

Accredited Testing Laboratory

**DAR–Registration Number
TTI–P–G 166/98**

Test report No. : 2-2422-A/01
Customer : Enraf B.V.
Product : 973 SmartRadar LT

Table of contents

1	General information.....	3
1.1	Notes	3
1.2	Testing laboratory.....	4
1.3	Details of applicant.....	4
1.4	Application details	4
1.5	Test item (EUT)	5
1.5.1	Operation conditions.....	5
1.5.2	Equipment under test	5
1.6	Test standards.....	6
2	Technical test	7
2.1	Summary of test results	7
2.2	Test environment.....	7
2.3	Measurement and test set-up	7
2.4	Test equipment utilized and test set-up	8
2.4.1	Radiated power and spurious radiation in the frequency range 4 GHz to 33 GHz (1. – 3. Harmonic)...	8
2.4.2	Radiated power and spurious radiation in the frequency range 33 GHz to 50 GHz (4. Harmonic).....	9
2.4.3	Spurious radiation in the frequency range up to 4 GHz.	10
2.5	Test results	11
2.5.1	Test results overview	11
3	Plots	19
4	Photos of EUT.....	23
5	Test results and calculation for FCC requirements.....	26

1 General information

1.1 Notes

The test results of this test report relate exclusively to the test item specified in 1.5 .

CETECOM ICT Services GmbH does not assume responsibility for any conclusions and generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the CETECOM ICT Services GmbH.

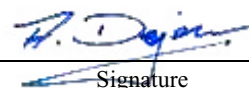
Tester :

01. Aug 2001

Date

Arno Dejon

Name


Signature

Technical responsibility for area of testing :

01. Aug 2001

Date

Klaus Kammerinke

Name


Signature

1.2 Testing laboratory

CETECOM ICT Services GmbH

Untertürkheimerstraße 6–10

66117 Saarbrücken

Germany

P.O. – Box 10 04 45

66004 Saarbrücken

Germany

Telefon : + 49 (0)681 598–0

Telefax : + 49 (0)681 598–9075

Accredited testing laboratory

DAR-registration number: **TTI-P-G 166/98**

Testing location, if different from CETECOM ICT Services GmbH:

Name :

Street :

Town :

Country :

Telephone :

Fax :

1.3 Details of applicant

Name : Enraf B.V.

Street : Roentgenweg 1

Town : 2624 BD Delft

Country : The Netherlands

Telephone : +31 15 2698 600

Fax : +31 15 2618 061

Contact person

Name : G.C. van Ginkel

Telephone : +31 15 2698 333

Fax : +31 15 2618 061

E-Mail : gvginkel@enraf.nl

1.4 Application details

Date of receipt of application : 15.02.2001

Date of receipt of test item : 14.03.2001

Date of test : 14.03.2001

1.5 Test item (EUT)

Description of EUT : Level gauge
Product name : Radar Level Gauge
Type name of product : 973 SmartRadar LT
Manufacturer : Enraf B.V.
: Roentgenweg 1
: 2624 BD Delft
: The Netherlands

Technical data

Frequency range : 9.4 GHz ... 10.7 GHz
EIRP PEP : 51.3 mW (17.1 dBm)
Type of modulation : 1G30F1N (FM CW)
Microwave modules : TX / RX – Module
Antennas : Planar antenna (tested), horn antenna, rod antenna
Normal power supply : 230 V AC
Extreme power supply : 85 ... 264 V AC

1.5.1 Operation conditions

Operation: : As soon as the equipment is powered up, TX and RX start operating
Purpose of operation : Radar level gauge for operation in metal tanks

1.5.2 Equipment under test

ENRAF Model 973 SmartRadar LT
Serial no. 973-01-158

1.6 Test standards

Draft ETSI EN 300 440 – 1

V1.3.1 (2000-07)

European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM);

Short range devices;

Radio equipment to be used in the 1 GHz to 40 GHz frequency range;

Part 1 : Technical characteristics and test methods

Draft ETSI EN 300 440 – 2

V1.1.1 (2000-07)

Candidate Harmonized European Standard (Telecommunications series)

Electromagnetic compatibility and Radio spectrum Matters (ERM);

Short range devices;

Radio equipment to be used in the 1 GHz to 40 GHz frequency range;

Part 2 : Harmonized EN under article 3.2 of the R&TTE Directive

2 Technical test

2.1 Summary of test results

- ☒ No deviations from the technical specification (s) were ascertained in the course of the performed tests.
- ☐ The deviations as specified in 2.5 were ascertained in the course of the performed tests.

The test report :

- ☒ describes the first test
- ☐ describes an additional test
- ☐ is a verification of documents
- ☐ is only valid with the test report no.

2.2 Test environment

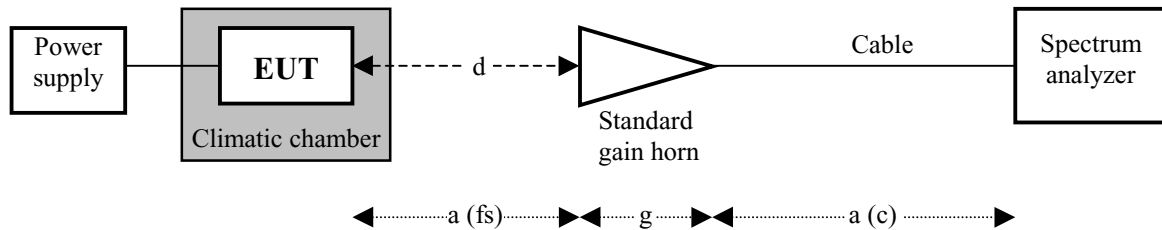
The environmental conditions are documented specially for each test.

2.3 Measurement and test set-up

The measurement and test set-up is defined in the technical specification EN/ETS 300 440-1.

2.4 Test equipment utilized and test set-up

2.4.1 Radiated power and spurious radiation in the frequency range 4 GHz to 33 GHz (1. – 3. Harmonic)



Frequency f [GHz]	Distance d [m]	Free space attenuation a(fs) [dB]	Antenna gain g [dBi]	Cable loss a(c) [dB]	System attenuation a(sys) [dB]
4.0 ... 18.0	1.0	52.4 @ 10.0 GHz	10.0	2.0	44.4
10.0	0.5	46.6 @ 10.173 GHz	16.7	2.0	31.9
10.0	1.0	52.4 @ 10.0 GHz	16.6	2.0	37.8
20.0	1.0	58.5	15.7	2.3	45.1
30.0	1.0	62.0	15.8	2.9	49.1
33.0	1.0	62.8	16.6	3.1	49.3

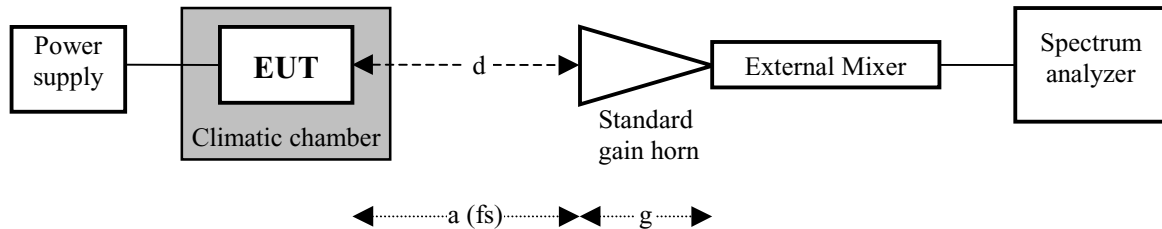
Calculation : System attenuation = free space attenuation – antenna gain + cable loss
 $a(\text{sys}) = a(\text{fs}) - g + a(\text{c})$

Test equipment	Manufacturer	Type	S/No.	Calibration due
Spectrum Analyser	HP	HP 8565E	3738A00773	05.05.2002
SGH 1.0 ... 18.0 GHz	EMCO	3115	9709-5289	10.12.2002
SGH 18 ... 27 GHz	narda	638	8206	10.12.2002
SGH 27 ... 40 GHz	narda	637	8216	10.12.2002
Adapter WG/SMA	narda	WOD	64088	10.12.2002
Adapter WG/SMA	flann	22024	213	10.12.2002
Power supply	HP	HP 6032A	2848A07227	01.07.2001
Climatic chamber	Vötsch	VUK 04/500	522/32678	01.05.2002
RF-cable	HP	5061-5359	P36303	01.03.2002

Measurement uncertainty

Test parameter	Measurement uncertainty
Power supply	±0.5 VAC
Temperature	±0.2 °C
Frequency	±0.01 ppm
eirp	±1.0 dB

2.4.2 Radiated power and spurious radiation in the frequency range 33 GHz to 50 GHz (4. Harmonic)



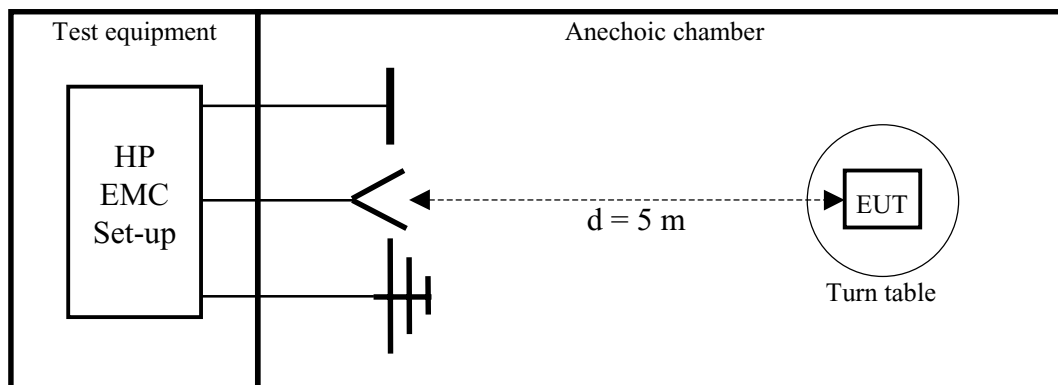
Frequency f [GHz]	Distance d [m]	Free space attenuation a(fs) [dB]	Antenna gain g [dBi]	System attenuation a(sys) [dB]
33.0	0.5	56.8	21.6	35.2
40.0	0.5	58.5	23.2	35.3
50.0	0.5	60.4	25.2	35.2

Calculation : System attenuation = free space attenuation – antenna gain
 $a(\text{sys}) = a(\text{fs}) - g$

Test equipment	Manufacturer	Type	S/No.	Calibration due
Spectrum Analyser	HP	HP 8565E	3738A00773	05.05.2002
SGH 33 ... 50 GHz	Thomson	COR	30000812	10.12.2002
Mixer 33 ... 50 GHz	HP	11970Q	2407A00626	01.10.2002
Power supply	HP	HP 6032A	2848A07227	01.07.2001
Climatic chamber	Vötsch	VUK 04/500	522/32678	01.05.2002

Measurement uncertainty

Test parameter	Measurement uncertainty
Power supply	±0.5 VAC
Temperature	±0.2 °C
Frequency	±0.01 ppm
eirp	±1.0 dB

2.4.3 Spurious radiation in the frequency range up to 4 GHz.


Test equipment	Manufacturer	Type	S/No.	Calibration due
Spectrum analyser	HP	HP 85660B	2478A05306	05.07.2001
Analyser display	HP	HP 85662A	2816A16541	05.07.2001
Quasi peak adapter	HP	HP 85650A	2811A01131	05.07.2001
RF-preselector	HP	HP 85685A	2833A00768	05.07.2001
Biconical antenna	Emco	3104	3758	01.07.2001
Log.-per.-antenna	Emco	3146	2304	01.07.2001
Double ridge horn	Emco	3115	3007	01.07.2001
Relay switch	R&S	RSU	375 339/002	01.07.2001
High pass filter	FSY Microwave	HM 985955	001	01.07.2001
Amplifier	Tron-Tech	P42-GA29	B2302	01.07.2001
Power supply	HP	HP 6038A	2848A07027	12.12.2001
RF-cable	HP	5061-5359	P36303	12.12.2001

Measurement uncertainty

Test parameter	Measurement uncertainty
Power supply	±0.1 VAC
Temperature	±0.2 °C
Frequency	±0.01 ppm
eirp	±1.0 dB

2.5 Test results

2.5.1 Test results overview

This test was performed :

☐ in addition to the test report no.

Verification of EUT :

☒ EUT is in accordance with the technical description

☐ EUT is not in accordance with the technical description

☒ The equipment is compliant to recommendation
CEPT/ERC/REC 70-03, Annex 6 , Non-specific Short Range Devices

☒ Equipment Class 3

☒ Power Class 11

☒ Duty cycle Class 4

TEST RESULTS against EN 300 440

LIST OF MEASUREMENTS : The list of measured parameters called for in ETS 300 440 is given below.

CLAUSE	PARAMETER TO BE MEASURED	PAGE
7	Transmitter parameters	
7.1	Equivalent isotropically radiated RF power	13
7.2	Permitted range of operating frequencies	14
7.3	Spurious emissions	
7.3.3	Conducted spurious emission (Not applicable)	15
7.3.4	Cabinet spurious radiation (Not applicable)	16
7.3.5	Radiated spurious emission	16
7.3.6	Additional requirements for FHSS equipment	17
7.4	Duty cycle	17
7.5	Additional requirements for FHSS equipment	17
8	Receiver parameters	
8.1	Adjacent channel selectivity	18
8.2	Adjacent band selectivity	18
8.3	Blocking or desensitization	18
8.4	Spurious emissions	
8.4.2	Conducted spurious emission	18
8.4.3	Cabinet spurious radiation	18
8.4.4	Radiated spurious emission	18

Equipment under test (EUT) : see page 5
 Ambient temperature : 21 °C
 Relative humidity : 52 %

TRANSMITTER PARAMETERS

CLAUSE 7

TRANSMITTER E.I.R.P.

CLAUSE 7.1

EUT operating mode : TX on and RX on
 Antenna assembly: Planar antenna
 Test set-up : Free radiation outside metal tank, Test no applicable for FCC.

TEST CONDITIONS		TRANSMITTER POWER			
		Frequency (GHz)	eirp (dBm)	EIRP (mW)	See plot on page
T (nom) = +20.0 °C	V (nom) = 230 V AC	9 – 11	17.1	51.3	19
T (min) = -40.0 °C	V (min) = 85 V AC	9 – 11	15,8	38,0	20
	V (max) = 264 V AC	9 – 11	15,8	38,0	20
T (max) = +60.0 °C	V (min) = 85 V AC	9 – 11	16.6	45,7	21
	V (max) = 264 V AC	9 – 11	16.6	45,7	21

LIMITS:

CLAUSE 7.1.3

Power class	Conducted or radiated power level P (mW)	Power class	Conducted or radiated power level P (mW)
8	10	13	1000
9	25	14	2000
11	100	(14a)	(5000)
12	500	15	8000

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 8

Verdict : Power class 11 limit is kept

Equipment under test (EUT) : see page 5
 Ambient temperature : 21 °C
 Relative humidity : 52 %

TRANSMITTER FREQUENCY RANGE

CLAUSE 7.2

EUT operating mode : TX on and RX on
 Antenna assembly: Planar antenna
 Test set-up : Free radiation outside metal tank

TEST CONDITIONS		FREQUENCY (GHz) at which -80 dBm/Hz occurs		
		lowest	highest	See plot on page
T (nom) = +20.0 °C	V (nom) = 230 V AC	9.503	10.523	—
T (min) = -40.0 °C	V (min) = 85 V AC	9.465	10.601	—
	V (max) = 264 V AC	9.465	10.601	—
T (max) = +60.0 °C	V (min) = 85 V AC	9.438	10.633	—
	V (max) = 264 V AC	9.438	10.633	—
Measured frequencies (lowest and highest)		f(lowest) = 9.438 GHz f(highest) = 10.633 GHz		

LIMITS:

CLAUSE 7.4.4

Under all test conditions	f(lowest) > 9.4 GHz	f(highest) < 10.7 GHz
---------------------------	---------------------	-----------------------

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 8

Verdict :	Transmitter frequency is in the range 9.4 to 10.7 GHz
-----------	---

Equipment under test (EUT) : see page 5

Ambient temperature : 21 °C

Relative humidity : 52 %

TRANSMITTER PARAMETERS SPURIOUS EMISSIONS CLAUSE 7.3**CONDUCTED SPURIOUS EMISSIONS CLAUSE 7.3.3 (NOT APPLICABLE)**

FREQUENCY (MHz)	MEASUREMENT BANDWIDTH (MHz)	SPURIOUS EMISSION LEVEL (dBm)

LIMITS:**CLAUSE 7.3.7**

Frequency range (MHz)	Radiated and conducted spurious emissions (nW) / (dBm)	
	operating	standby
47,0 to 74,0 87,5 to 118,0 174,0 to 230,0 470,0 to 862,0	4 nW / -54.0 dBm	2 nW / -57.0 dBm
Other frequencies 25 to 1000	250 nW / -36.0 dBm	2 nW / -57.0 dBm
Frequencies > 1000	1000 nW / -30.0 dBm	20 nW / -47.0 dBm

REFERENCE OF TEST EQUIPMENT USED : Not applicable

Verdict : Not applicable

Equipment under test (EUT) : see page 5
 Ambient temperature : 21 °C
 Relative humidity : 52 %

CABINET SPURIOUS RADIATION

CLAUSE 7.3.4 (NOT APPLICABLE)

EUT has no permanent antenna connector

RADIATED SPURIOUS EMISSIONS

CLAUSE 7.3.5

EUT operating mode : TX on and RX on
 Antenna assembly: Planar antenna
 Test set-up : **Radiation inside simulated metal tank**

FREQUENCY	MEASUREMENT BANDWIDTH (MHz)	SPURIOUS EMISSION LEVEL (dBm)	See plot on page
25 to 1000 MHz	0.120	Marker 1 : -59.2 dBm @ 99.28MHz Marker 2 : -60.3 dBm @ 243.56MHz	22
1000 to 4 000 MHz	1.000	nothing found	—
4 GHz to 9 GHz	1.000	nothing found	—
9.0 to 11.0 GHz	0.300	nothing found	—
11 to 50 GHz	1.000	nothing found	—

LIMITS:

CLAUSE 7.3.7

Frequency range (MHz)	Radiated and conducted spurious emissions (nW) / (dBm)	
	operating	standby
47,0 to 74,0 87,5 to 118,0 174,0 to 230,0 470,0 to 862,0	4 nW / -54.0 dBm	2 nW / -57.0 dBm
Other frequencies 25 to 1000	250 nW / -36.0 dBm	2 nW / -57.0 dBm
Frequencies > 1000	1000 nW / -30.0 dBm	20 nW / -47.0 dBm

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 8, 9, 10

Verdict : Radiation outside metal tank is below -30 dBm

Equipment under test (EUT) : see page 5

Ambient temperature : 21 °C

Relative humidity : 52 %

ADDITIONAL REQUIREMENTS FOR FHSS EQUIPMENT CLAUSE 7.3.6 (NOT APPLICABLE)

EUT is operating in mode FMCW

DUTY CYCLE CLAUSE 7.4 (NOT APPLICABLE)

EUT is operating in mode FMCW

TEST CONDITIONS		TRANSMITTER POWER			
Analyser resolution filter = 2.000 MHz		Middle frequency (GHz)	eirp (dBm)	EIRP (mW)	See plot on page

LIMITS:**CLAUSE 7.4.3**

Duty cycle class	Duty cycle ratio (%)
1	< 0.1
2	< 1.0
3	< 10.0
4	Up to 100

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 8

Verdict : Duty cycle class 4 is kept

Equipment under test (EUT) : see page 5
Ambient temperature : 21 °C
Relative humidity : 52 %

RECEIVER PARAMETERS

CLAUSE 8

ADJACENT CHANNEL SELECTIVITY

CLAUSE 8.1 (NOT APPLICABLE)

ADJACENT BAND SELECTIVITY

CLAUSE 8.2 (NOT APPLICABLE)

BLOCKING OR DESENSITIZATION

CLAUSE 8.3 (NOT APPLICABLE)

SPURIOUS EMISSIONS

CLAUSE 8.4 (NOT APPLICABLE)

CONDUCTED SPURIOUS EMISSION

EUT has integral antenna

CLAUSE 8.4.2 (NOT APPLICABLE)

CABINET RADIATION

EUT has no permanent antenna connector

CLAUSE 8.4.3 (NOT APPLICABLE)

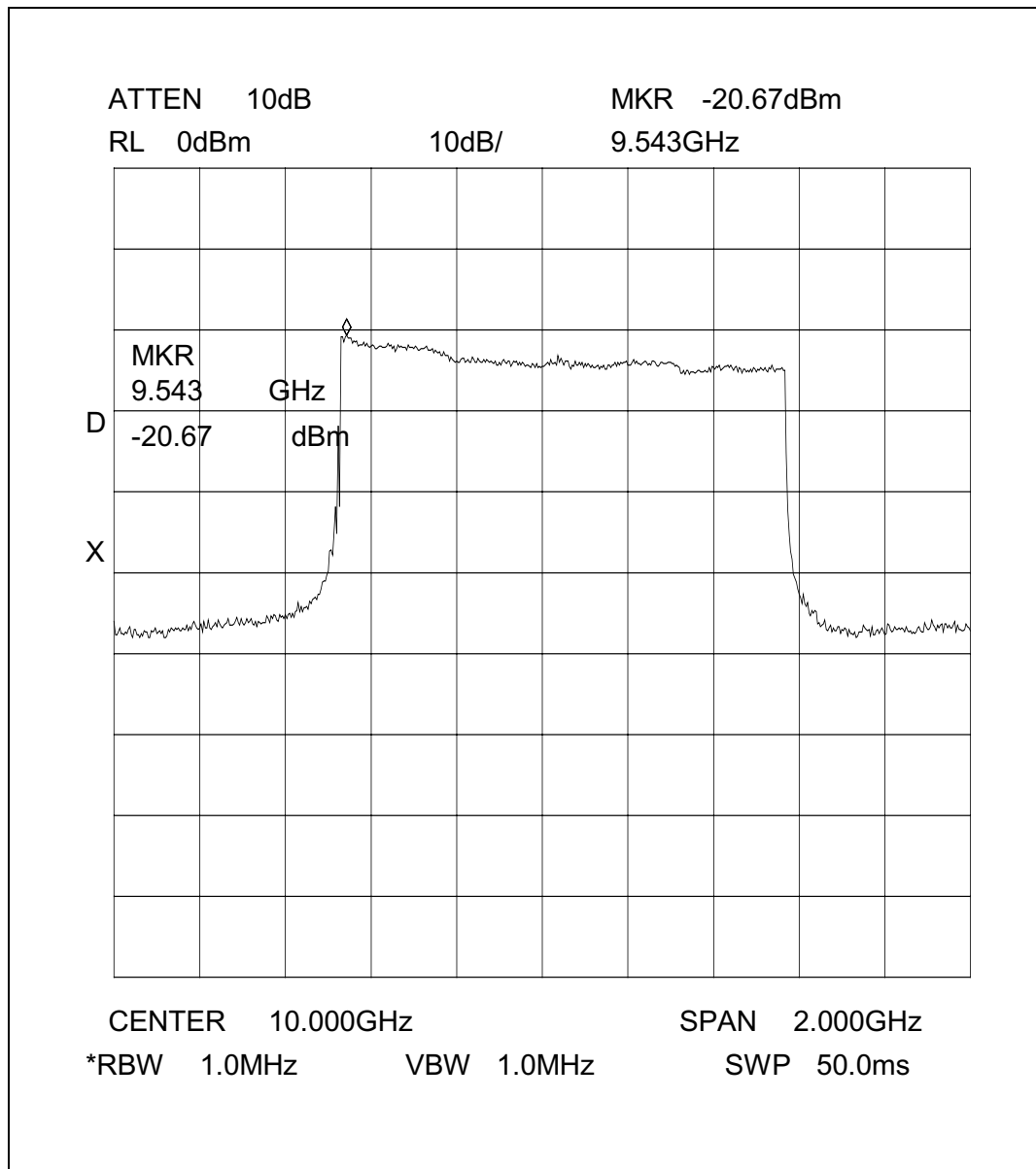
RADIATED SPURIOUS EMISSION

CLAUSE 8.4.4 (NOT APPLICABLE)

Verdict : Not applicable

3 Plots

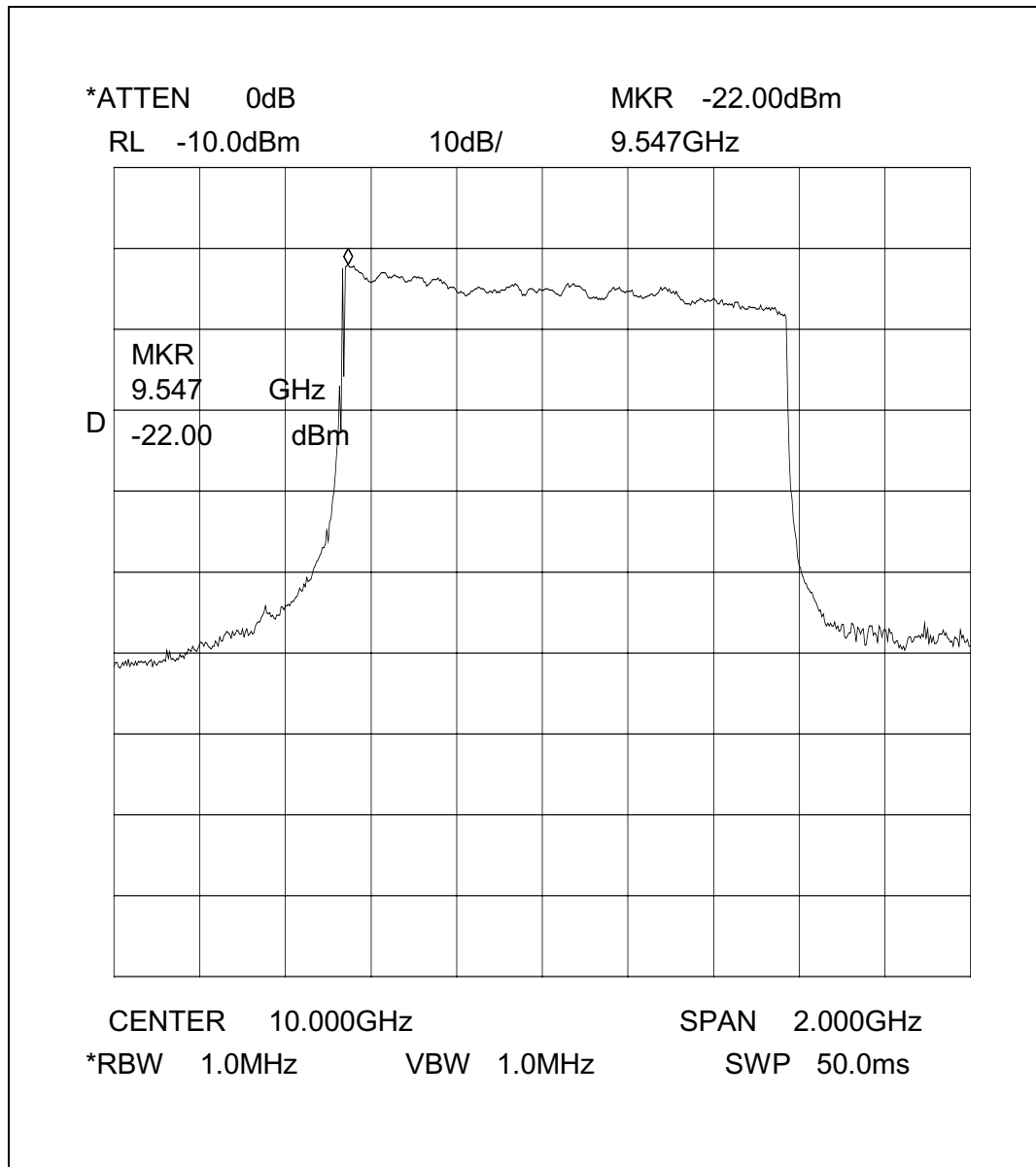
Plot 1



$$e_{irp} = -20.7 \text{ dBm (Analyzer)} + 37.8 \text{ dB (System)} = \underline{\underline{+17.1 \text{ dBm}}}$$

Measurement distance = 1 m

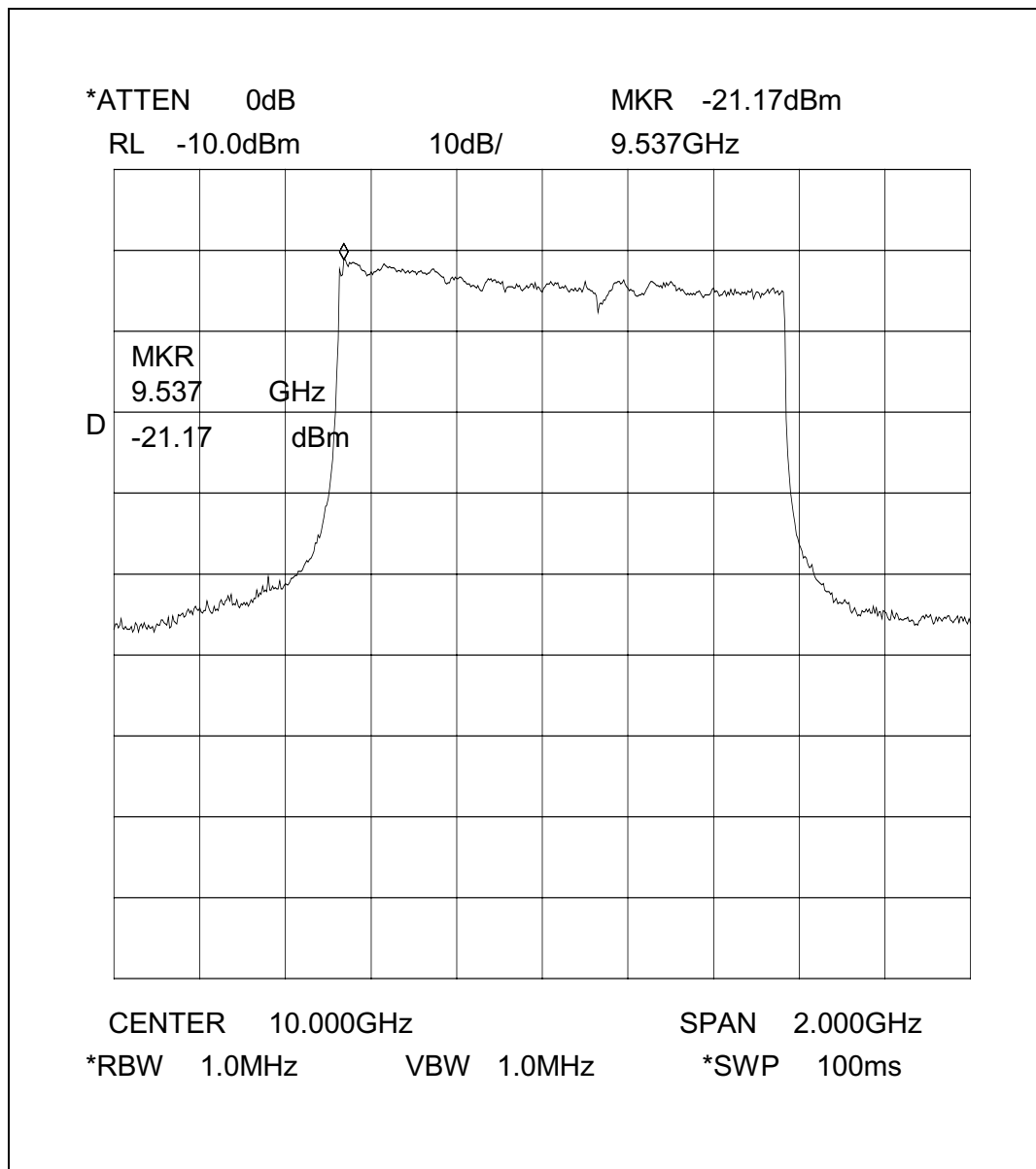
Plot 2



$$e_{irp} = -22.0 \text{ dBm (Analyzer)} + 37.8 \text{ dB (System)} = \underline{\underline{+15.8 \text{ dBm}}}$$

Measurement distance = 1 m

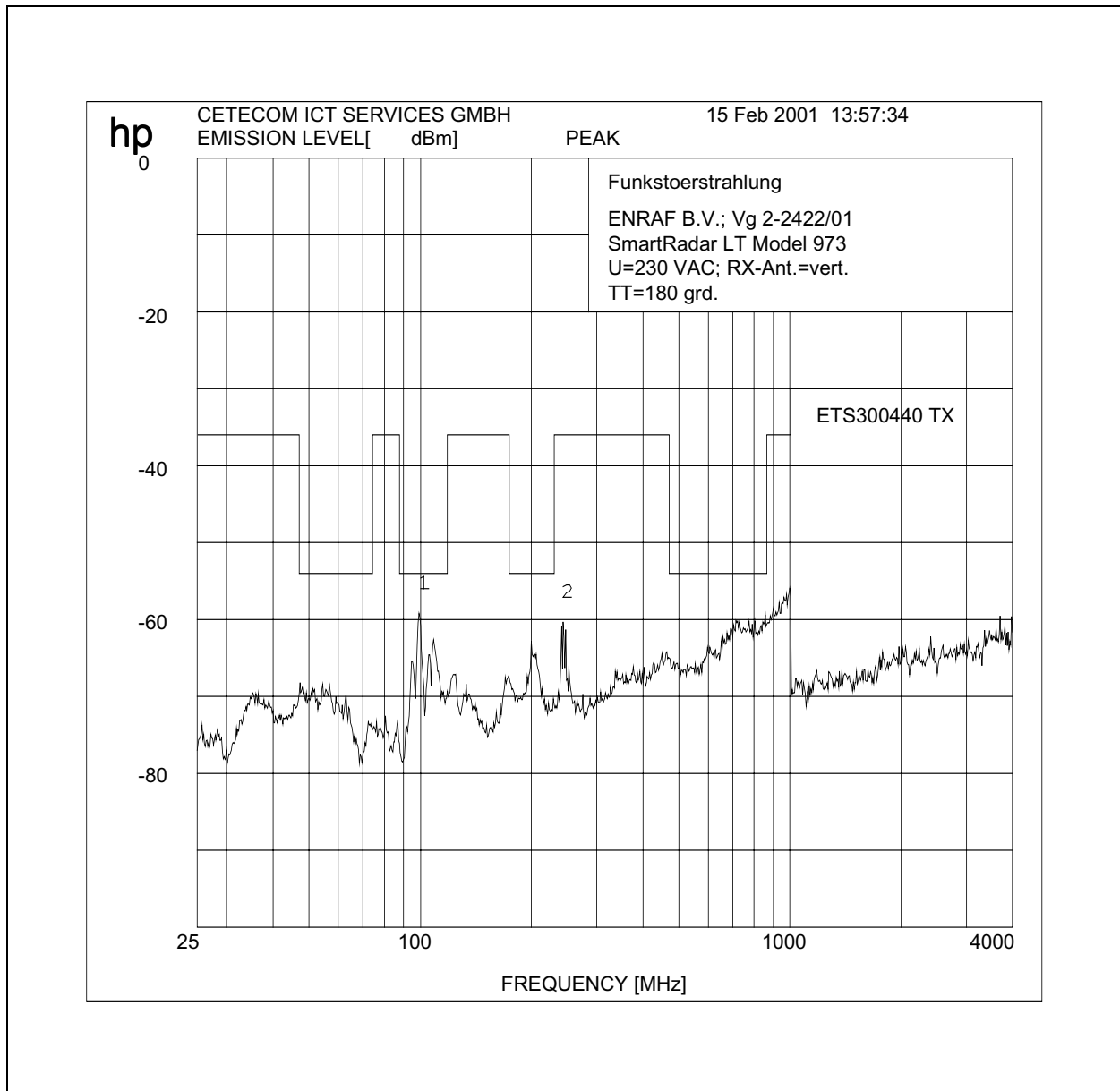
Plot 3



$$e_{irp} = -21.2 \text{ dBm (Analyzer)} + 37.8 \text{ dB (System)} = \underline{\underline{+16.6 \text{ dBm}}}$$

Measurement distance = 1 m

Plot 4



Marker 1 : **eirp = -59.2 dBm @ 99.28 MHz**

Marker 2 : **eirp = -60.3 dBm @ 243.56 MHz**

(Note : The title *Funkstoerstrahlung* in the plot means *Non-harmonic spurious radiated emission*)

5 Test results and calculation for FCC requirements

15.245	Radiated emission limits for field disturbance sensor
--------	---

Test conditions :

Frequency range	:	9.4 ... 10.7	GHz
Designation of emission	:	1G5F1N	
Power supply	:	85 ... 264	V AC
Temperature	:	-40 ... +60	° C

Test set-up : EUT is operating inside a simulated metallic tank.

Limits :

Distance (m)	Fundamental (GHz)	Power density ($\mu\text{W}/\text{cm}^2$)
3.0	10.500 – 10.550	7.5 mV/m

RX antenna (Standard gain horn) Gain = 16.6 dBi @ 10.0 GHz
 Aperture = 7.35 cm * 5.50 cm = 40.425 cm²

Measurements at 3.00 m distance :

Measured frequency range (GHz)	Res.-BW (MHz)	eirp (SA) (dBm)	eirp (SA) (dBpW)	e (dB $\mu\text{V}/\text{m}$)	E ($\mu\text{V}/\text{m}$)	t (°C)
9.0 ... 11.0	1.0	-62	+28	18.9	8.8	+21.0
9.0 ... 11.0	1.0	-62	+28	18.9	8.8	-40.0
9.0 ... 11.0	1.0	-62	+28	18.9	8.8	+60.0

Note 1 : The -62 dBm value is the noise floor on the analyzer screen. No signal from EUT was found above the noise floor of the measurement system.

FCC requirements passed :

Yes ☒

No ☐

15.209 (a)	General requirements for intentional radiation
-------------------	---

Test conditions :

Frequency range : 9.4 ... 10.7 GHz
 Designation of emission : 1G5F1N
 Power supply : 85 ... 264 V AC
 Temperature : +21 °C

Test set-up : EUT is operating inside a simulated metallic tank.

Limits :

Frequency (MHz)	Measurement distance (m)	Field strength e (dBμV/m) @ 3.0 m	Field strength E (μV/m)
0.009 – 0.490	300	88.5 ... 53.8	2400/F(kHz)
0.490 – 1.705	30	53.8 ... 43.0	24000/F(kHz)
1.705 – 30.0	30	49.5	30
30 – 88	3	40.0	100
88 – 216	3	43.5	150
216 – 960	3	46.0	200
above 960	3	54.0	500

Measurements at various distances :

Frequency band	Measured spurious	p (dBm)	eirp (dBpW)	e (dBμV/m)	E (μV/m)
0.009 ... 30.000 MHz	n.f. (Note 3)	(Note 3)	< 22.5	49.3	291.74
30.000 ... 4000.000 MHz	99.28 MHz 243.56 MHz	-59.2 -60.3	30.8 29.7	38.3 37.2	82.2 72.4
4.0 – 10.0 GHz	n.f.	< -62.0	< 28.0	< 35.5	< 59.6
10.0 – 20.0 GHz	n.f.	< -62.0	< 28.0	< 35.5	< 59.6
20 – 30.0 GHz	n.f.	< -62.0	< 28.0	< 35.5	< 59.6
30.0 – 40.0 GHz	n.f.	< -62.0	< 28.0	< 35.5	< 59.6
40.0 – 50.0 GHz	n.f.	< -62.0	< 28.0	< 35.5	< 59.6

Note 2 : n.f. = nothing found

Note 3 : The measurement distance is 3.0 m!
The field strength at 30.0 m is 20 dB less.

Calculation : Conversion from radiated power eirp (dBpW) into field strength
 e (dBμV/m) @ 3,0 m distance with antenna gain : **e = eirp + 7,5 – g**

FCC requirements passed :

Yes ☒

No ☐