

POWER SPECTRAL DENSITY - 4 PORT MODE



XMIT 2020.03.25.0

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFL	27-Feb-20	27-Feb-21
Block - DC	Fairview Microwave	SD3379	AMM	21-Sep-20	21-Sep-21
Generator - Signal	Agilent	N5173B	TIW	17-Jul-20	17-Jul-23

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The fundamental emission power spectral density was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

The method of section 5.2.4.5 of ANSI C63.26 was used to make the measurement. The method uses trace averaging across ON and OFF times of EUT transmissions using the spectrum analyzer's RMS detector. Following the measurement a duty cycle correction was applied by adding $[10\log(1/D)]$, where D is the duty cycle, to the measured power to compute the PSD during the transmit times.

RF conducted emissions testing was performed on one port. The FRIG antenna ports are essentially electrically identical (the RF power variation between antenna ports is small) and port 1 was selected to perform the testing under this effort as allowed by ANSI C63.26-2015 paragraphs 5.2.5.3, 5.7.2i and 6.4.

The total PSD of all antenna ports (at the radio output) was determined per ANSI C63.26-2015 paragraph 6.4.3.2.4.

The EIRP calculations were based upon ANSI C63.26-2015 sections 6.4.3.2.4, section 6.4.6.3, section 6.4.5.3 and section 6.4.5.2

The applicable FCC and ISED regulatory requirements for EIRP are as follows.

FCC Requirements:

27.50(d) The following power and antenna height requirements apply to stations transmitting in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz and 2180-2200 MHz bands:

(1) The power of each fixed or base station transmitting in the 1995-2000 MHz, 2110-2155 MHz, 2155-2180 MHz or 2180-2200 MHz band and located in any county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, is limited to:

(ii) An EIRP of 3280 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz. (2) The power of each fixed or base station transmitting in the 1995-2000 MHz, the 2110-2155 MHz 2155-2180 MHz band, or 2180-2200 MHz band and situated in any geographic location other than that described in paragraph (d)(1) of this section is limited to:

(ii) An EIRP of 1640 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.

ISED Requirements RSS-139 Section 6.5/SRSP-513 Section 5.1.1

SRSP-513 5.1 Radiated Power and Antenna Height Limits

5.1.1 Fixed and Base Stations

5.1.1.2 For fixed and base stations operating within the frequency range 2110-2180 MHz with a channel bandwidth greater than 1 MHz, the maximum permissible e.i.r.p. is 1640 watts/MHz e.i.r.p. (i.e. no more than 1640 watts e.i.r.p. in any 1 MHz band segment) with an antenna height above average terrain (HAAT) up to 300 metres.

5.1.1.3 Fixed and base stations located in geographic areas at a distance greater than 26 km from large or medium population centres and transmitting within the frequency range 2110-2180 MHz, may increase their e.i.r.p. up to a maximum of 3280 watts/MHz (i.e. no more than 3280 watts e.i.r.p. in any 1 MHz band segment), with an antenna HAAT up to 300 metres.

5.1.1.4 Fixed and base station antenna heights above average terrain may exceed 300 metres with a reduction in e.i.r.p. The maximum permissible e.i.r.p. for installations with antenna HAAT in excess of 300 metres is given in the following table:

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EUT: FRIG (C2PC FCC/ISED Approval for 5G)	Work Order: NOKI0025
Serial Number: RY142309120	Date: 4-Dec-20
Customer: Nokia Solutions and Networks	Temperature: 23.4 °C
Attendees: Mitchell Hill, John Rattanavong	Humidity: 28.5% RH
Project: None	Barometric Pres.: 1028 mbar
Tested by: Brandon Hobbs	Power: 54 VDC
	Job Site: TX05

TEST SPECIFICATIONS		Test Method	
FCC 27:2020		ANSI C63.26:2015	
RSS-139:2015		RSS-139:2015	

COMMENTS
 All measurement path losses were accounted for in the reference level offset including any attenuators, filters and DC blocks. AWS Band 1 carriers are enabled at maximum power (30 watts/carrier). The PSD was measured for a single carrier over the carrier channel bandwidth on port 1. The PSD was measured while transmitting one carrier on Port 1. The total PSD for multipoint (2x2 MIMO & 4x4 MIMO) operation was determined based upon ANSI 63.26 clause 6.4.3.2.4 (10 Log Nout). The total PSD for two port operation is single port PSD +3dB [i.e. 10 Log(2)]. The total PSD for four port operation is single port PSD +6dB [i.e. 10 Log(4)].

DEVIATIONS FROM TEST STANDARD

None

Configuration #	2	Signature	
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	Initial Value dBm/MHz	Duty Cycle Factor (dB)	Single Port dBm/MHz == PSD	Two Port (2x2 MIMO) dBm/MHz == PSD	Four Port (4x4 MIMO) dBm/MHz == PSD
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz					
5 MHz Bandwidth					
QPSK Modulation					
Low Channel 2112.5 MHz	38.460	0	38.46	41.46	44.46
Mid Channel 2132.5 MHz	38.424	0	38.42	41.42	44.42
High Channel 2152.5 MHz	38.528	0	38.53	41.53	44.53
16-QAM Modulation					
Low Channel 2112.5 MHz	38.475	0	38.48	41.48	44.48
Mid Channel 2132.5 MHz	38.447	0	38.45	41.45	44.45
High Channel 2152.5 MHz	38.600	0	38.60	41.60	44.60
64-QAM Modulation					
Low Channel 2112.5 MHz	38.480	0	38.48	41.48	44.48
Mid Channel 2132.5 MHz	38.521	0	38.52	41.52	44.52
High Channel 2152.5 MHz	38.505	0	38.51	41.51	44.51
256-QAM Modulation					
Low Channel 2112.5 MHz	38.392	0	38.39	41.39	44.39
Mid Channel 2132.5 MHz	38.429	0	38.43	41.43	44.43
High Channel 2152.5 MHz	38.373	0	38.37	41.37	44.37
10 MHz Bandwidth					
QPSK Modulation					
Low Channel 2115 MHz	35.234	0	35.23	38.23	41.23
Mid Channel 2132.5 MHz	35.447	0	35.45	38.45	41.45
High Channel 2150 MHz	35.362	0	35.36	38.36	41.36
16-QAM Modulation					
Low Channel 2115 MHz	36.091	0	36.09	39.09	42.09
Mid Channel 2132.5 MHz	36.126	0	36.13	39.13	42.13
High Channel 2150 MHz	36.185	0	36.19	39.19	42.19
64-QAM Modulation					
Low Channel 2115 MHz	35.429	0	35.43	38.43	41.43
Mid Channel 2132.5 MHz	35.776	0	35.78	38.78	41.78
High Channel 2150 MHz	35.617	0	35.62	38.62	41.62
256-QAM Modulation					
Low Channel 2115 MHz	35.355	0	35.36	38.36	41.36
Mid Channel 2132.5 MHz	35.546	0	35.55	38.55	41.55
High Channel 2150 MHz	35.441	0	35.44	38.44	41.44
15 MHz Bandwidth					
QPSK Modulation					
Low Channel 2117.5 MHz	33.499	0	33.50	36.50	39.50
Mid Channel 2132.5 MHz	33.765	0	33.77	36.77	39.77
High Channel 2147.5 MHz	33.715	0	33.72	36.72	39.72
16-QAM Modulation					
Low Channel 2117.5 MHz	35.038	0	35.04	38.04	41.04
Mid Channel 2132.5 MHz	35.188	0	35.19	38.19	41.19
High Channel 2147.5 MHz	35.180	0	35.18	38.18	41.18
64-QAM Modulation					
Low Channel 2117.5 MHz	33.691	0	33.69	36.69	39.69
Mid Channel 2132.5 MHz	33.817	0	33.82	36.82	39.82
High Channel 2147.5 MHz	33.829	0	33.83	36.83	39.83
256-QAM Modulation					
Low Channel 2117.5 MHz	33.528	0	33.53	36.53	39.53
Mid Channel 2132.5 MHz	33.821	0	33.82	36.82	39.82
High Channel 2147.5 MHz	33.745	0	33.75	36.75	39.75
20 MHz Bandwidth					
QPSK Modulation					
Low Channel 2120 MHz	32.278	0	32.28	35.28	38.28
Mid Channel 2132.5 MHz	32.565	0	32.57	35.57	38.57
High Channel 2145 MHz	32.542	0	32.54	35.54	38.54
16-QAM Modulation					
Low Channel 2120 MHz	33.951	0	33.95	36.95	39.95
Mid Channel 2132.5 MHz	34.172	0	34.17	37.17	40.17
High Channel 2145 MHz	34.153	0	34.15	37.15	40.15
64-QAM Modulation					
Low Channel 2120 MHz	32.412	0	32.41	35.41	38.41
Mid Channel 2132.5 MHz	32.617	0	32.62	35.62	38.62
High Channel 2145 MHz	32.667	0	32.67	35.67	38.67
256-QAM Modulation					
Low Channel 2120 MHz	32.406	0	32.41	35.41	38.41
Mid Channel 2132.5 MHz	32.694	0	32.69	35.69	38.69
High Channel 2145 MHz	32.692	0	32.69	35.69	38.69

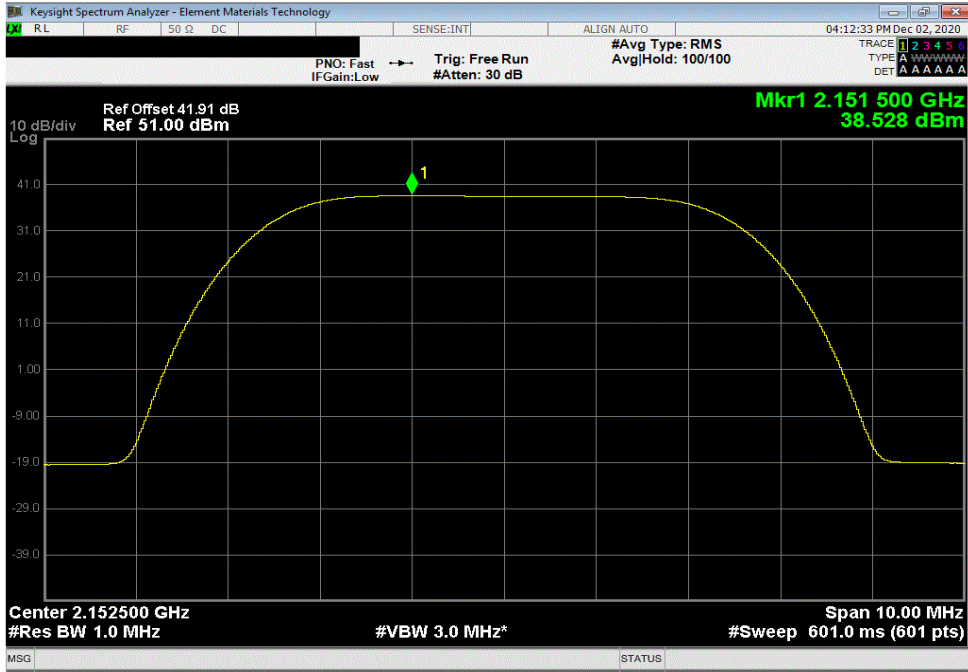
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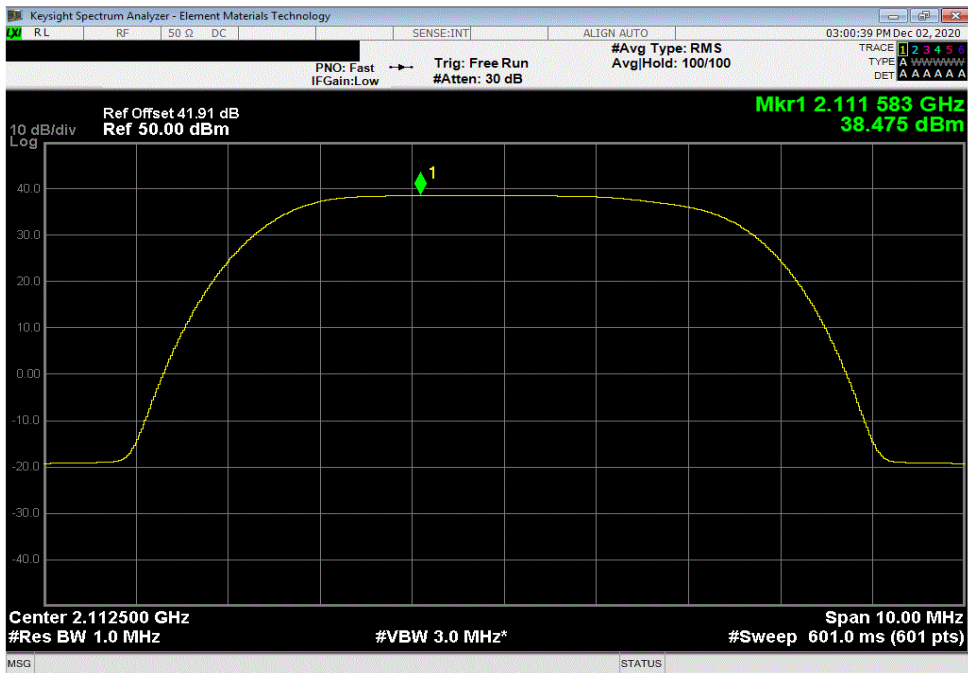
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 5 MHz Bandwidth, QPSK Modulation, High Channel 2152.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
38.528	0	38.5	41.528	44.528



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 5 MHz Bandwidth, 16-QAM Modulation, Low Channel 2112.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
38.475	0	38.5	41.5	44.5



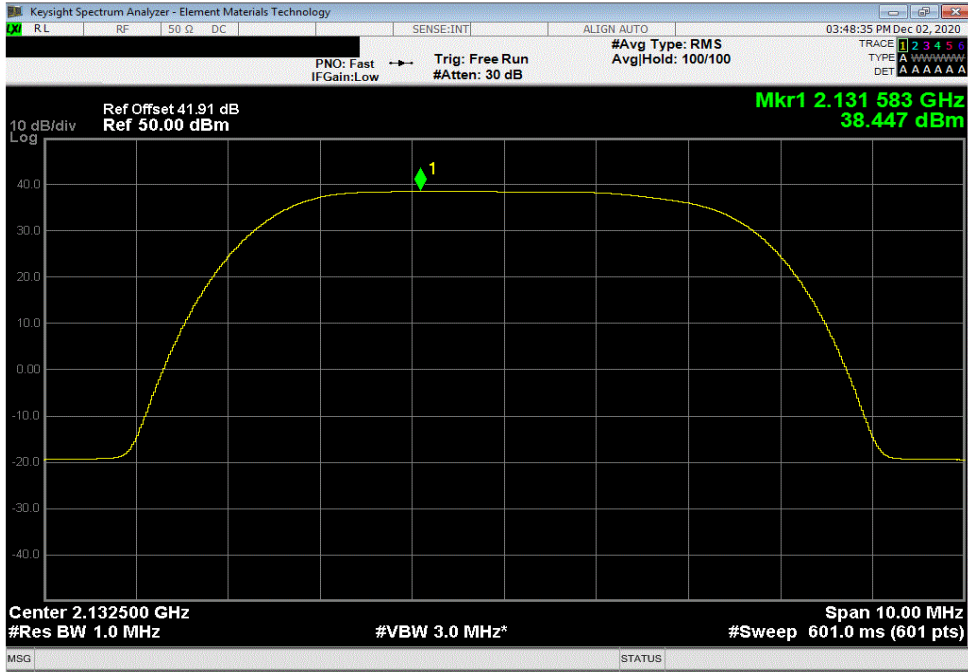
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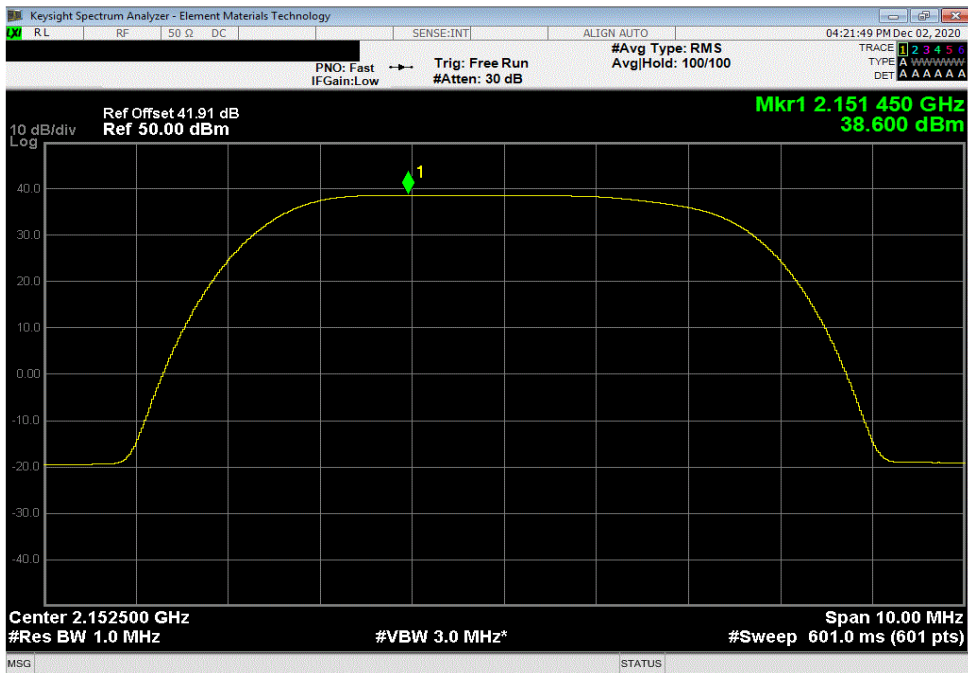
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 5 MHz Bandwidth, 16-QAM Modulation, Mid Channel 2132.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
38.447	0	38.4	41.447	44.447



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 5 MHz Bandwidth, 16-QAM Modulation, High Channel 2152.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
38.6	0	38.6	41.6	44.6



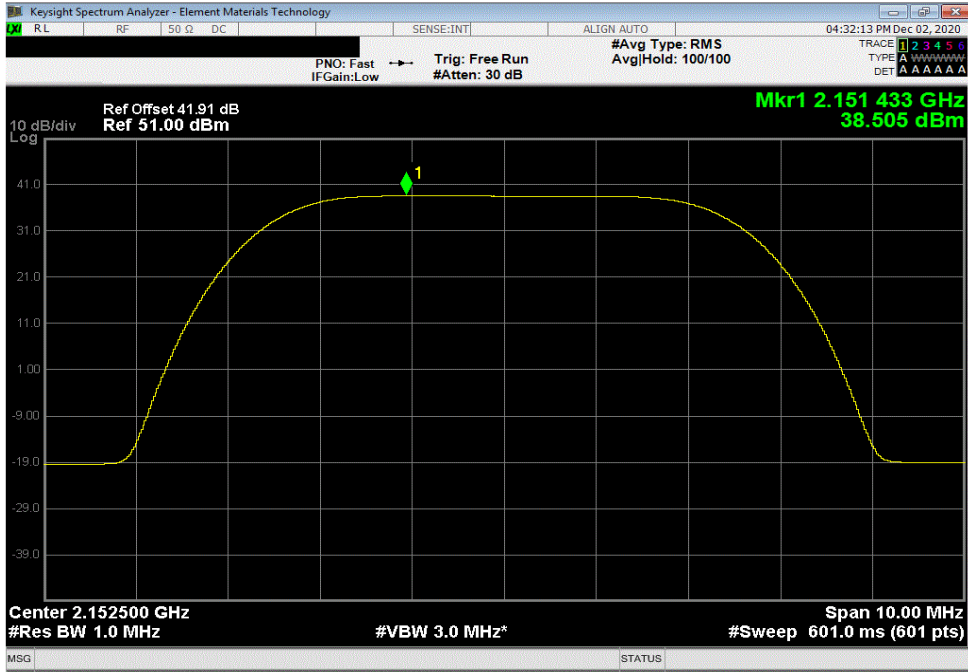
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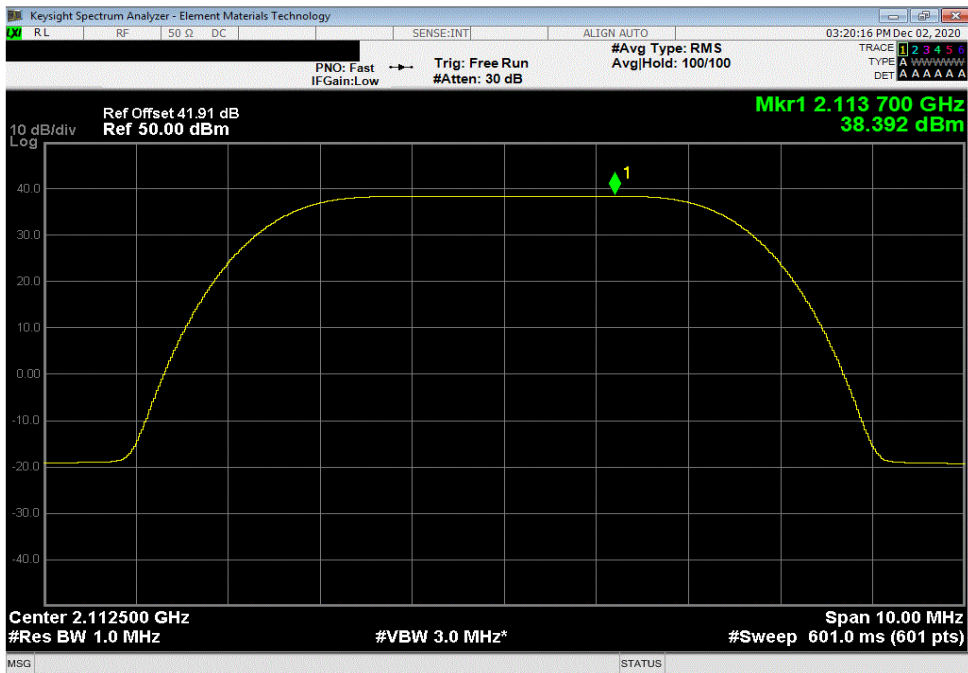
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 5 MHz Bandwidth, 64-QAM Modulation, High Channel 2152.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
38.505	0	38.5	41.505	44.505



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 5 MHz Bandwidth, 256-QAM Modulation, Low Channel 2112.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
38.392	0	38.4	41.4	44.4



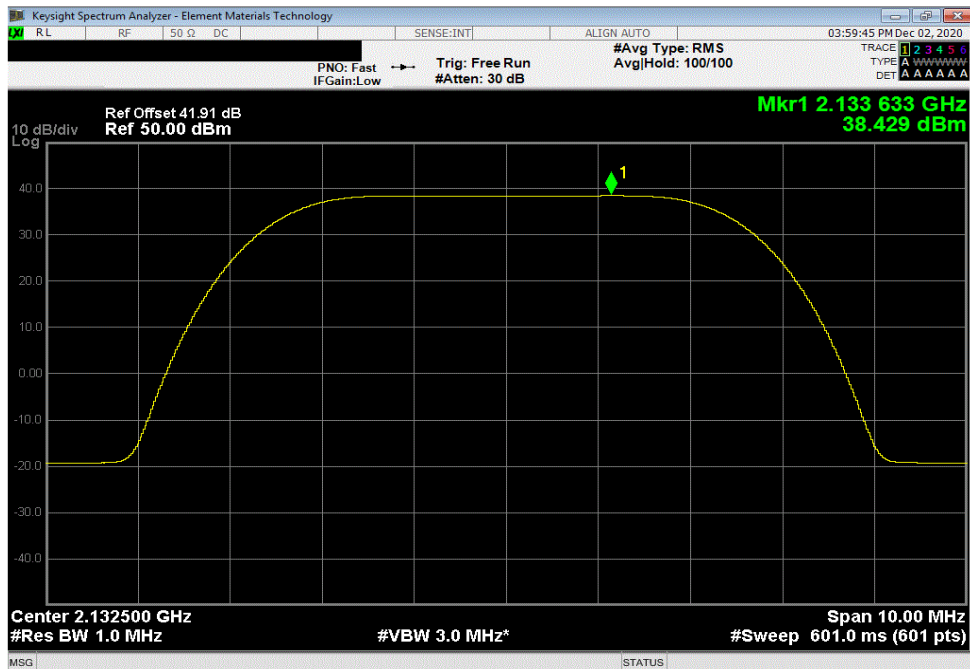
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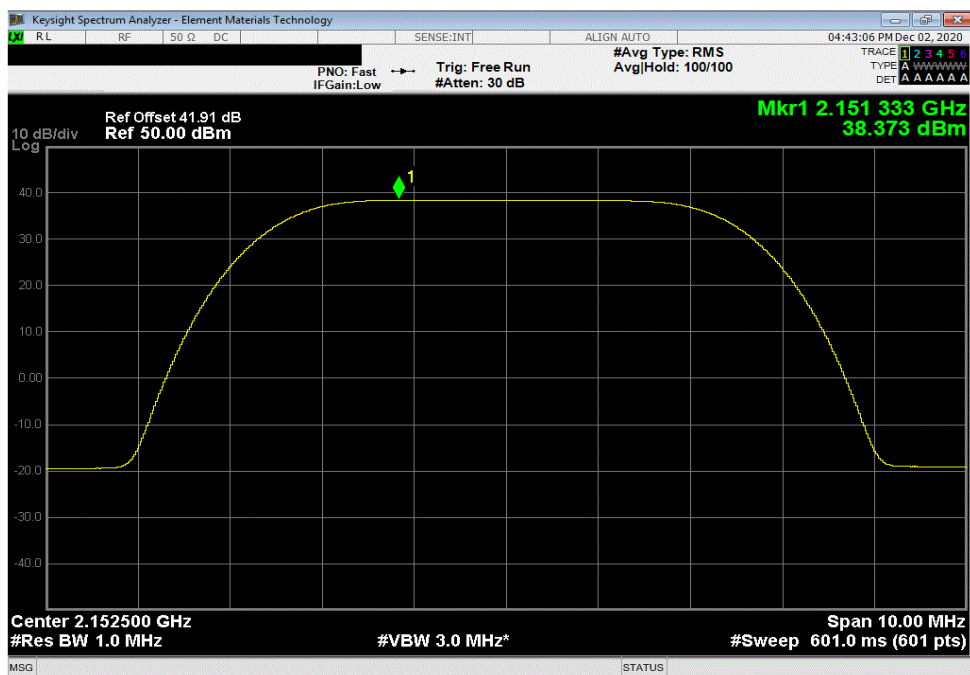
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 5 MHz Bandwidth, 256-QAM Modulation, Mid Channel 2132.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
38.429	0	38.4	41.429	44.429



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 5 MHz Bandwidth, 256-QAM Modulation, High Channel 2152.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
38.373	0	38.4	41.4	44.4



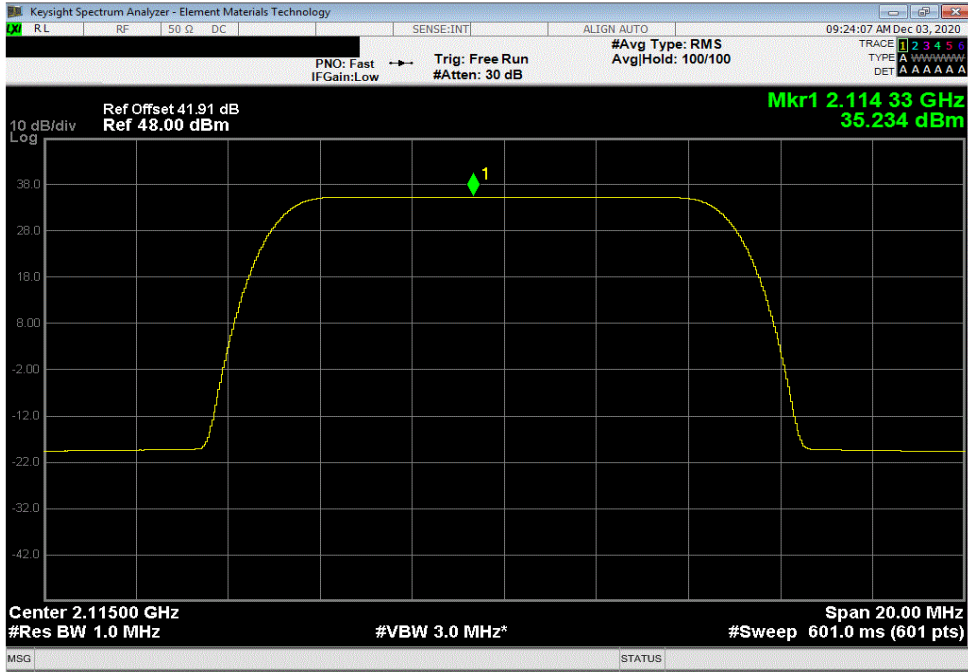
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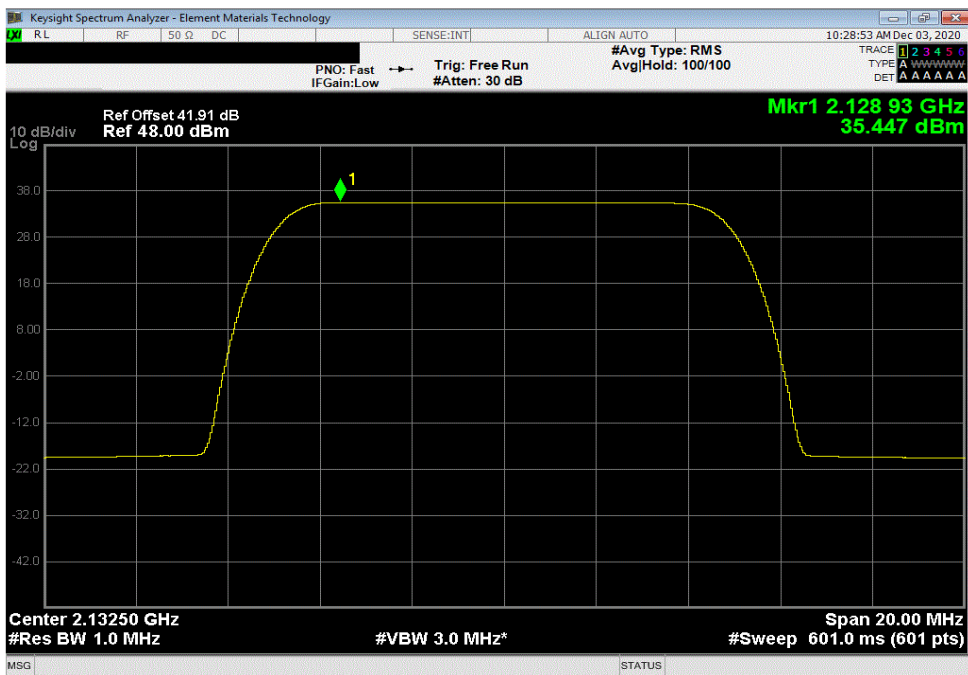
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, QPSK Modulation, Low Channel 2115 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.234	0	35.2	38.234	41.234



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, QPSK Modulation, Mid Channel 2132.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.447	0	35.4	38.4	41.4



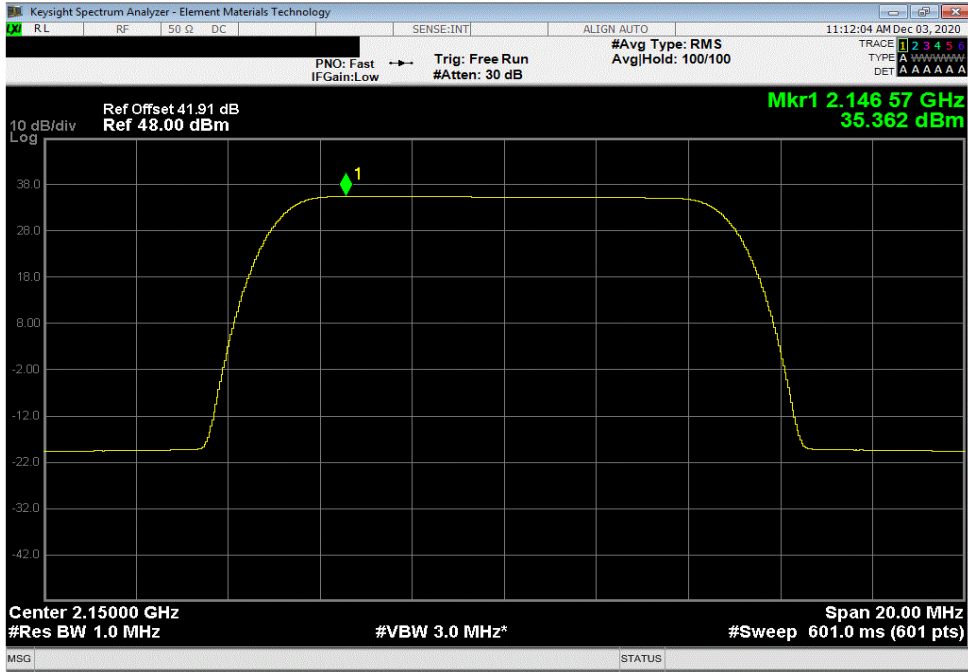
POWER SPECTRAL DENSITY - 4 PORT MODE



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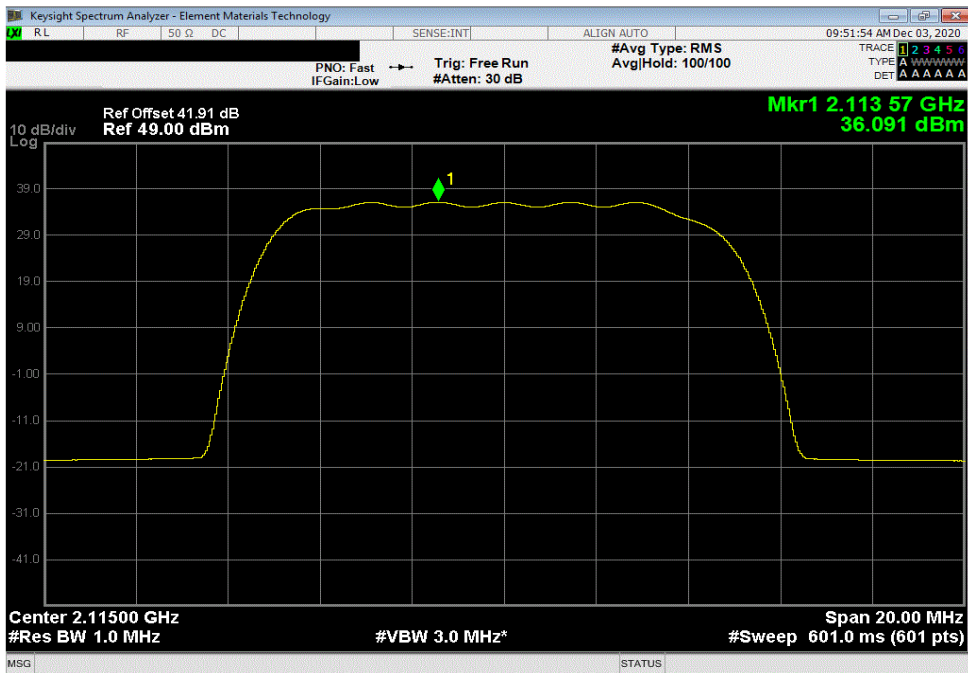
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, QPSK Modulation, High Channel 2150 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.362	0	35.4	38.362	41.362



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, 16-QAM Modulation, Low Channel 2115 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
36.091	0	36.1	39.1	42.1



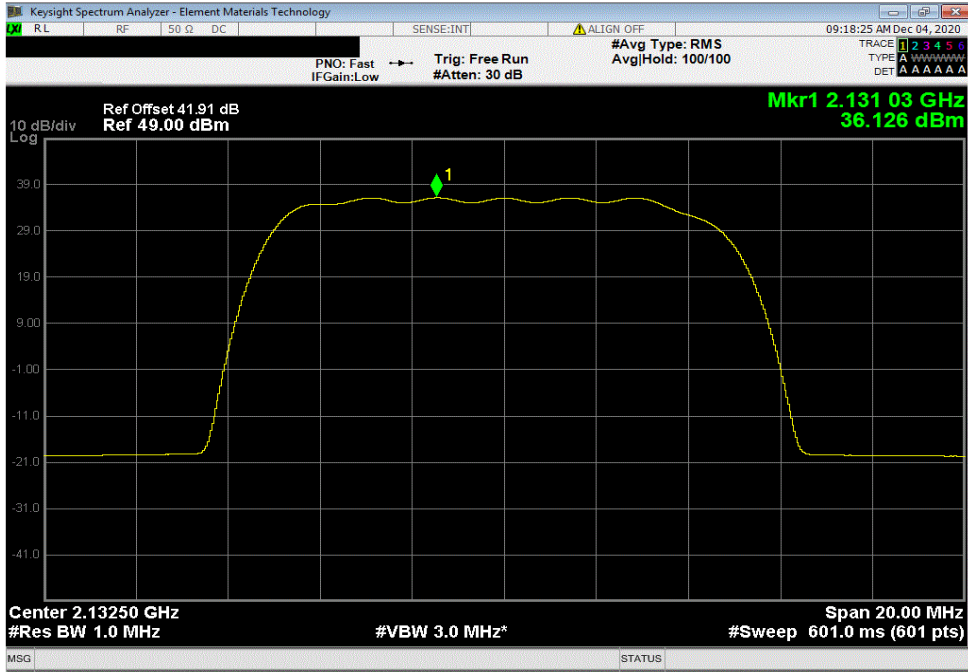
POWER SPECTRAL DENSITY - 4 PORT MODE



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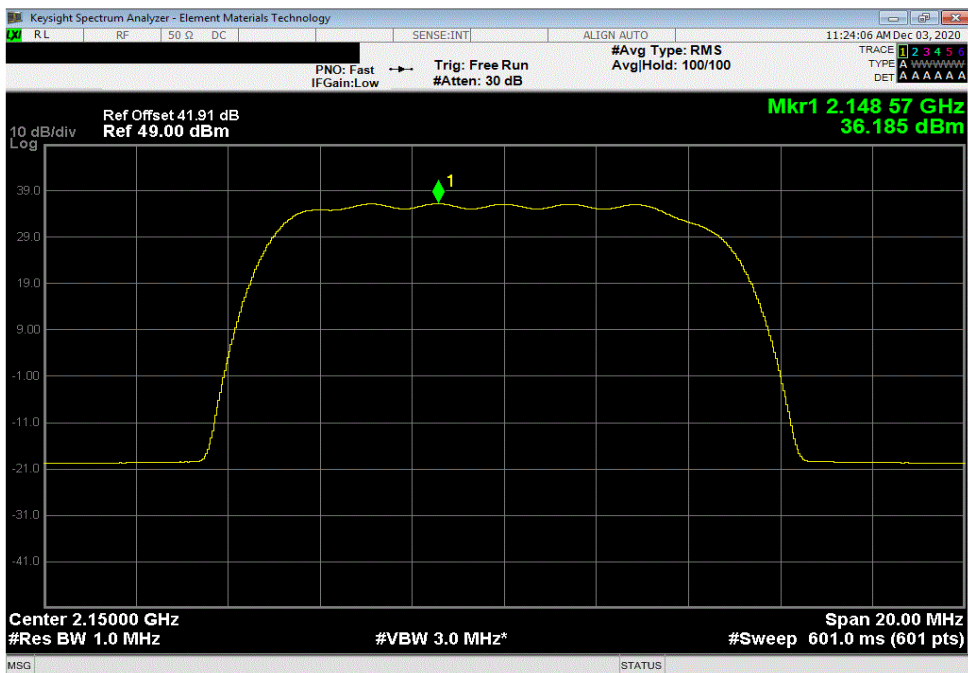
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, 16-QAM Modulation, Mid Channel 2132.5 MHz

	Initial Value dBm/MHz	Duty Cycle Factor (dB)	Single Port dBm/MHz == PSD	Two Port (2x2 MIMO) dBm/MHz == PSD	Four Port (4x4 MIMO) dBm/MHz == PSD
	36.126	0	36.1	39.126	42.126



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, 16-QAM Modulation, High Channel 2150 MHz

	Initial Value dBm/MHz	Duty Cycle Factor (dB)	Single Port dBm/MHz == PSD	Two Port (2x2 MIMO) dBm/MHz == PSD	Four Port (4x4 MIMO) dBm/MHz == PSD
	36.185	0	36.2	39.2	42.2



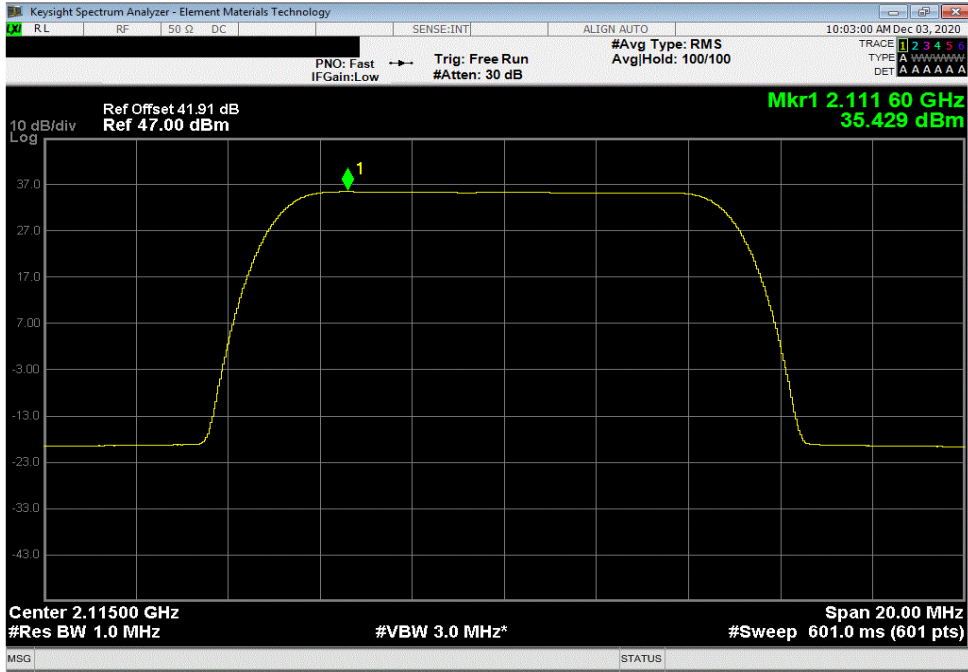
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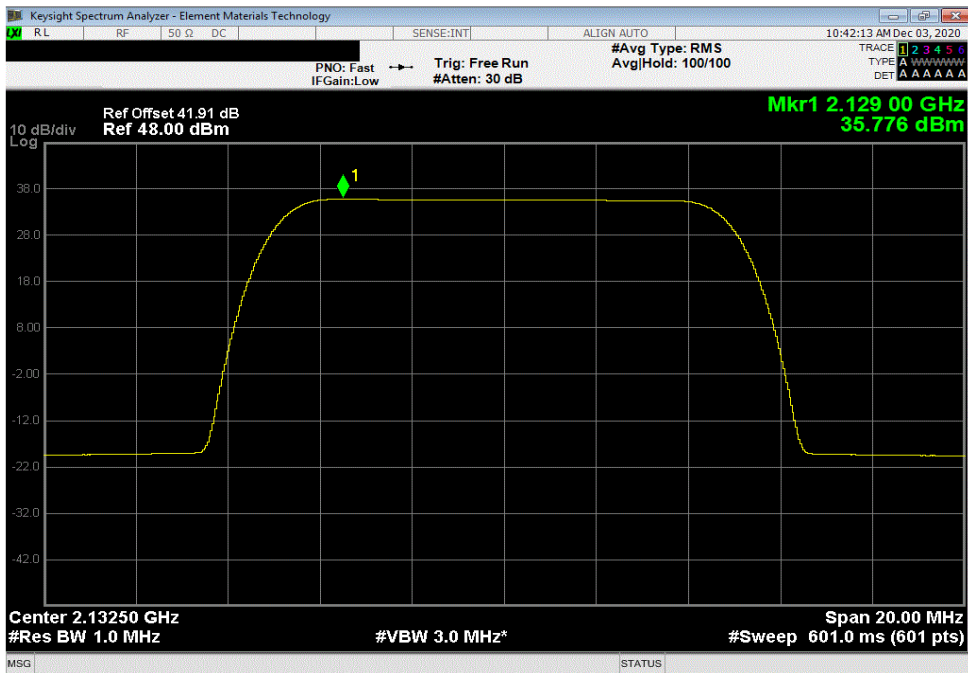
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, 64-QAM Modulation, Low Channel 2115 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.429	0	35.4	38.429	41.429



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, 64-QAM Modulation, Mid Channel 2132.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.776	0	35.8	38.8	41.8



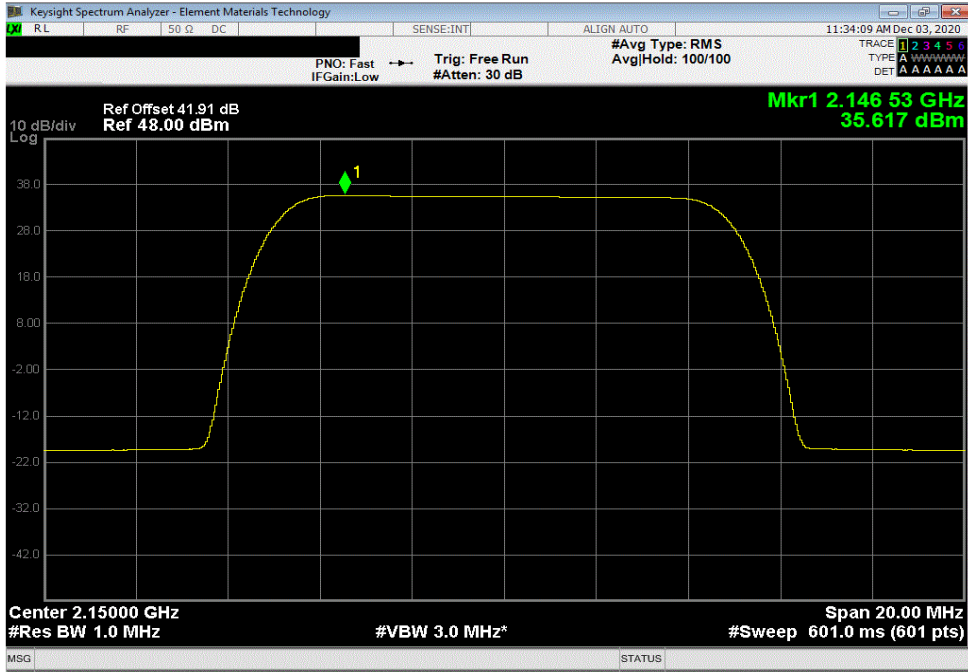
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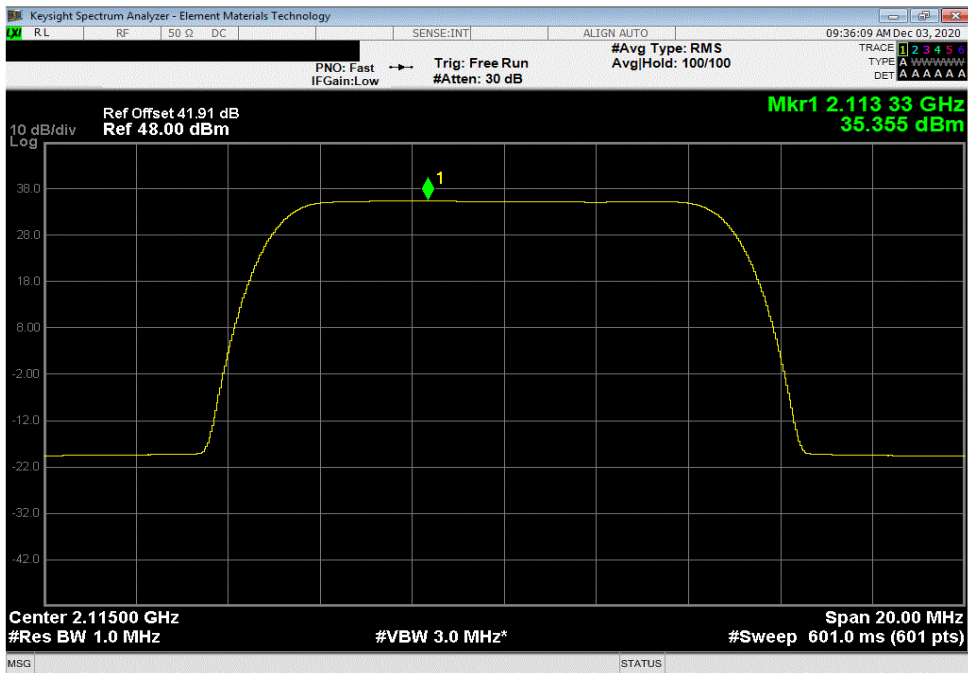
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, 64-QAM Modulation, High Channel 2150 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.617	0	35.6	38.617	41.617



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, 256-QAM Modulation, Low Channel 2115 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.355	0	35.4	38.4	41.4

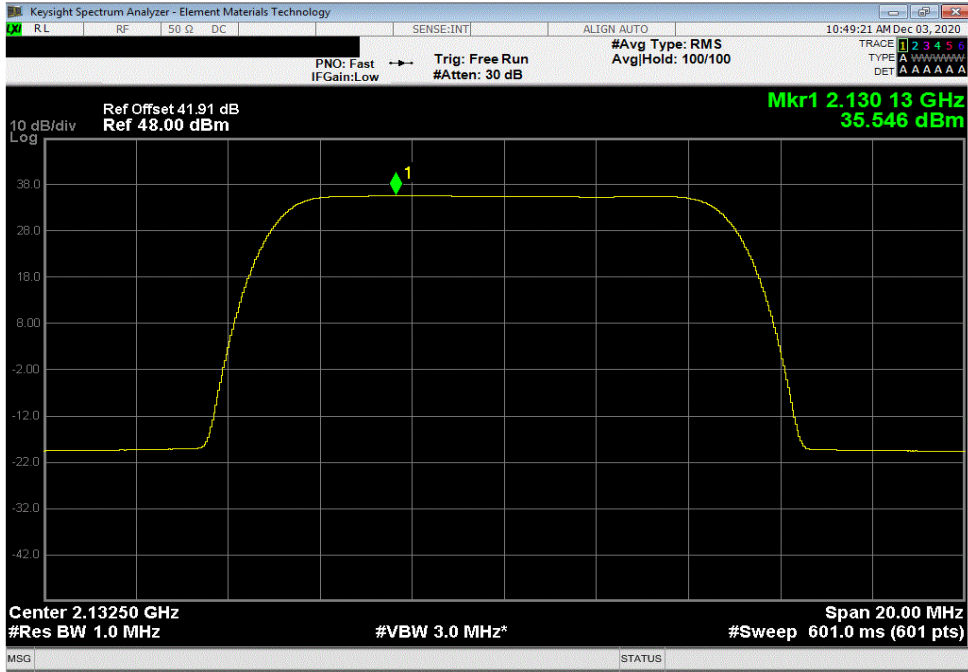


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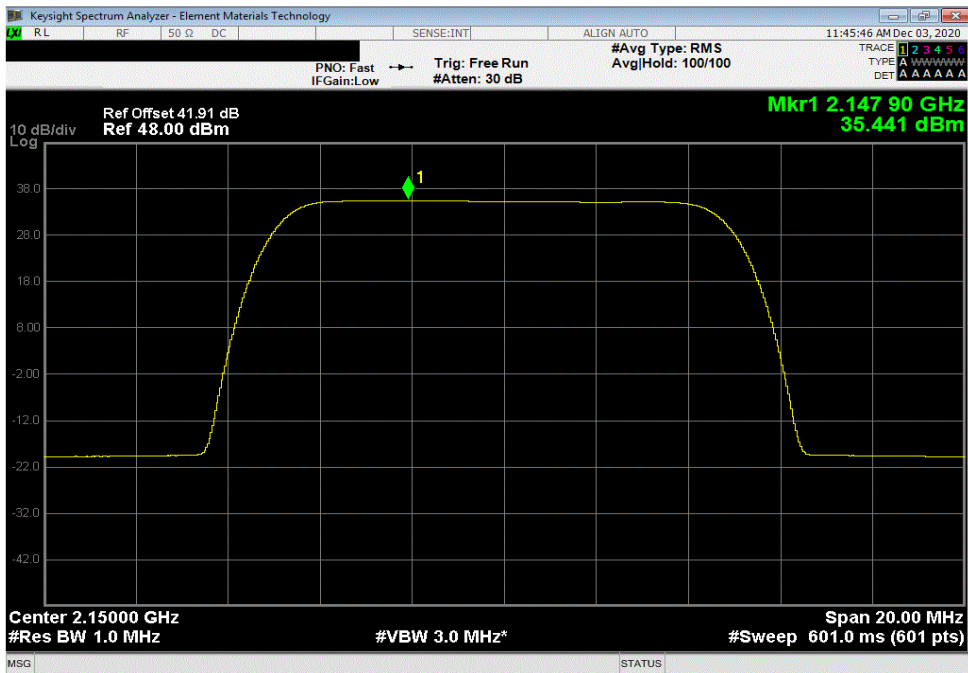


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30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, 256-QAM Modulation, Mid Channel 2132.5 MHz					
Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)	
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD	
35.546	0	35.5	38.546	41.546	



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 10 MHz Bandwidth, 256-QAM Modulation, High Channel 2150 MHz					
Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)	
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD	
35.441	0	35.4	38.4	41.4	



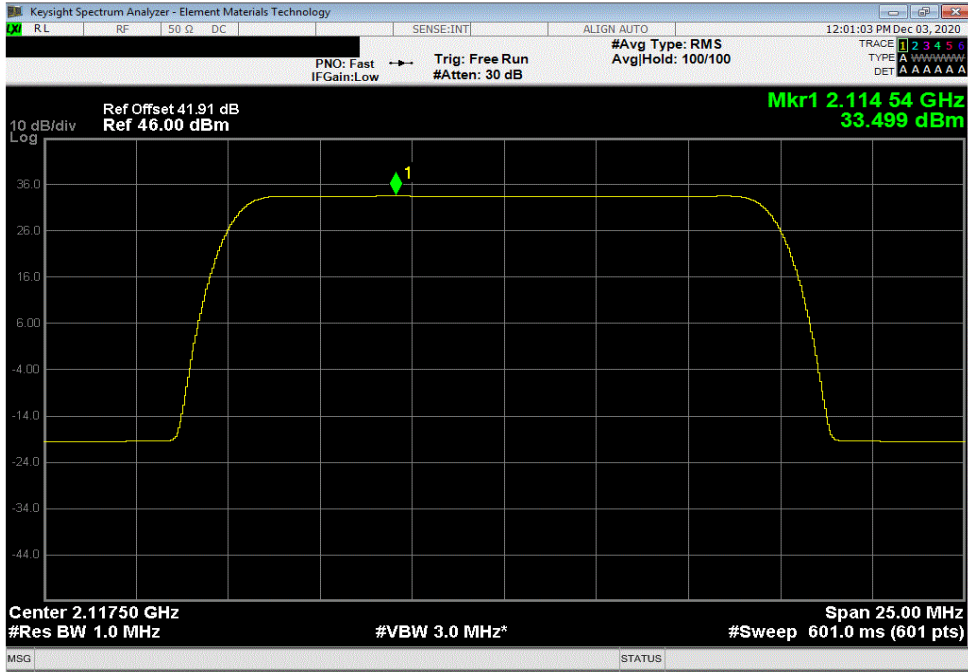
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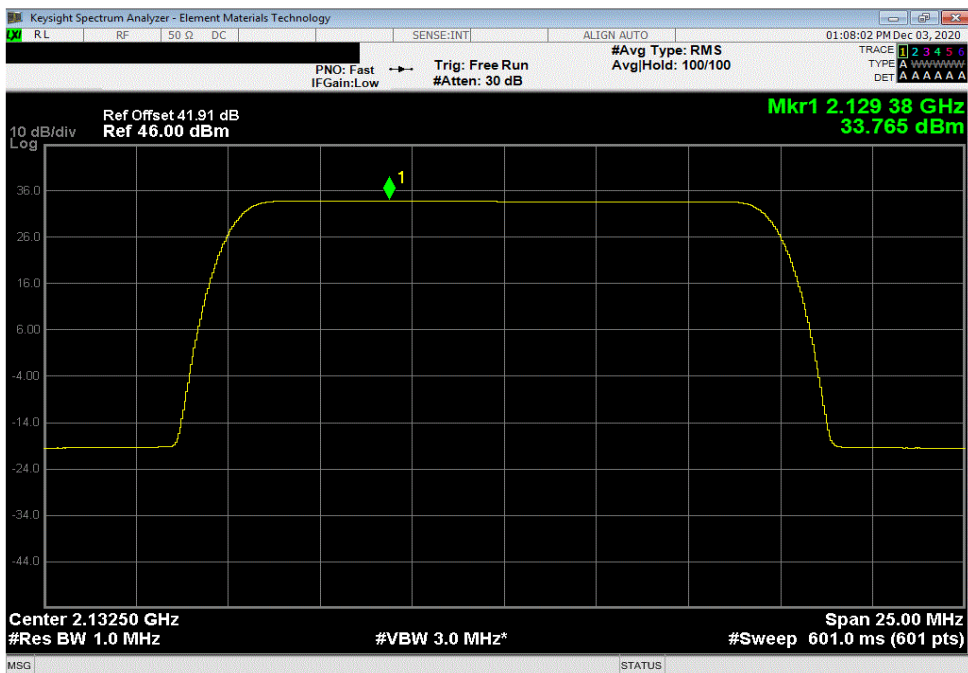
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, QPSK Modulation, Low Channel 2117.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
33.499	0	33.5	36.499	39.499



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, QPSK Modulation, Mid Channel 2132.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
33.765	0	33.8	36.8	39.8



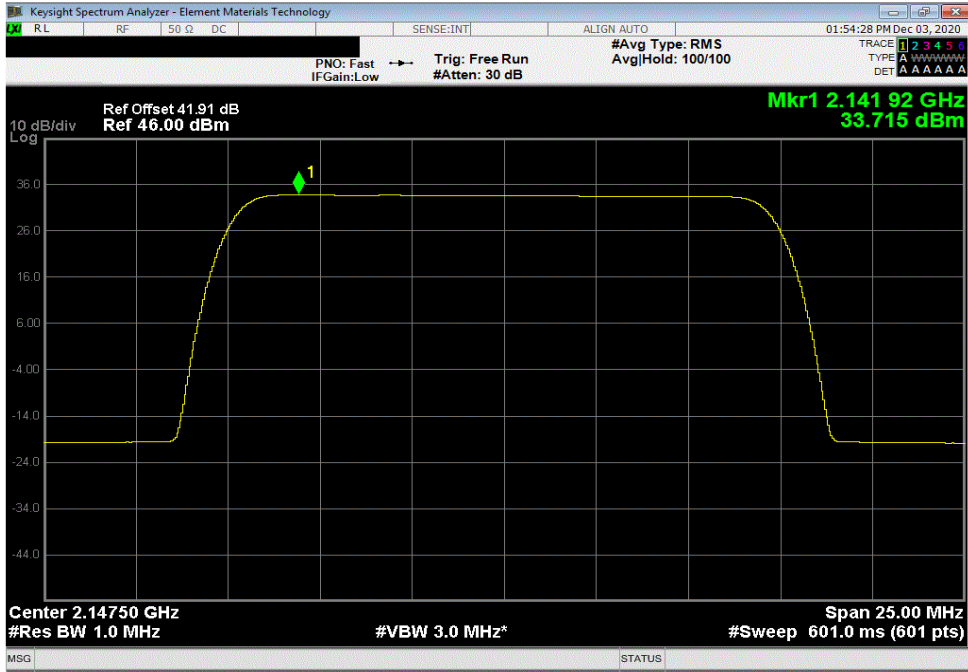
POWER SPECTRAL DENSITY - 4 PORT MODE



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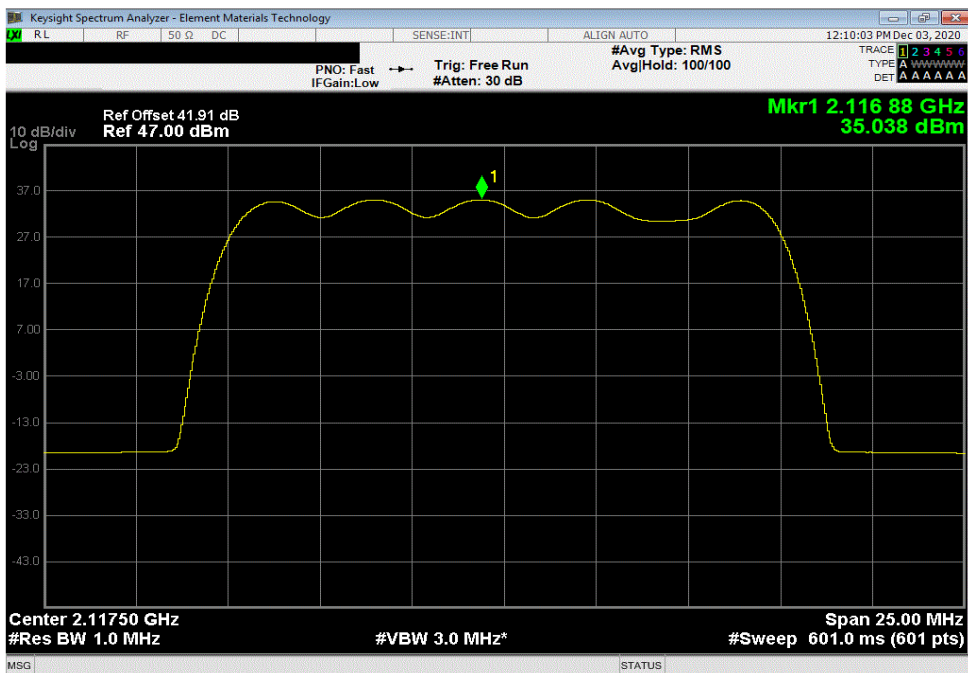
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, QPSK Modulation, High Channel 2147.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
33.715	0	33.7	36.715	39.715



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, 16-QAM Modulation, Low Channel 2117.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.038	0	35.0	38.0	41.0



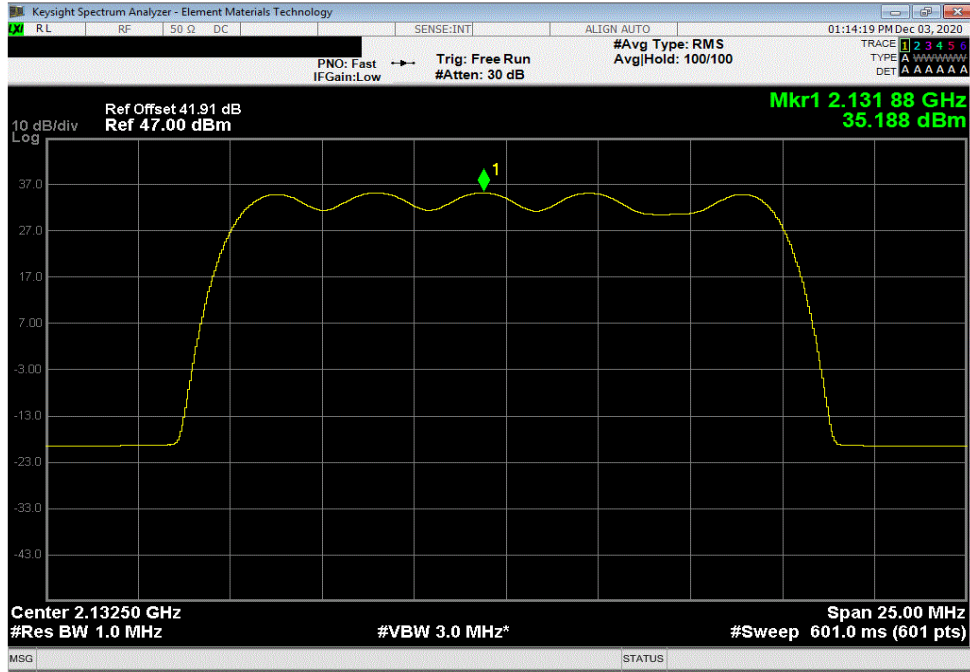
POWER SPECTRAL DENSITY - 4 PORT MODE



TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

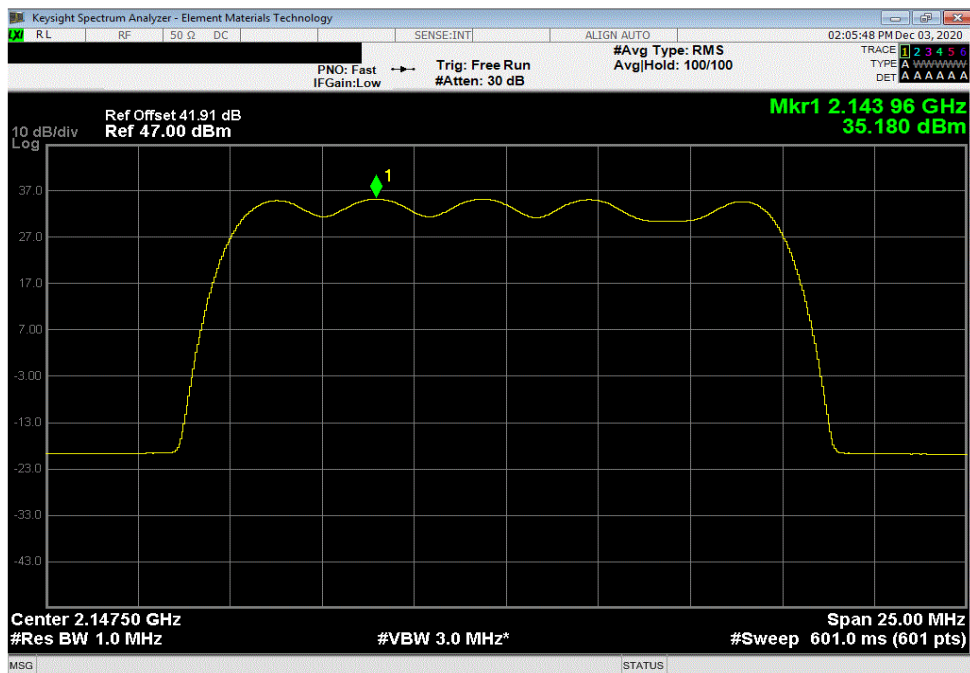
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, 16-QAM Modulation, Mid Channel 2132.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.188	0	35.2	38.188	41.188



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, 16-QAM Modulation, High Channel 2147.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
35.18	0	35.2	38.2	41.2



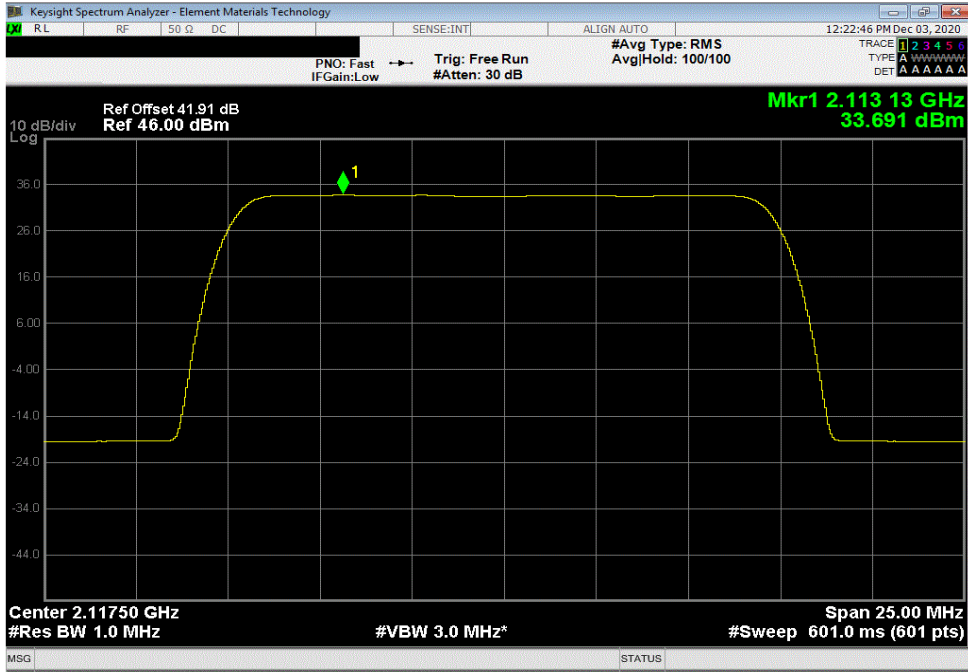
POWER SPECTRAL DENSITY - 4 PORT MODE



TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

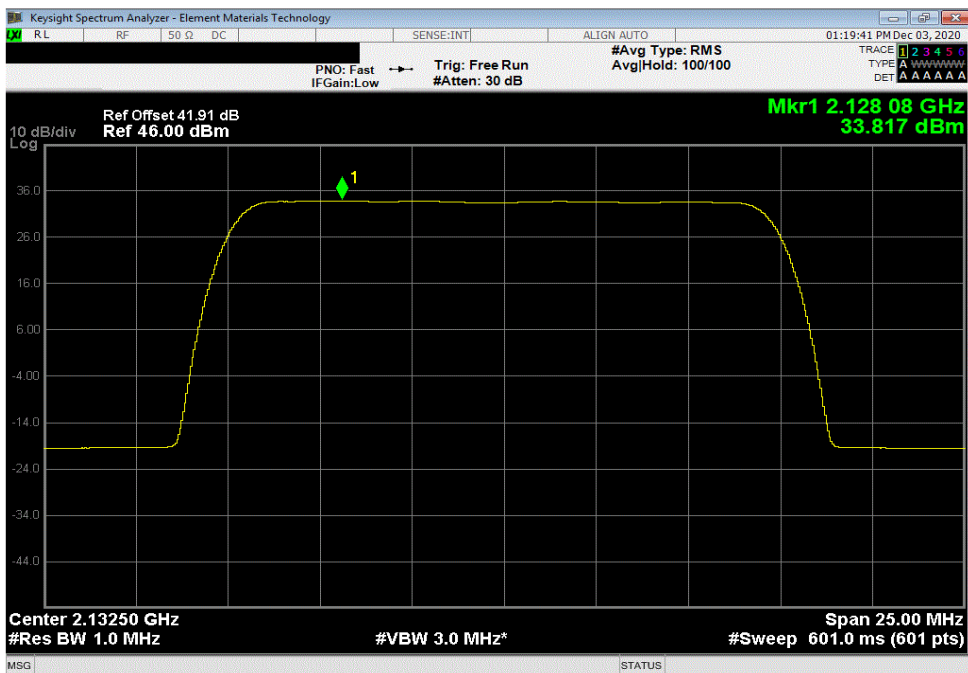
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, 64-QAM Modulation, Low Channel 2117.5 MHz

	Initial Value dBm/MHz	Duty Cycle Factor (dB)	Single Port dBm/MHz == PSD	Two Port (2x2 MIMO) dBm/MHz == PSD	Four Port (4x4 MIMO) dBm/MHz == PSD
	33.691	0	33.7	36.691	39.691



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, 64-QAM Modulation, Mid Channel 2132.5 MHz

	Initial Value dBm/MHz	Duty Cycle Factor (dB)	Single Port dBm/MHz == PSD	Two Port (2x2 MIMO) dBm/MHz == PSD	Four Port (4x4 MIMO) dBm/MHz == PSD
	33.817	0	33.8	36.8	39.8



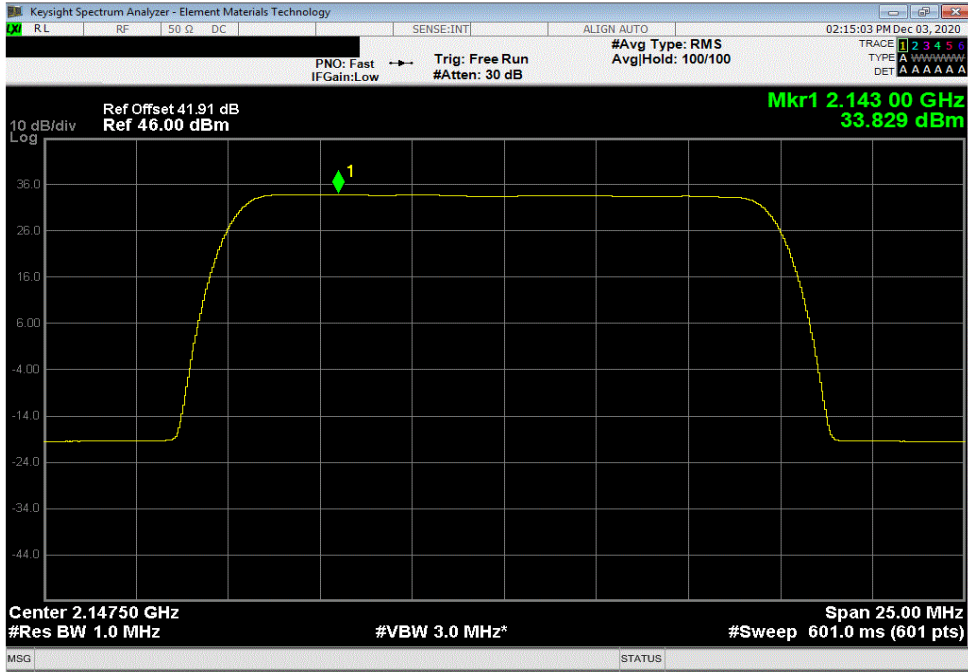
POWER SPECTRAL DENSITY - 4 PORT MODE



TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

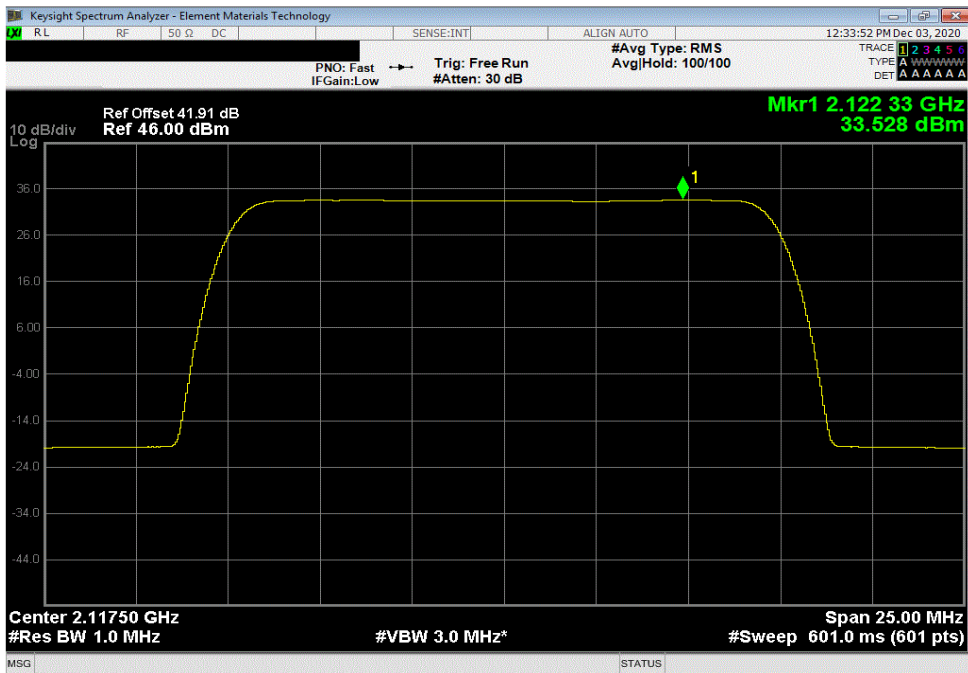
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, 64-QAM Modulation, High Channel 2147.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
33.829	0	33.8	36.829	39.829



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, 256-QAM Modulation, Low Channel 2117.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
33.528	0	33.5	36.5	39.5



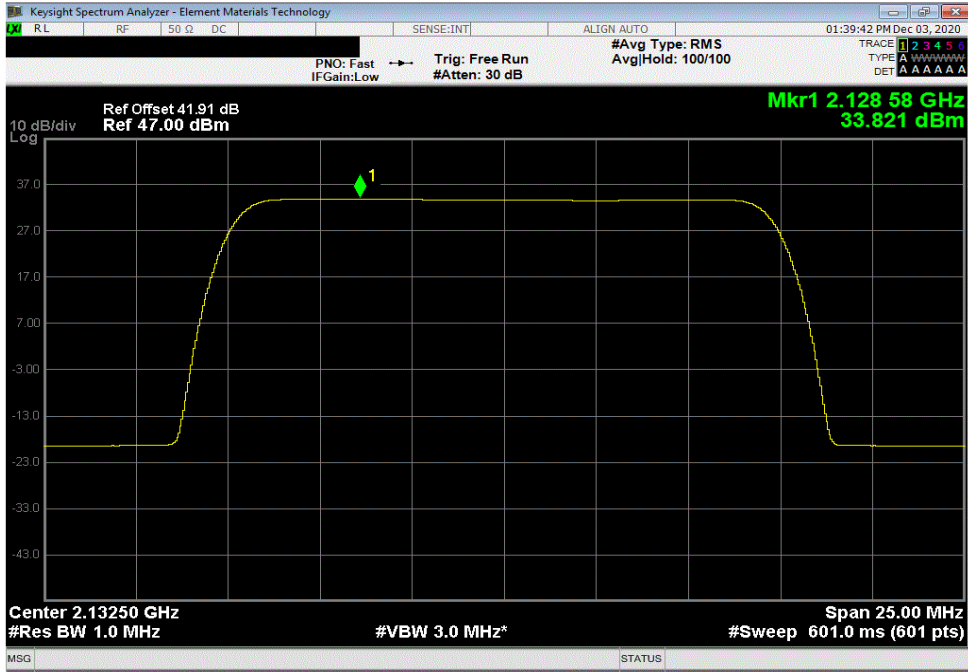
POWER SPECTRAL DENSITY - 4 PORT MODE



TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

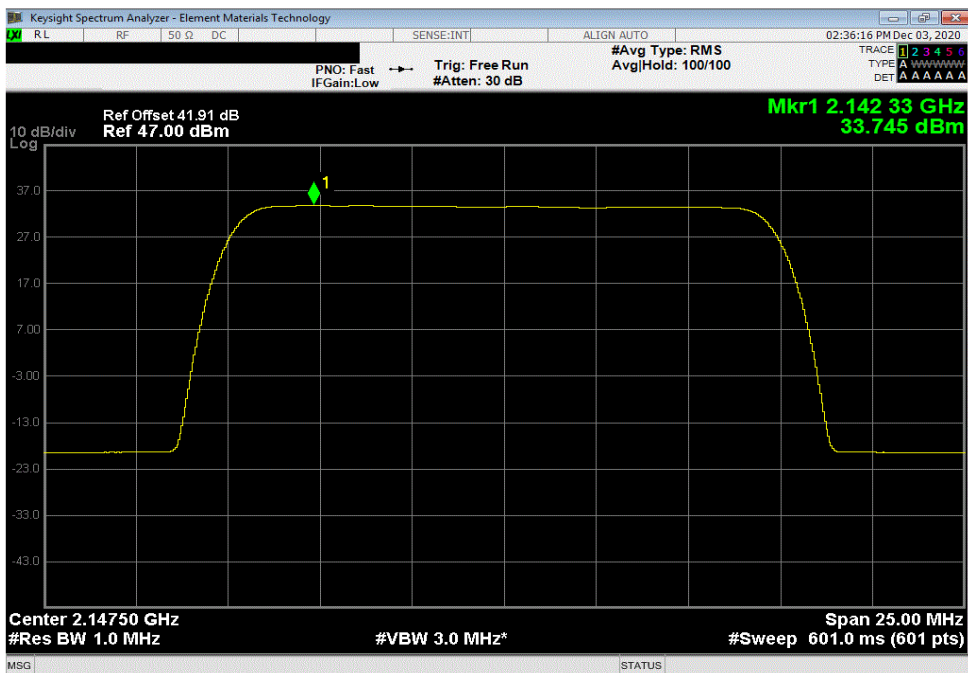
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, 256-QAM Modulation, Mid Channel 2132.5 MHz

	Initial Value dBm/MHz	Duty Cycle Factor (dB)	Single Port dBm/MHz == PSD	Two Port (2x2 MIMO) dBm/MHz == PSD	Four Port (4x4 MIMO) dBm/MHz == PSD
	33.821	0	33.8	36.821	39.821



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 15 MHz Bandwidth, 256-QAM Modulation, High Channel 2147.5 MHz

	Initial Value dBm/MHz	Duty Cycle Factor (dB)	Single Port dBm/MHz == PSD	Two Port (2x2 MIMO) dBm/MHz == PSD	Four Port (4x4 MIMO) dBm/MHz == PSD
	33.745	0	33.7	36.7	39.7



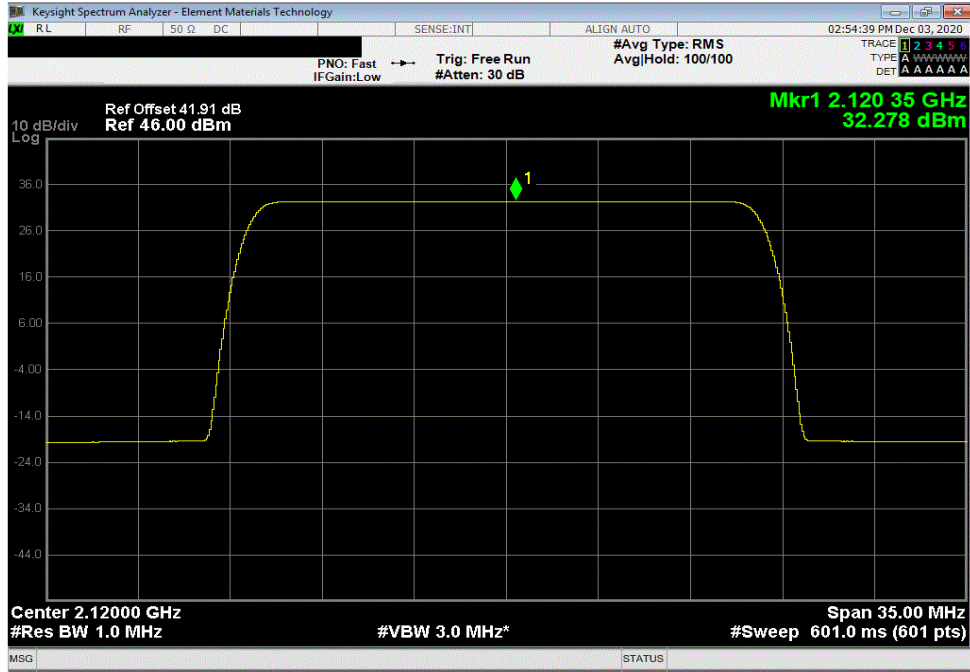
POWER SPECTRAL DENSITY - 4 PORT MODE



TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

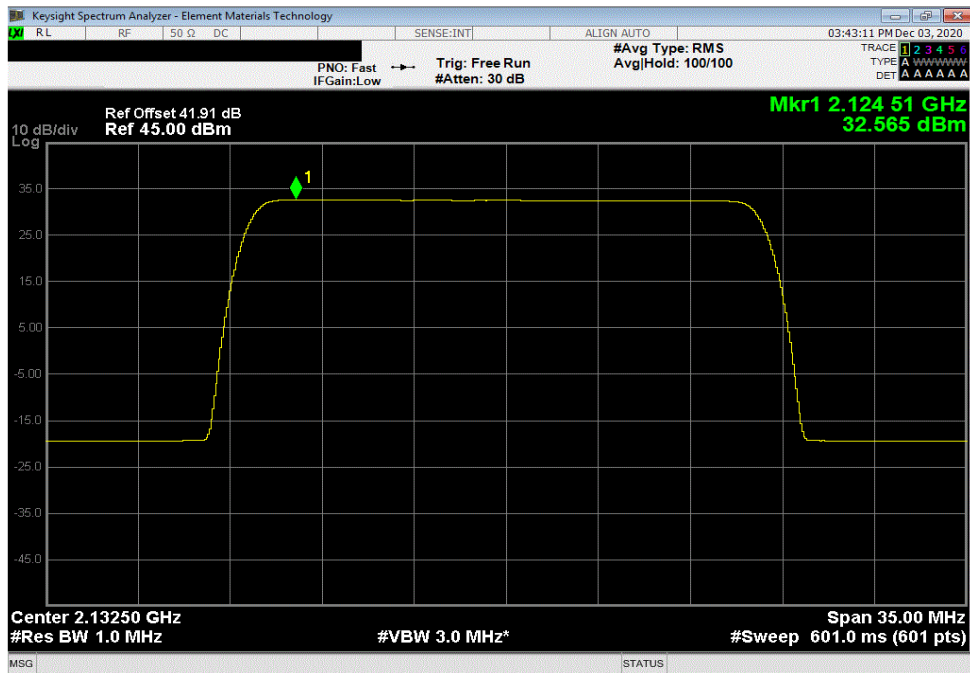
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, QPSK Modulation, Low Channel 2120 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
32.278	0	32.3	35.278	38.278



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, QPSK Modulation, Mid Channel 2132.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
32.565	0	32.6	35.6	38.6

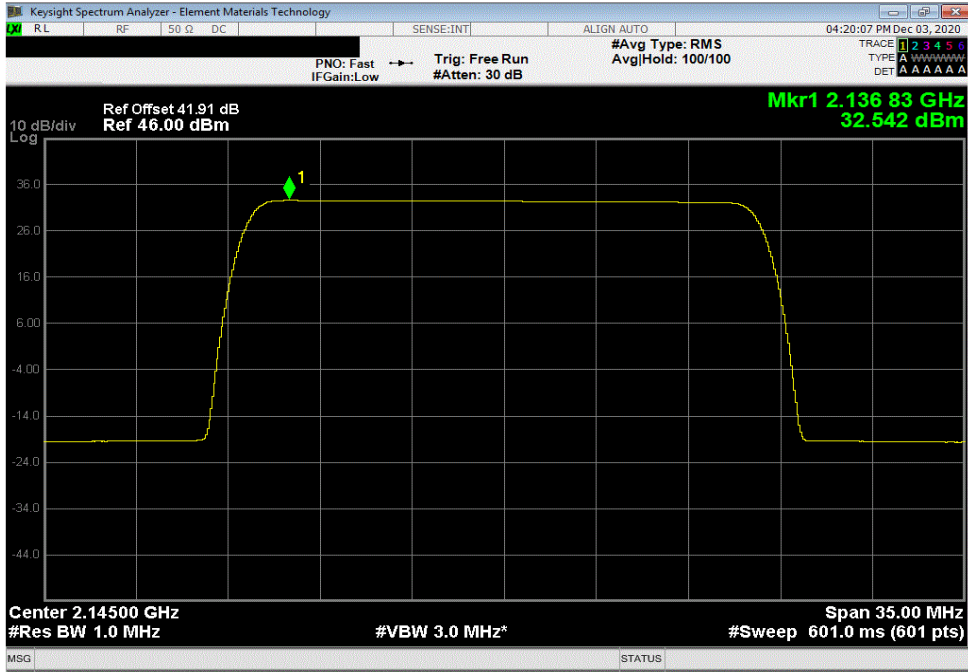


POWER SPECTRAL DENSITY - 4 PORT MODE

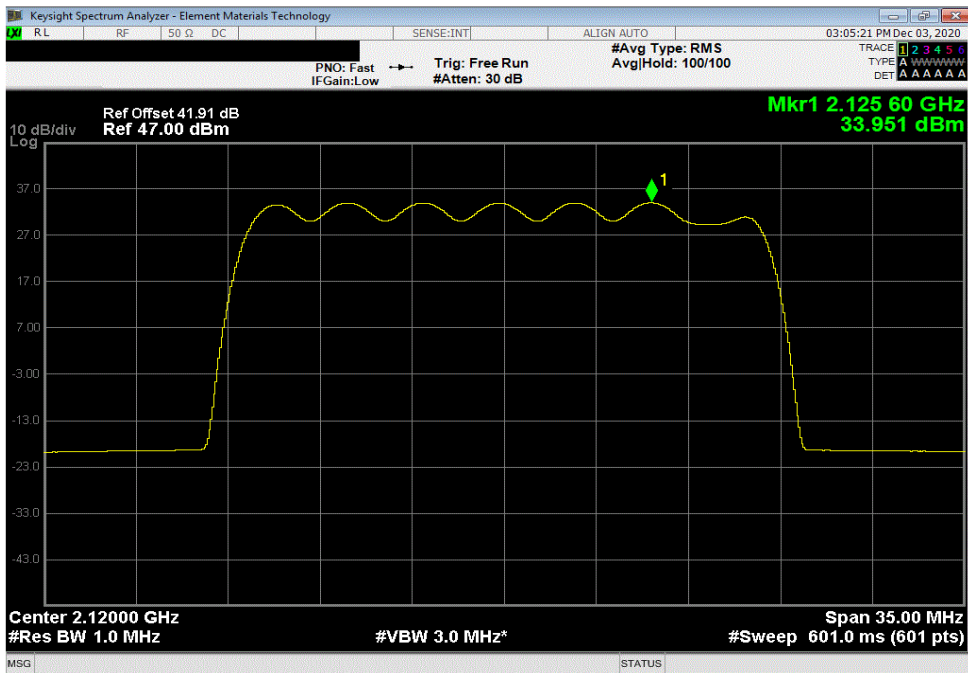


TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, QPSK Modulation, High Channel 2145 MHz					
Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)	
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD	
32.542	0	32.5	35.542	38.542	



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, 16-QAM Modulation, Low Channel 2120 MHz					
Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)	
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD	
33.951	0	34.0	37.0	40.0	



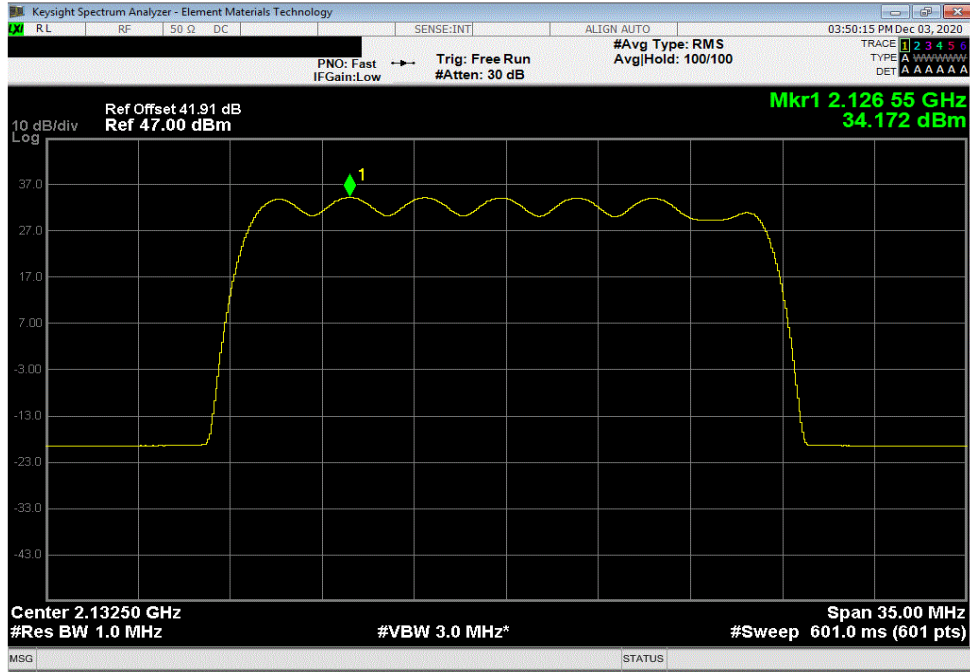
POWER SPECTRAL DENSITY - 4 PORT MODE



TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

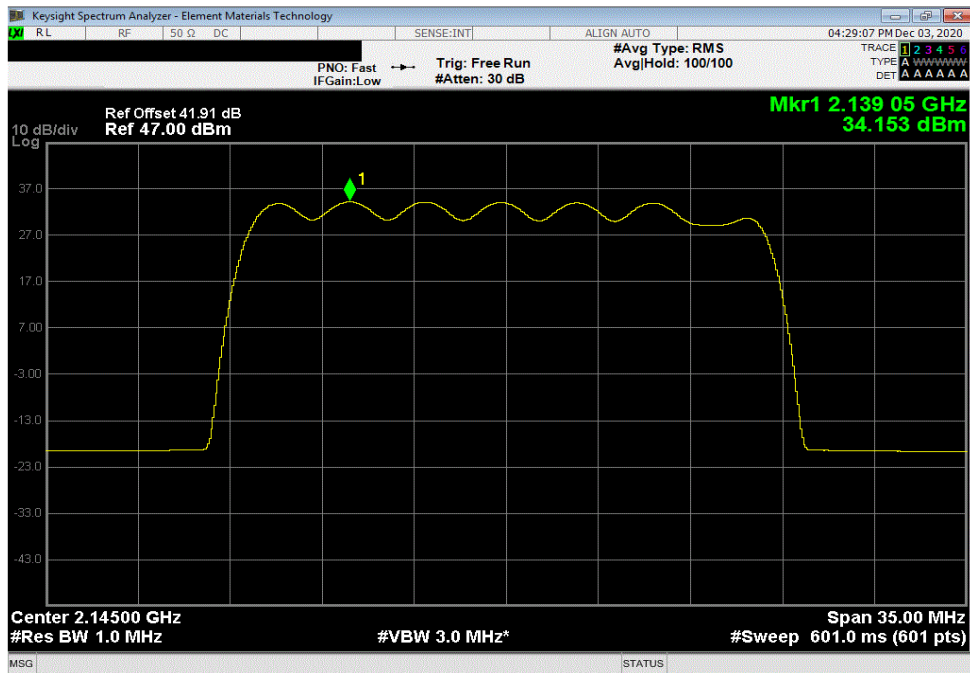
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, 16-QAM Modulation, Mid Channel 2132.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
34.172	0	34.2	37.172	40.172



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, 16-QAM Modulation, High Channel 2145 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
34.153	0	34.2	37.2	40.2



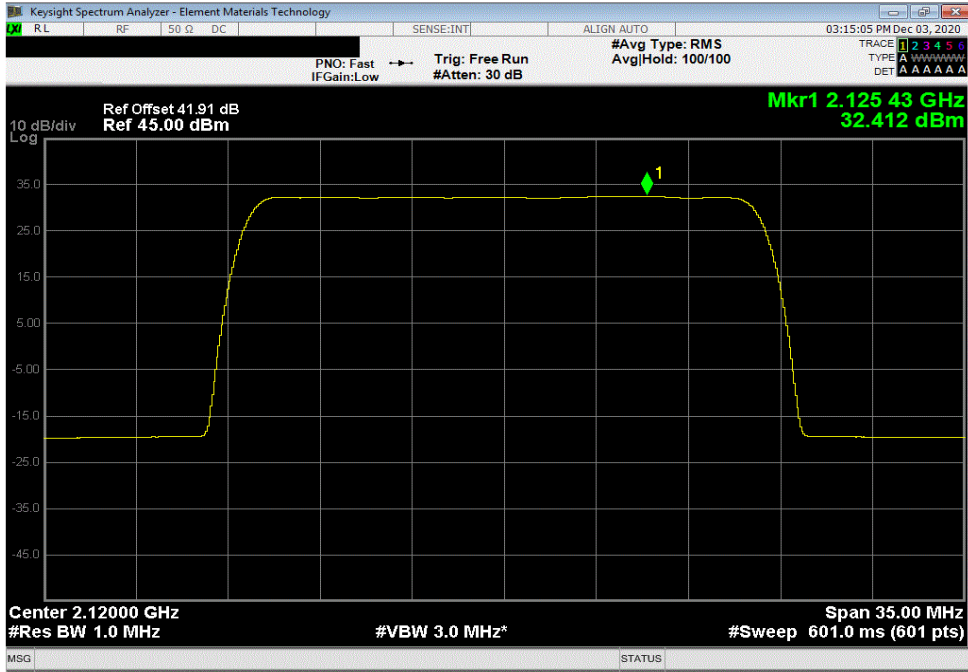
POWER SPECTRAL DENSITY - 4 PORT MODE



TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

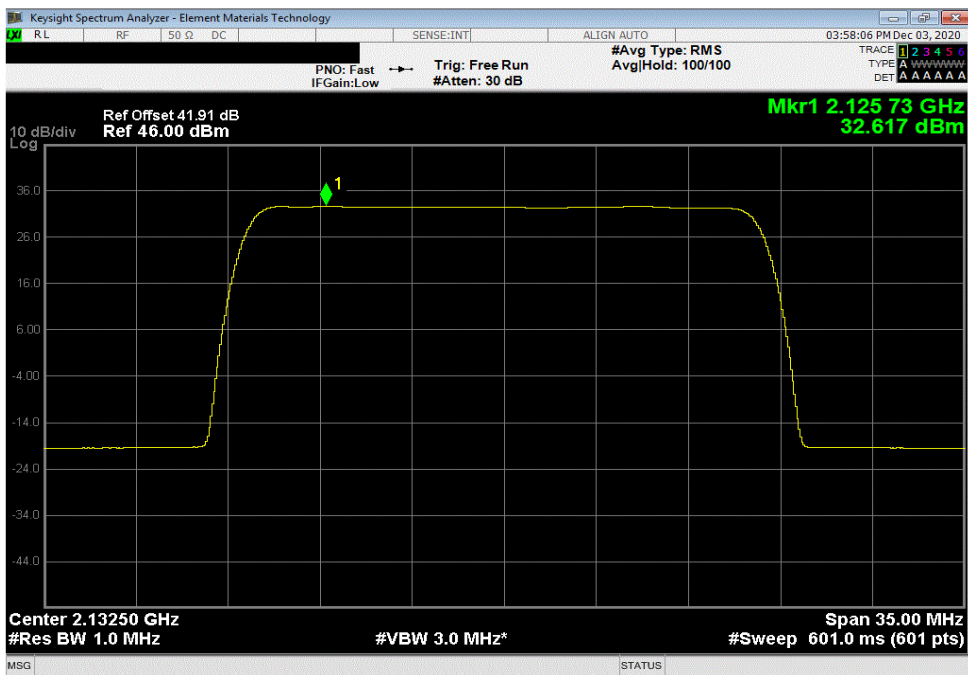
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, 64-QAM Modulation, Low Channel 2120 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
32.412	0	32.4	35.412	38.412



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, 64-QAM Modulation, Mid Channel 2132.5 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
32.617	0	32.6	35.6	38.6



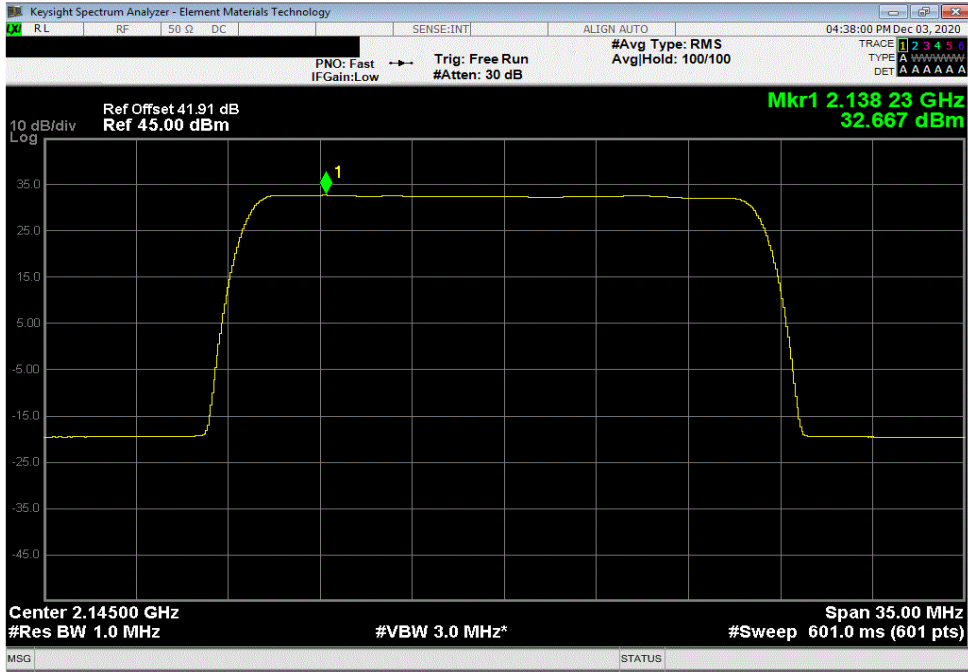
POWER SPECTRAL DENSITY - 4 PORT MODE



TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

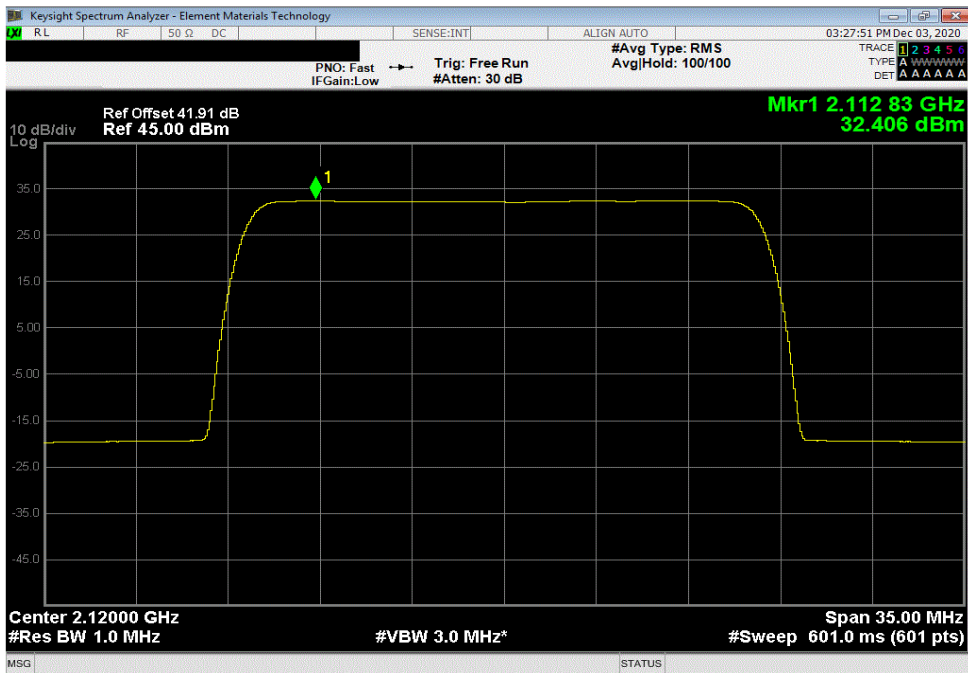
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, 64-QAM Modulation, High Channel 2145 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
32.667	0	32.7	35.667	38.667



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, 256-QAM Modulation, Low Channel 2120 MHz

Initial Value	Duty Cycle	Single Port	Two Port (2x2 MIMO)	Four Port (4x4 MIMO)
dBm/MHz	Factor (dB)	dBm/MHz == PSD	dBm/MHz == PSD	dBm/MHz == PSD
32.406	0	32.4	35.4	38.4



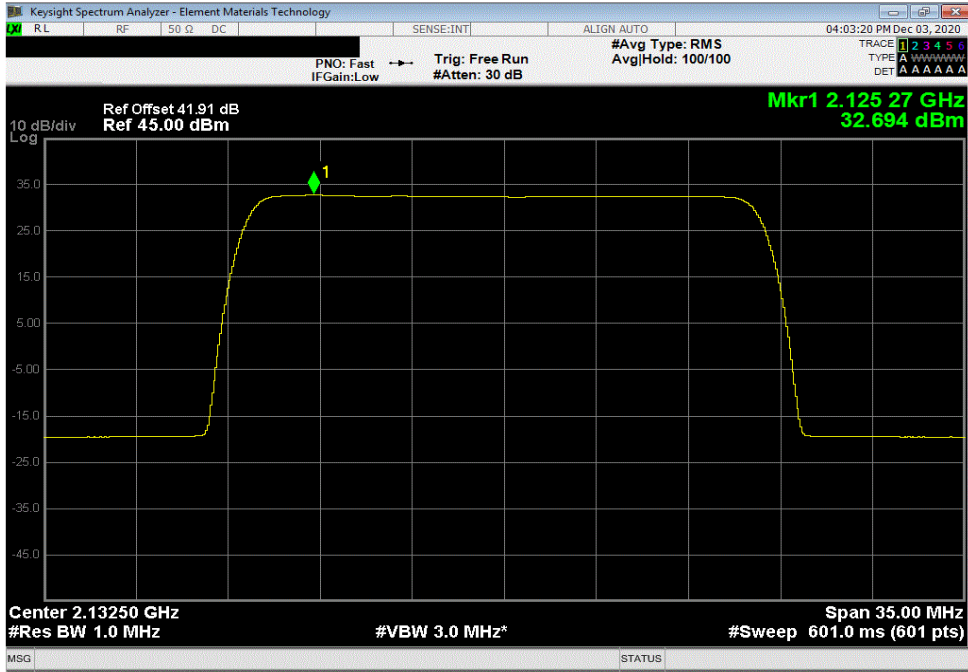
POWER SPECTRAL DENSITY - 4 PORT MODE



TkTx 2020.10.20.0 BETA XMI 2020.03.25.0

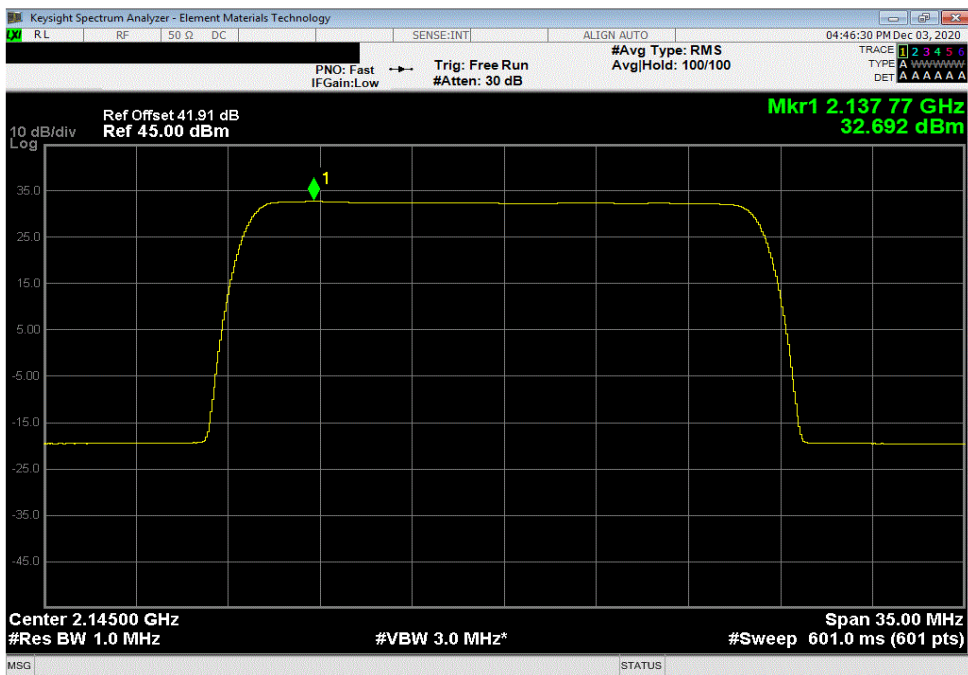
30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, 256-QAM Modulation, Mid Channel 2132.5 MHz

	Initial Value dBm/MHz	Duty Cycle Factor (dB)	Single Port dBm/MHz == PSD	Two Port (2x2 MIMO) dBm/MHz == PSD	Four Port (4x4 MIMO) dBm/MHz == PSD
	32.694	0	32.7	35.694	38.694



30 Watt Port 1, Band 1, 2110 MHz - 2155 MHz, 20 MHz Bandwidth, 256-QAM Modulation, High Channel 2145 MHz

	Initial Value dBm/MHz	Duty Cycle Factor (dB)	Single Port dBm/MHz == PSD	Two Port (2x2 MIMO) dBm/MHz == PSD	Four Port (4x4 MIMO) dBm/MHz == PSD
	32.692	0	32.7	35.7	38.7



POWER SPECTRAL DENSITY - 4 PORT MODE



Tb1Tx 2020.10.20.0 BETA XMt 2020.03.25.0

EIRP Calculations for Four Port MIMO Operations

EIRP calculations are needed at each transmitter location to optimize base station operational performance while meeting regulatory requirements. Each cell site installation needs to consider the power measurements in the radio certification report as well as site specific regulatory requirements (such as antenna height, population density, etc.), site installation parameters (line loss between antenna and radio, antenna parameters, etc.) and base station operational parameters (whether to operate two port or four port MIMO, carrier power level, channel bandwidth, modulation type, etc.) to optimize performance. Transmitter output power may be reduced in 0.1dB increments (from maximum) by base station setup parameters. Base station antennas are selected by the customer.

Kathrein antenna assembly model "80011867(Y2)" has a gain (dBi) of 17.3 ±0.3dB (maximum gain of 17.6dBi was used for the EIRP calculation) for AWS Band 1. This antenna assembly has a pair of ±45° cross-polarized radiators used for AWS Band 1. The four antenna RF inputs (used for AWS Band 1) on the antenna assembly are as follows: Y1+ L5 (+45°), Y1- L6 (-45°), Y2+ R7 (+45°) and Y2- R8 (-45°). The four FRIG transmitter outputs are connected to the antenna assembly RF inputs.

Equivalent Isotropically Radiated Power (EIRP) is calculated (as specified in ANSI C63.26-2015 section 6.4 for a system of correlated output signals) from the results of power measurements (highest measured PSD for each channel bandwidth type). The maximum antenna gain was used for this calculation. The cable loss between the antenna and transmitter is site dependent (will not be 0 dB) but for this worst case EIRP calculation 0 dB was used. Calculations of worst-case EIRP for four port MIMO are as follows:

Parameter	5 MHz Ch BW	10 MHz Ch BW	15 MHz Ch BW	20 MHz Ch BW
Worst Case PSD/Antenna Port	38.6 dBm/MHz	36.2 dBm/MHz	35.2 dBm/MHz	34.2 dBm/MHz
Cable Loss (site dependent)	0 dB	0 dB	0 dB	0 dB
Maximum Antenna Gain (G _{ant})	17.6 dBi	17.6 dBi	17.6 dBi	17.6 dBi
Directional Gain = G _{ant} + 10Log (2) Note 1	20.6 dBi	20.6 dBi	20.6 dBi	20.6 dBi
EIRP for Antenna Y1 +45° EIRP for Ant Y1 +45° ² PSD/ant port - Cable Loss + Dir Gain	59.2 dBm/MHz	56.8 dBm/MHz	55.8 dBm/MHz	54.8 dBm/MHz
EIRP for Antenna Y1 -45°	59.2dBm/MHz	56.8 dBm/MHz	55.8 dBm/MHz	54.8 dBm/MHz
EIRP subtotal for Y1 +45° and Y1 -45° See Note 2	832 Watts/MHz	479 Watts/MHz	380 Watts/MHz	302 Watts/MHz
EIRP for Antenna Y2 +45°	59.2 dBm/MHz	56.8 dBm/MHz	55.8 dBm/MHz	54.8 dBm/MHz
EIRP for Antenna Y2 -45°	59.2 dBm/MHz	56.8 dBm/MHz	55.8 dBm/MHz	54.8 dBm/MHz
EIRP subtotal for Y2 +45° and Y2 -45° See Note 2	832 Watts/MHz	479 Watts/MHz	380 Watts/MHz	302 Watts/MHz
EIRP Total = Y1 ±45° and Y2 ±45° See Note 3	1664 Watts/MHz 62.2 dBm/MHz	958 Watts/MHz 59.8 dBm/MHz	760 Watts/MHz 58.8 dBm/MHz	604 Watts/MHz 57.8 dBm/MHz

Note 1: The directional gain was calculated for two antennas since there are a pair of cross-polarized radiators. See ANSI C63.26 sections 6.4.5.3.3a) & 6.4.5.3.1a), and KDB 662911D01v02r01 paragraphs F)2)c)(i) & F)2)a)(i) for guidance.

Note 2: The EIRP per antenna polarity is required to be below the regulatory limit as described in ANSI C63.26-2015 section 6.4.6.3 b)2) and KDB 662911 D02v01 page 3 example (2) since the two transmitter outputs to each antenna are 90 degree-phase shifted relative to each other (cross-polarized radiators).

Note 3: Antenna Y1 an Y2 are correlated - the EIRPs are required to be summed and be below the regulatory limit as described in ANSI C63.26-2015 section 6.4.6.3 b)3) and KDB 662911 D02v01 page 3 example (3).

Calculation Summary

The worst case FRIG four port MIMO EIRP levels using antenna assembly model "80011867(Y2)" are:

- (1) Less than the FCC and ISED (3280 W/MHz or 65.16 dBm/MHz) EIRP Regulatory Limits for all (5, 10, 15 & 20MHz) channel bandwidths
- (2) Less than the FCC and ISED (1640 W/MHz or 62.15 dBm/MHz) EIRP Regulatory Limits for 10, 15 & 20MHz channel bandwidths
- (3) Over the FCC and ISED (1640 W/MHz or 62.15 dBm/MHz) EIRP Regulatory Limits by 0.05 dB for the 5MHz channel bandwidth. EIRP calculations are needed at each transmitter location to optimize base station operational performance while meeting regulatory requirements as noted above.