Starry, Inc.
TEST REPORT

SCOPE OF WORK
Emissions Testing – 24 GHz Titan Radio, Model Titan 24-360

REPORT NUMBER
105000232BOX-001.1

ISSUE DATE | **[REVISED DATE]**
April 13, 2022 | July 18, 2022

DOCUMENT CONTROL NUMBER
Non-Specific Radio Report Shell Rev. August 2020

EMISSIONS TEST REPORT

(FULL COMPLIANCE)

Report Number: 105000232BOX-001.1
Project Number: G105000232

Report Issue Date: April 13, 2022
Report Issue Date: July 18, 2022

Model(s) Tested: Titan 24-360

Standards: FCC 47CFR Part 30 Subpart C: 2022
FCC 47CFR Part 2: 2022
KDB 842590 D01 Upper Microwave Flexible Use Service v01r02 April 20, 2021

Tested by:
Intertek
70 Codman Hill Road
Boxborough, MA 01719
USA

Client:
Starry, Inc.
38 Chauncy St. Suite 200
Boston, MA 02111
USA

Report prepared by

Vathana Ven / Engineering Supervisor

Report reviewed by

Kouma Sinn / Engineering Supervisor

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining 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. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
3	Client Information	--
4	Description of Equipment Under Test and Variant Models	--
5	System Setup and Method	--
6	Output Power & Human RF Exposure FCC 47CFR Part 30 Subpart C, Section 30.202 (a): 2022	Pass
7	Out of Band (OOB) Domain FCC 47CFR Part 30 Subpart C, Section 30.203 (a) (b): 2022	Pass
8	Radiated Spurious Emissions FCC 47CFR Part 30 Subpart C, Section 30.203 (a) (b): 2022	Pass
9	Occupied Bandwidths FCC 47CFR Part 2.1049(i): 2022, FCC 47CFR Part 30 Subparts E Section 30.403:2022, KDB 842590 D01 Upper Microwave Flexible Use Service v01r02 April 20, 2021 Subclause 4.3, KDB 842590 D01 Upper Microwave Flexible Use Service v01r02 April 20, 2021; Section 4.3	Pass
10	Frequency Tolerance* FCC 47CFR Part 30 Subpart E Section 30.402: 2022	Pass
11	AC Mains Conducted Emissions FCC 47CFR Part 15 Subpart B: 2022	Pass
12	Revision History	--

*Notes: Frequency tolerance is not required in FCC 47CFR Part 30 Subpart C. Testing was performed under FCC 47CFR Part 30 Subpart E.

3 Client Information

This EUT was tested at the request of:

Client: Starry, Inc.
38 Chauncy St Suite 200
Boston, MA 02111
USA

Contact: Robert White
Telephone: None
Fax: None
Email: rwhite@starry.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Starry, Inc.
38 Chauncy St Suite 200
Boston, MA 02111
USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
24GHz Titan Radio	Starry, Inc.	Titan 24-360	2207250003

Receive Date:	March 4, 2022
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)
Multipoint Radio operating between 24.25-25.25 GHz

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
48 VDC	5.84 A	DC	N/A

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Continuous Transmitting

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	Proprietary Software that controls the operation of the radio.

Radio/Receiver Characteristics	
Frequency Band(s)	24.27-24.29 GHz, 24.77-25.09 GHz, 24.34-24.36 GHz, 24.84-25.16 GHz
Modulation Type(s)	OFDMA
Maximum Output Power	45.72 dBm EIRP (With 2 Paths and Beamforming)
Test Channels	24.27 GHz, 24.28 GHz, 24.29 GHz 24.77 GHz, 24.97 GHz, 25.09 GHz 24.34 GHz, 24.35 GHz, 24.36 GHz 24.84 GHz, 25.04 GHz, 25.16 GHz
Occupied Bandwidth	See section 9.3
MIMO Information (# of Transmit and Receive antenna ports)	8 TX / 8 RX ports, up to 4 spatial streams per polarization (8 in total), horizontal and vertical polarizations
Equipment Type	Proprietary upbanded and modified 802.11AC Radio
Antenna Type and Gain	Antenna Type and Gain: 24.25-25.25 GHz Patch antenna array feeding lens, 15.8 dBi

Variant Models:

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

None

5 System Setup and Method

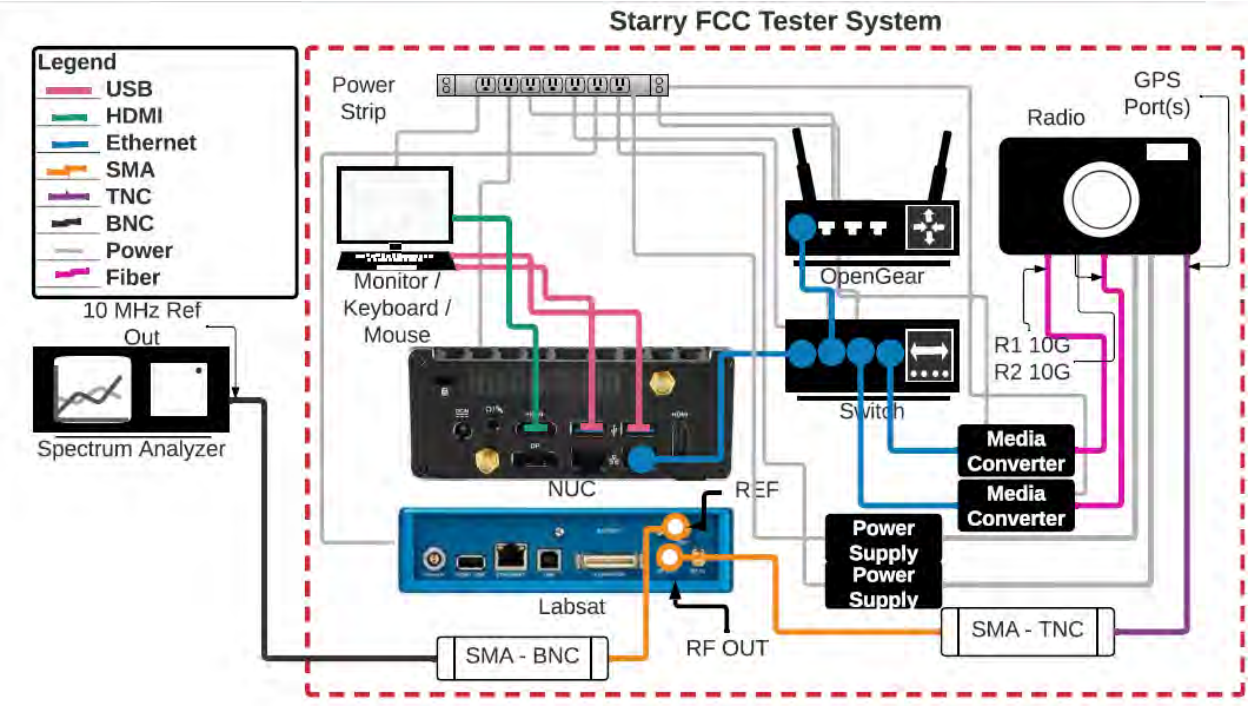
Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
--	AC Cord	1	None	None	AC Mains
--	AC Adapter	1	None	Yes	Power Supply
--	Ethernet	10	None	None	Support Equipment
--	Fiber (2)	10	Yes	None	Support Equipment

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Monitor	Dell	P2317H	CN-03GJ21-74261-6BP-3TKM-A00
Keyboard	Dell	KB216t	CN-ORKRON-71616-6CD-1FLE-A03
Mouse	Dell	MS116t	CN-0DVORH-LO300-81G-1GFC
5-Port Gigabit Ethernet Switch	Netgear	GS305v3	5U81095VA3835
FCC System Tester	Starry	JBC313U591W-31ACB	19CF319X002872
Labsat GNSS Simulator	Racelogic	LS03	082600
Wireless Router	Opengear	ACM7004	70041901043136
48VDC Power Supply	Meanwell	GST200A48	None

5.1 Method:

Configuration as required by FCC 47CFR Part 30 Subpart C: 2022, FCC 47CFR Part 2: 2022, ANSI C63.26:2015, and KDB 842590 D01 Upper Microwave Flexible Use Service v01r02 April 20, 2021.

5.2 EUT Block Diagram:



6 Output Power

6.1 Method

Tests are performed in accordance with FCC 47CFR Part 30 Subparts C: 2022, FCC 47CFR Part 2: 2022, KDB 842590 D01 Upper Microwave Flexible Use Service v01r02 April 20, 2021 Subclause 4.2, and ANSI C63.26:2015 Subclause 5.5.4.

The procedure described in Subclause 5.5.4 (field strength method) of ANSI C63.26-2015 was utilized to determine maximum power. Measurement was performed by using a radiated method. During measurement, EIRP power was converted to EIRP Output Powerby using antenna gain and distance factor. Power shown on the screenshots are conducted power. The EUT was transmitting at its duty cycle.

- Connect the test antenna for the fundamental frequency band to a Spectrum Analyzer.
- Set Spectrum Analyzer RBW, VBW, detector, span, and so on to the proper values.
- Place the EUT 1.5 meters above the ground reference plane and the far field test distance of 3 meters from the edge of the EUT to the test antenna.
- Set the EUT to transmit continuously on a channel with modulation.
- As the surfaces of the EUT are scanned, keep the test antenna pointed toward the EUT and slowly vary the test antenna polarization to cover all possible polarizations and orientations of the emission. And vary the test antenna height from 1 to 4 meters to maximize the emission.
- Record the measured reading with the test antenna fixed at the maximized position, polarization, and orientation. Record the measurement distance.
- The maximum field strength of the emission at the measurement distance is calculated by using Equation (19) of ANSI C63.10-2013 and the adjusted/corrected power at the output of the test antenna. The EIRP from the measured field strength is calculated by using Equation (22) of ANSI C63.10-2013 and convert to the linear form by using Equation (24) of ANSI C63.10-2013. If measurements were made at any distance other than the distance specified by the limit, Equations (20) and (21) of ANSI C63.10-2013 were used to extrapolate the maximum measured field strength. Far Field Distance (Rm) Calculation Rm = 2D2 /λ Where: D = largest dimension of the antenna aperture in meters λ = wavelength of the emission under investigation [300/fMHz] in meters D = 0.031 (m), λ = 300 (m/s) / 77.0135*103 (MHz) = 0.003895 (m), Rm = ((2*0.0312))/0.003895 = 0.49 (m). Measurements was made at 3 meters distance.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)
Radiated Emissions, 10m	30-1000 MHz	5.0 dB
Radiated Emissions, 3m	30-1000 MHz	4.6 dB
Radiated Emissions, 3m	1-6 GHz	4.9 dB
Radiated Emissions, 3m	6-15 GHz	5.1 dB
Radiated Emissions, 3m	15-18 GHz	4.7 dB
Radiated Emissions, 3m	18-40 GHz	4.7 dB

Sample Calculation

The cable loss, antenna factor, and path loss at 3 meters were compensated in the Spectrum Analyzer as a dB offset without the EUT antenna factor. The EIRP power is calculated from field strength reading at 3 meters as below.

EIRP (dBm) = E (dBµ/m) + 20 * LOG (D) – 104.7; where D is the measurement distance (in the far field region) in meters.
EIRP (dBm) = E (dBµV/m) – 95.26, where D = 3 m
EIRP Output Power(dBm) = EIRP (dBm) – EUT antenna gain (dBi)

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/20/2021	03/20/2022
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	02/08/2022	02/08/2023
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	12/27/2021	12/27/2022
CBLHF2012-5M-2'	5m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252676002	02/16/2022	02/16/2023

Software Utilized:

Name	Manufacturer	Version
None	--	--

6.3 Results – Output Power:

The sample tested was found to Comply.

Limit – FCC 47CFR Part 30 Subpart C, Section 30.202 (a): For fixed and base stations operating in connection with mobile systems, the average power of the sum of all antenna elements is limited to an equivalent isotopically radiated power (EIRP) density of +75dBm/100 MHz. For channel bandwidths less than 100 megahertz the EIRP must be reduced proportionally and linearly based on the bandwidth relative to 100 megahertz.

Frequency (GHz)	Transmitting Polarity	Modulation	Bandwidth (MHz)	*Beam Forming (dB)	EIRP From Plots (dBm)	Total EIRP Output Power (dBm/100 MHz)	Limit (dBm/100 MHz	Margin (dBm)
24.27	Vertical	MCS8	20	6	35.98	41.98	75	-33.02
24.28	Vertical	MCS8	20	6	37.58	43.58	75	-31.42
24.29	Vertical	MCS8	20	6	36.48	42.48	75	-32.52
24.77	Vertical	MCS8	20	6	34.81	40.81	75	-34.19
24.97	Vertical	MCS8	20	6	37.53	43.53	75	-31.47
25.09	Vertical	MCS8	20	6	35.32	41.32	75	-33.68
24.27	Horizontal	MCS8	20	6	34.97	40.54	75	-34.03
24.28	Horizontal	MCS8	20	6	38.33	44.33	75	-30.67
24.29	Horizontal	MCS8	20	6	37.42	43.42	75	-31.57
24.77	Horizontal	MCS8	20	6	34.54	40.54	75	-34.46
24.97	Horizontal	MCS8	20	6	38.33	44.33	75	-30.67
25.09	Horizontal	MCS8	20	6	37.77	43.77	75	-31.23
24.34	Vertical	MCS0	160	6	37.91	43.91	75	-31.09
24.35	Vertical	MCS0	160	6	37.92	43.92	75	-31.08
24.36	Vertical	MCS0	160	6	37.59	43.59	75	-31.41
24.84	Vertical	MCS0	160	6	37.79	43.79	75	-31.21
25.04	Vertical	MCS0	160	6	36.66	42.66	75	-32.34
25.16	Vertical	MCS0	160	6	35.15	41.15	75	-33.85
24.34	Horizontal	MCS0	160	6	39.65	45.65	75	-29.35
24.35	Horizontal	MCS0	160	6	39.43	45.43	75	-29.57
24.36	Horizontal	MCS0	160	6	39.20	45.20	75	-29.80
24.84	Horizontal	MCS0	160	6	39.72	45.72	75	-29.28
25.04	Horizontal	MCS0	160	6	39.19	45.19	75	-29.81
25.16	Horizontal	MCS0	160	6	39.25	45.25	75	-29.75

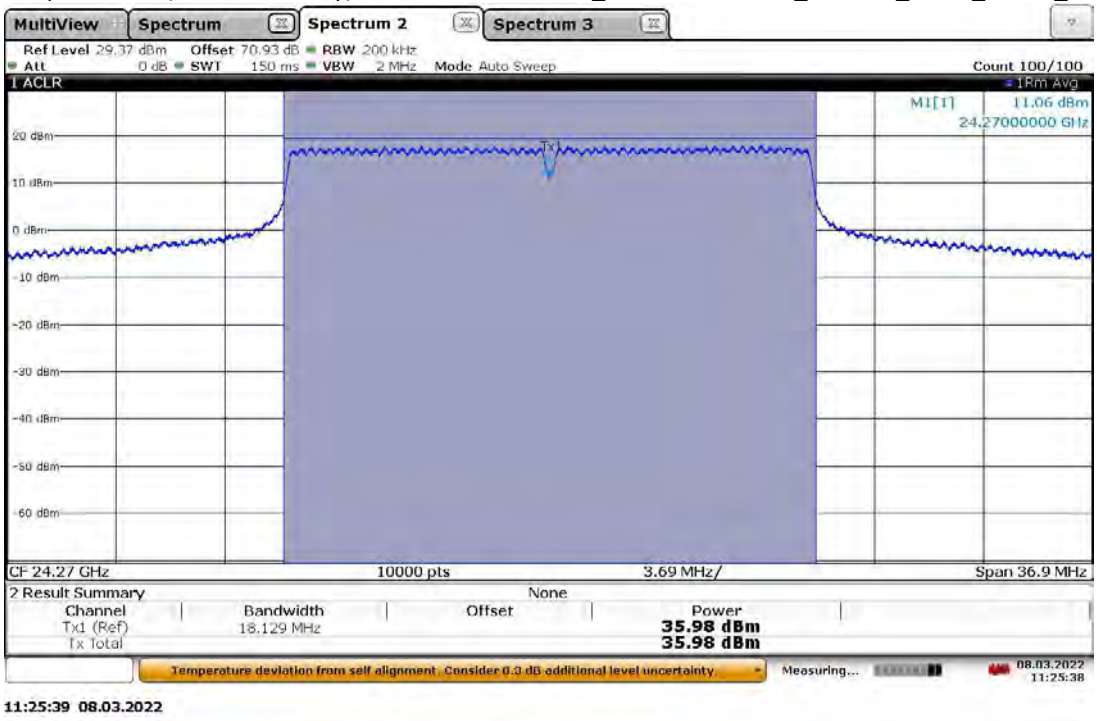
*Notes: Total EIRP Output Power = EIRP power from the plot in Section 6.5 + 6 dBi Beam Forming was internally compensated.

6.4 Setup Photographs:

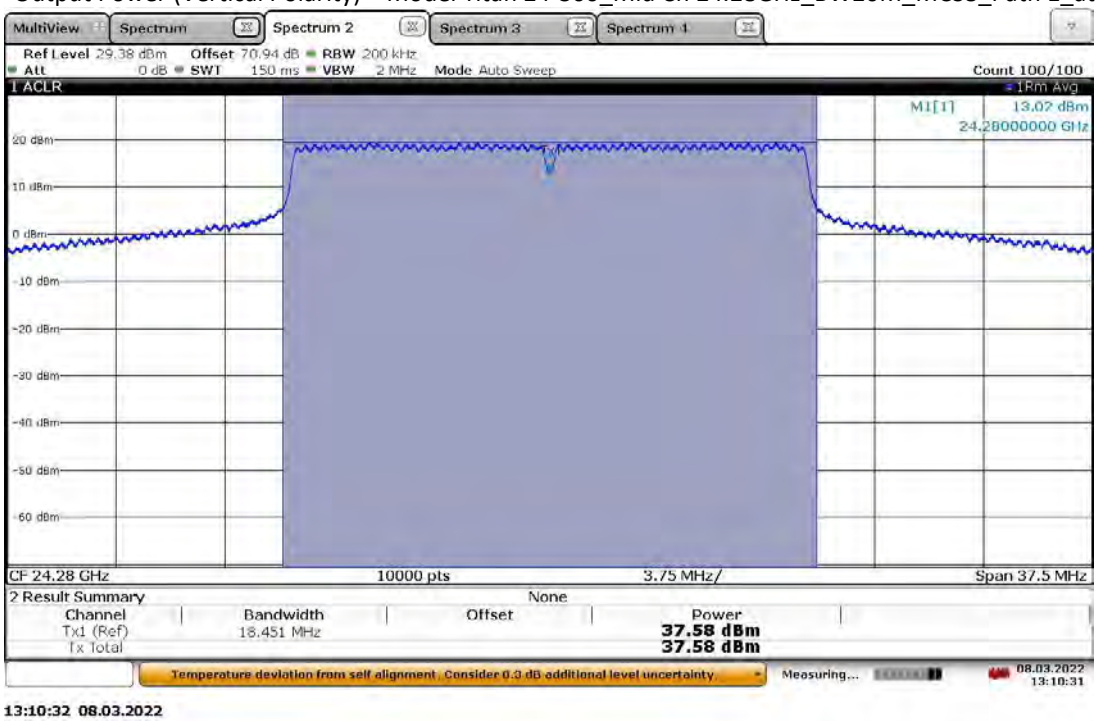
Setup Photographs are included in a separate file.

6.5 Plots/Data:

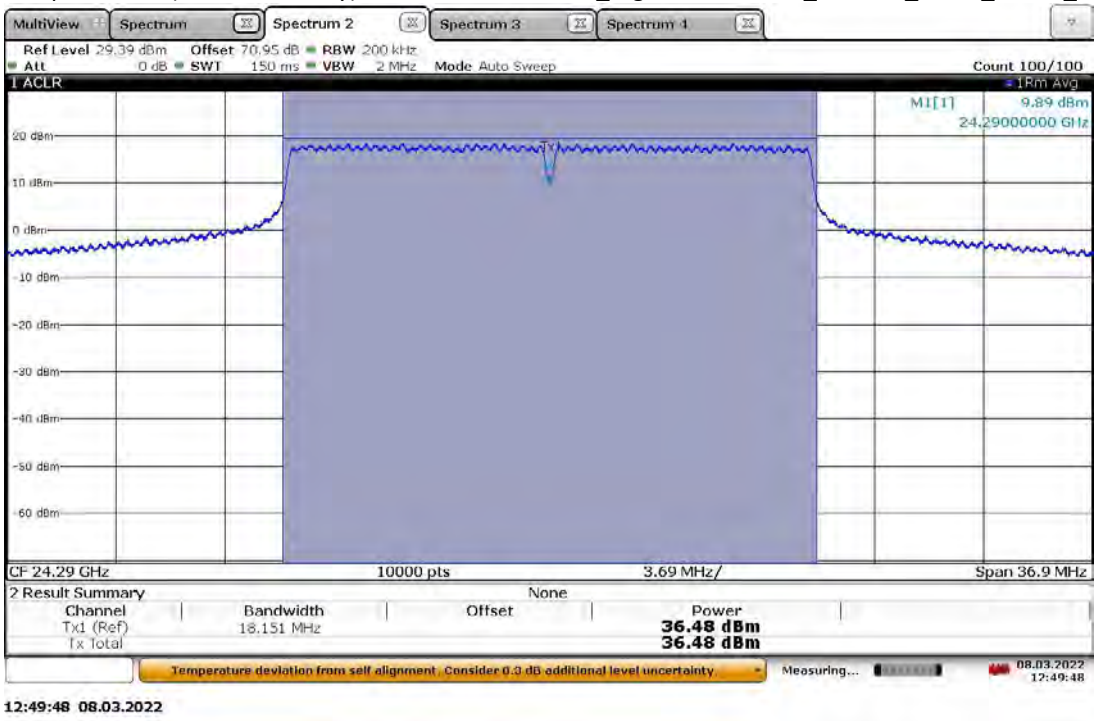
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_Low Ch 24.27GHz_BW20M_MCS8_Path 1_att10.5



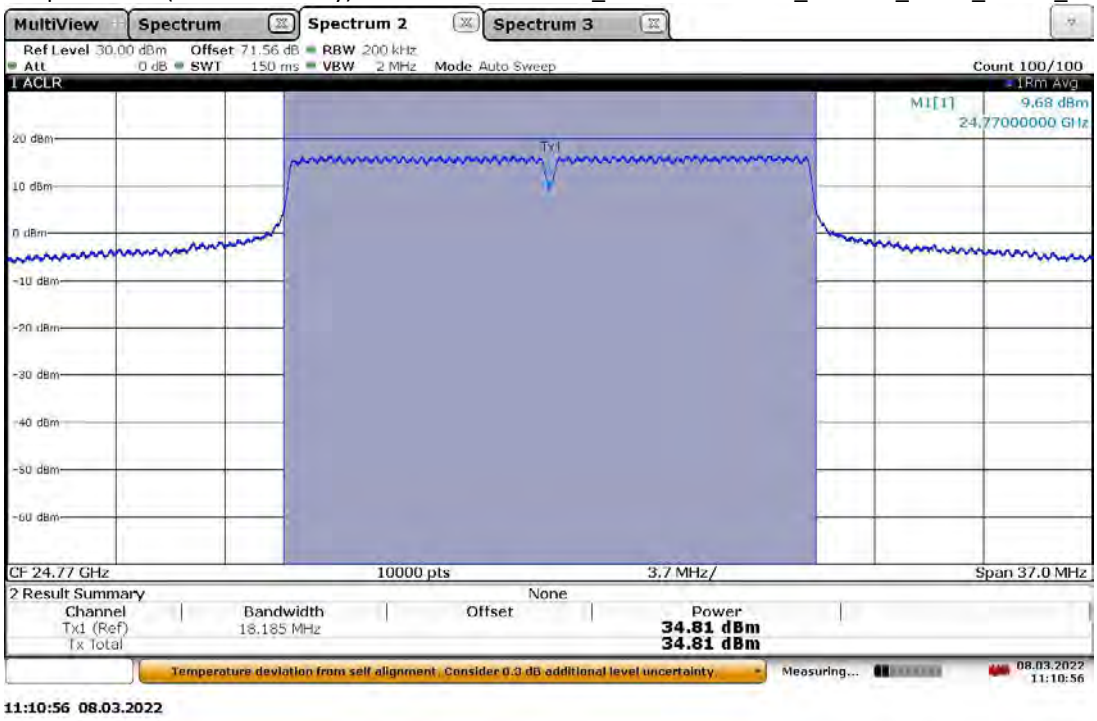
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_Mid Ch 24.28GHz_BW20M_MCS8_Path 1_att8.0



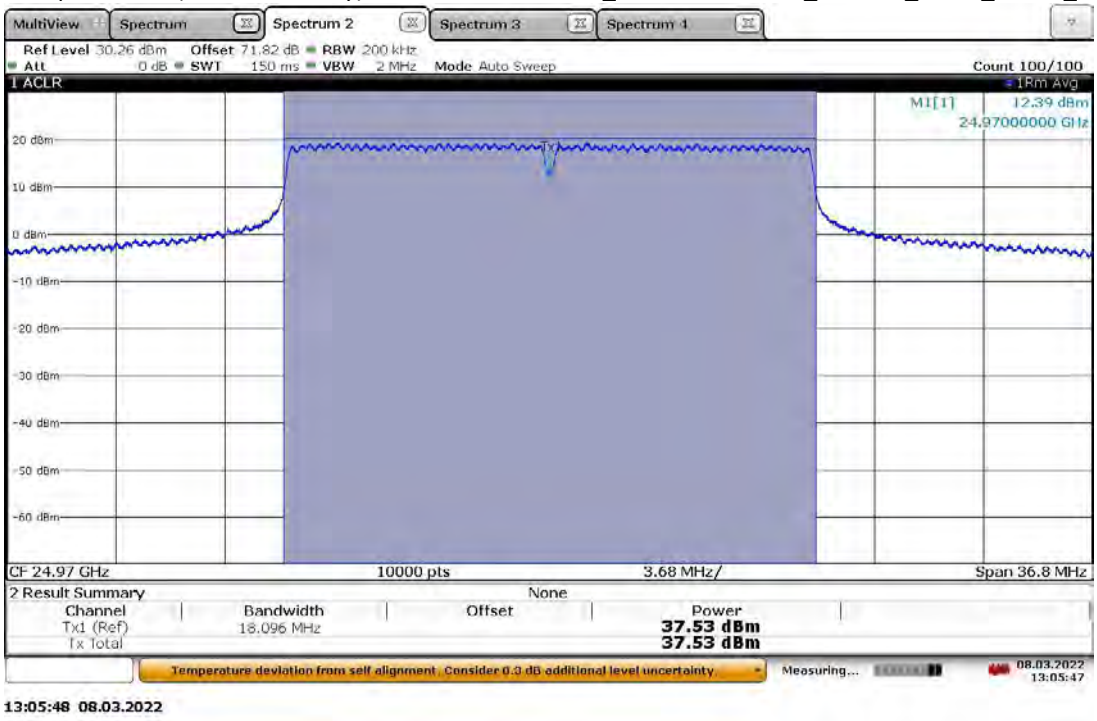
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_High Ch 24.29GHz_BW20M_MCS8_Path 1_att6.0



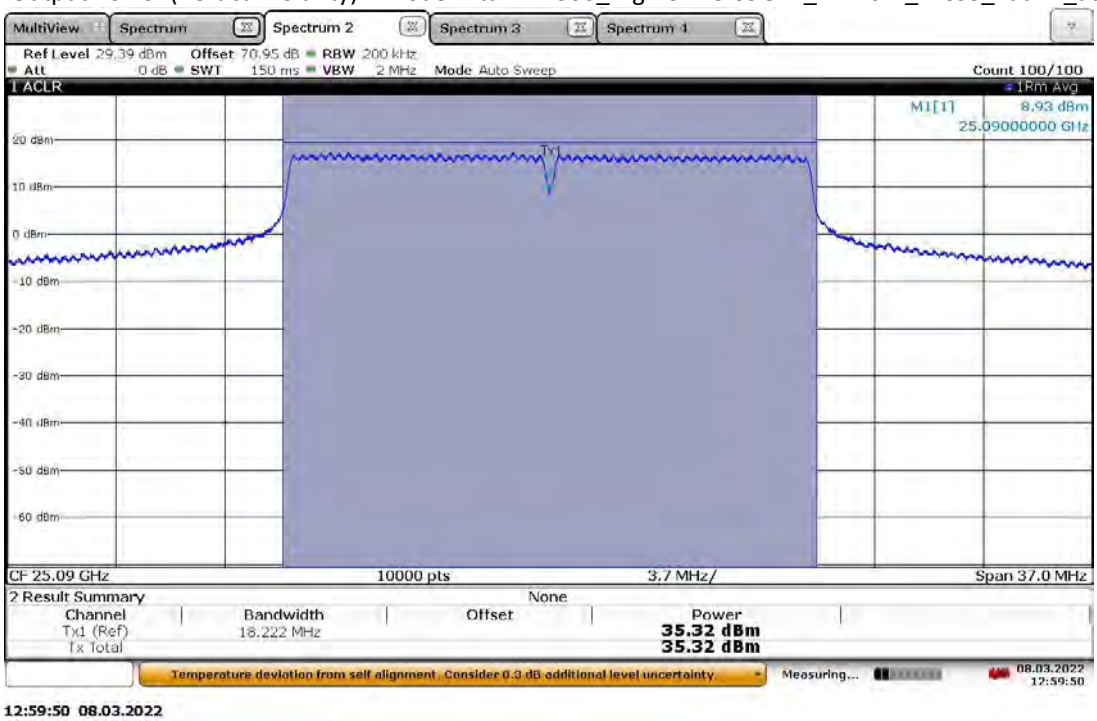
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_Low Ch 24.77GHz_BW20M_MCS8_Path 1_att12.5



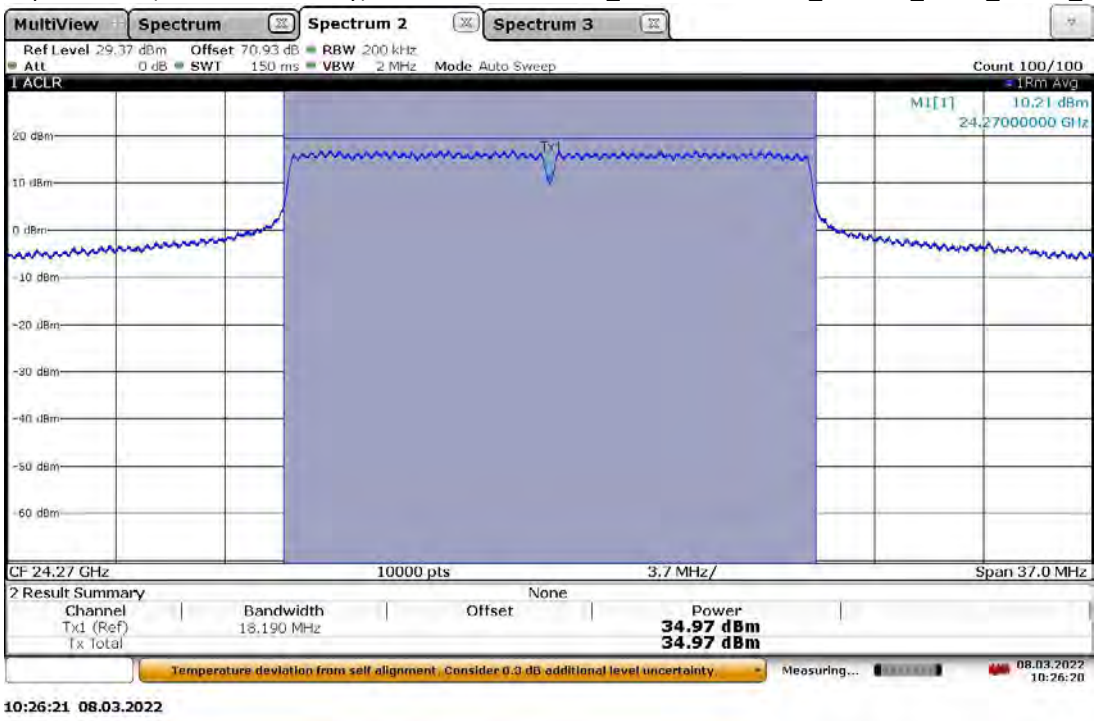
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_Mid Ch 24.97GHz_BW20M_MCS8_Path 1_att10



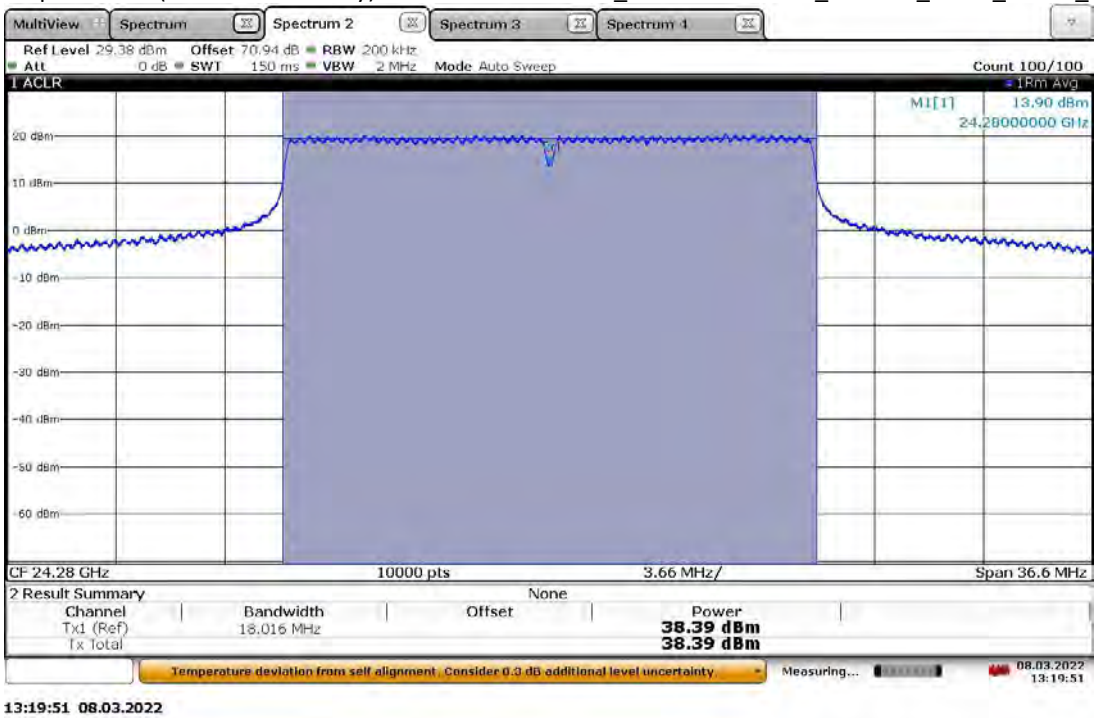
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_High Ch 25.09GHz_BW20M_MCS8_Path 1_att6.0



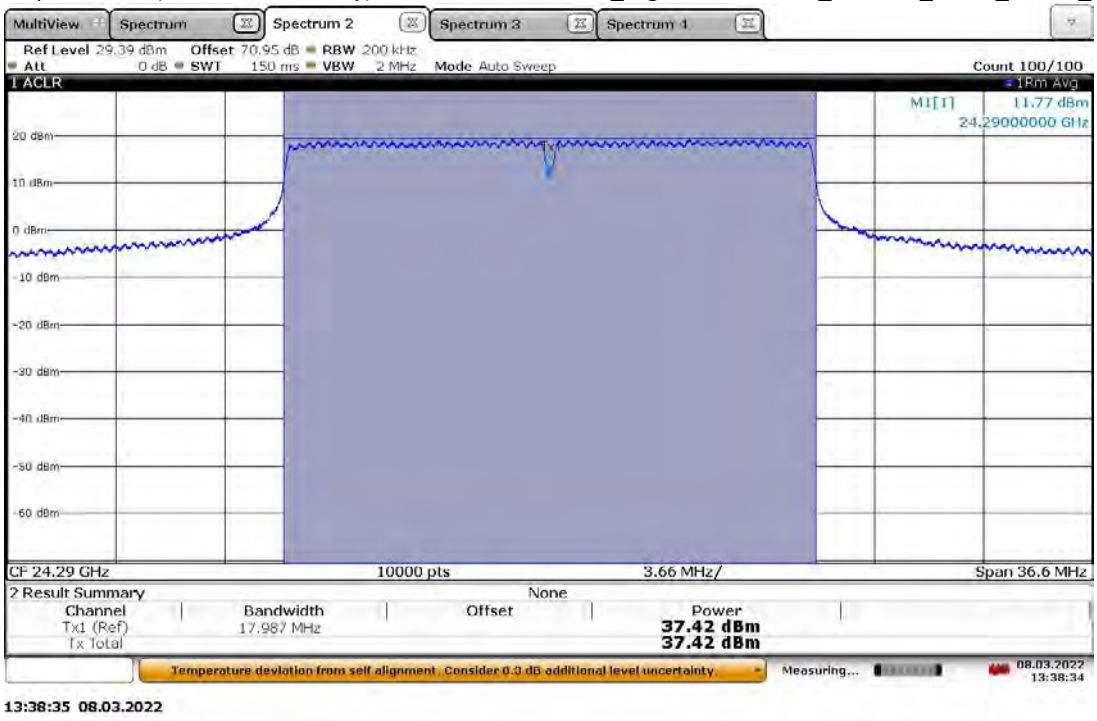
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_Low Ch 24.27GHz_BW20M_MCS8_Path 1_att12.0



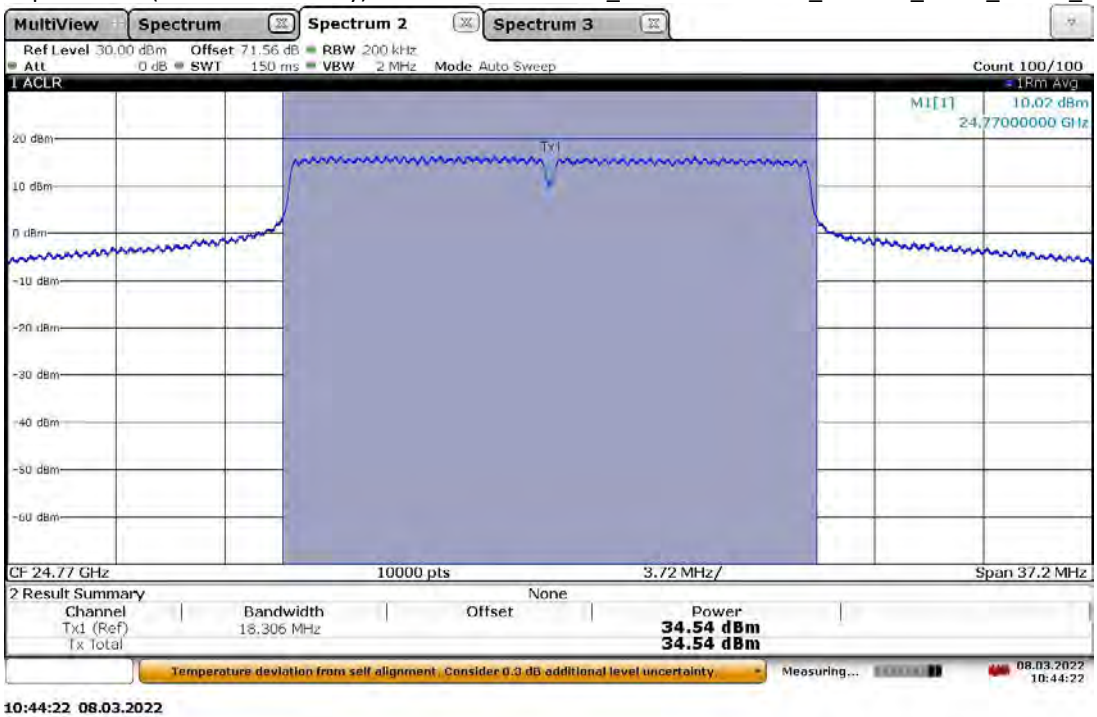
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_Mid Ch 24.28GHz_BW20M_MCS8_Path 1_att8.0



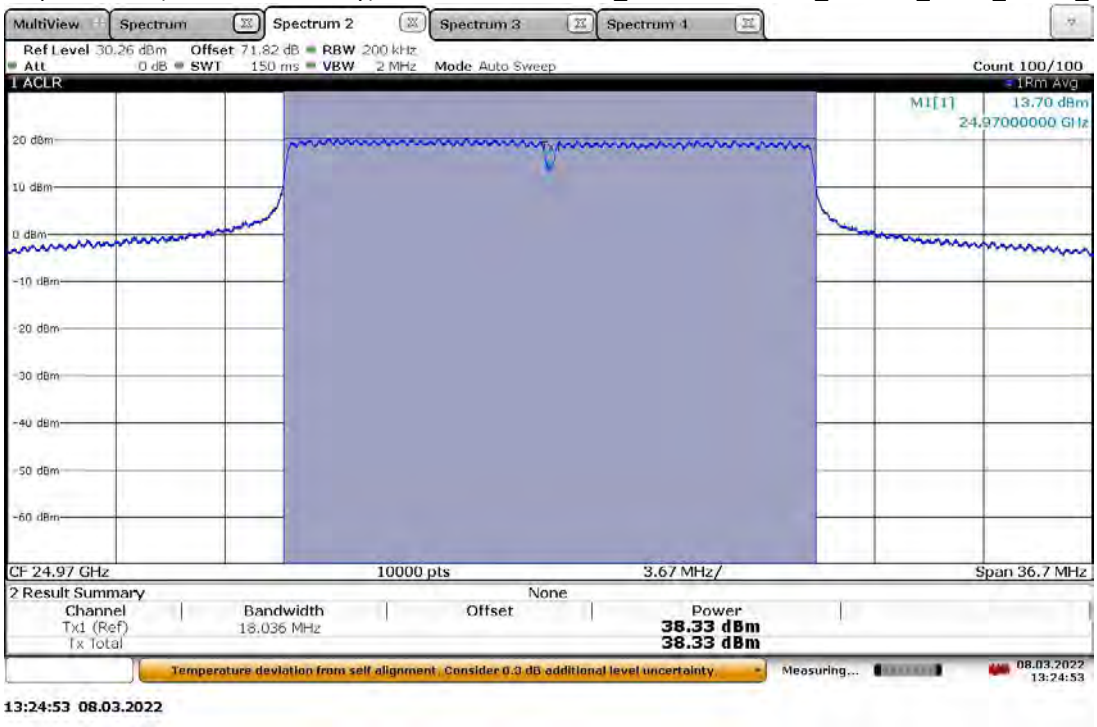
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_High Ch 24.29GHz_BW20M_MCS8_Path 1_att6.5



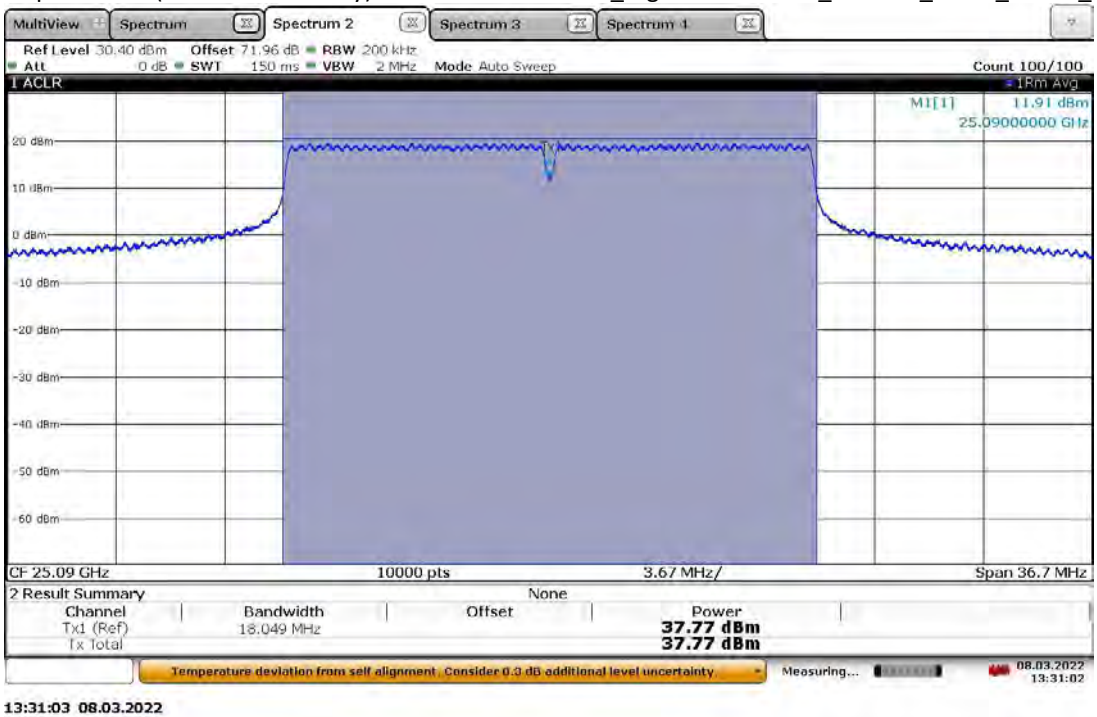
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_Low Ch 24.77GHz_BW20M_MCS8_Path 1_att12.5



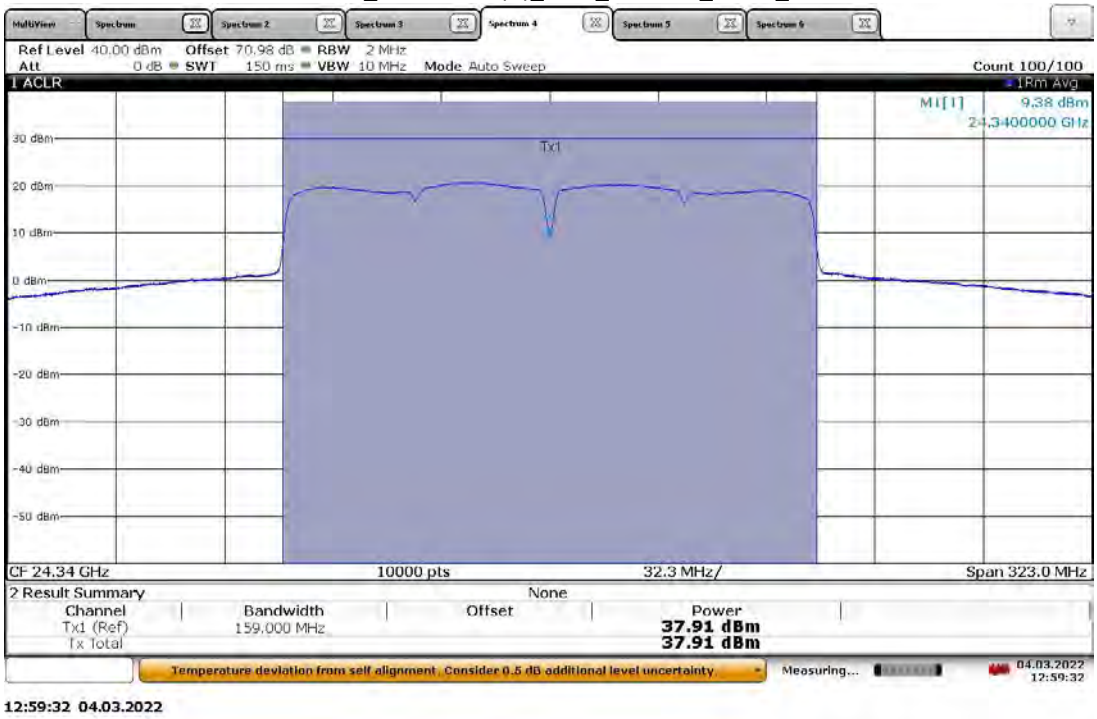
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_Mid Ch 24.97GHz_BW20M_MCS8_Path 1_att8.0



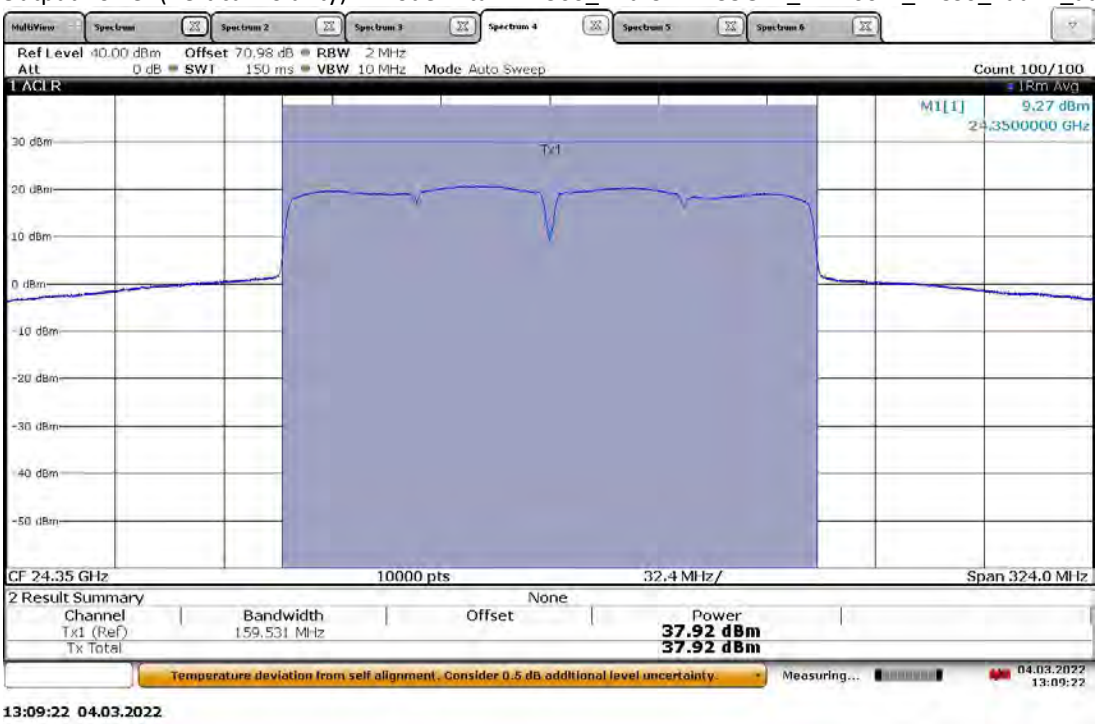
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_High Ch 25.09GHz_BW20M_MCS8_Path 1_att5.0



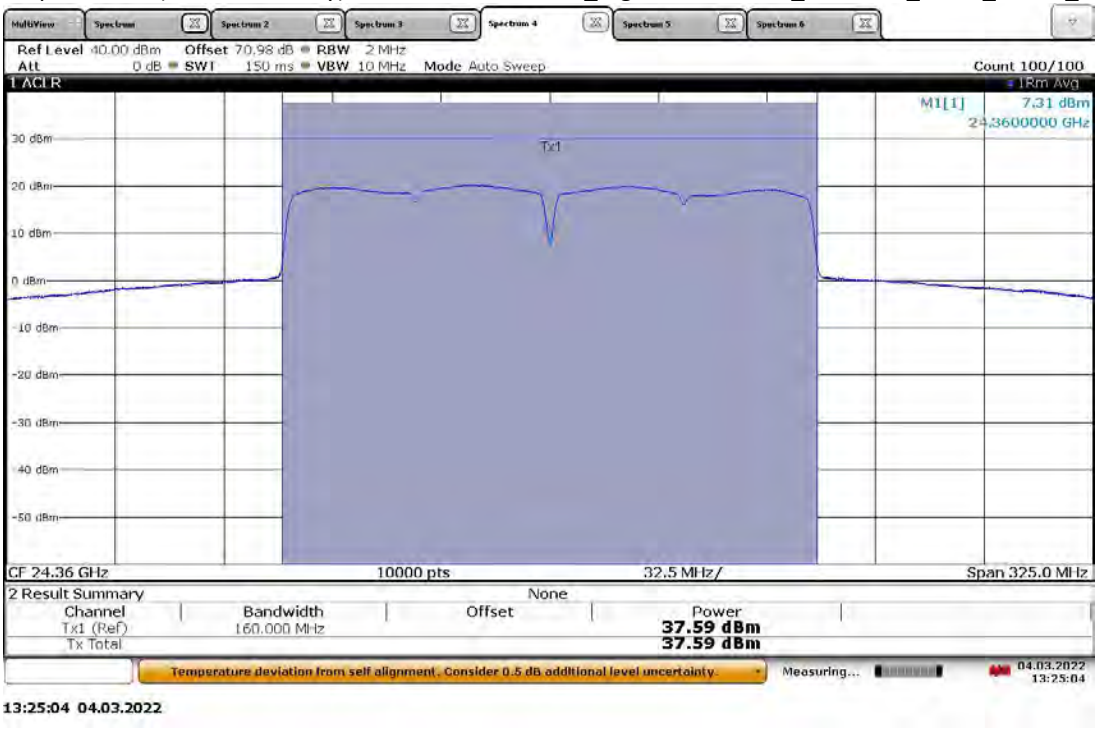
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_Low Ch 24.34GHz_BW160M_MCS0_Path 1_ATT 10.5
Titan 24-360_L24.34GHz (V)_PWR_160MHz_MCS0_Att10.5



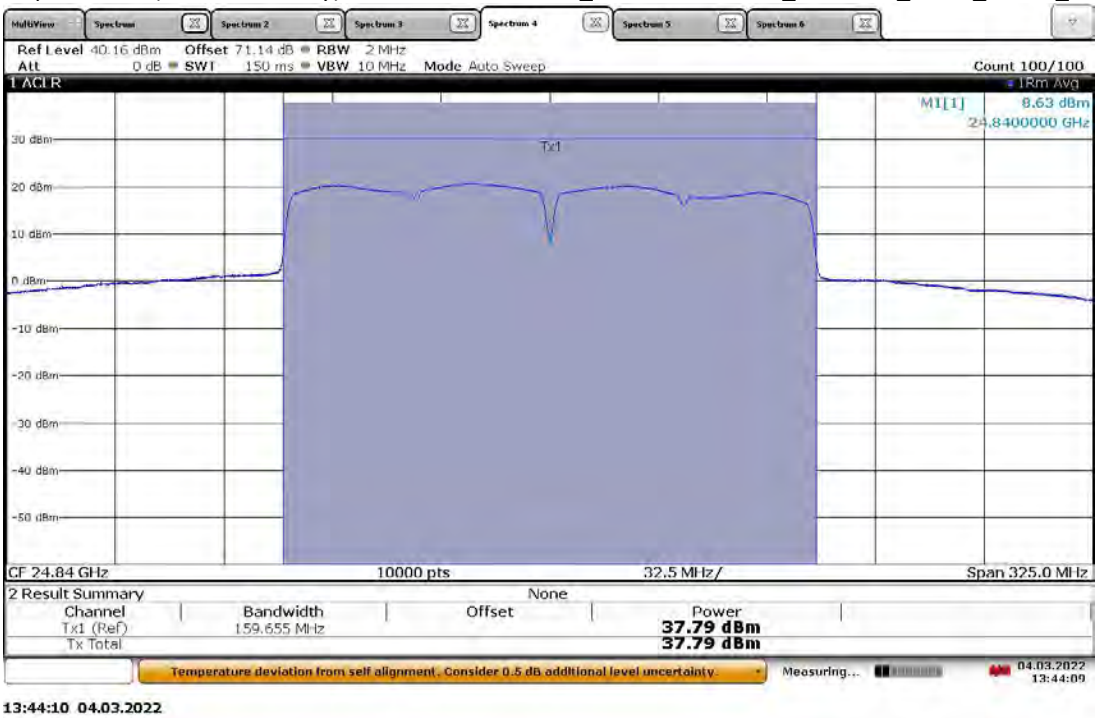
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_Mid Ch 24.35GHz_BW160M_MCS0_Path 1_att10.5



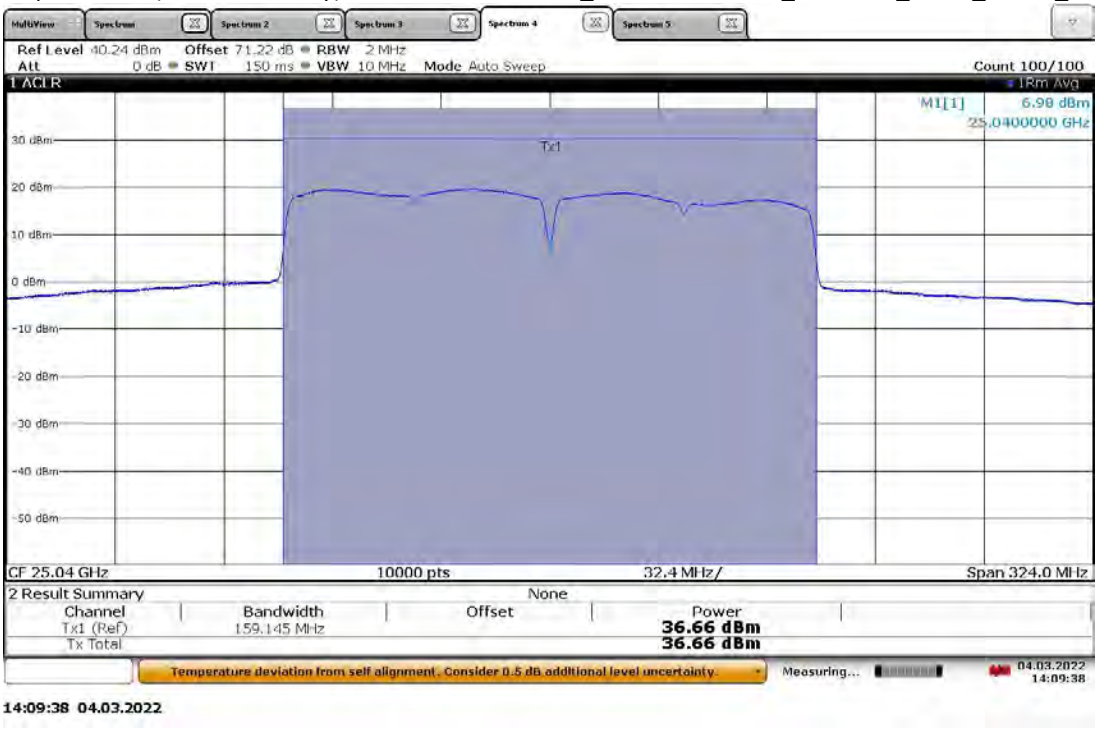
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_High Ch 24.36GHz_BW160M_MCS0_Path 1_ATT8.0



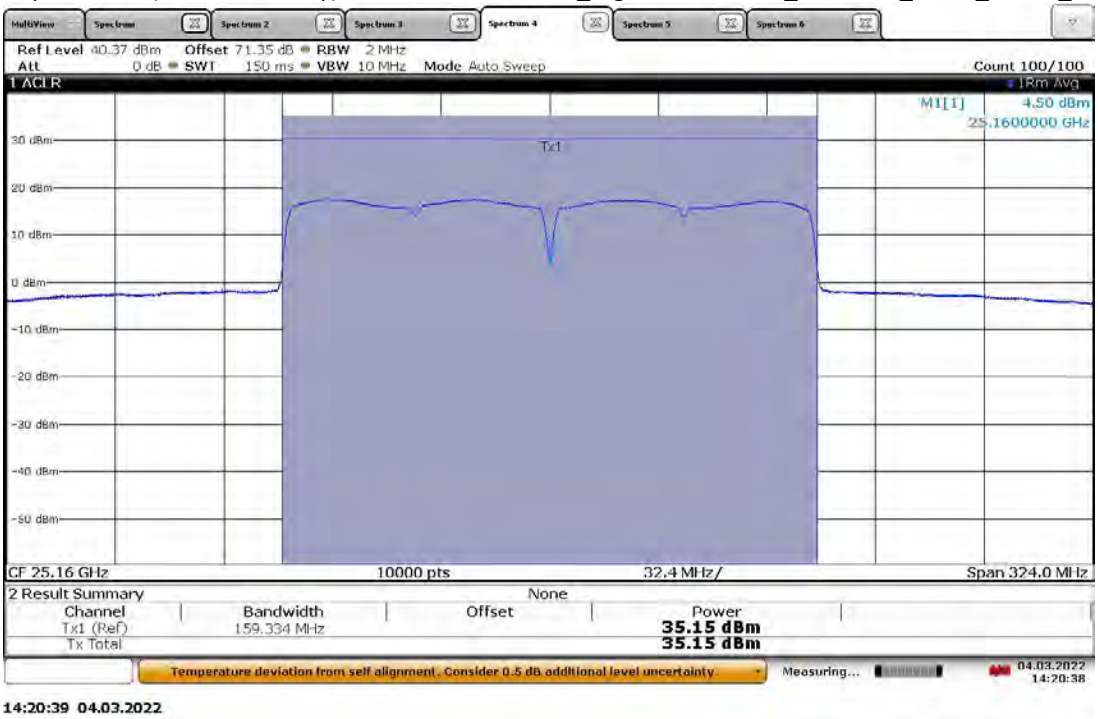
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_Low Ch 24.84GHz_BW160M_MCS0_Path 1_ATT10.5



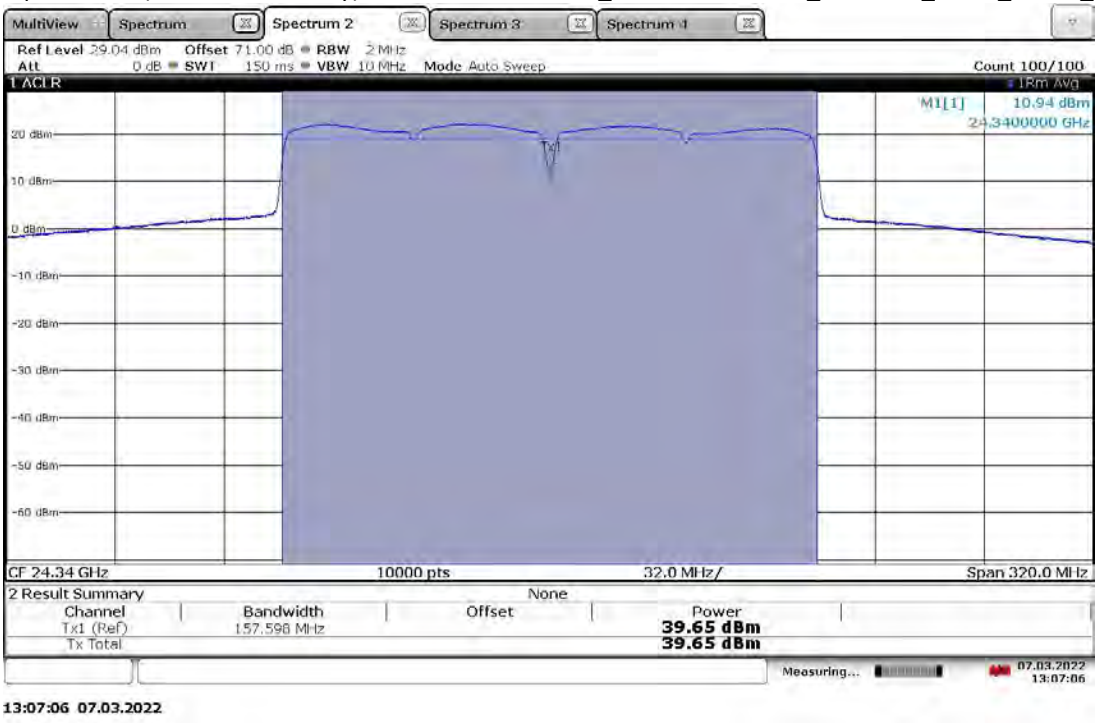
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_Mid Ch 25.04GHz_BW160M_MCS0_Path 1_ATT11.5



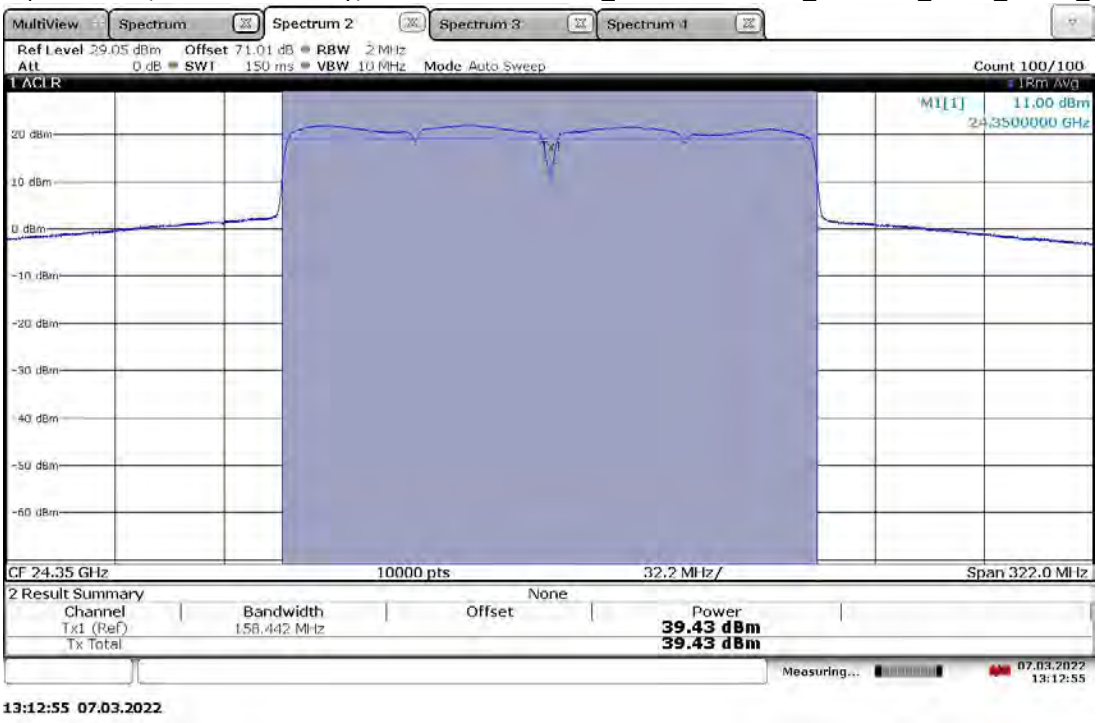
EIRP Output Power (Vertical Polarity) – Model Titan 24-360_High Ch 25.16GHz_BW160M_MCS0_Path 1_ATT10.0



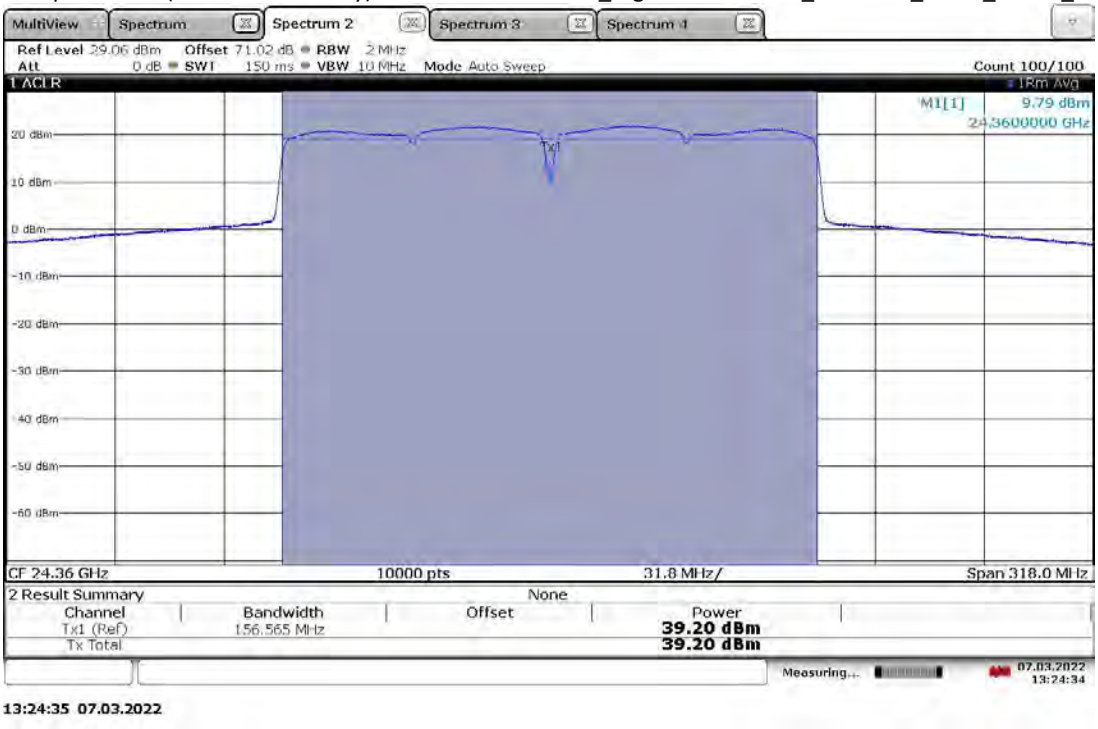
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_Low Ch 24.34 GHz_BW160M_MCS0_Path 1_ATT8.5



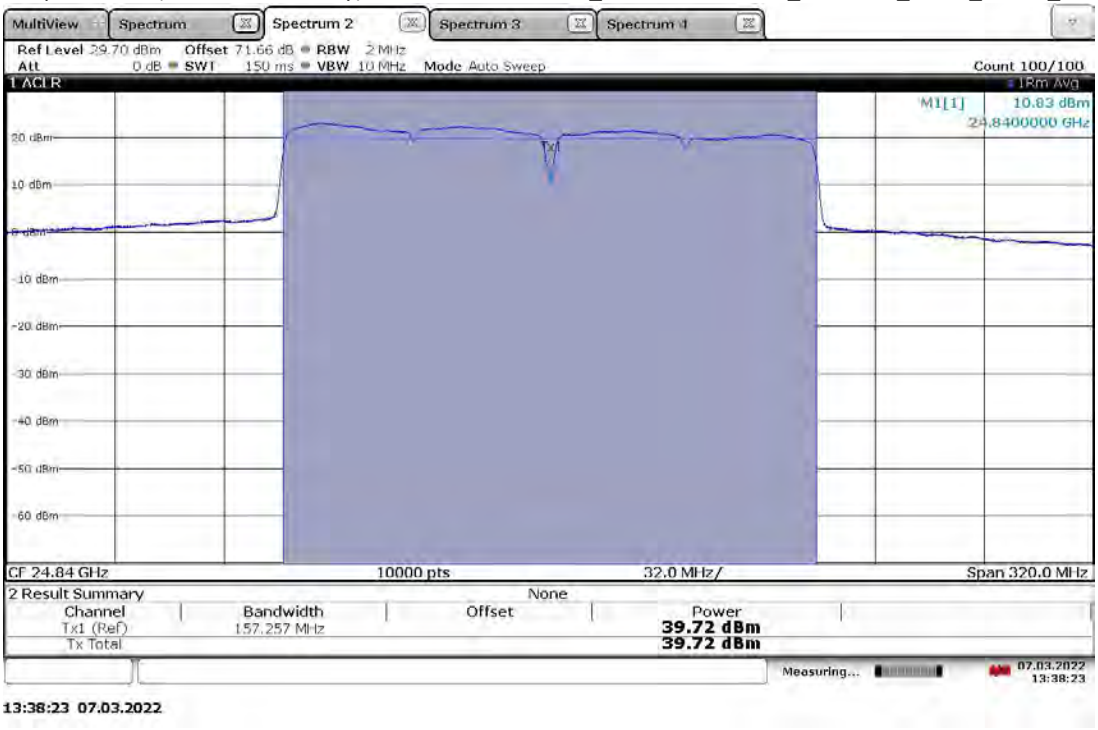
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_Mid Ch 24.35GHz_BW160M_MCS0_Path 1_ATT9.0



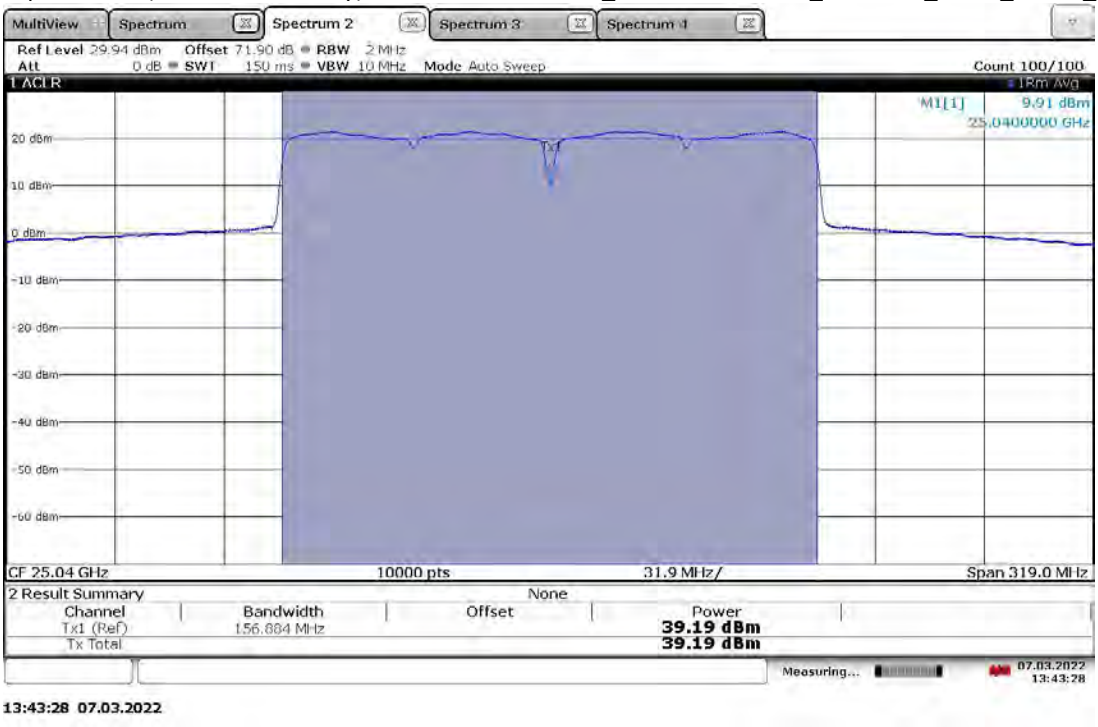
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_High Ch 24.36 GHz_BW160M_MCS0_Path 1_att8.0



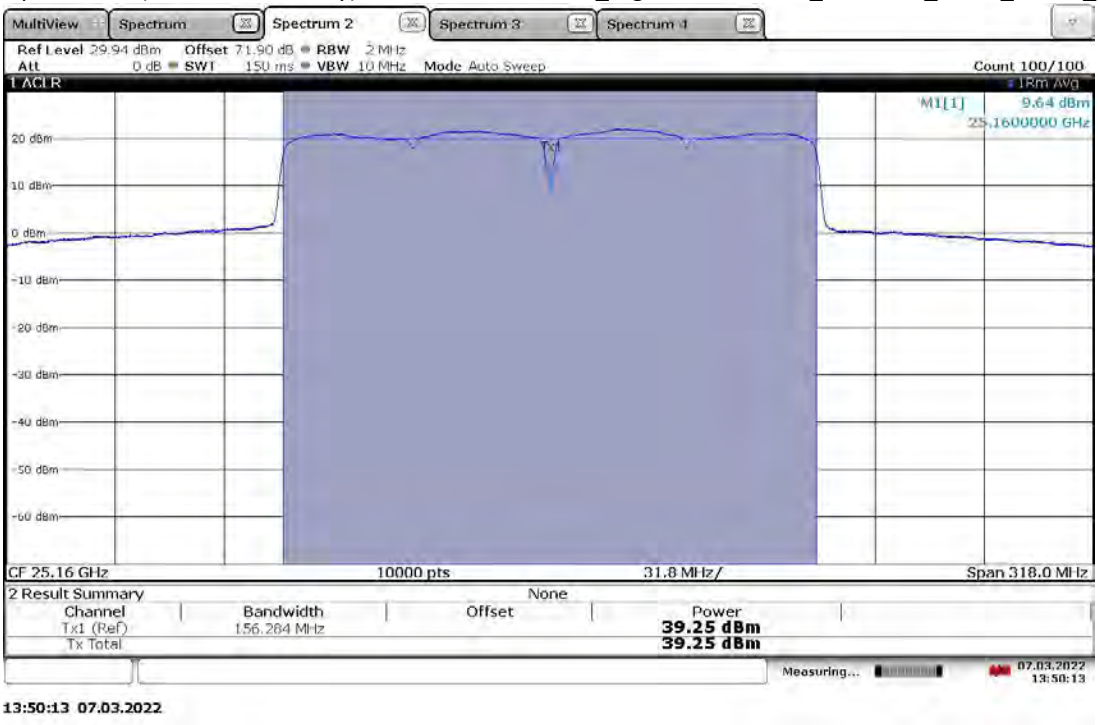
EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_Low Ch 24.84 GHz_BW160M_MCS0_Path 1_ATT10.0



EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_Mid Ch 25.04 GHz_BW160M_MCS0_Path 1_ATT10



EIRP Output Power (Horizontal Polarity) – Model Titan 24-360_High Ch 25.16 GHz_BW160M_MCS0_Path 1_ATT9.0



Test Personnel:	Kouma Sinn KPS	Test Date:	03/04/2022, 03/07/2022, 03/08/2022
Supervising/Reviewing Engineer: (Where Applicable)	Vathana F. Ven VFV		
Product Standard:	FCC 47CFR Part 30 Subpart C	Limit Applied:	See Report Section 6.3
Input Voltage:	48 VDC Via External P/S	Ambient Temperature:	25, 23, 23 ºC
Pretest Verification w/ BB Source:	**Yes**	Relative Humidity:	10, 30, 25 %
		Atmospheric Pressure:	1022, 1002, 1006 mbars

Deviations, Additions, or Exclusions: None

7 Out of Band (OOB) Domain

7.1 Method

Tests are performed in accordance with FCC 47CFR Part 30 Subpart C and KDB 842590 D01 Upper Microwave Flexible Use Service v01r02 April 20, 2021 Subclause 4.4.2. The measurement was made on the maximum field strength in the same worst-case orientation as in report Section 6.1

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)
Radiated Emissions, 10m	30-1000 MHz	5.0 dB
Radiated Emissions, 3m	30-1000 MHz	4.6 dB
Radiated Emissions, 3m	1-6 GHz	4.9 dB
Radiated Emissions, 3m	6-15 GHz	5.1 dB
Radiated Emissions, 3m	15-18 GHz	4.7 dB
Radiated Emissions, 3m	18-40 GHz	4.7 dB

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m

CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". The "Correction" includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the "Level" column.

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/20/2021	03/20/2022
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	02/08/2022	02/08/2023
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	12/27/2021	12/27/2022
CBLHF2012-5M-2'	5m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252676002	02/16/2022	02/16/2023

Software Utilized:

Name	Manufacturer	Version
None	--	--

7.3 Results:

The sample tested was found to Comply.

Limit – FCC 47CFR Part 30 Subpart C, Section 30.203 (a) (b): 2021

(a) The conductive power or the total radiated power of any emission outside a licensee's frequency block shall be −13 dBm/MHz or lower. However, in the bands immediately outside and adjacent to the licensee's frequency block, having a bandwidth equal to 10 percent of the channel bandwidth, the conductive power or the total radiated power of any emission shall be −5 dBm/MHz or lower.

(b)

(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater.

(2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges as the design permits.

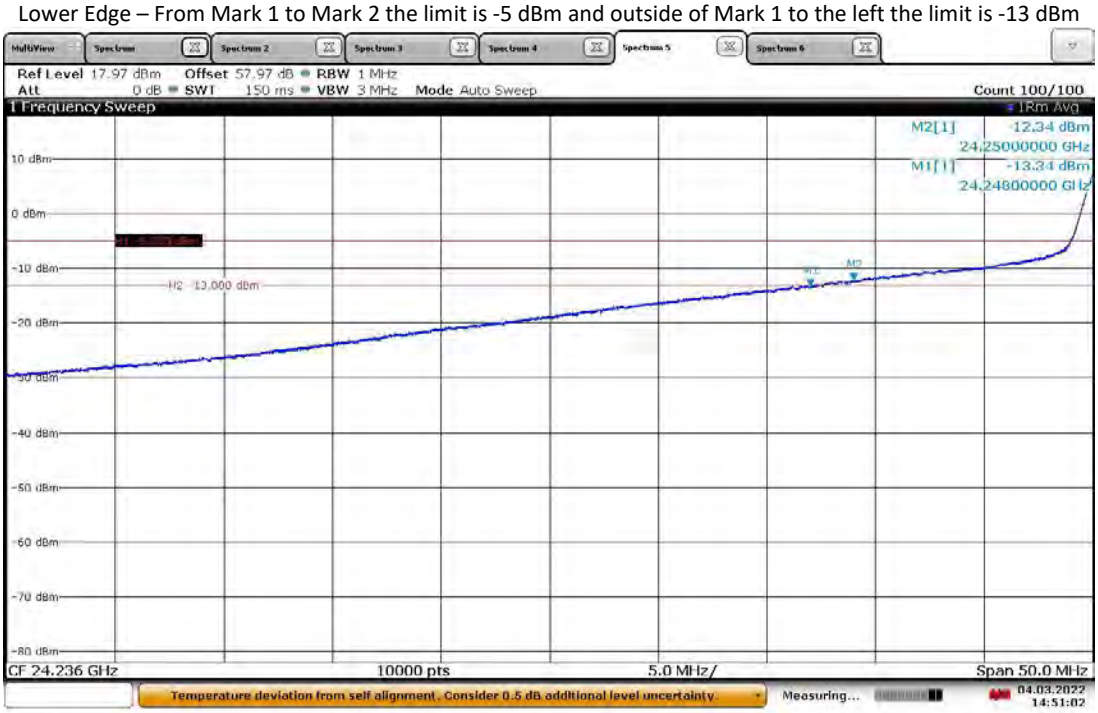
(3) The measurements of emission power can be expressed in peak or average values.

7.4 Setup Photographs:

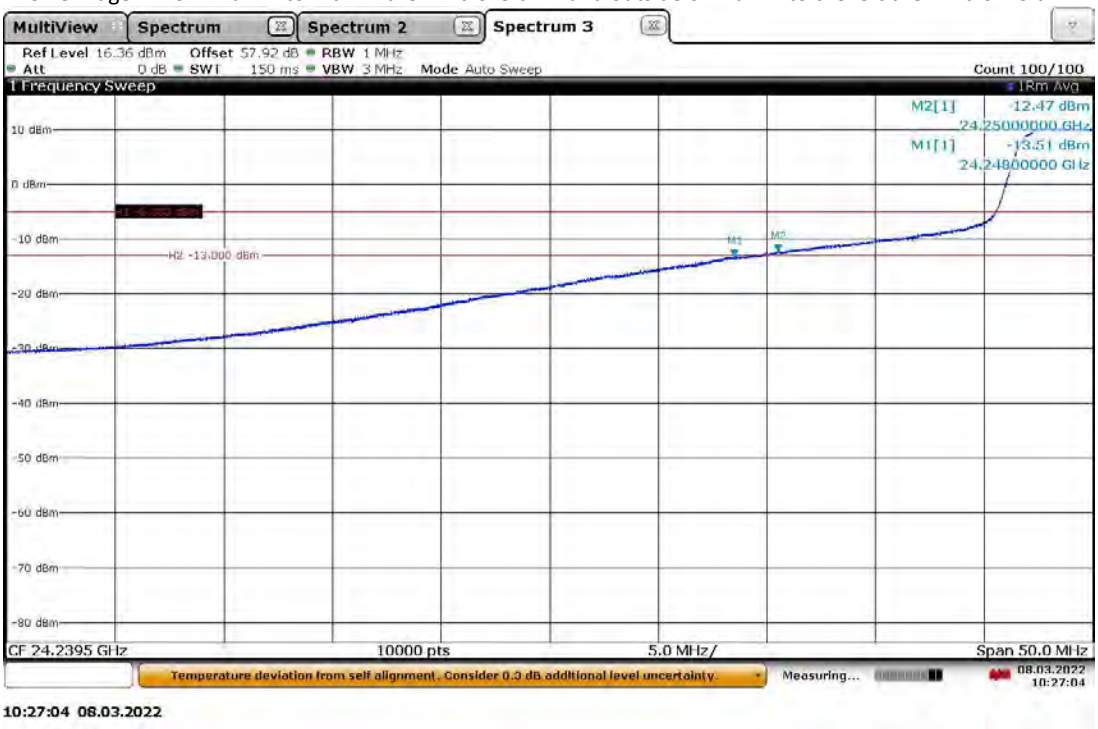
Setup Photographs are included in a separate file.

7.5 Plots/Data:

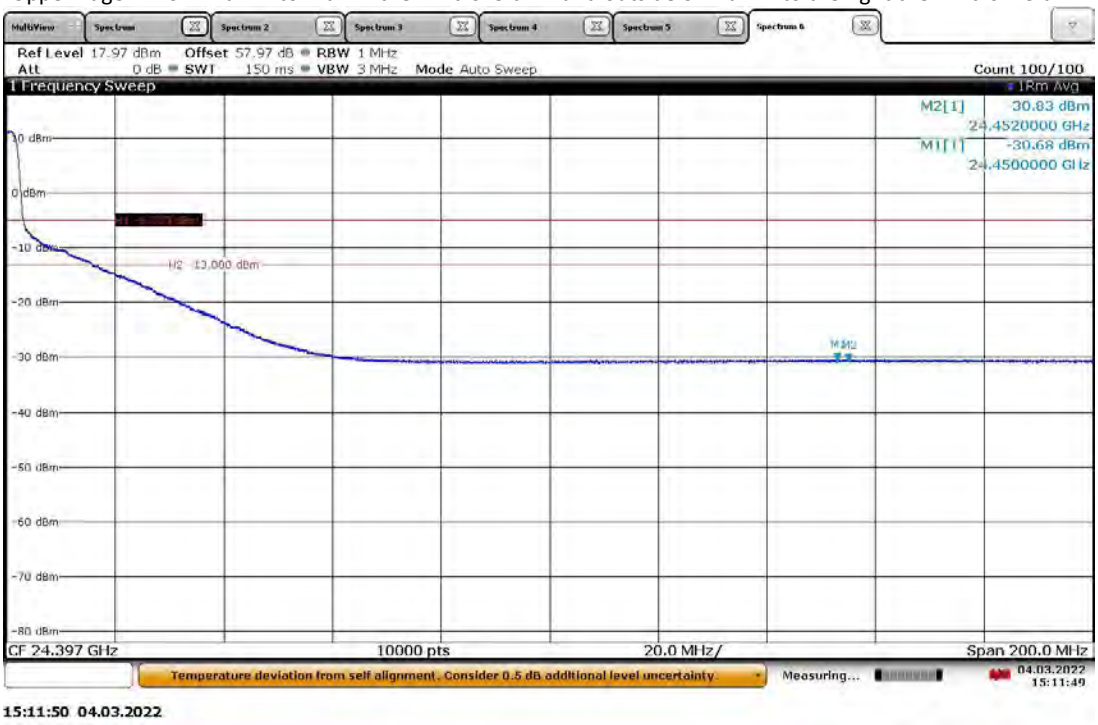
Authorized Band 24.25-24.45 GHz, Emission Mask (V) – Model Titan 24-360_Low Ch 24.27GHz_BW20M_MCS8_Path 1_att11.5
Lower Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 1 to the left the limit is -13 dBm



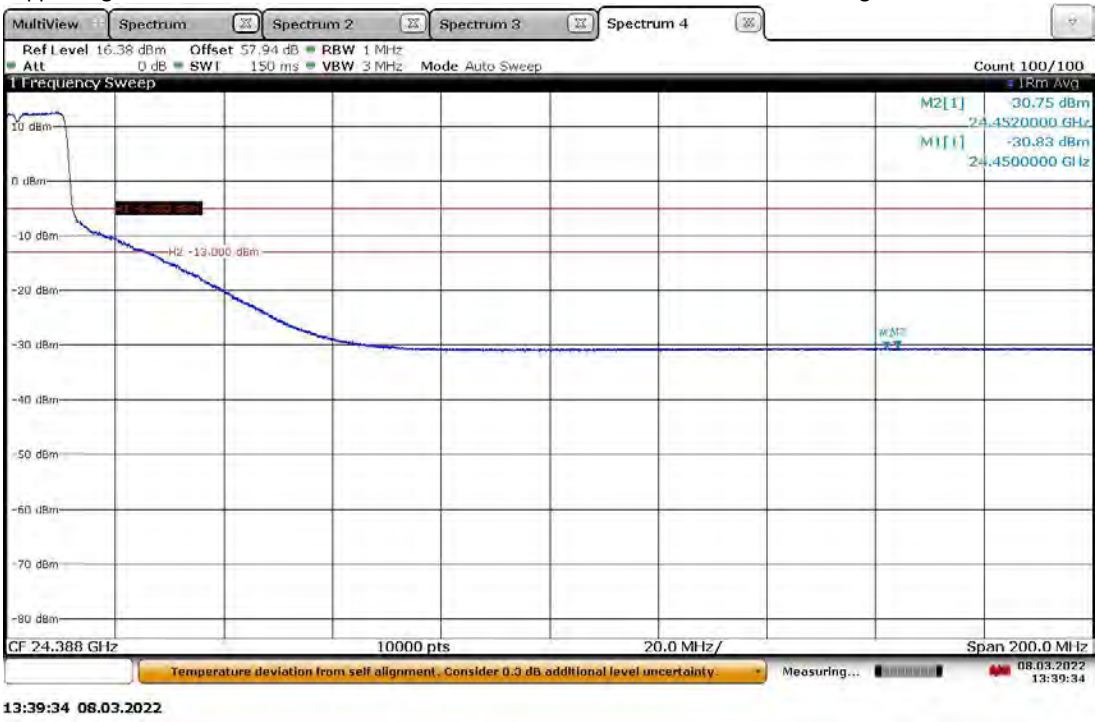
Authorized Band 24.25-24.45 GHz, Emission Mask (H) – Model Titan 24-360_24.27GHz_BW20M_MCS8_Path 1_att12.0
Lower Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 1 to the left the limit is -13 dBm



Authorized Band 24.25-24.45 GHz, Emission Mask (V) – Model Titan 24-360_High 24.29GHz_BW20M_MCS0_Path 1_att7.0
Upper Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 2 to the right the limit is -13 dBm



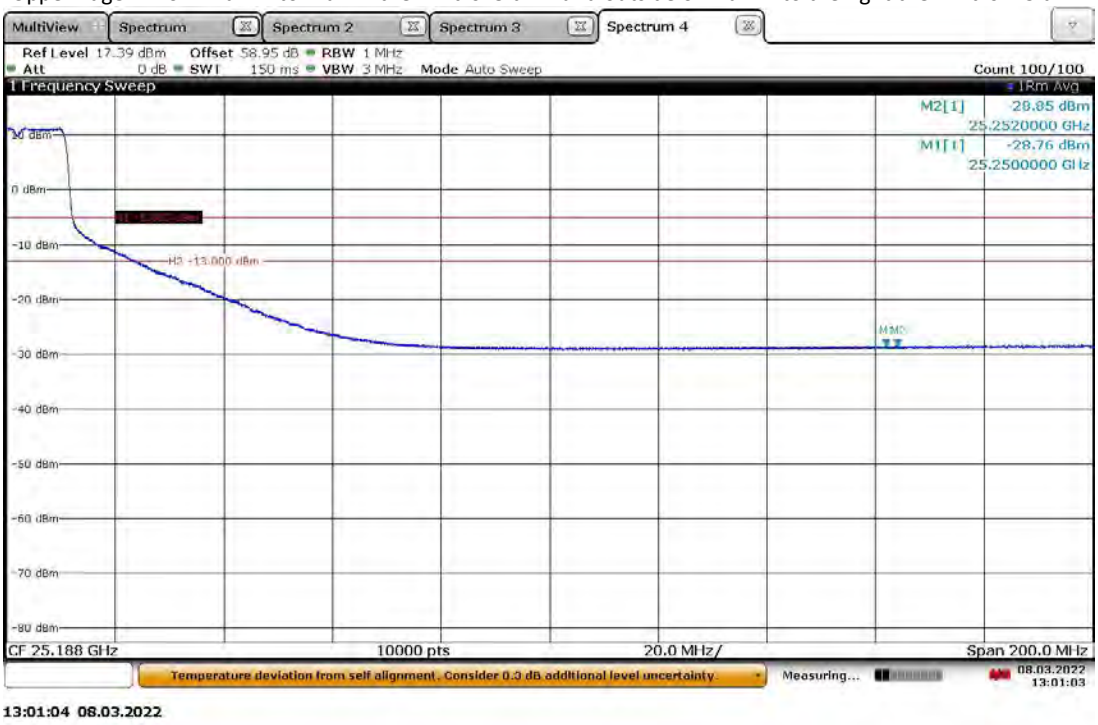
Authorized Band 24.25-24.45 GHz, Emission Mask (H) – Model Titan 24-360_High Ch 24.29GHz_BW20M_MCS0_Path 1_att6.5
Upper Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 2 to the right the limit is -13 dBm



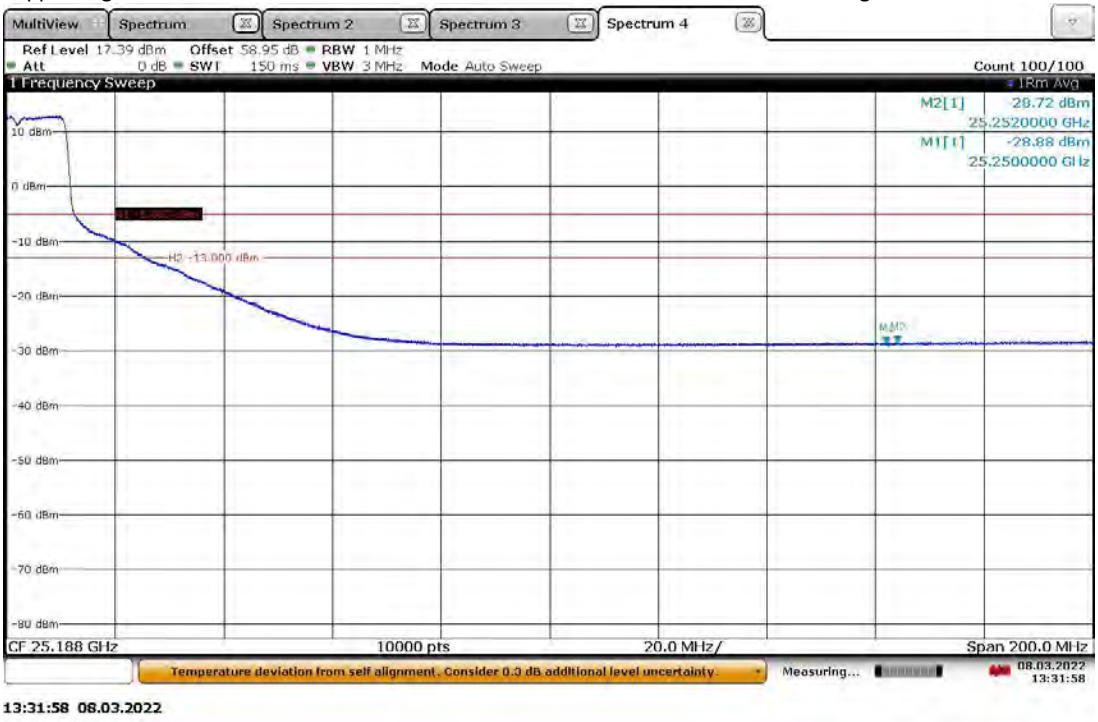
Authorized Band 24.75-25.25 GHz, Emission Mask (V) – Model Titan 24-360_24.77GHz_BW20M_MCS8_Path 1_att12.5
Lower Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 1 to the left the limit is -13 dBm

Authorized Band 24.75-25.25 GHz, Emission Mask (H) – Model Titan 24-360_Low Ch 24.77GHz_BW20M_MCS8_Path 1_att12.5
Lower Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 1 to the left the limit is -13 dBm

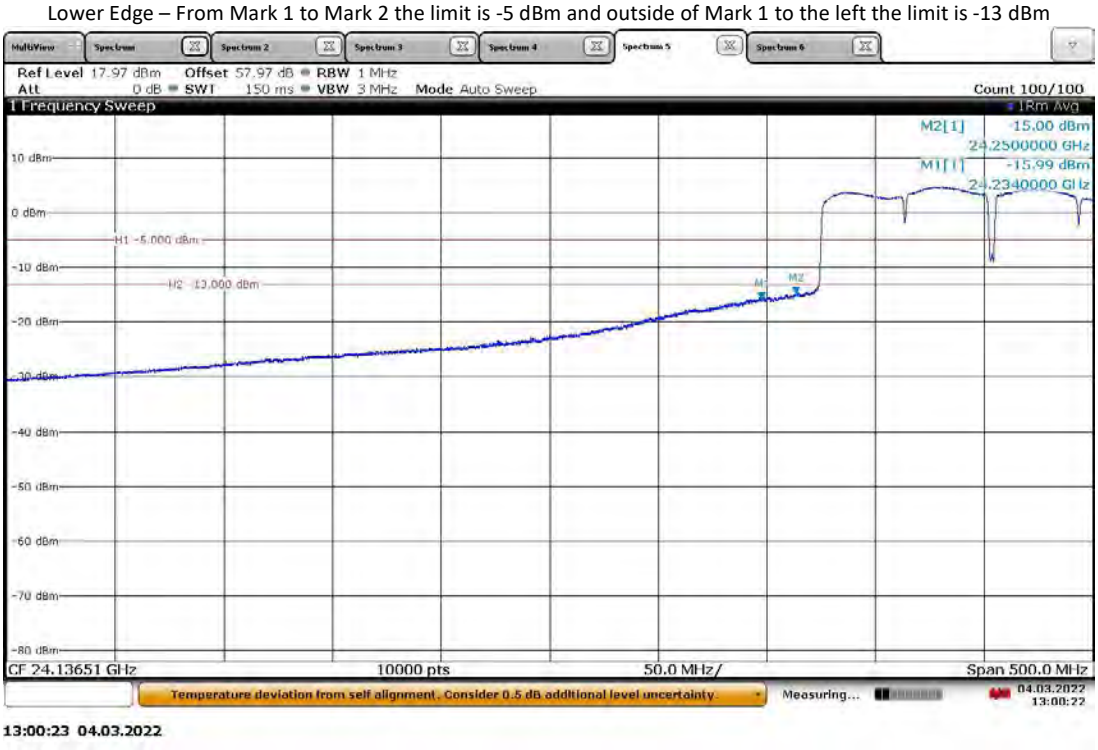
Authorized Band 24.75-25.25 GHz, Emission Mask (V) – Model Titan 24-360_High Ch 25.09GHz_BW20M_MCS8_Path 1_att6.0
Upper Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 2 to the right the limit is -13 dBm



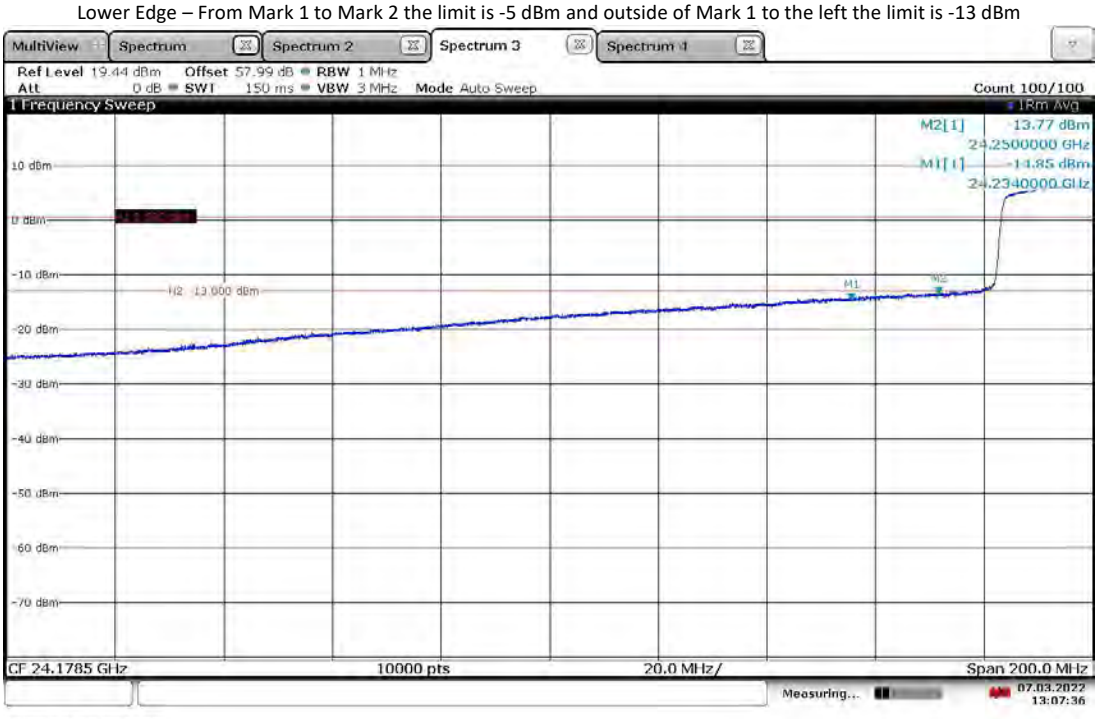
Authorized Band 24.75-25.25 GHz, Emission Mask (H) – Model Titan 24-360_25.09GHz_BW20M_MCS8_Path 1_att5.0
Upper Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 2 to the right the limit is -13 dBm



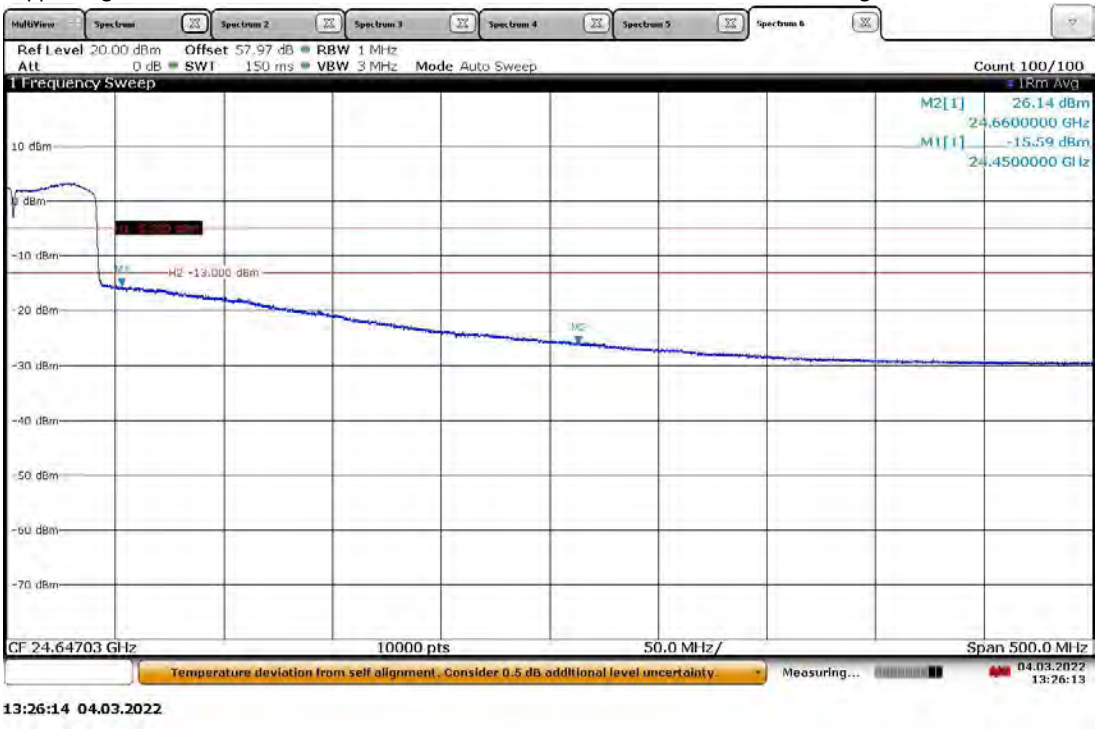
Authorized Band 24.25-24.45 GHz, Emission Mask (V) – Model Titan 24-360_Low Ch 24.34 GHz_BW160M_MCS0_Path 1_att10.5
Lower Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 1 to the left the limit is -13 dBm



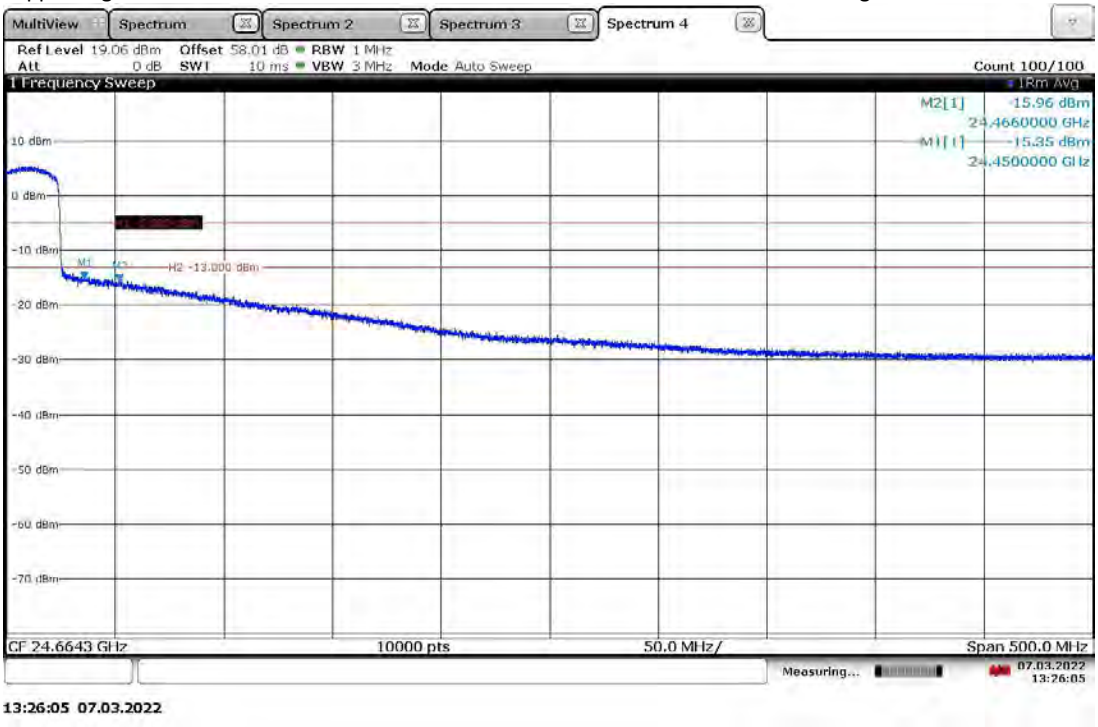
Authorized Band 24.25-24.45 GHz, Emission Mask (H) – Model Titan 24-360_Low Ch 24.34GHz_BW160M_MCS0_Path 1_att8.5
Lower Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 1 to the left the limit is -13 dBm



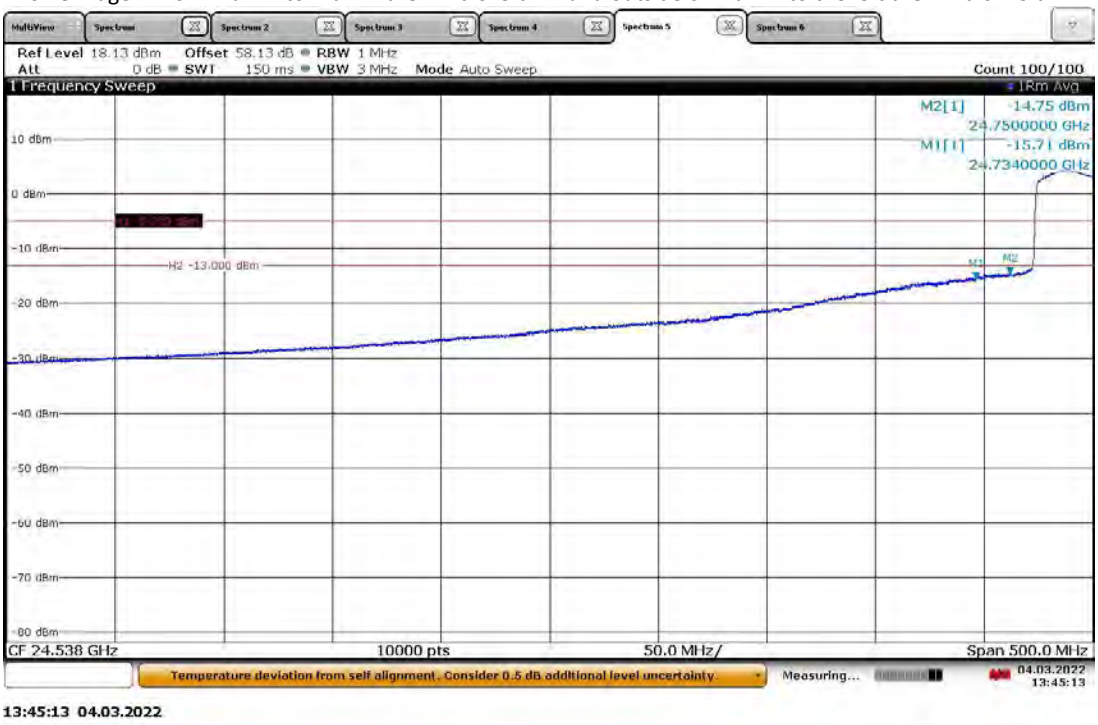
Authorized Band 24.25-24.45 GHz, Emission Mask (V) – Model Titan 24-360_24.36GHz_BW160M_MCS0_Path 1_att8.0
Upper Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 2 to the right the limit is -13 dBm



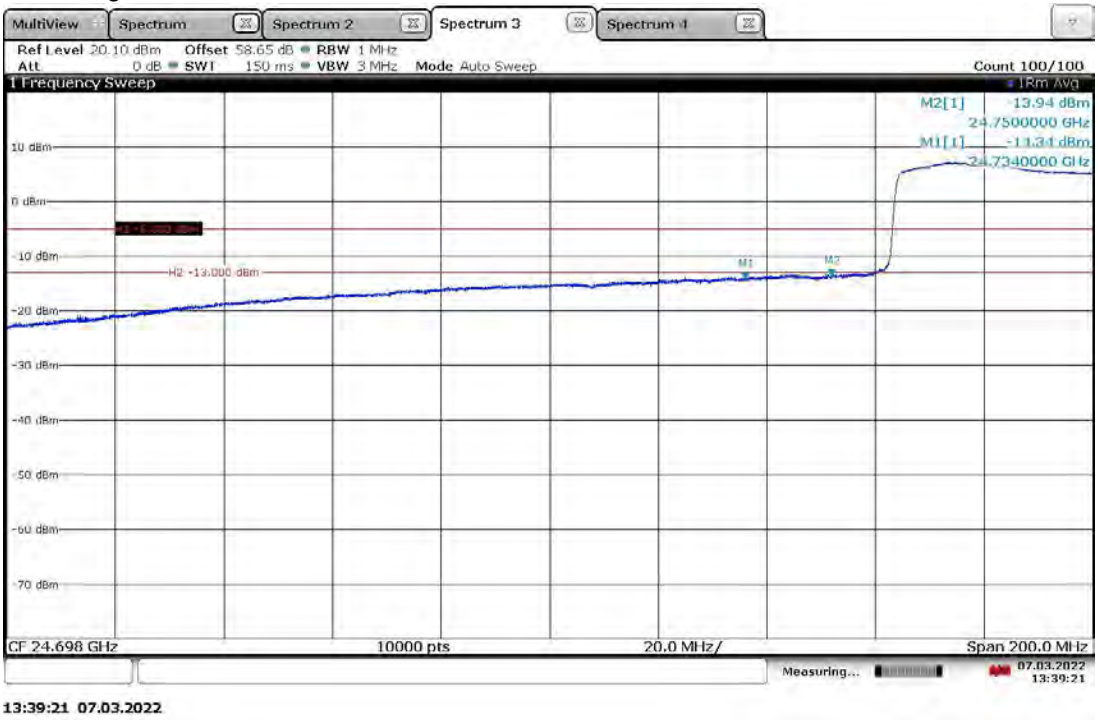
Authorized Band 24.25-24.45 GHz, Emission Mask (H) – Model Titan 24-360_High Ch 24.36 GHz_BW160M_MCS0_Path 1_att8.0
Upper Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 2 to the right the limit is -13 dBm



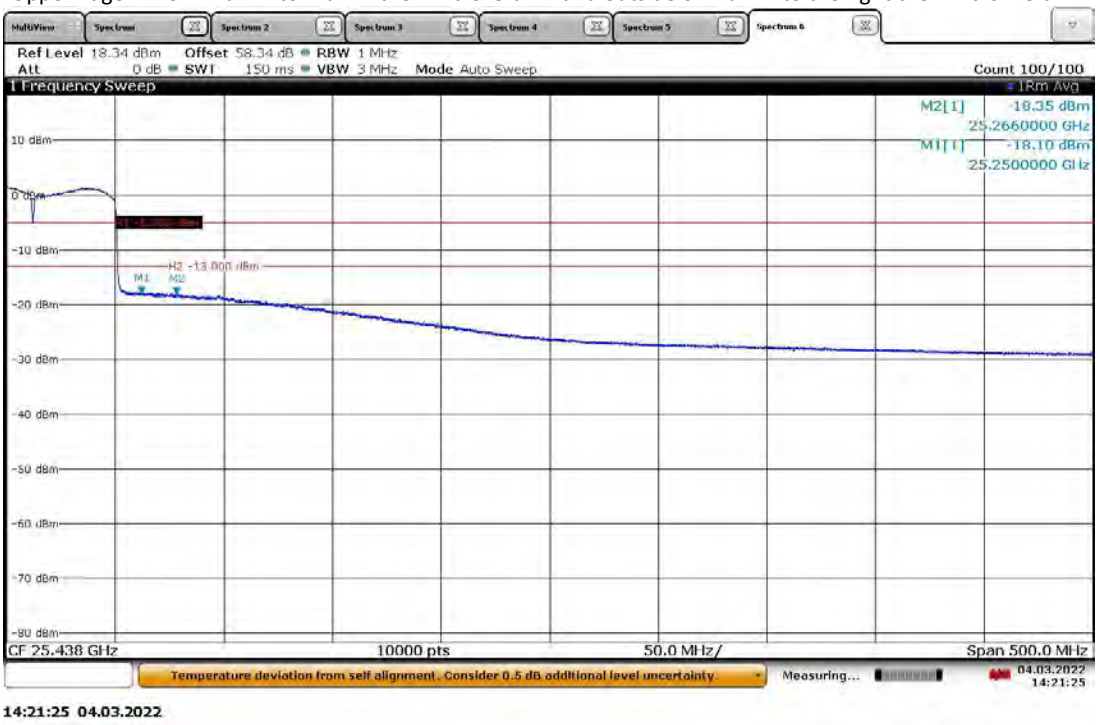
Authorized Band 24.75-25.25 GHz, Emission Mask (V) – Model Titan 24-360_Low Ch 24.84GHz_BW160M_MCS0_Path 1_att10
Lower Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 1 to the left the limit is -13 dBm



Authorized Band 24.75-25.25 GHz, Emission Mask (H) – Model Titan 24-360_Low Ch 24.84GHz_BW160M_MCS8_Path 1_att10.0
Lower Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 1 to the left the limit is -13 dBm

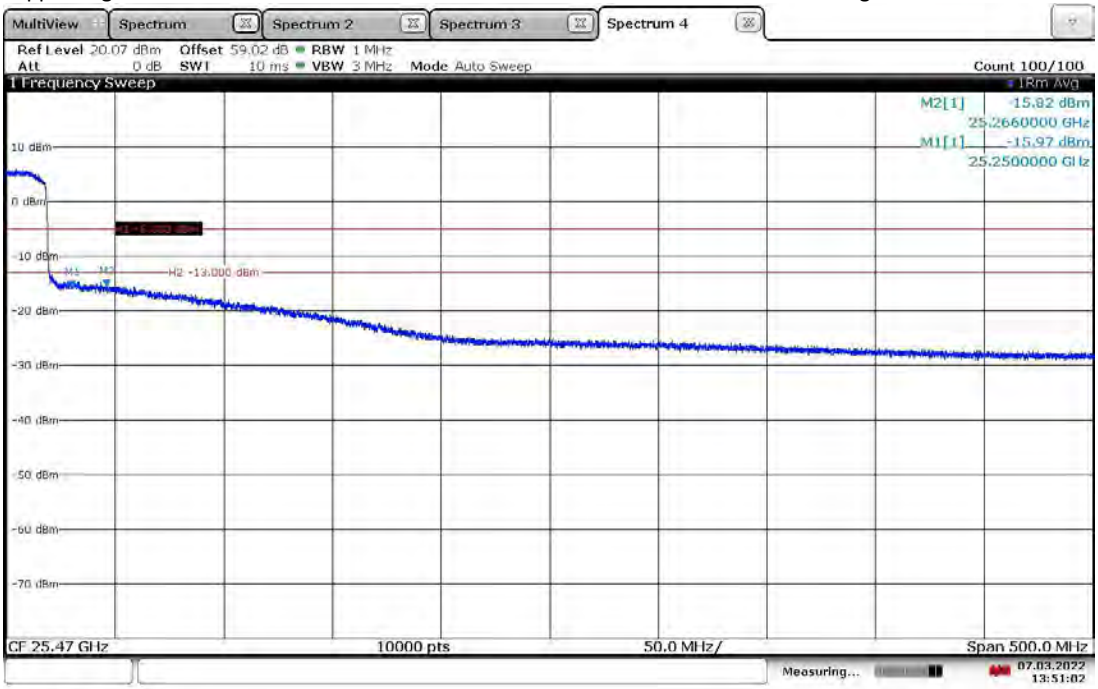


Authorized Band 24.75-25.25 GHz, Emission Mask (V) – Model Titan 24-360_High Ch 25.16 GHz_BW160M_MCS0_Path 1_att10
Upper Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 2 to the right the limit is -13 dBm



14:21:25 04.03.2022

Authorized Band 24.75-25.25 GHz, Emission Mask (H) – Model Titan 24-360_High Ch 25.16 GHz_BW160M_MCS8_Path 1_att12
Upper Edge – From Mark 1 to Mark 2 the limit is -5 dBm and outside of Mark 2 to the right the limit is -13 dBm



13:51:03 07.03.2022

Test Personnel:	Kouma Sinn KPS	Test Date:	03/04/2022, 03/07/2022, 03/08/2022
Supervising/Reviewing Engineer: (Where Applicable)	Vathana F. Ven VFV		
Product Standard:	FCC 47CFR Part 30 Subpart C	Limit Applied:	See Report Section 7.3
Input Voltage:	48 VDC Via External P/S	Ambient Temperature:	25, 23, 23 ºC
Pretest Verification w/ BB Source:	**Yes**	Relative Humidity:	10, 30, 25 %
		Atmospheric Pressure:	1022, 1002, 1006 mbars

Deviations, Additions, or Exclusions: None

8 Radiated Spurious Emissions

8.1 Method

Tests are performed in accordance with FCC 47CFR Part 30 Subpart C, KDB 842590 D01 Upper Microwave Flexible Use Service v01r02 April 20, 2021 Subclause 4.4.3. From 9kHz-1000 MHz testing was performed manually and from 1-13 GHz the measurements were made using the BAT-EMC automated software. From 13-100 GHz measurement was made manually at 3 meters with test antenna and EUT fixed at 1.5 meters high. The EUT was rotated from 0 to 360 degrees to find the worst-case emissions.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)
Radiated Emissions, 10m	30-1000 MHz	5.0 dB
Radiated Emissions, 3m	30-1000 MHz	4.6 dB
Radiated Emissions, 3m	1-6 GHz	4.9 dB
Radiated Emissions, 3m	6-15 GHz	5.1 dB
Radiated Emissions, 3m	15-18 GHz	4.7 dB
Radiated Emissions, 3m	18-40 GHz	4.7 dB

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG

Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/20/2021	03/20/2022
145109'	DC Block	Coaxial Components	5985-9	none	VBU	Verified
PRE11'	50dB gain pre-amp	Pasternack	PRE11	PRE11	09/02/2021	09/02/2022
145108'	EMI Test Receiver (20Hz - 40GHz)	Rohde & Schwarz	ESIB40	100209	06/22/2021	06/22/2022
HS002'	DC-18GHz cable 1.5M long	Huber & Suhner	SucoFlex 106A	HS002	12/06/2021	12/06/2022
145-406'	10m Track A In-floor Cable #1	Huber + Suhner	sucoflex 160-19220mm	001	07/22/2021	07/22/2022
IW001'	2 meter cable	Insulated Wire	2801-NPS	001	09/23/2021	09/23/2022
IW006'	DC-18GHz cable 8.4m long	Insulated Wire	2800-NPS	IW006	07/22/2021	07/22/2022
IW003'	8.4 meter cable	Insulated Wire	2800-NPS	003	10/15/2021	10/15/2022
PRE12'	Pre-amplifier	Com Power	PAM-118A	18040117	12/06/2021	12/06/2022
ETS002'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143260	08/24/2021	08/24/2022
145-414'	Cables 145-400 145-403 145-405 145-409	Huber + Suhner	3m Track A cables	multiple	07/09/2021	07/09/2022
IW002'	2 meter Armored cable	Insulated Wire	2800-NPS	002	09/23/2021	09/23/2022
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	02/22/2022	02/22/2023
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	11/02/2021	11/02/2022
CBLHF2012-5M-2'	5m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252676002	02/16/2022	02/16/2023
ETS003	9kHz-30MHz Active Loop Antenna	ETS Lindgren	6502	00143396	08/26/2021	08/26/2022
---	40-60 GHz Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	VDIWR19.0SAX-F	SAX835	03/31/2021	03/31/2023
---	60-90 GHz Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	VDIWR12.0SAX-F	SAX836	04/12/2021	04/12/2023
---	90-140 GHz Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	VDIWR8.0SAX-F	SAX837	06/11/2021	06/11/2023
---	140-220 GHz Spectrum Analyzer Extension Module	Virginia Diodes, Inc.	VDIWR5.1SAX-F	SAX838	05/11/2021	05/11/2023

Software Utilized:

Name	Manufacturer	Version
BAT-EMC	Nexio	3.18.0.16
EMI Boxborough.xls	Intertek	08/27/2010

8.3 Results:

The sample tested was found to Comply.

Limit – FCC 47CFR Part 30 Subpart C, Section 30.203 (a) (b):

(a) The conductive power or the total radiated power of any emission outside a licensee's frequency block shall be −13 dBm/MHz or lower. However, in the bands immediately outside and adjacent to the licensee's frequency block, having a bandwidth equal to 10 percent of the channel bandwidth, the conductive power or the total radiated power of any emission shall be −5 dBm/MHz or lower.

(b)

(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater.

(2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges as the design permits.

(3) The measurements of emission power can be expressed in peak or average values.

8.4 Setup Photographs:

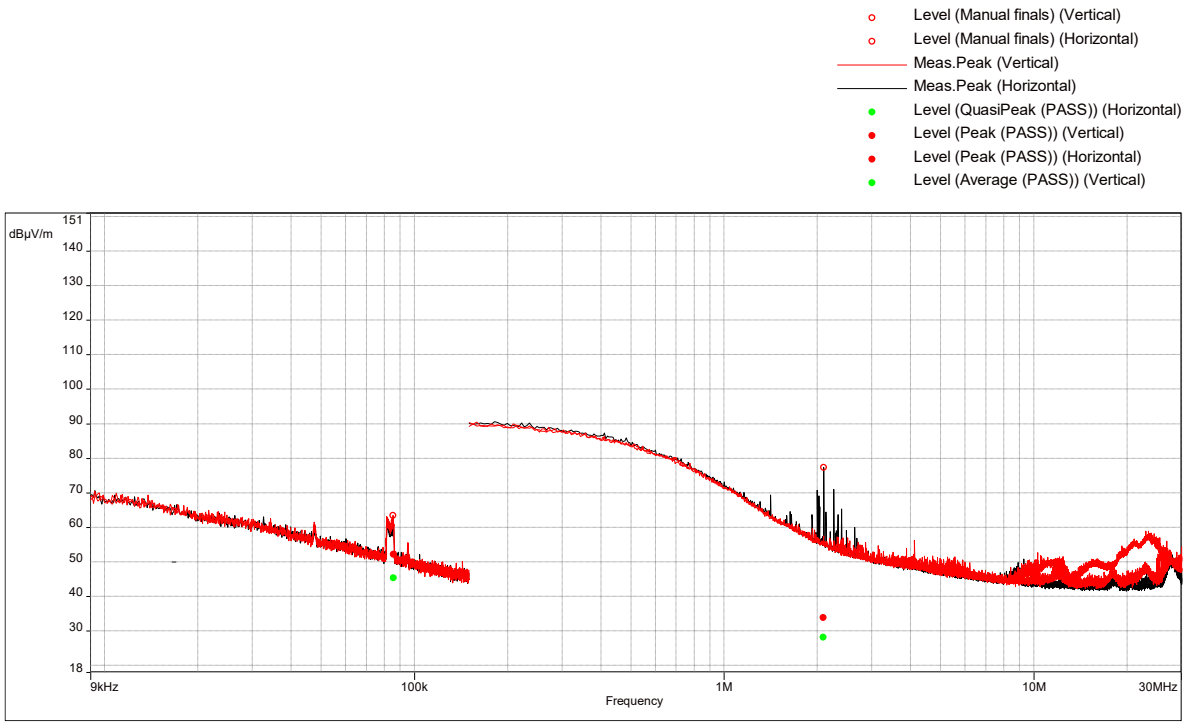
Setup Photographs are included in a separate file.

8.5 Plots/Data:

Test Information:

Date and Time	3/14/2022 11:44:59 AM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	24 C
Humidity	13 %
Atmospheric Pressure	1016 mbar
Comments	Scan 13: Low 24.34 GHz (Worst-case output power, 39_65 dBm), 160 MHz, MCS0, Att8_5, RE 9kHz-30MHz Loop antenna, Electric Field, 3m

Graph:

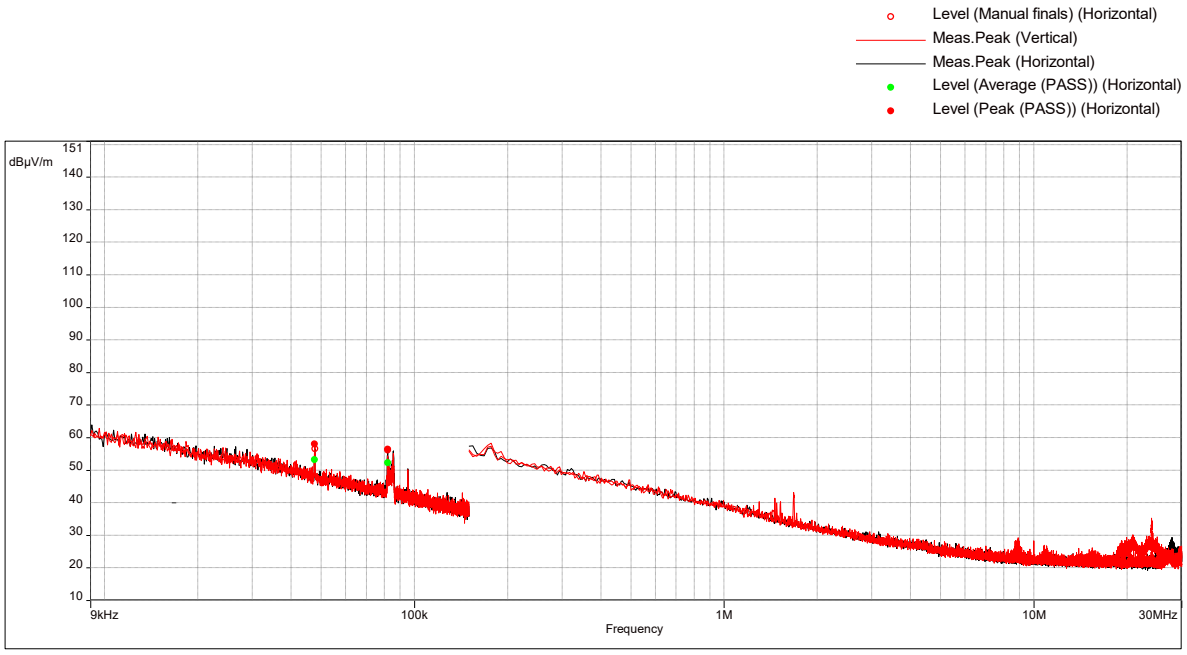


Results: Pre-scan was performed with a lower resolution bandwidth, the device was turned on and off for verification of real signals. No emissions from the EUT were detected. The signals on the plot were part of the ambient.

Test Information:

Date and Time	3/14/2022 1:40:45 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	24C
Humidity	13%
Atmospheric Pressure	1016mbar
Comments	Scan 14: Low 24.84 GHz (Worst-case output power, 39_7dBm), 160 MHz, MCS0, Att8_5, RE 9kHz-30MHz Loop antenna, Electric Field, 3m

Graph:



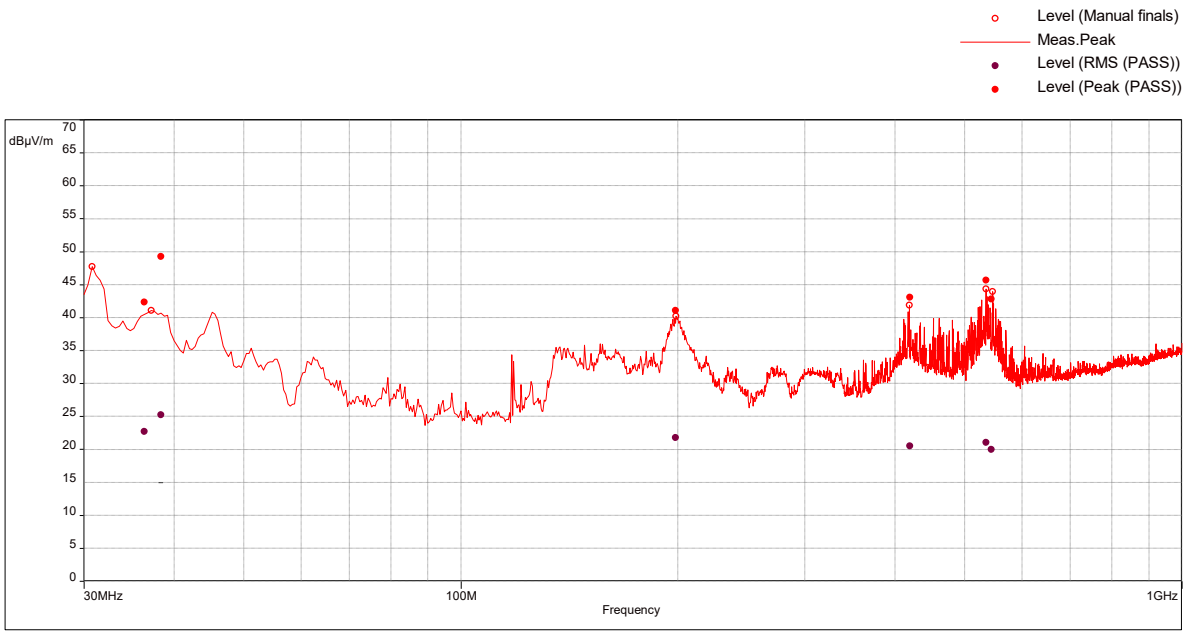
Results: Pre-scan was performed with a lower resolution bandwidth, the device was turned on and off for verification of real signals. No emissions from the EUT were detected. The signals on the plot were part of the ambient.

Low Channel 24.34 GHz (Worst-case output power, 39.65 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att8.5, RE 30-1000MHz

Test Information:

Date and Time	3/9/2022 11:23:47 AM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 4: Low Channel 24.34 GHz (Worst-case output power, 39.65 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att8.5, RE 30-1000MHz SA mode

Graph:



Results:

EIRP Peak (PASS) (6)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
36.44736842	42.31	-42.49	-13	-29.49	4.00	3.35	Vertical	1000000.00	-16.88
38.51578947	49.24	-35.56	-13	-22.56	3.00	3.18	Vertical	1000000.00	-18.20
198.5368421	41.05	-43.75	-13	-30.75	0.00	1.00	Vertical	1000000.00	-19.55
419.5894737	43.06	-41.74	-13	-28.74	39.00	1.63	Vertical	1000000.00	-14.95
534.8	45.62	-39.18	-13	-26.18	323.00	1.69	Vertical	1000000.00	-12.67
544.1684211	42.78	-42.02	-13	-29.02	314.00	3.99	Vertical	1000000.00	-12.50

RMS (PASS) (6)

Frequency (MHz)	SR	Level (dBµV/m)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
36.44736842	1	22.69	4.00	3.35	Vertical	1000000.00	-16.88
38.51578947	1	25.22	3.00	3.18	Vertical	1000000.00	-18.20
198.5368421	1	21.75	0.00	1.00	Vertical	1000000.00	-19.55
419.5894737	1	20.52	39.00	1.63	Vertical	1000000.00	-14.95
534.8	1	21.03	323.00	1.69	Vertical	1000000.00	-12.67
544.1684211	1	19.99	314.00	3.99	Vertical	1000000.00	-12.50

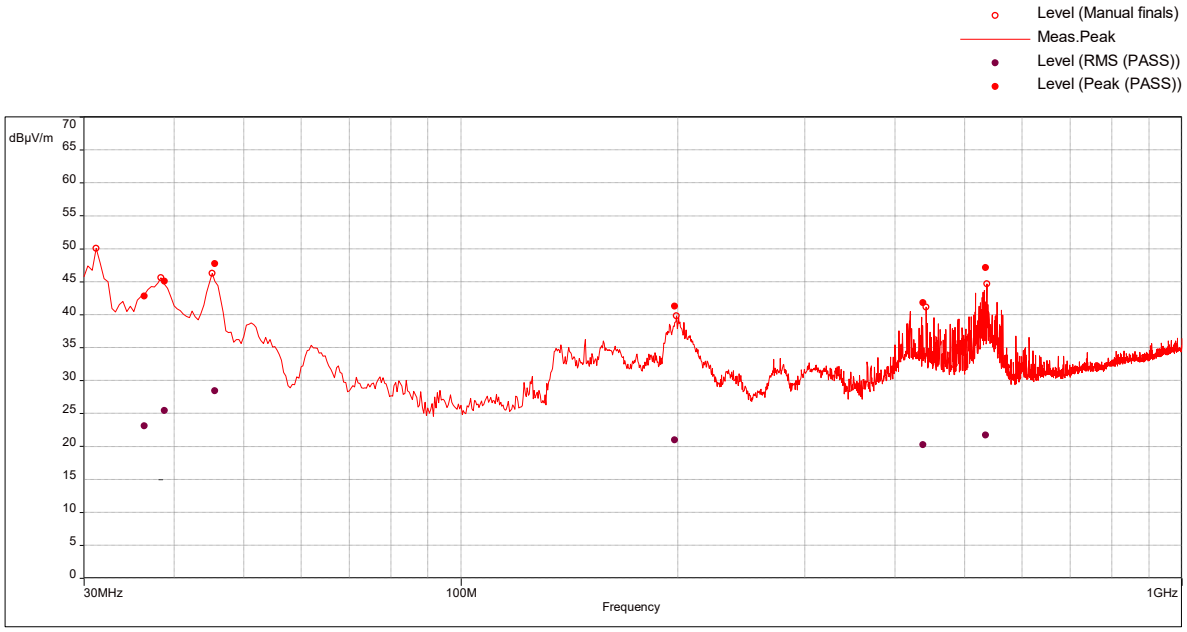
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Mid Channel 24.35 GHz (Worst-case output power, 39.48 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att9, RE 30-1000MHz

Test Information:

Date and Time	3/9/2022 10:17:59 AM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 2: Mid Channel 24.35 GHz (Worst-case output power, 39.48 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att9, RE 30-1000MHz SA mode

Graph:



Results:

EIRP Peak (PASS) (6)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
36.44736842	42.78	-42.02	-13	-29.02	0.00	3.68	Vertical	1000000.00	-16.88
38.92631579	45.07	-39.73	-13	-26.73	32.00	2.45	Vertical	1000000.00	-18.49
45.46315789	47.69	-37.11	-13	-24.11	227.00	2.41	Vertical	1000000.00	-23.10
198.1473684	41.27	-43.53	-13	-30.53	359.00	1.34	Vertical	1000000.00	-19.63
437.7894737	41.80	-43	-13	-30	338.00	1.69	Vertical	1000000.00	-14.57
534.5578947	47.09	-37.71	-13	-24.71	301.00	1.63	Vertical	1000000.00	-12.67

RMS (PASS) (6)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
36.44736842	23.13	0.00	3.68	Vertical	1000000.00	-16.88
38.92631579	25.41	32.00	2.45	Vertical	1000000.00	-18.49
45.46315789	28.39	227.00	2.41	Vertical	1000000.00	-23.10
198.1473684	20.95	359.00	1.34	Vertical	1000000.00	-19.63
437.7894737	20.21	338.00	1.69	Vertical	1000000.00	-14.57
534.5578947	21.70	301.00	1.63	Vertical	1000000.00	-12.67

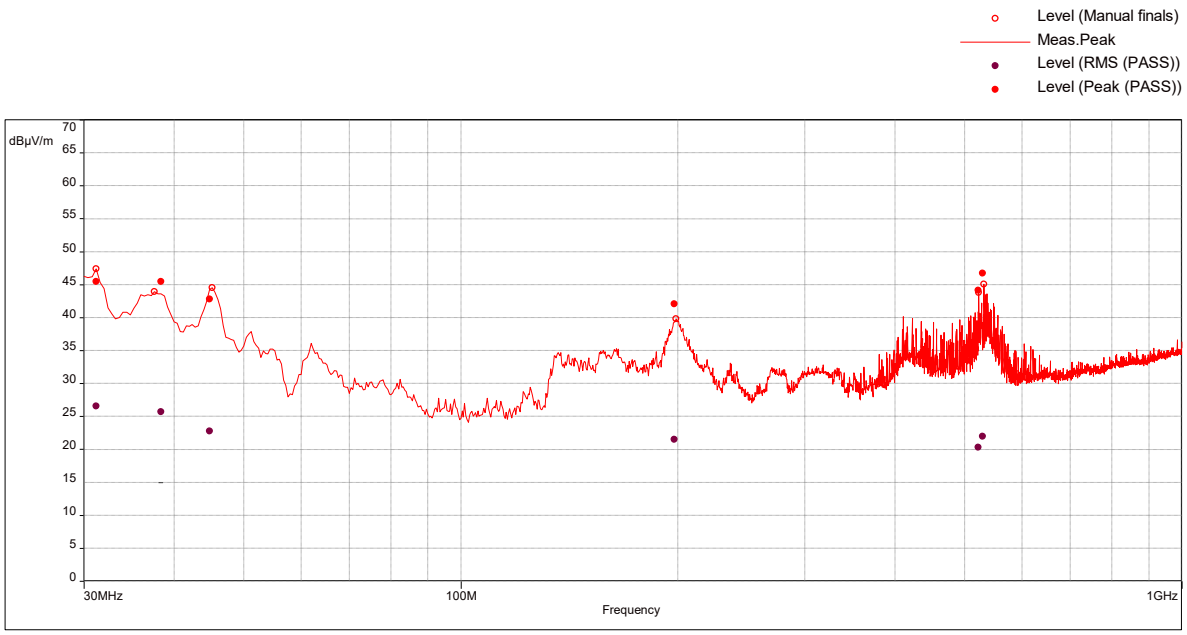
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

High Channel 24.36 GHz (Worst-case output power, 39.2 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att8.0, RE 30-1000MHz

Test Information:

Date and Time	3/9/2022 11:58:07 AM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 5: High 24.36 GHz (Worst-case output power, 39.2 dBm), 160 MHz, MCS0, Att8.0, RE 30-1000MHz SA mode

Graph:



Results:

EIRP Peak (PASS) (6)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
31.31578947	45.48	-39.32	-13	-26.32	302.00	1.00	Vertical	1000000.00	-13.49
38.38947368	45.44	-39.36	-13	-26.36	24.00	1.00	Vertical	1000000.00	-18.12
44.93684211	42.81	-41.99	-13	-28.99	68.00	1.96	Vertical	1000000.00	-22.75
197.7473684	42.08	-42.72	-13	-29.72	357.00	1.00	Vertical	1000000.00	-19.72
522.0105263	44.14	-40.66	-13	-27.66	315.00	1.86	Vertical	1000000.00	-12.93
529.2315789	46.70	-38.1	-13	-25.1	300.00	1.00	Vertical	1000000.00	-12.78

RMS (PASS) (6)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
31.31578947	26.54	302.00	1.00	Vertical	1000000.00	-13.49
38.38947368	25.72	24.00	1.00	Vertical	1000000.00	-18.12
44.93684211	22.78	68.00	1.96	Vertical	1000000.00	-22.75
197.7473684	21.48	357.00	1.00	Vertical	1000000.00	-19.72
522.0105263	20.28	315.00	1.86	Vertical	1000000.00	-12.93
529.2315789	21.97	300.00	1.00	Vertical	1000000.00	-12.78

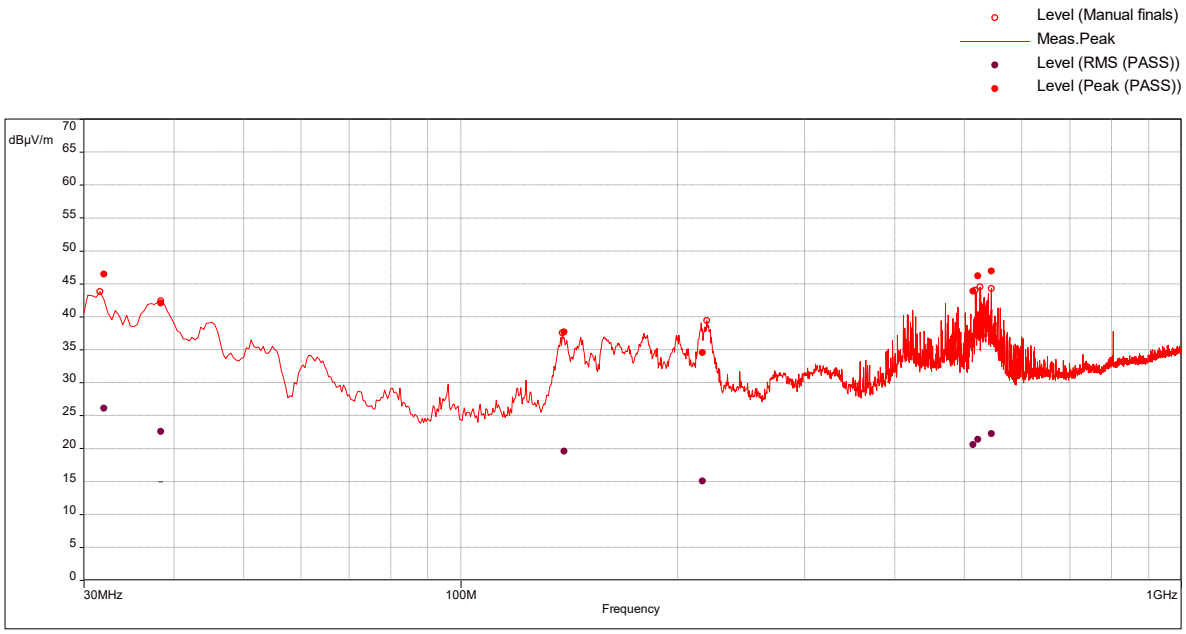
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Low Channel 24.84 GHz (Worst-case output power, 39.7 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att10, RE 30-1000MHz

Test Information:

Date and Time	3/9/2022 9:04:30 AM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 1: Low Channel 24.84 GHz (Worst-case output power, 39.7 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att10, RE 30-1000MHz SA mode

Graph:



Results:

EIRP Peak (PASS) (7)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
31.84210526	46.45	-38.35	-13	-25.35	321.00	1.00	Vertical	1000000.00	-13.85
38.4	42.03	-42.77	-13	-29.77	31.00	2.63	Vertical	1000000.00	-18.12
139.1894737	37.67	-47.13	-13	-34.13	0.00	1.00	Vertical	1000000.00	-19.26
216.4421053	34.56	-50.24	-13	-37.24	0.00	3.75	Vertical	1000000.00	-21.38
514.1789474	43.87	-40.93	-13	-27.93	292.00	1.00	Vertical	1000000.00	-13.06
521.7789474	46.17	-38.63	-13	-25.63	301.00	1.40	Vertical	1000000.00	-12.93
545.0631579	46.89	-37.91	-13	-24.91	322.00	1.00	Vertical	1000000.00	-12.50

RMS (PASS) (7)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
31.84210526	26.10	321.00	1.00	Vertical	1000000.00	-13.85
38.4	22.54	31.00	2.63	Vertical	1000000.00	-18.12
139.1894737	19.57	0.00	1.00	Vertical	1000000.00	-19.26
216.4421053	15.05	0.00	3.75	Vertical	1000000.00	-21.38
514.1789474	20.56	292.00	1.00	Vertical	1000000.00	-13.06
521.7789474	21.35	301.00	1.40	Vertical	1000000.00	-12.93
545.0631579	22.22	322.00	1.00	Vertical	1000000.00	-12.50

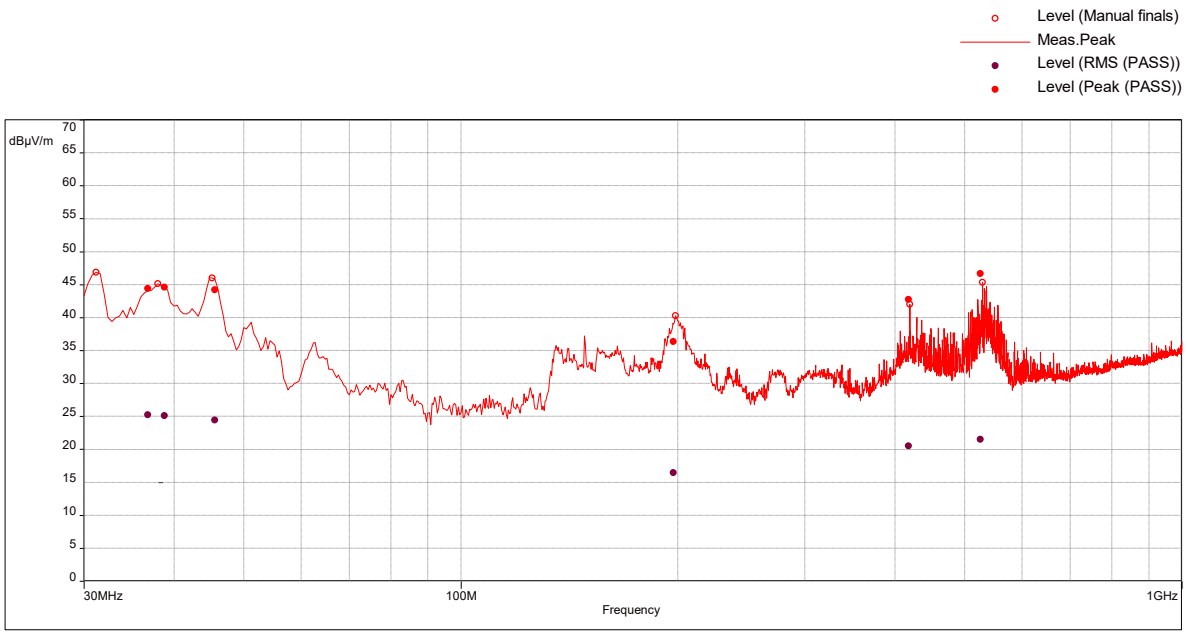
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Mid Channel 25.04 GHz (Worst-case output power, 39.19 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att10, RE 30-1000MHz

Test Information:

Date and Time	3/9/2022 12:30:47 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 6: Mid Channel 25.04 GHz (Worst-case output power, 39.19 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att10, RE 30-1000MHz SA mode

Graph:



Results:

EIRP Peak (PASS) (6)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
36.97368421	44.40	-40.4	-13	-27.4	10.00	1.00	Vertical	1000000.00	-17.25
38.78947368	44.58	-40.22	-13	-27.22	31.00	1.00	Vertical	1000000.00	-18.39
45.46315789	44.21	-40.59	-13	-27.59	243.00	2.62	Vertical	1000000.00	-23.10
197.0842105	36.37	-48.43	-13	-35.43	1.00	3.69	Vertical	1000000.00	-19.85
418.0210526	42.73	-42.07	-13	-29.07	40.00	1.51	Vertical	1000000.00	-15.02
525.5157895	46.65	-38.15	-13	-25.15	293.00	1.00	Vertical	1000000.00	-12.82

RMS (PASS) (6)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
36.97368421	25.24	10.00	1.00	Vertical	1000000.00	-17.25
38.78947368	25.11	31.00	1.00	Vertical	1000000.00	-18.39
45.46315789	24.44	243.00	2.62	Vertical	1000000.00	-23.10
197.0842105	16.42	1.00	3.69	Vertical	1000000.00	-19.85
418.0210526	20.47	40.00	1.51	Vertical	1000000.00	-15.02
525.5157895	21.47	293.00	1.00	Vertical	1000000.00	-12.82

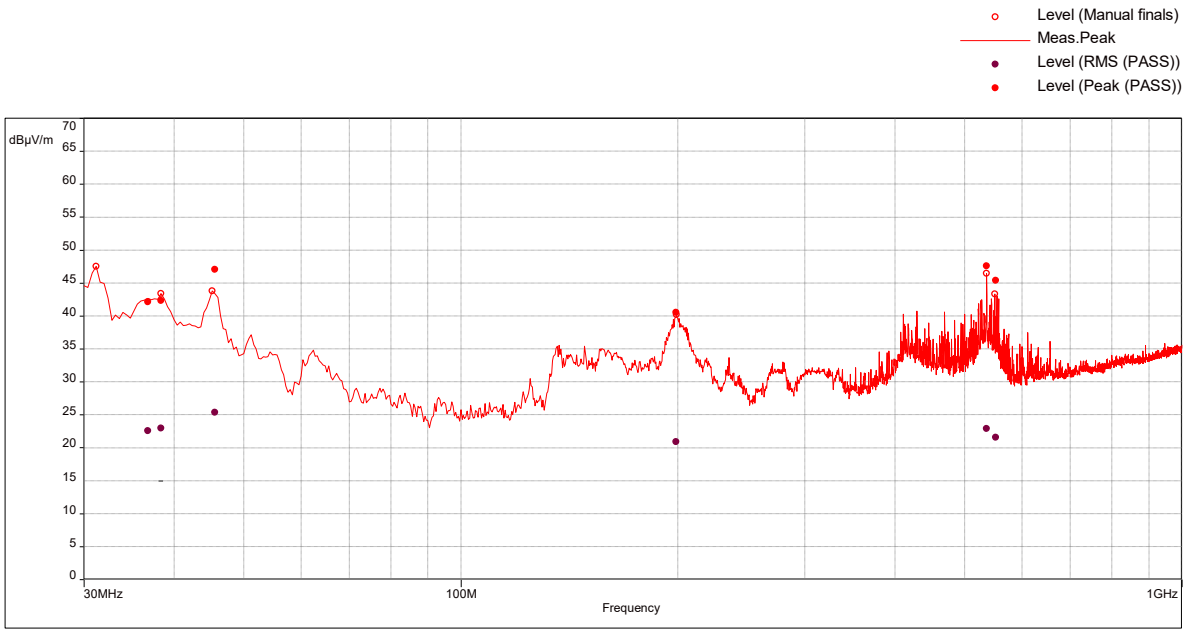
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

High Channel 25.16 GHz (Worst-case output power, 39.26 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att9, RE 30-1000MHz

Test Information:

Date and Time	3/9/2022 10:49:50 AM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 3: High Channel 25.16 GHz (Worst-case output power, 39.26 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att9, RE 30-1000MHz SA mode

Graph:



Results:

EIRP Peak (PASS) (6)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
36.71052632	42.13	-42.67	-13	-29.67	351.00	3.98	Vertical	1000000.00	-17.07
38.4	42.33	-42.47	-13	-29.47	24.00	1.58	Vertical	1000000.00	-18.12
45.46315789	47.03	-37.77	-13	-24.77	236.00	1.46	Vertical	1000000.00	-23.10
198.6736842	40.51	-44.29	-13	-31.29	0.00	1.29	Vertical	1000000.00	-19.52
535.7368421	47.57	-37.23	-13	-24.23	308.00	1.00	Vertical	1000000.00	-12.59
552.1052632	45.39	-39.41	-13	-26.41	310.00	1.00	Vertical	1000000.00	-12.35

RMS (PASS) (6)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
36.71052632	22.56	351.00	3.98	Vertical	1000000.00	-17.07
38.4	22.99	24.00	1.58	Vertical	1000000.00	-18.12
45.46315789	25.35	236.00	1.46	Vertical	1000000.00	-23.10
198.6736842	20.88	0.00	1.29	Vertical	1000000.00	-19.52
535.7368421	22.91	308.00	1.00	Vertical	1000000.00	-12.59
552.1052632	21.53	310.00	1.00	Vertical	1000000.00	-12.35

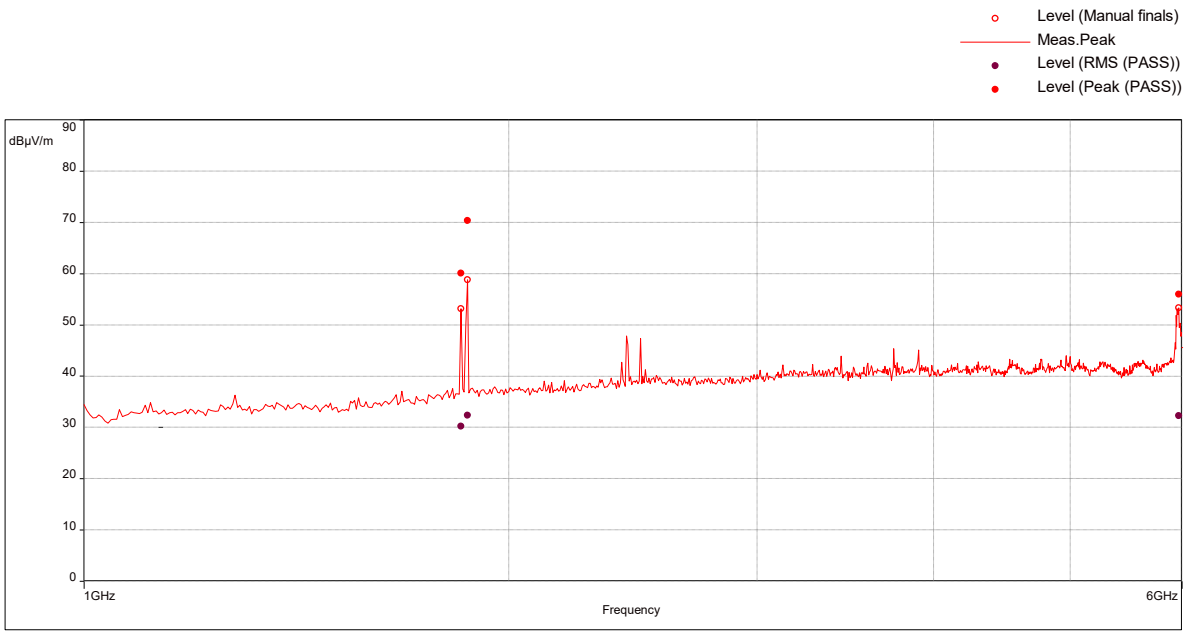
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Low Channel 24.34 GHz (Worst-case output power, 39.65 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att8.5, RE 1-6 GHz

Test Information:

Date and Time	3/9/2022 2:43:55 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 10: Low 24.34 GHz (Worst-case output power, 39.65 dBm), 160 MHz, MCS0, Att8.5, RE 1-6GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (3)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1851.315789	60.04	-35.16	-13	-22.16	164.00	2.75	Vertical	1000000.00	-5.03
1868.421053	70.34	-24.86	-13	-11.86	171.00	2.85	Vertical	1000000.00	-4.86
5971.578947	55.95	-39.25	-13	-26.25	54.00	1.01	Vertical	1000000.00	3.41

RMS (PASS) (3)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°) (dB)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1851.315789	30.19	164.00	2.75	Vertical	1000000.00	-5.03
1868.421053	32.38	171.00	2.85	Vertical	1000000.00	-4.86
5971.578947	32.23	54.00	1.01	Vertical	1000000.00	3.41

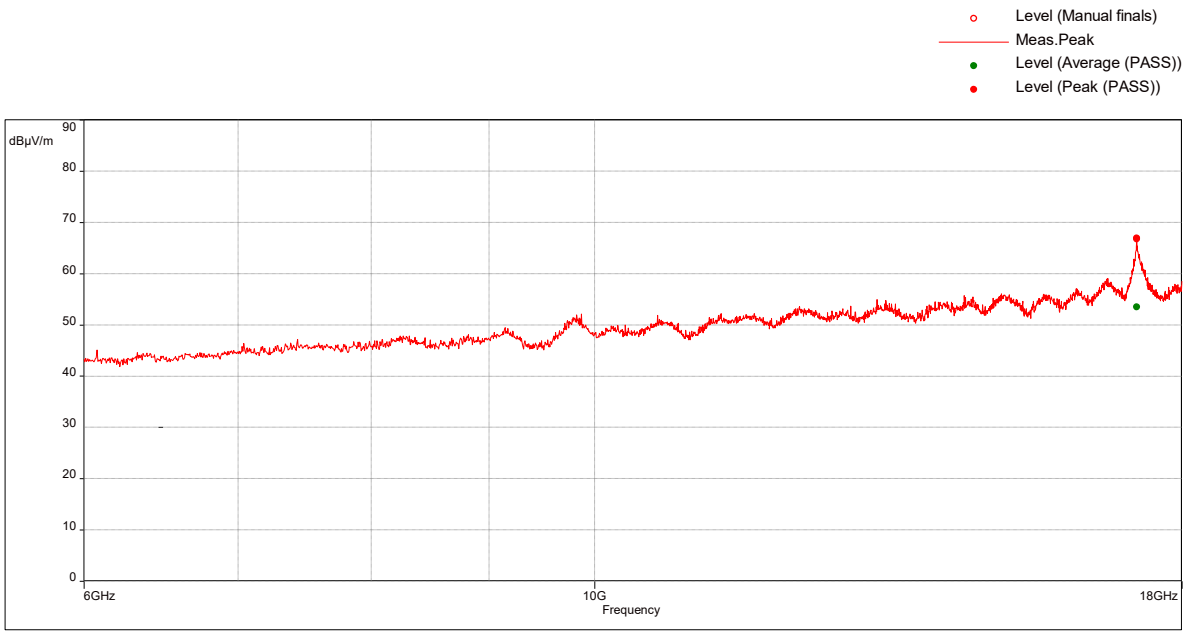
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Low Channel 24.34 GHz (Worst-case output power, 39.65 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att8.5, RE 6-18 GHz

Test Information:

Date and Time	3/14/2022 3:27:15 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	24C
Humidity	13%
Atmospheric Pressure	1016mbar
Comments	Scan 20: Low 25.34 GHz (Worst-case output power, 39_65dBm), 160 MHz, MCS0, Att8.5, ERA01, RE 6 to 18 GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (1)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
17203.94737	66.87	-28.33	-13	-15.33	337.00	3.49	Horizontal	1000000.00	31.02

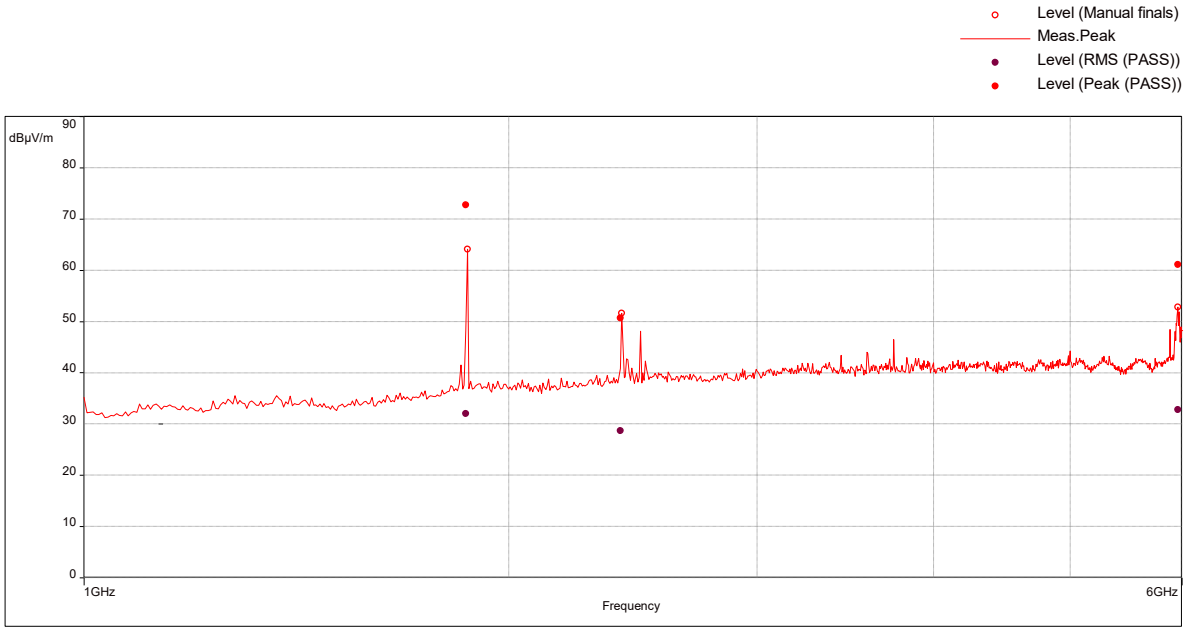
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Mid Channel 24.35 GHz (Worst-case output power, 39.48 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att9, RE 1-6 GHz

Test Information:

Date and Time	3/9/2022 3:00:22 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 11: Mid 24.35 GHz (Worst-case output power, 39.48 dBm), 160 MHz, MCS0, Att9.0,RE 1-6GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (3)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1866.578947	72.75	-22.45	-13	-9.45	329.00	2.70	Vertical	1000000.00	-4.88
2402.368421	50.64	-44.56	-13	-31.56	148.00	1.70	Vertical	1000000.00	-3.78
5957.631579	61.08	-34.12	-13	-21.12	184.00	1.25	Horizontal	1000000.00	3.38

RMS (PASS) (3)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°) (dB)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1866.578947	31.98	329.00	2.70	Vertical	1000000.00	-4.88
2402.368421	28.63	148.00	1.70	Vertical	1000000.00	-3.78
5957.631579	32.76	184.00	1.25	Horizontal	1000000.00	3.38

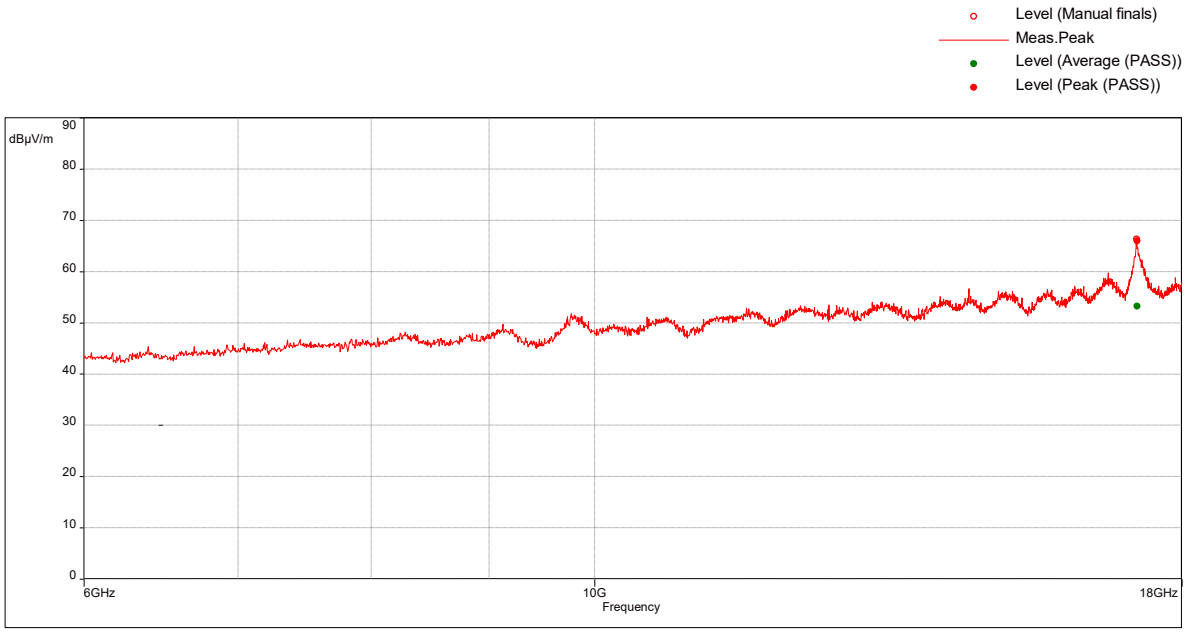
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Mid 24.35 GHz (Worst-case output power, 39.48 dBm), 160 MHz, MCS0, Att9, ERA01, RE 6 to 18 GHz

Test Information:

Date and Time	3/14/2022 3:10:06 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	24C
Humidity	13%
Atmospheric Pressure	1016mbar
Comments	Scan 19: Mid 24.35 GHz (Worst-case output power, 39_48 dBm), 160 MHz, MCS0, Att9, ERA01, RE 6 to 18 GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (1)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
17209.21053	65.96	-29.24	-13	-16.24	39.00	1.55	Horizontal	1000000.00	30.65

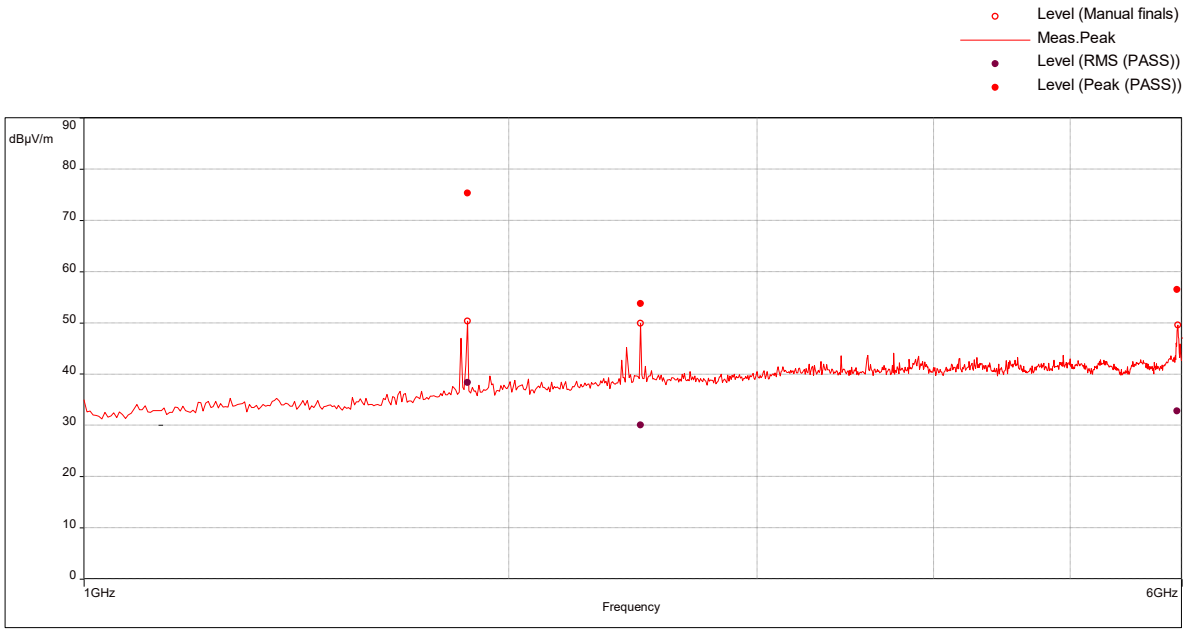
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

High Channel 24.36 GHz (Worst-case output power, 39.20 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att8, RE 1-6 GHz

Test Information:

Date and Time	3/9/2022 3:16:30 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 12: High 24.36 GHz (Worst-case output power, 39.2 dBm), 160 MHz, MCS0, Att8.0, RE 1-6GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (3)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1868.421053	75.33	-19.87	-13	-6.87	357.00	2.75	Vertical	1000000.00	-4.86
2480.263158	53.75	-41.45	-13	-28.45	112.00	3.94	Vertical	1000000.00	-3.04
5956.842105	56.49	-38.71	-13	-25.71	0.00	1.30	Vertical	1000000.00	3.37

RMS (PASS) (3)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°) (dB)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1868.421053	38.36	357.00	2.75	Vertical	1000000.00	-4.86
2480.263158	30.02	112.00	3.94	Vertical	1000000.00	-3.04
5956.842105	32.77	0.00	1.30	Vertical	1000000.00	3.37

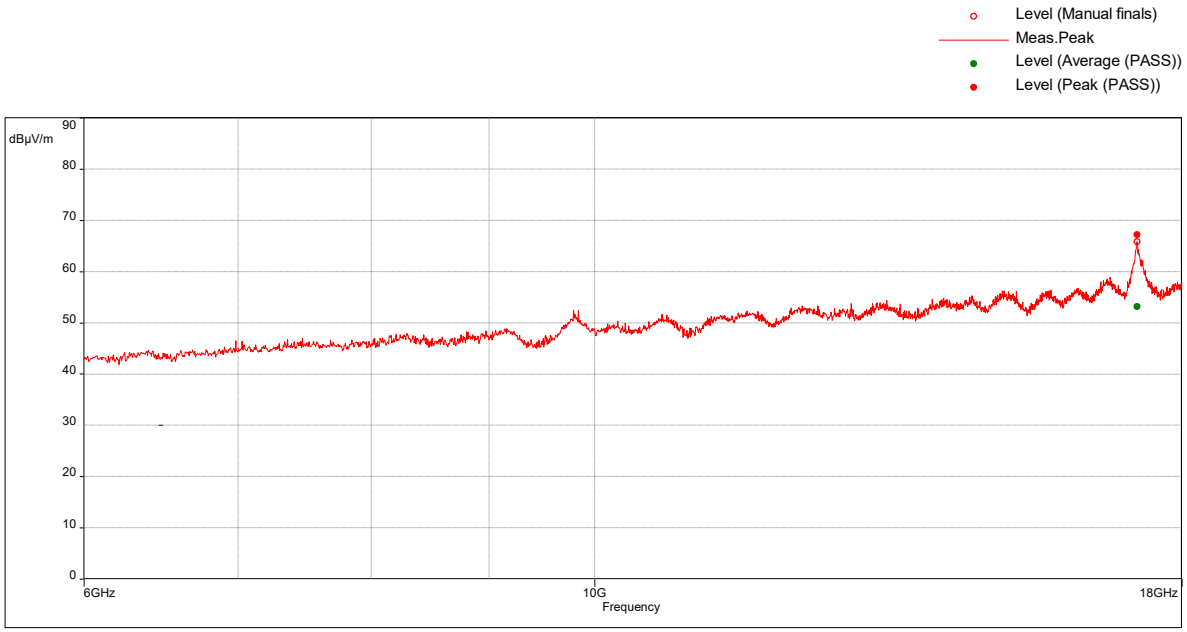
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

High Channel 24.36 GHz (Worst-case output power, 39.20 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att8, RE 6-18 GHz

Test Information:

Date and Time	3/14/2022 2:38:30 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	24C
Humidity	13%
Atmospheric Pressure	1016mbar
Comments	Scan 17: High 24.36 GHz (Worst-case output power, 39_2dBm), 160 MHz, MCS0, Att8, ERA01, RE 6 to 18 GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (1)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
17209.47368	67.15	-28.05	-13	-15.05	104.00	2.70	Horizontal	1000000.00	30.63

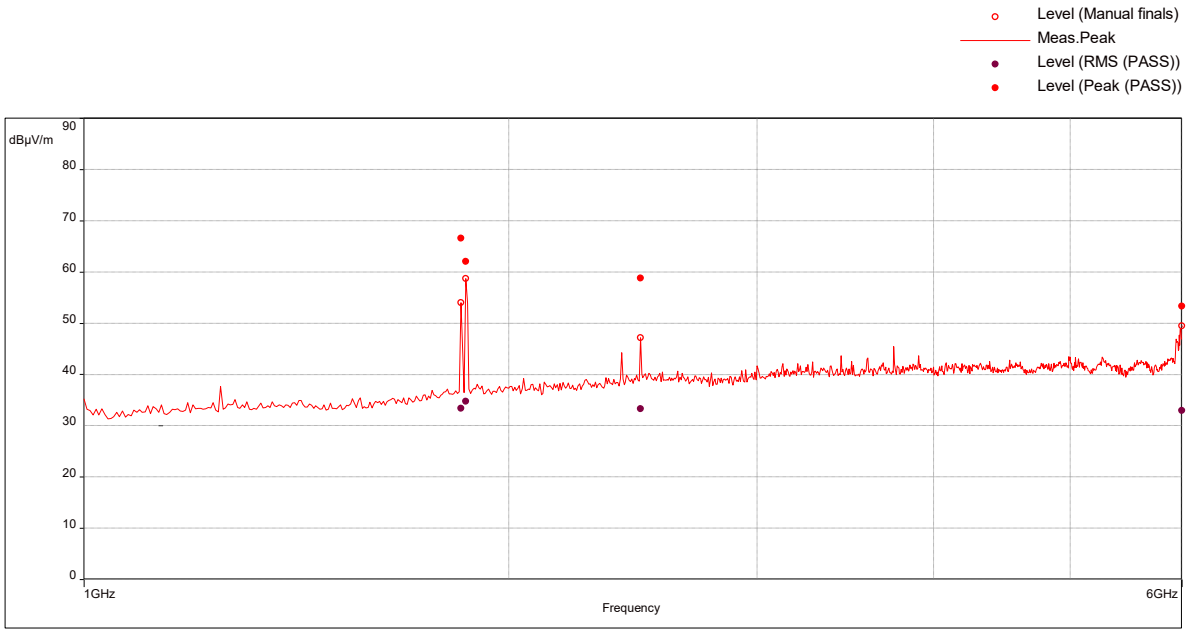
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Low Channel 24.84 GHz (Worst-case output power, 39.7 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att10, RE 1-6 GHz

Test Information:

Date and Time	3/9/2022 2:04:21 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 8: Low 24.84 GHz (Worst-case output power, 39.7 dBm), 160 MHz, MCS0, Att10, REA007, RE 1-6 GHzSA mode

Graph:



Results:

EIRP Peak (PASS) (4)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1851.052632	66.58	-28.62	-13	-15.62	344.00	3.39	Vertical	1000000.00	-5.03
1866.578947	62.01	-33.19	-13	-20.19	324.00	2.95	Horizontal	1000000.00	-4.88
2480	58.82	-36.38	-13	-23.38	110.00	1.30	Vertical	1000000.00	-3.04
5999.473684	53.35	-41.85	-13	-28.85	25.00	1.10	Vertical	1000000.00	3.49

RMS (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°) (dB)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1851.052632	33.38	344.00	3.39	Vertical	1000000.00	-5.03
1866.578947	34.74	324.00	2.95	Horizontal	1000000.00	-4.88
2480	33.27	110.00	1.30	Vertical	1000000.00	-3.04
5999.473684	32.90	25.00	1.10	Vertical	1000000.00	3.49

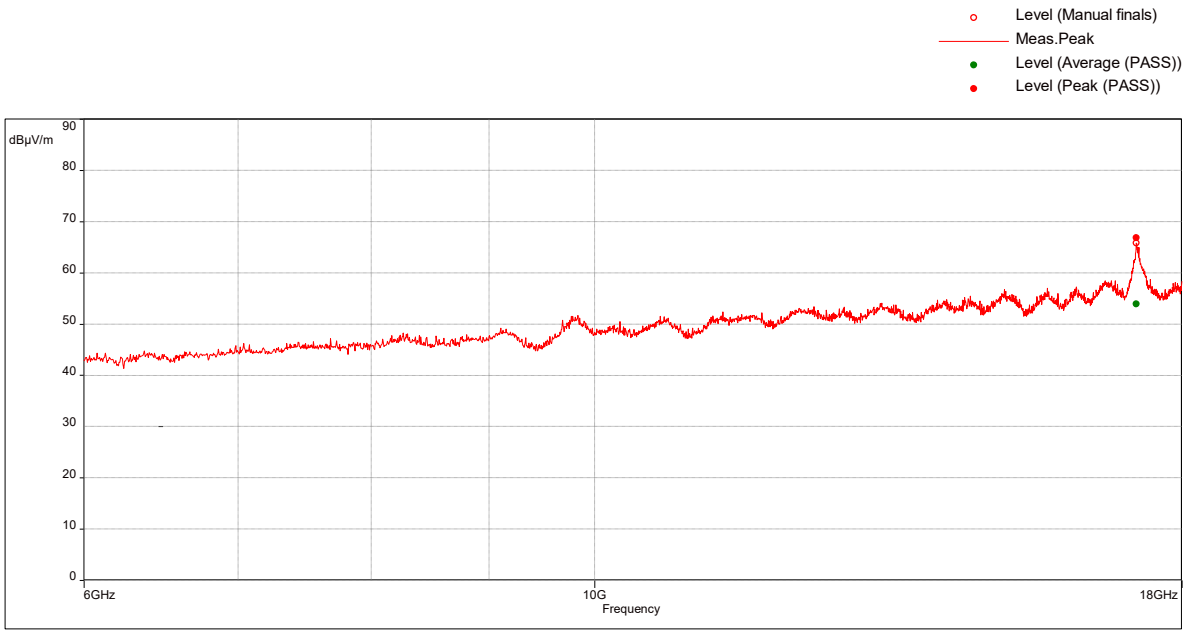
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Low 24.84 GHz (Worst-case output power, 39.7dBm), 160 MHz, MCS0, Att8_5, ERA01, RE 6 to 18 GHz

Test Information:

Date and Time	3/14/2022 2:10:30 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	24C
Humidity	13%
Atmospheric Pressure	1016mbar
Comments	Scan 15: Low 24.84 GHz (Worst-case output power, 39_7dBm), 160 MHz, MCS0, Att8_5, ERA01, RE 6 to 18 GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (1)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
17196.57895	66.86	-28.34	-13	-15.34	32.00	2.20	Horizontal	1000000.00	31.02

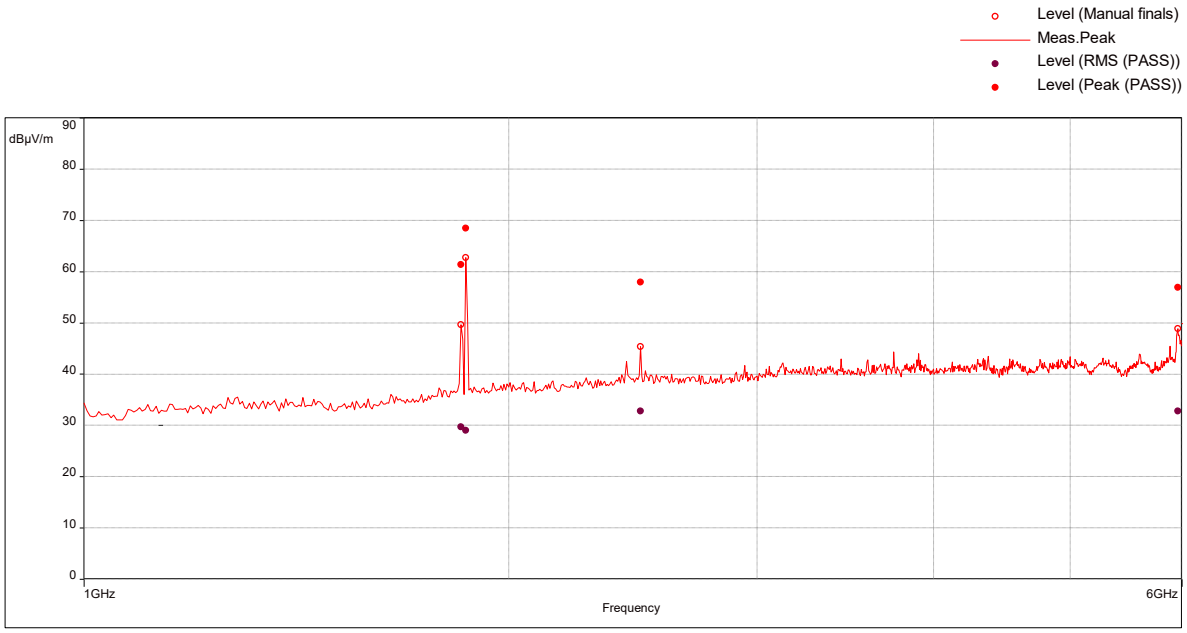
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Mid Channel 25.04 GHz (Worst-case output power, 39.19 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att10, RE 1-6 GHz

Test Information:

Date and Time	3/9/2022 1:24:32 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 7: Mid 25.04 GHz (Worst-case output power, 39.19 dBm), 160 MHz, MCS0, Att10, REA007, RE 1-6 GHzSA mode

Graph:



Results:

EIRP Peak (PASS) (4)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1851.052632	61.36	-33.84	-13	-20.84	82.00	3.25	Vertical	1000000.00	-5.03
1865.263158	68.48	-26.72	-13	-13.72	315.00	3.10	Horizontal	1000000.00	-4.90
2480.263158	57.89	-37.31	-13	-24.31	111.00	1.30	Vertical	1000000.00	-3.04
5957.631579	56.93	-38.27	-13	-25.27	52.00	1.05	Vertical	1000000.00	3.38

RMS (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°) (dB)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1851.052632	29.67	82.00	3.25	Vertical	1000000.00	-5.03
1865.263158	29.00	315.00	3.10	Horizontal	1000000.00	-4.90
2480.263158	32.76	111.00	1.30	Vertical	1000000.00	-3.04
5957.631579	32.75	52.00	1.05	Vertical	1000000.00	3.38

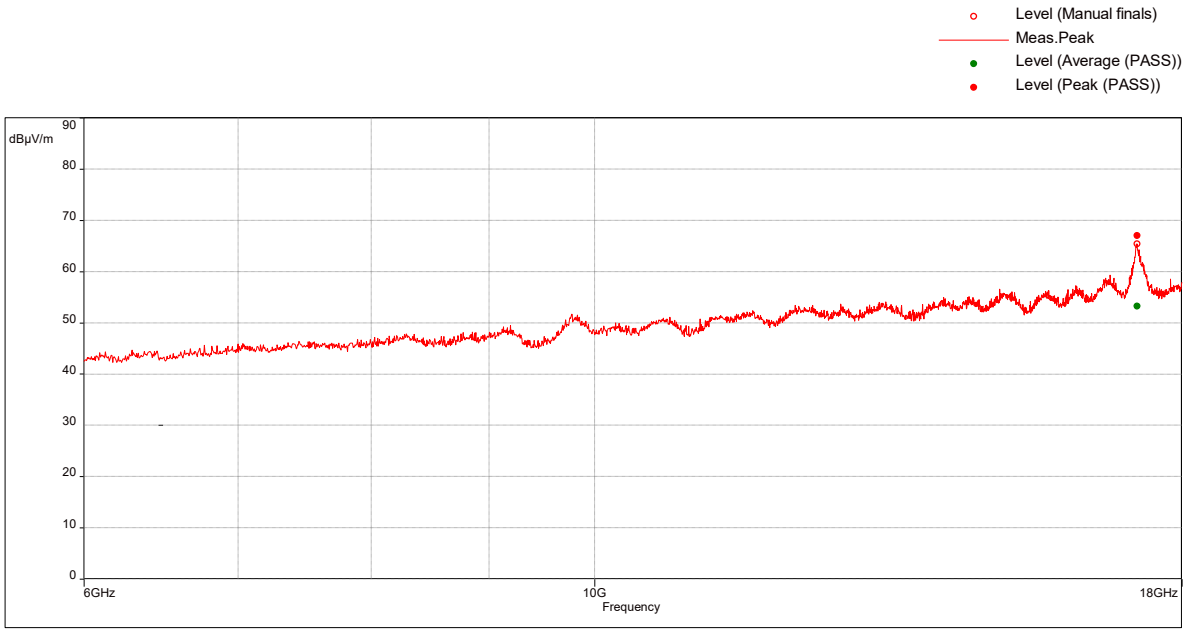
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Mid 25.04 GHz (Worst-case output power, 39.19dBm), 160 MHz, MCS0, Att10, ERA01, RE 6 to 18 GHz

Test Information:

Date and Time	3/14/2022 2:25:09 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	24C
Humidity	13%
Atmospheric Pressure	1016mbar
Comments	Scan 16: Mid 25.04 GHz (Worst-case output power, 39_19dBm), 160 MHz, MCS0, Att10, ERA01, RE 6 to 18 GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (1)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
17208.15789	66.98	-28.22	-13	-15.22	135.00	3.05	Horizontal	1000000.00	30.72

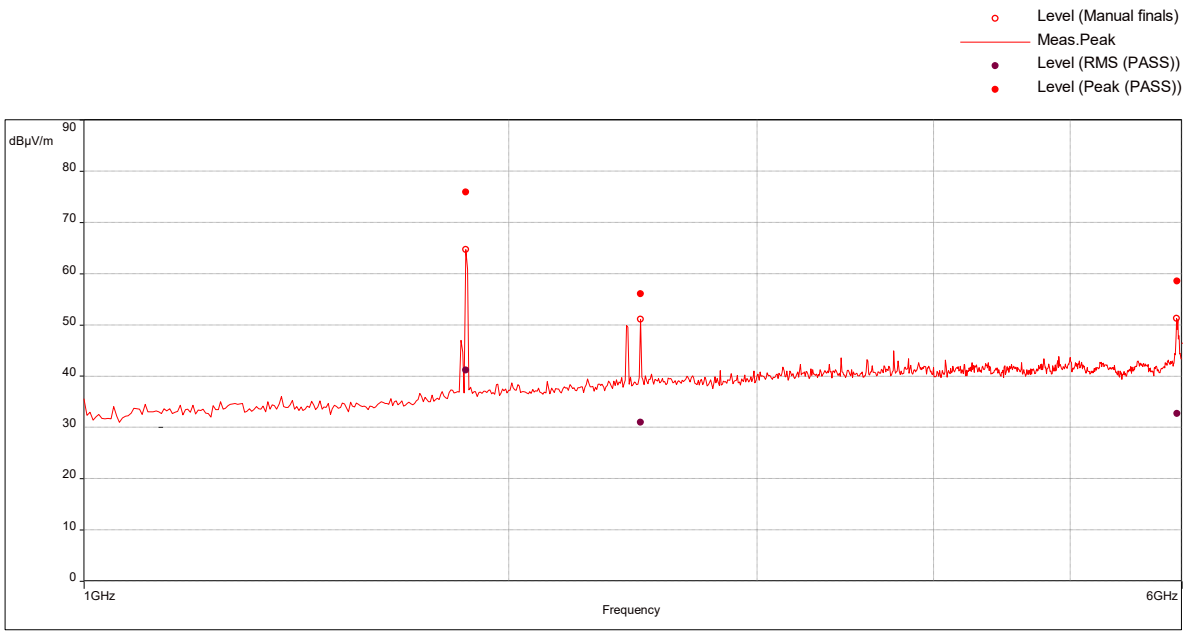
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

High Channel 25.16 GHz (Worst-case output power, 39.26 dBm), 160 MHz Bandwidth, MCS0 Modulation, Att9, RE 1-6 GHz

Test Information:

Date and Time	3/9/2022 2:25:49 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	23 C
Humidity	18 %
Atmospheric Pressure	1013 mbar
Comments	Scan 9: High 25.16 GHz (Worst-case output power, 39.26 dBm), 160 MHz, MCS0, Att9.0, RE 1-6GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (3)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1866.578947	75.88	-19.32	-13	-6.32	271.00	1.85	Vertical	1000000.00	-4.88
2480.263158	56.06	-39.14	-13	-26.14	112.00	2.35	Vertical	1000000.00	-3.04
5954.736842	58.49	-36.71	-13	-23.71	205.00	1.90	Horizontal	1000000.00	3.37

RMS (PASS) (3)

Frequency (MHz)	Level (dBµV/m)	Azimuth (°) (dB)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
1866.578947	41.15	271.00	1.85	Vertical	1000000.00	-4.88
2480.263158	30.95	112.00	2.35	Vertical	1000000.00	-3.04
5954.736842	32.65	205.00	1.90	Horizontal	1000000.00	3.37

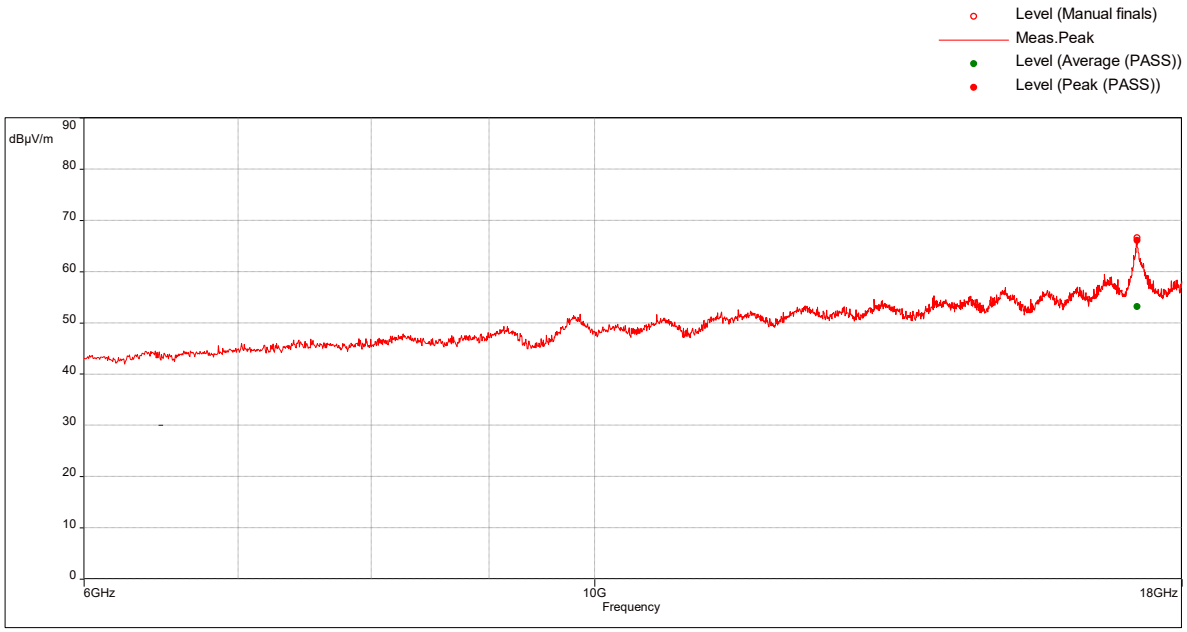
Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

High 25.16 GHz (Worst-case output power, 39.26 dBm), 160 MHz, MCS0, Att89, ERA01, RE 6 to 18 GHz

Test Information:

Date and Time	3/14/2022 2:52:46 PM
Client and Project Number	Starry
Engineer	Kouma Sinn
Temperature	24C
Humidity	13%
Atmospheric Pressure	1016mbar
Comments	Scan 18: High 25.16 GHz (Worst-case output power, 39_26 dBm), 160 MHz, MCS0, Att89, ERA01, RE 6 to 18 GHz SA mode

Graph:



Results:

EIRP Peak (PASS) (1)

Frequency (MHz)	Peak Level (dBµV/m)	EIRP Level (dBm)	Limit (dBm)	EIRP Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
17211.31579	66.08	-29.12	-13	-16.12	285.00	1.15	Vertical	1000000.00	30.50

Notes: The EIRP level (dBm) is calculated from the peak level readings (dBuV/m) as EIRP Level (dBm) = Peak Level (dBuV/m) + 20*Log(d)-104.8, where d is the measurement distance (in far field region) in meter.

Lower and Upper Bands at Low, Mid, and High channels: 160 MHz Bandwidth, MCS0 Modulation, 18-40 GHz

Spurious Emissions, 18-40 GHz, Tx 24.34 GHz, 24.35 GHz, 24.36 GHz; 24.84GHz, 25.04 Ghz, and 25.16 GHz

Company:	Starry		Antenna & Cables:	HF	Bands: N, LF, HF, SHF
Model #:	Titan 24-360		Antenna:	EMC004	EMC004
Serial #:	2207250003		Cable(s):	CBLHF2012-5M-2	CBLHF2012-2M-1
Engineers:	Vathana Ven	Location: 10m Ch.	Barometer:	DAV007	Filter: NONE
Project #:	G105000232	Date(s): 03/14/22			
Standard:	FCC Part 30		Temp/Humidity/Pressure:	25 deg C	13% 1015 mB
Receiver:	ROS005-1 (11-02-2022)	Limit Distance (m): 3			
PreAmp:	PRE8	Test Distance (m): 3			

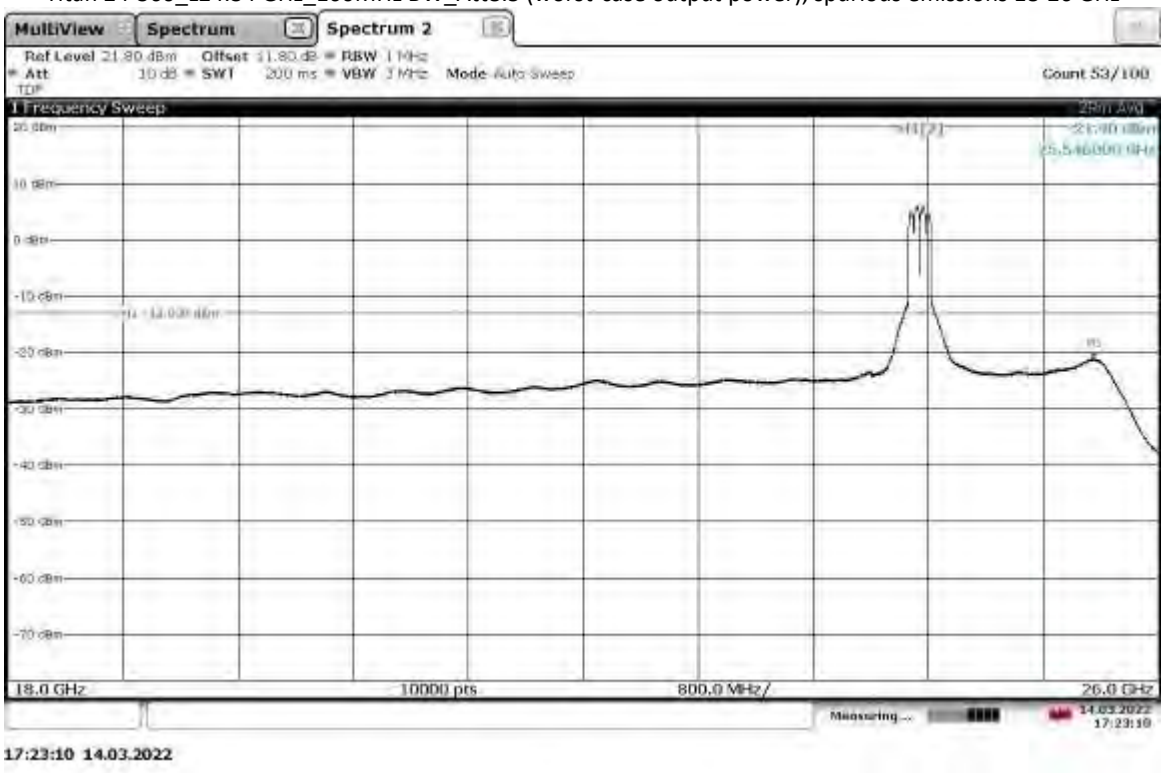
PreAmp Used? (Y or N): Y Voltage/Frequency: 120VAC 60Hz Frequency Range: 18-40GHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

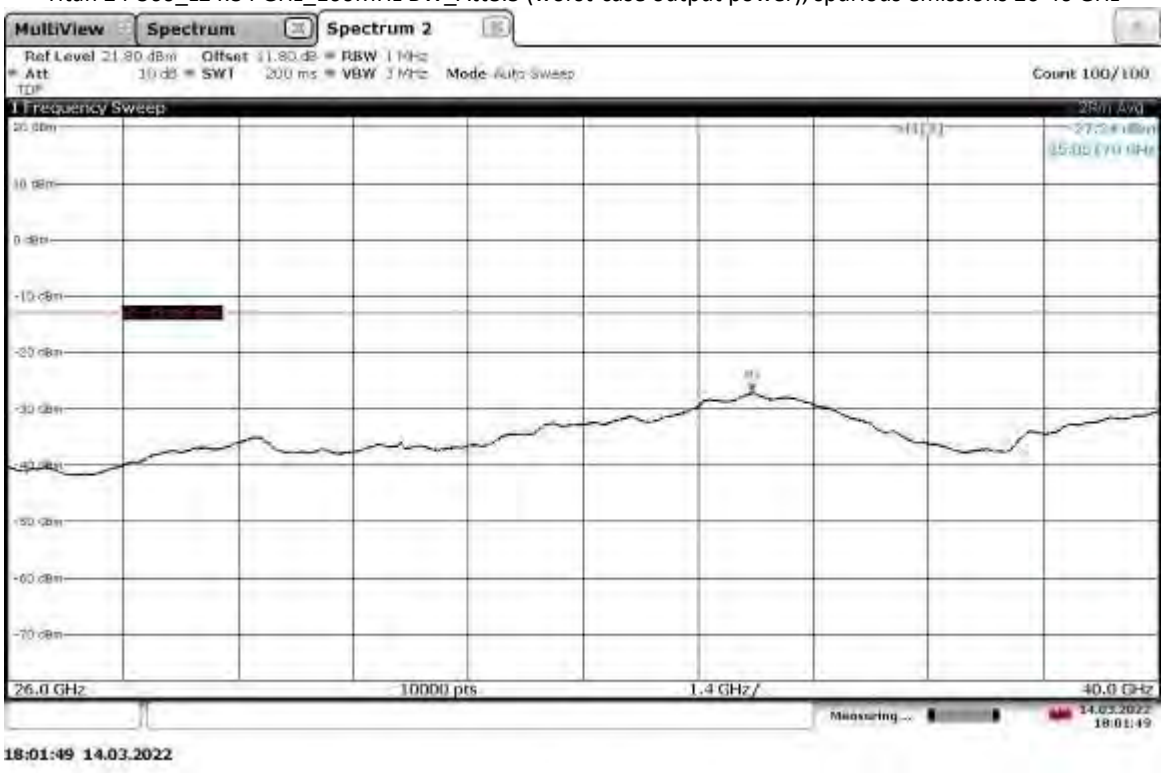
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(m)	Limit dB(m)	Margin dB	Bandwidth
BW=160MHz, MCS0, Tx @ Tx 24.34 GHz, 24.35 GHz, 24.36 GHz; 24.84GHz, 25.04 Ghz, and 25.16 GHz											
18-40GHz, no emissions were detected above the measuring equipment noise floor. See plots of noise floor.											

Titan 24-360_L24.34 GHz_160MHz BW_Att8.5 (worst-case output power), spurious emissions 18-26 GHz

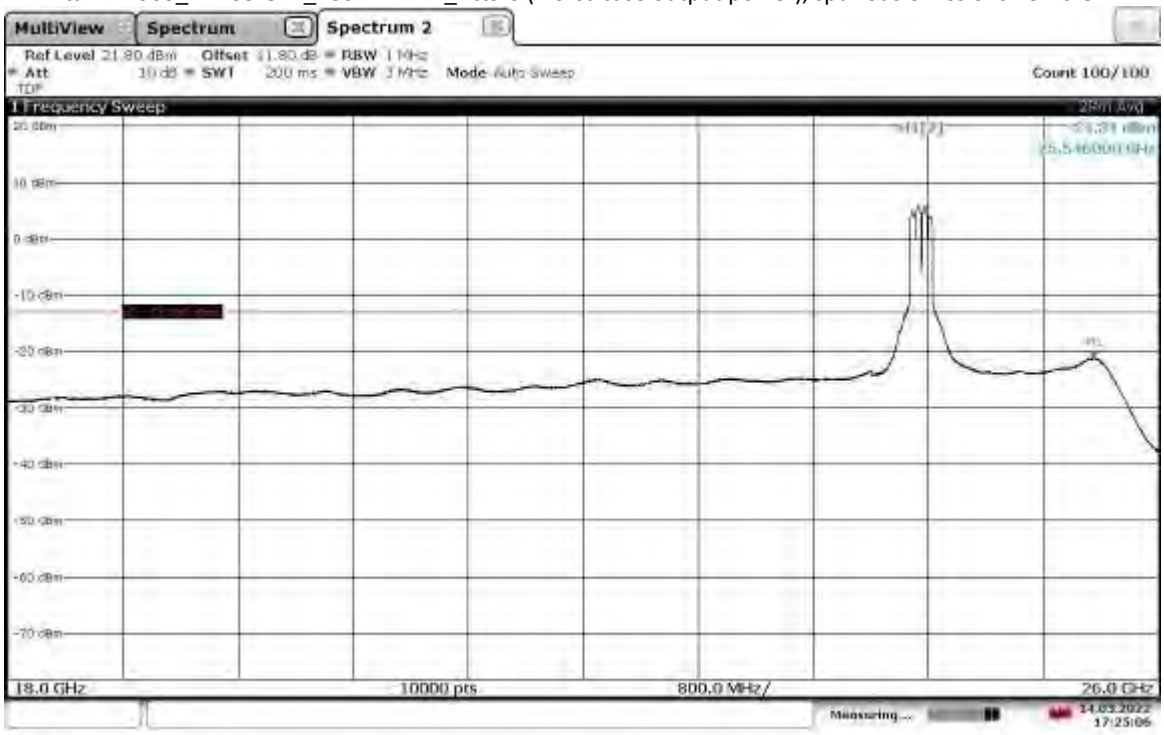


Titan 24-360_L24.34 GHz_160MHz BW_Att8.5 (worst-case output power), spurious emissions 26-40 GHz



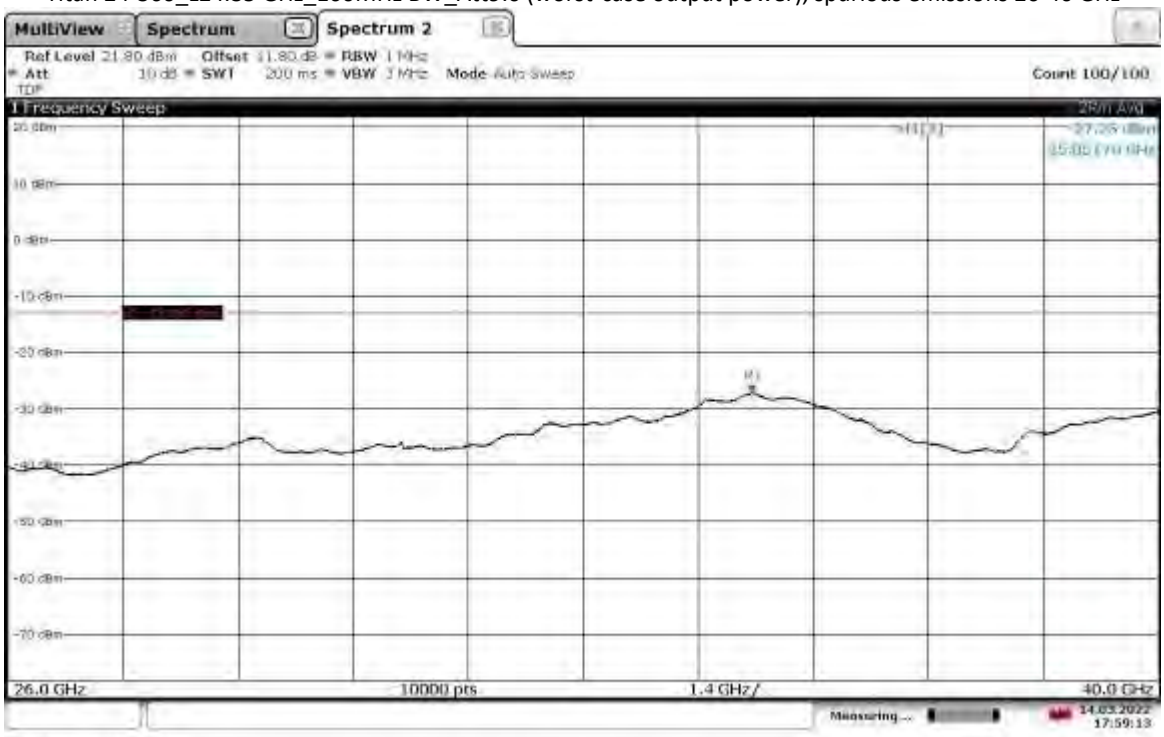
Note: Antenna factors, cable factors, pre-amp factors, and path loss factors were internally compensated.

Titan 24-360_L24.35 GHz_160MHz BW_Att9.0 (worst-case output power), spurious emissions 18-26 GHz



17:25:06 14.03.2022

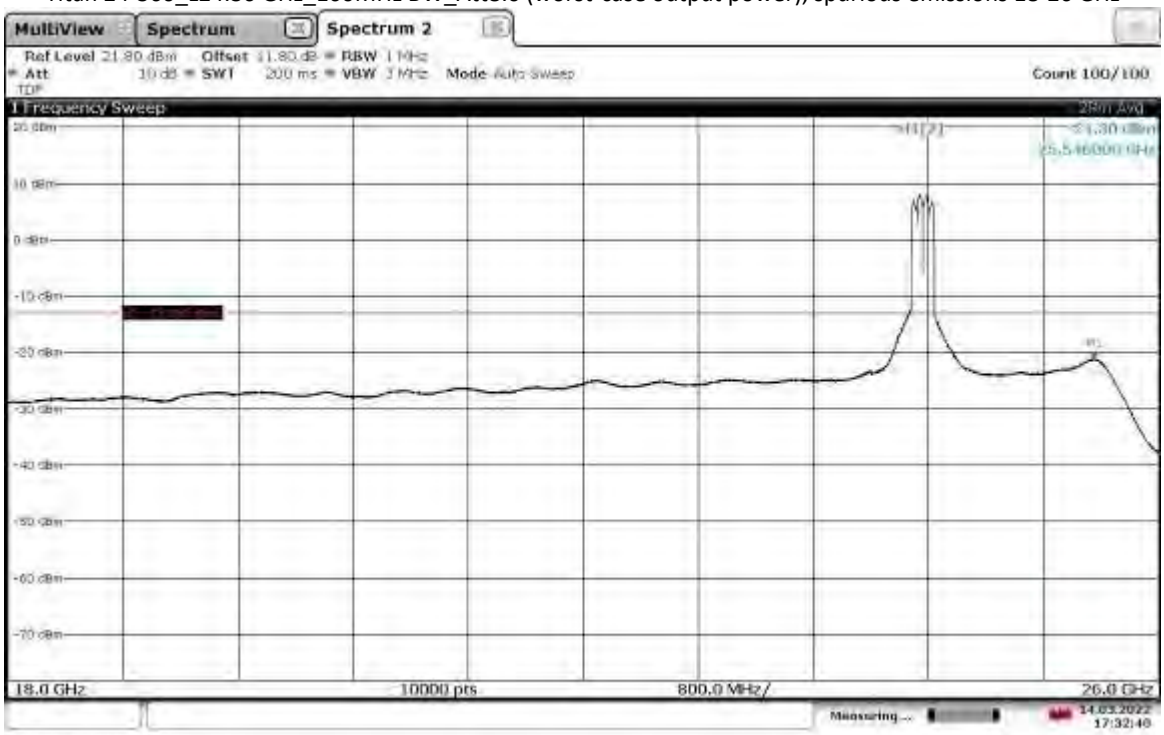
Titan 24-360_L24.35 GHz_160MHz BW_Att9.0 (worst-case output power), spurious emissions 26-40 GHz



17:59:14 14.03.2022

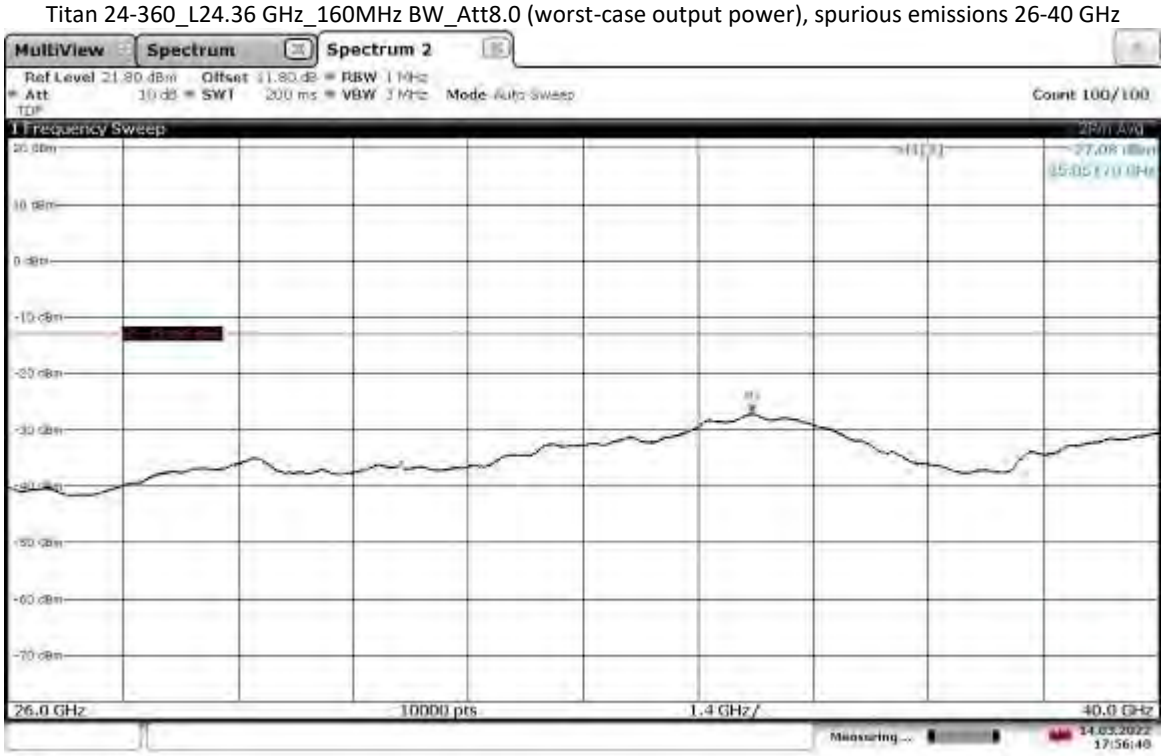
Note: Antenna factors, cable factors, pre-amp factors, and path loss factors were internally compensated

Titan 24-360_L24.36 GHz_160MHz BW_Att8.0 (worst-case output power), spurious emissions 18-26 GHz



17:32:40 14.03.2022

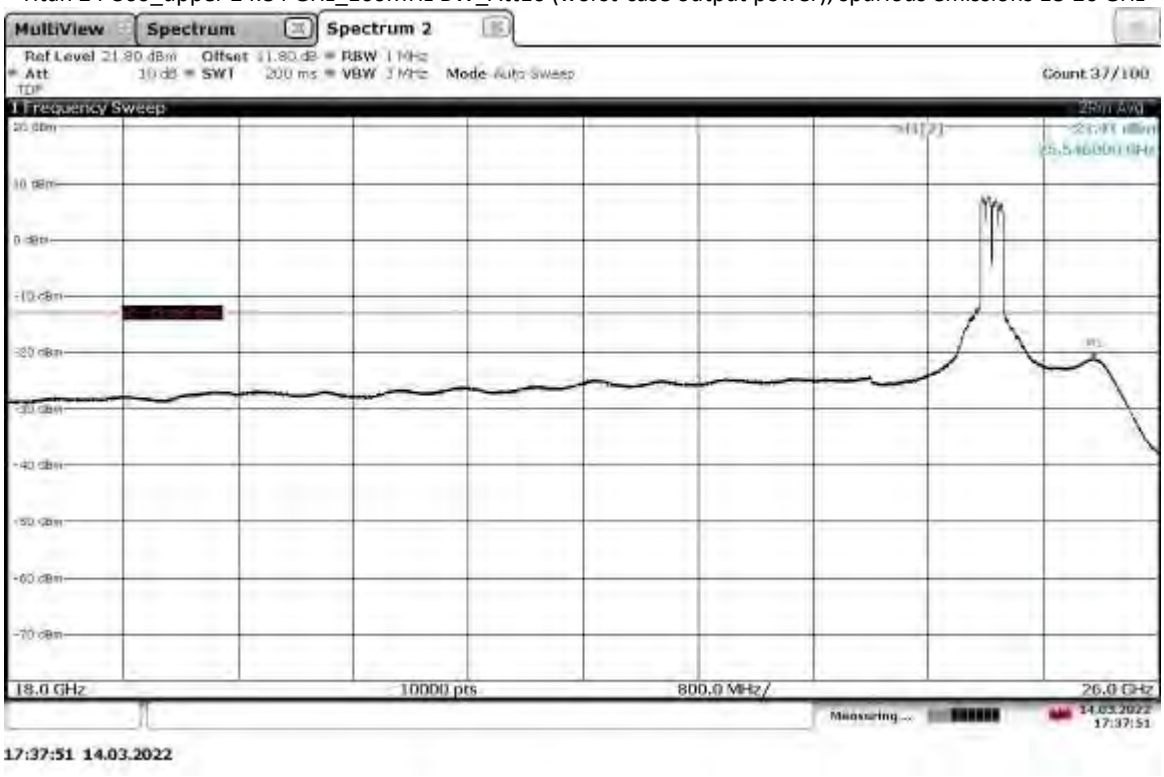
Titan 24-360_L24.36 GHz_160MHz BW_Att8.0 (worst-case output power), spurious emissions 26-40 GHz



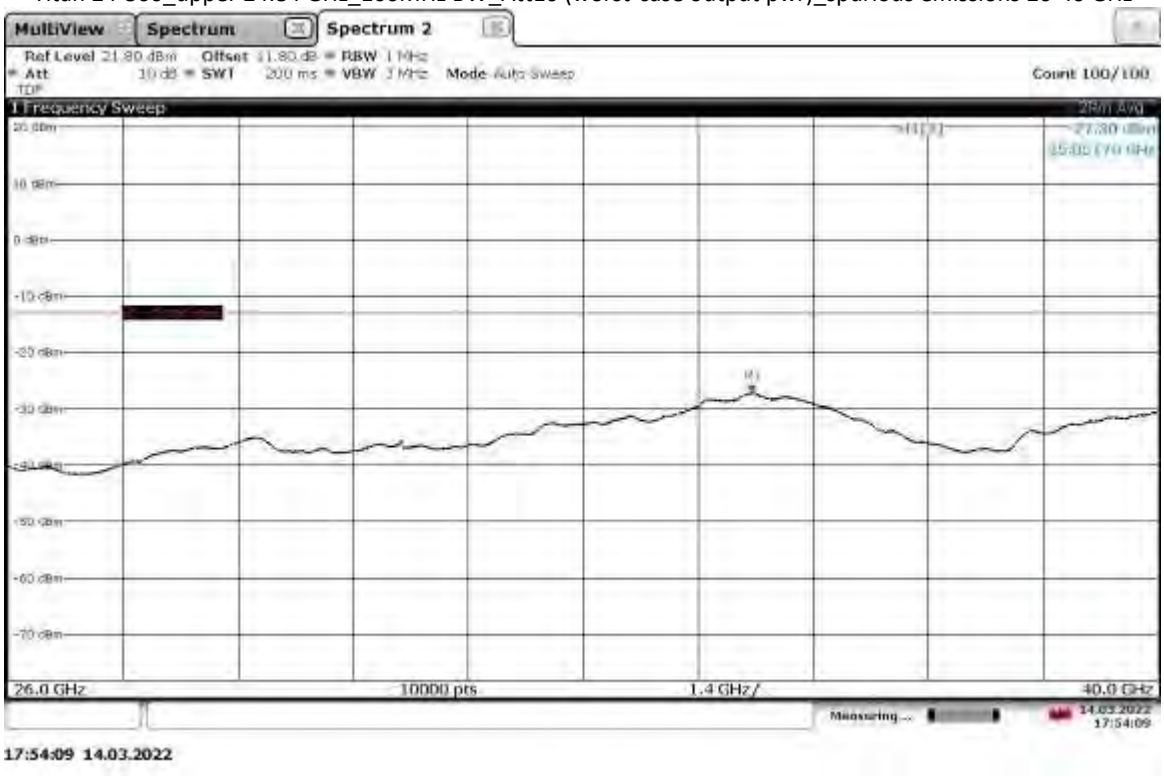
17:56:41 14.03.2022

Note: Antenna factors, cable factors, pre-amp factors, and path loss factors were internally compensated

Titan 24-360_upper 24.84 GHz_160MHz BW_Att10 (worst-case output power), spurious emissions 18-26 GHz

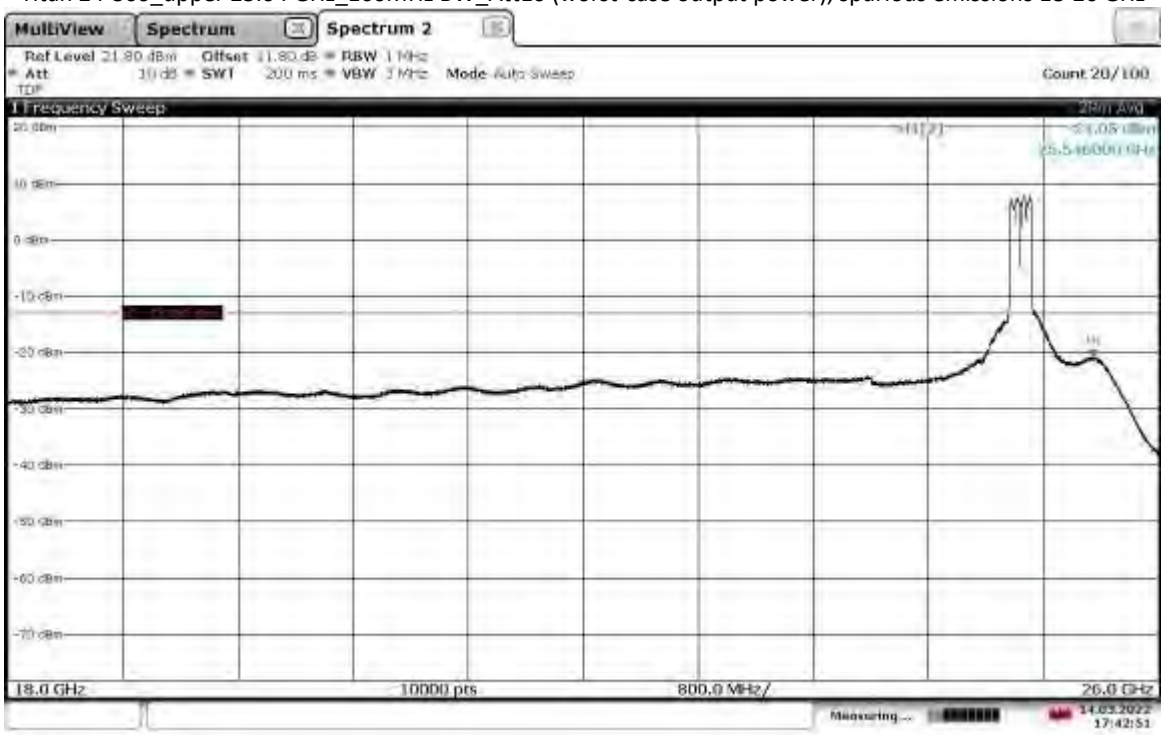


Titan 24-360_upper 24.84 GHz_160MHz BW_Att10 (worst-case output pwr)_spurious emissions 26-40 GHz

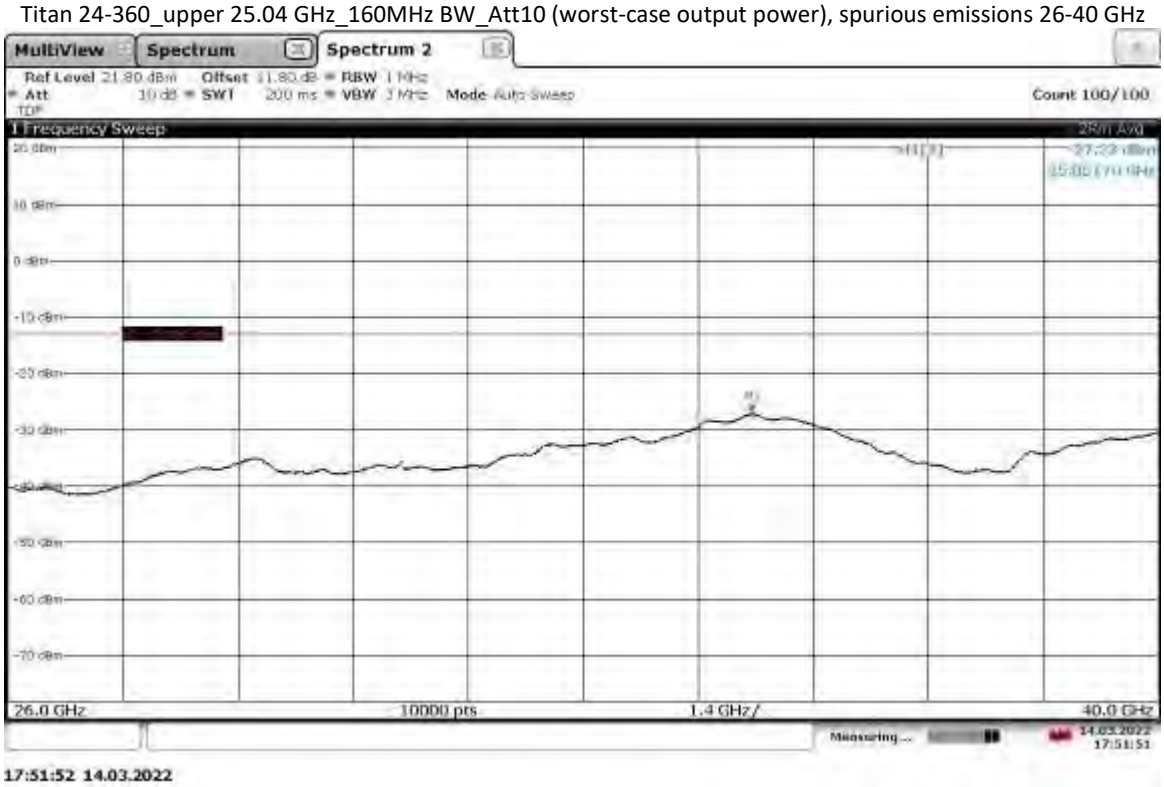


Note: Antenna factors, cable factors, pre-amp factors, and path loss factors were internally compensated

Titan 24-360_upper 25.04 GHz_160MHz BW_Att10 (worst-case output power), spurious emissions 18-26 GHz

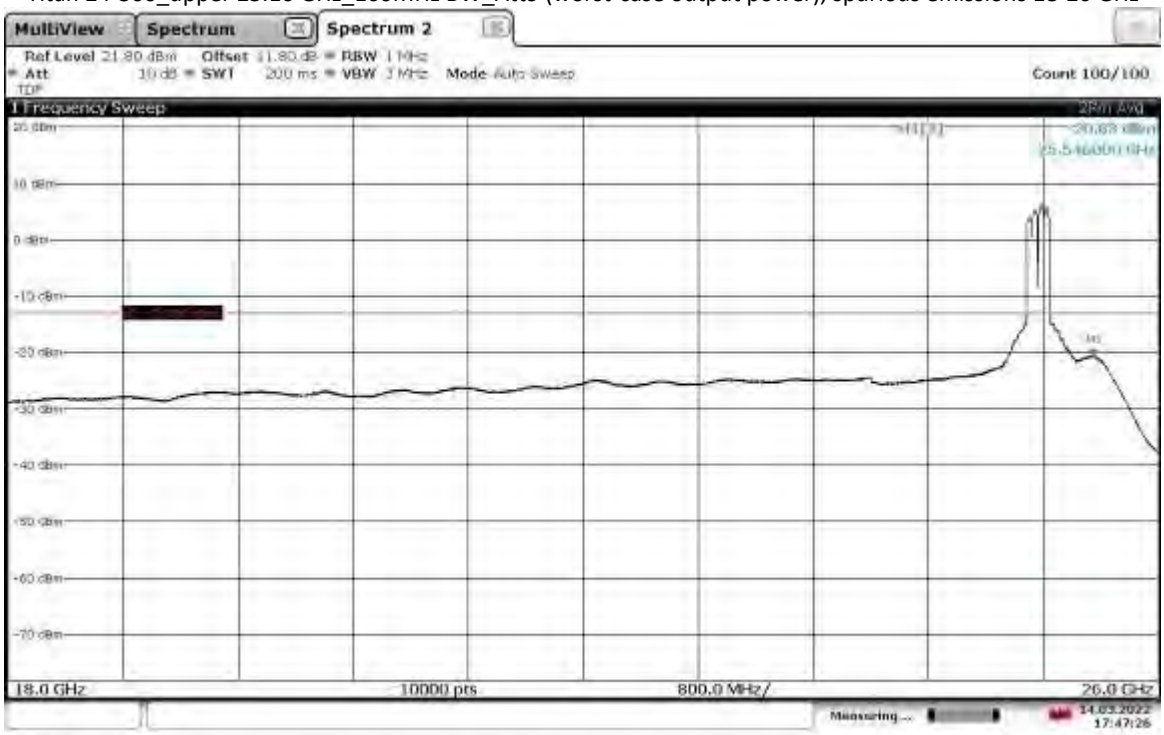


Titan 24-360_upper 25.04 GHz_160MHz BW_Att10 (worst-case output power), spurious emissions 26-40 GHz

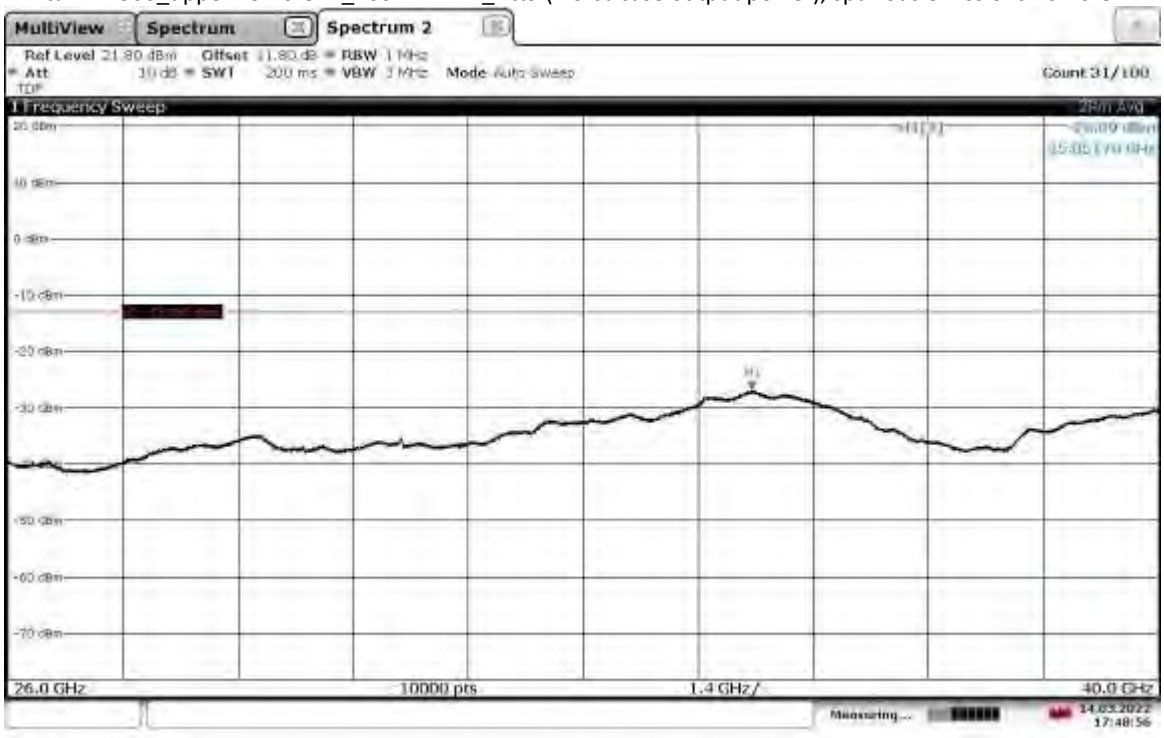


Note: Antenna factors, cable factors, pre-amp factors, and path loss factors were internally compensated

Titan 24-360_upper 25.16 GHz_160MHz BW_Att9 (worst-case output power), spurious emissions 18-26 GHz



Titan 24-360_upper 25.16 GHz_160MHz BW_Att9 (worst-case output power), spurious emissions 26-40 GHz



Note: Antenna factors, cable factors, pre-amp factors, and path loss factors were internally compensated

Spurious Emissions, 40-100 GHz, Tx 24.34 GHz, 24.35 GHz, 24.36 GHz; 24.84GHz, 25.04 Ghz, and 25.16 GHz

Company:	Starry			Antenna & Cables:	N	Bands: N, LF, HF, SHF	
Model #:	Titan 24-360			Antenna:	WR19	NONE.	
Serial #:	2207250003			Cable(s):	CBLHF2012-5M-2		
Engineers:	Vathana Ven	Location:	10m chamber	Barometer:	DAV007	Filter:	NONE
Project #:	G105000232	Date(s):	03/14/22				
Standard:	FCC Part 30			Temp/Humidity/Pressure:	25 deg C	13%	1015 mB
Receiver:	ROS005-1 (11-02-2022)	Limit Distance (m):	3				
PreAmp:	None	Test Distance (m):	3				

PreAmp Used? (Y or N): N Voltage/Frequency: 120VAC 60Hz Frequency Range: 40-100GHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

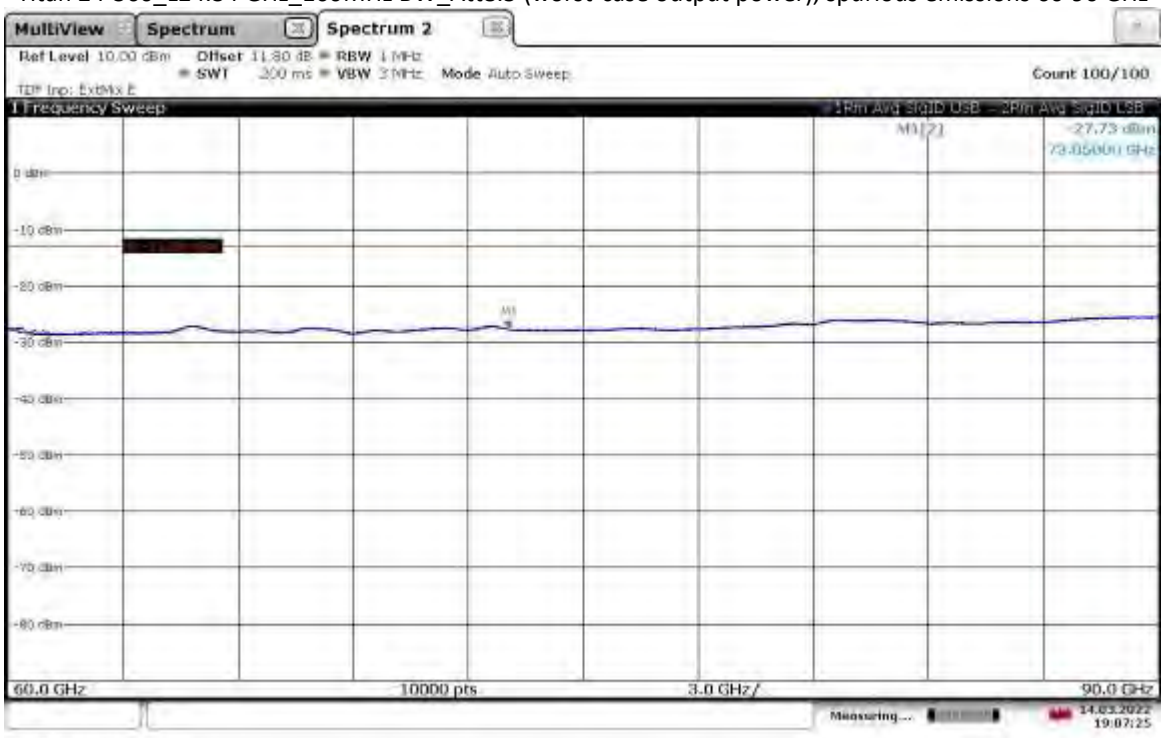
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency GHz	Reading dB(uV/m)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	
Note: BW=160MHz, MCS0, Tx @ Tx 24.34 GHz, 24.35 GHz, 24.36 GHz; 24.84GHz, 25.04 Ghz, and 25.16 GHz												
40-100GHz, no emissions were detected above the measuring equipment noise floor. See plots of noise floor.												FCC

Titan 24-360_L24.34 GHz_160MHz BW_Att8.5 (worst-case output power), spurious emissions 40-60 GHz

18:26:13 14.03.2022

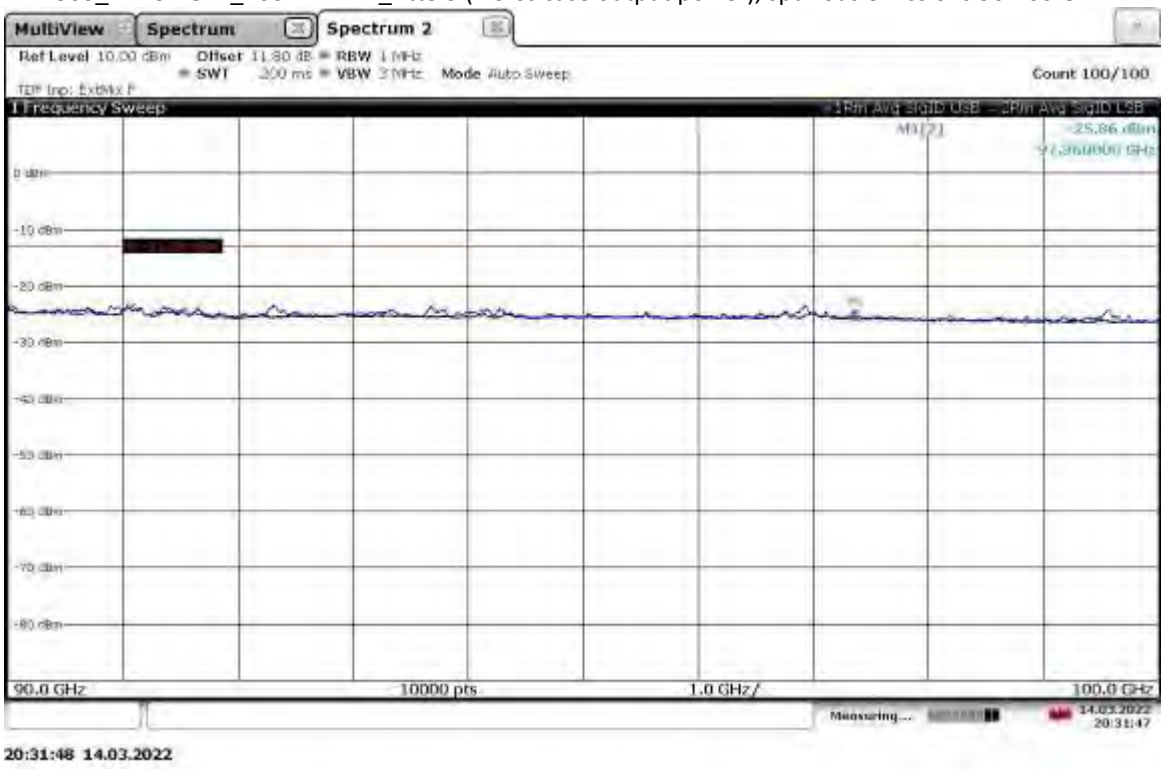
Titan 24-360_L24.34 GHz_160MHz BW_Att8.5 (worst-case output power), spurious emissions 60-90 GHz



19:07:25 14.03.2022

Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_L24.34 GHz_160MHz BW_Att8.5 (worst-case output power), spurious emissions 90-100 GHz

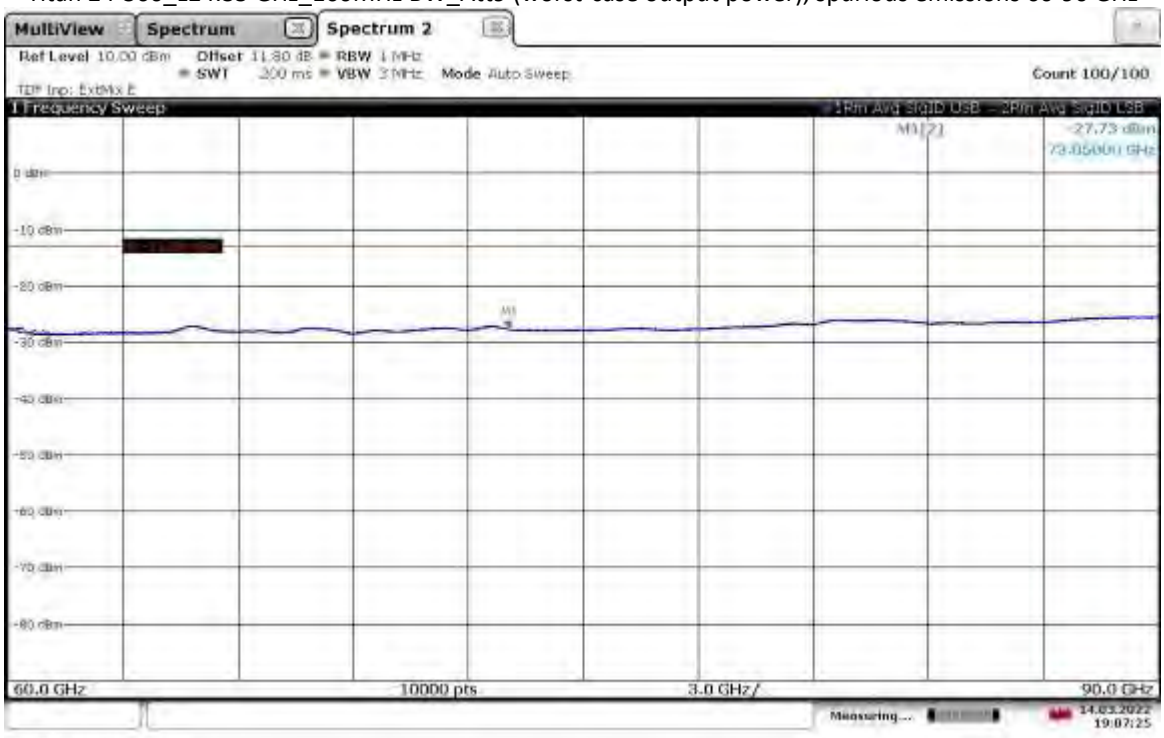


Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_L24.35 GHz_160MHz BW_Att9 (worst-case output power), spurious emissions 40-60 GHz

18:34:15 14.03.2022

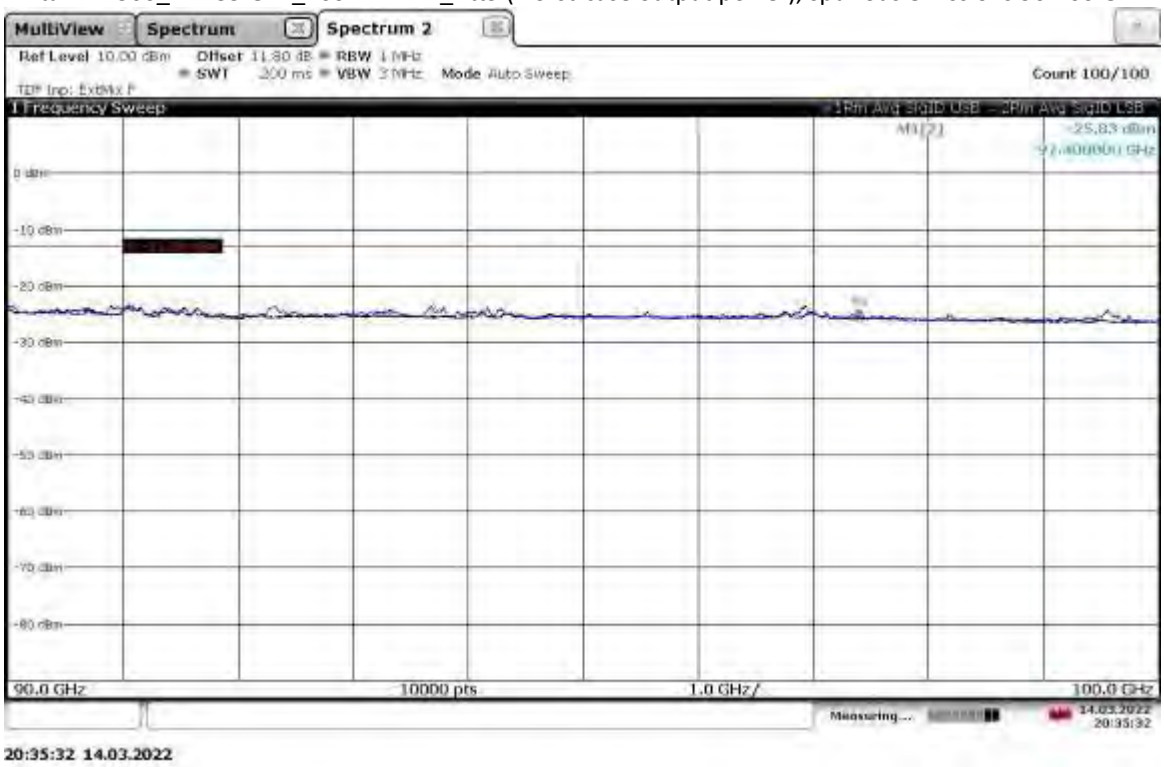
Titan 24-360_L24.35 GHz_160MHz BW_Att9 (worst-case output power), spurious emissions 60-90 GHz



19:07:25 14.03.2022

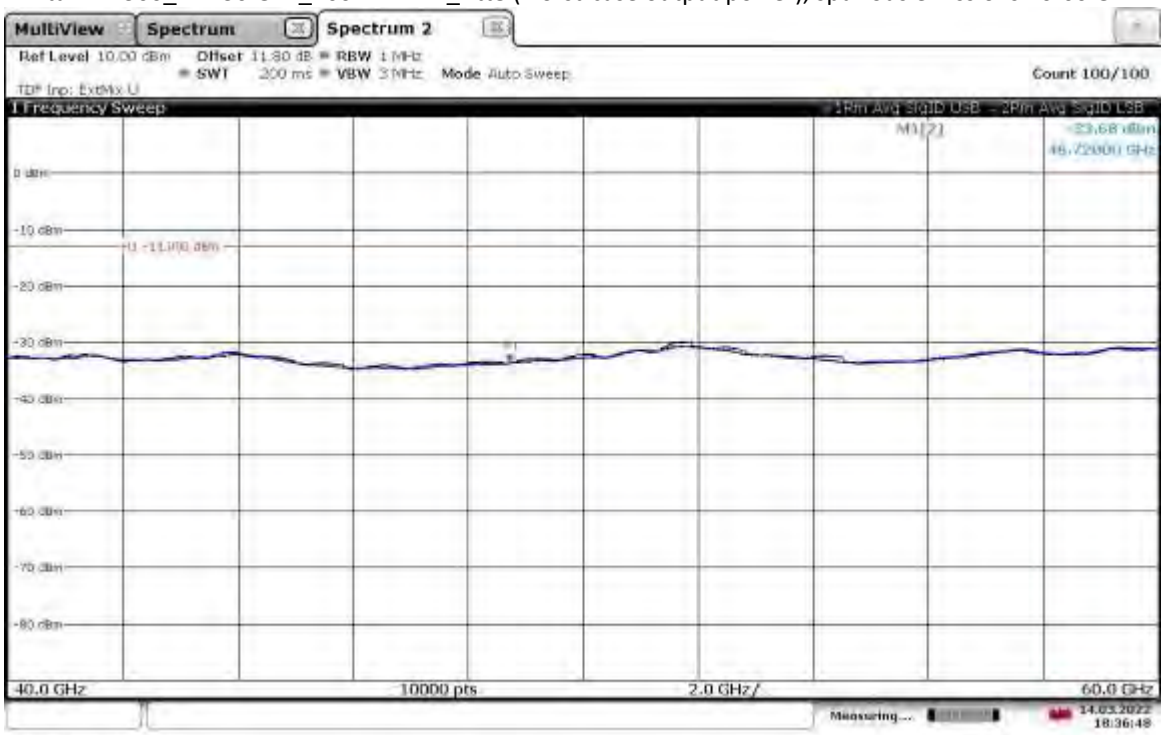
Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_L24.35 GHz_160MHz BW_Att9 (worst-case output power), spurious emissions 90-100 GHz



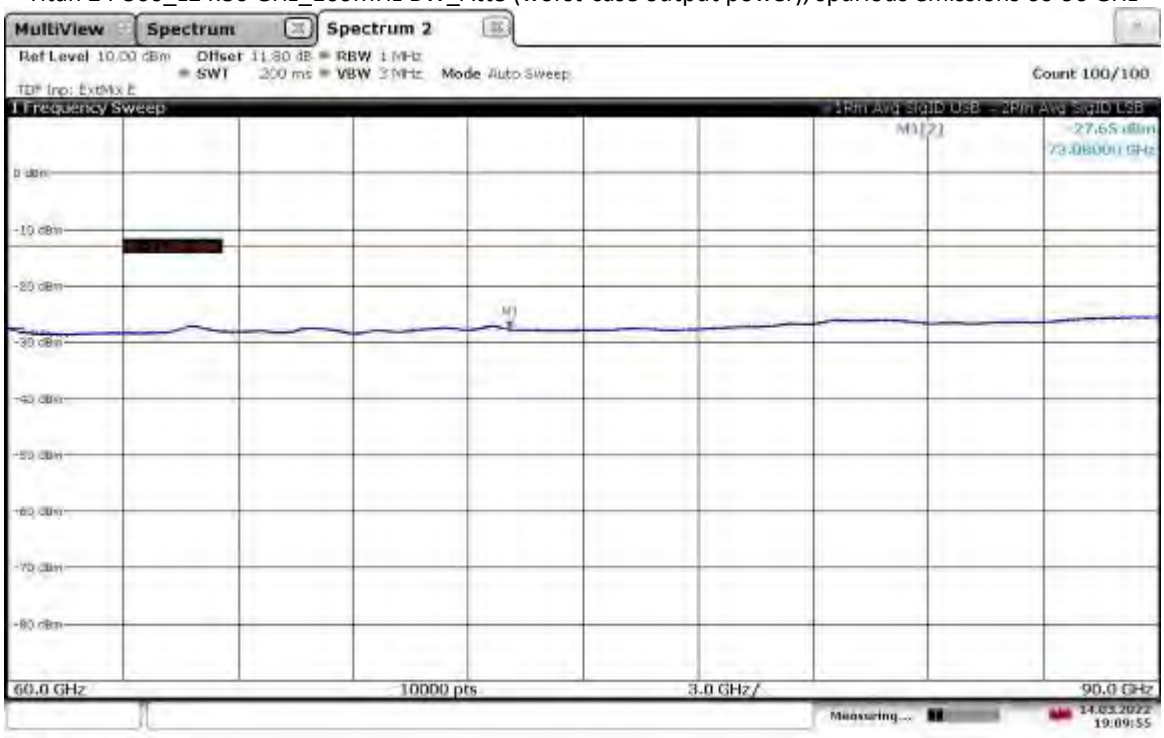
Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_L24.36 GHz_160MHz BW_Att8 (worst-case output power), spurious emissions 40-60 GHz



18:36:49 14.03.2022

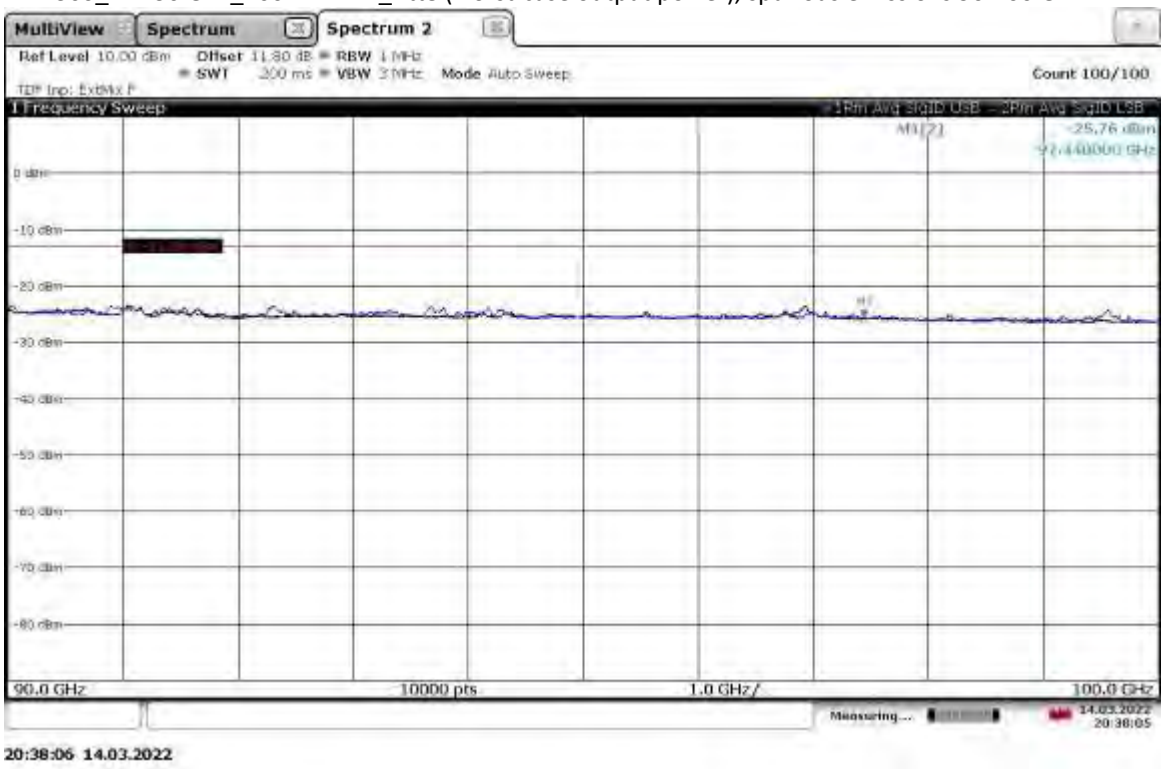
Titan 24-360_L24.36 GHz_160MHz BW_Att8 (worst-case output power), spurious emissions 60-90 GHz



19:09:55 14.03.2022

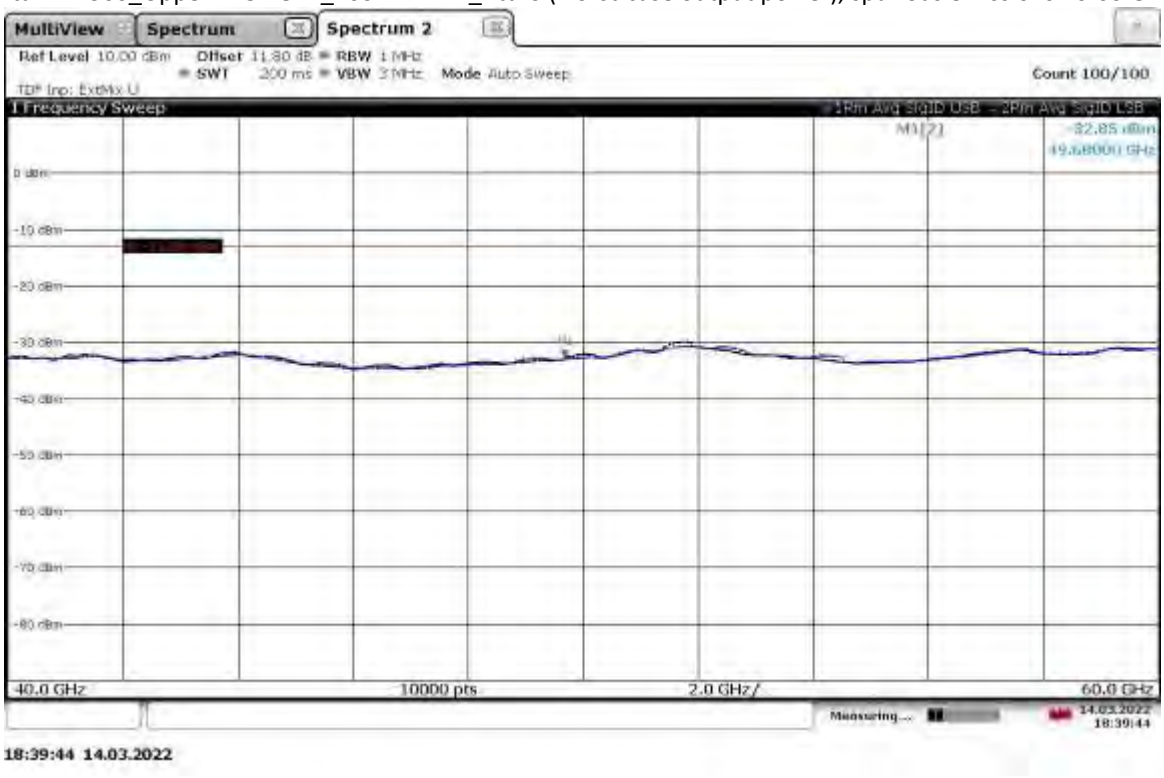
Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_L24.36 GHz_160MHz BW_Att8 (worst-case output power), spurious emissions 90-100 GHz

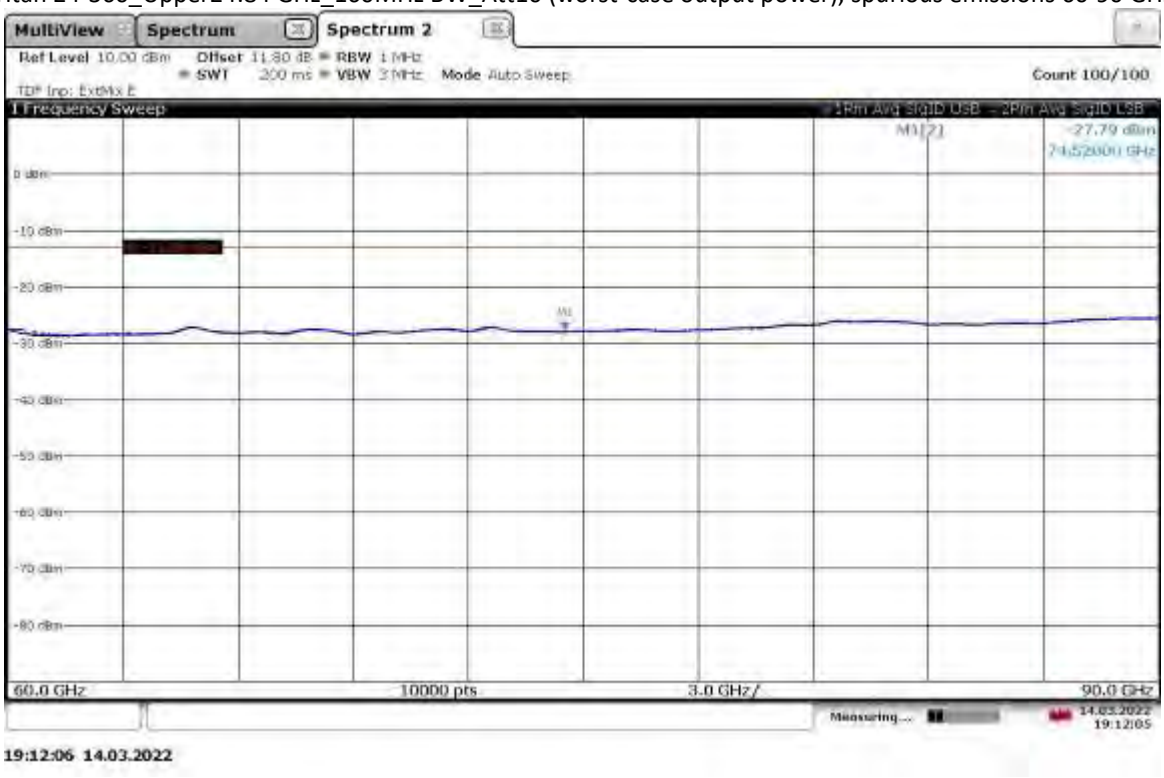


Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_Upper24.84 GHz_160MHz BW_Att10 (worst-case output power), spurious emissions 40-60 GHz

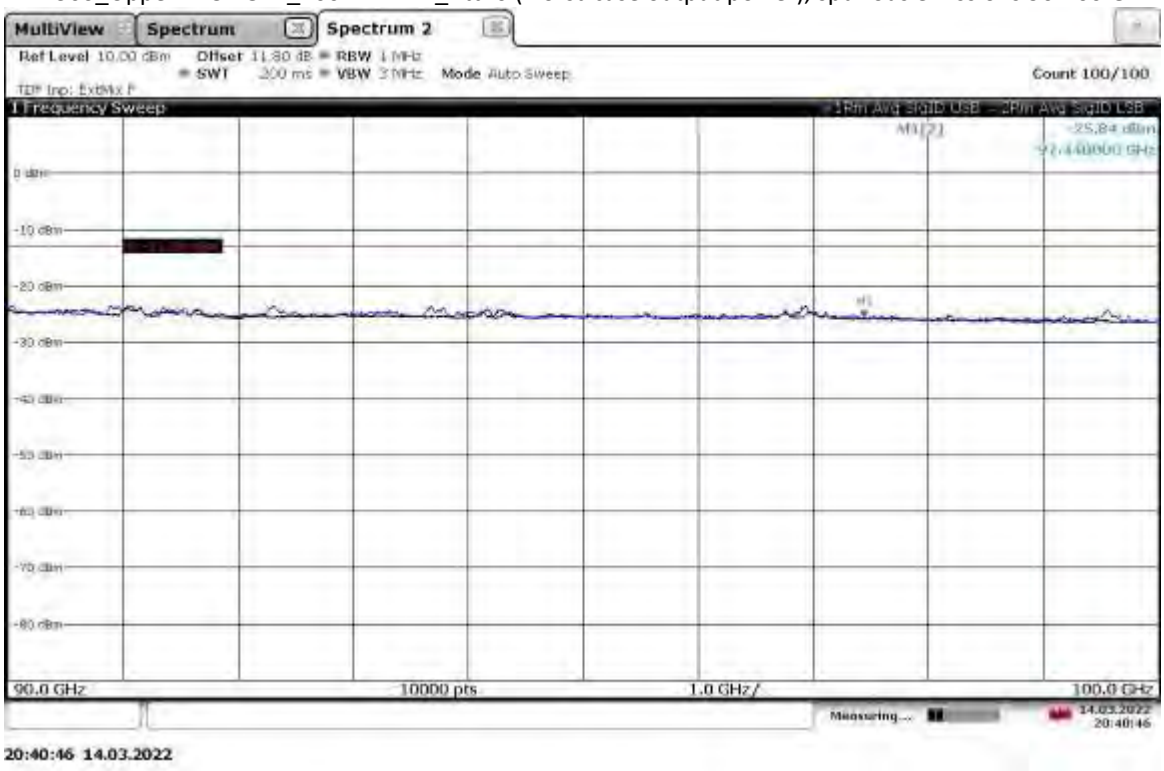


Titan 24-360_Upper24.84 GHz_160MHz BW_Att10 (worst-case output power), spurious emissions 60-90 GHz



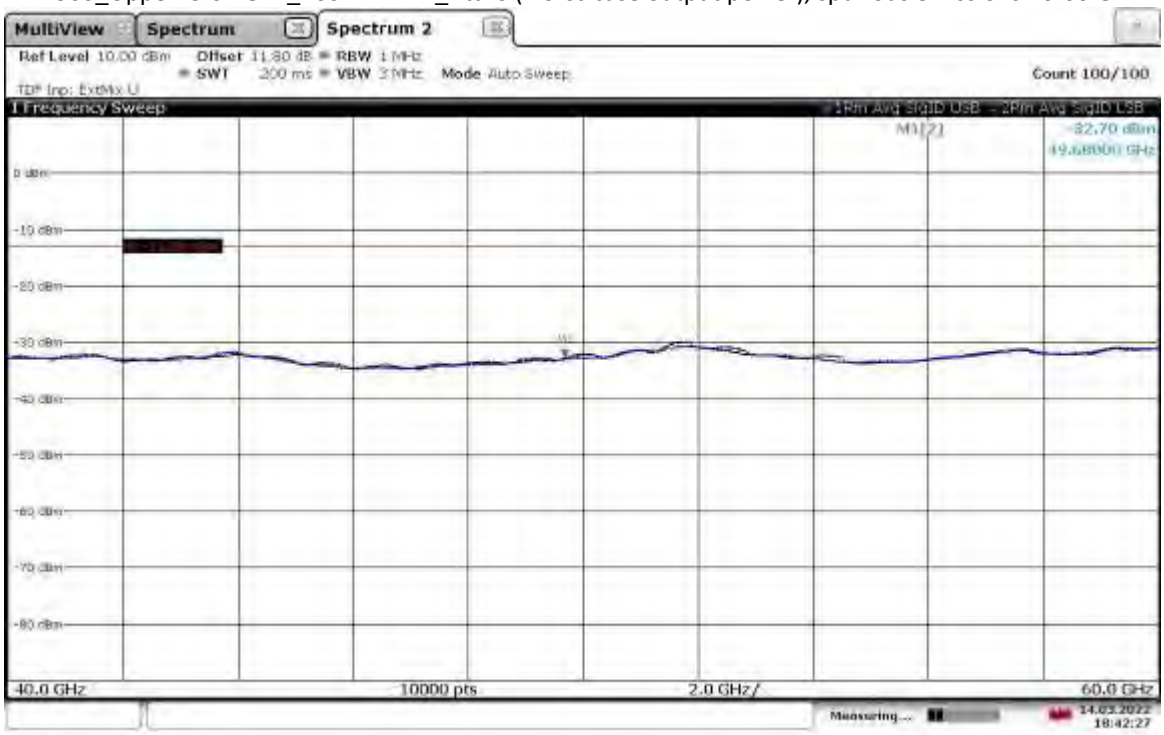
Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_Upper24.84 GHz_160MHz BW_Att10 (worst-case output power), spurious emissions 90-100 GHz



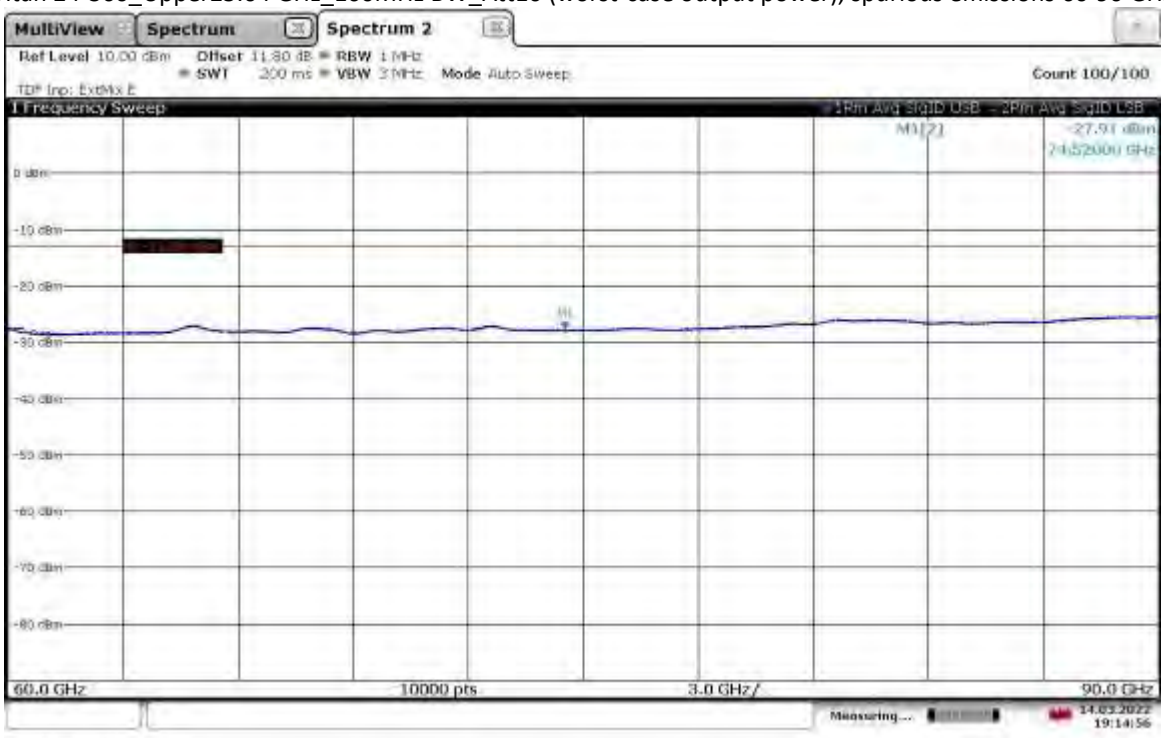
Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_Upper25.04 GHz_160MHz BW_Att10 (worst-case output power), spurious emissions 40-60 GHz



18:42:27 14.03.2022

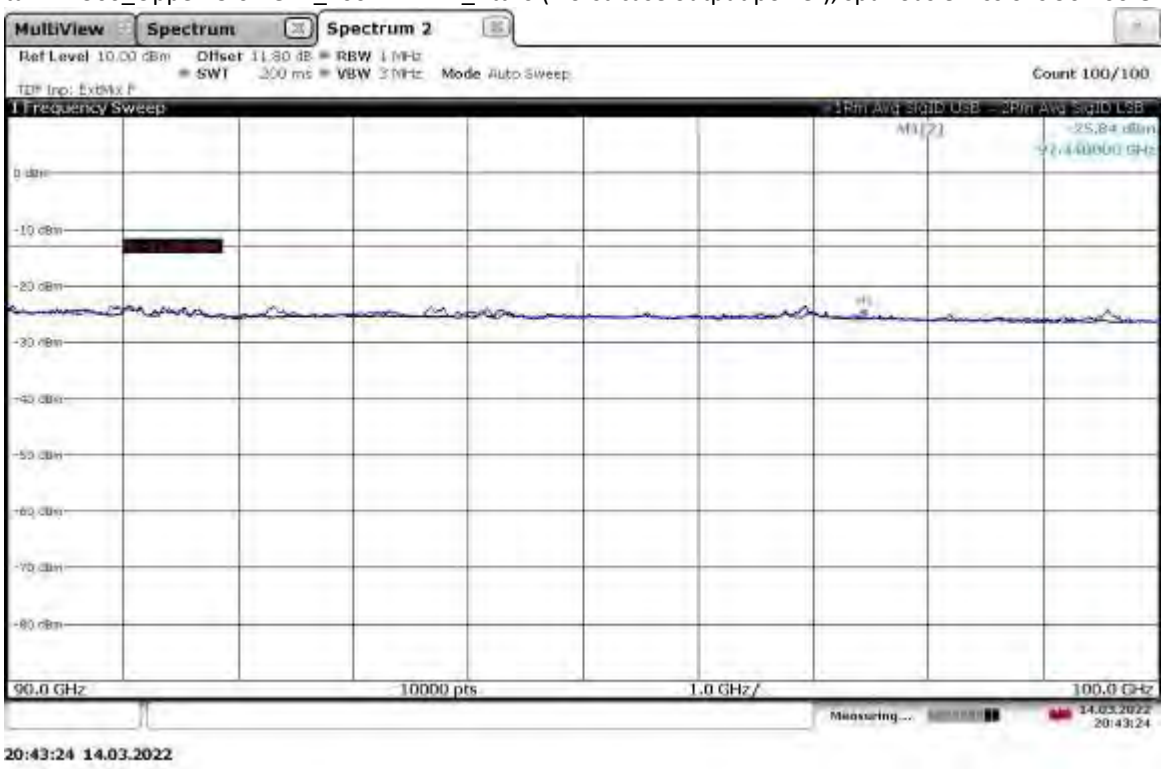
Titan 24-360_Upper25.04 GHz_160MHz BW_Att10 (worst-case output power), spurious emissions 60-90 GHz



19:14:56 14.03.2022

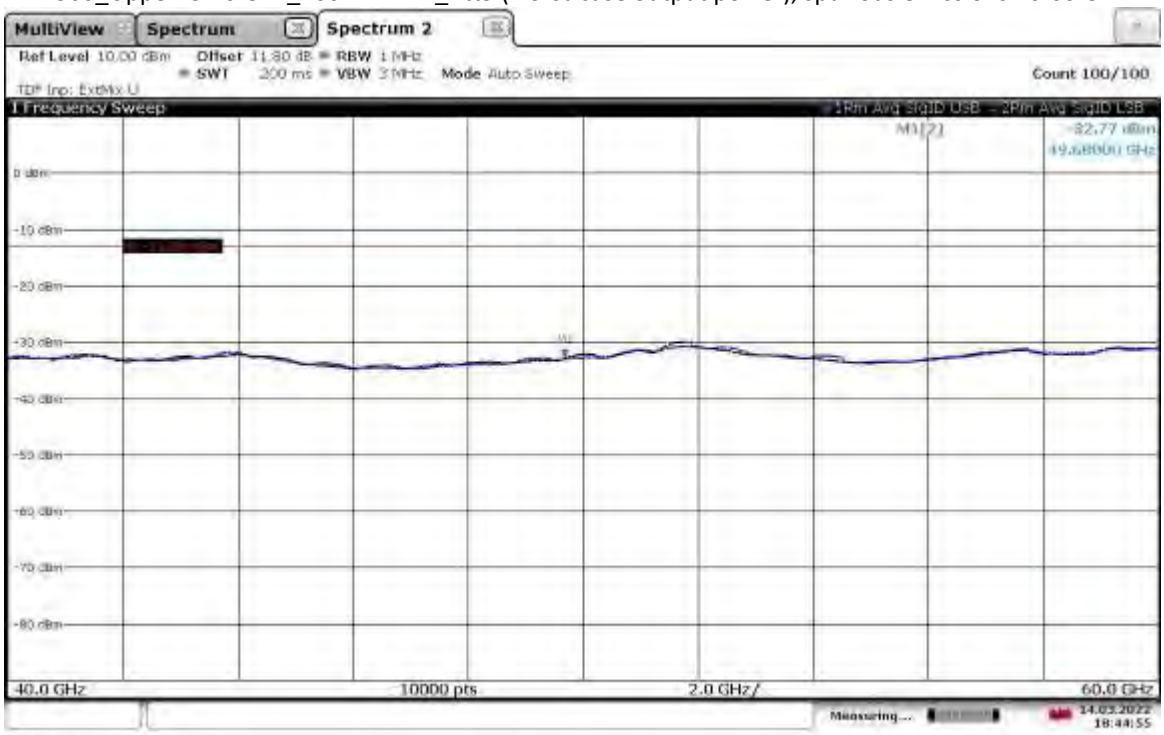
Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_Upper25.04 GHz_160MHz BW_Att10 (worst-case output power), spurious emissions 90-100 GHz



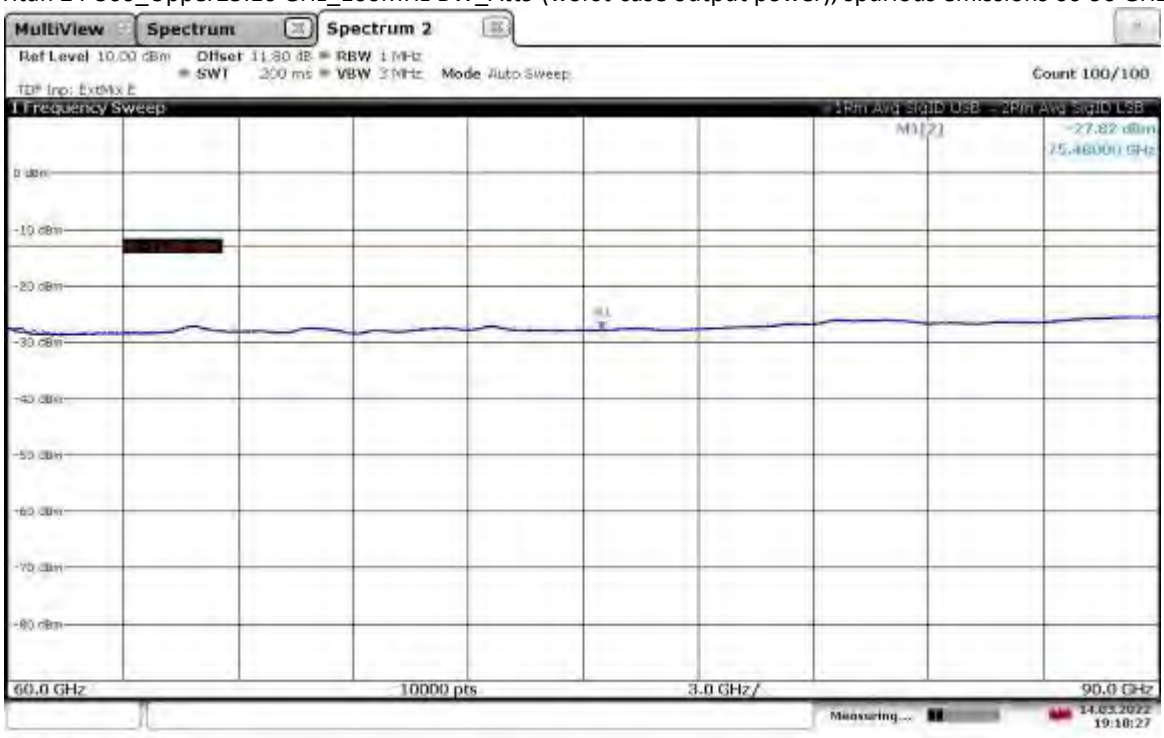
Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_Upper25.16 GHz_160MHz BW_Att9 (worst-case output power), spurious emissions 40-60 GHz



18:44:55 14.03.2022

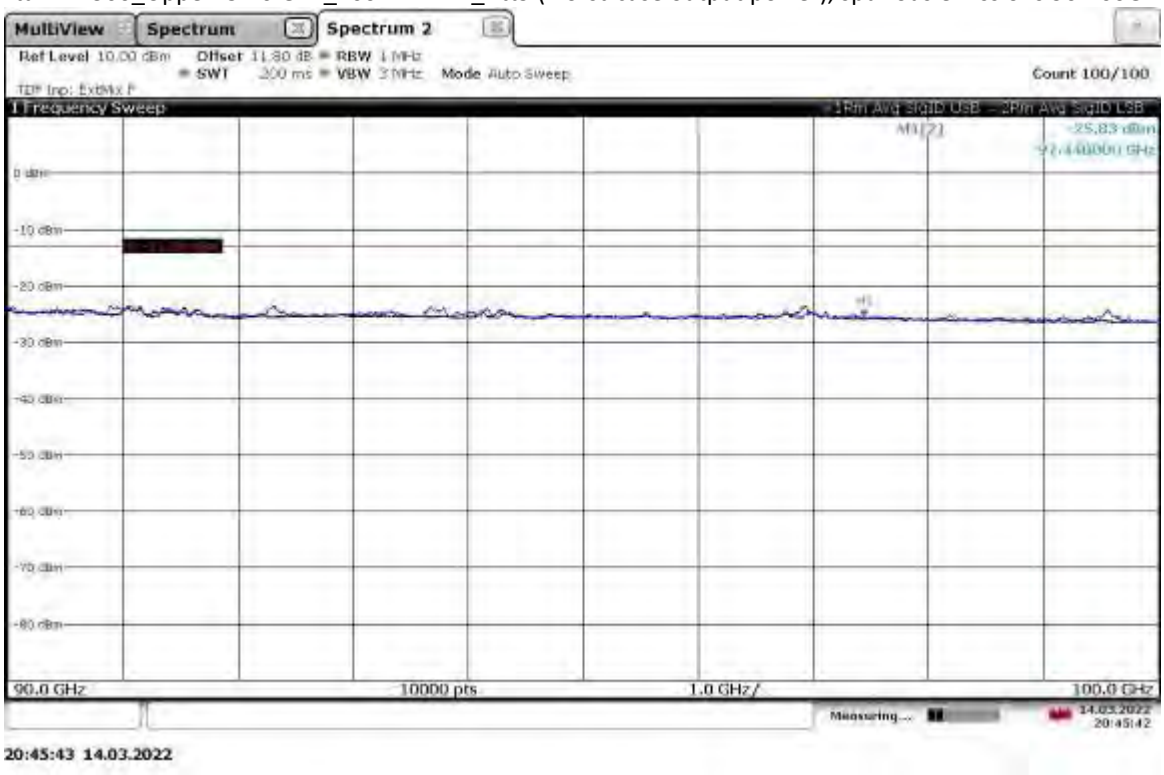
Titan 24-360_Upper25.16 GHz_160MHz BW_Att9 (worst-case output power), spurious emissions 60-90 GHz



19:18:27 14.03.2022

Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Titan 24-360_Upper25.16 GHz_160MHz BW_Att9 (worst-case output power), spurious emissions 90-100GHz



Notes: The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot.

Test Personnel:	Vathana F. Ven VFV	Test Date:	03/09/2022, 03/14/2022
	Kouma Sinn KPS		
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC 47CFR Part 30 Subparts C	Limit Applied:	See Report Section 8.3
Input Voltage:	48 VDC Via External P/S		
		Ambient Temperature:	23, 24 ºC
Pretest Verification w/ BB Source:	**Yes**	Relative Humidity:	18, 13 %
		Atmospheric Pressure:	1018, 1016 mbars

Deviations, Additions, or Exclusions: None

9 Occupied Bandwidths

9.1 Method

Tests are performed in accordance with FCC 47CFR Part 2.1049(i), FCC 47CFR Part 30 Subparts E Section 30.403, KDB 842590 D01 Upper Microwave Flexible Use Service v01r02 April 20, 2021 Subclause 4.3, and ANSI C63.26-2015 Subclause 5.4. The measurement was made on the maximum field strength in the same worst-case orientation as in report Section 6.1 with the Spectrum Analyzer setting as specified in ANSI C63.26-2015 Subclause 5.4.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

9.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/20/2021	03/20/2022
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	02/08/2022	02/08/2023
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	12/27/2021	12/27/2022
CBLHF2012-5M-2'	5m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252676002	02/16/2022	02/16/2023

Software Utilized:

Name	Manufacturer	Version
None	--	--

9.3 Results:

The sample tested was found to Comply.

Limit – FCC 47CFR Part 30 Subparts E Section 30.403: The maximum bandwidth authorized per frequency to the stations under this part of the section is 200 MHz.

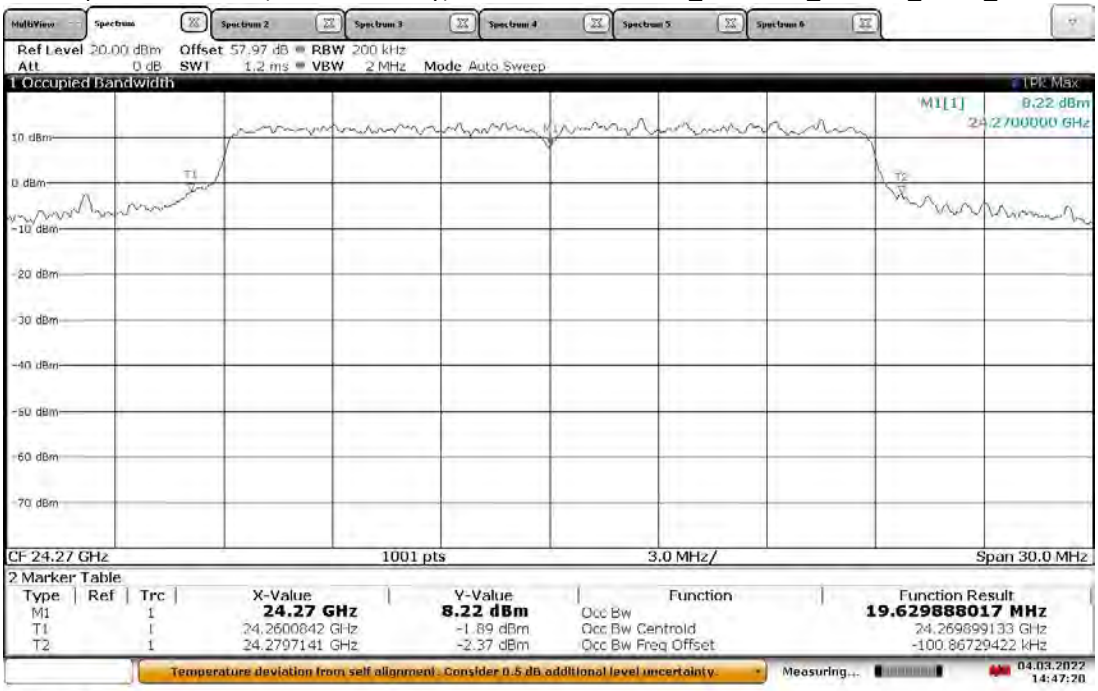
Frequency (GHz)	Transmitting Polarity	Modulation	Bandwidth (MHz)	Transmitting Path	Occupied Bandwidth (MHz)
24.27	Vertical	MCS8	20	1	19.63
24.28	Vertical	MCS8	20	1	19.81
24.29	Vertical	MCS8	20	1	19.62
24.77	Vertical	MCS8	20	1	19.93
24.97	Vertical	MCS8	20	1	19.54
25.09	Vertical	MCS8	20	1	19.94
24.27	Horizontal	MCS8	20	1	18.20
24.28	Horizontal	MCS8	20	1	18.02
24.29	Horizontal	MCS8	20	1	17.99
24.77	Horizontal	MCS8	20	1	18.31
24.97	Horizontal	MCS8	20	1	18.04
25.09	Horizontal	MCS8	20	1	18.05
24.34	Vertical	MCS0	160	1	159.20
24.35	Vertical	MCS0	160	1	159.53
24.36	Vertical	MCS0	160	1	160.04
24.84	Vertical	MCS0	160	1	159.66
25.04	Vertical	MCS0	160	1	159.15
25.16	Vertical	MCS0	160	1	159.33
24.34	Horizontal	MCS0	160	1	157.60
24.35	Horizontal	MCS0	160	1	158.44
24.36	Horizontal	MCS0	160	1	156.57
24.84	Horizontal	MCS0	160	1	157.26
25.04	Horizontal	MCS0	160	1	156.88
25.16	Horizontal	MCS0	160	1	156.29

9.4 Setup Photographs:

Setup Photographs are included in a separate file.

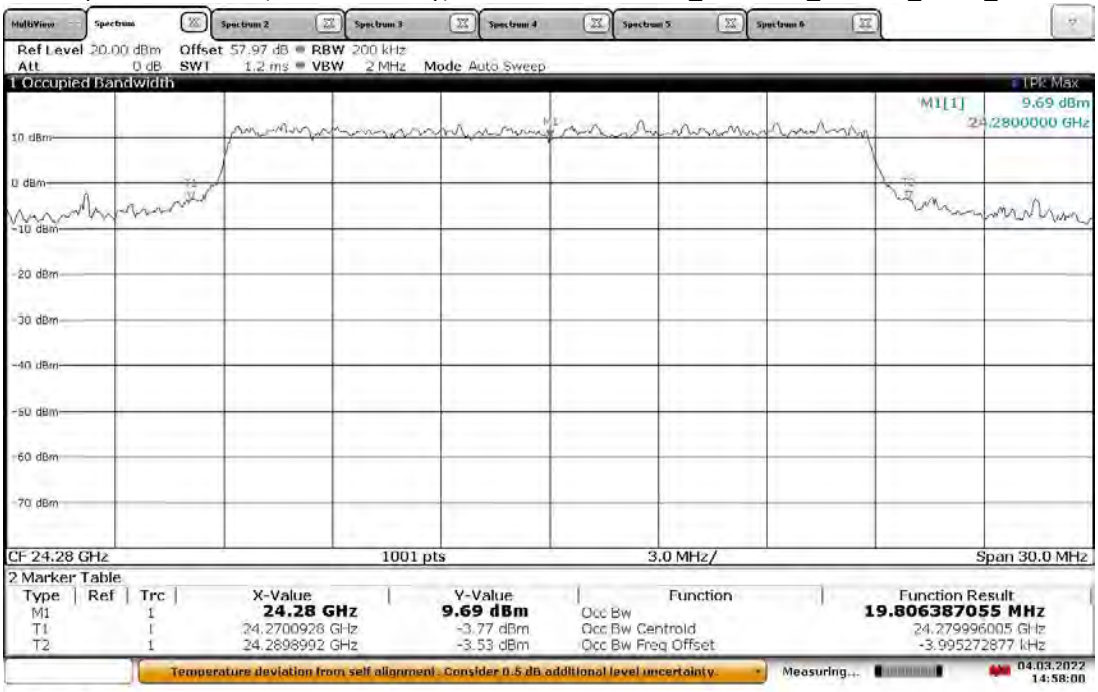
9.5 Plots/Data:

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_24.27GHz_BW20M_MCS8_Path 1



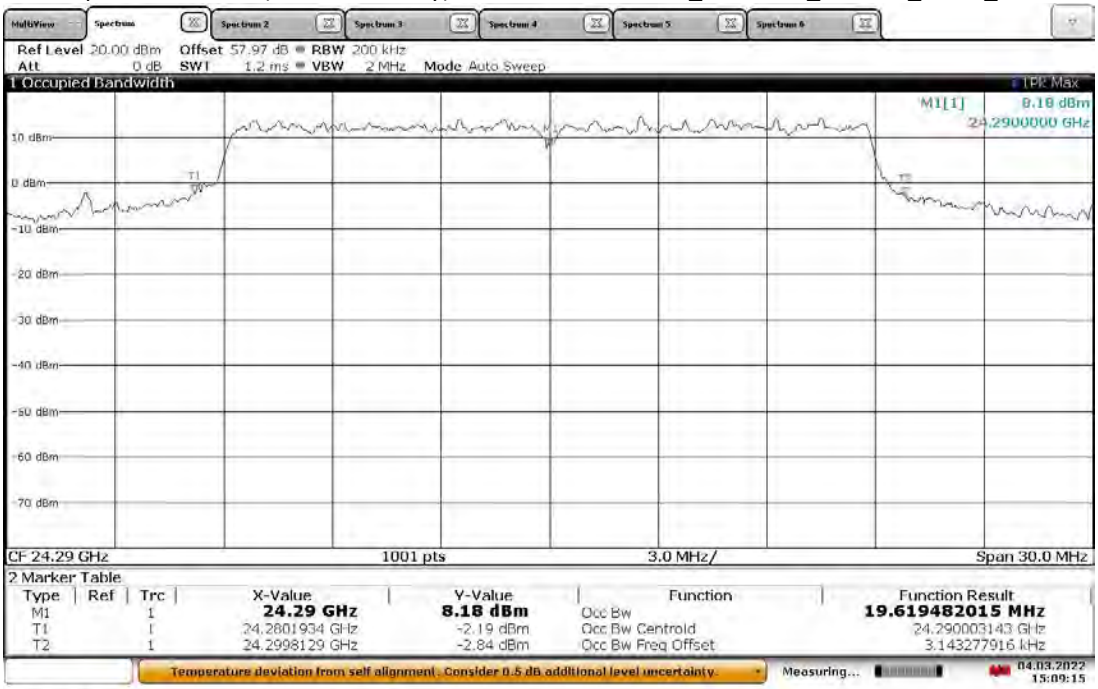
14:47:21 04.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_24.28GHz_BW20M_MCS8_Path 1



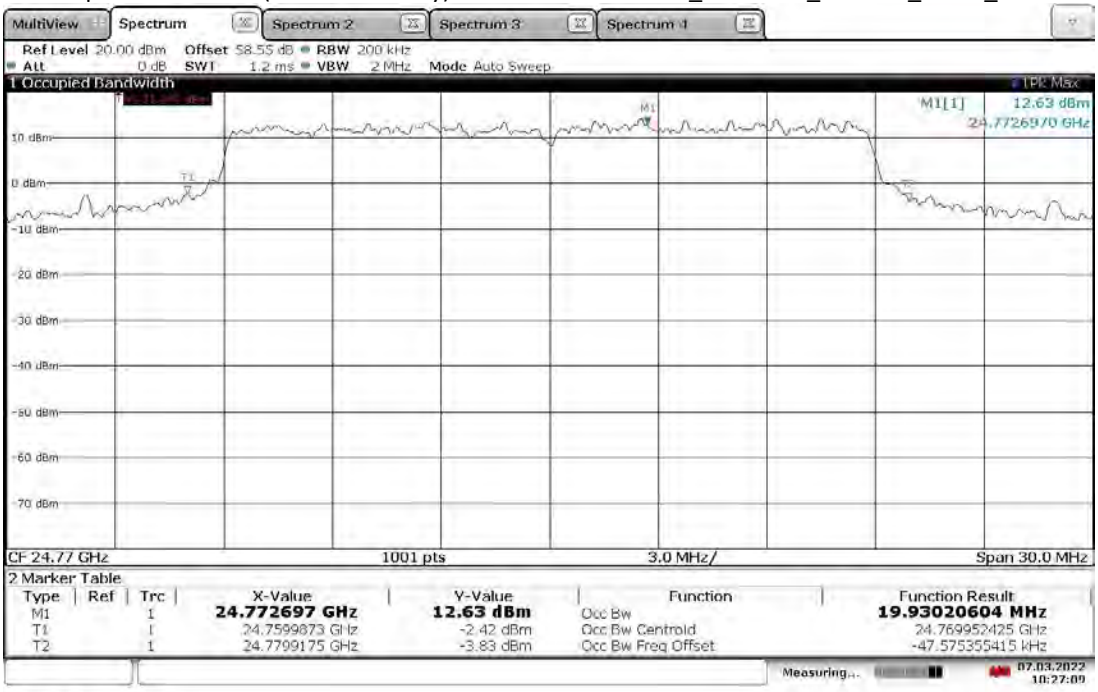
14:58:01 04.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_24.29GHz_BW20M_MCS8_Path 1



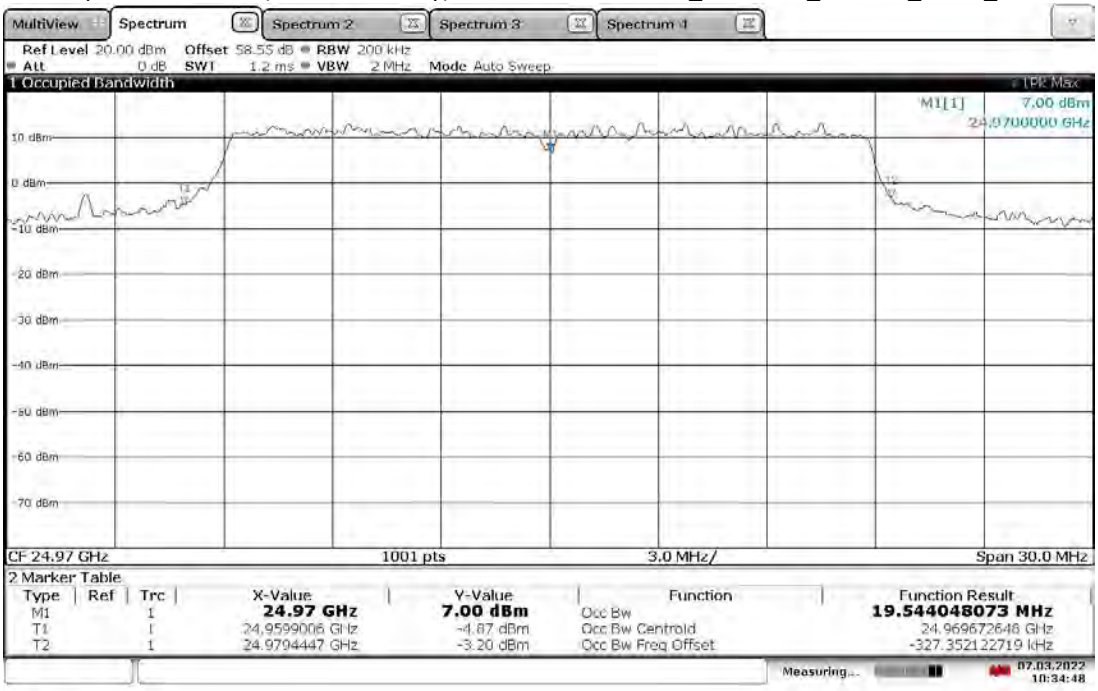
15:09:16 04.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_24.77GHz_BW20M_MCS8_Path 1



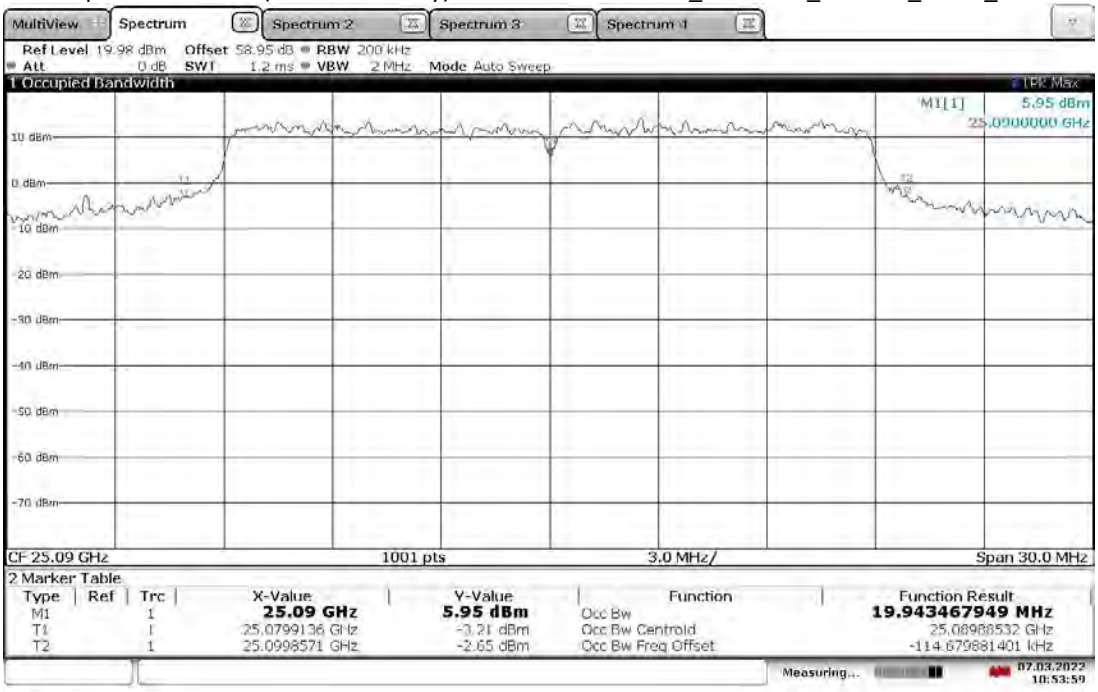
10:27:10 07.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_24.97GHz_BW20M_MCS8_Path 1



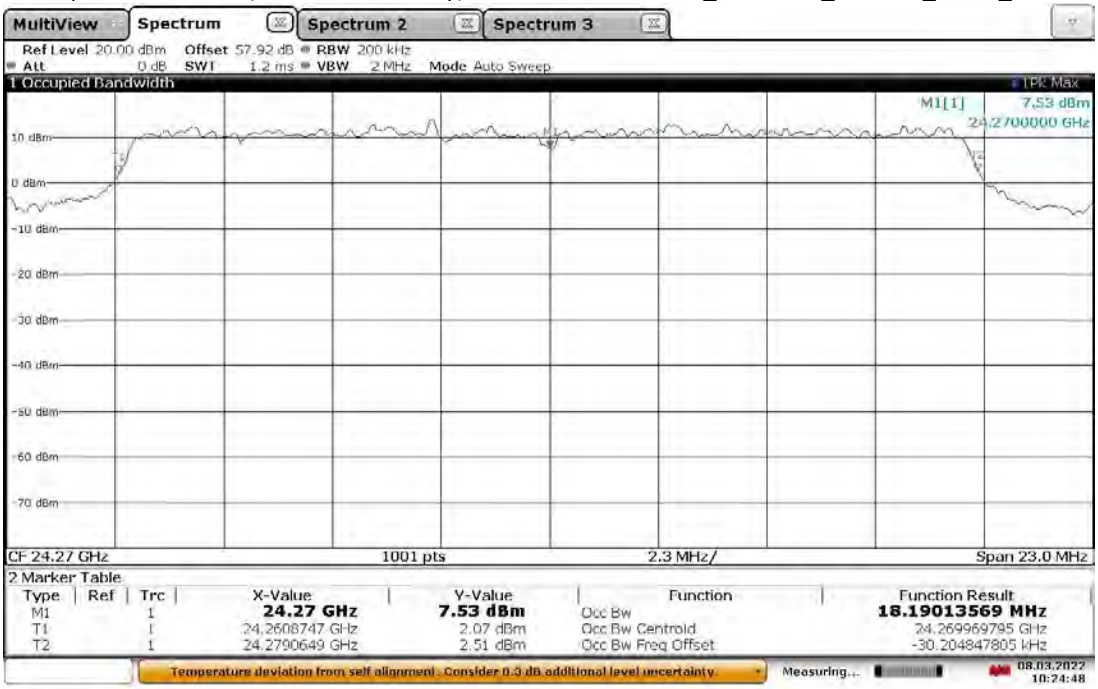
10:34:48 07.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_25.09GHz_BW20M_MCS8_Path 1



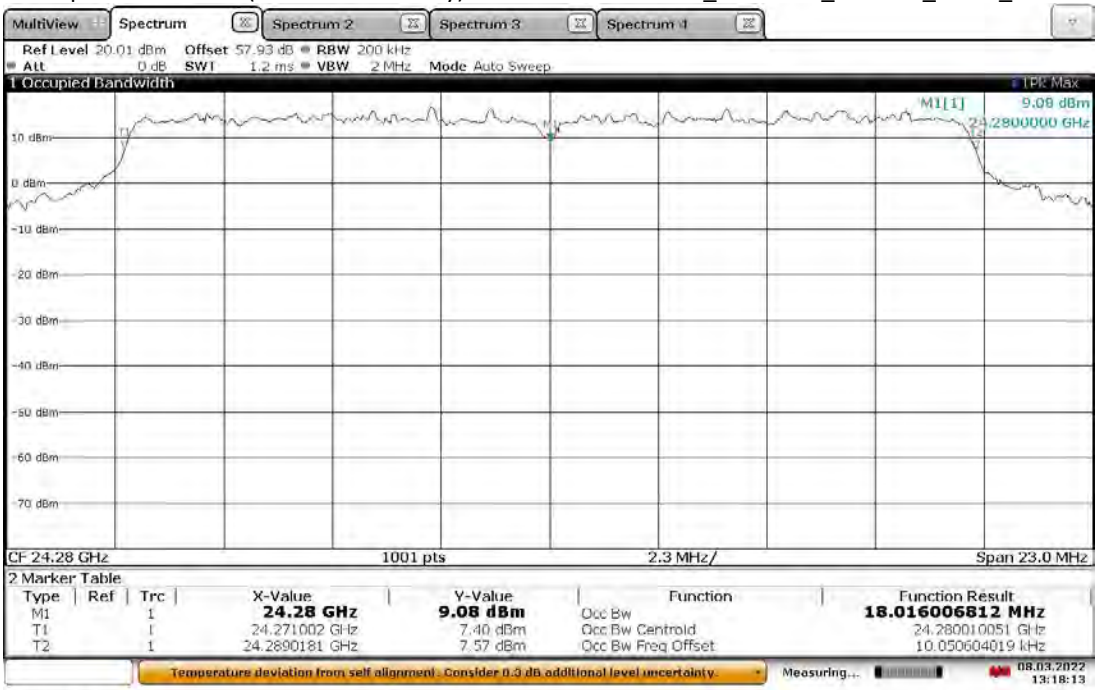
10:53:59 07.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_24.27GHz_BW20M_MCS8_Path 1



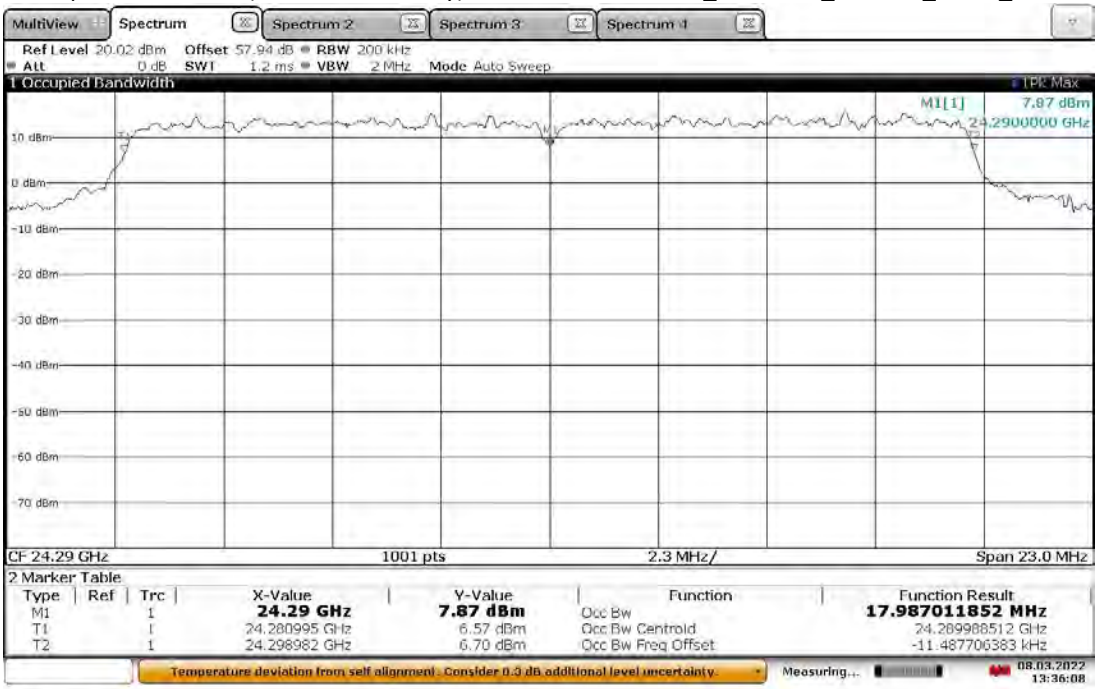
10:24:48 08.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_24.28GHz_BW20M_MCS8_Path 1



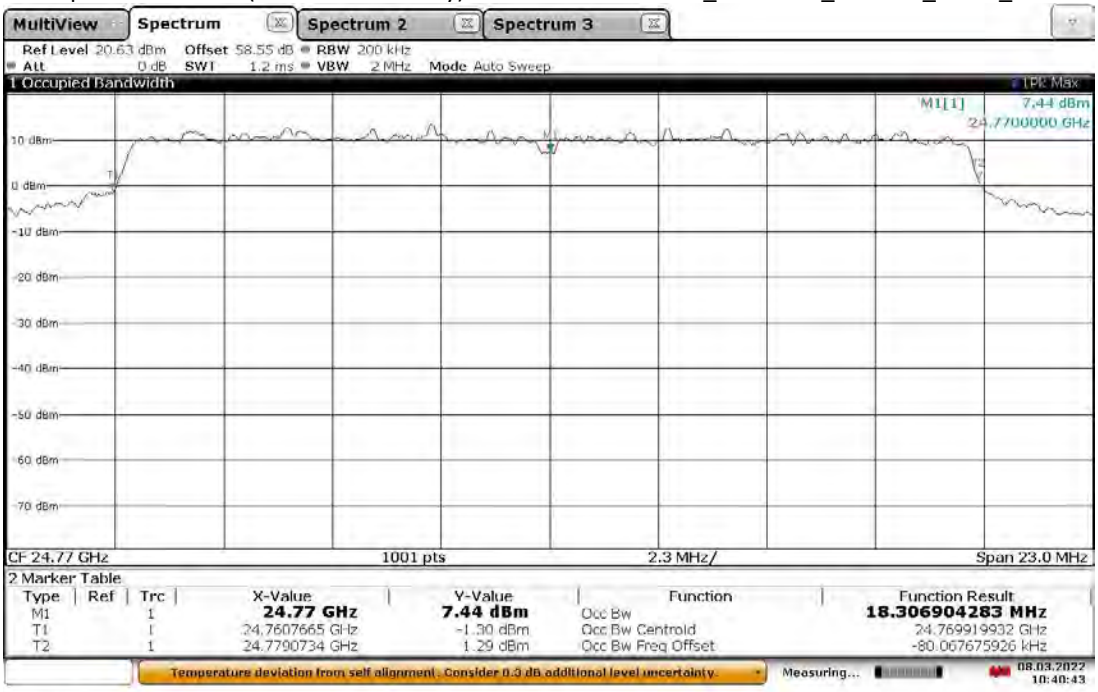
13:18:14 08.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_24.29GHz_BW20M_MCS8_Path 1



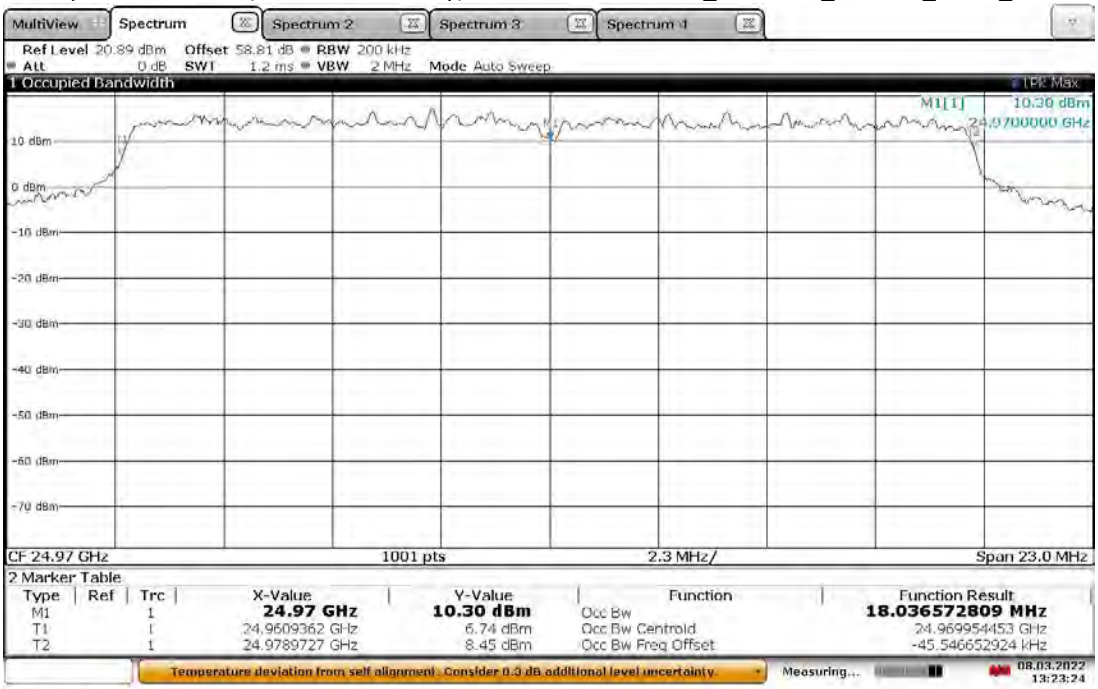
13:36:08 08.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_24.77GHz_BW20M_MCS8_Path 1



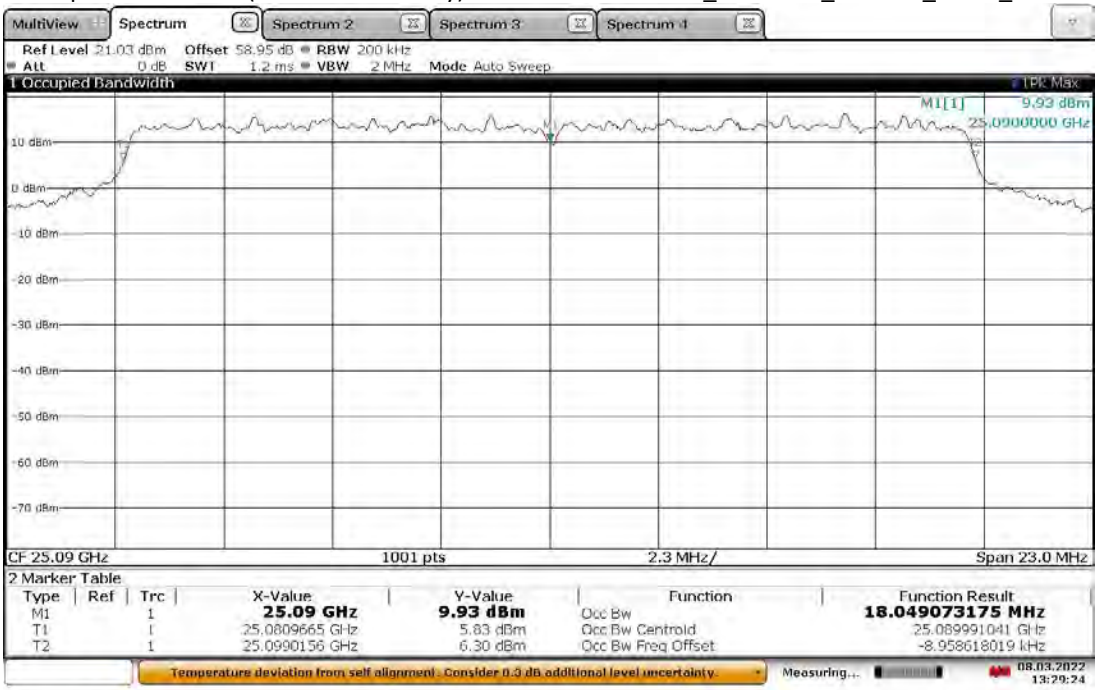
10:40:43 08.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_24.97GHz_BW20M_MCS8_Path 1



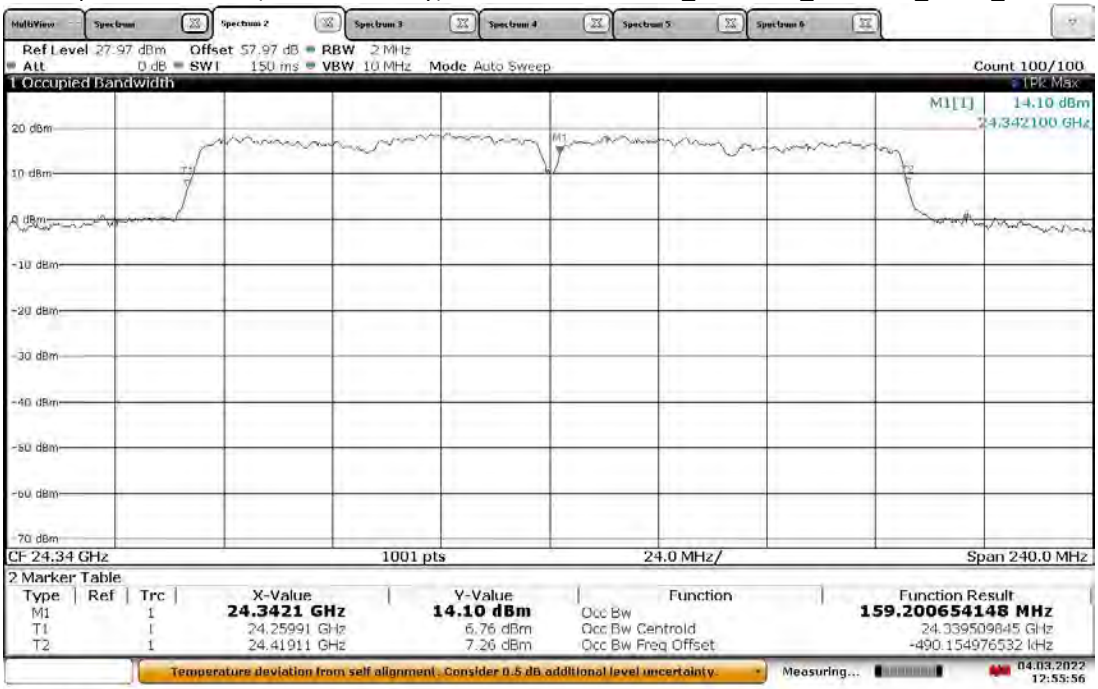
13:23:24 08.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_25.09GHz_BW20M_MCS8_Path 1



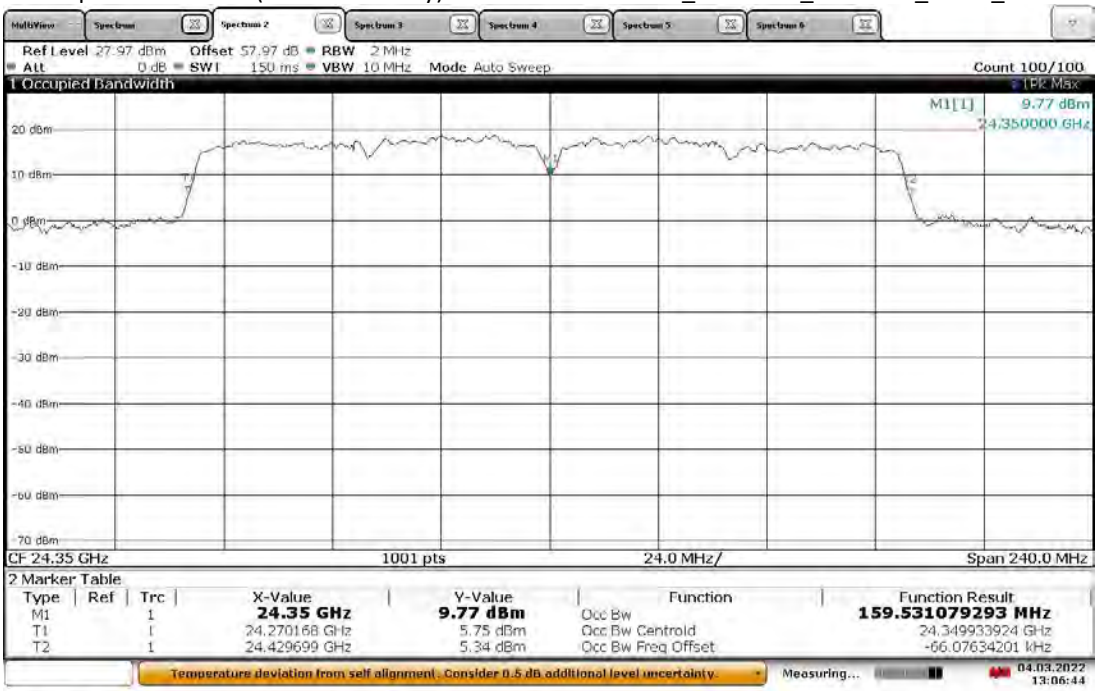
13:29:24 08.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_24.34GHz_BW160M_MCS0_Path 1



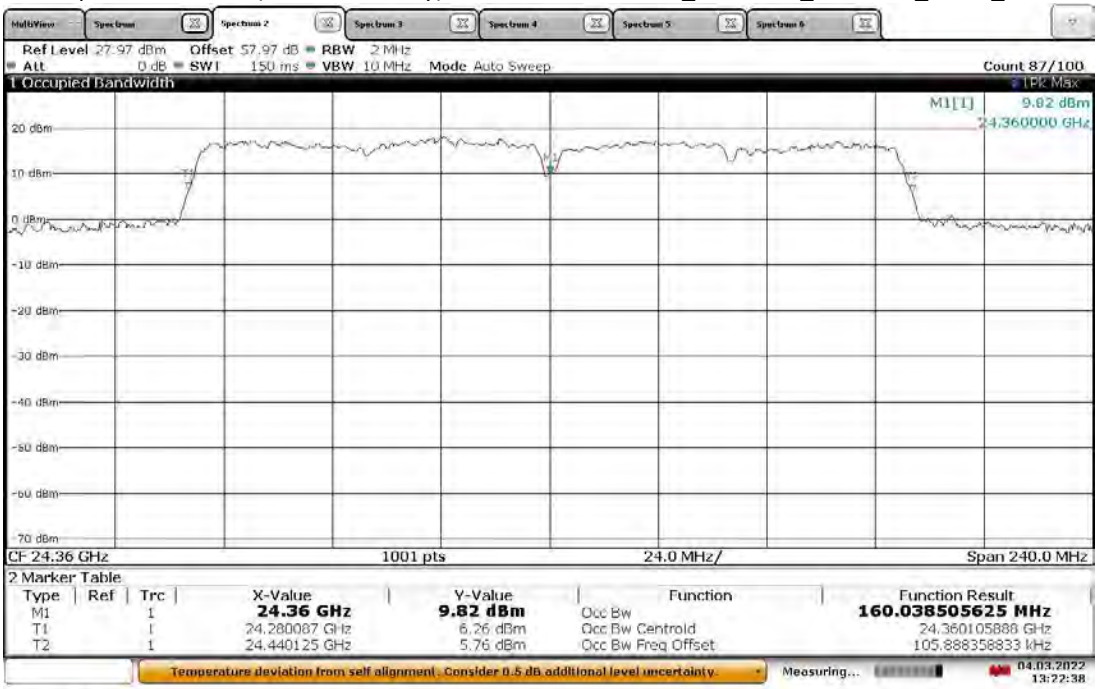
12:55:57 04.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_24.35GHz_BW160M_MCS0_Path 1



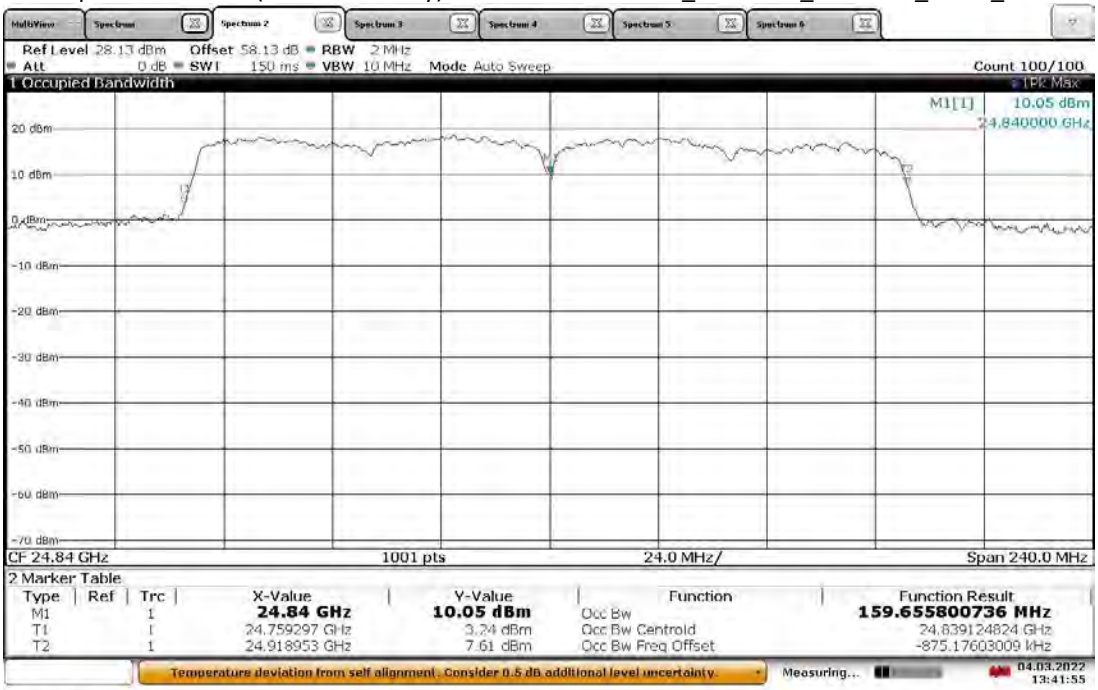
13:06:45 04.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_24.36GHz_BW160M_MCS0_Path 1



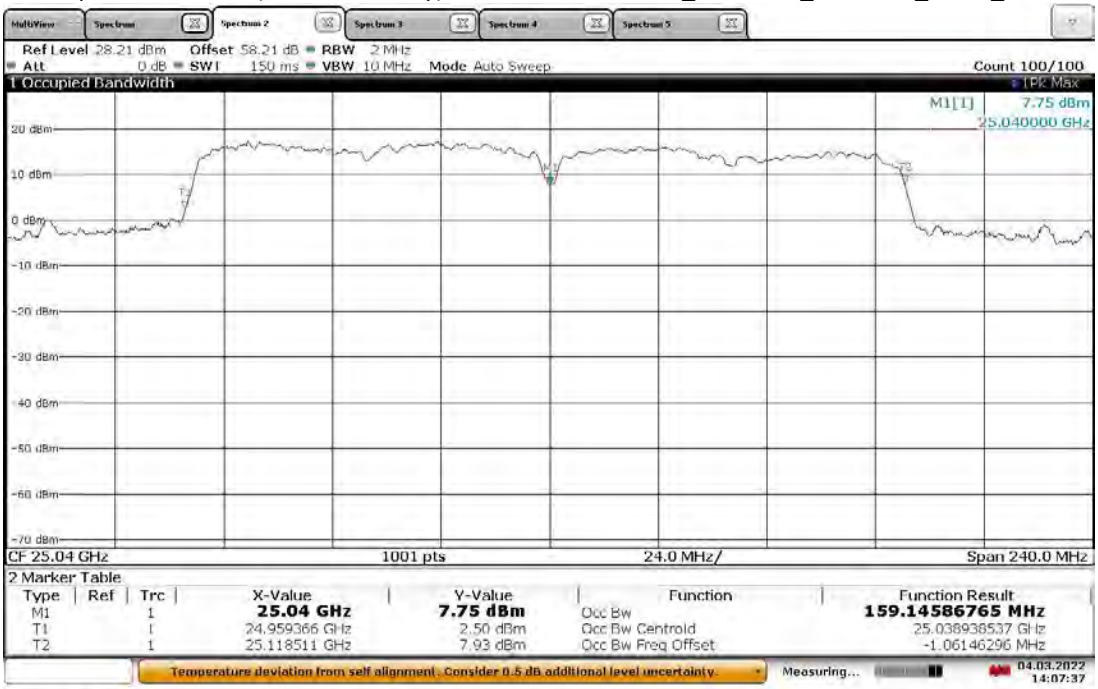
13:22:38 04.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_24.84GHz_BW160M_MCS0_Path 1



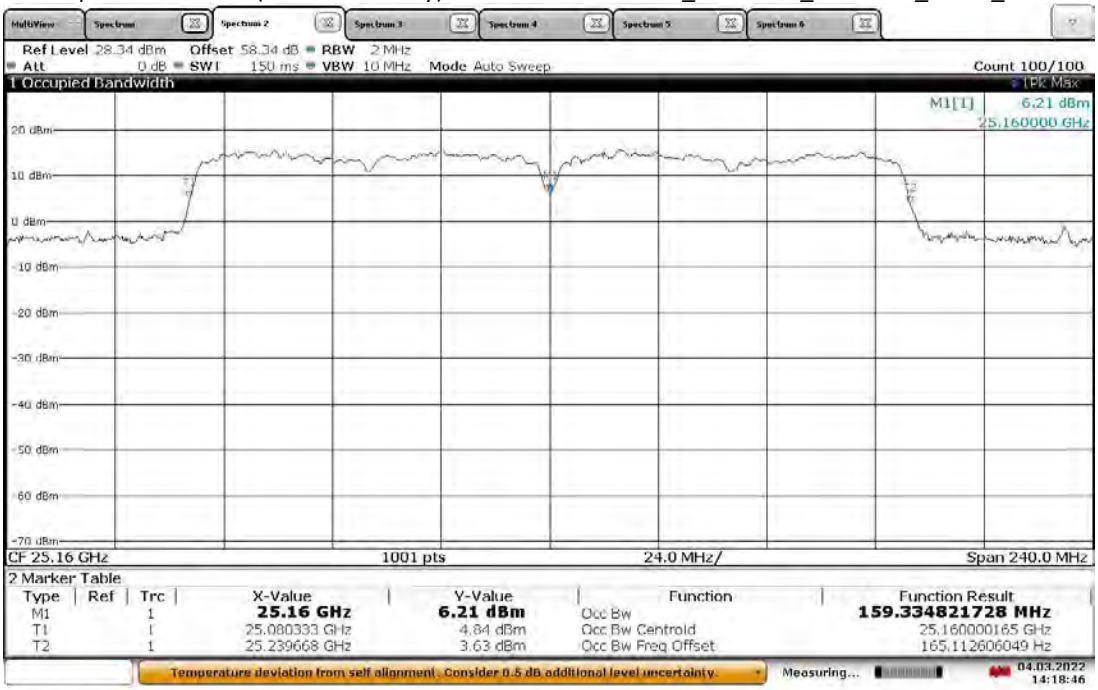
13:41:55 04.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_25.04GHz_BW160M_MCS0_Path 1



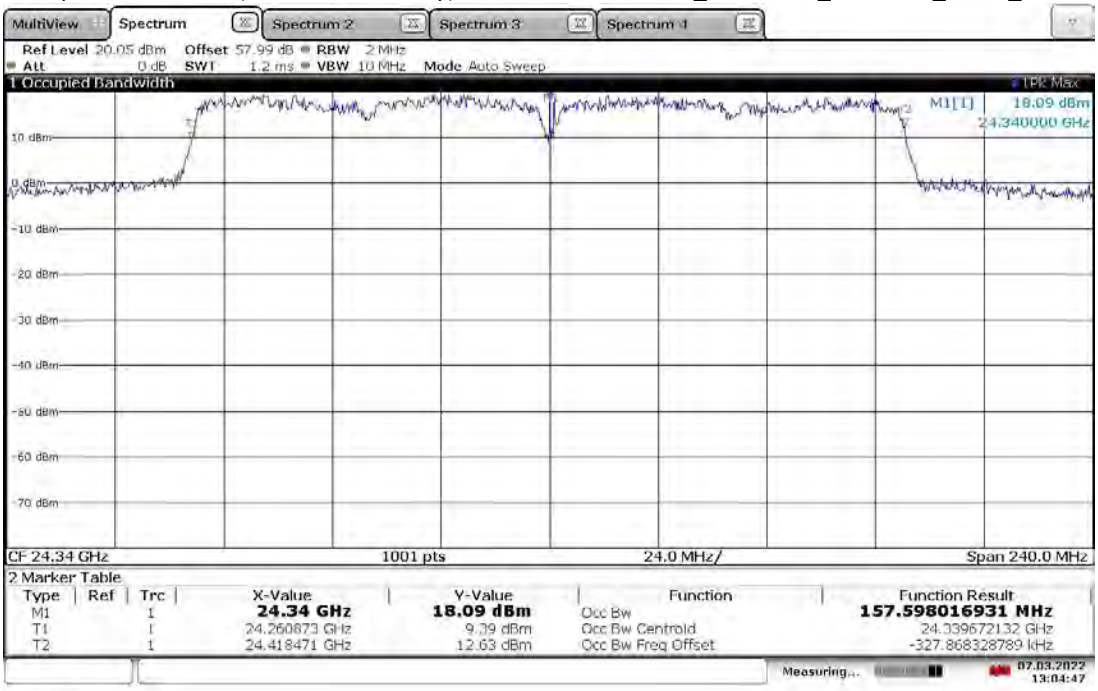
14:07:38 04.03.2022

Occupied Bandwidth (Vertical Polarity) – Model Titan 24-360_25.16GHz_BW160M_MCS0_Path 1



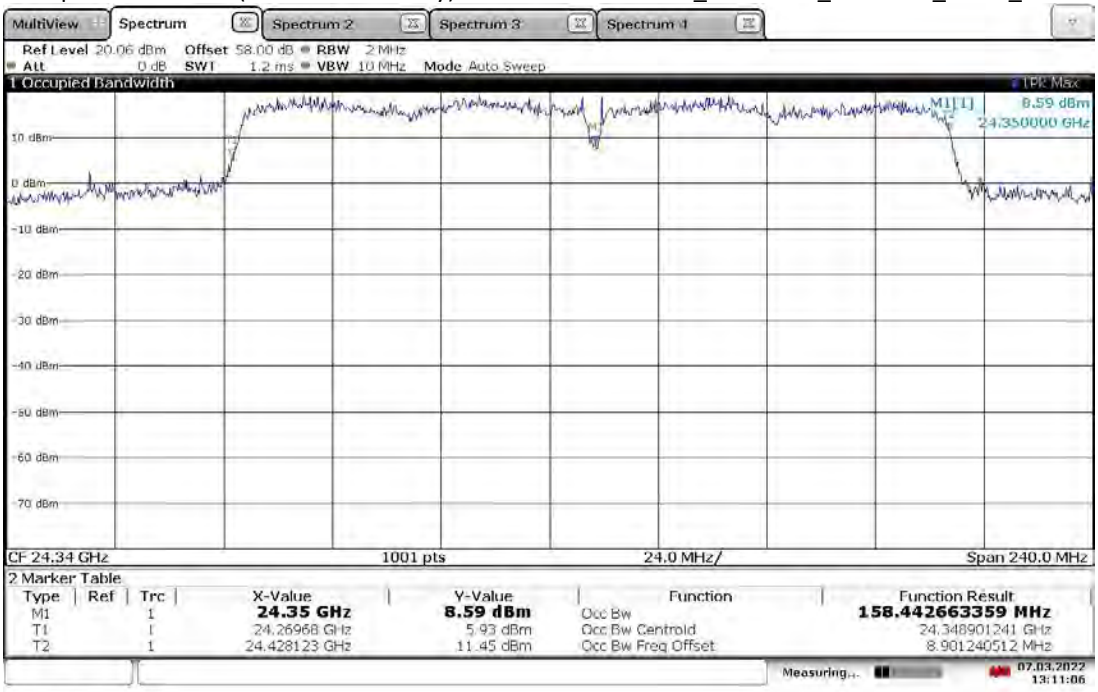
14:18:47 04.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_24.34MHz_BW160M_MCS0_Path 1



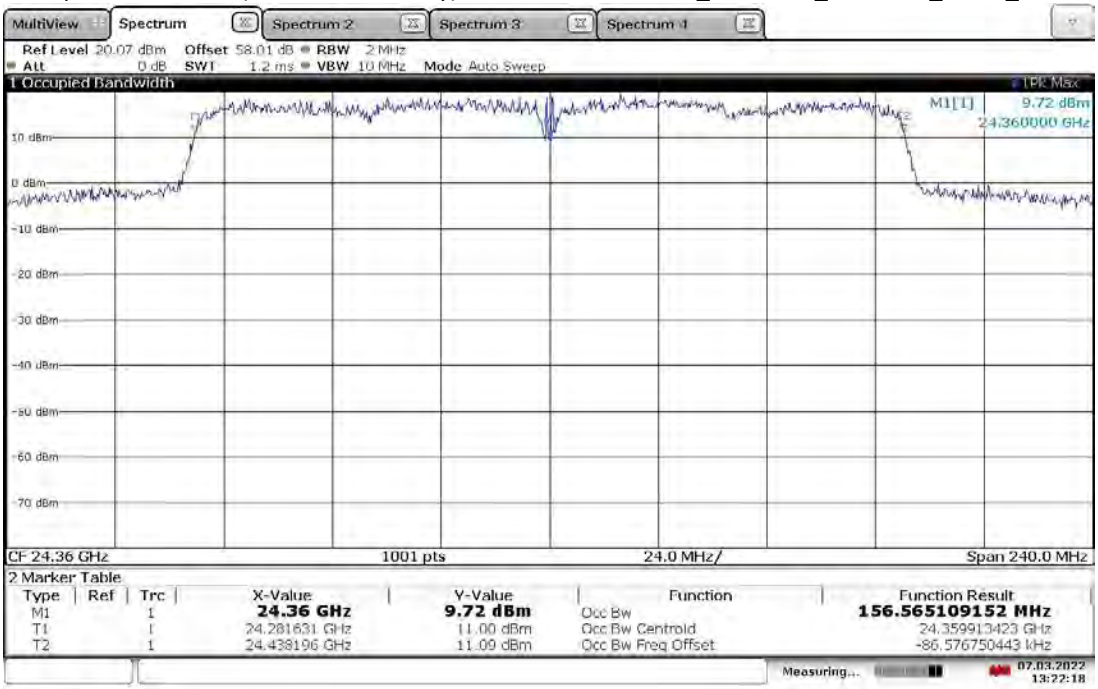
13:04:48 07.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_24.35MHz_BW160M_MCS0_Path 1



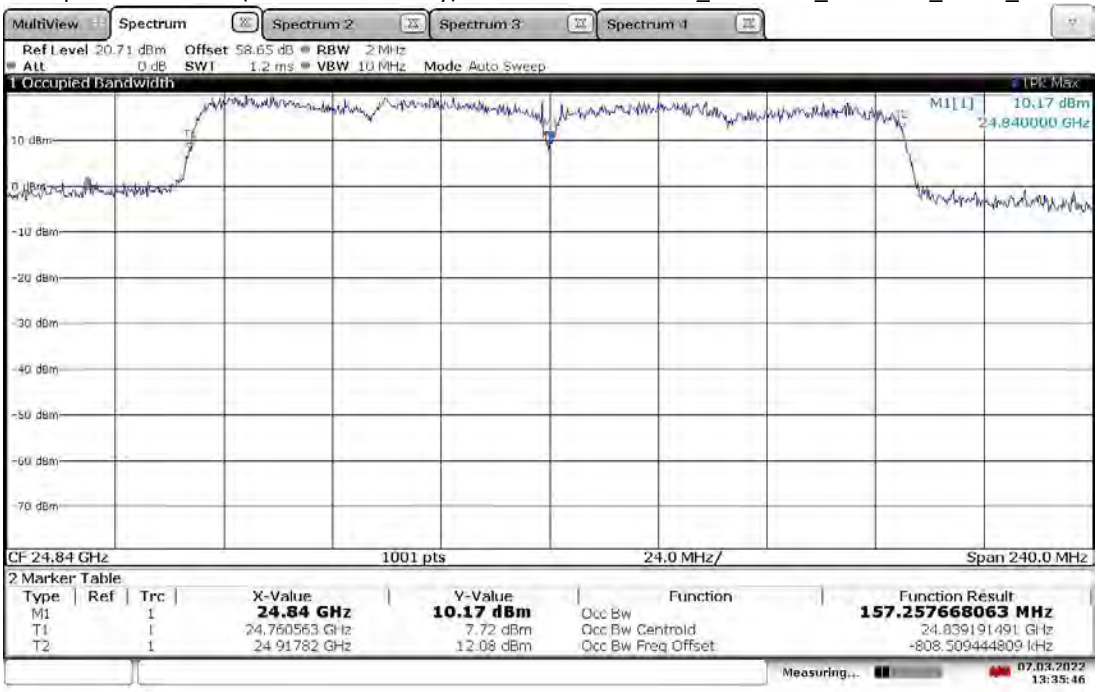
13:11:07 07.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_24.36GHz_BW160M_MCS0_Path 1



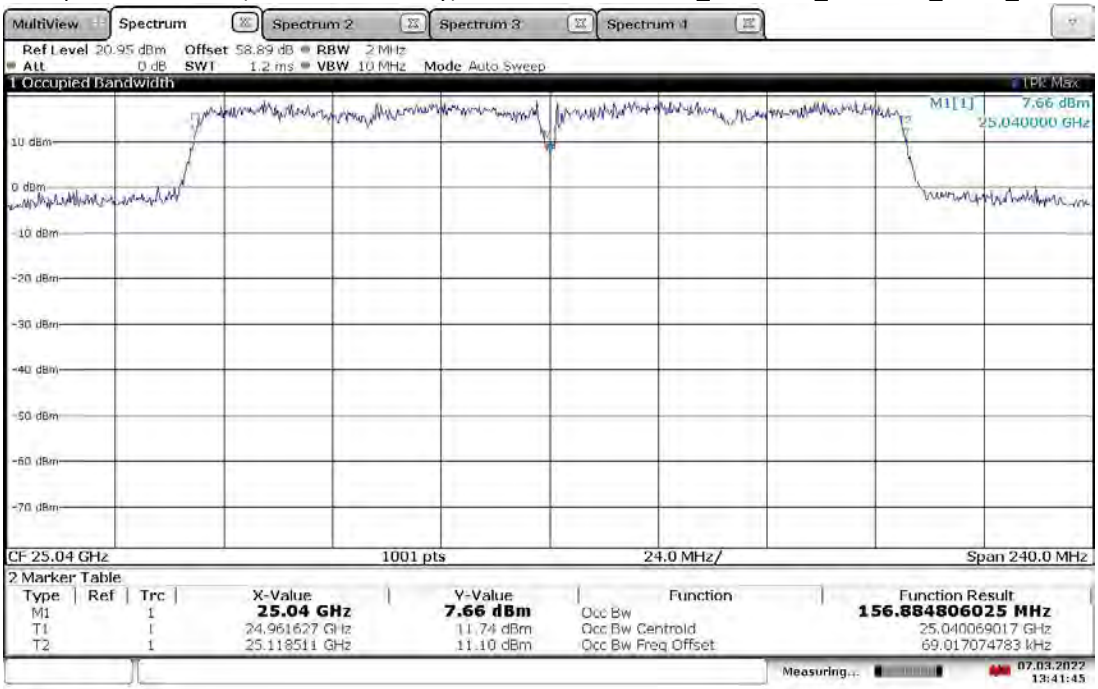
13:22:19 07.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_24.84GHz_BW160M_MCS0_Path 1



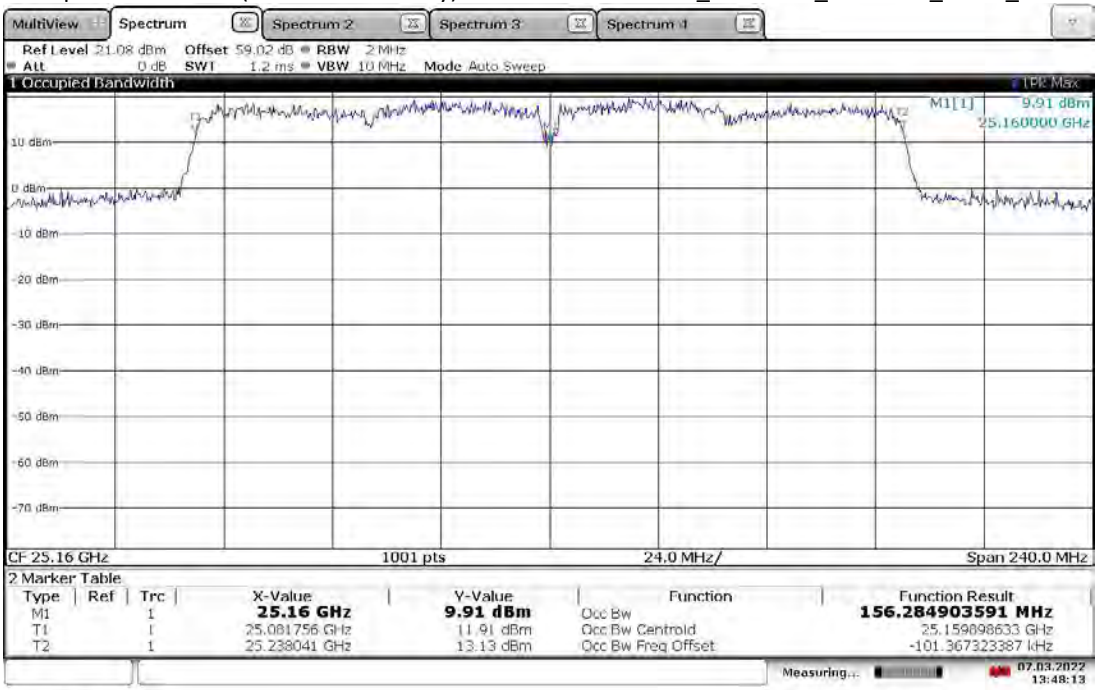
13:35:46 07.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_25.04GHz_BW160M_MCS0_Path 1



13:41:45 07.03.2022

Occupied Bandwidth (Horizontal Polarity) – Model Titan 24-360_25.16GHz_BW160M_MCS0_Path 1



13:48:14 07.03.2022

Test Personnel:	Kouma Sinn KPS	Test Date:	03/04/2022, 03/07/2022, 03/08/2022
Supervising/Reviewing Engineer: (Where Applicable)	Vathana F. Ven VFV		
Product Standard:	FCC 47CFR Part 30 Subpart C and E	Limit Applied:	See Report Section 9.3
Input Voltage:	48 VDC Via External P/S	Ambient Temperature:	25, 23, 23 ºC
Pretest Verification w/ BB Source:	**Yes**	Relative Humidity:	10, 30, 25 %
		Atmospheric Pressure:	1022, 1002, 1006 mbars

Deviations, Additions, or Exclusions: None

10 Frequency Stability

10.1 Method

Tests are performed in accordance with FCC 47CFR Part 30 Subparts E Section 30.402, FCC 47CFR Part 2.1055, FCC 47CFR Part 2.1041, KDB 842590 D01 Upper Microwave Flexible Use Service v01r02 April 20, 2021 Subclause 4.5, and ANSI C63.26-2015 Subclause 5.6.

TEST SITE: Safety Lab

10.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
SAF1153'	Freezing Rain\Icing\Temp\Humidity\ -73deg C to +190deg C, 95% humidity, Ice Freezing Rain	Cincinnati Sub-Zero	CTH-(FR)64-6-6-SC/AC	12-CT15628	11/22/2021	11/22/2022
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	02/08/2022	02/08/2023
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	12/27/2021	12/27/2022
FLU13'	Digital Multimeter	Fluke	87-5	23500632	11/16/2021	11/16/2022
CBLHF2012-5M-2'	5m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252676002	02/16/2022	02/16/2023
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/20/2021	03/20/2022

Software Utilized:

Name	Manufacturer	Version
EMI Boxborough.xls	Intertek	08/27/2010

10.3 Results:

The sample tested was found to Comply.

Limit – FCC 47CFR Part 30 Subparts E Section 30.402: The carrier frequency shall remain within ±0.001% with variation of voltages and temperatures.

10.4 Setup Photographs:

Setup Photographs are included in a separate file.

10.5 Test Data:

24.34 GHz Frequency Stability

Company: Starry
Model #: Titan 24-360
Serial #: 2207250003
Engineer(s): Vathana Ven Location: Safety
Project #: G105000232 Date(s): 03/15/22
Standard: FCC Part 30.402
Limit: 10 PPM 0.001%
Nominal f: 24340 MHz

Test Equipment Used:
SAF1153 EMC04 SAF784
ROS005-1 SAF1312 DAV005
CBLHF2012-5M-2 21 deg C 59% 1005 mB
Voltage: 48 VDC

%	Voltage Volts	Frequency GHz	Deviation kHz	Limit kHz
-15%	40.8	24.339965000	-0.055	243.40
+0%	48	24.340020000	0	243.40
+15%	55.2	24.340015000	-0.005	243.40

Temp Celsius	Frequency GHz	Deviation kHz	Limit kHz
-30	24.340059900	0.0399	243.40
-20	24.340045000	0.025	243.40
-10	24.339985000	-0.035	243.40
0	24.340020000	0	243.40
10	24.340050000	0.03	243.40
20	24.340020000	0	243.40
30	24.340020000	0	243.40
40	24.340030000	0.01	243.40
50	24.339970000	-0.05	243.40

24.35 GHz Frequency Stability

Company: Starry
Model #: Titan 24-360
Serial #: 2207250003
Engineer(s): Vathana Ven Location: Safety
Project #: G105000232 Date(s): 03/15/22
Standard: FCC Part 30.402
Limit: 10 PPM 0.001%
Nominal f: 24350 MHz

Test Equipment Used:
SAF1153 EMC04 SAF784
ROS005-1 SAF1312 DAV005
CBLHF2012-5M-2 21 deg C 59% 1005 mB
Voltage: 48 VDC

%	Voltage Volts	Frequency GHz	Deviation kHz	Limit kHz
-15%	40.8	24.349950000	-0.06	243.50
+0%	48	24.350010000	0	243.50
+15%	55.2	24.350020000	0.01	243.50

Temp Celsius	Frequency GHz	Deviation kHz	Limit kHz
-30	24.349970000	-0.04	243.50
-20	24.350084900	0.0749	243.50
-10	24.349960000	-0.05	243.50
0	24.349980000	-0.03	243.50
10	24.349955000	-0.055	243.50
20	24.350010000	0	243.50
30	24.349915100	-0.0949	243.50
40	24.349980000	-0.03	243.50
50	24.349915100	-0.0949	243.50

24.36 GHz Frequency Stability

Company: Starry
Model #: Titan 24-360
Serial #: 2207250003
Engineer(s): Vathana Ven Location: Safety
Project #: G105000232 Date(s): 03/15/22
Standard: FCC Part 30.402
Limit: 10 PPM 0.001%
Nominal f: 24360 MHz

Test Equipment Used:
SAF1153 EMC04 SAF784
ROS005-1 SAF1312 DAV005
CBLHF2012-5M-2 21 deg C 59% 1005 mB
Voltage: 48 VDC

%	Voltage Volts	Frequency GHz	Deviation kHz	Limit kHz
-15%	40.8	24.360030000	-0.0399	243.60
+0%	48	24.360069900	0	243.60
+15%	55.2	24.360020000	-0.0499	243.60

Temp Celsius	Frequency GHz	Deviation kHz	Limit kHz
-30	24.359830200	-0.240	243.60
-20	24.360089900	0.020	243.60
-10	24.360050000	-0.020	243.60
0	24.360015000	-0.055	243.60
10	24.359930100	-0.140	243.60
20	24.360069900	0.000	243.60
30	24.360144900	0.075	243.60
40	24.360010000	-0.060	243.60
50	24.359960000	-0.110	243.60

24.84 GHz Frequency Stability

Company: Starry
Model #: Titan 24-360
Serial #: 2207250003
Engineer(s): Vathana Ven Location: Safety
Project #: G105000232 Date(s): 03/15/22
Standard: FCC Part 30.402
Limit: 10 PPM 0.001%
Nominal f: 24840 MHz

Test Equipment Used:
SAF1153 EMC04 SAF784
ROS005-1 SAF1312 DAV005
CBLHF2012-5M-2 21 deg C 59% 1005 mB
Voltage: 48 VDC

%	Voltage Volts	Frequency GHz	Deviation kHz	Limit kHz
-15%	40.8	24.840094900	0.0949	248.40
+0%	48	24.840000000	0	248.40
+15%	55.2	24.839975000	-0.025	248.40

Temp Celsius	Frequency GHz	Deviation kHz	Limit kHz
-30	24.839980000	-0.02	248.40
-20	24.840089900	0.0899	248.40
-10	24.839860100	-0.1399	248.40
0	24.840015000	0.015	248.40
10	24.840069900	0.0699	248.40
20	24.840000000	0	248.40
30	24.839920100	-0.0799	248.40
40	24.839950000	-0.05	248.40
50	24.840084900	0.0849	248.40

25.04 GHz Frequency Stability

Company: Starry
Model #: Titan 24-360
Serial #: 2207250003
Engineer(s): Vathana Ven Location: Safety
Project #: G105000232 Date(s): 03/15/22
Standard: FCC Part 30.402
Limit: 10 PPM 0.001%
Nominal f: 25040 MHz

Test Equipment Used:
SAF1153 EMC04 SAF784
ROS005-1 SAF1312 DAV005
CBLHF2012-5M-2 21 deg C 59% 1005 mB
Voltage: 48 VDC

%	Voltage Volts	Frequency GHz	Deviation kHz	Limit kHz
-15%	40.8	25.040129900	0.2248	250.40
+0%	48	25.039905100	0	250.40
+15%	55.2	25.040109900	0.2048	250.40

Temp Celsius	Frequency GHz	Deviation kHz	Limit kHz
-30	25.039965000	0.0599	250.40
-20	25.039940100	0.035	250.40
-10	25.039910100	0.005	250.40
0	25.039980000	0.0749	250.40
10	25.040059900	0.1548	250.40
20	25.039905100	0	250.40
30	25.039985000	0.0799	250.40
40	25.040020000	0.1149	250.40
50	25.040020000	0.1149	250.40

25.16 GHz Frequency Stability

Company: Starry
Model #: Titan 24-360
Serial #: 2207250003
Engineer(s): Vathana Ven Location: Safety
Project #: G105000232 Date(s): 03/15/22
Standard: FCC Part 30.402
Limit: 10 PPM 0.001%
Nominal f: 25160 MHz

Test Equipment Used:
SAF1153 EMC04 SAF784
ROS005-1 SAF1312 DAV005
CBLHF2012-5M-2 21 deg C 59% 1005 mB
Voltage: 48 VDC

%	Voltage Volts	Frequency GHz	Deviation kHz	Limit kHz
-15%	40.8	25.160099900	0.1598	251.60
+0%	48	25.159940100	0	251.60
+15%	55.2	25.160000000	0.0599	251.60

Temp Celsius	Frequency GHz	Deviation kHz	Limit kHz
-30	25.159985000	0.0449	251.60
-20	25.159950000	0.0099	251.60
-10	25.160025000	0.0849	251.60
0	25.159980000	0.0399	251.60
10	25.160010000	0.0699	251.60
20	25.159940100	0	251.60
30	25.160045000	0.1049	251.60
40	25.159940100	0	251.60
50	25.159970000	0.0299	251.60

Test Personnel:	Vathana F. Ven VFV	Test Date:	03/15/2022
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC 47CFR Part 30 Subparts C and E	Limit Applied:	See Report Section 10.3
Input Voltage:	48VDC Via External P/S	Ambient Temperature:	21 °C
Pretest Verification w/ Signal generator:	**N/A**	Relative Humidity:	59 %
		Atmospheric Pressure:	1005 mBar

Deviations, Additions, or Exclusions: None

11 AC Main Conducted Emissions

11.1 Method

Tests are performed in accordance with FCC Part 15 Subpart B and ANSI C63.4.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
AC Line Conducted Emissions	150 kHz - 30 MHz	1.2 dB	3.4dB
Telco Port Emissions	150 kHz - 30 MHz	2.8 dB	5.0dB
AC Line Conducted Emissions	9 kHz - 150 MHz	2.2 dB	3.4 dB

As shown in the table above our conducted emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculations

The following is how net line-conducted readings were determined:

NF = RF + LF + CF + AF
Where NF = Net Reading in dBμV
RF = Reading from receiver in dBμV
LF = LISN or ISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBμV
$UF = 10^{(49.1\ dB\mu V / 20)}$ = 285.1 μV/m

When BAT-EMC Emission Software is used, the "Level" includes all losses and gains and is compared directly in the "Margin" column to the "Limit". The "Correction" includes LISN Factor, Attenuator, and Cable Loss. These are already accounted for in the "Level" column.

11.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV005	Weather Station	Davis	6250	MS191218083	02/11/2022	02/11/2023
LISN32`	LISN - CISPR16 Compliant 9kHz-30MHz	Com-Power	LI-215A	191955	05/11/2021	05/11/2022
CBL043`	3ft BNC to BNC	Hosiwell	Coax RG-58	CBL043	09/22/2021	09/22/2022
ROS002`	9kHz to 3GHz EMI Test Receiver	Rohde & Schwartz	ESCI 1166.5950K03	100067	06/24/2021	06/24/2022
WEI26`	Attenuator 20dB 2 Watts	Weinschel	WA18-20	1001015N0010004	05/18/2021	05/18/2022

Software Utilized:

Name	Manufacturer	Version
BAT-EMC	Nexio	3.20.0.21

11.3 Results:

The sample tested was found to Comply.

11.4 Setup Photograph:

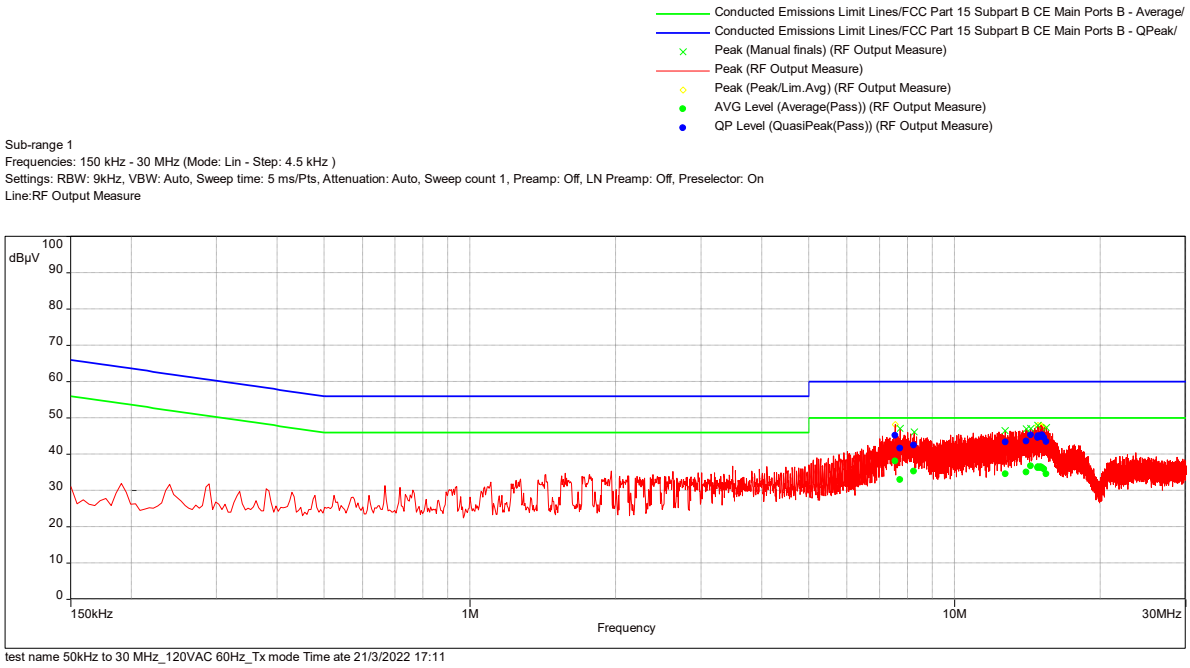
Setup Photographs are included in a separate file.

11.5 Plots/Data:

Test Information:

Date and Time	3/21/2022 4:58:47 PM
Client and Project Number	Starry_G104934070
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	18 %
Atmospheric Pressure	1002 mbars
Comments	50kHz to 30 MHz_120VAC 60Hz_Tx mode

Graph:



Results:

QuasiPeak(Pass) (13)

Frequency (MHz)	QP Level (dBµV)	QP Limit (dBuV)	QP Margin (dB)	Line	RBW	Meas.Time	Correction (dB)
7.533	45.15	60.00	-14.85	Neutral	9k	0.01	20.06
7.719	41.57	60.00	-18.43	Neutral	9k	0.01	20.06
8.245	42.50	60.00	-17.50	Neutral	9k	0.01	20.07
12.727	43.31	60.00	-16.69	Neutral	9k	0.01	20.10
14.062	43.49	60.00	-16.51	Neutral	9k	0.01	20.10
14.3485	45.29	60.00	-14.71	Neutral	9k	0.01	20.10
14.8695	44.56	60.00	-15.44	Neutral	9k	0.01	20.10
14.8735	44.96	60.00	-15.04	Neutral	9k	0.01	20.10
15.0135	44.76	60.00	-15.24	Neutral	9k	0.01	20.10
15.0645	45.05	60.00	-14.95	Neutral	9k	0.01	20.10
15.161	45.20	60.00	-14.80	Neutral	9k	0.01	20.10
15.301	44.49	60.00	-15.51	Neutral	9k	0.01	20.10
15.449	43.46	60.00	-16.54	Neutral	9k	0.01	20.10

Average(Pass) (13)

Frequency (MHz)	AVG Level (dBµV)	AVG Limit (dBuV)	AVG Margin (dB)	Line	RBW	Meas.Time	Correction (dB)
7.533	38.03	50.00	-11.97	Neutral	9k	0.01	20.06
7.719	32.96	50.00	-17.04	Neutral	9k	0.01	20.06
8.245	35.30	50.00	-14.70	Neutral	9k	0.01	20.07
12.727	34.57	50.00	-15.43	Neutral	9k	0.01	20.10
14.062	35.02	50.00	-14.98	Neutral	9k	0.01	20.10
14.3485	36.76	50.00	-13.24	Neutral	9k	0.01	20.10
14.8695	36.23	50.00	-13.77	Neutral	9k	0.01	20.10
14.8735	36.43	50.00	-13.57	Neutral	9k	0.01	20.10
15.0135	36.29	50.00	-13.71	Neutral	9k	0.01	20.10
15.0645	36.52	50.00	-13.48	Neutral	9k	0.01	20.10
15.161	36.21	50.00	-13.79	Neutral	9k	0.01	20.10
15.301	35.92	50.00	-14.08	Neutral	9k	0.01	20.10
15.449	34.54	50.00	-15.46	Neutral	9k	0.01	20.10

Test Personnel:	Vathana Ven VSV	Test Date:	03/21/2022
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC Part 15 Subpart B	Limit Applied:	Class B
Input Voltage:	120VAC 60Hz	Ambient Temperature:	24 °C
Pretest Verification w/ Signal generator:	**Yes**	Relative Humidity:	18 %
		Atmospheric Pressure:	1002 mbars

Deviations, Additions, or Exclusions: None

12 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	04/13/2022	105000232BOX-001	VFV	KPS	Original Issue
1	07/18/2022	105000232BOX-001.1	VFV	KPS	See notes below

Notes:

1) Replaced plots with a high resolution one.
2) On page 35, the title of the plots for both H and V state the EUT operating BW of 20M, was corrected to 160M.
3) On page 43, the title of the plot states, Low Channel 24.84 GHz, was corrected to 24.34 GHz.
4) On page 68, the title of the data states, Spurious Emissions, 18-40 GHz, was corrected to 40-1000 GHz.
5) For the data above 40 GHz, revised the note as 'The path loss was internally compensated as dB offset (-95.2 + 107 or 11.8 dB). The cable loss, antenna factor, mixer conversion loss, were internally compensated as Mixer Conversion Loss Table in part of the external mixer setup. This compensation is not shown in the plot'

13 Appendix A – Mixer Conversion Loss

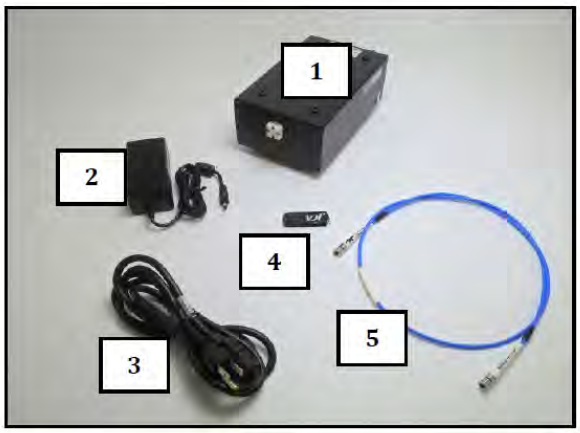
40-60 GHz Mixer Conversion Loss

WR19.0SAX-F

1 Product Overview

Product List (Quantity)	Serial Number(s)	Order No.	Date / Initials
WR19.0SAX-F (1)	SAX 835	21108A	03/26/2021 SAB

Product Description: This VDI product includes one WR19.0 Frequency Extender, intended for use with Rohde & Schwarz FSW spectrum analyzers. This user guide details the operation of the Frequency Extension Module.



No.	Part Description
1	SAX 835
2	9V Power Supply
3	AC Power Cable
4	USB Drive
5	LO Cable (not included)

Figure 1: Photograph of typical configuration. All items may not be included.
Note: Photographs and specifications of accessories (horns, waveguide straights, etc.) are not included in this user guide.

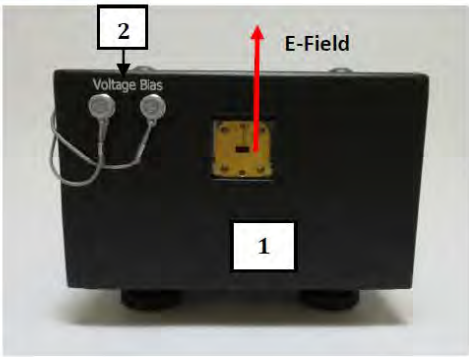
2 Warning and Caution Statements

WARNING AND CAUTION STATEMENTS	
WARNING	This product can be permanently damaged by Electrostatic Discharge (ESD). It is recommended that engineers and technicians wear a special grounded wrist strap when handling this component. In addition, the work environment around the component should be well grounded.
WARNING	Opening the blocks, parts, or components will damage the internal components. VDI is not responsible for the warranty or guaranty of products damaged as a result of improper handling, testing, biasing, or use by customer.
CAUTION	VDI assumes the customer is familiar with microwave, millimeter wave, and VDI products. The user and customer are expected to understand all safety guidelines, health hazards, and general advisories that may exist and are associated with the use of this device. VDI is not responsible for any human hazards that may exist or may occur while using this device.

3 Product Specifications

Virginia Diodes, Inc.

USER GUIDE



Description		Specification	Connector
RF Input [1]	Frequency Range	40-60GHz	WR19.0 UG-599/UM
	Power (Optimal / Damage)	<-20dBm / -10dBm	
Voltage Bias Port [2]	External Component Bias Voltage	+9V Output 50mA Maximum	LEMO 00 (f)
LO Input High Freq. [3]	Frequency Range	20-30GHz	2.9mm(f)
	Power (Typical† / Damage)	0dBm / 16dBm	
	Multiplication Factor	2	
LO Input Standard Freq. [4]*	Frequency Range	10-15GHz	2.9mm(f)
	Power (Typical† / Damage)	13dBm / 20dBm	
	Multiplication Factor	4	
IF Output Standard Freq. [4]*	Frequency Range	100MHz-2.5GHz	2.9mm(f)
IF Output High Freq. [5]	Frequency Range	100MHz-6GHz	2.9mm(f)
DC Input [6]	DC Power Connection	9V Output, 5A Maximum	2.1mm I.D. x 5.5mm O.D. x 9.5mm Male
Intrinsic Mixer**	SSB Conversion Loss***	9dB	-
Displayed Average Noise Level***		-152dBm/Hz	-

Table 1: General product specifications are shown.
† System is operational within +/- 3dB of nominal input power.
*Standard Freq. LO and IF share the same port.
**Intrinsic mixer conversion loss is measured before any IF amplification and cannot be accessed by user.
***See Section 5 for actual performance.

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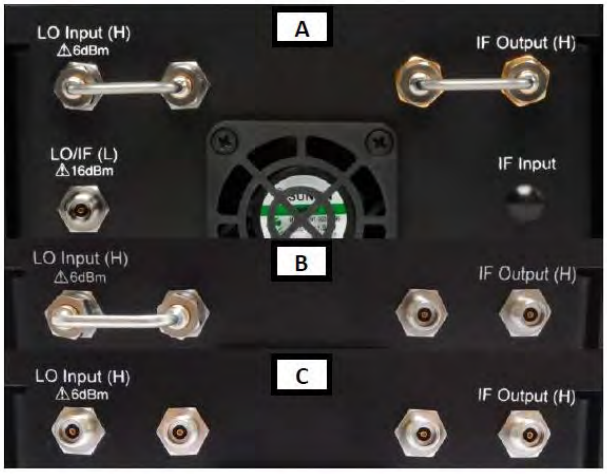

Configuration	LO Frequency	IF Frequency
A	Standard	Standard
B	Standard	High
C	High	High

Figure 2: Configuration details of dual LO input and dual IF output frequency modes are shown.

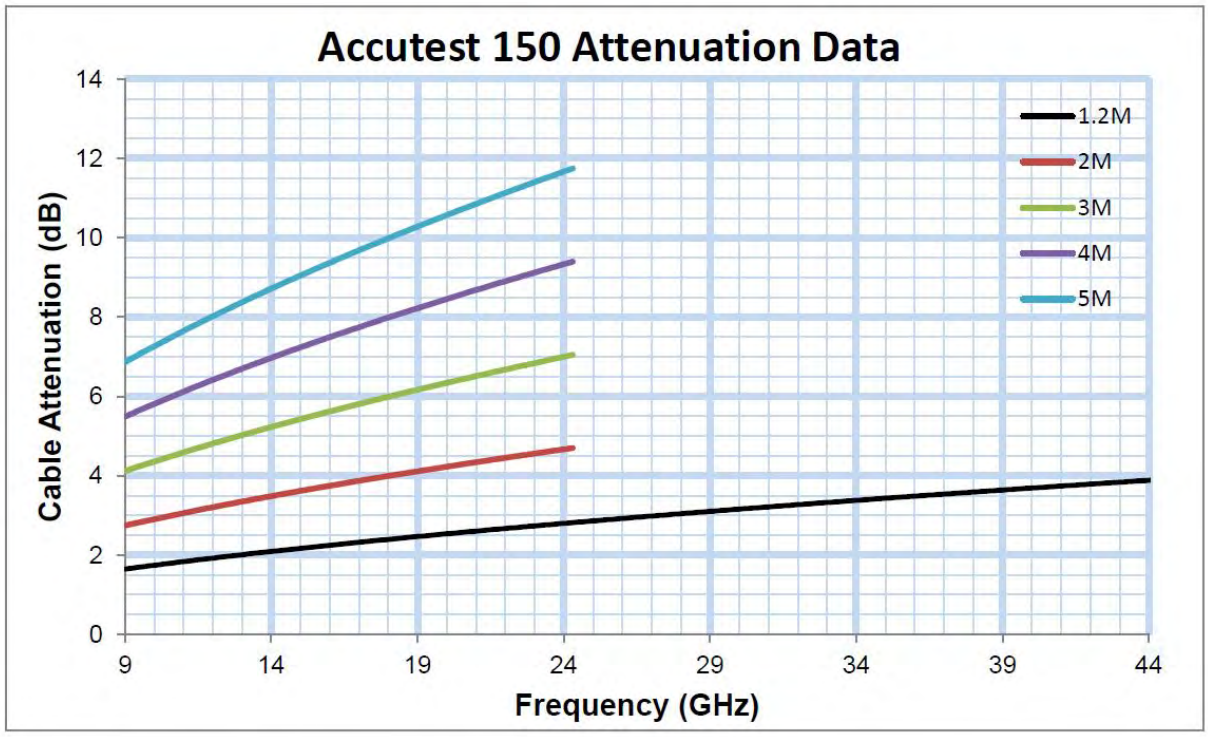

Figure 3: Insertion Loss of Accutest 150 (RF/LO Cable) with respect to frequency.

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4 General Operating Procedures and Guidelines

VDI assumes the customer is familiar with VDI products, and VDI is not responsible for the warranty or guaranty of products damaged as a result of improper handling, testing, biasing, or use by customer. VDI offers the following general guidelines for using these products and recommends the customer contact VDI at (434) 297-3257 for assistance if needed. The following procedures are a quick guide for turning on and off the product. In each case the individual steps must be followed in the proper sequence to avoid damaging critical components.

4.1 Required Operating Procedures

- DO NOT exceed damage limits listed in Table 1.
- DO NOT apply any external biases to the system.
- Make proper RF connections depending on desired configuration (i.e. Standard/High LO and Standard/High IF operation). Refer to Figure 2A-C for more information.

Failure to follow these procedures will damage or destroy the device.

4.2 Additional Guidelines, Limitations, and Recommendations

- The SAX is shipped with a reusable dust cover attached. Remove dust cover before operation.

4.3 Turn-On Procedure

1. The user and test bench must be properly grounded and protected against ESD.
2. With the LO and RF input power turned off, make all necessary connections (i.e. LO cable, AC cable, DC cable). See Figure 2A-C for configuration details.
3. Turn on the LO input power.
4. Turn on the small signal RF input power and monitor the IF output.

4.4 Turn-Off Procedure

1. The user and test bench must be properly grounded and protected against ESD.
2. Turn off the RF input power.
3. Turn off the LO input power.
4. Disconnect the DC Power Supply.
5. After completing turn-off procedures described above, it is now safe to turn off all other equipment on user test bench.

Contact VDI with questions or concerns regarding operational procedures and limitations.

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USER GUIDE

5 Product Performance

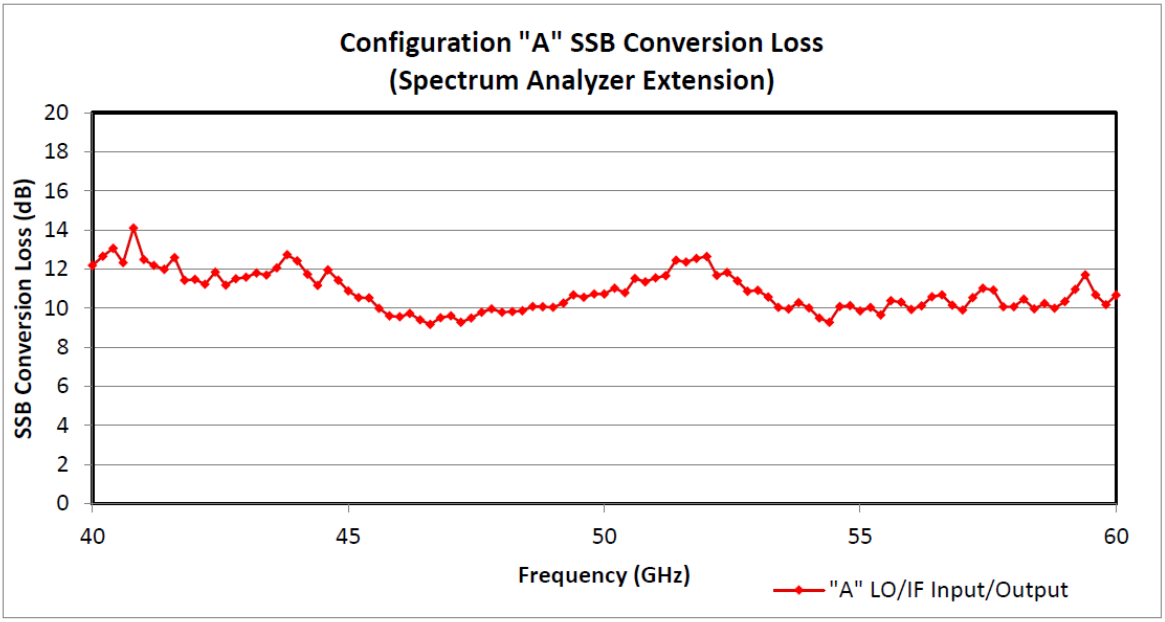

Figure 4: The product performance (SSB conversion loss vs. RF frequency) is shown for an LO input power of ~15dBm in Standard LO Frequency operation. IF power measured from "LO/IF" port with IF frequency fixed at 1.3GHz. CSV Data file included on USB Drive.

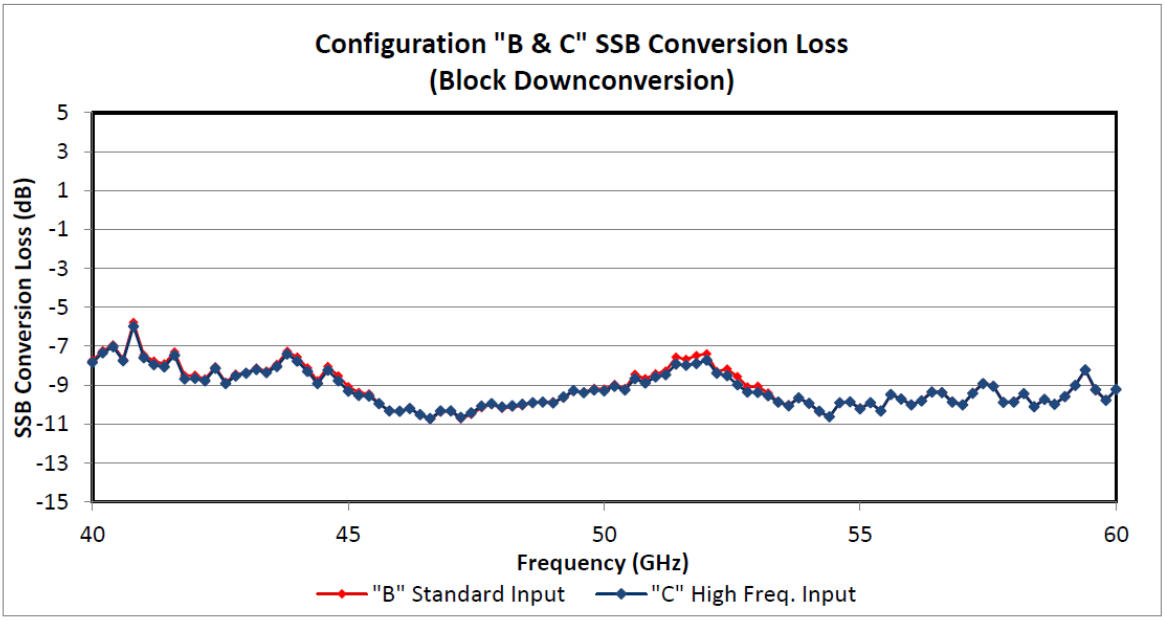

Figure 5: The product performance (SSB conversion loss vs. RF frequency) is shown for an LO input power of ~15dBm in Standard LO Frequency operation and LO input power of ~0dBm in High LO Frequency operation. IF power measured from "IF Output" port with IF frequency fixed at 1.3GHz. CSV Data file included on USB Drive.

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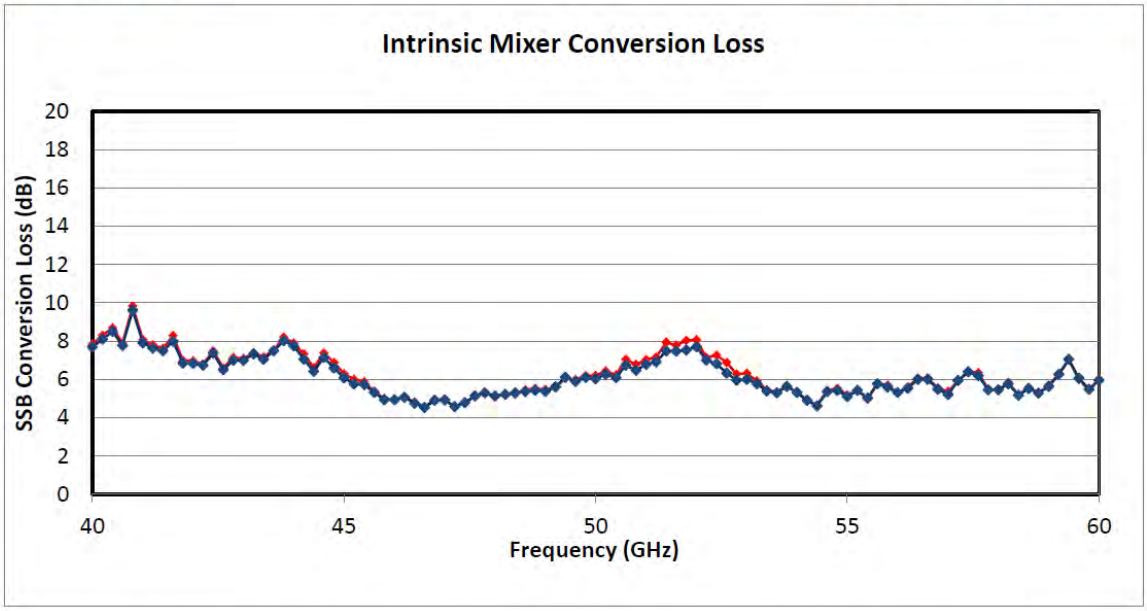


Figure 6: The product performance (SSB conversion loss vs. RF frequency) is shown for an LO input power of ~15dBm in Standard LO Frequency operation and LO input power of ~0dBm in High LO Frequency operation. IF power measured from mixer port with IF frequency fixed at 1.3GHz. Note: mixer port is not accessible for use by the user. CSV Data file included on USB Drive.

Measured Displayed Average Noise Level (dBm/Hz)	
Typical	-152.62

*Measured with a Keysight N9030A PXA Spectrum Analyzer.

SAX 835 Conversion Loss

Note: Out of band data is not guaranteed to be accurate

Freq(GHz)	"A" LO/IF Input/Output	"B" Standard Input	"C" High Freq. Input	High Freq. Intrinsic Mixer Loss	Standard Freq. Intrinsic Mixer Loss
40	12.18393	-7.73106531	-7.83106531	7.69093469	7.83793469
40.2	12.65257	-7.227428425	-7.346428425	8.089571575	8.295571575
40.4	13.04476	-6.935240346	-7.031240346	8.506759654	8.681759654
40.6	12.31643	-7.671565301	-7.756565301	7.763434699	7.913434699
40.8	14.09561	-5.784389207	-5.976389207	9.605610793	9.822610793
41	12.47222	-7.450776143	-7.586776143	7.911223857	8.075223857
41.2	12.17642	-7.766582166	-7.955582166	7.632417834	7.794417834
41.4	11.98468	-7.903316327	-8.068316327	7.491683673	7.628683673
41.6	12.58671	-7.300293808	-7.475293808	7.980706192	8.287706192
41.8	11.42126	-8.517743767	-8.682743767	6.840256233	6.992256233
42	11.46096	-8.504035139	-8.649035139	6.835964861	6.965964861
42.2	11.21847	-8.684527279	-8.781527279	6.735472721	6.799472721
42.4	11.83738	-8.055620485	-8.146620485	7.366379515	7.484379515
42.6	11.17569	-8.856309768	-8.917309768	6.502690232	6.599690232
42.8	11.49528	-8.435723496	-8.534723496	6.994276504	7.141276504
43	11.56904	-8.375963687	-8.395963687	6.987036313	7.103036313
43.2	11.79484	-8.120156119	-8.196156119	7.335843881	7.372843881
43.4	11.67951	-8.279490341	-8.364490341	7.050509659	7.176509659
43.6	12.05336	-7.943637944	-8.048637944	7.490362056	7.536362056
43.8	12.72018	-7.259817722	-7.400817722	8.024182278	8.205182278
44	12.40928	-7.555723107	-7.764723107	7.756276893	7.900276893
44.2	11.72591	-8.119091237	-8.296091237	7.052908763	7.335908763
44.4	11.15254	-8.774458098	-8.927458098	6.418541902	6.611541902
44.6	11.94911	-8.046893419	-8.235893419	7.146106581	7.381106581
44.8	11.41168	-8.535320915	-8.779320915	6.593679085	6.880679085
45	10.86545	-9.074546037	-9.315546037	6.077453963	6.296453963
45.2	10.52373	-9.371265586	-9.527265586	5.767734414	6.004734414
45.4	10.51426	-9.446741028	-9.563741028	5.714258972	5.882258972
45.6	9.986746	-9.939254477	-9.954254477	5.306745523	5.378745523
45.8	9.59202	-10.34998045	-10.33198045	4.939019546	4.994019546
46	9.54945	-10.34955021	-10.34255021	4.945449791	4.942449791
46.2	9.718601	-10.20139894	-10.20139894	5.06660106	5.08660106
46.4	9.4014	-10.51059989	-10.50859989	4.75540011	4.80640011
46.6	9.164813	-10.76618735	-10.72018735	4.525812655	4.559812655
46.8	9.49849	-10.37151002	-10.32451002	4.910489976	4.952489976
47	9.590663	-10.34933683	-10.32533683	4.919663167	4.930663167
47.2	9.264478	-10.73452184	-10.66252184	4.576478163	4.565478163

Freq(GHz)	"A" LO/IF Input/Output	"B" Standard Input	"C" High Freq. Input	High Freq. Intrinsic Mixer Loss	Standard Freq. Intrinsic Mixer Loss
47.4	9.487929	-10.49307072	-10.42707072	4.788929277	4.774929277
47.6	9.782794	-10.16320569	-10.07820569	5.142794307	5.116794307
47.8	9.95227	-9.987729761	-9.946729761	5.294270239	5.264270239
48	9.779821	-10.1941788	-10.1251788	5.128821195	5.129821195
48.2	9.817198	-10.11880169	-10.06180169	5.213198315	5.238198315
48.4	9.861049	-10.05895142	-9.99095142	5.29204858	5.22604858
48.6	10.07245	-9.889547923	-9.900547923	5.367452077	5.450452077
48.8	10.07077	-9.841233026	-9.876233026	5.424766974	5.527766974
49	10.02539	-9.862610661	-9.921610661	5.379389339	5.465389339
49.2	10.24586	-9.671136617	-9.615136617	5.606863383	5.561863383
49.4	10.6675	-9.289503278	-9.286503278	6.107496722	6.065496722
49.6	10.5412	-9.356800369	-9.393800369	5.891199631	5.991199631
49.8	10.71795	-9.170051536	-9.242051536	6.089948464	6.211948464
50	10.72015	-9.202846251	-9.294846251	6.036153749	6.207153749
50.2	11.01845	-8.967548981	-9.055548981	6.261451019	6.439451019
50.4	10.78694	-9.175059654	-9.246059654	6.097940346	6.231940346
50.6	11.51114	-8.446861426	-8.672861426	6.740138574	7.043138574
50.8	11.34446	-8.666536526	-8.891536526	6.471463474	6.789463474
51	11.54523	-8.420770486	-8.581770486	6.787229514	7.028229514
51.2	11.64424	-8.273764545	-8.461764545	6.912235455	7.159235455
51.4	12.45045	-7.554554578	-7.923554578	7.493445422	7.940445422
51.6	12.34762	-7.672378642	-7.986378642	7.465621358	7.783621358
51.8	12.53203	-7.48396897	-7.88396897	7.53103103	8.03103103
52	12.63471	-7.392294596	-7.710294596	7.710705404	8.068705404
52.2	11.66922	-8.296777367	-8.395777367	6.998222633	7.135222633
52.4	11.82163	-8.176370856	-8.512370856	6.820629144	7.266629144
52.6	11.38115	-8.567850502	-8.981850502	6.324149498	6.876149498
52.8	10.85834	-9.088660283	-9.362660283	5.949339717	6.282339717
53	10.90889	-9.054111321	-9.370111321	6.000888679	6.315888679
53.2	10.55653	-9.398471843	-9.553471843	5.768528157	5.922528157
53.4	10.02485	-9.857147743	-9.879147743	5.394852257	5.452852257
53.6	9.957231	-10.00976887	-10.05476887	5.300231127	5.343231127
53.8	10.28107	-9.656928444	-9.648928444	5.624071556	5.671071556
54	10.00557	-9.945426854	-9.944426854	5.313573147	5.316573147
54.2	9.483862	-10.38213777	-10.35113777	4.90986223	4.92486223
54.4	9.27475	-10.63425049	-10.62325049	4.602749509	4.658749509
54.6	10.07448	-9.899524203	-9.899524203	5.357475797	5.419475797
54.8	10.12309	-9.847914944	-9.861914944	5.428085056	5.530085056
55	9.843976	-10.19002385	-10.21402385	5.092976146	5.194976146
55.2	10.03561	-9.908389973	-9.910389973	5.416610027	5.438610027
55.4	9.643359	-10.31664094	-10.33464094	5.038359057	4.973359057

Freq(GHz)	"A" LO/IF Input/Output	"B" Standard Input	"C" High Freq. Input	High Freq. Intrinsic Mixer Loss	Standard Freq. Intrinsic Mixer Loss
55.6	10.37222	-9.49677748	-9.48777748	5.76322252	5.79722252
55.8	10.30295	-9.680049143	-9.713049143	5.588950857	5.707950857
56	9.930571	-10.00042911	-10.01842911	5.310570886	5.301570886
56.2	10.10271	-9.786290637	-9.816290637	5.528709363	5.602709363
56.4	10.57445	-9.318550175	-9.357550175	6.002449825	6.064449825
56.6	10.66912	-9.349881086	-9.393881086	6.004118914	6.076118914
56.8	10.14375	-9.840248304	-9.875248304	5.478751696	5.545751696
57	9.894501	-9.992499215	-10.01649921	5.211500785	5.371500785
57.2	10.52904	-9.407962195	-9.419962195	5.934037805	5.908037805
57.4	11.01629	-8.88670661	-8.91570661	6.39329339	6.41629339
57.6	10.9171	-9.033897975	-9.064897975	6.195102025	6.348102025
57.8	10.05695	-9.8670484	-9.8830484	5.4619516	5.4749516
58	10.06586	-9.834143573	-9.880143573	5.457856427	5.450856427
58.2	10.45513	-9.422873675	-9.434873675	5.770126325	5.841126325
58.4	9.959582	-10.09041812	-10.10741812	5.165581881	5.204581881
58.6	10.23535	-9.720652896	-9.738652896	5.511347104	5.584347104
58.8	9.987653	-9.967346763	-9.989346763	5.289653237	5.282653237
59	10.32975	-9.594251231	-9.600251231	5.624748769	5.691748769
59.2	10.94742	-9.004582916	-9.007582916	6.263417084	6.266417084
59.4	11.69635	-8.21964914	-8.21264914	7.04235086	7.01935086
59.6	10.67157	-9.294432287	-9.235432287	6.069567713	6.001567713
59.8	10.16657	-9.771428462	-9.783428462	5.485571538	5.447571538
60	10.64813	-9.237874856	-9.223874856	5.947125144	6.016125144

60-90 GHz Mixer Conversion Loss

Virginia Diodes, Inc.

USER GUIDE

WR12.0SAX-F

1 Product Overview

Product List (Quantity)	Serial Number(s)	Order No.	Date / Initials
WR12.0SAX-F (1)	SAX 836	21108B	04/06/2021 CXS

Product Description: This VDI product includes one WR12.0 Frequency Extender, intended for use with Rohde & Schwarz FSW spectrum analyzers. This user guide details the operation of the Frequency Extension Module.

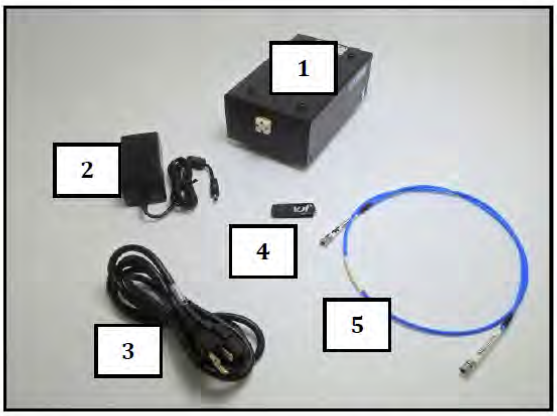


Figure 1: Photograph of typical configuration. All items may not be included.
Note: Photographs and specifications of accessories (horns, waveguide straights, etc.) are not included in this user guide.

No.	Part Description
1	SAX 836
2	9V Power Supply
3	AC Power Cable
4	USB Drive
5	LO Cable (not included)

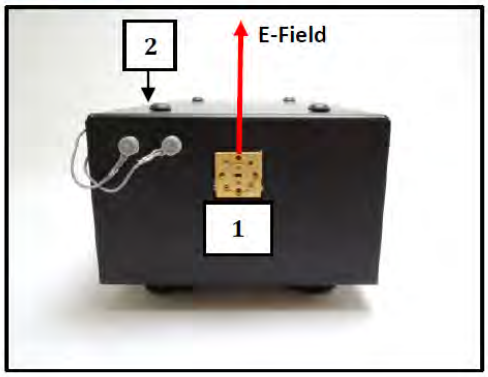
2 Warning and Caution Statements

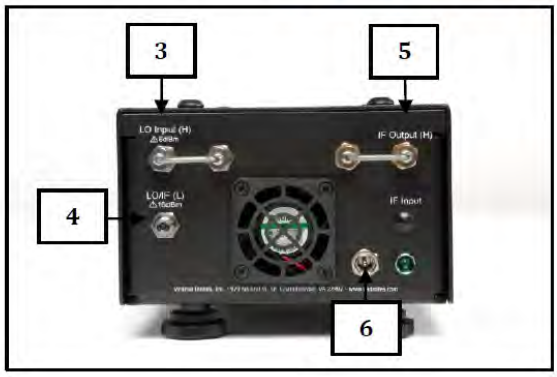
WARNING AND CAUTION STATEMENTS	
WARNING	This product can be permanently damaged by Electrostatic Discharge (ESD). It is recommended that engineers and technicians wear a special grounded wrist strap when handling this component. In addition, the work environment around the component should be well grounded.
WARNING	Opening the blocks, parts, or components will damage the internal components. VDI is not responsible for the warranty or guaranty of products damaged as a result of improper handling, testing, biasing, or use by customer.
CAUTION	VDI assumes the customer is familiar with microwave, millimeter wave, and VDI products. The user and customer are expected to understand all safety guidelines, health hazards, and general advisories that may exist and are associated with the use of this device. VDI is not responsible for any human hazards that may exist or may occur while using this device.

3 Product Specifications

Virginia Diodes, Inc.

USER GUIDE





Description		Specification	Connector
RF Input [1]	Frequency Range	60-90GHz	WR12.0 UG-599/UM
	Power (Optimal / Damage)	<-20dBm / -10dBm	
Voltage Bias Port [2]	External Component Bias Voltage	+9V Output 50mA Maximum	LEMO 00 (f)
LO Input High Freq. [3]	Frequency Range	10-15GHz	2.9mm(f)
	Power (Typical† / Damage)	0dBm / 16dBm	
	Multiplication Factor	6	
LO Input Standard Freq. [4]*	Frequency Range	10-15GHz	2.9mm(f)
	Power (Typical† / Damage)	13dBm / 20dBm	
	Multiplication Factor	6	
IF Output Standard Freq. [4]*	Frequency Range	100MHz-2.5GHz	2.9mm(f)
IF Output High Freq. [5]	Frequency Range	100MHz-9GHz	2.9mm(f)
DC Input [6]	DC Power Connection	9V Output, 5A Maximum	2.1mm I.D. x 5.5mm O.D. x 9.5mm Male
Intrinsic Mixer**	SSB Conversion Loss***	10dB	-
Displayed Average Noise Level***		-152dBm/Hz	-

Table 1: General product specifications are shown.
† System is operational within +/- 3dB of nominal input power.
*Standard Freq. LO and IF share the same port.
**Intrinsic mixer conversion loss is measured before any IF amplification and cannot be accessed by user.
***See Section 5 for actual performance.

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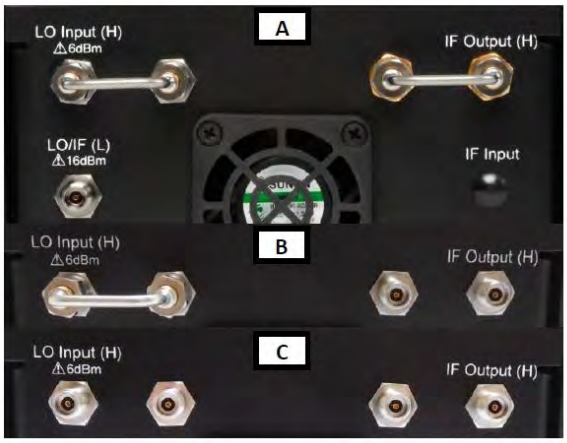
USER GUIDE



Configuration	LO Frequency	IF Frequency
A	Standard	Standard
B	Standard	High
C	High	High

Figure 2: Configuration details of dual LO input and dual IF output frequency modes are shown.

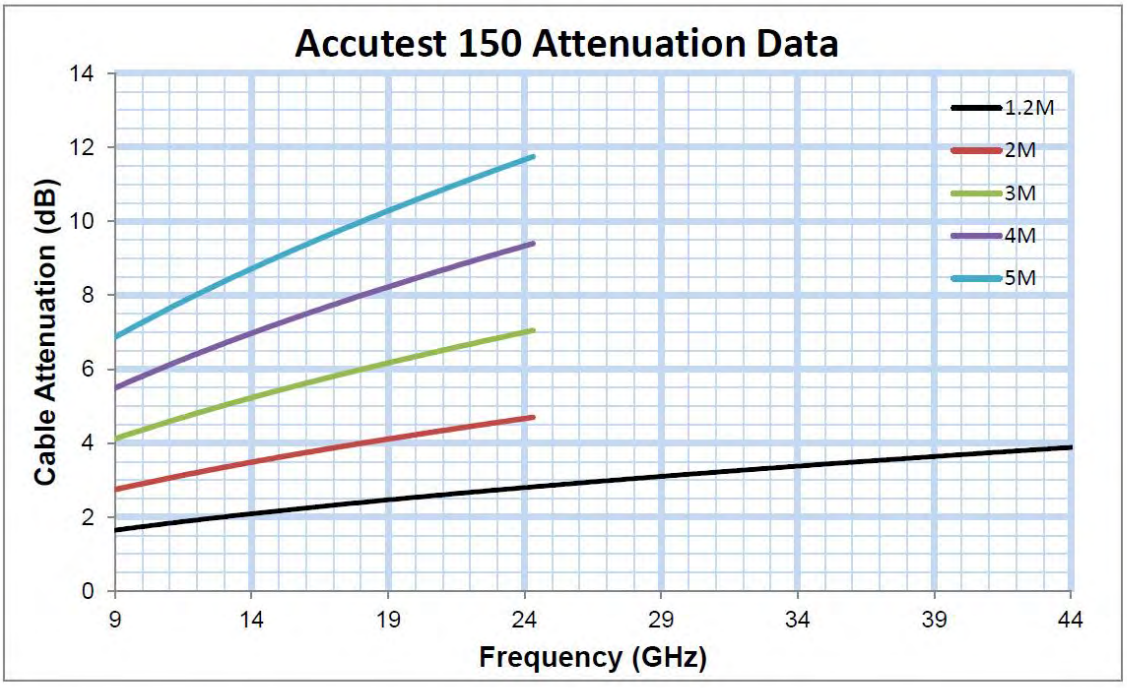


Figure 3: Insertion Loss of Accutest 150 (RF/LO Cable) with respect to frequency.

Virginia Diodes, Inc.

USER GUIDE

4 General Operating Procedures and Guidelines

VDI assumes the customer is familiar with VDI products, and VDI is not responsible for the warranty or guaranty of products damaged as a result of improper handling, testing, biasing, or use by customer. VDI offers the following general guidelines for using these products and recommends the customer contact VDI at (434) 297-3257 for assistance if needed. The following procedures are a quick guide for turning on and off the product. In each case the individual steps must be followed in the proper sequence to avoid damaging critical components.

4.1 Required Operating Procedures

- DO NOT exceed damage limits listed in Table 1.
- DO NOT apply any external biases to the system.
- Make proper RF connections depending on desired configuration (i.e. Standard/High LO and Standard/High IF operation). Refer to Figure 2A-C for more information.

Failure to follow these procedures will damage or destroy the device.

4.2 Additional Guidelines, Limitations, and Recommendations

- The SAX is shipped with a reusable dust cover attached. Remove dust cover before operation.

4.3 Turn-On Procedure

1. The user and test bench must be properly grounded and protected against ESD.
2. With the LO and RF input power turned off, make all necessary connections (i.e. LO cable, AC cable, DC cable). See Figure 2A-C for configuration details.
3. Turn on the LO input power.
4. Turn on the small signal RF input power and monitor the IF output.

4.4 Turn-Off Procedure

1. The user and test bench must be properly grounded and protected against ESD.
2. Turn off the RF input power.
3. Turn off the LO input power.
4. Disconnect the DC Power Supply.
5. After completing turn-off procedures described above, it is now safe to turn off all other equipment on user test bench.

Contact VDI with questions or concerns regarding operational procedures and limitations.

5 Product Performance

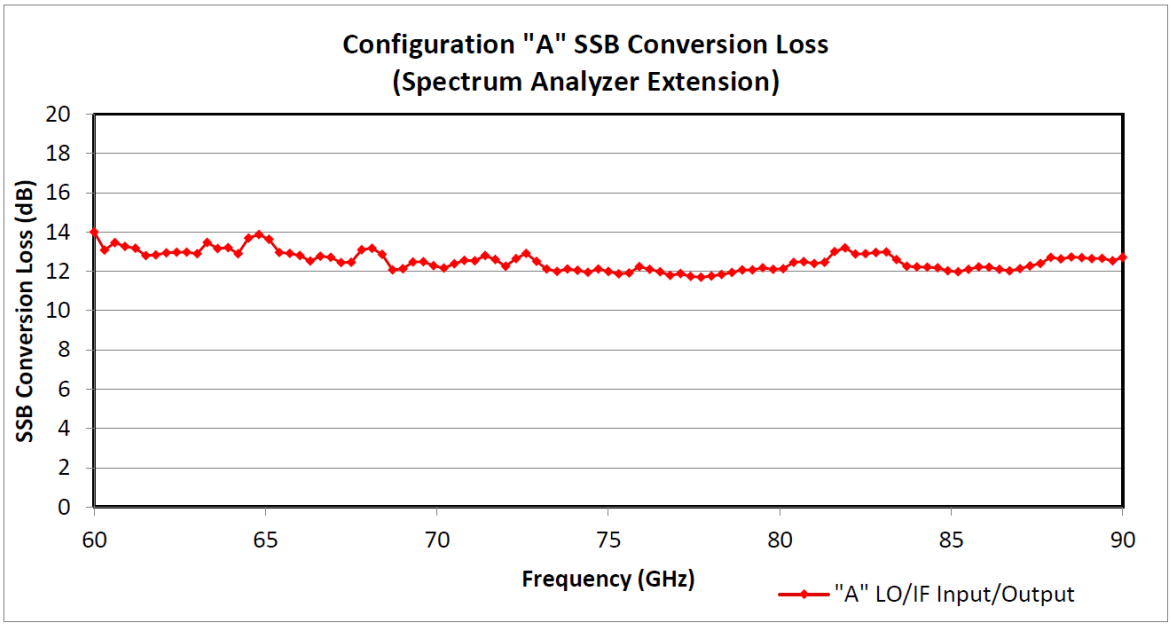


Figure 4: The product performance (SSB conversion loss vs. RF frequency) is shown for an LO input power of ~15dBm in Standard LO Frequency operation. IF power measured from "LO/IF" port with IF frequency fixed at 1.3GHz. CSV Data file included on USB Drive.

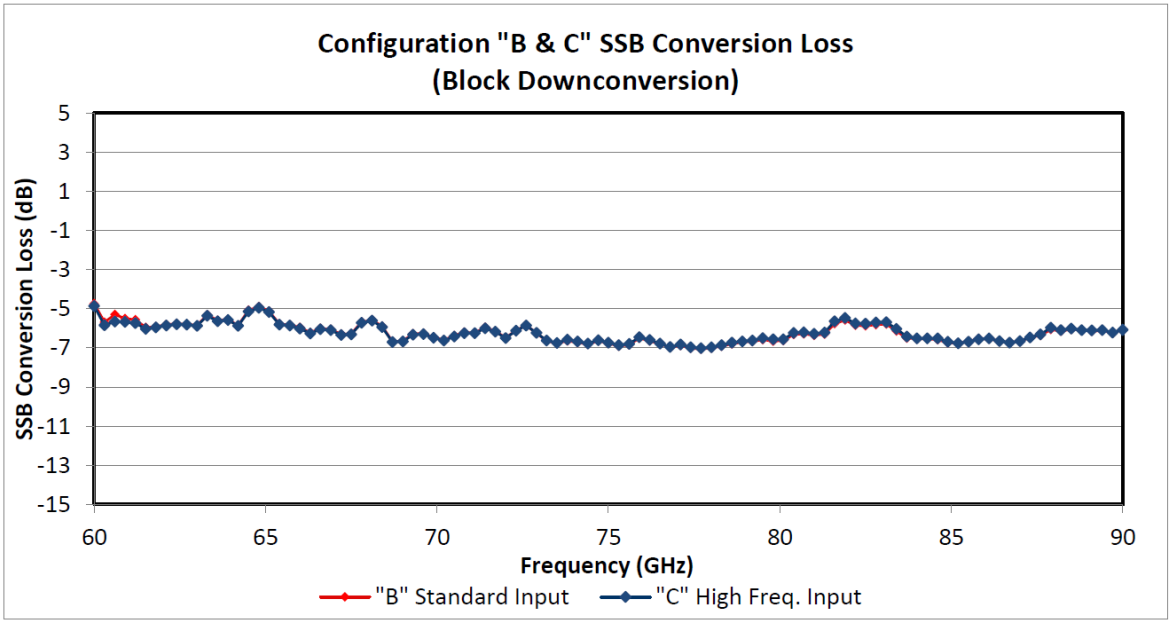


Figure 5: The product performance (SSB conversion loss vs. RF frequency) is shown for an LO input power of ~15dBm in Standard LO Frequency operation and LO input power of ~0dBm in High LO Frequency operation. IF power measured from "IF Output" port with IF frequency fixed at 1.3GHz. CSV Data file included on USB Drive.

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USER GUIDE

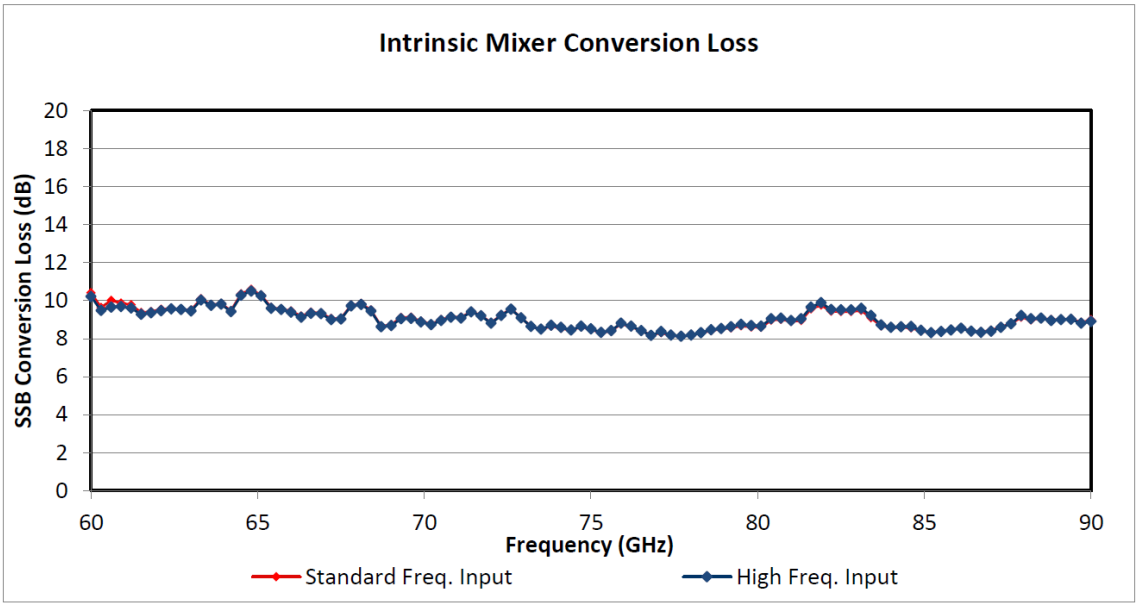


Figure 6: The product performance (SSB conversion loss vs. RF frequency) is shown for an LO input power of ~15dBm in Standard LO Frequency operation and LO input power of ~0dBm in High LO Frequency operation. IF power measured from mixer port with IF frequency fixed at 1.3GHz. Note: mixer port is not accessible for use by the user. CSV Data file included on USB Drive.

Measured Displayed Average Noise Level (dBm/Hz)	
Typical	-150.65

*Measured with a Keysight N9030A PXA Spectrum Analyzer.

SAX 836 Conversion Loss

Note: Out of band data is not guaranteed to be accurate

Freq(GHz)	"A" LO/IF Input/Output	"B" Standard Input	"C" High Freq. Input	High Freq. Intrinsic Mixer Loss	Standard Freq. Intrinsic Mixer Loss
60	14.00809673	-4.74690327	-4.86490327	10.22409673	10.40709673
60.3	13.08177247	-5.686227526	-5.842227526	9.482772474	9.645772474
60.6	13.44988267	-5.300117334	-5.655117334	9.656882666	10.01088267
60.9	13.26543128	-5.497568718	-5.666568718	9.689431282	9.877431282
61.2	13.17933468	-5.566665317	-5.739665317	9.610334683	9.782334683
61.5	12.80009579	-5.949904212	-6.025904212	9.275095788	9.380095788
61.8	12.82914386	-5.919856141	-5.953856141	9.363143859	9.427143859
62.1	12.94303505	-5.816964953	-5.851964953	9.468035047	9.537035047
62.4	12.97887686	-5.769123137	-5.797123137	9.562876863	9.595876863
62.7	12.96847511	-5.790524891	-5.806524891	9.521475109	9.549475109
63	12.90047744	-5.846522559	-5.880522559	9.443477441	9.500477441
63.3	13.47453136	-5.305468637	-5.358468637	10.03153136	10.09053136
63.6	13.16719015	-5.597809855	-5.631809855	9.743190145	9.784190145
63.9	13.21223698	-5.54176302	-5.57776302	9.80323698	9.83423698
64.2	12.89882197	-5.858178027	-5.877178027	9.423821973	9.472821973
64.5	13.68621534	-5.074784662	-5.137784662	10.27721534	10.35121534
64.8	13.87468986	-4.891310145	-4.952310145	10.50468986	10.58768986
65.1	13.63537185	-5.11962815	-5.16362815	10.24337185	10.29937185
65.4	12.96383529	-5.779164713	-5.809164713	9.594835287	9.641835287
65.7	12.90818146	-5.823818544	-5.864818544	9.523181456	9.563181456
66	12.79905144	-5.948948563	-6.018948563	9.387051437	9.445051437
66.3	12.52625358	-6.224746423	-6.264746423	9.128253577	9.178253577
66.6	12.77501349	-6.002986511	-6.044986511	9.332013489	9.386013489
66.9	12.70577709	-6.056222906	-6.098222906	9.304777094	9.340777094
67.2	12.44844547	-6.298554532	-6.348554532	8.999445468	9.058445468
67.5	12.45771307	-6.27928693	-6.30628693	9.03571307	9.05871307
67.8	13.09446348	-5.662536517	-5.710536517	9.711463483	9.745463483
68.1	13.18159215	-5.574407845	-5.614407845	9.789592155	9.842592155
68.4	12.86269872	-5.889301275	-5.932301275	9.452698725	9.498698725
68.7	12.06465654	-6.679343461	-6.704343461	8.624656539	8.651656539
69	12.12697909	-6.634020906	-6.663020906	8.681979094	8.730979094
69.3	12.47379099	-6.275209006	-6.320209006	9.048790994	9.109790994
69.6	12.49635632	-6.266643679	-6.302643679	9.061356321	9.119356321
69.9	12.29461412	-6.451385875	-6.487385875	8.877614125	8.913614125
70.2	12.15951216	-6.599487841	-6.628487841	8.725512159	8.760512159
70.5	12.38334399	-6.369656014	-6.416656014	8.946343986	8.999343986
70.8	12.55179008	-6.206209925	-6.243209925	9.126790075	9.154790075

Freq(GHz)	"A" LO/IF Input/Output	"B" Standard Input	"C" High Freq. Input	High Freq. Intrinsic Mixer Loss	Standard Freq. Intrinsic Mixer Loss
71.1	12.53542905	-6.22657095	-6.25057095	9.07142905	9.11942905
71.4	12.80331874	-5.95168126	-6.00068126	9.40331874	9.41931874
71.7	12.59441785	-6.142582148	-6.177582148	9.194417852	9.228417852
72	12.26506093	-6.485939069	-6.497939069	8.817060931	8.831060931
72.3	12.6529332	-6.105066802	-6.130066802	9.223933198	9.253933198
72.6	12.91123601	-5.84176399	-5.85376399	9.54023601	9.55323601
72.9	12.50543192	-6.253568082	-6.234568082	9.097431918	9.095431918
73.2	12.12384684	-6.638153158	-6.616153158	8.645846842	8.647846842
73.5	11.99820018	-6.767799823	-6.748799823	8.497200177	8.484200177
73.8	12.11430193	-6.643698071	-6.582698071	8.701301929	8.647301929
74.1	12.05944184	-6.710558164	-6.669558164	8.594441836	8.540441836
74.4	11.94565033	-6.811349671	-6.778349671	8.456650329	8.429650329
74.7	12.11754896	-6.642451036	-6.607451036	8.659548964	8.623548964
75	11.99113212	-6.768867875	-6.733867875	8.506132125	8.483132125
75.3	11.86630909	-6.900690911	-6.860690911	8.333309089	8.310309089
75.6	11.91810032	-6.838899678	-6.798899678	8.423100322	8.401100322
75.9	12.24548213	-6.500517867	-6.451517867	8.808482133	8.772482133
76.2	12.10239893	-6.643601074	-6.590601074	8.650398926	8.617398926
76.5	11.98551471	-6.789485292	-6.773485292	8.417514708	8.412514708
76.8	11.79713504	-6.968864956	-6.945864956	8.175135044	8.189135044
77.1	11.88064822	-6.869351775	-6.824351775	8.367648225	8.314648225
77.4	11.7419614	-7.018038601	-6.974038601	8.182961399	8.171961399
77.7	11.70070307	-7.05529693	-7.02129693	8.12070307	8.12070307
78	11.75970185	-6.99429815	-6.96829815	8.18070185	8.17970185
78.3	11.84442873	-6.900571271	-6.854571271	8.310428729	8.287428729
78.6	11.95018765	-6.799812349	-6.734812349	8.461187651	8.414187651
78.9	12.06854076	-6.706459237	-6.665459237	8.532540763	8.518540763
79.2	12.07851172	-6.674488276	-6.618488276	8.626511724	8.567511724
79.5	12.18083903	-6.574160969	-6.495160969	8.753839031	8.672839031
79.8	12.10740792	-6.654592085	-6.567592085	8.682407915	8.602407915
80.1	12.12624941	-6.617750592	-6.567750592	8.650249408	8.586249408
80.4	12.45676064	-6.305239365	-6.226239365	9.050760635	8.968760635
80.7	12.49277424	-6.273225761	-6.198225761	9.072774239	9.015774239
81	12.39938675	-6.35061325	-6.28161325	8.95738675	8.90238675
81.3	12.46230193	-6.292698068	-6.222698068	9.038301932	8.952301932
81.6	13.00393377	-5.757066234	-5.633066234	9.655933766	9.553933766
81.9	13.1857019	-5.5832981	-5.4612981	9.8847019	9.7637019
82.2	12.87742475	-5.848575252	-5.743575252	9.531424748	9.429424748
82.5	12.89518705	-5.867812949	-5.763812949	9.519187051	9.423187051
82.8	12.95150506	-5.81749494	-5.70349494	9.52050506	9.42650506
83.1	12.98575567	-5.77524433	-5.68224433	9.59075567	9.47675567

Freq(GHz)	"A" LO/IF Input/Output	"B" Standard Input	"C" High Freq. Input	High Freq. Intrinsic Mixer Loss	Standard Freq. Intrinsic Mixer Loss
83.4	12.59718822	-6.140811779	-6.029811779	9.215188221	9.091188221
83.7	12.25796009	-6.493039911	-6.419039911	8.712960089	8.670960089
84	12.23114021	-6.524859786	-6.506859786	8.586140214	8.569140214
84.3	12.20708834	-6.540911658	-6.506911658	8.629088342	8.584088342
84.6	12.18133493	-6.580665066	-6.515665066	8.645334934	8.565334934
84.9	12.01835551	-6.731644488	-6.691644488	8.437355512	8.409355512
85.2	11.97910956	-6.769890438	-6.757890438	8.310109562	8.331109562
85.5	12.09929486	-6.662705139	-6.685705139	8.368294861	8.384294861
85.8	12.22092835	-6.529071647	-6.559071647	8.449928353	8.487928353
86.1	12.21270567	-6.532294329	-6.513294329	8.549705671	8.545705671
86.4	12.10955656	-6.659443442	-6.661443442	8.391556558	8.413556558
86.7	12.01941635	-6.735583651	-6.734583651	8.320416349	8.351416349
87	12.12790597	-6.652094034	-6.659094034	8.388905966	8.431905966
87.3	12.2779043	-6.474095698	-6.469095698	8.598904302	8.628904302
87.6	12.39380025	-6.359199748	-6.316199748	8.776800252	8.773800252
87.9	12.70905543	-6.059944574	-5.963944574	9.212055426	9.121055426
88.2	12.63644451	-6.145555491	-6.093555491	9.051444509	8.987444509
88.5	12.72378687	-6.047213129	-6.017213129	9.075786871	9.078786871
88.8	12.69878056	-6.070219442	-6.093219442	8.943780558	8.993780558
89.1	12.64415049	-6.140849508	-6.113849508	8.990150492	8.997150492
89.4	12.66086495	-6.119135052	-6.096135052	9.011864948	9.040864948
89.7	12.54474949	-6.223250512	-6.212250512	8.804749488	8.861749488
90	12.70351072	-6.062489285	-6.075489285	8.899510715	8.976510715

90-140 GHz Mixer Conversion Loss

Virginia Diodes, Inc.

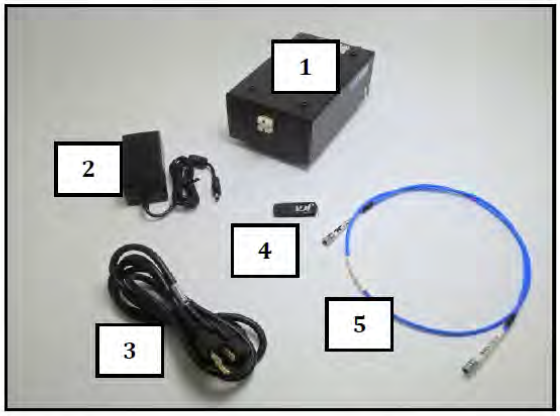
USER GUIDE

WR8.0SAX-F

1 Product Overview

Product List (Quantity)	Serial Number(s)	Order No.	Date / Initials
WR8.0SAX-F (1)	SAX 837	21108C	06/10/2021 DNS

Product Description: This VDI product includes one WR8.0 Frequency Extender, intended for use with Rohde & Schwarz FSW spectrum analyzers. This user guide details the operation of the Frequency Extension Module.



No.	Part Description
1	SAX 837
2	9V Power Supply
3	AC Power Cable
4	USB Drive
5	LO Cable (not included)

Figure 1: Photograph of typical configuration. All items may not be included.
Note: Photographs and specifications of accessories (horns, waveguide straights, etc.) are not included in this user guide.

2 Warning and Caution Statements

WARNING AND CAUTION STATEMENTS	
WARNING	This product can be permanently damaged by Electrostatic Discharge (ESD). It is recommended that engineers and technicians wear a special grounded wrist strap when handling this component. In addition, the work environment around the component should be well grounded.
WARNING	Opening the blocks, parts, or components will damage the internal components. VDI is not responsible for the warranty or guaranty of products damaged as a result of improper handling, testing, biasing, or use by customer.
CAUTION	VDI assumes the customer is familiar with microwave, millimeter wave, and VDI products. The user and customer are expected to understand all safety guidelines, health hazards, and general advisories that may exist and are associated with the use of this device. VDI is not responsible for any human hazards that may exist or may occur while using this device.

3 Product Specifications

Virginia Diodes, Inc.

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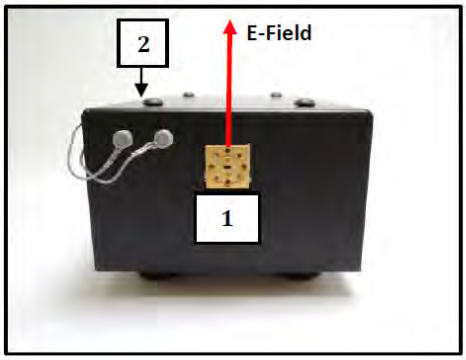

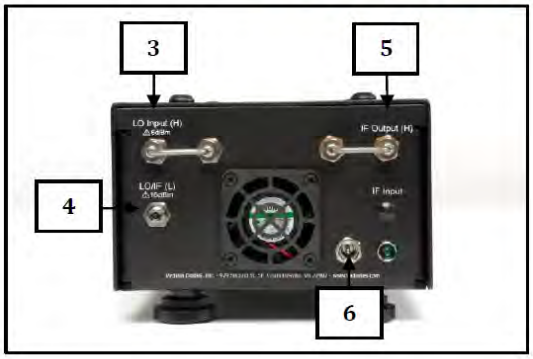

Description		Specification	Connector
RF Input [1]	Frequency Range	90-140GHz	WR8.0 UG-599/UM
	Power (Optimal / Damage)	<-20dBm / -10dBm	
Voltage Bias Port [2]	External Component Bias Voltage	+9V Output 50mA Maximum	LEMO 00 (f)
LO Input High Freq. [3]	Frequency Range	30-46.67GHz	2.9mm(f)
	Power (Typical† / Damage)	0dBm / 6dBm	
	Multiplication Factor	3	
LO Input Standard Freq. [4]*	Frequency Range	10-15.56GHz	2.9mm(f)
	Power (Typical† / Damage)	13dBm / 20dBm	
	Multiplication Factor	9	
IF Output Standard Freq. [4]*	Frequency Range	100MHz-2.5GHz	2.9mm(f)
IF Output High Freq. [5]	Frequency Range	100MHz-14GHz	2.9mm(f)
DC Input [6]	DC Power Connection	9V Output, 5A Maximum	2.1mm I.D. x 5.5mm O.D. x 9.5mm Male
Intrinsic Mixer**	SSB Conversion Loss***	10dB	-
Displayed Average Noise Level***		-150dBm/Hz	-

Table 1: General product specifications are shown.
† System is operational within +/- 3dB of nominal input power.
*Standard Freq. LO and IF share the same port.
**Intrinsic mixer conversion loss is measured before any IF amplification and cannot be accessed by user.
***See Section 5 for actual performance.

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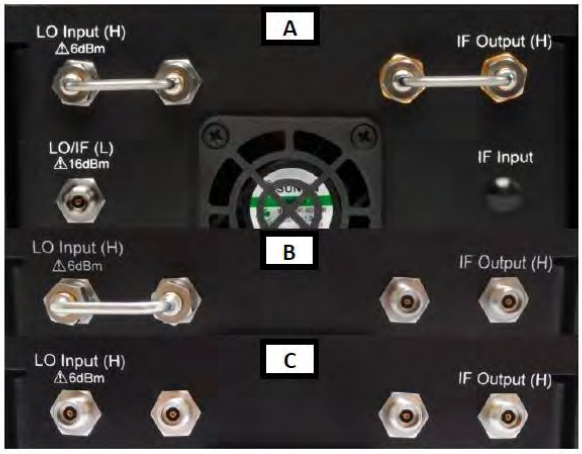

Configuration	LO Frequency	IF Frequency
A	Standard	Standard
B	Standard	High
C	High	High

Figure 2: Configuration details of dual LO input and dual IF output frequency modes are shown.

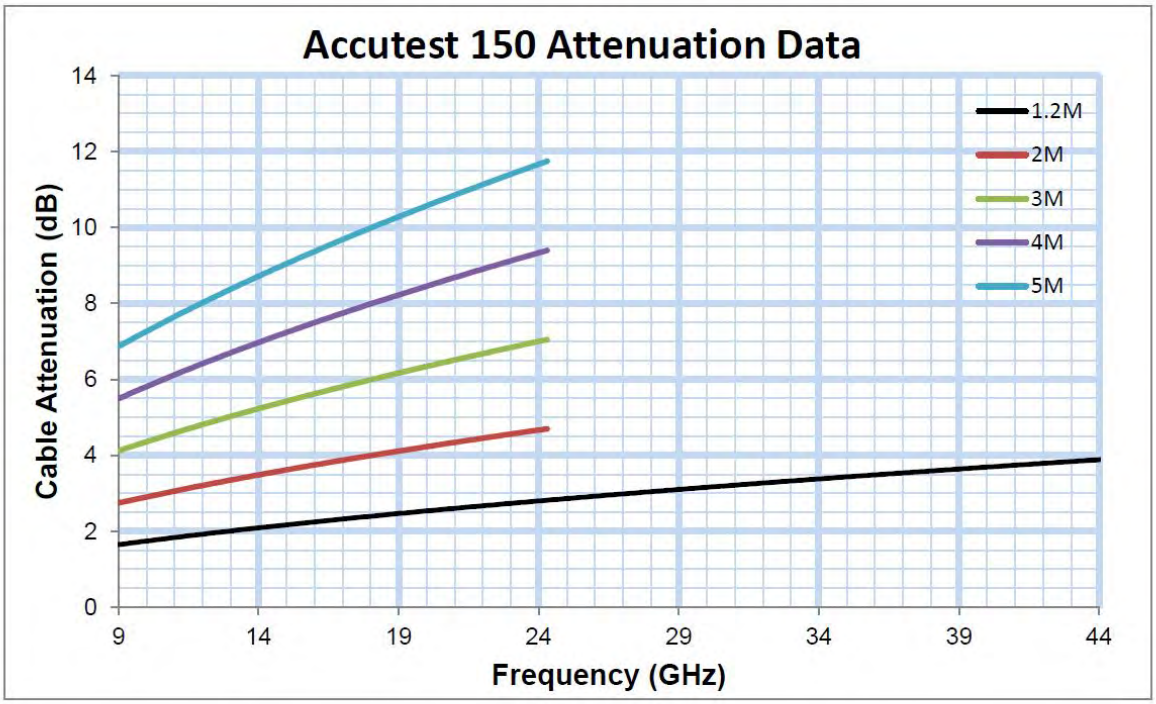

Figure 3: Insertion Loss of Accutest 150 (RF/LO Cable) with respect to frequency.

Virginia Diodes, Inc.

USER GUIDE

4 General Operating Procedures and Guidelines

VDI assumes the customer is familiar with VDI products, and VDI is not responsible for the warranty or guaranty of products damaged as a result of improper handling, testing, biasing, or use by customer. VDI offers the following general guidelines for using these products and recommends the customer contact VDI at (434) 297-3257 for assistance if needed. The following procedures are a quick guide for turning on and off the product. In each case the individual steps must be followed in the proper sequence to avoid damaging critical components.

4.1 Required Operating Procedures

- DO NOT exceed damage limits listed in Table 1.
- DO NOT apply any external biases to the system.
- Make proper RF connections depending on desired configuration (i.e. Standard/High LO and Standard/High IF operation). Refer to Figure 2A-C for more information.

Failure to follow these procedures will damage or destroy the device.

4.2 Additional Guidelines, Limitations, and Recommendations

- The SAX is shipped with a reusable dust cover attached. Remove dust cover before operation.

4.3 Turn-On Procedure

1. The user and test bench must be properly grounded and protected against ESD.
2. With the LO and RF input power turned off, make all necessary connections (i.e. LO cable, AC cable, DC cable). See Figure 2A-C for configuration details.
3. Turn on the LO input power.
4. Turn on the small signal RF input power and monitor the IF output.

4.4 Turn-Off Procedure

1. The user and test bench must be properly grounded and protected against ESD.
2. Turn off the RF input power.
3. Turn off the LO input power.
4. Disconnect the DC Power Supply.
5. After completing turn-off procedures described above, it is now safe to turn off all other equipment on user test bench.

Contact VDI with questions or concerns regarding operational procedures and limitations.

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5 Product Performance

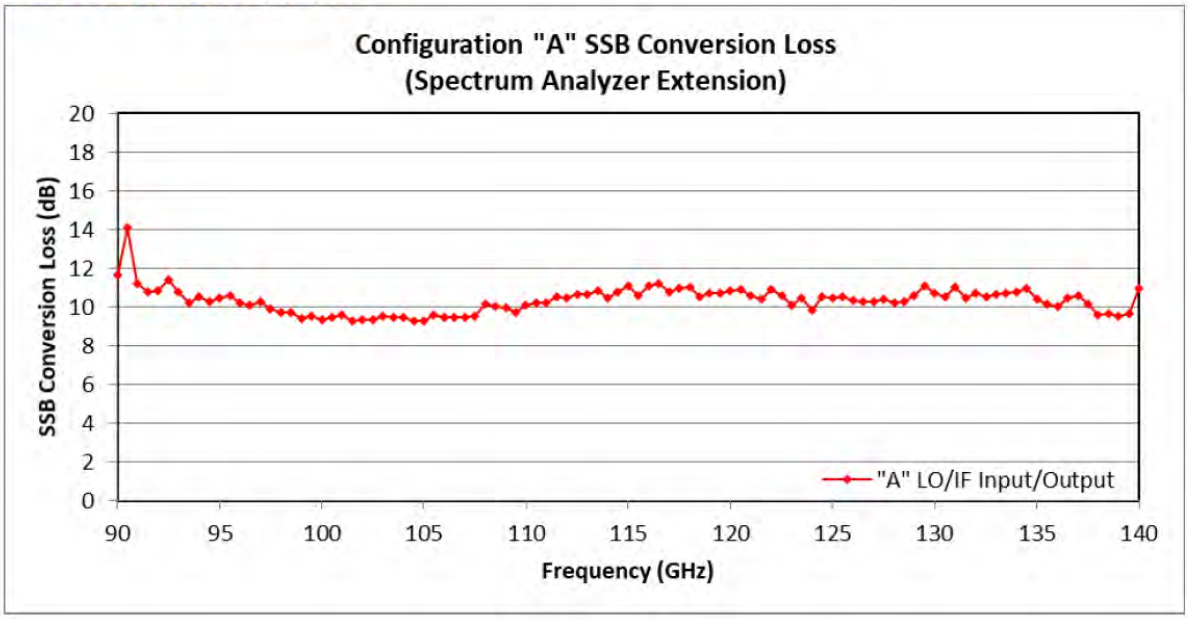

Figure 4: The product performance (SSB conversion loss vs. RF frequency) is shown for an LO input power of ~15dBm in Standard LO Frequency operation. IF power measured from "LO/IF" port with IF frequency fixed at 1.3GHz. CSV Data file included on USB Drive.

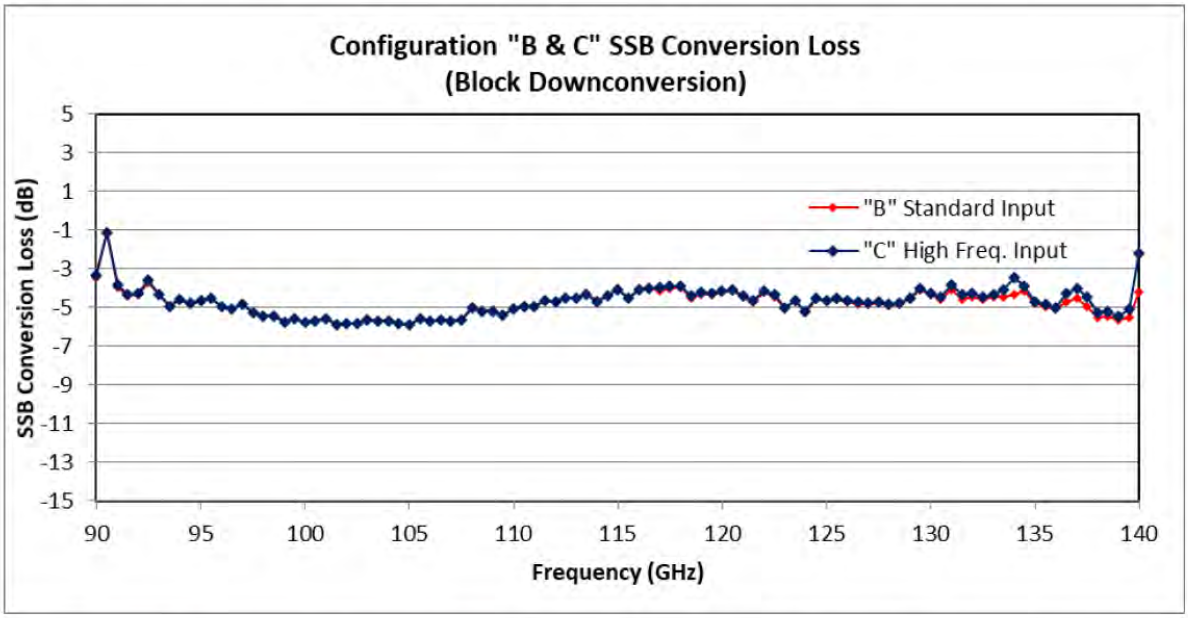

Figure 5: The product performance (SSB conversion loss vs. RF frequency) is shown for an LO input power of ~15dBm in Standard LO Frequency operation and LO input power of ~0dBm in High LO Frequency operation. IF power measured from "IF Output" port with IF frequency fixed at 1.3GHz. CSV Data file included on USB Drive.

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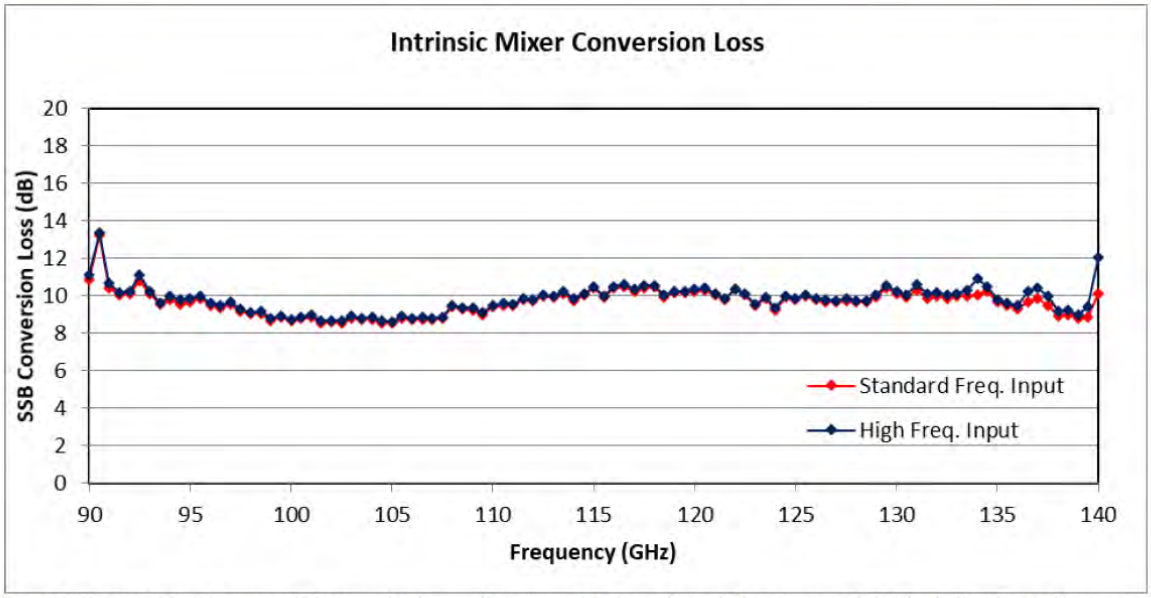

Figure 6: The product performance (SSB conversion loss vs. RF frequency) is shown for an LO input power of ~15dBm in Standard LO Frequency operation and LO input power of ~0dBm in High LO Frequency operation. IF power measured from mixer port with IF frequency fixed at 1.3GHz. Note: mixer port is not accessible for use by the user. CSV Data file included on USB Drive.

Measured Displayed Average Noise Level (dBm/Hz)	
Typical	-149.5

*Measured with a Keysight N9030A PXA Spectrum Analyzer.

SAX 837 Conversion Loss

Note: Out of band data is not guaranteed to be accurate.

Freq(GHz)	"A" LO/IF Input/Output	"B" Standard Input	"C" High Freq. Input	High Freq. Intrinsic Mixer Loss	Standard Freq. Intrinsic Mixer Loss
90	11.67514724	-3.451852763	-3.337852763	11.13014724	10.85114724
90.5	14.10568478	-1.079315219	-1.162315219	13.39768478	13.21768478
91	11.19284379	-3.952156213	-3.831156213	10.66284379	10.43484379
91.5	10.77353378	-4.372466216	-4.345466216	10.19653378	10.03853378
92	10.8156319	-4.3273681	-4.2933681	10.2776319	10.0966319
92.5	11.40549847	-3.724501532	-3.574501532	11.09249847	10.79149847
93	10.79724258	-4.331757419	-4.317757419	10.24124258	10.10624258
93.5	10.21914168	-4.91885832	-4.95285832	9.63014168	9.54914168
94	10.55024142	-4.587758581	-4.565758581	9.996241419	9.821241419
94.5	10.29788363	-4.822116373	-4.753116373	9.778883628	9.588883628
95	10.4741589	-4.669841103	-4.660841103	9.843158897	9.695158897
95.5	10.60265733	-4.50734267	-4.51534267	9.99665733	9.89265733
96	10.1907898	-4.953210203	-4.985210203	9.625789797	9.505789797
96.5	10.083555	-5.061445003	-5.079445003	9.479554997	9.372554997
97	10.30032929	-4.847670708	-4.859670708	9.661329292	9.553329292
97.5	9.894886965	-5.239113035	-5.255113035	9.296886965	9.162886965
98	9.696380637	-5.421619363	-5.441619363	9.135380637	9.034380637
98.5	9.728739538	-5.401260462	-5.427260462	9.168739538	9.038739538
99	9.401152675	-5.731847325	-5.746847325	8.803152675	8.707152675
99.5	9.542871349	-5.586128651	-5.600128651	8.951871349	8.840871349
100	9.367058164	-5.769941836	-5.782941836	8.777058164	8.658058164
100.5	9.496118475	-5.651881525	-5.678881525	8.901118475	8.787118475
101	9.563891248	-5.561108752	-5.575108752	8.981891248	8.875891248
101.5	9.294818879	-5.847181121	-5.869181121	8.686818879	8.578818879
102	9.32353949	-5.80946051	-5.83646051	8.70453949	8.60753949
102.5	9.312544107	-5.835455893	-5.854455893	8.691544107	8.586544107
103	9.538372928	-5.604627072	-5.619627072	8.933372928	8.824372928
103.5	9.440667741	-5.698332259	-5.705332259	8.834667741	8.727667741
104	9.473096285	-5.666903715	-5.678903715	8.866096285	8.770096285
104.5	9.295835708	-5.846164292	-5.856164292	8.670835708	8.571835708
105	9.26675987	-5.86924013	-5.87924013	8.63275987	8.53575987
105.5	9.587719809	-5.566280191	-5.585280191	8.920719809	8.823719809
106	9.447107698	-5.688892302	-5.696892302	8.806107698	8.722107698
106.5	9.47817723	-5.65582277	-5.66782277	8.86217723	8.77317723
107	9.445819292	-5.693180709	-5.715180709	8.831819292	8.718819292
107.5	9.506835045	-5.627164955	-5.646164955	8.896835045	8.804835045
108	10.15543137	-4.980568633	-5.021568633	9.515431367	9.429431367

Freq(GHz)	"A" LO/IF Input/Output	"B" Standard Input	"C" High Freq. Input	High Freq. Intrinsic Mixer Loss	Standard Freq. Intrinsic Mixer Loss
108.5	10.01501141	-5.139988586	-5.184988586	9.375011414	9.292011414
109	9.986943402	-5.163056598	-5.180056598	9.359943402	9.259943402
109.5	9.700311379	-5.427688621	-5.415688621	9.090311379	9.007311379
110	10.11440377	-5.034596231	-5.068596231	9.480403769	9.435403769
110.5	10.23931625	-4.896683751	-4.935683751	9.593316249	9.506316249
111	10.19914709	-4.941852911	-4.978852911	9.567147089	9.514147089
111.5	10.51961626	-4.630383737	-4.666383737	9.887616263	9.822616263
112	10.45156748	-4.687432519	-4.685432519	9.837567481	9.740567481
112.5	10.66102657	-4.482973427	-4.488973427	10.07402657	9.973026573
113	10.62316393	-4.517836074	-4.541836074	10.01716393	9.943163926
113.5	10.84547099	-4.287529014	-4.341529014	10.22647099	10.14647099
114	10.46605969	-4.667940312	-4.688940312	9.862059688	9.774059688
114.5	10.76937147	-4.369628526	-4.376628526	10.14637147	10.05437147
115	11.11837657	-4.04062343	-4.05262343	10.48737657	10.40737657
115.5	10.59959028	-4.534409721	-4.539409721	10.02759028	9.940590279
116	11.08255473	-4.042445266	-4.056445266	10.50855473	10.41955473
116.5	11.23473017	-3.950269828	-4.014269828	10.59973017	10.49673017
117	10.75491026	-4.152089736	-3.939089736	10.36291026	10.26991026
117.5	10.96623836	-4.013761637	-3.885761637	10.55123836	10.44823836
118	11.04450356	-3.973496442	-3.878496442	10.56050356	10.48550356
118.5	10.52617331	-4.502826691	-4.414826691	10.04817331	9.940173309
119	10.71214465	-4.310855347	-4.229855347	10.27714465	10.18914465
119.5	10.73550138	-4.318498616	-4.257498616	10.26750138	10.16450138
120	10.83361073	-4.226389267	-4.143389267	10.35961073	10.27661073
120.5	10.88819078	-4.15980922	-4.09380922	10.41419078	10.33619078
121	10.61391575	-4.435084247	-4.384084247	10.13691575	10.06591575
121.5	10.37585906	-4.697140936	-4.630140936	9.876859064	9.825859064
122	10.92118158	-4.177818422	-4.117818422	10.38918158	10.35018158
122.5	10.59706531	-4.452934691	-4.359934691	10.13506531	10.05606531
123	10.06564904	-5.02435096	-4.99135096	9.55564904	9.48764904
123.5	10.43854116	-4.643458841	-4.628458841	9.936541159	9.847541159
124	9.860132081	-5.249867919	-5.203867919	9.352132081	9.265132081
124.5	10.50591325	-4.589086747	-4.518086747	10.00491325	9.903913253
125	10.4479865	-4.673013497	-4.657013497	9.882986503	9.791986503
125.5	10.54246455	-4.560535451	-4.549535451	10.03846455	9.965464549
126	10.350356	-4.721644004	-4.674644004	9.874355996	9.804355996
126.5	10.27868628	-4.807313723	-4.735313723	9.805686277	9.713686277
127	10.26573962	-4.837260384	-4.798260384	9.773739616	9.685739616
127.5	10.39357186	-4.74042814	-4.71242814	9.85857186	9.76757186
128	10.2407497	-4.876250305	-4.819250305	9.737749695	9.661749695
128.5	10.27302715	-4.815972854	-4.774972854	9.753027146	9.666027146

Freq(GHz)	"A" LO/IF Input/Output	"B" Standard Input	"C" High Freq. Input	High Freq. Intrinsic Mixer Loss	Standard Freq. Intrinsic Mixer Loss
129	10.57790721	-4.539092789	-4.493092789	10.04490721	9.944907211
129.5	11.06294687	-4.055053128	-4.017053128	10.52894687	10.44894687
130	10.74665017	-4.351349831	-4.264349831	10.25565017	10.14965017
130.5	10.54234128	-4.571658716	-4.477658716	10.04334128	9.919341284
131	10.99784288	-4.095157118	-3.820157118	10.59784288	10.32284288
131.5	10.48624586	-4.582754137	-4.311754137	10.14424586	9.843245863
132	10.71127934	-4.428720663	-4.285720663	10.18227934	10.02627934
132.5	10.54574278	-4.587257219	-4.439257219	10.07174278	9.893742781
133	10.64369663	-4.477303375	-4.340303375	10.14769663	9.976696625
133.5	10.68664451	-4.43135549	-4.10535549	10.33764451	9.99364451
134	10.78700975	-4.313990247	-3.460990247	10.93500975	10.07700975
134.5	10.95997375	-4.161026252	-3.916026252	10.52797375	10.25597375
135	10.37279947	-4.751200533	-4.707200533	9.788799467	9.689799467
135.5	10.1724832	-4.934516804	-4.843516804	9.642483196	9.511483196
136	10.044754	-5.108245999	-4.999245999	9.512754001	9.332754001
136.5	10.45312533	-4.676874665	-4.252874665	10.25012533	9.695125335
137	10.61386016	-4.518139838	-3.994139838	10.42886016	9.852860162
137.5	10.14375506	-4.948244935	-4.476244935	9.965755065	9.481755065
138	9.604980629	-5.520019371	-5.270019371	9.185980629	8.939980629
138.5	9.663838852	-5.432161148	-5.190161148	9.272838852	9.004838852
139	9.512629562	-5.615370438	-5.452370438	9.013629562	8.813629562
139.5	9.644409056	-5.524590944	-5.063590944	9.413409056	8.893409056
140	10.95996759	-4.22003241	-2.22503241	12.05596759	10.15096759

Notes: The test equipment was provided by Starry, Inc. The vendor does not provide a calibration certificate.

Standard gain horn antenna inspection

Intertek

Equipment visual inspection

Equipment	Frequency (GHz)	Date	Initial
WR-19	40-60	3/10/2022	VFV
WR-12	60-90	3/10/2022	VFV
WR-8.0	90-140	3/10/2022	VFV

The Conical horn antennas were visually spected for damage prior to testing.
No damaged was observed.

14 Appendix B – Mixer Verification Certificates

VDIWR19.0SAX-F (40-60 GHz)

Virginia Diodes, Inc
979 2nd St. SE
Suite 309
Charlottesville, VA 22902
Phone: 434-297-3257
Fax: 434-297-3258

Certificate of Conformance

To: Starry, Inc.
38 Chauncy Street
2nd Floor
Boston, MA 02111
United States

From: Virginia Diodes, Inc
979 2nd St. SE
Suite 309
Charlottesville, VA 22902

Packing List No: 211085 **Today's Date:** 03/31/21
Shipping Date: 03/30/21 **PO Number:** PO20183

Quantity Shipped	Unit	Description	Order-Job Number
1	EA	VDIWR19.0SAX-F S/N: SAX 835	21108A-01
1	EA	RCHO19R CONICAL HORN ANTENNA	21108A-02

The VDI product(s) in this shipment meet(s) the guidelines for performance specifications established in accordance with the corresponding Purchase Order. Data presented in the User Guide, where applicable, has been obtained in accordance with VDI's Quality Management System. All instruments, used to obtain data, which require calibration have been calibrated with equipment traceable to the National Institute of Standards and Technology (NIST) and through NIST to the International System of Units (SI).

Authorized Signature
Virginia Diodes, Inc

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VDIWR12.0SAX-F (60-90 GHz)

Virginia Diodes, Inc
979 2nd St. SE
Suite 309
Charlottesville, VA 22902
Phone: 434-297-3257
Fax: 434-297-3258

Certificate of Conformance

To: Starry, Inc.
38 Chauncy Street
2nd Floor
Boston, MA 02111
United States

From: Virginia Diodes, Inc
979 2nd St. SE
Suite 309
Charlottesville, VA 22902

Packing List No: 211211
Shipping Date: 04/08/21
Today's Date: 04/12/21
PO Number: PO20183

Quantity Shipped	Unit	Description	Order-Job Number
1	EA	VDIWR12.0SAX-F S/N: SAX 836	21108B-01
1	EA	RCHO12RL Conical Horn Antenna	21108B-02

The VDI product(s) in this shipment meet(s) the guidelines for performance specifications established in accordance with the corresponding Purchase Order. Data presented in the User Guide, where applicable, has been obtained in accordance with VDI's Quality Management System. All instruments, used to obtain data, which require calibration have been calibrated with equipment traceable to the National Institute of Standards and Technology (NIST) and through NIST to the International System of Units (SI).

Authorized Signature
Virginia Diodes, Inc

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VDIWR8.0SAX-F (90-140 GHz)

Virginia Diodes, Inc
979 2nd St. SE
Suite 309
Charlottesville, VA 22902
Phone: 434-297-3257
Fax: 434-297-3258

Certificate of Conformance

To: Starry, Inc.
38 Chauncy Street
2nd Floor
Boston, MA 02111
United States

From: Virginia Diodes, Inc
979 2nd St. SE
Suite 309
Charlottesville, VA 22902

Packing List No: 212029 **Today's Date:** 06/11/21
Shipping Date: 06/11/21 **PO Number:** PO20183

Quantity Shipped	Unit	Description	Order-Job Number
1	EA	VDIWR8.0SAX-F WR8.0SAX-F / SN: SAX 837	21108C-01
1	EA	RCHO8RL WR8.0CH - Conical Horn Antenna / RCHO8RL	21108C-02

The VDI product(s) in this shipment meet(s) the guidelines for performance specifications established in accordance with the corresponding Purchase Order. Data presented in the User Guide, where applicable, has been obtained in accordance with VDI's Quality Management System. All instruments, used to obtain data, which require calibration have been calibrated with equipment traceable to the National Institute of Standards and Technology (NIST) and through NIST to the International System of Units (SI).

Authorized Signature
Virginia Diodes, Inc

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VDIWR5.1SAX-F (140-220 GHz)

Virginia Diodes, Inc
979 2nd St. SE
Suite 309
Charlottesville, VA 22902
Phone: 434-297-3257
Fax: 434-297-3258

Certificate of Conformance

To: Starry, Inc.
38 Chauncy Street
2nd Floor
Boston, MA 02111
United States

From: Virginia Diodes, Inc
979 2nd St. SE
Suite 309
Charlottesville, VA 22902

Packing List No: 211604 **Today's Date:** 05/11/21
Shipping Date: 05/11/21 **PO Number:** PO20183

Quantity Shipped	Unit	Description	Order-Job Number
1	EA	VDIWR5.1SAX-F WR5.1SAX-F / SN: SAX 838	21108D-01
1	EA	RCHO5RL WR5.1CH / SN: RCHO5RL	21108D-02

The VDI product(s) in this shipment meet(s) the guidelines for performance specifications established in accordance with the corresponding Purchase Order. Data presented in the User Guide, where applicable, has been obtained in accordance with VDI's Quality Management System. All instruments, used to obtain data, which require calibration have been calibrated with equipment traceable to the National Institute of Standards and Technology (NIST) and through NIST to the International System of Units (SI).

Authorized Signature
Virginia Diodes, Inc

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15 Appendix C – Test Laboratory Accreditation Scope

OET Accredited Test firm scope List

Test Firm: Intertek Testing Services NA Inc.

Scope	FCC Rule Parts	Maximum Assessed Frequency in Mhz	Status	Expiration Date	Recognition Date
Unintentional Radiators	FCC Part15, Subpart B	260000.00	Approved	06-30-2022	09-29-2017
Industrial, Scientific, and Medical Equipment	FCC Part 18	260000.00	Approved	06-30-2022	09-29-2017
Intentional Radiators	FCC Part 15 Subpart C	260000.00	Approved	06-30-2022	09-29-2017
UPCS	FCC Part 15, Subpart D	260000.00	Approved	06-30-2022	09-29-2017
U-NII without DFS Intentional Radiators	FCC Part 15, Subpart E	260000.00	Approved	06-30-2022	09-29-2017
U-NII with DFS Intentional Radiators	FCC Part 15, Subpart E	260000.00	Approved	06-30-2022	09-29-2017
UWB Intentional Radiators	FCC Part 15, Subpart F	260000.00	Approved	06-30-2022	09-29-2017
BPL Intentional Radiators	FCC Part 15, Subpart G	260000.00	Approved	06-30-2022	09-29-2017
White Space Device Intentional Radiators	FCC Part 15, Subpart H	260000.00	Approved	06-30-2022	09-29-2017
Commercial Mobile Services	Part 22 (cellular), Part 24, Part 25 (below 3 GHz), Part 27	260000.00	Approved	06-30-2022	09-29-2017
General Mobile Radio Services	Part 22 (non-cellular), Part 90 (below 3 GHz), Part 95 (below 3 GHz), Part 97 (below 3 GHz),Part 101 (below 3 GHz)	260000.00	Approved	06-30-2022	09-29-2017
Maritime and Aviation Radio Services	Part 80, Part 87	260000.00	Approved	06-30-2022	09-29-2017
Microwave and Millimeter Bands Radio Services	Part 25 (above 3 GHz), Part 30, Part 74, Part 90 (above 3 GHz), Part 95 (above 3 GHz), Part 97 (above 3 GHz) Part 101	260000.00	Approved	06-30-2022	09-29-2017
Broadcast Radio Services	Part 73, Part 74 (below 3 GHz)	260000.00	Approved	06-30-2022	09-29-2017
Signal Boosters	Part 20, Part 90.219	260000.00	Approved	06-30-2022	09-29-2017