



COMPLIANCE WORLDWIDE INC. TEST REPORT 252-11R1

In Accordance with the Requirements of

Industry Canada RSS 220, Issue 1, March 2009
Federal Communications Commission 47 CFR Part 15, Part F
Technical Requirements for Vehicular Radar Systems

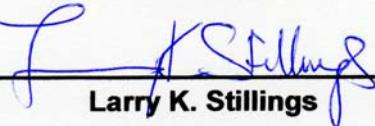
Issued to

Autoliv Electronics
1011B Pawtucket Blvd
PO Box 1858
Lowell, MA 01853
Tel: 978-674-6500

For the
24 GHz SRS Sensor
Autoliv Part Number : 6208428

FCC ID: WU8MRR25
IC: 8436B-6208428

Report Issued on July 13, 2011


Larry K. Stillings

Reviewed By


Brian F. Breault

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1. Scope

This test report certifies that the Autoliv Electronics 24 GHz Ultrawideband Sensor C6, New Design, as tested, meets the FCC Part 15, Subpart F and Industry Canada RSS 220 requirements. The scope of this test report is limited to the test sample provided by the client, only in as much as that sample represents other production units. If any significant changes are made to the unit, the changes shall be evaluated and a retest may be required. The report replaces CW Test Report 252-11 in full to add 99% Occupied BW measurement.

2. Product Details

2.1. Manufacturer:	Autoliv Electronics
2.2. Model Number:	6208428
2.3. Serial Number:	Reg Test Sensor
2.4. Description:	Vehicular Radar Sensor
2.5. Power Source:	DC 13.5 volts nominal – Automotive power system.
2.6. Hardware Revision:	10W42
2.7. Software Revision:	10W42
2.8. Modulation Type:	Pulse Modulation, Frequency Hopping
2.9. Operating Frequency:	25.05 GHz Nominal
2.10. EMC Modifications:	None

3. Product Configuration

3.1 Operational Characteristics & Software

Hardware Setup:

Connect the 24 GHz SRS Sensor lead set to the CANcard/DHSC dongle and the 13.5 VDC power supply (automotive battery).

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3. Product Configuration (continued)

3.2. EUT Hardware

Manufacturer	Model/Part # / Options	Serial Number	Input Volts	Freq (Hz)	Description/Function
Autoliv	6204828	Reg Test Sensor	13.5	DC	24 GHz Sensor

3.3. EUT Cables/Transducers

Manufacturer	Model/Part #	Length (m)	Shield Y/N	Description/Function
Custom	NA	10	N	Power and signal cable from Softing CANCard 2 DHSC to the DUT
Softing	CANCard 2 DHSC	0.5	N	Softing CANCard 2 DHSC dongle/cable

3.4. Support Equipment

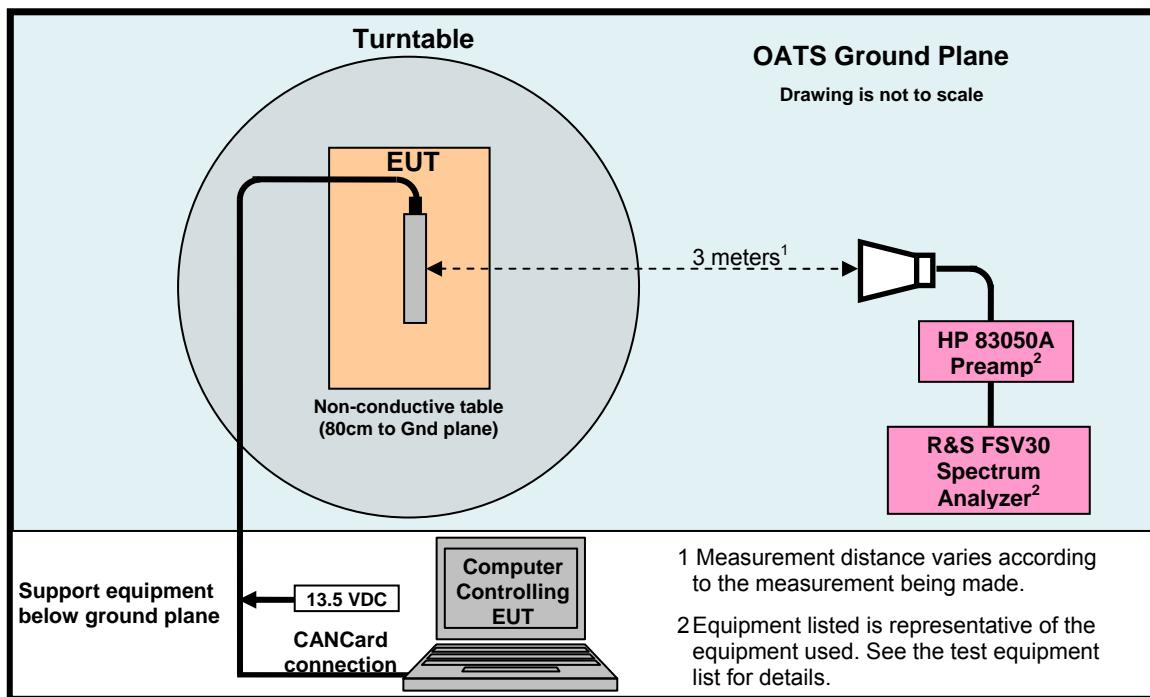
Manufacturer	Model/Part #	Serial Number	Input Voltage	Input Freq.	Description/Function
Dell	Latitude D830	CN-OHN338-48643-7AF-2781	120/240	50/60	Laptop computer
Softing	CANCard 2 DHSC	003700748	N/A	N/A	Dual CAN PC Card

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3. Product Configuration (continued)

3.5. Test Setup Diagram



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4. Measurements Parameters

4.1. Measurement Equipment Used to Perform Test

Device	Manufacturer	Model No.	Serial No.	Cal Due
Spectrum Analyzer 100 Hz to 26.5GHz	Agilent	E4407B	MY45104493	12/22/2012
Spectrum Analyzer 100 Hz to 26.5GHz	Agilent	E7405A	MY45115430	10/22/2011
Spectrum Analyzer 9 kHz to 30 GHz	Rohde & Schwarz	FSV30	100991	12/08/2011
Spectrum Analyzer 20 Hz to 40 GHz	Rohde & Schwarz	FSV40	100899	05/31/2013
Microwave Preamp 1 to 26.5 GHz	Hewlett Packard	8449B	3008A01323	12/1/2012
Microwave Preamp 2 to 50 GHz	Hewlett Packard	83050A	3331A00404	10/20/2012
Notch Filter 24.0 – 24.25 GHz	K&L Microwave	5NSP-00002	001	CBU
Bilog Antenna 30 MHz – 2 GHz	Com-Power	AC-220	25509	8/30/2011
Horn Antenna 1 to 18 GHz	Electro-Metrics	EM-6961	6337	10/19/2012
Horn Antenna 1 to 18 GHz	ComPower	AH-118	10078	7/23/2011
Horn Antenna 18 to 26.5 GHz	ComPower	AH-826	081051	6/30/2012
Horn Antenna 18 to 40 GHz	ComPower	AH-840	03075	7/20/2012
Horn Antenna 18 to 40 GHz	ComPower	AH-840	101032	4/6/2013
Horn Antenna 18 to 26.5 GHz WR42 to 3.5mm Adapter	Hughes Hewlett Packard	45820H-2020 K281C	037 3032A10738	Not Req'd
External Mixer WR28 Horn Antenna 26.5 to 40 GHz WR28 to 3.5mm Adapter	Hewlett Packard Alpha Industries Hewlett Packard	11970A 861A/599 R281A	3003A08210 324 03197	Not Req'd
External Mixer WR22 Horn Antenna 33 to 50 GHz WR22 to 3.5mm Adapter	Hewlett Packard Alpha Industries Hewlett Packard	11970Q 861B/383 Q281B	3003A01273 133 00116	Not Req'd
External Mixer WR19 Horn Antenna 40 to 60 GHz WR19 to 1.85mm Adapter	Hewlett Packard M/A Com Baytron Hewlett Packard	11970U 3-19-720 U281A	2332A00425 N/A 00209	Not Req'd
External Mixer WR12 Horn Antenna 50 to 75 GHz WR12 to 1.85mm Adapter	Hewlett Packard Aerowave Hewlett Packard	11970V 15-7025 V281B	2521A00357 N/A 00369	Not Req'd
External Mixer WR10 Horn Antenna 75 to 110 GHz	Hewlett Packard Alpha Industries	11970W 861A/387	2521A00230 359	Not Req'd
Anechoic Chamber 3 Meter – Free Space	Keene Ray Proof	S-81	R-2338	Not Req'd
DMM / Temperature	Fluke	187	79690058	11/29/2011
RF Signal Generator to 50 GHz	Agilent	83630B	3844A00851	3/21/2012
RF Signal Generator 40 to 60 GHz	Wiltron	6672A	604001	CBU
RF Power Meter	Boonton	4220A	203603AA	7/29/2012
Power Sensor 1 MHz to 40 GHz	Boonton	51081	29412	7/29/2012
Power Sensor 40 to 50 GHz	Boonton	51082	29425	7/29/2012
DC Variable Source 60 Volt, 3 Amp	Hewlett Packard	6296A	7M0599	12/10/2011
Thermal Chamber	Associated Testing Labs	SLHU-1-CRLC	N/A	N/A
3 dB & 10 dB Attenuators DC to 40 GHz	Narda	4768-3 4768-10	9610 9806	Not Req'd
Barometer – Temperature, Humidity & Pressure	Control Company	4195	ID236	11/09/2011

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4. Measurements Parameters (continued)

4.2. Measurement & Equipment Setup

Test Date:	4/1/2011 to 7/8/2011
Test Engineer:	Brian Breault, Larry Stillings
Normal Site Temperature (15 - 35°C):	21.6
Relative Humidity (20 -75%RH):	35
Frequency Range:	30 MHz to 100 GHz
Measurement Distance:	3 Meters
EMI Receiver IF Bandwidth:	100 kHz - 30 MHz to 1 GHz 1 MHz - Above 1 GHz
EMI Receiver Avg Bandwidth:	300 kHz - 30 MHz to 1 GHz 3 MHz - Above 1 GHz
Detector Function:	Peak, Quasi-Peak & Average

4.3. Measurement Procedure

Test measurements were made in accordance FCC Part 15.203, 15.249, 15.515, and IC RSS-220 Issue I.

The test methods used to generate the data in this test report is in accordance with ANSI C63.4: 2003, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

In accordance with ANSI C63.4-2003, section 13.1.4.1, (c), the device under test was rotated through three orthogonal axes to determine which attitude produced the highest emission relative to the limit. The attitude that produced the highest emission relative to the limit was used for all radiated emission measurements.

4.4. Measurement Uncertainty

The following uncertainties are expressed for an expansion/coverage factor of K=2.

RF Frequency (out of band)	$\pm 1 \times 10^{-8}$
Radiated Emission of Transmitter to 100 GHz	± 4.55 dB
Radiated Emission of Receiver	± 4.55 dB
Temperature	$\pm 0.91^\circ$ C
Humidity	$\pm 5\%$

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5. Measurements Summary

Test Requirement	FCC Rule Requirement	IC Rule Requirement	Test Report Section	Result	Comment
Antenna Requirement	15.203	RSS-GEN 7.1.4	6.1	Compliant	The antenna is housed within a sealed enclosure with the intentional radiator.
Operational Requirements	15.515 (a)	RSS-220 4	6.2	Compliant	
UWB Bandwidth	15.515 (b) 15.503 (d)	RSS-220 4.1	6.3	Compliant	
Occupied Bandwidth	N/A	RSS-GEN	6.3	Compliant	
Emissions Attenuation Above the Horizontal Plane	15.515 (c)	RSS-220 4.1(g)	6.4	Compliant	
Spurious Radiated Emissions	15.515 (d) 15.209	RSS-220 3.4 RSS-220 4.1(d)	6.5	Compliant	No measurable spurious emissions.
Radiated Emissions in GPS Bands	15.515 (e) 15.209	RSS-220 4.1(e)			No measurable spurious emissions.
Peak Emissions in a 50 MHz Bandwidth	15.515 (f)	RSS-220 4.1(h)	6.6	Compliant	
Conducted Emissions	15.207	RSS-GEN	N/A	N/A	Automotive Battery Powered Device
Effect of Supply Voltage Variations	2, 15.215	RSS-GEN	6.8	Compliant	
Transmitter Frequency Stability	N/A	RSS-GEN 4.7	6.9	Compliant	
Radio Frequency Exposure	FCC OET Bulletin 65	RSS-GEN	6.10	Compliant	

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6. Measurement Data

6.1. Antenna Requirement (15.203), RSS-GEN Section 7.1.4

Requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply

The antenna utilized by the device under test is an internal, non user replaceable unit.

6.2. Operational Requirements of the Device under Test (15.515 (a)), RSS-220 Sec 4

Requirement: Operation under the provisions of this section is limited to UWB field disturbance sensors mounted in terrestrial transportation vehicles. These devices shall operate only when the vehicle is operating, e.g., the engine is running. Operation shall occur only upon specific activation, such as upon starting the vehicle, changing gears, or engaging a turn signal.

The manufacturer states that the device under test complies with the requirements outlined in section 6.1 (FCC Part 15.515 (a)).

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6. Measurement Data (continued)

6.3. UWB Bandwidth (15.515 (b)), RSS-220 Section 4.1

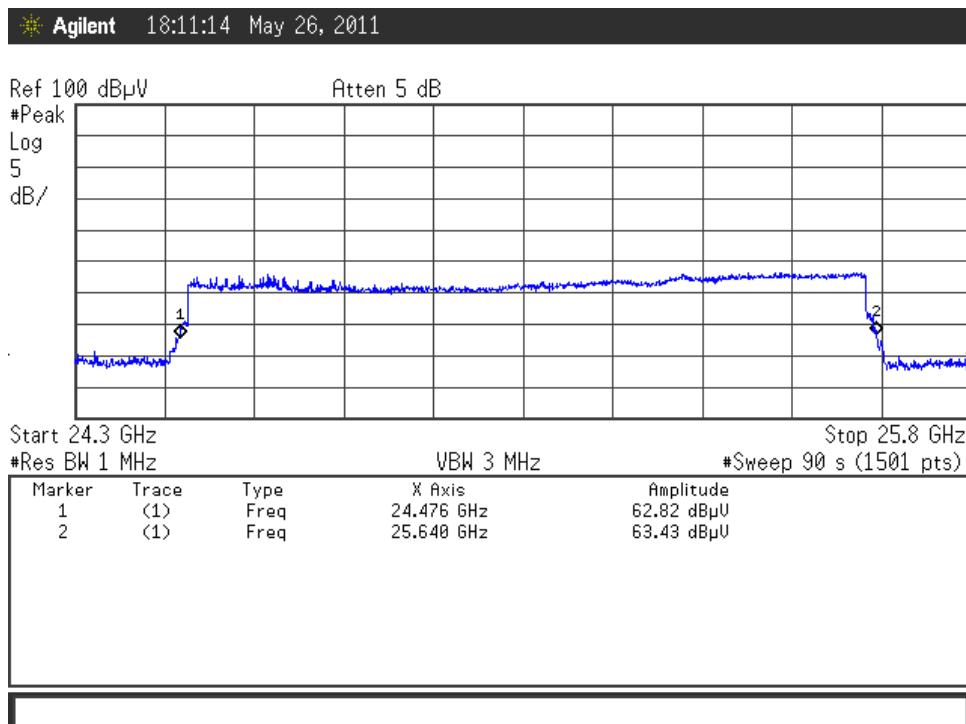
Requirement: The UWB bandwidth of a vehicular radar system operating under the provisions of this section shall be contained between 22 GHz and 29 GHz. In addition, the center frequency, f_c , and the frequency at which the highest level emission occurs, f_M , must be greater than 24.075 GHz. Operation under the provisions of this section is limited to UWB field disturbance sensors mounted in terrestrial transportation vehicles.

6.3.1. Measurement Data – Long Pulse Mode (Values in GHz)

f_M	The highest emission peak	25.300
f_L	10 dB below the highest peak	24.476
f_H	10 dB above the highest peak	25.640
f_c	Calculated: $(f_H + f_L) / 2$	25.058
Bandwidth	Calculated: $(f_H - f_L)$	1.164
Fractional BW	Calculated: $2 * (f_H - f_L) / (f_H + f_L)$	0.0465

Note: the Bandwidth is greater than 500 MHz and therefore the fractional bandwidth requirement does not need to be met.

6.3.2. Measurement Plot of 10 dB frequencies



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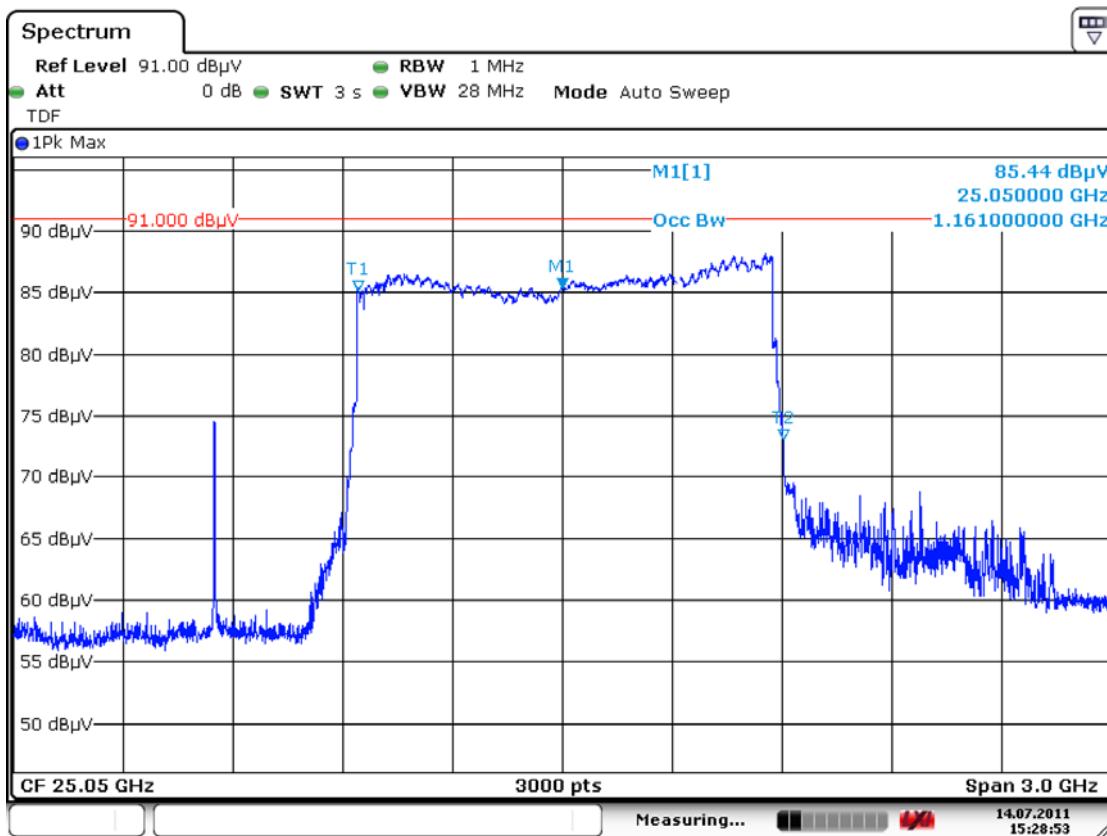
6. Measurement Data (continued)

6.3. Occupied Bandwidth RSS-GEN Section 4.6.1

Requirement: When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

Result: Compliant

Center Frequency	99% Power Bandwidth	Result
GHz	GHz	
25.05	1.161	Compliant



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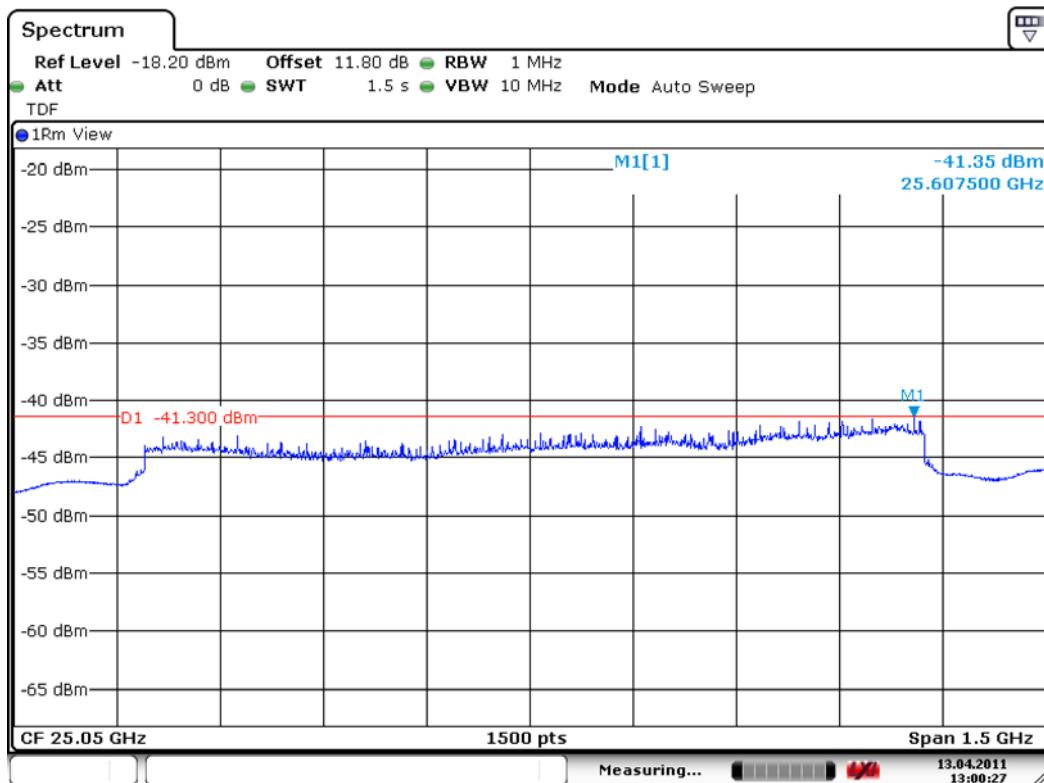
6. Measurement Data (continued)

6.3. UWB Radiated Emissions 22 to 26.5 GHz (15.515 (d), RSS-220 Section 3.4)

Frequency (GHz)	EIRP ¹ (dBm)	Limit (dBm)	Margin (dB)	Result
25.6075	-41.35	-41.30	0.05	Compliant

¹ Derived from the field strength measurements and adjusted for 3M distance.

6.3.3. Measurement Plot (RMS Power)



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6. Measurement Data (continued)

6.4. Emissions Attenuation above the Horizontal Plane

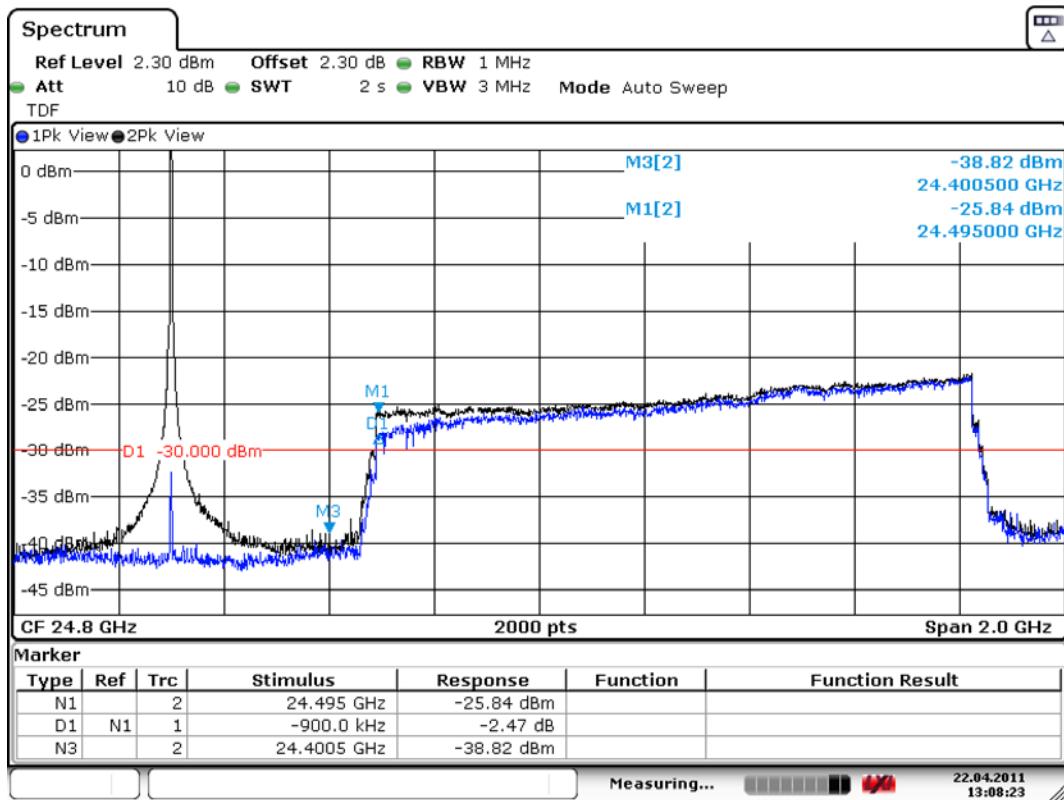
(15.515 (c), RSS-220 Section 4.1(g))

Requirement: Following proper installation, vehicular radar systems shall attenuate any emissions within the 23.6-24.0 GHz band that appear 30 degrees or greater above the horizontal plane by 25 dB below the limit specified in paragraph section 6.5 of this report. [January 1, 2005 requirement].30 dB by January 1, 2010 and 35 dB by January 1, 2014

Test Note: The 0 value on the plots in this section refer to the absolute limit outlined in section 6.5 of this report.

Result: Compliant, the EUT does not emit any signals in the 23.6 to 24 GHz Range.

6.4.1 Plot of ISM Carrier & UWB Signal (with and without K&L Microwave 24 GHz Notch Filter Showing no signals in the satellite band below 24 GHz, made at 1 Meter



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6. Measurement Data (continued)

6.5. Spurious Radiated Emissions (15.515 (d), 15.209, RSS-220 Section 4.1(d))

Requirement: The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in Section 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency (MHz)	EIRP (dBm)
960 - 1610	-75.3
1610 - 22000	-61.3
22000 - 29000	-41.3
29000 - 31000	-51.3
Above 31000	-61.3

Spurious Radiated Emissions in GPS Bands

(15.515 (e), 15.209, RSS-220 Section 4.1(e))

Requirement: In addition to the radiated emission limits specified in the table in paragraph (d) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency (MHz)	EIRP (dBm)
1164 - 1240	-85.3
1559 - 1610	-85.3

Radiated Emissions Field Strength Limits at 3 Meters

(Section 15.209, RSS-GEN)

Frequency (MHz)	Field Strength (dB μ V/m)
30 - 88	40
88 - 216	43.5
216 - 960	46
960 - 100,000	54

Test Notes: Refer to Section 4.1 for the test equipment used and Section 4.2 for the test equipment setups.

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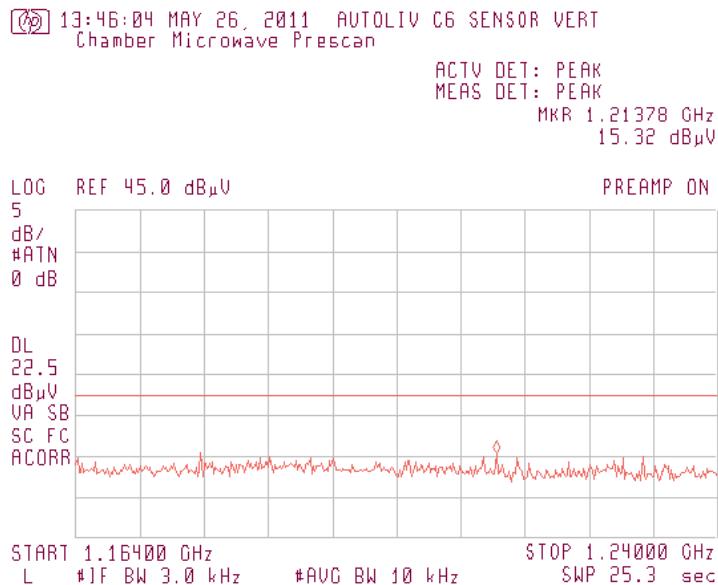
6. Measurement Data (continued)

6.5. Spurious Radiated Emissions (15.515 (d), 15.209, RSS-220 Section 4.1(d))

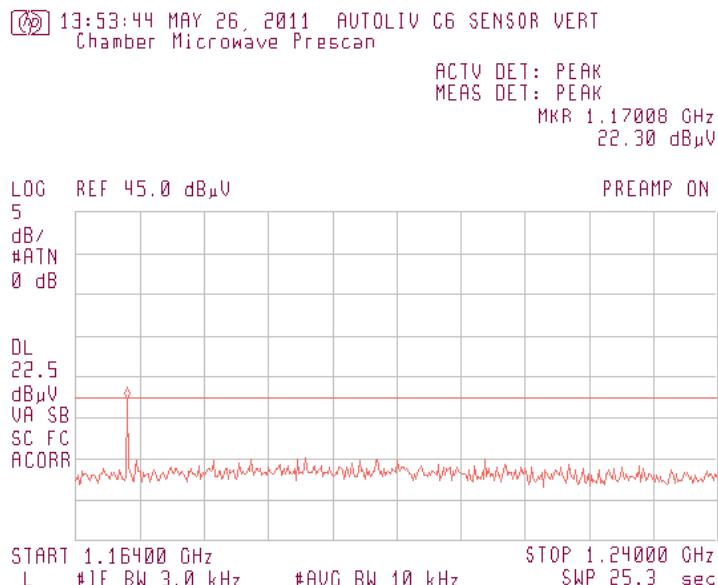
6.5.1. 30 MHz to 960 MHz, measured at 3 Meters

The device was prescreened in our 3 Meter Semi-Anechoic Chamber. There were no measurable emissions below 960 MHz on our 3 Meter OATS.

Horizontal Measurement Polarity 1164 to 1240 MHz



Vertical Measurement Polarity 1164 to 1240 MHz



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6. Measurement Data (continued)

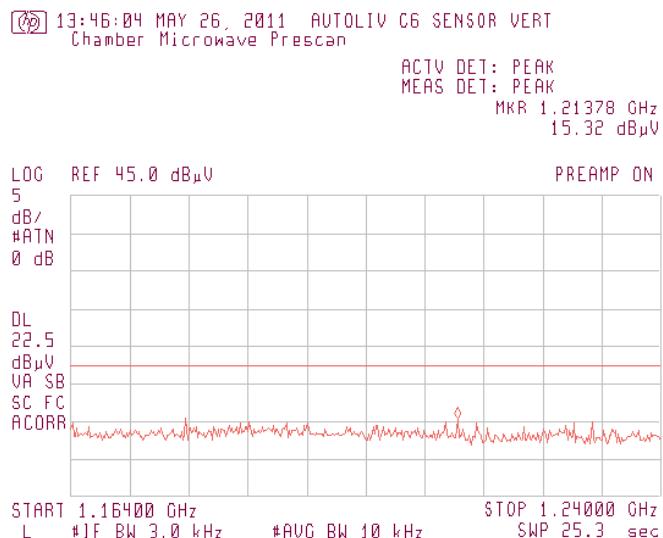
6.5. Spurious Radiated Emissions (15.515 (d), 15.209, RSS-220 Section 4.1(d))

Spurious Radiated Emissions in GPS Bands (15.515 (e), 15.209, RSS-GEN)

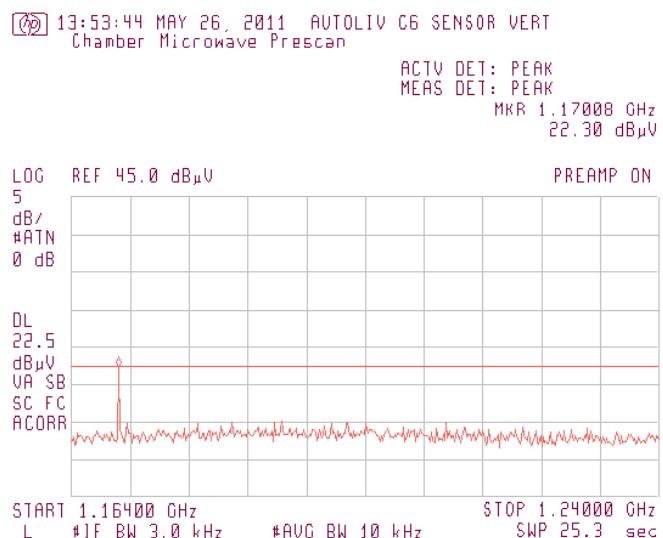
6.5.2 1164 to 1240 MHz & 1559 to 1610 MHz

There were no broadband emissions related to the UWB transmitter. Measured signals were narrowband and related to the microprocessor / clocks and do not fall under the requirements of this section. Measurements were made at 1 Meter and the -85.3 dBm limit was converted to a field strength limit of 22.5 dB μ V/m.

6.5.2.1 Horizontal Measurement Polarity 1164 to 1240 MHz



6.5.2.2 Vertical Measurement Polarity 1164 to 1240 MHz



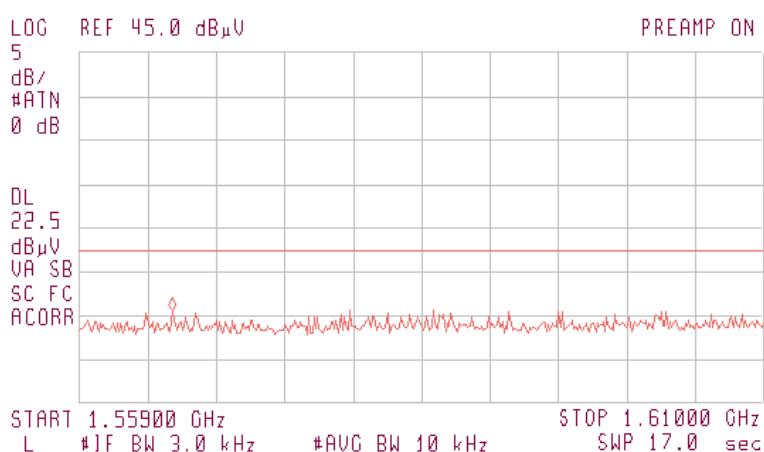
6. Measurement Data (continued)

6.5. Spurious Radiated Emissions (15.515 (d), 15.209, RSS-220 Section 4.1(d))

Spurious Radiated Emissions in GPS Bands (15.515 (e), 15.209, RSS-GEN)

6.5.2.3 Horizontal Measurement Polarity 1559 to 1610 MHz

13:39:34 MAY 26, 2011 AUTOLIV C6 SENSOR VERT
Chamber Microwave Prescan
ACTV DET: PEAK
MEAS DET: PEAK
MRR 1.55689 GHz
15.62 dBm



6.5.2.4 Vertical Measurement Polarity 1559 to 1610 MHz

13:28:24 MAY 26, 2011 AUTOLIV C6 SENSOR VERT
Chamber Microwave Prescan
ACTV DET: PEAK
MEAS DET: PEAK
MKR 1.59955 GHz
16.13 dBmU



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6. Measurement Data (continued)

6.5. Spurious Radiated Emissions (15.515 (d), 15.209, RSS-220 Section 4.1(d))

6.5.3. 960 MHz to 40 GHz

There were no other measurable emissions between 960 MHz and 40 GHz

6.5.4. 40 GHz to 100 GHz

Frequency (GHz)	Amplitude (dB μ V/m) ²		Average Limit	Margin (dB)	Ant Pol	Ant Ht	TT Pos	Result
	Peak	Avg	Avg		H/V	cm	Deg	
48 - 52	There were no measurable emissions				Compliant			
72 - 77	There were no measurable emissions				Compliant			
96 - 100	There were no measurable emissions				Compliant			

¹ Individual points representing the low, middle and high points of the device under test were taken across the span of the measured signal in non-sweeping mode. Refer to Section 3.1 for information regarding sweeping vs. non-sweeping modes.

² Measurement taken at 50 centimeters and corrected for a 3-meter distance.
Distance and measurement equipment correction factors are included in the columns 2 and 3 test data.

There were no other measurable emissions between 40 and 100 GHz

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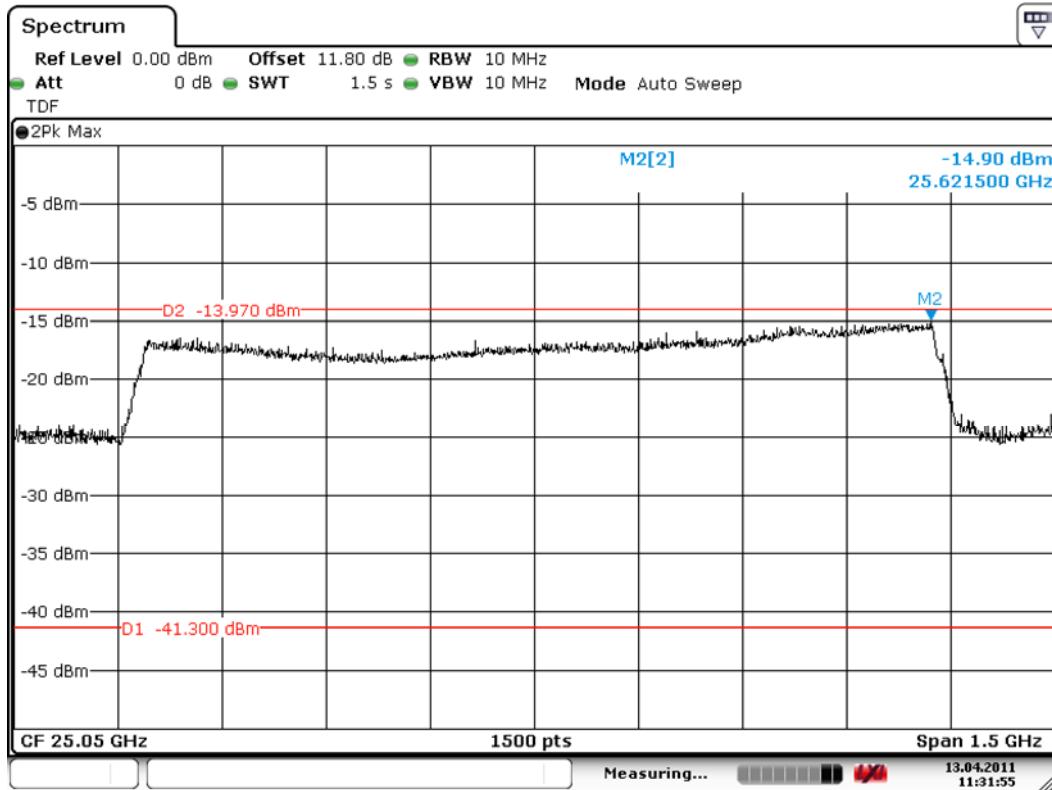
6. Measurement Data (continued)

6.6. Peak Emissions in a 50 MHz Bandwidth (15.515 (f), RSS-220 Section 4.1 (h))

Requirement: There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_M . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in Section 15.521.

Refer to the measurement data in Section 6.3. The resolution bandwidth used to perform the measurements was 10 MHz and the limit was adjusted to -13.97 dBm at 3 meters.

Highest emission peak (f_M) GHz:	25.6215
Adjusted limit based on a 10 MHz bandwidth:	-13.97
Measured value in a 10 MHz bandwidth:	-14.90
Margin:	0.93



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6. Measurement Data (continued)

6.7. Devices that Employ Gated Transmissions

Requirement: The emission levels from devices operating under the provisions of this section that employ gated transmissions may be measured with the gating active. Measurements made in this manner shall be repeated over multiple sweeps with the analyzer set for maximum hold until the amplitude stabilizes.

6.8. Effect of Voltage Variations on Peak Emissions (15.215, RSS-GEN)

Requirement: Devices operating under this provision shall not increase in amplitude or change in bandwidth of the emission whereas it would fall out of the requirements of these rules.

Result: Compliant

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6. Measurement Data (continued)

6.9. Transmitter Frequency Stability of Unmodulated Carrier (RSS-GEN 4.7)

Requirement: Frequency stability is a measure of frequency drift due to temperature and supply voltage variations with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage. Measure the device at temperatures of -30, +20 and +50 degrees C at the rated supply voltage and at a temperature of +20 degrees C at +/- 15 percent of the rated supply voltage. Measurement should be made on an unmodulated carrier frequency.

Test Conditions			Occupied Frequency Range	
			f_L (GHz)	f_H (GHz)
T_{nom}	25.9 °C	V_{nom} 13.5 VDC	24.09447	24.10327
T_{min}	-20 °C	V_{min} 9.0 VDC	24.09487	24.10387
		V_{max} 15.0 VDC	24.09487	24.10387
T_{max}	+55 °C	V_{min} 9.0 VDC	24.09467	24.10347
		V_{max} 15.0 VDC	24.09467	24.10347
Worst Case			24.09447	24.10387

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6.10. Public Exposure to Radio Frequency Energy Levels (15.247(i) (1.1307 (b)(1)) RSS-GEN 5.5, RSS 102

6.10.1. MPE Power Density Table.

MPE Distance (cm)	DUT Output Power (dBm)	DUT Antenna Gain (dBi)	Power Density		Limit (mW/cm ²)	Result
			(mW/cm ²)	(W/m ²)		
(1)	(2)	(3)	(4)		(5)	
20	-14.9	12.2	0.0001068	0.0010684	1	Compliant

$$PD = \frac{OP + AG}{(4 \times \pi \times d^2)}$$

PD = Power Density

OP = DUT Output Power (dBm)

AG = Antenna Gain (dBi)

D = MPE Distance

1. Reference CFR 2.1093(b): For purposes of this section, a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.
2. Section 6.1 of this test report.
3. Power density is calculated from conducted power output measurement and antenna gain.
4. Reference CFR 1.1310, Table 1: Limits for Maximum Permissible Exposure (MPE), Section (B): Limits for General Population/Uncontrolled Exposure.

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8. Test Site Description

Compliance Worldwide is located at 357 Main Street in Sandown, New Hampshire. The test sites at Compliance Worldwide are used for conducted and radiated emissions testing in accordance with Federal Communications Commission (FCC) and Industry Canada standards. A description of the test sites is on file with the FCC (registration number **96392**) and Industry Canada (file number **IC 3023A-1**).

The radiated emissions test site is a 3 and 10 meter enclosed open area test site (OATS). Personnel, support equipment and test equipment are located in the basement beneath the OATS ground plane.

The conducted emissions site is part of a 16' x 20' x 12' ferrite tile chamber and uses one of the walls for the vertical ground plane required by EN 55022.

Both sites are designed to test products or systems 1.5 meter W x 1.5 meter L x 2.0 meter H, floor standing or table top.