Radio Test Report

Dense Air Ltd

STC-v11-Node-n77

AAB

47 CFR Part 27 Effective Date 1st October 2022
↳ 47CFR part 2J Effective Date 1st October 2021
TNB: Licensed Non-Broadcast Station Transmitter

Test Date: 5th June 2023 to 30th August 2023
Report Number: 08-14156-3-23 Issue 01

The testing was carried out by RN Electronics Ltd, an independent test house, at their test facility located at:

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This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF communiqué dated April 2017).

File Name: Dense Air Ltd.14156-3 Issue 01

Arnolds Court, Arnolds Farm Lane, Mountnessing, Brentwood Essex, CM13 1UT

Certificate of Test 14156-3

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of FCC Part 27. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	STC-v11-Node-n77
Model Number:	AAB
Unique Serial Number:	AABA31700703
Applicant:	Dense Air Ltd Atlas House, Globe Business Park, Parkway, Third Avenue Marlow, Buckinghamshire SL7 1EY
Proposed FCC ID	2BBSF-SC11-AAB
Full measurement results are detailed in Report Number:	08-14156-3-23 Issue 01
Test Standards:	47 CFR Part 27 Effective Date 1st October 2022 ↳ 47CFR part 2J Effective Date 1st October 2021 TNB: Licensed Non-Broadcast Station Transmitter

NOTE:
Certain tests were not performed based upon applicant's declarations. Certain other requirements are subject to applicant's declaration only and have not been tested/verified. For details refer to section 3 of this report. This report pertains to the 5G NR functionality of the device, for 60 GHz functionality please refer to report 08-14156-1-23.

DEVIATIONS: No deviations have been applied.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Date Of Test: 5th June 2023 to 30th August 2023

Test Engineer:
Jack Chilvers

Jack Chilvers
Digitally signed by: Jack Chilvers
DN: CN = Jack Chilvers email = Jack.Chilvers@kiwa.com C = GB O = RN Electronics OU = RN Electronics
Date: 2023.11.14 12:58:01 Z

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Customer Representative:

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Peter Warburg
DAEC5C08D22747C...
Peter Warburg
14-11-2023

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Dense Air Ltd Atlas House Globe Business Park Parkway, Third Avenue Marlow Buckinghamshire SL7 1EY	
Manufacturer of EUT	Dense Air Ltd	
Full Name of EUT	STC-v11-Node-n77	
Model Number of EUT	AAB	
Serial Number of EUT	AABA31700703	
Date Received	5th June 2023	
Date of Test:	5th June 2023 to 30th August 2023	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	14th November 2023	
Main Function	The unit is a 5G Base Station with integrated optical networking and 60GHz mmWave radio.	
Information Specification	Height	770mm
	Width	400mm
	Depth	<770mm
	Weight	<20.2kg
	Voltage	+45VDC Nominal
	Current	<5A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Pole Mounted
Choice of model(s) for type tests	Production model
Antenna details	Custom 5G Dipole Array Antennas Switched Beam Antenna (SBA)
Antenna port	8 external SMA ports P1-P8 are available
Baseband Data port (yes/no)?	N/A
Highest Signal generated/used in EUT	69.12 GHz (60 GHz transceiver highest channel)
Lowest Signal generated/used in EUT	9kHz
Hardware Version (HVIN)	v1.1
Software Version	5G Radio - SR19.50 60GHz mmWave Radio - Rel 0.16
Firmware Version (FVIN)	Particle - 509
Type of Equipment	Outdoor 5G Small Cell Base Station
Technology Type	5G NR and 60 GHz millimetre wave with GPS
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	3700 – 3980 MHz
EUT Declared Modulation Parameters	QPSK, 16QAM, 64QAM, 256QAM
EUT Declared Power level	Up to +27dBm max. conducted per carrier +47dBm EIRP per carrier radiated
EUT Declared Signal Bandwidths	40 & 60 MHz
EUT Declared Channel Spacing's	40 & 60 MHz
EUT Declared Duty Cycle	75 %
Unmodulated carrier available?	No
Declared frequency stability	20 Hz
RX Parameters	
Alignment range – receiver	3700 – 3980 MHz
EUT Declared RX Signal Bandwidth	40 & 60 MHz
Receiver Signal Level (RSL)	-90.6dBm/Ch. BW conducted
FCC Parameters	
FCC Transmitter Class	TNB: Licensed Non-Broadcast Station Transmitter

Note: RF Parameters above relate to 5G NR functionality, for 60GHz functionality see test report 08-14156-1-23.

2.3 Functional description

The streetCell v1.1 is a 5G Small Cell Base Station with a switchable antenna designed to allow 5G radio coverage optimisation in each deployment, the streetCell v1.1 also supports multiple back haul options including fixed optical or 60GHz mmWave radio to the core network directly or via another streetCell v1.1 unit.

2.4 Modes of operation

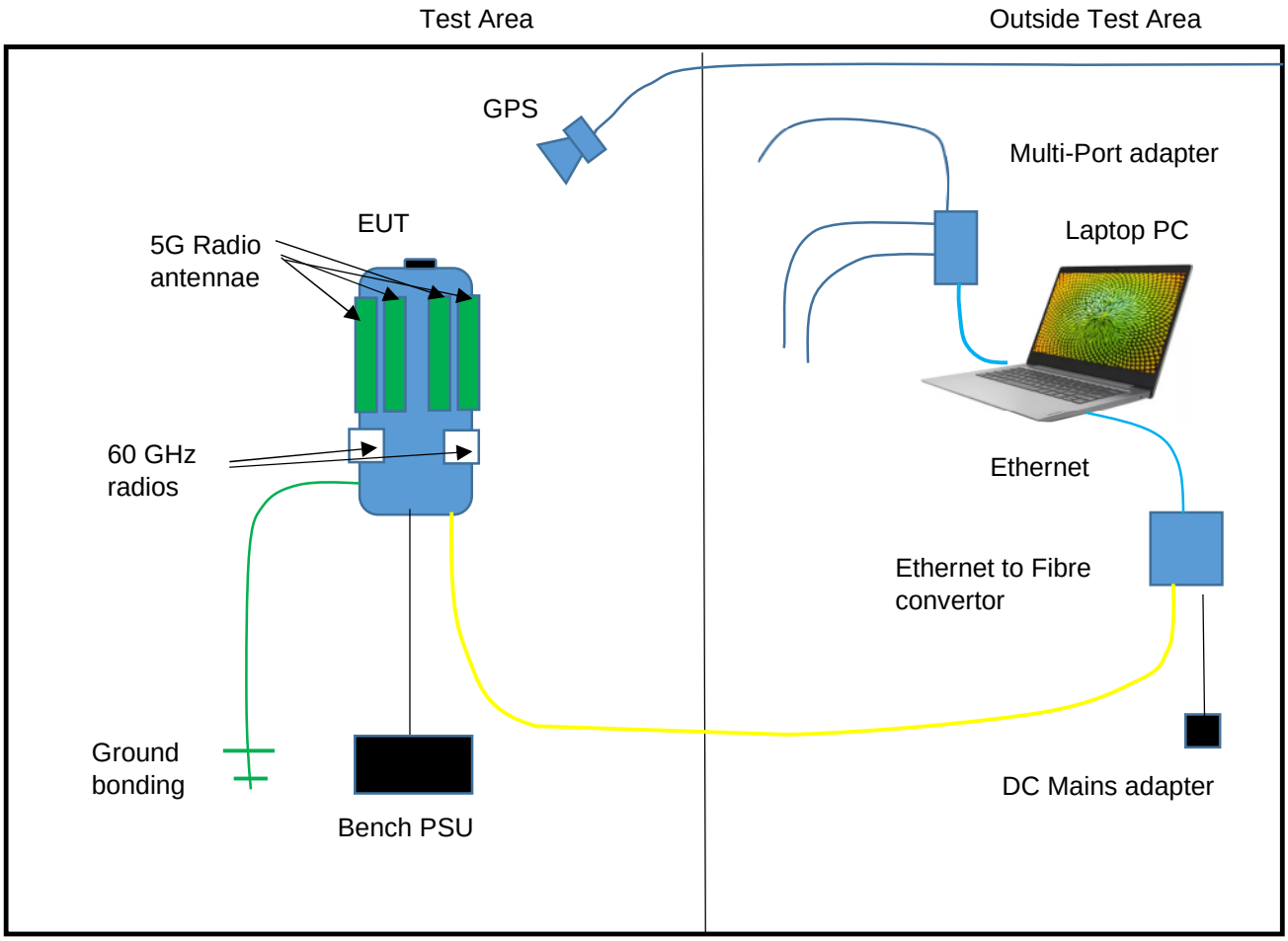
Mode Reference	Description	Used for testing
Mode 1	Transmitting full power Low channel at 3720 MHz using 40MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 2	Transmitting full power Low channel at 3720 MHz using 40MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 3	Transmitting full power Low channel at 3720 MHz using 40MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 4	Transmitting full power Low channel at 3720 MHz using 40MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 5	Transmitting full power Mid channel at 3840 MHz using 40MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 6	Transmitting full power Mid channel at 3840 MHz using 40MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 7	Transmitting full power Mid channel at 3840 MHz using 40MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 8	Transmitting full power Mid channel at 3840 MHz using 40MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 9	Transmitting full power High channel at 3960 MHz using 40MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 10	Transmitting full power High channel at 3960 MHz using 40MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 11	Transmitting full power High channel at 3960 MHz using 40MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 12	Transmitting full power High channel at 3960 MHz using 40MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 13	Transmitting full power Low channel at 3730 MHz using 60MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 14	Transmitting full power Low channel at 3730 MHz using 60MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 15	Transmitting full power Low channel at 3730 MHz using 60MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 16	Transmitting full power Low channel at 3730 MHz using 60MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 17	Transmitting full power Mid channel at 3840 MHz using 60MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 18	Transmitting full power Mid channel at 3840 MHz using 60MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 19	Transmitting full power Mid channel at 3840 MHz using 60MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 20	Transmitting full power Mid channel at 3840 MHz using 60MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 21	Transmitting full power High channel at 3950 MHz using 60MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 22	Transmitting full power High channel at 3950 MHz using 60MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 23	Transmitting full power High channel at 3950 MHz using 60MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes

Mode 24	Transmitting full power High channel at 3950 MHz using 60MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%.	Yes
Mode 25	Transmitting full power Low channel at 3720 MHz using 40MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%. 60GHz RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 26	Transmitting full power Low channel at 3720 MHz using 40MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 27	Transmitting full power Low channel at 3720 MHz using 40MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 28	Transmitting full power Low channel at 3720 MHz using 40MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 29	Transmitting full power Mid channel at 3840 MHz using 40MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 30	Transmitting full power Mid channel at 3840 MHz using 40MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 31	Transmitting full power Mid channel at 3840 MHz using 40MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 32	Transmitting full power Mid channel at 3840 MHz using 40MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 33	Transmitting full power High channel at 3960 MHz using 40MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 34	Transmitting full power High channel at 3960 MHz using 40MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 35	Transmitting full power High channel at 3960 MHz using 40MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 36	Transmitting full power High channel at 3960 MHz using 40MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 37	Transmitting full power Low channel at 3730 MHz using 60MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 38	Transmitting full power Low channel at 3730 MHz using 60MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 39	Transmitting full power Low channel at 3730 MHz using 60MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 40	Transmitting full power Low channel at 3730 MHz using 60MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 41	Transmitting full power Mid channel at 3840 MHz using 60MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 42	Transmitting full power Mid channel at 3840 MHz using 60MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes

Mode 43	Transmitting full power Mid channel at 3840 MHz using 60MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 44	Transmitting full power Mid channel at 3840 MHz using 60MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 45	Transmitting full power High channel at 3950 MHz using 60MHz BW with QPSK modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 46	Transmitting full power High channel at 3950 MHz using 60MHz BW with 16QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 47	Transmitting full power High channel at 3950 MHz using 60MHz BW with 64QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes
Mode 48	Transmitting full power High channel at 3950 MHz using 60MHz BW with 256QAM modulation on worst case RF port P6 with duty cycle of 75%. RAD0 and RAD1 both also transmitting on 64.8 GHz max power MCS5 on beam 32.	Yes

Note: Not all modes are stated. Preliminary scans were made of power on stated RF ID configs & ports to determine any worst-case RF port for tests, this was found to be P6 ID config 1 and was used for final measurements, see section 2.5 below.

2.5 EUT set-up and emissions configuration



The unit was powered from a bench power supply connected to a 120 V / 60 Hz supply. The power supply was set to 45 VDC. In end-user operation the EUT is normally mounted to a metal pole, to replicate this in the test chamber a grounding braid was connected to the EUT metal enclosure, and this was bonded to the ground plane floor of the chamber.
The EUT incorporates a 5G cellular radio which can operate at the same time as the 60GHz radios in the device. During radiated emissions tests the 5G radio was configured into a transmit mode on required channels and the 60 GHz radios were also configured into transmit. The EUT was assessed for any intermodulation products with all antennas in place. Spurious emissions testing was also performed with the 5GNR device antennae disconnected and RF ports P1 to P8 terminated into 50Ohm loads. The 5G radio was configured using the laptop PC running specialised engineering software (Qualcomm QRCT). The PC was located outside the test chamber/ or removed from the test chamber/test area prior to test. The unit was also configured using a laptop PC and terminal software to allow permanent transmit modes of the 60 GHz function of the device, on both of the 60 GHz radios with individual beam settings of choice. Terminal software was used to configure the 60GHz radio.

The 5G radio was assessed at the maximum default power setting per carrier of +27dBm (Internal modem output +33 dBm) using the following channels, Bandwidths and modulations:
Low = 3720 MHz, 40MHz BW, QPSK, 16QAM, 64QAM and 256QAM Modulation
Mid = 3840 MHz, 40MHz BW, QPSK, 16QAM, 64QAM and 256QAM Modulation
High = 3960 MHz, 40MHz BW, QPSK, 16QAM, 64QAM and 256QAM Modulation
Low = 3730 MHz, 60MHz BW, QPSK, 16QAM, 64QAM and 256QAM Modulation
Mid = 3840 MHz, 60MHz BW, QPSK, 16QAM, 64QAM and 256QAM Modulation
High = 3950 MHz, 60MHz BW, QPSK, 16QAM, 64QAM and 256QAM Modulation

The 5G NR houses two extensive RF switching modules which could be set into various RF switching routes to the 8 RF ports/feeds (4 ports on either side of the device) and the 4 Antenna sectors. This is demonstrated in the applicants RF switching/routing table included in the theory of operation document provided for the certification. The EUT can operate in a 4TX (4 port summed) mode of operation as a worst case. Antenna mapping for the 5G Radios and sectors is also included in the technical theory of operation document submitted with the application. Please refer to the technical operation theory document supplied with the certification application for any further details.

Pre-scans to determine 60GHz radio function worst case modulation scheme were also performed, where all modulations were assessed in turn (MCS0 to MCS12). For final intermodulation tests modulation scheme MCS5 was used as this was found to be worst-case.

The 60GHz radio was assessed in combination with the 5GNR at the maximum power setting (as per factory calibration) using the following channels and Bandwidth:
Low = 58.32 GHz, 2.16GHz BW, MCS5
Mid = 64.8 GHz, 2.16GHz BW, MCS5
High = 69.12 GHz, 2.16GHz BW, MCS5

Below is a table of pre-compliance power testing performed on the 5G Radio to identify the worst-case ID config and RF port/feed. Results below show that ID config 1 and ID config 9 provided the highest power over the 8 RF ports/feeds. Port/Feed 6 was identified as producing the highest power out of all the RF port/feeds.

40 MHz Mid Chan 33 dBm QPSK set on QWRT software								
ID	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**
1			28.1	27.47	28.32	28.51		
2	24.99	25.45	25.11	25.02	23.5	23.85	23.7	24.03
3			27.77	27.35				
4					27.86	27.52		
5	24.91	25.17	24.9	24.55	24.85	23.9		
6			27.41	26.9	25.25	24.62	23.93	24.26
7	25.34	25.17	24.25	24.3			24.25	24.38
8	25.15	25.81			24.76	24.81	23.94	24.48
9	25.54	26.2					25.31	25.86
10	24.47	25.35	24.52	24.94				
11					24.47	23.8	23.18	23.88
Max (dBm)	**25.54**	**26.2**	**28.1**	**27.47**	**28.32**	**28.51**	**25.31**	**25.86**
Linear (Watt)	0.3581	0.4169	0.6457	0.5585	0.6792	0.7096	0.3396	0.3855

Linear sum highest P1,P3,P5,P7 (W) Sector A	2.0226
Power sum highest P1,P3,P5,P7 (dBm) Sector A	33.06
Linear sum highest P2,P4,P6,P8 (W) Sector B	2.0705
Power sum highest P2,P4,P6,P8 (dBm) Sector B	33.16
P6 (dBm) + 10 log(4) dB, dBm	34.53

For the purposes of tests in this report, ID config1 and RF port/feed P6 was identified and used as a worst case/highest RF power output port. Where required for certain tests all 4 port summation calculations are using the “Measure and add 10 log(NANT) dB, where NANT is the number of outputs” method from KDB 662911 D01 v02r01, where n is the number of ports in this case = 4. This method provides a slight over estimation of test results to ensure, regardless of RF switching scheme, that the EUT remains compliant with the rules/limits.

2.5.1 Signal leads

Port Name	Cable Type	Connected
DC Input	Twisted 2 Core	Yes
Point-of-Presence	Full Duplex Fibre	Yes
Daisy Chain 1	Full Duplex Fibre	Yes
Daisy Chain 2	Full Duplex Fibre	Yes
Grounding point	Copper braid	Yes
Debug Ethernet	Cat5	No (Applicant declares for engineering use only)
Debug Serial	Cat5	No (Applicant declares for engineering use only)
Debug USB	USB	No (Applicant declares for engineering use only)

3 Summary of test results

The STC-v11-Node-n77, AAB was tested for compliance to the following standards:

47 CFR Part 27 Effective Date 1st October 2022
↳ 47CFR part 2J Effective Date 1st October 2021
TNB: Licensed Non-Broadcast Station Transmitter

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. Spurious emissions at antenna terminals	FCC Part 27 Clause 27.53(l) & 2.1051	PASSED[1]
2. RF Power Output	FCC Part 27 Clause 27.50(j)(2) & 2.1046	PASSED
3. RF Power Output PAPR	FCC Part 27 Clause 27.50(j)(4)	PASSED
4. RF Power Output PSD	FCC Part 27 Clause 27.50(j)	PASSED
5. Field strength of spurious radiations	FCC Part 27 Clause 27.53(l) & 2.1053	PASSED[1]
6. Frequency stability	FCC Part 27 Clause 27.54 & 2.1055	PASSED
7. Occupied Bandwidth	FCC Part 2 Clause 2.1049	PASSED
8. Band edge / spectrum mask additional emissions limitations	FCC Part 27 Clause 27.53(l) & 2.1051	PASSED
9. Modulation characteristics	FCC Part 27 Clause 2.1047	PROVIDED
10. Adjacent Channel Power	FCC Part 27 Clause 27.53 & 2.1047	NOT APPLICABLE[2]

[1] Spectrum below 30MHz started at a frequency of 9 kHz based on the lowest signal generated/used within the equipment as declared by the applicant, Spectrum investigated up to a frequency of 40GHz based on 10 times the highest channel/ signal generated in equipment of 3980 MHz.

[2] Test not applicable to EUT's operating in the 3700-3980 MHz Band.

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	FCC Part 27	2022	Miscellaneous Wireless Communications Services
4.1.2	47CFR part 2J	2021	Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations
4.1.3	KDB 971168 D01 v03	2017	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Measurement Guidance for Certification of Licensed Digital Transmitters
4.1.4	ANSI C63.26	2015	American National Standard for Compliance testing of transmitters used in Licensed radio services
4.1.5	KDB 662911 D01 v02r01	2013	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Emissions Testing of Transmitters with Multiple Outputs in the Same Band
4.1.6	TIA-603-E	2016	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards, Telecommunications Industry Association, June 2010
4.1.7	KDB662911 D02 v01	2011	MIMO with Cross-Polarized Antenna

4.2 Deviations

No deviations were applied

4.3 Tests at extremes of temperature & voltage

The following test conditions were used to simulate testing at nominal or extremes.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	45V DC
T minimum	-30 °C	V minimum	40.5V DC
T maximum	50 °C	V maximum	49.5V DC

Extremes of voltage are based on manufacturers declaration of +/-10%.
Extremes of temperature are based upon manufacturer's declaration and rule part 2.1055.
The ambient test conditions of humidity and pressure in the laboratory were as specified in each specific test section within this report

4.4 Test fixtures

In order to measure RF parameters at temperature extremes, the EUT was tested in a temperature-controlled chamber as follows:

The EUT's RF port was used.

5 Tests, methods and results

5.1 Spurious emissions at antenna terminals

5.1.1 Test methods

Test Requirements:	FCC Part 27 Clause 2.1053 & 27.53(l) [Reference 4.1.1 of this report]
Test Method:	FCC Part 27 Clause 27.53(l) [Reference 4.1.1 of this report]
	FCC Part 2 Clause 2.1051 [Reference 4.1.2 of this report]
	KDB 971168 Clause 3.6 & 4.7 [Reference 4.1.3 of this report]
	ANSI C63.26 Clause 5.5 [Reference 4.1.4 of this report]
	KDB 662911 Clause E(3)(a)iii [Reference 4.1.5 of this report]
Limits:	FCC Part 27 Clause 27.53(l) [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the External RF ports. The EUT was operated in Modes 1 to 26 for this test.

5.1.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section at Site N. A complete scan of emissions from the lowest frequency generated/ used within the equipment up to 10 times the highest frequency generated/ used was made, to identify any signals within 20dB of the limits. Any identified spurious signals were measured in the required bandwidths. RF Port/Feed P6 was tested and plotted as worst case/highest power port from preliminary scans. Per KDB 662911 D01 for multiple Transmitter output ports, 10Log(NANT) dB (+6.02 dB for 4 antenna ports) was used to apply a +6.02 dB addition to the single port measured results, for comparison with the limits.

5.1.4 Test equipment

E615, E725, E853, H071

See Section 8 for more details

5.1.5 Test results

Temperature of test environment	21°C
Humidity of test environment	45-50%
Pressure of test environment	102kPa

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
Low channel	3720 MHz

Modulation	Spurious Frequency (MHz)	Measured Spurious Level (dBm) Single Port	Difference to Limit (dB)	Summed 4 RF port results (+6.02 dB) (dBm)	4 RF ports summed Difference to Limit (dB)
QPSK	3699	-39.37	-26.37	-33.35	-20.35
16QAM	3699	-41.99	-28.99	-35.97	-22.97
64QAM	3699	-39.82	-26.82	-33.8	-20.8
256QAM	3699	-36.21	-23.21	-30.19	-17.19
QPSK	3741	-23.92	-10.92	-17.90	-4.90
16QAM	3741	-26.55	-13.55	-20.53	-7.53
64QAM	3741	-24.58	-11.58	-18.56	-5.56
256QAM	3741	-22.59	-9.59	-16.57	-3.57

Plots
CSE, 9kHz-3699MHz, Low Chan, 40 MHz, P6, ID 1
CSE, 3741MHz-40GHz, Low Chan, 40 MHz, P6, ID 1

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
Mid channel	3840 MHz

Modulation	Spurious Frequency (MHz)	Measured Spurious Level (dBm) Single Port	Difference to Limit (dB)	Summed 4 RF port results (+6.02 dB) (dBm)	4 RF ports summed Difference to Limit (dB)
QPSK	3819	-37.25	-24.25	-31.23	-18.23
16QAM	3819	-37.04	-24.04	-31.02	-18.02
64QAM	3819	-36.59	-23.59	-30.57	-17.57
256QAM	3819	-35.59	-22.59	-29.57	-16.57
QPSK	3861	-24.79	-11.79	-18.77	-5.77
16QAM	3861	-27.21	-14.21	-21.19	-8.19
64QAM	3861	-25.84	-12.84	-19.82	-6.82
256QAM	3861	-24.33	-11.33	-18.31	-5.31

Plots
CSE, 9kHz-3809MHz, Mid Chan, 60 MHz, P6, ID 1
CSE, 3861MHz-40GHz, Mid Chan, 40 MHz, P6, ID 1

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
High channel	3960 MHz

Modulation	Spurious Frequency (MHz)	Measured Spurious Level (dBm) Single Port	Difference to Limit (dB)	Summed 4 RF port results (+6.02 dB) (dBm)	4 RF ports summed Difference to Limit (dB)
QPSK	3939	-35.05	-22.05	-29.03	-16.03
16QAM	3939	-29.13	-16.13	-23.11	-10.11
64QAM	3939	-32.14	-19.14	-26.12	-13.12
256QAM	3939	-32.59	-19.59	-26.57	-13.57
QPSK	3961	-23.19	-10.19	-17.17	-4.17
16QAM	3961	-24.67	-11.67	-18.65	-5.65
64QAM	3961	-23.46	-10.46	-17.44	-4.44
256QAM	3961	-22.62	-9.62	-16.6	-3.6

Plots
CSE, 9kHz-3939MHz, High Chan, 40 MHz, P6, ID 1
CSE, 3981MHz-40GHz, High Chan, 40 MHz, P6, ID 1

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
Low channel	3730 MHz

Modulation	Spurious Frequency (MHz)	Measured Spurious Level (dBm) Single Port	Difference to Limit (dB)	Summed 4 RF port results (+6.02 dB) (dBm)	4 RF ports summed Difference to Limit (dB)
QPSK	3699	-33.64	-20.64	-27.62	-14.62
16QAM	3699	-27.75	-14.75	-21.73	-8.73
64QAM	3699	-40.12	-27.12	-34.1	-21.1
256QAM	3699	-32.26	-19.26	-26.24	-13.24
QPSK	3761	-24.15	-11.15	-18.13	-5.13
16QAM	3761	-27.13	-14.13	-21.11	-8.11
64QAM	3761	-24.16	-11.16	-18.14	-5.14
256QAM	3761	-24.02	-11.02	-18	-5

Plots
CSE, 9kHz-3699MHz, Low Chan, 60 MHz, P6, ID 1
CSE, 3761MHz-40GHz, Low Chan, 60 MHz, P6, ID 1

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
Mid channel	3840 MHz

Modulation	Spurious Frequency (MHz)	Measured Spurious Level (dBm) Single Port	Difference to Limit (dB)	Summed 4 RF port results (+6.02 dB) (dBm)	4 RF ports summed Difference to Limit (dB)
QPSK	3809	-36.23	-23.23	-30.21	-17.21
16QAM	3809	-28.19	-15.19	-22.17	-9.17
64QAM	3809	-32.58	-19.58	-26.56	-13.56
256QAM	3809	-36.07	-23.07	-30.05	-17.05
QPSK	3871	-25.52	-12.52	-19.5	-6.5
16QAM	3871	-28.16	-15.16	-22.14	-9.14
64QAM	3871	-23.77	-10.77	-17.75	-4.75
256QAM	3871	-23.24	-10.24	-17.22	-4.22

Plots
CSE, 9kHz-3809MHz, Mid Chan, 60 MHz, P6, ID 1
CSE, 3871MHz-40GHz, Mid Chan, 60 MHz, P6, ID 1

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
High channel	3950 MHz

Modulation	Spurious Frequency (MHz)	Measured Spurious Level (dBm) Single Port	Difference to Limit (dB)	Summed 4 RF port results (+6.02 dB) (dBm)	4 RF ports summed Difference to Limit (dB)
QPSK	3919	-31.61	-18.61	-25.59	-12.59
16QAM	3919	-25.88	-12.88	-19.86	-6.86
64QAM	3919	-32.15	-19.15	-26.13	-13.13
256QAM	3919	-34.41	-21.41	-28.39	-15.39
QPSK	3981	-23.27	-10.27	-17.25	-4.25
16QAM	3981	-27.29	-14.29	-21.27	-8.27
64QAM	3981	-23.59	-10.59	-17.57	-4.57
256QAM	3981	-21.97	-8.97	-15.95	-2.95

Plots
CSE, 9kHz-3919MHz, High Chan, 60 MHz, P6, ID 1
CSE, 3981MHz-40GHz, High Chan, 60 MHz, P6, ID 1

The plots referred to in the above table may be found in section 6.

Note: For additional emissions limitations at the band edge/spectrum mask, plots for all combinations of modulation schemes, channel bandwidths and Low and high channel frequencies have been shown in band edge section.

LIMITS:
27.53(l) 3.7 GHz Service
(1) For base station operations in the 3700–3980 MHz band, the conducted power of any emission outside the licensee's authorized bandwidth shall not exceed −13 dBm/MHz.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: ± 2.8 dB up to 26.5 GHz. 26.5 – 40 GHz

5.2 RF Power Output

5.2.1 Test methods

Test Requirements:	FCC Part 27 Clause 27.50(j)(2), (4), (5) [Reference 4.1.1 of this report]
Test Method:	FCC Part 27 Clause 27.50(j)(4), (5) [Reference 4.1.1 of this report]
	FCC Part 2 Clause 2.1046 [Reference 4.1.2 of this report]
	KDB 971168 Clause 5.4/5.5 [Reference 4.1.3 of this report]
	ANSI C63.26 Clause 5.2.5.3/5.2.4.5 [Reference 4.1.4 of this report]
	KDB 662911 Clause E [Reference 4.1.5 of this report]
Limits:	FCC Part 27 Clause 27.50(j)(2) [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the external RF ports.
Preliminary scans of power made on stated RF ID configs & ports to determine worst case RF port for tests this was found to be P6 and ID config 1.
The EUT was operated in Modes 1 to Modes 26 for this test.
The EUT was set to each mode and test signal in turn (see section 2.4) and highest power levels recorded.

5.2.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section.
Channel power function of the analyser was used with an RMS detector. For test modes not utilising 100% duty cycle, and as the duty cycle of the EUT was constant (within +-1%) a duty cycle correction was added on to the result using the following equation: 10.Log(1/0.75) where 0.75 is the duty cycle (75%) and equates to 1.25dB correction, see clause 5.2.4.4.2 and 5.2.4.3.4 of ANSI C63.26 for methodology. Duty correction was accounted for in the spectrum analyser along with any network/attenuation losses.

Measurements were made on a test bench in site N.

5.2.4 Test equipment

E887, E899, E928, F153, F249, H071

See Section 8 for more details

5.2.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Preliminary scans of power were made on stated RF ID configs & ports to determine worst case port for tests. This was found to be P6 and ID config 1 and was used for final measurements. Per KDB 662911, 10Log(4) = +6.02 dB was added to single port results to calculate worst case power with 4 RF ports transmitting, before the antenna array gain was added to determine overall Radiated power with respect to the limits. Power results measured below are total power over the channel Bandwidth, PSD results for power measured in 1MHz RBW are shown in section 5.4, channel power plots shown in section 6 also show PSD in 1MHz results.

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Low channel	3720 MHz

Test Instance modulation	Average Cond Power (dBm) TX Chain 1	Average Cond Power (dBm) TX Chain 2	Average Cond Power (dBm) TX Chain 3	Average Cond Power (dBm) TX Chain 4	Antenna Gain dBi	Total Cond Pow MIMO 4 Port (Watts)	Total Power EIRP (dBm) (incl Ant G)	Power Limit (dBm)	Power Margin (dB)
QPSK	26.95	26.95	26.95	26.95	14	1.982	46.97	62.15	-15.18
16QAM	28.10	28.10	28.10	28.10	14	2.583	48.12	62.15	-14.03
64QAM	28.24	28.24	28.24	28.24	14	2.667	48.26	62.15	-13.89
256QAM	28.28	28.28	28.28	28.28	14	2.692	48.30	62.15	-13.85

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Mid channel	3840 MHz

Test Instance modulation	Average Cond Power (dBm) TX Chain 1	Average Cond Power (dBm) TX Chain 2	Average Cond Power (dBm) TX Chain 3	Average Cond Power (dBm) TX Chain 4	Antenna Gain dBi	Total Cond Pow MIMO 4 Port (Watts)	Total Power EIRP (dBm) (incl Ant G)	Power Limit (dBm)	Power Margin (dB)
QPSK	28.15	28.15	28.15	28.15	14	2.613	48.17	62.15	-13.98
16QAM	28.24	28.24	28.24	28.24	14	2.667	48.26	62.15	-13.89
64QAM	27.13	27.13	27.13	27.13	14	2.066	47.15	62.15	-15.00
256QAM	28.45	28.45	28.45	28.45	14	2.799	48.47	62.15	-13.68

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
High channel	3960 MHz

Test Instance modulation	Average Cond Power (dBm) TX Chain 1	Average Cond Power (dBm) TX Chain 2	Average Cond Power (dBm) TX Chain 3	Average Cond Power (dBm) TX Chain 4	Antenna Gain dBi	Total Cond Pow MIMO 4 Port (Watts)	Total Power EIRP (dBm) (incl Ant G)	Power Limit (dBm)	Power Margin (dB)
QPSK	27.28	27.28	27.28	27.28	14	2.138	47.30	62.15	-14.85
16QAM	27.09	27.09	27.09	27.09	14	2.047	47.11	62.15	-15.04
64QAM	27.08	27.08	27.08	27.08	14	2.042	47.10	62.15	-15.05
256QAM	27.36	27.36	27.36	27.36	14	2.178	47.38	62.15	-14.77

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Low channel	3730 MHz

Test Instance modulation	Average Cond Power (dBm) TX Chain 1	Average Cond Power (dBm) TX Chain 2	Average Cond Power (dBm) TX Chain 3	Average Cond Power (dBm) TX Chain 4	Antenna Gain dBi	Total Cond Pow MIMO 4 Port (Watts)	Total Power EIRP (dBm) (incl Ant G)	Power Limit (dBm)	Power Margin (dB)
QPSK	27.65	27.65	27.65	27.65	14	2.328	47.67	62.15	-14.48
16QAM	27.76	27.76	27.76	27.76	14	2.388	47.78	62.15	-14.37
64QAM	27.23	27.23	27.23	27.23	14	2.114	47.25	62.15	-14.90
256QAM	27.18	27.18	27.18	27.18	14	2.090	47.20	62.15	-14.95

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Mid channel	3840 MHz

Test Instance modulation	Average Cond Power (dBm) TX Chain 1	Average Cond Power (dBm) TX Chain 2	Average Cond Power (dBm) TX Chain 3	Average Cond Power (dBm) TX Chain 4	Antenna Gain dBi	Total Cond Pow MIMO 4 Port (Watts)	Total Power EIRP (dBm) (incl Ant G)	Power Limit (dBm)	Power Margin (dB)
QPSK	28.21	28.21	28.21	28.21	14	2.649	48.23	62.15	-13.92
16QAM	28.30	28.30	28.30	28.30	14	2.704	48.32	62.15	-13.83
64QAM	28.02	28.02	28.02	28.02	14	2.535	48.04	62.15	-14.11
256QAM	27.84	27.84	27.84	27.84	14	2.433	47.86	62.15	-14.29

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
High channel	3950 MHz

Test Instance modulation	Average Cond Power (dBm) TX Chain 1	Average Cond Power (dBm) TX Chain 2	Average Cond Power (dBm) TX Chain 3	Average Cond Power (dBm) TX Chain 4	Antenna Gain dBi	Total Cond Pow MIMO 4 Port (Watts)	Total Power EIRP (dBm) (incl Ant G)	Power Limit (dBm)	Power Margin (dB)
QPSK	26.50	26.50	26.50	26.50	14	1.787	46.52	62.15	-15.63
16QAM	26.60	26.60	26.60	26.60	14	1.828	46.62	62.15	-15.53
64QAM	26.43	26.43	26.43	26.43	14	1.758	46.45	62.15	-15.70
256QAM	26.94	26.94	26.94	26.94	14	1.977	46.96	62.15	-15.19

Channel power Plots may be found in section 6.

Test Instance modulation	Measured duty cycle %	Duty cycle correction to 100%
QPSK	74.2	1.29 dB
16QAM	76.4	1.17 dB
64QAM	74.2	1.29 dB
256QAM	74.2	1.29 dB

Note: Plots showing duty cycle correction for each modulation scheme is evidenced in section 6.7 of this report

LIMITS:
The power of each fixed or base station transmitting in the 3700–3980 MHz band and situated in any geographic location other than that described in paragraph (j)(1) of Part 27.50(j0) is limited to an EIRP of 1640 Watts/MHz. This limit applies to the aggregate power of all antenna elements in any given sector of a base station.
Note: PSD results are shown below in section 5.4 which show power measured per MHz for comparison to limits. 1640W/MHz = 62.15dBm/MHz.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.0 dB

5.3 RF Power Output PAPR

5.3.1 Test methods

Test Requirements:	FCC Part 27 Clause 27.50(j)(4) [Reference 4.1.1 of this report]
Test Method:	FCC Part 27 Clause 27.50(j)(4) [Reference 4.1.1 of this report]
	KDB 971168 Clause 5.7.2 [Reference 4.1.3 of this report]
	ANSI C63.26 Clause 5.2.3.4 [Reference 4.1.4 of this report]
Limits:	FCC Part 27 Clause 27.50(j)(4) [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the External RF ports. The EUT was operated in Modes 1 to 26.

5.3.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section.
The Spectrum analysers CCDF power function was used to determine Peak to Average Power ratio over 0.1% transmission time. Analyser plots were captured.

Measurements were made in test site N.

5.3.4 Test equipment

E534, E887, E899, E928, F153, F249, H071

See Section 8 for more details

5.3.5 Test results

Temperature of test environment	22°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Low channel	3720 MHz

Test Instance modulation	CCDF pk to av plot ref filename	Peak to AV ratio (dB)	PK to AV Limit (dB)	PK to AV Margin (dB)
QPSK	14156-3 PAPR 40 MHz Low Chan QPSK	8.35	13	-4.65
16QAM	14156-3 PAPR 40 MHz Low Chan 16 QAM	8.36	13	-4.64
64QAM	14156-3 PAPR 40 MHz Low Chan 64 QAM	8.31	13	-4.69
256QAM	14156-3 PAPR 40 MHz Low Chan 256 QAM	8.35	13	-4.65

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Mid channel	3840 MHz

Test Instance modulation	CCDF pk to av plot ref filename	Peak to AV ratio (dB)	PK to AV Limit (dB)	PK to AV Margin (dB)
QPSK	14156-3 PAPR 40 MHz Mid Chan QPSK	8.37	13	-4.63
16QAM	14156-3 PAPR 40 MHz Mid Chan 16 QAM	8.54	13	-4.46
64QAM	14156-3 PAPR 40 MHz Mid Chan 64 QAM	8.39	13	-4.61
256QAM	14156-3 PAPR 40 MHz Mid Chan 256 QAM	8.4	13	-4.6

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
High channel	3960 MHz

Test Instance modulation	CCDF pk to av plot ref filename	Peak to AV ratio (dB)	PK to AV Limit (dB)	PK to AV Margin (dB)
QPSK	14156-3 PAPR 40 MHz High Chan QPSK	8.33	13	-4.67
16QAM	14156-3 PAPR 40 MHz High Chan 16 QAM	8.37	13	-4.63
64QAM	14156-3 PAPR 40 MHz High Chan 64 QAM	8.39	13	-4.61
256QAM	14156-3 PAPR 40 MHz High Chan 256 QAM	8.35	13	-4.65

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Low channel	3730 MHz

Test Instance modulation	CCDF pk to av plot ref filename	Peak to AV ratio (dB)	PK to AV Limit (dB)	PK to AV Margin (dB)
QPSK	14156-3 PAPR 60 MHz Low Chan QPSK	8.38	13	-4.62
16QAM	14156-3 PAPR 60 MHz Low Chan 16 QAM	8.32	13	-4.68
64QAM	14156-3 PAPR 60 MHz Low Chan 64 QAM	8.57	13	-4.43
256QAM	14156-3 PAPR 60 MHz Low Chan 256 QAM	8.37	13	-4.63

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Mid channel	3840 MHz

Test Instance modulation	CCDF pk to av plot ref filename	Peak to AV ratio (dB)	PK to AV Limit (dB)	PK to AV Margin (dB)
QPSK	14156-3 PAPR 60 MHz Mid Chan QPSK	8.32	13	-4.68
16QAM	14156-3 PAPR 60 MHz Mid Chan 16 QAM	8.31	13	-4.69
64QAM	14156-3 PAPR 60 MHz Mid Chan 64 QAM	8.32	13	-4.68
256QAM	14156-3 PAPR 60 MHz Mid Chan 256 QAM	8.33	13	-4.67

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
High channel	3950 MHz

Test Instance modulation	CCDF pk to av plot ref filename	Peak to AV ratio (dB)	PK to AV Limit (dB)	PK to AV Margin (dB)
QPSK	14156-3 PAPR 60 MHz High Chan QPSK	8.33	13	-4.67
16QAM	14156-3 PAPR 60 MHz High Chan 16 QAM	8.34	13	-4.66
64QAM	14156-3 PAPR 60 MHz High Chan 64 QAM	8.31	13	-4.69
256QAM	14156-3 PAPR 60 MHz High Chan 256 QAM	8.23	13	-4.77

Plots referred to in the above table may be found in section 6.

LIMITS:
Equipment employed must be authorized in accordance with the provisions of § 27.51. Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (j)(5) of this section. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.0 dB

5.4 RF Power Output PSD

5.4.1 Test methods

Test Requirements:	FCC Part 27 Clause 27.50(j)(2) [Reference 4.1.1 of this report]
Test Method:	FCC Part 27 Clause 27.50(j)(4) [Reference 4.1.1 of this report]
	KDB 971168 Clause 5.4/5.5 [Reference 4.1.3 of this report]
	ANSI C63.26 Clause 5.2.5.3/5.2.4.5 [Reference 4.1.4 of this report]]
	KDB 662911 Clause E [Reference 4.1.5 of this report]
Limits:	FCC Part 27 Clause 27.50(j)(2) [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was configured as for the Average conducted power test. The EUT was operated in Modes 1 to 26 for this test.

5.4.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section.
The Spectrum analysers Channel power and PSD power function was used to determine Power Spectral Density over 1MHz RBW. Plots were captured. For test modes not utilising 100% duty cycle, and as the duty cycle of the EUT was constant (within +-1%) a duty cycle correction was added on to the result using the following equation: 10.Log(1/0.75) where 0.75 is the duty cycle (75%) and equates to 1.25dB correction, see clause 5.2.4.4.2 and 5.2.4.3.4 of ANSI C63.26 for methodology. Duty correction was accounted for in the spectrum analyser along with any network/attenuation losses.

Measurements were made in test site N.

5.4.4 Test equipment

E887, E899, E928, F153, F249, H071

See Section 8 for more details

5.4.5 Test results

Temperature of test environment	21°C
Humidity of test environment	52%
Pressure of test environment	102kPa

Preliminary scans of power were made on stated RF ID configs & ports to determine worst case port for tests. This was found to be P6 and ID config 1 and was used for final measurements. Per KDB 662911, 10Log(4) = +6.02 dB was added to single port results to calculate worst case power with 4 RF ports transmitting, before the antenna array gain was added to determine overall Radiated power PSD/MHz with respect to the limits.

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM, 256QAM
Low channel	3720 MHz

Test Instance modulation	Average PSD Power (dBm/MHz) TX Chain 1	Average PSD Power (dBm/MHz) 4 Ports	Antenna Gain dBi	Total PSD per MHz 4 Port (Watts)	Total PSD (dBm/1MHz) 4 Port (incl Ant G)	PSD Limit (dBm/MHz)	PSD Margin (dB)
QPSK	10.93	16.95	14	0.050	30.951	62.15	-31.199
16QAM	12.08	18.10	14	0.065	32.101	62.15	-30.049
64QAM	12.21	18.23	14	0.067	32.231	62.15	-29.919
256QAM	12.26	18.28	14	0.067	32.281	62.15	-29.869

Test Instance modulation	Plot filename reference
QPSK	14156-3 40 MHz Low Chan QPSK
16QAM	14156-3 40 MHz Low Chan 16 QAM
64QAM	14156-3 40 MHz Low Chan 64 QAM
256QAM	14156-3 40 MHz Low Chan 256 QAM

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256 QAM
Mid channel	3840 MHz

Test Instance modulation	Average PSD Power (dBm/MHz) TX Chain 1	Average PSD Power (dBm/MHz) 4 Ports	Antenna Gain dBi	Total PSD per MHz 4 Port (Watts)	Total PSD (dBm/1MHz) 4 Port (incl Ant G)	PSD Limit (dBm/MHz)	PSD Margin (dB)
QPSK	12.13	18.15	14	0.065	32.151	62.15	-29.999
16QAM	12.22	18.24	14	0.067	32.241	62.15	-29.909
64QAM	11.11	17.13	14	0.052	31.131	62.15	-31.019
256QAM	12.43	18.45	14	0.070	32.451	62.15	-29.699

Test Instance modulation	Plot filename reference
QPSK	14156-3 40 MHz Mid Chan QPSK
16QAM	14156-3 40 MHz Mid Chan 16 QAM
64QAM	14156-3 40 MHz Mid Chan 64 QAM
256QAM	14156-3 40 MHz Mid Chan 256 QAM

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256 QAM
High channel	3960 MHz

Test Instance modulation	Average PSD Power (dBm/MHz) TX Chain 1	Average PSD Power (dBm/MHz) 4 Ports	Antenna Gain dBi	Total PSD per MHz 4 Port (Watts)	Total PSD (dBm/1MHz) 4 Port (incl Ant G)	PSD Limit (dBm/MHz)	PSD Margin (dB)
QPSK	11.25	17.27	14	0.053	31.271	62.15	-30.879
16QAM	11.07	17.09	14	0.051	31.091	62.15	-31.059
64QAM	11.06	17.08	14	0.051	31.081	62.15	-31.069
256QAM	11.34	17.36	14	0.054	31.361	62.15	-30.789

Test Instance modulation	Plot filename reference
QPSK	14156-3 40 MHz High Chan QPSK
16QAM	14156-3 40 MHz High Chan 16 QAM
64QAM	14156-3 40 MHz High Chan 64 QAM
256QAM	14156-3 40 MHz High Chan 256 QAM

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Low channel	3730 MHz

Test Instance modulation	Average PSD Power (dBm/MHz) TX Chain 1	Average PSD Power (dBm/MHz) 4 Ports	Antenna Gain dBi	Total PSD per MHz 4 Port (Watts)	Total PSD (dBm/1MHz) 4 Port (incl Ant G)	PSD Limit (dBm/MHz)	PSD Margin (dB)
QPSK	9.87	15.89	14	0.039	29.891	62.15	-32.259
16QAM	9.98	16.00	14	0.040	30.001	62.15	-32.149
64QAM	9.45	15.47	14	0.035	29.471	62.15	-32.679
256QAM	9.4	15.42	14	0.035	29.421	62.15	-32.729

Test Instance modulation	Plot filename reference
QPSK	14156-3 60 MHz Low Chan QPSK
16QAM	14156-3 60 MHz Low Chan 16 QAM
64QAM	14156-3 60 MHz Low Chan 64 QAM
256QAM	14156-3 60 MHz Low Chan 256 QAM

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM ,256QAM
Mid channel	3840 MHz

Test Instance modulation	Average PSD Power (dBm/MHz) TX Chain 1	Average PSD Power (dBm/MHz) 4 Ports	Antenna Gain dBi	Total PSD per MHz 4 Port (Watts)	Total PSD (dBm/1MHz) 4 Port (incl Ant G)	PSD Limit (dBm/MHz)	PSD Margin (dB)
QPSK	10.43	16.45	14	0.044	30.451	62.15	-31.699
16QAM	10.52	16.54	14	0.045	30.541	62.15	-31.609
64QAM	10.24	16.26	14	0.042	30.261	62.15	-31.889
256QAM	10.05	16.07	14	0.040	30.071	62.15	-32.079

Test Instance modulation	Plot filename reference
QPSK	14156-3 60 MHz Mid Chan QPSK
16QAM	14156-3 60 MHz Mid Chan 16 QAM
64QAM	14156-3 60 MHz Mid Chan 64 QAM
256QAM	14156-3 60 MHz Mid Chan 256 QAM

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
High channel	3950 MHz

Test Instance modulation	Average PSD Power (dBm/MHz) TX Chain 1	Average PSD Power (dBm/MHz) 4 Ports	Antenna Gain dBi	Total PSD per MHz 4 Port (Watts)	Total PSD (dBm/1MHz) 4 Port (incl Ant G)	PSD Limit (dBm/MHz)	PSD Margin (dB)
QPSK	8.71	14.73	14	0.030	28.731	62.15	-33.419
16QAM	8.82	14.84	14	0.030	28.841	62.15	-33.309
64QAM	8.65	14.67	14	0.029	28.671	62.15	-33.479
256QAM	9.16	15.18	14	0.033	29.181	62.15	-32.969

Test Instance modulation	Plot filename reference
QPSK	14156-3 60 MHz High Chan QPSK
16QAM	14156-3 60 MHz High Chan 16 QAM
64QAM	14156-3 60 MHz High Chan 64 QAM
256QAM	14156-3 60 MHz High Chan 256 QAM

Any plots referred to in the above table may be found in section 6.

LIMITS:
The power of each fixed or base station transmitting in the 3700–3980 MHz band and situated in any geographic location other than that described in paragraph (j)(1) of Part 27.50(j0 is limited to an EIRP of 1640 Watts/MHz. This limit applies to the aggregate power of all antenna elements in any given sector of a base station.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.0 dB

5.5 Field strength of spurious radiations

5.5.1 Test methods

Test Requirements:	FCC Part 27 Clause 27.53(I)(1) [Reference 4.1.1 of this report]
Test Method:	FCC Part 27 Clause 27.53(I)(1) [Reference 4.1.1 of this report]
	KDB 971168 Clause 7 [Reference 4.1.3 of this report]
	ANSI C63.26 Clause 5.5 [Reference 4.1.4 of this report]
Limits:	FCC Part 27 Clause 27.53(I)(1) [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was tested in an ALSE. The EUT was examined in its declared normal use position. The EUT was operated in Modes 1 to 48 for this test. The EUT was tested with 8 RF ports terminated into 50 Ohms, and then retested with its 4 antenna arrays connected to test for any intermodulation emissions between 5G NR frequencies and 60GHz radio frequencies, both 60GHz radios were in operation for intermodulation tests and both were set to MCS5 on middle channel.

5.5.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section at Site B, M and H. Peak field strength from the EUT was maximised by rotating it 360 degrees. Appropriate band-pass filters were used to ensure the fundamentals did not distort the results. Only signals found within 20dB of limits are reported.
An RMS detector was used for any final measurements.

25MHz - 1GHz.
The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. Substitution method was performed using tuned dipoles and a calibrated bi-conical antenna.

1GHz – 40GHz.
The measuring antenna was used in both Horizontal and Vertical polarisations. Substitution method was performed using standard gain horn antennas.

5.5.4 Test equipment

E136, E296-2, E330, E411, E412, E624, E743, LPE364, TMS78, TMS79, TMS81, TMS82

See Section 8 for more details

5.5.5 Test results

Temperature of test environment	18-23°C
Humidity of test environment	37-52%
Pressure of test environment	99-102kPa

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Low channel	3720 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No Signals within 20dB of the limit.				

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Mid channel	3840 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No Signals within 20dB of the limit.				

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
High channel	3960 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No Signals within 20dB of the limit.				

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Low channel	3730 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No Signals within 20dB of the limit.				

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
Mid channel	3840 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No Signals within 20dB of the limit.				

Setup Table

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK,16QAM,64QAM,256QAM
High channel	3950 MHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No Signals within 20dB of the limit.				

LIMITS:
27.53(l) (1) For base station operations in the 3700–3980 MHz band, the conducted power of any emission outside the licensee's authorized bandwidth shall not exceed −13 dBm/MHz. Compliance with this paragraph (l)(1) is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: 30MHz - 1GHz ± 3.9 dB, 1 – 18 GHz ±3.5dB, 18 – 26.5 GHz ±3.9dB, 26.5 – 40 GHz ±3.9dB

5.6 Frequency stability

5.6.1 Test methods

Test Requirements:	FCC Part 27 Clause 27.54 [Reference 4.1.1 of this report]
Test Method:	FCC Part 2 Clause 2.1055 [Reference 4.1.2 of this report]
	KDB 971168 Clause 9 [Reference 4.1.3 of this report]
	ANSI C63.26 Clause 5.6 [Reference 4.1.4 of this report]
Limits:	FCC Part 27 Clause 27.54 [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was placed in a temperature-controlled chamber and thermal balance was achieved before tests began. The EUT emission measurements were made at the EUT External RF ports. The EUT was operated on Low and High frequency channels using Modes 1 – 4, 9 - 16 and 21 - 26 for this test.

5.6.3 Test procedure

Tests were made in accordance with the Test Method noted above, using the measuring equipment listed in the 'Test Equipment' Section. The EUT was not provided with a CW test mode, as such tests were performed on the modulated signals. Refer to clause 5.6.4 for procedure. As the frequency stability requirement is for the fundamental emissions to stay within the authorized bands of operation, A reference point was established at the applicable unwanted emissions limits, using the RBW equal to the RBW required by the rule part for band edge emissions. Each modulated signal trace data was captured to ensure it remained within the applicable band emissions limits, at the lower and upper channel frequencies, see clause 5.6.4(l) of ANSI C63.10:2015 for further method details.
Temperature stability was achieved at each temperature test level before taking measurements. At nominal temperature the supply voltage to EUT was varied over the manufacturer's declared endpoints.
Tests were performed using Test Site J.

5.6.4 Test equipment

E253, E533, E938, F077, H071, L264, S036, TMS57

See Section 8 for more details

5.6.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK
Low channel	3720 MHz
High channel	3960 MHz

Test conditions		Level at band edge(dBm) Low channel	Level at band edge(dBm) High channel
-30°C	Volts Nominal (45)	-25.18	-28.38
-20°C	Volts Nominal (45)	-30.05	-32.37
-10°C	Volts Nominal (45)	-27.11	-29.27
0°C	Volts Nominal (45)	-24.94	-35.44
10°C	Volts Nominal (45)	-25.89	-32.42
20°C	Volts Minimum (40.5)	-35.54	-29.28
	Volts Nominal (45)	-27.84	-30.73
	Volts Maximum (49.5)	-25.02	-30.62
30°C	Volts Nominal (45)	-33.04	-29.97
40°C	Volts Nominal (45)	-27.5	-33.65
55°C	Volts Nominal (45)	-29.12	-33.28
-13dBm Limit -6.02dB for 4 port TX		-19.02	-19.02
Closest Margin to limit 0°C Lower and -30°C upper channel		-5.94	-9.38

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK
Low channel	3730 MHz
High channel	3950 MHz

Test conditions		Level at band edge(dBm) Low channel	Level at band edge(dBm) High channel
-30°C	Volts Nominal (45)	-23.41	-21.73
-20°C	Volts Nominal (45)	-21.79	-24.65
-10°C	Volts Nominal (45)	-25.4	-23.36
0°C	Volts Nominal (45)	-25.12	-22.32
10°C	Volts Nominal (45)	-23.72	-24.49
20°C	Volts Minimum (40.5)	-27.29	-20.98
	Volts Nominal (45)	-25.36	-25.14
	Volts Maximum (49.5)	-23.15	-26.94
30°C	Volts Nominal (45)	-22.98	-24.46
40°C	Volts Nominal (45)	-25.22	-27.72
55°C	Volts Nominal (45)	-25.26	-24.47
-13dBm Limit -6.02dB for 4 port TX		-19.02	-19.02
Closest Margin to limit -20°C Lower and 20°C upper channel		-2.79	-1.98

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	16 QAM
Low channel	3720 MHz
High channel	3960 MHz

Test conditions		Level at band edge(dBm) Low channel	Level at band edge(dBm) High channel
-30°C	Volts Nominal (45)	-27.97	-25.73
-20°C	Volts Nominal (45)	-25.98	-28.56
-10°C	Volts Nominal (45)	-27.15	-27.04
0°C	Volts Nominal (45)	-31.25	-29.52
10°C	Volts Nominal (45)	-31.84	-31.59
20°C	Volts Minimum (40.5)	-27.02	-30.37
	Volts Nominal (45)	-26.84	-28.93
	Volts Maximum (49.5)	-27.06	-24.29
30°C	Volts Nominal (45)	-28.82	-33.14
40°C	Volts Nominal (45)	-27.95-	-28.82-
55°C	Volts Nominal (45)	-26.70	-30.07
-13dBm Limit -6.02dB for 4 port TX		-19.02	-19.02
Closest Margin to limit -20°C Lower and 20°C upper channel		-6.98	-5.29

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	16 QAM
Low channel	3730 MHz
High channel	3950 MHz

Test conditions		Level at band edge(dBm) Low channel	Level at band edge(dBm) High channel
-30°C	Volts Nominal (45)	-22.82	-23.79
-20°C	Volts Nominal (45)	-21.07	-23.05
-10°C	Volts Nominal (45)	-23.23	-24.86
0°C	Volts Nominal (45)	-24.3	-24.78
10°C	Volts Nominal (45)	-22.62	-23.49
20°C	Volts Minimum (40.5)	-25.78	-27.29
	Volts Nominal (45)	-25.22	-22.98
	Volts Maximum (49.5)	-24.43	-26.34
30°C	Volts Nominal (45)	-23.3	-23.92
40°C	Volts Nominal (45)	-23.04	-25.75
55°C	Volts Nominal (45)	-21.81	-24.49
-13dBm Limit -6.02dB for 4 port TX		-19.02	-19.02
Closest Margin to limit -20°C Lower and 20°C upper channel		-2.07	-4.05

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	64 QAM
Low channel	3720 MHz
High channel	3960 MHz

Test conditions		Level at band edge(dBm) Low channel	Level at band edge(dBm) High channel
-30°C	Volts Nominal (45)	-30.26	-27.51
-20°C	Volts Nominal (45)	-35.49	-27.95
-10°C	Volts Nominal (45)	-31.96	-32.54
0°C	Volts Nominal (45)	-32.05	-28.18
10°C	Volts Nominal (45)	-32.56	-27.49
20°C	Volts Minimum (40.5)	-34.03	-33.71
	Volts Nominal (45)	-32.98	-24.41
	Volts Maximum (49.5)	-29.84	-27.41
30°C	Volts Nominal (45)	-26.76	-34.99
40°C	Volts Nominal (45)	-29.63	-36.27
55°C	Volts Nominal (45)	-34.11	-27.66
-13dBm Limit -6.02dB for 4 port TX		-19.02	-19.02
Closest Margin to limit 30°C Lower and 20°C upper channel		-7.76	-5.41

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	64 QAM
Low channel	3730 MHz
High channel	3950 MHz

Test conditions		Level at band edge(dBm) Low channel	Level at band edge(dBm) High channel
-30°C	Volts Nominal (45)	-21.93	-21.64
-20°C	Volts Nominal (45)	-20.71	-24.61
-10°C	Volts Nominal (45)	-25.84	-22.39
0°C	Volts Nominal (45)	-25.72	-26.73
10°C	Volts Nominal (45)	-26.35	-25.1
20°C	Volts Minimum (40.5)	-26.5	-29.24
	Volts Nominal (45)	-25.89	-25.35
	Volts Maximum (49.5)	-26.82	-28.56
30°C	Volts Nominal (45)	-24.34	-27.38
40°C	Volts Nominal (45)	-28.06	-24.55
55°C	Volts Nominal (45)	-24.68	-26.74
-13dBm Limit -6.02dB for 4 port TX		-19.02	-19.02
Closest Margin to limit -20°C Lower and -30°C upper channel		-1.71	-2.64

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	256 QAM
Low channel	3720 MHz
High channel	3960 MHz

Test conditions		Level at band edge(dBm) Low channel	Level at band edge(dBm) High channel
-30°C	Volts Nominal (45)	-23.25	-34.99
-20°C	Volts Nominal (45)	-26.06	-37.56
-10°C	Volts Nominal (45)	-28.93	-36.55
0°C	Volts Nominal (45)	-30.53	-39.26
10°C	Volts Nominal (45)	-34.74	-29.66
20°C	Volts Minimum (40.5)	-30.09	-28.4
	Volts Nominal (45)	-31.62	-29.62
	Volts Maximum (49.5)	-29.77	-31.42
30°C	Volts Nominal (45)	-31.91	-26.28
40°C	Volts Nominal (45)	-29.33	-33.98
55°C	Volts Nominal (45)	-34.11	-27
-13dBm Limit -6.02dB for 4 port TX		-19.02	-19.02
Closest Margin to limit -30°C Lower and 30°C upper channel		-4.25	-7.28

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	256 QAM
Low channel	3730 MHz
High channel	3950 MHz

Test conditions		Level at band edge(dBm) Low channel	Level at band edge(dBm) High channel
-30°C	Volts Nominal (45)	-22.12	-24.13
-20°C	Volts Nominal (45)	-25.13	-25.28
-10°C	Volts Nominal (45)	-26.39	-24.90
0°C	Volts Nominal (45)	-23.39	-25.24
10°C	Volts Nominal (45)	-21.83	-26.21
20°C	Volts Minimum (40.5)	-23.42	-24.28
	Volts Nominal (45)	-25.24	-27.05
	Volts Maximum (49.5)	-27.84	-26.58
30°C	Volts Nominal (45)	-27.13	-27.63
40°C	Volts Nominal (45)	-26.10	-23.27
55°C	Volts Nominal (45)	-24.09	-26.36
-13dBm Limit -6.02dB for 4 port TX		-19.02	-19.02
Closest Margin to limit 10°C Lower and 40°C upper channel		-2.83	-5.13

LIMITS:
27.54, The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.
These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 0.7 ppm

5.7 Occupied Bandwidth

5.7.1 Test methods

Test Requirements:	FCC Part 2 Clause 2.1049 [Reference 4.1.2 of this report]
Test Method:	KDB 971168 Clause 4 [Reference 4.1.3 of this report]
	ANSI C63.26 Clause 5.4 [Reference 4.1.4 of this report]
Limits:	FCC Part 27 Clause 27.54 [Reference 4.1.1 of this report]

5.7.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the External RF ports. The EUT was operated in Modes 1 to 26 for this test.

5.7.3 Test procedure

Tests were performed using Test Site N.

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment' Section. A 1% of occupied bandwidth was set as RBW, 3x VBW, auto sweep time and max hold settings were used for the 26dB / 99% bandwidth.

The EUT was set to each Bandwidth/mod scheme in turn (see section 2.4) and 26 dB bandwidth / 99% bandwidth recorded.

5.7.4 Test equipment

E534, E899, F153, E928, E887, F249, H071

See Section 8 for more details

5.7.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK
Low channel	3720 MHz
Mid channel	3840 MHz
High channel	3960 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz)	37.789	37.795	37.778
Plot for 99 % Bandwidth (MHz)	14156-3 BW, QPSK, 40MHz, Low Chan	14156-3 BW, QPSK, 40MHz, Mid Chan	14156-3 BW, QPSK, 40MHz, High Chan
26 dB Bandwidth (MHz)	39.86	39.66	39.58
FLOW Worst case (MHz)	3700.128425	3820.157572	3940.32491
FHIGH Worst case (MHz)	3739.988425	3859.817572	3979.90491

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK
Low channel	3730 MHz
Mid channel	3840 MHz
High channel	3950 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz)	57.735	57.908	57.823
Plot for 99 % Bandwidth (MHz)	14156-3 BW, QPSK, 60MHz, Low Chan	14156-3 BW, QPSK, 60MHz, Mid Chan	14156-3 BW, QPSK, 60MHz, High Chan
26 dB Bandwidth (MHz)	59.6	59.85	59.84
FLOW Worst case (MHz)	3700.35496	3810.016962	3919.97876
FHIGH Worst case (MHz)	3759.95496	3869.866962	3979.81876

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	16QAM
Low channel	3720 MHz
Mid channel	3840 MHz
High channel	3960 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz)	37.763	37.753	37.882
Plot for 99 % Bandwidth (MHz)	14156-3 BW, 16 QAM, 40MHz, Low Chan	14156-3 BW, 16 QAM, 40MHz, Mid Chan	14156-3 BW, 16 QAM, 40MHz, High Chan
26 dB Bandwidth (MHz)	39.46	39.56	39.47
FLOW Worst case (MHz)	3700.266798	3820.2328	3940.275058
FHIGH Worst case (MHz)	3739.726798	3859.7928	3979.745058

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	16QAM
Low channel	3730 MHz
Mid channel	3840 MHz
High channel	3950 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz)	57.763	57.85	57.835
Plot for 99 % Bandwidth (MHz)	14156-3 BW, 16 QAM, 60MHz, Low Chan	14156-3 BW, 16 QAM, 60MHz, Mid Chan	14156-3 BW, 16 QAM, 60MHz, High Chan
26 dB Bandwidth (MHz)	59.65	59.78	59.77
FLOW Worst case (MHz)	3700.180102	3810.16534	3920.045728
FHIGH Worst case (MHz)	3759.830102	3869.94534	3979.815728

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	64QAM
Low channel	3720 MHz
Mid channel	3840 MHz
High channel	3960 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz)	37.805	37.847	37.9966
Plot for 99 % Bandwidth (MHz)	14156-3 BW, 64 QAM, 40MHz, Low Chan	14156-3 BW, 64 QAM, 40MHz, Mid Chan	14156-3 BW, 64 QAM, 40MHz, High Chan
26 dB Bandwidth (MHz)	39.8	36.62	39.52
FLOW Worst case (MHz)	3700.20933	3821.052405	3940.261427
FHIGH Worst case (MHz)	3740.00933	3858.899405	3979.781427

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	64QAM
Low channel	3730 MHz
Mid channel	3840 MHz
High channel	3950 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz)	57.694	57.788	57.748
Plot for 99 % Bandwidth (MHz)	14156-3 BW, 64 QAM, 60MHz, Low Chan	14156-3 BW, 64 QAM, 60MHz, Mid Chan	14156-3 BW, 64 QAM, 60MHz, High Chan
26 dB Bandwidth (MHz)	59.48	59.81	59.73
FLOW Worst case (MHz)	3700.41114	3810.054462	3920.071774
FHIGH Worst case (MHz)	3759.89114	3869.864462	3979.801774

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	256QAM
Low channel	3720 MHz
Mid channel	3840 MHz
High channel	3960 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz)	37.968	37.897	37.853
Plot for 99 % Bandwidth (MHz)	14156-3 BW, 256 QAM, 40MHz, Low Chan	14156-3 BW, 256 QAM, 40MHz, Mid Chan	14156-3 BW, 256 QAM, 40MHz, High Chan
26 dB Bandwidth (MHz)	39.46	39.6	39.54
FLOW Worst case (MHz)	3700.38499	3820.251826	3940.206447
FHIGH Worst case (MHz)	3739.84499	3859.851826	3979.746447

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	256QAM
Low channel	3730 MHz
Mid channel	3840 MHz
High channel	3950 MHz

	Low channel	Mid channel	High channel
99 % Bandwidth (MHz)	57.492	57.825	57.779
Plot for 99 % Bandwidth (MHz)	14156-3 BW, 256 QAM, 60MHz, Low Chan	14156-3 BW, 256 QAM, 60MHz, Mid Chan	14156-3 BW, 256 QAM, 60MHz, High Chan
26 dB Bandwidth (MHz)	59.49	59.64	59.66
FLOW Worst case (MHz)	3700.38327	3810.191875	3920.162052
FHIGH Worst case (MHz)	3759.87327	3869.831875	3979.822052

Analyser plots for the 99% & 26dB bandwidth can be found in Section 6 of this report.

LIMITS:
The 26dB bandwidth of the emission must be contained within the designated frequency band.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

5.8 Band edge / spectrum mask additional emissions limitations

5.8.1 Test methods

Test Requirements:	FCC Part 27 Clause 27.53(l) [Reference 4.1.1 of this report]
Test Method:	FCC Part 27 Clause 27.53(l) [Reference 4.1.1 of this report]
	KDB 971168 Clause 6 [Reference 4.1.3 of this report]
	ANSI C63.26 Clause 5.7 [Reference 4.1.4 of this report]
	KDB 662911 Clause E [Reference 4.1.5 of this report]
Limits:	FCC Part 27 Clause 27.53(l) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the External RF ports. The EUT was operated in Modes 1 to 26 for this test.

5.8.3 Test procedure

Tests were made in accordance with the Test Method noted above, using the measuring equipment listed in the 'Test Equipment' Section. A RBW of minimum 1% of EUT BW was used to measure emissions within 1MHz of the band edges, without the need to integrate back to 1MHz, from +1MHz outside the lower and upper band edges measurements are referenced/integrated to 1MHz RBW. All modulation schemes in combination with channel bandwidths and upper and lower channel frequencies were assessed and plotted. (See section 2.4 for mode details). Per KDB 662911, 10Log(4) = +6.02 dB was added to single port results to calculate worst case emissions at band edges with 4 RF ports transmitting.
The EUT was tested in Site N.

5.8.4 Test equipment

E887, E899, E928, F153, F249, H071

See Section 8 for more details

5.8.5 Test results

Temperature of test environment	22°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
Low channel	3720 MHz

Low channel Test Instance modulation	Band edge result Single Port 1 (dBm)	Plot reference Port 1	Band edge result Single Port 1+6.02dB summed (4ports) (dBm)	Single Port 1 (dB) Margin	4 Port (dB) Margin
QPSK	-26.63	P6 QPSK Low Chan 40 MHz PWR	-20.61	-13.63	-7.61
16QAM	-25.19	P6 16 QAM Low Chan 40 MHz PWR	-19.17	-12.19	-6.17
64QAM	-28.29	P6 64 QAM Low Chan 40 MHz PWR	-22.27	-15.29	-9.27
256QAM	-30.28	P6 256 QAM Low Chan 40 MHz PWR	-24.26	-17.28	-11.26

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	40 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
High channel	3960 MHz

High channel Test Instance modulation	Band edge result Single Port 1 (dBm)	Plot reference Port 1	Band edge result Single Port 1+6.02dB summed (4ports) (dBm)	Single Port 1 (dB) Margin	4 Port (dB) Margin
QPSK	-28.23	P6 QPSK High Chan 40 MHz PWR	-22.21	-15.23	-9.21
16QAM	-27.19	P6 16 QAM High Chan 40 MHz PWR	-21.17	-14.19	-8.17
64QAM	-28.47	P6 64 QAM High Chan 40 MHz PWR	-22.45	-15.47	-9.45
256QAM	-30.83	P6 256 QAM High Chan 40 MHz PWR	-24.81	-17.83	-11.81

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
Low channel	3730 MHz

Low channel Test Instance modulation	Band edge result Single Port 1 (dBm)	Plot reference Port 1	Band edge result Single Port 1+6.02dB summed (4ports) (dBm)	Single Port 1 (dB) Margin	4 Port (dB) Margin
QPSK	-21.55	P6 QPSK Low Chan 60 MHz PWR	-15.53	-8.55	-2.53
16QAM	-22.94	P6 16 QAM Low Chan 60 MHz PWR	-16.92	-9.94	-3.92
64QAM	-25.23	P6 64 QAM Low Chan 60 MHz PWR	-19.21	-12.23	-6.21
256QAM	-22.34	P6 256 QAM Low Chan 60 MHz PWR	-16.32	-9.34	-3.32

Band	3700-3980 MHz
Power Level	+33 dBm conducted (set)
Channel Spacing	60 MHz
Mod Scheme	QPSK, 16QAM, 64QAM, 256QAM
High channel	3950 MHz

High channel Test Instance modulation	Band edge result Single Port 1 (dBm)	Plot reference Port 1	Band edge result Single Port 1+6.02dB summed (4ports) (dBm)	Single Port 1 (dB) Margin	4 Port (dB) Margin
QPSK	-24.49	P6 QPSK High Chan 60 MHz PWR	-18.47	-11.49	-5.47
16QAM	-23.06	P6 16 QAM High Chan 60 MHz PWR	-17.04	-10.06	-4.04
64QAM	-26.46	P6 64 QAM High Chan 60 MHz PWR	-20.44	-13.46	-7.44
256QAM	-24.83	P6 256 QAM High Chan 60 MHz PWR	-18.81	-11.83	-5.81

The plots referred to in the above table may be found in section 6.

LIMITS:

For base station operations in the 3700–3980 MHz band, the conducted power of any emission outside the licensee's authorized bandwidth shall not exceed −13 dBm/MHz. This is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: ± 2.8 dB

5.9 Modulation characteristics

PROVIDED: Please see section 2.2 for details of manufacturers declaration on modulations used.

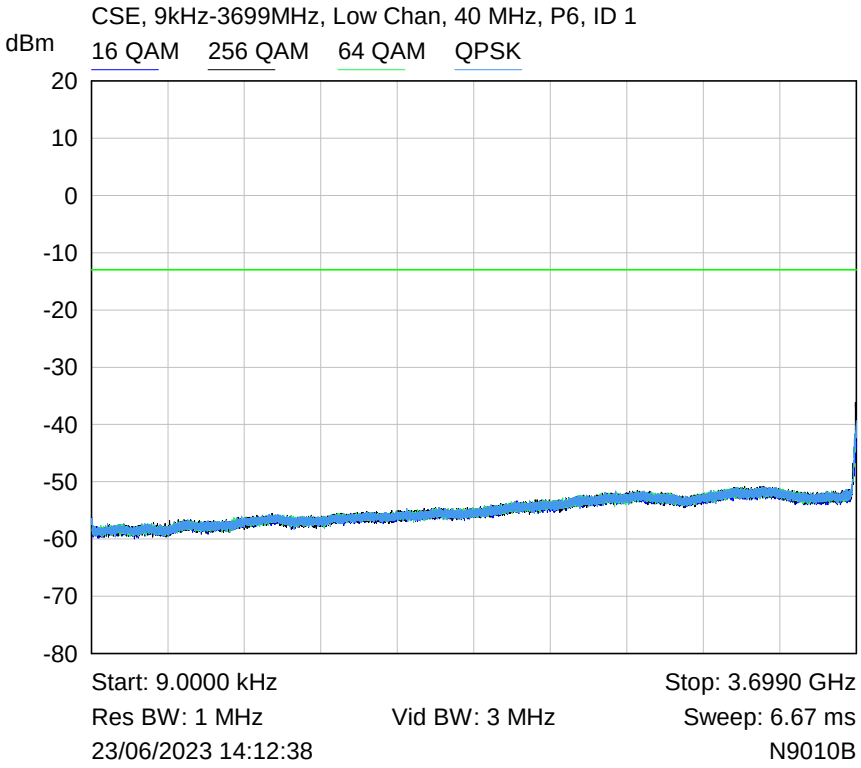
5.10 Adjacent Channel Power

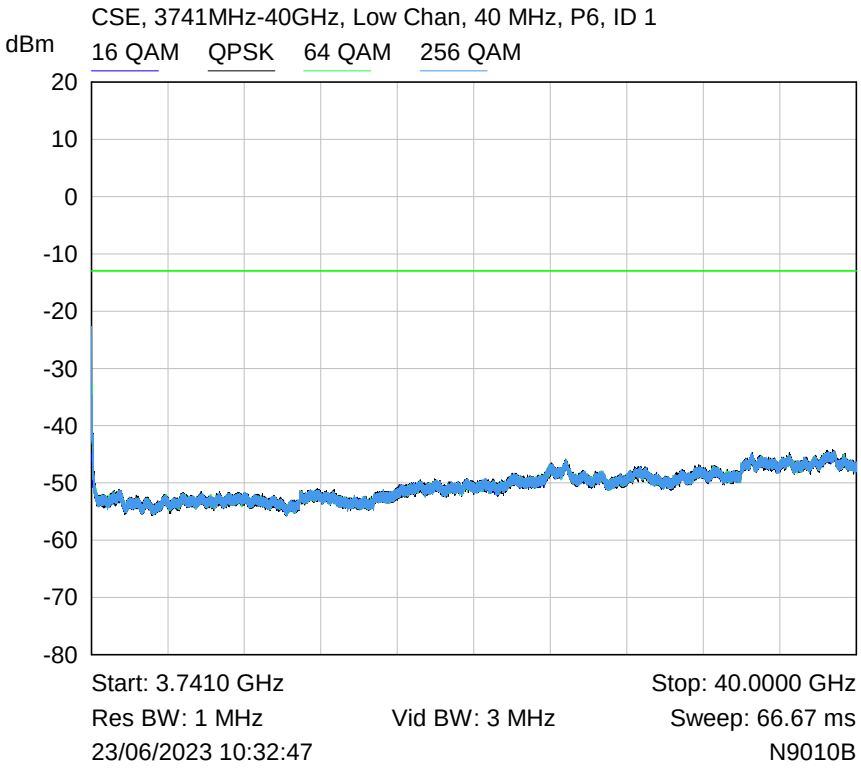
NOT APPLICABLE: Test not applicable to EUT's operating in the 3700-3980 MHz Band.

6 Plots/Graphical results

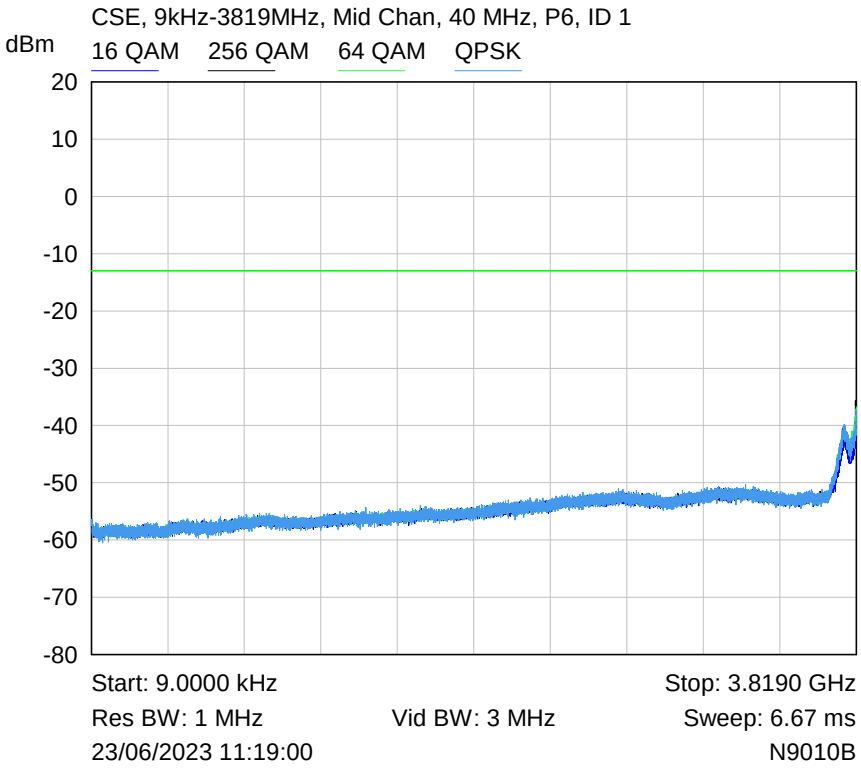
6.1 Spurious emissions at antenna terminals

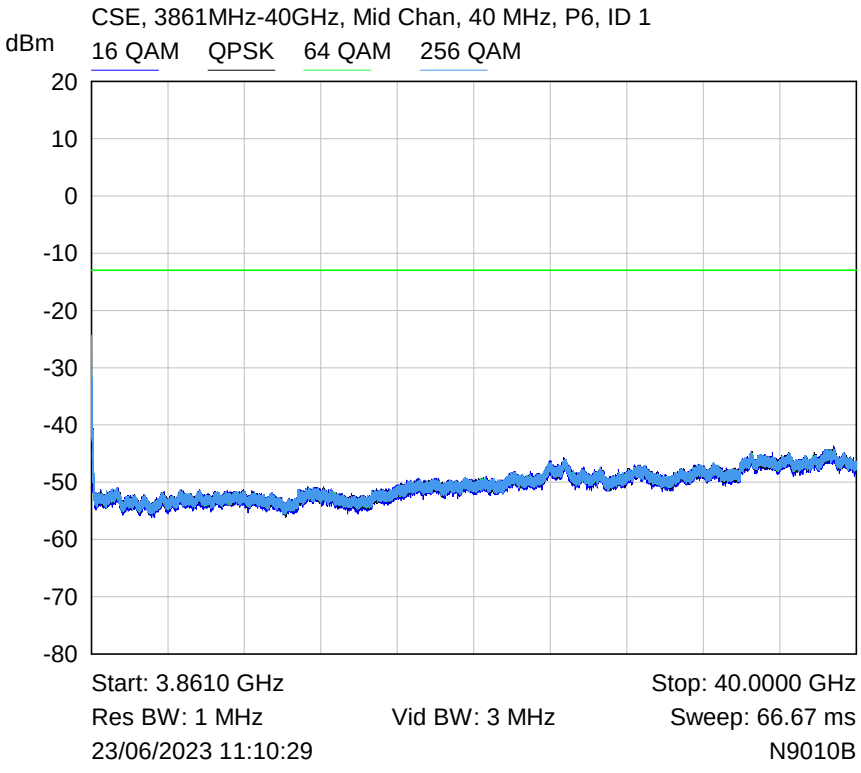
RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 40 MHz



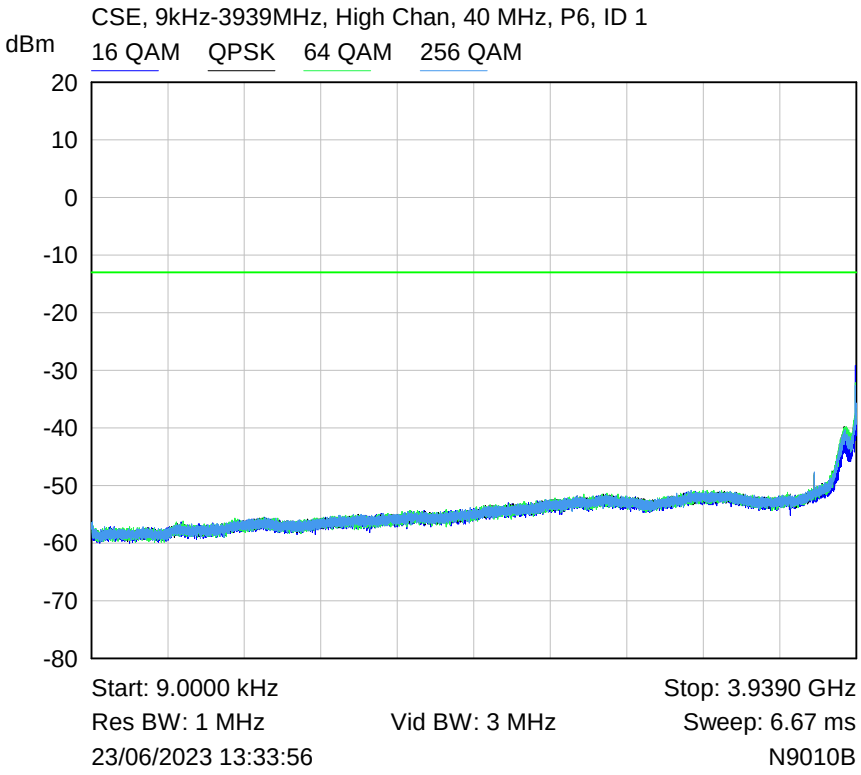


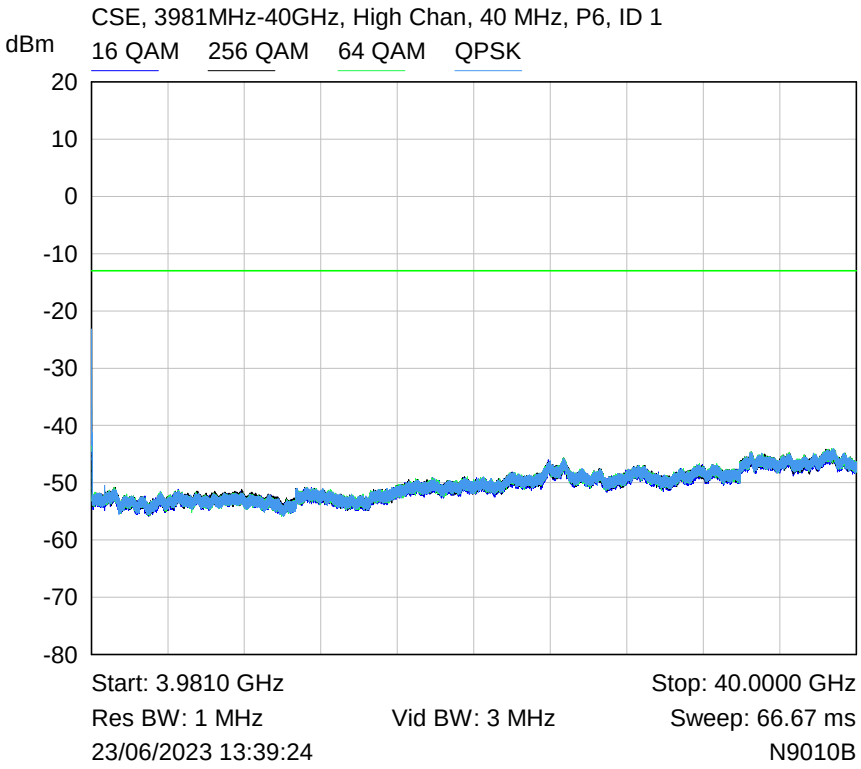
RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 40 MHz



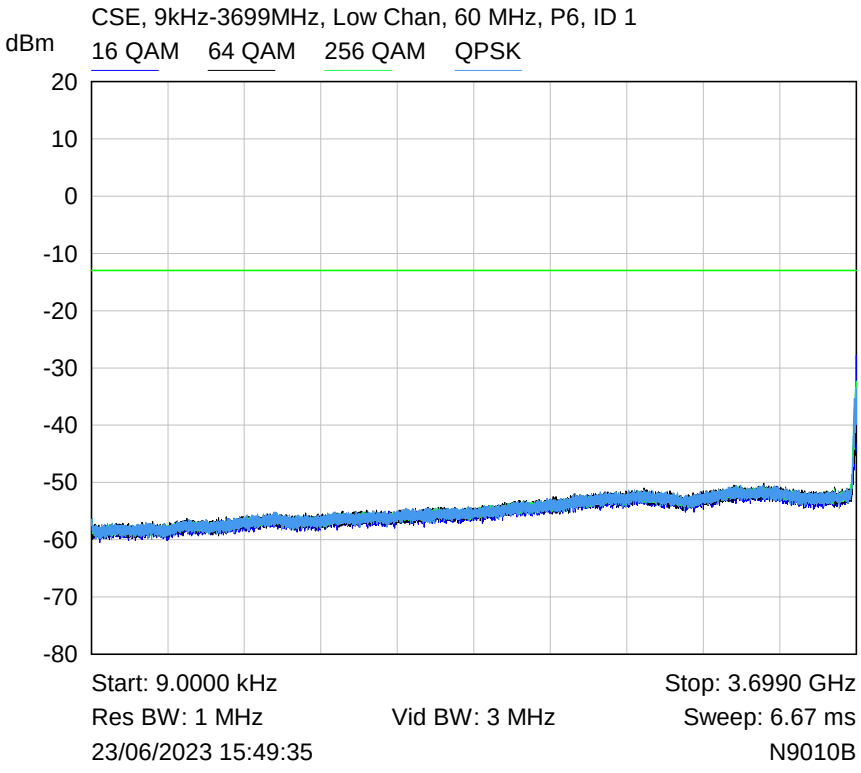


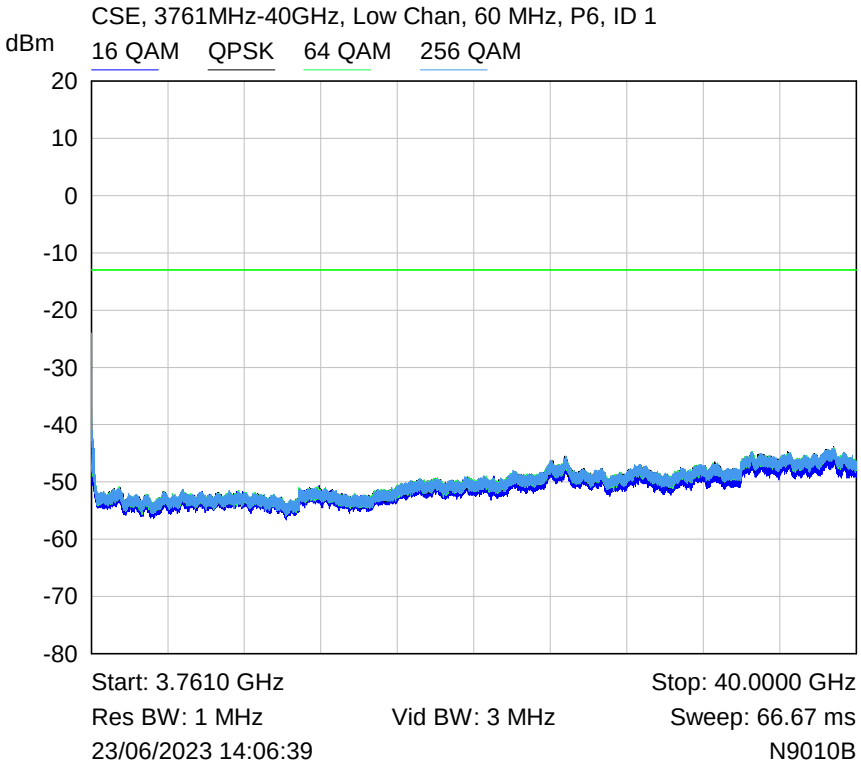
RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 40 MHz



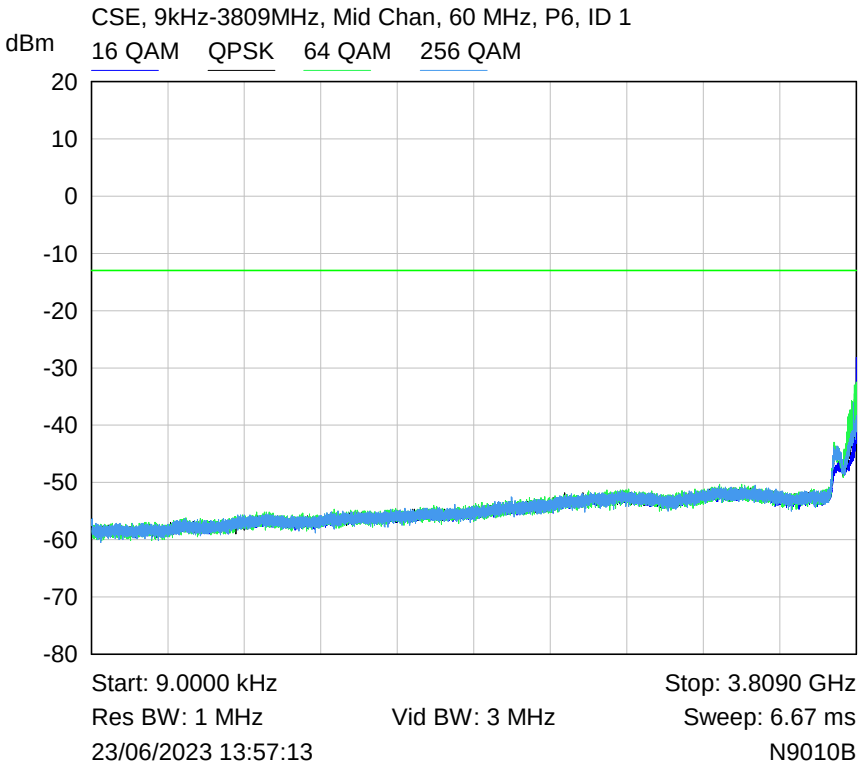


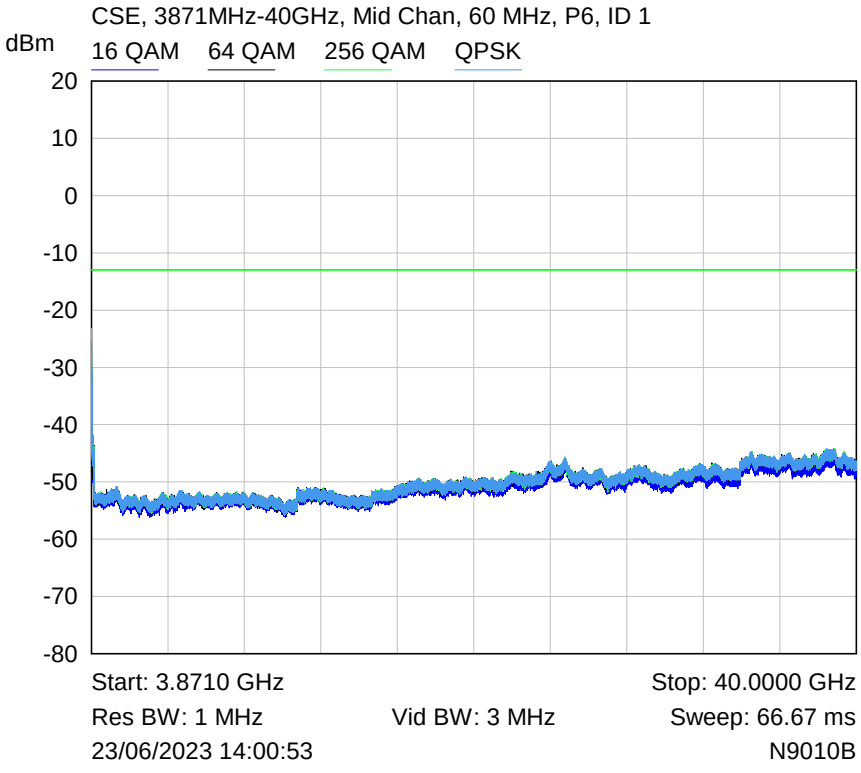
RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 60 MHz



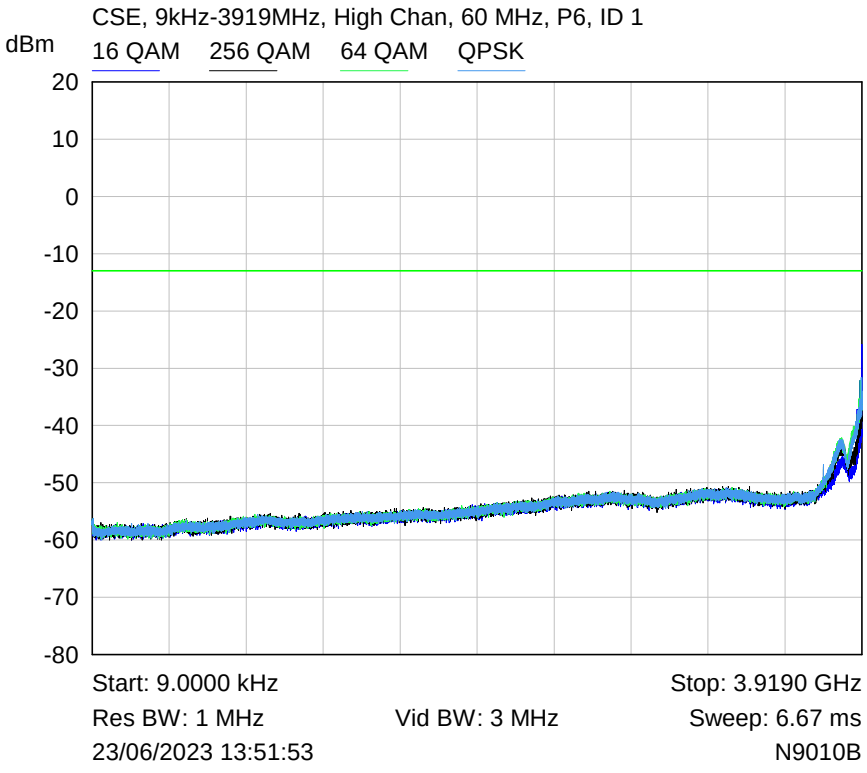


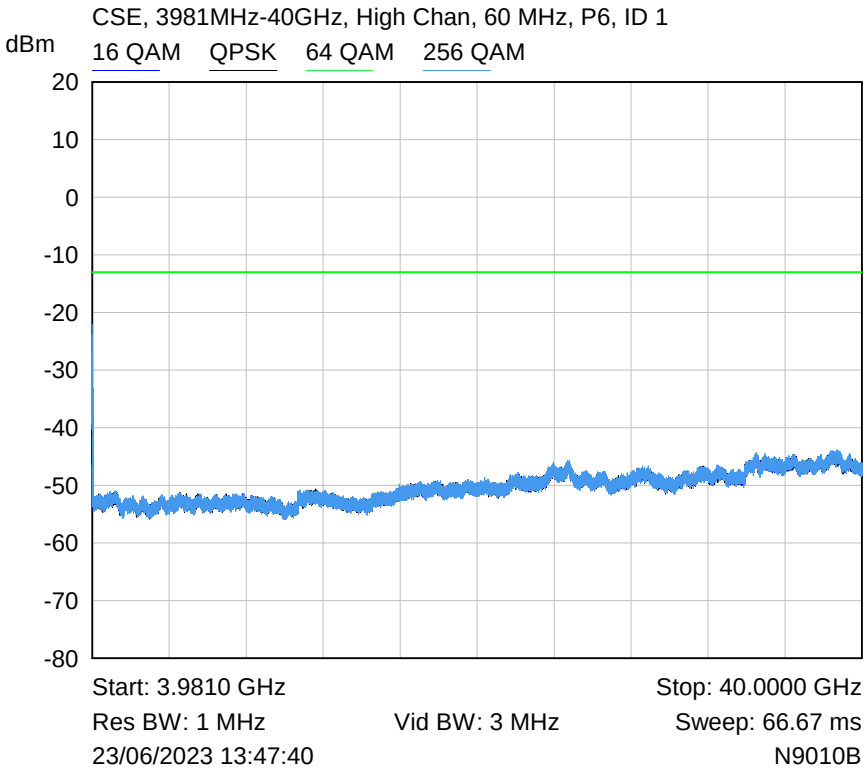
RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 60 MHz





RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 60 MHz





6.2 RF Power Output PAPR

RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 40 MHz, Low Channel

QPSK

16QAM

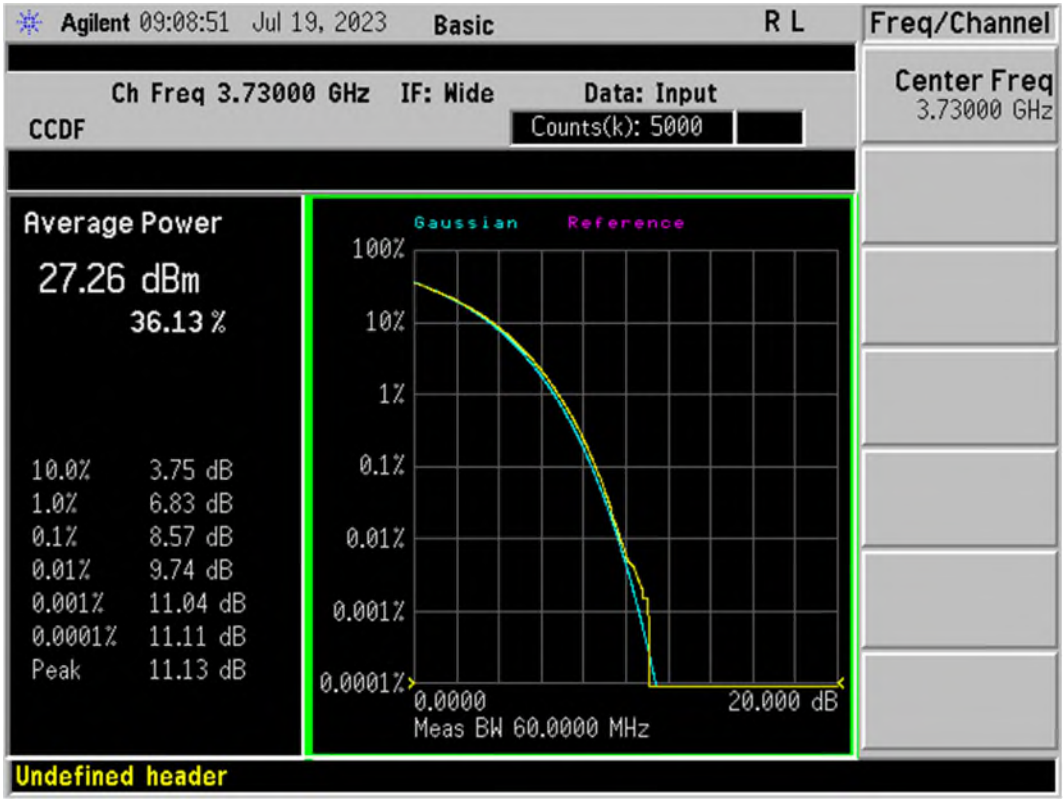
64QAM

256QAM

RF Parameters: RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 60 MHz, Low Channel

QPSK

16QAM



64QAM

256QAM

RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 40 MHz, Mid Channel

QPSK

16QAM

64QAM

256QAM

RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 60 MHz, Mid Channel

QPSK

16QAM

64QAM

256QAM

RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 40 MHz, High Channel

QPSK

16QAM

64QAM

256QAM

RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 60 MHz, High Channel

QPSK

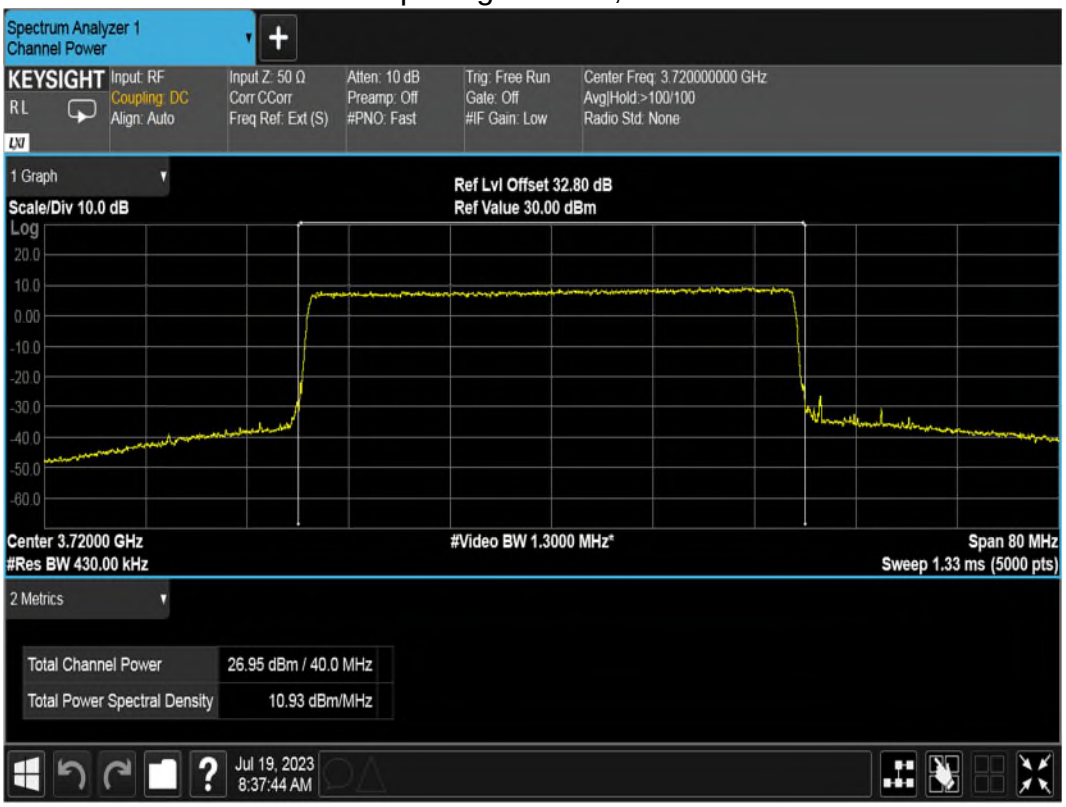
16QAM

64QAM

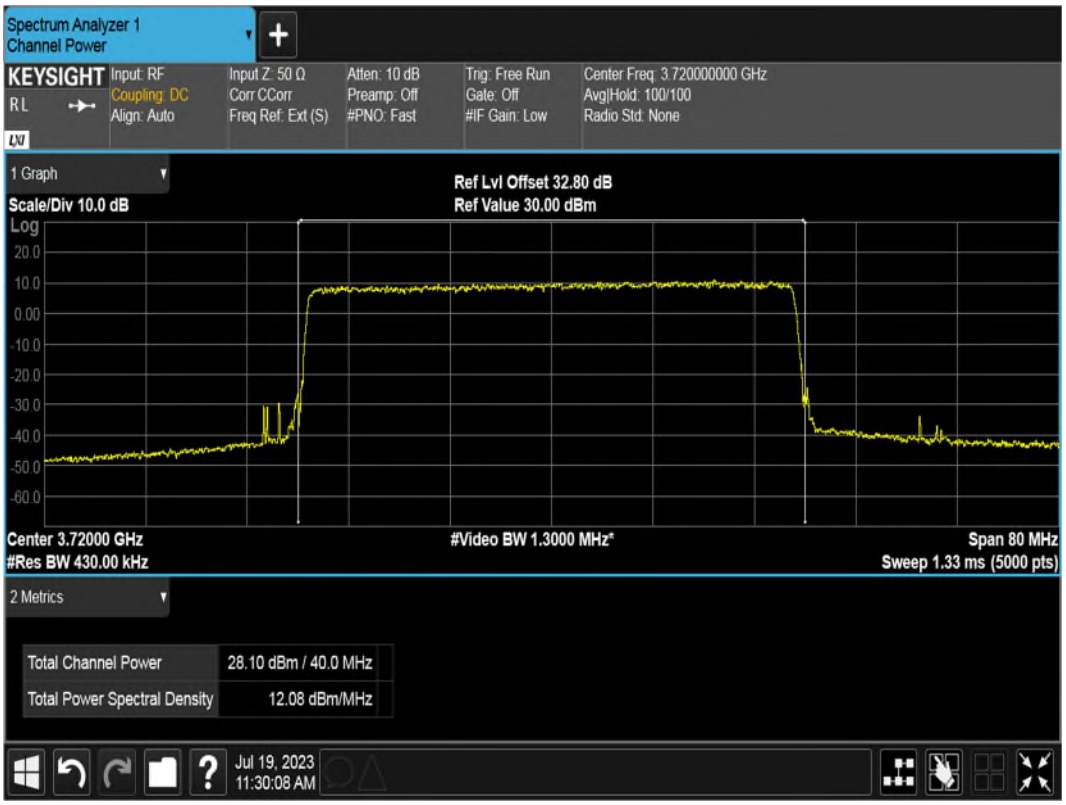
256QAM

6.3 RF Power Output PSD

RF Parameters: RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 40 MHz, Low Channel



QPSK

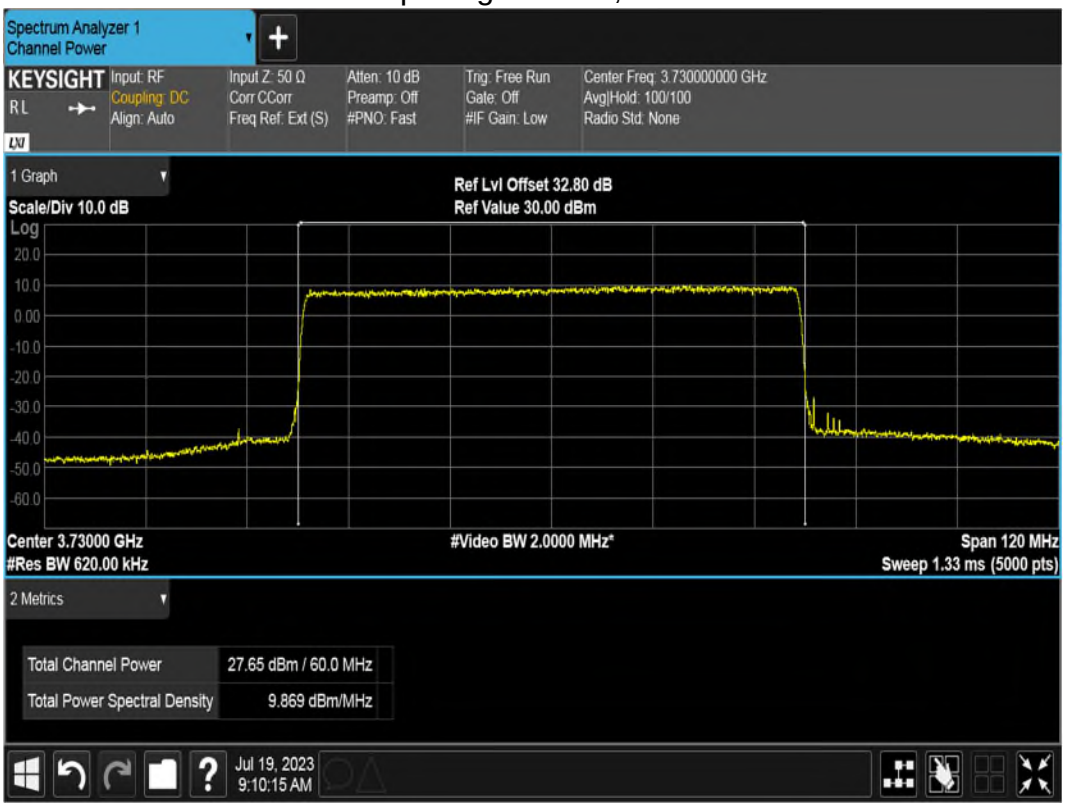


16QAM

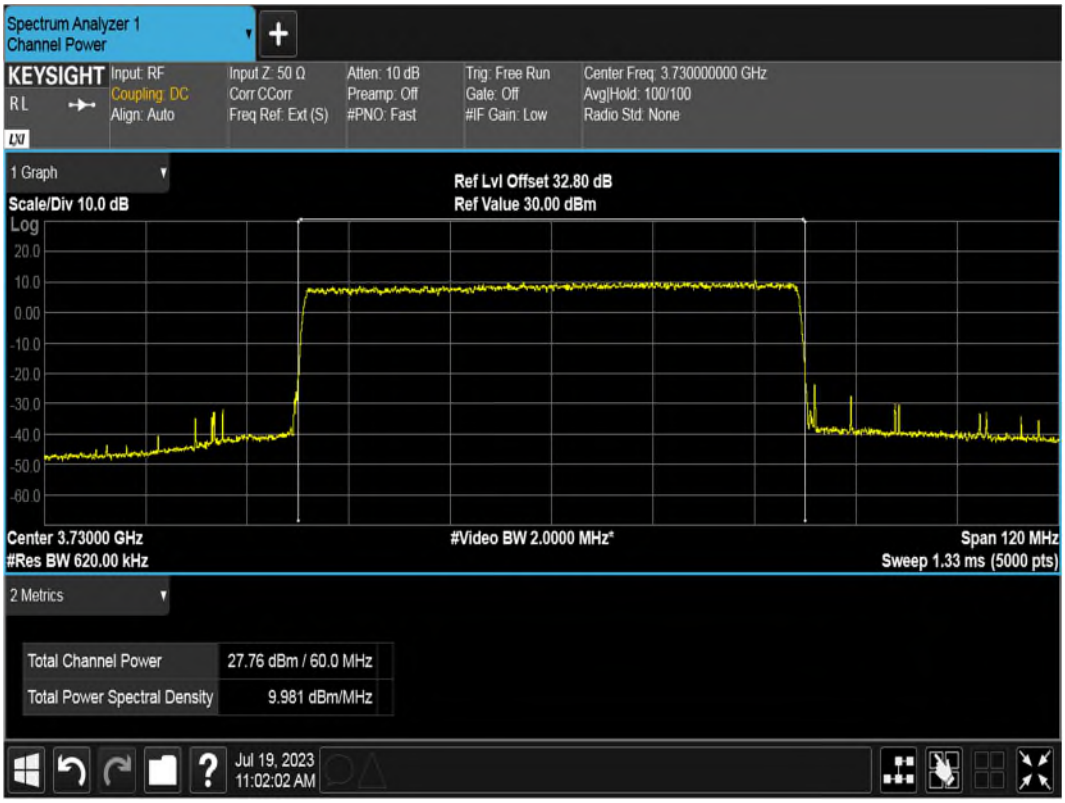
64QAM

256QAM

RF Parameters: RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 60 MHz, Low Channel

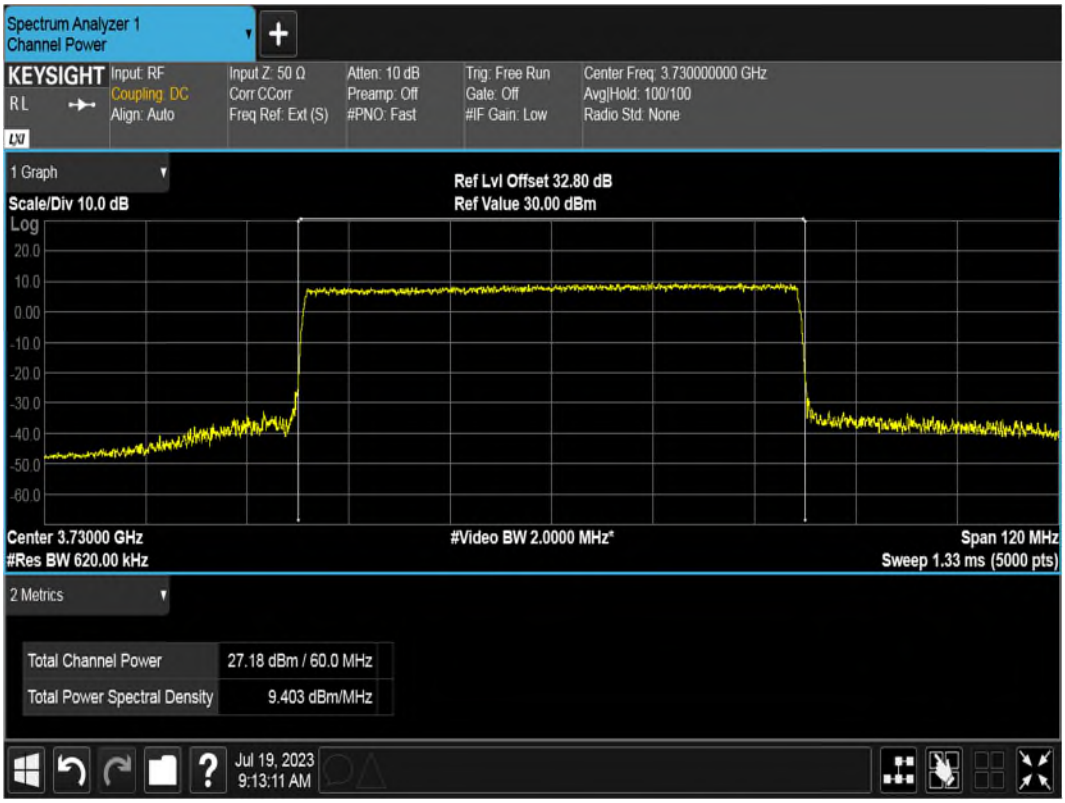


QPSK



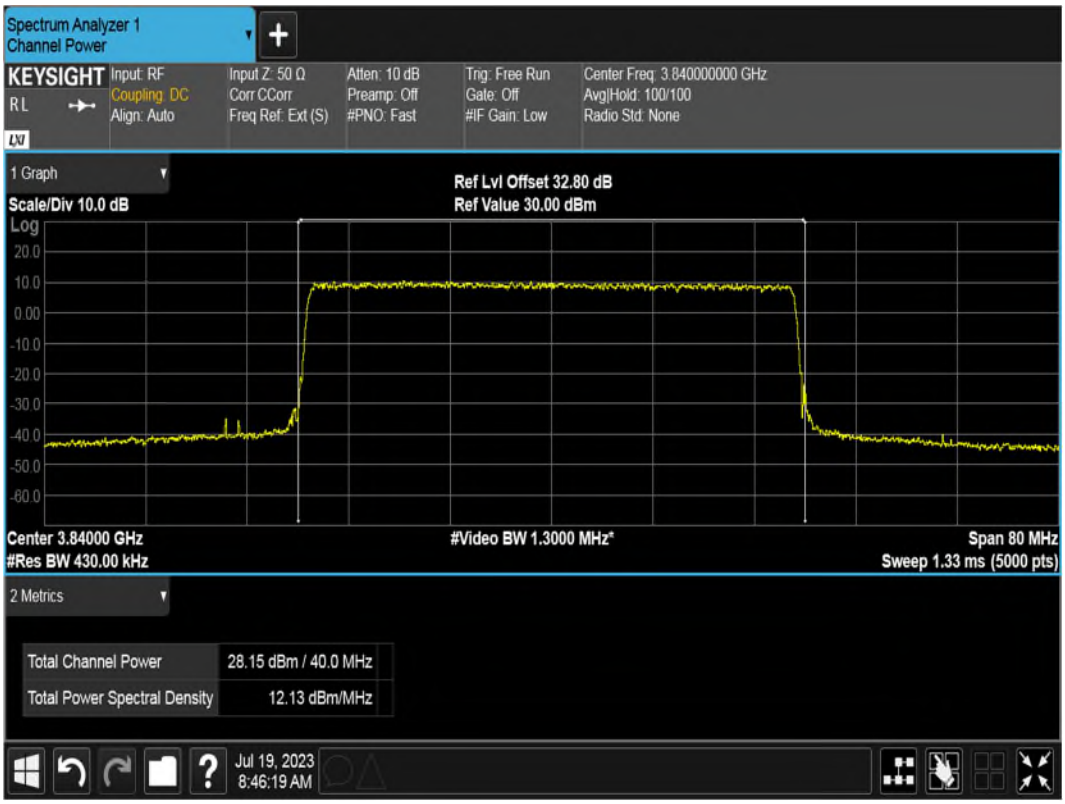
16QAM

64QAM

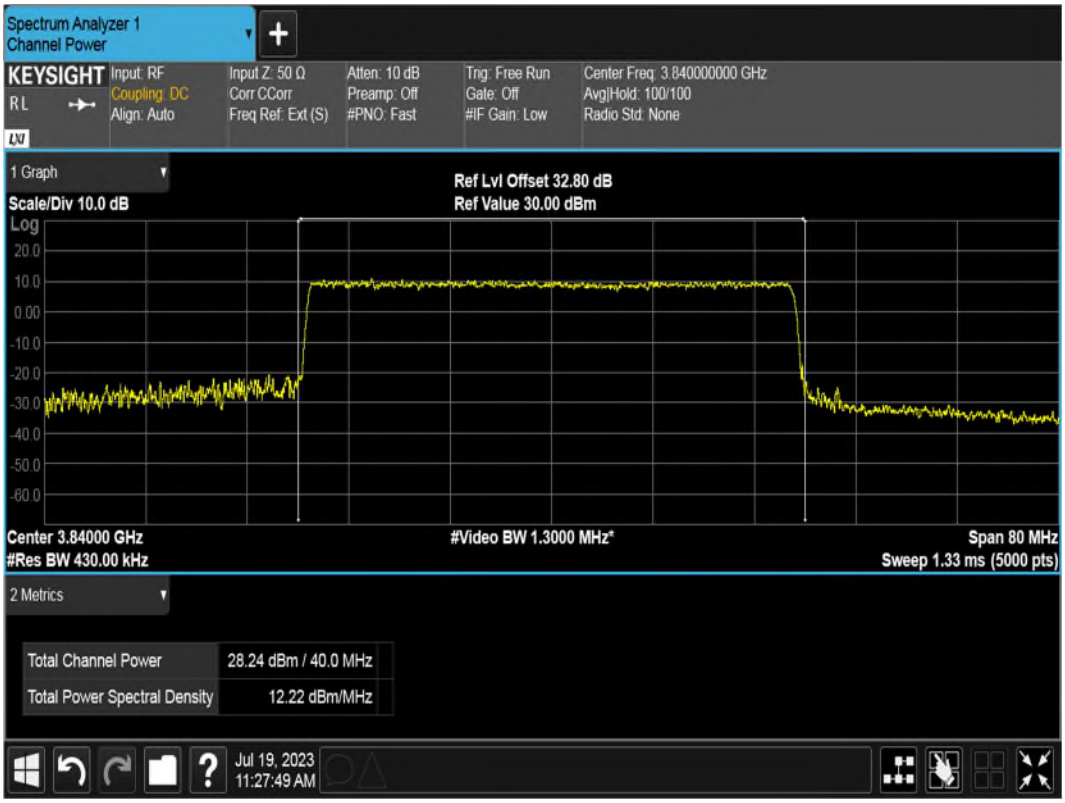


256QAM

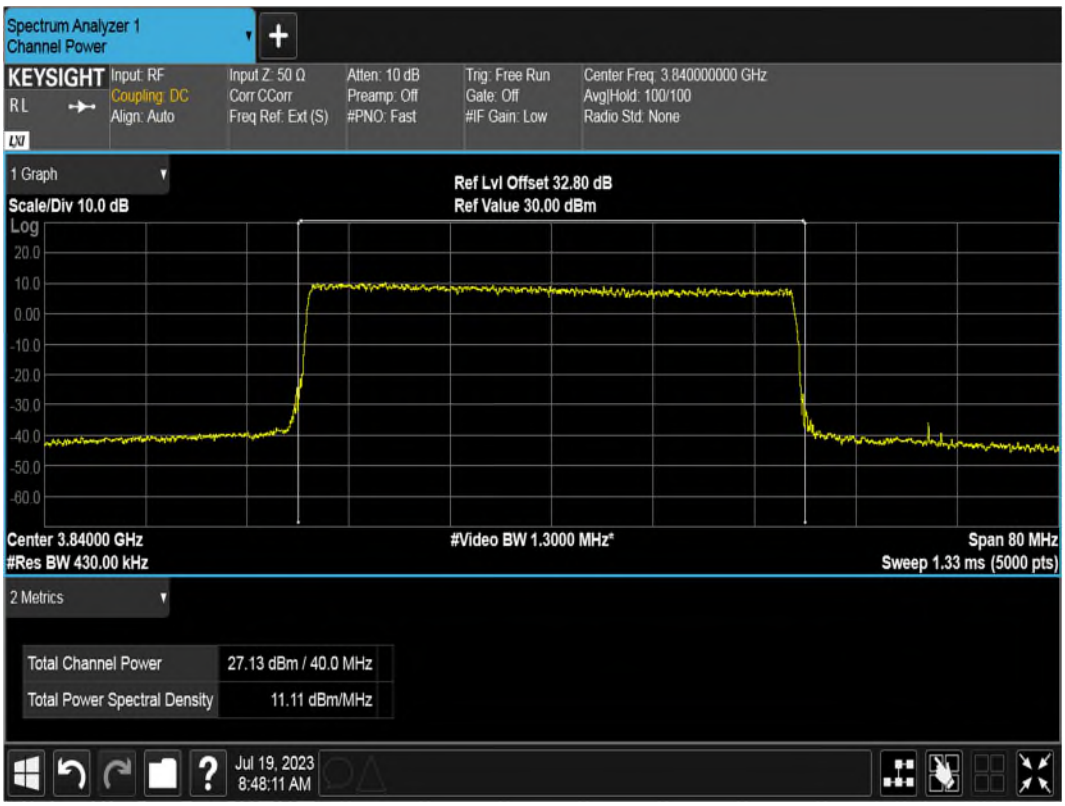
RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 40 MHz, Mid Channel



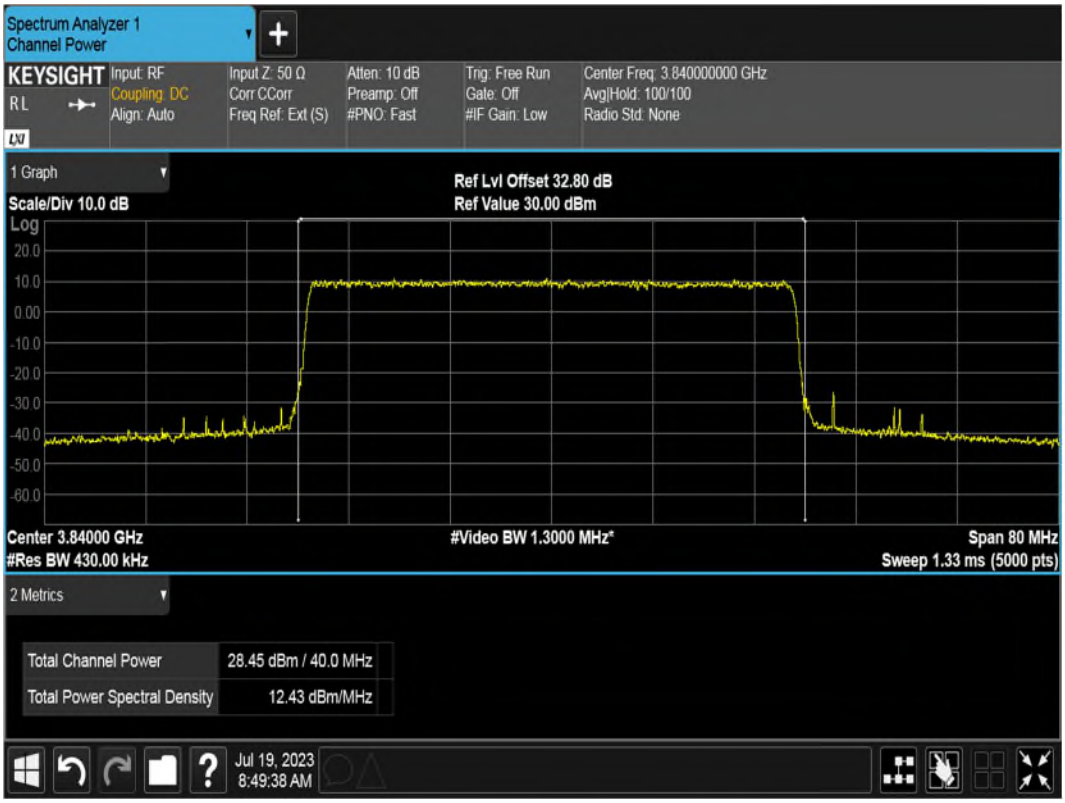
QPSK



16QAM

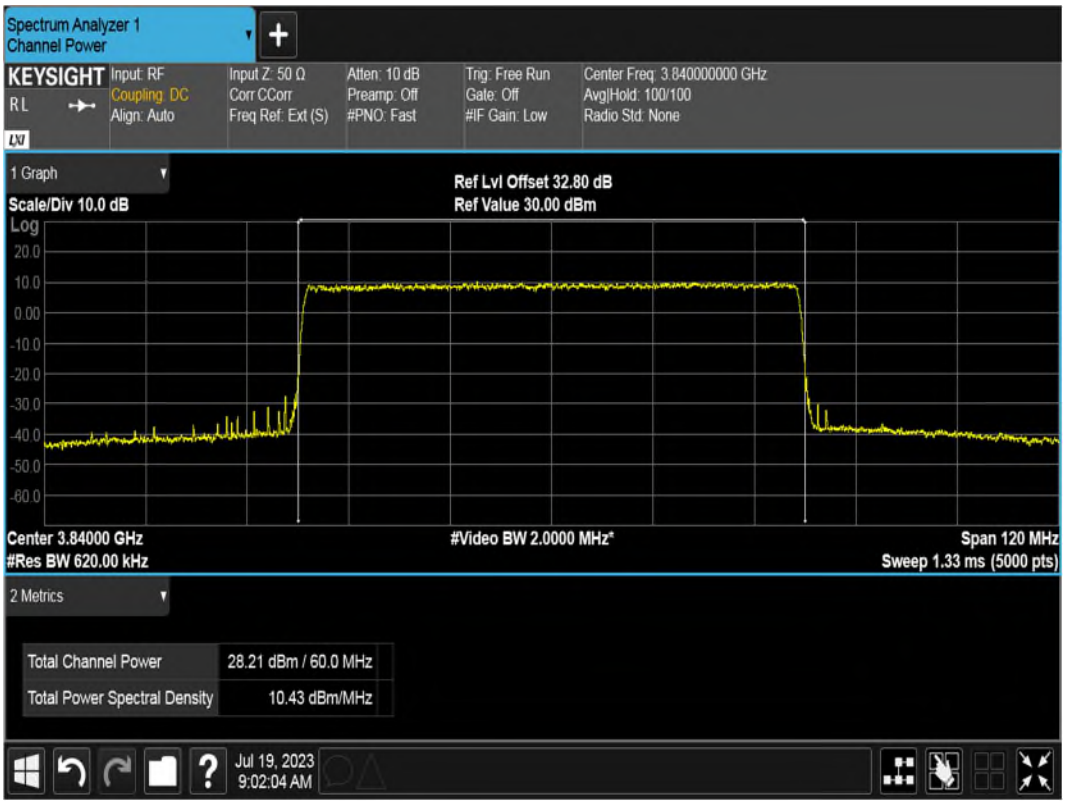


64QAM

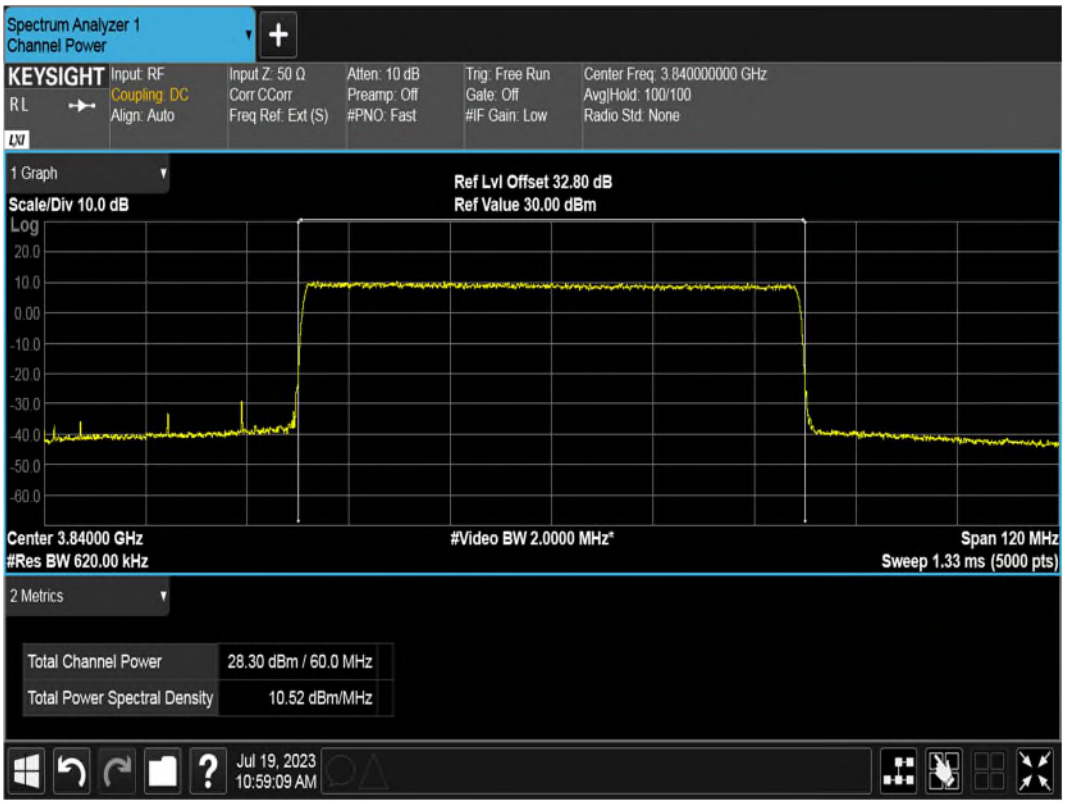


256QAM

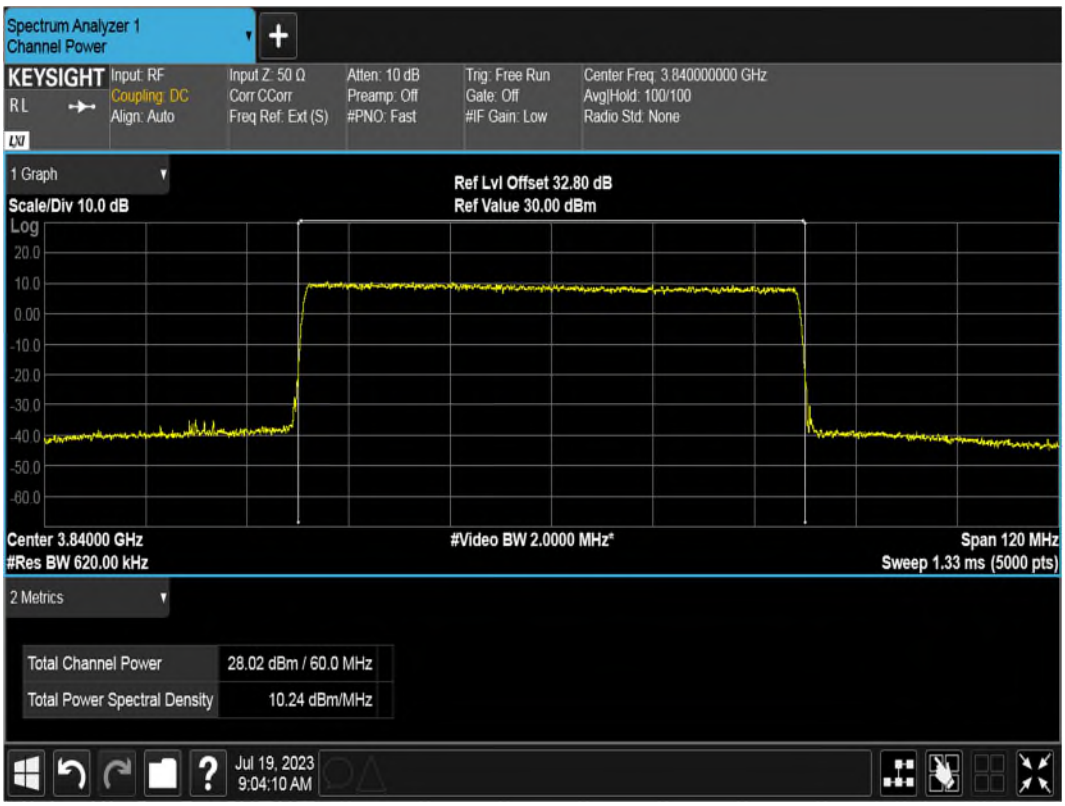
RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 60 MHz, Mid Channel



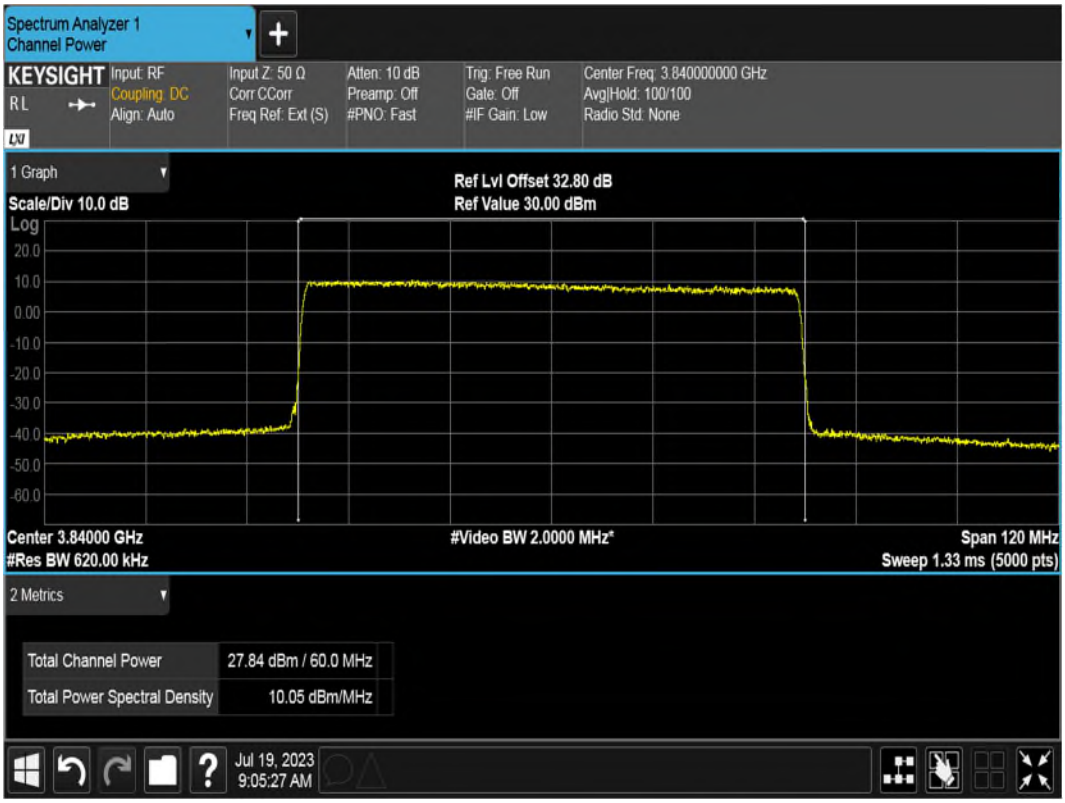
QPSK



16QAM

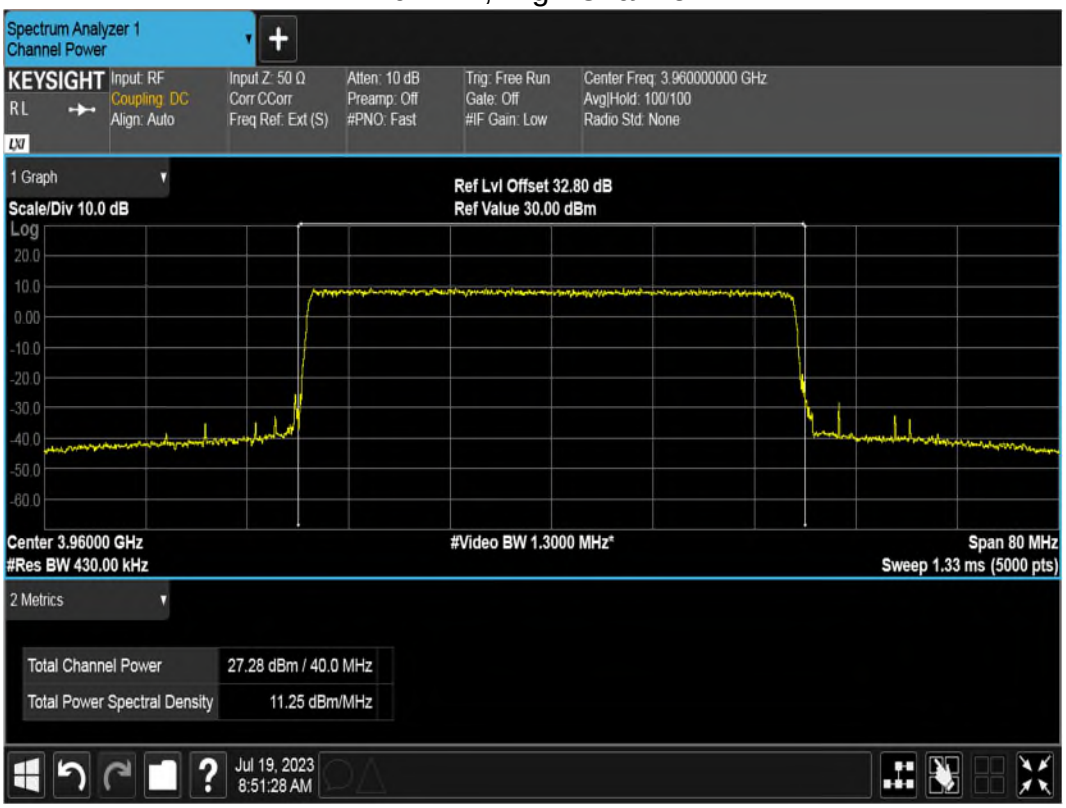


64QAM

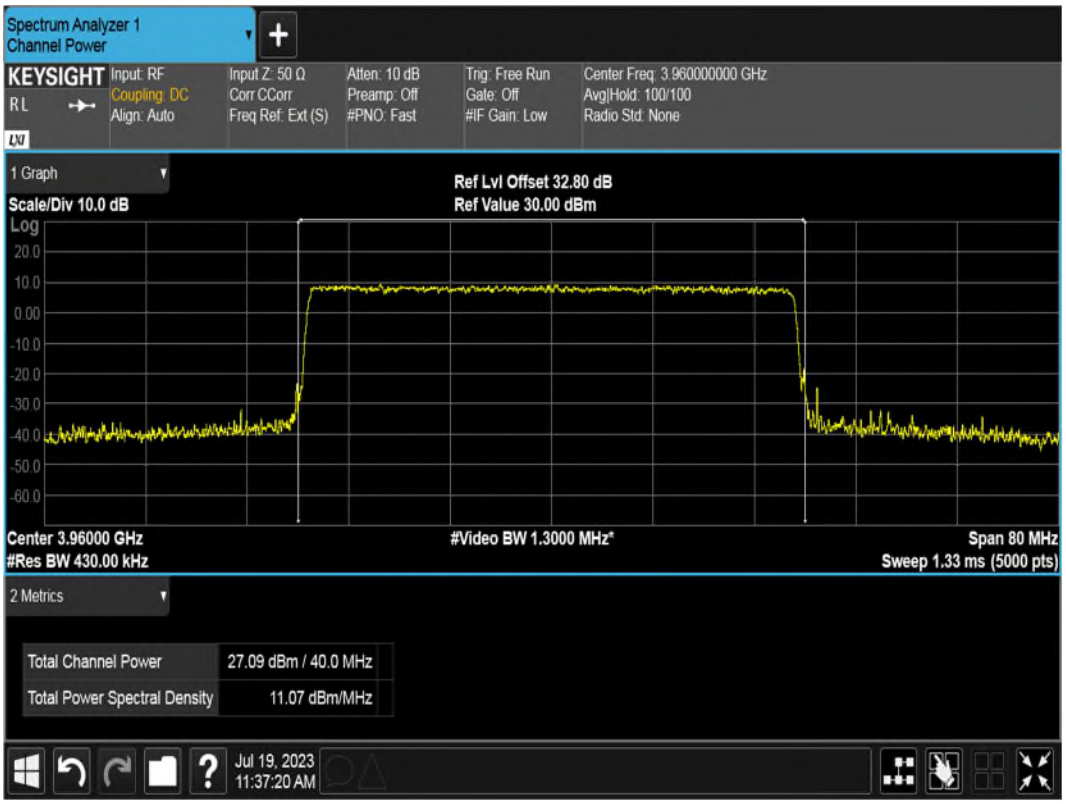


256QAM

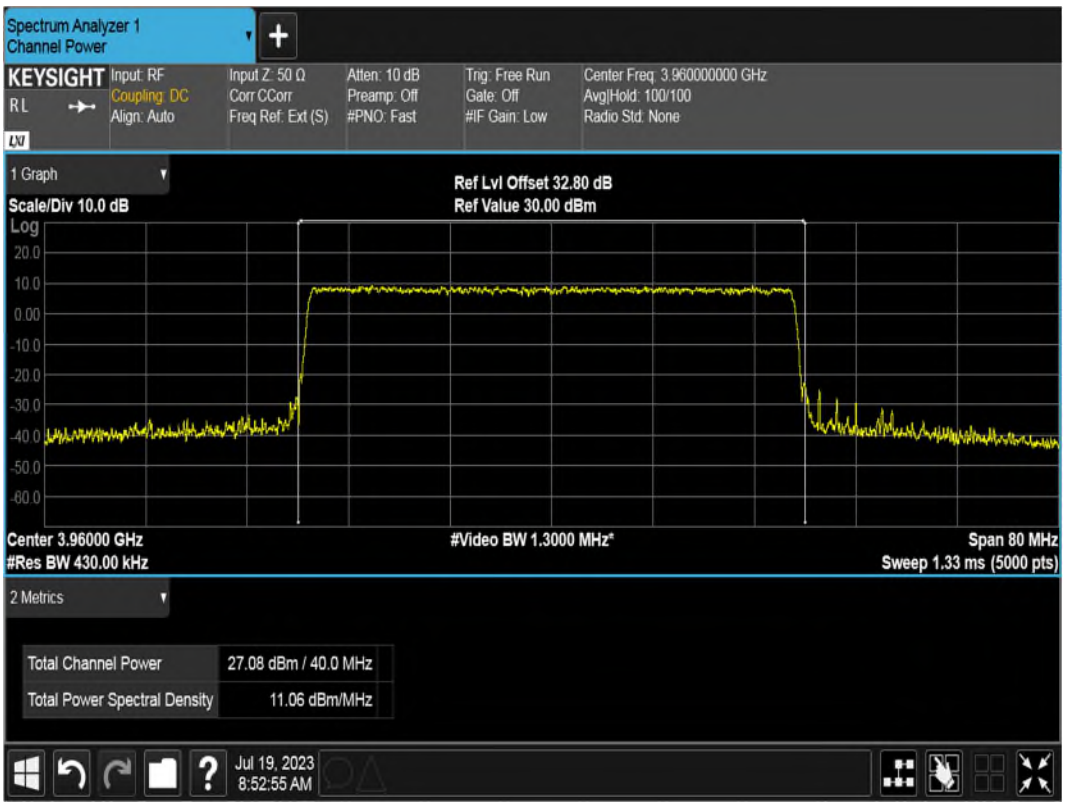
RF Parameters: Band 3700-3980 MHz, Power +33 dBm conducted (set), Channel Spacing 40 MHz, High Channel



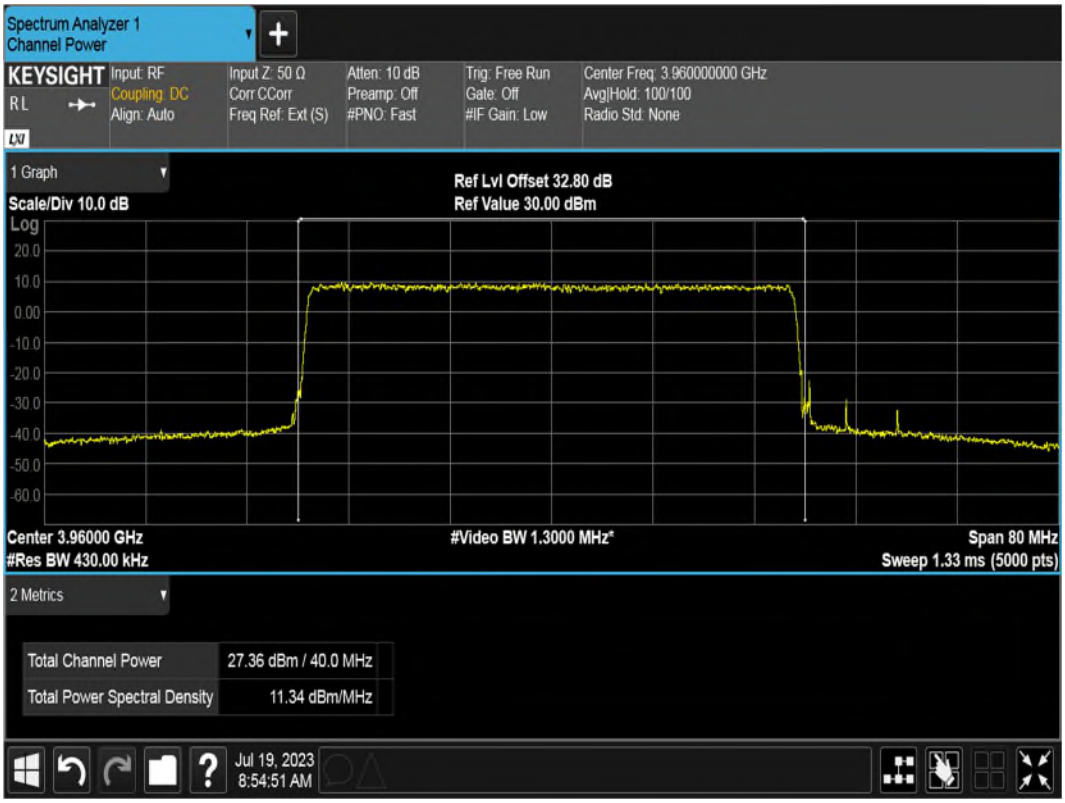
QPSK



16QAM



64QAM



256QAM