# 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. |
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| 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.<br>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

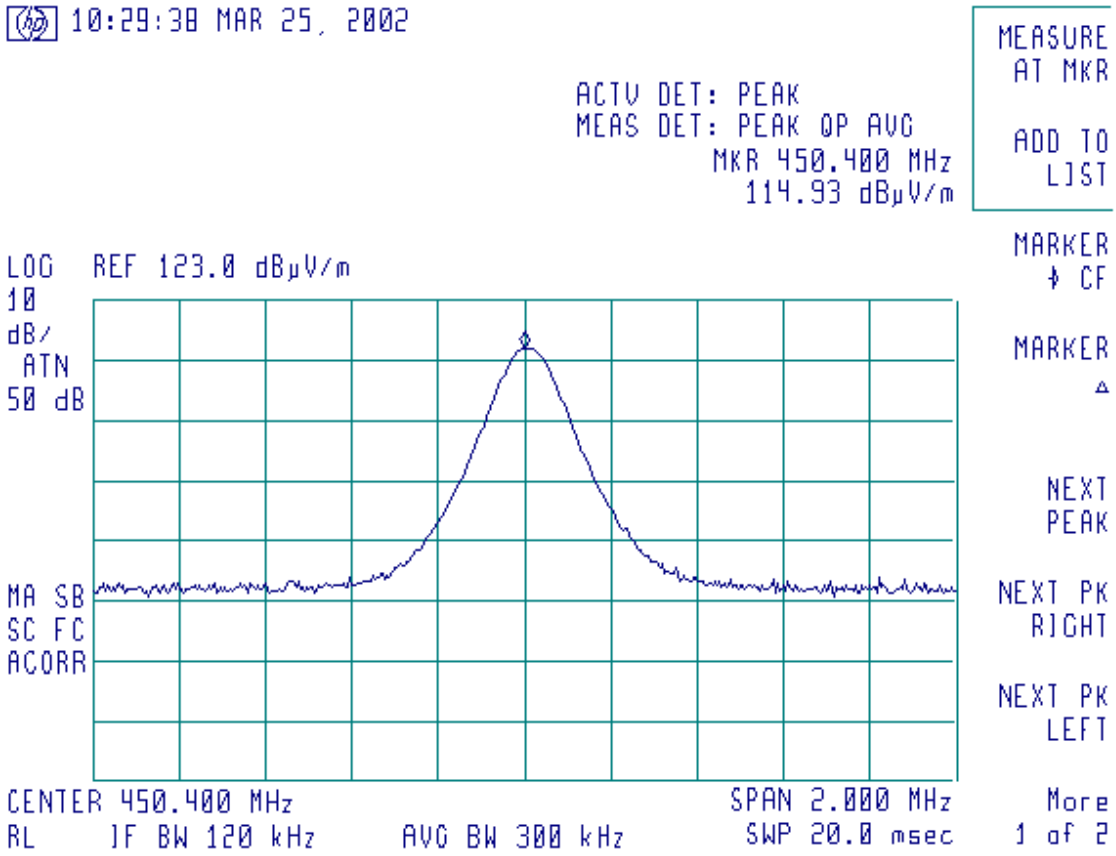
MEASUREMENTS PERFORMED AT 3 METRES DISTANCE

| 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 |

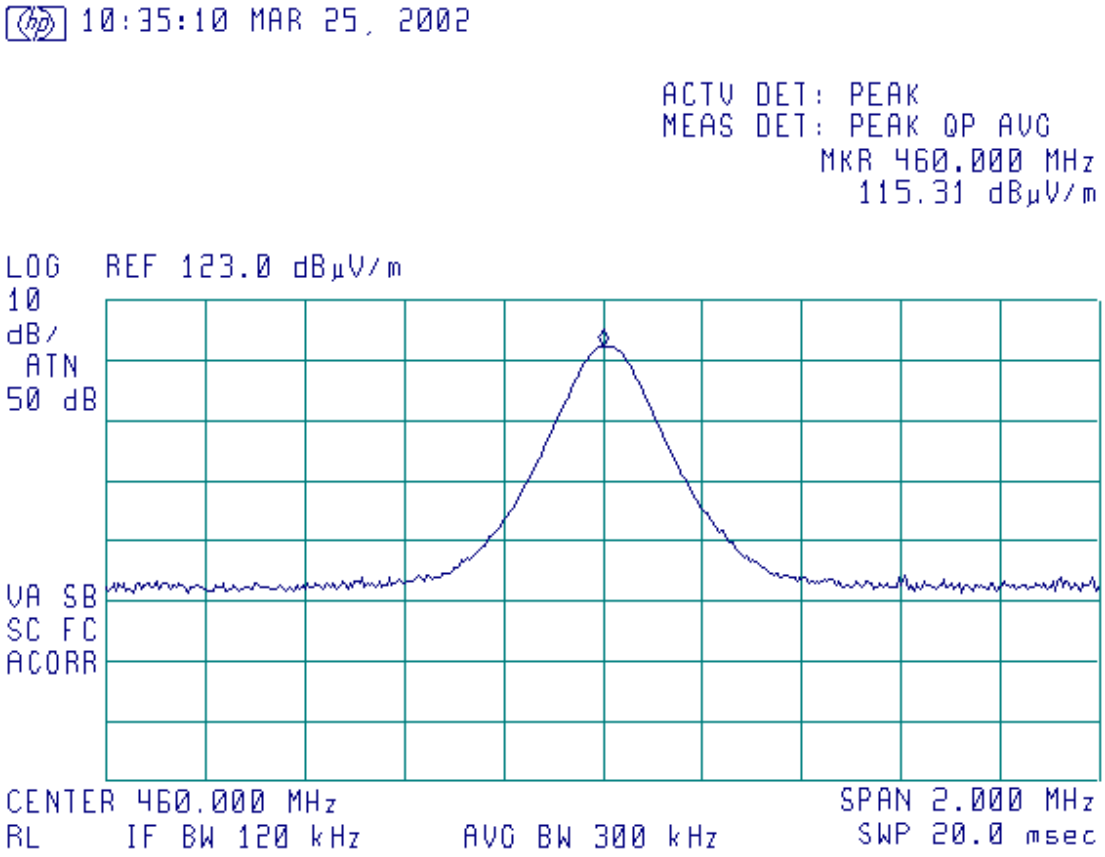
**Test parameters:**
Test results listed in the table were obtained throughout the testing with biconilog antenna in vertical polarization, peak detector and resolution bandwidth 120 kHz.

**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**

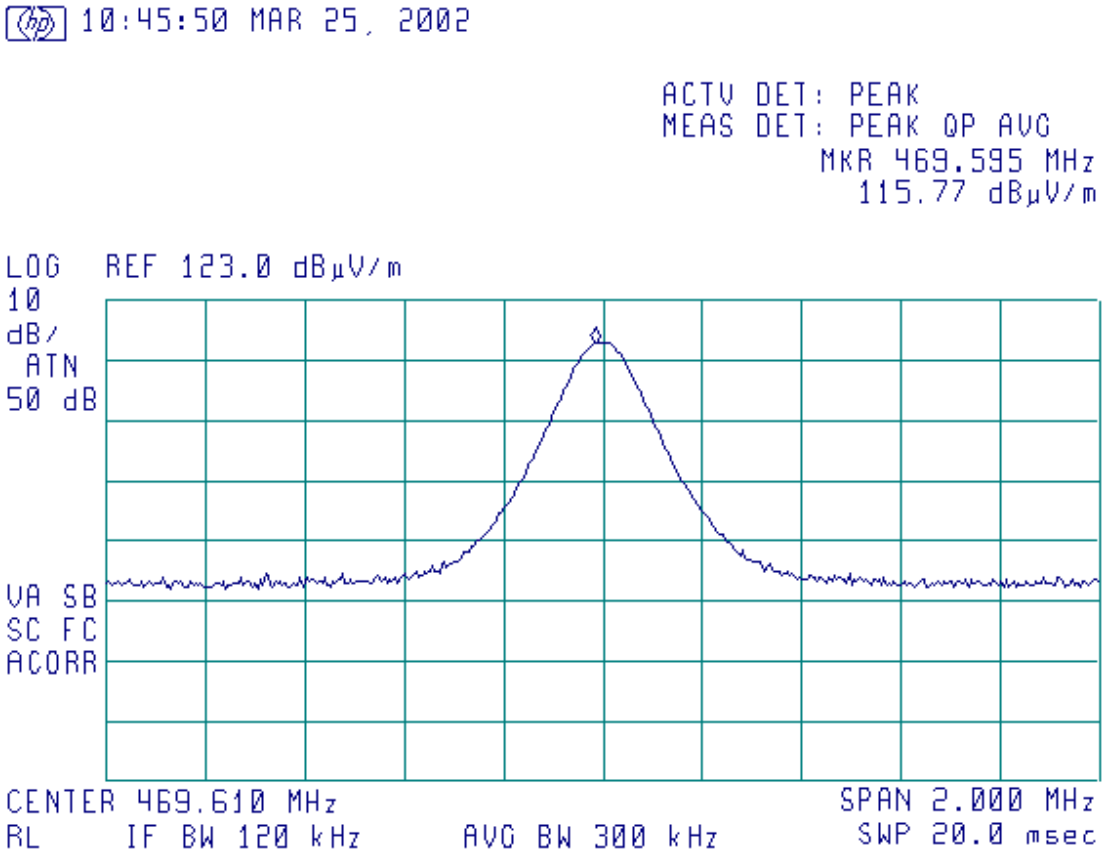
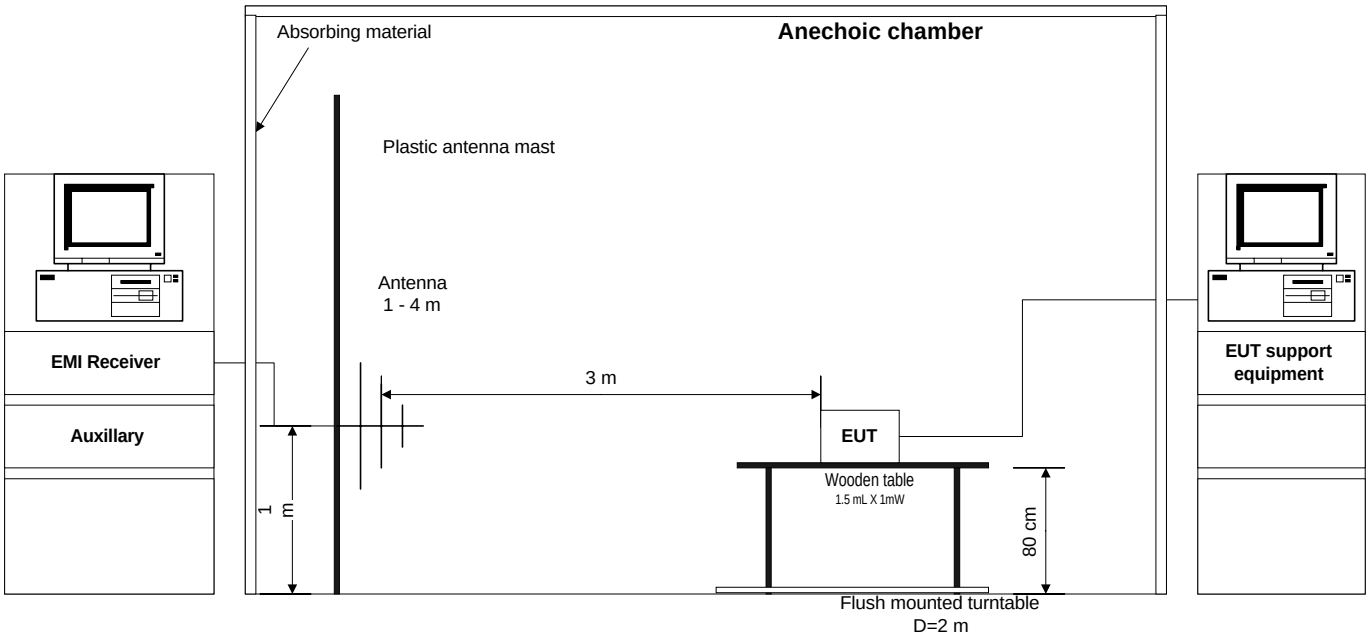


**Figure 4.1.1**
**Set up for ERP measurement**



## 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**

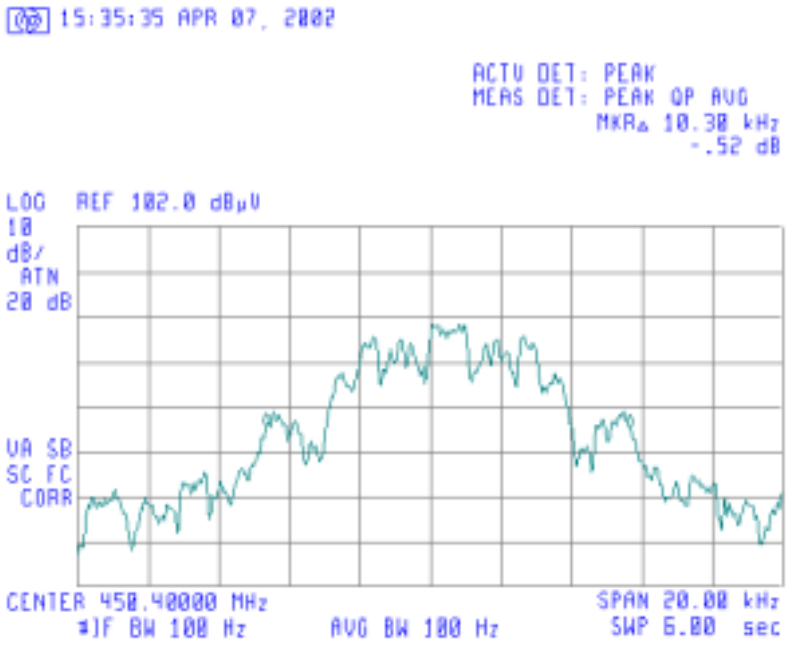
| Frequency, MHz | OBW, kHz | Pass / Fail |
|---|---|---|
| 450.4000 | 10.30 | Pass |
| 460.0009 | 10.40 | Pass |
| 469.6000 | 10.85 | Pass |

**Reference numbers of test equipment used**

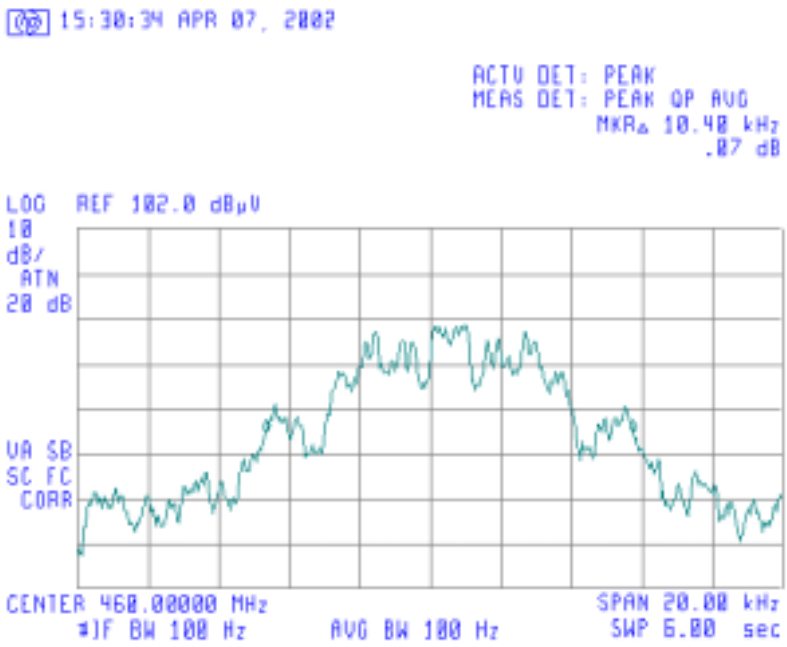
| | | | | | |
|---|---|---|---|---|---|
| 0465 | 0591 | 0604 | 1425 | 1536 | 1620 |

Full description is in Appendix A.

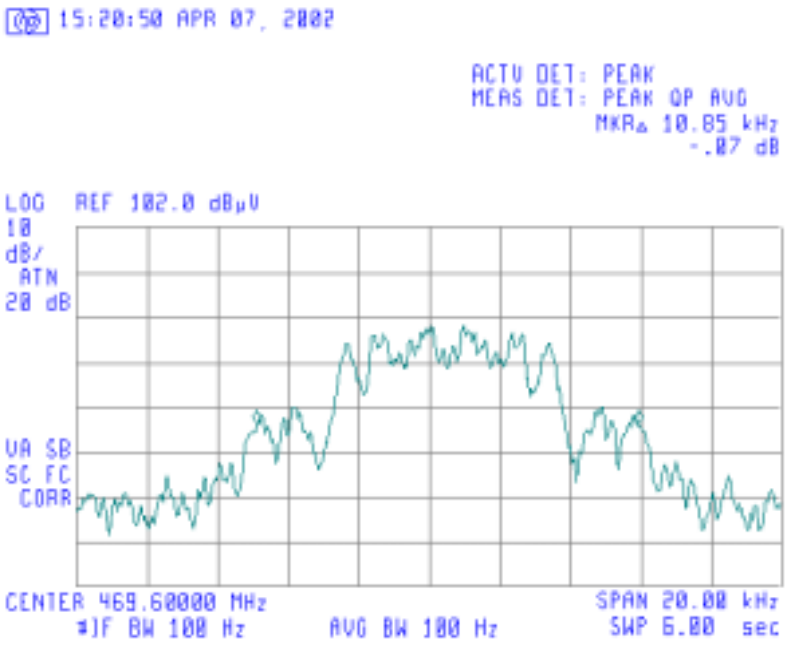
**Plot 4.2.1**
**Occupied bandwidth measurements test result**



**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.

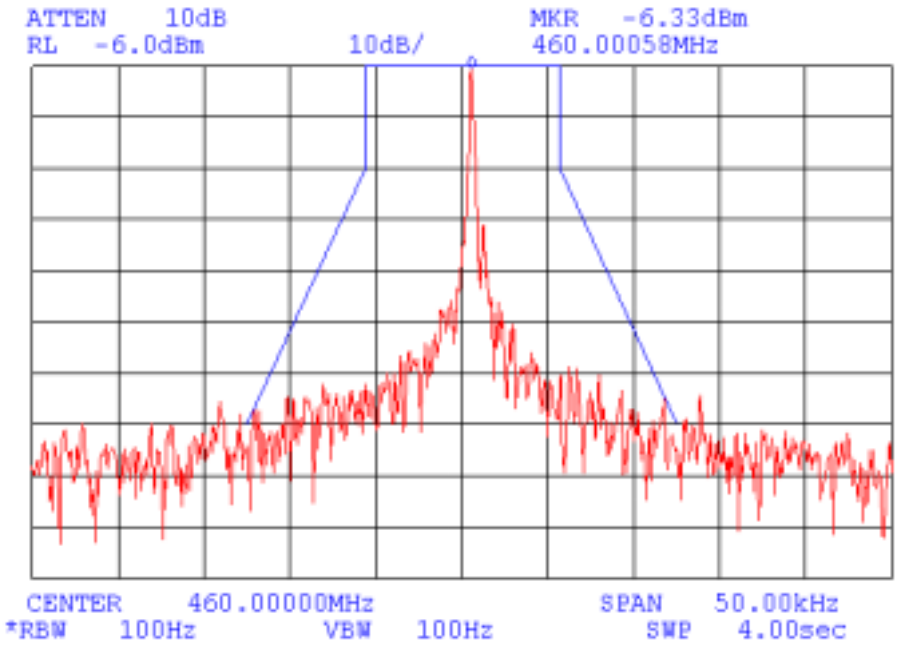
**Reference numbers of test equipment used**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0041 | 0446 | 0465 | 0589 | 0604 | 1004 | 1424 | 1940 |
| 1947 | | | | | | | |

Full description is in Appendix A.

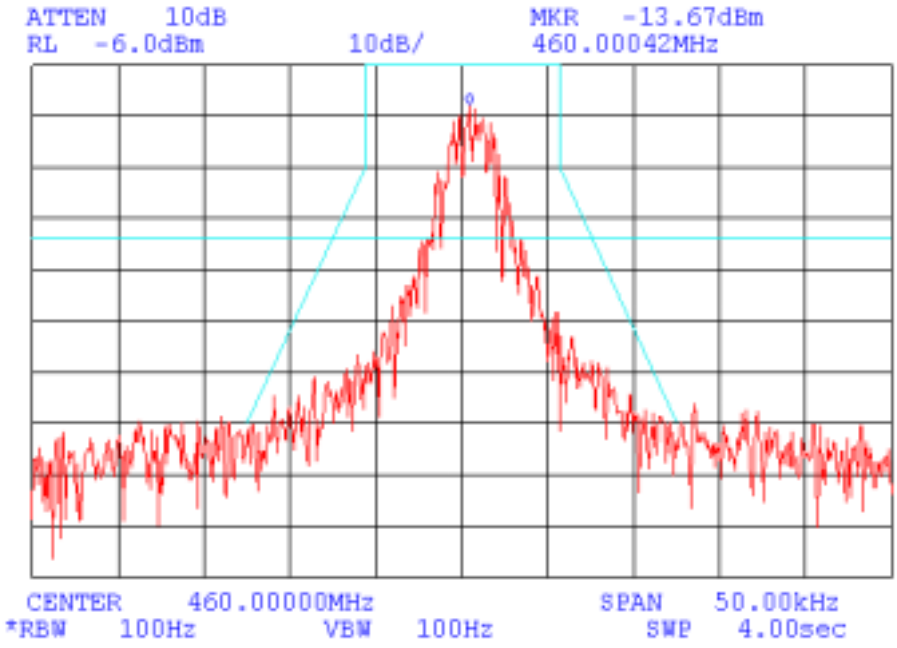
**Plot 4.3.1**
**Emission mask test results**

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



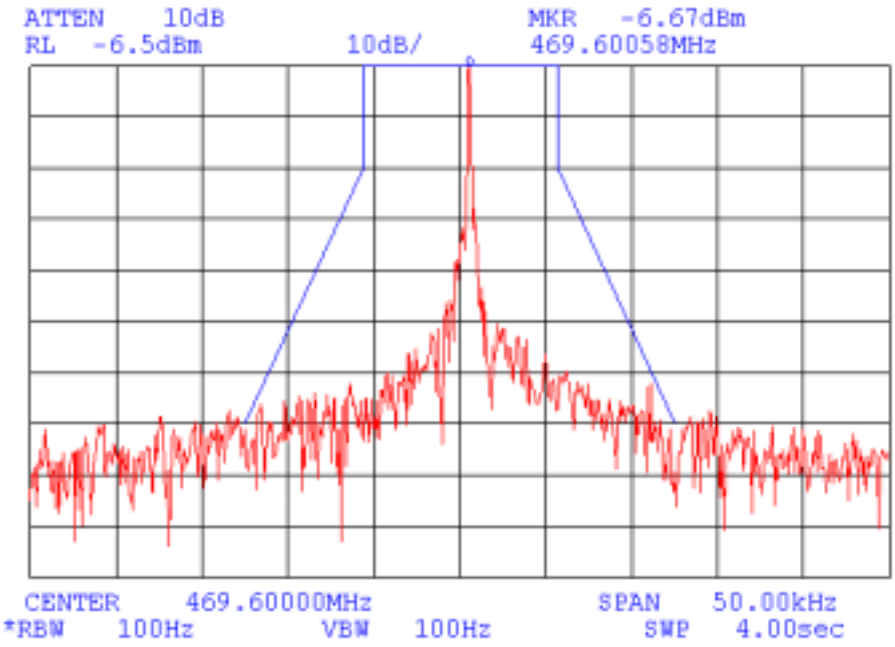
**Plot 4.3.2**
**Emission mask test results**

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



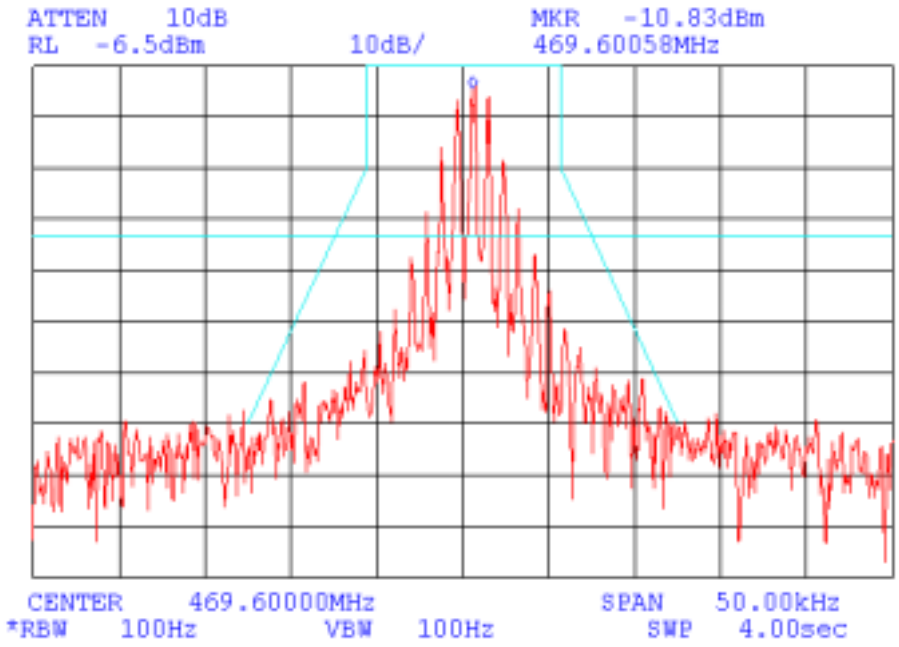
**Plot 4.3.3**
**Emission mask test results**

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



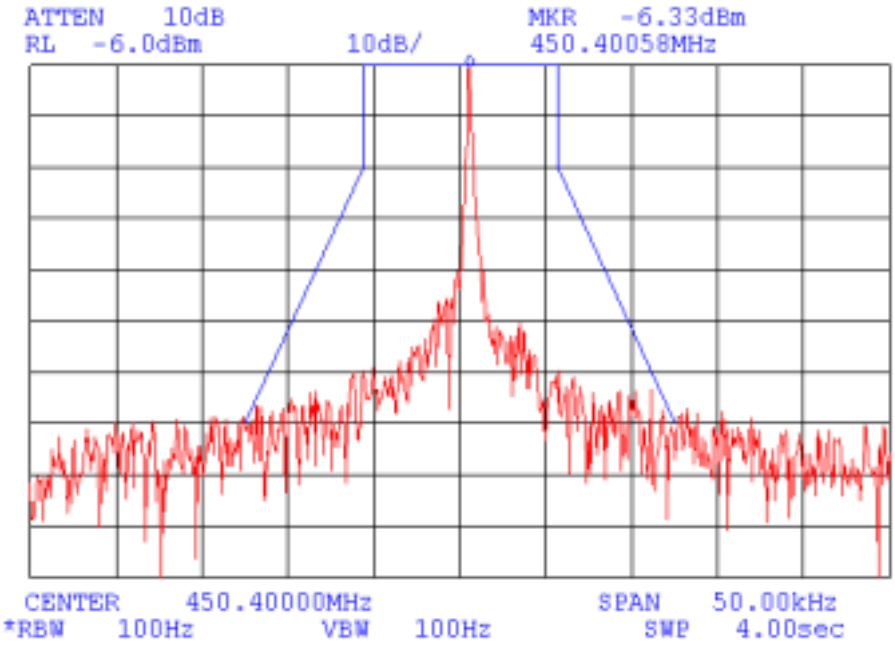
**Plot 4.3.4**
**Emission mask test results**

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



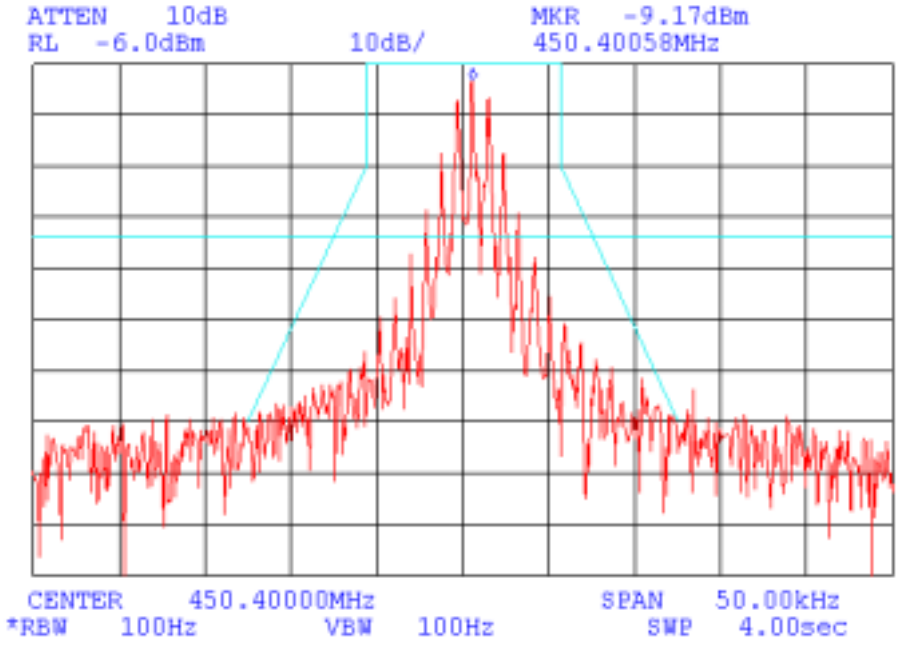
**Plot 4.3.5**
**Emission mask test results**

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



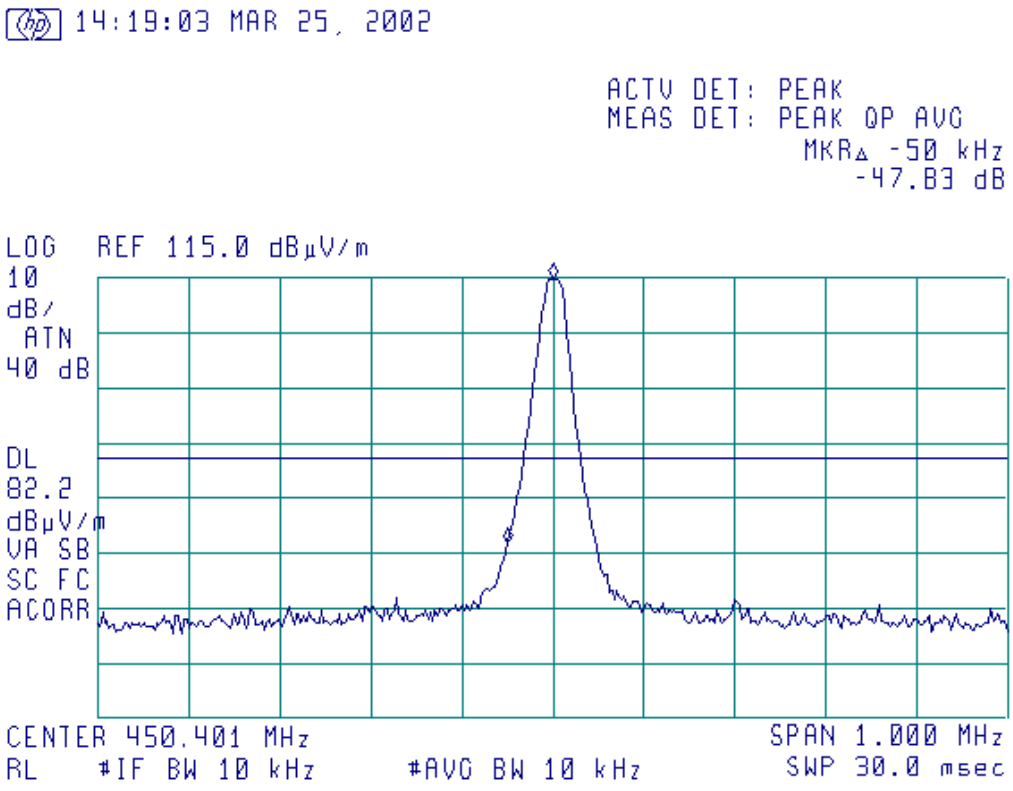
**Plot 4.3.6**
**Emission mask test results**

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



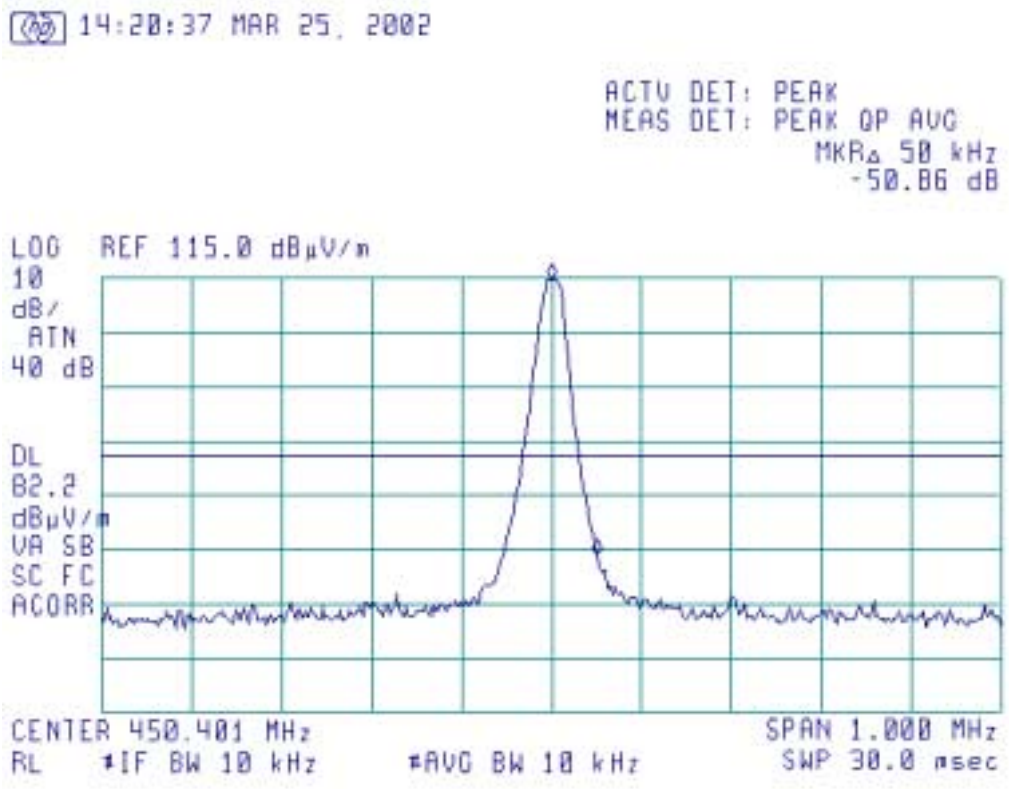
**Plot 4.3.7**
**Spurious emissions measurement test results**

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



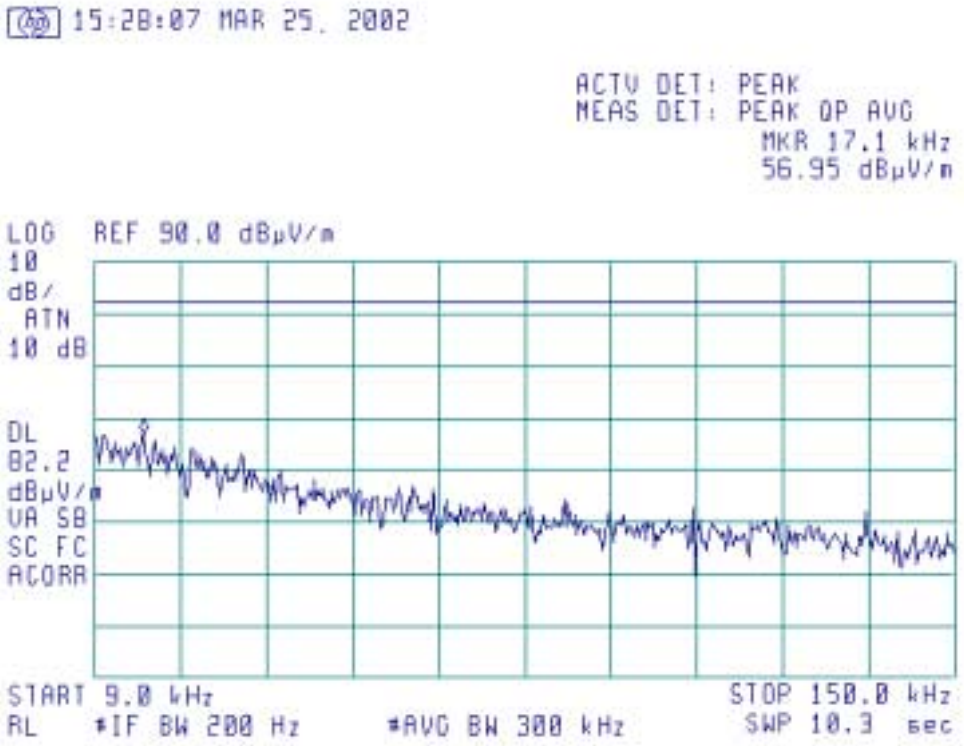
**Plot 4.3.8**
**Spurious emissions measurement test results**

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



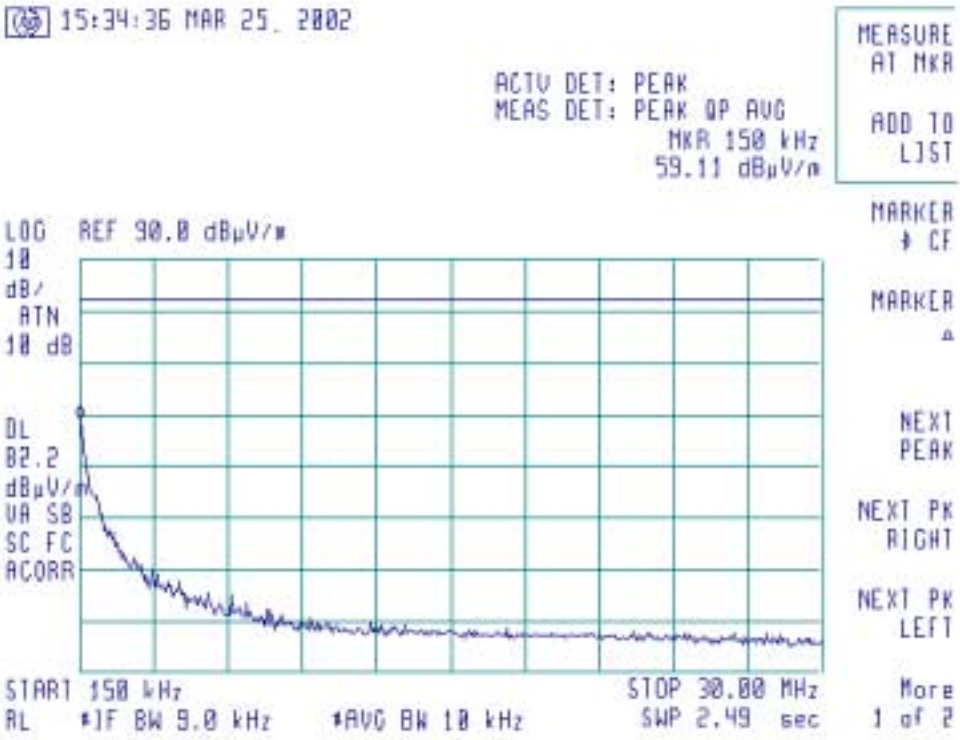
**Plot 4.3.9**
**Spurious emissions measurement test results**

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



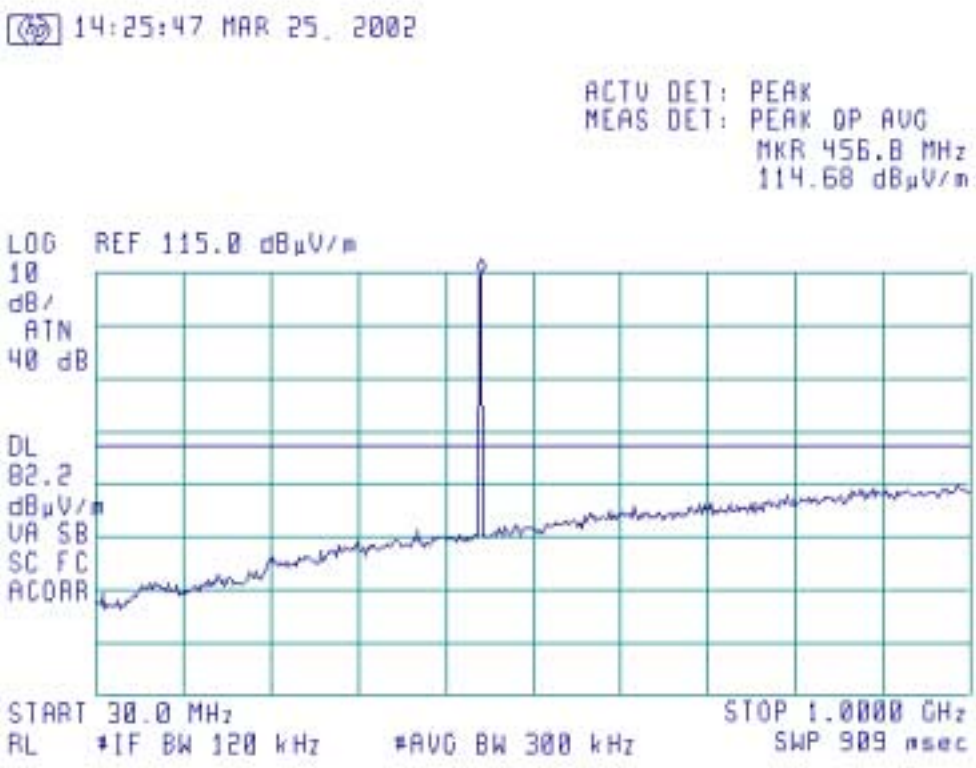
**Plot 4.3.10**
**Spurious emissions measurement test results**

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



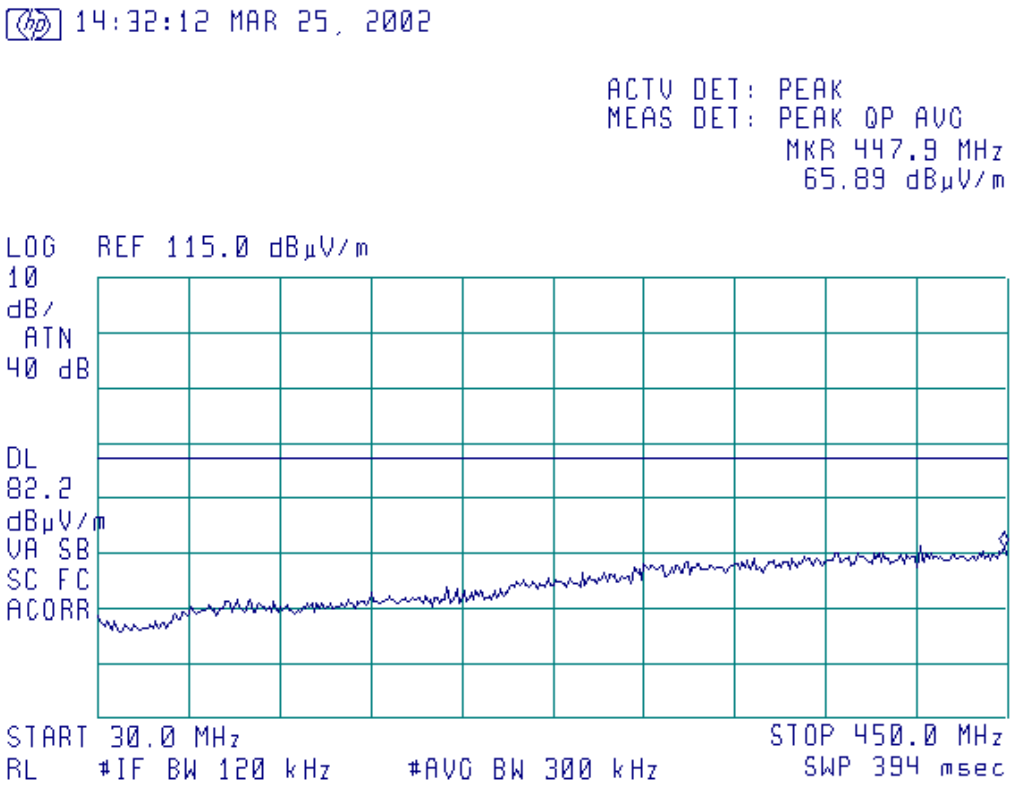
**Plot 4.3.11**
**Spurious emissions measurement test results**

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



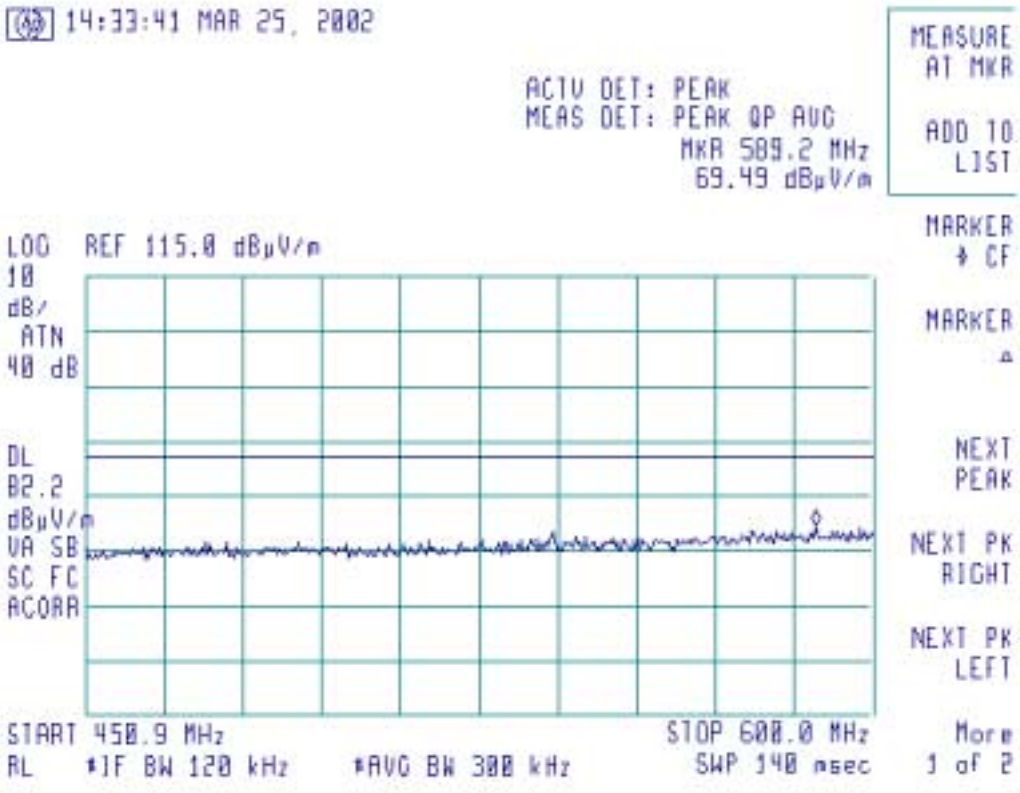
**Plot 4.3.12**
**Spurious emissions measurement test results**

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



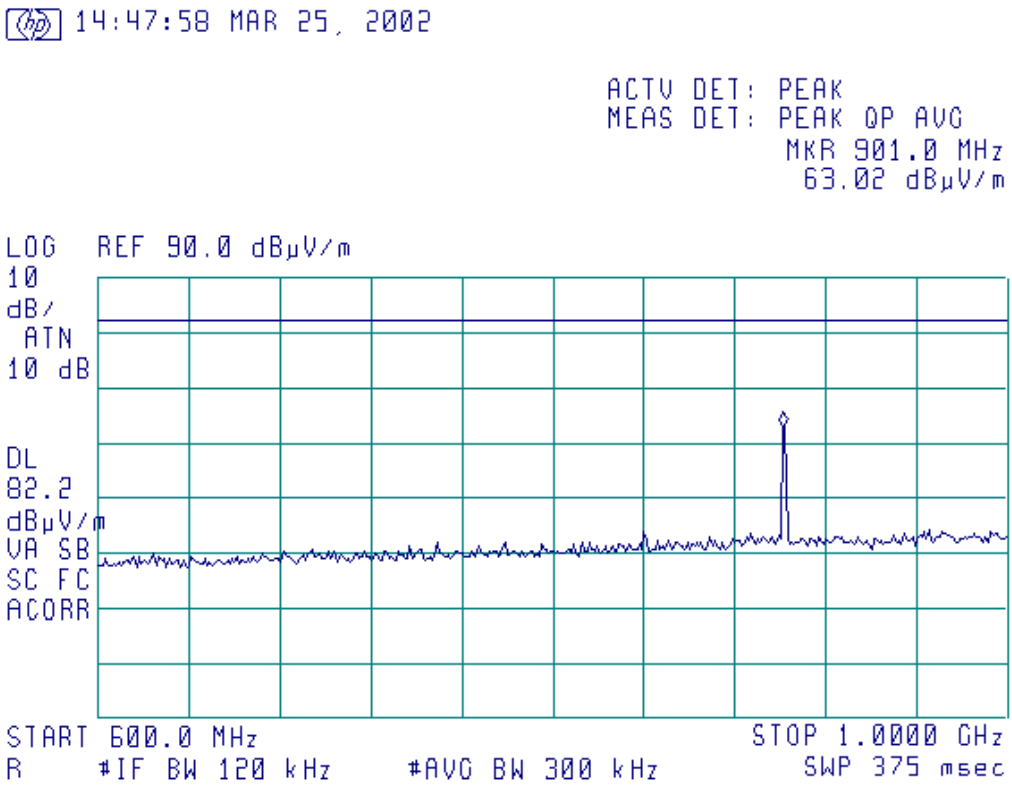
**Plot 4.3.13**
**Spurious emissions measurement test results**

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



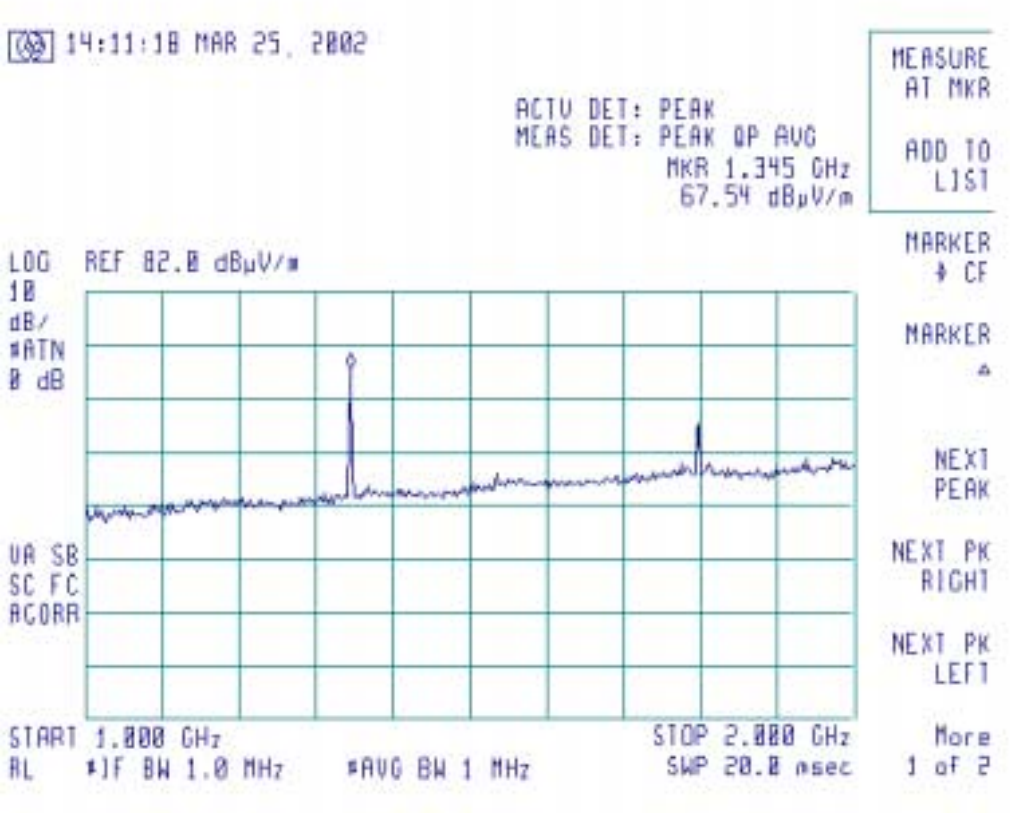
**Plot 4.3.14**
**Spurious emissions measurement test results**

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



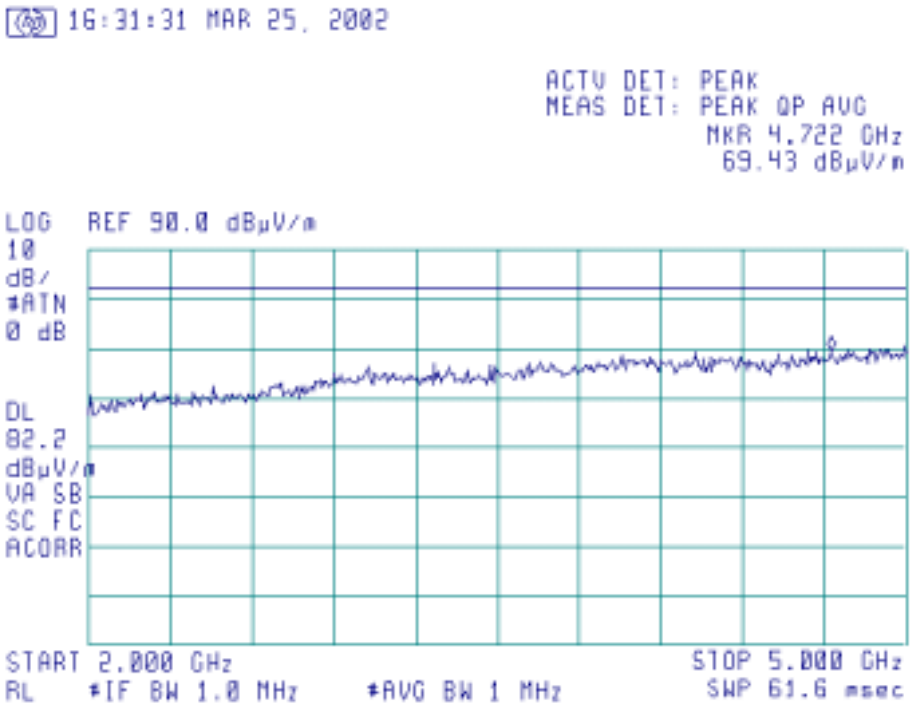
**Plot 4.3.15**
**Spurious emissions measurement test results**

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



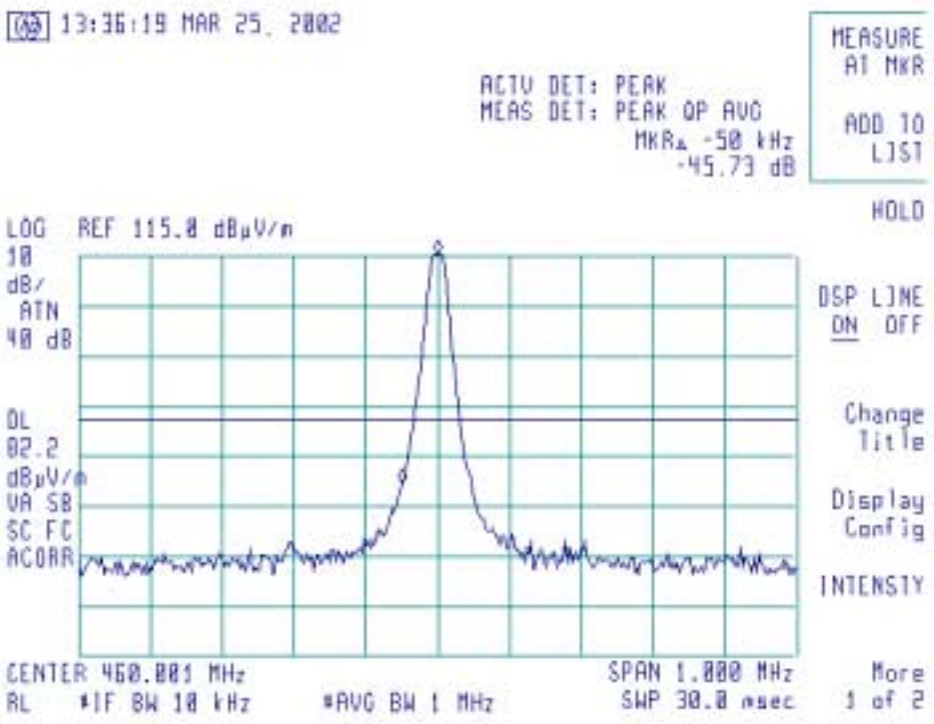
**Plot 4.3.16**
**Spurious emissions measurement test results**

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



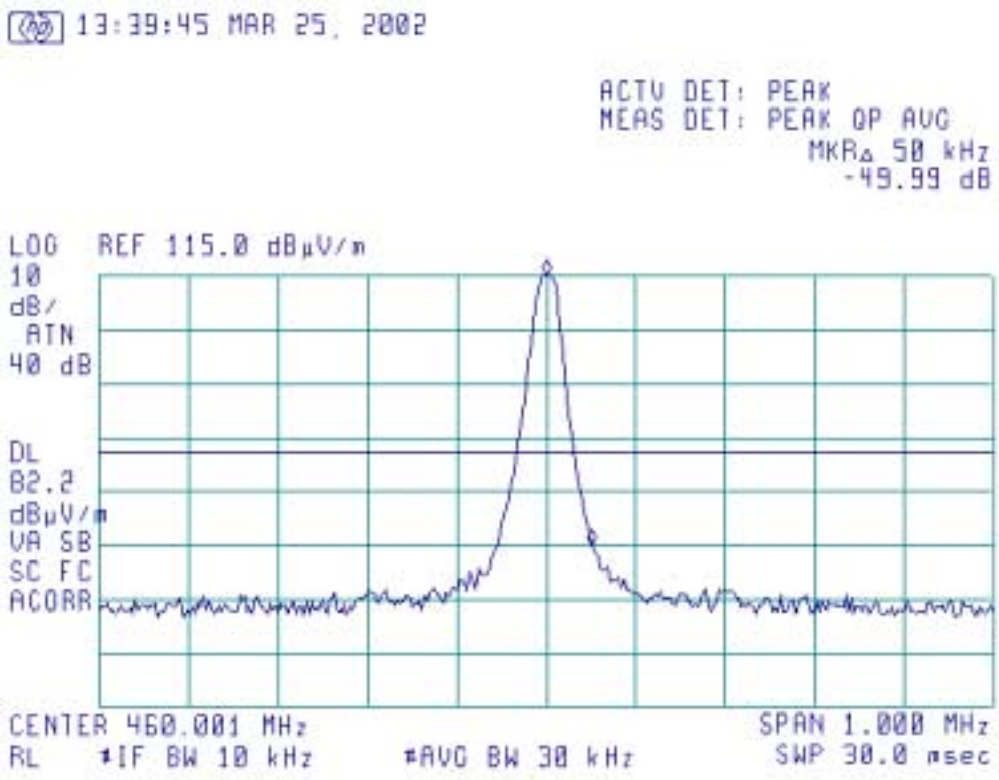
**Plot 4.3.17**
**Spurious emissions measurement test results**

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



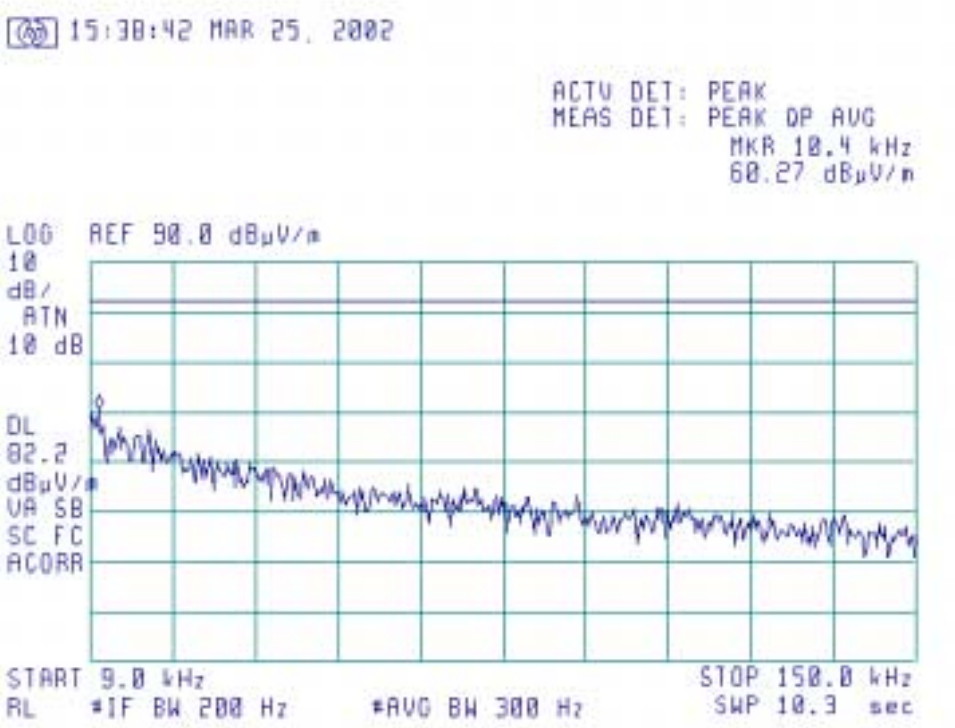
**Plot 4.3.18**
**Spurious emissions measurement test results**

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



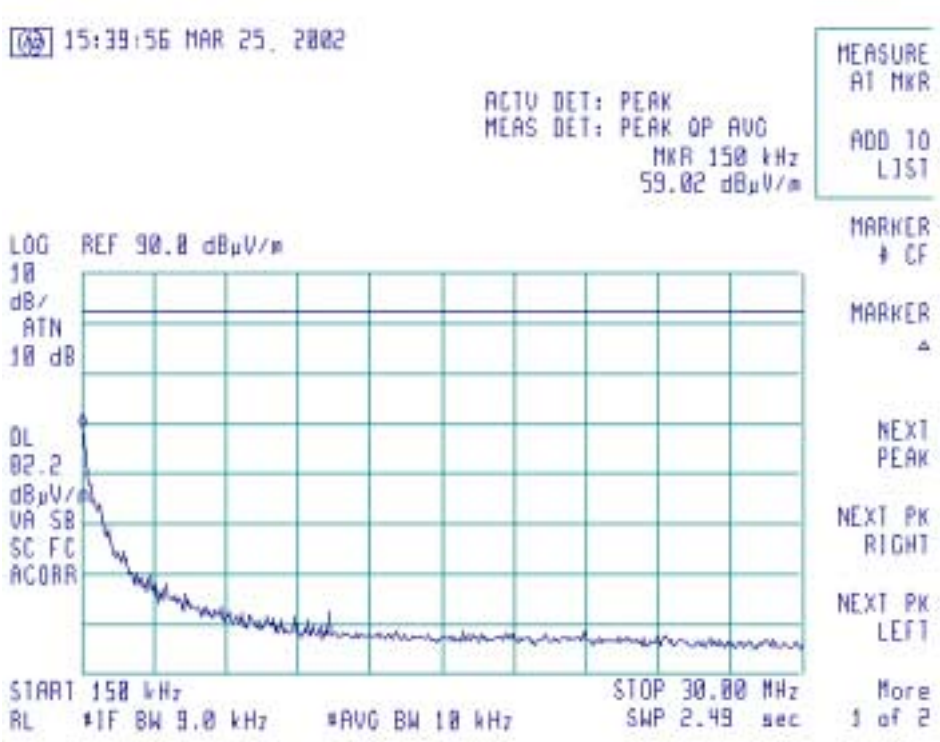
**Plot 4.3.19**
**Spurious emissions measurement test results**

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



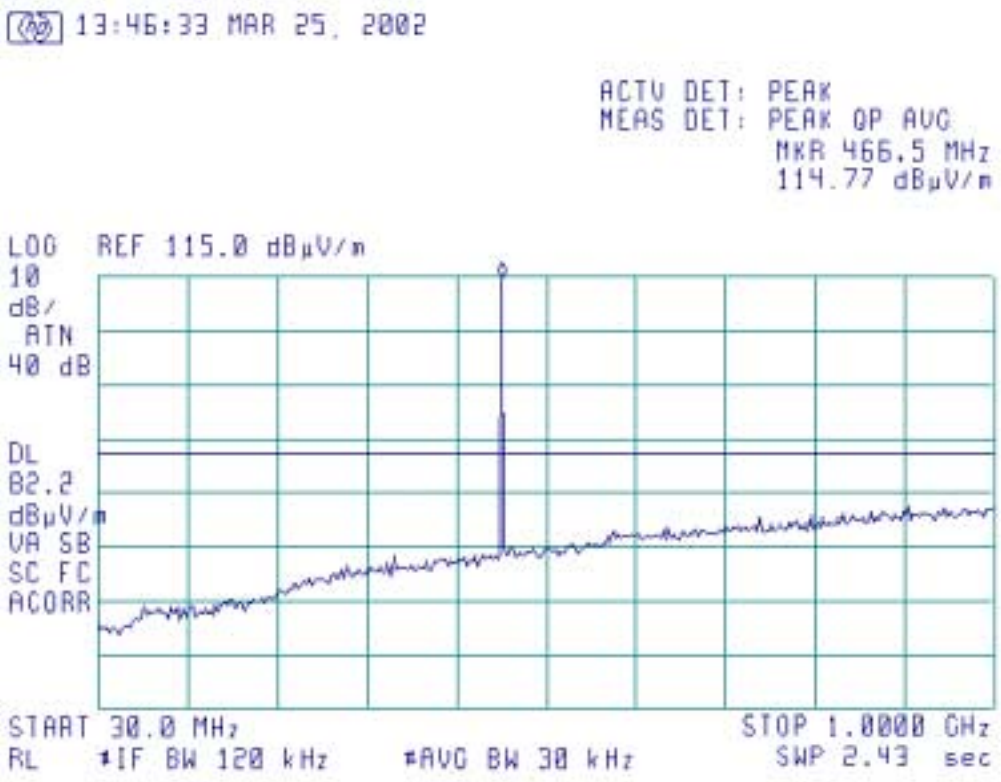
**Plot 4.3.20**
**Spurious emissions measurement test results**

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



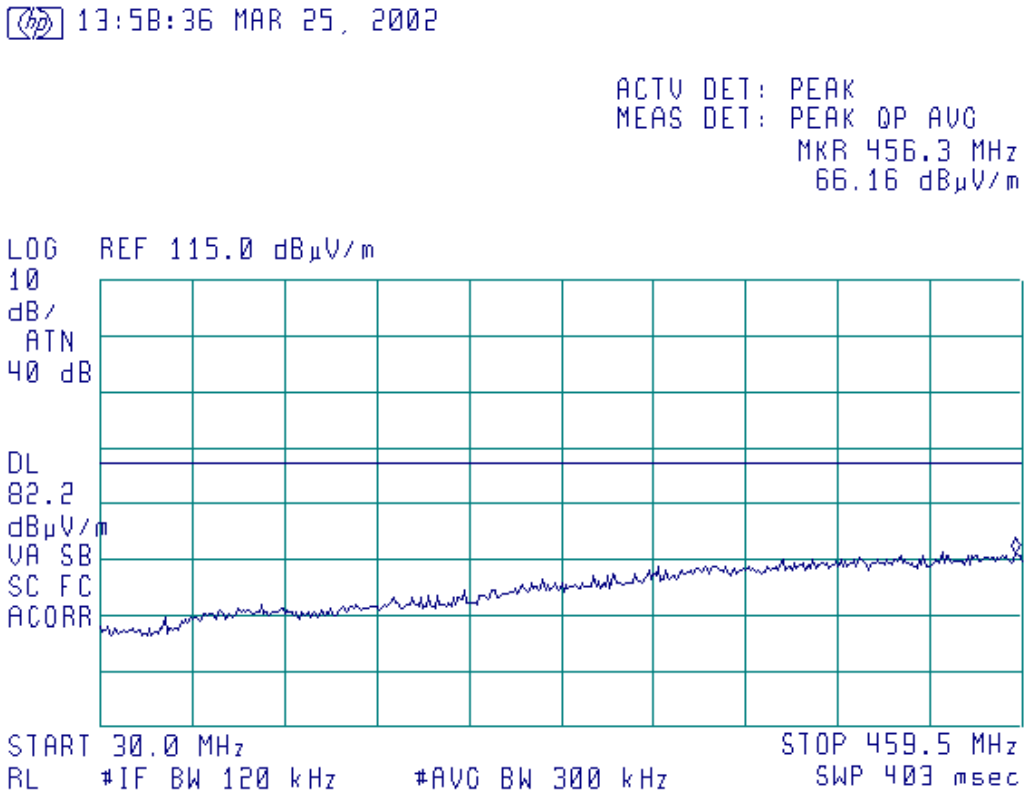
**Plot 4.3.21**
**Spurious emissions measurement test results**

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



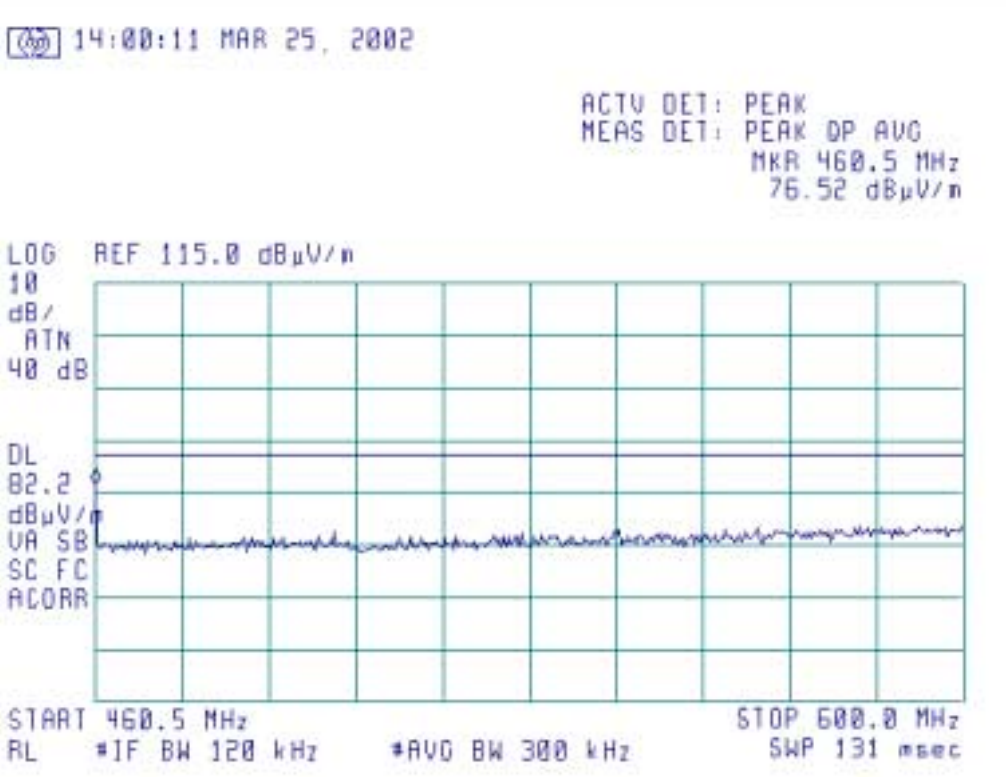
**Plot 4.3.22**
**Spurious emissions measurement test results**

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



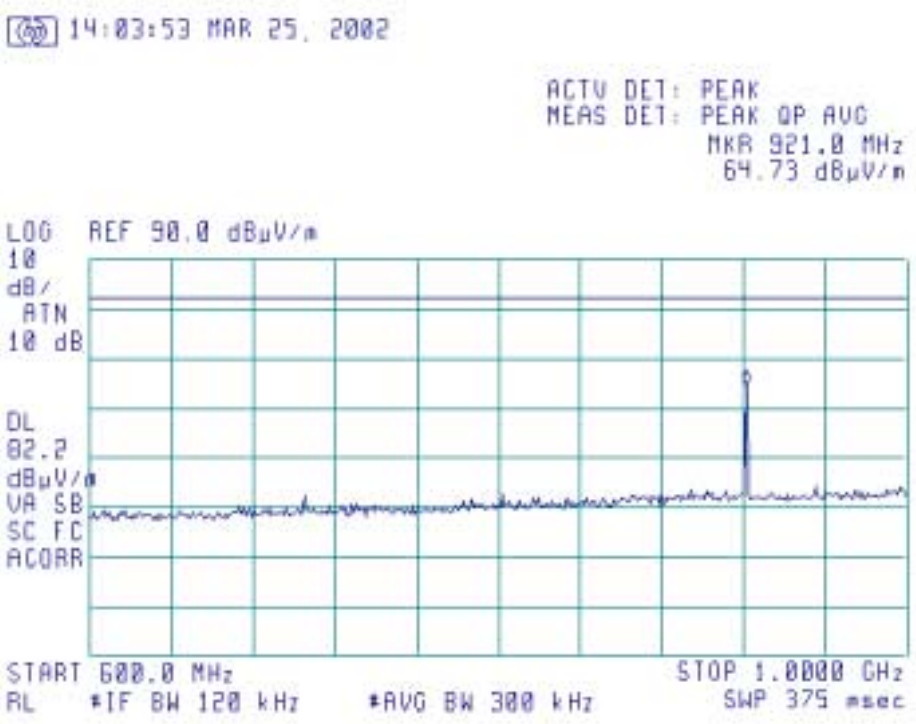
**Plot 4.3.23**
**Spurious emissions measurement test results**

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



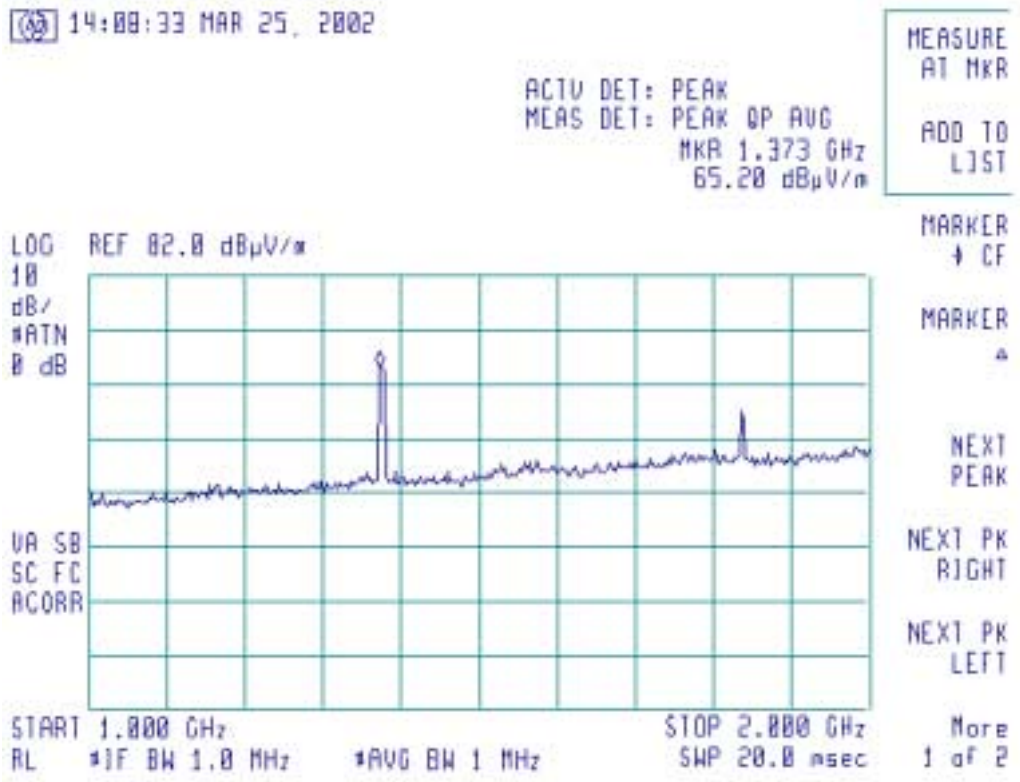
**Plot 4.3.24**
**Spurious emissions measurement test results**

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



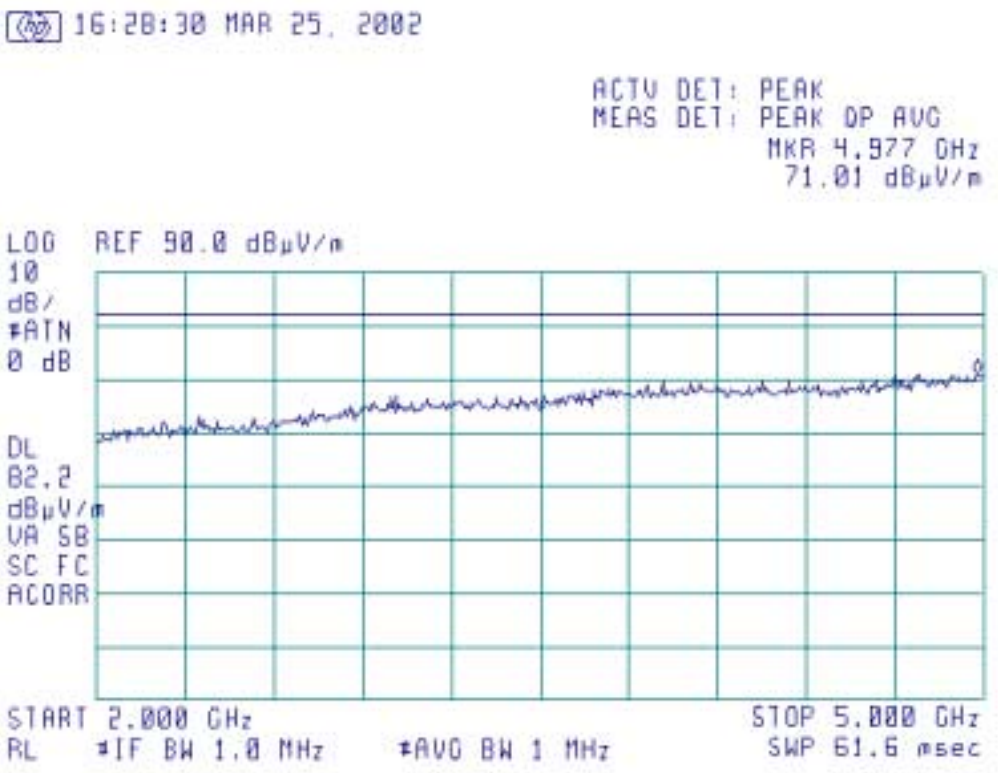
**Plot 4.3.25**
**Spurious emissions measurement test results**

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



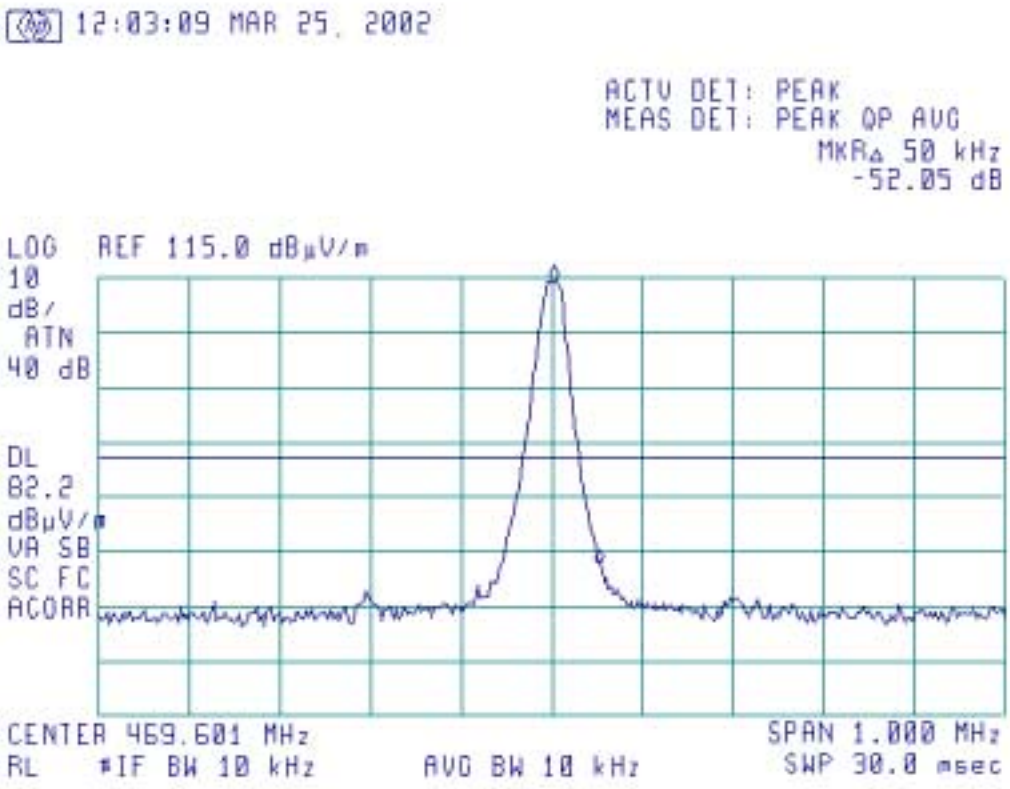
**Plot 4.3.26**
**Spurious emissions measurement test results**

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



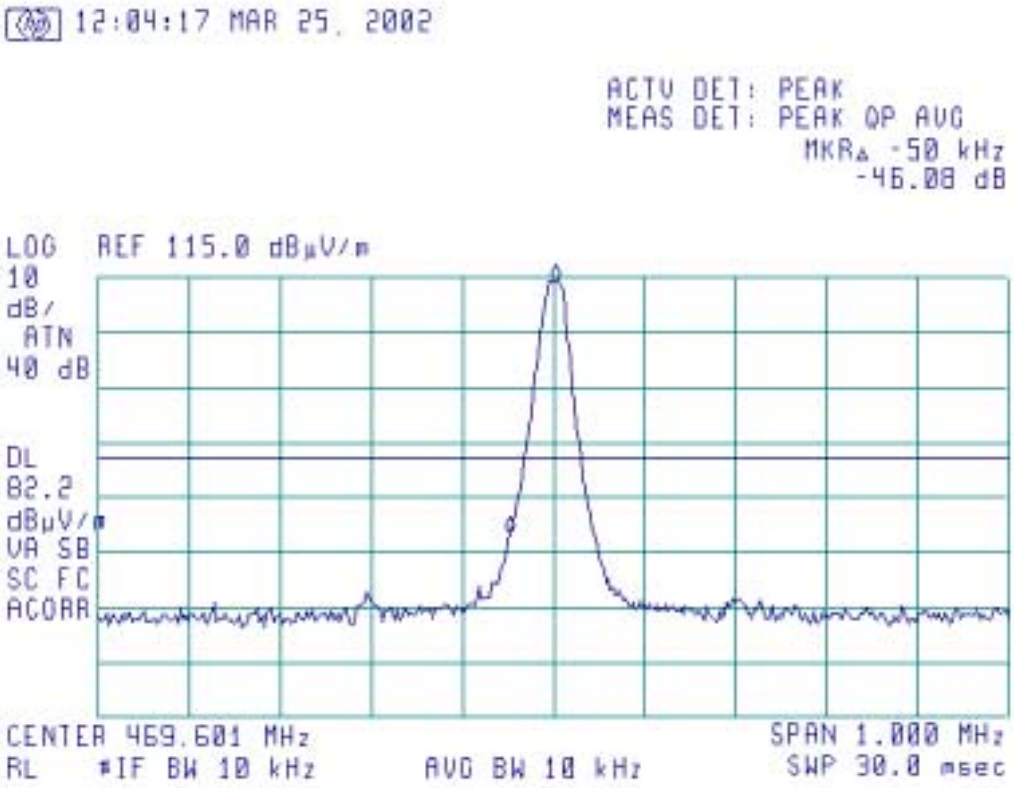
**Plot 4.3.27**
**Spurious emissions measurement test results**

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



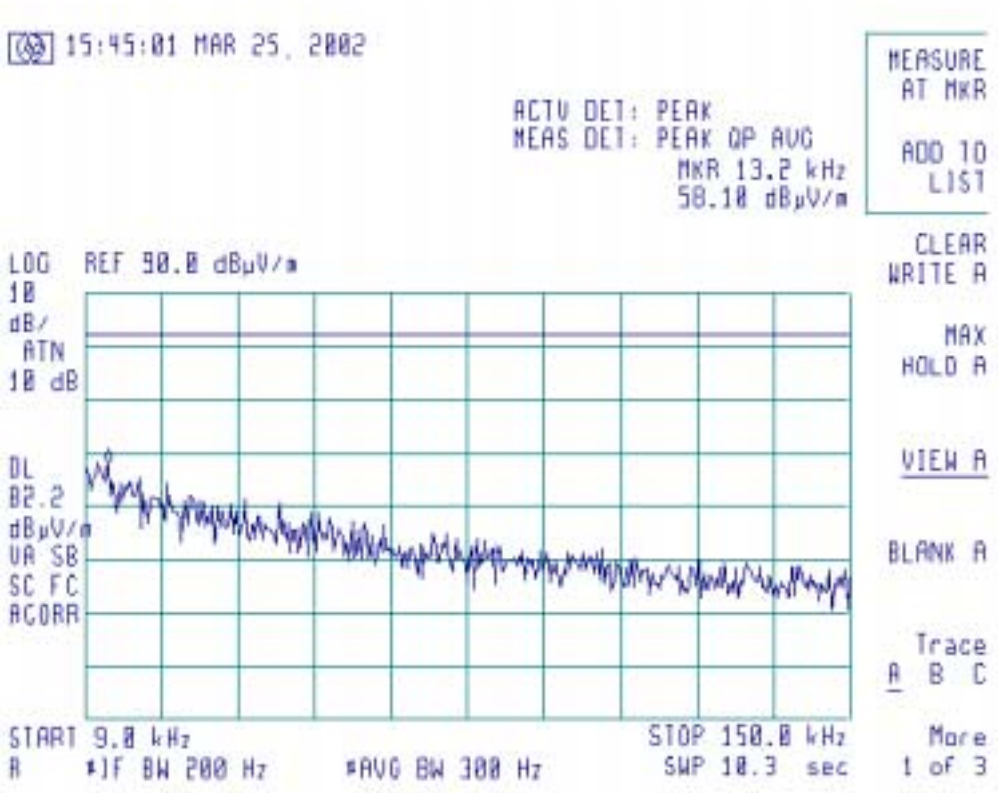
**Plot 4.3.28**
**Spurious emissions measurement test results**

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



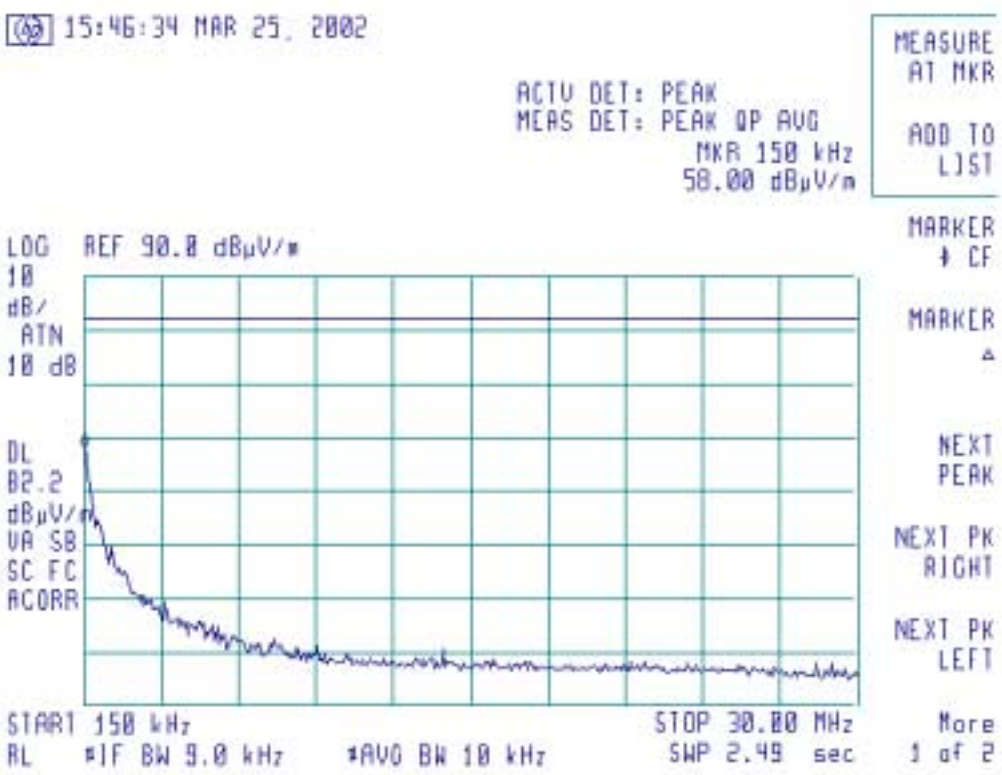
**Plot 4.3.29**
**Spurious emissions measurement test results**

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



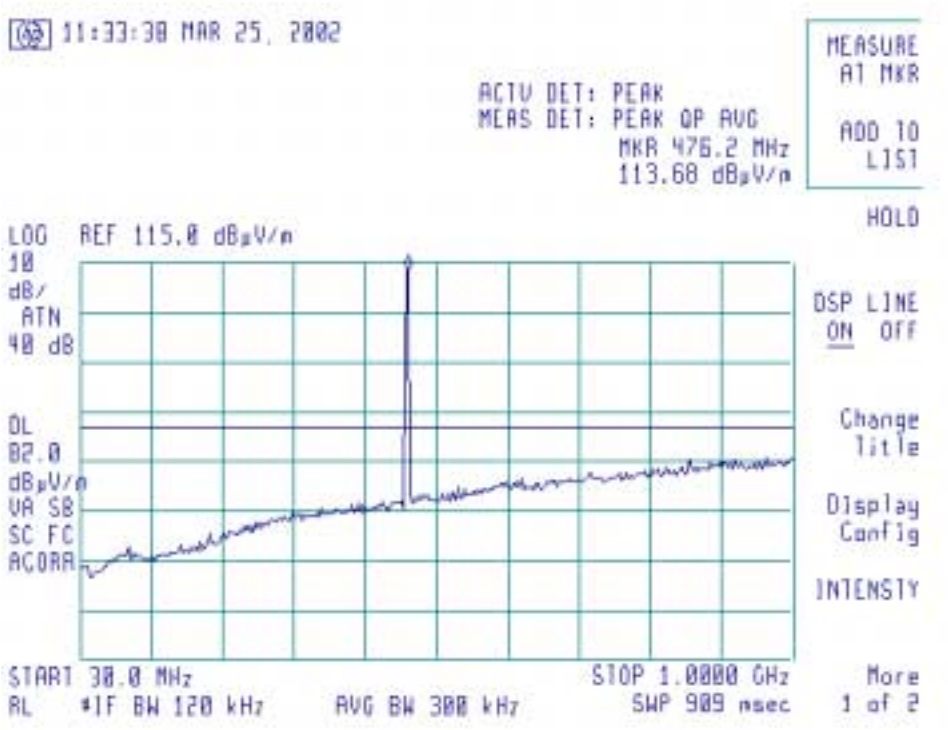
**Plot 4.3.30**
**Spurious emissions measurement test results**

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



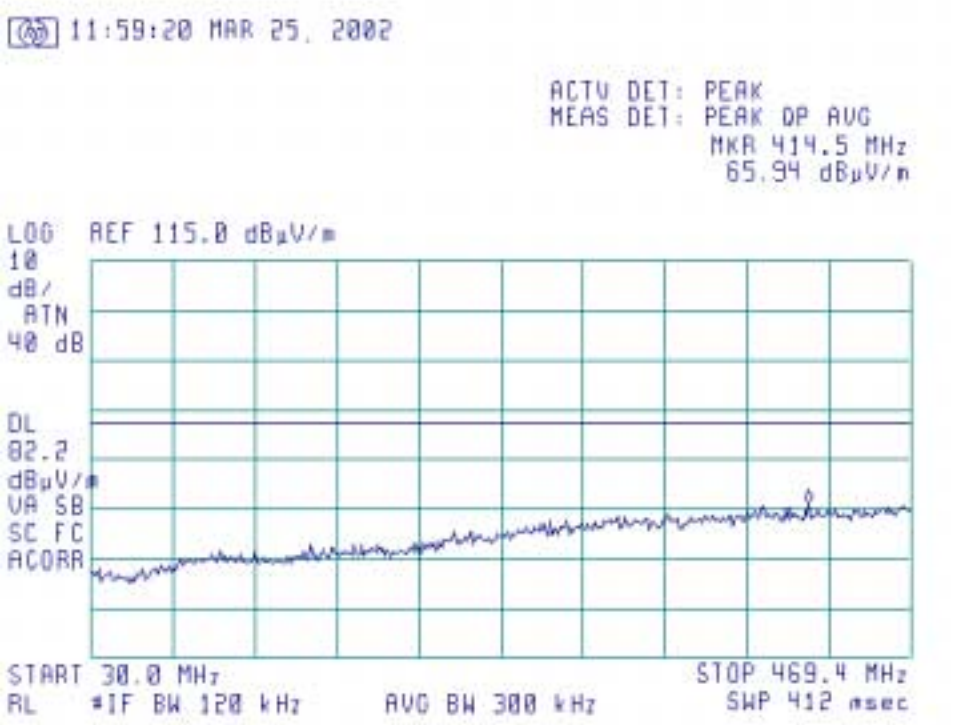
**Plot 4.3.31**
**Spurious emissions measurement test results**

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



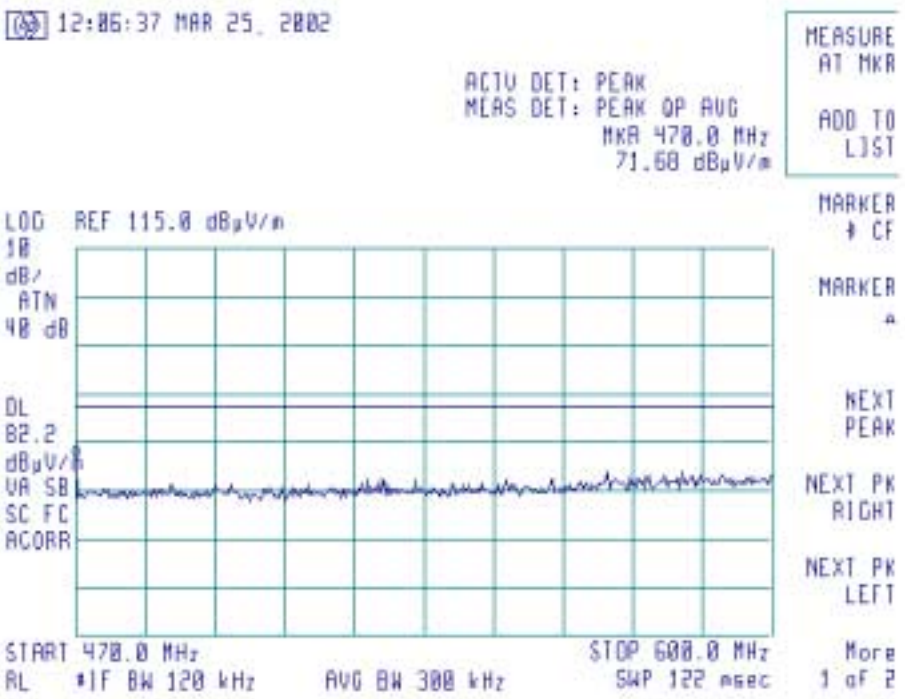
**Plot 4.3.32**
**Spurious emissions measurement test results**

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



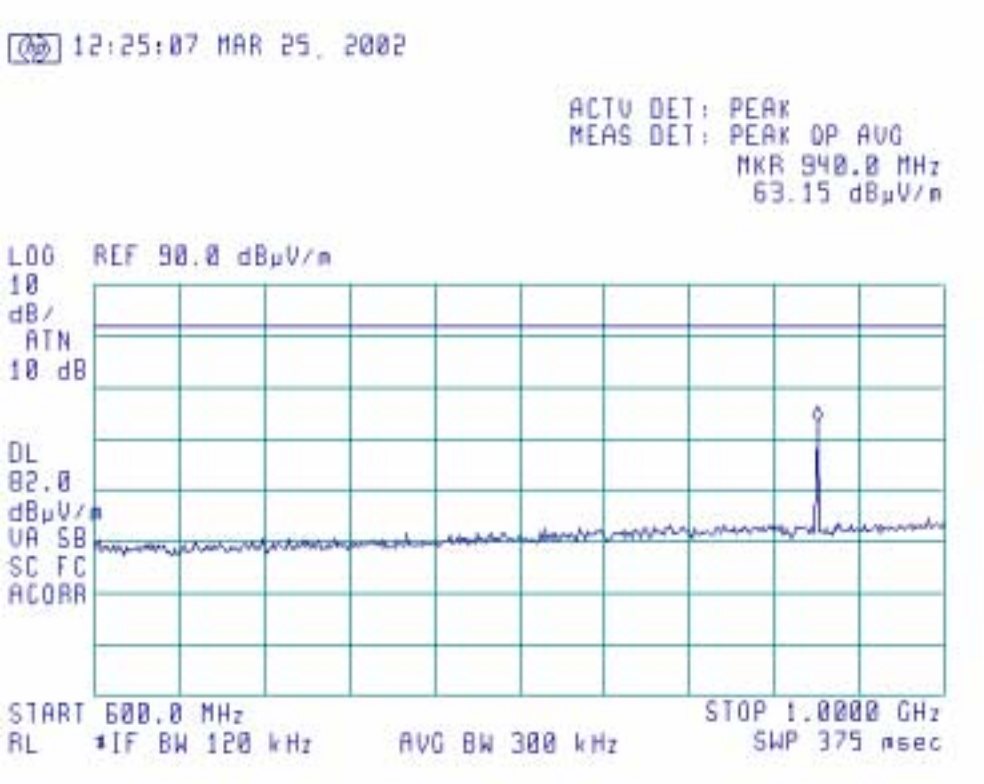
**Plot 4.3.33**
**Spurious emissions measurement test results**

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



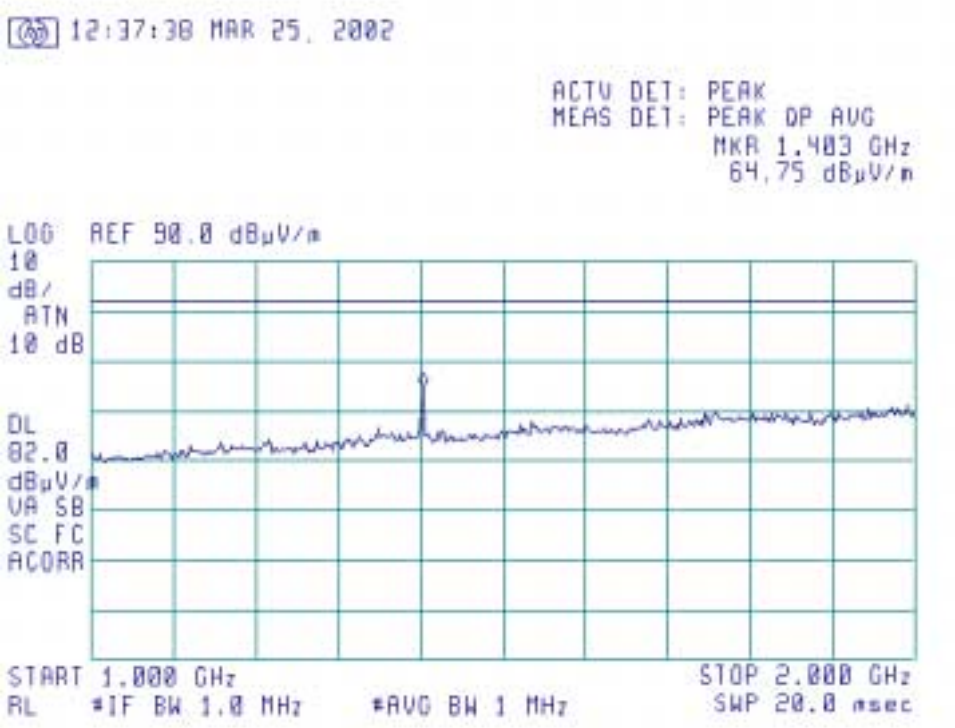
**Plot 4.3.34**
**Spurious emissions measurement test results**

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



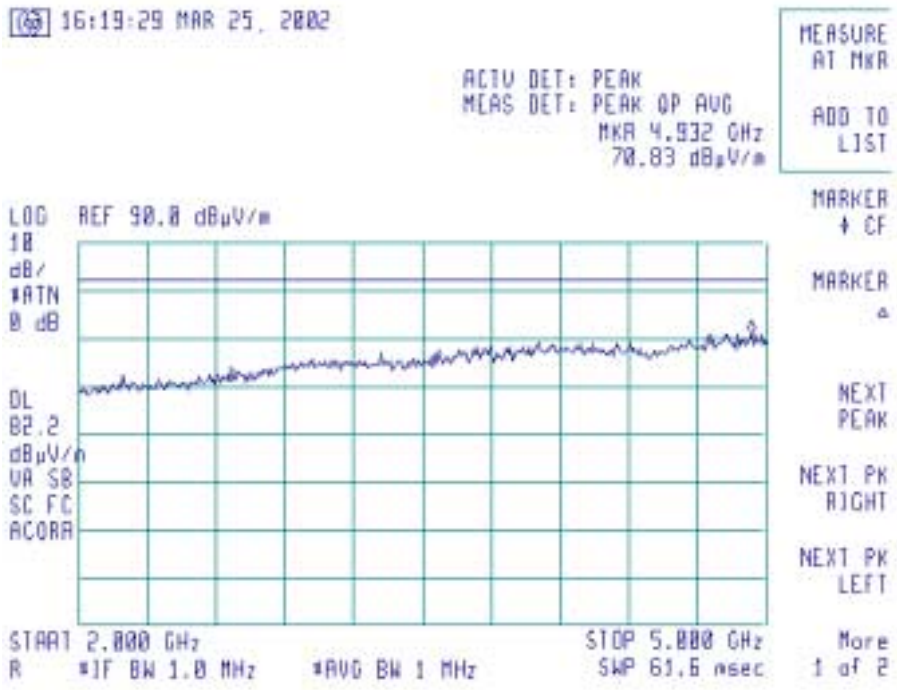
**Plot 4.3.35**
**Spurious emissions measurement test results**

| | |
|---|---|
| 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.

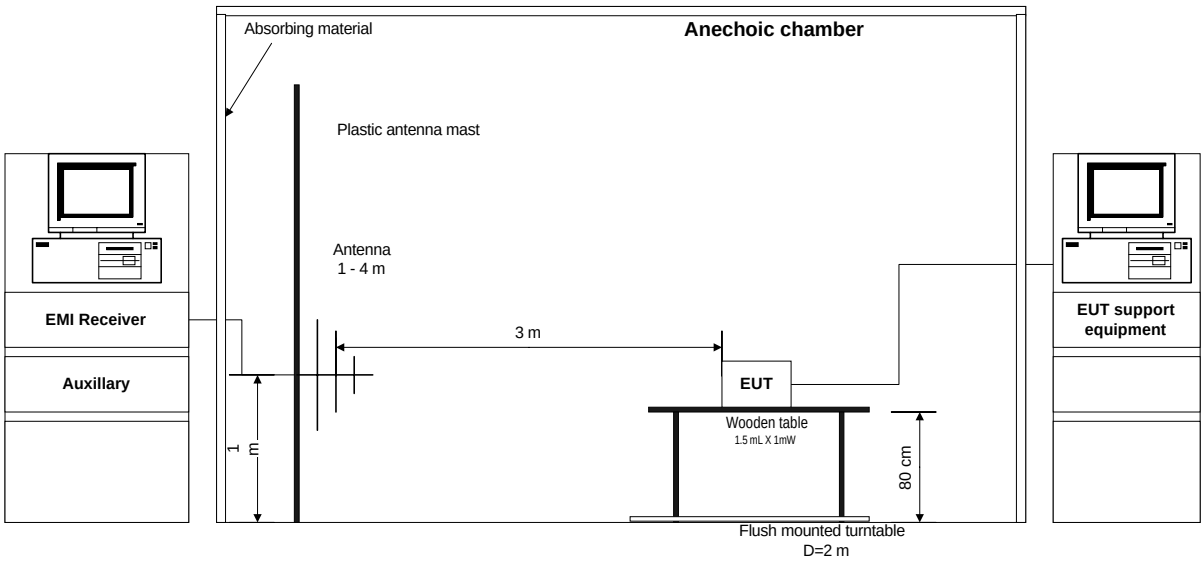
**Reference numbers of test equipment used**

| | | | | |
|---|---|---|---|---|
| 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

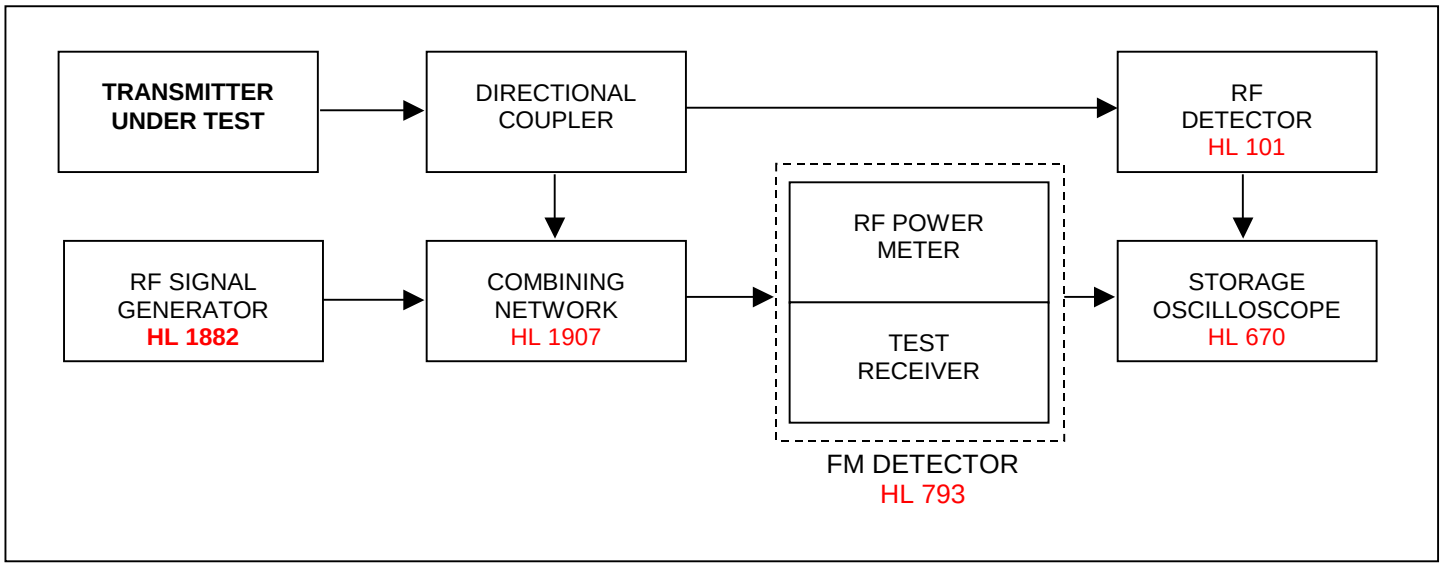
### 4.6.1 General

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

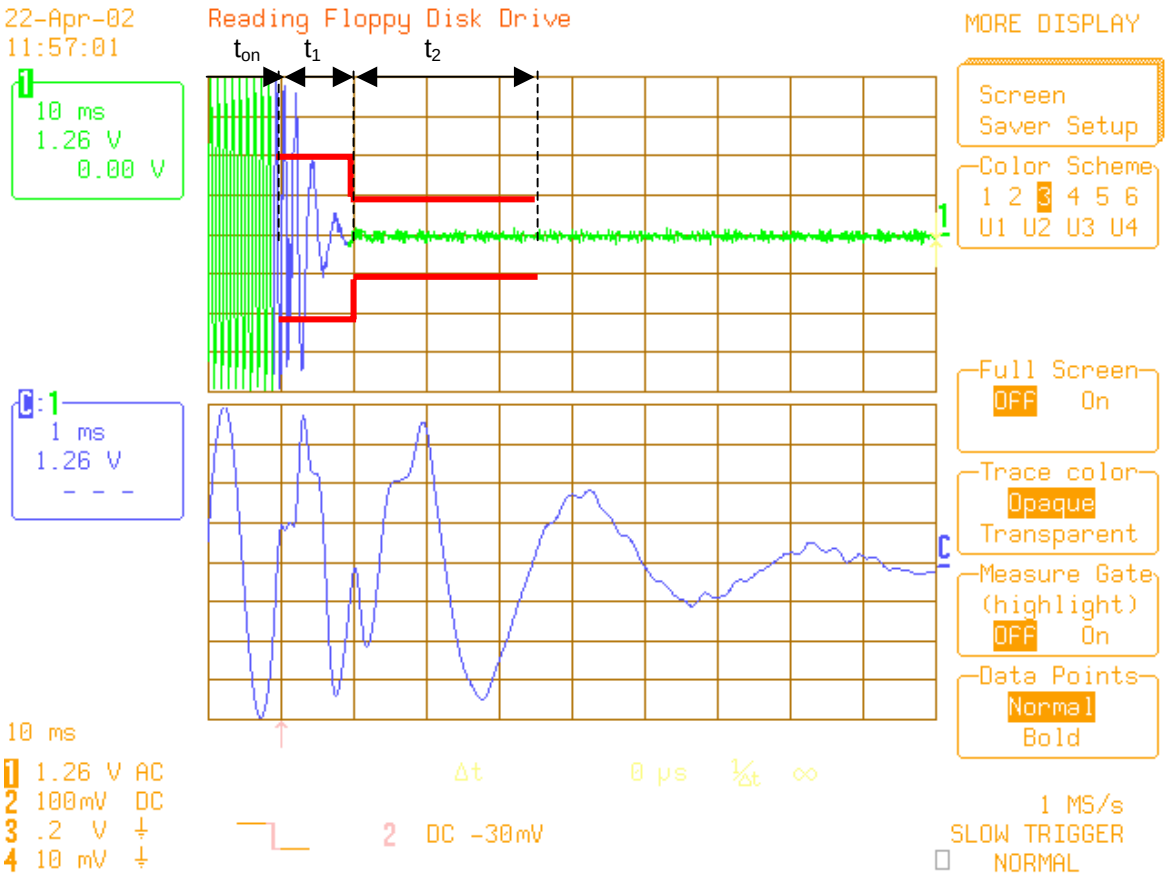
**Reference numbers of test equipment used**

| | | | | |
|---|---|---|---|---|
| HL 670 | HL 1907 | HL 101 | HL 793 | HL 1882 |

Full description is in Appendix A.

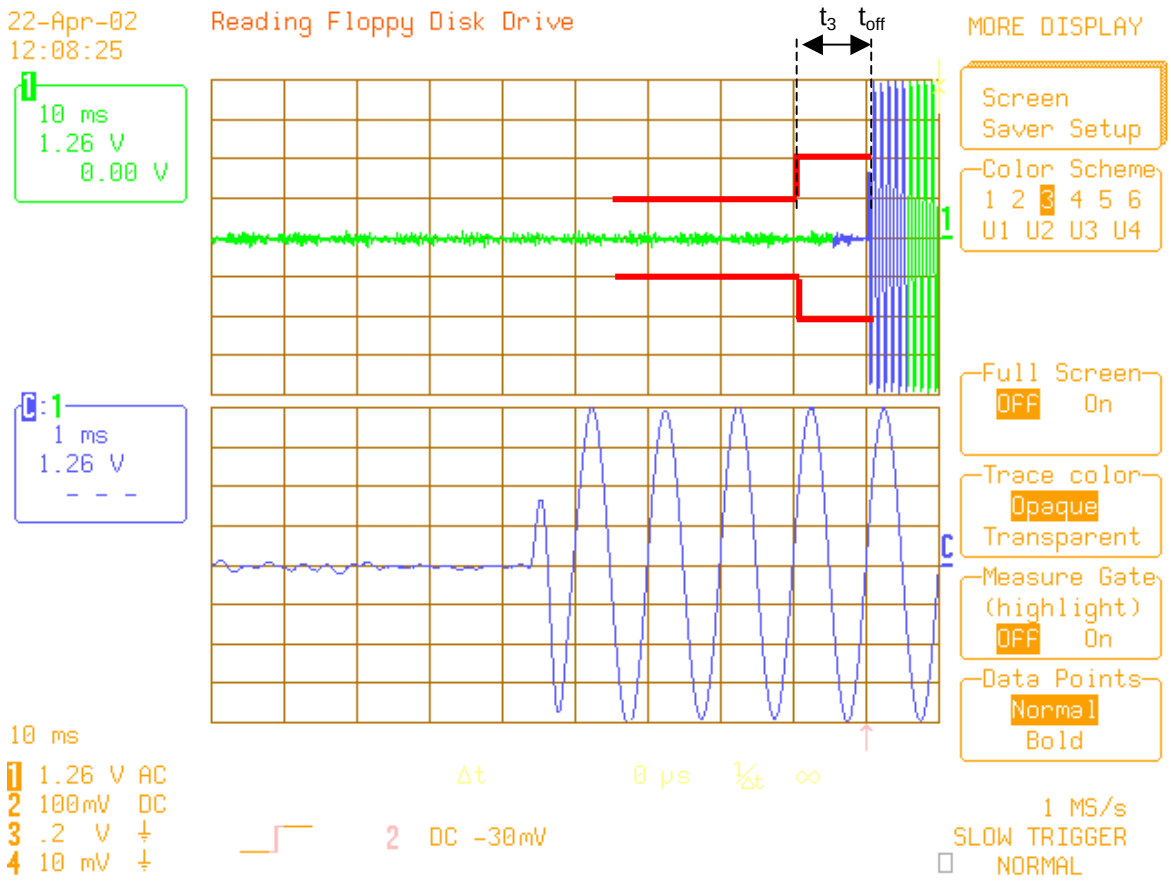
**Plot 4.6.1**
**Turn On test results**

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

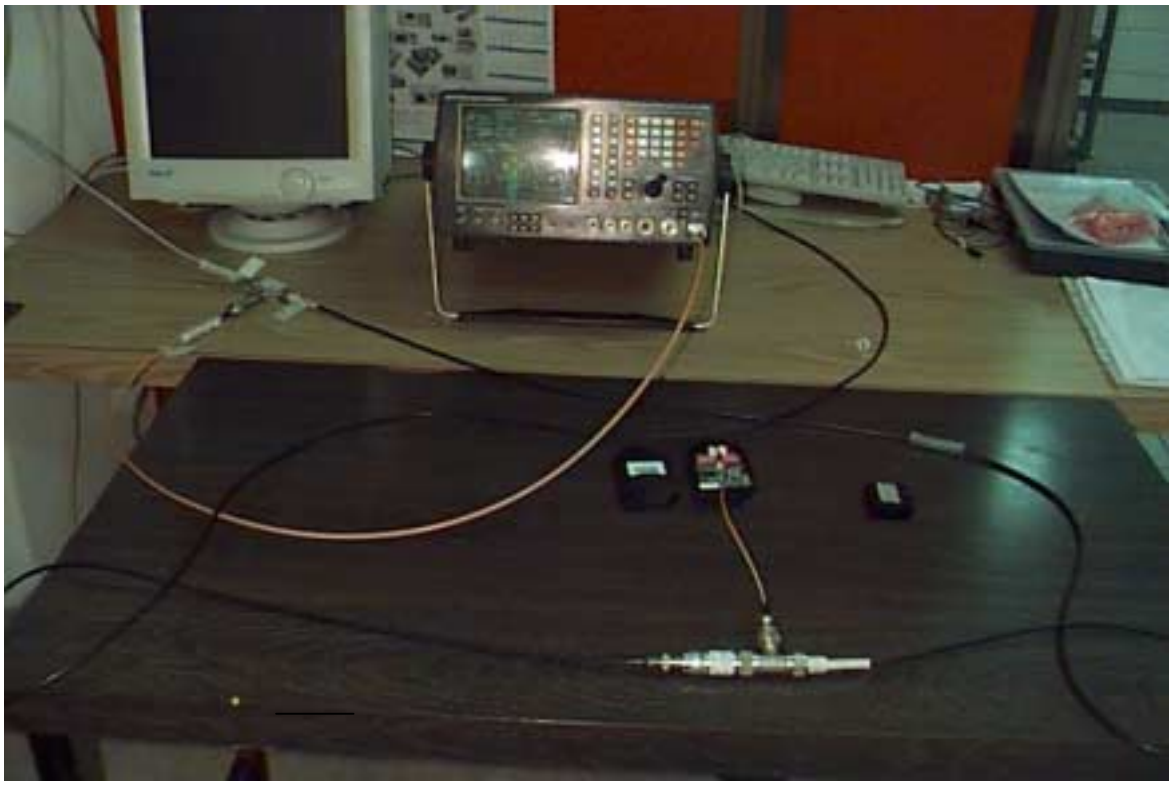


**Plot 4.6.2**
**Turn Off test results**

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).