



UNIVERSITA' DEGLI STUDI DI PERUGIA
POLO SCIENTIFICO E DIDATTICO DI TERNI

Facoltà di Ingegneria

Laboratorio di Caratterizzazione Elettromagnetica

TEST REPORT

N° 121, Rev. 0

Equipment Under Test (EUT)

AMS02 UG CRATE, Model: QM, S/N: Not Available
AMS02 UGPD CRATE, Model: QM, S/N: Not Available

Produced by
INFN Rome

OBJECT

TEST	REFERENCE DOCUMENTS
RF Conducted Energy Emission CE01, 30 Hz + 15 KHz	SSP 30237 Rev. F; Customer requirements (attachment V).
RF Conducted Energy Emission CE03, 15 kHz + 50 MHz	SSP 30237 Rev. F; Customer requirements (attachment V).
RF Radiated Energy Emission CE03, 14 kHz + 15.5 GHz	SSP 30237 Rev. F; Customer requirements (attachment V).
Mode Switching Transients Envelope, CE 07	SSP 30237 Rev. F; Customer requirements (attachment V).
Electromagnetic Energy Injection CS01, 30Hz-50KHz	SSP 30237 Rev. F; Customer requirements (attachment V).
Electromagnetic Energy Injection CS02, 50KHz-50MHz	SSP 30237 Rev. F; Customer requirements (attachment V).
Conducted Pulse susceptibility CS06, 10µS-150nS	SSP 30237 Rev. F; Customer requirements (attachment V).
Radiated Pulse susceptibility RS02, 10µS-150nS	SSP 30237 Rev. F; Customer requirements (attachment V).
Radiated Electric Field Susceptibility 14KHz-15.2 GHz	SSP 30237 Rev. F; Customer requirements (attachment V).

Terni, 18 GIU. 2008

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25 to 28/03/2008

INDEX

1. EUT	pag. 3
2. Test site	pag. 5
3. RF Conducted Energy Emission CE 03, 15 kHz ÷ 50 MHz	pag. 6
4. RF Radiated Energy Emission RE 02, 14 kHz ÷ 15.5 GHz	pag. 7
5. RF Conducted Energy Emission CE 01, 30 Hz ÷ 15 kHz	pag. 8
6. Mode Switching Transients Envelope, CE 07	pag. 9
7. Electromagnetic Energy Injection CS 01, 30 Hz ÷ 50 kHz	pag. 10
8. Electromagnetic Energy Injection CS 02, 50 kHz ÷ 50 MHz	pag. 11
9. Conducted Pulse susceptibility CS 06, 10 µS ÷ 150 nS	pag. 12
10. Radiated Pulse susceptibility RS 02, 10 µS ÷ 150 nS	pag. 13
11. Radiated Electric Field Susceptibility RS 03 14 kHz ÷ 15.2 GHz	pag. 14

Attachments

Attachment I (7 pages): Photographic documentation.

Attachment II (4 pages): Results of conducted emissions tests.

Attachment III (8 pages): Results of radiated emissions tests.

Attachment IV (10 pages): Test level applied in radiated and conducted susceptibility tests.

Attachment V (5 pages): Customer requirements.

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25 to 28/03/2008**1. EUT**

The equipment under test (EUT) is the:

AMS02 UG CRATE, Model: QM, S/N: Not Available
AMS02 UGPD CRATE, Model: QM, S/N: Not Available

produced by: INFN Rome (Italy)

Customer:

INFN Rome (Italy)

The EUT is powered by 28VDC; return lead is connected at the ground plane. Figures 1 and 2 show the EUT and the general setup of the tests. Table 1 shows all the common equipments/facilities used in all tests. Table 2 shows the requirements and the applicability of the tests. The setup layout and the tests are realized in agreement with SSP 30237 Rev. F and customer requirements (attachment V).

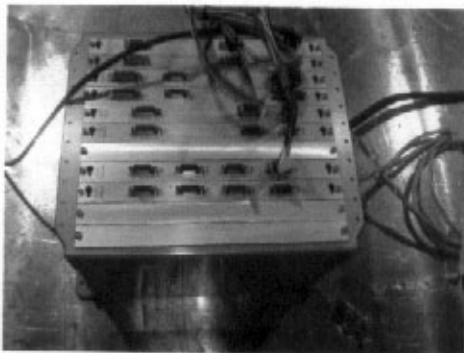


Figure 1: EUT

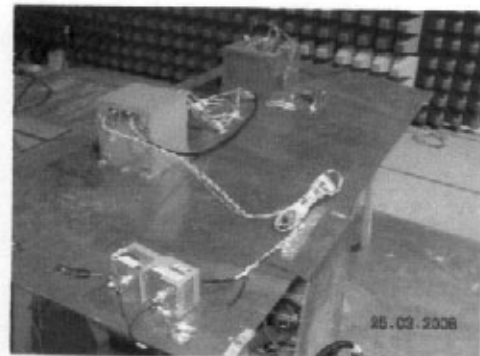


Figure 2: test setup

Tab. 1: Common equipments/facilities used in all tests.

Equipment	Manufacturer	Model	Serial Number	Calibration Due Date
Semi Anechoic Chamber	Siemens - Matsushita	Project 003-005-126/99° Contract 93-900736 12/1999, Design C62128- A0502-A59-1-7606	Product B83117- A1231-T161	22/03/2009
10.0 μ F \pm 10% R.F. Capacitor	Solar Electronics	6512-106R	0609 11 0609 21	n.r.

Tab. 2: Requirements and applicability of the tests.

TEST	Applicability
RF Conducted Energy Emission CE01, 30 Hz + 15 kHz	Main supply cable +28V

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RF Conducted Energy Emission CE03, 15 kHz ÷ 50 MHz	Main supply cable +28V
RF Radiated Energy Emission CE03, 14 kHz ÷ 15.5 GHz	Equipment
Mode Switching Transients Envelope, CE 07	Main supply cable +28V
Electromagnetic Energy Injection CS01, 30Hz ÷ 50 kHz	Main supply cable +28V
Electromagnetic Energy Injection CS02, 50KHz ÷ 50 MHz	Main supply cable +28V
Conducted Pulse susceptibility CS06, 10µs ÷ 150 ns	Main supply cable +28V
Radiated Pulse susceptibility RS02, 10 µs ÷ 150 ns	Equipment enclosure
Radiated Electric Field Susceptibility 14 kHz ÷ 15.2 GHz	Equipment enclosure

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ELECTROMAGNETIC COMPATIBILITY TEST REPORT

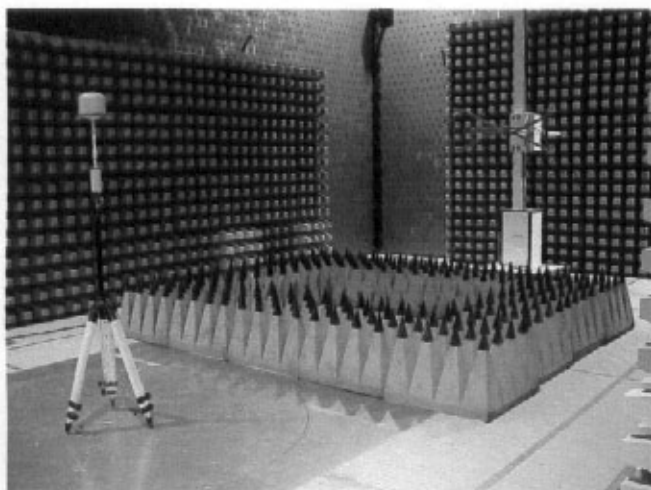
N.° 121
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EUT:
AMS02 UG CRATE, Model: QM, S/N: Not Available
AMS02 UGPD CRATE, Model: QM, S/N: Not Available

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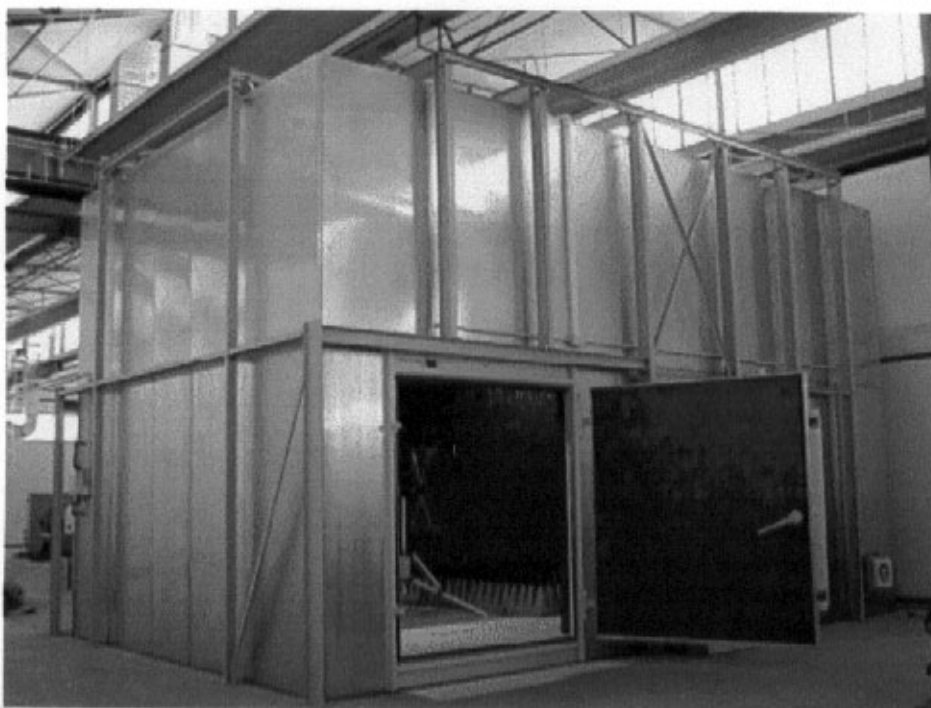
2. TEST SITE

The EMC tests have been performed in the Laboratory of Electromagnetic Characterization of the "Polo Scientifico e Didattico di Terni", University of Perugia, Faculty of Engineering, Via Pentima Bassa 21, 05100 Terni.



Semi-anechoic chamber:

- Dimensions: 9.15 m, 8.00 m, 5.55 m.
- Turn table capacity: 1000 kg.
- Automatic mast for antenna movement.
- Electromagnetic absorbing: ferrite and cones.
- Anechoic range: 30 MHz ÷ 18 GHz.
- Shielding range: 10 kHz ÷ 18 GHz.



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25 to 28/03/2008**3. RF CONDUCTED ENERGY EMISSION CE 03, 15 kHz ÷ 50 MHz**

STANDARD: SSP 30237 Rev. F.

Scope

The scope of this test is to verify the conducted emissions of the EUT in the frequency range from 15 kHz up to 50 MHz.

Test procedures

This test is performed in agreement with the requirements of follow documents: SSP 30237 Rev. F; Customer requirements (attachment V). The test is performed in some different frequency ranges (most interesting ranges for this system) and in some different EUT functional conditions. In attachment II for each plot a note under the picture describe EUT functional condition.

The test is performed on positive power lead of J631 cable.

Environmental ConditionsTemperature 16°C
Humidity 38%**Test equipment**

Type	Manufacture	Model	Serial Number	Calibration Due Date
R.F. Current Probe	Solar Electronics	6741-1	882720	26/04/2008
Spectrum Analyser	Agilent	E4407B	MY41441068	16/05/2008
Data Acquisition	Personal computer	-	-	n.r.

(n.r. = not required)

Results

Graphical plots are visible in attachment II. This test is performed with the addition of a 470µF 63V electrolytic capacitor placed in the back plane between +29V lead and ground.

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25 to 28/03/2008**4. RF RADIATED ENERGY EMISSION RE 02, 14 kHz ÷ 15.5 GHz**

STANDARD: SSP 30237 Rev. F.

Scope

The scope of this test is to verify the radiated emissions (electric field) of the EUT in the frequency range from 14 kHz up to 15.5 GHz in narrowband.

Test procedures

This test is performed in agreement with the requirements of follow document: SSP 30237 Rev. F; Customer requirements (attachment V).

The test is performed with cable not shielded and in operative condition.

Environmental ConditionsTemperature 15°C
Humidity 38%**Test equipment**

Type	Manufacture	Model	Serial Number	Calibration Due Date
Spectrum Analyser	Agilent	E4407B	MY41441068	16/05/2008
Active Monopole Antenna	A.H. System	SAS-550-1B	313	20/04/2008
Log - periodic antenna	Electro-metrics	EM-6950	848	01/10/2008
Bi - conical Antenna	Electro-metrics	EM-6912A	704	01/10/2008
Double Ridge Guide Horn Antenna	A.H. Systems	SAS-571	539	01/10/2008
Data Acquisition	Personal computer	-	-	n.r.

(n.r. = not required)

Results

Graphical plots are visible in attachment III.

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AMS02 UGPD CRATE, Model: QM, S/N: Not AvailableTest Date
25 to 28/03/2008**5. RF Conducted Energy Emission CE 01, 30 Hz ÷ 15 KHz**

STANDARD: SSP 30237 Rev. F.

Scope

The scope of this test is to verify the conducted emissions of the EUT in the frequency range from 30 Hz up to 15 kHz.

Test procedures

This test is performed in agreement with the requirements of follow document: SSP 30237 Rev. F; Customer requirements (attachment V). The test is performed on positive power lead of J631 cable.

Environmental ConditionsTemperature 15°C
Humidity 38%**Test equipment**

Type	Manufacture	Model	Serial Number	Calibration Due Date
Oscilloscope	Tektronix	TDS210	B023805	06/04/2008
Current Probe	Hameg	HZ56	P 98 - 04 - 6347	20/04/2008
Data Acquisition	Personal computer	-	-	n.r.

(n.r. = not required)

Results

Graphical plots are visible in attachment II.

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25 to 28/03/2008**6. Mode Switching Transients Envelope, CE 07.****STANDARD:** SSP 30237 Rev. F.**Scope**

The scope of this test is to verify the waveform of voltage during switching on transient.

Test procedures

This test is performed in agreement with the requirements of follow document: SSP 30237 Rev. F; Customer requirements (attachment V).

Environmental ConditionsTemperature 18°C
Humidity 35%**Test equipment**

Type	Manufacture	Model	Serial Number	Calibration Due Date
Oscilloscope	Tektronix	TDS210	B023805	06/04/2008
Mercury Switch	CEM	-	-	n.r.,
500MHz Oscilloscope Voltage Probe	Tektronix	P6139A	10001108	06/04/2008
Data Acquisition	Personal computer	-	-	n.r.

(n.r. = not required)

Results

Graphical plots are visible in attachment II.

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AMS02 UGPD CRATE, Model: QM, S/N: Not Available

Test Date
25 to 28/03/2008

7. Electromagnetic Energy Injection CS01, 30 Hz – 50 kHz.

STANDARD: SSP 30237 Rev. F.

Scope

The scope of this test is to verify the ability of EUT withstand a sinusoidal low frequency signal coupled into supply lead.

Test procedures

This test is performed in agreement with the requirements of follow document: SSP 30237 Rev. F; Customer requirements (attachment V).

The test is performed on positive power lead of J631 cable.

Environmental Conditions

Temperature 18°C
Humidity 35%

Test equipment

Type	Manufacture	Model	Serial Number	Calibration Due Date
Oscilloscope	Tektronix	TDS210	B023805	06/04/2008
Signal Generator	Hameg	HM8130	130981P-03074	16/10/2008
Audio Isolation Transformer	Solar Electronics	6220-1A	-	n.r.
Power Amplifier	FBT	HP2100	FBR 063 O	16/10/2008

(n.r. = not required)

Results

Communication with UGPD lost during the test.No permanent damages are noted after the test.

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25 to 28/03/2008**8. Electromagnetic Energy Injection CS02, 50 kHz – 50 MHz.**

STANDARD: SSP 30237 Rev. F.

Scope

The scope of this test is to verify the ability of EUT withstand a sinusoidal radiofrequency signal coupled into supply lead.

Test procedures

This test is performed in agreement with the requirements of follow document: SSP 30237 Rev. F; Customer requirements (attachment V).

The test is performed on positive power lead of J631 cable.

Environmental ConditionsTemperature 18°C
Humidity 35%**Test equipment**

Type	Manufacture	Model	Serial Number	Calibration Due Date
Oscilloscope	Tektronix	TDS210	B023805	06/04/2008
Coupler	CEM	CS02/001	001A	08/10/2008
Signal Generator	Rode & Schwartz	SMY01	833104/011	03/10/2008
DC - RF Dummy Load (50 Ω)	Esco	1030020	803	12/04/2008
Power Amplifier	Amplifier Research	25A250A	307913	03/10/2008

Results

No failures, degradations of performances and permanent damages are noted during and after test.

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25 to 28/03/2008**10. Radiated Pulse susceptibility RS02, 10 μ s – 150 ns**

STANDARD: SSP 30237 Rev. F.

ScopeThe scope of this test is to verify the ability of EUT withstand 10 μ s and 150 ns pulses radiated from a wire placed in proximity of EUT.**Test procedures**

This test is performed in agreement with the requirements of follow document: SSP 30237 Rev. F; Customer requirements (attachment V). The pulse repetition rate was 30 p.p.s, the test duty was 5 minutes for each waveform. The Pulses are applied in positive and negative polarity.

Environmental ConditionsTemperature 20°C
Humidity 38%**Test equipment**

Type	Manufacture	Model	Serial Number	Calibration Due Date
Transient Pulse Generator	Solar Electronics	8282-1	030978	30/04/2008
Oscilloscope	Tektronix	TDS210	B023805	06/04/2008
500MHz Oscilloscope Voltage Probe	Tektronix	P6139A	10001108	06/04/2008
Data Acquisition	Personal computer	-	-	n.r.

(n.r. = not required)

Results

No failures, degradations of performances and permanent damages are noted during and after test.

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25 to 28/03/2008**11. Radiated Electric Field Susceptibility RS 03 14 kHz - 15.2 GHz**

STANDARD: SSP 30237 Rev. F.

Scope

The scope of this test is to verify the ability of EUT withstand radiofrequency electric field.

Test procedures

This test is performed in agreement with the requirements of follow document: SSP 30237 Rev. F; Customer requirements (attachment V).

Environmental ConditionsTemperature 19°C
Humidity 40%**Test equipment**

Type	Manufacture	Model	Serial Number	Calibration Due Date
Power Amplifier	Huges	1277-H09 F0000	129	24/10/2008
Power Amplifier	Huges	1177-H01 F0000	185	24/10/2008
Power Amplifier	Huges	1177-H02 F0000	248	24/10/2008
Power Amplifier	Varian	V7U6991K1D	6208	24/10/2008
Signal Generator	HP	8673C	2645A00405	24/10/2008
Signal Generator	Rode & Schwartz	SMY01	833104/011	03/10/2008
Power Amplifier	Schaffner	CBA9413A	9908	16/10/2008
Power Amplifier	Amplifier Research	25A250A	307913	03/10/2008
Double Ridge Guide Horn Antenna	A.H. System	SAS-571	539	01/10/2008
X - Wing Bi - log Antenna	Schaffner	CBL 6141A	4170	03/10/2008
Passive Monopole Antenna	A.H. System	SAS-551	202	03/10/2008

(n.r. = not required)

Results

Applied field levels are visible in attachment IV. Power supply cables on PSU was not shielded during the test. Connectors was covered with alluminium foil. All the other cables was shielded during the test. 0Ω Resistor is removed on S9011A. No failures, degradations of performances and permanent damages are noted during and after test.

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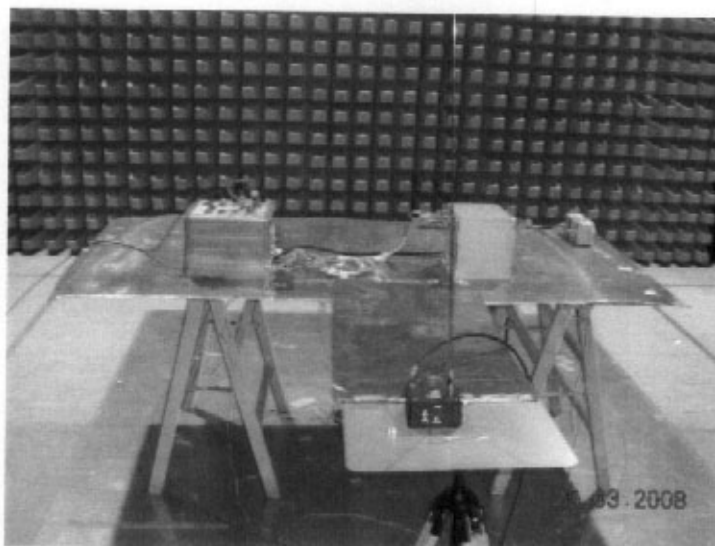
Ing. Antonio Faba

Approved by

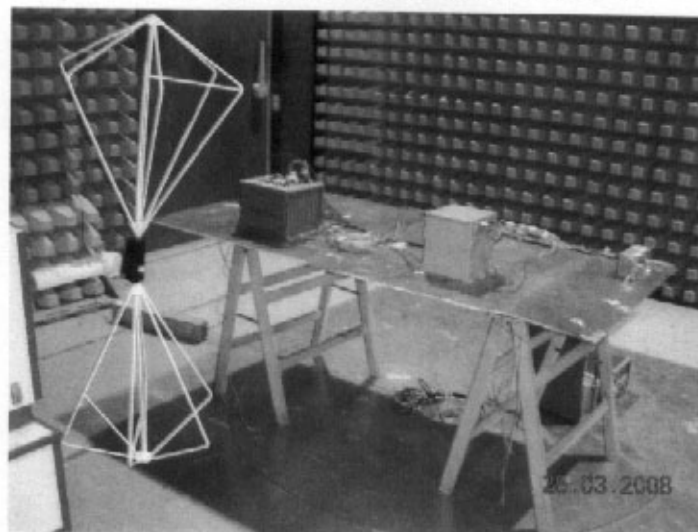
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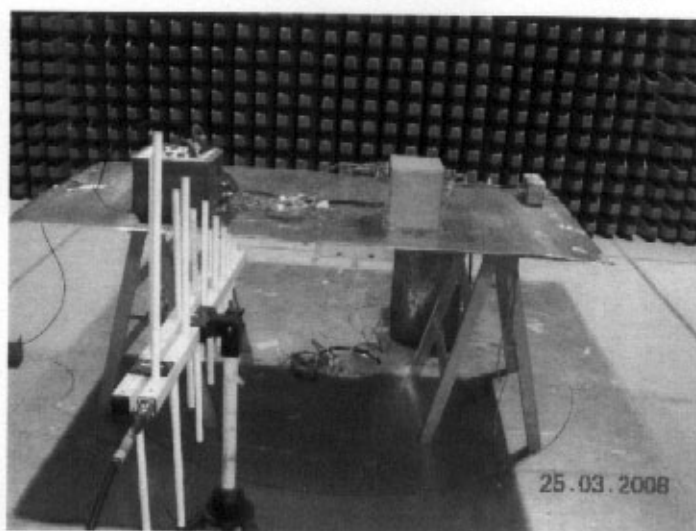
Attachment I Photographic Documentation



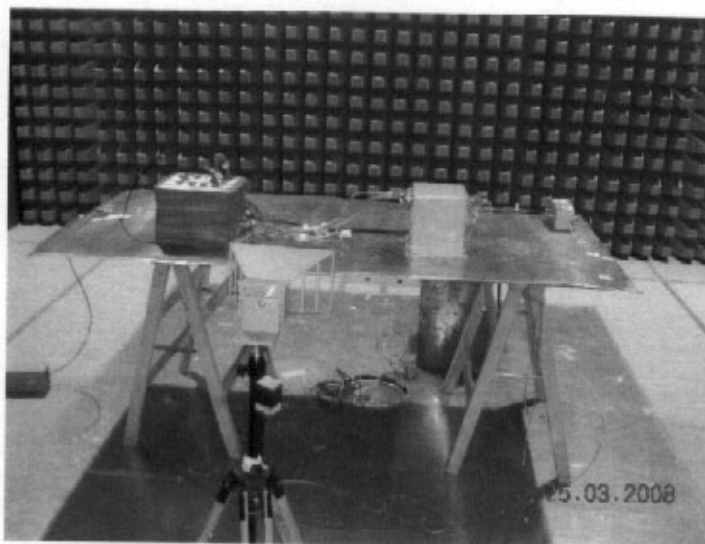
Picture 1: RE 02, 14 kHz – 30 MHz.



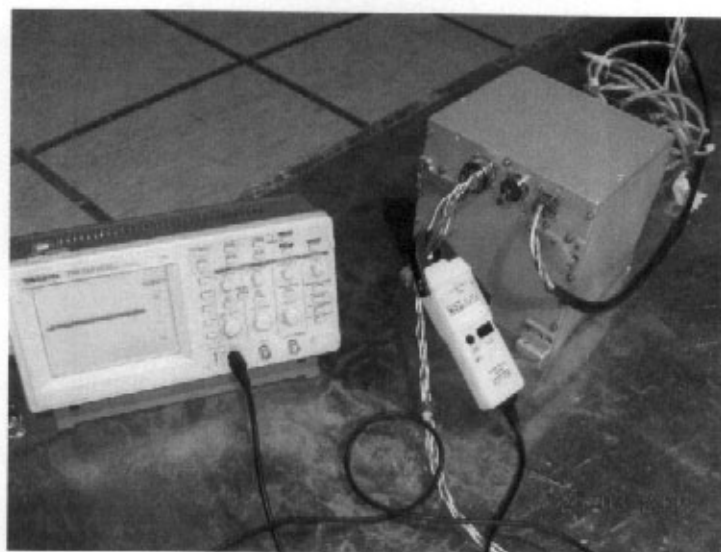
Picture 2: RE 02, 30 MHz – 300 MHz



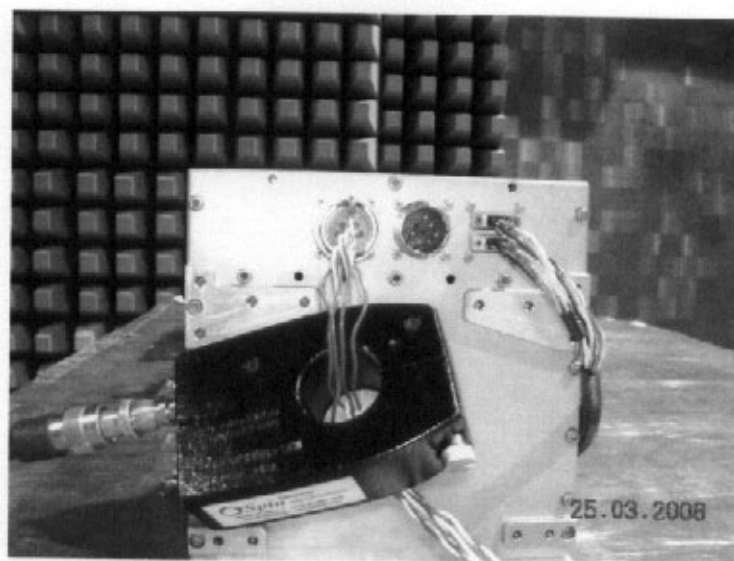
Picture 3: RE 02, 300 MHz – 700 MHz



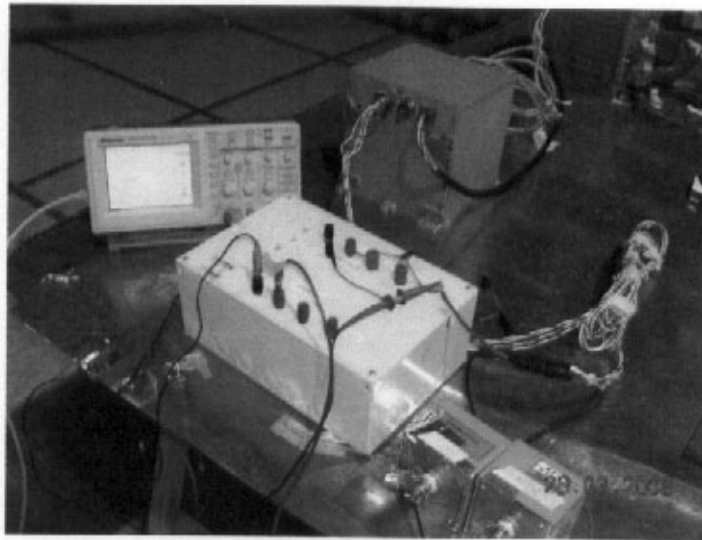
Picture 4: RE 02, above 1 GHz



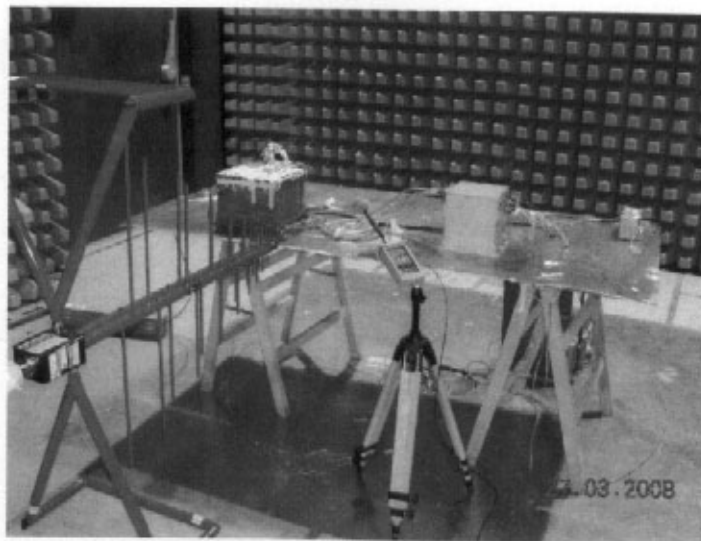
Picture 5: CE 01



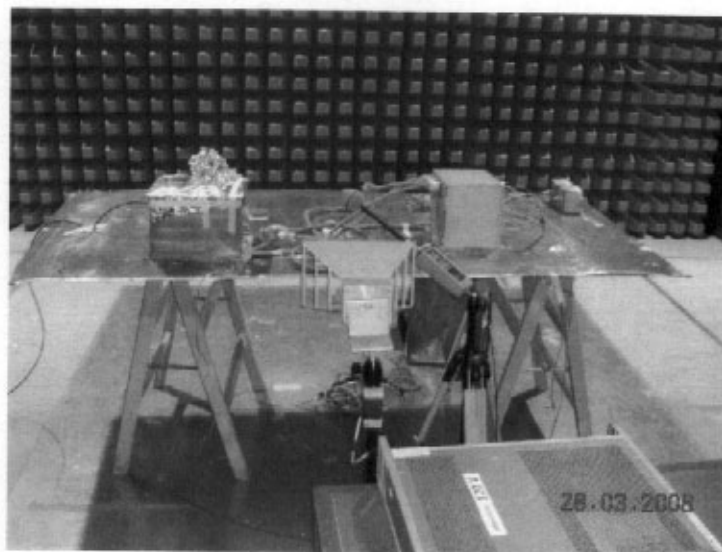
Picture 6: CE 03



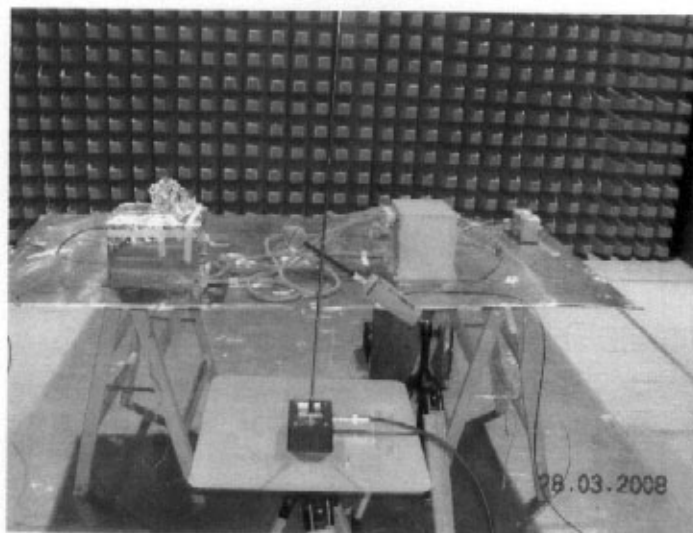
Picture 7: CE 07



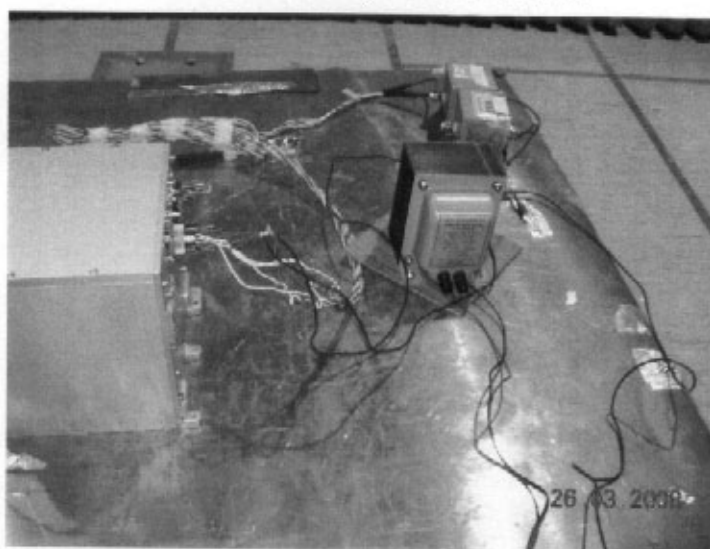
Picture 8: RS 03, 30 MHz - 1 GHz



Picture 9: RS 03, Above 1 GHz



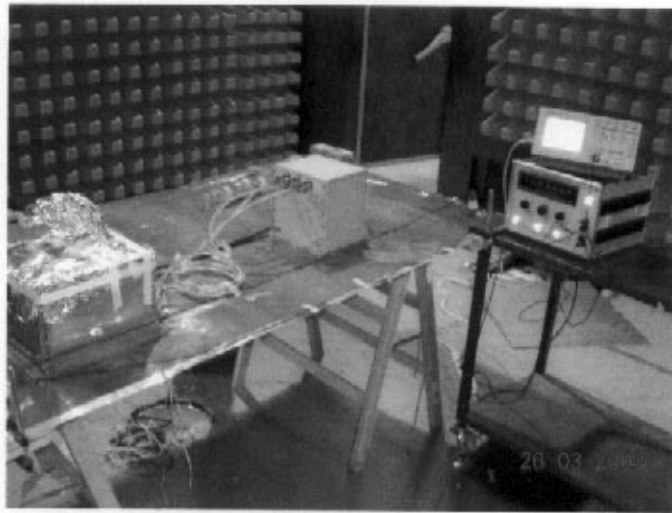
Picture10: RS 03, 14KHz-10MHz



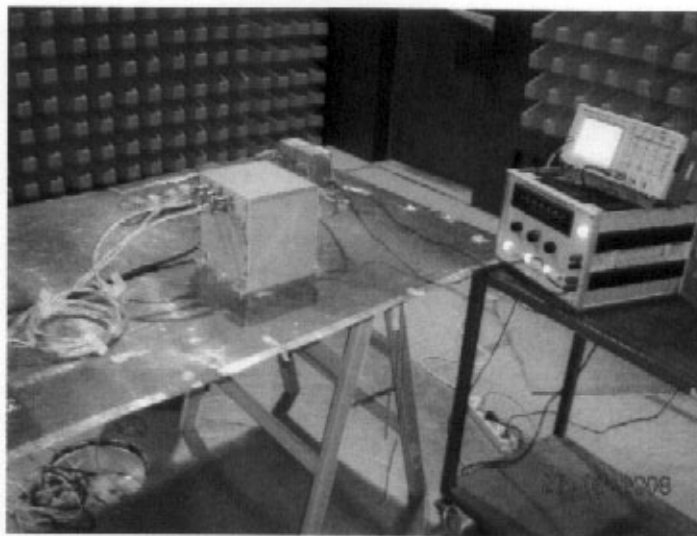
Picture 11: CS 01



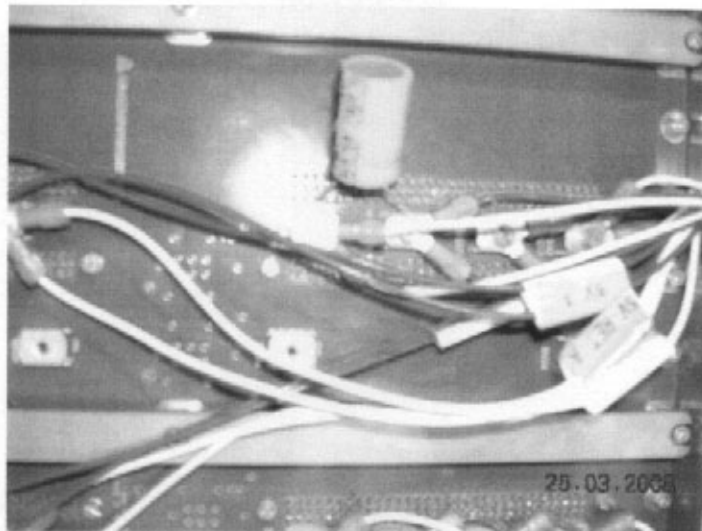
Picture 12: CS 02



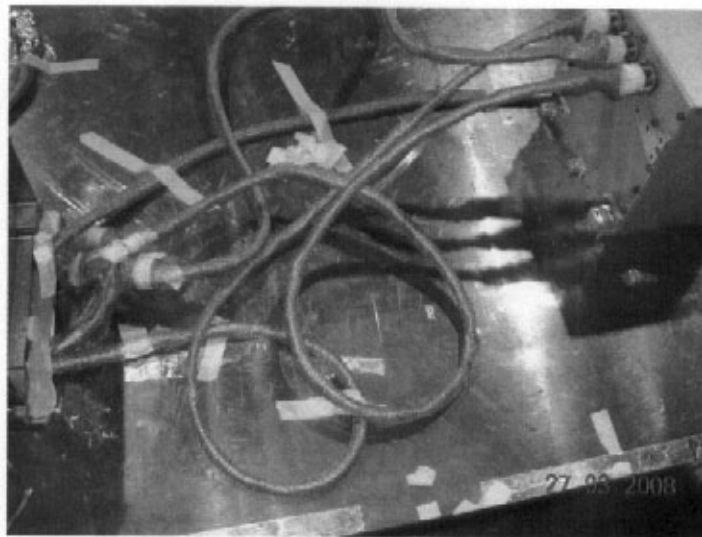
Picture13: RS 02



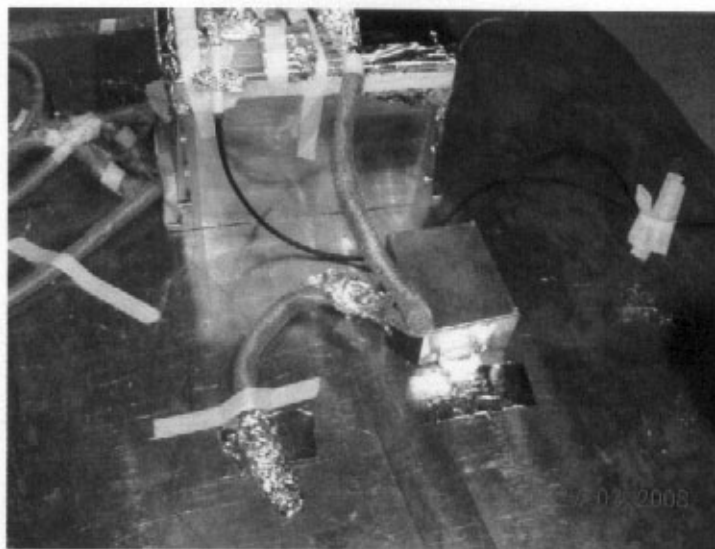
Picture14: CS 06



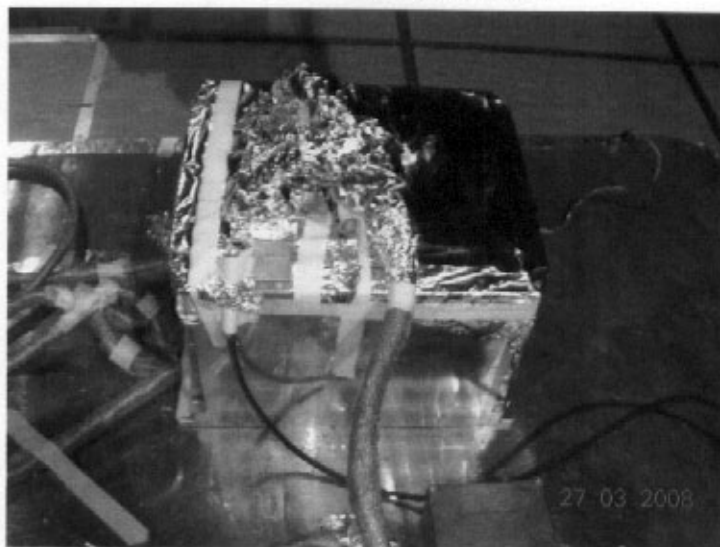
Picture 15: Detail of 470µF capacitor add in CE 03 test



Picture 16: Cable shielding



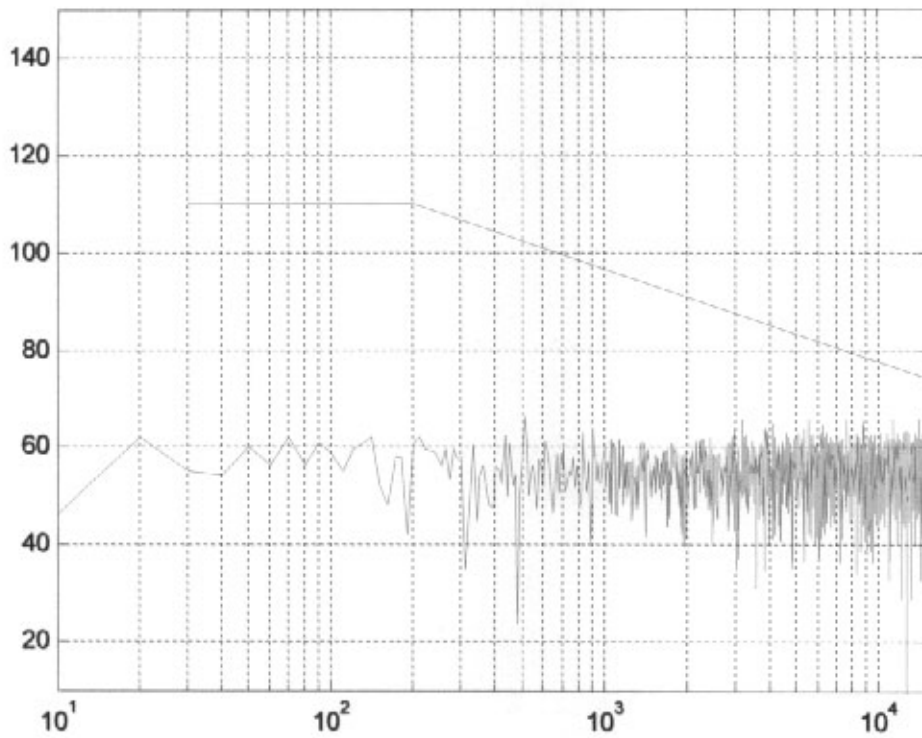
Picture 17: Cable shielding



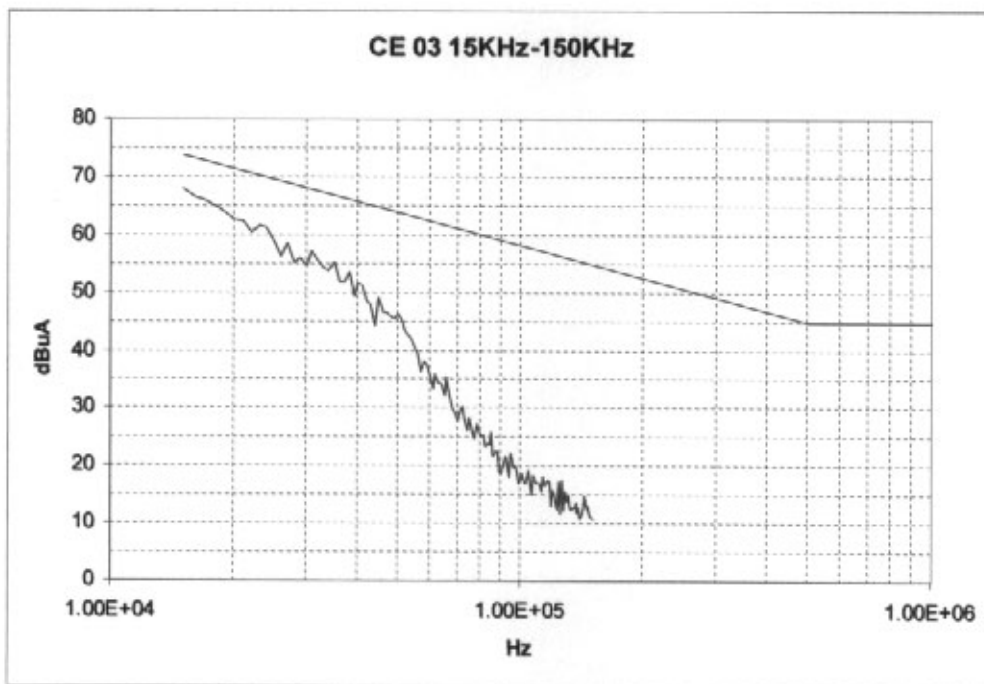
Picture 18: Cable shielding

Attachment II

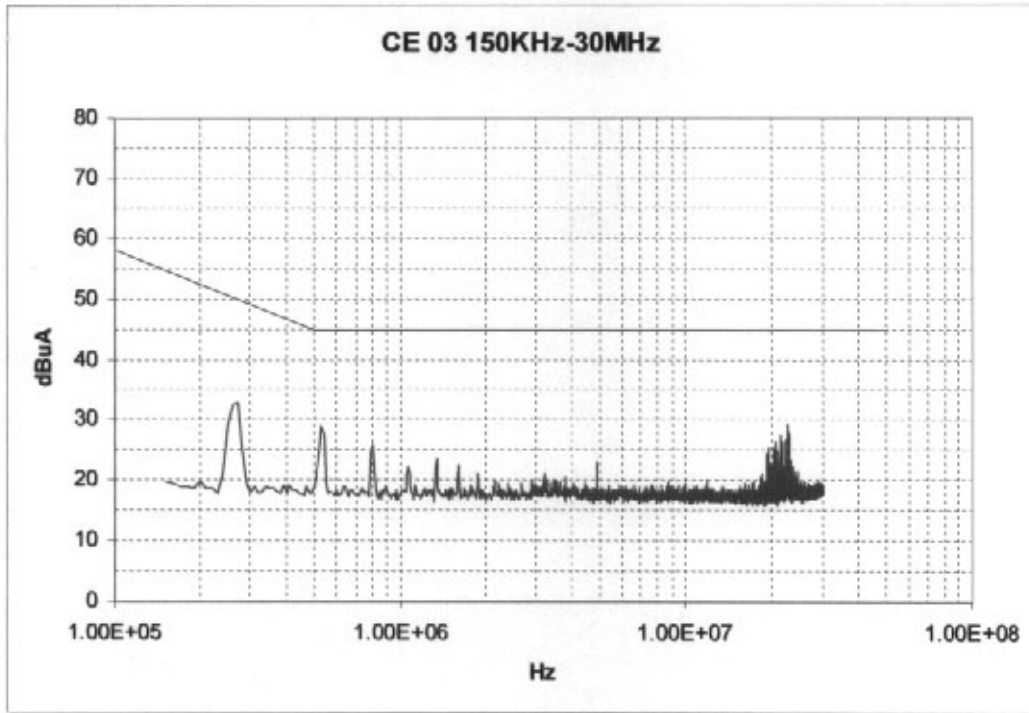
Results of Conducted Emission



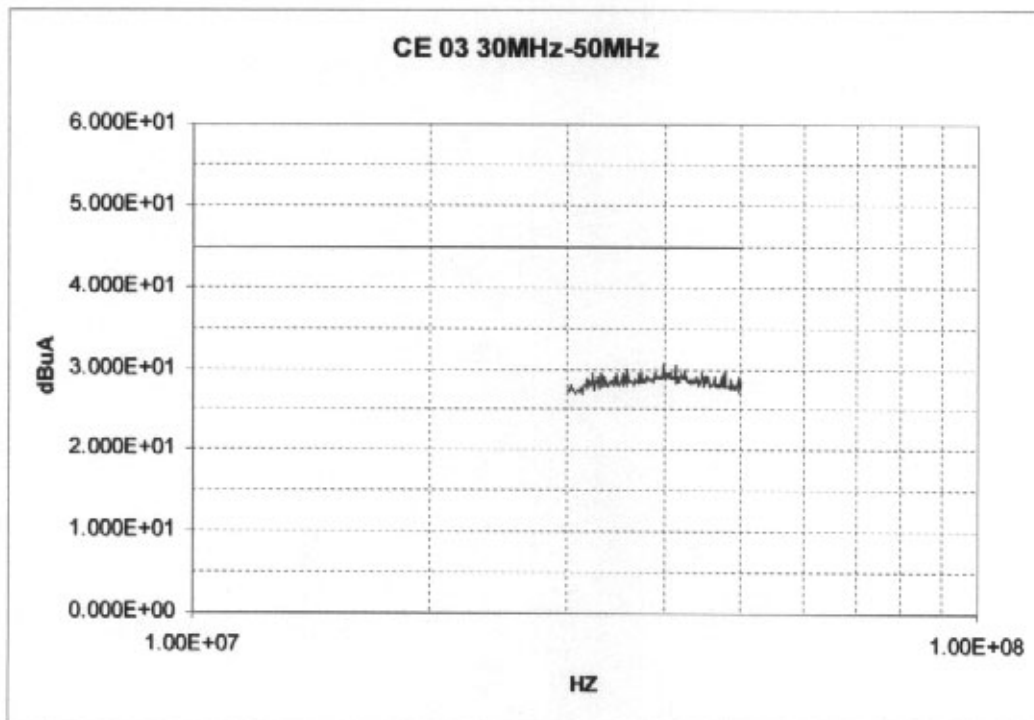
Picture 1: CE 01(dBµA/Hz), + 28V Lead, all on.



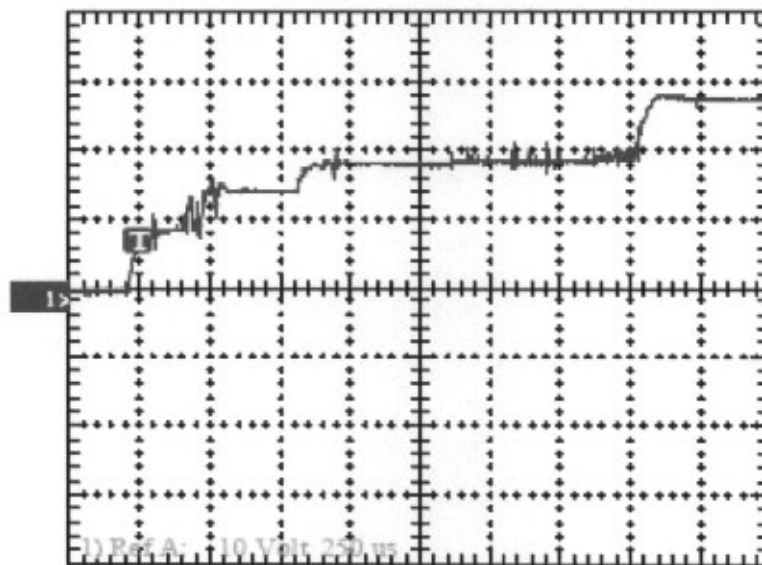
Picture 2: CE 03



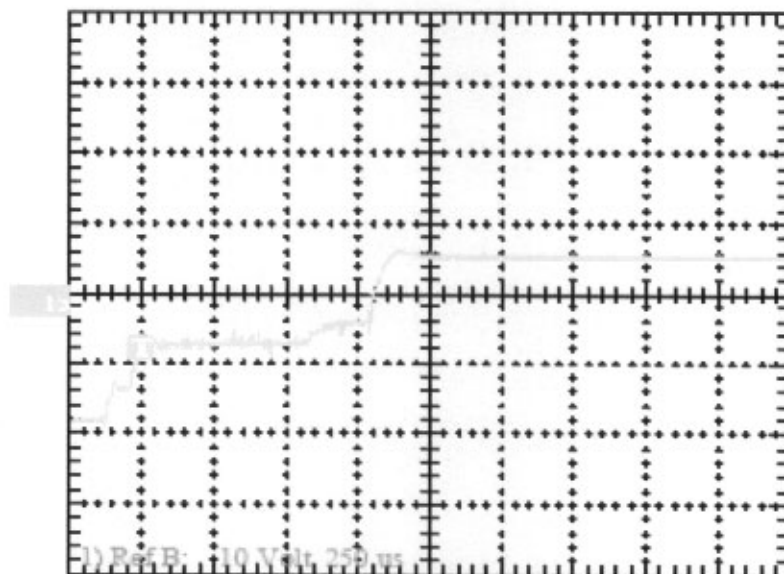
Picture 3: CE03



Picture 4: CE 03



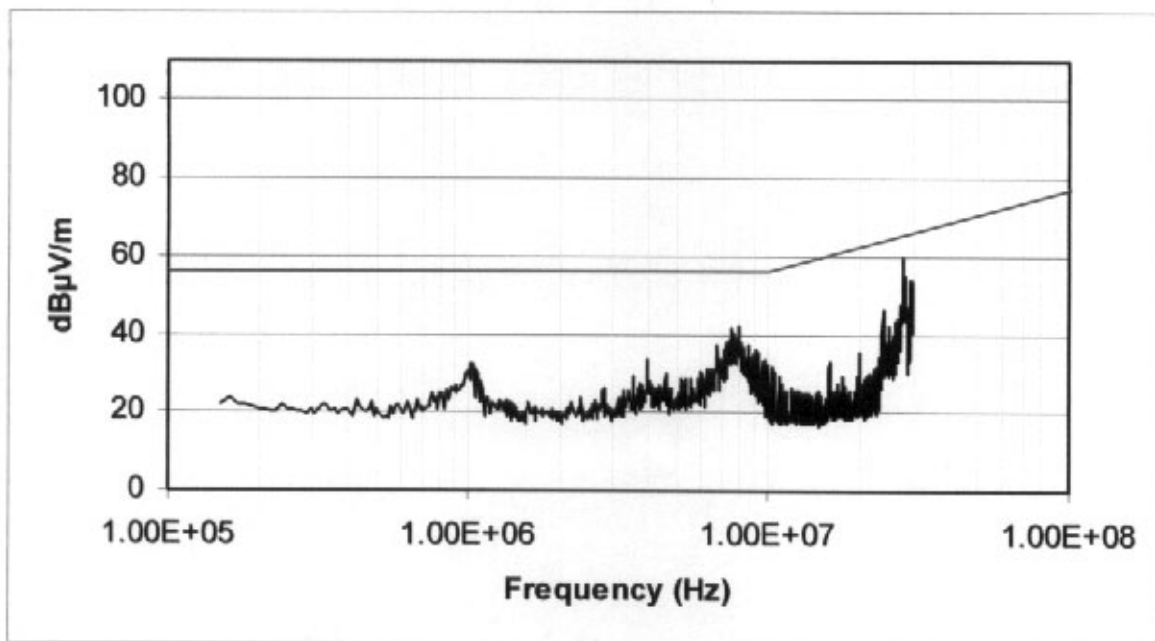
Picture 5: CE 07 Power on switching transient Waveform.



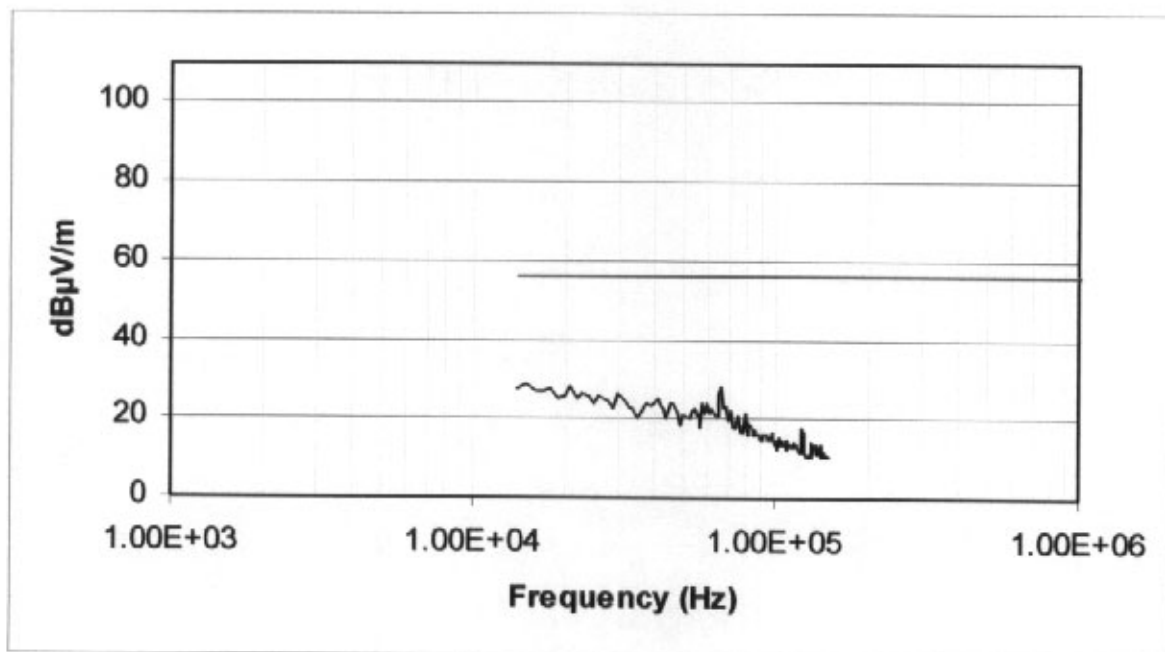
Picture 6: CE 07 Power off switching transient Waveform.

Attachment III

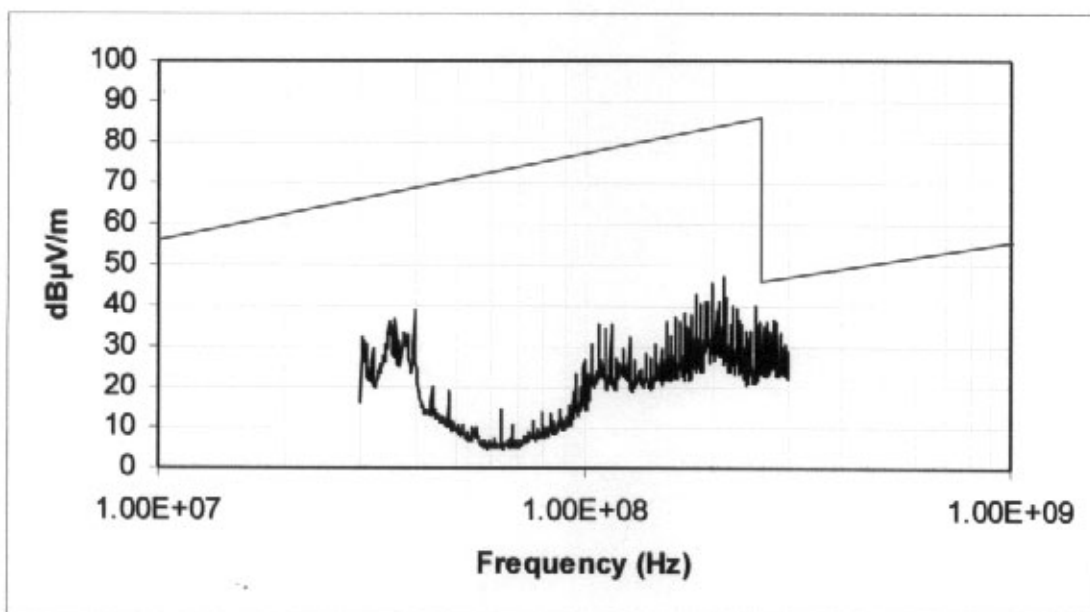
Results of radiated emissions



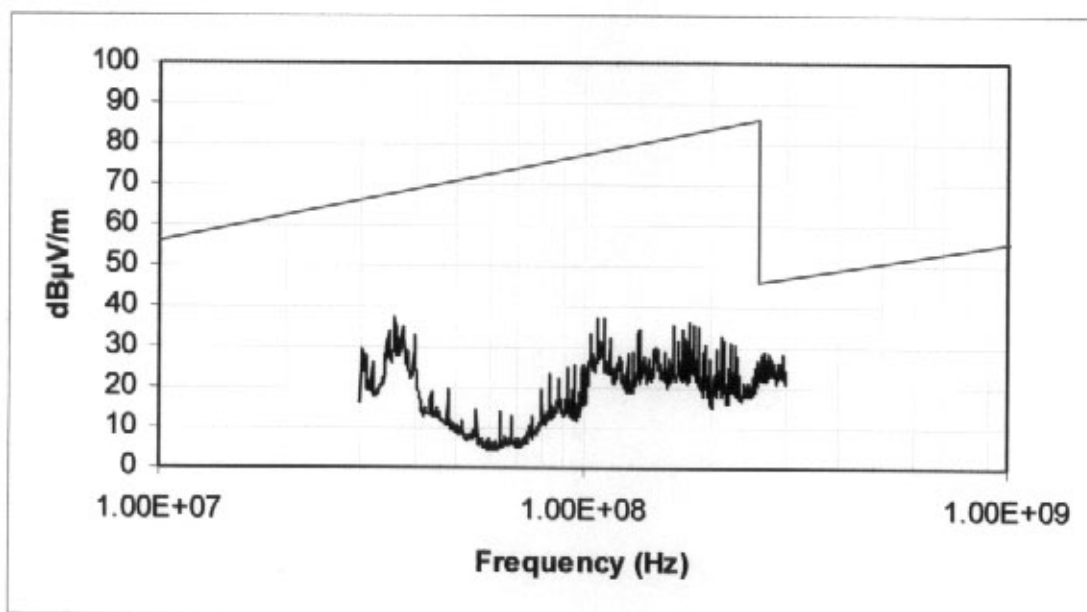
Picture 1: RE 02, 150 kHz – 30 MHz



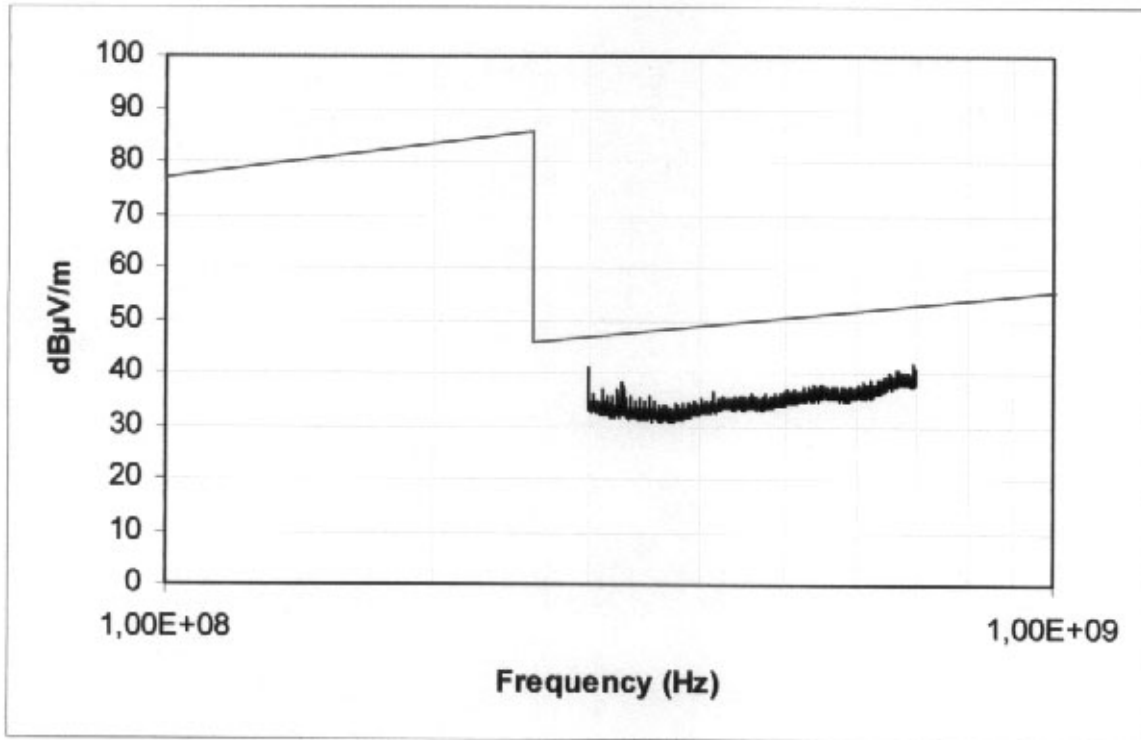
Picture 2: RE 02, 14 kHz – 30 MHz



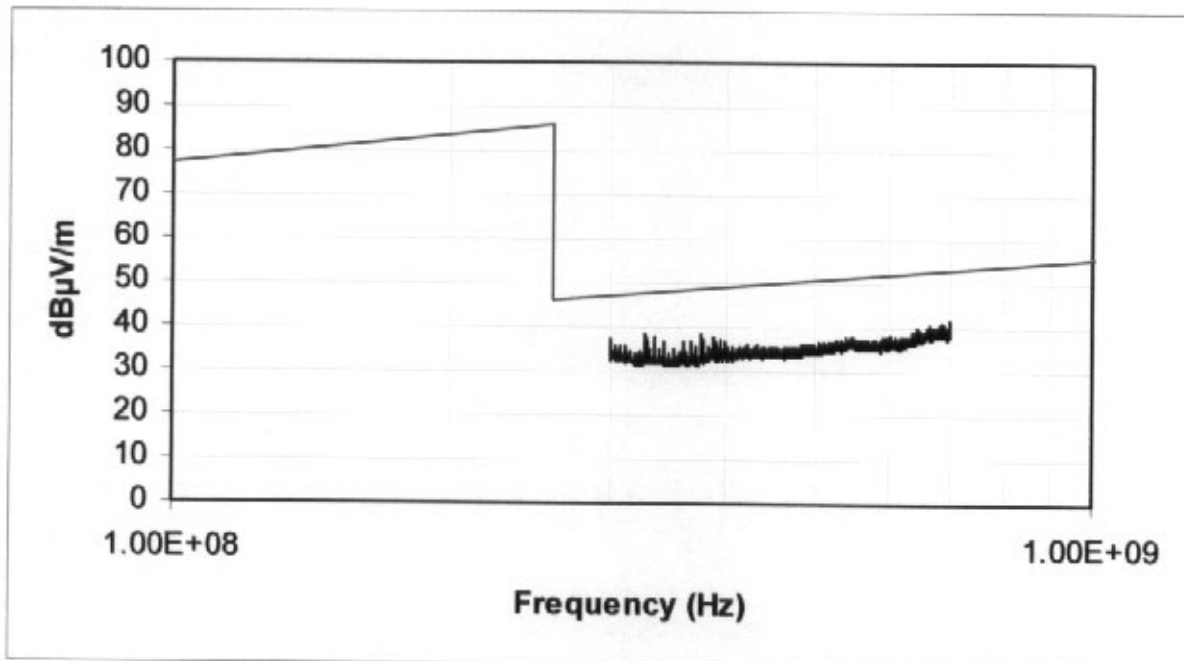
Picture 3: RE 02, 30 MHz – 300 MHz Pol.V.



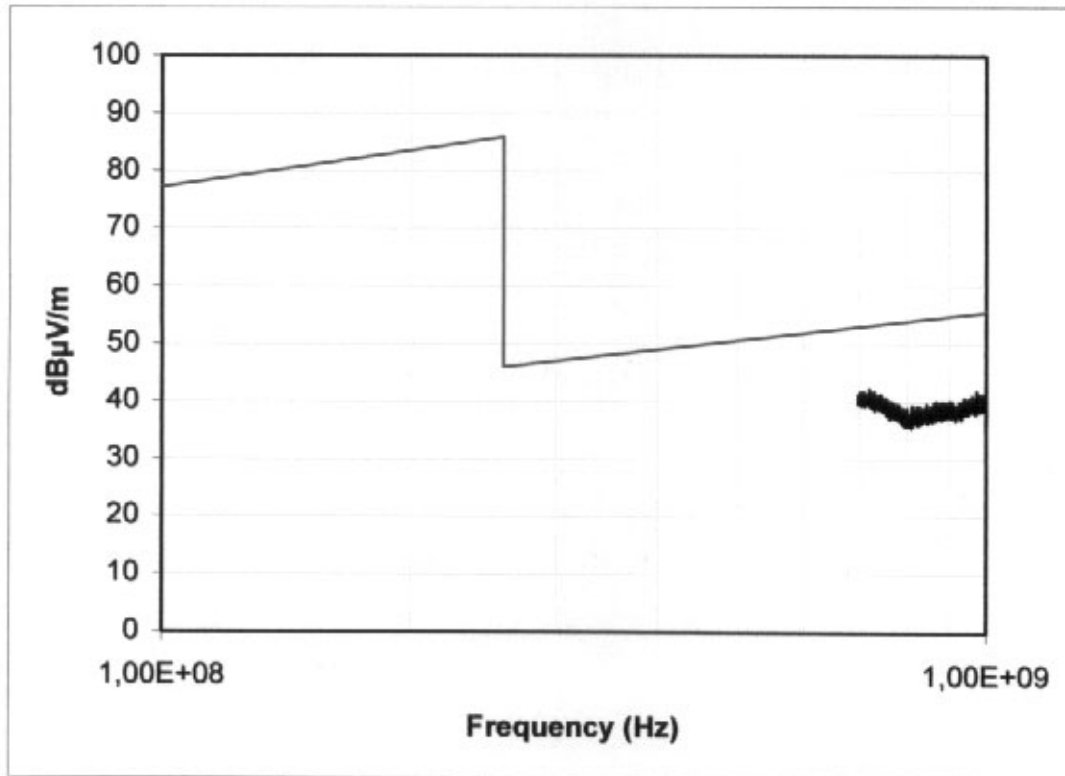
Picture 4: RE 02, 30 MHz – 300 MHz Pol.H.



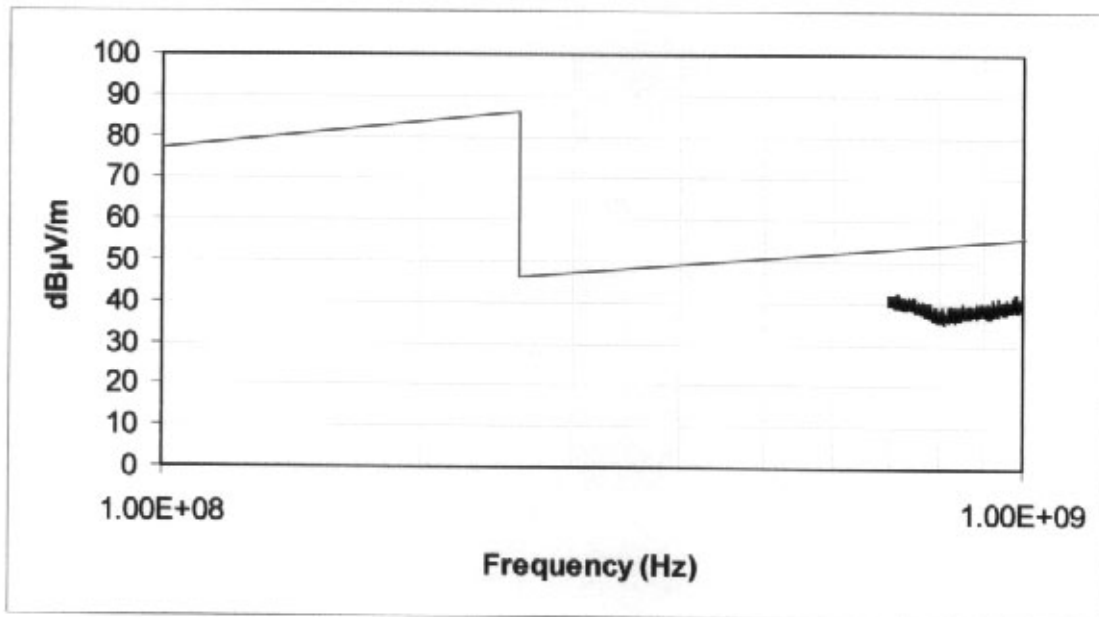
Picture 5: RE 02, 300 MHz – 700 MHz Pol.V.



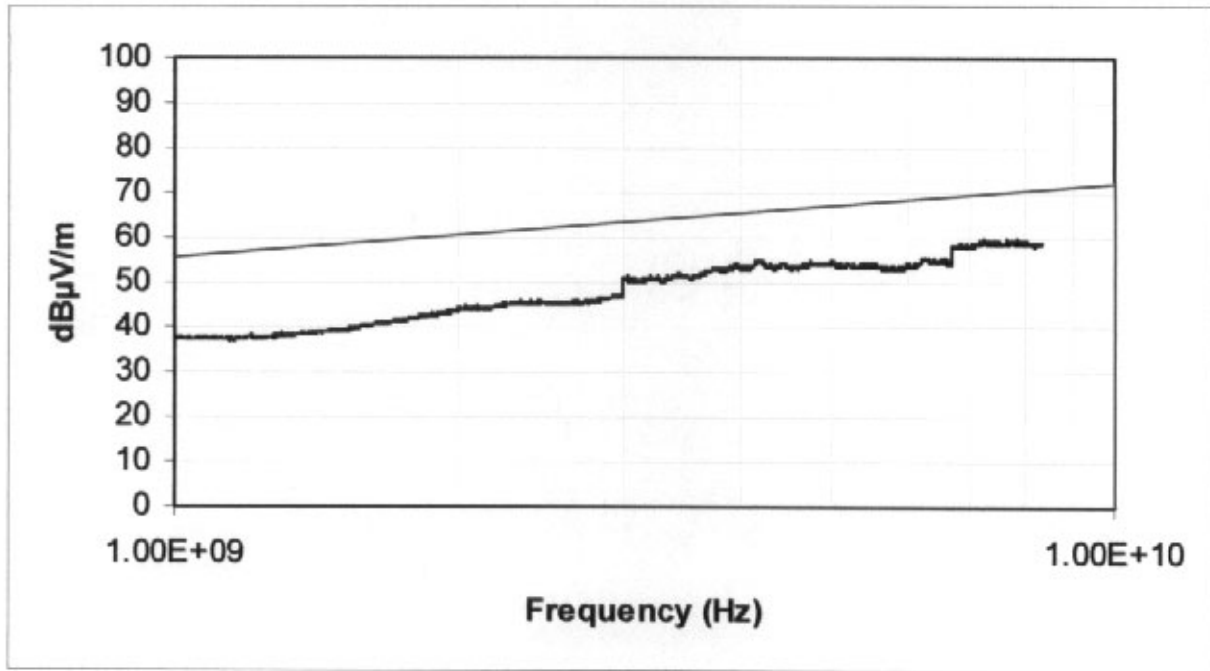
Picture 6: RE 02, 300 MHz – 700 MHz Pol.H.



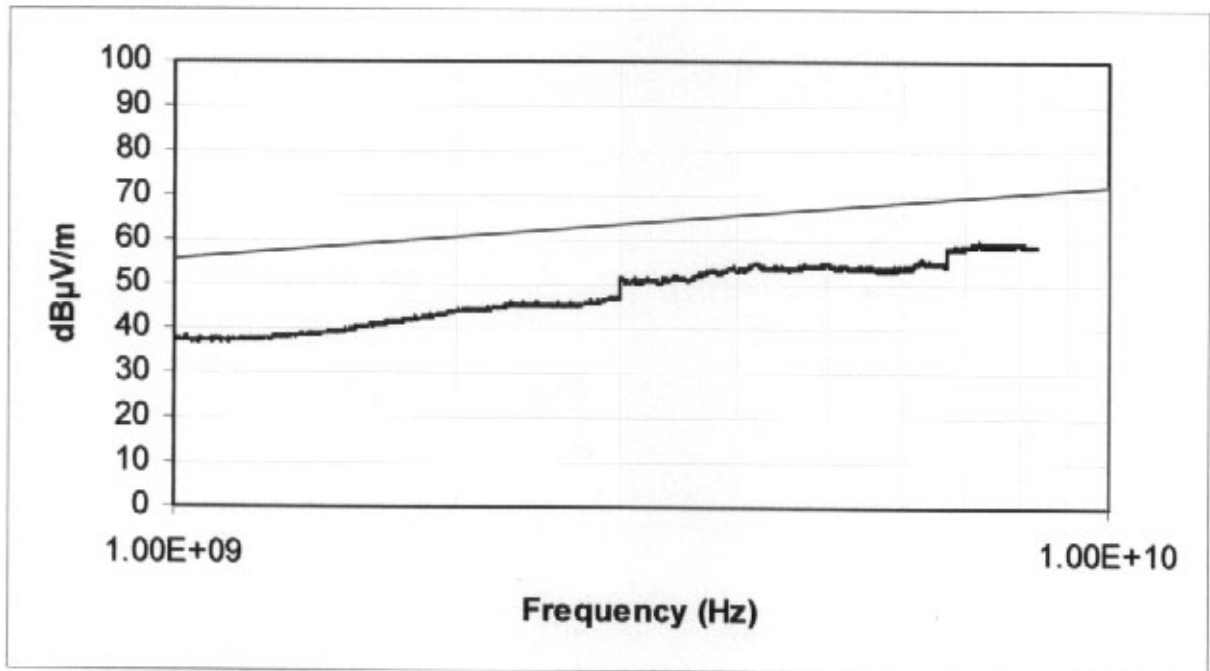
Picture 7: RE 02, 700 MHz - 1GHz Pol.V.



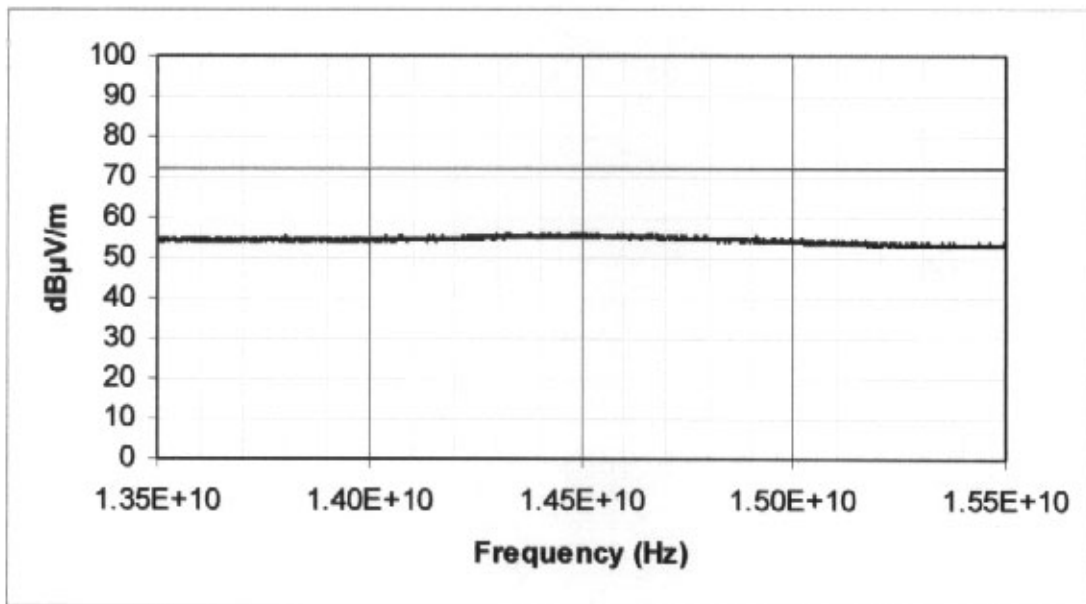
Picture 8: RE 02, 700 MHz - 1GHz Pol.H.



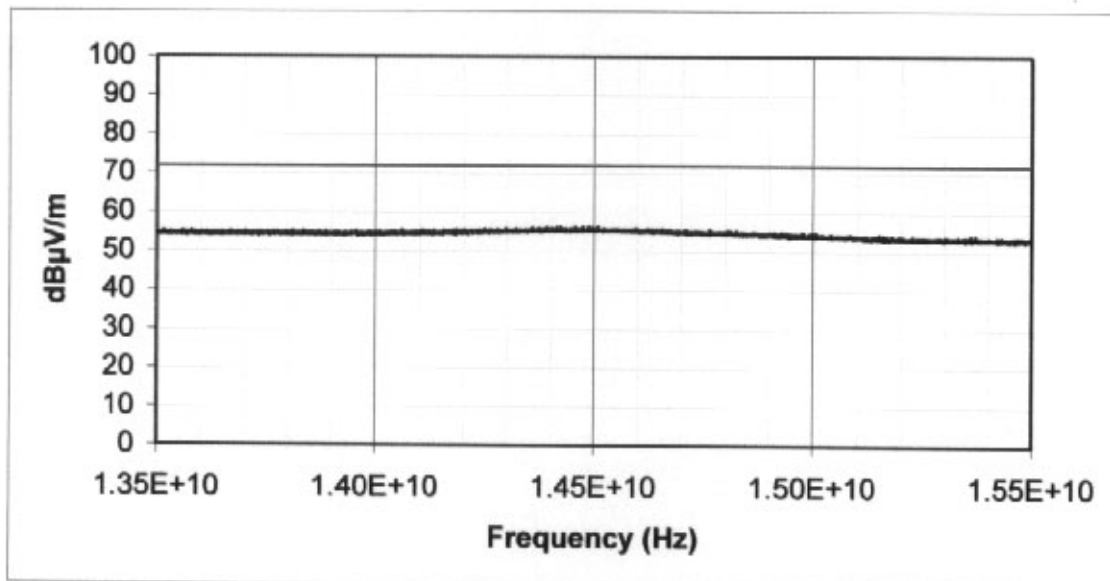
Picture 9: RE 02, 1 GHz – 10 GHz Pol H



Picture 10: RE 02, 1 GHz – 10 GHz Pol V



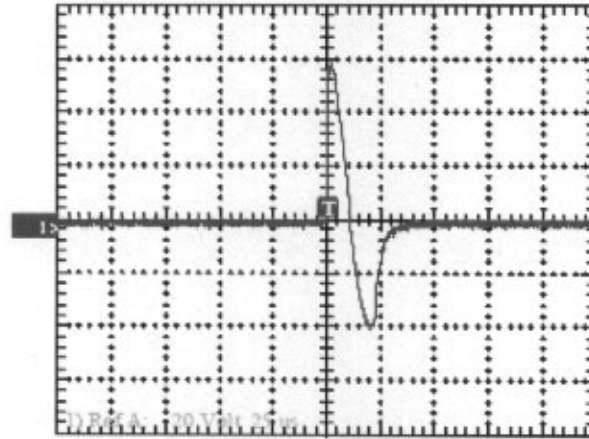
Picture 11: RE 02, 13.5 GHz - 15.5 GHz Pol H



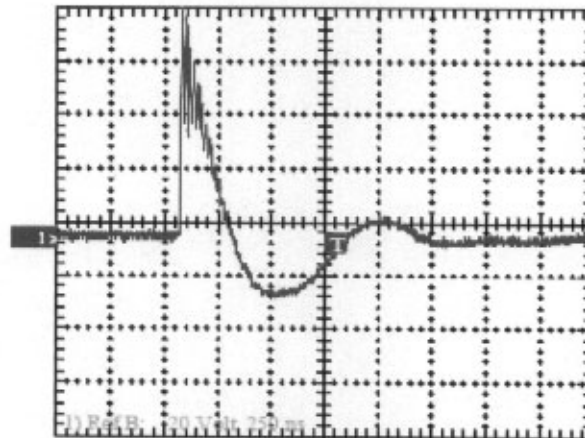
Picture 12: RE 02, 13.5 GHz - 15.5 GHz Pol H

Attachment IV

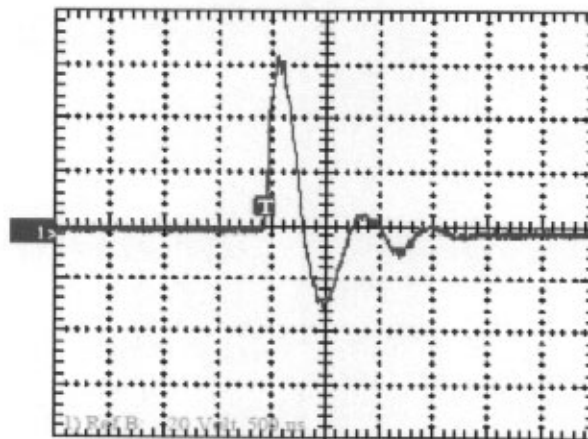
Test level applied in radiated at conducted susceptibility tests



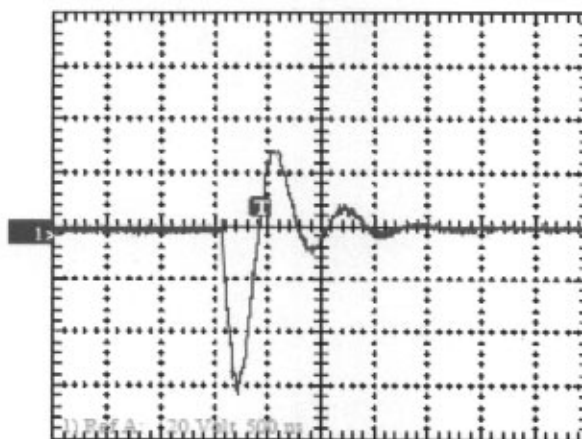
Picture 1: CS 06, 10 μ S Waveform-Calibration.



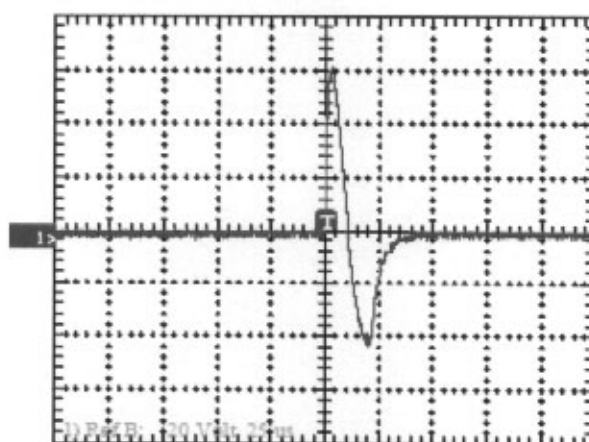
Picture 2: CS 06, 150 ns Positive Waveform-Calibration.



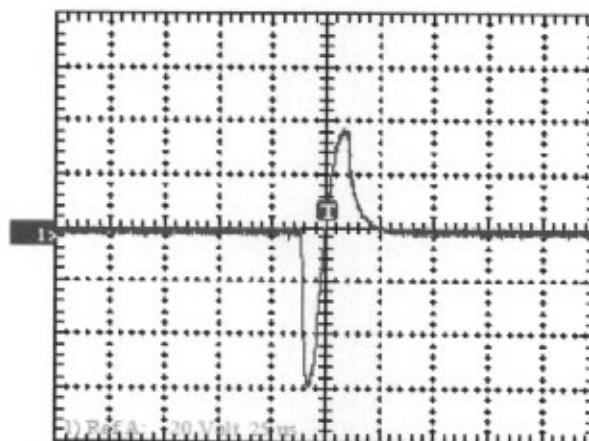
Picture 3: RS 02, 150 ns Positive Waveform.



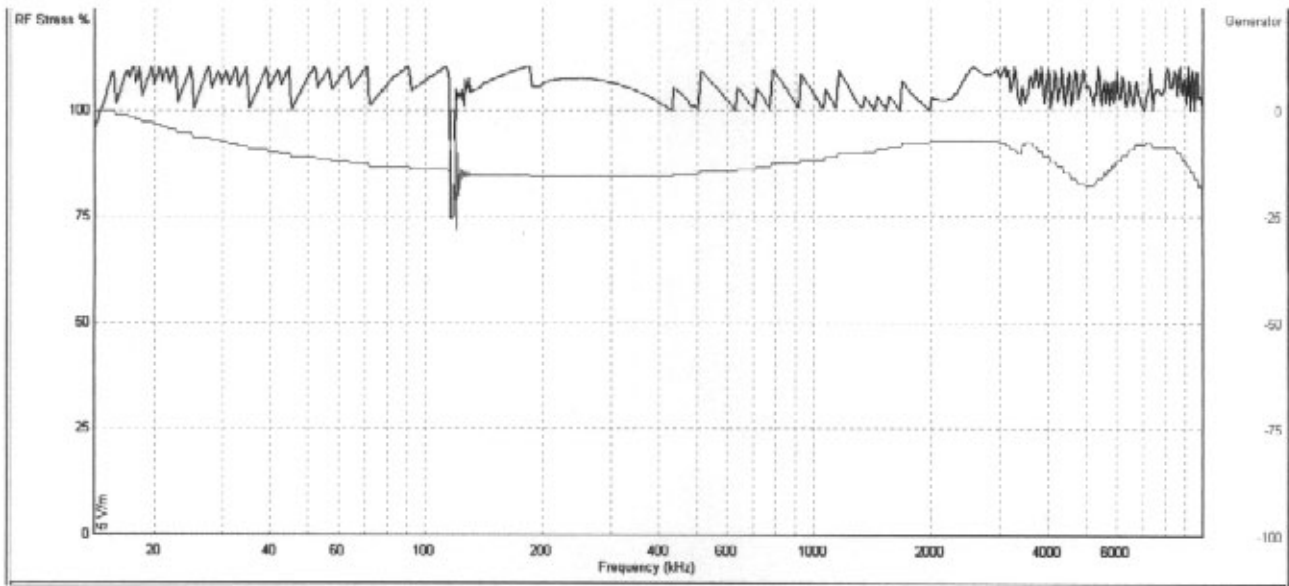
Picture 4: RS 02, 150 nS Negative Waveform.



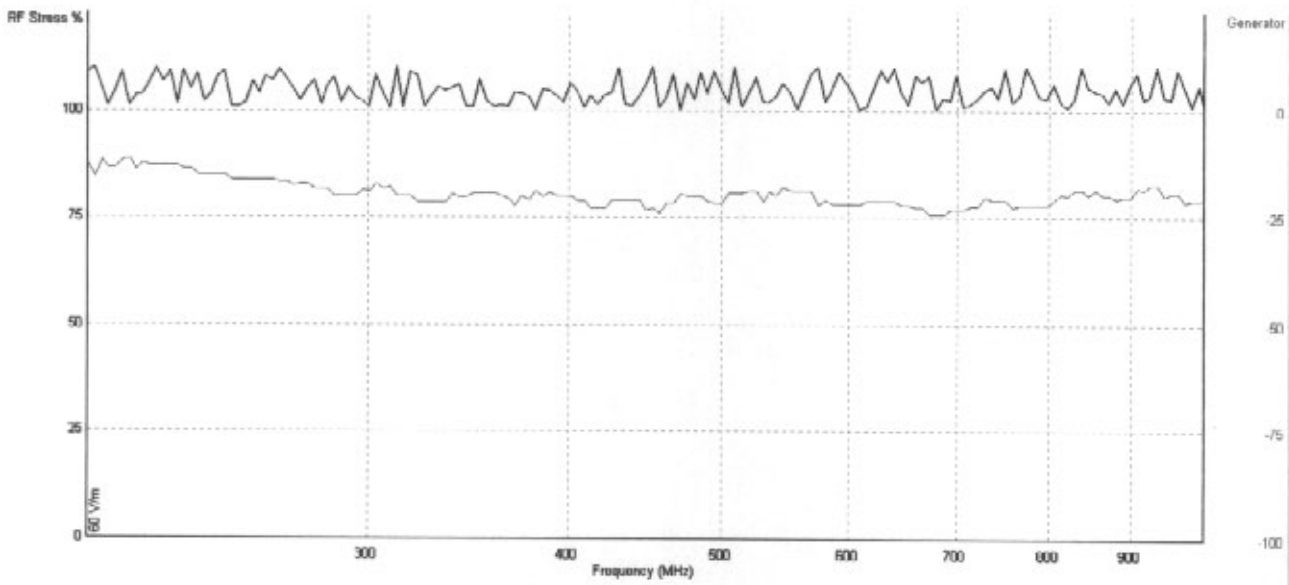
Picture 5: RS 02, 10 μ S Positive Waveform.



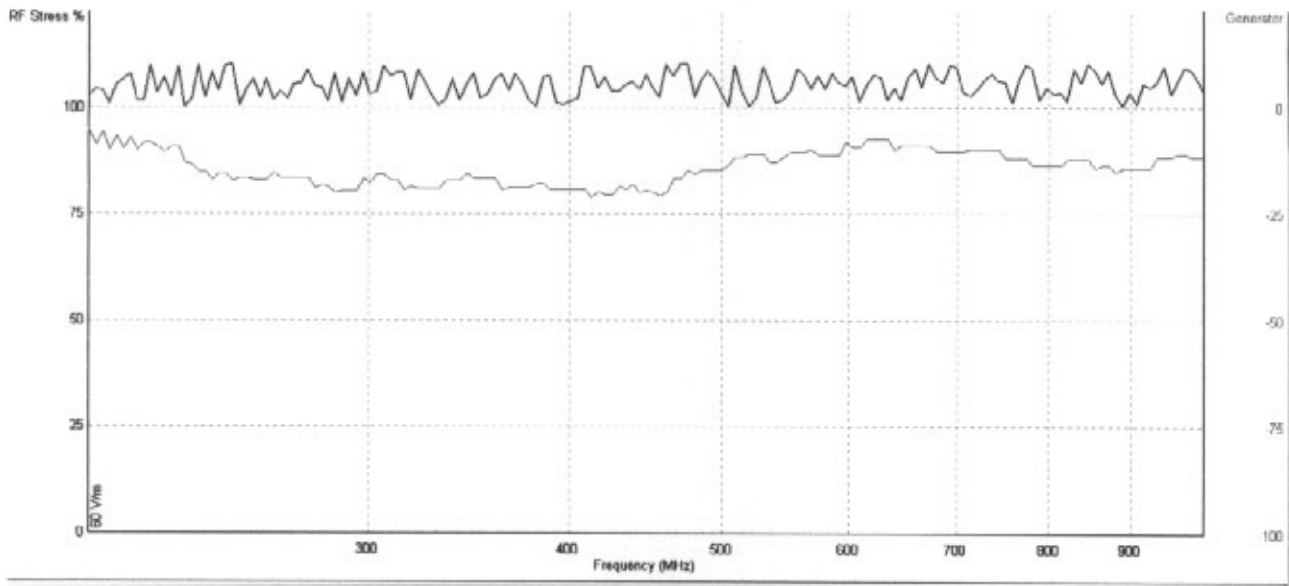
Picture 6: RS 02, 10 μ S negative Waveform.



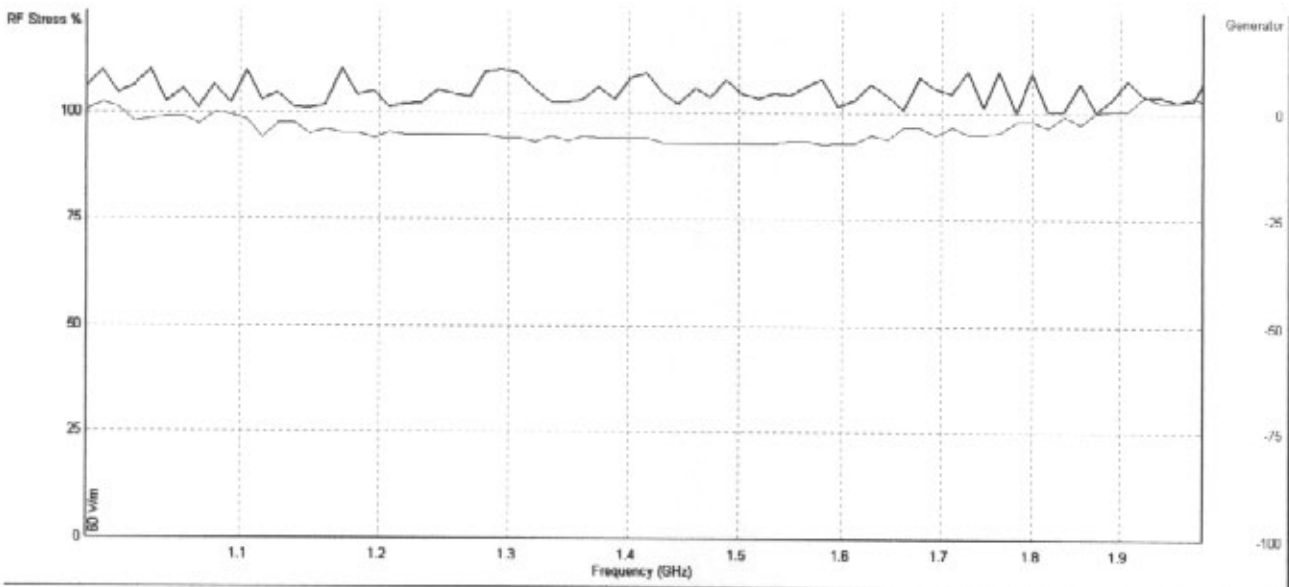
Picture 7: Field Applied in 14 kHz – 10 MHz range.



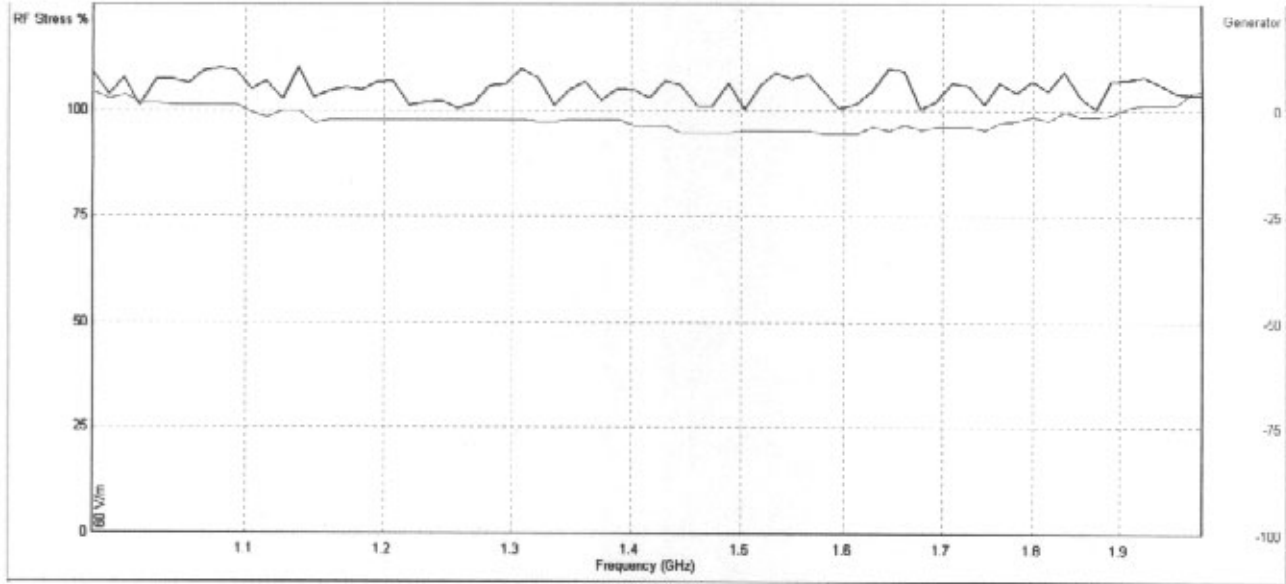
Picture 8: Field applied in 200 MHz – 1 GHz range Pol. H.



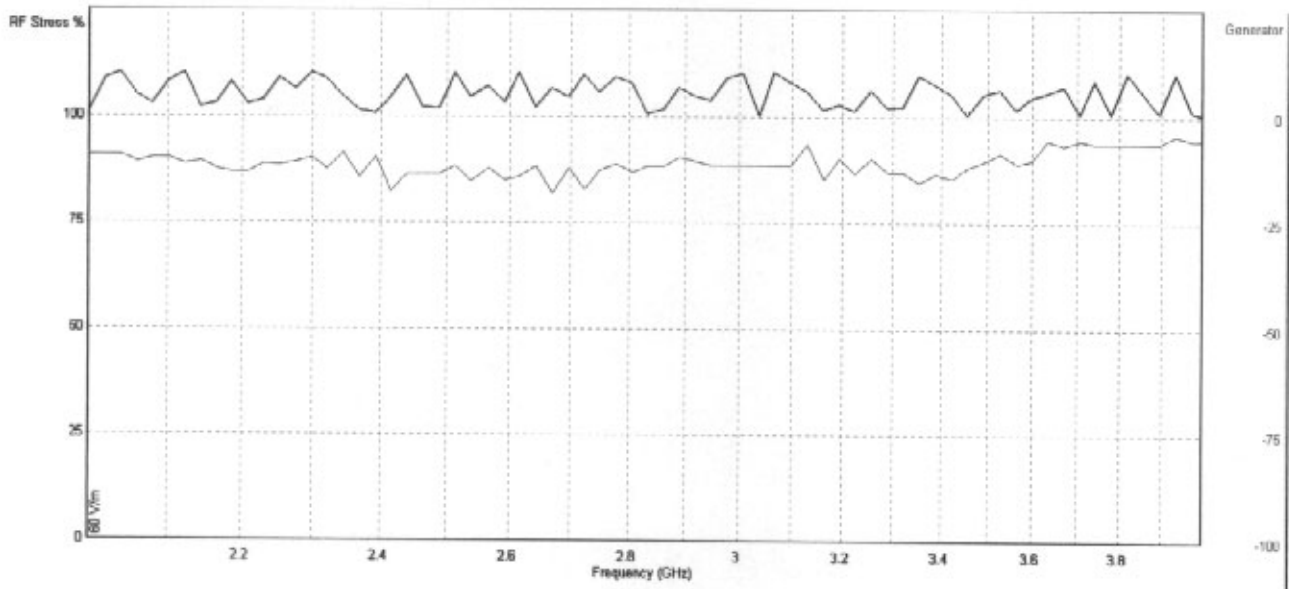
Picture 9: Field applied in 200 MHz – 1 GHz range Pol. V.



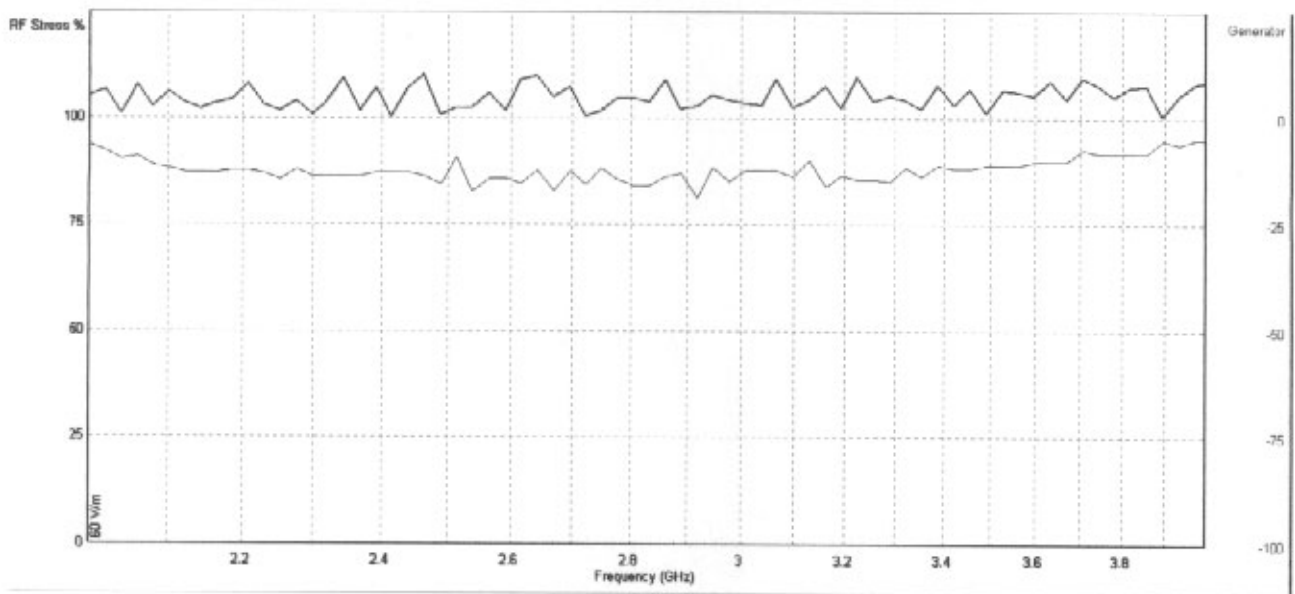
Picture 10: Field applied in 1 GHz – 2 GHz range Pol. H.



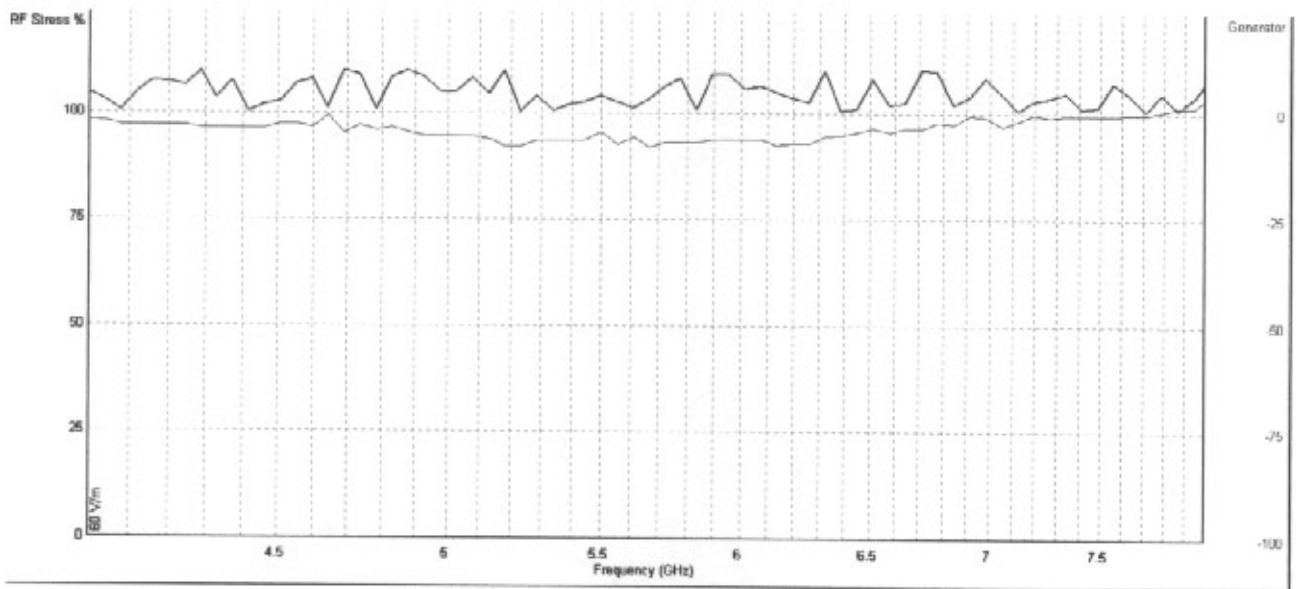
Picture 11: Field applied in the range 1 GHz – 2 GHz Pol. V.



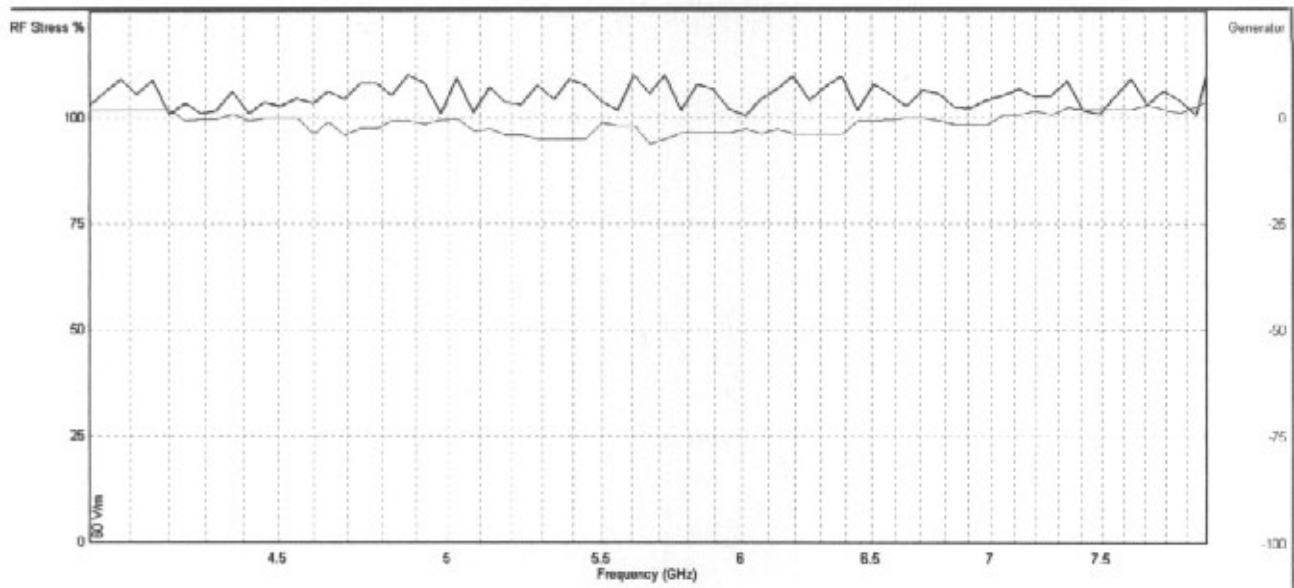
Picture 12: Field applied in the range 2 GHz – 4 GHz Pol. II.



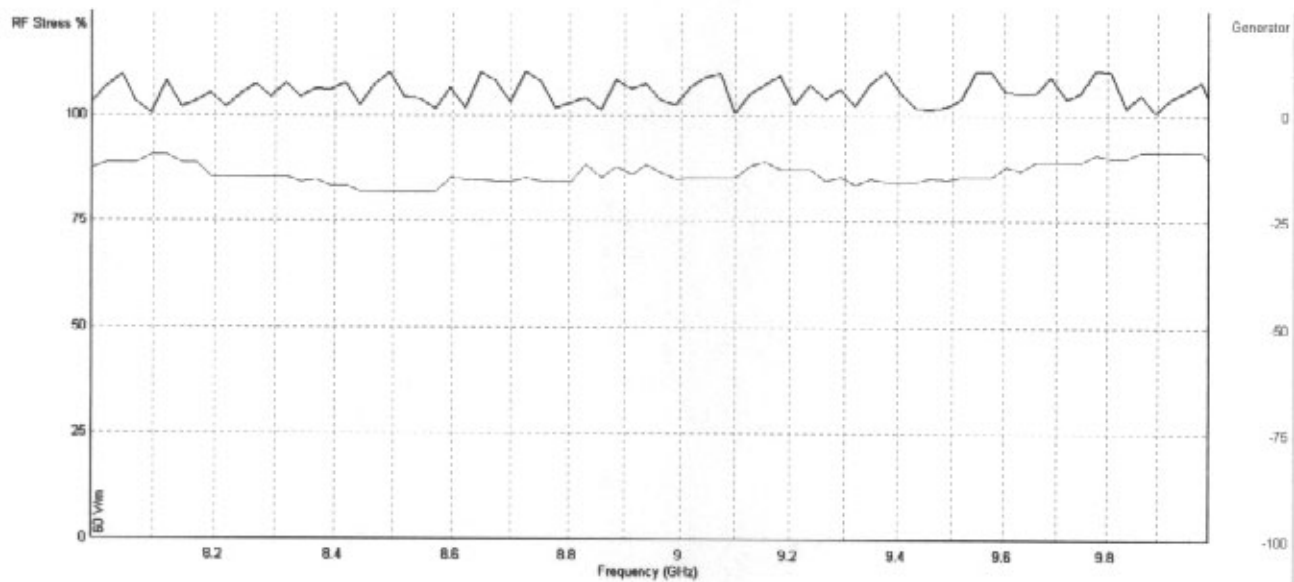
Picture 13: Field applied in the range 2 GHz – 4 GHz Pol. V.



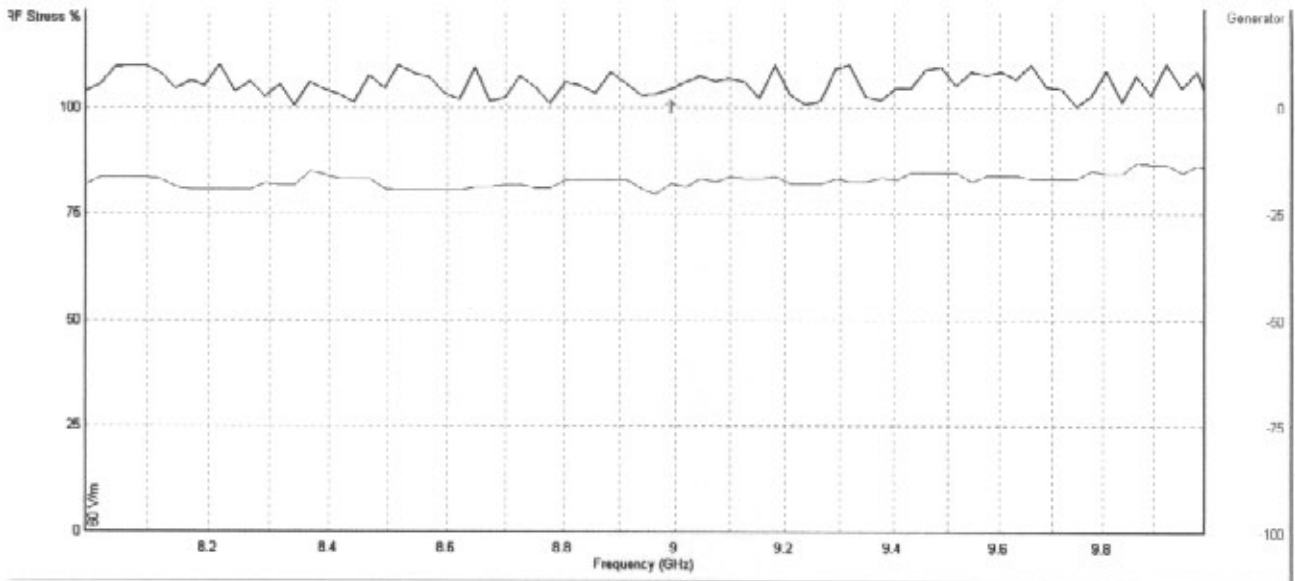
Picture 14: Field applied in the range 4 GHz – 8 GHz Pol. H.



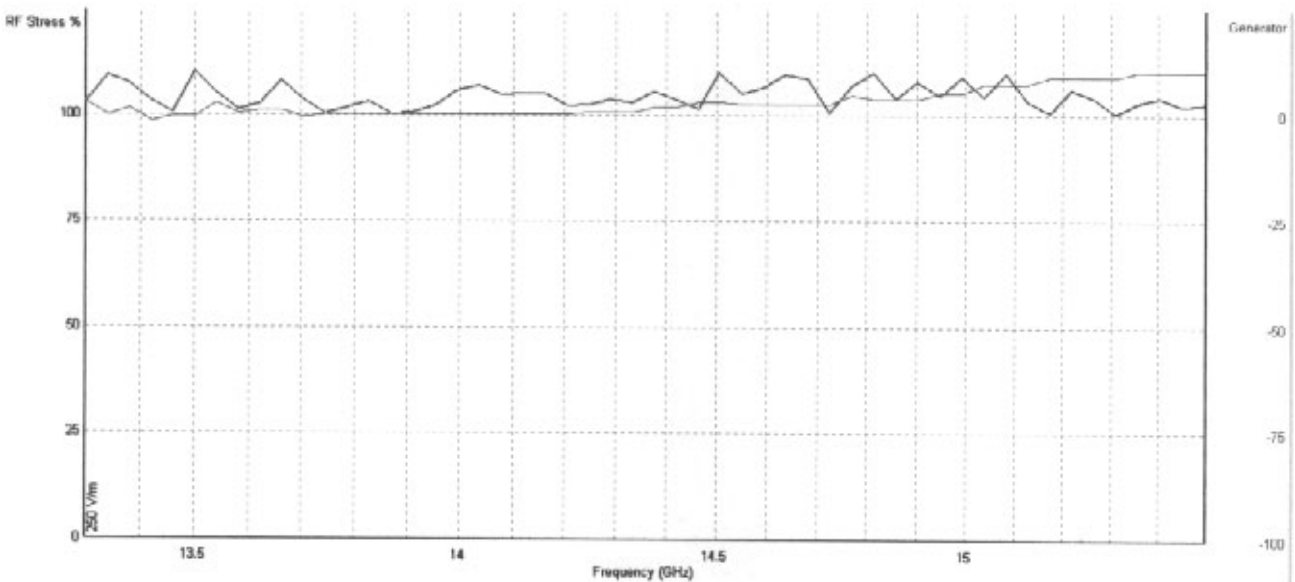
Picture 15: Field applied in the 4 GHz – 8 GHz range Pol. V.



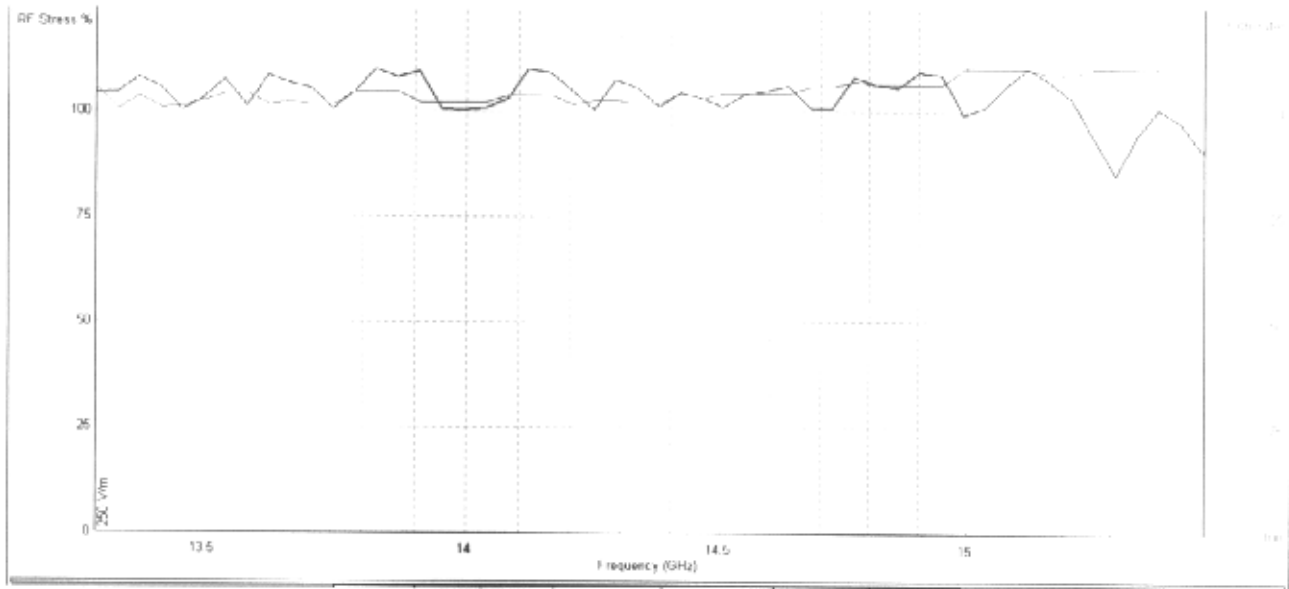
Picture 16: Field applied in the 8 GHz – 10 GHz range Pol. II.



Picture 17: Field applied in the 8 GHz – 10 GHz range Pol. V.



Picture 18: Field applied in 13.7 GHz - 15.2 GHz range Pol. H.



Picture 19: Field applied in 13.7 GHz - 15.2 GHz range Pol.V.

Note: In picture 7 and 19 low fields points are replayed for each frequency in manual mode till read 250 V/m on field meter. The antenna is placed at 20 cm from EUT.

Attachment V

Customer Requirements

Table 1. CE01 Emission Limits

Frequency	Emissions
30 Hz to 200 Hz	110 dBuA
200 Hz to 15 kHz	Decreasing log linearly with increasing frequency from 110 to 74 dBuA

* narrowband, NBW <= 100 Hz.

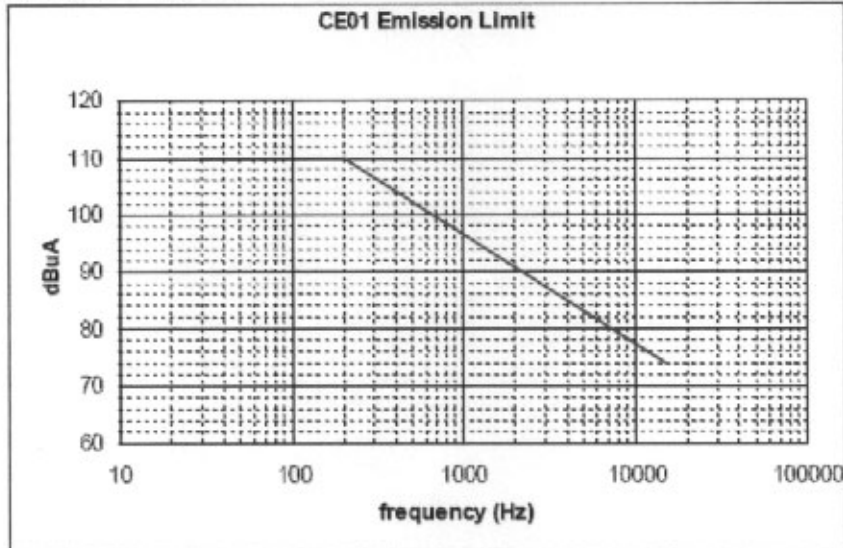


Table 2. CE03 Emission Limits

Frequency	Emissions
15 kHz to 500 kHz	Decreasing log linearly with increasing frequency from 74 to 45 dBuA
500 kHz to 50 MHz	45 dBuA

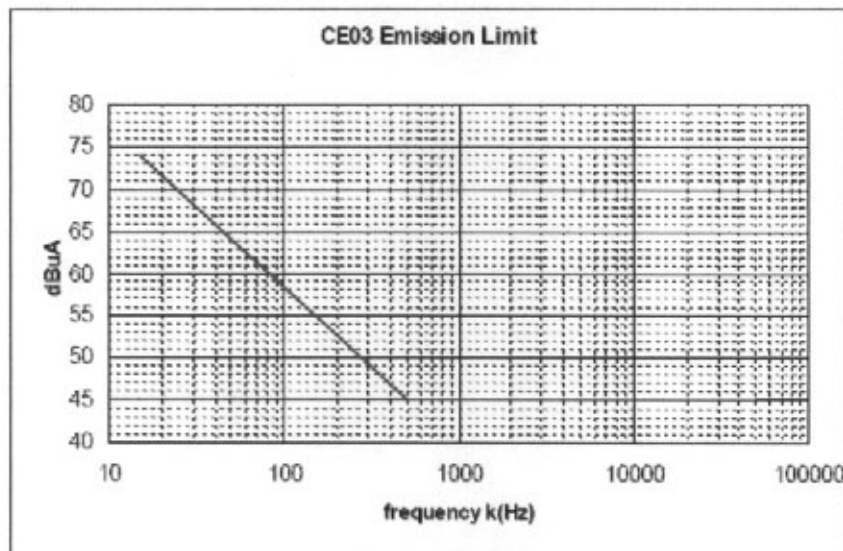


Table 3. CE07 Mode Switching Transients Envelope

Time (us)	Percentage of Nominal Line Voltage
0.1 – 10	+ 50%
10 – 50	Decreasing log linearly with increasing time from + 50 to + 20%
50 – 1000	Decreasing log linearly with increasing time from + 20 to + 5% or + 6 Volts(V), whichever is greater
1000 – 10,000	+ 6% or + 0.5 V, whichever is greater
10,000 – 100,000	+ 5% or + 0.5 V, whichever is greater

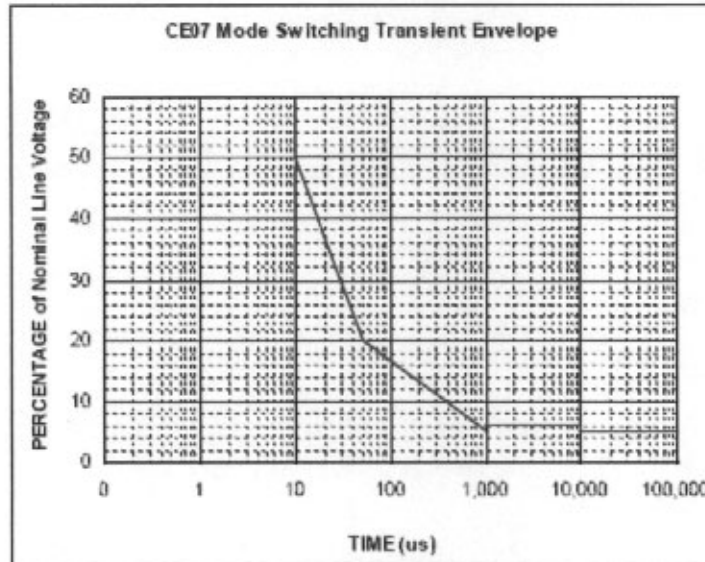


Table 4. CS01 Electromagnetic Energy Injection

Frequency	Voltage
30 Hz – 2 kHz	5 Vrms or 10% of supply voltage (E1), whichever is less
2 kHz – 50 kHz	Decreasing log linearly with increasing frequency from 5 Vrms, or E1 whichever is less, to either 1 Vrms or 1 % of the supply voltage, whichever is less

The requirement is also met when the audio power source adjusted to dissipate 50 Watts in a 0.5 ohm load, cannot develop the required voltage at the EUT power input terminals, and the EUT is not susceptible to the output of the signal source.

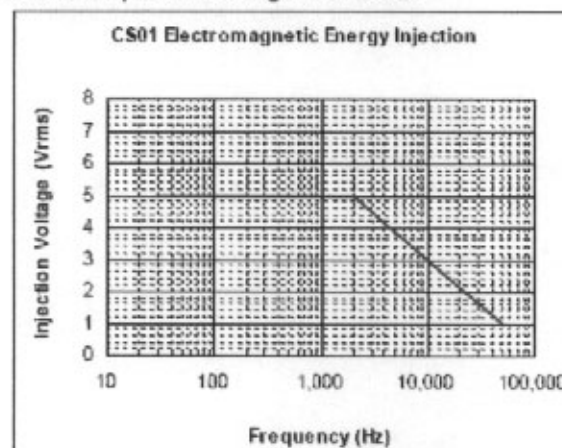
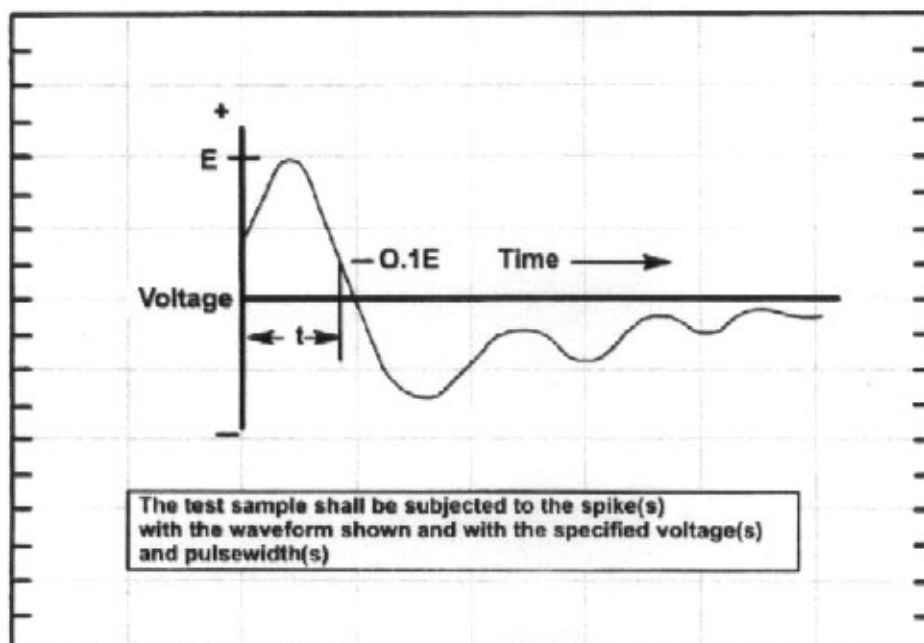


Table 5. CS02 Electromagnetic Energy Injection

Frequency	Voltage
50 kHz – 50 MHz	1 Vrms The requirement is also met under the following condition: A 1 Watt source of 50 ohms impedance cannot develop the required voltage at the EUT power input terminals, and the EUT is not susceptible to the output of the signal source.

Table 6. CS06 Limits

SPIKE #1	$E = \pm$ Twice the nominal line voltage, $t = 10 \mu s \pm 20\%$
SPIKE #2	$E = \pm$ Twice the nominal line voltage, $t = 0.15 \mu s \pm 20\%$



SPIKE #1 $E = \pm$ Twice the nominal line voltage, $t = 10$ microseconds ± 20 percent

SPIKE #2 $E = \pm$ Twice the nominal line voltage, $t = 0.15$ microseconds ± 20 percent

CS06 and RS02 Equipment Limit

Table 7. RE02 Field Emission Limits (Narrowband)

Frequency	Emissions
14 kHz – 10 MHz	56 dBuV/m
10 MHz – 259 MHz	Increasing log linearly with increasing frequency from 56 to 86 dBuV/m (16 dB per decade)
259 MHz – 10 GHz	Increasing log linearly with increasing frequency from 46 to 72 dBuV/m (16 dB per decade)
13.5 GHz – 15.5 GHz	72 dBuV/m

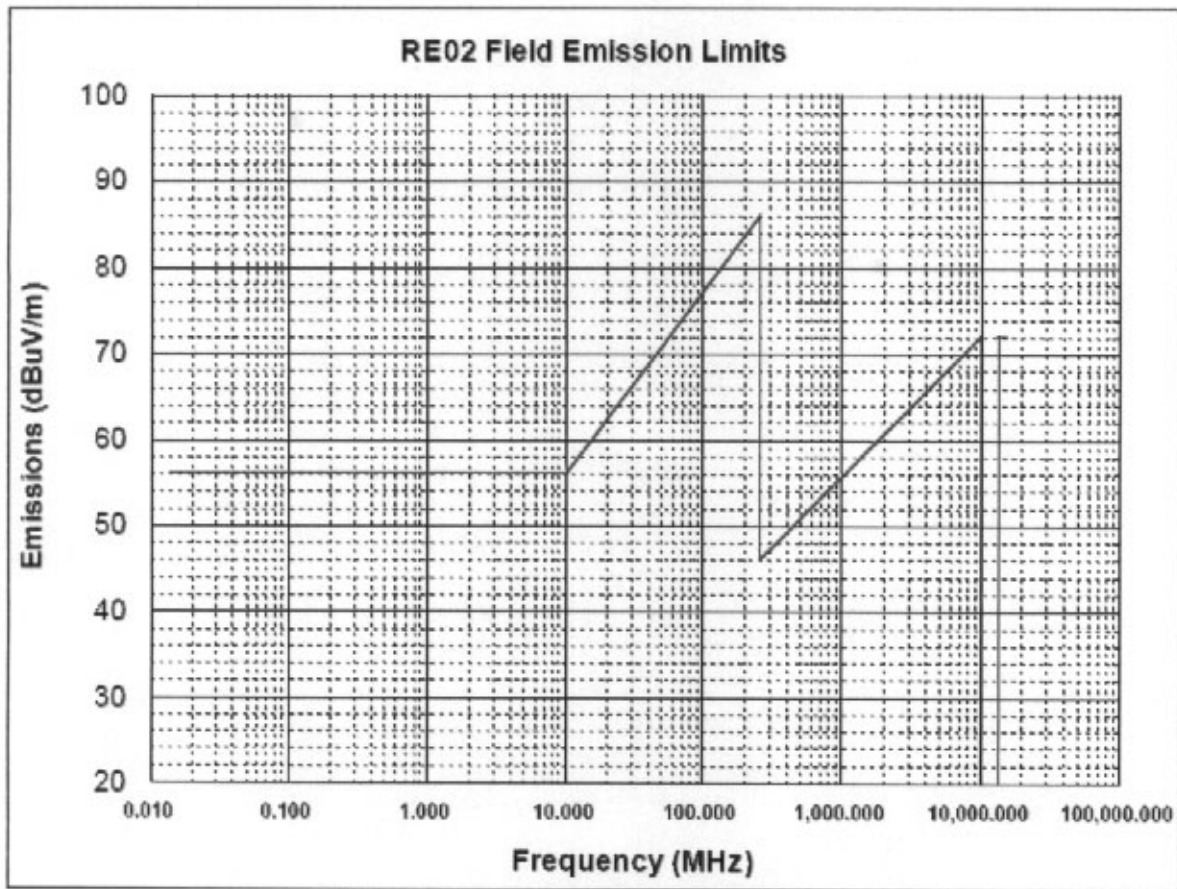


Table 8. RS02 Limits

SPIKE #1	E = ± Twice the nominal line voltage, t = 10 us ± 20%
SPIKE #2	E = ± Twice the nominal line voltage, t = 0.15 us ± 20%

* The waveform is the same as that specified for CS06 test.

Table 9. RS03 Limit Level

Frequency/Range	Radiated Electric Field Level
14 kHz – 10 MHz	5 V/m
200 MHz – 8 GHz	60 V/m
8 GHz – 10 GHz	50 V/m
2.2 GHz	161 V/m
8.5 GHz	79 V/m
13.7 GHz – 15.2 GHz	250 V/m