TEST REPORT # EMCC-980162IDAA, 2003-JUN-18

EQUIPMENT UNDER TEST:

Type:	ARS 2-C
Serial Number:	1103070007
Equipment Category:	Part 15 Forward-Looking Field Disturbance Sensor, Vehicle Radar System
Manufacturer:	Conti Temic GmbH
Address:	Sieboldstrasse 19 90411 Nürnberg Germany
Phone:	+49-911-9526-2100
Fax:	+49-911-9526-2354
Applicant:	A.D.C. Automotive Distance Control Systems GmbH
Address:	Kemptener Strasse 99 88131 Lindau (Bodensee) Germany
Phone:	+49-8382-9699-0
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RELEVANT STANDARD: 47 CFR Part 15C - Intentional Radiators, §15.253 Spurious Emissions, only

MEASUREMENT PROCEDURE USED:

☒ ANSI C63.4-1992 ☐ FCC/OET MP-4 (1987) ☒ IEEE Std C95.3-1991

TEST REPORT PREPARED BY:

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TEST PERSONNEL:

Reinhard Sauerschell

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Winfried Hoffmann

Test of Conti Temic GmbH Type ARS 2-C, Serial number 1103070007
to 47 CFR Part 15C - Intentional Radiators, §15.253

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1 GENERAL INFORMATION

1.1 Purpose

The purpose of this report is to show compliance to the FCC regulations for devices operating under section 15.253 of the Code of Federal Regulations title 47.

1.2 Limits and Reservations

The test results in this report apply only to the particular Equipment Under Test (EUT) as declared in this report.
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1.3 Test Location

Company Name:	EMCC DR. RAŠEK
Street:	Moggast 72-74
City:	91320 Ebermannstadt
Country:	Germany
Laboratory:	Test Laboratory of EMCC DR. RAŠEK FCC Registration Number: 90566 This site has been fully described in a report submitted to the FCC, and accepted in the letter dated February 09, 2000 Registration Number 90566.
Phone:	+49-9194-9016
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1.4 Manufacturer

Company Name:	Conti Temic GmbH
Street:	Sieboldstrasse 19
City:	90411 Nürnberg
Country:	Germany
Phone:	+49-911-9526-2100
Fax:	+49-911-9526-2354

1.5 Applicant

Company Name: A.D.C. Automotive Distance Control Systems GmbH
Street: Kemptener Strasse 99
City: 88131 Lindau (Bodensee)
Country: Germany
Name for contact purposes: Mr Peter Glocker
Phone: +49-8382-9699-62
Fax: +49-8382-9699-94
E-mail: peter.glocker@adc-gmbh.de

1.6 Dates

Date of receipt of EUT: CW 18/2003
Test date: CW 25/2003

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

Description:	Adaptive Cruise Control Pulse Doppler RADAR System
Device designation:	Part 15 Forward-Looking Field Disturbance Sensor, Vehicle Radar System
Type:	ARS 2-C [1]
No. of units:	one
Serial number:	1103070007
Transmit Frequency:	76 to 77 GHz
Type of modulation:	Pulse Doppler
Pulse repetition frequency:	286 to 667 kHz
Pulse width:	33 ns
Class of emission (ITU):	50M0 P0N
Measurement distance:	1 to 150 m
RF power:	200 µW average nominal
Antenna:	Integral
Rated input voltage:	12.0 VDC nominal

2.2 EUT Peripherals

The EUT was tested as stand alone unit
- with supplied cable bundle (CAN-bus matched with resistors),
- with automatic power on feature: after power on the unit turned to normal operation mode (in motion mode) by itself,
- with standard lead acid vehicle battery 12 VDC and standard laboratory DC power supply as back up.

2.3 Mode of Operation During Testing

The equipment under test (EUT) was operated during the tests under the the following condition:
- in motion mode (unit was prepared by applicant in that way, that unit turned to in motion mode by itself after power on).

2.4 Modifications Required for Compliance

None

[1] The ARS 2-C is a variant of the ARS 2-A as full tested according to test report EMCC-980162IAA, 2003-FEB-06.

3 TEST RESULTS SUMMARY

Summary of Test Results

Requirement	CFR Section	Report Section	Test Result
Antenna Requirement	15.203		not tested
Conducted Emissions	15.207		n.a.
Radiated Spurious Emissions	15.209, 15.253(c)		Pass
Power Density Limits (Fundamental)	15.253(b)		not tested
Operation within the band, 20 dB bandwidth, frequency stability	15.253(e), 15.215(c)		not tested
Radio frequency exposure	15.253(f)		not tested

NOTE: "not tested" parameters on applicants request. The ARS 2-C is a variant of the ARS 2-A as full tested according to test report EMCC-980162IAA, 2003-FEB-06.

The client has made the determination that EUT Condition, Characterization, and Mode of Operation are representative of production units, and meet the requirements of the specifications referenced herein.

Consistent with Industry practice, measurement and test equipment not directly involved in obtaining measurement results but having an impact on measurements (such as cable loss, antenna factors, etc.) are factored into the "Correction Factor" documented in certain test results. Instrumentation employed for testing meets tolerances consistent with known Industry Standards and Regulations.

The measurements contained in this report were made in accordance with the procedure ANSI C63.4 - 1992 and IEEE Std C95.3-1991. All requirements were found to be within the limits outlined in this report.
The test results in this report apply only to the particular Equipment Under Test (EUT) as declared in this report.

Test Personnel: Reinhard Sauerschell
Issuance Date: 2003-06-18

4 RADIATED EMISSIONS

Test Requirement: FCC CFR47, Part 15C
Test Procedure: ANSI C63.4:1992

4.1 Regulation

Section 15.253 Operation within the bands 46.7-46.9 GHz and 76.0-77.0 GHz.
(a) Operation within the bands 46.7-46.9 GHz and 76.0-77.0 GHz is restricted to vehicle-mounted field disturbance sensors used as vehicle radar systems. The transmission of additional information, such as data, is permitted provided the primary mode of operation is as a vehicle-mounted field disturbance sensor. Operation under the provisions of this section is not permitted on aircraft or satellites.
(b) The radiated emission limits within the bands 46.7-46.9 GHz and 76.0-77.0 GHz are as follows:
(1) If the vehicle is not in motion, the power density of any emission within the bands specified in this section shall not exceed 200 nW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.
(2) For forward-looking vehicle-mounted field disturbance sensors, if the vehicle is in motion the power density of any emission within the bands specified in this section shall not exceed 60 µW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.
(c) The power density of any emissions outside the operating band shall consist solely of spurious emissions and shall not exceed the following:
(1) Radiated emissions below 40 GHz shall not exceed the general limits in Section 15.209 of this part.
(2) Radiated emissions outside the operating band and between 40 GHz and 200 GHz shall not exceed the following:
(ii) For forward-looking vehicle-mounted field disturbance sensors operating in the band 76-77 GHz: 600 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.
(3) For radiated emissions above 200 GHz from field disturbance sensors operating in the 76-77 GHz band: the power density of any emission shall not exceed 1000 pW/cm² at a distance of 3 meters from the exterior surface of the radiating structure.
(4) For field disturbance sensors operating in the 76-77 GHz band, the spectrum shall be investigated up to 231 GHz.
(d) The provisions in Section 15.35 of this part limiting peak emissions apply.
(e) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

Section 15.35 Measurement detector functions and bandwidths.
(b) On any frequency of frequencies above 1000 MHz, the radiated limits shown are based upon the use of measurement instrumentation employing an average detector function. When average radiated emission measurements are specified in the regulations, including emission measurements below 1000 MHz, there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules in this part, e.g., see § 15.255. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. Measurement of AC power line conducted emissions are performed using a CISPR quasipeak detector, even for devices for which average radiated emission measurements are specified.

Section 15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100	3
88–216	150	3
216–960	200	3
Above 960	500	3

(b) In the emission table above, the tighter limit applies at the band edges.

(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

4.2 Radiated Emissions Test, up to 26.5 GHz [2]

4.2.1 Test Equipment

Type	Manufacturer/ Model No.	Serial No.	Last Calibration	Next Calibration
Receiver (30 MHz - 1 GHz)	Rohde & Schwarz ESS	825132/015	July 2002	July 2003
Antenna (30 MHz - 1 GHz)	EMCO 3143	9604-1269	June 2002	Dec. 2003
Receiver (1 GHz - 26.5 GHz)	Rohde & Schwarz ESAI-D ESMI-RF ESMI-B1	833771/008 833827/002 832504/005	May 2002	Nov. 2003
Antenna (1 GHz - 18 GHz)	Schwarzbeck BBHA 9120 D	137	Oct. 2001	Oct. 2003
Standard Gain Horn Antenna (18 GHz - 26.5 GHz)	Mid Century MC 20/31B	1362/86	May 2002	May 2004

4.2.2 Test Procedures

For tabletop equipment, the EUT is placed on a 1 meter by 1.5 meters wide and 0.8 meter high nonconductive table that sits on a flush mounted metal turntable. Floor standing equipment is placed directly on the flush mounted metal turntable. The EUT is connected to its associated peripherals with any excess I/O cabling bundled to approximately 1 meter.

The EUT was tested as a tabletop equipment, connected with peripherals as described in chapter 2.2.

The tests were performed in one mode as described in chapter 2.3.
The initial step in collecting radiated data is a peak scan of the measurement range with an EMI test receiver under closer distances as given in the rule. The significant peaks are then measured with the appropriate distance and detectors.
Worst case radiated emissions are listed under chapter: test results.

[2] The end frequency 26.5 GHz of this chapter was selected because of the end frequency of the coaxial RF input of the spectrum analyzer used as test receiver.

Radiated Emissions Test Characteristics	
Frequency range	30 MHz - 26,500 MHz
Test distance	3 m
Test instrumentation resolution bandwidth	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (1,000 MHz - 26,500 MHz)
Test instrumentation detector	QP (30 MHz - 1,000 MHz)
	AV/PK (1,000 MHz - 26,500 MHz)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/Horizontal

4.2.3 Calculation of Field Strength Limits

Calculation: microvolts/meter to dBµV/m

Frequency	Field Strength		Measurement distance	Remarks
(MHz)	(microvolts/meter)	(dBµV/m)	(meters)	
30–88	100	40	3	
88–216	150	43.5	3	
216–960	200	46	3	
960-26,500	500	54	3	

4.2.4 Average Correction Factor

NOTE: All AV measurements were performed using the test receiver's average detector and the max. hold facility; the average value measured directly without the necessity of additional correction factor.

4.2.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF
where
FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB

Assume a receiver reading of 23.5 dBµV is obtained. The Antenna Factor of 7.4 dB(1/m) and a Cable Factor of 1.1 dB are added, giving a field strength of 32 dBµV/m. The 32 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 23.5 + 7.4 + 1.1 = 32 [dBµV/m]

Level in µV/m = Common Antilogarithm (32/20) = 39.8

4.2.6 Test Results

Device: Adaptive Cruise Control Pulse Doppler RADAR System
Type: ARS 2-C
Serial number: 1103070007

PRODUCT EMISSIONS DATA											
No	Emission Frequency [MHz]	Receiver Mode and Bandwidth [kHz]	Test Distance [m]	Receiver Reading RA [dBµV]	Correction Factor AF+CF [dB(1/m)]	Distance Extrapola-tion Factor DF [dB]	Result = Corrected Reading FS [dBµV/m]	Spec Limit [dBµV/m]	Polari-zation Ant	Margin [dB]	Remark
1	40	120, QP	3	27.7	10.5	0	38.2 QP	40 QP	v	1.8	
2	60	120, QP	3	19	7	0	26 QP	40 QP	v	14	
3	12,750	1000, AV	1	16	40.3	9.5	46.8 AV	54 AV	v	7.2	
		1000, PK	1	24.4	40.3	9.5	55.2 PK	74 PK	v	18.8	
4	25,500	1000, AV	0.3	20.8	41	20	41.8 AV	54 AV	v	12.2	
		1000, PK	1	20.4	41	9.5	51.9 PK	74 PK	v	22.1	

The EUT meets the requirements of this section.

Test Personnel: Reinhard Sauerschell

Test Date: 2003-06-18

4.3 Radiated Emissions Test, 26.5 GHz to 231 GHz (outside the operating band)

4.3.1 Test Equipment

Type	Manufacturer/ Model No.	Serial No.	Last Calibration	Next Calibration
Receiver (26.5 GHz - 110 GHz) Waveguide Mixer LO Amplifier	Rohde & Schwarz ESAI-D ESMI-RF ESMI-B1 R&S/Tektronix FS-Z40/WM782A FS-Z60/WM782U FS-Z75/WM782V FS-Z110/WM782W R&S, FS-Z30	 833771/008 833827/002 832504/005 840448/007 840449/001 840450/005 840451/005 775850/002	May 2002	Nov. 2003
Standard Gain Horn Ant.	FMI/Pro N 2224-25	49	May 2002	May 2004
Standard Gain Horn Ant.	FMI/ProN 2424-25	30	May 2002	May 2004
Standard Gain Horn Ant	Electrof./Tho WG25-25	001	May 2002	May 2004
Standard Gain Horn Ant.	Electrof./Tho WG27-25	001	May 2002	May 2004
Spectrum Analyzer Waveguide Mixer Waveguide Mixer Waveguide Transition Diplexer	Tektronix 2755A1 Tektronix WM 490 F Tektronix WM 490 G Tektronix 119-1728-00 Textronix 015-0385-00	B 010245 B 020970 B 020958 678B/0567 003/900	Dec. 2002	Dec. 2003
Standard Gain Horn Ant.	FMI/Pro N 2824-25	24	May 2002	May 2004
Standard Gain Horn Ant.	FMI/Pro N 3024-25	001	May 2002	May 2004
Standard Gain Horn Ant.	Electrof./Tho WR-3	001	May 2002	May 2004

4.3.2 Test Procedures

The basic test setups and procedures are the same as for the tests 30 MHz to 26.5 GHz. Above 26.5 GHz additional external mixers have to be used, which results in additional correction factors.
Due to high mixer loss at very high frequencies the distance between the EUT and the test antenna was reduced to very low values (some cm) to detect any emissions.
The operating band 76 GHz to 77 GHz was excluded.

Radiated Emissions Test Characteristics	
Frequency range	26,500 MHz - 231,000 MHz
Test distance	0.01 - 3 * m
Test instrumentation resolution bandwidth	1 MHz
Test instrumentation detector	PK
Receive antenna scan height	no height scan performed due to high gain antenna
Receive antenna polarization	Vertical/Horizontal

* According to Section 15.31 (f) (1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. (...) When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

4.3.3 Calculations of Spurious Emissions Limits

Frequency	Field Strength		Measurement distance	Remarks
(MHz)	(microvolts/meter)	(dBµV/m)	(meters)	
26,500 – 40,000	500	54	3	

Frequency	Power Density		Measurement distance	Remarks
(MHz)	pW/cm²	dBm/cm²	(meters)	
40,000 – 200,000	600	-62.2	3	
> 200,000	1000	-60.0	3	

4.3.4 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Mixer Loss. The basic equation with a sample calculation is as follows:

FS = RA + AF + ML
where
FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB(1/m)
ML = Mixer Loss in dB

Assume a receiver reading of 10.2 dBµV is obtained. The Antenna Factor of 38.8 dB(1/m) and a Mixer Loss of 22 dB are added, giving a field strength of 71 dBµV/m. The 71 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 10.2 + 38.8 + 22 = 71 [dBµV/m]

Level in µV/m = Common Antilogarithm (71/20) = 3,548

For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f)(1) the field strength is calculated by adding additionally an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements). The basic equation with a sample calculation is as follows:

FS = RA + AF + ML + DF
where
FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB(1/m)
ML = Mixer Loss in dB
DF = Distance Extrapolation Factor in dB,
where DF = 20 log (Dtest/Dspec) where Dtest = Test Distance and Dspec = Specified Distance.

Assume the tests performed at a reduced Test Distance of 1 m instead of the Specified Distance of 3 m giving a Distance Extrapolation Factor of DF = 20 log(1m/3m) = -9.5 dB.
Assuming a receiver reading of 10.2 dBµV is obtained. The Antenna Factor of 38.3 dB(1/m), the Mixer Loss of 22 dB and the Distance Factor of -9.5 dB are added, giving a field strength of 61.5 dBµV/m. The 61.5 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = 10.2 + 38.8 + 22 - 9.5 = 61.5 [dBµV/m]

Level in µV/m = Common Antilogarithm (61.5/20) = 1,188

4.3.5 Power Density Calculation

The power density is calculated by using the reading, mixer loss, effective aperture of the antenna and distance correction factor (20 dB/dec relation).
The basic calculation is similar as described in the chapter above with the difference, that the result is the power density:

PD = RA + ML + DF - A
where
PD = Power Density in dBm/cm²,
RA = Receiver Amplitude in dBm,
ML = Mixer Loss in dB,
DF = Distance Extrapolation Factor in dB,
A = effective Antenna Aperture in dB(cm²)
where DF = 20 log (Dtest/Dspec) where Dtest = Test Distance and Dspec = Specified Distance, and A = 10 log (effective Antenna Aperture in cm²).

For an assumed result of -60 dBm/cm² the level in pW/cm² is:
10^9 x Common Antilogarithm (-60/10) = 1,000

4.3.6 Test Results

Device: Adaptive Cruise Control Pulse Doppler RADAR System
Type: ARS 2-C
Serial number: 1103070007

PRODUCT EMISSIONS DATA, **26.5 GHz < f < 40 GHz**

No	Emission Frequency [MHz]	Receiver Mode and Bandwidth [kHz]	Test Distance [m]	Receiver Reading RA [dBµV]	Antenna Factor AF [dB(1/m)]	Mixer Loss ML [dB]	Distance Extrapolation Factor DF [dB]	Result = Corrected Reading FS [dBµV/m]	Spec Limit [dBµV/m]	Polarization Ant	Margin [dB]

No emissions found above noise within this frequency band

Test of Conti Temic GmbH Type ARS 2-C, Serial number 1103070007
to 47 CFR Part 15C - Intentional Radiators, §15.253

PRODUCT EMISSIONS DATA, **f > 40 GHz** (excluding the operation band)

Receiver Mode: PK
Bandwidth: 1000 kHz
Polarization of antenna: h/v (worst case)
Gain of measurement antennas: f<220GHz: 25 dBi, f>220GHz: 30 dBi

No	Emission Frequency [MHz]	Test Distance [m]	Receiver Reading RA [dBm]	Mixer Loss ML [dB]	Distance Extrapolation Factor DF [dB]	Eff. Antenna Area A [dB(cm²)]	Result = Corrected Reading FS [dBm/cm²]	Spec Limit [dBm/cm²]	Margin [dB]	Remark
1	76,000	1	-93	31	-9.5	5.9	-77.4	-62.2	15.2	noise, lower band edge
2	77,000	1	-95	31	-9.5	5.8	-79.3	-62.2	17.1	noise, upper band edge
NOTE: no emissions found above noise over the whole frequency range										

The EUT meets the requirements of this section.

Test Personnel: Reinhard Sauerschell

Test Date: 2003-06-18

5 MISCELLANEOUS COMMENTS AND NOTES

None.

6 LIST OF ANNEXES

Following annexes are separated parts from this test report.

Description	Pages
Annex 1: Photographs of test setups	3
Annex 2: Photographs of equipment under test (EUT), external views	5