TEST REPORT

EMC DEPARTMENT

RAYMARINE UK LTD

Test of: Raymarine UK Ltd.
12kW Open Array Digital Radar

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

(Leisure Marine Radar Equipment)

Test Report Serial No. 649/1080

Checked By: **Mike Thompson** EMC Engineer	Approved By: **Peter Bowen** Compliance Manager
Tested By: **Michael Howes**	Author: **Michael Howes** EMC Engineer
Issue Date: **25th January, 2008**	**Test Dates:** **3rd January to 17th January 2008**

Table of Contents

1 Client Information

Company Name	Raymarine 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:	12kW Open Array Digital Radar	
Unique Type Identification:	12kW Super High Definition Pedestal	E52082
Serial Number:	12kW Super High Definition Pedestal	EMC071219a
	Voltage Converter Module	EMC071219c
Country of Manufacture:	Hungary	
FCC ID Number:	FCC ID: PJ5-DP12KW	
Date of Receipt:	19th December 2007	

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: 12kW X-band transmitter with 4ft or 6ft open array antenna.
Display Unit: Compatible with E Series and G Series
Voltage Converter Module

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:	12kW Pedestal (48" OA): 25kg (55.1lbs) 12kW Pedestal (72" OA): 29kg (63.9lbs)
Dimensions:	12kW Pedestal: 412mm x 324mm x 402mm
Interface Ports:	Combined Power and Network

2.5 Support Equipment

Support equipment used throughout test:

Item	**Unique Type Identification & Serial Number**
E120 Display	EMC071219d
Seatalk^{HS} Switch	EMC081104a
Compaq Laptop	LT1367

3 Test Specification, Methods and Procedures

3.1 Test Specification

Reference:	FCC Part 80: 2007 and 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 C63.4-2001, 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.
Purpose of Test:	To demonstrate compliance of the 12kW Open Array Digital 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, 450 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 12kW Pedestal was powered via the Voltage Converter Module. The Pedestal was connected to a Seatalk^{HS} Switch with the standard 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 55dBuV/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 peak levels measured were less than 55dBuv/m

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

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

The following table lists frequencies at which significant emissions were measured using Peak detector functions.

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

Plots of measurement scans can be found in Appendix D.

Frequency (GHz)	Antenna Polarization	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Result
18.848	Vertical	111.02	130.78	19.76	Complied
28.269	Vertical	108.01	130.78	22.77	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.

Plots of the scans can be found in Appendix D.

Frequency (GHz)	Antenna Polarization	Level (dBm)	Limit (dBm)	Margin (dB)	Result
3.426	Vertical	-1.39	17.76	16.37	Complied
18.856	Vertical	5.74	17.76	12.02	Complied
28.278	Vertical	10.82	17.76	6.94	Complied
39.225	Vertical	10.87	17.76	6.89	Complied

7.4 Peak Power

These measurements were performed with the 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	11.4
100	11.4
150	11.4
250	11.5
350	11.9
450	11.8
600	11.8
1000	11.7

Note 1: Power is measured at the antenna port and the losses in the circulator and rotating joint have been accounted for during the measurement.

7.5 Pulse Width

Plots can be found in Appendix D.

In order to determine the characteristics of the various pulses, the 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	85.4
100	104.9
150	158.7
250	257.5
350	353.3
450	453.1
600	610.8
1000	1046

7.6 Pulse Repetition Frequency

In order to determine the characteristics of the various pulses, the 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	3036
100	3036
150	3036
250	3036
350	2004
450	1518
600	1318
1000	821.31

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	11.4	3036	85.4	2.95
100	11.4	3036	104.9	3.63
150	11.4	3036	158.7	5.49
250	11.5	3036	257.5	8.99
350	11.9	2004	353.3	8.43
450	11.8	1518	453.1	8.12
600	11.8	1318	610.8	9.49
1000	11.7	821.31	1046	10.05

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 12.0	10.2	9.435737
100% of 12.0	12.0	9.435256
100% of 24.0	24.0	9.434776
115% of 24.0	27.6	9.434936

1000ns

% of Nominal Volts	Volts (dc)	Measured Frequency (GHz)
85% of 12.0	10.2	9.424199
100% of 12.0	12.0	9.424519
100% of 24.0	24.0	9.425808
115% of 24.0	27.6	9.426442

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 115% of the highest operating voltage.

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 (GHz)
-30	9.440
-20	9.436
-10	9.440
0	9.434
+10	9.436
+20	9.432
+30	9.434
+40	9.430
+50	9.432

1000ns

Temperature ºC	Measured Frequency (GHz)
-30	9.432
-20	9.428
-10	9.434
0	9.428
+10	9.430
+20	9.426
+30	9.426
+40	9.422
+50	9.424

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 ESU 40 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	45.51
100	41.83
150	34.69
250	27.16
350	22.28
450	19.47
600	18.35
1000	16.83

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	Upper
75	85.4	9317.564	9482.436
100	104.9	9314.423	9485.577
150	158.7	9309.452	9490.548
250	257.5	9305.825	9494.175
350	353.3	9304.246	9495.754
450	453.1	9303.311	9496.689
600	610.8	9302.456	9497.544
1000	1046	9301.434	9498.566

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 Cal Due
318	Peak Power Analyser	HP	8991A	3248A00128	01/10/2008
1721	Receiver	Rohde & Schwarz	ESU 40	100017	23/10/2008
886	Receiver	Rohde & Schwarz	ESI 26	832692/006	08/01/2008
375	EMI Analyser	HP	7405A	US39150138	04/10/2009*
424	DVM	Fluke	83	63550394	02/10/2008
1520	Microwave Sig. Gen. 0.01-40GHz	Rohde & Schwarz	SMR40	10-300074685	02/10/2008*
440	PSU 3-15V 25A	Palstar	PS30M	92534722	Not Reqd ***
442	Antenna 0.09-30MHz	Schaffner	HLA6120	1122	06/01/2010*
482	Antenna 18-26.5GHz	Credowan	20-R-2843-0007	36755	29/09/2008**
483	Antenna 26.5-40GHz	Credowan	S.G. Horn	None	29/09/2008**
1719	Antenna 1.0-18.0GHz	Schwarzbeck	BBHA9120D	578	20/10/2008*
1802	Antenna 30-2000MHz	Chase	CBL6141A	22932	04/12/2008*
n/a	Microwave Cable	Agilent	5061-5458	EMC Cable 6	As Required
n/a	Microwave Cable	Agilent	5061-5458	EMC Cable 11	As Required
RD14	Microwave Coupler	Flann	16270-40-23	116317	As Required
n/a	Inline Attenuator 10dB	Narda	MOD 768-10	47	As Required
n/a	Inline Attenuator 10dB	Narda	MOD 768-10	75	As Required
n/a	Inline Attenuator 10dB	Suhner	6810.17.B	13	As Required
n/a	WG16 to N Adaptor	Flann	16094-NF10	100	As Required
n/a	Microwave Power Load	Mitec Europe	EM2190	3731-1	As Required
n/a	Microwave Power Load	n/a	n/a	EMC Coupler 1	Not Required

Notes:

* 2 year calibration cycle in accordance with manufacturer's recommendations.

** 3 year calibration cycle in accordance with manufacturer's recommendations.

*** Voltage monitored using Item 424

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 setup using the R&S ESU40 receiver and SMR40 signal generator (under ESU40 control as a pseudo-tracking generator).

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 - 9500MHz), 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 11.9kW by conducted methods. Consequently, a level of 11.9mW 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 with a 4ft open array antenna. The antenna was aligned with the horn antenna connected to the spectrum analyser and adjusted to peak the analyser response. A reading of 183.8dBuV/m was obtained.

The calculation for the radiated emissions limit line is:

Po(peak)dBuV/m – 43 – $10\log_{10}$ P(mean)watts,

$183.8 – 43 – 10\log_{10} 10.05 =$ **130.78dBuV/m**

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., $70.43 – 43 – 10\log_{10} 10.05 =$ **17.76dBm**

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 open array 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.

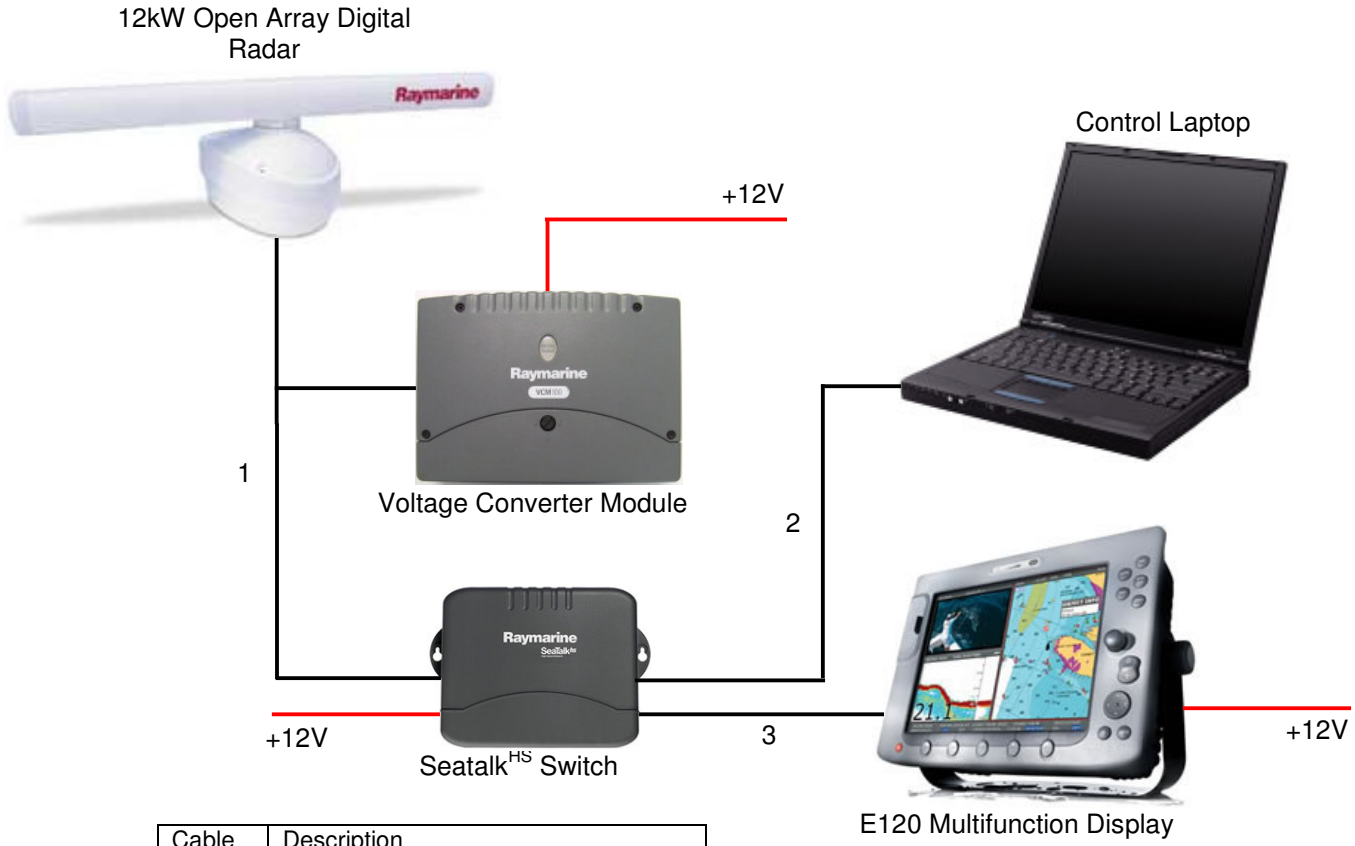
All testing was carried out within a semi-anechoic chamber at a distance of 3m. The conducting ground plane between the antenna and the EUT was covered with ferrite and pyramidal absorbing material. For all tests, the open array antenna was replaced with a rotating microwave load.

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

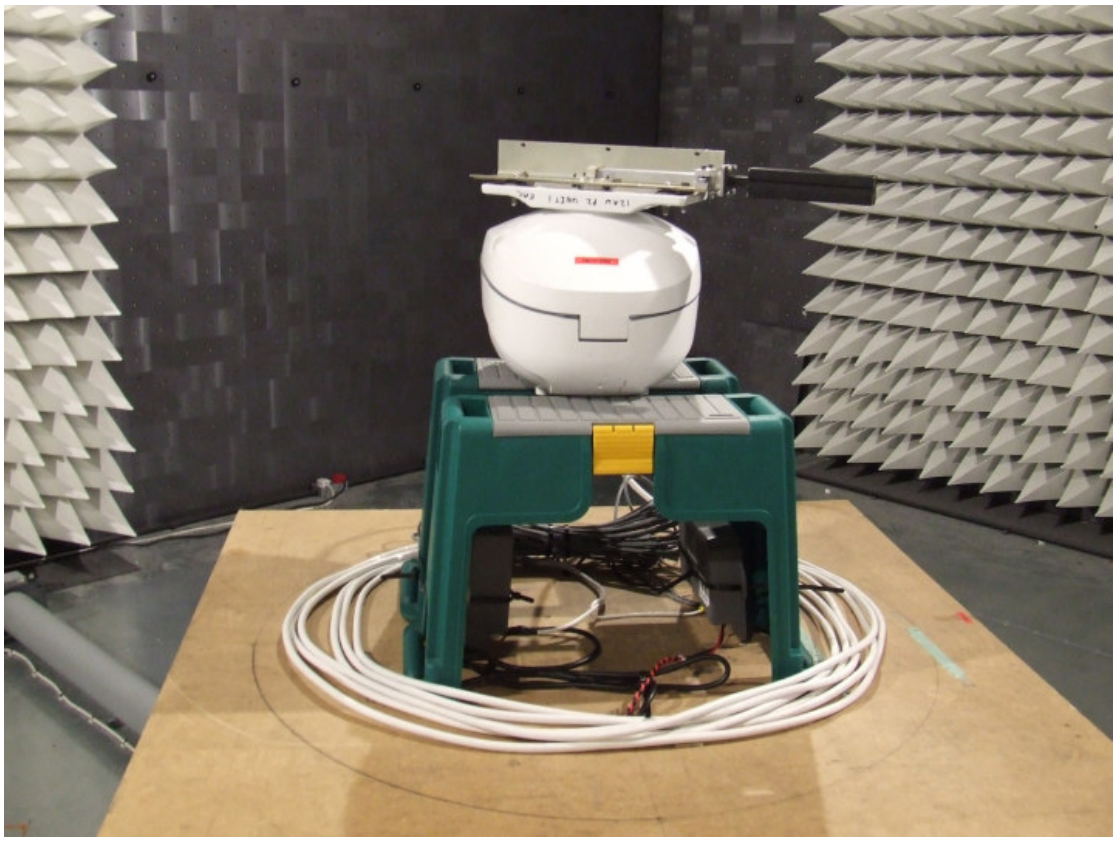
The 12kW Pedestal and Voltage Converter Module were arranged in as near a representative configuration as was practicable. The display unit, which is not directly part of the test, was placed on the turntable floor. The Pedestal, VCM100 and excess scanner interconnection cable were placed upon a non-conducting 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 Pedestal support. Due to its size and construction, this cable cannot be bundled.

C.1 Connection diagram



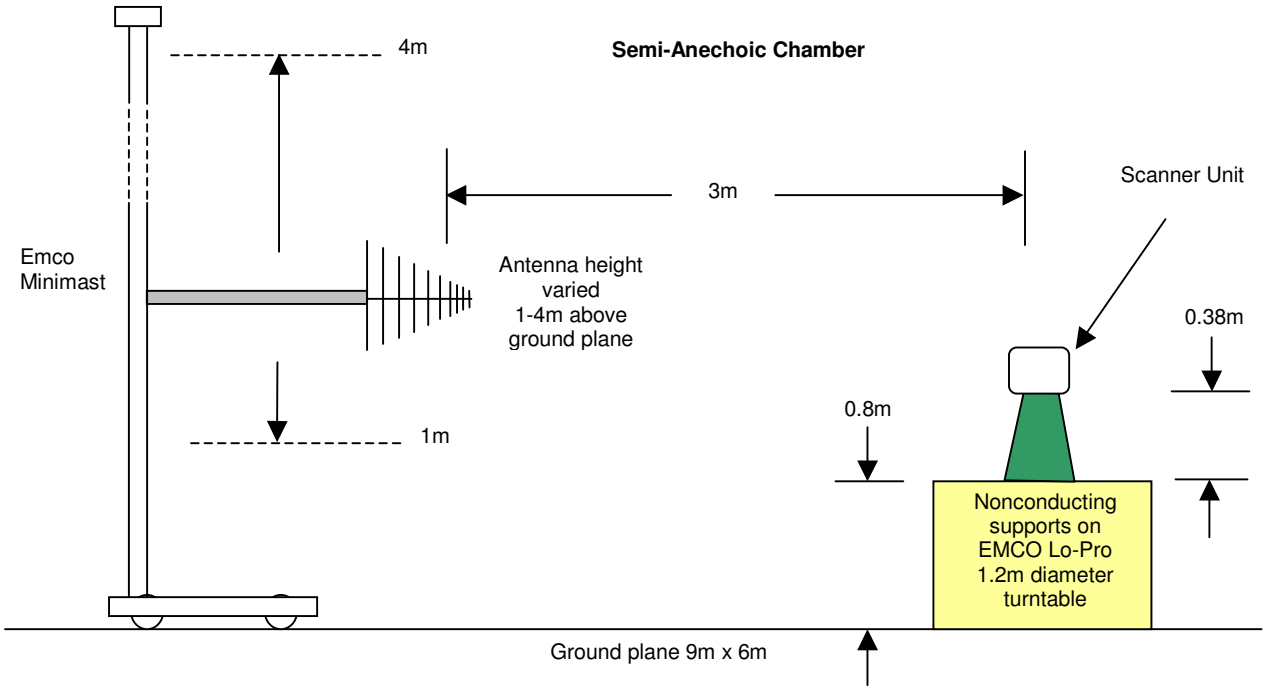
Cable	Description
1	15m Combined Ethernet/Power cable
2,3	10m CAT 5 Ethernet cable

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

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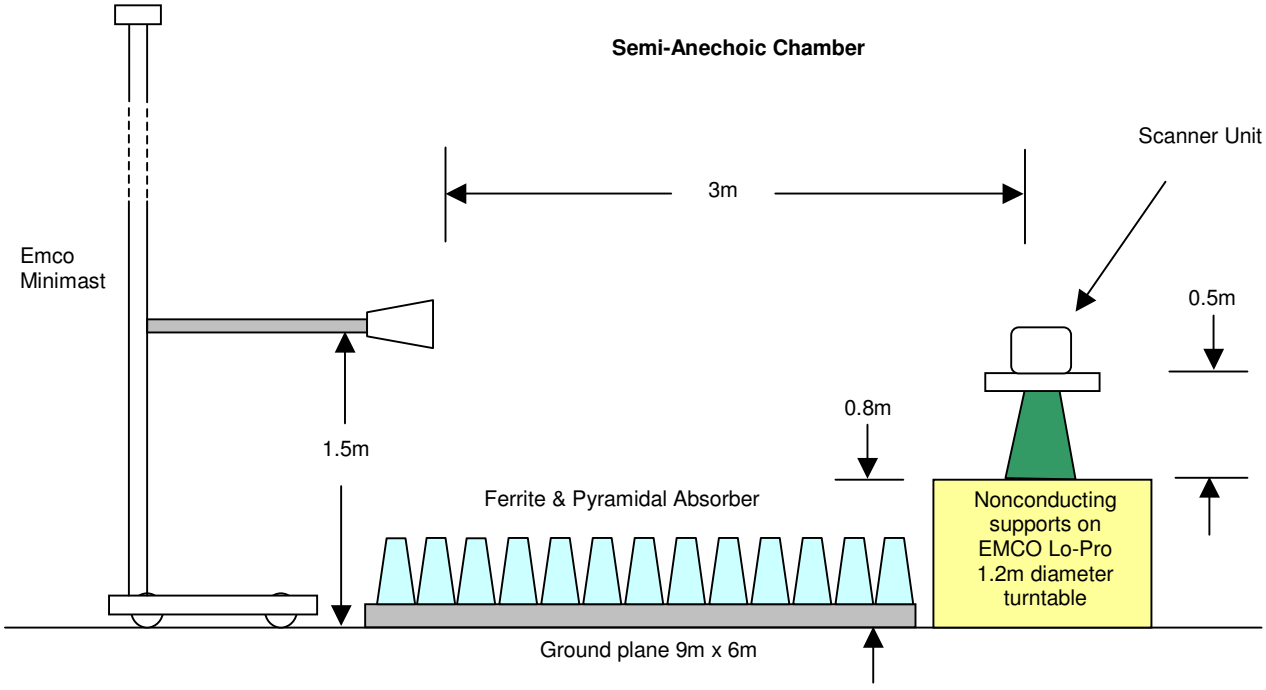

Appendix D Graphical Test Results

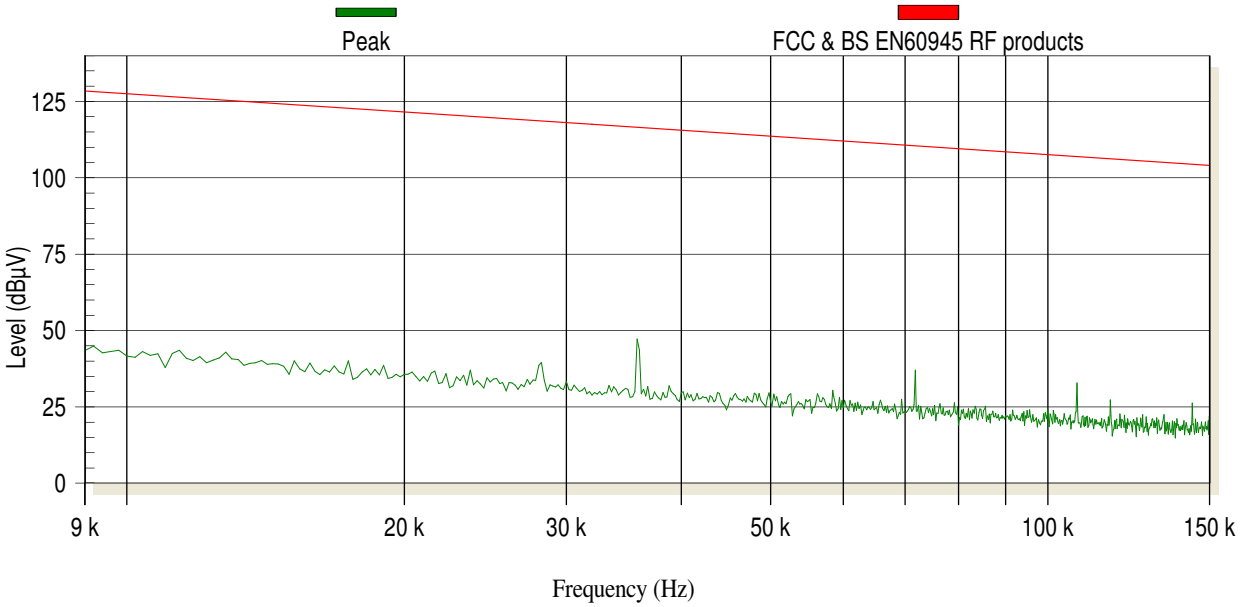

Figure 1 Radiated Emissions 9kHz to 150kHz Loop Face on

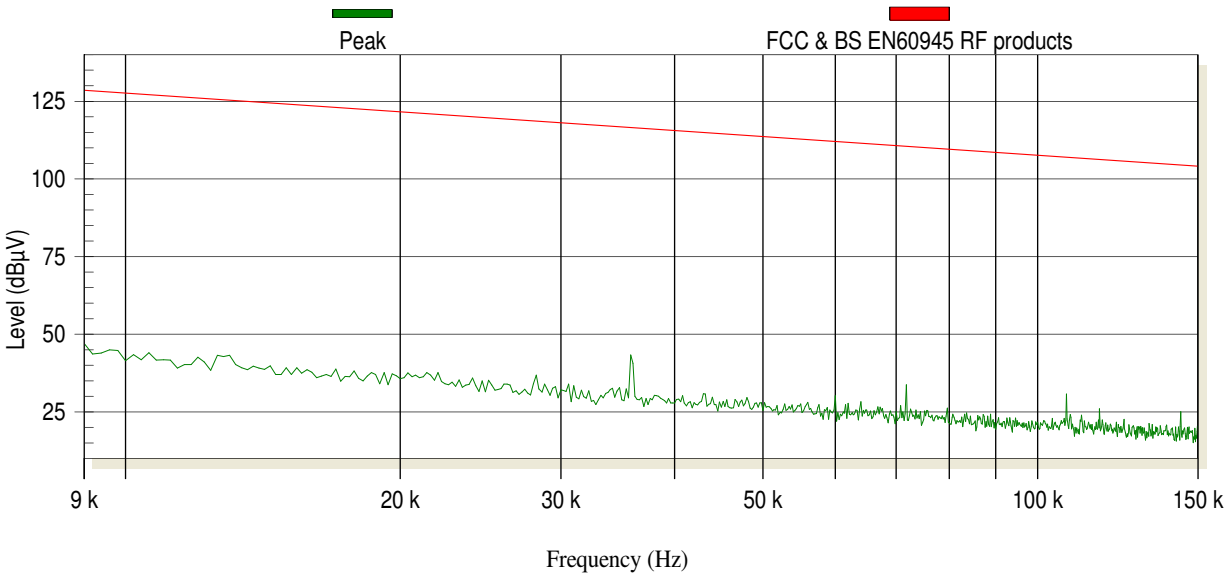

Figure 2 Radiated Emissions 9kHz to 150kHz Loop Side on

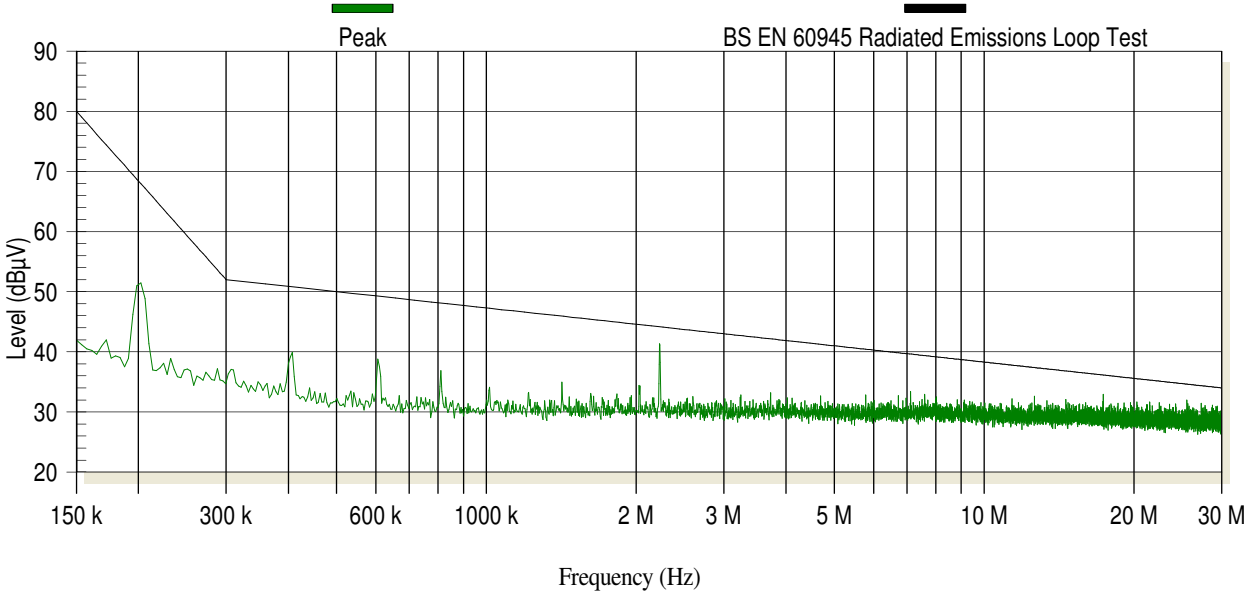

Figure 3 Radiated Emissions 150kHz to 30MHz Loop Side on

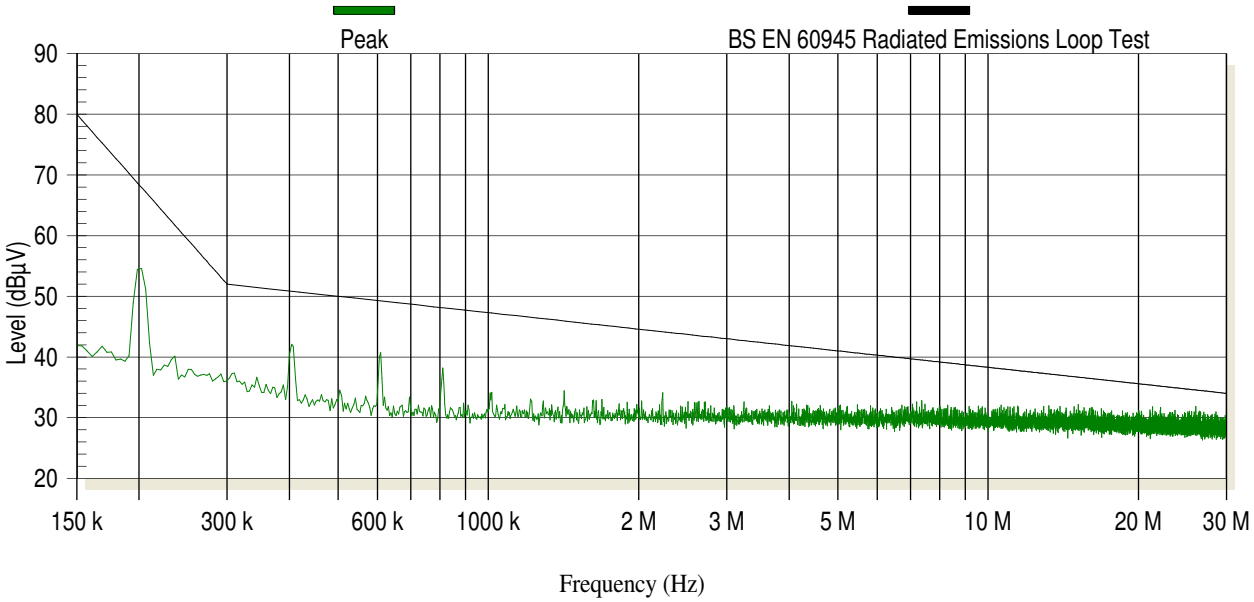

Figure 4 Radiated Emissions 150kHz to 30MHz Loop Face On

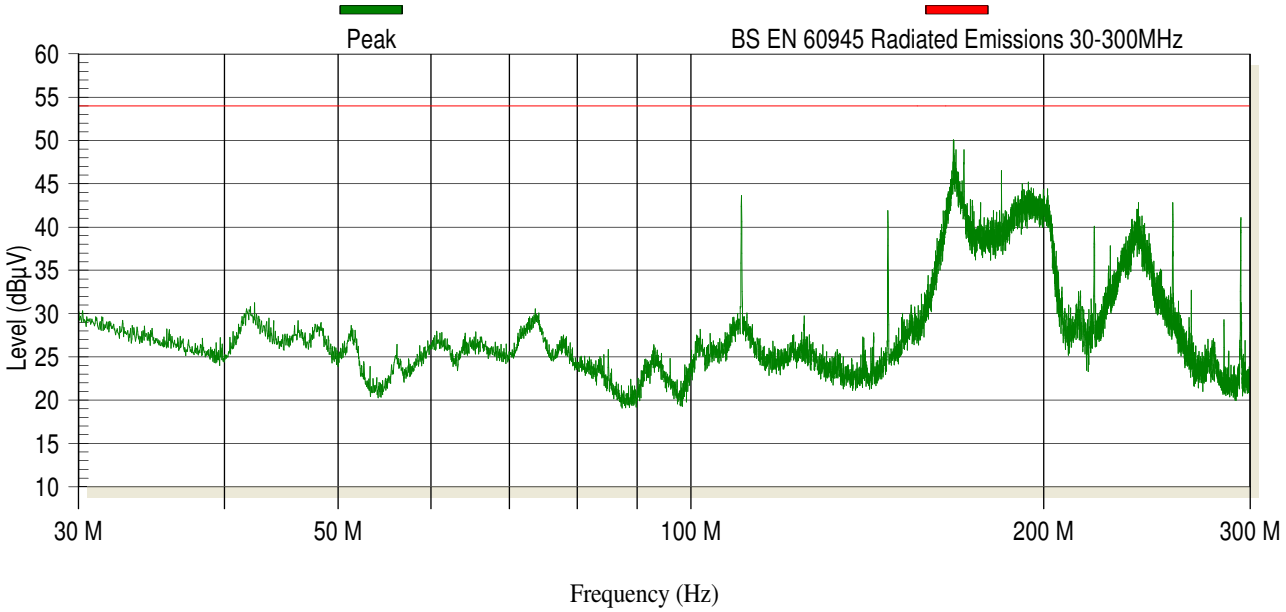

Figure 5 Radiated Emissions 30MHz to 300MHz

Frequency (MHz)	Angle	Polarisation	Height (m)	QP Level (dBµV/m)	QP Margin (dB)
166.767	157.5	V	2.4	39.2	-14.77
167.43	0	H	1.5	37.3	-16.7
167.612	150	V	2.3	40.7	-13.29
167.998	120	V	2.2	40.6	-13.38
168.245	145	V	2.3	41.7	-12.34
168.483	125	V	2.6	41.1	-12.95
168.974	157.5	V	2.8	41	-13.03
169.34	135	V	2.2	40	-13.97
170.995	140	V	2.7	49.3	-4.7
184.081	120	V	2	41.4	-12.57

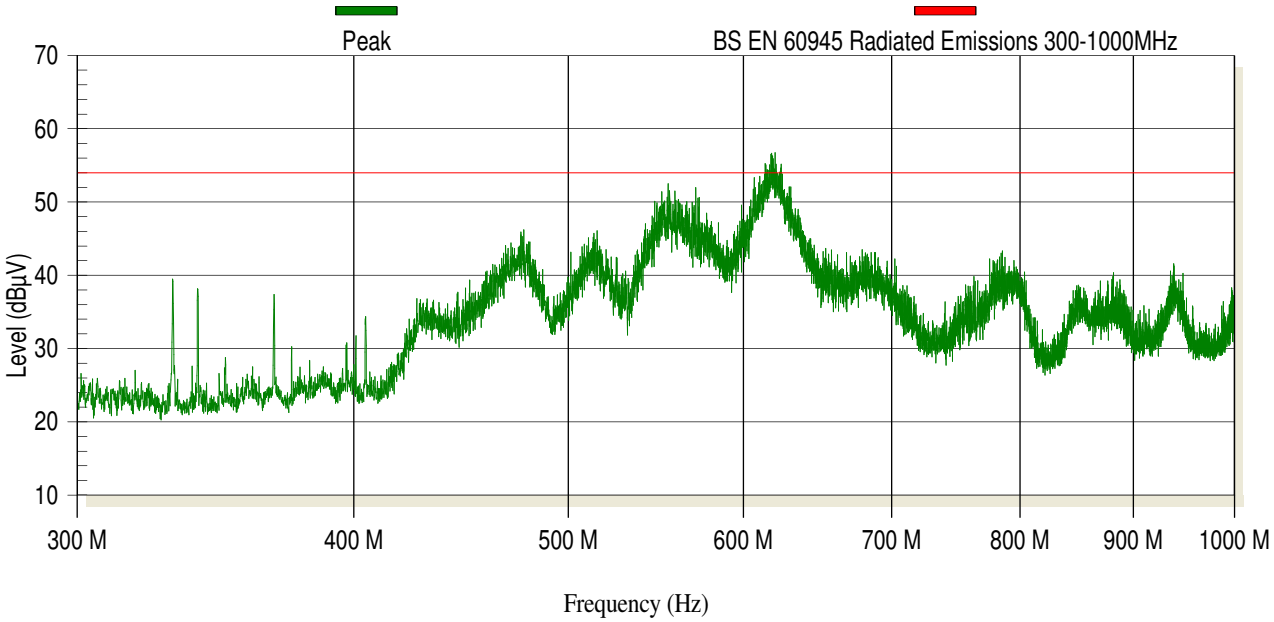

Figure 6 Radiated Emissions 300MHz to 1GHz

Frequency (MHz)	Angle	Polarisation	Height (m)	QP Level (dBµV/m)	QP Margin (dB)
613.636	320	V	1.5	46.4	-7.6
614.645	325	V	1.5	45.9	-8.14
615.219	315	V	1.5	47.1	-6.89
617.5	315	V	1.5	47.5	-6.48
618.021	315	V	1.5	47.3	-6.66
618.702	315	V	1.5	47.6	-6.4
619.36	315	V	1.5	47.8	-6.22
619.829	325	V	1.5	47.4	-6.64
622.206	315	V	1.5	46.8	-7.25
623.085	315	V	1.5	46.3	-7.71

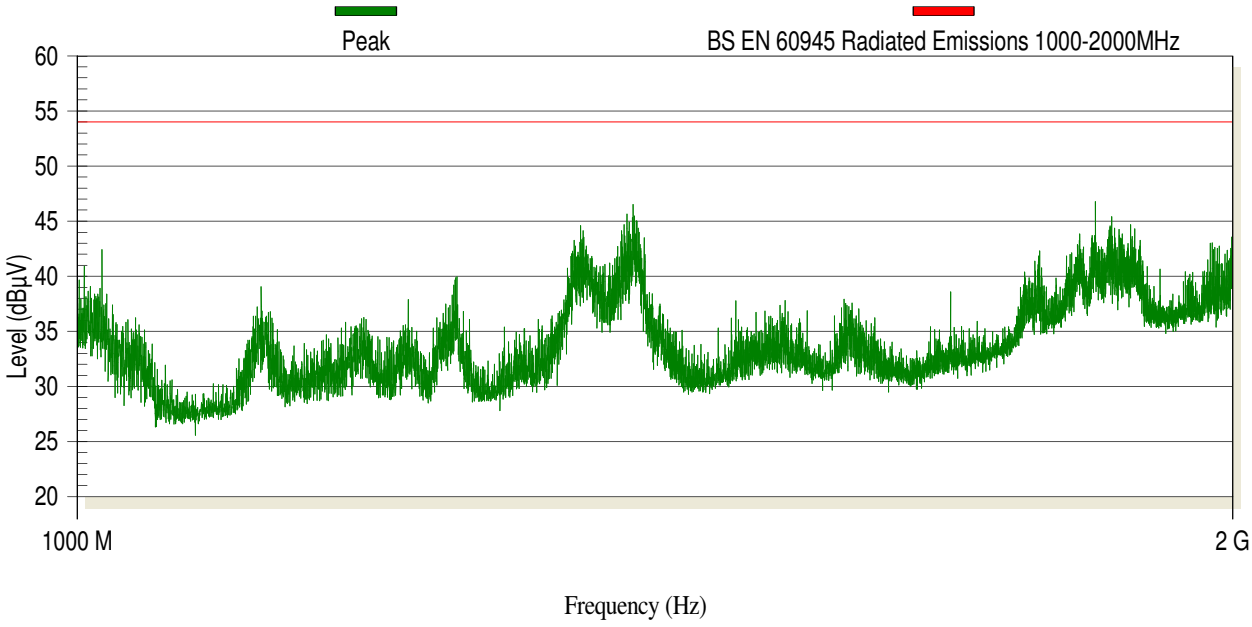

Figure 7 Radiated Emissions 1GHz to 2GHz

Frequency (MHz)	Angle	Polarisation	Height (m)	QP Level (dBµV/m)	QP Margin (dB)
1389.278	222.5	V	1.6	36.9	-17.07
1392.075	227.5	V	2	37.2	-16.8
1393.077	225	V	2.1	37.1	-16.89
1393.436	222.5	V	1.9	37.6	-16.44
1395.114	227.5	V	1.5	36.7	-17.29
1396.064	237.5	V	1.5	36.9	-17.07
1397.181	227.5	V	1.5	37.8	-16.18
1399.259	225	V	1.5	37	-16.97
1841.144	90	V	2.5	35.9	-18.13
1857.194	315	V	1.5	35.6	-18.39

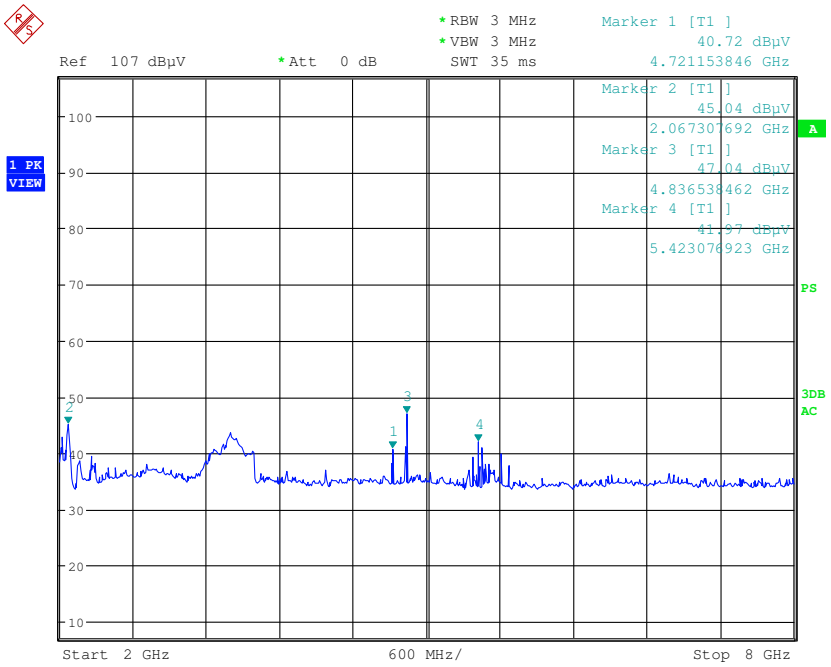

Figure 8 Radiated Emissions 450ns Pulse width 2GHz to 8GHz

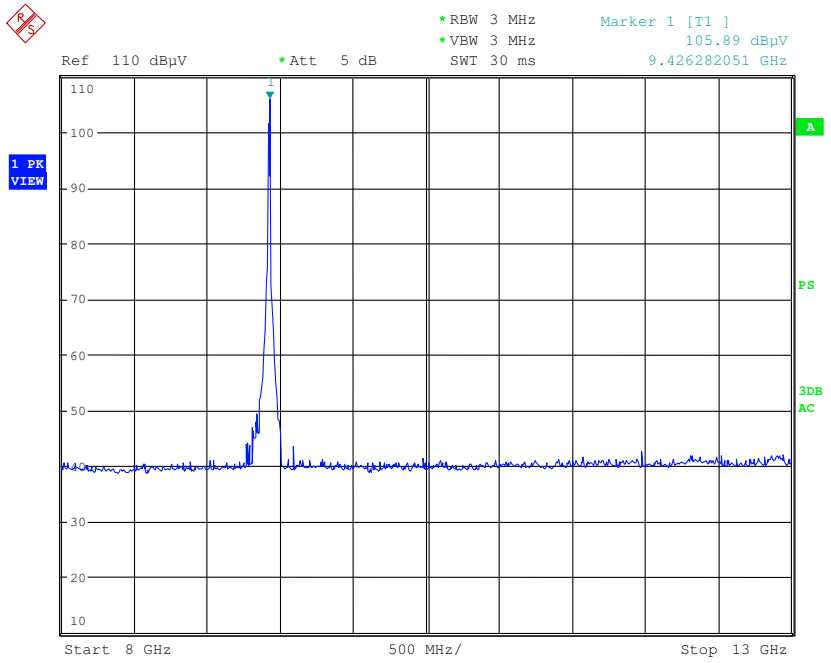

Figure 9 Radiated Emissions 1000ns Pulse width 8GHz to 13GHz

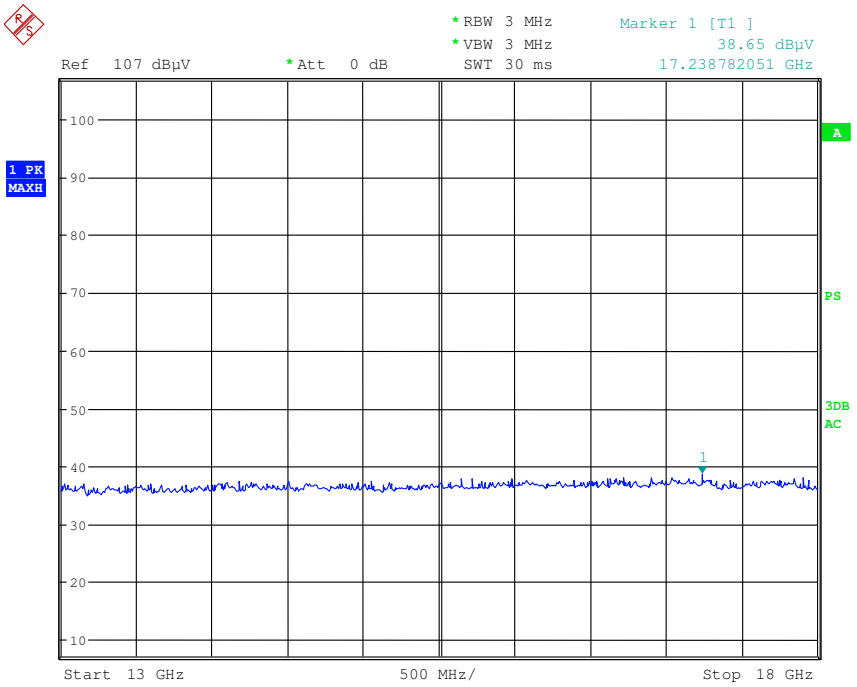

Figure 10 Radiated Emissions 75ns Pulse width 13GHz to 18GHz

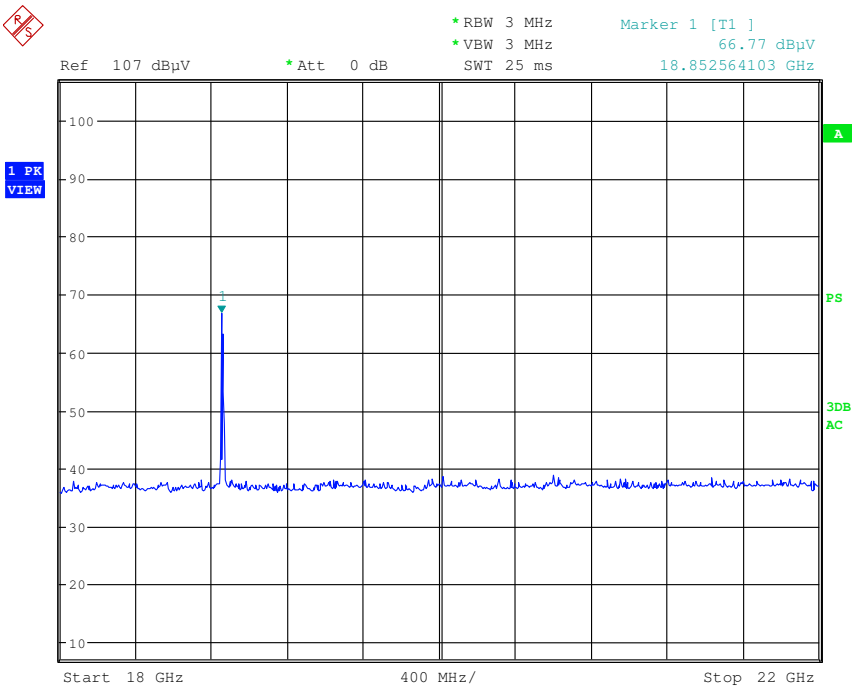

Figure 11 Radiated Emissions 1000ns Pulse width 18GHz to 22GHz

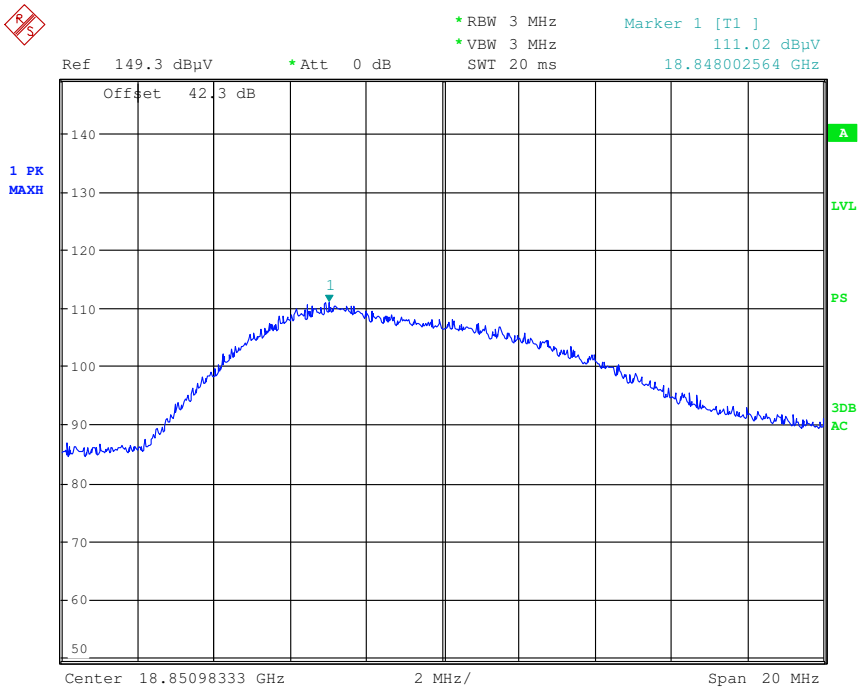

Figure 12 Radiated Emissions 1000ns Pulse width 18.8GHz

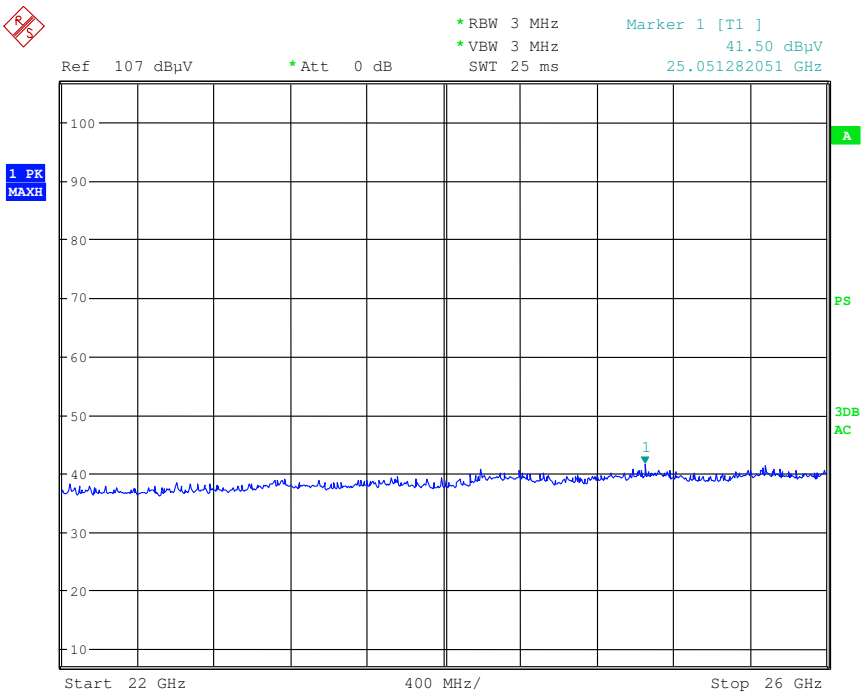

Figure 13 Radiated Emissions 450ns Pulse width 22GHz to 26GHz

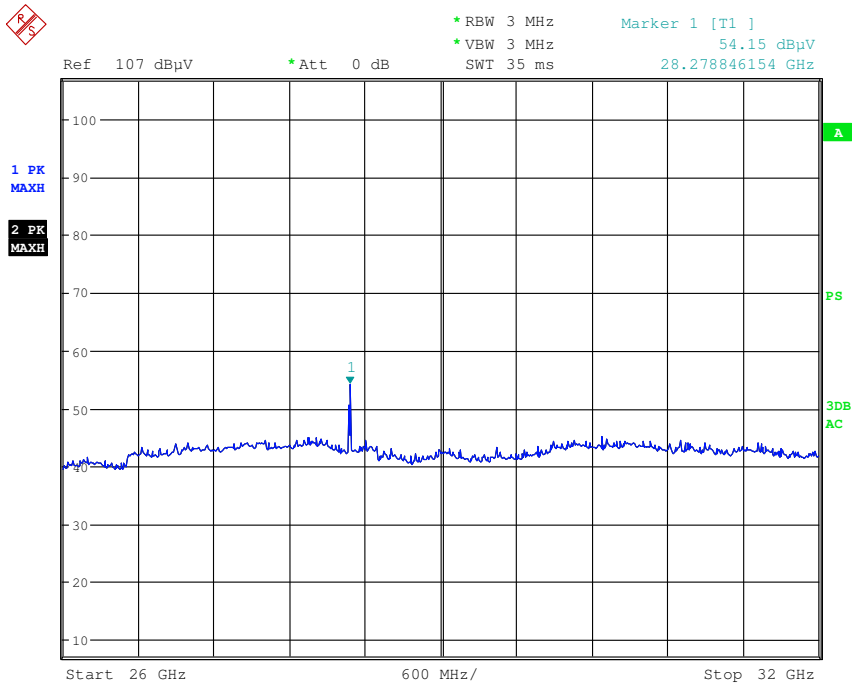

Figure 14 Radiated Emissions 1000ns Pulse width 26GHz to 32GHz

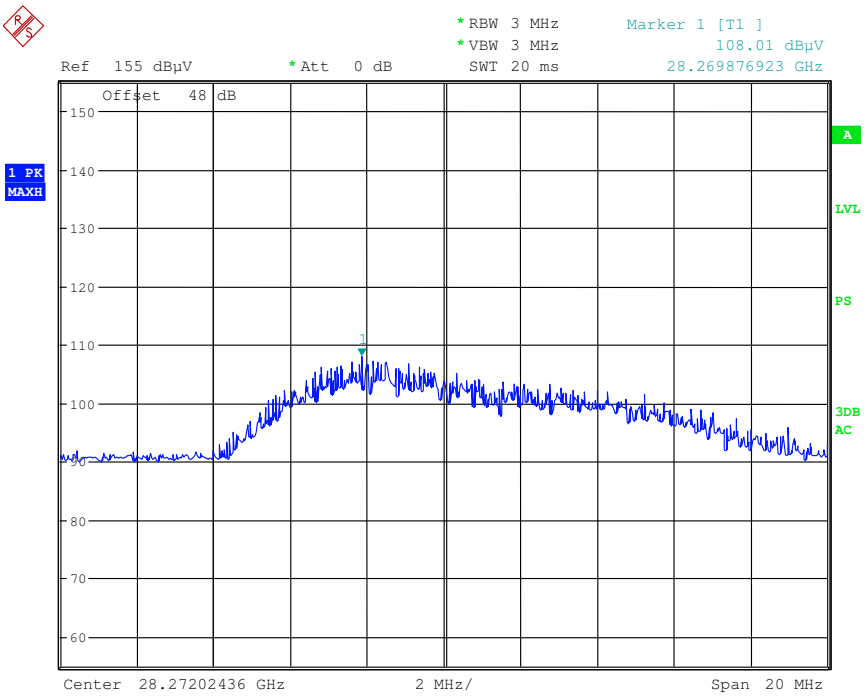

Figure 15 Radiated Emissions 1000ns Pulse width 28.2GHz

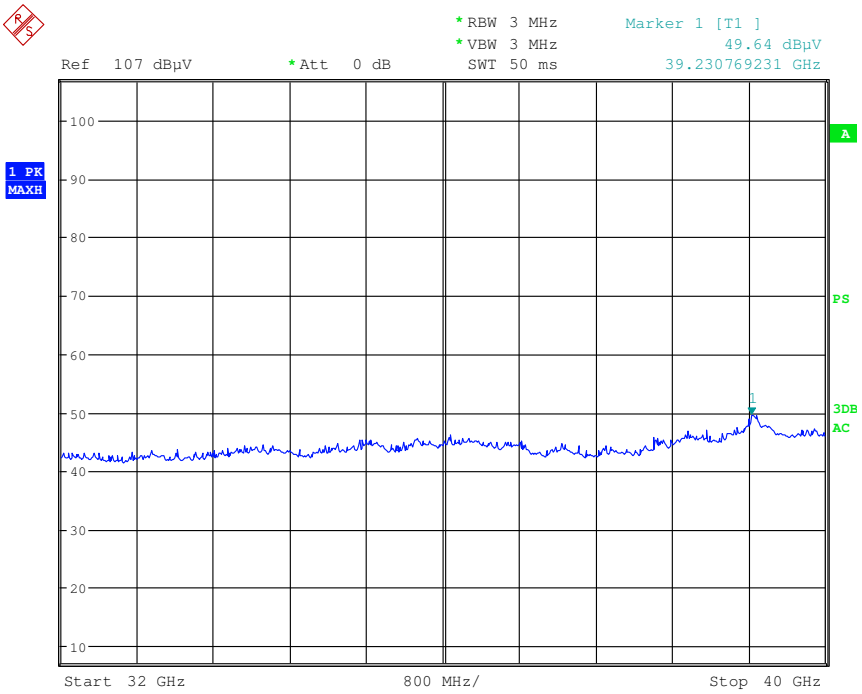

Figure 16 Radiated Emissions 75ns Pulse width 32GHz to 40GHz

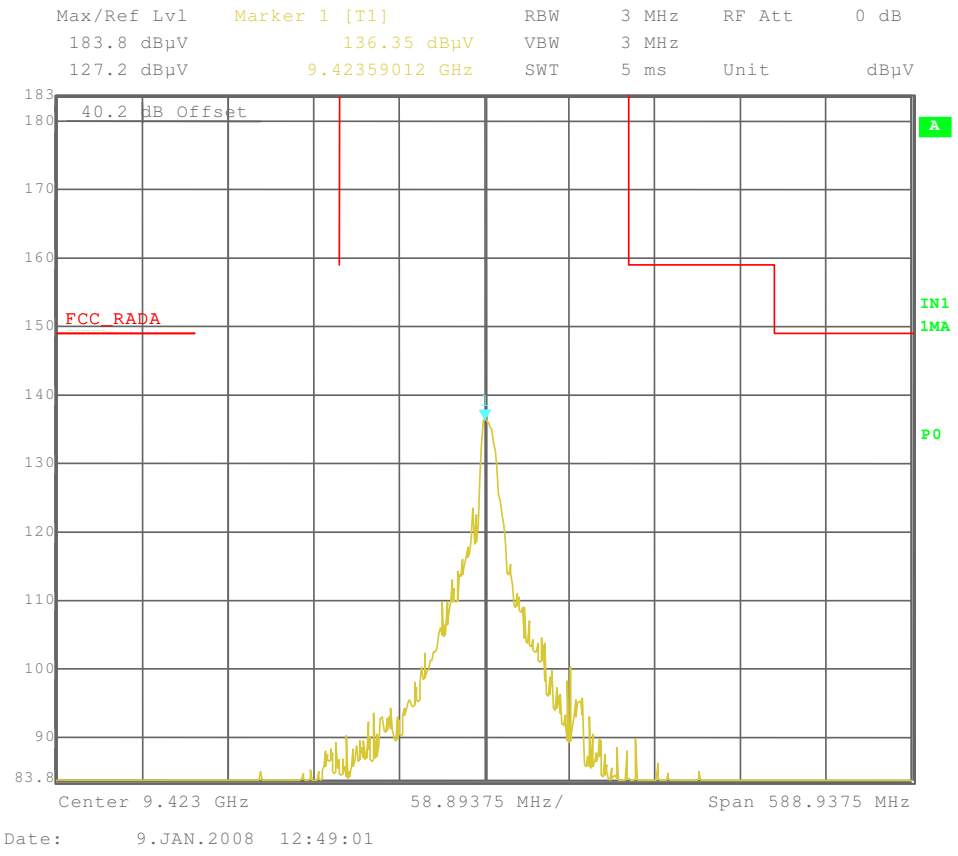

Figure 17 Main Pulse Radiated Measurement 1000ns Pulse (Antenna Not fitted)

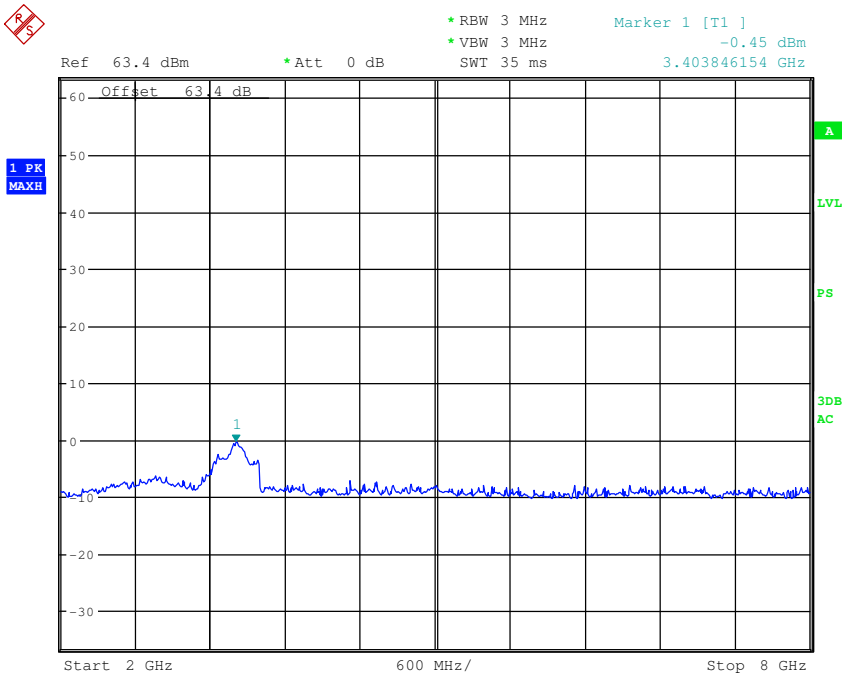

Figure 18 Conducted Emissions 1000ns Pulse 2GHz to 8GHz

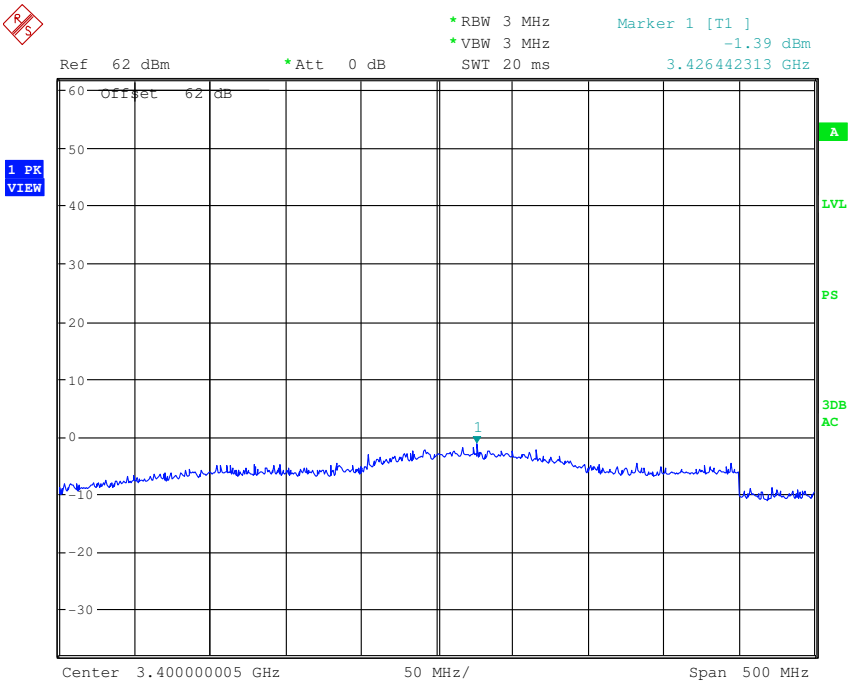

Figure 19 Conducted Emissions 1000ns Pulse 3.4GHz

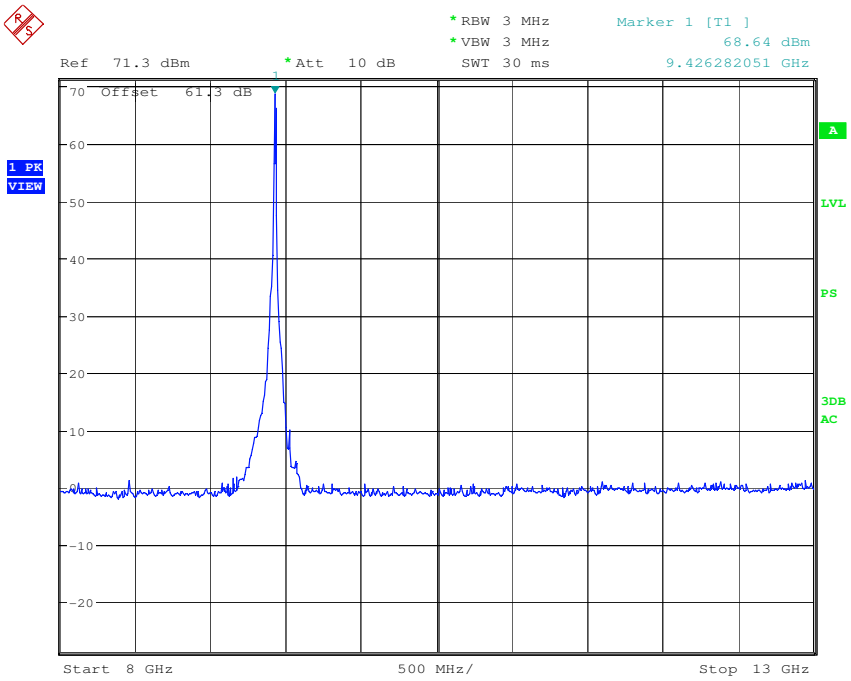

Figure 20 Conducted Emissions 1000ns Pulse 8GHz to 13GHz

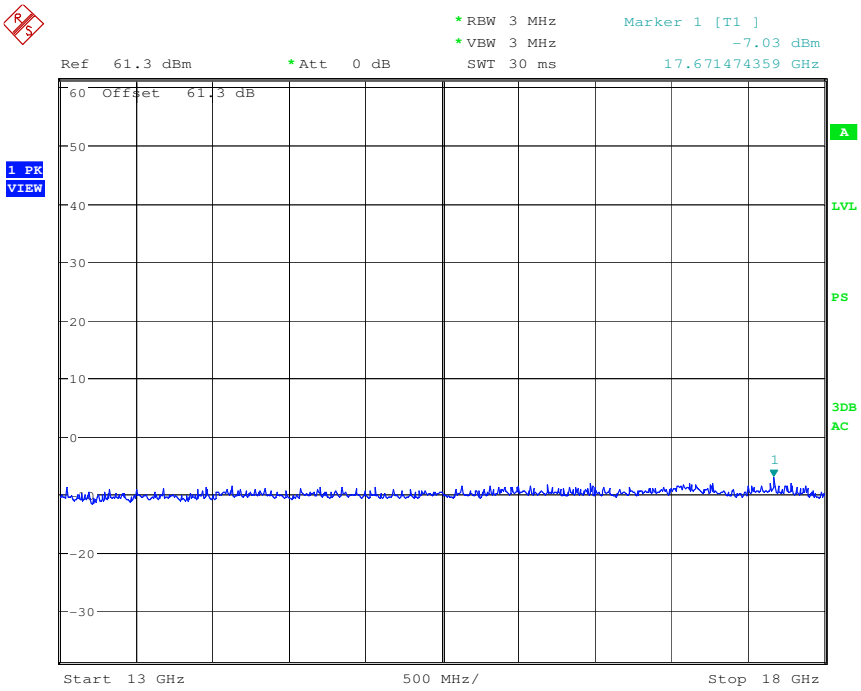

Figure 21 Conducted Emissions 75ns Pulse 13GHz to 18GHz

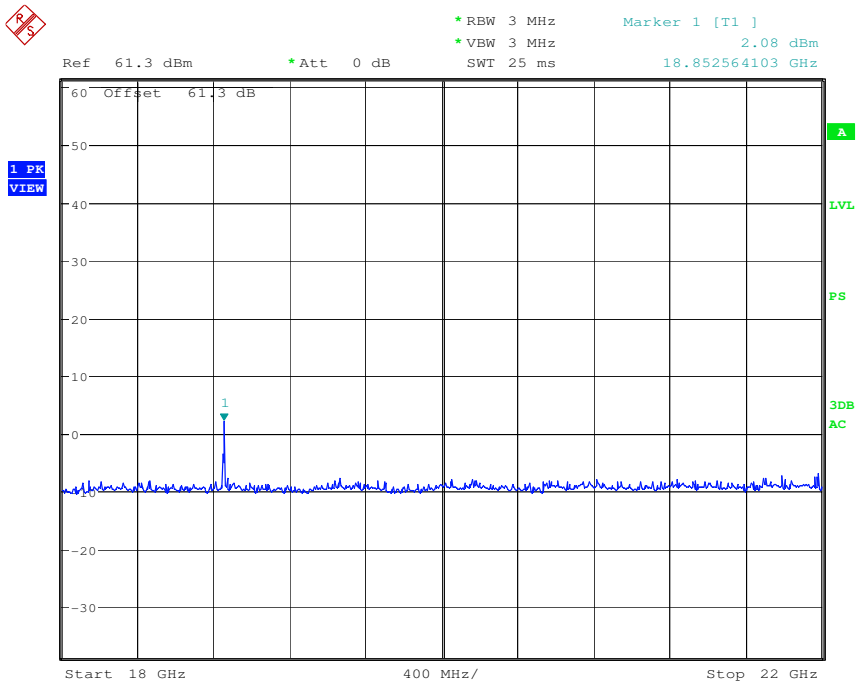

Figure 22 Conducted Emissions 1000ns Pulse 18GHz to 22GHz

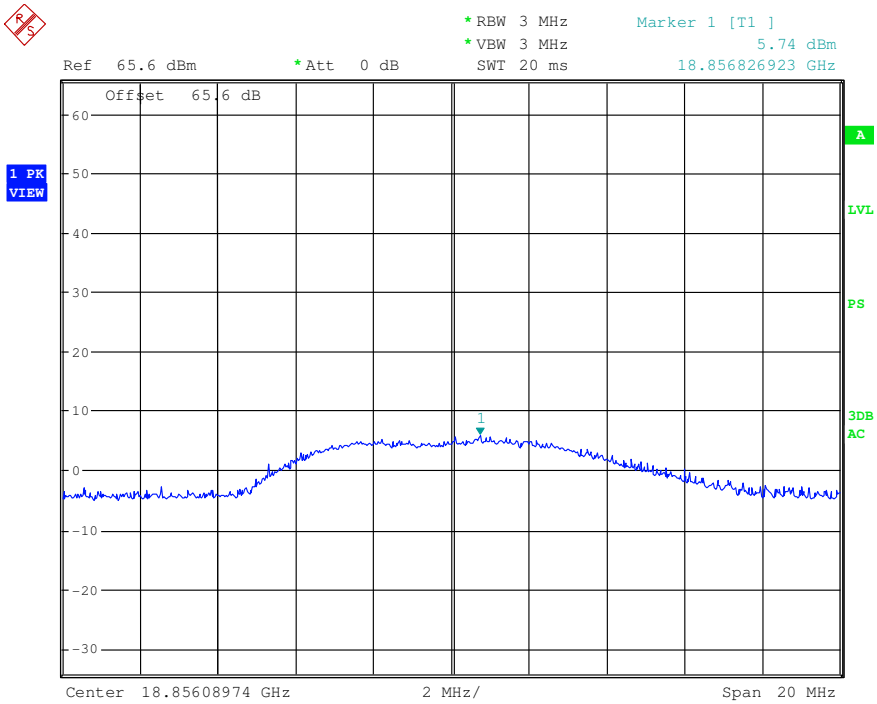

Figure 23 Conducted Emissions 1000ns Pulse 18.8GHz

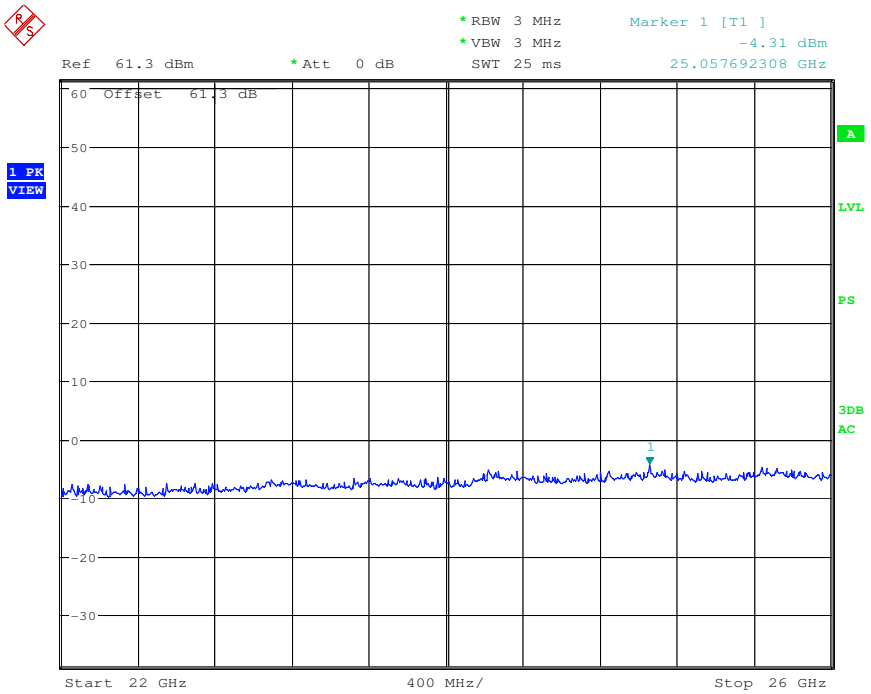

Figure 24 Conducted Emissions 450ns Pulse 22GHz to 26GHz

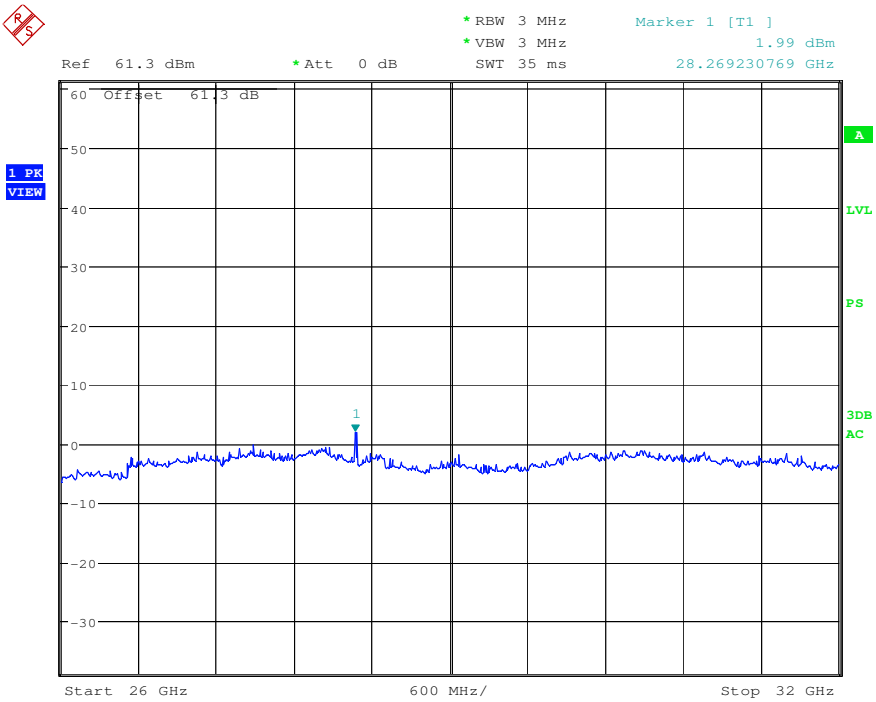

Figure 25 Conducted Emissions 1000ns Pulse 26GHz to 32GHz

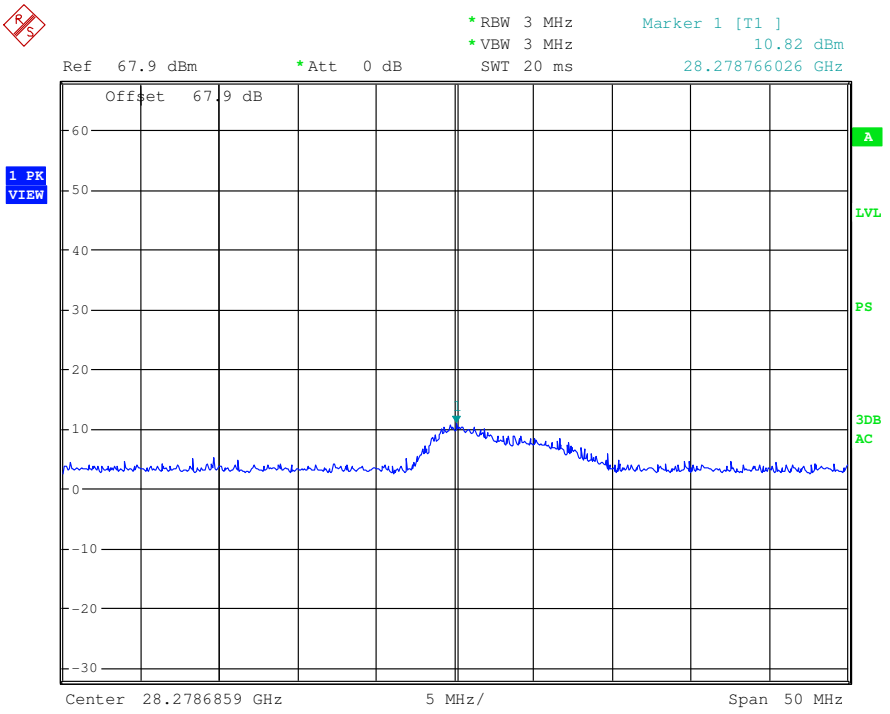

Figure 26 Conducted Emissions 1000ns Pulse 28.2GHz

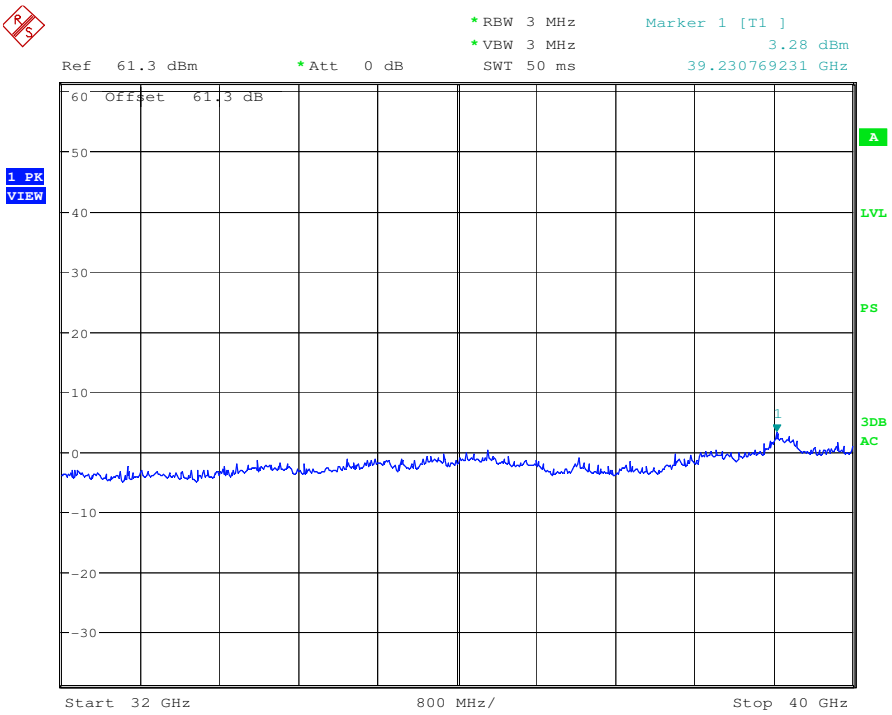

Figure 27 Conducted Emissions 450ns Pulse 32GHz to 40GHz

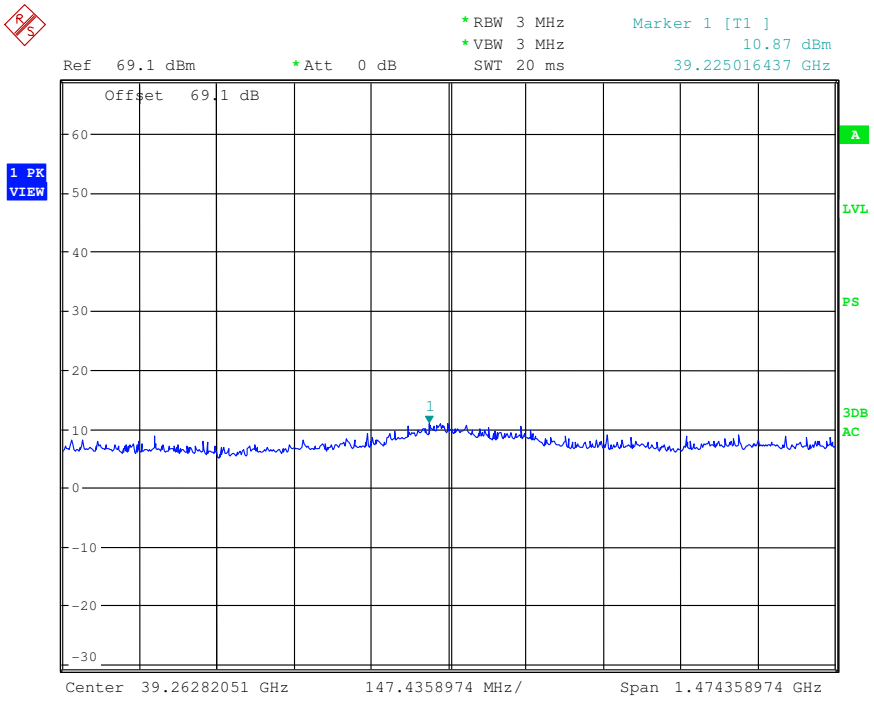

Figure 28 Conducted Emissions 1000ns Pulse 39.2GHz

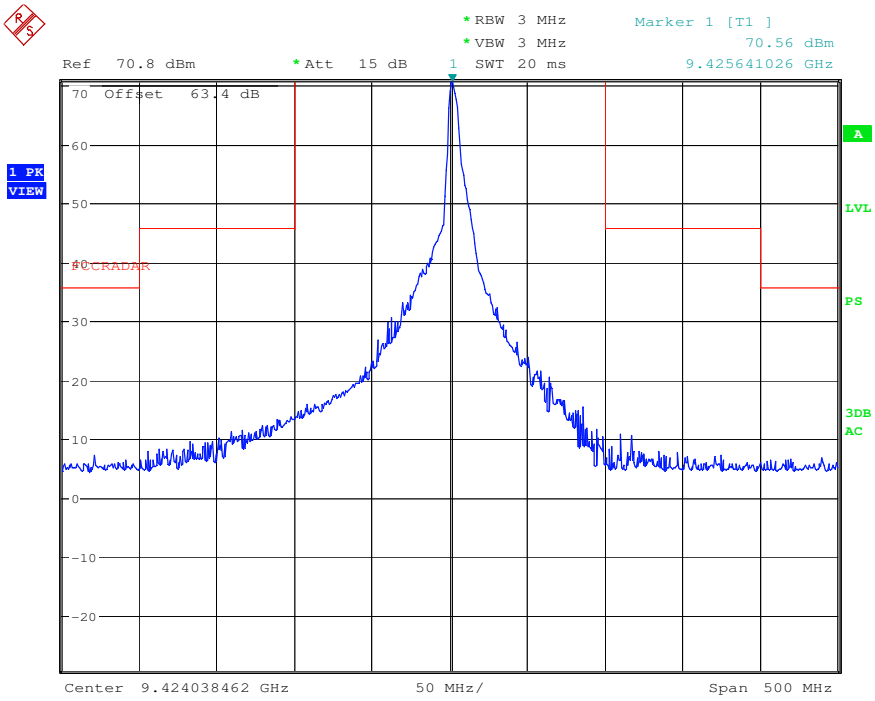

Figure 29 Main Pulse Conducted Measurement 1000ns Pulse

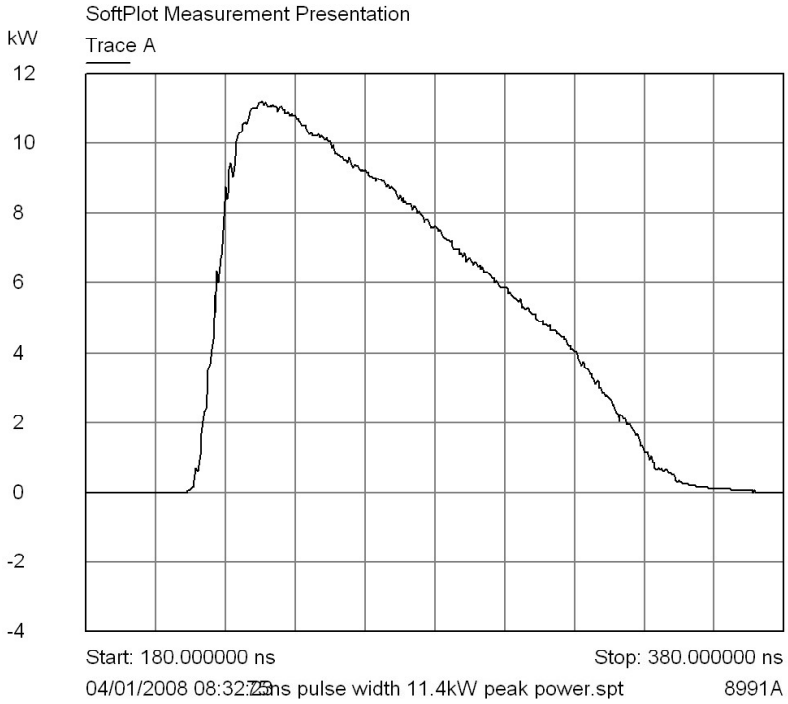

Figure 30 Pulse Characterisation 75ns

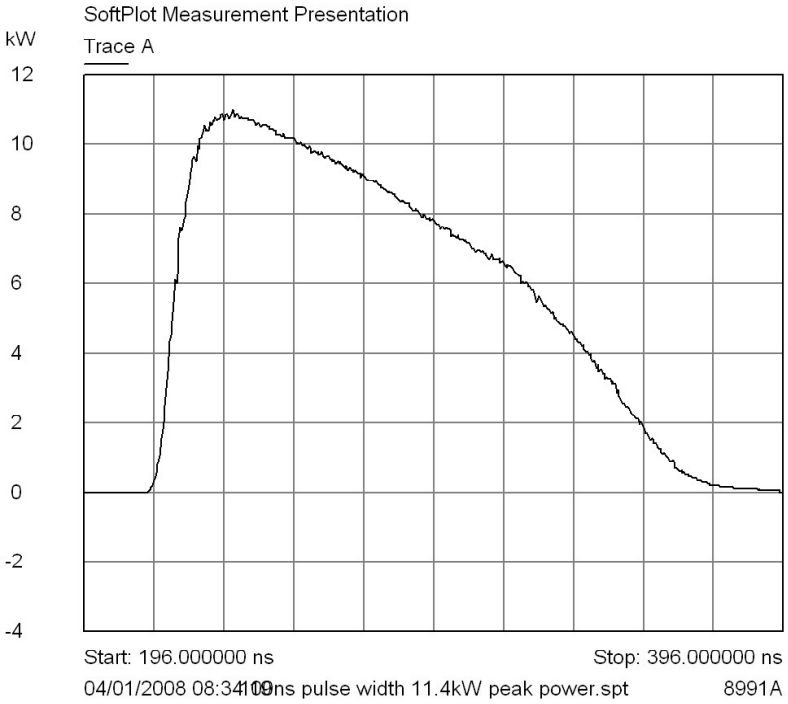

Figure 31 Pulse Characterisation 100ns

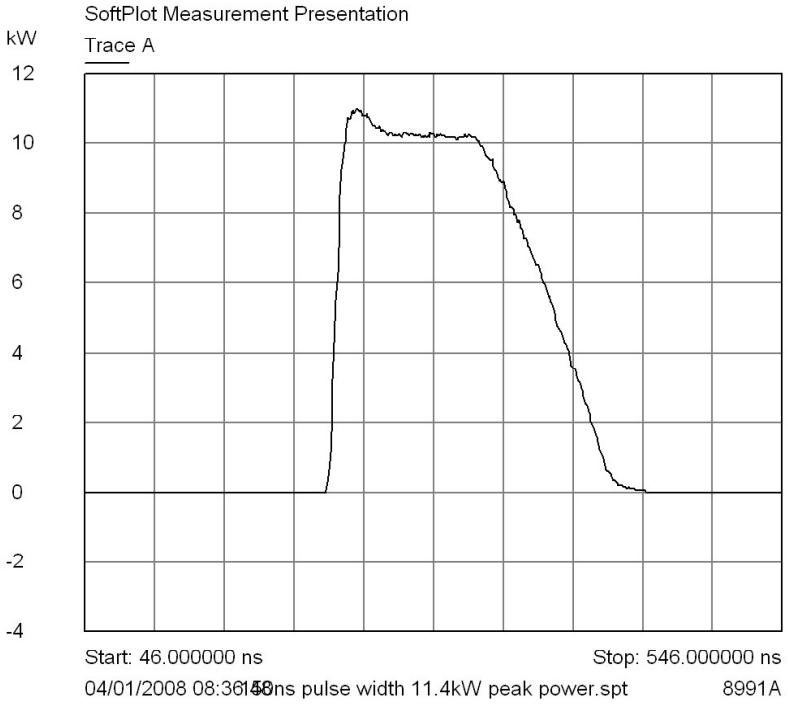

Figure 32 Pulse Characterisation 150ns

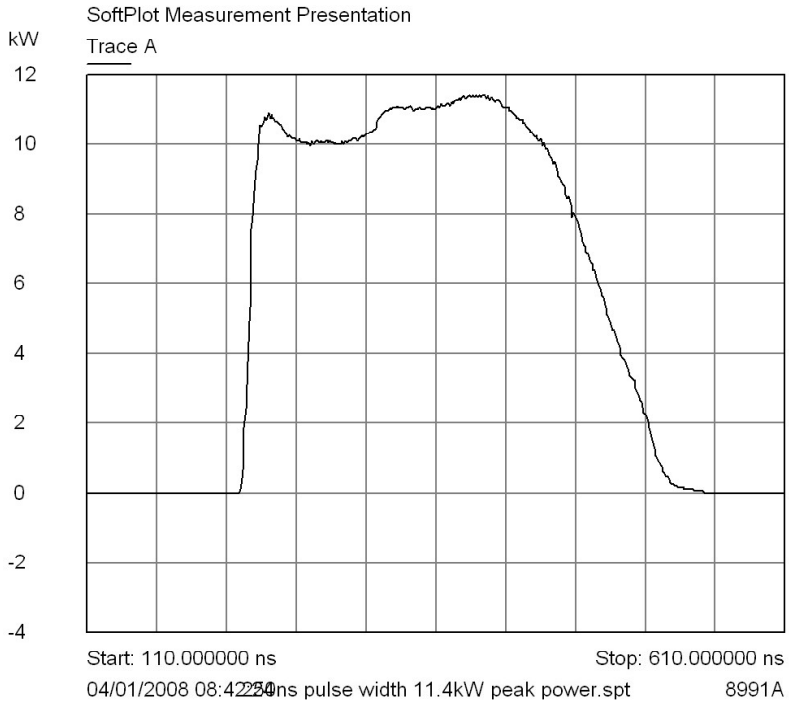

Figure 33 Pulse Characterisation 250ns

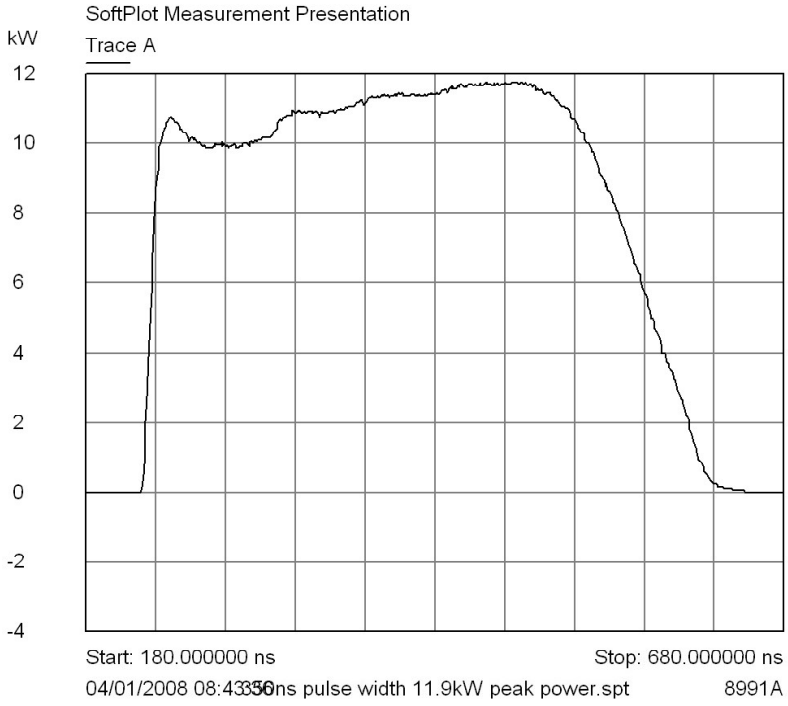

Figure 34 Pulse Characterisation 350ns

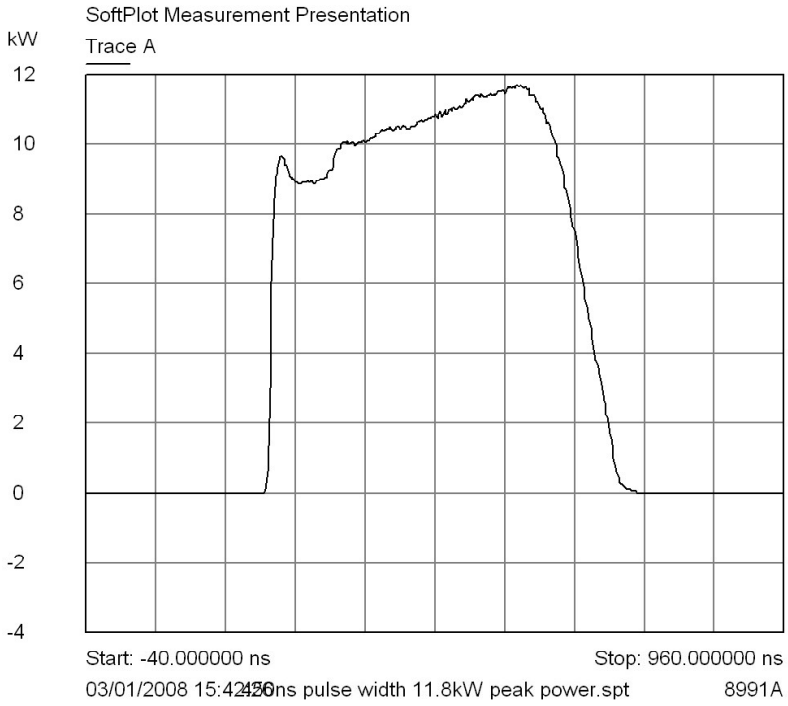

Figure 35 Pulse Characterisation 450ns

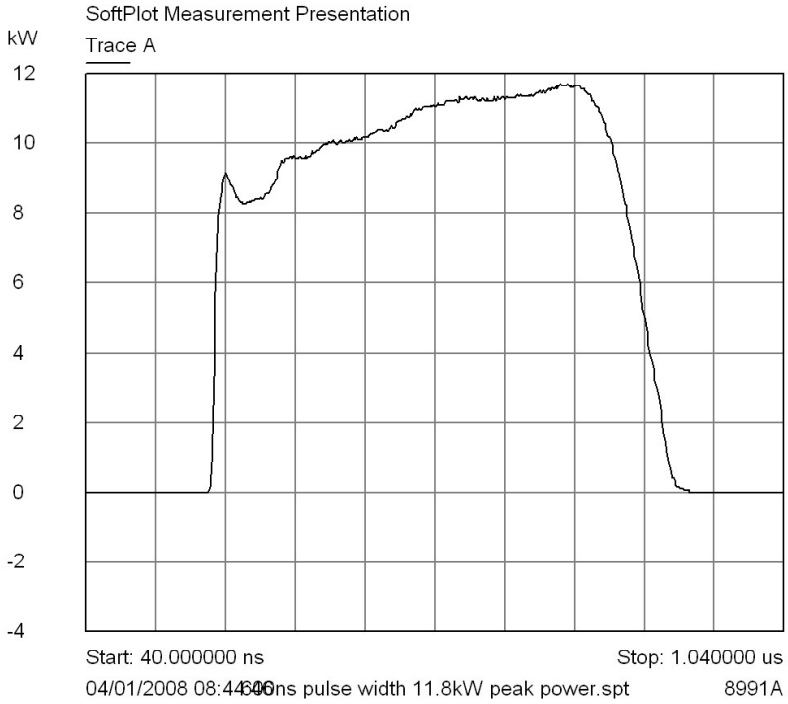

Figure 36 Pulse Characterisation 600ns

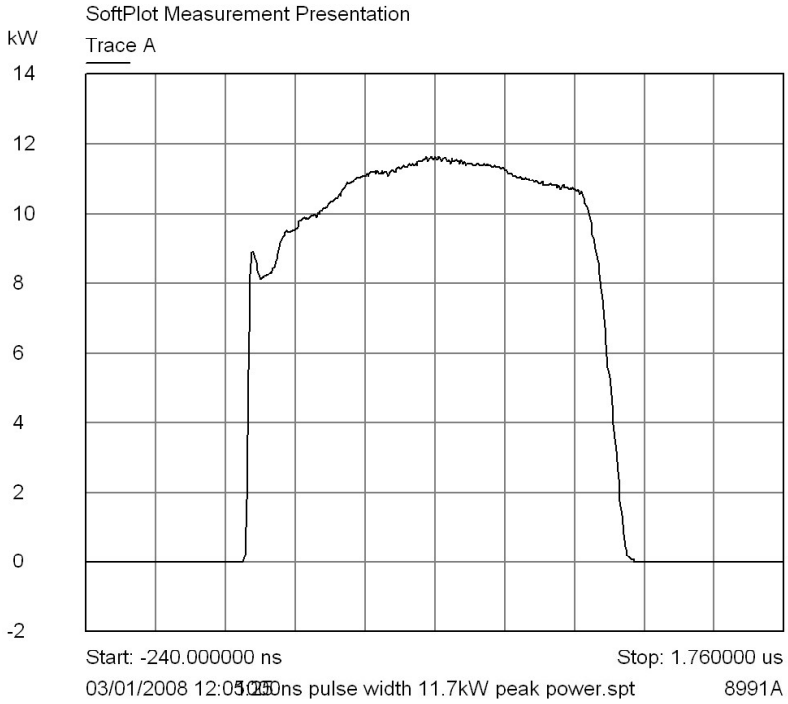

Figure 37 Pulse Characterisation 1000ns

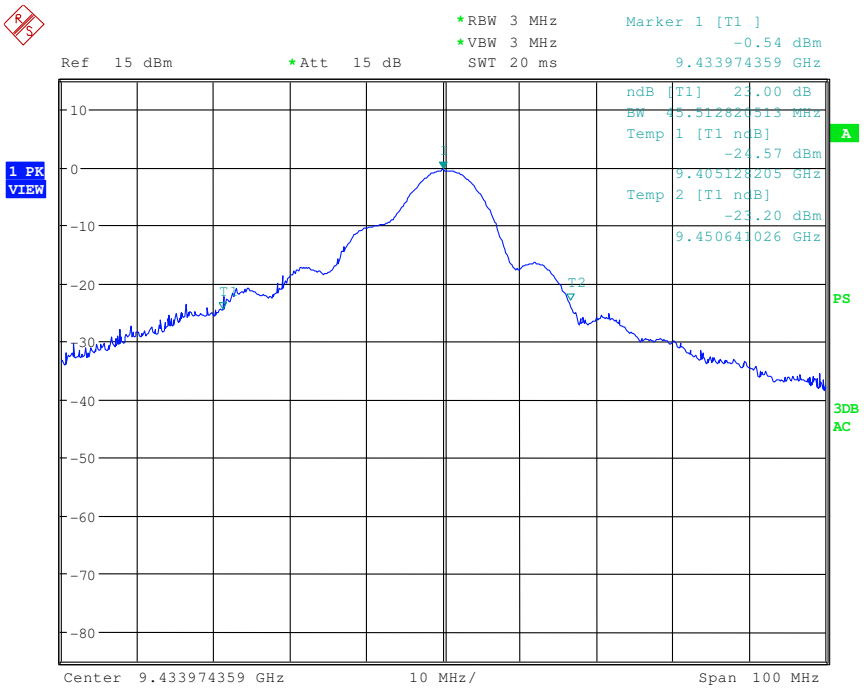

Figure 38 Occupied Bandwidth 75ns Pulse

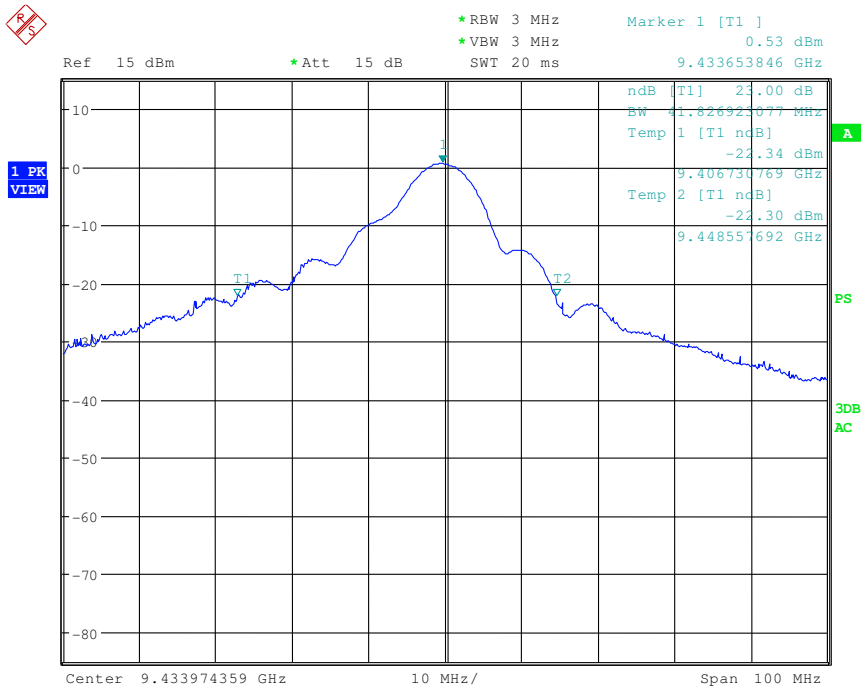

Figure 39 Occupied Bandwidth 100ns Pulse

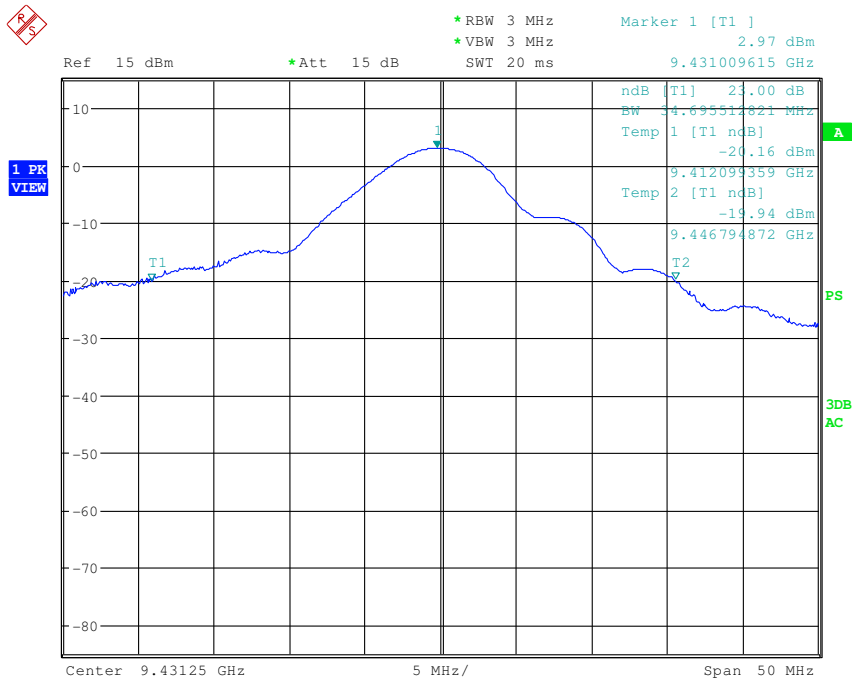

Figure 40 Occupied Bandwidth 150ns Pulse

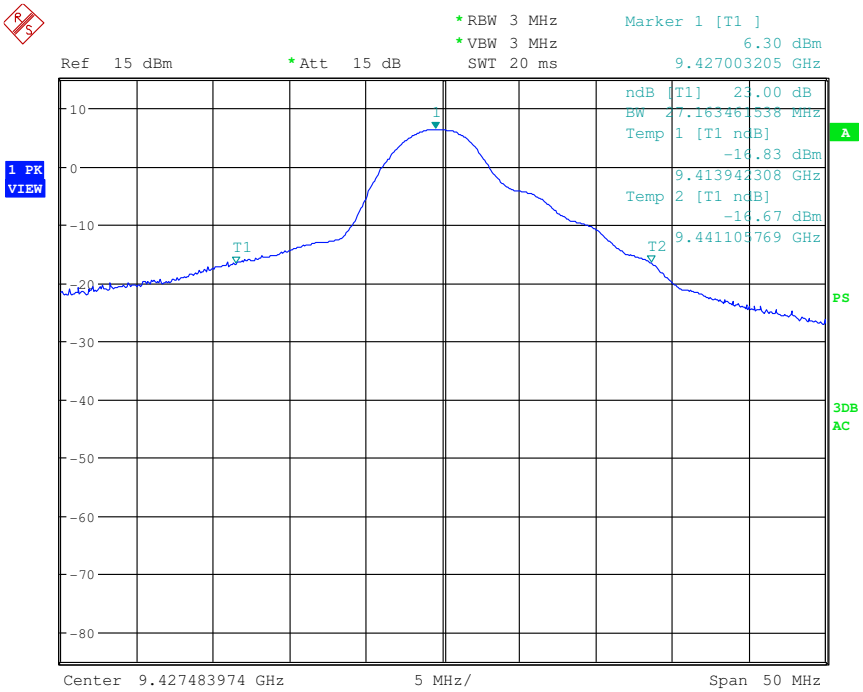

Figure 41 Occupied Bandwidth 250ns Pulse

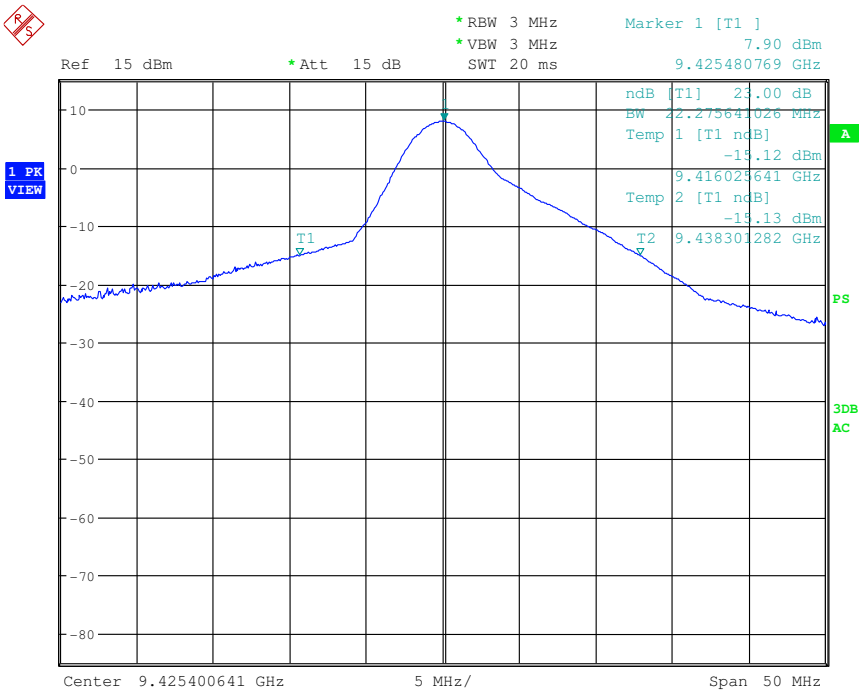

Figure 42 Occupied Bandwidth 350ns Pulse

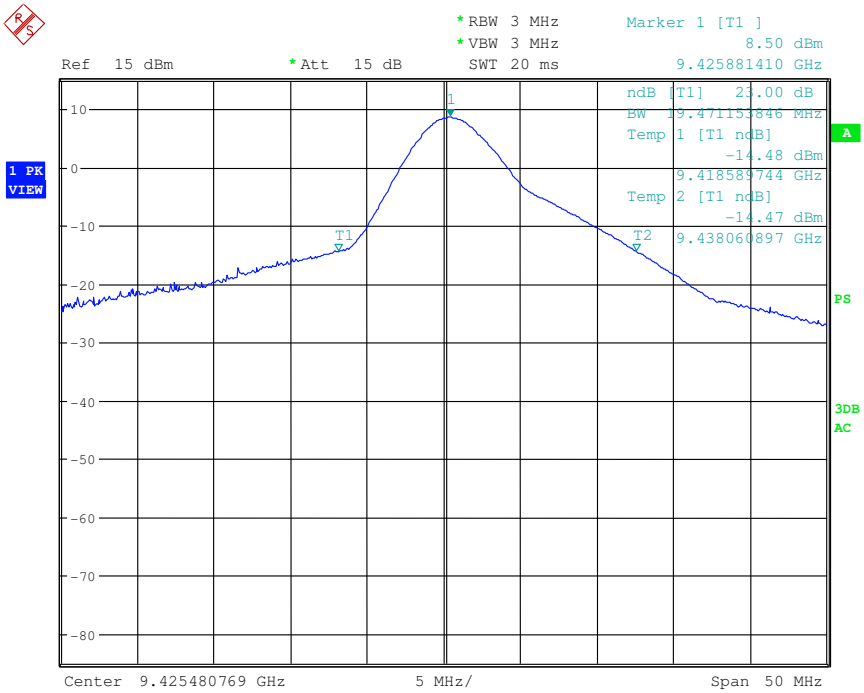

Figure 43 Occupied Bandwidth 450ns Pulse

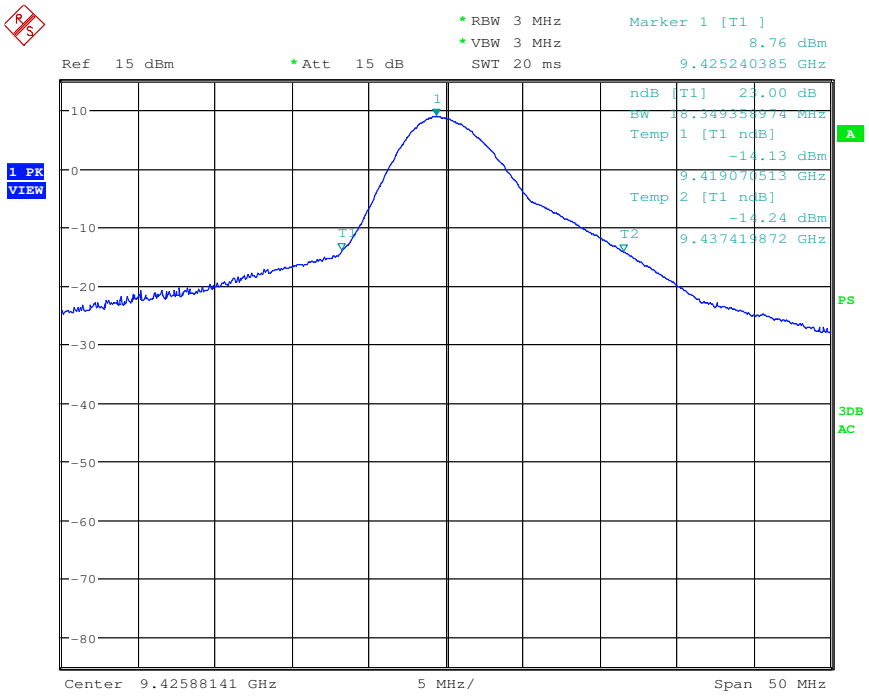

Figure 44 Occupied Bandwidth 600ns Pulse

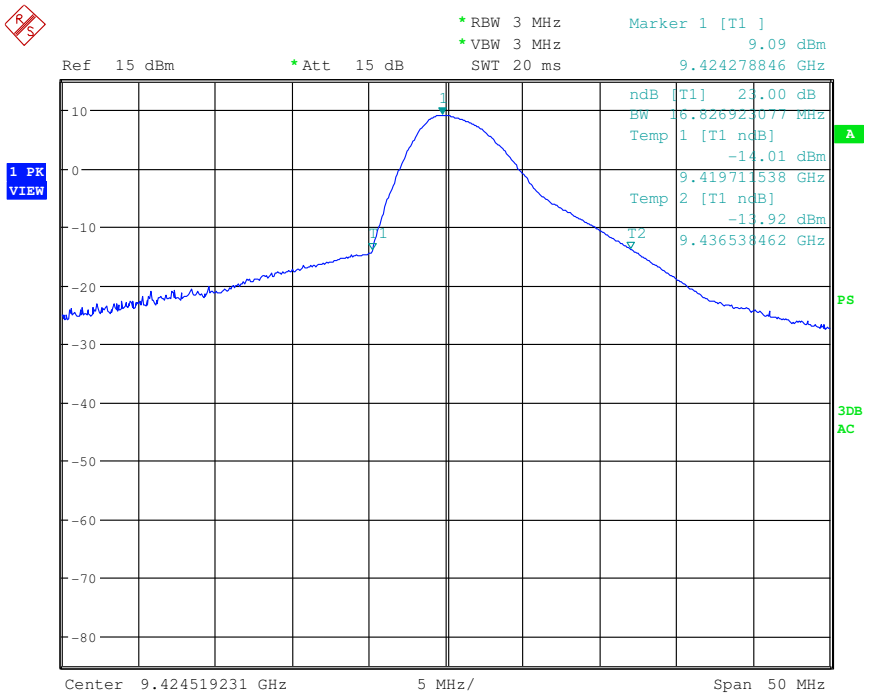

Figure 45 Occupied Bandwidth 1000ns Pulse