ELECTROMAGNETIC EMISSIONS TEST REPORT

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

for

Miltel Communications Ltd.

EQUIPMENT UNDER TEST:

Transmitter of automatic meter reading system, model Speed HPTx

FCC ID: MLLSPEEDHPTX15-17

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ACCREDITED
839.01
Electrical

Description of equipment under test

Test items	Transmitter of automatic meter reading system
Manufacturer	Miltel Communications Ltd.
Types (Models)	Speed HPTx
Receipt date	August 6, 2000

Applicant information

Applicant's representative	Mr. Erez Sharabi, project manager
Applicant's responsible person	Mr. Yarum Locker, general manager
Company	Miltel Communications Ltd.
Address	7 Leshem street
P.O.Box	7374
Postal code	49170
City	Petach Tikva
Country	Israel
Telephone number	+972 3926 9550
Telefax number	+972 3924 6550

Test performance

Project Number:	14186
Location	Hermon Laboratories
Test started	August 6, 2000
Test completed	January 15, 2001
Purpose of test	The EUT certfiication in accordance with CFR 47, part 2, §2.1033; part 90 subpart I,
Test specification(s)	FCC part 90 subpart I, §§90.205, 90.209, 90.210, 90.211, 90.213; part 15 subpart B §15.109

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1 Summary and signatures

The EUT, transmitter Speed HPTx of automatic meter reading system, was tested according to FCC part 90 subpart I, §§90.205, 90.209, 90.210, 90.213, part 15 subpart B §15.109 and found to comply with the standard requirements.

Test description	Specification reference	Test report paragraph	Pass / Fail
RF output power	90.205, 2.1046	4.1	Pass
Occupied bandwidth	90.209 2.1049	4.2	Pass
Emission mask	90.210	4.3	Pass
Conducted spurious emissions	90.210 2.1051	4.3	Pass
Radiated spurious emissions	90.210 2.1053	4.3	Pass
Modulation characteristics	2.1047	4.3	Pass
Frequency stability vs temperature	90.213 2.1055	4.4	Pass
Frequency stability vs voltage	2.1055	4.4	Pass
Radiated emissions	15.109	4.5	Pass

Test report prepared by:

Mrs. Marina Cherniavsky, certification engineer

Test report approved by:

Mr. Michael Nikishin, EMC group leader

Dr. Edward Usoskin, C.E.O.

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.

2 General information

2.1 Abbreviations and acronyms

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

cm	centimeter
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
m	meter
MHz	megahertz
MW	milliwatt
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
VCO	volt control oscillator
W	watt

2.2 Specification references

CFR 47 part 15: 10/1999	Radio Frequency Devices
CFR 47 part 90: 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 kHz 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, Speed HPTx, is a data link transmitter that is used for data acquisition in Miltel's water consumption readings collection system. The automatic meter reading system is a fully computerized radio device. It requires no human intervention after initial installation. The system enables remote, continuous and accurate reading of water consumption. The Speed HPTx transmits the data acquired from water meters to a regional concentrator. The concentrator transfers the data to the central computer for data collection and for further analysis and reporting. The transmitter is powered by an internal 3.6 V lithium battery and can be connected to several meters (e.g. water) in parallel. The transmitter is enclosed in a plastic enclosure. An integral wire antenna soldered to the internal Printed Circuit Board is used.

2.3.1 Changes made in EUT

To withstand the standard requirements the temperature compensation was added to the VCO.

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-1082 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 4628 8001
Fax: +972 4628 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

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 1996 with an M. Sc. EE degree and certified by the National Association of Radio and Telecommunications Engineers, Inc. as an EMC accredited test laboratory engineer, the certificate No. is ATL–0005–E.
I have obtained 3 years experience in EMC measurements and have been with Hermon Laboratories since 1998.

Name: Mr. Michael Nikishin Signature: _____
Position: EMC group leader Date: January 30, 2001

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 am an engineer, graduated from university in 1971, with an MScEE degree, have obtained 28 years experience in electronic products design and development, have been with Hermon Laboratories since 1991. Also, I am a telecommunication class II engineer certified by the National Association of Radio and Telecommunications Engineers, Inc. (USA.), the certificate no. is E2-03410.

Name: Mrs. Marina Cherniavsky Signature: _____
Position: technical writer Date: January 30, 2001

4 Emissions measurements

4.1 Effective radiated power measurements according to FCC part 90 paragraph 205(d)

4.1.1 General

This test was performed to determine maximal effective radiated power. The standard maximum allowable ERP is 1 W (30 dBm).

4.1.2 Test procedure

The test was performed in the anechoic chamber with biconilog antenna at 3-meter test distance, i.e. the distance between measuring antenna and EUT boundary as shown in Figure 4.1.1, Photographs 4.1.1, 4.1.2. The EUT in transmission mode was installed on the 0.8 m high wooden table placed on the metal turntable flush mounted with the ground plane. The transmitter was tested in 3 orthogonal positions. To find the maximum radiation measuring antenna height was changed from 1 to 4 m, the turntable was rotated 360° and the antennas polarization was changed from vertical to horizontal.
The field strength generated by the EUT was measured at 3 unmodulated carrier frequencies (low, middle, high) 150.3 MHz, 160.2 MHz and 169.8 MHz. The EUT was tested by the substitution method with dipole antenna. The EUT was replaced with calibrated antenna connected to signal generator. The signal generator output levels corresponded to measured field strength were recorded and the power was calculated from equation:

$$ERP = P_{out\ gen} - \text{Cable loss} + \text{Antenna gain}.$$

The measured field strength result 110.36 dBμV/m (see Plot 4.1.1) at frequency 169.8 MHz corresponds to 17.2 dBm output power of the signal generator. Maximum ERP was calculated from equation:

$ERP_{max} = P_{out\ gen}$ – Cable loss + Antenna gain = 17.2 dBm – 1.6 dB + 0.91 dB = 16.51 dBm = 44.8 mW.

The test results are recorded in Table 4.1.1 and are shown in Plots 4.1.1 to 4.1.6. The EUT was found to be in compliance with the standard requirements and passed the test.

Reference numbers of test equipment used

HL 0030	HL 0465	HL 0521	HL 0604	HL 0614	HL 0661	HL 1447

Full description is in Appendix A.

Table 4.1.1 Effective radiated power measurement test results

DATE: January 4, 2001
RELATIVE HUMIDITY: 49%
AMBIENT TEMPERATURE: 23°C

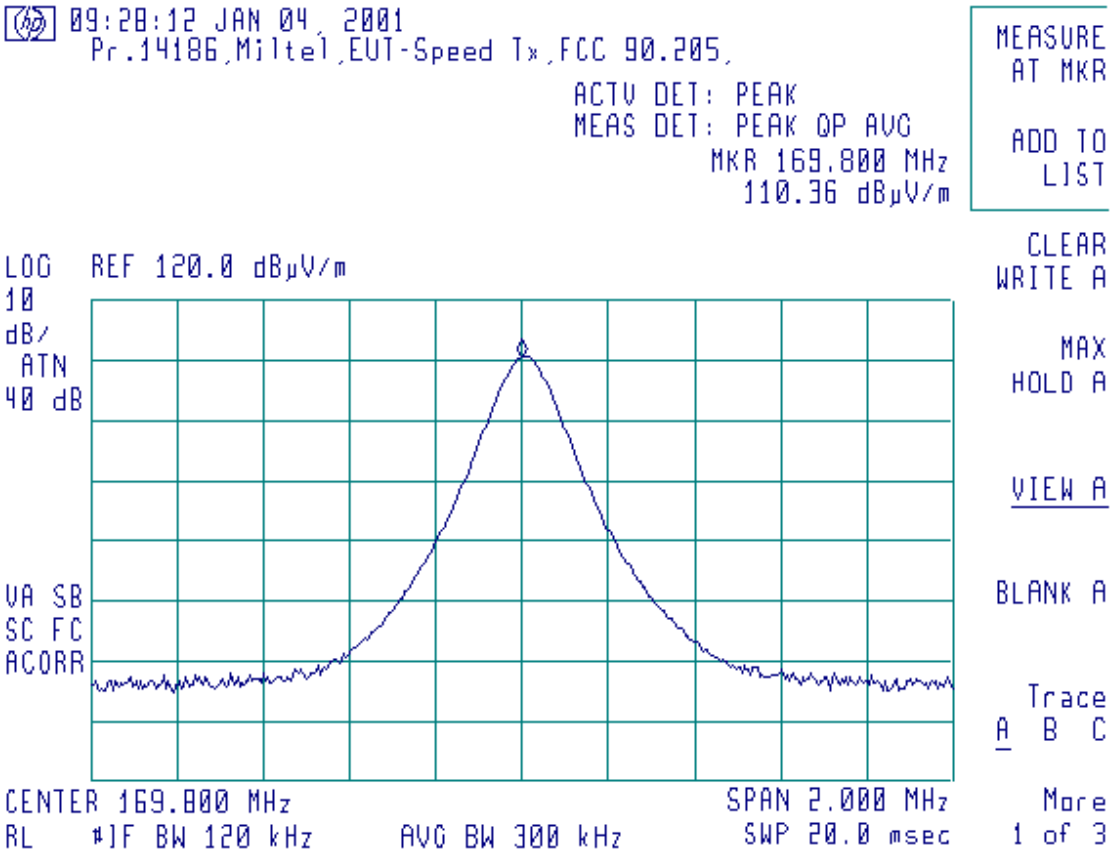
MEASUREMENTS PERFORMED AT 3 METRES DISTANCE

Frequency, MHz	Antenna pol.	Radiated measured result, dBµV/m	Antenna gain, dB	Cable loss, dB	Gener. P_{out} dBm	ERP, dBm	Spec. limit, dBm	Margin, dB	Pass/ Fail
150.3	H	108.57	1.02	1.6	10.5	9.92	30	20.08	Pass
150.3	V	108.33	1.02	1.6	13.5	12.92	30	17.08	Pass
160.2	H	111.15	0.98	1.6	13.15	12.53	30	17.47	Pass
160.2	V	110.00	0.98	1.6	16.8	15.38	30	14.62	Pass
169.8	H	113.96	0.91	1.6	16.0	15.31	30	14.49	Pass
169.8	V	110.36	0.91	1.6	17.2	16.51	30	13.49	Pass

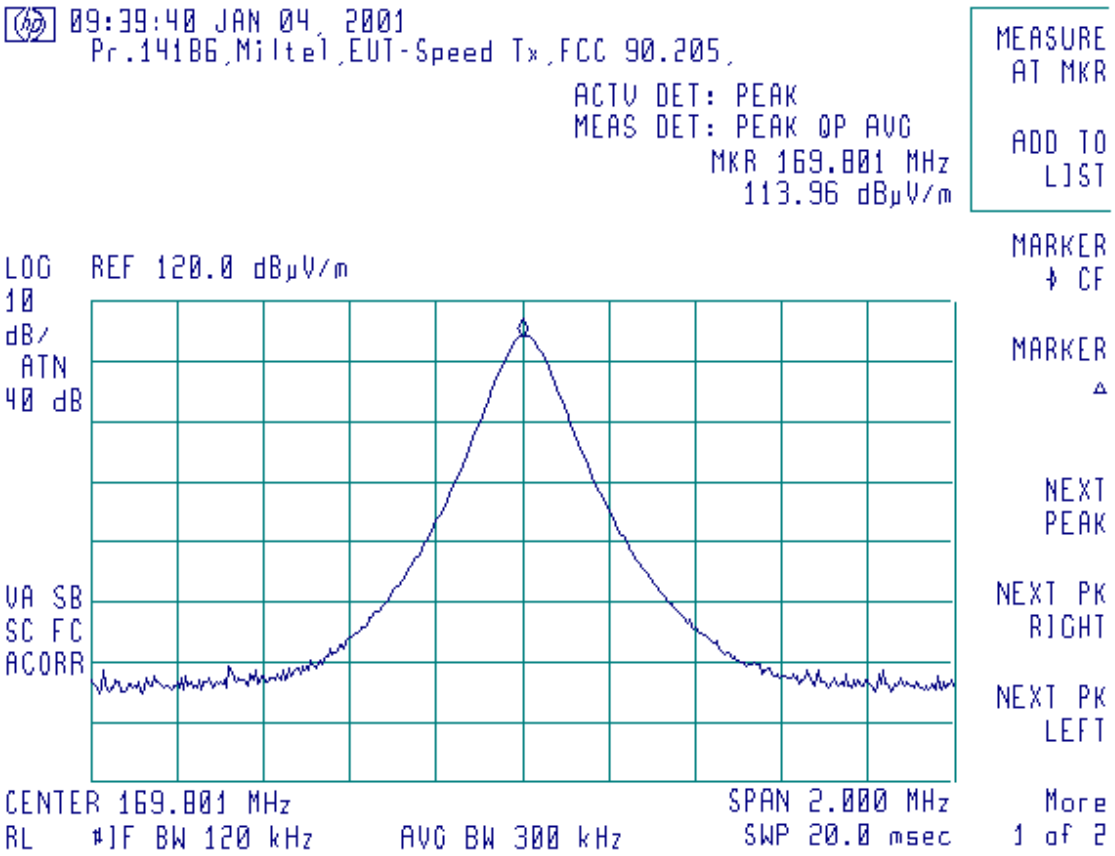
Test parameters:
Test results listed in the table were obtained throughout the testing with dipole antenna, peak detector and resolution bandwidth 120 kHz.

Table calculations and abbreviations:
ERP (dBm) = P_{out} (dBm) – cable loss (dB) + antenna gain (dB)
Margin = dB below (negative if above) specification limit.

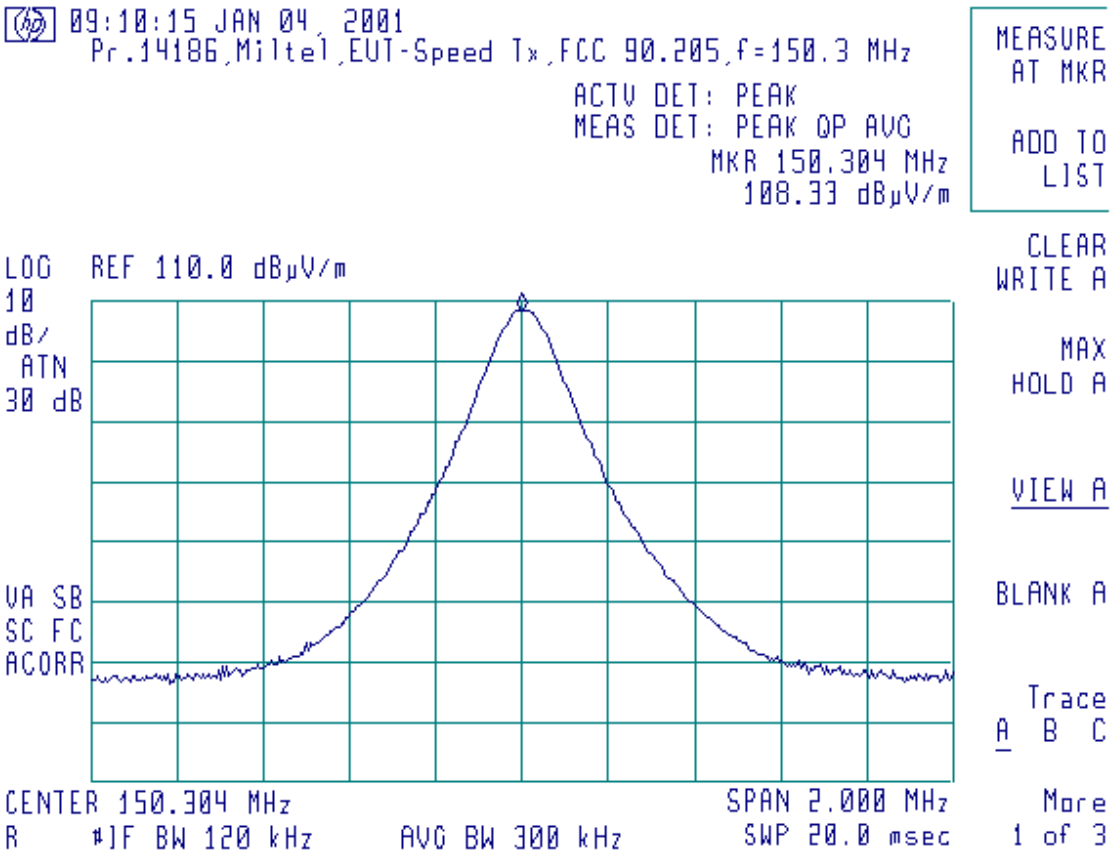
Plot 4.1.1 Electric field strength measurement test results at 169.8 MHz



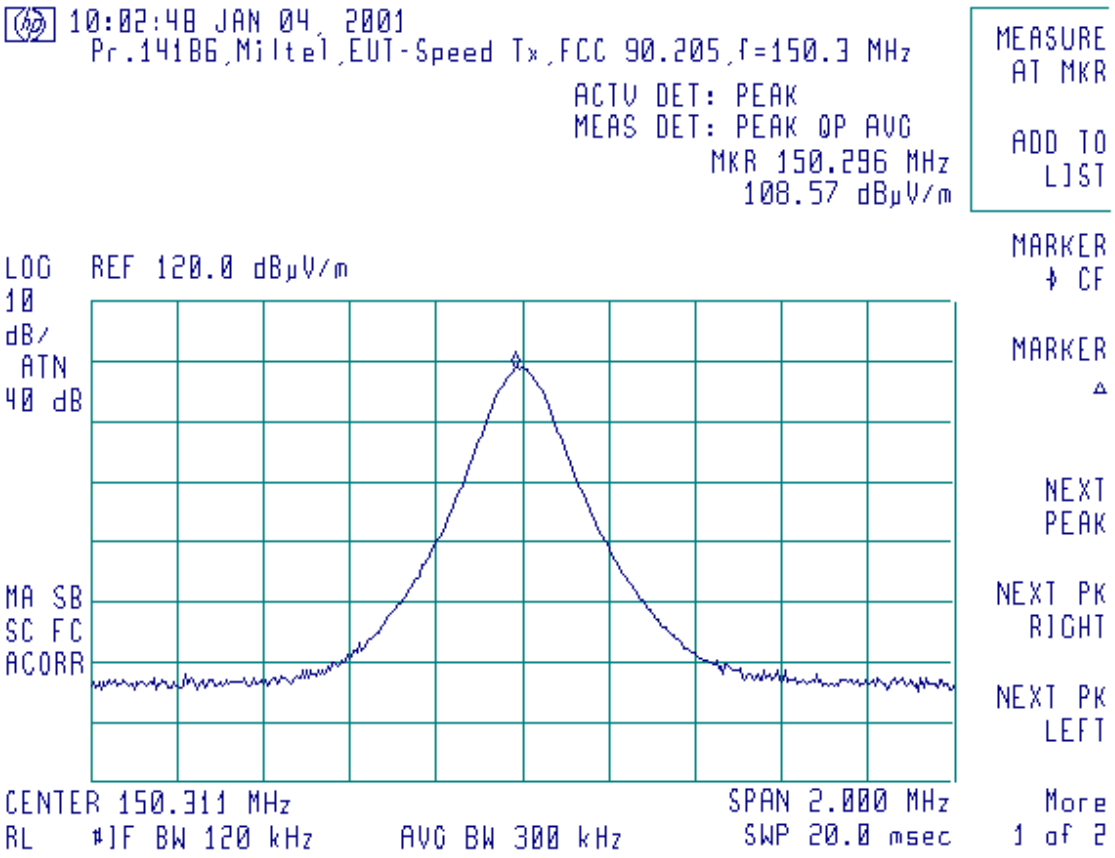
Plot 4.1.2 Electric field strength measurement test results at 169.8 MHz



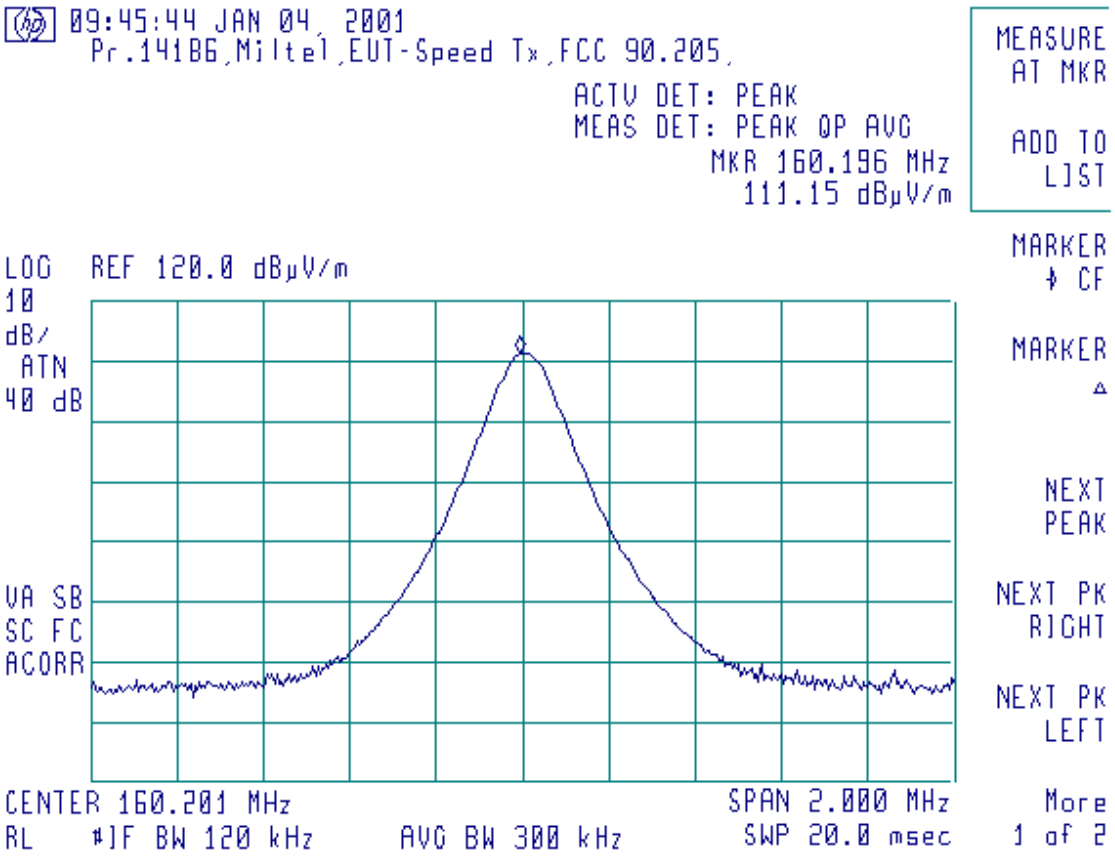
Plot 4.1.3 Electric field strength measurement test results at 150.3 MHz



Plot 4.1.4 Electric field strength measurement test results at 150.3 MHz



Plot 4.1.5 Electric field strength measurement test results at 160.2 MHz



Plot 4.1.6 Electric field strength measurement test results at 160.2 MHz

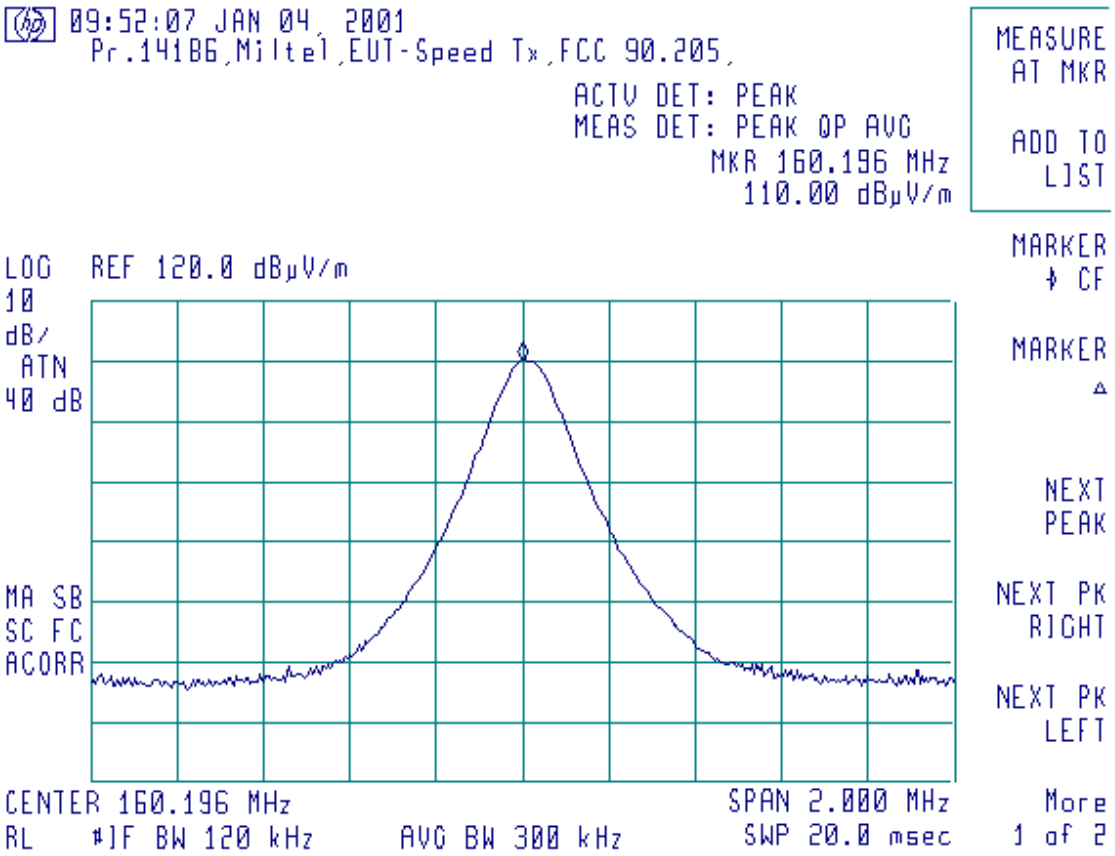
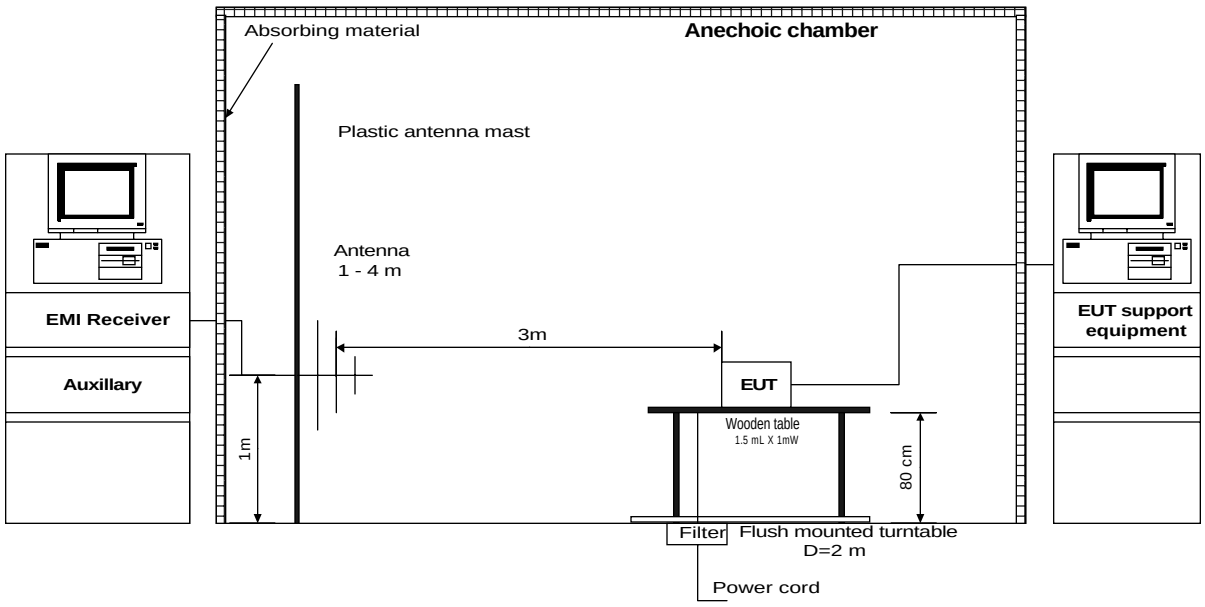
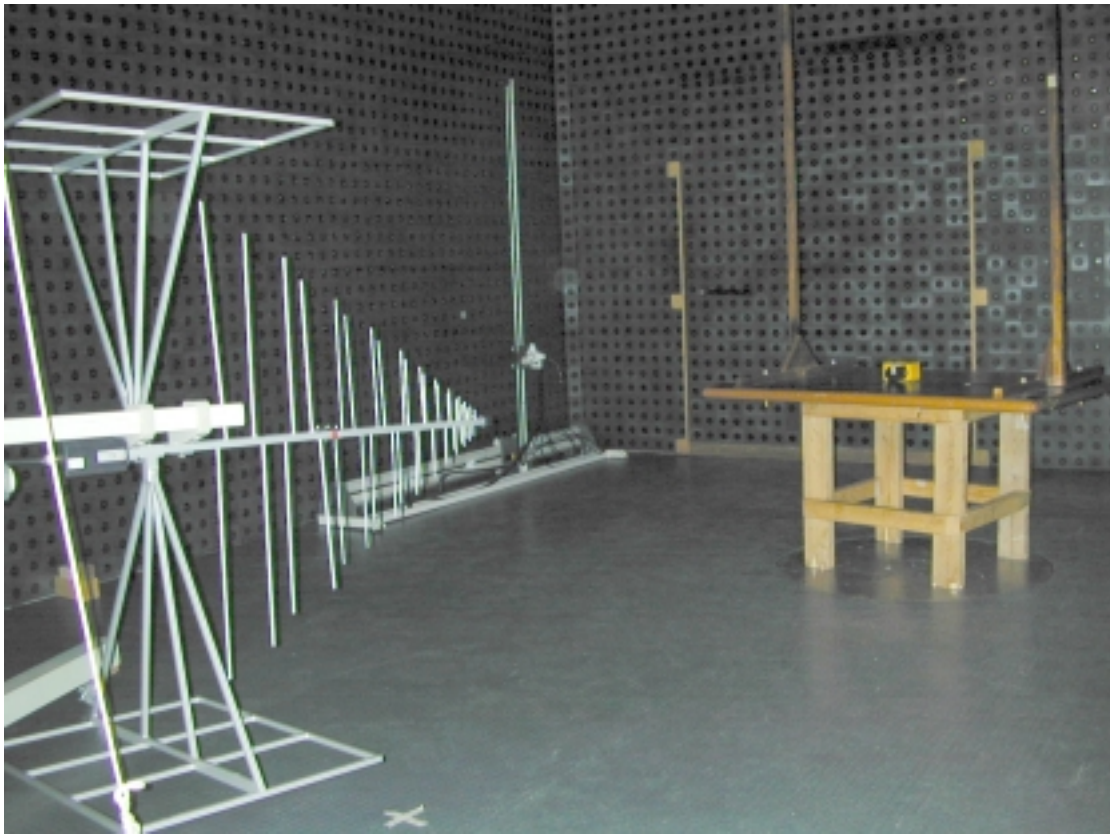


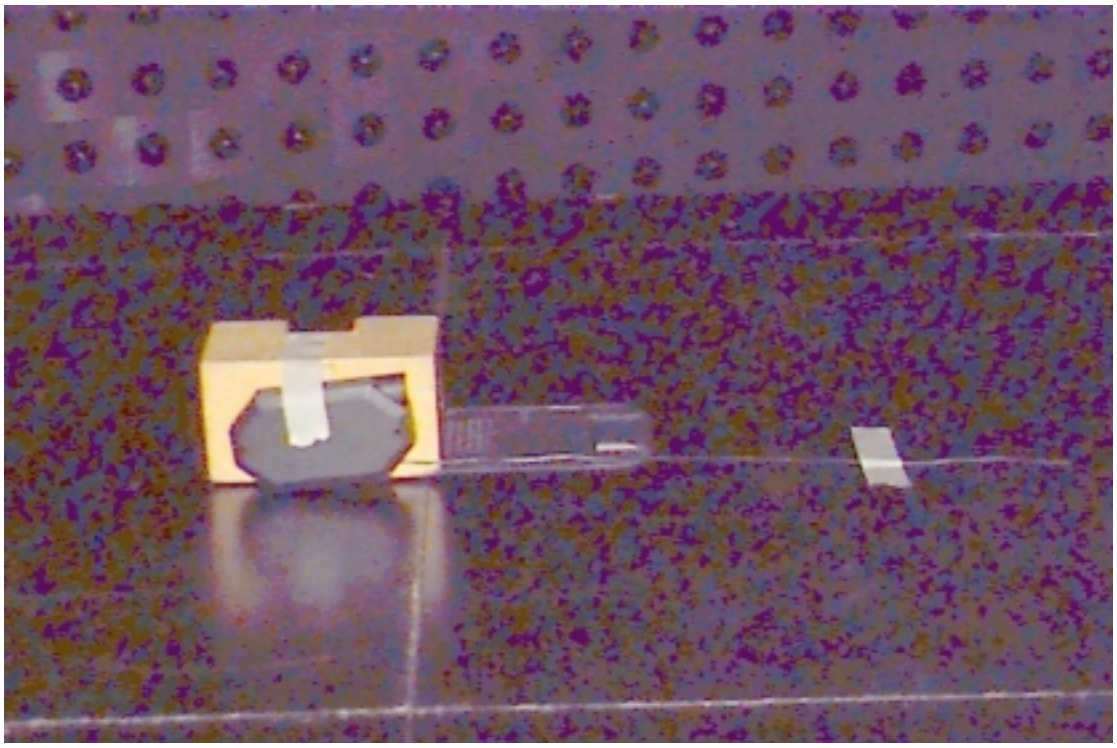
Figure 4.1.1
Set up for ERP measurement



Photograph 4.1.1
Set up for ERP measurement



Photograph 4.1.2
Set up for ERP measurement



4.2 Occupied bandwidth measurements according to FCC part 90 paragraph 209

4.2.1 General

According to paragraph 90.209 (5) the maximum authorized bandwidth shall be 20 kHz in the 150 – 174 MHz frequency band.

4.2.2 Test procedure

The measurements were performed using spectrum analyzer.

The occupied bandwidth was measured as a frequency band between points where power envelope of carrier, modulated with normal signal, drops 23 dB below unmodulated carrier.

Measured occupied bandwidth was 13.15 kHz for low channel frequency.

The test results are recorded in Table 4.2.1 and shown in Plots 4.2.1 to 4.2.3.

Table 4.2.1
Occupied bandwidth measurements

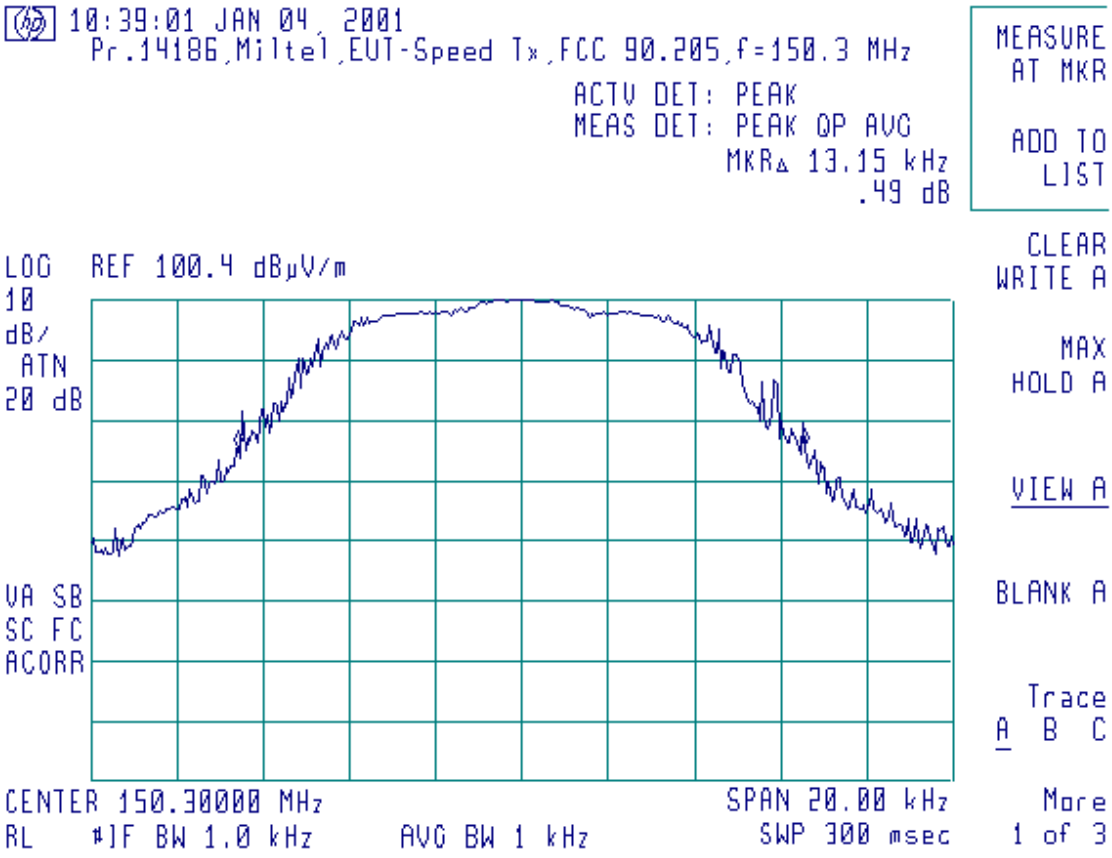
Frequency, MHz	OBW, kHz	Pass / Fail
150.3	13.15	Pass
160.2	11.45	Pass
169.3	11.05	Pass

Reference numbers of test equipment used

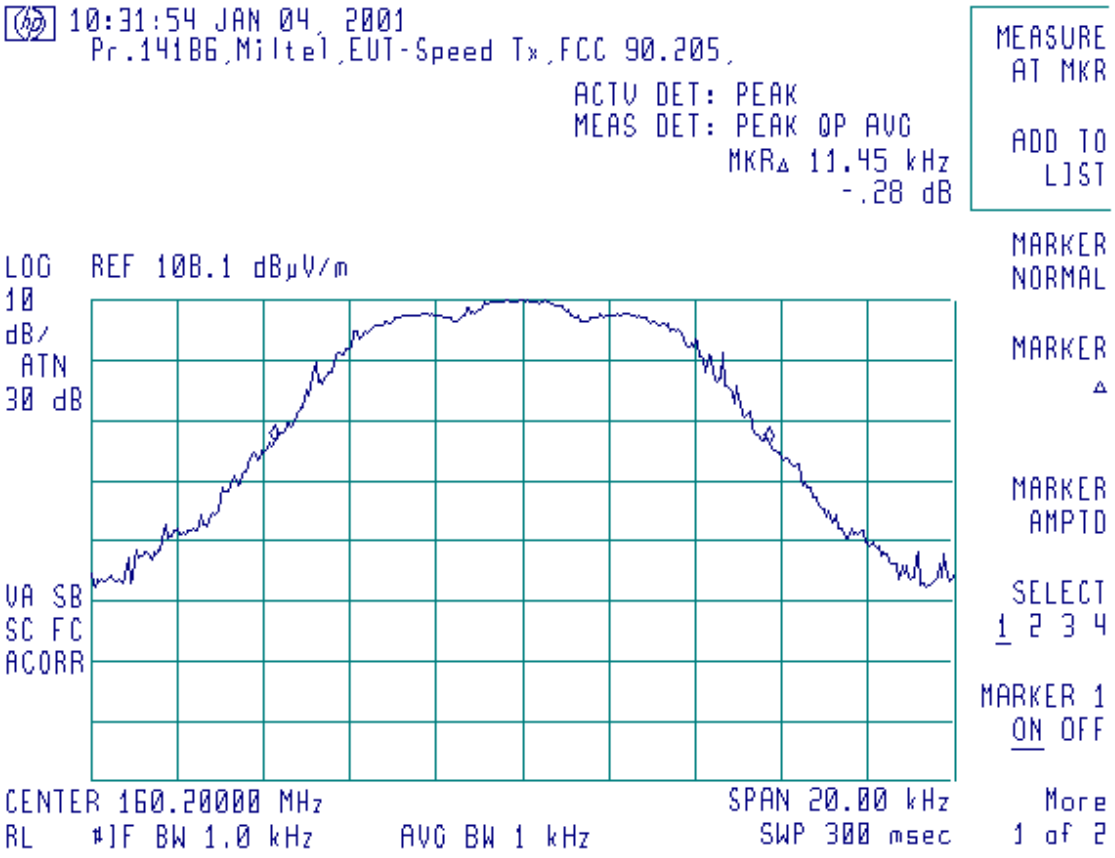
HL 0465	HL 0521	HL 0604			

Full description is in Appendix A.

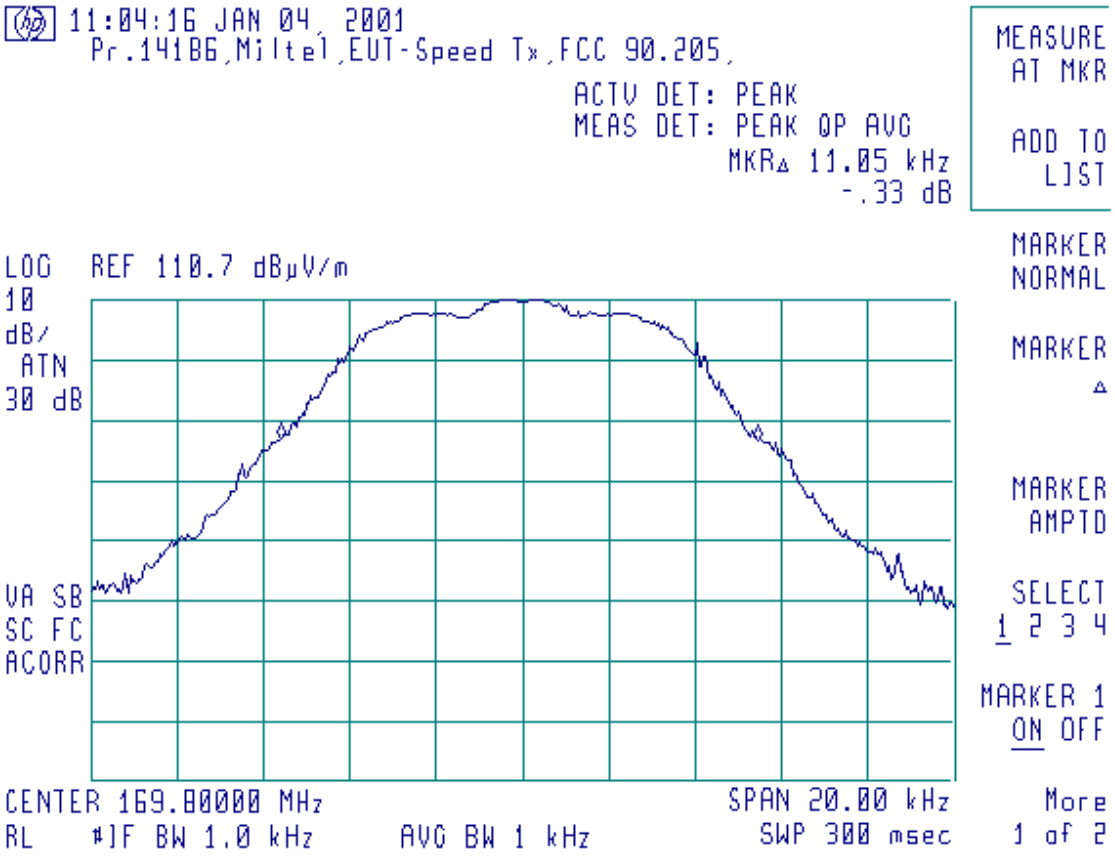
Plot 4.2.1
Occupied bandwidth measurements test result



Plot 4.2.2
Occupied bandwidth measurements test result



Plot 4.2.3
Occupied bandwidth measurements test result



4.3 Emission mask according to FCC part 90 paragraph 210(c)

4.3.1 General

The power of any emission must be attenuated below the transmitter unmodulated carrier output power (P in watts) as follows:

1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: at least 83 log (f_d /5) dB;
2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: 29 log (f_d^2/11) dB or 50 dB, whichever is the lesser attenuation;
3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth by at least 43 + 10 log (P) dB.

4.3.2 Test procedure

The emission mask, calculated according to formulas (1) – (3) is shown in Table 4.3.1 and Plots 4.3.1 to 4.3.3.
Radiated spurious emissions were measured in the anechoic chamber at 3-m test distance: with loop antenna in the range 9 kHz to 30 MHz and biconilog antenna in the range 30 MHz to 2000 MHz as shown in Photographs 4.3.1 to 4.3.3.
Maximum permitted output power level is 1 W.
As defined in paragraph 90.209 (5), the maximum authorized bandwidth is 20 kHz, hence ±250% of this bandwidth is equal to ±50 kHz.
The specified limit 43 + 10 log (P) was converted in EIRP units – 13 dBm and in field strength units as follows:

E = sqrt(30P) /r, where P = –13 dBm = 0.05 mW = 5×10^{-5} W.

E [dBμV/m] = 20 log {10^6 x sqrt ($30x5x10^{-5}$)/3} = 82.2 dBμV/m.

This limit was applied to spurious emissions throughout the following frequency ranges:
9 kHz to 150.25 MHz and 150.35 MHz to 2 GHz,
9 kHz to 160.15 MHz and 160.25 MHz to 2 GHz,
9 kHz to 169.75 MHz and 169.85 MHz to 2 GHz - according to paragraph 2.1057, a1.

The EUT was set up on the wooden table, as shown in Figure 4.3.2.
To find maximum radiation the turntable was rotated 360°, the measuring antenna height varied from 1 to 4 m and the antennas polarization was changed from vertical to horizontal.

The received values were compared with calculated field strength limit E = 82.2 dBμV/m and the results, which were found closer than 10 dB to the limit, were measured by means of substitution method.
The test results are recorded in Table 4.3.2 and shown in Plots 4.3.1 to 4.3.9. The EUT was found to comply with standard requirements.

Reference numbers of test equipment used

HL 0465	HL 0521	HL 0604	HL 0614	HL 1424

Full description is in Appendix A.

Table 4.3.1
Emission mask limit

Date/Time:	January 4 2001 5:00:19 PM
Ambient Temperature:	22 Deg. C
Relative Humidity:	49%
Test Name:	Emission mask
Customer:	Miltel
Test Specification:	FCC 90.210(c)
EUT:	Speed Tx
Operator Name:	Nikishin M.
Notes:	Limit table

FCC90.210C

	SEG #	FREQ (MHz)	UPPER (dBm)	LOWER (dBm)	TYPE
->	1	-.0500	-50.0	-175.0	FLT
	2	-.0241	-50.0	-175.0	SLP
	3	-.0100	-27.8	-175.0	SLP
	4	-.0100	-25.0	-175.0	SLP
	5	-.0050	0.0	-175.0	FLT
	6	0.0000	0.0	-175.0	FLT
	7	0.0050	0.0	-175.0	SLP
	8	0.0100	-25.0	-175.0	SLP
	9	0.0100	-27.8	-175.0	SLP
	10	0.0241	-50.0	-175.0	FLT
	11	0.0500	-50.0	-175.0	FLT
	12				

SELECT SEGMENT NUMBER : 1

Table 4.3.2
Radiated spurious emissions test results

TEST SPECIFICATION: FCC part 90, subpart I
DATE: January 4, 2001
RELATIVE HUMIDITY: 49%
AMBIENT TEMPERATURE: 22°C

MEASUREMENTS PERFORMED AT 3-METER DISTANCE

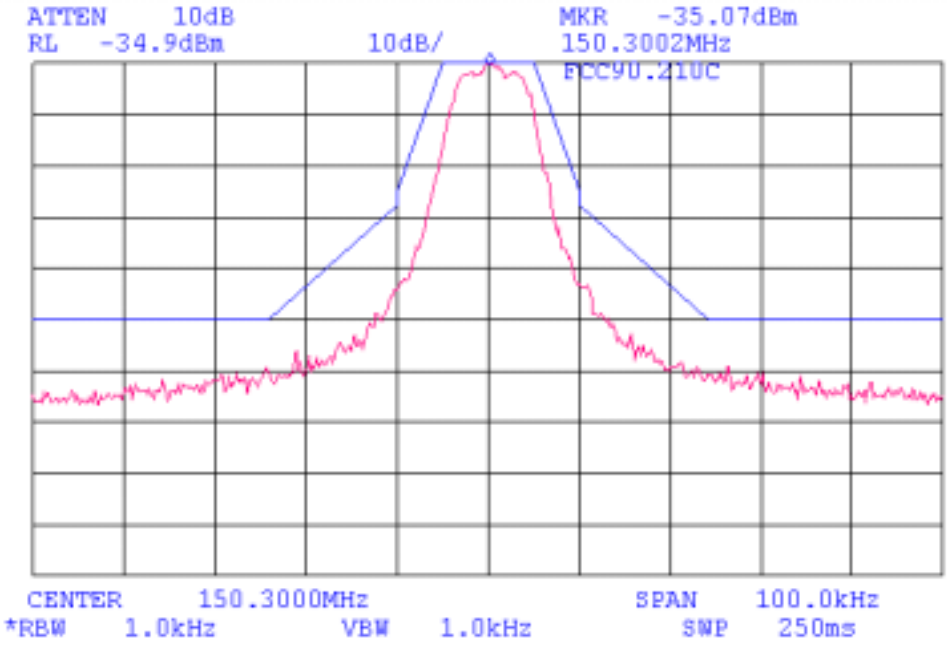
Frequency MHz	Ant. type	Ant. pol.	Measured result dB(μV/m)	Antenna gain dB	Cable loss dB	Gen. P out dBm	ERP dBm	Limit dBm	Margin dB	Pass/ Fail
300.624	TD	H	71.23	1.74	2.1	-28.2	-28.56	-13	15.56	Pass

Test parameters:
Detector type = Peak.
Resolution bandwidth = 120 kHz below

Table calculations and abbreviations:
ERP (dBm) = P out gen. (dBm) – Cable loss (dB) + Antenna gain (dB).
Ant. pol. = antenna polarization (H- horizontal)
Ant. type = antenna type (TD – tunable dipole).
Margin = dB below (negative if above) limit.

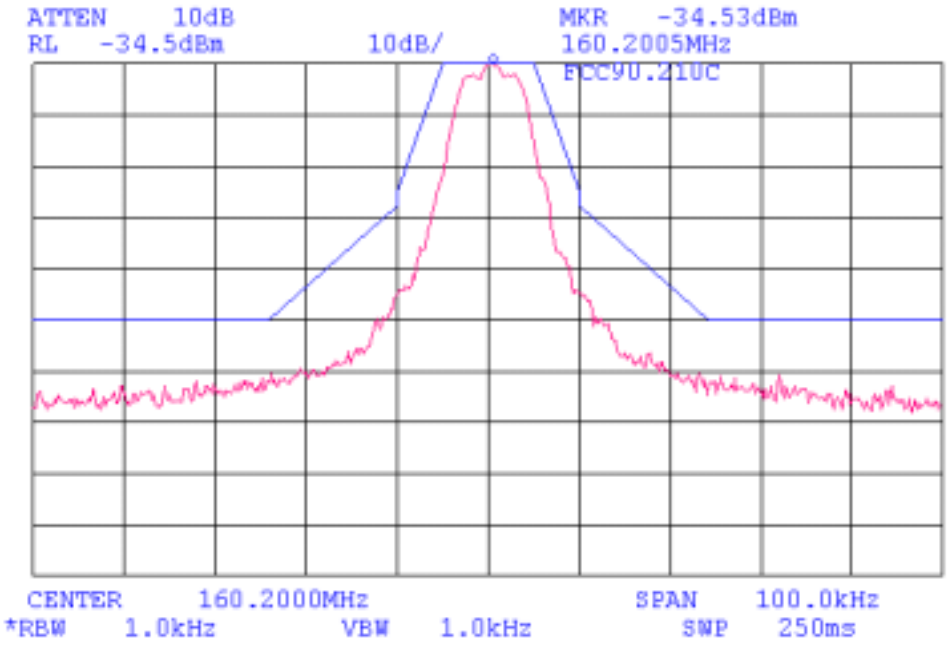
Plot 4.3.1
Emission mask test results

Date/Time:	January 4 2001 4:27:41 PM
Ambient Temperature:	22 Deg. C
Relative Humidity:	49%
Test Name:	Emission mask
Customer:	Miltel
Test Specification:	FCC 90.210(c)
EUT:	Speed Tx
Operator Name:	Nikishin M.
Notes:	Low channel 150.3 MHz



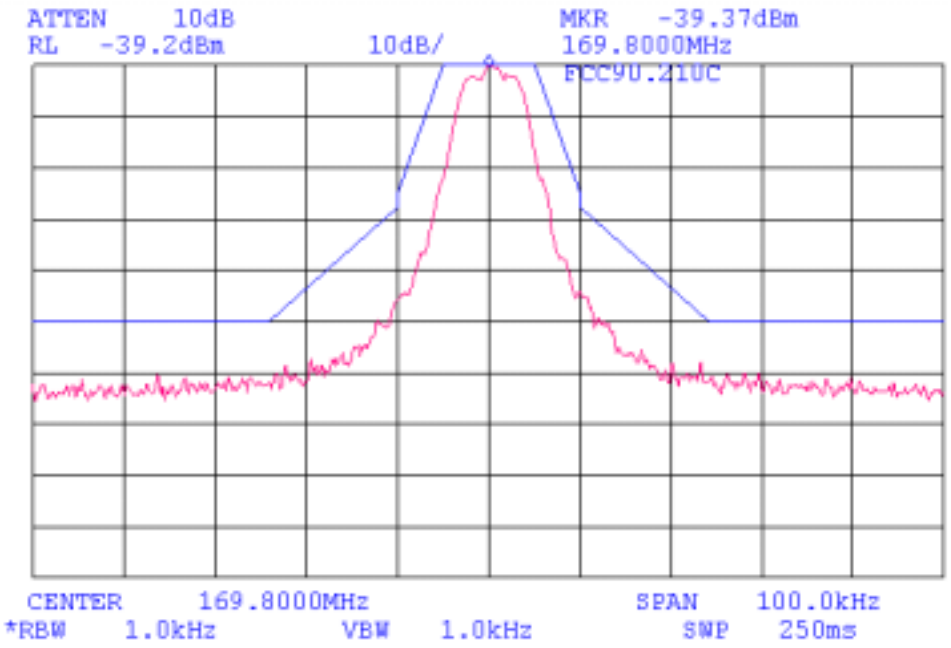
Plot 4.3.2
Emission mask test results

Date/Time:	January 4 2001 4:27:41 PM
Ambient Temperature:	22 Deg. C
Relative Humidity:	49%
Test Name:	Emission mask
Customer:	Miltel
Test Specification:	FCC 90.210(c)
EUT:	Speed Tx
Operator Name:	Nikishin M.
Notes:	Mid channel 160.2 MHz



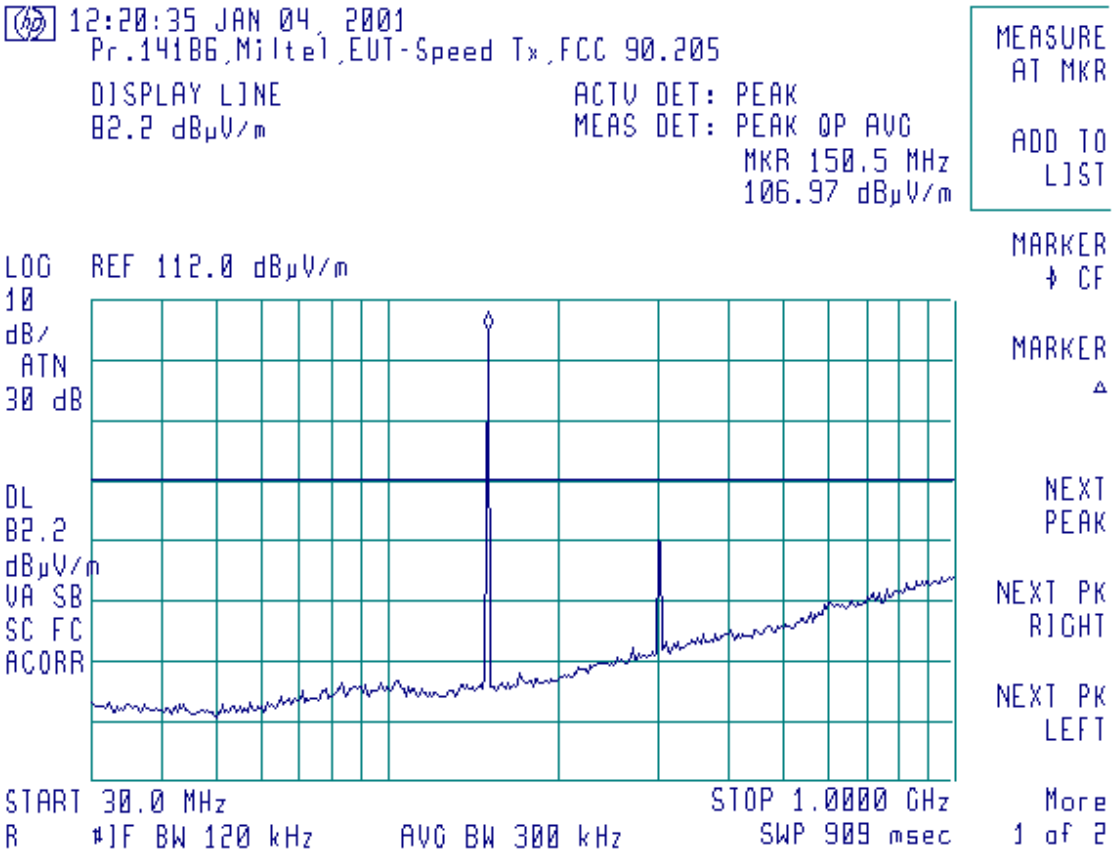
Plot 4.3.3
Emission mask test results

Date/Time:	January 4 2001 4:47:33 PM
Ambient Temperature:	22 Deg. C
Relative Humidity:	49%
Test Name:	Emission mask
Customer:	Miltel
Test Specification:	FCC 90.210(c)
EUT:	Speed Tx
Operator Name:	Nikishin M.
Notes:	High channel 169.8 MHz



Plot 4.3.4
Spurious emissions measurement test results

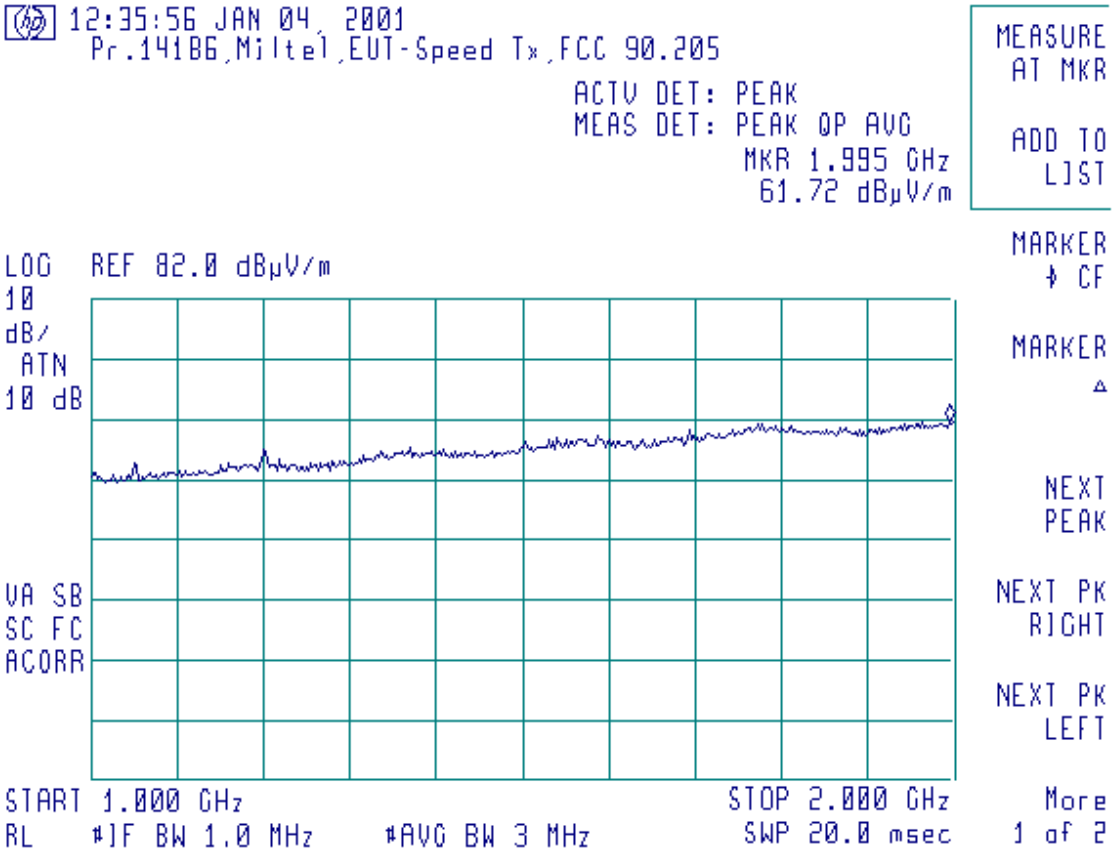
Date/Time	1/4/01 12:20:34 PM
Test Name	Spurious emission
EUT Model Number	SPEED Tx
Analyzer Model Number	HP8546A
Site Description	Anechoic chamber
Operator Name	Nikishin M.
Customer Name	Miltel
Notes	Channel:low channel
Frequency, MHz:	150.3



Signal	Freq (MHz)	Peak Amp (dBuV/m)	Corrections (dB)	Comments
1	300.623711	71.23	16.51	

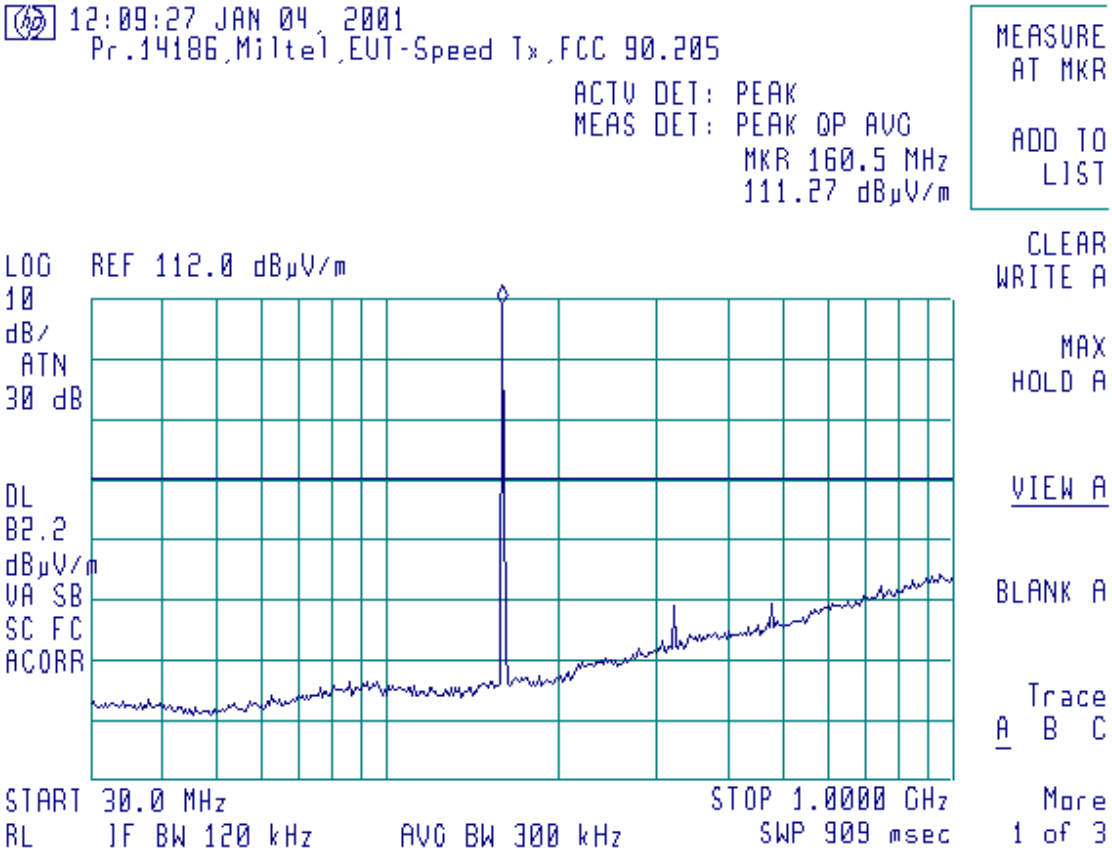
Plot 4.3.5
Spurious emissions measurement test results

Date/Time	1/4/01 12:34:19 PM
Test Name	Spurious emission
EUT Model Number	SPEED Tx
Analyzer Model Number	HP8546A
Site Description	Anechoic chamber
Operator Name	Nikishin M.
Customer Name	Miltel
Notes	Channel:low
Frequency, MHz:	150.3



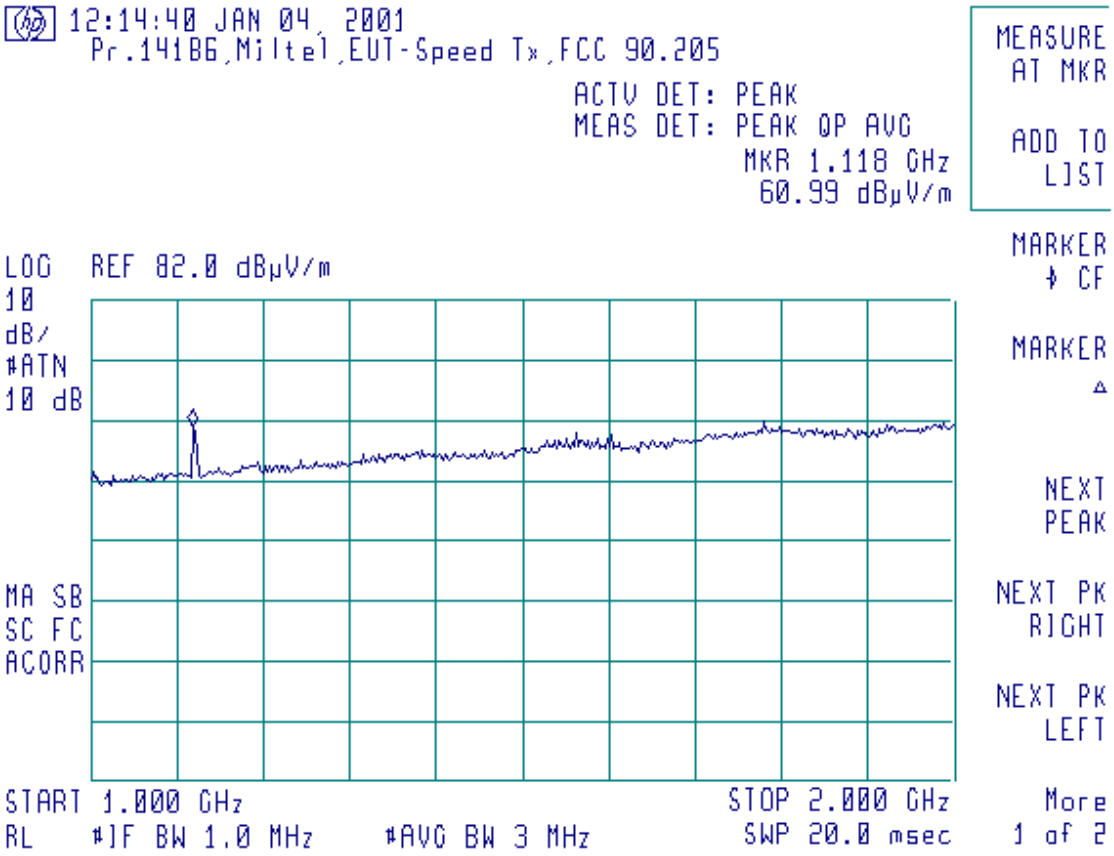
Plot 4.3.6
Spurious emissions measurement test results

Date/Time	1/4/01 12:09:26 PM
Test Name	Spurious emission
EUT Model Number	SPEED Tx
Analyzer Model Number	HP8546A
Site Description	Anechoic chamber
Operator Name	Nikishin M.
Customer Name	Miltel
Notes	Channel:mid
Frequency, MHz:	160.2



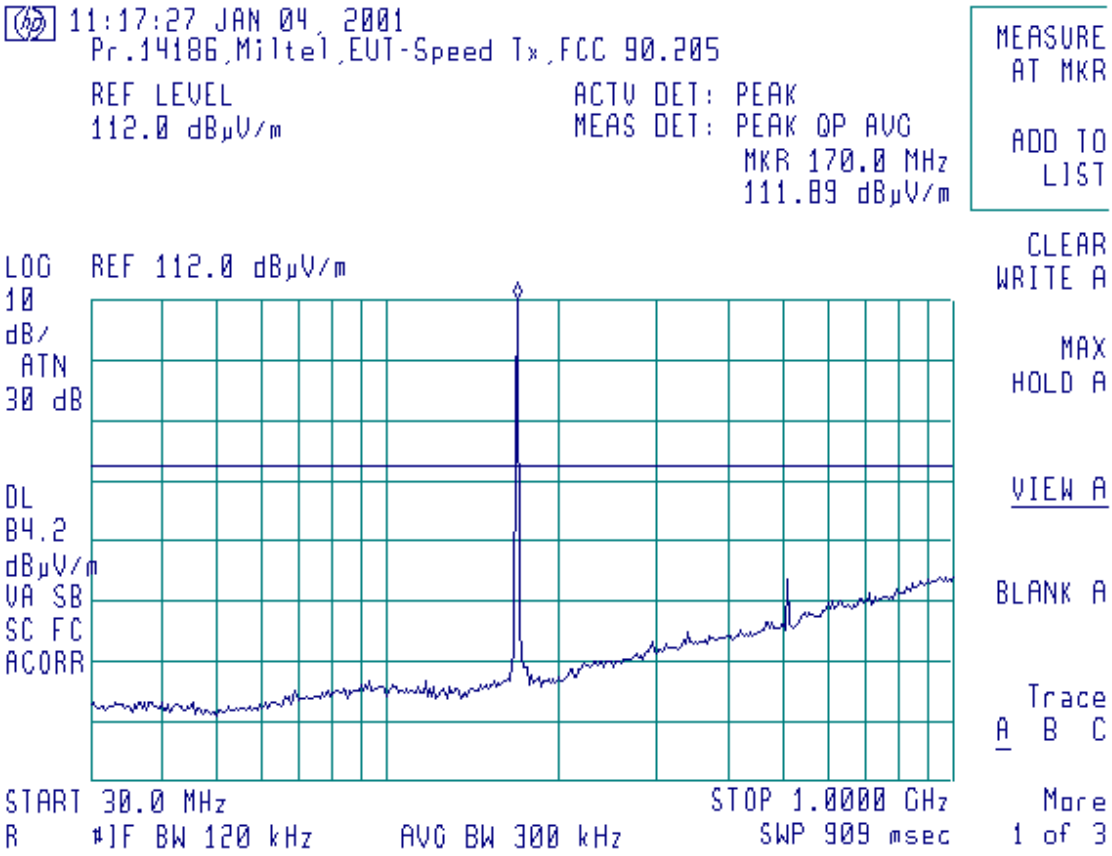
Plot 4.3.7
Spurious emissions measurement test results

Date/Time	1/4/01 12:14:39 PM
Test Name	Spurious emission
EUT Model Number	SPEED Tx
Analyzer Model Number	HP8546A
Site Description	Anechoic chamber
Operator Name	Nikishin M.
Customer Name	Miltel
Notes	Channel:mid
Frequency, MHz:	160.2



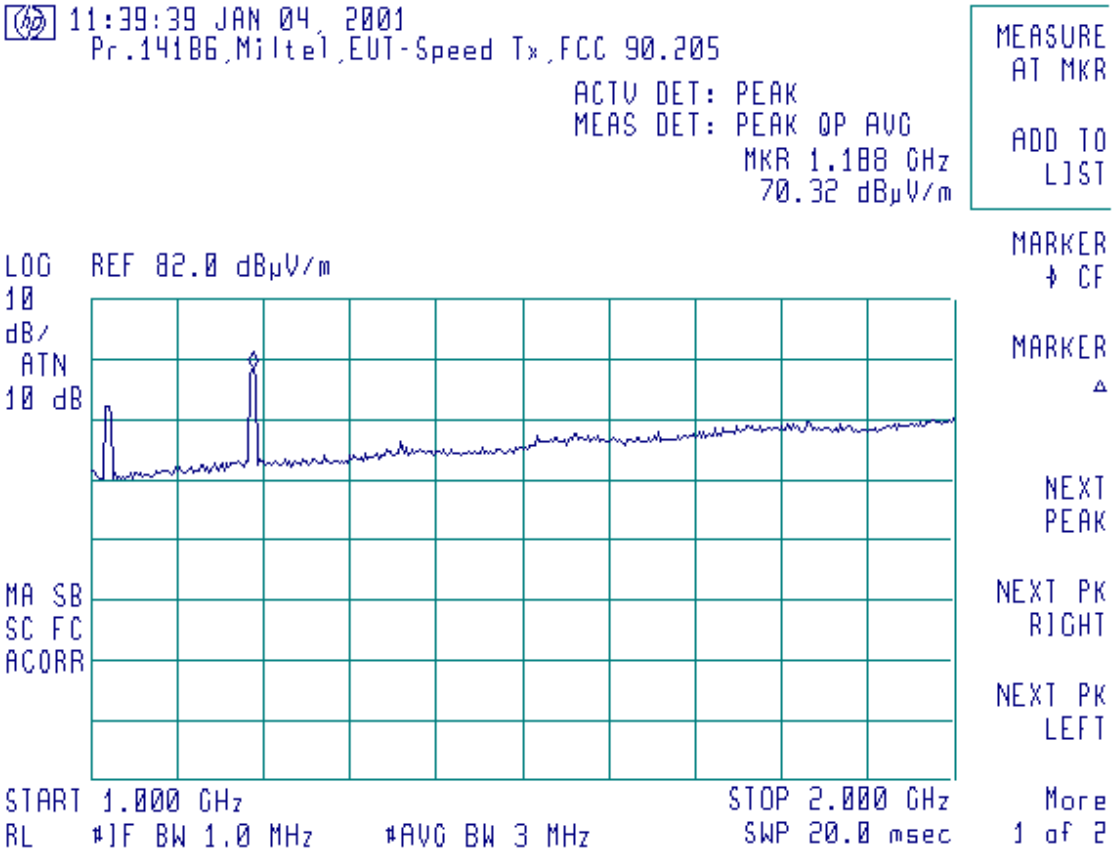
Plot 4.3.8
Spurious emissions measurement test results

Date/Time	1/4/01 11:17:26 AM
Test Name	Spurious emission
EUT Model Number	SPEED Tx
Analyzer Model Number	HP8546A
Site Description	Anechoic chamber
Operator Name	Nikishin M
Customer Name	Miltel
Notes	High channel 169.8 MHz

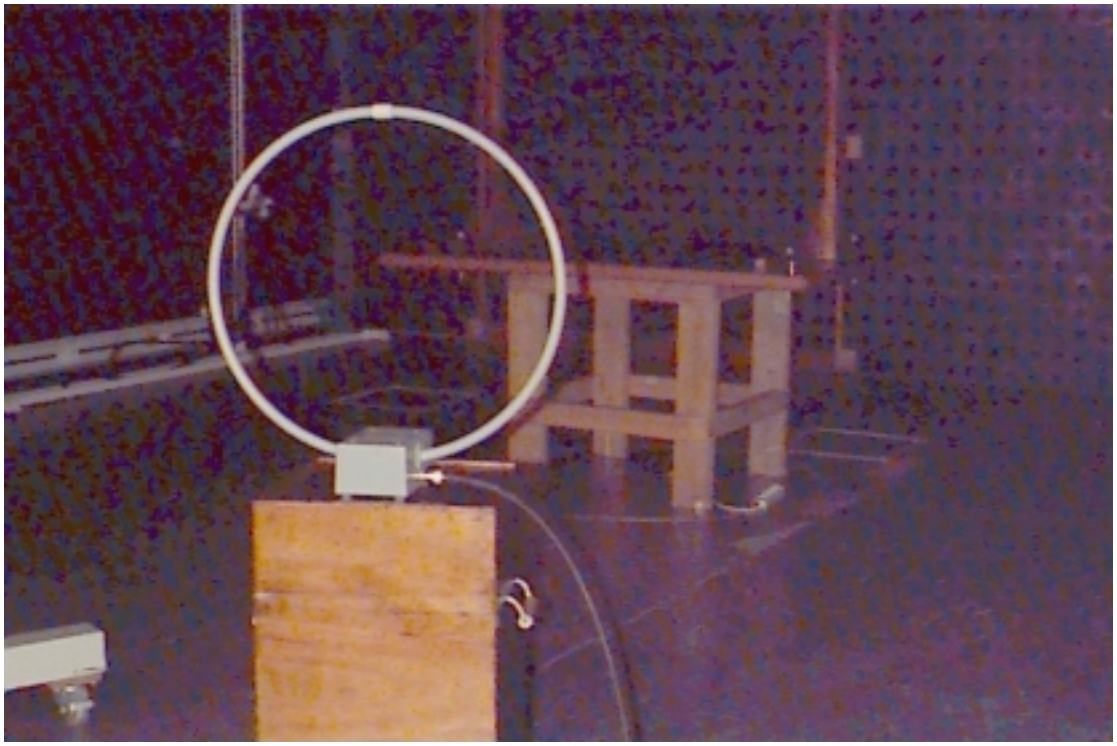


Plot 4.3.9
Spurious emissions measurement test results

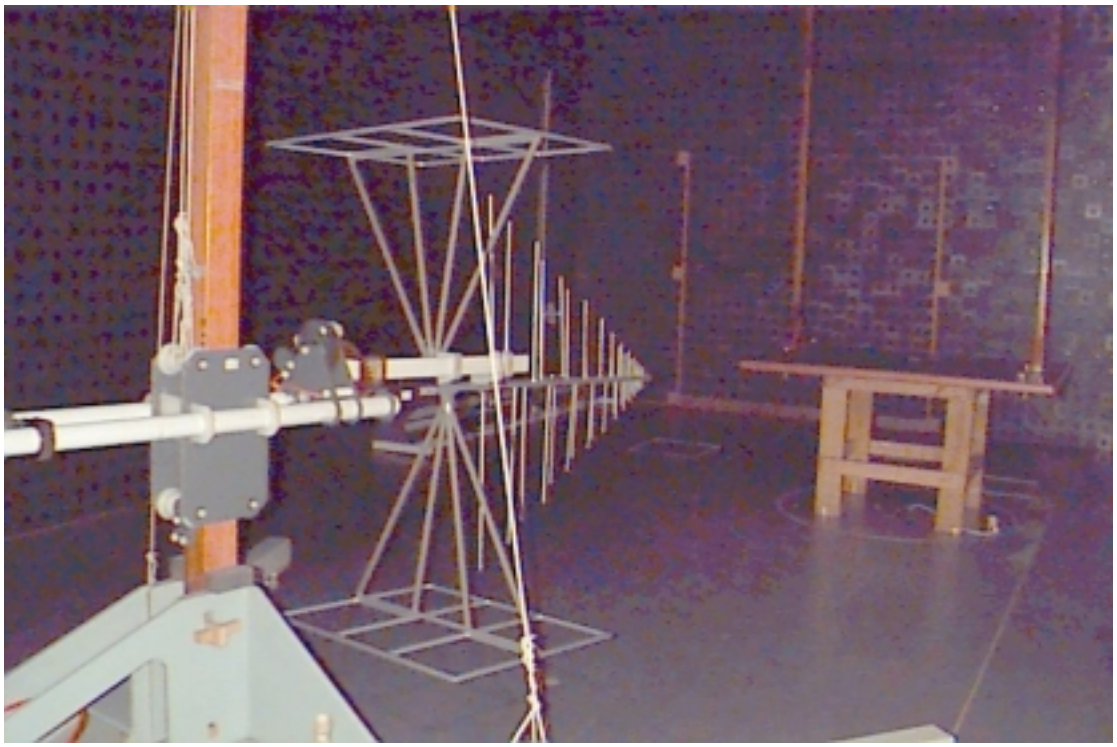
Date/Time	1/4/01 11:33:14 AM
Test Name	Spurious emission
EUT Model Number	SPEED Tx
Analyzer Model Number	HP8546A
Site Description	Anechoic chamber
Operator Name	Nikishin M.
Customer Name	Miltel
Notes	Channel:high
Frequency, MHz:	169.8



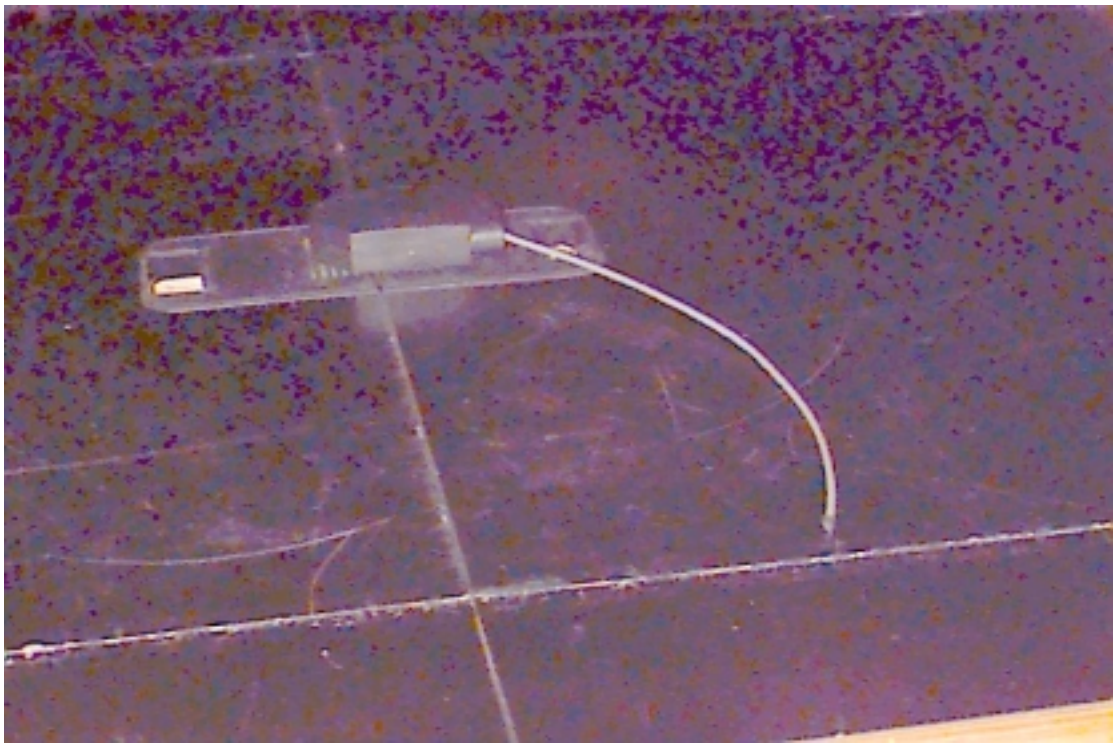
Photograph 4.3.1
Spurious emissions test setup,
9 kHz – 30 MHz frequency range



Photograph 4.3.2
Spurious emissions test setup,
30 – 2000 MHz frequency range



Photograph 4.3.3
Spurious emissions test setup



4.4 Frequency stability measurements according to FCC part 90 paragraph 213

4.4.1 General

According to paragraph 90.213, the minimum frequency stability limit (in parts per million) is 5 ppm for fixed equipment in frequency range 150 – 174 MHz.
For frequency 150 000 000 Hz the specified limit is ±750 Hz.

4.4.2 Test procedure

The EUT frequency stability was investigated for various temperatures in the range from –30°C to +50°C at the middle frequency channel.
Test results were recorded in Table 4.4.1. The maximum measured displacement was -619 Hz.
The EUT was found to comply with the standard requirements.

Reference numbers of test equipment used

HL 0278	HL 0493	HL 0507	HL 0558	HL 0574

Full description is in Appendix A.

Table 4.4.1
Frequency stability test results

Temperature, °C	Voltage, V	Frequency, Hz	Displacement, Hz	Limit, Hz	Pass/ Fail
-30	3.6	160 199 830	-462	-750	Pass
-20	3.6	160 200 286	-6	-750	Pass
-10	3.6	160 200 501	209	750	Pass
0	3.6	160 200 639	347	750	Pass
10	3.6	160 200 550	258	750	Pass
20	3.6	160 200 292	Reference	Reference	Reference
20	3.06	160 200 300	8	750	Pass
20	4.14	160 200 293	1	750	Pass
30	3.6	160 200 126	-166	-750	Pass
40	3.6	160 199 673	**-619**	-750	Pass
50	3.6	160 199 697	-595	-750	Pass

4.5 Radiated emission measurements according to FCC part 15 subpart B §15.109

4.5.1 General

This test was performed to measure radiated emissions from the incorporated digital device of the EUT and also to verify the EUT full compliance with §15.109.

Radiated emission measurements specification limits are given in Table 4.5.1 below:

Table 4.5.1
Limits for electric field strength, quasi-peak detector @3 meter distance

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

4.5.2 Test procedure

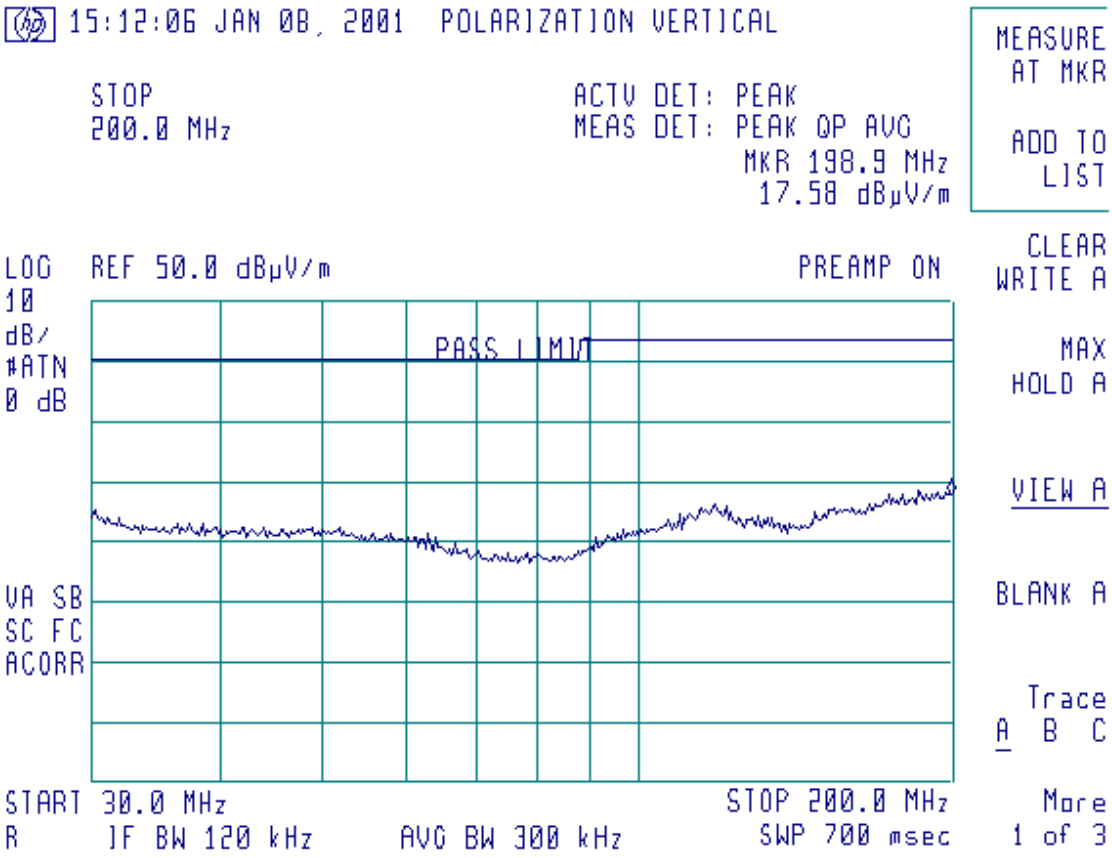
The radiated emissions measurements of the EUT digital part were performed in the anechoic chamber at 3 meter measuring distance in the frequency range from 30 MHz to 1 GHz with biconical and log periodic antennas.
The EUT in stand-by mode was placed on the wooden table as shown in Figure 4.5.1. To find maximum radiation the turntable was rotated 360^{o}, the measuring antennas height changed from 1 to 4 m, and the antennas polarization was changed from vertical to horizontal.
The measurements were performed with the EMI receiver settings: RBW=120 kHz, peak detector.
The results of measurements are shown in Plots 4.5.1 to 4.5.4. All the found emissions were at least 20 dB below the specified limit.

Reference numbers of test equipment used

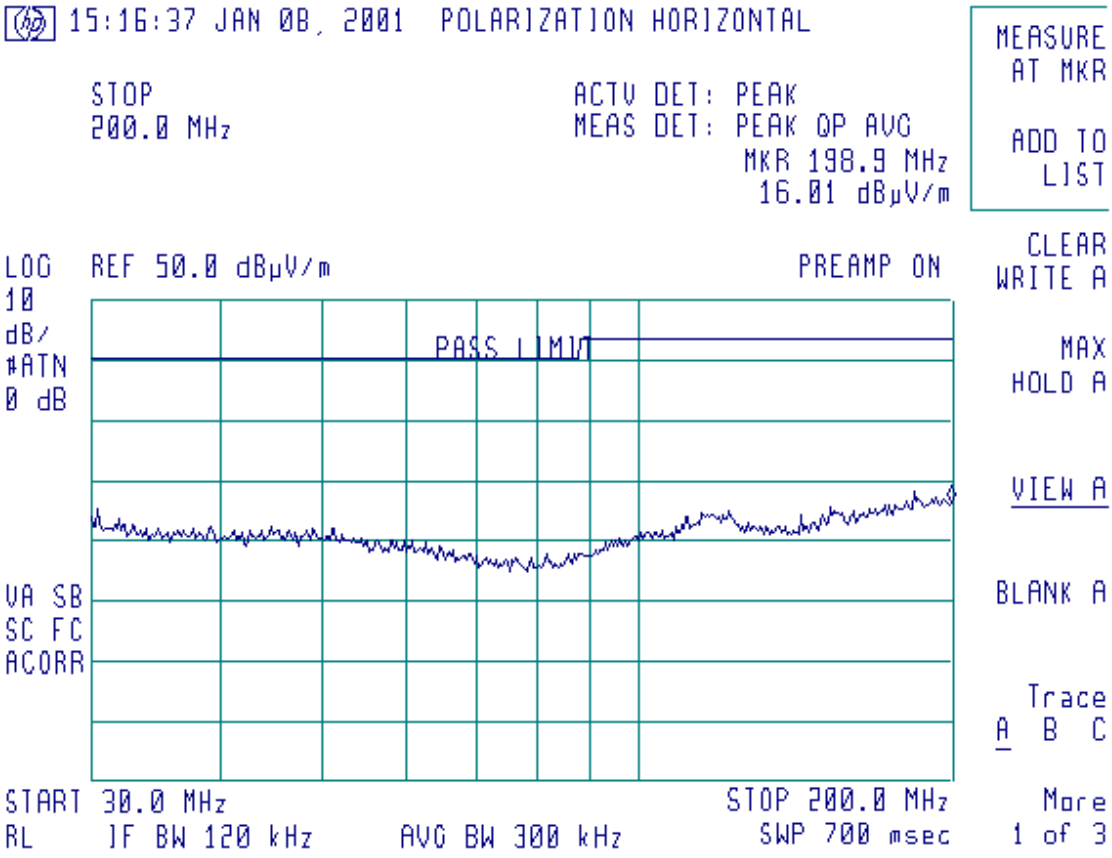
HL 0465	HL 0566	HL 0569	HL 1430	

Full description is in Appendix A.

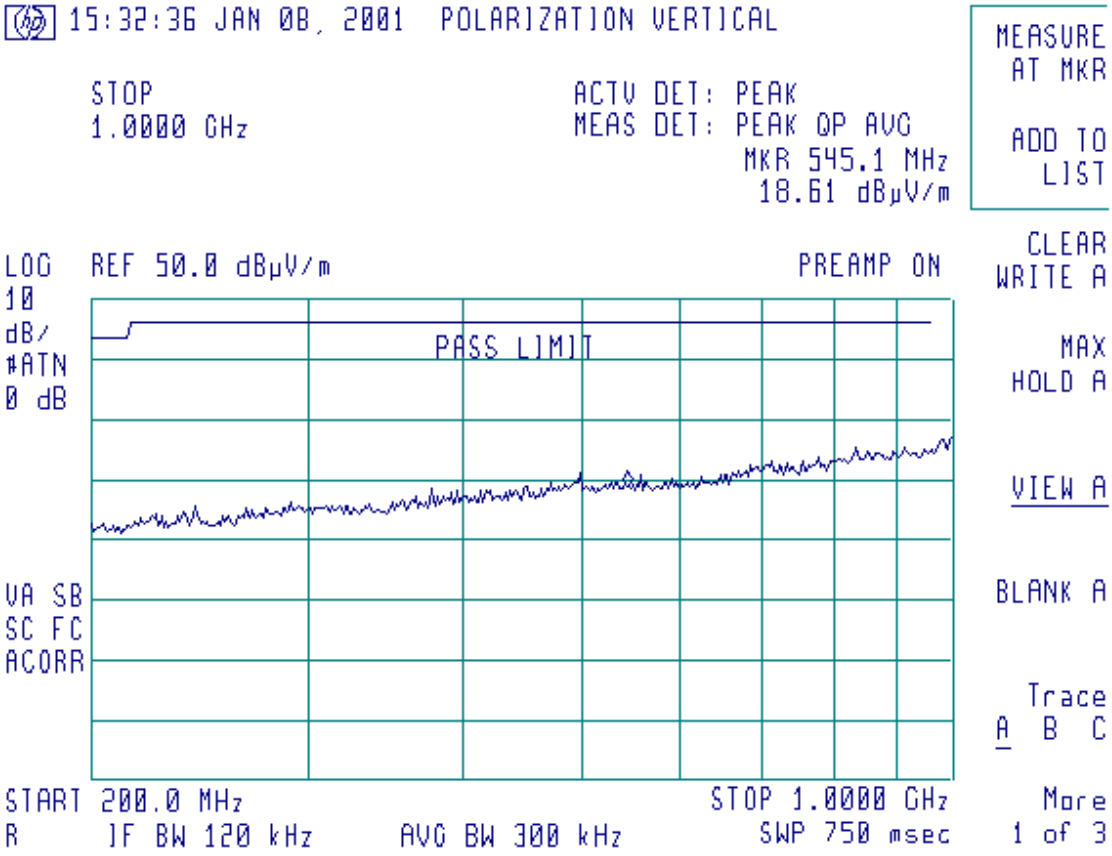
**Plot 4.5.1 Radiated emission measurements test results,
electric field, frequency range 30 MHz - 200 MHz
vertical polarization**



**Plot 4.5.2 Radiated emission measurements test results,
electric field, frequency range 30 MHz - 200 MHz
horizontal polarization**



**Plot 4.5.3 Radiated emission measurements test results,
electric field, frequency range 200 MHz - 1 GHz
vertical polarization**



**Plot 4.5.4 Radiated emission measurements test results,
electric field, frequency range 200 MHz - 1 GHz
horizontal polarization**

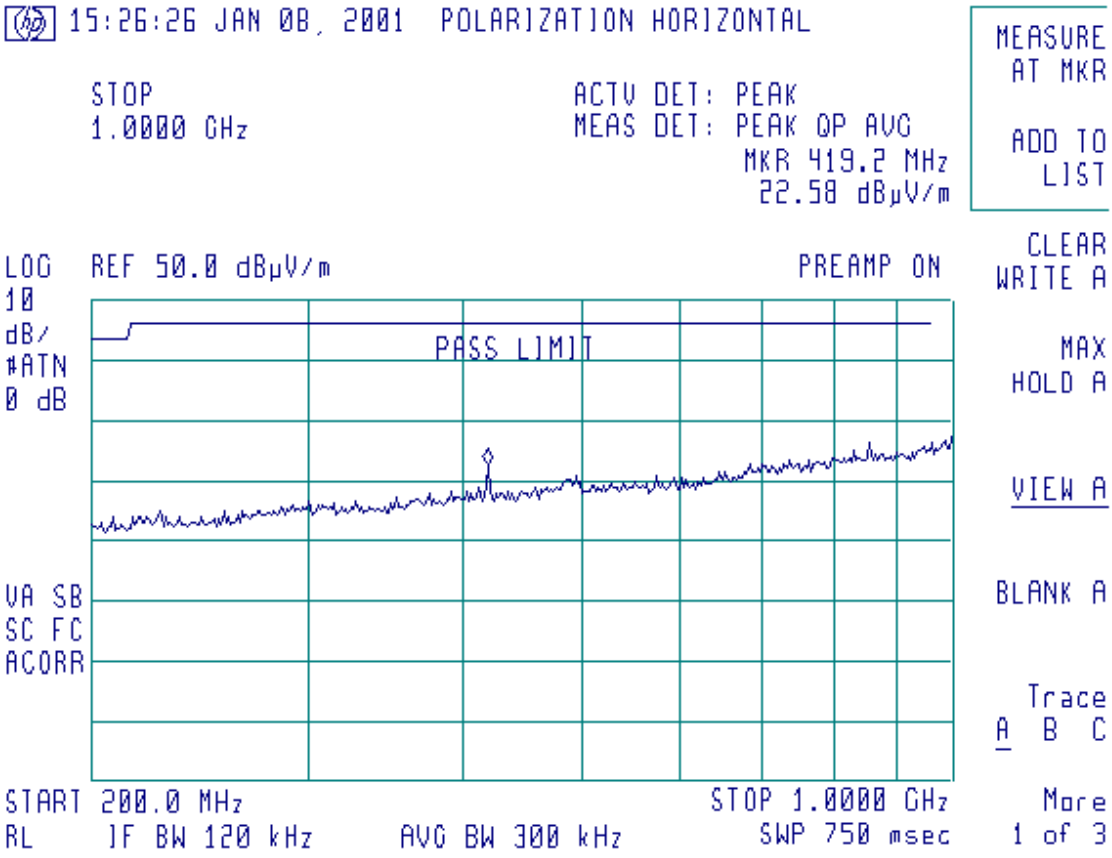
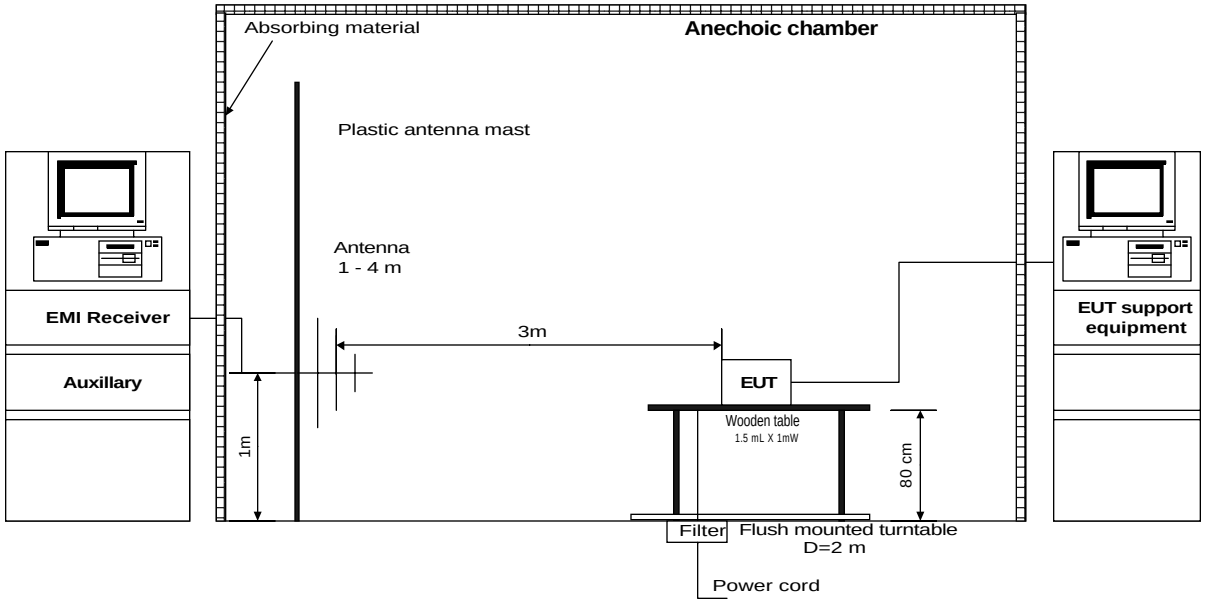


Figure 4.5.1
Radiated emissions test setup for table-top equipment



APPENDIX A - Test equipment and ancillaries used for tests

HL serial No.	Description	Manufacturer information			Due calibr.
		Name	Model No.	Serial No.	
0030	Antenna, dipole, tunable 30-200 MHz	Electro-Metrics	TDA 25/30	261	4/01
0278	Thermometer, -200 - +760C	Fluke	51K/J	5468	3/01
0465	Anechoic Chamber 9 (L) x 6.5 (W) x 5.5 (H) m	Hermon Labs	AC-1	023	3/03
0493	Oven temperature	Thermotron	S-1.2 Mini-Max	4016	3/01
0507	Spectrum Analyzer, 9 kHz - 1.8 GHz	Hewlett Packard	HP 8591A	2926U00162	5/01
0521	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A	0319	7/01
0558	Multimeter Digital	Fluke	76	0904	3/01
0566	Antenna, Biconical, 20-200 MHz	Electro-Metrics	BIA 25/30	3566	4/01
0569	Antenna, Log Periodic, 200-1000MHz	Electro-Metrics	LPA 25/30	1953	4/01
0574	Simulation test equipment, Temperature –80C to +3000C, humidity 20% to 98%	Tenney Engineering	Tenney 14	19	2/01 check
0604	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141	9611-1011	12/01
0614	Antenna Dipole Tunable 200 –1000 MHz	Electro-Metrics	TDS 30-1/30-2	334	2/02
0661	Generator Swept Signal, 10MHz to 40GHz+ 10dBm	Hewlett Packard	83640B	0266	5/01
0815	Cable, coax, RG-214, 7.3 m, N-type connectors, inside anechoic chamber	Hermon Labs	C214-7	151	8/01
0816	Cable, coax, RG-214, 8 m, N-type connectors, outside anechoic chamber	Hermon Labs	C214-8	152	8/01
1424	Spectrum analyzer	Agilent Technologies	8564EC	3946A00219	9/01
1430	EMI Receiver System, 9 kHz - 2.9 GHz	Agilent Technologies	8542E	3807A00262	9/01
1447	Cable, 10 m	Harbour Industries	MIL 17/60-RG142	1447	9/01

APPENDIX B-Test equipment correction factors

Antenna factor, 3 m test distance
Biconical antenna
Electro-Metrics, model BIA-25/30
Ser.No.3566

Frequency MHz	Antenna Factor dB(1/m)	Frequency MHz	Antenna Factor dB(1/m)
30	14.7	120	16.8
35	12.9	125	15.5
40	12.6	130	15.5
45	12.8	135	15.1
50	12.6	140	14.8
55	11.8	145	15.1
60	11.7	150	16.9
65	10.4	155	17.2
70	9.2	160	17.3
75	9.1	165	17.8
80	9.1	170	18.3
85	9.5	175	19.0
90	11.2	180	19.5
95	12.6	185	20.0
100	13.7	190	20.4
105	14.2	195	20.5
110	15.3	200	20.6
115	17.1		

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

Antenna factor, 3 m test distance
Log periodic antenna
Electro-Metrics, model LPA-25/30
Ser.No.1953

Frequency MHz	Antenna Factor dB(1/m)	Frequency MHz	Antenna Factor dB(1/m)
200	15.2	625	25.2
225	15.1	650	25.8
250	16.3	675	27.2
275	17.2	700	27.6
300	19.6	725	27.6
325	18.4	750	27.6
350	19.0	775	28.0
375	20.0	800	28.2
400	20.9	825	29.4
425	21.3	850	29.9
450	22.1	875	30.0
475	22.7	900	30.4
500	23.2	925	30.6
525	23.9	950	30.8
550	24.2	975	31.6
575	24.6	1000	32.1
600	24.7		

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

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

Frequency, MHz	Antenna Factor, dB(1/m)	Frequency, MHz	Antenna Factor, dB(1/m)
26	7.8	940	24.0
28	7.8	960	24.1
30	7.8	980	24.5
40	7.2	1000	24.9
60	7.1	1020	25.0
70	8.5	1040	25.2
80	9.4	1060	25.4
90	9.8	1080	25.6
100	9.7	1100	25.7
110	9.3	1120	26.0
120	8.8	1140	26.4
130	8.7	1160	27.0
140	9.2	1180	27.0
150	9.8	1200	26.7
160	10.2	1220	26.5
170	10.4	1240	26.5
180	10.4	1260	26.5
190	10.3	1280	26.6
200	10.6	1300	27.0
220	11.6	1320	27.8
240	12.4	1340	28.3
260	12.8	1360	28.2
280	13.7	1380	27.9
300	14.7	1400	27.9
320	15.2	1420	27.9
340	15.4	1440	27.8
360	16.1	1460	27.8
380	16.4	1480	28.0
400	16.6	1500	28.5
420	16.7	1520	28.9
440	17.0	1540	29.6
460	17.7	1560	29.8
480	18.1	1580	29.6
500	18.5	1600	29.5
520	19.1	1620	29.3
540	19.5	1640	29.2
560	19.8	1660	29.4
580	20.6	1680	29.6
600	21.3	1700	29.8
620	21.5	1720	30.3
640	21.2	1740	30.8
660	21.4	1760	31.1
680	21.9	1780	31.0
700	22.2	1800	30.9
720	22.2	1820	30.7
740	22.1	1840	30.6
760	22.3	1860	30.6
780	22.6	1880	30.6
800	22.7	1900	30.6
820	22.9	1920	30.7
840	23.1	1940	30.9
860	23.4	1960	31.2
880	23.8	1980	31.6
900	24.1	2000	32.0
920	24.1		

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