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Measured Radio Frequency Emissions
From

# Schrader Electronics Receiver
# Model(s): 7694419

Report No. 415031-284
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**Summary**

Tests for compliance with FCC Regulations Part 15, Subpart B, and Industry Canada RSS-210/GEN, were performed on Schrader Electronics Limited model 7694419. This device is subject to the Rules and Regulations as a Receiver. As a Digital Device it is exempt, but such measurements were made to assess the receiver's overall emissions.

In testing completed on April 3, 2006, the device tested in the worst case met the allowed Class B specifications for radiated emissions by more than 13.5 dB (see p. 6). The conducted emissions tests do not apply, since the device is powered from a 12 VDC system.

## 1. Introduction

Schrader Electronics Limited model 7694419 was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989, and with Industry Canada RSS-210, Issue 6 and RSS-Gen, Issue 1, September, 2005. The tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-2003 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057).

## 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 (0.1-1500 MHz) | | Hewlett-Packard, 182T/8558B |
| Spectrum Analyzer (9kHz-22GHz) | X | Hewlett-Packard 8593A SN: 3107A01358 |
| Spectrum Analyzer (9kHz-26GHz) | X | Hewlett-Packard 8593E, SN: 3412A01131 |
| Spectrum Analyzer (9kHz-26GHz) | | Hewlett-Packard 8563E, SN: 3310A01174 |
| Spectrum Analyzer (9kHz-40GHz) | | Hewlett-Packard 8564E, SN: 3745A01031 |
| Power Meter | | Hewlett-Packard, 432A |
| Power Meter | | Anritsu, ML4803A/MP |
| Harmonic Mixer (26-40 GHz) | | Hewlett-Packard 11970A, SN: 3003A08327 |
| Harmonic Mixer (40-60 GHz) | | Hewlett-Packard 11970U, SN: 2332A00500 |
| Harmonic Mixer (75-110 GHz) | | Hewlett-Packard 11970W, SN: 2521A00179 |
| Harmonic Mixer (140-220 GHz) | | Pacific Millimeter Prod., GMA, SN: 26 |
| S-Band Std. Gain Horn | | S/A, Model SGH-2.6 |
| C-Band Std. Gain Horn | | University of Michigan, NRL design |
| XN-Band Std. Gain Horn | | University of Michigan, NRL design |
| X-Band Std. Gain Horn | | 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) | | FXR, Inc., U638A |
| U-band horn (40-60 GHz) | | Custom Microwave, HO19 |
| W-band horn(75-110 GHz) | | Custom Microwave, HO10 |
| G-band horn (140-220 GHz) | | Custom Microwave, HO5R |
| Bicone Antenna (30-250 MHz) | X | University of Michigan, RLBC-1 |
| Bicone Antenna (200-1000 MHz) | X | University of Michigan, RLBC-2 |
| Dipole Antenna Set (30-1000 MHz) | X | 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) | X | Avantak, A11-1, A25-1S |
| Amplifier (5-4500 MHz) | X | Avantak |
| Amplifier (4.5-13 GHz) | | Avantek, AFT-12665 |
| Amplifier (6-16 GHz) | | Trek |
| Amplifier (16-26 GHz) | | Avantek |
| LISN Box | | University of Michigan |
| Signal Generator | X | Hewlett-Packard 8657B |

## 3. Configuration and Identification of Device Under Test

The DUT is a 433.92 MHz superheterodyne receiver, designed for onboard motorcycle security/convenience applications, and as such, it is powered from an vehicular 12 VDC source. It is housed in a plastic case approximately 6 by 3 by 3 inches. Antenna is integral. For testing, a generic harness was provided by the manufacturer. In the receiver digital section, the decoding, signal processing, etc. are performed by a microprocessor timed by an 4.0 MHz crystal.

The DUT was designed by Schrader, 11, Technology Park, Belfast Road,, Antrim BT41 1QS, Northern Ireland. It is identified as:

Schrader Receiver
Model(s): 7694419
FCC ID: MRXBMW433RX
IC: 2546A-BMW433RX

### 3.1 Modifications Made

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

## 4. Emission Limits

The DUT tested falls under Part 15, Subpart B, "Unintentional Radiators". The pertinent test frequencies, with corresponding emission limits, are given in Tables 4.1 and 4.2 below.

### 4.1 Radiated Emission Limits

Table 4.1. Radiated Emission Limits (Ref: FCC 15.33, 15.35, and 15.109; IC RSS-210, 2.6 Table 2).

| Freq. (MHz) | $E_{lim}$ (3m) μV/m | $E_{lim}$ (3m) dB(μV/m) |
|---|---|---|
| 30-88 | 100 | 40.0 |
| 88-216 | 150 μV/m | 43.5 |
| 216-960 | 200 μV/m | 46.0 |
| 960-2000 | 500 μV/m | 54.0 |

Note: Quasi-Peak readings apply to 1000 MHz (120 kHz BW)
Average readings apply above 1000 MHz (1 MHz BW)

### 4.2 Power Line Conducted Emission Limits

Table 4.3 Conducted Emission Limits (FCC:15.107 (CISPR); IC: RSS-Gen, 7.2.2 Table 2).

| Frequency MHz | Class A (dBμV) | | Class B (dBμV) | |
|---|---|---|---|---|
| | Quasi-peak | Average | Quasi-peak | Average |
| .150 - 0.50 | 79 | 66 | 66 - 56* | 56 - 46* |
| 0.50 – 5.0 | 73 | 60 | 56 | 46 |
| 5.0 – 30.0 | 73 | 60 | 60 | 50 |

Notes:
1. The lower limit shall apply at the transition frequency
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15-0.50 MHz:

*Class B Quasi-peak: dBμV = 50.25 - 19.12*log( f )
*Class B Average: dBμV = 40.25 - 19.12*log( f )

3. 9 kHz RBW

### 4.3 Antenna Power Conduction Limits

Ref: FCC 15.111(a). Pmax = 2 nW; for frequency range see Table 4.1.

## 5. Emission Tests and Results

NOTE: Even though the FCC and/or Industry Canada specify that both the radiated and conductive emissions be measured using the Quasi-Peak and/or average detection schemes, we normally use peak detection since Quasi-Peak is cumbersome to use with our instrumentation. In case the measurement fails to meet the limits, or the measurement is near the limit, it is re-measured using appropriate detection. We note that since the peak detected signal is always higher or equal to the Quasi-Peak or average detected signal, the margin of compliance may be better, but not worse, than indicated in this report. The type of detection used is indicated in the data table, Table 5.1.

### 5.1 Anechoic Chamber Radiated Emission Tests

To familiarize with the radiated emission behavior of the DUT, it was studied and measured in the shielded anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with turntable, antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

To study and test for radiated emissions, the DUT was powered by a laboratory power supply at 12 VDC. A MHz CW signal was injected (radiated) from a nearby signal generator using a short wire antenna. The DUT was taped to a Styrofoam block and placed on the test table on each of the three axis. At each orientation, the table was rotated to obtain maximum signal for vertical and horizontal emission polarizations. This sequence was repeated throughout the required frequency range.

In the chamber we studied and recorded all the emissions using a ridge-horn antenna, which covers 200 MHz to 5000 MHz, up to 2 GHz. In scanning from 30 MHz to 2.0 GHz, there were no spurious emissions observed other than the LO and injection signal ( MHz), and the LO harmonics. Figures 5.1 and 5.2 show emissions measured 0-1000 MHz and 1000-2000 MHz, respectively. These measurements are made with a ridge-horn antenna at 3m, with spectrum analyzer in peak hold mode and the receiver rotated in all orientations. The measurements up to 1000 MHz (Fig. 5.1) are used for initial evaluation only, while those above 1000 MHz (Fig. 5.2) are used in final assessment for compliance.

### 5.2 Open Area Test Site Radiated Emission Tests

The DUT was then moved to the 3 meter Open Area Test Site where measurements were repeated up to 1000 MHz using a small Bicone, or dipoles when the measurement is near the limit. The DUT was exercised as described in Sec. 5.1 above. The measurements were made with a spectrum analyzer using 120 kHz IF bandwidth and peak detection mode, and, when appropriate, using Quasi-Peak or average detection (see 5.0). Sometimes lower IF bandwidth is used to help bring signals out of noise and this is noted in the data table. Photographs included in this filing show the DUT on the Open Area Test Site (OATS).

The emissions from digital circuitry were measured using a standard Bicone. These results are also presented in Table 5.1.

**5.3 Computations and Results for Radiated Emissions**

To convert the dBm's measured on the spectrum analyzer to dB(μV/m), we use expression

$$E_3(\mathrm{dB}\mu\mathrm{V/m}) = 107 + P_R + K_A - K_G$$

where $P_R$ = power recorded on spectrum analyzer, dB, measured at 3m
$K_A$ = antenna factor, dB/m
$K_G$ = pre-amplifier gain, including cable loss, dB

When presenting the data, at each frequency the highest measured emission under all of the possible orientations is given. Computations and results are given in Table 5.1. There we see that the DUT meets the limit by 13.5 dB.

**5.4 Conducted Emission Tests**

These tests do not apply, since the DUT is powered from an 12 VDC system.

**6. Other Measurements**

**6.1 Emission Spectrum Near Fundamental**

Near operating frequency the emission spectrum is measured typically over 50 MHz span with and without injection signal. In the case of this device, the only measurable emissions are at the LO and 2XLO frequencies. These data are taken with the DUT close to antenna and hence amplitudes are relative. The plots are shown in Figure 6.1.

**6.2 Effect of Supply Voltage Variation**

The DUT has been designed to operate from 12 VDC power. Using a spectrum analyzer, relative radiated emissions were recorded at the 2XLO (846.4 MHz) as voltage was varied from 6.0 to 18.0 VDC. Figure 6.2 shows the emission variation.

**6.3 Operating Voltage and Current**

V = 12 VDC
I = 46 mADC

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## Table 5.1 Highest Emissions Measured

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Radiated Emission - RF** | | | | | | | | | | | Schrader BMW Rx.; 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 | 423.2 | Sbic | H | -84.2 | QPk | 21.6 | 21.3 | 23.1 | 46.0 | 22.9 | max. of all, noise |
| 2 | 423.2 | Sbic | V | -84.5 | QPk | 21.6 | 21.3 | 22.8 | 46.0 | 23.2 | max. of all, noise |
| 3 | 846.4 | Sbic | H | -84.6 | QPk | 27.9 | 18.0 | 32.3 | 46.0 | 13.7 | max. of all, noise |
| 4 | 846.4 | Sbic | V | -84.4 | QPk | 27.9 | 18.0 | 32.5 | 46.0 | **13.5** | max. of all, noise |
| 5 | 1000.0 | Horn | H | -71.0 | Pk | 20.6 | 28.0 | 28.6 | 54.0 | 25.4 | max. of all, noise |
| 6 | 1100.0 | Horn | H | -69.0 | Pk | 21.0 | 28.1 | 30.9 | 54.0 | 23.1 | max. of all, noise |
| 7 | 1200.0 | Horn | H | -68.0 | Pk | 21.3 | 28.3 | 32.0 | 54.0 | 22.0 | max. of all, noise |
| 8 | 1300.0 | Horn | H | -70.0 | Pk | 21.4 | 28.2 | 30.2 | 54.0 | 23.8 | max. of all, noise |
| 9 | 1400.0 | Horn | H | -68.5 | Pk | 21.8 | 27.9 | 32.4 | 54.0 | 21.6 | max. of all, noise |
| 10 | 1500.0 | Horn | H | -69.0 | Pk | 22.2 | 28.2 | 32.0 | 54.0 | 22.0 | max. of all, noise |
| 11 | 1600.0 | Horn | H | -69.0 | Pk | 22.4 | 28.3 | 32.1 | 54.0 | 21.9 | max. of all, noise |
| 12 | | | | | | | | | | | |
| 13 | | | | | | | | | | | |
| 14 | | | | | | | | | | | |
| 15 | | | | | | | | | | | |
| 16 | | | | | | | | | | | |
| 17 | | | | | | | | | | | |
| 18 | | | | | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | | | | | | | | | | | |
| 21 | | | | | | | | | | | |
| 22 | Digital emissions more than 20 dB below FCC/IC Class B Limit. | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | | | | | | | | | | | |
| 25 | | | | | | | | | | | |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Conducted Emissions** | | | | | | | |
| # | Freq. MHz | Line Side | Det. Used | Vtest dBμV | Vlim dBμV | Pass dB | Comments |
| | | | | | | | |
| | Not applicable | | | | | | |
| | | | | | | | |
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Meas. 04/03/2005; U of Mich.

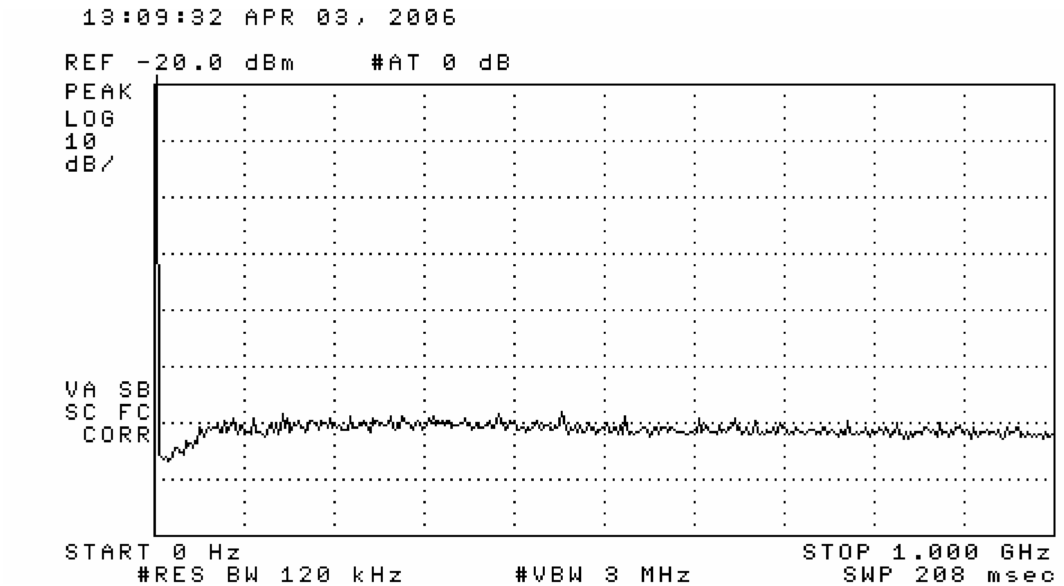



Figure 5.1. Emissions measured at 3 meters in chamber, 0-1000 MHz.

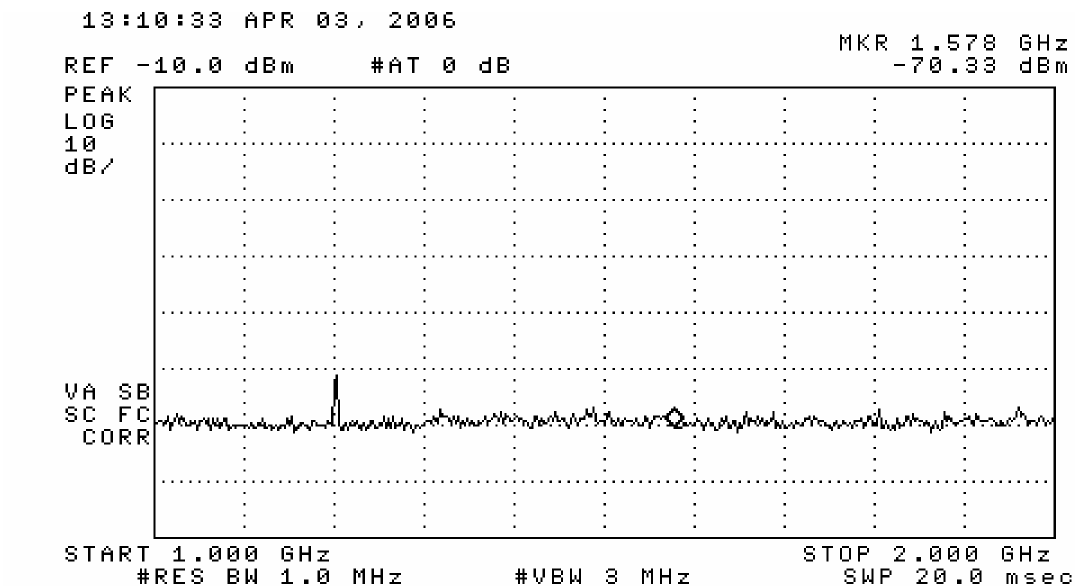



Figure 5.2. Emissions measured at 3 meters in chamber, 1000-2000 MHz.

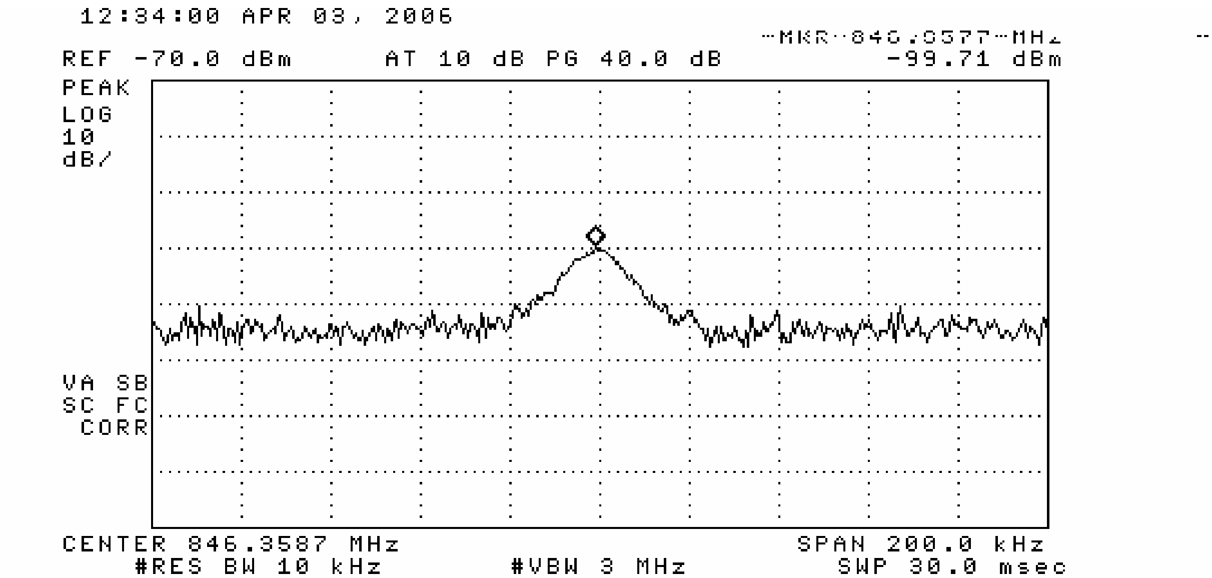



Figure 6.1. Relative receiver emissions.

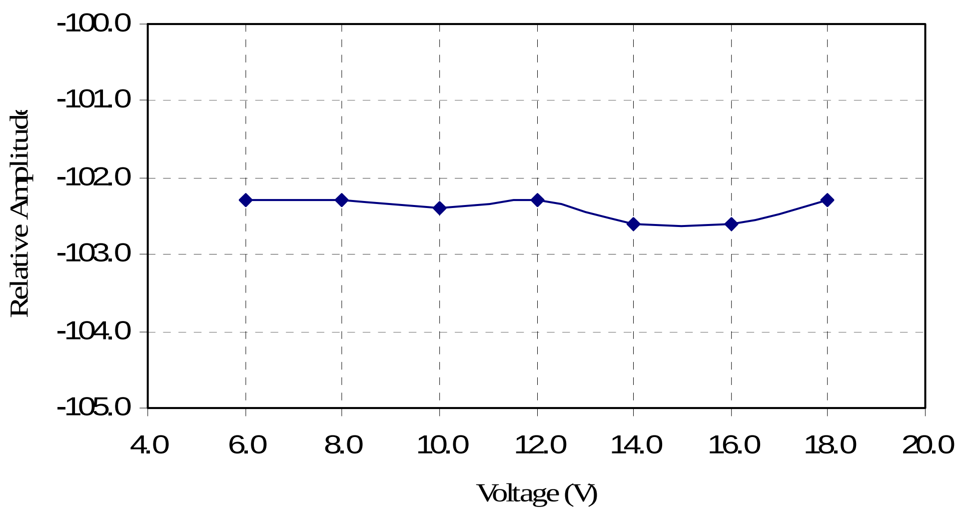
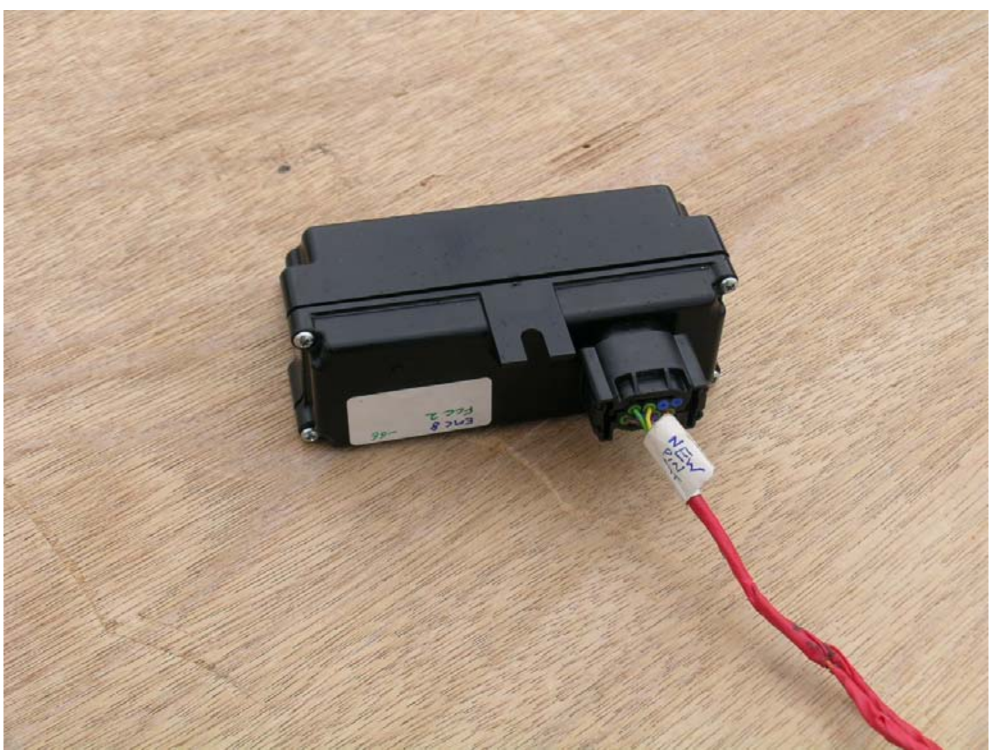



Figure 6.2. Relative emission at vs. supply voltage.

DUT on OATS



DUT on OATS (close-up)