Radio Test Report

Cambridge Communication Systems Ltd

Metnet

V4

47 CFR Part 101C
47 CFR Part 2J
Effective Date 1st October 2014

Test Date: 23rd June 2015 to 3rd August 2015
Report Number: 08-8048-2-15 Issue 01

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Certificate of Test 8048-2

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:	V4
Unique Serial Number:	000227
Manufacturer:	Cambridge Communication Systems Ltd 2362, 3rd Floor, Mount Pleasant House Huntingdon Road Cambridge CB3 0RN
Full measurement results are detailed in Report Number:	08-8048-2-15 Issue 01
Test Standards:	47 CFR Part 101C 47 CFR Part 2J Effective Date 1st October 2014 Class TNB intentional radiator

DEVIATIONS:
Deviations have not 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: 23rd June 2015 to 3rd August 2015

Test Engineer: Ian Rose
Digitally signed by: Ian Rose
DN: CN = Ian Rose email = Ian@rnnelectronics.com C = GB O = RN Electronics
Date: 2015.09.24 09:03:25 Z

Approved By:
Technical Director

Customer Representative:

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Cambridge Communication Systems Ltd 2362 3rd Floor Mount Pleasant House Huntingdon Road Cambridge CB3 0RN	
Manufacturer of EUT	Cambridge Communication Systems Ltd	
Brand name of EUT	Metnet	
Model Number of EUT	V4	
Serial Number of EUT	000227	
Date Received	13th May 2015	
Date of Test:	23rd June 2015 to 3rd August 2015	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Created	26th August 2015	
Visual Description	A cylindrical cast aluminium housing with integrated heatsink fins. Underside of unit houses two Ethernet ports and an AC power port along with LED indicators. The top side houses a diplexer with a waveguide port for connection to an antenna. Provision is made for an overall cover to provide environmental protection.	
Main Function	28GHz wireless backhaul	
Information Specification	Height	185 mm
	Width	202 mm diameter
	Depth	202 mm diameter
	Weight	4.5 kg
	Voltage	90-265 VAC
	Current	0.15 A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Mounted on lamp post
Choice of model(s) for type tests	Production models
Antenna details	Integral 16 sector antenna
Antenna port	WR34
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	29.156 GHz
Lowest Signal generated in EUT	25 MHz
TX Parameters	
Alignment range – transmitter	27.5-29.5 GHz
EUT Declared Modulation Parameters	QPSK, 16QAM, 64QAM
EUT Declared Power level	25dBm (QPSK), 21dBm (16QAM), 18dBm (64QAM)
EUT Declared Signal Bandwidths	100 MHz and 112 MHz
EUT Declared Channel Spacing's	100 MHz and 112 MHz
EUT Declared Duty Cycle	100 % for test, actual duty is dependent on capacity requirements and network topology
Unmodulated carrier available?	Yes
Declared frequency stability	+/-2.5 ppm over 20 years

Fixed Link Parameters	
Station Type	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	112 MHz
EMO/ChS System Type	Multi rate, multi format
Gross Bit Rate	4.29 (480 Mbps in 112 MHz)
ATPC used	ATPC2
ATPC Power Range	16 dB
ATPC Tolerance	+/-1 dB
Activation Threshold	RSSI -54 dBm
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 of 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 measurement
RTPC used	RTPC2
RTPC Power Range	16 dB
RTPC Step Size	1 dB
RFC used	Not used
RFC Frequency Range	Not applicable
RFC Frequency Tolerances	Not applicable
Frequency Error Long Term (ageing)	+/-2.5 ppm / 20 years
Frequency Error Long Term (years)	+/-4.6 ppm
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

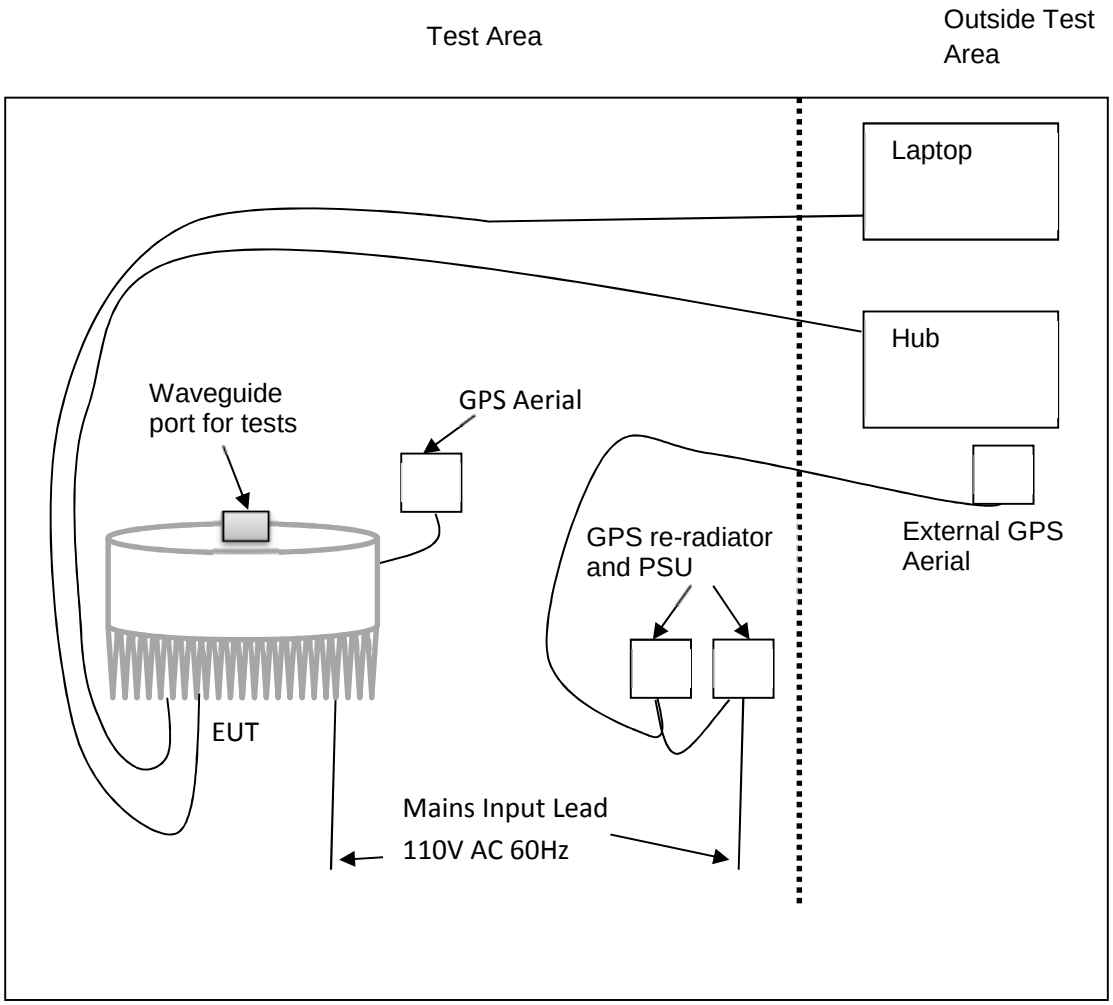
2.3 Functional description

The product is a 28GHz self-organising 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	27.556GHz, 100MHz BW, QPSK	Yes
TX2	27.556GHz, 112MHz BW, QPSK	Yes
TX3	27.556GHz, 100MHz BW, 16QAM	Yes
TX4	27.556GHz, 112MHz BW, 16QAM	Yes
TX5	27.556GHz, 100MHz BW, 64QAM	Yes
TX6	27.556GHz, 112MHz BW, 64QAM	Yes
TX7	28.2485GHz, 100MHz BW, QPSK	Yes
TX8	28.2485GHz, 112MHz BW, QPSK	Yes
TX9	28.2485GHz, 100MHz BW, 16QAM	Yes
TX10	28.2485GHz, 112MHz BW, 16QAM	Yes
TX11	28.2485GHz, 100MHz BW, 64QAM	Yes
TX12	28.2485GHz, 112MHz BW, 64QAM	Yes
TX13	29.156GHz, 100MHz BW, QPSK	Yes
TX14	29.156GHz, 112MHz BW, QPSK	Yes
TX15	29.156GHz, 100MHz BW, 16QAM	Yes
TX16	29.156GHz, 112MHz BW, 16QAM	Yes
TX17	29.156GHz, 100MHz BW, 64QAM	Yes
TX18	29.156GHz, 112MHz BW, 64QAM	Yes
TX19	27.556GHz, CW tone	Yes
TX20	28.2485GHz, CW tone	Yes
TX21	29.156GHz, CW tone	Yes

2.5 Emissions configuration



The unit was powered from the AC mains. All conducted tests were performed at the waveguide port. For radiated emissions tests a transition with a 10 dB attenuator plus load were fitted to the waveguide port. The unit also required a GPS lock in order to operate. To obtain a GPS signal for the EUT a second external GPS antenna was connected to an internal GPS re-radiator antenna located in close proximity to the EUT. The EUT was set-up and controlled from a laptop connected via Ethernet and by using a terminal window to communicate via the EUT's IP address. Special GUI software control was provided by CCS Ltd to access and set-up the EUT channel frequency, power level and modulation scheme. However, only the 112 MHz signal bandwidth was supported by this interface. For tests associated with the 100 MHz signal bandwidth setting the EUT had to be sent direct SSH commands from the terminal window. The direct commands also allowed setting of power and modulation scheme. For all tests performed using the 112 MHz bandwidth setting the EUT TX duty cycle was 100%. For all tests using the 100 MHz bandwidth setting the following EUT duty cycles were measured and accounted for in applicable tests: -

QPSK 73.5 %
16QAM 62.8 %
64QAM 56.9 %

Refer to section 2.4 of this report for further information on modes of test.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Power	Bulgin PX0410 unscreened 3 core mains cable	Yes
Ethernet 0	Bulgin PX0835 UTP CAT5 cable	Yes
Ethernet 1	Bulgin PX0835 UTP CAT5 cable	Yes

3 Summary of test results

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

47 CFR Part 101C & 47 CFR Part 2J
Effective Date 1st October 2014, Class TNB intentional radiator

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	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	2014	Part 101 – Fixed Microwave Services
4.1.2	47CFR part 2J	2014	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	2009	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-C	2004	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards, Telecommunications Industry Association, November, 2002.

R.N. Electronics Ltd sites H, M and OATS are listed with the FCC. Registration Number 293246

4.2 Deviations

Deviations have not 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	110 V AC
T minimum	-30 °C	V minimum	93.5 V AC
T maximum	50 °C	V maximum	126.5 V 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: -

36-55 %; 101-102 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], TIA-603-C [Reference 4.1.6 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 100 MHz or 112 MHz bandwidth settings were found to be worst case for emissions and therefore the EUT was operated in TX1, TX7 and TX13 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 17 GHz up to 100 GHz was made, to identify any signals within 20dB of the limits. The 17 GHz start frequency was used as the EUT's WR34 waveguide ports lowest cut-off frequency is stated as 17.3 Hz. 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 modulation characteristics section.

The EUT was tested in Site A.

5.1.4 Test equipment

E296-6, E412, E433, E486, E489, E490, E576, E577, E599, E600, E498, E487, E550, E329, E455, E522, E561, E324, E555

See Section 9 for more details

5.1.5 Test results

Temperature of test environment	22-24 °C
Humidity of test environment	38-55 %
Pressure of test environment	101-102 kPa

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	28.2485 GHz

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

Plot Reference
J8048-2 28.2485GHz QPSK 100MHz BW 17 - 18GHz
J8048-2 28.2485GHz QPSK 100MHz BW 18 - 22GHz
J8048-2 28.2485GHz QPSK 100MHz BW 22 - 26GHz
J8048-2 28.2485GHz QPSK 100MHz BW 26 - 26.5GHz
J8048-2 28.2485GHz QPSK 100MHz BW 26.5 - 30GHz
J8048-2 28.2485GHz QPSK 100MHz BW 30 - 34GHz
J8048-2 28.2485GHz QPSK 100MHz BW 34 - 38GHz
J8048-2 28.2485GHz QPSK 100MHz BW 38 - 40GHz
J8048-2 28.2485GHz QPSK 100MHz BW 40 - 44GHz
J8048-2 28.2485GHz QPSK 100MHz BW 44 - 48GHz
J8048-2 28.2485GHz QPSK 100MHz BW 48 - 52GHz
J8048-2 28.2485GHz QPSK 100MHz BW 52 - 56GHz
J8048-2 28.2485GHz QPSK 100MHz BW 56 - 60GHz
J8048-2 28.2485GHz QPSK 100MHz BW 60 - 64GHz
J8048-2 28.2485GHz QPSK 100MHz BW 64 - 68GHz
J8048-2 28.2485GHz QPSK 100MHz BW 68 - 72GHz
J8048-2 28.2485GHz QPSK 100MHz BW 72 - 75GHz
J8048-2 28.2485GHz QPSK 100MHz BW 75 - 79GHz
J8048-2 28.2485GHz QPSK 100MHz BW 79 - 83GHz
J8048-2 28.2485GHz QPSK 100MHz BW 83 - 87GHz
J8048-2 28.2485GHz QPSK 100MHz BW 87 - 91GHz
J8048-2 28.2485GHz QPSK 100MHz BW 91 - 95GHz
J8048-2 28.2485GHz QPSK 100MHz BW 95 - 99GHz
J8048-2 28.2485GHz QPSK 100MHz BW 99 - 100GHz

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 modulation characteristics section. Whilst low, middle and high channels have been fully tested, only middle channel plots across the entire spectrum are shown within this report to minimise report size.

LIMITS:
Part 101.111, -13 dBm

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:
<± 3.6 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-C [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 TX1 - TX18 modes for this test. 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. For test modes not utilising 100% duty cycle, a duty cycle correction was performed on the result using the following equation: 10.Log(100/x) where x is the duty cycle in percent, this was performed in the power meter and confirmed by calculation.

Measurements were made on a test bench in site A.

5.2.4 Test equipment

E291-2, E412, E312, E490, E615, E289

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	20 °C
Humidity of test environment	40 %
Pressure of test environment	102 kPa

Band	27.5-28.35 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	27.556 GHz
High channel	28.2485 GHz

Test conditions		Carrier Power (dBm) Low	Carrier Power (dBm) High
Temp Ambient	Volts Nominal	23.20	23.50
Maximum TX Power observed (dBm)		23.20	23.50
Variation in TX power observed (dB)		-1.80	-1.50

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	29.156 GHz

Test conditions		Carrier Power (dBm)
		Low
Temp Ambient	Volts Nominal	23.30
Maximum TX Power observed (dBm)		23.30
Variation in TX power observed (dB)		-1.70

Band	27.5-28.35 GHz
Power Level	25 dBm
Channel Spacing	112 MHz
Mod Scheme	QPSK
Low channel	27.556 GHz
High channel	28.2485 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	23.83	23.43
Maximum TX Power observed (dBm)		23.83	23.43
Variation in TX power observed (dB)		-1.17	-1.57

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	112 MHz
Mod Scheme	QPSK
Low channel	29.156 GHz

Test conditions		Carrier Power (dBm)
		Low
Temp Ambient	Volts Nominal	23.80
Maximum TX Power observed (dBm)		23.80
Variation in TX power observed (dB)		-1.20

Band	27.5-28.35 GHz
Power Level	21 dBm
Channel Spacing	100 MHz
Mod Scheme	16 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	20.26	19.96
Maximum TX Power observed (dBm)		20.26	19.96
Variation in TX power observed (dB)		-0.74	-1.04

Band	29.1-29.25 GHz
Power Level	21 dBm
Channel Spacing	100 MHz
Mod Scheme	16 QAM
Low channel	29.156 GHz

Test conditions		Carrier Power (dBm)
		Low
Temp Ambient	Volts Nominal	19.70
Maximum TX Power observed (dBm)		19.70
Variation in TX power observed (dB)		-1.30

Band	27.5-28.35 GHz
Power Level	21 dBm
Channel Spacing	112 MHz
Mod Scheme	16 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	21.12	20.85
Maximum TX Power observed (dBm)		21.12	20.85
Variation in TX power observed (dB)		0.12	-0.15

Band	29.1-29.25 GHz
Power Level	21 dBm
Channel Spacing	112 MHz
Mod Scheme	16 QAM
Low channel	29.156 GHz

Test conditions		Carrier Power (dBm)
		Low
Temp Ambient	Volts Nominal	20.96
Maximum TX Power observed (dBm)		20.96
Variation in TX power observed (dB)		-0.04

Band	27.5-28.35 GHz
Power Level	18 dBm
Channel Spacing	100 MHz
Mod Scheme	64 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	17.40	17.15
Maximum TX Power observed (dBm)		17.40	17.15
Variation in TX power observed (dB)		-0.6 / -0.85	-0.85

Band	29.1-29.25 GHz
Power Level	18 dBm
Channel Spacing	100 MHz
Mod Scheme	64 QAM
Low channel	29.156 GHz

Test conditions		Carrier Power (dBm)
		Low
Temp Ambient	Volts Nominal	17.34
Maximum TX Power observed (dBm)		17.34
Variation in TX power observed (dB)		-0.66

Band	27.5-28.35 GHz
Power Level	18 dBm
Channel Spacing	112 MHz
Mod Scheme	64 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

Test conditions		Carrier Power (dBm)	Carrier Power (dBm)
		Low	High
Temp Ambient	Volts Nominal	18.56	18.39
Maximum TX Power observed (dBm)		18.56	18.39
Variation in TX power observed (dB)		0.56	0.39

Band	29.1-29.25 GHz
Power Level	18 dBm
Channel Spacing	112 MHz
Mod Scheme	64 QAM
Low channel	29.156 GHz

Test conditions		Carrier Power (dBm)
		Low
Temp Ambient	Volts Nominal	18.40
Maximum TX Power observed (dBm)		18.40
Variation in TX power observed (dB)		0.40

LIMITS:
Part 101.113, +55 dBW ERP

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: -
<± 0.82 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-C [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 a test fixture. The EUT was operated in TX19 and TX20 and TX21 mode 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.
Tests were performed using Test Site A.

5.3.4 Test equipment

E555, L264, TMS38, TMS57, LPE377

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	24 °C
Humidity of test environment	36 %
Pressure of test environment	101 kPa

Band	27.5-28.35 GHz
Power Level	25 dBm
Channel Spacing	N/A
Mod Scheme	CW Tone
Low channel	27.556 GHz
High channel	28.2485 GHz

Test conditions		Frequency Reading (MHz) Low	Frequency Reading (MHz) High
-30°C	Volts Nominal (110)	0.000027	0.000052
-20°C	Volts Nominal (110)	0.000033	-0.000023
-10°C	Volts Nominal (110)	-0.000028	0.000052
0°C	Volts Nominal (110)	-0.000014	0.000003
10°C	Volts Nominal (110)	-0.000008	0.000022
20°C	Volts Minimum (93.5)	-0.000022	0.000013
	Volts Nominal (110)	0.000009	0.000017
	Volts Maximum (126.5)	-0.000005	0.000012
30°C	Volts Nominal (110)	-0.000010	-0.000001
40°C	Volts Nominal (110)	-0.000007	0.000006
50°C	Volts Nominal (110)	-0.000003	0.000014
Max Frequency Error per chan (Hz)		+33 / -28	+52 / -23
Max Frequency Error observed (MHz)		0.000033	0.000052

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	N/A
Mod Scheme	CW Tone
Low channel	29.156 GHz

Test conditions		Frequency Reading (MHz) Low
-30°C	Volts Nominal (110)	0.000035
-20°C	Volts Nominal (110)	0.000046
-10°C	Volts Nominal (110)	-0.000019
0°C	Volts Nominal (110)	-0.000002
10°C	Volts Nominal (110)	0.000002
20°C	Volts Minimum (93.5)	-0.000021
	Volts Nominal (110)	0.000004
	Volts Maximum (126.5)	-0.000030
30°C	Volts Nominal (110)	0.000014
40°C	Volts Nominal (110)	-0.000020
50°C	Volts Nominal (110)	-0.000015
Max Frequency Error per chan (Hz)		+46 / -30
Max Frequency Error observed (MHz)		0.000046

Maximum variation observed was +0.00000018%

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-C [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 tested whilst connected to the AC power for maximised emissions. The EUT was operated in TX1 - TX18 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 2.4MHz RBW, 8MHz 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

E412, E615, E490, E485, E486

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	22 °C
Humidity of test environment	40 %
Pressure of test environment	102 kPa

Band	27.5-28.35 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
99% Bandwidth (MHz)	94.3289	93.6022
Plot reference	8048-2 Low chan QPSK 100MHz BW	8048-2 Mid chan QPSK 100MHz BW

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	29.156 GHz

	Low
99% Bandwidth (MHz)	92.7633
Plot reference	8048-2 Top chan QPSK 100MHz BW

Band	27.5-28.35 GHz
Power Level	25 dBm
Channel Spacing	112 MHz
Mod Scheme	QPSK
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
99% Bandwidth (MHz)	102.7597	102.6486
Plot reference	8048-2 Low chan QPSK 112MHz BW	8048-2 Mid chan QPSK 112MHz BW

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	112 MHz
Mod Scheme	QPSK
Low channel	29.156 GHz

	Low
99% Bandwidth (MHz)	102.0034
Plot reference	8048-2 Top chan QPSK 112MHz BW

Band	27.5-28.35 GHz
Power Level	21 dBm
Channel Spacing	100 MHz
Mod Scheme	16 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
99% Bandwidth (MHz)	93.3481	93.7812
Plot reference	8048-2 Low chan 16QAM 100MHz BW	8048-2 Mid chan 16QAM 100MHz BW

Band	29.1-29.25 GHz
Power Level	21 dBm
Channel Spacing	100 MHz
Mod Scheme	16 QAM
Low channel	29.156 GHz

	Low
99% Bandwidth (MHz)	93.3225
Plot reference	8048-2 Top chan 16QAM 100MHz BW

Band	27.5-28.35 GHz
Power Level	21 dBm
Channel Spacing	112 MHz
Mod Scheme	16 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
99% Bandwidth (MHz)	103.4069	102.4179
Plot reference	8048-2 Low chan 16QAM 112MHz BW	8048-2 Mid chan 16QAM 112MHz BW

Band	29.1-29.25 GHz
Power Level	21 dBm
Channel Spacing	112 MHz
Mod Scheme	16 QAM
Low channel	29.156 GHz

	Low
99% Bandwidth (MHz)	102.1328
Plot reference	8048-2 Top chan 16QAM 112MHz BW

Band	27.5-28.35 GHz
Power Level	18 dBm
Channel Spacing	100 MHz
Mod Scheme	64 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
99% Bandwidth (MHz)	95.255	95.5526
Plot reference	8048-2 Low chan 64QAM 100MHz BW	8048-2 Mid chan 64QAM 100MHz BW

Band	29.1-29.25 GHz
Power Level	18 dBm
Channel Spacing	100 MHz
Mod Scheme	64 QAM
Low channel	29.156 GHz

	Low
99% Bandwidth (MHz)	95.4016
Plot reference	8048-2 Top chan 64QAM 100MHz BW

Band	27.5-28.35 GHz
Power Level	18 dBm
Channel Spacing	112 MHz
Mod Scheme	64 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
99% Bandwidth (MHz)	102.5932	103.2876
Plot reference	8048-2 Low chan 64QAM 112MHz BW	8048-2 Mid chan 64QAM 112MHz BW

Band	29.1-29.25 GHz
Power Level	18 dBm
Channel Spacing	112 MHz
Mod Scheme	64 QAM
Low channel	29.156 GHz

	Low
99% Bandwidth (MHz)	103.2984
Plot reference	8048-2 Top chan 64QAM 112MHz BW

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

LIMITS:

Part 101.109: 150 MHz (band 29.1 – 29.25 GHz)
850 MHz (band 27.5 – 28.35 GHz)

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-C [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 100MHz or 112MHz bandwidth settings were found to be worst case for emissions and, therefore, the EUT was operated in TX2, TX8 and TX14 modes.

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 and 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 – 40 GHz at 0.3metres, & 40 – 100 GHz at 0.1metres

The EUT was tested in Site M and Site B.

5.5.4 Test equipment

E131, E268, E411, E412, E428, E453, TMS78, TMS79, TMS933, E615, E624, E624, E268, E296-2, E296-4, E296-5, E296-6, E330, E580, E503, E579

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	22 °C
Humidity of test environment	43 %
Pressure of test environment	102 kPa

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

LIMITS:
Part 101.111, -13 dBm

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:
<± 3.4 dB

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-C [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. All test modes specified in section 2.4 were initially checked; QPSK modulation scheme using 100 MHz or 112 MHz bandwidth settings were found to be worst case for emissions. The EUT was operated in TX1 - TX18 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, 3 MHz 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, E433, E486, E490, E615

See Section 9 for more details

5.6.5 Test results

Temperature of test environment	23 °C
Humidity of test environment	40 %
Pressure of test environment	101.5 kPa

Band	27.5-28.35
Power Level	25 dBm
Channel	100 MHz
Mod	QPSK
Low channel	27.556
High	28.2485

	Low	High
Nominal, Maximised RF	25 dBm	25 dBm
Nominal plot reference	J8048-2 Band Edge Chan 27.556 GHz	J8048-2 Band Edge Chan 28.2485 GHz

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field strength	25 dBm
Nominal plot reference	J8048-2 Band Edge Chan 29.156 GHz BW100MHz QPSK

Band	27.5-28.35
Power Level	25 dBm
Channel	112 MHz
Mod	QPSK
Low channel	27.556
High	28.2485

	Low	High
Nominal, Maximised RF	25 dBm	25 dBm
Nominal plot reference	J8048-2 Band Edge Chan 27.556 GHz	J8048-2 Band Edge Chan 28.2485 GHz

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	112 MHz
Mod Scheme	QPSK
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field strength	25 dBm
Nominal plot reference	J8048-2 Band Edge Chan 29.156 GHz BW112MHz QPSK

Band	27.5-28.35
Power Level	21 dBm
Channel	100 MHz
Mod	16 QAM
Low	27.556
High	28.2485

	Low	High
Nominal, Maximised RF	21 dBm	21 dBm
Nominal plot reference	J8048-2 Band Edge Chan 27.556 GHz	J8048-2 Band Edge Chan 28.2485 GHz

Band	29.1-29.25 GHz
Power Level	21 dBm
Channel Spacing	100 MHz
Mod Scheme	16 QAM
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field strength	21 dBm
Nominal plot reference	J8048-2 Band Edge Chan 29.156 GHz BW100MHz 16QAM

Band	27.5-28.35
Power Level	21 dBm
Channel	112 MHz
Mod	16 QAM
Low	27.556
High	28.2485

	Low	High
Nominal, Maximised RF	21 dBm	21 dBm
Nominal plot reference	J8048-2 Band Edge Chan 27.556 GHz	J8048-2 Band Edge Chan 28.2485 GHz

Band	29.1-29.25 GHz
Power Level	21 dBm
Channel Spacing	112 MHz
Mod Scheme	16 QAM
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field strength	21 dBm
Nominal plot reference	J8048-2 Band Edge Chan 29.156 GHz BW112MHz 16QAM

Band	27.5-28.35
Power Level	18 dBm
Channel	100 MHz
Mod	64 QAM
Low	27.556
High	28.2485

	Low	High
Nominal, Maximised RF	18 dBm	18 dBm
Nominal plot reference	J8048-2 Band Edge Chan 27.556 GHz	J8048-2 Band Edge Chan 28.2485 GHz

Band	29.1-29.25 GHz
Power Level	18 dBm
Channel Spacing	100 MHz
Mod Scheme	64 QAM
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field strength	18 dBm
Nominal plot reference	J8048-2 Band Edge Chan 29.156 GHz BW100MHz 64QAM

Band	27.5-28.35
Power Level	18 dBm
Channel	112 MHz
Mod	64 QAM
Low	27.556
High	28.2485

	Low	High
Nominal, Maximised RF	18 dBm	18 dBm
Nominal plot reference	J8048-2 Band Edge Chan 27.556 GHz	J8048-2 Band Edge Chan 28.2485 GHz

Band	29.1-29.25 GHz
Power Level	18 dBm
Channel Spacing	112 MHz
Mod Scheme	64 QAM
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field strength	18 dBm
Nominal plot reference	J8048-2 Band Edge Chan 29.156 GHz BW112MHz 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 [Reference 4.1.1 of this report]
Test Method:	KDB 971168 D01 v02r02 [Reference 4.1.3 of this report], TIA-603-C [Reference 4.1.6 of this report]
Limits:	47CFR part 101C Part 101.109 [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 - TX18 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 2.4 MHz RBW, 8 MHz 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, middle 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, E485, E486, E490, E615

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	24 °C
Humidity of test environment	42 %
Pressure of test environment	101 kPa

Band	27.5-28.35 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
Nominal, Maximised RF Output / field strength	25dBm	25dBm
Nominal plot reference	27.556GHz QPSK 100MHz BW	28.2485GHz QPSK 100MHz BW

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	QPSK
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field strength	25dBm
Nominal plot reference	29.156GHz QPSK 100MHz BW

Band	27.5-28.35 GHz
Power Level	25 dBm
Channel Spacing	112 MHz
Mod Scheme	QPSK
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
Nominal, Maximised RF Output / field strength	25dBm	25dBm
Nominal plot reference	27.556GHz QPSK 112MHz BW	28.2485GHz QPSK 112MHz BW

Band	29.1-29.25 GHz
Power Level	25 dBm
Channel Spacing	112 MHz
Mod Scheme	QPSK
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field strength	25dBm
Nominal plot reference	29.156GHz QPSK 112MHz BW

Band	27.5-28.35 GHz
Power Level	25 dBm
Channel Spacing	100 MHz
Mod Scheme	16 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
Nominal, Maximised RF Output / field	21dBm	21dBm
Nominal plot reference	27.556GHz 16QAM 100MHz BW	28.2485GHz 16QAM 100MHz BW

Band	29.1-29.25 GHz
Power Level	21 dBm
Channel Spacing	100 MHz
Mod Scheme	16 QAM
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field	21dBm
Nominal plot reference	29.156GHz 16QAM 100MHz BW

Band	27.5-28.35 GHz
Power Level	21 dBm
Channel Spacing	112 MHz
Mod Scheme	16 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
Nominal, Maximised RF Output / field	21dBm	21dBm
Nominal plot reference	27.556GHz 16QAM 112MHz BW	28.2485GHz 16QAM 112MHz BW

Band	29.1-29.25 GHz
Power Level	21 dBm
Channel Spacing	112 MHz
Mod Scheme	16 QAM
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field	21dBm
Nominal plot reference	29.156GHz 16QAM 112MHz BW

Band	27.5-28.35 GHz
Power Level	18 dBm
Channel Spacing	100 MHz
Mod Scheme	64 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
Nominal, Maximised RF Output / field	18dBm	18dBm
Nominal plot reference	27.556GHz 64QAM 100MHz BW	28.2485GHz 64QAM 100MHz BW

Band	29.1-29.25 GHz
Power Level	18 dBm
Channel Spacing	100 MHz
Mod Scheme	64 QAM
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field	18dBm
Nominal plot reference	29.156GHz 64QAM 100MHz BW

Band	27.5-28.35 GHz
Power Level	18 dBm
Channel Spacing	112 MHz
Mod Scheme	64 QAM
Low channel	27.556 GHz
High channel	28.2485 GHz

	Low	High
Nominal, Maximised RF Output / field	18dBm	18dBm
Nominal plot reference	27.556GHz 64QAM 112MHz BW	28.2485GHz 64QAM 112MHz BW

Band	29.1-29.25 GHz
Power Level	18 dBm
Channel Spacing	112 MHz
Mod Scheme	64 QAM
Low channel	29.156 GHz

	Low
Nominal, Maximised RF Output / field	18dBm
Nominal plot reference	29.156GHz 64QAM 112MHz BW

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

LIMITS:
Part 101.109: 150 MHz (band 29.1 – 29.25 GHz)
850 MHz (band 27.5 – 28.35 GHz)

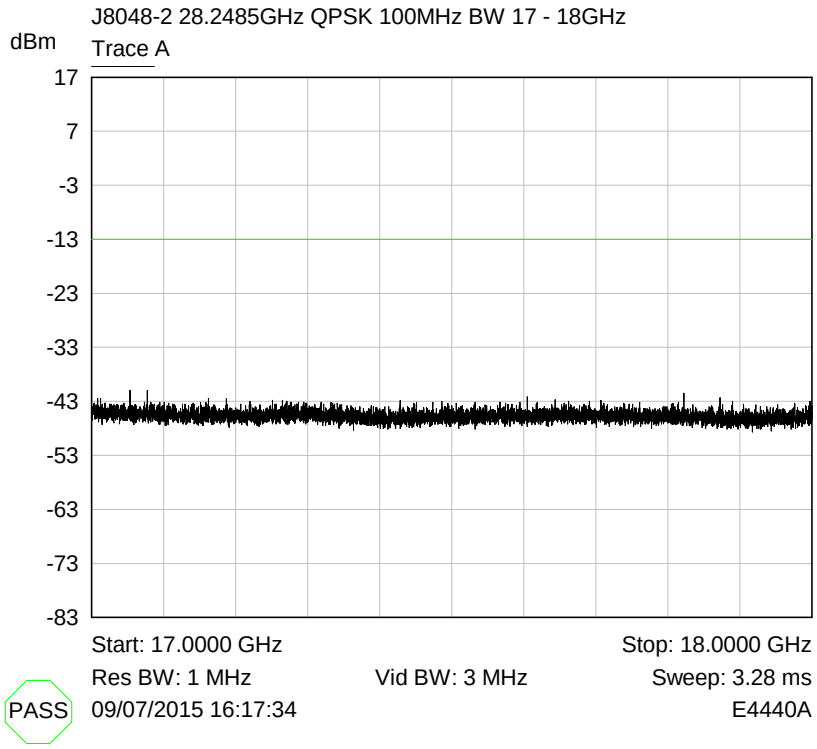
These results show that the EUT has PASSED this test.

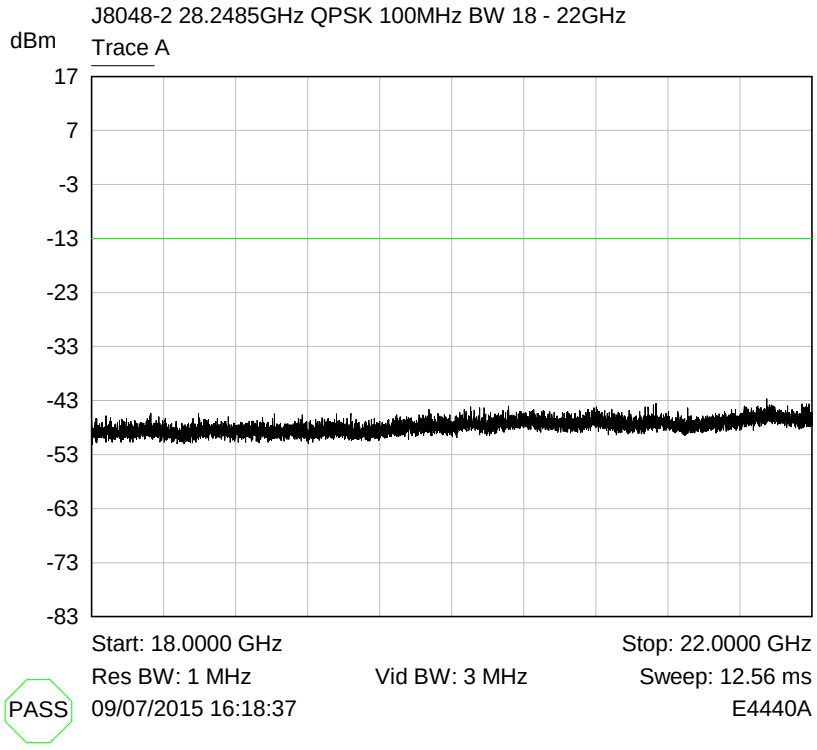
The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

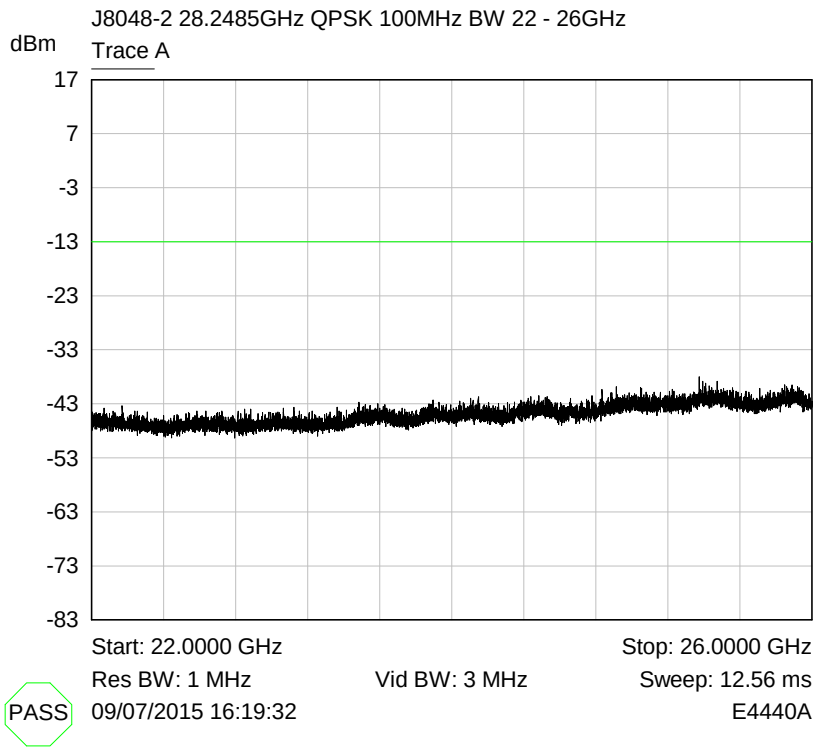
6 Plots/Graphical results

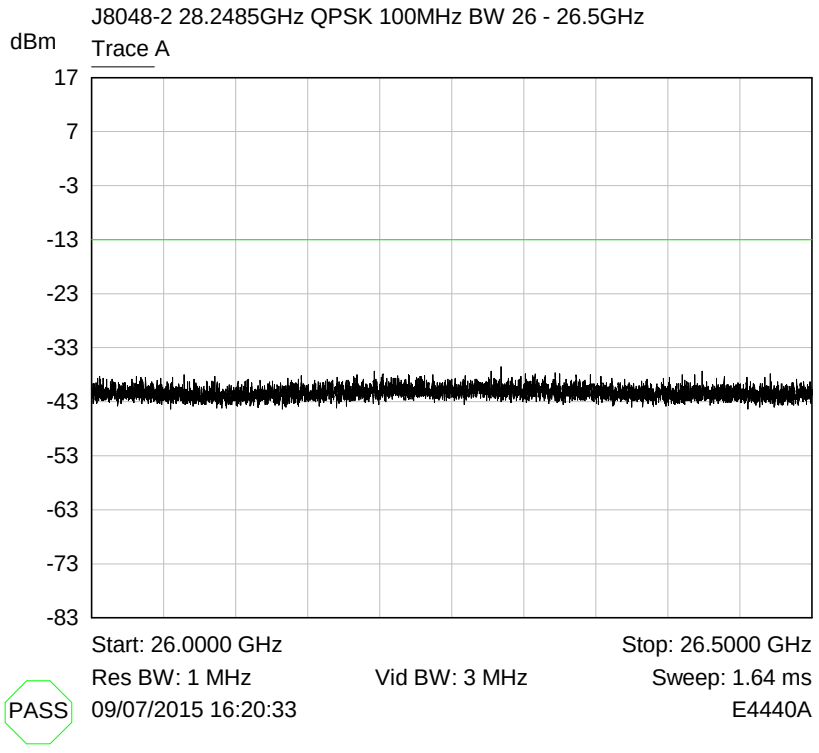
6.1 Spurious emissions at antenna terminals

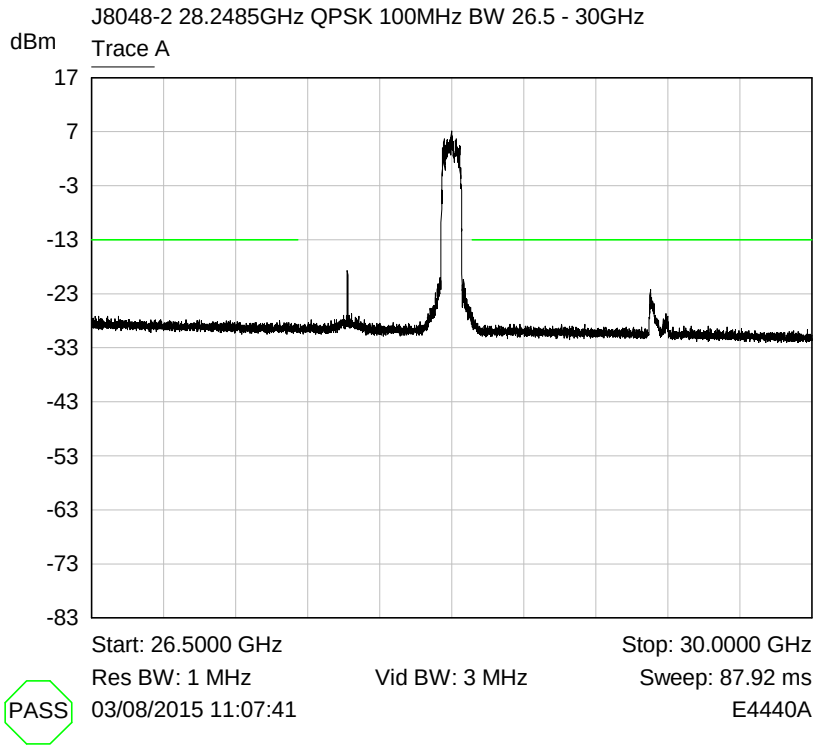
RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 28.2485 GHz

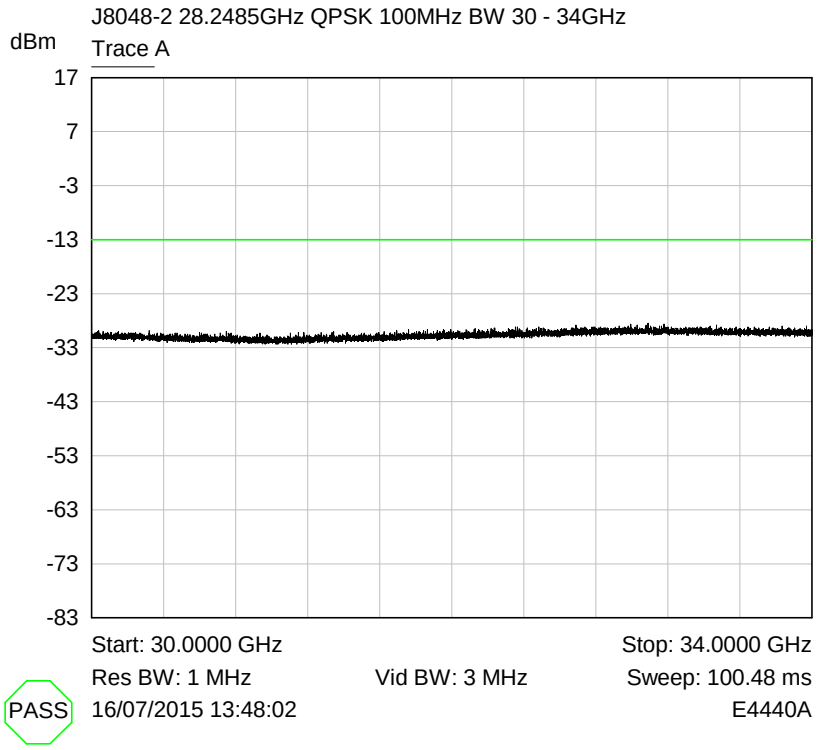


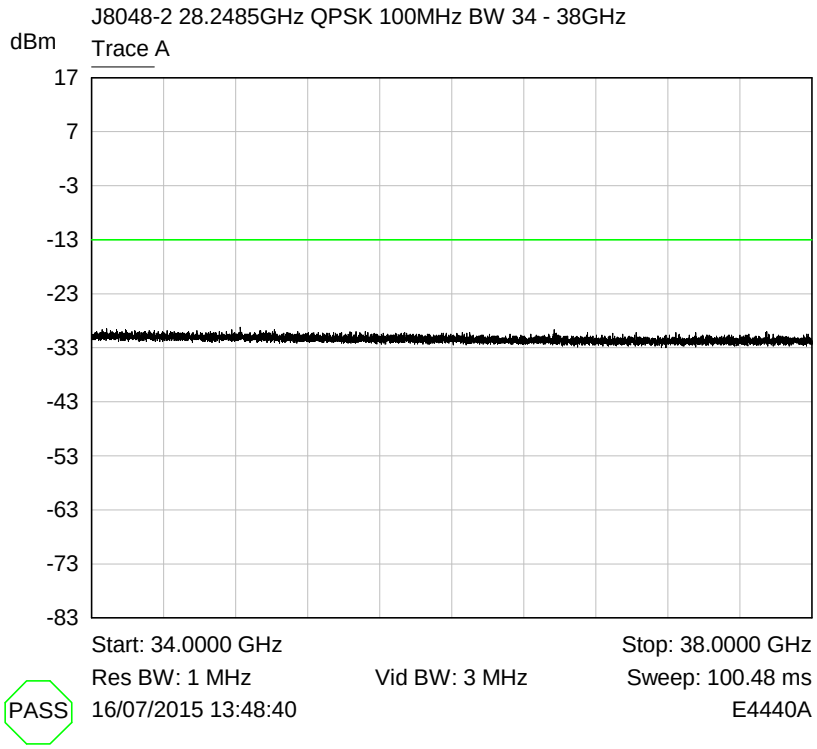


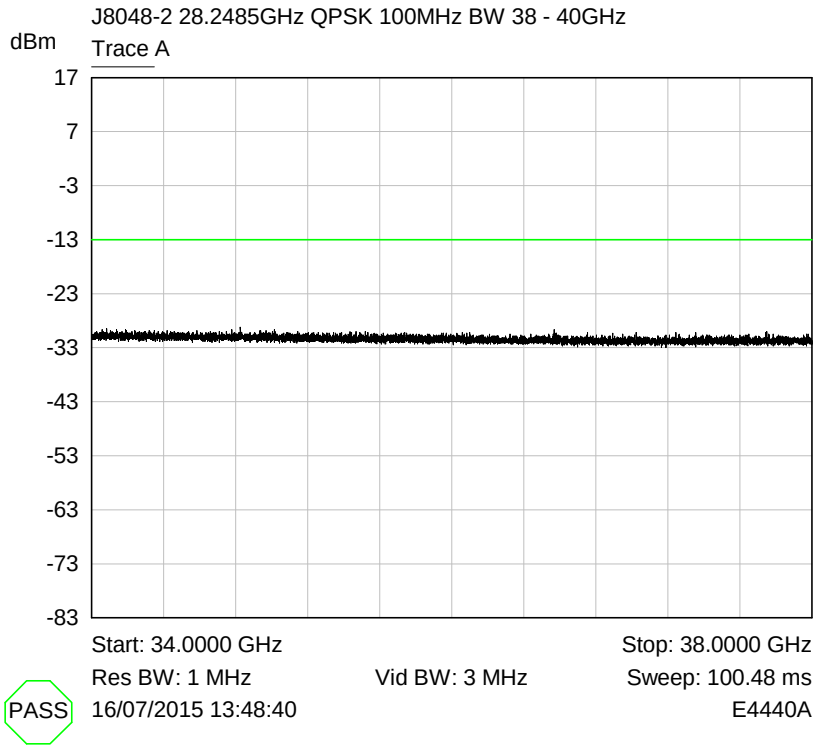


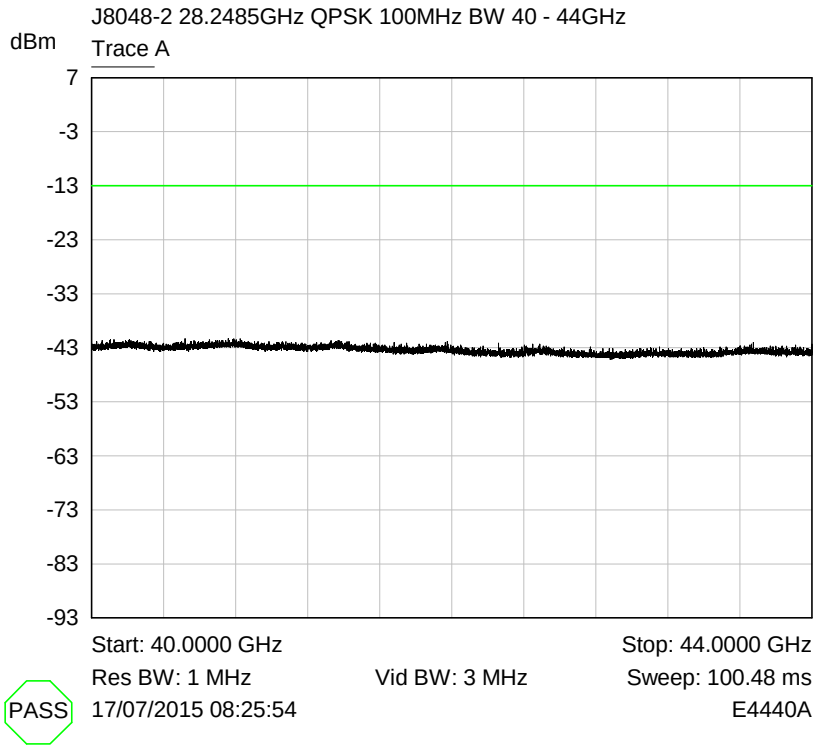


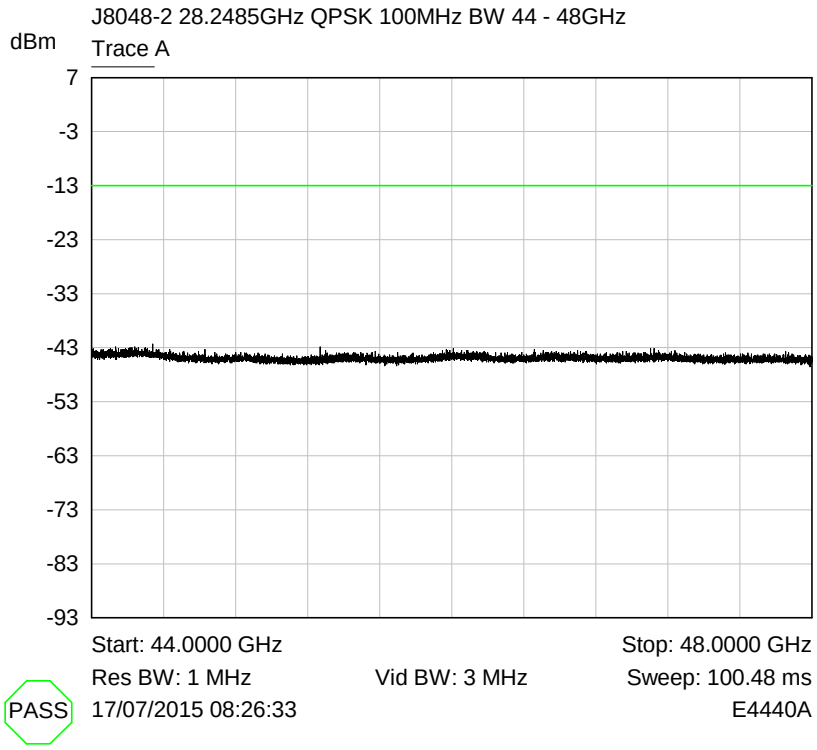


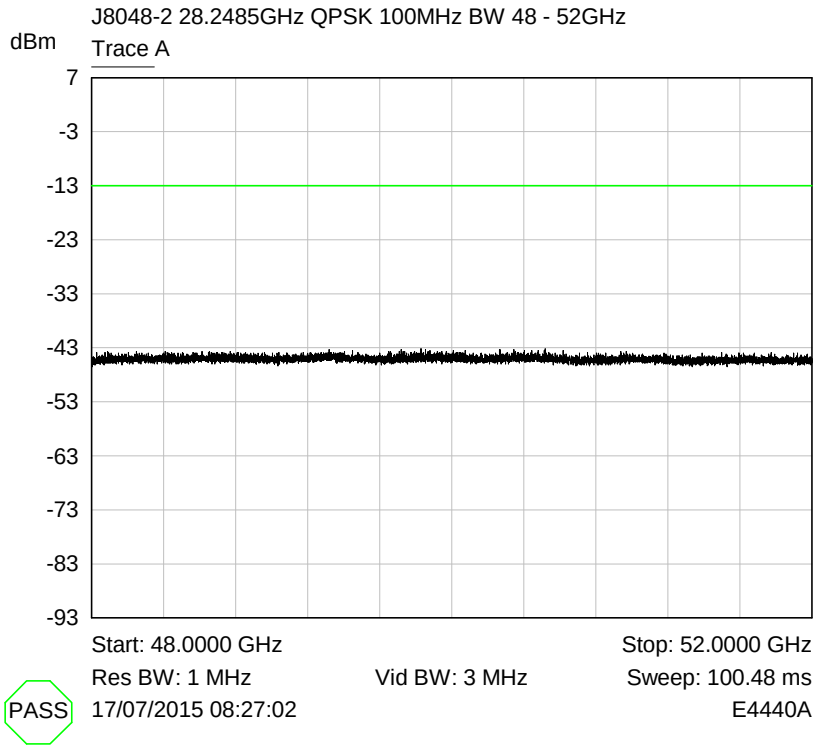


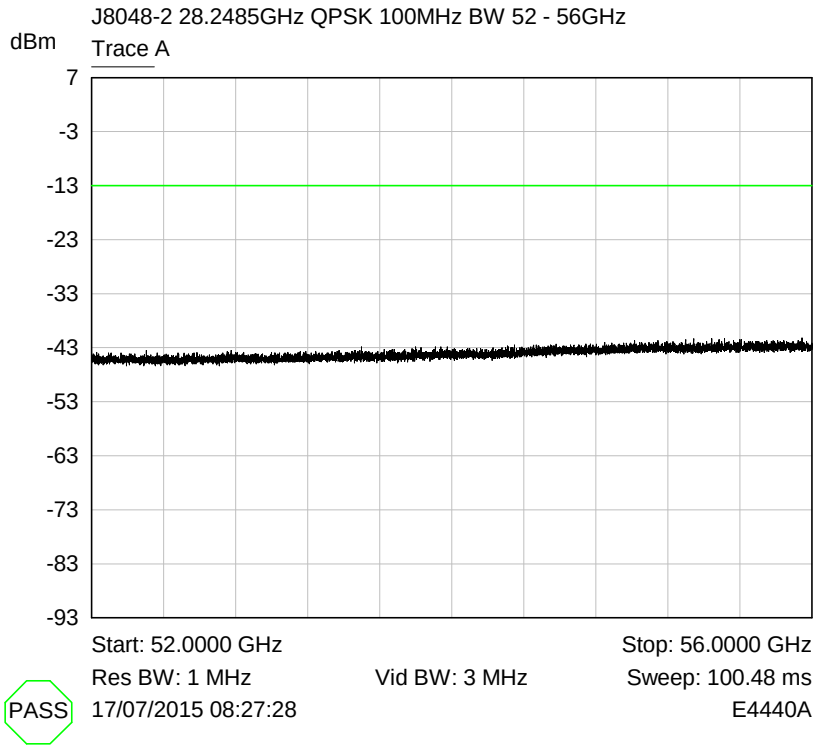


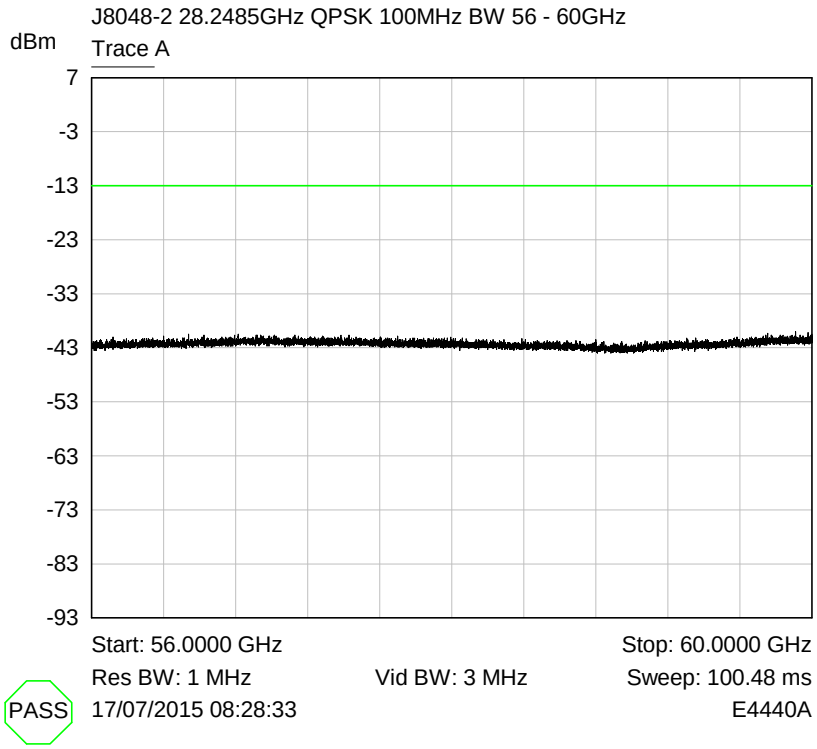


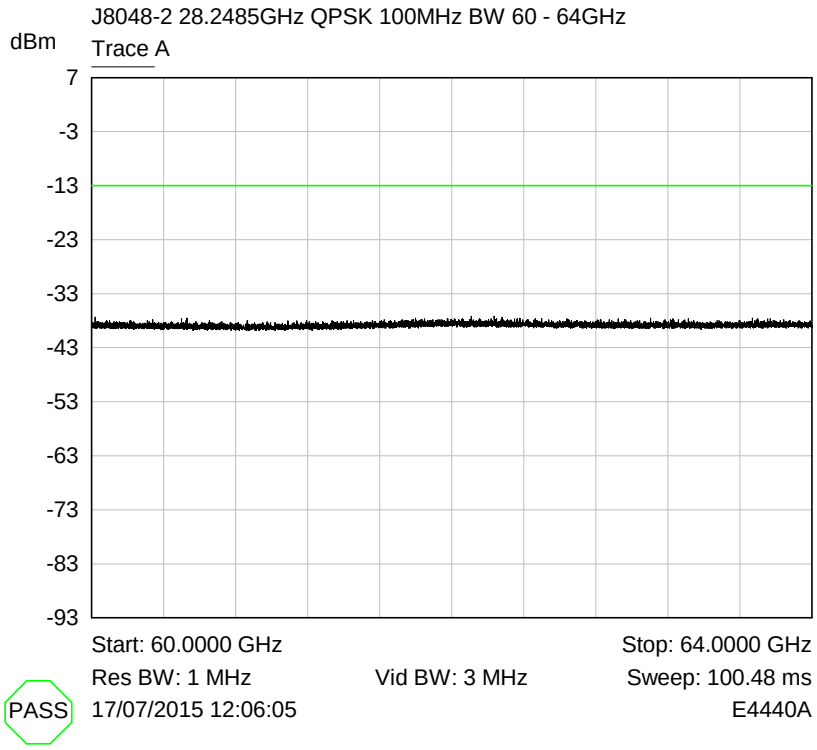

J8048-2 28.2485GHz QPSK 100MHz BW 40 - 44GHz
dBm
Trace A
7
-3
-13
-23
-33
-43
-53
-63
-73
-83
-93
Start: 40.0000 GHz
Stop: 44.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
PASS
17/07/2015 08:25:54
E4440A

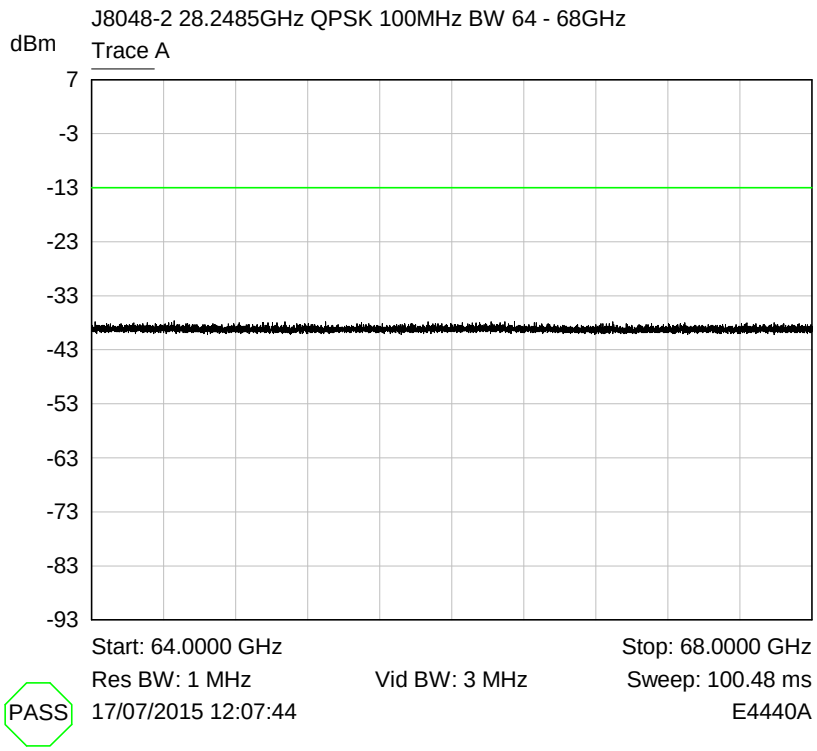

J8048-2 28.2485GHz QPSK 100MHz BW 44 - 48GHz
dBm
Trace A
7
-3
-13
-23
-33
-43
-53
-63
-73
-83
-93
Start: 44.0000 GHz
Stop: 48.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
PASS
17/07/2015 08:26:33
E4440A

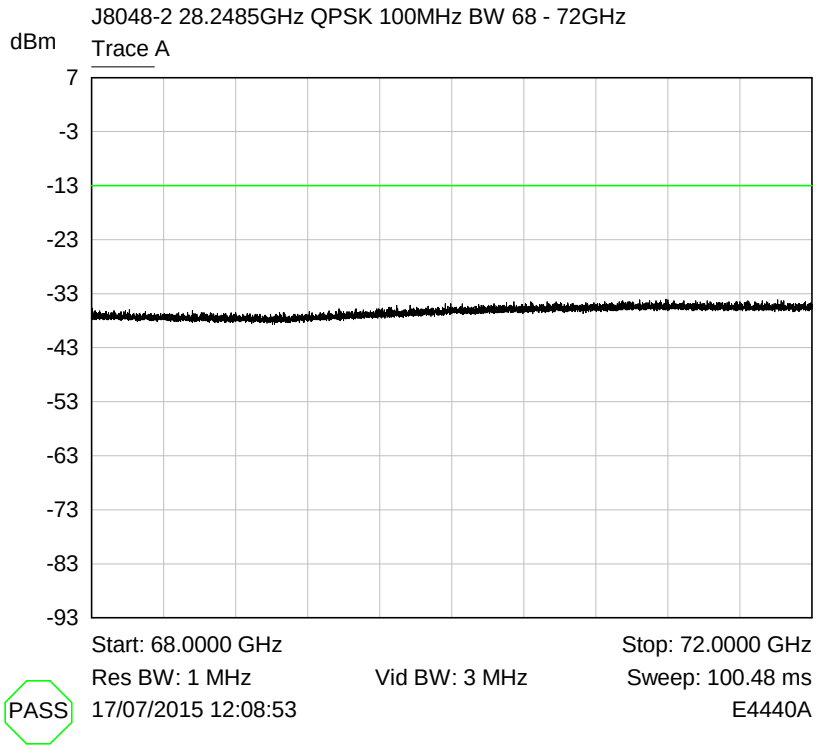


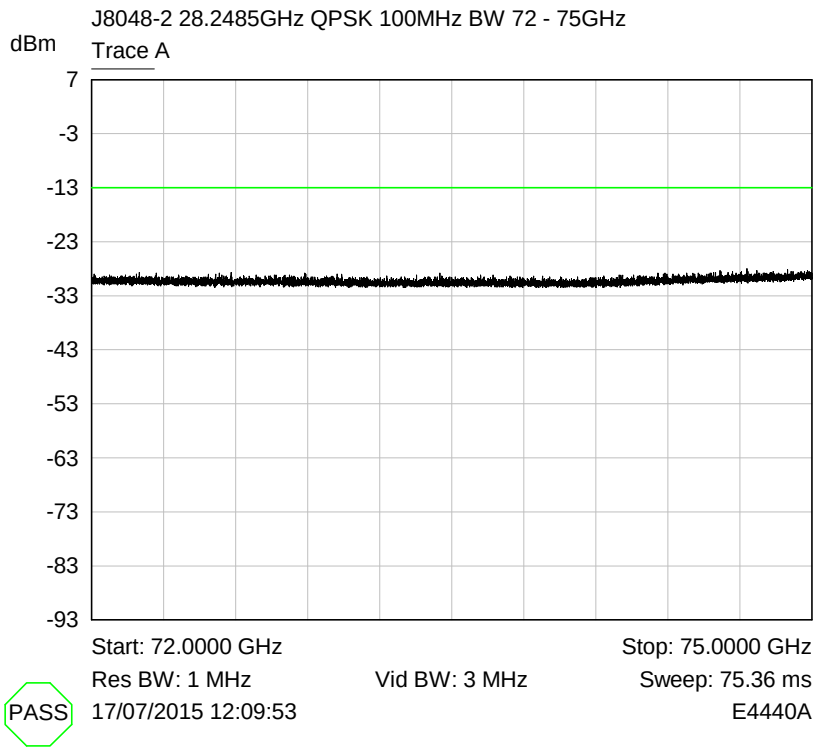


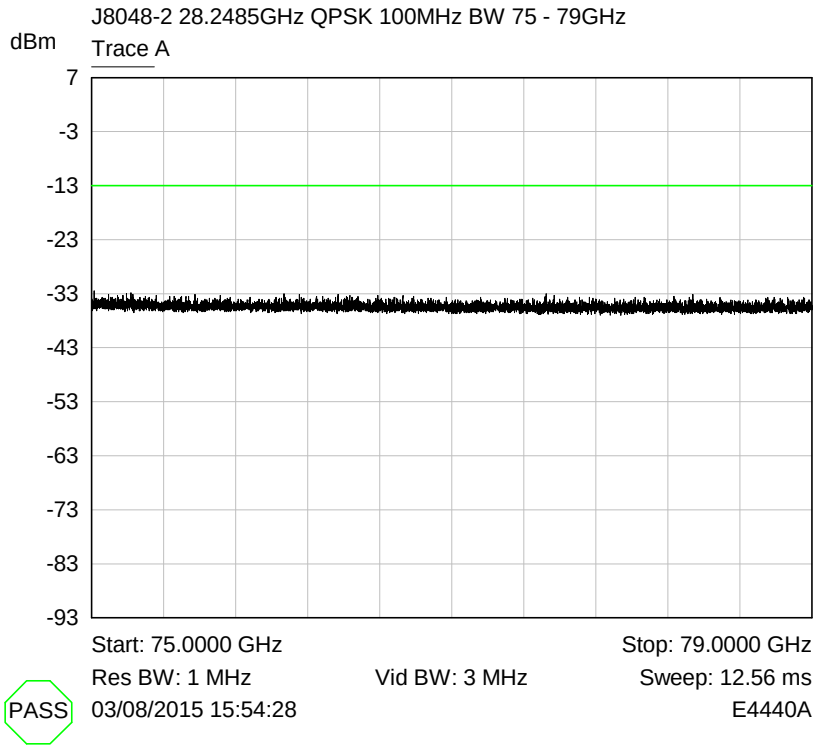


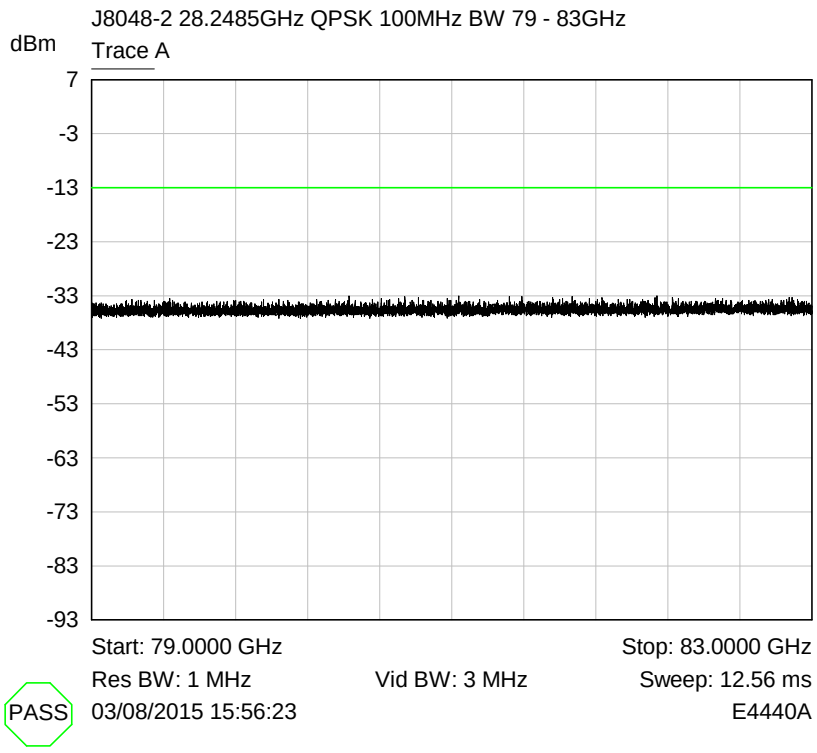


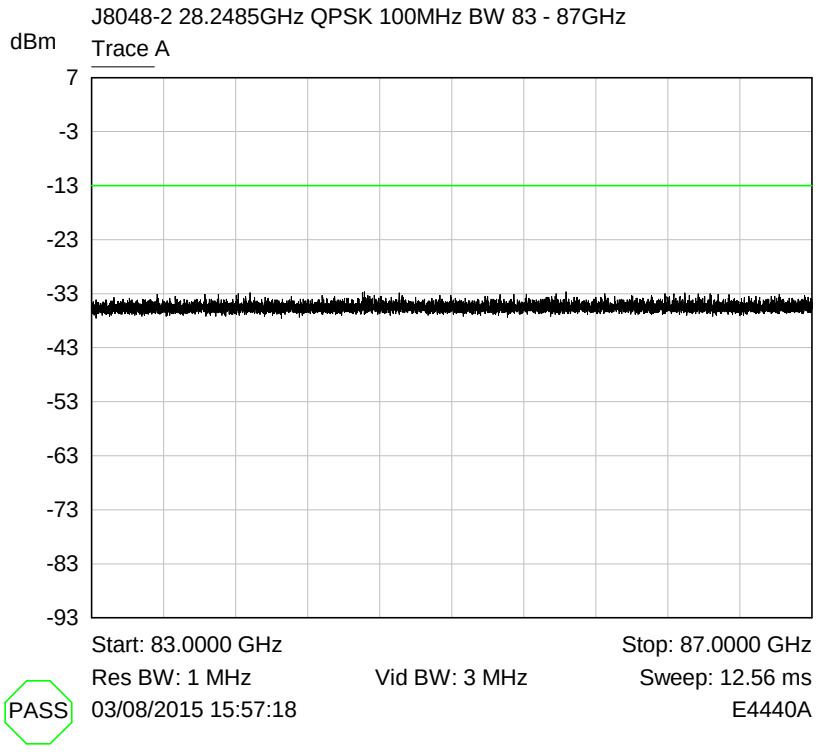

J8048-2 28.2485GHz QPSK 100MHz BW 64 - 68GHz
dBm
Trace A
7
-3
-13
-23
-33
-43
-53
-63
-73
-83
-93
Start: 64.0000 GHz
Stop: 68.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
PASS
17/07/2015 12:07:44
E4440A

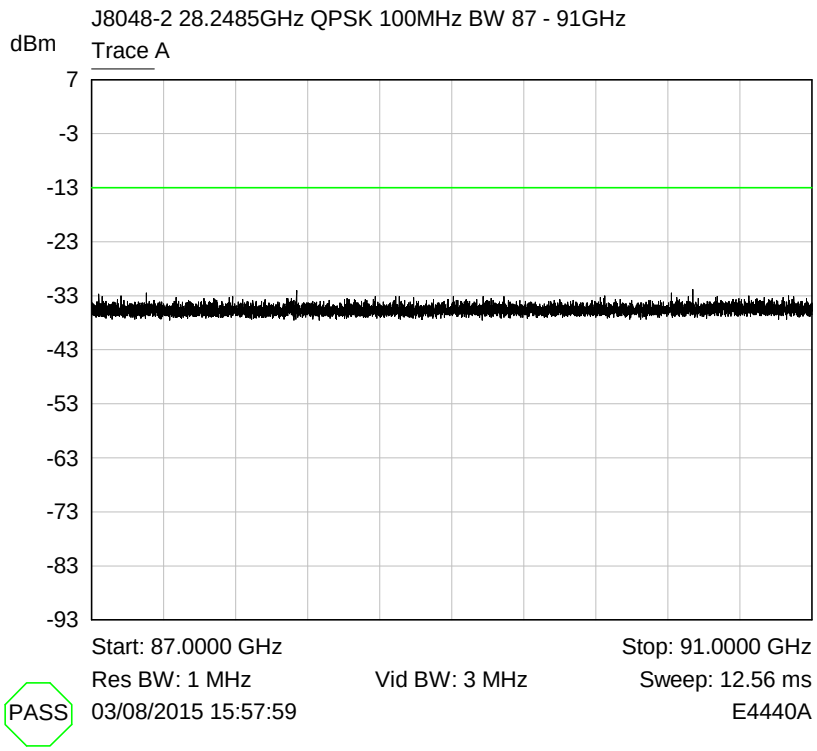

J8048-2 28.2485GHz QPSK 100MHz BW 68 - 72GHz
dBm
Trace A
7
-3
-13
-23
-33
-43
-53
-63
-73
-83
-93
Start: 68.0000 GHz
Stop: 72.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
PASS
17/07/2015 12:08:53
E4440A

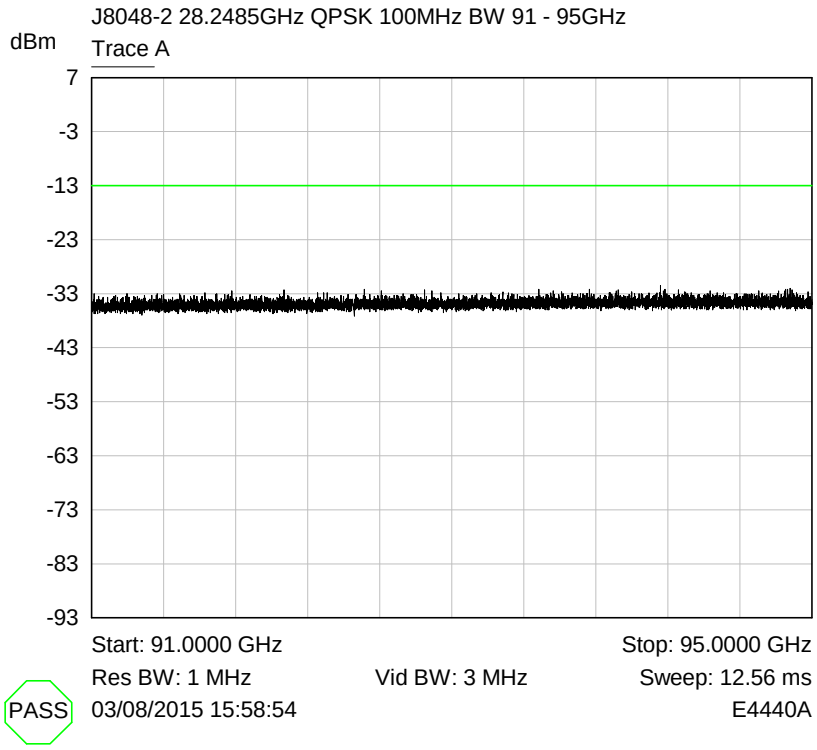

J8048-2 28.2485GHz QPSK 100MHz BW 72 - 75GHz
dBm
Trace A
7
-3
-13
-23
-33
-43
-53
-63
-73
-83
-93
Start: 72.0000 GHz
Stop: 75.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 75.36 ms
PASS
17/07/2015 12:09:53
E4440A

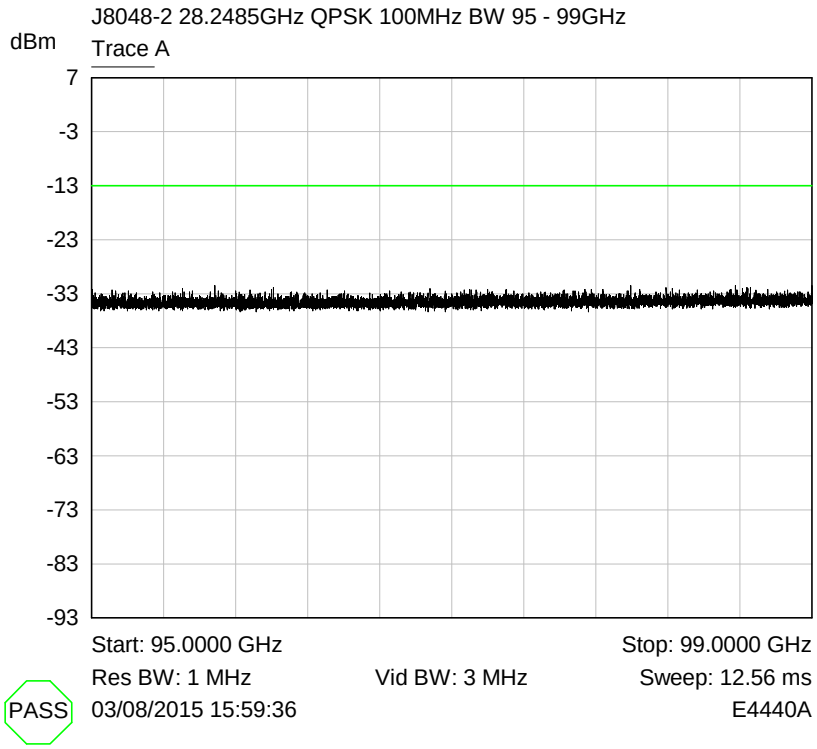

J8048-2 28.2485GHz QPSK 100MHz BW 75 - 79GHz
dBm
Trace A
7
-3
-13
-23
-33
-43
-53
-63
-73
-83
-93
Start: 75.0000 GHz
Stop: 79.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 12.56 ms
PASS
03/08/2015 15:54:28
E4440A

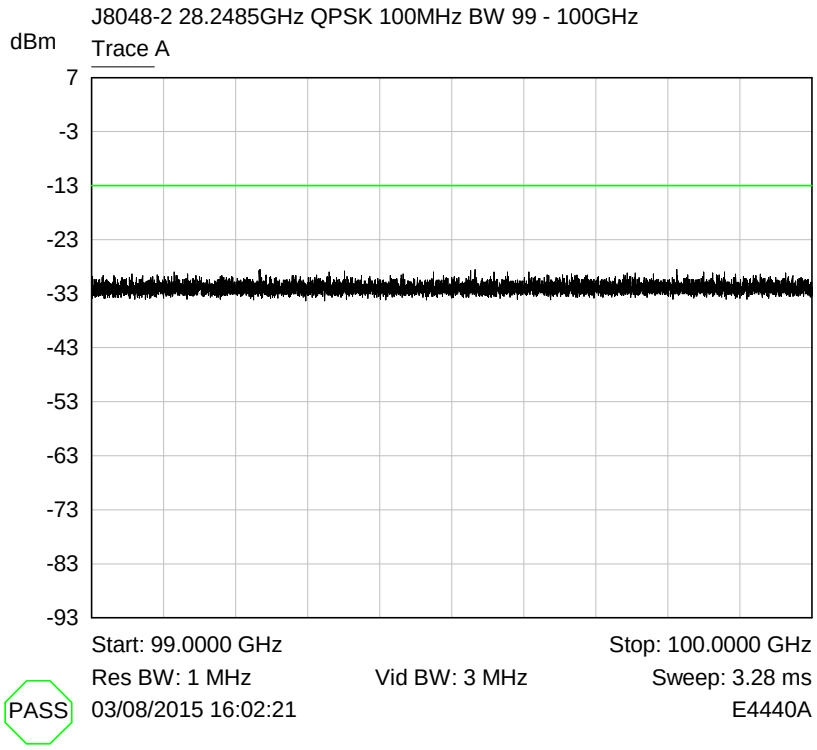





J8048-2 28.2485GHz QPSK 100MHz BW 87 - 91GHz
dBm
Trace A
7
-3
-13
-23
-33
-43
-53
-63
-73
-83
-93
Start: 87.0000 GHz
Stop: 91.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 12.56 ms
PASS
03/08/2015 15:57:59
E4440A

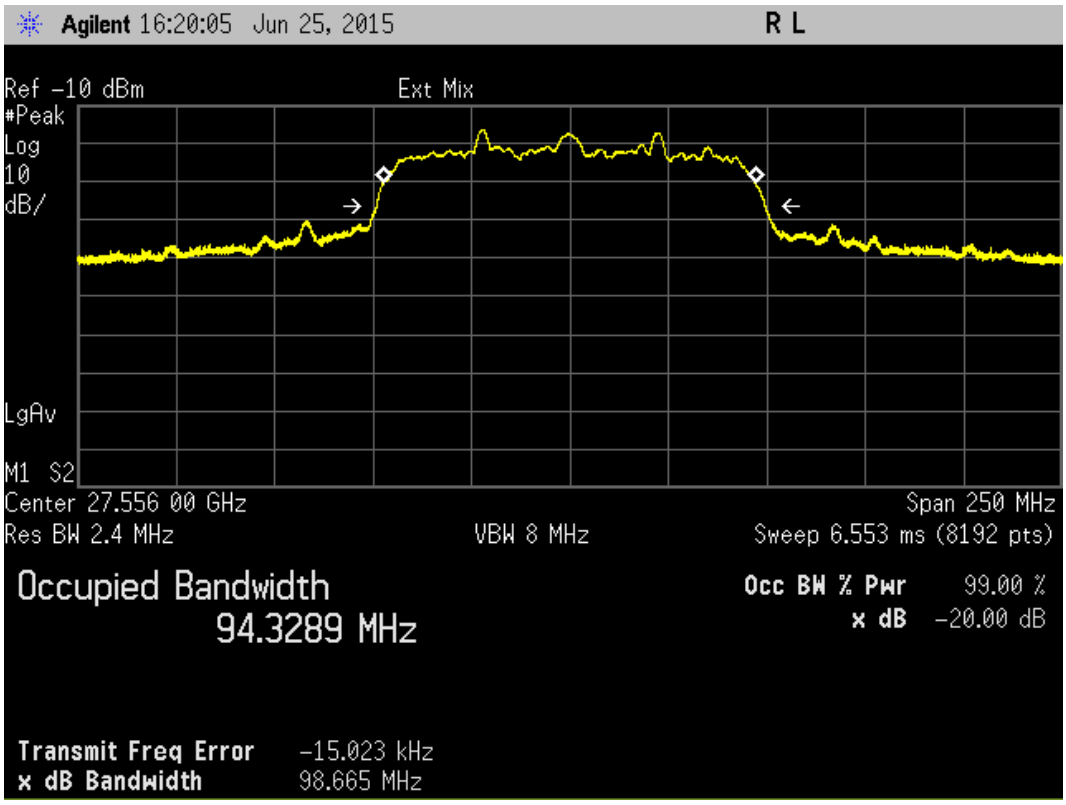

J8048-2 28.2485GHz QPSK 100MHz BW 91 - 95GHz
dBm
Trace A
7
-3
-13
-23
-33
-43
-53
-63
-73
-83
-93
Start: 91.0000 GHz
Stop: 95.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 12.56 ms
PASS
03/08/2015 15:58:54
E4440A



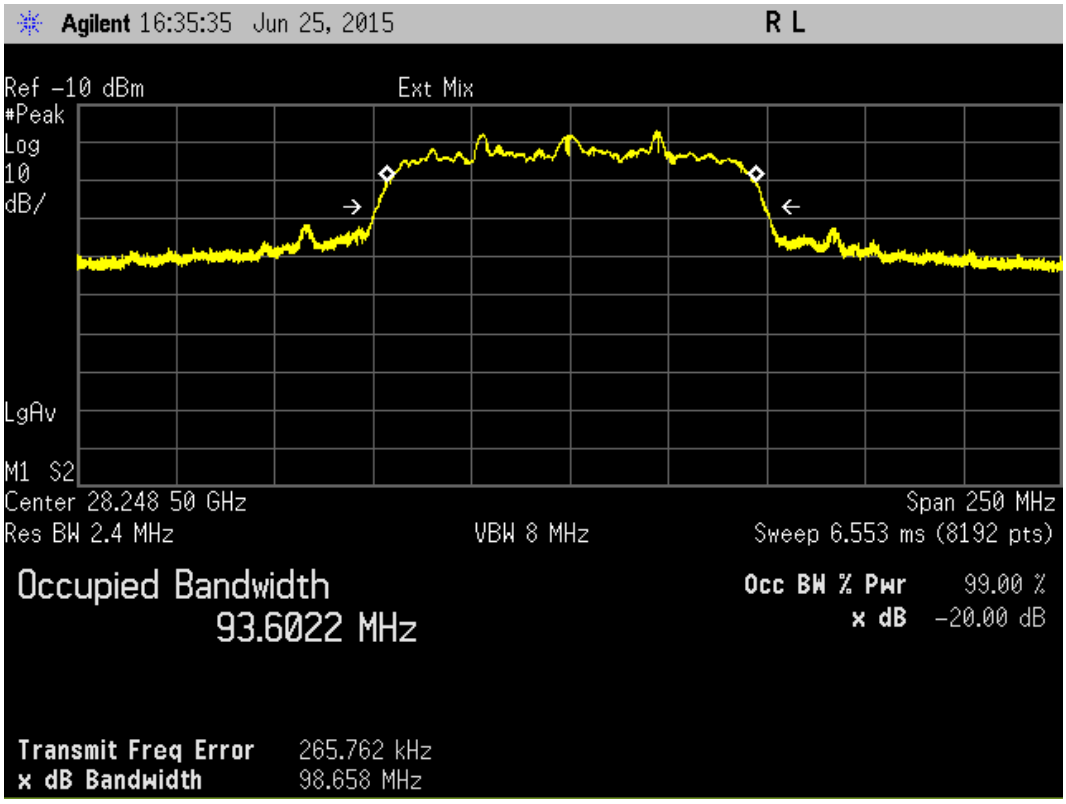


6.2 Occupied bandwidth

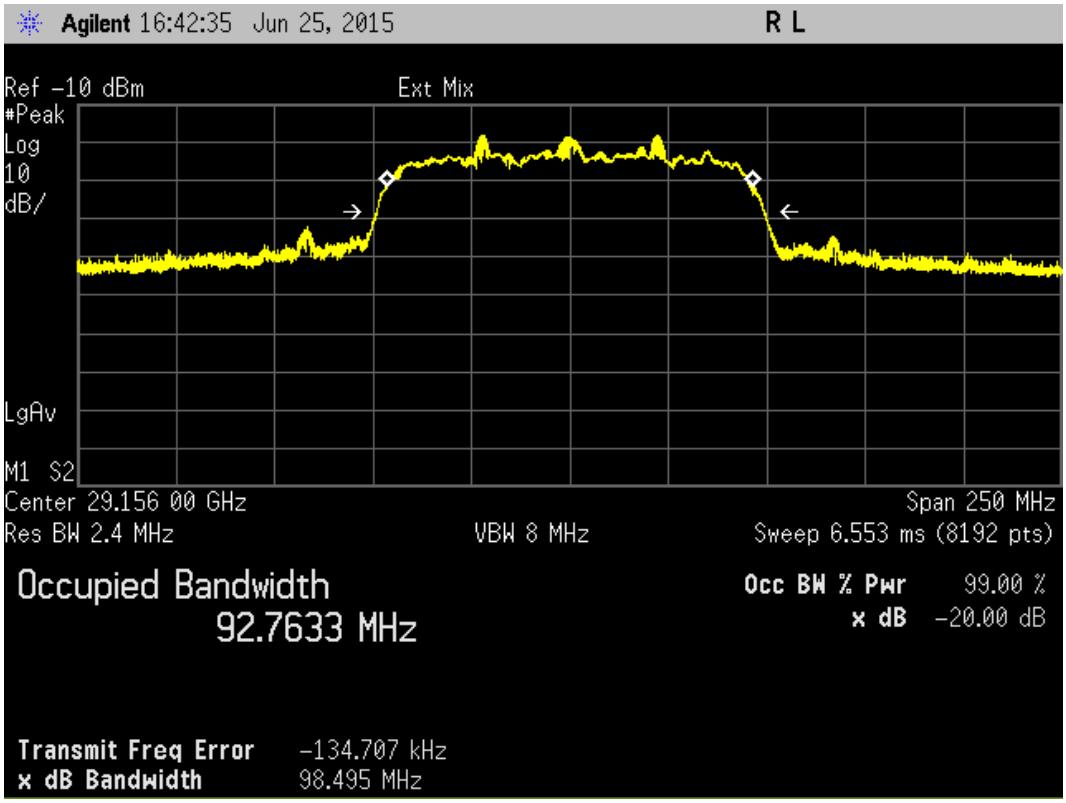
RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 27.556 GHz



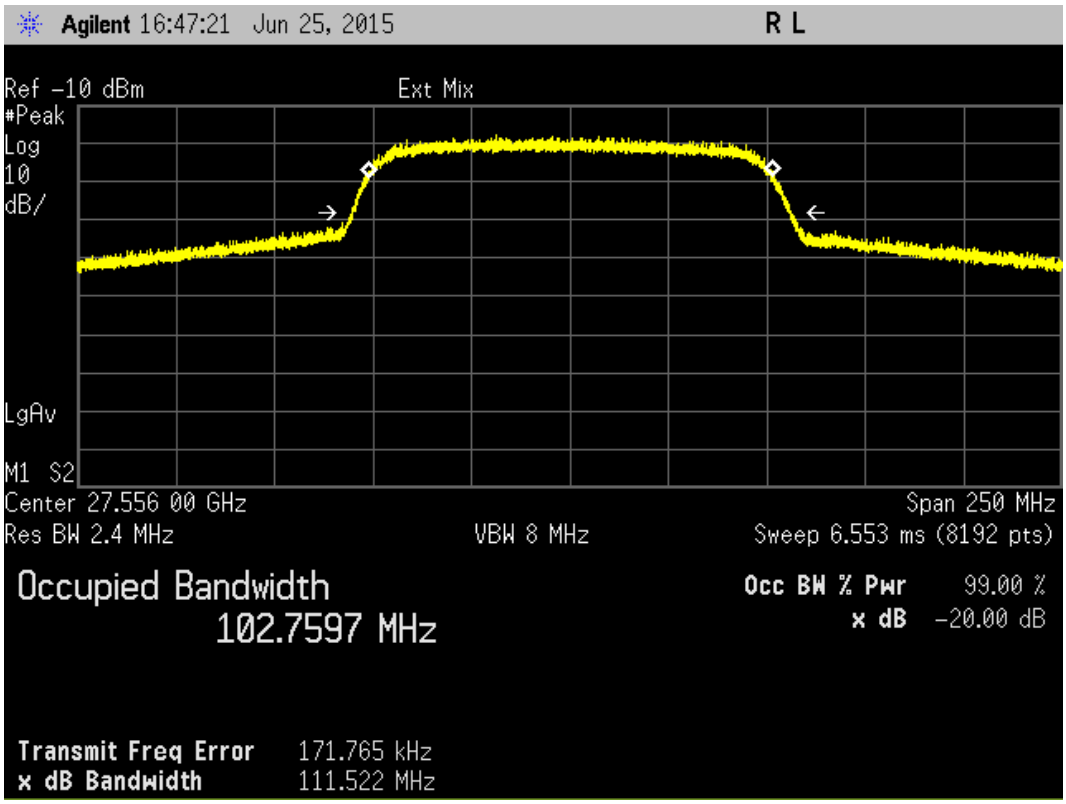
RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 28.2485 GHz



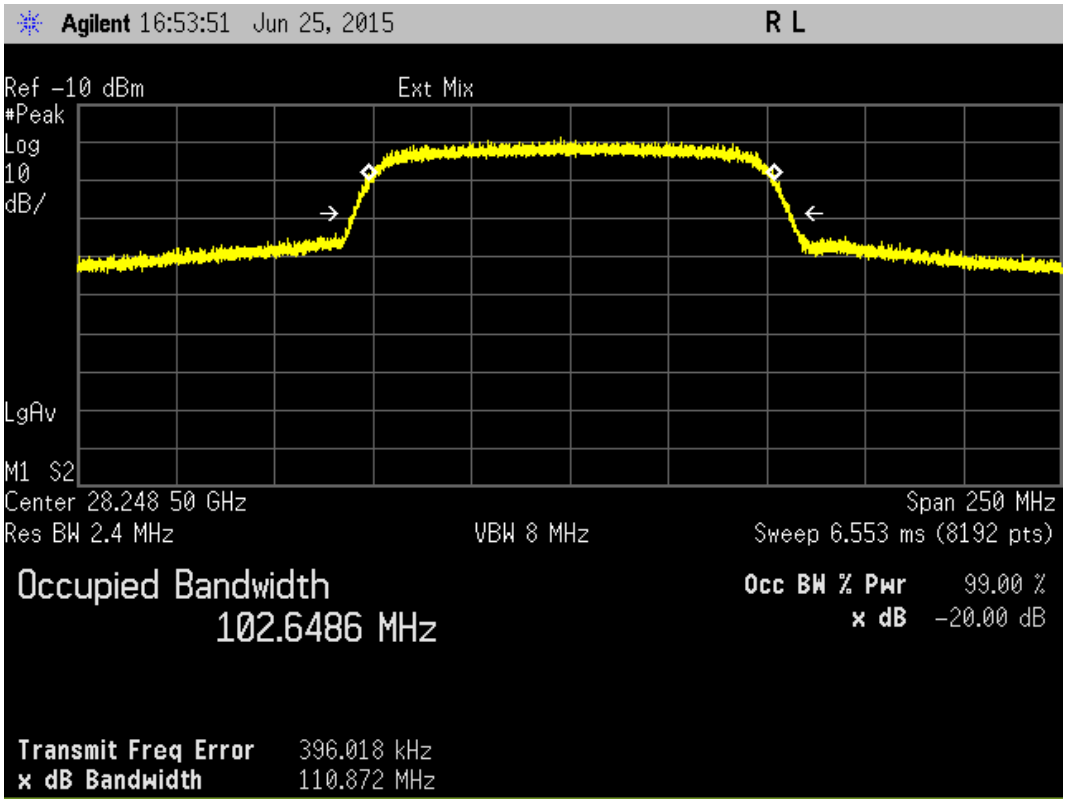
RF Parameters: Band 29.1-29.25 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 29.156 GHz



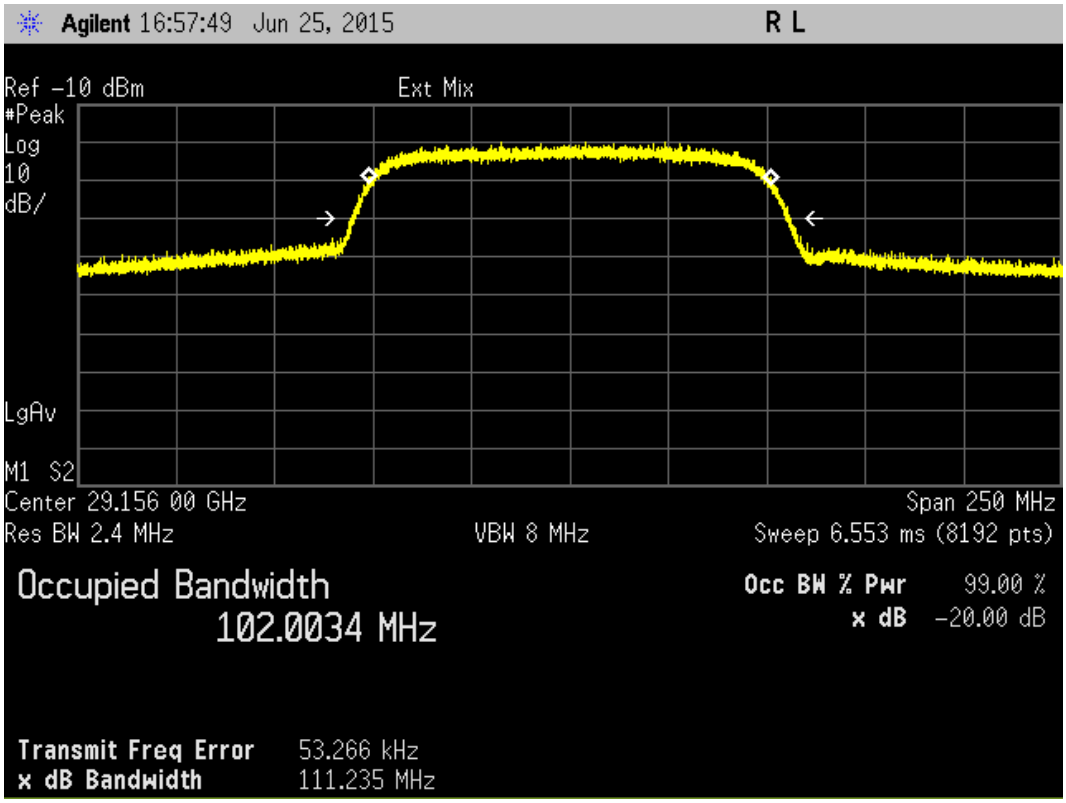
RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 112 MHz, Modulation QPSK, Channel 27.556 GHz



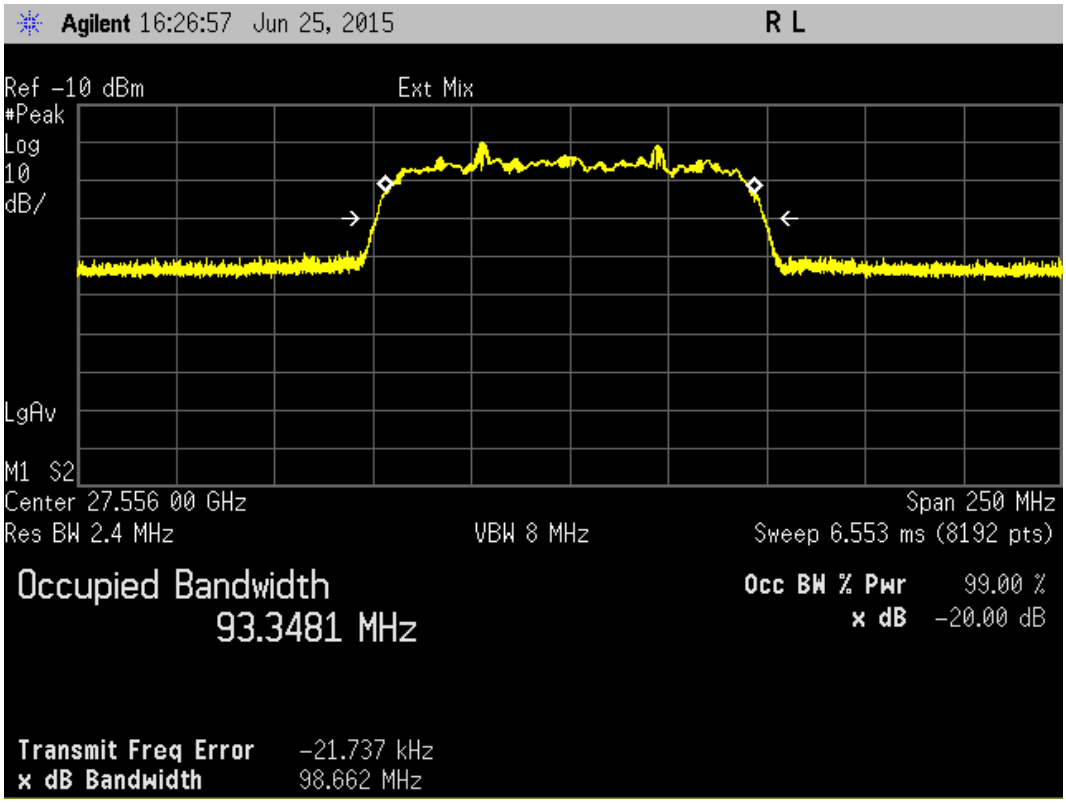
RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 112 MHz, Modulation QPSK, Channel 28.2485 GHz



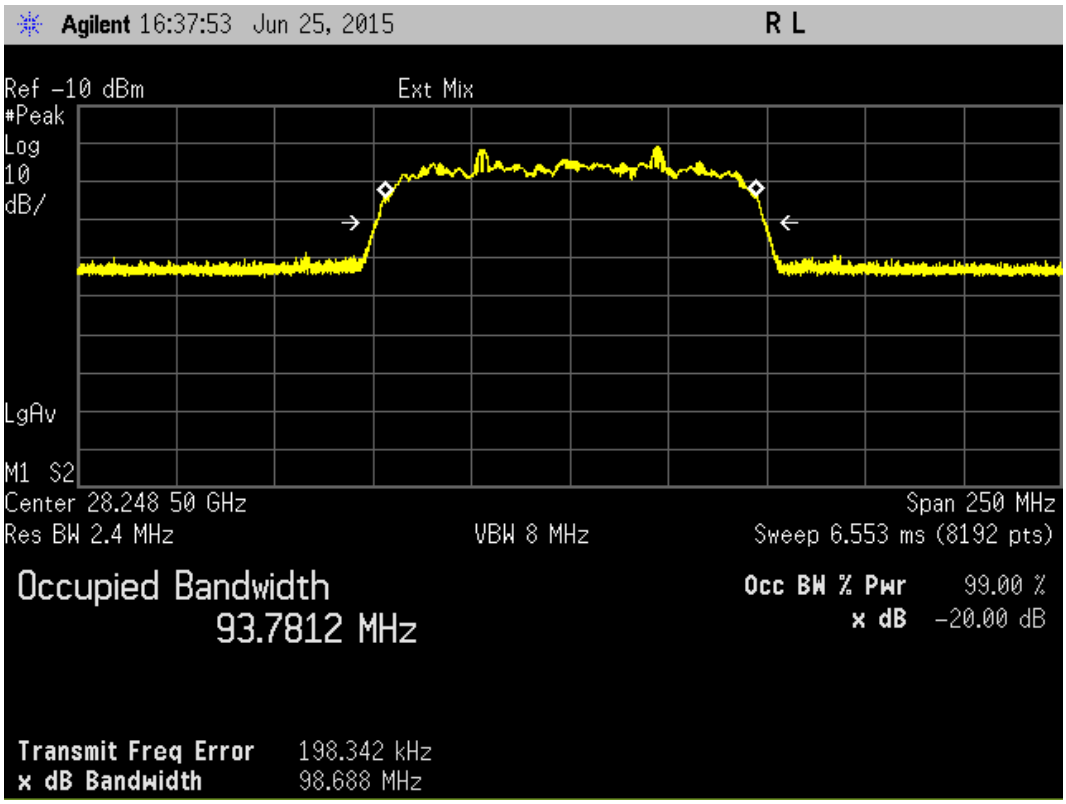
RF Parameters: Band 29.1-29.25 GHz, Power 25 dBm, Channel Spacing 112 MHz, Modulation QPSK, Channel 29.156 GHz



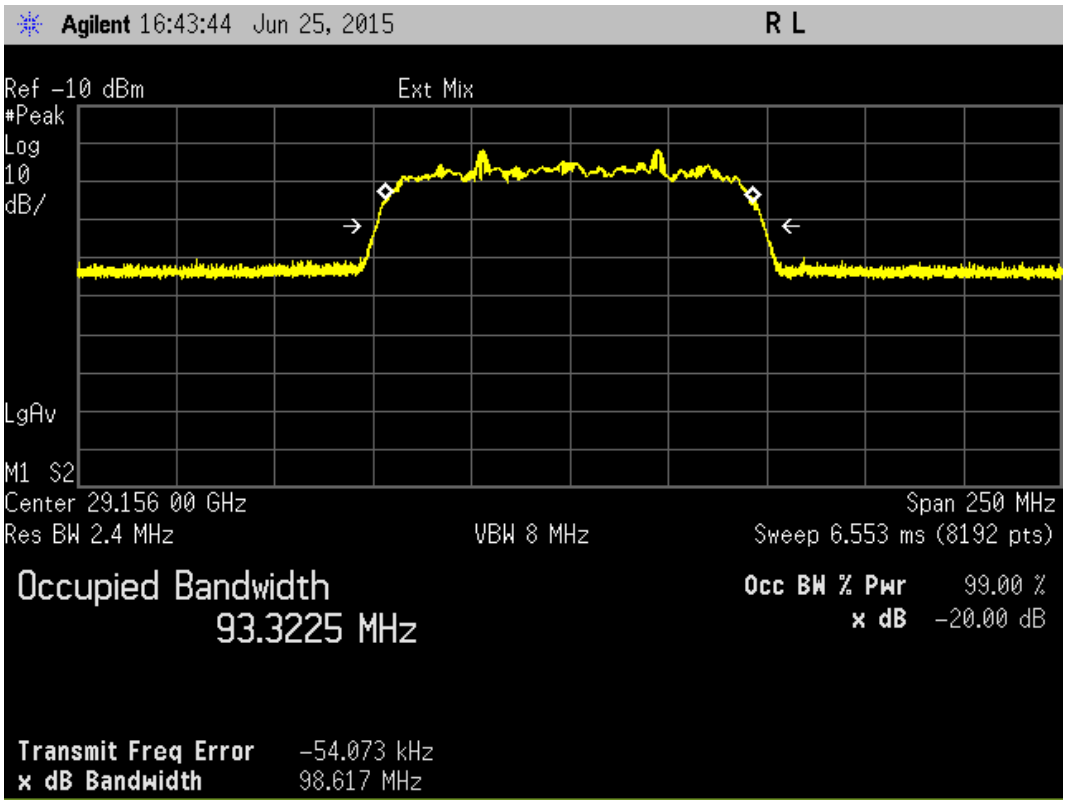
RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 100 MHz, Modulation 16 QAM, Channel 27.556 GHz



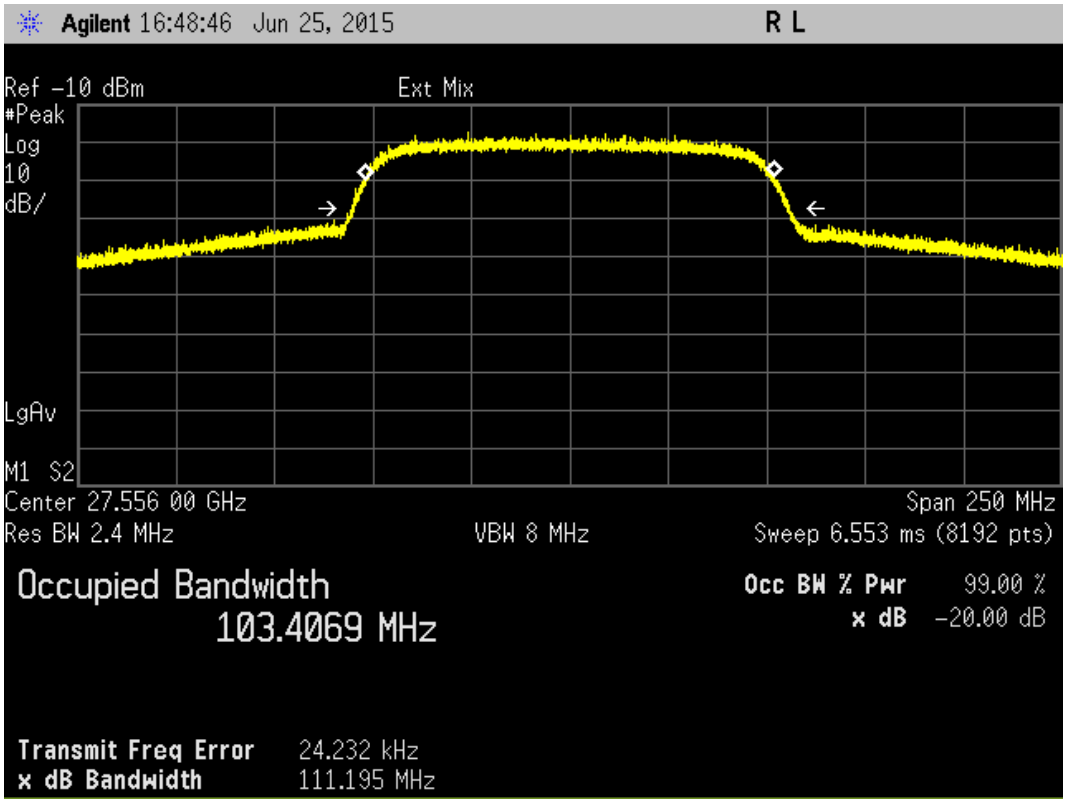
RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 100 MHz, Modulation 16 QAM, Channel 28.2485 GHz



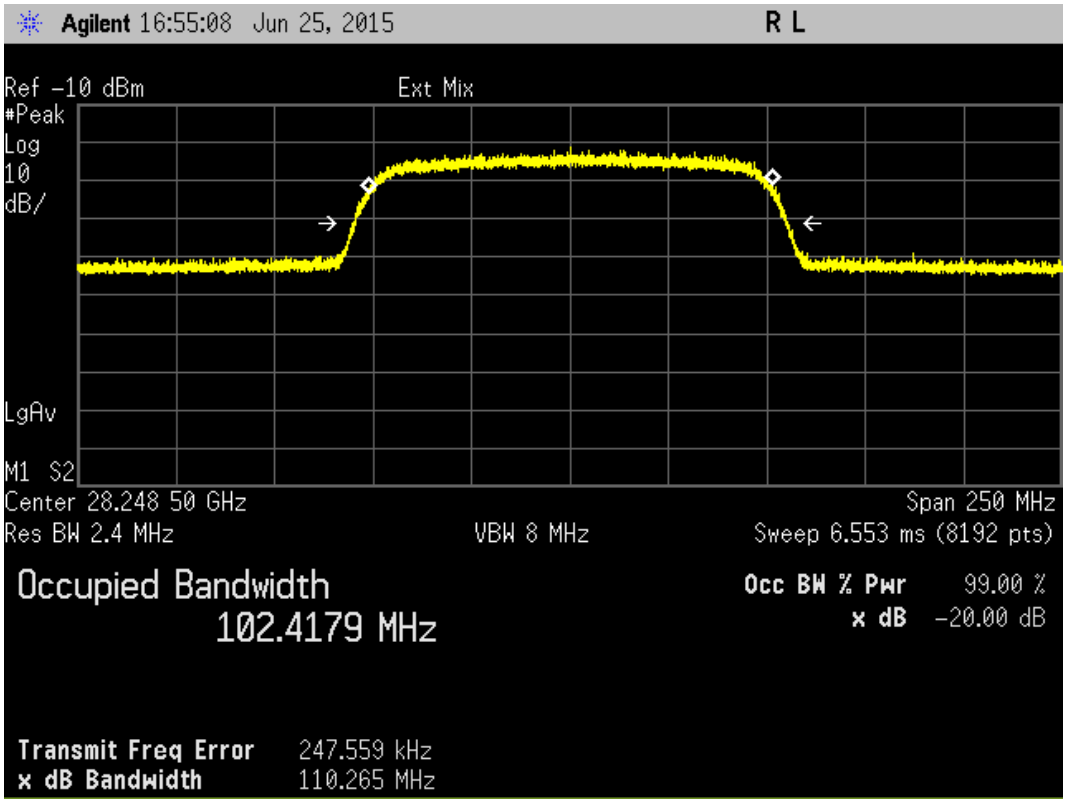
RF Parameters: Band 29.1-29.25 GHz, Power 21 dBm, Channel Spacing 100 MHz, Modulation 16 QAM, Channel 29.156 GHz



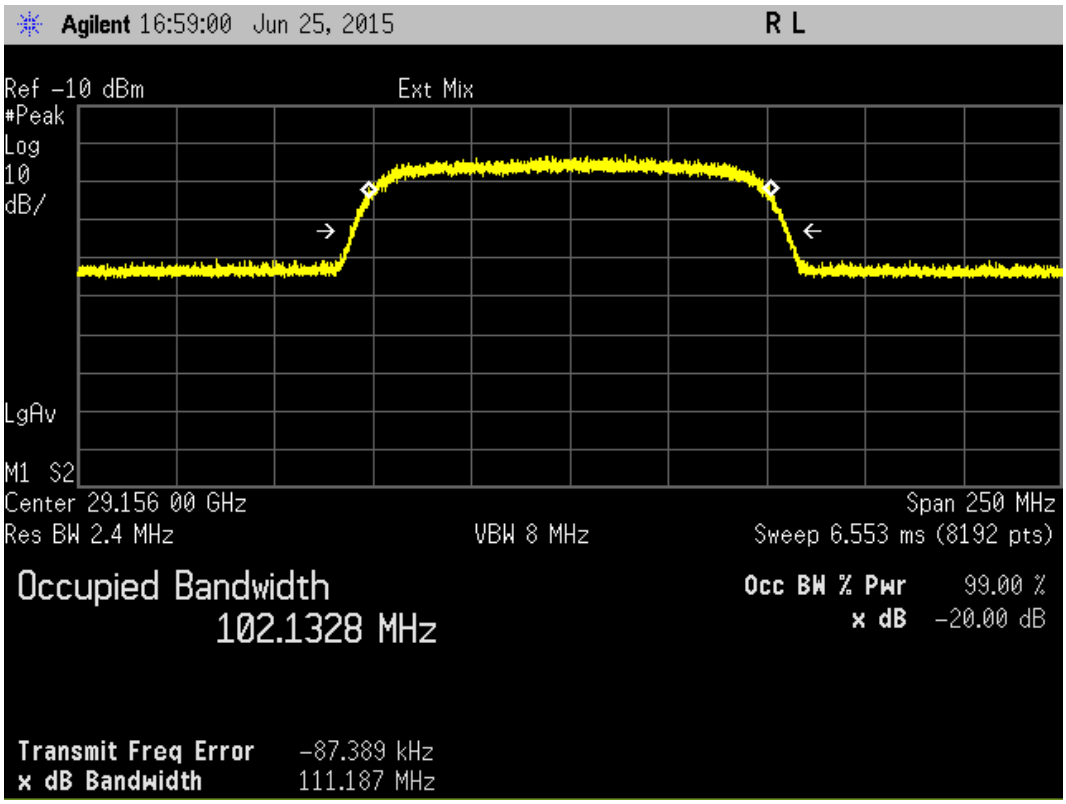
RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 112 MHz, Modulation 16 QAM, Channel 27.556 GHz



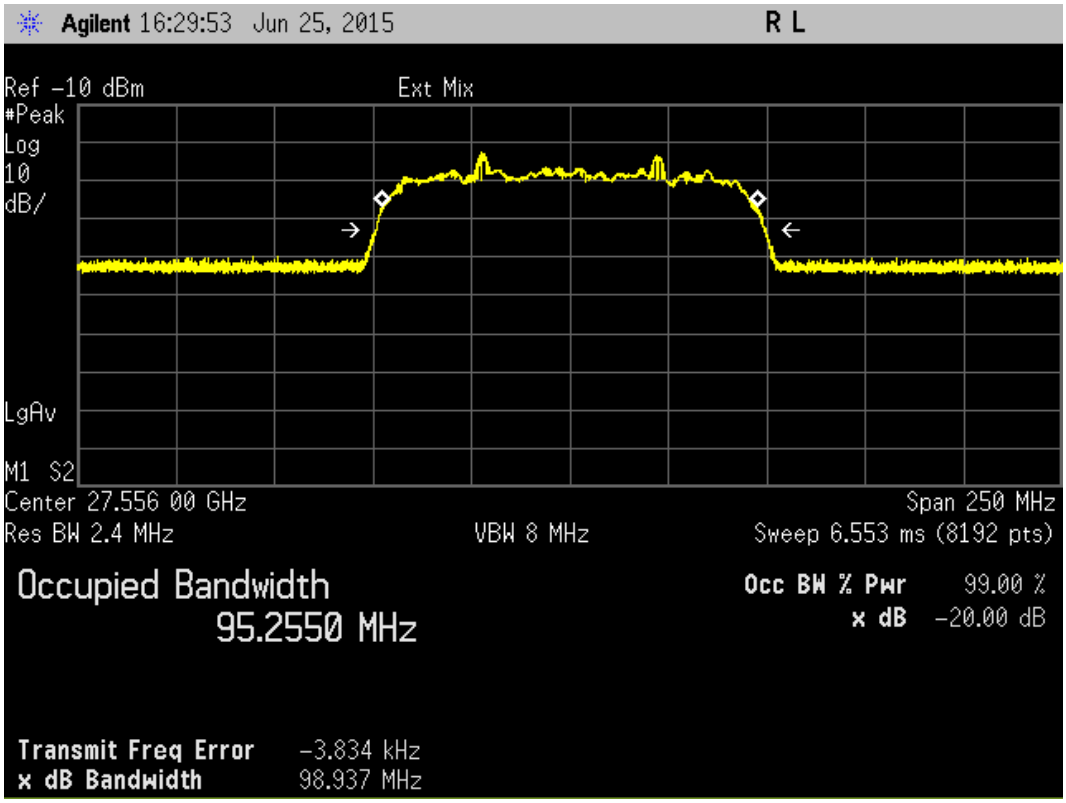
RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 112 MHz, Modulation 16 QAM, Channel 28.2485 GHz



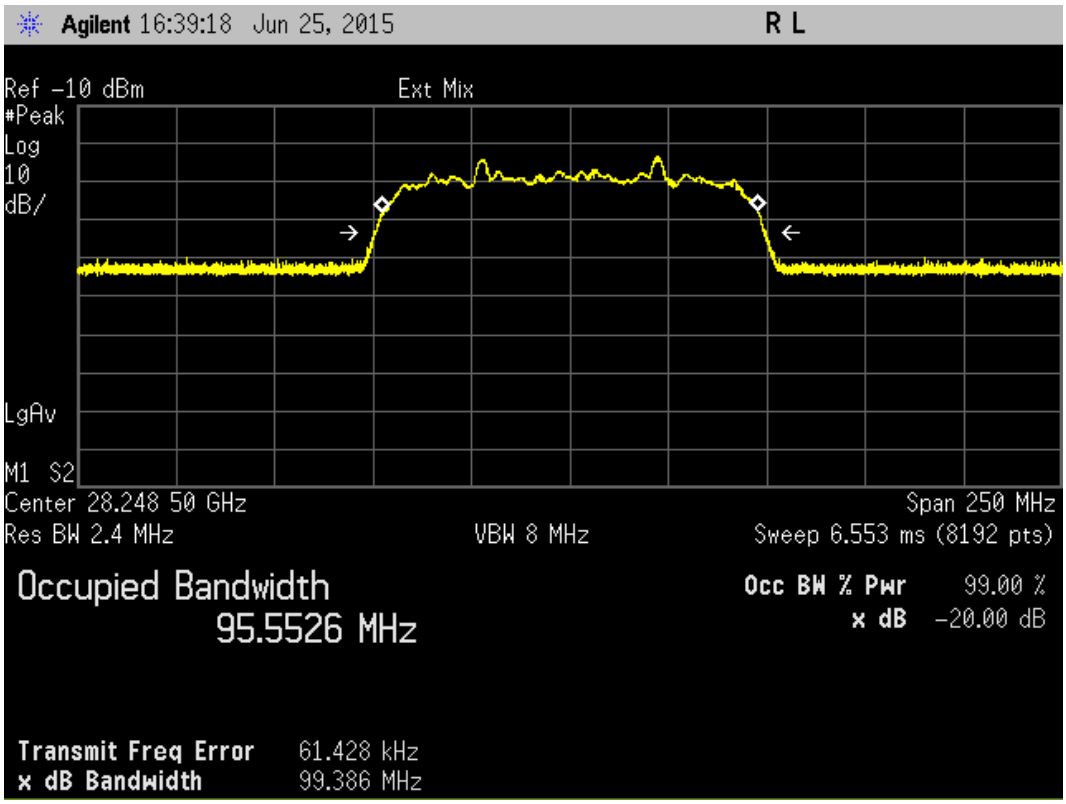
RF Parameters: Band 29.1-29.25 GHz, Power 21 dBm, Channel Spacing 112 MHz, Modulation 16 QAM, Channel 29.156 GHz



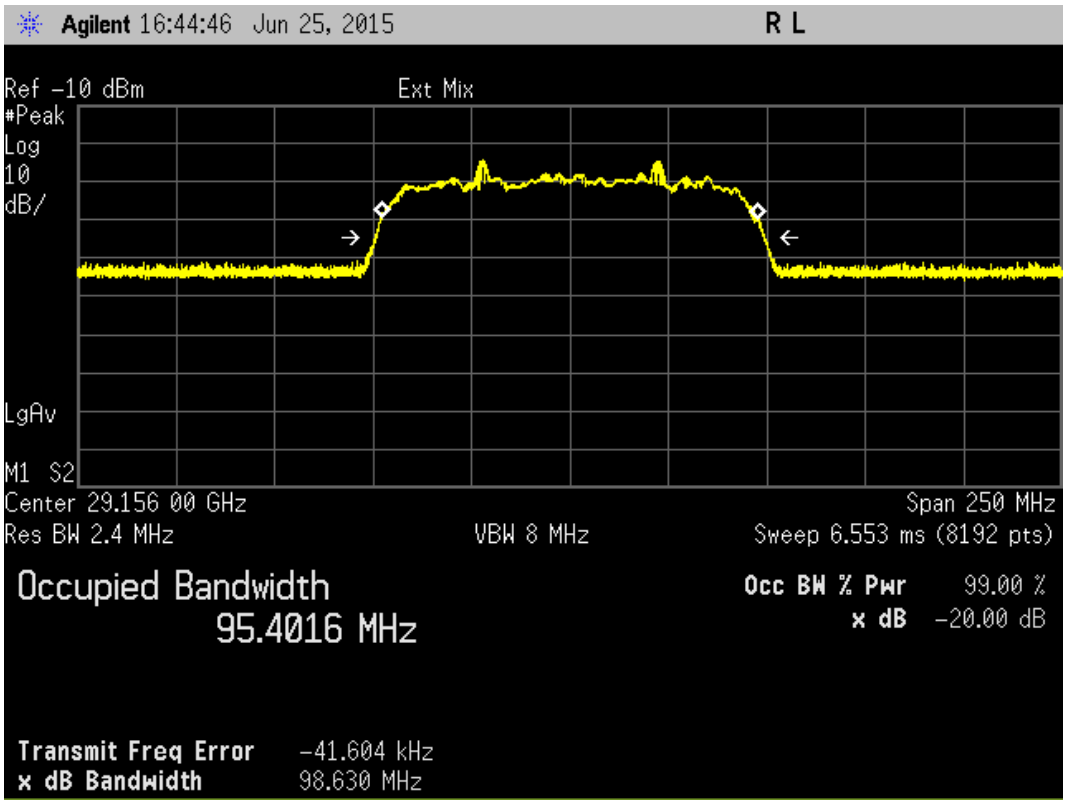
RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 100 MHz, Modulation 64 QAM, Channel 27.556 GHz



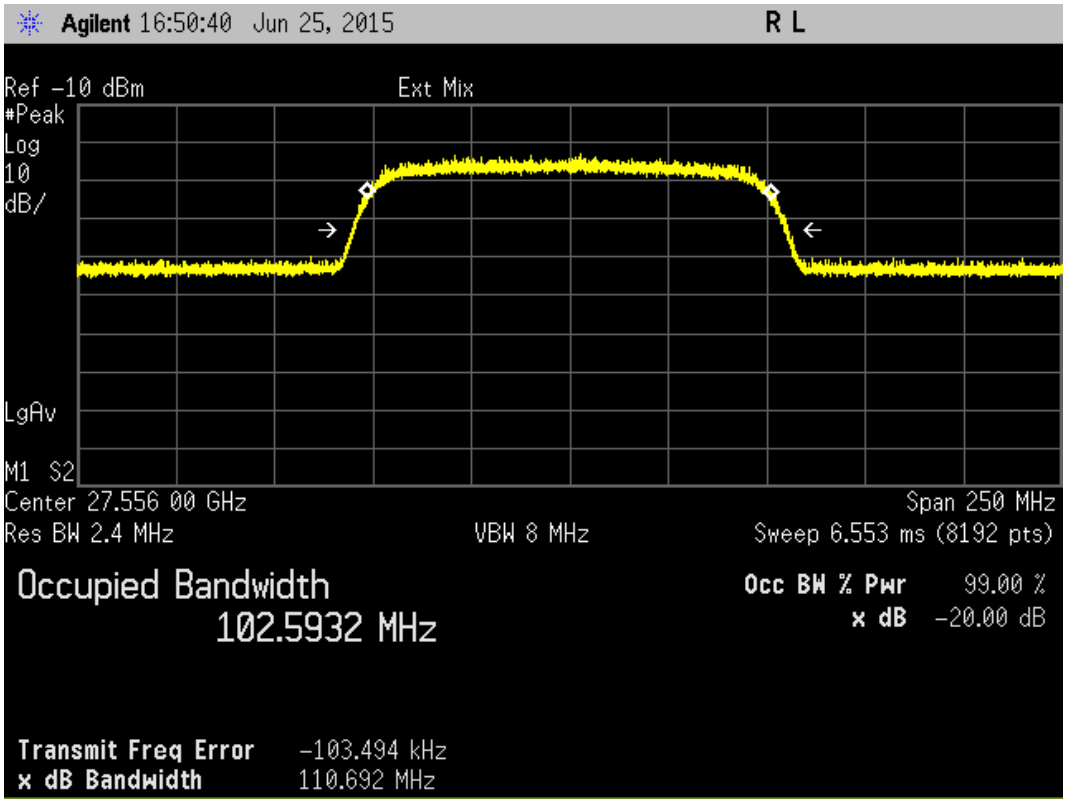
RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 100 MHz, Modulation 64 QAM, Channel 28.2485 GHz



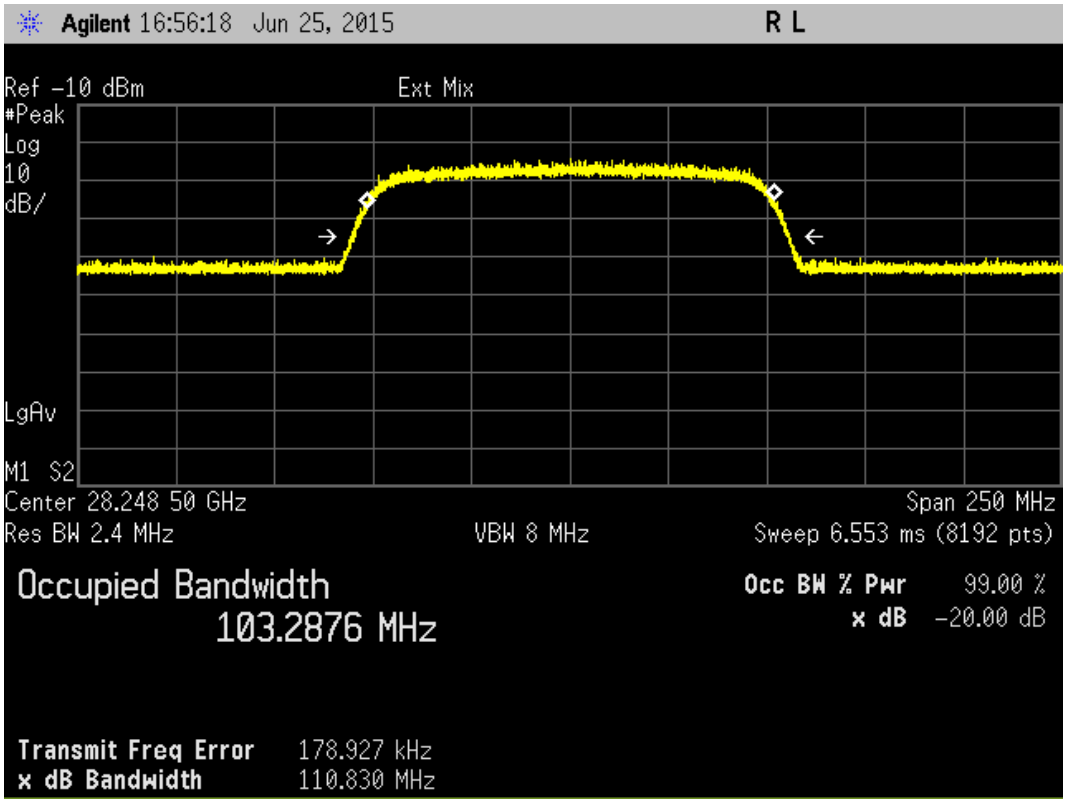
RF Parameters: Band 29.1-29.25 GHz, Power 18 dBm, Channel Spacing 100 MHz, Modulation 64 QAM, Channel 29.156 GHz



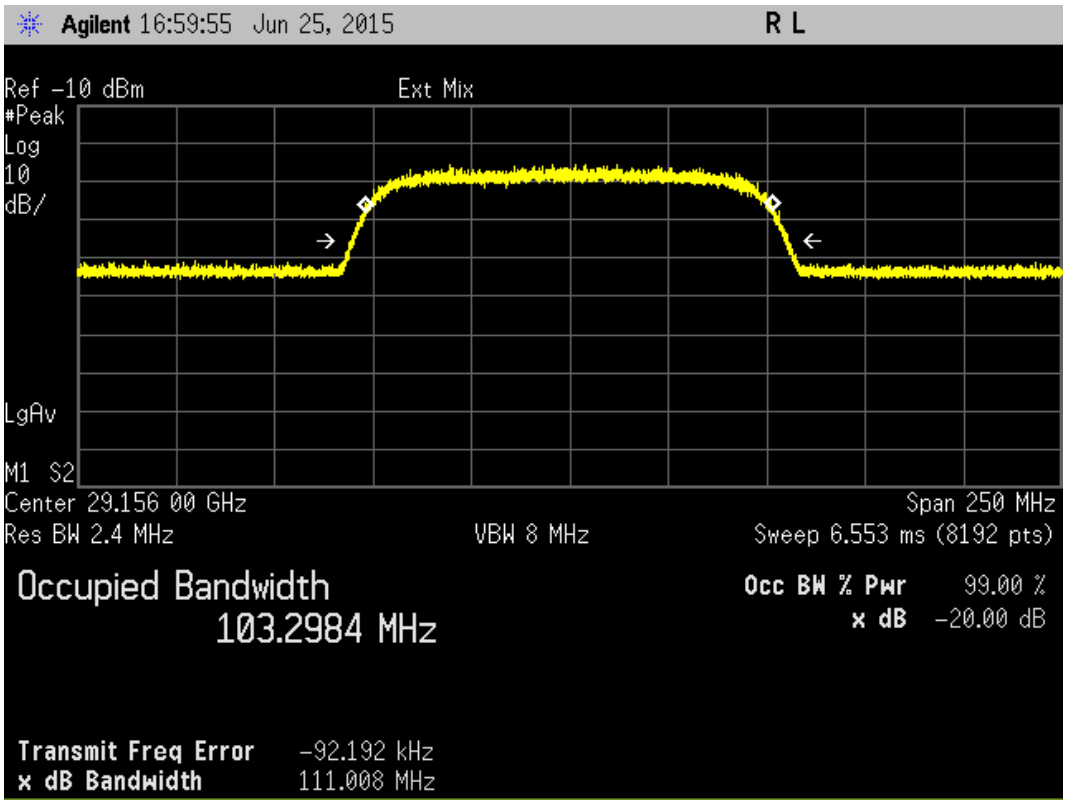
RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 112 MHz, Modulation 64 QAM, Channel 27.556 GHz



RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 112 MHz, Modulation 64 QAM, Channel 28.2485 GHz

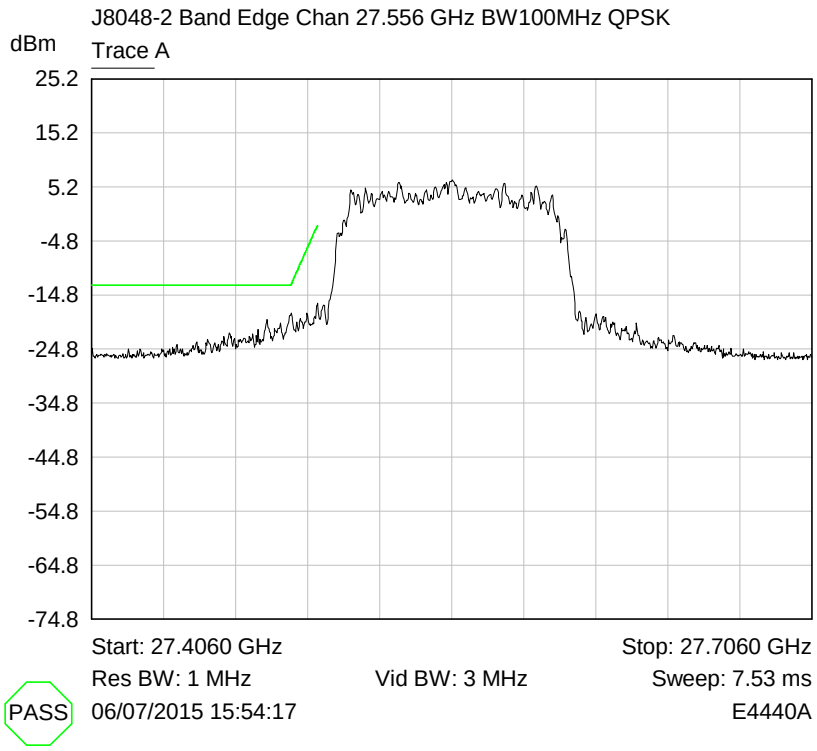


RF Parameters: Band 29.1-29.25 GHz, Power 18 dBm, Channel Spacing 112 MHz, Modulation 64 QAM, Channel 29.156 GHz



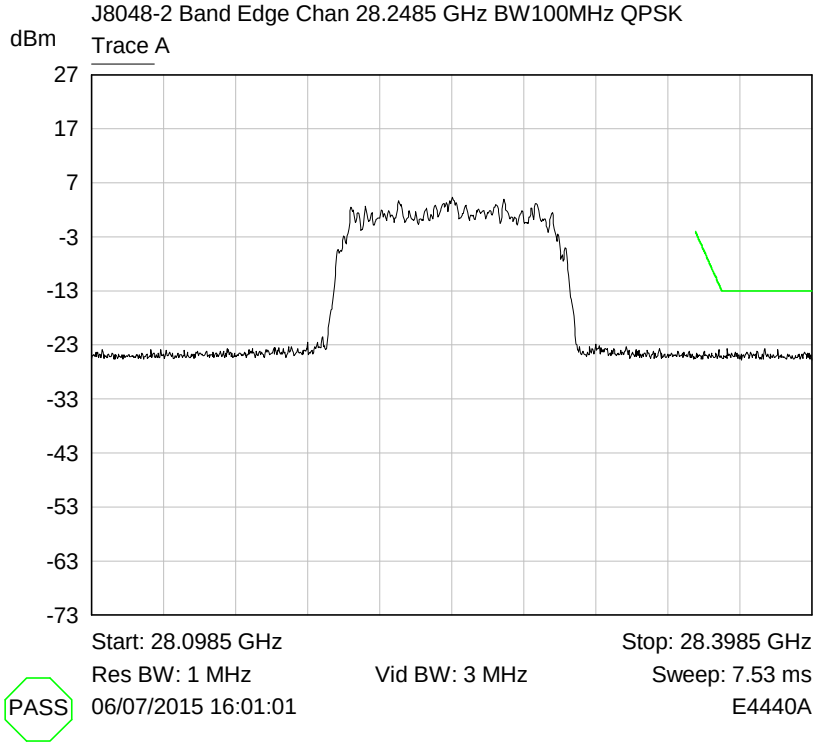
6.3 Band edge / spectrum mask additional emissions limitations

RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 27.556 GHz



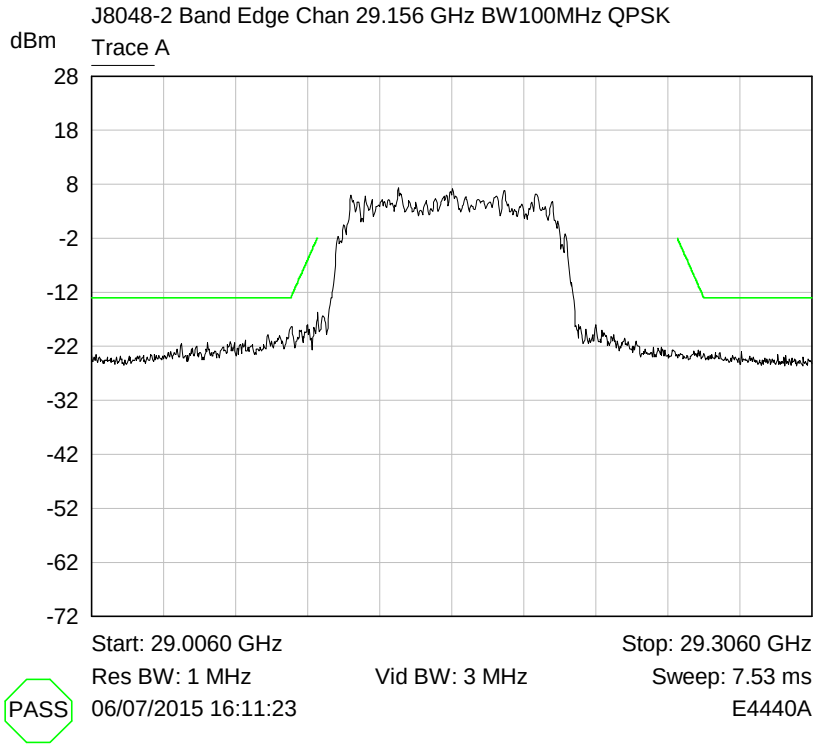
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 28.2485 GHz



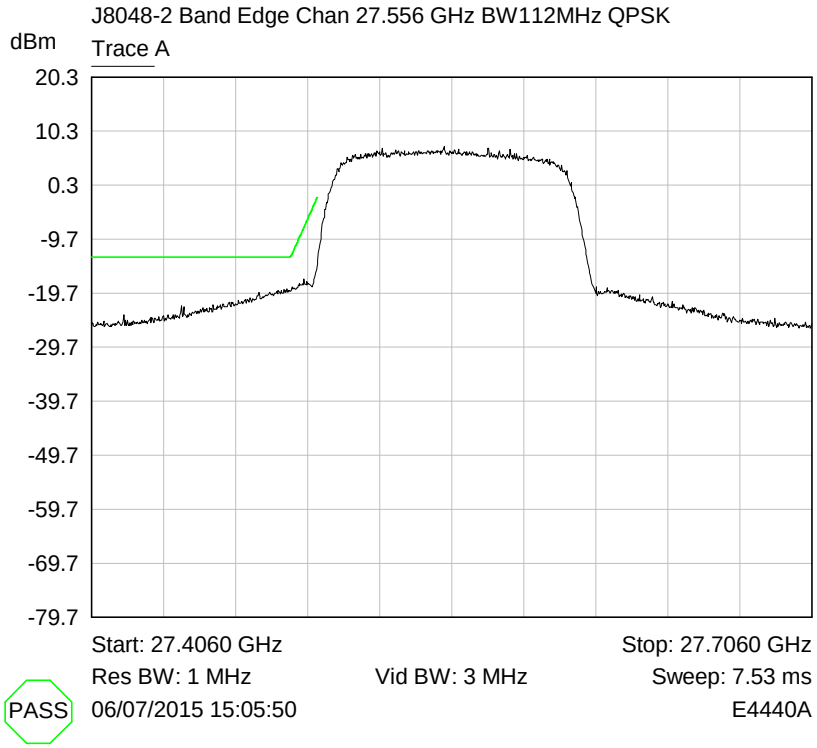
Nominal Temperature, Nominal Voltage

RF Parameters: Band 29.1-29.25 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 29.156 GHz



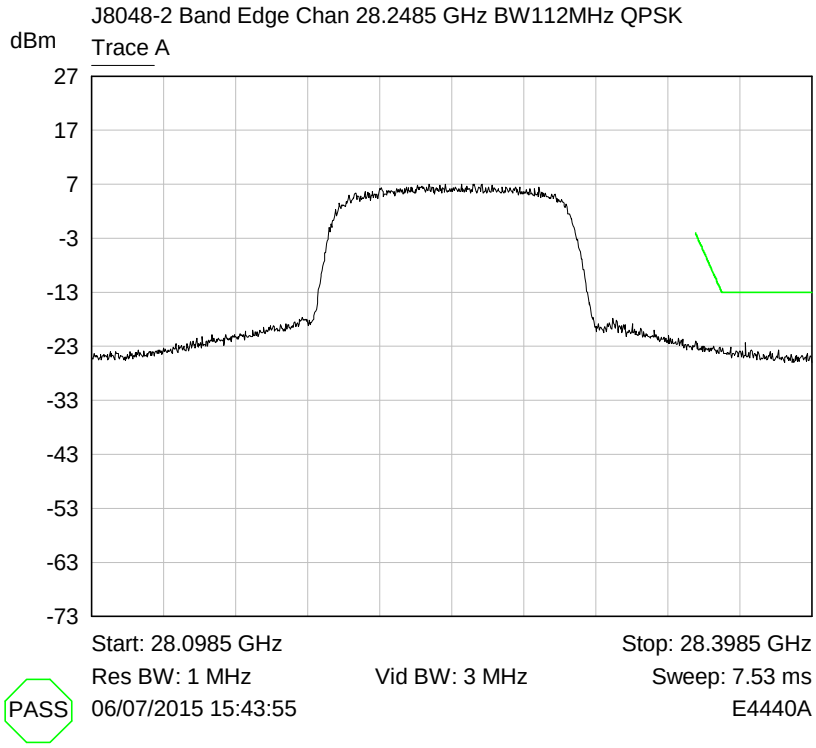
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 112 MHz, Modulation QPSK, Channel 27.556 GHz



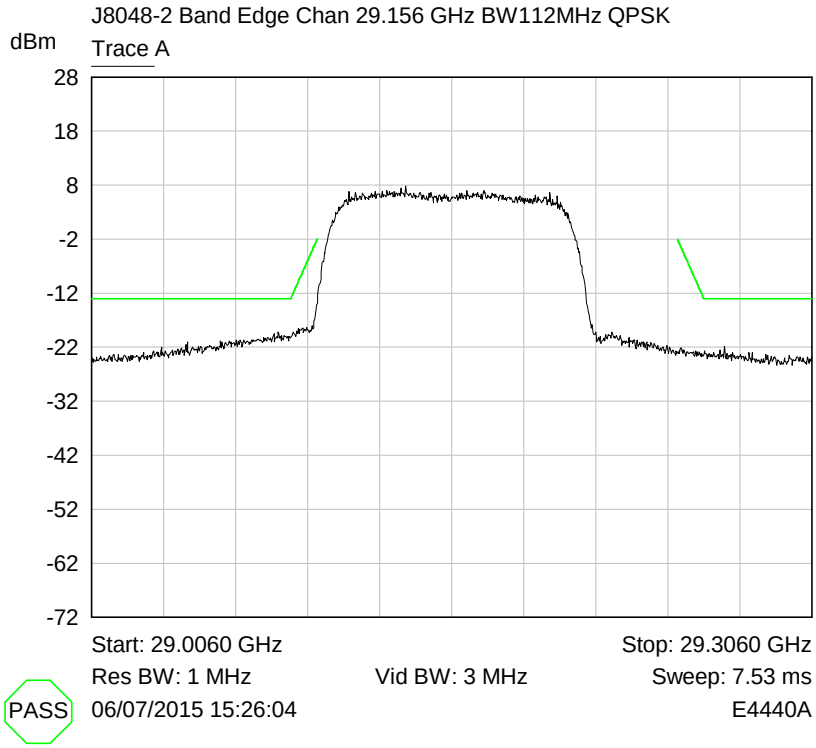
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 112 MHz, Modulation QPSK, Channel 28.2485 GHz



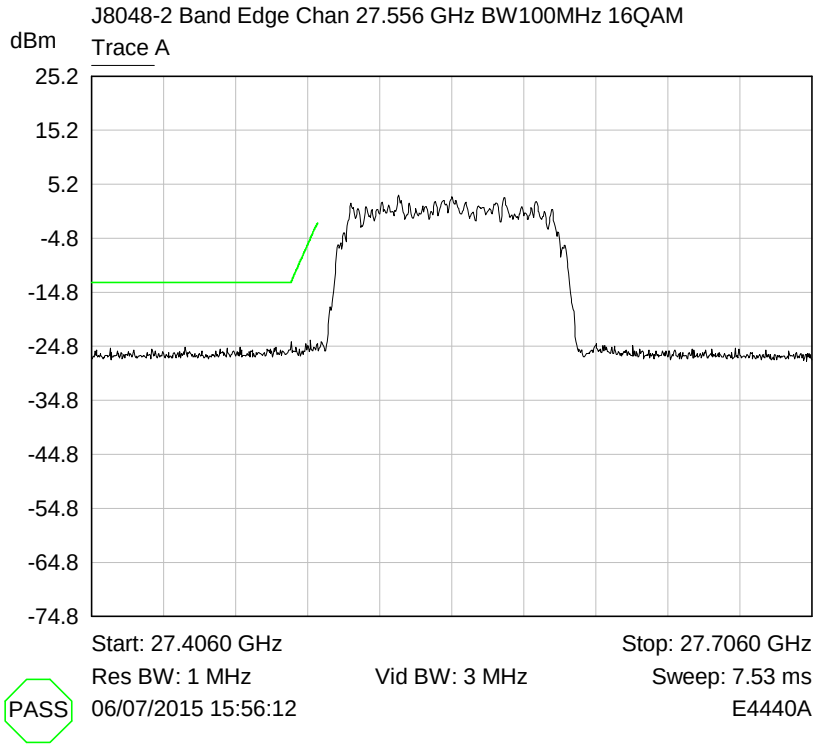
Nominal Temperature, Nominal Voltage

RF Parameters: Band 29.1-29.25 GHz, Power 25 dBm, Channel Spacing 112 MHz, Modulation QPSK, Channel 29.156 GHz



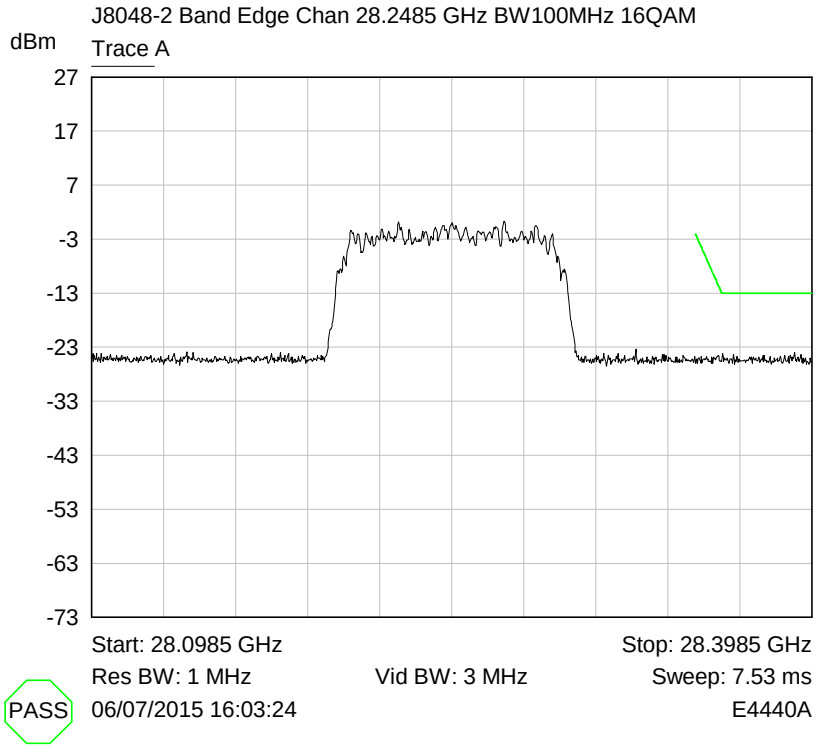
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 100 MHz, Modulation 16 QAM, Channel 27.556 GHz



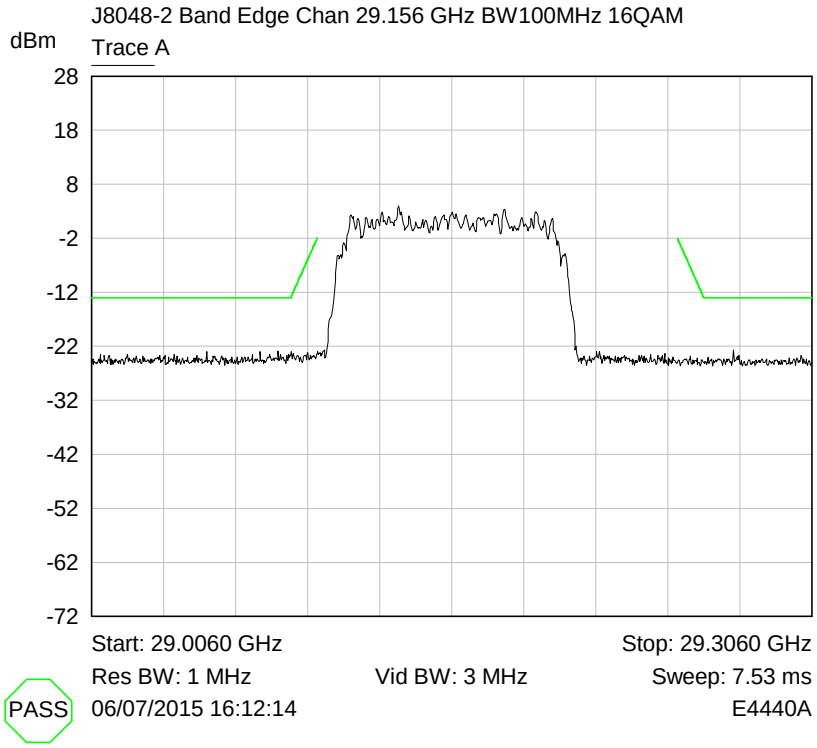
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 100 MHz, Modulation 16 QAM, Channel 28.2485 GHz



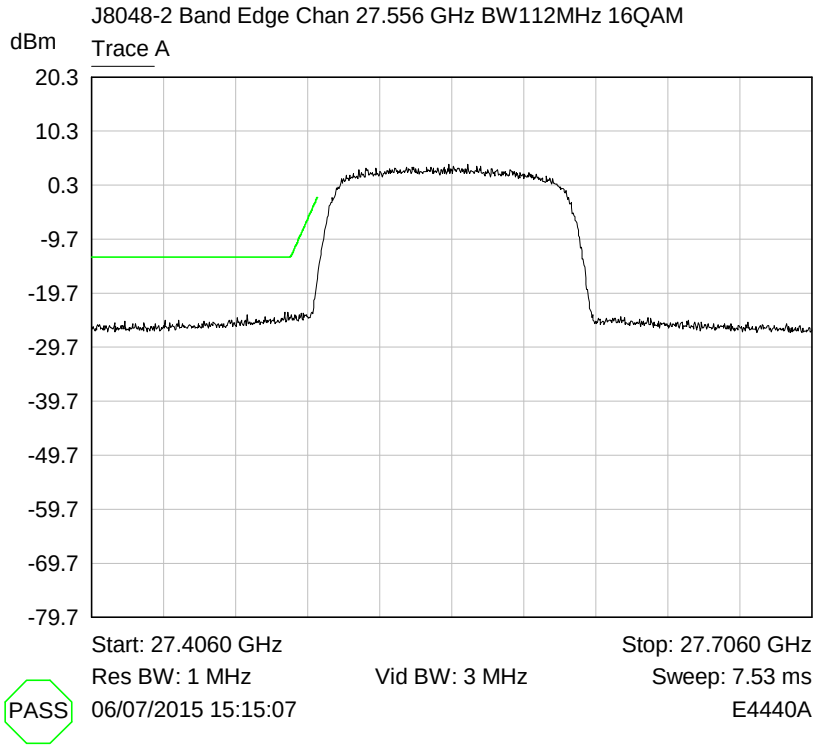
Nominal Temperature, Nominal Voltage

RF Parameters: Band 29.1-29.25 GHz, Power 21 dBm, Channel Spacing 100 MHz, Modulation 16 QAM, Channel 29.156 GHz



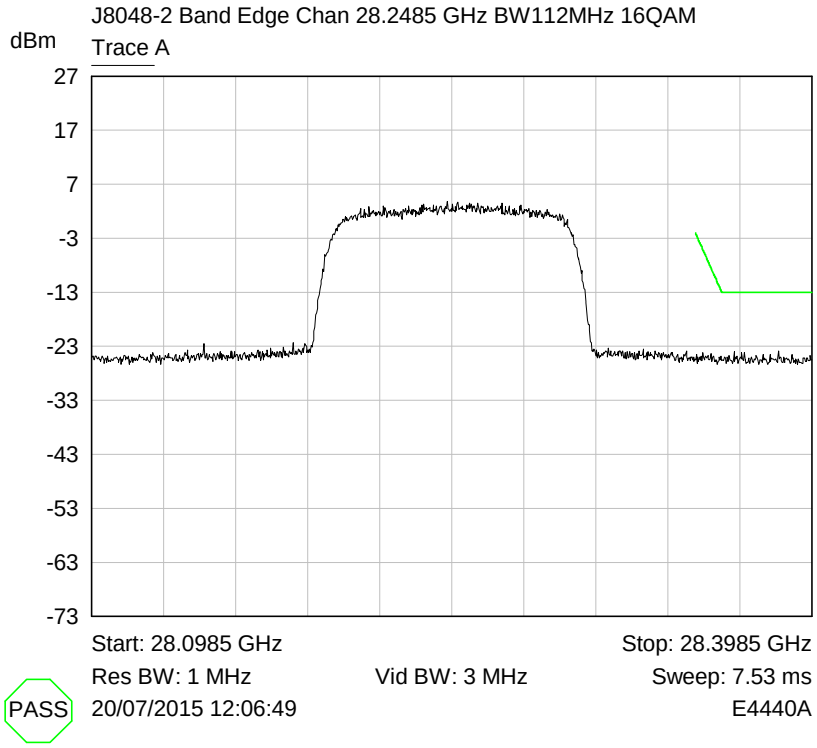
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 112 MHz, Modulation 16 QAM, Channel 27.556 GHz



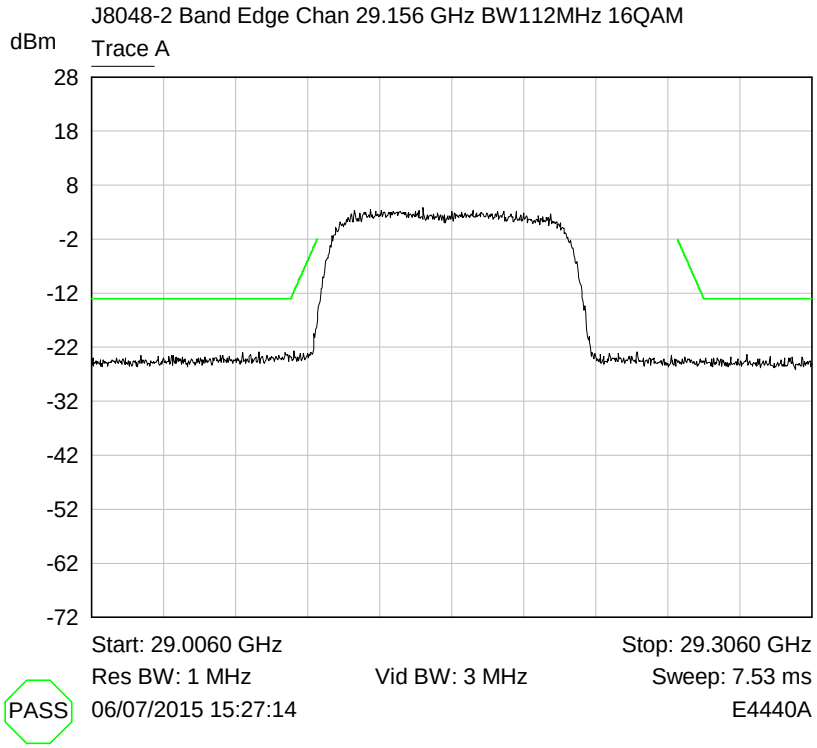
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 112 MHz, Modulation 16 QAM, Channel 28.2485 GHz



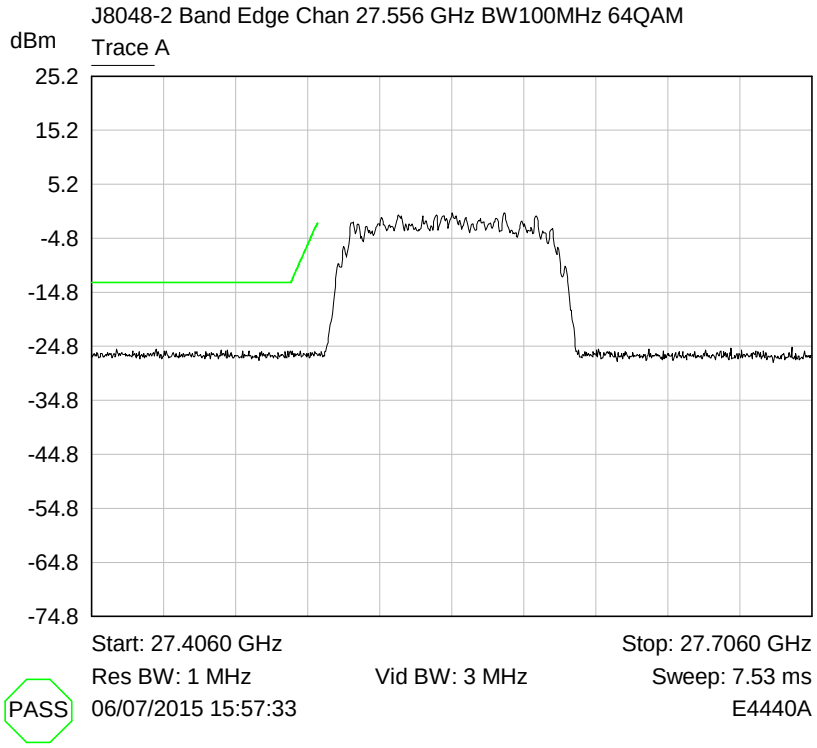
Nominal Temperature, Nominal Voltage

RF Parameters: Band 29.1-29.25 GHz, Power 21 dBm, Channel Spacing 112 MHz, Modulation 16 QAM, Channel 29.156 GHz



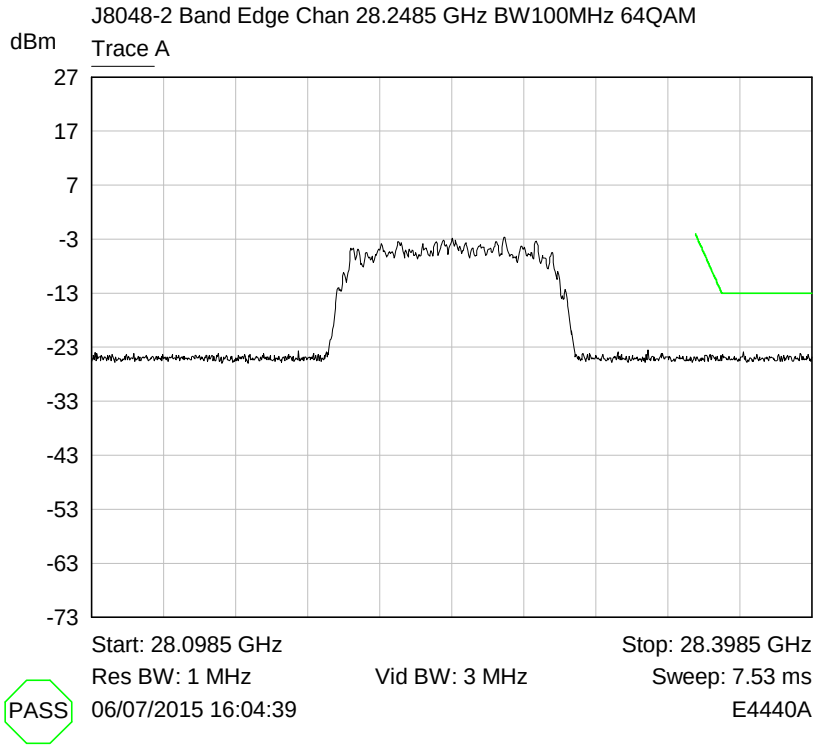
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 100 MHz, Modulation 64 QAM, Channel 27.556 GHz



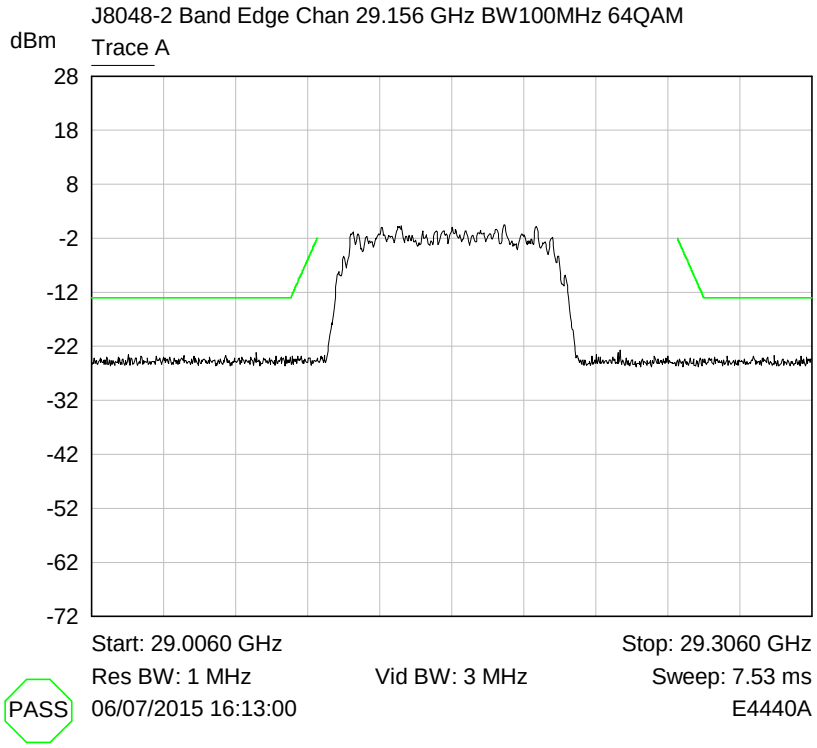
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 100 MHz, Modulation 64 QAM, Channel 28.2485 GHz



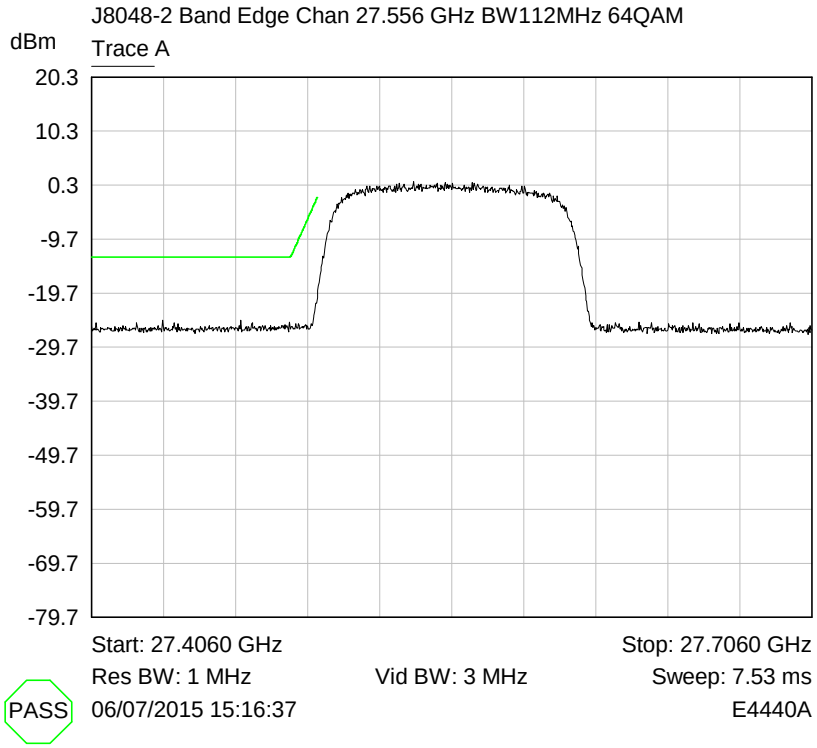
Nominal Temperature, Nominal Voltage

RF Parameters: Band 29.1-29.25 GHz, Power 18 dBm, Channel Spacing 100 MHz, Modulation 64 QAM, Channel 29.156 GHz



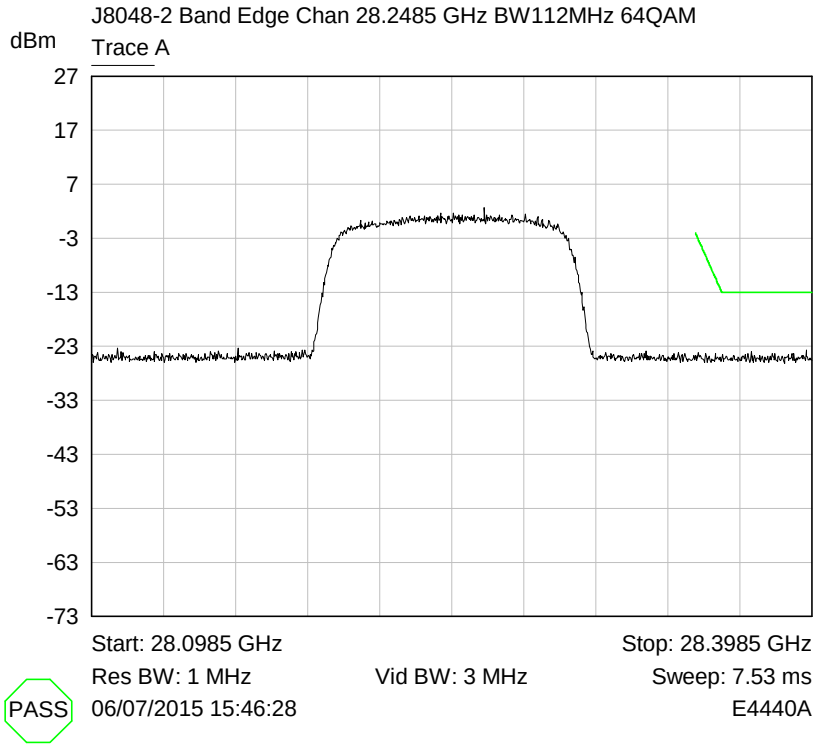
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 112 MHz, Modulation 64 QAM, Channel 27.556 GHz



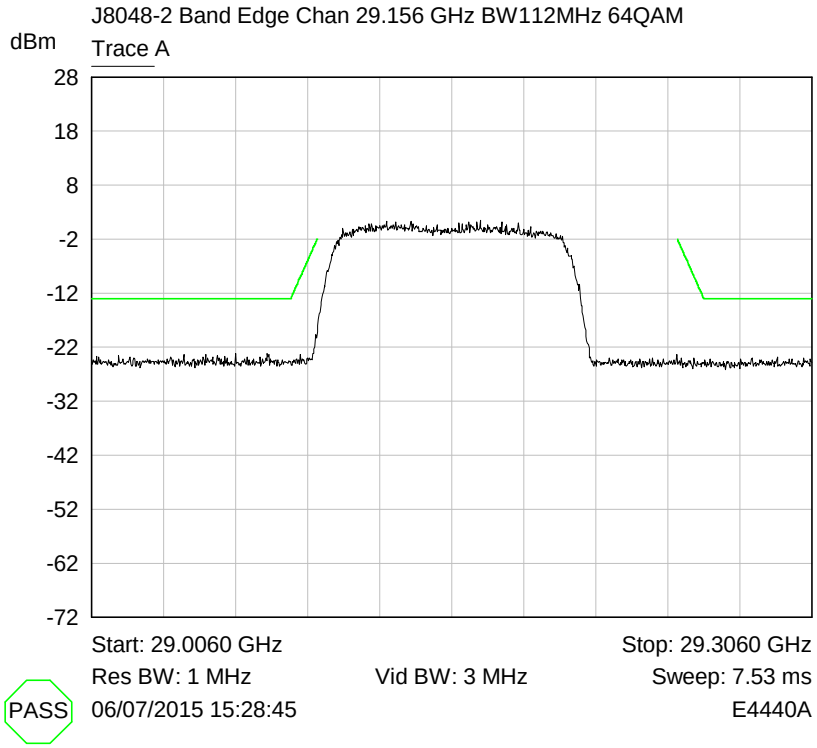
Nominal Temperature, Nominal Voltage

RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 112 MHz, Modulation 64 QAM, Channel 28.2485 GHz



Nominal Temperature, Nominal Voltage

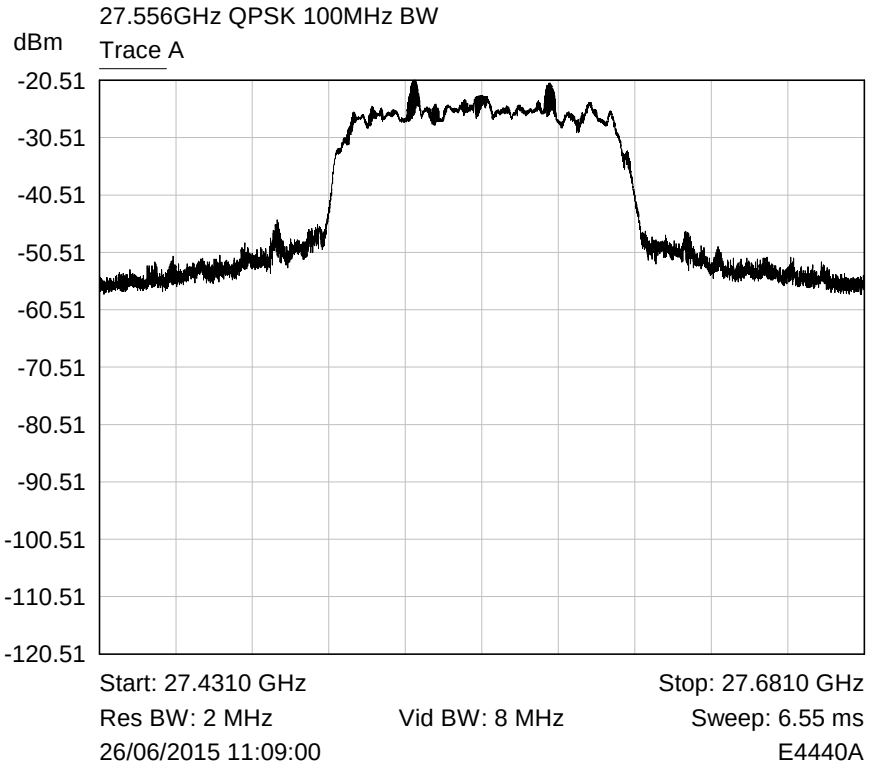
RF Parameters: Band 29.1-29.25 GHz, Power 18 dBm, Channel Spacing 112 MHz, Modulation 64 QAM, Channel 29.156 GHz



Nominal Temperature, Nominal Voltage

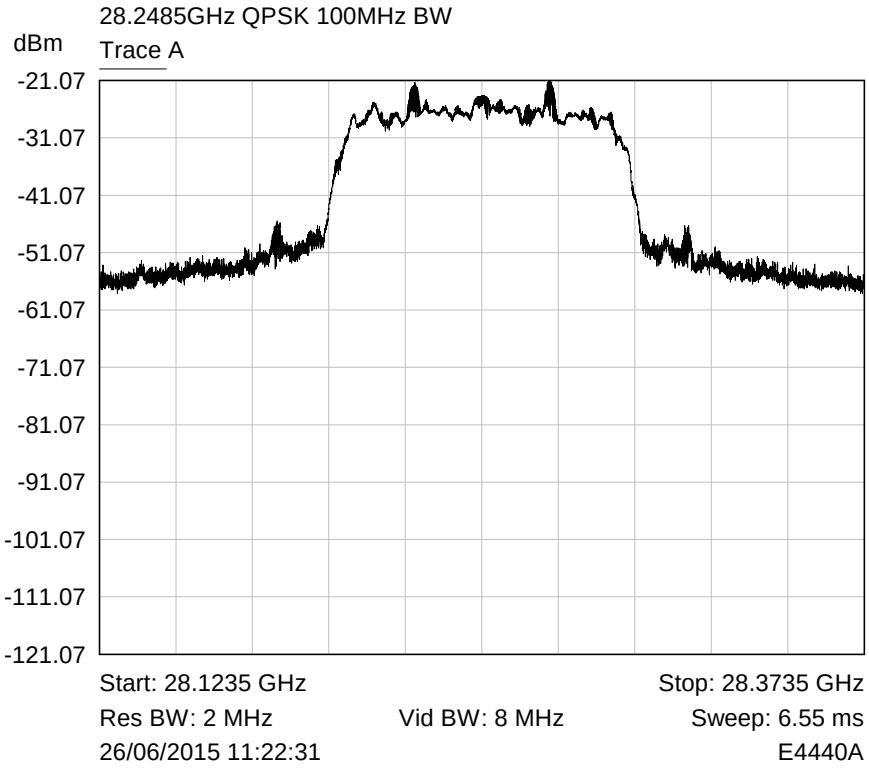
6.4 Modulation characteristics

RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 27.556 GHz



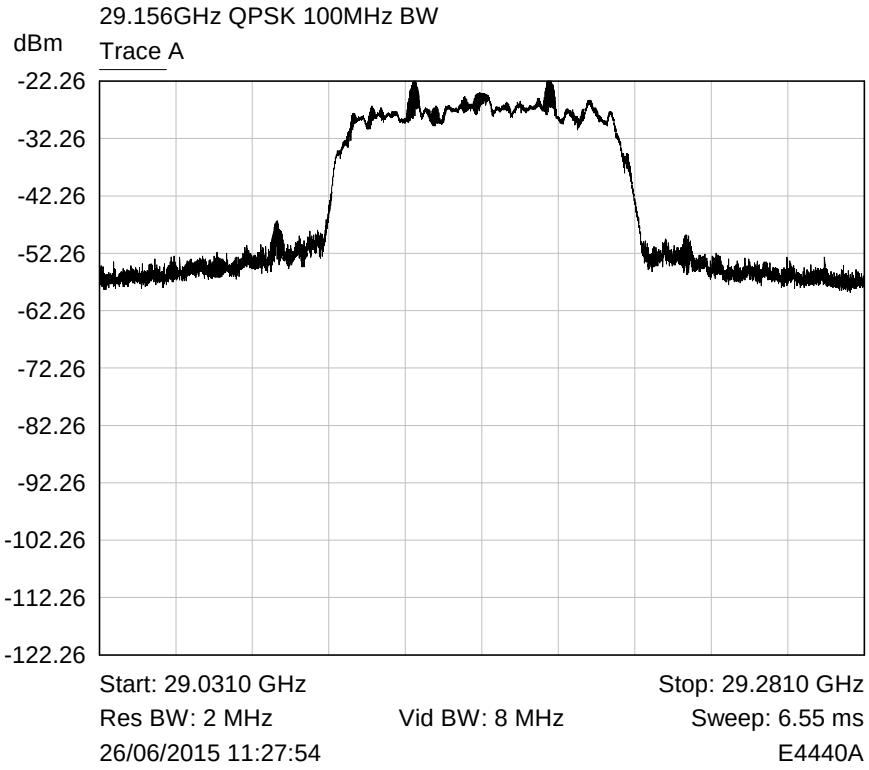
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 28.2485 GHz



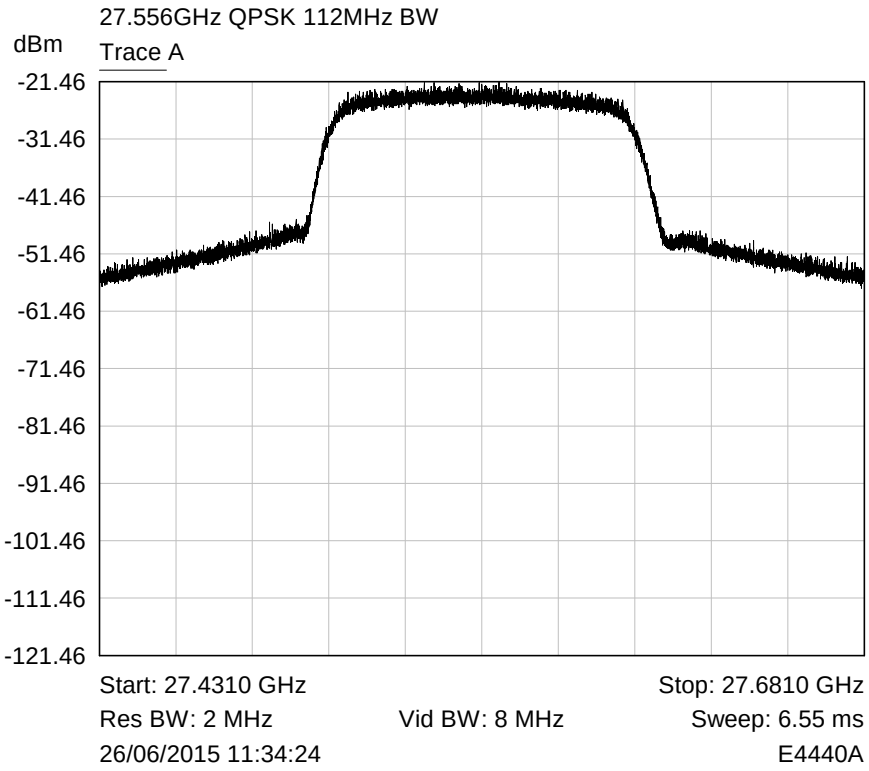
Nominal, Maximised RF Output / field strength

RF Parameters: Band 29.1-29.25 GHz, Power 25 dBm, Channel Spacing 100 MHz, Modulation QPSK, Channel 29.156 GHz



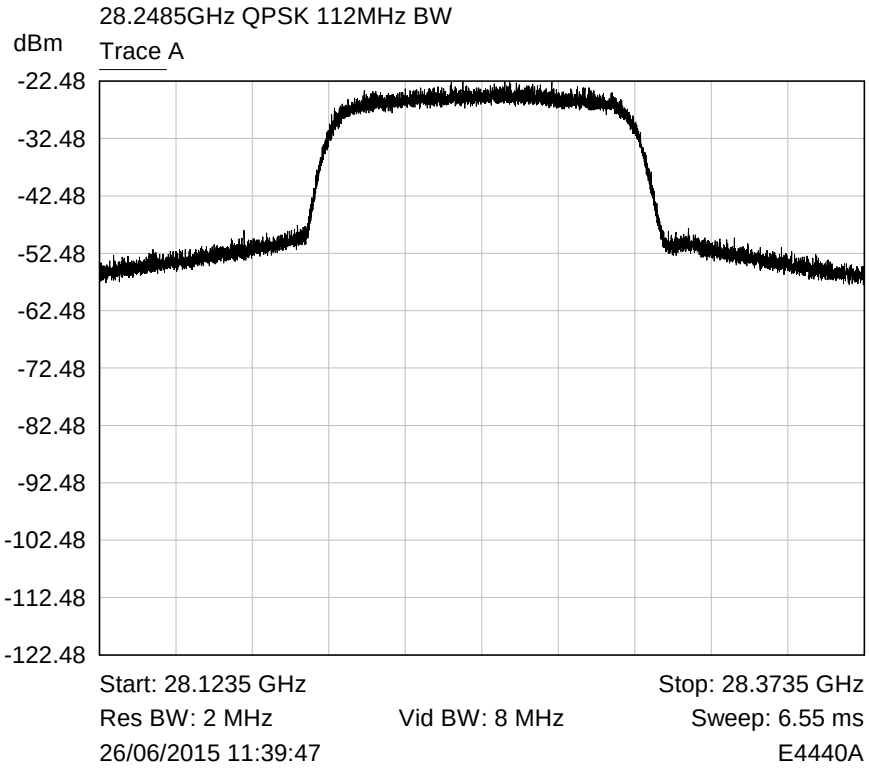
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 112 MHz, Modulation QPSK, Channel 27.556 GHz



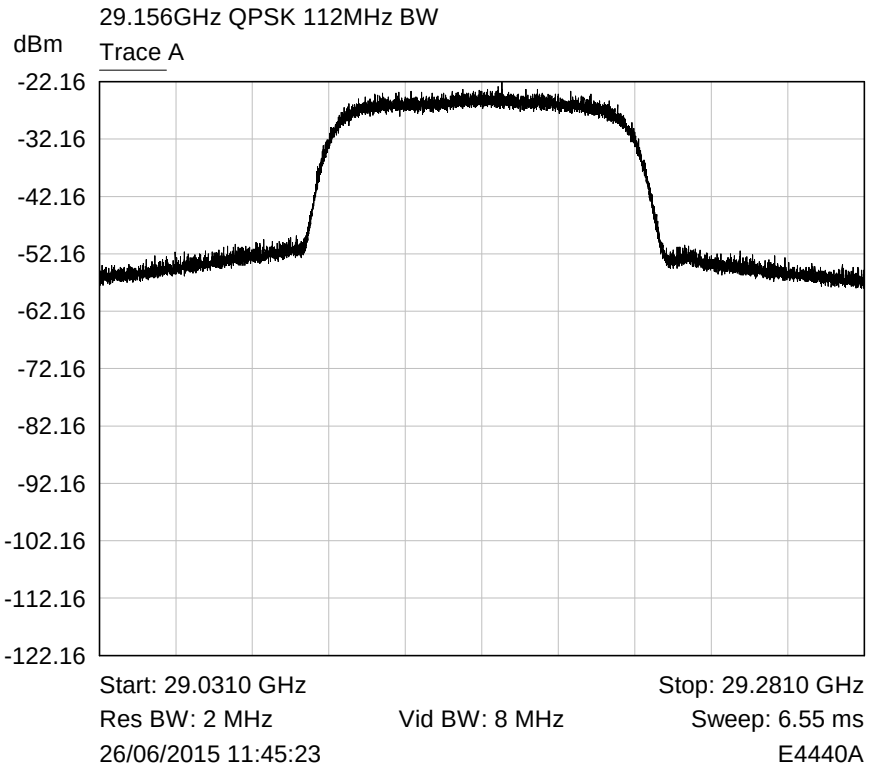
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 25 dBm, Channel Spacing 112 MHz, Modulation QPSK, Channel 28.2485 GHz



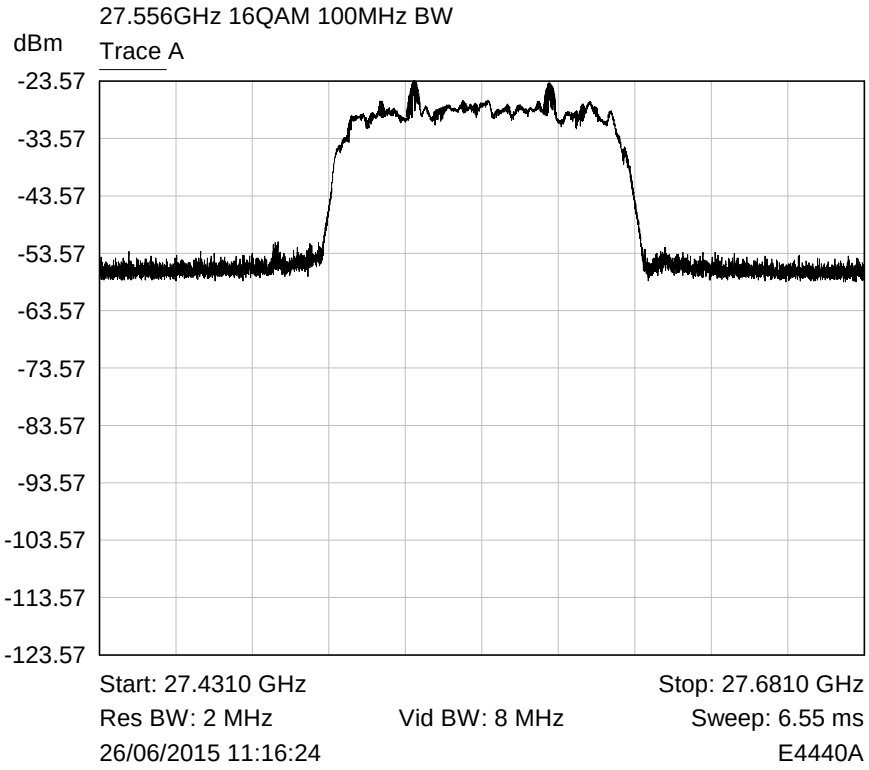
Nominal, Maximised RF Output / field strength

RF Parameters: Band 29.1-29.25 GHz, Power 25 dBm, Channel Spacing 112 MHz, Modulation QPSK, Channel 29.156 GHz



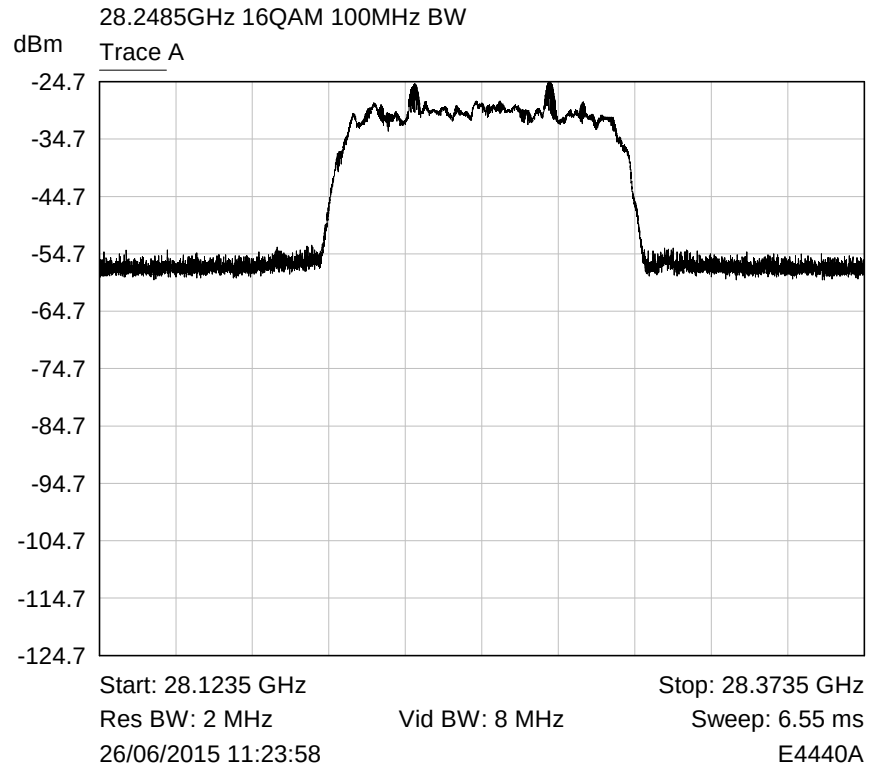
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 100 MHz, Modulation 16 QAM, Channel 27.556 GHz



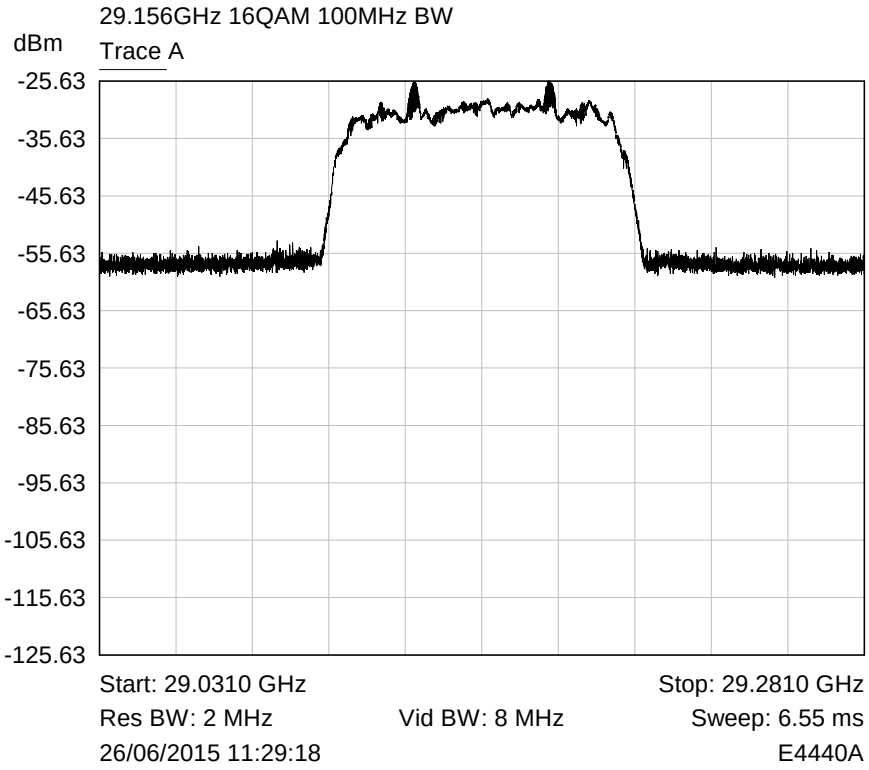
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 100 MHz, Modulation 16 QAM, Channel 28.2485 GHz



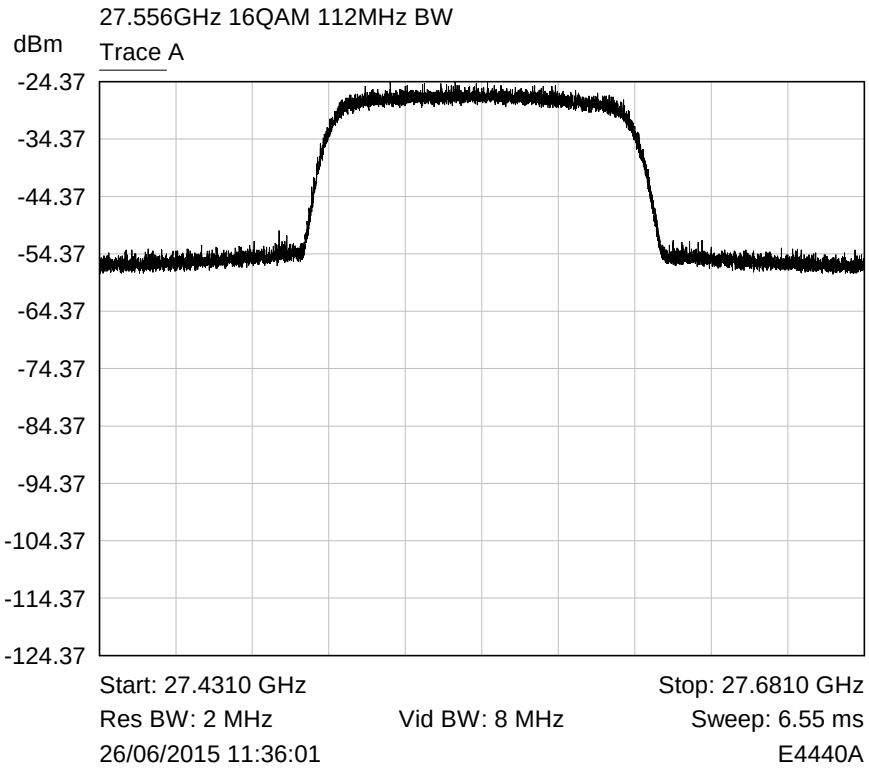
Nominal, Maximised RF Output / field strength

RF Parameters: Band 29.1-29.25 GHz, Power 21 dBm, Channel Spacing 100 MHz, Modulation 16 QAM, Channel 29.156 GHz



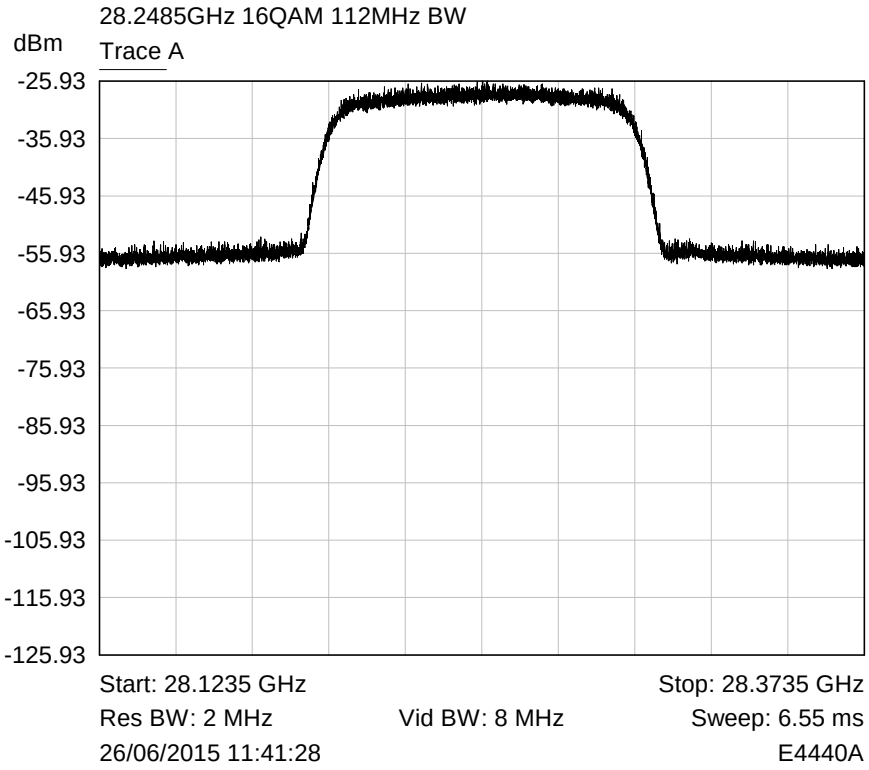
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 112 MHz, Modulation 16 QAM, Channel 27.556 GHz



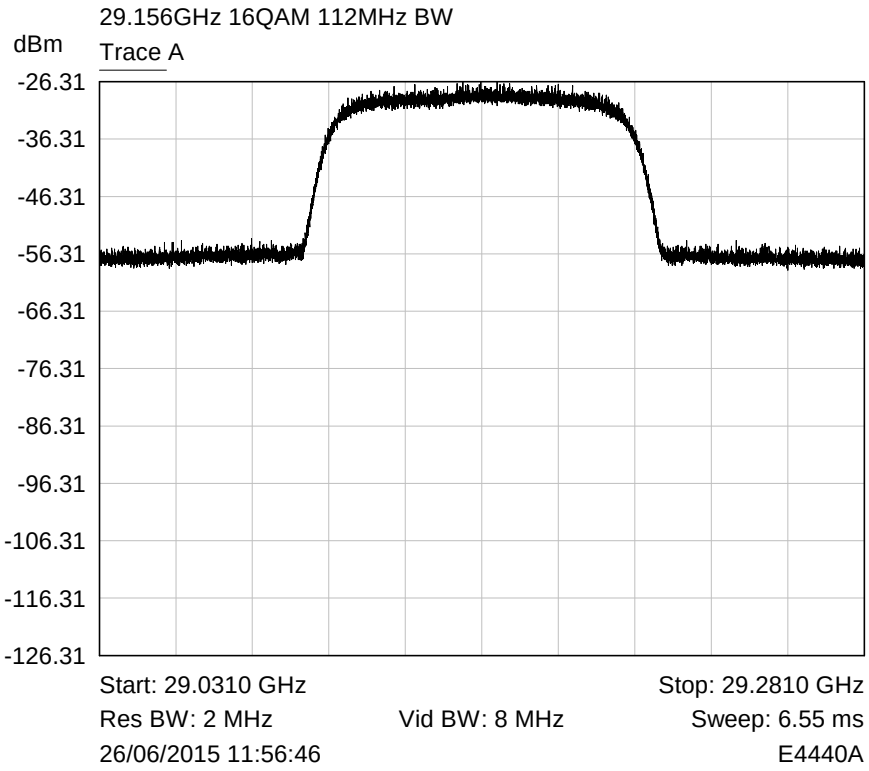
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 21 dBm, Channel Spacing 112 MHz, Modulation 16 QAM, Channel 28.2485 GHz



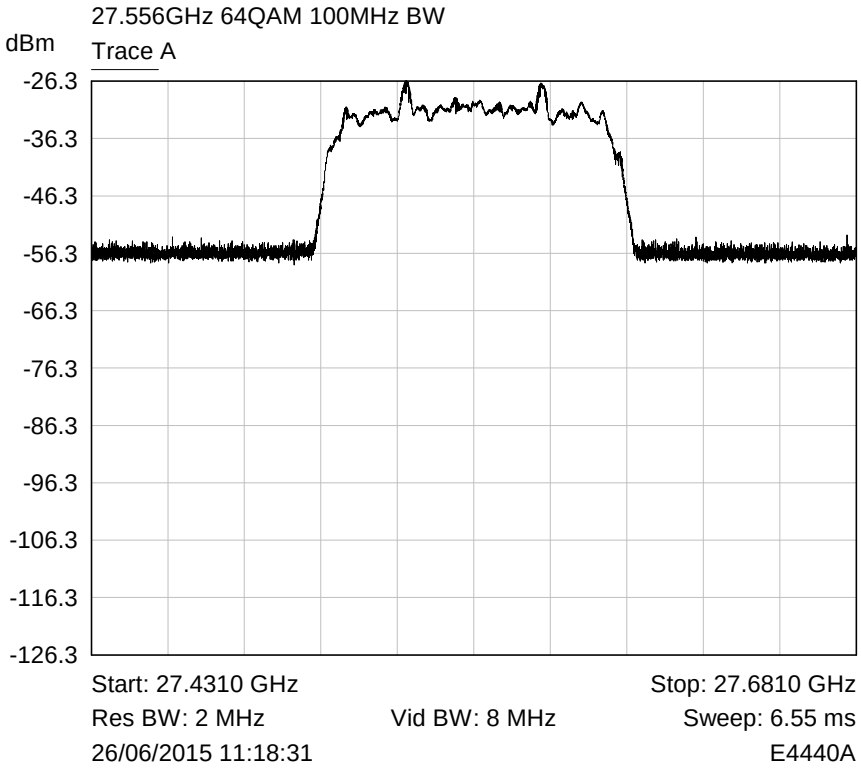
Nominal, Maximised RF Output / field strength

RF Parameters: Band 29.1-29.25 GHz, Power 21 dBm, Channel Spacing 112 MHz, Modulation 16 QAM, Channel 29.156 GHz



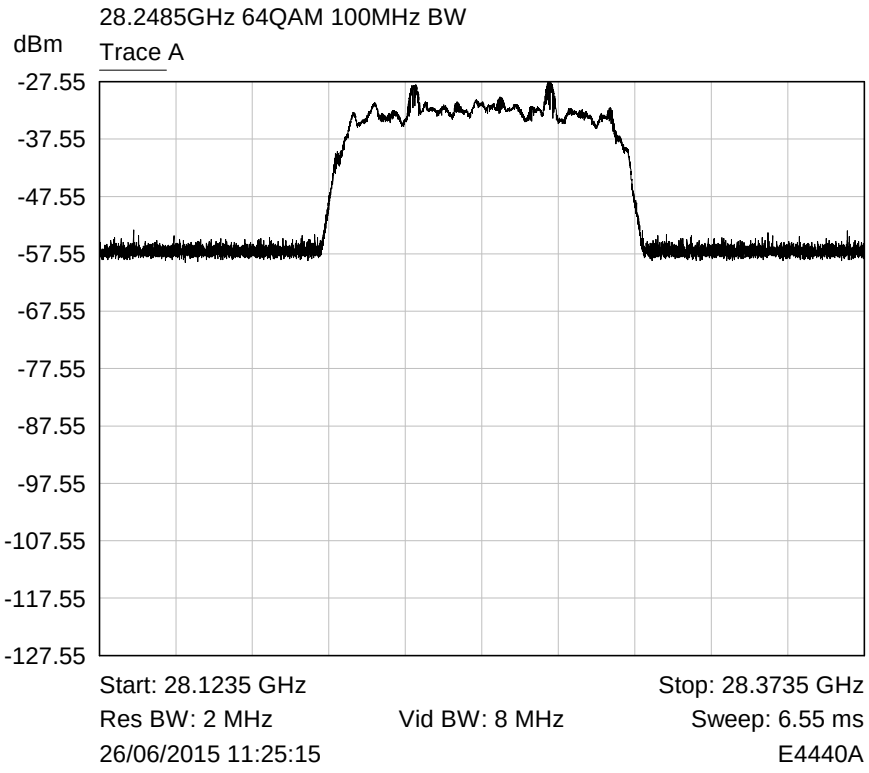
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 100 MHz, Modulation 64 QAM, Channel 27.556 GHz



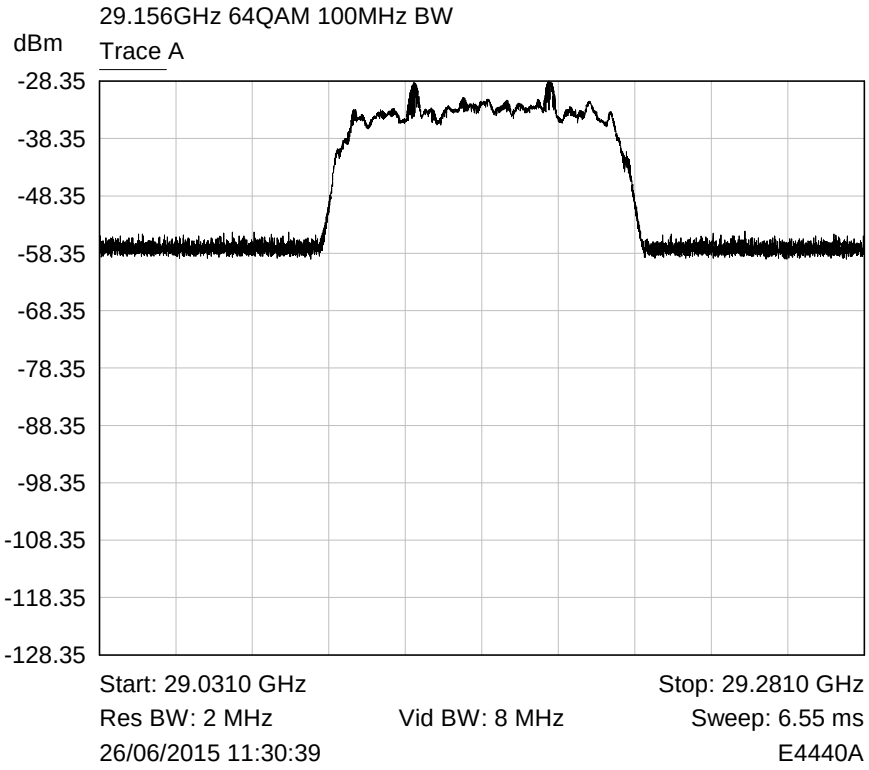
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 100 MHz, Modulation 64 QAM, Channel 28.2485 GHz



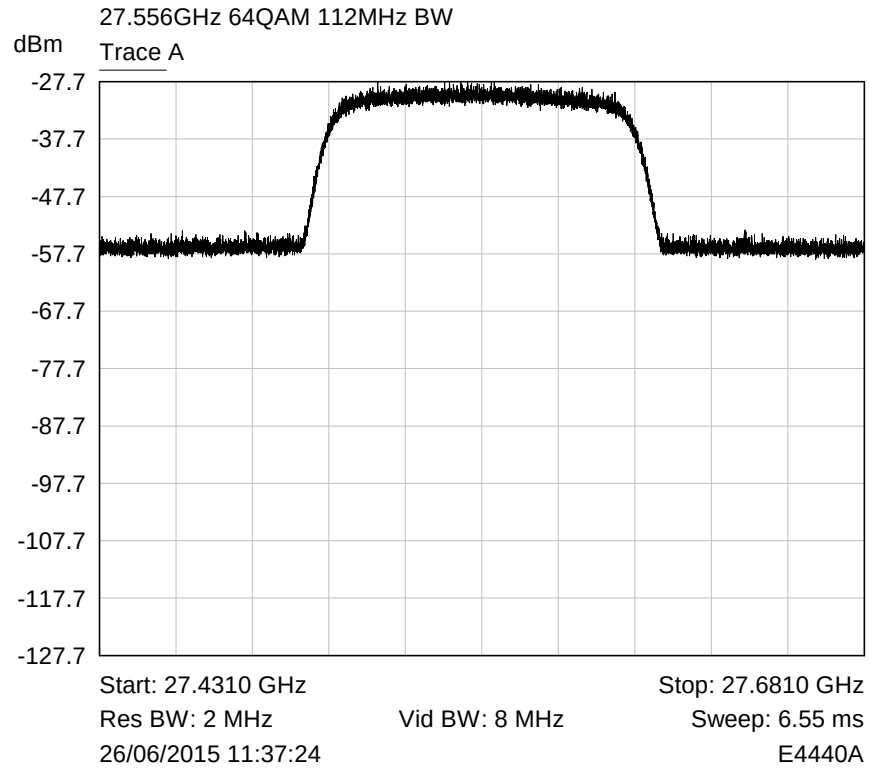
Nominal, Maximised RF Output / field strength

RF Parameters: Band 29.1-29.25 GHz, Power 18 dBm, Channel Spacing 100 MHz, Modulation 64 QAM, Channel 29.156 GHz



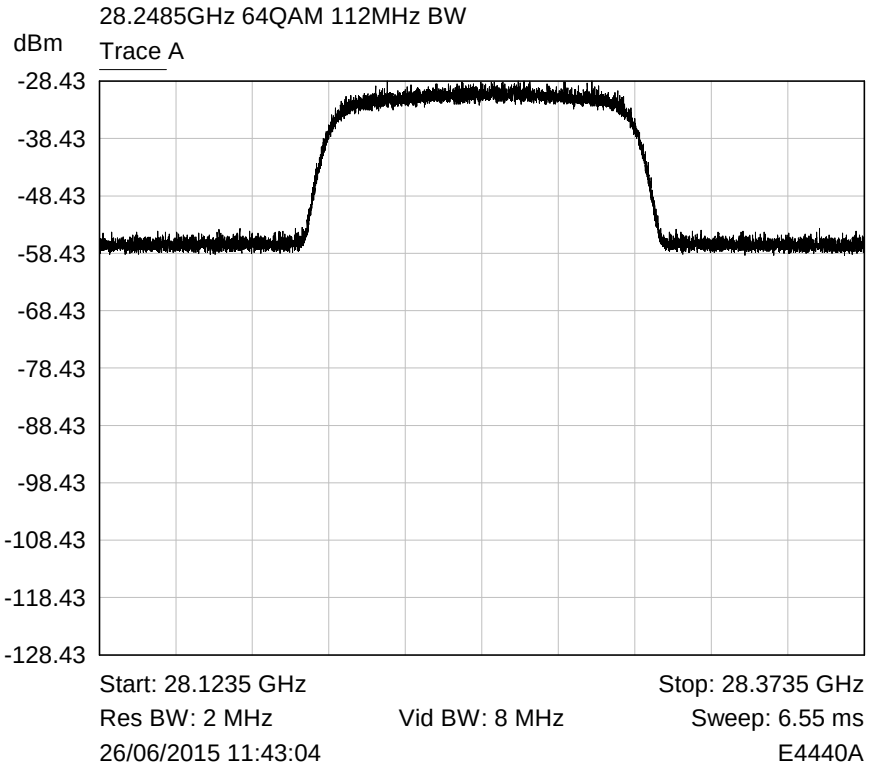
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 112 MHz, Modulation 64 QAM, Channel 27.556 GHz



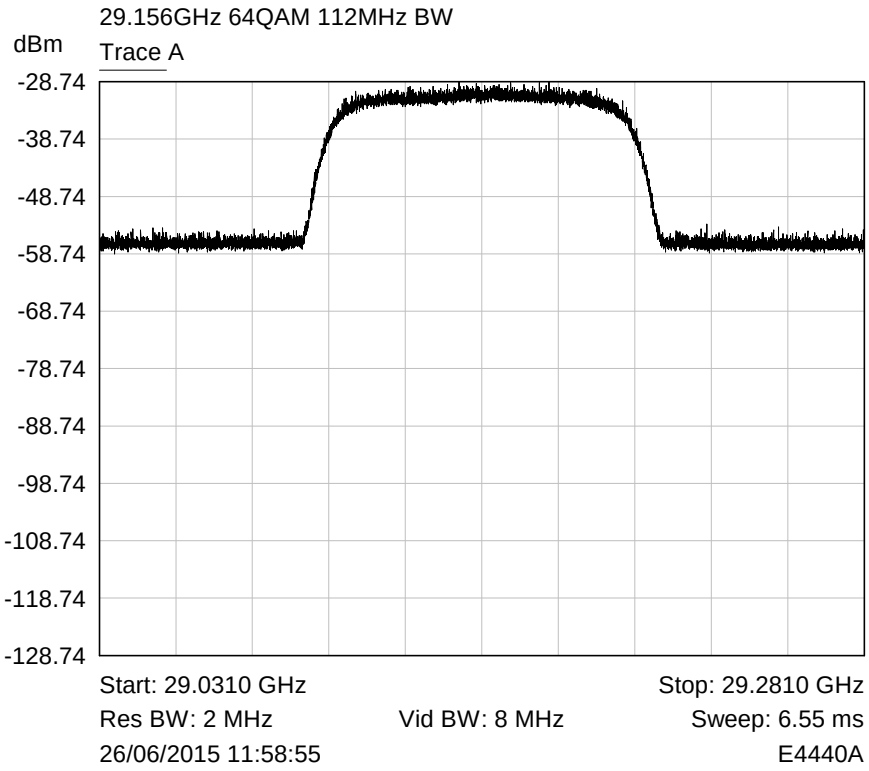
Nominal, Maximised RF Output / field strength

RF Parameters: Band 27.5-28.35 GHz, Power 18 dBm, Channel Spacing 112 MHz, Modulation 64 QAM, Channel 28.2485 GHz



Nominal, Maximised RF Output / field strength

RF Parameters: Band 29.1-29.25 GHz, Power 18 dBm, Channel Spacing 112 MHz, Modulation 64 QAM, Channel 29.156 GHz



Nominal, Maximised RF Output / field strength

7 Explanatory Notes

7.1 Explanation of waveguide cut-off frequency

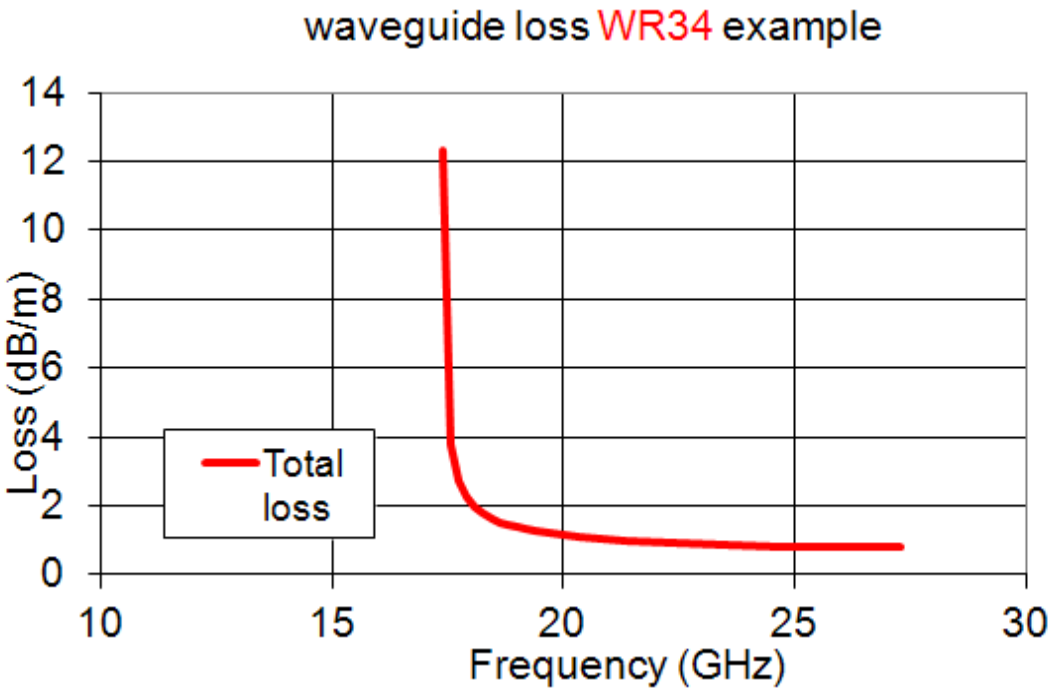
Rationale for lowest conducted emissions test frequency for EUT's using Waveguide RF ports:
In order to determine lowest frequency cut-off of a waveguide the following must be known:
Broadwall (largest) Dimension in mm of waveguide (for purposes of this equation = A)
Speed of light (29.979 cm/ns) (for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

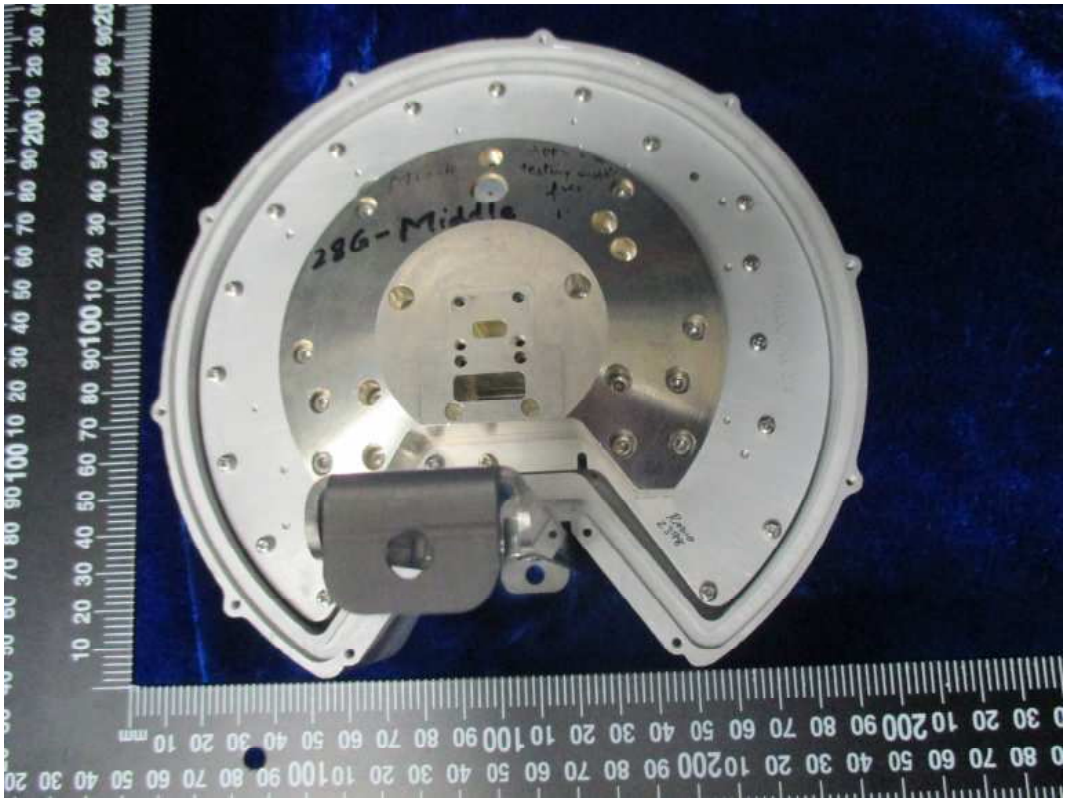
$f_{lowercutoff}$ = (B / 2A)

$f_{lowercutoff}$ = 29.979 / 1.7272 = 17.357 GHz.

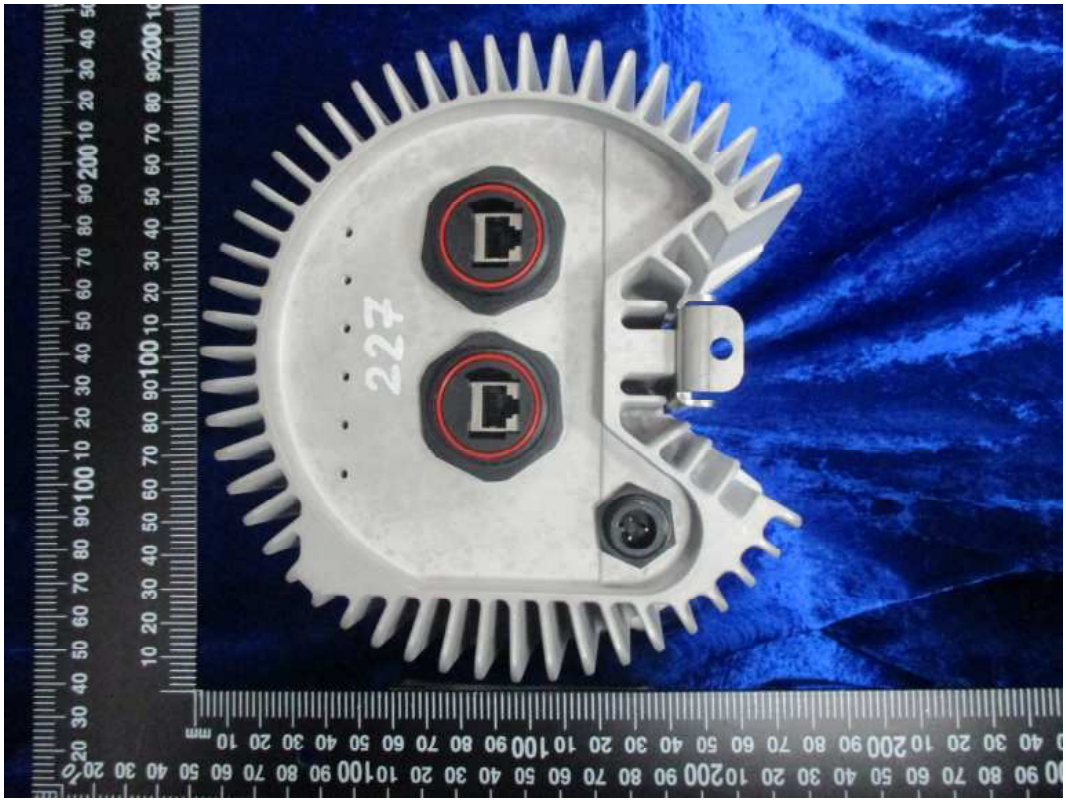


8 Photographs

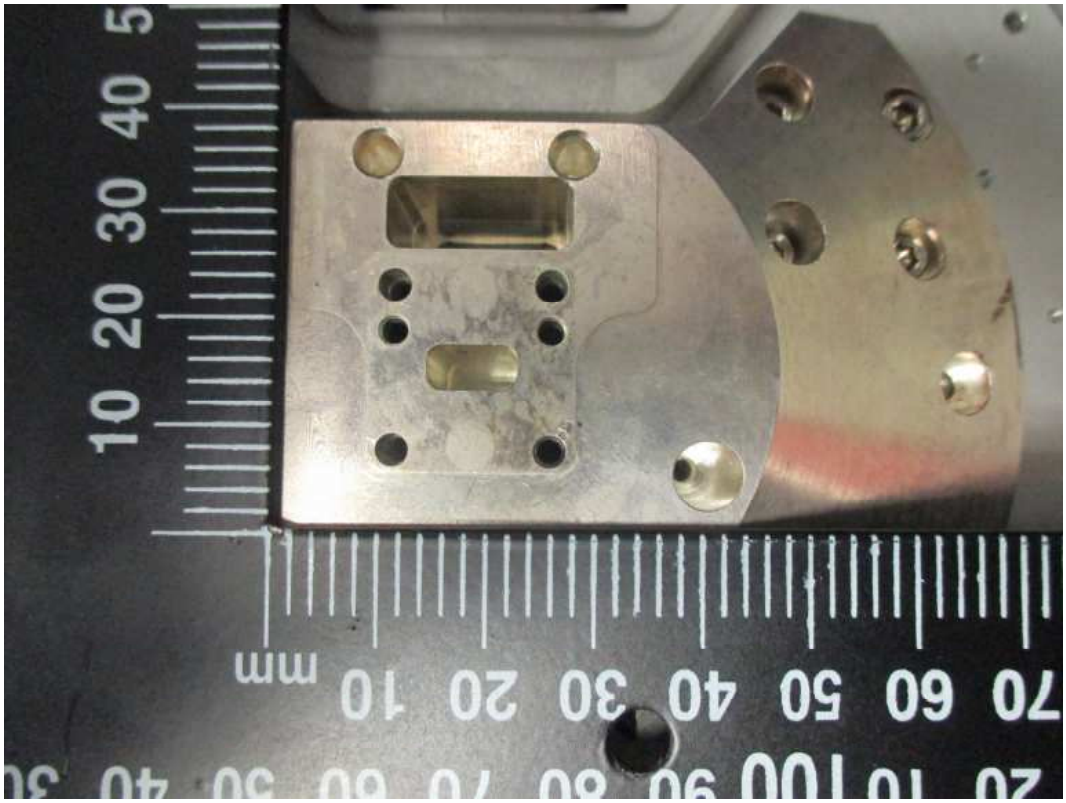
8.1 EUT Front View



8.2 EUT Reverse Angle



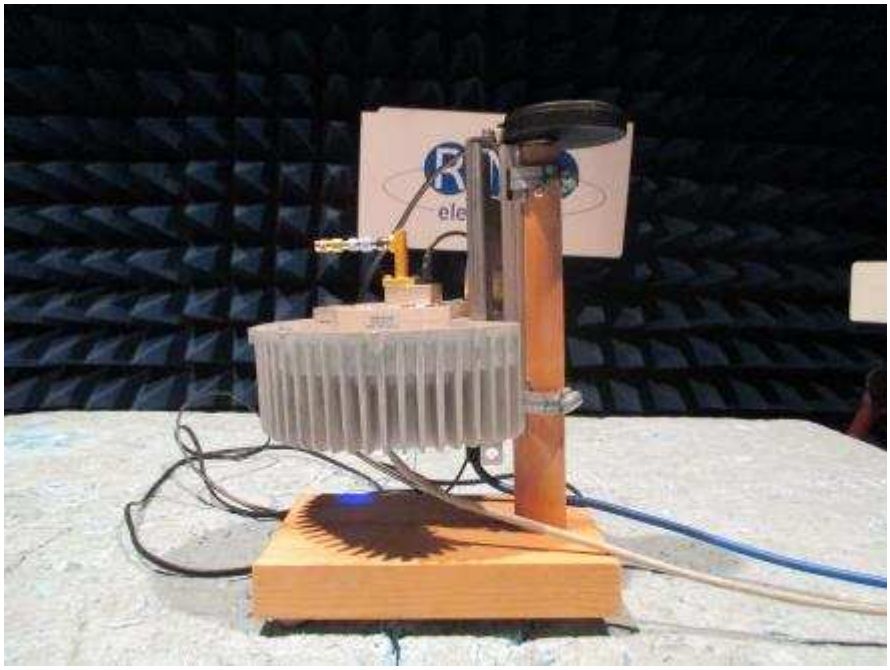
8.3 EUT Antenna Port

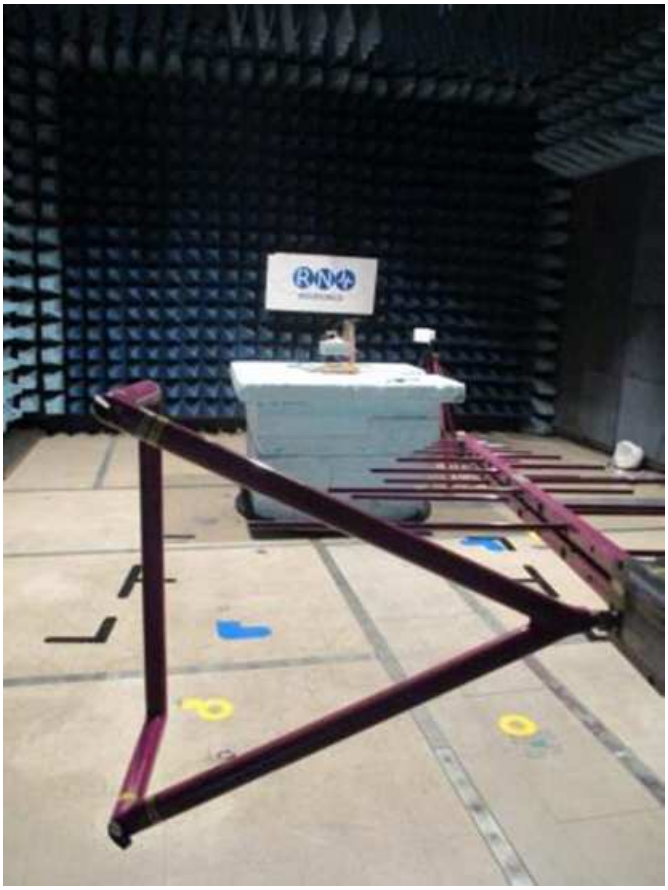


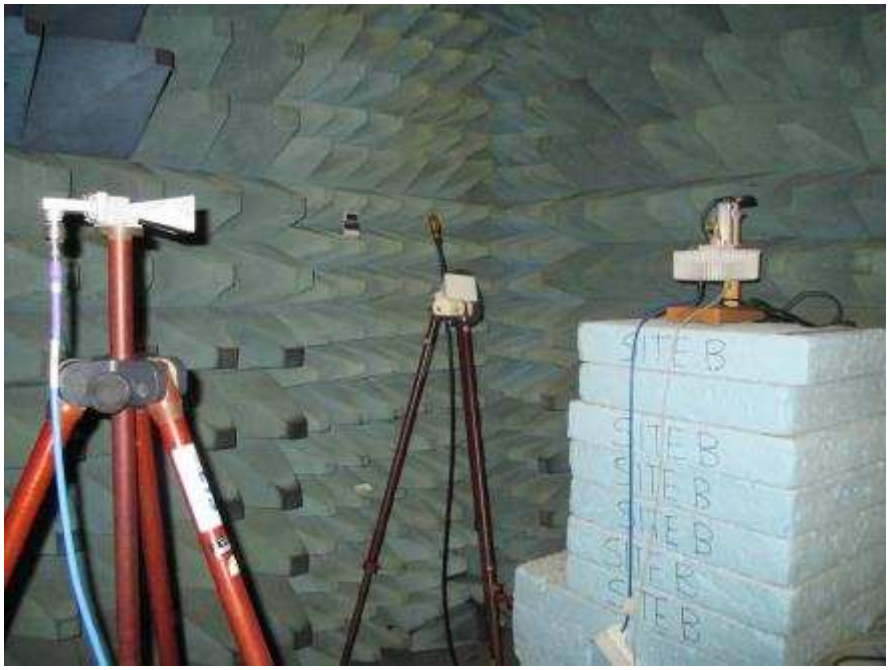
8.4 EUT Display & Controls

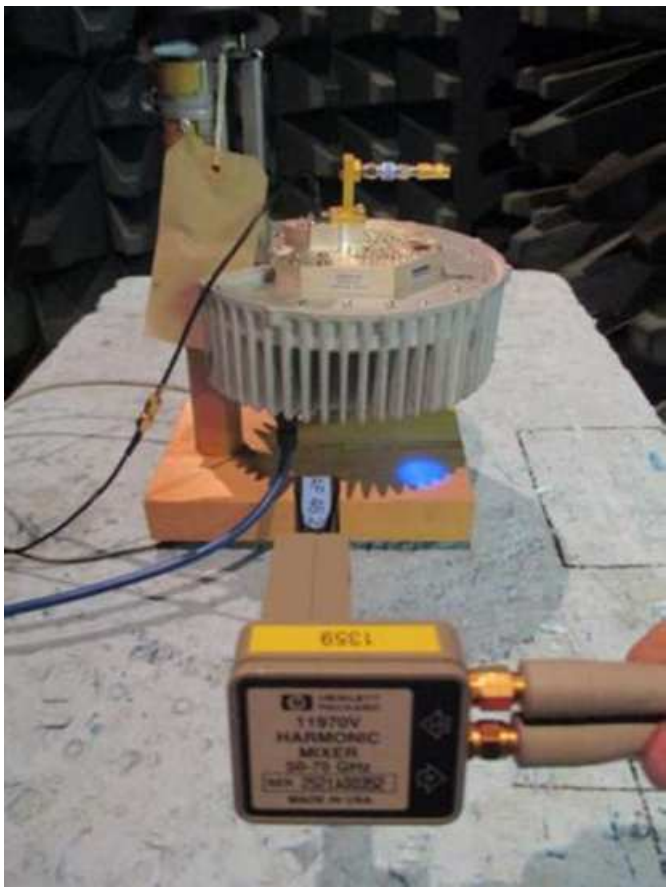
8.5 EUT ID Label

8.6 Test set-up, spurious radiated emissions









8.7 Set-up diagrams

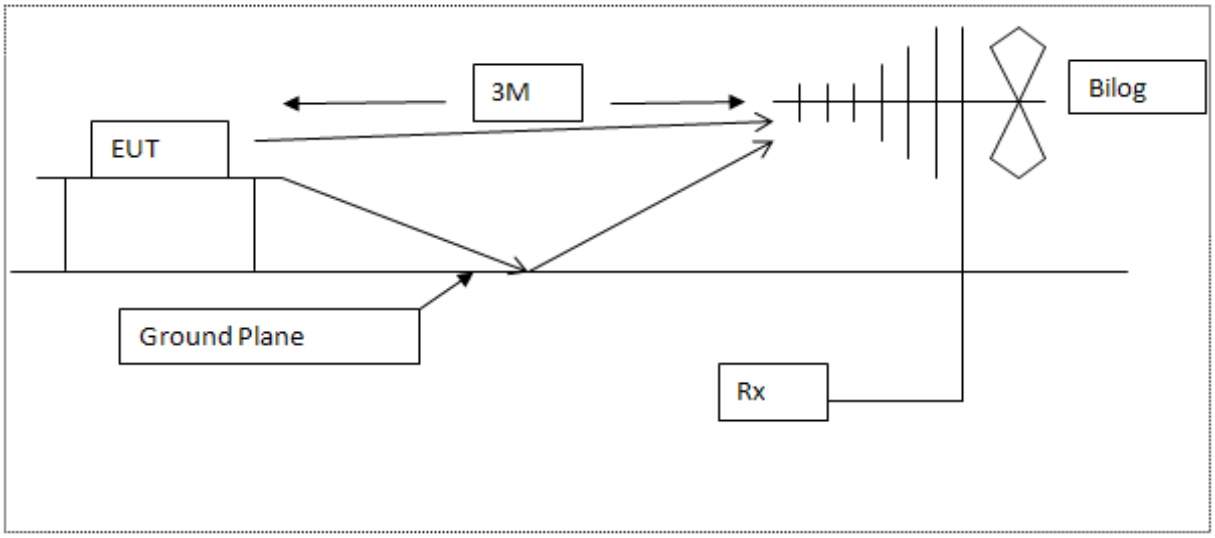


Diagram of the radiated emissions test setup 30 - 1000 MHz

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
E131	ESG-3000A	Signal Generator	Hewlett Packard	09-Jan-2015	24 months
E268	BHA 9118	1-18 GHz Horn Antenna	Schaffner	08-Apr-2015	24 months
E289	8449B	22-40GHZ H40 Block Down Converter	HP	10-Dec-2014	12 months
E291-2	6960B	Power Meter	Marconi Instruments	01-Dec-2014	24 months
E296-2	11970A	Harmonic Mixer 26.5-40 GHz	HP	26-Feb-2014	24 months
E296-4	11970U	Harmonic Mixer 40-60 GHz	HP	19-Aug-2015*	24 months
E296-5	11970V	Harmonic Mixer 50-75 GHz	HP	19-Aug-2015*	24 months
E296-6	11970W	Harmonic Mixer 75-110 GHz	HP	3-Sep-2015*	24 months
E312	6924	Power Sensor 10MHz - 40GHz	Marconi Instruments	18-Mar-2014	24 months
E324	BARO	Barometer	TFA	18-May-2015	6 months
E329	8349B	Microwave Amplifier 2-20 GHz	Agilent	16-Sep-2014	12 months
E330	2224-20	Flann Horn 26.5-40 GHz	FMI	14-Apr-2015	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	29-Apr-2015	12 months
E412	E4440A	3 Hz - 26.5 GHz PSA	Agilent Technologies	29-Apr-2015	24 months
E428	HF906	1-18 GHz Horn Antenna	Rhode & Schwarz	28-Jan-2014	24 months
E433	MG3693A	Signal Generator 30GHz	Anritsu	01-Jul-2014	24 months
E453	20240-20-AA	Std Gain Horn Antenna 17.6 - 26.7 GHz	FMI Ltd	07-May-2015	12 months
E455	-	Wave Source Module 50 - 75 GHz	Agilent	04-Sep-2015*	24 months
E485	11974-60028	Preselector PSU	Agilent	n/a	n/a
E486	11974A	Pre-select Mixer 26.5 - 40GHz	Agilent	07-Sep-2015*	24 months
E487	11974U	40 - 60GHz Preselect Mixer	Agilent	04-Sep-2015*	24 months
E489	24/11	WR19 Rotary Attenuator 40-60GHz	Flann Microwave	13-Feb-2014	24 months
E490	22/11	WR28 Rotary Attenuator 26.5-40GHz	Flann Microwave	13-Feb-2014	24 months
E498	4768-20	20dB Attenuator	Narda	07-Oct-2014	12 months
E503	2524-20	40-60 GHz Horn Antenna	FMI	14-Apr-2015*	12 months
E522	MP81B4	Power Sensor 75 - 110GHz	Anritsu	02-Jul-2014	12 months
E550	11974V	Preselected Mixer 50 - 75GHz	Agilent	04-Sep-2015*	24 months
E555	CMV 5E-1	5A Variac	Carroll & Meynell Ltd	n/a	n/a
E561	85100W	75-100GHz mm Source	Agilent	04-Sep-2015*	12 months
E576	27/11	WR10 Rotary Attenuator 74-112GHz	Flann Microwave	03-Dec-2014	24 months
E577	2511	Rotary Attenuator 50-76GHz	Flann Microwave	03-Dec-2014	24 months
E579	27240	Standard Gain Horn 75GHz - 110GHz	FMI Ltd	14-Apr-2015	12 months
E580	24240	Standard Gain Horn 40GHz - 60GHz	FMI Ltd	14-Apr-2015	12 months
E599	ML4803A	Power Meter	Anritsu	21-Aug-2014	24 months
E600	MA4002B, MP716A4	Sensor Adaptor with 50 GHz - 75 GHz Waveguide Sensor	Anritsu	21-Aug-2014	24 months
E615	4768-10	10dB Attenuator	Narda	09-Apr-2015	12 months
E624	E4440A	3 Hz - 26.5 GHz PSA	Agilent Technologies	23-Sep-2013	24 months
L264	DT75	Digital Thermometer	Instrotech Ltd	06-Dec-2013	24 months
LPE377	8564E	Spectrum Analyser 9kHz - 40GHz	Agilent Technologies	24-Apr-2014	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	05-Jun-2015	12 months
TMS79	3160-09	Std Gain Horn Antenna 18-26.5 GHz	ETS Systems	05-Jun-2015	12 months
TMS933	CBL6141A	Bilog Antenna 30MHz - 2GHz	York EMC	29-Sep-2014	24 months

* Equipment was within calibration dates for tests and has been re-calibrated since date of tests.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	-	GPS riser board and antenna	CCS Ltd	-
2	-	Diplexer	CCS Ltd	140909003
3	Satellite Pro	Laptop	Toshiba	1E0501095
4	Vaio	Laptop	Sony	54193762 1000031
5	GS108E	Gigabit Ethernet hub	Netgear	3uH1465C00673

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	1-2 GHz Pre-Amplifier	RN Electronics Ltd	-
E612	GPS-QBW-20N	GPS Antenna	ANDREW	-
N532	-	GPS Repeater	-	-

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 Compliance information

Products subject to the Declaration of Conformity procedure are required to be supplied with a compliance information statement. A copy of this statement may be included here:

Certified equipment - DoC not required.

13 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

14 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		