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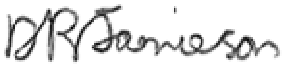
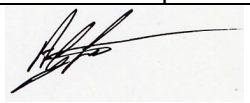
Test Report for Quantum Express Marine Radar - Radar RF Tests

To FCC CFR 47 parts 2 and 80 (October 2015)

Model Number	E70210		
Product Description	Maritime Radar		
Report Number	EMC2015/006		
Report Version	V1.03		
Report Author	 Dave Jamieson	Date	11th January 2016
Technical Check	 Mike Thompson	Date	12th January 2016
Approval	 Andy Little	Date	12th January 2016

Test Date Range	8th September 2015 to 7th January 2016

Product Status	PASS

The test data and results contained within this report relate only to the items tested.

1 Report History

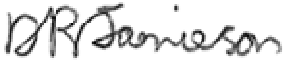
Version	Date	Reason for change
1.00	As cover sheet	Initial Issue.
1.01	18/12/2015	Power tests over temperature data added.
1.02	08/01/2016	Frequency test data over temperature added.
1.03	12/01/2016	MT feedback with minor changes.

2 FCC Test Summary

Test Name	Specification	Section	Result
Radiated Spurious Emissions	FCC CFR 47 Part 2	2.1053	Pass
	FCC CFR 47 Part 80	80.211(f)	Pass
Conducted Spurious Emissions	FCC CFR 47 Part 2	2.1051	Pass
	FCC CFR 47 Part 80	80.211(f)	Pass
RF Power Output – Peak Power	FCC CFR 47 Part 2	2.1046(a)	Pass
	FCC CFR 47 Part 80	80.215(n)(3)	Pass
RF Power Output – Pulse Width	FCC CFR 47 Part 2	2.1046(a)	For declaration only.
	FCC CFR 47 Part 80	80.215(a)	
RF Power Output – PRF	FCC CFR 47 Part 2	2.1047(a)	For declaration only.
	FCC CFR 47 Part 80	80.213(g)	
RF Power Output – Average Power	FCC CFR 47 Part 2	2.1046(a)	For declaration only.
	FCC CFR 47 Part 80	80.215(n)(3)	
Variation of Frequency with Voltage	FCC CFR 47 Part 2	2.1055(d)	Pass
Variation of Frequency with Temperature	FCC CFR 47 Part 2	2.1055(a, b)	Pass
Transmitter Frequency Tolerance	FCC CFR 47 Part 80	80.209(b)	Pass
Occupied Bandwidth	FCC CFR 47 Part 2	2.1049(i)	For declaration only.
	FCC CFR 47 Part 80	80.205	
Suppression of Interference Aboard Ships	FCC CFR 47 Part 80	80.217(b)	Pass

3 Attestations

This equipment has been tested in accordance with the standards identified in this report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in these reports.
All measuring instruments used to determine the status of the product's compliance to the identified standards are calibrated regularly in accordance with UKAS requirements.
A comprehensive system of traceable calibration in accordance with ISO9001 is maintained.

Name/Position	Signature	Date
Dave Jamieson EMC Engineer		11th January 2016

I attest that the necessary measurements were made, under my supervision at Raymarine UK Ltd, Marine House, Cartwright Drive, Fareham, PO15 5RJ.

Andy Little
Compliance Manager

Date: 12th January 2016

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4 Test Information

4.1 Test Facilities

Site 1	9m x 6m x 5.5m Semi Anechoic Chamber	FCC ID IC Certification	371673 4069B-2
Site 2	8m x 4m x 3m Fully Anechoic, Free Space Chamber		
Site 3	6m x 3m x 2.5m Screened Room	GND reference plane	1.25 x 2.5m 1.05m x 2.0m
Site 4	6m x 3m x 2.5m Screened Room	GND reference plane	2.0m x 1.15m
Site 5	2m x 3m x 2.5m Screened Room		
Site 6	4m x 3m x 2.5m Screened Room	GND reference plane	1.25 x 2.5m
Site 7	2m x 3m x 2.5m Screened Room		
Site 8	4m x 3m x 2.5m Screened Room	GND reference plane	1.25 x 2.5m
Site 9	Surge & ESD Room	GND reference plane	5 x 2m

4.2 Overall Test Conditions

Date	Ambient Temperature (°C)	Relative Humidity (%)	Air Pressure (mbar)
08/09/15	18.7	51	962
09/09/15	18.9	52	955
10/09/15	19.7	53	955
30/10/15	21.3	55	947
03/11/15	21.3	51	945
04/11/15	20.7	55	944
07/01/16	N/A	N/A	N/A

4.3 Performance Criterion

Performance Criterion A	The EUT shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed, as defined in the relevant equipment standard and in the technical specification published by the manufacturer.
Performance Criterion B	The EUT shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed, as defined in the relevant equipment standard and in the technical specification published by the manufacturer. During the test, degradation or loss of function or performance which is self recoverable is, however, allowed, but no change of actual operating state or stored data is allowed.
Performance Criterion C	Temporary degradation or loss of function or performance is allowed during the test, provided the function is self-recoverable, or can be restored at the end of the test by the operation of the controls, as defined in the relevant equipment standard and in the technical specification published by the manufacturer.

4.4 Test Methods

The objective of the report is to perform testing according to the following specifications:

Number	Standard Number	Document Title
1	FCC CFR 47 Part 2 (2nd November, 2015)	Frequency allocations and radio treaty matters; General rules and regulations
2	FCC CFR 47 Part 80 (2nd November, 2015)	Stations in the Maritime Services

4.4.1 Deviations from Test Methods

None

5 EUT Information

5.1 Test Rationale

Full compliance

5.2 Description of Equipment under Test (EUT)

Date of Receipt:	07/09/2015
Client:	Paul Thomas
Brand Name:	Raymarine
Product Range:	Quantum Express Radar
Country of Manufacture:	Hungary
Operational voltage range:	12V to 24V

Unit 1

Model Name or Number:	Quantum Express Radar
Unique Type Identification:	E70210
Serial Number:	0750122 (EMC2015/001)
CCT Diagram Number(s) & Issue:	Main Board: 1003643 Issue 3 PSU Board: 1003653 Issue 5 Wired Extender: 1003493 Issue 2
PCB Assembly Number(s) & Issue:	Main Board: 1003644 Issue 3 PSU Board: 1003654 Issue 7 Wired Extender: 1003494 Issue 2
Software Version:	IF App: 0.78 PSU App: 0.29 FPGA Version: V2.63 Wired Extender: v1.0
Modifications to Unit:	None.
Modulation Type	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM Pulsed FM for Pulse
Modulation Technology	DSSS, OFDM, Pulse
Transfer Rate	IEEE 802.11b: 11/5.5/2/1Mbps IEEE 802.11g: 54/48/36/24/18/12/9/6Mbps
Frequency Range	2400MHz - 2483.5MHz 9300MHz – 9500MHz
Number of Channels	802.11b: 11 802.11g: 11 Pulse: 1

Unit 2

Model Name or Number:	Quantum Express Radar
Unique Type Identification:	E70210
Serial Number:	0750120 (EMC2015/002)
CCT Diagram Number(s) & Issue:	Main Board: 1003643 Issue 3 PSU Board: 1003653 Issue 5 Wired Extender: 1003493 Issue 2
PCB Assembly Number(s) & Issue:	Main Board: 1003644 Issue 3 PSU Board: 1003654 Issue 7 Wired Extender: 1003494 Issue 2
Software Version:	IF App: 0.78 PSU App: 0.29 FPGA Version: V2.63 Wired Extender: v1.0
Modifications to Unit:	Radar antenna connection removed and replaced with SMA connector with 50 ohm termination.
Modulation Type	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM Pulsed FM for Pulse
Modulation Technology	DSSS, OFDM, Pulse
Transfer Rate	IEEE 802.11b: 11/5.5/2/1Mbps IEEE 802.11g: 54/48/36/24/18/12/9/6Mbps
Frequency Range	2400MHz - 2483.5MHz 9300MHz – 9500MHz
Number of Channels	802.11b: 11 802.11g: 11 Pulse: 1

5.3 Additional information

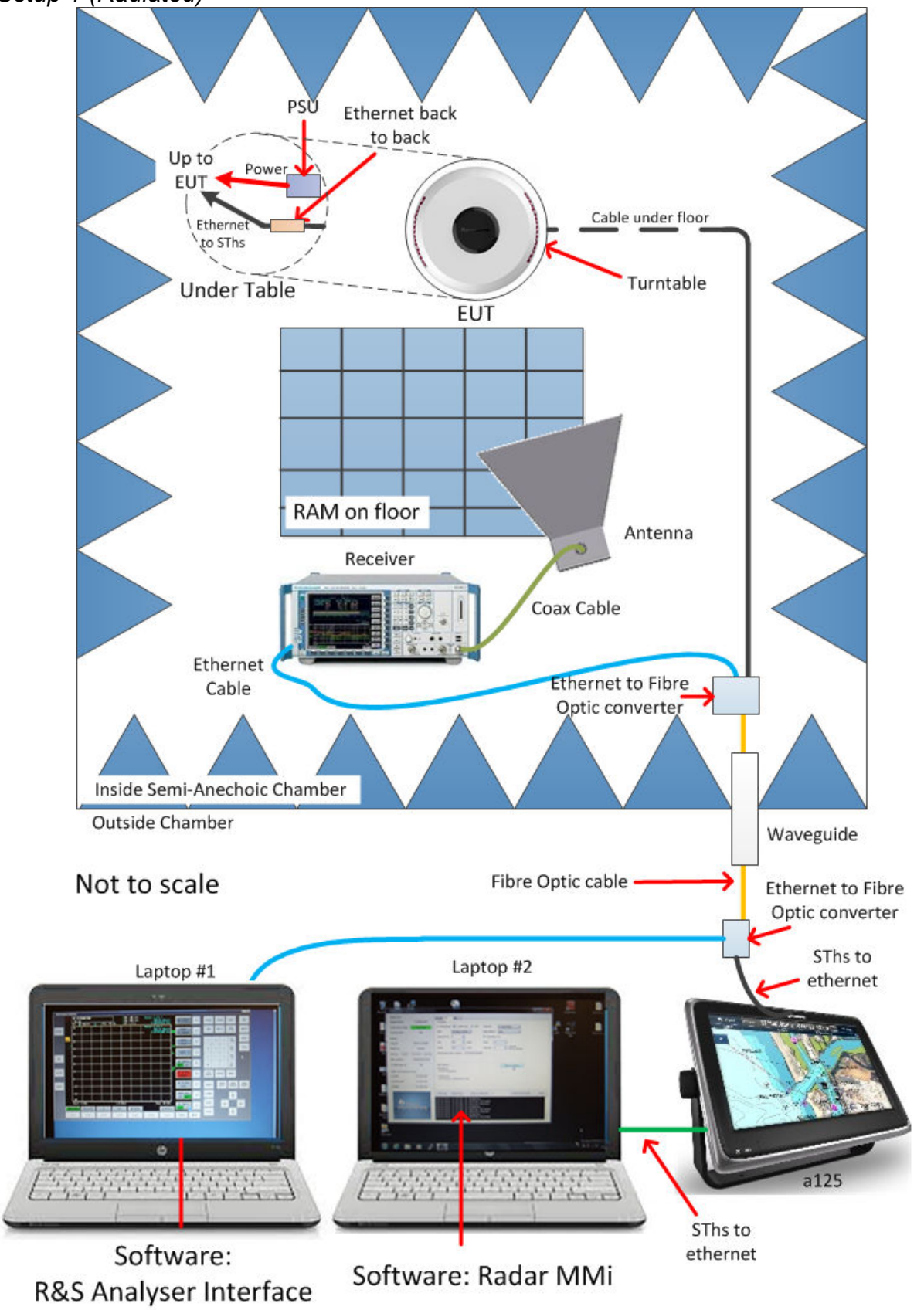
None.

5.4 Description of Auxiliary Equipment

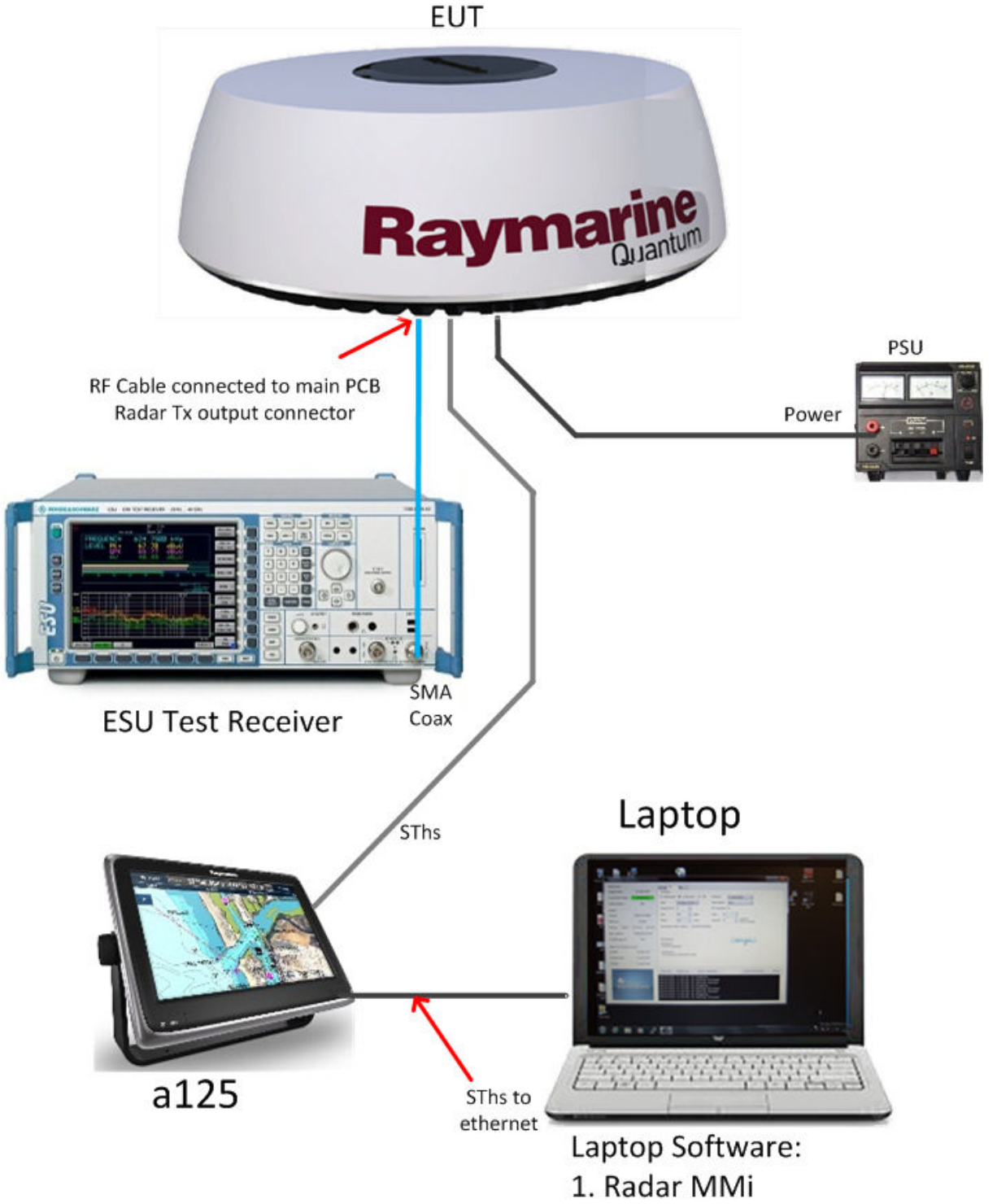
Product Type	Part Number	Serial Number
Laptop	Compaq 6910p	CND83026CQ
a125	E70235	0640008

5.5 Test Configurations and Operating Modes

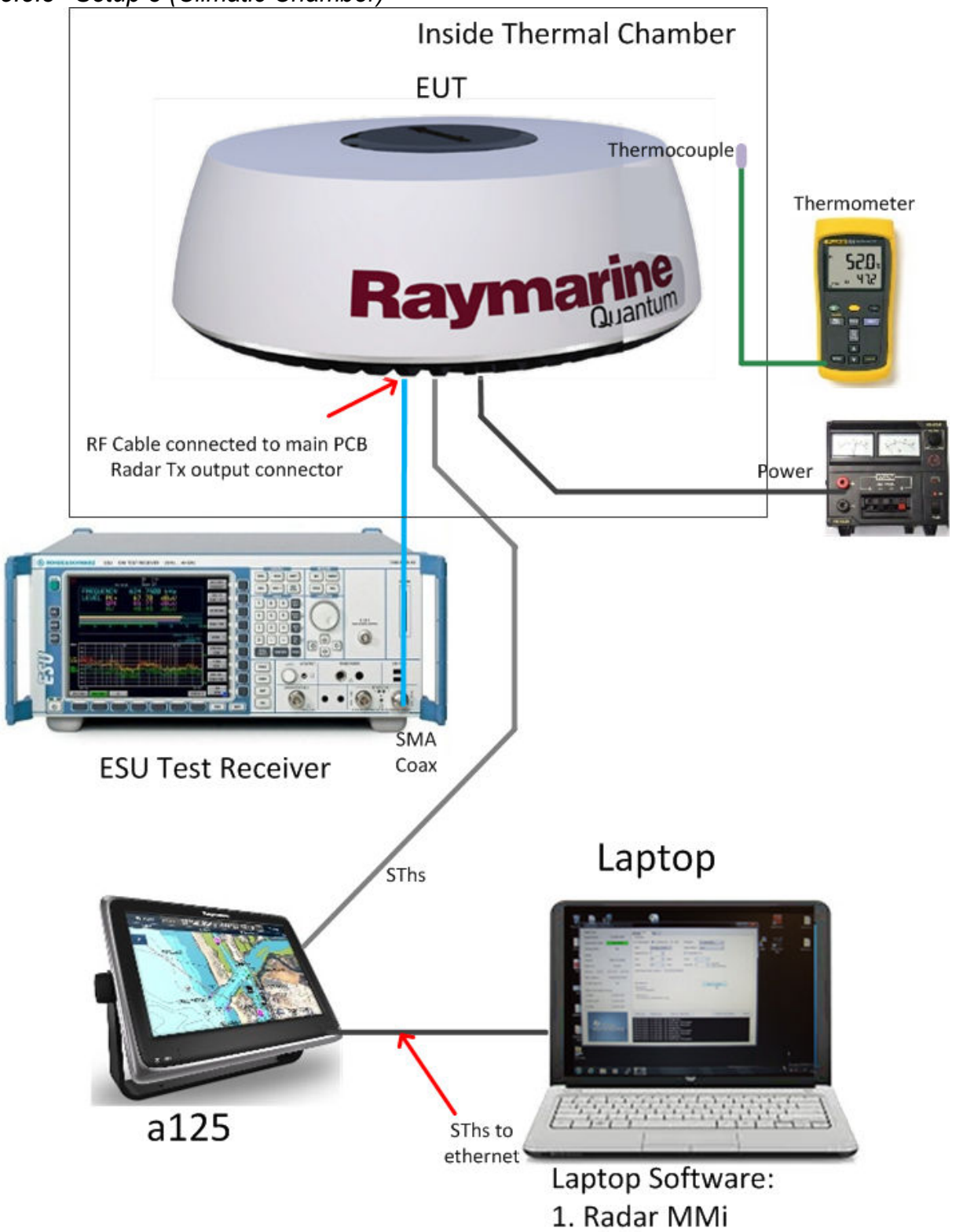
5.5.1 Setup 1 (Radiated)



5.5.2 Setup 2 (Conducted)

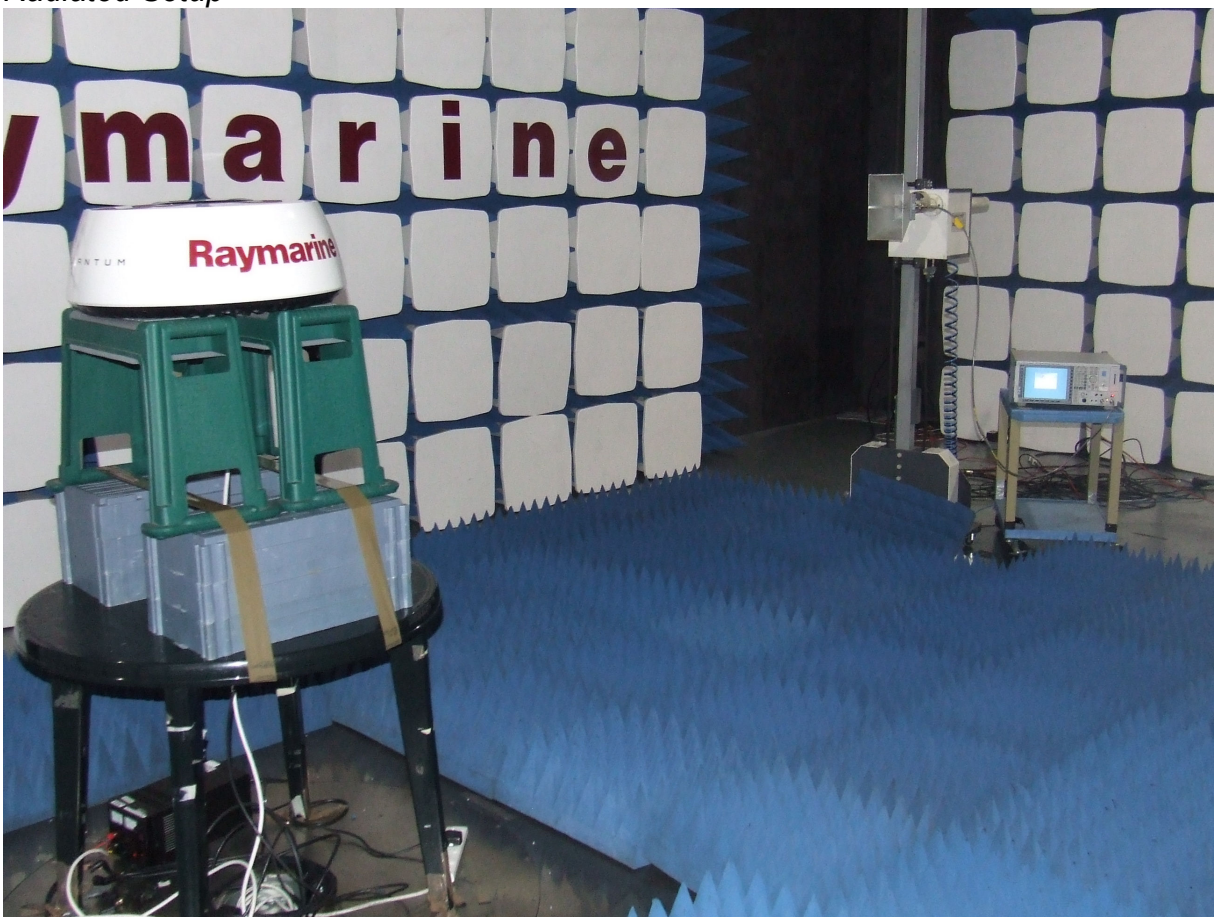


5.5.3 Setup 3 (Climatic Chamber)

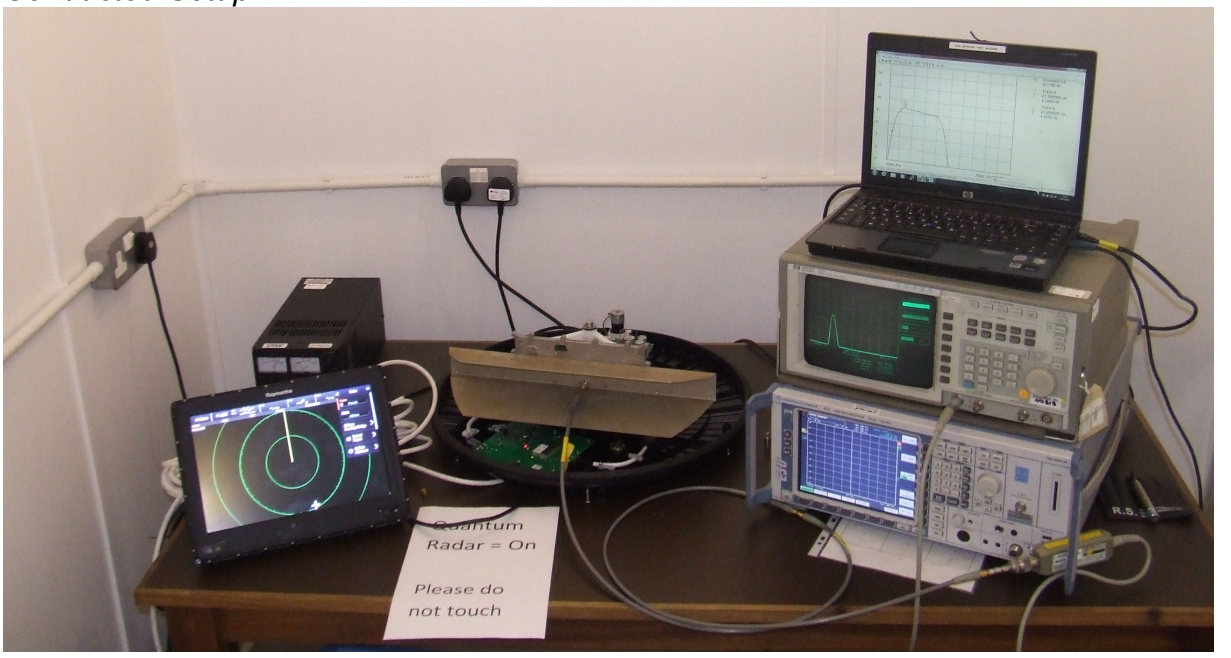


5.6 Test Photographs

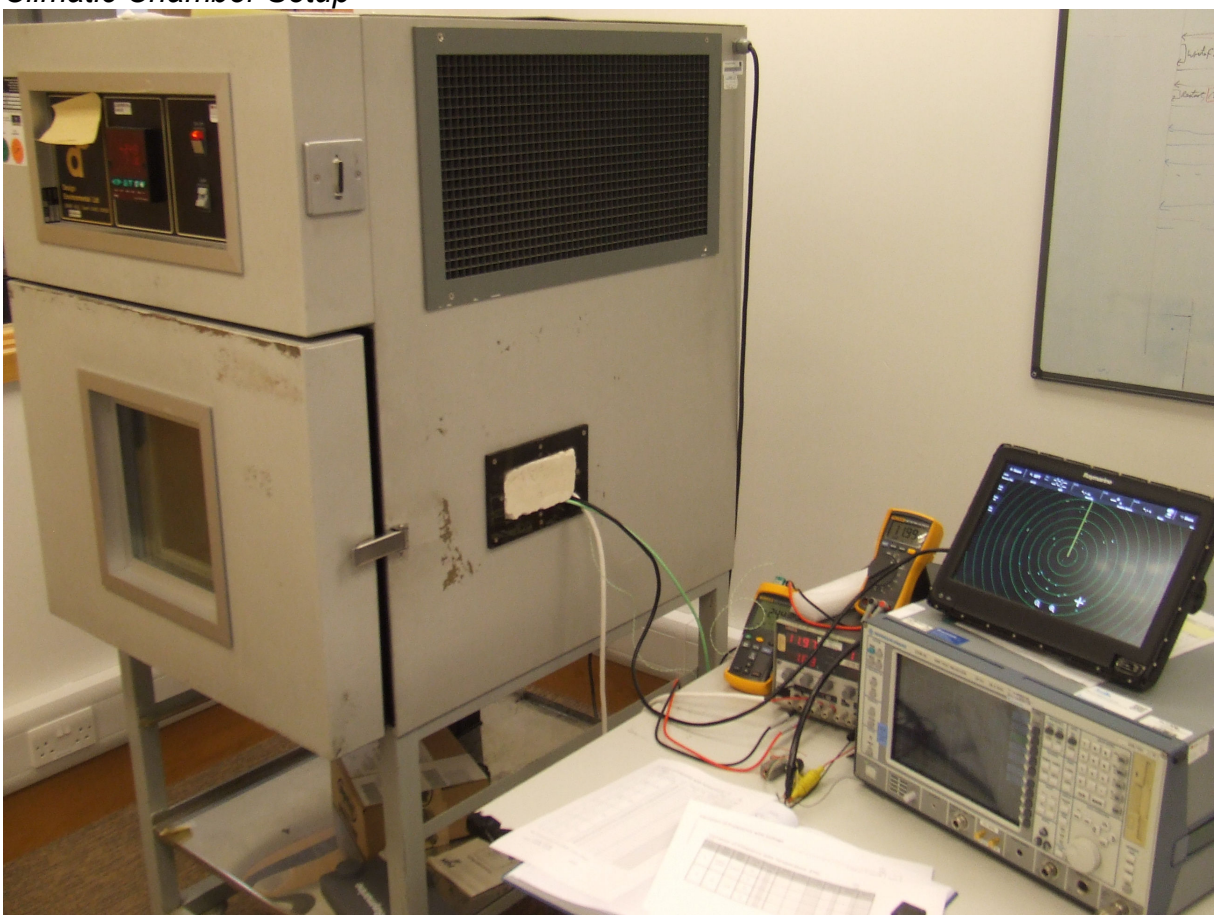
5.6.1 Radiated Setup



5.6.2 Conducted Setup



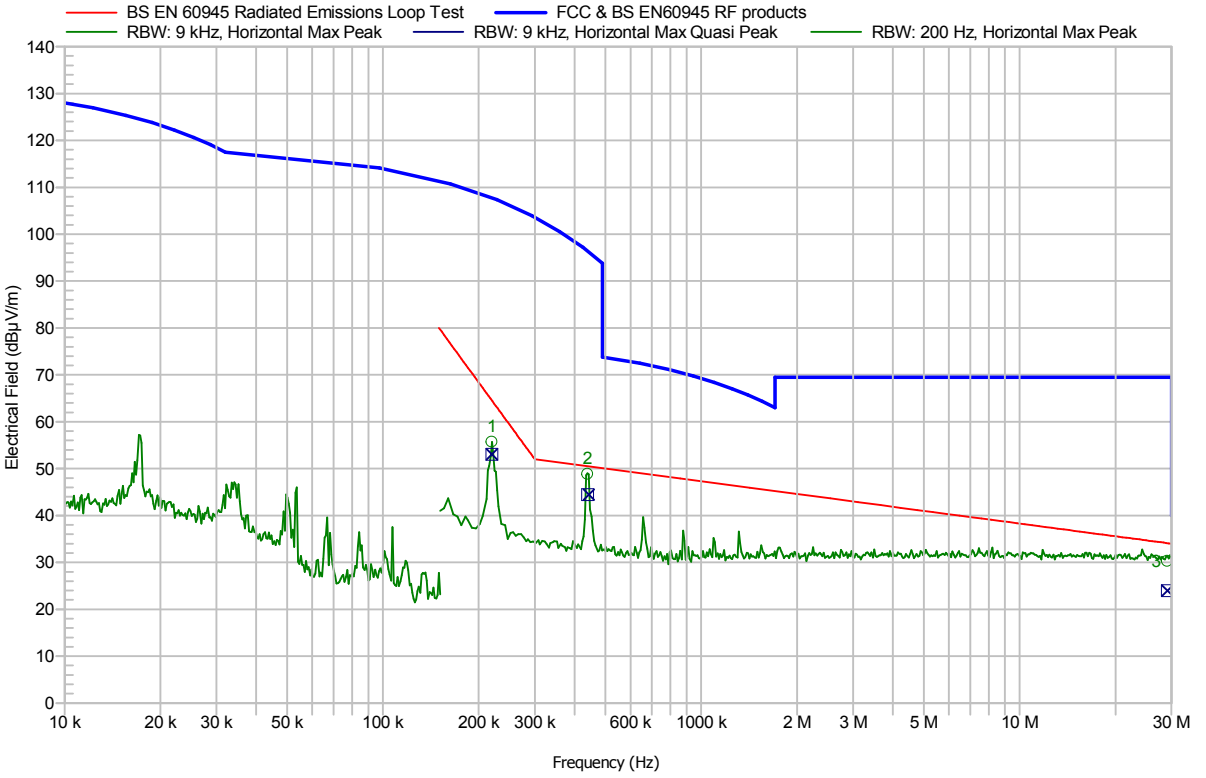
5.6.3 *Climatic Chamber Setup*



6 Test Results

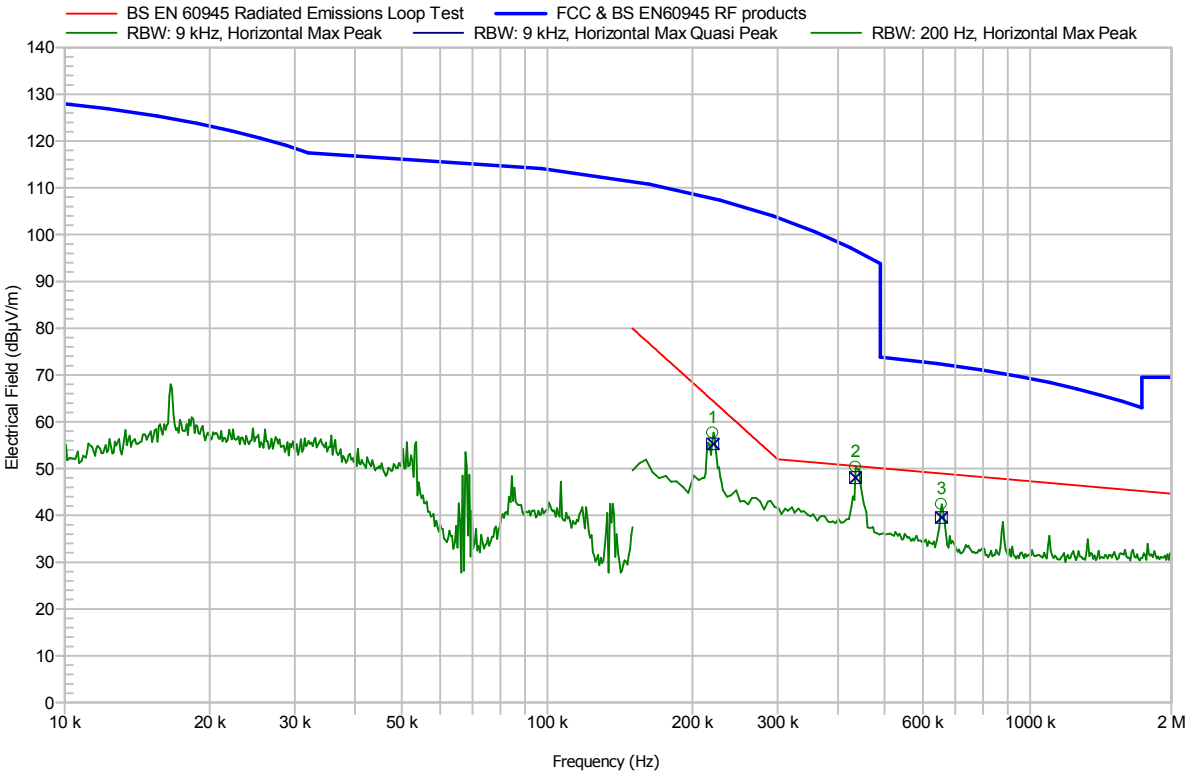
6.1 Radiated Spurious Emissions

6.1.1.1 10kHz to 30MHz – 24V nom – X Polarity (Side on)



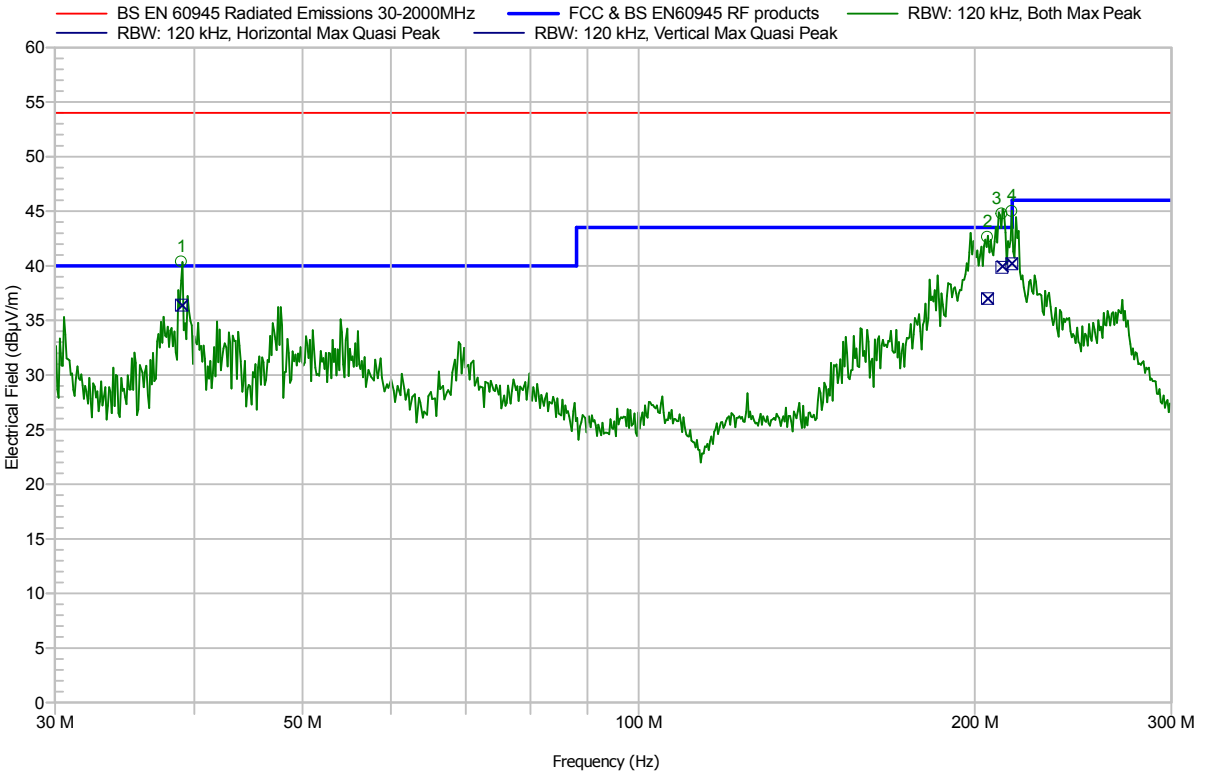
Nr	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Polarization
1	220 kHz	55.68 dBµV/m	53.05 dBµV/m	-11.48 dB	Pass	157 Degree	Horizontal
2	440 kHz	48.82 dBµV/m	44.46 dBµV/m	-6.04 dB	Pass	165 Degree	Horizontal
3	29.115 MHz	30.27 dBµV/m	23.97 dBµV/m	-10.14 dB	Pass	22 Degree	Horizontal

6.1.1.2 10kHz to 30MHz – 24V nom – Y Polarity (Face on)



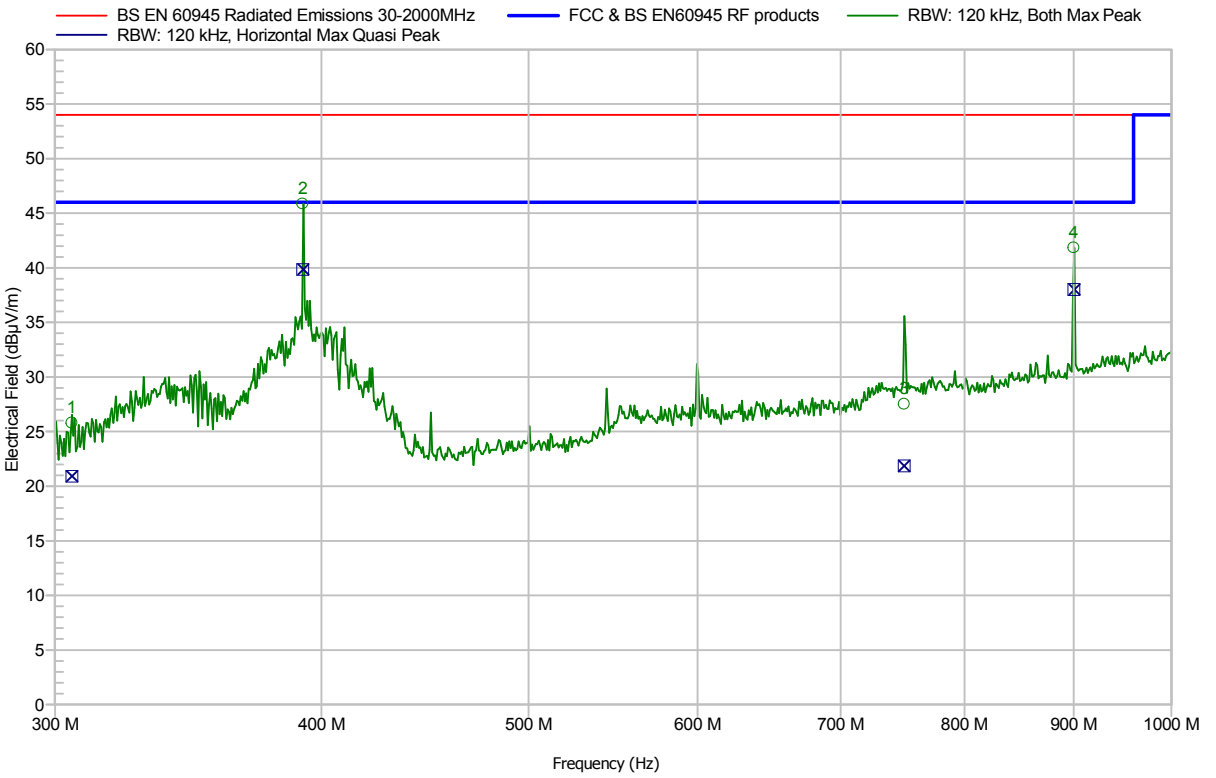
Nr	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Polarization
1	220 kHz	57.66 dBµV/m	55.27 dBµV/m	-9.26 dB	Pass	22 Degree	Horizontal
2	435 kHz	50.36 dBµV/m	48.08 dBµV/m	-2.47 dB	Pass	90 Degree	Horizontal
3	655 kHz	42.4 dBµV/m	39.54 dBµV/m	-9.41 dB	Pass	105 Degree	Horizontal

6.1.1.3 30MHz to 300MHz – 24V nom



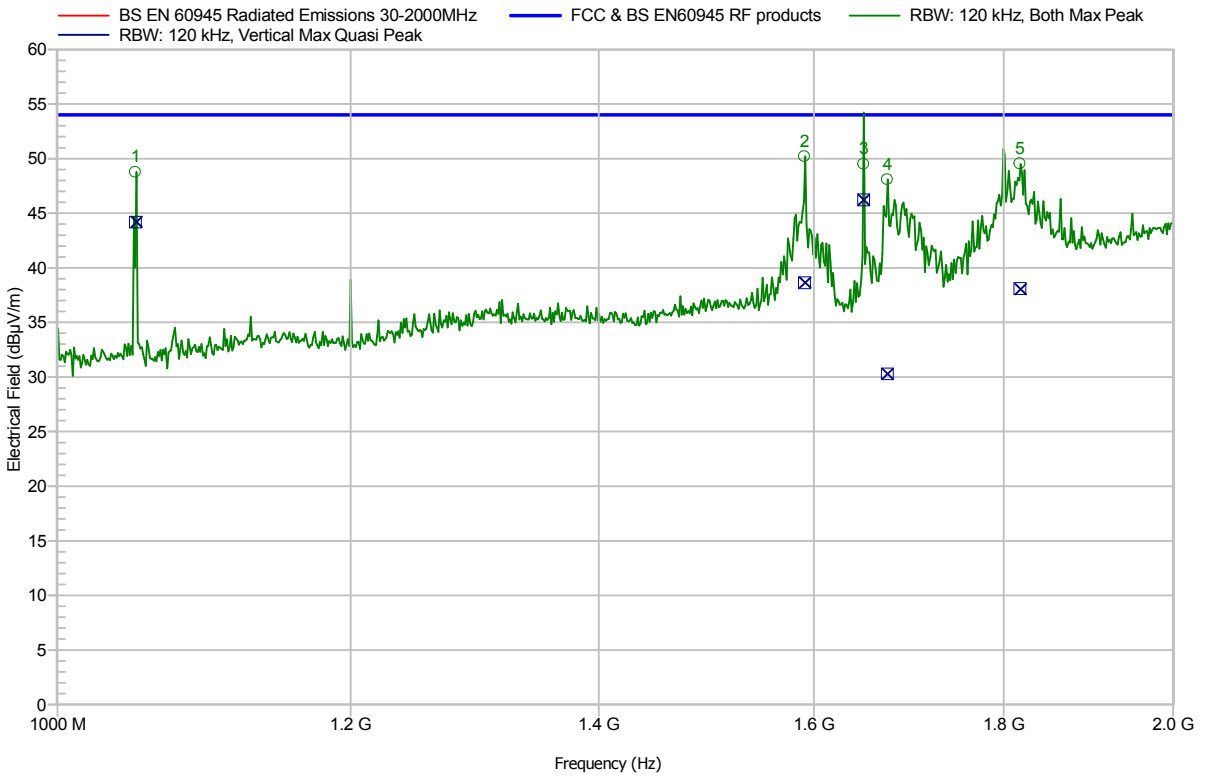
Nr	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Polarization
1	38.951 MHz	40.37 dBµV/m	36.41 dBµV/m	-3.59 dB	Pass	285 Degree	Vertical
2	205.281 MHz	42.63 dBµV/m	37 dBµV/m	-6.5 dB	Pass	202 Degree	Horizontal
3	211.407 MHz	44.76 dBµV/m	39.87 dBµV/m	-3.63 dB	Pass	202 Degree	Horizontal
4	215.842 MHz	44.99 dBµV/m	40.19 dBµV/m	-3.31 dB	Pass	195 Degree	Horizontal

6.1.1.4 300MHz to 1GHz – 24V nom



Nr	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Polarization
1	305.594 MHz	25.78 dBµV/m	20.91 dBµV/m	-25.09 dB	Pass	157 Degree	Horizontal
2	391.928 MHz	45.86 dBµV/m	39.84 dBµV/m	-6.16 dB	Pass	270 Degree	Horizontal
3	749.65 MHz	27.51 dBµV/m	21.86 dBµV/m	-24.14 dB	Pass	240 Degree	Horizontal
4	900.01 MHz	41.84 dBµV/m	38.01 dBµV/m	-7.99 dB	Pass	202 Degree	Horizontal

6.1.1.5 1GHz to 2GHz – 24V nom



Nr	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Polarization
1	1.05 GHz	48.76 dBµV/m	44.19 dBµV/m	-9.81 dB	Pass	330 Degree	Vertical
2	1.59 GHz	50.19 dBµV/m	38.63 dBµV/m	-15.37 dB	Pass	285 Degree	Vertical
3	1.65 GHz	49.5 dBµV/m	46.22 dBµV/m	-7.78 dB	Pass	255 Degree	Vertical
4	1.675 GHz	48.08 dBµV/m	30.28 dBµV/m	-23.72 dB	Pass	202 Degree	Vertical
5	1.818 GHz	49.54 dBµV/m	38.1 dBµV/m	-15.9 dB	Pass	15 Degree	Vertical

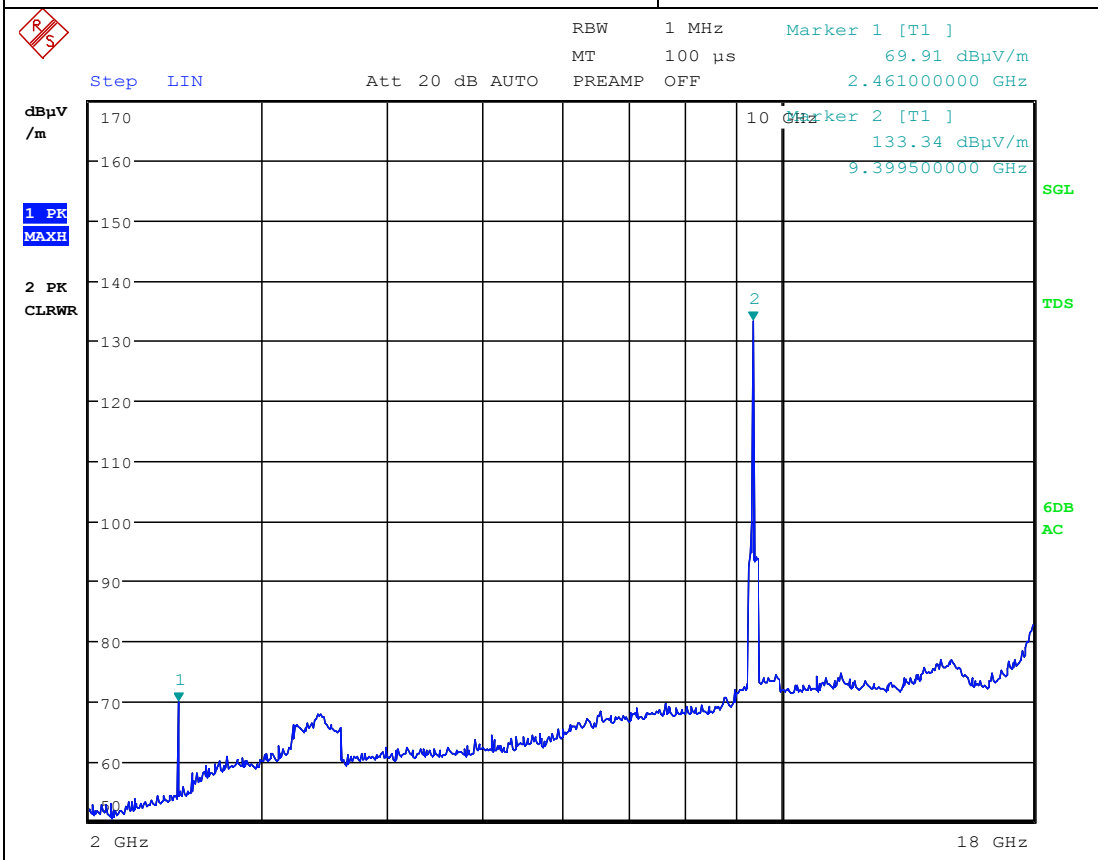
Comments: Results only performed at 24V as no major difference in emissions found when checking at 12V.

In the ranges from 30MHz to 2GHz the measurement is performed as a spectrum analyser type, with 10 scans of 5 seconds across a given band.
When peak levels were measured with quasi-peak, the dwell would be 1 second.

Tested by: D.Jamieson
Test Date: 8th to 10th September 2015
Test Status: **PASS**

6.1.2 Radiated Emissions 2GHz-18GHz (Vertical Polarisation)

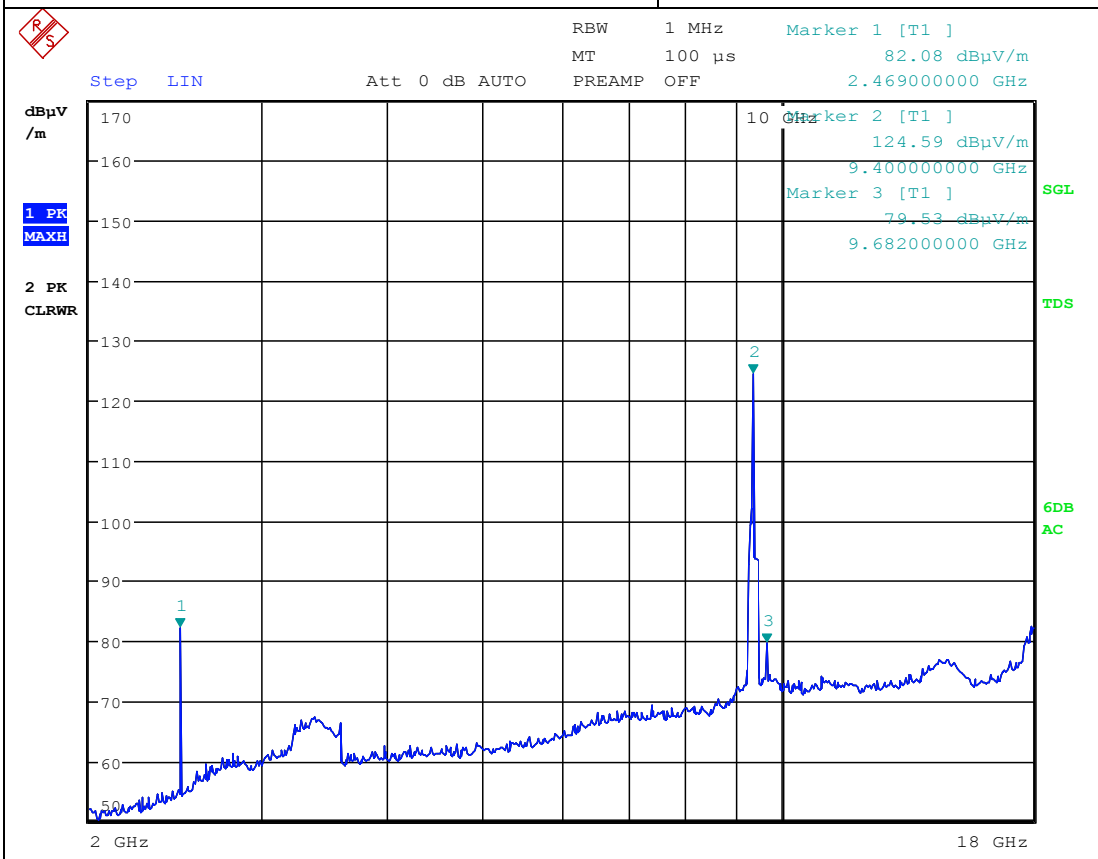
Tx Frequency	Frequency Range
9.4GHz	2GHz to 18GHz



Date: 30.OCT.2015 14:30:33

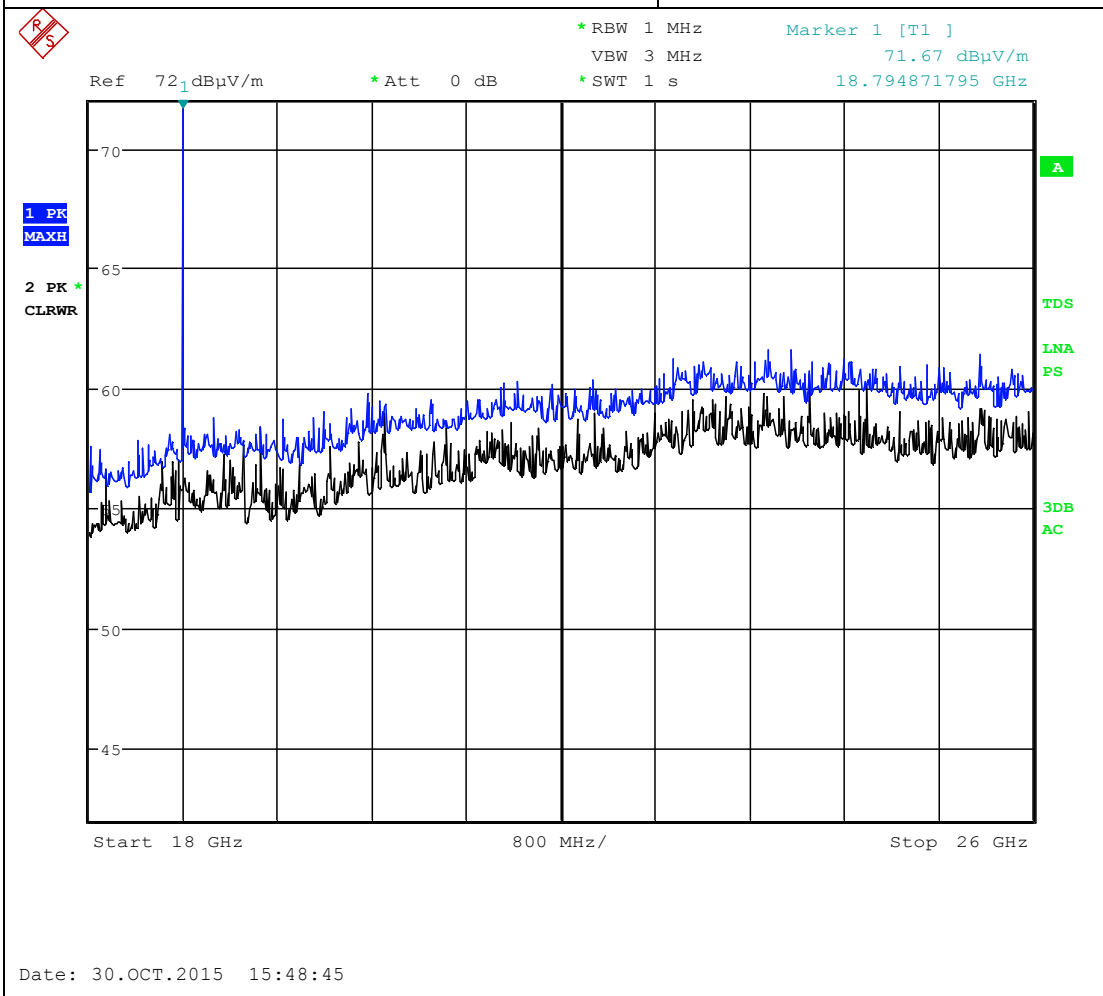
6.1.3 Radiated Emissions 2GHz-18GHz (Horizontal Polarisation)

Tx Frequency	Frequency Range
9.4GHz	2GHz to 18GHz



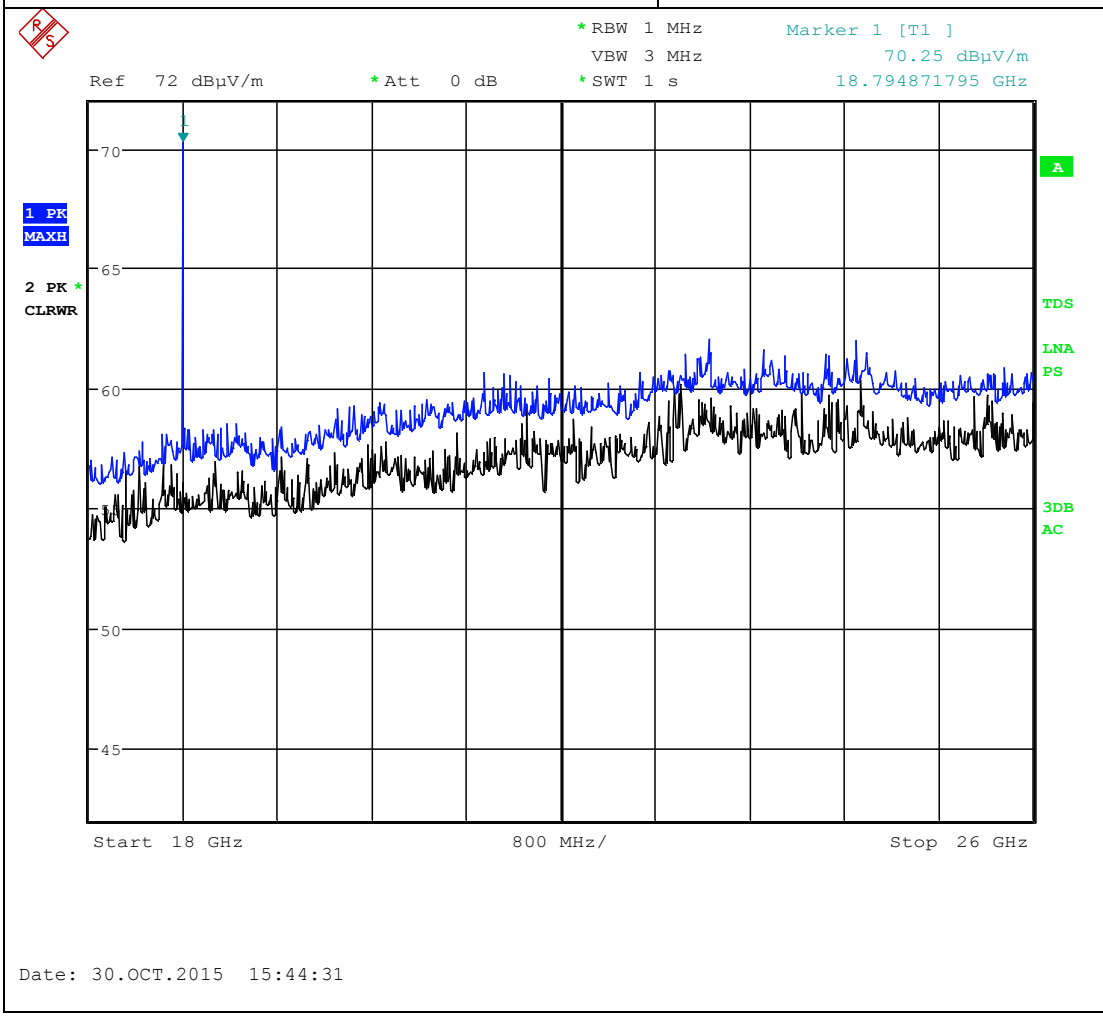
6.1.4 Radiated Emissions 18GHz-26GHz (Vertical Polarisation)

Tx Frequency	Frequency Range
9.4GHz	18GHz to 26GHz



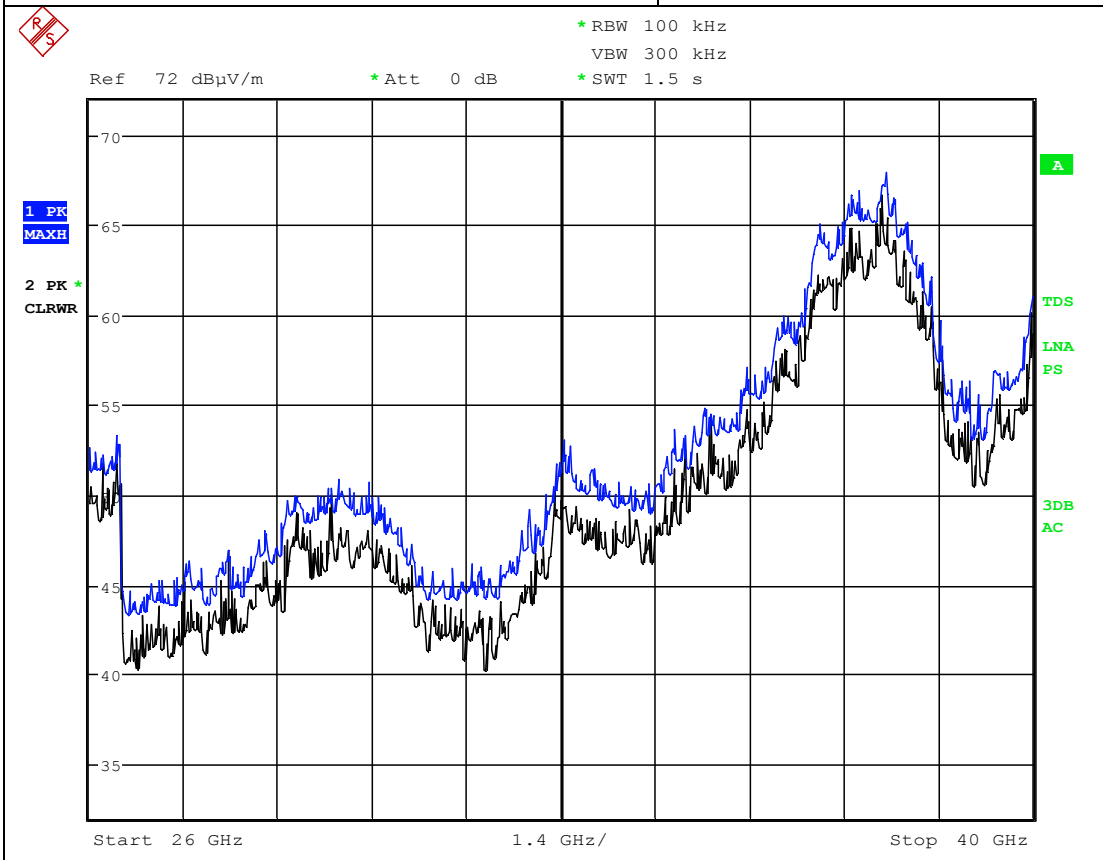
6.1.5 Radiated Emissions 18GHz-26GHz (Horizontal Polarisation)

Tx Frequency	Frequency Range
9.4GHz	18GHz to 26GHz



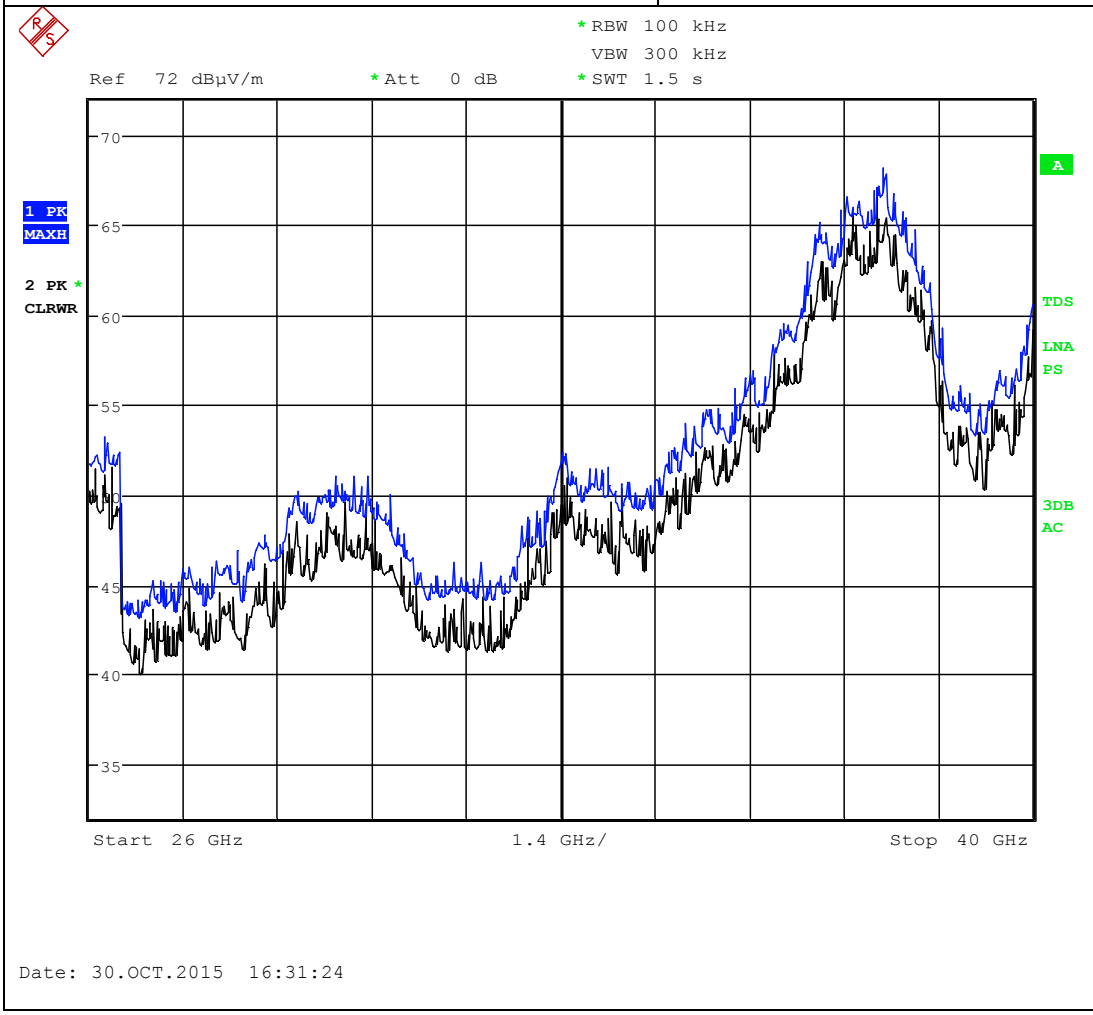
6.1.6 Radiated Emissions 26GHz-40GHz (Vertical Polarisation)

Tx Frequency	Frequency Range
9.4GHz	26GHz to 40GHz



6.1.7 Radiated Emissions 26GHz-40GHz (Horizontal Polarisation)

Tx Frequency	Frequency Range
9.4GHz	26GHz to 40GHz



Notable frequencies:

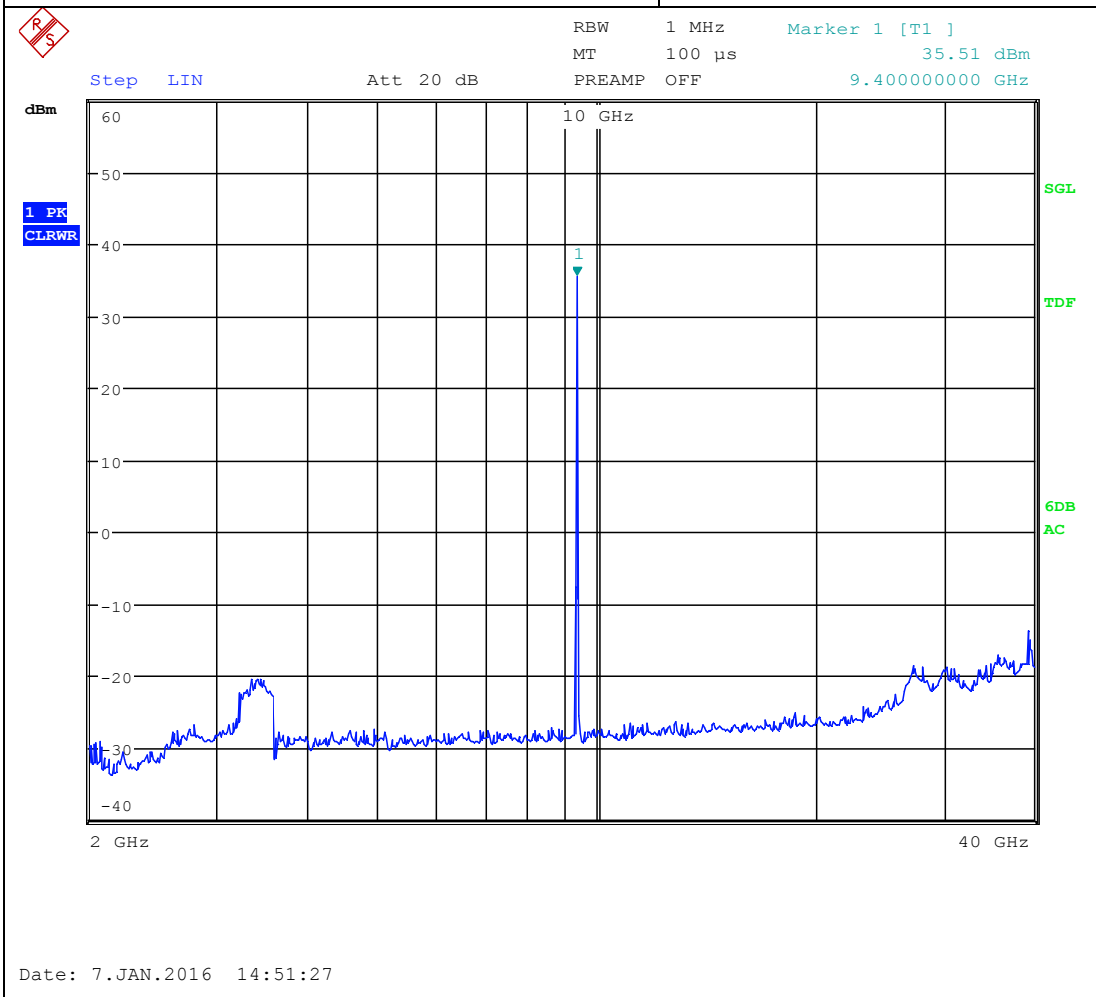
Frequency	Polarisation	Tuned Frequency	Max hold (dBµV/m)
2.461GHz	V	2.462GHz	103.3
2.469GHz	H	2.462GHz	108.0
9.39995GHz	V	9.4GHz	142.3
9.4GHz	H	9.4GHz	157.3
9.682GHz	H	9.682GHz	82.2

Comments: Notable frequencies were separately scanned and peaks taken.
Tested by: D.Jamieson
Test Date: 10kHz- 2GHz: 8th to 10th September 2015; 2GHz-40GHz: 30th October 2015
Test Unit: 1
Test Setup: Radiated
Test Status: Pass

6.2 Conducted Spurious Emissions

6.2.1 2GHz to 40GHz Plot

Tx Frequency	Frequency Range
9.4GHz	2GHz to 40GHz



Note: Plot measured with uncorrected for cable factor.

6.2.2 Limit Line

Note: Mean power taken as worst case = 0.22235W = -6.53dBm

Frequency	Limit
<8.9GHz	-36.47dBC
8.9GHz to 9.2GHz	-35dBC
9.2GHz to 9.3GHz	-25dBC
9.5GHz to 9.6GHz	-25dBC
9.6GHz to 9.9GHz	-35dBC
>9.9GHz	-36.47dBC

6.2.3 *Peak Analysis*

Other than the carrier, no other peaks were detected. For completeness, the following table lists the potential harmonics of the RADAR.

Frequency	Level (dBm)	Cable Correction (dB)	Corrected dBm	Limit (dB)	Limit Margin (dB)	Result
9.4GHz	35.51	3.07	38.58	N/A	N/A	N/A
18.8GHz	-25.95	4.20	-21.75	2.11	-23.86	Pass
28.2GHz	-25.40	4.04	-21.36	2.11	-23.47	Pass
37.6GHz	-19.17	11.90	-7.27	2.11	-9.38	Pass

Comments: None.
Tested by: D.Jamieson
Test Date: 7th January 2016
Test Unit: 2
Test Setup: Conducted
Test Status: Pass

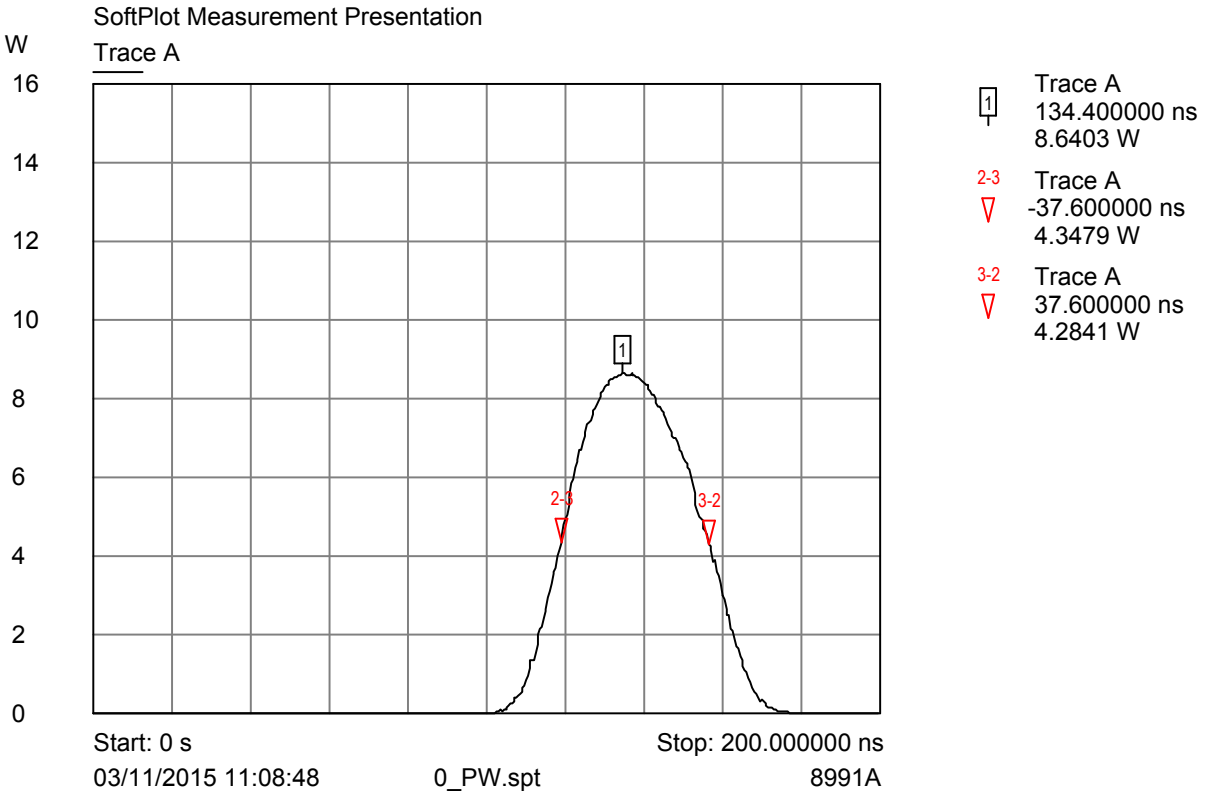
6.3 RF Output Power – Peak Power

6.3.1 Tabulated Results

Index	MFD Display (nm)	Peak Level (W)	Limit	Result
0	0.0625	8.64	20W	Pass
1	0.125	8.65	20W	Pass
2	0.25	8.66	20W	Pass
3	0.375	9.56	20W	Pass
4	0.5	9.50	20W	Pass
5	0.75	9.36	20W	Pass
6	1	9.34	20W	Pass
7	1.5	9.23	20W	Pass
8	2	9.17	20W	Pass
9	3	9.10	20W	Pass
10	4	9.04	20W	Pass
11	6	8.95	20W	Pass
12	8	8.85	20W	Pass
13	12	8.91	20W	Pass
14	16	8.75	20W	Pass
15	24	8.78	20W	Pass

6.3.2 Plots

6.3.2.1 Index 0

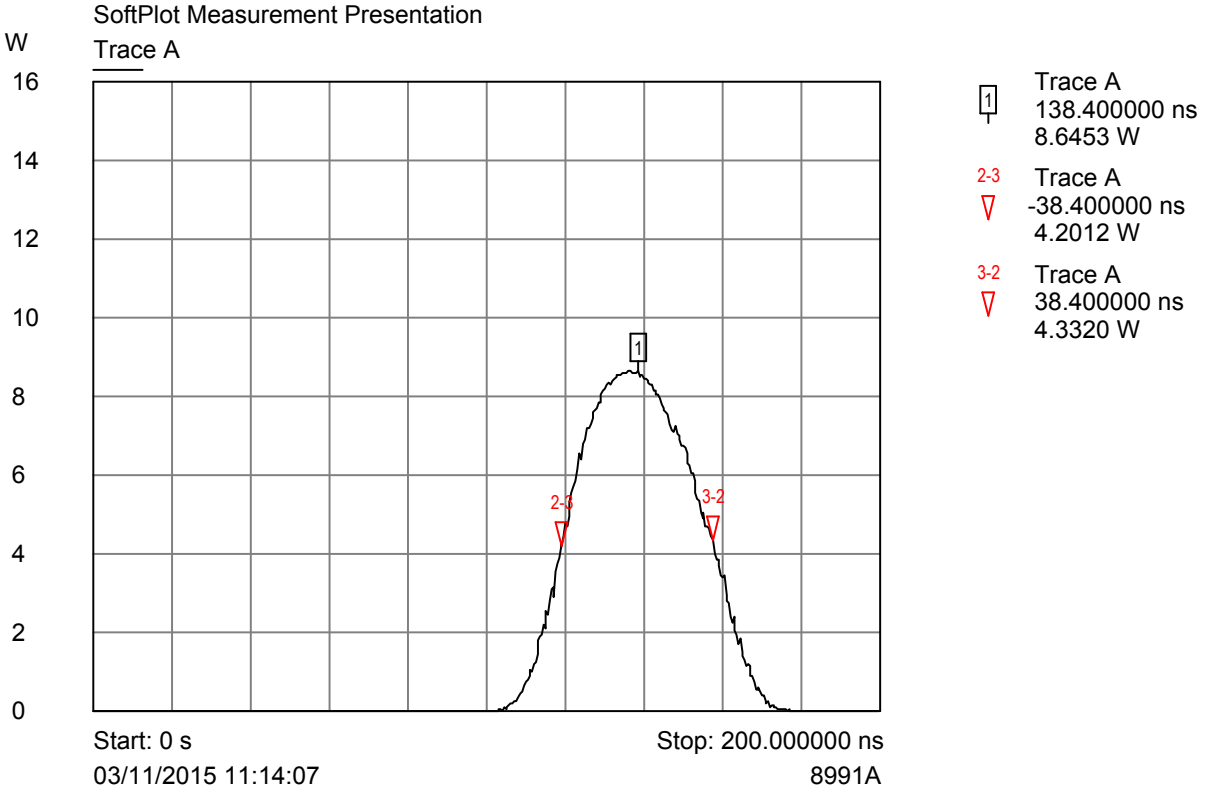


Trace A
134.400000 ns
8.6403 W

2-3 Trace A
-37.600000 ns
4.3479 W

3-2 Trace A
37.600000 ns
4.2841 W

6.3.2.2 Index 1

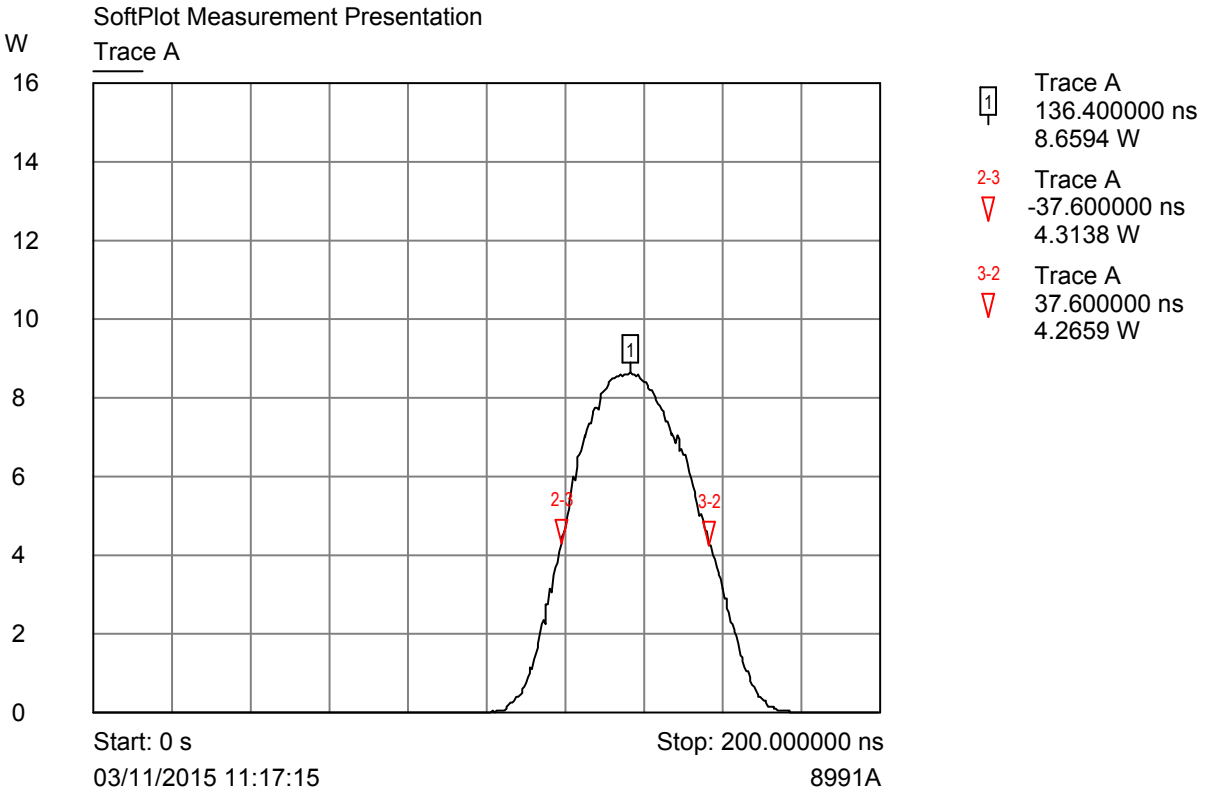


Trace A
138.400000 ns
8.6453 W

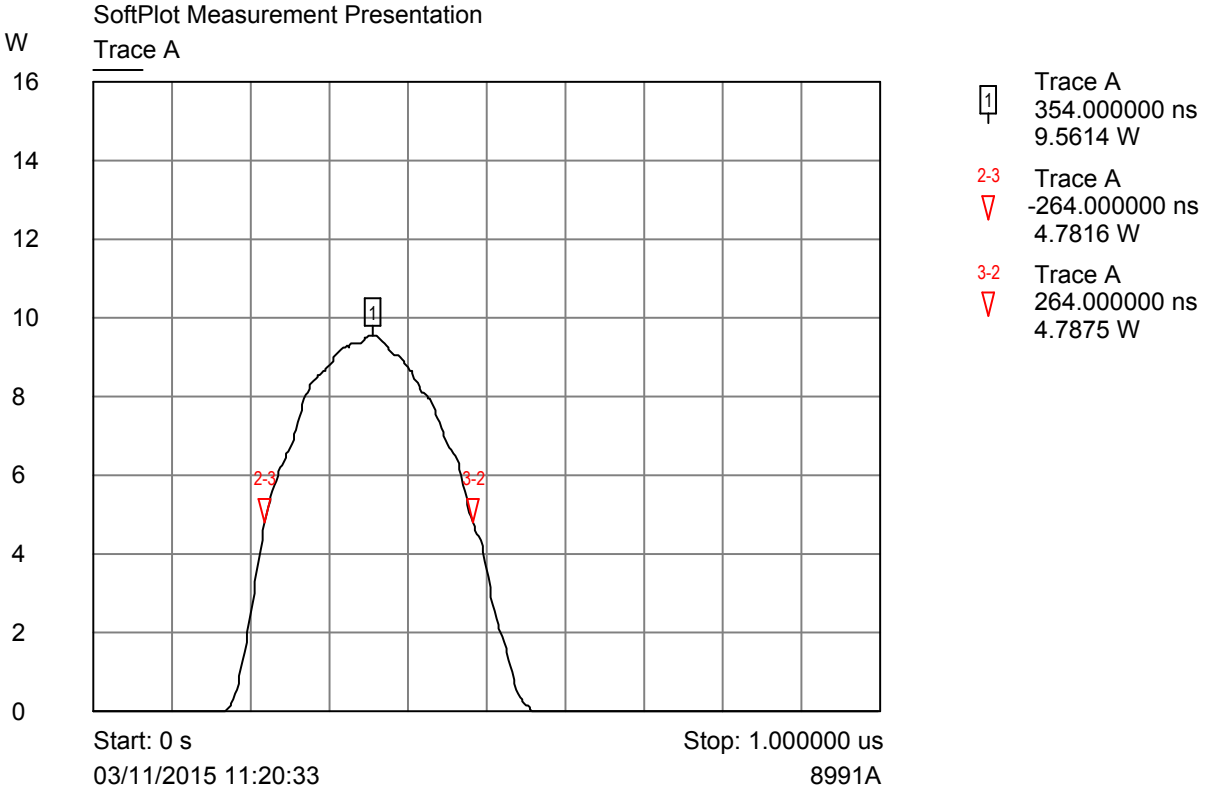
2-3 Trace A
-38.400000 ns
4.2012 W

3-2 Trace A
38.400000 ns
4.3320 W

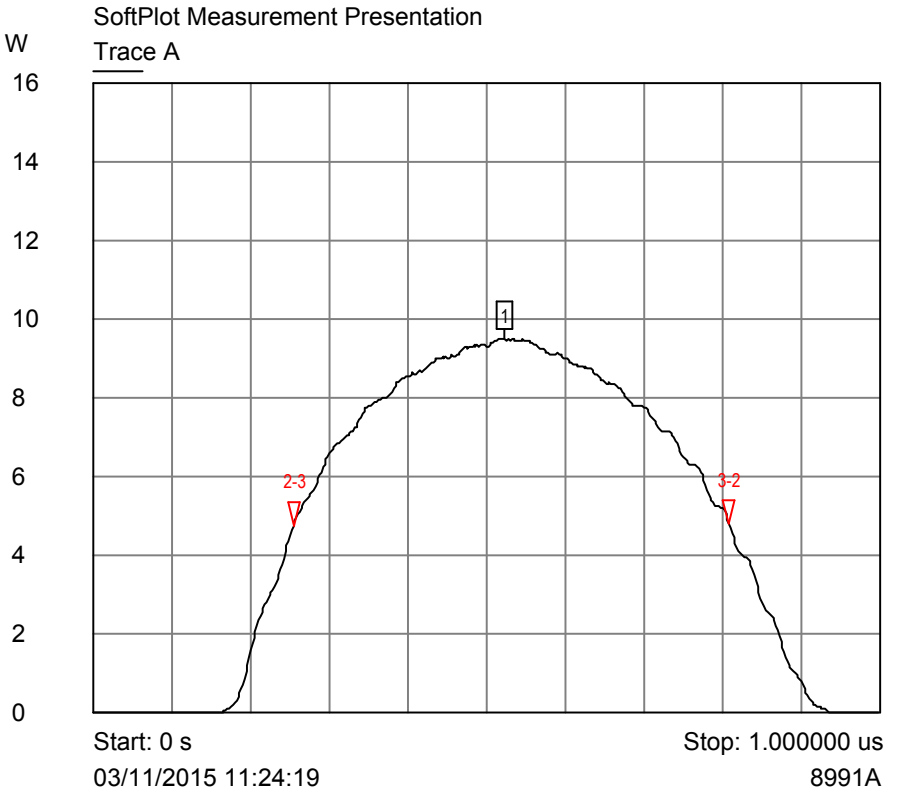
6.3.2.3 Index 2



6.3.2.4 Index 3



6.3.2.5 Index 4

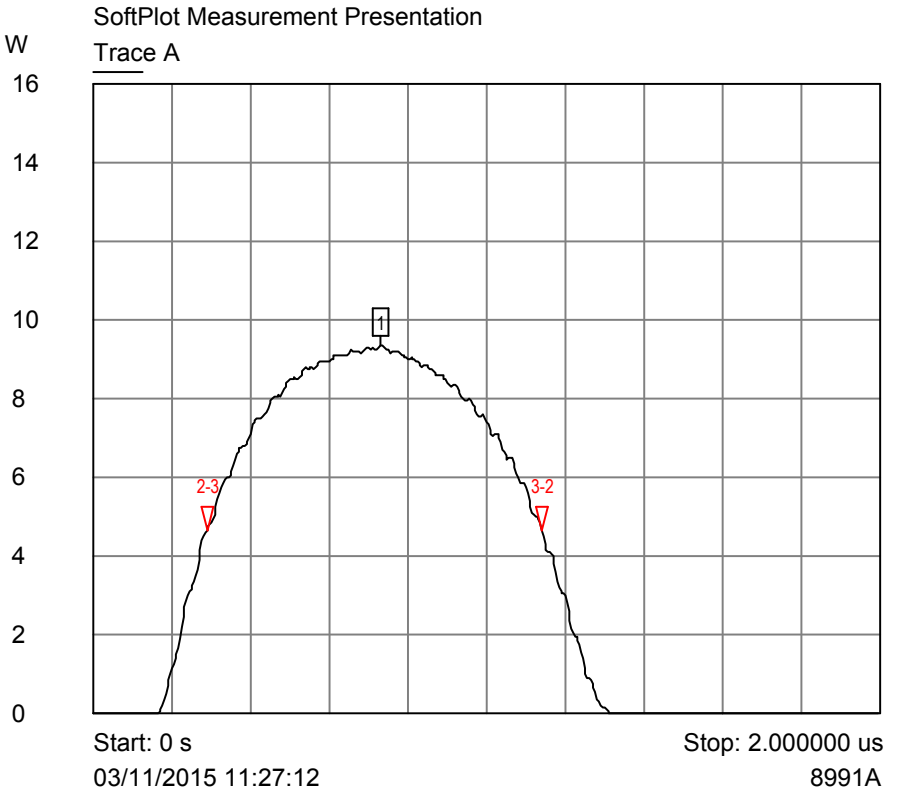


1 Trace A
522.000000 ns
9.5036 W

2-3 Trace A
-554.000000 ns
4.7452 W

3-2 Trace A
554.000000 ns
4.7793 W

6.3.2.6 Index 5

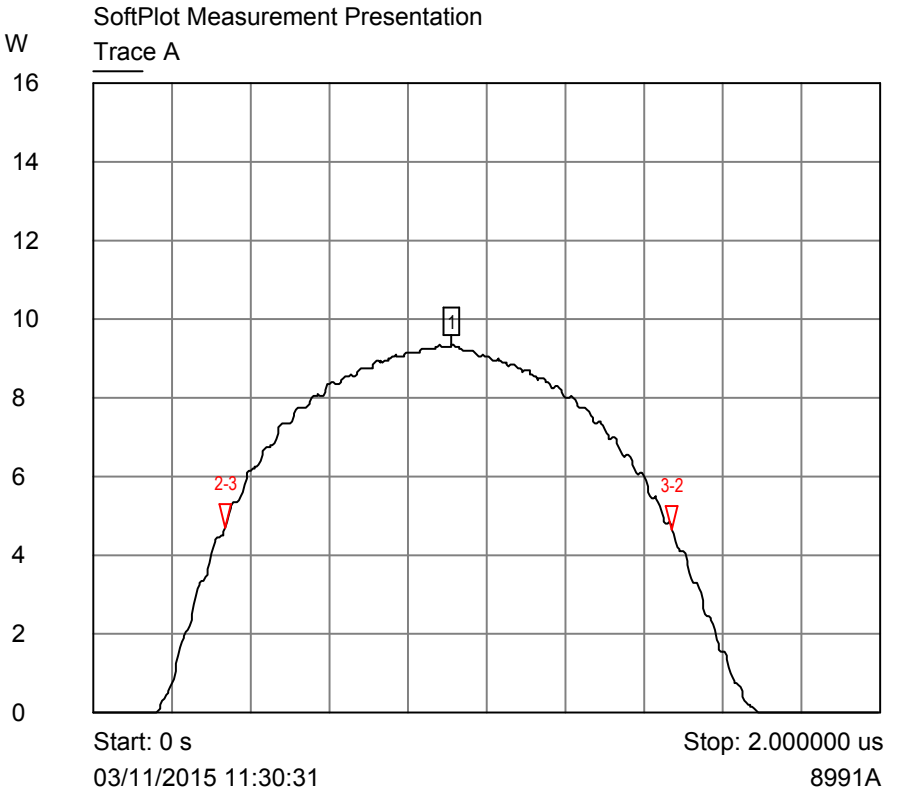


1 Trace A
732.000000 ns
9.3587 W

2-3 Trace A
-852.000000 ns
4.6632 W

3-2 Trace A
852.000000 ns
4.6468 W

6.3.2.7 Index 6

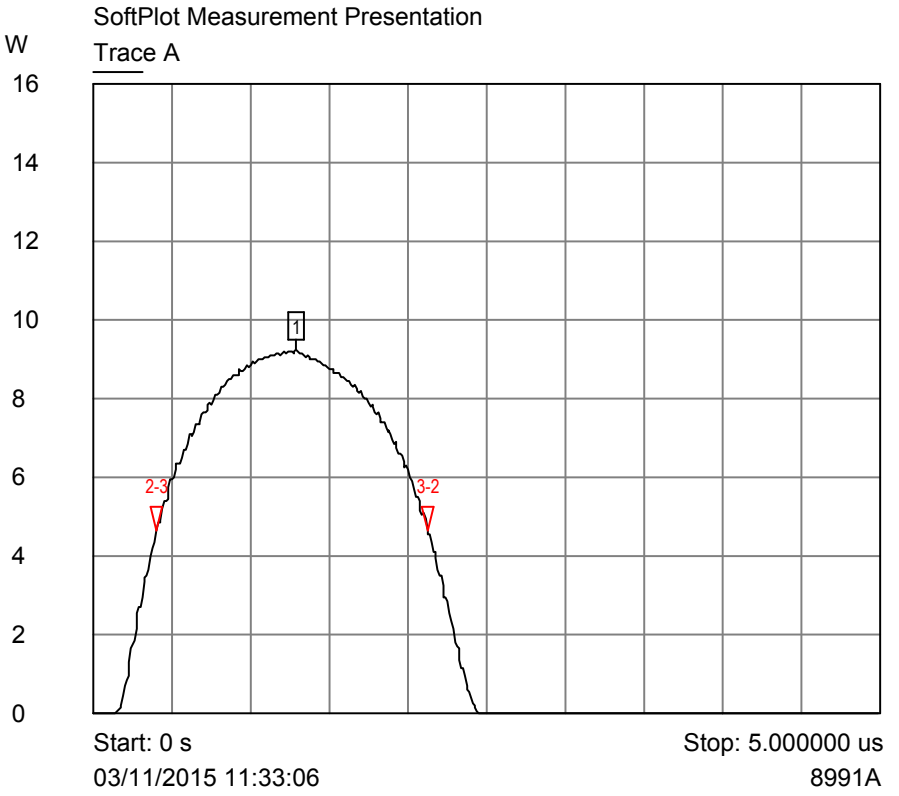


1 Trace A
912.000000 ns
9.3350 W

2-3 Trace A
-1.136000 us
4.6955 W

3-2 Trace A
1.136000 us
4.6477 W

6.3.2.8 Index 7

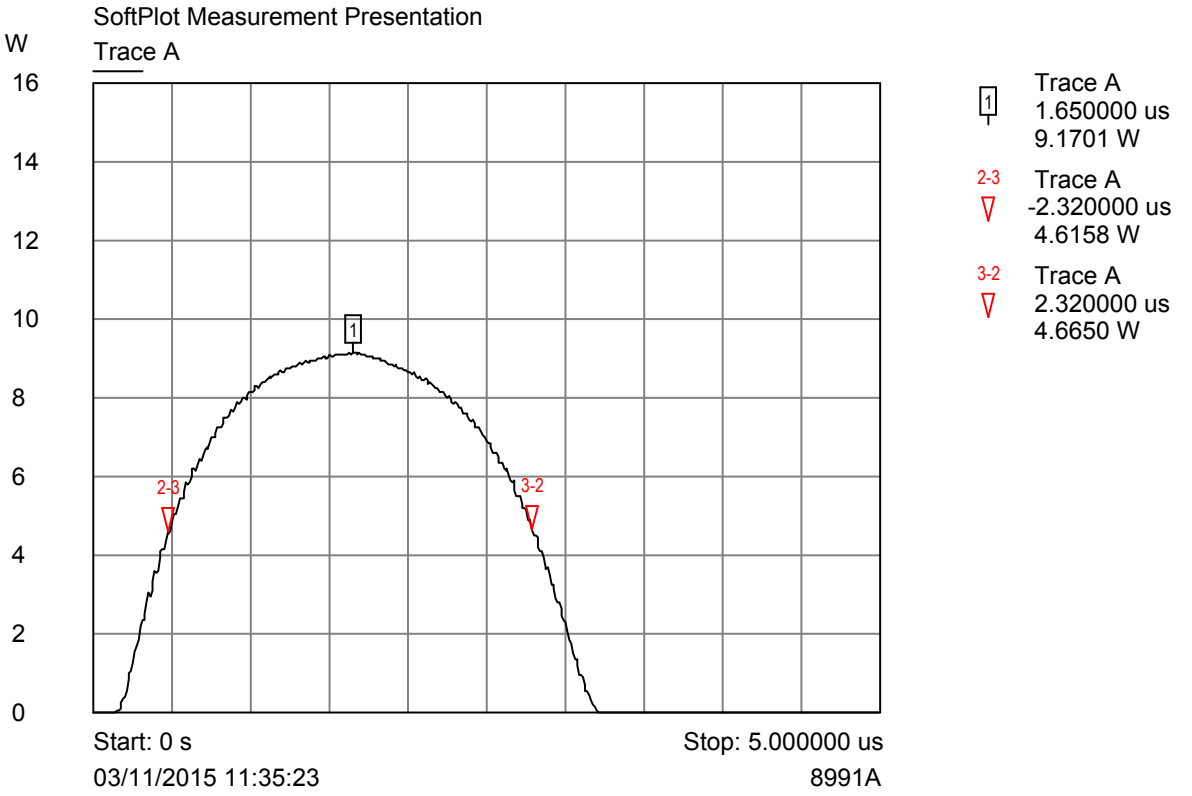


1 Trace A
1.290000 us
9.2284 W

2-3 Trace A
-1.720000 us
4.6645 W

3-2 Trace A
1.720000 us
4.6399 W

6.3.2.9 Index 8

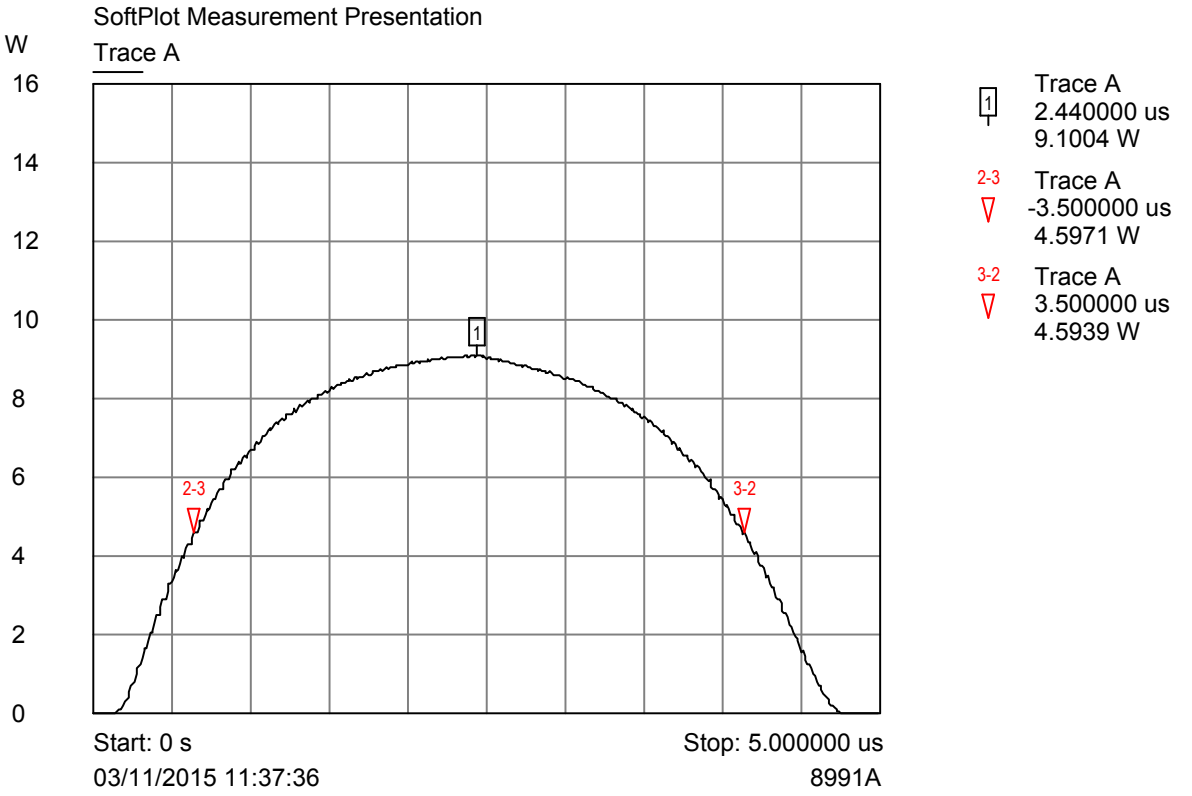


1 Trace A
1.650000 us
9.1701 W

2-3 Trace A
-2.320000 us
4.6158 W

3-2 Trace A
2.320000 us
4.6650 W

6.3.2.10 Index 9

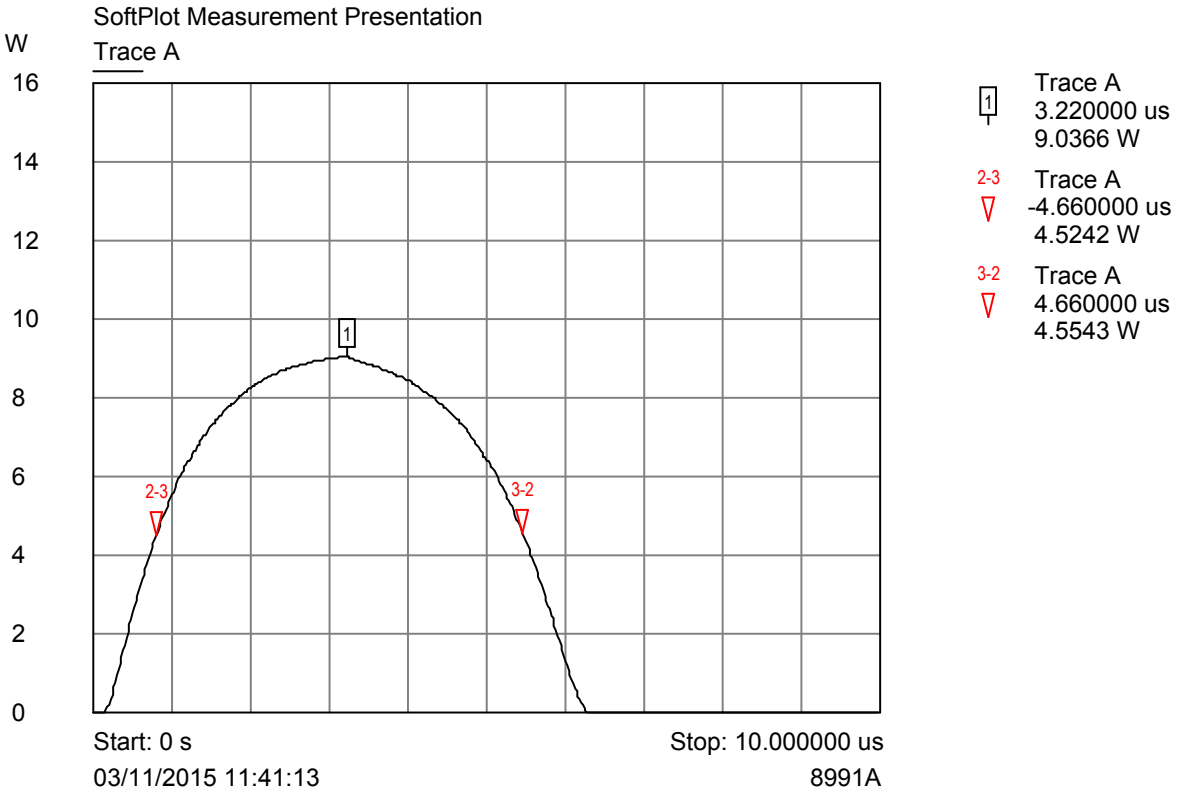


1 Trace A
2.440000 us
9.1004 W

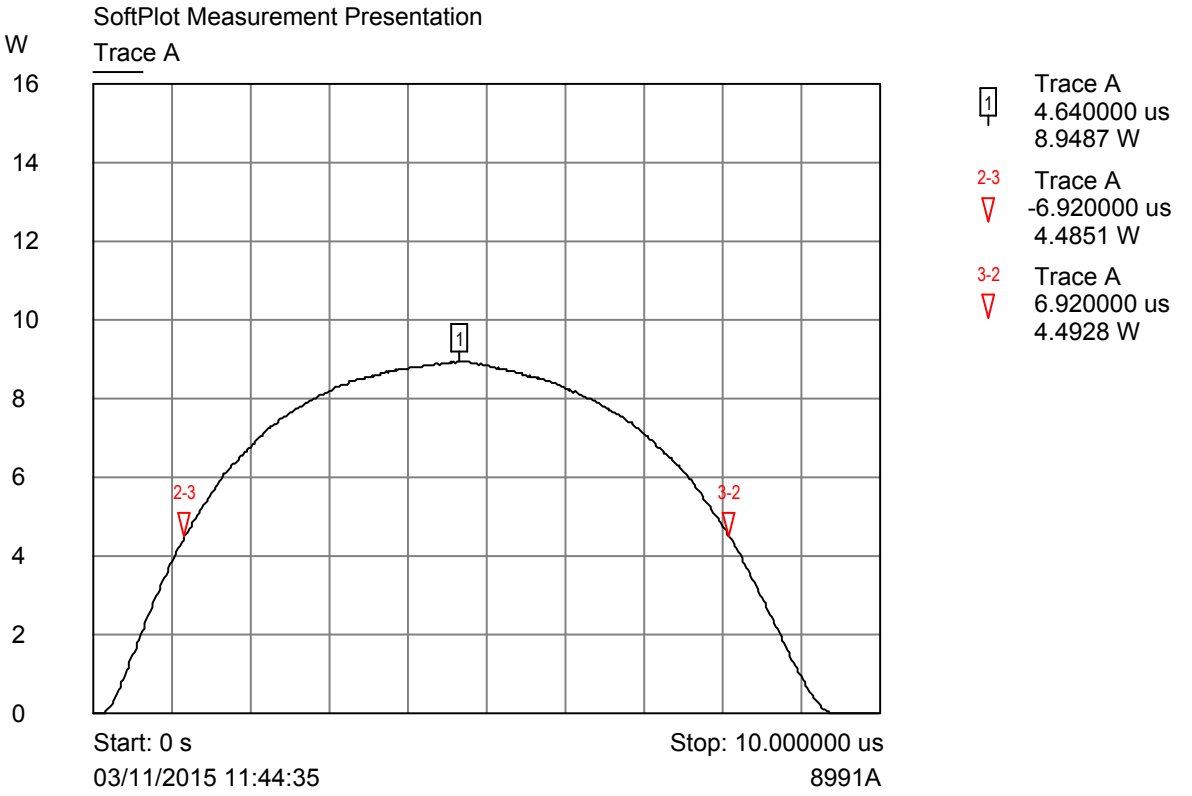
2-3 Trace A
-3.500000 us
4.5971 W

3-2 Trace A
3.500000 us
4.5939 W

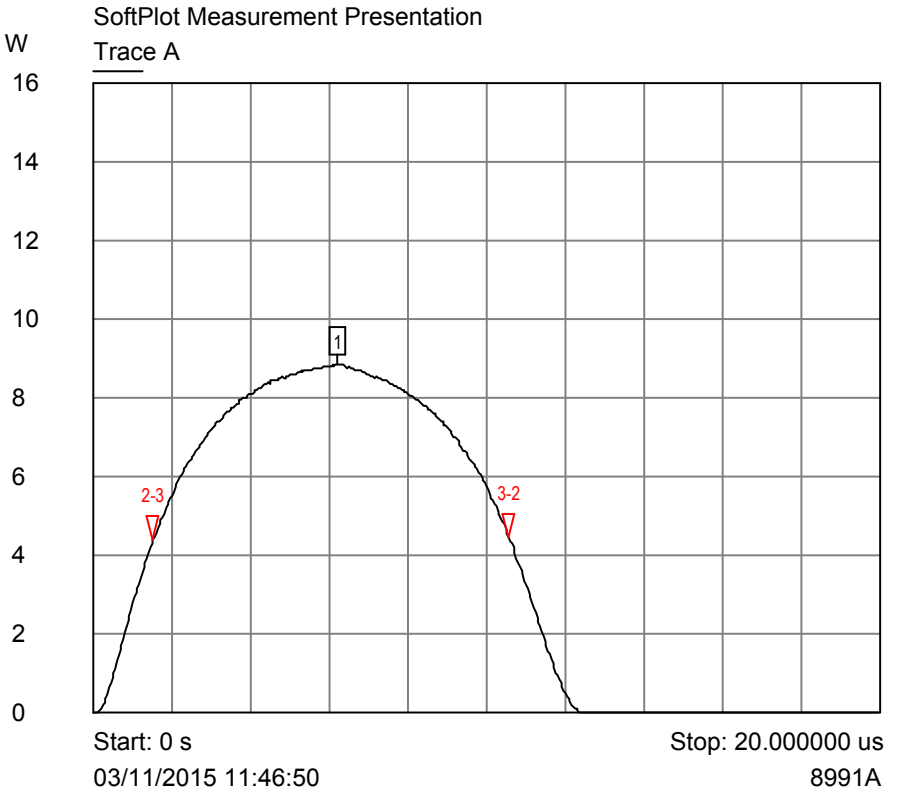
6.3.2.11 Index 10



6.3.2.12 Index 11



6.3.2.13 Index 12

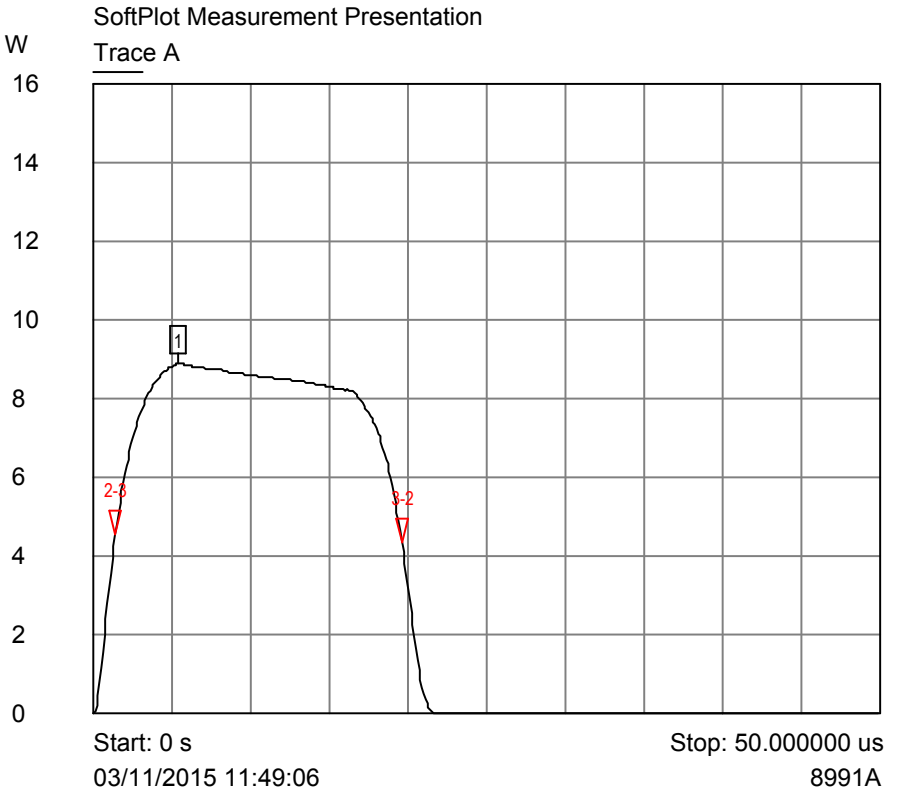


1 Trace A
6.200000 us
8.8517 W

2-3 Trace A
-9.040000 us
4.3903 W

3-2 Trace A
9.040000 us
4.4605 W

6.3.2.14 Index 13

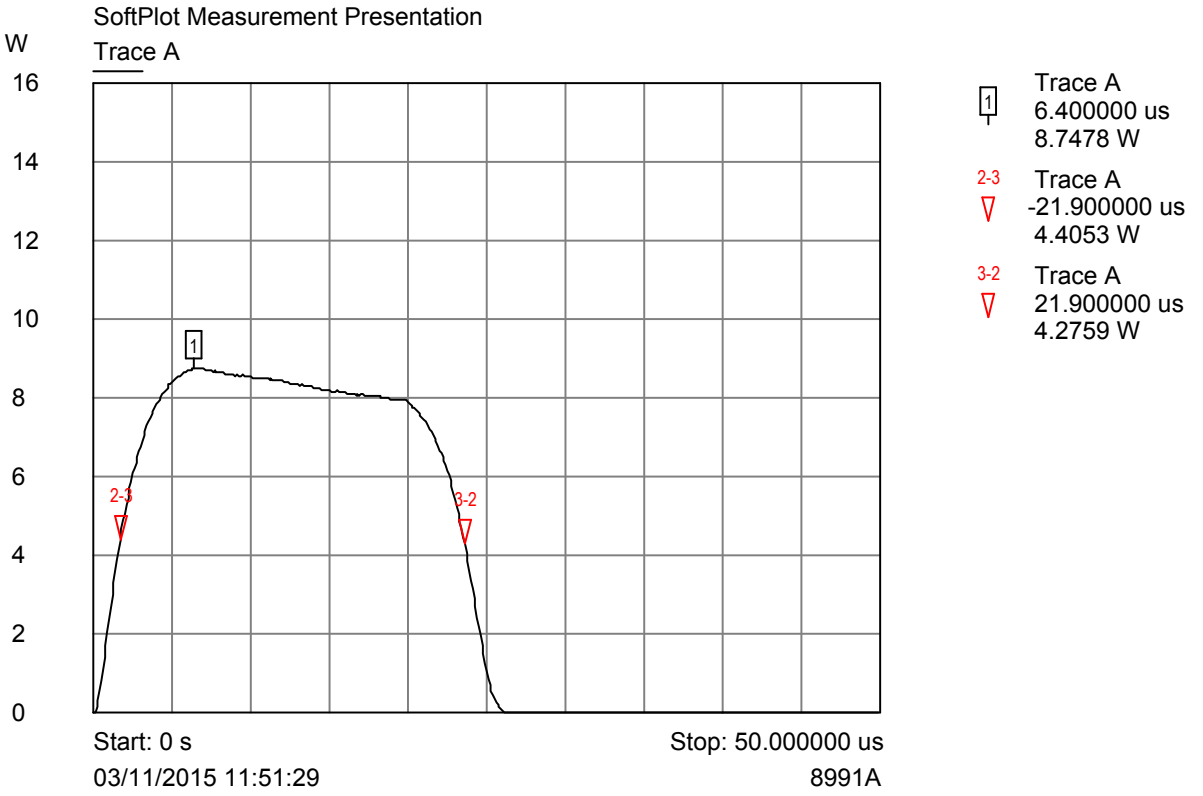


1 Trace A
5.400000 us
8.9100 W

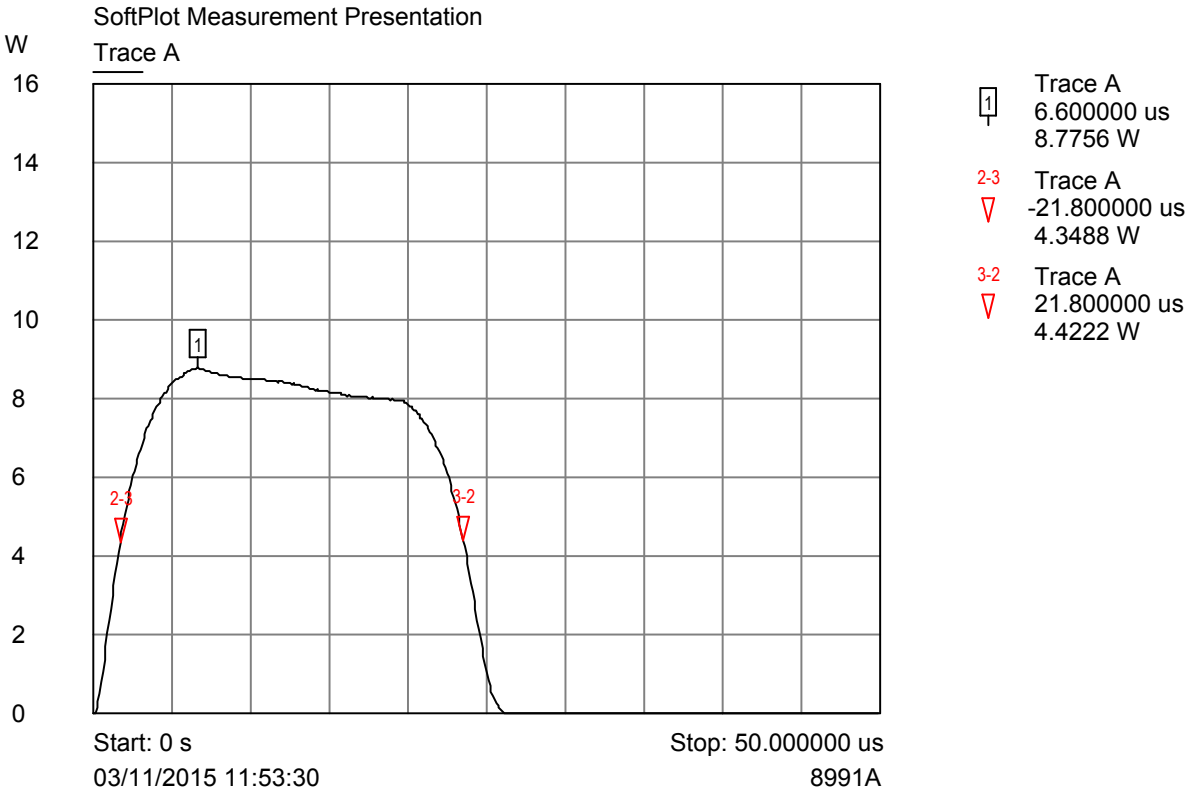
2-3 Trace A
-18.200000 us
4.5529 W

3-2 Trace A
18.200000 us
4.3616 W

6.3.2.15 Index 14



6.3.2.16 Index 15



Comments: None.
Tested by: D.Jamieson
Test Date: 3rd to 4th November 2015
Test Unit: 2
Test Setup: Conducted
Test Status: Pass

6.4 RF Output Power – Average Power

		Measured			Calculated		Calculated	Measured	Calculated
Index	MFD Display (nm)	Measured PRF Min (µs)	Measured PRF Max (µs)	Peak Level (W)	Average PRF (µs)	Average PRF (Hz)	Half power peak level (W)	Half power Pulse Width (µs)	Average Power (mW)
0	0.0625	224	595	8.64	409.50	2442	4.32	0.0376	0.79
1	0.125	224	595	8.65	409.50	2442	4.325	0.0384	0.81
2	0.25	224	595	8.66	409.50	2442	4.33	0.0376	0.80
3	0.375	224	595	9.56	409.50	2442	4.78	0.2640	6.16
4	0.5	224	595	9.50	409.50	2442	4.75	0.5540	12.85
5	0.75	224	595	9.36	409.50	2442	4.68	0.8520	19.47
6	1	224	595	9.34	409.50	2442	4.67	1.1360	25.91
7	1.5	224	595	9.23	409.50	2442	4.615	1.7200	38.77
8	2	224	595	9.17	409.50	2442	4.585	2.3200	51.95
9	3	224	595	9.10	409.50	2442	4.55	3.5000	77.78
10	4	224	595	9.04	409.50	2442	4.52	4.6600	102.87
11	6	224	595	8.95	409.50	2442	4.475	6.9200	151.24
12	8	224	595	8.85	409.50	2442	4.425	9.0400	195.37
13	12	635.6	1088	8.91	861.80	1160	4.455	18.2000	188.17
14	16	635.6	1088	8.75	861.80	1160	4.375	21.9000	222.35
15	24	635.6	1088	8.78	861.80	1160	4.39	21.8000	222.10

Comments: None.
Tested by: D.Jamieson
Test Date: 3rd to 4th November 2015
Test Unit: N/A
Test Setup: N/A
Test Status: For declaration only.

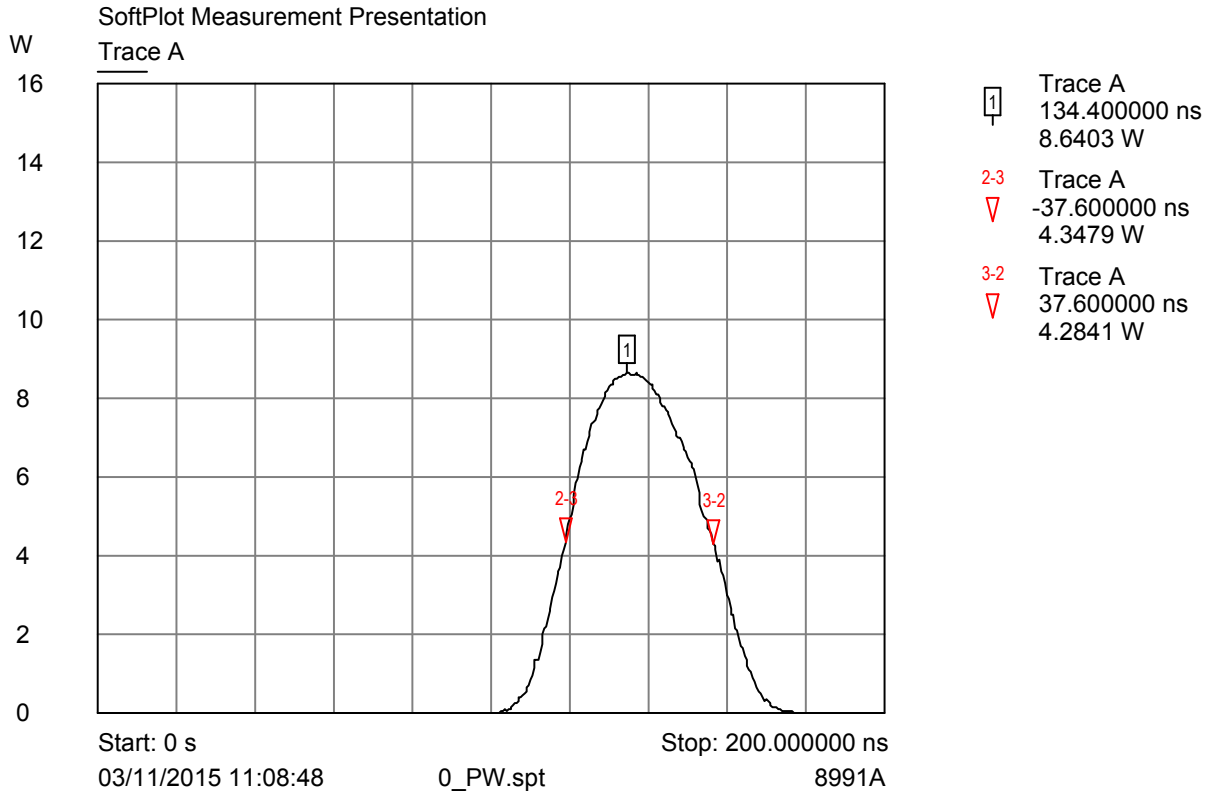
6.5 RF Output Power – Pulse Width

6.5.1 Pulse Width Results Summary

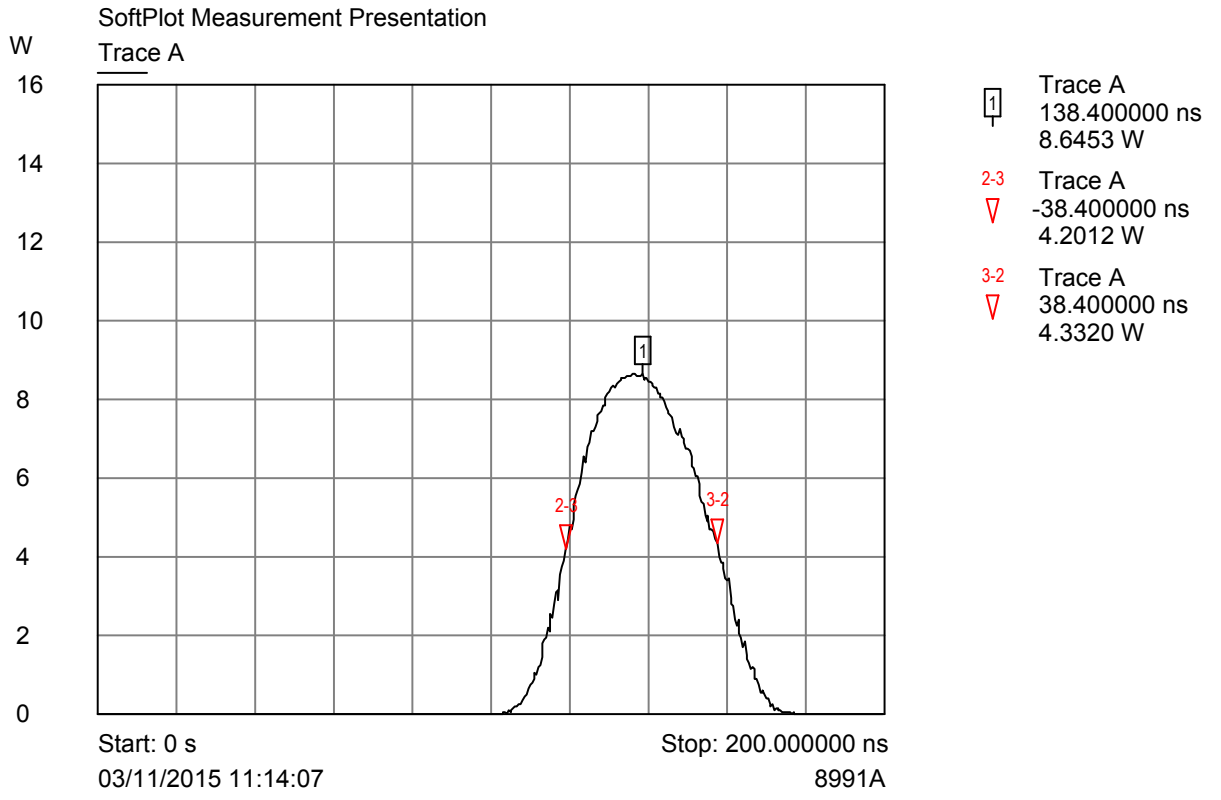
		Measured	Calculated	Measured
Index	MFD Display (nm)	Peak Level (W)	Half power peak level (W)	Half power Pulse Width (µs)
0	0.0625	8.64	4.32	0.0376
1	0.125	8.65	4.325	0.0384
2	0.25	8.66	4.33	0.0376
3	0.375	9.56	4.78	0.2640
4	0.5	9.50	4.75	0.5540
5	0.75	9.36	4.68	0.8520
6	1	9.34	4.67	1.1360
7	1.5	9.23	4.615	1.7200
8	2	9.17	4.585	2.3200
9	3	9.10	4.55	3.5000
10	4	9.04	4.52	4.6600
11	6	8.95	4.475	6.9200
12	8	8.85	4.425	9.0400
13	12	8.91	4.455	18.2000
14	16	8.75	4.375	21.9000
15	24	8.78	4.39	21.8000

6.5.2 *Pulse Width Plots*

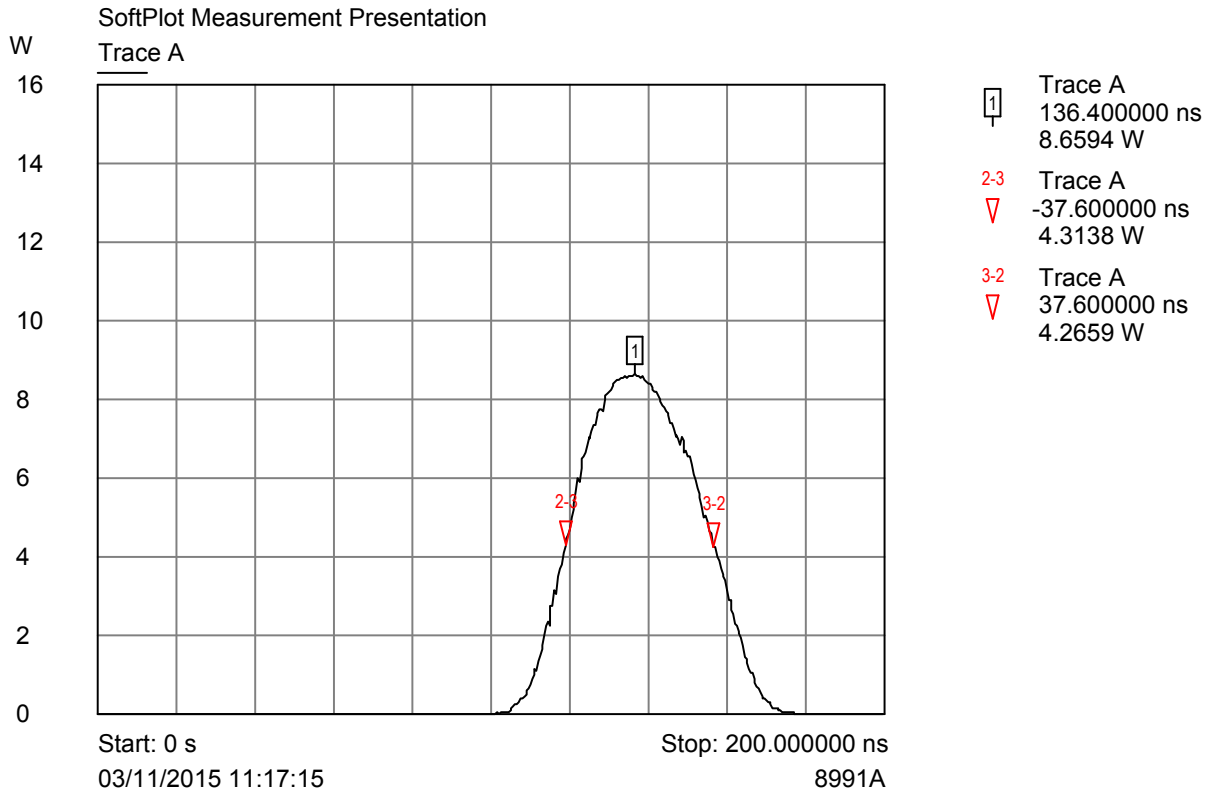
Index	Pulse Width
0	37.6ns



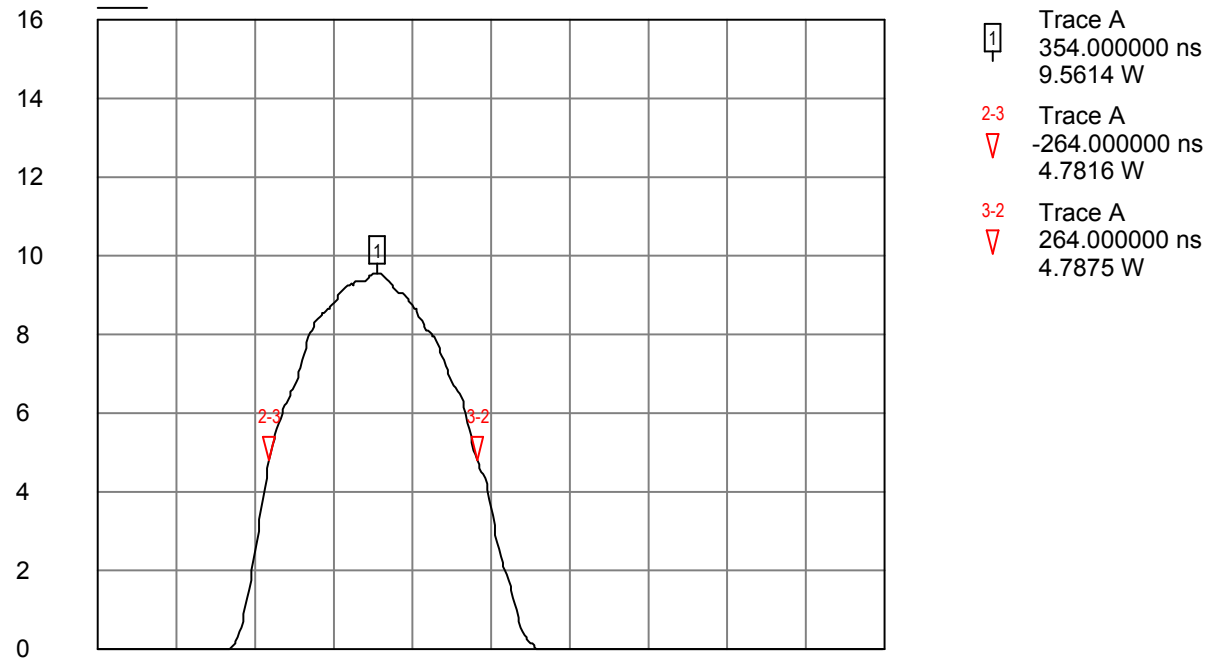
Index	Pulse Width
1	38.4ns



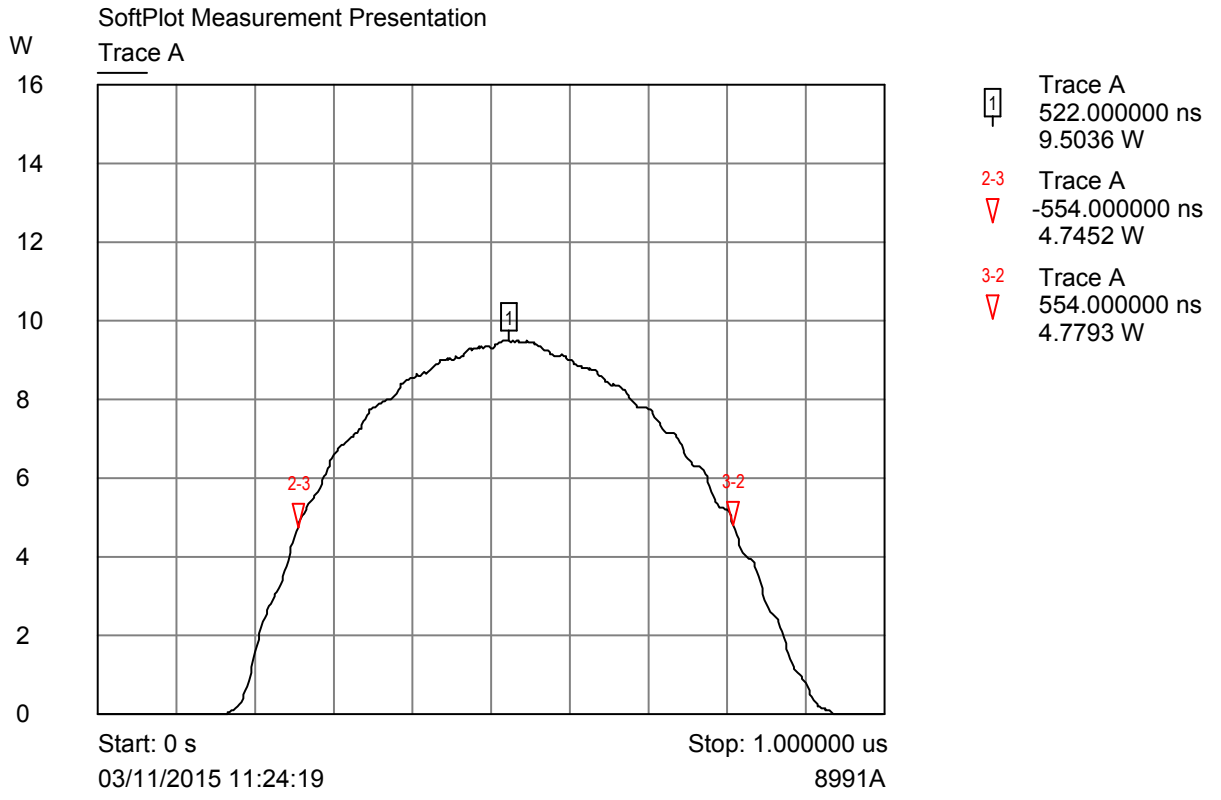
Index	Pulse Width
2	37.6ns



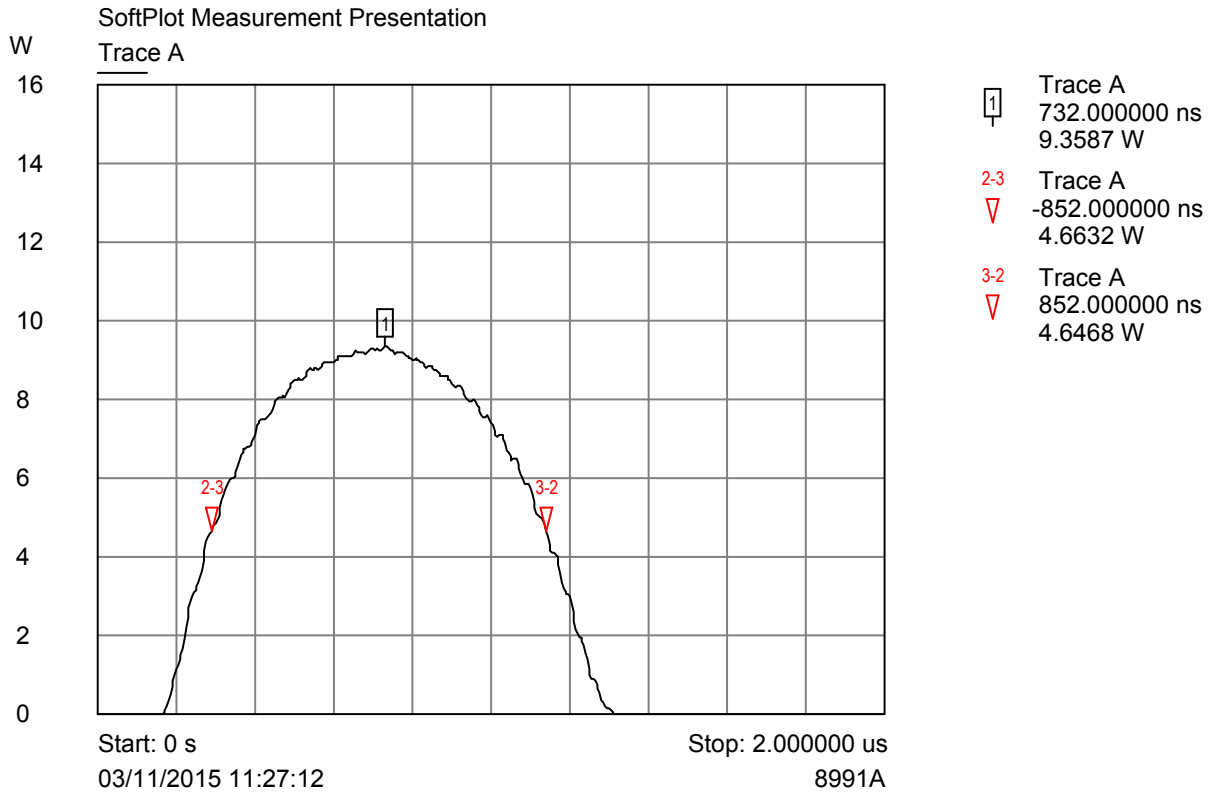
Index	Pulse Width
3	264ns



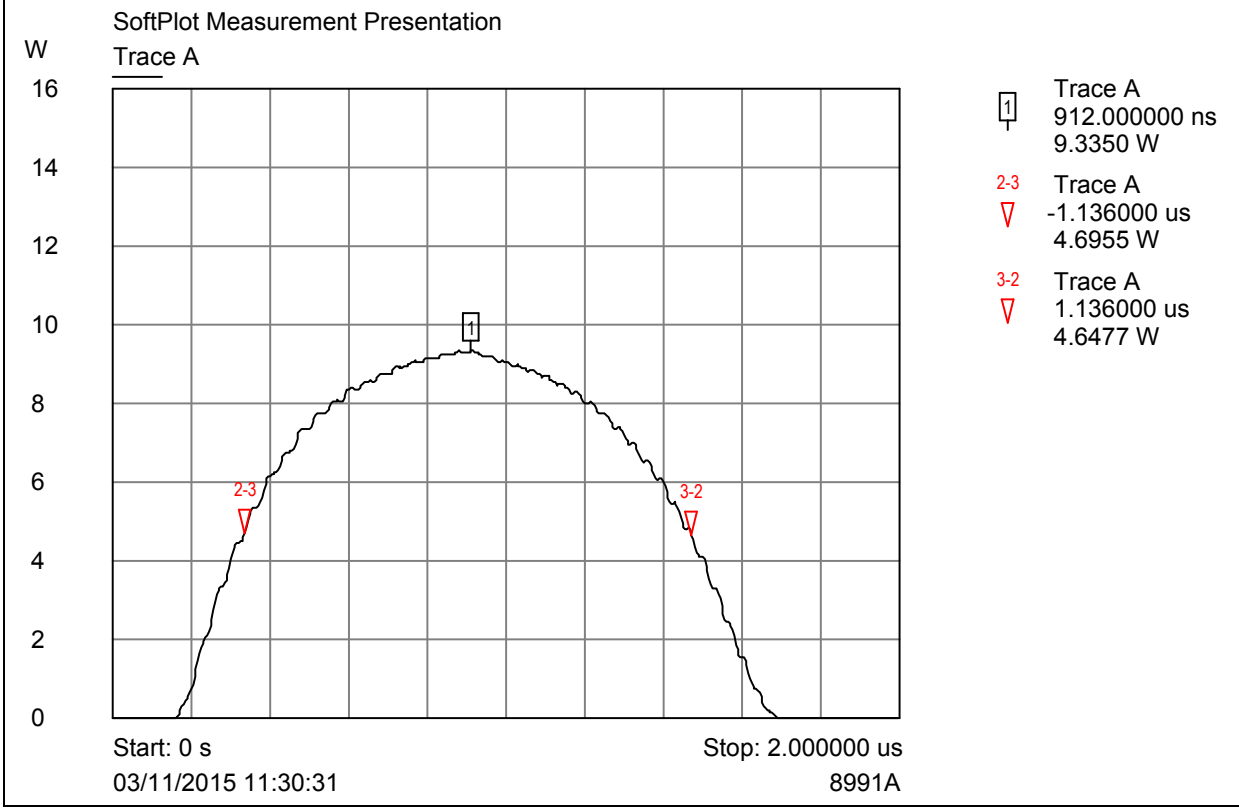
Index	Pulse Width
4	554ns



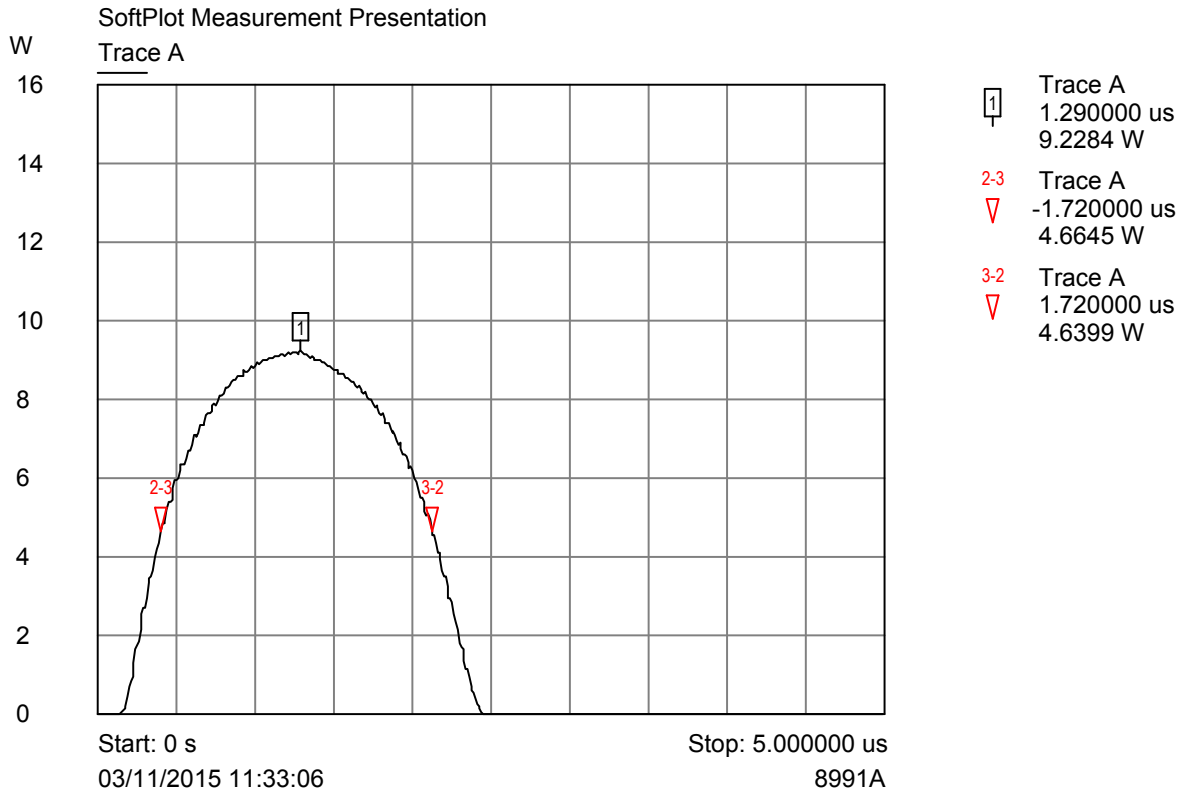
Index	Pulse Width (µs)
5	0.852



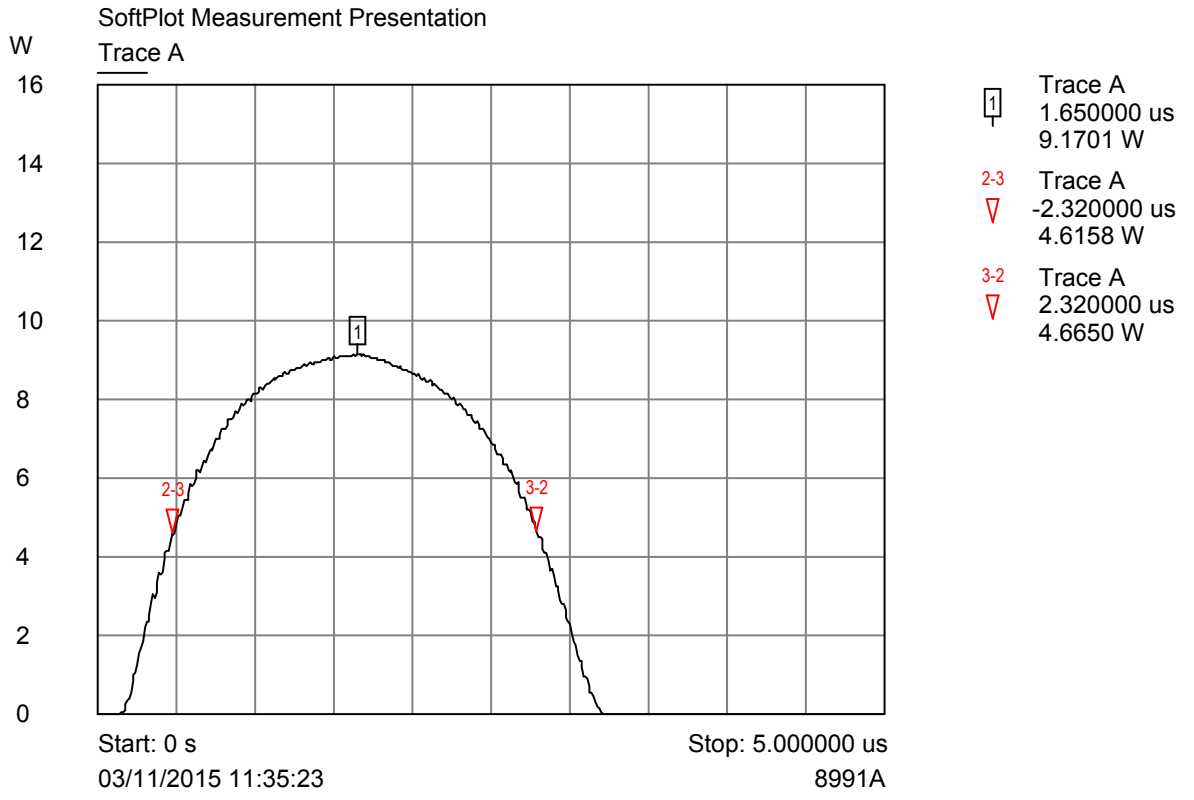
Index	Pulse Width (µs)
6	1.136



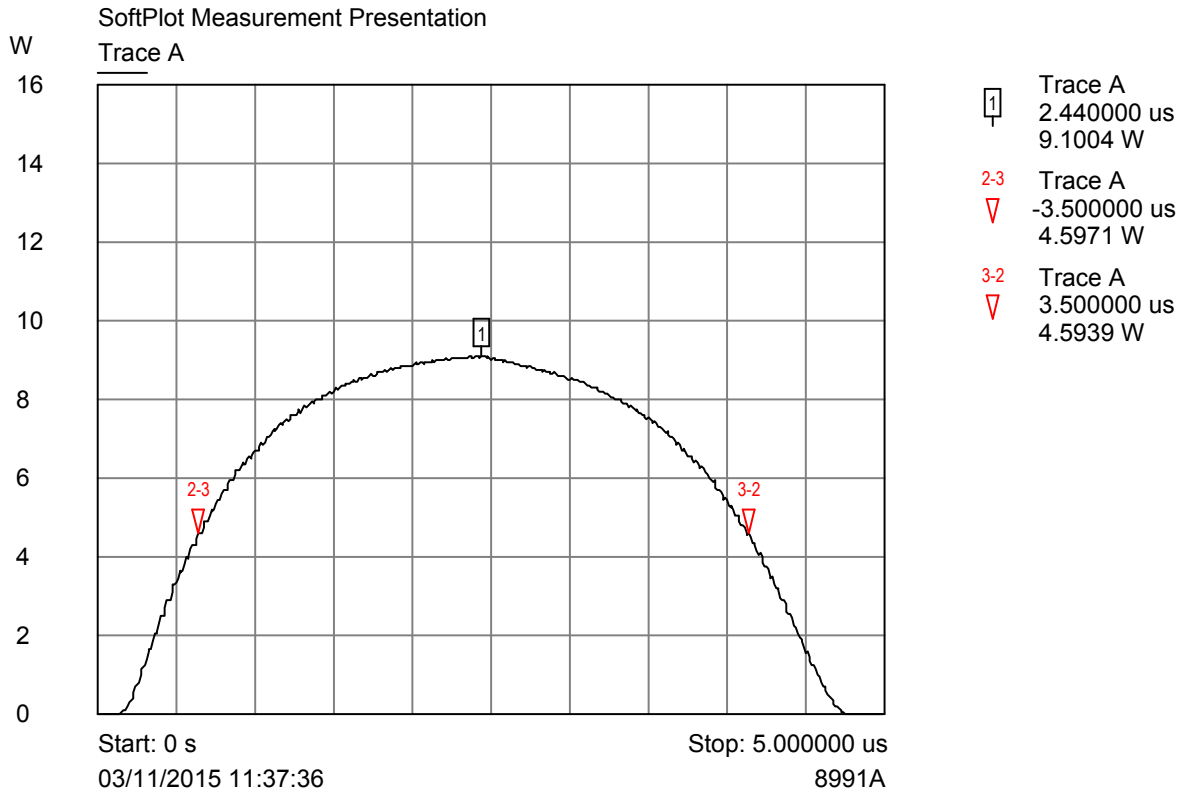
Index	Pulse Width (µs)
7	1.720



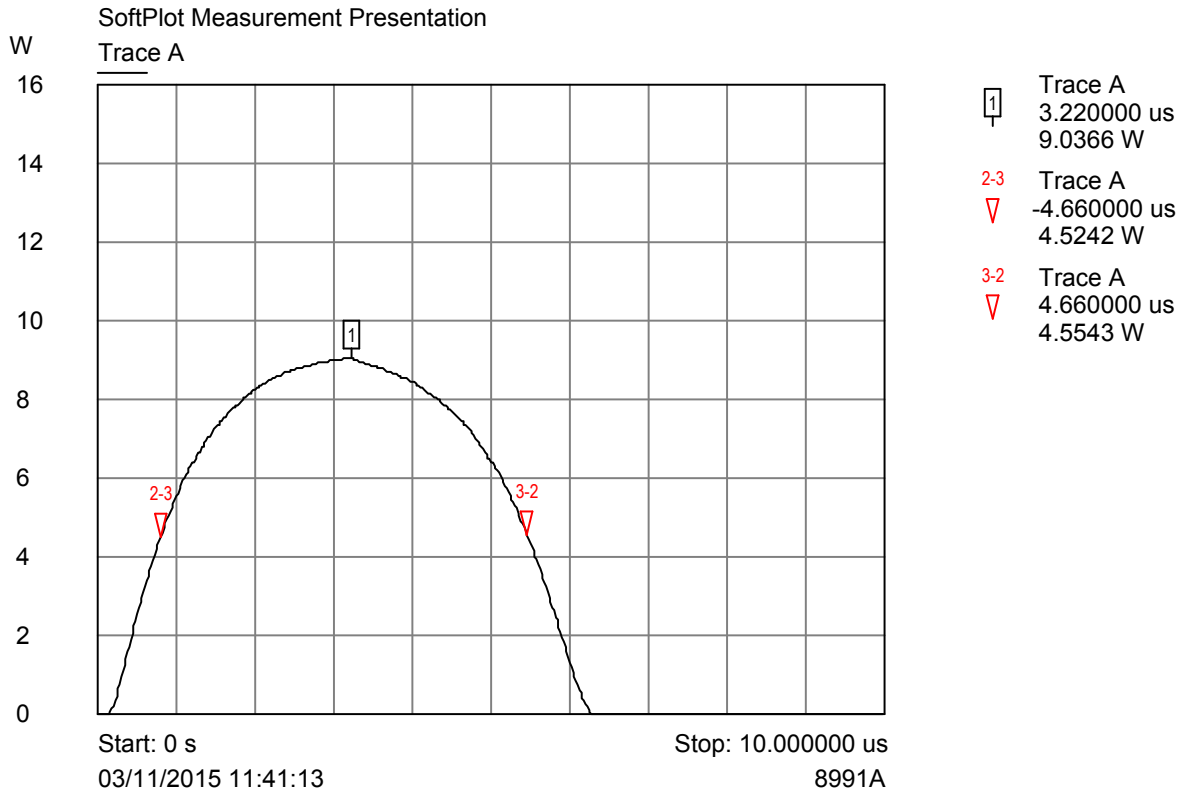
Index	Pulse Width (µs)
8	2.320



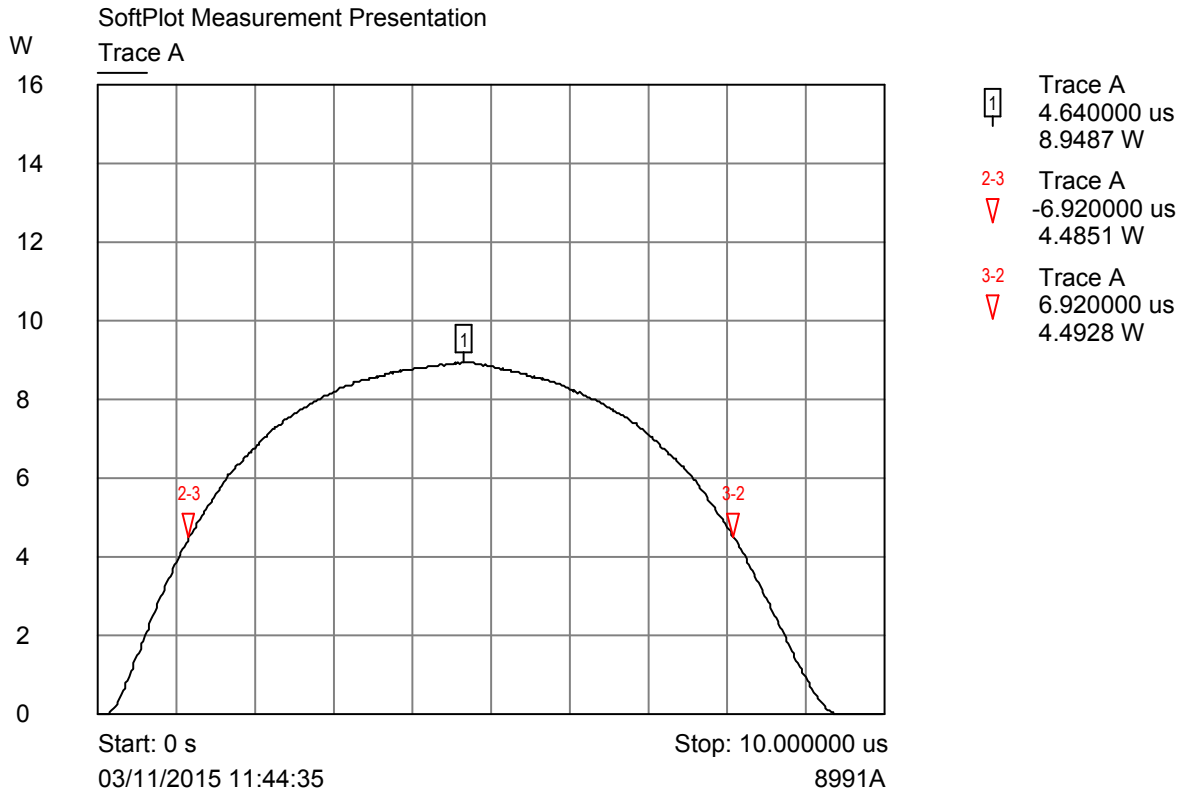
Index	Pulse Width (µs)
9	3.500



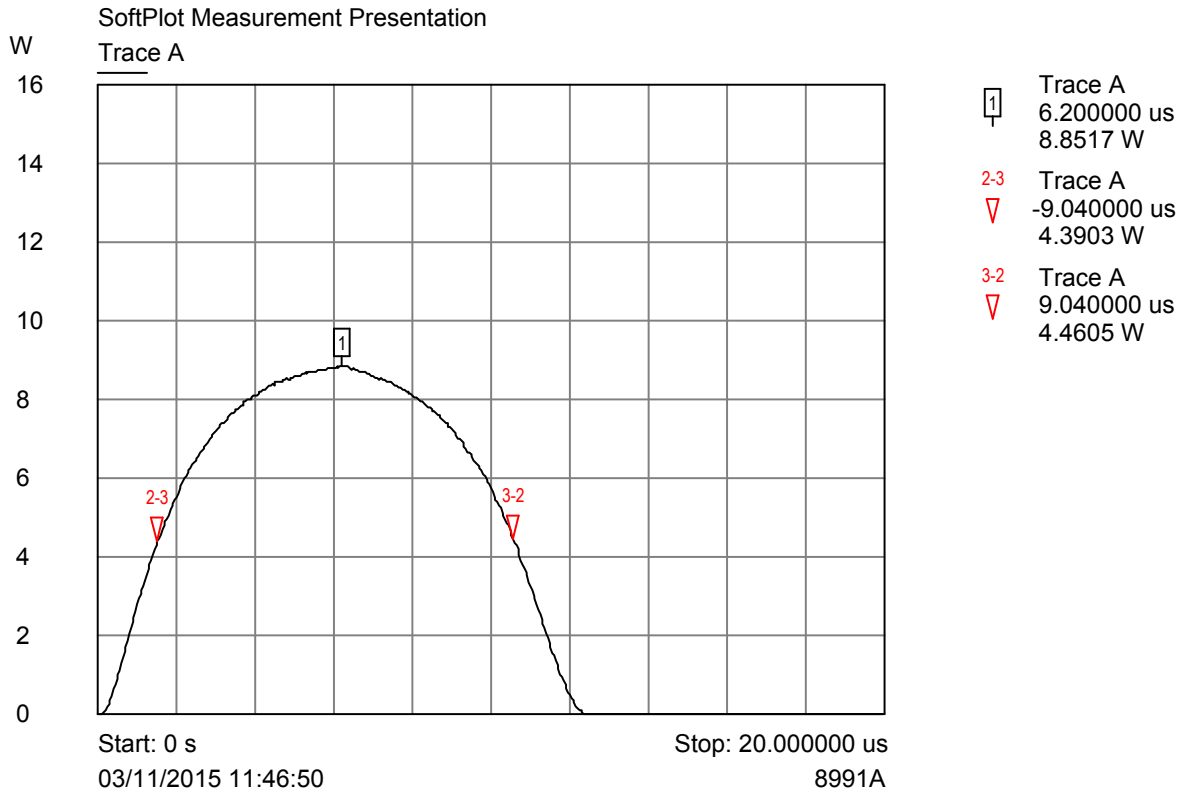
Index	Pulse Width (µs)
10	4.660



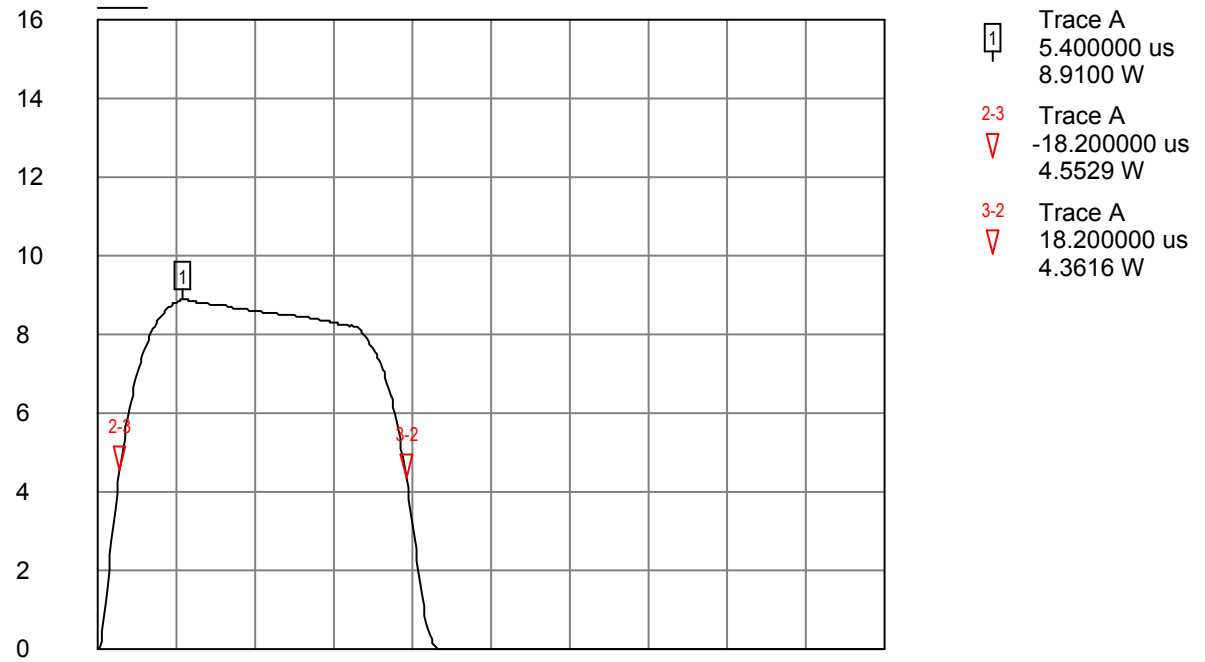
Index	Pulse Width (µs)
11	6.920



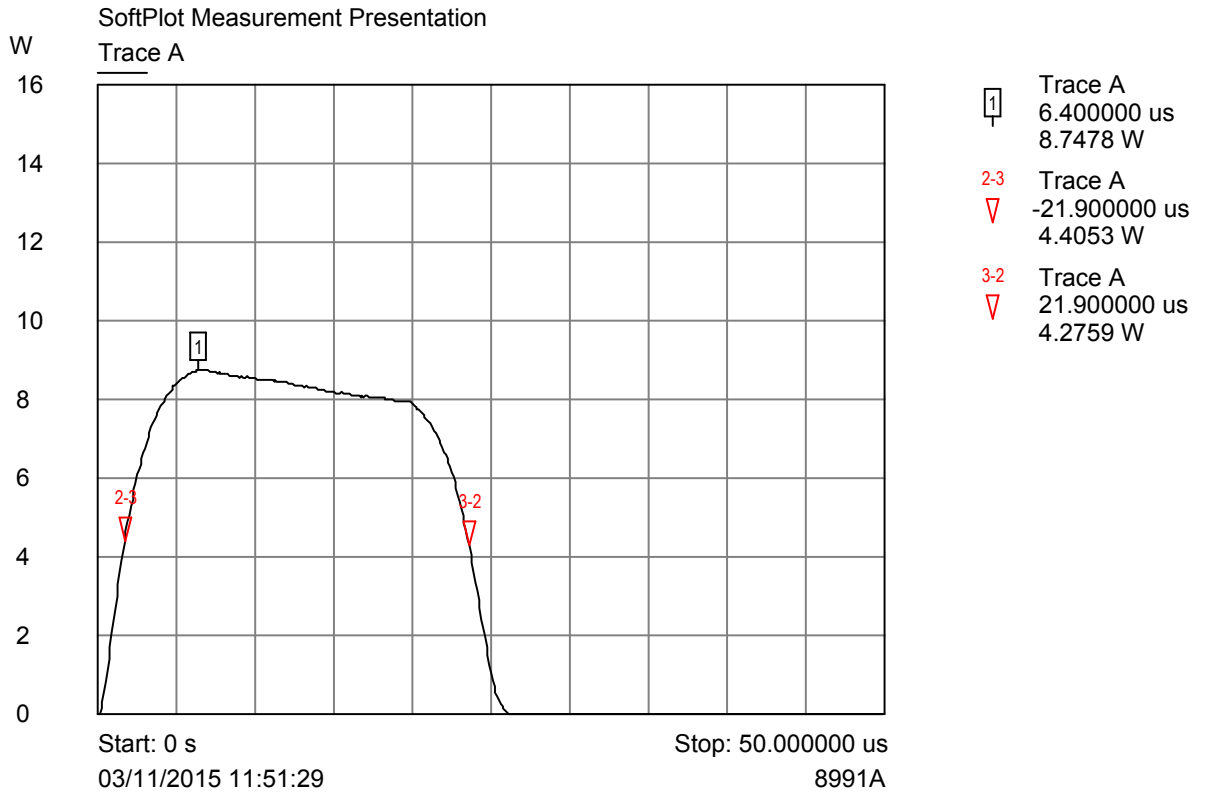
Index	Pulse Width (µs)
12	9.040



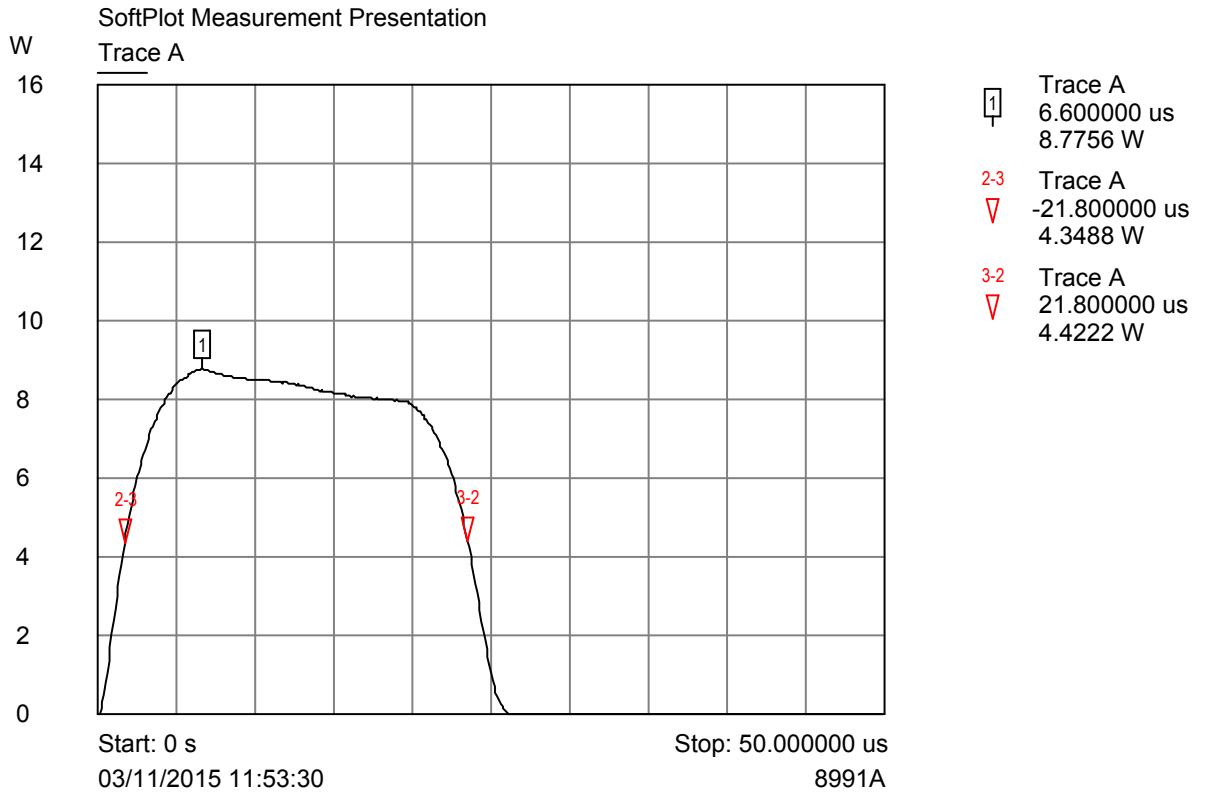
Index	Pulse Width (µs)
13	18.200



Index	Pulse Width (µs)
14	21.900



Index	Pulse Width (µs)
15	21.800



Comments: None.
Tested by: D.Jamieson
Test Date: 3rd to 4th November 2015
Test Unit: 2
Test Setup: Conducted
Test Status: For declaration only.

6.6 RF Output Power – Pulse Repetition Frequency

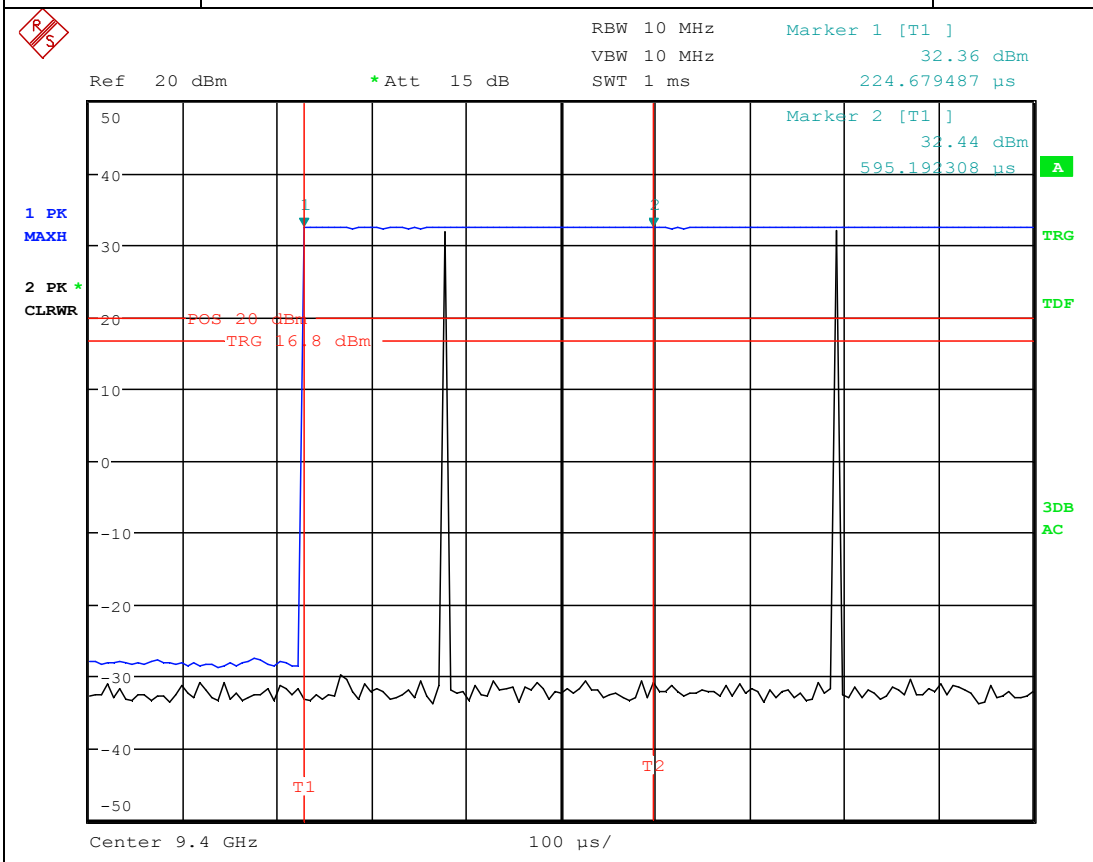
6.6.1 Pulse Repetition Results Summary

Quantum uses a radar discrimination feature which jitters the PRF, therefore the PRF is taken to be the mean value between the minimum and maximum PRFs.

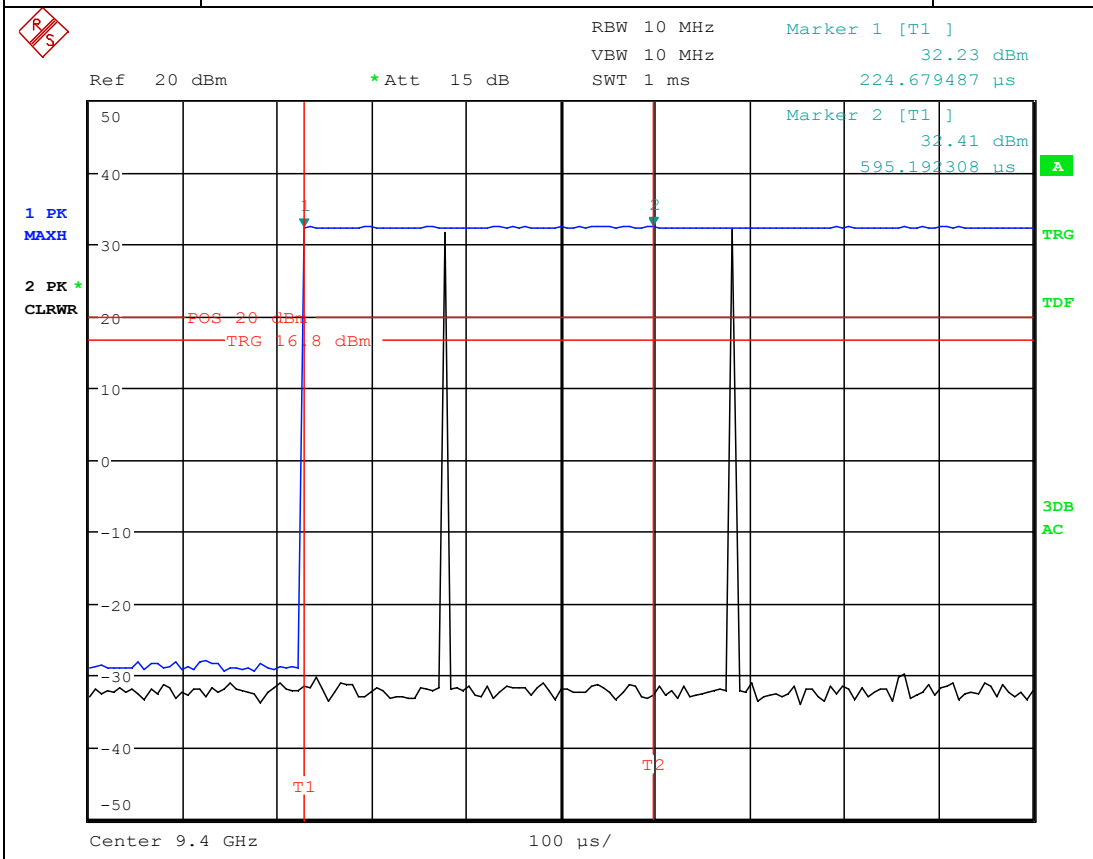
		Measured		Calculated	
Index	MFD Display (nm)	Min Pulse Repetition Time (µs)	Max Pulse Repetition Time (µs)	Average Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
0	0.0625	224	595	409.50	2442
1	0.125	224	595	409.50	2442
2	0.25	224	595	409.50	2442
3	0.375	224	595	409.50	2442
4	0.5	224	595	409.50	2442
5	0.75	224	595	409.50	2442
6	1	224	595	409.50	2442
7	1.5	224	595	409.50	2442
8	2	224	595	409.50	2442
9	3	224	595	409.50	2442
10	4	224	595	409.50	2442
11	6	224	595	409.50	2442
12	8	224	595	409.50	2442
13	12	635.6	1088	861.80	1160
14	16	635.6	1088	861.80	1160
15	24	635.6	1088	861.80	1160

6.6.2 *Pulse Repetition Plots*

Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
0	409.50	2442

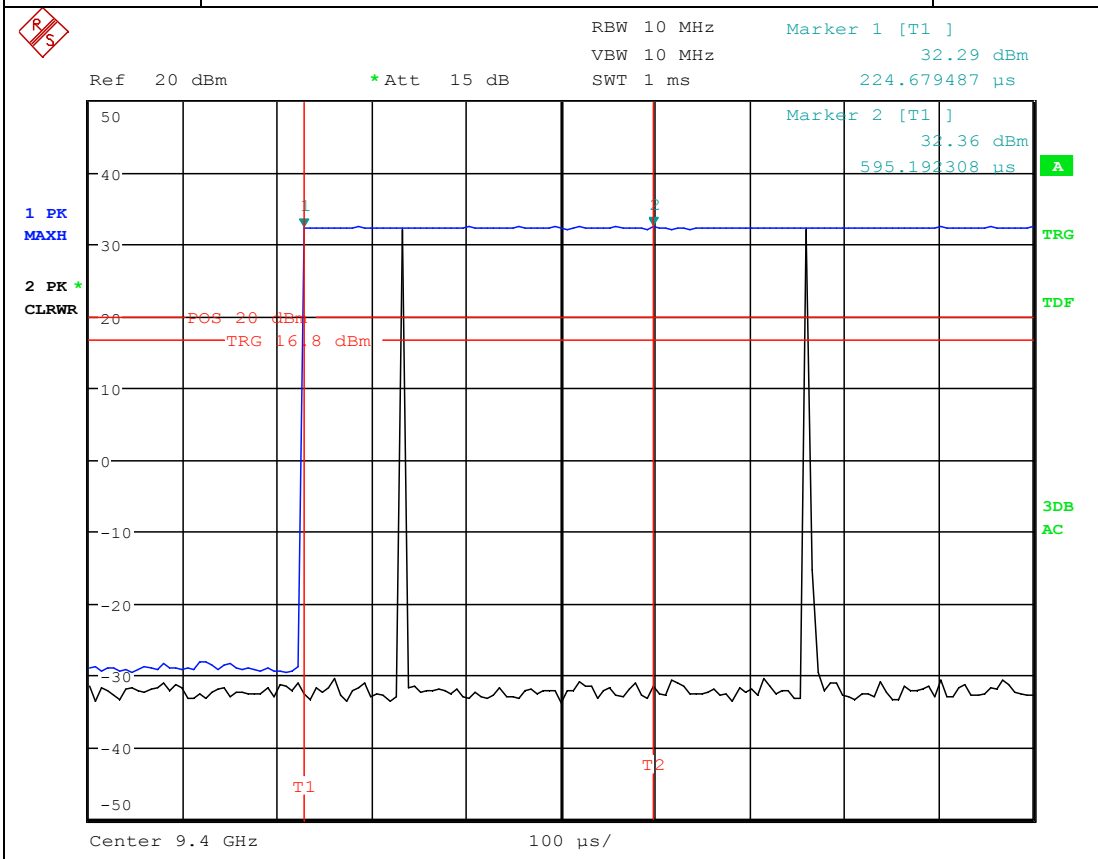


Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
1	409.50	2442



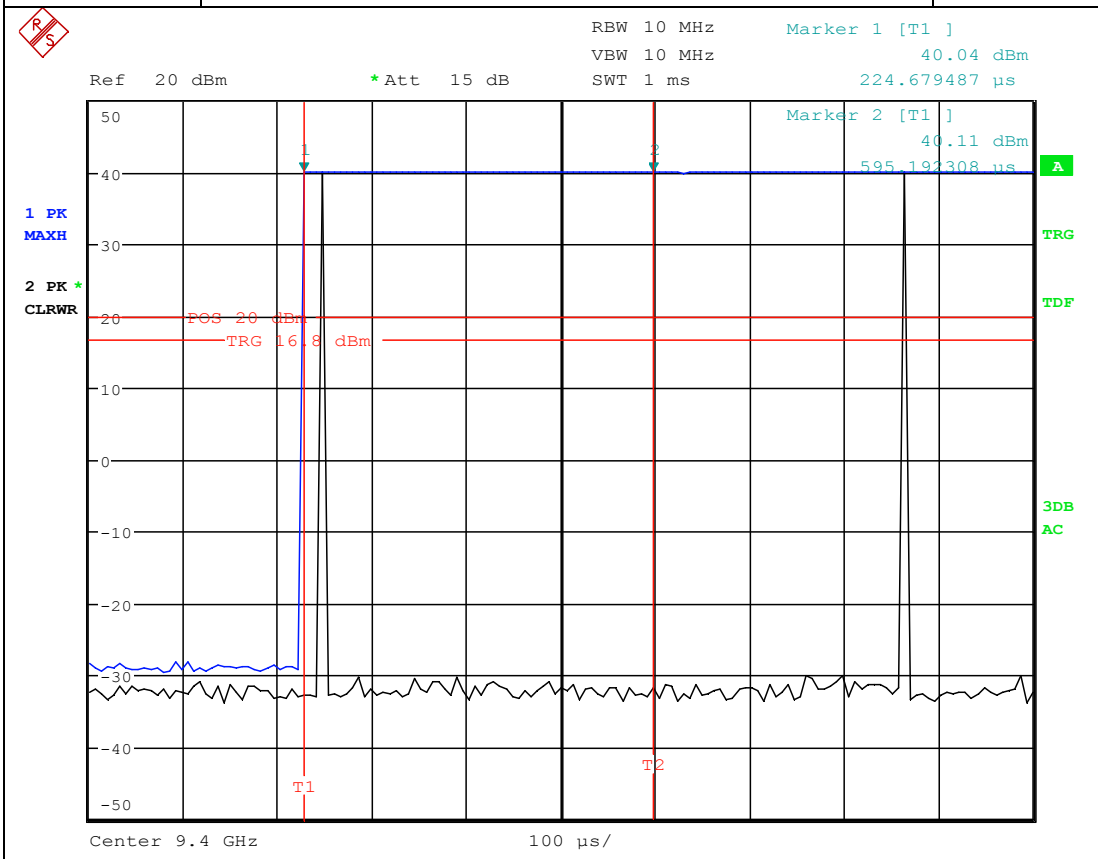
Date: 4.NOV.2015 15:58:32

Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
2	409.50	2442



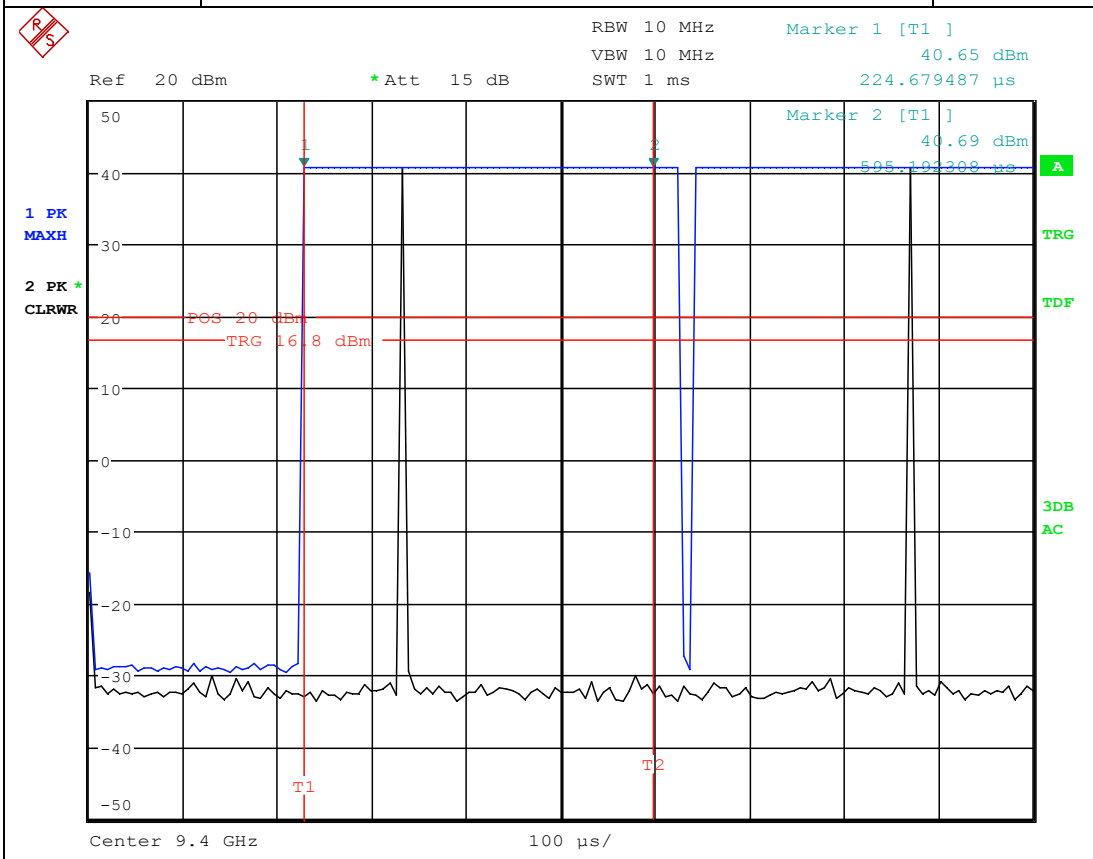
Date: 4.NOV.2015 15:58:57

Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
3	409.50	2442

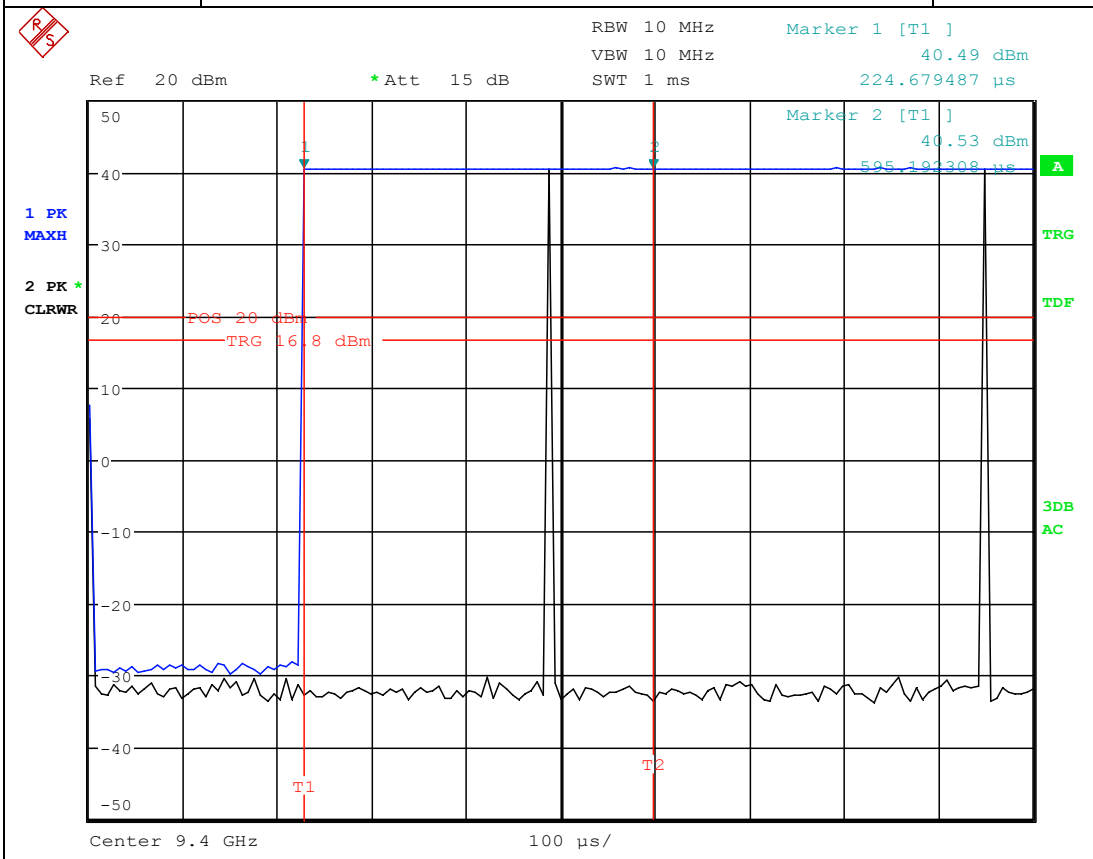


Date: 4.NOV.2015 15:59:23

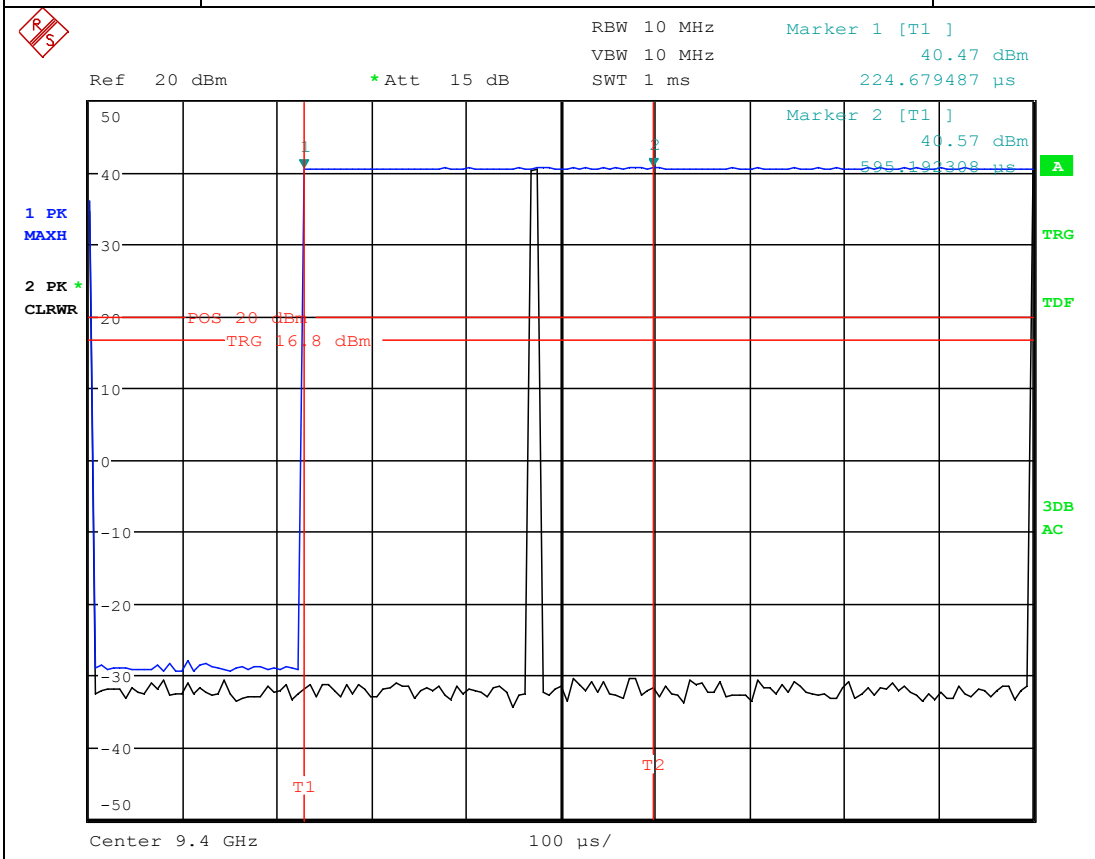
Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
4	409.50	2442



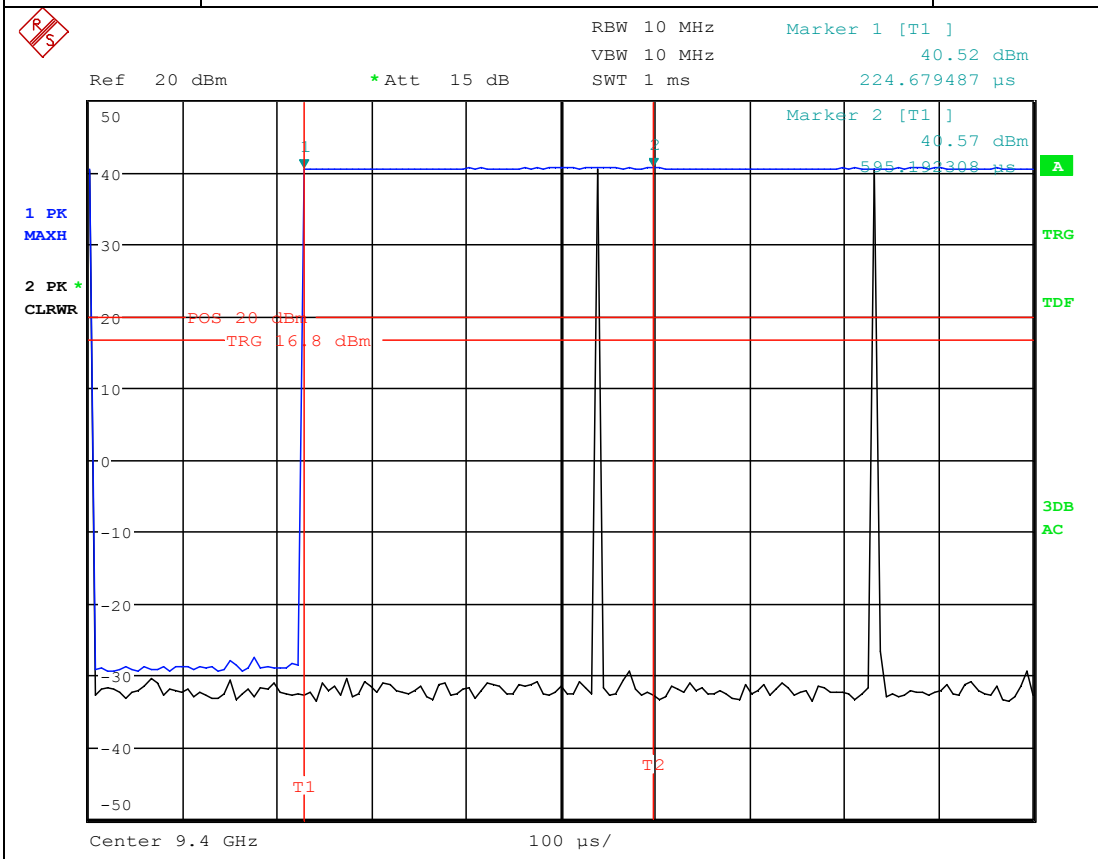
Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
5	409.50	2442



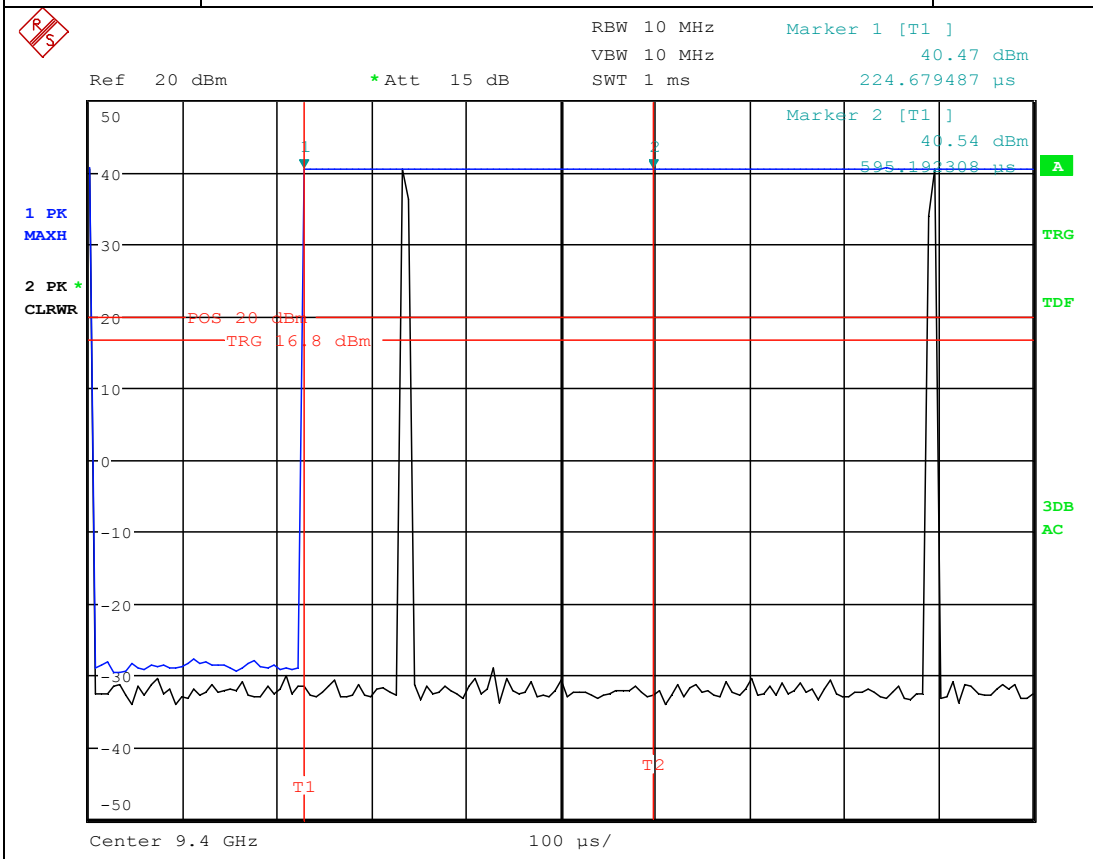
Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
6	409.50	2442



Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
7	409.50	2442

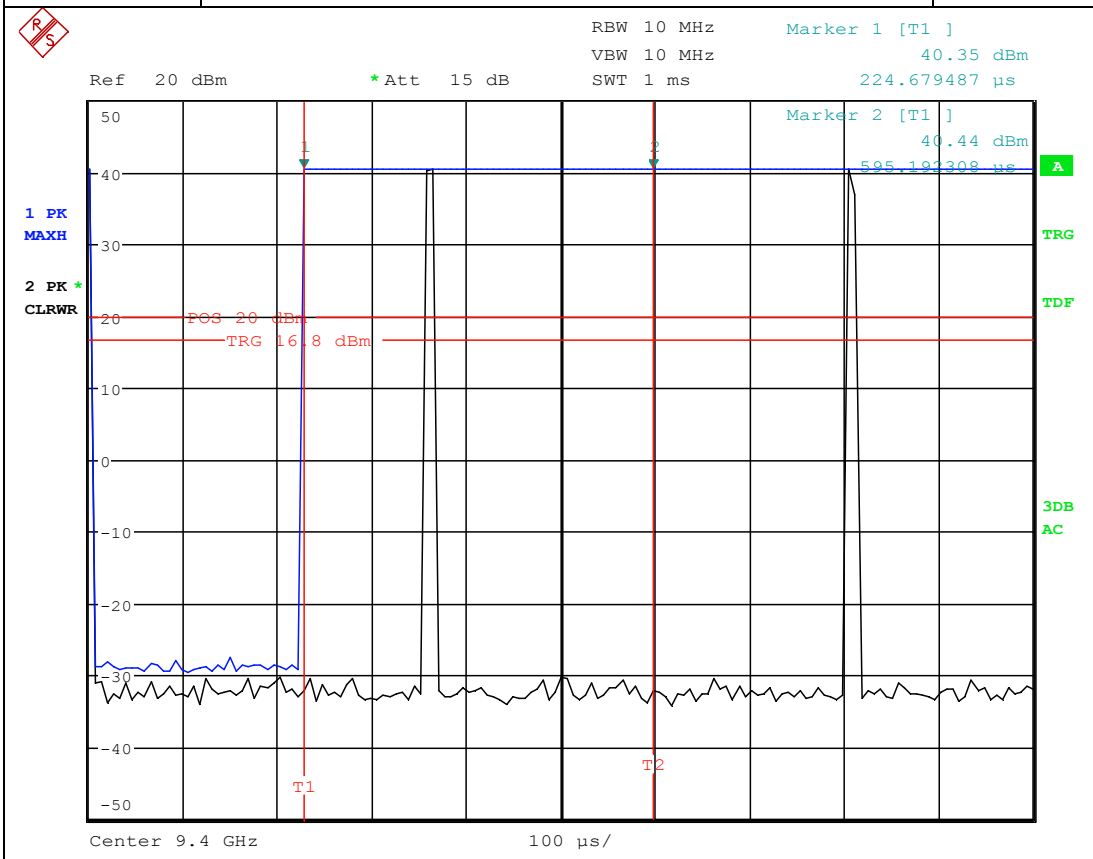


Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
8	409.50	2442



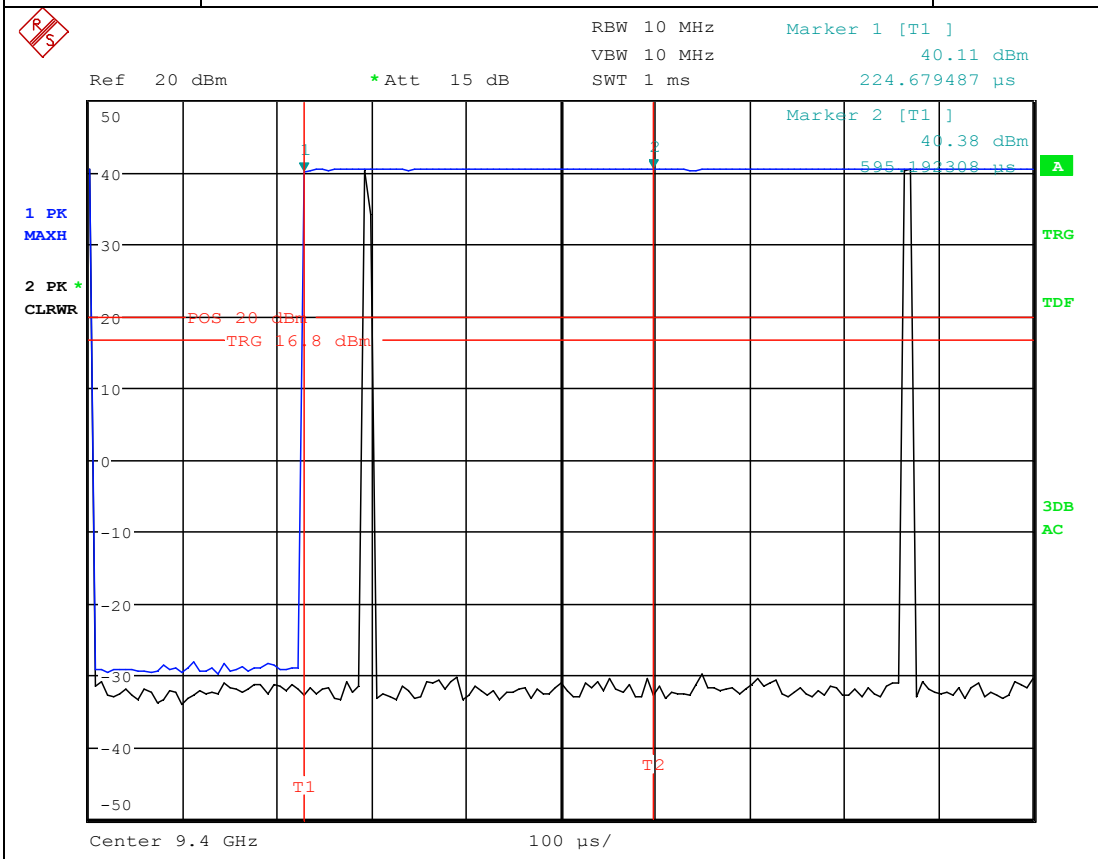
Date: 4.NOV.2015 16:01:09

Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
9	409.50	2442

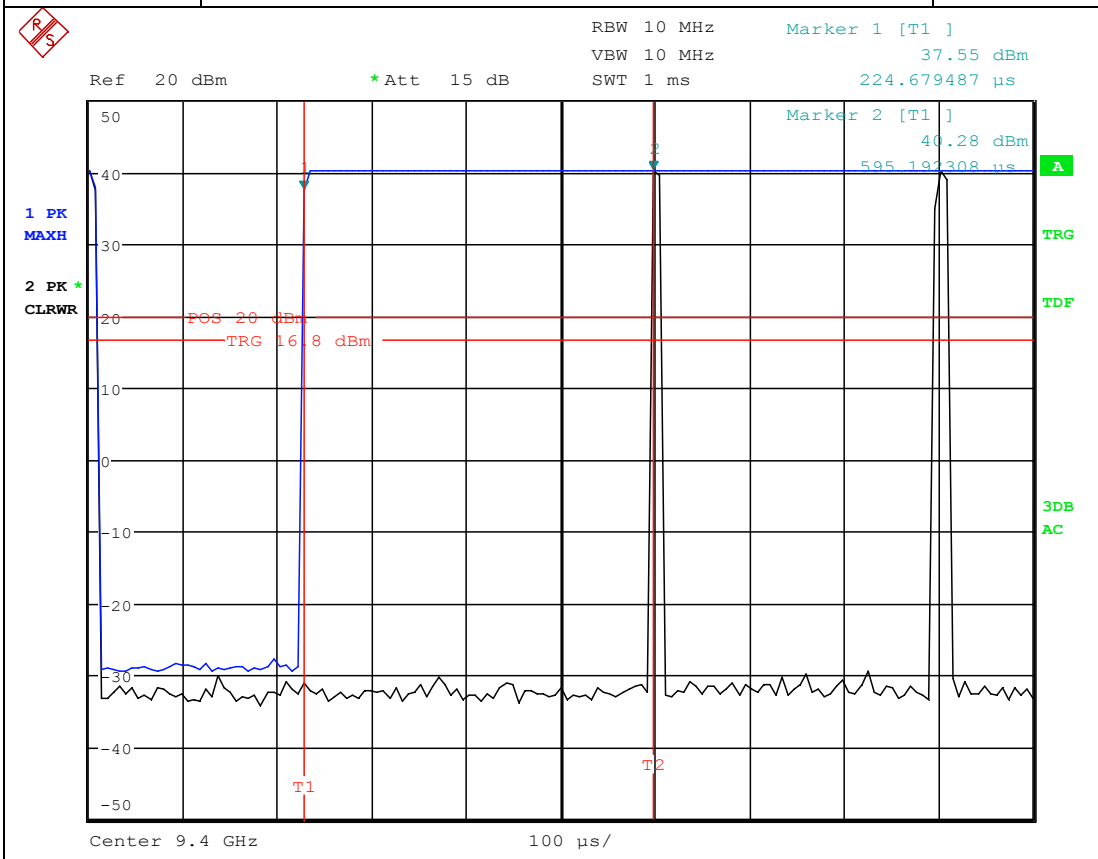


Date: 4.NOV.2015 16:01:49

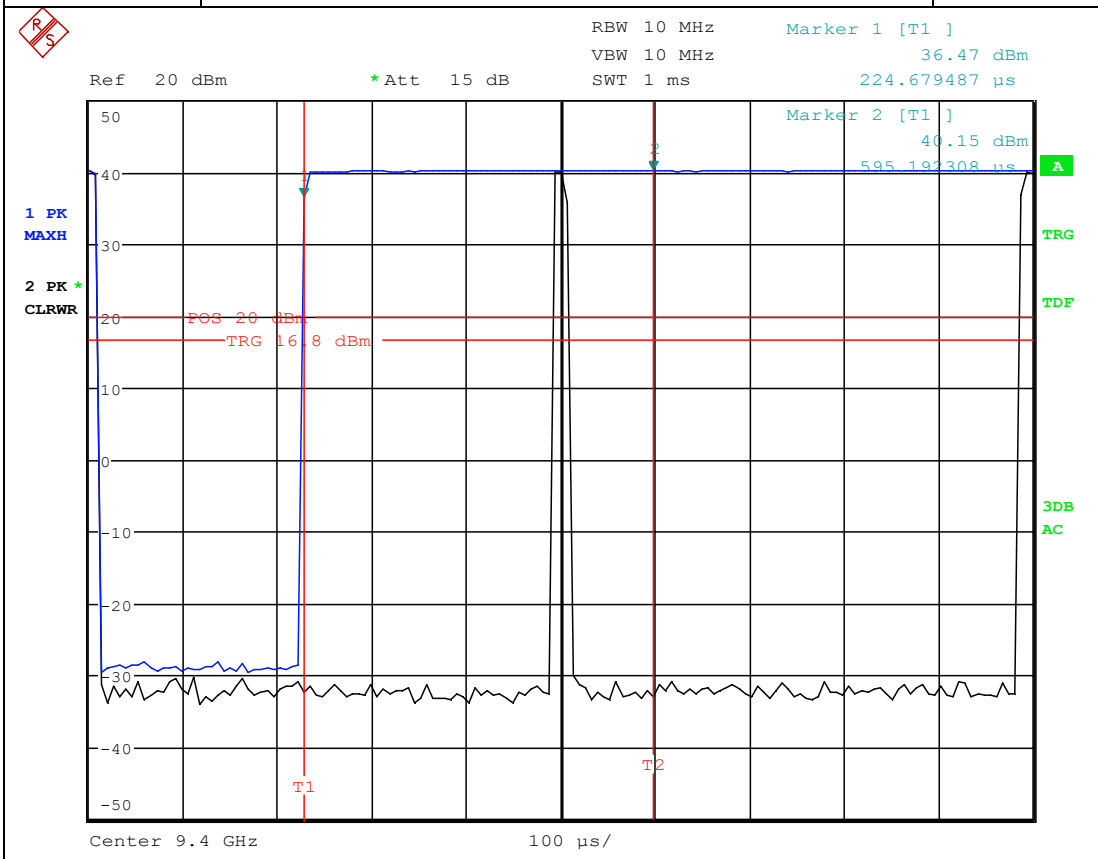
Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
10	409.50	2442



Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
11	409.50	2442

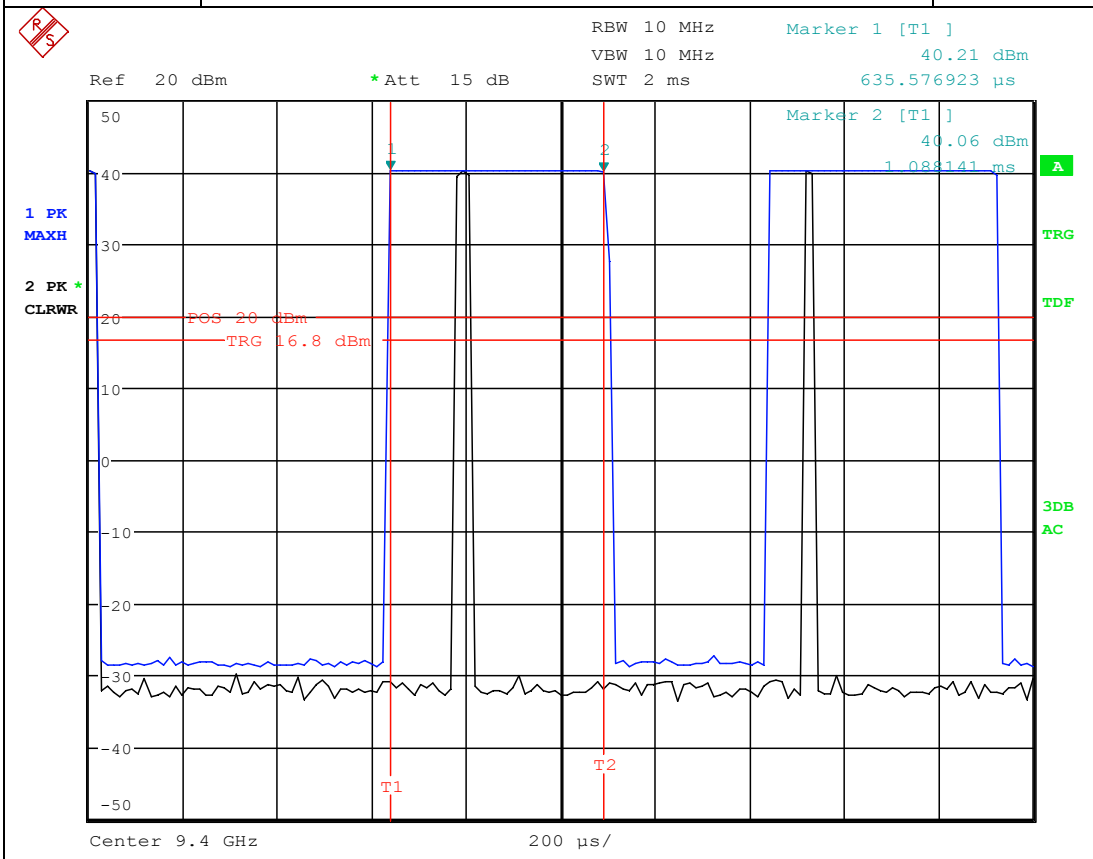


Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
12	409.50	2442

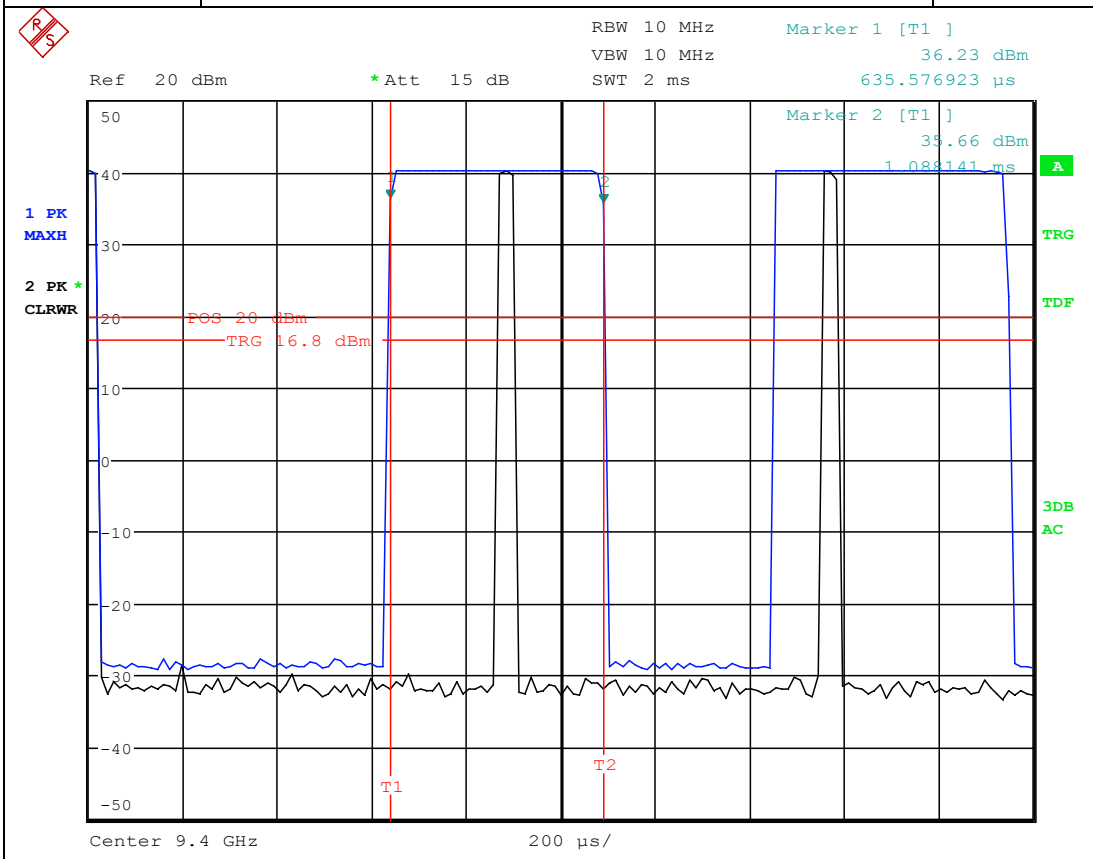


Date: 4.NOV.2015 16:02:57

Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
13	861.80	1160

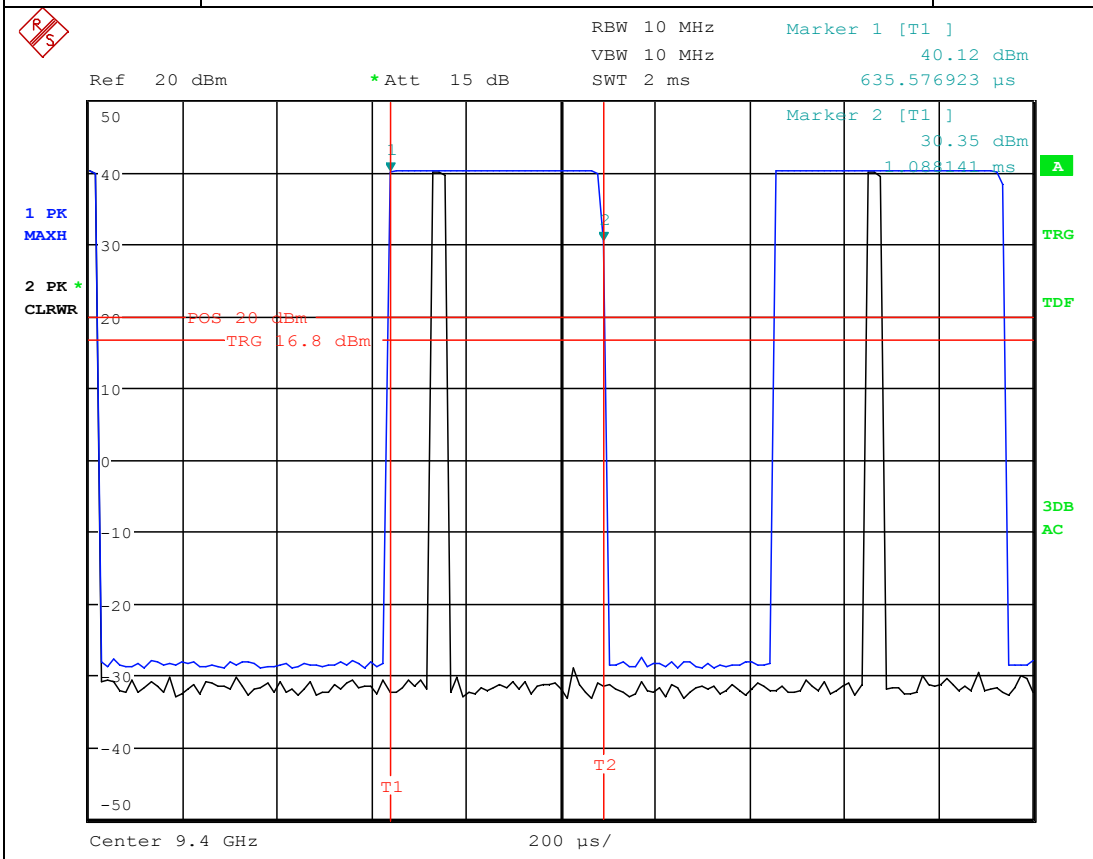


Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
14	861.80	1160



Date: 4.NOV.2015 16:05:18

Index	Pulse Repetition Time (µs)	Pulse Repetition Frequency (Hz)
15	861.80	1160



Comments: None.
Tested by: D.Jamieson
Test Date: 4th November 2015
Test Unit: 2
Test Setup: Conducted
Test Status: For declaration only.

6.7 Variation of Frequency with Voltage

Min Frequency Limit = 9.3GHz + (1.5/Pulse width (µs))
Max Frequency Limit = 9.5GHz – (1.5/Pulse width (µs))

Index	MFD Display (nm)	Pulse Width (µs)	Voltage Calc	Voltage (V)	Centre Freq (Hz)	Limit Low (Hz)	Limit High (Hz)	Result
0	0.0625	0.0376	85% of 12V	10.2	9397244490	9300000040	9499999960	PASS
			100% of 12V	12	9398246490	9300000040	9499999960	PASS
			100% of 24V	24	9398246490	9300000040	9499999960	PASS
			115% of 24V	27.6	9398747490	9300000040	9499999960	PASS
5	0.75	0.852	85% of 12V	10.2	9399749500	9300000002	9499999998	PASS
			100% of 12V	12	9400250500	9300000002	9499999998	PASS
			100% of 24V	24	9399749500	9300000002	9499999998	PASS
			115% of 24V	27.6	9399248500	9300000002	9499999998	PASS
10	4	4.66	85% of 12V	10.2	9399749500	9300000000	9500000000	PASS
			100% of 12V	12	9399749500	9300000000	9500000000	PASS
			100% of 24V	24	9399749500	9300000000	9500000000	PASS
			115% of 24V	27.6	9399749500	9300000000	9500000000	PASS
15	24	21.8	85% of 12V	10.2	9399749500	9300000000	9500000000	PASS
			100% of 12V	12	9399749500	9300000000	9500000000	PASS
			100% of 24V	24	9399749500	9300000000	9500000000	PASS
			115% of 24V	27.6	9399749500	9300000000	9500000000	PASS

Comments: A 30 minute stabilisation time was allowed after each temperature step.
Tested by: D. Jamieson
Test Date: 7th January 2016
Test Unit: 2
Test Setup: Climatic Chamber
Test Status: Pass

6.8 Variation of Frequency with Temperature

Min Frequency Limit = 9.3GHz + (1.5/Pulse width (µs))
Max Frequency Limit = 9.5GHz – (1.5/Pulse width (µs))

Index	MFD Display (nm)	Pulse Width (µs)	Temp (°C)	Centre Freq (Hz)	Limit Low (Hz)	Limit High (Hz)	Result
0	0.0625	0.0376	-25	9399751010	9300000040	9499999960	Pass
			-20	9399253020	9300000040	9499999960	Pass
			-10	9399749500	9300000040	9499999960	Pass
			0	9398246490	9300000040	9499999960	Pass
			10	9398747490	9300000040	9499999960	Pass
			20	9398747490	9300000040	9499999960	Pass
			30	9398246490	9300000040	9499999960	Pass
			40	9398747490	9300000040	9499999960	Pass
			50	9398246490	9300000040	9499999960	Pass
5	0.75	0.852	-25	9399751010	9300000002	9499999998	Pass
			-20	9399253020	9300000002	9499999998	Pass
			-10	9399749500	9300000002	9499999998	Pass
			0	9399749500	9300000002	9499999998	Pass
			10	9399749500	9300000002	9499999998	Pass
			20	9399749500	9300000002	9499999998	Pass
			30	9399749500	9300000002	9499999998	Pass
			40	9399749500	9300000002	9499999998	Pass
			50	9399749500	9300000002	9499999998	Pass
10	4	4.66	-25	9399751010	9300000000	9500000000	Pass
			-20	9399253020	9300000000	9500000000	Pass
			-10	9399749500	9300000000	9500000000	Pass
			0	9399749500	9300000000	9500000000	Pass
			10	9399749500	9300000000	9500000000	Pass
			20	9399749500	9300000000	9500000000	Pass
			30	9399749500	9300000000	9500000000	Pass
			40	9399749500	9300000000	9500000000	Pass
			50	9399749500	9300000000	9500000000	Pass
15	24	21.8	-25	9399751010	9300000000	9500000000	Pass
			-20	9399749500	9300000000	9500000000	Pass
			-10	9399749500	9300000000	9500000000	Pass
			0	9399749500	9300000000	9500000000	Pass
			10	9399749500	9300000000	9500000000	Pass
			20	9399749500	9300000000	9500000000	Pass
			30	9399749500	9300000000	9500000000	Pass
			40	9399749500	9300000000	9500000000	Pass
			50	9399749500	9300000000	9500000000	Pass

Comments: A 30 minute stabilisation time was allowed after each temperature step.
Tested by: D. Jamieson
Test Date: 7th January 2016
Test Unit: 2
Test Setup: Climatic Chamber
Test Status: Pass

6.9 Transmitter Frequency Tolerance

Index	MFD Display (nm)	Pulse Width (µs)	Test	Limit Low (Hz)	Limit High (Hz)	Worst Case Frequency deviation (Hz)	Result
0	0.0625	0.0376	Temperature Variation	9300000040	9499999960	9398246490	Pass
			Voltage Variation	9300000040	9499999960	9397244490	Pass
5	0.75	0.852	Temperature Variation	9300000002	9499999998	9399253020	Pass
			Voltage Variation	9300000002	9499999998	9399248500	Pass
10	4	4.66	Temperature Variation	9300000000	9500000000	9399253020	Pass
			Voltage Variation	9300000000	9500000000	9399749500	Pass
15	24	21.8	Temperature Variation	9300000000	9500000000	9399749500	Pass
			Voltage Variation	9300000000	9500000000	9399749500	Pass

Comments: Calculated. For more information, see above test sections 6.7 and 6.8.
Tested by: D.Jamieson
Test Date: 7th January 2016
Test Unit: 2
Test Setup: Climatic Chamber
Test Status: Pass

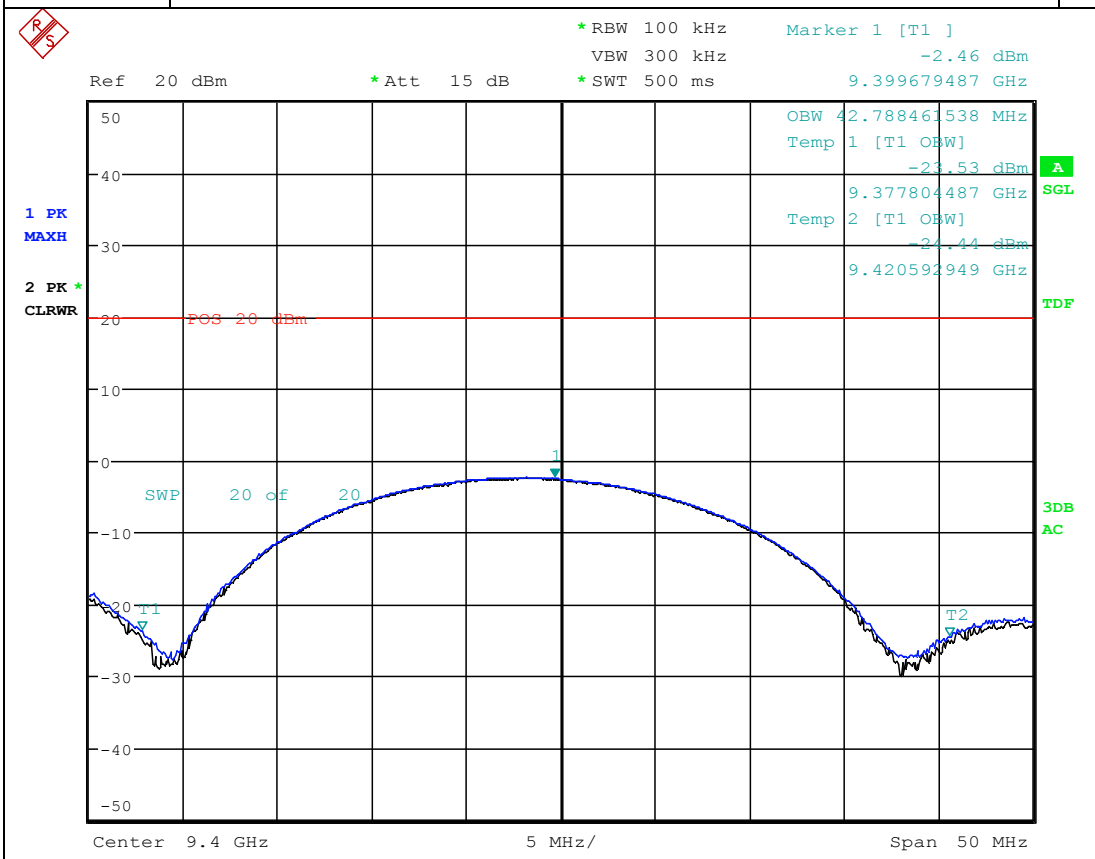
6.10 Occupied Bandwidth

6.10.1 Occupied Bandwidth – Test Summary

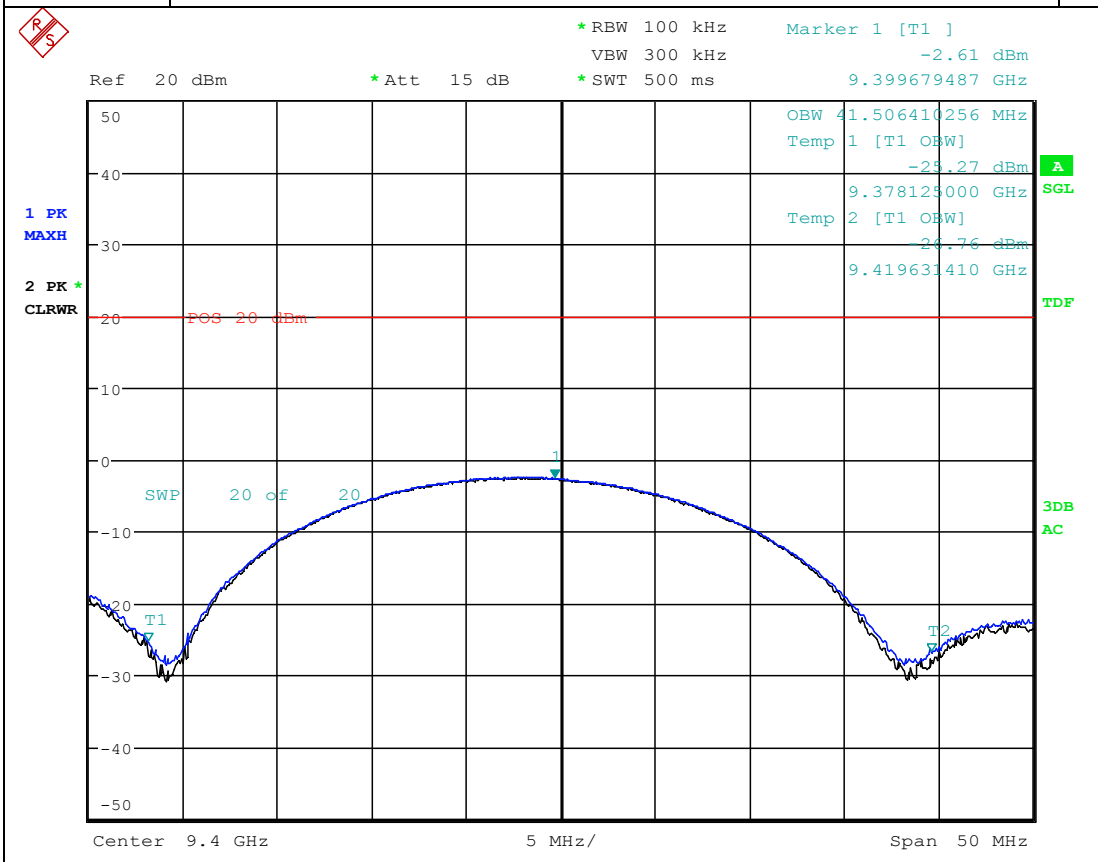
Index	MFD Display (nm)	Measured OBW (100kHz RBW) (MHz)
0	0.0625	42.788
1	0.125	41.506
2	0.25	40.865
3	0.375	27.324
4	0.5	19.071
5	0.75	13.063
6	1	9.936
7	1.5	6.651
8	2	5.048
9	3	3.446
10	4	2.564
11	6	1.763
12	8	1.282
13	12	0.946
14	16	0.753
15	24	0.753

6.10.2 Occupied Bandwidth – Plots

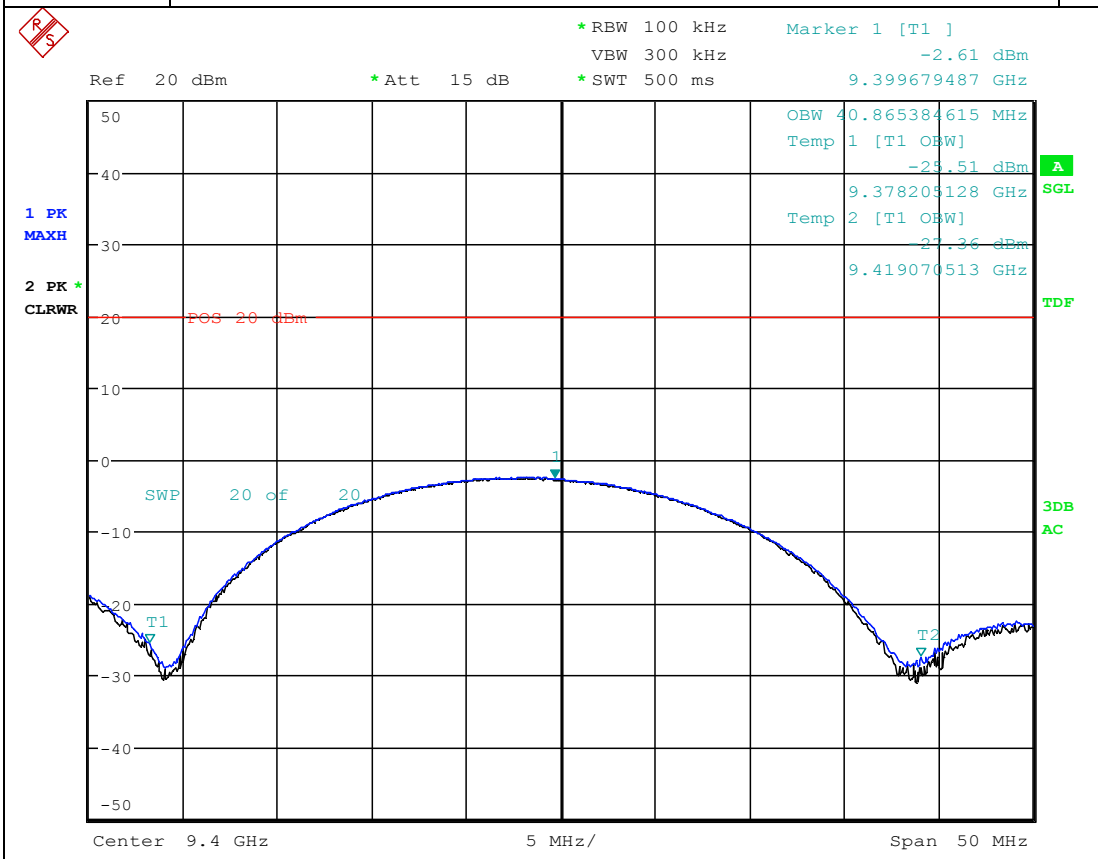
Index		Occupied Bandwidth (MHz)
0		42.788



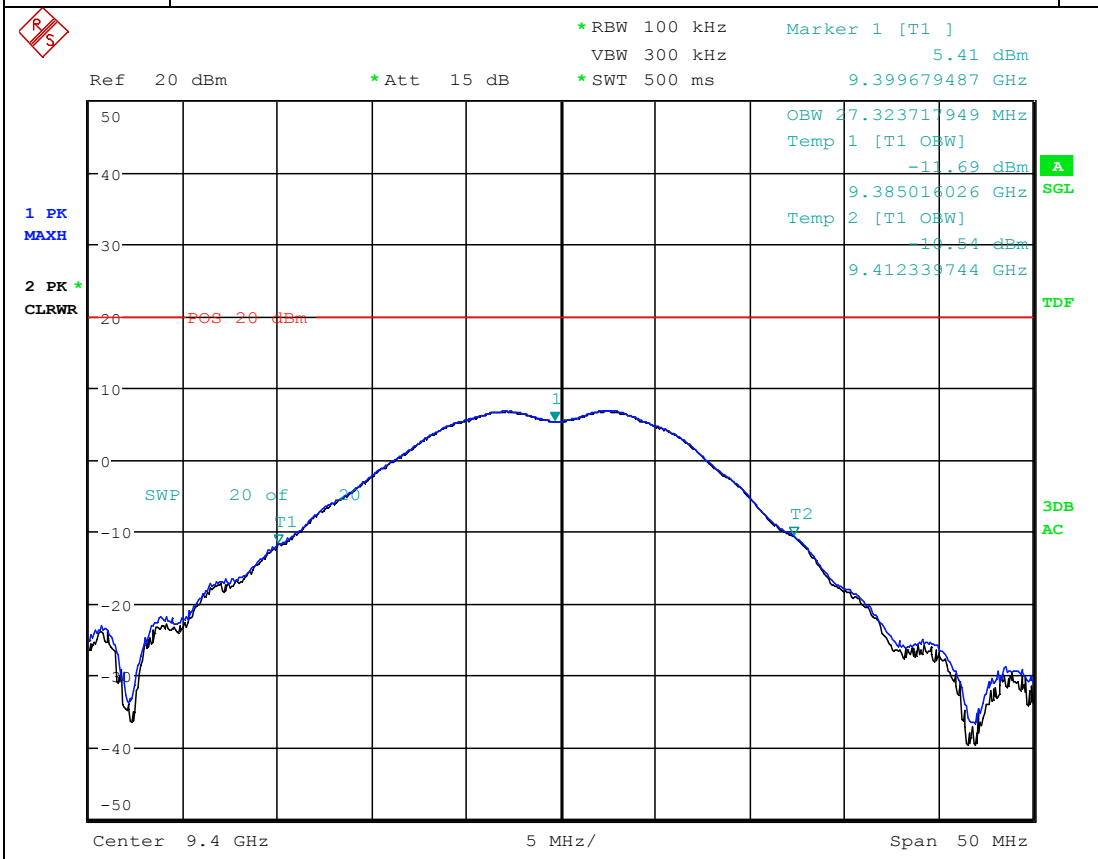
Index		Occupied Bandwidth (MHz)
1		41.506



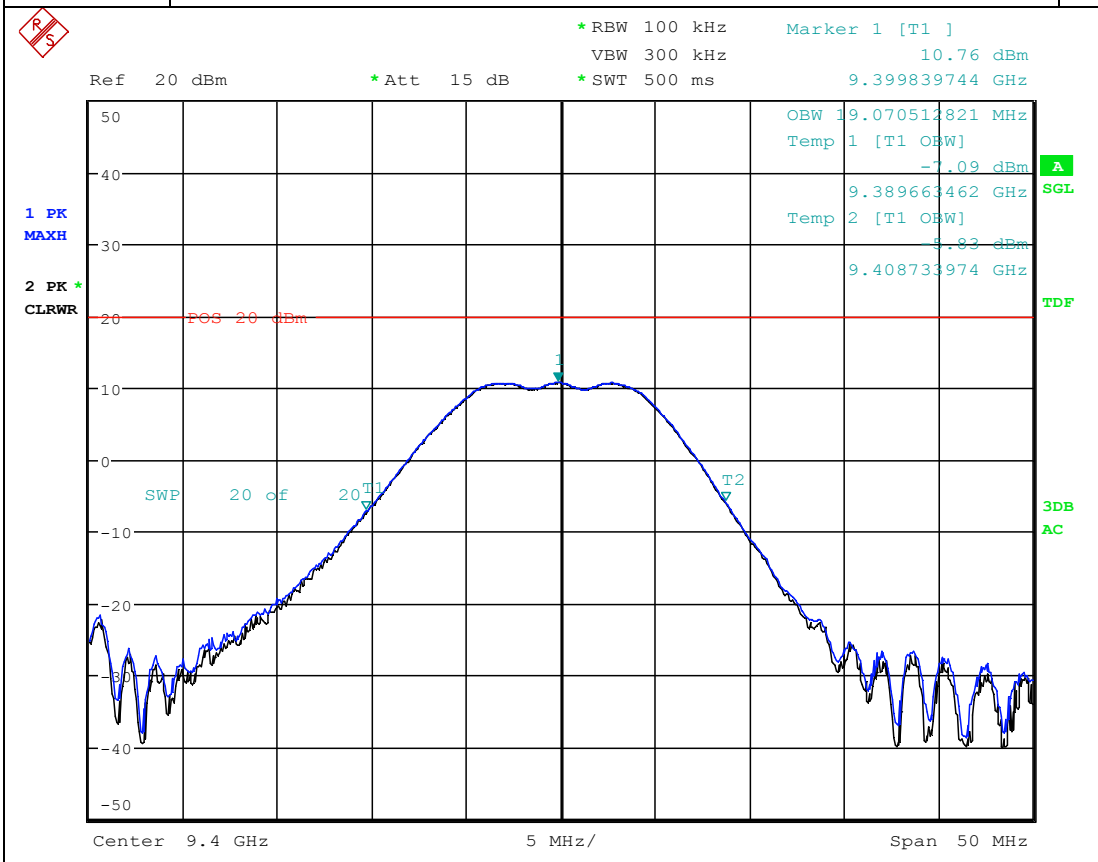
Index		Occupied Bandwidth (MHz)
2		40.865



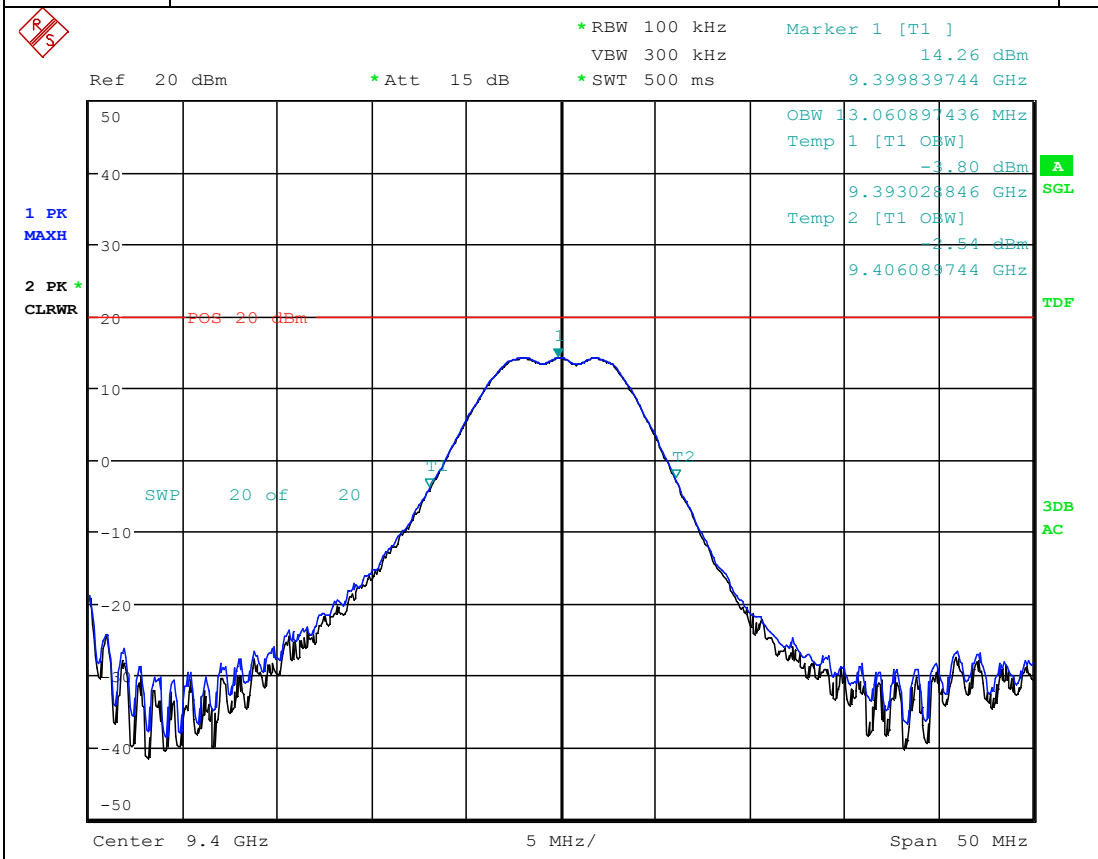
Index		Occupied Bandwidth (MHz)
3		27.324



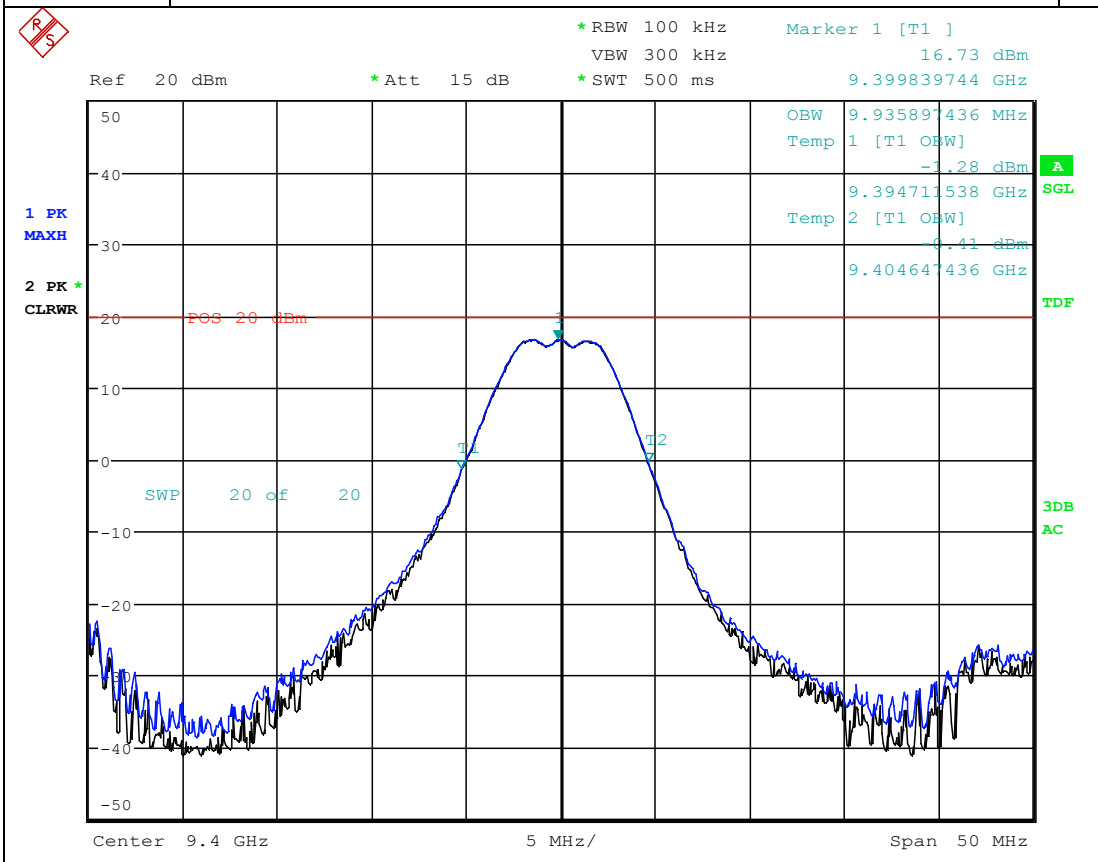
Index		Occupied Bandwidth (MHz)
4		19.071



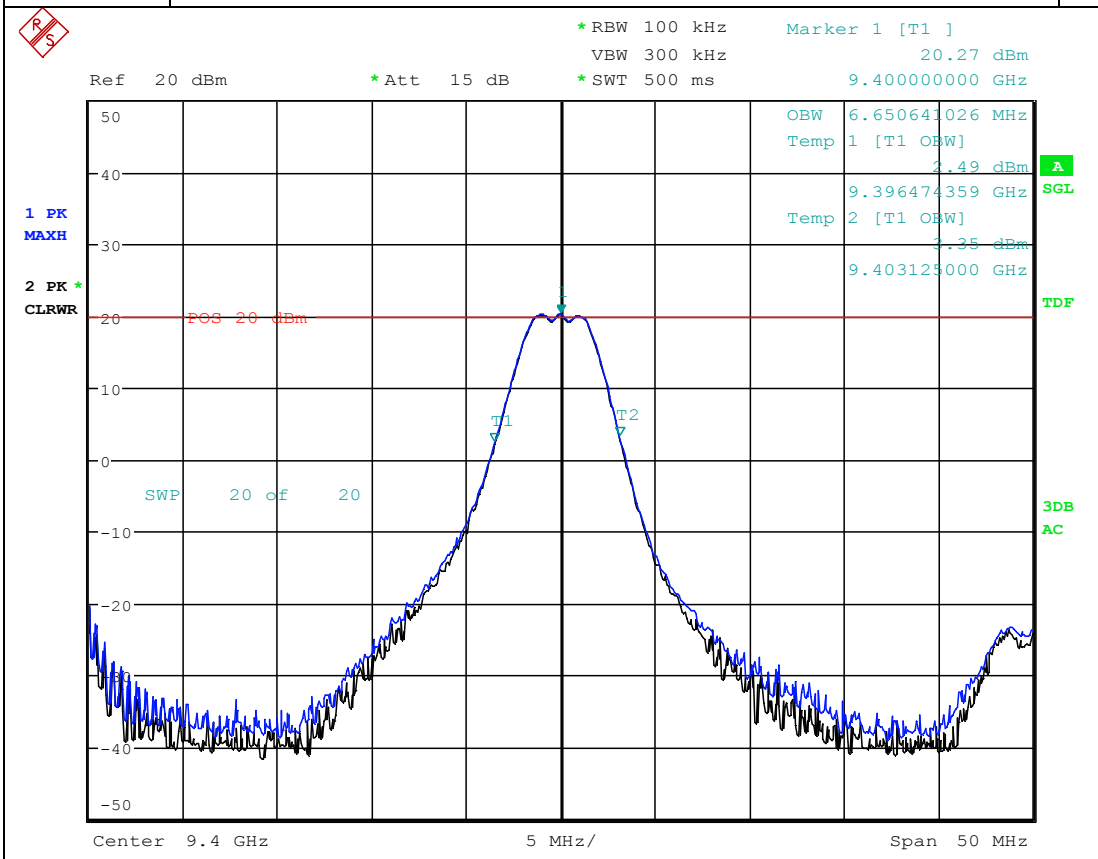
Index		Occupied Bandwidth (MHz)
5		13.063



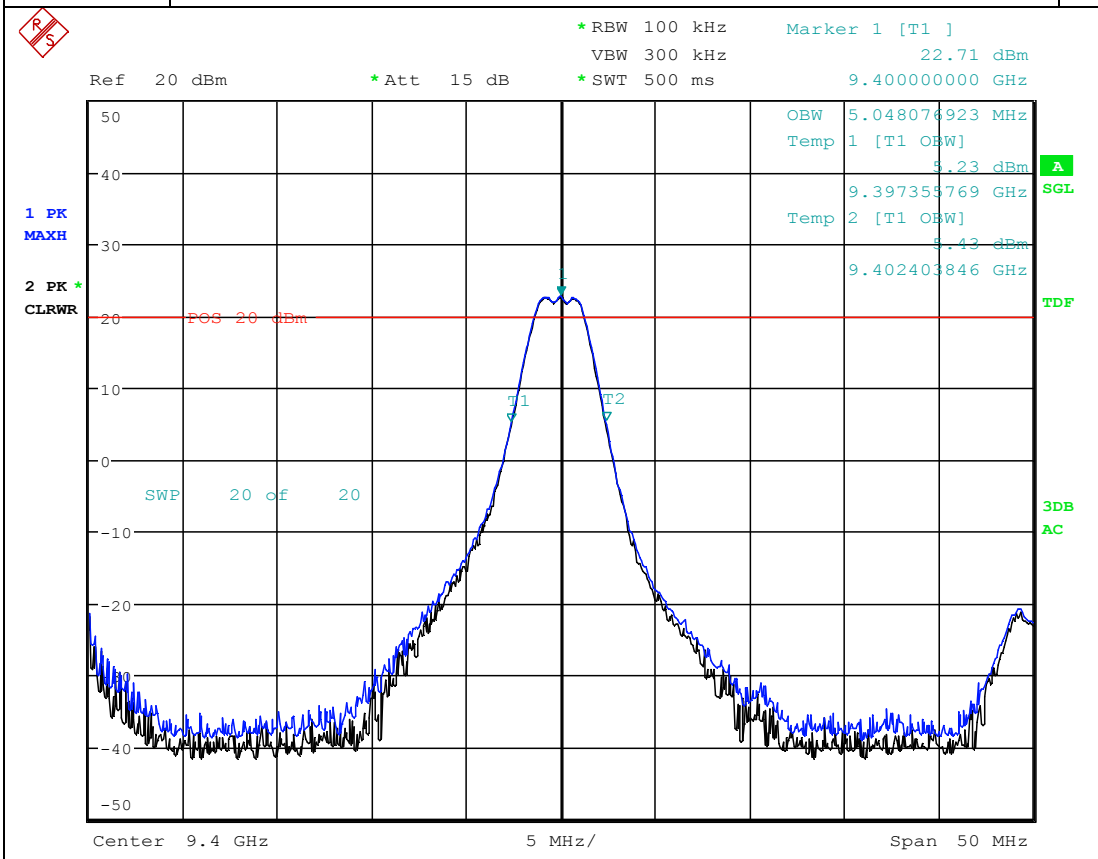
Index		Occupied Bandwidth (MHz)
6		9.936



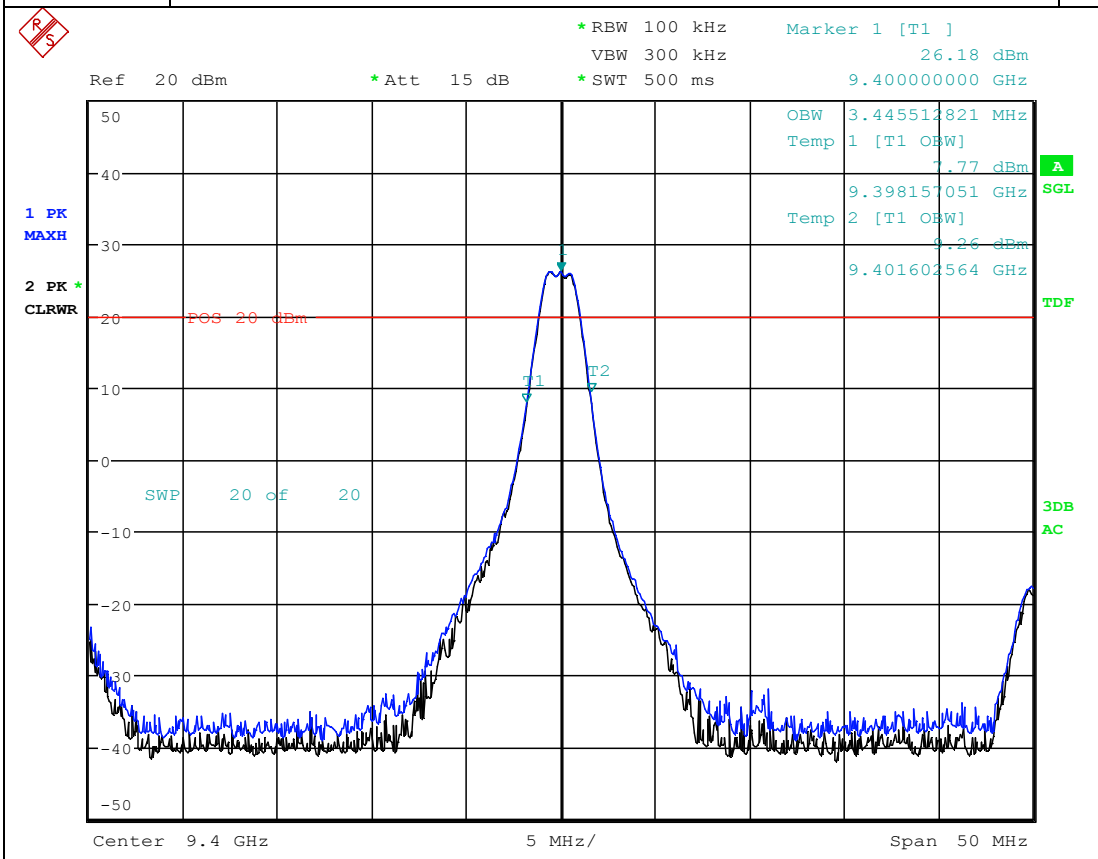
Index		Occupied Bandwidth (MHz)
7		6.651



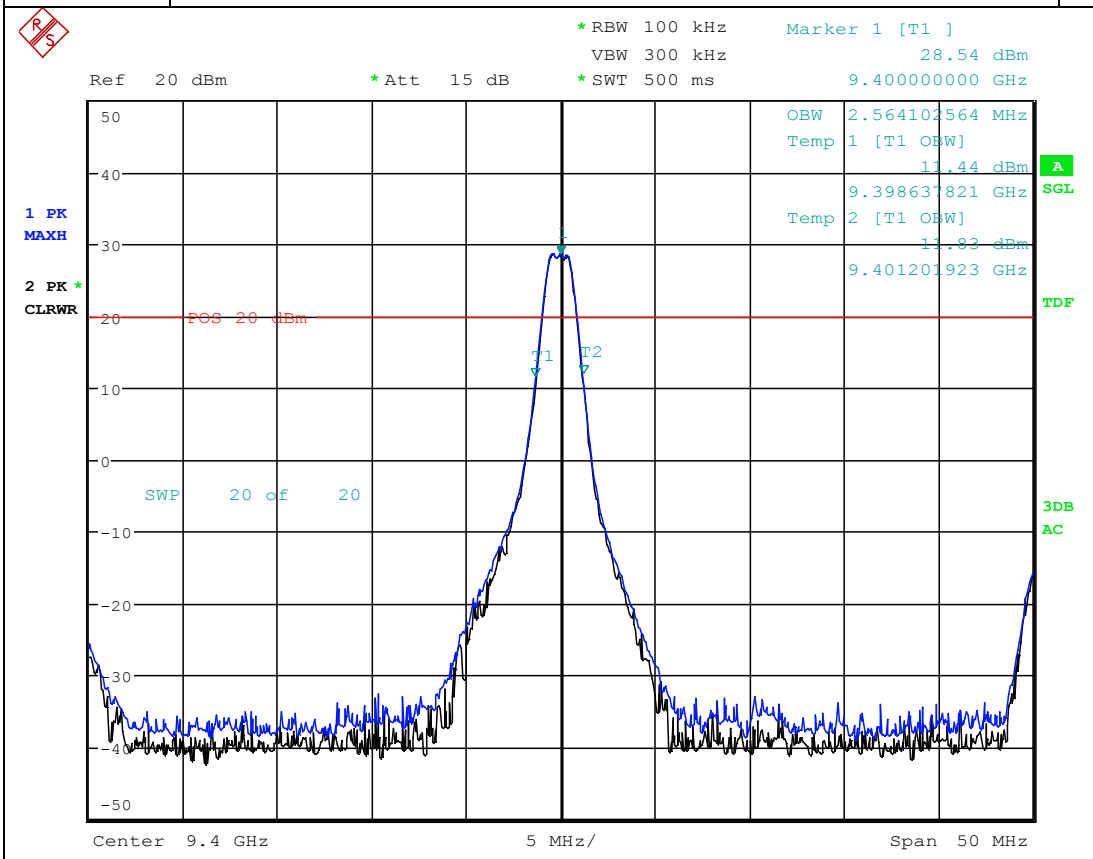
Index		Occupied Bandwidth (MHz)
8		5.048



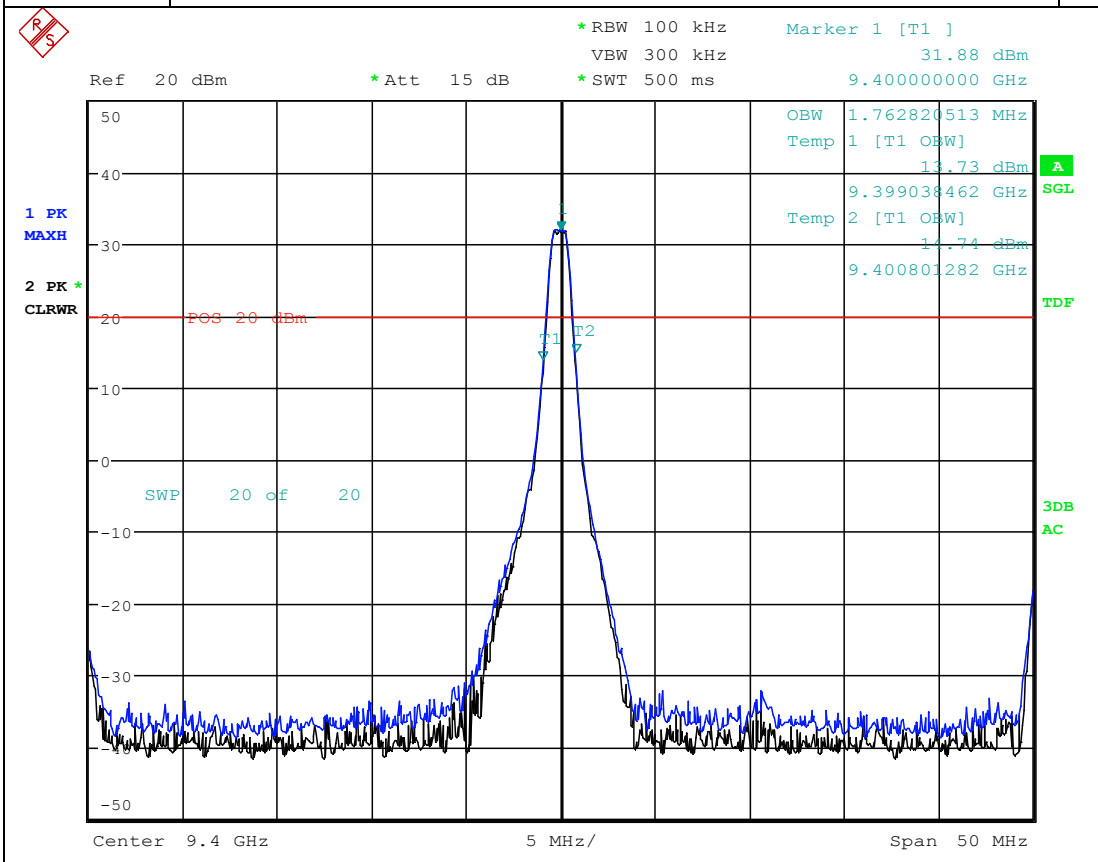
Index		Occupied Bandwidth (MHz)
9		3.446



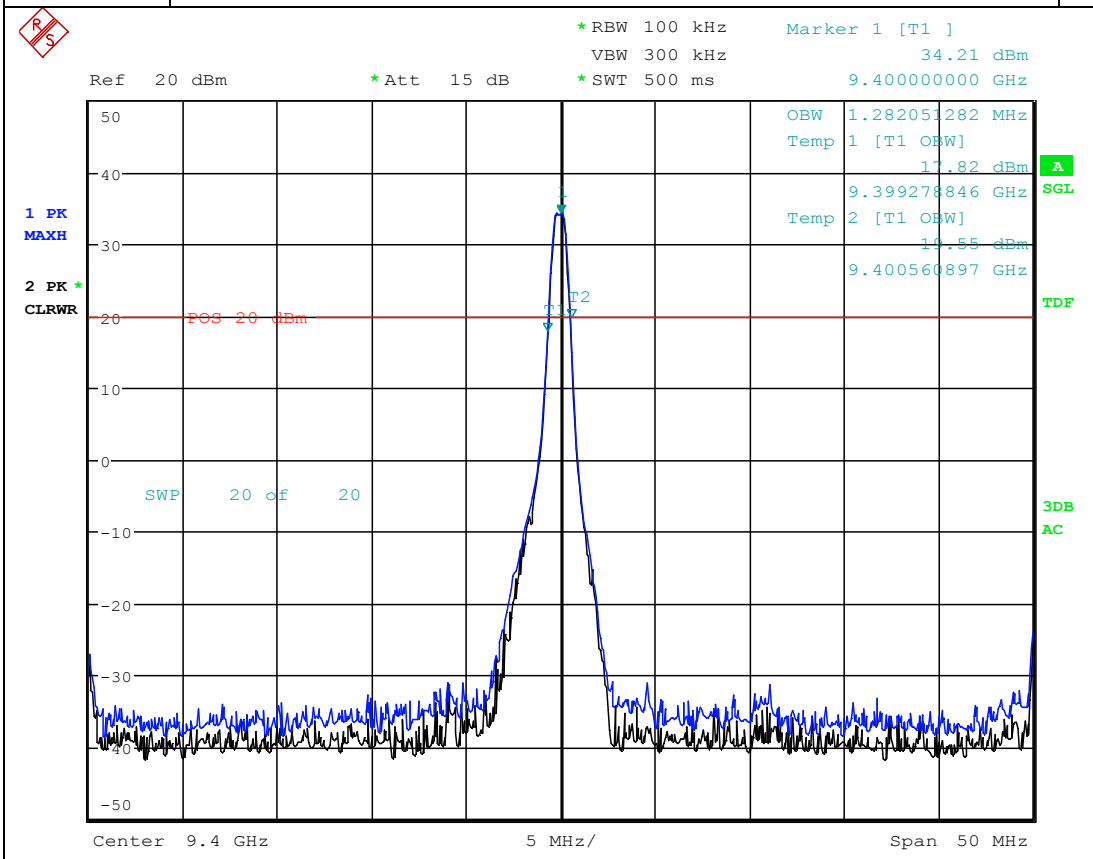
Index		Occupied Bandwidth (MHz)
10		2.564



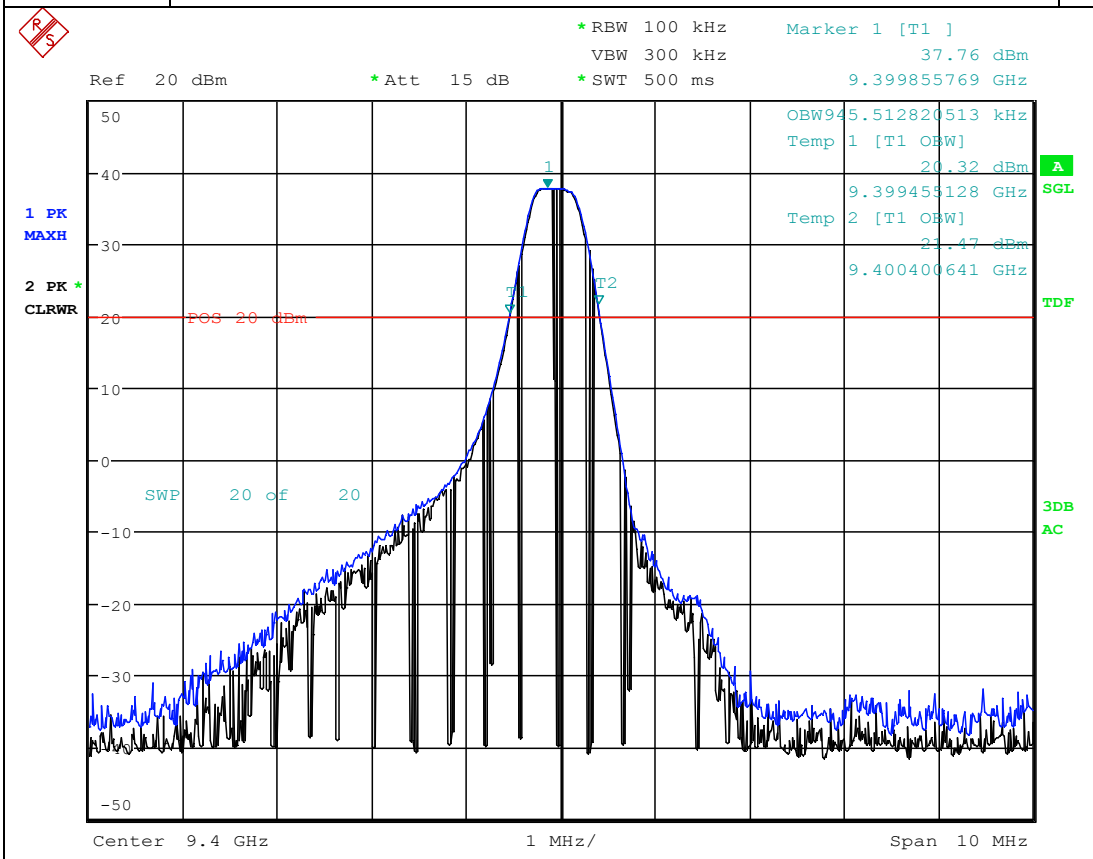
Index		Occupied Bandwidth (MHz)
11		1.763



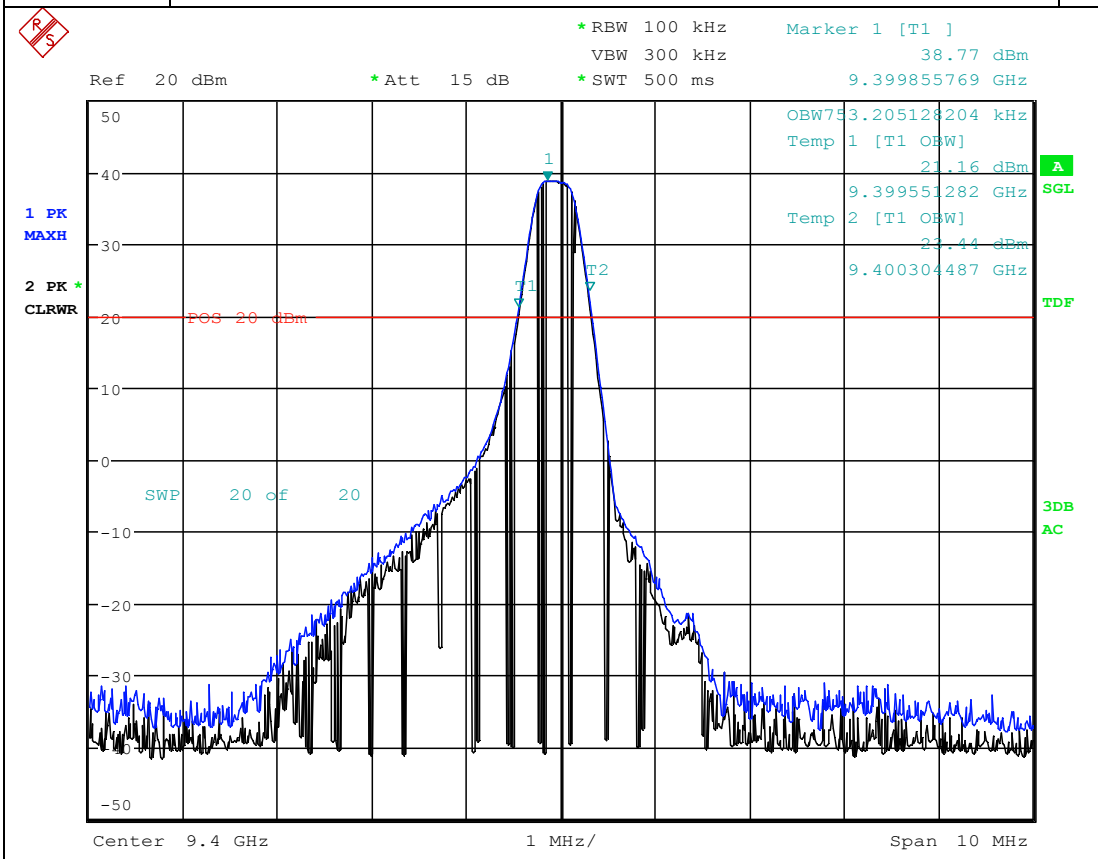
Index		Occupied Bandwidth (MHz)
12		1.282



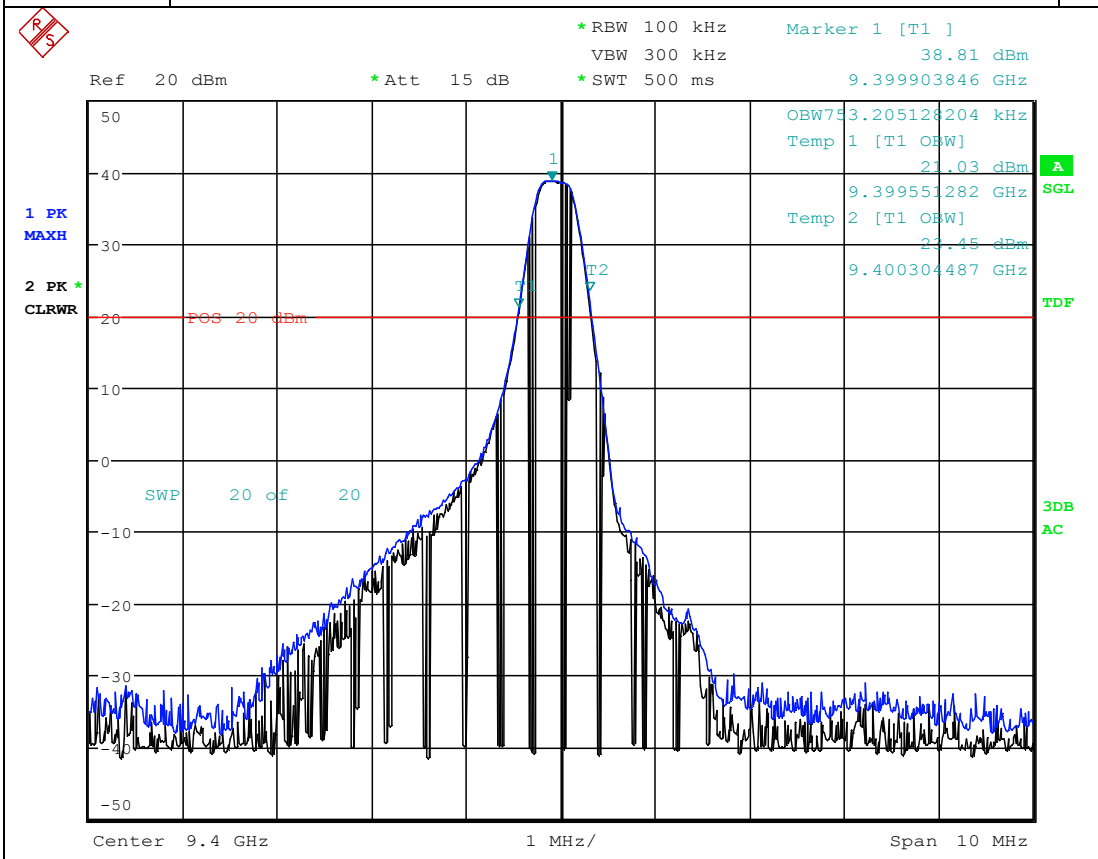
Index		Occupied Bandwidth (MHz)
13		0.946



Index		Occupied Bandwidth (MHz)
14		0.753



Index		Occupied Bandwidth (MHz)
15		0.753



Comments: None.
Tested by: D.Jamieson
Test Date: 4th November 2015
Test Unit: Unit 2
Test Setup: Conducted
Test Status: For declaration only.

6.11 Suppression of Interference Aboard Ships

6.11.1 Limit

10kHz to 2GHz: FCC limit for radiated emissions to 15.209(a) used.
2GHz to 40GHz: Conducted measurement with below limit:

Conducted Limit:

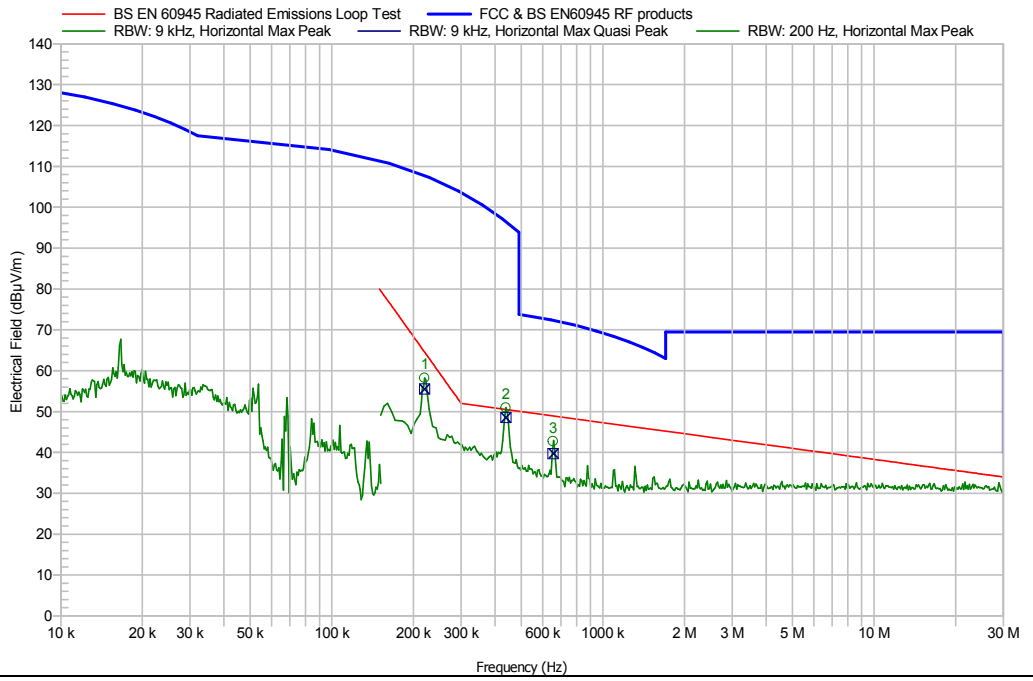
	Power to artificial antenna	
Frequency Range	**(µW)**	**dBm**
300MHz to 40GHz	400000	26.02

6.11.2 Results Summary

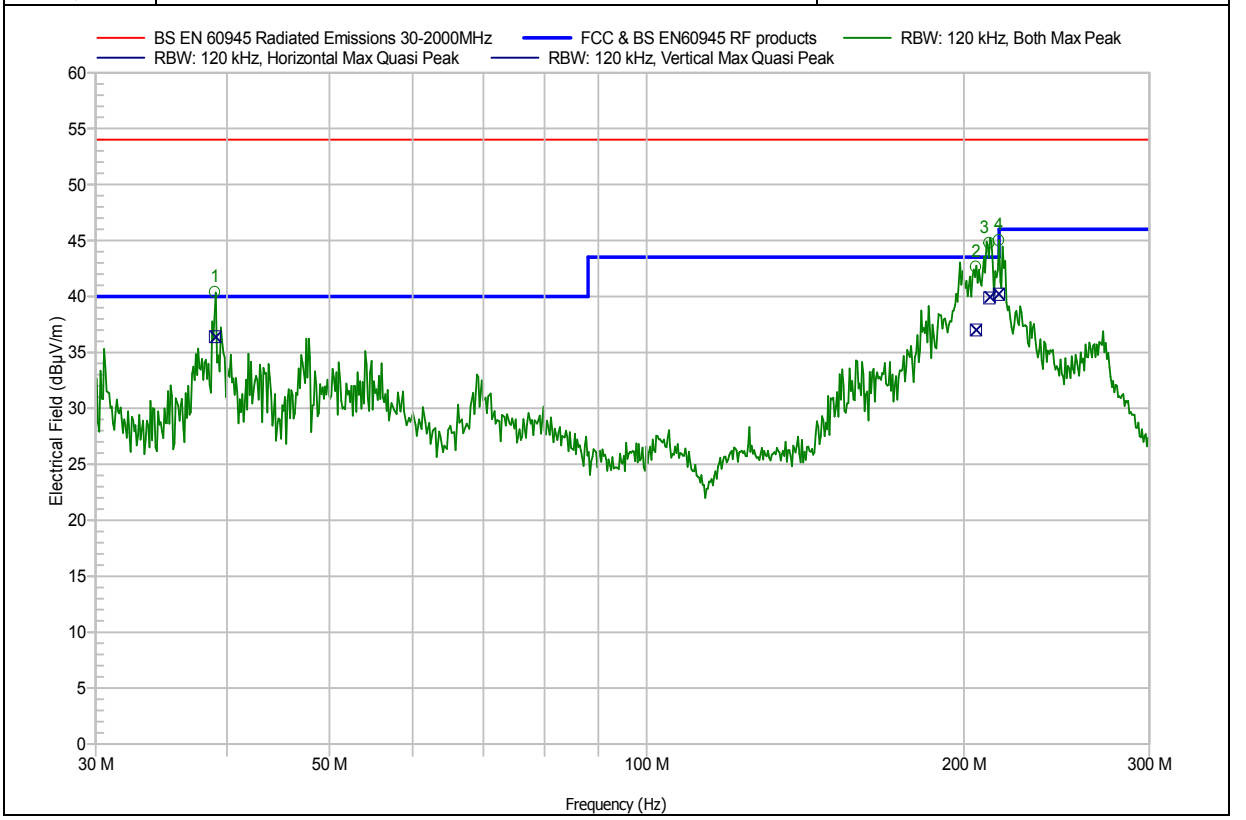
Frequency Range	Result
10kHz to 30MHz	Pass
30MHz to 300MHz	Pass
300MHz to 1GHz	Pass
1GHz to 2GHz	Pass
2GHz to 40GHz	Pass

6.11.3 Plots

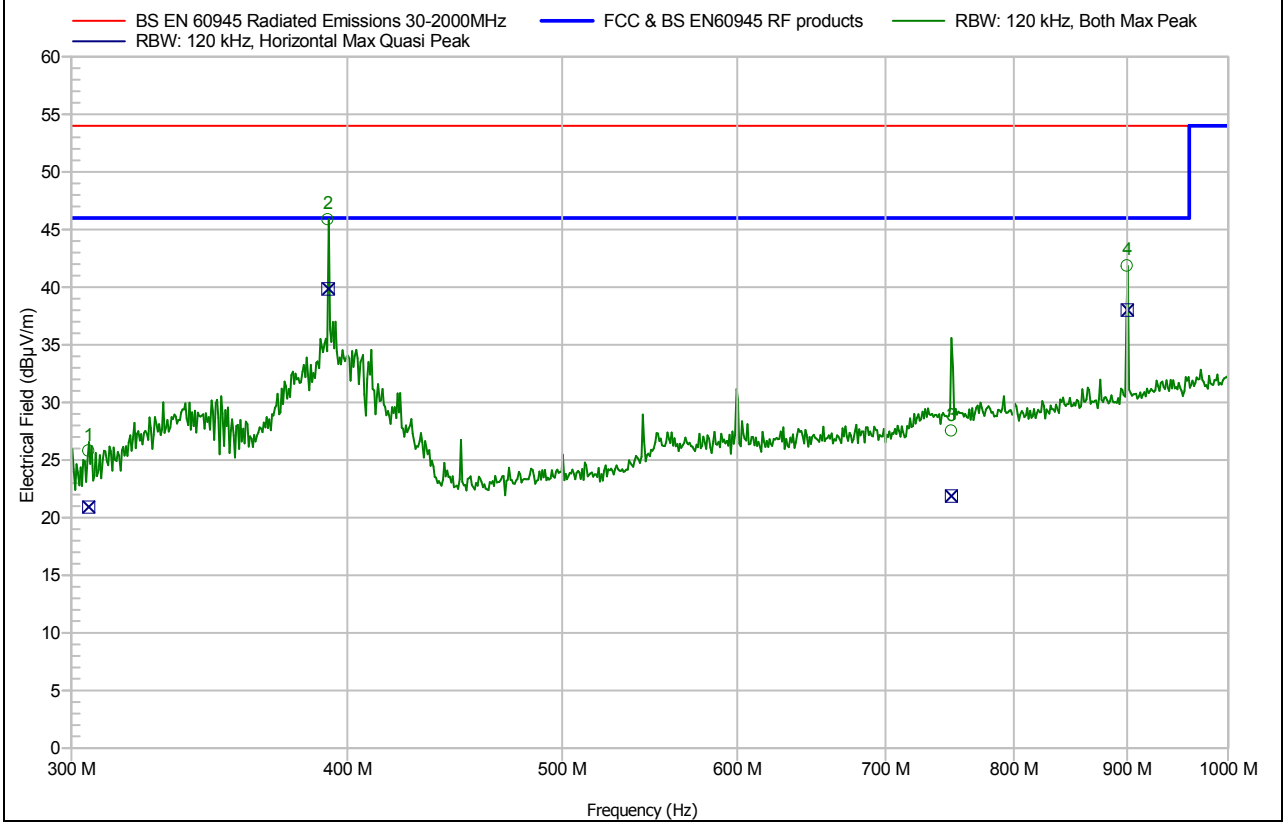
Index	Unit with radar Tx terminated	Frequency Range
N/A		10kHz to 30MHz



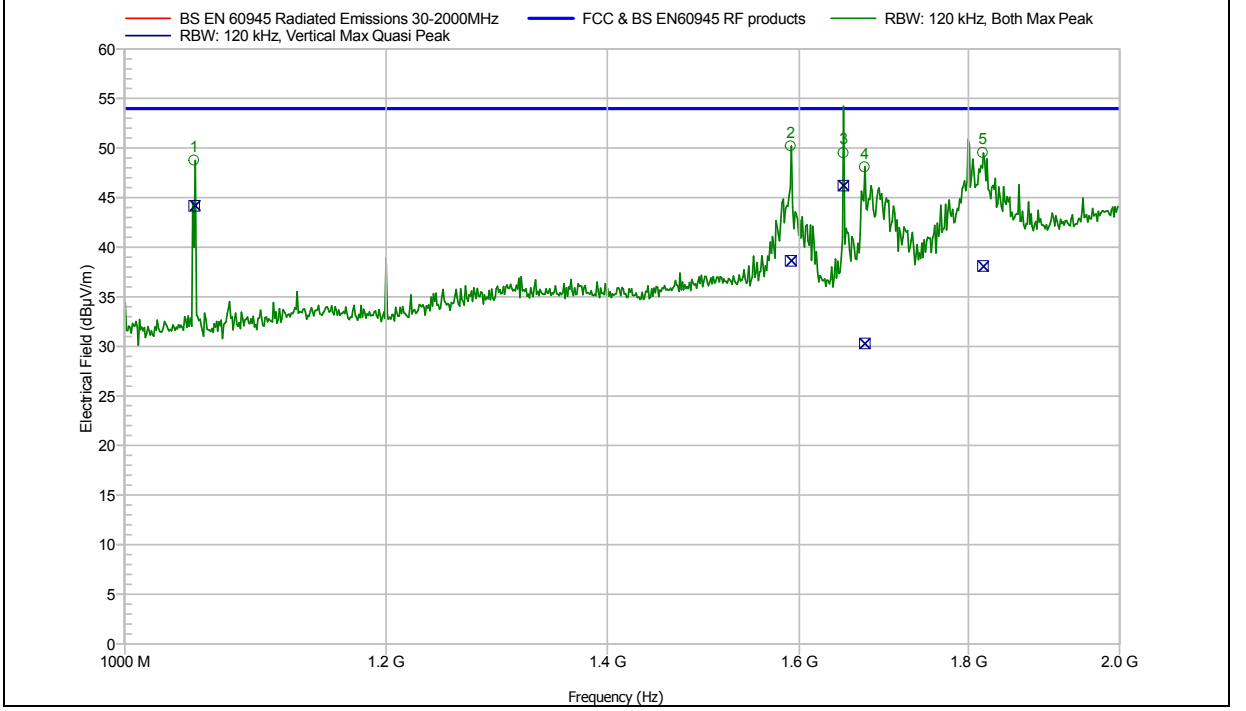
Index	Unit with radar Tx terminated	Frequency Range
N/A		30MHz to 300MHz



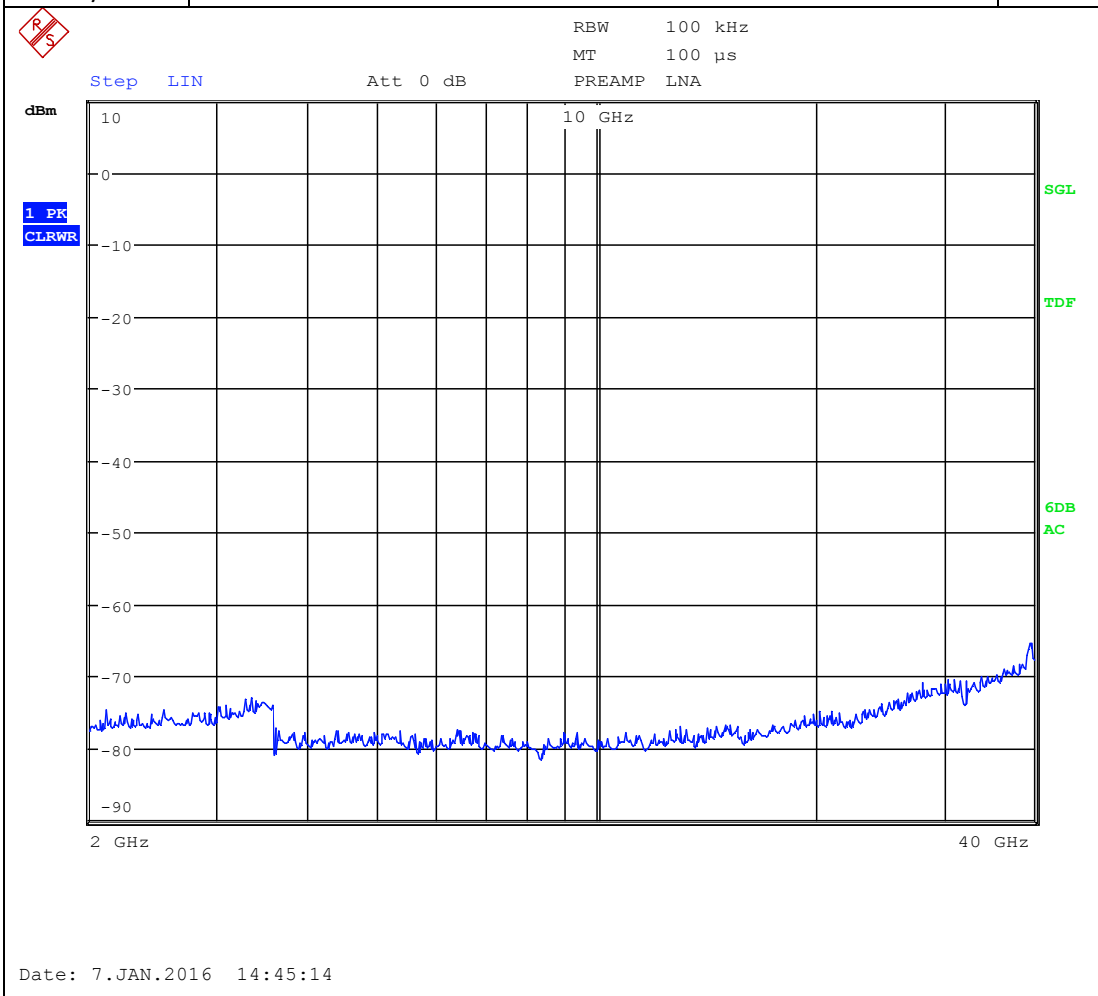
Index	Unit with radar Tx terminated	Frequency Range
N/A		300MHz to 1GHz



Index	Unit with radar Tx terminated	Frequency Range
N/A		1GHz to 2GHz



Index	Unit in Standby	Frequency Range
N/A		2GHz to 40GHz



Note that 30dB external attenuation was used, and that this, along with the cable factor, were not accounted for. The cable factor maximum loss was 12dB.

Comments: None.
Tested by: D.Jamieson
Test Date: Radiated: 9th to 10th September 2015. Conducted: 7th January 2016
Test Unit: Radiated = Unit 1; Conducted = Unit 2
Test Setup: Radiated and Conducted
Test Status: For declaration only.

7 List of Test Equipment

7.1 Radiated Spurious Emissions

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Test Site 1- S/A Chamber	Global EMC		Site 1 - GE004_AC3	02074	01/12/2017
Antenna Mast (4m)	Inn-co GmbH MM4000		MM4000/056/13750806/L	02075	Cal not required
Turntable Site 4	Inn-co GmbH DS1200S		DS1200S/175/13750806/L	02076	Cal not required
Mast/Turntable Controller Site 4	Inn-co GmbH Co 2000		CO/2000/359/137/50806/L	02077	Cal not required
Computer (Site 1)	HP Compaq dc7800p CMT		CZC8170C7M	N/A	Cal not required
Emissions Software	DARE! RadiMation v5.3.18		N/A	N/A	Cal not required
EMI Receiver 9kHz-3GHz	ESCI		100416	01692	19/02/2016
Antenna 30-2000MHz	Chase	CBL6141	22932	01802	24/07/2016
Loop Antenna 9khz - 30MHz	Chase	HLA6120	1122	00442	20/03/2016
Loop Power Supply	Chase	CBP9720	1076	00450	Not Calibrated
Power Supply Unit	Palstar	PS30M	130348923	01218	Not Calibrated
Digital Multimeter	Fluke	115	96520337	02249	15/01/2016
Power Supply Unit	Palstar	PS-06	130616126	01936	Not Calibrated
EMI Receiver 20Hz to 40GHz	Rohde & Schwarz	ESU40	100017	01721	15/04/2016
Antenna Horn 1-18GHz	Chase	BBHA9120D	9120D-128	00852	16/11/2017
Antenna Horn 18GHz-26GHz	Credowan 20-R-2843-0007		36755	00482	03/12/2017
Antenna Horn 26GHz-40GHz	Credowan	CRW 26-40	108335	00483	03/12/2017

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.2 Conducted Spurious Emissions

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Power Supply Unit	Thurlby Thandar	CPX 200	98733	00320	Cal not required
EMI Receiver 20Hz to 40GHz	Rohde & Schwarz	ESU40	100017	01721	15/04/2016

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.3 RF Output Power – Peak Power

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Peak Power Analyser	Hewlett-Packard	8991A	3248A00128	00318	06/01/2016
Peak Power Sensor	Hewlett-Packard	84812A	3318A01050	00479	06/01/2016
Power Supply Unit	Palstar	PS30M	G290775402	02021	Not calibrated

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.4 RF Output Power - Average

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Peak Power Analyser	Hewlett-Packard	8991A	3248A00128	00318	06/01/2016
Peak Power Sensor	Hewlett-Packard	84812A	3318A01050	00479	06/01/2016
Power Supply Unit	Palstar	PS30M	G290775402	02021	Not calibrated
EMI Receiver 9kHz-26.5GHz	Rohde & Schwarz	ESI26	832692/006	00886	23/11/2016

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.5 RF Output Power – Pulse Width

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Peak Power Analyser	Hewlett-Packard	8991A	3248A00128	00318	06/01/2016
Peak Power Sensor	Hewlett-Packard	84812A	3318A01050	00479	06/01/2016
Power Supply Unit	Palstar	PS30M	G290775402	02021	Not calibrated
EMI Receiver 9kHz-26.5GHz	Rohde & Schwarz	ESI26	832692/006	00886	23/11/2016

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.6 RF Output Power – Pulse Repetition Frequency

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Peak Power Analyser	Hewlett-Packard	8991A	3248A00128	00318	06/01/2016
Peak Power Sensor	Hewlett-Packard	84812A	3318A01050	00479	06/01/2016
Power Supply Unit	Palstar	PS30M	G290775402	02021	Not calibrated
EMI Receiver 9kHz-26.5GHz	Rohde & Schwarz	ESI26	832692/006	00886	23/11/2016

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.7 Variation of Frequency with Voltage

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Climatic Chamber	DESIGN ENVIROMENTAL LTD	FS120-40	1830	01118	05/01/2016
Thermometer	FLUKE	52	92510060	01741	26/11/2016
Power Supply Unit	Thurlby Thandar	CPX 200	98733	00320	Cal not required
Digital Multimeter	Fluke	115	96520337	02249	15/01/2016
EMI Receiver 9kHz-26.5GHz	Rohde & Schwarz	ESI26	832692/006	00886	23/11/2016

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.8 Variation of Frequency with Temperature

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Climatic Chamber	DESIGN ENVIROMENTAL LTD	FS120-40	1830	01118	05/01/2016
Thermometer	FLUKE	52	92510060	01741	26/11/2016
Power Supply Unit	Thurlby Thandar	CPX 200	98733	00320	Cal not required
Digital Multimeter	Fluke	115	96520337	02249	15/01/2016
EMI Receiver 9kHz-26.5GHz	Rohde & Schwarz	ESI26	832692/006	00886	23/11/2016

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.9 Transmitter Frequency Tolerance

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Climatic Chamber	DESIGN ENVIROMENTAL LTD	FS120-40	1830	01118	05/01/2016
Thermometer	FLUKE	52	92510060	01741	26/11/2016
Power Supply Unit	Thurlby Thandar	CPX 200	98733	00320	Cal not required
Digital Multimeter	Fluke	115	96520337	02249	15/01/2016
EMI Receiver 9kHz-26.5GHz	Rohde & Schwarz	ESI26	832692/006	00886	23/11/2016

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.10 Occupied Bandwidth

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Peak Power Analyser	Hewlett-Packard	8991A	3248A00128	00318	06/01/2016
Peak Power Sensor	Hewlett-Packard	84812A	3318A01050	00479	06/01/2016
Power Supply Unit	Palstar	PS30M	G290775402	02021	Not calibrated
EMI Receiver 9kHz-26.5GHz	Rohde & Schwarz	ESI26	832692/006	00886	23/11/2016

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.

7.11 Suppression of Interference Aboard Ships

Test Equipment Type	Manufacturer and Type Number		Serial Number	Cal No.	Cal Due
Test Site 1- S/A Chamber	Global EMC		Site 1 - GE004_AC3	02074	01/12/2017
Antenna Mast (4m)	Inn-co GmbH MM4000		MM4000/056/13750806/L	02075	Cal not required
Turntable Site 4	Inn-co GmbH DS1200S		DS1200S/175/13750806/L	02076	Cal not required
Mast/Turntable Controller Site 4	Inn-co GmbH Co 2000		CO/2000/359/137/50806/L	02077	Cal not required
Computer (Site 1)	HP Compaq dc7800p CMT		CZC8170C7M	N/A	Cal not required
Emissions Software	DARE! RadiMation v5.3.18		N/A	N/A	Cal not required
EMI Receiver 9kHz-3GHz	ESCI		100416	01692	19/02/2016
Antenna 30-2000MHz	Chase	CBL6141	22932	01802	24/07/2016
Loop Antenna 9khz - 30MHz	Chase	HLA6120	1122	00442	20/03/2016
Loop Power Supply	Chase	CBP9720	1076	00450	Not Calibrated
Power Supply Unit	Palstar	PS30M	130348923	01218	Not Calibrated
Digital Multimeter	Fluke	115	96520337	02249	15/01/2016
Power Supply Unit	Palstar	PS-06	130616126	01936	Not Calibrated
Power Supply Unit	Thurlby Thandar	CPX 200	98733	00320	Cal not required
EMI Receiver 20Hz to 40GHz	Rohde & Schwarz	ESU40	100017	01721	15/04/2016

In accordance with UKAS requirements, all measuring equipment is on a calibration cycle.