) Pk dBm | Pr (Pwr Rx.) QPk/Avg | Ka dB/m | Kg dB | E-Field @ 3m Pk dBµV/m | E-Field @ 3m QPk/Avg dBµV/m | FCC/IC Class B E3lim dBµV/m | FCC/IC Class B Pass dB | CE Class B E3lim dBµV/m | CE Class B Pass dB | FCC/IC Class A E3lim dBµV/m | FCC/IC Class A Pass dB | CE Class A E3lim dBµV/m | CE Class A Pass dB | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 89.0 | BICEMCO01 | V | | | 9.5 | 37.5 | 13.7 | | 43.5 | 29.8 | 40.5 | 26.8 | 54.0 | 40.3 | 50.5 | 36.8 | background |
| 2 | 90.9 | BICEMCO01 | V | | | 9.6 | 37.5 | 6.0 | | 43.5 | 37.5 | 40.5 | 34.5 | 54.0 | 48.0 | 50.5 | 44.5 | background |
| 3 | 93.1 | BICEMCO01 | V | | | 9.6 | 37.4 | 5.3 | | 43.5 | 38.2 | 40.5 | 35.2 | 54.0 | 48.7 | 50.5 | 45.2 | background |
| 4 | 93.8 | BICEMCO01 | H | | | 9.7 | 37.4 | 9.9 | | 43.5 | 33.6 | 40.5 | 30.6 | 54.0 | 44.1 | 50.5 | 40.6 | background |
| 5 | 95.4 | BICEMCO01 | V | | | 9.7 | 37.4 | 11.1 | | 43.5 | 32.4 | 40.5 | 29.4 | 54.0 | 42.9 | 50.5 | 39.4 | background |
| 6 | 96.4 | BICEMCO01 | V | | | 9.8 | 37.4 | 10.7 | | 43.5 | 32.8 | 40.5 | 29.8 | 54.0 | 43.3 | 50.5 | 39.8 | background |
| 7 | 97.8 | BICEMCO01 | V | | | 9.9 | 37.3 | 19.4 | | 43.5 | 24.1 | 40.5 | **21.1** | 54.0 | 34.6 | 50.5 | 31.1 | background |
| 8 | 98.5 | BICEMCO01 | V | | | 9.9 | 37.3 | 18.3 | | 43.5 | 25.2 | 40.5 | 22.2 | 54.0 | 35.7 | 50.5 | 32.2 | background |
| 9 | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | |

*QPk detection below 1 GHz, Avg detection at or above 1 GHz with receiver bandwidth as specified at top of table.