Report on the FCC and Industry Canada Testing of:

Alphatron Marine USA Inc
25kW X-Band Marine Radar Scanner/Tx/Rx,
Model: NKE 2255

In accordance with FCC 47 CFR Part 80, FCC 47 CFR Part 2, Industry Canada RSS-238 and Industry Canada RSS-GEN

Prepared for: Alphatron Marine USA Inc
1205, Butler Road, League City, TEXAS, 77573
UNITED STATES

FCC ID: 2ADJKNKE2255 IC: 12477A-NKE2255

Add value.
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Document Number: 75942754-01 | Issue: 02

SIGNATURE			
			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Matthew Russell	Senior Engineer	Authorised Signatory	28 March 2019

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT
The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 80, FCC 47 CFR Part 2, Industry Canada RSS-238 and Industry Canada RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

SIGNATURE			
			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Neil Rousell	Test Engineer	Testing	28 March 2019
Graeme Lawler	Test Engineer	Testing	28 March 2019

FCC Accreditation
90987 Octagon House, Fareham Test Laboratory

Industry Canada Accreditation
IC2932B-1 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with FCC 47 CFR Part 80: 2017, FCC 47 CFR Part 2: 2017, Industry Canada RSS-238: Issue 01 (07-2013) and Industry Canada RSS-GEN: Issue 05 (04-2018).

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Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	30 January 2019
2	FCC ID and IC ID amended	

Table 1

1.2 Introduction

Applicant	Alphatron Marine USA Inc
Manufacturer	Alphatron Marine USA Inc
Model Number(s)	NKE-2255
Serial Number(s)	LC30003
Hardware Version(s)	Issue 01 (07-2013)
Software Version(s)	v00.00.01.00
Number of Samples Tested	1
Test Specification/Issue/Date	FCC 47 CFR Part 80: 2017 FCC 47 CFR Part 2: 2017 Industry Canada RSS-238: Issue 01 (07-2013) Industry Canada RSS-GEN: Issue 05 (04-2018)
Order Number Date	2018PO-00399 17-April-2018
Date of Receipt of EUT	11-June-2018
Start of Test	17-July-2018
Finish of Test	16-November-2018
Name of Engineer(s)	Neil Rousell and Graeme Lawler
Related Document(s)	ITU-R M.1177-4 ITU-R SM 1541-6 Keysight Radar Measurements Application Note – 5989-7575EN

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 80, FCC 47 CFR Part 2, Industry Canada RSS-238 and Industry Canada RSS-GEN is shown below.

Section	Specification Clause				Test Description	Result	Comments/Base Standard
	Part 80	Part 2	RSS-238	RSS-GEN			
Configuration and Mode: Transmit - 120 V AC 60 Hz							
2.1	80.205 and 80.207	2.1049	2.2 & 4.3	6.7	Occupied Bandwidth	Pass	ITU-R M.1177-4
2.2	80.209(b)	2.1055	4.1	6.11	Transmitter Frequency Stability	Pass	
2.3	80.211(f)	2.1051	4.3	6.13	Spurious Emissions at Antenna Terminals	Pass	ITU-R M.1177-4 Keysight Radar Measurements Application Note – 5989-7575EN
2.4	80.211(f)	2.1053	4.3	6.13	Radiated Spurious Emissions	Pass	
2.5	80.215(a)(3)	2.1046	4.2	6.12	RF Output Power	Pass	ITU-R M.1177-4
2.6	80.205 and 80.207	2.1047(d)	2.2 & 3.2(a)	-	Modulation Characteristics	Pass	ITU-R M.1177-4

1.4 Application Form

EQUIPMENT DESCRIPTION	
Model Name/Number	NKE-2255 25KW X-Band Marine Radar Scanner/Tx/Rx
Part Number	NKE-2255
Hardware Version	v1.00 Production sample.
Software Version	v00.00.01.00
FCC ID (if applicable)	2ADJKNKE2255
Industry Canada ID (if applicable)	12477A-NKE2255
Technical Description (Please provide a brief description of the intended use of the equipment)	25kW scanner/turning unit for radar on high seas vessel.

INTENTIONAL RADIATORS									
Technology	Frequency Band (MHz)	Conducted Declared Output Power (dBm)	Antenna Gain (dBi)	Supported Bandwidth (s) (MHz)	Modulation Scheme(s)	ITU Emission Designator	Test Channels (MHz)		
							Bottom	Middle	Top
Magnetron	X-Band	44dBW	6FT HS - 30.1dBi 7FT - 30.8dBi 9FT - 31.7dBi	9.41GHz +/- 30MHz	Pulse	79M50PON	N/A	9.41 GHz	N/A

UN-INTENTIONAL RADIATOR	
Highest frequency generated or used in the device or on which the device operates or tunes	
Lowest frequency generated or used in the device or on which the device operates or tunes	
Class A Digital Device (Use in commercial, industrial or business environment) ☐ Class B Digital Device (Use in residential environment only) ☐	

Power Source			
AC	Single Phase	Three Phase	Nominal Voltage
	120 V		
External DC	Nominal Voltage		Maximum Current
	24 V (via AC/DC convertor)		
Battery	Nominal Voltage		Battery Operating End Point Voltage
	N/A		
Can EUT transmit whilst being charged?			Yes ☐ No ☐

EXTREME CONDITIONS			
Maximum temperature	+55°C (operational) +70C (storage)	Minimum temperature	-25°C (operational and storage).

Ancillaries
Please list all ancillaries which will be used with the device.
Depends upon the model of radar used with the NKE-2255 scanner - See TUV MED Cert: MED000113 issue3 21 May.18 - p2/5.

ANTENNA CHARACTERISTICS				
☐	Antenna connector		State impedance	Ohm
☐	Temporary antenna connector		State impedance	Ohm
☒	Integral antenna	Type		
☐	External antenna	Type		

I hereby declare that the information supplied is correct and complete.

Name: James Moon

Position held: Compliance Manager Date: 21 June 2018

1.5 Product Information

1.5.1 Technical Description

25kW scanner/turning unit for radar on high seas vessel. Antenna information is displayed in the tables below.

1.5.2 Antenna Details

The information below was supplied by the manufacturer: Japan Radio Company Ltd

ITU emission type	79M50PON
Gain	30.1 dBi
Beam width	Horizontal: < 1.2°
Side lobe suppression values End lobe suppression values	< -23dB within ± 10°, <-30 outside ± 10°

Table 2 NKE – 2225 - 6HS 6ft

ITU emission type	79M50PON
Gain	30.8 dBi
Beam width	< 1.0°
Side lobe suppression values End lobe suppression values	< -23dB within ± 10°, <-30 outside ± 10°

Table 3 NKE – 2255 - 7 7ft

ITU emission type	79M50PON
Gain	31.7 dBi
Beam width	< 0.8°
Side lobe suppression values End lobe suppression values	< -23dB within ± 10°, <-30 outside ± 10°

Table 4 NKE – 2255 - 9 9ft

1.5.3 Test Setup Diagram(s)

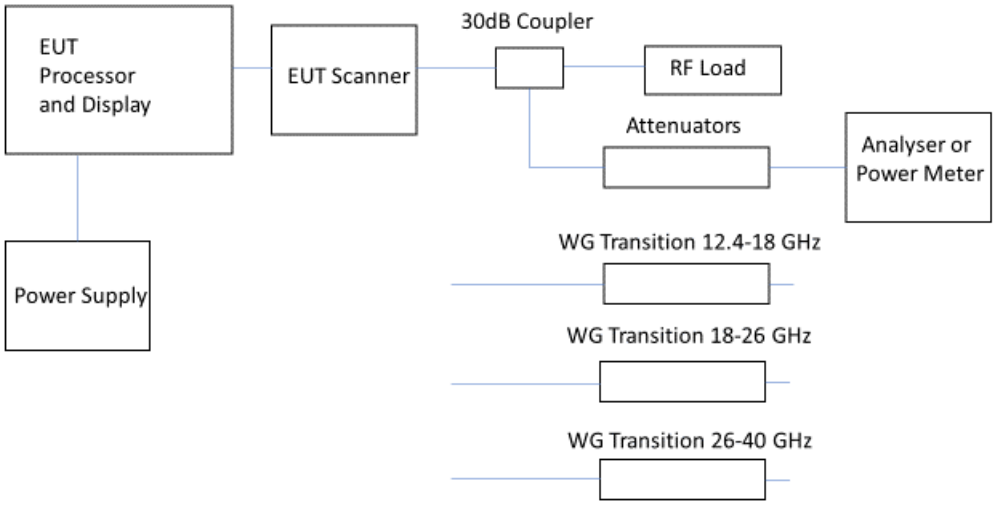
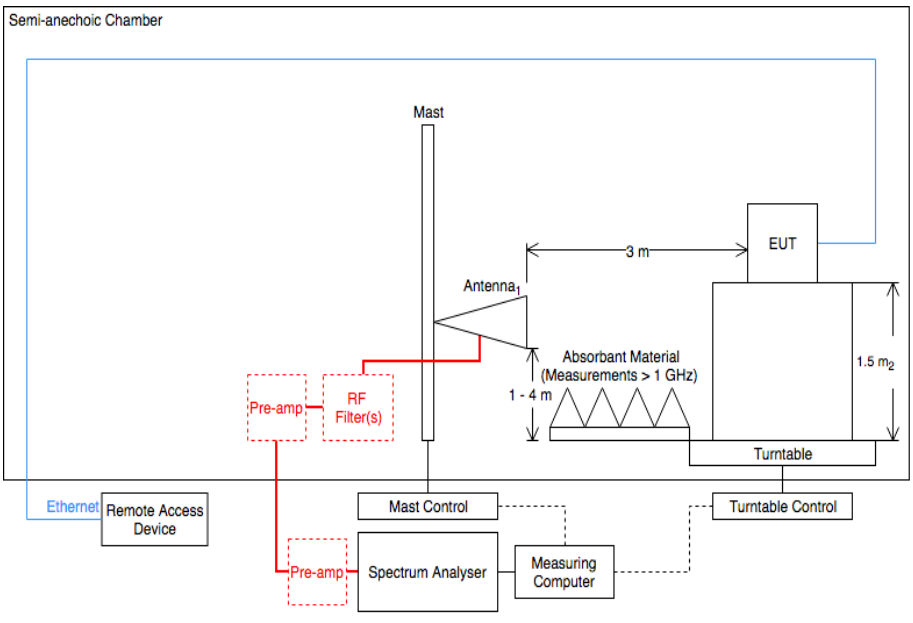


Figure 1 - Test Configuration for Conducted Measurements



1 Antenna is boresighted for measurements < 1 GHz.
2 Height from the EUT to ground is 0.8 m for measurements < 1 GHz.

Figure 2 – Radiated Spurious Emissions Setup

1.5.4 EUT Configuration and Rationale for Radiated Spurious Emissions

The EUT was placed on the non-conducting platform in a manner typical of a normal installation.

Ports on the EUT were terminated with loads as described in ANSI C63.4 clause 6.2.4. For EUT's with multiple connectors of the same type, additional interconnecting cables were connected, and pre-scans performed to determine whether the level of the emissions were increased by >2 dB.

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Serial Number: LC30003			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 5

1.8 Test Location

TÜV SÜD conducted the following tests at our Fareham Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: Transmit - 120 V AC 60 Hz		
Occupied Bandwidth	Neil Rousell	UKAS
Transmitter Frequency Stability	Neil Rousell	UKAS
Spurious Emissions at Antenna Terminals	Neil Rousell	UKAS
Radiated Spurious Emissions	Graeme Lawler	UKAS
RF Output Power	Neil Rousell	UKAS
Modulation Characteristics	Neil Rousell	UKAS

Table 6

Office Address:

Octagon House
Concorde Way
Segensworth North
Fareham
Hampshire
PO15 5RL
United Kingdom

2 Test Details

2.1 Occupied Bandwidth

2.1.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.205 & 80.207
FCC 47 CFR Part 2, Clause 2.1049
Industry Canada RSS-238, Clause 2.2 & 4.3
Industry Canada RSS-GEN, Clause 6.7

2.1.2 Equipment Under Test and Modification State

NKE – 2255, S/N: LC30003 - Modification State 0

2.1.3 Date of Test

30-July-2018

2.1.4 Test Method

The measurements were made using a Spectrum Analyser with the RBW set to 1 MHz and the VBW to 3 MHz

40 dB bandwidth

The detector was set to RMS and a long sweep time employed with the trace set to Max Hold. The peak of the fundamental was measured and markers at -40 dBc were positioned above and below the center frequency. The Marker Delta function result was recorded.

Occupied (99%) bandwidth

A Peak Detector and Max Hold trace were used.

2.1.5 Environmental Conditions

Ambient Temperature	25.6 °C
Relative Humidity	60.2 %

2.1.6 Test Results

Transmit - 120 V AC 60 Hz

Pulse type	-40 dB Bandwidth (MHz)
LP3	34.7
LP2	37.8
LP1	42.4
MP3	61.8
MP2	72.9
MP1	83.7
SP1	127.5

Table 7 – 40dB Bandwidth Results

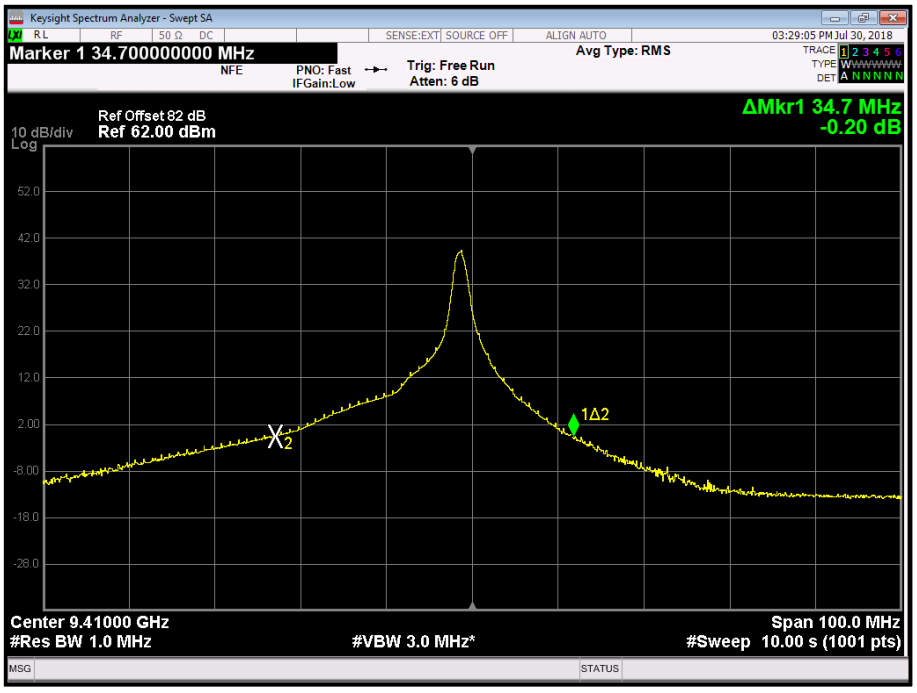


Figure 3 - LP3

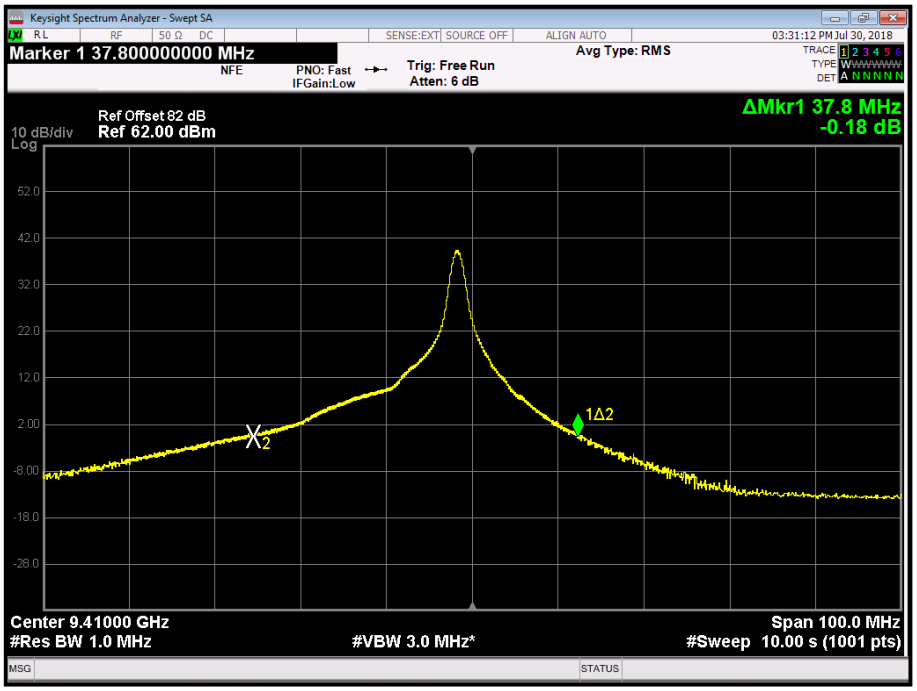


Figure 4 - LP2

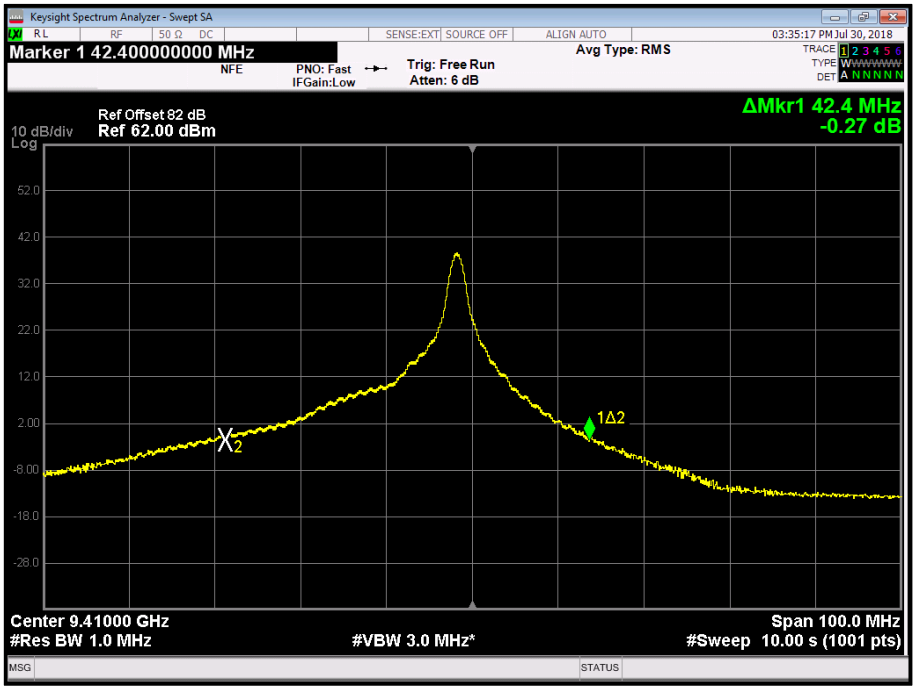


Figure 5 - LP1

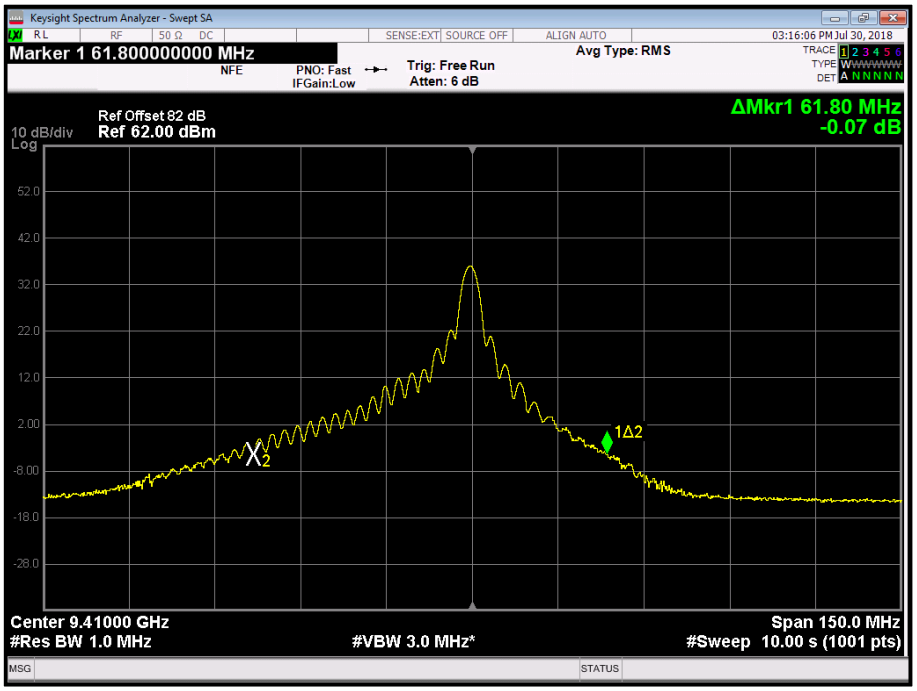


Figure 6 - MP3

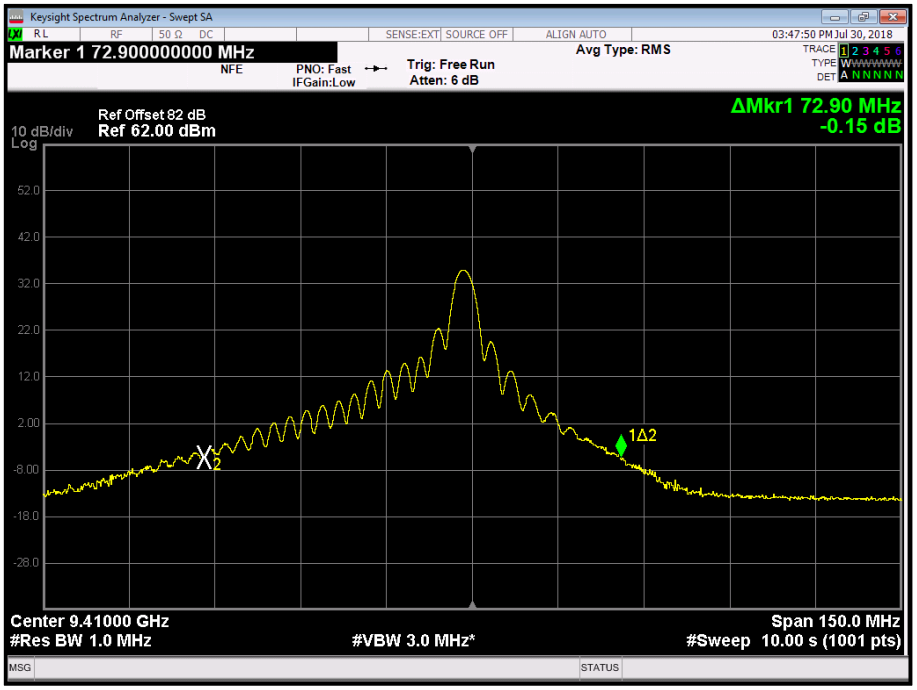


Figure 7 - MP2

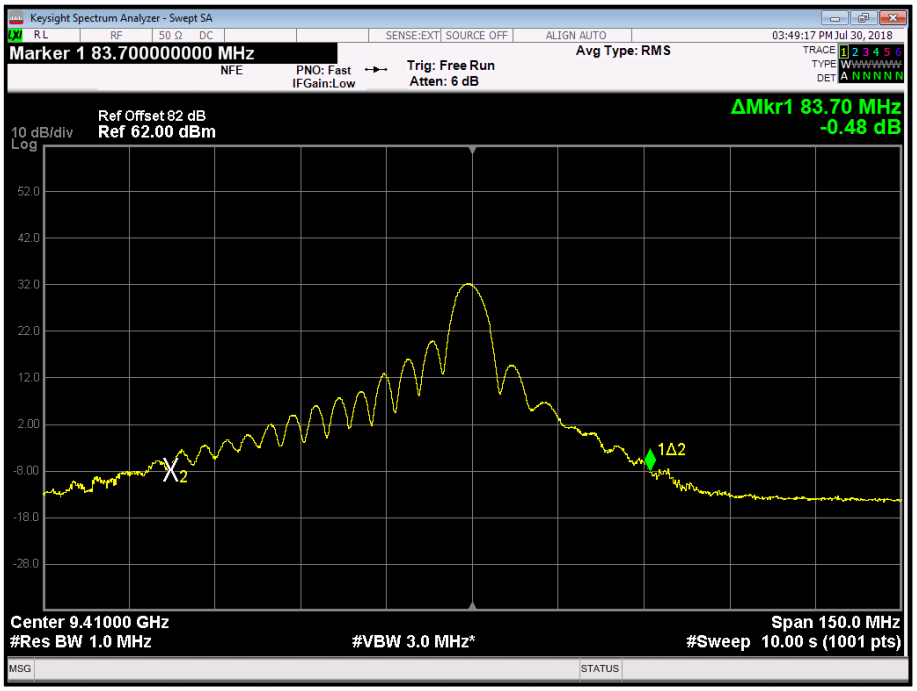


Figure 8 - MP1

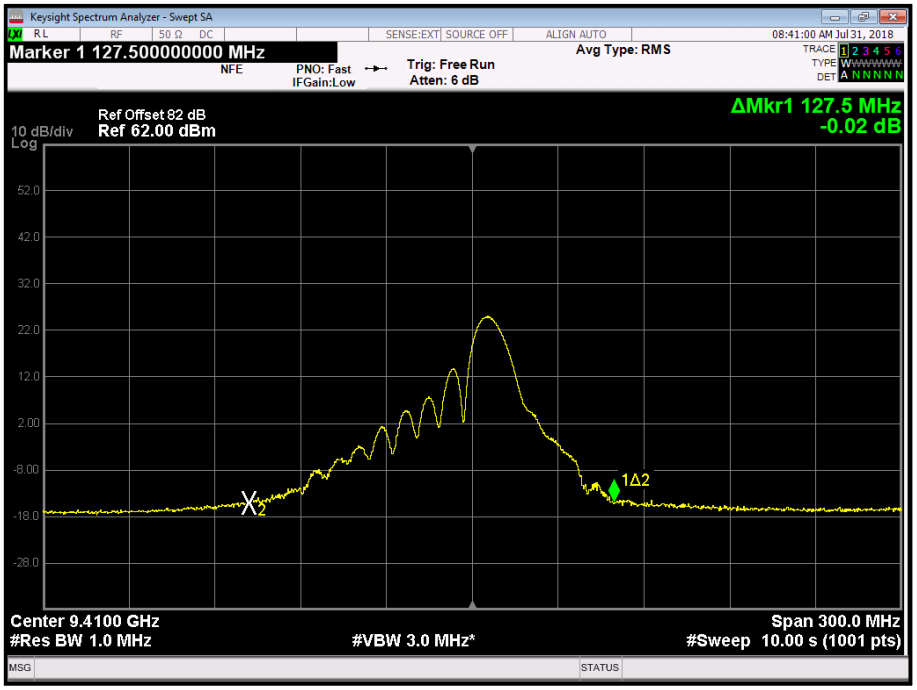


Figure 9 - SP1

Transmit - 120 V AC 60 Hz

Pulse type	Occupied Bandwidth (MHz)

LP3	9.4
LP2	10.5
LP1	10.7
MP3	19.9
MP2	23.9
MP1	34.0
SP1	51.0

Table 5 - Occupied Bandwidth Results

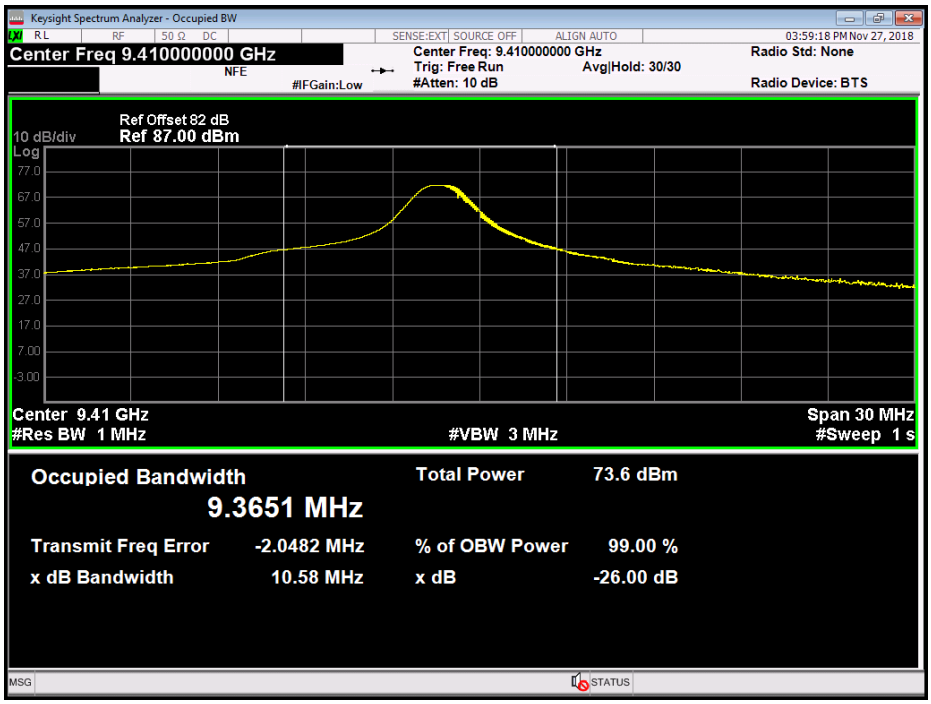


Figure 10 - LP3

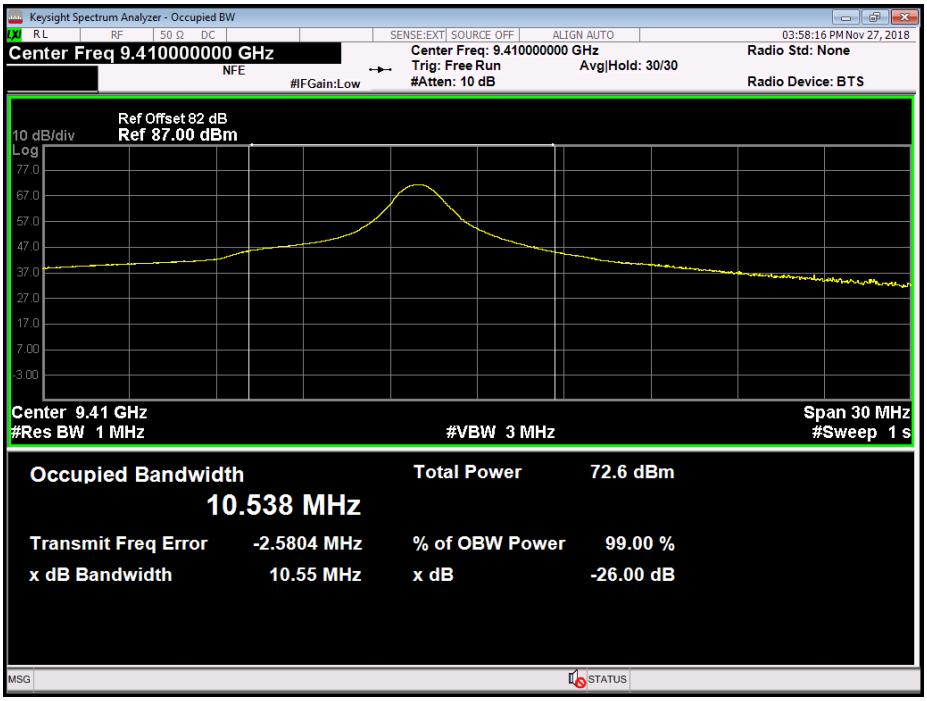


Figure 11 - LP2

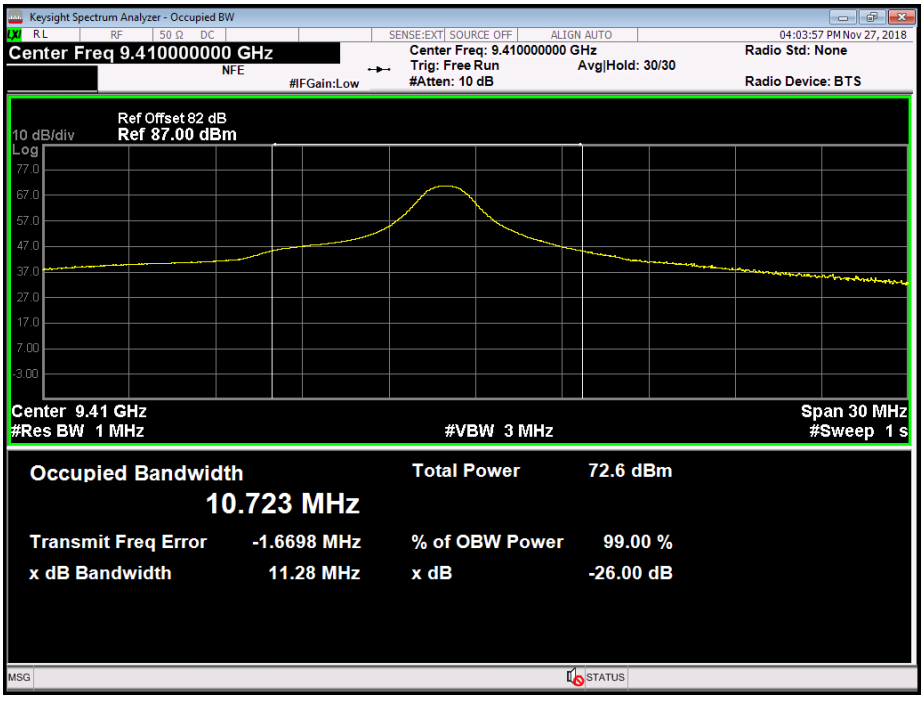


Figure 12 - LP1

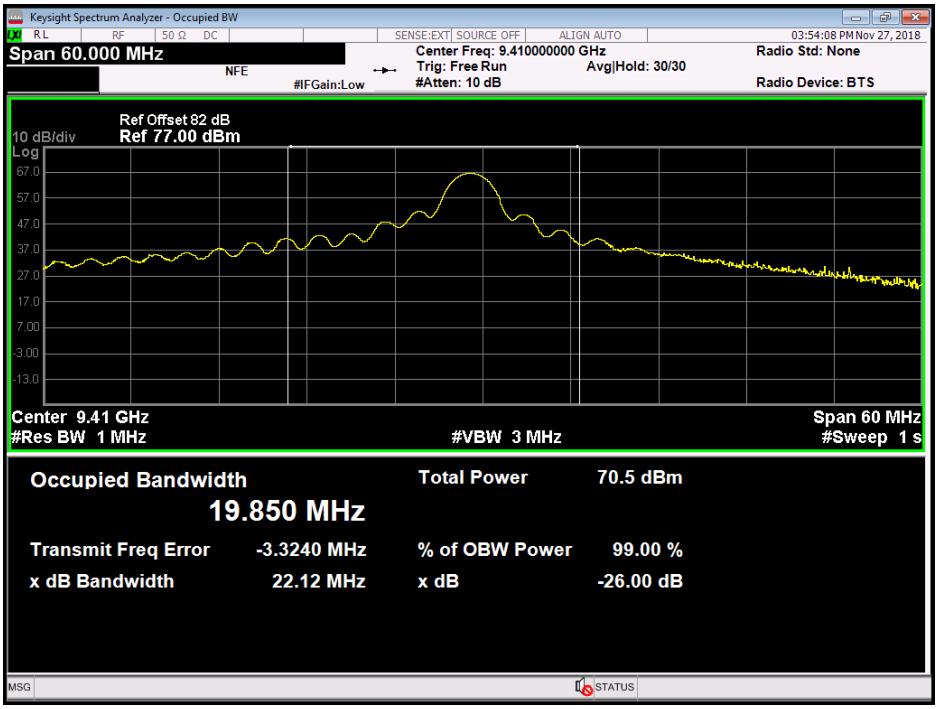


Figure 13 - MP3

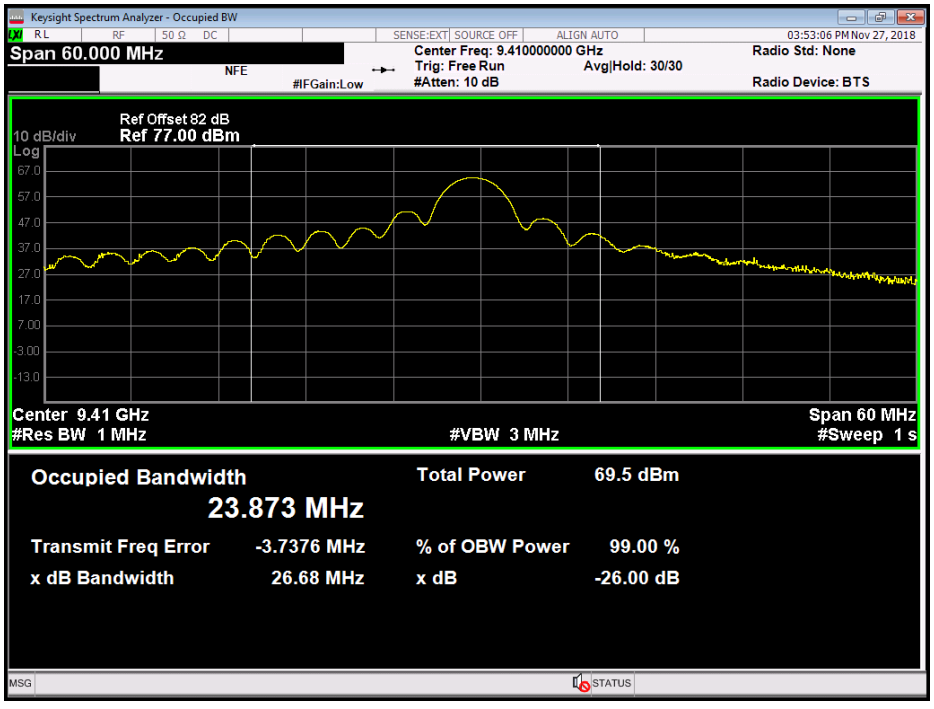


Figure 14 - MP2

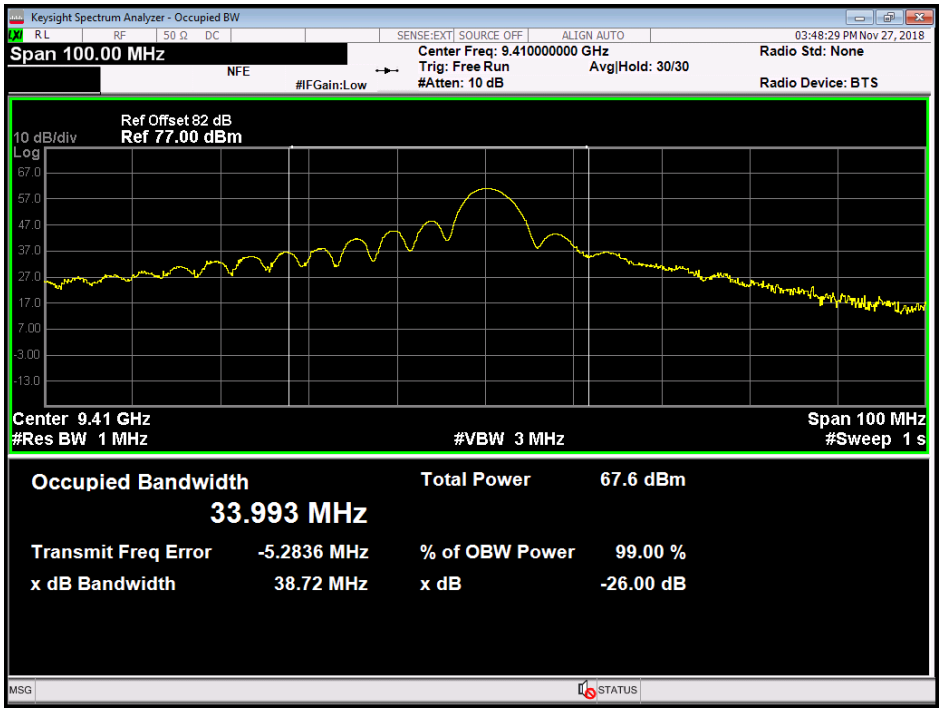


Figure 15 - MP1

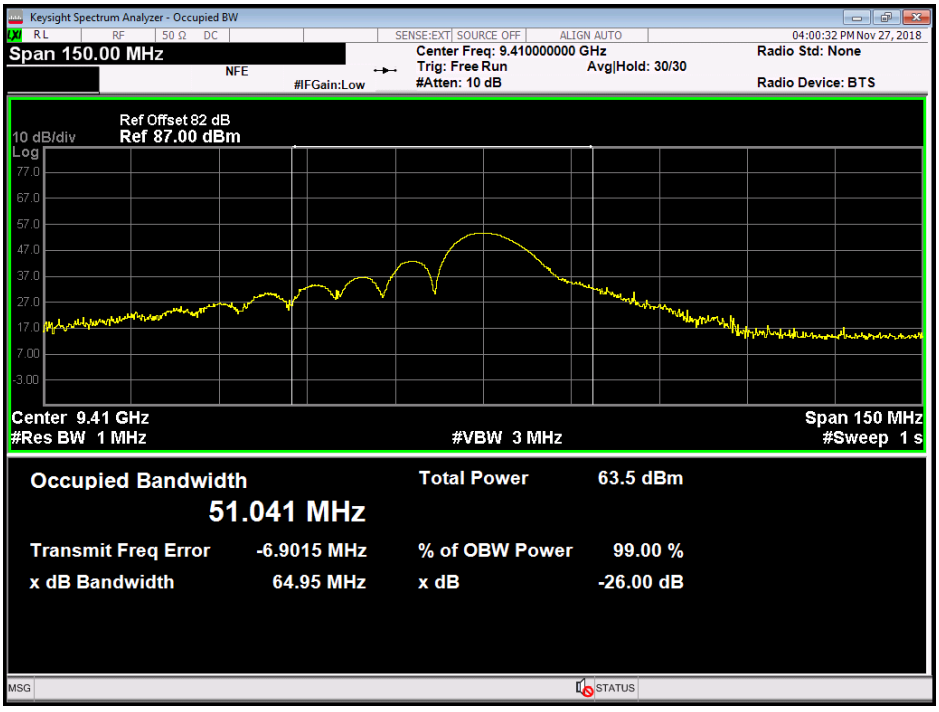


Figure 16 - SP1

FCC 47 CFR Part 80, Limit Clause 80.209(b)

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

Remarks:

See also Frequency Stability for demonstration of compliance fundamental <1.5/T MHz of upper and lower authorised bandwidth.

Industry Canada RSS-238

None Specified

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Programmable Power Supply	California Inst	2001RP	1898	-	TU
Hygromer	Rotronic	Hygropalm	2404	12	26-Apr-2019
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	06-Oct-2018
Coupler	ATM	90-302A-30-6-6	H328005-01	-	O/P Mon
Load	Pasternack	PE6824	-	-	TU
Attenuator (20dB, 100W)	Weinschel	48-20-43	4870	12	17-Jul-2019
Attenuator (30dB, 100W)	Weinschel	48-30-43	4871	12	17-Jul-2019
Cable (18GHz	Rosenberger	LU7-036-2000	5038	-	O/P Mon
Cable (18GHz	Rosenberger	LU7-036-2000	5039	-	O/P Mon

Table 6

TU – Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.2 Transmitter Frequency Stability

2.2.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.209(b),
FCC 47 CFR Part 2, Clause 2.1055
Industry Canada RSS-238, Clause 4.1
Industry Canada RSS-GEN, Clause 6.11

2.2.2 Equipment Under Test and Modification State

NKE – 2255, Serial Number: LC30003 - Modification State 0

2.2.3 Date of Test

17-July-2018 to 18-July-2018

2.2.4 Test Method

This test was performed in accordance with ANSI C63.26 clause 5.6 and Industry Canada RSS-GEN clause 6.11.

The EUT was placed in a Climatic Chamber and its Frequency Error measured over the temperature range of -30°C to +50°C. In addition, measurements were made at ±15 % of the nominal voltage at 20°C. A Spectrum Analyser was used with a Peak detector and Max Hold trace. Once the trace had stabilized, a marker was used to measure the peak and record the frequency. Extreme temperature Frequency Error measurement results were made against a reference measurement at 20 ºC and compared with the specification limits.

2.2.5 Environmental Conditions

Ambient Temperature	21.8 °C
Relative Humidity	44.0 %

2.2.6 Test Results

Transmit - 120 V AC 60 Hz

Voltage	Measured Frequency (MHz)	Frequency Error (ppm)
102 V AC 60 Hz	9412.394614	-398.05
120 V AC 60 Hz	9416.140281	0
138 V AC 60 Hz	9414.641696	-159.25

Table 7 - Frequency Stability Under Voltage Variations, Pulse Type SP1

Voltage	Measured Frequency (MHz)	Frequency Error (ppm)
102 V AC 60 Hz	9411.177982	-205.78
120 V AC 60 Hz	9413.114351	0
138 V AC 60 Hz	9413.455527	36.26

Table 8 - Frequency Stability Under Voltage Variations, Pulse Type MP1

Voltage	Measured Frequency (MHz)	Frequency Error (ppm)
102 V AC 60 Hz	9411.619310	-237.76
120 V AC 60 Hz	9413.856642	0
138 V AC 60 Hz	9412.900080	-101.65

Table 9 - Frequency Stability Under Voltage Variations, Pulse Type MP2

Voltage	Measured Frequency (MHz)	Frequency Error (ppm)
102 V AC 60 Hz	9412.491790	-179.45
120 V AC 60 Hz	9414.180414	0
138 V AC 60 Hz	9413.523763	-69.78

Table 10 - Frequency Stability Under Voltage Variations, Pulse Type MP3

Voltage	Measured Frequency (MHz)	Frequency Error (ppm)
102 V AC 60 Hz	9411.537579	-99.31
120 V AC 60 Hz	9412.472099	0
138 V AC 60 Hz	9411.727342	-79.15

Table 11 - Frequency Stability Under Voltage Variations, Pulse Type LP1

Voltage	Measured Frequency (MHz)	Frequency Error (ppm)
102 V AC 60 Hz	9411.537579	-63.48
120 V AC 60 Hz	9412.472099	0
138 V AC 60 Hz	9411.727342	46.43

Table 12 - Frequency Stability Under Voltage Variations, Pulse Type LP2

Voltage	Measured Frequency (MHz)	Frequency Error (ppm)
102 V AC 60 Hz	9411.537579	-69.25
120 V AC 60 Hz	9412.472099	0
138 V AC 60 Hz	9411.727342	-59.60

Table 13 - Frequency Stability Under Voltage Variations, Pulse Type LP3

Temperature	Measured Frequency (MHz)	Frequency Error (ppm)
+50 °C	9409.792777	-674.55
+40 °C	9412.875934	-346.90
+30 °C	9411.443060	-499.17
+20 °C	9416.140281	0.00
+10 °C	9415.782287	-38.04
0 °C	9419.444153	351.10
-10 °C	9417.854002	182.12
-20 °C	9422.213486	645.40
-30 °C	9423.728794	806.43
FCC Limits: 80.209(b) 1.5/T MHz	Lower: 9321.428571 MHz Upper: 9478.571429 MHz	

Table 14 - Frequency Stability Under Temperature Variations, Pulse Type SP1

Temperature	Measured Frequency (MHz)	Frequency Error (ppm)
+50 °C	9408.632433	-589.58
+40 °C	9410.993228	-338.70
+30 °C	9411.174038	-319.49
+20 °C	9414.180414	0.00
+10 °C	9414.600151	44.61
0 °C	9418.263553	433.91
-10 °C	9416.525279	249.19
-20 °C	9419.760810	593.03
-30 °C	9421.802847	810.04
FCC Limits: 80.209(b) 1.5/T MHz	Lower: 9307.5 MHz Upper: 9492.5 MHz	

Table 15 - Frequency Stability Under Temperature Variations, Pulse Type MP1

Temperature	Measured Frequency (MHz)	Frequency Error (ppm)
+50 °C	9407.419174	-684.11
+40 °C	9410.966359	-307.15
+30 °C	9411.355551	-265.79
+20 °C	9413.856642	0.00
+10 °C	9414.744732	94.38
0 °C	9416.716257	303.89
-10 °C	9415.535359	178.40
-20 °C	9419.032488	550.04
-30 °C	9420.901153	748.62
FCC Limits: 80.209(b) 1.5/T MHz	Lower: 9305 MHz Upper: 9495 MHz	

Table 16 - Frequency Stability Under Temperature Variations, Pulse Type MP2

Temperature	Measured Frequency (MHz)	Frequency Error (ppm)
+50 °C	9407.600484	-585.96
+40 °C	9410.765610	-249.60
+30 °C	9410.768604	-249.28
+20 °C	9413.114351	0.00
+10 °C	9414.745811	173.38
0 °C	9417.593038	475.95
-10 °C	9416.427470	352.08
-20 °C	9419.370584	664.85
-30 °C	9421.566887	898.25
FCC Limits: 80.209(b) 1.5/T MHz	Lower: 9303.75 MHz Upper: 9496.25 MHz	

Table 17 - Frequency Stability Under Temperature Variations, Pulse Type MP3

Temperature	Measured Frequency (MHz)	Frequency Error (ppm)
+50 °C	9407.034916	-568.98
+40 °C	9409.647479	-291.34
+30 °C	9411.205352	-125.79
+20 °C	9412.389013	0.00
+10 °C	9415.040191	281.74
0 °C	9416.286556	414.19
-10 °C	9415.855703	368.40
-20 °C	9419.202186	724.04
-30 °C	9420.765881	890.21
FCC Limits: 80.209(b) 1.5/T MHz	Lower: 9301.875 MHz Upper: 9498.125 MHz	

Table 18 - Frequency Stability Under Temperature Variations, Pulse Type LP1

Temperature	Measured Frequency (MHz)	Frequency Error (ppm)
+50 °C	9407.355965	-452.52
+40 °C	9407.934227	-391.06
+30 °C	9410.502842	-118.10
+20 °C	9411.614144	0.00
+10 °C	9413.964201	249.74
0 °C	9415.707262	434.98
-10 °C	9415.611819	424.83
-20 °C	9419.780816	867.87
-30 °C	9420.244342	917.13
FCC Limits: 80.209(b) 1.5/T MHz	Lower: 9301.5 MHz Upper: 9498.5 MHz	

Table 19 - Frequency Stability Under Temperature Variations, Pulse Type LP2

Temperature	Measured Frequency (MHz)	Frequency Error (ppm)
+50 °C	9407.829363	-493.38
+40 °C	9408.982580	-370.83
+30 °C	9411.617152	-90.86
+20 °C	9412.472099	0.00
+10 °C	9415.187791	288.60
0 °C	9416.454721	423.23
-10 °C	9416.123998	388.09
-20 °C	9420.624941	866.40
-30 °C	9419.740929	772.46
FCC Limits: 80.209(b) 1.5/T MHz	Lower: 9301.25 MHz Upper: 9498.75 MHz	

Table 20 - Frequency Stability Under Temperature Variations, Pulse Type LP3

FCC 47 CFR Part 80, Limit Clause 80.209(b)

When pulse modulation is used in land and ship radar stations operating in the bands above 2.4 GHz the frequency at which maximum emission occurs must be within the authorized bandwidth and must not be closer than 1.5/T MHz to the upper and lower limits of the authorized bandwidth where ‘‘T’’ is the pulse duration in microseconds. In the band 14.00–14.05 GHz the centre frequency must not vary more than 10 MHz from 14.025 GHz.

Industry Canada RSS-238, Limit Clause 4.1

The carrier frequency shall not depart from the reference frequency in excess of 800 ppm for equipment which operates in the band 2900-3100 MHz nor in excess of 1250 ppm for equipment which operates in the band 9225-9500 MHz.

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1 and RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	20-Oct-2018
Programmable Power Supply	California Inst	2001RP	1898	-	O/P Mon
Hygrometer	Rotronic	I-1000	3220	12	30-Aug-2018
DMM	Fluke	179	4006	12	13-Dec-2018
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	20-Oct-2018
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	06-Oct-2018
Climatic Chamber	Aralab	FitoTerm 300E45	4823	-	O/P Mon
Coupler	ATM	90-302A-30-6-6	H328005-01	-	O/P Mon
Load	Pasternack	PE6824	-	-	TU

Table 21

O/P Mon – Output Monitored using calibrated equipment
TU – Traceability Unscheduled

2.3 Spurious Emissions at Antenna Terminals

2.3.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.211(f)
FCC 47 CFR Part 2, Clause 2.1051
Industry Canada RSS-238, Clause 4.3
Industry Canada RSS-GEN, Clause 6.13

2.3.2 Equipment Under Test and Modification State

NKE – 2255, Serial Number: LC30003 - Modification State 0

2.3.3 Date of Test

30-July-2018 to 16-November-2018

2.3.4 Test Method

<250 % Authorized Bandwidth

The EUT was connected to a Spectrum Analyser via a WR90 Waveguide Directional Coupler with additional attenuation. The mask reference level was set to the Peak value of the carrier. An RBW of 1 MHz and a VBW of 3 MHz was used for all tests. The mask was derived based on the measured 40 dB Bandwidth as measured in Section 2.3 of this report. For FCC measurements, an RMS detector was used and for Industry Canada, a Peak detector was utilised.

>250 % Authorized Bandwidth

The test equipment was configured as shown in the setup diagram. A search was made over the range 9 kHz to 40 GHz using a 1 MHz RBW and 3 MHz VBW filter. A peak detector was used in conjunction with a Max Hold trace. Any emissions that were noted over the test range were then measured in conjunction with 'Keysight Radar Measurements Application Note – 5989-7575EN'. The span was reduced and the RBW and sweep time adjusted to show the emission in a Pulse Spectrum view. The peak emission value was measured and recorded, and the true Peak value calculated to account for the Pulse Desensitization of the Spectrum Analyser. This result can be directly compared to the Industry Canada limit requirements. To determine compliance against FCC limits, a Duty Cycle Correction Factor based on the Pulse Characteristics, (see section 2.6), is applied to the Peak Level results to give the Average value.

Declared Carrier Power: 74 dBm
Industry Canada Limit: -60 dBc
Industry Canada Limit (dBm) = 74 – 60 = +14 dBm

FCC Limit = 74 - (43 + 10log(P)) = -13 dBm
where P = 25000 W

2.3.5 Environmental Conditions

Ambient Temperature	25.6 °C
Relative Humidity	60.2 %

2.3.6 Test Results

Transmit - 120 V AC 60 Hz (FCC)

<250 % Authorized Bandwidth Results

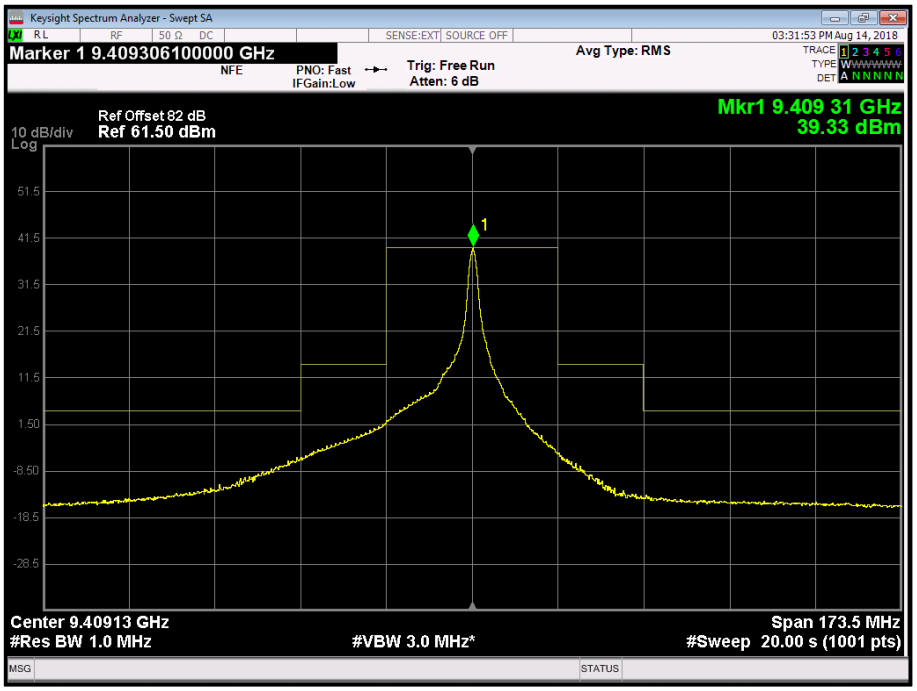


Figure 17 - Unmodulated / LP3 Pulse - FCC Transmitter Mask

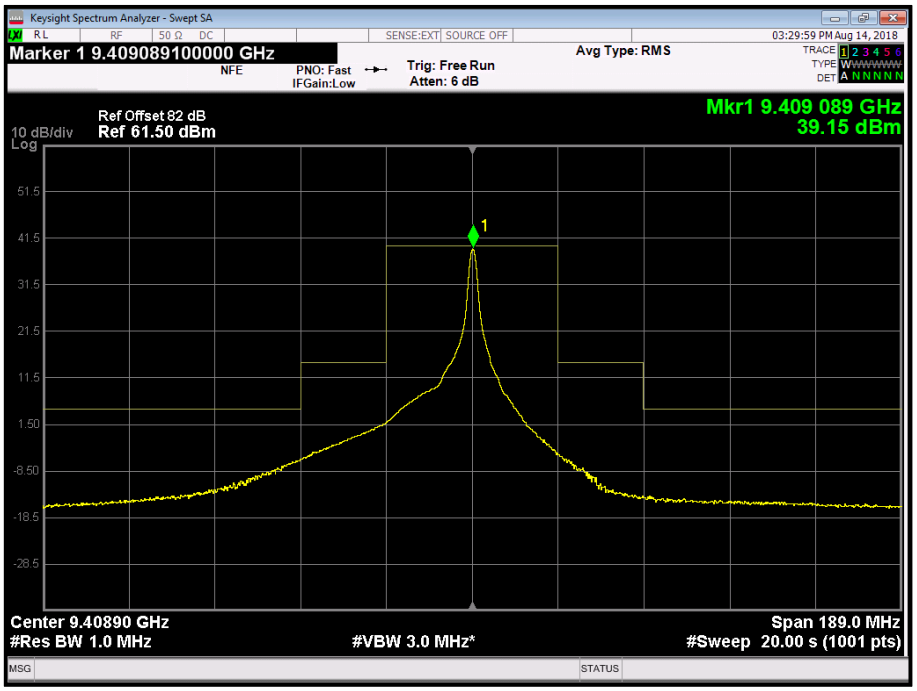


Figure 18 - Unmodulated / LP2 Pulse - FCC Transmitter Mask

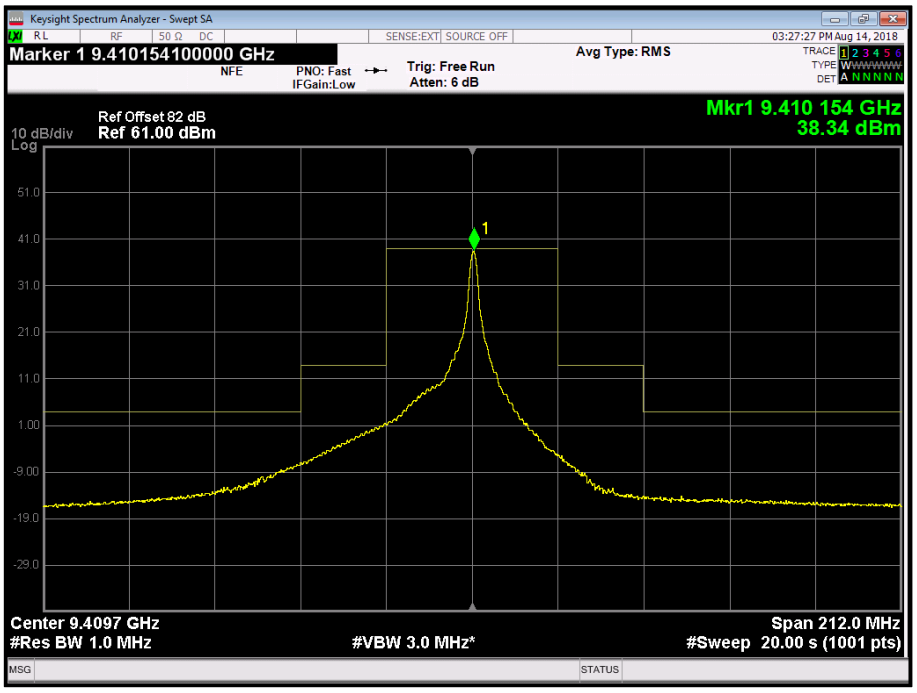


Figure 19 - Unmodulated / LP1 Pulse - FCC Transmitter Mask

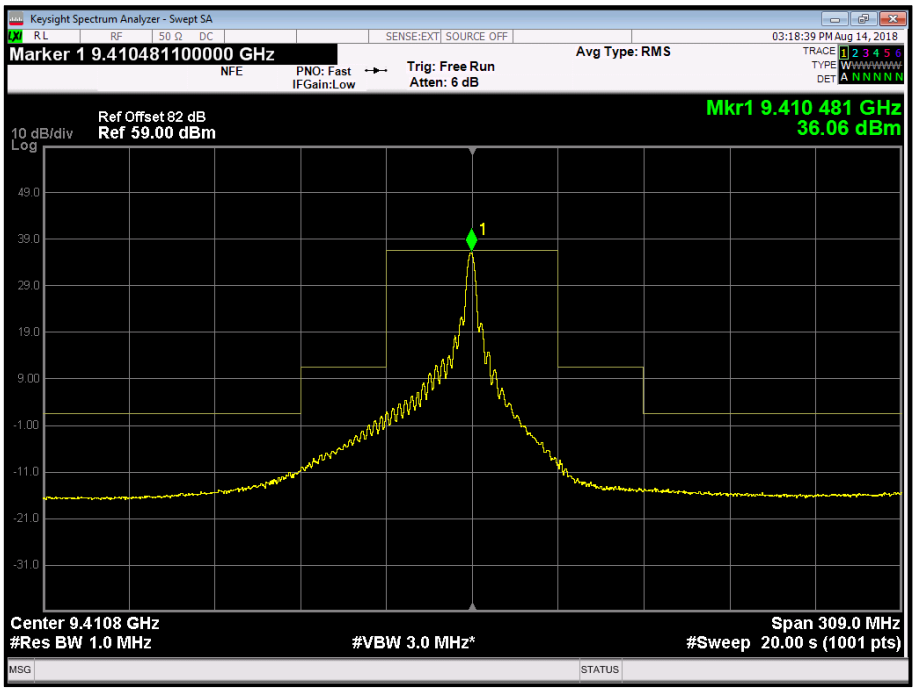


Figure 20 - Unmodulated / MP3 Pulse - FCC Transmitter Mask

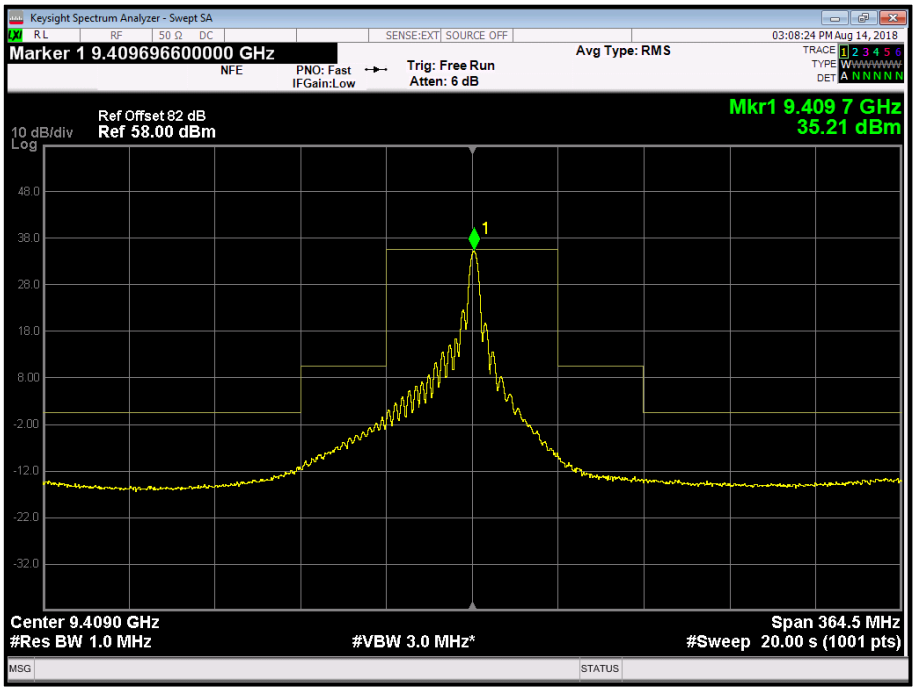


Figure 21 - Unmodulated / MP2 Pulse - FCC Transmitter Mask

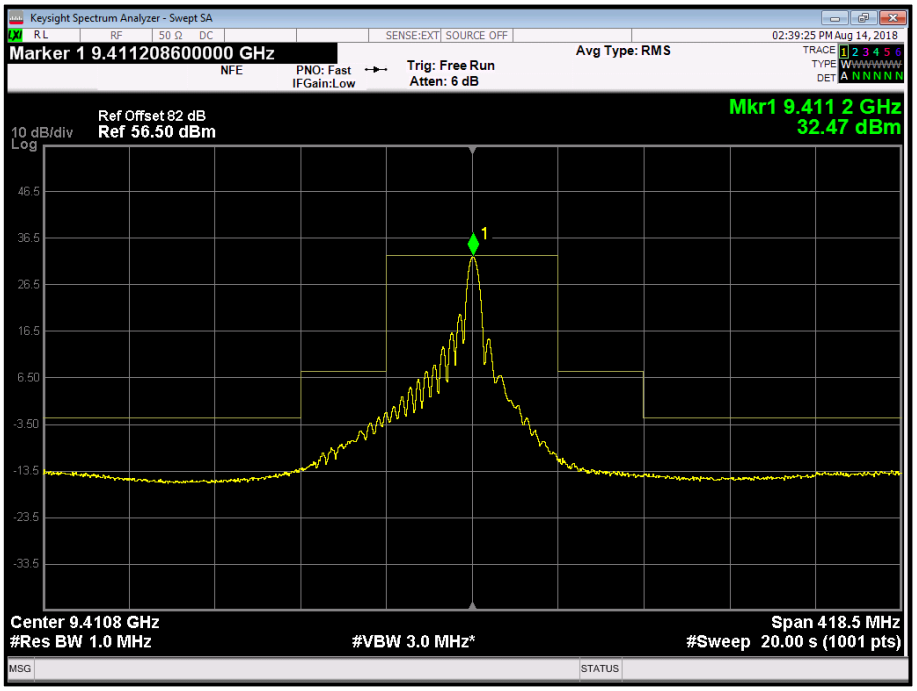


Figure 22 - Unmodulated / MP1 Pulse - FCC Transmitter Mask

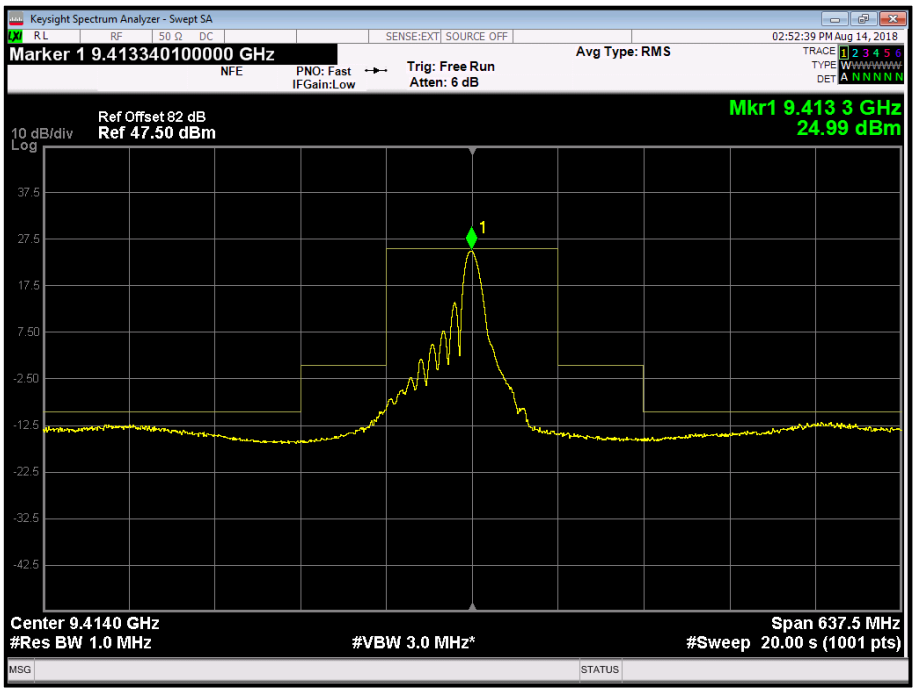


Figure 23 - Unmodulated / SP1 Pulse - FCC Transmitter Mask

Transmit - 120 V AC 60 Hz (ISED)

In accordance with ITU-R M.1177-4 Clause 4, the 40 dB Bandwidth was calculated for each pulse type, (SP1, MP1, MP2, MP3, LP1, LP2, LP3). The calculations used are detailed in ITU-R SM.1541-6 Annex 8 Clause 3.1. In this case, the Radar pulse type used for the calculations was for non-FM pulse radars:

$B_{-40} = K / SQRT(t * t_r)$

A value of K = 7.6 was used as the output power was <100 kW and the rise time for all pulses was <0.014t.

Based on the measured Pulse Rise and Pulse Width times, the 40 dB Bandwidths were calculated:

Pulse type	Pulse Width (us)	Pulse Rise Time (ns)	Calculated 40dB Bandwidth (MHz)
SP1	0.067	10.8	282.53
MP1	0.189	13.1	152.78
MP2	0.299	15.1	113.11
MP3	0.400	14.5	99.79
LP1	0.800	16.7	65.75
LP2	1.000	19.4	54.57
LP3	1.170	18.9	51.11

Table 8 – 40 dB Bandwidth for each Pulse Type

In accordance with RSS-238, the analyser RBW was set to 1 MHz and the VBW to 3 MHz. A Peak detector was configured with the trace set to Max Hold. The sweep points were set to > 2 * (Span / RBW). The trace was allowed to stabilize, and the result checked against the mask. The plots can be seen on the following pages.

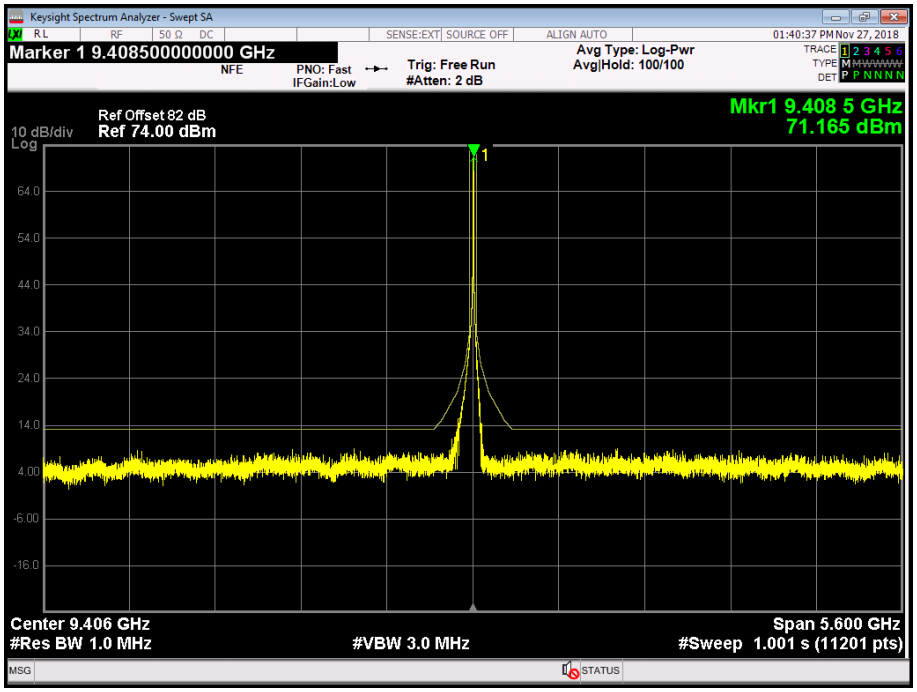


Figure 24 - Unmodulated / LP3 Pulse - Industry Canada Transmitter Mask

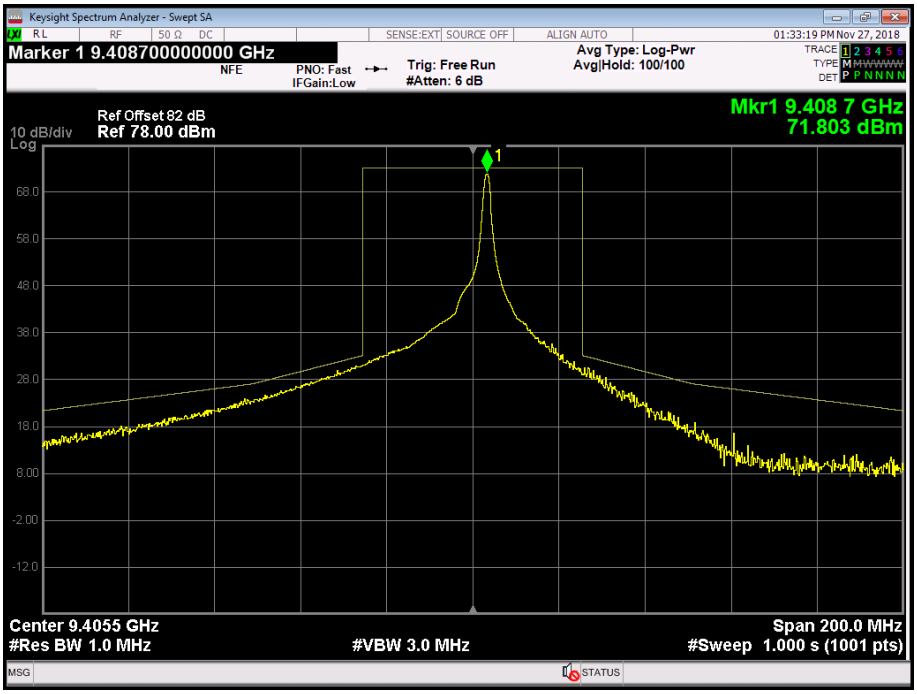


Figure 25 - Unmodulated / LP3 Pulse - Industry Canada Transmitter Mask Zoom

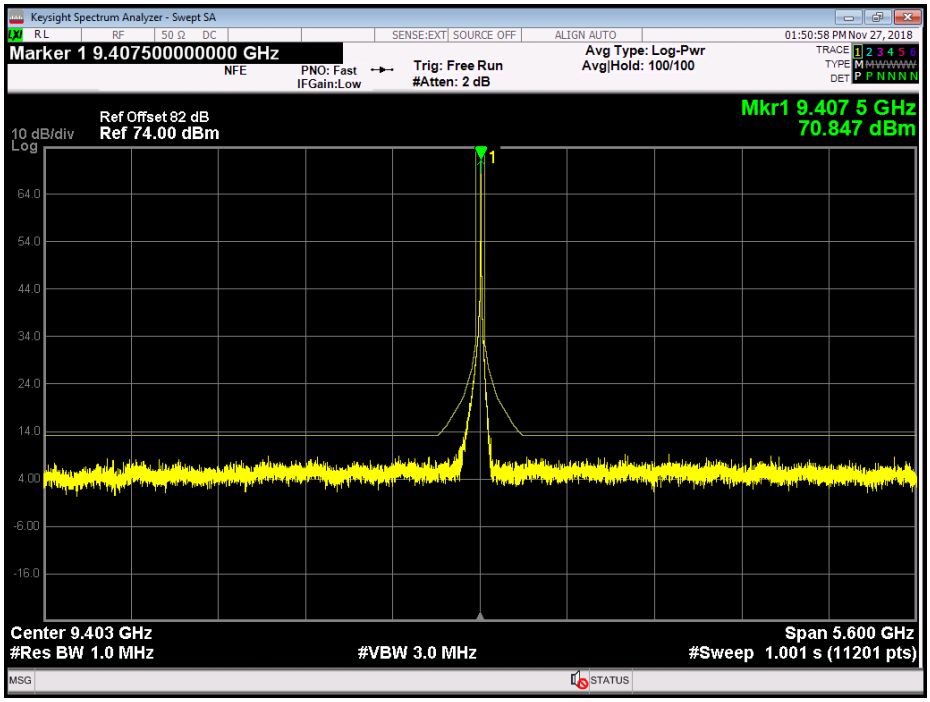


Figure 26 - Unmodulated / LP2 Pulse - Industry Canada Transmitter Mask

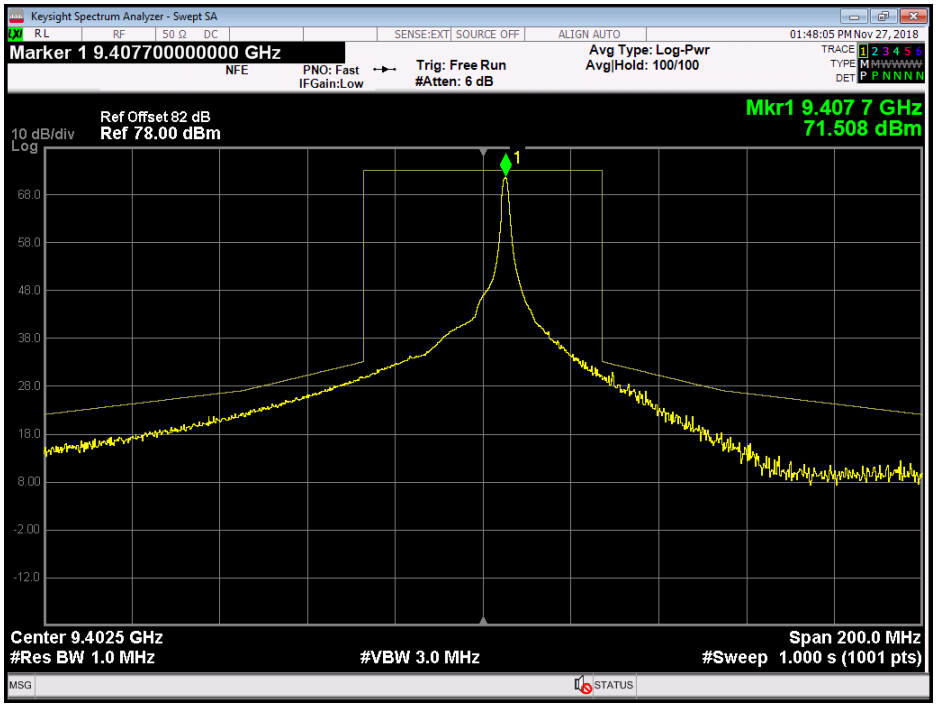


Figure 27 - Unmodulated / LP2 Pulse - Industry Canada Transmitter Mask Zoom

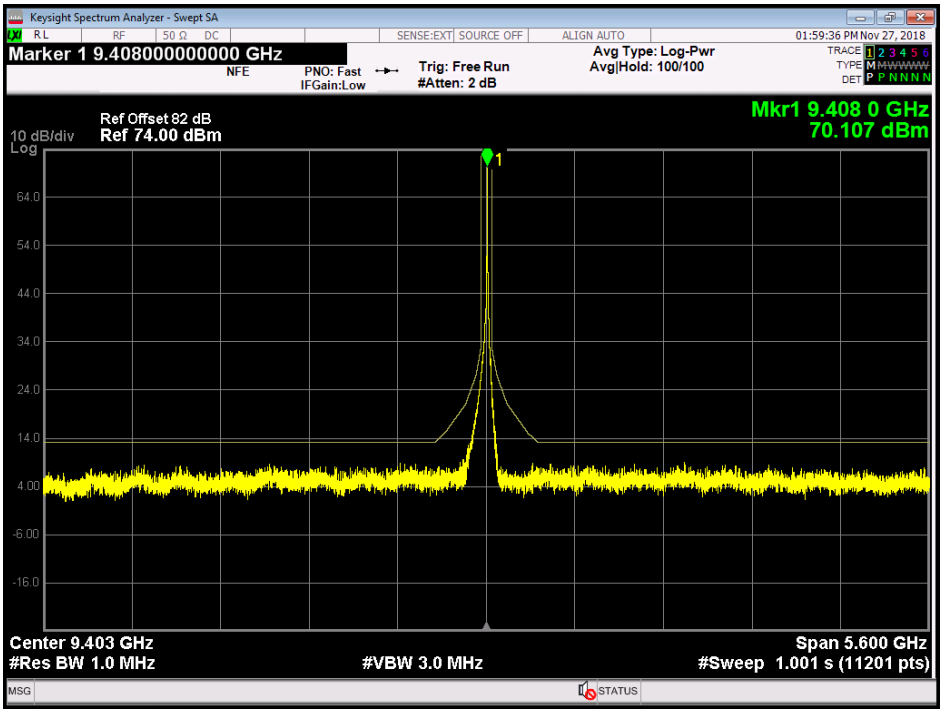


Figure 28 - Unmodulated / LP1 Pulse - Industry Canada Transmitter Mask

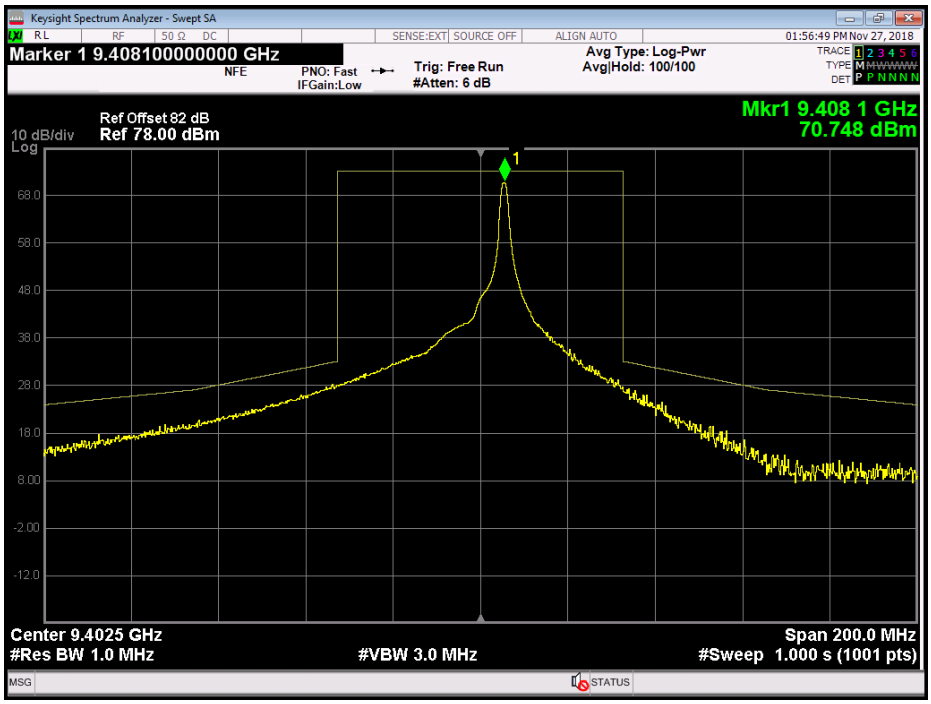


Figure 29 - Unmodulated / LP1 Pulse - Industry Canada Transmitter Mask Zoom

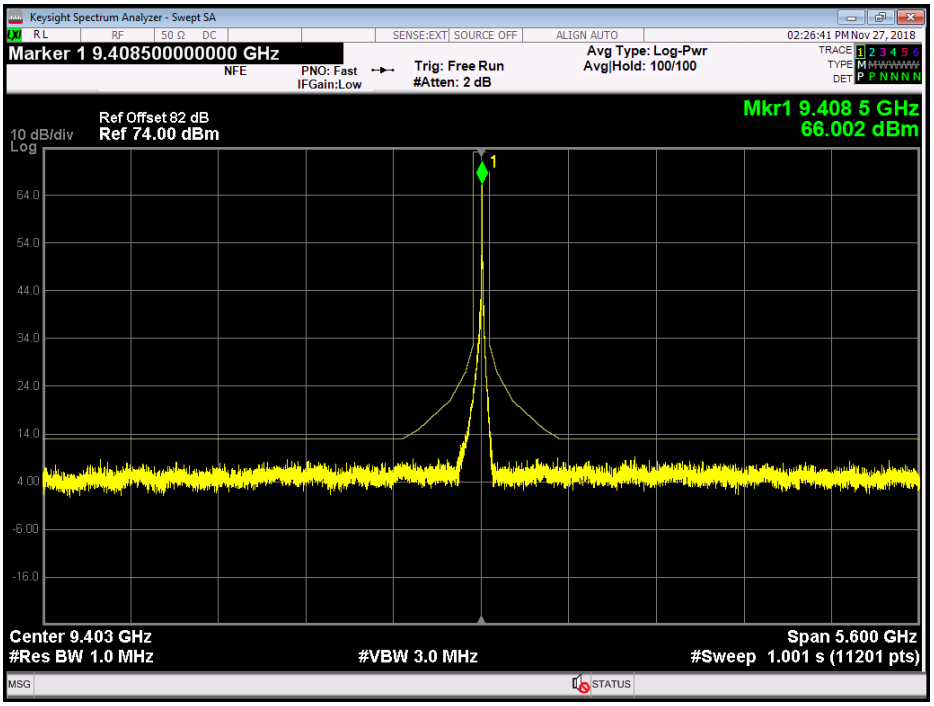


Figure 30 - Unmodulated / MP3 Pulse - Industry Canada Transmitter Mask

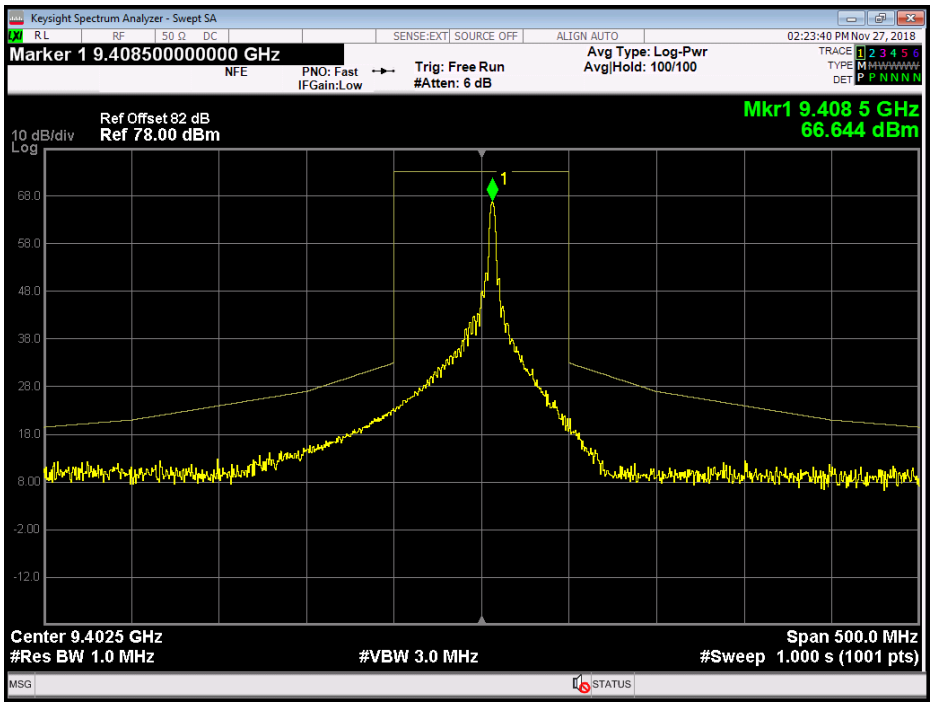


Figure 31 - Unmodulated / MP3 Pulse - Industry Canada Transmitter Mask Zoom

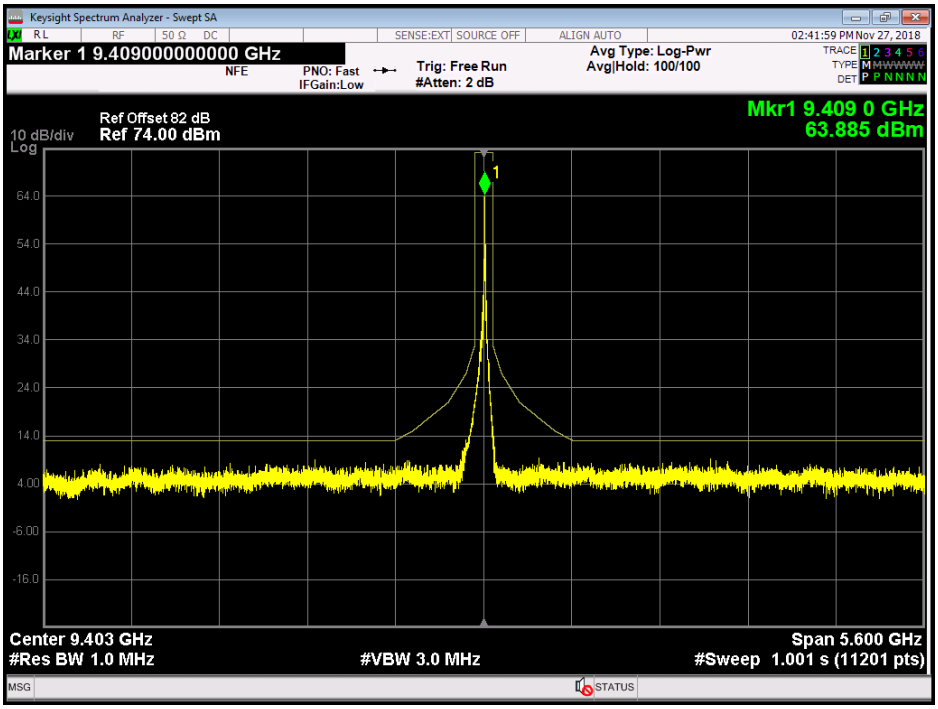


Figure 32 - Unmodulated / MP2 Pulse - Industry Canada Transmitter Mask

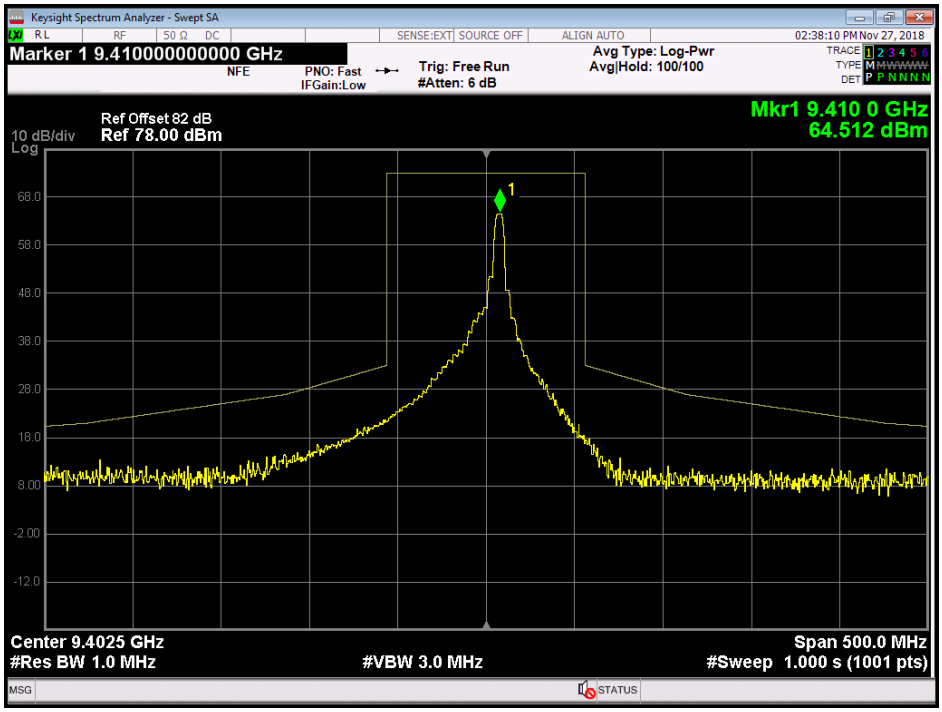


Figure 33 - Unmodulated / MP2 Pulse - Industry Canada Transmitter Mask Zoom

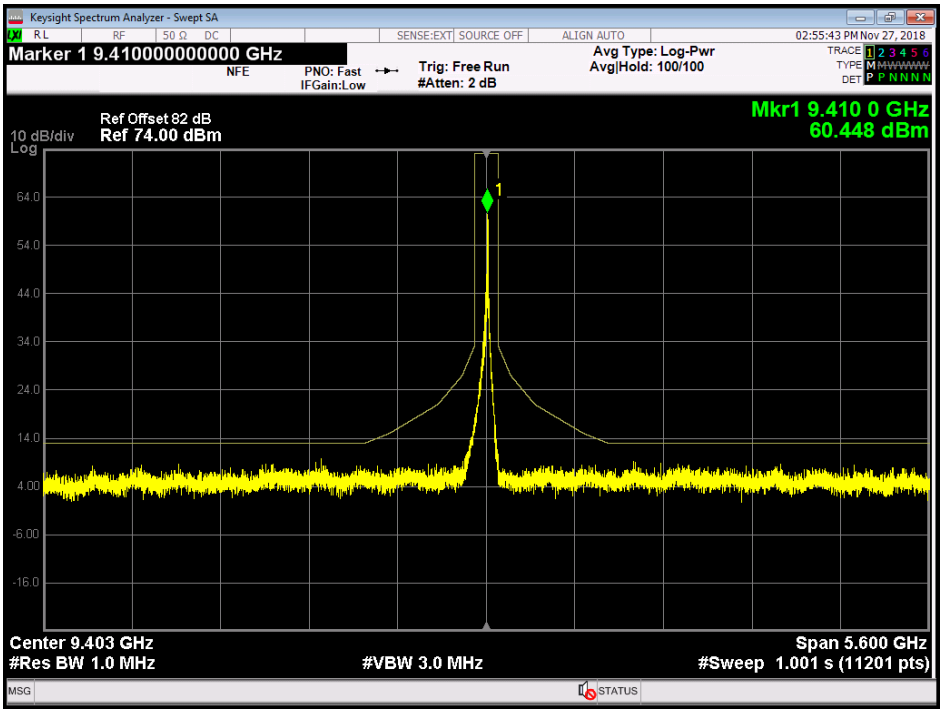


Figure 34 - Unmodulated / MP1 Pulse - Industry Canada Transmitter Mask

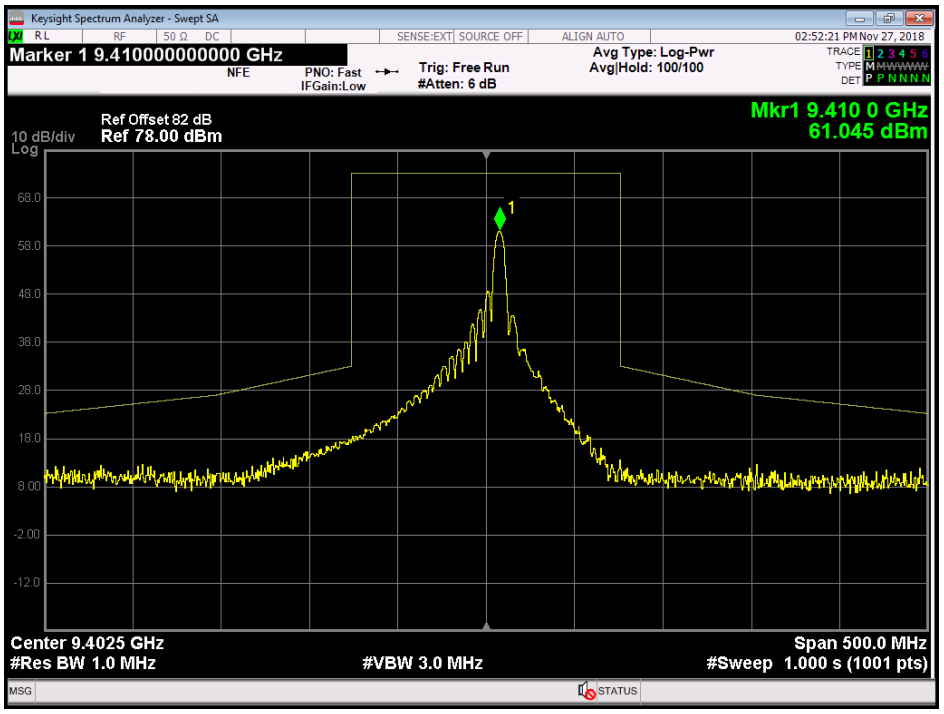


Figure 35 - Unmodulated / MP1 Pulse - Industry Canada Transmitter Mask Zoom

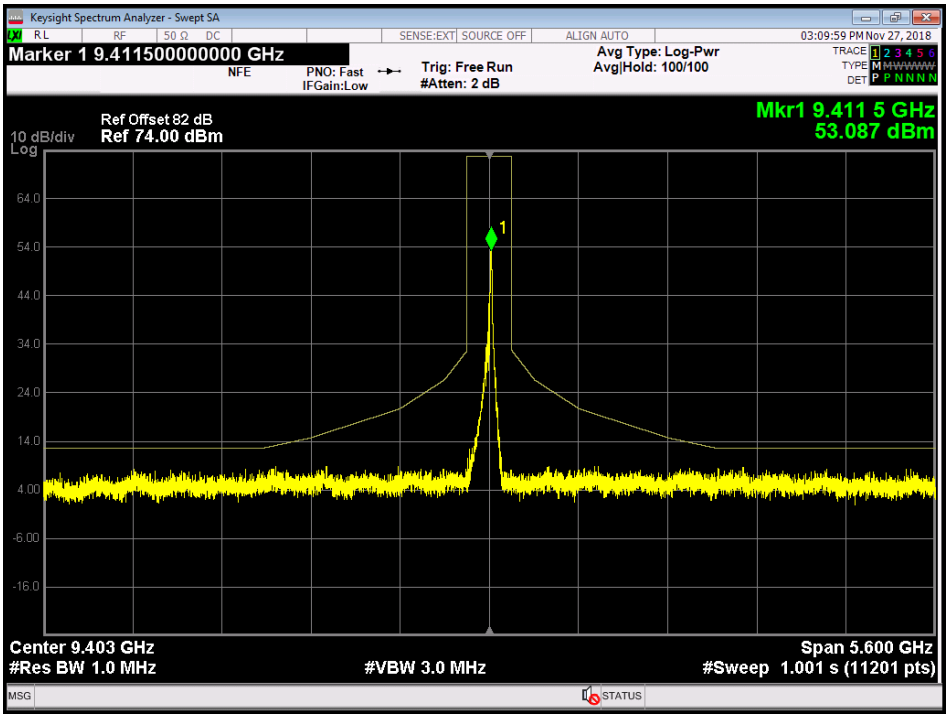


Figure 36 - Unmodulated / SP1 Pulse - Industry Canada Transmitter Mask

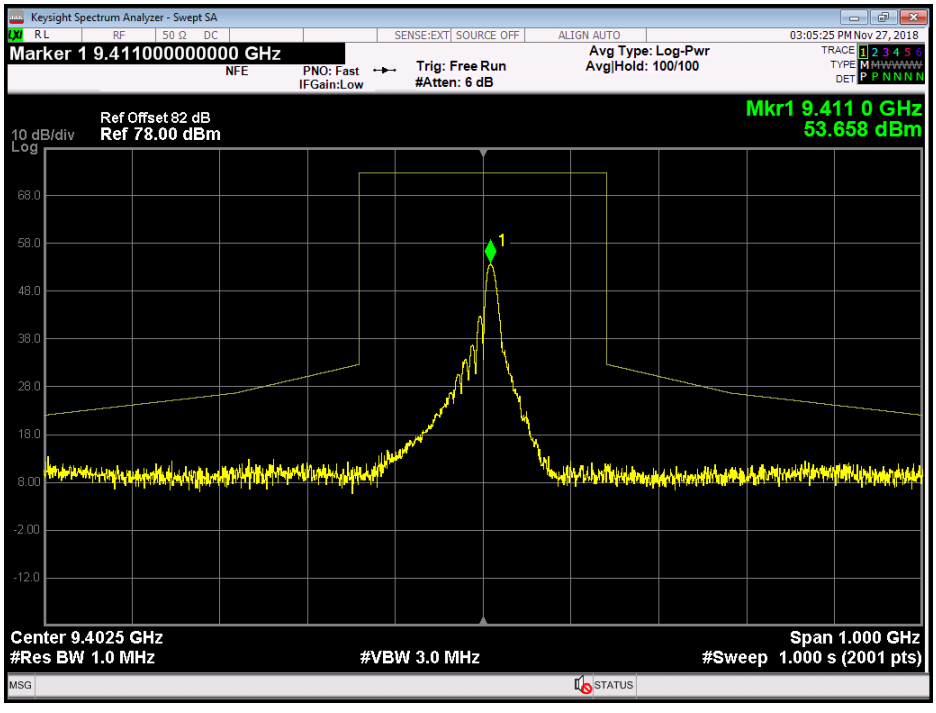


Figure 37 - Unmodulated / SP1 Pulse - Industry Canada Transmitter Mask Zoom

>250 % Authorized Bandwidth Results

Pulse Type	Measured Frequency	Peak Level (dBm)	Duty Cycle Correction Factor (dB)	Average Level (dBm)	FCC Limit (dBm)	Industry Canada Limit (dBm)	Result
SP1	18.8206	3.74	-38.03	-34.29	-13	+14	Pass
SP1	28.2280	-7.60	-38.03	-45.63	-13	+14	Pass
MP1	18.8180	5.03	-33.47	-28.44	-13	+14	Pass
MP1	28.2276	-7.76	-33.47	-41.23	-13	+14	Pass
MP2	18.8140	4.58	-32.44	-27.86	-13	+14	Pass
MP2	28.2199	-3.65	-32.44	-36.09	-13	+14	Pass
MP3	18.8144	2.92	-32.52	-29.60	-13	+14	Pass
MP3	28.2188	2.59	-32.52	-29.93	-13	+14	Pass
LP1	18.8129	7.12	-32.22	-25.10	-13	+14	Pass
LP1	28.2177	0.99	-32.22	-31.23	-13	+14	Pass
LP2	18.8163	6.26	-31.87	-25.61	-13	+14	Pass
LP2	28.2157	0.96	-31.87	-30.91	-13	+14	Pass
LP3	18.8163	3.55	-32.13	-28.58	-13	+14	Pass
LP3	28.2173	-2.00	-32.13	-34.13	-13	+14	Pass

FCC 47 CFR Part 80, Limit Clause 80.211(f)

On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;

On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB;

On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log_{10}$ (mean power in watts) dB.

Industry Canada RSS-238, Limit Clause 4.3

The unwanted emission and the transmitter power shall be measured using a peak detector.

The unwanted emission power in any 1 MHz bandwidth shall be attenuated below the transmitter peak power by at least 20dB per decade from the edge of the 40dB bandwidth and beyond.

The unwanted emissions power shall not need to be attenuated more than 60dB below the transmitter peak power.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Hygromer	Rotronic	Hygropalm	2404	12	26-Apr-2019
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	02-Oct-2018
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	06-Mar-2019
Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	20-Oct-2018
Rubidium Standard	Rohde & Schwarz	XSRM	1316	6	20-Oct-2018
Programmable Power Supply	California Inst	2001RP	1898	-	O/P Mon
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	06-Oct-2018
DMM	Fluke	179	4006	12	13-Dec-2018
Coupler	ATM	90-302A-30-6-6	H328005-01	-	O/P Mon
Load	Pasternack	PE6824	-	-	TU
Attenuator (20dB, 100W)	Weinschel	48-20-43	4870	12	17-Jul-2019
Attenuator (30dB, 100W)	Weinschel	48-30-43	4871	12	17-Jul-2019
Cable (18GHz	Rosenberger	LU7-036-2000	5038	-	O/P Mon
Cable (18GHz	Rosenberger	LU7-036-2000	5039	-	O/P Mon
Waveguide	Quasar	QTT16SB-UBR-UBR-18	-	-	O/P Mon
Waveguide	Quasar	QTT18SB-UBR-UBR-20	-	-	O/P Mon
Waveguide	Quasar	QTT20SB-UBR-UBR-22	-	-	O/P Mon
Waveguide	Quasar	QTT16SB-UBR-UBR-17	-	-	O/P Mon
Waveguide	Quasar	QTT17SB-UBR-UBR-18	-	-	O/P Mon
Waveguide	Quasar	QTT18SB-UBR-UBR-19	-	-	O/P Mon
Waveguide adaptor	Quasar	QWC19SB-UBR-SMAF	-	-	O/P Mon
Waveguide adaptor	Quasar	QWC22SB-UBR-K-F	-	-	O/P Mon
Waveguide adaptor	Quasar	QWC20SB-UBR-K-F	-	-	O/P Mon

Table 22

TU – Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.4 Radiated Spurious Emissions

2.4.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.211(f)
FCC 47 CFR Part 2, Clause 2.1053
Industry Canada RSS-238, Clause 4.3
Industry Canada RSS-GEN, Clause 6.13

2.4.2 Equipment Under Test and Modification State

NKE – 2255, Serial Number: LC30003 - Modification State 0

2.4.3 Date of Test

29-July-2018

2.4.4 Test Method

This test was performed in accordance with ANSI C63.26, clause 5.7.

2.4.5 Environmental Conditions

Ambient Temperature	19.8 °C
Relative Humidity	66.1 %

2.4.6 Test Results

Transmit - 120 V AC 60 Hz

Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)	Angle(Deg)	Height(m)	Polarity
*						

Table 9 – 30 MHz to 1 GHz – Radiated

*No emissions were detected within 10 dB of the limit

Frequency (GHz)	Result (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
	Peak	Duty Cycle Corrected Average	Industry Canada Peak	FCC Pt80 Average	Peak	Average
18.819	81.43	59.84	109.2 dBuV/m	82.2 dBuV/m	27.77	22.36
28.227	85.20	63.62	109.2 dBuV/m	82.2 dBuV/m	24.30	18.58

Table 10 – 9410 MHz – 1 GHz to 40 GHz – Radiated

To determine the average value of each emission, a peak measurement was performed, and a duty cycle correction was applied to the peak measurement. Duty (dB) = 20log (On time/ (On time + Off time)) = -21.59dB measured over 100mS burst. Testing was performed with LP3.

The limits have been converted to field strength using equation c) from ANSI c63.26 clause 5.2.7 The field strength limit dBuV/m = EIRP (dBm) – 20log(D) + 104.8 where D is the measurement distance.

FCC Pt 80 Field strength limit = -13 – 20log(3) + 104.8 = 82.2 dBuV/m

Industry Canada Limit = 14 – 20log(3) + 104.8 = 109.2 dBuV/m

No other emissions were detected within 10 dB of the limit

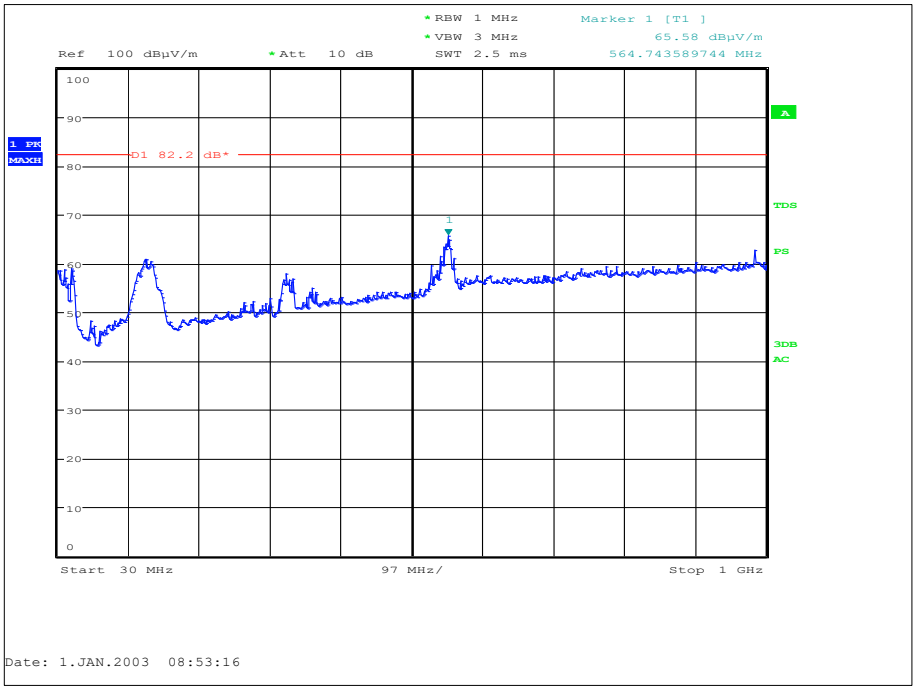


Figure 38 - 30 MHz to 1 GHz - Combined Polarity

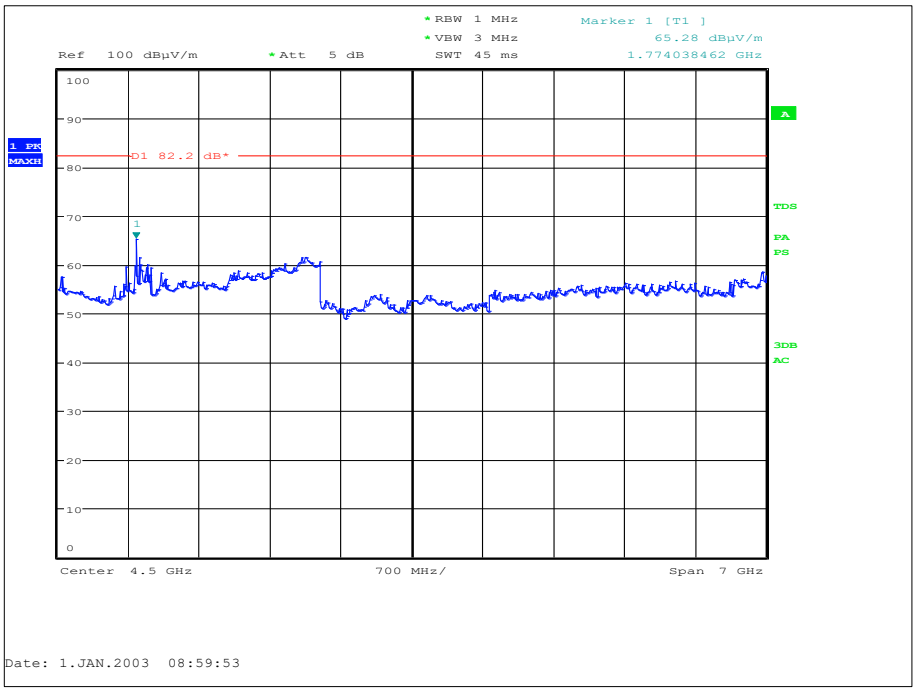


Figure 39 - 1 GHz to 8 GHz - Combined Polarity

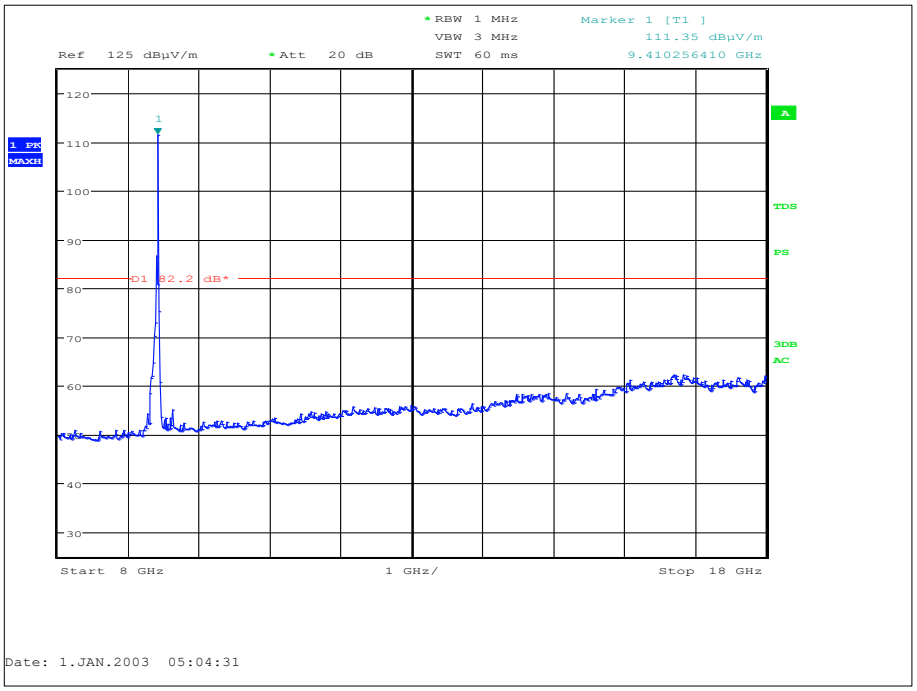


Figure 40 - 8 GHz to 18 GHz - Combined Polarity

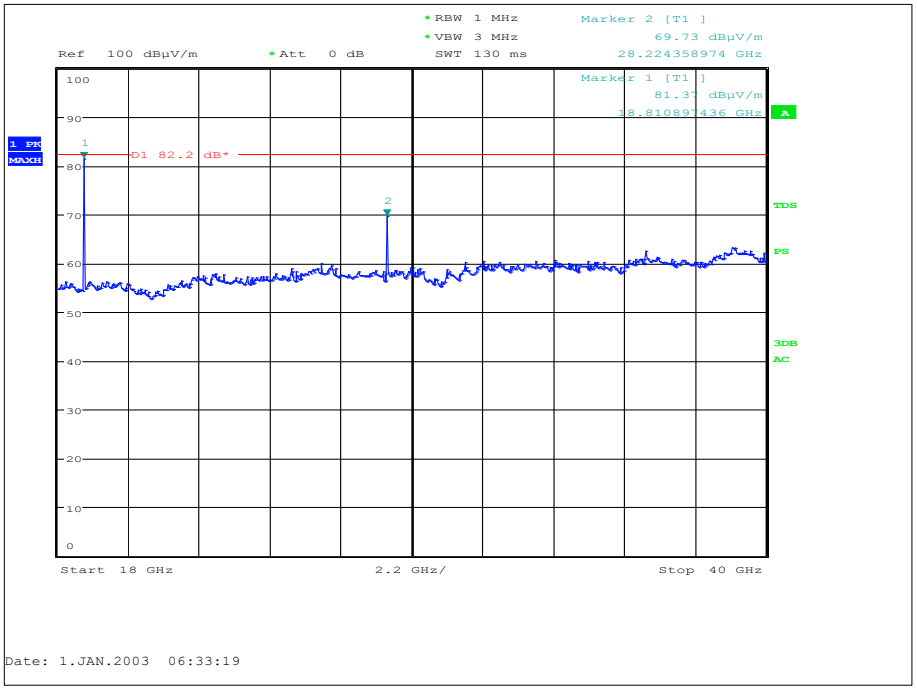


Figure 41 - 18 GHz to 40 GHz - Combined Polarity

FCC 47 CFR Part 80, Limit Clause 80.211(f)

On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;

On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB;

On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log_{10}$ (mean power in watts) dB.

Industry Canada RSS-238, Limit Clause 4.3

The unwanted emission and the transmitter power shall be measured using a peak detector.

The unwanted emission power in any 1 MHz bandwidth shall be attenuated below the transmitter peak power by at least 20 dB per decade from the edge of the 40dB bandwidth and beyond.

The unwanted emissions power shall not need to be attenuated more than 60 dB below the transmitter peak power.

2.4.7 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 7.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Antenna 18-40GHz (Double Ridge Guide)	Link Microtek Ltd	AM180HA-K-TU2	230	24	02-May-2020
Turntable Controller	Heinrich Diesel	HD 050	280	-	TU
Antenna with permanent attenuator (Bilog)	Schaffner	CBL6143	287	24	15-May-2020
Pre-Amplifier	Phase One	PS04-0086	1533	12	12-Jan-2019
18GHz - 40GHz Pre-Amplifier	Phase One	PSO4-0087	1534	12	02-Feb-2019
Screened Room (7)	Siemens	Siemens	1547	0	18-July-2019
Multimeter	Iso-tech	IDM 101	2118	12	08-Feb-2019
Signal Generator	Rohde & Schwarz	SMR40	3171	12	17-Nov-2018
EMI Test Receiver	Rohde & Schwarz	ESU40	3506	12	22-Nov-2018
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	3916	-	TU
Mast Controller	Maturo Gmbh	NCD	3917	-	TU
1501A 4.0M Km Km Cable	Rhophase	KPS-1501A-4000-KPS	4301	12	19-Feb-2019
Cable (Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4526	6	31-Aug-2018
Cable (Yellow, Rx, Km-Km 2m)	Scott Cables	KPS-1501-2000-KPS	4527	6	15-Aug-2018
Double Ridged Waveguide Horn Antenna	ETS-Lindgren	3117	4722	12	01-Mar-2019
9m N type RF cable	Rosenberger	2303-0 9.0m PNm	4827	6	04-Jan-2019
Hygrometer	Rotronic	HP21	4989	12	26-Apr-2019

Table 11

TU – Traceability Unscheduled

2.5 RF Output Power

2.5.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.215(b)(3)
FCC 47 CFR Part 2 Clause 2.1046
Industry Canada RSS-238, Clause 4.2
Industry Canada RSS-GEN, Clause 6.12

2.5.2 Equipment Under Test and Modification State

NKE – 2255, Serial Number: LC30003 - Modification State 0

2.5.3 Date of Test

25-July-2018

2.5.4 Test Method

Using a Network Analyser, the path loss between the EUT and the Power Sensor was measured. The loss was entered as a correction into the Power Meter which was connected via attenuators and a WR90 30dB Waveguide Directional Coupler to the EUT. Peak power measurements were made, and the Average derived by applying a Duty Cycle correction factor to the results based on the measured pulse characteristics, (see section 2.2).

2.5.5 Environmental Conditions

Ambient Temperature	19.6 - 23.0 °C
Relative Humidity	33.0 - 59.7 %

2.5.6 Test Results

Transmit - 120 V AC 60 Hz

Pulse type	Nominal Centre Frequency	Peak Output Power		Average Carrier Power	
		W	dBm	W	dBm
LP3	9410 MHz	20511.6	73.12	3.11	34.92
LP2	9410 MHz	20606.3	73.14	8.77	39.43
LP1	9410 MHz	20370.4	73.09	11.55	40.63
MP3	9410 MHz	20090.9	73.03	11.28	40.52
MP2	9410 MHz	19952.6	73.00	12.00	40.79
MP1	9410 MHz	20183.7	73.05	13.16	41.19
SP1	9410 MHz	18535.3	72.68	11.12	40.46

Table 24 - RF Output Power

The antenna gain was declared by the manufacturer as: 29 dBi.

FCC 47 CFR Part 80.215(a)(3) and Industry Canada RSS-238, Limit Clause 4.2

The transmitter output power shall not exceed 60 kW and the antenna gain shall not exceed 35 dBi.

2.5.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Hygromer	Rotronic	Hygropalm	2404	12	26-Apr-2019
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	02-Oct-2018
P-Series Power Meter	Agilent Technologies	N1911A	3980	12	28-Sep-2018
50 MHz-18 GHz Wideband Power Sensor	Agilent Technologies	N1921A	3982	12	28-Sep-2018
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	06-Mar-2019
Coupler	ATM	90-302A-30-6-6	H328005-01	-	O/P Mon
Load	Pasternack	PE6824	-	-	TU
Attenuator (20dB, 100W)	Weinschel	48-20-43	4870	12	17-Jul-2019
Attenuator (30dB, 100W)	Weinschel	48-30-43	4871	12	17-Jul-2019
Cable (18GHz	Rosenberger	LU7-036-2000	5038	-	O/P Mon
Cable (18GHz	Rosenberger	LU7-036-2000	5039	-	O/P Mon

Table 25

O/P Mon – Output Monitored using calibrated equipment
TU = Traceability Unscheduled

2.6 Modulation Characteristics

2.6.1 Specification Reference

FCC 47 CFR Part 80, Clause 80.205 and 80.207
FCC 47 CFR Part 2, Clause 2.1047(d)
Industry Canada RSS-238, Clause 2.2 & 3.2(a)

2.6.2 Equipment Under Test and Modification State

NKE – 2255, Serial Number: LC30003 - Modification State 0

2.6.3 Date of Test

23-July-2018

2.6.4 Test Method

The EUT was connected via a WR90 Waveguide Directional Coupler and attenuators to a Peak Power Analyser and the Width and Rise Time of each pulse type was measured.

The EUT was then connected via the WR90 Waveguide Directional Coupler and attenuators to a Spectrum Analyser and the Pulse Repetition Interval, (PRI), of each pulse type was measured. The Pulse Repetition Rate was calculated (1/PRI) and recorded.

The emission designator for the product was: P0N

2.6.5 Environmental Conditions

Ambient Temperature	24.6 °C
Relative Humidity	54.1 %

2.6.6 Test Results

Transmit - 120 V AC 60 Hz

Pulse type	Radar Pulse Width (µs)	Repetition Rate (Hz)	Pulse Rise Time (ns)
LP3	1.175	510.73	18.888
LP2	1.002	650.62	19.355
LP1	0.8004	751.31	16.764
MP3	0.4006	1401.35	14.457
MP2	0.2986	1898.61	15.097
MP1	0.1889	2252.25	13.119
SP1	0.0673	2249.72	10.841

Table 26 - Modulation Characteristics

FCC 47 CFR Part 2, Limit Clause 2.1047(d), RSS-238 Clause 3.2(a)

Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 2.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Programmable Power Supply	California Inst	2001RP	1898	-	TU
Hygromer	Rotronic	Hygropalm	2404	12	26-Apr-2019
Network Analyser	Rohde & Schwarz	ZVA 40	3548	12	02-Oct-2018
Peak Power Analyser	Hewlett Packard	8990A	0107	12	17-Aug-2019
Power Sensor	Hewlett Packard	84812A	2743	12	17-Aug-2019
Calibration Unit	Rohde & Schwarz	ZV-Z54	4368	12	06-Mar-2019
PXA Signal Analyser	Keysight Technologies	N9030A	4654	12	06-Oct-2018
Attenuator (20dB, 100W)	Weinschel	48-20-43	4870	12	17-Jul-2019
Attenuator (30dB, 100W)	Weinschel	48-30-43	4871	12	17-Jul-2019
Coupler	ATM	90-302A-30-6-6	H328005-01	-	O/P Mon
Load	Pasternack	PE6824	-	-	TU
Cable (18GHz	Rosenberger	LU7-036-2000	5038	-	O/P Mon
Cable (18GHz	Rosenberger	LU7-036-2000	5039	-	O/P Mon

Table 27

TU – Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

3 Photographs

3.1 Test Setup Photographs

Figure 42 – Radiated Setup

Figure 43 – Conducted Setup

Figure 44 – Conducted Setup

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Occupied Bandwidth	± 1444 Hz
Transmitter Frequency Stability	± 2610 kHz
Spurious Emissions at Antenna Terminals	± 3.45 dB
Radiated Spurious Emissions	30 MHz to 1 GHz: ± 5.2 dB 1 GHz to 40 GHz: ± 6.3 dB
RF Output Power	± 0.96 dB
Modulation Characteristics	± 5%