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: MLLSPEEDHPTX450

Description of equipment under test

Test items	Transmitter of automatic meter reading system
Manufacturer	Miltel Communications Ltd.
Types (Models)	Speed HPTx
Receipt date	April 4, 2002

Applicant information

Applicant's representative	Mr. Erez Sharabi, V.P. engineering
Applicant's responsible person	Mr. Yarum Locker, C.E.O.
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

Test started	April 4, 2002
Test completed	April 11, 2002
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, 90.213; part 15 subpart B §15.109
Test Location:	Hermon Laboratories Ltd. Certified Test Facilities

Contents

1 Summary and signatures

The EUT, Speed HPTx transmitter 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
Radiated spurious emissions	90.210 2.1053	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

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
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: 10/2001	Radio Frequency Devices
CFR 47 part 90: 10/2001	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 operating in 450 –470 MHz frequency range and 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.

3 Test Facility Description

Tests were performed at Hermon Laboratories Ltd. by Miltel personnel. Hermon Laboratories is a fully independent, private EMC, Safety and Telecommunications 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 the Industry of Canada for electromagnetic emissions (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 TNO Certification EP&S (Netherlands) for a number of EMC, Telecommunications, Safety standards, and by AMTAC (UK) for safety of medical devices. The laboratory is accredited by the American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for Electromagnetic Compatibility, Product Safety, Telecommunications and Environmental Simulation (for exact scope please refer to Certificate No. 839.01).

4 Emissions measurements

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

4.1.1 General

This test was performed to determine maximal effective radiated power. The standard maximum allowable ERP is 2 W (33 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. 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 carrier frequencies (low, middle, high) 450.4009 MHz, 460.0009 MHz and 469.6009 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 115.77 dBμV/m (see Plot 4.1.3) at frequency 469.6 MHz corresponds to 17.9 dBm output power of the signal generator. Maximum ERP was calculated from equation:

$$ERP_{max} = P_{out\ gen} - \text{Cable loss} + \text{Antenna gain} =$$
$$17.9\ \text{dBm} - 1.1\ \text{dB} + 0.54\ \text{dB} = 17.34\ \text{dBm} = 54.2\ \text{mW}.$$

The test results are recorded in Table 4.1.1 and are shown in Plots 4.1.1 to 4.1.3. The EUT was found to be in compliance with the standard requirements and passed the test.

Reference numbers of test equipment used

0465	0521	0604	0614	0661	1947	

Full description is in Appendix A.

Table 4.1.1 Effective radiated power measurement test results

DATE: March 25, 2002
RELATIVE HUMIDITY: 49%
AMBIENT TEMPERATURE: 24°C

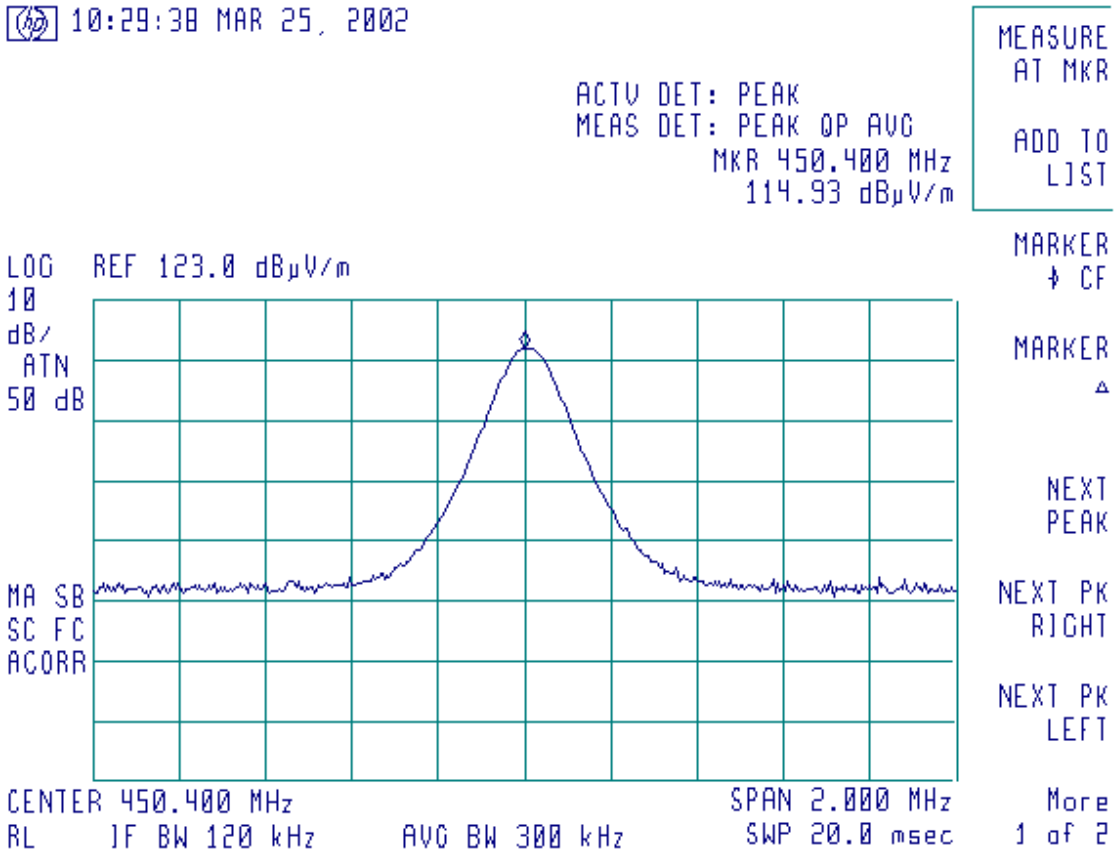
MEASUREMENTS PERFORMED AT 3 METRES DISTANCE

Frequency, MHz	Radiated measured result, dBµV/m	Antenna gain, dB	Cable loss, dB	Gener. P_{out} dBm	ERP, dBm	Spec. limit, dBm	Margin, dB	Pass/ Fail
450.400	114.93	0.96	1.1	17.0	16.86	33	16.14	Pass
460.000	115.31	0.75	1.1	17.5	17.15	33	15.85	Pass
469.610	115.77	0.54	1.1	17.9	17.34	33	15.66	Pass

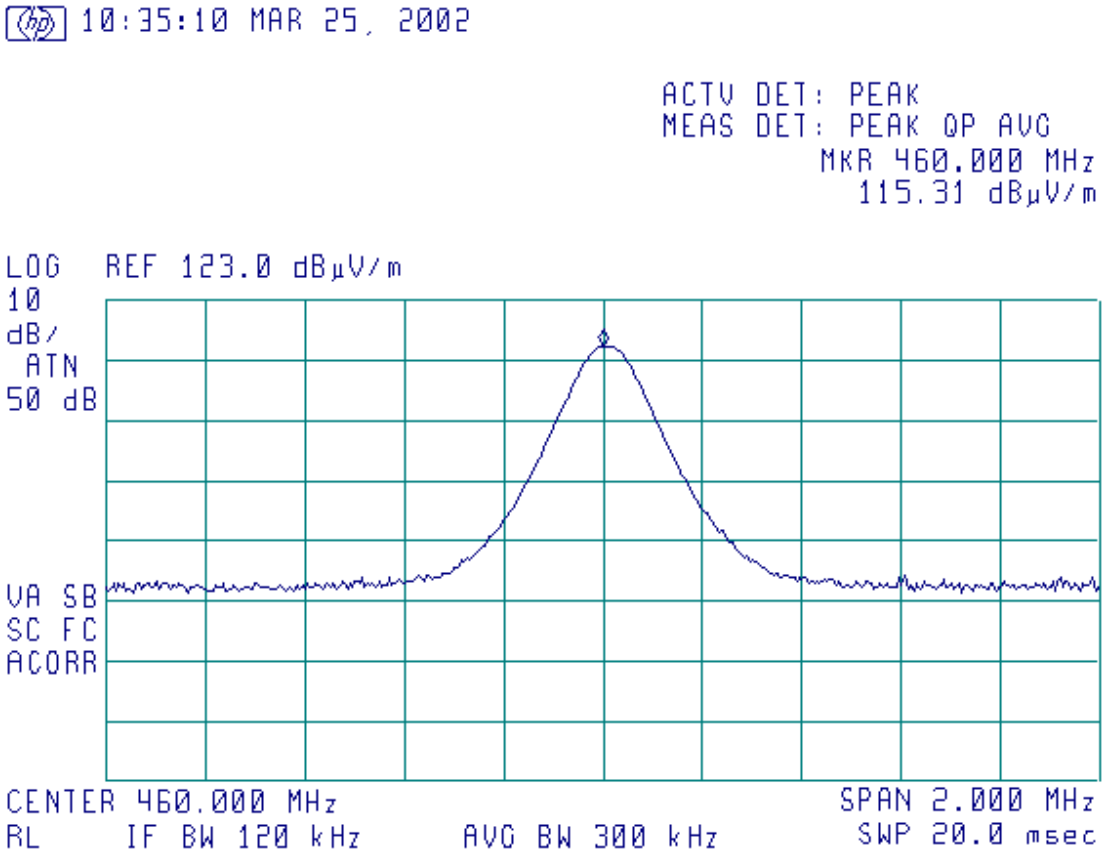
Test parameters:
Test results listed in the table were obtained throughout the testing with biconilog antenna in vertical polarization, peak detector and resolution bandwidth 120 kHz.

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 450.4 MHz



Plot 4.1.2 Electric field strength measurement test results at 460.0 MHz



Plot 4.1.3 Electric field strength measurement test results at 469.6 MHz

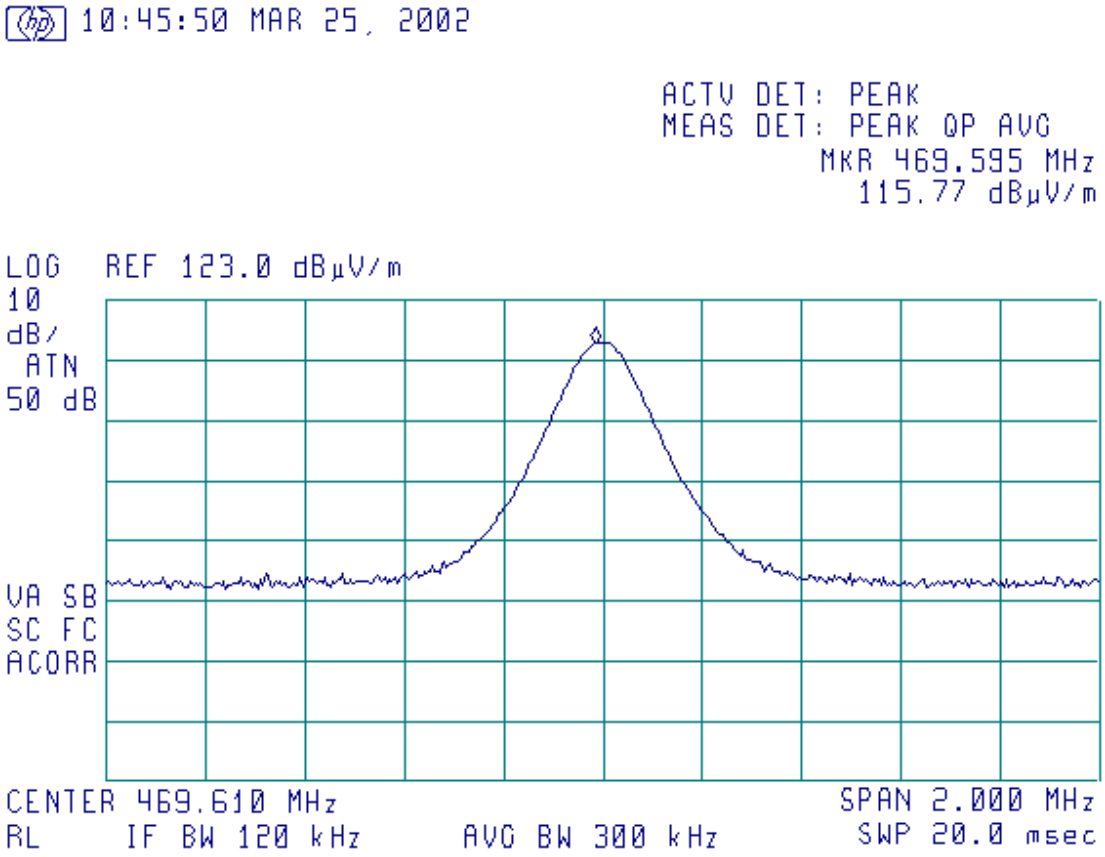
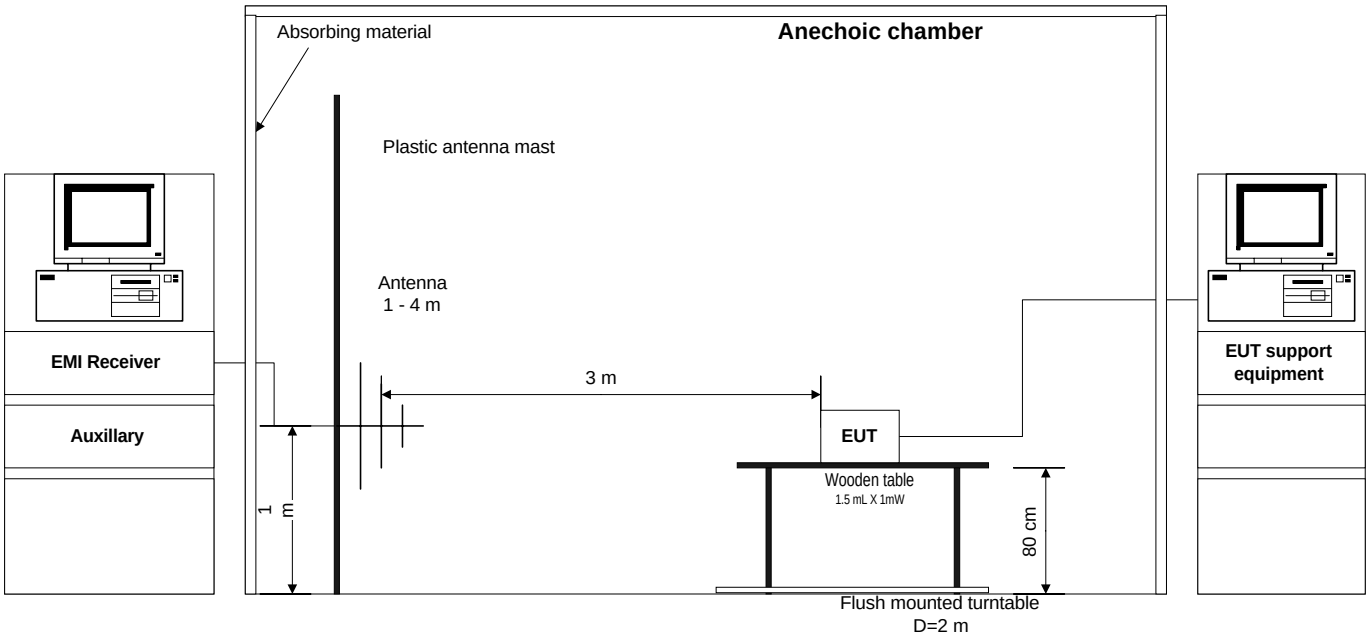


Figure 4.1.1
Set up for ERP measurement



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 11.25 kHz in the 450 – 470 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 10.40 kHz for middle 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

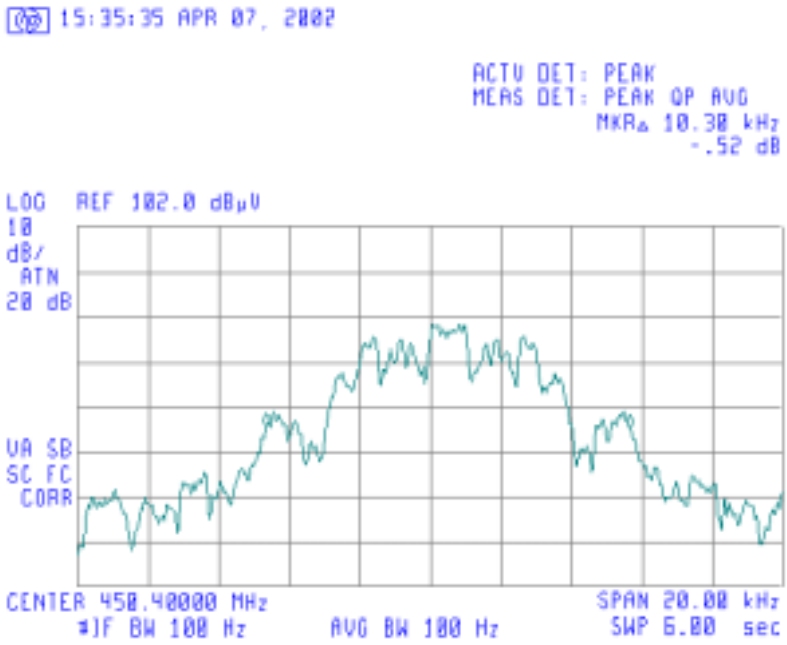
Frequency, MHz	OBW, kHz	Pass / Fail
450.4000	10.30	Pass
460.0009	10.40	Pass
469.6000	10.85	Pass

Reference numbers of test equipment used

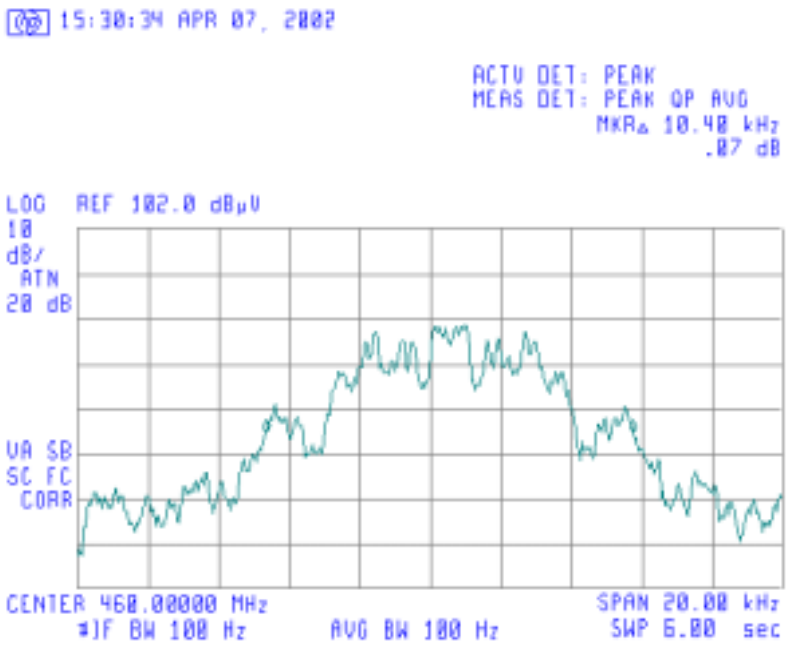
0465	0591	0604	1425	1536	1620

Full description is in Appendix A.

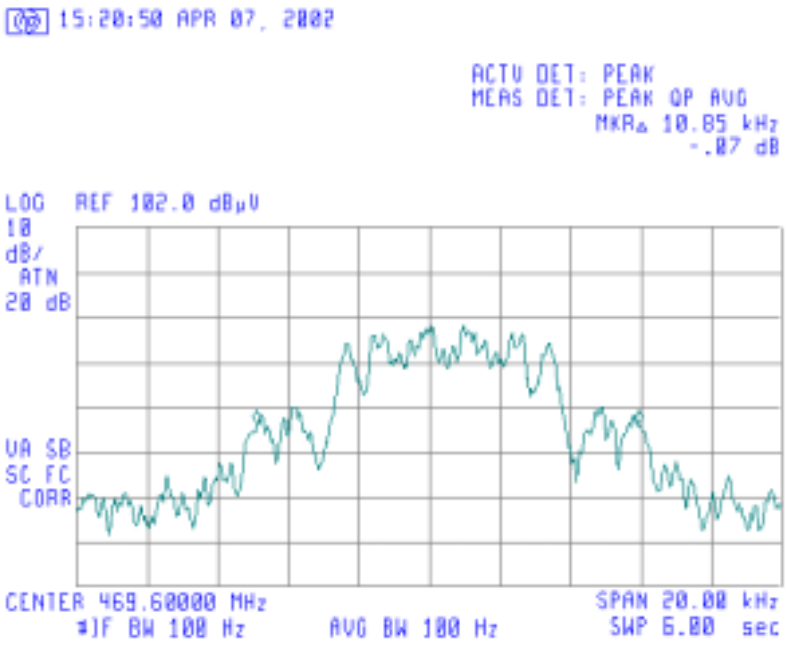
Plot 4.2.1
Occupied bandwidth measurements test result



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 from the center of the authorized bandwidth f_o to 5.625 kHz removed from f_o Zero dB;
2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz, but not more than 12.5 kHz:
   at least 7.27 (f_d – 2.88 kHz) dB;
3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: at least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

4.3.2 Test procedure

The emission mask, calculated according to formulas (1) – (3) and measured results are shown in Plots 4.3.1 to 4.3.6.
Radiated spurious emissions were measured in the anechoic chamber at 3-m test distance: with the loop antenna in the range 9 kHz to 30 MHz,
the biconilog - in the range 30 MHz to 2000 MHz
the double ridged guide – in frequency range from 2000 to 5000 MHz.
The specified limit 50 + 10 log (P) was converted in EIRP units – 20 dBm and in field strength units as follows:

E = sqrt(30P) /r, where P = –20 dBm = 0.01 mW = 10^{-5} W.

E [dBμV/m] = 20 log {10^6 x sqrt ($30x10^{-5}$)/3} = 75.2 dBμV/m.

This limit was applied to spurious emissions throughout the following frequency ranges:
9 kHz to 450.35 MHz and 450.45 MHz to 5 GHz,
9 kHz to 459.95 MHz and 460.05 MHz to 5 GHz,
9 kHz to 469.55 MHz and 469.65 MHz to 5 GHz - according to paragraph 2.1057(a)(1).

The EUT was set up on the wooden table, as shown in Figure 4.1.1.
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 = 75.2 dBμV/m and found at least 3 dB below the limit (note: the accompanying test result plots 4.3.7 – 4.3.36 were processed with a field strength limit of 82.2 dBμV/m where the received values were at least 10 dB below this limit). The test results and spectrum analyzer settings are shown in Plots 4.3.7 to 4.3.36.
The EUT was found to comply with standard requirements.

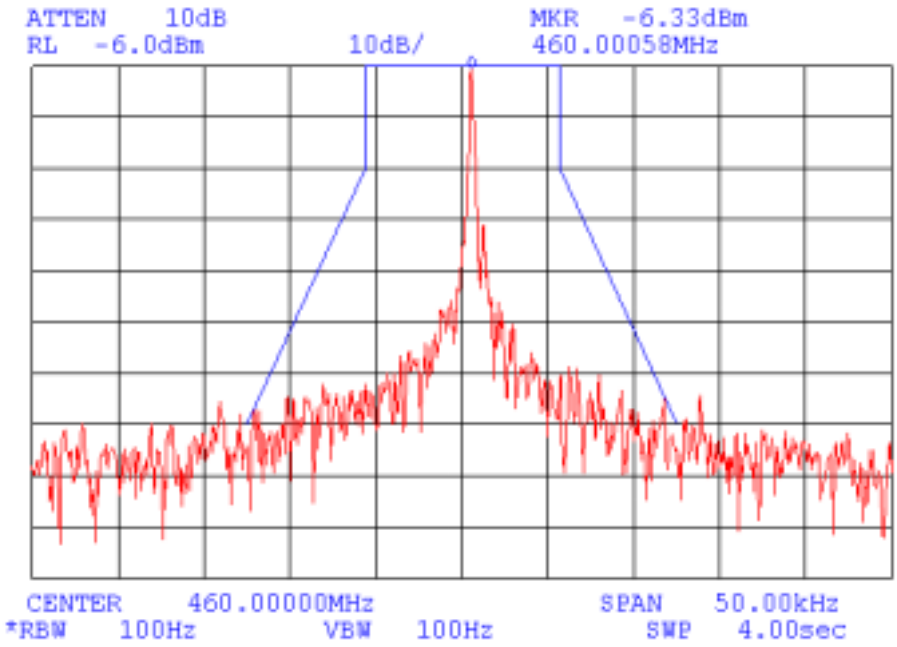
Reference numbers of test equipment used

0041	0446	0465	0589	0604	1004	1424	1940
1947							

Full description is in Appendix A.

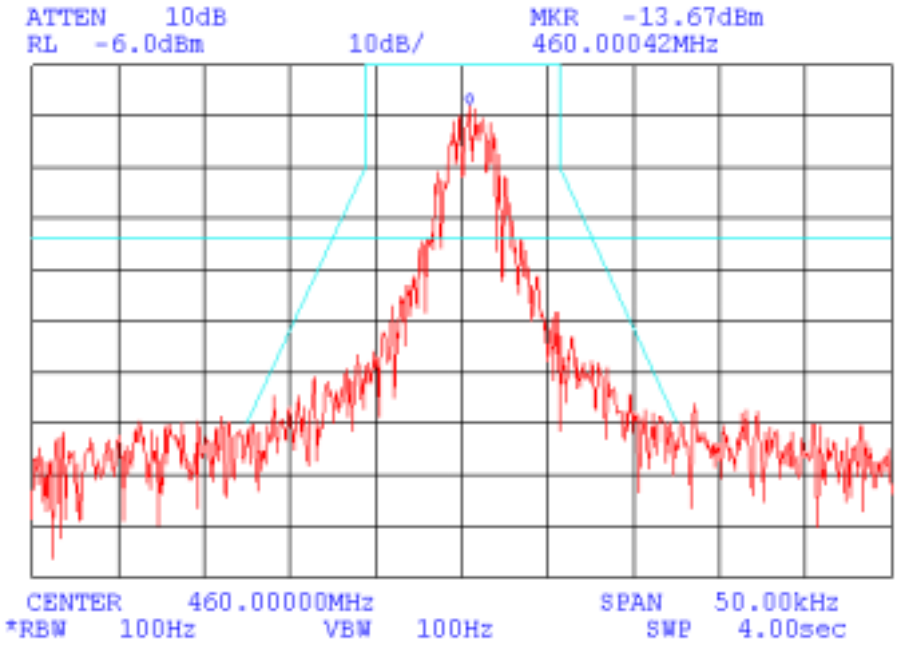
Plot 4.3.1
Emission mask test results

Date/Time:	April 8 2002 8:38:42 AM
Test Name:	Emission mask
Customer:	Miltel
EUT:	Speed HPTx
Notes:	Ext.Att=20 dB



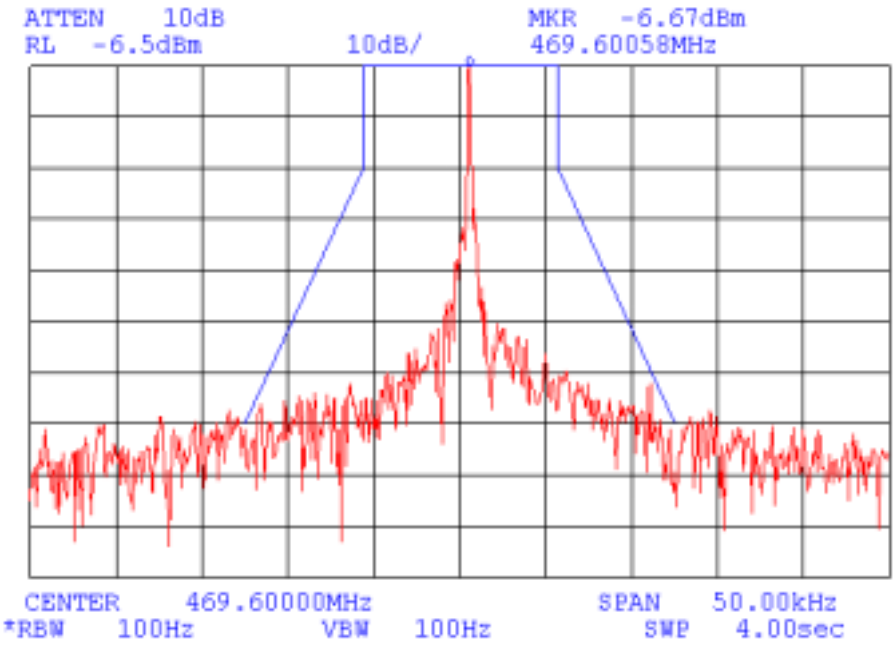
Plot 4.3.2
Emission mask test results

Date/Time:	April 8 2002 8:41:08 AM
Test Name:	Emission mask
Customer:	Miltel
EUT:	Speed HPTx
Notes:	Ext.Att=20 dB



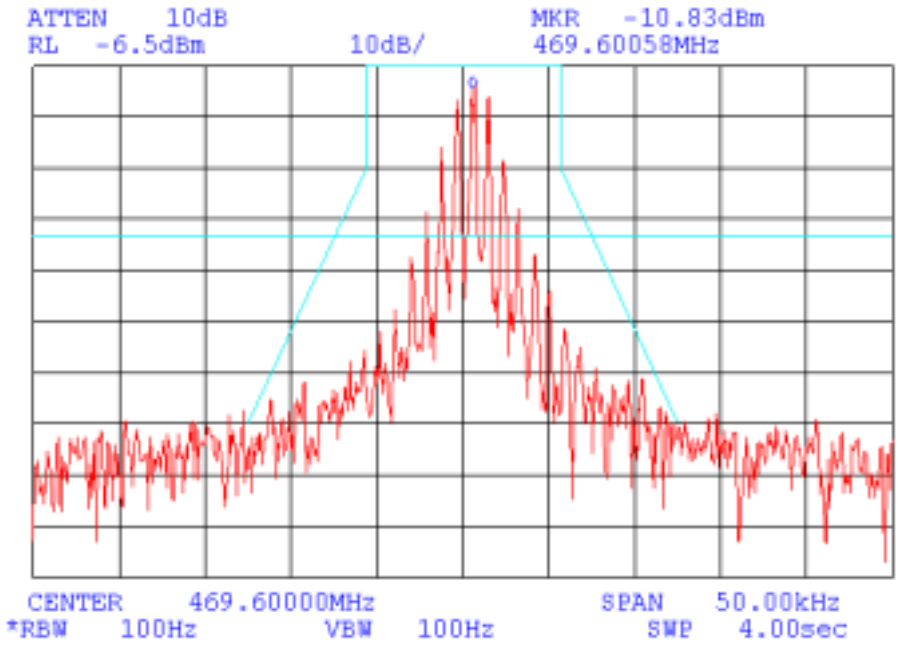
Plot 4.3.3
Emission mask test results

Date/Time:	April 8 2002 8:50:08 AM
Test Name:	Emission mask
Customer:	Miltel
EUT:	Speed HPTx
Notes:	Ext.Att=20 dB



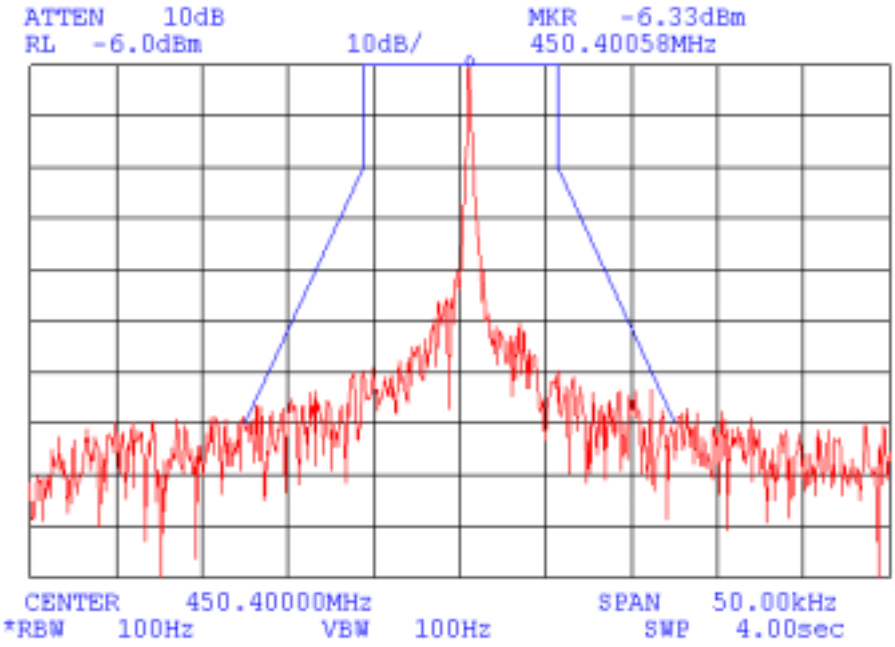
Plot 4.3.4
Emission mask test results

Date/Time:	April 8 2002 8:51:17 AM
Test Name:	Emission mask
Customer:	Miltel
EUT:	Speed HPTx
Notes:	Ext.Att=20 dB



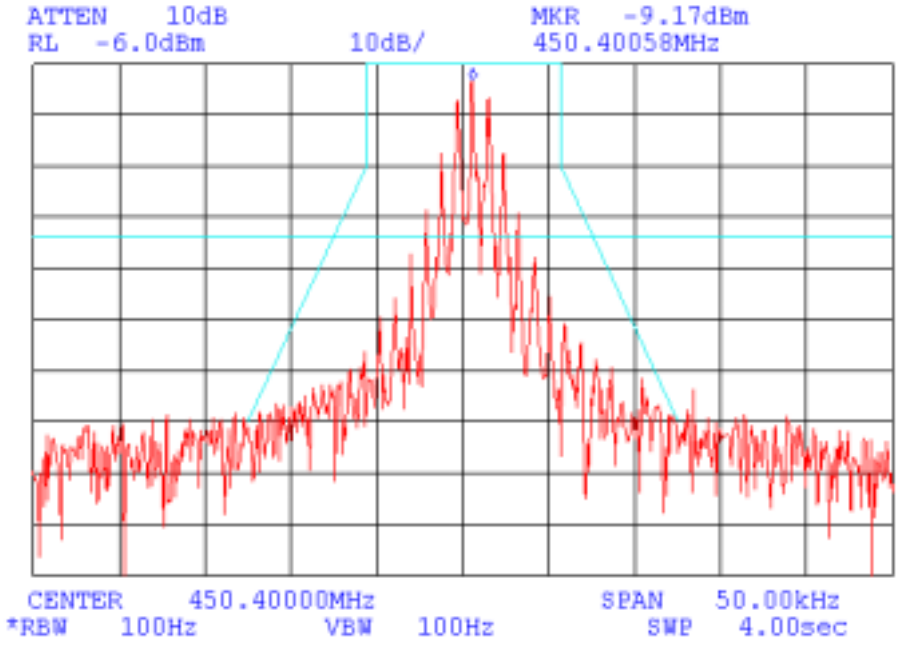
Plot 4.3.5
Emission mask test results

Date/Time:	April 8 2002 8:53:36 AM
Test Name:	Emission mask
Customer:	Miltel
EUT:	Speed HPTx
Notes:	Ext.Att=20 dB



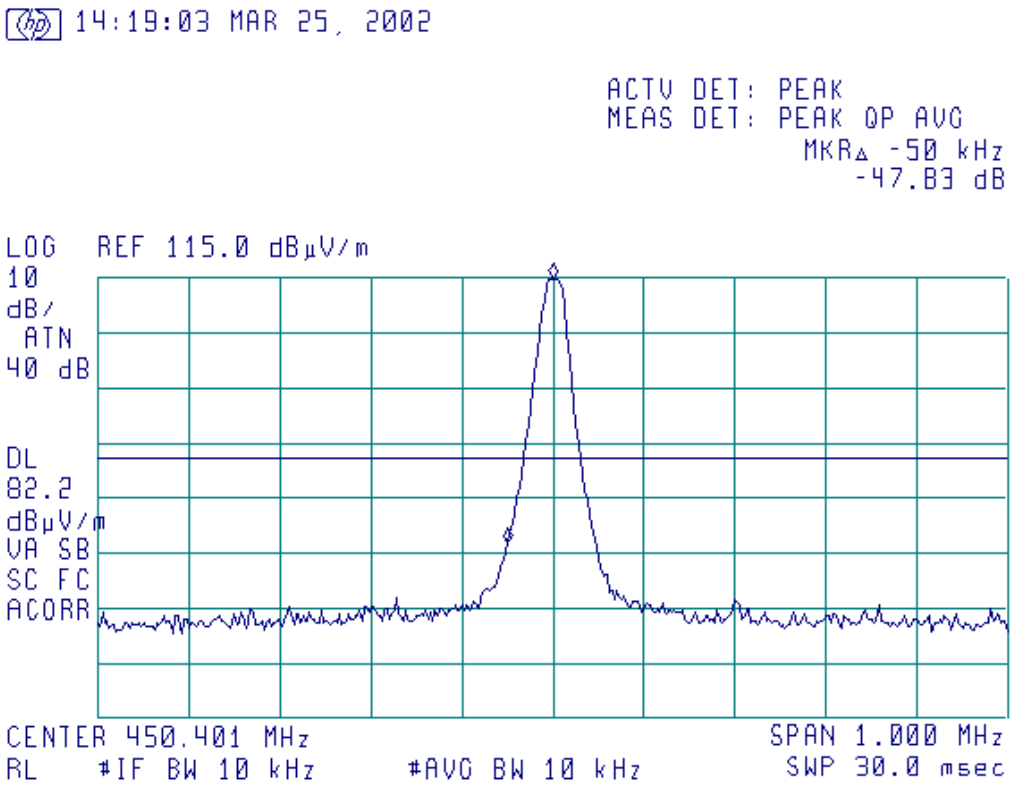
Plot 4.3.6
Emission mask test results

Date/Time:	April 8 2002 8:54:35 AM
Test Name:	Emission mask
Customer:	Miltel
EUT:	Speed HPTx
Notes:	Ext.Att=20 dB



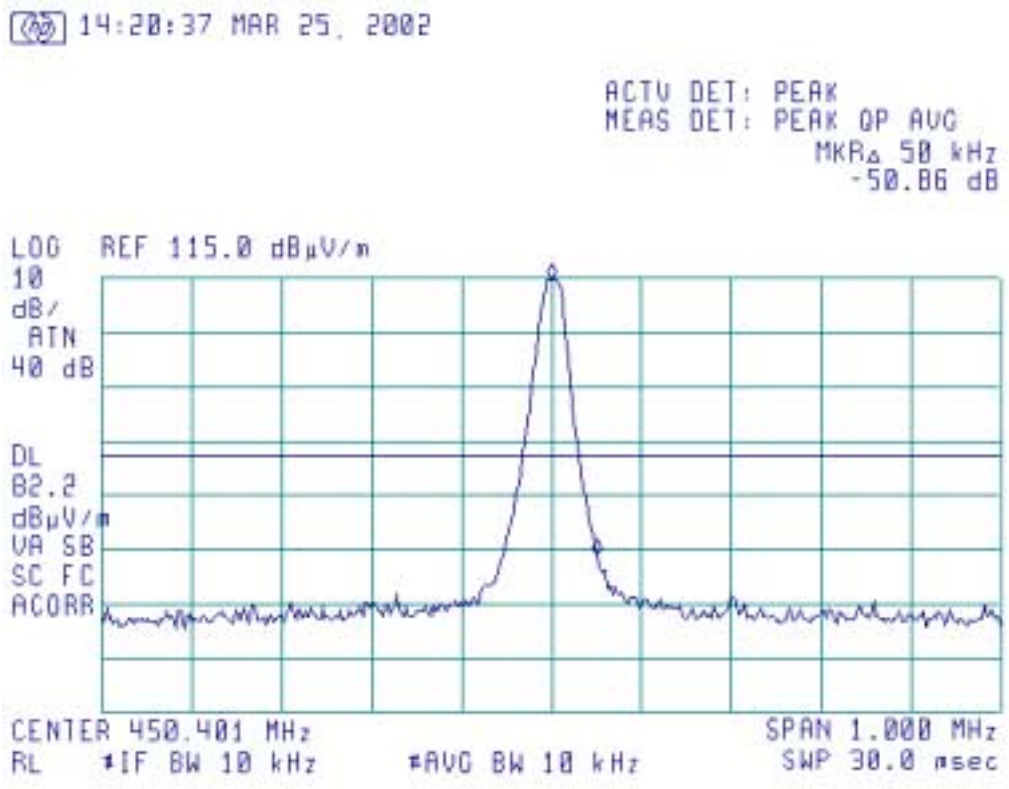
Plot 4.3.7
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



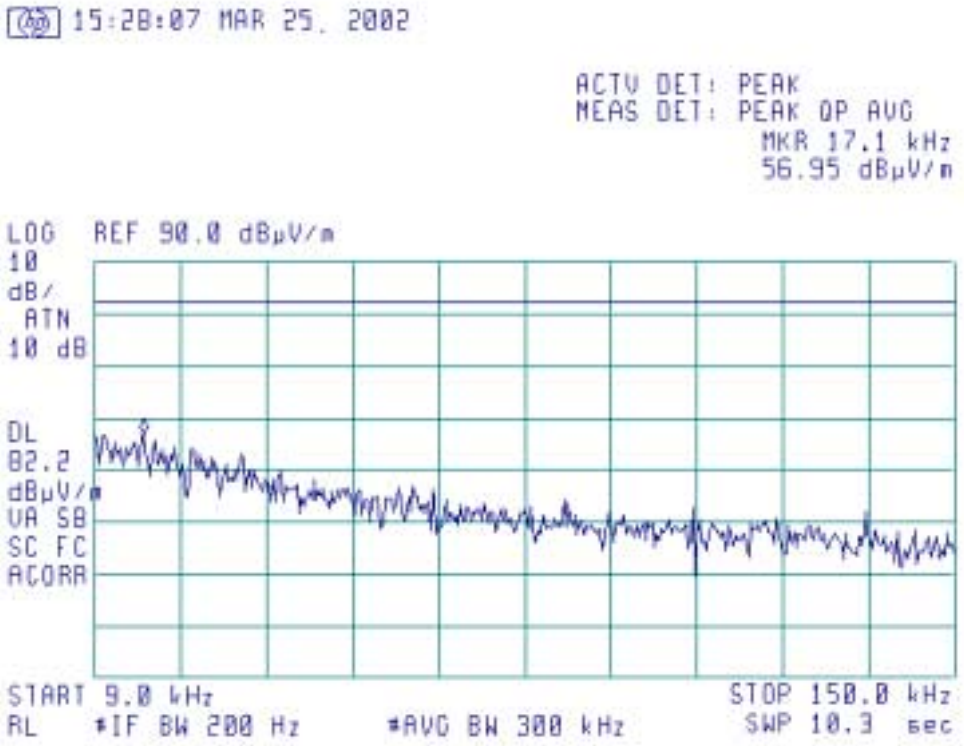
Plot 4.3.8
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



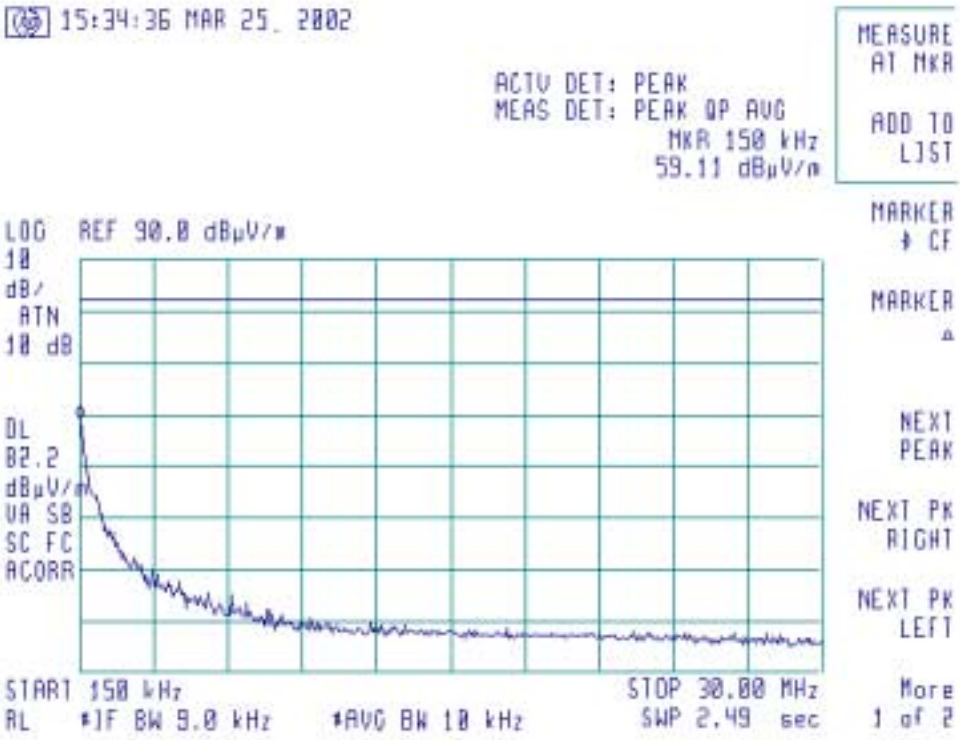
Plot 4.3.9
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



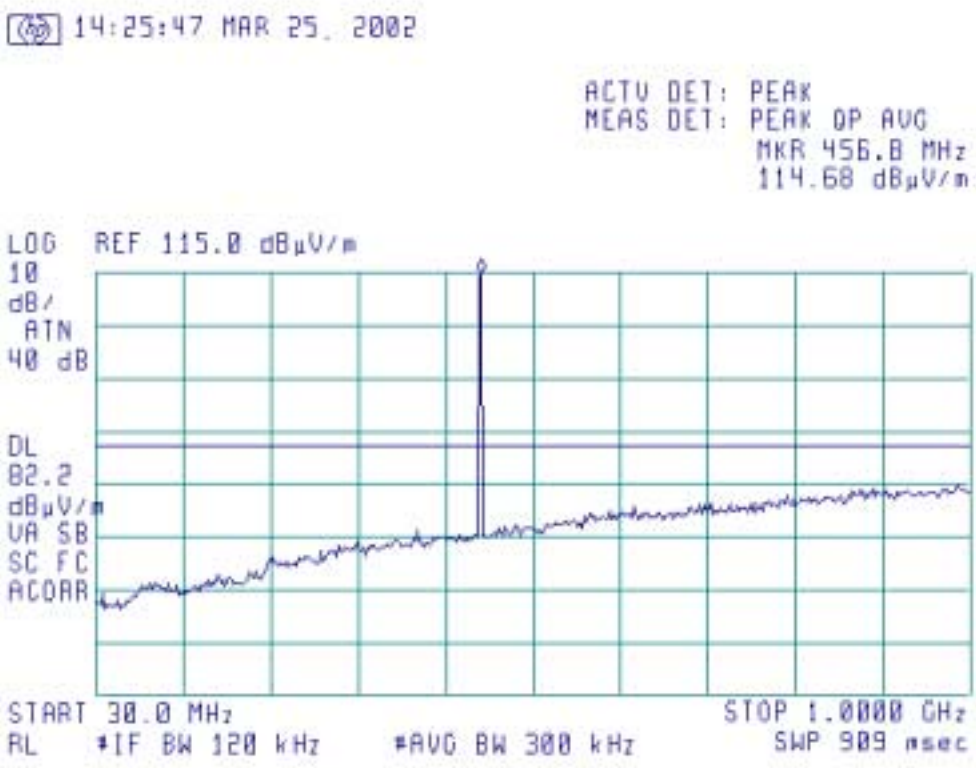
Plot 4.3.10
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



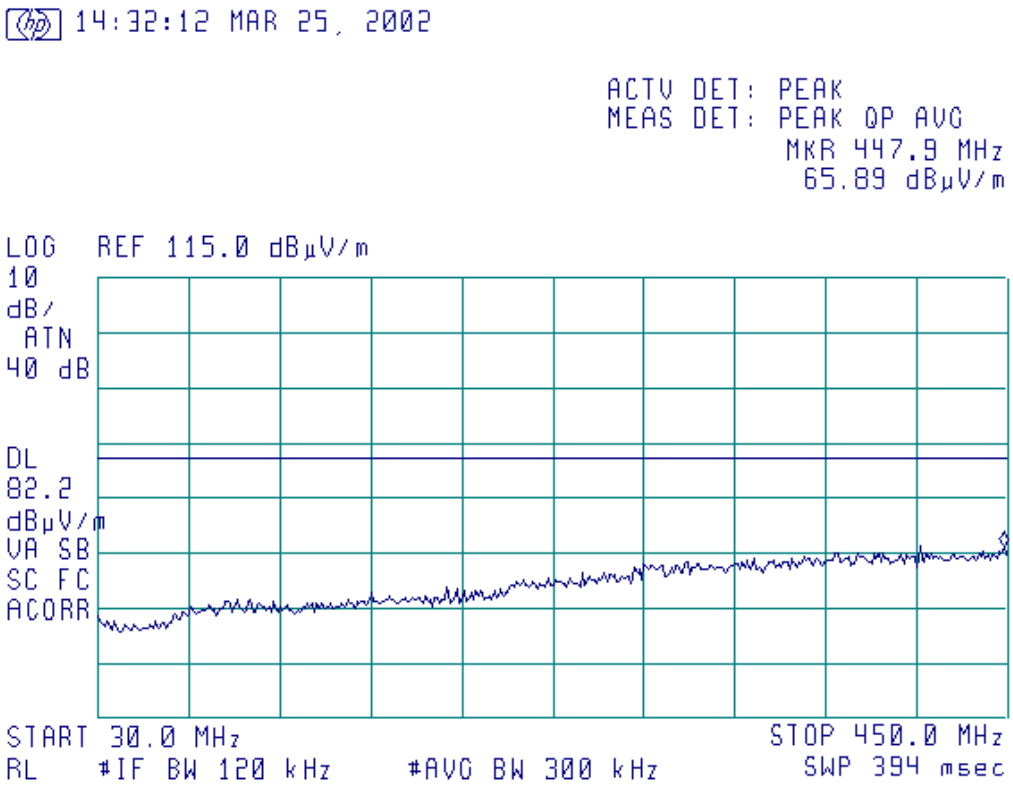
Plot 4.3.11
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



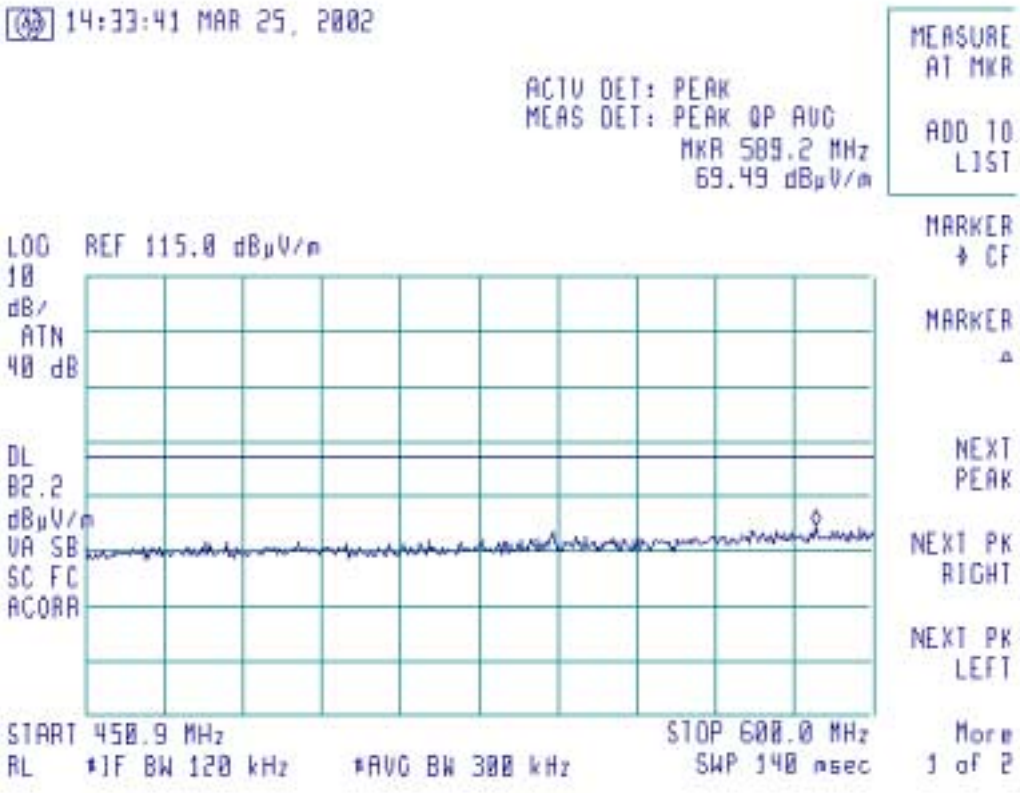
Plot 4.3.12
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



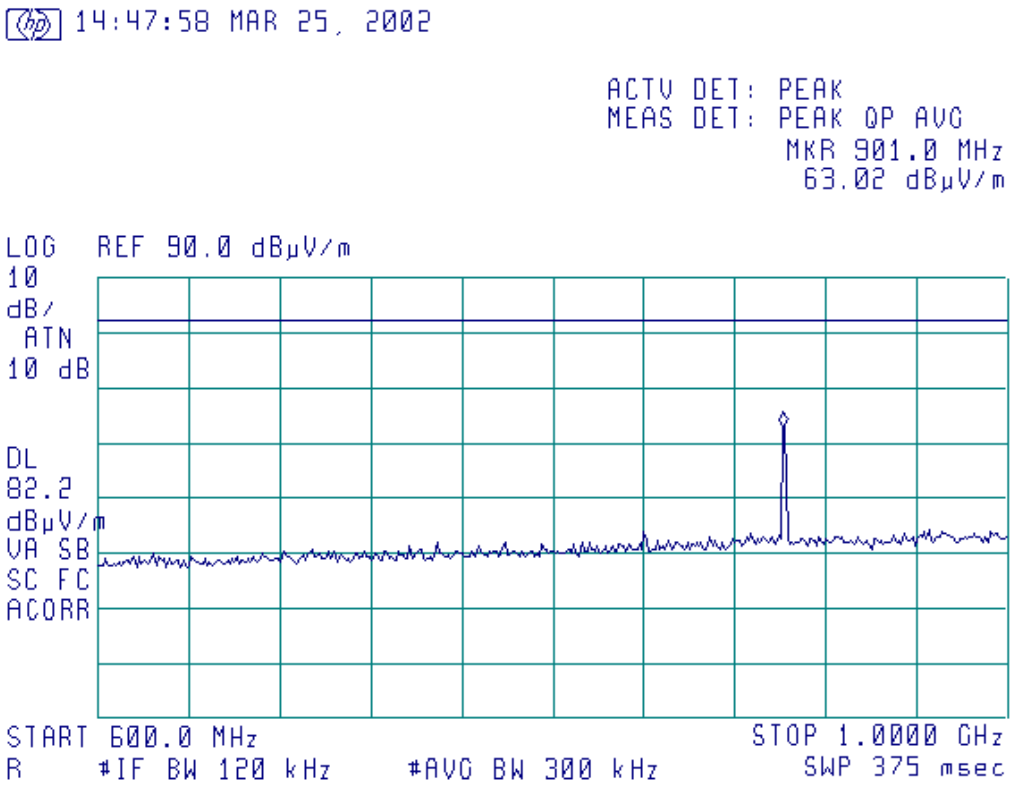
Plot 4.3.13
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



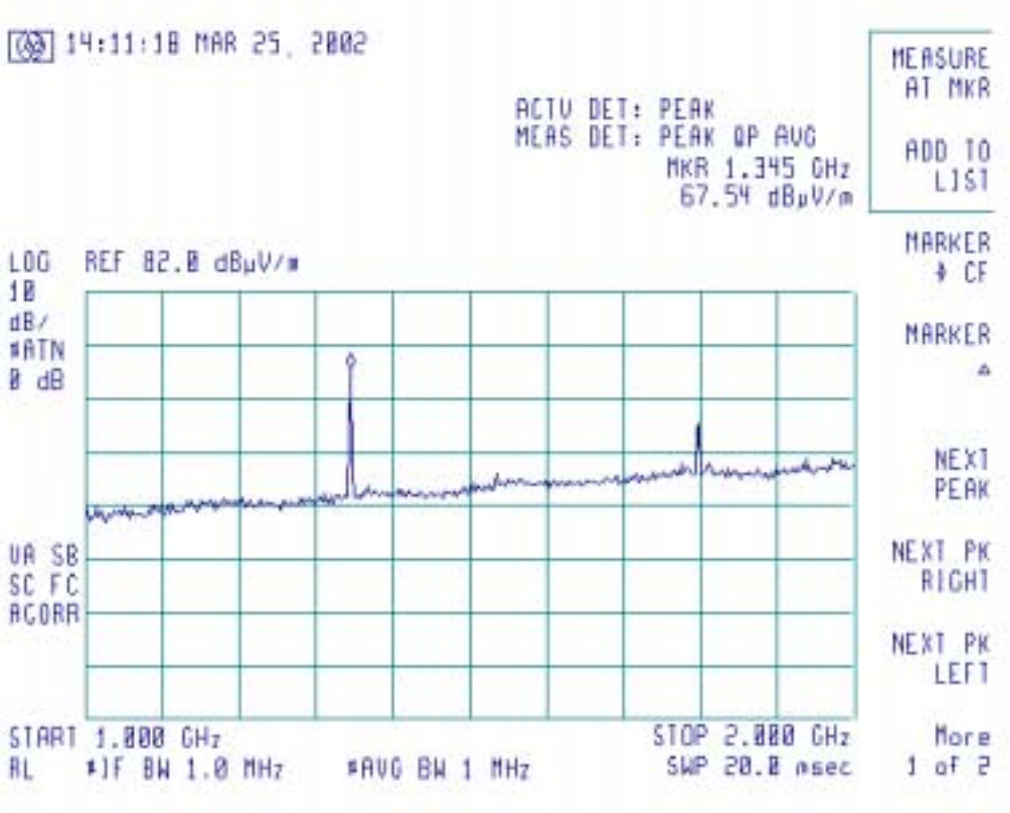
Plot 4.3.14
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



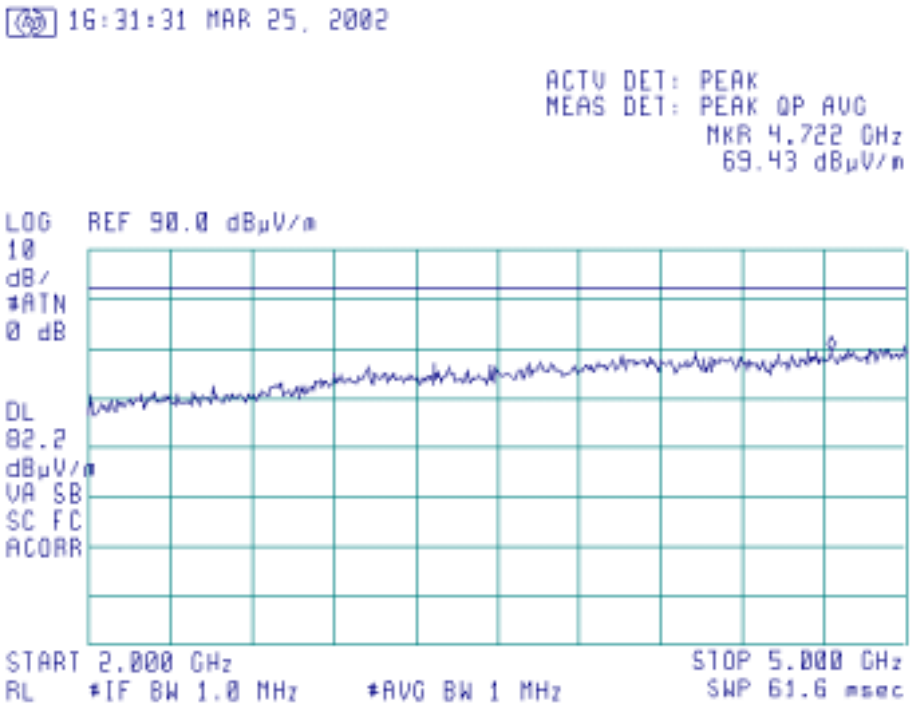
Plot 4.3.15
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



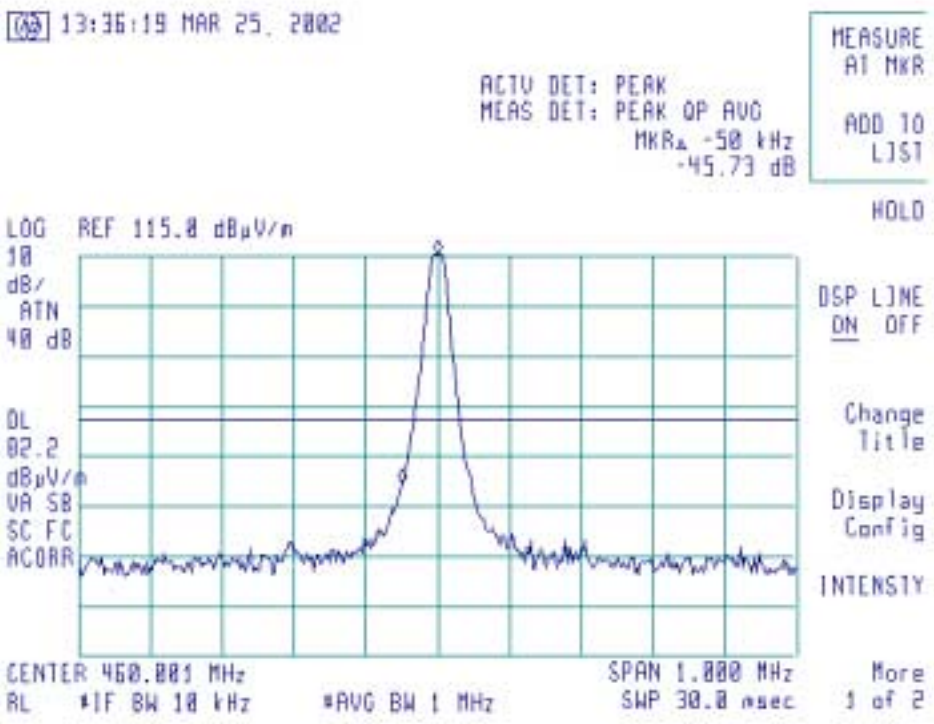
Plot 4.3.16
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=450.4009 MHz



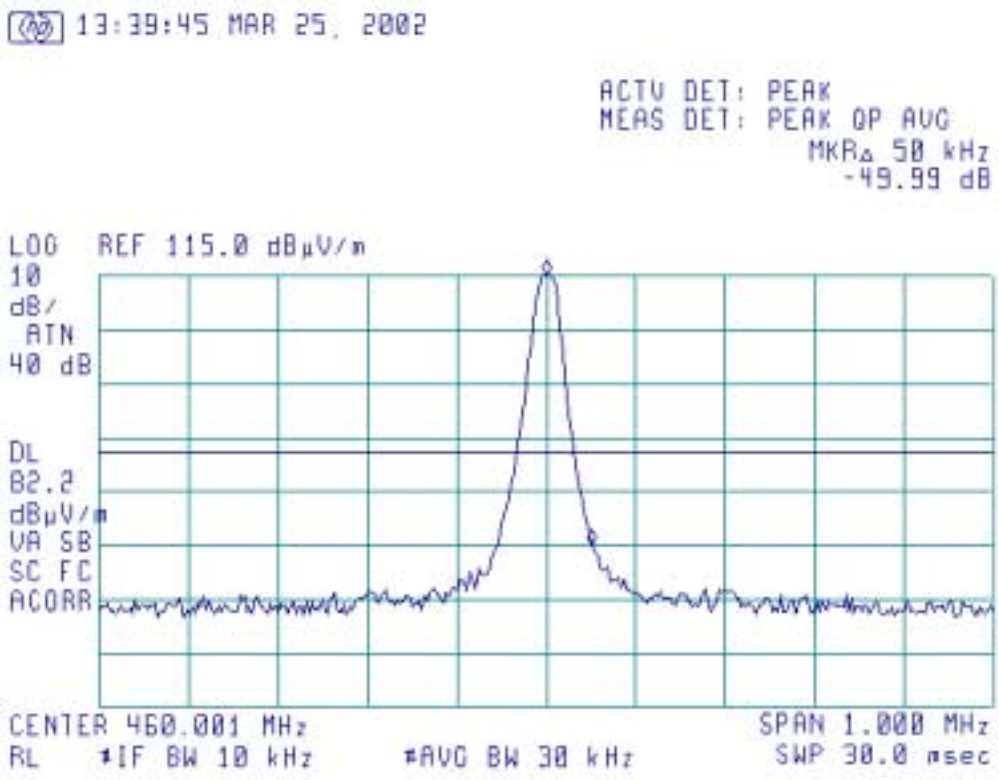
Plot 4.3.17
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.009 MHz



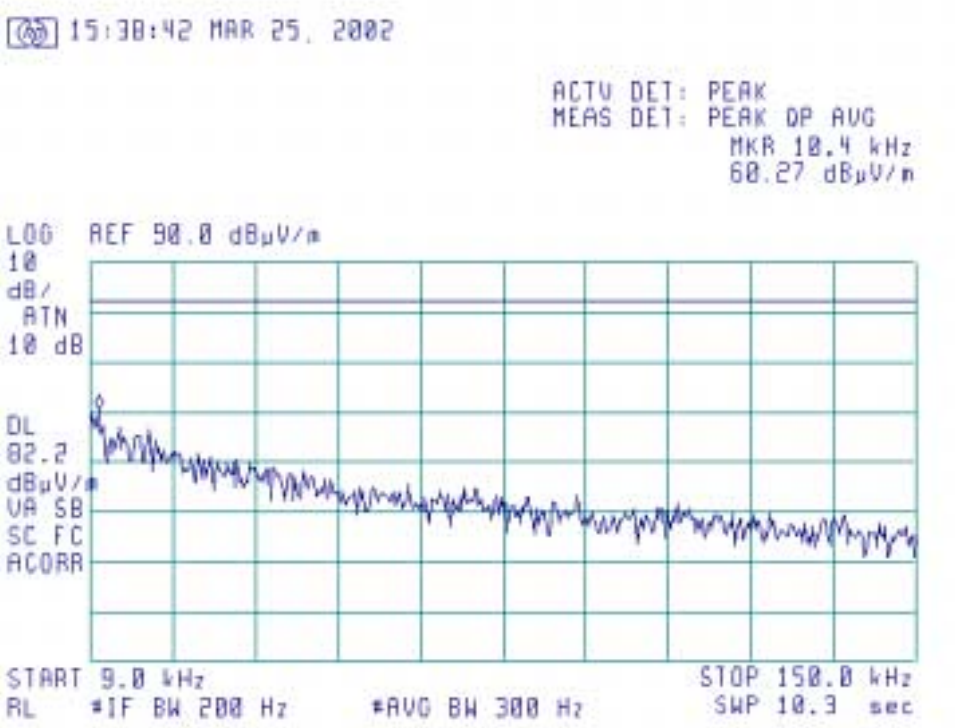
Plot 4.3.18
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.009 MHz



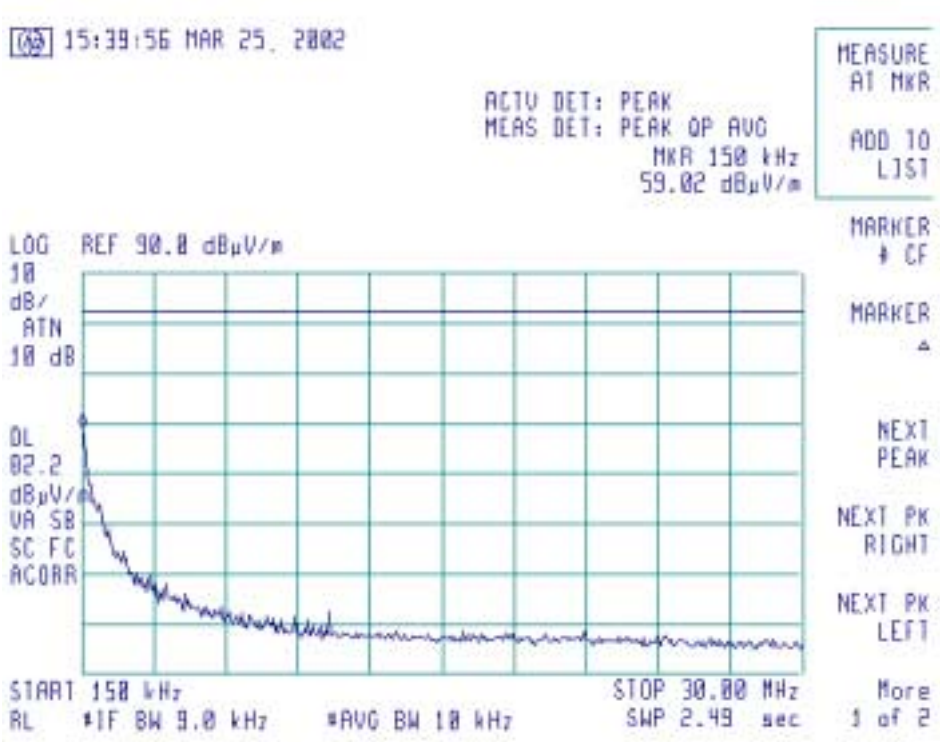
Plot 4.3.19
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.0009 MHz



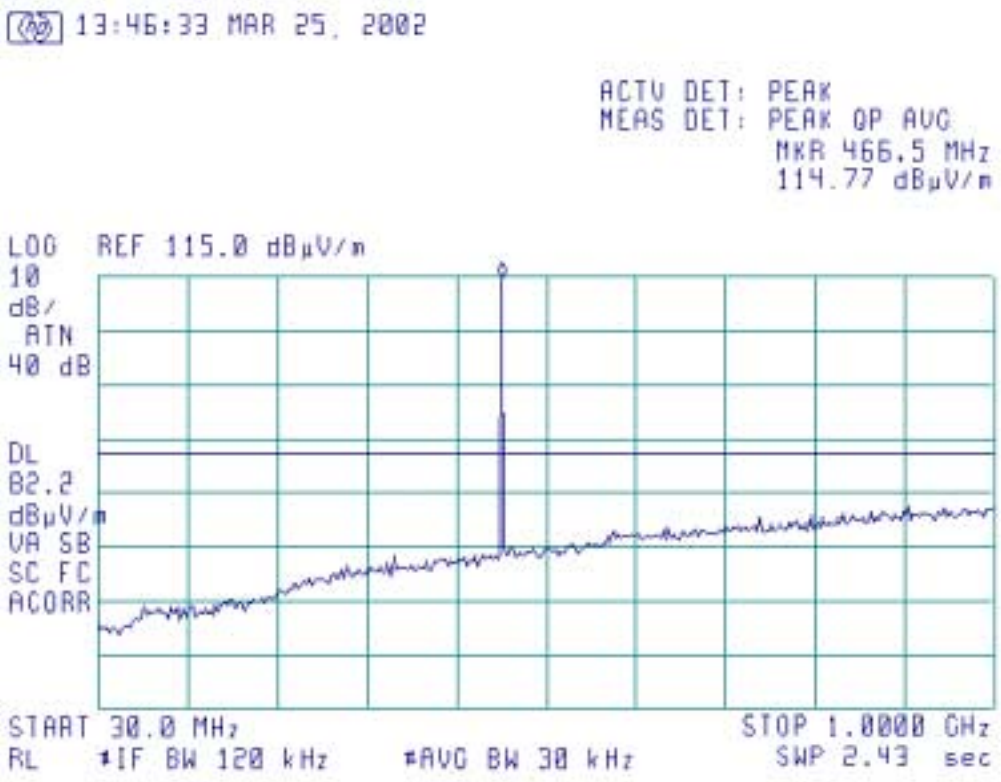
Plot 4.3.20
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.0009 MHz



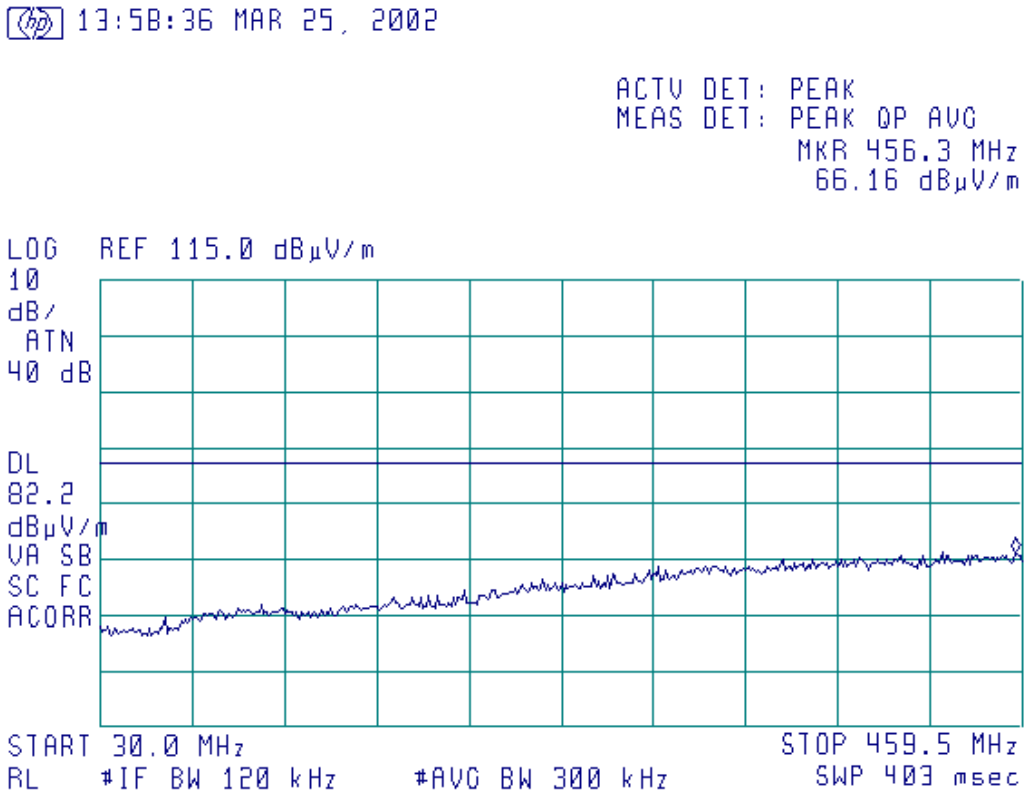
Plot 4.3.21
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.009 MHz



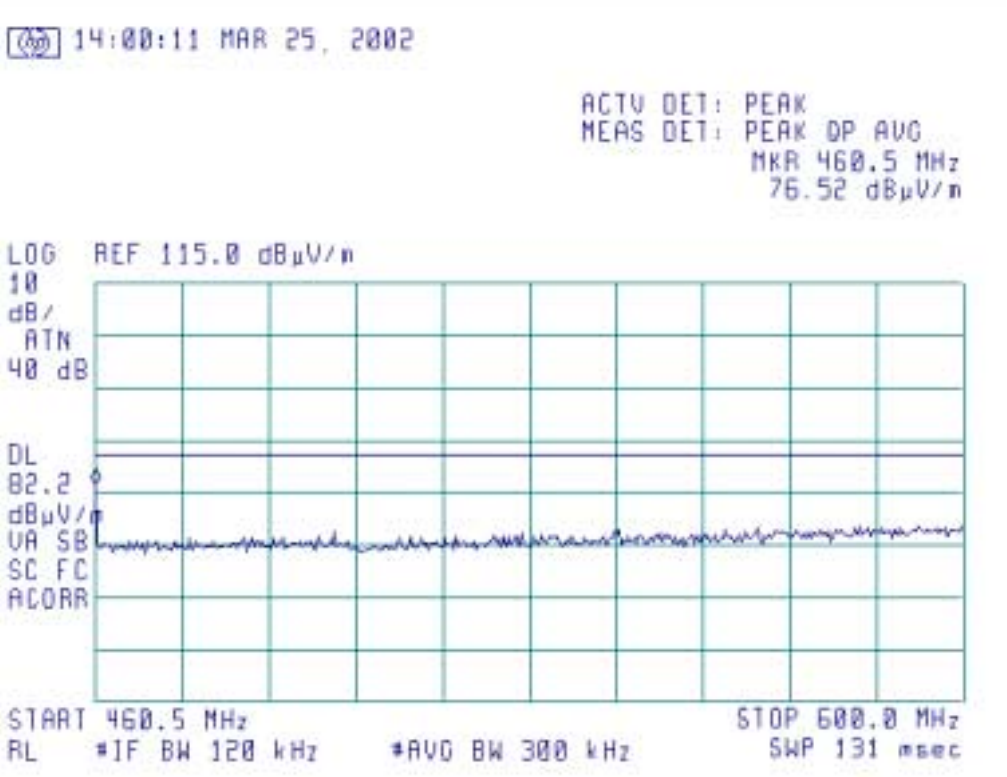
Plot 4.3.22
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.009 MHz



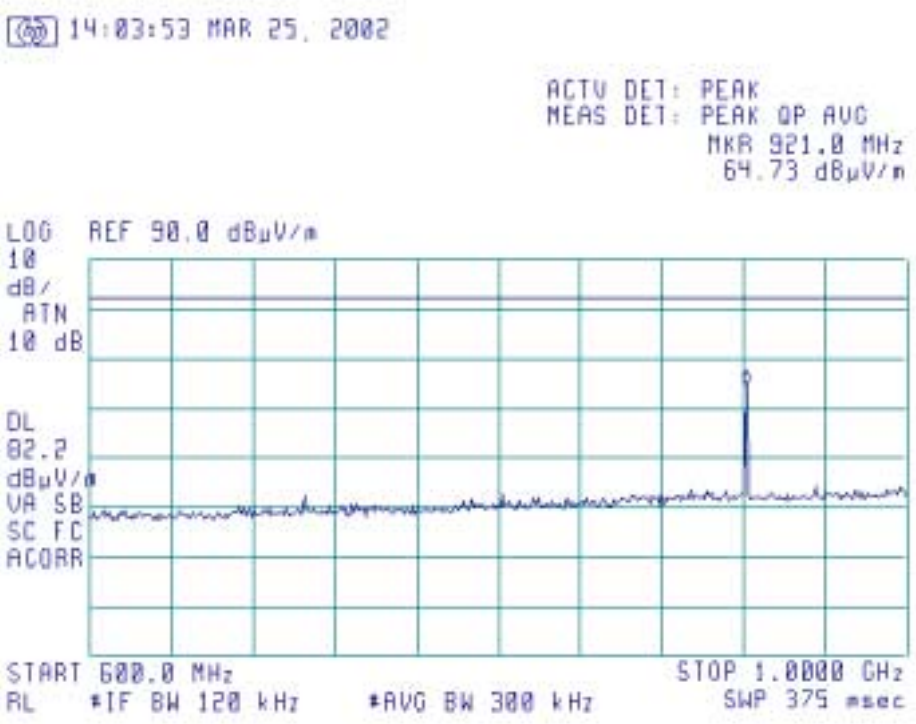
Plot 4.3.23
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.009 MHz



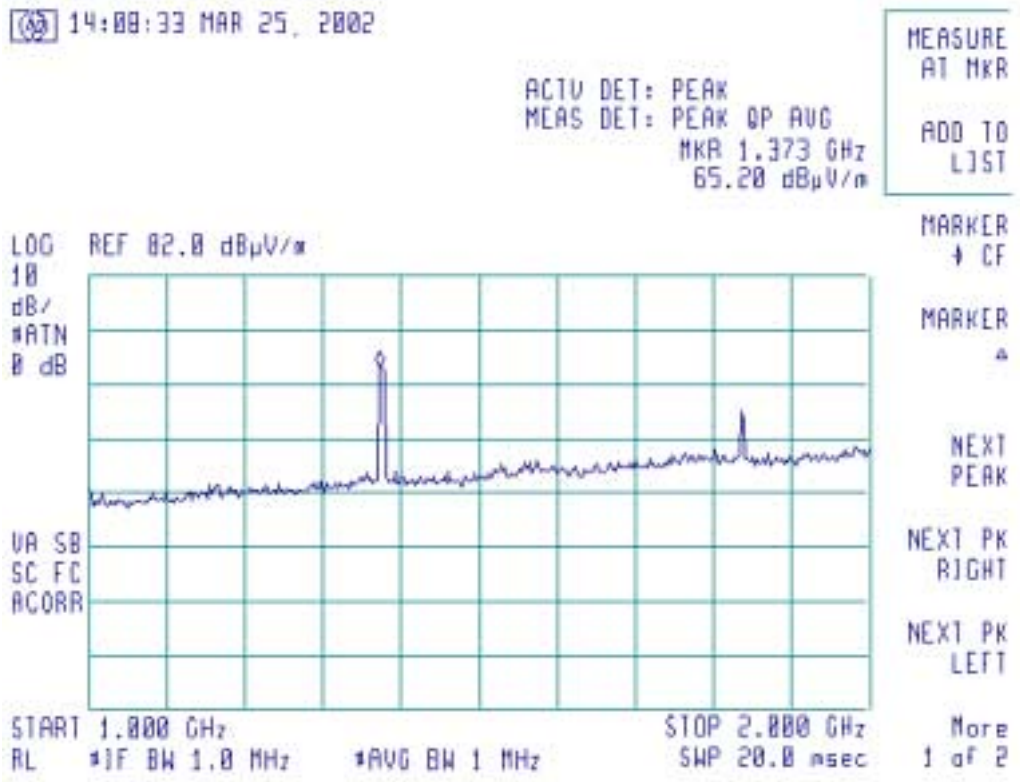
Plot 4.3.24
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.009 MHz



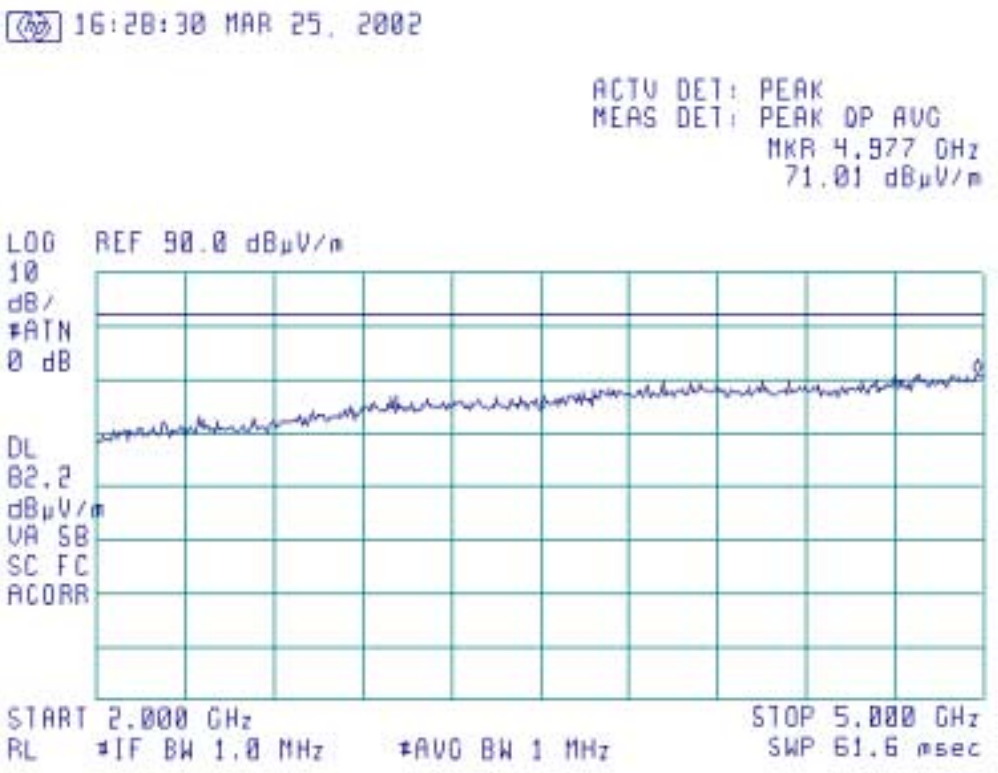
Plot 4.3.25
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.009 MHz



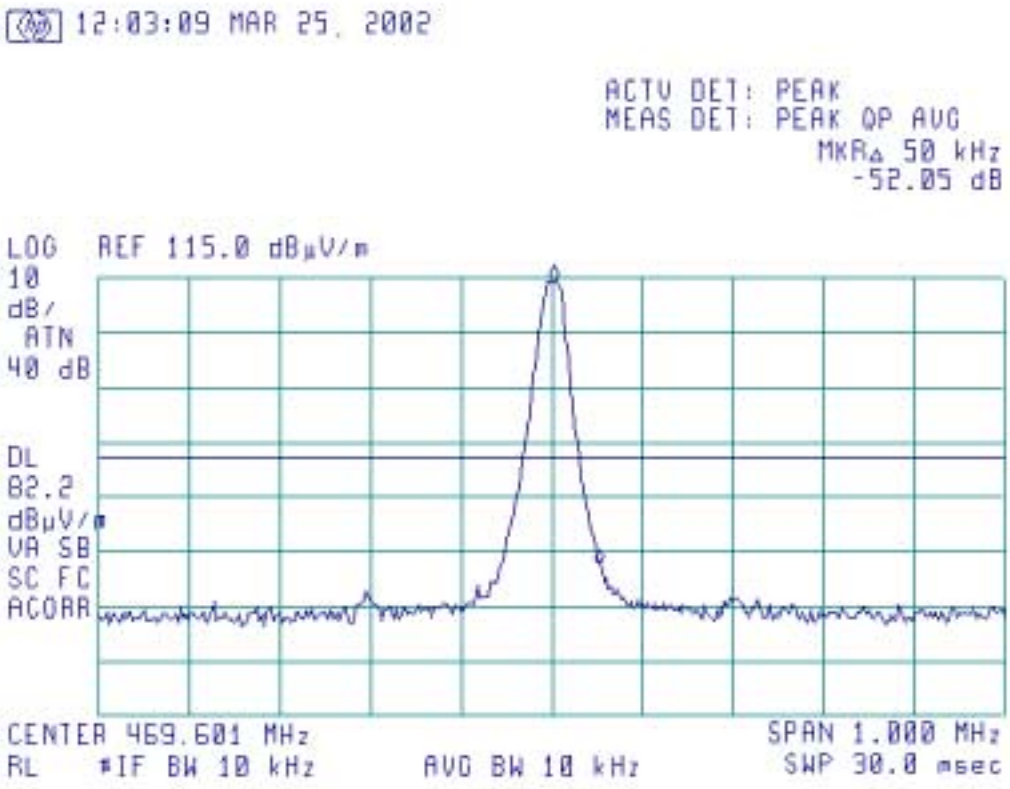
Plot 4.3.26
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=460.009 MHz



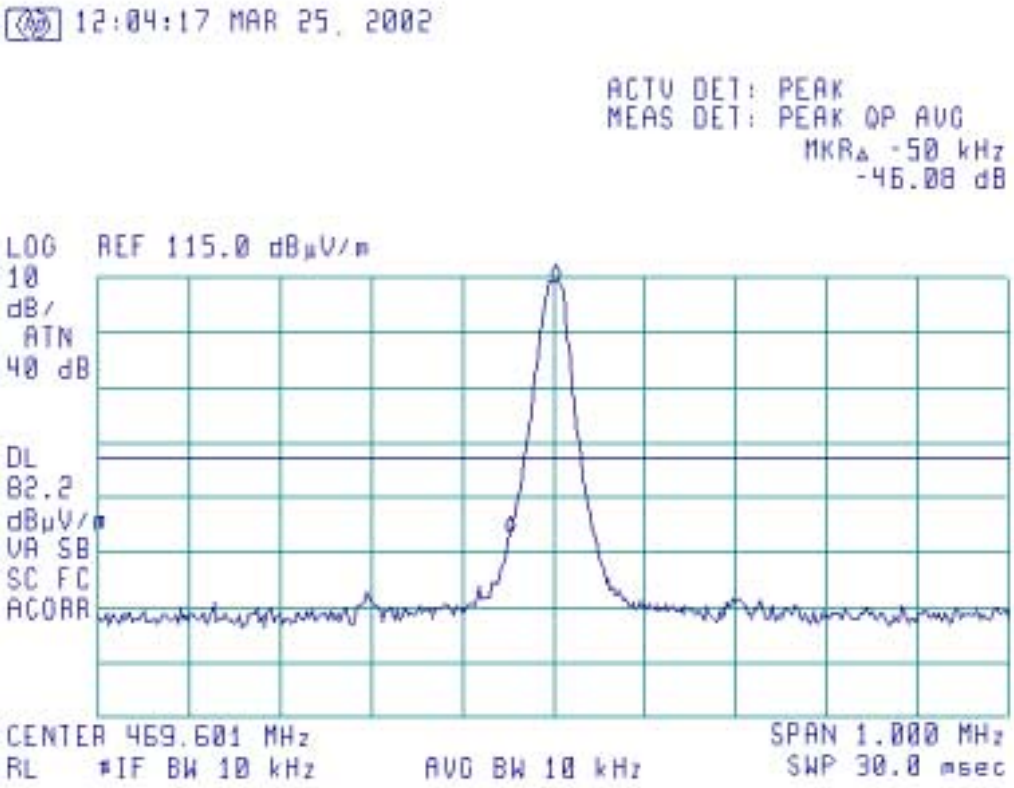
Plot 4.3.27
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6 MHz



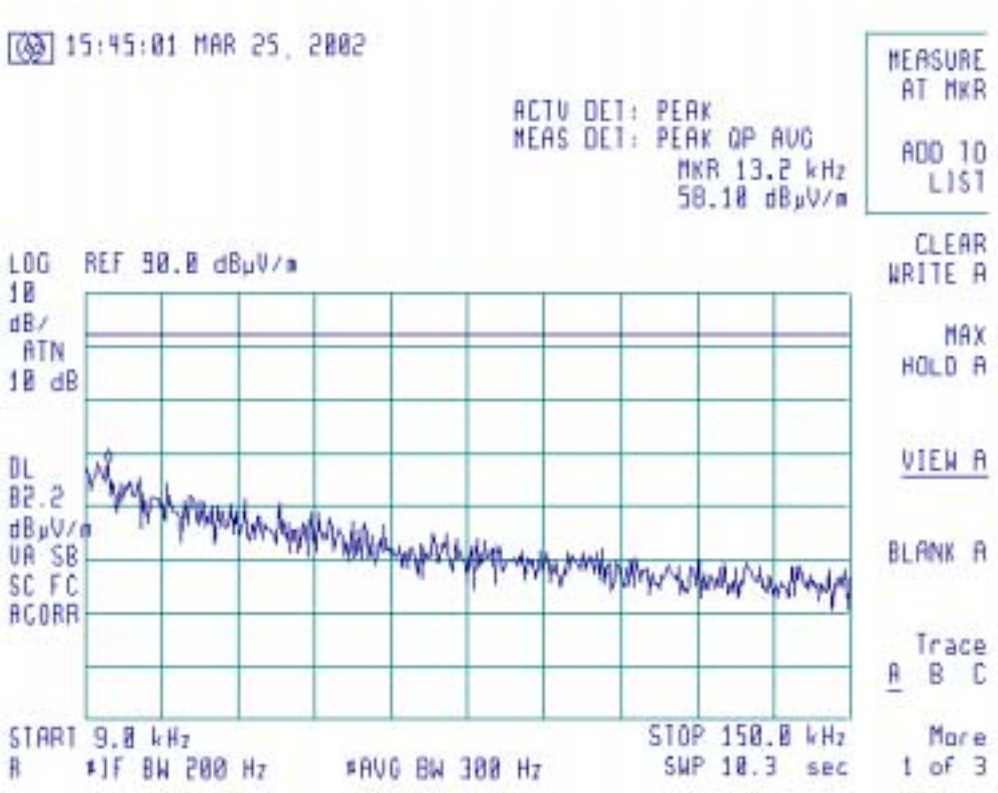
Plot 4.3.28
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6 MHz



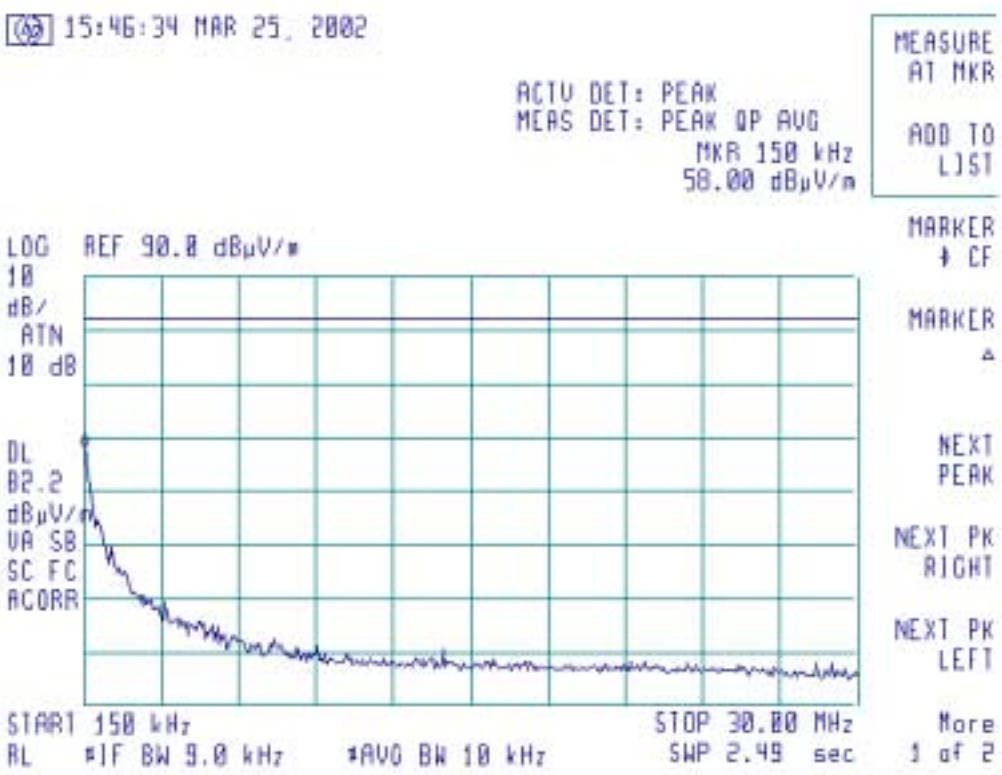
Plot 4.3.29
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6009 MHz



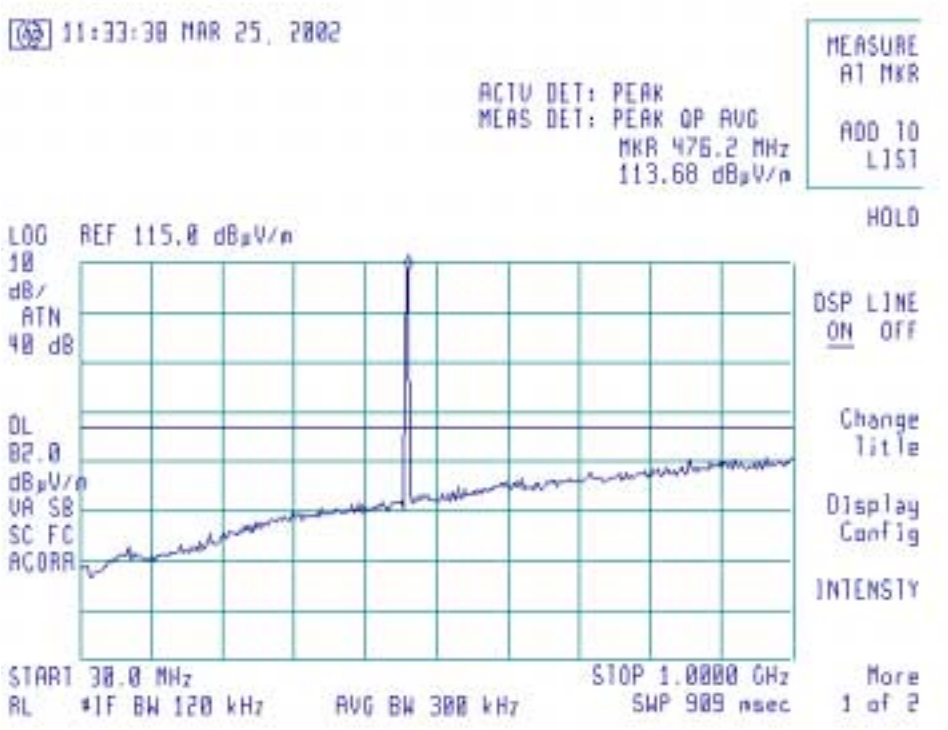
Plot 4.3.30
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6009 MHz



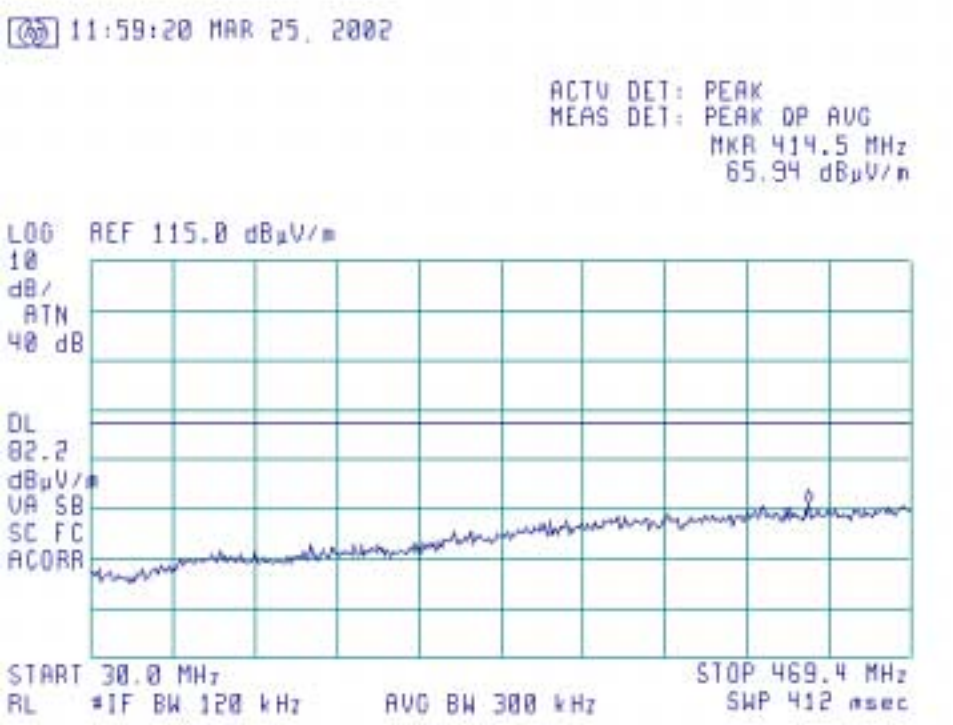
Plot 4.3.31
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6 MHz



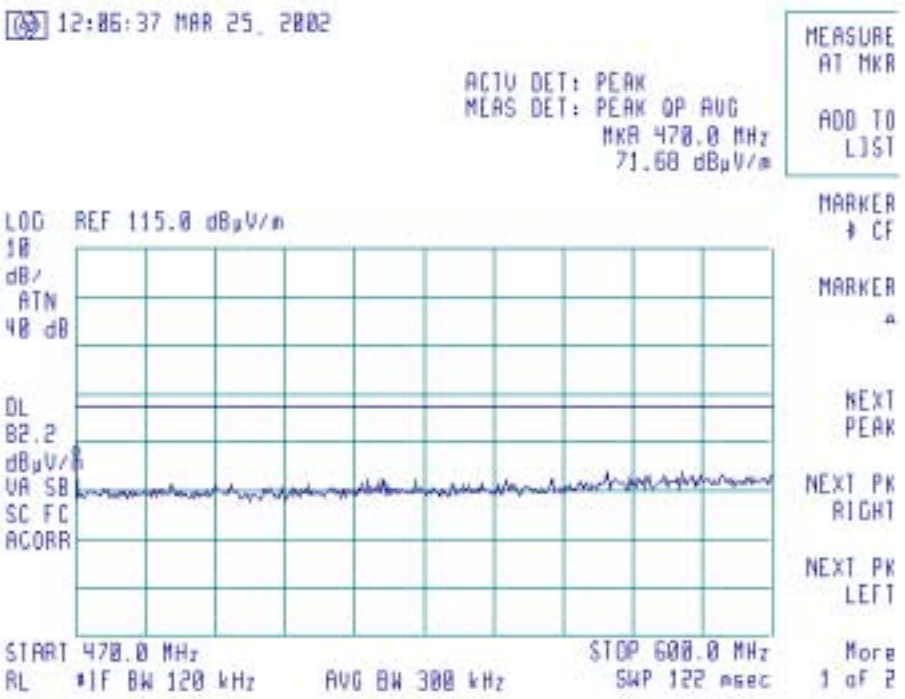
Plot 4.3.32
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6 MHz



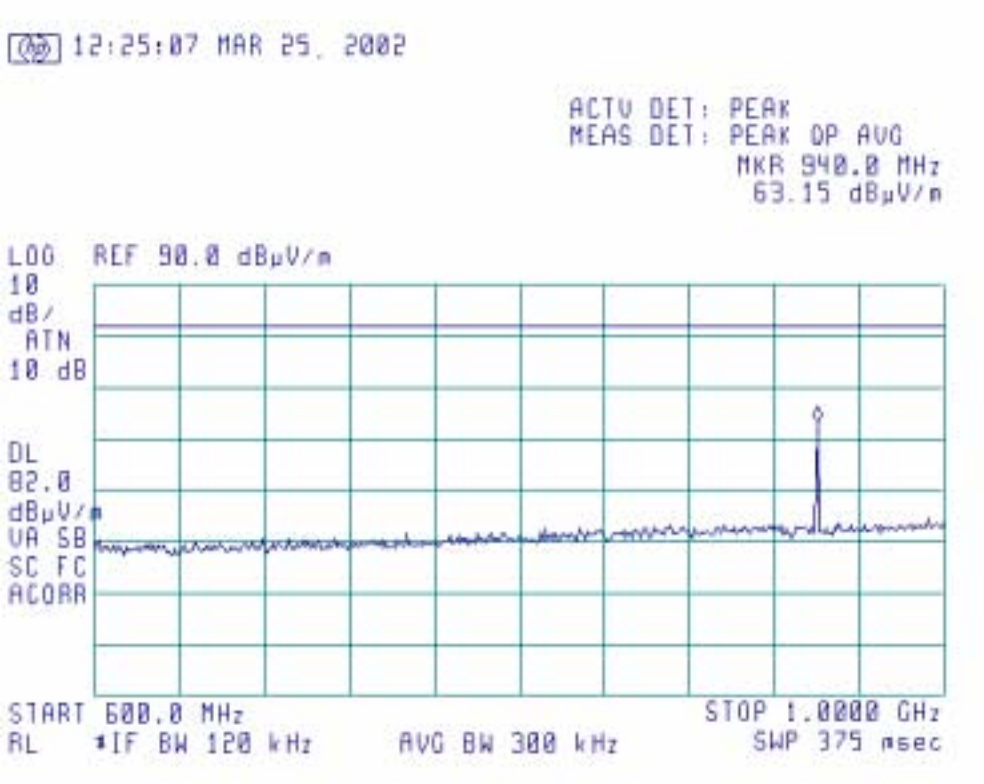
Plot 4.3.33
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6 MHz



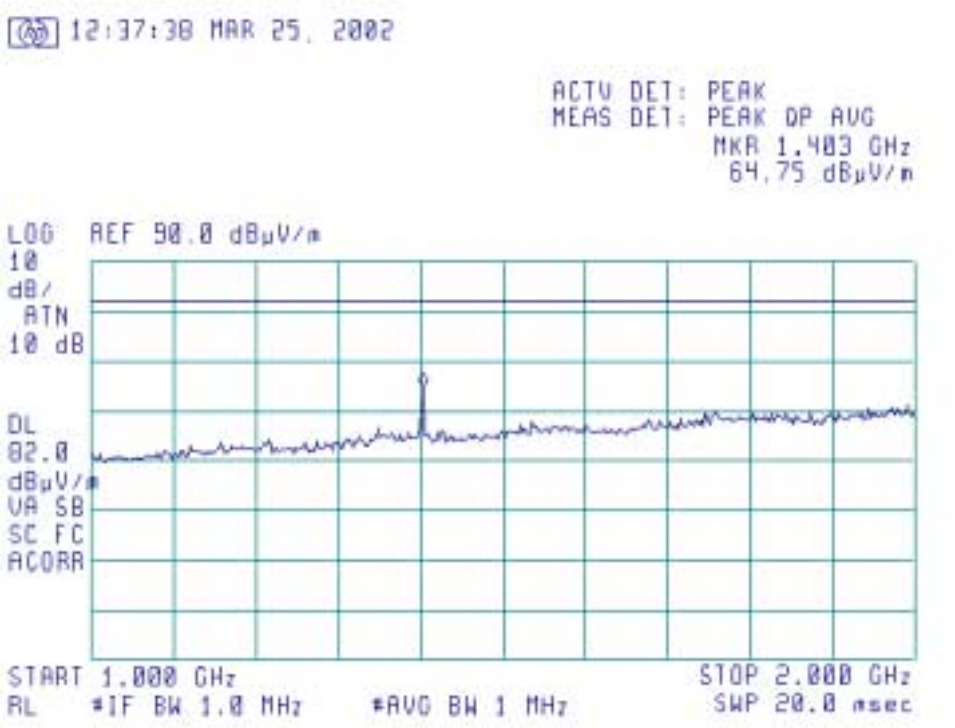
Plot 4.3.34
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6 MHz



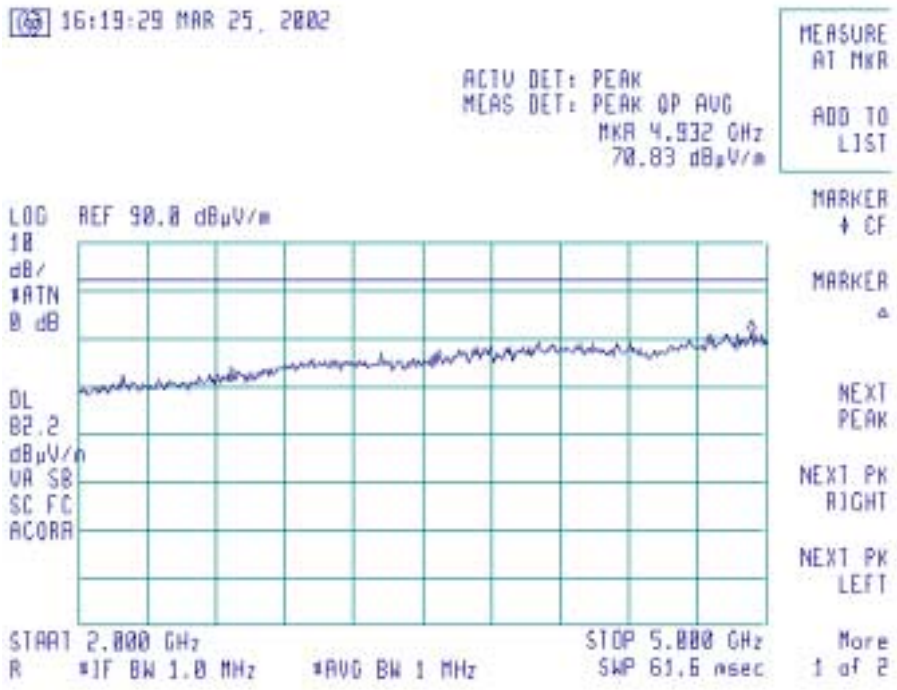
Plot 4.3.35
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6 MHz



Plot 4.3.36
Spurious emissions measurement test results

Test Name	Spurious emission
EUT Model Number	Speed HPTx
Customer Name	Miltel
Note	F=469.6009 MHz



4.4 Frequency stability measurements according to FCC part 90 paragraph 213

4.4.1 General

According to paragraph 90.213, the frequency stability limit (in parts per million) is 2.5 ppm in the frequency range 450 – 470 MHz.
For frequency 450 400 708 Hz the specified limit is ±1126 Hz
for 460 000 692 Hz - ±1150 Hz
for 469 600 759 Hz - ±1174 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 low, middle and high frequency channels.
Test results were recorded in Tables 4.4.1 to 4.4.6. The maximum measured displacement was - 910 Hz.
The EUT was found to comply with the standard requirements.

Reference numbers of test equipment used

0493	0558	0758	0808	

Full description is in Appendix A.

Table 4.4.1
Frequency stability test results vs supply voltage
Frequency: 450.400 MHz, limit: ±1126 Hz

Temperature: 22°C

Voltage, V	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
Ucc=3.6V	450400816	+108	startup	Pass
	450400748	+40	+2	Pass
	450400712	+4	+5	Pass
	450400708	0	+10	Pass
Ucc=3.2V	450400864	+156	startup	Pass
	450400805	+97	+2	Pass
	450400773	+65	+5	Pass
	450400762	+54	+10	Pass
Ucc=4.14V	450400808	+100	startup	Pass
	450400685	-23	+2	Pass
	450400639	-69	+5	Pass
	450400613	-95	+10	Pass

Reference frequency: 450400708 Hz

Table 4.4.2
Frequency stability test results vs ambient temperature
Reference frequency: 450400708 Hz, limit: ±1126 Hz

Temperature, °C	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
t°=30°C	450400675	-33	startup	Pass
	450400583	-125	+2	Pass
	450400554	-154	+5	Pass
	450400533	-175	+10	Pass
t°=40°C	450400200	-508	startup	Pass
	450400118	-590	+2	Pass
	450400122	-586	+5	Pass
	450400126	-582	+10	Pass
t°=50°C	450399939	-769	startup	Pass
	450399988	-720	+2	Pass
	450400007	-701	+5	Pass
	450400021	-687	+10	Pass
t°=10°C	450401103	395	startup	Pass
	450401048	340	+2	Pass
	450401046	338	+5	Pass
	450401046	338	+10	Pass
t°=0°C	450400745	37	startup	Pass
	450400848	140	+2	Pass
	450400842	134	+5	Pass
	450400850	142	+10	Pass
t°=-10°C	450400593	-115	startup	Pass
	450400790	82	+2	Pass
	450400855	147	+5	Pass
	450400764	56	+10	Pass
t°=-20°C	450400634	-74	startup	Pass
	450400825	117	+2	Pass
	450400842	134	+5	Pass
	450400838	130	+10	Pass
t°=-30°C	450399248	-933	startup	Pass
	450400261	-447	+2	Pass
	450400296	-412	+5	Pass
	450400272	-436	+10	Pass

Table 4.4.3
Frequency stability test results vs supply voltage
Frequency: 460.000 MHz, limit: ±1150 Hz

Temperature: 22°C

Voltage, V	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
Ucc=3.6V	460000707	+15	startup	Pass
	460000700	+8	+2	Pass
	460000697	+5	+5	Pass
	460000692	0	+10	Pass
Ucc=3.2V	460000759	+67	startup	Pass
	460000751	+59	+2	Pass
	460000741	+49	+5	Pass
	460000741	+49	+10	Pass
Ucc=4.14V	460000639	-53	startup	Pass
	460000611	-81	+2	Pass
	460000597	-95	+5	Pass
	460000583	-109	+10	Pass

Reference frequency: 460000692 Hz

Table 4.4.4
Frequency stability test results vs ambient temperature
Reference frequency: 460000692 Hz, limit: ±1150 Hz

Temperature, °C	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
t°=30°C	460000680	-12	startup	Pass
	460000583	-109	+2	Pass
	460000552	-140	+5	Pass
	460000541	-151	+10	Pass
t°=40°C	460000196	-496	startup	Pass
	460000121	-571	+2	Pass
	460000121	-571	+5	Pass
	460000114	-578	+10	Pass
t°=50°C	459999974	-718	startup	Pass
	460000014	-678	+2	Pass
	460000025	-667	+5	Pass
	460000041	-651	+10	Pass
t°=10°C	460001050	358	startup	Pass
	460001075	383	+2	Pass
	460001075	383	+5	Pass
	460001075	383	+10	Pass
t°=0°C	460000836	144	startup	Pass
	460000941	249	+2	Pass
	460000924	232	+5	Pass
	460000938	246	+10	Pass
t°=-10°C	460000863	171	startup	Pass
	460001054	362	+2	Pass
	460001126	434	+5	Pass
	460001002	310	+10	Pass
t°=-20°C	460000590	-102	startup	Pass
	460001084	392	+2	Pass
	460001132	440	+5	Pass
	460001120	428	+10	Pass
t°=-30°C	459999782	-910	startup	Pass
	460000611	-81	+2	Pass
	460000703	11	+5	Pass
	460000711	19	+10	Pass

Table 4.4.5
Frequency stability test results vs supply voltage
Frequency: 469.600 MHz, limit: ±1174 Hz

Temperature: 22°C

Voltage, V	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
Ucc=3.6V	469600899	+140	startup	Pass
	469600813	+54	+2	Pass
	469600768	+9	+5	Pass
	469600759	0	+10	Pass
Ucc=3.2V	469600903	+144	startup	Pass
	469600850	+91	+2	Pass
	469600818	+59	+5	Pass
	469600808	+49	+10	Pass
Ucc=4.14V	469600882	+123	startup	Pass
	469600760	+1	+2	Pass
	469600706	-53	+5	Pass
	469600674	-85	+10	Pass

Reference frequency: 469600759 Hz

Table 4.4.6
Frequency stability test results vs ambient temperature
Reference frequency: 469600759 Hz, limit: ±1174 Hz

Temperature, °C	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
t°=30°C	469600696	-63	startup	Pass
	469600604	-155	+2	Pass
	469600568	-191	+5	Pass
	469600552	-207	+10	Pass
t°=40°C	469600195	-564	startup	Pass
	469600142	-617	+2	Pass
	469600114	-645	+5	Pass
	469600106	-653	+10	Pass
t°=50°C	469599949	-810	startup	Pass
	469600021	-738	+2	Pass
	469600039	-720	+5	Pass
	469600048	-711	+10	Pass
t°=10°C	469601073	314	startup	Pass
	469601083	324	+2	Pass
	469601089	330	+5	Pass
	469601087	328	+10	Pass
t°=0°C	469600746	-13	startup	Pass
	469600816	57	+2	Pass
	469600888	129	+5	Pass
	469600897	138	+10	Pass
t°=-10°C	469600682	-77	startup	Pass
	469600921	162	+2	Pass
	469600743	-16	+5	Pass
	469600774	15	+10	Pass
t°=-20°C	469600650	-109	startup	Pass
	469600830	71	+2	Pass
	469600868	109	+5	Pass
	469600880	121	+10	Pass
t°=-30°C	469599250	-1050	startup	Pass
	469600116	-643	+2	Pass
	469600310	-449	+5	Pass
	469600370	-389	+10	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 the biconilog antenna.
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 Plot 4.5.1. All the found emissions were at least 20 dB below the specified limit.

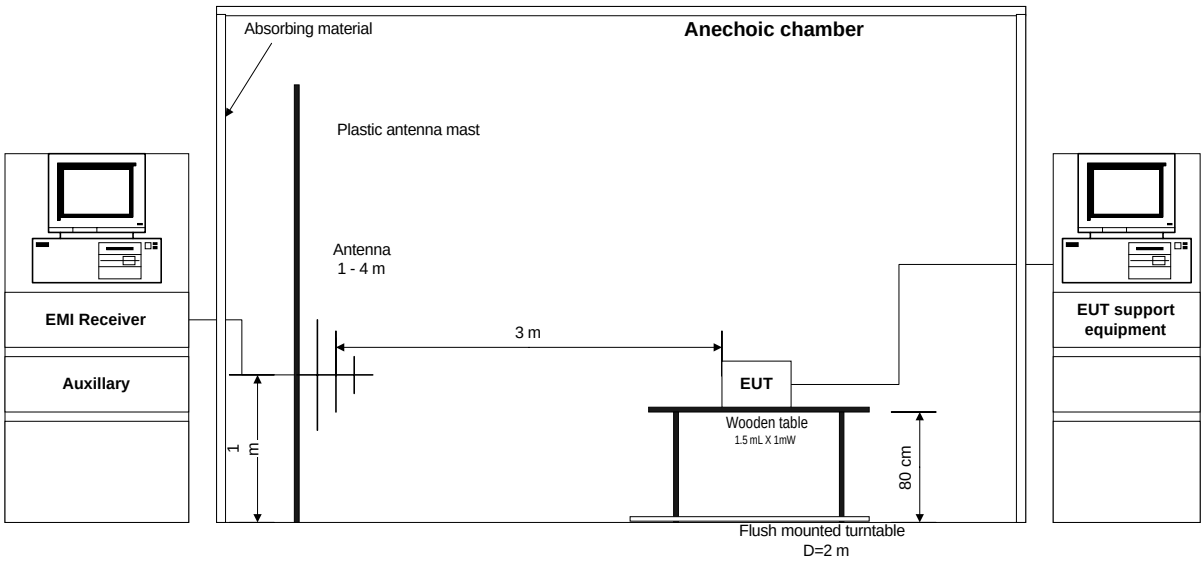
Reference numbers of test equipment used

0465	0521	0589	1004	

Full description is in Appendix A.

Plot 4.5.1 Radiated emission measurements test results,
electric field, frequency range 30 MHz - 1000 MHz

Figure 4.5.1
Radiated emissions test setup for table-top equipment



4.6 Transient Frequency Behavior according to FCC part 90 Paragraph 214

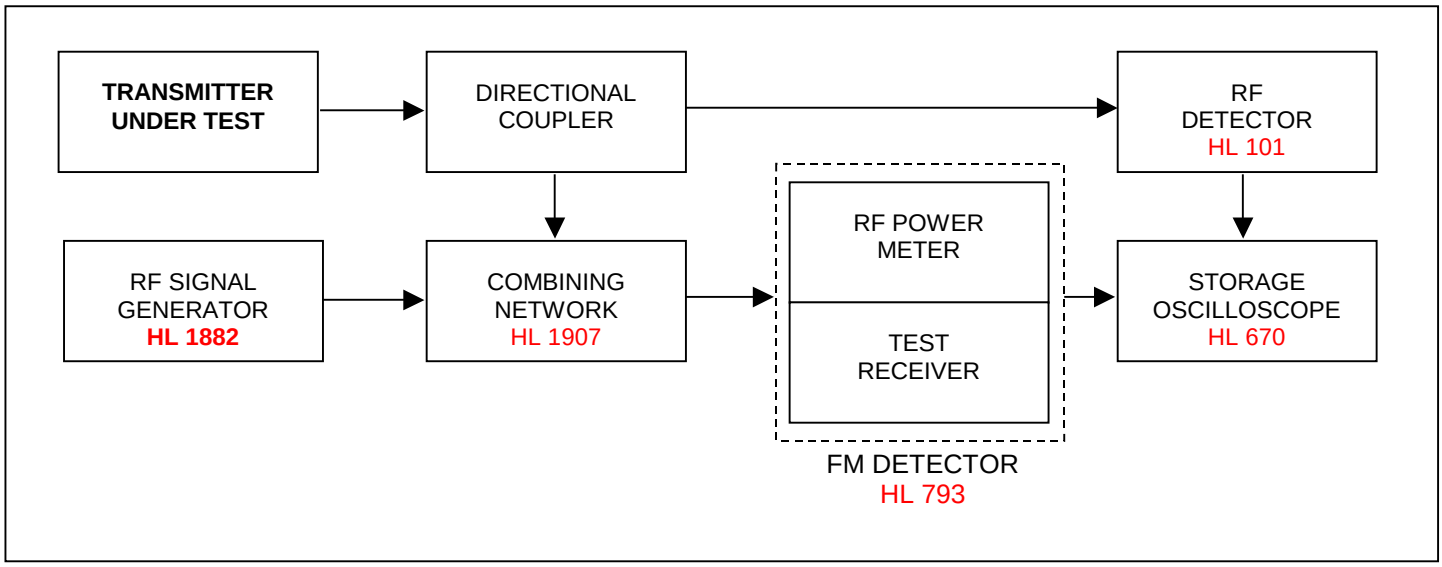
4.6.1 General

This test was performed to determine the maximum frequency difference limits during the time intervals as defined in part 90 paragraph 214.

4.6.2 Test Procedure

The transmitter was tested for transient frequency behavior using the test methodology defined in TIA/EIA-603-A (2.2.19.3). The test set up is depicted below in Figure 4.6.1. The functions of the RF power meter and the test receiver were performed by a Marconi FM Detector (HL793). The scope (HL 670) was triggered by a signal from the transmitter.

Figure 4.6.1
Transient Frequency Behavior Test Set Up



The test results as per 90.214 are recorded in Table 4.6.1 and shown in Plots 4.6.1 – 4.6.2.

Table 4.6.1
Transient Frequency Measurements

Time Intervals	Maximum Frequency Difference KHz.	Pass / Fail
t_1 = 10 msec.	±12.5*	Pass
t_2 = 25 msec.	±6.25*	Pass
During the time from the end of t_2 to the beginning of t_3 the frequency difference must not exceed the limit specified in 90.213 (±2.5 PPM x 460 MHz. = ±1.15 KHz.)		Pass
t_3 = 10 msec.	±12.5*	Pass

* The frequency difference during this time period may exceed the defined maximum frequency difference because the transmitter carrier output power rating is less than 6 watts

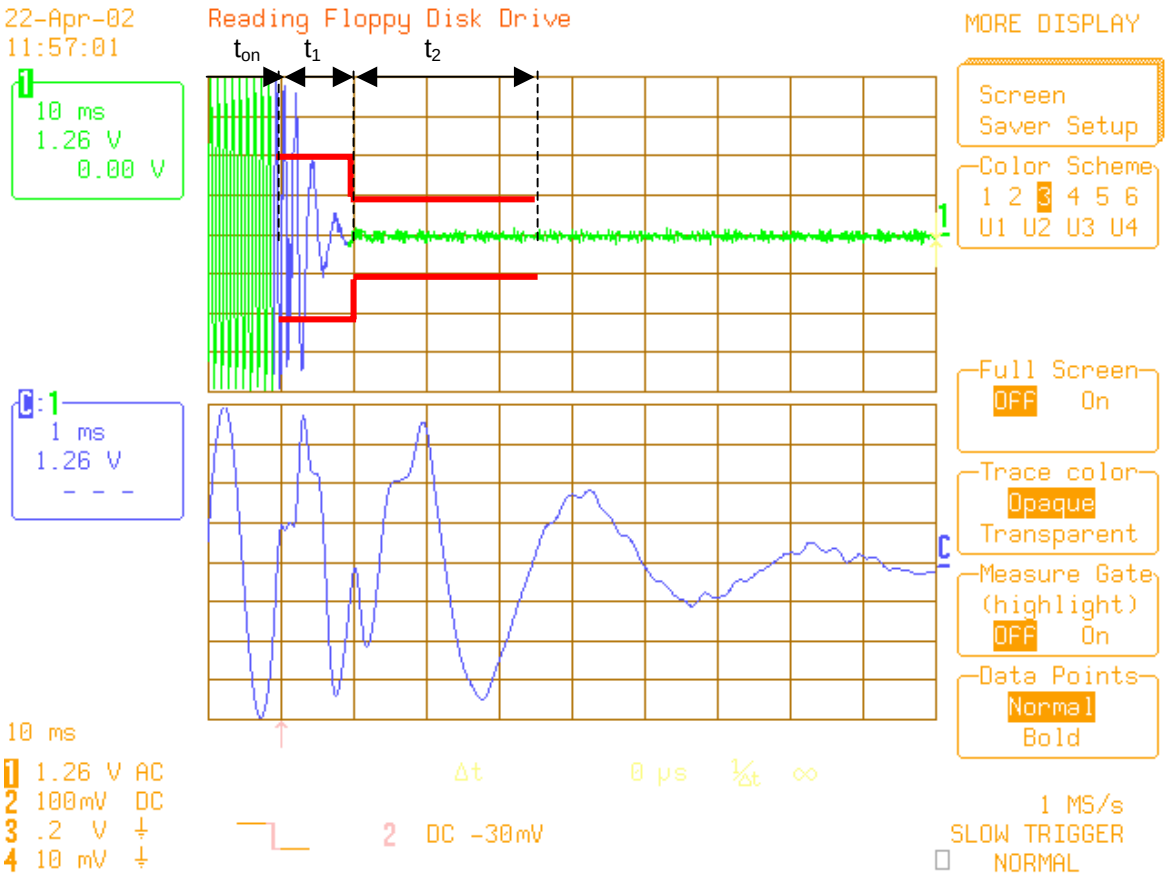
Reference numbers of test equipment used

HL 670	HL 1907	HL 101	HL 793	HL 1882

Full description is in Appendix A.

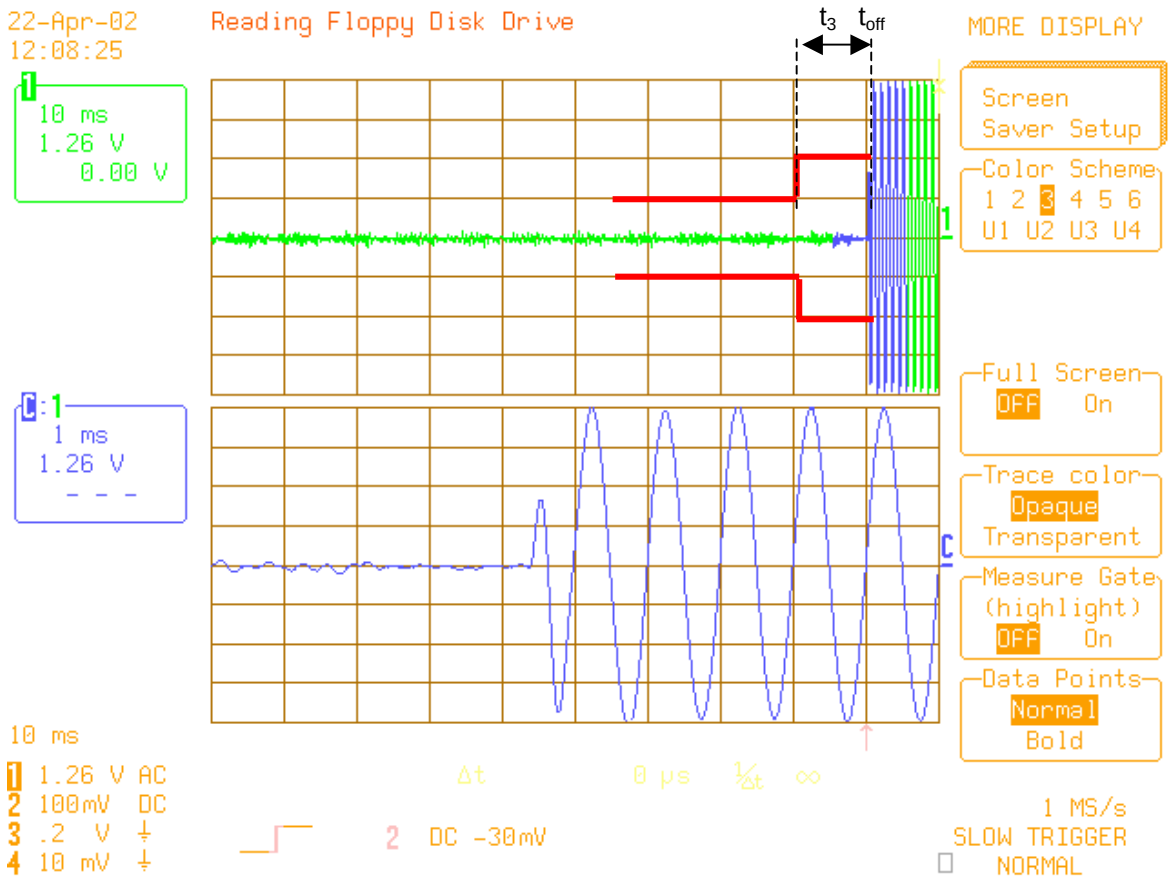
Plot 4.6.1
Turn On test results

Date/Time: April 22 2002 11:57:01 AM
Test Name: Turn On
Customer: Miltel
EUT: Speed HPTx

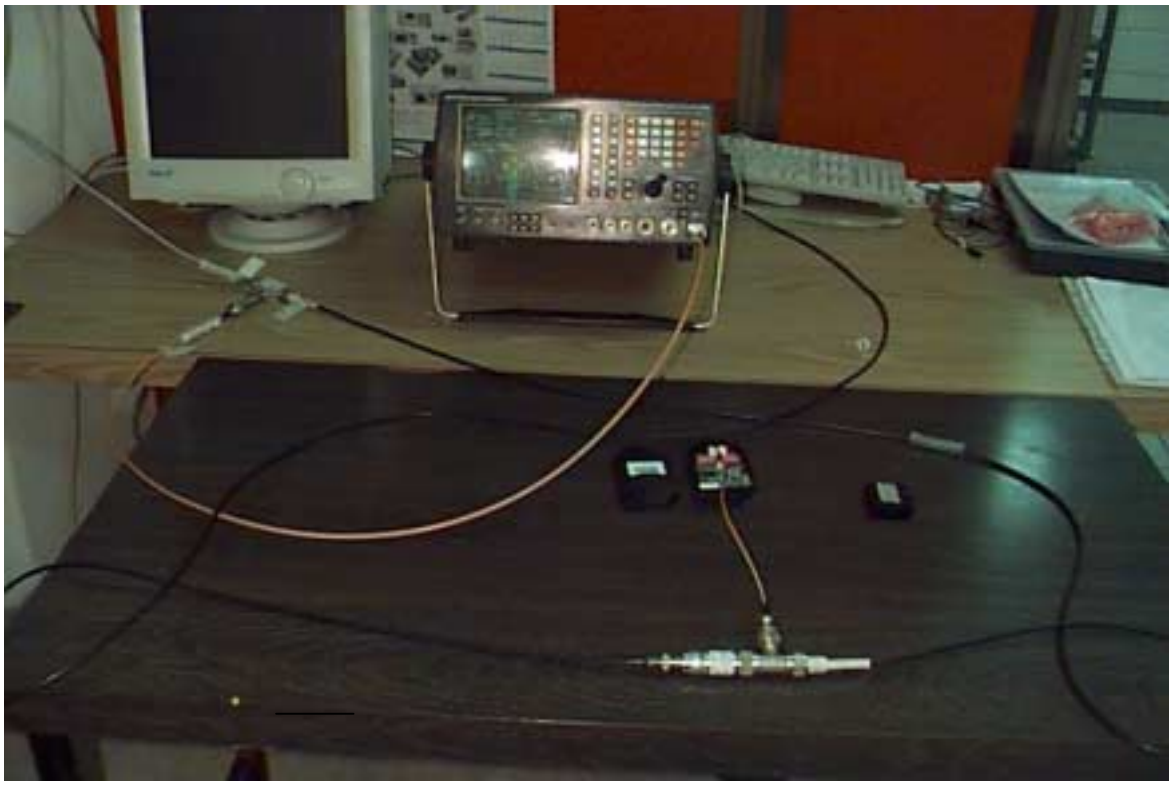


Plot 4.6.2
Turn Off test results

Date/Time: April 22 2002 12:08:25 PM
Test Name: Turn Off
Customer: Miltel
EUT: Speed HPTx



Transient Frequency Behavior Test Set Up



APPENDIX A - Test equipment and ancillaries used for tests

No.	Description	Manufacturer information			Due calibr.
		Name	Model No.	Serial No.	
0041	Double ridged guide antenna, 1-18 GHz	Electro-Metrics	RGA 50/60	2811	3/03
0101	Detector crystal, 0.01 – 12.4 GHz	Hewlett Packard	420A	101	11/02 Check
0446	Active Loop Antenna 10 kHz-30 MHz	Electro-Mechanics	6502	2857	10/02
0465	Anechoic Chamber 9 (L) x 6.5 (W) x 5.5 (H) m	HL	AC-1	023	3/03
0493	Oven temperature	Thermotron	S-1.2 Mini-Max	4016	9/02
0521	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A	0319	9/02
0558	Multimeter Digital	Fluke	76	0904	10/02
0589	Cable Coaxial, A2POL118.2, 3m	GORE	GORE-3	589	12/02
0591	Attenuator 10 dB, 50 Ohm, N-type, 2W	Elisra Electronic Systems	MW2100-N-Type	3	1/03
0604	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141	9611-1011	1/03
0614	Antenna Dipole Tunable 200 –1000 MHz	Electro-Metrics	TDS 30-1/30-2	334	1/03
0661	Generator Swept Signal, 10 MHz to 40GHz+ 10dBm	Hewlett Packard	83640B	0266	9/02
0670	Oscilloscope, Digital storage 500MHz, 2Gs/s, 4ch with Telecom Mask Tester	LeCroy Corporation	LC 334A+MT01/02	2387	8/02
0758	Power supply, 36 V, 1 A	Horizon Electronics	DHR 36-1	5361231	6/02 Check
0793	Radio communication test set	Marconi Instruments	2955	9507/179	2/03
0808	Analyzer spectrum, 100 Hz to 2.2 GHz, AM/FM modulator	Anritsu	MS2601B	M178731	3/03
1004	Cable coaxial, PSWJ4, 6 m	ANDREW	ANDREW-6	163	12/02
1424	Spectrum analyzer, 30 Hz - 40 GHz	Agilent Technologies	8564EC	3946A00219	8/02
1425	EMI Receiver System, 9 kHz - 2.9 GHz	Agilent Technologies	8542E	3710A00222	9/02
1536	Cable RF, 2 m	Alpha Wire	RG-58C/U	NA	9/02
1620	Attenuator, 50 Ohm, 2 W, DC to 8 GHz, 10 dB	Midwest Microwave	0217-10-NNN-02	NA	1/03
1882	Generator signal, 0.1 – 990 MHz	Hewlett Packard	8656A	2228A03615	9/02
1907	Power splitter/combiner, 5-500 MHz	Mini-Circuits	ZFSCC-2-1	NA	7/02
1940	Cable 40 GHz, 1.5 m, blue	Rhophase Microwave Ltd.	KPS-1503A-1500-KPS	T4663	10/02
1947	Cable 18 GHz, 6.5 m, blue	Rhophase Microwave Ltd	NPS-1803A-6500-NPS	T4974	10/02

APPENDIX B-Test equipment correction factors

Biconilog antenna factor, 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).