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FCC PART 80, 90

RADAR TEST REPORT

APPLICANT	NAVICO AUCKLAND LTD
	44 ARRENWAY DRIVE, ROSEDALE P.O. Box 331146
	TAKAPUNA, AUCKLAND 0632 New Zealand
FCC ID	RAYHALO
MODEL NUMBER	HALO
PRODUCT DESCRIPTION	MARINE PULSE COMPRESSION RADAR
DATE SAMPLE RECEIVED	4/6/2015
DATE TESTED	4/7/2015
TESTED BY	Christian Pawlak
APPROVED BY	Sid Sanders
TEST RESULTS	☒ PASS ☐ FAIL

Report Number	Version Number	Description	Issue Date
268YAUT15TestReport.docx	Rev.1	Initial Issue	4/7/2015
	Rev. 1.5	Corrected Typo on Freq. Stab. Test	4/16/15

**THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL
WITHOUT THE WRITTEN APPROVAL OF TIMCO ENGINEERING, INC.**

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GENERAL REMARKS

The attached report shall not be reproduced except in full without the written permission of Timco Engineering Inc.

The test results relate only to the items tested.

Summary

The device under test does:

- ☒ Fulfill the general approval requirements as identified in this test report
- ☐ Not fulfill the general approval requirements as identified in this test report

Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025:2005 requirements.

I attest that the necessary measurements were made, under my supervision, at:

Timco Engineering Inc.
849 NW State Road 45
Newberry, FL 32669



Authorized Signatory Name:

Christian Pawlak
Engineering Project Manager

Date: 4/7/2015

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EUT SPECIFICATION

EUT Description	MARINE PULSE COMPRESSION RADARMARINE PULSE COMPRESSION RADAR
FCC ID	RAYHALO
Model Number	HALO
Serial Number	N/A
Operating Frequency	9400-9495 MHz
Type of Emission	V8X
Modulation	PULSE
EUT Power Source	☐ 110–120Vac/50– 60Hz
	☒ DC Power (13.6VDC)
	☐ Battery Operated Exclusively
Test Item	☐ Prototype
	☐ Pre-Production
	☒ Production
Type of Equipment	☐ Fixed
	☒ Mobile
	☐ Portable
Antenna Gain	30dBi

TEST SETUP INFORMATION

Test facility	Timco Engineering, Inc. 849 NW State Road 45, Newberry, FL 32669
Test Condition	The EUT was tested under normal temperature and humidity. The temperature was 26°C with a relative humidity of 50%. Barometric Pressure:30.13 in.
Modifications	None
Test Exercise	The EUT operated in a normal manner.
Applicable Standards	ANSI/TIA 603-D;2010 , FCC CFR 47 Part 80

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TEST REPORT SUMMARY

Rule Part No.	Scope of Work	Status Pass/Fail/NA
Part 2.1033(c)(8), Part 2.1046(a), Part 80.215	RF Power Output	PASS
Part 2.1033(c) (4) Part 2.1047(a)(6) Part 80.213	Modulation Characteristics of Pulses	PASS
2.1049(c), Part 80.211 90.210(b), 90.210 (c) 90.210(d), 90.210(e)	Occupied Bandwidths	PASS
2.1051(a), Part 80.211	Antenna Conducted Emissions	PASS
2.1053, Part 90	Field Strength Spurious Emissions	PASS
Part 2.1055, Part 80.209, 90.213	Frequency Stability	PASS

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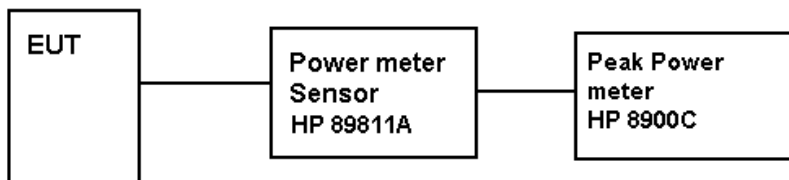
RF POWER OUTPUT

Rule Part No.: Part 2.1046(a), Part 80, 90

Test Requirements:

Method of Measurement: RF power is measured by connecting a 50-ohm, Peak Power Watt meter to the RF output connector. With a nominal voltage, and the transmitter properly adjusted the RF output measures:

Test Setup Diagram:



Test Data:

OUTPUT POWER: High = 25 Watts Peak

Average Power = 1.0Watt

Part 2.1033 (C)(8) DC Input into the final amplifier

FOR POWER SETTING (HIGH) INPUT POWER: Volts DC = 36
Current Amperes = 3.8
= 136.8 Watts

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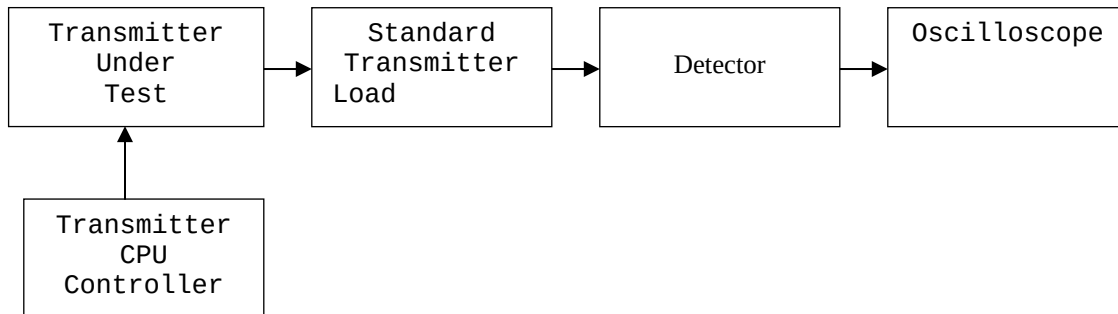
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MODULATION CHARACTERISTICS

Method of Measurement: ANSI/TIA 603-D

Test Setup Diagram:



The device under test is capable of pulse durations of many styles and durations.

Range		1	2	3	4	5	6	7	
	Centre-Freq. MHz	9410	9410	9438	9450-9470	9466-9486	9486-9490	9486-9495	
	Freq. Deviation MHz	0	+/-16.0	+/-16.0	+/-8.0	+/-47.0	+/-2.0	+/-1.0	
0.0625		50nsec							2882
0.125		50nsec							2882
0.25		50nsec	2usec						2882
0.5		50nsec	2usec						2882
0.75		50nsec	2usec	8usec					2174
1		50nsec	2usec	8usec					2174
1.5		50nsec	2usec	8usec	16usec				1730
2		50nsec	2usec	8usec	16usec				1730
3		50nsec	2usec	8usec	16usec	32usec			1435
4		50nsec	2usec	8usec	16usec	32usec			1435
6		50nsec	2usec	8usec	16usec	32usec	64usec		824
8		50nsec	2usec	8usec	16usec	32usec	64usec		824
12		50nsec	2usec	8usec	16usec	32usec	64usec		824
16		50nsec	2usec	8usec	16usec	32usec	64usec		824
24		50nsec	2usec	8usec	16usec	32usec	64usec		824
36		50nsec	2usec	8usec	16usec	32usec		96usec	520
48		50nsec	2usec	8usec	16usec	32usec		96usec	520
64		50nsec	2usec	8usec	16usec	32usec		96usec	520

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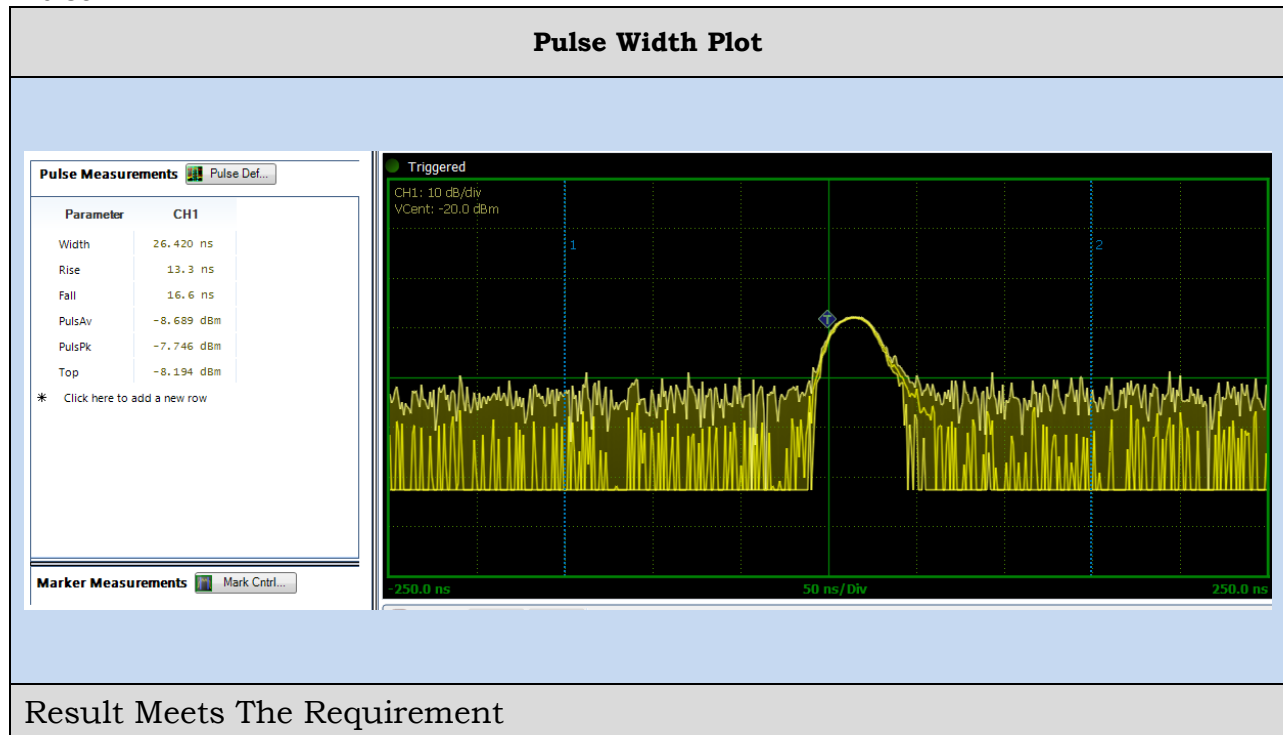
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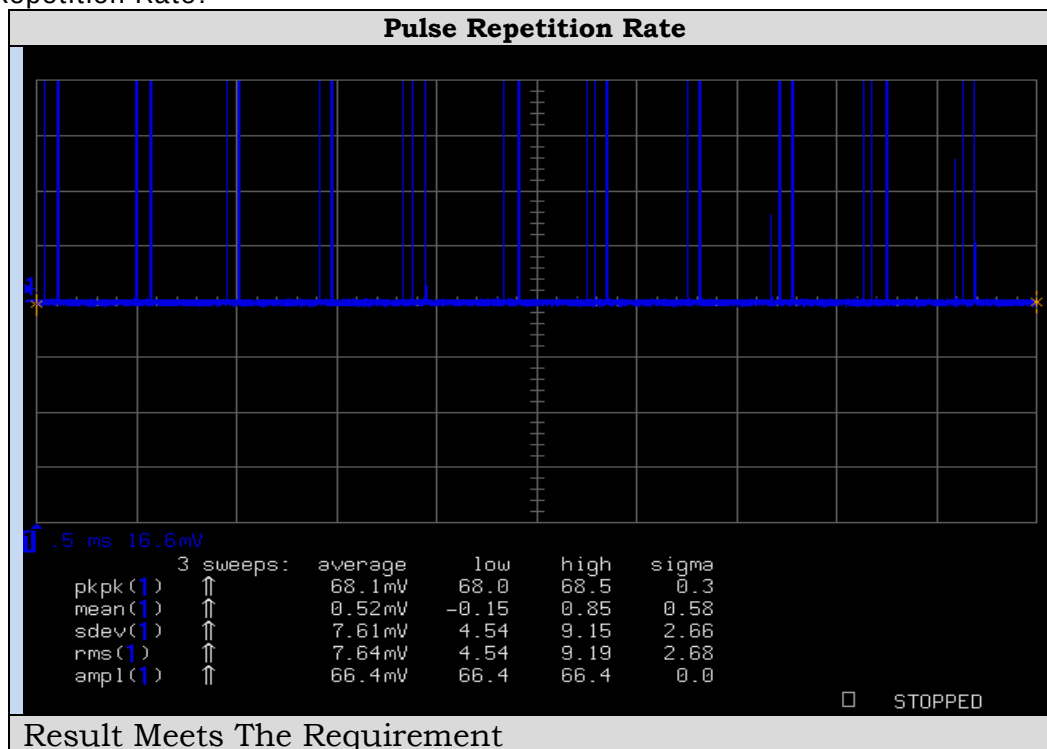
MODULATION CHARACTERISTICS(Cont.)

Pulse 1:



Result Meets The Requirement

Pulse Repetition Rate:



Result Meets The Requirement

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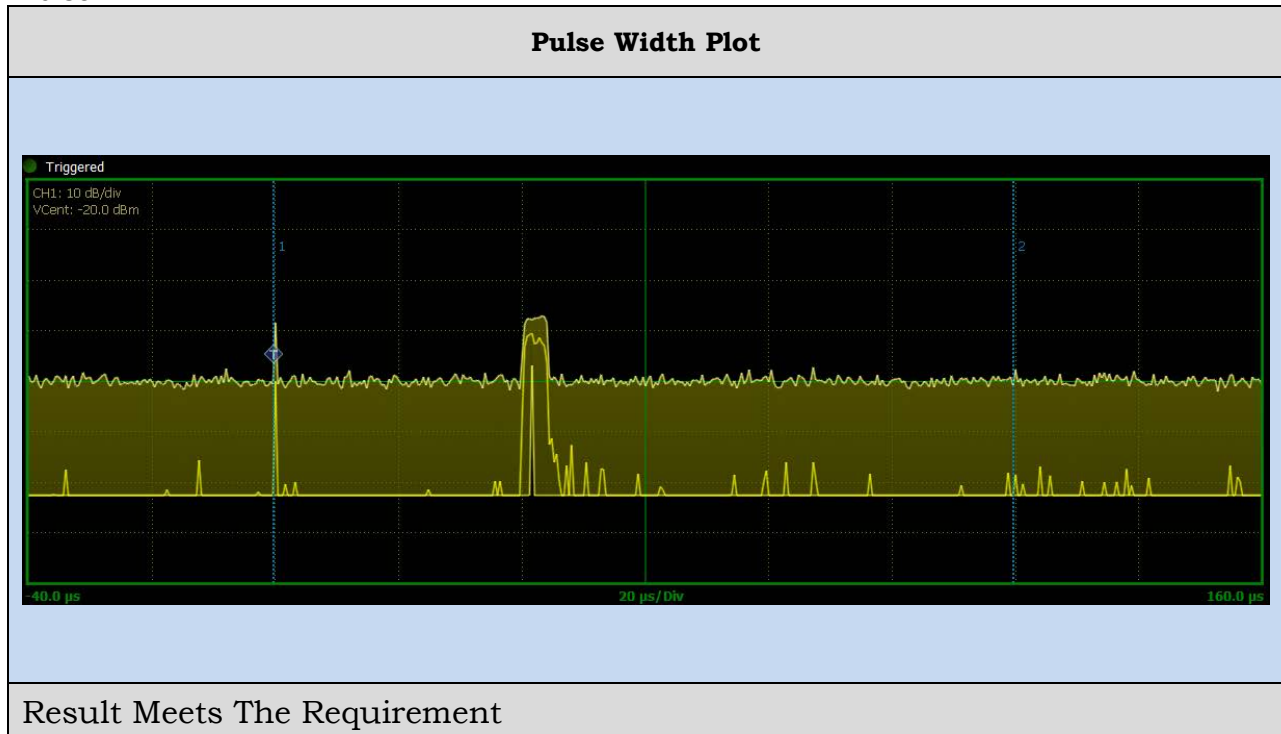
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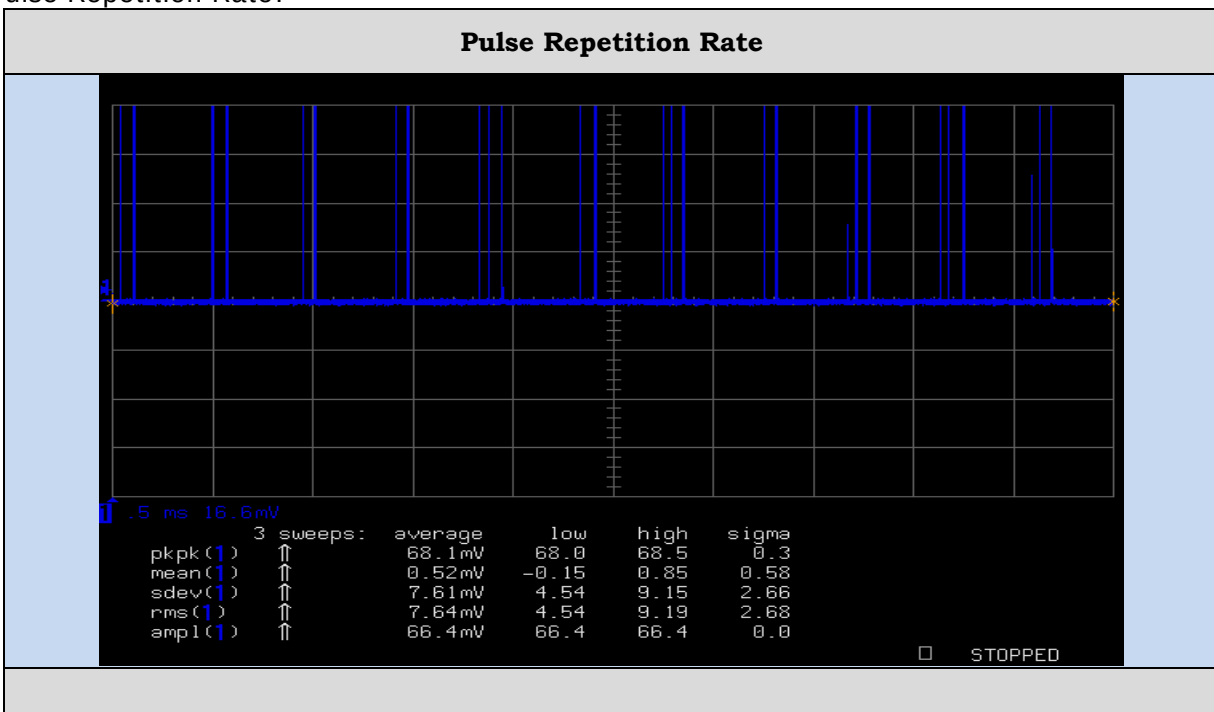
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MODULATION CHARACTERISTICS(Cont.)

Pulse 2:



Pulse Repetition Rate:



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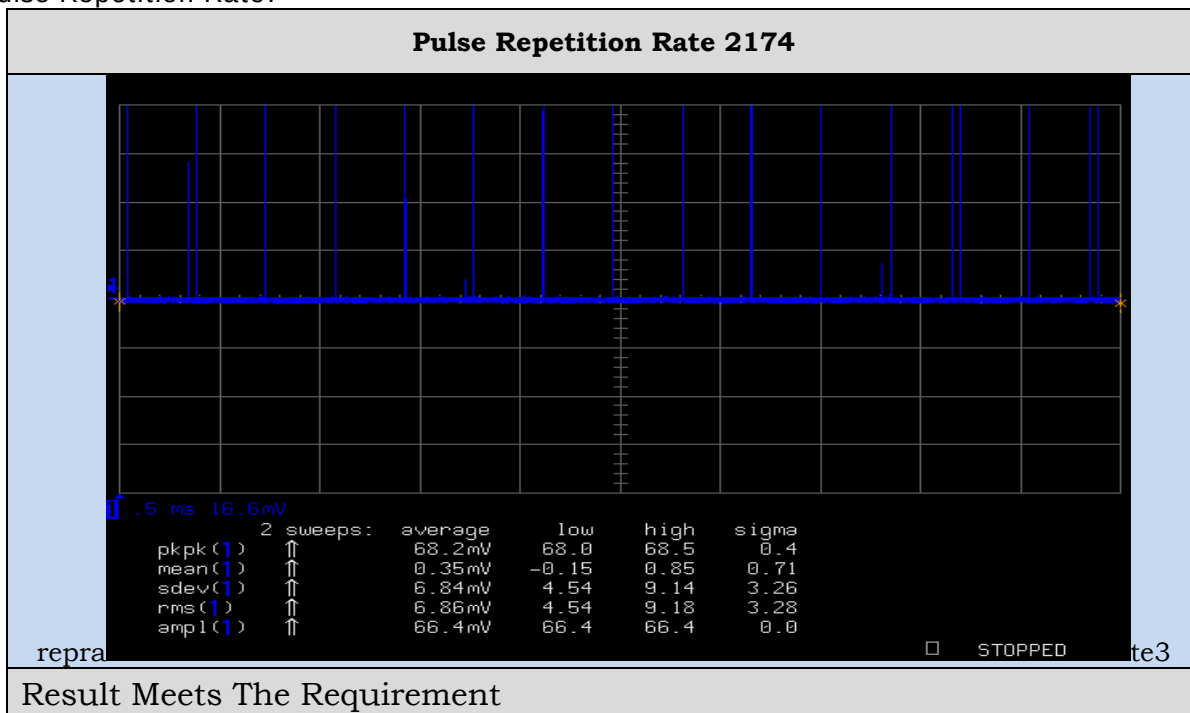
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MODULATION CHARACTERISTICS(Cont.)

Pulse 3:



Pulse Repetition Rate:



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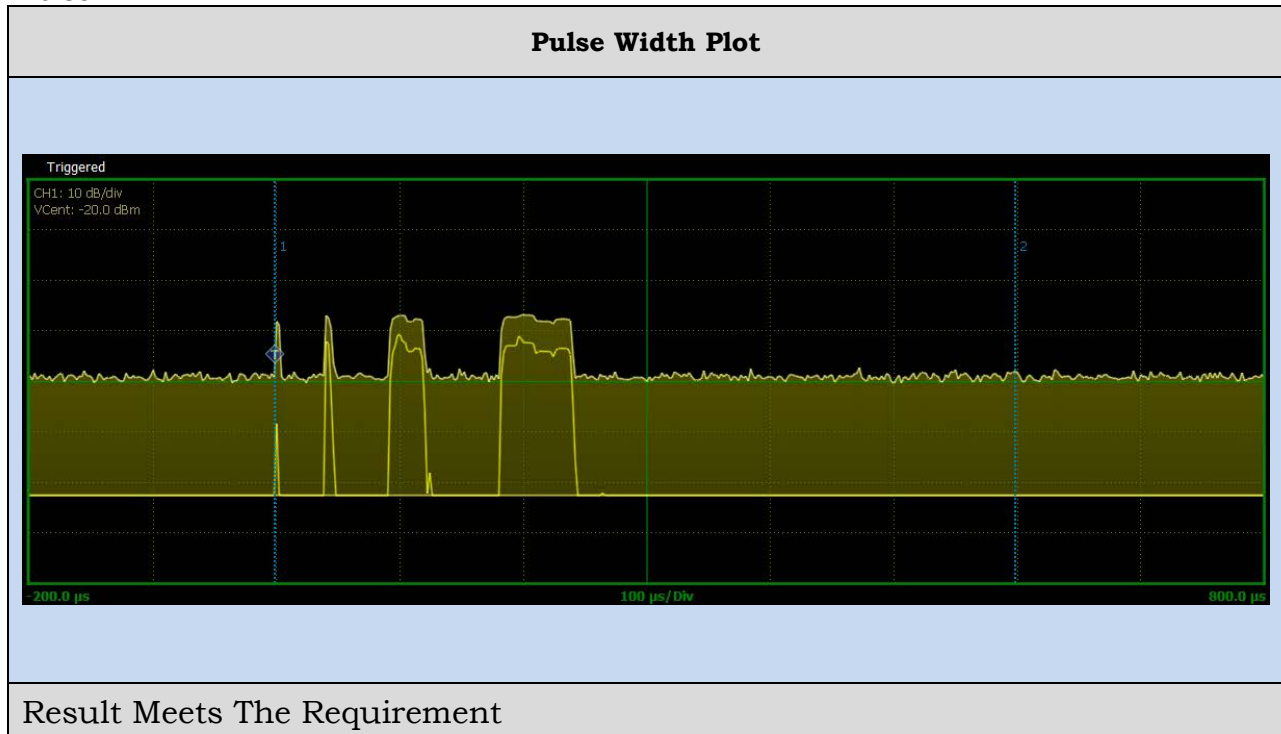
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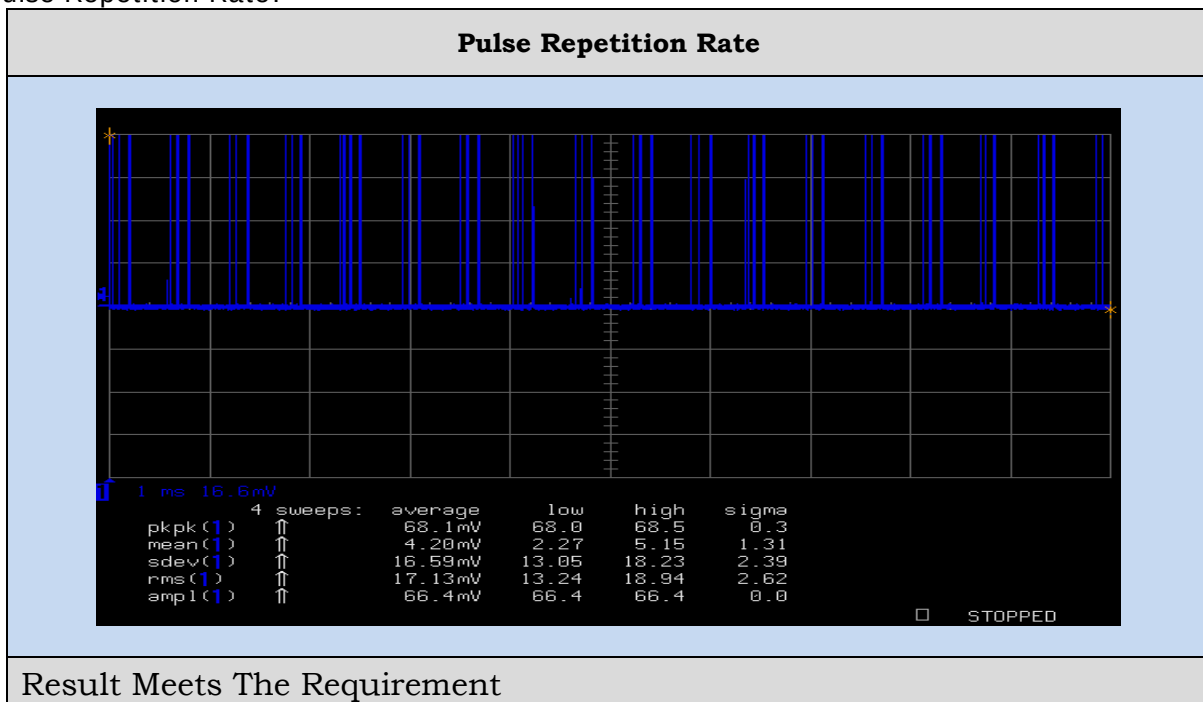
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MODULATION CHARACTERISTICS(Cont.)

Pulse 4:



Pulse Repetition Rate:



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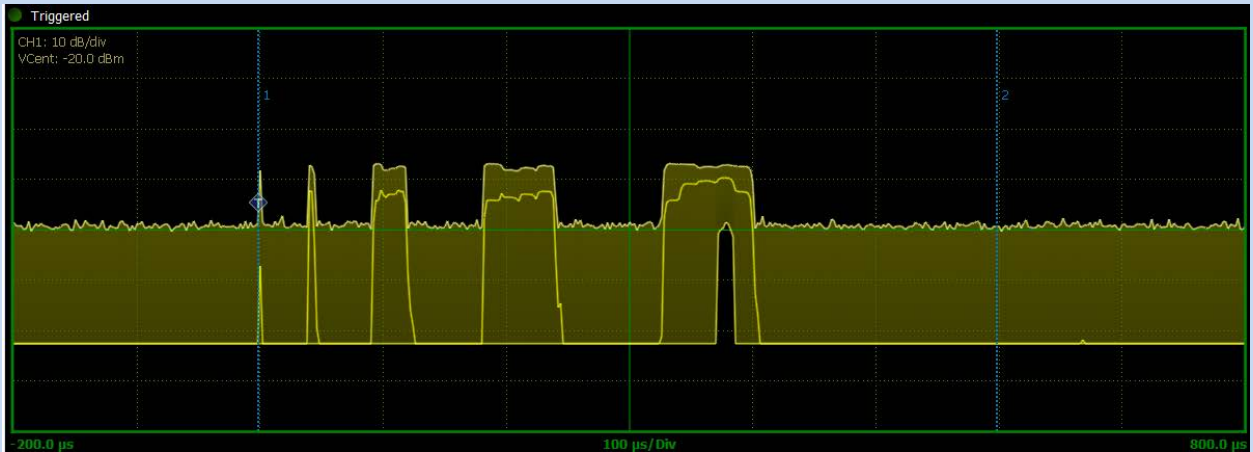
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MODULATION CHARACTERISTICS(Cont.)

Pulse 5:

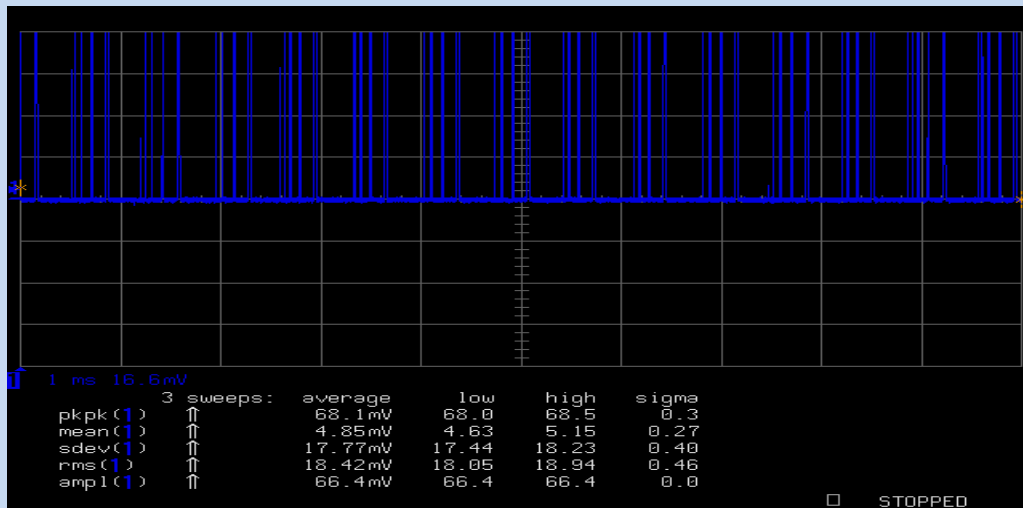
Pulse Width Plot



Result Meets The Requirement

Pulse Repetition Rate:

Pulse Repetition Rate



Result Meets The Requirement

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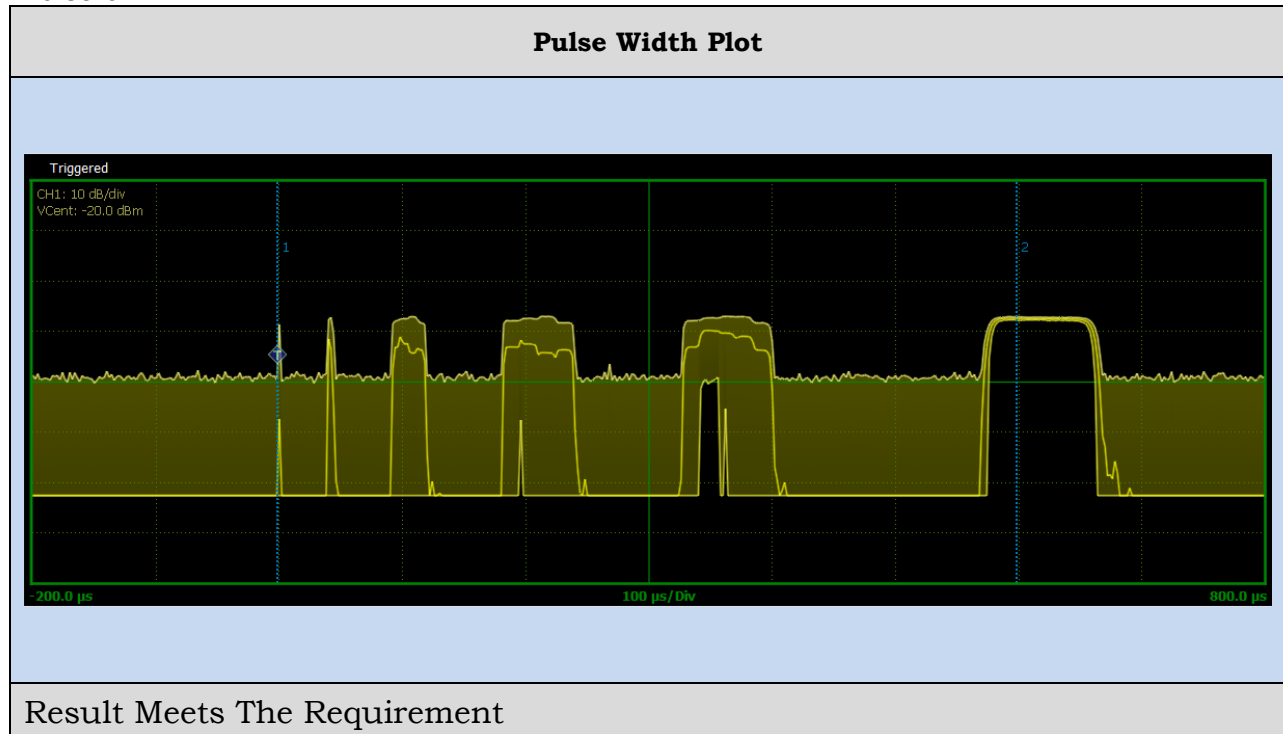
Applicant: NAVICO AUCKLAND LTD

FCC ID: RAYHALO

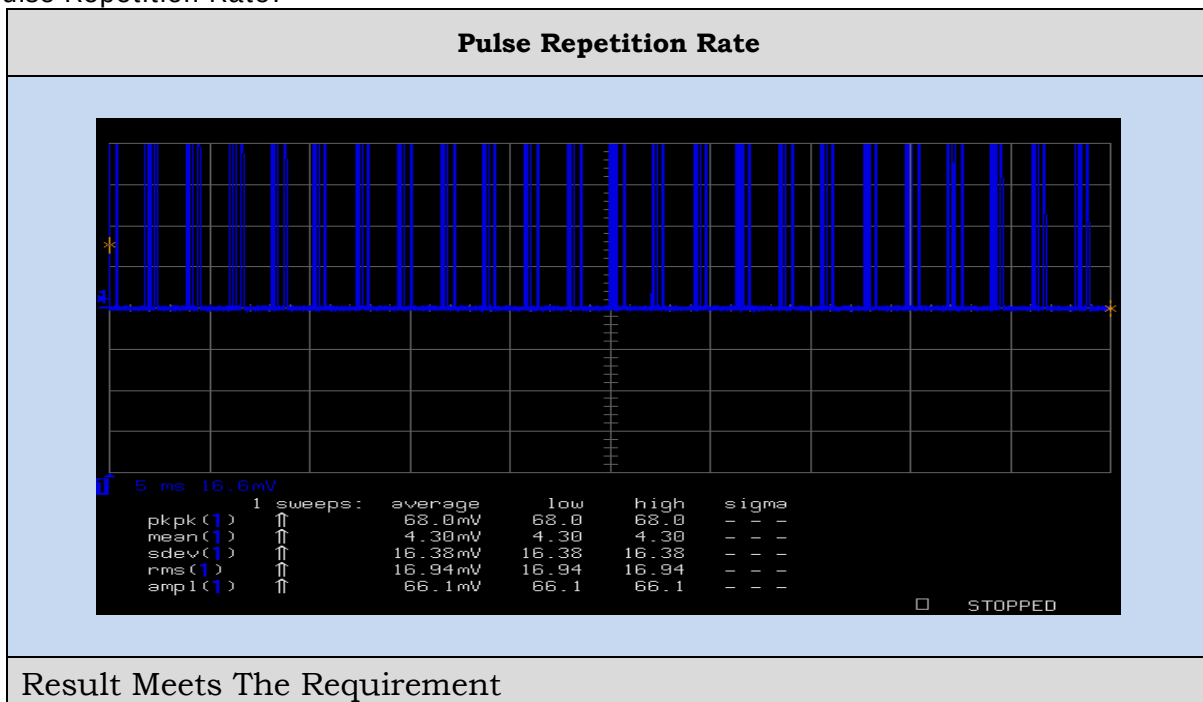
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MODULATION CHARACTERISTICS(Cont.)

Pulse 6L:



Pulse Repetition Rate:



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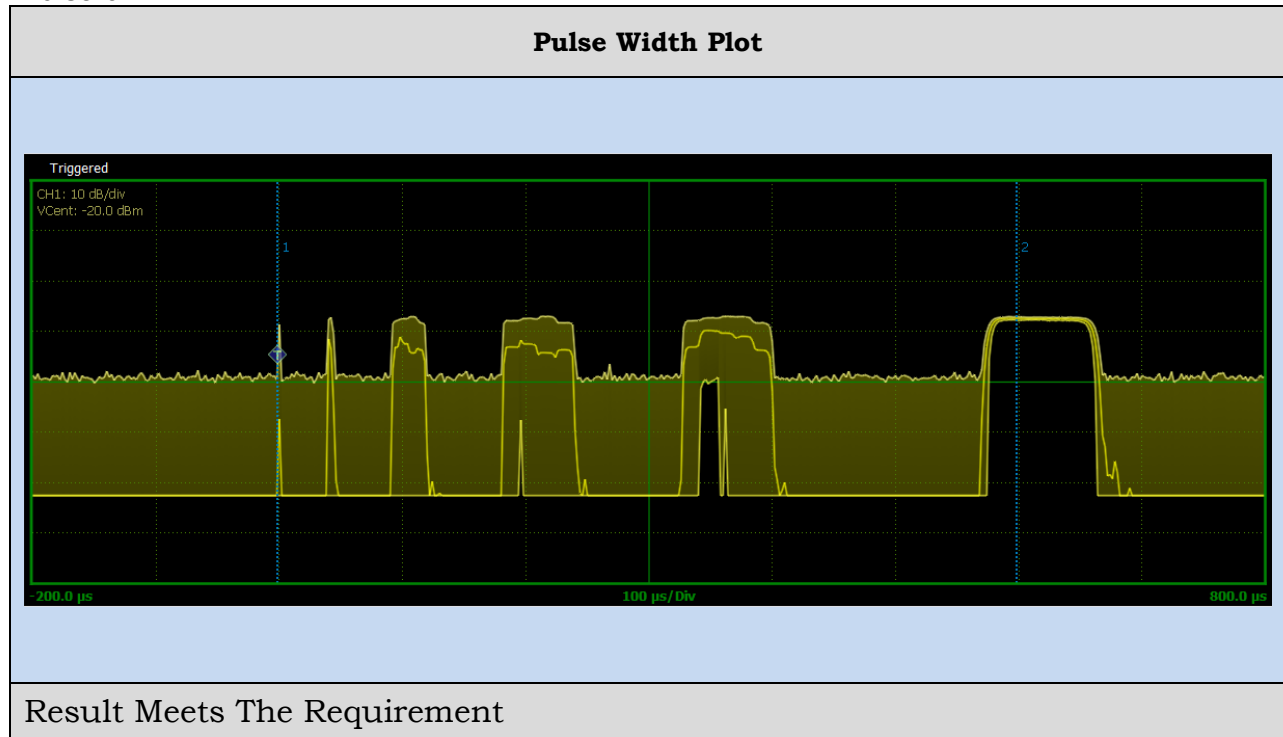
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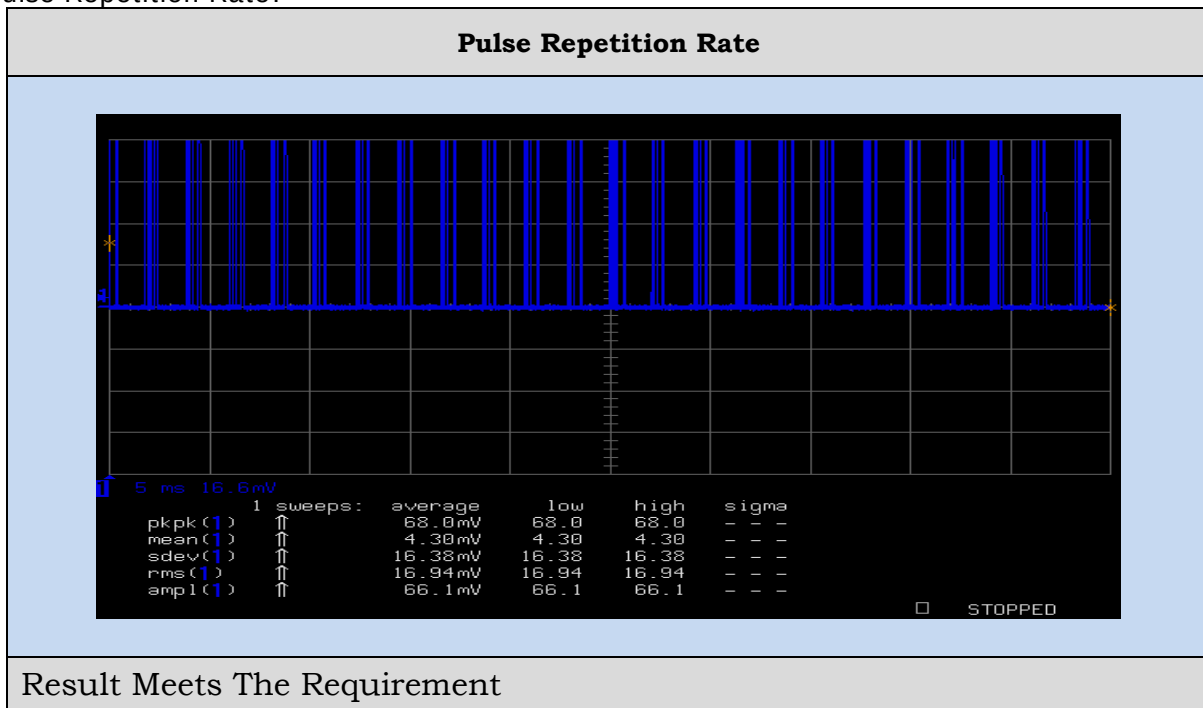
Report: N\NAVICO AUCKLAND_RAY\268YAUT15\268YAUT15TestReport.docx

MODULATION CHARACTERISTICS(Cont.)

Pulse 6L:



Pulse Repetition Rate:



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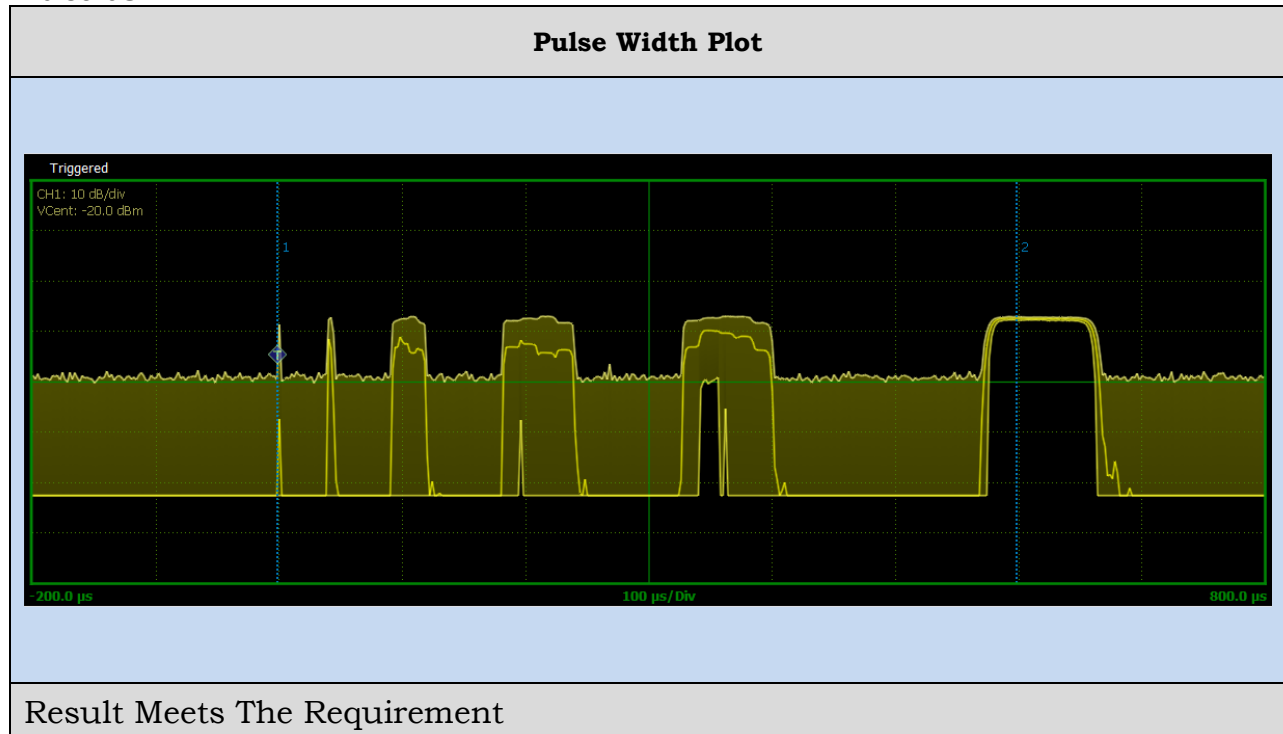
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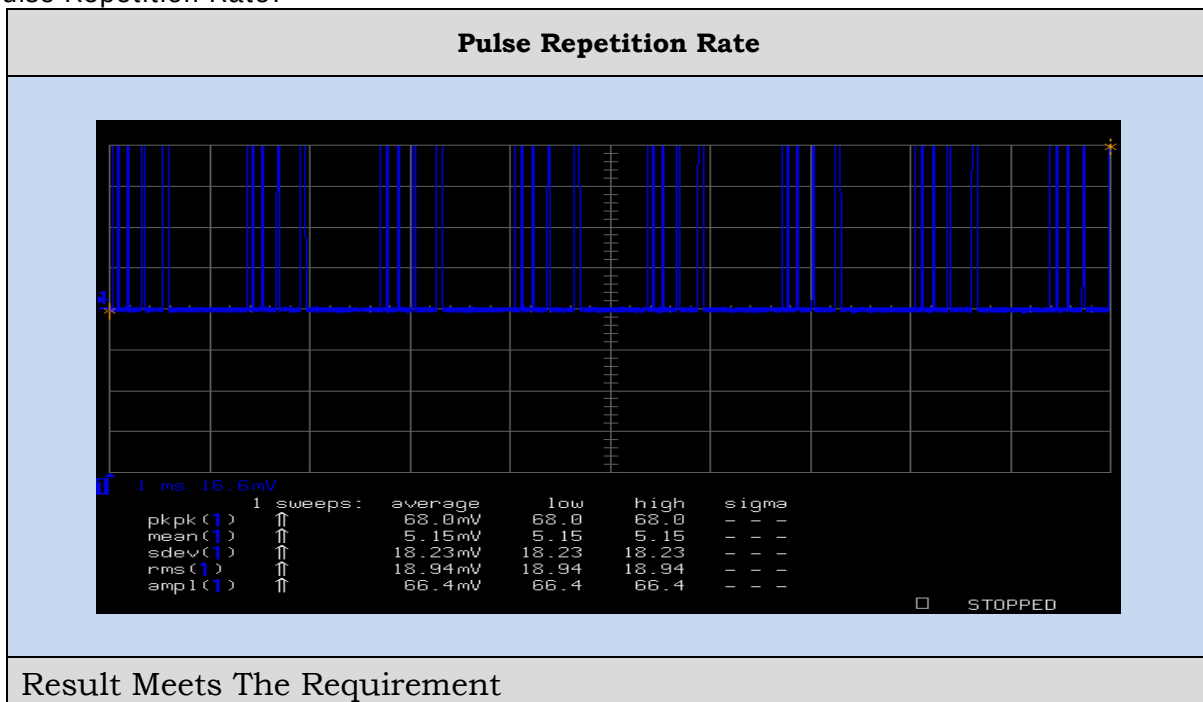
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MODULATION CHARACTERISTICS(Cont.)

Pulse 6S:



Pulse Repetition Rate:



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Applicant: NAVICO AUCKLAND LTD

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OCCUPIED BANDWIDTH

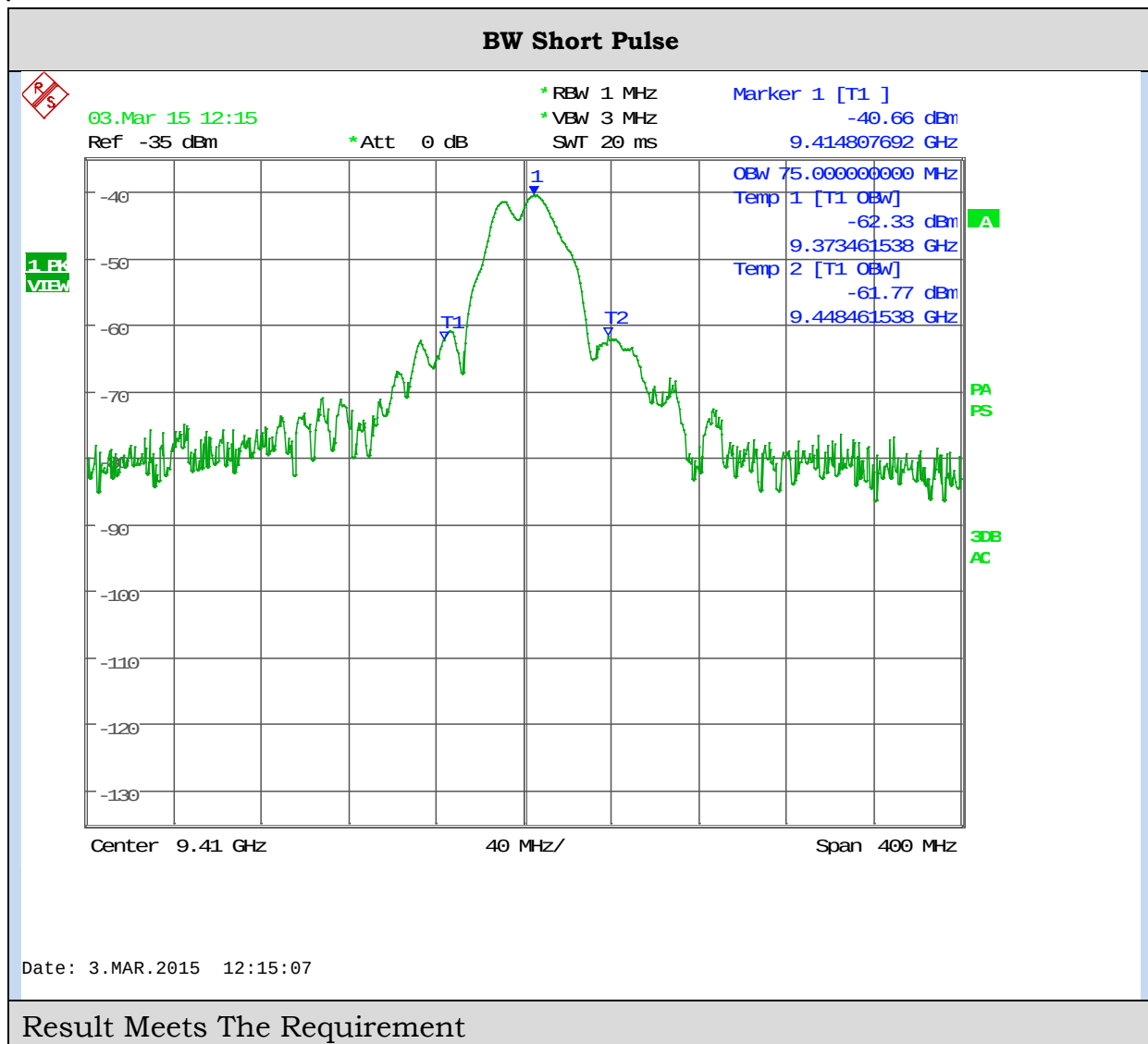
Rule Part No.: 80.211, 90.210

Requirement: The emission mask for this device requires that the emission only need stay in the band.

Measurement Method:

OBW for a short duration pulse #1

:



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Applicant: NAVICO AUCKLAND LTD

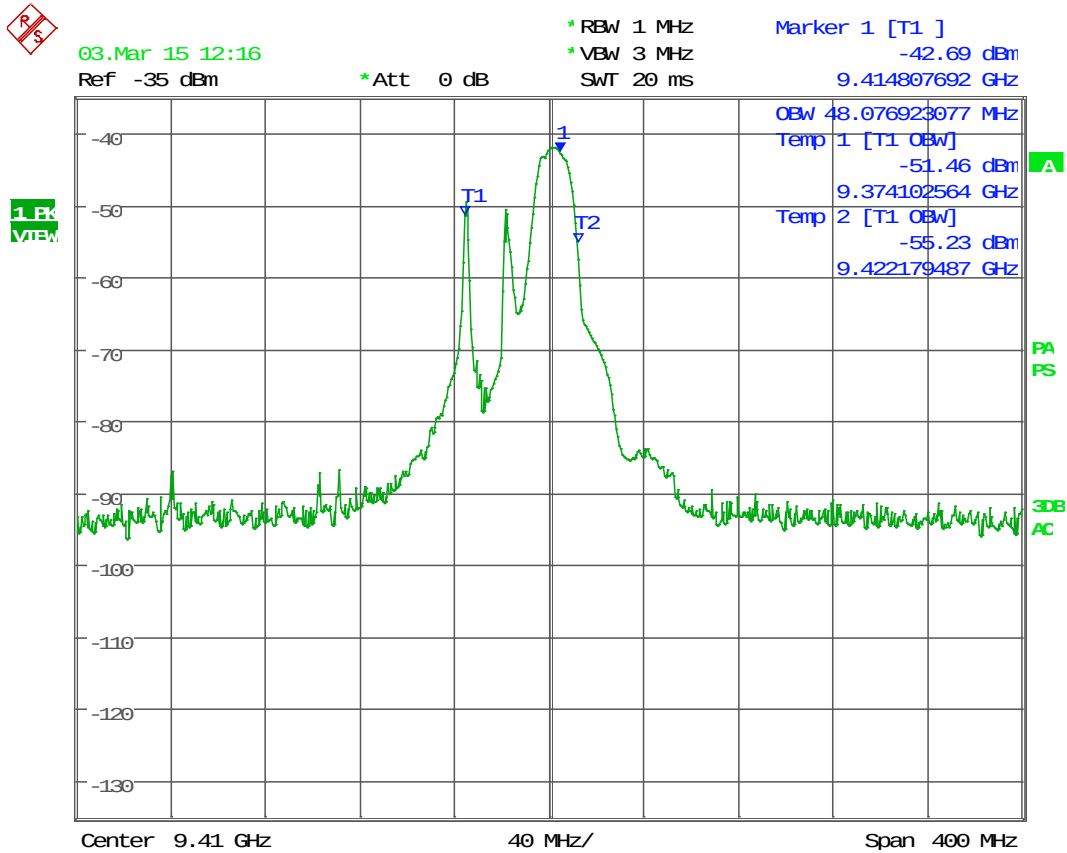
FCC ID: RAYHALO

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OCCUPIED BANDWIDTH

Rule Part No.: 80.211, 90.210

OBW for pulse #2



Date: 3.MAR.2015 12:16:23

Applicant: NAVICO AUCKLAND LTD

FCC ID: RAYHALO

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OCCUPIED BANDWIDTH

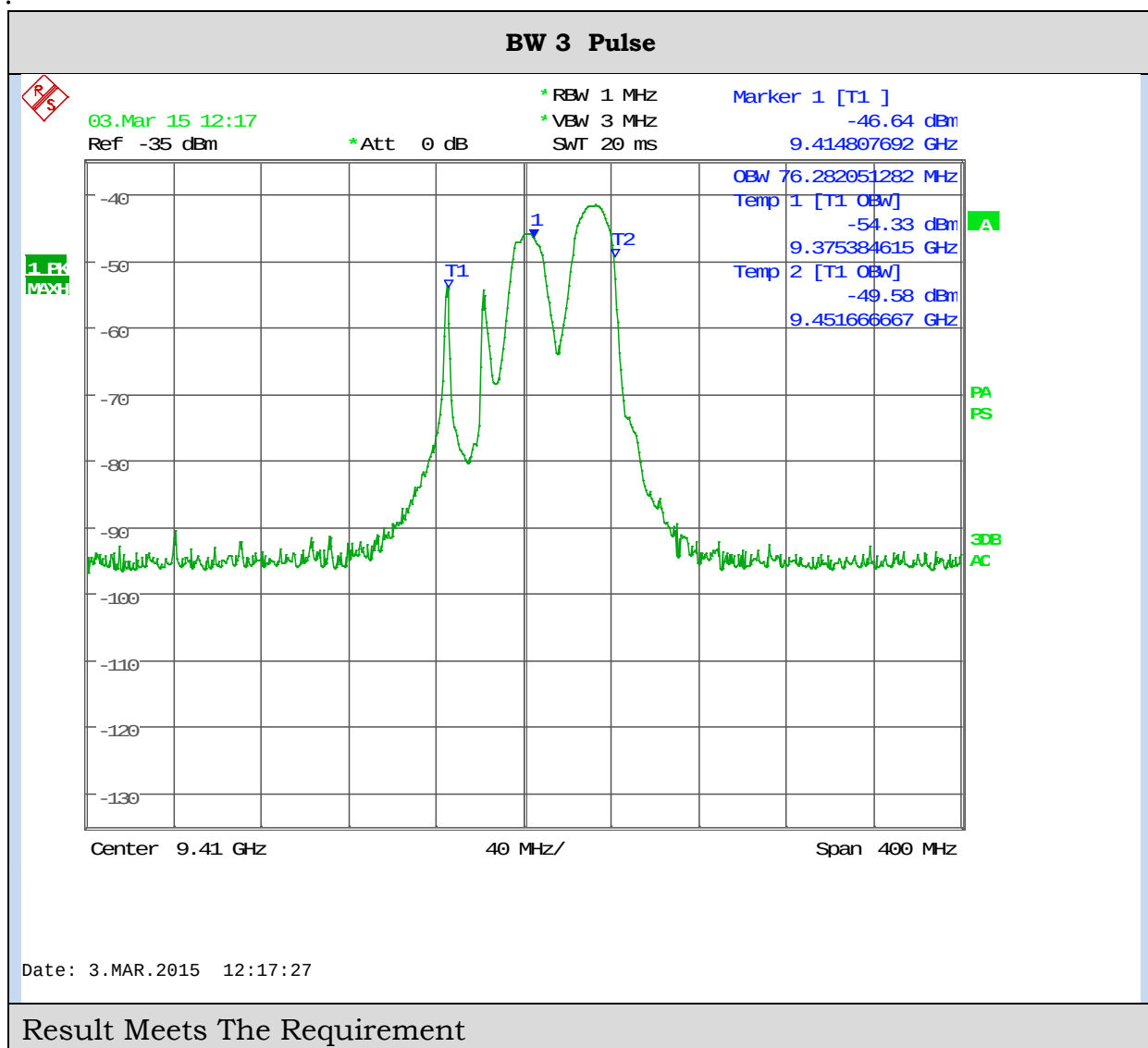
Rule Part No.: 80.211, 90.210

Requirement: The emission mask for this device requires that the emission only need stay in the band.

Measurement Method:

OBW for a short duration pulse #3

:



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Applicant: NAVICO AUCKLAND LTD

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OCCUPIED BANDWIDTH

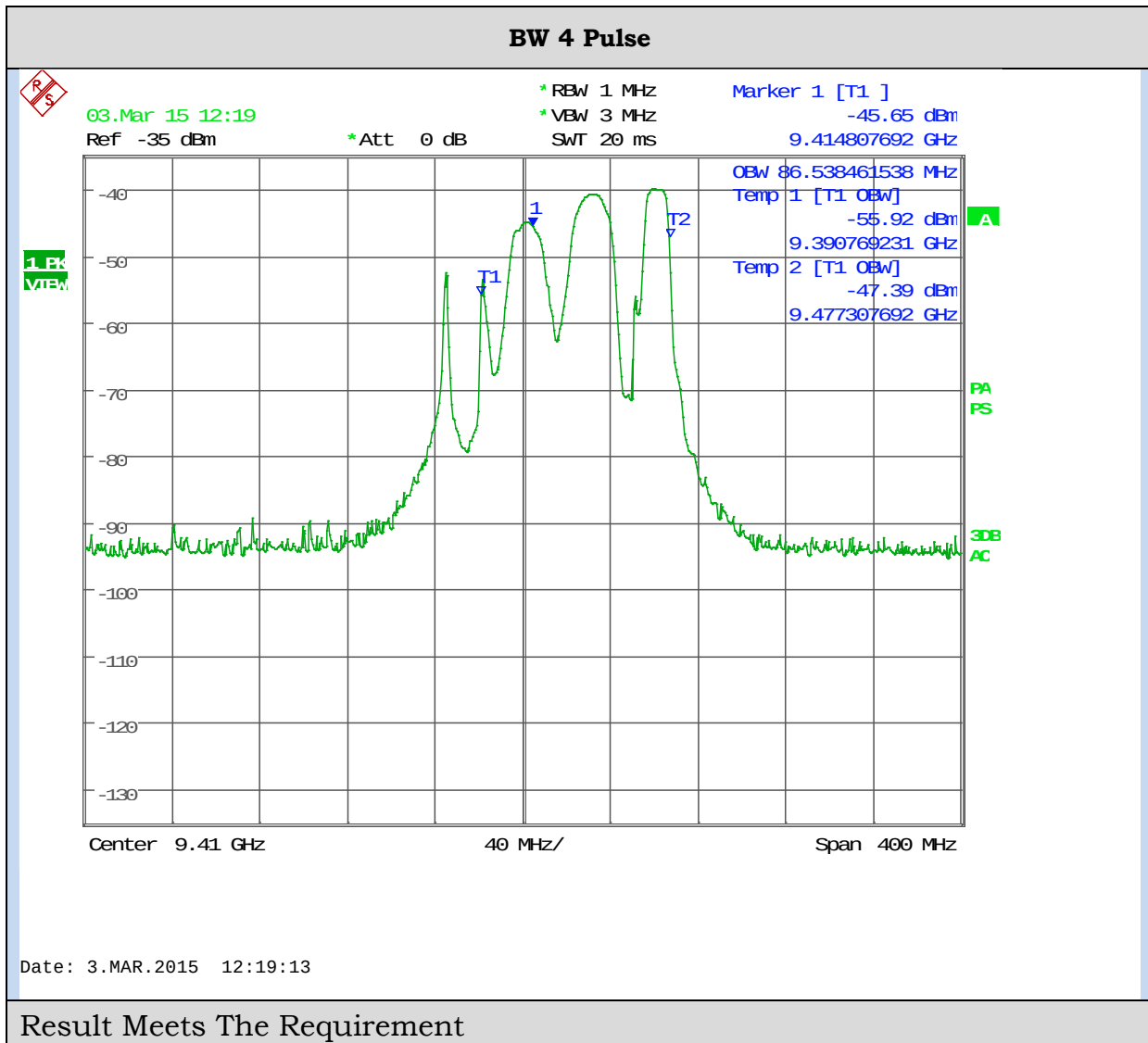
Rule Part No.: 80.211, 90.210

Requirement: The emission mask for this device requires that the emission only need stay in the band.

Measurement Method:

OBW for 4 pulse

:



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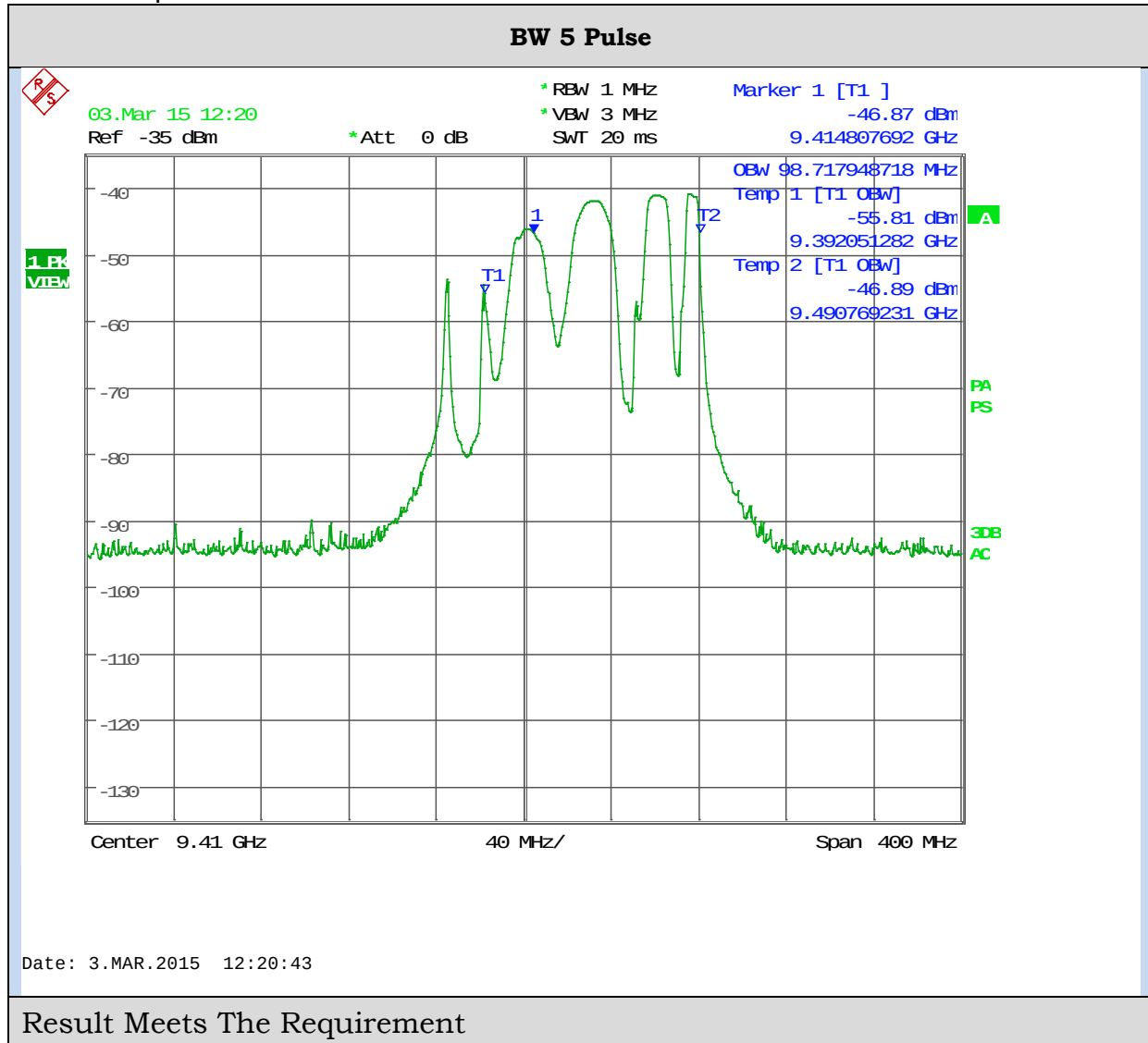
OCCUPIED BANDWIDTH

Rule Part No.: 80.211, 90.210

Requirement: The emission mask for this device requires that the emission only need stay in the band.

Measurement Method:

OBW for 5 pulse :



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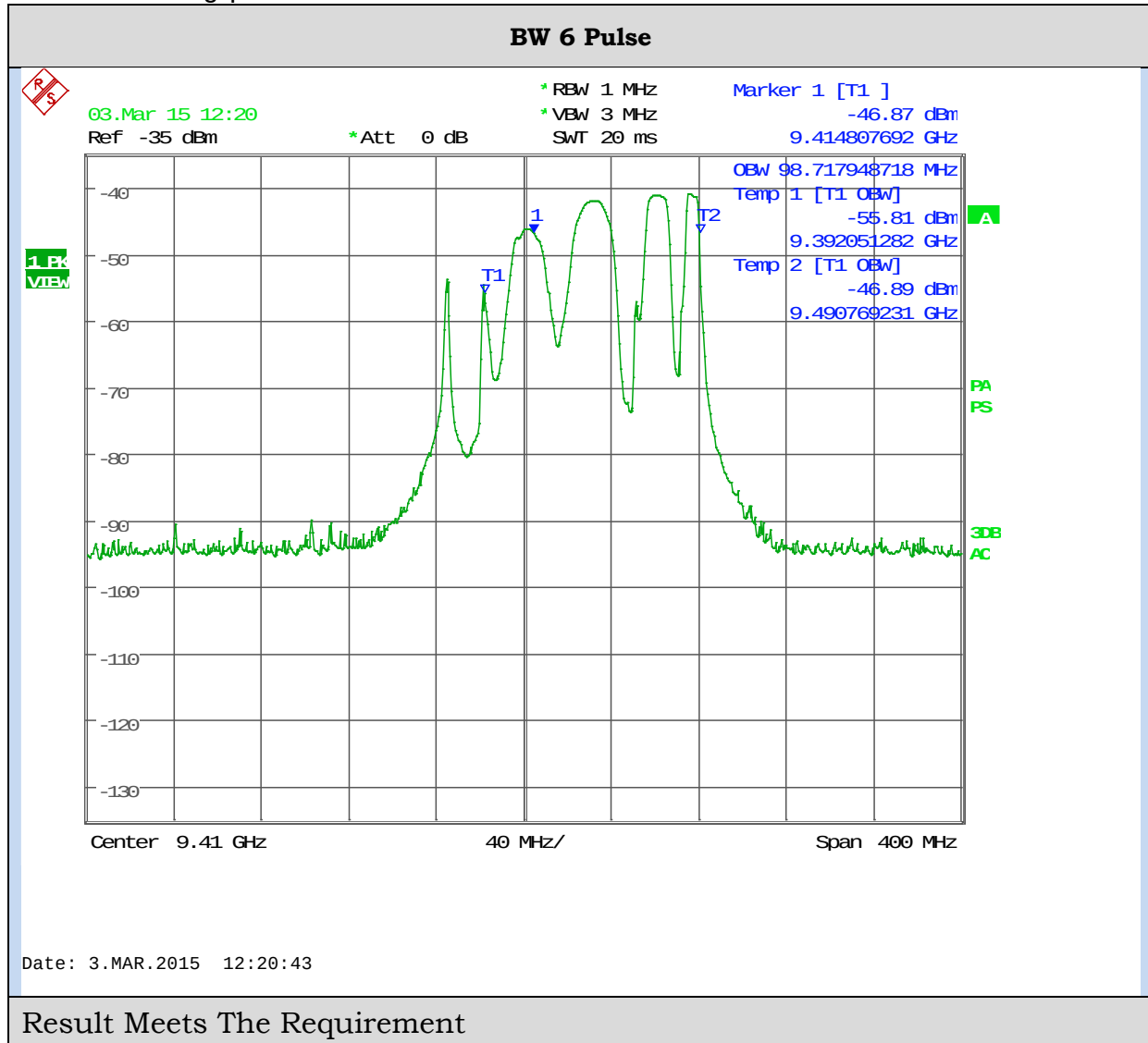
OCCUPIED BANDWIDTH

Rule Part No.: 80.211, 90.210

Requirement: The emission mask for this device requires that the emission only need stay in the band.

Measurement Method:

OBW for 6 Long pulse :



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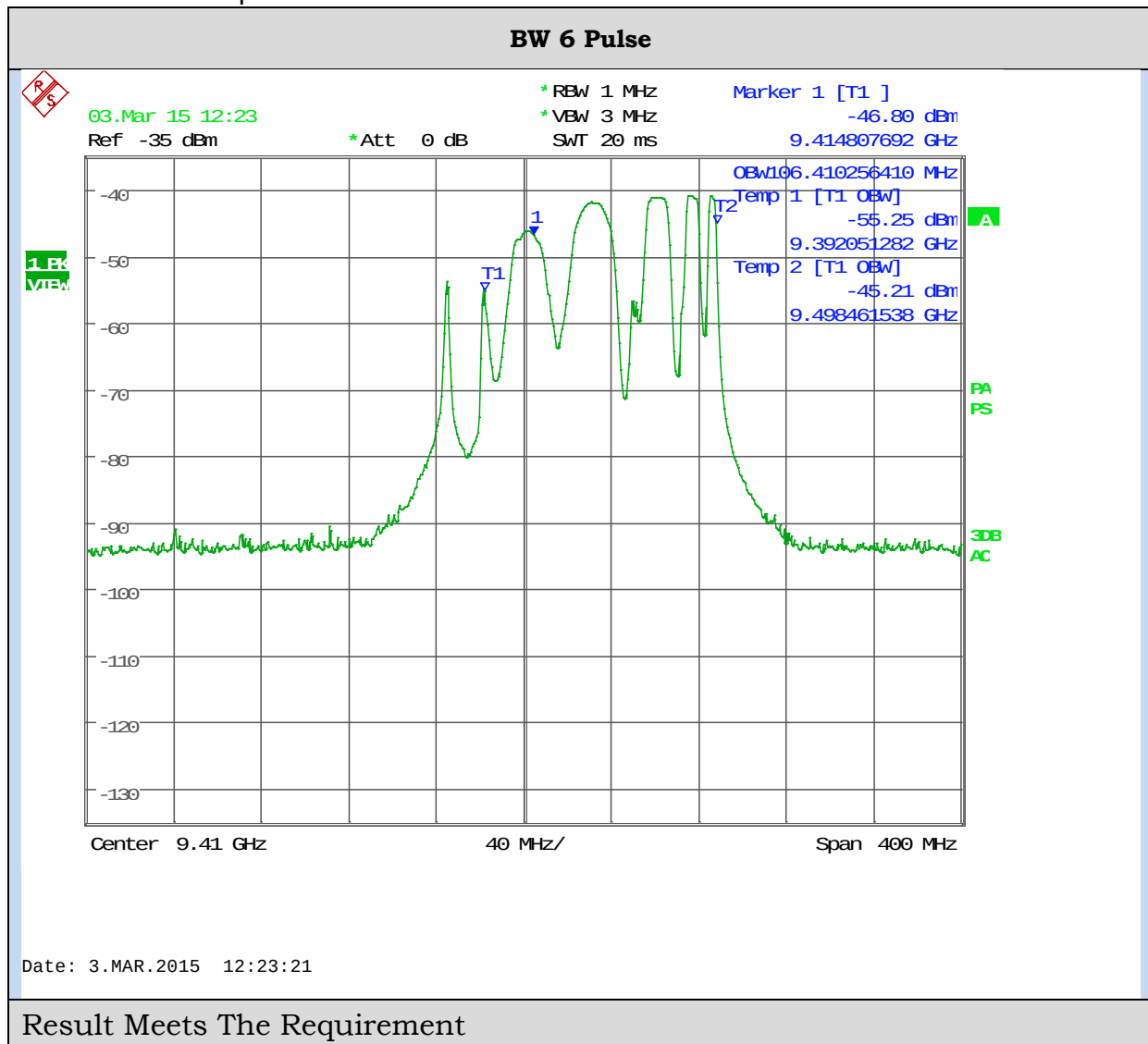
OCCUPIED BANDWIDTH

Rule Part No.: 80.211, 90.210

Requirement: The emission mask for this device requires that the emission only need stay in the band.

Measurement Method:

OBW for 6 Short pulse :



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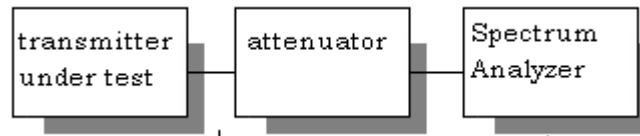
SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Rule Part No.: Part 2.1051(a) & 80.217, 90

Requirements: $43 + 10\log(\text{mean power})$
 $43 + 10\log(2) = 46 \text{ dB}$

Method of Measurement: The spectrum was scanned from 0.4 to at least the 10th harmonic of the fundamental or 40 GHz. The measurements were made in accordance with standard ANSI/TIA 603 or ANSI 63.4:2003.

The mean power was calculated based on the standard formula for radar systems:
 $P_a = P_m \cdot T_d \cdot f_r$. Where T_d is pulse duration, P_m is peak power, and f_r is pulse rep rate.



Test Data: Worst case: single pulse mode setting 15 (longest pulse)

Test Data: Single Pulse

	dBm	dBm	Watts	Margin	Note
Power Output	33	33	2		
	Frequency	dBm	dBc		
	9410	33	0	0	
	18820	-15	48	2	
	28230	-35	68	22	1
	37640	-36	69	23	1

Note 1: No emission, reading indicates noise floor.

Results: Meet requirement.

SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

Test Data: Six Pulse

Applicant: NAVICO AUCKLAND LTD

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	dBm	dBm	Watts	Margin	Note
Power Output	33	33	2		
	Frequency	dBm	dBc		
	9410	33	0	0	
	18820	-15	49.5	2	
	28230	-35	69	23	1
	37640	-36	69	23	1
	47050	-29	62	16	1
	56460	-29	62	16	1
	65870	-35	68	22	1
	75280	-33	66	20	1
	84690	-35	68	22	1
	94100	-38	71	25	1

Note 1: No emission, reading indicates noise floor.

All pulse combinations were checked & the data presented represents the worse case and all pulse combinations were checked to 40GHz.

Results: Meets requirement.

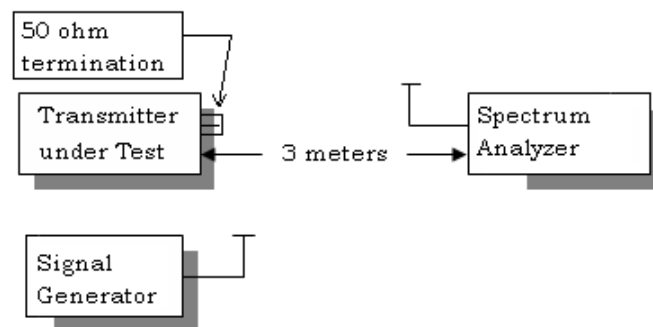
FIELD STRENGTH OF SPURIOUS EMISSIONS

Rule Parts. No.: Part 2.1053

Requirements: The FCC limits for radiated emissions are the same as previously stated for the conducted emissions.

METHOD OF MEASUREMENT: The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from 30 MHz to at least the tenth harmonic of the fundamental or 40 GHz. This test was conducted per ANSI/TIA 603 using the substitution method.

Test Setup Diagram:



Test Data:

Harmonics were measured to 40GHz.

Emission Frequency (MHz)		Power Mode		ERP Power Output (dBm)		ERP Power Output (Watts)		FCC Requirement dB		Bandwidth - BW - kHz	
9,410.00		Hi		33.00		2.00		46.00		25.00	
Emission Frequency (MHz)	Ant. Polarity	EUT Signal Reading	Signal Generator Reading	Coax Loss (dB)	Filter Insertion Loss	Substitution Antenna	ERP (dBm)	Below Carrier (dBc)	Margin		

Emission Frequency (MHz)	Ant. Polarity	Below Carrier (dBc)	Margin
18,820.00	V	59.43	46.43
28,230.00	V	53.12	40.12
37,640.00	H	70.44	57.44

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FREQUENCY STABILITY

Rule Parts. No.: Part 2.1055, Part 80, 90.213

Requirements: Emission need only remain in the band.

Method of Measurements: ANSI/TIA 603-C:2004

Test Data:

Temperature	Low Frequency GHz	High Frequency GHz	Cycles	PPM
25°C (reference)	9.4100	9.486		
-30°C	9.4111	9.496	1050	111.583
-20°C	9.4095	9.4860	-500	-53.135
-10°C	9.4095	9.4855	-500	-53.135
0°C	9.4108	9.4855	800	85.016
10°C	9.4090	9.4838	-1000	-106.270
20°C	9.4100	9.4860	0	0.000
30°C	9.4090	9.4855	-1000	-106.270
40°C	9.4090	9.4855	-1000	-106.270
50°C	9.4095	9.4840	-500	-53.135
Battery Voltage	Frequency		Cycles	PPM
-15%	9.4100		0	0.000
15%	9.4100		0	0.000

Results: Meets requirements.

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EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
24 Volt Power Supply	Astron	VLS-25M	9510040	N/A	N/A
Antenna: Log-Periodic Chamber	Eaton	96005	1243	05/31/13	05/31/15
LISN (Primary)	Electro-Metrics	EM-7820	2682	02/26/13	08/26/15
Temperature Chamber LARGE	Tenney Engineering	TTRC	11717-7	08/19/14	08/19/16
DC Power Supply	HP	6286A	2411A09414	N/A	N/A
Frequency Counter Large Chamber	HP	5352B	2632A00165	06/26/13	06/26/15
3-Meter Semi-Anechoic Chamber	Panashield	N/A	N/A	12/31/13	12/31/15
Sweep/Signal Generator	Anritsu	68369B	985112	08/29/13	08/29/15
Oscilloscope	LeCroy	LT364	00414	08/22/13	08/22/15
Software: Field Strength Program	Timco	N/A	Version 4.0	N/A	N/A
USB Peak Power Sensor 50 MHz to 18 GHz	Boonton	55318	9224	11/06/14	11/06/16
EMI Test Receiver R & S ESU 40 Chamber	Rohde & Schwarz	ESU 40	100320	03/11/14	03/11/16
Bi-Directional Coupler	HP	778D	1144A08107	05/06/13	05/06/15

*EMI RECEIVER SOFTWARE VERSION

The receiver firmware used was version 4.43 Service Pack 3

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Applicant: NAVICO AUCKLAND LTD

FCC ID: RAYHALO

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