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Testing of  
**Electromagnetic Emissions**  
per

**USA: CFR Title 47, Part 15.109**

are herein reported for

**Robert Bosch Corporation**  
**PFJG2EX23**

Test Report No.: 417124-679r1  
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Report by: Valdis V. Liepa Report Date of Issue: August 6, 2014  
Valdis V. Liepa, Ph.D.

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**Results of testing completed on (or before) July 22, 2014 are as follows.**

**Emissions:** Radiated spurious emissions associated with the receive chain of this device **COMPLY** the regulatory limit(s) by no less than 5.2 dB. RF conducted emissions via the EUT's external antenna port **COMPLY** with the regulatory limit by 18.9 dB.

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# 1 Test Specifications, General Procedures, and Location

## 1.1 Test Specification and General Procedures

The ultimate goal of Robert Bosch Corporation 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 Robert Bosch Corporation PFJG2EX23 for compliance to:

| Country/Region | Rules or Directive          | Referenced Section(s)     |
|----------------|-----------------------------|---------------------------|
| United States  | Code of Federal Regulations | CFR Title 47, Part 15.109 |

In association with the rules and directives outlined above, the following specifications and procedures are followed herein.

|                 |                                                                                                                                        |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------|
| 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" |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------|

## 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.

| <b>Test Instrument</b>             | <b>Manufacturer/Model</b>              | <b>Q Number</b> |
|------------------------------------|----------------------------------------|-----------------|
| Spectrum Analyzer (9kHz-26GHz)     | Hewlett-Packard 8593E, SN: 3412A01131  | HP8593E1        |
| Power Meter                        | Hewlett-Packard, 432A                  | HP432A1         |
| Harmonic Mixer (26-40 GHz)         | Hewlett-Packard 11970A, SN: 3003A08327 | HP11970A1       |
| Harmonic Mixer (40-60 GHz)         | Hewlett-Packard 11970U, SN: 2332A00500 | HP11970U1       |
| Harmonic Mixer (75-110 GHz)        | Hewlett-Packard 11970W, SN: 2521A00179 | HP11970W1       |
| Harmonic Mixer (140-220 GHz)       | Pacific Millimeter Prod., GMA, SN: 26  | PMPGMA1         |
| S-Band Std. Gain Horn              | S/A, Model SGH-2.6                     | SBAND1          |
| C-Band Std. Gain Horn              | University of Michigan, NRL design     | CBAND1          |
| XN-Band Std. Gain Horn             | University of Michigan, NRL design     | XNBAND1         |
| X-Band Std. Gain Horn              | S/A, Model 12-8.2                      | XBAND1          |
| X-band horn (8.2- 12.4 GHz)        | Narda 640                              | XBAND2          |
| X-band horn (8.2- 12.4 GHz)        | Scientific Atlanta , 12-8.2, SN: 730   | XBAND3          |
| K-band horn (18-26.5 GHz)          | FXR, Inc., K638KF                      | KBAND1          |
| Ka-band horn (26.5-40 GHz)         | FXR, Inc., U638A                       | KABAND1         |
| U-band horn (40-60 GHz)            | Custom Microwave, HO19                 | UBAND1          |
| W-band horn(75-110 GHz)            | Custom Microwave, HO10                 | WBAND1          |
| G-band horn (140-220 GHz)          | Custom Microwave, HO5R                 | GBAND1          |
| Bicone Antenna (30-250 MHz)        | University of Michigan, RLBC-1         | LBBIC1          |
| Bicone Antenna (200-1000 MHz)      | University of Michigan, RLBC-2         | HBBIC1          |
| Dipole Antenna Set (30-1000 MHz)   | 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)  | University of Michigan                 | UMRH1           |
| Magnetic Field Strength Probe      | HP 11941A                              | HPMFSP1         |
| Electric Field Strength Probe      | EG&G ACD-4A(R)                         | EGGACD41        |
| Amplifier (5-1000 MHz)             | Avantek, A11-1, A25-1S                 | AVAMP1          |
| Amplifier (5-4500 MHz)             | Avantek                                | AVAMP2          |
| Amplifier (4.5-13 GHz)             | Avantek, AFT-12665                     | AVAMP3          |
| Amplifier (6-16 GHz)               | Trek                                   | TRAMP1          |
| Amplifier (16-26 GHz)              | Avantek                                | AVAMP4          |
| LISN Box                           | University of Michigan                 | UMLISN1         |
| Signal Generator                   | Hewlett-Packard 8657B                  | HPSG1           |

2 Configuration and Identification of the Equipment Under Test

2.1 Description and Declarations

The EUT is a superheterodyne receiver. The EUT is approximately 4 x 2 x 0.5 in in dimension, and is depicted in Figure 1. It is powered by a 13.2 VDC vehicle power system. In use, this device is permanently affixed in a motor vehicle. Table 2 outlines provider declared EUT specifications.

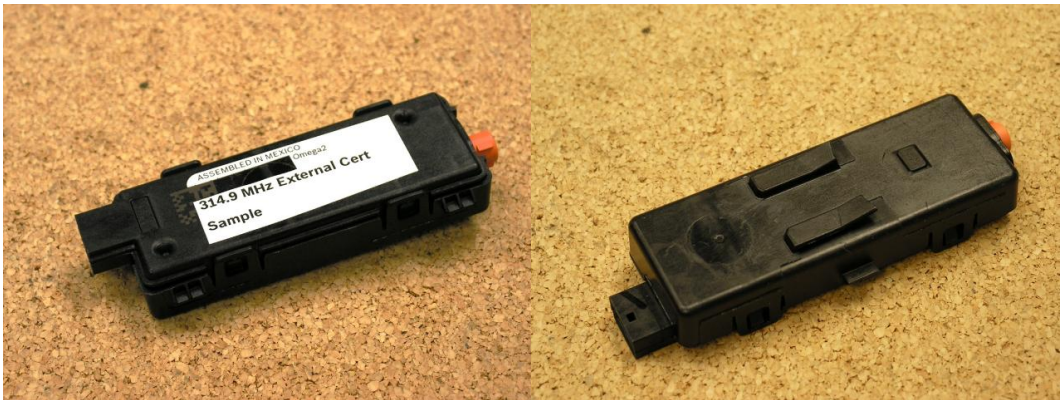


Figure 1: Photos of EUT.

Table 2: EUT Declarations.

| General Declarations |           |                    |              |
|----------------------|-----------|--------------------|--------------|
| Equipment Type:      | Receiver  | Country of Origin: | Not Declared |
| Nominal Supply:      | 13.2 VDC  | Oper. Temp Range:  | Not Declared |
| Frequency Range:     | 314.9 MHz | Antenna Dimension: | Not Declared |
| Antenna Type:        | external  | Antenna Gain:      | Not Declared |
| United States        |           |                    |              |
| FCC ID Number:       | PFJG2EX23 | Classification:    | CYY          |

2.1.1 EUT Configuration

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

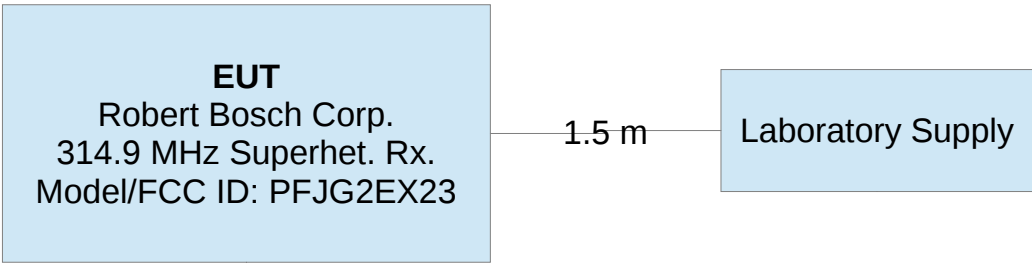


Figure 2: EUT Test Configuration Diagram.

**2.1.2 Modes of Operation**

The EUT operates as a superheterodyne receiver.

**2.1.3 Variants**

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

**2.1.4 Test Samples**

Two samples in total were provided. One Rx awake sample and one normal sample to take apart for photos.

**2.1.5 Functional Exerciser**

Normal operating EUT functionality was verified by observation LO(VCO) of the receiver.

**2.1.6 Modifications Made**

No modifications were made to the EUT.

**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).

### 3 Emissions

#### 3.1 General Test Procedures

##### 3.1.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are first evaluated in our shielded fully anechoic chamber. Spectrum and modulation characteristics of all emissions are recorded, and emissions above 1 GHz are fully characterized. The anechoic chamber contains a set-up similar to that of our outdoor 3-meter site, with a turntable and antenna mast. 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 ANSI C63.4 / CISPR-22 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

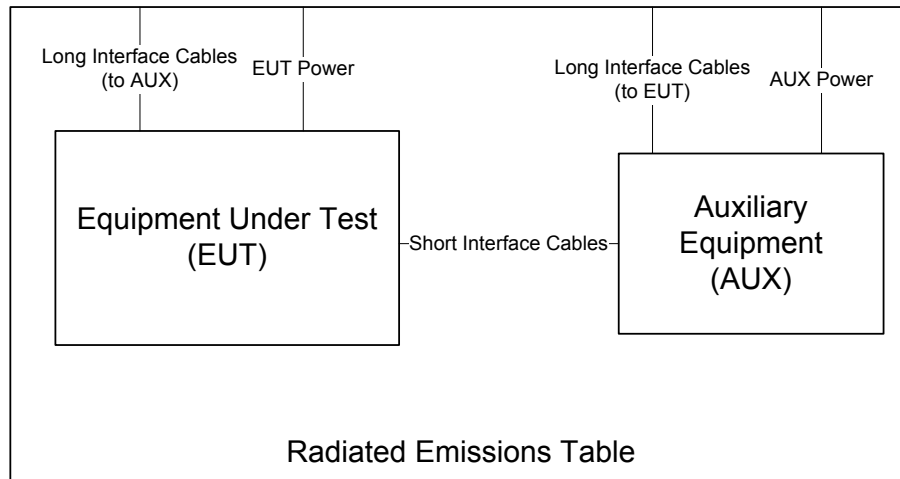


Figure 3: Radiated Emissions Diagram of the EUT.

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.

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 as the test antenna. It is placed at a 1 meter receive height and appropriate low frequency magnetic field extrapolation to the regulatory limit distance is employed. 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° 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. 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 compute, 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**

**Receive Antenna Port Conducted Emissions** The EUT employs a receiver operating between 30 and 960 MHz that employs a  $50\Omega$  receive antenna port. Antenna terminal conducted emissions measurements are made on this port(s) by connecting the EUT port directly to the  $50\Omega$  measurement receiver and recording all signals up to 5 times the highest tuned receive frequency or 1 GHz, whichever is greater.

**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.

## 3.2 Unintentional Emissions

### 3.2.1 Antenna Terminal Receiver Spurious

The EUT employs one or more external receive antenna terminals (ports). With the receiver antenna terminal connected to a termination equal to the impedance specified or employed for the antenna, the power at the antenna terminal at any frequency within the range of measurements specified shall not exceed 2.0 nanowatts. Measurements of conducted spurious emissions are detailed in Section 3.2.3 of this report.

### 3.2.2 Radiated Receiver Spurious

The results for the measurement of radiated receiver spurious emissions (emissions arising from the receiver chain, e.g. LO or VCO) at the nominal voltage and temperature are reported in Table 3. Receive chain emissions are measured to 5 times the highest receive chain frequency employed or 4 GHz, whichever is higher. If no emissions are detected, only those noise floor emissions at the LO/VCO frequency are reported. Relative relative emissions are depicted in Figure 5.

Table 3: Receiver Chain Spurious Emissions  $\geq 30$  MHz.

| Frequency Range                 | Det    | IF Bandwidth | Video Bandwidth |
|---------------------------------|--------|--------------|-----------------|
| 25 MHz $\leq f \leq 1\,000$ MHz | Pk/QPk | 120 kHz      | 300 kHz         |
| $f > 1\,000$ MHz                | Pk     | 1 MHz        | 3 MHz           |
| $f > 1\,000$ MHz                | Avg    | 1 MHz        | 10kHz           |

| Radiated Emission - RF |                |              |              |           |              |            |          |                    |                       |            | Bosch Rx; FCC/IC        |
|------------------------|----------------|--------------|--------------|-----------|--------------|------------|----------|--------------------|-----------------------|------------|-------------------------|
| #                      | Freq.<br>MHz   | Ant.<br>Used | Ant.<br>Pol. | Pr<br>dBm | Det.<br>Used | Ka<br>dB/m | Kg<br>dB | E3<br>dB $\mu$ V/m | E3lim<br>dB $\mu$ V/m | Pass<br>dB | Comments                |
| 1                      | 314.7          | Sbic         | H            | -80.7     | Pk           | 18.9       | 20.8     | 24.4               | 46.0                  | 21.6       | max. of all, noise      |
| 2                      | 314.7          | Sbic         | V            | -81.7     | Pk           | 18.9       | 20.8     | 23.4               | 46.0                  | 22.6       | max. of all, noise      |
| 3                      | 629.4          | Sbic         | H            | -80.2     | Pk           | 25.2       | 17.7     | 34.3               | 46.0                  | 11.7       | max. of all, noise      |
| 4                      | 629.4          | Sbic         | V            | -77.8     | Pk           | 25.2       | 17.7     | 36.7               | 46.0                  | 9.3        | max. of all, noise      |
| 5                      | 944.1          | Sbic         | H            | -79.4     | Pk           | 28.9       | 15.7     | 40.8               | 46.0                  | 5.2        | max. of all, background |
| 6                      | 944.1          | Sbic         | V            | -79.7     | Pk           | 28.9       | 15.7     | 40.5               | 46.0                  | 5.5        | max. of all, background |
| 7                      |                |              |              |           |              |            |          |                    |                       |            |                         |
| 8                      | 1 to 2 GHz     | R-Horn       | H            | -67.7     | Pk           | 19.6       | 28.0     | 30.9               | 54.0                  | 23.1       | max. of all, noise      |
| 9                      | 2 to 2.9 GHz   | R-Horn       | H            | -70.3     | Pk           | 22.5       | 28.2     | 31.0               | 54.0                  | 23.0       | max. of all, noise      |
| 10                     | 2.9 to 4.5 GHz | R-Horn       | H            | -71.5     | Pk           | 25.0       | 24.5     | 36.1               | 54.0                  | 17.9       | max. of all, noise      |
| 11                     |                |              |              |           |              |            |          |                    |                       |            |                         |
| 12                     |                |              |              |           |              |            |          |                    |                       |            |                         |
| 13                     |                |              |              |           |              |            |          |                    |                       |            |                         |

TEST EQUIPMENT USED: HP8593E1, HBBIC1, UMRH

Meas. 07/22/2014; U of Mich.

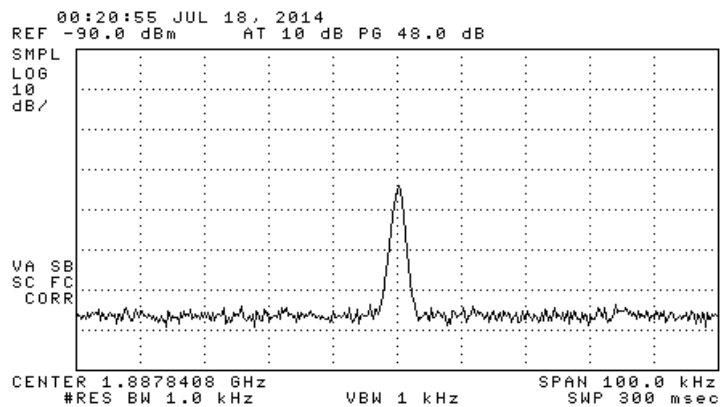


Figure 5: Receiver LO (or VCO) relative emission.

### 3.2.3 Conducted Receiver Spurious

The EUT employs one or more external receive antenna terminals. Measurement of conducted spurious emissions out of such ports at the nominal voltage and temperature were measured in accordance with the regulations. Radiated emissions are performed with these ports terminated. Tabulated results of these measurements are provided in Figure 6 below.

| Frequency Range                  | Det    | IF Bandwidth | Video Bandwidth |
|----------------------------------|--------|--------------|-----------------|
| 25 MHz $\leq$ f $\leq$ 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           |

| Conducted Emission - RF |              |              |              |          |              |            |          |            |            |            | Bosch Rx; FCC/IC |
|-------------------------|--------------|--------------|--------------|----------|--------------|------------|----------|------------|------------|------------|------------------|
| #                       | Freq.<br>MHz | Ant.<br>Used | Ant.<br>Pol. | Pr<br>pW | Det.<br>Used | Ka<br>dB/m | Kg<br>dB | Pout<br>nW | Plim<br>nW | Pass<br>dB | Comments         |
| 1                       | 3.0          | COND         | NA           | 26.00    | Pk           |            |          | .026000    | 2.0        | 18.9       |                  |
| 2                       | 24.5         | COND         | NA           | 1.00     | Pk           |            |          | .001000    | 2.0        | 33.0       |                  |
| 3                       | 49.0         | COND         | NA           | 0.50     | Pk           |            |          | .000500    | 2.0        | 36.0       |                  |
| 4                       | 73.0         | COND         | NA           | 0.70     | Pk           |            |          | .000700    | 2.0        | 34.6       |                  |
| 5                       | 318.0        | COND         | NA           | 0.04     | Pk           |            |          | .000043    | 2.0        | 46.7       |                  |
| 6                       | 1700.0       | COND         | NA           | 0.14     | Pk           |            |          | .000138    | 2.0        | 41.6       |                  |
| 7                       | 2300.0       | COND         | NA           | 0.18     | Pk           |            |          | .000178    | 2.0        | 40.5       |                  |
| 8                       | 2600.0       | COND         | NA           | 0.15     | Pk           |            |          | .000148    | 2.0        | 41.3       |                  |
| 9                       | 3700.0       | COND         | NA           | 0.13     | Pk           |            |          | .000132    | 2.0        | 41.8       |                  |
| 10                      |              |              |              |          |              |            |          |            |            |            |                  |
| 11                      |              |              |              |          |              |            |          |            |            |            |                  |
| 12                      |              |              |              |          |              |            |          |            |            |            |                  |
| 13                      |              |              |              |          |              |            |          |            |            |            |                  |

TEST EQUIPMENT USED: HP8593E1

Meas. 07/22/2014; U of Mich.

Figure 6: Conducted Receiver Emissions Measured.