2360

Radio Test Report

Cambridge Communication Systems Ltd

Metnet

Metnet V4

47 CFR Part 101C Effective Date 1st October 2015

↳ 47CFR part 2J Effective Date 1st October 2015

TNB: Licensed Non-Broadcast Station Transmitter

Test Date: 21st July 2016 to 2nd August 2016

Report Number: 08-9004-1-16 Issue 02

R.N. Electronics Ltd.
Arnolds Court
Arnolds Farm Lane
Mountnessing
Essex
CM13 1UT
U.K.

www.RNelectronics.com

Telephone: +44 (0) 1277 352219
Email: sales@RNelectronics.com

File Name: Cambridge Communication Systems Ltd.9004-1 Issue 02

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

Certificate of Test 9004-1

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of 47CFR part 101C. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	Metnet
Model Number:	Metnet V4
Unique Serial Number:	002440
Applicant:	Cambridge Communication Systems Ltd 3rd Floor, Mount Pleasant House, Huntingdon Road Cambridge CB3 0RN
Proposed FCC ID	2ACV4-UMBRA28-003
Full measurement results are detailed in Report Number:	08-9004-1-16 Issue 02
Test Standards:	47 CFR Part 101C Effective Date 1st October 2015 ↳ 47CFR part 2J Effective Date 1st October 2015 TNB: Licensed Non-Broadcast Station Transmitter

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: 21st July 2016 to 2nd August 2016

Test Engineer:

Approved By:
Radio Approvals Manager

Digitally signed by: Daniel Sims
DN: CN = Daniel Sims C = GB O = RN Electronics Ltd
Date: 2016.08.19 12:10:37 Z

Customer Representative:

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1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Cambridge Communication Systems Ltd 3rd Floor Mount Pleasant House Huntingdon Road Cambridge CB3 0RN	
Manufacturer of EUT	Cambridge Communication Systems Ltd	
Full Name of EUT	Metnet	
Model Number of EUT	Metnet V4	
Serial Number of EUT	002440	
Date Received	19th July 2016	
Date of Test:	21st July 2016 to 2nd August 2016	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Created	3rd August 2016	
Main Function	24 GHz wireless backhaul	
Information Specification	Height	185 mm
	Width	202 mm
	Depth	202 mm
	Weight	4.2 kg
	Voltage	100-264 V AC
	Current	0.15A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Mounted on lamppost
Choice of model(s) for type tests	Production models
Antenna details	Integral 16 sector antenna. Also external dish antenna option available (high gain node)
Antenna port	WR34
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	26.5 GHz
Lowest Signal generated in EUT	25 MHz
Hardware Version	Metnet V4
Software Version	Not declared
Firmware Version	Not declared
Type of Equipment	Fixed link
Technology Type	Proprietary STDMA multipoint transceiver
Geo-location (yes/no)	Yes
TX Parameters	
Alignment range – transmitter	25.05 GHz to 25.25 GHz
EUT Declared Modulation Parameters	QPSK, 16QAM, 64QAM
EUT Declared Power level	25 dBm (QPSK), 22 dBm (16QAM), 19 dBm (64QAM) all +/-3 dB
EUT Declared Signal Bandwidths	100 MHz and 50 MHz
EUT Declared Channel Spacing's	100 MHz and 50 MHz
EUT Declared Duty Cycle	Not declared
Unmodulated carrier available?	Yes
Declared frequency stability	+/- 2.5 ppm over 20 years

Fixed Link Parameters	
Station Type	RS (nodes are peers that can take on different roles-regard as relay station although a node can act as all three
EqC-PET	T
EqC-SET	HC
EqC-EMO	6
EqC-ChS	100 MHz and 50 MHz
EMO/ChS System Type	Multi rate, multi format
Gross Bit Rate (per Hertz)	4.29
ATPC used	ATPC2
ATPC Power Range	16 dB
ATPC Tolerance	+/- 1 dB
Activation Threshold	-54dBm
Activation/Deactivation Description	ATPC2 is only used to reduce (but never increase) the actual transmit power for individual data links in two circumstances: (1) if the predicted RSSI is above -54 dBm in order to avoid receiver compression and consequent reduction in SNR. The predicted RSSI is based on link attenuation measurements made continuously by the nodes. (2) large networks of nodes are divided into autonomous partitions, on a geographical basis, ideally with high isolation between them. Transmit power may be reduced on particular links to ensure that any interference imposed on adjacent partitions is at an acceptable level. Again, this is automatically determined from the network wide attenuation measurements.
RTPC used	Type 2
RTPC Power Range	16 dB
RTPC Step Size	1 dB
RFC used	Not used
RFC Frequency Range	N/A
RFC Frequency Tolerances	N/A
Frequency Error Long Term (ageing)	+/-2.5 ppm/20 years
Frequency Error Long Term (years)	+/-4.6ppm
TX Frequency Shutdown on loss Synchronisation	TX is disabled if the radio is not locked
Adaptive/Dynamic Modulation Used	The system continually monitors link quality and changes modulation setting for a link based on assessment of FEC iterations and link SNR
TX Burst Timings	Variable

2.3 Functional description

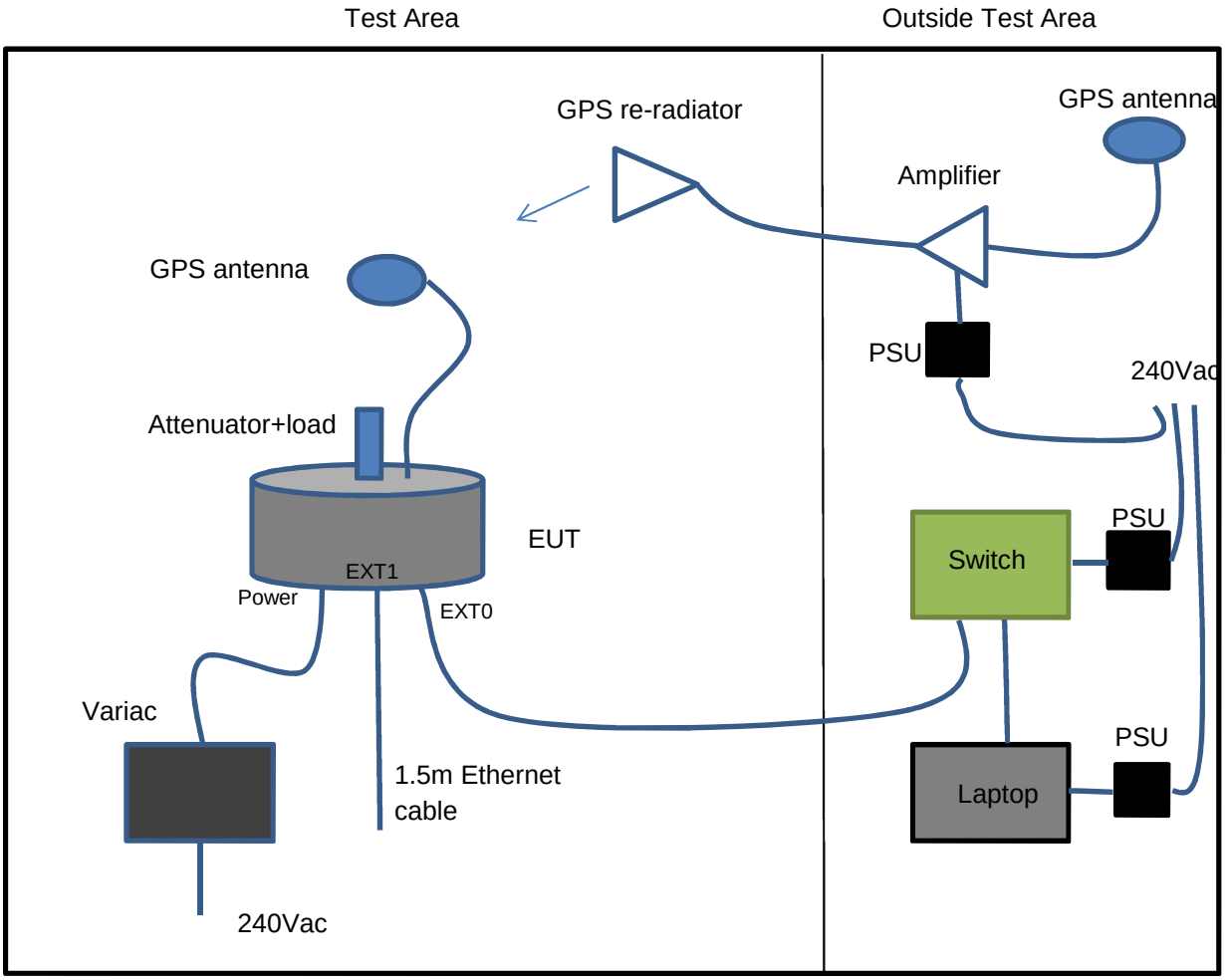
The product is a 24 GHz self-organizing transceiver capable of sustaining simultaneous links with multiple peer nodes to provide wireless backhaul for access equipment such as cellular base stations. The product is designed to be mounted on street furniture such as lampposts to support dense deployments of small cell base stations.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX1	25.075 GHz, 25 dBm, 50 MHz BW, QPSK	Yes
TX2	25.075 GHz, 22 dBm, 50 MHz BW, 16QAM	Yes
TX3	25.075 GHz, 19 dBm, 50 MHz BW, 64QAM	Yes
TX4	25.225 GHz, 25 dBm, 50 MHz BW, QPSK	Yes
TX5	25.225 GHz, 22 dBm, 50 MHz BW, 16QAM	Yes
TX6	25.225 GHz, 19 dBm, 50 MHz BW, 64QAM	Yes
TX7	25.1 GHz, 25 dBm, 100 MHz BW, QPSK	Yes
TX8	25.1 GHz, 22 dBm, 100 MHz BW, 16QAM	Yes
TX9	25.1 GHz, 19 dBm, 100 MHz BW, 64QAM	Yes
TX10	25.2 GHz, 25 dBm, 100 MHz BW, QPSK	Yes
TX11	25.2 GHz, 22 dBm, 100 MHz BW, 16QAM	Yes
TX12	25.2 GHz, 19 dBm, 100 MHz BW, 64QAM	Yes
TX13	CW tone 25.075 GHz (+10 MHz) 10 dBm	Yes
TX14	CW tone 25.225 GHz (+10 MHz) 10 dBm	Yes
TX15	CW tone 25.1 GHz (+10 MHz) 10 dBm	Yes
TX16	CW tone 25.2 GHz (+10 MHz) 10 dBm	Yes
Normal mode	EUT set up in a multi-mesh network communicating with several other nodes using dynamic modulation dependent on link quality	No

Note: No requirement to perform link mode testing in part 101.

2.5 Emissions configuration



The unit was powered from AC mains. All conducted tests were performed at the waveguide port. For radiated tests a transition with an attenuator plus load were fitted to the waveguide port. The unit also required a GPS lock in order for it to operate. To obtain a GPS signal for the unit a second external GPS antenna was connected to an internal GPS re-radiator antenna located in close proximity to the EUT. Special GUI software control was provided by CCS Ltd to access and set up the EUT channel frequency, power level and modulation schemes. The transmit mode was 100% continuous with modulation and the power settings for each channel were as stated below:-

QPSK = 25 dBm
16QAM = 22 dBm
64QAM = 19 dBm

Please refer to section 2.4 for further details of modes of test.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Power	Exterior grade power cable, commercial connector	Yes
EXT0	CAT 5E/RJ45	Yes
EXT1	CAT 5E/RJ45	Yes

3 Summary of test results

The Metnet, Metnet V4 was tested for compliance to the following standard(s) :

47 CFR Part 101C Effective Date 1st October 2015
↳ 47CFR part 2J Effective Date 1st October 2015

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	47CFR part 2J Part 2.1051, 47CFR part 101C Part 101.111	PASSED[1]
2. RF Power Output	47CFR part 2J Part 2.1046, 47CFR part 101C Part 101.113	PASSED
3. Frequency stability	47CFR part 2J Part 2.1055, 47CFR part 101C Part 101.107	PASSED
4. Occupied bandwidth	47CFR part 2J Part 2.1049, 47CFR part 101C Part 101.109	PASSED
5. Field strength of spurious radiations	47CFR part 2J Part 2.1053, 47CFR part 101C Part 101.111	PASSED
6. Band edge / spectrum mask additional emissions limitations	47CFR part 2J Part 2.1051, 47CFR part 101C Part 101.113	PASSED
7. Modulation characteristics	47CFR part 2J Part 2.1047, 47CFR part 101C Part 101.113 & 101.141(a)(1)	PASSED

[1] Spectrum investigated started at a frequency of 17 GHz due to the EUT's WR34 waveguide port low frequency cut off being 17.3 GHz. Please see section 7 calculations / explanations for further justification.

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	47CFR part 101C	2015	Part 101 – Fixed Microwave Services
4.1.2	47CFR part 2J	2015	Part 2 – Frequency Allocations and radio treaty matters; General rules and regulations
4.1.3	KDB 971168 D01 v02r02	2014	Measurement Guidance for Certification of Licensed Digital Transmitters
4.1.4	ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
4.1.5	ITU-R SM.329-12	2012	Unwanted emissions in the spurious domain
4.1.6	TIA-603-D	2010	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards, Telecommunications Industry Association, June 2010

4.2 Deviations

No deviations have been 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	110V AC
T minimum	-30 °C	V minimum	93.5V AC
T maximum	50 °C	V maximum	126.5V AC

Extremes of voltage are based on nominal +/-15%.

Extremes of temperature are based upon specification requirement.

The ambient test conditions of humidity and pressure in the laboratory were as follows:

68 %; 102 kPa.

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 equipment internal waveguide port was used for testing.

5 Tests, methods and results

5.1 Spurious emissions at antenna terminals

5.1.1 Test methods

Test Requirements:	47CFR part 2J Part 2.1051 [Reference 4.1.2 of this report], 47CFR part 101C Part 101.111 [Reference 4.1.1 of this report]
Test Method:	KDB 971168 D01 v02r02 [Reference 4.1.3 of this report], ITU-R SM.329-12 [Reference 4.1.5 of this report]
Limits:	47CFR part 101C Part 101.111 [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 waveguide port. All test modes specified in section 2.4 were initially checked; QPSK modulation scheme using both 50MHz and 100MHz bandwidth settings were found to be worst case for emissions and, therefore, the EUT was operated in TX1, TX4, TX7 and TX10 modes for this test.

5.1.3 Test procedure

Tests were made in accordance with the Test Method noted above, using the measuring equipment listed in the 'Test Equipment' Section. A complete scan of emissions from 17GHz up to 100GHz was made, to identify any signals within 20dB of the limits. The 17GHz start frequency was used as the EUT's WR34 waveguide ports lowest cut-off frequency is stated as 17.3GHz. Any identified spurious signals were measured in the required bandwidths using an RMS detector. Emissions limitations of part 101C for conducted spectrum mask requirements are included within section 5.6 of this report.

The EUT was tested in Site A.

5.1.4 Test equipment

E296-2, E296-4, E296-5, E296-6, E329, E412, E455, E486, E550, E602, E456, E632, E291-2, E485, E487, E562,

See Section 9 for more details

5.1.5 Test results

Temperature of test environment	24°C
Humidity of test environment	52%
Pressure of test environment	102kPa

Setup Table

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	50 MHz
Mod Scheme	QPSK
Low channel	25.075 GHz
High channel	25.225 GHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
No spurious emissions found within 20 dB of limits		

Setup Table

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	25.1 GHz
High channel	25.2 GHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)
No spurious emissions found within 20 dB of limits		

Plots
9004-1 25.1 GHz, 100 MHz BW, QPSK 17-19 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 19-23 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 23-26.5 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 26.5-30 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 30-34 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 34-38 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 38-40 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 40-44 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 44-48 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 48-52 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 52-56 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 56-60 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 60-64 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 64-68 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 68-72 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 72-75 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 75-79 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 79-83 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 83-87 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 87-91 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 91-95 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 95-99 GHz
9004-1 25.1 GHz, 100 MHz BW, QPSK 99-100 GHz

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 sections 5.6 and 5.7. Whilst all channels have been fully tested, only 25.1 GHz channel plots across the entire spectrum are shown within this report to minimise report size.

LIMITS:
Part 101.111, -13dBm

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

5.2 RF Power Output

5.2.1 Test methods

Test Requirements: 47CFR part 2J Part 2.1046 [Reference 4.1.2 of this report],
47CFR part 101C Part 101.113 [Reference 4.1.1 of this report]

Test Method: KDB 971168 D01 v02r02 [Reference 4.1.3 of this report],
TIA-603-D [Reference 4.1.6 of this report]

Limits: 47CFR part 101C Part 101.113 [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

The EUT was measured on a bench using a power meter connected to the external waveguide port. The EUT was operated in all modes listed in section 2.4. Covering all bandwidths, modulation schemes and channel settings.

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. Power meter reading stated is maximum power observed using an average power head.

Measurements were made on a test bench in site A.

5.2.4 Test equipment

E291-2, E632, E555

See Section 9 for more details

5.2.5 Test results

Temperature of test environment 25°C
Humidity of test environment 45%
Pressure of test environment 102kPa

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	50 MHz
Mod Scheme	QPSK
Low channel	25.075 GHz
High channel	25.225 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	24.30	24.20
Maximum TX Power observed (dBm)		24.30	24.20
Variation in TX power observed to Declared power (dB)		-0.7 / -0.7	-0.8 / -0.8

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	25.1 GHz
High channel	25.2 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	24.20	24.10
Maximum TX Power observed (dBm)		24.20	24.10
Variation in TX power observed to Declared power (dB)		-0.8 / -0.8	-0.9 / -0.9

Band	25.05-25.25 GHz
Power Level	22 dBm
Channel Spacing	50 MHz
Mod Scheme	16QAM
Low channel	25.075 GHz
High channel	25.225 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	21.80	21.60
Maximum TX Power observed (dBm)		21.80	21.60
Variation in TX power observed to Declared power (dB)		-0.2 / -0.2	-0.4 / -0.4

Band	25.05-25.25 GHz
Power Level	22 dBm
Channel Spacing	100 MHz
Mod Scheme	16QAM
Low channel	25.1 GHz
High channel	25.2 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	21.60	21.50
Maximum TX Power observed (dBm)		21.60	21.50
Variation in TX power observed to Declared power (dB)		-0.4 / -0.4	-0.5 / -0.5

Band	25.05-25.25 GHz
Power Level	19 dBm
Channel Spacing	50 MHz
Mod Scheme	64QAM
Low channel	25.075 GHz
High channel	25.225 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	19.10	18.90
Maximum TX Power observed (dBm)		19.10	18.90
Variation in TX power observed to Declared power (dB)		0.1 / 0.1	-0.1 / -0.1

Band	25.05-25.25 GHz
Power Level	19 dBm
Channel Spacing	100 MHz
Mod Scheme	64QAM
Low channel	25.1 GHz
High channel	25.2 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	18.90	18.80
Maximum TX Power observed (dBm)		18.90	18.80
Variation in TX power observed to Declared power (dB)		-0.1 / -0.1	-0.2 / -0.2

LIMITS:
Part 101.113, +55dBW

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 Frequency stability

5.3.1 Test methods

Test Requirements: 47CFR part 2J Part 2.1055 [Reference 4.1.2 of this report],
47CFR part 101C Part 101.107 [Reference 4.1.1 of this report]

Test Method: KDB 971168 D01 v02r02 [Reference 4.1.3 of this report],
TIA-603-D [Reference 4.1.6 of this report]

Limits: 47CFR part 101C Part 101.107 [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was placed in a temperature controlled chamber. The EUT emissions were observed by means of connection to the waveguide port. The EUT was operated in TX13 - TX16 modes for this test.

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. Temperature stability was achieved at each test level before taking measurements. The measurement was performed on a CW signal with a 10 MHz tone offset, which was accounted for in the measurement results. Frequency error is referenced to the channel frequency.

Tests were performed using Test Site A.

5.3.4 Test equipment

E434, E498, E555, E642, L264, TMS38, TMS57

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	20°C
Humidity of test environment	68%
Pressure of test environment	102kPa

Band	25.05-25.25 GHz
Power Level	10 dBm
Channel Spacing	50 MHz
Mod Scheme	CW tone
Low channel	25.075 GHz
High channel	25.225 GHz

Test conditions		Frequency Reading (MHz) Low	Frequency Reading (MHz) High
-30°C	Volts Nominal (110)	-0.000340	-0.000410
-20°C	Volts Nominal (110)	-0.000470	-0.000470
-10°C	Volts Nominal (110)	-0.000410	-0.000470
0°C	Volts Nominal (110)	-0.000220	-0.000280
10°C	Volts Nominal (110)	-0.000220	-0.000280
20°C	Volts Minimum (93.5)	-0.000220	-0.000220
	Volts Nominal (110)	-0.000160	-0.000280
	Volts Maximum (126.5)	-0.000160	-0.000220
30°C	Volts Nominal (110)	-0.000280	-0.000280
40°C	Volts Nominal (110)	-0.000220	-0.000280
50°C	Volts Nominal (110)	-0.000280	-0.000160
Max Frequency Error per chan (Hz)		+ 0 / -470	+0 / -470
Max Frequency Error observed (MHz)		-0.000470	-0.000470

Band	25.05-25.25 GHz
Power Level	10 dBm
Channel Spacing	100 MHz
Mod Scheme	CW tone
Low channel	25.1 GHz
High channel	25.2 GHz

Test conditions		Frequency Reading (MHz) Low	Frequency Reading (MHz) High
-30°C	Volts Nominal (110)	-0.000160	-0.000220
-20°C	Volts Nominal (110)	-0.000280	-0.000220
-10°C	Volts Nominal (110)	-0.000280	-0.000220
0°C	Volts Nominal (110)	-0.000280	-0.000280
10°C	Volts Nominal (110)	-0.000220	-0.000220
20°C	Volts Minimum (93.5)	-0.000220	-0.000160
	Volts Nominal (110)	-0.000220	-0.000220
	Volts Maximum (126.5)	-0.000220	-0.000220
30°C	Volts Nominal (110)	-0.000220	-0.000160
40°C	Volts Nominal (110)	-0.000280	-0.000220
50°C	Volts Nominal (110)	-0.000220	-0.000220
Max Frequency Error per chan (Hz)		+ 0 / -280	+ 0 / -280
Max Frequency Error observed (MHz)		-0.000280	-0.000280

Maximum variation observed was 0.00000187%

LIMITS:
Part 101.107, +/-0.001%

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

5.4 Occupied bandwidth

5.4.1 Test methods

Test Requirements:	47CFR part 2J Part 2.1049 [Reference 4.1.2 of this report], 47CFR part 101C Part 101.109 [Reference 4.1.1 of this report]
Test Method:	KDB 971168 D01 v02r02 [Reference 4.1.3 of this report], TIA-603-D [Reference 4.1.6 of this report]
Limits:	47CFR part 101C Part 101.109 [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was tested on a bench. The EUT was operated in TX1 - TX12 modes.

5.4.3 Test procedure

Tests were performed using Test Site A. Tests were made in accordance with the Test Method noted above using the measuring equipment noted in the 'Test Equipment' Section. A 2 MHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 99% bandwidth. The EUT was set to each Bandwidth/mod scheme in turn (see section 2.4) and 99% bandwidth recorded.

5.4.4 Test equipment

E624, E301, E252

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	25°C
Humidity of test environment	54%
Pressure of test environment	102kPa

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	50 MHz
Mod Scheme	QPSK
Low channel	25.075 GHz
High channel	25.225 GHz

	Low	High
99% Bandwidth (MHz)	46.5105	46.4744
Plot reference	9004-1 25.075 GHz, 50 MHz BW, QPSK	9004-1 25.225 GHz, 50 MHz BW, QPSK

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	25.1 GHz
High channel	25.2 GHz

	Low	High
99% Bandwidth (MHz)	92.0396	92.1804
Plot reference	9004-1 25.1 GHz, 100 MHz BW, QPSK	9004-1 25.2 GHz, 100 MHz BW, QPSK

Band	25.05-25.25 GHz
Power Level	22 dBm
Channel Spacing	50 MHz
Mod Scheme	16QAM
Low channel	25.075 GHz
High channel	25.225 GHz

	Low	High
99% Bandwidth (MHz)	46.1437	46.1998
Plot reference	9004-1 25.075 GHz, 50 MHz BW, 16QAM	9004-1 25.225 GHz, 50 MHz BW, 16QAM

Band	25.05-25.25 GHz
Power Level	22 dBm
Channel Spacing	100 MHz
Mod Scheme	16QAM
Low channel	25.1 GHz
High channel	25.2 GHz

	Low	High
99% Bandwidth (MHz)	91.7831	92.005
Plot reference	9004-1 25.1 GHz, 100 MHz BW, 16QAM	9004-1 25.2 GHz, 100 MHz BW, 16QAM

Band	25.05-25.25 GHz
Power Level	19 dBm
Channel Spacing	50 MHz
Mod Scheme	64QAM
Low channel	25.075 GHz
High channel	25.225 GHz

	Low	High
99% Bandwidth (MHz)	46.0844	46.2981
Plot reference	9004-1 25.075 GHz, 50 MHz BW, 64QAM	9004-1 25.225 GHz, 50 MHz BW, 64QAM

Band	25.05-25.25 GHz
Power Level	19 dBm
Channel Spacing	100 MHz
Mod Scheme	64QAM
Low channel	25.1 GHz
High channel	25.2 GHz

	Low	High
99% Bandwidth (MHz)	91.6915	91.695
Plot reference	9004-1 25.1 GHz, 100 MHz BW, 64QAM	9004-1 25.2 GHz, 100 MHz BW, 64QAM

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

LIMITS:
Part 101.109: 40 MHz[7] (band 24.25 – 25.25 GHz)

[7] For channel block assignments in the 24,250-25,250 MHz and 38,600-40,000 MHz bands, the authorized bandwidth is equivalent to an unpaired channel block assignment or to either half of a symmetrical paired channel block assignment. When adjacent channels are aggregated, equipment is permitted to operate over the full channel block aggregation without restriction.

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 %

5.5 Field strength of spurious radiations

5.5.1 Test methods

Test Requirements:	47CFR part 2J Part 2.1053 [Reference 4.1.2 of this report], 47CFR part 101C Part 101.111 [Reference 4.1.1 of this report]
Test Method:	KDB 971168 D01 v02r02 [Reference 4.1.3 of this report], TIA-603-D [Reference 4.1.6 of this report]
Limits:	47CFR part 101C Part 101.111 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was tested in an ALSE and ambient conditions were monitored. The EUT was examined in its declared normal use position. All test modes specified in section 2.4 were initially checked; QPSK modulation scheme using 50 MHz or 100MHz was found to be worst case for emissions and, therefore, the EUT was operated in TX1, TX4, TX7 and TX10 modes for this test.

5.5.3 Test procedure

Tests were made in accordance with the Test Method noted above, using the measuring equipment listed in the 'Test Equipment' Section. Peak field strength from the EUT was maximised by rotating it 360 degrees. An RMS detector was used for final measurements.

25MHz - 1GHz.
The measuring antenna was scanned 1 - 4m in both Horizontal and Vertical polarisations. Substitution method was performed using tuned dipoles / a calibrated bi-conical antenna. Measurement distance of 3metres was used.
1GHz – 100GHz.
The measuring antenna was used in both Horizontal and Vertical polarisations. Substitution method was performed using standard gain horn antennas. Measurement distances used were: 1 – 6 GHz at 3metres, 6 – 18 GHz at 1.2metres, 18 – 75 GHz at 0.3metres, & 75 – 100 GHz at 0.1metres.

The EUT was tested in Site B.

5.5.4 Test equipment

E268, E296-2, E296-4, E296-5, E296-6, E327, E329, E330, E331, E412, E428, E453, E456, E503, E562, E579, E580, E602, TMS78, TMS79, E289, E454, E455

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	18-20°C
Humidity of test environment	60-63%
Pressure of test environment	102kPa

Setup Table

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	50 MHz
Mod Scheme	QPSK
Low channel	25.075 GHz
High channel	25.225 GHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No spurious emissions found within 20 dB of limits				

File Name: Cambridge Communication Systems Ltd.9004-1 Issue 02

Setup Table

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	25.1 GHz
High channel	25.2 GHz

Spurious Frequency (MHz)	Measured Spurious Level (dBm)	Difference to Limit (dB)	Antenna Polarisation	EUT Polarisation
No spurious emissions found within 20 dB of limits				

No spurious emissions found within 20dB of limits for any of the channel frequencies, in combination with the channel bandwidths & modulation schemes.

LIMITS:
Part 101.111, -13dBm

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:
25MHz - 1GHz ± 3.9 dB, 1 – 18 GHz ±3.5dB, 18 – 26.5 GHz ±3.9dB, 26.5 – 60 GHz ±3.9dB, 60 – 110 GHz ±4.4dB

5.6 Band edge / spectrum mask additional emissions limitations

5.6.1 Test methods

Test Requirements:	47CFR part 2J Part 2.1051 [Reference 4.1.2 of this report], 47CFR part 101C Part 101.113 [Reference 4.1.1 of this report]
Test Method:	KDB 971168 D01 v02r02 [Reference 4.1.3 of this report], TIA-603-D [Reference 4.1.6 of this report]
Limits:	47CFR part 101C Part 101.111 [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was operated on a test bench. Measurements were made at the waveguide port. The EUT was operated in TX1 - TX12 modes 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. A 1 MHz RBW, 3x VBW, auto sweep time and max hold settings were used to show the band edge. All modulation schemes / rates in combination with channel bandwidths and upper and lower channel frequencies were assessed and plotted. (See section 2.4 for modes details).

The EUT was tested in Site A.

5.6.4 Test equipment

E412, E301, E252

See Section 9 for more details

5.6.5 Test results

Temperature of test environment	24°C
Humidity of test environment	55%
Pressure of test environment	102kPa

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	50 MHz
Mod Scheme	QPSK
Low channel	25.075 GHz
High channel	25.225 GHz

	Low	High
Nominal, Maximised RF Output / field strength	25 dBm	25 dBm
Nominal plot reference	9004-1 25.075 GHz, 50 MHz BW, QPSK	9004-1 25.225 GHz, 50 MHz BW, QPSK

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	25.1 GHz
High channel	25.2 GHz

	Low	High
Nominal, Maximised RF Output / field strength	25 dBm	25 dBm
Nominal plot reference	9004-1 25.1 GHz, 100 MHz BW, QPSK	9004-1 25.2 GHz, 100 MHz BW, QPSK

Band	25.05-25.25 GHz
Power Level	22 dBm
Channel Spacing	50 MHz
Mod Scheme	16QAM
Low channel	25.075 GHz
High channel	25.225 GHz

	Low	High
Nominal, Maximised RF Output / field strength	22 dBm	22 dBm
Nominal plot reference	9004-1 25.075 GHz, 50 MHz BW, 16QAM	9004-1 25.225 GHz, 50 MHz BW, 16QAM

Band	25.05-25.25 GHz
Power Level	22 dBm
Channel Spacing	100 MHz
Mod Scheme	16QAM
Low channel	25.1 GHz
High channel	25.2 GHz

	Low	High
Nominal, Maximised RF Output / field strength	22 dBm	22 dBm
Nominal plot reference	9004-1 25.1 GHz, 100 MHz BW, 16QAM	9004-1 25.2 GHz, 100 MHz BW, 16QAM

Band	25.05-25.25 GHz
Power Level	19 dBm
Channel Spacing	50 MHz
Mod Scheme	64QAM
Low channel	25.075 GHz
High channel	25.225 GHz

	Low	High
Nominal, Maximised RF Output / field strength	19 dBm	19 dBm
Nominal plot reference	9004-1 25.075 GHz, 50 MHz BW, 64QAM	9004-1 25.225 GHz, 50 MHz BW, 64QAM

Band	25.05-25.25 GHz
Power Level	19 dBm
Channel Spacing	100 MHz
Mod Scheme	64QAM
Low channel	25.1 GHz
High channel	25.2 GHz

	Low	High
Nominal, Maximised RF Output / field strength	19 dBm	19 dBm
Nominal plot reference	9004-1 25.1 GHz, 100 MHz BW, 64QAM	9004-1 25.2 GHz, 100 MHz BW, 64QAM

Analyser plots for the bandwidth masks can be found in Section 6 of this report.

LIMITS:
Part 101.111, mask calculation to (a)(2)(ii).

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:
<± 4.1 dB

5.7 Modulation characteristics

5.7.1 Test methods

Test Requirements:	47CFR part 2J Part 2.1047 [Reference 4.1.2 of this report], 47CFR part 101C Part 101.113 & 101.141 [Reference 4.1.1 of this report]
Test Method:	KDB 971168 D01 v02r02 [Reference 4.1.3 of this report], TIA-603-D [Reference 4.1.6 of this report]
Limits:	47CFR part 101C Part 101.109 & 101.141 [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 waveguide port. The EUT was operated in TX1 - TX12 modes for this test.

5.7.3 Test procedure

Tests were made in accordance with the Test Method noted above, using the measuring equipment listed in the 'Test Equipment' Section. A 2 MHz RBW, 3x VBW, auto sweep time and max hold settings were used to show the modulation characteristics. All modulation schemes / rates in combination with channel bandwidths and Low and High channel frequencies were assessed and plotted. (See section 2.4 for modes details).

The EUT was tested in Site A.

5.7.4 Test equipment

E412, E301, E252

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	24°C
Humidity of test environment	55%
Pressure of test environment	102kPa

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	50 MHz
Mod Scheme	QPSK
Low channel	25.075 GHz
High channel	25.225 GHz

	Low	High
Nominal, Maximised RF Output / field strength	25 dBm	25 dBm
Nominal plot reference	9004-1 25.075 GHz, 50 MHz BW, QPSK	9004-1 25.225 GHz, 50 MHz BW, QPSK

Band	25.05-25.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	25.1 GHz
High channel	25.2 GHz

	Low	High
Nominal, Maximised RF Output / field strength	25 dBm	25 dBm
Nominal plot reference	9004-1 25.1 GHz, 100 MHz BW, QPSK	9004-1 25.2 GHz, 100 MHz BW, QPSK

Band	25.05-25.25 GHz
Power Level	22 dBm
Channel Spacing	50 MHz
Mod Scheme	16QAM
Low channel	25.075 GHz
High channel	25.225 GHz

	Low	High
Nominal, Maximised RF Output / field strength	22 dBm	22 dBm
Nominal plot reference	9004-1 25.075 GHz, 50 MHz BW, 16QAM	9004-1 25.225 GHz, 50 MHz BW, 16QAM

Band	25.05-25.25 GHz
Power Level	22 dBm
Channel Spacing	100 MHz
Mod Scheme	16QAM
Low channel	25.1 GHz
High channel	25.2 GHz

	Low	High
Nominal, Maximised RF Output / field strength	22 dBm	22 dBm
Nominal plot reference	9004-1 25.1 GHz, 100 MHz BW, 16QAM	9004-1 25.2 GHz, 100 MHz BW, 16QAM

Band	25.05-25.25 GHz
Power Level	19 dBm
Channel Spacing	50 MHz
Mod Scheme	64QAM
Low channel	25.075 GHz
High channel	25.225 GHz

	Low	High
Nominal, Maximised RF Output / field strength	19 dBm	19 dBm
Nominal plot reference	9004-1 25.075 GHz, 50 MHz BW, 64QAM	9004-1 25.225 GHz, 50 MHz BW, 64QAM

Band	25.05-25.25 GHz
Power Level	19 dBm
Channel Spacing	100 MHz
Mod Scheme	64QAM
Low channel	25.1 GHz
High channel	25.2 GHz

	Low	High
Nominal, Maximised RF Output / field strength	19 dBm	19 dBm
Nominal plot reference	9004-1 25.1 GHz, 100 MHz BW, 64QAM	9004-1 25.2 GHz, 100 MHz BW, 64QAM

Analyser plots showing the modulation characteristics can be found in Section 6 of this report.

Based on the declared gross bit rate of 4.29 per Hertz, and 50MHz and 100MHz bandwidths used the bit rate in bits per second of 214MB/s and 429 MB/s fulfils the requirement of part 101.141.

LIMITS:
Part 101.109: 40 MHz[7] (band 24.25 – 25.25 GHz)
[7] For channel block assignments in the 24,250-25,250 MHz and 38,600-40,000 MHz bands, the authorized bandwidth is equivalent to an unpaired channel block assignment or to either half of a symmetrical paired channel block assignment. When adjacent channels are aggregated, equipment is permitted to operate over the full channel block aggregation without restriction.
Part 101.141: Microwave transmitters employing digital modulation techniques and operating below 25.25 GHz (except for MVDDS stations in the 12,200–12,700 MHz band) must, with appropriate multiplex equipment, comply with the following additional requirements: The bit rate, in bits per second, must be equal to or greater than the bandwidth specified by the emission designator in Hertz.

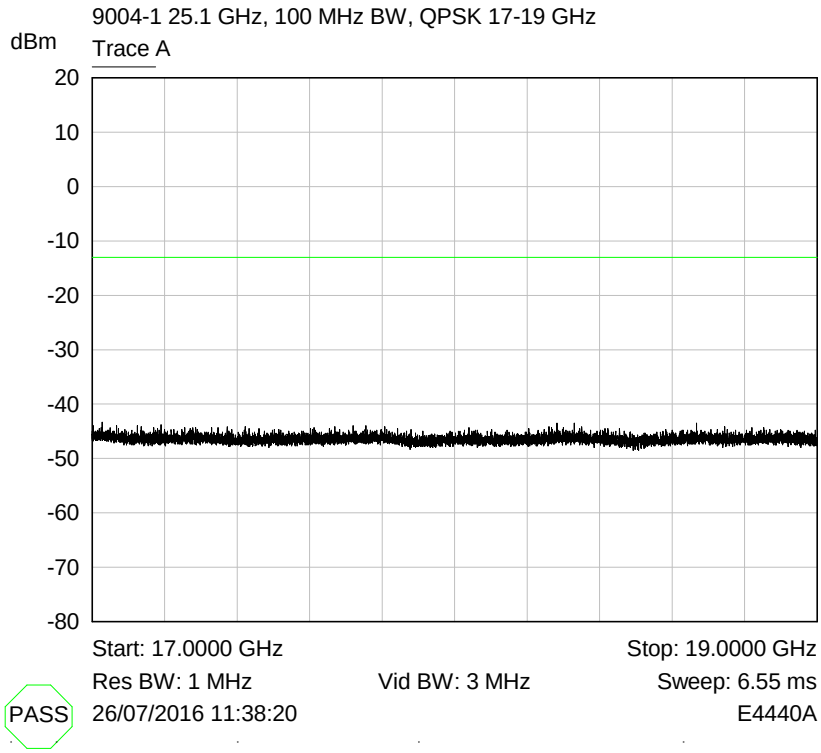
These results show that the EUT has PASSED this test.

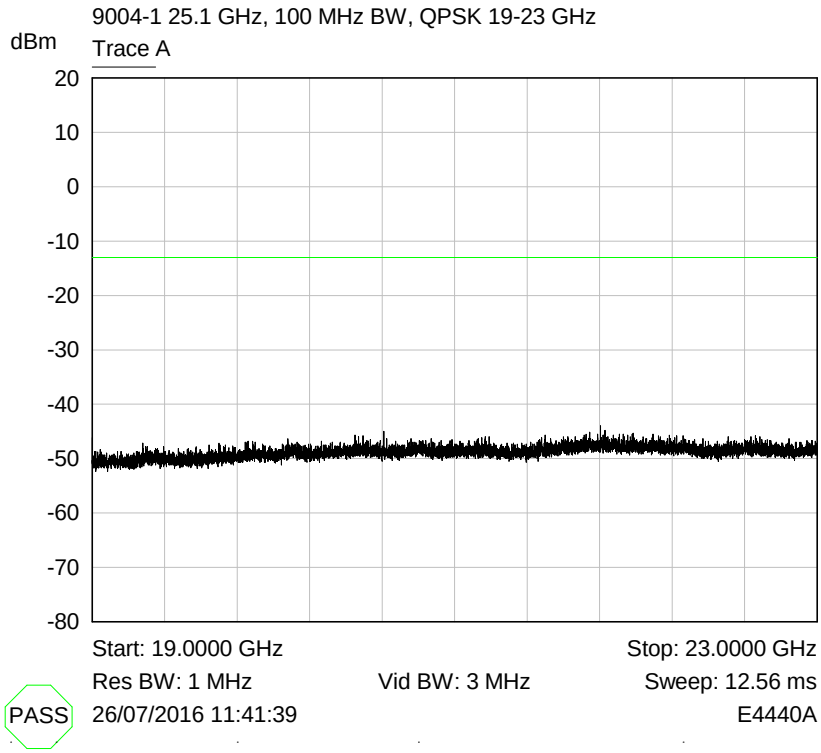
The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
Bandwidth <± 1.9 %

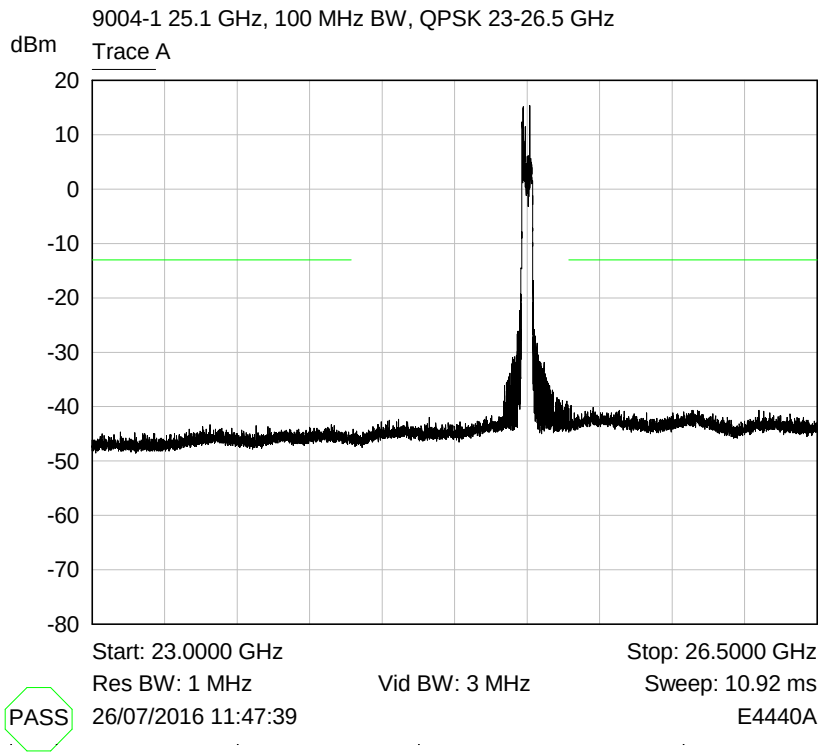
6 Plots/Graphical results

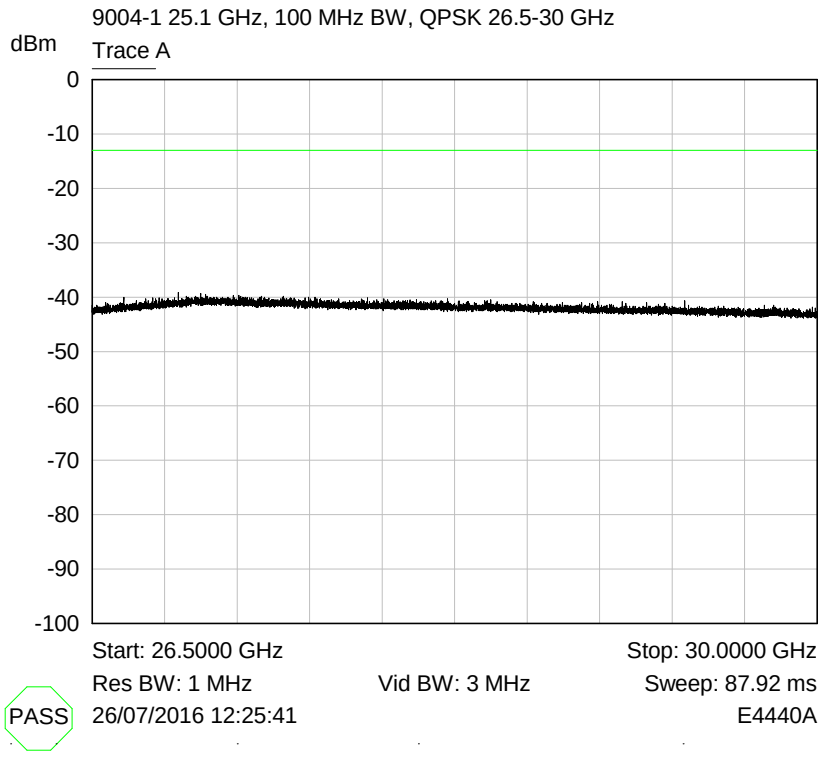
6.1 Spurious emissions at antenna terminals

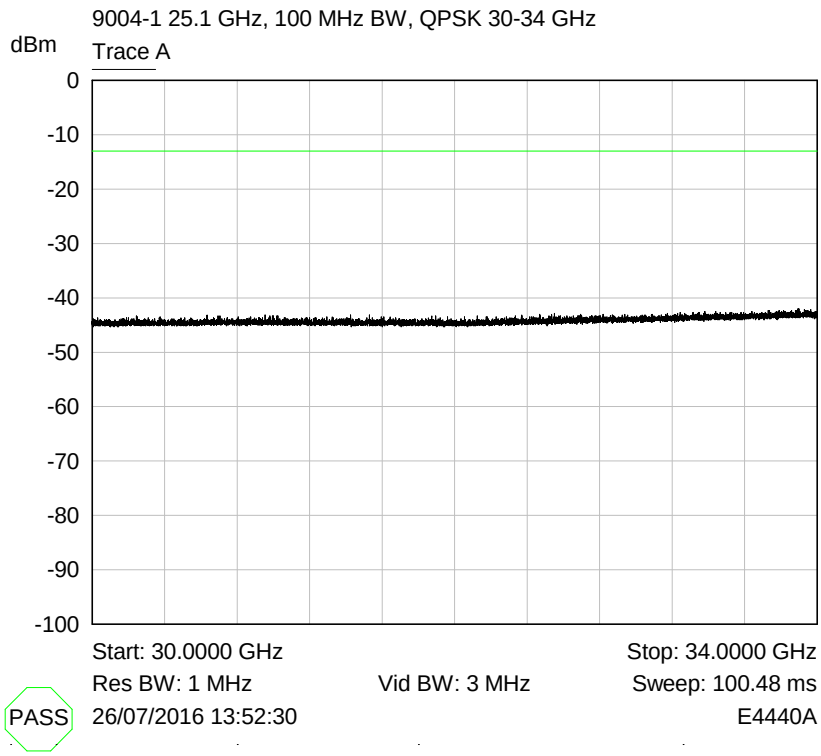
RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 25.1 GHz

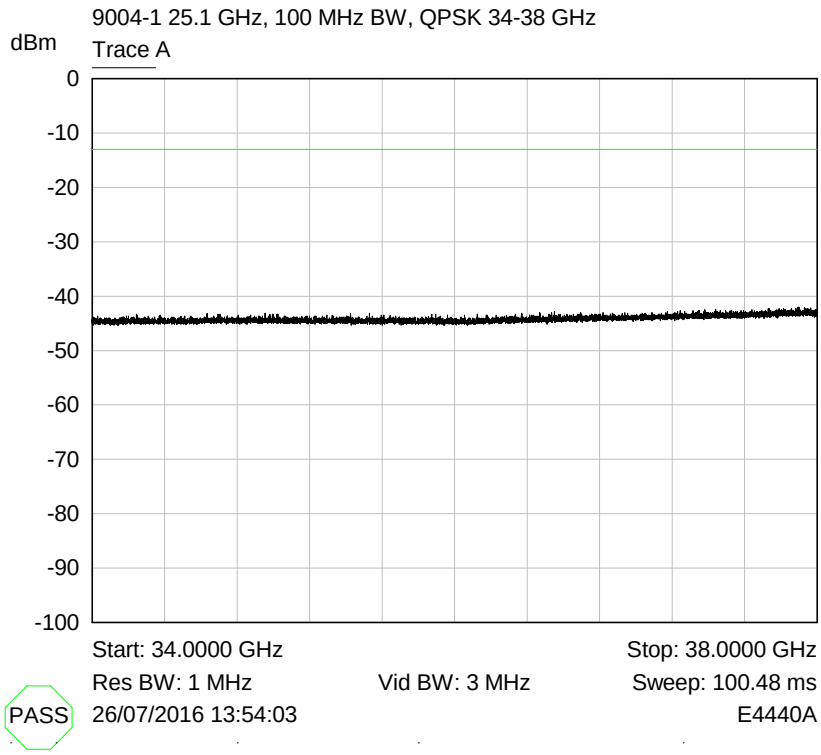


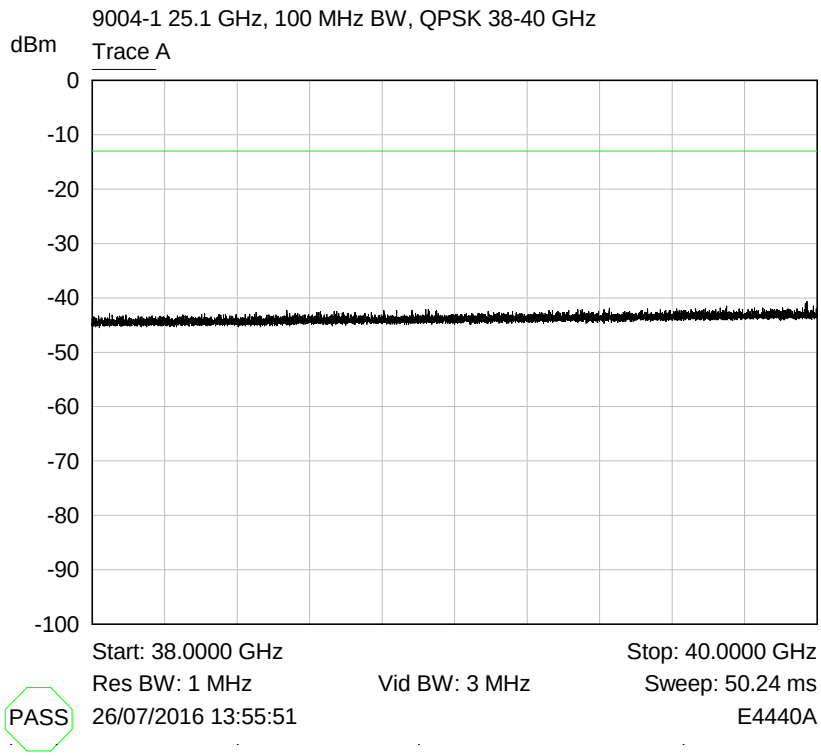


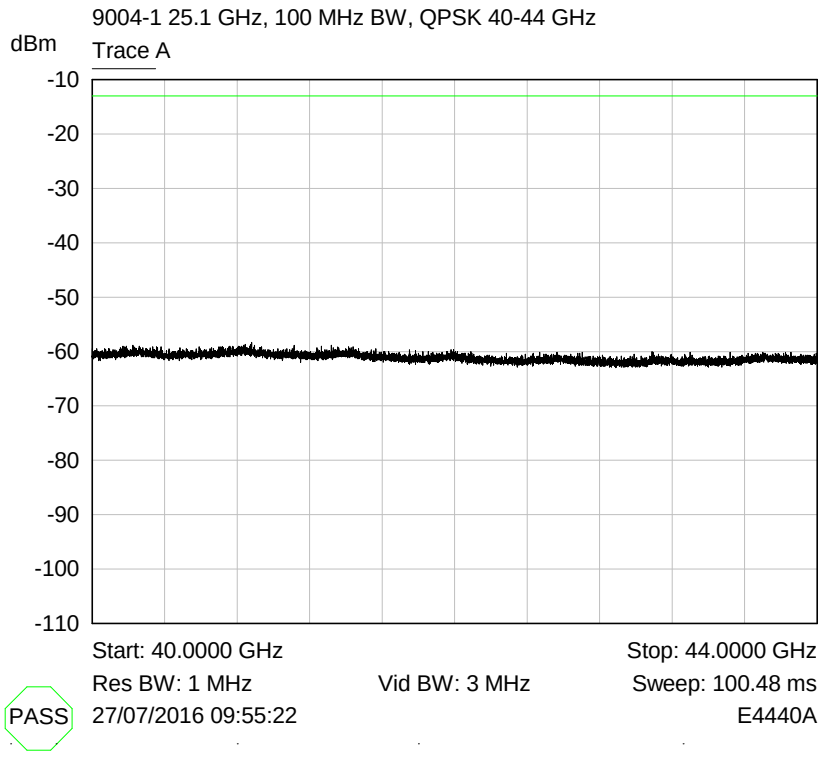

9004-1 25.1 GHz, 100 MHz BW, QPSK 23-26.5 GHz
dBm
Trace A
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start: 23.0000 GHz
Stop: 26.5000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 10.92 ms
PASS
26/07/2016 11:47:39
E4440A

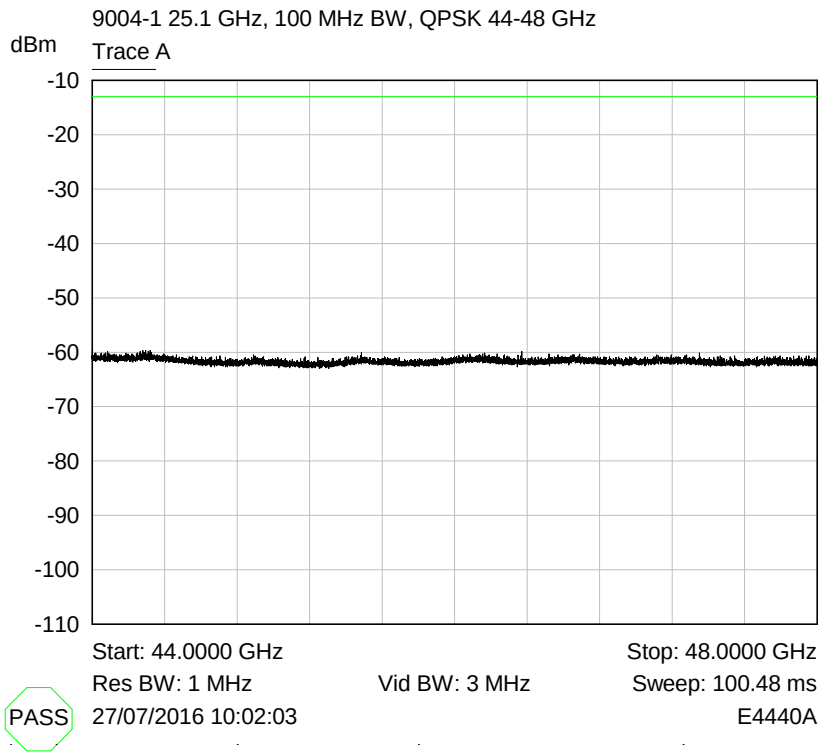

9004-1 25.1 GHz, 100 MHz BW, QPSK 26.5-30 GHz
dBm
Trace A
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
Start: 26.5000 GHz
Stop: 30.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 87.92 ms
PASS
26/07/2016 12:25:41
E4440A

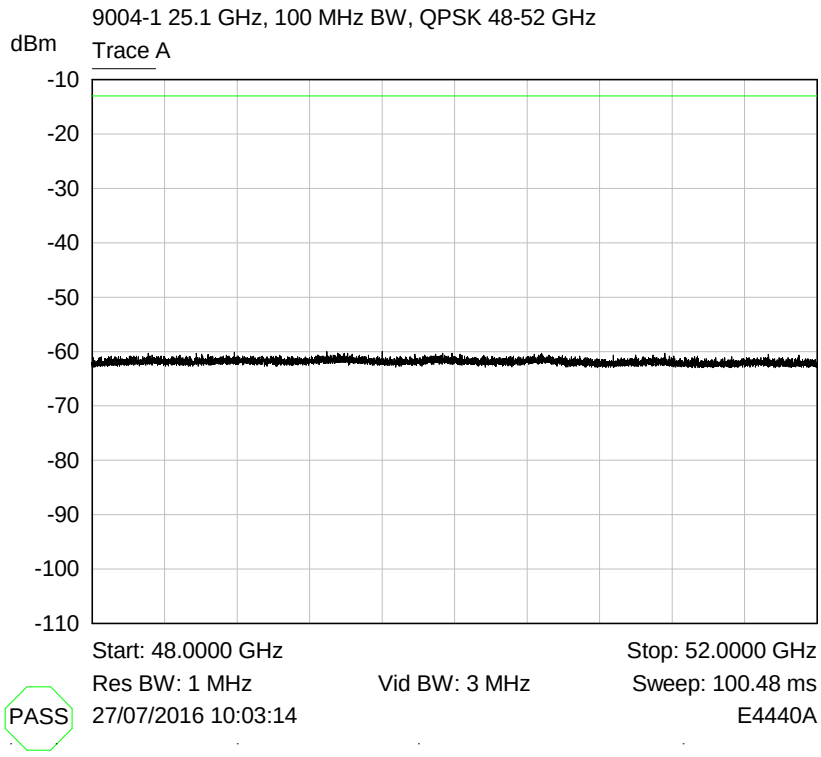


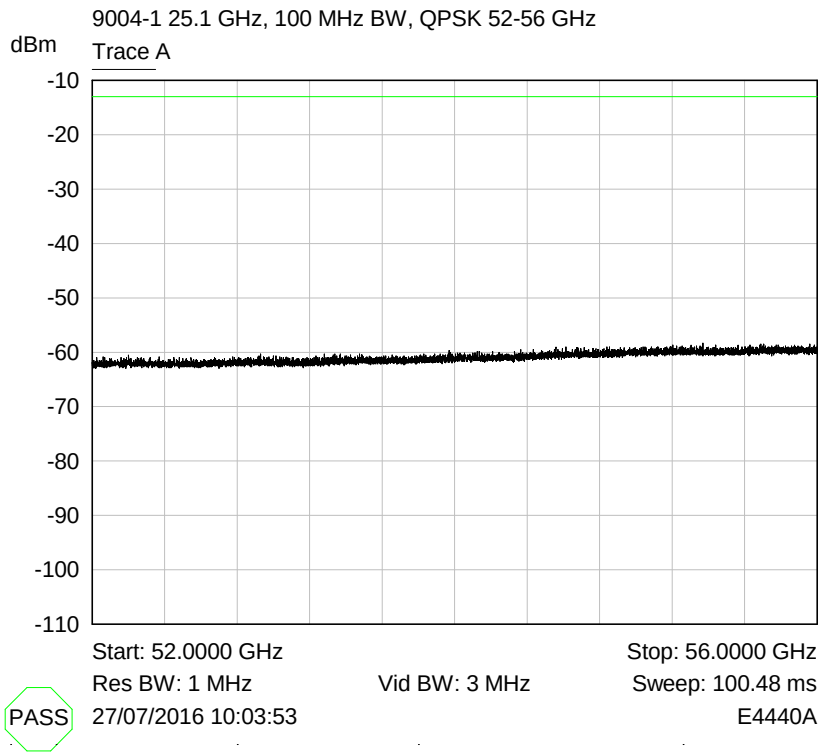


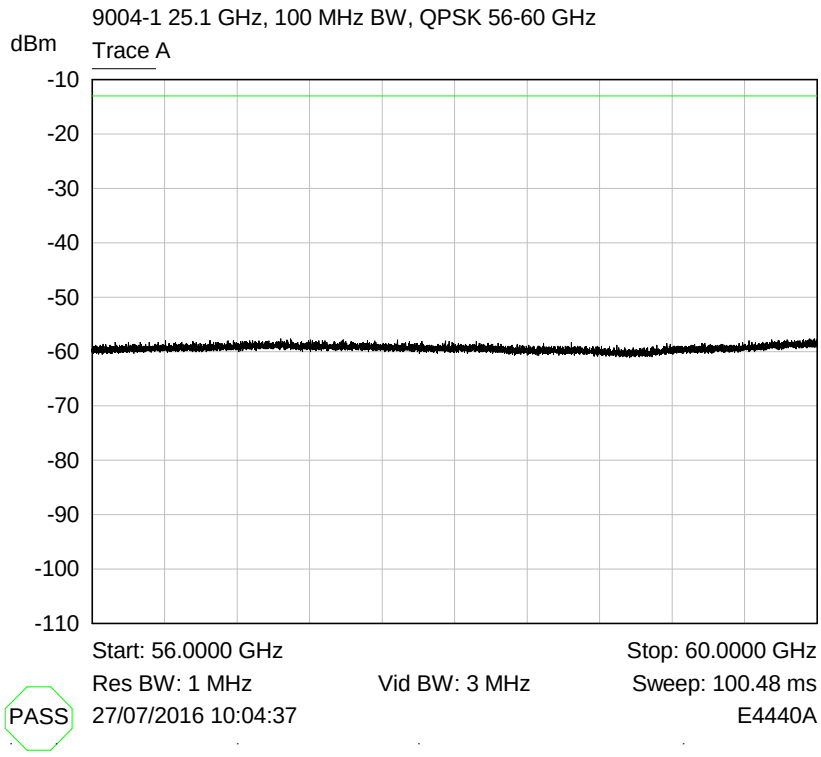

9004-1 25.1 GHz, 100 MHz BW, QPSK 38-40 GHz
dBm
Trace A
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
Start: 38.0000 GHz
Stop: 40.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 50.24 ms
PASS
26/07/2016 13:55:51
E4440A

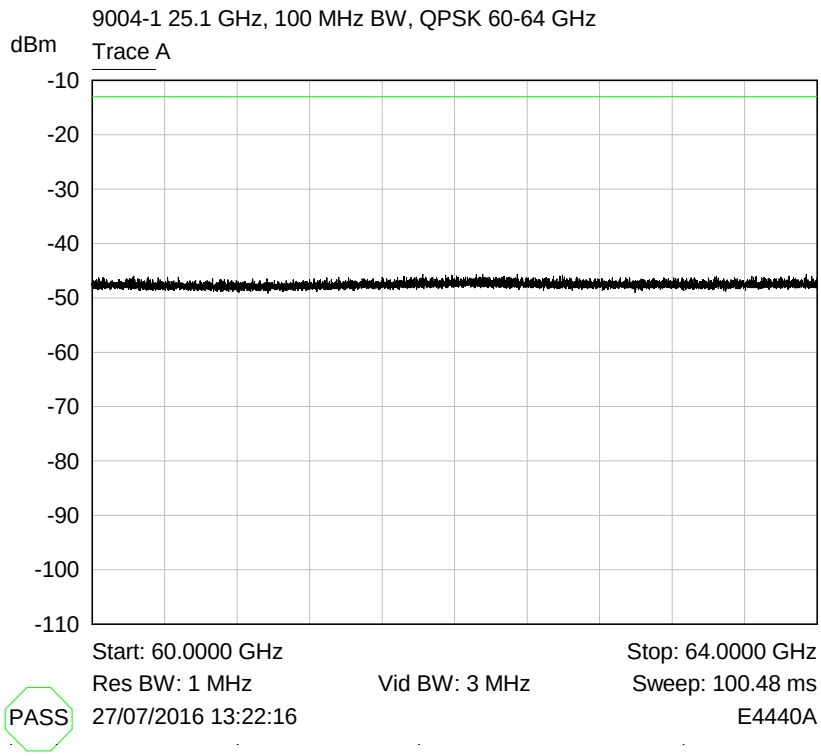

9004-1 25.1 GHz, 100 MHz BW, QPSK 40-44 GHz
dBm
Trace A
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
Start: 40.0000 GHz
Stop: 44.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
PASS
27/07/2016 09:55:22
E4440A

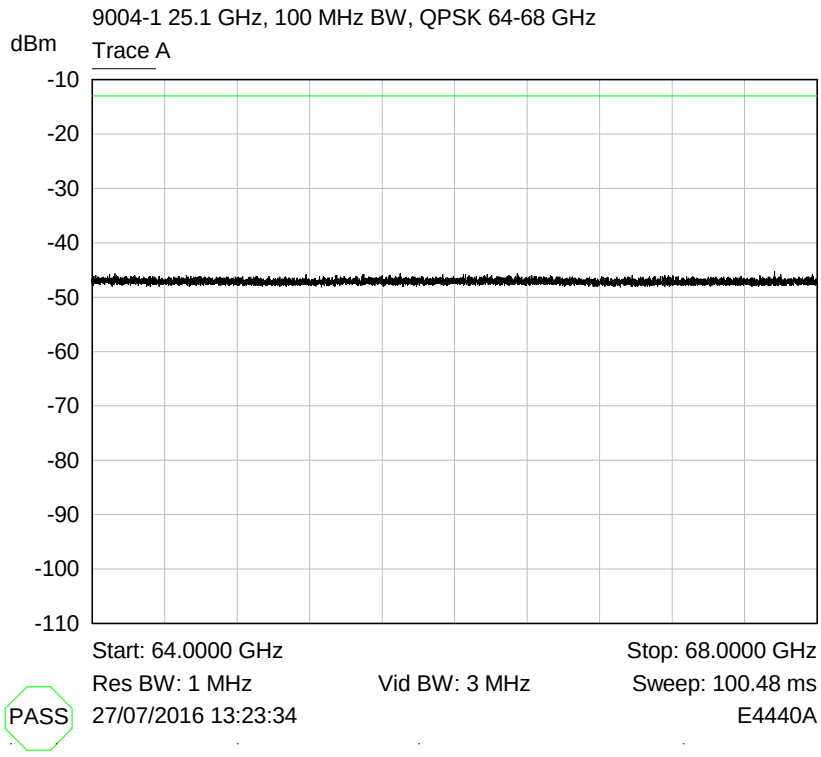


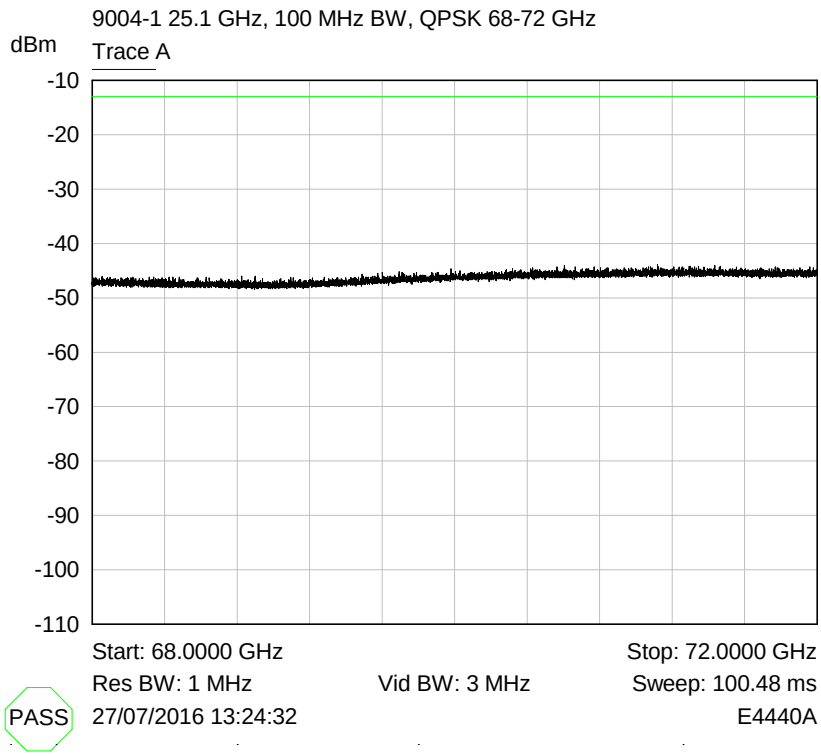


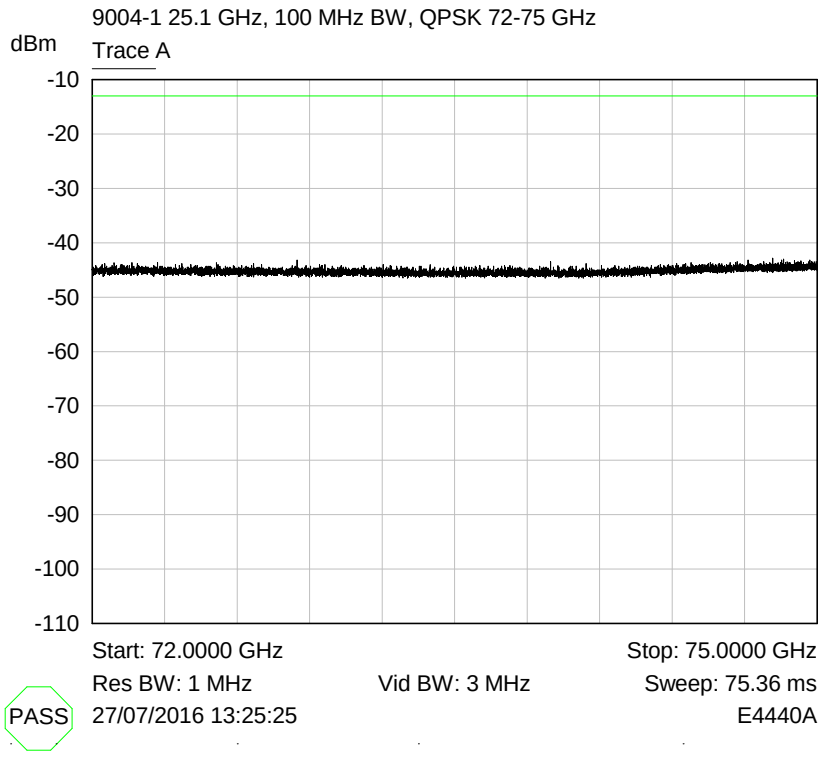

9004-1 25.1 GHz, 100 MHz BW, QPSK 52-56 GHz
dBm
Trace A
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
Start: 52.0000 GHz
Stop: 56.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
PASS
27/07/2016 10:03:53
E4440A

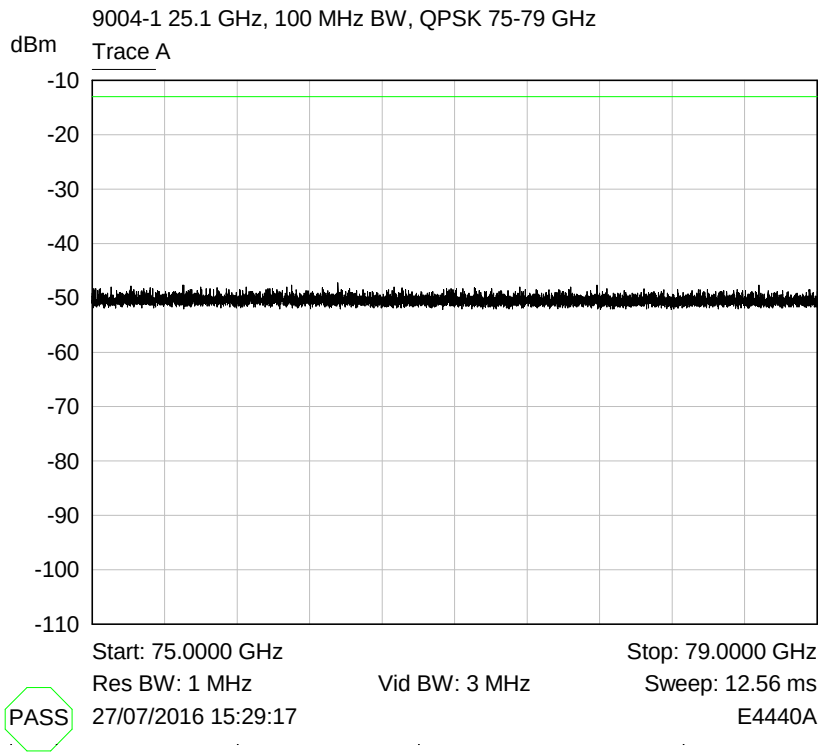

9004-1 25.1 GHz, 100 MHz BW, QPSK 56-60 GHz
dBm
Trace A
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
Start: 56.0000 GHz
Stop: 60.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
PASS
27/07/2016 10:04:37
E4440A

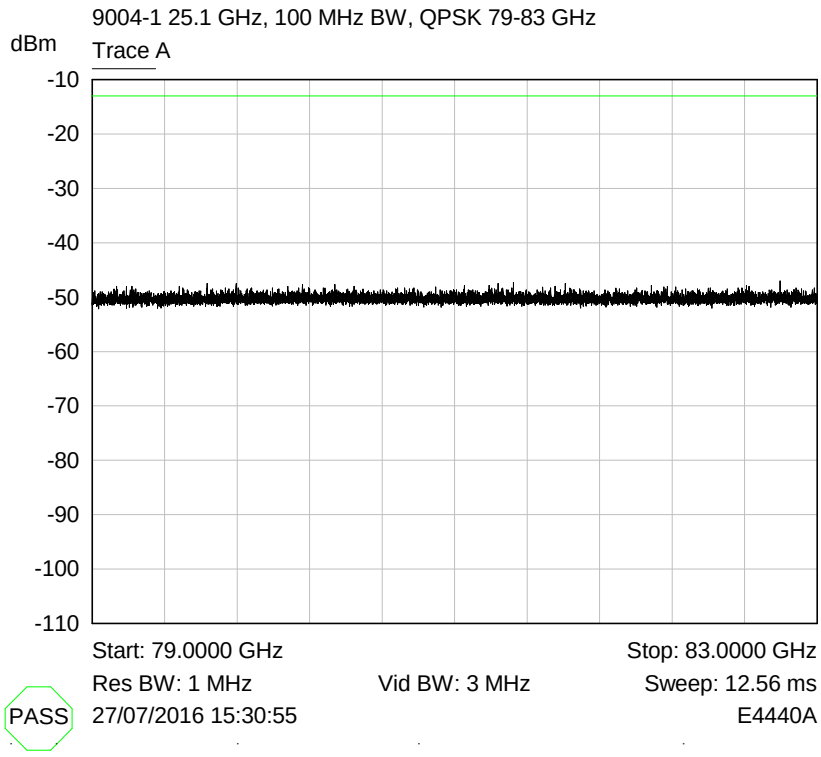


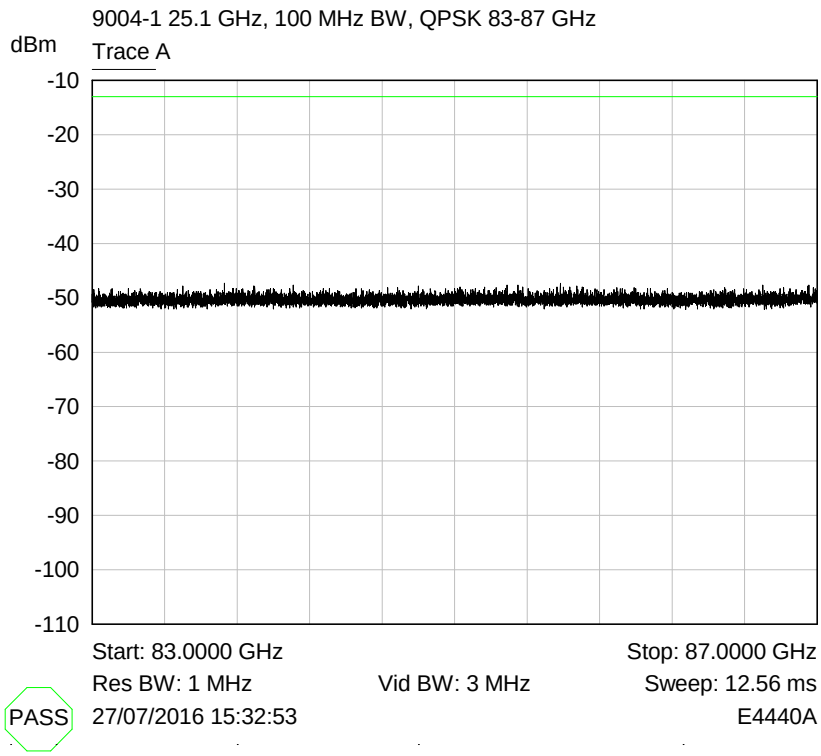


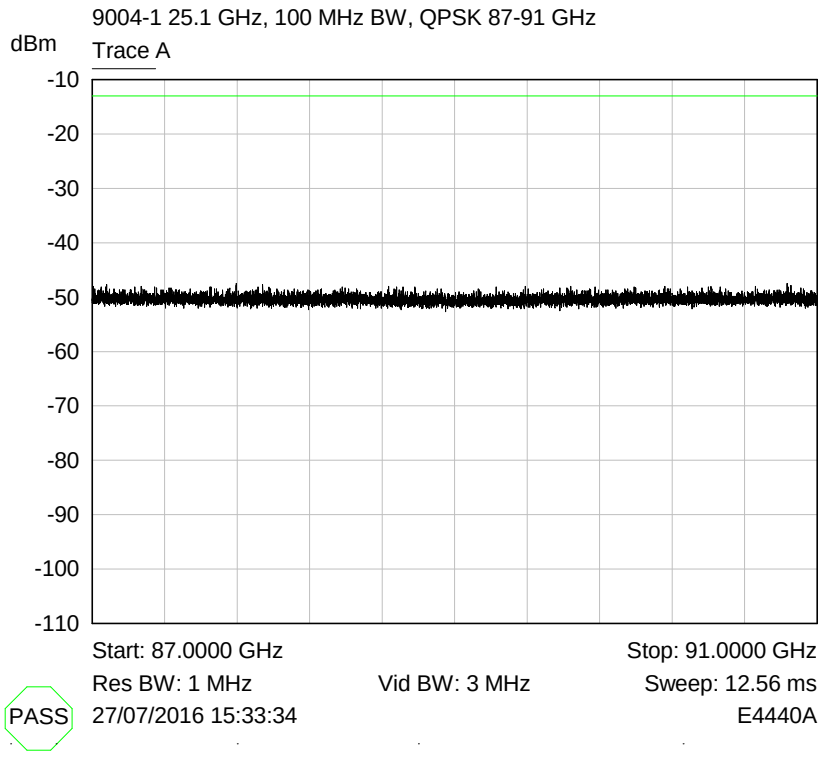

9004-1 25.1 GHz, 100 MHz BW, QPSK 68-72 GHz
dBm
Trace A
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
Start: 68.0000 GHz
Stop: 72.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
PASS
27/07/2016 13:24:32
E4440A

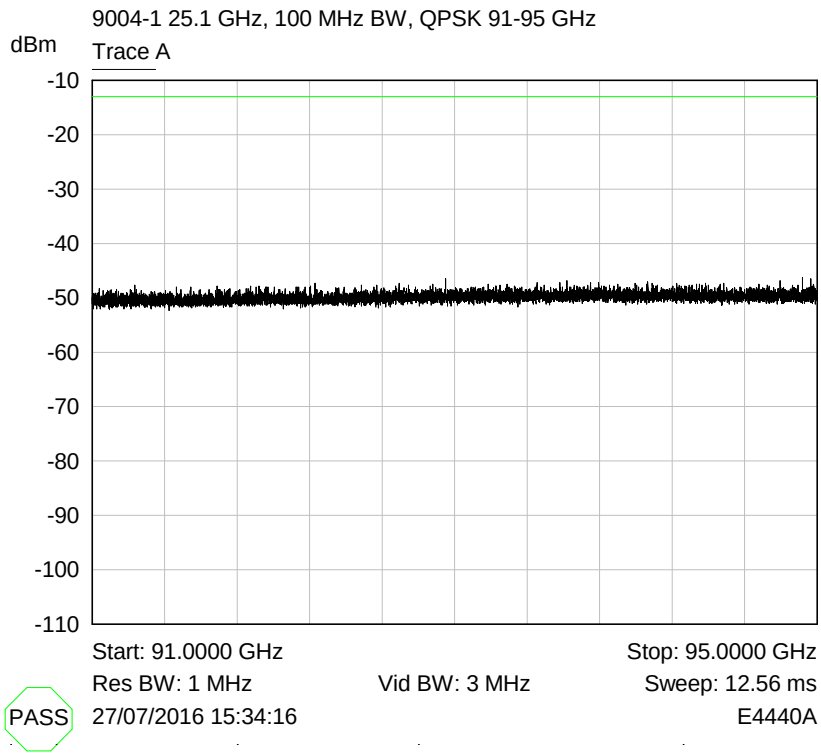

9004-1 25.1 GHz, 100 MHz BW, QPSK 72-75 GHz
dBm
Trace A
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
Start: 72.0000 GHz
Stop: 75.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 75.36 ms
PASS
27/07/2016 13:25:25
E4440A

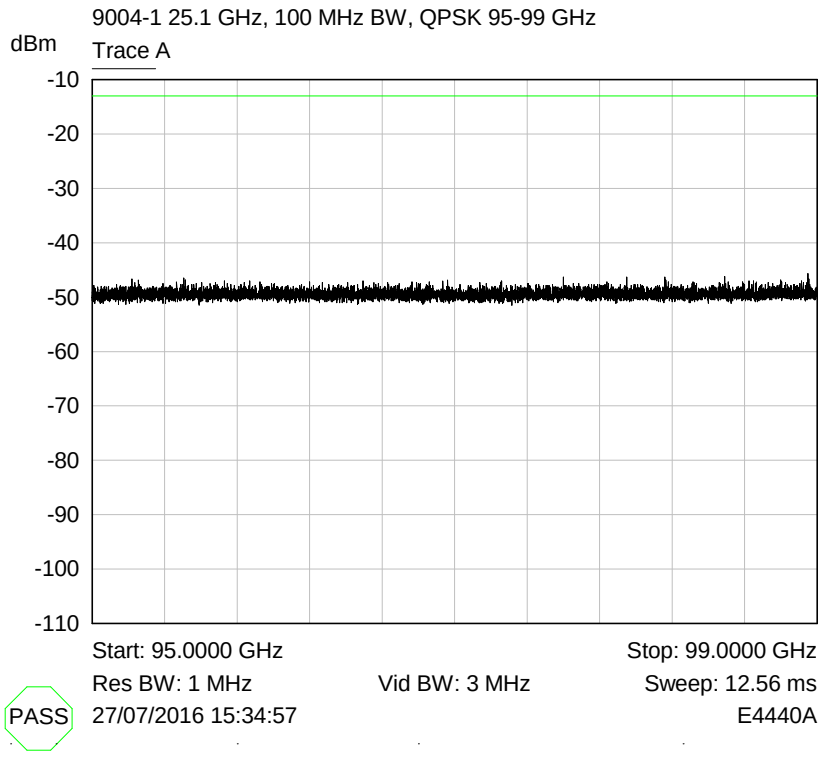


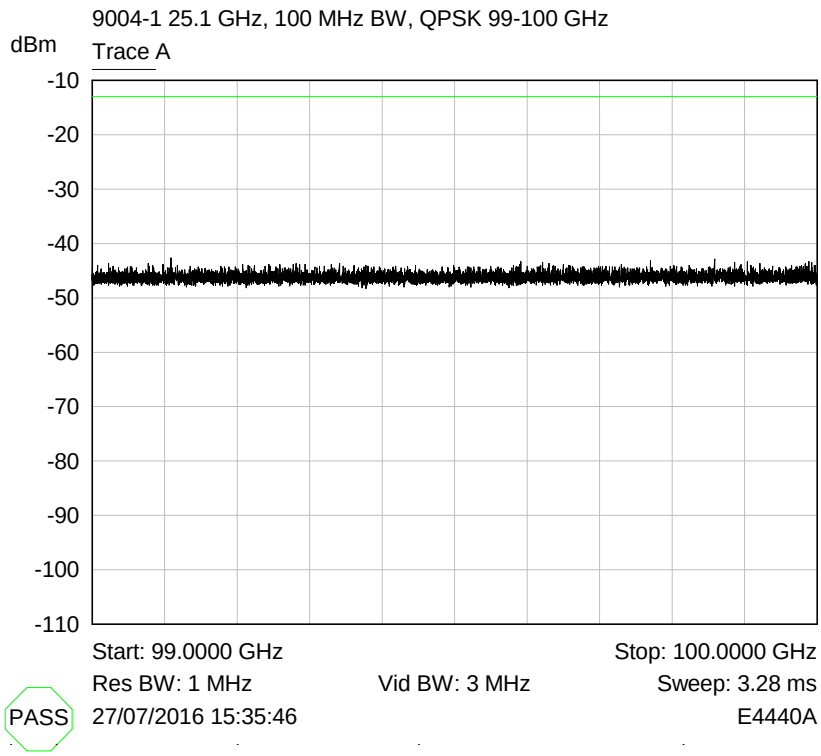






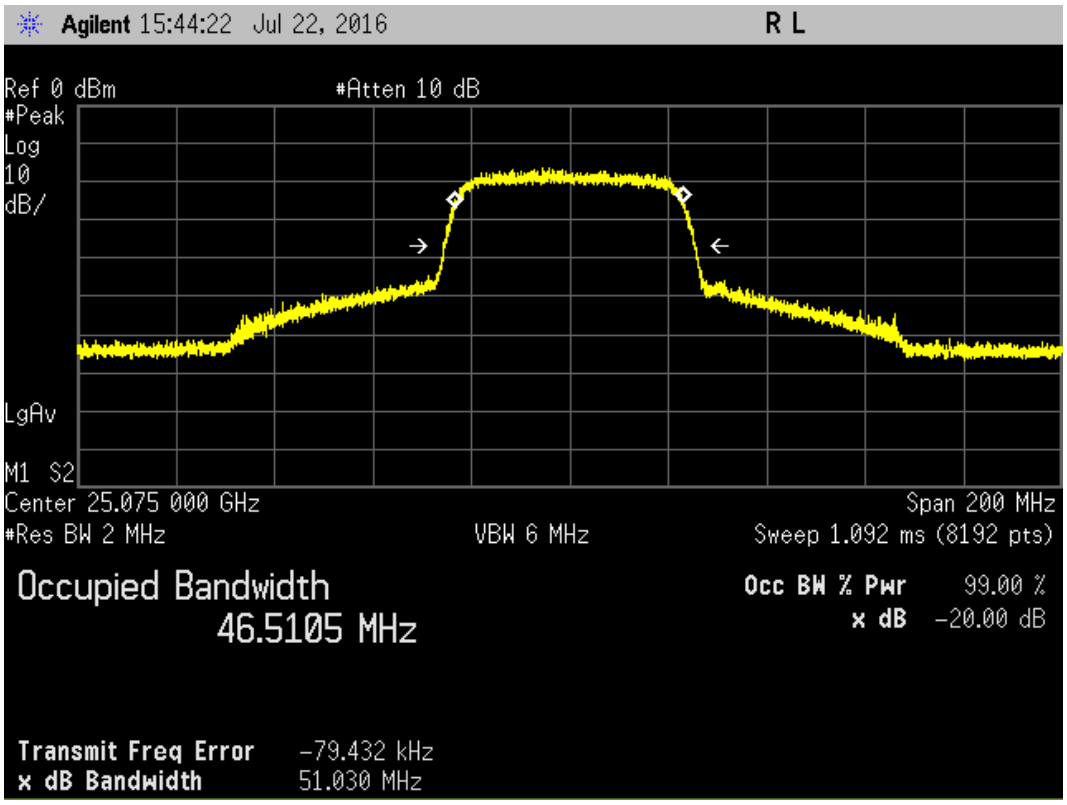

9004-1 25.1 GHz, 100 MHz BW, QPSK 91-95 GHz
dBm
Trace A
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
Start: 91.0000 GHz
Stop: 95.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 12.56 ms
PASS
27/07/2016 15:34:16
E4440A


9004-1 25.1 GHz, 100 MHz BW, QPSK 95-99 GHz
dBm
Trace A
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
Start: 95.0000 GHz
Stop: 99.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 12.56 ms
PASS
27/07/2016 15:34:57
E4440A



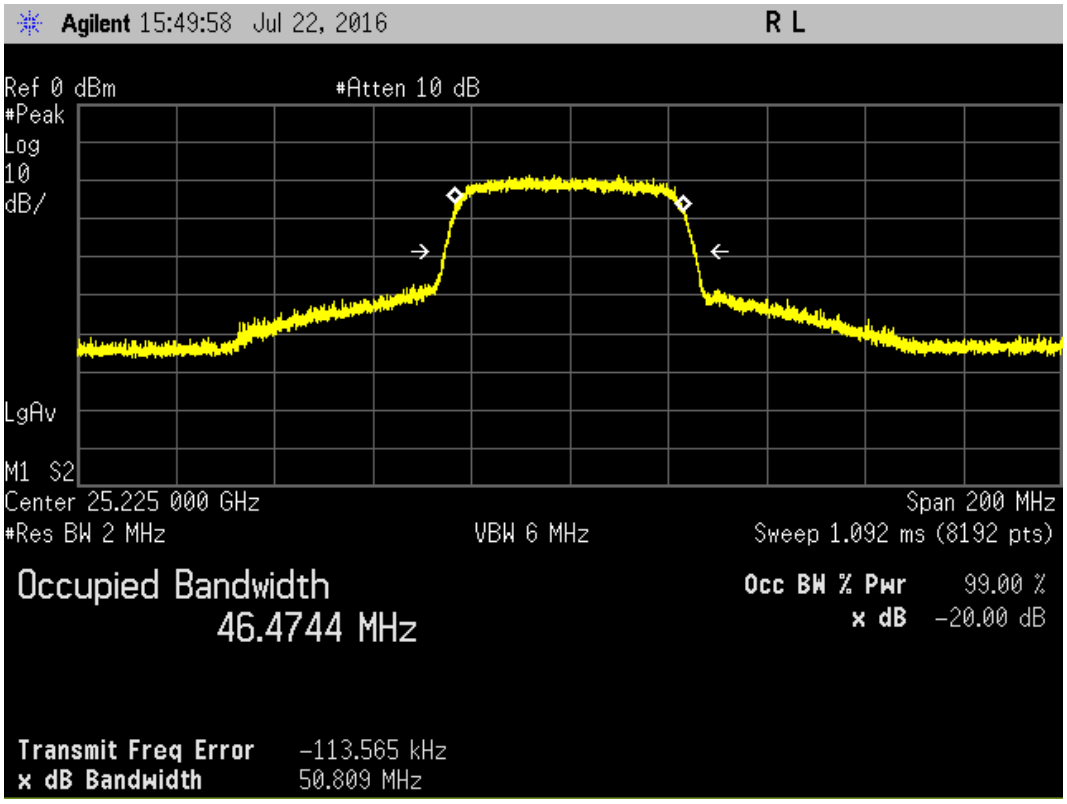
6.2 Occupied bandwidth

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 50 MHz, Modulation QPSK, Channel 25.075 GHz



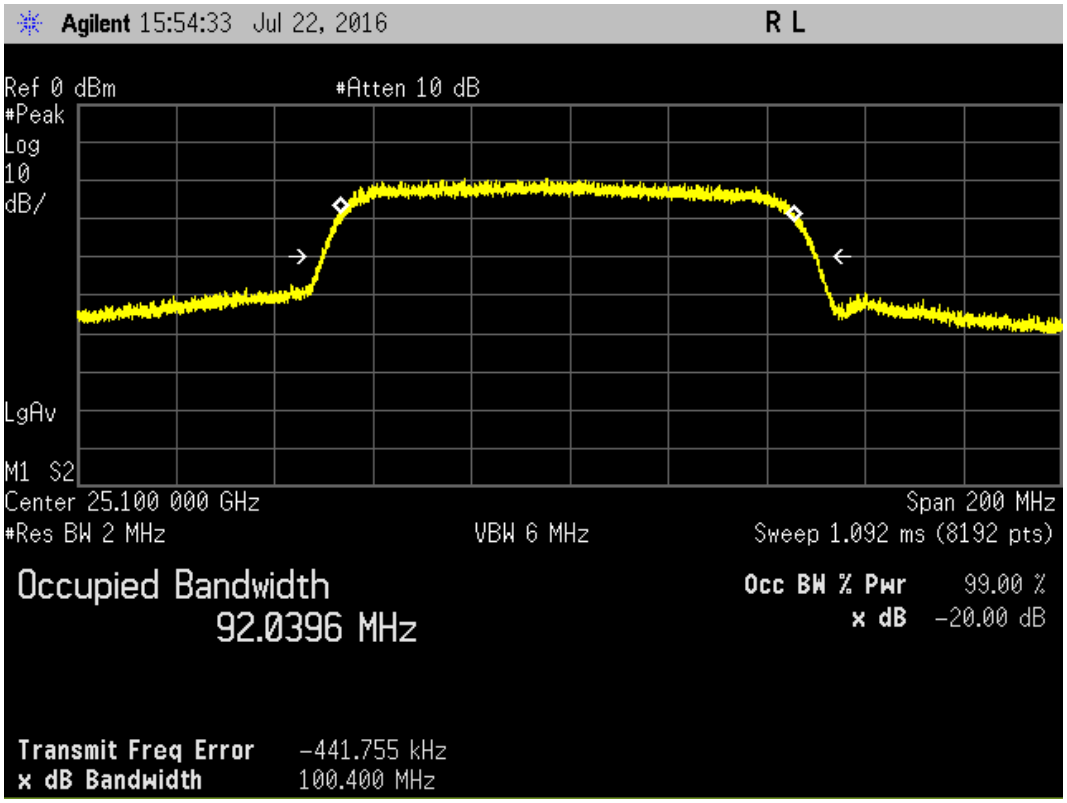
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 50 MHz, Modulation QPSK, Channel 25.225 GHz



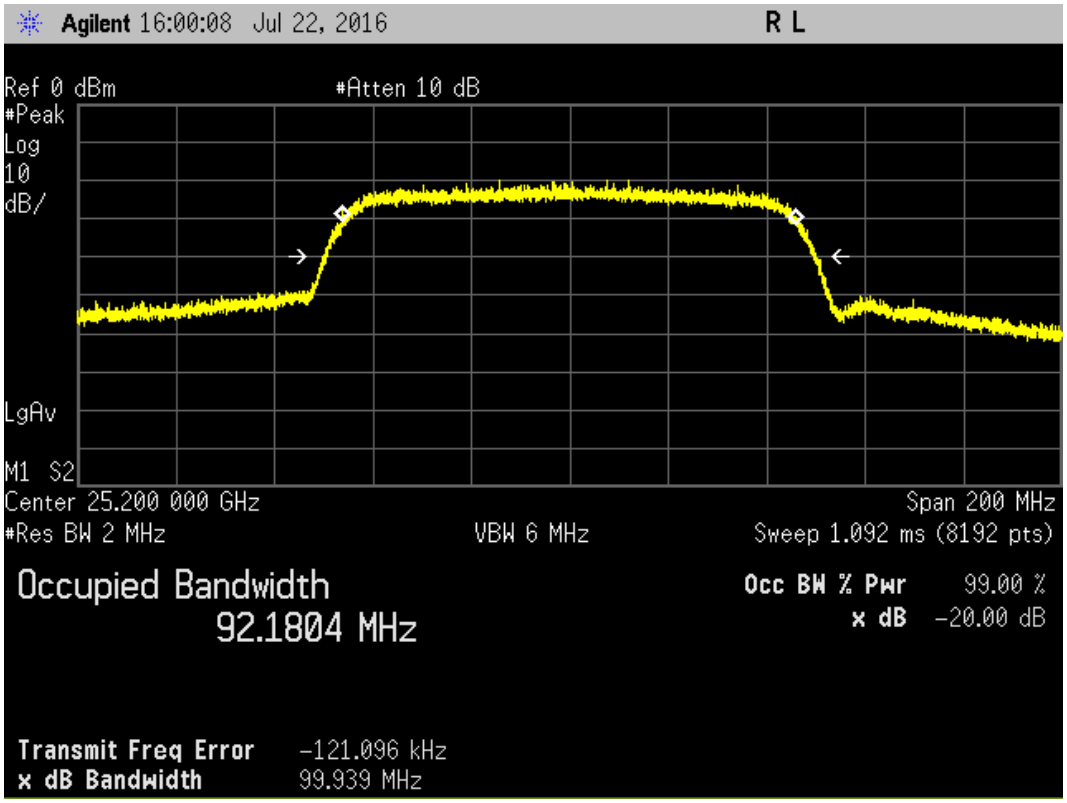
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 25.1 GHz



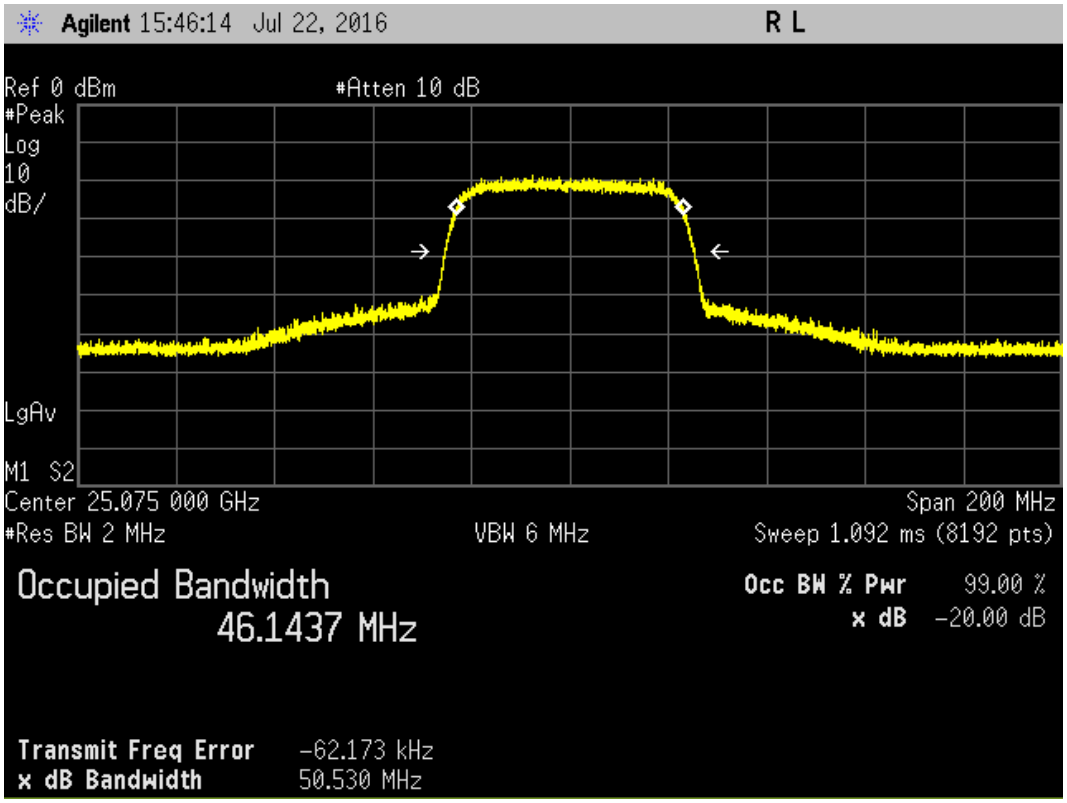
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 25.2 GHz



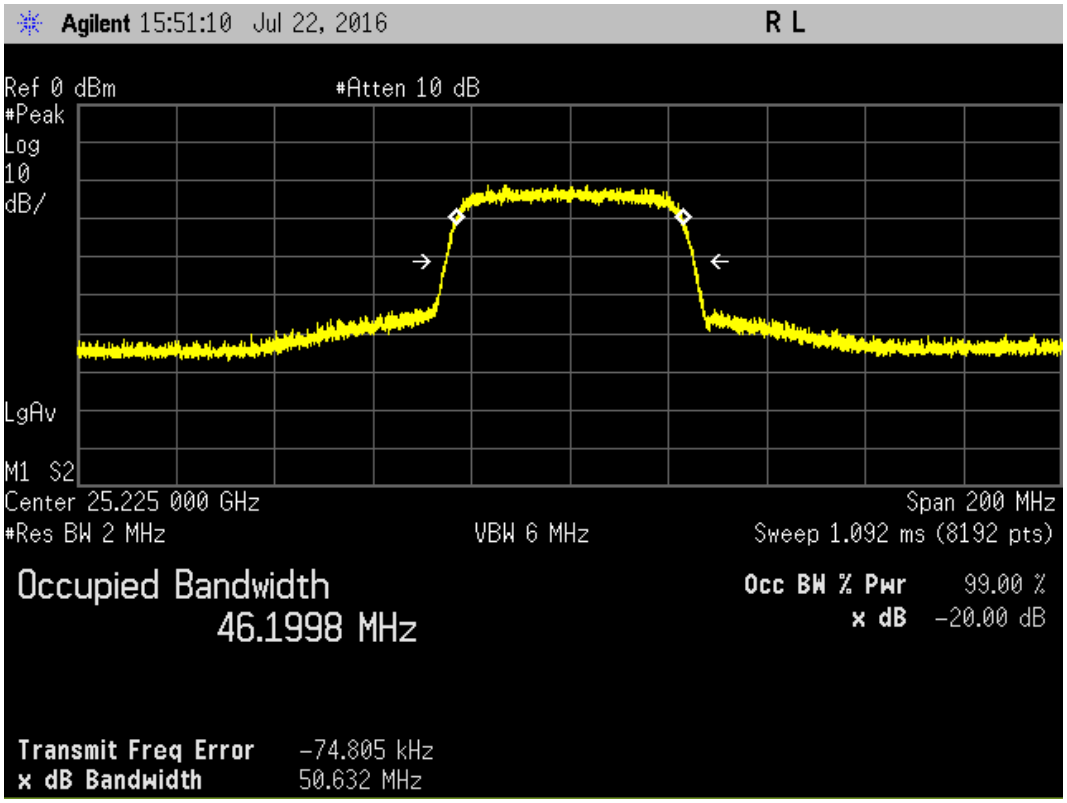
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 50 MHz, Modulation 16QAM, Channel 25.075 GHz



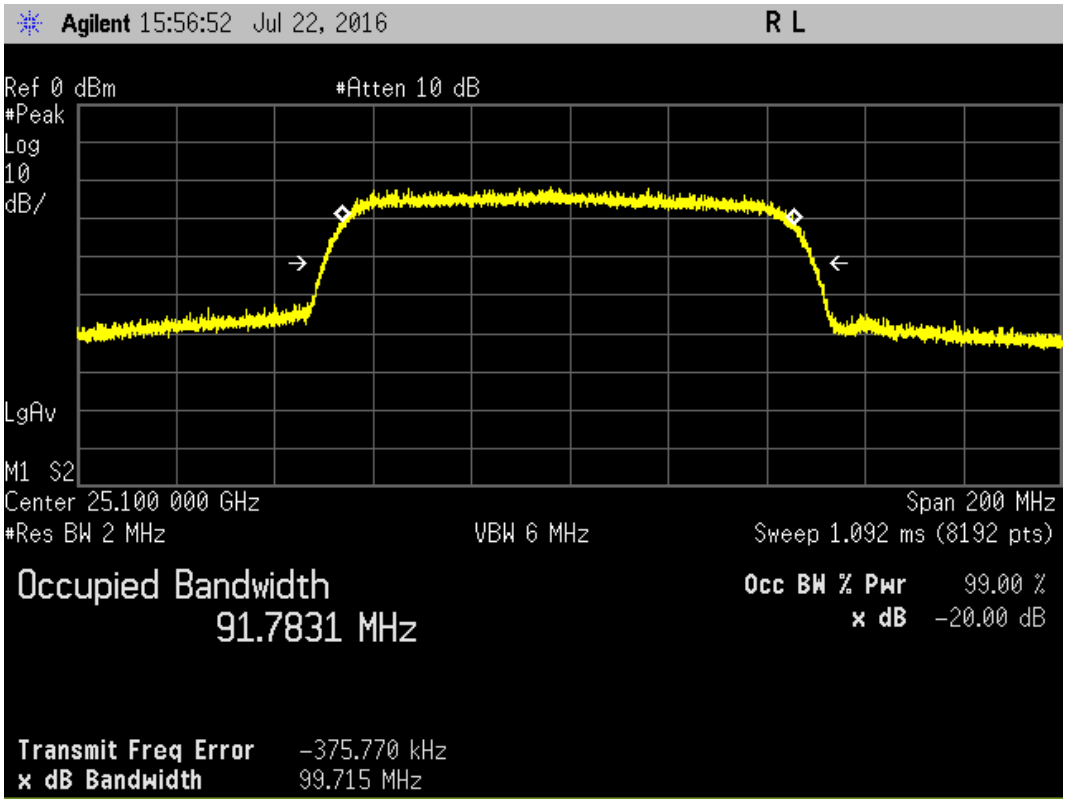
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 50 MHz, Modulation 16QAM, Channel 25.225 GHz



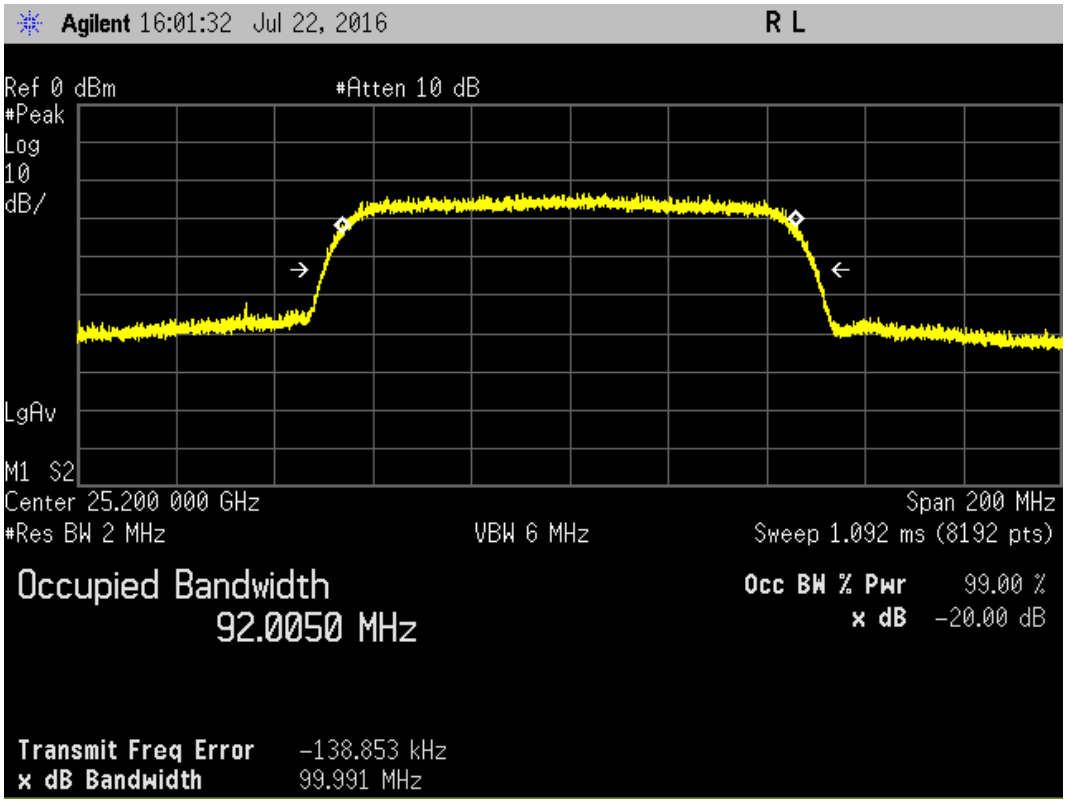
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 100 MHz, Modulation 16QAM, Channel 25.1 GHz



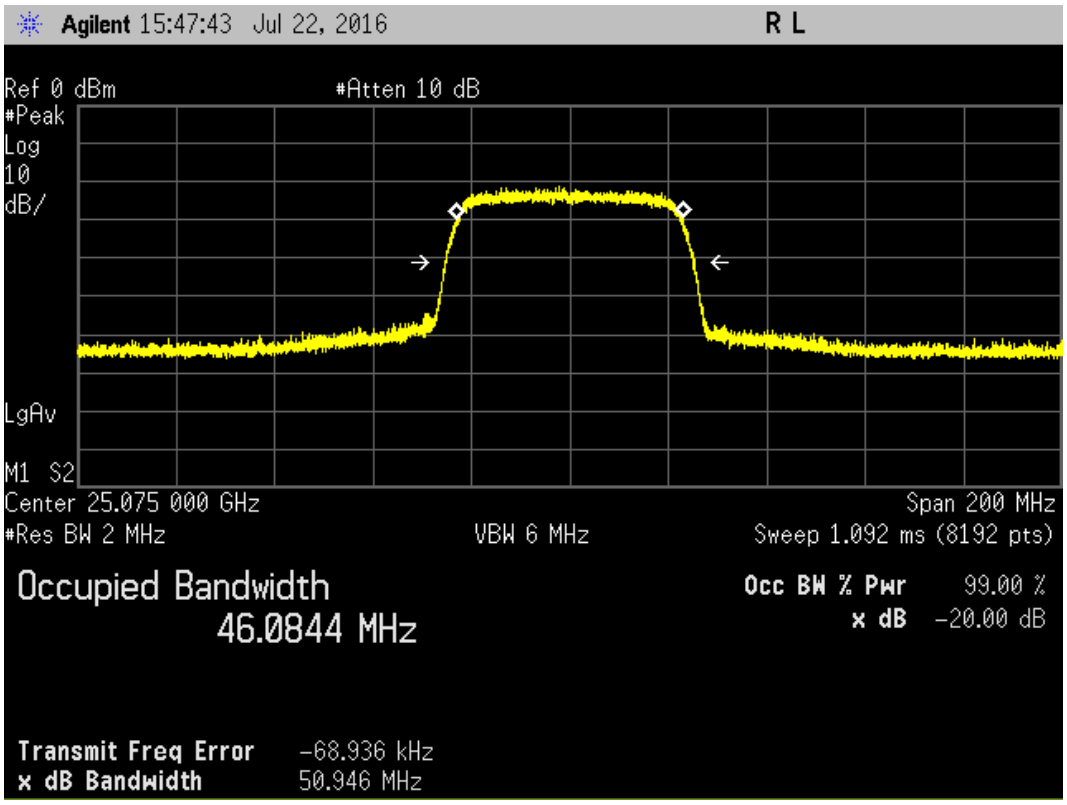
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 100 MHz, Modulation 16QAM, Channel 25.2 GHz



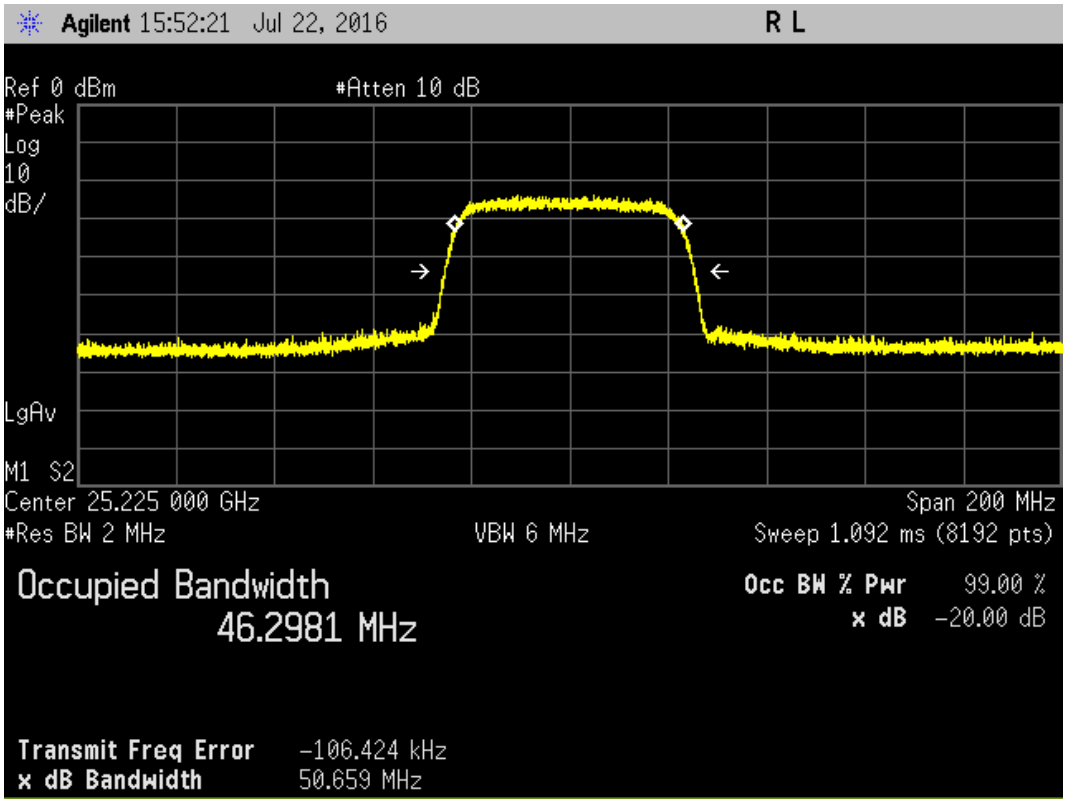
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 50 MHz, Modulation 64QAM, Channel 25.075 GHz



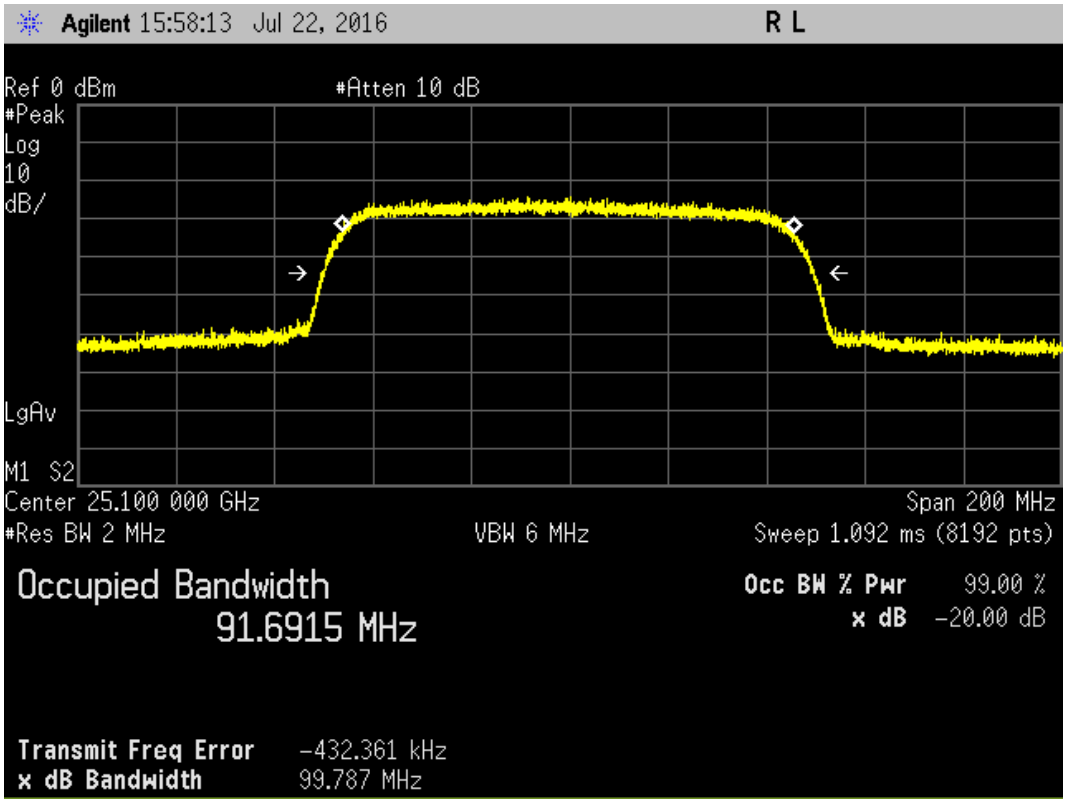
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 50 MHz, Modulation 64QAM, Channel 25.225 GHz



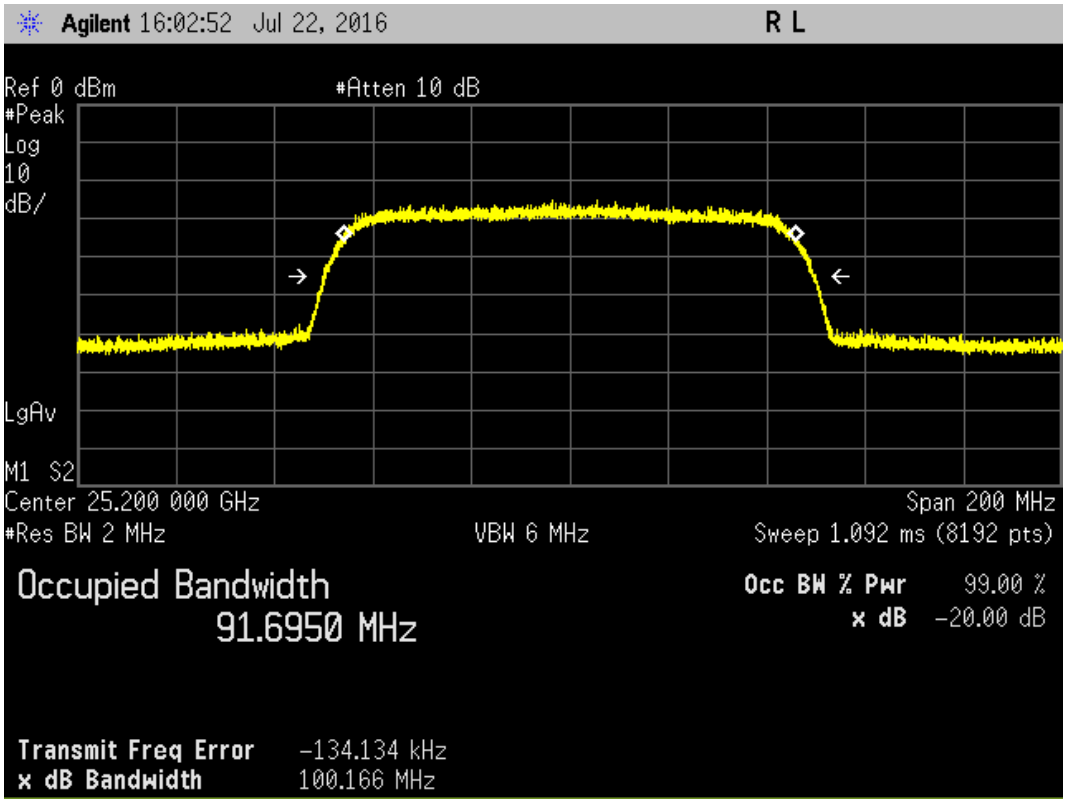
Plot for 99% Bandwidth (MHz)

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 100 MHz, Modulation 64QAM, Channel 25.1 GHz



Plot for 99% Bandwidth (MHz)

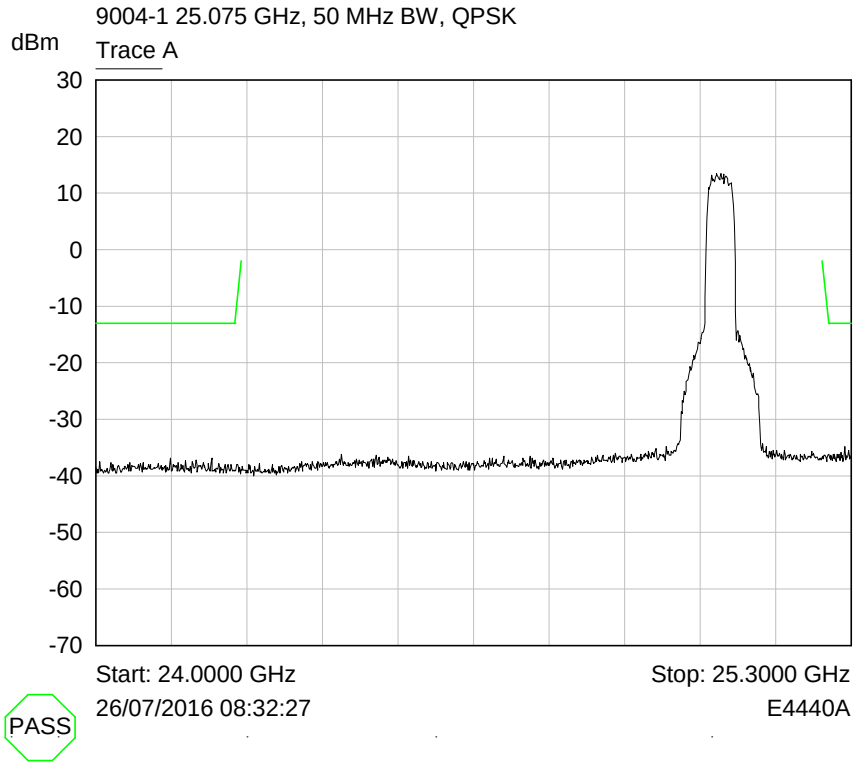
RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 100 MHz, Modulation 64QAM, Channel 25.2 GHz



Plot for 99% Bandwidth (MHz)

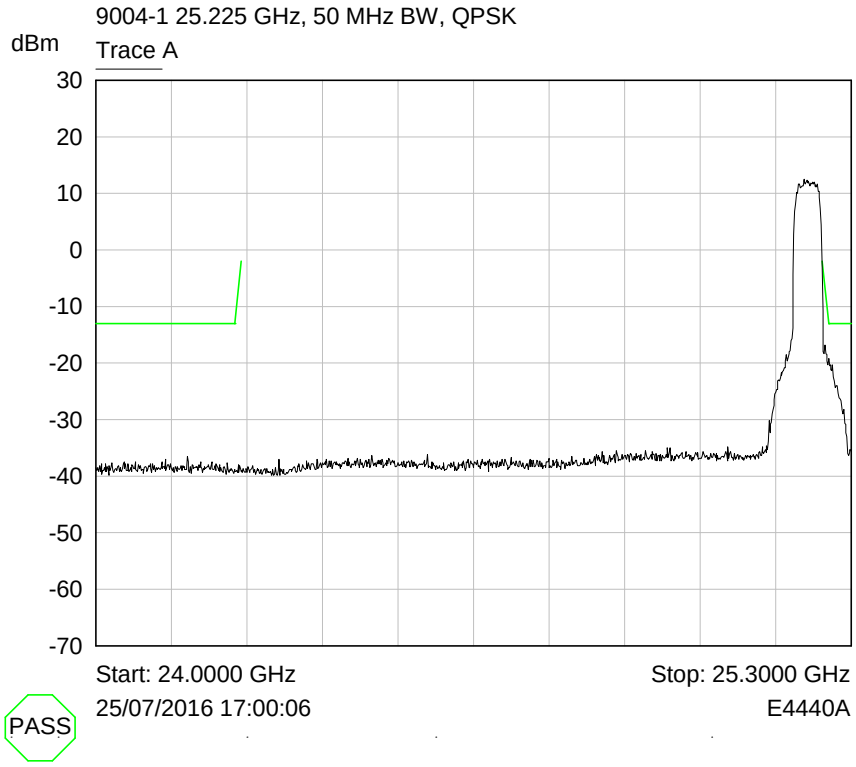
6.3 Band edge / spectrum mask additional emissions limitations

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 50 MHz, Modulation QPSK, Channel 25.075 GHz



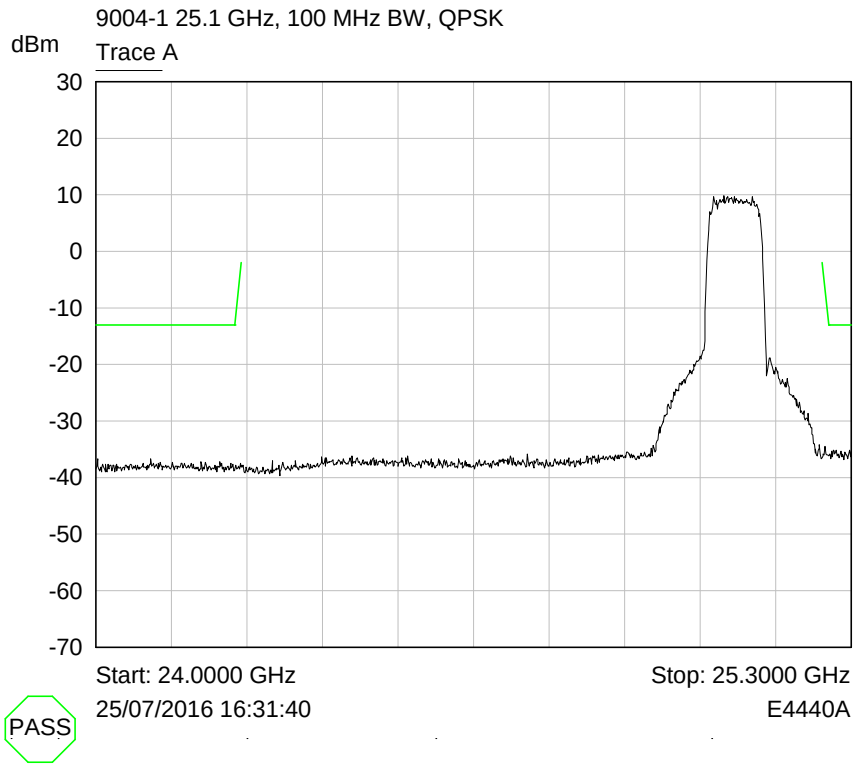
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 50 MHz, Modulation QPSK, Channel 25.225 GHz



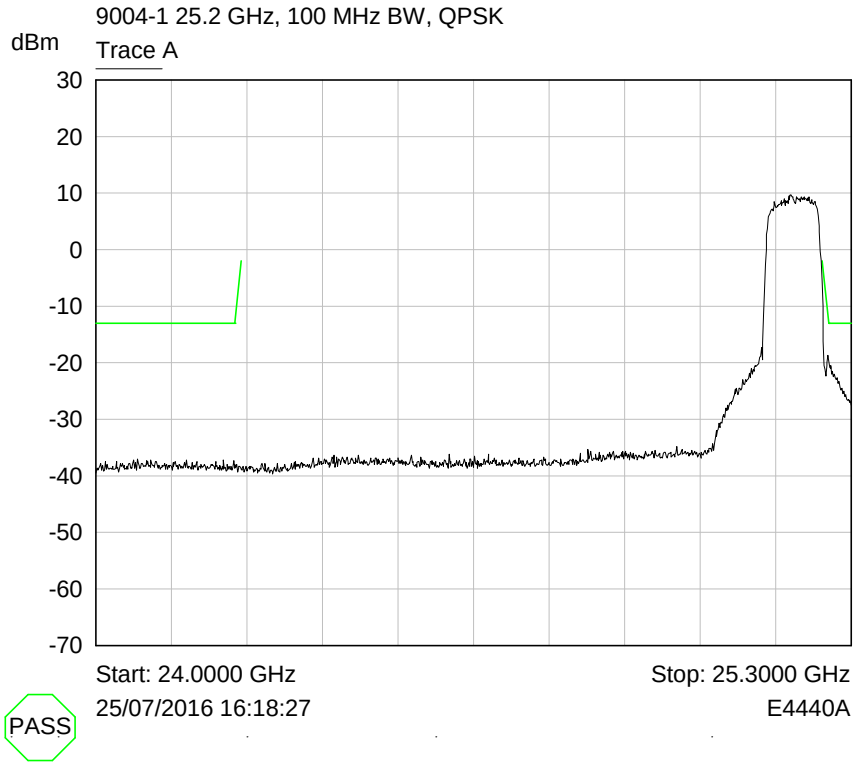
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 25.1 GHz



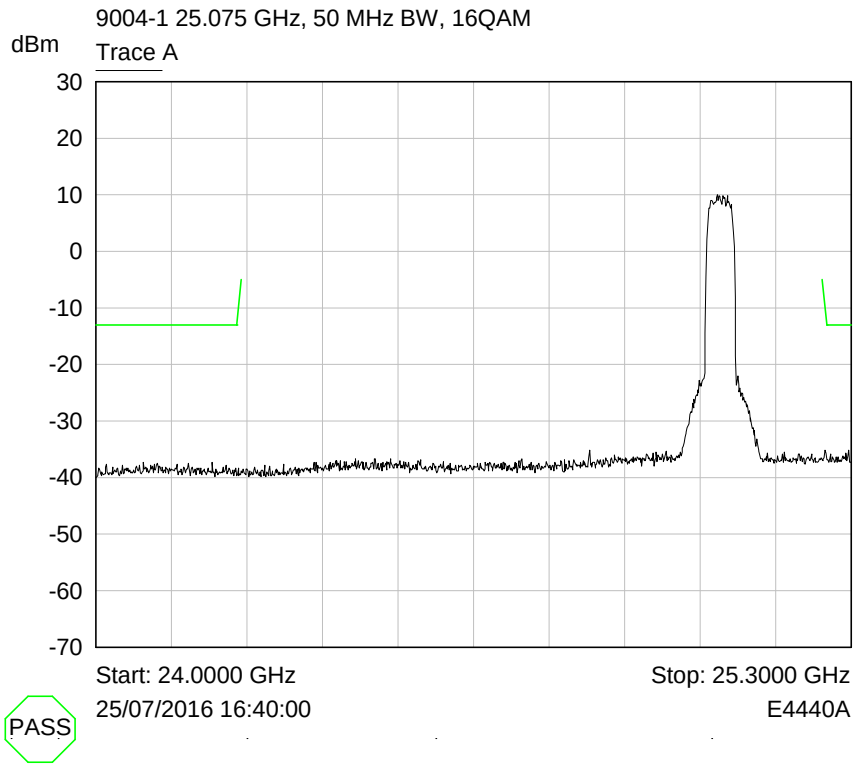
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 25.2 GHz



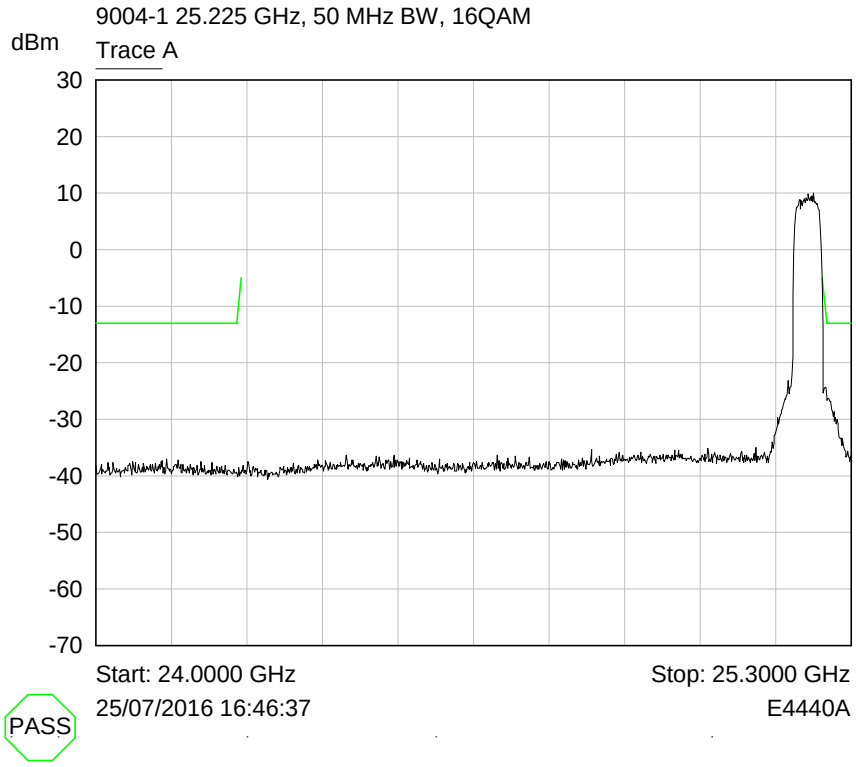
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 50 MHz, Modulation 16QAM, Channel 25.075 GHz



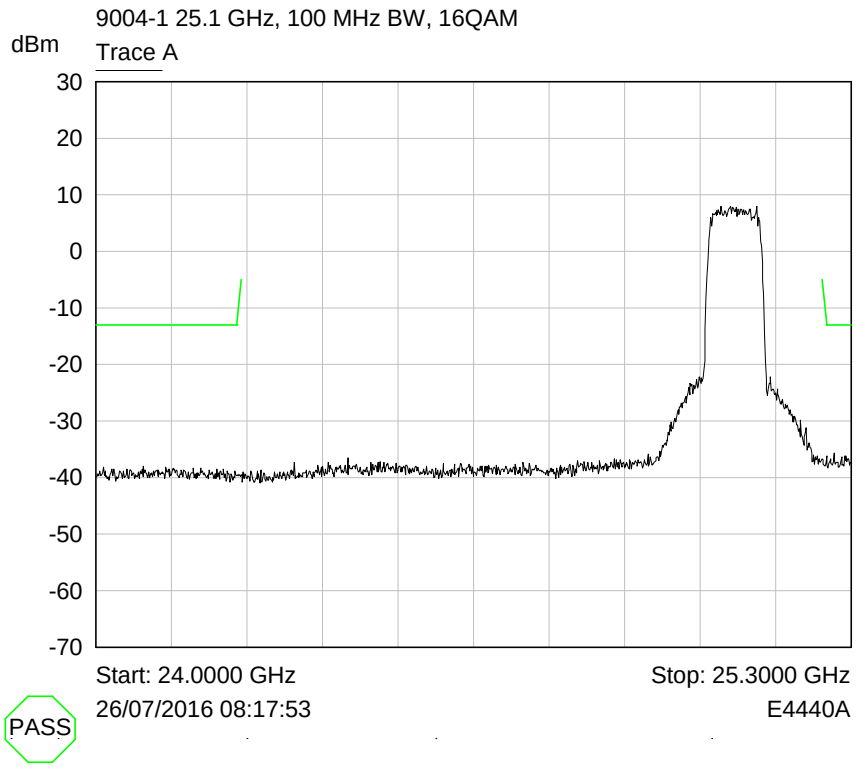
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 50 MHz, Modulation 16QAM, Channel 25.2 GHz



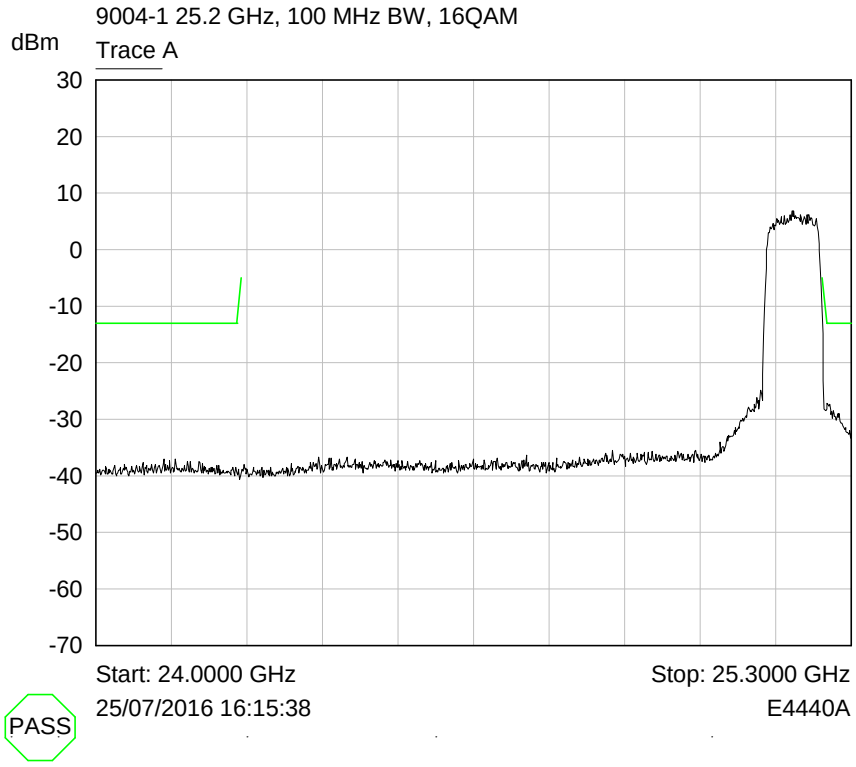
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 100 MHz, Modulation 16QAM, Channel 25.1 GHz



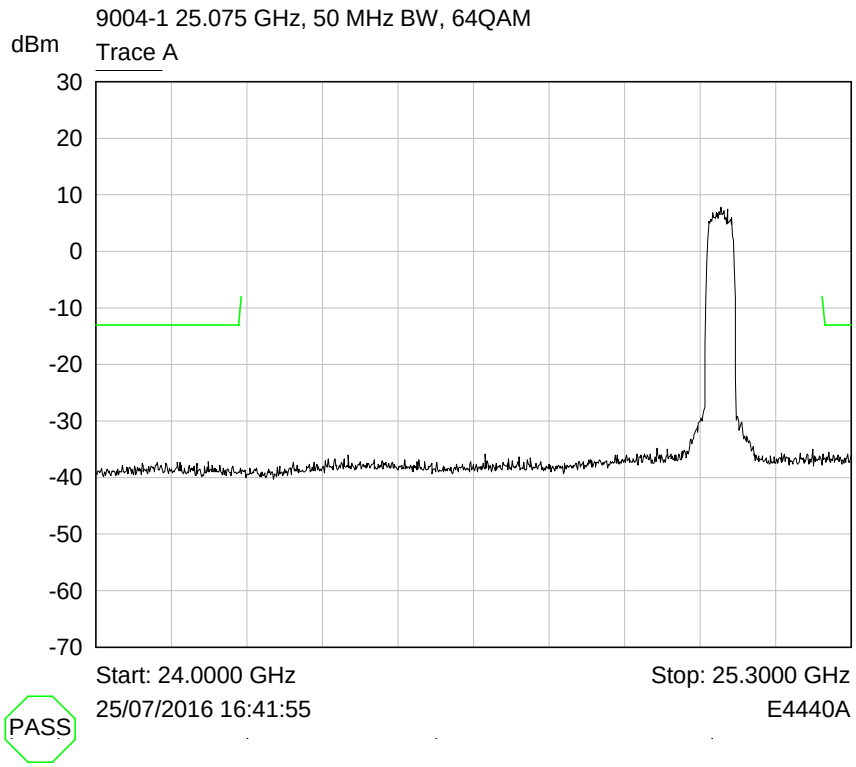
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 100 MHz, Modulation 16QAM, Channel 25.2 GHz



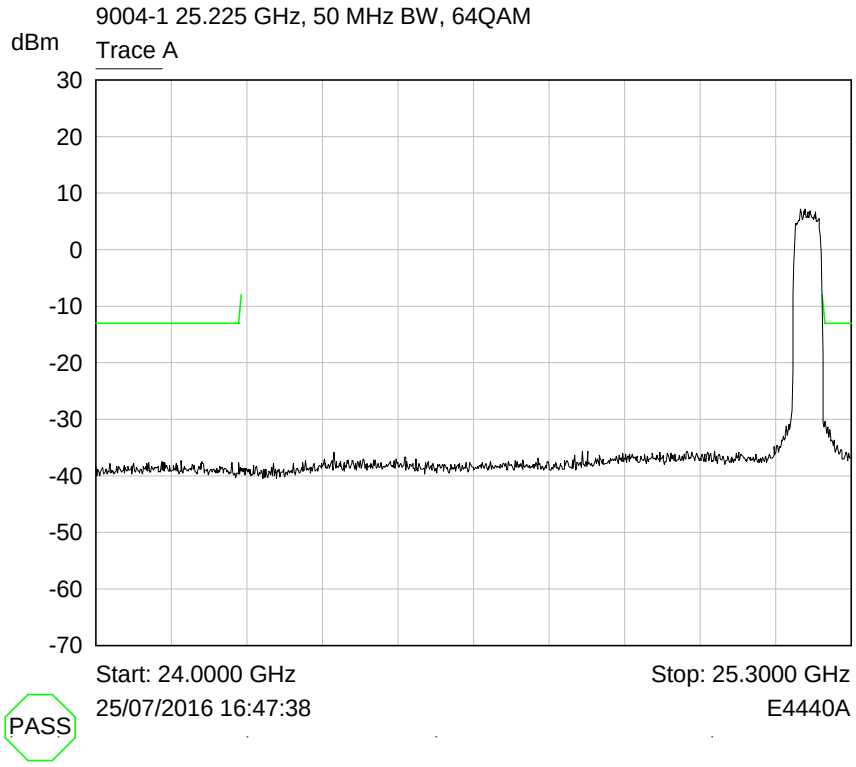
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 50 MHz, Modulation 64QAM, Channel 25.1 GHz



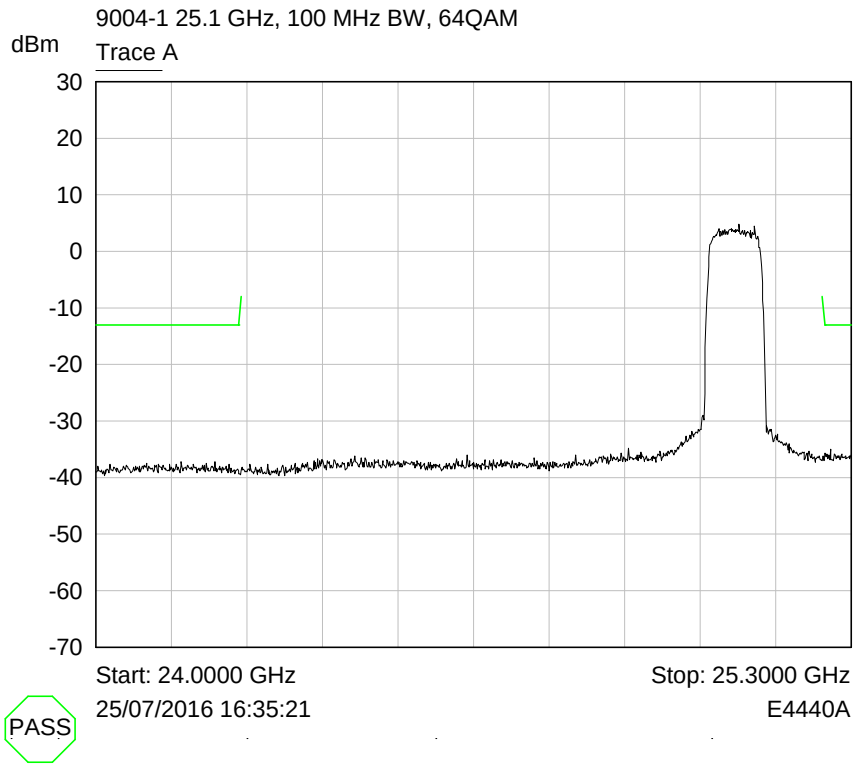
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 50 MHz, Modulation 64QAM, Channel 25.225 GHz



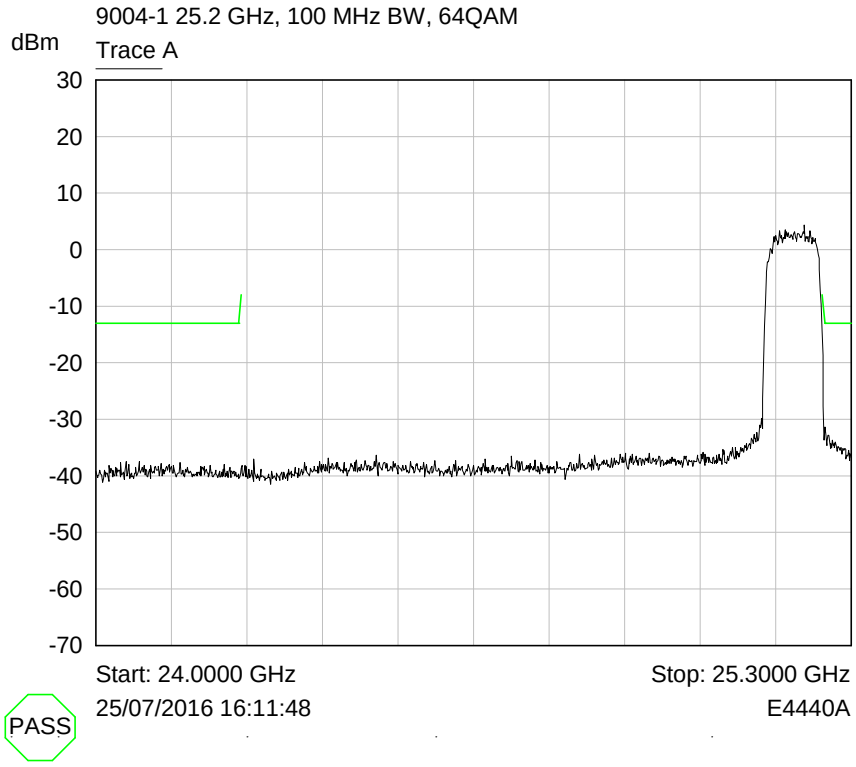
Plot for band edge mask

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 100 MHz, Modulation 64QAM, Channel 25.1 GHz



Plot for band edge mask

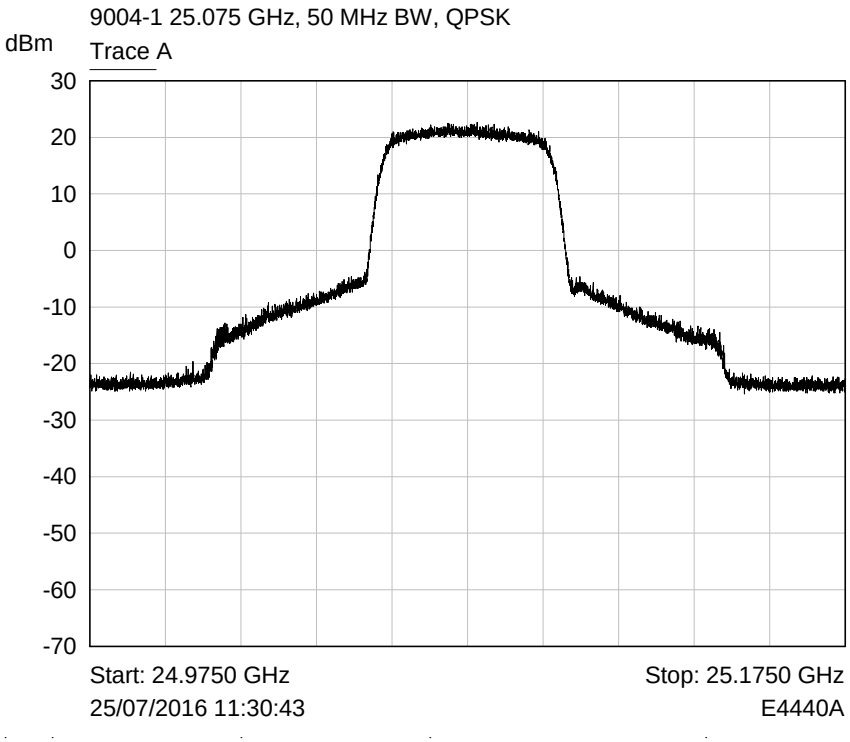
RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 100 MHz, Modulation 64QAM, Channel 25.2 GHz



Plot for band edge mask

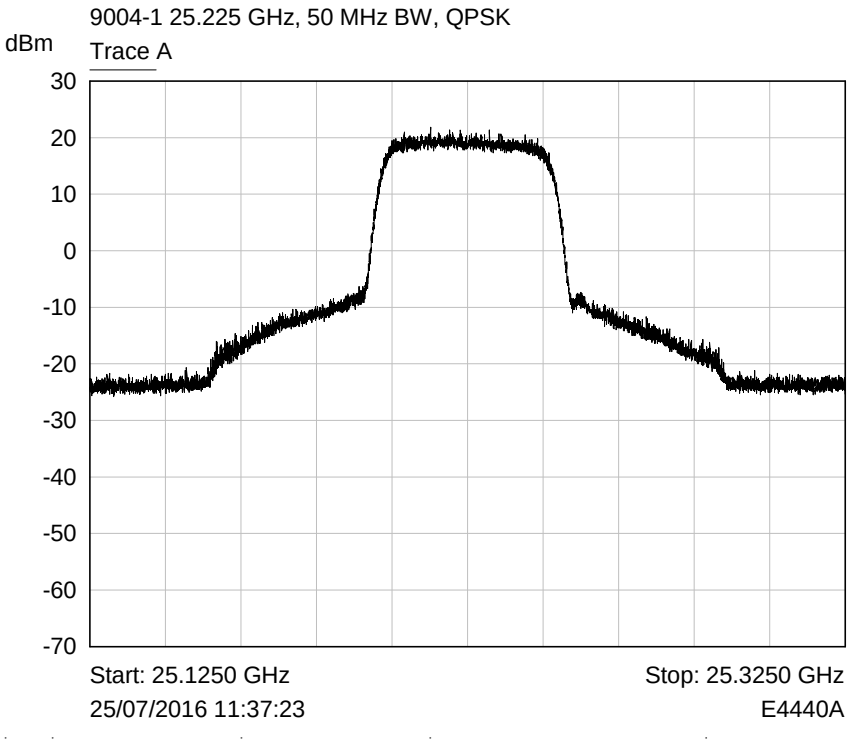
6.4 Modulation characteristics

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 50 MHz, Modulation QPSK, Channel 25.075 GHz



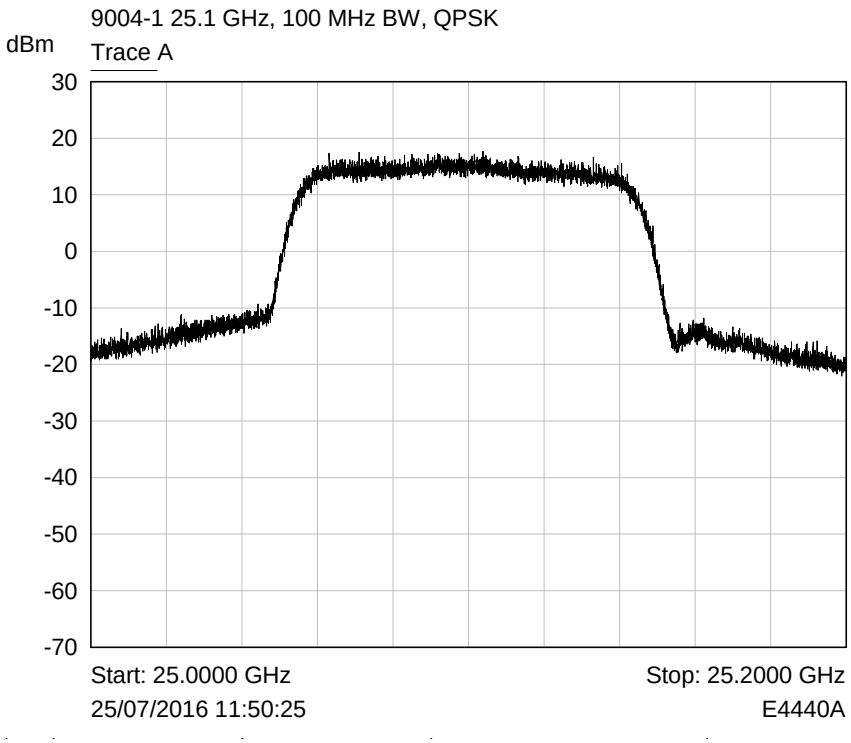
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 50 MHz, Modulation QPSK, Channel 25.225 GHz



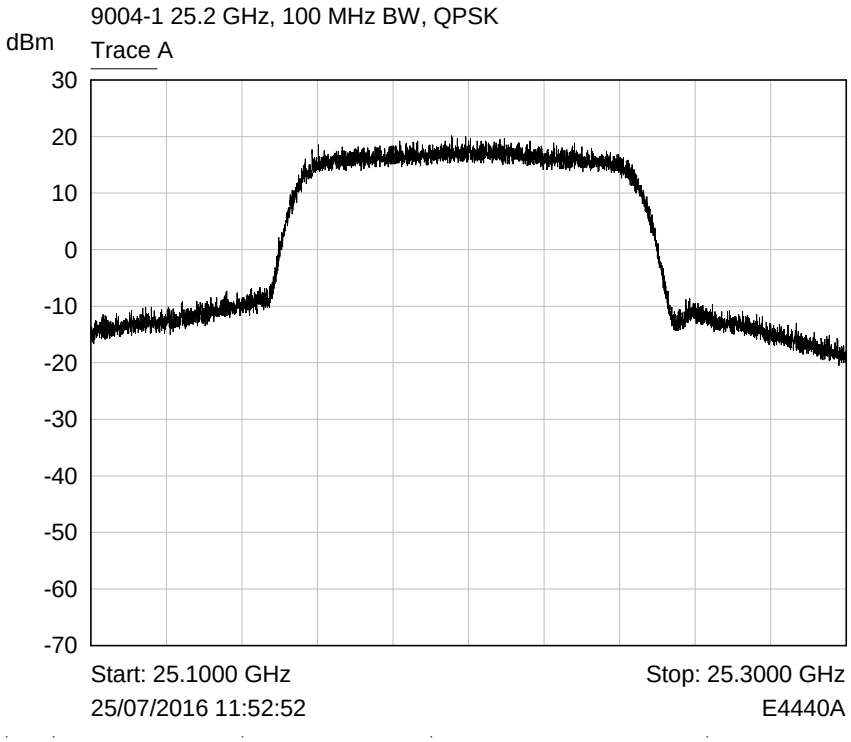
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 25.1 GHz



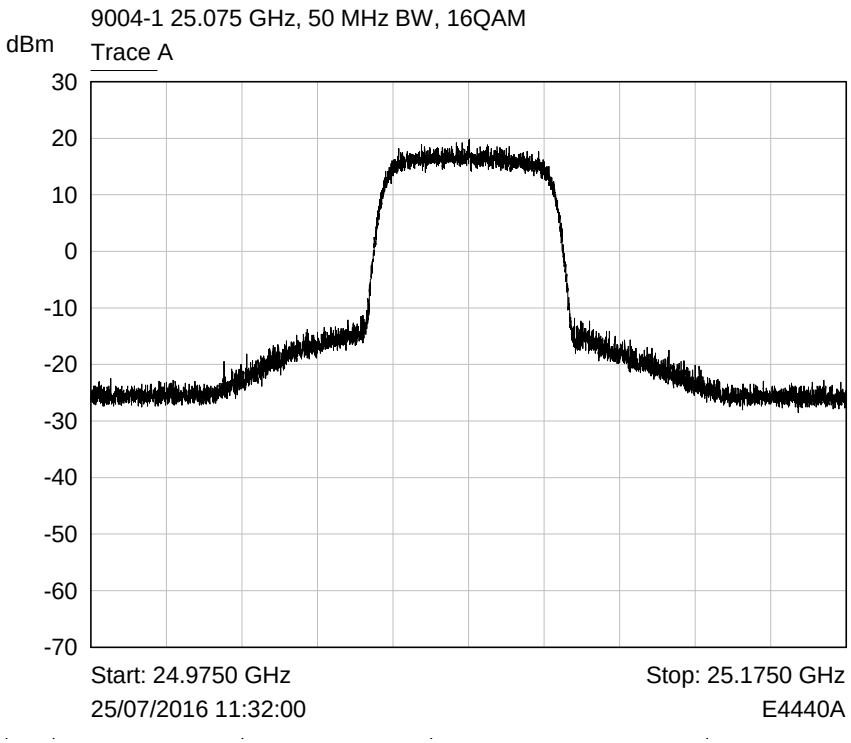
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 25.2 GHz



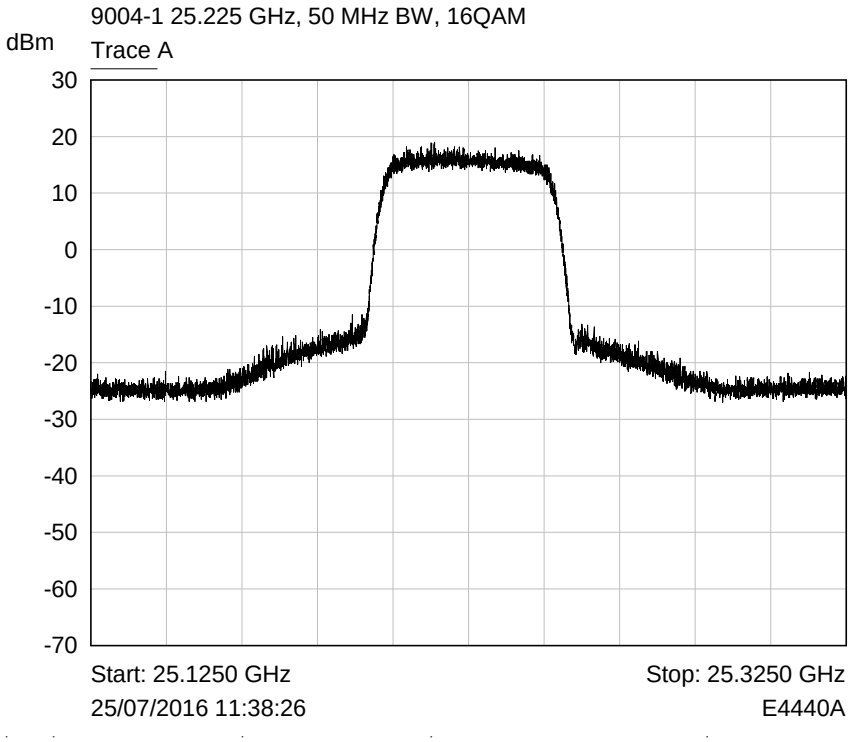
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 50 MHz, Modulation 16QAM, Channel 25.075 GHz



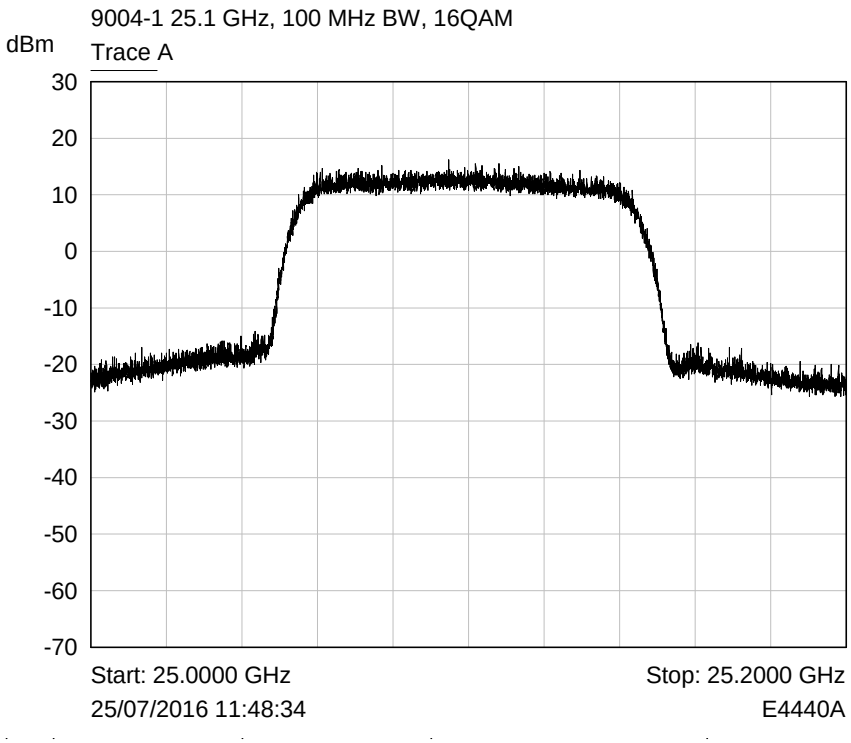
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 50 MHz, Modulation 16QAM, Channel 25.225 GHz



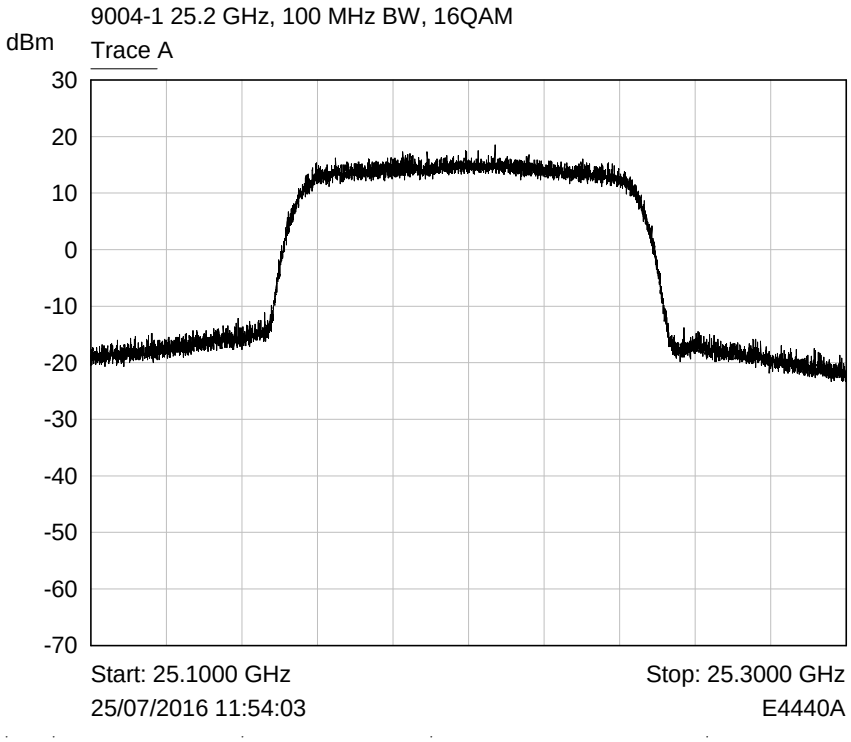
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 100 MHz, Modulation 16QAM, Channel 25.1 GHz



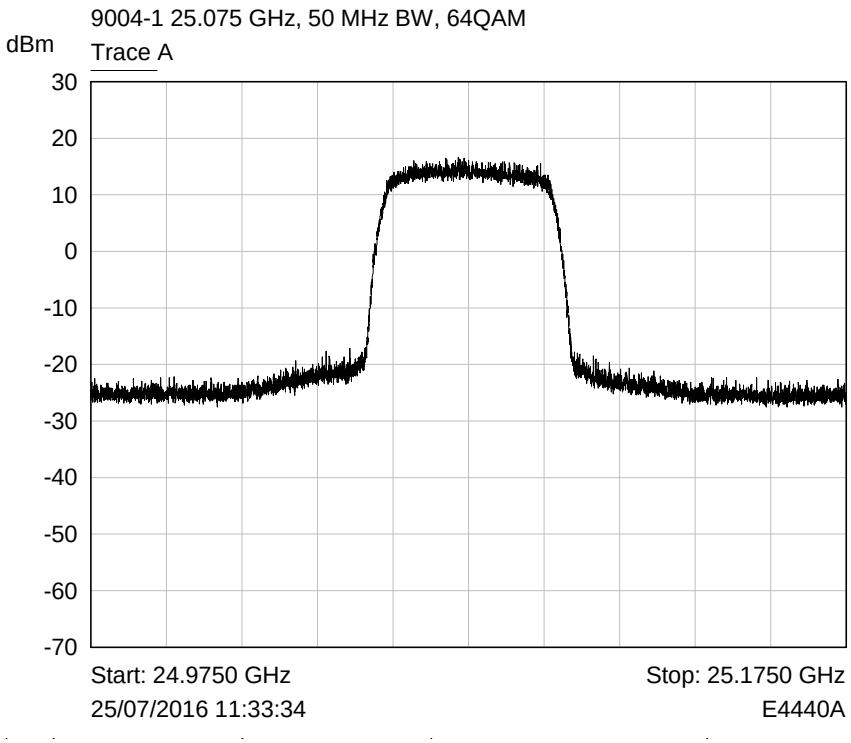
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 22 dBm, Channel Spacing 100 MHz, Modulation 16QAM, Channel 25.2 GHz



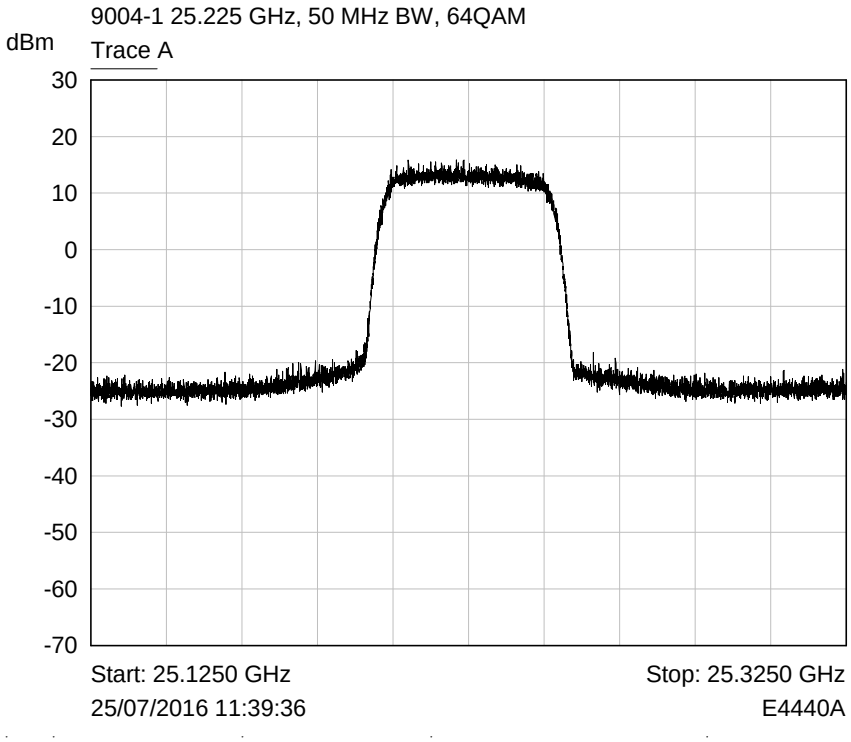
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 50 MHz, Modulation 64QAM, Channel 25.075 GHz



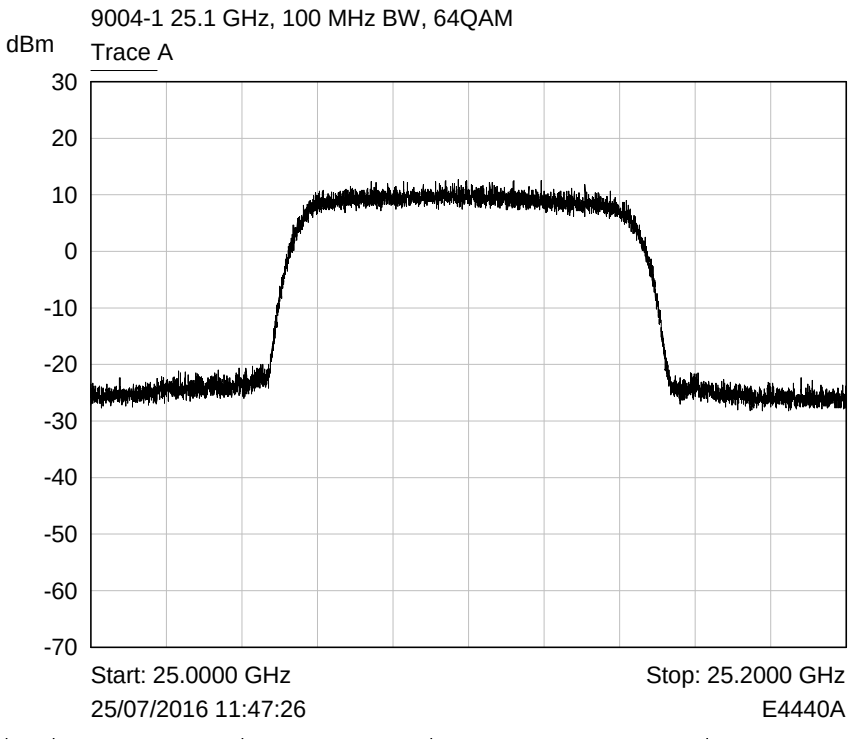
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 50 MHz, Modulation 64QAM, Channel 25.225 GHz



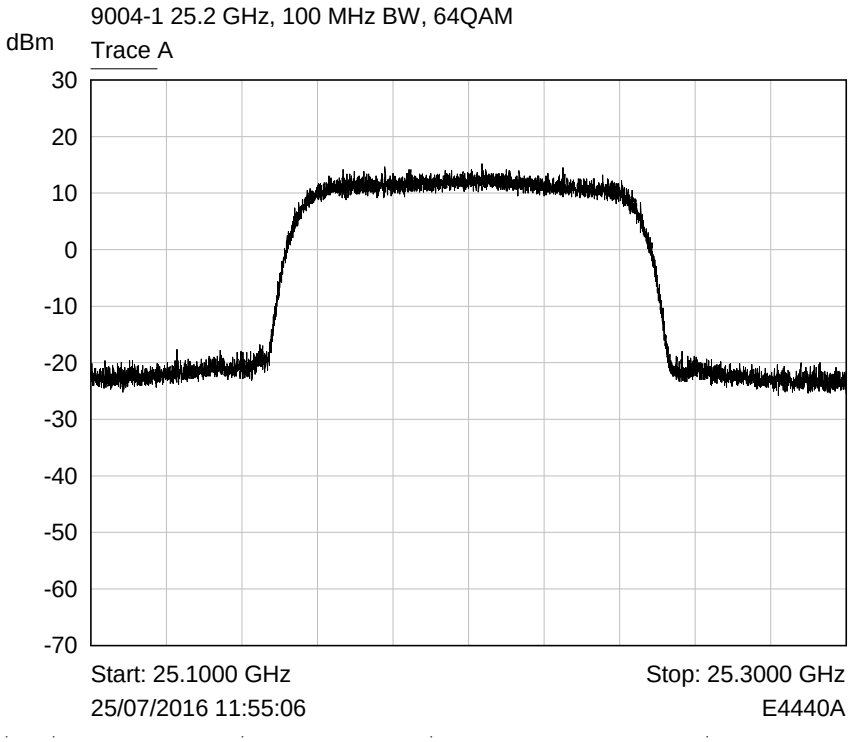
Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 100 MHz, Modulation 64QAM, Channel 25.1 GHz



Plot of modulation

RF Parameters: Band 25.05-25.25 GHz, 19 dBm, Channel Spacing 100 MHz, Modulation 64QAM, Channel 25.2 GHz



Plot of modulation

7 Explanatory Notes

7.1 Explanation of waveguide cut-off frequency

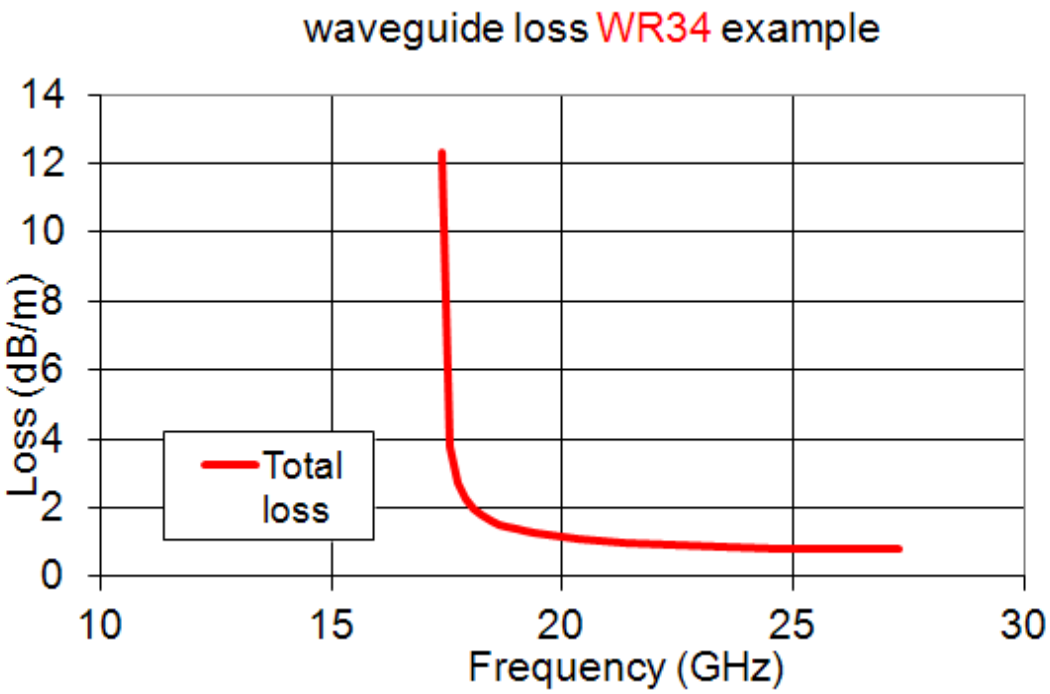
Rationale for lowest conducted emissions test frequency for EUT's using Waveguide RF ports:
In order to determine lowest frequency cut-off of a waveguide the following must be known:
Broadwall (largest) Dimension in mm of waveguide (for purposes of this equation = A)
Speed of light (29.979 cm/ns) (for purposes of this equation = B)
The wavelength (λ) upper frequency cut-off distance in cm (= 2 x A).

Waveguide used by the EUT within this test report is WR34 which has a Broadwall (largest) dimension of = 8.636mm.
Thus:
The wavelength (λ) upper frequency cut-off distance in cm is 2 x 0.8636 = 1.7272cm

The following equation may then be used to calculate the lowest cut off frequency of the waveguide:

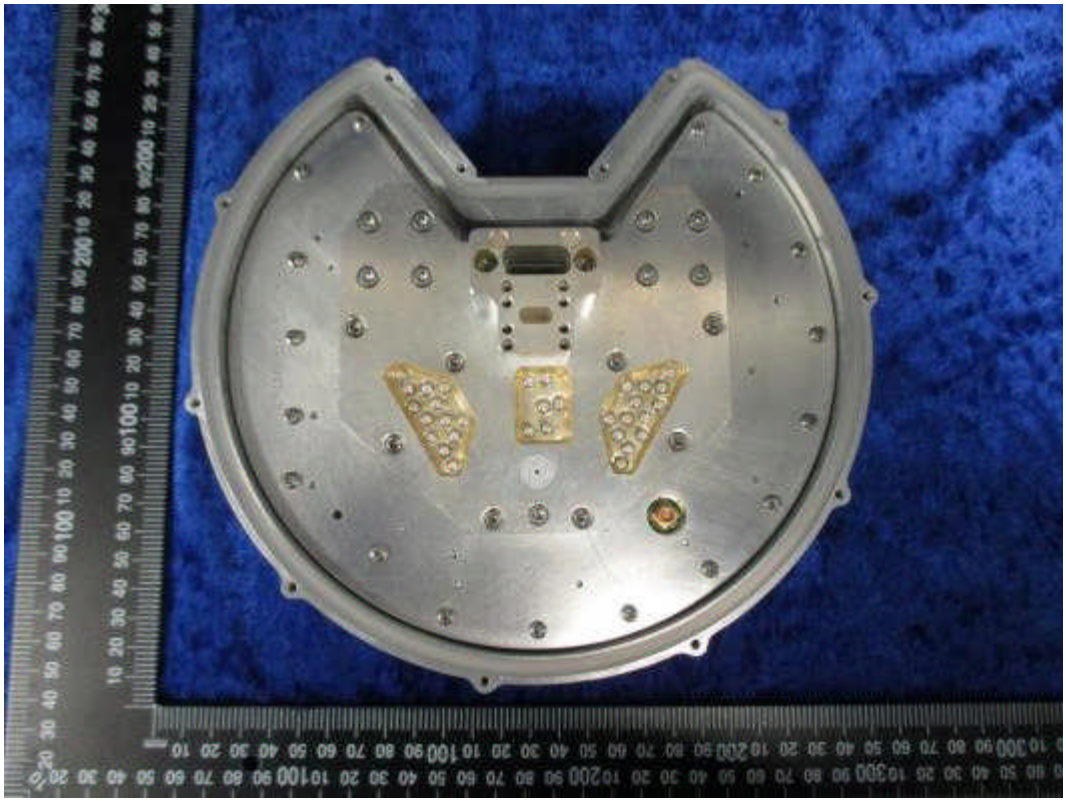
$f_{lowercutoff}$ = (B / 2A)

$f_{lowercutoff}$ = 29.979 / 1.7272 = 17.35699398 GHz.



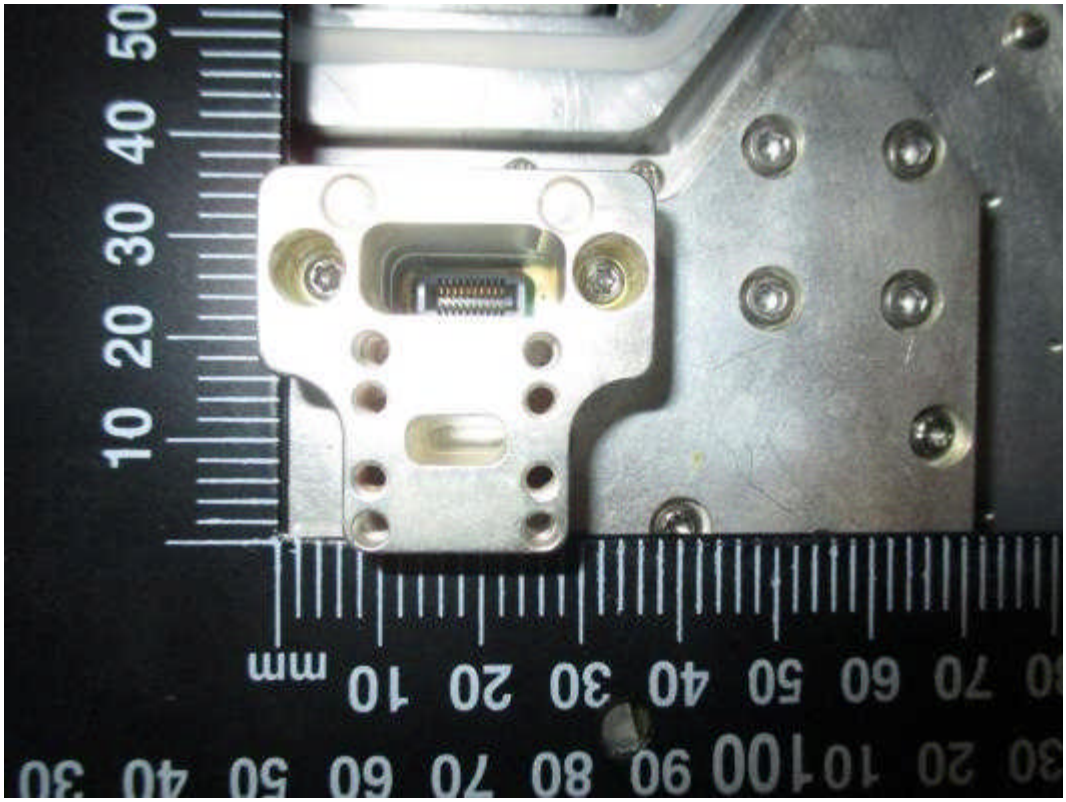
8 Photographs

8.1 EUT Front View



8.2 EUT Reverse Angle

8.3 EUT Antenna Port

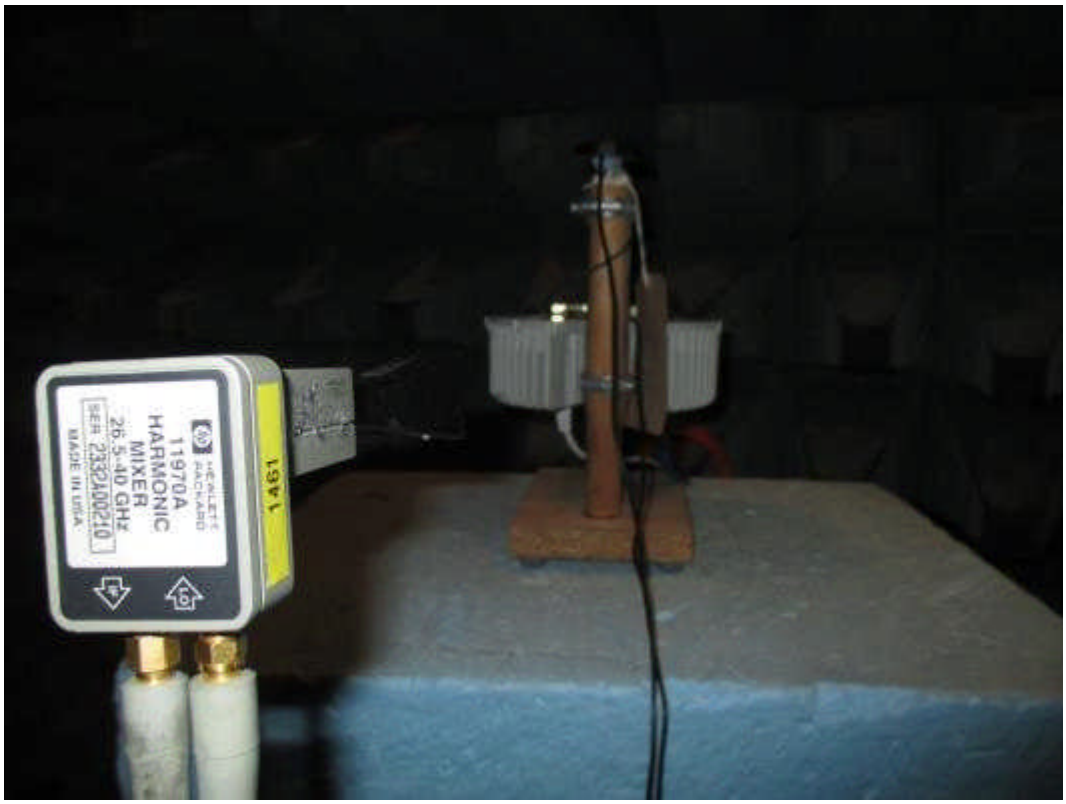


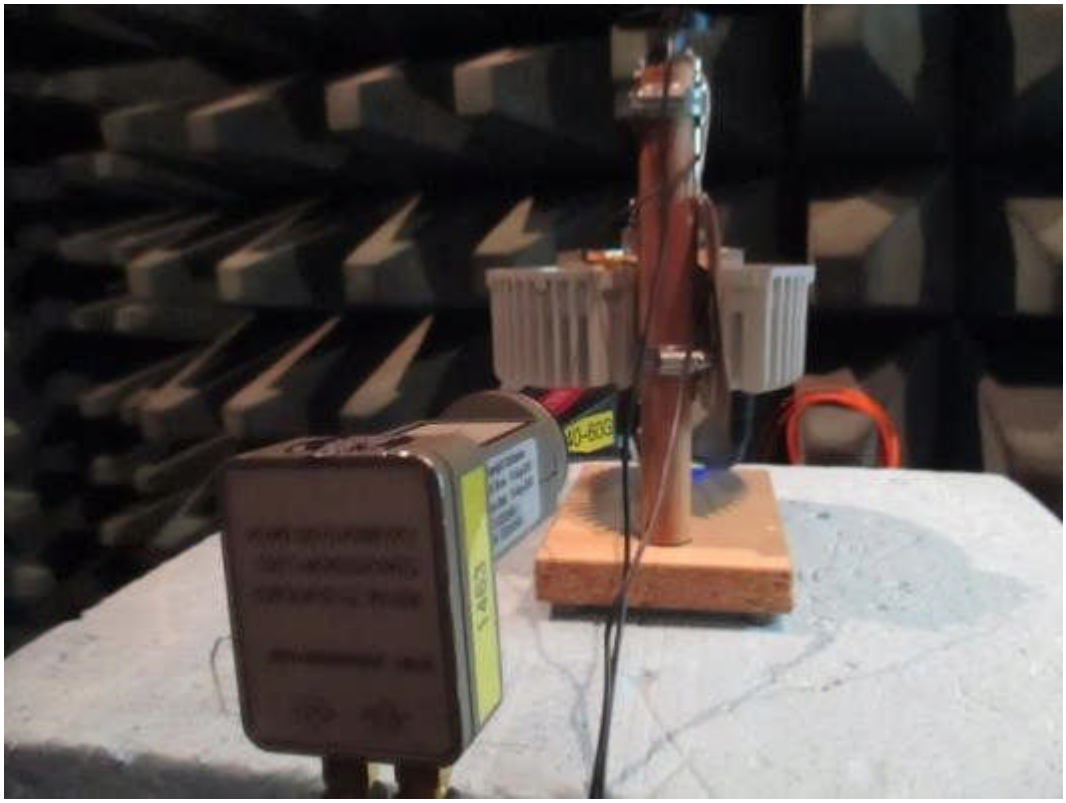
8.4 EUT Display & Controls

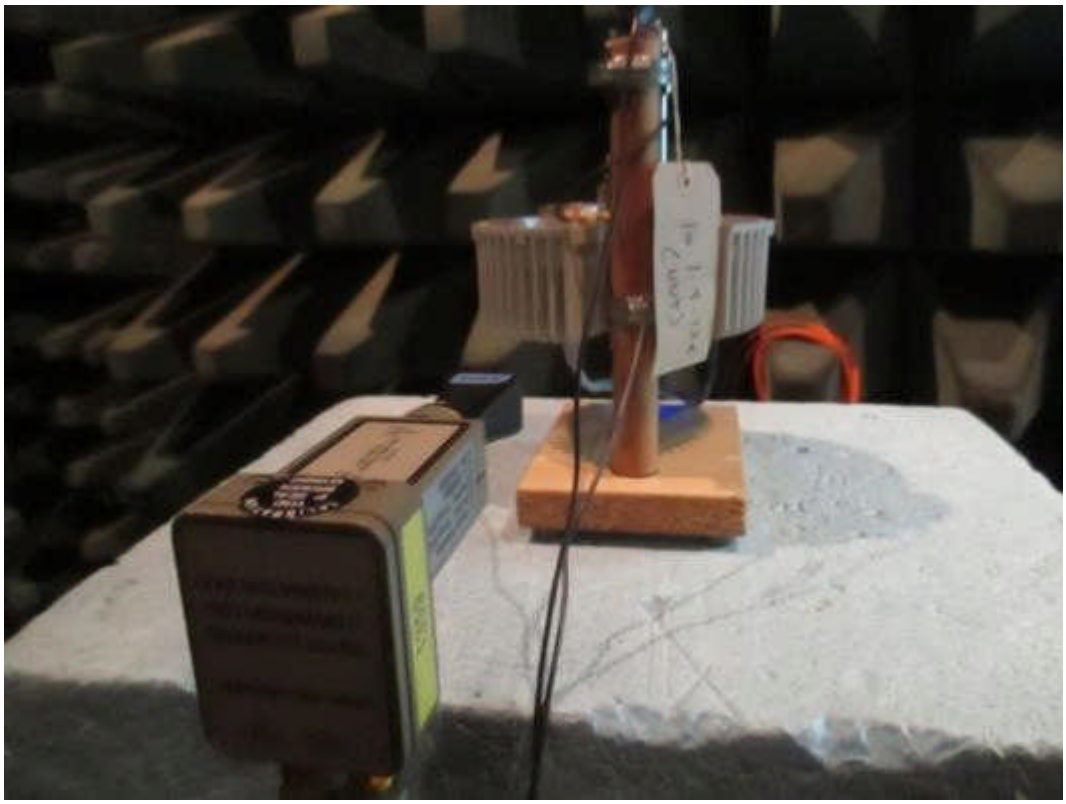
8.5 EUT ID Label

8.6 30-1000MHz Spurious emissions test set-up

8.7 Above 1GHz Spurious emissions test set-up


HEWLETT PACKARD
11970A
HARMONIC MIXER
26.5-40 GHz
SER 2332A00210
MADE IN USA
1461
RF
LO





8.8 Radiated emission diagram

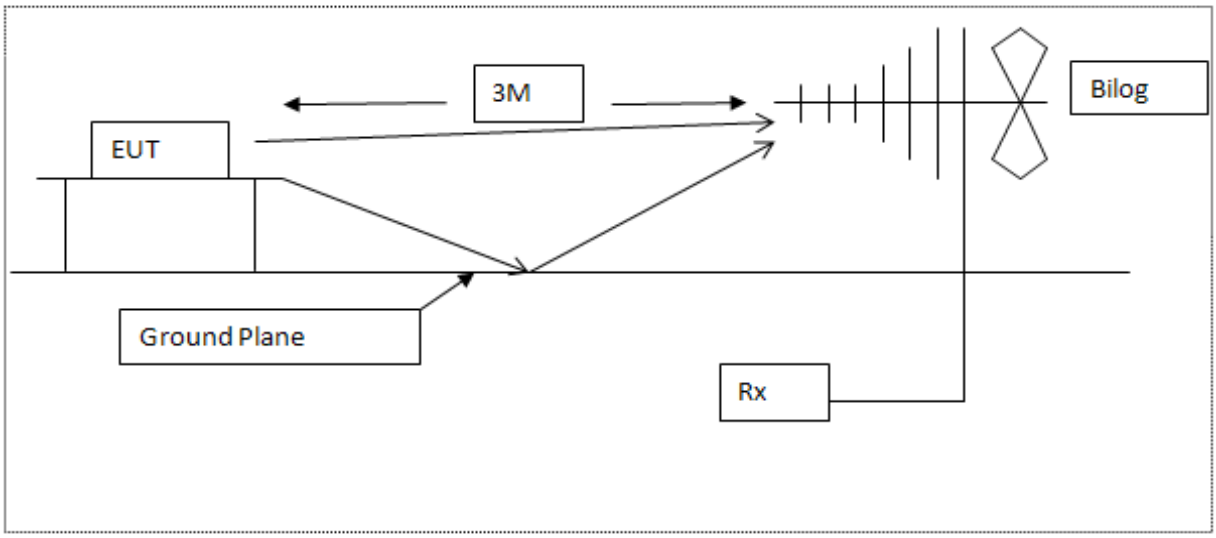


Diagram of the radiated emissions test setup 30 - 1000 MHz

9 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E252	6810.19.A	Attenuator 10 dB	Suhner	*11-Aug-2016	12 months
E268	BHA 9118	1-18 GHz Horn Antenna	Schaffner	08-Apr-2015	24 months
E289	8449B	22-40GHZ opt H40 Block Down Converter	Hewlett Packard	22-Dec-2015	12 months
E291-2	6960B	RF Power Meter	Marconi Instruments	22-Mar-2016	24 months
E296-2	11970A	Harmonic Mixer 26.5-40 GHz	Hewlett Packard	07-Sep-2015	24 months
E296-4	11970U	Harmonic Mixer 40-60 GHz	Hewlett Packard	19-Aug-2015	24 months
E296-5	11970V	Harmonic Mixer 50-75 GHz	Hewlett Packard	20-Aug-2015	24 months
E296-6	11970W	Harmonic Mixer 75-110 GHz	Hewlett Packard	03-Sep-2015	24 months
E301	8493C	Attenuator 20dB 26.5GHz	Hewlett Packard	17-May-2016	12 months
E327	CBL6141A	Bi-log Antenna	Schaffner	20-Jul-2016	24 months
E329	8349B	Microwave Amplifier 2-20 GHz	Hewlett Packard	07-Nov-2015	12 months
E330	2224-20	Flann Horn 26.5-40 GHz	FMI	26-Apr-2016	12 months
E331	22093-KF20	Flann Horn 26.5-40 GHz	FMI	26-Apr-2016	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	06-Jul-2016	24 months
E428	HF906	1-18 GHz Horn Antenna	Rohde & Schwarz	04-Apr-2016	12 months
E434	G3RUH	10MHz GPS Disciplined Oscillator	James Miller	N/A	N/A
E453	20240-20-AA	Std Gain Horn Antenna 17.6 - 26.7 GHz	FMI Ltd	05-May-2016	12 months
E454	18240-20	Std Gain Horn Antenna 11.9 - 18.0 GHz	FMI Ltd	03-Jun-2016	12 months
E455	85100V	Wave Source Module 50 - 75 GHz	Hewlett Packard	19-Sep-2015	24 months
E456	83554A MM	Wave Source Module 26.5 - 40.0 GHz	Hewlett Packard	07-Sep-2015	24 months
E485	11974-60028	Preselector PSU	Agilent Technologies	N/A	N/A
E486	11974A	Pre-select Mixer 26.5 - 40GHz	Agilent Technologies	07-Sep-2015	24 months
E487	11974U	40 - 60GHz Preselect Mixer	Agilent Technologies	13-Jun-2015	24 months
E498	4768-20	Attenuator 20dB 40GHz	Narda	07-Oct-2015	12 months
E503	2524-20	50-75 GHz Horn Antenna	FMI	26-Apr-2016	12 months
E550	11974V	Preselected Mixer 50 - 75GHz	Hewlett Packard	19-May-2015	24 months
E555	CMV 5E-1	5A Variac	Carroll & Meynell Ltd	N/A	N/A
E562	83555A	33-50GHz mm Source	Agilent Technologies	04-Sep-2015	12 months
E579	27240	Standard Gain Horn 75GHz - 110GHz	FMI Ltd	26-Apr-2016	12 months
E580	24240	Standard Gain Horn 40GHz - 60GHz	FMI Ltd	26-Apr-2016	12 months
E602	MG3692A	Signal Generator 10MHz - 20GHz	Anritsu	20-Jan-2015	24 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	22-Dec-2015	24 months
E632	6934	Power Sensor - 50Ω	IFR	26-Aug-2015	12 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Keysight	27-Nov-2015	12 months
L264	DT75	Digital Thermometer	Instrotech Ltd	02-Dec-2015	24 months
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	N/A	N/A
TMS57	2534	Digital Multimeter	Philips	06-Mar-2015	24 months
TMS78	3160-08	Std Gain Horn Antenna 12.4-18 GHz	ETS Systems	03-Jun-2016	12 months
TMS79	3160-09	Std Gain Horn Antenna 18-26.5 GHz	ETS Systems	03-Jun-2016	12 months

* Equipment was in calibration dates for tests and has since been re-calibrated.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	GS108	Network switch	Netgear	21622C3H00FE1
2	E15	Laptop	Acer	NXMLTEK059514097F63400

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
E341	WBH218	Broadband Horn Antenna 1.5 - 18 GHz	Q-par	2532
E442	RN-AFT-2063	Pre-Amplifier 1-2 GHz	RN Electronics Ltd	-
E612	GPS-QBW-20N	GPS Antenna	ANDREW	-

11 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

11.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 Description of test sites

Site A Radio / Calibration Laboratory and anechoic chamber

Site B Semi-anechoic chamber

Site B1 Control Room for Site B

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)
VCCI Registration No. C-2823

Site G Screened Room (Control Room for Site H)

Site H 3m Semi-anechoic chamber (indoor OATS)
FCC Registration No. 293246
IC Registration No. 5612A-2

Site J Screened Room

Site K Screened Room (Control Room for Site M)

Site M 3m Semi-anechoic chamber (indoor OATS)
FCC Registration No. 293246

Site Q Fully-anechoic chamber

Site OATS 3m and 10m Open Area Test Site
FCC Registration No. 293246
IC Registration No. 5612A-1
VCCI Registration No. R-2580

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

13 Abbreviations and units

%	Percent	LBT	Listen Before Talk
µA/m	microAmps per metre	LO	Local Oscillator
µV	microVolts	mA	milliAmps
µW	microWatts	max	maximum
AC	Alternating Current	kPa	Kilopascal
ALSE	Absorber Lined Screened Enclosure	Mbit/s	MegaBits per second
AM	Amplitude Modulation	MHz	MegaHertz
Amb	Ambient	mic	Microphone
ATPC	Automatic Transmit Power Control	min	minimum
BER	Bit Error Rate	mm	milliMetres
ºC	Degrees Celsius	ms	milliSeconds
C/I	Carrier / Interferer	mW	milliWatts
CEPT	European Conference of Postal and Telecommunications Administrations	NA	Not Applicable
COFDM	Coherent OFDM	nom	Nominal
CS	Channel Spacing	nW	nanoWatt
CW	Continuous Wave	OATS	Open Area Test Site
dB	deciBels	OFDM	Orthogonal Frequency Division Multiplexing
dBµA/m	deciBels relative to 1µA/m	ppm	Parts per million
dBµV	deciBels relative to 1µV	PRBS	Pseudo Random Bit Sequence
dBc	deciBels relative to Carrier	QAM	Quadrature Amplitude Modulation
dBm	deciBels relative to 1mW	QPSK	Quadrature Phase Shift Keying
DC	Direct Current	R&TTE	Radio and Telecommunication Terminal Equipment
DTA	Digital Transmission Analyser	Ref	Reference
EIRP	Equivalent Isotropic Radiated Power	RF	Radio Frequency
ERP	Effective Radiated Power	RFC	Remote Frequency Control
EU	European Union	RSL	Received Signal Level
EUT	Equipment Under Test	RTP	Room Temperature and Pressure
FM	Frequency Modulation	RTPC	Remote Transmit Power Control
FSK	Frequency Shift Keying	Rx	Receiver
g	Grams	s	Seconds
GHz	GigaHertz	SINAD	Signal to Noise And Distortion
Hz	Hertz	Tx	Transmitter
IF	Intermediate Frequency	V	Volts
kHz	kiloHertz		