REPORT

For

Dali Wireless, Inc.

535 Middlefield Road, Suite 280
Menlo Park, CA 94025

Date:	02 DECEMBER 2019
Report No.:	18280-3E
Revision No.:	1
Project No.:	18280
Equipment:	Advanced Digital Distributed Antenna System
Model No.:	hd37-3-PS-FHB-21-5N-D0
FCC ID:	HCOHD373PSFHB21A

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Unit 205 – 8291 92 ST., Delta, BC
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TEST REPORT_FCC Part 90		
Private Land Mobile Services		
Report Reference No.....:	18280-3E	
Report Revision History. .....:	✓ Rev. 0: 21 NOVEMBER 2019 ✓ Rev. 1: 02 DECEMBER 2019	
Compiled by (+ signature).....	Daniel Lee	
Approved by (+ signature).....	Jeremy Lee	
Date of issue .....:	02 December 2019	
Total number of pages	98	
FCC Site Registration No.:	CA5970	
IC Site Registration No.:	5970A-2	
Testing Laboratory.....:	LabTest Certification Inc.	
Address .....:	Unit 3128-20800 Westminster HWY, Richmond, B.C. V6V 2W3 Canada	
Applicant's name.....:	Dali Wireless, Inc.	
Address .....:	535 Middlefield Road, Suite 280, Menlo Park, CA 94025	
Manufacture's Name .....:	Dali Wireless (Canada) Inc.	
Address .....:	8618 Commerce Court, Burnaby, B.C. V5A 4N6, Canada	
Test specification:		
Standards .....:	➢ FCC Part 2; 2019 ➢ FCC Part 90; 2019	
Test procedure .....:	➢ FCC KDB 935210 D05 Indus Booster Basic Meas v01r03: April 15, 2019 ➢ ANSI/TIA-603- E-2016 ➢ ANSI C63.4:2014	
Non-standard test method……..:	N/A	
Test Report Form(s) Originator .....:	Jeremy Lee	
Master TRF .....:	1036_Rev2 – RF Report Template	
Test item description:		
Trade Mark .....:	hd37™	
Model/Type reference .....:	hd37-3-PS-FHB-21-5N-D0	

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Serial Number .....:	10911111RA1B98001
FCC ID .....:	HCOHD373PSFHB21A
Possible test case verdicts:	
- test case does not apply to the test object.....:	N/A
- test object does meet the requirement .....:	P (Pass)
- test object does not meet the requirement .....:	F (Fail)
Testing:	
Date of receipt of test item .....:	07 November 2019
Date (s) of performance of tests.....:	07 to 08 November 2019

Revision History

Revision	Date	Reason For Change	Author(s)
0	21 November 2019	Initial Data	Daniel Lee
1	02 December 2019	Corrected information on page 74 , 76	Jeremy Lee

Device Under Test Description

Application for ..... :	PS 800/450/150 Remote Unit, Tri Band Medium Power DAS
Passing Transmit Frequency ..... :	851 MHz – 862 MHz 450 MHz – 470 MHz 152 MHz – 174 MHz
Operating Transmit Frequency FCC ..... :	851 MHz – 861 MHz 450 MHz – 454 MHz 456 MHz – 462.5375 MHz 462.7375 MHz – 467.5375 MHz 467.7375 MHz – 512 MHz 150.8 MHz – 156.2475 MHz 157.1875 MHz – 161.575 MHz 161.775 MHz – 161.9625 MHz 162. 0375 MHz – 173.4 MHz
Passing Receive Frequency	806 MHz – 817 MHz 450 MHz – 470 MHz

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Operating Receive Frequency FCC	806 MHz – 816 MHz 450 MHz – 454 MHz 456 MHz – 462.5375 MHz 462.7375 MHz – 467.5375 MHz 467.7375 MHz – 512 MHz
Number of Channels ..... :	Up to 64 channels
Rated RF Output(e.i.r.p.) ..... :	37 dBm
Modulation Type ..... :	P25 Phase I C4FM, CQPSK; P25 Phase II HDQPSK on full band of Band 800, Band 450 and Band 150; FM on Band 800 between 851 MHz – 854 MHz only;
Equipment mobility ..... :	Fixed
Operating condition ..... :	-40 to +50 °C
Mass of equipment (g) ..... :	< 27,700g
Dimension(W X D X H)	410 mm X 230 mm X 696 mm
Nominal Voltages for:	48 V stand-alone equipment 48 V combined (or host) equipment
Supply Voltage:	_____ AC _____ Amps 48V DC 7.083 Amps
If DC Power:	___ Internal Power Supply √ External Power Supply ___ Battery ☐ Nickel Cadmium ☐ Alkaline ☐ Nickel-Metal Hydride ☐ Lithium-Ion ☐ Other

Program details

Testing Facility by procedure:		
☒	**Radiated Measurement**	LabTest Certification Inc.
Testing location/ address.....:		Unit 3128-20800 Westminster HWY, Richmond, B.C. V6V 2W3 Canada
☒	**Conducted Measurement**:	LabTest Certification Inc.
Testing location/ address.....:		Unit 3128-20800 Westminster HWY, Richmond, B.C. V6V 2W3 Canada

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Summary of testing:	
Tests performed (name of test and test clause): **Conducted Measurement** **Radiated Emissions on Enclosure**	**Testing location:** **Bench top, Richmond** **In SAC, Richmond**

The tests indicated in Test Summary were performed on the product constructed as described below. The test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.
Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. LabTest does not make any claims of compliance for samples or variants which were not tested.

Description of Equipment Under Test and Variant Models

Description:
The hd37 /800PS/450PS/150 PS is a tri-band remote unit that provides at least 5 W of output power on each band. The tri-band unit supports up to 3 bands in a sealed type 2 chassis for Class A operation.

On the downlink path the hd37 PS remote receives an aggregated stream of digitized RF signals from an *air*Host PS, which it then converts into analog RF signals. Depending on the frequency band, the signal is amplified in the RF module and then sent out through simplex RF ports to an external filter.

On the UL path the hd37 PS remote receives analog RF signals for the RF band, from an external filter. The RF signals are converted into a digital data stream and then delivered over optical fiber to an *air*Host PS. The hd37 PS remote also accommodates a 1 Gbps Ethernet backhaul for transporting the data from nearby IP devices such as security cameras and Wi-Fi access points.

The intentional transmitter only exists in the downlink path and hence the EMC tests in this report dedicated to the downlink emission.

In order to build up a complete signal booster system, the *air*Host was connected as the Auxiliary device. The *air*Host does not have anntenna port, where the signal was injected and ejected via coaxial cables.

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Variant Models:
The following variant models were not tested as part of this evaluation, but they have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. Labtest does not make any claims of compliance for samples or variants which were not tested.

hd37-3-PS-FHB-21-5N-D0 – tri band 800PS 450PS 150PS model as tested

Tri Band
1. hd37-3-PS-FHB-21-5N-D0 (hd37 with 150,450,800PS)
2. hd33-3-PS-FHB-21-5N-D0 (hd33 with 150,450,800PS)

Dual Band:
1. hd37-2-PS-HB-21-3N-D0 (hd37 with 450,800PS)
2. hd33-2-PS-HB-21-3N-D0 (hd33 with 450,800PS)
3. hd37-2-PS-FH-21-4N-D0 (hd37 with 450,150PS)
4. hd33-2-PS-FH-21-4N-D0 (hd33 with 450,150PS)
5. hd37-2-PS-FB-21-3N-D0 (hd37 with 150,800PS)
6. hd33-2-PS-FB-21-3N-D0 (hd33 with 150,800PS)

Single Band:
1. hd37-1-PS-H-21-2N-D0 (hd37 with 450PS)
2. hd33-1-PS-H-21-2N-D0 (hd33 with 450PS)
3. hd37-1-PS-F-21-2N-D0 (hd37 with 150PS)
4. hd33-1-PS-F-21-2N-D0 (hd33 with 150PS)
5. hd37-1-PS-B-21-1N-D0 (hd37 with 800PS)
6. hd33-1-PS-B-21-1N-D0 (hd33 with 800PS)

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Client Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
EUT	*hd37, 800PS, 450PS, 150PS*	Dali Wireless Inc.	hd37-3-PS-FHB-21-5N-D0	EUT where the RF (I/O) antenna attached via duplexers/multiplexer when necessary.
AE1	*airHost, 800PS, 450PS, 150PS*	Dali Wireless Inc.	AH37-3-PS-FHB-21-5N-D0	Auxiliary equipment, which is the front end of signal booster system air interfaced to donor Base Station.
AE2	Dali Matrix Console	Dali Wireless Inc.	hdCNSL-1-8-4-120G-AC	Auxiliary equipment provides the configuration and control interface to *air*Host and *hd*37.
AE3	Power Supply	MeanWell	HLG-480H-48	AC to DC Converter, I/P: 120VAC, 60Hz, 5.5A O/P: +48VDC, 480W
Abbreviations: EUT - Equipment Under Test, AE - Auxiliary/Associated Equipment, or SIM - Simulator (Not Subjected to Test)				

Software and Firmware

Use*	Description	Version
EUT	Software installed	1.0.10_dev431
AE1	Software installed	1.0.10_dev431
AE2	Software installed	1.0.10_dev431
Abbreviations: EUT - Equipment Under Test, AE - Auxiliary/Associated Equipment, or SIM - Simulator (Not Subjected to Test)		

Input/Output Ports

Port #	Name	Type*	Cable Max. >3m	Cable Shielded	Comments
1	DC Power Port	DC	No	No	Dual feed 48 VDC Assembly
2	8 * RF Input/Output Ports	I/O	No	No	N-Type Coaxial
3	2 * Optical Fibre I/O Ports	I/O	No	No	LC/UPC Duplex
4	2 * TP	TP	No	No	RJ-45

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*Note: AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
I/O = Signal Input or Output Port (Not Involved in Process Control)
TP = Telecommunication Ports

Power Interface

Mode #	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
1	48	-	-	DC	-	

EUT Operation Modes

Mode #	Description
1	UL and DL transmission and receiving ON

EUT Configuration Modes

Mode #	Description
1	airHost maximum input threshold set to -55 dBm, uplink attenuation set to 0dB; *hd*37 uplink and downlink attenuation set to 0dB.

Test Equipment Verified for function

Model #	Description	Checked Function	Results
N9038A	Spectrum Analyzer	Frequency and Amplitude	Connected 50MHz and -20 dBm Ref_siganl and checked OK.
JB1	Antenna, 30 to 2000MHz	Checked structure	Normal – no damage.
SAS-571	Antenna, 1 to 18GHz	Checked structure	Normal – no damage.
AL-130	Antenna, 9kHz to 30MHz	Checked structure	Normal – no damage.
KT-N5172B	Signal Generator, up to 6GHz	Frequency, Amplitude and Modulation	Within MFR Specs
KT-N9010A	Spectrum Analyzer	Frquency and Amplitude	Within MFR Specs

Test Station Cables and Loads

Model #	Manufacture	Description
3 * TM8-N1S1-59	MegaPhase	3 times N male to SMA male coaxial cable in 60 inches
TM8-N1S1-24	MegaPhase	N male to SMA male coaxial cable in 24 inches
2 * 49-30-34	Aeroflex	30dB 150W attenuators

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Test Station Insertion Loss

	Band 800	Band 450	Band 150	
DL Transmitter	31 dB	30.7 dB	30.3 dB	
DL Receiver	30.6 dB	30.4 dB	30.2 dB	

Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests:

Parameter	Uncertainty
Radio Frequency	±1 ppm
Total RF Power: Conducted	±1 dB
RF Power Density: Conducted	±2.75 dB
Spurious Emissions: Conducted	±3 dB
Temperature	±1 °C
Humidity	±5 %
Radiated Emission, 30 to 300MHz	± 3.87 dB
Radiated Emission, 300 to 1,000MHz	± 4.79 dB
Radiated Emission, 1 to 10GHz	± 5.03 dB

Uncertainty figures are valid to a confidence level of 95%.

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Result Summary

The Compliance Status is a judgment based on the direct measurements and calculated highest emissions to appropriate standard limits. Measurement uncertainty values, provided on calibration certificates, were not be used in the judgment of the final status of compliance.

FCC Part 2 & 90			
Test Type	**Regulation**	**Measurement Method**	**Result**
AGC Threshold	FCC KDB 935210 D05, v01r03, Section 4.2	ANSI TIA-603- E-2016	PASS
Out of Band Rejection	FCC KDB 935210 D05, v01r03, Section 4.3	ANSI TIA-603- E-2016	PASS
Input-versus-output Signal Comparison	FCC KDB 935210 D05, v01r03, Section 4.4	ANSI TIA-603- E-2016	PASS
Input/output Power and Amplifier/Booster Gain	FCC KDB 935210 D05, v01r03, Section 4.5	ANSI TIA-603- E-2016	PASS
Noise Figure	FCC KDB 935210 D05, v01r03, Section 4.6	ANSI TIA-603- E-2016	PASS
Measuring out-of-band/out-of-block (including intermodulation) and spurious emissions	FCC KDB 935210 D05, v01r03, Section 4.7	ANSI TIA-603- E-2016	PASS
Frequency stability	FCC KDB 935210 D05, v01r03, Section 4.8	ANSI TIA-603- E-2016	PASS
Spurious emissions radiated measurements	FCC KDB 935210 D05, v01r03, Section 4.9	ANSI C63.4:2014	PASS

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AGC Threshold

Governing Doc	FCC Part 2 2.1046(a) FCC Part 90.219(d)	Room Temperature (°C)	20.5
Test Procedure	ANSI/TIA-603- E-2016; FCC KDB 935210 D05, v01r03;	Relative Humidity (%)	38.6
Test Location	Richmond	Barometric Pressure (kPa)	101.8
Test Engineer	Daniel Lee	Date	Nov. 08, 2019
EUT Voltage	☒ +48VDC ☐ 120VAC @ 60Hz		

Test Equipment Used	Manufacturer	Model	Serial Number	Calibration	Calibration due
Signal Generator	Keysight	N5172B	MY53050270	06/12/19	06/12/21
Spectrum Analyzer	Keysight	N9010A	MY50520285	07/29/19	07/23/21

Frequency Range:	☒ 851 MHz – 861 MHz ☒ 450 MHz – 470 MHz ☒ 152 MHz – 174 MHz
Detector:	☒ Peak
Type of Facility:	☒ Test bench
Distance:	☒ Direct
Arrangement of EUT:	☒ Table-top only ☐ Floor-standing only ☐ Rack Mounted
Output Power is less than 37.8 dBm in band 800, less than 37.9 dBm in band 450, and less than 37.7 dBm in band 150.	
Compliant ☒ Non-Compliant ☐ Not Applicable ☐	

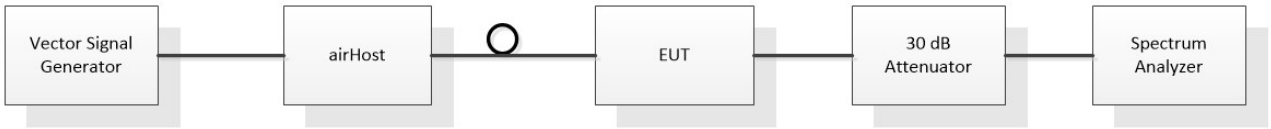
Test setup

Description of test set-up:

Output power is measured by connecting a spectrum analyzer to RF output connector of EUT via 30dB Attenuator. With a nominal input power and the amplifier properly adjusted the RF output is measured.

The EUT was set to **Operation Mode #1 with configuration Mode #1.**

The maximum output power is measured when the Automatic Level Control (ALC) starting to compress the power and hold to a constant level.



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Results – Output Power FCC Requirement

Frequency Range (MHz)	Frequency (MHz)	Input Power Trip ALC (dBm)	Output Power (dBm)	Output Power (Watt)
851 - 861	851.0125	-53.5	37.8	6.03
	856	-53.5	37.5	5.62
	860.9875	-52.5	37.4	5.50
450 -470	450.0125	-56.5	37.7	5.89
	460	-55.5	37.4	5.50
	469.9875	-53	37.9	6.17
152 - 174	152.025	-56.5	37.7	5.89
	161.79	-56	37.4	5.50
	173.275	-57	37.2	5.25

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Occupied Bandwidth

Governing Doc	FCC Part 2 2.1049	Room Temperature (°C)	20.5
Test Procedure	ANSI/TIA-603- E-2016; FCC KDB 935210 D05, v01r03	Relative Humidity (%)	38.6
Test Location	Richmond	Barometric Pressure (kPa)	101.8
Test Engineer	Daniel Lee	Date	Nov 08, 2019
EUT Voltage	☒ +48VDC ☐ 120VAC @ 60Hz		

Test Equipment Used	Manufacturer	Model	Serial Number	Calibration	Calibration due
Signal Generator	Keysight	N5172B	MY53050270	06/12/19	06/12/21
Spectrum Analyzer	Keysight	N9010A	MY50520285	07/29/19	07/29/21

Frequency Range:	☒ 851 MHz – 861 MHz ☒ 450 MHz – 470 MHz ☒ 152 MHz – 174 MHz
Detector:	☒ Peak
Type of Facility:	☒ Test bench
Distance:	☒ Direct
Arrangement of EUT:	☒ Table-top only ☐ Floor-standing only ☐ Rack Mounted

Output signal has an occupied channel bandwidth less than the designated channel bandwidth on any location on the operating band.

- C4FM < 12.5 kHz
- CQPSK < 6.25 kHz
- HDQPSK < 12.5 kHz
- 4 kHz FM with 1kHz deviation < 12.5 kHz

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

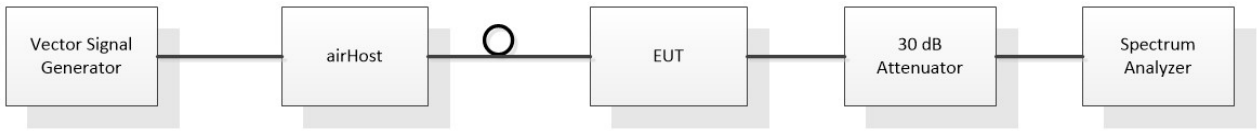
Test setup

Description of test set-up:

Occupied Bandwidth is measured by connecting a Spectrum Analyzer to the RF output connector via 30dB attenuator. The required measurement resolution bandwidth (RBW) is 1% of the emission bandwidth. 99% energy rule was applied to measure the occupied channel bandwidth. The emission bandwidth is measured as the width of the signal between two frequency points on the channel edge, outside of which the transmission power is attenuated at least 26dB below the transmitter output power
The EUT was set to **Operation Mode #1 with configuration Mode #1.**

The occupied bandwidth of DL output is measured under one input conditions:

- Nominal: with input 0.5dB below AGC threshold



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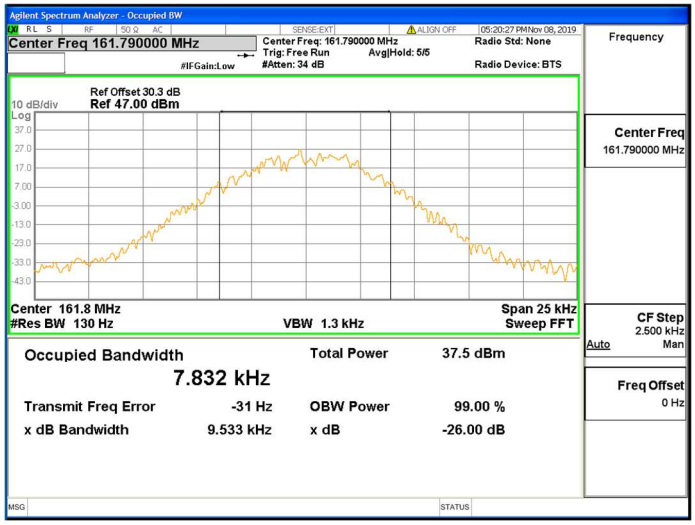
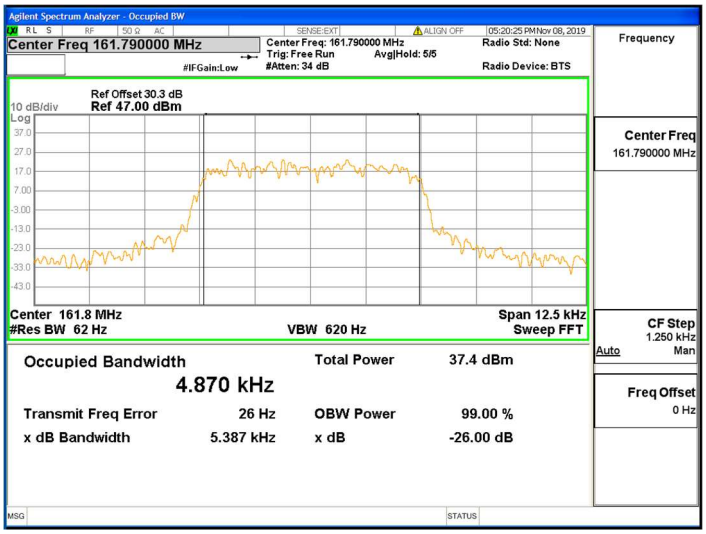
Results – Occupied Bandwidth (OBW)

C4FM Signal at 161.79 MHz



CQPSK Signal at 161.79 MHz



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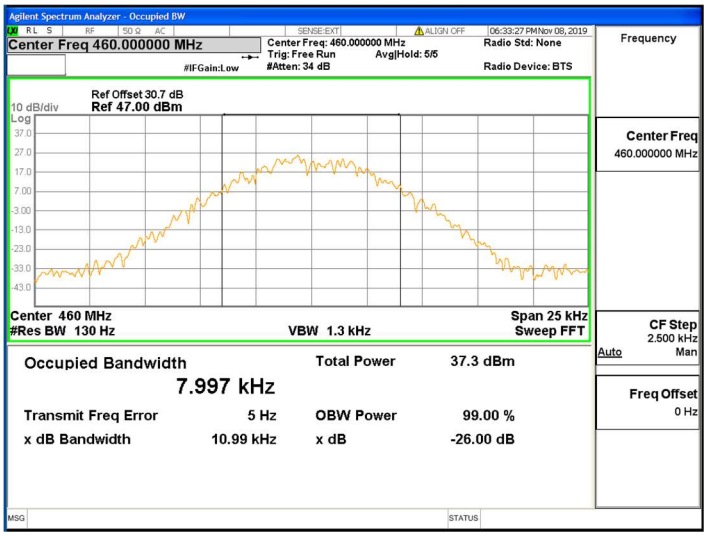
HDQPSK Signal at 161.79 MHz

C4FM Signal at 460 MHz



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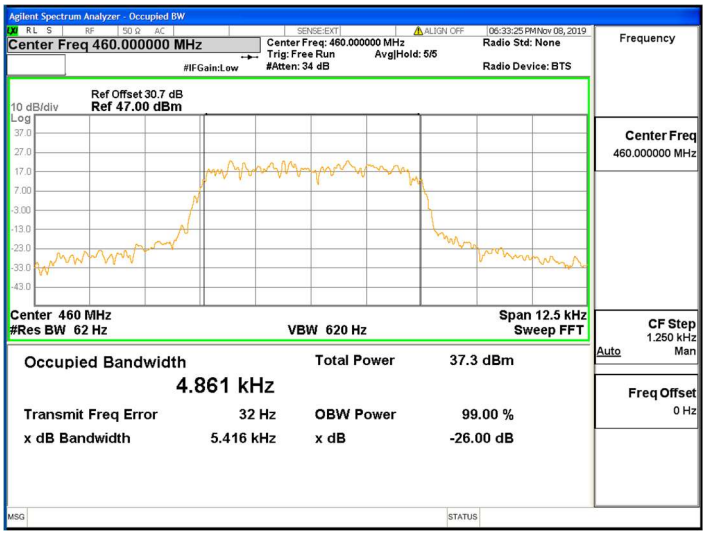
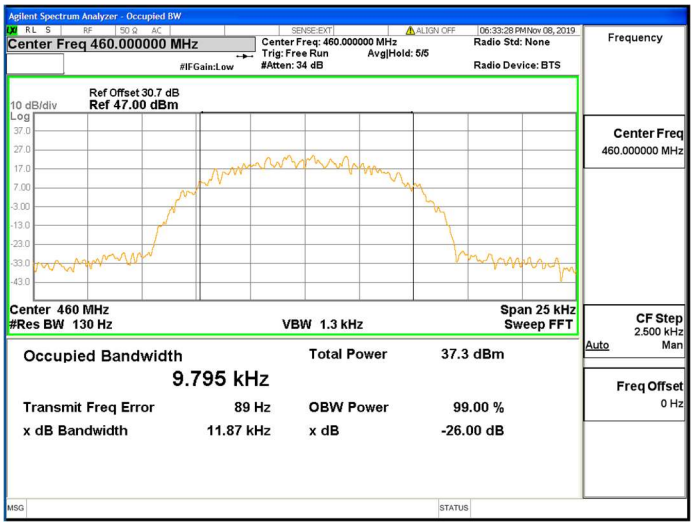
CQPSK Signal at 460 MHz



HDQPSK Signal at 460 MHz



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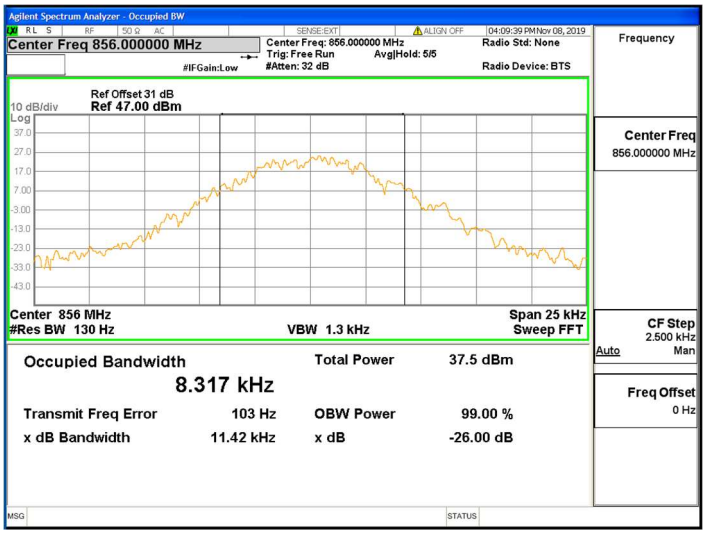
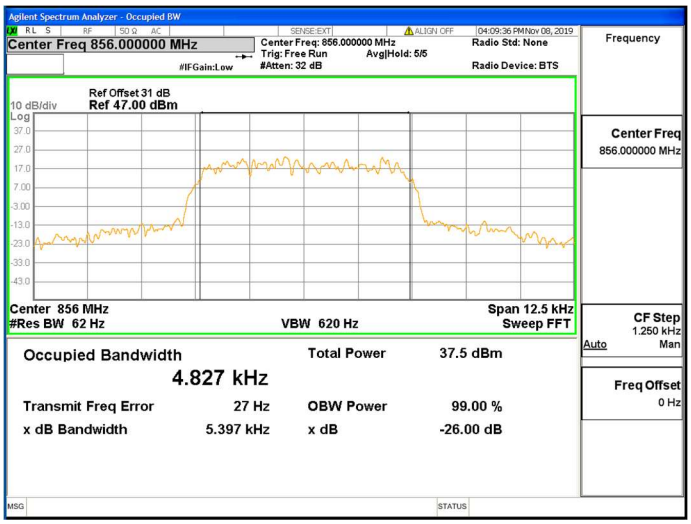
C4FM Signal at 856 MHz



CQPSK Signal at 856 MHz



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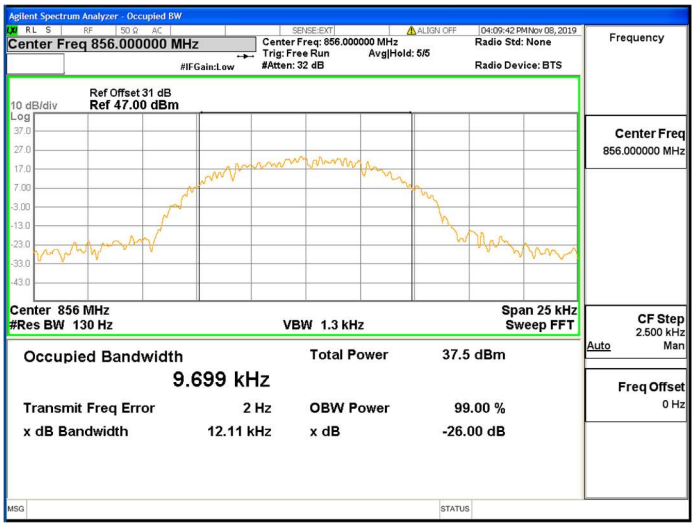
HDQPSK Signal at 856 MHz



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Out of Band Rejection

Governing Doc	FCC Part 2 2.1046(a) FCC Part 90.219(d)	Room Temperature (°C)	20.5
Test Procedure	ANSI/TIA-603- E; FCC KDB 935210 D05, v01r03	Relative Humidity (%)	38.6
Test Location	Richmond	Barometric Pressure (kPa)	101.8
Test Engineer	Daniel Lee	Date	Nov. 08, 2019
EUT Voltage	☒ +48VDC	☐ 120VAC @ 60Hz	

Test Equipment Used	Manufacturer	Model	Serial Number	Calibration	Calibration due
Signal Generator	Keysight	N5172B	MY53050270	06/12/19	08/12/21
Spectrum Analyzer	Keysight	N9010A	MY50520285	07/29/19	08/23/21

Frequency Range:	☒ Product Passband ± 250%
Detector:	☒ Peak
RBW/VBW:	☒ 1 to 5% of the EUT passband / ≥ 3 X RBW
Type of Facility:	☒ Tabletop
Distance:	☒ Direct

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

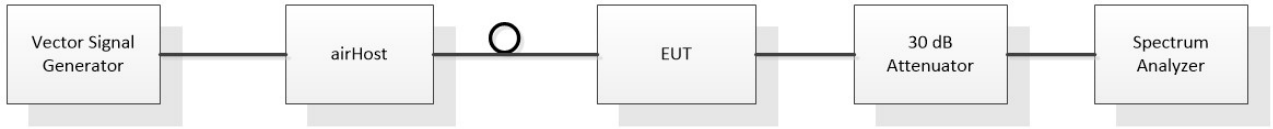
Test setup

Description of test set-up:

The procedure used was ANSI/TIA-603-E-2016 and FCC KDB 935210 D05 Indus Booster Basic Meas v01r03. The signal booster was set to maximum gain. A swept CW signal was set to the range of ±250 % of the product pass band. The CW ampltitude was set to 3 dB below the AGC threshold so that the ALC should not activate throughout the test.

After the max-hold sweep trace was completed, a marker was set to the peak amplitude, and a 20dB bandwidth was measured between two additional markers fall 20 dB from the peak.

The EUT was set to **Operation Mode #1 with configuration Mode #1.**



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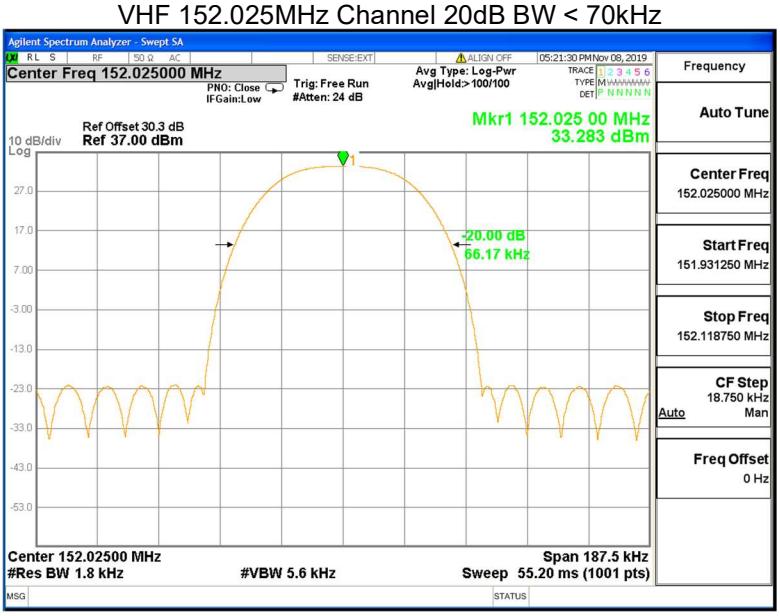
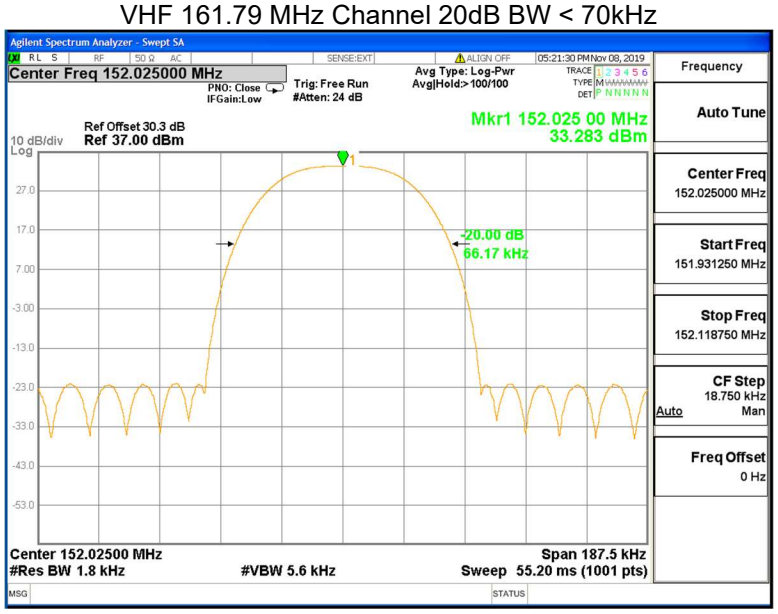
Results

VHF 152.025MHz Channel 20dB BW < 70kHz



VHF 161.79 MHz Channel 20dB BW < 70kHz



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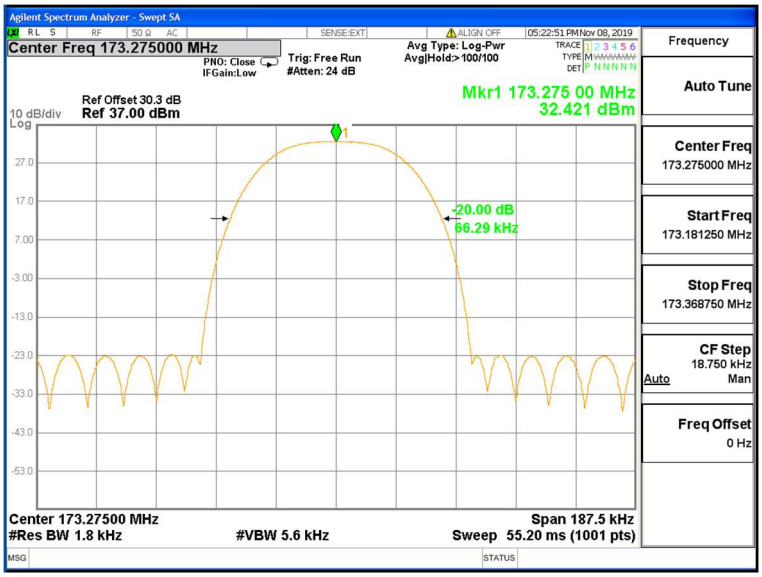
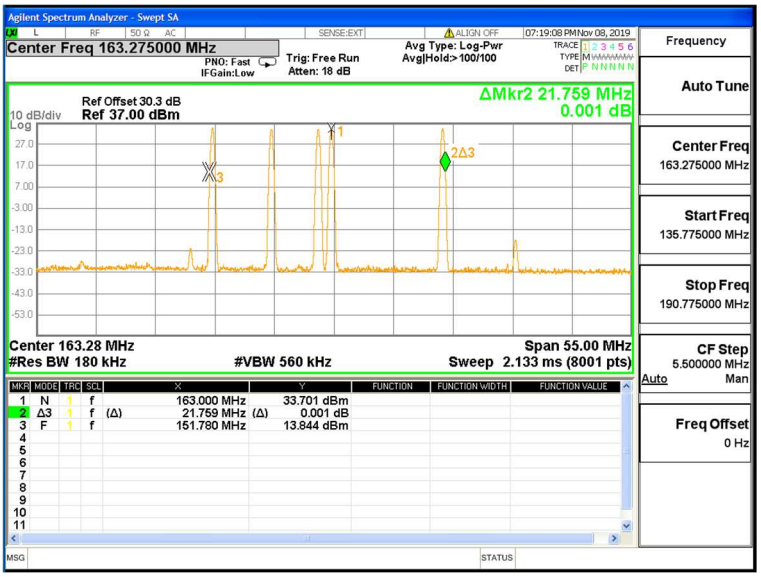
VHF 173.275 MHz Channel 20dB BW < 70kHz



150PS Total 20dB BW < 21.8MHz



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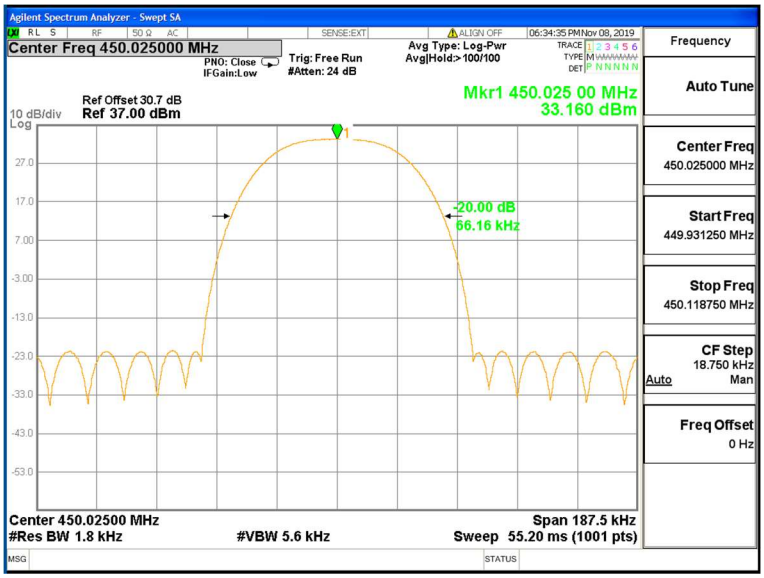
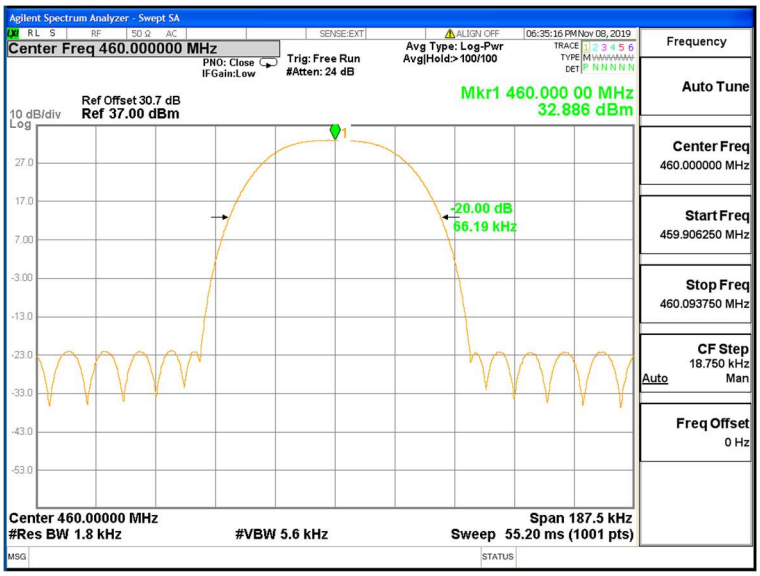
UHF 450.025 MHz Channel 20dB BW < 70kHz



UHF 460 MHz Channel 20dB BW < 70kHz



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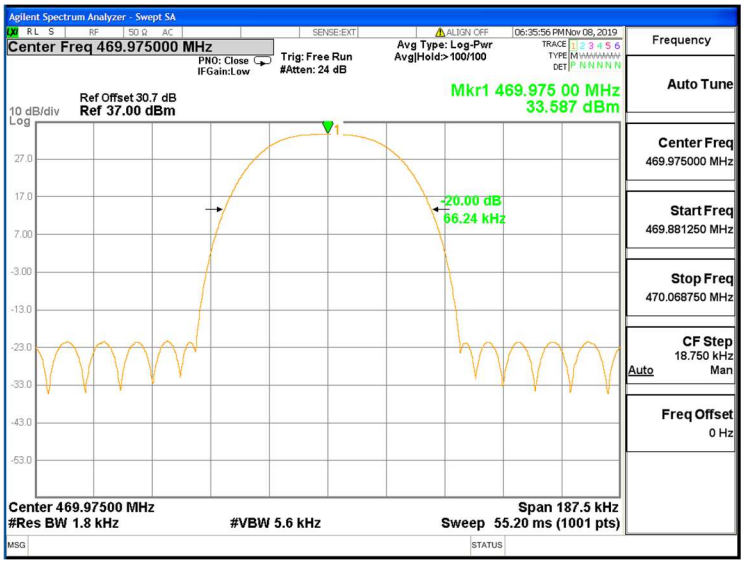
UHF 469.975 MHz Channel 20dB BW < 70kHz



450PS Total 20dB BW < 20.5MHz

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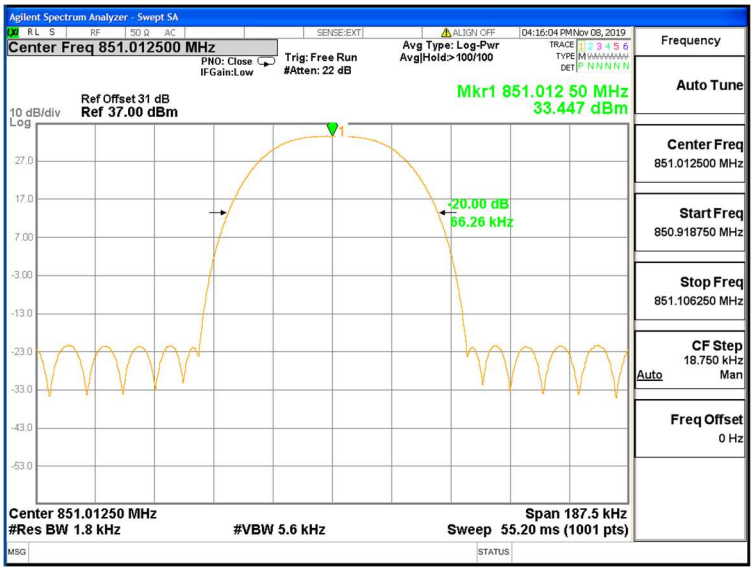
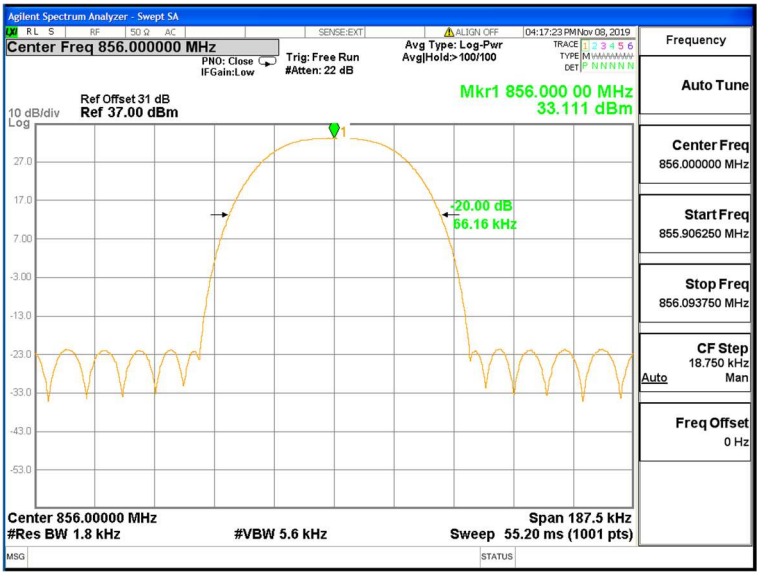
800PS 851.0125 MHz Channel 20dB BW < 70kHz



800PS 856 MHz Channel 20dB BW < 70kHz



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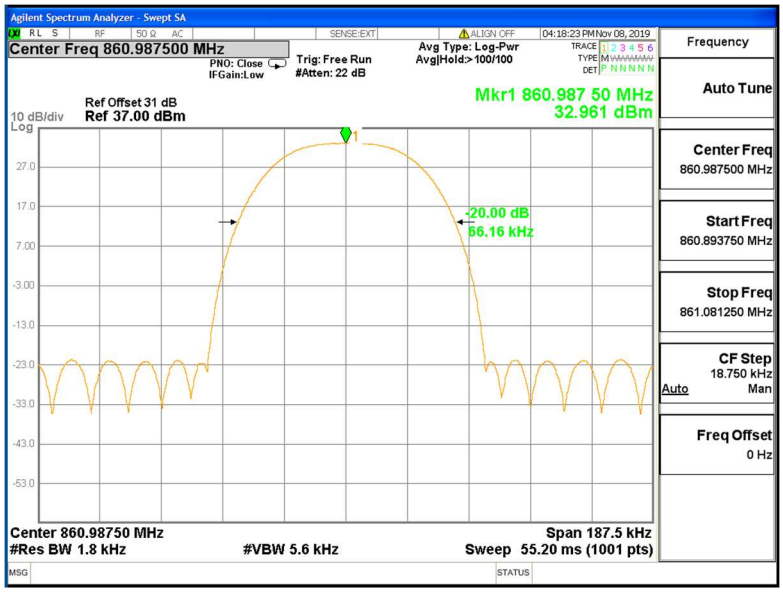
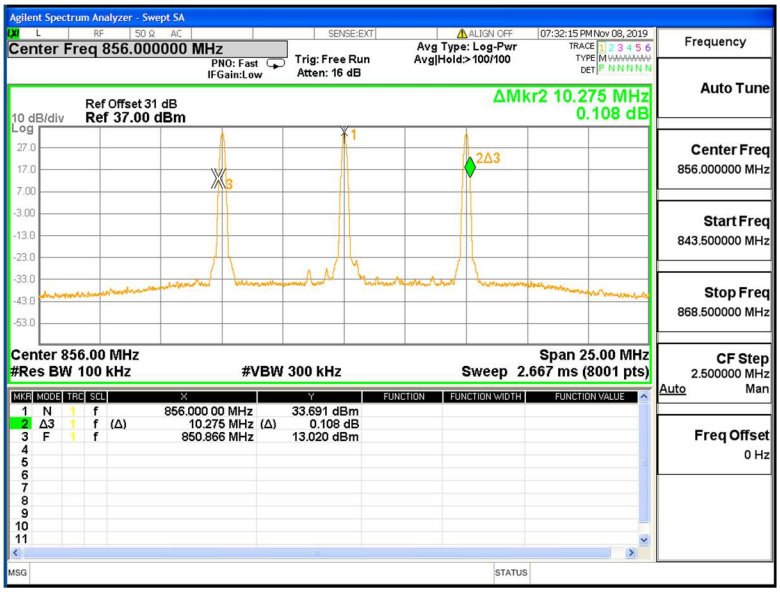
800PS 860.9875 MHz Channel 20dB BW < 70kHz



800PS Total 20dB BW < 10.3MHz



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