



REPORT

For

Dali Wireless, Inc.

535 Middlefield Road, Suite 280
Menlo Park, CA 94025

Date: April 3, 2021
Report No.: 20.01.20346-1
Revision No.: 0
Project No.: 20346
Equipment: Advanced Digital Distributed Antenna System
Model No.: hd37-2-PS-BG-21-1N-D0-2
FCC ID: HCOHD372PSBG21A



ONE STOP GLOBAL CERTIFICATION SOLUTIONS



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TEST REPORT_FCC Part 2 & 90	
Private Land Mobile Services	
Report Reference No.	20.01.20346
Report Revision History.	✓ Rev. 0: 03 April 2021
Compiled by (+ signature)	Jeremy Lee 
Approved by (+ signature)	David Johanson 
Date of issue	03 April 2021
Total number of pages	
FCC Site Registration No.: CA5970	
IC Site Registration No.: CA5970	
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	
Manufacturer's Name	
Dali Wireless (Canada) Inc.	
Address	
8618 Commerce Court, Burnaby, B.C. V5A 4N6, Canada	
Test specification: 61	
Standards	
<ul style="list-style-type: none"> ➤ FCC Part 2; 2020 ➤ FCC Part 90; 2020 	
Test procedure	
<ul style="list-style-type: none"> ➤ FCC KDB 935210 D05 Indus Booster Basic Meas v01r04: 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	
hd37-2-PS-BG-21-1N-D0-2	

Serial Number..... :	1091123E01BB0000
FCC ID	HCOHD372PSBG21A
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	31 March 2021
Date (s) of performance of tests	31 March to 01 April 2021

Revision History

Revision	Date	Reason For Change	Author(s)
0	03 April 2021	Initial Data	Jeremy Lee

Device Under Test Description

Application for	PS 800/450 Remote Unit, Dual Band Medium Power DAS
Passing Transmit Frequency	851 MHz – 861 MHz 406.1 MHz – 411 MHz
Operating Transmit Frequency FCC	851 MHz – 861 MHz 406.1 MHz – 411 MHz
Passing Receive Frequency	806 MHz – 816 MHz 415 MHz – 420 MHz
Operating Receive Frequency FCC	806 MHz – 816 MHz 415 MHz – 420 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 and Band UHF; FM on Band 800 between 851 MHz – 861 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:	<u>48 V</u> stand-alone equipment <u>48 V</u> combined (or host) equipment
Supply Voltage:	_____ AC _____ Amps <u>48V</u> DC <u>5.5</u> Amps
If DC Power:	<input type="checkbox"/> Internal Power Supply <input checked="" type="checkbox"/> External Power Supply <input type="checkbox"/> Battery <input type="checkbox"/> Nickel Cadmium <input type="checkbox"/> Alkaline <input type="checkbox"/> Nickel-Metal Hydride <input type="checkbox"/> Lithium-Ion <input type="checkbox"/> Other

Program details

Testing Facility by procedure:		
<input checked="" type="checkbox"/>	Radiated Measurement	LabTest Certification Inc.
Testing location/ address..... :		Unit 3128-20800 Westminster HWY, Richmond, B.C. V6V 2W3 Canada
<input checked="" type="checkbox"/>	Conducted Measurement:	LabTest Certification Inc.
Testing location/ address..... :		Unit 3128-20800 Westminster HWY, Richmond, B.C. V6V 2W3 Canada

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
<p>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.</p> <p>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.</p>	

Description of Equipment Under Test and Variant Models

Description:

The hd37 /800PS/UHF PS is a dual-band remote unit that provides at least 5 W of output power on each band. The dual-band unit supports up to 2 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 *hdHost* 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 *hdHost* 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 *hdHost* was connected as the Auxiliary device. The *hdHost* does not have antenna port, where the signal was injected and ejected via coaxial cables.



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.

hd37-2-PS-BG-21-1N-D0-2 – Dual band 800PS UHF PS model as tested

Single Band:

1. hd37-1-PS-G-21-1N-D0 (hd37 with UHF PS)
2. hd33-1-PS-G-21-1N-D0 (hd33 with UHF PS)
3. hd37-1-PS-B-21-1N-D0 (hd37 with 800PS)
4. hd33-1-PS-B-21-1N-D0 (hd33 with 800PS)

Client Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
EUT	<i>hd37, 800PS, UHF PS</i>	Dali Wireless Inc.	hd37-3-PS-BG-21-3N-D0	EUT where the RF (I/O) antenna attached via duplexers/multiplexer when necessary.
AE1	<i>hdHost, 800PS, UHF PS</i>	Dali Wireless Inc.	hdHost-3-PS-BG-21-4N-D0	Auxiliary equipment, which is the front end of system interfaced to Base Station.
AE2	Dali Matrix Console	Dali Wireless Inc.	hdCNSL-1-8-4-120G-AC	Auxiliary equipment provides the configuration and control interface to <i>hdHost</i> and <i>hd37</i> .
AE3	Power Supply	MeanWell	HGL-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	5.0.0-5490
AE1	Software installed	5.0.0-5490
AE2	Software installed	5.0.0-5490

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	3 * 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

*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	hdHost maximum input threshold set to -10 dBm, uplink attenuation set to 0dB; hd37 uplink and downlink attenuation set to 0dB.

Test Equipment Verified for function

Model #	Description	Checked Function	Results
N9038A	Spectrum Analyzer	Frequency and Amplitude	In Tolerance
N9010A	Spectrum Analyzer	Frequency and Amplitude	In Tolerance
N5172B	Signal Generator	Frequency, Amplitude and Modulation	In Tolerance
JB1	Antenna, 30 to 1000MHz	Checked structure	Normal – no damage.
SAS-571	Antenna, 1 to 18GHz	Checked structure	Normal – no damage.
SAS-540	Antenna, 30 to 300MHz	Checked structure	Normal – no damage.
VUSLP9111B	Antenna, 300 to 1,000MHz	Checked structure	Normal – no damage.
8449B	Pre-Amplifier	Gain	In Tolerance
5001i	AC Power Source	Measured the Output power	In Tolerance

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
1 * 49-30-34	Aeroflex	30dB 150W attenuators

Test Station Insertion Loss

	Band 800	Band UHF		
DL Transmitter	31.1 dB	30.7 dB		
DL Receiver	0.6 dB	0.4 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 %
DC and Low Frequency Voltages	± 3 %
Radiated Emission, 30 to 6,000MHz	± 4.95 dB

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

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 90			
Test Type	Regulation	Measurement Method	Result
AGC Threshold	FCC KDB 935210 D05, v01r04, Section 4.2	ANSI TIA-603- E-2016	PASS
Out of Band Rejection	FCC KDB 935210 D05, v01r04, Section 4.3	ANSI TIA-603- E-2016	PASS
Input-versus-output Signal Comparison	FCC KDB 935210 D05, v01r04, Section 4.4	ANSI TIA-603- E-2016	PASS
Input/output Power and Amplifier/Booster Gain	FCC KDB 935210 D05, v01r04, Section 4.5	ANSI TIA-603- E-2016	PASS
Noise Figure	FCC KDB 935210 D05, v01r04, 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, v01r04, Section 4.7	ANSI TIA-603- E-2016	PASS
Frequency stability	FCC KDB 935210 D05, v01r04, Section 4.8	ANSI TIA-603- E-2016	PASS
Spurious emissions radiated measurements	FCC KDB 935210 D05, v01r04, Section 4.9	ANSI C63.4:2014	PASS

AGC Threshold

Governing Doc	FCC Part 2 2.1046(a) FCC Part 90.219(d)	Room Temperature (°C)	20.0		
Test Procedure	ANSI/TIA-603- E-2016; FCC KDB 935210 D05, v01r04;	Relative Humidity (%)	30.0		
Test Location	Richmond	Barometric Pressure (kPa)	102.1		
Test Engineer	Jeremy Lee	Date	01 April 2021		
EUT Voltage	<input checked="" type="checkbox"/> +48VDC <input type="checkbox"/> 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:	<input checked="" type="checkbox"/> 851 MHz – 861 MHz <input checked="" type="checkbox"/> 406.1 MHz – 411 MHz				
Detector:	<input checked="" type="checkbox"/> Peak				
Type of Facility:	<input checked="" type="checkbox"/> Test bench				
Distance:	<input checked="" type="checkbox"/> Direct				
Arrangement of EUT:	<input checked="" type="checkbox"/> Table-top only <input type="checkbox"/> Floor-standing only <input type="checkbox"/> Rack Mounted				
Output Power is less than 37.0 dBm in band 800, and less than 37.0 dBm in band UHF.					
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>					

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.

```

    graph LR
        VSG[Vector Signal Generator] --- hdHost[hdHost]
        hdHost --- EUT[EUT]
        EUT --- Att[30 dB Attenuator]
        Att --- SA[Spectrum Analyzer]
    
```

Results – Output Power FCC Requirement

Frequency Range (MHz)	Frequency (MHz)	Input Power Trip ALC (dBm)	Output Power (dBm)	Output Power (W)
851 - 861	851.0125	-9.5	36.9	4.8978
	856.0000	-9.8	37.0	5.0119
	860.9875	-9.4	37.0	5.0119
406.1 -411	406.1125	-10.8	37.0	5.0119
	408.5500	-10.7	37.0	5.0119
	410.9875	-10.7	37.0	5.0119

Occupied Bandwidth

Governing Doc	FCC Part 2 2.1049	Room Temperature (°C)	20.0		
Test Procedure	ANSI/TIA-603- E-2016; FCC KDB 935210 D05, v01r04	Relative Humidity (%)	30.0		
Test Location	Richmond	Barometric Pressure (kPa)	102.1		
Test Engineer	Jeremy Lee	Date	01 April 2021		
EUT Voltage	<input checked="" type="checkbox"/> +48VDC <input type="checkbox"/> 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:	<input checked="" type="checkbox"/> 851 MHz – 861 MHz <input checked="" type="checkbox"/> 406.1 MHz – 411 MHz				
Detector:	<input checked="" type="checkbox"/> Peak				
Type of Facility:	<input checked="" type="checkbox"/> Test bench				
Distance:	<input checked="" type="checkbox"/> Direct				
Arrangement of EUT:	<input checked="" type="checkbox"/> Table-top only <input type="checkbox"/> Floor-standing only <input type="checkbox"/> Rack Mounted				
Output signal has an occupied channel bandwidth less than the designated channel bandwidth on any location on the operating band. <ul style="list-style-type: none"> - C4FM < 12.5 kHz - CQPSK < 6.25 kHz - HDQPSK < 12.5 kHz 					
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>					

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:

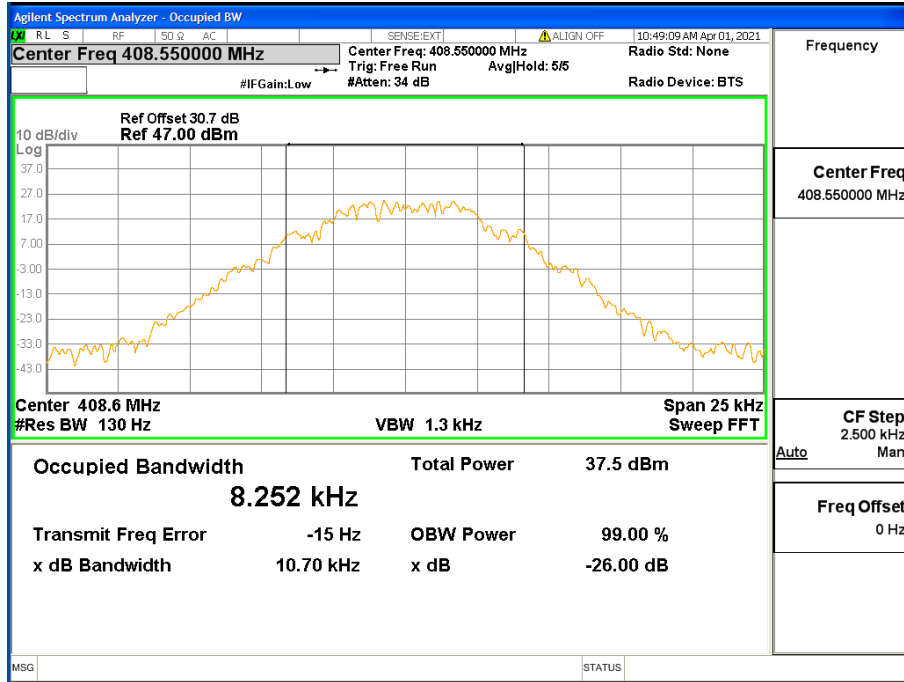
- Nominal: with input 0.5dB below AGC threshold

```

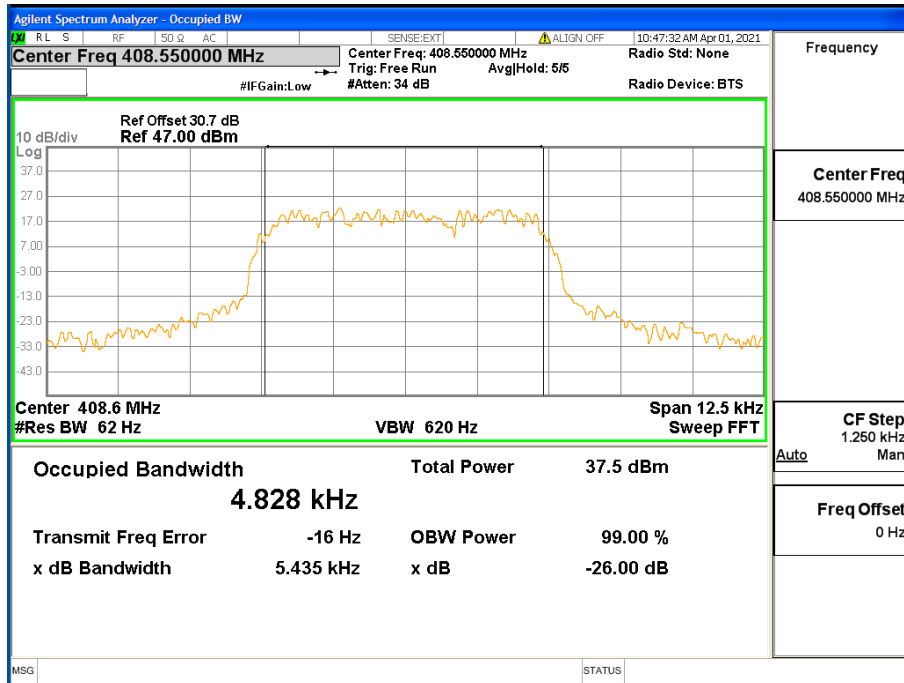
    graph LR
      A[Vector Signal Generator] --- B[hdHost]
      B --- C(( ))
      C --- D[EUT]
      D --- E[30 dB Attenuator]
      E --- F[Spectrum Analyzer]
    
```

Results – Occupied Bandwidth (OBW)

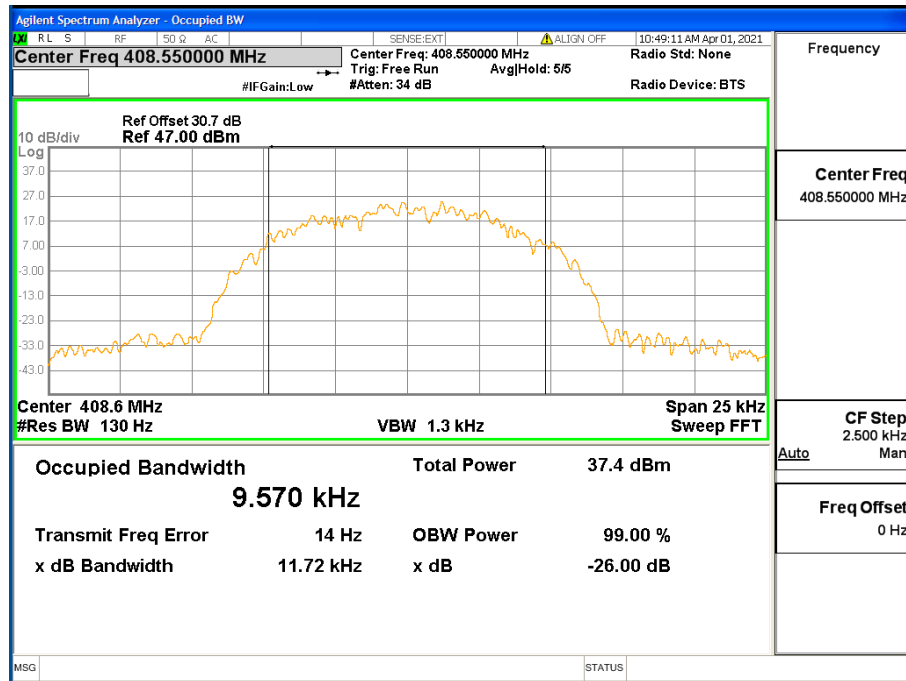
C4FM Signal at 408.550 MHz



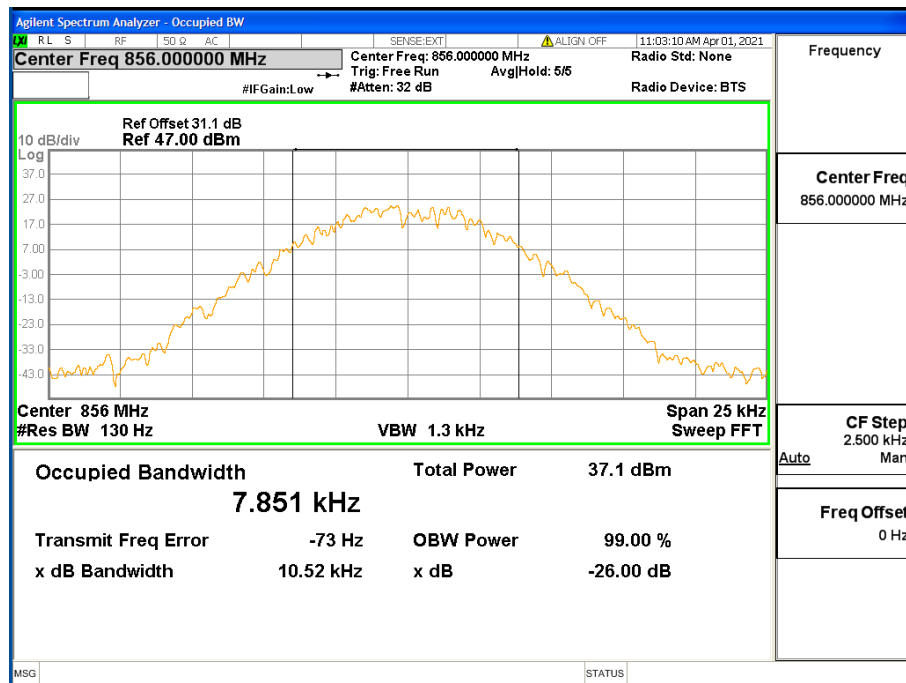
CQPSK Signal at 408.550 MHz



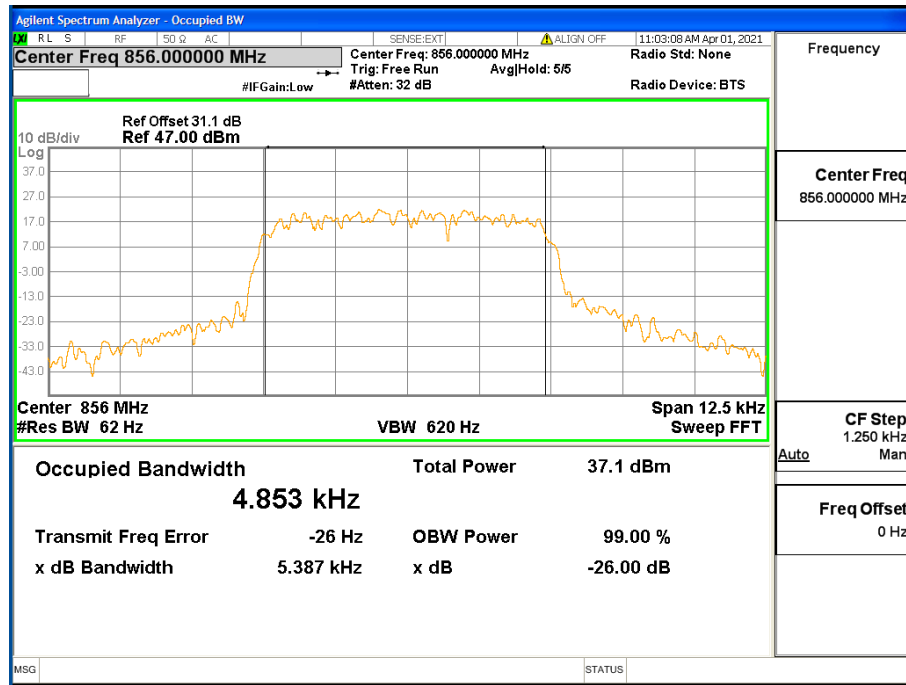
HDQPSK Signal at 408.550 MHz



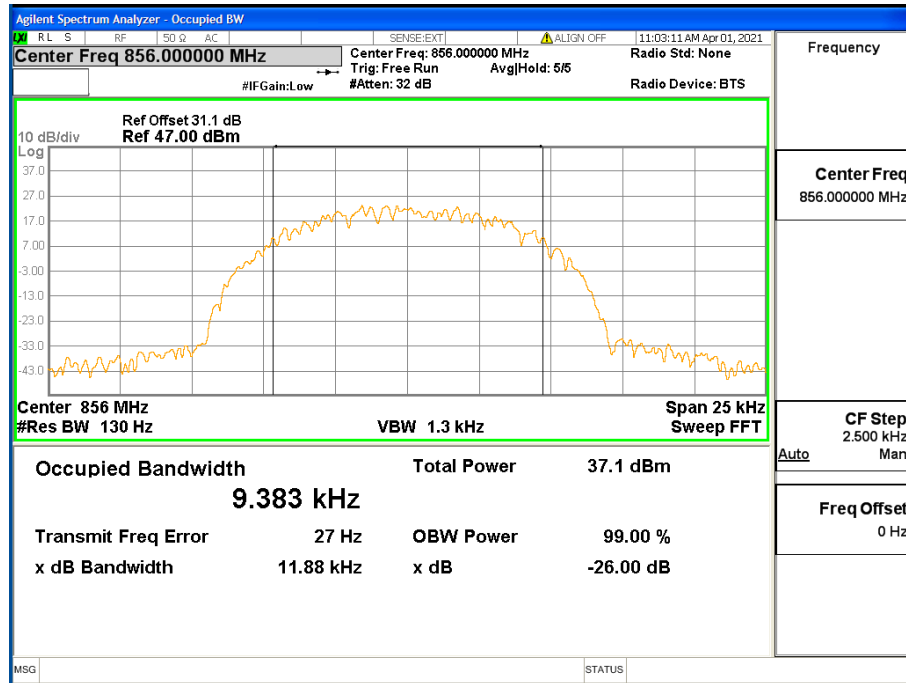
C4FM Signal at 856 MHz



CQPSK Signal at 856 MHz



HDQPSK Signal at 856 MHz



Out of Band Rejection

Governing Doc	FCC Part 2 2.1046(a) FCC Part 90.219(d)	Room Temperature (°C)	20.0		
Test Procedure	ANSI/TIA-603- E; FCC KDB 935210 D05, v01r04	Relative Humidity (%)	30.0		
Test Location	Richmond	Barometric Pressure	102.1		
Test Engineer	Jeremy Lee	Date	01 April 2021		
EUT Voltage	<input checked="" type="checkbox"/> +48VDC <input type="checkbox"/> 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:	<input checked="" type="checkbox"/> Product Passband \pm 250%				
Detector:	<input checked="" type="checkbox"/> Peak				
RBW/VBW:	<input checked="" type="checkbox"/> 0.1% of 5 times of passband bandwidth				
Type of Facility:	<input checked="" type="checkbox"/> Tabletop				
Distance:	<input checked="" type="checkbox"/> Direct				
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>					

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 v01r04. The signal booster was set to maximum gain. A swept CW signal was set to the range of $\pm 250\%$ of the product pass band. The CW amplitude was set to 3 dB below the AGC threshold so that the ALC should not activate throughout the test.

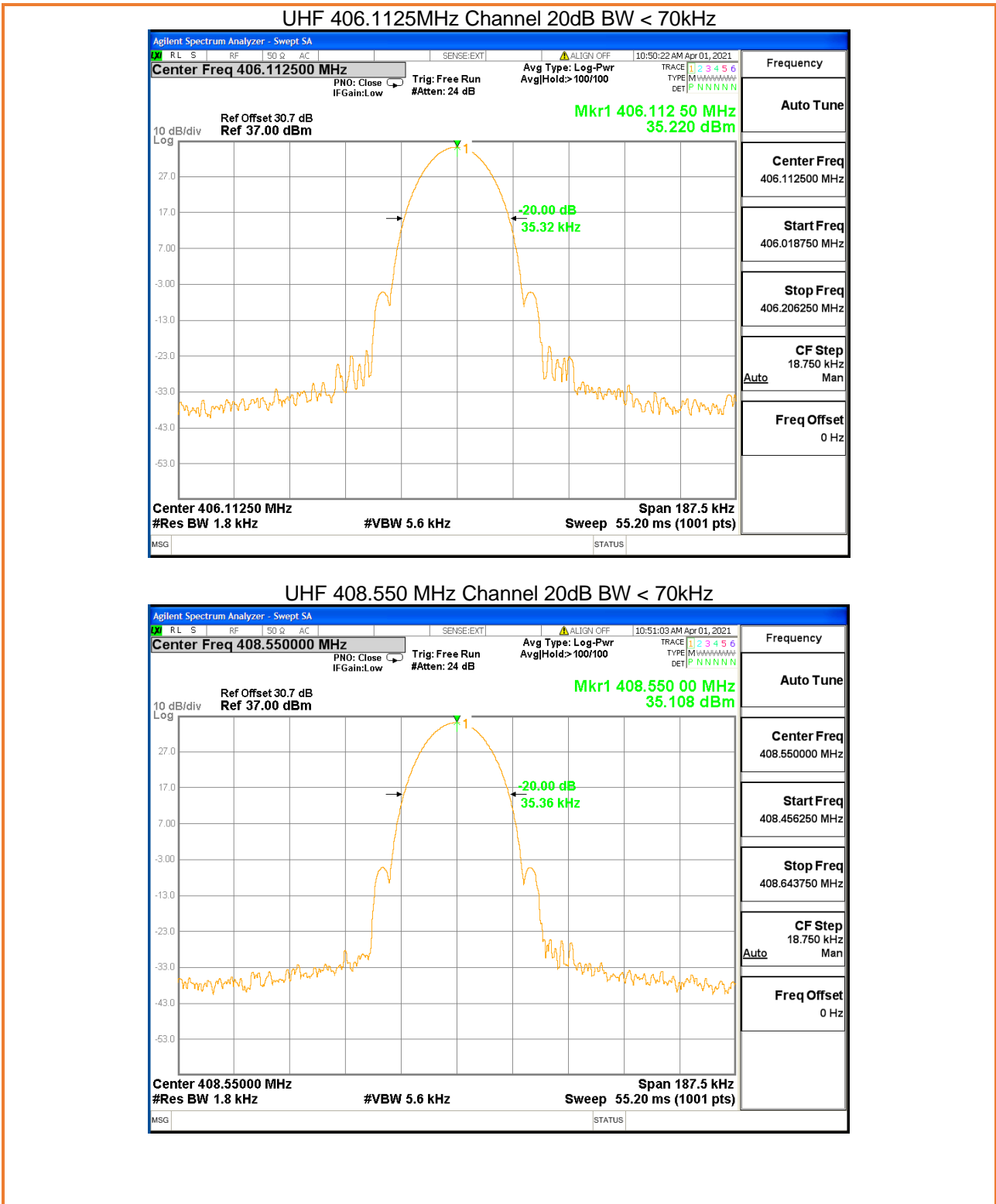
After the max-hold sweep trace was completed, a marker was set to the peak amplitude, and a 20dB bandwidth was measured between two additional markers fall 20 dB from the peak.

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

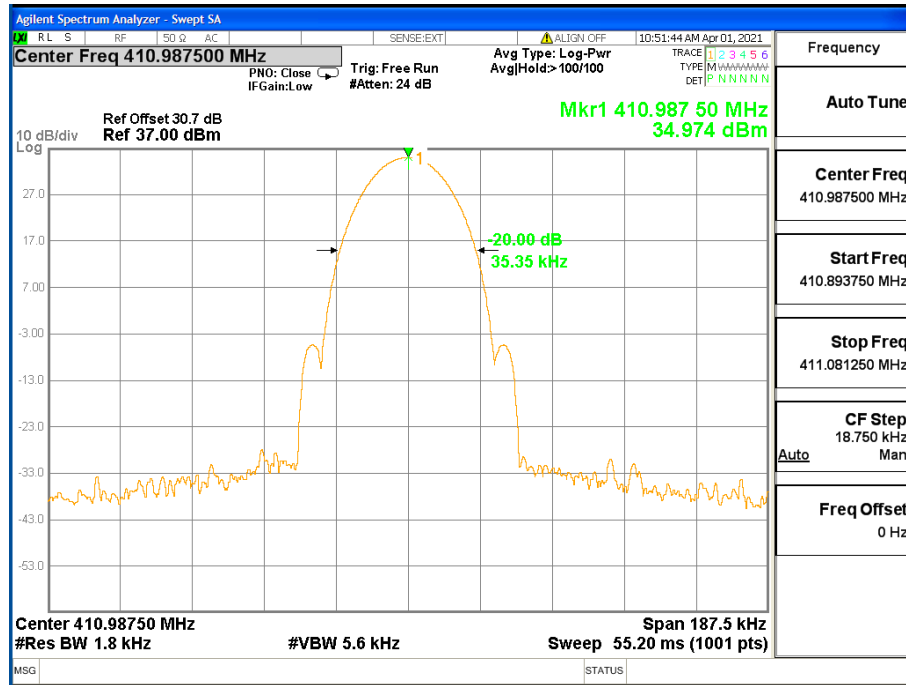
```

    graph LR
      A[Vector Signal Generator] --- B[hdHost]
      B --- C(( ))
      C --- D[EUT]
      D --- E[30 dB Attenuator]
      E --- F[Spectrum Analyzer]
    
```

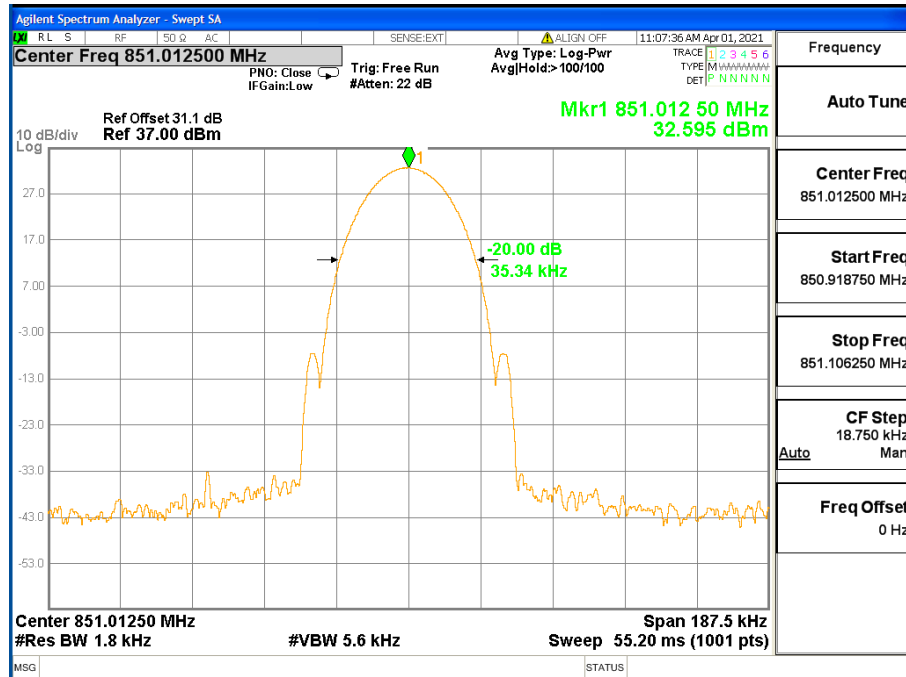
Results



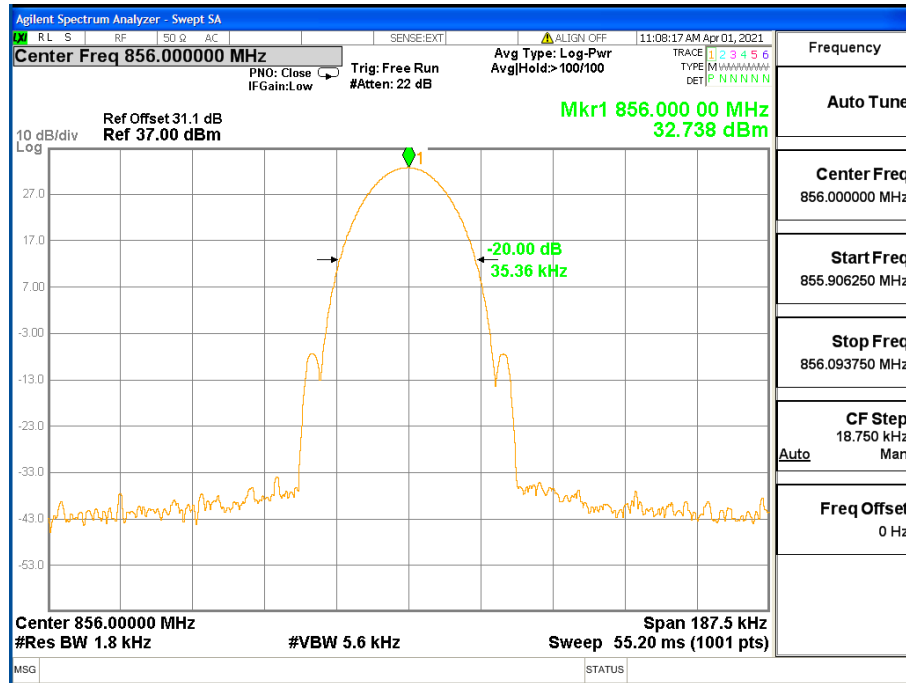
UHF 410.9875 MHz Channel 20dB BW < 70kHz



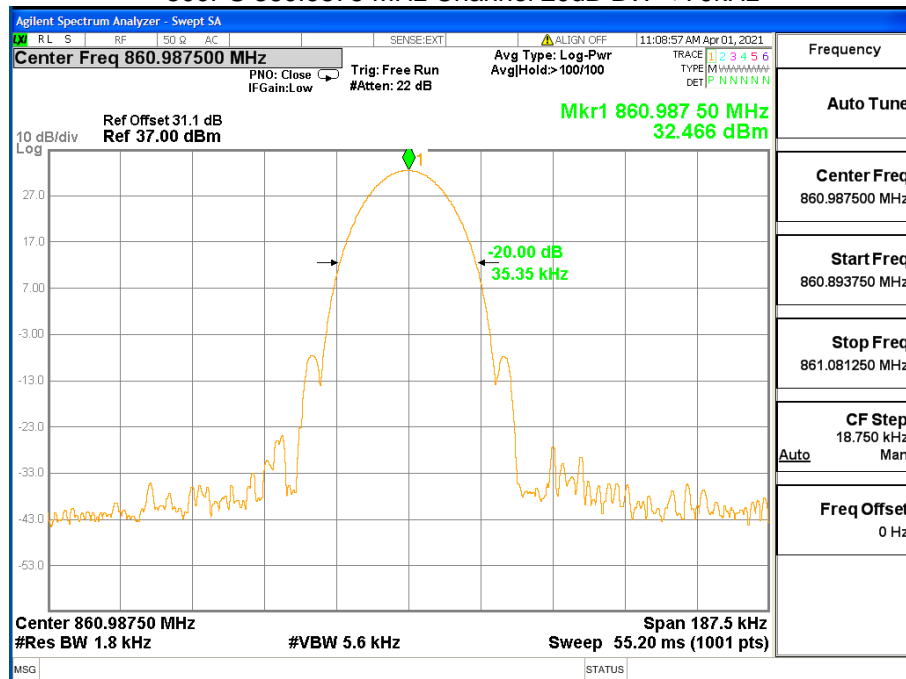
800PS 851.0125 MHz Channel 20dB BW < 70kHz



800PS 856 MHz Channel 20dB BW < 70kHz



800PS 860.9875 MHz Channel 20dB BW < 70kHz



Input-Versus-Output Signal Comparison

Governing Doc	FCC Part 90.210 (j) (h) (g) (c) (d) and (e)		Room Temperature (°C)	20.0	
Test Procedure	ANSI/TIA-603- E; FCC KDB 935210 D05, v01r04		Relative Humidity (%)	30.0	
Test Location	Richmond		Barometric Pressure	102.1	
Test Engineer	Jeremy Lee		Date	01 April 2021	
EUT Voltage	<input checked="" type="checkbox"/> +48VDC		<input type="checkbox"/> 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:	<input checked="" type="checkbox"/> 851 MHz – 861 MHz		<input checked="" type="checkbox"/> 406.1 MHz – 411 MHz		
Detector:	<input checked="" type="checkbox"/> Peak				
RBW/VBW:	<input checked="" type="checkbox"/> 100 Hz				
Type of Facility:	<input checked="" type="checkbox"/> Testbench				
Distance:	<input checked="" type="checkbox"/> direct connect				
Arrangement of EUT:	<input checked="" type="checkbox"/> Table-top only		<input type="checkbox"/> Floor-standing only		<input type="checkbox"/> Rack Mounted
<p>Based on FCC Part90.210, transmitters without audio low pass filter used in frequency band 851 - 854 MHz must comply to emission mask H; 854 - 861 MHz must comply to emission mask G;</p> <p>Signal of all types of modulation is contained within the emission mask.</p> <p>Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/></p>					

Test setup

Description of test set-up:

Spectrum Emission Mask is measured by connecting a Spectrum Analyzer to the RF output connector. The input power was adjusted to produce maximum output power on the antenna port. The reference level was measured with integrated BW of the designated channel BW. The emission was measured with RBW 100 Hz.

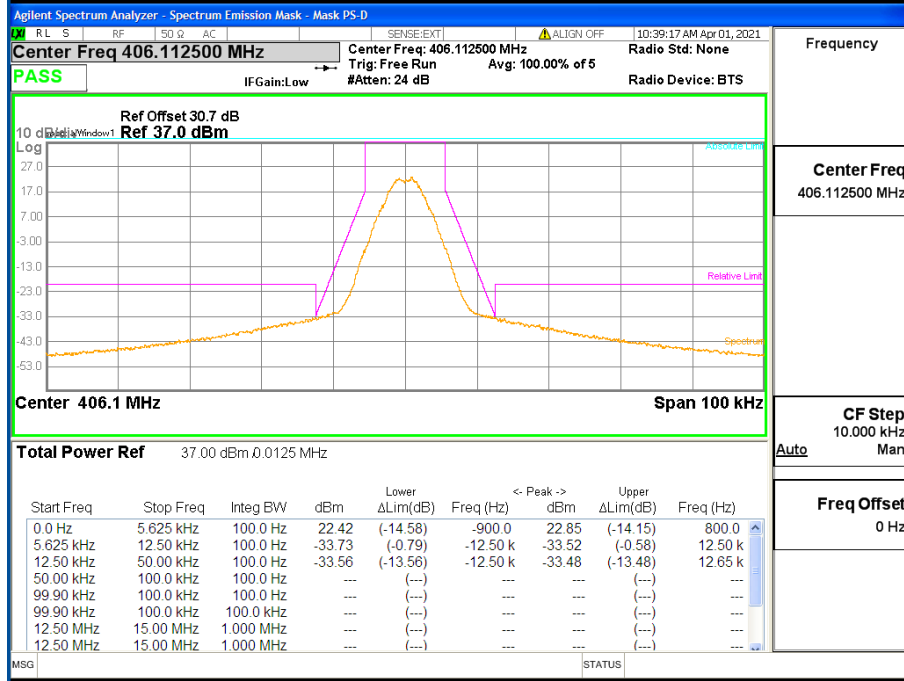
The EUT was set to **Operation Mode #1 with configuration Mode #1.**

```

    graph LR
        A[Vector Signal Generator] --- B[hdHost]
        B --- C(( ))
        C --- D[EUT]
        D --- E[30 dB Attenuator]
        E --- F[Spectrum Analyzer]
    
```

Results

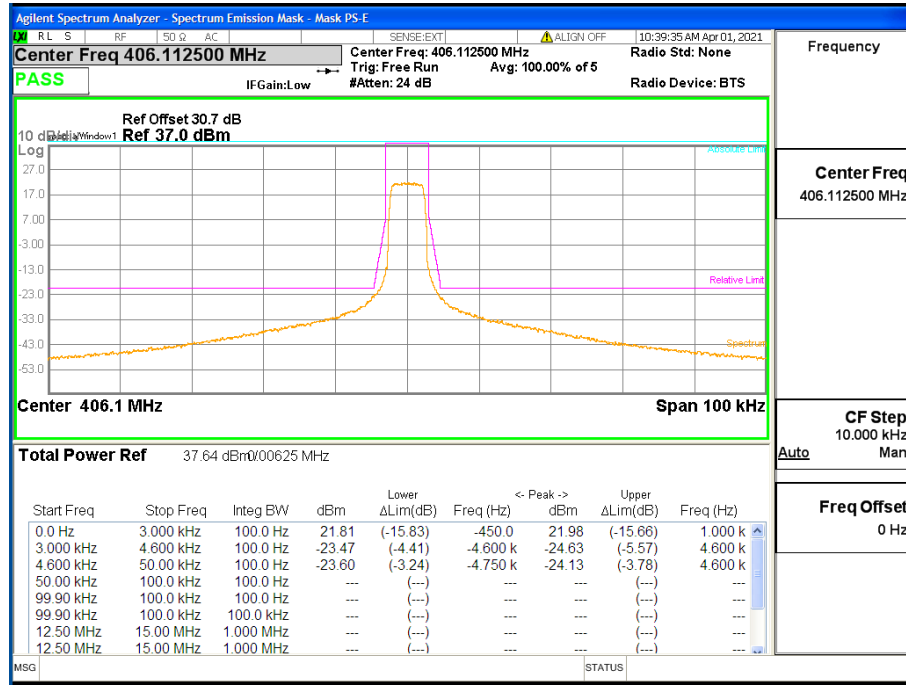
At AGC C4FM 406.1125 MHz - Mask D



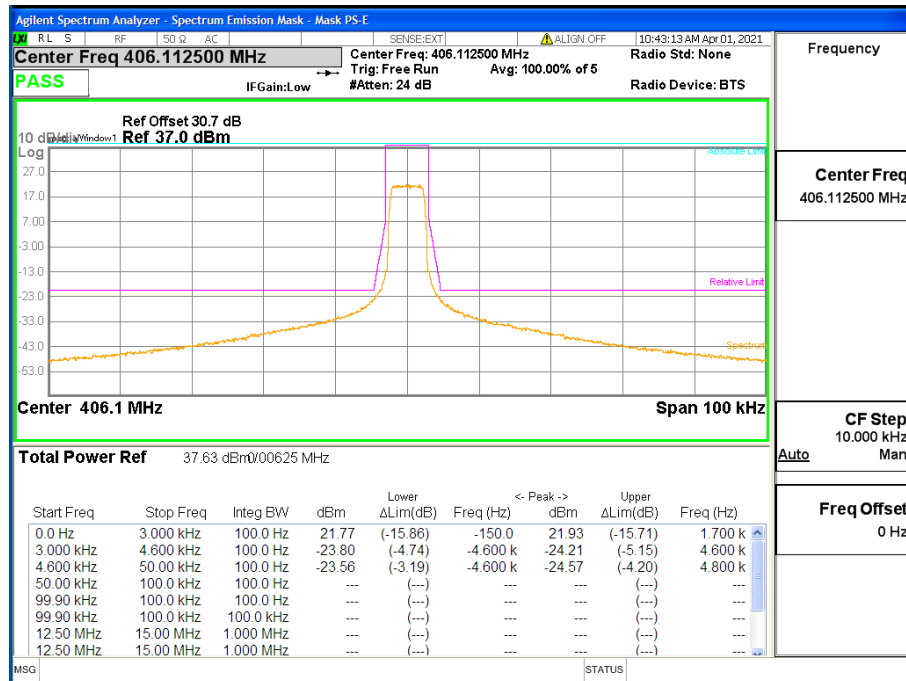
3dB above the AGC threshold Output C4FM 406.1125 MHz - Mask D



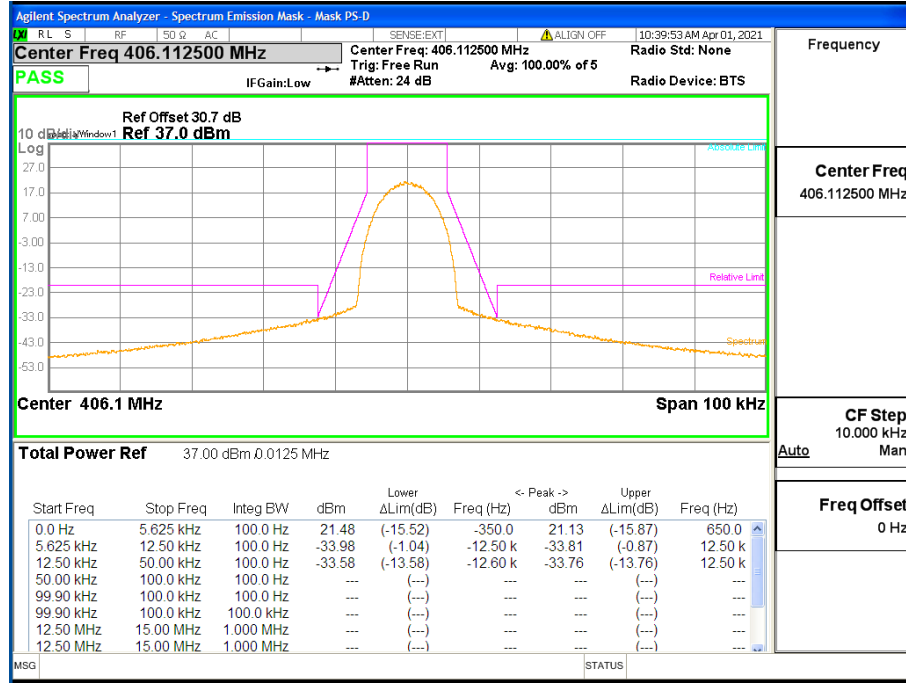
At AGC CQPSK 406.1125 MHz - Mask E



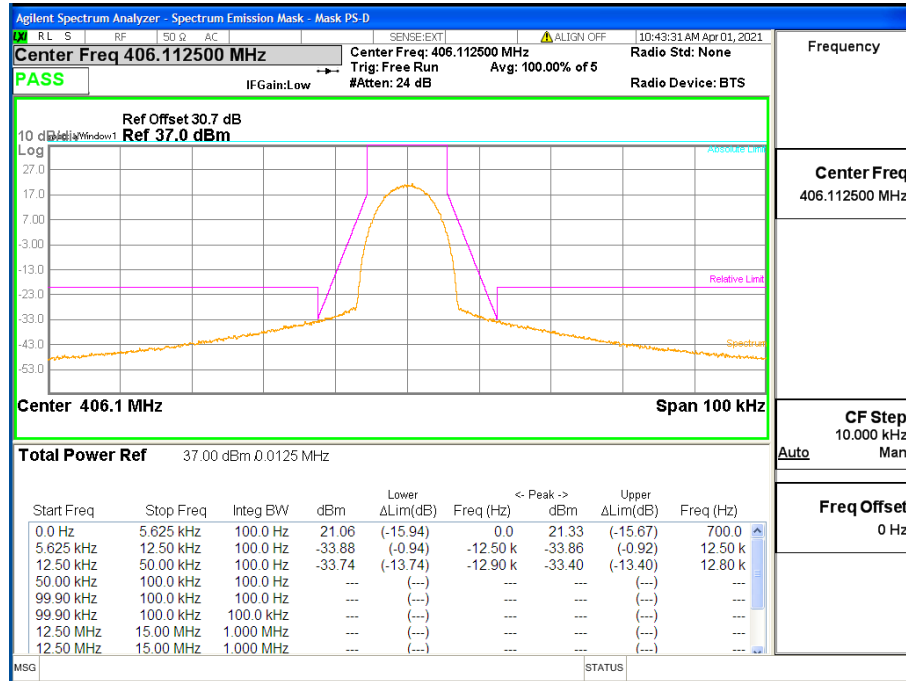
3dB above the AGC threshold Output CQPSK 406.1125 MHz - Mask E



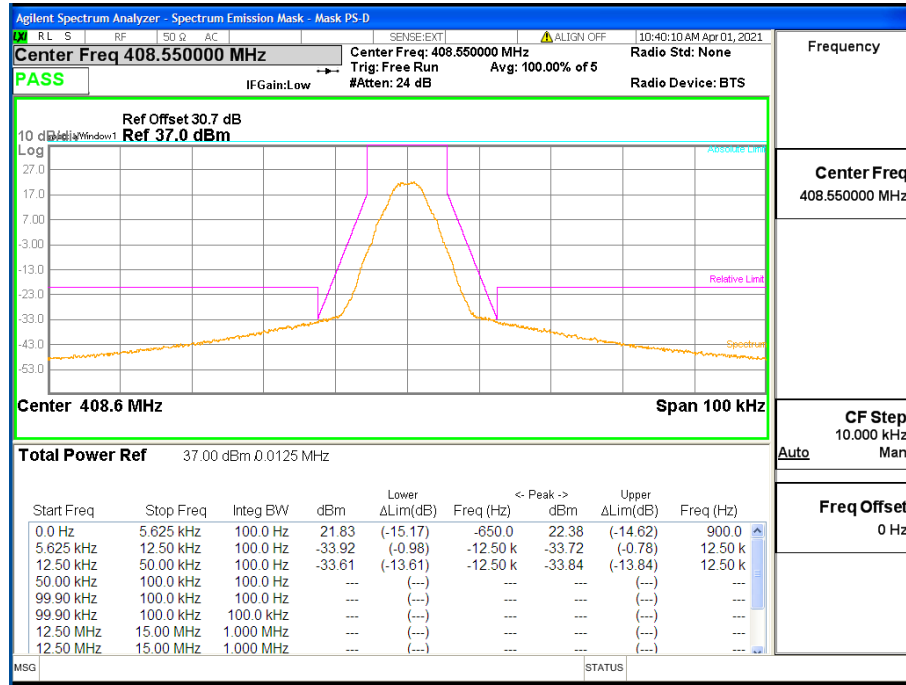
At AGC HDQPSK 406.1125 MHz - Mask D



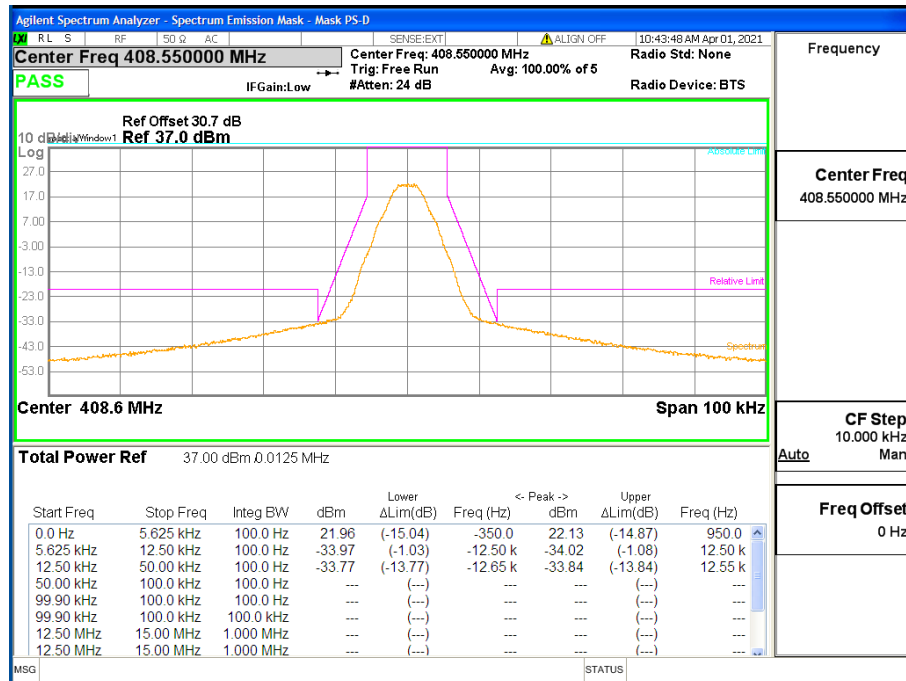
3dB above the AGC threshold Output HDQPSK 406.1125 MHz - Mask D



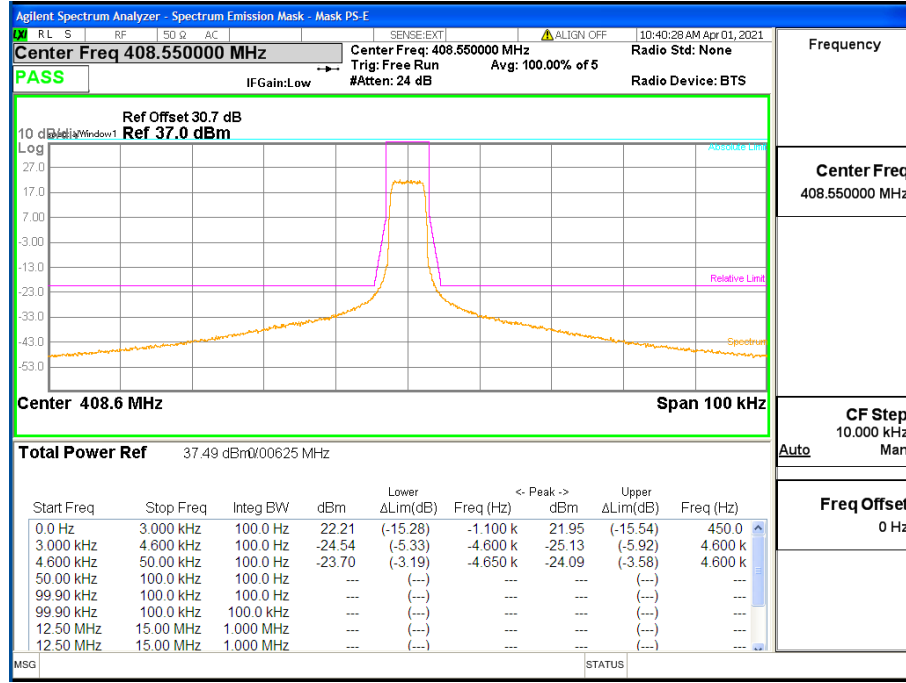
At AGC C4FM 408.550 MHz - Mask D



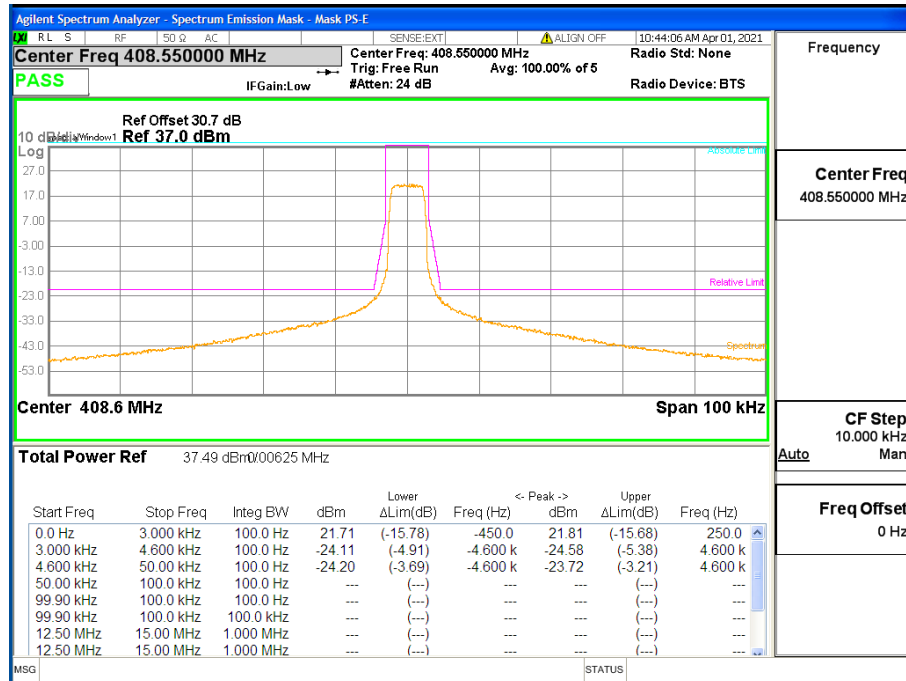
3dB above the AGC threshold Output C4FM 408.550 MHz - Mask D



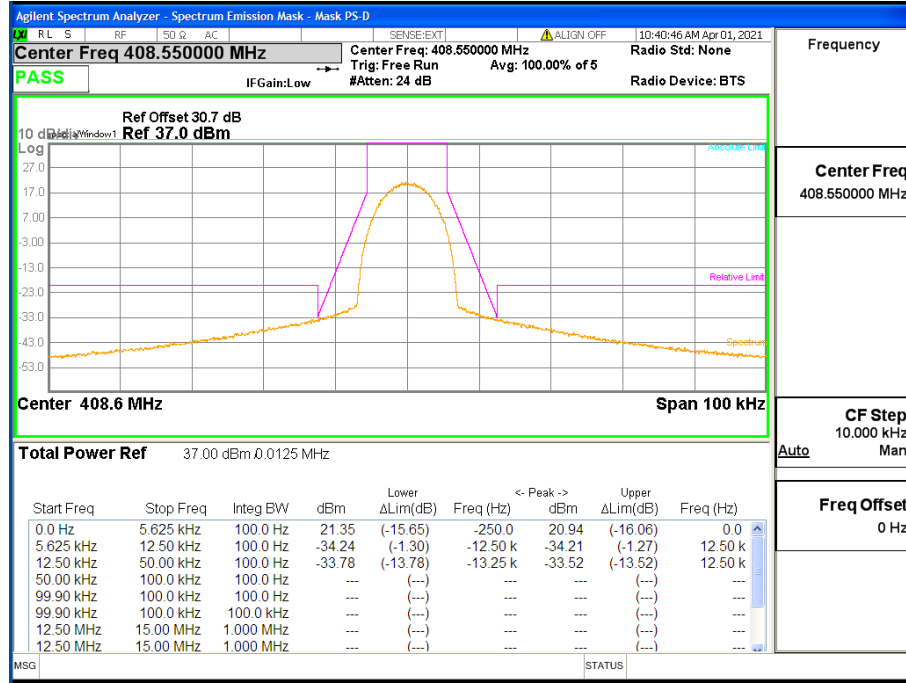
At AGC CQPSK 408.550 MHz - Mask E



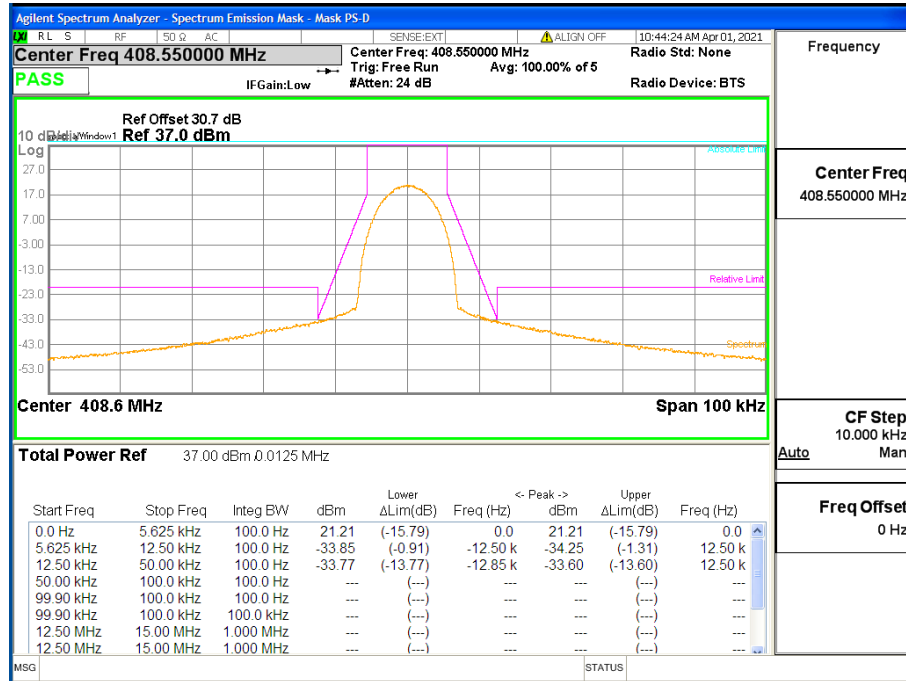
3dB above the AGC threshold Output CQPSK 408.550 MHz - Mask E



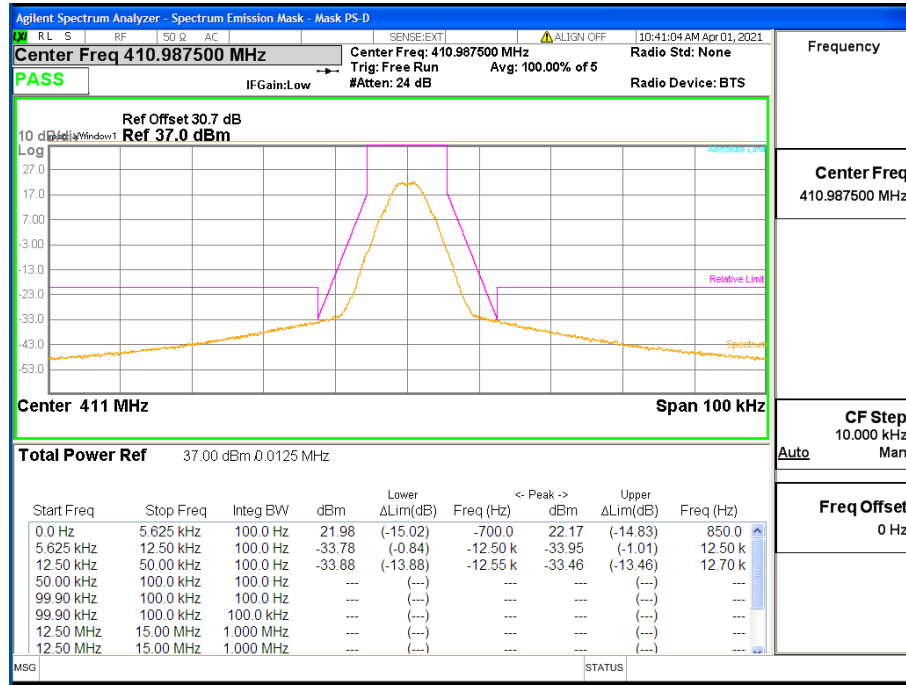
AT AGC HDQPSK 408.550 MHz - Mask D



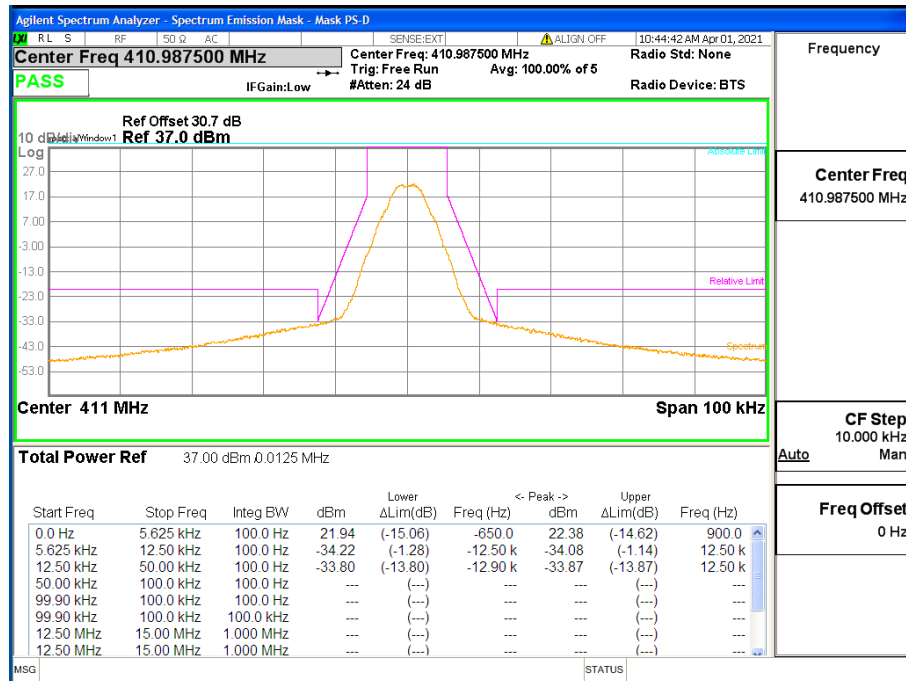
3dB above the AGC threshold Output HDQPSK 408.550 MHz - Mask D



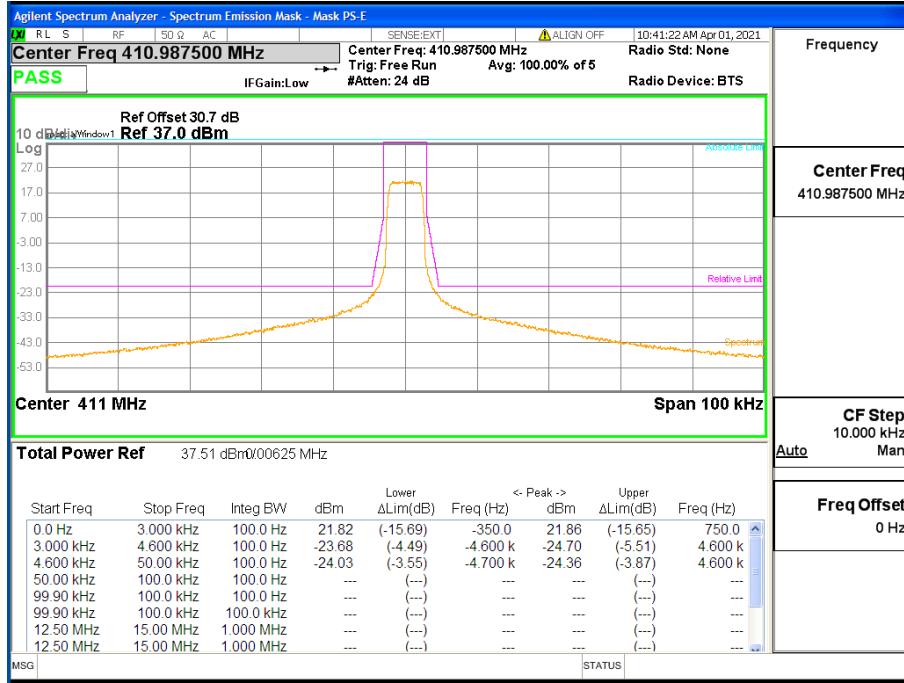
At AGC C4FM 410.9875 MHz - Mask D



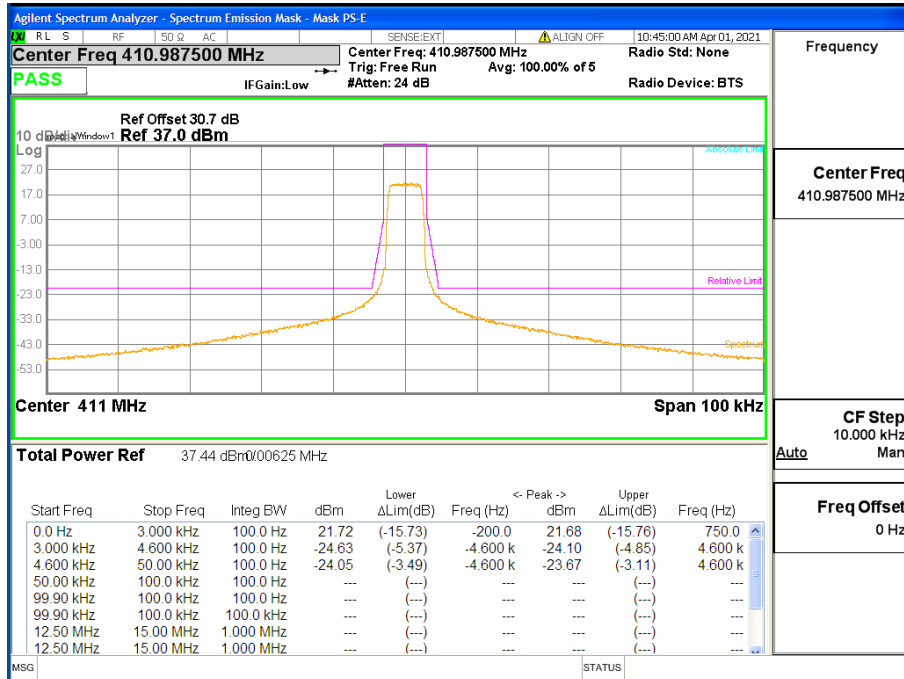
3dB above the AGC threshold Output C4FM 410.9875 MHz - Mask D



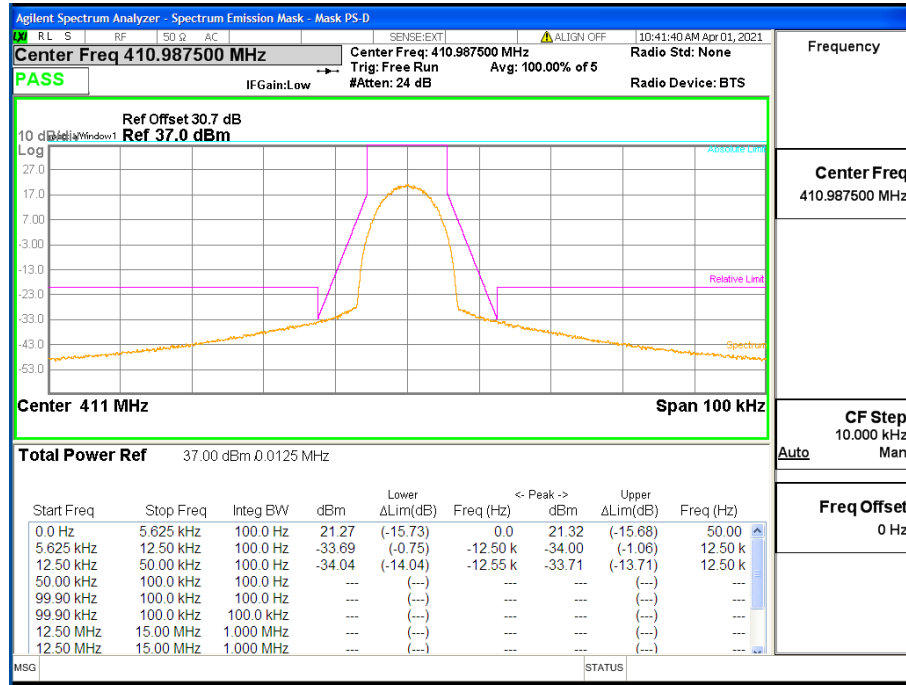
AT AGC CQPSK 410.9875 MHz - Mask E



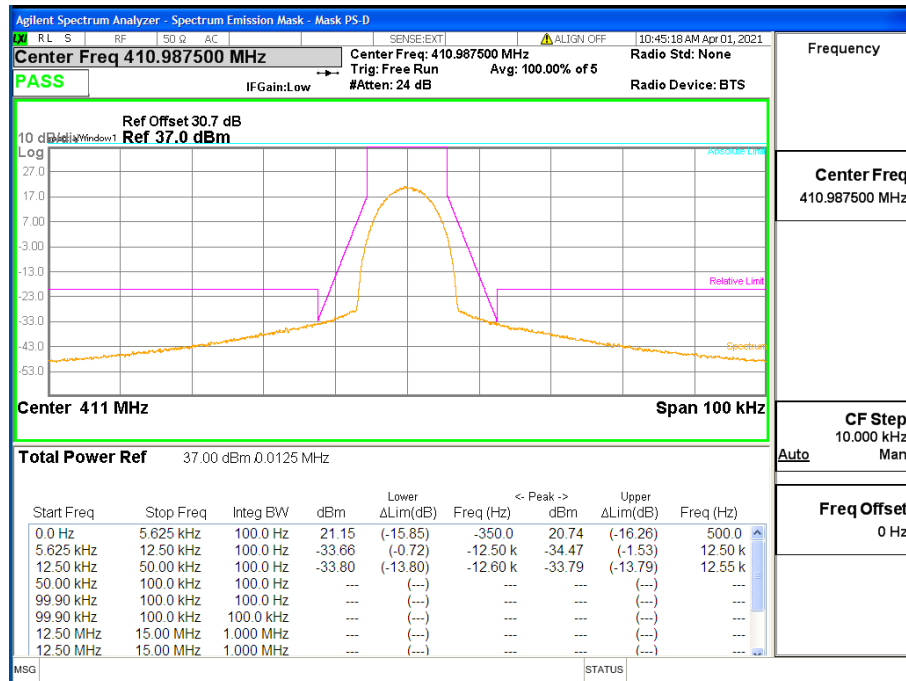
3dB above the AGC threshold Output CQPSK 410.9875 MHz - Mask E



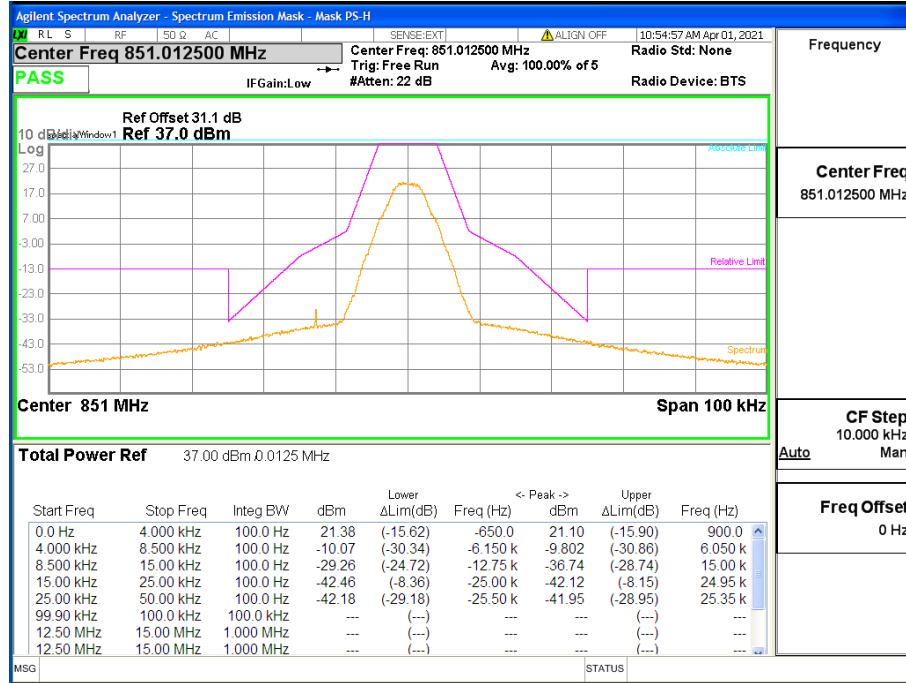
At AGC HDQPSK 410.9875 MHz - Mask D



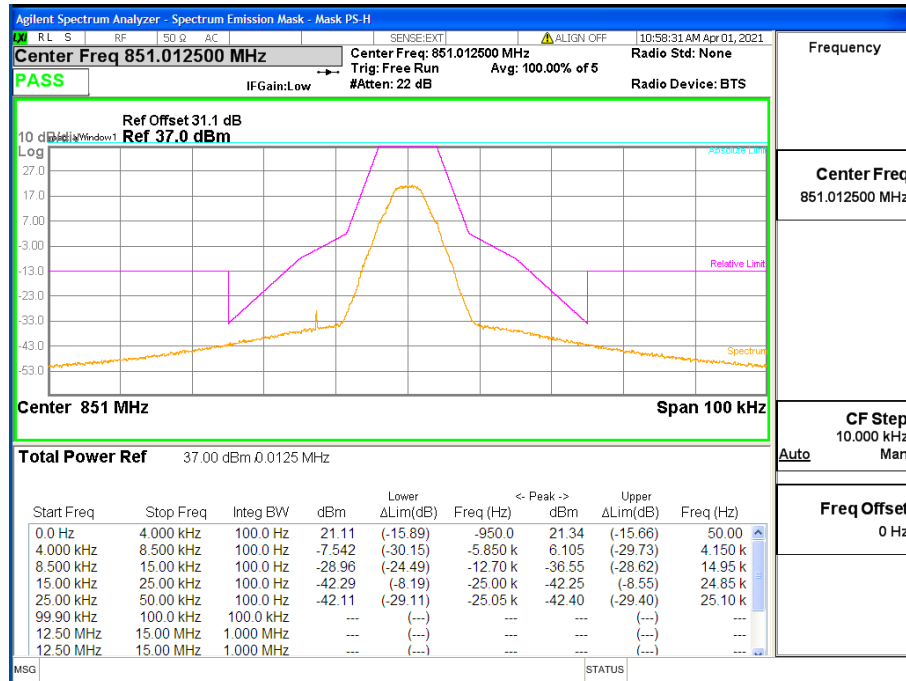
3dB above the AGC threshold Output HDQPSK 410.9875 MHz - Mask D



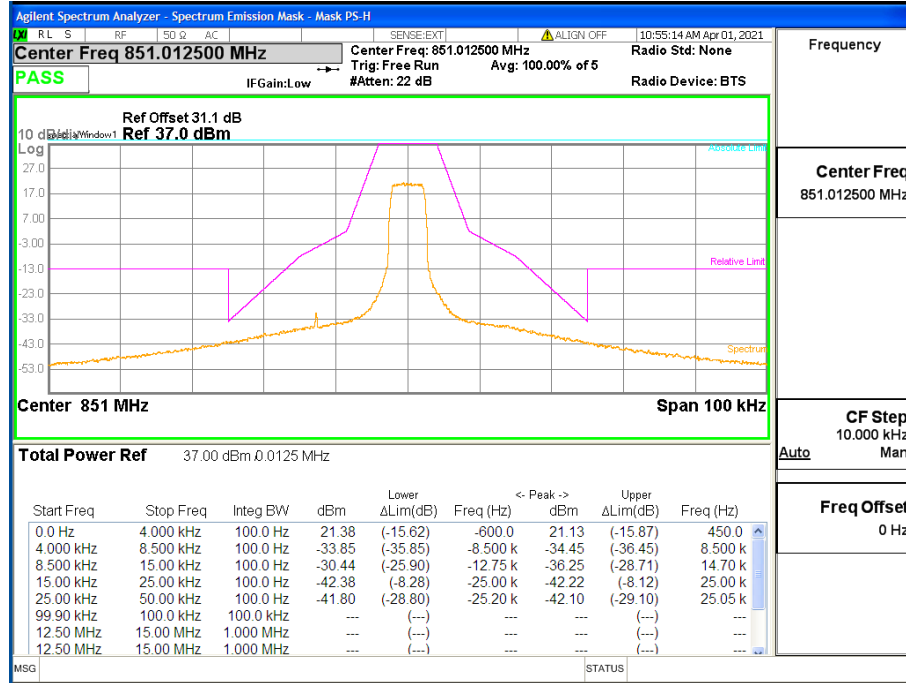
At AGC C4FM 851.0125 MHz - Mask H



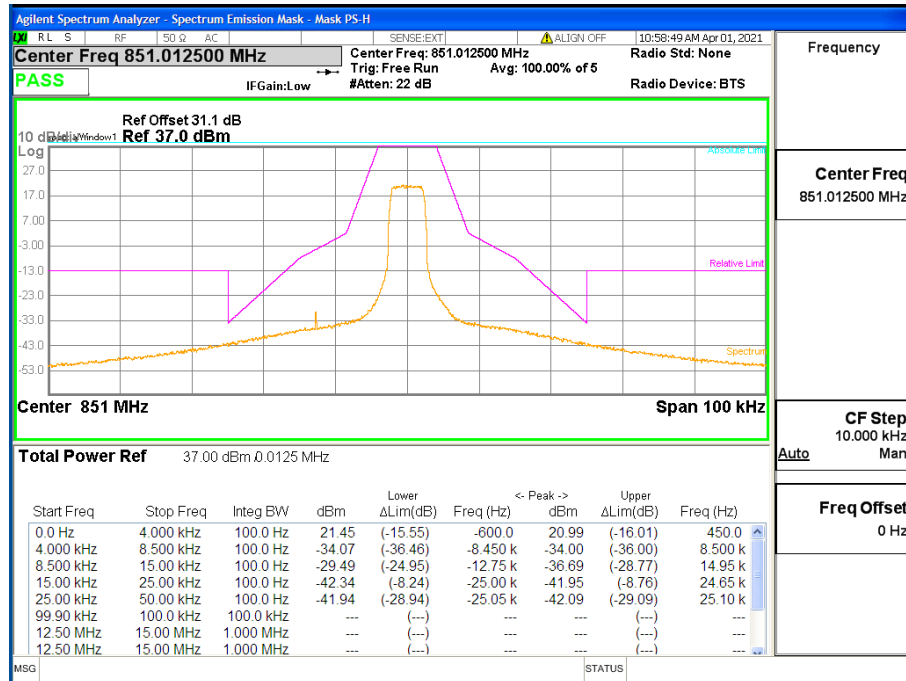
3dB above the AGC threshold Output C4FM 851.0125 MHz - Mask H



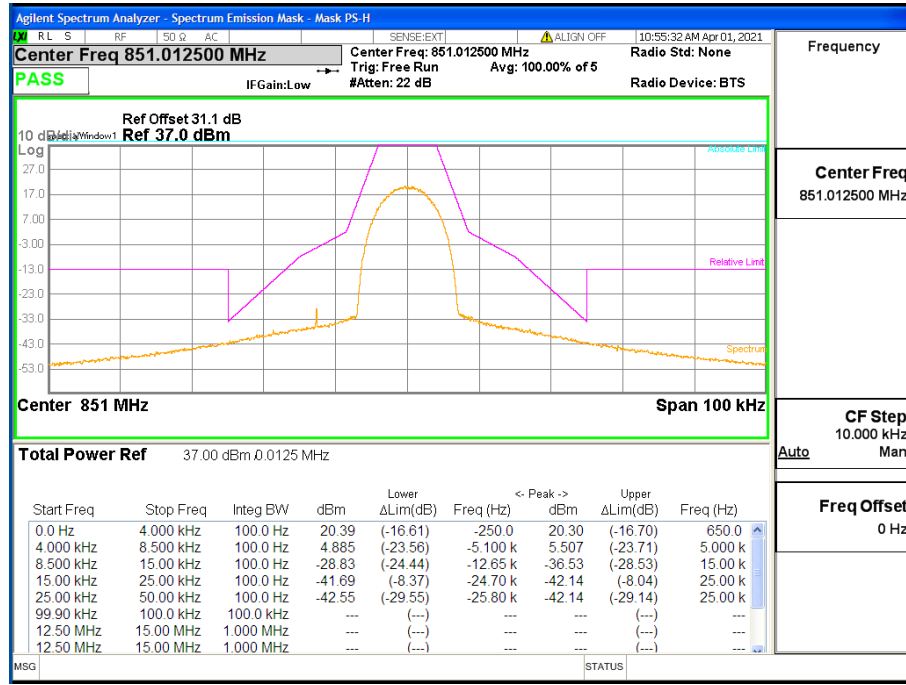
At AGC CQPSK 851.0125 MHz - Mask H



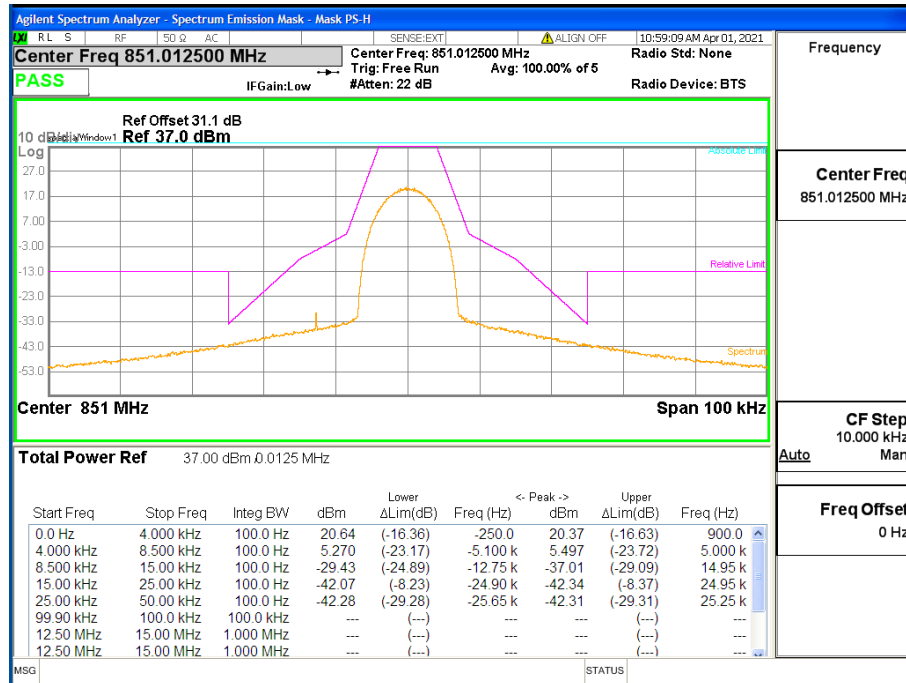
3dB above the AGC threshold Output CQPSK 851.0125 MHz - Mask H



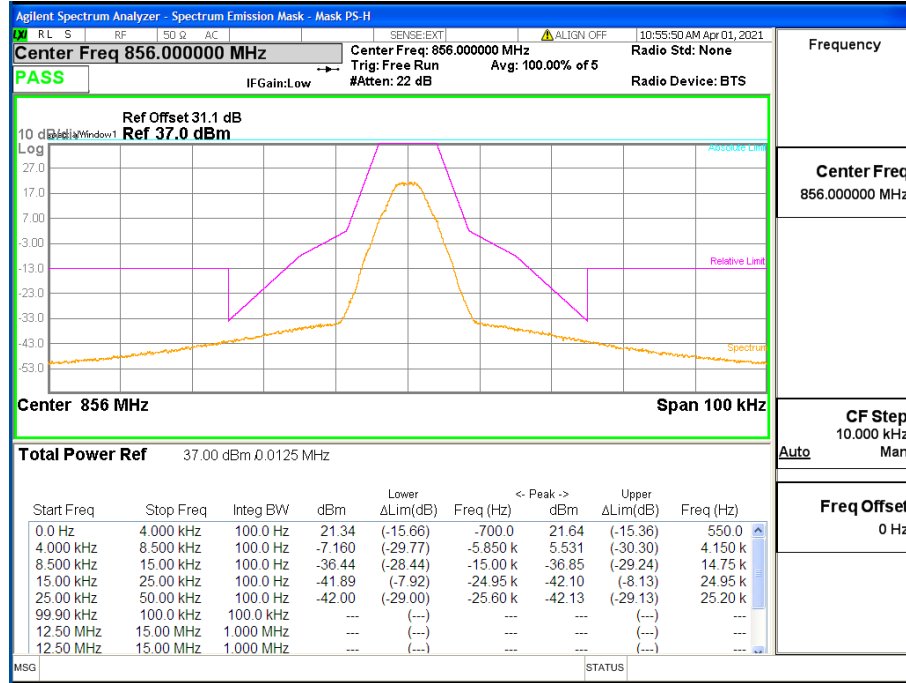
At AGC HDQPSK 851.0125 MHz - Mask H



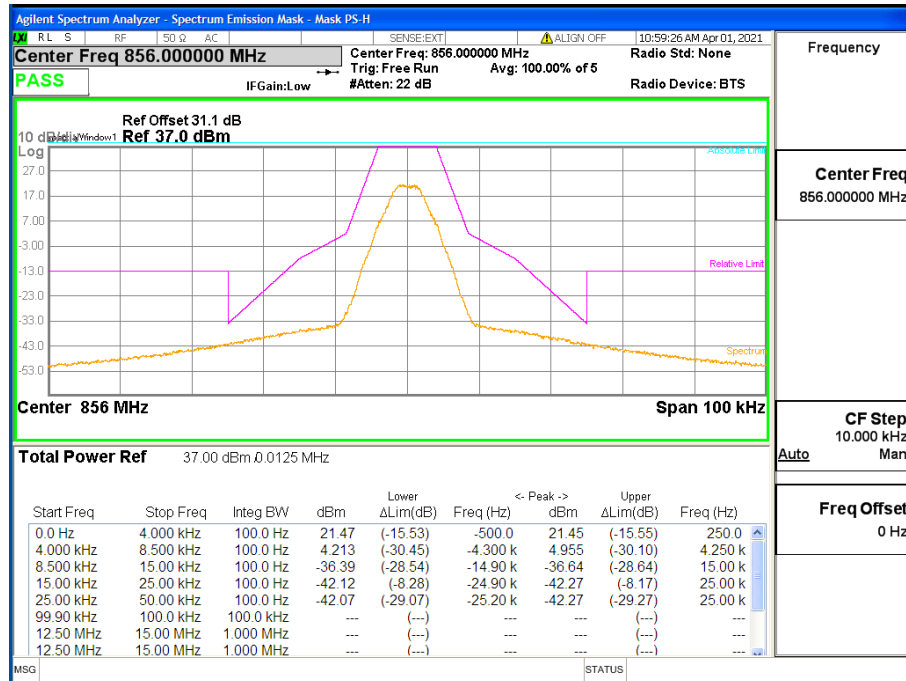
3dB above the AGC threshold Output HDQPSK 851.0125 MHz - Mask H



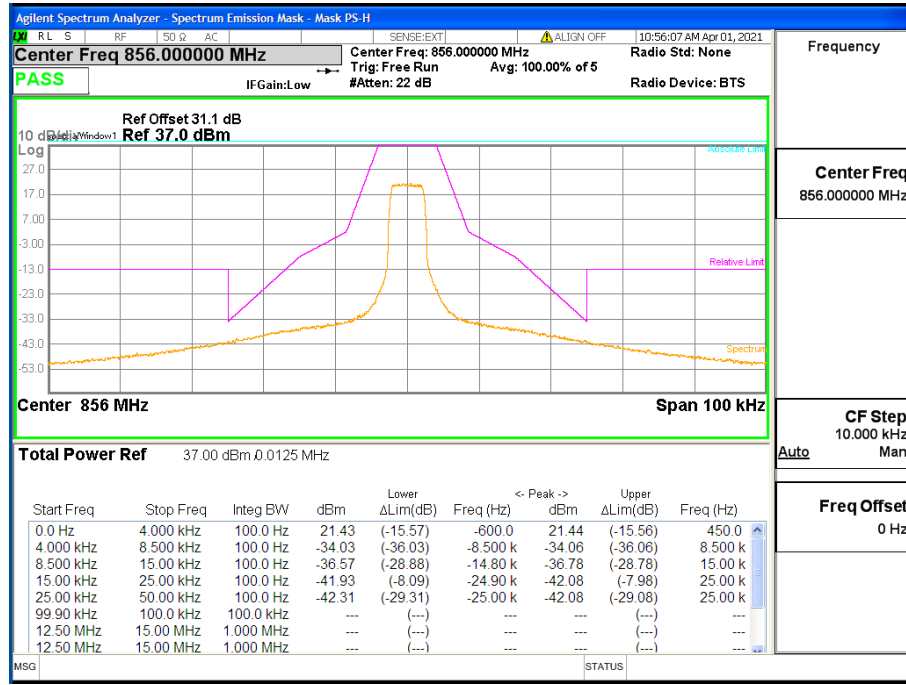
At AGC C4FM 856.000 MHz - Mask H



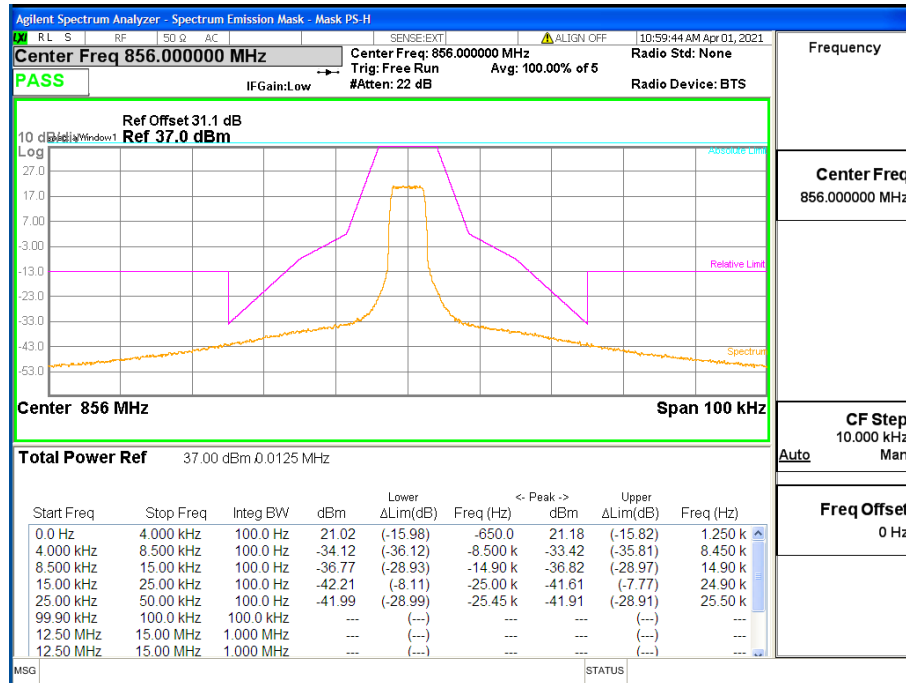
3dB above the AGC threshold Output C4FM 856.000 MHz - Mask H



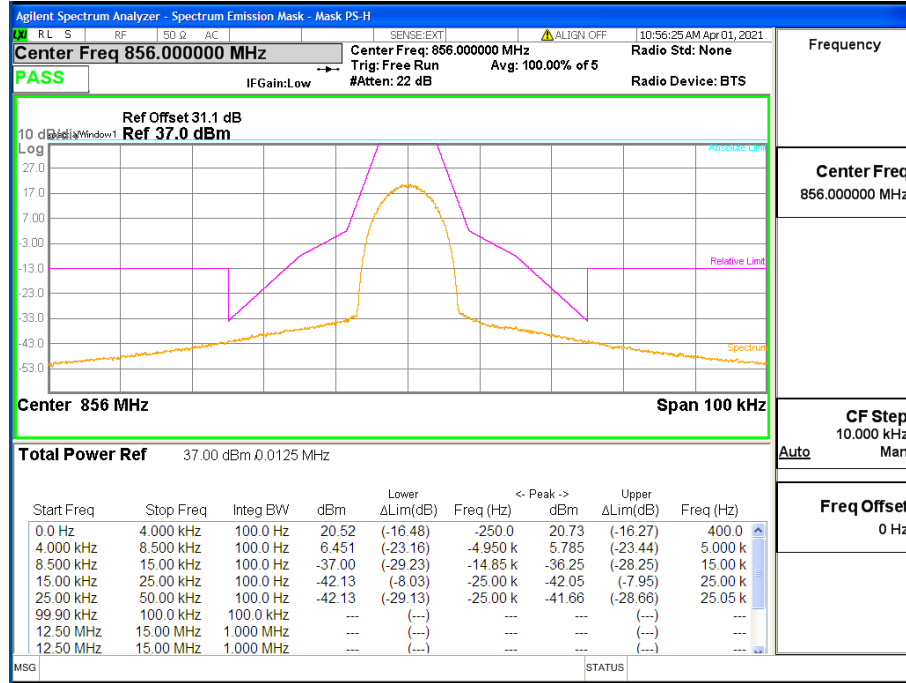
At AGC CQPSK 856.000 MHz - Mask H



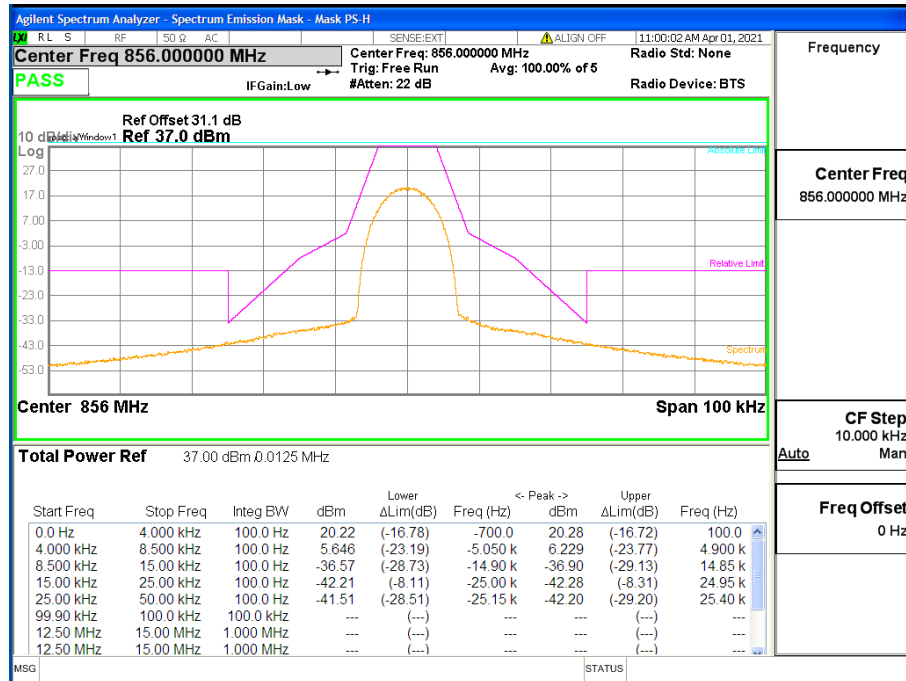
3dB above the AGC threshold Output CQPSK 856.000 MHz - Mask H



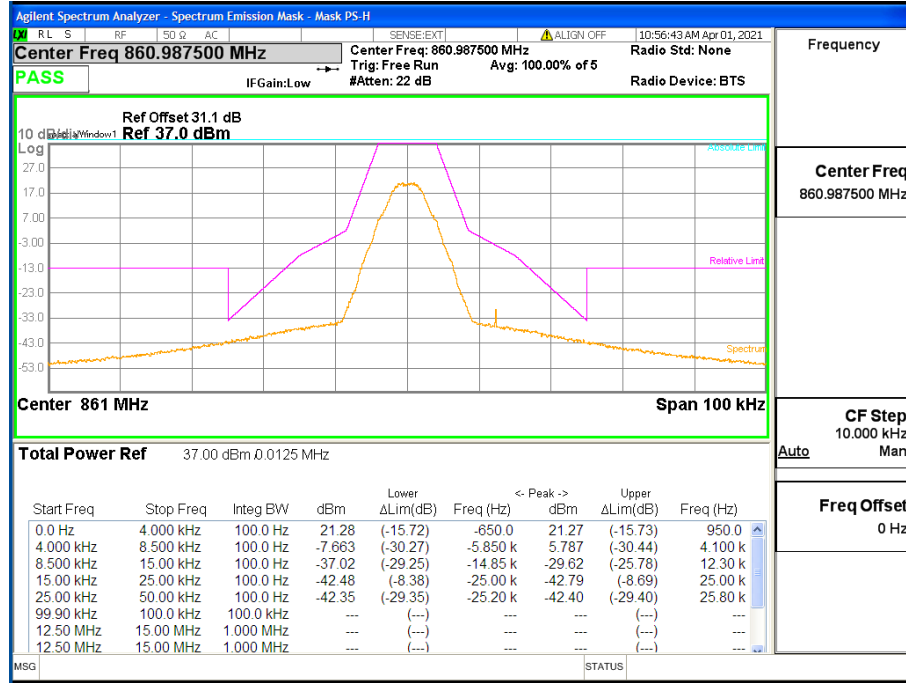
At AGC HDQPSK 856.000 MHz - Mask H



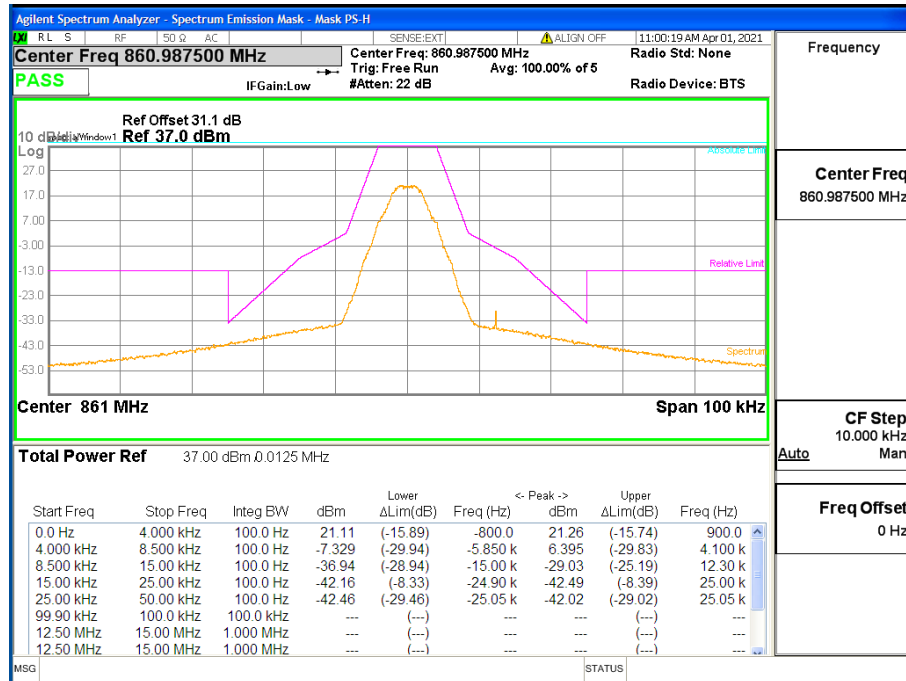
3dB above the AGC threshold Output HDQPSK 856.000 MHz - Mask H



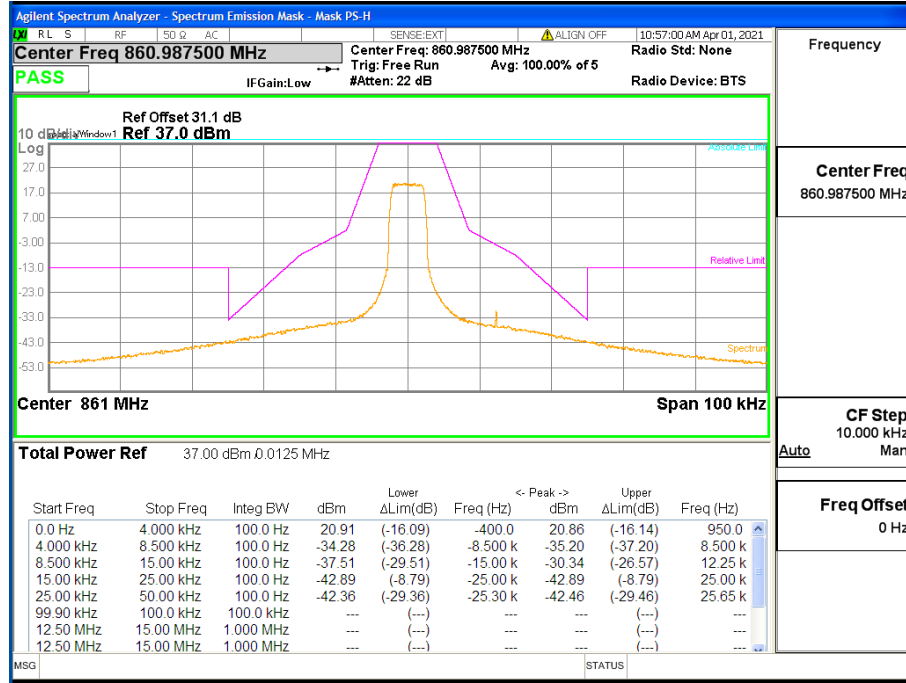
At AGC C4FM 860.9875 MHz - Mask H



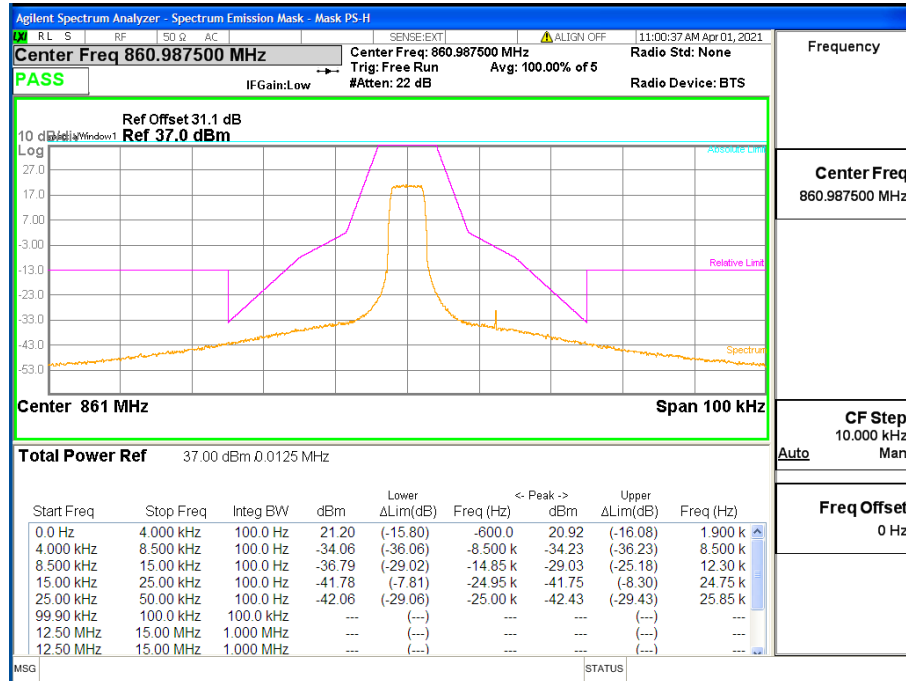
3dB above the AGC threshold Output C4FM 860.9875 MHz - Mask H



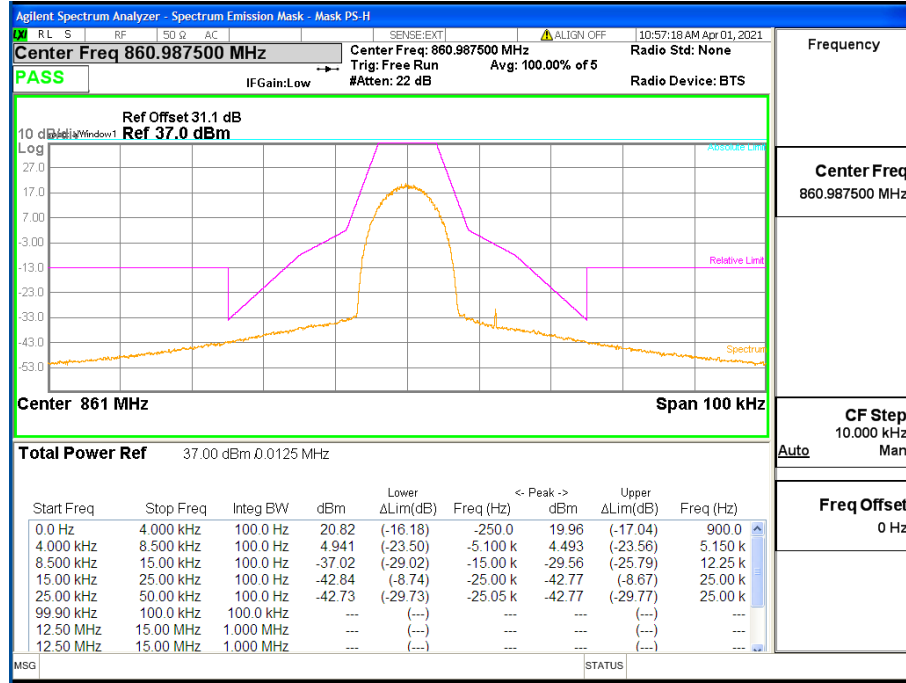
At AGC CQPSK 860.9875 MHz - Mask H



3dB above the AGC threshold Output CQPSK 860.9875 MHz - Mask H



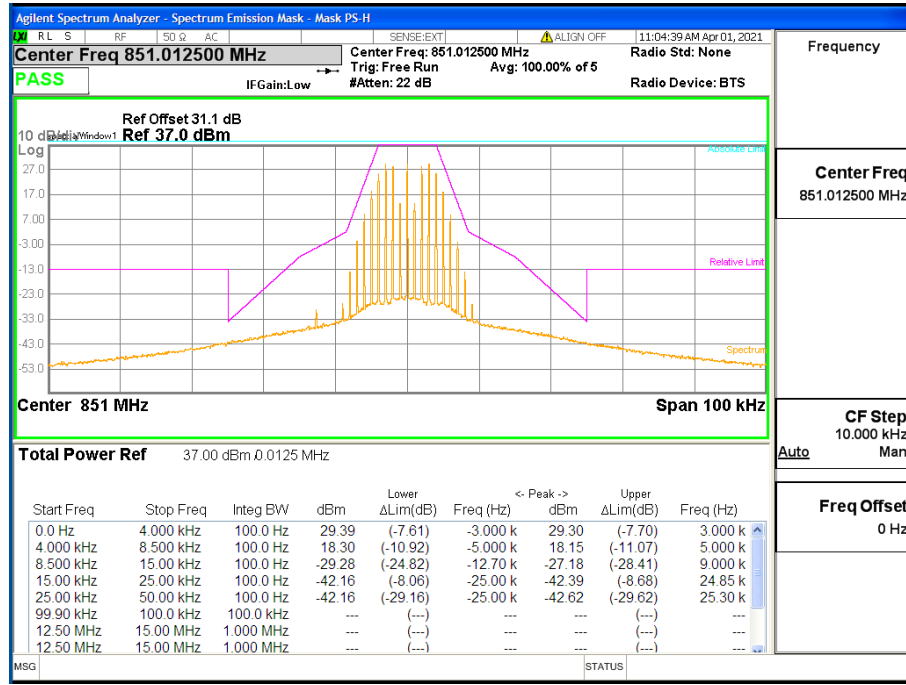
At AGC HDQPSK 860.9875 MHz - Mask H



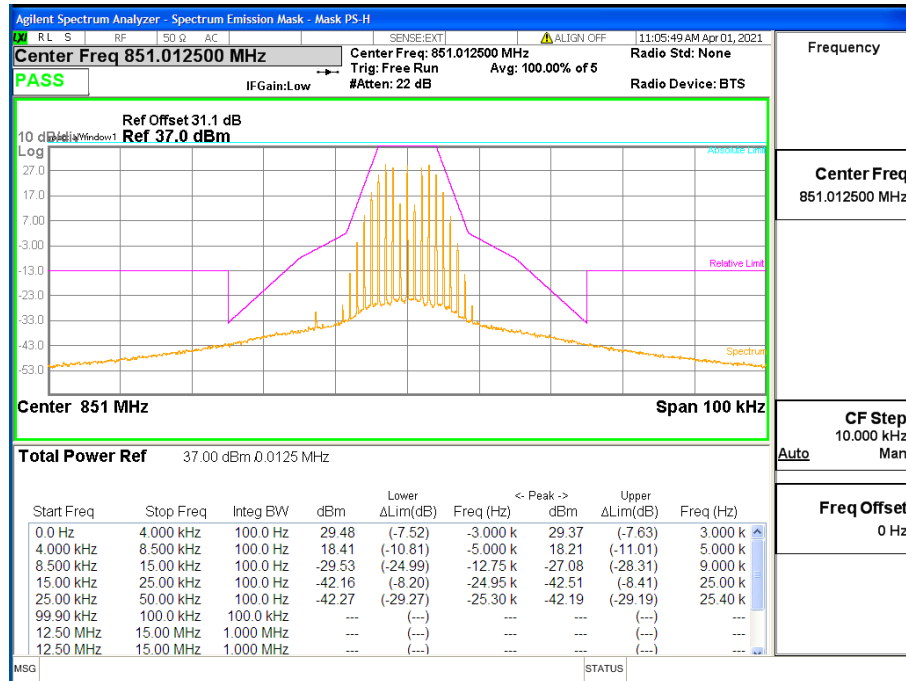
3dB above the AGC threshold Output HDQPSK 860.9875 MHz - Mask H



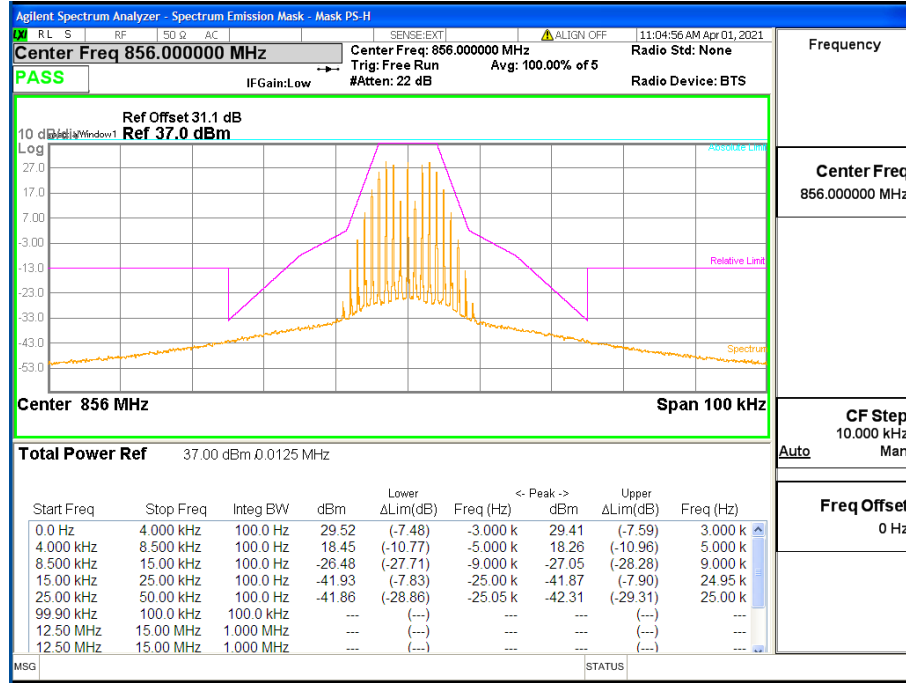
At AGC FM 850.0125 MHz - Mask H



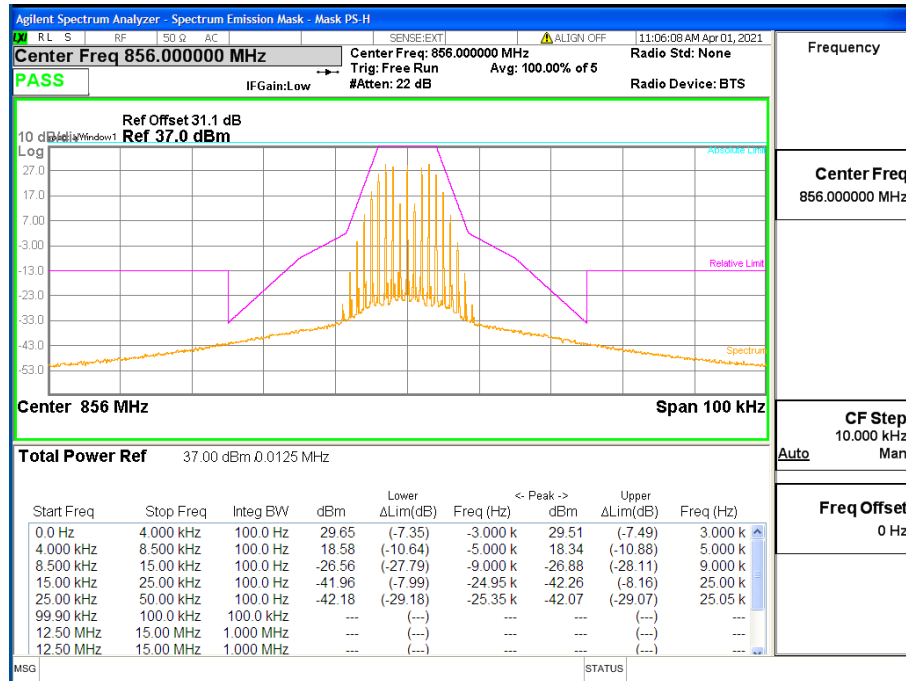
3dB above the AGC threshold Output FM 850.0125 MHz - Mask H



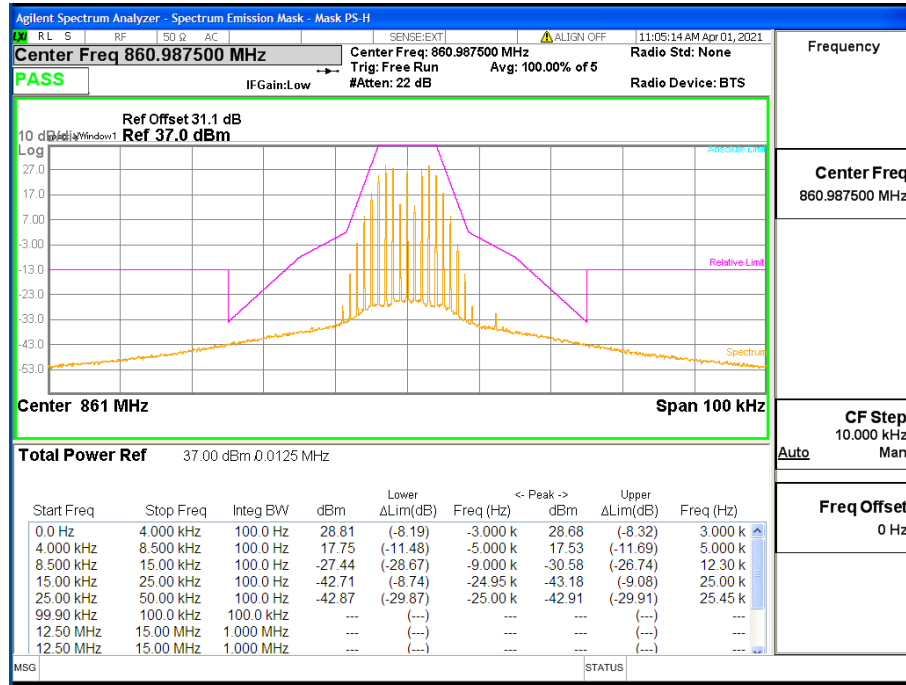
At AGC FM 856.000 MHz - Mask H



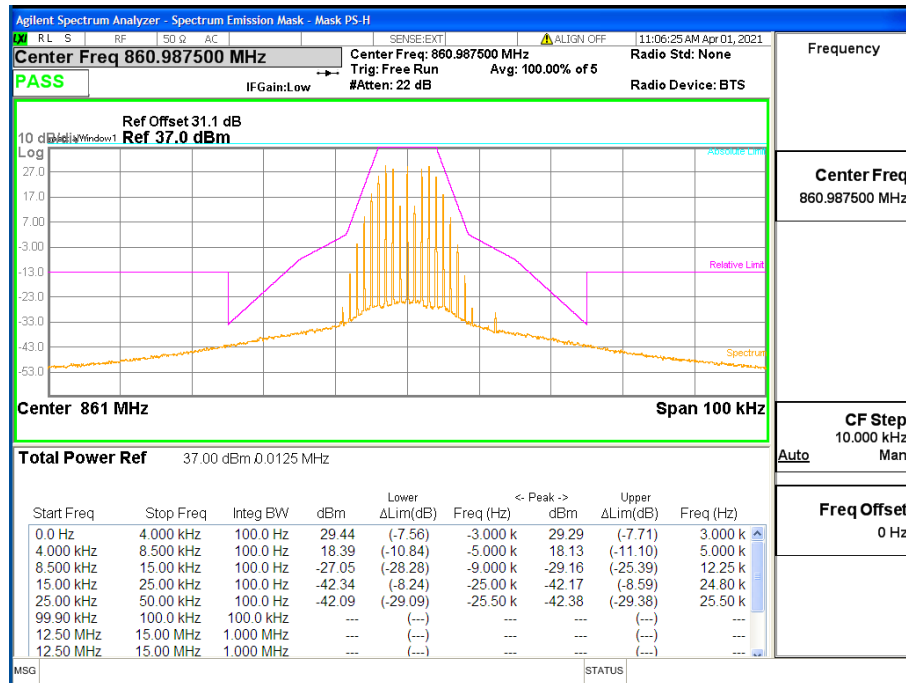
3dB above the AGC threshold Output FM 856.000 MHz - Mask H



At AGC FM 860.9875 MHz - Mask H



3dB above the AGC threshold Output FM 860.9875 MHz - Mask H



Input/output Power and Amplifier/Booster Gain

Governing Doc	FCC Part 90.219	Room Temperature (°C)	20.0		
Test Procedure	ANSI/TIA-603- E; FCC KDB 935210 D05, v01r04	Relative Humidity (%)	30.0		
Test Location	Richmond	Barometric Pressure (kPa)	102.1		
Test Engineer	Jeremy Lee	Date	01 April 2021		
EUT Voltage	<input checked="" type="checkbox"/> +48VDC <input type="checkbox"/> 120VAC @ 60Hz				
Test Equipment Used	Manufacturer	Model	Identifier	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
Span:	<input checked="" type="checkbox"/> Max Gain Frequency ± 1500kHz				
Detector:	<input checked="" type="checkbox"/> Peak				
RBW/VBW:	<input checked="" type="checkbox"/> 100k Hz/ 300 kHz				
Type of Facility:	<input checked="" type="checkbox"/> Tabletop				
Distance:	<input checked="" type="checkbox"/> Direct				
Maximum booster gain is 46.9 dB.					
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>					

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 v01r04:. A CW tone was input at the frequency where the system gain is the maximum in the pass band, with the nominal input power level -9.6 dBm. The spectrum analyzer was connected to the output RF port via a 50 Ohm 30 dB attenuator. The maximum hold trace and peak detector was used to capture the output power. The output power minus the input power (-9.6 dBm) equals to the booster gain in dB.

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

```

    graph LR
      A[Vector Signal Generator] --> B[hdHost]
      B --> C(( ))
      C --> D[EUT]
      D --> E[30 dB Attenuator]
      E --> F[Spectrum Analyzer]
    
```

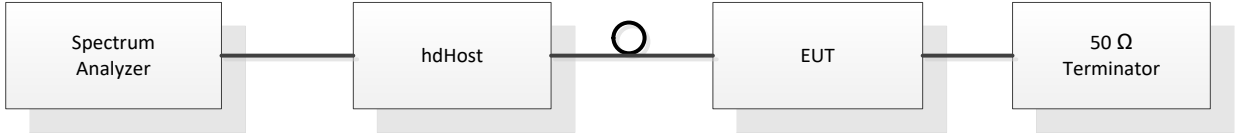
Results

Test Band	Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
UHF	408.550	-10.7	37.0	47.7
800PS	856	-9.8	37.0	46.8

Noise Figure

Governing Doc	FCC Part 90.219	Room Temperature (°C)	20.0		
Test Procedure	ANSI/TIA-603- E; FCC KDB 935210 D05, v01r04	Relative Humidity (%)	30.0		
Test Location	Richmond	Barometric Pressure	102.1		
Test Engineer	Jeremy Lee	Date	01 April 2021		
EUT Voltage	<input type="checkbox"/> DC <input checked="" type="checkbox"/> 120VAC @ 60Hz via HGL-480H-48				
Test Equipment Used	Manufacturer	Model	Serial Number	Calibration	Calibration due
Spectrum Analyzer	Keysight	N9010A	MY50520285	07/29/19	07/23/21
Frequency Range:	<input checked="" type="checkbox"/> 2 times of the passband on each band				
Detector:	<input checked="" type="checkbox"/> Average				
RBW:	<input checked="" type="checkbox"/> 910 kHz				
Type of Facility:	<input checked="" type="checkbox"/> Tabletop				
Distance:	<input checked="" type="checkbox"/> Direct				
Noise Figure on each band is less than the 9 dB required.					
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>					

Test setup

Description of test set-up:
<p>Based on FCC KDB 935210 D05 Indus Booster Basic Meas v01r04: 2019, the system maximum gain and the noise density is measured. Measurements were performed within the EUT's passband.</p> <p>The noise figure is then calculated by $NF = NP - Gain + KTB \text{ Noise}$; where</p> <p>NP is in band noise power per Herz,</p> <p>Gain is measured at the maximum noise frequency with -55 dBm input signal in UL.</p> <p>KTB Noise is 174dB/Hz at room temperature.</p> <p>The EUT was set to Operation Mode #1 with configuration Mode #1.</p>
 <pre> graph LR SA[Spectrum Analyzer] --- hdHost[hdHost] hdHost --- EUT[EUT] EUT --- T[50 Ω Terminator] </pre>

Results

Test Band	Link	Gain (dB)	kTB (dBm/Hz)	Measured Value (dBm/Hz)	Noise Figure (dB)
UHF	UpLink	56.3	-174	-112.1	5.6
800PS	UpLink	55.7	-174	-111.5	6.8

Out-Of-Band / Out-Of-Block Intermodulation and Spurious Emissions

Governing Doc	FCC Part 90.219	Room Temperature (°C)	20.0		
Test Procedure	ANSI/TIA-603- E; FCC KDB 935210 D05, v01r04	Relative Humidity (%)	30.0		
Test Location	Richmond	Barometric Pressure (kPa)	102.1		
Test Engineer	Jeremy Lee	Date	01 April 2021		
EUT Voltage	<input checked="" type="checkbox"/> +48VDC <input type="checkbox"/> 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:	<input checked="" type="checkbox"/> Max Gain Frequency ± 50kHz				
Detector:	<input checked="" type="checkbox"/> Average				
RBW/VBW:	<input checked="" type="checkbox"/> 100/910Hz				
Type of Facility:	<input checked="" type="checkbox"/> Tabletop				
Distance:	<input checked="" type="checkbox"/> Direct				
On 800 band and UHF band: The intermodulation product of 2 tone is below the -13dBm emission limit with input power <ul style="list-style-type: none"> - 0.5dBm below AGC threshold and - 3 dB above AGC threshold 					
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>					

Test setup

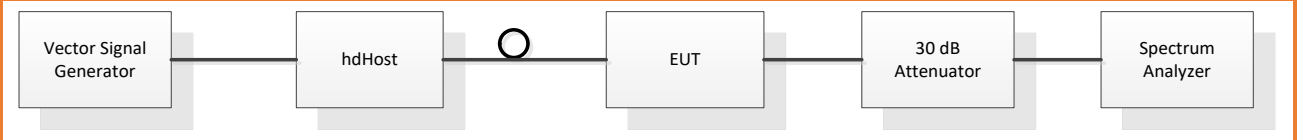
Description of test set-up:

The procedure used was ANSI/TIA-603-E-2016. Two tones (CW) method was used. The input power to the amplifier was set at maximum drive level by combining the two tones. The two tones were chosen in such a way (1) the third order intermodulation product frequencies are located within the pass band of the DUT and (2) they produce the worst-case emissions out of band. All signals were modulated.

Based on FCC KDB 935210 D05 Indus Booster Basic Meas v01r04: 2019, the two tone was located on either side of the maximum gain frequency in the passing band, and separated with the available spacing, which is 12.5kHz.

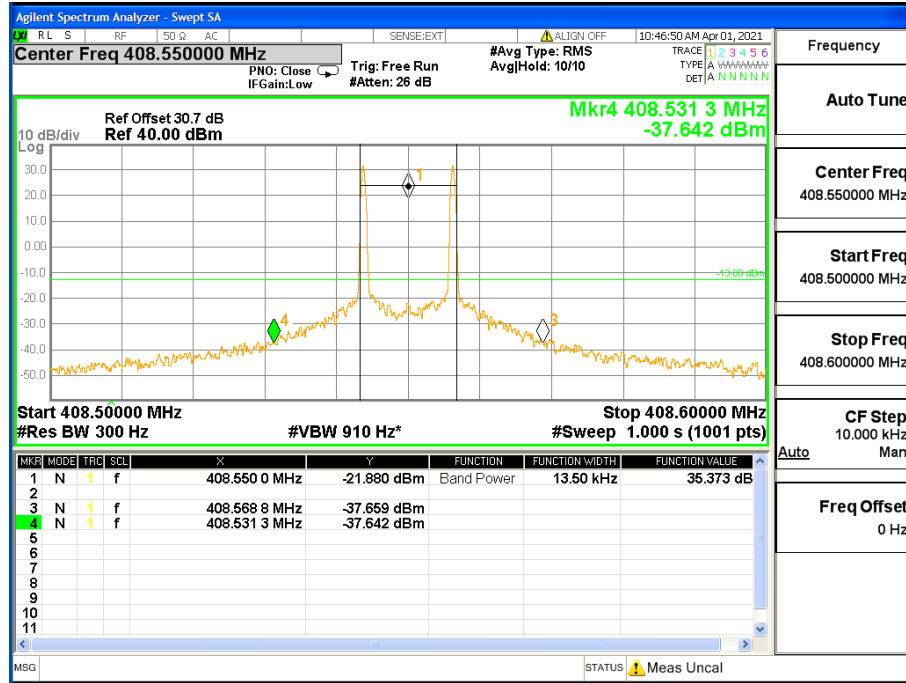
Measurements were performed with modulated -tone at identical input amplitude which produced integrated maximum rated output power.

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

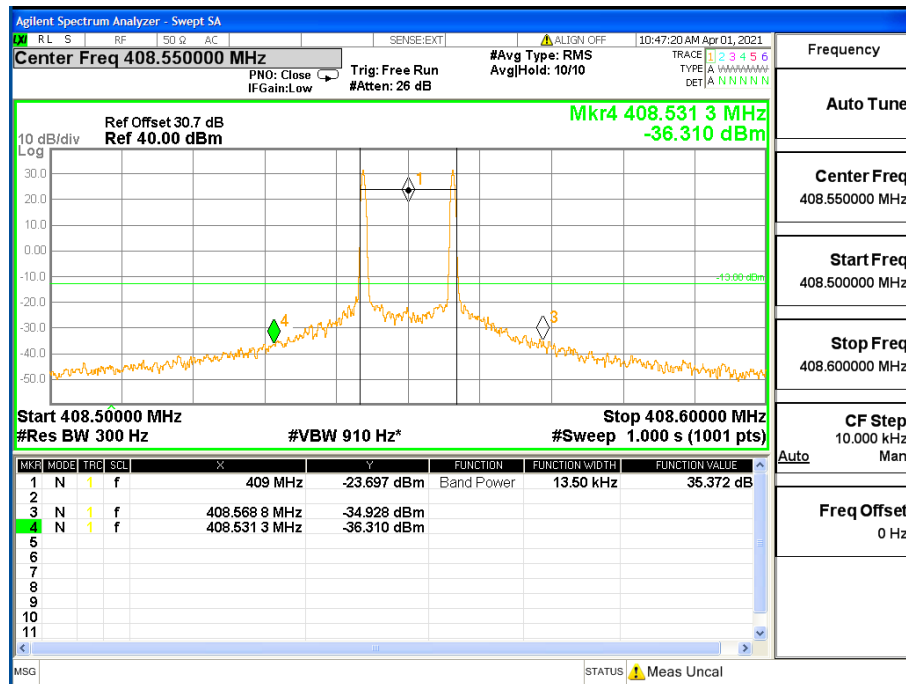


Results Screenshots

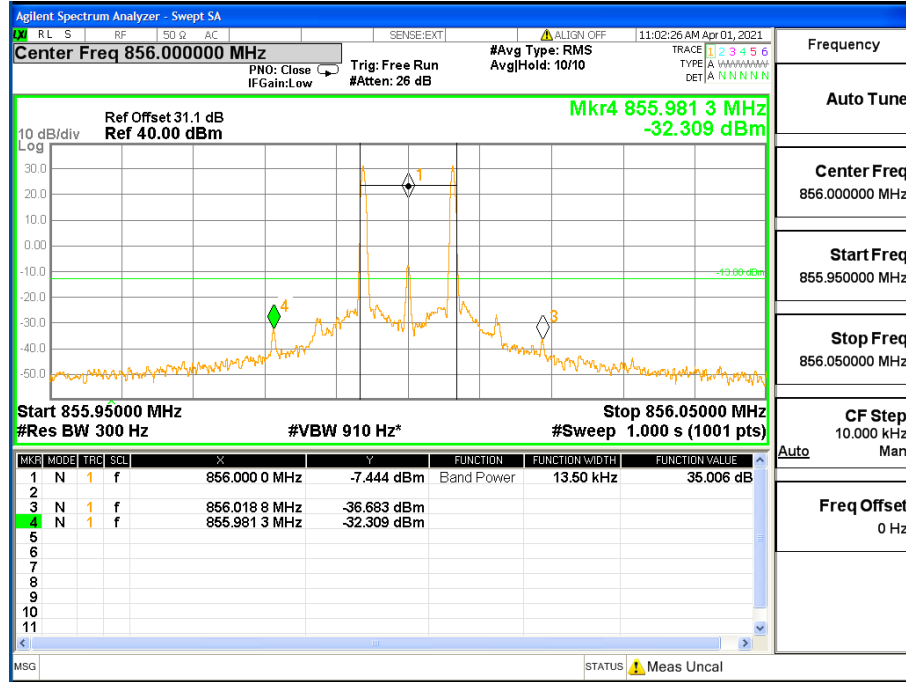
408.550 MHz:
 At Input Power 0.5 dB below AGC threshold



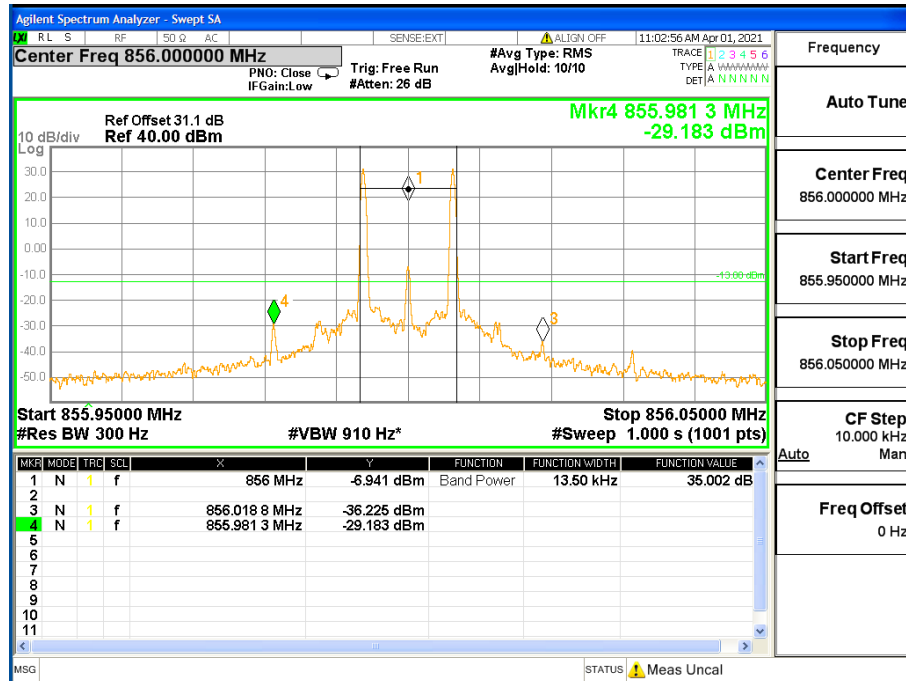
At Input Power 3 dB above AGC threshold



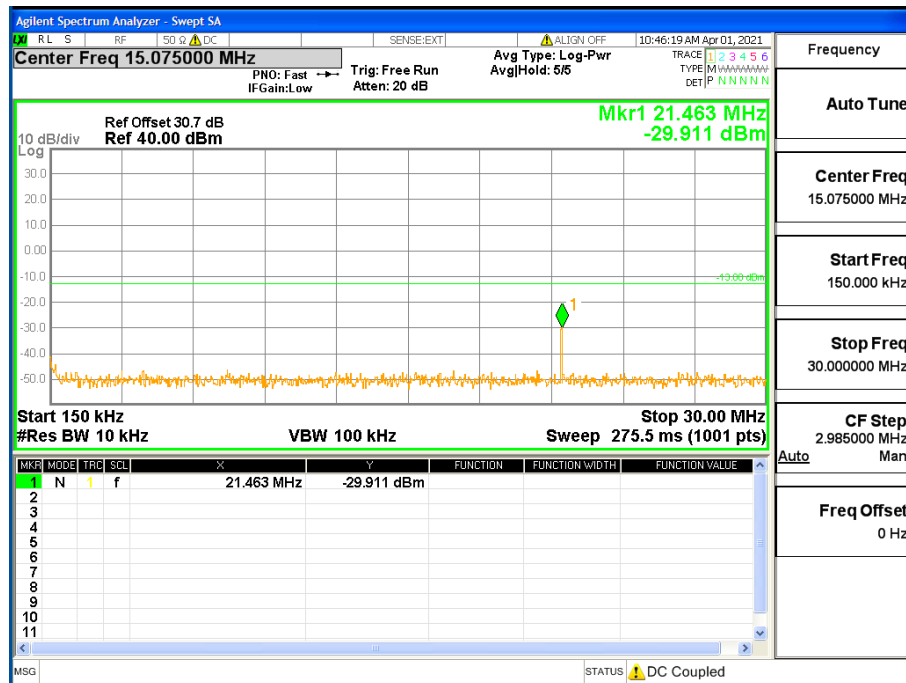
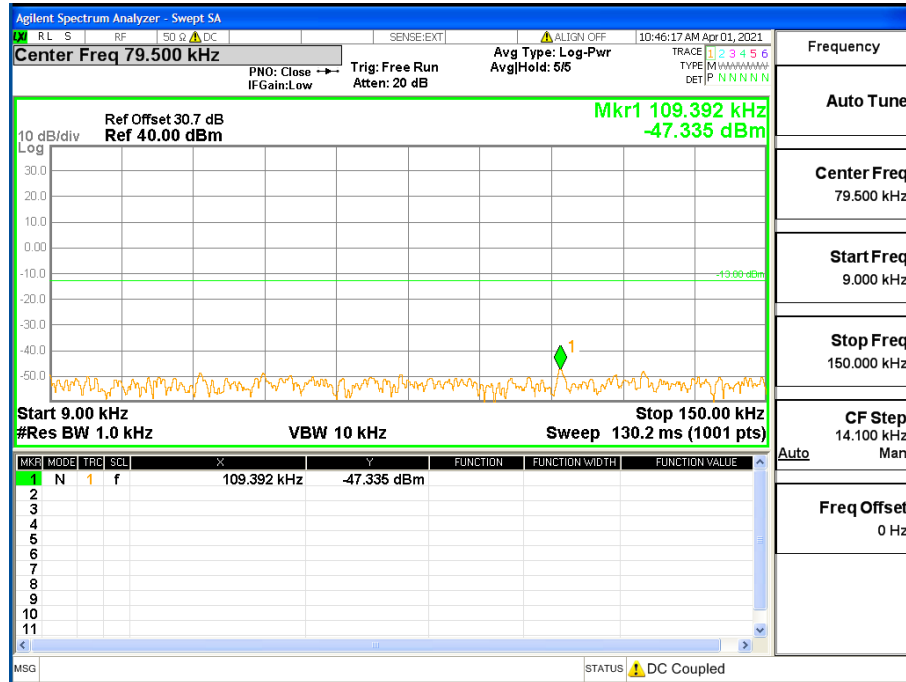
856 MHz:
 At Input Power 0.5 dB below AGC threshold

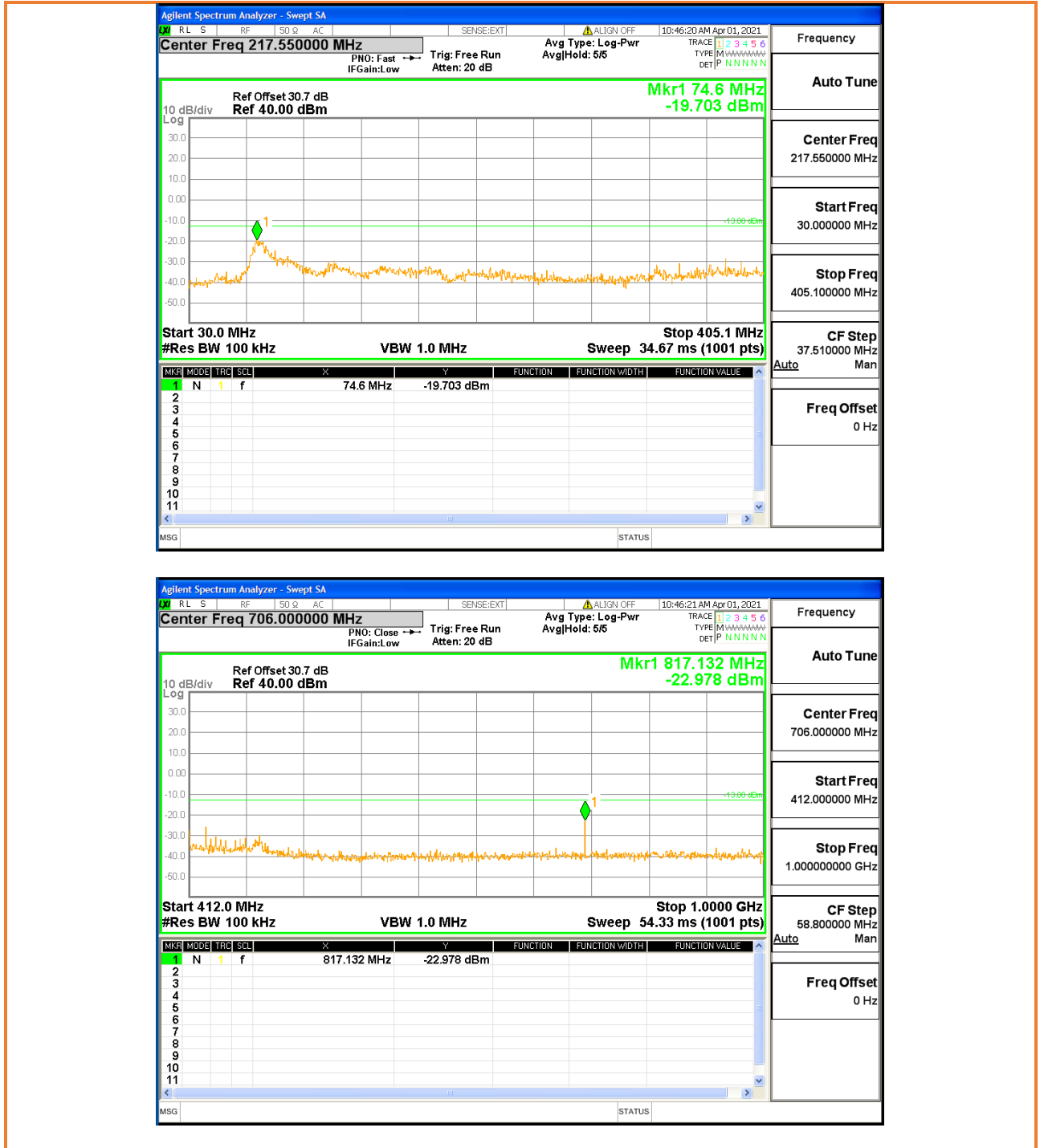


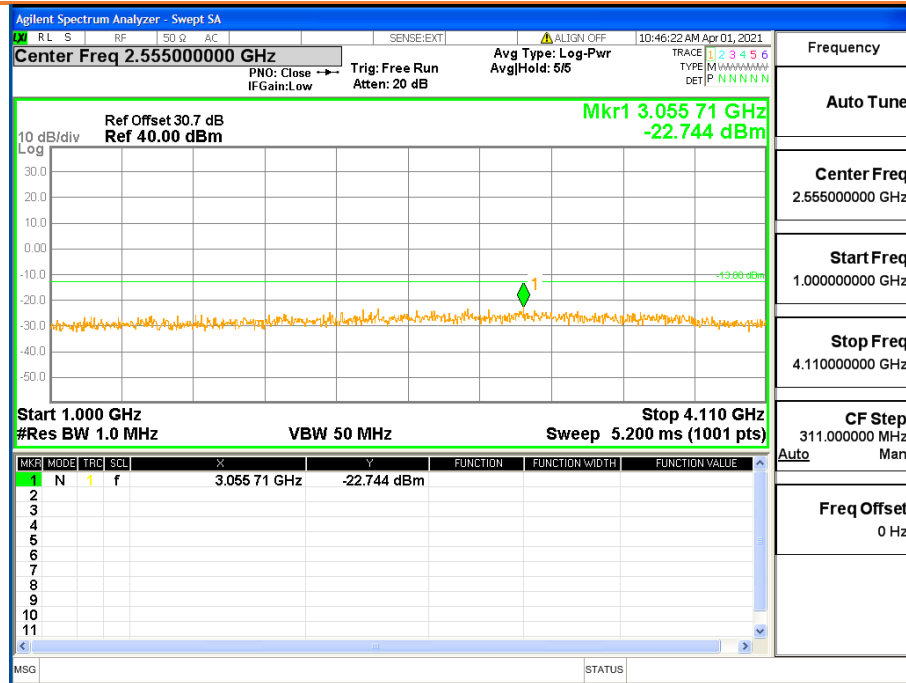
At Input Power 3 dB above AGC threshold



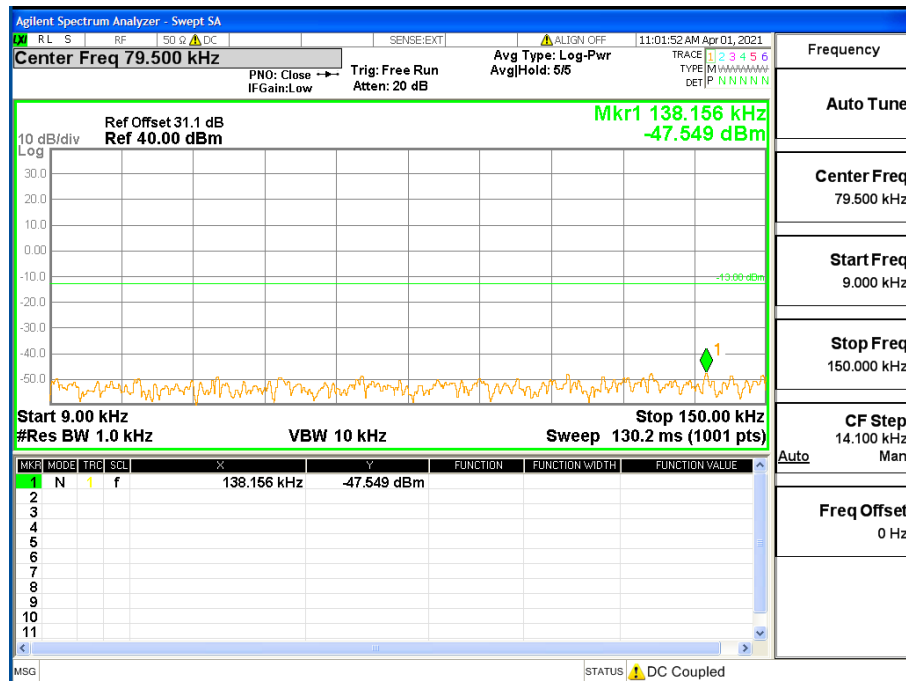
Spurious UHF

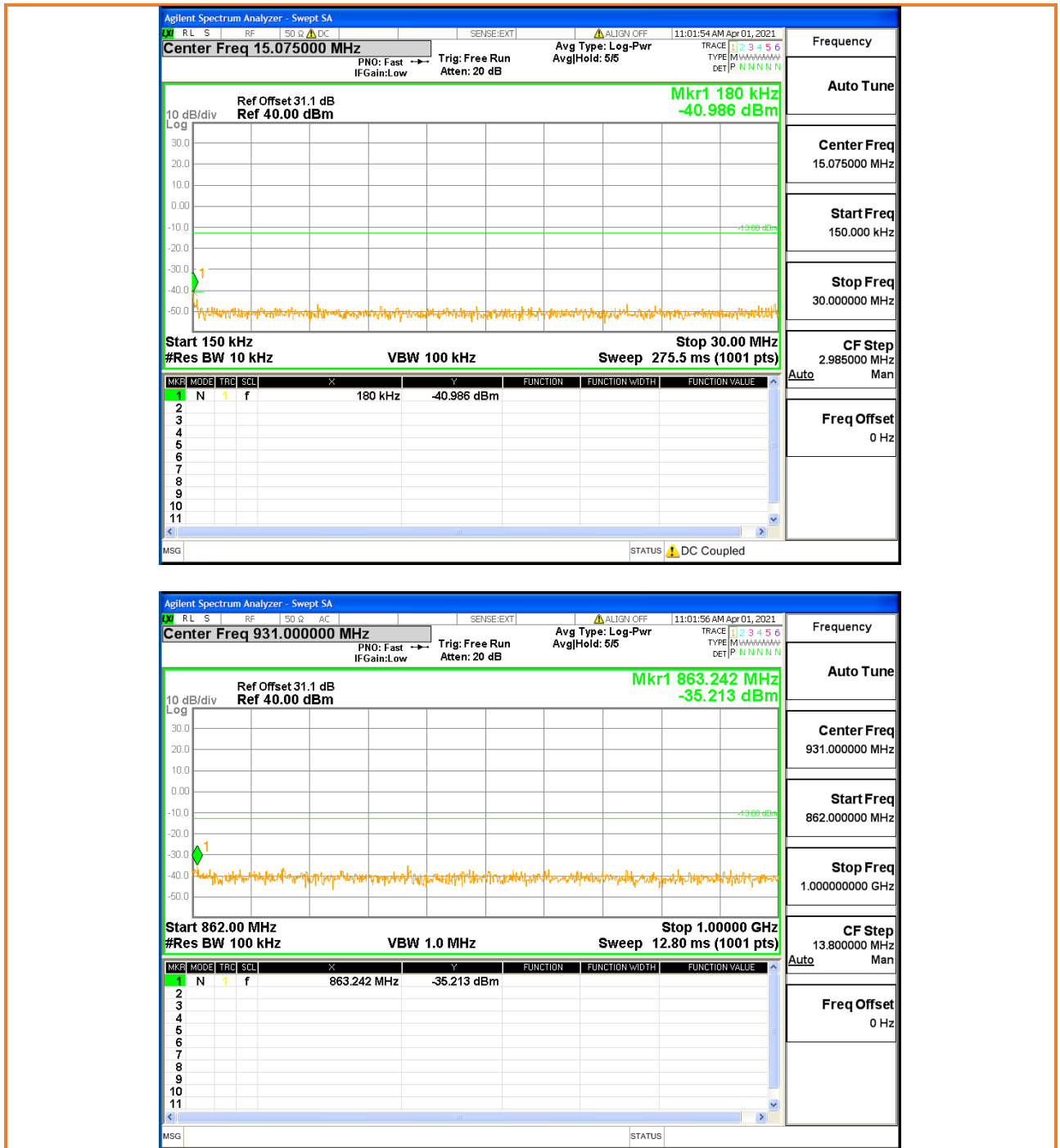






Spurious / 800PS







Frequency Stability

The hdHost and hd37 are synchronized to the same reference clock. Therefore there is no frequency error after down and up frequency conversion are performed.

The frequency stability check is not applicable to the EUT.

Spurious emissions radiated measurements

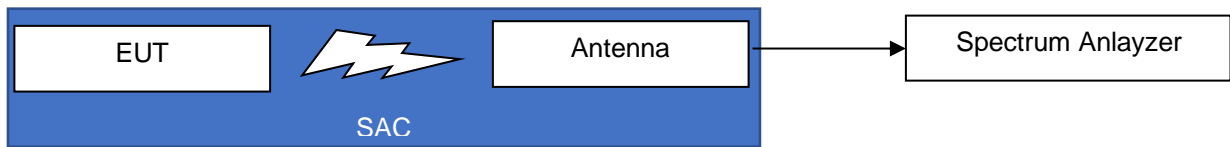
Governing Doc	FCC Part 2.1053, FCC Part 90.210 & FCC Part 90.219	Room Temperature (°C)	20.4 to 21.3		
Test Procedure	ANSI C63.4	Relative Humidity (%)	30.0 to 30.3		
Test Location	Richmond	Barometric Pressure (kPa)	102.7 to 102.9		
Test Engineer	Daniel Lee	Date	31 March 2021		
EUT Voltage	<input checked="" type="checkbox"/> +48VDC <input type="checkbox"/> 120VAC @ 60Hz				
Test Equipment Used	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMC Analyzer	KeySight	N9038A	702	27-May-2020	27-May-2021
Broadband Antenna	Sunol	JB1	371	24-Sep-2020	24-Sep-2022
BiCon Antenna	A.H Systems	SAS-540	1115	29-Apr-2019	29-Apr-2021
Horn Antenna	A.H Systems	SAS-571	227C	12-Aug-2020	12-Aug-2022
Motion Controller	Sunol	SC104V	235A	IHC ¹	IHC ¹
Antenna Tower	Sunol	TWR95-4	235B	IHC ¹	IHC ¹
Turn Table	Sunol	SM46C	235C	IHC ¹	IHC ¹
EMC Shielded Enclosure	USC	USC-26	374	IHC ¹	IHC ¹
RF Cable	MRO	n/a	n/a	IHC ²	IHC ²
RF Preamplifier	Agilent	8449B	273	IHC ²	IHC ²
AC Power Source	California Instruments	5001i	059	IHC ³	IHC ³
Used Software	<input checked="" type="checkbox"/> Tile 7! v7.3.0.6				
Used Template	_FCC_RadEmi_30-1000MHz_Spur_20201008 _FCC_RadEmi_1-18GHz_Spur_20200824				
Note1) In House Calibration Ref. # 4 Note2) In House Calibration Ref. # 6 Note3) In House Calibration Ref. # 7					
Frequency Range:	<input type="checkbox"/> 9kHz-30MHz	<input checked="" type="checkbox"/> 30-1000MHz	<input checked="" type="checkbox"/> 1-9GHz		
Detector:	<input checked="" type="checkbox"/> Peak (for Prescan)	<input checked="" type="checkbox"/> Quasi-Peak(for Formal)	<input checked="" type="checkbox"/> Average(for Formal)		
RBW/VBW:	<input type="checkbox"/> 9/30kHz	<input checked="" type="checkbox"/> 120/300kHz	<input checked="" type="checkbox"/> 1/3MHz		
Type of Facility:	<input checked="" type="checkbox"/> SAC	<input checked="" type="checkbox"/> FSOATS	<input type="checkbox"/> <i>in-situ</i>		
Distance:	<input checked="" type="checkbox"/> 3meter	<input type="checkbox"/> 10meter	<input type="checkbox"/> 1meter		
Arrangement of EUT:	<input checked="" type="checkbox"/> Table-top only	<input type="checkbox"/> Floor-standing only	<input type="checkbox"/> Rack Mounted		
Compliant <input checked="" type="checkbox"/> Non-Compliant <input type="checkbox"/> Not Applicable <input type="checkbox"/>					

Test setup

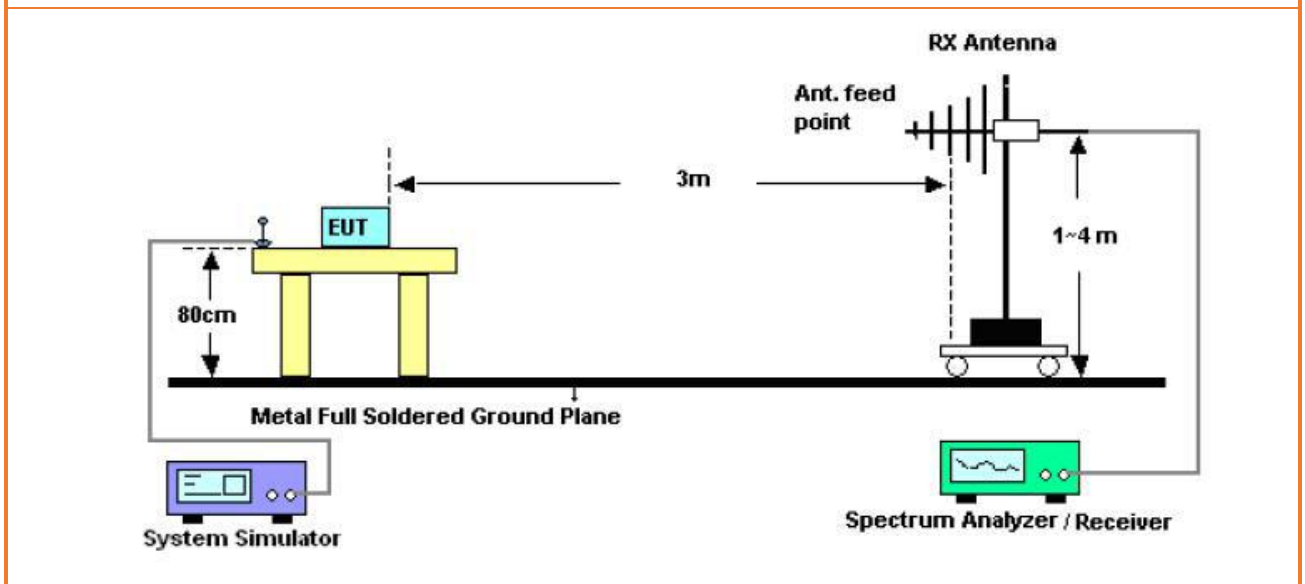
Description of test set-up:

The EUT was placed on a nonconducting platform (i.e., an “EUT support table”), of nominal size 1 m by 1.5 m, whose top surface is nominally 80 cm above the reference ground plane. The EUT was set up on 3 meters away from the EUT. The EUT was set continually on its Radio, 5W Max., which was downlinked from airHost. And the output of RF was terminated via 30dB attenuator, for rejecting the high power of carrier. The lowest, middle and highest channels were used for measuring of all radiated spurious emissions .

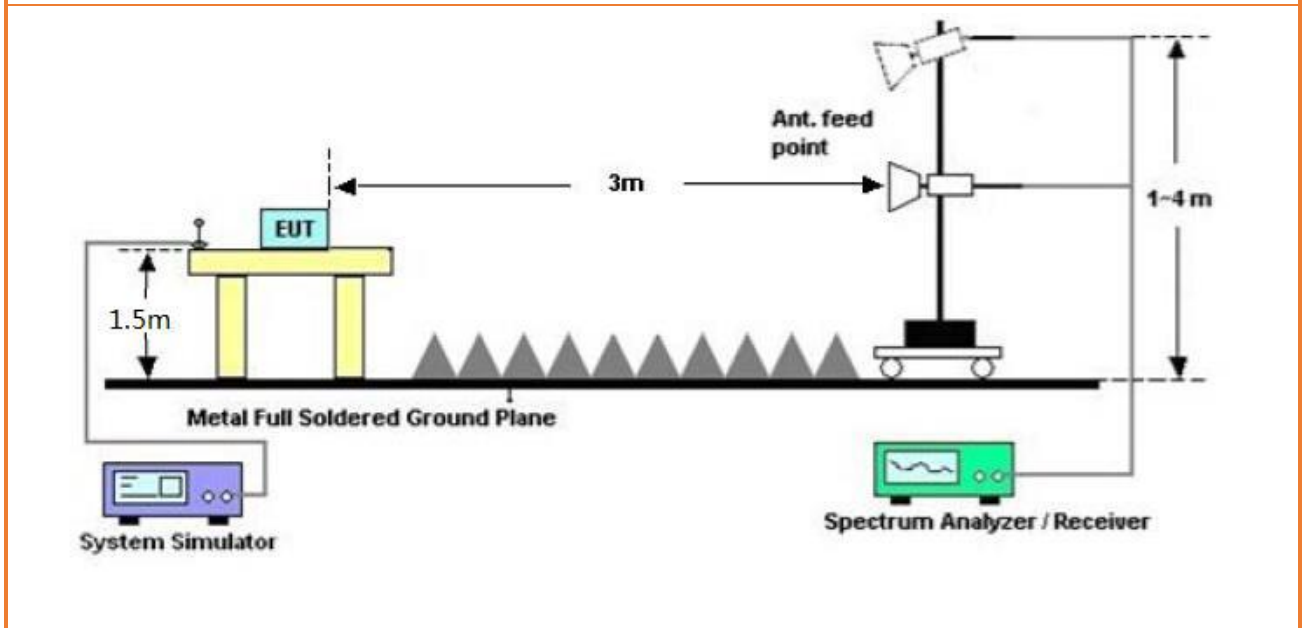
The EUT was set to **Operation Mode #1 with configuration Mode #1.**



- Radiated Emission 30 to 1000MHz, with JB-1



- Radiated Emission 1 to 9GHz, with SAS-571



Measurement Procedure

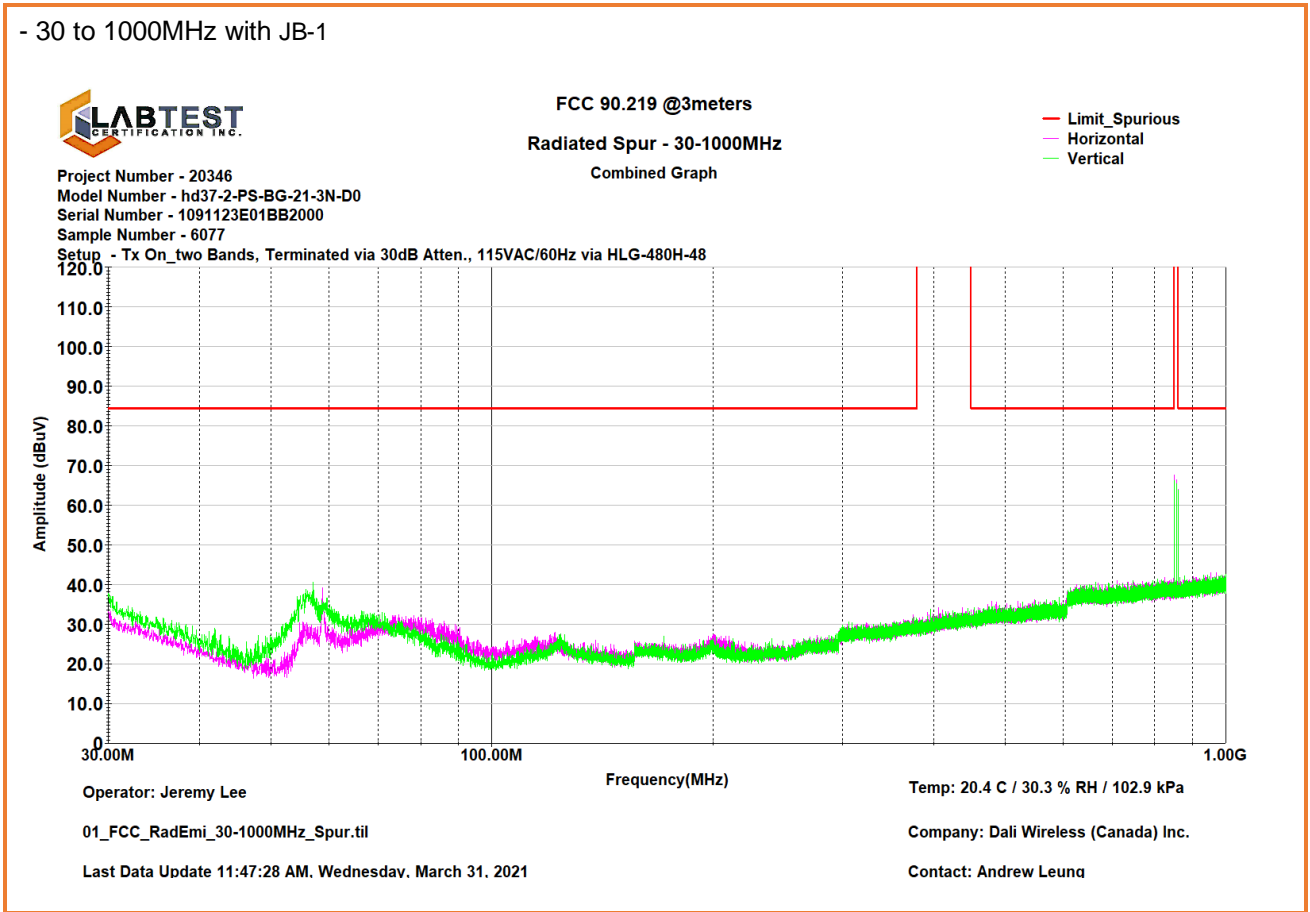
Testing was performed in accordance with the test standard(s) referenced in the test summary section of this report. The Equipment Under Test (EUT) was configured based upon the requirements of the applicable test standard. Initially, the primary emission frequencies are identified by positioning a broadband receive antenna three meter from the EUT.

Scans were made with an EMC Analyzer, controlled by EMC Test Software, Tile7!, from 30kHz to 9GHz with the receiver in the peak mode. The receiver IF bandwidth was 9kHz, 120 kHz or 1MHz as appropriate for the frequency and scan step was about 30kHz. To ensure that the maximum emission at each discrete frequency of interest is observed, the receive antenna is varied in height from one to four meters and rotated to produce horizontal and vertical polarities while the turntable is rotated to determine the worst emitting configuration. Under 30MHz was only tested at 1meter height and Antenna was changed both polarization, Horizontal and Vertical. Measurements were then made using CISPR quasi peak when the peak readings were within 10dB of the limit line. The numerical results are included herein to demonstrate compliance.

Test Result

The output of EUT was set to 5 Watts(+37dBm), the PASS level of Spurious is: $43 + 10\log(P) = 43 + 10\log(5) = 50\text{dB}$ attenuation = -13dBm Since of radiated measurement was performed at 3 meters, the limit line was converted to dBuV/m using the formulas ad outlined in KDB 971168: -13 dBm ERP = 84.38 dBuV/m at 3 meters. Spurious Emission level (dBuV/m) = Detected level (dBuV) + Path Loss(dB) + Antenna Factor (dB/m) - Preamplifier's Gain (dB)

Graphical Representation for Emission - Radiated 30MHz to 1GHz



Graphical Representation for Emission - Radiated 1 to 10GHz

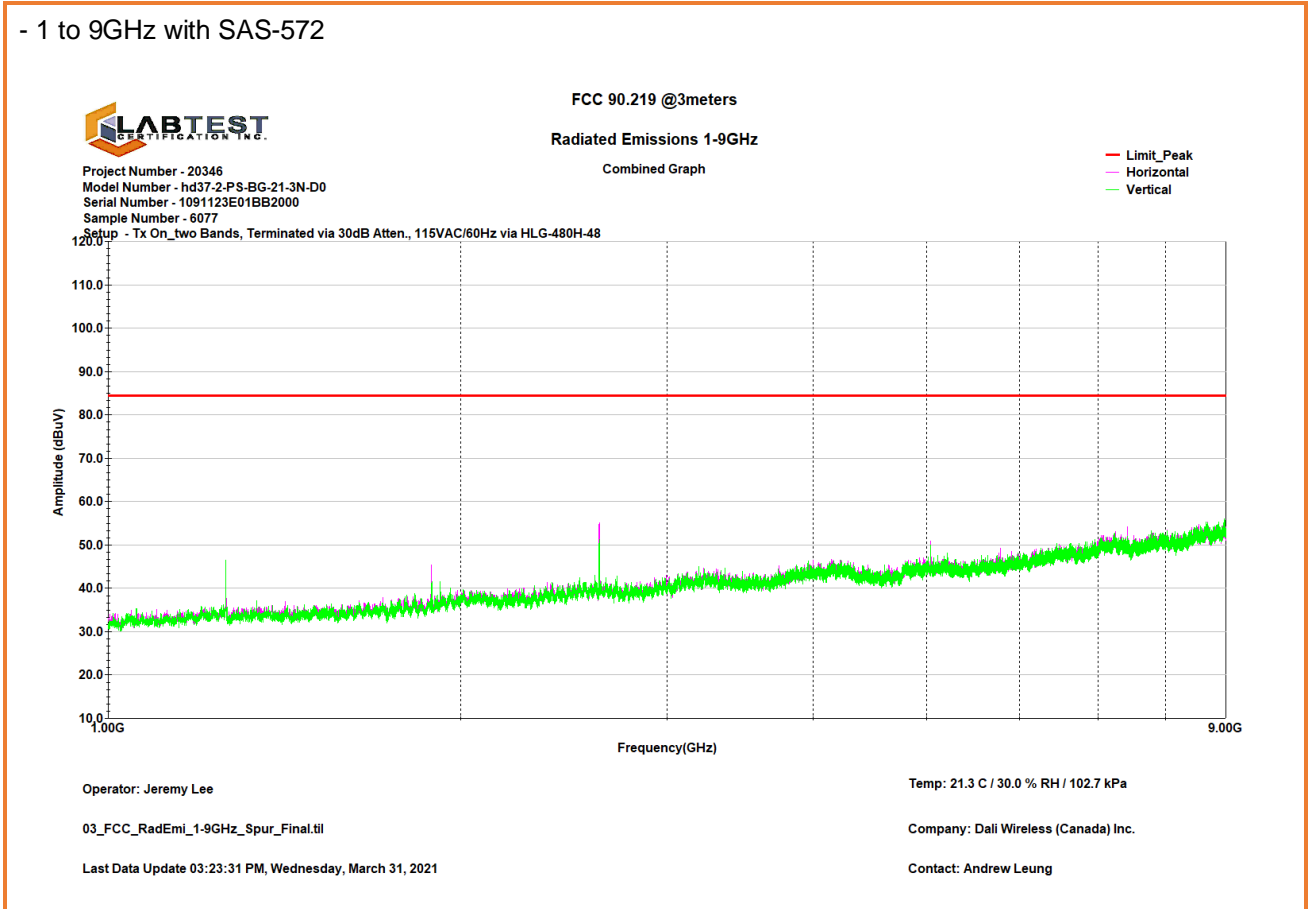


Table Representation for Emission - Radiated 30MHz to 9GHz

No Emissions were measured. All emissions detected, other than the fundamental, were related to the Digital Mode circuitry. No Transmitter Spurious Emissions were detectable and are greater than 20dB below the limit line.

END of REPORT