TEST REPORT

EMC DEPARTMENT

RAYMARINE UK LTD

Test of: Raymarine UK Ltd.
4kW Digital Radome Radar

To: FCC Part 80: 2007
and FCC Part 2: 2007

(Leisure Marine Radar Equipment)

Test Report Serial No. 698/1038a

Checked By: Andy Little Senior Compliance Engineer	Approved By: Peter Bowen Compliance Manager
Tested By: Mike Thompson / Paul Pitt	Author: Mike Thompson EMC Engineer

Issue Date: **1st Dec 2008**	**Test Dates:** **21st October 2008 to 29th October 2008**

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1 Client Information

Company Name	Raymarine UK Ltd.
Address:	Robinson Way Anchorage Park Portsmouth Hampshire PO3 5TD England, U.K.
Contact Name:	Mr. P. Bowen, Compliance Manager

2 Equipment Under Test (EUT)

2.1 Identification of Equipment Under Test (EUT)

Brand Name:	Raymarine
Model Name or Number:	RD418D 4kW 18" Digital Radome Radar RD424D 4kW 24" Digital Radome Radar
Unique Type Identification:	18" 4kW Digital Radome Radar with 10m Cable E92129 18" 4kW Digital Radome Radar with no cable E92130 24" 4kW Digital Radome Radar with 10m Cable E92131 24" 4kW Digital Radome Radar with no cable E92132
Part and Serial Number of product tested:	18" 4kW Digital Radome Radar (RD418D) P/No. E92130 S/No. 080925B
Country of Manufacture:	Hungary
FCC ID Number:	FCC ID: PJ5-18DD4KW 18" 4kW Digital Radome Radar FCC ID: PJ5-24DD4KW 24" 4kW Digital Radome Radar
Date of Receipt:	23rd September 2008

2.2 Description of EUT

The equipment under test is an X-band marine radar intended for use on leisure craft and small workboats, and is comprised of:

Scanner Unit: 4kW X-band transmitter within 18" or 24" Radome.
Display Unit: Compatible with any compatible Raymarine multifunction display

This test report covers both 18" & 24" systems. The hardware is common to both systems; the only difference being the plastic housing and antenna size (width).

2.3 Modifications incorporated in EUT

The EUT has not been modified from what is described by the Model Name and Unique Type Identification stated above.

2.4 Additional information related to Testing

Power Supply Requirement:	Nominal 12-24V DC supply
Intended Operating Environment:	Leisure Marine & Small Workboats
Weight:	4kW Radome (18”): 9.5kg (21lbs) 4kW Radome (24”): 10kg (22lbs)
Dimensions:	4kW Radome (18”): 521mm (20.5”) Ø x 247mm (9.7”) Height 4kW Radome (24”): 625mm (25.67”) Ø x 247mm (9.7”) Height
Interface Ports:	Combined Power and Network

2.5 Support Equipment

Description	Unique Type Identifier	Serial Number
E120 Multifunction Display	Raymarine Part No. E02013	S/No. EMC070122A
Seatalk^{HS} Switch	Raymarine Part No. E55058	S/No. EMC0811049

3 Test Specification, Methods and Procedures

3.1 Test Specification

Reference:	FCC Part 80: 2007and FCC Part 2:2007
Title:	Code of Federal Regulations, Part 80 (47CFR): 2007 Stations in the maritime services Code of Federal Regulations, Part 2 (47CFR): 2007 Frequency Allocations and radio treaty matters; general rules and regulations
Comments:	The test facility used for the radiated emissions portions of these tests is an alternative test site as described in ANSI C63.4-2003, being a 3m test range within a semi-anechoic chamber, with antenna height scanning from 1 – 4 metres and meeting the +/-4dB NSA criterion. It is registered with the FCC under the 2.948 (47CFR) listing procedure with Reference Number 970522, and was last recalibrated in July 2008.
Purpose of Test:	To demonstrate compliance of the 4kW Digital Radome Radar to the appropriate clauses of Parts 2 and 80 of the FCC Rules.

3.2 Methods and Procedures

The methods and procedures used were as detailed in:

ANSI C63.2-1996
Title: American National Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz – Specifications

ANSI C63.4-2003
Title: 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

ANSI C63.5-2006
Title: American National Standard for Electromagnetic Compatibility – Radiated Emission Measurements in Electromagnetic Interference (EMI) Control – Calibration of Antennas (9 kHz to 40 GHz)

CISPR 16-1 (1999)
Title: Specification for radio disturbance and immunity measuring apparatus and methods
Part 1: Radio disturbance and immunity measuring apparatus

CISPR 16-4 (2002)
Title: Specification for radio disturbance and immunity measuring apparatus and methods
Part 4: Uncertainty in EMC measurements

3.3 Definition of Measurement Equipment

The measurement equipment used complied with the requirements of the standards referenced in the Methods and Procedures section above. Appendix A contains a list of the test equipment used.

4 Deviations from the Test Specification

None.

5 Operation of the EUT during Testing

5.1 Operating Conditions

1. Radiated Emissions, 9kHz to 40GHz: The EUT was located on a non-conducting support above a turntable on a 3m test range within a semi-anechoic chamber (Raymarine Site 3)

2. The EUT was located in a laboratory environment for all other tests.

3. During testing, the EUT was powered by a nominal 12V DC supply except when measuring Frequency Variation with Voltage. [FCC Part 2, 1055(d)]

5.2 Operating Modes

The EUT was tested in the following operating modes:

1. Radiated emissions: Transmitting into a rotating non-reflective load with the transmitter set to 75 and 1000ns pulse widths.

2. Conducted emissions: Transmitting into a fixed non-reflective load with the transmitter set to 75, 450 and 1000ns pulse widths.

3. Variation of transmit frequency with voltage and temperature: The transmitter was set to the half nautical mile range (75ns pulse width) and the six nautical mile range (1000ns pulse width).

4. Transmitter power, pulse width, occupied bandwidth and P.R.F. Transmitting into a fixed non-reflective load.

5.3 Configuration and peripherals

1. The 4kW 18” Radome was connected to a Seatalk^{HS} Switch & 12V power with a cable of 15m length. The Seatalk^{HS} Switch was also connected to an E120 display unit with a standard 10m CAT 5 network cable. A transmit dummy load was connected to the radar antenna port. A 12V DC supply was connected to the Radar, Seatalk^{HS} Switch and Display Unit.

2. This configuration is defined as being likely to be the worst case as regards emissions.

3. Appendix A of this report contains a full list of test equipment used and Appendix C contains a schematic diagram of the test configuration.

6 Summary of Test Results

6.1 Summary of Tests

6.1.1 Radiated Spurious Emissions

Frequency Range	Specification Reference	Compliance Status
9kHz to 40GHz	2.1053 and 80.211(f)	Complied

6.1.2 Conducted Spurious Emissions

Frequency Range	Specification Reference	Compliance Status
9kHz to 40GHz	2.1051 and 80.211(f)	Complied

6.1.3 RF Power Output

6.1.3.1 Peak Power

Nominal Pulsewidth Range (ns)	Specification Reference	Compliance Status
75 to 1000	2.1046(a) and 80.215(a)	Complied

6.1.3.2 Average Power

Nominal Pulsewidth Range (ns)	Specification Reference	Compliance Status
75 to 1000	2.1046(a) and 80.215(a)	Complied

6.1.3.3 Pulse Width

Nominal Pulsewidth Range (ns)	Specification Reference	Compliance Status
75 to 1000	2.1046(a) and 80.215(a)	Complied

6.1.3.4 PRF

Nominal Pulsewidth Range (ns)	Specification Reference	Compliance Status
75 to 1000	2.1047(d) and 80.213(g)	Complied

6.1.4 Variation of Frequency with Voltage

6.1.4.1 75ns

Nominal Pulsewidth (ns)	Specification Reference	Compliance Status
75	2.1055(d)	Complied

6.1.4.2 1000ns

Nominal Pulsewidth (ns)	Specification Reference	Compliance Status
1000	2.1055(d)	Complied

6.1.5 Variation of Frequency with Temperature

6.1.5.1 75ns

Nominal Pulsewidth (ns)	Specification Reference	Compliance Status
75	2.1055(a and b)	Complied

6.1.5.2 1000ns

Nominal Pulsewidth (ns)	Specification Reference	Compliance Status
1000	2.1055(a and b)	Complied

6.1.6 Occupied Bandwidth

Nominal Pulsewidth Range (ns)	Specification Reference	Compliance Status
75 to 1000	2.1049(i) and 80.205	Complied

6.1.7 Transmitter Frequency Tolerance

Nominal Pulsewidth Range (ns)	Specification Reference	Compliance Status
75 to 1000	80.209(b)	Complied

6.1.8 Suppression of Interference Aboard Ships

80.217. When the radar is in the Standby mode of operation, the local oscillator is automatically switched off.

6.2 Location of Tests

All the measurements described in this report were performed in the EMC Department at the premises of Raymarine Ltd., Robinson Way, Anchorage Park, Portsmouth, Hampshire PO3 5TD, England, U.K.

7 Measurements, Examinations and Derived Results

7.1 General Comments

This section contains test results only. Details of the test methods and procedures can be found in Appendix B of this report.

Measurement uncertainties are stated in accordance with the requirements of CISPR 16-4:2002. Please refer to Section 8 for details of measurement uncertainties.

The highest frequency generated by the EUT is 9.4GHz. Consequently, tests were performed up to 40GHz.

7.2 Field Strength Measurements

7.2.1 Magnetic Field Measurements: Frequency Range 9 kHz to 30 MHz

Plots of measurements using a peak detector can be found in Appendix D.

No emissions exceeded a level of 50dBuV/m.

Details of the limit line calculation can be seen in Appendix B.

7.2.2 Electric Field Measurements: Frequency Range 30 MHz to 2000 MHz

Plots of measurements can be found in Appendix D.

The highest quasi-peak levels measured were less than 54dBuv/m

Details of the limit line calculation can be seen in Appendix B

7.2.3 Electric Field Measurements: Frequency Range: 2GHz to 40GHz

Plots of measurement scans can be found in Appendix D.

The following table lists frequencies at which significant emissions were measured using Peak detector functions. Although these emissions are not required to be recorded, being more than 20dB lower than the limit line, they are included for completeness as they are all magnetron-related.

Details of the limit line calculation can be seen in Appendix B

Frequency (GHz)	Antenna Polarization	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Result
18.8	Vertical	105.37	135.91	30.54	Complied
28.197	Vertical	103.02	135.91	32.89	Complied
37.608	Vertical	98.41	135.91	37.5	Complied

7.3 Conducted Emissions

7.3.1 Peak Detector measurements on RF port

The design of the RF coupling from the magnetron to the antenna forms an effective high pass/band pass filter arrangement. The peak energy level of radar requires considerable attenuation in order to prevent the analyser from going into compression. This limits the maximum dBc figure that can be obtained without changing the resolution bandwidth of the analyser. Since the signal is wideband compared to the resolution bandwidth, it is critical to the measurement accuracy that the resolution bandwidth settings remain consistent throughout the testing where possible.

Measurements were performed from 2 GHz to 40GHz with the EUT set to 75ns, 450ns and 1000ns; measurements were performed within and around the transmitter frequency allocation.

Details of the limit line calculation can be found in Appendix B.

All emissions were more than 20dB below the required limit. Plots of the scans can be found in Appendix D.

7.4 Peak Power

These measurements were performed with an HP Peak Power Analyser and sensor connected to the EUT antenna port via a coupler and in-line attenuator.

Pulse Width (ns)	Measured Power (kW)
75	3.98
100	3.85
150	3.82
250	3.82
350	3.83
450	3.82
600	3.67
1000	3.78

Note 1: Power is measured at the antenna port and will be less than the nominal magnetron output due to normal losses in the circulator and rotating joint.

7.5 Pulse Width

Plots can be found in Appendix D.

In order to determine the characteristics of the various pulses, an HP Peak Power Analyser was connected to the EUT antenna port via a coupler and inline attenuator.

Nominal Pulse Width (ns)	Measured Pulse Width (ns)
75	69
100	101
150	155
250	263
350	360
450	459
600	615
1000	1042

7.6 Pulse Repetition Frequency

In order to determine the characteristics of the various pulses, an HP Peak Power Analyser and sensor was connected to the EUT antenna port via a coupler and in-line attenuator.

Pulse Width (ns)	Measured P.R.F. (Hz)
75	3018
100	3018
150	3018
250	3018
350	2004
450	1474
600	1305
1000	738

7.7 Average Power

Measured at the antenna port.

Nominal Pulse Width (ns)	Peak Power (kW)	P.R.F. (Hz)	Measured Pulse Width (ns)	Average Power (Watts)
75	3.98	3018	69	0.83
100	3.85	3018	101	1.17
150	3.82	3018	155	1.79
250	3.82	3018	263	3.03
350	3.83	2004	360	2.76
450	3.82	1474	459	2.58
600	3.67	1305	615	2.95
1000	3.78	738	1042	2.91

Note 1: The previous subsections detail the results required to make the above calculation.

7.8 Variation of frequency with input voltage

The frequency of the EUT was measured at each voltage.

75ns

% of Nominal Volts	Volts (dc)	Measured Frequency (GHz)
85% of 12.00	10.2	9.400669
100% of 12.0	12.0	9.400706
100% of24.0	24.0	9.400813
130% of 24.0	31.2	9.400869

1000ns

% of Nominal Volts	Volts (dc)	Measured Frequency (GHz)
85% of 12.00	10.2	9.398004
100% of 12.0	12.0	9.398072
100% of 24.0	24.0	9.398184
130% of 24.0	31.2	9.398321

Note: The equipment can be operated from any voltage within the nominal range 12 to 24 without requiring any adjustment. Therefore, the testing was performed from 85% of the lowest to 130% of the highest operating voltage. This exceeds FCC requirements but is required for compliance with the rules of other administrations.

7.9 Variation of frequency with temperature

The EUT scanner unit was situated in an environmental test chamber and set for normal operation at the shortest pulse width. The antenna port was connected via a coupler and in-line attenuator to the input of the HP E7405 analyser.

The chamber was then set to –30°C. After a 30-minute delay to allow for temperature stabilisation, the EUT frequency was monitored until there was no measurable frequency change. The frequency was recorded. The EUT was then set for normal operation at the longest pulse width, and the frequency monitored until there was no measurable frequency change. The frequency was recorded.

The chamber temperature was then increased by 10°C with the process repeated at this temperature, and at further increments of 10°C up to and including +50°C.

75ns

Temperature °C	Measured Frequency (Hz)
-30	9.414 GHz
-20	9.411 GHz
-10	9.410 GHz
0	9.409 GHz
+10	9.408 GHz
+20	9.404 GHz
+30	9.404 GHz
+40	9.400 GHz
+50	9.400 GHz

1000ns

Temperature °C	Measured Frequency (Hz)
-30	9.410GHz
-20	9.408 GHz
-10	9.406 GHz
0	9.405 GHz
+10	9.403 GHz
+20	9.400 GHz
+30	9.399 GHz
+40	9.396 GHz
+50	9.396 GHz

7.10 Occupied Bandwidth

Plots can be found in Appendix D.

The 99.5% (-23dBc) power bandwidth was measured for each pulse width using the delta function of the HP70000 receiver. Owing to the shape of the pulse it was not always possible to measure the bandwidth at the exact –23db point. Consequently, the next lower point was taken. This has the effect of slightly increasing the measured bandwidth above the actual 99.5% bandwidth.

Nominal Pulse Width (ns)	99.5% Power Bandwidth (MHz)
75	48.75
100	41.94
150	32.31
250	24.86
350	22.49
450	18.06
600	12.83
1000	11.28

7.11 Transmitter Frequency Tolerance

7.11.1 Specification: 80.209(b)

"When pulse modulation is used in land and ship radar stations operating in the bands above 2.4GHz the frequency at which maximum emission occurs must be within the authorised bandwidth and must not be closer than 1.5/T MHz to the upper and lower limits of the authorised bandwidth where "T" is the pulse duration in microseconds."

7.11.2 Calculation

Authorised Bandwidth: 9300MHz to 9500MHz

Specification Limits: [Lower] 9300 + 1.5/T
[Upper] 9500 - 1.5/T

Transmitter Frequency Tolerances

Nominal Pulse Width (ns)	Actual Pulse Width (ns)	Specification Limits (MHz) Lower	Specification Limits (MHz) Upper
75	69	9314.493	9485.507
100	101	9309.901	9490.099
150	155	9306.452	9493.548
250	263	9303.802	9496.198
350	360	9302.778	9497.222
450	459	9302.179	9497.821
600	615	9301.626	9498.374
1000	1042	9300.96	9499.04

From examining the transmitter frequency data from the Variation of Frequency with Voltage and Variation of Frequency with Temperature results pages, it can be seen that the transmitter is within the calculated specification.

8 Measurement Uncertainty

Measurement uncertainty was calculated after reference to CISPR 16-4:2002. In order to determine compliance with the limit for emissions tests, the specification states that, where the calculated uncertainty exceeds the value of Ucispr, the difference in dB is to be added to the instrument reading. The corrections shown in the table below are therefore added to the reported measurements before assessing compliance with the limits.

Measurement Type	Confidence Level (*k* = 2)	Calculated Uncertainty	Ucispr	Correction
Radiated Emissions: Electric Field Strength 30MHz-1GHz	95%	+/- 6.8dB	4.5dB(<300MHz) 5.2dB(>300MHz)	+2.3dB(<300MHz) +1.6dB(>300MHz)
Radiated Emissions: Electric Field Strength 1GHz-26.5GHz	95%	+/- 7.3dB	Under consideration (5.2dB assumed)	+2.1dB
Radiated Emissions: Electric Field Strength 26.5-40GHz	95%	+/-7.6dB	Under consideration (5.2dB assumed)	+2.4dB

Note 1. All test equipment and antennae used for the tests described in this report have current traceable calibration to UKAS or equivalent standard.

Note 2. All reported measurements include the appropriate offsets for antenna factors, coupler and cable losses, etc.

Appendix A Test Equipment Used

Ref. No.	Device	Manufacturer	Model No.	Serial No.	Next Calibration
00318	Peak Power Analyser	HP	8991A	3248A00128	30.09.2009
425-34	HP70000 Spectrum Analyzer*	HP	HP70000	As below	As below
00430	Mainframe	HP	HP70001A	3230A05180	16.07.2009
00425	Display Section	HP	HP70004A	3040A01640	16.07.2009
00426	I.F. Section	HP	HP70902A	3206A03917	16.07.2009
00427	I.F Section	HP	HP70903A	3331A02727	16.07.2009
00428	Local Oscillator	HP	HP70900B	3345A01913	16.07.2009
00429	Ext.mixer interface	HP	HP70907B	3533A00576	16.07.2009
00431	Digitizer	HP	HP70700A	3716A01071	16.07.2009
00432	Precision F. Ref.	HP	HP70310A	3127A02429	16.07.2009
00433	RF Section	HP	HP70909A	3136A00120	16.07.2009
00434	Option 001 Preamp	HP	70620B	3550A00850	16.07.2009
00789	Microwave Mixer 26.5-40GHz**	HP	11970A	3003A08859	17.08.2009
00886	Receiver	Rohde & Schwarz	ESI 26	832692/006	04.02.2009
00618	DVM	Fluke	85	65690477	30.09.2009
01520	Microwave Sig. Gen. 0.01-40GHz	Rohde & Schwarz	SMR40	10-300074685	06.06.2009
00440	PSU 3-15V 25A***	Palstar	PS30M	G450673814	N/A
00376	PSU 0-60V***	Farnell	AP50-60	1140	02.09.2009
00442	Antenna 0.09-30MHz	Schaffner	HLA6120	1122	11.02.2010
00482	Antenna 18-26.5GHz**	Credowan	20-R-2843-0007	36755	29.09.2008
00483	Antenna 26.5-40GHz**	Credowan	S.G. Horn	None	29.09.2008
00852	Antenna 1.0-18.0GHz	Schwarzbeck	BBHA9120D	128	02.10.2009
01802	Antenna 30-2000MHz*	Chase	CBL6141B	22932	27.06.2010
EM06	Microwave Cable	Agilent	5061-5458	EMC Cable 6	As Required
EM09	Microwave Cable	Agilent	5061-5458	EMC Cable 9	As Required
RD14	Microwave Coupler	Flann	16270-40-23	116317	As Required
RD21	Inline Attenuator 10dB	Narda	4779-10	8	As Required
	Inline Attenuator 10dB	Suhner	6810.17.B	13	As Required
RD40	WG16 to N Adaptor	Flann	16094-NF10	100	As Required
RD42	WG16 to N Adaptor	Mitec Europe	M0926-7-11	3711-2	As Required
RD50	Microwave Power Load	CMT	MPT90-1A	942117-003	Not Reqd.

Notes:

* 2 year calibration cycle

** 3 year calibration cycle

*** Voltage monitored using Item 618

All test equipment, except cables, wave guide components and attenuators, are on a calibration cycle in accordance with UKAS requirements. Items marked calibration as required are calibrated during the test using the R&S microwave signal generator and the HP70000 Analyzer.

Calibration validity of items 00482 and 00483 was extended for 4 weeks in order to complete testing. Previous calibrations show a variation of around 0.5dB max. Both these antennas have now been removed from service for recalibration.

Appendix B Measurement Methods.

B.1 Calculating Emissions Limit Lines

For both radiated emissions and conducted spurious emissions from the antenna port, with an Assigned Frequency of 9410MHz (Authorised Band 9310 - 9510MHz), the limits close to the magnetron frequency are:

Over the ranges 9210 - 9310MHz and 9510 - 9610MHz: -25dBc
Over the ranges 8910 - 9210MHz and 9610 - 9910MHz: -35dBc

To establish the radiated emissions limit for the product on frequencies outside the range 8910 - 9910MHz, the EUT was placed on the test site with the measuring equipment located at a distance of three metres.
The magnetron was disconnected and replaced with a WG16 to N-type coaxial connector adaptor, which was connected to a signal generator with an unmodulated output at 9.4GHz. The rotating joint was connected, via an adaptor and attenuator, to a power meter and sensor.

The signal generator was unable to reproduce the actual peak power output of the intentional radiator – measured as 3.98kW by conducted methods. Consequently, a level of 3.97mW was reproduced at the antenna port, requiring a factor of +60dB to be applied at the analyser.

The rotating joint adaptor, attenuator and power measurement equipment were removed and replaced first with the 18” flare antenna and then with the 24” flare antenna. The antenna was aligned with the horn antenna connected to the spectrum analyser and adjusted to peak the analyser response.

A reading of 183.72 dBuV/m was obtained from the 18” antenna.

A reading of 184.26 dBuV/m was obtained from the 24” antenna

The calculation for the radiated emissions limit line is:
18” Antenna
Po(peak)dBuV/m – 43 – $10\log_{10}$ P(mean)watts,
183.72 – 43 – $10\log_{10}$ 3.03 = **135.91dBuV/m**
24” Antenna
Po(peak)dBuV/m – 43 – $10\log_{10}$ P(mean)watts,
184.26 – 43 – $10\log_{10}$ 3.03 = **136.46 dBuV/m**

The tighter limit line for the 18” Antenna was used throughout the test.

For conducted spurious emissions from the antenna port, the calculation to establish the limit line for frequencies outside the range 8910 - 9910MHz is:

Po(peak)dBm – 43 – $10\log_{10}$ P(mean)watts,
i.e., 66 – 43 – $10\log_{10}$ 3.03 = **18.19 dBm**

B.2 Radiated Emissions (9 kHz to 2 GHz)

Radiated emissions measurements were performed in accordance with the standard, against appropriate limits for a Peak detector.

All testing was carried out within a semi-anechoic chamber at a distance of 3m. For all tests, the antenna was replaced with a rotating microwave load.

Measurements were split into five sub ranges to accommodate receiver bandwidth and antenna changes. Over each range, the same measurement procedure was used. The antenna was initially set to a height of 1.5m. The receiver was set to step through the appropriate frequency range in “Peak and Hold” mode, with the antenna firstly in vertical polarisation and then in horizontal polarisation. The EUT was then rotated clockwise through 90 degrees, then 180 degrees and finally 270 degrees, with the measurement process repeated at each 90 degree point, thus building up a profile of peak emissions. Emissions of significance were noted. For each of these emissions, the antenna polarisation was changed to give the higher reading; the turntable was then rotated through 360 degrees to find the area of the EUT radiating the highest level and, for frequencies above 30MHz, the antenna height was then varied between 1 and 4m above the ground plane to further maximise the signal before remeasurement.

Measurements above 30MHz were performed using broadband antennas. Below 30MHz, a magnetic loop antenna was used.

B.3 Radiated Emissions 2 GHz to 40 GHz

Radiated emissions measurements were performed against appropriate limits for a Peak detector. All measurements were carried out using horn antennas.

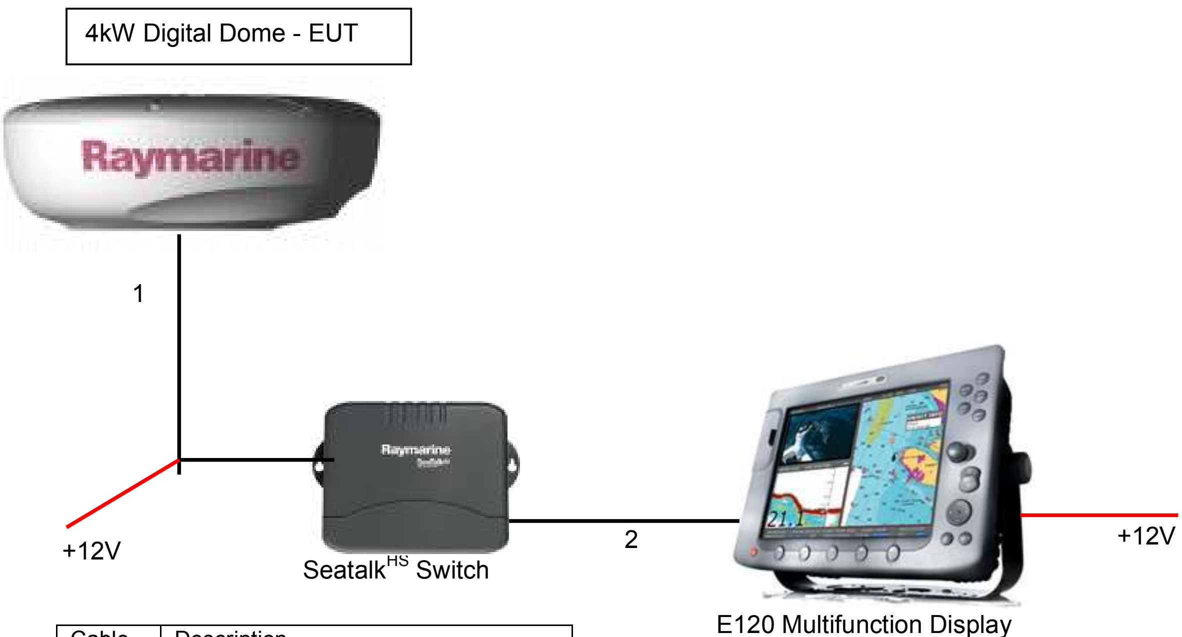
All testing was carried out within a semi-anechoic chamber at a distance of 3m. The conducting ground plane between the antenna and the EUT was covered with ferrite and pyramidal absorbing material. For all tests, the antenna was replaced with a rotating microwave load.

Measurements were split into sub ranges to accommodate antenna changes. Over each range, the same measurement procedure was used. The antenna was set to a height of 1.5m. The analyser was set to sweep through the appropriate frequency range in “Max Hold” mode, with the antenna in vertical polarisation. The EUT was slowly rotated clockwise through 360 degrees and then back to 000 degrees, thus building up a profile of peak emissions. The antenna was then changed to horizontal polarisation and the process continued. Emissions of significance were noted. For each of these emissions, the antenna polarisation was changed to give the higher reading; the turntable was then rotated to find the area of the EUT radiating the highest level. Measurements within 20dB of the limit line were recorded.

Appendix C Test Configuration Drawings

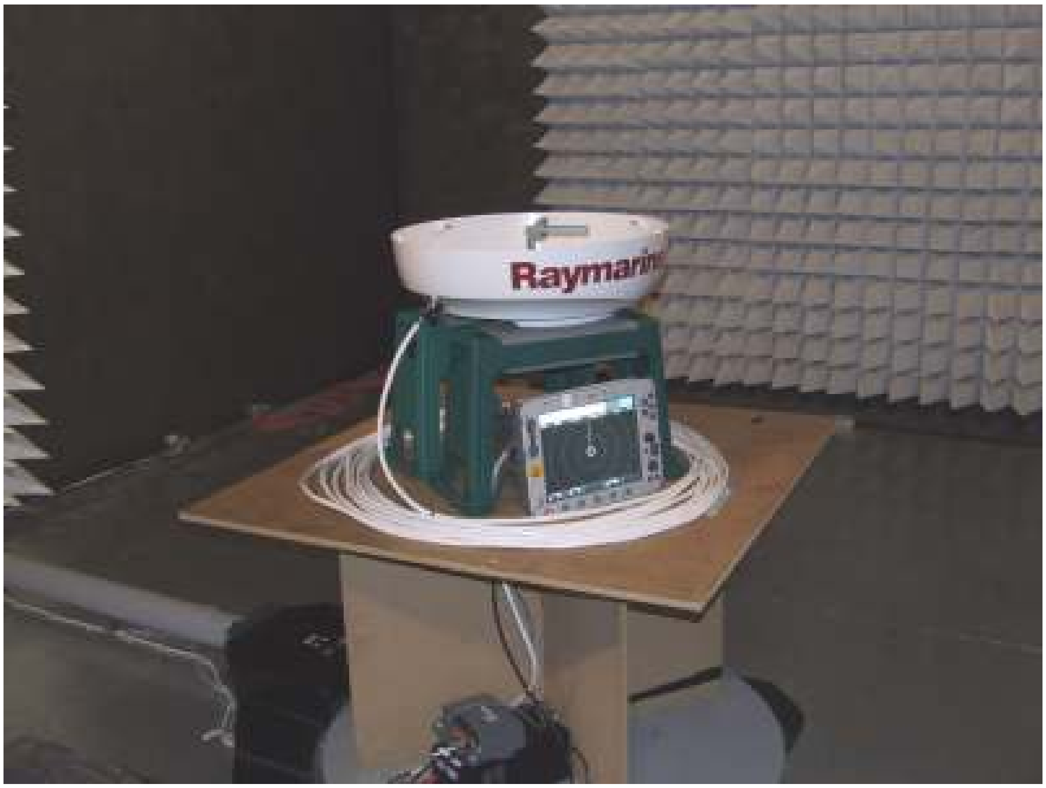
The 4kW Digital Radome Radar was arranged in as near a representative configuration as was practicable. The radar and excess scanner interconnection cable were placed upon a non-conducting support on the turntable such that the surface of the support was 0.8m above the ground plane. For tests below 1GHz, the scanner unit was placed centrally above the display unit on a non-conducting support 0.38m high. Above 1GHz, this support was increased to 0.5m, aligning the magnetron and circulator assembly height with the receiving horn antenna. The power lead was connected to a 12V power supply; the screen of this cable was connected to the ground plane. The radar interconnection cable was coiled around the radar support. Due to its size and construction, this cable cannot be bundled.

C.1 Connection diagram



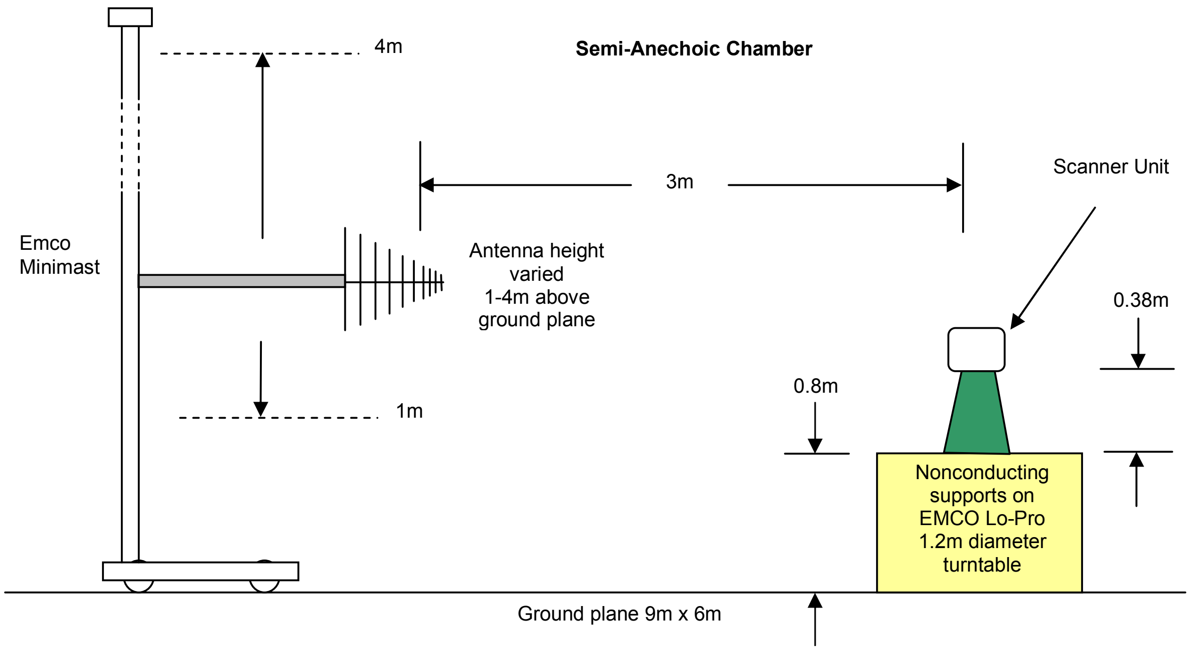
Cable	Description
1	15m Combined Ethernet/Power cable
2	10m CAT 5 Ethernet cable

C.2 Radiated Emissions Setup – General Arrangement



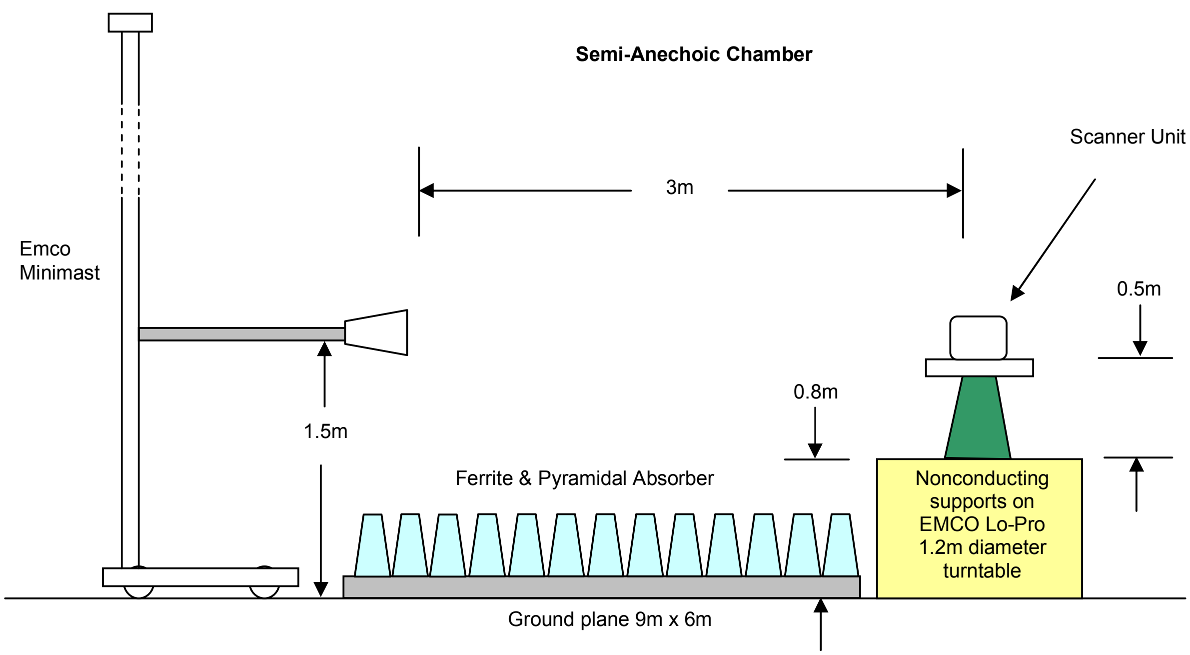
C.3 Radiated Emissions 9 kHz to 2 GHz – General Arrangement

NOT TO SCALE



C.4 Radiated Emissions 2GHz to 40 GHz – General Arrangement

NOT TO SCALE



Appendix D Graphical Test Results

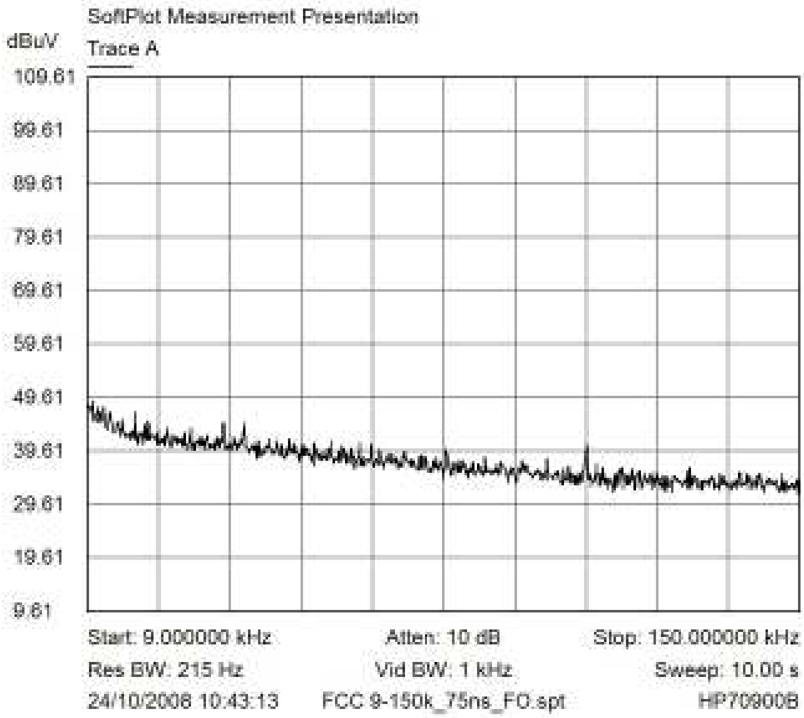


Figure 1 Radiated Emissions 9kHz to 150kHz Loop Face on

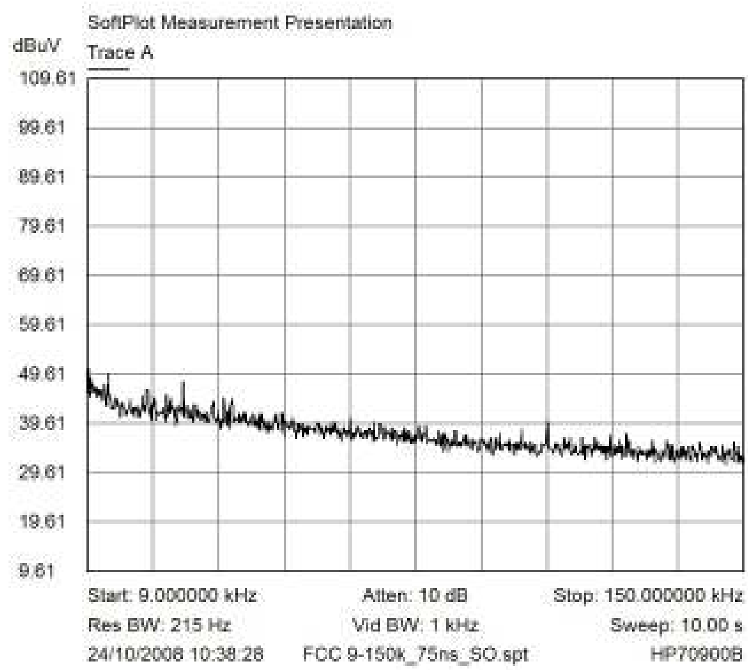


Figure 2 Radiated Emissions 9kHz to 150kHz Loop Side on

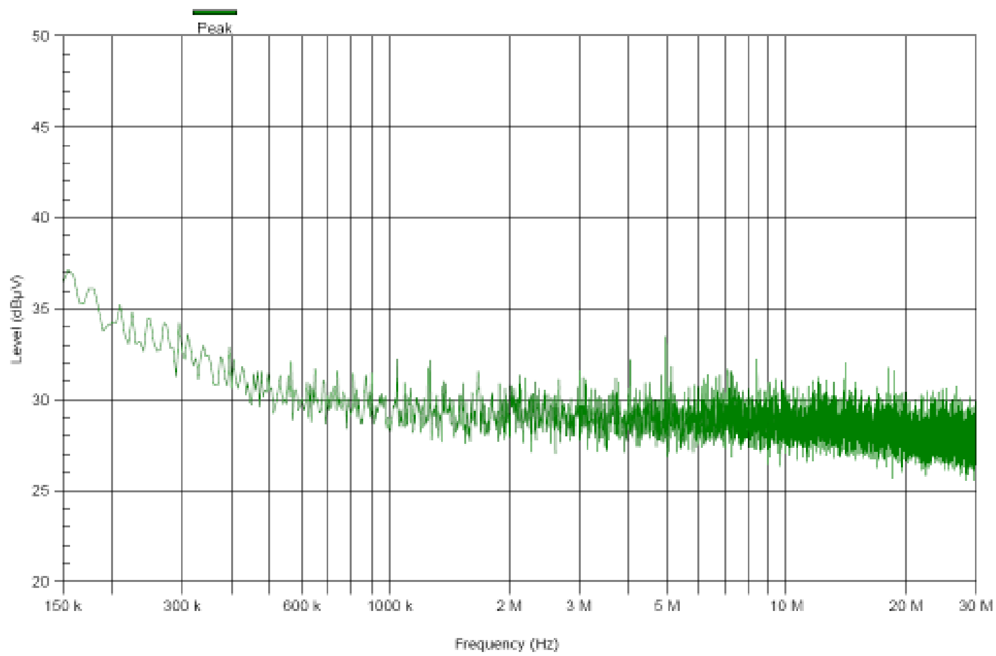


Figure 3 Radiated Emissions 150kHz to 30MHz Loop Side on

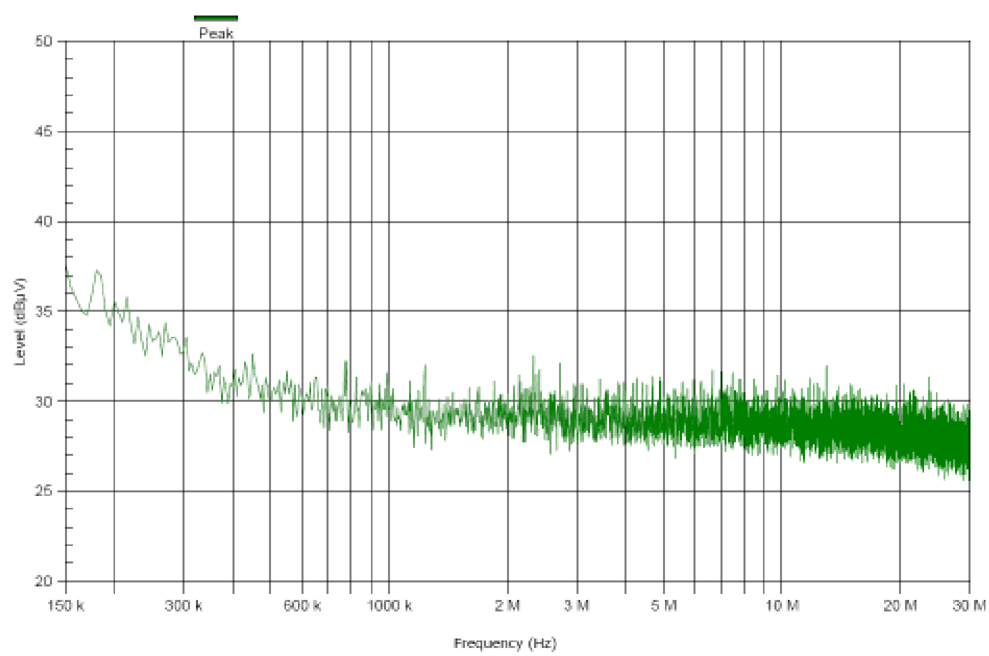


Figure 4 Radiated Emissions 150kHz to 30MHz Loop Face On

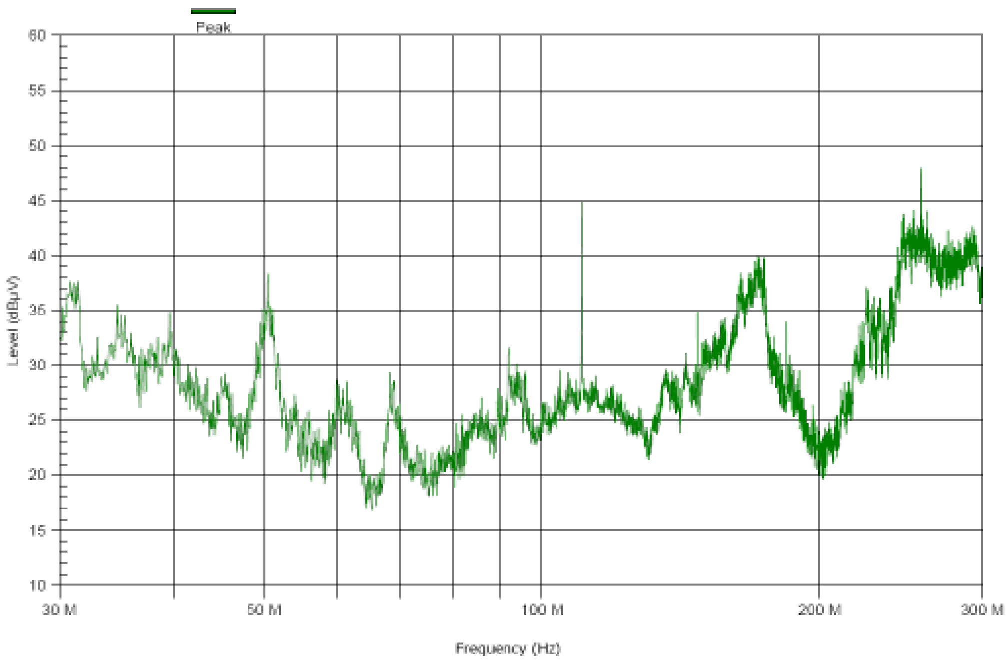


Figure 5 Radiated Emissions 30MHz to 300MHz

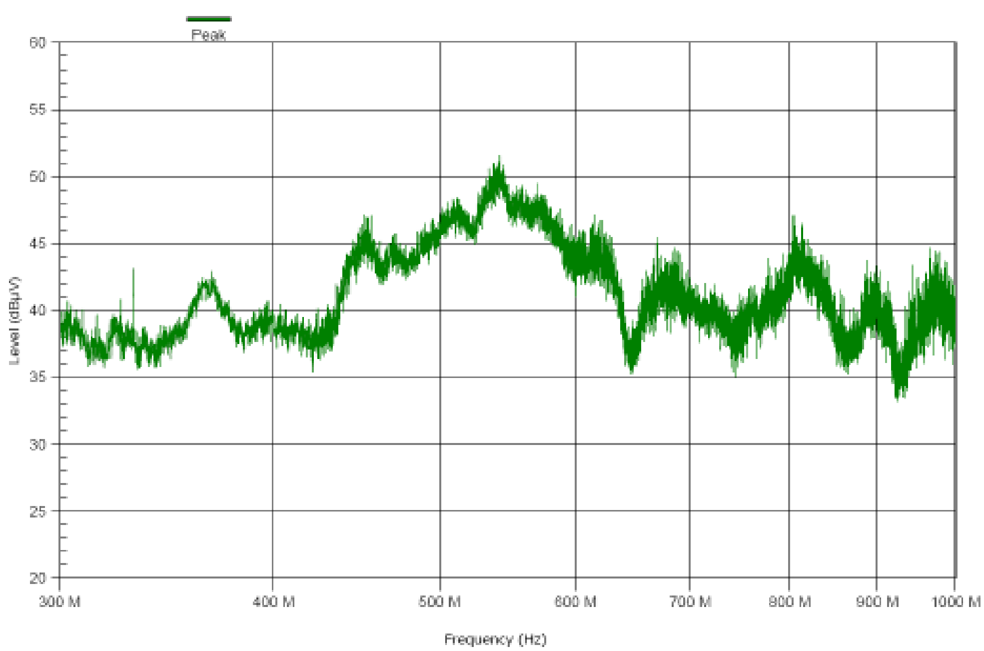


Figure 6 Radiated Emissions 300MHz to 1GHz

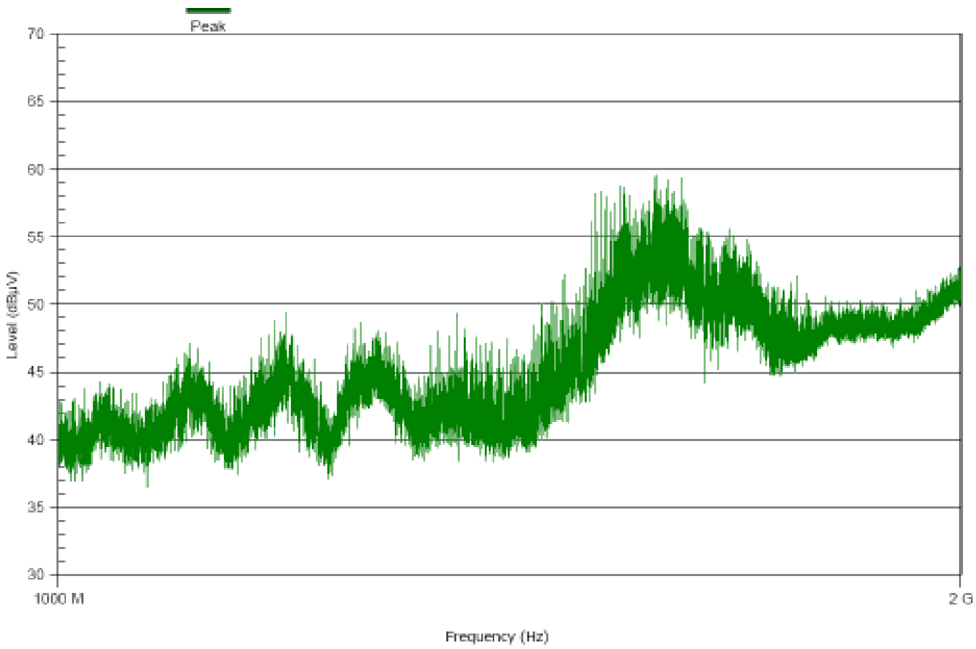


Figure 7 Radiated Emissions 1GHz to 2GHz

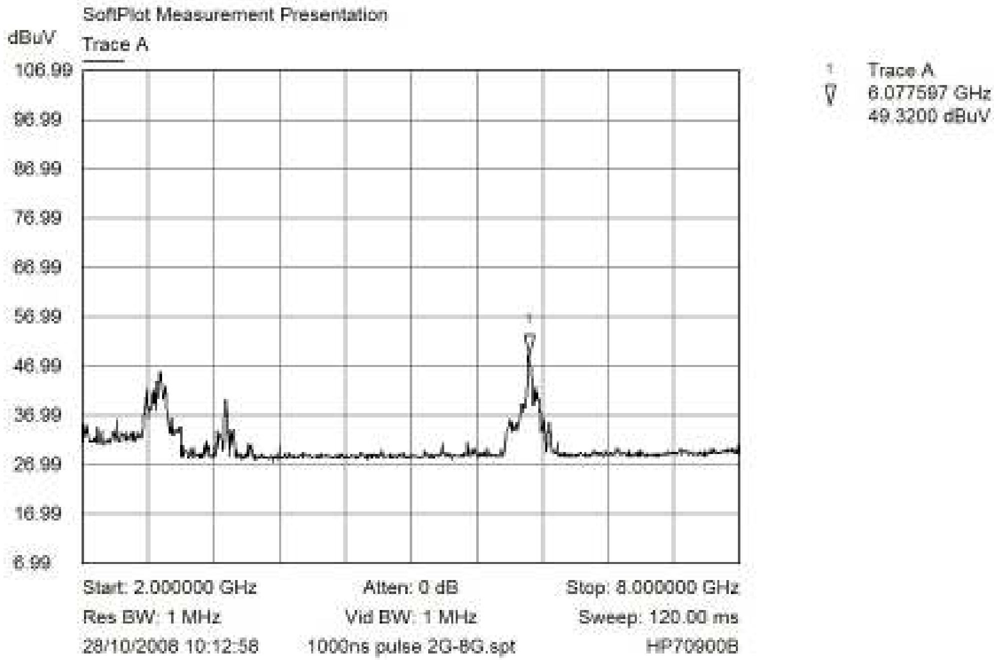


Figure 8 Radiated Emissions 1000ns Pulse width 2GHz to 8GHz

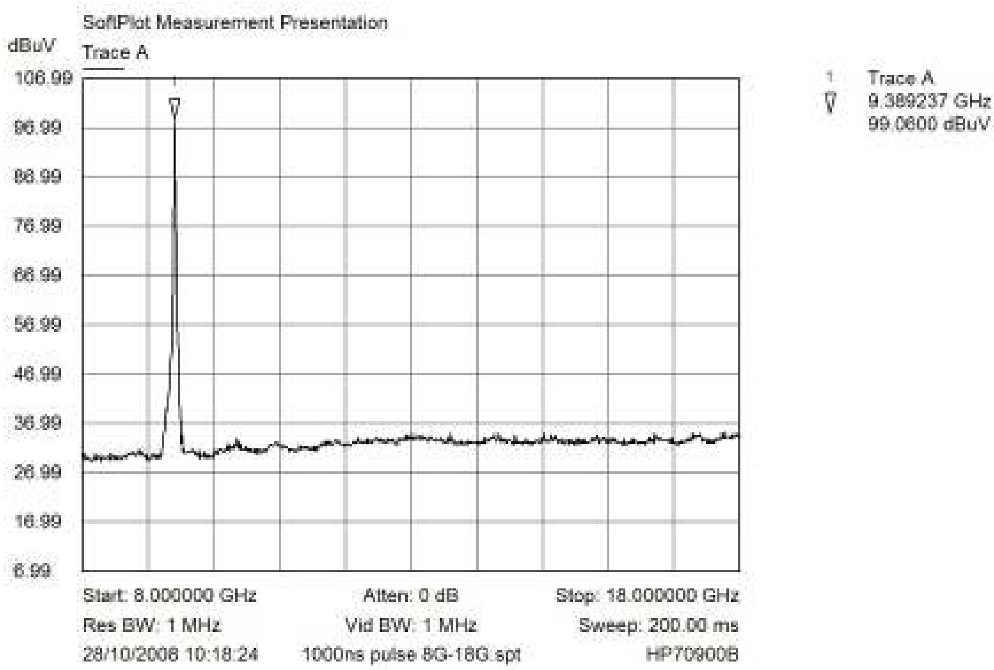


Figure 9 Radiated Emissions 1000ns Pulse width 8GHz to 18GHz

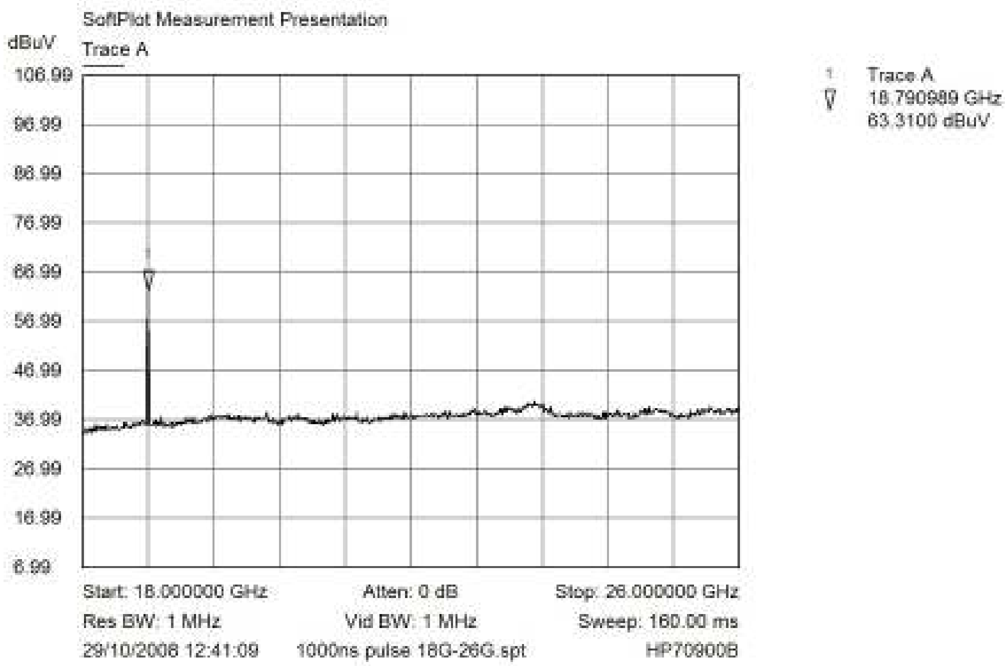


Figure 10 Radiated Emissions 1000ns Pulse width 18GHz to 26GHz

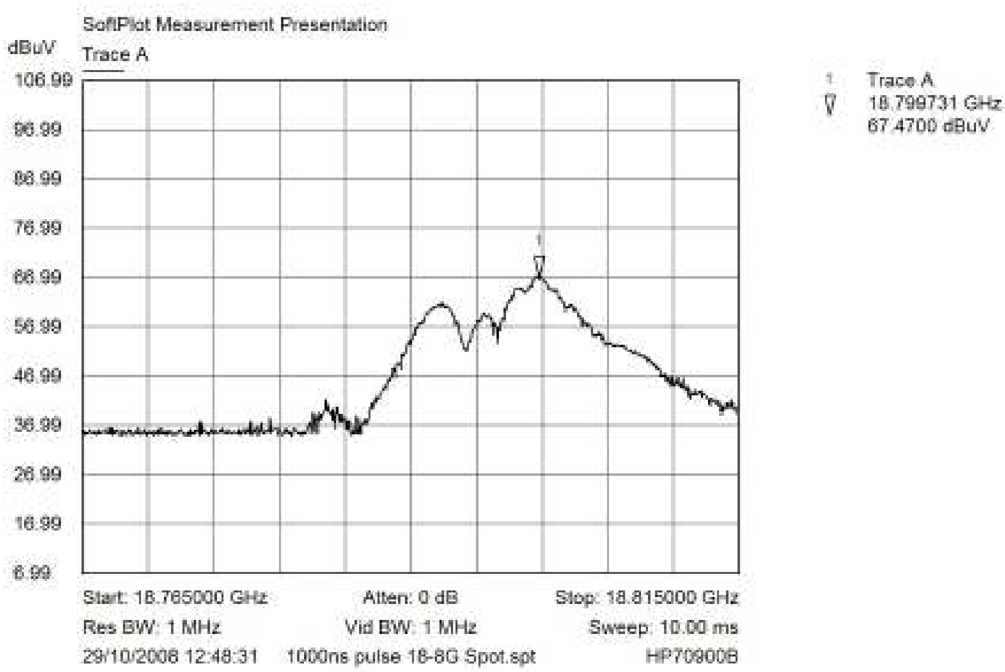


Figure 11 Radiated Emissions 1000ns Pulse width @ 18.8GHz

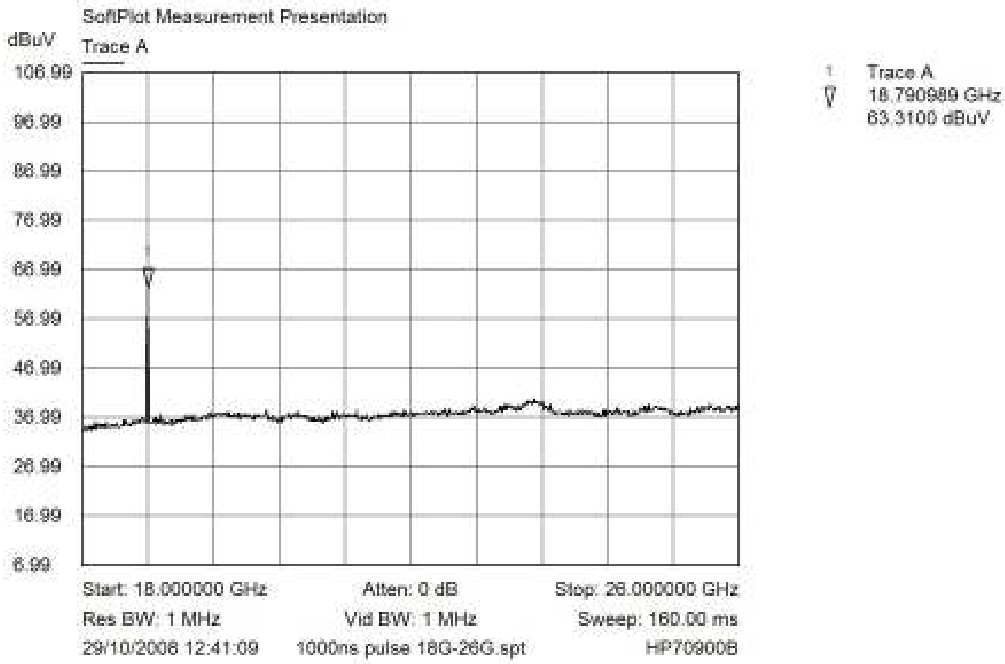


Figure 12 Radiated Emissions 1000ns Pulse width 18GHz to 26GHz

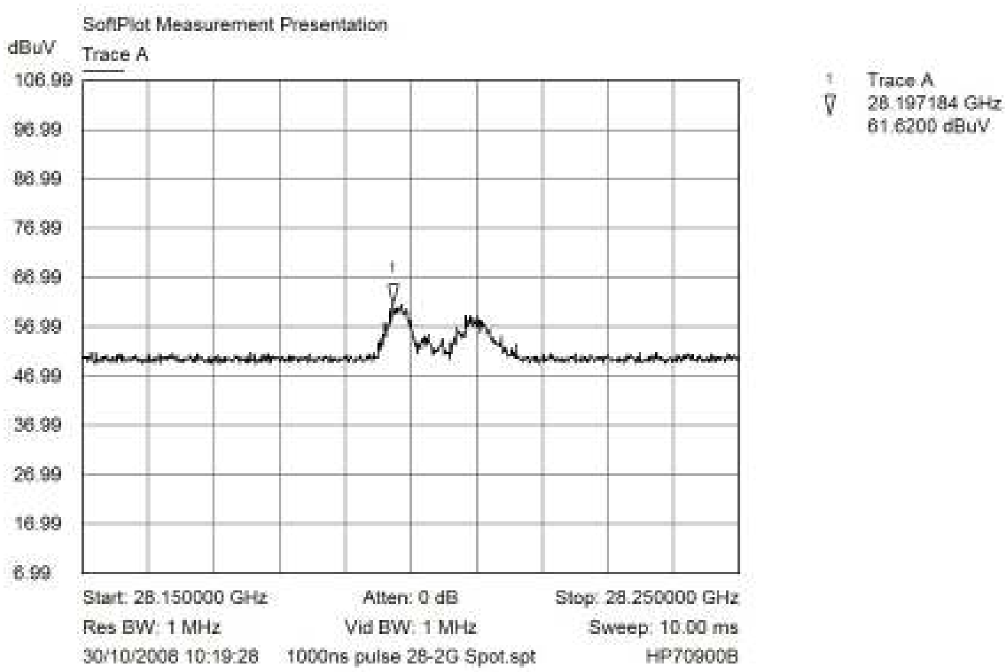


Figure 13 Radiated Emissions 1000ns Pulse width 28.2GHz Spot

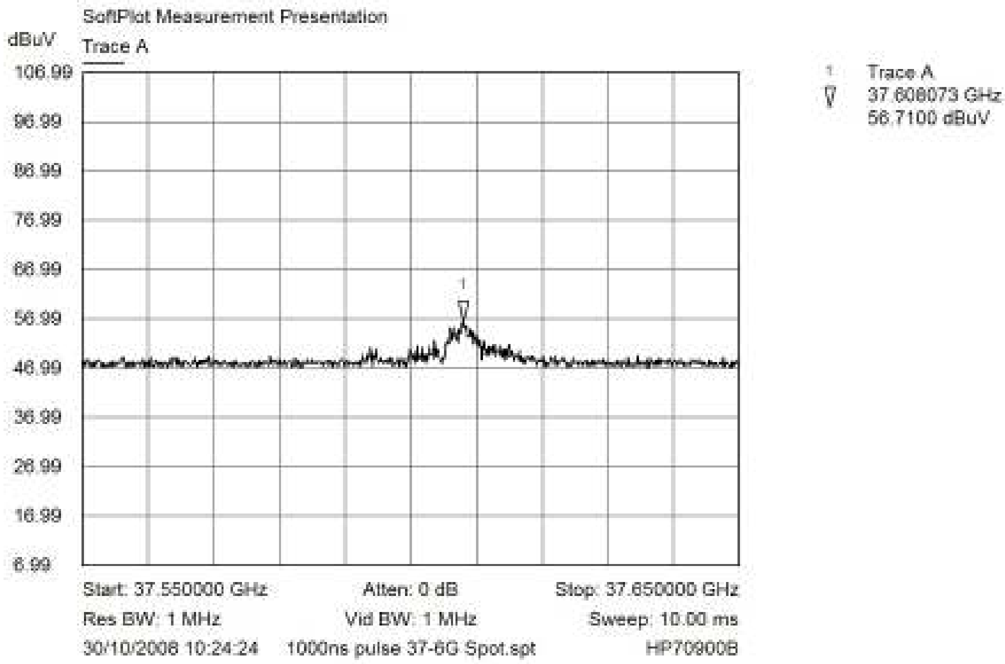


Figure 14 Radiated Emissions 1000ns Pulse width 37.6GHz Spot

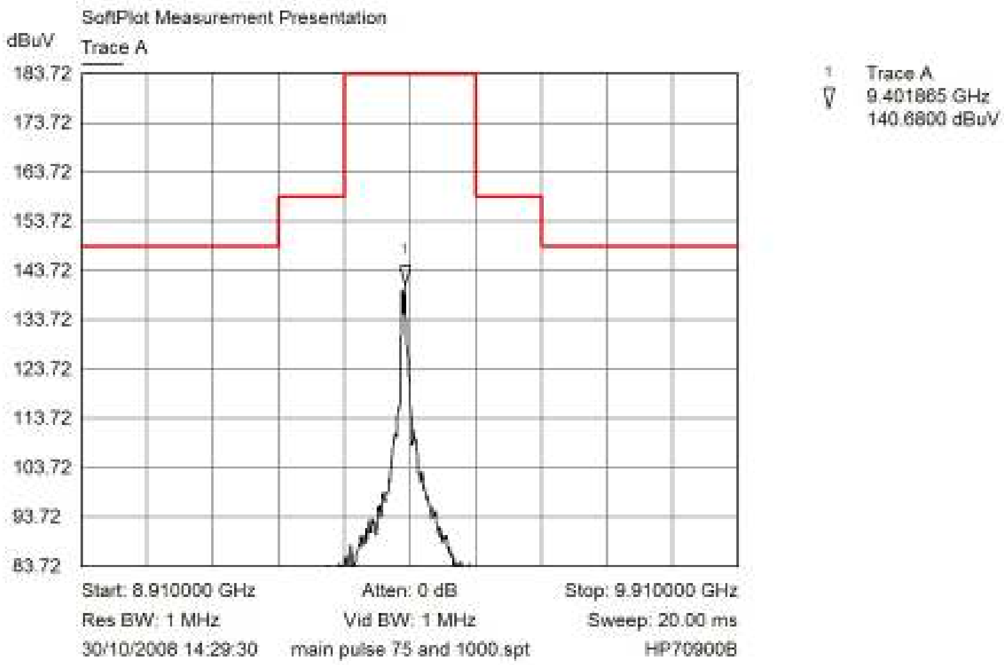


Figure 15 Main Pulse Measurement 75ns & 1000ns Composite Pulse (Antenna not fitted)

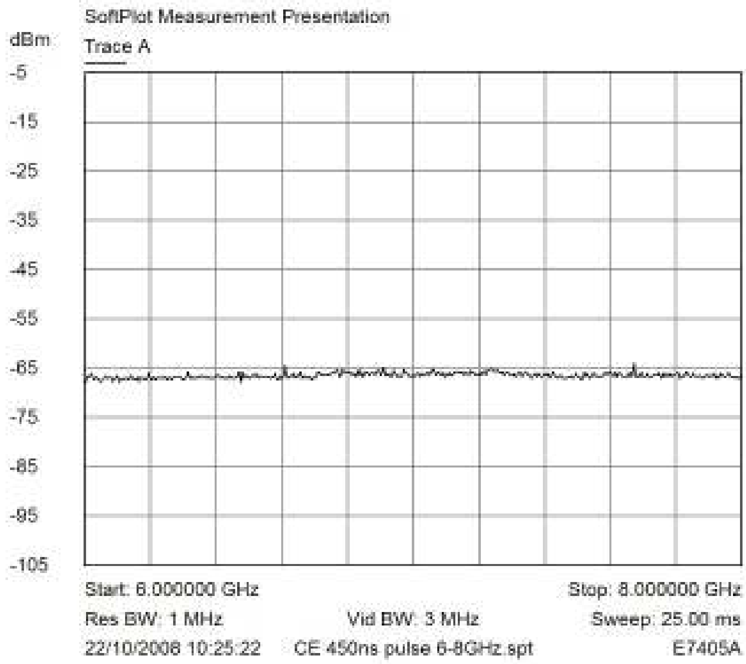


Figure 16 Conducted Emissions 450ns Pulse 6GHz to 8GHz

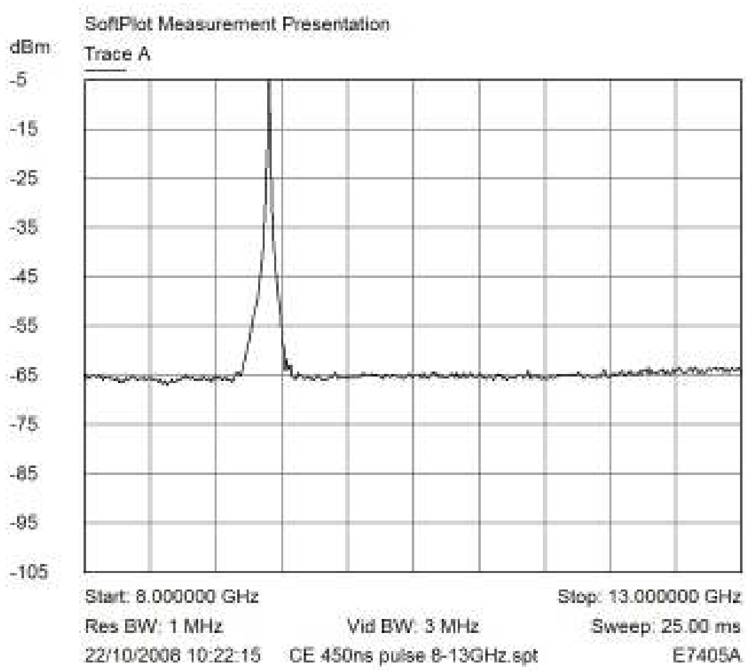


Figure 17 Conducted Emissions 450ns Pulse 8GHz to 13GHz

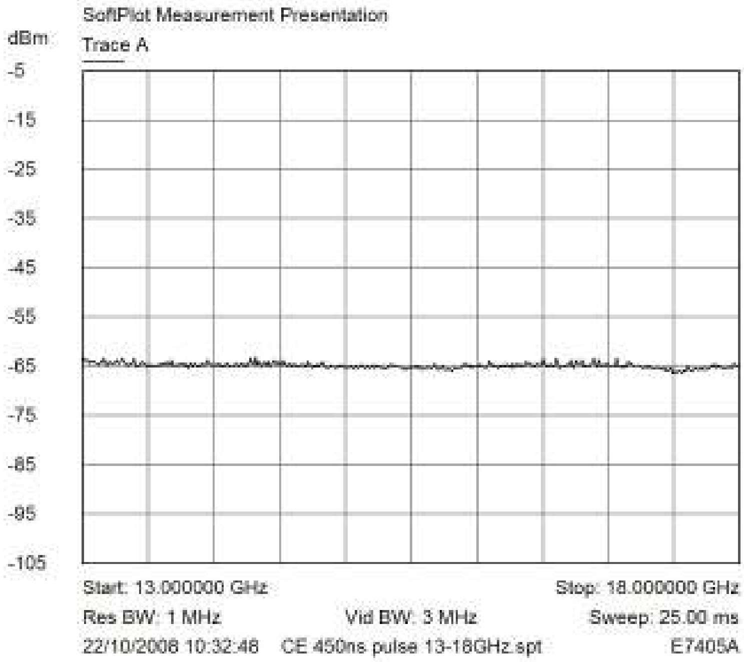


Figure 18 Conducted Emissions 450ns Pulse 13GHz to 18GHz

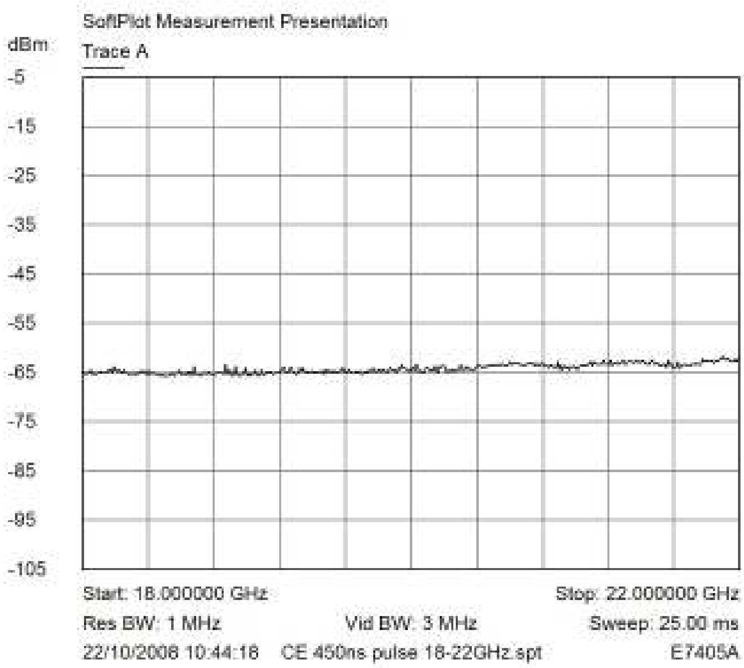


Figure 19 Conducted Emissions 450ns Pulse 18GHz to 22GHz

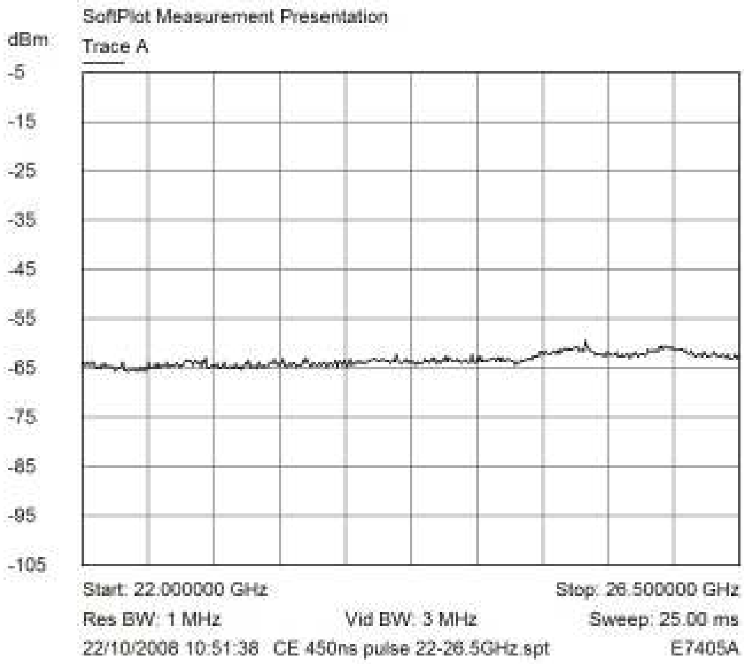


Figure 20 Conducted Emissions 450ns Pulse 22GHz to 26.5GHz

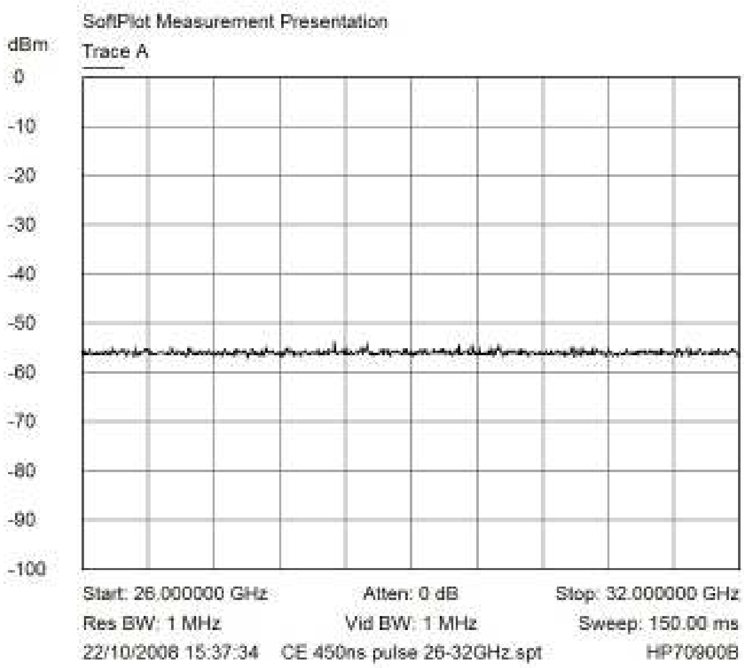


Figure 21 Conducted Emissions 450ns Pulse 26GHz to 32GHz

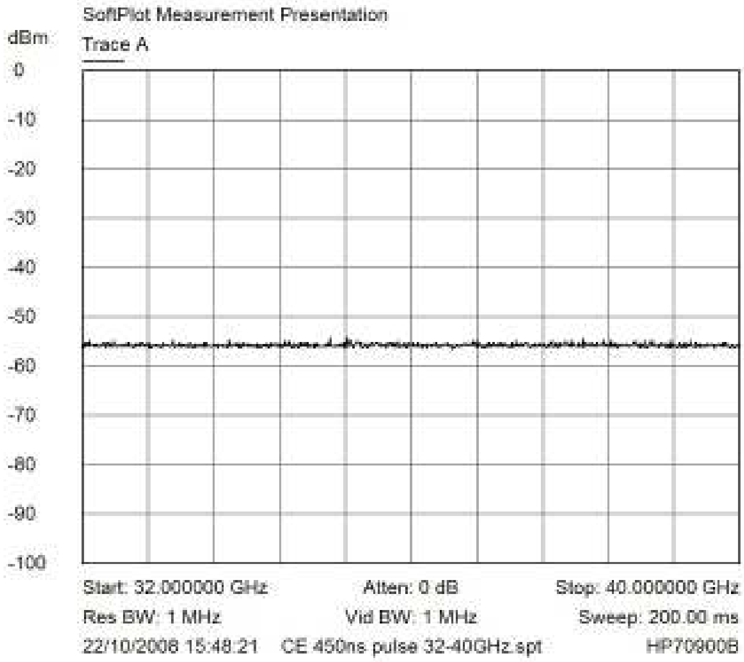


Figure 22 Conducted Emissions 450ns Pulse 32GHz to 40GHz

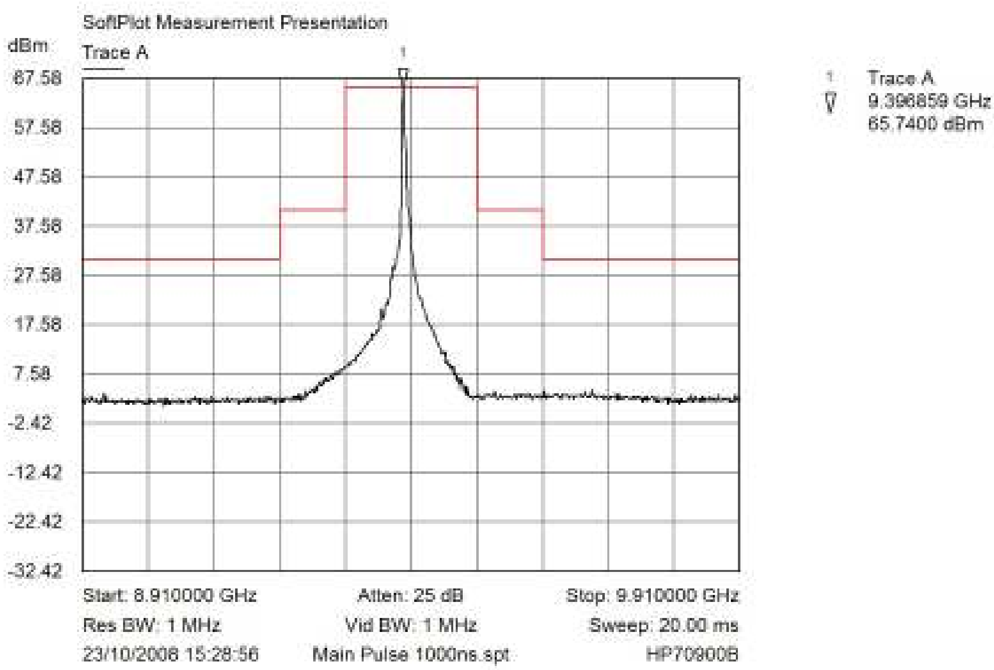


Figure 23 Main Pulse Measurement 1000ns Pulse

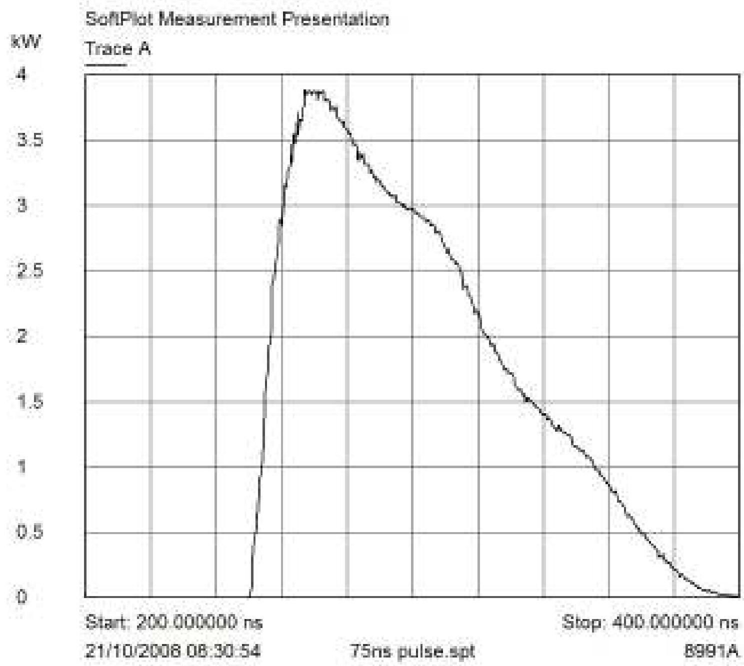


Figure 24 Pulse Characterisation 75ns

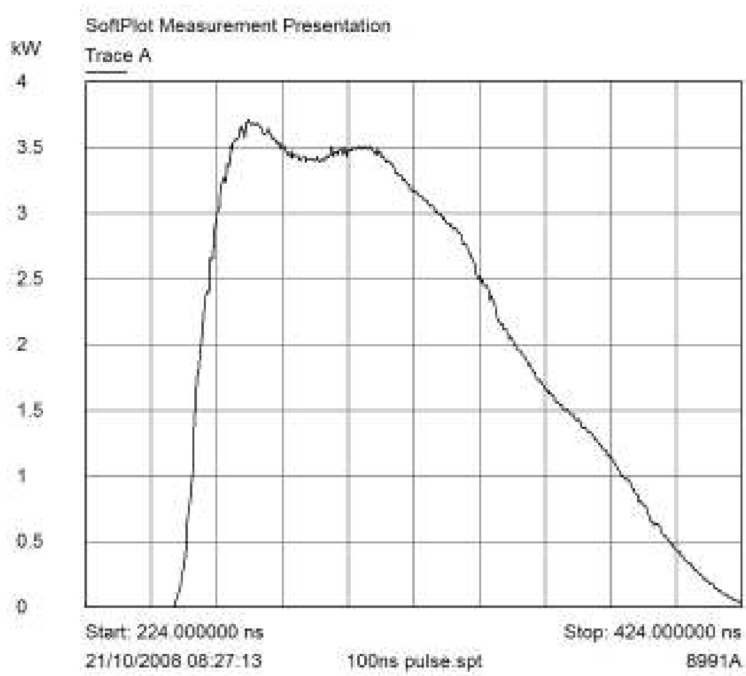


Figure 25 Pulse Characterisation 100ns

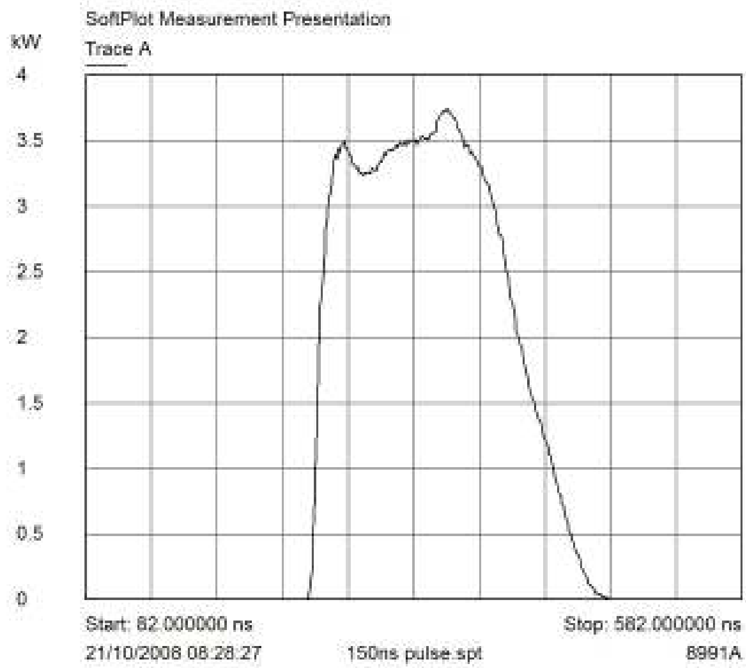


Figure 26 Pulse Characterisation 150ns

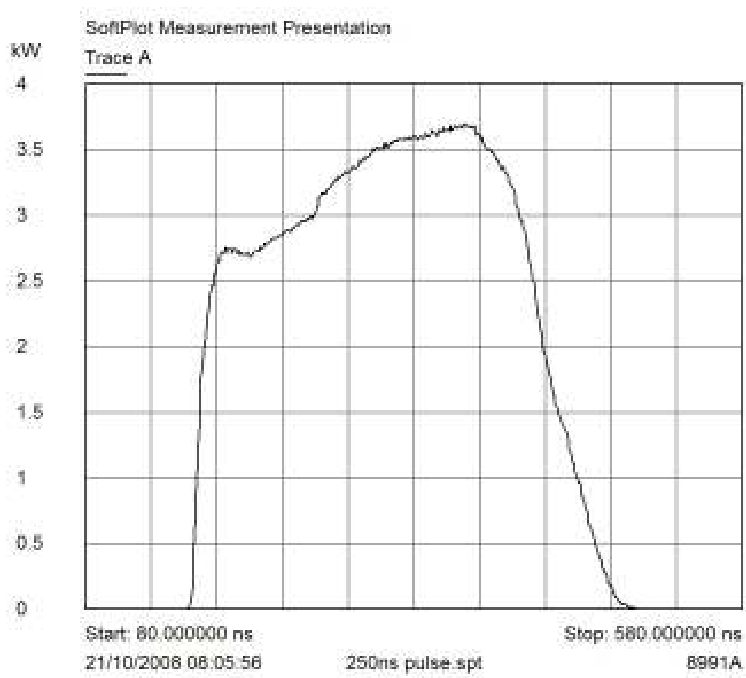


Figure 27 Pulse Characterisation 250ns

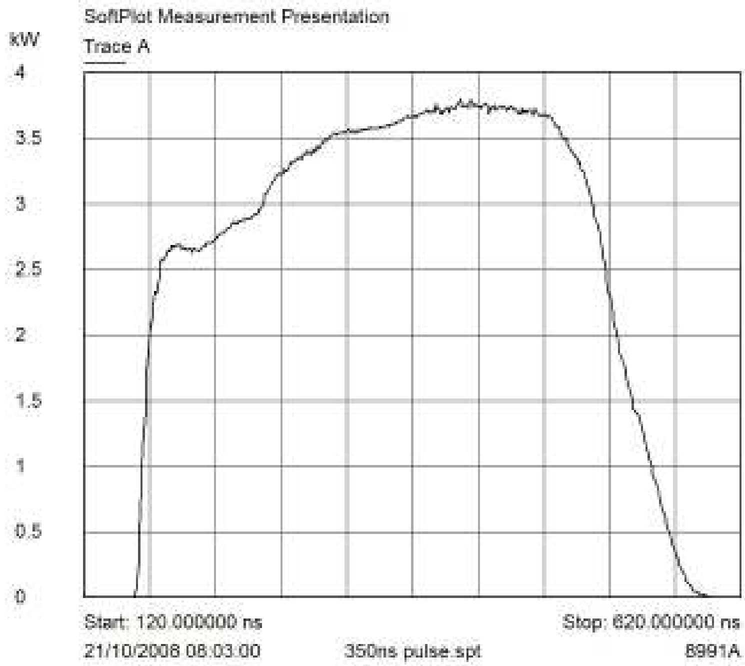


Figure 28 Pulse Characterisation 350ns

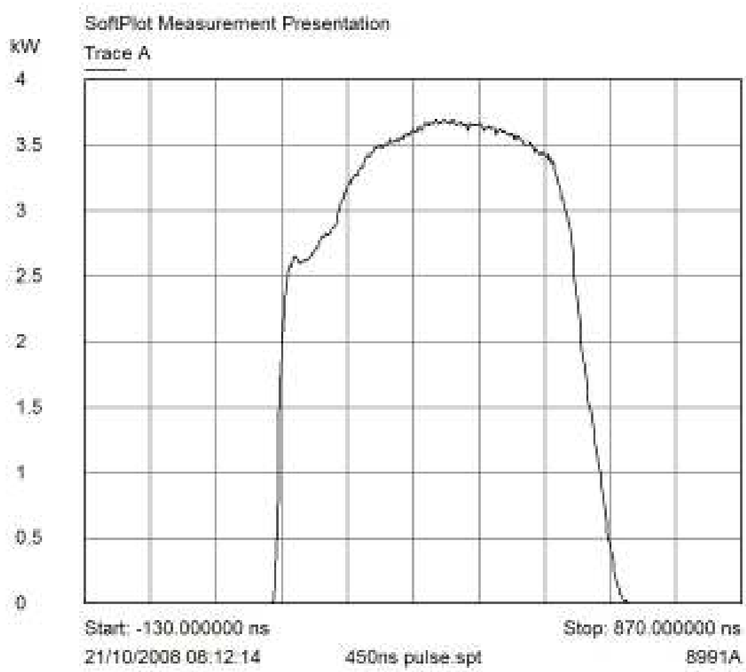


Figure 29 Pulse Characterisation 450ns

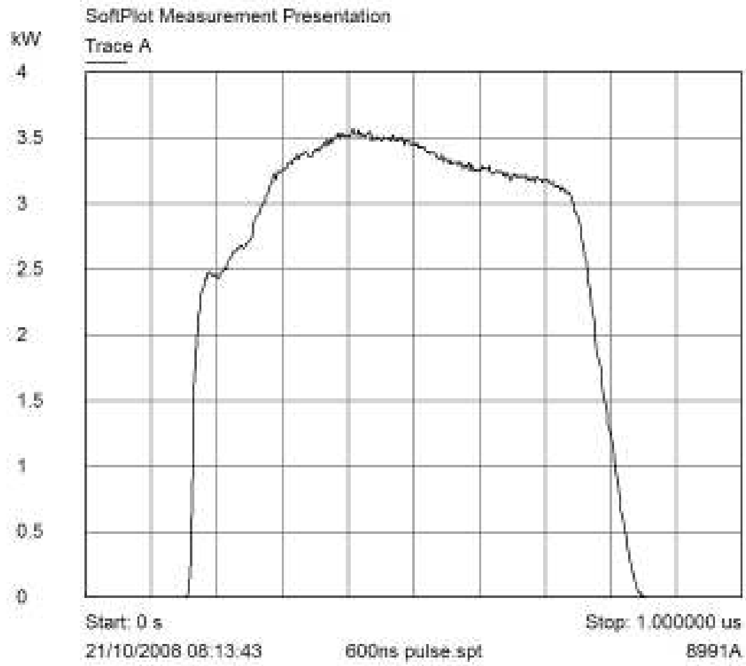


Figure 30 Pulse Characterisation 600ns

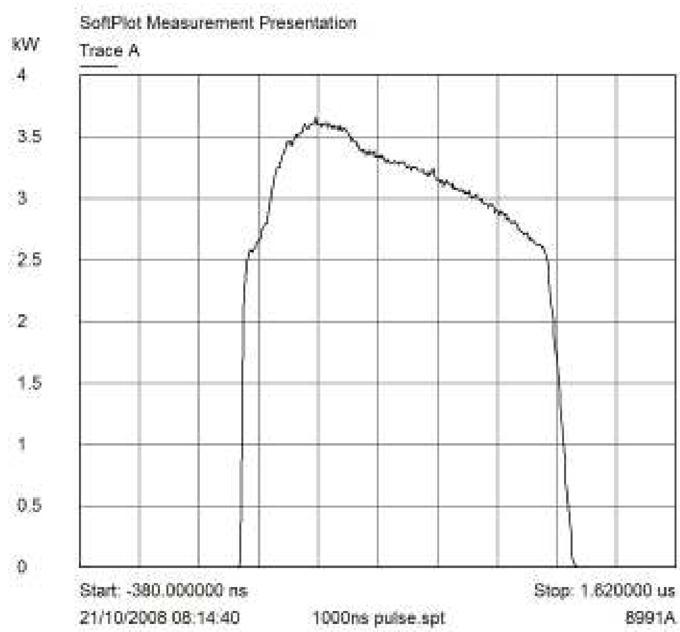


Figure 31 Pulse Characterisation 1000ns

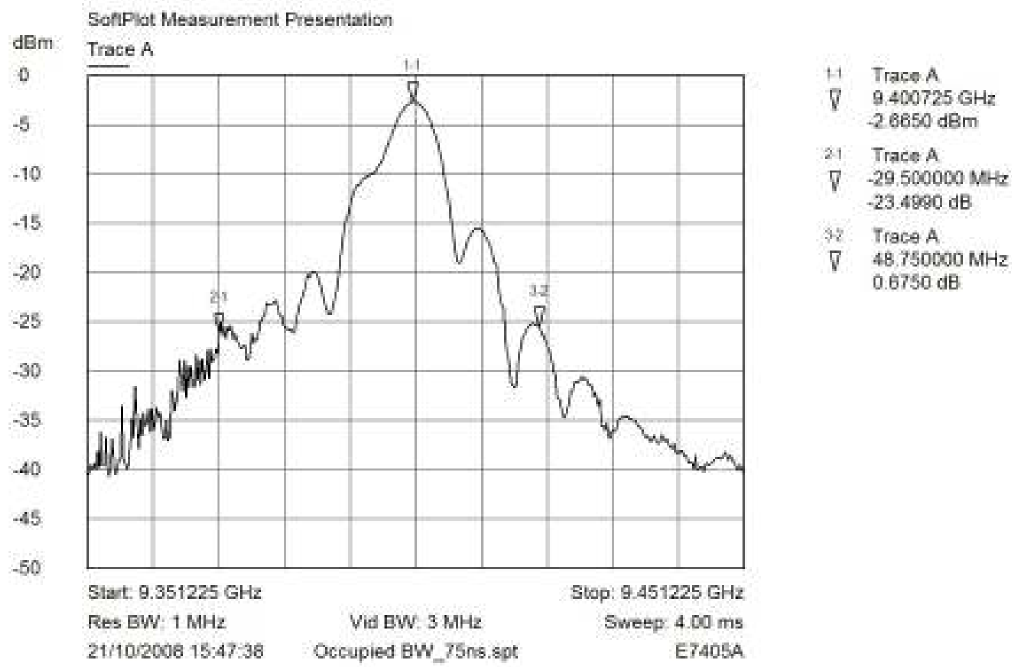


Figure 32 Occupied Bandwidth 75ns Pulse

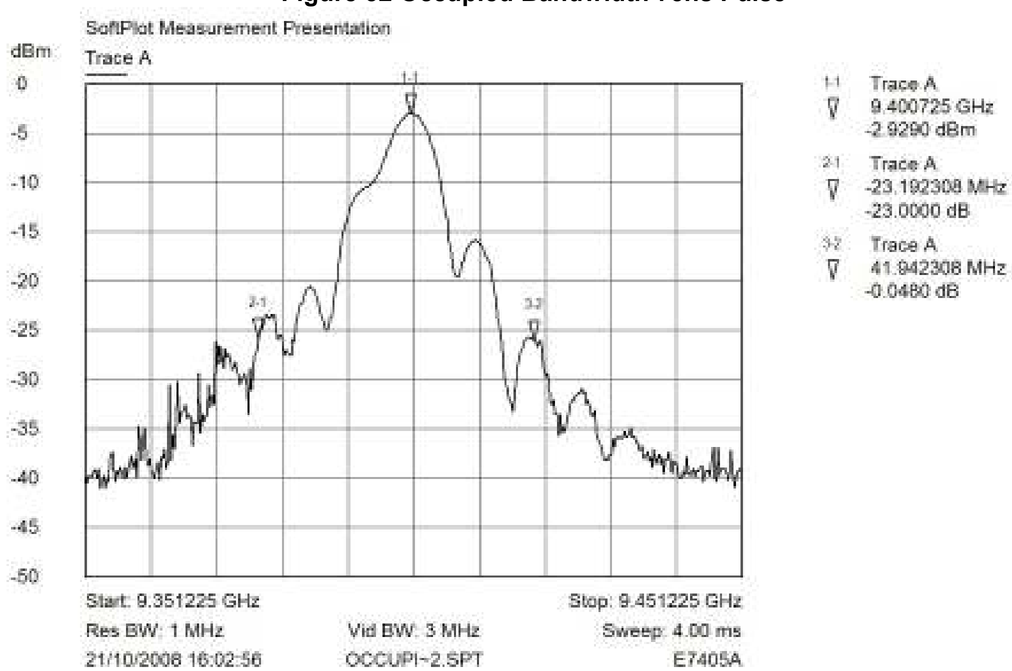


Figure 33 Occupied Bandwidth 100ns Pulse

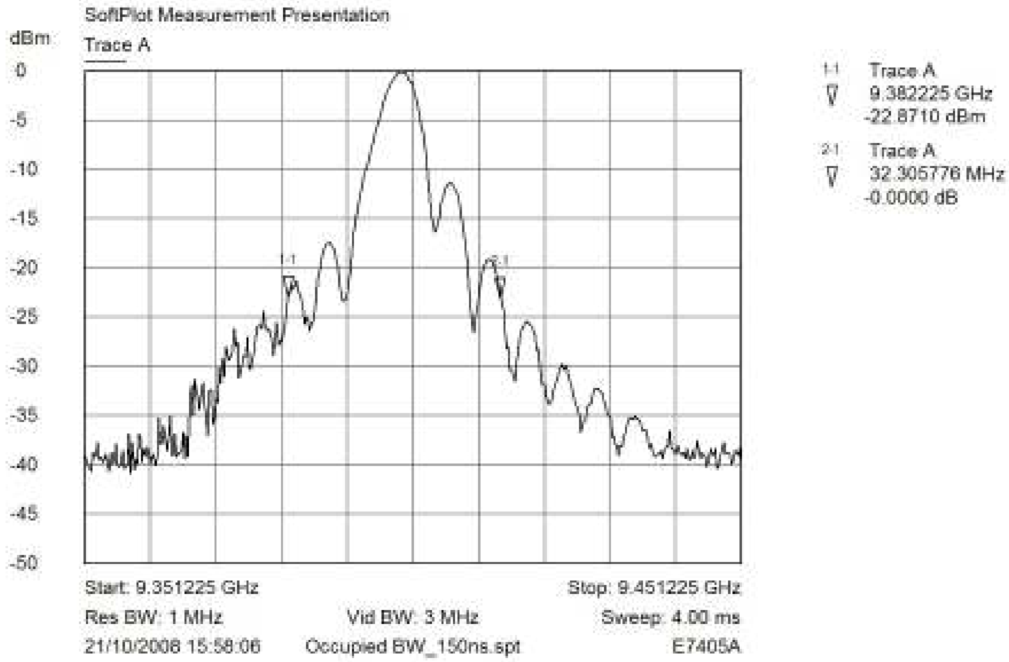


Figure 34 Occupied Bandwidth 150ns Pulse

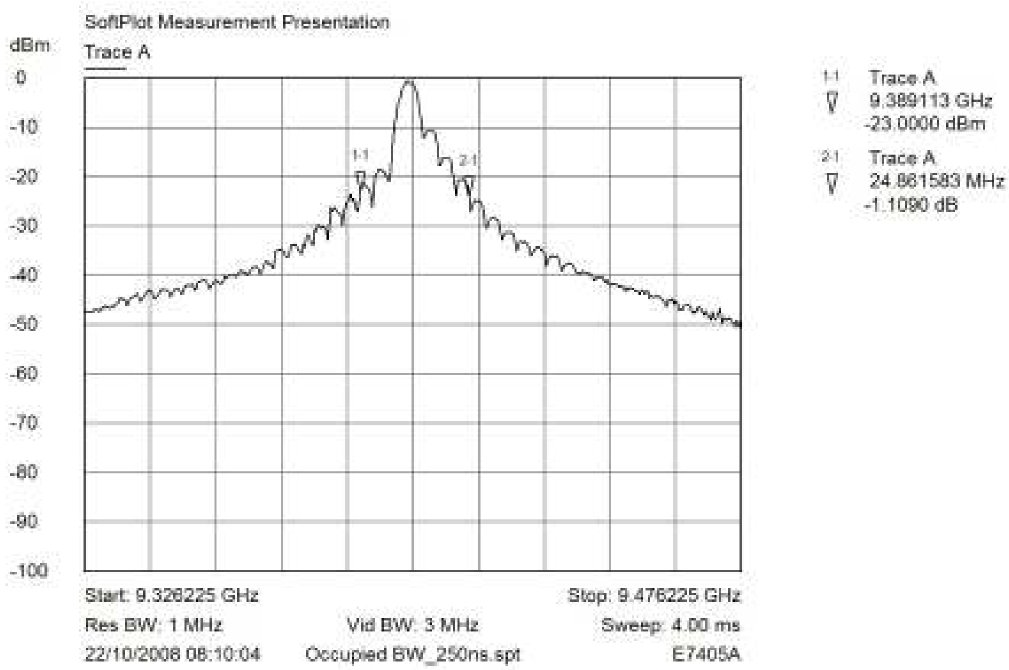


Figure 35 Occupied Bandwidth 250ns Pulse

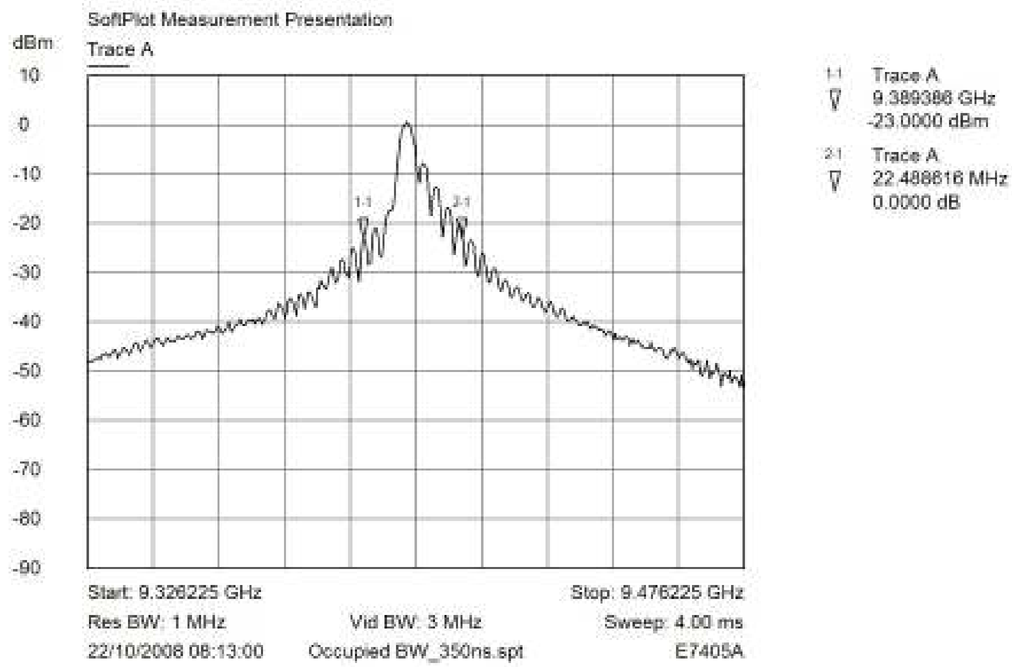


Figure 36 Occupied Bandwidth 350ns Pulse

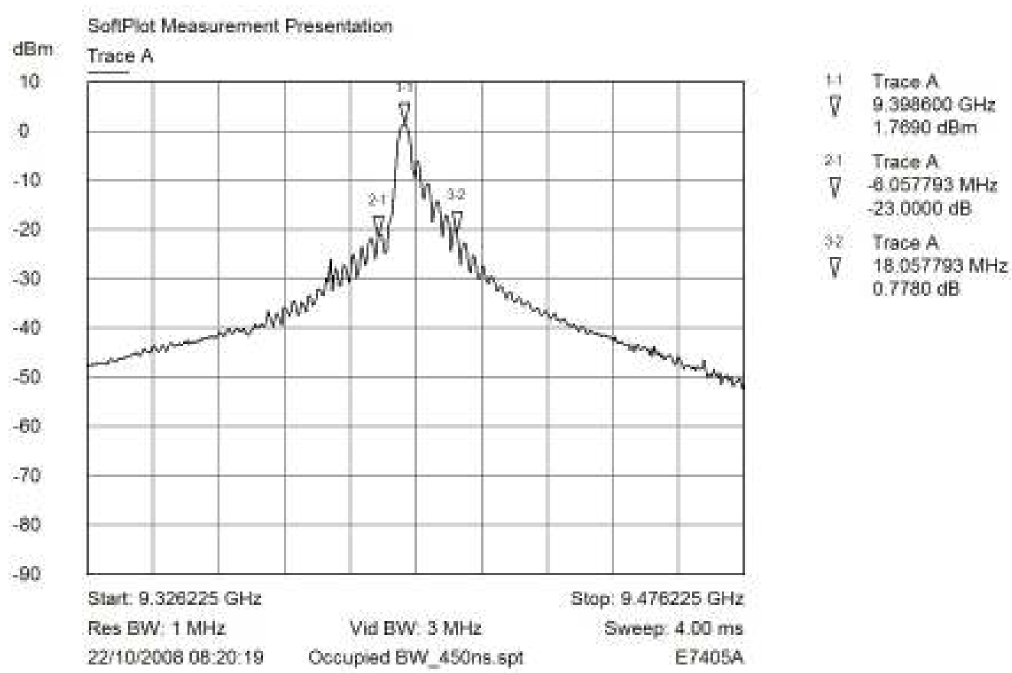


Figure 37 Occupied Bandwidth 450ns Pulse

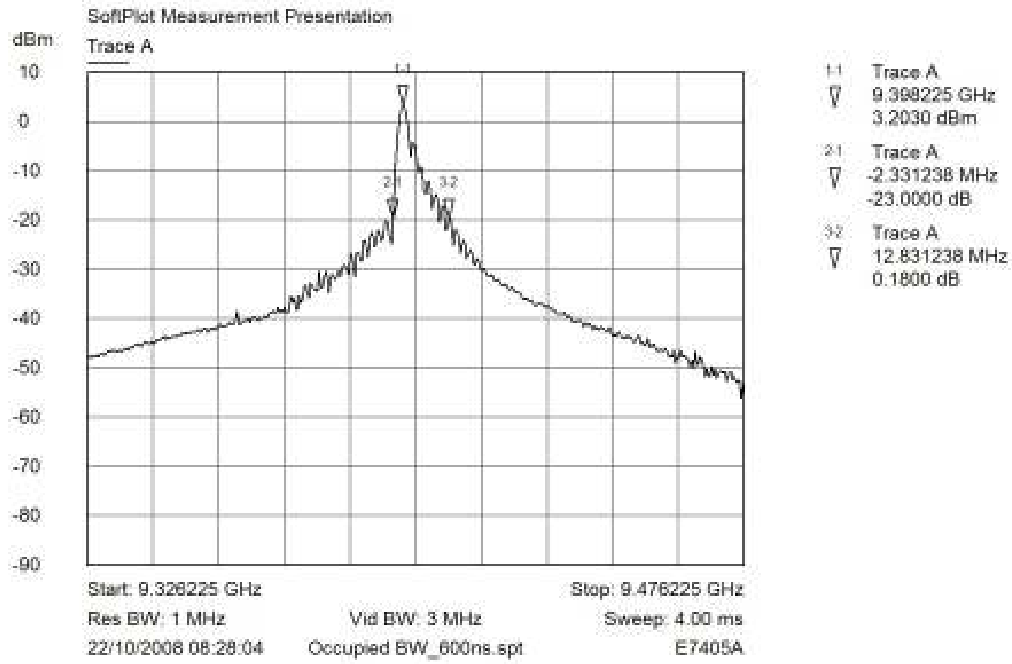


Figure 38 Occupied Bandwidth 600ns Pulse

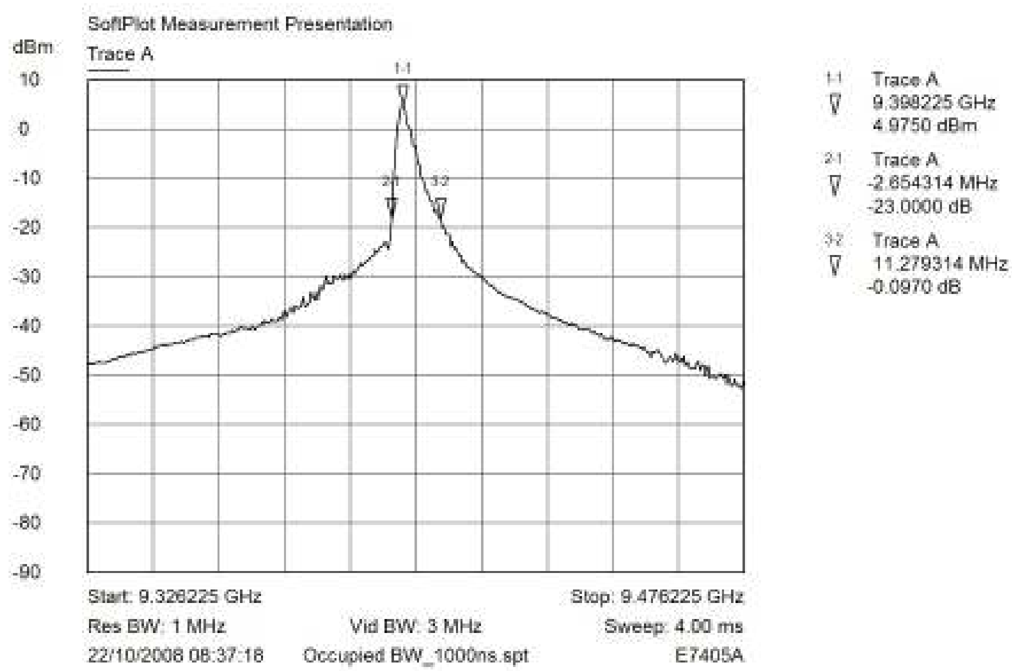


Figure 39 Occupied Bandwidth 1000ns Pulse