HERMON LABORATORIES

ELECTROMAGNETIC EMISSIONS TEST REPORT

ACCORDING TO FCC CFR 47 PART 15 SUBPART B, PART 90 SUBPART I

for

Tadiran Telematics

EQUIPMENT UNDER TEST:

Personal alert locator, model PAL 2US

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ACCREDITED
839.01
Electrical

Description of equipment under test

Test items	Personal alert locator
Manufacturer	Tadiran Telematics
Types (Models)	**PAL 2US**
Receipt date	July 16, 2000

Applicant information

Applicant's representative	Mr. Genik Anatoly
Applicant's responsible person	Mr. Hanan Raviv, project manager
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Test performance

Project Number:	14159
Location	Hermon Laboratories
Test started	July 16, 2000
Test completed	August 20, 2000
Purpose of test	Apparatus verification in accordance with emissions requirements
Test specification(s)	FCC part 15 subpart B class B, part 90 subpart I

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1 Summary and signatures

The EUT, personal alert locator PAL 2US, was found complying with the limits of FCC part 15 subpart B class B and with FCC part 90 subpart I requirements.

Test performed by:

Mrs. El. Pitt, test engineer

Mr. Yu. Neuman, test engineer

Test report prepared by:

Mrs. V. Mednikov, certification engineer

Test report approved by:

Mr. M. Nikishin, EMC group leader

Mr. Alex Usoskin, QA manager

The A2LA logo endorsement applies only to the test methods and the standards that are listed in the scope of Hermon Laboratories accreditation by A2LA.
Through this report a point is used as the decimal separator, while thousands are counted with a comma.
This report is in conformity with EN 45001 and ISO GUIDE 25.
The test results relate only to the items tested.
This test report must not be reproduced in any form except in full with the approval of Hermon Laboratories Ltd.

2 General information

2.1 Abbreviations and acronyms

The following abbreviations and acronyms are applicable to this test report:

AC	alternating current
cm	centimeter
CE	conducted emissions
dB	decibel
dBm	decibel referred to one milliwatt
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
DC	direct current
EMC	electromagnetic compatibility
EUT	equipment under test
GHz	gigahertz
H	height
Hz	hertz
kHz	kilohertz
kV	kilovolt
L	length
LISN	line impedance stabilization network
m	meter
MHz	megahertz
NA	not applicable
NARTE	National Association of Radio and Telecommunications Engineers, Inc.
PC	personal computer
QP	quasi-peak (detector)
RE	radiated emission
RMS	root-mean-square
sec	second
V	volt
W	width

2.2 Specification references

CFR 47 part 15 subpart B: 10/1998	Radio Frequency Devices, Subpart B.
CFR 47 part 90 subpart I: 10/1999	Private land mobile radio services, Subpart I
ANSI C63.2:06/1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 Hz to 40 GHz-Specifications.
ANSI C63.4:1992	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

2.3 EUT description

The EUT is an alarm transmitter for personal alert location system, which operates at frequency 907.997333 MHz.

The EUT is energized from internal 5.6 V battery.

The transmitter is equipped with integral antenna.

Modes of operation:

1) location transmission mode;
2) ECM transmission mode;
3) stand-by;
4) charging.

The last two modes coincide during charge.

2.4 EUT test configuration

The EUT ports and lines description is given in Table 2.4.1, the support/test equipment description - in Table 2.4.2.
Test configuration is given in Figure 2.4.1.

Table 2.4.1
EUT ports and lines

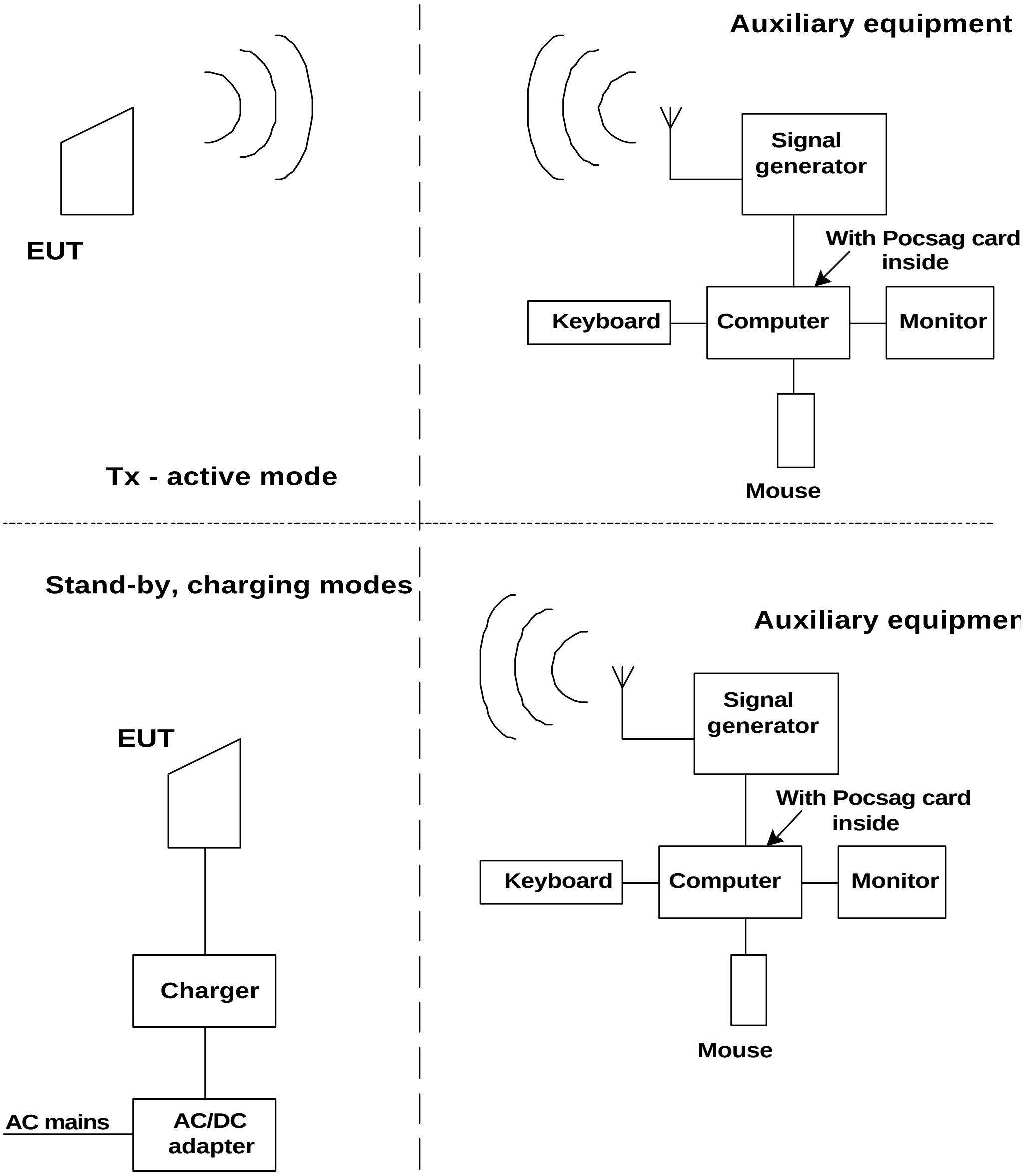
Port type	Port description	Quantity	Cable type description	Cable length, m	Connected to
Power	12 V DC	1	unshielded	1.5	AC/DC adapter
Power	DC charge	1	shielded	0.3	charger

Table 2.4.2

EUT support/test equipment

Description	Manufacturer	Model number	Serial number	FCC-ID number
Personal Computer	Unitel	No markings		
Monitor	Casper	TM 515	V92173393	No mark
Keyboard	BTC	BTC 52 series	3001503710	E5X5R5BTC
Signal generator	Marconi	2023	112181/077	No mark

Figure 2.4.1
EUT test configuration



2.5 EUT verification. Labeling requirements (CFR 47, FCC part 15, sections 15.19, 15.109)

A device subject to verification shall bear the following label in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. **Operation is subject to the following two conditions:** (1) **This device may not cause harmful interference, and** (2) **this device must accept any interference received, including interference that may cause undesired operation.**

For a Class B digital device the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
-Reorient or relocate the receiving antenna.
-Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.

For a Class A and Class B digital device the instructions furnished the user shall include the following caution:

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

3 Test facility description

3.1 General

Tests were performed at Hermon Laboratories, which is a fully independent, private EMC, Safety and Telecommunication testing facility. Hermon Laboratories is listed by the Federal Communications Commission (USA) for all parts of Code of Federal Regulations 47 (CFR 47) and by Industry Canada for radiated measurements (file numbers IC 2186-1 for OATS and IC 2186-2 for anechoic chamber), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-809 for anechoic chamber, C-845 for conducted emissions site), assessed by NMi Certin B.V. (Netherlands) for a number of EMC, Telecommunications, Safety standards, and assessed by AMTAC (UK) for safety of Medical Devices. The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO GUIDE 25/EN 45001 for EMC, Telecommunications and Product Safety Information Technology Equipment (Certificate No. 839.01).

Address: PO Box 23, Binyamina 30550, Israel
Telephone: +972 6628 8001
Fax: +972 6628 8277

Person for contact: Mr. Alex Usoskin, testing and QA manager.

3.2 Equipment calibration

The test equipment has been calibrated according to its recommended procedures and is within the manufacturer's published limit of error. The standards and instruments used in the calibration system conform to the present requirements of MIL-STD-45662A.
The laboratory standards are calibrated by the third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements.

3.2.1 Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Conducted emissions with LISN	9 kHz to 30 MHz: ± 2.1 dB
Radiated emissions in the open field test site at 10 m measuring distance	Biconilog antenna: ±3.2 dB Log periodic antenna: ±3 dB Biconical antenna: ±4 dB Double ridged guide antenna: ± 2.36 dB
Radiated emissions in the anechoic chamber at 3 m measuring distance	Biconilog antenna: ±3.2 dB

3.3 Statement of qualification

The test measurement data supplied in this test measurement report having been received by me, is hereby duly certified. The following is a statement of my qualifications:
I am an engineer, graduated from university in 1974 with an MScEE degree, have obtained 26 years experience in EMC measurements and have been with Hermon Laboratories since 1991.

Name: Mrs. Eleonora Pitt		Signature:	
Position: test engineer		Date:	August 25, 2000

The test measurement data supplied in this test measurement report having been received by me, is hereby duly certified. The following is a statement of my qualifications.
I am an engineer, graduated from university in 1992 with an MScEE degree, have obtained 7 years experience in research and development of electronic devices.

I have been with Hermon Laboratories since January 2000.

Name: Mr. Yuri Neuman		Signature:	
Position: test engineer		Date:	August 25, 2000

I hereby certify that this test measurement report was prepared by me and is hereby duly certified. The following is a statement of my qualifications.
I have a university degree and more than 10 years experience in document processing.
I have been with Hermon Laboratories since May 1999.

Name: Mrs. Valeria Mednikov		Signature:	
Position: technical writer		Date:	August 25, 2000

4 Emissions measurements

4.1 Conducted emissions measurements according to FCC part 15 subpart B

4.1.1 General

Conducted emission measurements specification limits are given in Table 4.1.1 below.

Table 4.1.1
Limits for conducted emission on AC power lines

Frequency, MHz	Class B equipment limit, dB(mV)
0.45 - 30	48

4.1.2 Test procedure

The EUT was tested in charging mode.

The test was performed in the shielded room. The EUT was set up on the wooden table as shown in Figure 4.1.1, in configuration, given in Figure 2.4.1. Frequency range from 450 kHz to 30 MHz was investigated.
The measurements were performed on the 120 V AC 60 Hz power lines (both neutral and phase) by means of the LISN, connected to the spectrum analyzer. The unused coaxial connector of the LISN was terminated in 50 Ω. The position of the EUT cables was varied to determine maximum emission level. Quasi peak detector (resolution bandwidth = 9 kHz) was used.

The worst test results are recorded in Table 4.1.2.

Test results are shown in Plots 4.1.1 to 4.1.2.

Reference numbers of test equipment used

HL 0447	HL 0465	HL 0521	HL 0787	HL 1003

Full description is in Appendix A.

Table 4.1.2 Conducted emission measurement results on EUT power lines

Frequency range : 450 kHz - 30 MHz
Detector : quasi peak
Resolution bandwidth: 9 kHz
Line: Neutral

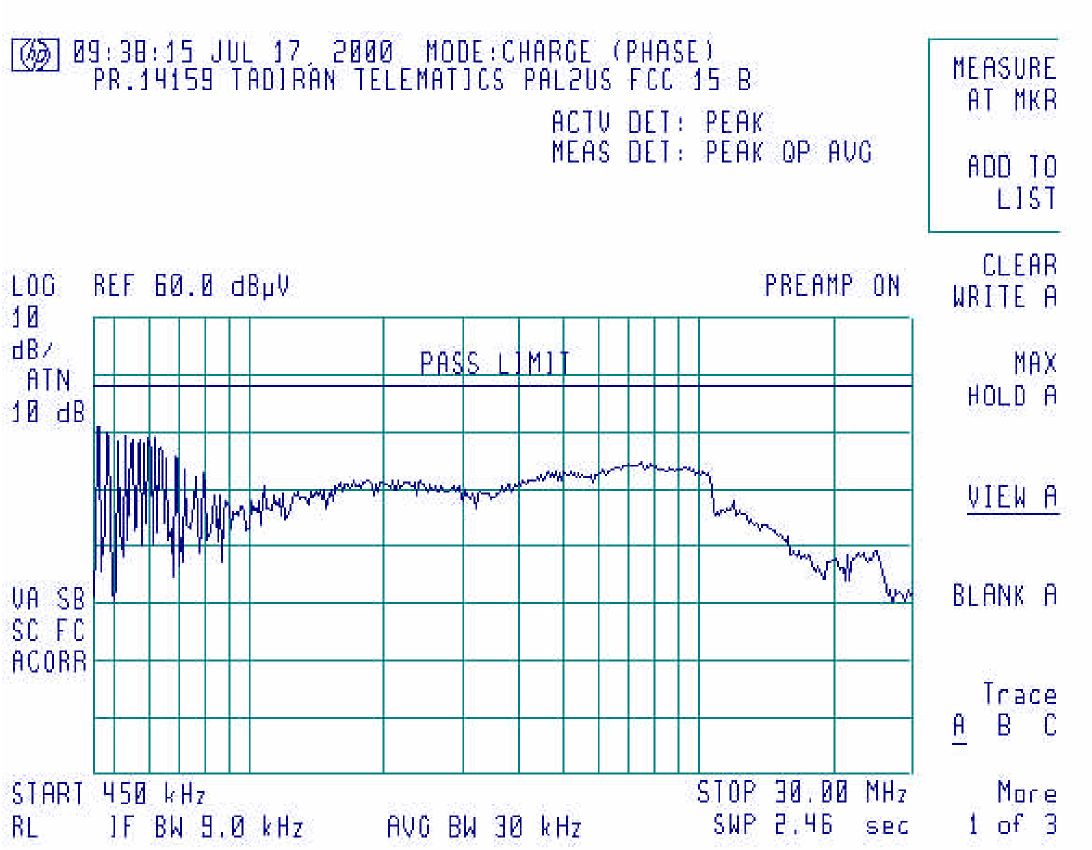
TEST SPECIFICATION: FCC part 15, subpart B, Class B
DATE: October 24, 1999
RELATIVE HUMIDITY: 52%
AMBIENT TEMPERATURE: 21°C

Frequency, MHz	Conducted emissions, dB (mV)	Limit, dB (mV)	Margin, dB	Pass/ Fail
0.449988	38.6	48	9.94	Pass
0.469994	35.93	48	12.07	Pass
0.499994	34.96	48	13.04	Pass
0.599994	35.15	48	12.85	Pass
0.699994	33.23	48	14.77	Pass

Table calculations and abbreviations:
Conducted emission = EMI meter reading (dBμV) + cable loss (dB) + LISN correction factor (dB).
For LISN correction factor refer to Appendix B.
Margin = dB below (negative if above) limit.

Plot 4.1.1
Conducted emission measurements on power line

Test specification: FCC part 15 subpart B class B
Frequency range: 450 kHz-30 MHz
EUT: PAL US
Line: phase
Detector: peak



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Plot 4.1.2
Conducted emission measurements on power line

Test specification: FCC part 15 subpart B class B
Frequency range: 450 kHz-30 MHz
EUT: PAL US
Line: neutral
Detector: peak

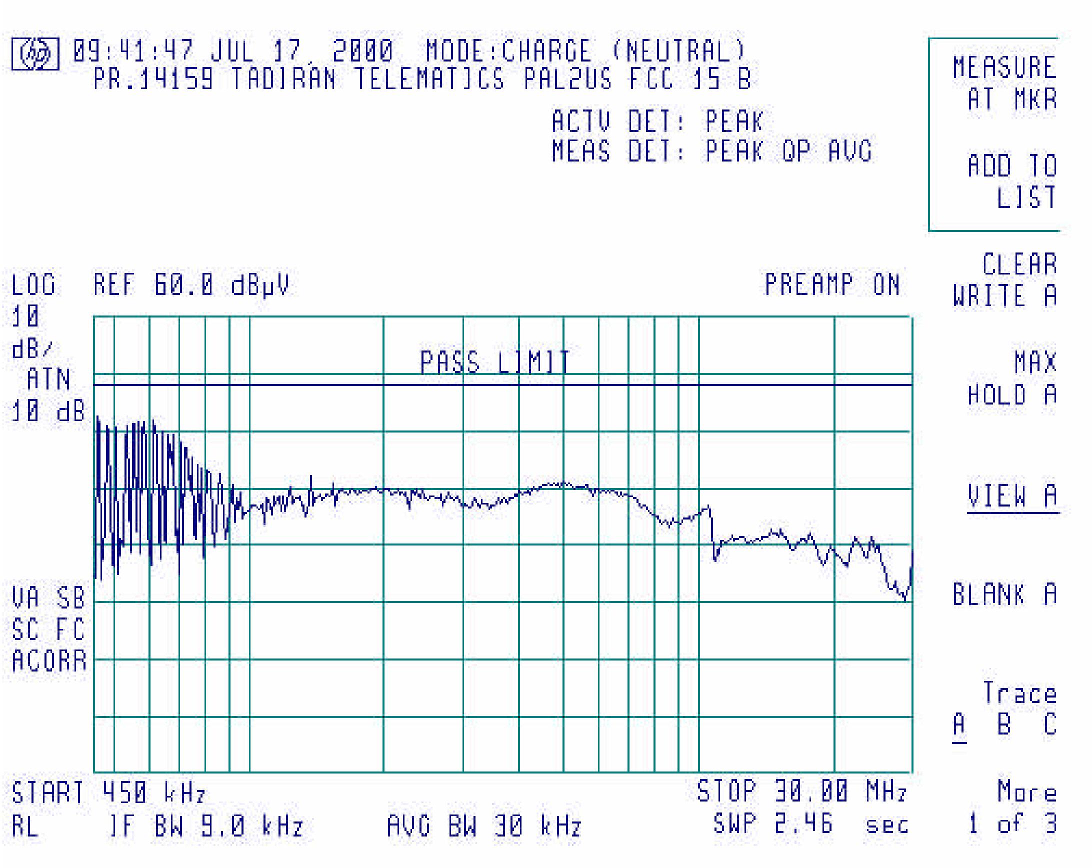
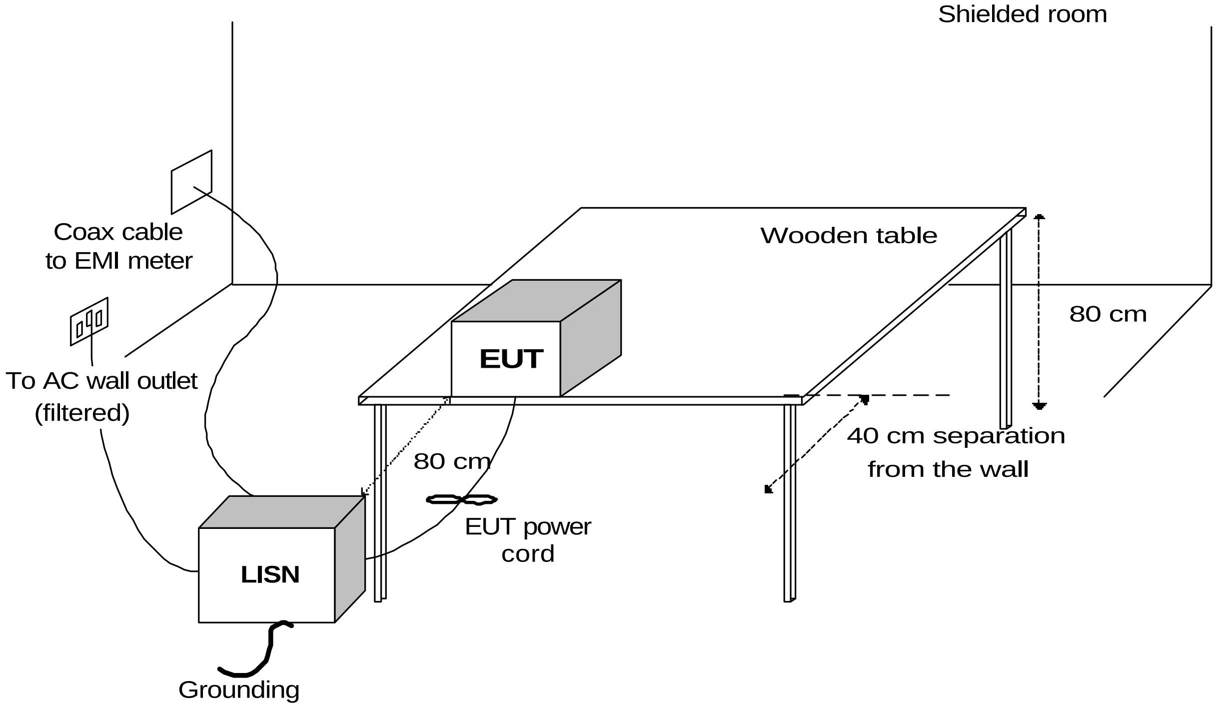


Figure 4.1.1
Conducted emissions test setup for table-top equipment



Photograph 4.1.1
Conducted emission measurements test setup

Photograph 4.1.2
Conducted emission measurements test setup

4.2 Radiated emission measurements according to FCC part 15 subpart B

4.2.1 General

Radiated emission measurements specification limits are given in Table 4.2.1 below:

Table 4.2.1
Limits for electric field strength, quasi-peak detector

Frequency MHz	Class B equipment dB(μV/m) @3 meter distance
30 - 88	40
88 - 216	43.5
216 - 960	46
960 - 5000	54

4.2.2 Test procedure

The highest frequency used in the digital part of the EUT f = 11.947 MHz hence the frequency range from 30 MHz to 1 GHz was investigated (FCC, 15.33, b). The EUT was tested in stand-by mode.

The EUT was set up on the wooden turntable in the anechoic chamber, as shown in Figure 4.2.1. For full test configuration refer to Figure 2.4.1.

Frequency range from 30 MHz to 1 GHz was investigated with biconilog antenna installed at 3 meter distance.

To find maximum radiation the turntable was rotated 360^{o}, the measuring antenna height varied from 1 to 4 m and the antennas polarization was changed from vertical to horizontal.
The test results are shown in Plot 4.2.1.

All the measured emissions were found at least 16 dB below specified limit.

Reference numbers of test equipment used

HL 0465	HL 0521	HL 0604

Full description is in Appendix A.

Plot 4.2.1 Radiated emission measurements test results, electric field, frequency range 30 MHz - 1 GHz

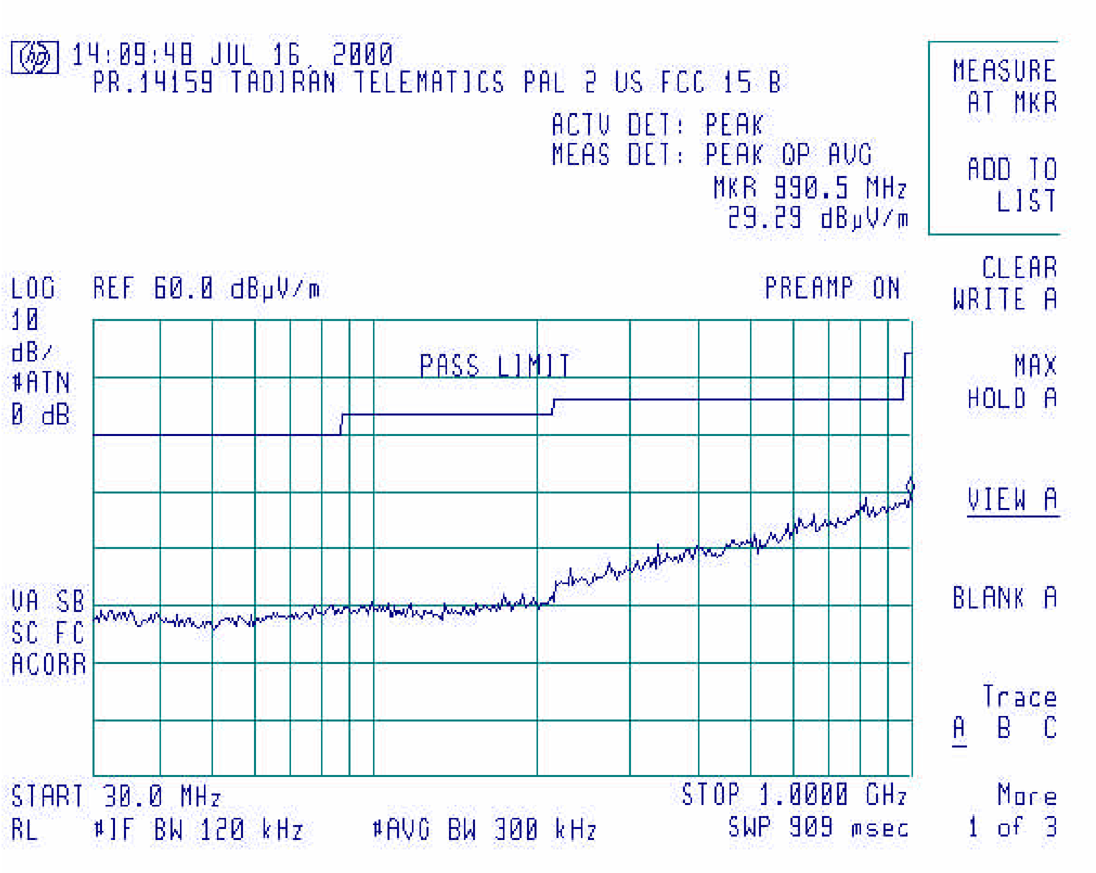
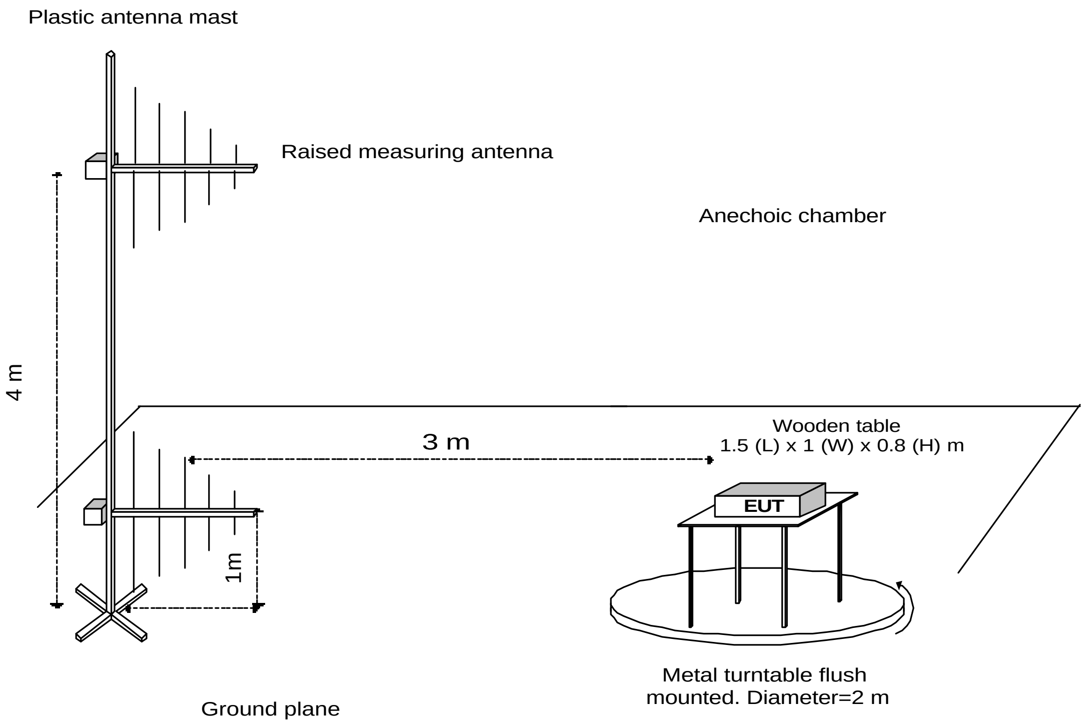
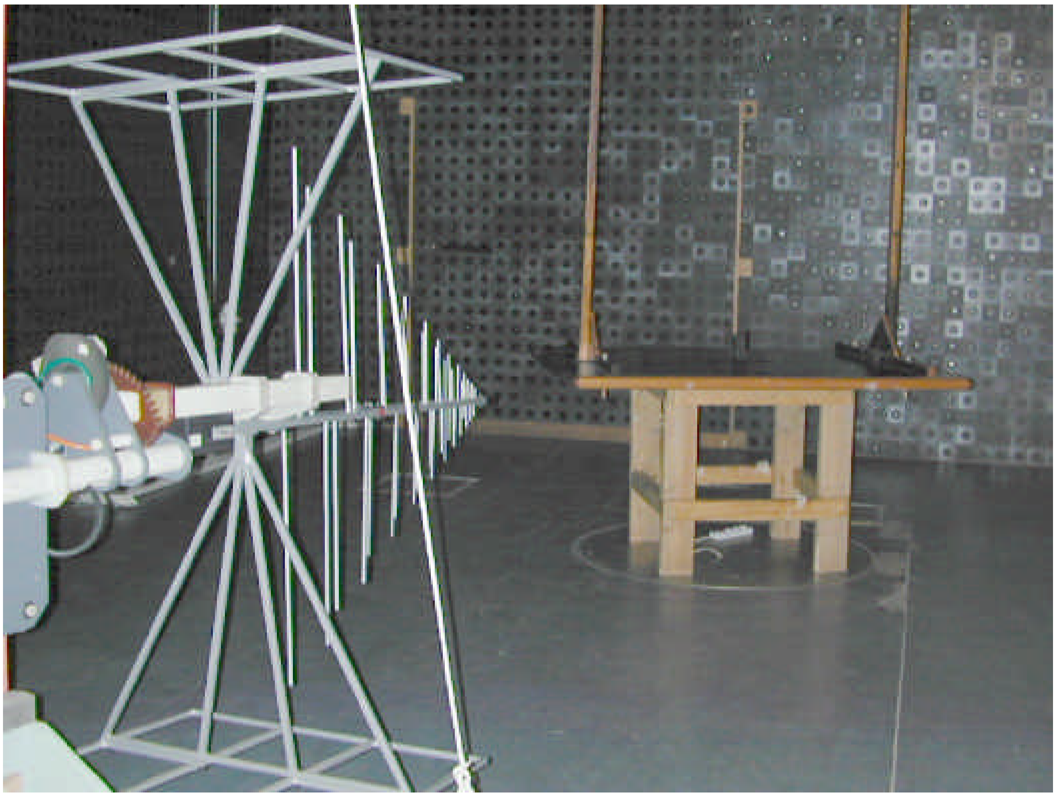


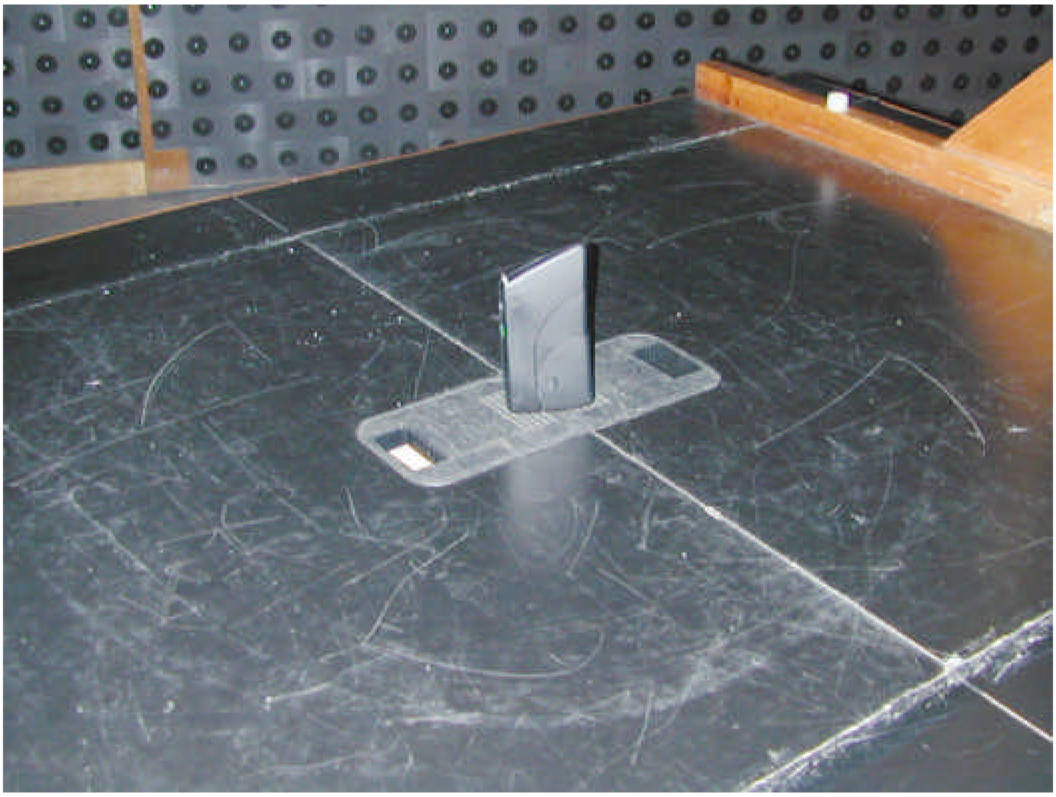
Figure 4.2.1
Radiated emissions test setup for table-top equipment



Photograph 4.2.1
Setup for radiated emission measurements
30 MHz – 1 GHz



Photograph 4.2.2
Setup for radiated emission measurements
30 MHz – 1 GHz



4.3 Effective radiated power measurements according to FCC part 90 paragraph 205j

4.3.1 General

This test was performed to determine maximal effective radiated power.
The standard specification limit is 30 W ERP.

4.3.2 Test procedure

The EUT was tested according to the substitution method with dipole antenna, in 3 orthogonal positions. The test was performed in the anechoic chamber at 3-meter test distance, i.e. the distance between measuring antenna and EUT boundary.
The EUT (in location transmission mode) was placed on wooden table. Electric field strength values were recorded. Then the EUT was replaced with dipole antenna connected to signal generator. The generator output was adjusted to obtain an electric field strength level equal to that of the EUT.

The maximum measured field strength result was 132.67 dBμV/m (see Plot 4.3.1) at frequency 908.35 MHz that corresponds to 32.91 dBm output power of the signal generator. Maximum ERP was calculated from equation:

ERP_{max} = $P_{out\ gen}$ – Cable loss + Antenna gain = 32.91 dBm – 1.36 dB + 1.7 dB = 33.31 dBm = 2.14 W.

The test was repeated for the EUT in ECM transmission mode.

The maximum measured field strength result was 133.86 dBμV/m (see Plot 4.3.2) at frequency 908.7 MHz that corresponds to 34.1 dBm output power of the signal generator. Maximum ERP was calculated from equation:

ERP_{max} = $P_{out\ gen}$ – Cable loss + Antenna gain = 34.1 dBm – 1.36 dB + 1.7 dB = 34.44 dBm = 2.78 W.

The test results are recorded in Table 4.3.1.

Reference numbers of test equipment used

HL 0521	HL 0589	HL 0604	HL 0614	HL 0661	HL 1098	HL 1175

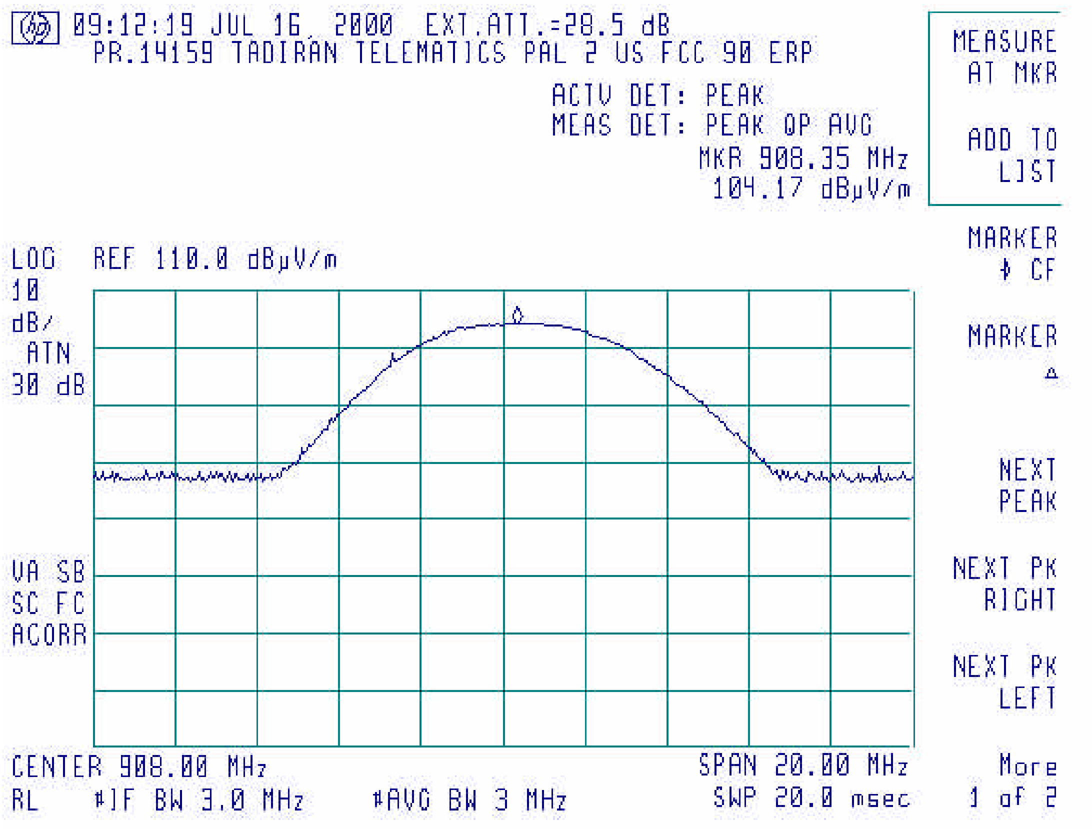
Full description is in Appendix A.

Table 4.3.1
Effective radiated power measurement test result

Frequency, MHz	EUT oper. mode	Radiated measured result, dBμV/m	Resol. band-width, kHz	Antenna gain, dB	Cable loss, dB	Gener. P_{out} dBm	ERP, dBm	Spec. limit, dBm	Margin, dB	Pass/ Fail
908.35	location transmis.	132.67	3000	1.7	1.36	32.91	33.31	44.8	11.49	Pass
908.70	ECM transmis.	133.86	3000	1.7	1.36	34.1	34.44	44.8	10.36	Pass

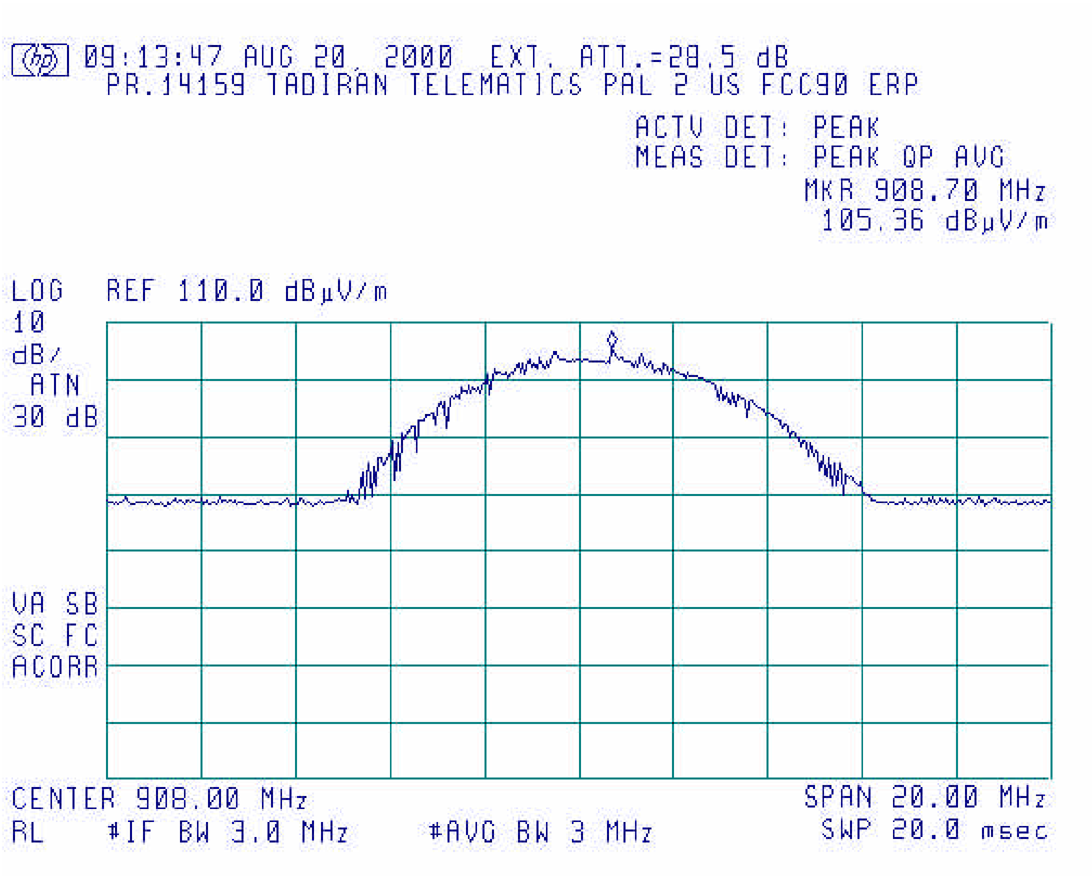
Test measurement result listed in the table was obtained throughout the testing with peak detector and antenna in vertical polarization.

Plot 4.3.1
ERP measurement,
location transmission mode



External attenuation 28.5 dB
E= 104.17+28.5=132.67 dBuV/m

Plot 4.3.2
ERP measurement,
ECM transmission mode



External attenuation 28.5 dB
E = 105.36 + 28.5 = 133.86 dBuV/m.

4.4 Occupied bandwidth measurements according to FCC part 90 paragraph 209

4.4.1 General

According to paragraph 90.209 (5) the maximum authorized bandwidth for multilateration LMS operations shall be 5.75 MHz in the 904.00 – 909.75 MHz band.

4.4.2 Test procedure

The measurements were performed using biconilog antenna, RBW = 300 kHz.

The occupied bandwidth was measured as a frequency band between points where power envelope of carrier, modulated with normal signal, drops 26 dB below unmodulated carrier.

For the EUT in location transmission mode OBW = 4.75 MHz was obtained.

For the EUT in ECM transmission mode OBW = 3.35 MHz was obtained.

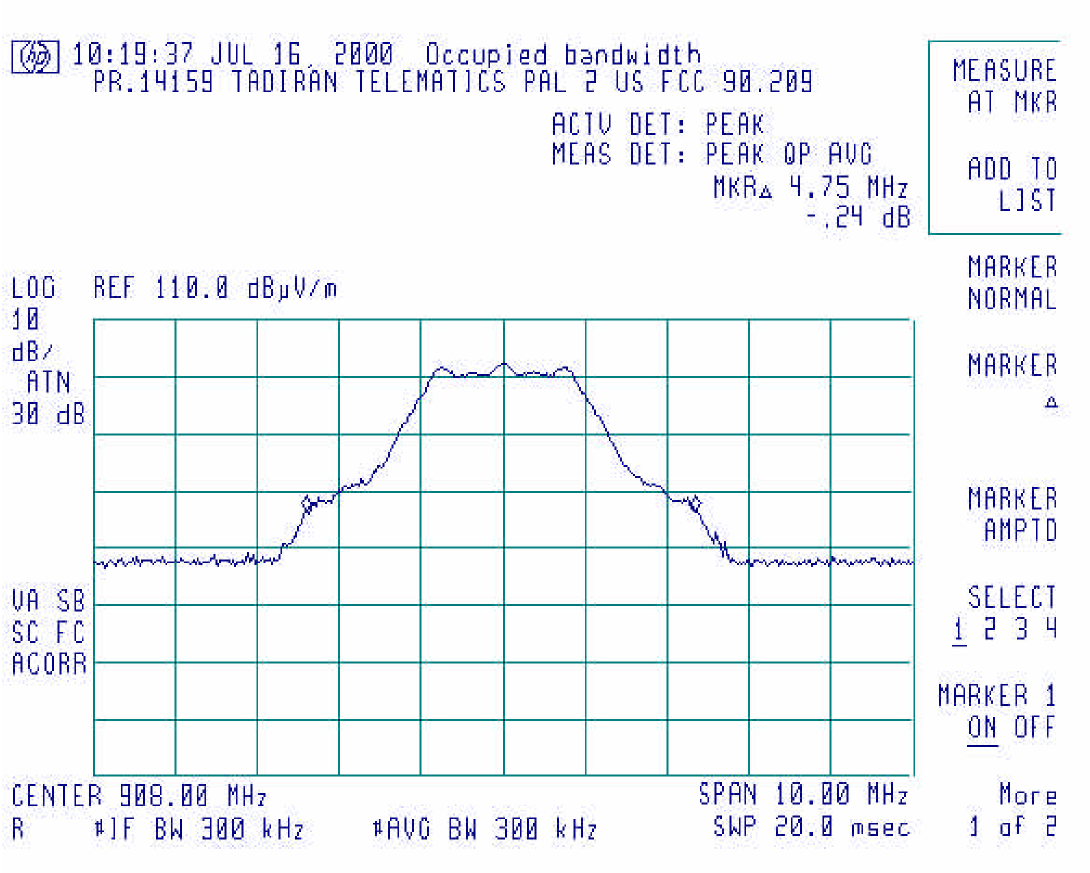
The test results and spectrum analyzer settings are shown in Plots 4.4.1, 4.4.2.

Reference numbers of test equipment used

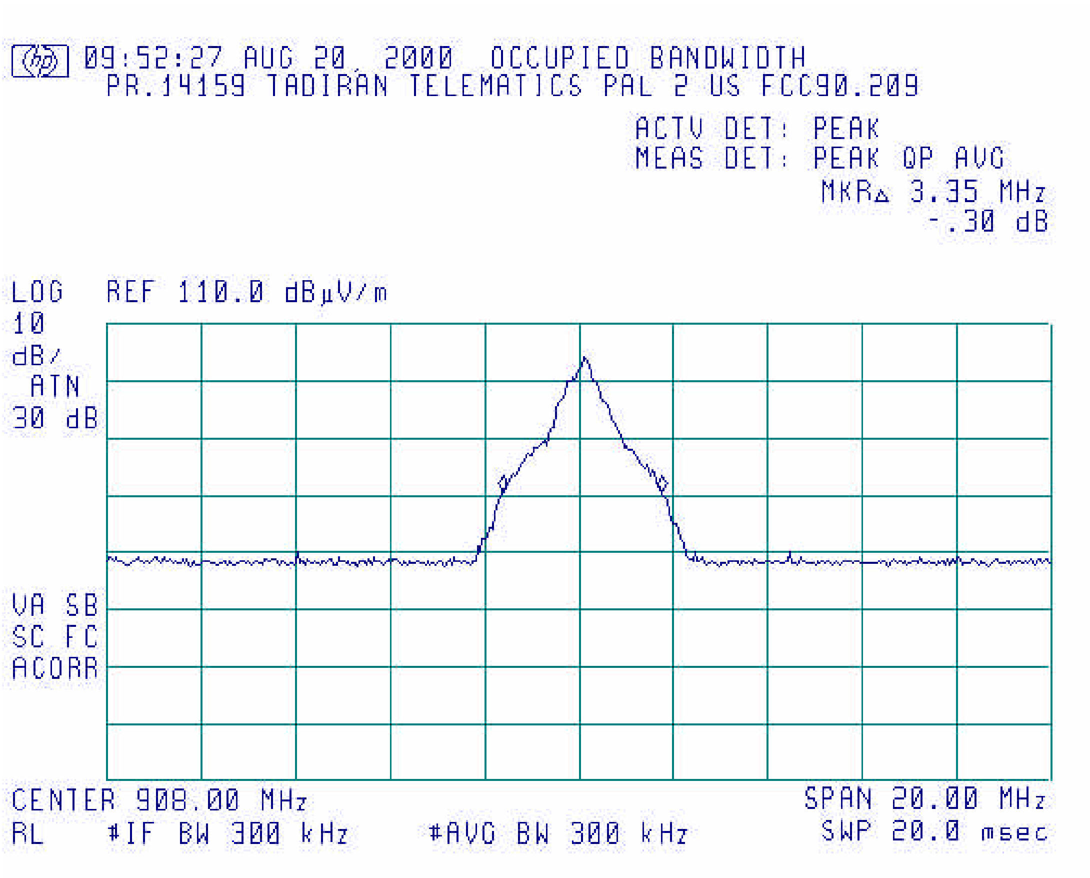
HL 0465	HL 0521	HL 0604	HL 1098

Full description is in Appendix A.

Plot 4.4.1
Occupied bandwidth measurements test result,
location transmission mode



Plot 4.4.2
Occupied bandwidth measurements test result,
ECM transmission mode



4.5 Emission mask according to FCC part 90 paragraph 210

4.5.1 General

In any 100 kHz band, the center frequency of which is removed from the center of authorized sub-band by more than 50 percent of the authorized bandwidth, the power of emissions shall be attenuated below the transmitter output power, as specified by the following equation, but in no case less than 31 dB:

$$A = 16 + 0.4\,(D - 50) + 10 \log B \qquad (*)$$

where
A is attenuation (in decibels) below the maximum permitted output power level;
B is the authorized bandwidth in megahertz;
D is displacement of the center frequency of the measurement bandwidth from the center frequency of the authorized sub-band, expressed as a percentage of the authorized bandwidth B.
Attenuation greater than 66 dB is not required.

4.5.2 Test procedure

Maximum permitted output power level is 30 W as specified in 90.205j. Hence the mask is expressed in attenuation below 30 W level.

B = 5.75 MHz is the authorized band (904.0 to 909.75 MHz);
F_0 is the center of the assigned band;
31 dB point refers to 68.5% displacement (3.939 MHz);
66 dB point refers to 156% displacement (8.97 MHz).

For the EUT in location transmission mode the actual measured ERP of Tx was found 33.31dBm = 2.14 W. Upon this the mask may be expressed in attenuation vs the measured carrier, but in this case correction factor

$$X = 10 \log(30W) - 10 \log(2.14\ W) = 14.8 - 3.3 = 11.5\ dB$$

shall be subtracted from the values received in equation (*).

The original mask and the mask obtained as a result of calculations are shown in Figure 4.5.1 (a,b).

For the EUT in ECM transmission mode the actual measured ERP of Tx was found 34.44dBm = 2.78 W. Upon this the mask may be expressed in attenuation vs the measured carrier, but in this case correction factor

$$X = 10 \log(30W) - 10 \log(2.78\ W) = 14.8 - 4.44 = 10.36\ dB$$

shall be subtracted from the values received in equation (*).

The original mask and the mask obtained as a result of calculations are shown in Figure 4.5.2 (a,b).

Emission mask measurements were performed in the anechoic chamber at 3 m distance with biconilog antenna.

Test results are shown in Plots 4.5.1 to 4.5.6.

The EUT was found to comply with requirements of paragraph 210.

Hence attenuation more than 66 dB is not required, the same limit was applied to spurious emissions throughout the following frequency ranges: 9 kHz to 897.905 MHz and 915.845 MHz to 10 GHz (according to paragraph 2.1057, a1).

Spurious emissions were measured in the anechoic chamber at 3-meter test distance, refer to Photographs 4.2.1, 4.2.2, 4.5.1, 4.5.2, 4.5.3.
The frequency range 9 kHz to 10 GHz was investigated with loop antenna (from 9 kHz to 30 MHz), biconilog antenna (from 30 MHz to 1 GHz) and double ridged guide antenna (from 1 to 10 GHz).

Spurious emissions were compared with the limit, expressed in absolute values as follows:

$$E_{lim\ spur} = E_{carrier} - Att_{lim} ,$$

where

for the EUT in location transmission mode

$E_{carrier}$ = 132.67 dB(µV/m);

Att_{lim} = 54.5 dB – maximal attenuation versus carrier (refer to emission mask, Figure 4.5.1);

$$E_{lim\ spur} = 132.67 - 54.5 = 78.17 \text{ dB}(\mu V/m).$$

and for the EUT in ECM transmission mode
$E_{carrier}$ = 133.86 dB(µV/m);

Att_{lim} = 55.64 dB – maximal attenuation versus carrier (refer to emission mask, Figure 4.5.2);

$$E_{lim\ spur} = 133.86 - 55.64 = 78.22 \text{ dB}(\mu V/m).$$

Test results are shown in Table 4.5.1 and Plots 4.5.7 to 4.5.19 (location transmission mode) and 4.5.20 to 4.5.37 (ECM transmission mode).

The EUT was found to comply with standard requirements.

Reference numbers of test equipment used

HL 0025	HL 0041	HL 0413	HL 0446	HL 0465	HL 0521	HL 0547	HL 0589
HL 0604	HL 0614	HL 0661	HL 0872	HL 1098	HL 1116	HL 1175	HL 1176
HL 1200							

Full description is in Appendix A.

Table 4.5.1
Harmonics measurements,
location transmission mode

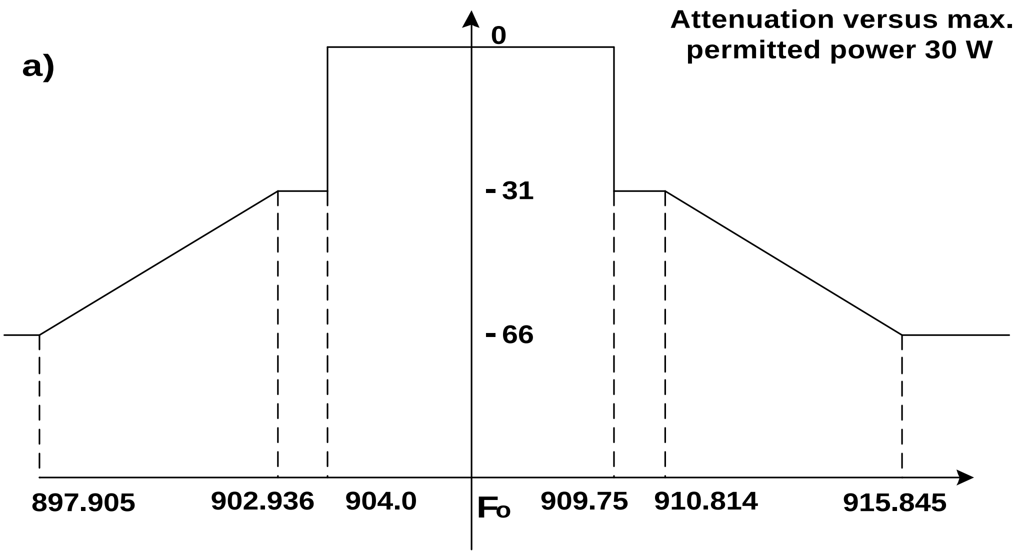
TEST SPECIFICATION:	FCC, part 90
DATE:	July 16, 2000
RELATIVE HUMIDITY:	60%
AMBIENT TEMPERATURE:	23°C
TEST PERFROMED IN:	ANECHOIC CHAMBER
DISTANCE BETWEEN ANTENNA AND EUT:	3m
METHOD OF MEASUREMENTS	Substitution

Frequency, MHz	EUT oper. mode	Radiated measured result, dB(µV/m)	Resol. band-width, kHz	Antenna gain, dB	Cable loss, dB	Gener. P_{out} dBm	ERP, dBm	Spec. limit, dBm	Margin, dB	Pass/ Fail
1816	ECM transmis.	69.91	100	6.7	1.97	-30.5	-25.77	-21.2	4.57	Pass
1823	location transmis.	71.23	100	6.7	1.97	-29	-24.27	-21.2	3.07	Pass
2724	ECM transmis.	54.53	100	7.7	2.5	-47.5	-42.3	-21.2	21.1	Pass
2726	location transmis.	52.82	100	7.7	2.50	-49	-43.8	-21.2	22.6	Pass
5448	ECM transmis.	48.62	100	4.4	3.7	-43.5	-42.8	-21.2	21.6	Pass
5456	location transmis.	52.20	100	4.4	3.70	-40	-39.3	-21.2	18.1	Pass
6356	location transmis.	46.8	100	5.3	4.00	-43	-41.7	-21.2	20.5	Pass
6356	ECM transmis.	59.65	100	5.3	4.0	-30	-28.7	-21.2	7.5	Pass
7264	location transmis.	43.75	100	6.4	4.5	-48	-46.1	-21.2	24.9	Pass
7264	ECM transmis.	46.72	100	6.4	4.5	-45	-43.1	-21.2	21.9	Pass

ERP = $P_{out\ gen}$ + Ant. gain – Cable loss

Figure 4.5.1
Emission mask (F_0 = 906.875 MHz),
location transmission mode

a)



b)

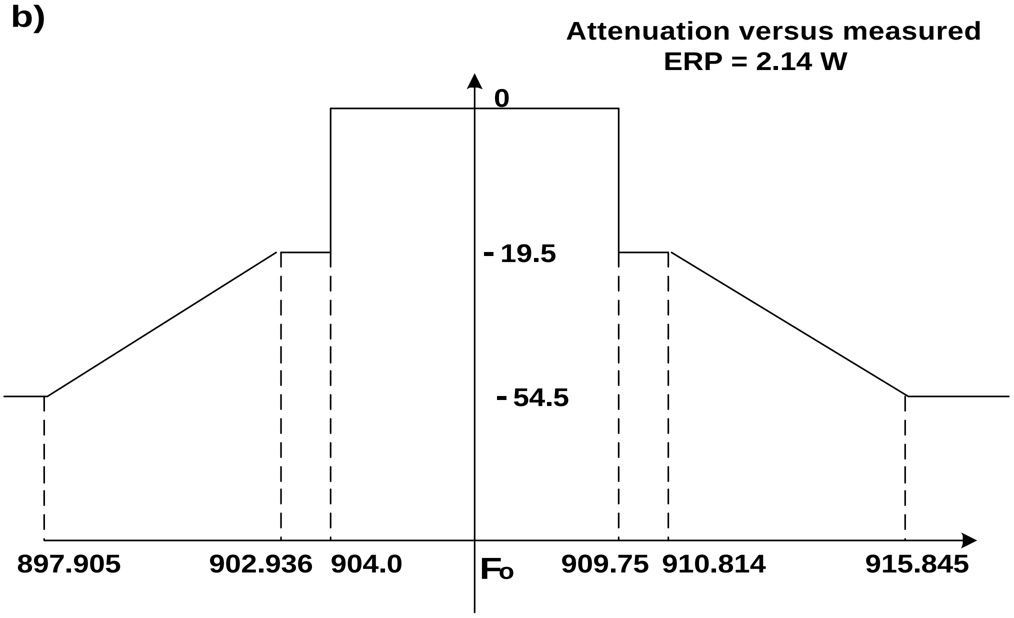
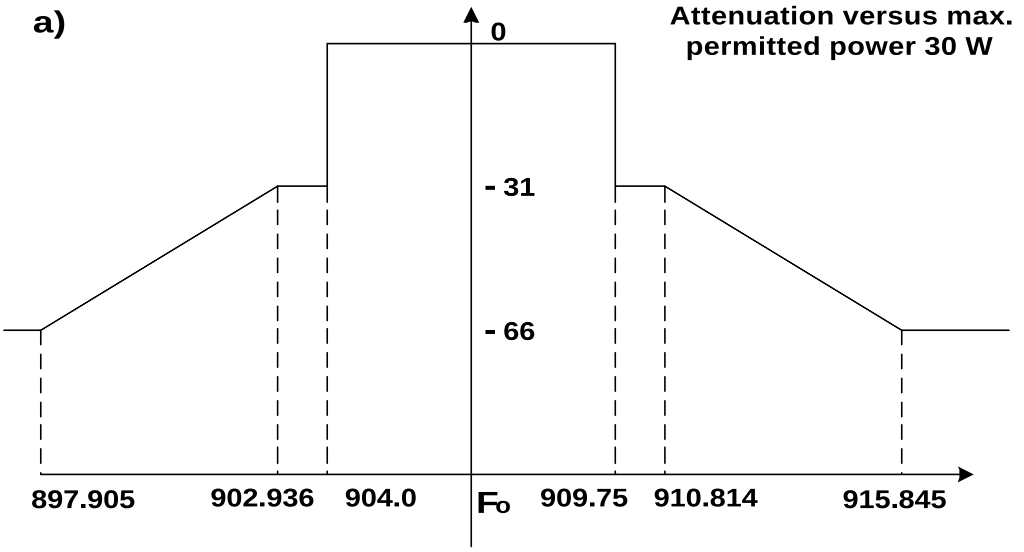
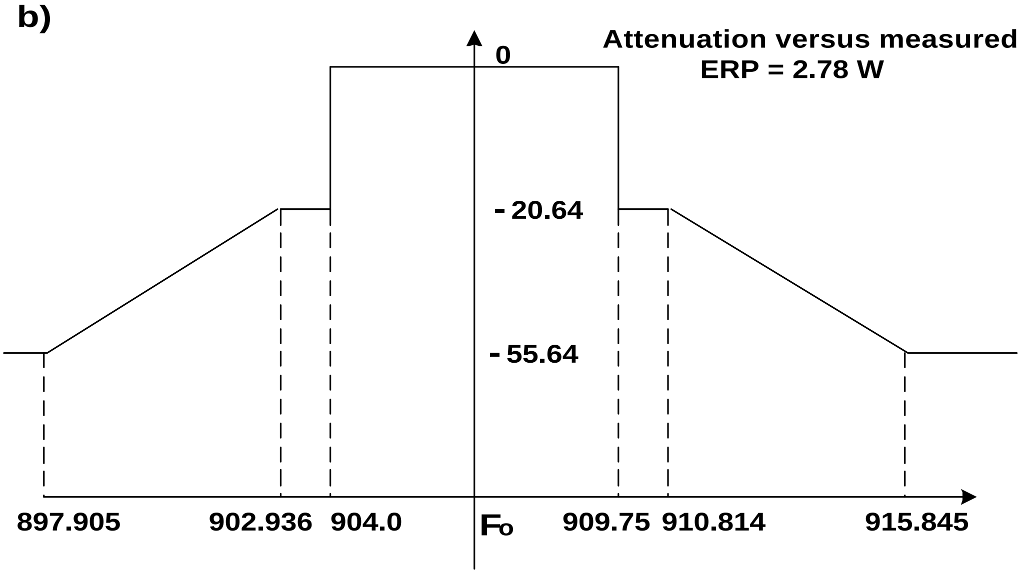


Figure 4.5.2
Emission mask (F_0 = 906.875 MHz),
ECM transmission mode

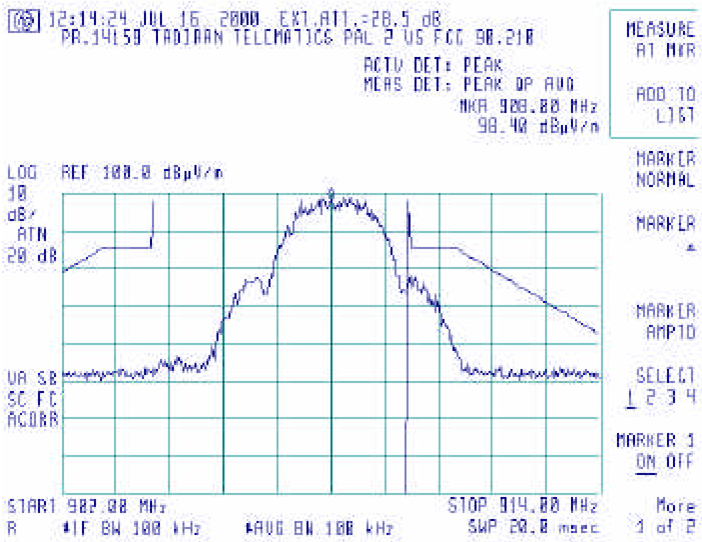
a)



b)

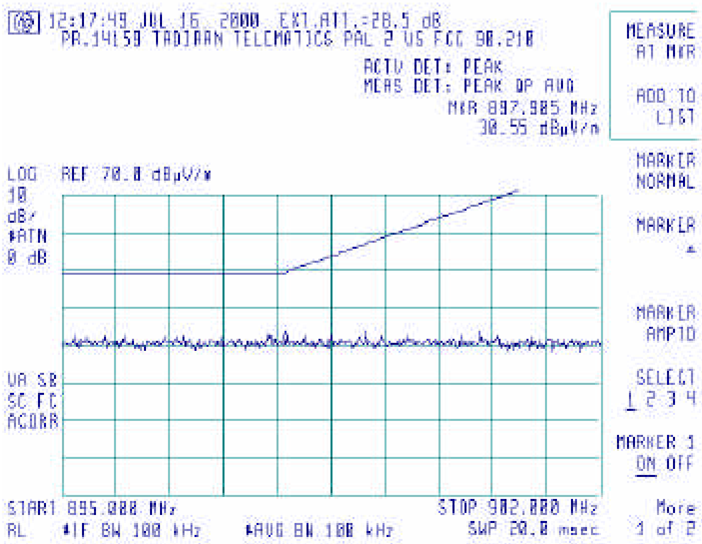


Plot 4.5.1
Emission mask for the EUT in location transmission mode,
frequency range 902 - 914 MHz



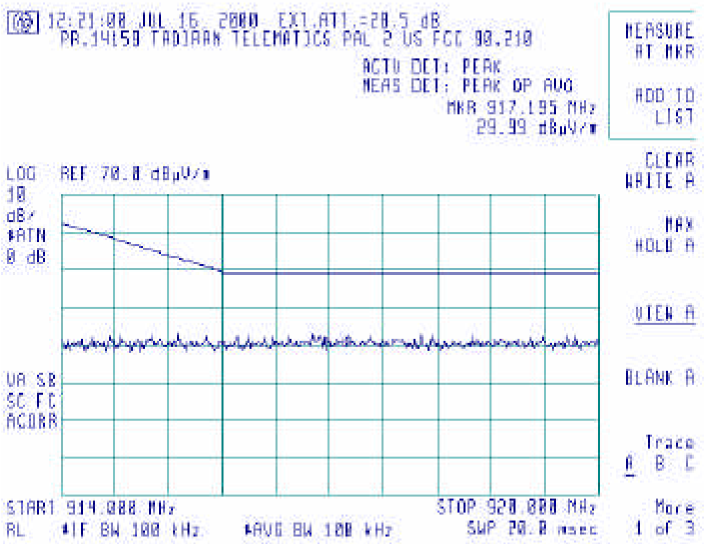
External attenuation 28.5 dB

Plot 4.5.2
Emission mask for the EUT in location transmission mode,
frequency range 895 – 902 MHz



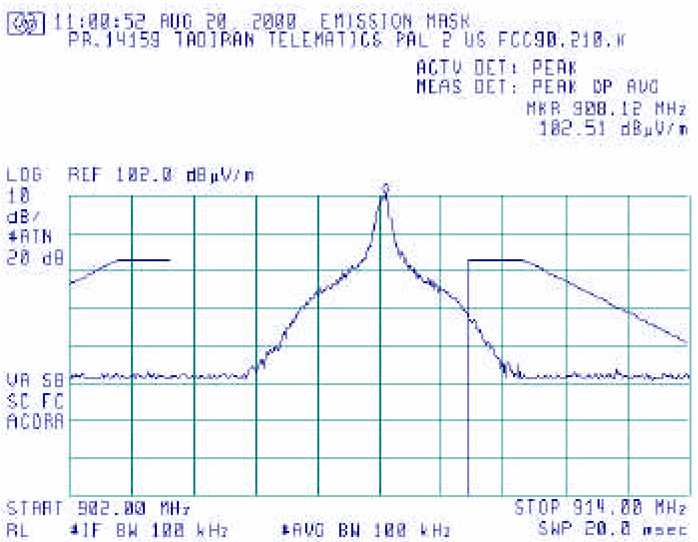
External attenuation 28.5 dB

Plot 4.5.3
Emission mask for the EUT in location transmission mode, frequency range 914 - 920 MHz

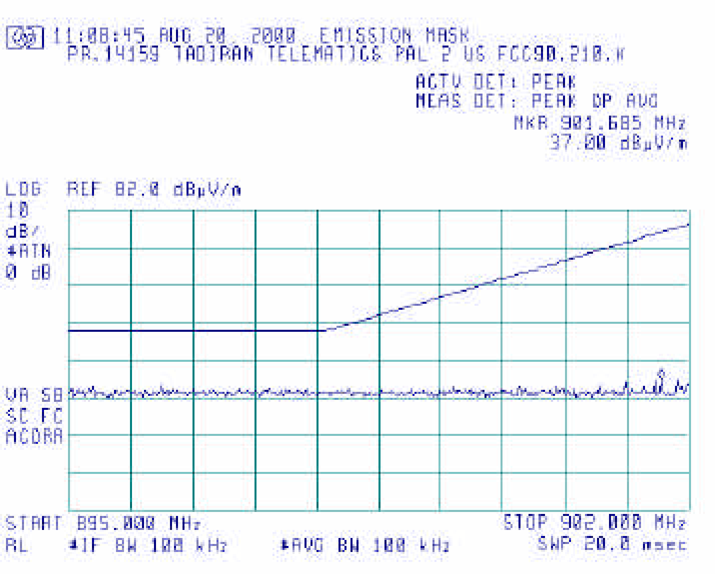


External attenuation 28.5 dB

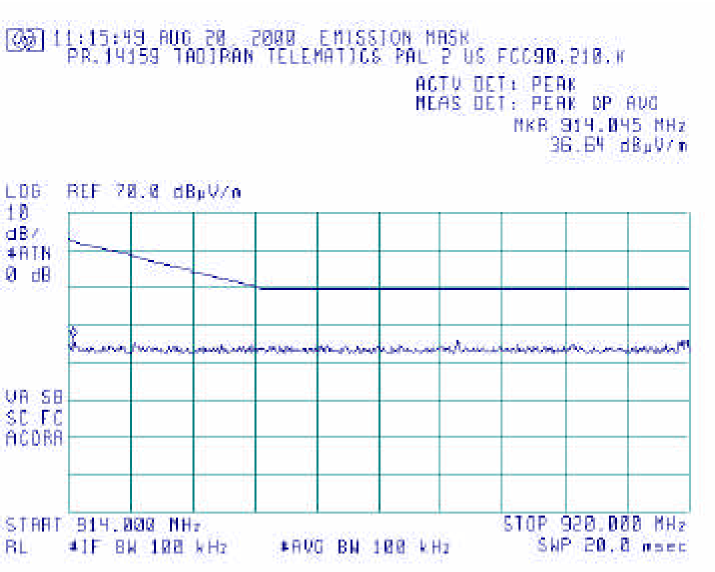
Plot 4.5.4
Emission mask for the EUT in ECM transmission mode



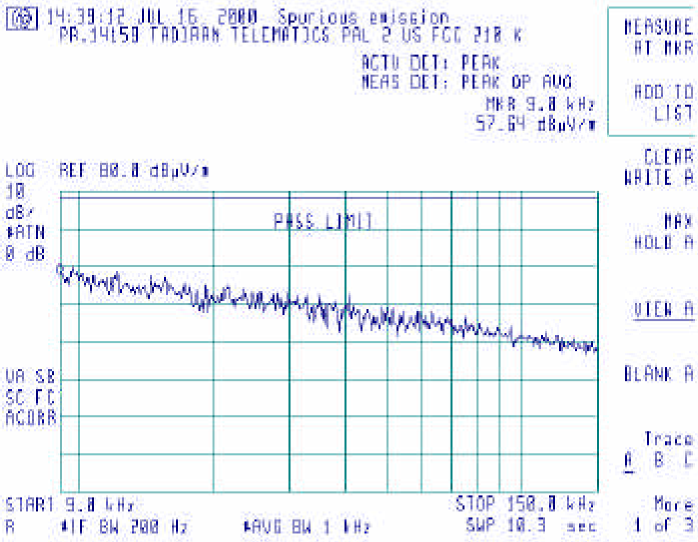
Plot 4.5.5
Emission mask for the EUT in ECM transmission mode, frequency range 895 – 902 MHz



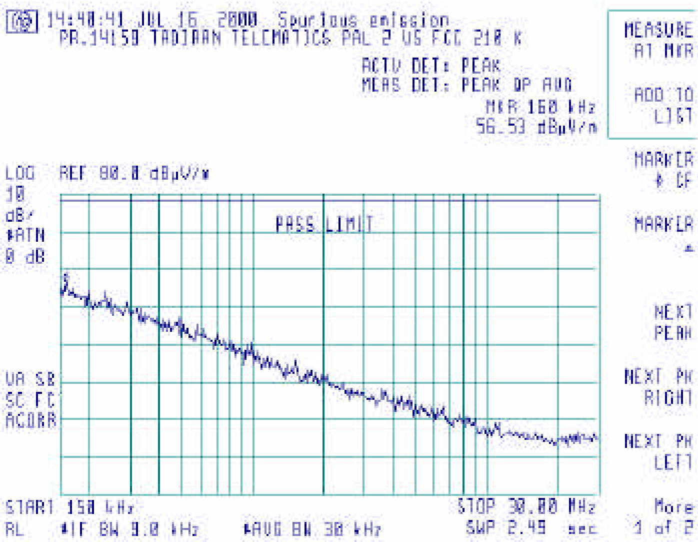
Plot 4.5.6
Emission mask for the EUT in ECM transmission mode, frequency range 914 - 920 MHz



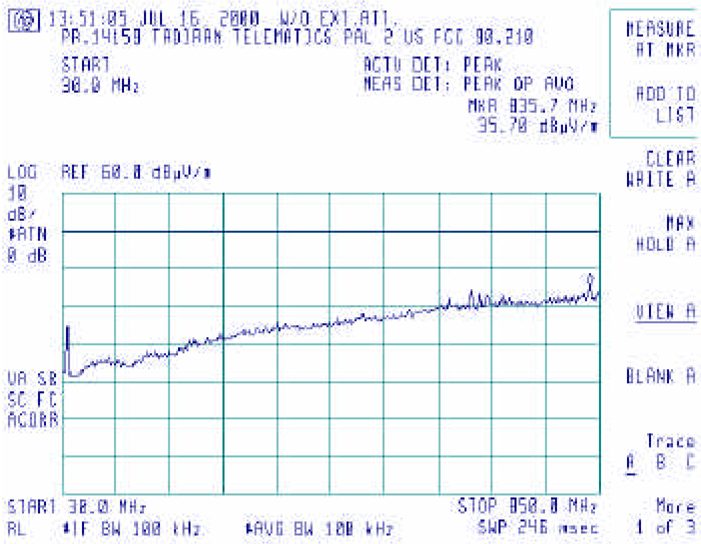
Plot 4.5.7
Frequency range 9 – 150 kHz,
location transmission mode



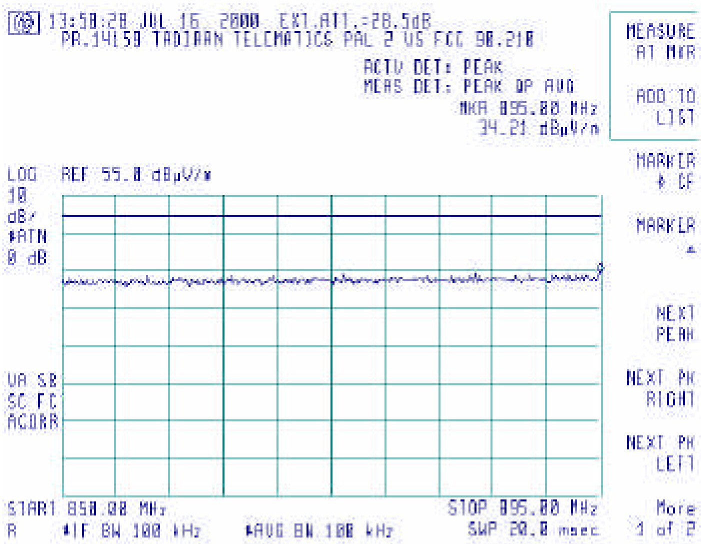
Plot 4.5.8
Frequency range 150 kHz – 30 MHz,
location transmission mode



Plot 4.5.9
Frequency range 30 – 850 MHz,
location transmission mode

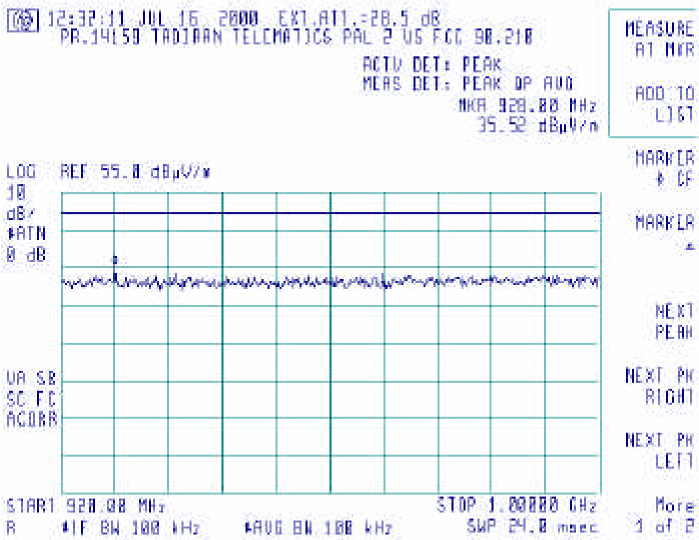


Plot 4.5.10
Frequency range 850 – 895 MHz,
location transmission mode



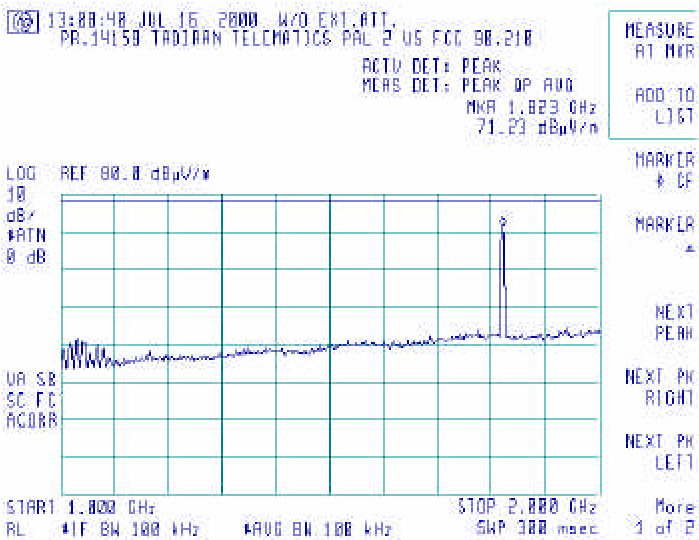
External attenuation 28.5 dB

Plot 4.5.11
Frequency range 920 - 1000 MHz,
location transmission mode

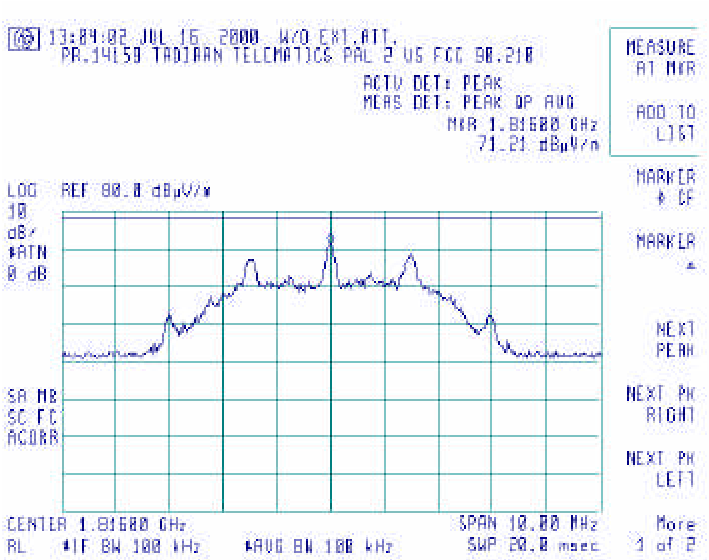


External attenuation 28.5 dB

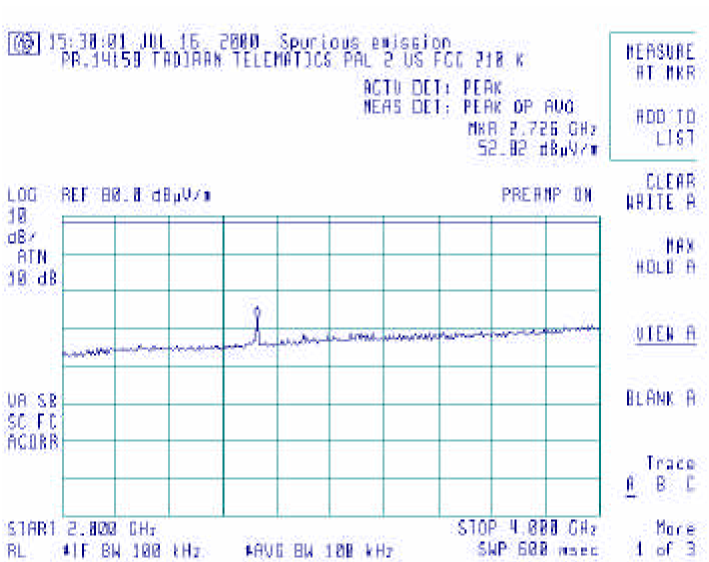
Plot 4.5.12
Frequency range 1 – 2 GHz,
location transmission mode



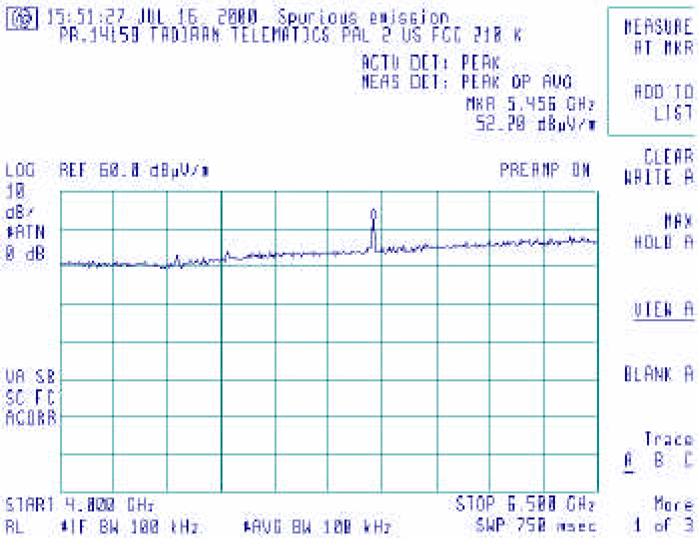
Plot 4.5.13
2nd harmonic
location transmission mode



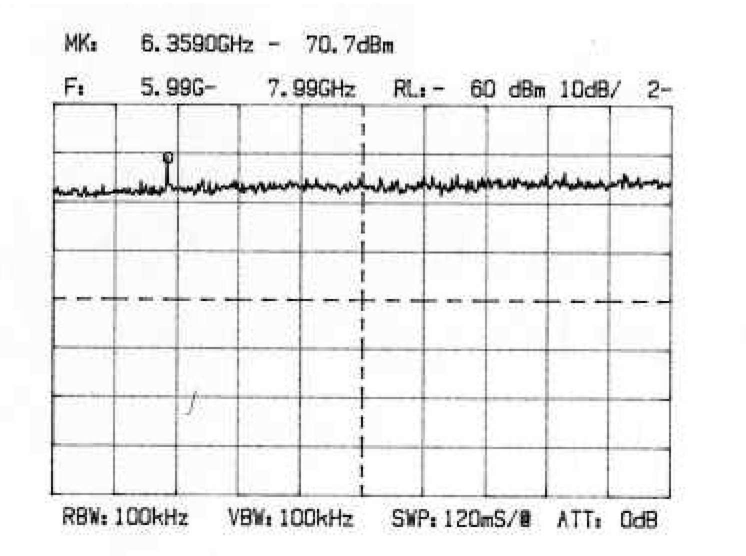
Plot 4.5.14
3rd harmonic,
location transmission mode



Plot 4.5.15
6th harmonic,
location transmission mode

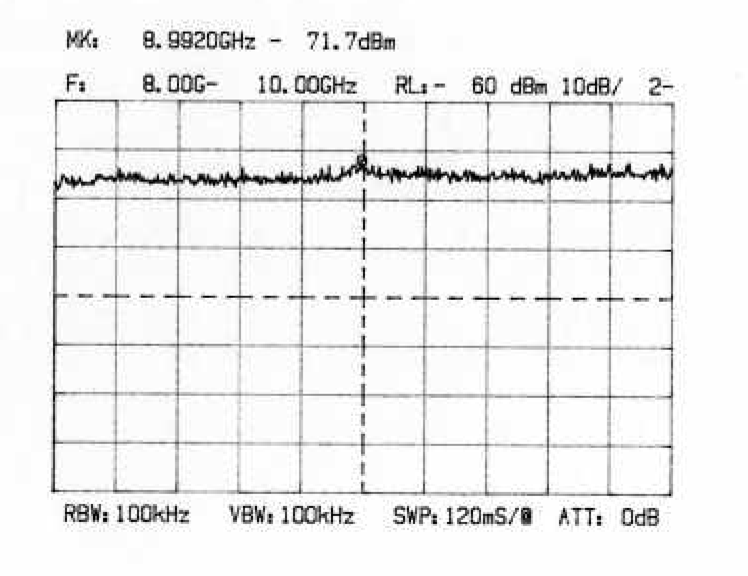


Plot 4.5.16
Frequency range 6 – 8 GHz,
location transmission mode



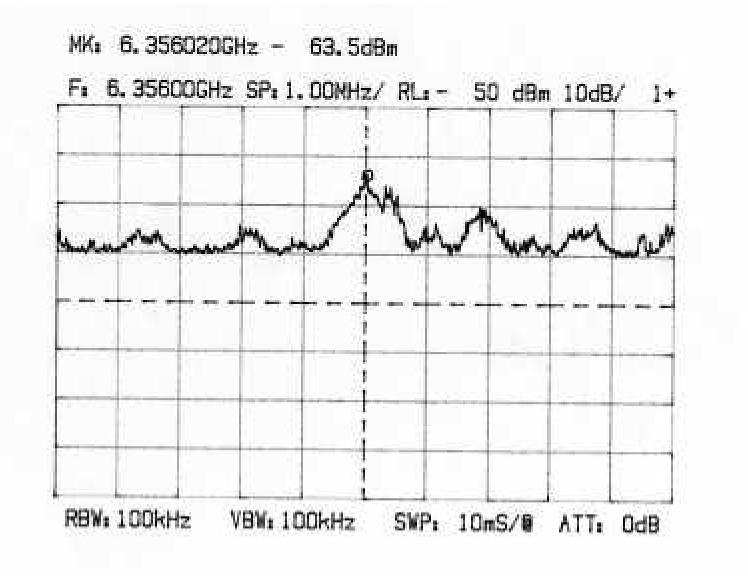
Amplifier gain 35 dB

Plot 4.5.17
Frequency range 8 – 10 GHz,
location transmission mode



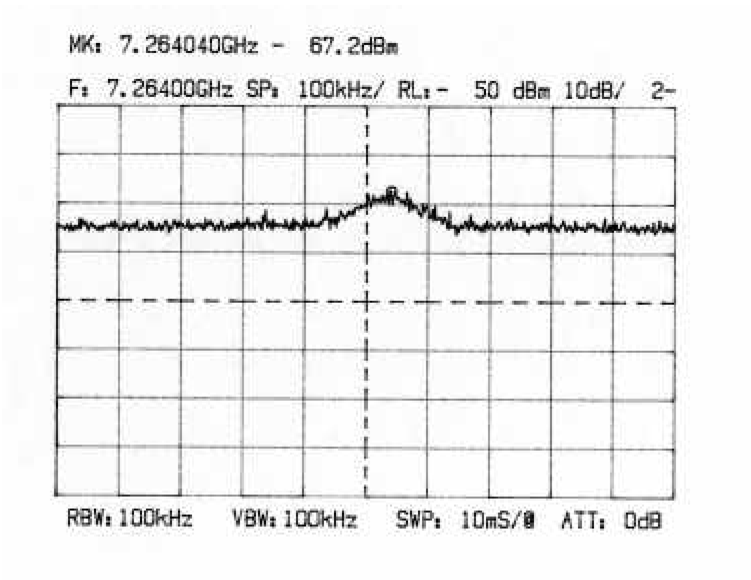
Amplifier gain 35 dB

Plot 4.5.18
7th harmonic,
location transmission mode



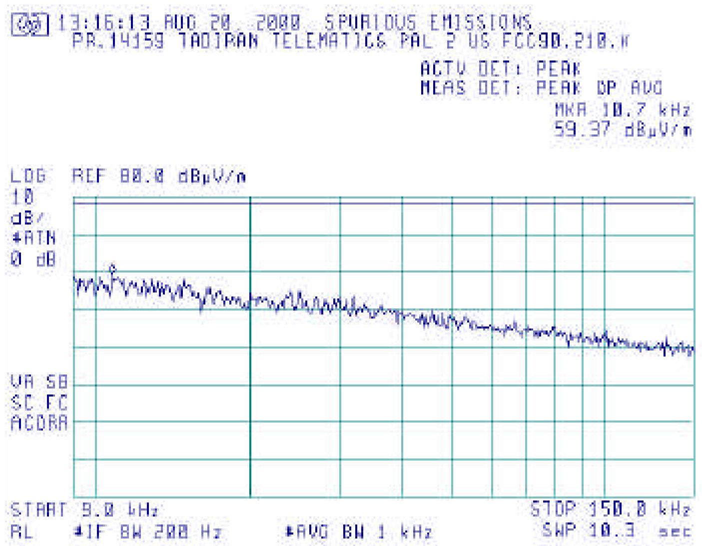
Amplifier gain 35 dB
AF = 35.3 dB, CL = 3.0 dB,
$E = V_{SA} + 107 + AF + CL - AG = 46.8$ dBμV/m

Plot 4.5.19
8th harmonic,
location transmission mode

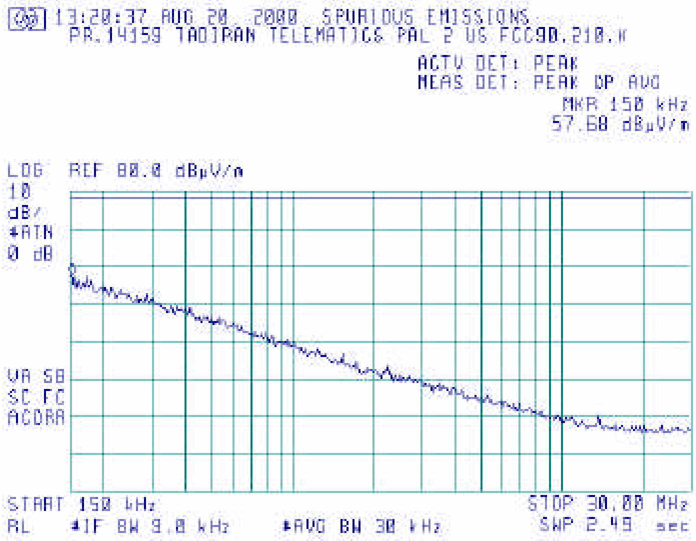


Amplifier gain 35 dB
AF = 35.7 dB, CL = 3.25 dB,
$E = V_{SA} + 107 + AF + CL - AG = 43.75$ dBmV/m

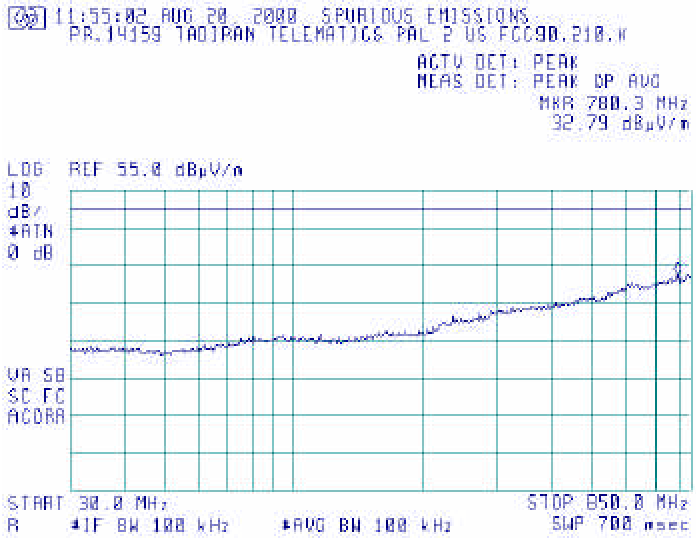
Plot 4.5.20
Frequency range 9-150 kHz,
ECM transmission mode



Plot 4.5.21
Frequency range 150 kHz – 30 MHz,
ECM transmission mode

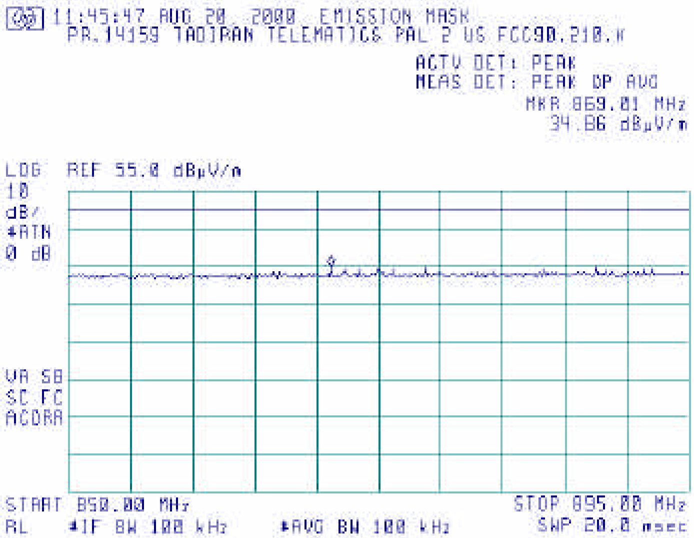


Plot 4.5.22
Frequency range 30 – 850 MHz,
ECM transmission mode



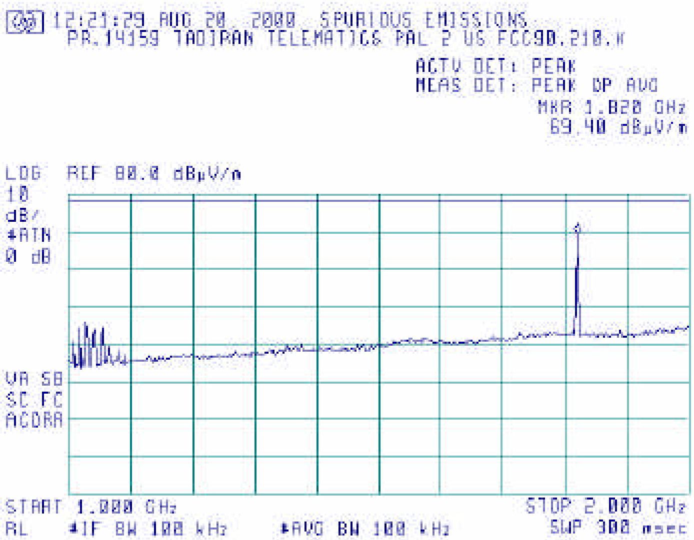
External attenuation 28.5 dB

Plot 4.5.23
Frequency range 850 - 895 MHz,
ECM transmission mode

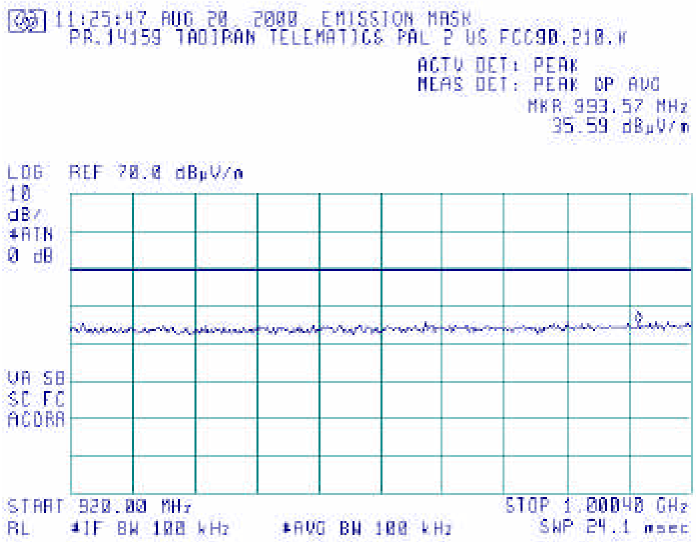


External attenuation 28.5 dB

Plot 4.5.24
Frequency range 895 – 902 MHz,
ECM transmission mode

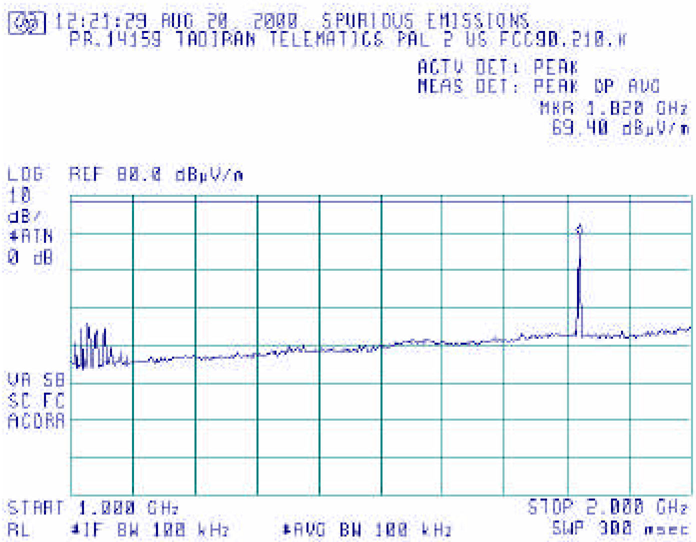


Plot 4.5.25
Frequency range 920 – 1000 MHz,
ECM transmission mode

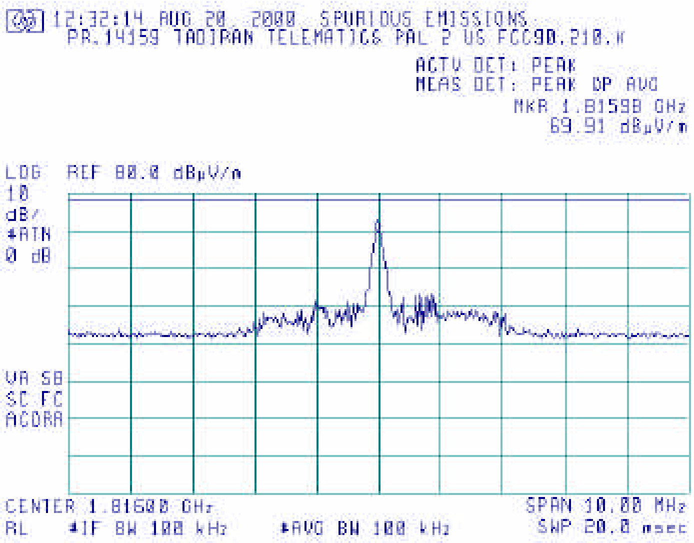


External attenuation 28.5 dB

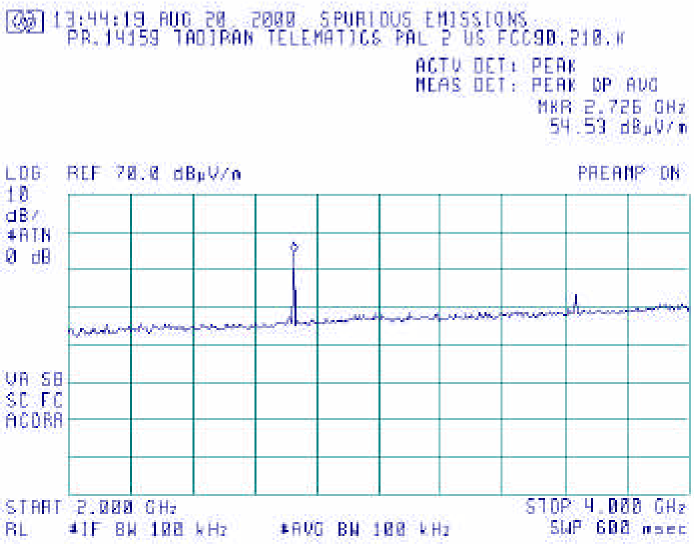
Plot 4.5.26
Frequency range 1 – 2 GHz,
ECM transmission mode



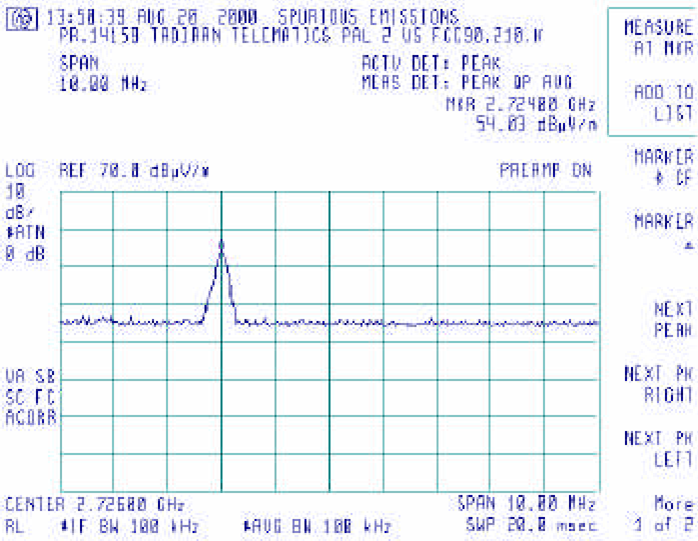
Plot 4.5.27
2nd harmonic,
ECM transmission mode



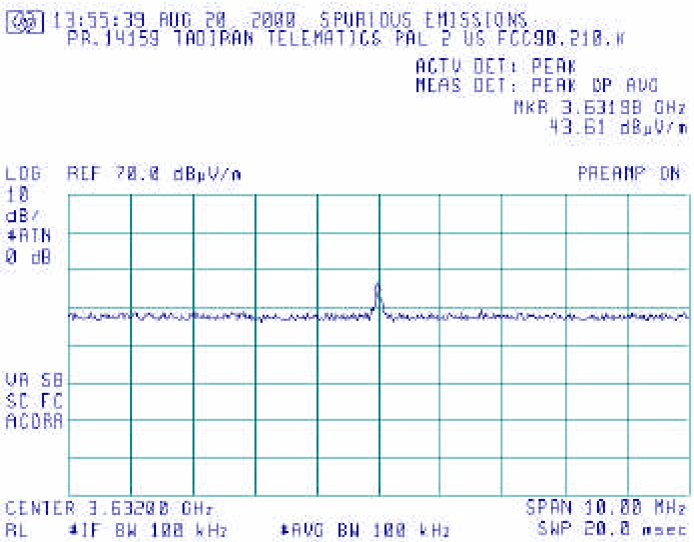
Plot 4.5.28
Frequency range 2 – 4 GHz,
ECM transmission mode



Plot 4.5.29
3rd harmonic,
ECM transmission mode



Plot 4.5.30
4th harmonic,
ECM transmission mode



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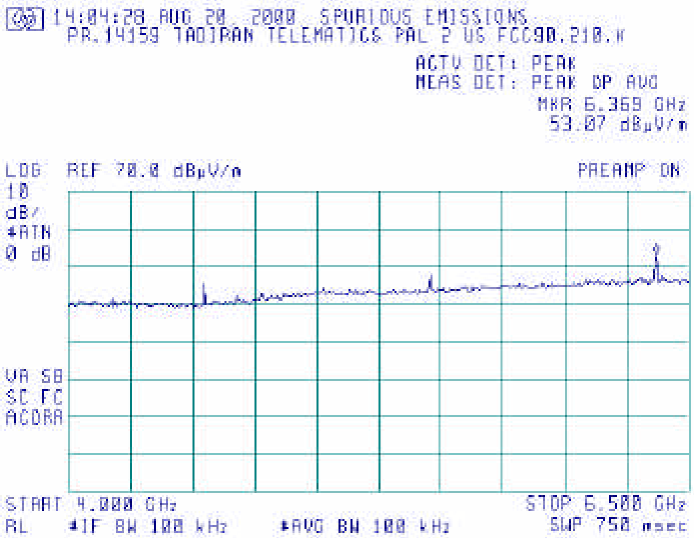
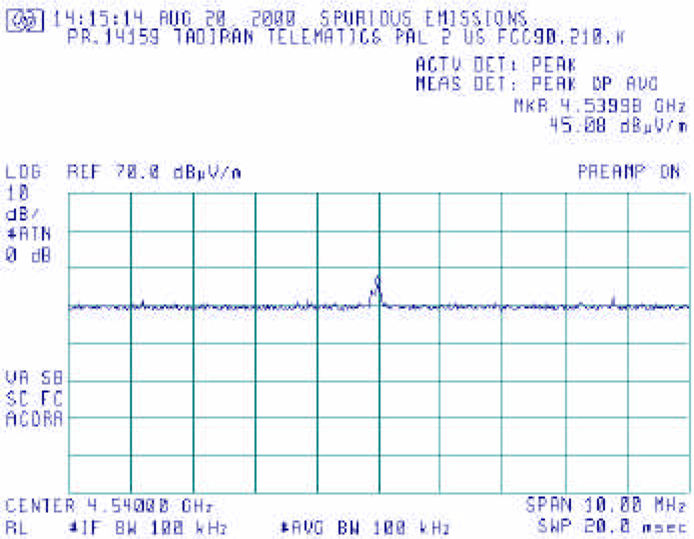
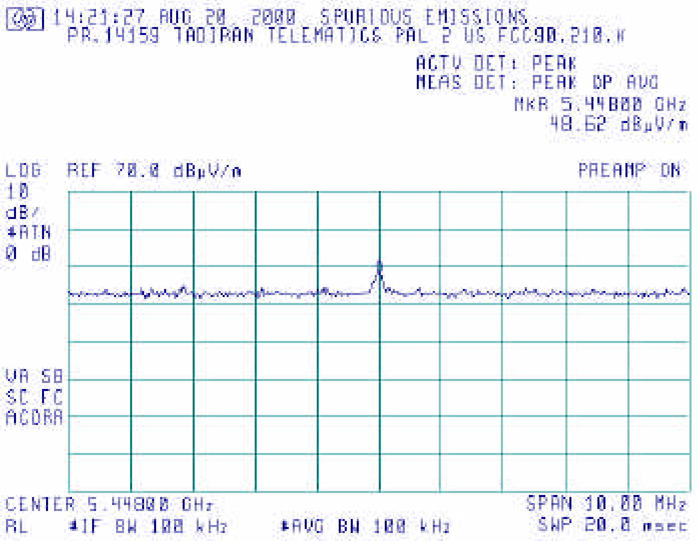
Plot 4.5.31
Frequency range 4 – 6.5 GHz,
ECM transmission mode



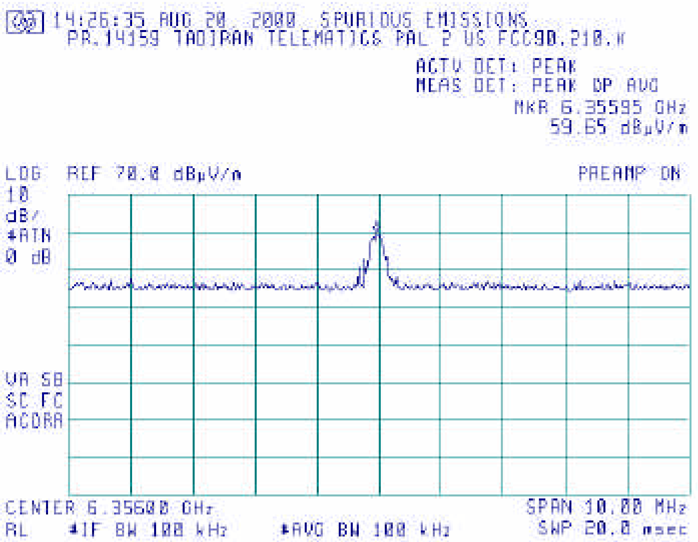
Plot 4.5.32
5th harmonic,
ECM transmission mode



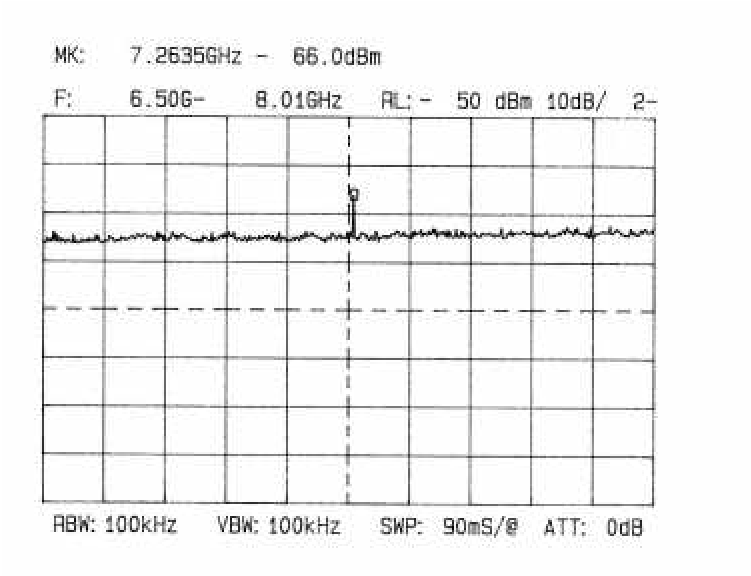
Plot 4.5.33
6th harmonic,
ECM transmission mode



Plot 4.5.34
7th harmonic,
ECM transmission mode

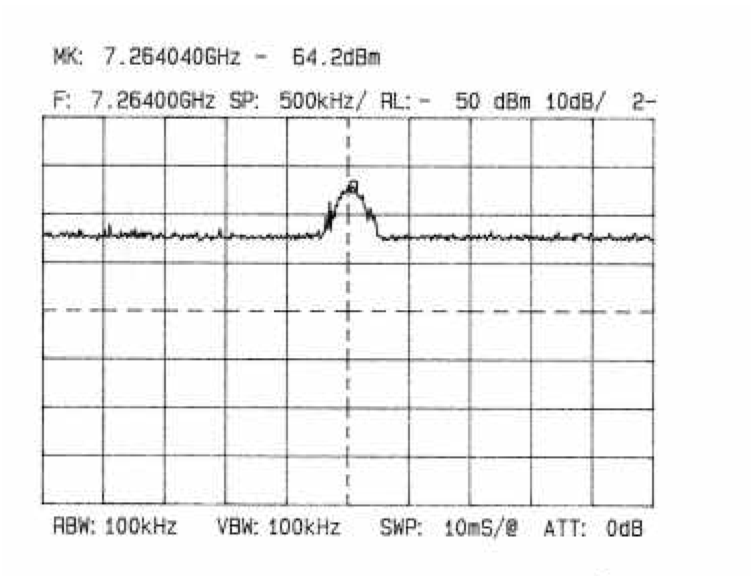


Plot 4.5.35
Frequency range 6.5 – 8 GHz,
ECM transmission mode



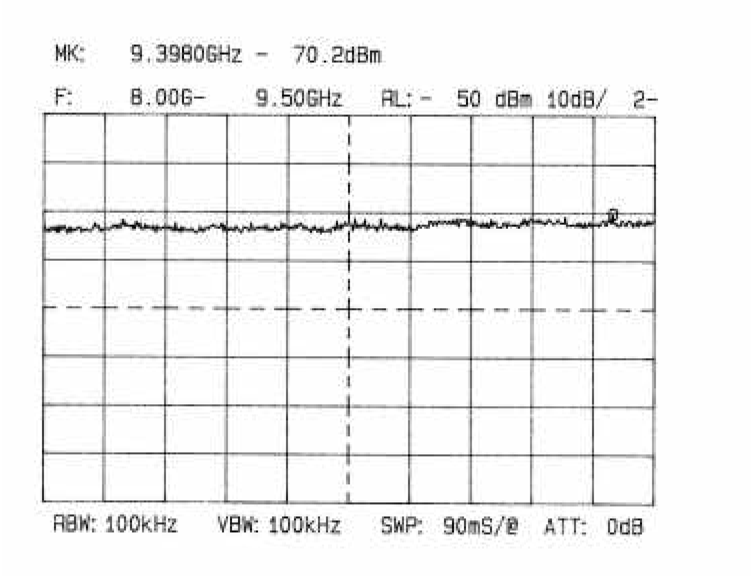
Amplifier gain 35 dB

Plot 4.5.36
8th harmonic,
ECM transmission mode

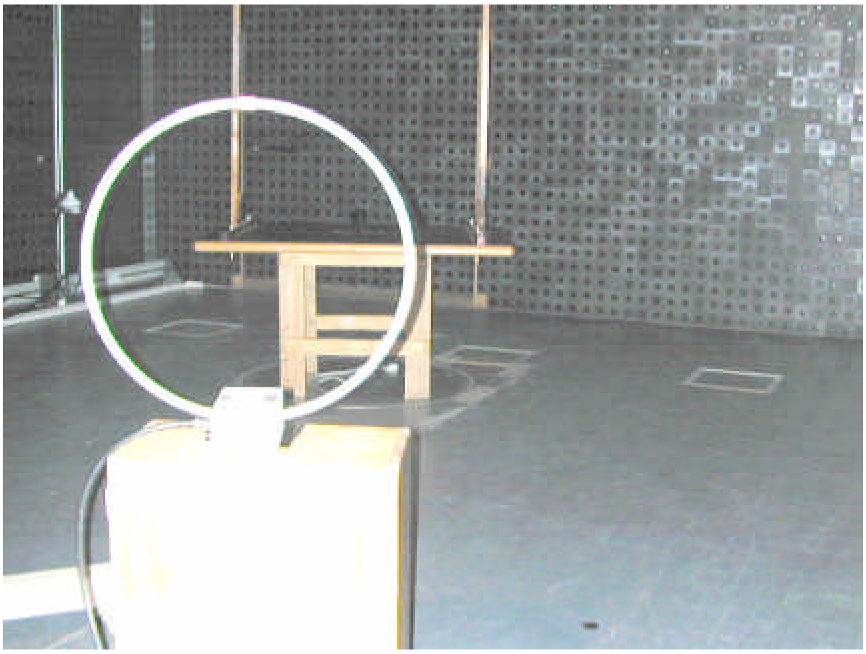


Amplifier gain 35 dB
AF = 35.7 dB, CL = 3.25 dB,
$E = V_{SA} + 107 + AF + CL - AG = 46.75$ dBmV/m

Plot 4.5.37
Frequency range 8 – 9.5 GHz,
ECM transmission mode

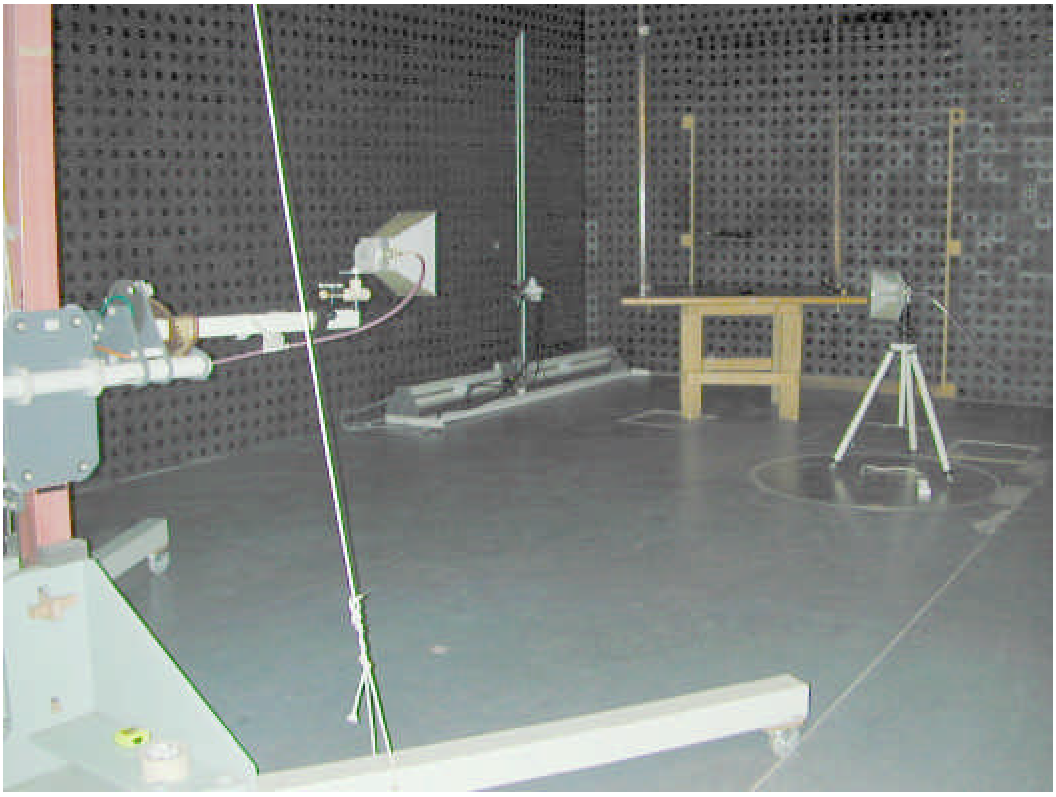


Photograph 4.5.1
Spurious emissions test setup,
9 kHz – 30 MHz frequency range



Photograph 4.5.2
Spurious emissions test setup,
1 – 10 GHz frequency range

Photograph 4.5.3
Harmonics measurement,
substitution method



4.6 Frequency stability measurements according to FCC part 90 paragraph 213

4.6.1 General

According to paragraph 90.213, the minimum frequency stability limit (in parts per million) is 2.5 for mobile equipment in frequency range 902 – 928 MHz.

For frequency 907997333 Hz the specified limit is 2270 Hz.

4.6.2 Test procedure

The EUT was set up as shown in Photographs 4.6.1, 4.6.2.

The frequency stability was investigated for various temperatures in the range from –30°C to +50°C.

Test results are recorded in Table 4.6.1.

The EUT was found to comply with requirements of paragraph 90.213.

Reference numbers of test equipment used

HL 0027	HL 0493	HL 0559	HL 1098

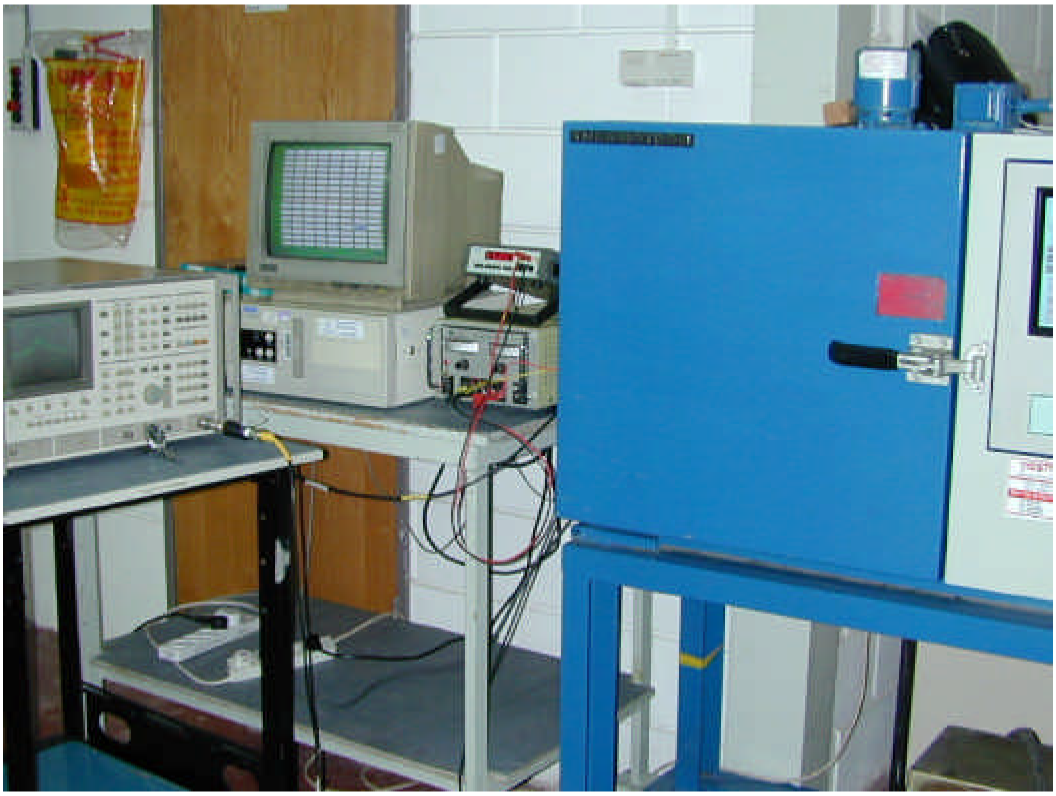
Full description is in Appendix A.

Table 4.6.1
Frequency stability test results

Temperature, °C	Voltage, V	Frequency, Hz	Displacement, Hz	Limit, Hz	Pass/ Fail
-30	5.2	907 997 287	-270	2270	Pass
-20	5.2	907 997 268	-289	2270	Pass
-10	5.2	907 997 395	-162	2270	Pass
0	5.2	907 997 587	30	2270	Pass
10	5.2	907 997 635	78	2270	Pass
20	5.2	907 997 556	-1	2270	Pass
24	4.5	907 997 505	-52	2270	Pass
24	5.2	907 997 557	Reference	Reference	–
24	5.6	907 997 553	-4	2270	Pass
30	5.2	907 997 417	-140	2270	Pass
40	5.2	907 997 309	-248	2270	Pass
50	5.2	907 997 257	-300	2270	Pass

Photograph 4.6.1
Frequency stability test setup

Photograph 4.6.2
Frequency stability test setup



APPENDIX A - Test equipment and ancillaries used for tests

HL Serial No.	Serial No.	Description	Manufacturer	Model No.	Due Calibr.
0025	5837	Spectrum Analyzer, 10 kHz-23 GHz	Anritsu	MS-710C	8/01
0027	4838	Spectrum analyzer, 50 Hz-2 GHz	Anritsu	MS-611A	10/00
0041	2811	Double Ridged Guide Antenna, 1-18 GHz	Electro-Metrics	RGA 50/60	8/01
0413	C-8	Cable, Coax, Microwave, DC-18 GHz, TNC-TNC, 4m	Gore	R3C01C01162 .6	2/01
0446	2857	Active Loop Antenna 10 kHz-30 MHz	Electro-Mechanics	6502	11/00
0447	0447	LISN, 16/2, 300 V RMS	Hermon Labs	LISN 16-1	12/00
0465	023	Anechoic Chamber 9 (L) x 6.5 (W) x 5.5 (H) m	Hermon Labs	AC-1	3/01
0493	4016	Oven temperature	Thermotron	S-1.2 Mini-Max	3/01
0521	0319	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A	7/01
0547	400	Amplifier, GaAs FET,RF 6-18 GHz,2 W30 dB,12 V/1.2 A, N.F4.5 dB	Avantek	AMT - 12407 M	12/00
0559	0903	Multimeter Digital	Fluke	Fluke 76	3/01
0589	589	Cable Coaxial, GORE A2POL118.2, 3m	Hermon Labs	GORE-3	11/00
0604	9611-1011	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141	7/01
0614	334	Antenna Dipole Tunable 200 –1000 MHz	Electro-Metrics	TDS 30-1/30-2	2/01
0661	0266	Generator Swept Signal, 10MHz to 40GHz+ 10dBm	Hewlett Packard	83640B	2/01
0672	027	Shielded Room 4.6(L) x 4.2(W) x2.4(H) m	Hermon Labs	SR-3	5/01 Check
0787	1877	Transient limiter	Hewlett Packard	11947A-8ZE	11/00
0817	153	Cable, coax, RG-58, 8 m, N-type connectors	Hermon Labs	C58-8	8/00
0872	8767	Cable coax	Amplifier Research	PFP01P01039 4	7/01
1003	161	Cable coaxial, M17/164, 10 m	Hermon Labs	C17164-10	3/00
1098	1098	Attenuator, 50 Ohm, 2W, DC to 1600 MHz, 6 dB	Bird	8305-300-N	8/01
1116	186	Double Ridged Guide Antenna, 1-18 GHz	Hermon Labs	A1-18	4/01
1175	NA	Microwave 5 m cable	Gore	01C02245.2	2/01
1176	NA	Microwave cable	Suhner	NA	2/01
1200	0240	Quadruplexer	Elettronica	UE 84	2/01

APPENDIX B-Test equipment correction factors

Correction factor
Line impedance stabilization network
model ANS-25/2
Electro-Metrics

Frequency, kHz	Correction Factor
10	4.9
15	2.86
20	1.83
25	1.25
30	0.91
35	0.69
40	0.53
50	0.35
60	0.25
70	0.18
80	0.14
90	0.11
100	0.09
125	0.06
150	0.04

The correction factor dB is to be added to the meter readings (dB/μv) of the interference analyzer or spectrum analyzer.

Antenna, Tunable Dipole. TDS-30 (HL 0614)
Antenna factor and antenna gain

F, MHz	AF	Gain
200	14.3	2.12
225	15.2	2.04
250	16.1	2.06
275	17.0	1.99
300	18.0	1.74
325	18.6	1.84
350	19.2	1.88
400	20.4	1.84
450	22.3	0.96
500	24.2	-0.02
500	23.7	0.48
550	24.1	0.91
600	24.0	1.76
700	24.5	2.60
800	27.0	1.26
900	27.6	1.68
1000	28.1	2.10

Antenna factor
Biconilog antenna EMCO, model 3141
Ser.No.1011

Frequency, MHz	Antenna Factor, dB(1/m)
26	7.8
28	7.8
30	7.8
40	7.2
60	7.1
70	8.5
80	9.4
90	9.8
100	9.7
110	9.3
120	8.8
130	8.7
140	9.2
150	9.8
160	10.2
170	10.4
180	10.4
190	10.3
200	10.6
220	11.6
240	12.4
260	12.8
280	13.7
300	14.7
320	15.2
340	15.4
360	16.1
380	16.4
400	16.6
420	16.7
440	17.0
460	17.7
480	18.1
500	18.5
520	19.1
540	19.5
560	19.8
580	20.6
600	21.3
620	21.5
640	21.2
660	21.4
680	21.9
700	22.2
720	22.2
740	22.1
760	22.3
780	22.6
800	22.7
820	22.9
840	23.1
860	23.4
880	23.8
900	24.1
920	24.1

Frequency, MHz	Antenna Factor, dB(1/m)
940	24.0
960	24.1
980	24.5
1000	24.9
1020	25.0
1040	25.2
1060	25.4
1080	25.6
1100	25.7
1120	26.0
1140	26.4
1160	27.0
1180	27.0
1200	26.7
1220	26.5
1240	26.5
1260	26.5
1280	26.6
1300	27.0
1320	27.8
1340	28.3
1360	28.2
1380	27.9
1400	27.9
1420	27.9
1440	27.8
1460	27.8
1480	28.0
1500	28.5
1520	28.9
1540	29.6
1560	29.8
1580	29.6
1600	29.5
1620	29.3
1640	29.2
1660	29.4
1680	29.6
1700	29.8
1720	30.3
1740	30.8
1760	31.1
1780	31.0
1800	30.9
1820	30.7
1840	30.6
1860	30.6
1880	30.6
1900	30.6
1920	30.7
1940	30.9
1960	31.2
1980	31.6
2000	32.0

Antenna factor is to be added to receiver meter reading in dB(μV) to convert to field intensity in dB(μV/meter).

Antenna factor
Double ridged guide antenna, model A1-18
S/N 186

Freq, MHz	ANTENNA FACTOR, dB(1/m)
1000.0	24.6
1500.0	26.4
2000.0	29.7
2500.0	31.1
3000.0	31.5
3500.0	32.7
4000.0	36.1
4500.0	36.1
5000.0	39.9
5500.0	40.5
6000.0	40.4
6500.0	41.0
7000.0	41.2
7500.0	41.2
8000.0	44.3
8500.0	40.7
9000.0	39.3
9500.0	41.3
10000.0	42.8
10500.0	43.8
11000.0	47.0
11500.0	46.3
12000.0	43.4
12500.0	41.8
13000.0	41.9
13500.0	44.5
14000.0	44.8
14500.0	44.9
15000.0	44.4
15500.0	43.4
16000.0	42.6
16500.0	43.6
17000.0	42.3
17500.0	45.9
18000.0	45.3

Antenna Factor
Active Loop Antenna
Model 6502
S/N 2857

Frequency, MHz	Antenna Factor, dB
0.009	-32.8
0.010	-33.8
0.020	-38.3
0.050	-41.1
0.075	-41.3
0.100	-41.6
0.150	-41.7
0.250	-41.6
0.500	-41.8
0.750	-41.9
1.000	-41.4
2.000	-41.5
3.000	-41.4
4.000	-41.4
5.000	-41.5
10.000	-41.9
15.000	-41.9
20.000	-42.2
25.000	-42.8
30.000	-44.0

Antenna factor is to be added to receiver meter reading in dB(μV) to convert to field intensity in dB(μV)/meter