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Measured Radio Frequency Emissions
From

Siemens/Continental Receiver
FCC ID: M3N5WY8106
IC: 267F-5WY8106

Report No. 415031-419
April 21, 2008

For:
Siemens VDO Automotive / Continental
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Summary

Tests for compliance with FCC Regulations Part 15, Subpart B, and Industry Canada RSS-210/GEN, were performed on Siemens/Continental model/PN(s) 5WY8106. 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 March 19, 2008, the device tested in the worst case met the allowed Class B specifications for radiated emissions by 11.1 dB (see p. 6). The conducted emissions tests do not apply, since the device is powered from a 12 VDC system.

1. Introduction

Siemens/Continental model/PN(s) 5WY8106 was(were) 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, Issue 7; RSS-Gen, Issue 2; June, 2007. 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 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 (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

3.1 Design and Identification of the Device

The DUT was designed by Siemens VDO Automotive / Continental, 4685 Investment Drive, Troy, MI 48098. It is identified as:

Siemens/Continental Receiver
Model/PN(s): 5WY8106
FCC ID: M3N5WY8106
IC: 267F-5WY8106

3.2 Models

There is only one model of the device. The DUT is a 315 MHz superheterodyne receiver, designed for onboard automobile security/convenience applications, and as such, it is powered from an automotive 12 VDC source. It is housed in a plastic case approximately 3 by 3 by 1.5 inches. Antenna is internal. 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 a 15.92 MHz oscillator.

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	Class A (dBμV)		Class B (dBμV)	
MHz	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

Even though the FCC and Industry Canada specify 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 the appropriate detection scheme. Note, a peak detected signal is always greater than or equal to the Quasi-Peak or average detected signal. In this report the margin of compliance may be better, but not worse than that indicated. The type of detection used is indicated in the data table, Table 5.1.

5.1 Anechoic Chamber Radiated Emission Tests
To become familiar with the emission behavior of the DUT, the device was first studied and measured in a shielded semi-anechoic chamber. In the chamber is a set-up similar to that of an outdoor 3-meter site, with a 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 22 VDC. The receiver was activated, attached 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. Detection of the LO required the addition of an LNA. 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 less than 3m distance, 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
After the chamber measurements are complete, emissions are re-measured on the outdoor 3-meter open area test site up to 1 GHz using tuned dipoles and/or a high frequency biconical antenna. 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 Section 5.0). Sometimes lower IF bandwidth is used to help bring signals out of noise and this is noted in the data table. The DUT is placed on the test table flat, on its side, and on its end, and worst case emissions are recorded. Photographs included in this filing show the DUT on the 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

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

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 11.1 dB.

5.4 Conducted Emission Tests
These tests do not apply, since the DUT is powered from a 12 VDC system.

6. Other Measurements

6.1 Emission Spectrum
The only detectable RF emission occurs at the LO or 2 x LO. The emission spectrum is measured typically over 1 MHz span. This data is taken with the DUT close to antenna and hence amplitudes are relative. The plot is 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 LO (or 2 x LO) 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 = 6.5 mADC

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Table 5.1 Highest Emissions Measured

Radiated Emission - RF											ont./Siem., RFA 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	325.7	Sbic	H	-84.2	QPk	19.2	21.8	20.2	46.0	25.8	max. of all, noise
2	325.7	Sbic	V	-84.0	QPk	19.2	21.8	20.4	46.0	25.6	max. of all, noise
3	651.4	Sbic	H	-79.1	QPk	25.5	18.7	34.7	46.0	11.3	max. of all, noise
4	651.4	Sbic	V	-78.9	QPk	25.5	18.7	34.9	46.0	**11.1**	max. of all, noise
5	977.1	Sbic	H	-83.8	QPk	29.2	16.7	35.7	54.0	18.3	max. of all, noise
6	977.1	Sbic	V	-83.7	QPk	29.2	16.7	35.8	54.0	18.2	max. of all, noise
7	1001.0	Horn	H	-72.0	Pk	19.6	28.0	26.6	54.0	27.4	max. of all, noise
8	1100.0	Horn	H	-71.6	Pk	20.0	28.1	27.4	54.0	26.6	max. of all, noise
9	1200.0	Horn	H	-71.8	Pk	20.4	28.1	27.5	54.0	26.5	max. of all, noise
10	1300.0	Horn	H	-70.0	Pk	20.7	28.1	29.6	54.0	24.4	max. of all, noise
11	1400.0	Horn	H	-69.9	Pk	21.0	28.1	30.0	54.0	24.0	max. of all, noise
12	1500.0	Horn	H	-69.3	Pk	21.3	28.1	30.9	54.0	23.1	max. of all, noise
13	1600.0	Horn	H	-68.9	Pk	21.5	28.1	31.6	54.0	22.4	max. of all, noise
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											

Digital Radiated Emissions*											
#	Freq. kHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3 dBμV/m	E3lim dBμV/m	Pass dB	Comments
1											
2											
3											
4	Digital emissions more than 20 dB below FCC/IC Class B Limit.										
5											
6											
7											
8											
9	* For devices used in transportation vehicles, digital emissions are exempt from FCC regulations per FCC 15										

Meas. 03/19/2008; U of Mich.

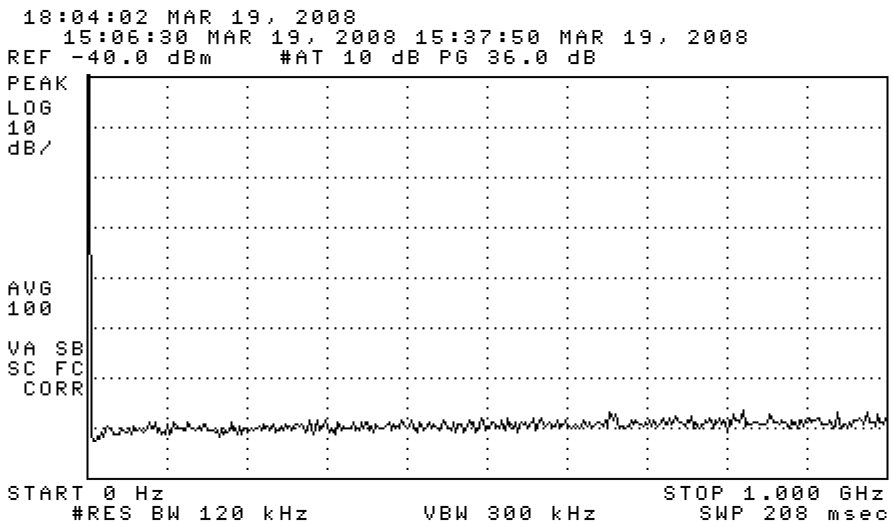


Figure 5.1. Emissions measured at 3 meters in chamber, 0-1000 MHz.

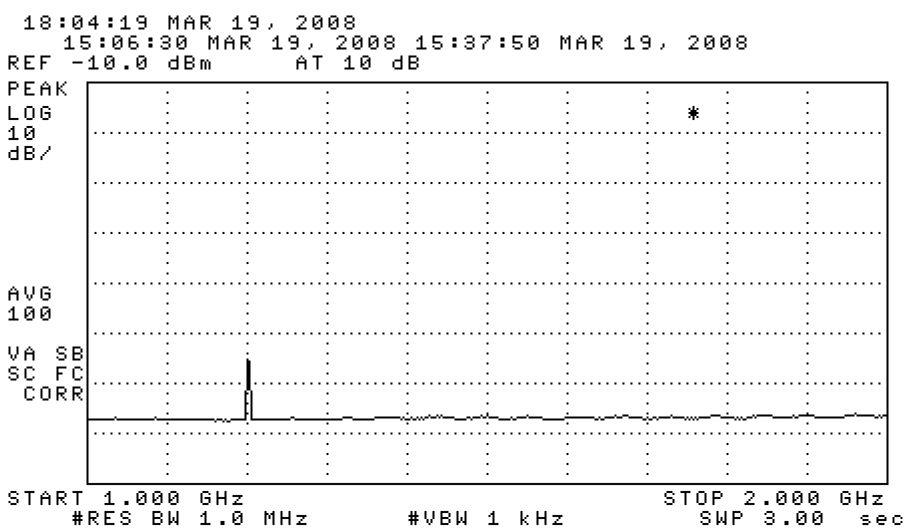


Figure 5.2. Emissions measured at 3 meters in chamber, 1000-2000 MHz.
(emission at 1200 MHz is background)

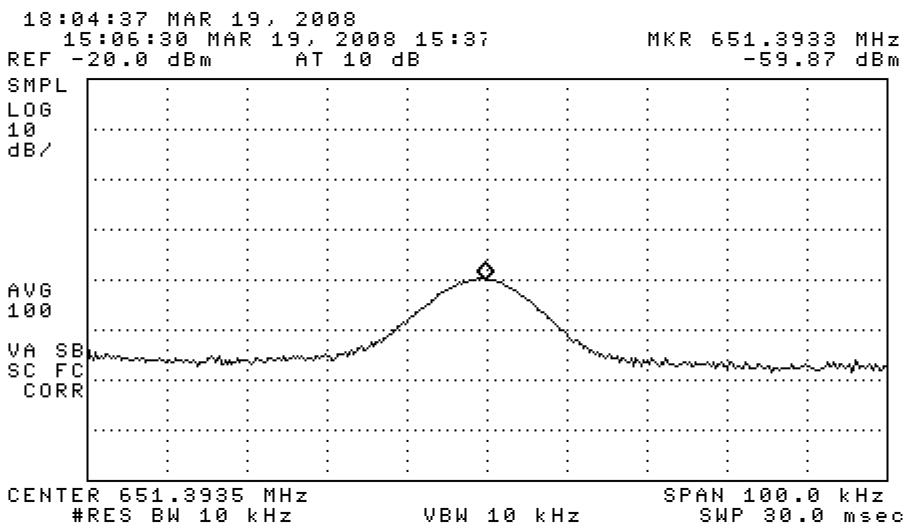


Figure 6.1. Relative receiver emissions.

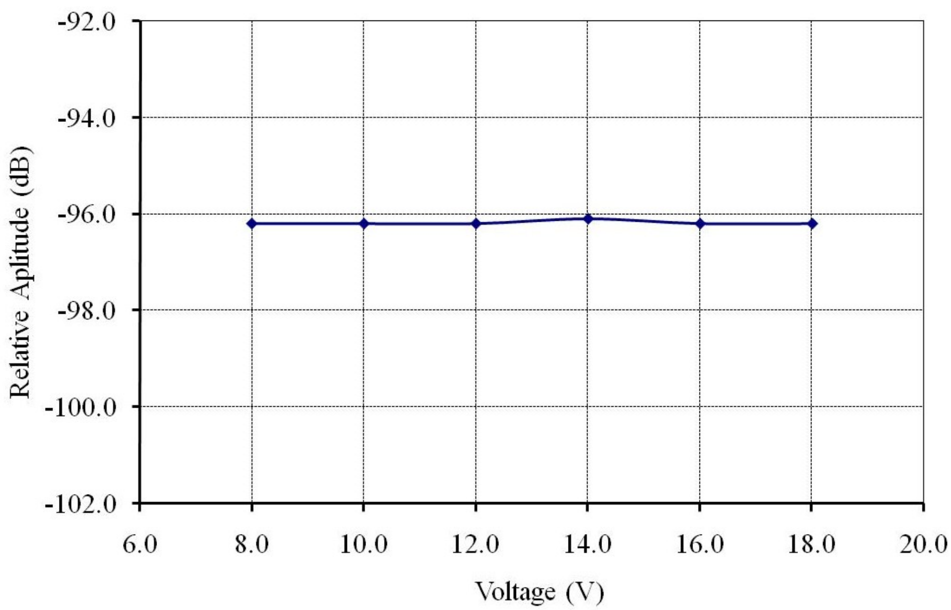
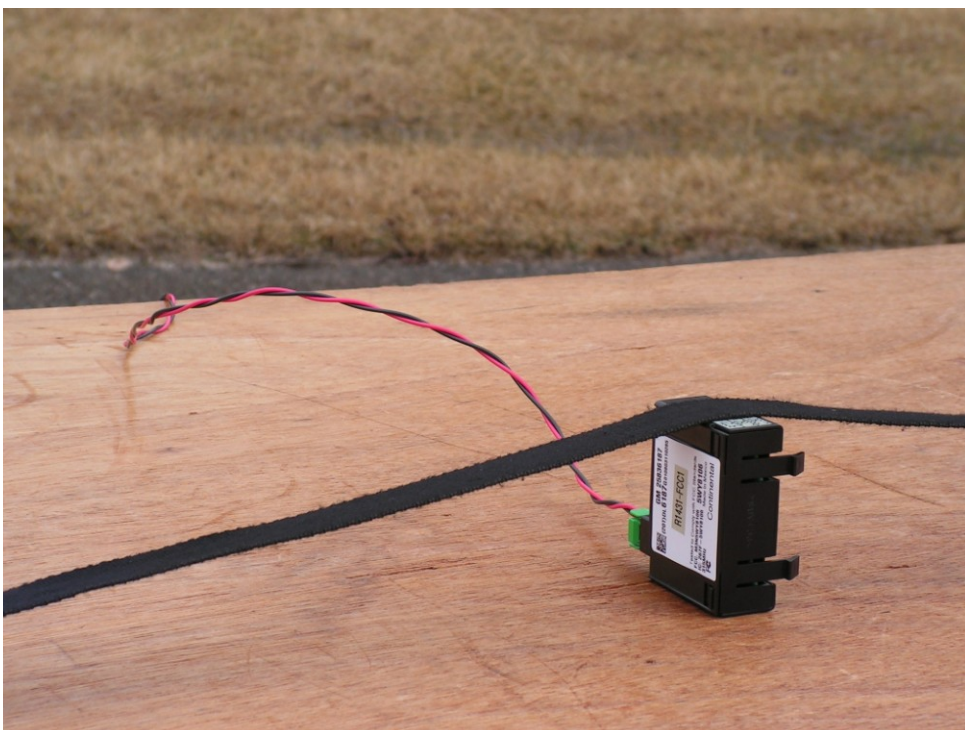


Figure 6.2. Relative emission vs. supply voltage.

DUT on OATS – one of 3 axes tested



DUT on OATS (close-up) – one of 3 axes tested