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Testing of

Electromagnetic Emissions

per

USA: CFR Title 47, Part 15.253
Canada: IC RSS-251/GEN

are herein reported for

Autoliv Electronics 77 GHz MMRV1

Test Report No.: 417124-20150416-01r1

Applicant/Provider:
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Measured by: Valdis V. Liepa, Ph.D. Report Approved by: Valdis V. Liepa, Ph.D.

Report by: Valdis V. Liepa, Ph.D. Report Date of Issue: April 16, 2015

Results of testing completed on (or before) April 10, 2015 are as follows.

Emissions: The transmitter intentional emissions **COMPLY** with the regulatory limit(s) by no less than 32.2 dB. Transmit chain spurious harmonic emissions **COMPLY** by no less than 26.2 dB.

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1 Test Specifications, General Procedures, and Location

1.1 Test Specification and General Procedures

The ultimate goal of Autoliv Electronics 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 Autoliv Electronics 77 GHz MMRV1 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-251/GEN

Autoliv Electronics 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	"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"
Industry Canada	"The Measurement of Occupied Bandwidth"

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.

Test Instrument	Manufacturer/Model	Q Number
Spectrum Analyzer (9kHz-26GHz)	Hewlett-Packard 8593E, SN: 3412A01131	HP8593E1
Spectrum Analyzer (10Hz-2.9GHz)	Hewlett-Packard 8593E, SN: 3412A01131	HP8560E1
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 an automotive radar. The EUT is approximately 10 x 6 x 1.5 cm 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:	Radar	**Country of Origin:**	Not Declared
Nominal Supply:	13.2 VDC	**Oper. Temp Range:**	-40^o C to $+85^o$ C
Frequency Range:	76.01 to 76.99 GHz	**Antenna Dimension:**	4 cm
Antenna Type:	integral patch arrays	**Antenna Gain:**	12.7 dBi (declared)
Number of Channels:	Not Declared	**Channel Spacing:**	Not Declared
Alignment Range:	Not Declared	**Type of Modulation:**	FMCW
United States			
FCC ID Number:	WU877MMRV1	**Classification:**	FDS
Canada			
IC Number:	8436B-77MMRV1	**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.

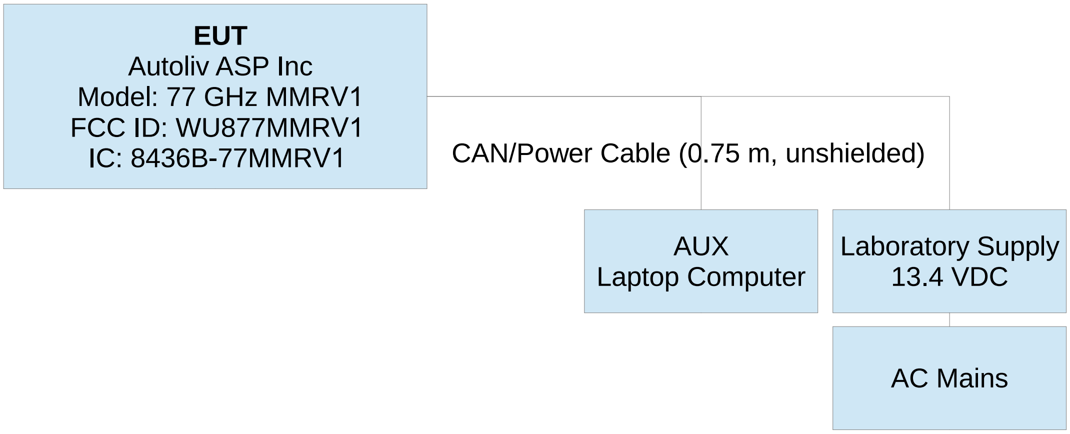


Figure 2: EUT Test Configuration Diagram.

2.1.4 Test Samples

Six samples in all were provided; one normal operating (modulating) device), three CW fixed frequency sample at 76.010, 76.500, and 76.980 GHz for peak power measurement, one normal operating sample communicating with a computer for functionality verification during testing, and one sample dismantled for photos.

2.1.5 Functional Exerciser

Normal operating EUT functionality was verified by CAN bus activity.

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). 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 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 modes is thus 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 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

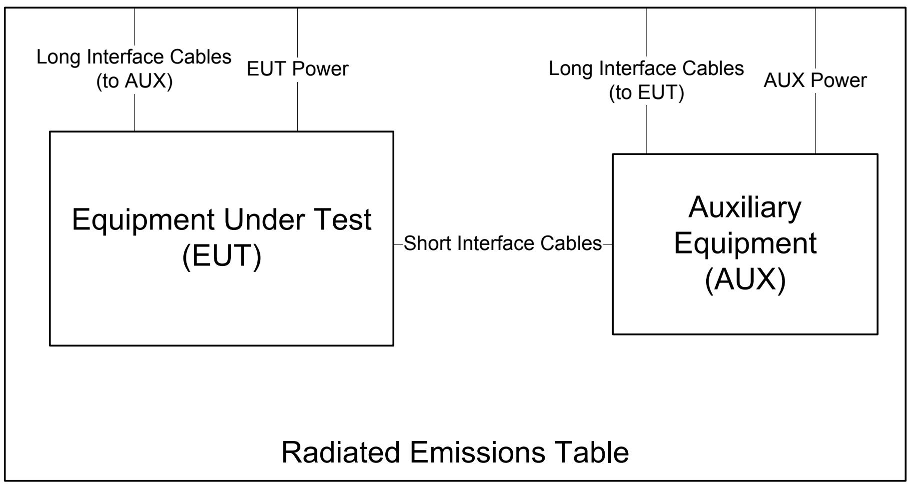


Figure 3: Radiated Emissions Diagram of the EUT.

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^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 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 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.

Where regulations call for substitution method measurements, the EUT is replaced by a substitution dipole or standard gain antenna 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 input 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 λ 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.

3.2 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:**	30-Mar-15
				Test Engineer:	Valdis V. Liepa
				EUT	Autoliv 77GHz MMRV1
				Meas. Distance:	10 cm

Pulsed Operation / Duty Cycle

Transmit Mode	Voltage (V)	Test Frequency(1) (GHz)	Cycle Time (ms)	On-Time(2) (ms)	Exposure Duty Correction(3) (dB)	FMCW Period (ms)	Max Dwell/Chirp(4) (ms)	Chirps / On-Time(5) (#)	Max On-Time/Cycle (ms)	Spread Duty(6) (dB)
MR FMCW Up-Chirp (Subfig (a))	13.4	76.500	40.0	6.65		0.051	0.00092	131	0.120	-25.3
LR FMCW Up-Chirp (Subfig (a))	13.4	76.500	40.0	6.65		0.051	0.00133	131	0.175	-23.6
Up-Chirp Mode Total Duty over Time			40.0	13.3	-4.8	**Worst-Case On-Time in 1MHz IFBW; 100 ms window**				**-20.0**
MR FMCW Dwn-Chirp (Subfig (b))	13.4	76.500	40.3	6.84		0.051	0.00092	134	0.123	-25.2
LR FMCW Dwn-Chirp (Subfig (b))	13.4	76.500	40.3	6.84		0.051	0.00133	134	0.178	-23.5
Down Chirp Total Duty over Time			40.3	13.7	**-4.7**	**Worst-Case On-Time in 1MHz IFBW; 100 ms window**				**-20.0**

(1) Mid Range and Long Rage Chirps observed overlapping at mid band.
(2) Mid-Range On-Time = 13.3ms / 2 = 6.65 ms (FMCW sweep – wide band), occurs once every 40.0 ms chirp cycle.
Long Range On-Time = 13.3ms / 2 = 6.65 ms (FMCW sweep – narrow band), occurs once every 40.0 ms chirp cycle.
(3) Exposure Duty Correction = 10*Log(Total On-Time/Cycle-Time);
(4) Max Dwell / MHz / Chirp is the measured worst case pulse length measured in any given 1 MHz RBW, per chirp.
(5) Chirps / On-Time = On-Time / FMCW Period
(6) Spread Duty = 10*log10(Total On-Time/Cycle / Total Cycle Time); in both cases FMCW on-time in 1 MHz per 100 ms window is less than 1%, so 20dB duty per 15.35 is applied.
Equipment Used: HP8560E1, HP8593E1, HP11970W1, WBAND1

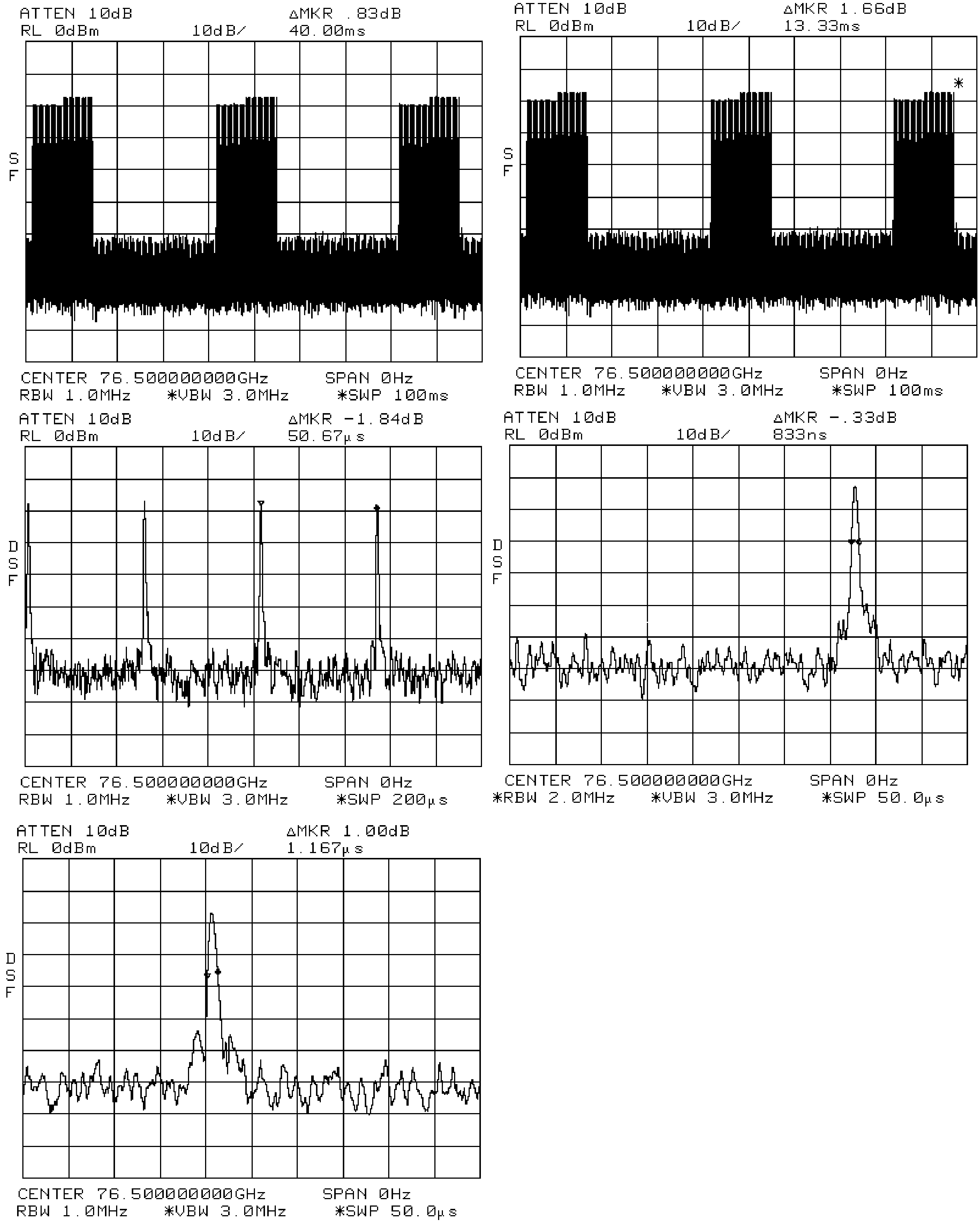


Figure 5(a): Pulsed Emission Characteristics (Duty Cycle).

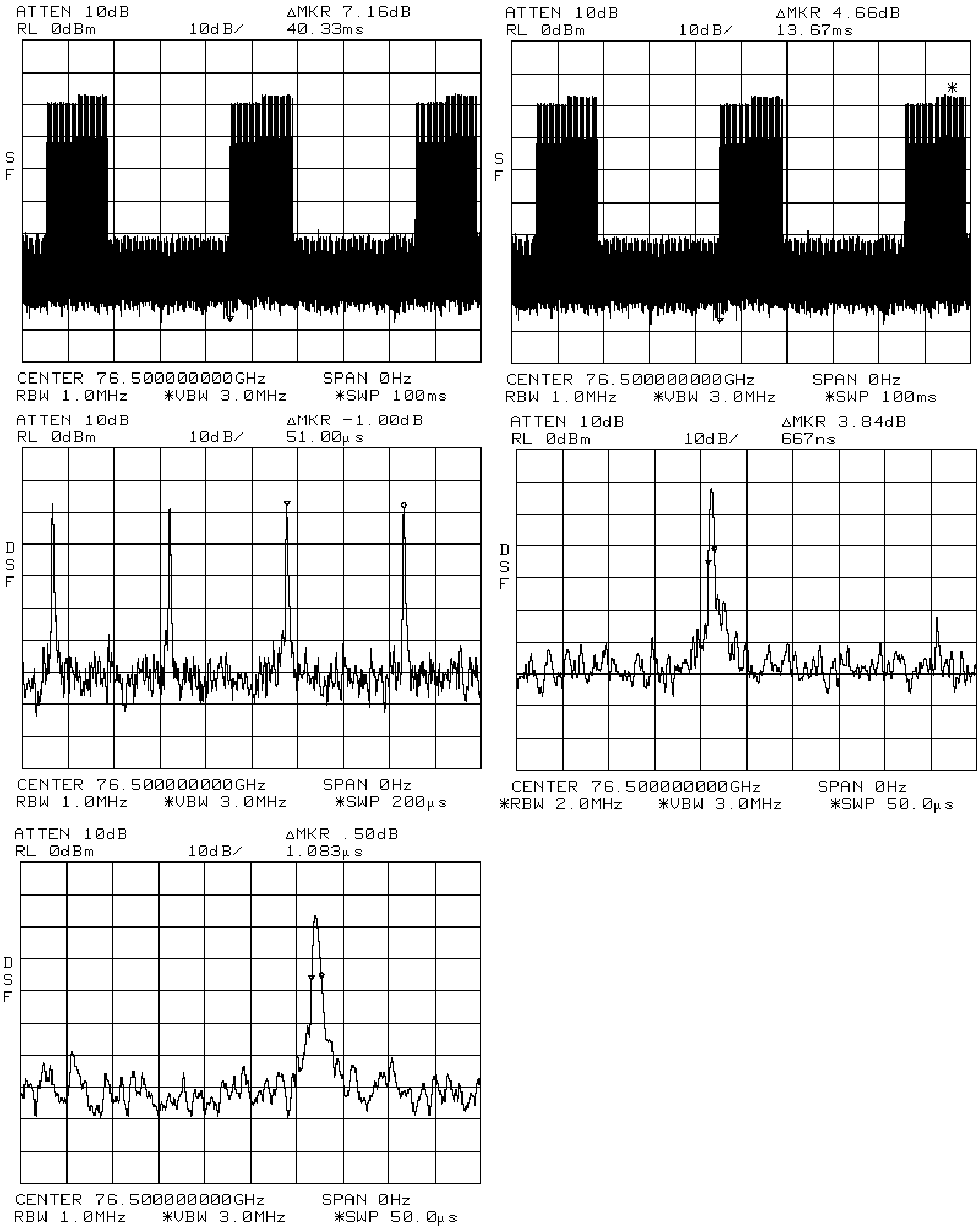


Figure 5(b): Pulsed Emission Characteristics (Duty Cycle).

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 20 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**	**Test Date:**	30-Mar-15
Freq > 1 GHz	Pk	1 MHz	**Test Engineer:**	Valdis V. Liepa
	VBW	**Span**	**EUT**	Autoliv 77GHz MMRV1
	3 MHz	1200 MHz	**Meas. Distance:**	10 cm

Occupied Bandwidth							
Transmit Mode	Temperature (C)	Voltage (V)	20dB OBW (MHz)	fL (MHz)	fH (MHz)	OBW Limit (MHz)	Pass/Fail
Up-Chirp	20.0	13.4	977.0	76018.0	76995.0	1000.0	
Down-Chirp	20.0	13.4	982.0	76013.0	76995.0	1000.0	
Maximum OBW			**982.0**			-	Pass

Equipment Used: HP8560E1, HP8593E1, HP11970W1, WBAND1

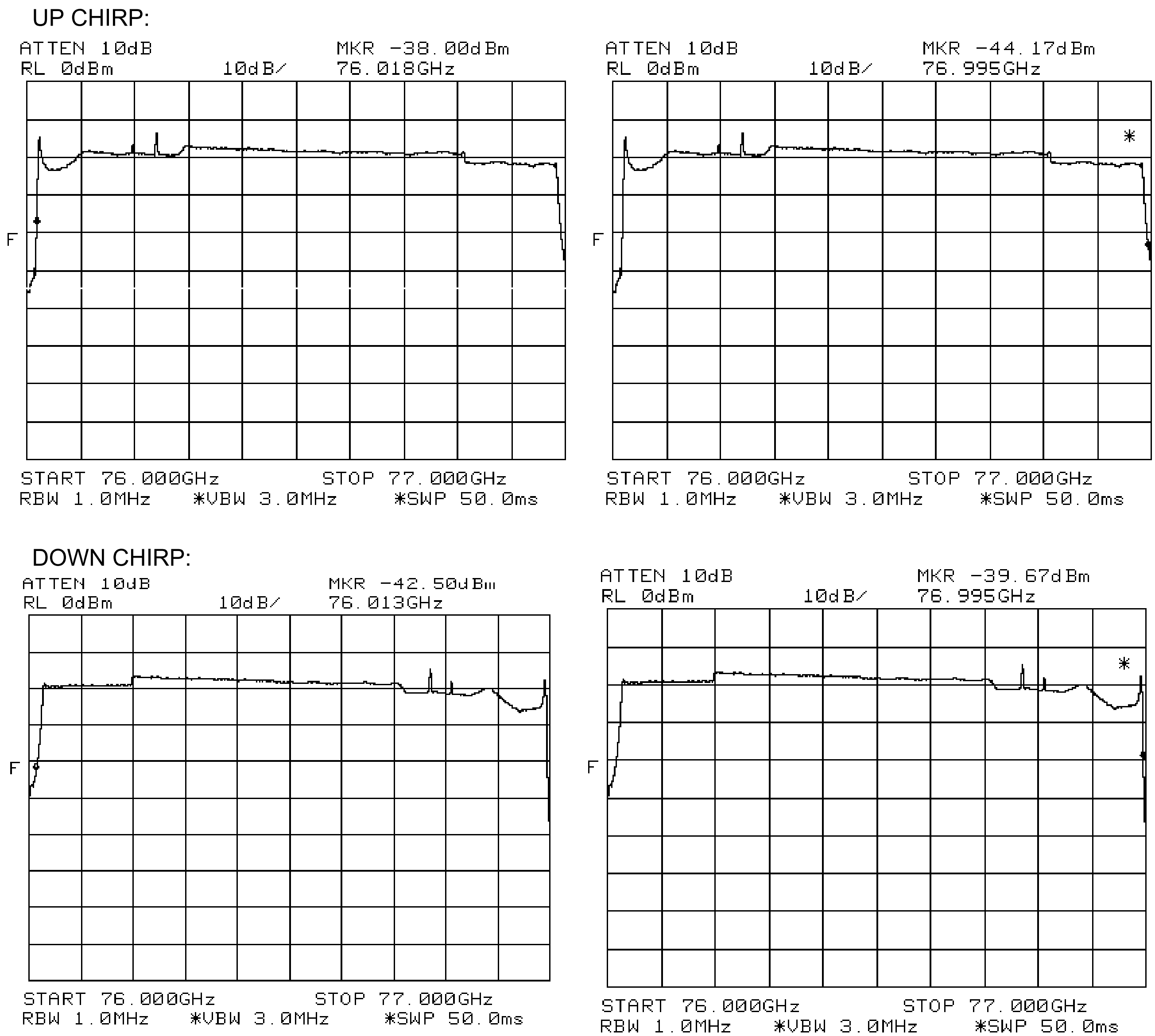


Figure 6: Intentional Emission Bandwidth.

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	Avg	1 MHz	10 kHz

Test Date:	30-Mar-15
Test Engineer:	Valdis V. Liepa
EUT:	Autoliv 77GHz MMRV1
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	76010.0	76010.0	Horn W	H/V	4.0	45.3	0.0	-35.1	-55.1	3.0	3.0	0.8	0.0	117.2	97.2	22.0	2.0	-38.5	-58.5	-5.5	-10.6	33.0	Low
2	20	13.4	76500.0	76500.0	Horn W	H/V	4.0	45.3	0.0	-36.2	-56.2	3.0	3.0	0.8	0.0	116.1	96.1	20.9	0.9	-39.6	-59.6	-5.5	-10.6	34.1	Mid
3	20	13.4	76980.0	76980.0	Horn W	H/V	4.0	45.3	0.0	-34.3	-54.3	3.0	3.0	0.8	0.0	118.0	98.0	22.8	2.8	-37.7	-57.7	-5.5	-10.6	**32.2**	High
4																									
5																									

(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.

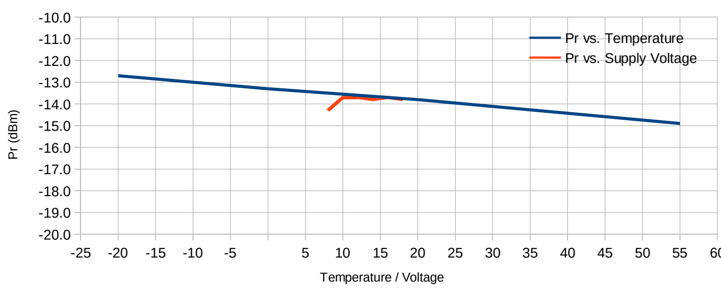
(3) EIRP is computed from field strength at 3 meter distance. If emission is within 6 dB of regulatory limit, then substitution method measurement is employed to determine exact EIRP.

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

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

(6) Industry Canada S3 Limit for fundamental is 60uW/cm^2 (-12.2 dBm) for forward looking, 30 uW/cm^2 (-15.2 dBm) for side looking, and 200nW/cm^2 (-37.0 dBm) for stationary radars.

	Temp.	Freq.	Pr		Volt.	Freq.	Pr
#	(C)	MHz	(dBm)		(V)	MHz	(dBm)
6					18.0	76500.0	-13.8
7	55	76498	-14.9		16.0	76500.0	-13.7
8	20	76500	-13.8		14.0	76500.0	-13.8
9	.0	76500	-13.3		12.0	76500.0	-13.7
10	-20	76502	-12.7		10.0	76500.0	-13.7
11					8.0	76500.0	-14.3
12							
13							
14							
15							
16							
17							



Equipment Used: HP8560E1, HP8593E1, HP11970W1, WBAND1

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:	30-Mar-15
			Test Engineer:	Valdis V. Liepa
MPE Field Strength Limit	61	V/m	**EUT Mode:**	CW
MPE Power Density Limit	1.0	mW/cm2	**Meas. Distance:**	3m

Freq. GHz	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
76.010	20.00	22	-4.7	17.3	4.00	0.81	1.2	0.011	
76.500	20.00	20.9	-4.7	16.2	4.00	0.82	1.1	0.008	
76.980	20.00	22.8	-4.7	18.1	4.00	0.82	1.2	0.013	

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
f > 1 000 MHz	Pk	1 MHz	3 MHz
f > 1 000 MHz	Avg	1 MHz	10 kHz

Test Date:	03/31/15
Test Engineer:	Valdis V. Liepa
EUT:	Autoliv 77GHz MMRV1
Mode:	Modulated (Up-chirp & Down-Chirp)
Meas. Distance:	See Table.

FREQ < 40 GHZ

	Env.		Frequency Band		Antenna + Cable***					Rx. Power		Range Correction*				E-Field @ DR		EIRP*		S @ DR		E-Field Limit			
	Temp.	Volt.	Start	Stop	Type	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		H/V	cm	dB/m	dB	dBm		m	m	m	dB	dBuV/m		dBm		dBm/cm2		dBuV/m		dB	Comments
1																									
2																									
3		THE EUT EMPLOYS NO INTERNAL OSCILLATORS OR CRYSTALS BELOW 40 GHZ RELATED TO THE RF CHAIN (TX OR RX) FOR THE DEVICE. THE EUT IS PHASE LOCKED FROM A 25 MHZ CRYSTAL. ANY EMISSIONS BELOW 40 GHZ WOULD BE NON-RF RELATED (DIGITAL) EMISSIONS WHICH ARE EXEMPT FOR VEHICULAR MOUNTED APPLICATIONS.																							
4																									
5																									
6																									

FREQ >= 40 GHZ

	Env.		Frequency Band		Antenna + Cable***					Rx. Power		Range Correction*				E-Field @ DR		EIRP*		S @ DR		FCC S Limit			
	Temp.	Volt.	Start	Stop	Type	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		H/V	cm	dB/m	dB	dBm		m	m	m	dB	dBuV/m		dBm		dBm/cm2		dBm/cm2		dB	Comments
8	20	13.4	40.0	60.0	Horn U	H/V	6.3	39.1	0.0	-61.5	-71.2	0.30	3.0	1.6	-34.5	50.1	40.4	-45.1	-54.8	-105.6	-115.3		-62.2	43.4	
9	20	13.4	50.0	75.0	Horn V	H/V	4.0	40.1	0.0	-59.5	-68.0	0.30	3.0	0.8	-28.5	59.1	50.6	-36.1	-44.6	-96.7	-105.2		-62.2	34.4	
10	20	13.4	75.0	76.0	Horn W	H/V	4.0	45.3	0.0	-56.3	-65.0	0.30	3.0	0.8	-28.6	67.3	58.7	-27.9	-36.5	-88.4	-97.1		-62.2	**26.2**	
11	20	13.4	77.0	110.0	Horn W	H/V	4.0	46.4	0.0	-59.7	-71.8	0.30	3.0	1.2	-31.8	61.9	49.8	-33.3	-45.4	-93.9	-106.0		-62.2	31.7	
12	20	13.4	110.0	140.0	Horn G	H/V	4.0	54.0	0.0	-62.0	-71.2	0.30	3.0	1.5	-33.9	65.1	55.9	-30.1	-39.3	-90.7	-99.9		-62.2	28.5	
13	20	13.4	140.0	200.0	Horn G	H/V	4.0	54.0	0.0	-50.2	-54.3	0.10	3.0	2.1	-56.1	54.7	50.6	-40.5	-44.6	-101.1	-105.2		-62.2	38.8	
14	20	13.4	200.0	231.0	Horn G	H/V	4.0	54.0	0.0	-60.5	-71.2	0.10	3.0	2.5	-57.4	43.1	32.4	-52.1	-62.8	-112.6	-123.3		-60.0	52.6	
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* 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 4cm in dimension.

Equipment Used: HP8560E1, HP8593E1, HP11970W1, GBAND1, WBAND1, UBAND1, KABAND1, KBAND1, XBAND1, XNBAND1, CBAND1, UMRH1, AVAMP2, AVAMP3