TEST REPORT # EMCC-030430C, 2005-MAY-09

EQUIPMENT UNDER TEST:

Type:	SU70-10NR
Serial Number:	04536
Equipment Category:	Part 80, MRD
Manufacturer:	GEM Elettronica
Address:	Via A. Vespucci, 9 - P.O. Box 280 63039 S. Benedetto del Tronto (AP) Italy
Applicant:	Raytheon Marine GmbH
Address:	Zeyestrasse 16-24 24106 Kiel Germany
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RELEVANT STANDARD: 47 CFR Part 80, stations in the maritime services

MEASUREMENT PROCEDURE USED:

☒ ANSI C63.4-2003 ☐ FCC/OET MP-4 (1987) ☒ IEEE Std C95.3-1991

TEST REPORT PREPARED BY:

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Reinhard Sauerschell

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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 part 80 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.
This test report shall not be reproduced except in full without the written permission of EMCC DR. RAŠEK.

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 04, 2003 Registration Number 90566.
Phone:	+49-9194-9016
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1.4 Manufacturer

Company Name:	GEM Elettronica
Street:	Via A. Vespucci, 9 - P.O. Box 280
City:	63039 S. Benedetto del Tronto (AP)
Country:	Italy

1.5 Applicant

Company Name:	Raytheon Marine GmbH
Street:	Zeyestrasse 16-24
City:	24106 Kiel
Country:	Germany
Name for contact purposes:	Mr Robert Zissen
Phone:	+49-431-3019-613
Fax:	+49-431-3019-612
E-mail:	Robert_Zissen@raykiel.com

1.6 Dates

Date of receipt of EUT:	CW 16/2005
Test date:	CW 17/2005

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

Description:	Marine RADAR System
Device designation:	Part 80, MRD
Type:	SU70-10NR
Ident No:	2.808250
P/N:	AA123405
No. of units:	one
Serial number:	04536
Peak power (nominal):	10 kW (typical)
Radiation frequency:	9410 ± 30 MHz
Type of modulation:	Pulse, P0N

Pulse Pattern	SHORT	MEDIUM	LONG	EXTRALONG
Pulse Width PW	80 ns	300 ns	600 ns	1.2 µs
Pulse Repetition Frequency PRF	3200 Hz	1600 Hz	800 Hz	500 Hz

Modulator:	fully solid state
Receiver type:	logarithmic, fully solid state
Intermediate Frequency (I.F.):	60 MHz ± 2 MHz
I.F. bandwidth:	20 MHz with short and medium pulses; 4 MHz with long and extralong pulses (with ± 10% tolerance)
Duplexer:	ferrite circulator with solid state limiter diode
Antenna:	Several antenna arrays available, tests performed w/o antenna
Rated input voltage:	24.0 VDC nominal

2.2 EUT Peripherals

The EUT was tested together with

Designation	Type	Serial No	Ident No	Drawing No
Display and control unit	NSC 18	00112	4001898	900.023.NG001
Connection module		0025	4001855	948-008.NG001
Dummy load (instead of antenna)	RANATEC X910-5 (VSWR: 1.05)	3664		

2.3 Mode of Operation During Testing

The equipment under test (EUT) was operated during the tests under the following condition:

- transmit mode with all four different pulse patterns.

2.4 Modifications Required for Compliance

None

3 TEST RESULTS SUMMARY

Summary of Test Results

Requirement	CFR Section	Report Section	Test Result
R.F. Power Output Duty Cycle = PRF x Pulse Width Peak Power = Average Power/Duty Cycle	2.1046(a), 80.215(a)	4	no limits given
Modulation Characteristics Pulse widths PRF	2.1047, 80.213(g)	5	no limits given
Occupied Bandwidth	2.1049(i), 80.209(b), 80.211(f)	6	passed
Spurious Emissions at Antenna Port	2.1051, 80.211(f)	7	passed
Radiated Spurious Emissions	2.1053, 80.211(f)	8	passed
Frequency Stability – temperature & voltage variation	2.1055, 80.209(b)	9	passed

The client has declared, 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 - 2003 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: 2005-05-09

4 RF POWER OUTPUT

4.1 Regulation

§ 2.1046 Measurements required: RF power output.
(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

§ 80.215 Transmitter power.
(a) Transmitter power shown on the radio station authorization is the maximum power the licensee is authorized to use. Power is expressed in the following terms:
(3) For P0N and F3N emission: Mean power.

4.2 Basic Test Procedures

The mean (average) RF output power was tested in two ways:

- measuring the peak power, pulse width and pulse repetition frequency with a diode detector and oscilloscope and further calculating the mean (average) power for each pulse pattern,
- measuring the mean (average) power directly with a thermo coupled power head for each pulse pattern.

The RF power signal was coupled out using a directional coupler between the RF output of EUT and the dummy load.

4.3 Peak Power, PW, PRF

4.3.1 Test Setup and Procedure

The peak power and the timing parameters of the RF pulse were measured with a suitable diode detector, which delivered a DC pulse signal imaging the envelope of the RF pulse signal. The DC pulse amplitude corresponds with the RF pulse signal amplitude by individual factors, which can be taken from calibration tables and/or directly measured and verified by using a calibrated RF pulse signal source.

The RF signals of the EUT were taken with a directional coupler between the RF output of EUT and the dummy load, which was used instead of the antenna. Additional attenuators were inserted to get practicable signal levels at the input of the detector. The output of the detector was connected with a oscilloscope.

The tests were performed with the all four possible pulse patterns of the EUT.

4.3.2 Test Equipment

Type	Manufacturer/ Model No.	Serial No.	Last Calibration	Calibration Interval
Dig. Storage Scope	Tektronix TDS3034	B011288	2004-06	12 months
Wideband Coax Detector	Hewlett-Packard H01-8472A	006	2005-04 *	
Directional Coupler	GHz-Microwave X-362-30	001	2005-04 *	
25W/20dB Attenuator	Weinschel 46-20-34	BL2173	2003-07	24 months
5 W Attenuator 10dB	Weinschel, 2	BH 4277	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0873	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0889	2003-07	24 months
NAdapter, X	Std., UG 39/N	001	2005-04 *	
Test Generator (10 MHz – 40 GHz)	Hewlett-Pack. 83640A-4008	3009A00182	2001-11	48 months
Programmable Power Source	R&S NGPE40	451292/0529	n.a	n.a.
Digital Multimeter	CONRAD ME-42	CC344177	2004-06	24 months

* Equipment individually calibrated just before the tests.

4.3.3 Test Results, raw data

Pulse Pattern	Pulse Width PW [ns]	Pulse Repetition Frequency PRF [Hz]		Pulse Amplitude [mV]	Plots No
		Range	Middle		
Short	58.4	2 720 - 3 230	2 975	8.05	1, 2
Medium	272	1 850 - 2 150	2 000	7.6	3, 4
Long	588	952 - 1 073	1 013	7.96	5, 6
Extralong	1 080	708 - 799	754	7.68	7, 8

Plots are in Annex 3 to this test report.

4.3.4 Test Results, calculation

Calculation procedures:

- The Amplitude Reading [mV] of the DC signal from the diode detector output corresponds to the RF input signal [dBm] from the EUT.
- The Attenuator [dB] describes the overall attenuation of the directional coupler and the inserted fixed attenuators.
- Peak Power [dBm] = Power at Diode Detector [dBm] + Attenuator [dB]
- Duty Cycle = PRF x Pulse Width (values taken from raw data table above).
- Average Power [W] = Peak Power [W] x Duty Cycle

Pulse Pattern	Amplitude Reading	RF Power at Diode Detector	Attenuator	Duty Cycle	RF Peak Power		RF Mean (Average) Power	
	[mV]	[dBm]	[dB]		[dBm]	[W]	[dBm]	[W]
Short	8.05	-1.4	70	173E-6	68.6	7 244	31	1.26
Medium	7.6	-1.5	70	544E-6	68.5	7 079	35.9	3.85
Long	7.96	-1.4	70	596E-6	68.6	7 244	36.3	4.31
Extralong	7.68	-1.5	70	814E-6	68.5	7 079	37.6	5.76

4.4 Mean (Average) Power

4.4.1 Test Setup and Procedure

The mean (average) power of the RF pulse signal was measured with a thermo coupled power detector, which delivered directly the power reading at the power meter.

The RF signals of the EUT were taken with a directional coupler between the RF output of EUT and the dummy load, which was used instead of the antenna. Additional attenuators were inserted to get practicable signal levels at the input of the thermo coupled power detector. The output of the detector was connected with the power meter.

The tests were performed with the all four possible pulse patterns of the EUT.

4.4.2 Test Equipment

Type	Manufacturer/ Model No.	Serial No.	Last Calibration	Calibration Interval
RF Power Meter	Rohde & Schwarz NRVD	843246/036	2004-10	24 months
Power Sensor 40 GHz	Rohde & Schwarz NRV-Z55	845988/003	2004-04	24 months
Directional Coupler	GHz-Microwave X-362-30	001	2005-04 *	
25W/20dB Attenuator	Weinschel 46-20-34	BL2173	2003-07	24 months
5 W Attenuator 10dB	Weinschel, 2	BH 4277	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0873	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0889	2003-07	24 months
NAdapter, X	Std., UG 39/N	001	2005-04 *	
Programmable Power Source	R&S NGPE40	451292/0529	n.a	n.a.
Digital Multimeter	CONRAD ME-42	CC344177	2004-06	24 months

* Equipment individually calibrated just before the tests.

4.4.3 Test Results

Calculation procedures:

- The Attenuator [dB] describes the overall attenuation of the directional coupler and the inserted fixed attenuators.
- Average Power [dBm] = Reading at power meter [dBm] + Attenuator [dB]

Pulse Pattern	Reading at power meter	Attenuator	RF Mean (Average) Power	
	[dBm]	[dB]	[dBm]	[W]
Short	-29.0	60	31.0	1.26
Medium	-23.5	60	36.5	4.47
Long	-23.0	60	37.0	5.01
Extralong	-21.8	60	38.2	6.61

5 MODULATION CHARACTERISTICS

5.1 Regulation

§ 2.1047 Measurements required: Modulation characteristics.
(d) Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

§ 80.213 Modulation requirements.
(g) Radar stations operating in the bands above 2.4 GHz may use any type of modulation consistent with the bandwidth requirements in § 80.209(b).

§ 80.209 Transmitter frequency tolerances.
(b) When pulse modulation is used in land and ship radar stations operating in the bands above 2.4 GHz the frequency at which maximum emission occurs must be within the authorized bandwidth and must not be closer than 1.5/T MHz to the upper and lower limits of the authorized bandwidth where ‘‘T’’ is the pulse duration in microseconds.

5.2 Test Setup, Procedure and Results

Time domain signal measurements and results are described above in chapter 4.3 Peak Power, PW, PRF.

Frequency domain measurements and results are described below in chapter 6 Occupied Bandwidth.

6 OCCUPIED BANDWIDTH, TRANSMITTER FREQUENCY TOLERANCES

6.1 Regulation

§ 2.1049 Measurements required: Occupied bandwidth.
The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:
(i) Transmitters designed for other types of modulation - when modulated by an appropriate signal of sufficient amplitude to be representative of the type of service in which used. A description of the input signal should be supplied.

§ 80.209 Transmitter frequency tolerances.
(b) When pulse modulation is used in land and ship radar stations operating in the bands above 2.4 GHz the frequency at which maximum emission occurs must be within the authorized bandwidth and must not be closer than 1.5/T MHz to the upper and lower limits of the authorized bandwidth where ‘‘T’’ is the pulse duration in microseconds.

6.2 Test Setup and Procedure

Frequency domain measurements were performed with a spectrum analyzer

- for occupied bandwidth test (99 percent of the total mean power, i.e. 0.5 percent at band edges) with appropriate test feature (OPB),
- for 1.5/T MHz distance test to the upper and lower limits of the authorized bandwidth.

The RF signals of the EUT were taken with a directional coupler between the RF output of EUT and the dummy load, which was used instead of the antenna. Additional attenuators were inserted to get practicable signal levels at the input of the spectrum analyzer.

The occupied bandwidth test was performed with different resolution bandwidths RBW.

The tests were performed with the all four possible pulse patterns of the EUT.

6.3 Test Equipment

Type	Manufacturer/ Model No.	Serial No.	Last Calibration	Calibration Interval
EMI Receiver / Analyzer 40 GHz,	Rohde & Schwarz ESIB 40	100126	2003-07	24 months
Directional Coupler	GHz-Microwave X-362-30	001	2005-04 *	
25W/20dB Attenuator	Weinschel 46-20-34	BL2173	2003-07	24 months
5 W Attenuator 10dB	Weinschel, 2	BH 4277	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0873	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0889	2003-07	24 months
Programmable Power Source	R&S NGPE40	451292/0529	n.a	n.a.
Digital Multimeter	CONRAD ME-42	CC344177	2004-06	24 months
NAdapter, X	Std., UG 39/N	001	2005-04 *	

* Equipment individually calibrated just before the tests.

6.4 Test Results, Occupied Bandwidth

Calculation procedures:

- no calculation procedures necessary due to direct reading of OPB reading at spectrum analyzer

Pulse Pattern	Resolution Bandwidth [kHz]	OPB Reading at spectrum analyzer [MHz]	Attenuator (informative) [dB]	Plot
Short	1 000	87.37	80	1
	5 000	70.14	80	2
Medium	1 000	31.86	80	3
	5 000	64.53	80	4
Long	100	13.73	80	5
	1 000	13.33	80	6
	5 000	33.67	80	7
Extralong	100	9.22	80	8
	1 000	9.54	80	9
	5 000	29.66	80	10

Plots are in Annex 4 to this test report.

6.5 Test Results, Transmitter Frequency Tolerances

Calculation procedures:

- 1.5/T MHz distances calculated with measured pulse durations in microseconds.
- Lower limit = 9 300 MHz + 1.5/T.
- Upper limit = 9 500 MHz – 1.5/T.
- Upper and lower limits of the authorized bandwidth verified with the frequencies taken during OPB test with spectrum analyzer (refer to plots above, chapter 6.4).

Calculation of limits:					
Pulse Pattern	Pulse Width PW (T) [ns]	1.5/T [MHz]	lower limit [MHz]	upper limit [MHz]	Remarks
Short	58.4	25.7	9 325.7	9 474.3	
Medium	272	5.5	9 305.5	9 494.5	
Long	588	2.55	9 302.55	9 497.45	
Extralong	1 080	1.4	9 301.4	9 498.6	

Results:				
Pulse Pattern	Resolution Bandwidth [kHz]	lower frequency where 0.5 percent of the total mean power [MHz]	upper frequency where 0.5 percent of the total mean power [MHz]	Plot to chapter 6.1.3
Short	1 000	9 351.7	9 439.2	1
	5 000	9 367.3	9 437.6	2
Medium	1 000	9 384.7	9 416.6	3
	5 000	9 370.7	9 435.4	4
Long	100	9 391.8	9 405.6	5
	1 000	9 391.8	9 405.2	6
	5 000	9 381.8	9 415.6	7
Extralong	100	9 393.5	9 402.8	8
	1 000	9 392.2	9 401.9	9
	5 000	9 381.7	9 411.5	10

Finding:
The EUT meets the requirements of this section.

7 SPURIOUS EMISSIONS AT ANTENNA PORT

7.1 Regulation

§ 2.1051 Measurements required: Spurious emissions at antenna terminals.
The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 80.211 Emission limitations.
The emissions must be attenuated according to the following schedule.
(f) The mean power when using emissions other than those in paragraphs (a), (b), (c) and (d) of this section:
(1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;
(2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and
(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus 10lg (mean power in watts) dB.

§ 2.1057 Frequency spectrum to be investigated.
(a) In all of the measurements set forth in §§ 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

7.2 Test Setup and Procedure

Spurious emissions measurements were performed with a spectrum analyzer.

The RF signals of the EUT were taken with a directional coupler between the RF output of EUT and the dummy load, which was used instead of the antenna.
At the coupling output of the directional coupler additional attenuators, filters and tapered transitions were inserted to get practicable signal levels at the input of the spectrum analyzer.
The directional coupler and attached small parts were measured prior to the tests to get the insertion losses over the whole frequency range up to 40 GHz.
Start frequency for the conducted test at the antenna port of the EUT was 0.8 times the cut off frequency of the X-band waveguide of the EUT, i.e. f_{start} = 0.8 x 6.56 GHz = 5.25 GHz.

The tests were performed with the all four possible pulse patterns of the EUT.

7.3 Test Equipment

Type	Manufacturer/ Model No.	Serial No.	Last Calibration	Calibration Interval
EMI Receiver / Analyzer 40 GHz,	Rohde & Schwarz ESIB 40	100126	2003-07	24 months
Receiver / Analyzer 26.5 GHz	Rohde & Schwarz ESAI-D ESMI-RF ESMI-B1	 833771/008 833827/002 832504/005	2005-01	18 months
Directional Coupler	GHz-Microwave X-362-30	001	2005-04 *	
25W/20dB Attenuator	Weinschel 46-20-34	BL2173	2003-07	24 months
5 W Attenuator 10dB	Weinschel, 2	BH 4277	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0873	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0889	2003-07	24 months
Tap.Transition MX	Hewlett-Packard, MX 292B	001	2005-04 *	
Tap.Transition MP	Hewlett-Packard, MP 292Be	8707	2005-04 *	
Tapered Transition NP	Hewlett-Packard, NP 292 A	48278	2005-04 *	
Tapered Transition NK	Hewlett-Packard, NK 292 A	001	2005-04 *	
Tapered Transition K to R	fmi, 20000-22	001	2005-04 *	
Wav./Kf/SMAf-Adap.,R-band	fmi/pro nova, 22093-KF20	122282	2005-04 *	
Wav./SMAf Adapt.,K-band	GHz Gardena , K 173	001	2005-04 *	
Lowpass Filter	Microphase, LTP 7000AB	505	2005-04 *	
NAdapter, X	Std., UG 39/N	001	2005-04 *	
Programmable Power Source	R&S NGPE40	451292/0529	n.a	n.a.
Digital Multimeter	CONRAD ME-42	CC344177	2004-06	24 months

* Equipment individually calibrated just before the tests.

7.4 Test Results

Calculation procedures for limits:

- Calculating the frequencies for limits: assigned frequency plus/minus 50/100/250 percent of the authorized bandwidth (= 9,500 MHz - 9,300 MHz = 200 MHz).
- Calculating the attenuation limit: 43 plus 10lg (mean power in watts) dB

Assigned frequency (AF) [MHz]	AF - 50 % [MHz]	AF + 50 % [MHz]	AF - 100 % [MHz]	AF + 100 % [MHz]	AF - 250 % [MHz]	AF + 250 % [MHz]
9 410	9 310	9 510	9 210	9 610	8 910	9 910

Pulse Pattern	RF Mean (Average) Power [W]	Attenuation of spurious emissions 43 plus 10lg (mean power in watts) [dB]
Short	1.26	44.0
Medium	4.47	49.5
Long	5.01	50.0
Extralong	6.61	51.2

Plots are in Annex 5 to this test report.

7.4.1 Test Results: short

Calculation procedures:

- Reading [dBm] taken from the plots + Attenuator [dB] as inserted = Result [dBm].
- Verifying Result [dBm] with Limit [dBm]

Results: short							
Frequency MHz	Reading dBm	Attenuator dB	Result dBm	Limit dBc	dBm	Margin dB	Remark
9 411	-28.5	76	47.5	0			Carrier
9 210 ... 9 310	-65	76	11	-25	22.5	11.5	-100% ... -50%
9 510 ... 9 610	-64	76	12	-25	22.5	10.5	+50% ... +100%
8 910 ... 9 210	-72	76	4	-35	12.5	8.5	-250% ... -100%
9 610 ... 9 910	-64	76	12	-35	12.5	0.5	+100% ... +250%
8 910	-78	76	-2	-44	3.5	5.5	-250%
9 910	-82	76	-6	-44	3.5	9.5	+250%
18 800	-34.9	30	-4.9	-44	3.5	8.4	2nd Harmonic
28 214	-22.7	16	-6.7	-44	3.5	10.2	3rd Harmonic
34 048	-29.1	13	-16.1	-44	3.5	19.6	
37 619	-19.6	18	-1.6	-44	3.5	5.1	4th Harmonic

7.4.2 Test Results: medium

Results: medium							
Frequency MHz	Reading dBm	Attenuator dB	Result dBm	Limit dBc	dBm	Margin dB	Remark
9 405	-27.7	86	58.3	0			Carrier
9 210 ... 9 310	-75	86	11	-25	33.3	22.3	-100% ... -50%
9 510 ... 9 610	-75	86	11	-25	33.3	22.3	+50% ... +100%
8 910 ... 9 210	-82	86	4	-35	23.3	19.3	-250% ... -100%
9 610 ... 9 910	-74	86	12	-35	23.3	11.3	+100% ... +250%
8 910	-84	86	2	-49.5	8.8	6.8	-250%
9 910	-87	86	-1	-49.5	8.8	9.8	+250%
18 800	-22.5	30	7.5	-49.5	8.8	1.3	2nd Harmonic
28 204	-16.5	16	-0.5	-49.5	8.8	9.3	3rd Harmonic
37 619	-16.4	18	1.6	-49.5	8.8	7.2	4th Harmonic

7.4.3 Test Results: long

Results: long							
Frequency MHz	Reading dBm	Attenuator dB	Result dBm	Limit dBc	dBm	Margin dB	Remark
9 403	-28.4	90	61.6	0			Carrier
9 210 ... 9 310	-80	90	10	-25	36.6	26.6	-100% ... -50%
9 510 ... 9 610	-79	90	11	-25	36.6	25.6	+50% ... +100%
8 910 ... 9 210	-87	90	3	-35	26.6	23.6	-250% ... -100%
9 610 ... 9 910	-82	90	8	-35	26.6	18.6	+100% ... +250%
8 910	-88	90	2	-50	11.6	9.6	-250%
9 910	-90	90	0	-50	11.6	11.6	+250%
18 783	-26.3	30	3.7	-50	11.6	7.9	2nd Harmonic
28 177	-16	16	0	-50	11.6	11.6	3rd Harmonic
37 581	-10.2	18	7.8	-50	11.6	3.8	4th Harmonic

7.4.4 Test Results: extralong

Results: extralong							
Frequency MHz	Reading dBm	Attenuator dB	Result dBm	Limit dBc	dBm	Margin dB	Remark
9 403	-23.7	90	66.3	0			Carrier
9 210 ... 9 310	-80	90	10	-25	41.3	31.3	-100% ... -50%
9 510 ... 9 610	-81	90	9	-25	41.3	32.3	+50% ... +100%
8 910 ... 9 210	-87	90	3	-35	31.3	28.3	-250% ... -100%
9 610 ... 9 910	-81	90	9	-35	31.3	22.3	+100% ... +250%
8 910	-87	90	3	-51.2	15.1	12.1	-250%
9 910	-90	90	0	-51.2	15.1	15.1	+250%
18 783	-21.5	30	8.5	-51.2	15.1	6.6	2nd Harmonic
28 177	-15.6	16	0.4	-51.2	15.1	14.7	3rd Harmonic
37 592	-7.3	18	10.7	-51.2	15.1	4.4	4th Harmonic

Finding:
The EUT meets the requirements of this section.

8 RADIATED SPURIOUS EMISSIONS

8.1 Regulation

§ 2.1053 Measurements required: Field strength of spurious radiation.
(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
(2) All equipment operating on frequencies higher than 25 MHz.

§ 80.211 Emission limitations.
The emissions must be attenuated according to the following schedule.
(f) The mean power when using emissions other than those in paragraphs (a), (b), (c) and (d) of this section:
(1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;
(2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and
(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus 10lg (mean power in watts) dB.

§ 2.1057 Frequency spectrum to be investigated.
(a) In all of the measurements set forth in §§ 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

8.2 Test Setup and Procedure

Spurious emissions measurements were performed with spectrum analyzer and appropriate antennas in different distances in order to get sufficient signals.
Start frequency was 9 kHz. Stop frequency was 40 GHz.
In the low frequency range from 9 kHz to 30 MHz the H-field test procedure was used, at distance 3 m.
Between 30 MHz and 1 GHz a broadband biconilog antenna was used, at distance 3 m.
Above 1 GHz horn antennas were used, at distances <= 3 m.
All tests were performed in a absorber chamber for test distance 3 m.

The tests were performed with the all four possible pulse patterns of the EUT.

Two methods for evaluating the limits were applied:

- PEAK measurement, where the equivalent radiated power ERP of the carrier is the reference level for the limit calculation, and
- RMS measurement with the internal RMS detector of the spectrum analyzer and taking the fix limit ERP = - 13 dBm.

ERP Limit Calculation (PEAK measurements)

With the formula

E [dBµV/m] = EIRP [dBm] + 104.77 [dB] - 20 lg D

the equivalent isotropically radiated power can be calculated, where
- E is the field strength in [dBµV/m]
- at a defined distance D [m],
- when the power EIRP in [dBm] is radiated by an isotropic antenna.

If a halfwave dipole antenna is the radiating part, the field strength increases by the gain of the halfwave dipole of 2.1 dBi. In this case the EIRP changes to ERP (equivalent radiated power).

Hence, the reference levels of the carrier - when the EUT operates with a halfwave dipole antenna - can be calculated.

For these calculations the results from the spurious emissions at antenna port measurements as above will be used to consider the influence of the resolution bandwidth RBW of the spectrum analyzer:

Pulse pattern	Carrier power	Field Strength dBµV/m
	dBm	@ 3 m
short	47.5	144.8
medium	58.3	155.6
long	61.6	158.9
extralong	66.3	163.6

Note: the reference field strength is calculated for a mainly used distance of 3 m. For other distances the distance correction calculation with 20 dB/decade (inverse linear-distance for field strength measurements) is considered.

Limits for spurious emissions: the limit [dBc] is calculated with 43 plus 10lg (mean power in watts) dB, as above already described.

Pulse pattern	Carrier power dBm	Field Strength dBµV/m @ 3 m	Limit dBc	Limit dBµV/m
short	47.5	144.8	-44	100.8
medium	58.3	155.6	-49.5	106.1
long	61.6	158.9	-50	108.9
extralong	66.3	163.6	-51.2	112.4

ERP Limit Calculation (RMS measurements)

The formula from § 80.211 (3) 43 plus 10lg (mean power in watts) dB results always in the constant value of -13 dBm, when the reference level of the carrier is the mean (average) power:

Limit = reference level (mean power [dBW]) - 43 + 10lg (mean power in watts) [dB]
= -43 dBW = - 13 dBm

Further the field strength can be calculated as shown above:

E [dBµV/m] = ERP [dBm] + 106.87 [dB] - 20 lg D

when used a halfwave dipole antenna.

For a distance D of 3 m the field strength is 84.3 dBµV/m.

At other distances, the field strength have to be calculated accordingly.

8.3 Test Equipment

Type	Manufacturer/ Model No.	Serial No.	Last Calibration	Calibration Interval
EMI Receiver / Analyzer 40 GHz,	Rohde & Schwarz ESIB 40	100126	2003-07	24 months
25W/20dB Attenuator	Weinschel 46-20-34	BL2173	2003-07	24 months
5 W Attenuator 10dB	Weinschel, 2	BH 4277	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0873	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0889	2003-07	24 months
Lowpass Filter	Microphase, LTP 7000AB	505	2005-04 *	
Standard Gain Horn Ant (26.5 GHz - 40 GHz)	FMI/ProN. , 2224-25	49	2003-09	24 months
Standard Gain Horn Antenna (18 GHz - 26.5 GHz)	Mid Century MC 20/31B	1363/86	2004-08	24 months
Antenna (30 MHz - 1 GHz)	EMCO 3142	9601-1002	2005-03	36 months
Antenna (1 GHz - 12 GHz)	Schwarzbeck BBHA 9120 D	248	2004-03	24 months
Loop Antenna	R&S, HFH 2-Z2	892665/004	2004-07	24 months
Anechoic Room 3-2	EMCC/FRANK.	001		
Programmable Power Source	R&S NGPE40	451292/0529	n.a	n.a.
Digital Multimeter	CONRAD ME-42	CC344177	2004-06	24 months

* Equipment individually calibrated just before the tests.

8.4 Test Results

Up to 18 GHz the reading at the receivers are in field strength [dBµV/m] due to internal activated correction factor.
Above 18 GHz the reading is basically the raw data in [dBµV], where further calculations (adding antenna factor, cable loss) are applied.
At few frequencies the reading was already corrected with an offset at the spectrum analyzer. Therefore the correction factor in the tables below is given with value 0.

Representative plots are in Annex 6 to this test report.

PEAK and RMS measurements, up to 18 GHz (carrier excluded)

Frequency MHz	Reading dBµV/m	Detector	Resolution Bandwidth kHz	Distance m	Limit dBµV/m	Marging dB	Remarks
0.076	52	PEAK	0.20	3	100.8	48.8	H-field, all pulses, worst case
1.28	61	PEAK	0.20	3	100.8	39.8	H-field, all pulses, worst case
245	28	PEAK	100	3	100.8	72.8	E-field, all pulses, worst case
1 769	66	PEAK	1 000	3	100.8	34.8	E-field, all pulses, worst case
0.076	50	RMS	0.20	3	84.3	34.3	H-field, all pulses, worst case
1.28	47	RMS	0.20	3	84.3	37.3	H-field, all pulses, worst case
245	8	RMS	100	3	84.3	76.3	noise
1 769	41	RMS	1 000	3	84.3	43.3	noise

PEAK measurements, above 18 GHz

Frequency MHz	Reading dBµV	Detector	Resolution Bandwidth kHz	Correction factor dB/m	Distance m	Distance corr. factor dB	Result dBµV/m	Limit dBµV/m	Marging dB	Remarks
18 795	93.0	PEAK	10 000	0.0	2	-4	89.5	100.8	11.3	short
18 802	100.0	PEAK	10 000	0.0	2	-4	96.5	106.1	9.6	medium
18 783	60.3	PEAK	10 000	40.0	2	-4	96.8	108.9	12.1	long
18 792	99.3	PEAK	10 000	0.0	2	-4	95.8	112.4	16.6	extralong
28 193	58.3	PEAK	10 000	39.0	1	-10	87.8	100.8	13.0	short
28 203	65.3	PEAK	10 000	39.0	1	-10	94.8	106.1	11.3	medium
28 175	66.5	PEAK	10 000	39.0	1	-10	96.0	108.9	12.9	long
28 177	68.4	PEAK	10 000	39.0	1	-10	97.9	112.4	14.5	extralong
37 590	54.3	PEAK	10 000	41.5	1	-10	86.3	100.8	14.5	short
37 604	61.9	PEAK	10 000	41.5	1	-10	93.9	106.1	12.2	medium
37 566	63.4	PEAK	10 000	41.5	1	-10	95.4	108.9	13.5	long
37 573	66.2	PEAK	10 000	41.5	1	-10	98.2	112.4	14.2	extralong

RMS measurements, above 18 GHz

Frequency MHz	Reading dBµV	Detector	Resolution Bandwidth kHz	Correction factor dB/m	Distance m	Distance corr. factor dB	Result dBµV/m	Limit dBµV/m	Marging dB	Remarks
18 795	56.0	RMS	10 000	0.0	2	-4	52.5	84.3	31.8	short
18 802	62.0	RMS	10 000	0.0	2	-4	58.5	84.3	25.8	medium
18 783	23.0	RMS	10 000	40.0	2	-4	59.5	84.3	24.8	long
18 792	61.4	RMS	10 000	0.0	2	-4	57.9	84.3	26.4	extralong
28 193	26.0	RMS	10 000	39.0	1	-10	55.5	84.3	28.8	short
28 203	28.0	RMS	10 000	39.0	1	-10	57.5	84.3	26.8	medium
28 175	31.0	RMS	10 000	39.0	1	-10	60.5	84.3	23.8	long
28 177	33.0	RMS	10 000	39.0	1	-10	62.5	84.3	21.8	extralong
37 590	24.0	RMS	10 000	41.5	1	-10	56.0	84.3	28.3	short
37 604	27.0	RMS	10 000	41.5	1	-10	59.0	84.3	25.3	medium
37 566	28.0	RMS	10 000	41.5	1	-10	60.0	84.3	24.3	long
37 573	30	RMS	10 000	41.5	1	-10	62.0	84.3	22.3	extralong

Finding:
The EUT meets the requirements of this section.

9 FREQUENCY STABILITY - TEMPERATURE AND VOLTAGE VARIATION

9.1 Regulation

§ 2.1055 Measurements required: Frequency stability.
(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(2) From -20° to +50° centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to- Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.
(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

§ 80.209 Transmitter frequency tolerances.
(b) When pulse modulation is used in land and ship radar stations operating in the bands above 2.4 GHz the frequency at which maximum emission occurs must be within the authorized bandwidth and must not be closer than 1.5/T MHz to the upper and lower limits of the authorized bandwidth where ‘‘T’’ is the pulse duration in microseconds.

9.2 Test Setup and Procedure

Frequency stability measurements were performed with a spectrum analyzer and its internal counter feature.
The RF signals of the EUT were taken with a directional coupler between the RF output of EUT and the dummy load, which was used instead of the antenna. Additional attenuators were inserted to get practicable signal levels at the input of the spectrum analyzer.
Tests were made with 50 kHz resolution bandwidth for proper carrier readings.

The tests were performed with the all four possible pulse patterns of the EUT.

During temperature tests the EUT was installed in a climatic chamber. After reaching the wanted temperature inside the chamber the unit was stabilized over a time of min. 30 minutes.

Short term effects were measured within 0.5 minute after TX power on operation.
Long term effects were measured after min. 20 minutes after TX power on.

Calculating the limits:

Under chapter 6.1.4 above the 1.5/T distance for each pulse pattern was calculated:

Pulse Pattern	Pulse Width PW (T) [ns]	1.5/T [MHz]	lower limit [MHz]	upper limit [MHz]	Remarks
Short	58.4	25.7	9 325.7	9 474.3	
Medium	272	5.5	9 305.5	9 494.5	
Long	588	2.55	9 302.55	9 497.45	
Extralong	1 080	1.4	9 301.4	9 498.6	

Further the occupied bandwidths were according chapter 6.1.3:

Pulse Pattern	Resolution Bandwidth [kHz]	OPB Reading at spectrum analyzer [MHz]
Short	1 000	87.37
	5 000	70.14
Medium	1 000	31.86
	5 000	64.53
Long	100	13.73
	1 000	13.33
	5 000	33.67
Extralong	100	9.22
	1 000	9.54
	5 000	29.66

The test is passed, when following condition is given:

Tested mid frequency - (0.5 x OPB) > Lower frequency limit.
Tested mid frequency + (0.5 x OPB) < Upper frequency limit.

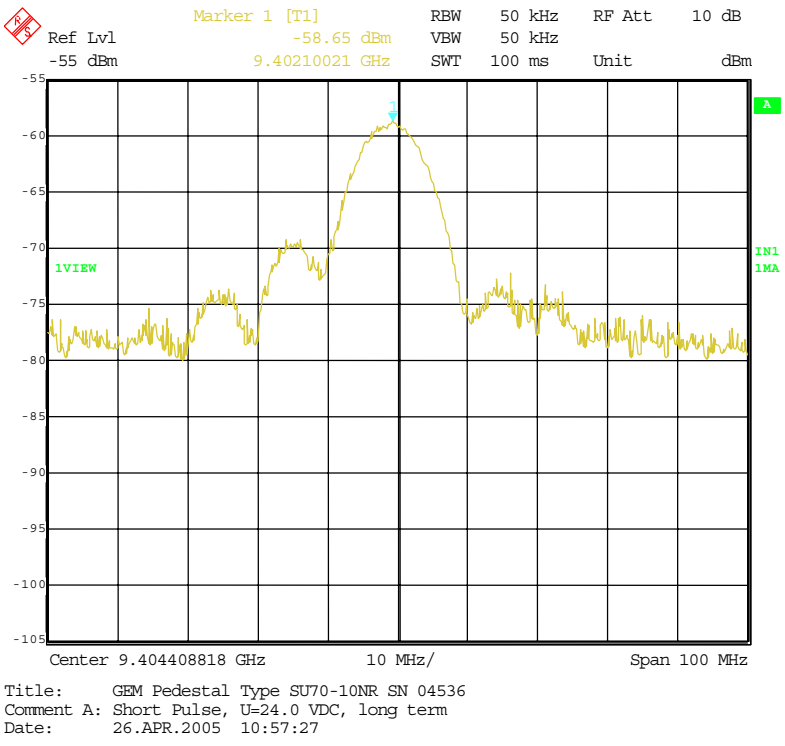
9.3 Test Equipment

Type	Manufacturer/ Model No.	Serial No.	Last Calibration	Calibration Interval
EMI Receiver / Analyzer 40 GHz,	Rohde & Schwarz ESIB 40	100126	2003-07	24 months
Directional Coupler	GHz-Microwave X-362-30	001	2005-04 *	
25W/20dB Attenuator	Weinschel 46-20-34	BL2173	2003-07	24 months
5 W Attenuator 10dB	Weinschel, 2	BH 4277	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0873	2003-07	24 months
5 W Attenuator 20dB	Weinschel, 2	BH 0889	2003-07	24 months
Programmable Power Source	R&S NGPE40	451292/0529	n.a	n.a.
Digital Multimeter	CONRAD ME-42	CC344177	2004-06	24 months
NAdapter, X	Std., UG 39/N	001	2005-04 *	
Climatic Test Unit	Feutron, KPK3626/51	137	n.a.	
Thermogygrometer	Testo, 608-H2	001	2004-06	24 months

* Equipment individually calibrated just before the tests.

9.4 Test Results

Representative plot:



Title: GEM Pedestal Type SU70-10NR SN 04536
Comment A: Short Pulse, U=24.0 VDC, long term
Date: 26.APR.2005 10:57:27

Frequency stability under variation of supply voltage								
Supply voltage	Frequency [MHz]							
	Pulse: short		Pulse: medium		Pulse: long		Pulse: extralong	
VDC	short term	long term	short term	long term	short term	long term	short term	long term
20.4	9 408.367	9 402.000	9 404.659	9 397.500	9 403.257	9 397.200	9 402.655	9 396.087
24.0	9 408.066	9 402.100	9 404.459	9 397.700	9 403.457	9 396.800	9 402.756	9 396.288
27.6	9 408.066	9 401.900	9 404.259	9 397.300	9 404.359	9 396.580	9 403.257	9 396.388

Frequency stability under variation of temperature								
Temperature	Frequency [MHz]							
°C	Pulse: short		Pulse: medium		Pulse: long			
	short term	long term	short term	long term	short term	long term	short term	long term
-20	9 412.616	9 412.728	9 408.511	9 408.731	9 408.178	9 406.733	9 407.179	9 404.845
-10	9 410.397	9 411.062	9 406.735	9 407.278	9 407.068	9 405.401	9 405.515	9 404.514
0	9 408.842	9 409.286	9 405.624	9 405.401	9 405.624	9 403.736	9 404.182	9 403.070
10	9 405.735	9 406.179	9 402.073	9 402.404	9 402.406	9 400.517	9 401.296	9 400.073
20	9 408.700	9 408.063	9 404.220	9 403.622	9 403.890	9 401.847	9 403.410	9 401.070
30	9 407.398	9 404.263	9 404.718	9 400.100	9 402.737	9 398.934	9 401.377	9 398.822
40	9 404.984	9 405.844	9 402.211	9 401.426	9 400.082	9 399.961	9 402.376	9 399.517
50	9 404.292	9 403.736	9 401.407	9 400.405	9 401.518	9 398.408	9 400.075	9 398.074

Evaluation (with max. OPB results):
All frequency data in MHz

Evaluation, voltage variation				
	Pulse:short	Pulse: medium	Pulse: long	Pulse: extralong
Min. mid frequency	9 401.900	9 397.300	9 396.580	9 396.087
Max. mid frequency	9 408.367	9 404.659	9 404.359	9 403.257
OPB	87.37	64.53	33.67	29.66
0.5 x OPB	43.685	32.265	16.835	14.83
Min. F lower	9 358.215	9 365.035	9 379.745	9 381.257
Max. F upper	9 452.052	9 436.924	9 421.194	9 418.087
Limit F lower	9 325.700	9 305.500	9 302.550	9 301.400
Limit F upper	9 474.300	9 494.500	9 497.450	9 498.600

Evaluation, temperature variation				
	Pulse:short	Pulse: medium	Pulse: long	Pulse: extralong
Min. mid frequency	9 403.736	9 400.100	9 398.408	9 398.074
Max. mid frequency	9 412.728	9 408.731	9 408.178	9 407.179
OPB	87.37	64.53	33.67	29.66
0.5 x OPB	43.685	32.265	16.835	14.83
Min. F lower	9 360.051	9 367.835	9 381.573	9 383.244
Max. F upper	9 456.413	9 440.996	9 425.013	9 422.009
Limit F lower	9 325.700	9 305.500	9 302.550	9 301.400
Limit F upper	9 474.300	9 494.500	9 497.450	9 498.600

Finding:
The EUT meets the requirements of this section.

10 MISCELLANEOUS COMMENTS AND NOTES

None.

11 LIST OF ANNEXES

Following annexes are separated parts from this test report.

Description	Pages
Annex 1: Photographs of test setups	4
Annex 2: Photographs of equipment under test (EUT)	6
Annex 3: Plots to chapter 4.3 Peak Power, PW, PRF	2
Annex 4: Plots to chapter 6 Occupied Bandwidth, Transmitter Frequency Tolerances	3
Annex 5: Plots to chapter 7 Spurious Emissions at Antenna Port	10
Annex 6: Plots to chapter 8 Radiated Spurious Emissions	6