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 MLLSpeed HPRx450

Description of equipment under test

Test items	Transmitter of automatic meter reading system
Manufacturer	Miltel Communications Ltd.
Types (Models)	MLLSpeed HPRx450
Receipt date	August 18, 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	August 18, 2002
Test completed	October 20, 2002
Test specification(s)	FCC part 90 subpart I, §§90.205, 90.209, 90.210, 90.213; 90.214; part 15 subpart B §15.109; subpart C §15.207
Test Location:	Hermon Laboratories Ltd. Certified Test Facilities

Contents

1 Summary and signatures

The EUT, MLLSpeed HPRx450 transmitter of automatic meter reading system, was tested according to FCC part 90 subpart I, §§90.205, 90.209, 90.210, 90.213, 90.214; part 15 subpart B §15.109, subpart C §15.207 and found to comply with the §90.213 of the standard requirements.

Test description	Specification reference	Test report paragraph	Pass / Fail
RF output power	90.205, 2.1046	3.1	Pass
Occupied bandwidth	90.209 2.1049	3.2	Pass
Emission mask	90.210(d)	3.3	Pass
Conducted spurious emissions	90.210(d) 2.1051	3.3	Pass
Radiated spurious emissions	90.210(d) 2.1053	3.3	Pass
Frequency stability vs temperature	90.213 2.1055	3.4	Pass
Frequency stability vs voltage	2.1055	3.5	Pass
Transient frequency behavior	90.214	3.6	Pass
Conducted emissions	15.207	3.7	Pass
Radiated emissions	15.109	3.8	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
W	watt

2.2 Specification references

CFR 47 part 15: 10/2002	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, MLLSpeed HPRx,450 is a data link transceiver operating in 450 – 470 MHz. The channel separation is 12.5 kHz, fast frequency shift key (FFSK) type of modulation is used. The device utilizes the same antenna connector for transmitter and receiver and is powered by 120 V AC/12 V DC adapter.
The EUT operating frequencies generated by clocks are 3.5795 MHz, 4.0 MHz, 10.245 MHz, 13.2256 MHz, 20.0 MHz, by local oscillator – 458.9 MHz.

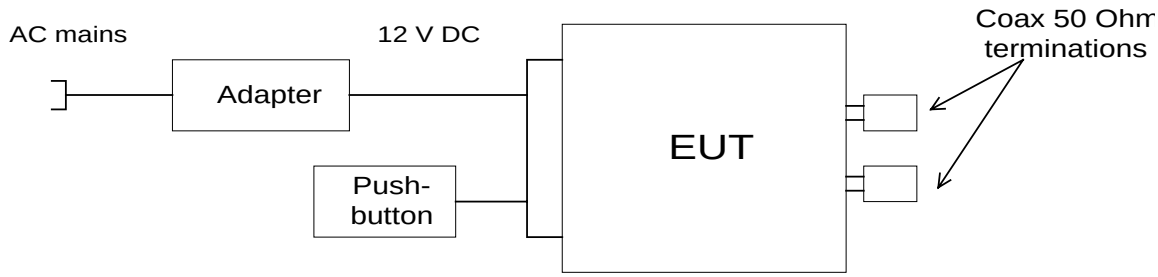
2.4 EUT test configuration

The EUT ports and lines description is given in Table 2.4.1, test configuration is shown in Figure 2.4.1.

Table 2.4.1 EUT ports and lines

Port type	Port description	Connector type	Quantity	Cable type description	Cable length, m	Connected to
Power	DC power	D-type, 9 pin	1	Unshielded	1	Adapter
Control	Frequency change	As above		Unshielded	0.2	Push-button
Signal	RF	UHF	2	Coax 50 Ω	NA	Termination

Figure 2.4.1 EUT test configuration



3 Emissions measurements

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

3.1.1 General

This test was performed to determine maximal effective radiated power. The standard maximum allowable ERP is 2 W (33 dBm).

3.1.2 Test procedure

The EUT was connected to the spectrum analyzer through the 40 dB attenuator and the radio transmission was activated.
The three Plots 3.1.1 to 3.1.3 show the maximum RF output power measured at 3 carrier frequencies (low, middle, high) 450.47 MHz, 460.00 MHz and 469.57 MHz with the 40 dB external to the spectrum analyzer attenuation, therefore 40 dB should be added to the plotted results.
The Table 3.1.1 below gives output power in dBm.

Table 3.1.1
Transmitter output RF power test results

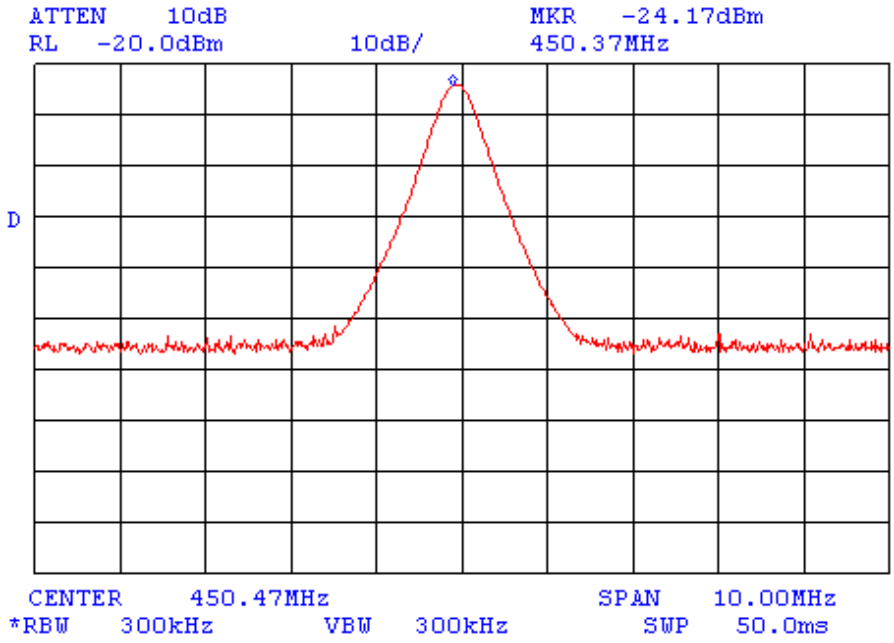
Frequency, MHz	Measured result, dBm	Peak output power, dBm	Limit, dBm	Margin, dB	Result
450.47	-24.17	15.83	33	17.17	Pass
460.00	-23.83	16.17	33	16.83	Pass
469.57	-23.67	16.33	33	16.67	Pass

Reference numbers of test equipment used

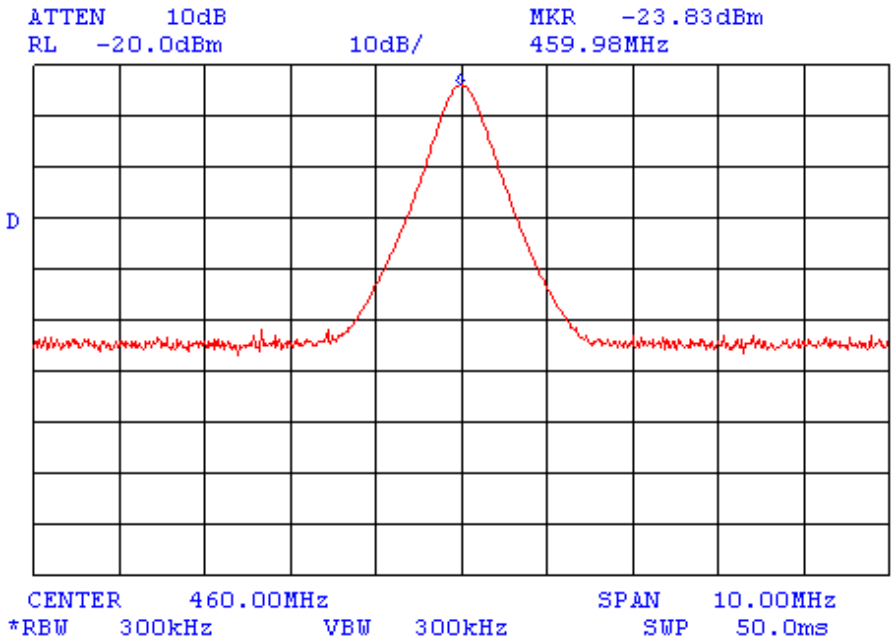
1424	1650	1651				

Full description is in Appendix A.

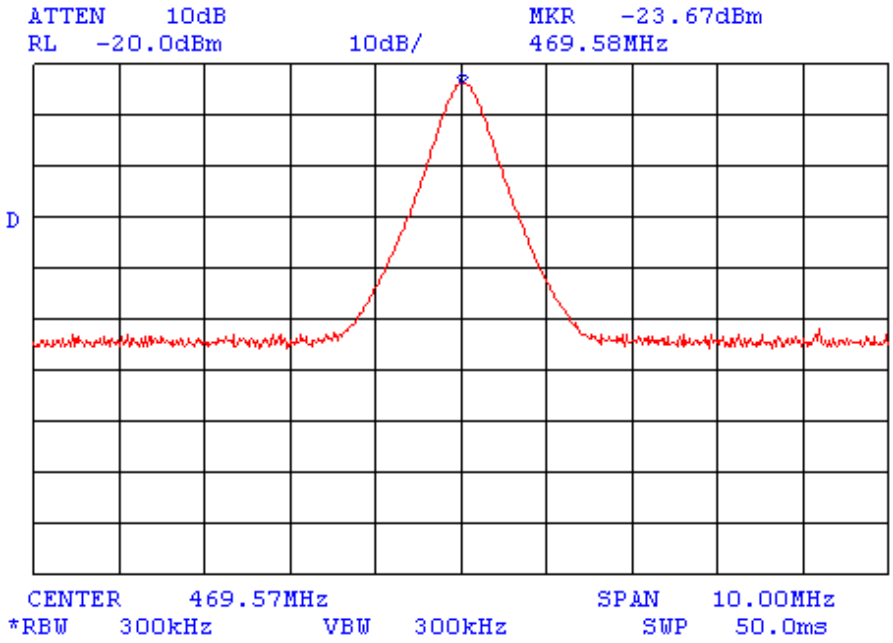
Plot 3.1.1 RF output power measurement test results at 450.47 MHz



Plot 3.1.2 RF output power measurement test results at 460.0 MHz



Plot 3.1.3 RF output power measurement test results at 469.6 MHz



3.2 Occupied bandwidth measurements according to FCC part 90 paragraph 209

3.2.1 General

According to paragraph 90.209 (5) the maximum authorized bandwidth shall be 11.25 kHz in the 450 – 470 MHz frequency band.

3.2.2 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 10.2 kHz for high channel frequency.

The test results are recorded in Table 3.2.1 and shown in Plots 3.2.1 to 3.2.3.

Table 3.2.1
Occupied bandwidth measurements

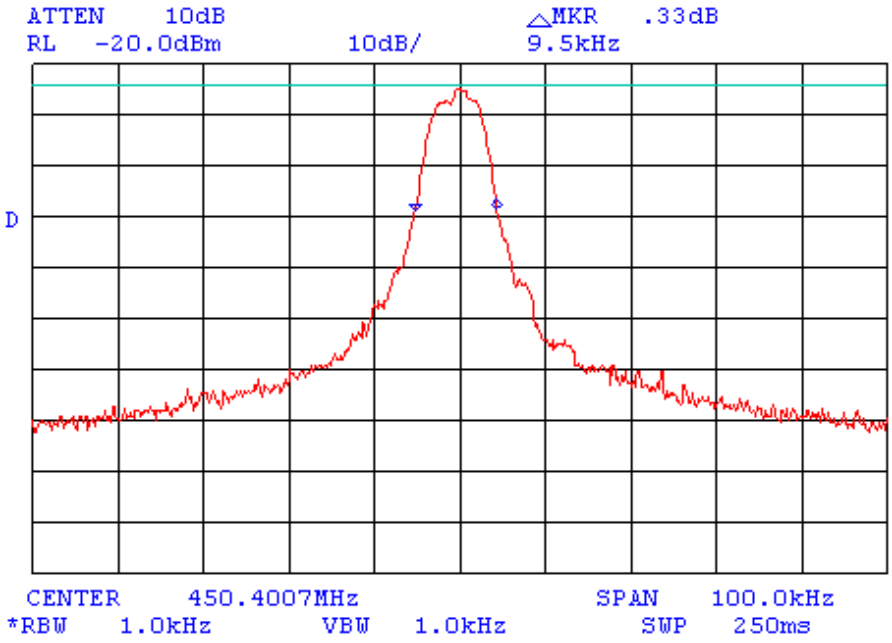
Frequency, MHz	OBW, kHz	Pass / Fail
450.4007	9.5	Pass
460.0000	9.5	Pass
469.6000	10.2	Pass

Reference numbers of test equipment used

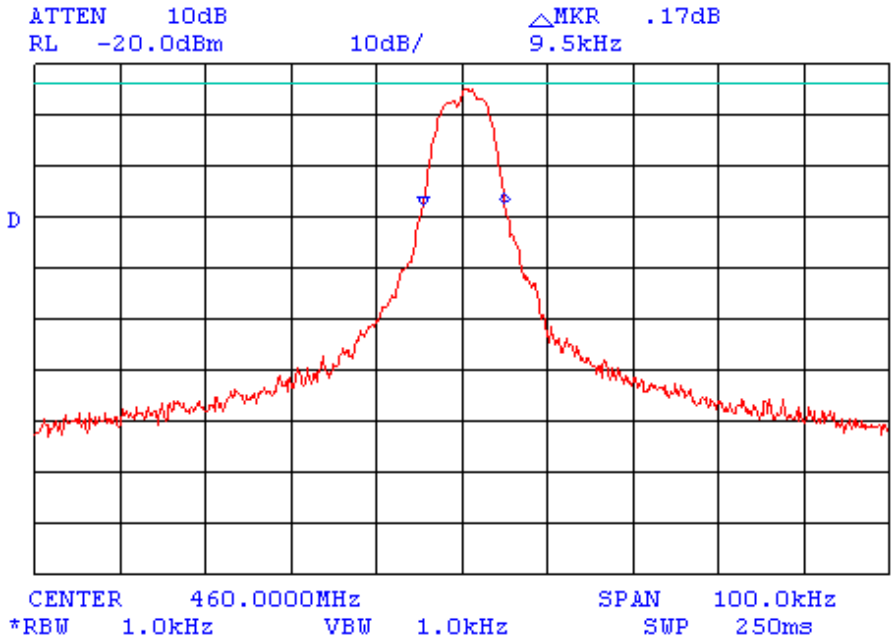
1424	1650	1651			

Full description is in Appendix A.

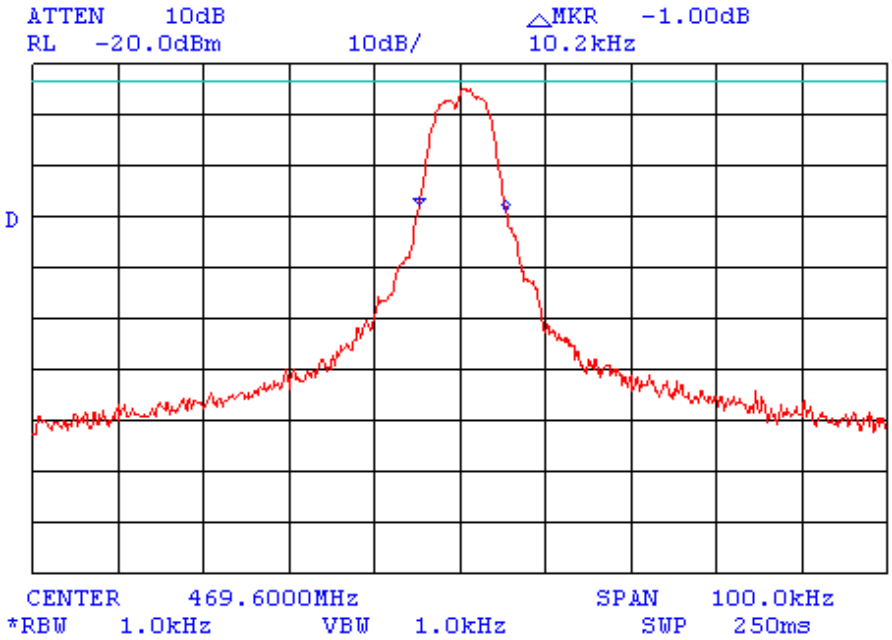
Plot 3.2.1
Occupied bandwidth measurements test result



Plot 3.2.2
Occupied bandwidth measurements test result



Plot 3.2.3
Occupied bandwidth measurements test result



3.3 Emission mask according to FCC part 90 paragraph 210(d)

3.3.1 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.

3.3.2 Test procedure

The emission mask calculated according to formulas (1) – (3) and measured results are shown in Plots 3.3.1 to 3.3.3.

Conducted spurious emissions were measured at the EUT output terminals in the frequency range from 9 kHz up to 5 GHz, test results are shown in Plots 3.3.4 to 3.3.36. The specified limit 50 + 10 log (P) was converted in EIRP units – 20 dBm and applied 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).

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 biconilcal - in the range 30 MHz to 200 MHz,
the log periodic - in the range 200 MHz to 1000 MHz,
the double ridged guide – in frequency range from 1000 to 5000 MHz.
The EUT was set up on the 80 cm height wooden table, as shown in Figures 3.3.1, 3.3.2 and Photographs 3.3.1 to 3.3.3.
To find maximum radiation the turntable was rotated 360^o, the biconical, log periodic, double ridged guide measuring antennas height varied from 1 to 4 m and the antennas polarization was changed from vertical to horizontal.
The test results were shown in Plots 3.3.37 to 3.3.54.

To find spurious emissions attenuation below the unmodulated carrier the substitution method was used. The EUT was replaced with a substitution antenna connected to signal generator. The measuring antenna height was changed from 1 to 4 m to find a maximum radiation. The level of the signal generator output was adjusted until the previously recorded field strength maximum reading was obtained as depicted in Tables 3.3.1 to 3.3.3.

The maximum transmitter output power is 0.042 W (16.33 dBm), and attenuation shall be

$$50 + 10 \log 0.04 = 36.17 \text{ dB}$$

The dipole equivalent power was calculated using the equation:

P_d (dBm) = $P_{out\ gen}$ (dBm) - cable loss (dB) + G_a (dBd), where

P_d is the dipole equivalent power
$P_{out\ gen}$ is the generator output power
G_a is the gain of the substitution antenna used relative to an ideal half-wave dipole antenna.
The attenuation below the unmodulated carrier power is calculated according to the formula:

Attenuation (dB) =10 log {P [mW]}(dBm) - P_d (dBm)

The test results are recorded in Tables 3.3.1 to 3.3.3. The EUT was found to comply with standard requirements.

Reference numbers of test equipment used

0041	0446	0465	0521	0566	0569	0589	0592
0593	0594	1004	1425	1566	1637	1826	1849
1850	1942	1947	1984	2009	2109		

Reference numbers of test equipment used for substitution method

0412	0521	0589	0614	1116	1939	1947	1984

Full description is in Appendix A.

Figure 3.3.1
Set up for radiated emissions measurement

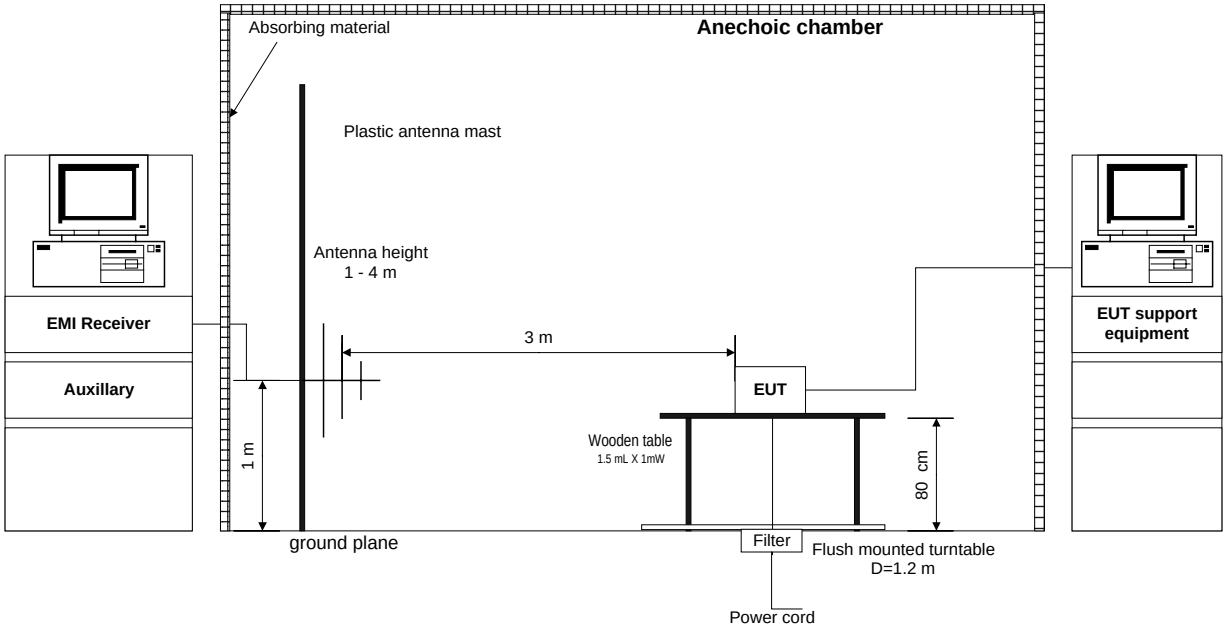
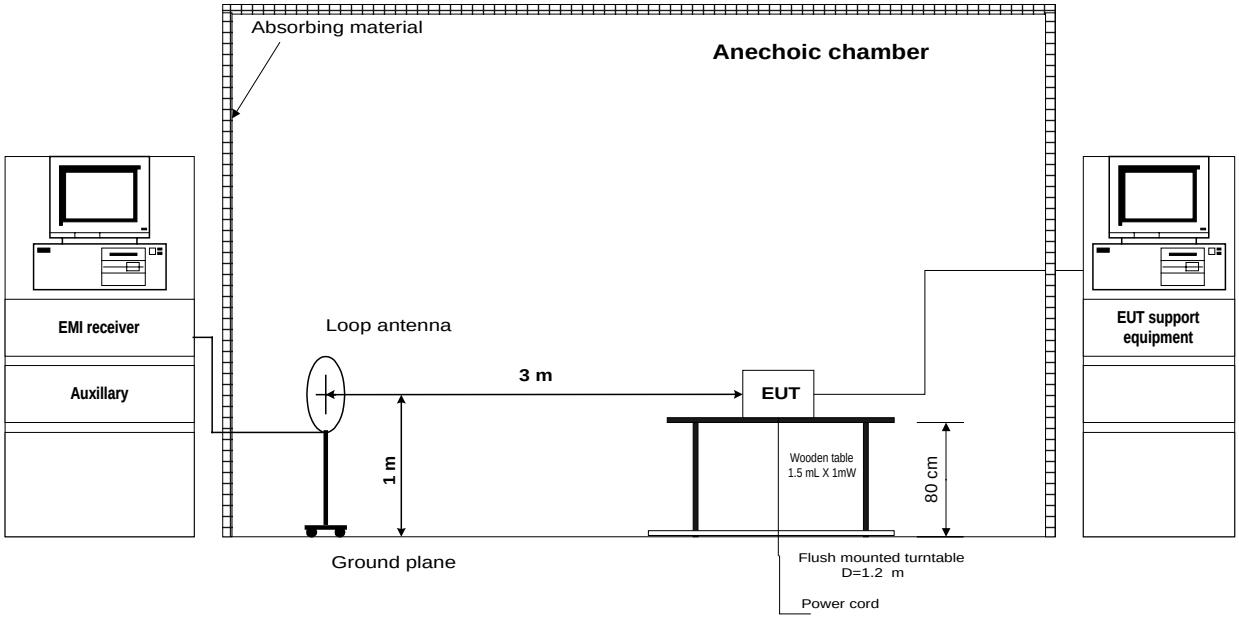
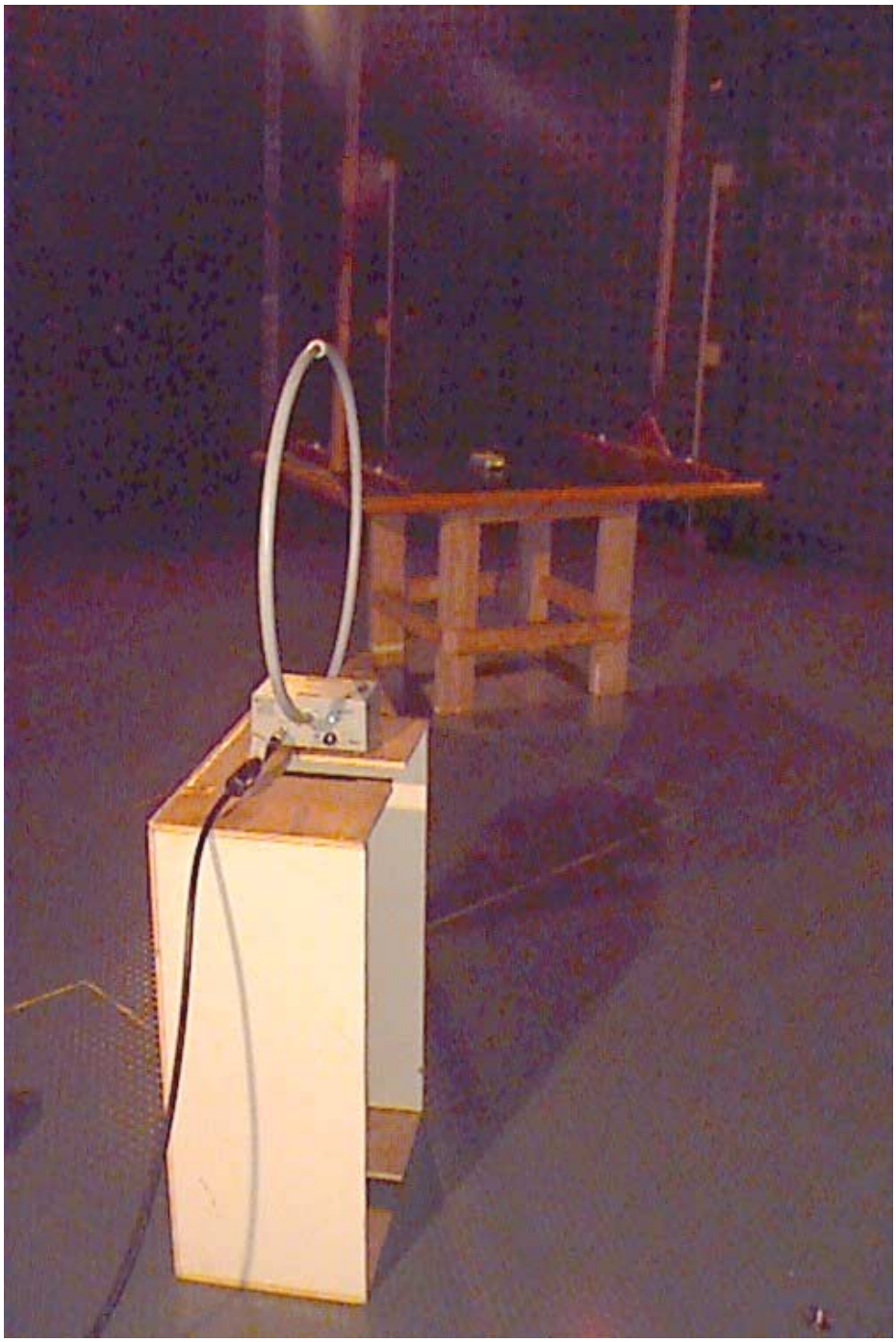


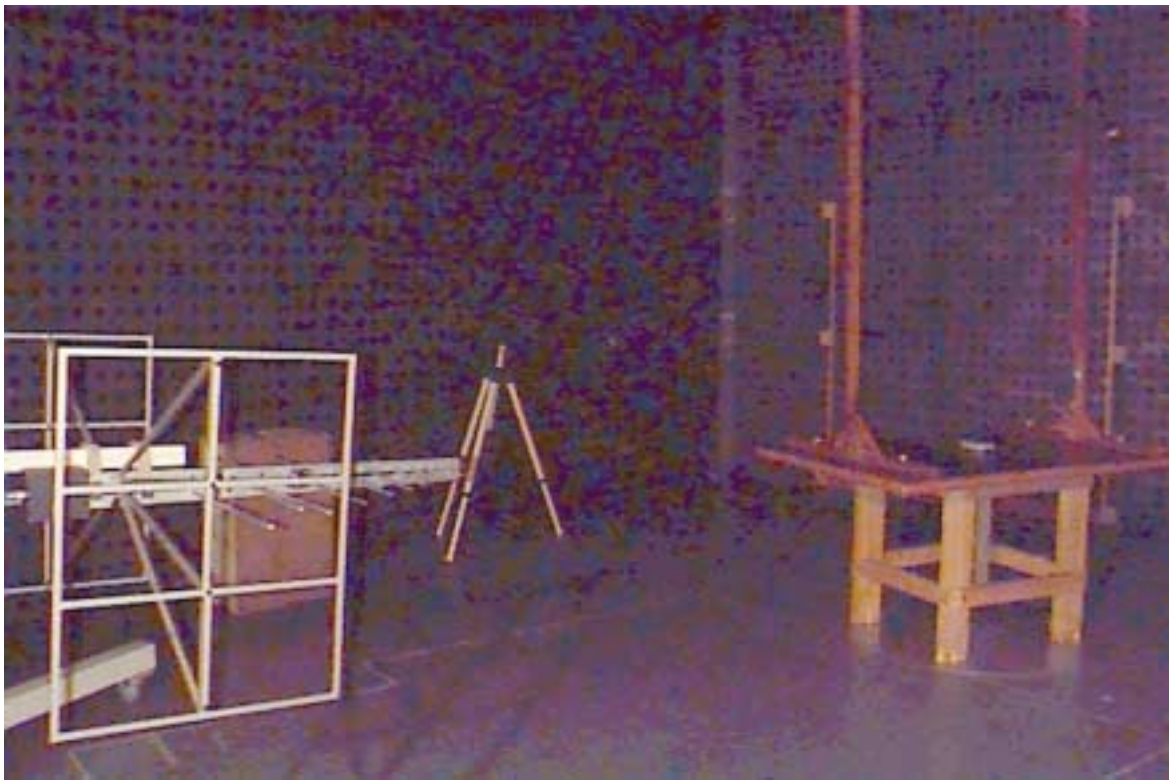
Figure 3.3.2
Set up for radiated emissions measurement in 9 kHz to 30 MHz frequency range



Photograph 3.3.1
Radiated emissions measurement setup



Photograph 3.3.2
Radiated emissions measurement setup



Photograph 3.3.3
Radiated emissions measurement setup

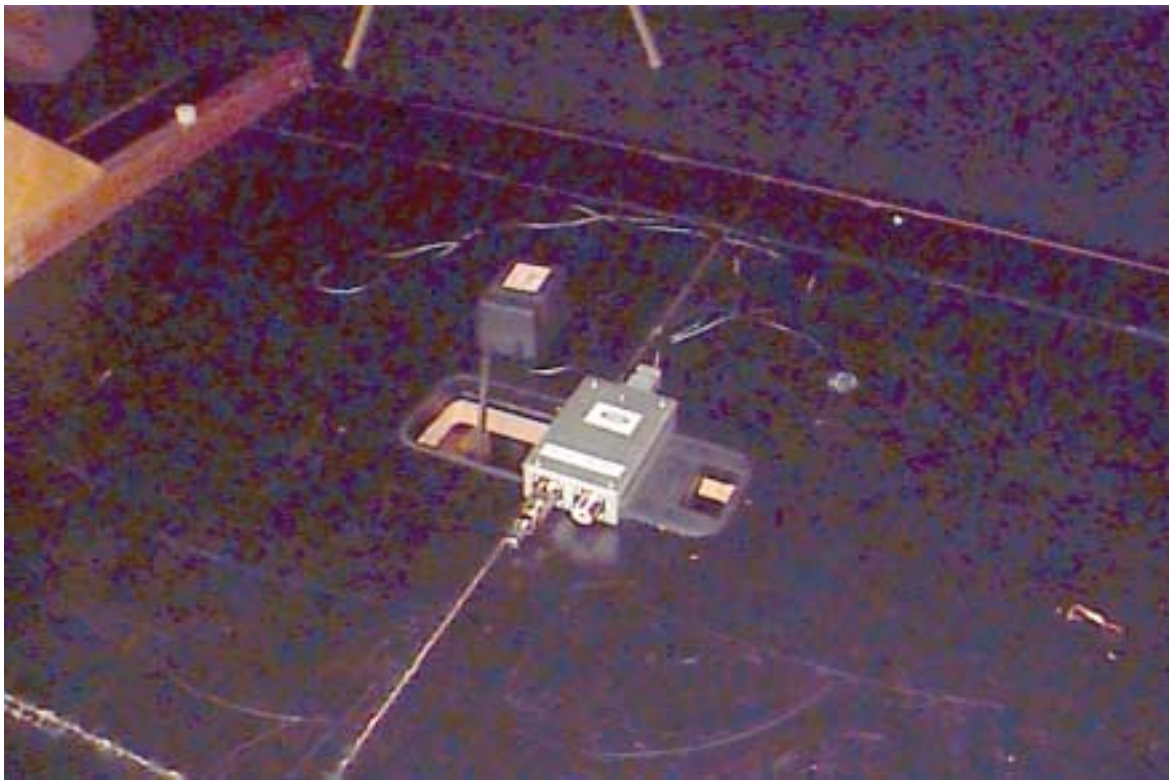


Table 3.3.1
Spurious emissions (harmonics) measurement test results

Carrier frequency F_c = 450.39 MHz

DATE:	January 12, 2003
TEST PERFORMED AT:	OATS
RELATIVE HUMIDITY:	40%
AMBIENT TEMPERATURE:	22°C
AIR PRESSURE	1015 hPa
DISTANCE BETWEEN ANTENNA AND EUT:	3 m
DETECTOR TYPE:	Peak

Frequency, MHz	RBW, kHz	Ant type	Ant. pol	Radiated measured result, dB(uV/m)	Generator P_{out}, dBm	Cable loss, dB	Antenna gain, dBd	Dipole equivalent power, dBm	Attenuat, dBc	Limit, dBc	Margin, dB	Pass/ Fail
450.39	10	LP	V	44.65	-33.9	0.42	-1.19	-35.5	51.7	36.17	15.5	Pass
1351	1000	DRG	V	46.1	-57.18	2.09	4.8	-54.5	70.6	36.17	34.5	Pass
1802	1000	DRG	H	53.3	-39.30	2.38	4.77	-36.9	53.1	36.17	16.9	Pass
2252	1000	DRG	V	48.8	-50.70	2.9	4.7	-48.9	65.1	36.17	28.9	Pass

Acronyms and abbreviations:
RBW = resolution bandwidth
Ant. type = antenna type: LP (log periodic), DRG (double ridged guide)
Ant. pol = antenna polarization: V-vertical, H- horizontal
Margin = dB below (negative if above) specification limit.

Table 3.3.2
Spurious emissions (harmonics) measurement test results

Carrier frequency F_c = 460.0015 MHz

DATE:	January 12, 2003
TEST PERFORMED AT:	OATS
RELATIVE HUMIDITY:	40%
AMBIENT TEMPERATURE:	22°C
AIR PRESSURE	1015 hPa
DISTANCE BETWEEN ANTENNA AND EUT:	3 m
DETECTOR TYPE:	Peak

Frequency, MHz	RBW, kHz	Ant type	Ant. pol	Radiated measured result, dB(uV/m)	Generator P_{out}, dBm	Cable loss, dB	Antenna gain, dBd	Dipole equivalent power, dBm	Attenuat, dBc	Limit, dBc	Margin, dB	Pass/ Fail
460.0015	10	LP	V	55.3	-37.8	0.42	-1.17	-39.4	55.6	36.17	19.4	Pass
1840	1000	DRG	V	53.4	-45.67	2.38	4.70	-43.4	59.5	36.17	23.4	Pass
1380	1000	DRG	H	45.24	-56.94	2.09	4.88	-54.2	70.3	36.17	34.2	Pass

Acronyms and abbreviations:
RBW = resolution bandwidth
Ant. type = antenna type: LP (log periodic), DRG (double ridged guide)
Ant. pol = antenna polarization: V-vertical, H- horizontal
Margin = dB below (negative if above) specification limit.

Table 3.3.3
Spurious emissions (harmonics) measurement test results

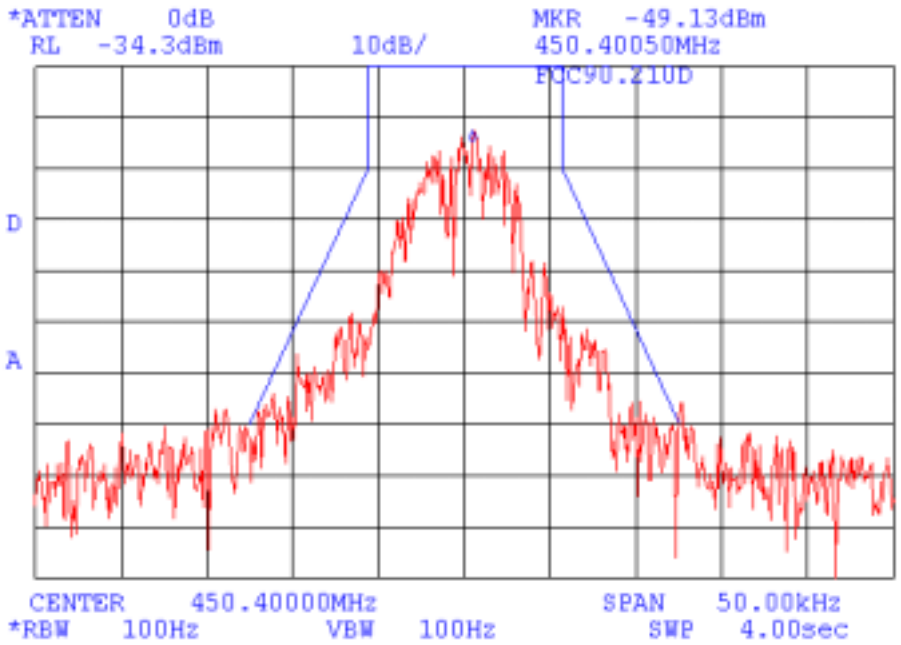
Carrier frequency F_c = 468.27 MHz

DATE:	January 12, 2003
TEST PERFORMED AT:	OATS
RELATIVE HUMIDITY:	40%
AMBIENT TEMPERATURE:	22°C
AIR PRESSURE	1015 hPa
DISTANCE BETWEEN ANTENNA AND EUT:	3 m
DETECTOR TYPE:	Peak

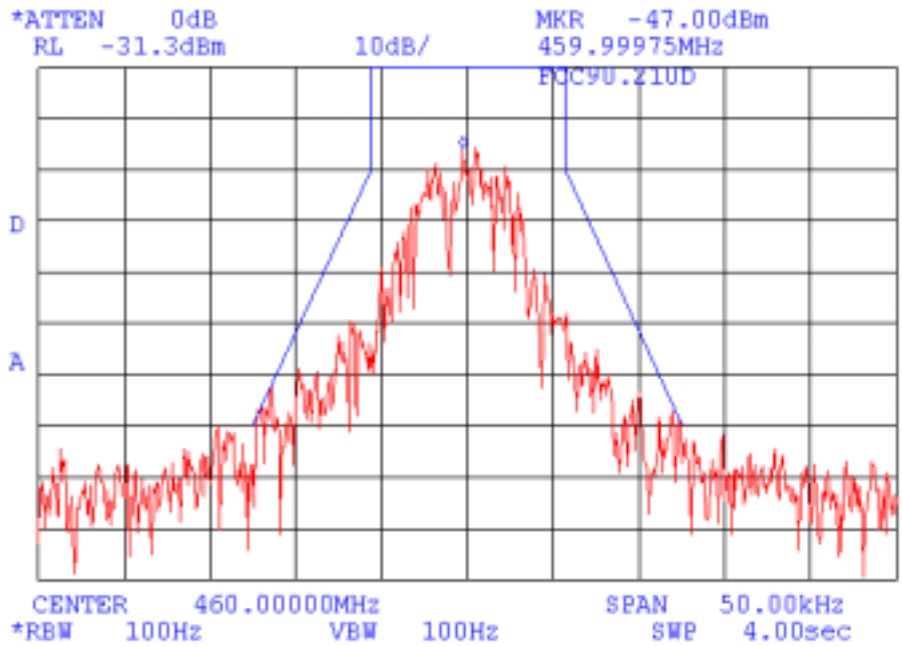
Frequency, MHz	RBW, kHz	Ant type	Ant. pol	Radiated measured result, dB(uV/m)	Generator P_{out}, dBm	Cable loss, dB	Antenna gain, dBd	Dipole equivalent power, dBm	Attenuat, dBc	Limit, dBc	Margin, dB	Pass/ Fail
468.27	10	LP	V	61.5	-35.4	0.42	-1.18	-37.0	53.2	36.17	17.0	Pass
1409	1000	DRG	V	47.8	-56.73	2.09	4.96	-53.9	70.0	36.17	33.83	Pass
1878	1000	DRG	V	52.9	-45.79	2.38	4.63	-43.5	59.7	36.17	23.5	Pass

Acronyms and abbreviations:
RBW = resolution bandwidth
Ant. type = antenna type: LP (log periodic), DRG (double ridged guide)
Ant. pol = antenna polarization: V-vertical, H- horizontal
Margin = dB below (negative if above) specification limit.

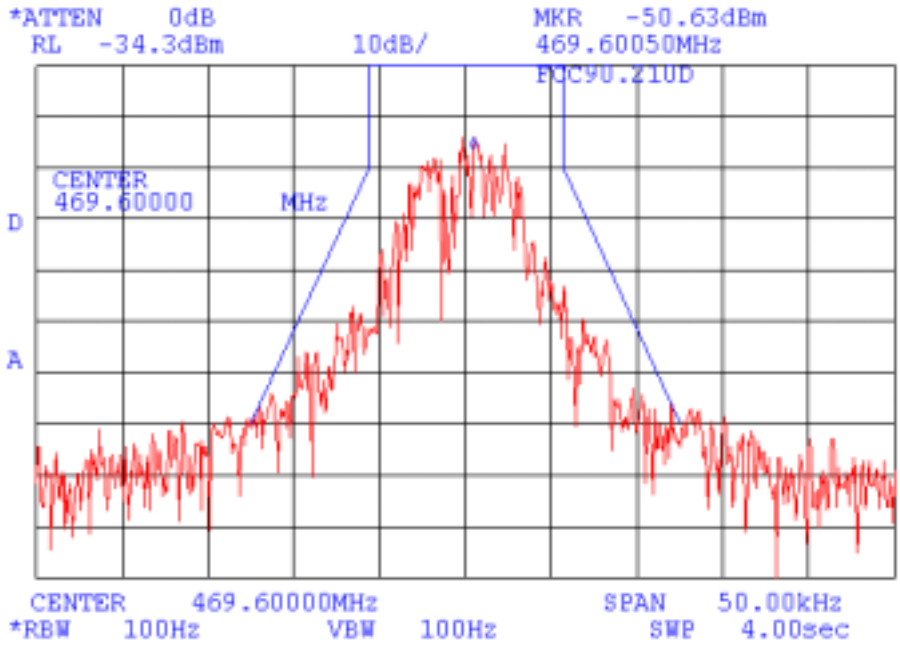
Plot 3.3.1
Emission mask test results



Plot 3.3.2
Emission mask test results

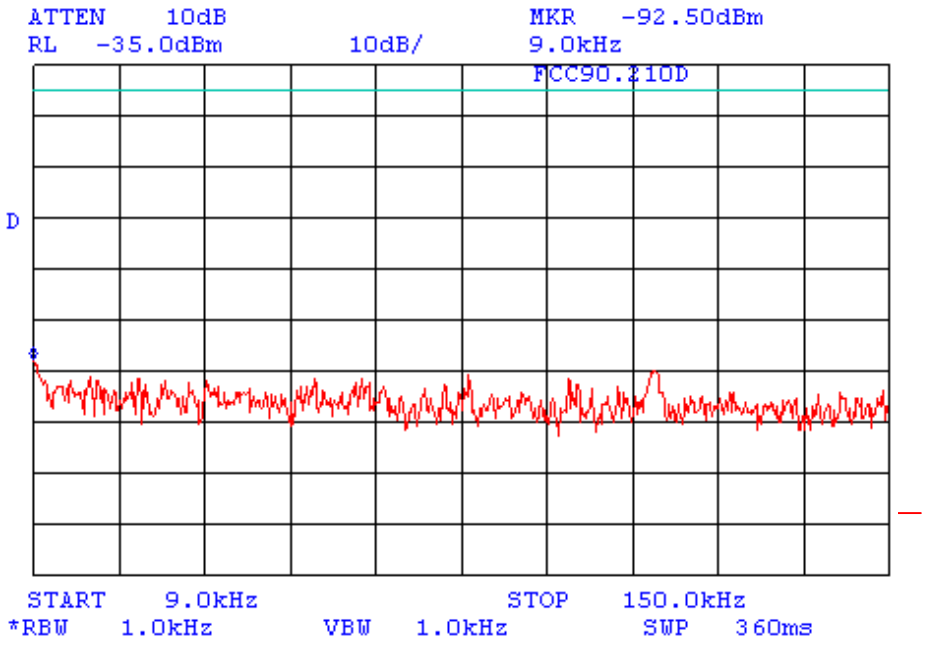


Plot 3.3.3
Emission mask test results



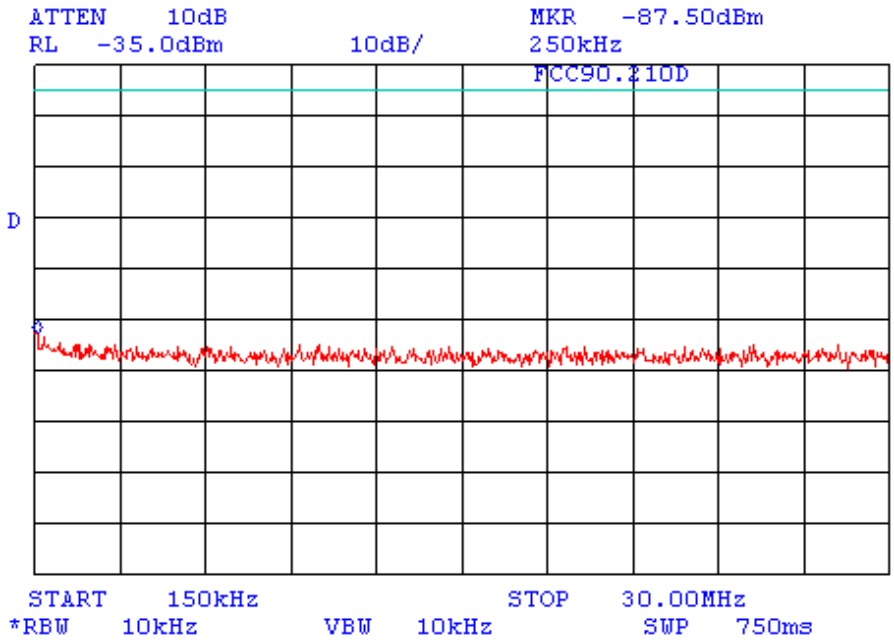
Plot 3.3.4
Conducted spurious emissions measurement test results

F=450.400 MHz
External attenuation = 20 dB



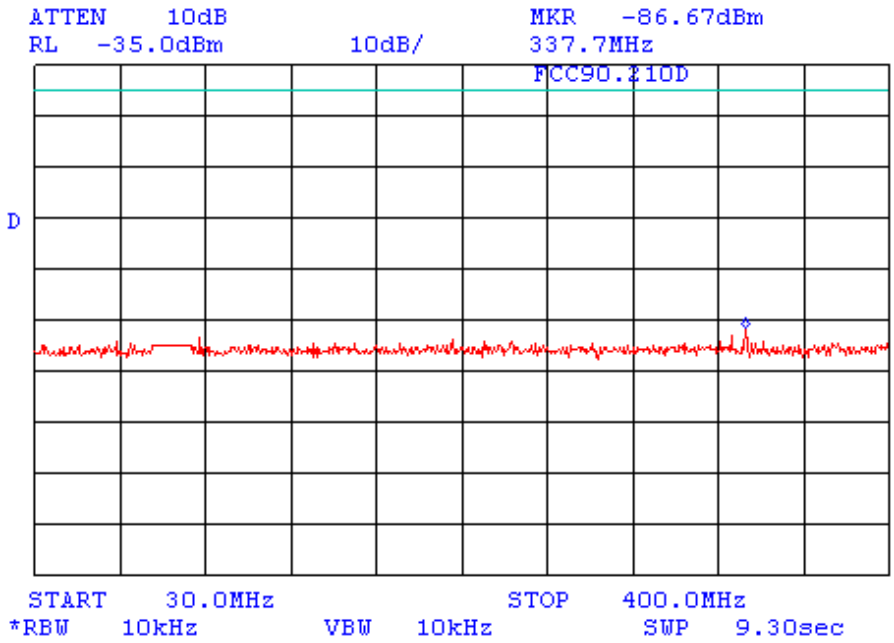
Plot 3.3.5
Conducted spurious emissions measurement test results

F=450.400 MHz
External attenuation = 20 dB



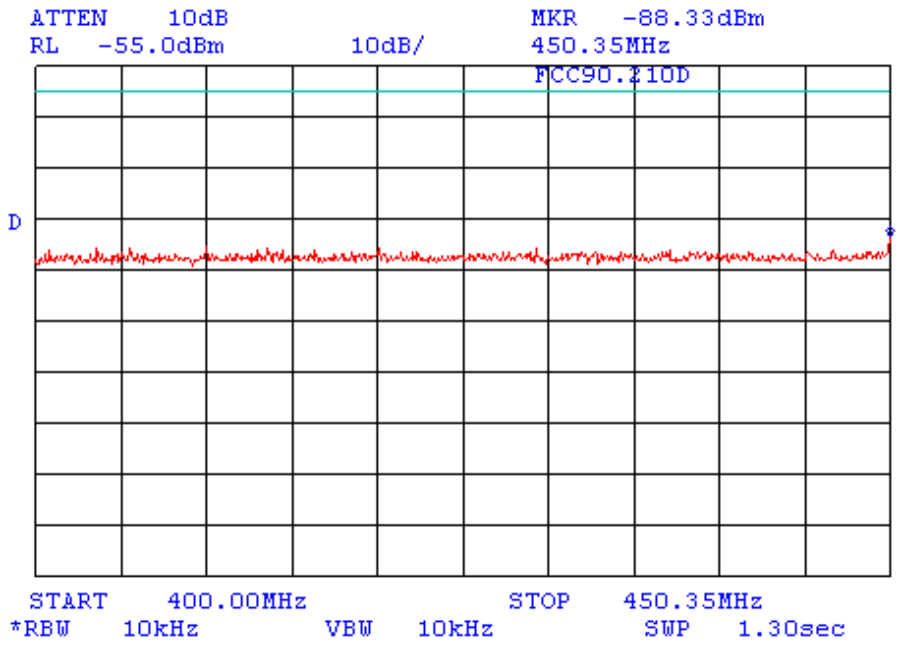
Plot 3.3.6
Conducted spurious emissions measurement test results

F=450.400 MHz
External attenuation = 20 dB



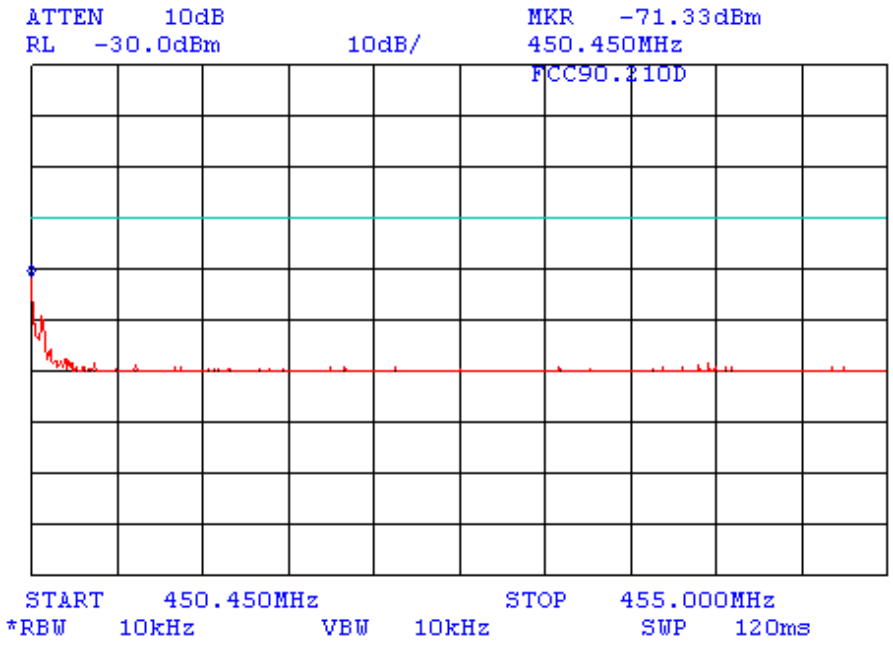
Plot 3.3.7
Conducted spurious emissions measurement test results

F=450.400 MHz
External attenuation = 40 dB



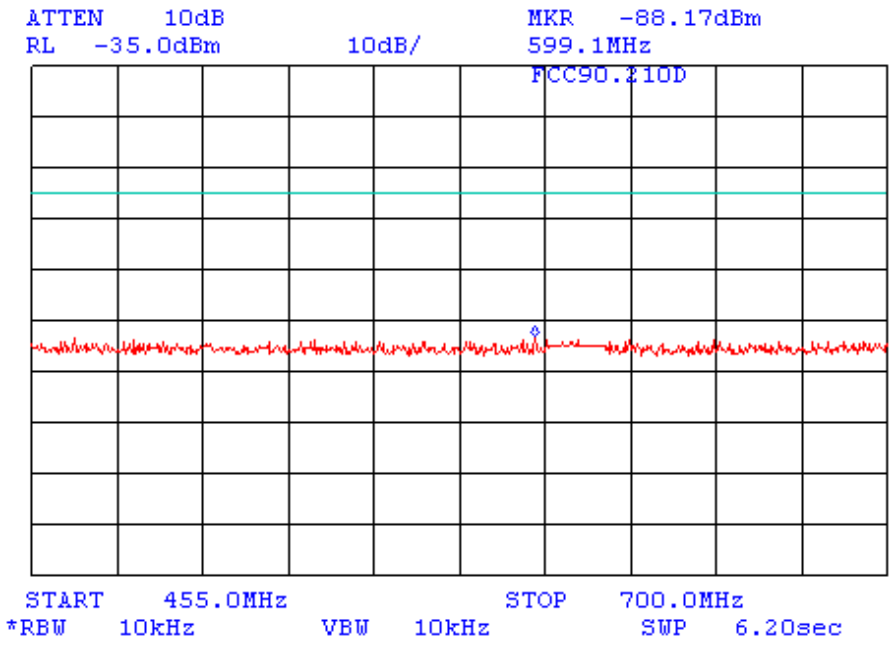
Plot 3.3.8
Conducted spurious emissions measurement test results

F=450.400 MHz
External attenuation = 40 dB



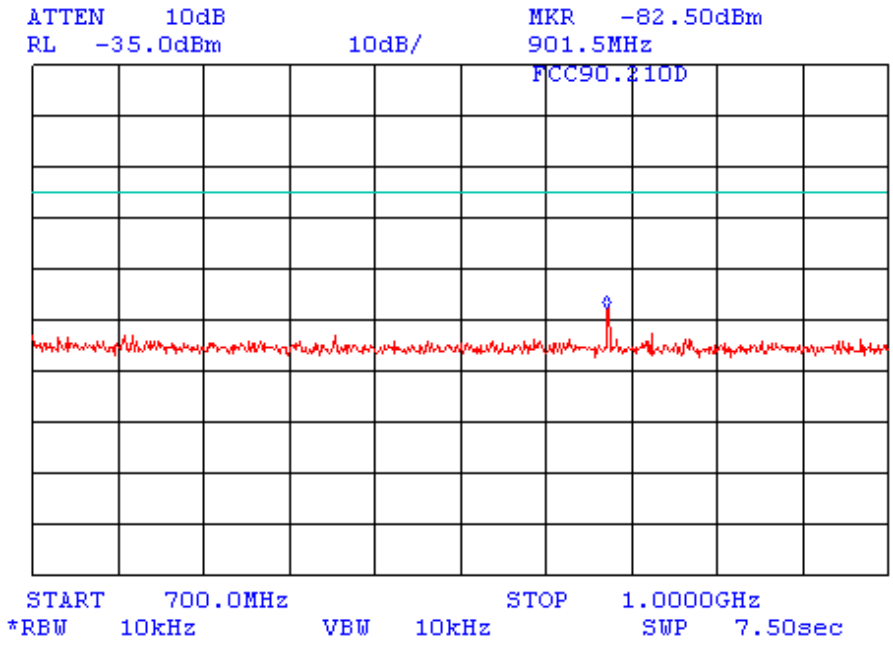
Plot 3.3.9
Conducted spurious emissions measurement test results

F=450.400 MHz
External attenuation = 40 dB



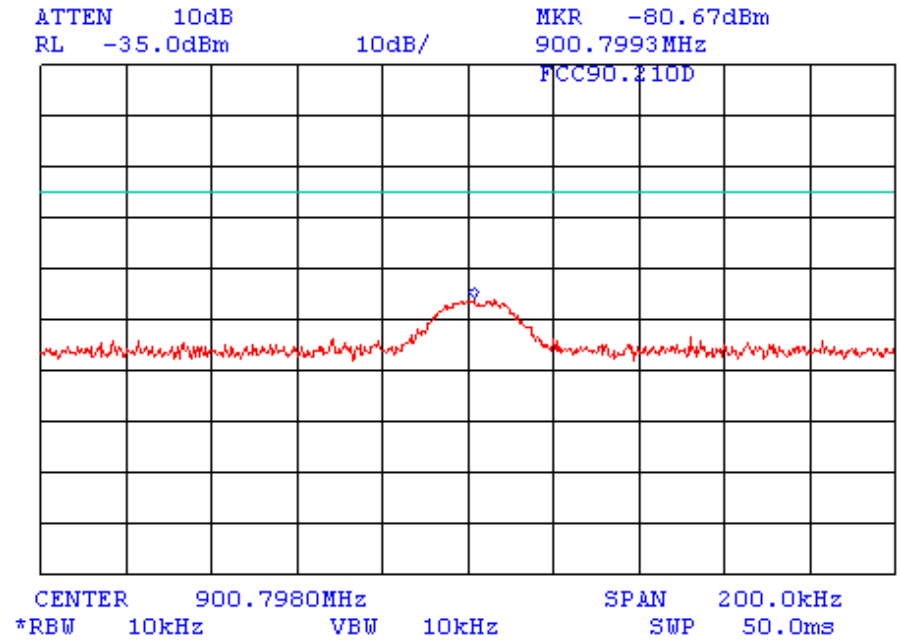
Plot 3.3.10
Conducted spurious emissions measurement test results

F=450.400 MHz
External attenuation = 40 dB



Plot 3.3.11
Conducted spurious emissions measurement test results

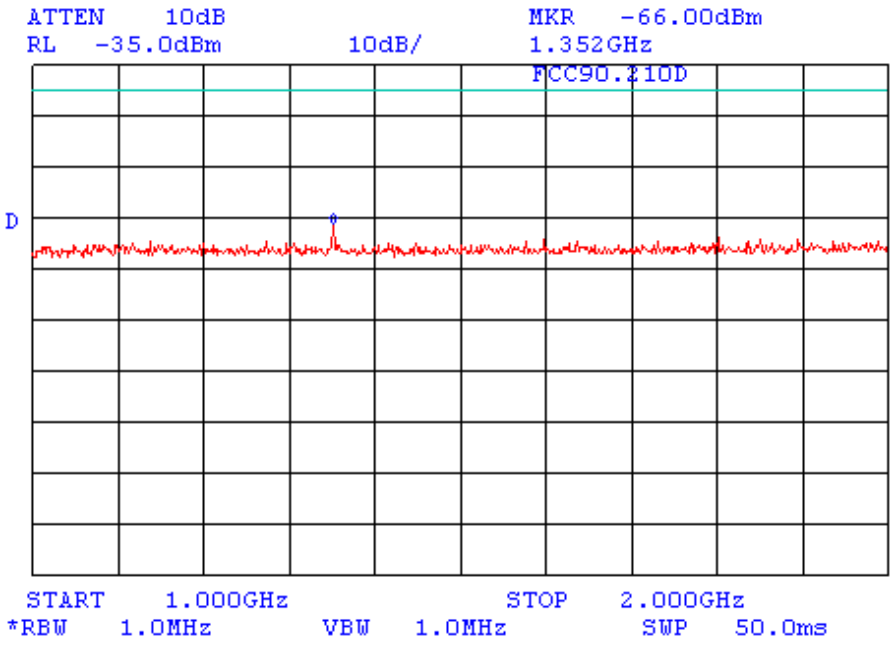
F=450.400 MHz
External attenuation = 40 dB



F=900.8 MHz P=-80.67 dBm +40 dB =-40.67 dBm
Limit: -20 dBm

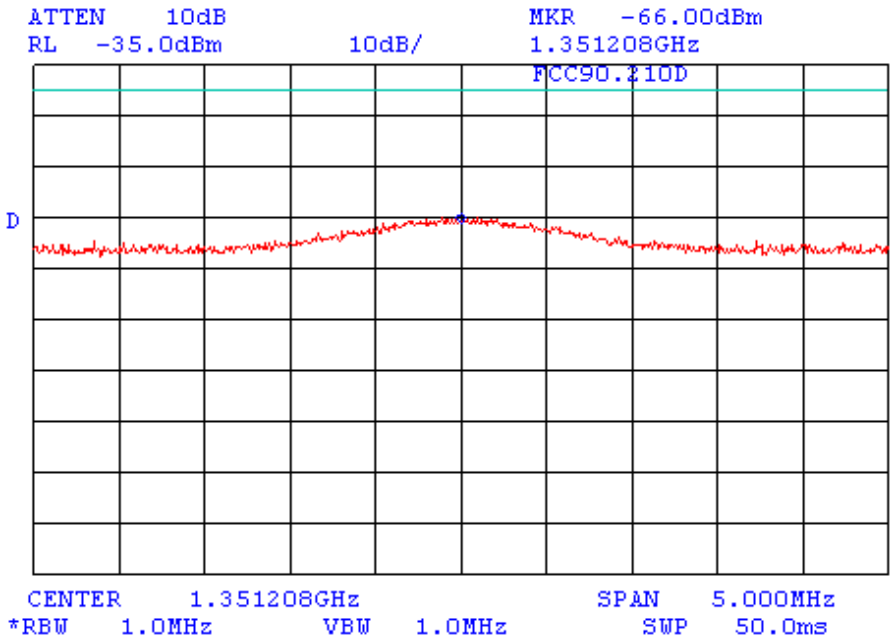
Plot 3.3.12
Conducted spurious emissions measurement test results

F=450.400 MHz
External attenuation = 20 dB



Plot 3.3.13
Conducted spurious emissions measurement test results

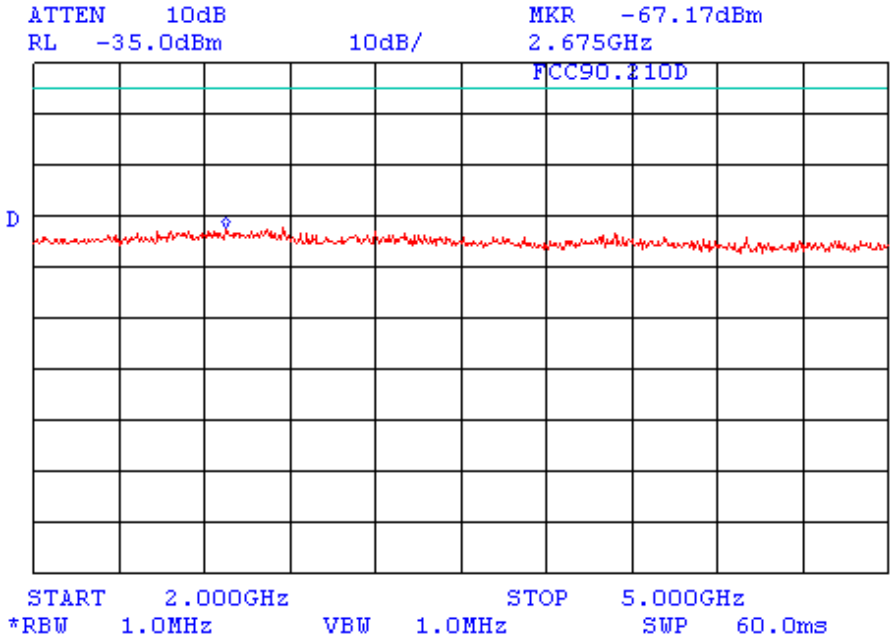
F=450.400 MHz
External attenuation = 20 dB



F=1351.2 MHz P= -66 dBm+20 dB=-46 dBm

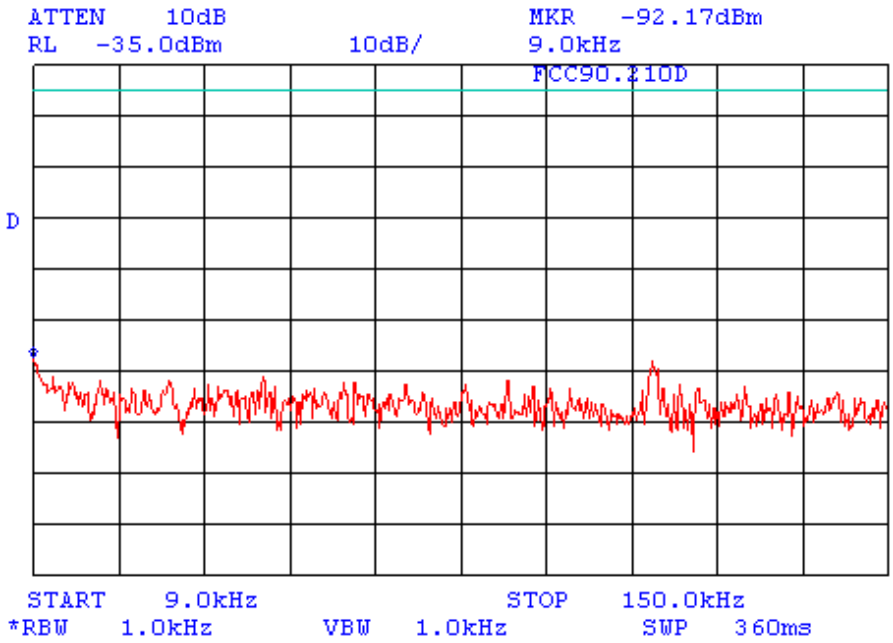
Plot 3.3.14
Conducted spurious emissions measurement test results

F=450.400 MHz
External attenuation = 20 dB



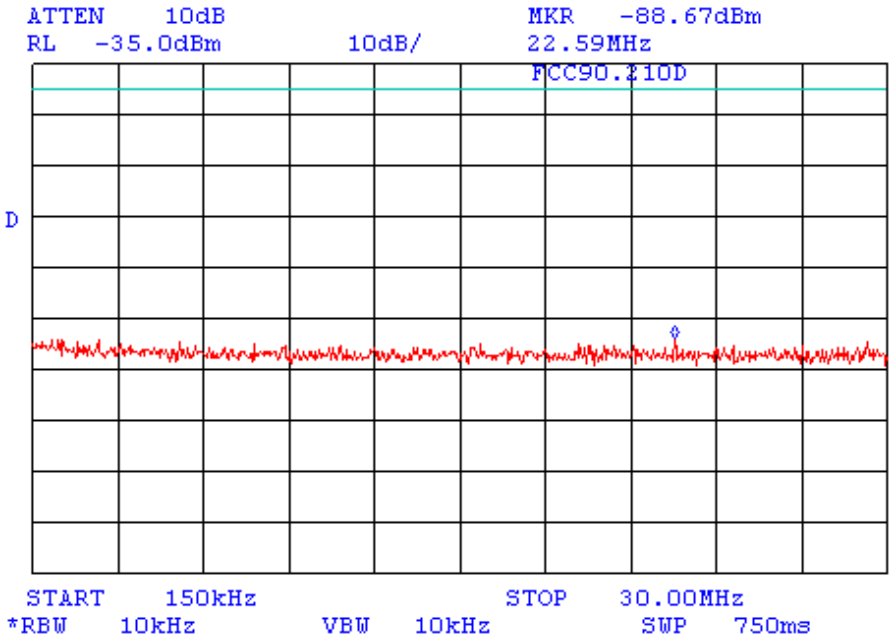
Plot 3.3.15
Conducted spurious emissions measurement test results

F=460.000 MHz
External attenuation = 20 dB



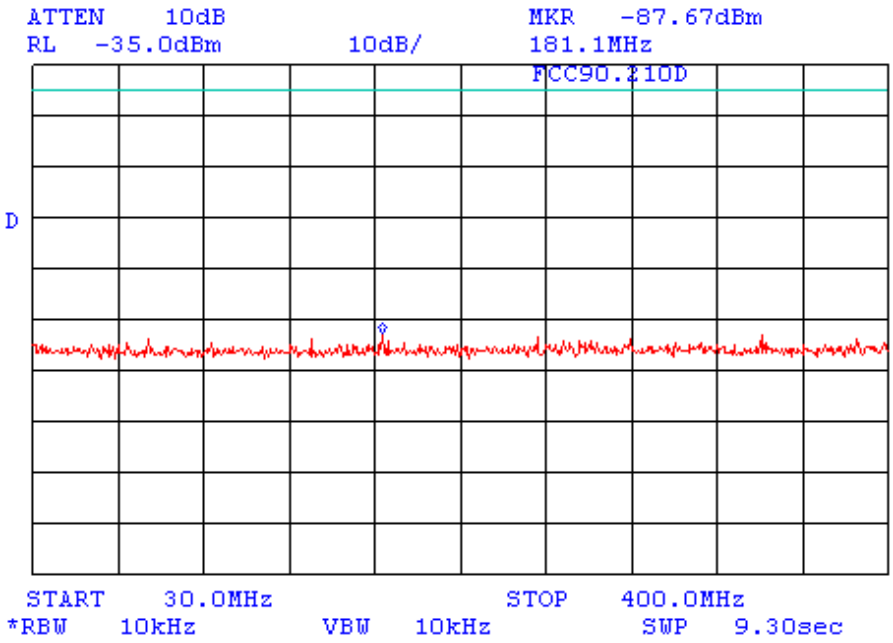
Plot 3.3.16
Conducted spurious emissions measurement test results

F=460.000 MHz
External attenuation = 20 dB



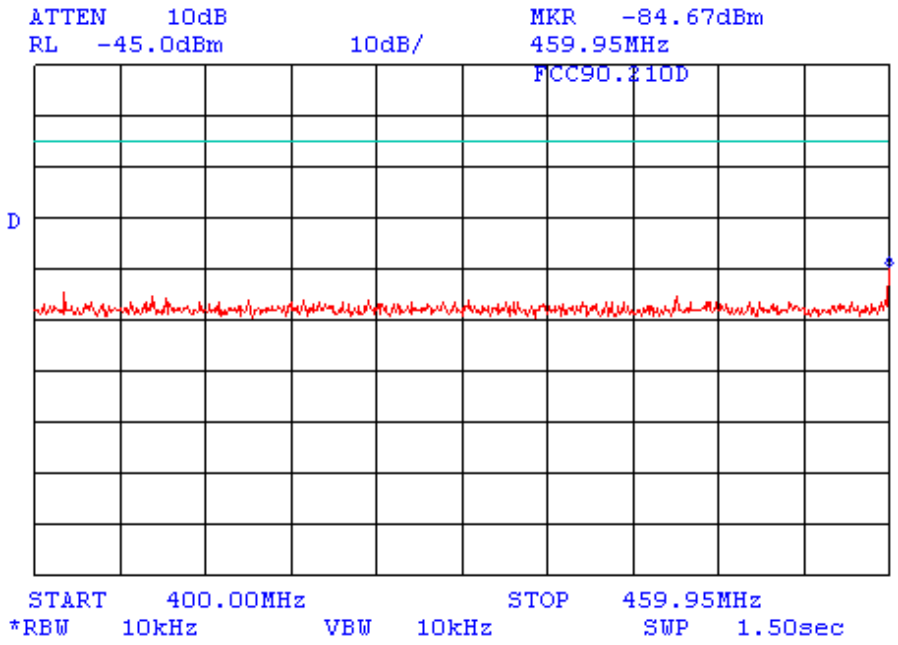
Plot 3.3.17
Conducted spurious emissions measurement test results

F=460.000 MHz
External attenuation = 20 dB



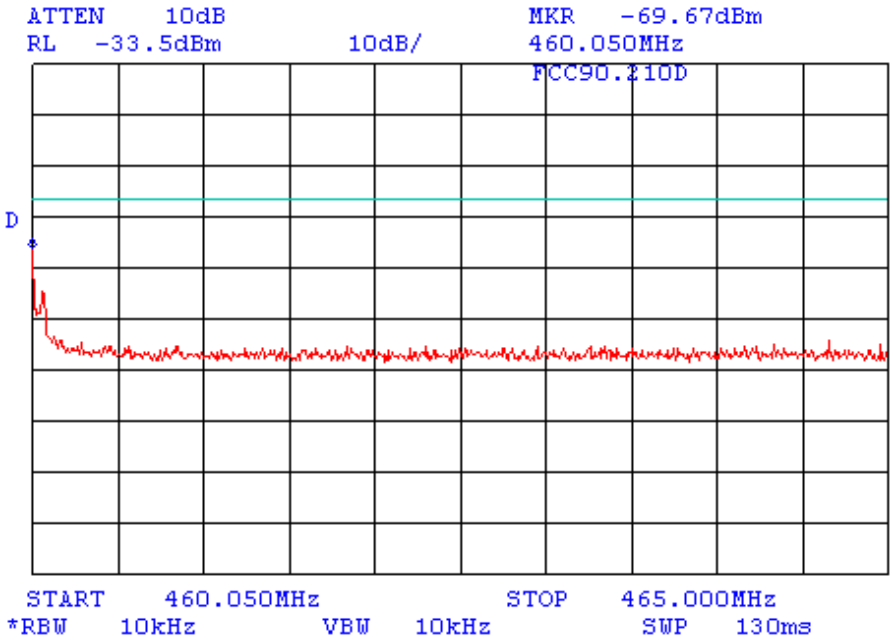
Plot 3.3.18
Conducted spurious emissions measurement test results

F=460.000 MHz
External attenuation = 40 dB



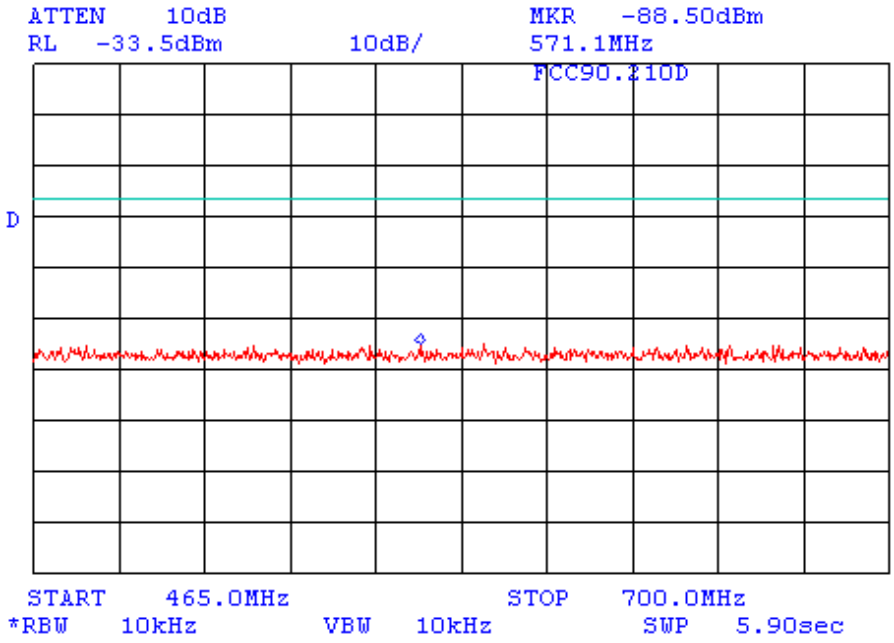
Plot 3.3.19
Conducted spurious emissions measurement test results

F=460.000 MHz
External attenuation = 40 dB



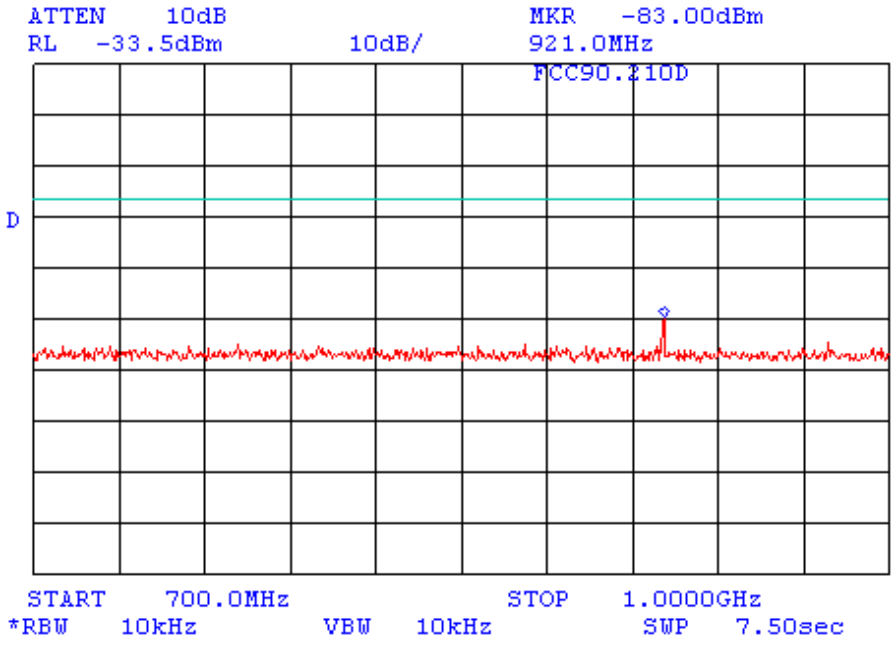
Plot 3.3.20
Conducted spurious emissions measurement test results

F=460.000 MHz
External attenuation = 40 dB



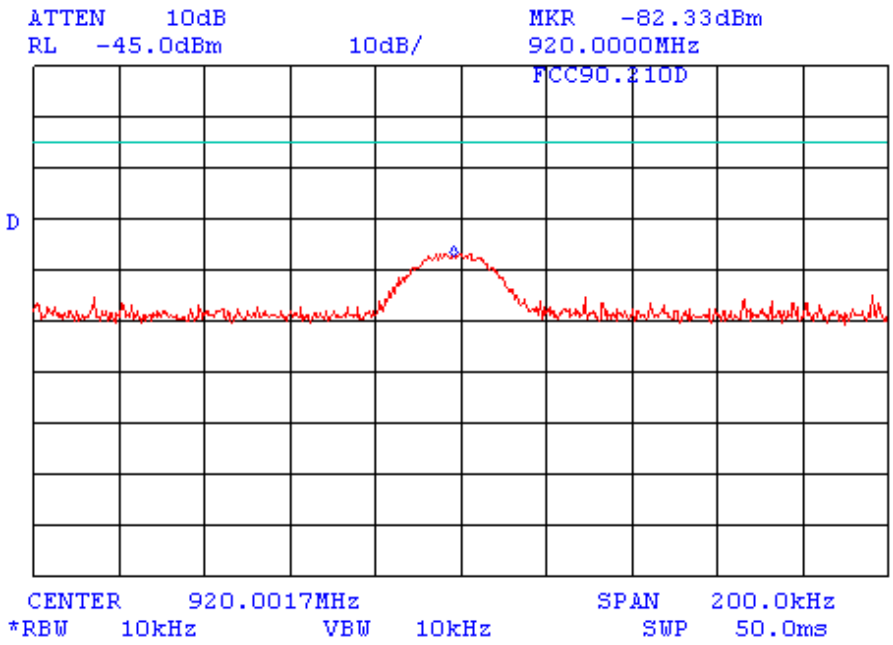
Plot 3.3.21
Conducted spurious emissions measurement test results

F=460.000 MHz
External attenuation = 40 dB



Plot 3.3.22
Conducted spurious emissions measurement test results

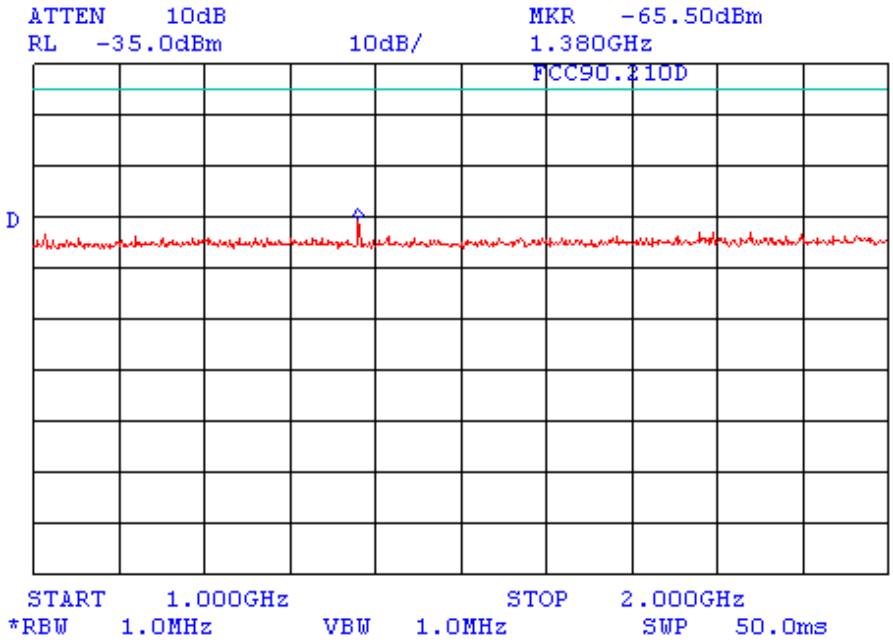
F=460.000 MHz
External attenuation = 40 dB



P=-82.33 dBm+40 dB =-42.33 dBm

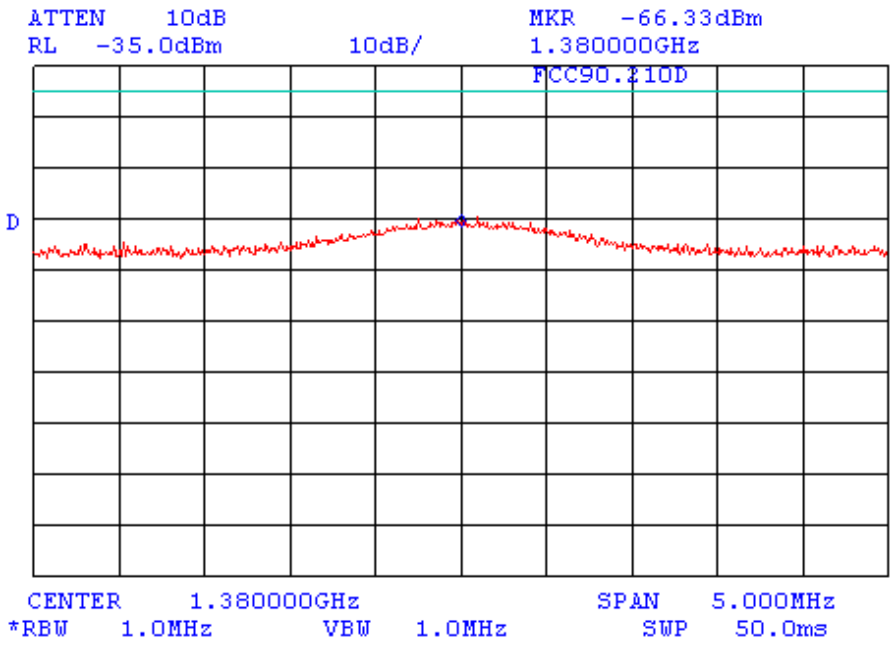
Plot 3.3.23
Conducted spurious emissions measurement test results

F=460.000 MHz
External attenuation = 20 dB



Plot 3.3.24
Conducted spurious emissions measurement test results

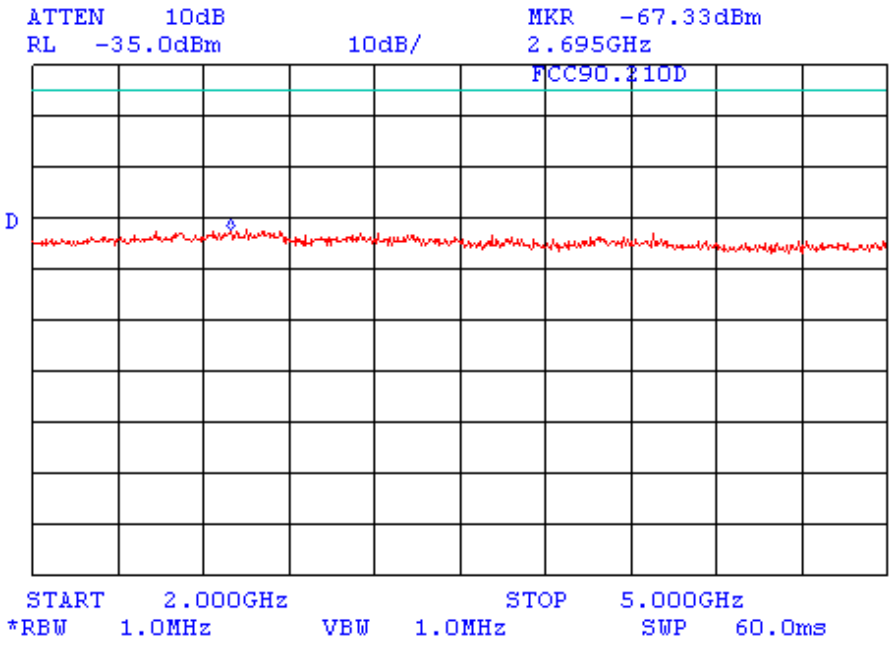
F=460.000 MHz
External attenuation = 20 dB



F=1380 MHz P=-66.33 dBm +20 dB=-46.33 dBm

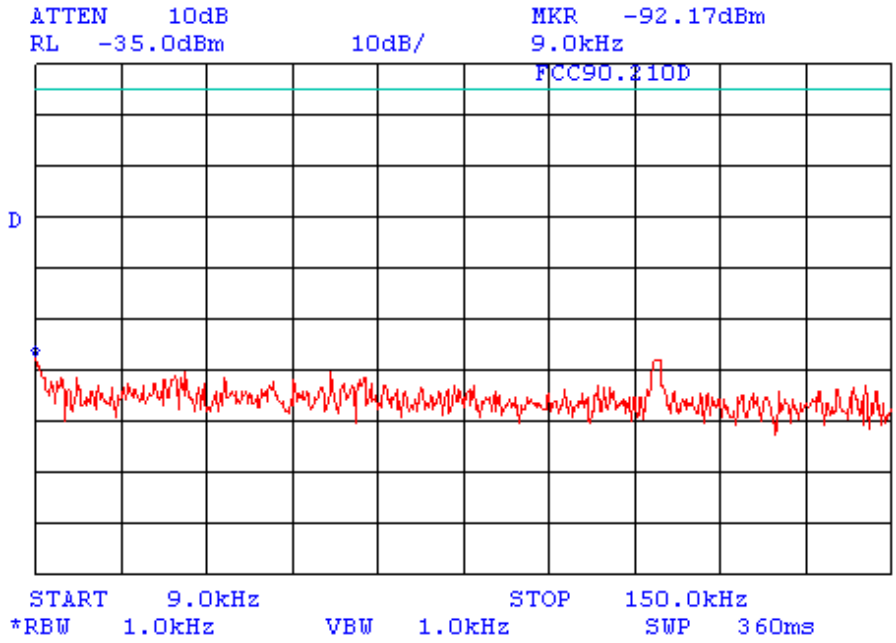
Plot 3.3.25
Conducted spurious emissions measurement test results

F=460.000 MHz
External attenuation = 20 dB



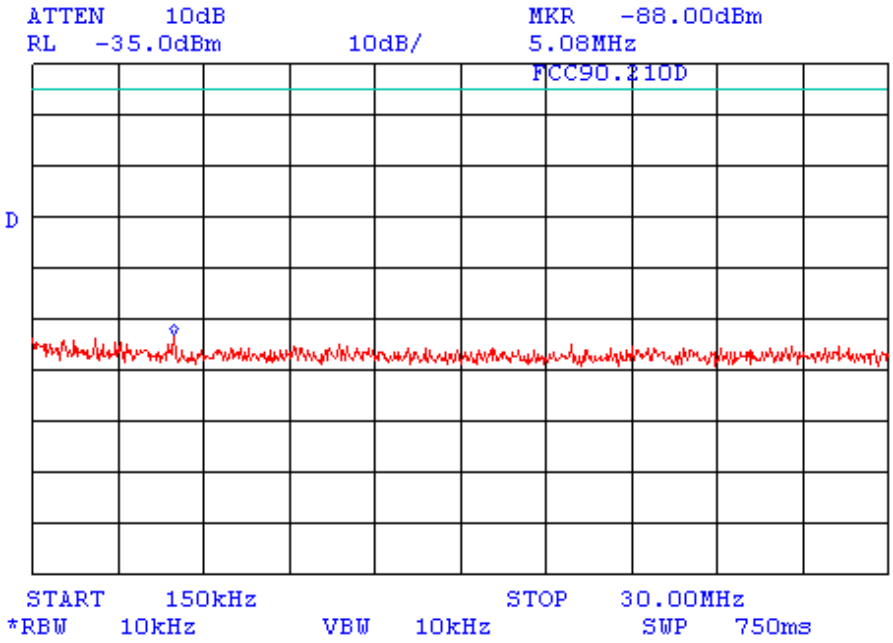
Plot 3.3.26
Conducted spurious emissions measurement test results

F=469.600 MHz
External attenuation = 20 dB



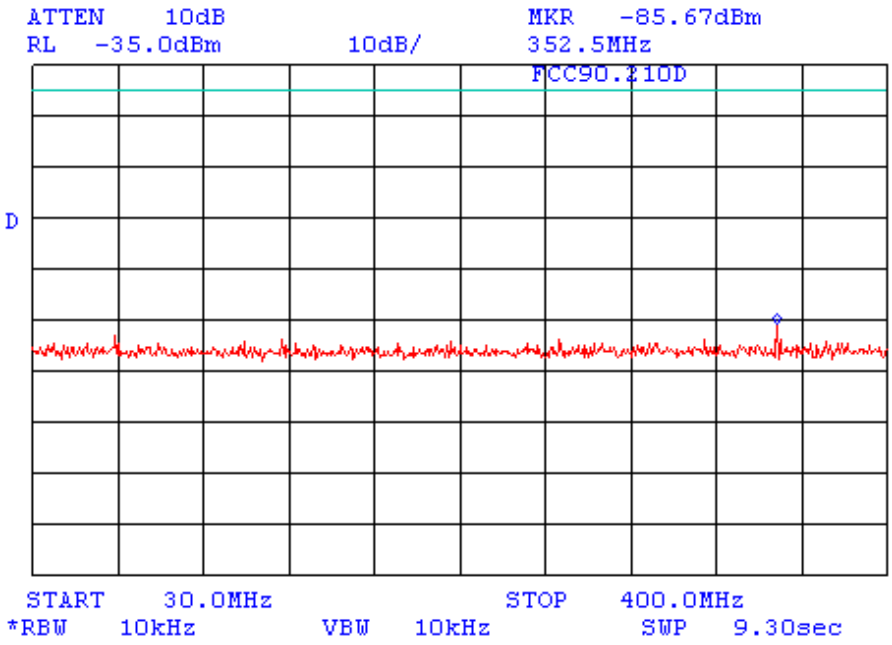
Plot 3.3.27
Conducted spurious emissions measurement test results

F=469.600 MHz
External attenuation = 20 dB



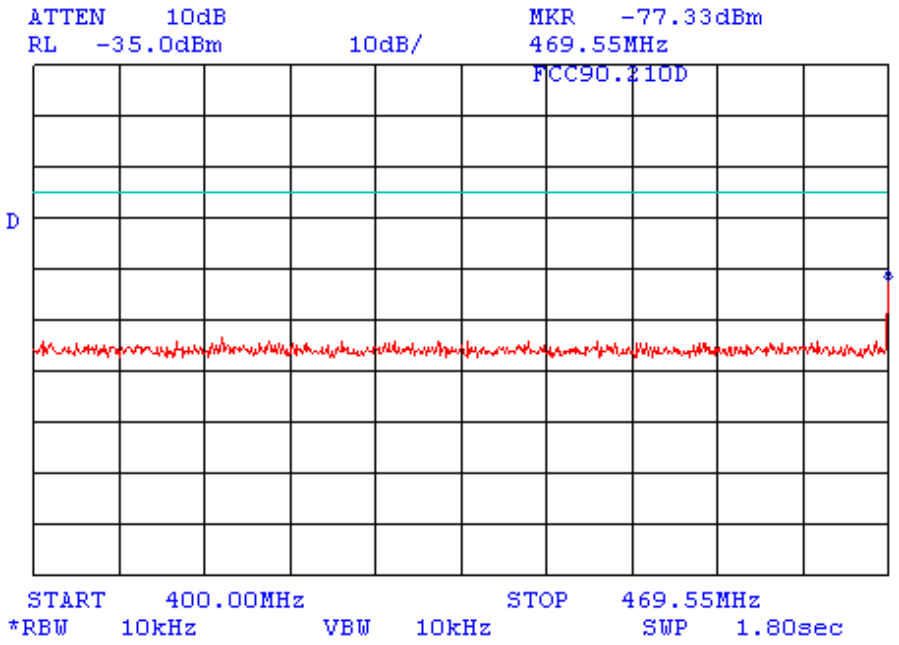
Plot 3.3.28
Conducted spurious emissions measurement test results

F=469.600 MHz
External attenuation = 20 dB



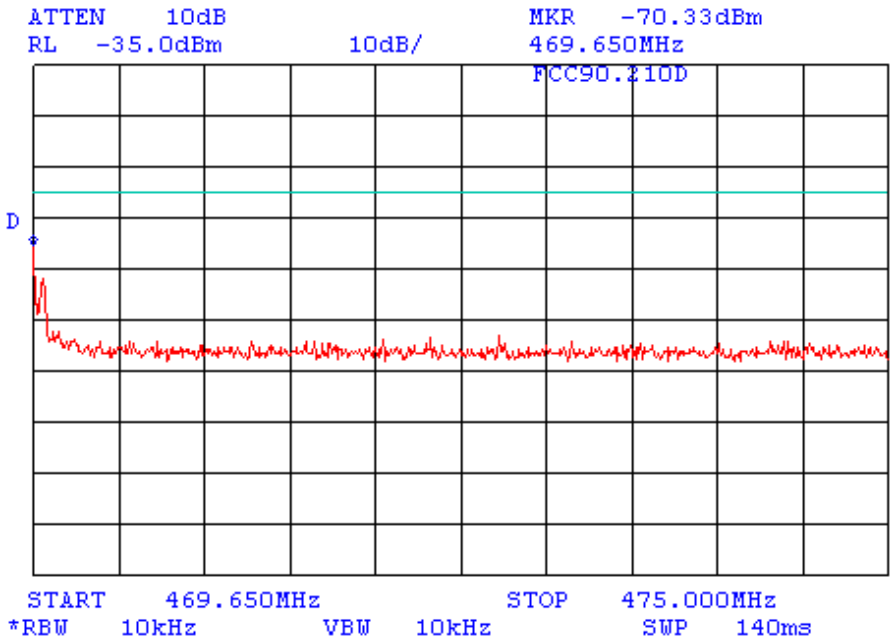
Plot 3.3.29
Conducted spurious emissions measurement test results

F=469.600 MHz
External attenuation = 40 dB



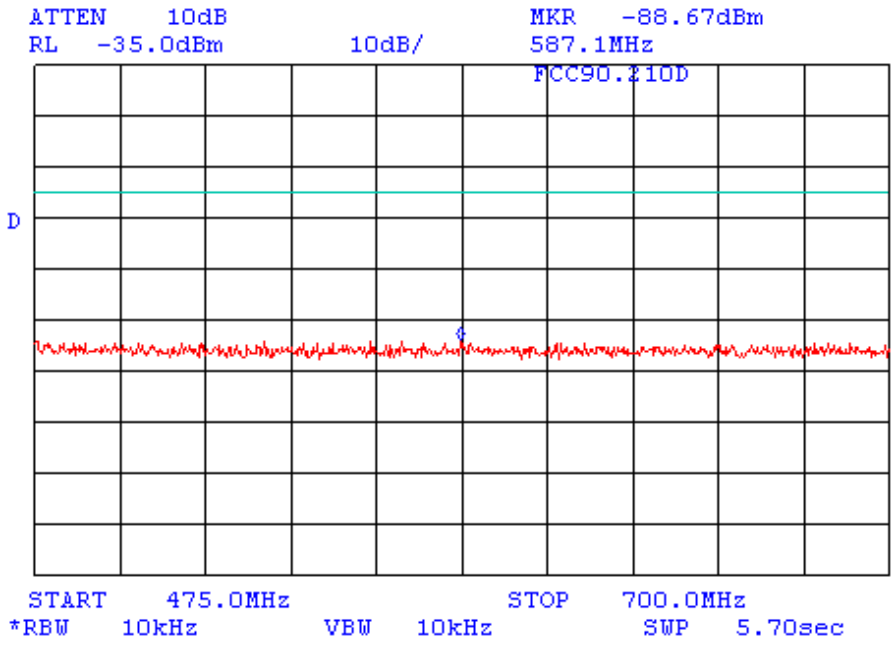
Plot 3.3.30
Conducted spurious emissions measurement test results

F=469.600 MHz
External attenuation = 40 dB



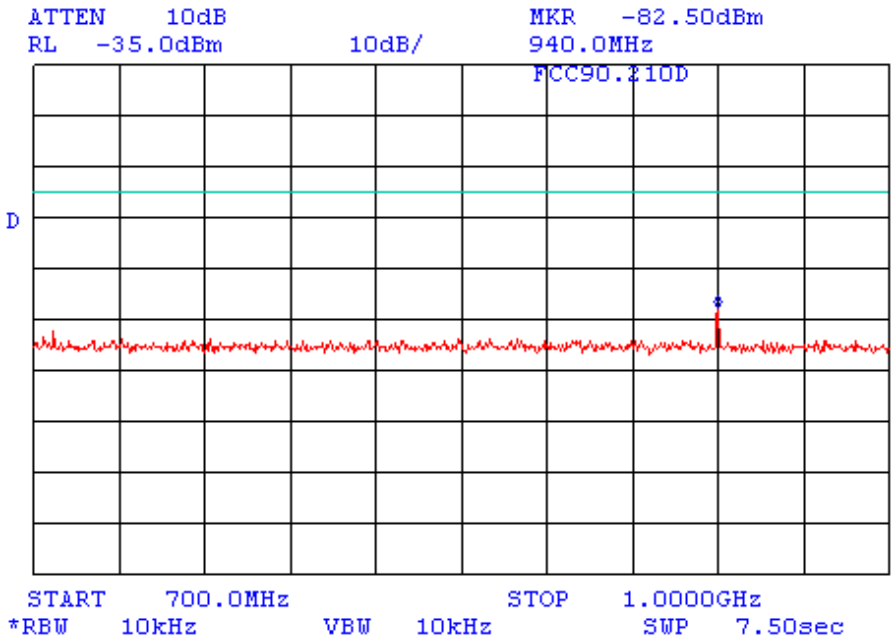
Plot 3.3.31
Conducted spurious emissions measurement test results

F=469.600 MHz
External attenuation = 40 dB



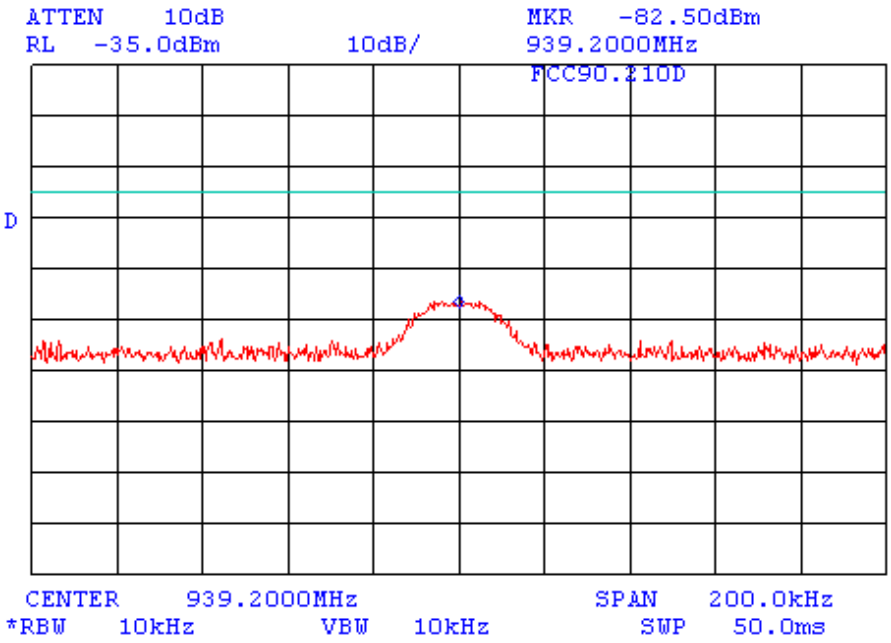
Plot 3.3.32
Conducted spurious emissions measurement test results

F=469.600 MHz
External attenuation = 40 dB



Plot 3.3.33
Conducted spurious emissions measurement test results

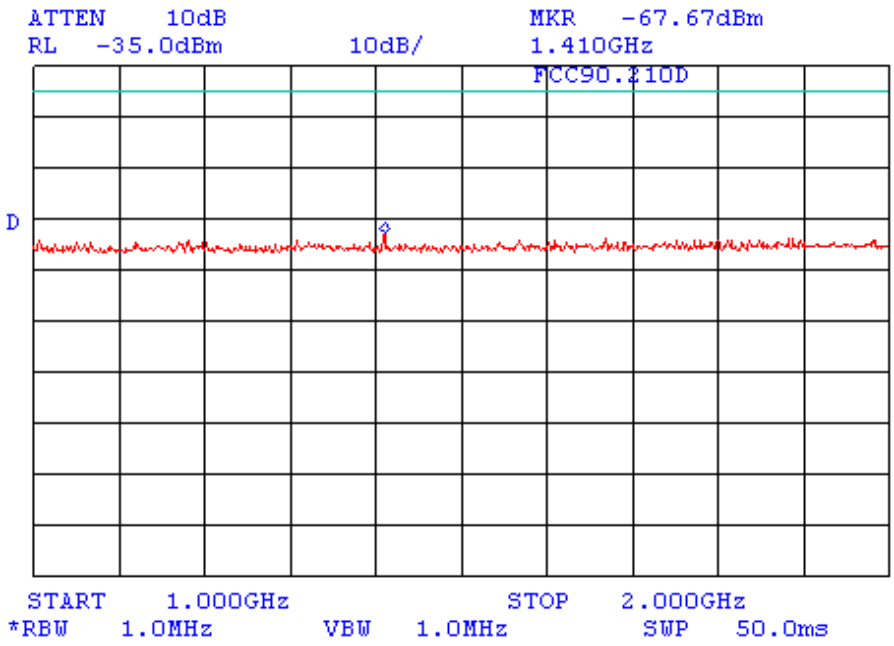
F=469.600 MHz
External attenuation = 40 dB



F=939.2 MHz P=-82.5 dBm +40 dB=-42.5 dBm

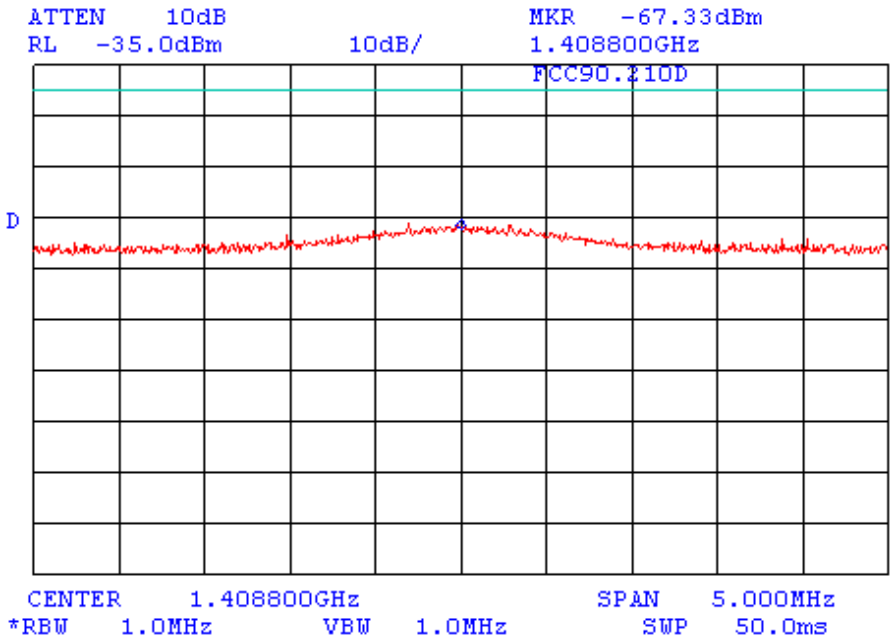
Plot 3.3.34
Conducted spurious emissions measurement test results

F=469.600 MHz
External attenuation = 20 dB



Plot 3.3.35
Conducted spurious emissions measurement test results

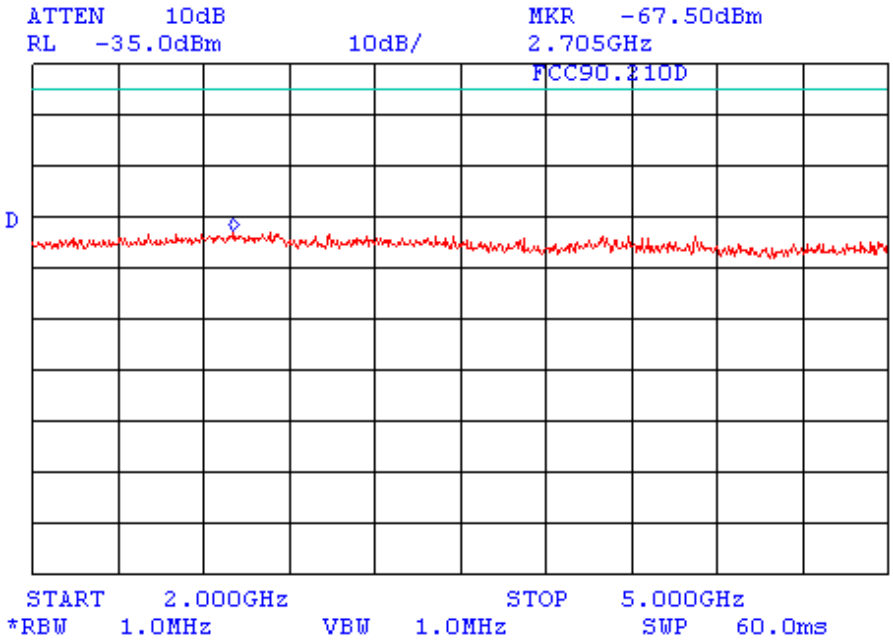
F=469.600 MHz
External attenuation = 20 dB



F=1408.8 MHz P=-67.33 dBm +20 dB =-47.33 dBm

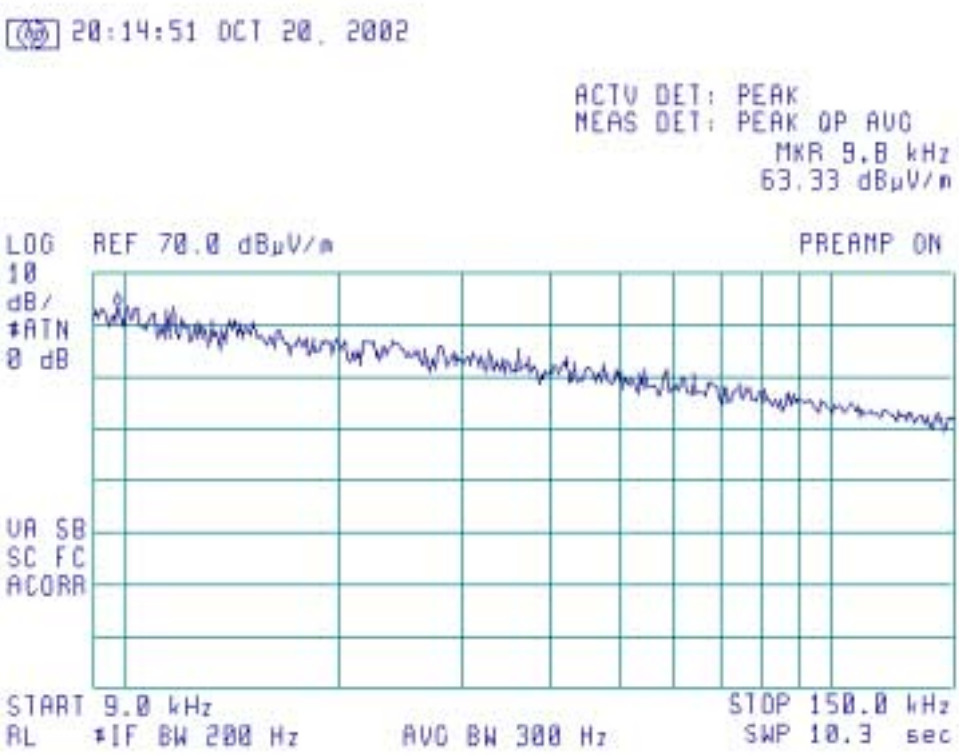
Plot 3.3.36
Conducted spurious emissions measurement test results

F=469.600 MHz
External attenuation = 20 dB



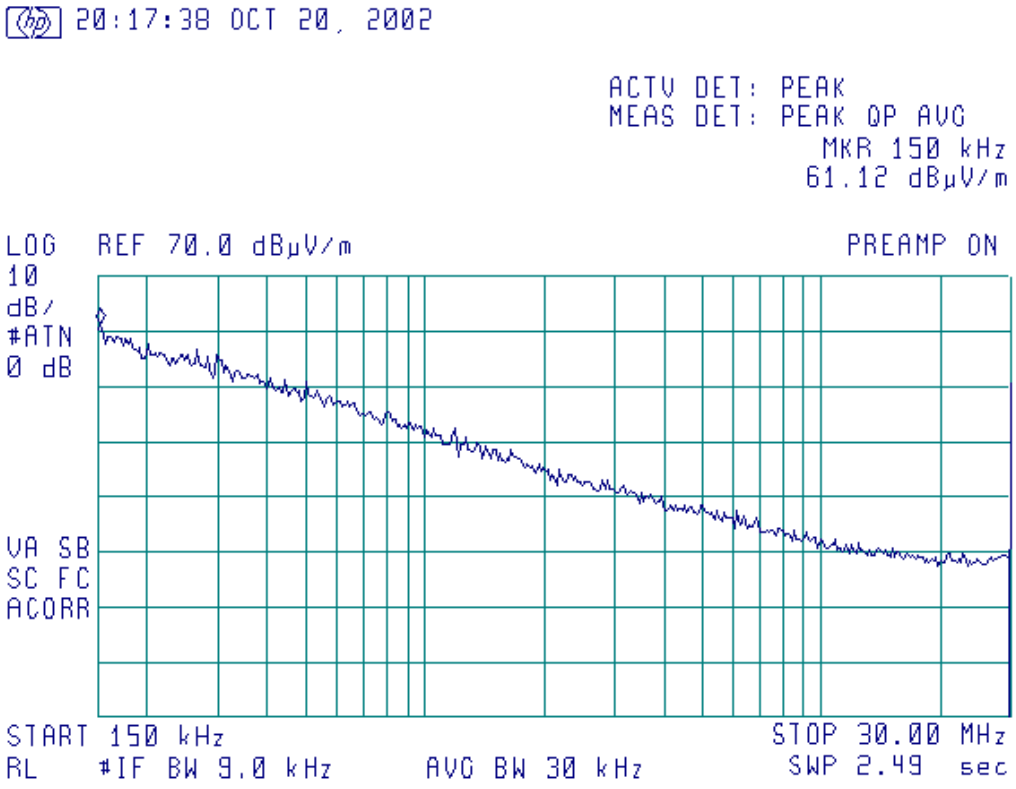
Plot 3.3.37
Radiated spurious emissions measurement test results

F=450.400 MHz



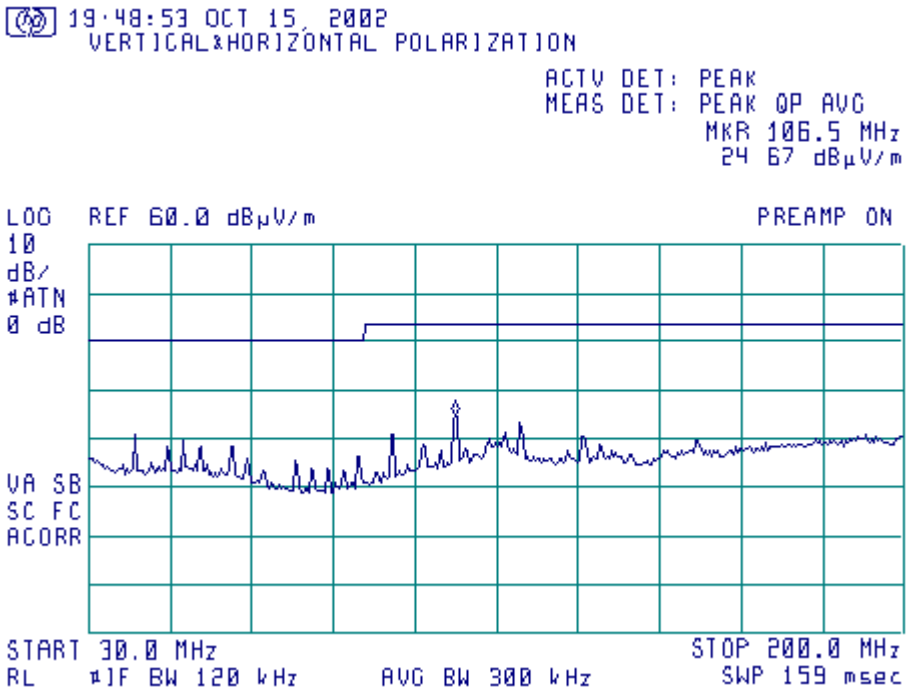
Plot 3.3.38
Radiated spurious emissions measurement test results

F=450.400 MHz



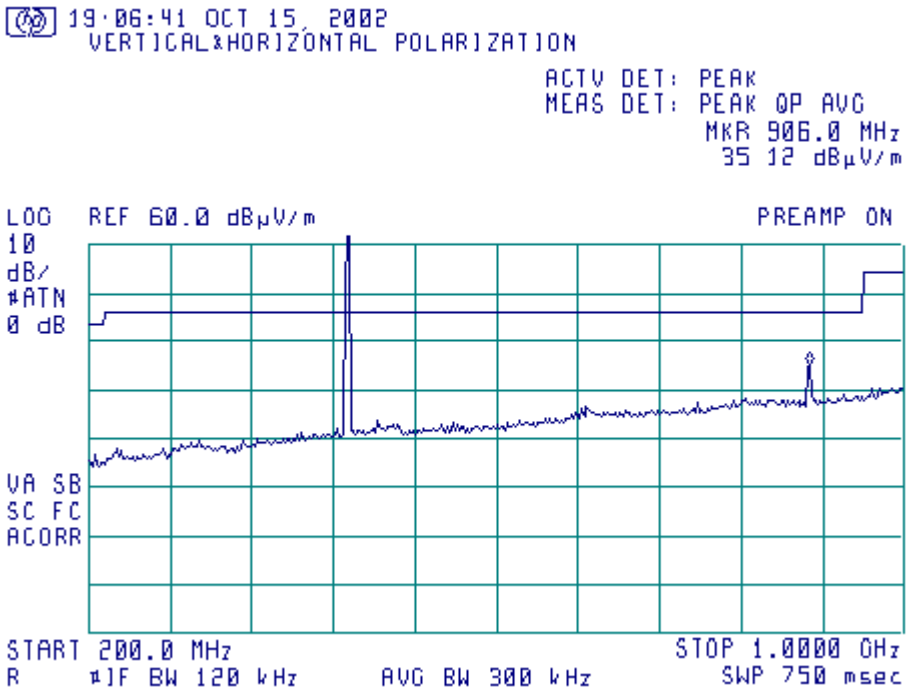
Plot 3.3.39
Radiated spurious emissions measurement test results

F=450.400 MHz



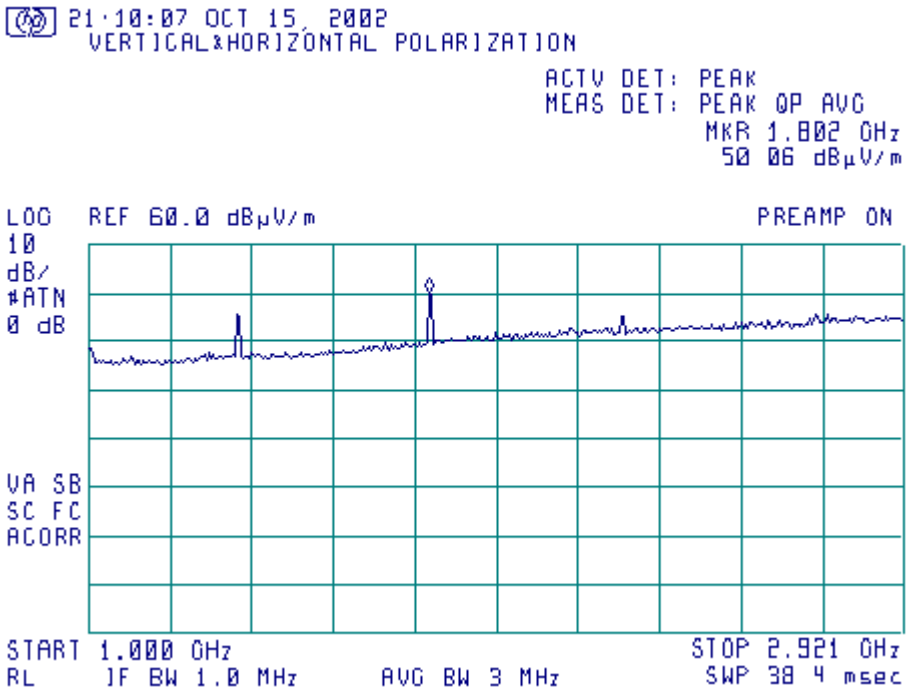
Plot 3.3.40
Radiated spurious emissions measurement test results

F=450.400 MHz



Plot 3.3.41
Radiated spurious emissions measurement test results

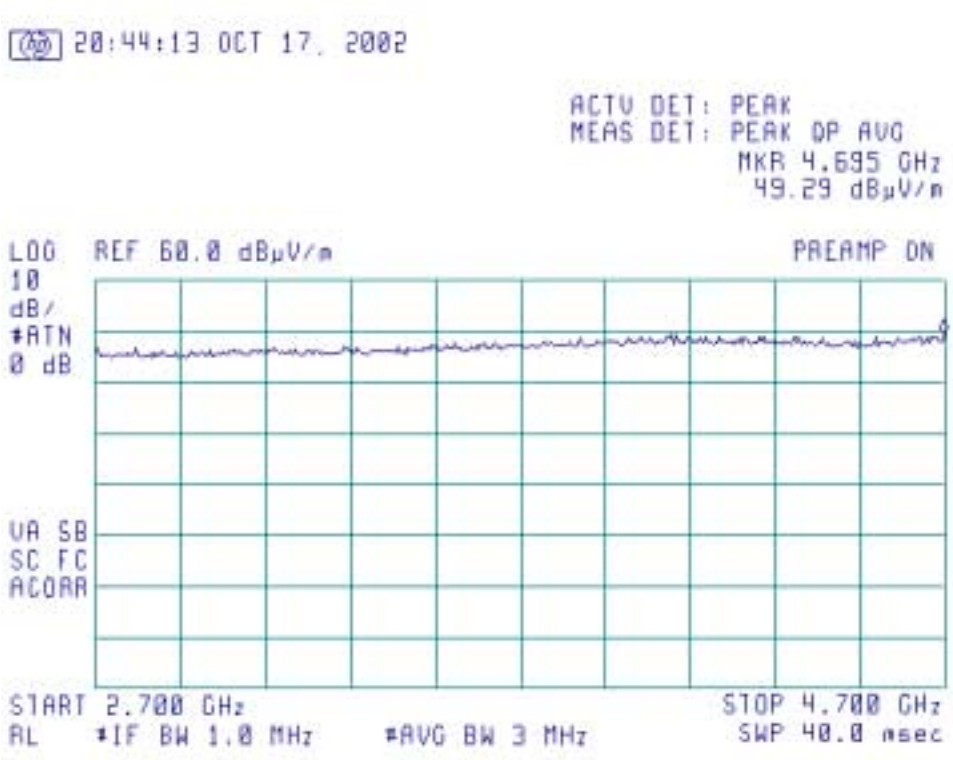
F=450.400 MHz



The 3rd, 4th and 5th harmonics of fundamental – refer to Table 3.3.1.

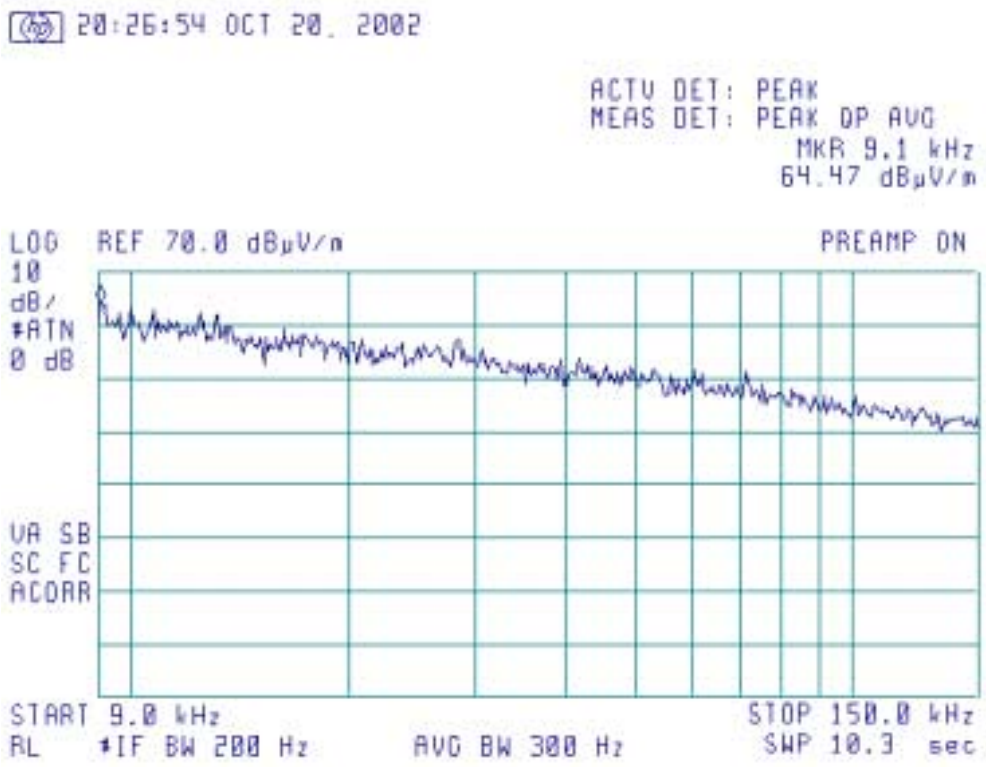
Plot 3.3.42
Radiated spurious emissions measurement test results

F=450.400 MHz



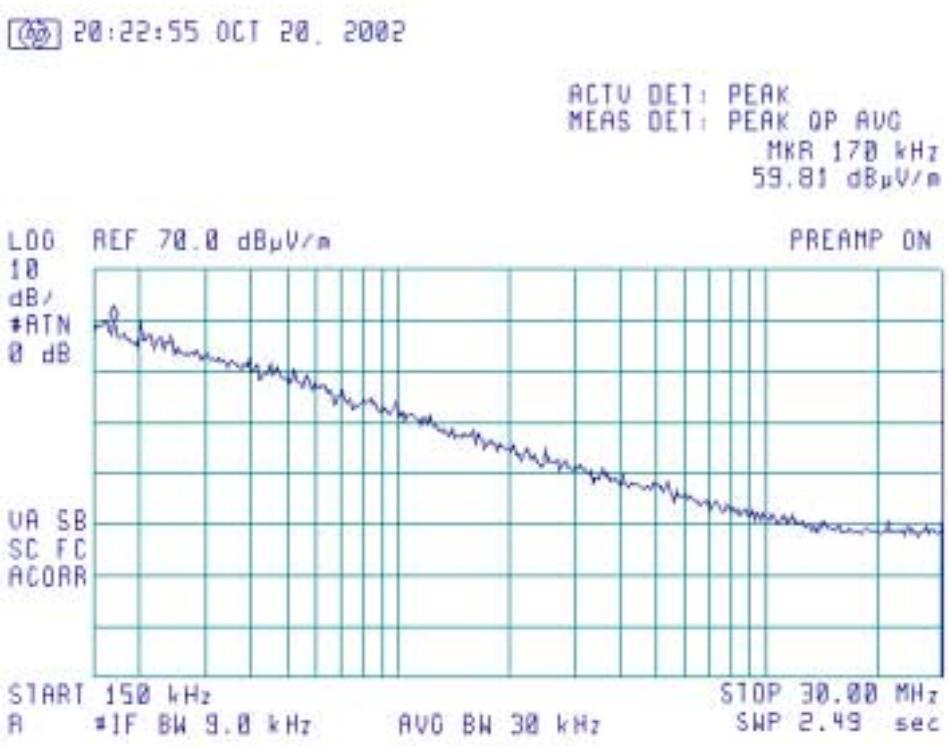
Plot 3.3.43
Radiated spurious emissions measurement test results

F=460.000 MHz



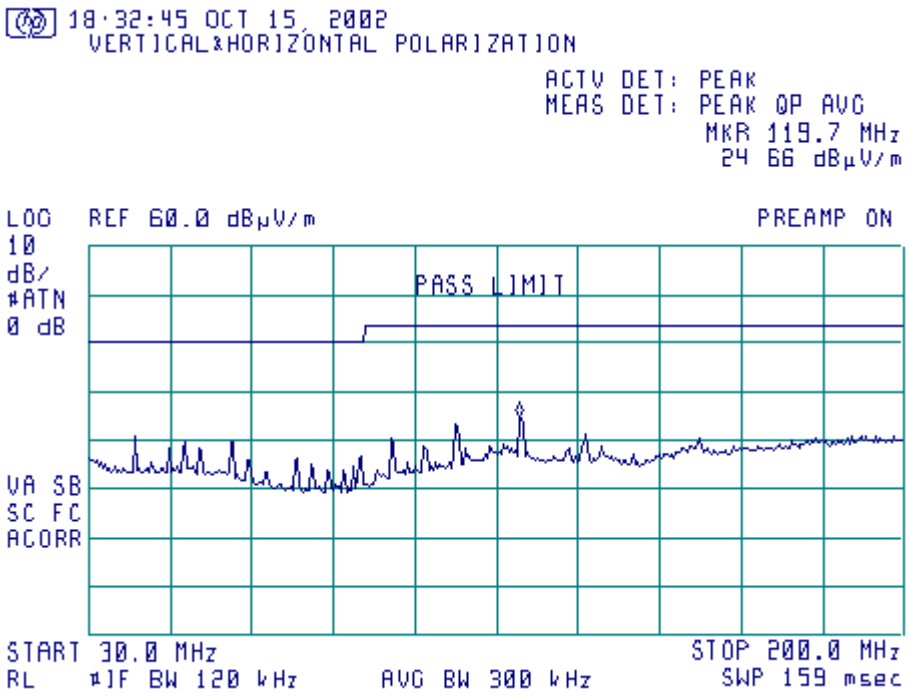
Plot 3.3.44
Radiated spurious emissions measurement test results

F=460.000 MHz



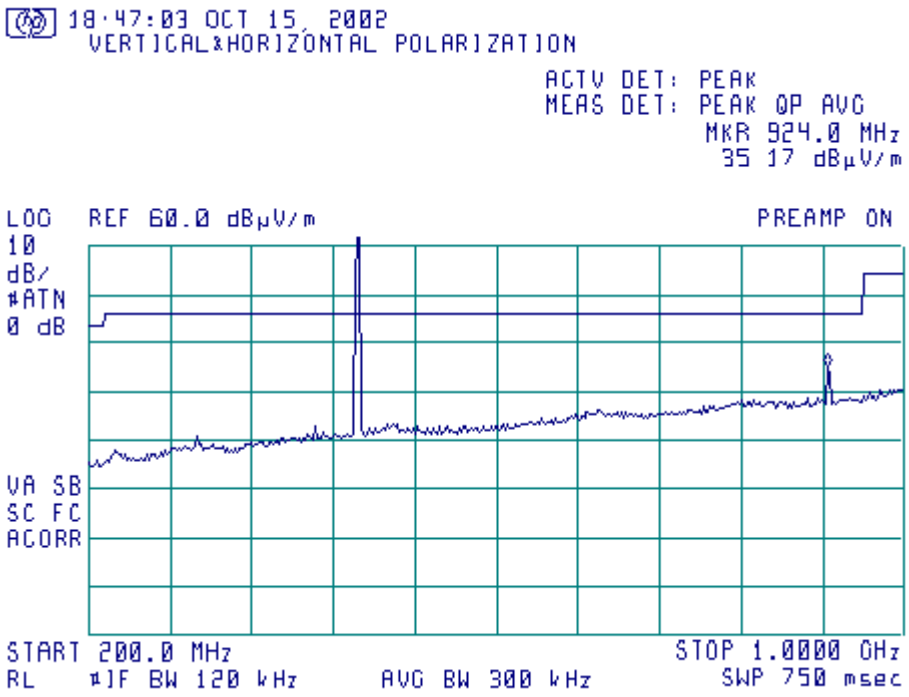
Plot 3.3.45
Radiated spurious emissions measurement test results

F=460.000 MHz



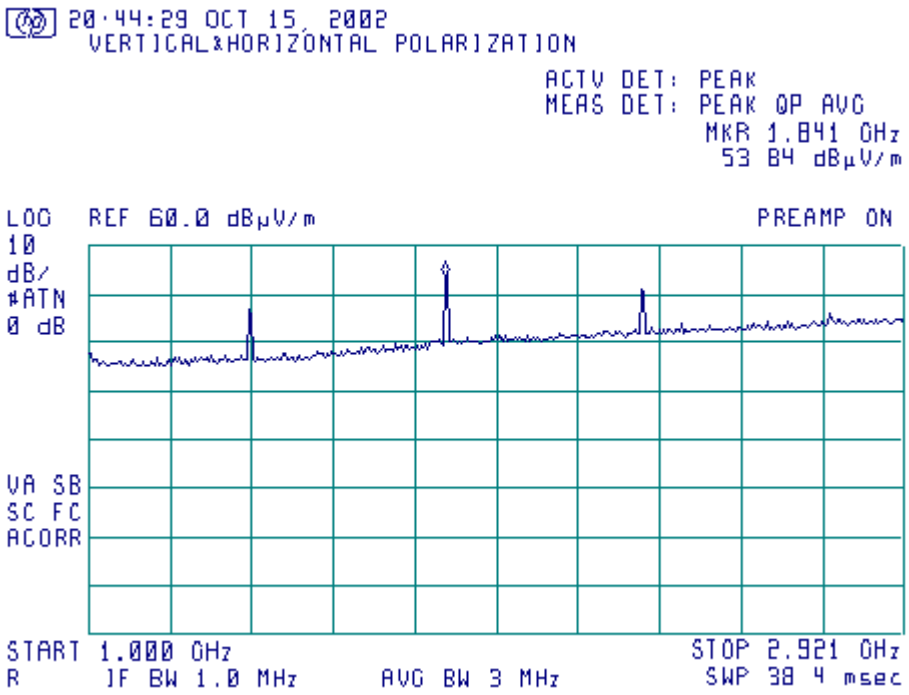
Plot 3.3.46
Radiated spurious emissions measurement test results

F=460.000 MHz



Plot 3.3.47
Radiated spurious emissions measurement test results

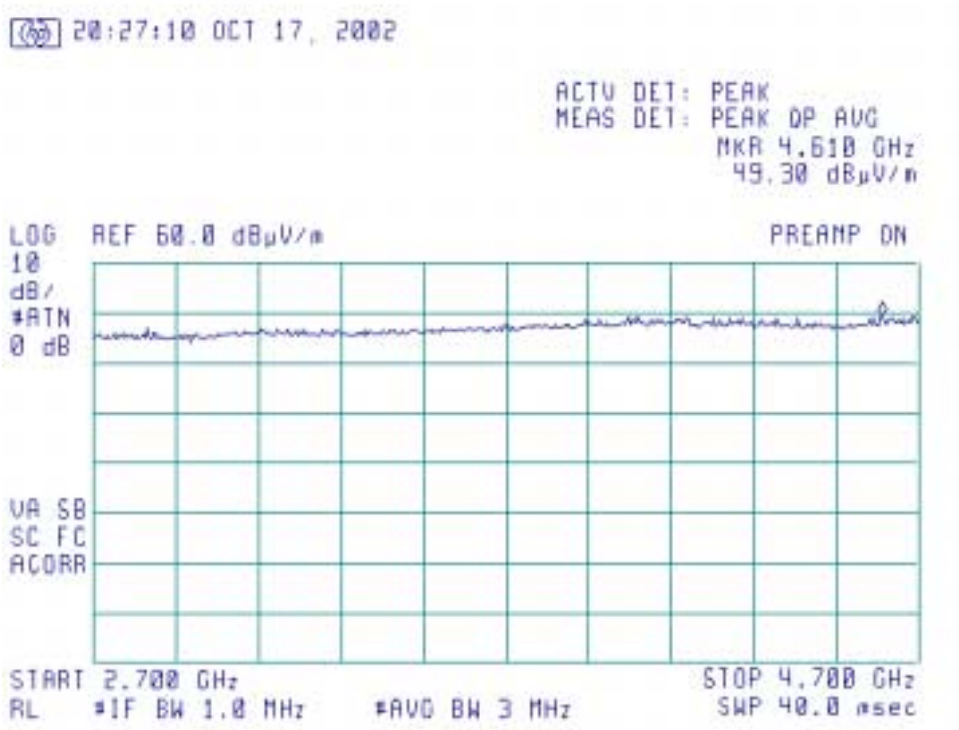
F=460.000 MHz



The 3rd, 4th and 5th harmonics of fundamental – refer to Table 3.3.1.

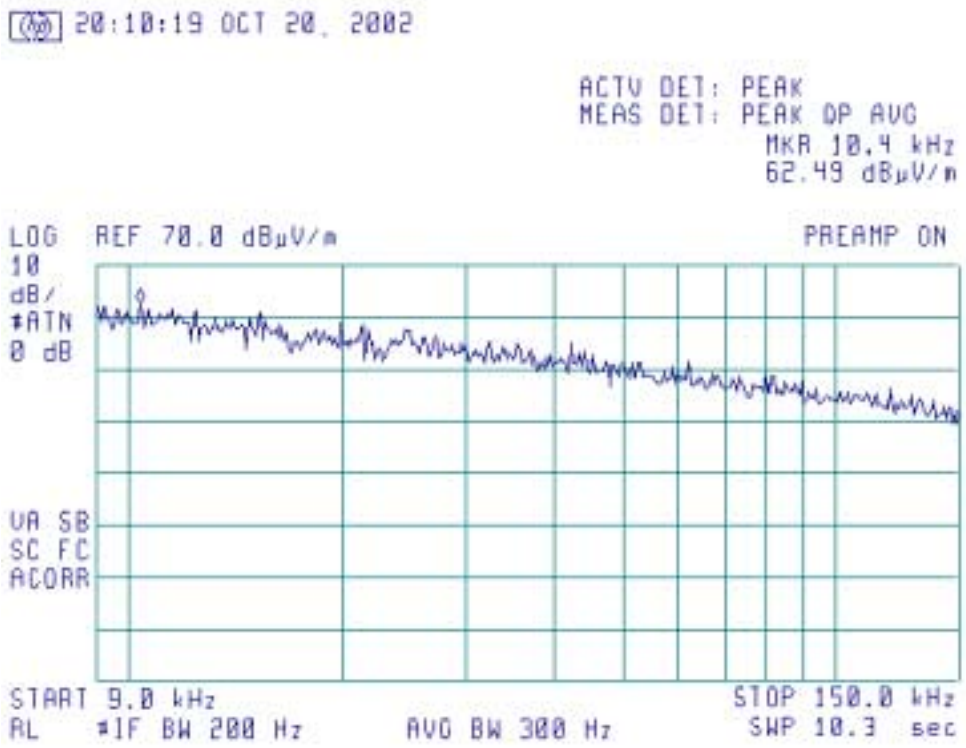
Plot 3.3.48
Radiated spurious emissions measurement test results

F=460.000 MHz



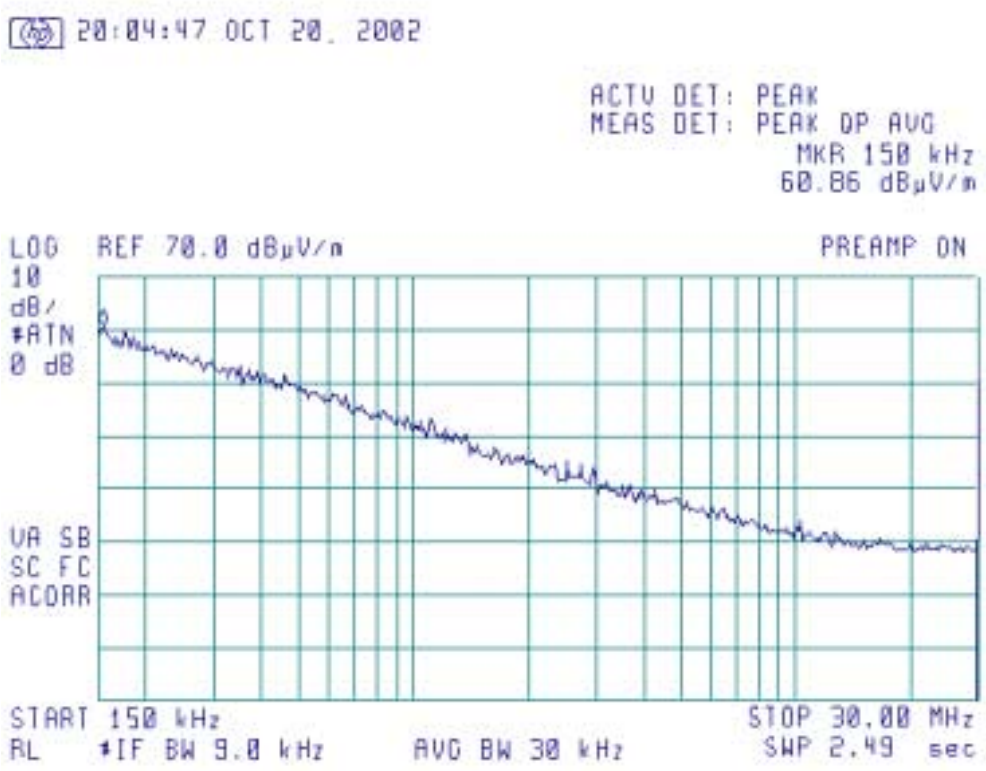
Plot 3.3.49
Radiated spurious emissions measurement test results

F=469.600 MHz



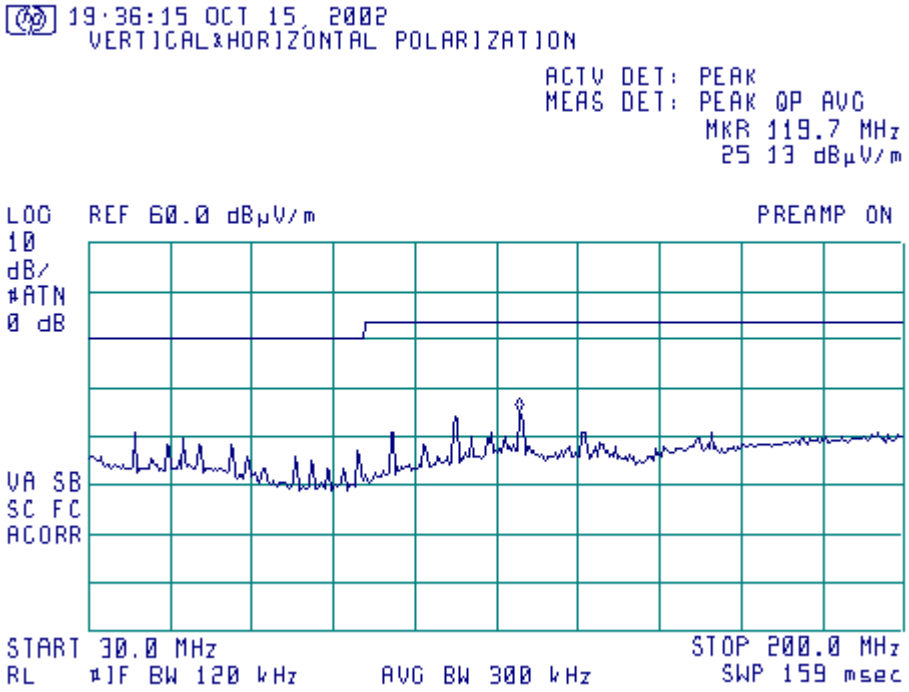
Plot 3.3.50
Radiated spurious emissions measurement test results

F=469.600 MHz



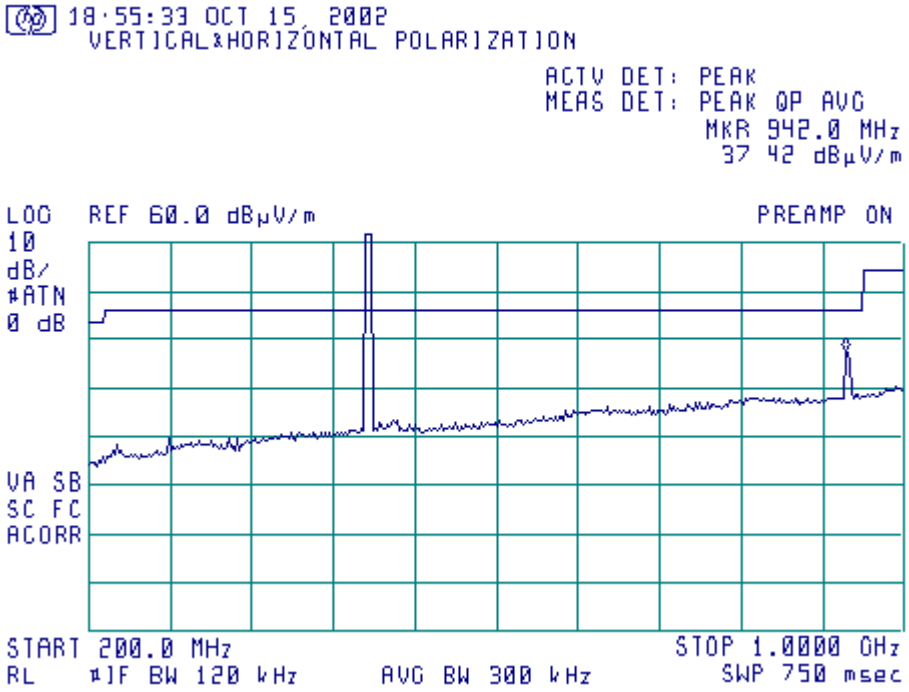
Plot 3.3.51
Radiated spurious emissions measurement test results

F=469.600 MHz



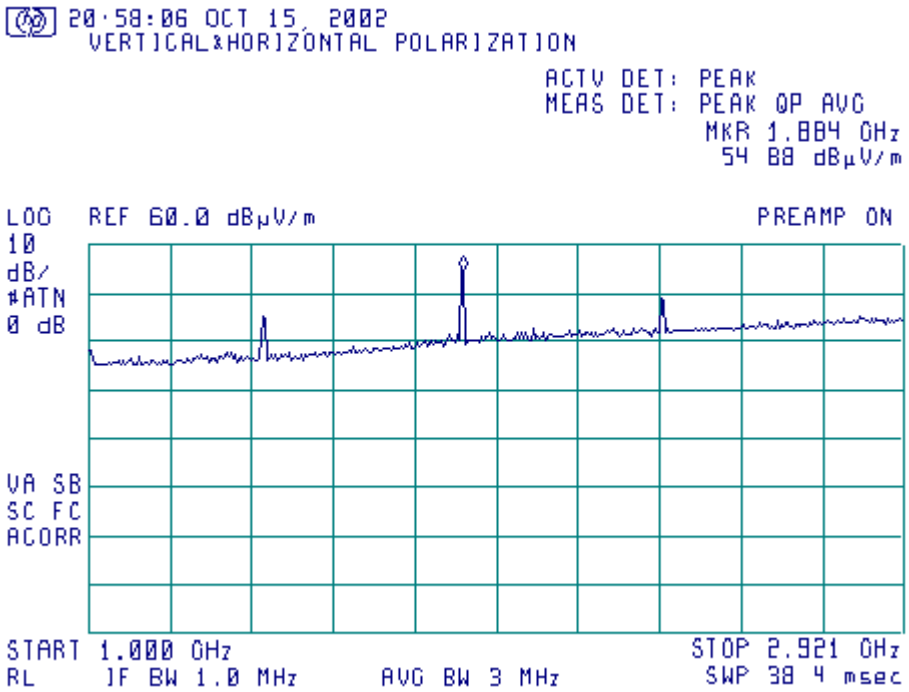
Plot 3.3.52
Radiated spurious emissions measurement test results

F=469.600 MHz



Plot 3.3.53
Radiated spurious emissions measurement test results

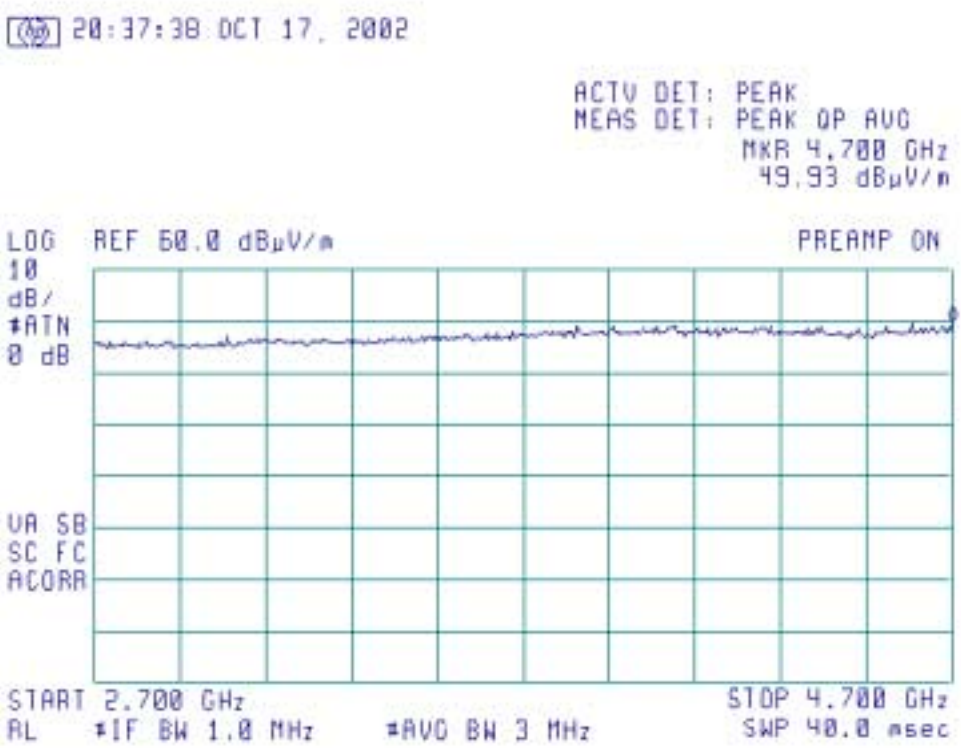
F=469.600 MHz



The 3rd, 4th and 5th harmonics of fundamental – refer to Table 3.3.1.

Plot 3.3.54
Radiated spurious emissions measurement test results

F=469.600 MHz



3.4 Frequency stability measurements according to FCC part 90 paragraph 213

3.4.1 General

According to paragraph 90.213, the frequency stability limit (in parts per million) for equipment with a 12.5 kHz channel bandwidth in frequency range 450 – 470 MHz is 2.5 ppm.
For frequency 450 400 140 Hz the specified limit is ±1126 Hz
460 000 140 Hz - ±1150 Hz
469 600 150 Hz - ±1174 Hz.

3.4.2 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 3.4.1 to 3.4.6. The maximum measured displacement was 1000 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 3.4.1
Frequency stability test results vs supply voltage
Frequency: 450.400 110 MHz, limit: ±1126 Hz

Temperature: 20°C

Voltage, V	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
Ucc=12 V	450 400 120	+10	startup	Pass
	450 400 120	+10	+2	Pass
	450 400 110	0	+5	Pass
	450 400 110	0	+10	Pass
Ucc=9 V	450 400 110	0	startup	Pass
	450 400 100	-10	+2	Pass
	450 400 100	-10	+5	Pass
	450 400 100	-10	+10	Pass
Ucc=15 V	450 400 110	0	startup	Pass
	450 400 110	0	+2	Pass
	450 400 110	0	+5	Pass
	450 400 110	0	+10	Pass

Reference frequency: 450 400 110 Hz

Table 3.4.2
Frequency stability test results vs ambient temperature
Reference frequency: 450 400 110 Hz, limit: ±1126 Hz

Temperature, °C	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
t°=30°C	450 399 970	-140	startup	Pass
	450 399 960	-150	+2	Pass
	450 399 960	-150	+5	Pass
	450 399 970	-140	+10	Pass
t°=40°C	450 399 880	-230	startup	Pass
	450 399 880	-230	+2	Pass
	450 399 880	-230	+5	Pass
	450 399 880	-230	+10	Pass
t°=50°C	450 400 600	490	startup	Pass
	450 400 590	480	+2	Pass
	450 400 580	470	+5	Pass
	450 400 570	460	+10	Pass
t°=10°C	450 400 160	50	startup	Pass
	450 400 150	40	+2	Pass
	450 400 150	40	+5	Pass
	450 400 150	40	+10	Pass
t°=0°C	450 400 300	190	startup	Pass
	450 400 310	200	+2	Pass
	450 400 300	190	+5	Pass
	450 400 300	190	+10	Pass
t°=-10°C	450 401 060	950	startup	Pass
	450 401 070	960	+2	Pass
	450 401 070	960	+5	Pass
	450 401 070	960	+10	Pass
t°=-20°C	450 400 890	780	startup	Pass
	450 400 840	730	+2	Pass
	450 400 860	750	+5	Pass
	450 400 860	750	+10	Pass
t°=-30°C	450 400 520	410	startup	Pass
	450 400 510	400	+2	Pass
	450 400 490	380	+5	Pass
	450 400 460	350	+10	Pass

Table 3.4.3
Frequency stability test results vs supply voltage
Frequency: 460 000 120 MHz, limit: ±1150 Hz

Temperature: 20°C

Voltage, V	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
Ucc=12 V	460 000 040	-80	startup	Pass
	460 000 060	-60	+2	Pass
	460 000 100	-20	+5	Pass
	460 000 120	0	+10	Pass
Ucc=9 V	460 000 140	+20	startup	Pass
	460 000 140	+20	+2	Pass
	460 000 130	+10	+5	Pass
	460 000 120	0	+10	Pass
Ucc=15 V	460 000 130	+10	startup	Pass
	460 000 130	+10	+2	Pass
	460 000 130	+10	+5	Pass
	460 000 130	+10	+10	Pass

Reference frequency: 460.000120 Hz

Table 3.4.4
Frequency stability test results vs ambient temperature
Reference frequency: 460 000 120 Hz, limit: ±1150 Hz

Temperature, °C	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
t°=30°C	459 999 990	-130	startup	Pass
	459 999 980	-140	+2	Pass
	459 999 990	-130	+5	Pass
	459 999 990	-130	+10	Pass
t°=40°C	459 999 880	-240	startup	Pass
	459 999 870	-250	+2	Pass
	459 999 860	-260	+5	Pass
	459 999 850	-270	+10	Pass
t°=50°C	460 000 680	560	startup	Pass
	460 000 640	520	+2	Pass
	460 000 590	470	+5	Pass
	460 000 560	440	+10	Pass
t°=10°C	460 000 150	30	startup	Pass
	460 000 150	30	+2	Pass
	460 000 150	30	+5	Pass
	460 000 140	20	+10	Pass
t°=0°C	460 000 500	380	startup	Pass
	460 000 460	340	+2	Pass
	460 000 420	300	+5	Pass
	460 000 390	270	+10	Pass
t°=-10°C	460 001 110	990	startup	Pass
	460 001 110	990	+2	Pass
	460 001 110	990	+5	Pass
	460 001 100	980	+10	Pass
t°=-20°C	460 000 830	710	startup	Pass
	460 000 830	710	+2	Pass
	460 000 820	700	+5	Pass
	460 000 840	720	+10	Pass
t°=-30°C	460 000 510	390	startup	Pass
	459 999 640	-480	+2	Pass
	460 000 520	400	+5	Pass
	460 000 500	380	+10	Pass

Table 3.4.5
Frequency stability test results vs supply voltage
Frequency: 469.600 130 MHz, limit: ±1174 Hz

Temperature: 22°C

Voltage, V	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
Ucc=12 V	469 600 14	+10	startup	Pass
	469 600 14	+10	+2	Pass
	469 600 13	0	+5	Pass
	469 600 13	0	+10	Pass
Ucc=9 V	469 600 12	-10	startup	Pass
	469 600 13	0	+2	Pass
	469 600 13	0	+5	Pass
	469 600 13	0	+10	Pass
Ucc=15 V	469 600 13	0	startup	Pass
	469 600 13	0	+2	Pass
	469 600 13	0	+5	Pass
	469 600 13	0	+10	Pass

Reference frequency: 469.600 130 Hz

Table 3.4.6
Frequency stability test results vs ambient temperature
Reference frequency: 469.600 130 Hz, limit: ±1174 Hz

Temperature, °C	Frequency, Hz	Displacement, Hz	Time, min	Pass/ Fail
t°=30°C	469 599 970	-160	startup	Pass
	469 599 960	-170	+2	Pass
	469 599 960	-170	+5	Pass
	469 599 960	-170	+10	Pass
t°=40°C	469 599 870	-260	startup	Pass
	469 599 860	-270	+2	Pass
	469 599 860	-270	+5	Pass
	469 599 860	-270	+10	Pass
t°=50°C	469 600 610	480	startup	Pass
	469 600 590	460	+2	Pass
	469 600 580	450	+5	Pass
	469 600 570	440	+10	Pass
t°=10°C	469 600 150	20	startup	Pass
	469 600 160	30	+2	Pass
	469 600 160	30	+5	Pass
	469 600 160	30	+10	Pass
t°=0°C	469 600 370	240	startup	Pass
	469 600 350	220	+2	Pass
	469 600 350	220	+5	Pass
	469 600 350	220	+10	Pass
t°=-10°C	469 601 120	990	startup	Pass
	469 601 130	1000	+2	Pass
	469 601 130	1000	+5	Pass
	469 601 130	1000	+10	Pass
t°=-20°C	469 600 920	790	startup	Pass
	469 600 900	770	+2	Pass
	469 600 910	780	+5	Pass
	469 600 900	770	+10	Pass
t°=-30°C	469 600 570	440	startup*	Pass
	469 600 540	410	+2	Pass
	469 600 510	380	+5	Pass
	469 600 490	360	+10	Pass

3.5 Transient frequency behavior according to FCC part 90 paragraph 214

3.5.1 General

Transmitters designed to operate in 450 – 470 MHz frequency range with 12.5 kHz channels must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time interval [1,2]	Maximum frequency difference[3]
t_1=10 ms [4]	12.5 kHz
t_2=25 ms	6.25 kHz
t_3=10 ms [4]	12.5 kHz

[1] – t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing

t_1 is the time period immediately following t_{on}

t_2 is the time period immediately following t_1

t_3 is the time period from the instant when the transmitter is turned off until t_{off}

t_{off} is the instant when the 1 kHz test signal starts to rise.

[2] – 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 FCC part 90 §90.213.

[3] – Difference between the actual transmitter frequency and the assigned transmitter frequency.

[4] - The frequency difference during this time period may exceed the maximum frequency difference for this time period because the transmitter carrier output power rating is less than 6 watts.

3.5.2 Test procedure

The EUT was setup as shown in Photograph 3.5.1. The transmitter was activated, the signal trace was observed. The frequency was maintained within allowable limits during t_1=10 ms and t_2=25 ms, also it remained within limits following t_2. The test results were recorded in Plots 3.5.1, 3.5.2, 3.5.4 and 3.5.6.
The transmitter was turned off and the frequency behavior was observed. The test results were recorded in Plots 3.5.3, 3.5.5 and 3.5.7.

The EUT was found to comply with the standard requirements.

Reference numbers of test equipment used

0539	0670	0783	0793	1508	1509	1518	1521
1527	2227						

Full description is in Appendix A.

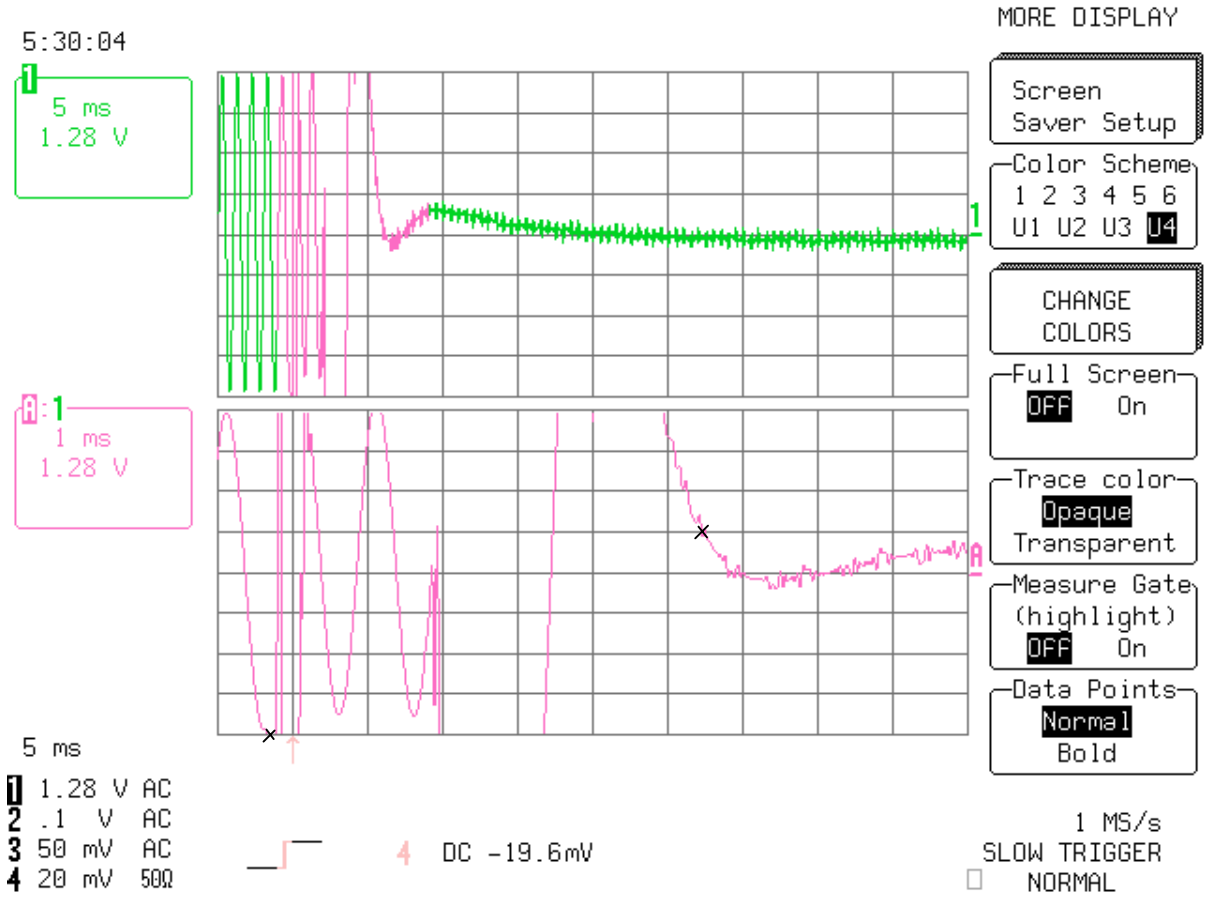
Table 3.5.1 Transient frequency behavior test results

TEST SPECIFICATION: 47CFR part 90, section 90.214
DATE: October 16, 2002
RELATIVE HUMIDITY: 43%
AMBIENT TEMPERATURE: 25°C
AIR PRESSURE: 1009 hPa

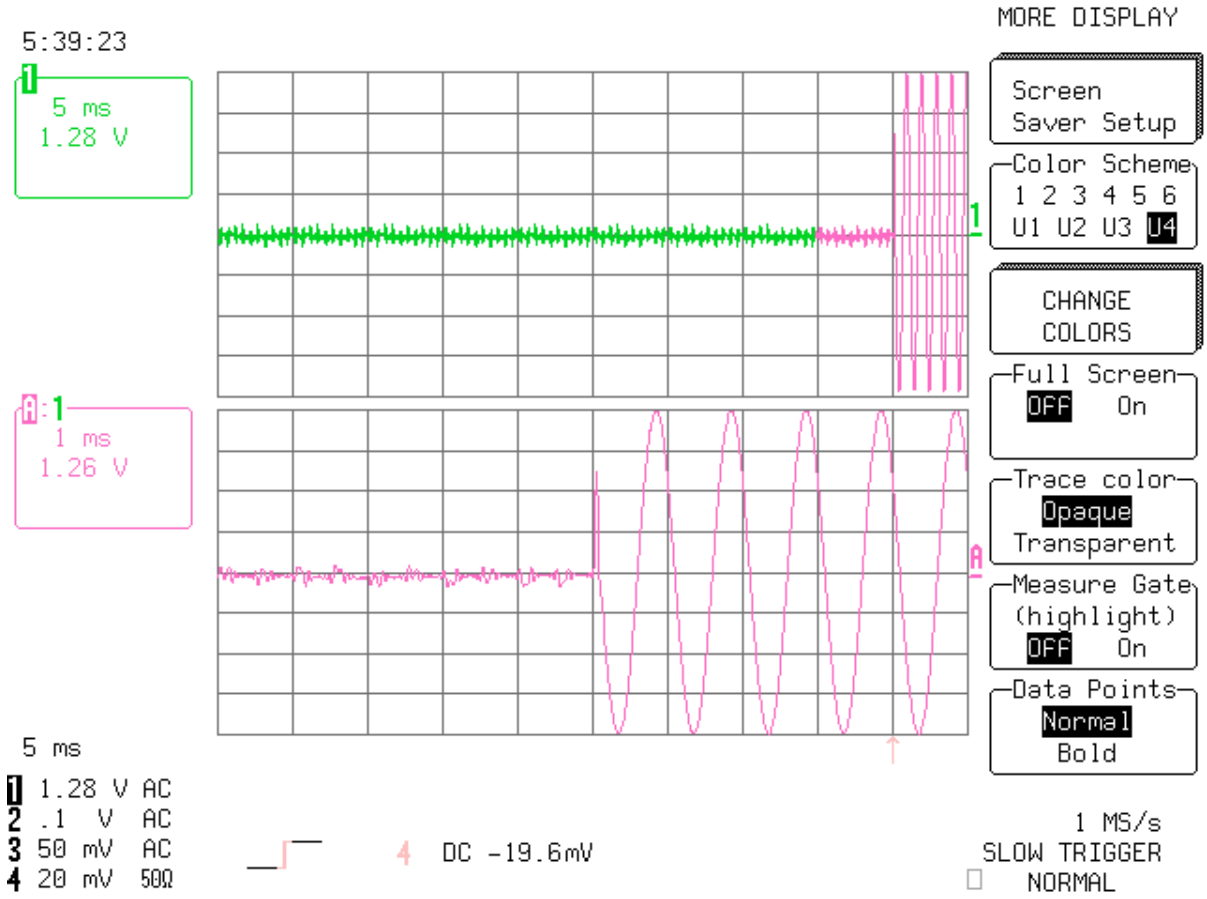
Frequency, MHz	Maximum frequency difference, kHz	Measured time interval, ms	Limit, ms	Refer to plot	Verdict
450.4	12.5*	t_1 = 5.84	10	3.5.1	Pass
	6.25	t_2 = NA	25	3.5.1	Pass
	12.5*	t_3 = 0.084	10	3.5.2	Pass
460.0	12.5*	t_1 = 6.56	10	3.5.3	Pass
	6.25	t_2 = NA	25	3.5.3	Pass
	12.5*	t_3 = 0.096	10	3.5.4	Pass
469.6	12.5*	t_1 = 6.64	10	3.5.5	Pass
	6.25	t_2 = NA	25	3.5.5	Pass
	12.5*	t_3 = 0.12	10	3.5.6	Pass

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

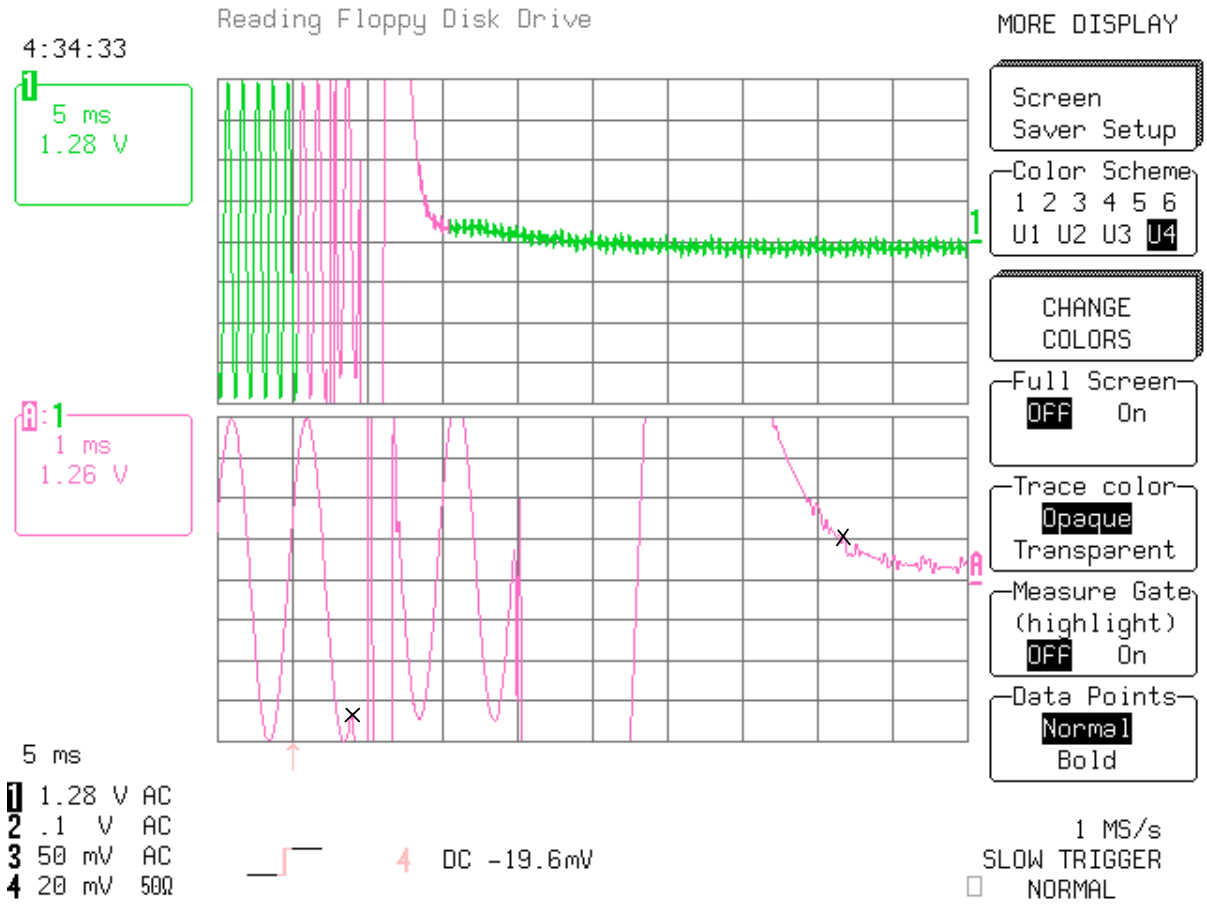
Plot 3.5.1
Transient frequency behavior @ Tx on
at 450.4 MHz



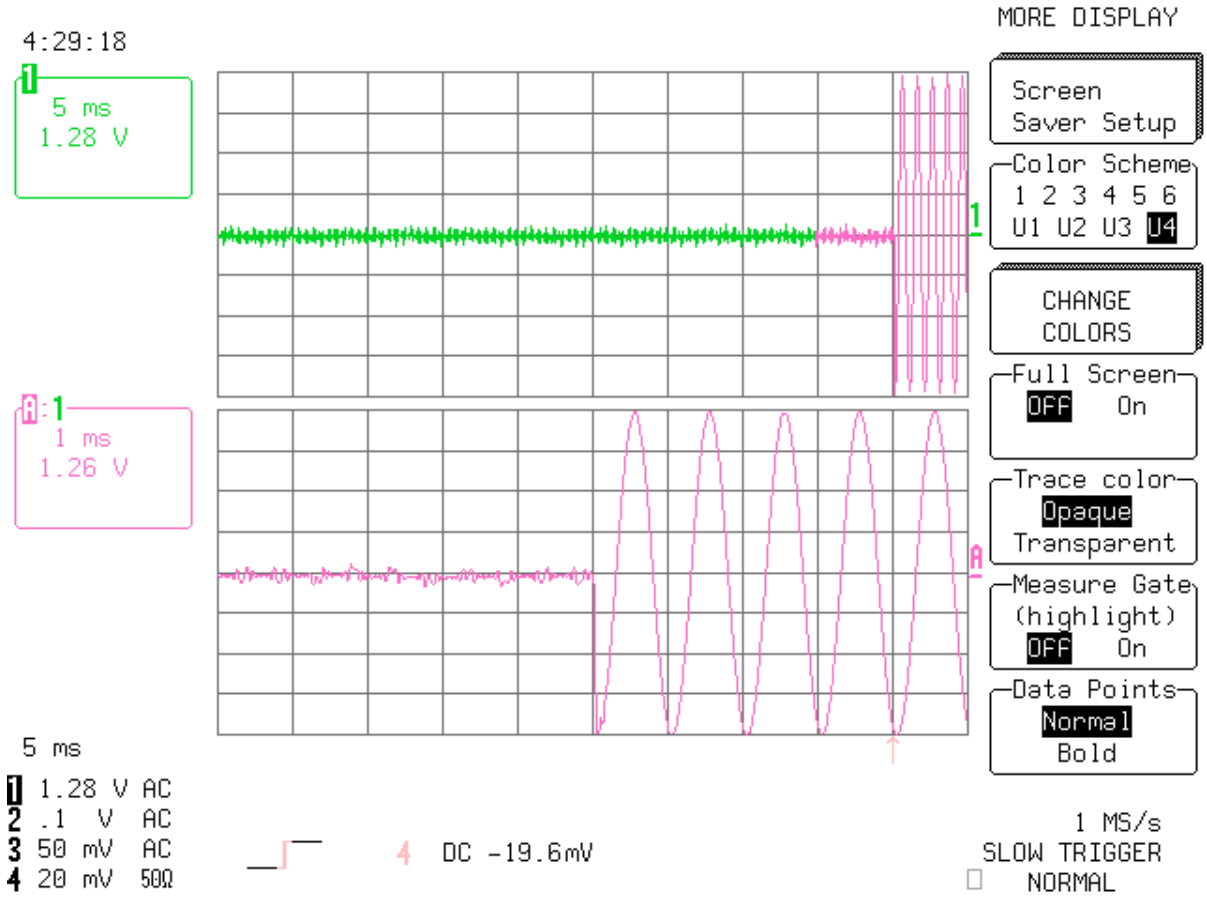
Plot 3.5.2
Transient frequency behavior @ Tx off
at 450.4 MHz



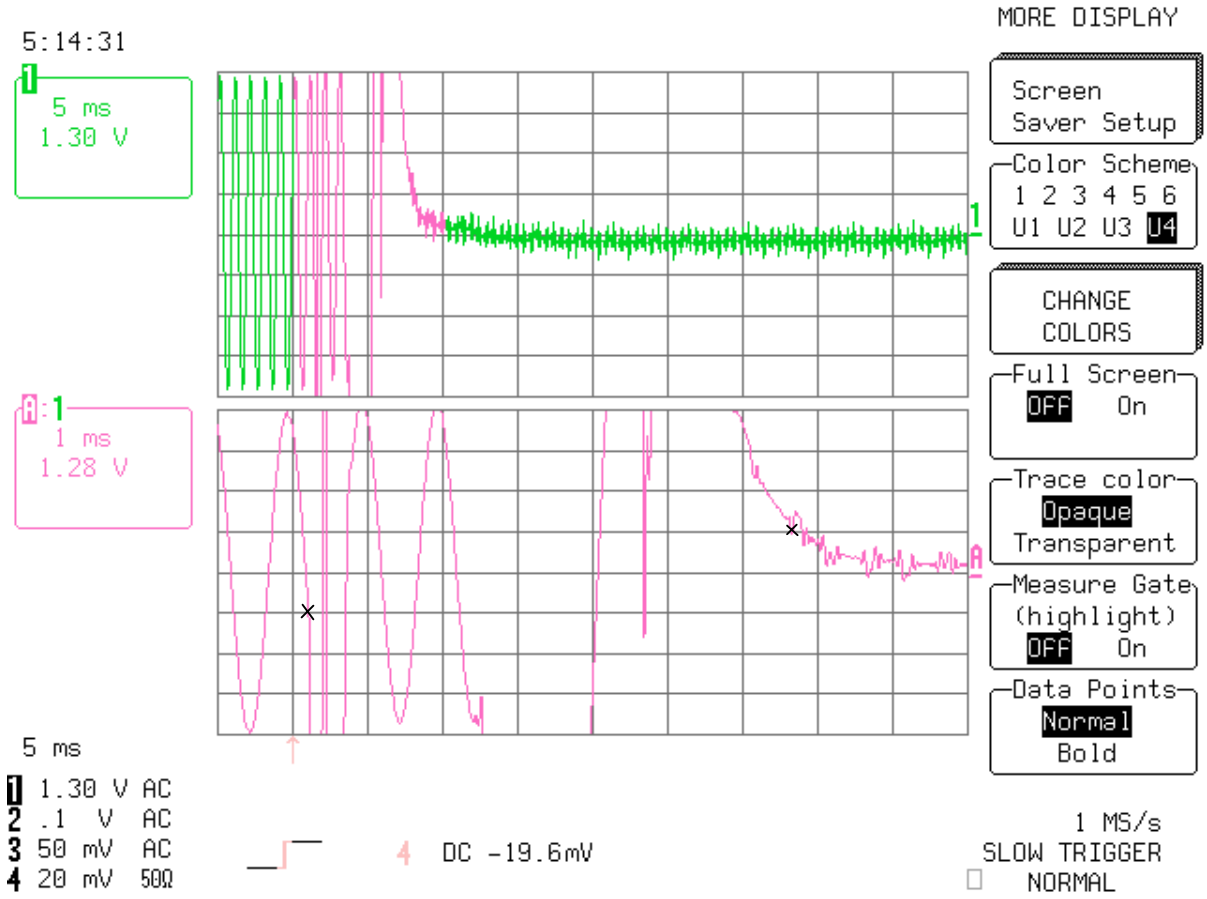
Plot 3.5.3
Transient frequency behavior @ Tx on
at 460.0 MHz



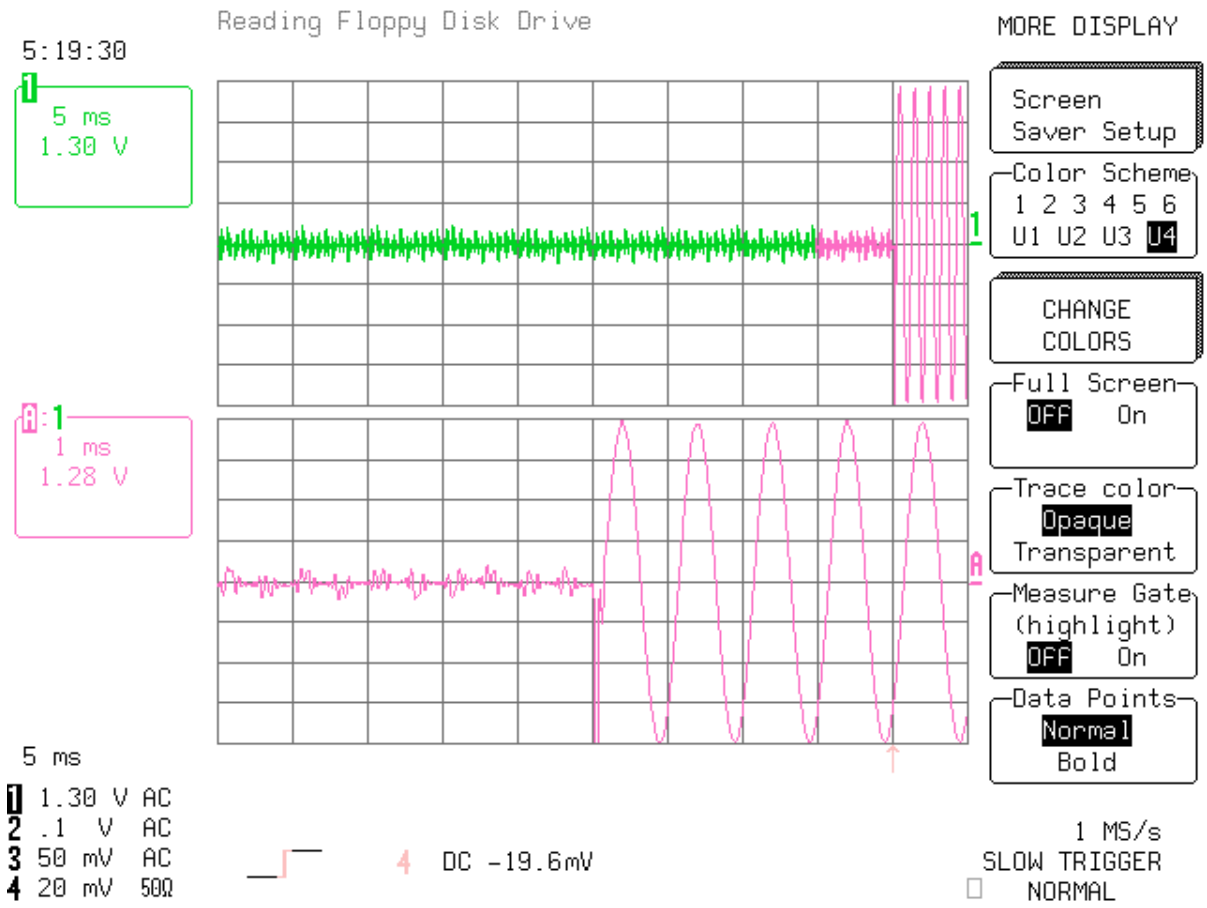
Plot 3.5.4
Transient frequency behavior @ Tx off
at 460.0 MHz



Plot 3.5.5
Transient frequency behavior @ Tx on
at 469.6 MHz



Plot 3.5.6
Transient frequency behavior @ Tx off
at 469.6 MHz



Photograph 3.5.1
Setup for transient frequency behavior measurement

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

3.6.1 General

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

Radiated emission measurements specification limits are given in Table 3.6.1 below:

Table 3.6.1
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

3.6.2 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 up to 5th harmonic of the receiver local oscillator with the biconilog and double ridged guide antennas.
The EUT in stand-by mode was placed on the wooden table as shown in Figure 3.3.1 and Photographs 3.3.2, 3.3.3. 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 results of measurements were recorded in Table 3.6.2 and shown in Plots 3.6.1 to 3.6.4.

Reference numbers of test equipment used

0041	0465	0521	0589	0592	0593	0594	0604
1004	1425	1566	1826	1849	1850	1942	2009
2109							

Full description is in Appendix A.

Table 3.6.2 Radiated emission measurements test results

TEST SPECIFICATION:	47CFR part 15, subpart B, class B
DATE:	October 16, 2002
RELATIVE HUMIDITY:	43%
AMBIENT TEMPERATURE:	25°C
AIR PRESSURE:	1009 hPa
THE EUT WAS TESTED AS:	TABLE-TOP
TEST PERFORMED AT:	Anechoic chamber
DISTANCE BETWEEN ANTENNA AND EUT:	3 m
FREQUENCY RANGE:	30 MHz – 2 GHz
DETECTOR TYPE:	QUASI-PEAK
RESOLUTION BANDWIDTH:	120 kHz

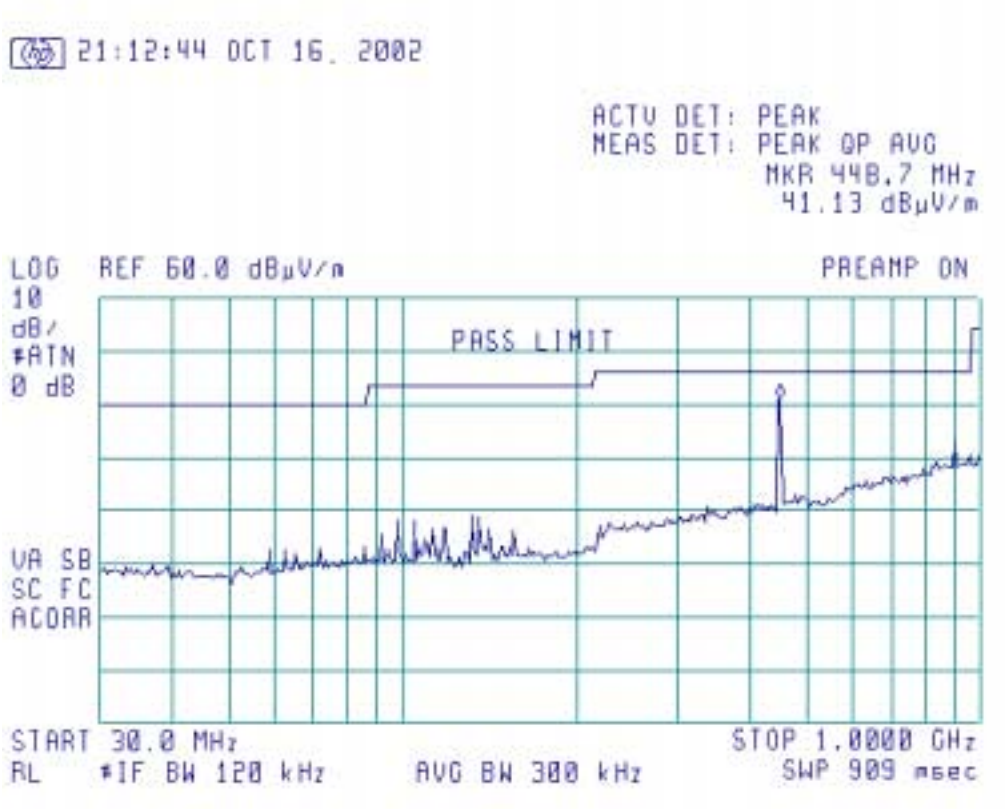
Frequency, MHz	Ant. pol.	Ant. hgt., m	TT pos., (^{o})	Radiated emissions, dB (μV/m)	Specification class B limit, dB (μV/m)	Margin, dB	Pass/ Fail
105.905000	H	1.0	140	21.53	43.5	21.97	**Pass**
119.138750	V	1.0	28	20.05	43.5	23.45	**Pass**
449.306500	H	1.8	90	42.95	46.0	3.05	**Pass**
898.602750	H	1.0	90	32.44	46.0	13.56	**Pass**

The test results recorded in the table were obtained throughout the testing with biconilog antenna and quasi-peak detector with resolution bandwidth = 120 kHz.

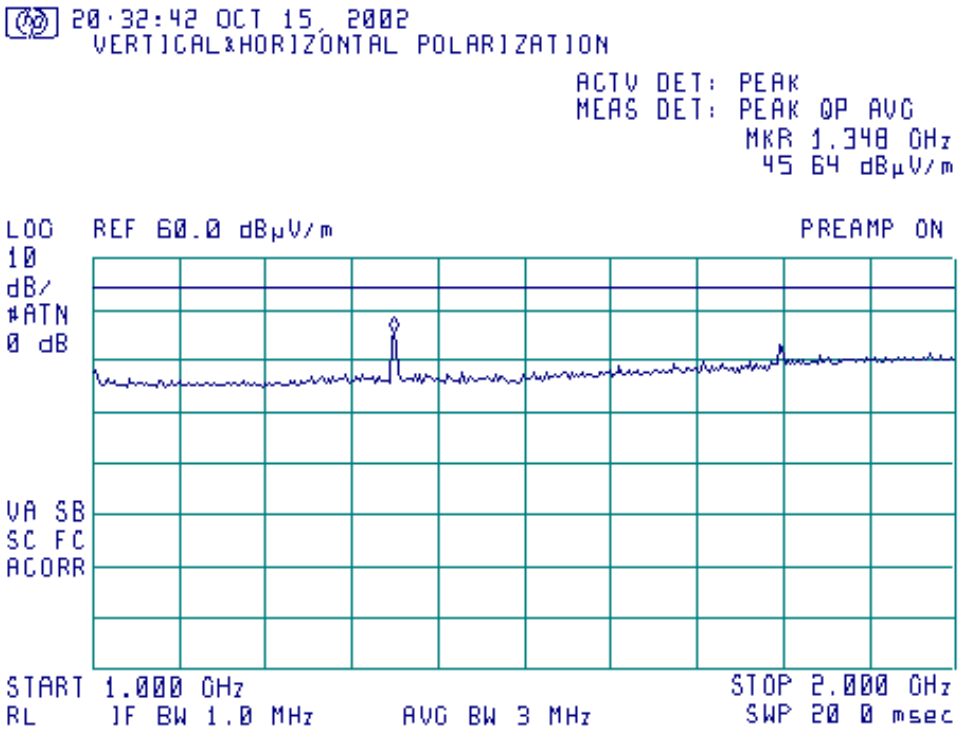
Table calculations and abbreviations:

Radiated emission dB(μV/m) = measured results dB(μV) + correction factor dB(1/m).
Ant. pol. = antenna polarization (V-vertical, H-horizontal).
Ant. hgt. = antenna height.
TT pos. = turntable position in degrees, (EUT front panel = 0^o).
Margin = dB below (negative if above) specification limit.

Plot 3.6.1
Radiated emission measurements test results,
frequency range 30 MHz - 1000 MHz

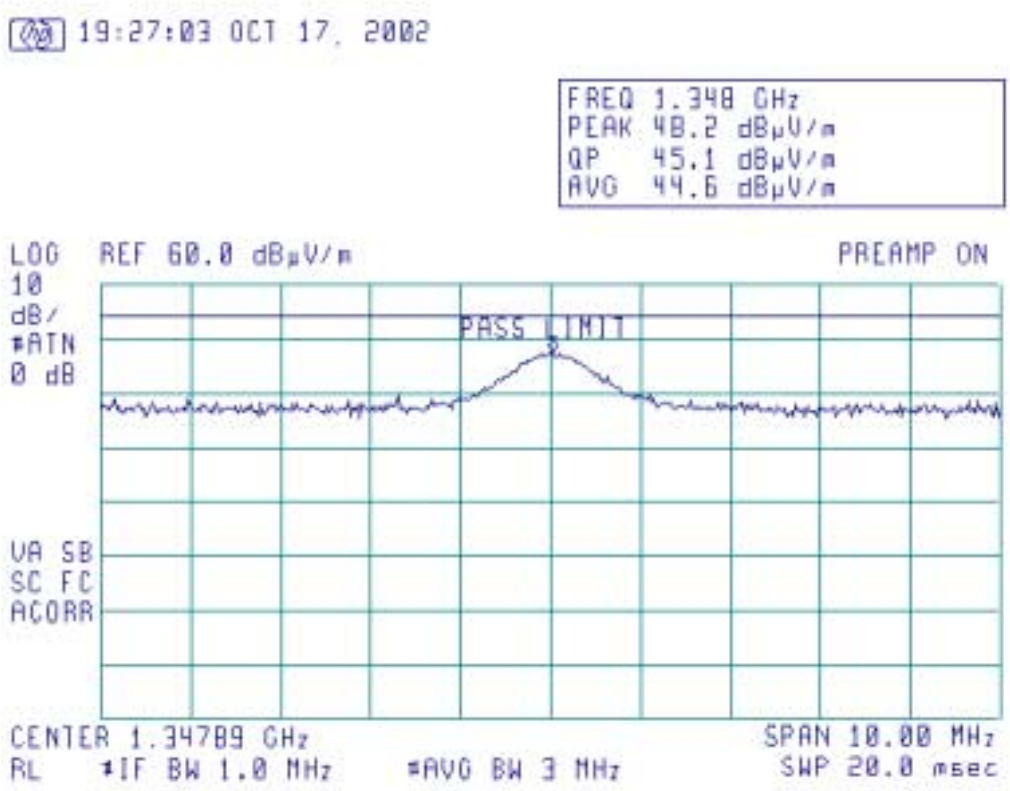


Plot 3.6.2
Radiated emission measurements test results,
frequency range 1000 MHz – 2000 MHz



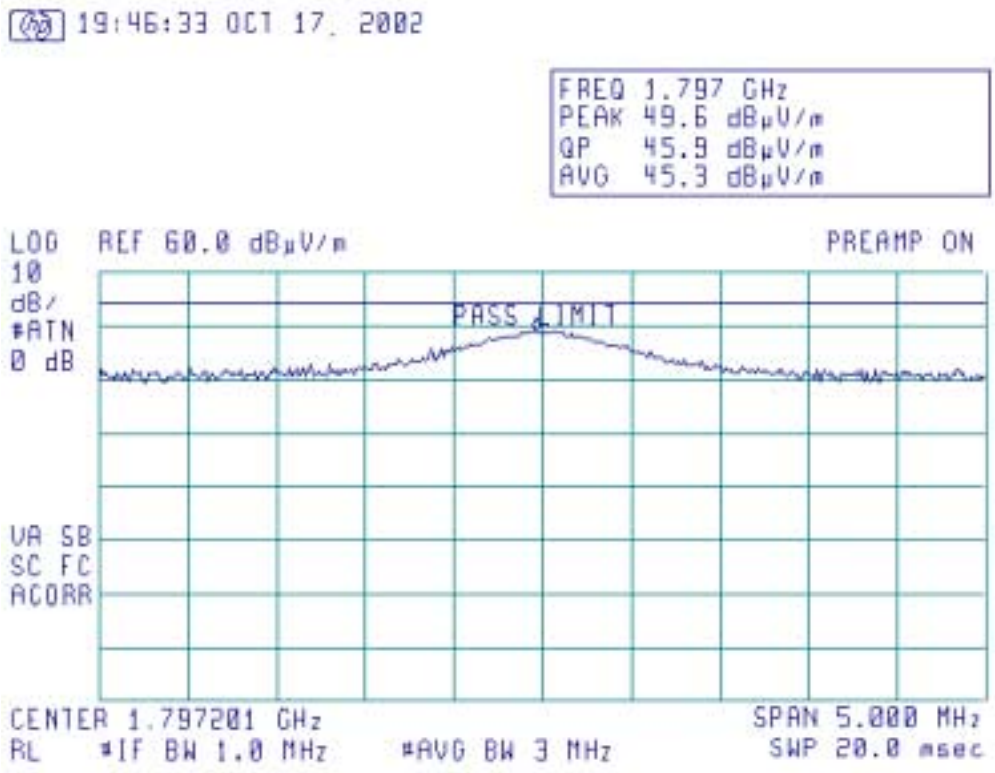
The 3rd and 4th harmonics of LO.

Plot 3.6.3
Radiated emission measurements test results,
3rd harmonic of local oscillator



Antenna polarization	Vertical
Antenna height	1 meter
TT position	97°

Plot 3.6.4
Radiated emission measurements test results,
4th harmonic of local oscillator



Antenna polarization	Vertical
Antenna height	1 meter
TT position	158°

3.7 Mains terminal radio interference voltage measurements

3.7.1 General

This test was performed to measure common mode conducted emissions at the power port. Specification test limits are given in Table 3.7.1. The worst test results (the lowest margins) were recorded in Table 3.7.2 and shown in the associated plots.

Table 3.7.1
Mains terminal radio interference voltage specification test limits

Frequency, MHz	Class B equipment, dB(μV)
0.45 – 30	48.0

3.7.2 Test procedure

The EUT was set up as shown in Figure 3.7.1 and the associated photograph, energized and the performance check was conducted. The measurements were performed at mains terminals by means of the LISN, connected to a spectrum analyzer in the frequency range referred to in Table 3.7.1.
Unused coaxial connector of the LISN was terminated with 50 Ω. Quasi-peak detector was used throughout the testing as referred to in Table 3.7.2.
The position of the device cables was varied to determine maximum emission level.
The EUT was found to be in compliance with the standard requirements and passed the test.

Reference numbers of test equipment used

0447	0672	0787	1430	1501	1511	

Full description is given in Appendix A.

Table 3.7.2
Radio frequency interference voltage test results

TEST SPECIFICATION:	47CFR part 15, subpart B, class B
DATE:	October 14, 2002
RELATIVE HUMIDITY:	42%
AMBIENT TEMPERATURE:	24°C
AIR PRESSURE:	1006 hPa
THE EUT WAS TESTED AS:	TABLE-TOP
DETECTOR USED:	QUASI-PEAK
FREQUENCY RANGE:	150 kHz – 30 MHz
RESOLUTION BANDWIDTH:	9 kHz

Quasi-peak detector

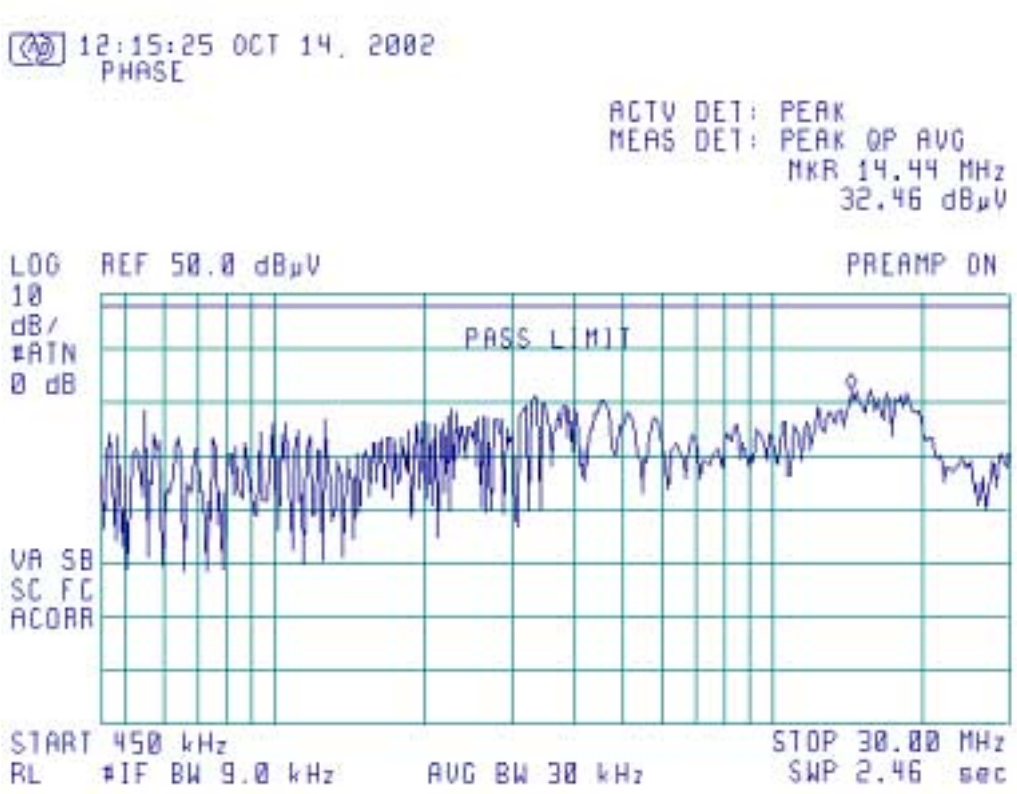
Frequency, MHz	Line ID	Measured emissions, dB (μV)	Specification class B limit, dB (μV)	Margin, dB	Pass/ Fail
0.760292	N	32.86	48.00	15.14	**Pass**
1.462447	N	31.59	48.00	16.41	**Pass**
1.988398	N	32.78	48.00	15.22	**Pass**
2.865860	N	32.65	48.00	15.35	**Pass**
3.340020	Ph	31.21	48.00	16.79	**Pass**
4.511820	Ph	30.90	48.00	17.10	**Pass**
14.660695	Ph	31.54	48.00	16.46	**Pass**
18.584410	Ph	31.25	48.00	16.75	**Pass**

Table calculations and abbreviations:

- Line ID = line identification (Ph - phase, N - neutral).
- Measured conducted emissions = EMI meter reading (dBμV) + cable loss (dB) + LISN correction factor (dB). (For LISN correction factor refer to Appendix B).
- Margin = dB below (negative if above) specification limit.

Plot 3.7.1
Mains terminal radio interference voltage test results

LINE:	PHASE
LIMIT:	QUASI-PEAK
DETECTOR:	PEAK



Plot 3.7.2
Mains terminal radio interference voltage test results

LINE:	NEUTRAL
LIMIT:	QUASI-PEAK
DETECTOR:	PEAK

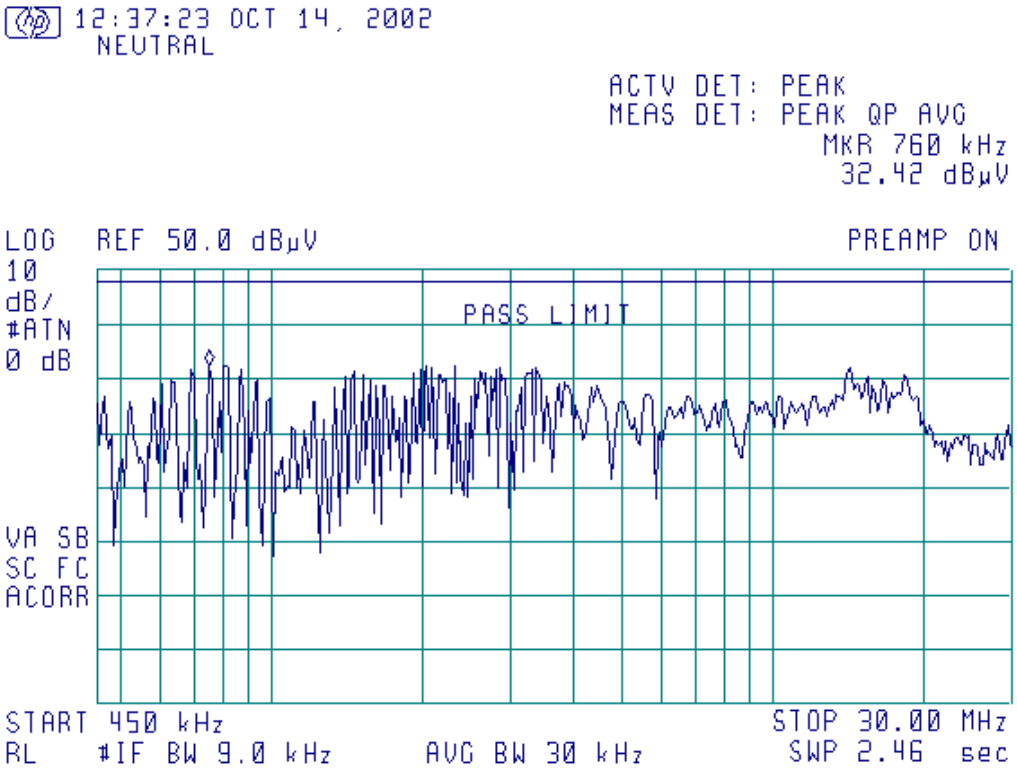
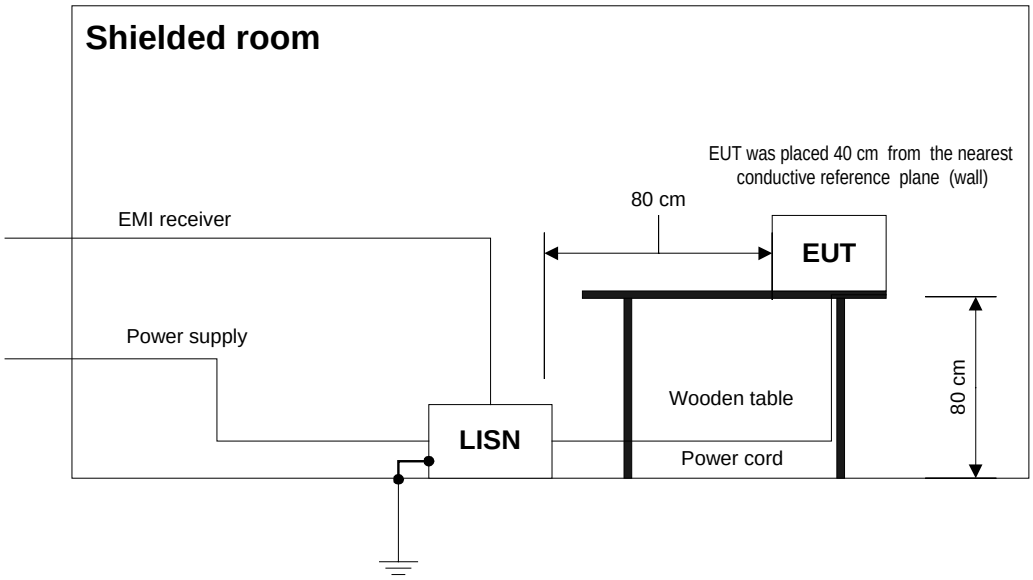
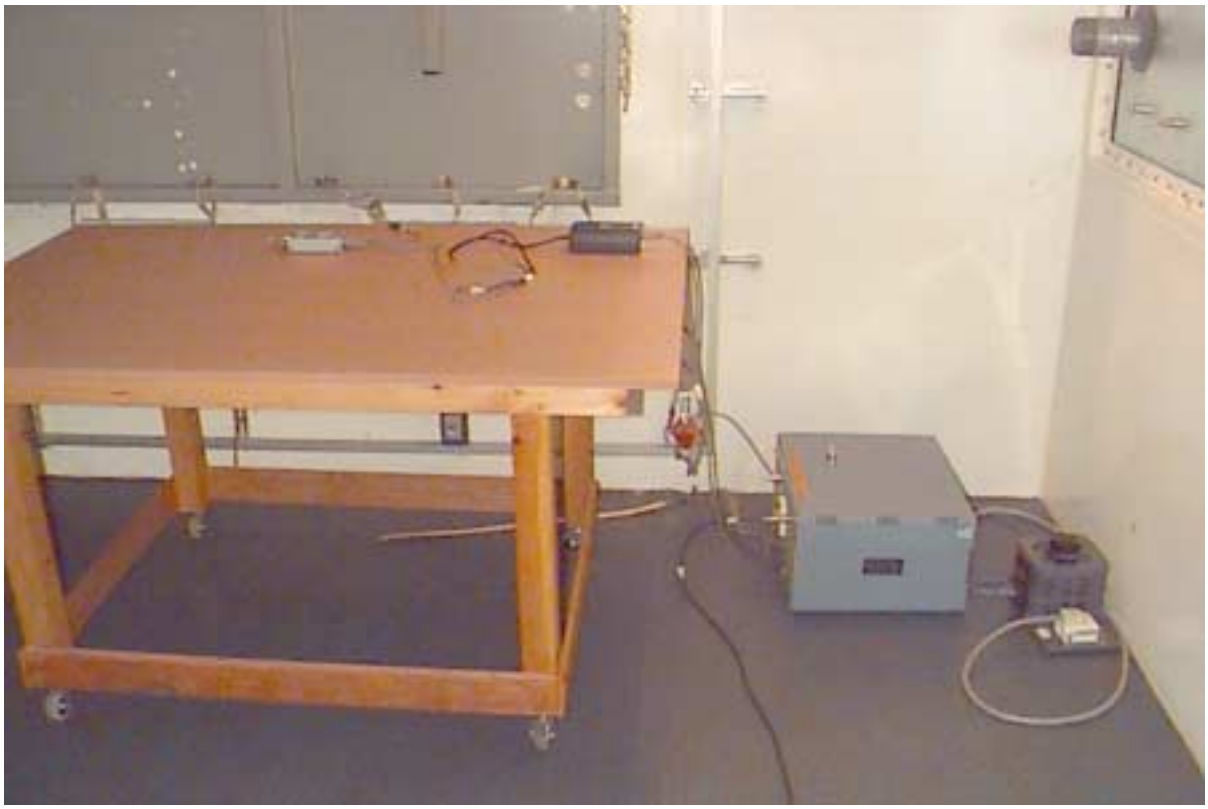


Figure 3.7.1
Setup for mains terminal radio interference voltage test, table-top equipment



Photograph 3.7.1
Setup for mains terminal radio interference voltage test



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
0412	Cable, Coax, Microwave, DC-18 GHz, N-N, 3 m	Gore	36Q01Q0111 8.2	412	9/03
0446	Active Loop Antenna 10 kHz-30 MHz	Electro-Mechanics	6502	2857	10/03
0447	LISN, 16/2, 300 V RMS	Hermon Labs	LISN 16-1	447	11/03
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	9/03
0521	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A	0319	9/03
0539	Generator signal	Marconi Instruments	52023-001H	1041	12/03
0558	Multimeter Digital	Fluke	76	0904	10/03
0566	Antenna, Biconical, 20-200 MHz	Electro-Metrics	BIA 25/30	3566	11/03
0569	Antenna, Log Periodic, 200-1000MHz	Electro-Metrics	LPA 25/30	1953	4/03
0589	Cable Coaxial, A2POL118.2, 3m	GORE	GORE-3	589	12/03
0592	Position controller	Hermon Labs	L2-SR3000	100	5/03 check
0593	Antenna Mast, 1-4 m/ 1-6 m Pneumatic	Hermon Labs	AM-F1	101	2/03 check
0594	Turntable for Anechoic Chamber, flush mounted, d=1.2 m, pneumatic	Hermon Labs	WDC1	102	1/04 check
0604	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141	9611-1011	1/04
0614	Antenna Dipole Tunable 200 –500 MHz	Electro-Metrics	TDS 30-1	334	1/04
0670	Oscilloscope, Digital storage 500MHz, 2Gs/s, 4ch with Telecom Mask Tester	LeCroy Corporation	LC 334A	2387	8/03
0672	Shielded Room 4.6(L) x 4.2(W) x2.4(H) m	Hermon Labs	SR-3	027	11/03 Check
0758	Power supply, 36 V, 1 A	Horizon Electronics	DHR 36-1	5361231	6/03 Check
0783	Tester Leakage 230 V Current Standard IEC 601	HL	MD2-L-601	142	8/03
0787	Transient limiter	Hewlett Packard	11947A-8ZE	3107A01877	11/03
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	12/03
1116	Antenna horn, 1-18 GHz	Hermon Labs	A1-18	186	3/03
1424	Spectrum analyzer, 30 Hz - 40 GHz	Agilent Technologies	8564EC	3946A00219	8/03

No.	Description	Manufacturer information			Due calibr.
		Name	Model No.	Serial No.	
1425	EMI Receiver System, 9 kHz - 2.9 GHz	Agilent Technologies	8542E	3710A00222	9/03
1430	EMI Receiver System, 9 kHz - 2.9 GHz	Agilent Technologies	8542E	3807A00262	9/03
1501	Cable RF, 6 m	Belden	M17/167 MIL-C-17	NA	12/03
1508	Cable RF, 2 m	Telequis	RG-58 C/U	NA	9/03
1509	Cable RF, 2 m	Telequis	RG-58 C/U	NA	9/03
1511	Cable RF, 8 m	Belden	M17/167 MIL-C-17	NA	9/03 Check
1518	Cable RF, 0.5 m	Telequis	MIL-C-17F-RG 058	NA	12/03
1521	Cable RF, 1.0 m	Telequis	MIL-C-17F-RG 058 CU	NA	9/03
1527	Cable RF, 1.3 m	Telequis	MIL-C-17F-RG 058 CU	NA	12/03
1566	Cable RF, 2 m	Huber-Suhner	Sucoflex 104PE	13094/4PE	12/03
1637	Cable, RG-214, 6 m	Hermon Labs	C214-6	1637	12/03
1650	Attenuators set (2, 3, 5, 20 dB), DC – 18 GHz	M/A –COM	2082		3/03
1651	Attenuators set (2, 3, 5, 20 dB), DC – 18 GHz	M/A –COM	2082		3/03
1826	Antenna mast and turntable position controller	Sh. I. Machines	CRL-4	1	5/03 Check
1849	Antenna mast with polarity control	Sh. I. Mashines	AM-F4	NA	1/04 check
1850	Turntable	Sh. I. Mashines	TT-M-3	NA	1/04 check
1939	Cable 40 GHz, 1.5 m, green	Rhophase Microwave Ltd.	KPS-1503A-1500-KPS	T4664	10/03
1942	Cable 18 GHz, 4 m, blue	Rhophase Microwave Ltd	SPS-1803A-4000-NPS	T4658	10/03
1947	Cable 18 GHz, 6.5 m, blue	Rhophase Microwave Ltd	NPS-1803A-6500-NPS	T4974	10/03
1984	Antenna, double ridged waveguide horn, 1-18 GHz, 300 W, N-type	EMC Test Systems	3115	9911-5964	12/03
2009	Cable RF, 8 m	Alpha Wire	RG-214	NA	12/03
2109	Anechoic chamber 6 (L) x 5.5 (W) x 2.95 (H) m	Hermon Labs	AC-2	NA	12/03 Check
2227	Crystal Detector 0.01-18 GHz	Hewlett Packard	8472A	NA	10/03

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).