Radio Test Report

Cambridge Communication Systems Ltd

Metnet 60G CPE V2

G60UV030088

47 CFR Part 15.255 Effective Date 1st October 2019
DXX: Part 15 Low Power Communication Device Transmitter
Test Date: 23rd June 2020 to 30th June 2020
Report Number: 06-11390-1-20 Issue 01

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

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

Certificate of Test 11390-1

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of 47 CFR Part 15C. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	Metnet 60G CPE V2
Model Number:	G60UV030088
Unique Serial Number:	522
Applicant:	Cambridge Communication Systems Ltd Victory House Chivers Way Histon Cambridge CB24 9ZR
Full measurement results are detailed in Report Number:	06-11390-1-20 Issue 01
Test Standards:	47 CFR Part 15.255 Effective Date 1st October 2019 DXX: Part 15 Low Power Communication Device Transmitter

NOTE:
Certain tests were not performed based upon manufacturer's declarations. Certain other requirements are subject to manufacturer declaration only and have not been tested / verified. For details refer to section 3 of this report.

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:	23rd June 2020 to 30th June 2020
Test Engineer:	Ian Rose Digitally signed by: Ian Rose DN: CN = Ian Rose email = ian@RNElectronics.com C = GB O = RN Electronics Ltd Date: 2020.08.26 12:20:49 Z
Approved By: Radio Approvals Manager	Digitally signed by: Daniel Sims DN: CN = Daniel Sims C = GB O = RN Electronics Ltd Date: 2020.08.26 09:00:40 Z
Customer Representative:	

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1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Cambridge Communication Systems Ltd Victory House Chivers Way Histon Cambridge CB24 9ZR	
Manufacturer of EUT	Cambridge Communication Systems Ltd	
Full Name of EUT	Metnet 60G CPE V2	
Model Number of EUT	G60UV03xxyy (xx refers to customer/OEM number and yy refers to colour casing)	
Serial Number of EUT	522	
Date Received	29th May 2020	
Date of Test:	23rd June 2020 to 30th June 2020	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	17th August 2020	
Main Function	60 GHz mmwave backhaul.	
Information Specification	Height	183 mm
	Width	123 mm
	Depth	43 mm
	Weight	1.25 kg
	Voltage	48-57 V DC
	Current	0.5 A
EUT Supplied PSU	Manufacturer	Phihong
	Model number	POE29U-1AT(PL)
	Serial number	P193903153A2
	Input voltage	100-240 V AC
	Input current	0.8 A
	Output	56 V DC @ 0.536 A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Mounted on a lamppost or on a wall
Choice of model(s) for type tests	Production sample
Antenna details	Integral phase array beamforming, gain 22 dBi
Antenna port	No. Integral antenna
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	69.12 GHz
Lowest Signal generated in EUT	25 MHz
Hardware Version	V1
Software Version	Metnet_node_CPEv2-dev_eng-RF-Approvals-2020.001
Firmware Version	-
Type of Equipment	60 GHz radio
Technology Type	IEEE 802.11ad
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	57-71 GHz
EUT Declared Modulation Parameters	mcs1-mcs12 (QPSK, 16QAM)
EUT Declared Power level	+40 dBm EIRP
EUT Declared Signal Bandwidths	2.16 GHz
EUT Declared Channel Spacing's	2.16 GHz
EUT Declared Duty Cycle	Not declared
Unmodulated carrier available?	Yes
Declared frequency stability	Not declared
RX Parameters	
Alignment range – receiver	57-71 GHz
EUT Declared RX Signal Bandwidth	2.16 GHz
Receiver Signal Level (RSL)	Not declared
Method of Monitoring Receiver BER	1 % PER
FCC Parameters	
FCC Transmitter Class	DXX: Part 15 Low Power Communication Device Transmitter

2.3 Functional description

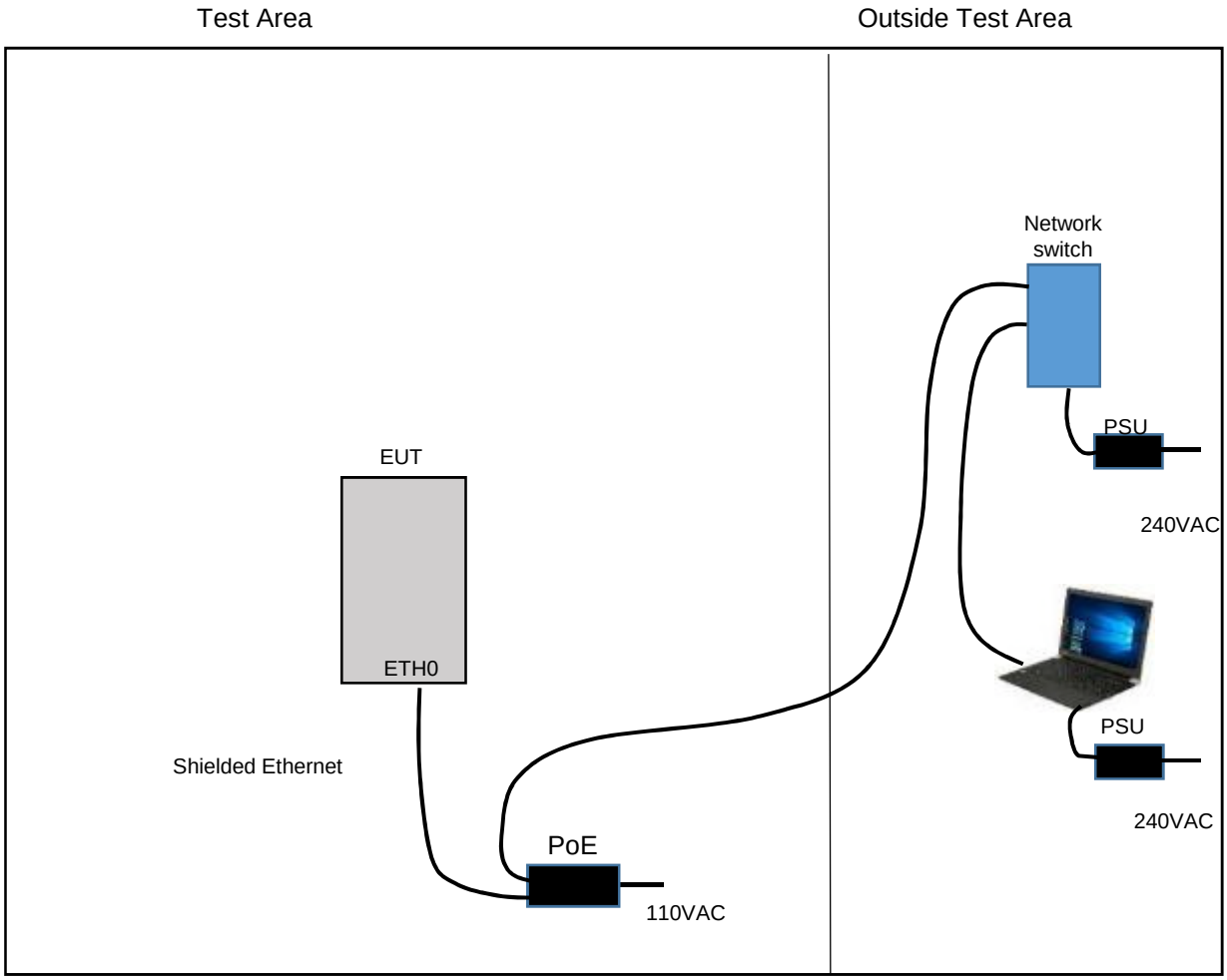
The product is a self-organising transceiver capable of sustaining point to multipoint link with peer node to provide wireless backhaul for access equipment such as cellular base stations. The product is designed to be mounted on street furniture such as lamp posts or residential houses. Equipment contains a single 60-GHz transceiver connected to a steerable multi element antenna array. Unit is powered via power over Ethernet. The equipment also contains a GPS receiver.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX1	58.32 GHz 40 dBm mcs1	Yes
TX2	58.32 GHz 40 dBm mcs2	Yes
TX3	58.32 GHz 40 dBm mcs3	Yes
TX4	58.32 GHz 40 dBm mcs4	Yes
TX5	58.32 GHz 40 dBm mcs5	Yes
TX6	58.32 GHz 40 dBm mcs6	Yes
TX7	58.32 GHz 40 dBm mcs7	Yes
TX8	58.32 GHz 40 dBm mcs8	Yes
TX9	58.32 GHz 40 dBm mcs9	Yes
TX10	58.32 GHz 40 dBm mcs10	Yes
TX11	58.32 GHz 40 dBm mcs11	Yes
TX12	58.32 GHz 40 dBm mcs12	Yes
TX13	60.48 GHz 40 dBm mcs1	Yes
TX14	60.48 GHz 40 dBm mcs2	Yes
TX15	60.48 GHz 40 dBm mcs3	Yes
TX16	60.48 GHz 40 dBm mcs4	Yes
TX17	60.48 GHz 40 dBm mcs5	Yes
TX18	60.48 GHz 40 dBm mcs6	Yes
TX19	60.48 GHz 40 dBm mcs7	Yes
TX20	60.48 GHz 40 dBm mcs8	Yes
TX21	60.48 GHz 40 dBm mcs9	Yes
TX22	60.48 GHz 40 dBm mcs10	Yes
TX23	60.48 GHz 40 dBm mcs11	Yes
TX24	60.48 GHz 40 dBm mcs12	Yes
TX25	62.64 GHz 40 dBm mcs1	Yes
TX26	62.64 GHz 40 dBm mcs2	Yes
TX27	62.64 GHz 40 dBm mcs3	Yes
TX28	62.64 GHz 40 dBm mcs4	Yes
TX29	62.64 GHz 40 dBm mcs5	Yes
TX30	62.64 GHz 40 dBm mcs6	Yes
TX31	62.64 GHz 40 dBm mcs7	Yes
TX33	62.64 GHz 40 dBm mcs9	Yes
TX34	62.64 GHz 40 dBm mcs10	Yes
TX35	62.64 GHz 40 dBm mcs11	Yes
TX36	62.64 GHz 40 dBm mcs12	Yes
TX37	64.8 GHz 40 dBm mcs1	Yes
TX38	64.8 GHz 40 dBm mcs2	Yes
TX39	64.8 GHz 40 dBm mcs3	Yes
TX40	64.8 GHz 40 dBm mcs4	Yes
TX41	64.8 GHz 40 dBm mcs5	Yes
TX42	64.8 GHz 40 dBm mcs6	Yes
TX43	64.8 GHz 40 dBm mcs7	Yes
TX44	64.8 GHz 40 dBm mcs8	Yes
TX45	64.8 GHz 40 dBm mcs9	Yes
TX46	64.8 GHz 40 dBm mcs10	Yes
TX47	64.8 GHz 40 dBm mcs11	Yes
TX48	64.8 GHz 40 dBm mcs12	Yes
TX49	66.96 GHz 40 dBm mcs1	Yes
TX50	66.96 GHz 40 dBm mcs2	Yes
TX51	66.96 GHz 40 dBm mcs3	Yes
TX52	66.96 GHz 40 dBm mcs4	Yes
TX53	66.96 GHz 40 dBm mcs5	Yes
TX54	66.96 GHz 40 dBm mcs6	Yes

TX55	66.96 GHz 40 dBm mcs7	Yes
TX56	66.96 GHz 40 dBm mcs8	Yes
TX57	66.96 GHz 40 dBm mcs9	Yes
TX58	66.96 GHz 40 dBm mcs10	Yes
TX59	66.96 GHz 40 dBm mcs11	Yes
TX60	66.96 GHz 40 dBm mcs12	Yes
TX61	69.12 GHz 40 dBm mcs1	Yes
TX62	69.12 GHz 40 dBm mcs2	Yes
TX63	69.12 GHz 40 dBm mcs3	Yes
TX64	69.12 GHz 40 dBm mcs4	Yes
TX65	69.12 GHz 40 dBm mcs5	Yes
TX66	69.12 GHz 40 dBm mcs6	Yes
TX67	69.12 GHz 40 dBm mcs7	Yes
TX68	69.12 GHz 40 dBm mcs8	Yes
TX69	69.12 GHz 40 dBm mcs9	Yes
TX70	69.12 GHz 40 dBm mcs10	Yes
TX71	69.12 GHz 40 dBm mcs11	Yes
TX72	69.12 GHz 40 dBm mcs12	Yes
TX73	58.32 GHz 40 dBm mcs0	No
TX74	60.48 GHz 40 dBm mcs0	No
TX75	62.64 GHz 40 dBm mcs0	No
TX76	64.8 GHz 40 dBm mcs0	No
TX77	66.96 GHz 40 dBm mcs0	No
TX78	69.12 GHz 40 dBm mcs0	No
TX79	58.32 GHz CW tone	Yes
TX80	64.8 GHz CW tone	Yes
TX81	69.12 GHz CW tone	Yes
LK1	Self-establishing link with paired node	No

2.5 Emissions configuration



The unit was powered from 56 V DC via a PoE power supply powered from 110 V AC mains. The unit was configured with engineering menus via a terminal program to allow permanent transmit modes of the device on the channels and modulation schemes as stated within section 2.4 of this report. In addition the radio allows circular beam steering. The beam value is settable between 0 and 63, with 0 being omnidirectional and 1 to 63 being a sector angle. RN Electronics performed initial investigations in 0.5° steps through a 360° EUT rotation for all beam settings.

The power settings for each channel were as stated below:-

Channel 1 = 58.32 GHz, power level +40 dBm (all modulation schemes)
Channel 2 = 60.48 GHz, power level +40 dBm (all modulation schemes)
Channel 3 = 62.64 GHz, power level +40 dBm (all modulation schemes)
Channel 4 = 64.8 GHz, power level +40 dBm (all modulation schemes)
Channel 5 = 66.96 GHz, power level +40 dBm (all modulation schemes)
Channel 6 = 69.12 GHz, power level +40 dBm (all modulation schemes)

Modulation schemes available were BPSK (MCS1 to MCS5), QPSK (MCS6 to MCS9) and 16QAM (MCS10 to MCS12) with the following measured duty cycles: - MCS1 94.1 %, MCS2 89.7 %, MCS3 87.6 %, MCS4 86.1 %, MCS5 84.9 %, MCS6 83.1 %, MCS7 80.2 %, MCS8 78.1 %, MCS9 76.7 %, MCS10 75.1 %, MCS11 72.9 %, MCS12 68.9 %.

2.5.1 Signal leads

Port Name	Cable Type	Connected
Ethernet	Shielded CAT5E	Yes

3 Summary of test results

The Metnet 60G CPE V2, G60UV030088 was tested for compliance to the following standard(s) :

47 CFR Part 15.255 Effective Date 1st October 2019
DXX: Part 15 Low Power Communication Device Transmitter

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

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15C Part 15.207	PASSED
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	NOT APPLICABLE[1]
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209	PASSED
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15C Part 15.255(d)(2)	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.255(d)(2)/(3)/(4)	PASSED[2]
6. Frequency stability	47 CFR Part 15C Part 15.255(f)	PASSED
7. Peak & Average EIRP	47 CFR Part 15C Part 15.255(c)(1)(i)/(ii)	PASSED
8. Peak Conducted Power	47 CFR Part 15C Part 15.255(c)(3)/(4)	PASSED[3]
9. 6 dB Occupied bandwidth	47 CFR Part 15C Part 15.2(e)(1)	PASSED

[1] Spectrum below 30MHz started at a frequency of 150 kHz based on the lowest declared signal generated within the equipment of 25 MHz.
[2] Spectrum investigated up to a frequency of 200 GHz.
[3] EUT does not have a conducted RF port, however, calculation has been provided to determine conducted power against the limit from maximum EIRP measured and antenna gain.

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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	47 CFR Part 15C	2019	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
4.1.3	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
4.1.4	KDB 842590 D01 v01	2019	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Basic certification requirements and measurement procedures for Upper Microwave Flexible Use Service (UMFUS) devices

4.2 Deviations

No deviations were applied

4.3 Tests at extremes of temperature & voltage

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

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	110V AC
T minimum	-40 °C	V minimum	93.5V AC
T maximum	50 °C	V maximum	126.5V AC

Extremes of voltage are based on nominal +/-15% of mains input to PoE supply.

Extremes of temperature are based upon manufacturer's declaration.

The ambient test conditions of humidity and pressure in the laboratory were as specified in each specific test section within this report

4.4 Test fixtures

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

The front door of the chamber was replaced with a 100 mm thick Styrofoam panel and the tests performed radiated with EUT directing power out of the chamber towards the measuring equipment.

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.207 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.2 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.207 [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

The EUT was placed on a wooden table 0.8m above the ground plane and connected to a LISN via a 1m mains cable. Details of the Peripheral and Ancillary Equipment connected for this test are listed in section 10. During the initial scan, no discernible difference in emissions could be observed when operating on different channels or modulation schemes. For final test the EUT was operated in modeTX48.

5.1.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed in the 'Test Equipment' Section. Measurements were made on the live and neutral conductors using both average and quasi-peak detection.

At least 6 signals within 20dB and/or all signals within 10dB of the limit were investigated.

Tests were performed in Test Site F.

5.1.4 Test equipment

E150, E035, ZSW1, E624, E411, TMS937, TMS938

See Section 9 for more details

5.1.5 Test results

Temperature of test environment	21°C
Humidity of test environment	55%
Pressure of test environment	101kPa

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs12
Mid channel	64.8 GHz

Plot refs
11390-1 Cond 1 AC Live 150k-30M Average
11390-1 Cond 1 AC Live 150k-30M Quasi-Peak
11390-1 Cond 1 AC Neutral 150k-30M Average
11390-1 Cond 1 AC Neutral 150k-30M Quasi-Peak

Table of signals measured for Cond 1 AC Live 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.166	58.8	52.6	-12.6	31.8	-23.4
2	0.185	56.2	49.3	-15.0	30.4	-23.9
3	0.193	55.3	48.5	-15.4	28.2	-25.7
4	0.225	50.8	45.3	-17.3	24.8	-27.8
5	0.294	45.6	39.0	-21.4	20.8	-29.6
6	0.301	44.8	39.1	-21.1	25.8	-24.4
7	0.365	44.4	39.6	-19.0	27.3	-21.3
8	0.430	40.4	35.9	-21.4	20.0	-27.3
9	1.223	41.8	39.0	-17.0	27.0	-19.0
10	1.340	41.5	38.3	-17.7	29.1	-16.9

11	1.467	41.4	38.0	-18.0	28.0	-18.0
12	1.588	41.2	38.0	-18.0	25.5	-20.5
13	3.206	41.4	38.3	-17.7	30.0	-16.0
14	7.550	44.2	41.0	-19.0	34.2	-15.8

Table of signals measured for Cond 1 AC Neutral 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.162	59.1	53.3	-12.1	32.8	-22.6
2	0.180	57.1	50.3	-14.2	30.6	-23.9
3	0.197	54.7	48.1	-15.6	27.4	-26.3
4	0.255	49.1	42.1	-19.5	21.5	-30.1
5	0.271	46.9	41.5	-19.6	25.5	-25.6
6	0.295	44.3	39.1	-21.3	22.0	-28.4
7	0.354	41.2	34.8	-24.1	17.8	-31.1
8	0.391	41.4	38.3	-19.7	34.6	-13.4
9	1.127	40.2	37.9	-18.1	26.5	-19.5
10	1.251	41.2	38.6	-17.4	27.4	-18.6
11	1.361	41.4	37.3	-18.7	28.0	-18.0
12	1.584	41.0	37.8	-18.2	25.7	-20.3
13	3.213	40.6	38.0	-18.0	30.1	-15.9
14	6.884	44.4	40.6	-19.4	33.6	-16.4
15	8.764	44.4	41.0	-19.0	34.9	-15.1

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.207: as given in the above tables / drawn on the respective plots.

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:

150kHz to 30MHz ±3.6dB.

5.2 Radiated emissions 9 - 150 kHz

NOT APPLICABLE: Spectrum below 30MHz started at a frequency of 150 kHz based on the lowest declared signal generated within the equipment of 25 MHz.

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.255(d)(2) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.3 & 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.209/15.255(d)(2) [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was examined in its normal use position. Radiated Emissions testing was performed with the EUT powered from the manufacturers power supply whilst powered from 110 V AC. During the initial scan no discernible difference in emissions could be observed when operating on different channels or modulation schemes. The EUT was operated in TX48 mode.

5.3.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required performed on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment was rotated 360 degrees to record the worst case emissions.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site M.

5.3.4 Test equipment

TMS81, ZSW1, E624, E411, E465

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	21°C
Humidity of test environment	54%
Pressure of test environment	101kPa

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs12
Channel	64.8 GHz

Plot refs
11390-1 Rad 1 150k-30MHz Para
11390-1 Rad 1 150k-30MHz Perp

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
The general limits of 15.209 are as drawn on the respective plots.

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:

9kHz - 30MHz ±3.9dB.

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.255(d)(2) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.3 & 6.5 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.255(d)(2) [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was examined in its normal use position. Radiated Emissions testing was performed with the EUT powered from the manufacturers power supply whilst powered from 110 V AC. During the initial scan no discernible difference in emissions could be observed when operating on different channels or modulation schemes. The EUT was operated in TX48 mode.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below. Measurements were made on a site listed with the FCC. The equipment was rotated 360 degrees and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site M.

5.4.4 Test equipment

LPE364, E743, NSA-M, ZSW1, E624, E411, E465

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	20°C
Humidity of test environment	55%
Pressure of test environment	101kPa

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs12
Channel	64.8 GHz

Plot refs
11390-1 Rad 1 VHF Horiz
11390-1 Rad 1 VHF Vert
11390-1 Rad 1 UHF Horiz
11390-1 Rad 1 UHF Vert

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

Table of signals measured for Rad 1 Vertical 30m-1G

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	30.526	31.6	25.4	-14.6
2	37.124	44.0	38.7	-1.3
3	47.792	34.9	29.3	-10.7
4	74.449	30.5	25.7	-14.3
5	81.575	34.9	29.4	-10.6

Table of signals measured for Rad 1 Horizontal 30m-1G

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	30.759	28.6	22.4	-17.6
2	192.120	31.4	26.0	-17.5
3	193.071	30.9	25.1	-18.4
4	199.432	30.3	24.8	-18.7
5	199.837	30.0	24.5	-19.0
6	577.831	33.4	26.8	-19.2
7	578.715	33.4	26.8	-19.2
8	643.360	34.8	28.7	-17.3

Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only 64.8 GHz channel plots are shown in this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

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

30MHz - 1000MHz ±6.1dB.

5.5 Radiated emissions above 1 GHz

5.5.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.255(d)(2)/(3)/(4) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.3 & 6.6 & 9.8 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.255(d)(2)/(3)/(4) [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at distances listed in 5.5.3. The EUT was examined in its normal use position. Radiated Emissions testing was performed with the EUT powered from the manufacturers power supply whilst powered from 110 V AC. During the initial scan worst case modulation scheme was seen to be mcs12. The EUT was operated in TX5 and TX41 and TX65 modes.

5.5.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below.

Measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. Horn antennas were used at heights where the whole of the EUT was contained within the main beam. The EUT was rotated through 360 degrees to record the worst case emissions. A measurement distance of 3m was used between the test range 1 - 6GHz, 1.2m was used in the test range 6 - 18GHz, 0.3m was used in the test range 18 - 75GHz, 0.1m was used in the test range 75-110GHz and 0.1/0.03m was used in the test range 110-200 GHz.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using test Sites A, M.

5.5.4 Test equipment

E136, E296-2, E296-6, E330, E411, E412, E465, E485, E487, E503, E577, E579, E580, E638, E714, E722, E755, E760, E771, E777, E781, E908, E942, TMS78, TMS79, TMS82, VSWR-M, ZSW1

See Section 9 for more details

5.5.5 Test results

Temperature of test environment 18-28°C
Humidity of test environment 32-54%
Pressure of test environment 102kPa

Setup Table

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs12
Low channel	58.32 GHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1595	38.3	-35.7	24.6	-29.4	Upright	Horizontal
2475	44.9	-29.1	41	-13	Upright	Vertical
2475	42.1	-31.9	35.8	-18.2	Upright	Horizontal
4797	45.1	-28.9	30.1	-23.9	Upright	Horizontal
56711	78.2	-7.1	76.6	-8.7	Upright	Volumetric

Plots
11390-1 58.32 GHz mcs12 56-57.1 GHz

Setup Table

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs12
Mid channel	64.8 GHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1595	38.3	-35.7	24.6	-29.4	Upright	Horizontal
2475	44.9	-29.1	41	-13	Upright	Vertical
2475	42.1	-31.9	35.8	-18.2	Upright	Horizontal
4797	45.1	-28.9	30.1	-23.9	Upright	Horizontal

Plots
11390-1 Rad 1 1-2GHz Horiz
11390-1 Rad 1 1-2GHz Vert
11390-1 Rad 1 2-5GHz Horiz
11390-1 Rad 1 2-5GHz Vert
11390-1 Rad 1 5-6GHz Horiz
11390-1 Rad 1 5-6GHz Vert
11390-1 Rad 1 6upto10GHz Horiz
11390-1 Rad 1 6upto10GHz Vert
11390-1 Rad 1 10upto12_5GHz Horiz
11390-1 Rad 1 10upto12_5GHz Vert
11390-1 12.4 to 15 GHz horiz
11390-1 12.4 to 15 GHz vert
11390-1 15 to 18 GHz horiz
11390-1 15 to 18 GHz vert
11390-1 18 to 21 GHz horiz
11390-1 18 to 21 GHz vert
11390-1 21 to 24 GHz horiz
11390-1 21 to 24 GHz vert
11390-1 24 to 26.5 GHz horiz
11390-1 24 to 26.5 GHz vert
11390-1 64.8 GHz mcs12 26.5-30 GHz
11390-1 64.8 GHz mcs12 30-34 GHz
11390-1 64.8 GHz mcs12 34-38 GHz
11390-1 64.8 GHz mcs12 38-40 GHz
11390-1 64.8 GHz mcs12 40-44 GHz
11390-1 64.8 GHz mcs12 44-48 GHz
11390-1 64.8 GHz mcs12 48-52 GHz
11390-1 64.8 GHz mcs12 52-56 GHz
11390-1 64.8 GHz mcs12 56-57.1 GHz
11390-1 64.8 GHz mcs12 70.9-75 GHz
11390-1 64.8 GHz mcs12 75-79 GHz
11390-1 64.8 GHz mcs12 79-83 GHz
11390-1 64.8 GHz mcs12 83-87 GHz
11390-1 64.8 GHz mcs12 87-90 GHz
11390-1 64.8 GHz mcs12 90-100 GHz
11390-1 64.8 GHz mcs12 100-110 GHz
11390-1 64.8 GHz mcs12 110-120 GHz
11390-1 64.8 GHz mcs12 120-130 GHz
11390-1 64.8 GHz mcs12 130-140 GHz
11390-1 64.8 GHz mcs12 140-150 GHz
11390-1 64.8 GHz mcs12 150-160 GHz
11390-1 64.8 GHz mcs12 160-170 GHz

11390-1 64.8 GHz mcs12 170-180 GHz
11390-1 64.8 GHz mcs12 180-190 GHz
11390-1 64.8 GHz mcs12 190-200 GHz

Setup Table

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs12
High channel	69.12 GHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1595	38.3	-35.7	24.6	-29.4	Upright	Horizontal
2475	44.9	-29.1	41	-13	Upright	Vertical
2475	42.1	-31.9	35.8	-18.2	Upright	Horizontal
4797	45.1	-28.9	30.1	-23.9	Upright	Horizontal

Plots
11390-1 69.12 GHz mcs12 70.9-75 GHz

Peak detector “Max held” Analyser plots against the Average limit line can be found in Section 6 of this report.

Note: Whilst Low, Mid and High channels were tested, full plots for only Mid channel are shown in this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.255 (d)(3) between 40 GHz and 200 GHz the level of the emissions shall not exceed 90pW/cm2 at a distance of 3m. This is equivalent to 85.3 dBµV/m at a distance of 3 m. Calculations are based on ANSI C63.10 clauses 9.4-9.7.
The general limits of 15.209 are as drawn on the respective plots.

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 – 18 GHz ±3.5dB, 18 – 26.5 GHz ±3.9dB, 26.5 – 60 GHz ±3.9dB, 60 – 110 GHz ±4.4dB, 110 – 200 GHz ±5.9dB.

5.6 Frequency stability

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.255(f) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.8 / 9.14 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.255(f) [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was placed in a temperature controlled chamber. The EUT's emissions were observed by means of a test fixture. The EUT was operated in TX79 to TX81 modes for this test.

5.6.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below. Temperature stability was achieved at each test temperature level before taking measurements using the counter function of a spectrum analyser adjusted for the tone offset of 859 kHz.

Tests were performed using Test Site A.

5.6.4 Test equipment

E187, E434, E602, E755, E781, E908, E920, N579, TMS38, TMS57, TMS80

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 25-28°C
Humidity of test environment 34%
Pressure of test environment 101-102kPa

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	CW tone
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

Test conditions		Frequency Error (MHz) Low channel	Frequency Error (MHz) Mid channel	Frequency Error (MHz) High channel
-40°C	Volts Nominal (110)	58319.922370	64799.913156	69119.907165
-20°C	Volts Nominal (110)	58319.915690	64799.907415	69119.902276
-20°C	Volts Nominal (110)	58319.915690	64799.907415	69119.902276
-10°C	Volts Nominal (110)	58319.926920	64799.917943	69119.909555
0°C	Volts Nominal (110)	58319.930742	64799.923720	69119.919188
10°C	Volts Nominal (110)	58319.931748	64799.924277	69119.919332
20°C	Volts Minimum (93.5)	58319.921419	64799.911595	69119.904530
	Volts Nominal (110)	58319.921419	64799.911595	69119.904530
	Volts Maximum (126.5)	58319.921419	64799.911595	69119.904530
30°C	Volts Nominal (110)	58319.921950	64799.913767	69119.909905
40°C	Volts Nominal	58319.917046	64799.907054	69119.899787

	(110)			
50°C	Volts Nominal (110)	58319.912737	64799.903224	69119.897413
Max Frequency Error per chan (Hz)		+-68252 / -87263	+-75723 / -96776	+-80668 / -102587
Max Frequency Error observed (MHz)		-0.087263	-0.096776	-0.102587

Results shown above have been corrected for the offset tone of 859 kHz.

Maximum variation observed was -0.102587 kHz. Refer to 6 dB BW test results for BW of signal contained within the band 57-71 GHz.

LIMITS:
15.255 (f) Fundamental emissions must be contained within the frequency band specified during all conditions of operation.

These results show that the EUT has PASSED this test.

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

5.7 Peak & Average EIRP

5.7.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.255(c)(1)(i)/(ii) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 9.10 & 9.11 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.255(c)(1)(i)/(ii) [Reference 4.1.1 of this report]

5.7.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The EUT antenna was positioned and aligned with the measuring antenna. The EUT was measured at a distance of 0.6 metres. EIRP testing was performed with EUT powered from the manufacturers power supply whilst powered from 110 V AC. During initial scans modulation scheme mcs5 was found to produce the most power. The EUT was operated in TX1 to TX12 and TX37 to TX48 and TX61 to TX72 modes.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below.

Measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. A Horn antenna was used to align with and measure the radiated power from the EUT. A wideband RF detector was used with a digital oscilloscope to measure the Peak and Average power. A measurement distance of 0.6 m was used to maintain the far field condition at the frequency of interest whilst maintaining enough EUT transmitted signal into the detector. Substitution was performed to determine the results.

Tests were performed using test Site A.

5.7.4 Test equipment

E577, E599, E600, E602, E627, E717, E781, E851, E852, E908

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	26°C
Humidity of test environment	40%
Pressure of test environment	102kPa

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs5
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

Test conditions	Low channel	Mid channel	High channel
Peak EIRP measured (dBm)	38.90	40.20	39.60
Difference to peak limit (dB)	-4.1	-2.8	-3.4
Average EIRP measured (dBm)	38.2	39.4	38.9
Difference to average limit (dB)	-1.8	-0.6	-1.1
Beam setting for maximum EIRP	35	41	32

LIMITS:
15.255 (c(i) the average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 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: ±5.3 dB.

5.8 Peak Conducted Power

5.8.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.255(e) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 9.7 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.255(e) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The results from the EIRP tests in section 5.7 above were used.

5.8.3 Test procedure

A calculation was performed in accordance with ANSI C63.10:2013 clause 9.7. Equation 27 using the following formula:

$$P_{COND} = EIRP_{LINEAR} / G_{EUT}$$

Where:
P_{COND} is conducted power in Watts.
$EIRP_{LINEAR}$ is equivalent isotropically radiated power in Watts
G_{EUT} is numeric gain of EUT radiating element (Antenna)

5.8.4 Test equipment

Not required

5.8.5 Test results

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs5
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

Test conditions	Low channel	Mid channel	High channel
Peak EIRP measured (dBm)	38.90	40.20	39.60
Beam setting for maximum	35	41	32
Peak EIRP measured in Watts	7.762	10.471	9.120
Calculated Peak conducted power (W)	0.049	0.066	0.058

Antenna gain is declared as 22dBi (numeric gain is therefore 158.5)

15.255 (e) the peak transmitter conducted output power shall not exceed 500 mW.

These results show that the EUT has PASSED this test.

5.9 6 dB Occupied bandwidth

5.9.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.255(e)(1) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 9.3 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.255(e)(1) [Reference 4.1.1 of this report]

5.9.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 0.6 metres. The EUT was tested with the EUT powered from the manufacturers power supply whilst powered from 110 V AC. The EUT was operated in to TX12 and TX37 to TX48 and TX61 to modes.

5.9.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below. A 100 kHz RBW, 3x VBW, peak detector, auto sweep time and max hold settings were used for the 6 dB bandwidth.

Tests were performed using test Site A.

5.9.4 Test equipment

E602, E717, E755, E781, E908, E920

See Section 9 for more details

5.9.5 Test results

Temperature of test environment	26°C
Humidity of test environment	30%
Pressure of test environment	102kPa

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs1
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1591.6	1564	1618.9
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs1 BW	11390-1 64.8 GHz 40 dBm mcs1 BW	11390-1 69.12 GHz 40 dBm mcs1 BW

FLOW Worst case (MHz)	57549.9	57477.7	57495.4
FHIGH Worst case (MHz)	59141.5	59151.9	59128.1

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs2
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1674.2	1605	1630.1
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs2 BW	11390-1 64.8 GHz 40 dBm mcs2 BW	11390-1 69.12 GHz 40 dBm mcs2 BW

FLOW Worst case (MHz)	57477.7	63978.5	68287.7
FHIGH Worst case (MHz)	59151.9	65583.5	69917.8

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs3
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1632.7	1605.4	1502.2
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs3 BW	11390-1 64.8 GHz 40 dBm mcs3 BW	11390-1 69.12 GHz 40 dBm mcs3 BW

FLOW Worst case (MHz)	57495.4	63978.5	68305.4
FHIGH Worst case (MHz)	59128.1	65583.9	69807.6

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs4
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1581.7	1608.9	1605.9
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs4 BW	11390-1 64.8 GHz 40 dBm mcs4 BW	11390-1 69.12 GHz 40 dBm mcs4 BW

FLOW Worst case (MHz)	57522.2	63975	68284.2
FHIGH Worst case (MHz)	59103.9	65583.9	69890.1

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs5
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1677.6	1553.6	1636.1
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs5 BW	11390-1 64.8 GHz 40 dBm mcs5 BW	11390-1 69.12 GHz 40 dBm mcs5 BW

FLOW Worst case (MHz)	57485.1	64002.7	68254
FHIGH Worst case (MHz)	59162.7	65556.3	69890.1

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs6
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1608.5	1608.9	1637
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs6 BW	11390-1 64.8 GHz 40 dBm mcs6 BW	11390-1 69.12 GHz 40 dBm mcs6 BW

FLOW Worst case (MHz)	57495.4	63975	68280.8
FHIGH Worst case (MHz)	59103.9	65583.9	69917.8

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs7
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1671.1	1595.1	1619.8
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs7 BW	11390-1 64.8 GHz 40 dBm mcs7 BW	11390-1 69.12 GHz 40 dBm mcs7 BW

FLOW Worst case (MHz)	57481.2	63988.8	68298
FHIGH Worst case (MHz)	59152.3	65583.9	69917.8

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs8
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1653.4	1622.3	1619.8
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs8 BW	11390-1 64.8 GHz 40 dBm mcs8 BW	11390-1 69.12 GHz 40 dBm mcs8 BW

FLOW Worst case (MHz)	57498.9	63961.6	68298
FHIGH Worst case (MHz)	59152.3	65583.9	69917.8

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs9
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1691.4	1639.6	1663.8
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs9 BW	11390-1 64.8 GHz 40 dBm mcs9 BW	11390-1 69.12 GHz 40 dBm mcs9 BW

FLOW Worst case (MHz)	57467.8	63972	68254
FHIGH Worst case (MHz)	59159.2	65611.6	69917.8

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs10
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1663.8	1681.7	1581.2
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs10 BW	11390-1 64.8 GHz 40 dBm mcs10 BW	11390-1 69.12 GHz 40 dBm mcs10 BW

FLOW Worst case (MHz)	57495.4	64002.2	68336.1
FHIGH Worst case (MHz)	59159.2	65683.9	69917.3

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs11
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1650.4	1608.9	1581.7
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs11 BW	11390-1 64.8 GHz 40 dBm mcs11 BW	11390-1 69.12 GHz 40 dBm mcs11 BW

FLOW Worst case (MHz)	57495	63975	68335.6
FHIGH Worst case (MHz)	59145.4	65583.9	69917.3

Band	57-71 GHz
Power Level	40 dBm (EIRP)
Channel Spacing	2.16 GHz
Mod Scheme	mcs12
Low channel	58.32 GHz
Mid channel	64.8 GHz
High channel	69.12 GHz

	Low channel	Mid channel	High channel
6 dB Bandwidth (MHz) Nominal Temp & Volts	1650.4	1623.2	1581.7
Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts	11390-1 58.32 GHz 40 dBm mcs12 BW	11390-1 64.8 GHz 40 dBm mcs12 BW	11390-1 69.12 GHz 40 dBm mcs12 BW

FLOW Worst case (MHz)	57495	63961.2	68335.6
FHIGH Worst case (MHz)	59145.4	65584.4	69917.3

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

LIMITS:
15.255(e)(1) & 15.255(f) The 6 dB bandwidth of the emission must be contained within the designated frequency band.

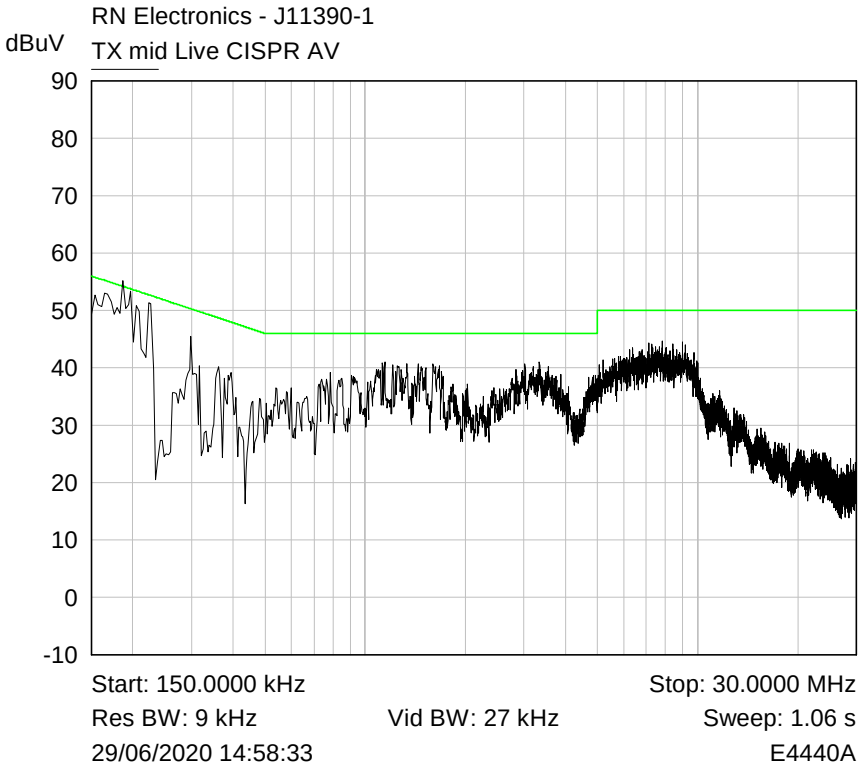
These results show that the EUT has PASSED this test.

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

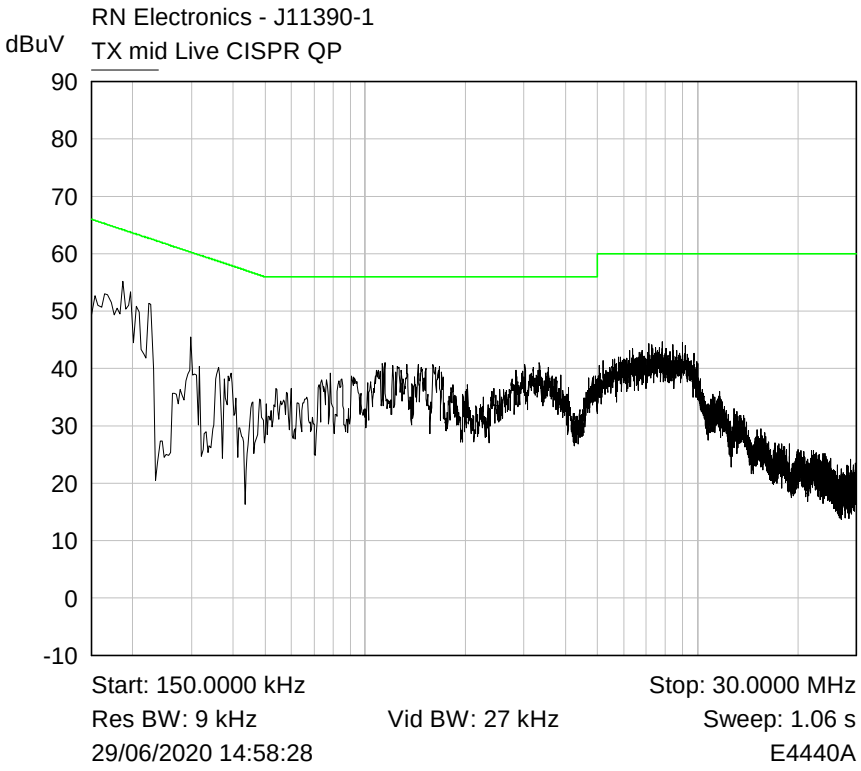
6 Plots/Graphical results

6.1 AC power line conducted emissions

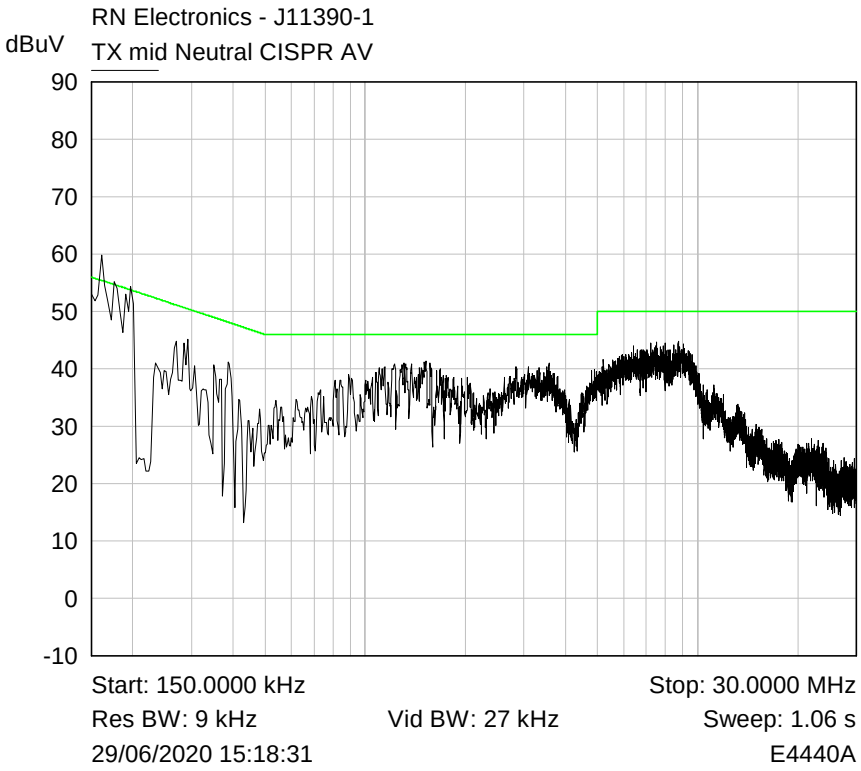
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs12, Channel 64.8 GHz



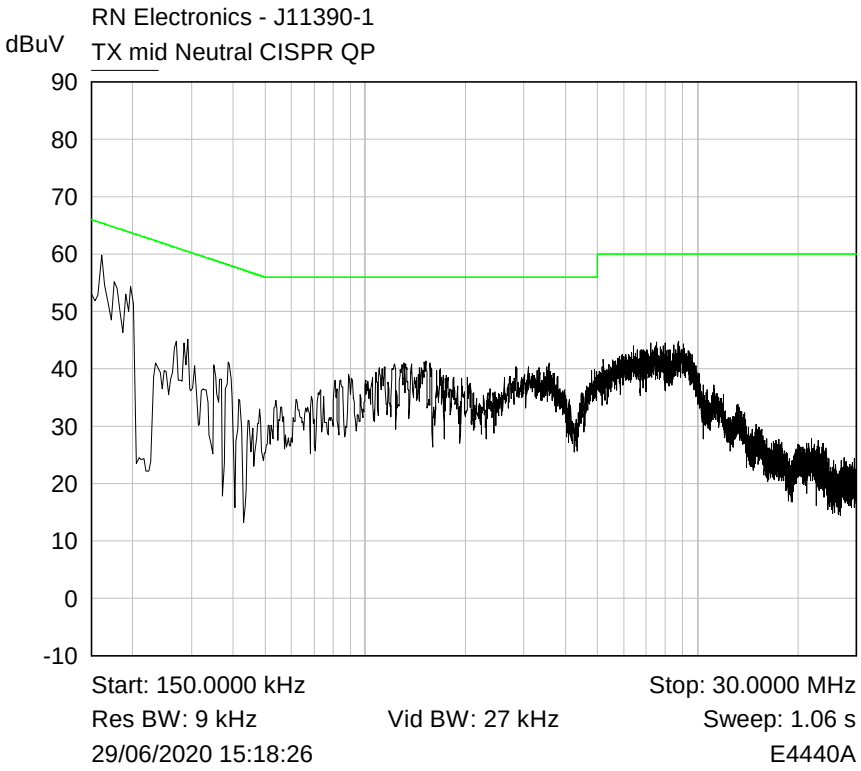
Plot of Live150k-30M Average



Plot of Live150k-30M Quasi-Peak



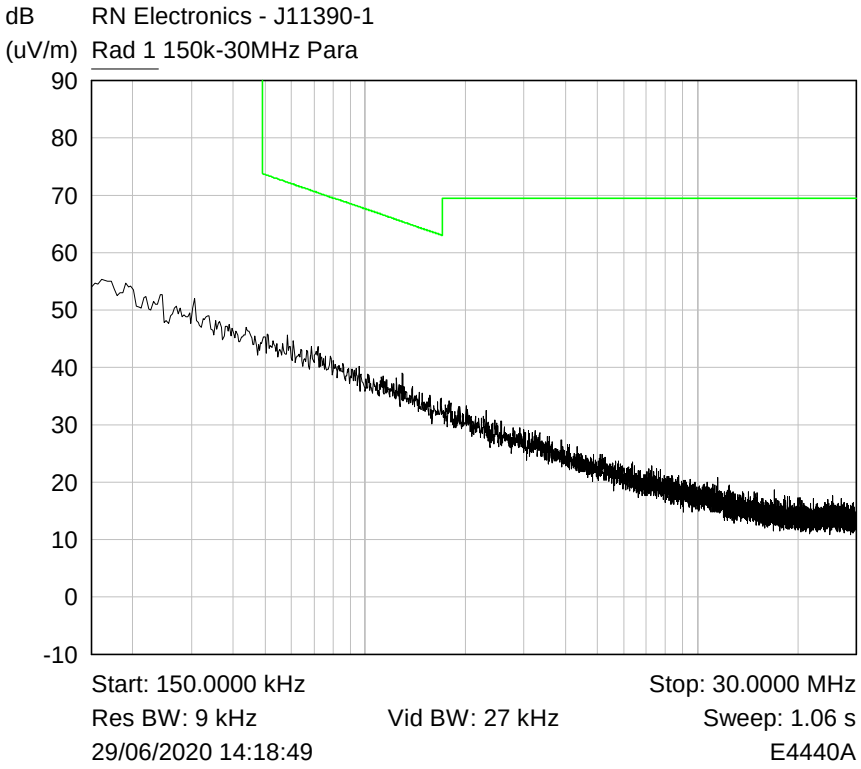
Plot of Neutral150k-30M Average



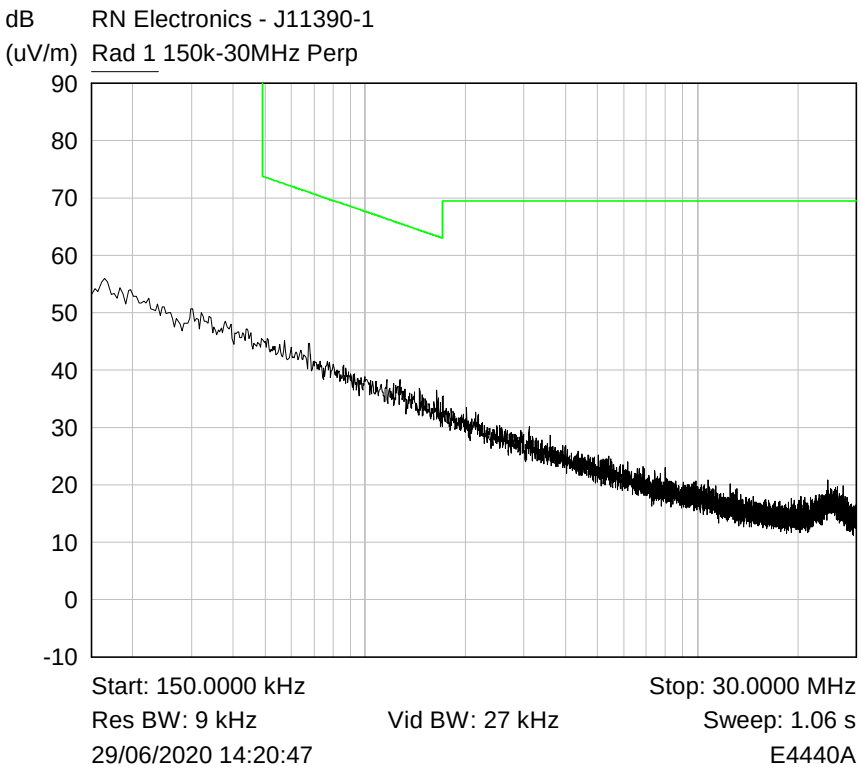
Plot of Neutral150k-30M Quasi-Peak

6.2 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs12, Channel 64.8 GHz



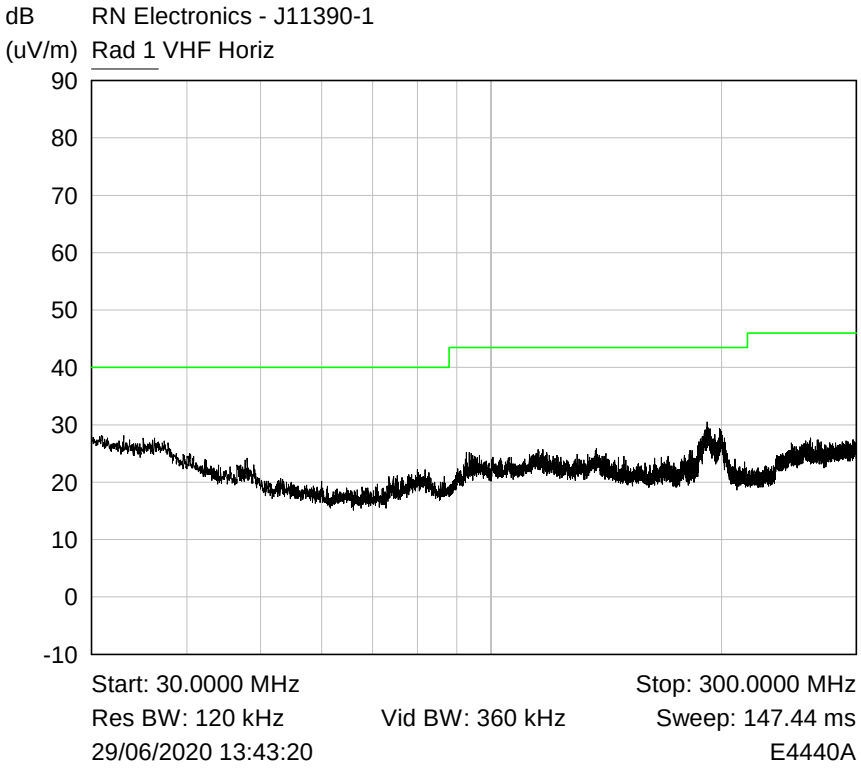
Plot of 150kHz-30MHz Parallel



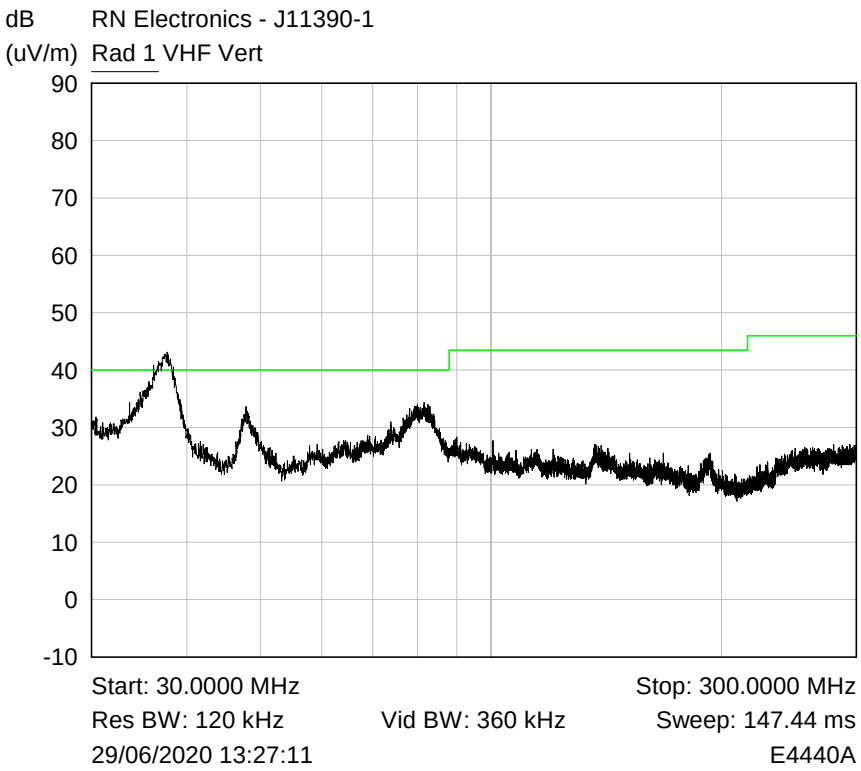
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions 30 MHz -1 GHz

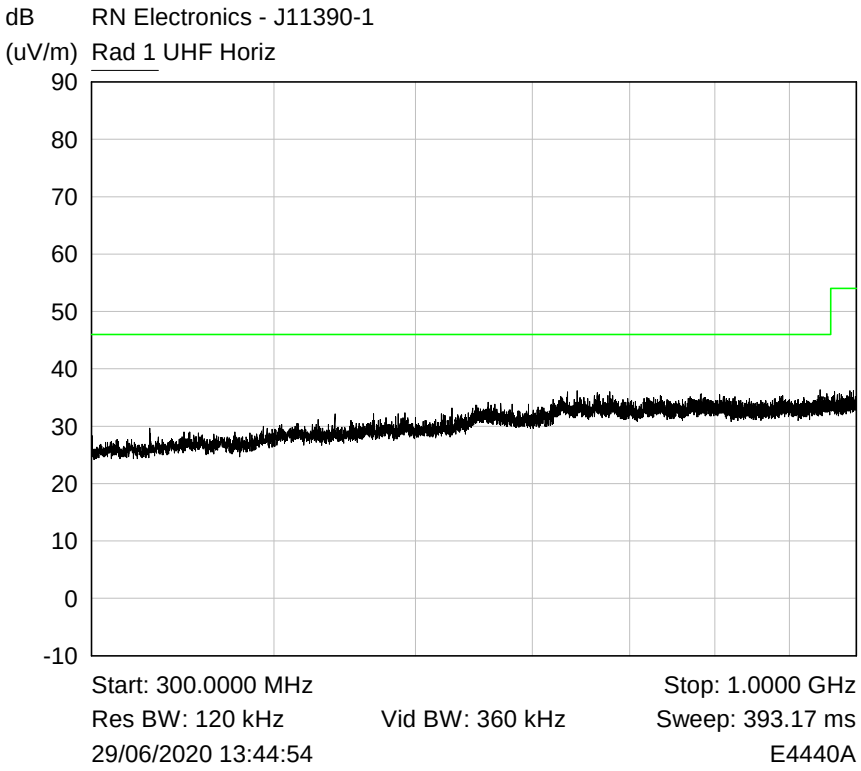
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs12, Channel 64.8 GHz



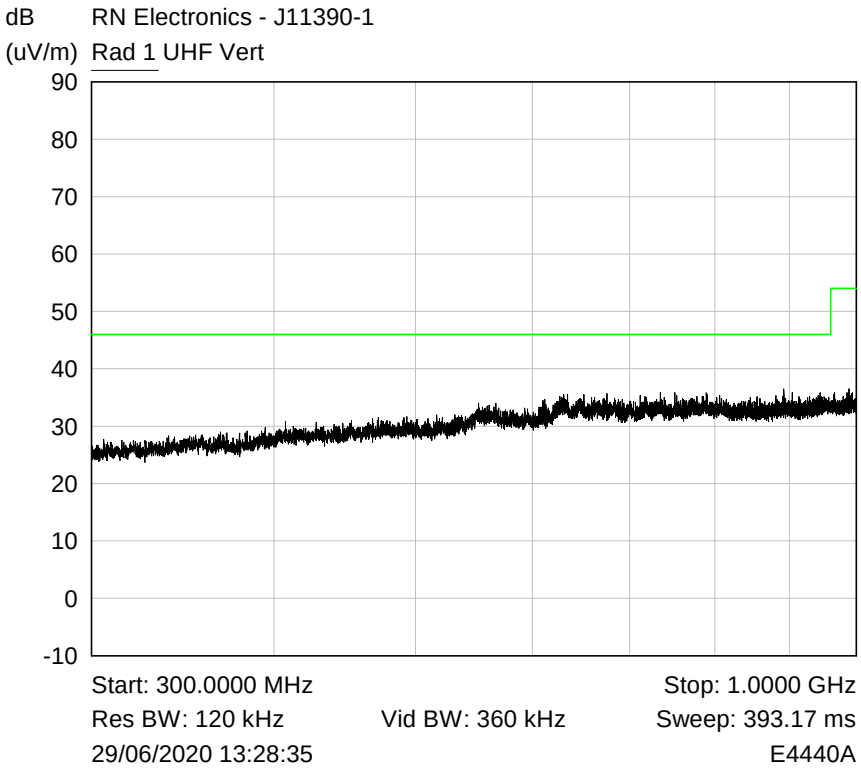
Plot of Peak emissions for VHF Horizontal against the QP limit line.



Plot of Peak emissions for VHF Vertical against the QP limit line.



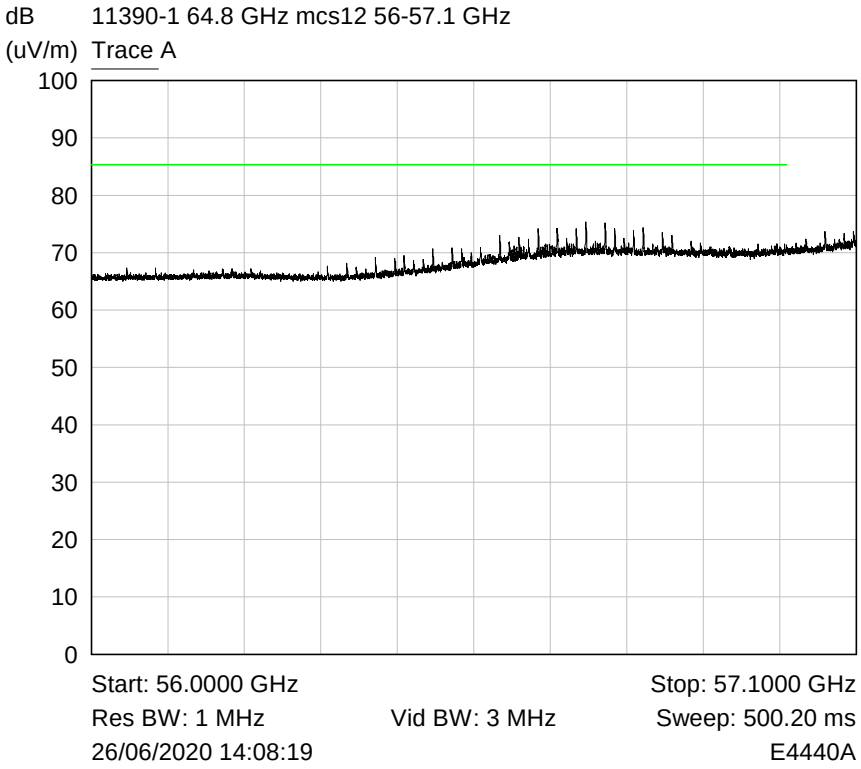
Plot of Peak emissions for UHF Horizontal against the QP limit line.



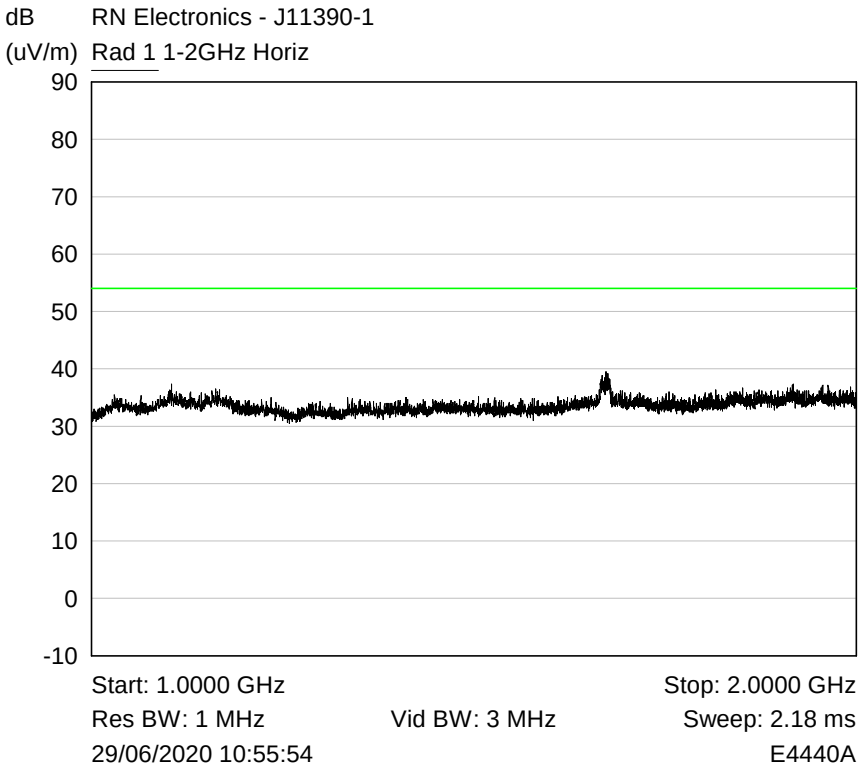
Plot of Peak emissions for UHF Vertical against the QP limit line.

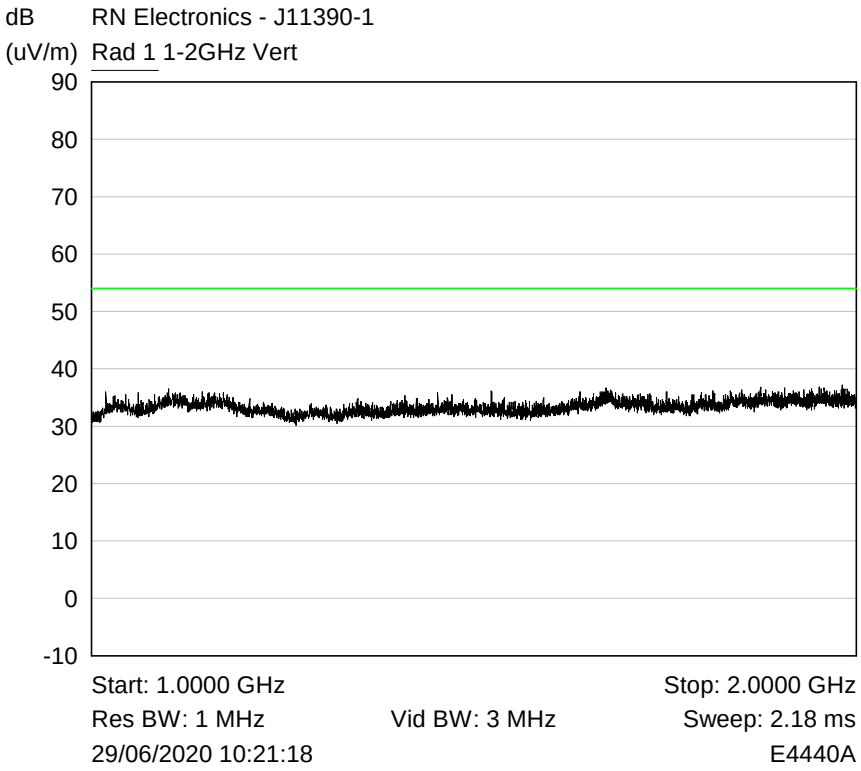
6.4 Radiated emissions above 1 GHz

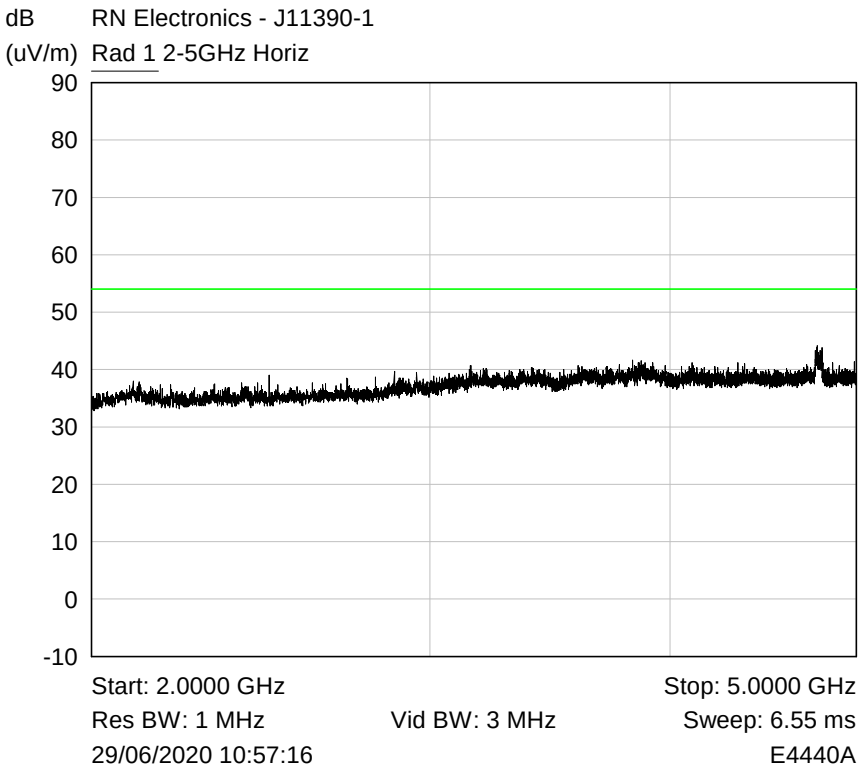
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs12, Channel 58.32 GHz

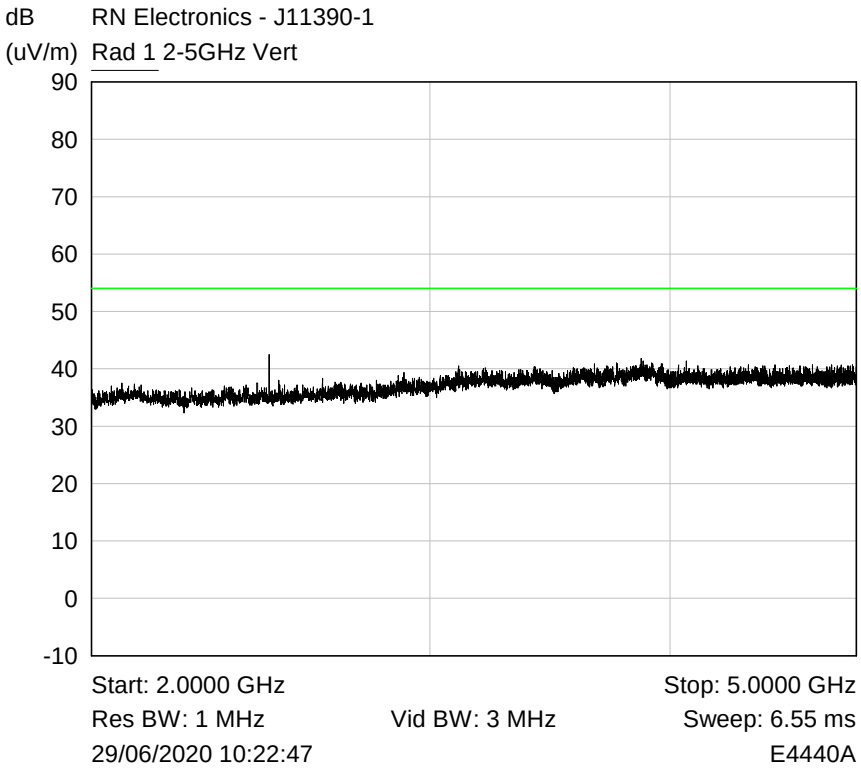


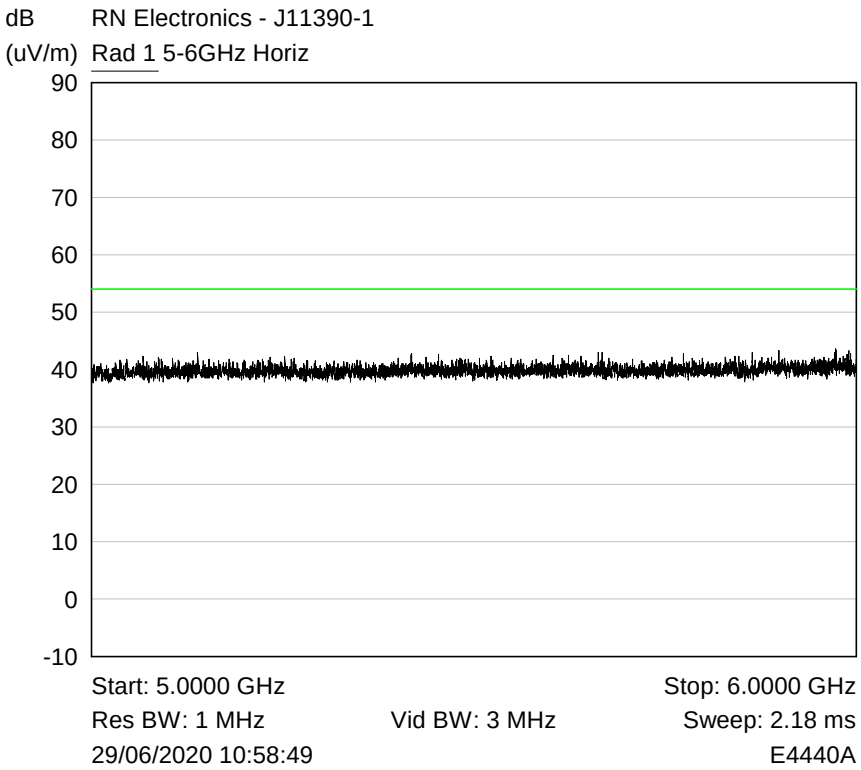
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs5, Channel 64.8 GHz

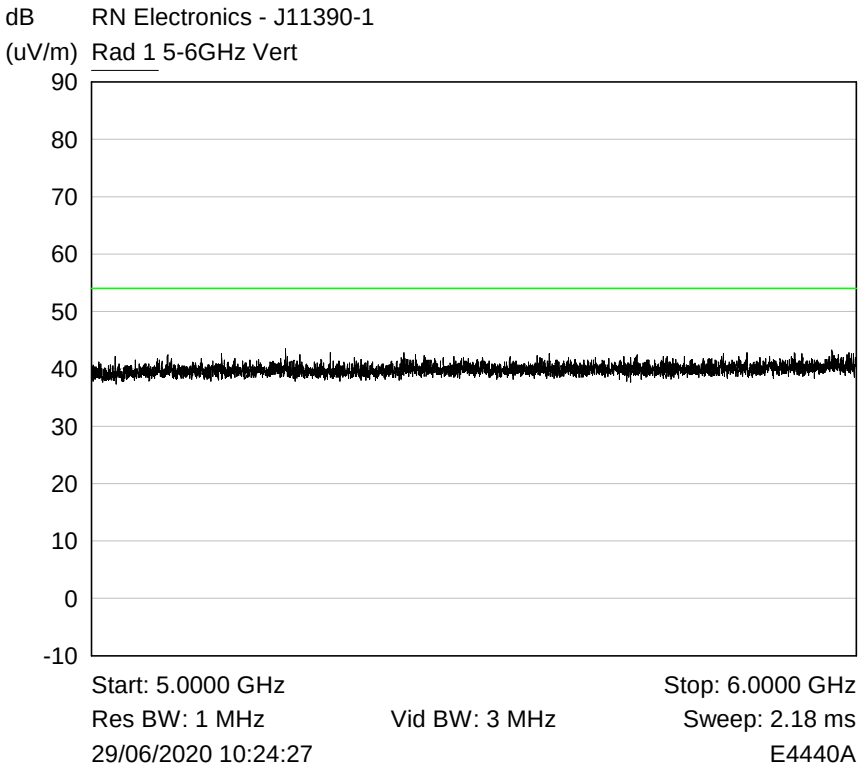


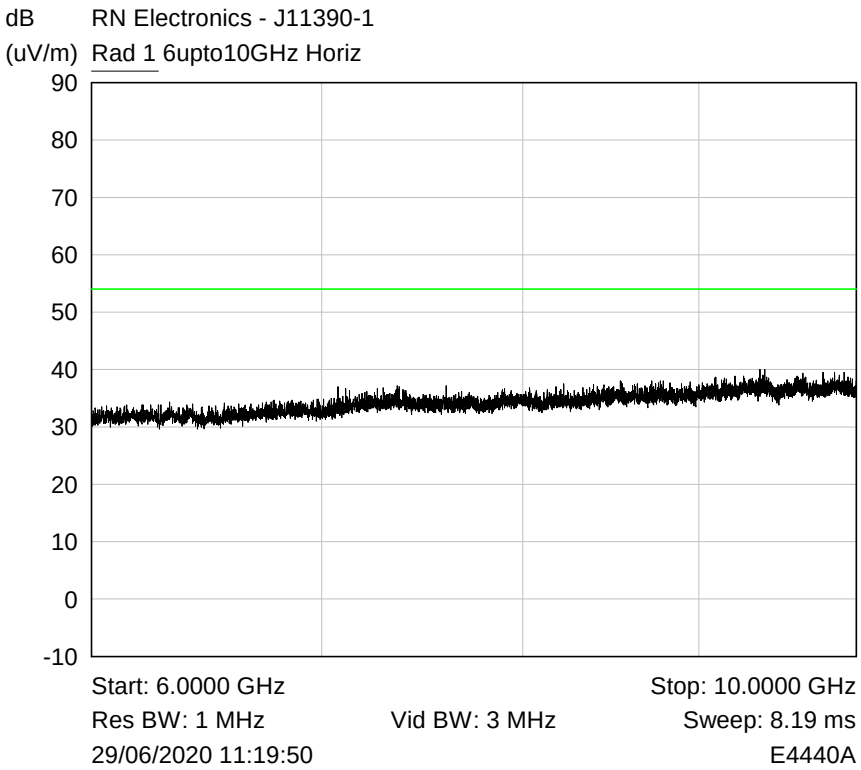

dB
(uV/m)
RN Electronics - J11390-1
Rad 1 1-2GHz Vert
90
80
70
60
50
40
30
20
10
0
-10
Start: 1.0000 GHz
Stop: 2.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 2.18 ms
29/06/2020 10:21:18
E4440A

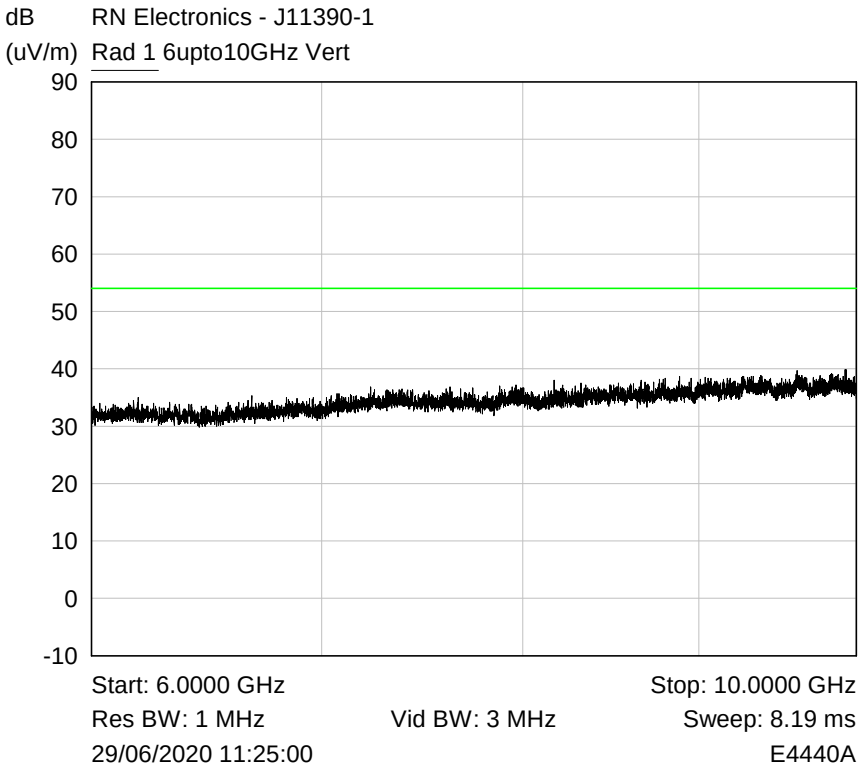

dB
(uV/m)
RN Electronics - J11390-1
Rad 1 2-5GHz Horiz
90
80
70
60
50
40
30
20
10
0
-10
Start: 2.0000 GHz
Stop: 5.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 6.55 ms
29/06/2020 10:57:16
E4440A

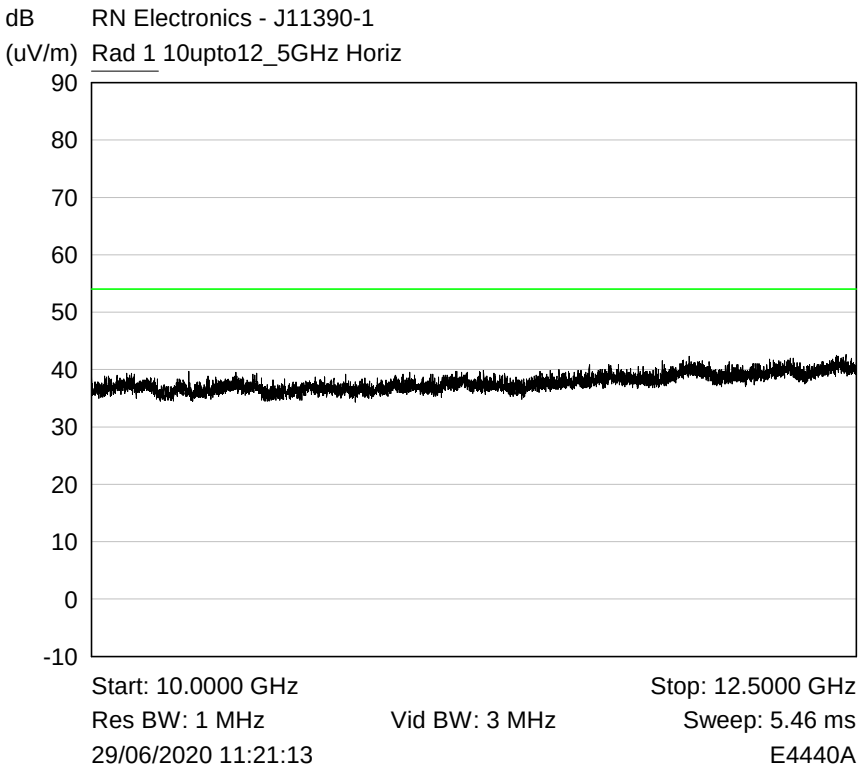

dB
(uV/m)
RN Electronics - J11390-1
Rad 1 2-5GHz Vert
90
80
70
60
50
40
30
20
10
0
-10
Start: 2.0000 GHz
Stop: 5.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 6.55 ms
29/06/2020 10:22:47
E4440A

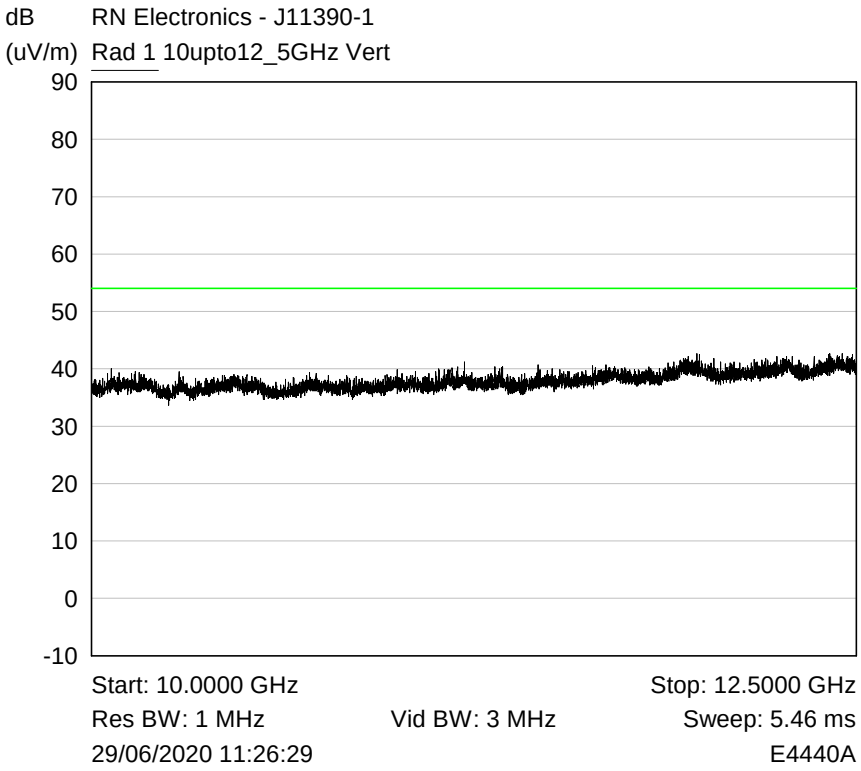

dB
(uV/m)
RN Electronics - J11390-1
Rad 1 5-6GHz Horiz
90
80
70
60
50
40
30
20
10
0
-10
Start: 5.0000 GHz
Stop: 6.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 2.18 ms
29/06/2020 10:58:49
E4440A

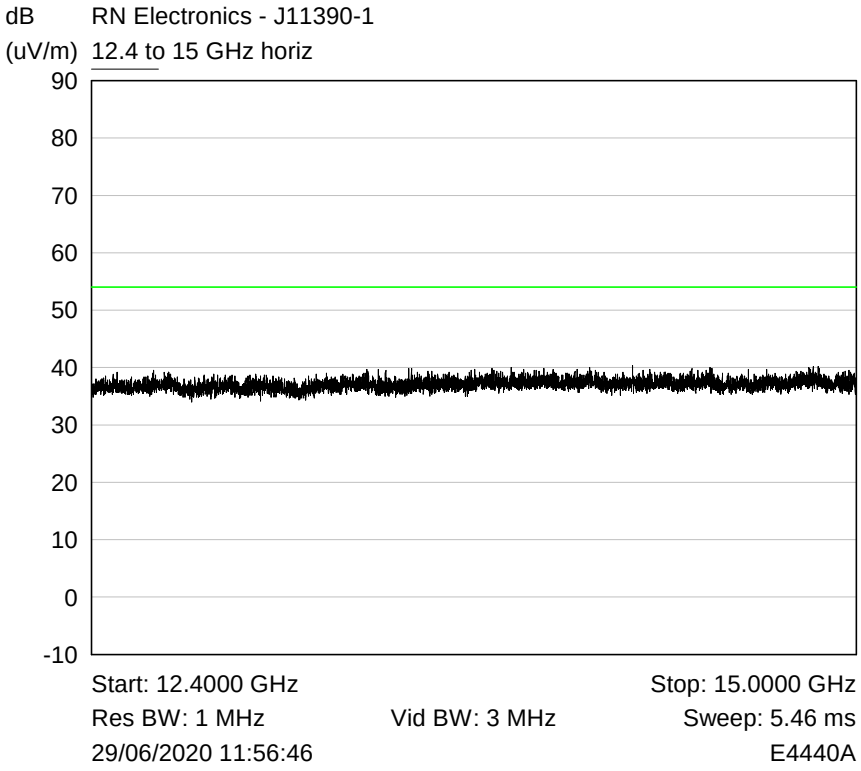


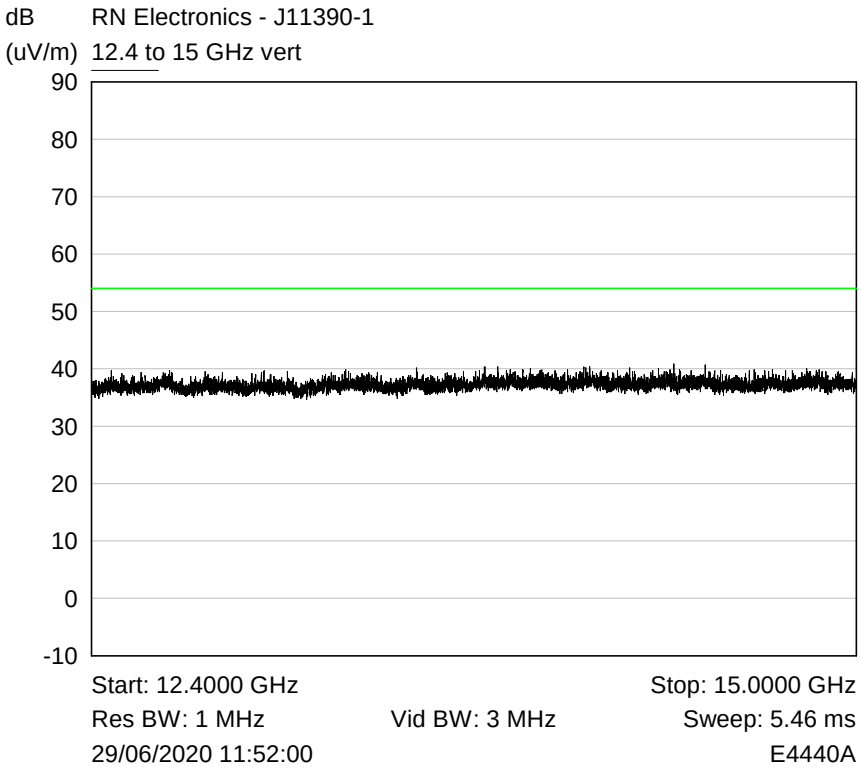


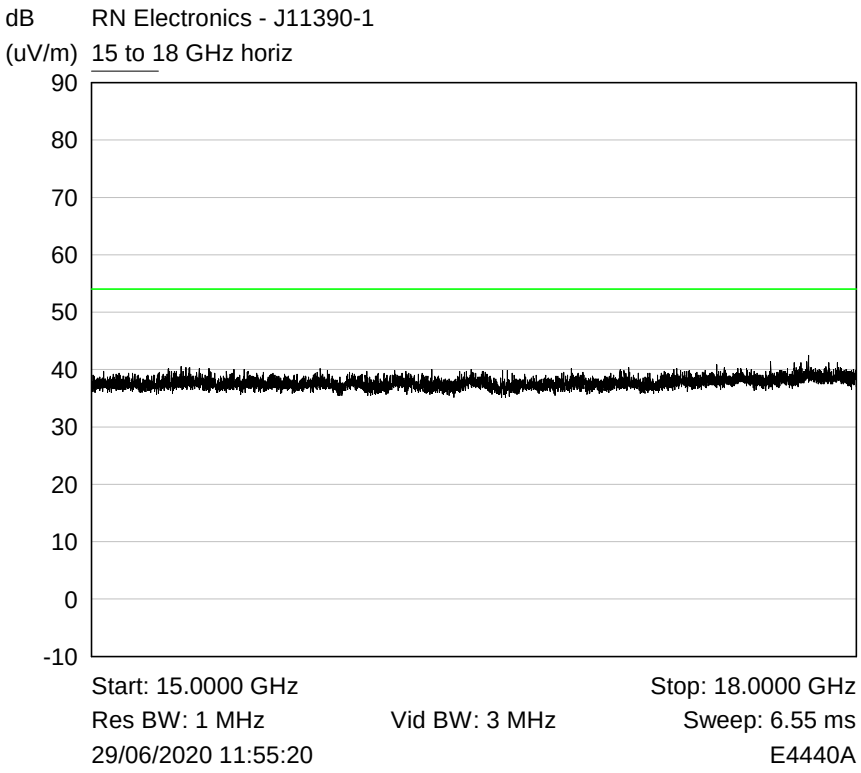


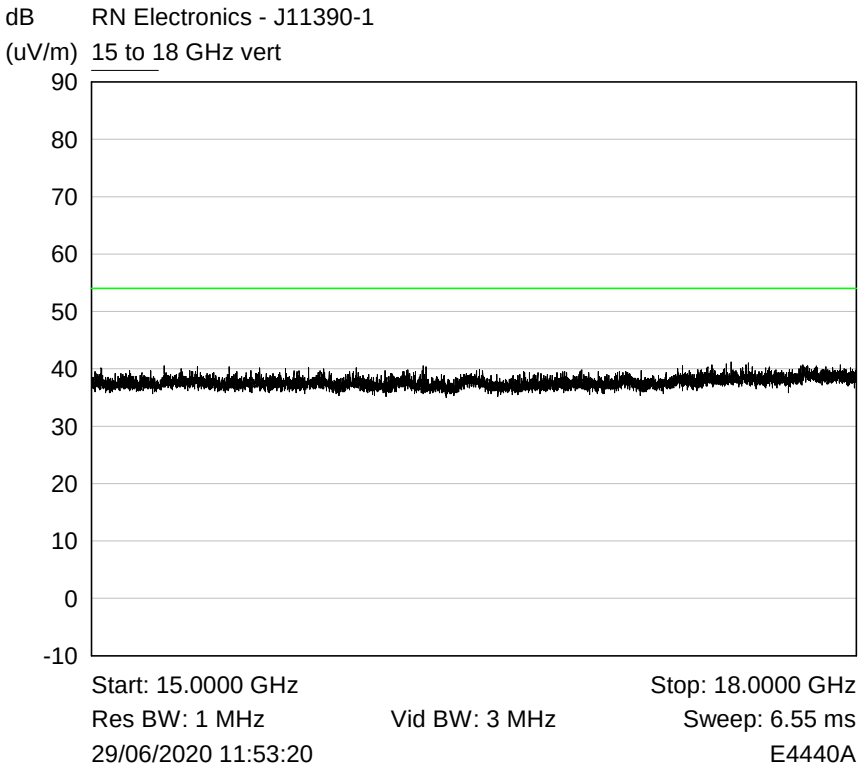


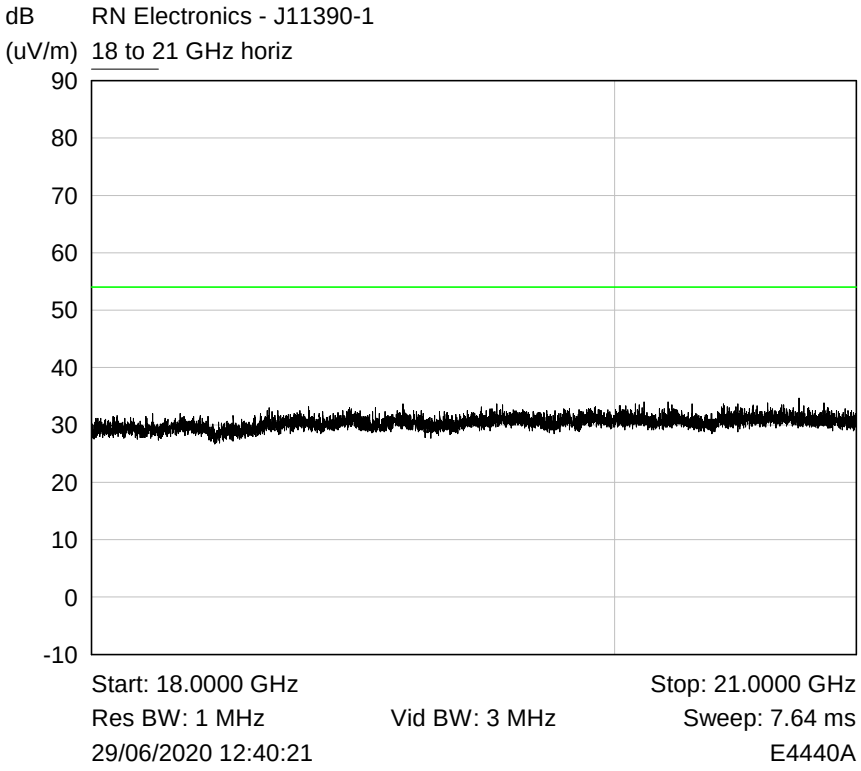


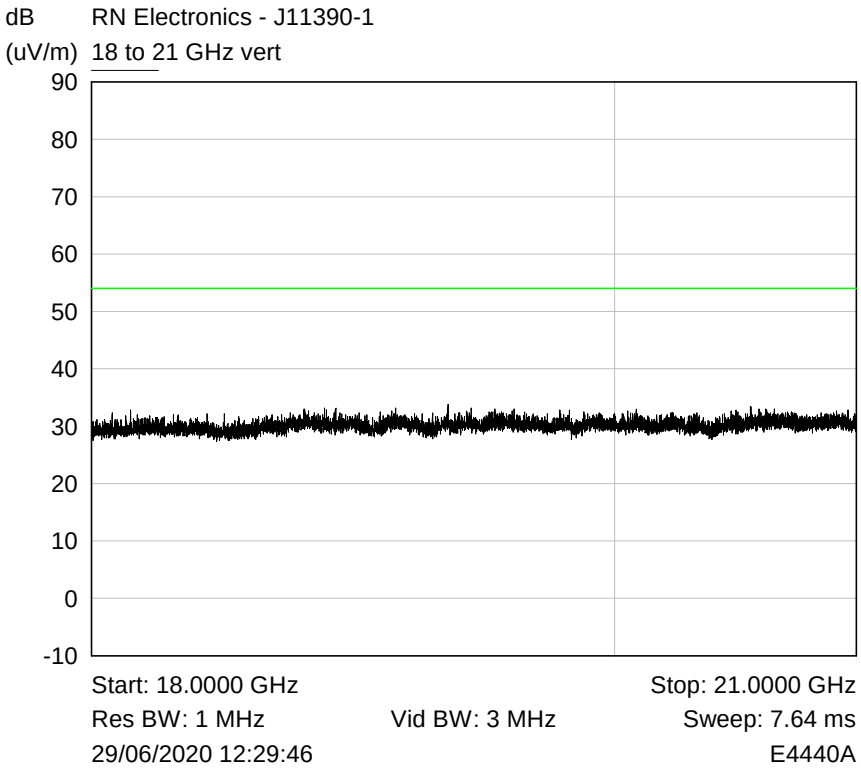


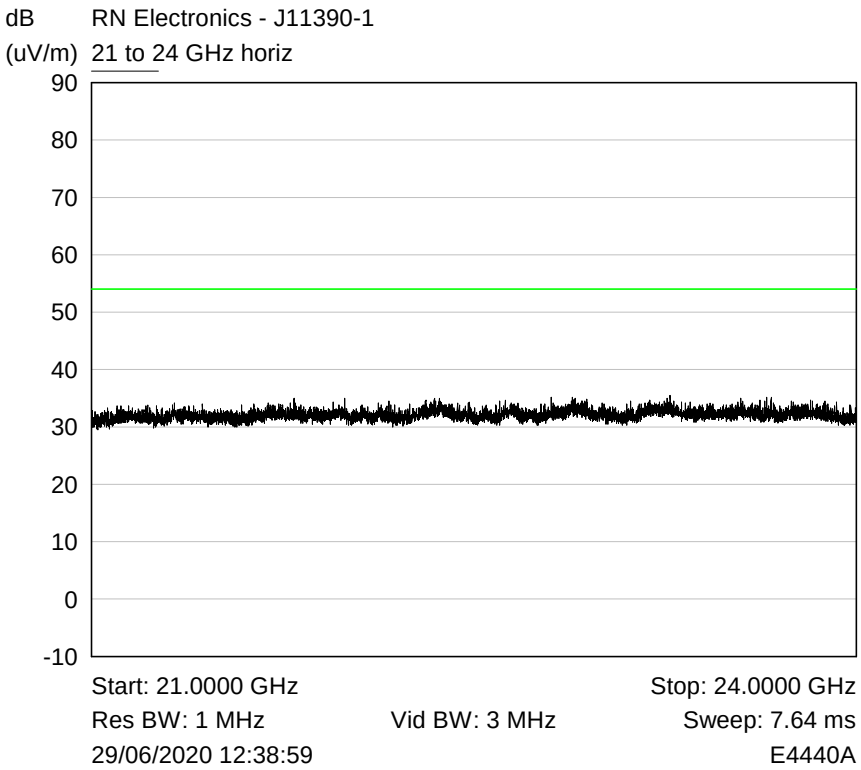


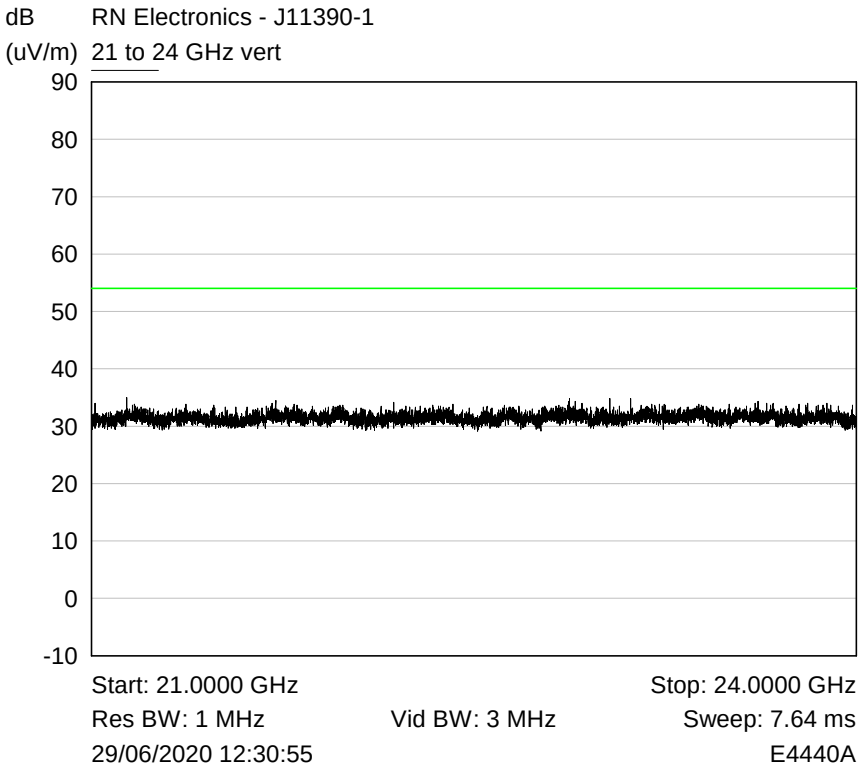


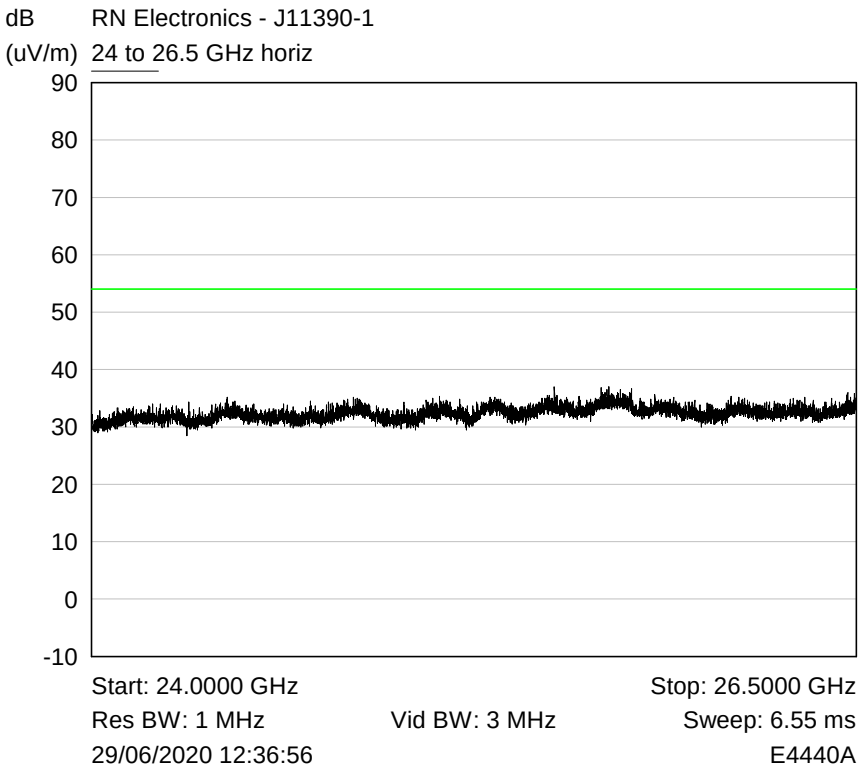

dB
(uV/m)
RN Electronics - J11390-1
15 to 18 GHz vert
90
80
70
60
50
40
30
20
10
0
-10
Start: 15.0000 GHz
Stop: 18.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 6.55 ms
29/06/2020 11:53:20
E4440A

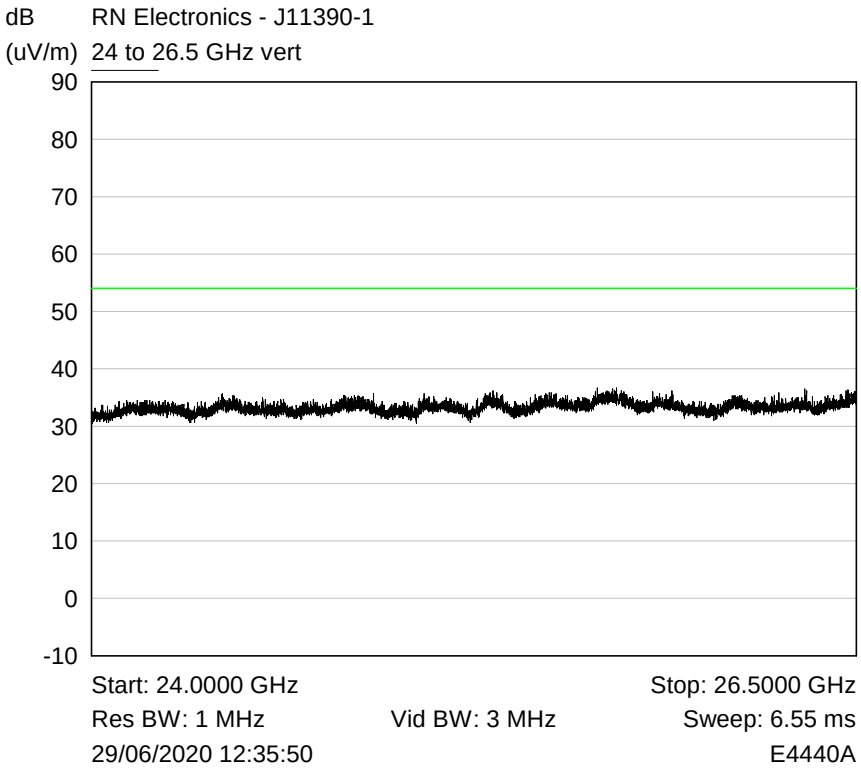

dB
(uV/m)
RN Electronics - J11390-1
18 to 21 GHz horiz
90
80
70
60
50
40
30
20
10
0
-10
Start: 18.0000 GHz
Stop: 21.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 7.64 ms
29/06/2020 12:40:21
E4440A

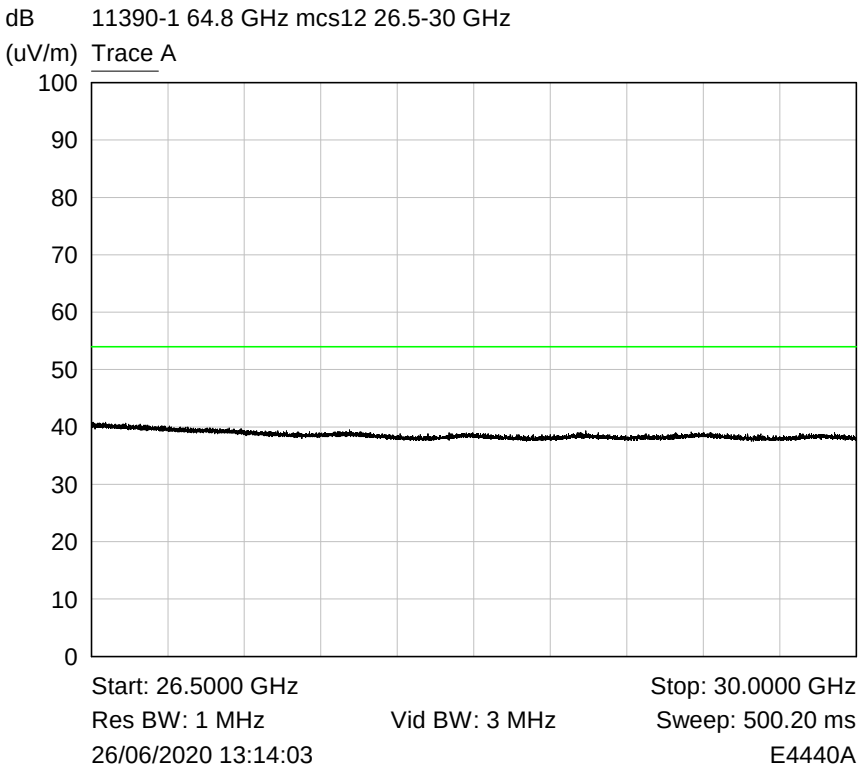


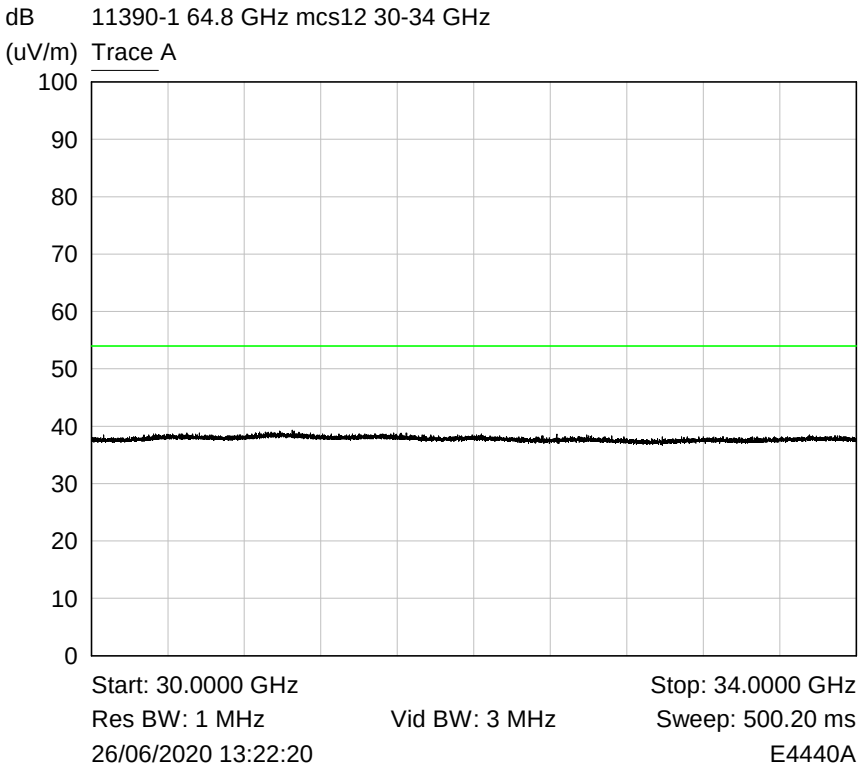


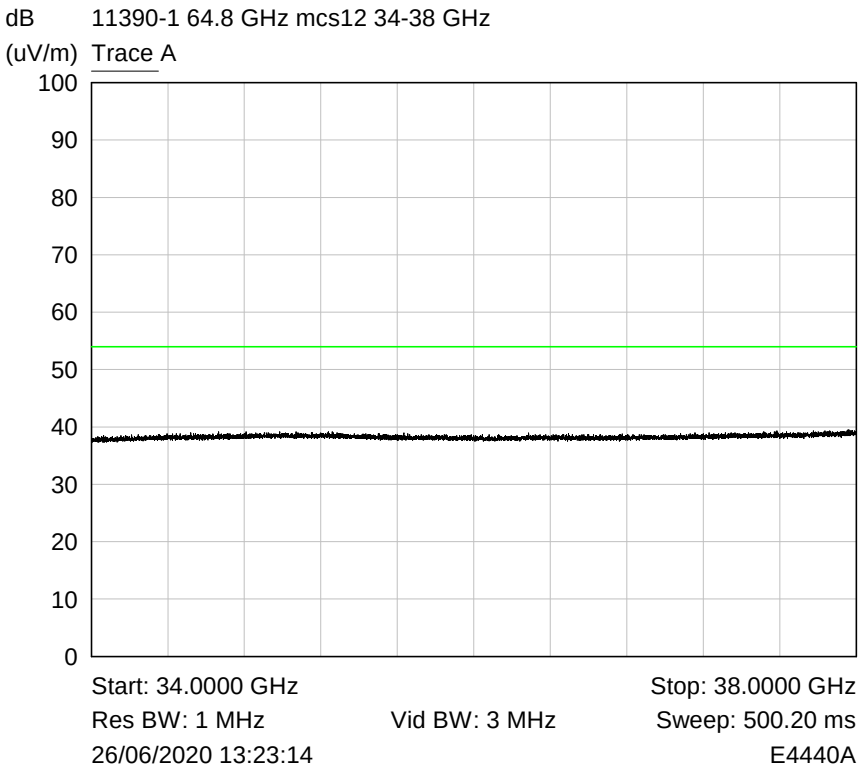


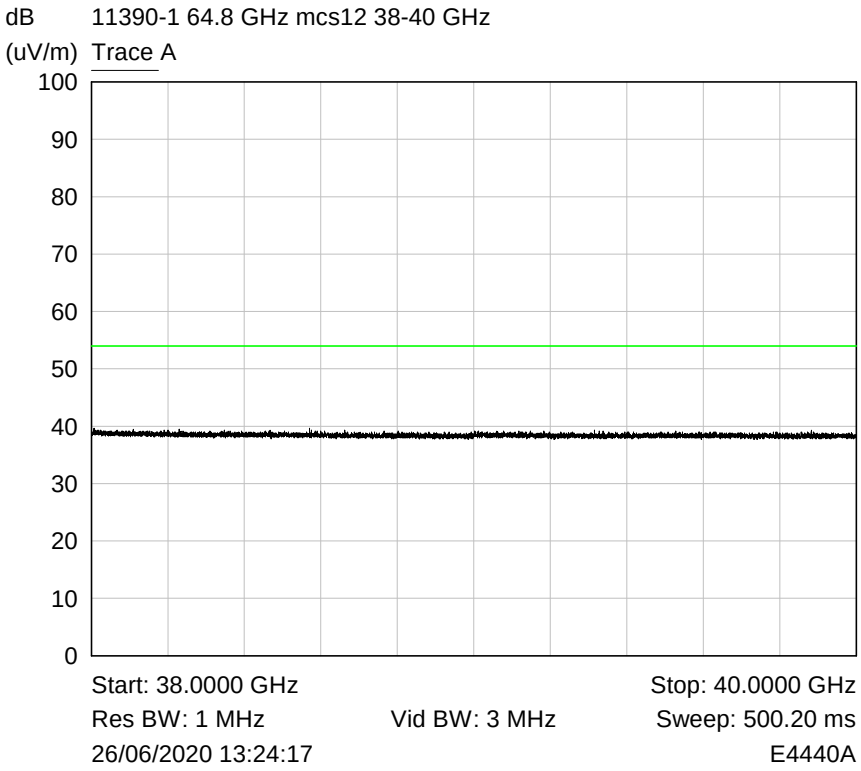


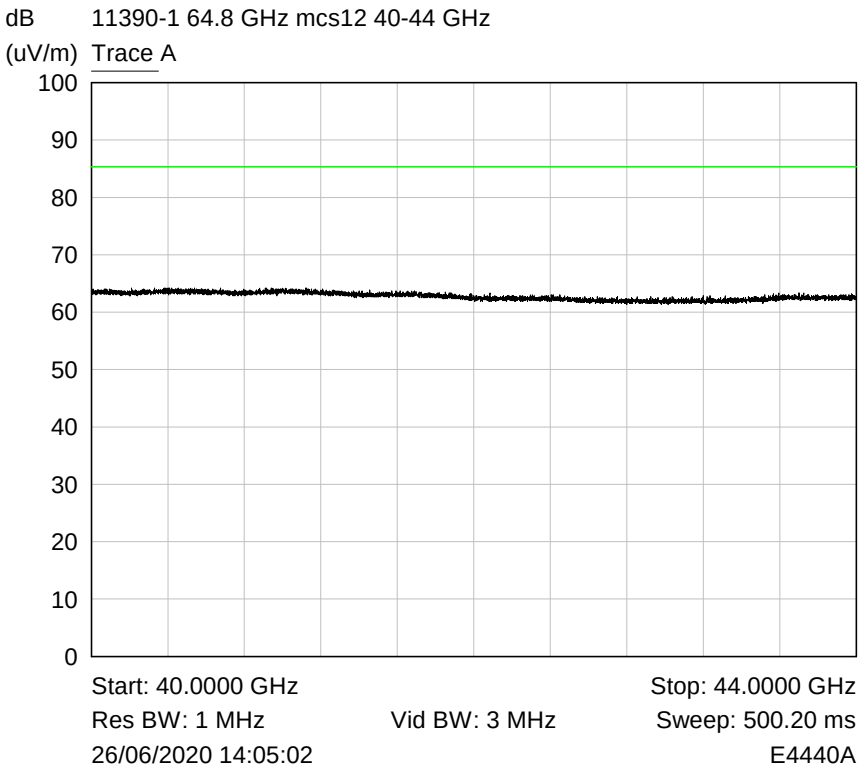


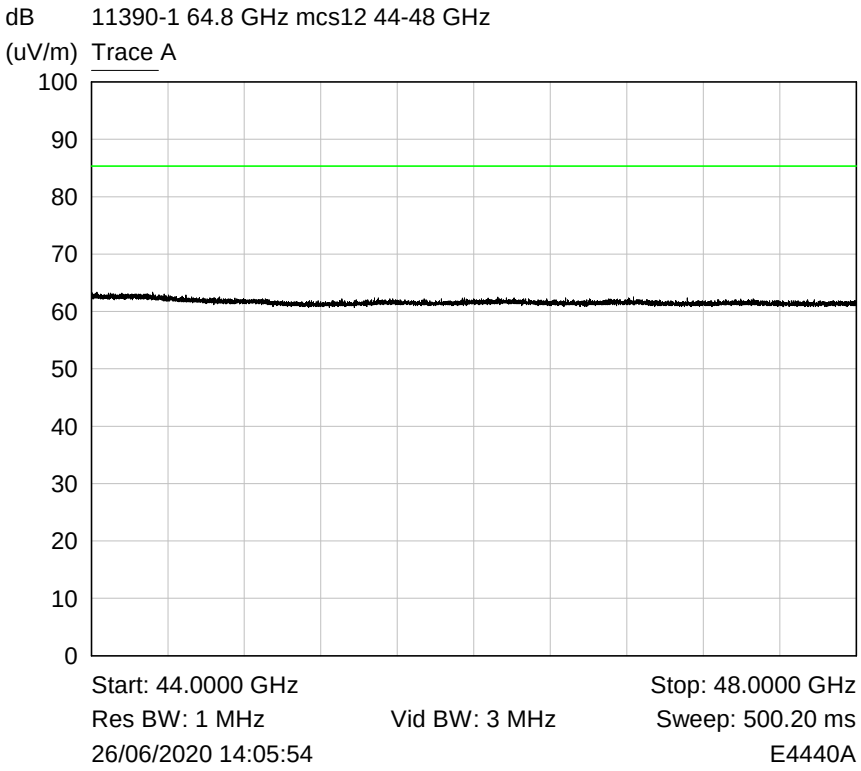


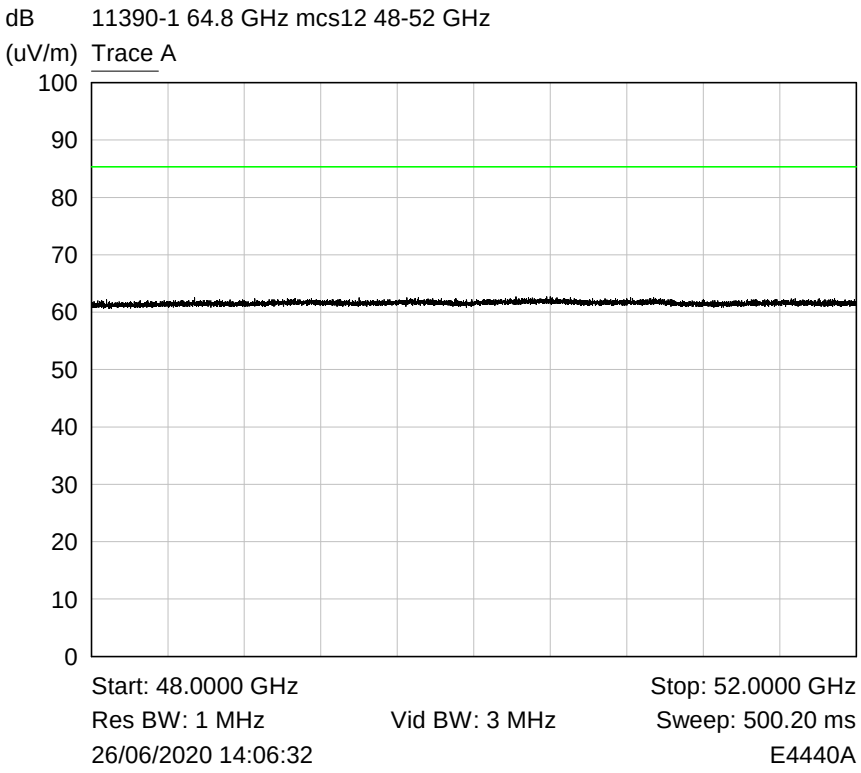


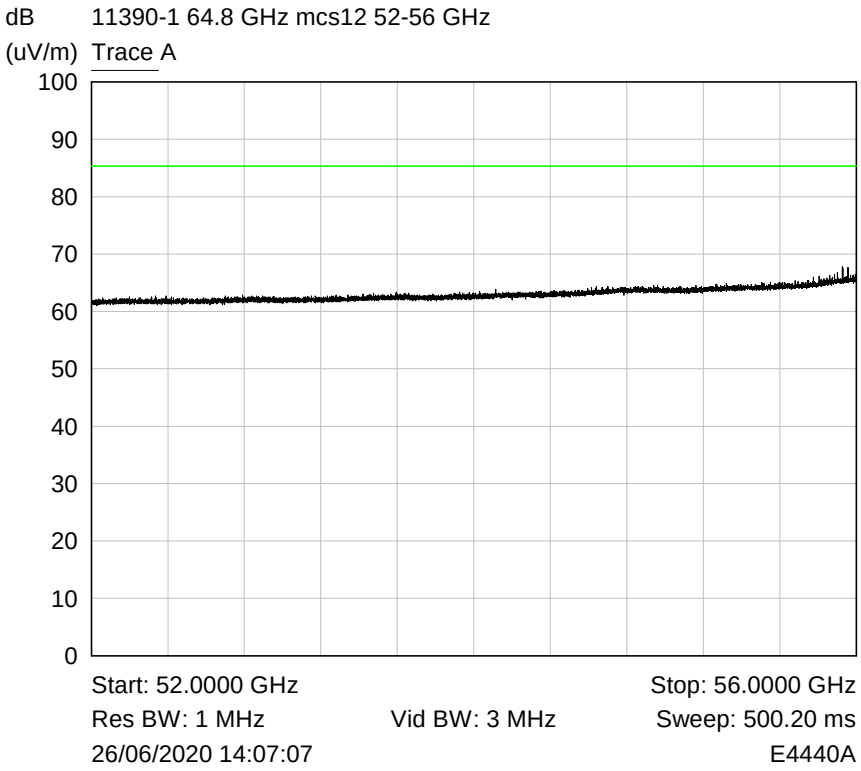


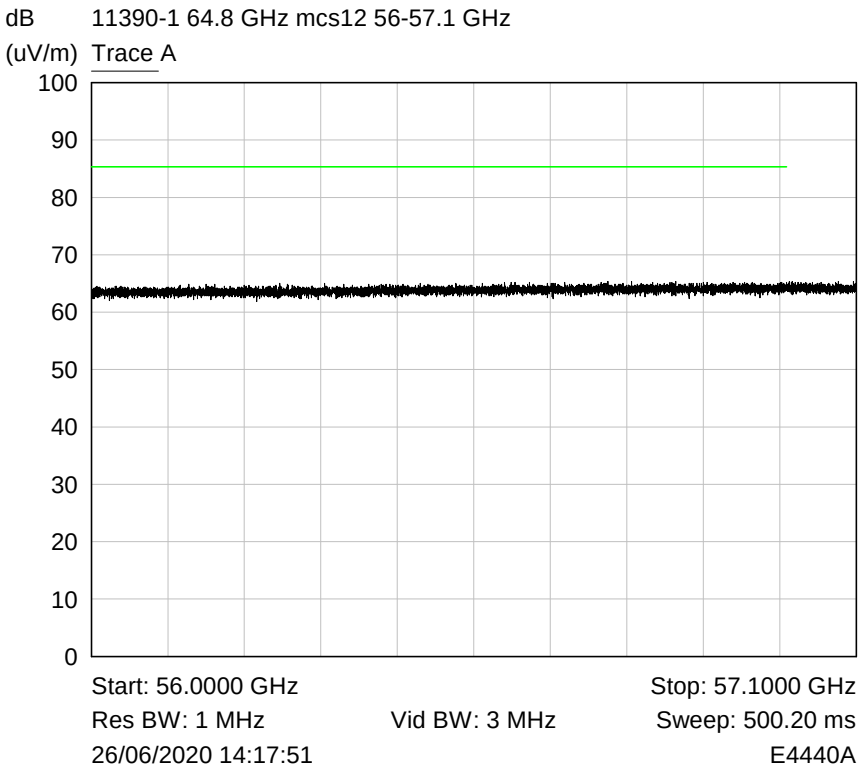


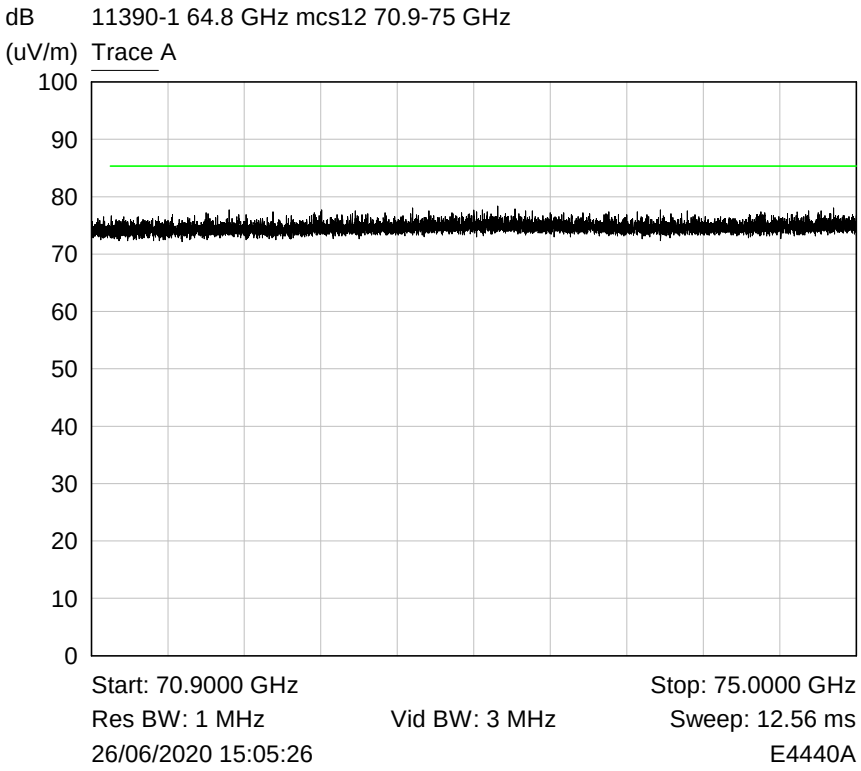


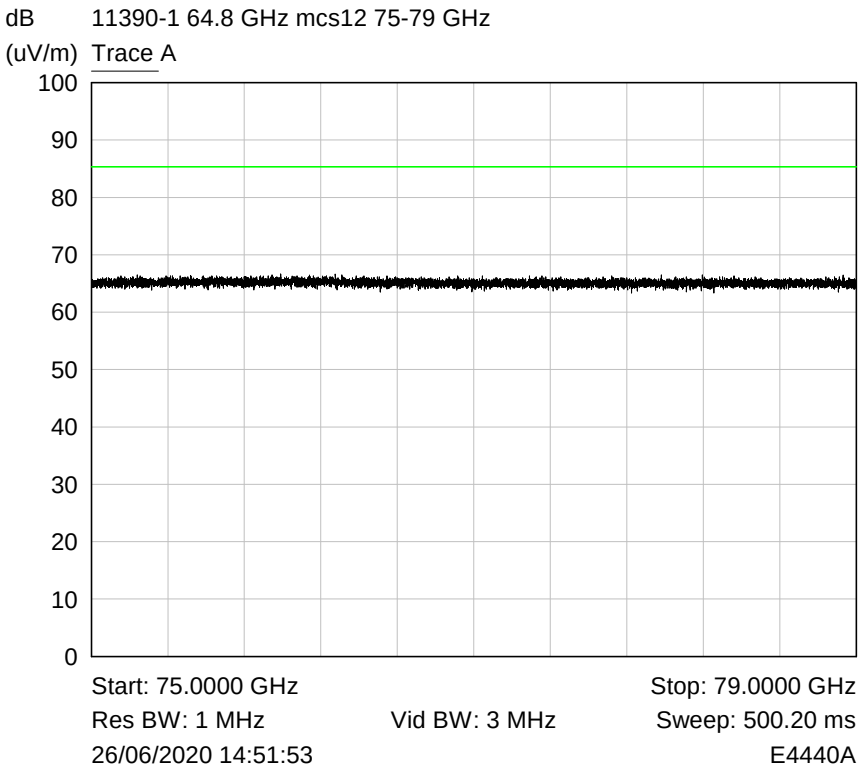


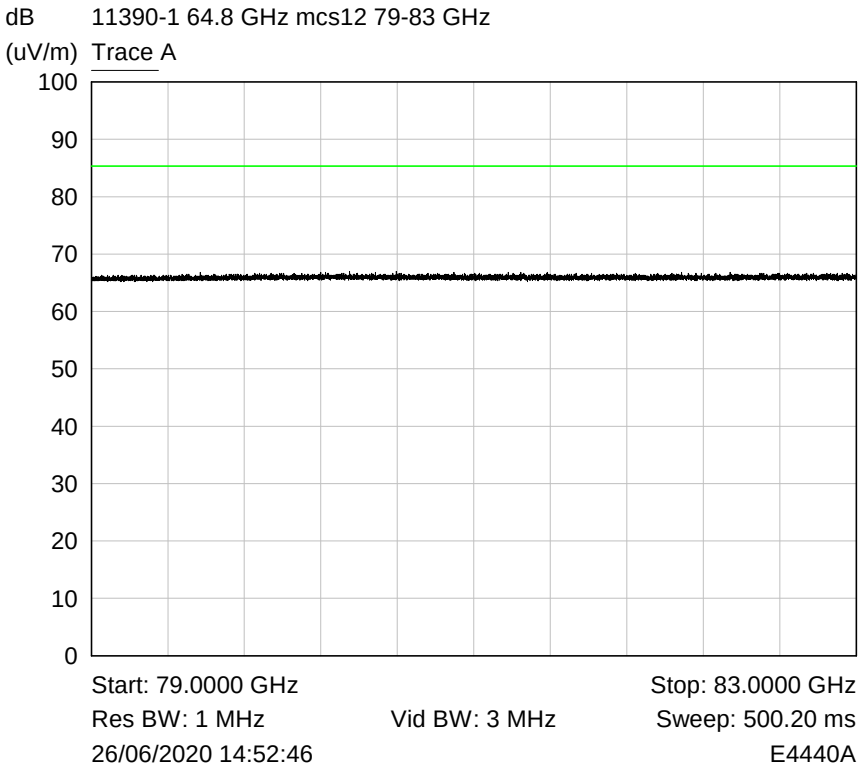


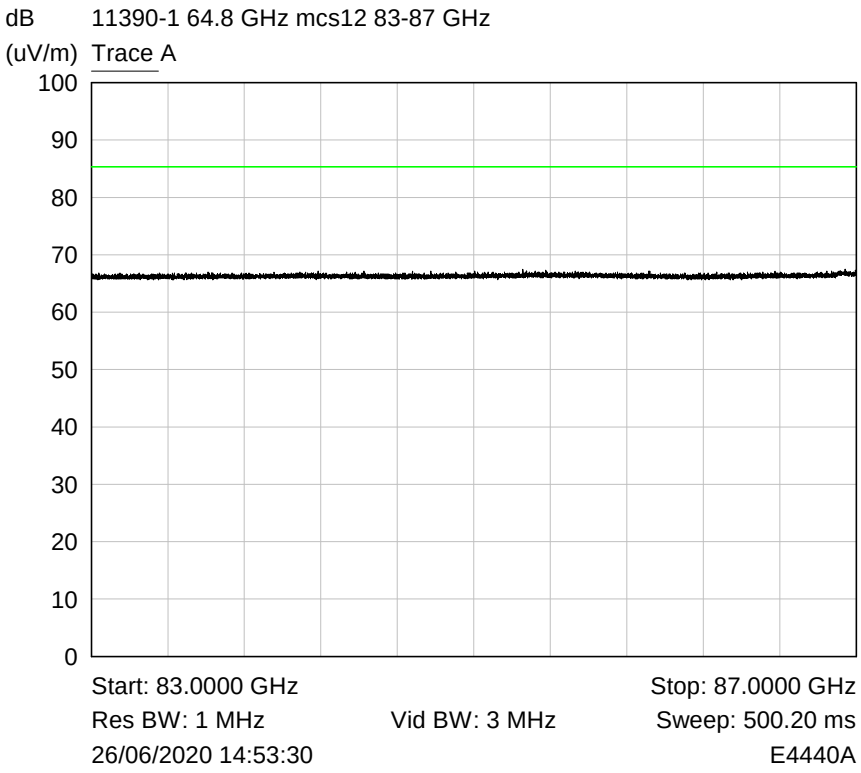


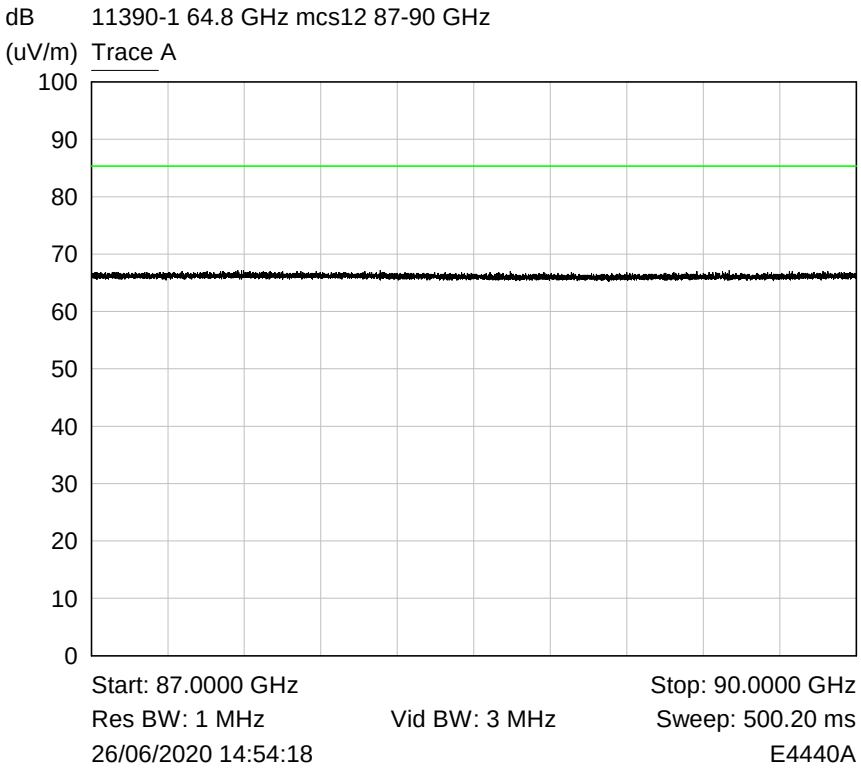


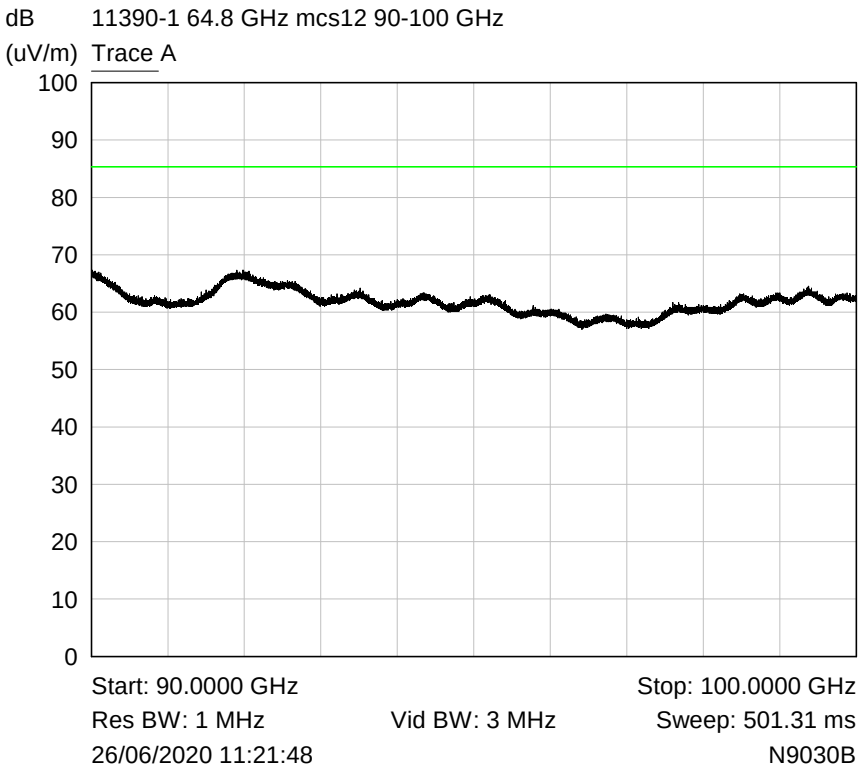


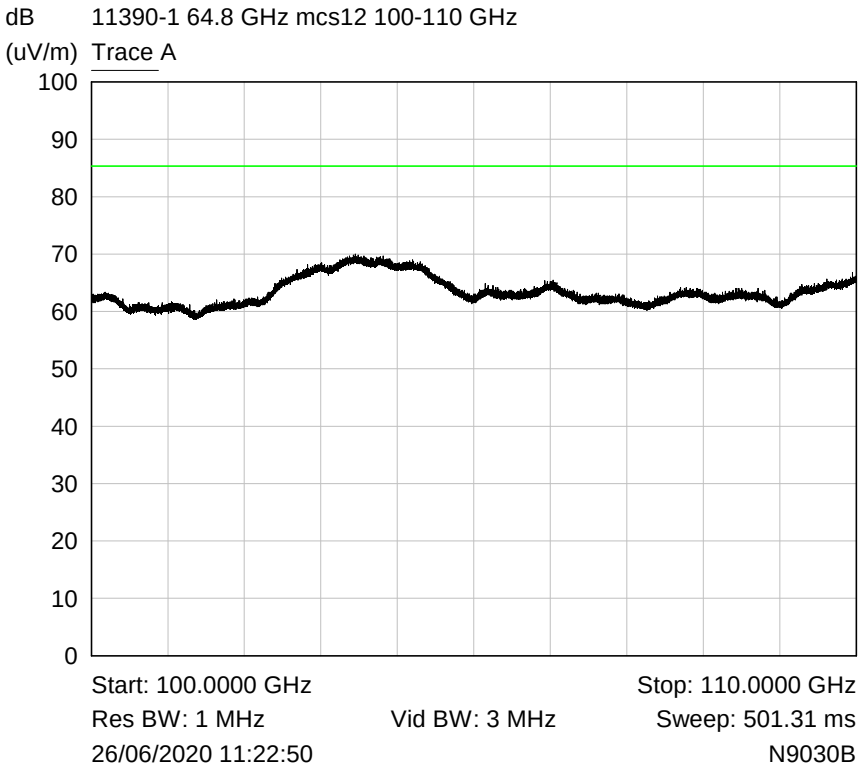


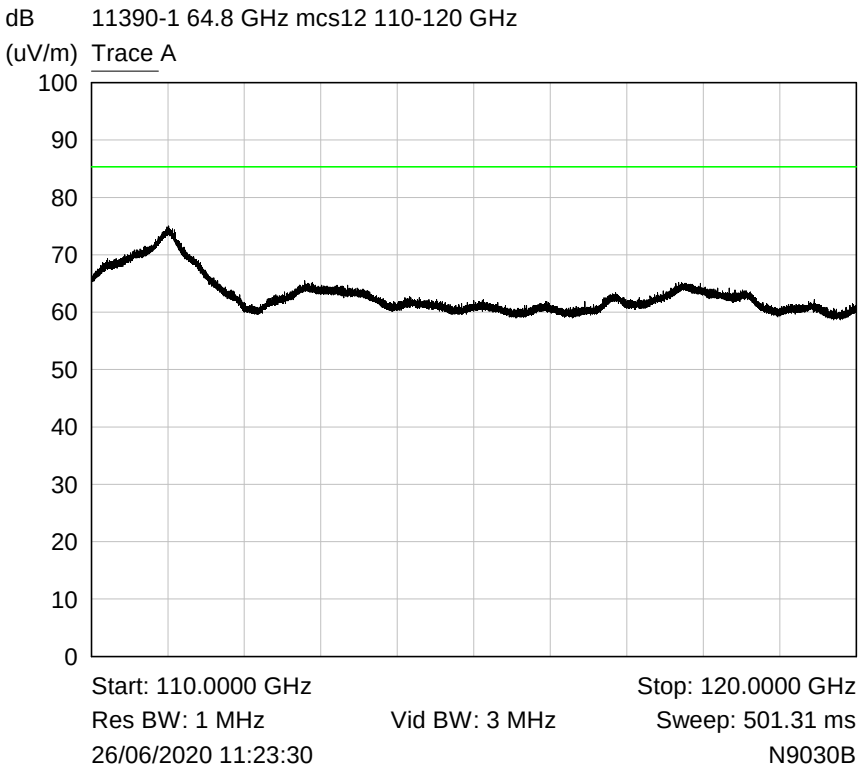


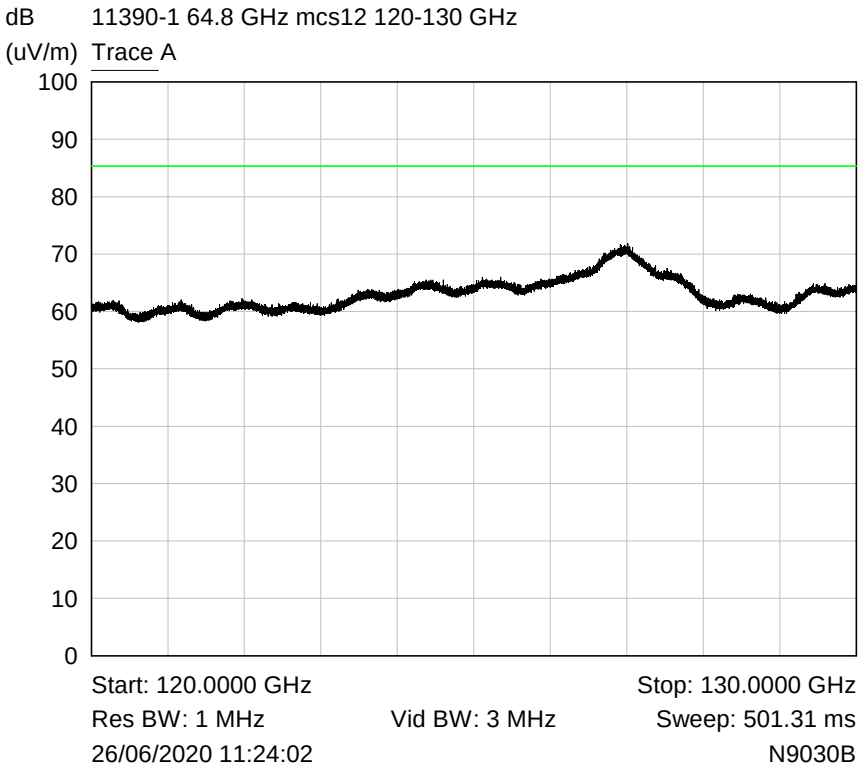


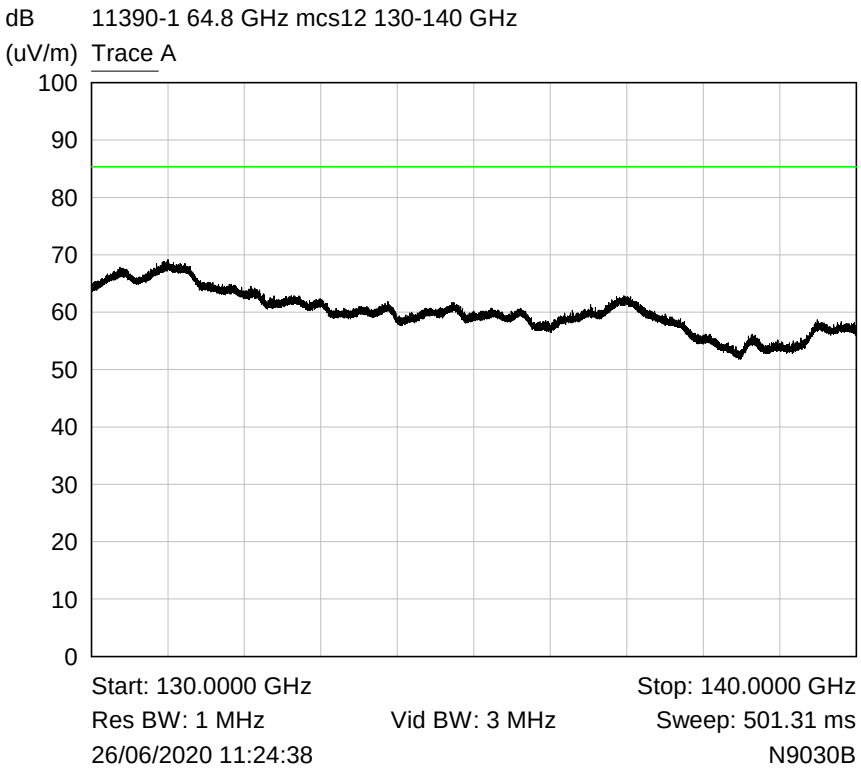


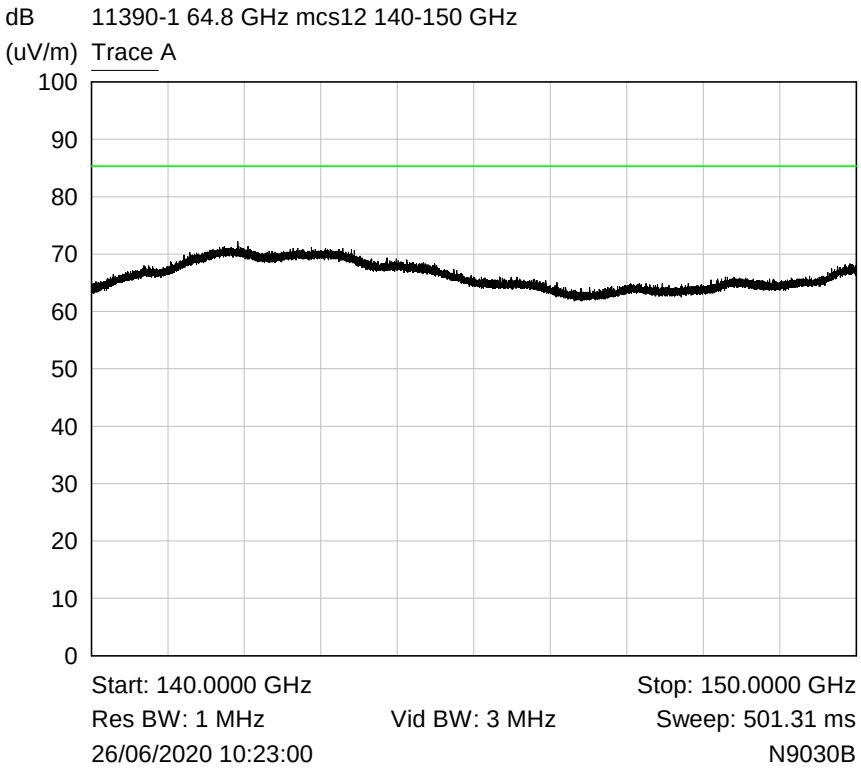


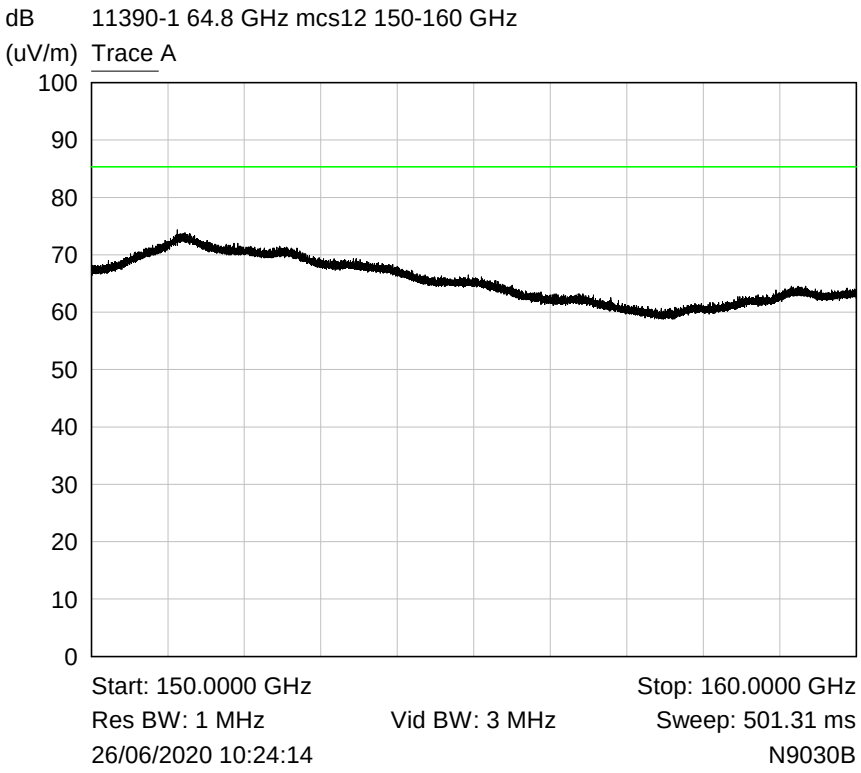


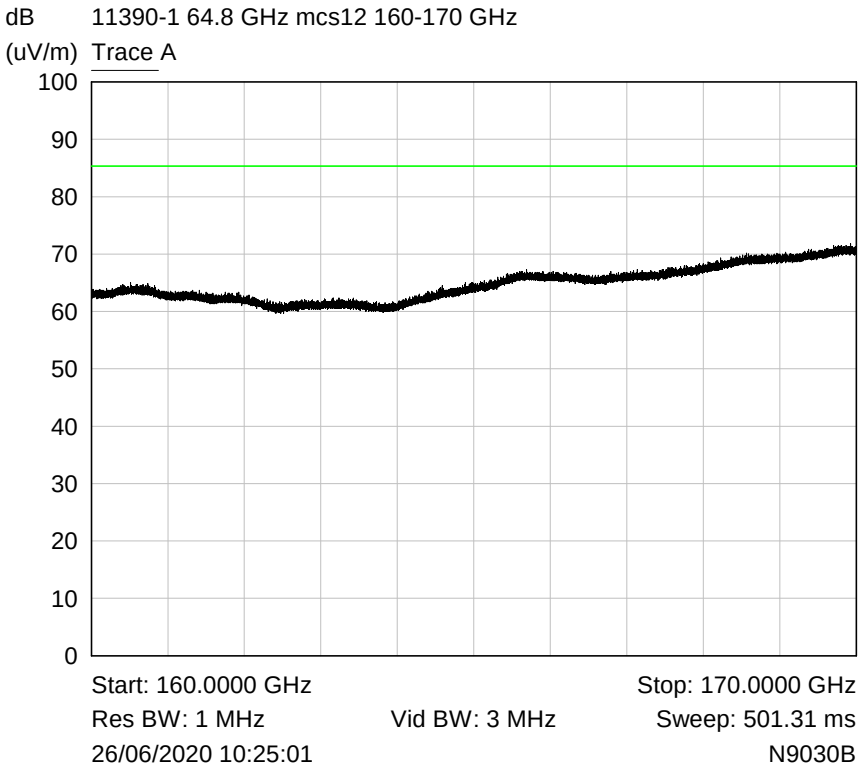


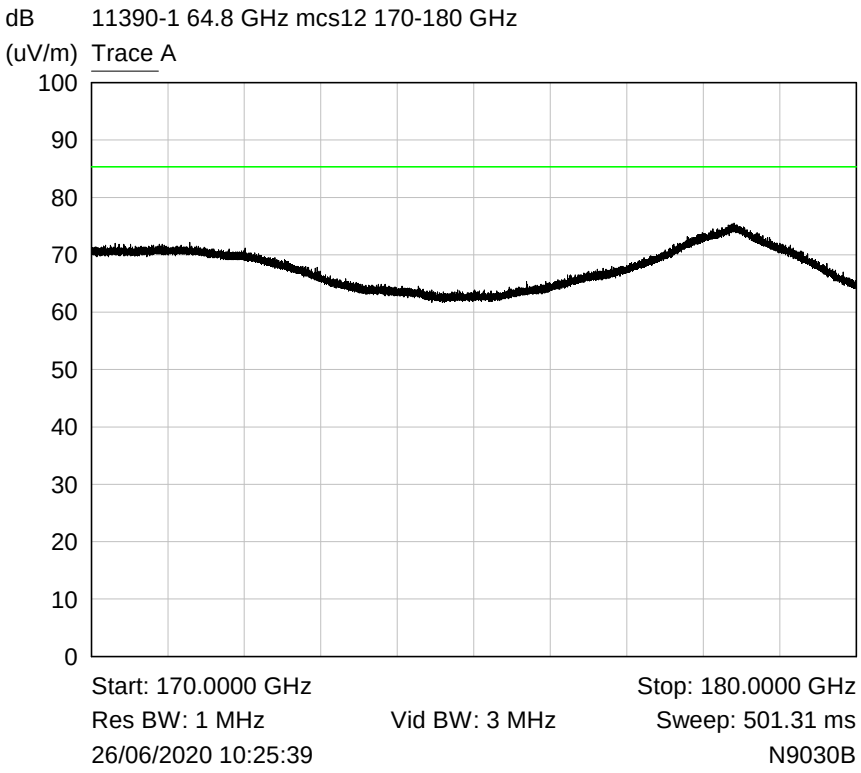


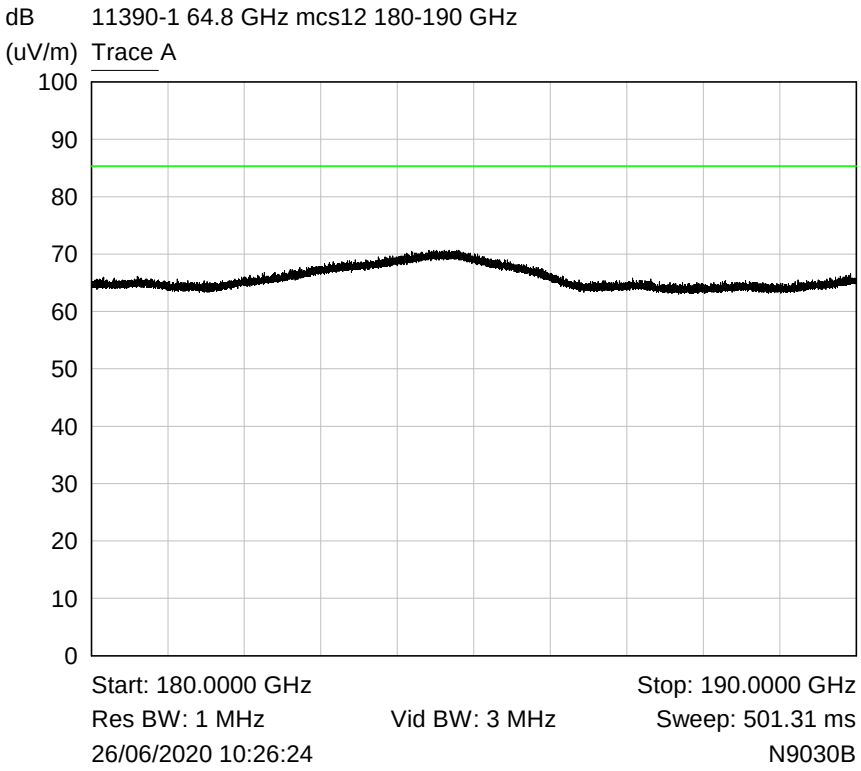


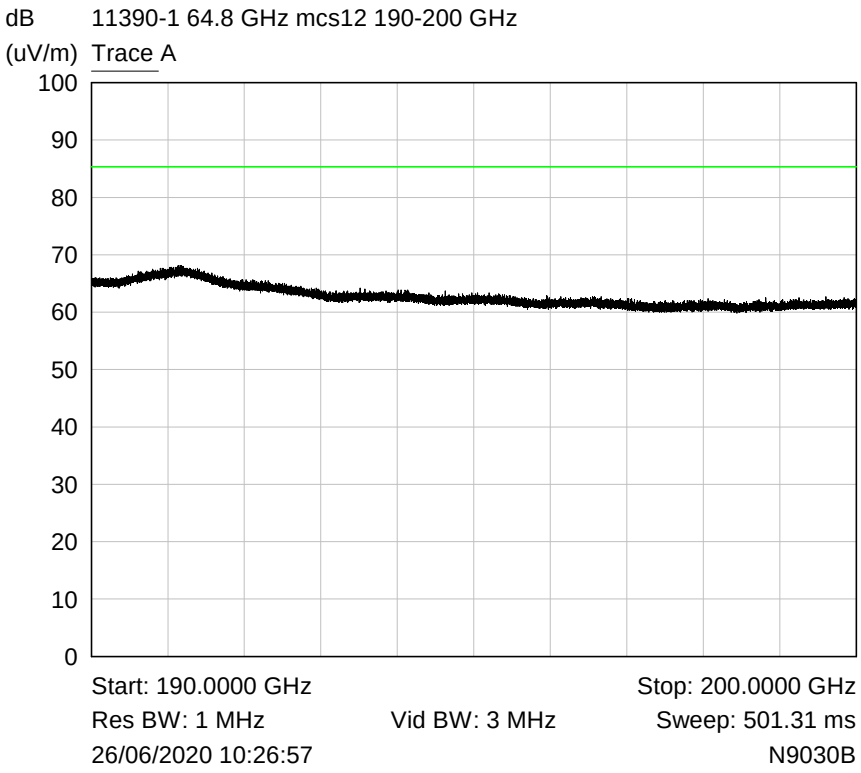




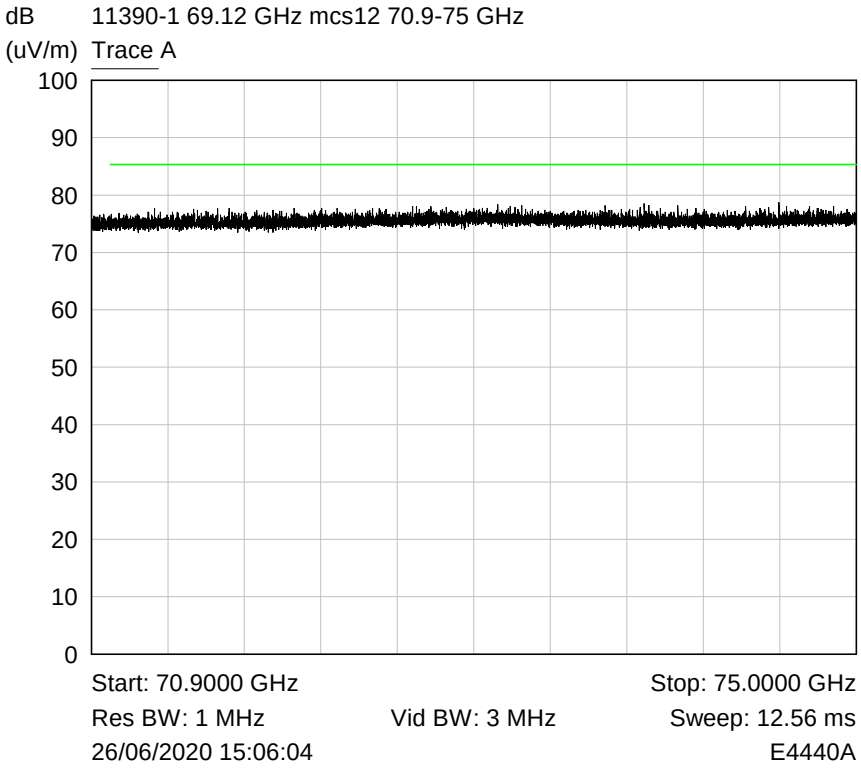






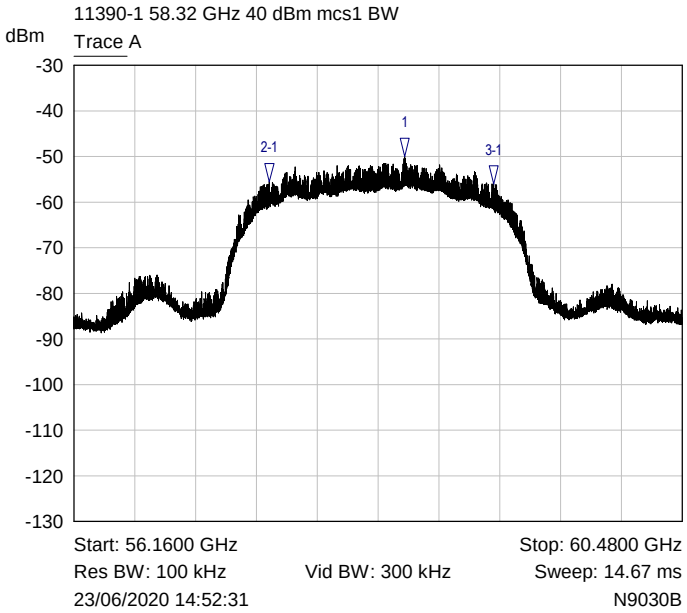


RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs5, Channel 69.12 GHz



6.5 6 dB Occupied bandwidth

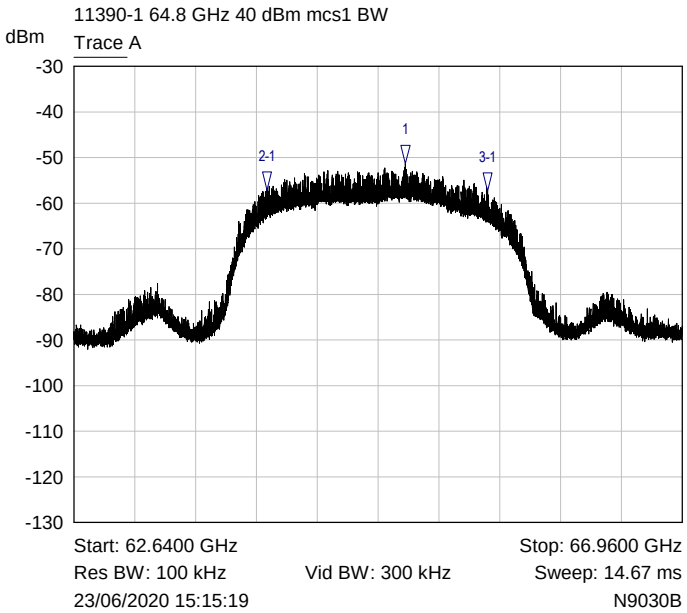
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs1, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.5090 GHz	-50.06 dBm	
2-1	Trace A	57.5499 GHz	-5.37 dB	
3-1	Trace A	59.1415 GHz	-5.86 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

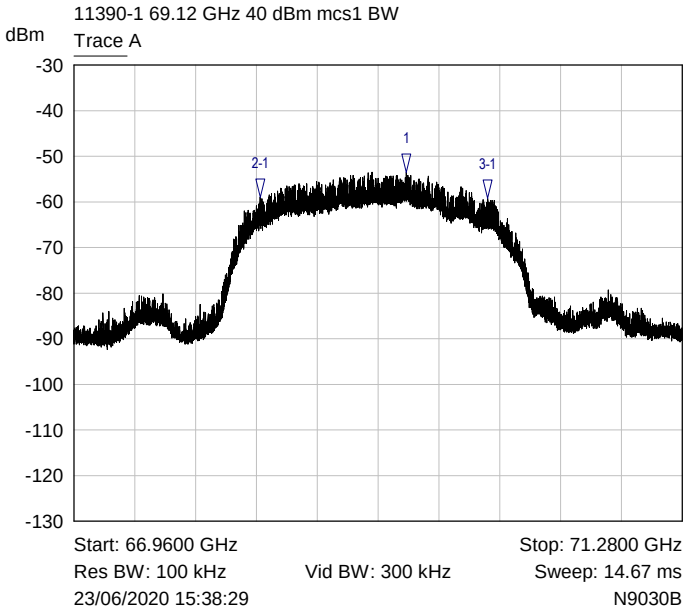
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs1, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.9925 GHz	-51.39 dBm	
2-1	Trace A	64.0130 GHz	-5.72 dB	
3-1	Trace A	65.5770 GHz	-5.91 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

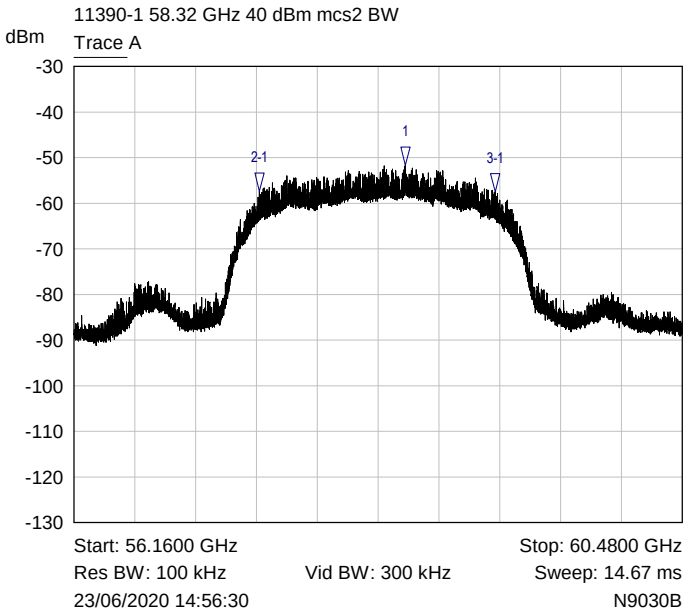
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs1, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.3194 GHz	-53.53 dBm	
2-1	Trace A	68.2812 GHz	-5.40 dB	
3-1	Trace A	69.9001 GHz	-5.71 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

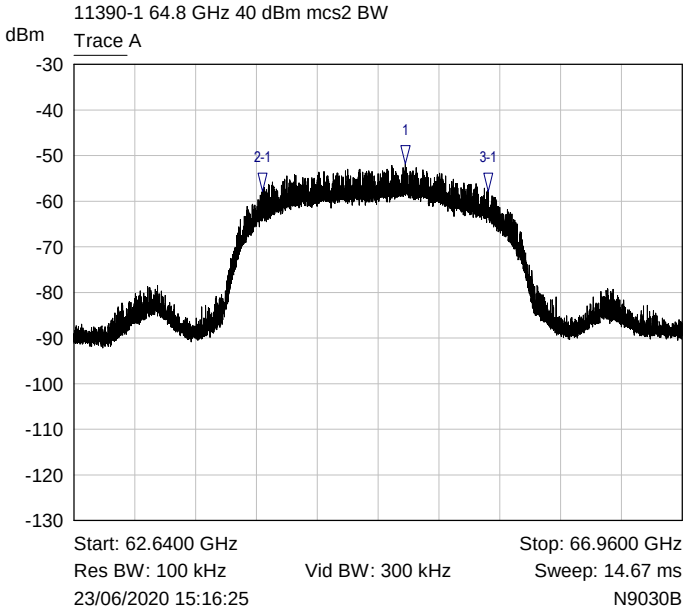
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs2, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.5159 GHz	-51.61 dBm	
2-1	Trace A	57.4777 GHz	-5.66 dB	
3-1	Trace A	59.1519 GHz	-5.85 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

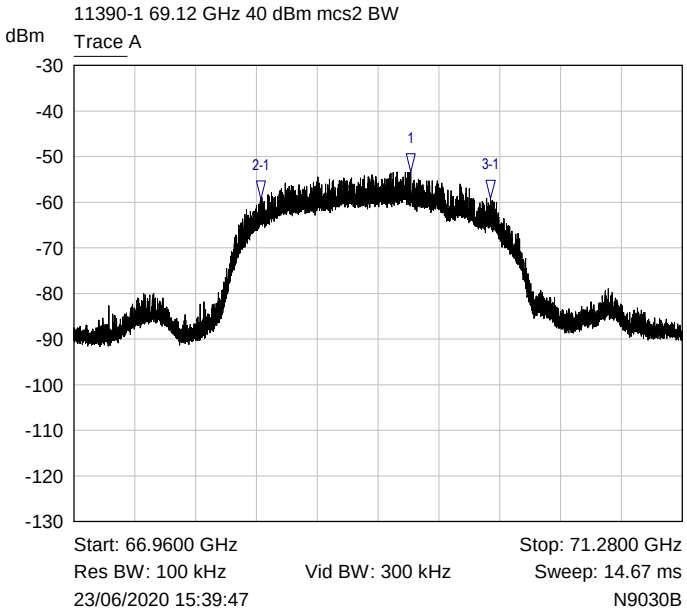
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs2, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.9959 GHz	-51.84 dBm	
2-1	Trace A	63.9785 GHz	-6.07 dB	
3-1	Trace A	65.5835 GHz	-5.95 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

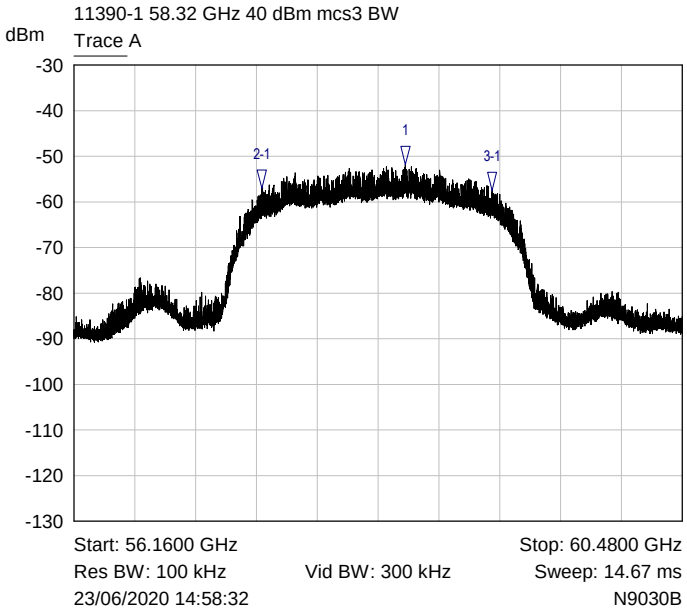
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs2, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.3540 GHz	-53.37 dBm	
2-1	Trace A	68.2877 GHz	-5.92 dB	
3-1	Trace A	69.9178 GHz	-5.85 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

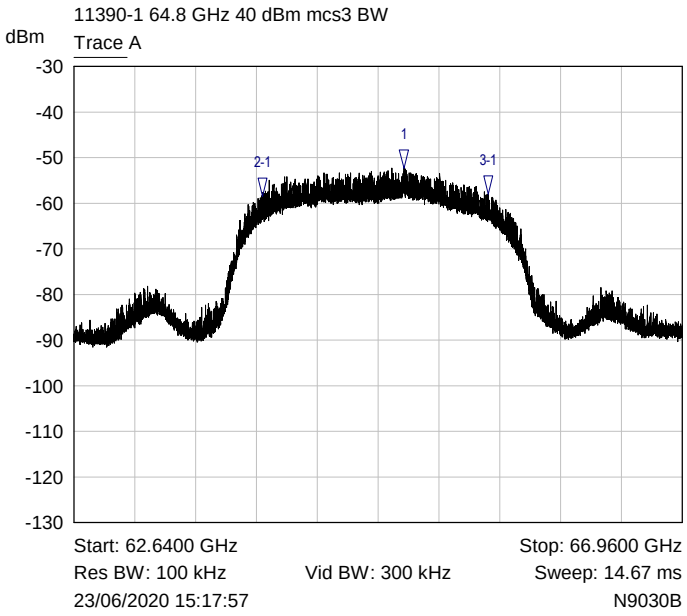
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs3, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.5159 GHz	-51.86 dBm	
2-1	Trace A	57.4954 GHz	-5.18 dB	
3-1	Trace A	59.1281 GHz	-5.72 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

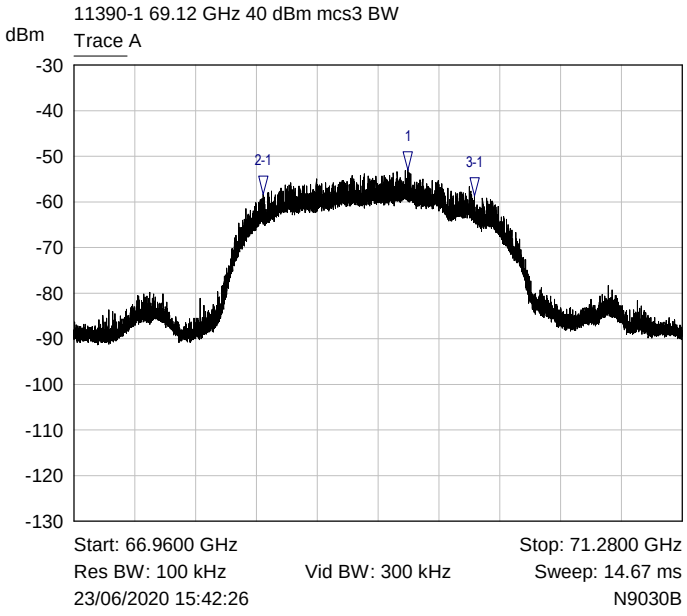
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs3, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.9856 GHz	-52.29 dBm	
2-1	Trace A	63.9785 GHz	-6.20 dB	
3-1	Trace A	65.5839 GHz	-5.76 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

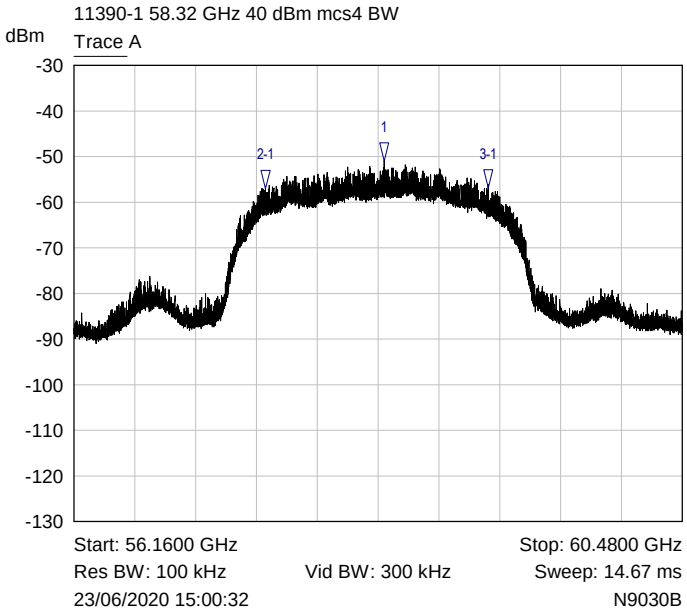
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs3, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.3298 GHz	-52.92 dBm	
2-1	Trace A	68.3054 GHz	-5.43 dB	
3-1	Trace A	69.8076 GHz	-5.79 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

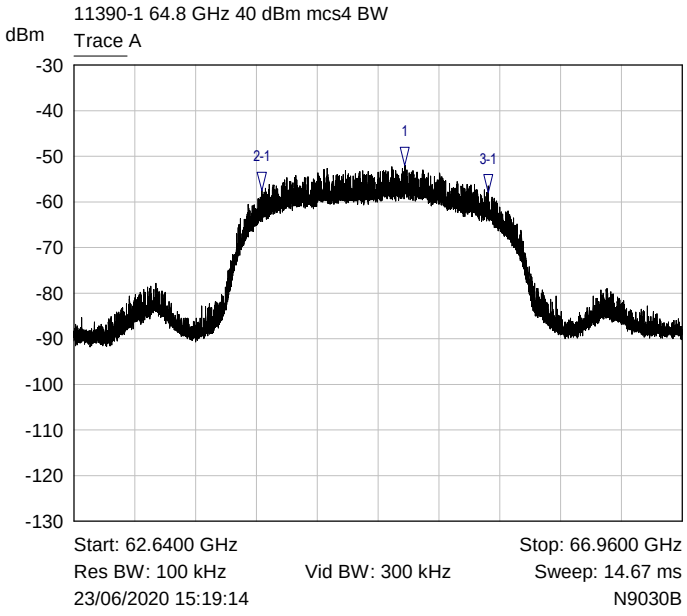
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs4, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.3617 GHz	-51.03 dBm	
2-1	Trace A	57.5222 GHz	-5.91 dB	
3-1	Trace A	59.1039 GHz	-5.78 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

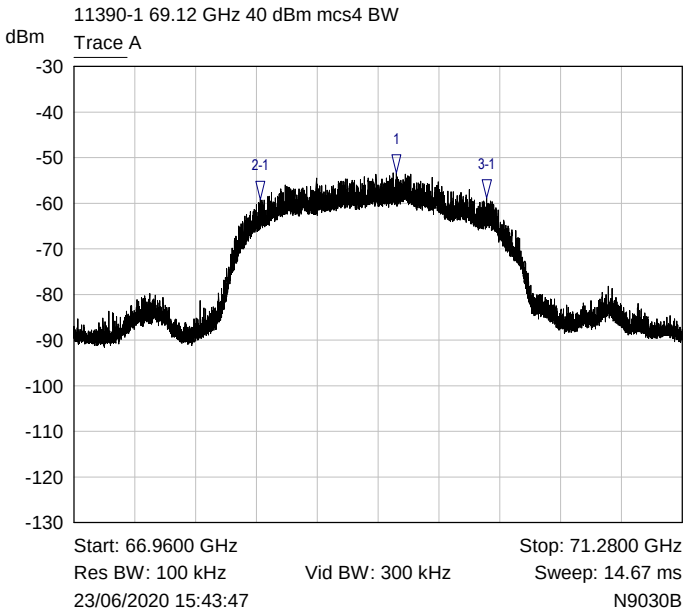
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs4, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.9895 GHz	-52.02 dBm	
2-1	Trace A	63.9750 GHz	-5.44 dB	
3-1	Trace A	65.5839 GHz	-5.94 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

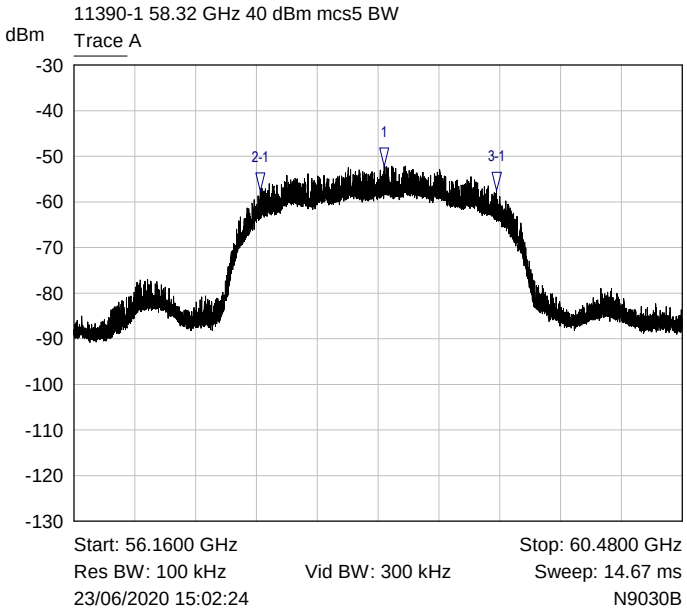
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs4, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.2503 GHz	-53.32 dBm	
2-1	Trace A	68.2842 GHz	-5.92 dB	
3-1	Trace A	69.8901 GHz	-5.44 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

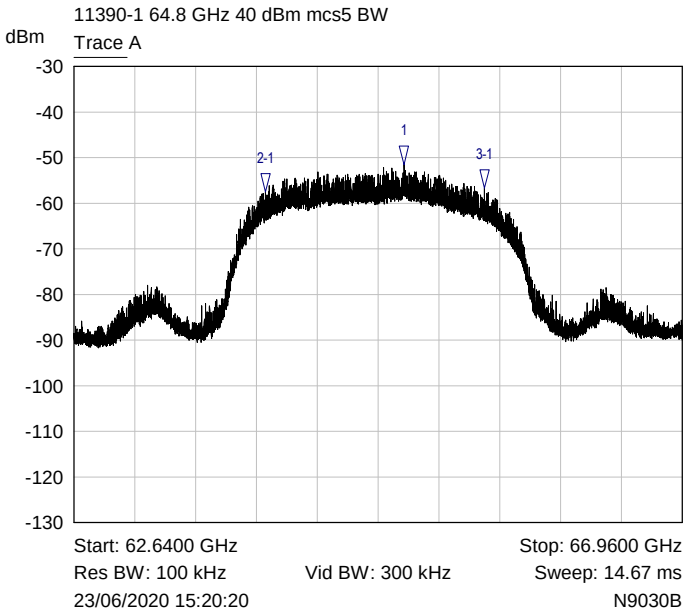
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs5, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.3617 GHz	-52.10 dBm	
2-1	Trace A	57.4851 GHz	-5.58 dB	
3-1	Trace A	59.1627 GHz	-5.41 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

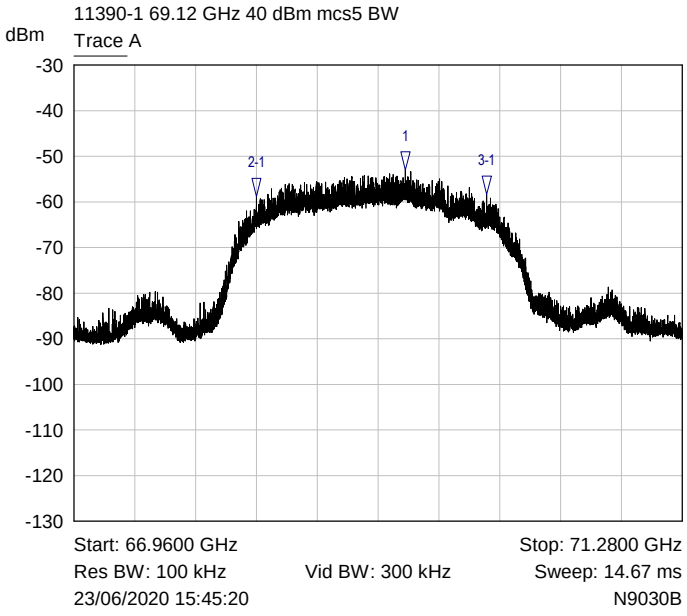
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs5, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.9856 GHz	-51.55 dBm	
2-1	Trace A	64.0027 GHz	-5.95 dB	
3-1	Trace A	65.5563 GHz	-5.10 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

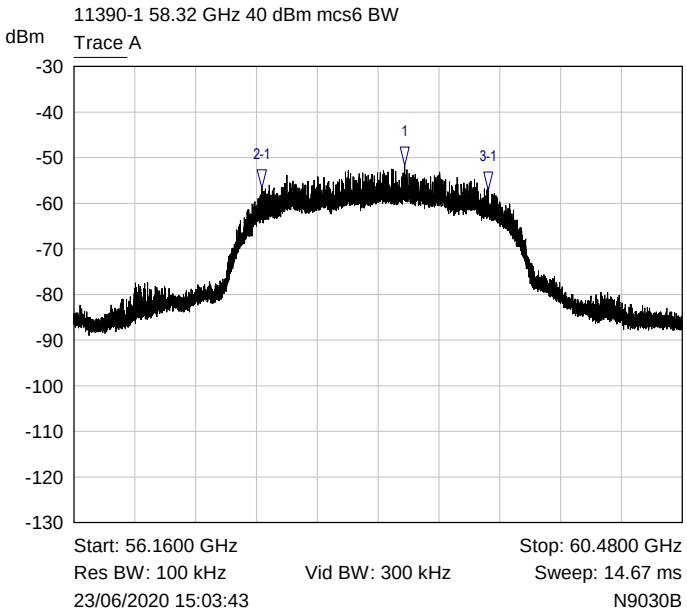
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs5, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.3129 GHz	-53.07 dBm	
2-1	Trace A	68.2540 GHz	-5.75 dB	
3-1	Trace A	69.8901 GHz	-5.34 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

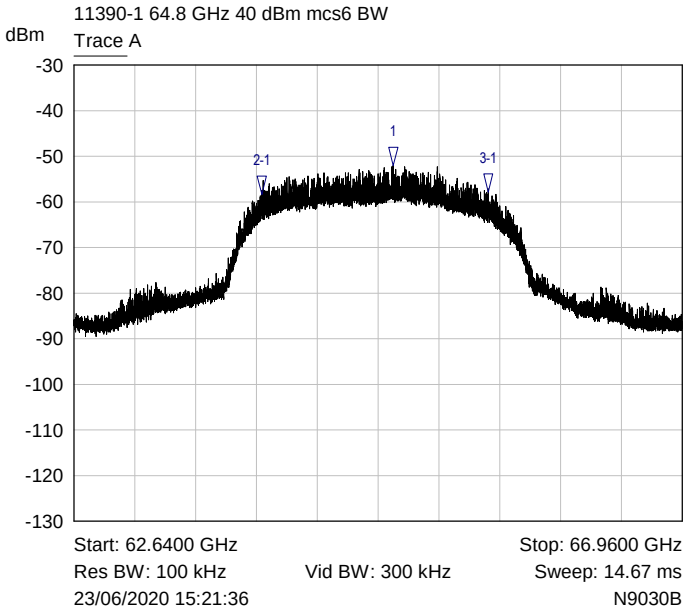
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs6, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.5095 GHz	-51.60 dBm	
2-1	Trace A	57.4954 GHz	-5.12 dB	
3-1	Trace A	59.1039 GHz	-5.51 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

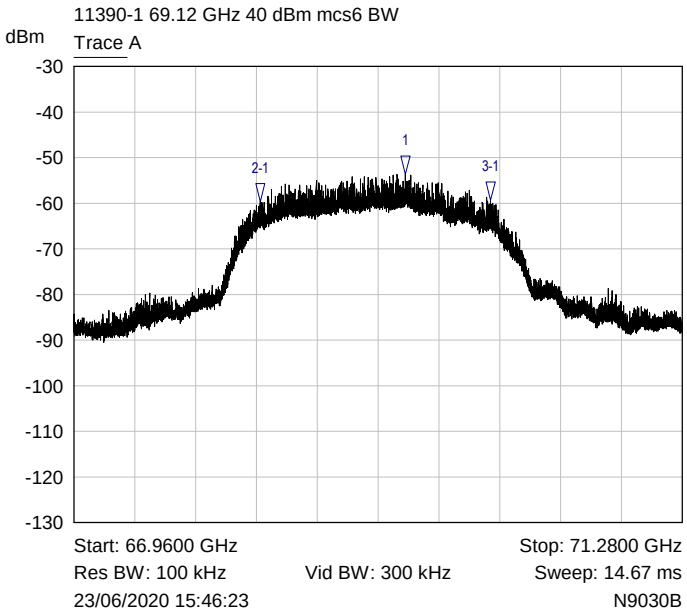
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs6, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.9069 GHz	-52.03 dBm	
2-1	Trace A	63.9750 GHz	-6.29 dB	
3-1	Trace A	65.5839 GHz	-5.87 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

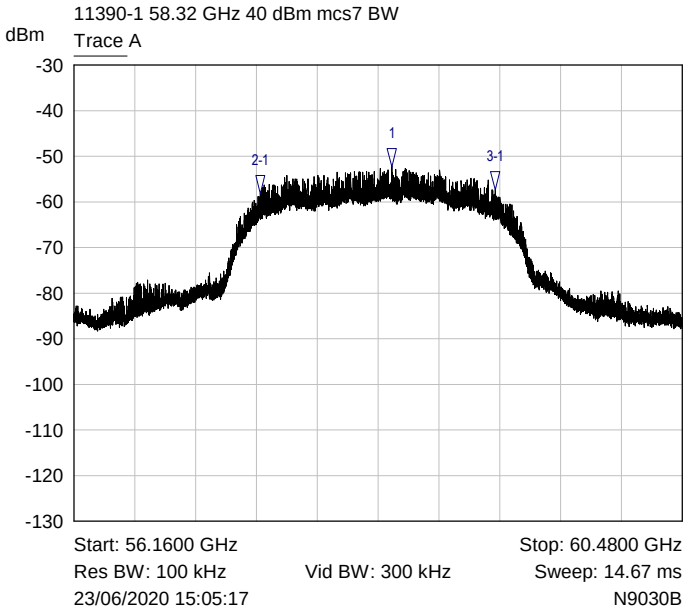
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs6, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.3125 GHz	-53.67 dBm	
2-1	Trace A	68.2808 GHz	-5.98 dB	
3-1	Trace A	69.9178 GHz	-5.63 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

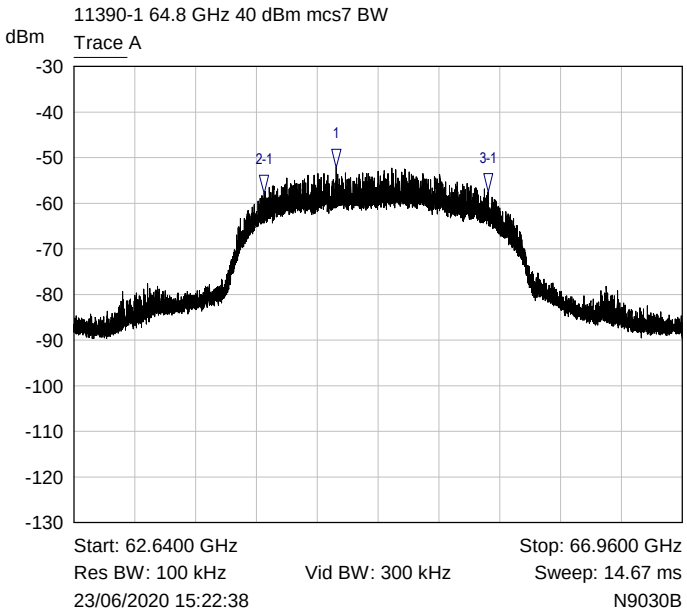
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs7, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.4161 GHz	-52.36 dBm	
2-1	Trace A	57.4812 GHz	-5.81 dB	
3-1	Trace A	59.1523 GHz	-4.91 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

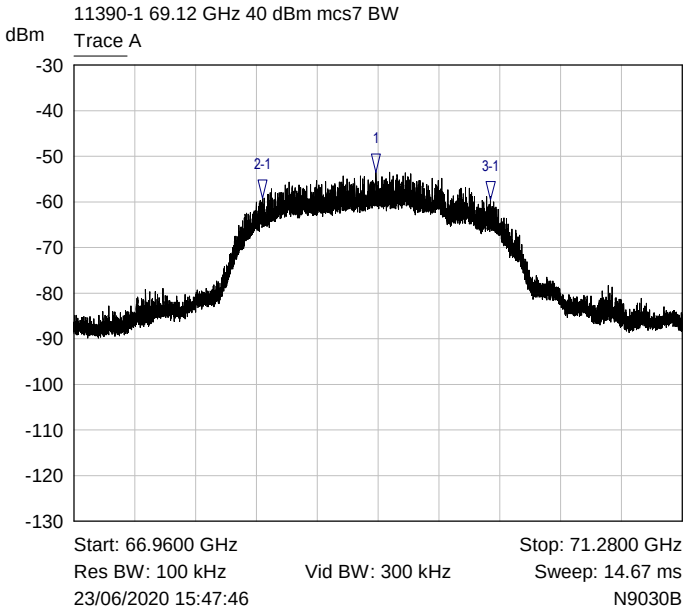
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs7, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.5047 GHz	-52.12 dBm	
2-1	Trace A	63.9888 GHz	-5.64 dB	
3-1	Trace A	65.5839 GHz	-5.41 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

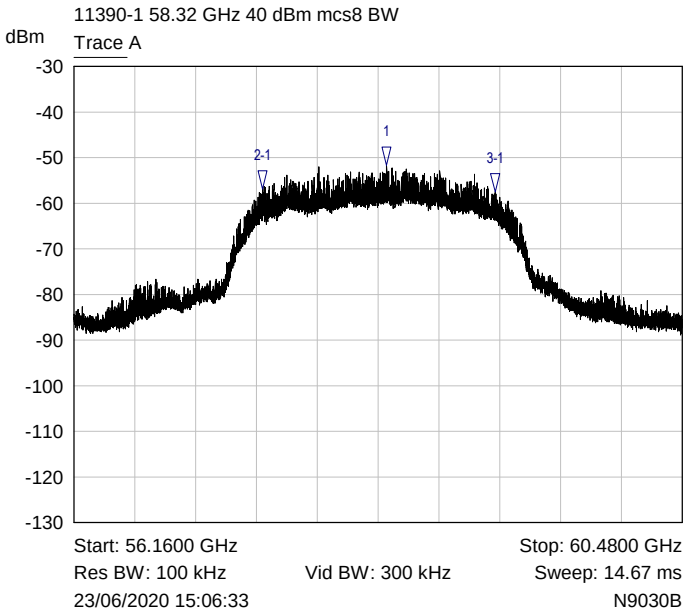
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs7, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.1064 GHz	-53.47 dBm	
2-1	Trace A	68.2980 GHz	-5.66 dB	
3-1	Trace A	69.9178 GHz	-6.11 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

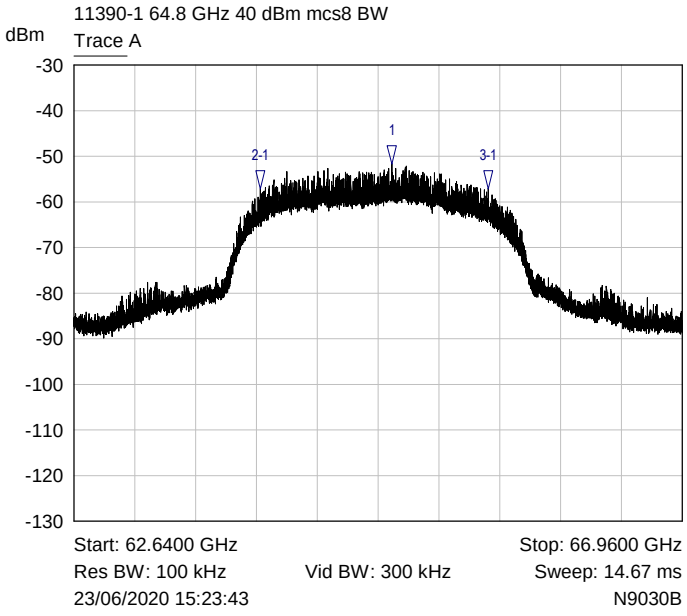
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs8, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.3820 GHz	-51.63 dBm	
2-1	Trace A	57.4989 GHz	-5.25 dB	
3-1	Trace A	59.1523 GHz	-5.92 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

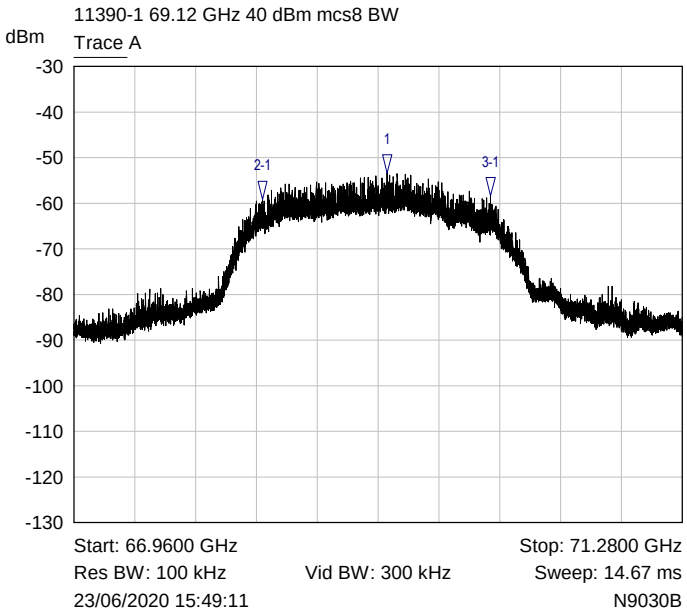
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs8, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.8961 GHz	-51.70 dBm	
2-1	Trace A	63.9616 GHz	-5.51 dB	
3-1	Trace A	65.5839 GHz	-5.39 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

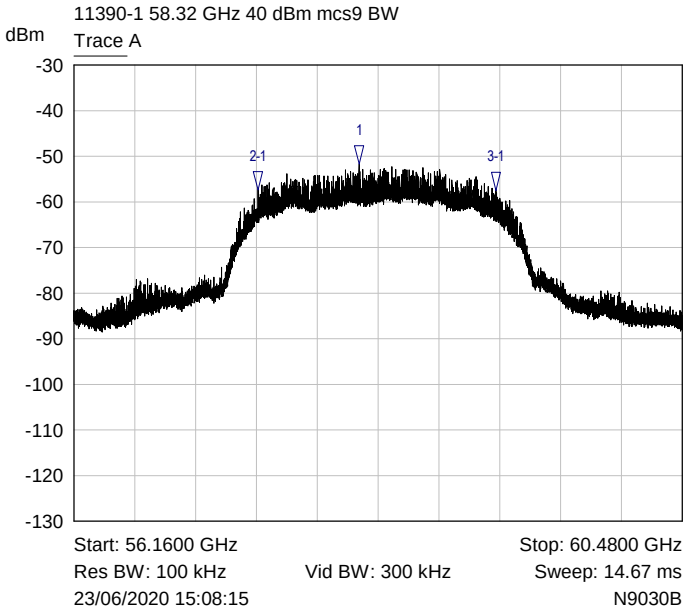
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs8, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.1850 GHz	-53.31 dBm	
2-1	Trace A	68.2980 GHz	-5.87 dB	
3-1	Trace A	69.9178 GHz	-5.07 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

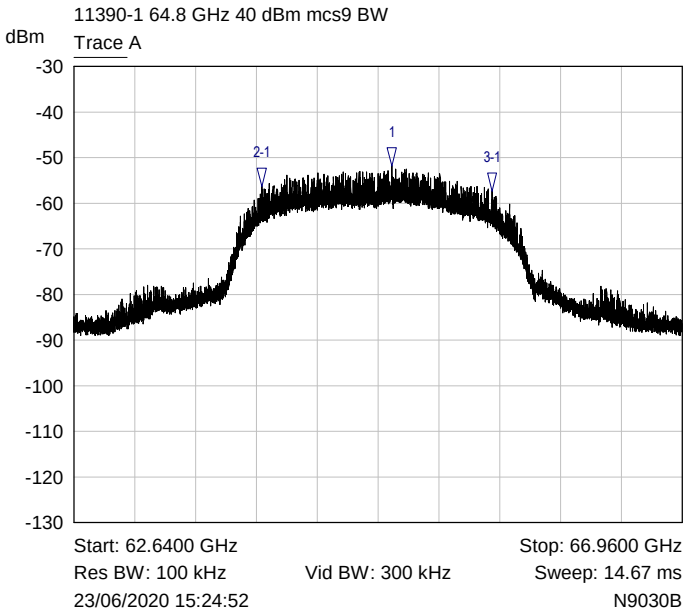
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs9, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.1824 GHz	-51.66 dBm	
2-1	Trace A	57.4678 GHz	-5.70 dB	
3-1	Trace A	59.1592 GHz	-5.83 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

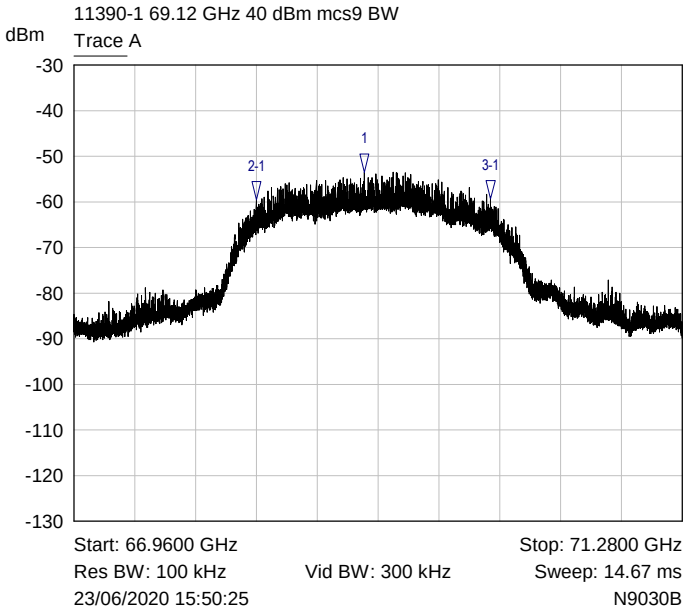
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs9, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.8961 GHz	-51.88 dBm	
2-1	Trace A	63.9720 GHz	-4.53 dB	
3-1	Trace A	65.6116 GHz	-5.45 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

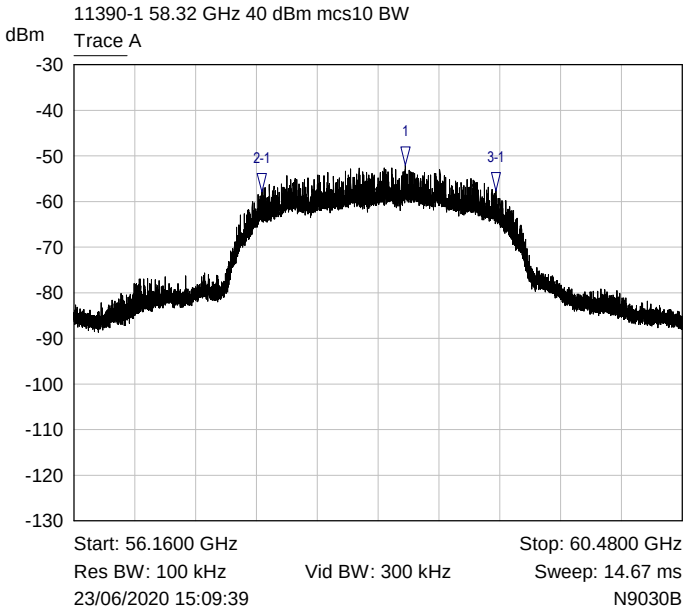
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs9, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.0239 GHz	-53.49 dBm	
2-1	Trace A	68.2540 GHz	-5.95 dB	
3-1	Trace A	69.9178 GHz	-5.87 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

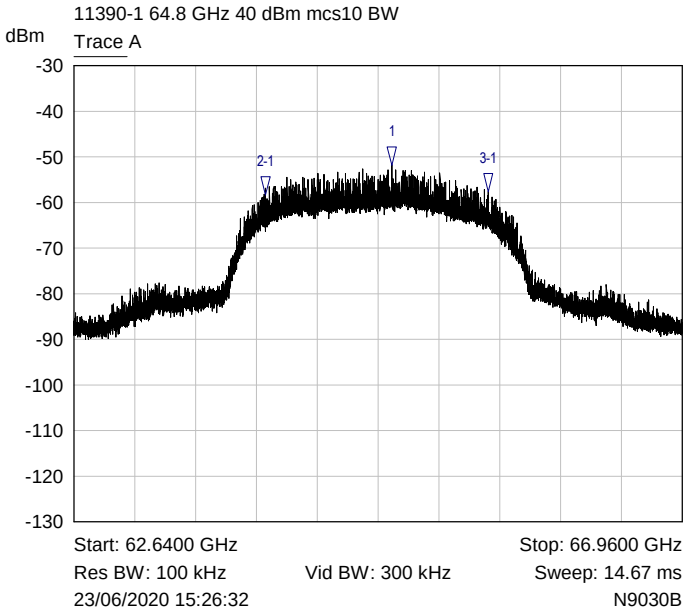
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs10, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.5129 GHz	-52.06 dBm	
2-1	Trace A	57.4954 GHz	-5.73 dB	
3-1	Trace A	59.1592 GHz	-5.65 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

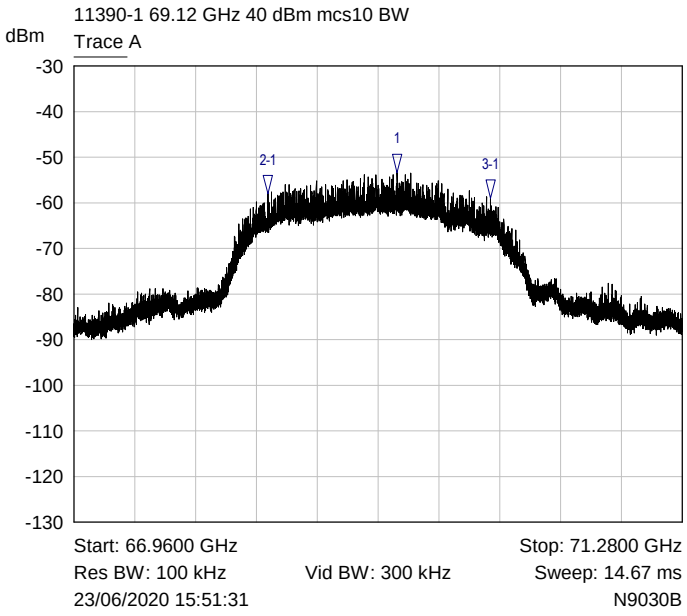
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs10, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.8961 GHz	-51.86 dBm	
2-1	Trace A	64.0022 GHz	-6.42 dB	
3-1	Trace A	65.5839 GHz	-5.87 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

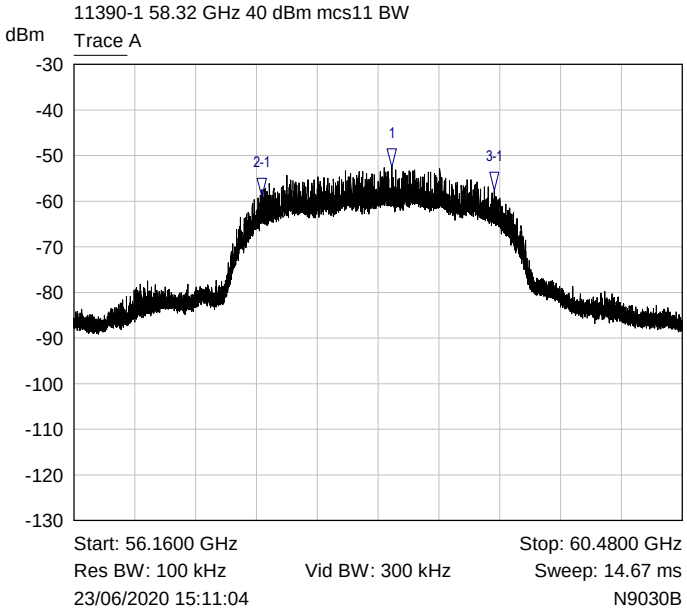
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs10, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.2576 GHz	-53.26 dBm	
2-1	Trace A	68.3361 GHz	-4.81 dB	
3-1	Trace A	69.9173 GHz	-5.74 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

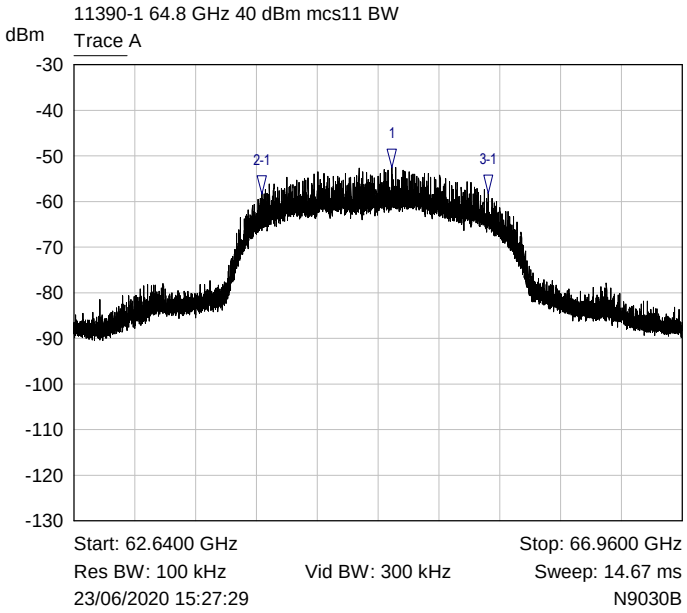
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs11, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.4161 GHz	-52.49 dBm	
2-1	Trace A	57.4950 GHz	-6.43 dB	
3-1	Trace A	59.1454 GHz	-5.16 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

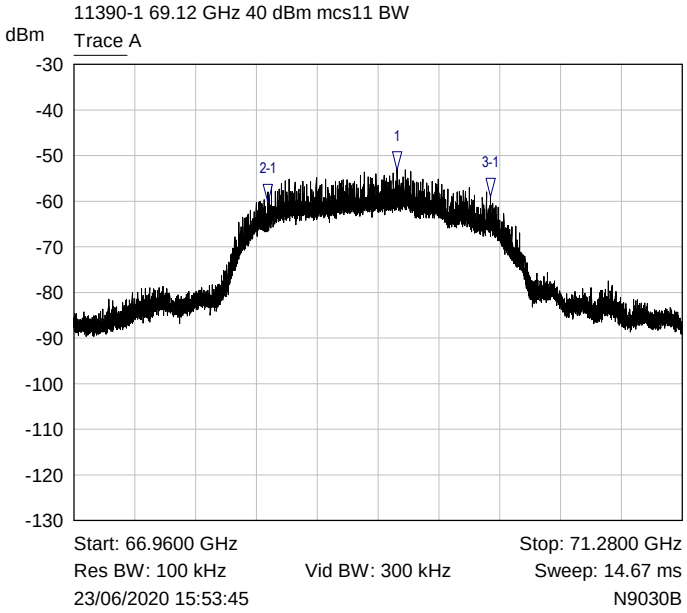
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs11, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.8961 GHz	-52.49 dBm	
2-1	Trace A	63.9750 GHz	-5.89 dB	
3-1	Trace A	65.5839 GHz	-5.63 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

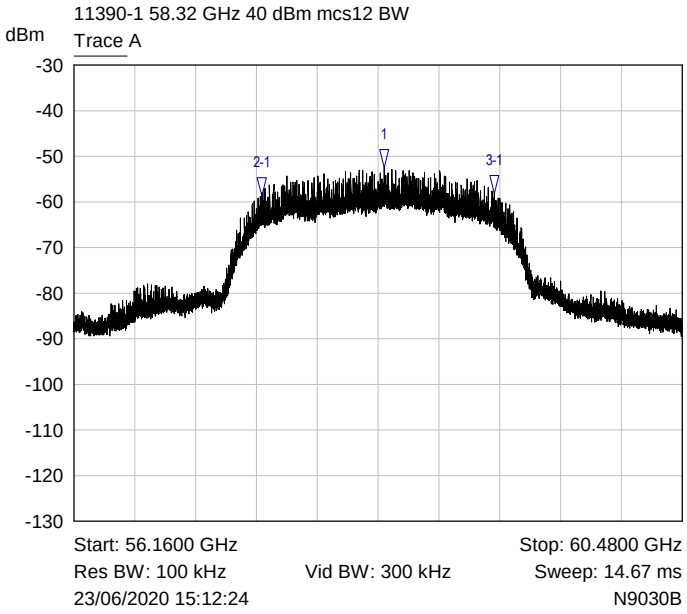
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs11, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.2576 GHz	-53.14 dBm	
2-1	Trace A	68.3356 GHz	-7.11 dB	
3-1	Trace A	69.9173 GHz	-5.90 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

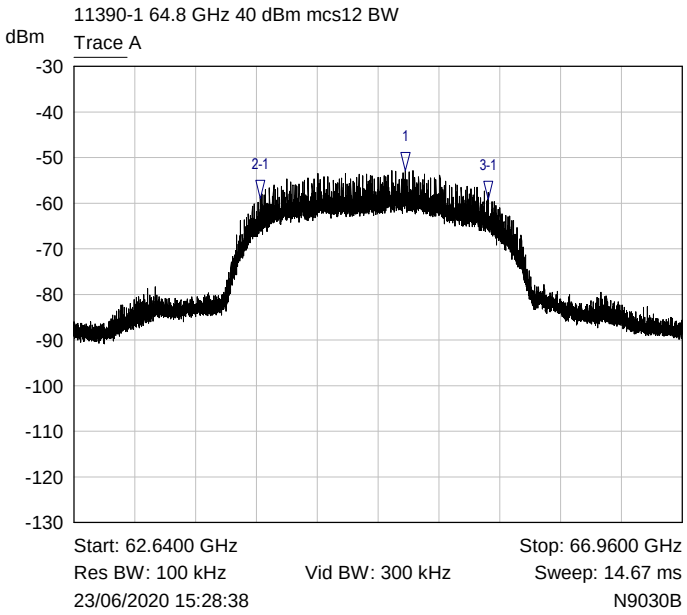
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs12, Channel 58.32 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	58.3617 GHz	-52.53 dBm	
2-1	Trace A	57.4950 GHz	-6.12 dB	
3-1	Trace A	59.1454 GHz	-5.63 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

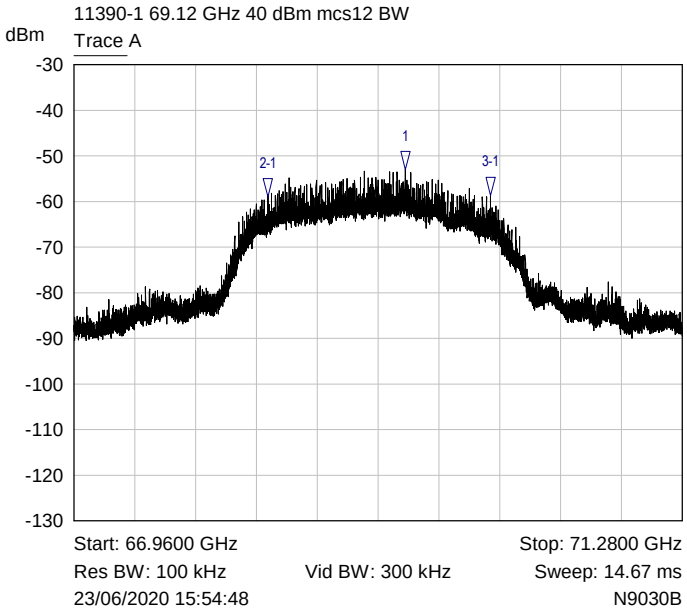
RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs12, Channel 64.8 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	64.9929 GHz	-52.80 dBm	
2-1	Trace A	63.9612 GHz	-6.12 dB	
3-1	Trace A	65.5844 GHz	-6.42 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

RF Parameters: Band 57-71 GHz, Power 40 dBm (EIRP), Channel Spacing 2.16 GHz, Modulation mcs12, Channel 69.12 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	69.3125 GHz	-52.93 dBm	
2-1	Trace A	68.3356 GHz	-6.10 dB	
3-1	Trace A	69.9173 GHz	-5.77 dB	

Plot for 6 dB Bandwidth (MHz) Nominal Temp & Volts

7 Explanatory Notes

7.1 Explanation of Table of Signals Measured

Measurements are made as required by the standard. These measurements are made and recorded using detectors, either peak, quasi peak or average dependant on the test. A table of results has been given following the relevant plots. This table looks similar to the one illustrated below dependant on the measurements required by the test: -

Signal No.	Freq (MHz)	Peak Amp (dBuV)	Pk – Lim 1 (dB)	QP Amp (dBuV)	QP - Lim1 (dB)	Av Amp (dBuV)	Av - Lim1 (dB)
1	12345	54.9	-10.5	48	-12.6	37.6	-14.4

Column One - Labelled Signal No. is an incremental number that the receiver has given to each signal that has been measured.

Column Two - Labelled Freq (MHz) is the approximate frequency of the signal received.

Column Three - Labelled Peak Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the peak detector.

Column Four - Labelled Pk - Lim1 (dB) is the difference in level from the peak signal given to the active limit line. If this column appears in the table the peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Five - Labelled QP Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the quasi-peak detector.

Column Six - Labelled QP - Lim1 (dB) is the difference in level from the quasi-peak signal given to the active limit line. If this column appears in the table the quasi-peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Seven - Labelled Av Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the average detector.

Column Eight - Labelled Av - Lim1 (dB) is the difference in level from the average signal given to the active limit line. If this column appears in the table the average detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Only signals highlighted in red are deemed to exceed the limit of the detector required.

7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in μV/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dBμV/m referenced to the measuring instrument inputs. RN Electronics calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

(a) limit of 500 μV/m equates to 20.log (500) = 54 dB μV/m.

(b) limit of 300 μV/m at 10m equates to 20.log (300 . 10/3) = 60 dB μV/m at 3m

(c) limit of 30 μV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBμV/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

The measurement receiver used for emissions testing, performs the field strength (FS) calculations automatically. The receiver combines the signal amplitude (RA), Antenna Factor (AF) and Cable Loss (CL) factors for the frequency to be measured.

Example calculation: - FS = RA + AF + CL.

Receiver amplitude (RA)	Antenna factor (3m) (AF)	Cable loss (CL)	Field strength result (3m) (FS)
20dBuV	25 dB	3 dB	48dBuV/m

Additional calculation examples per ANSI C63.10 clause 9.4 – 9.6 equations 21, 22, 25 & 26:

Equation 21: $E_{Linear} = 10^{((E_{log}-120)/20)}$
And therefore equation 21 transposed is: $E_{Log} = 20xLog(E_{Linear}) +120$
Where:
E_{Linear} is the field strength of the emission in V/m
E_{Log} is the field strength of the emissions in dBµV/m

Equation 22: $EIRP = E_{Meas} + 20log(d_{Meas}) -104.7$
Where:
EIRP is equivalent isotropically radiated power in dBm
E_{Meas} is the field strength of the emission at the measurement distance in dBµV/m
d_{Meas} is the measurement distance in metres

Equation 25: $PD = EIRP_{Linear} / 4\pi d^2$
And therefore equation 25 transposed is: $EIRP_{Linear} = PD \times 4\pi d^2$
Where:
PD is the power density at distance specified by the limit, in W/m^2
$EIRP_{Linear}$ is the equivalent isotropically radiated power in Watts
d is the distance at which the power density limit is specified in metres

Equation 26: $PD = E^2_{Speclimit} / 377$
And therefore equation 26 transposed is: $E_{Spec\ limit} = \sqrt{(PD \times 377)}$
Where:
PD is the power density at distance specified by the limit, in W/m^2
$E_{spec\ limit}$ is the field strength at the distance specified by the limit in V/m

Example:
Radiated spurious emissions limit at 3metres of $90pW/cm^2$.

$90pW/cm^2 \times 100^2 = 0.9\ \mu W/m^2$ = (EIRP Linear)

Equation 25 transposed: $0.9 \times 10^{-6} \times 4 \times \pi \times 3^2 = 0.0001017876$ W
And
Equation 26 transposed: $E_{Spec\ limit} = \sqrt{(0.9x10^{-6} \times 377)} = 0.01842$ V/m.
And
Equation 21 transposed: $E_{Log} = 20Log(0.01842) +120 = 85.3$dBµV/m @ 3m.

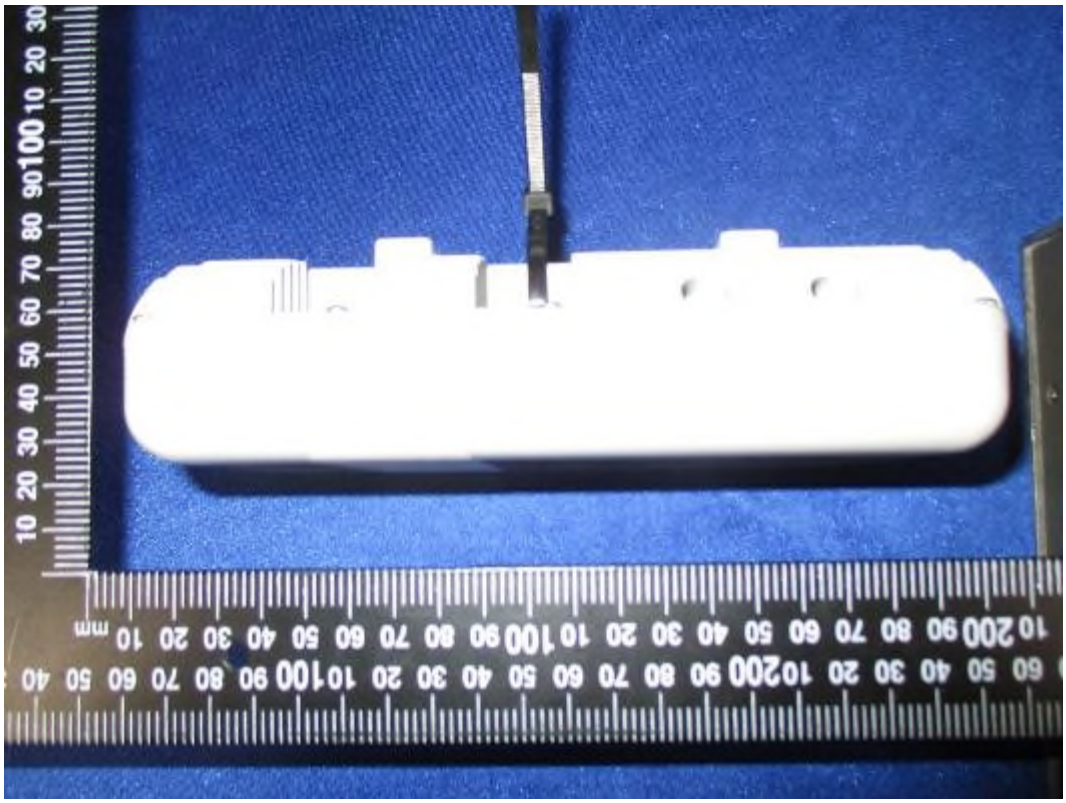
8 Photographs

8.1 EUT Front View

8.2 EUT Reverse Angle

8.3 EUT Left side View

8.4 EUT Right side View



8.5 EUT Antenna Port

Photos not included due to confidentiality of internal photos

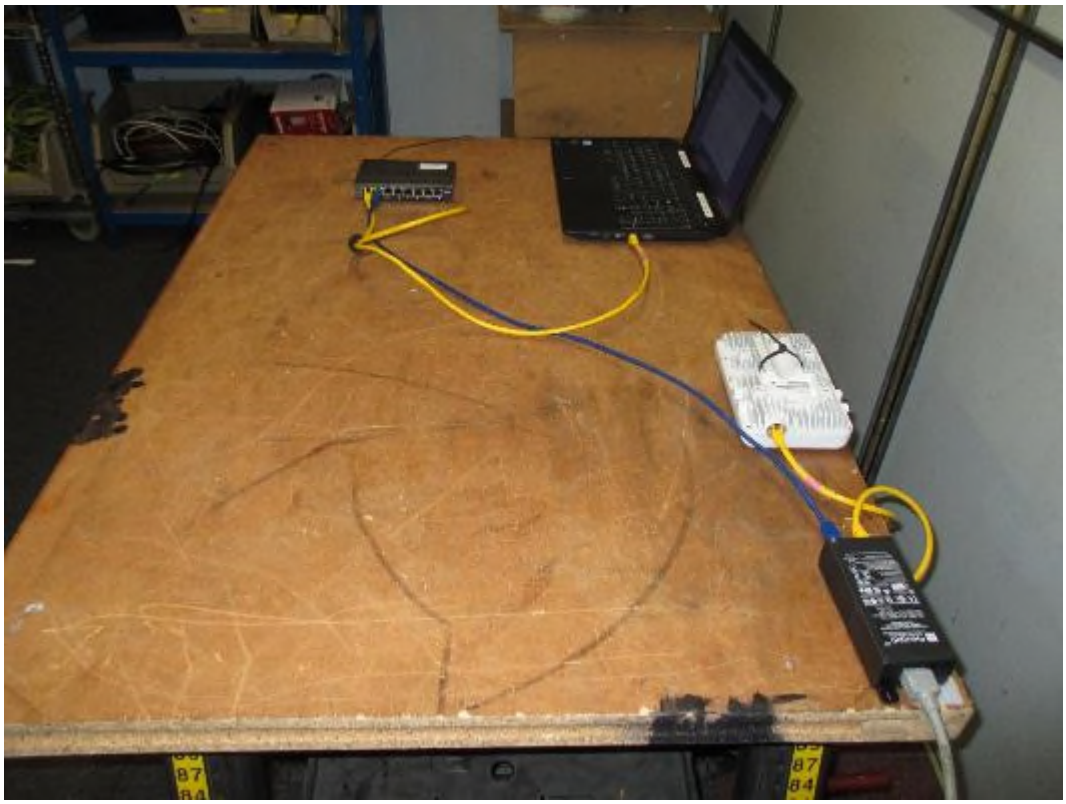
8.6 EUT Display & Controls

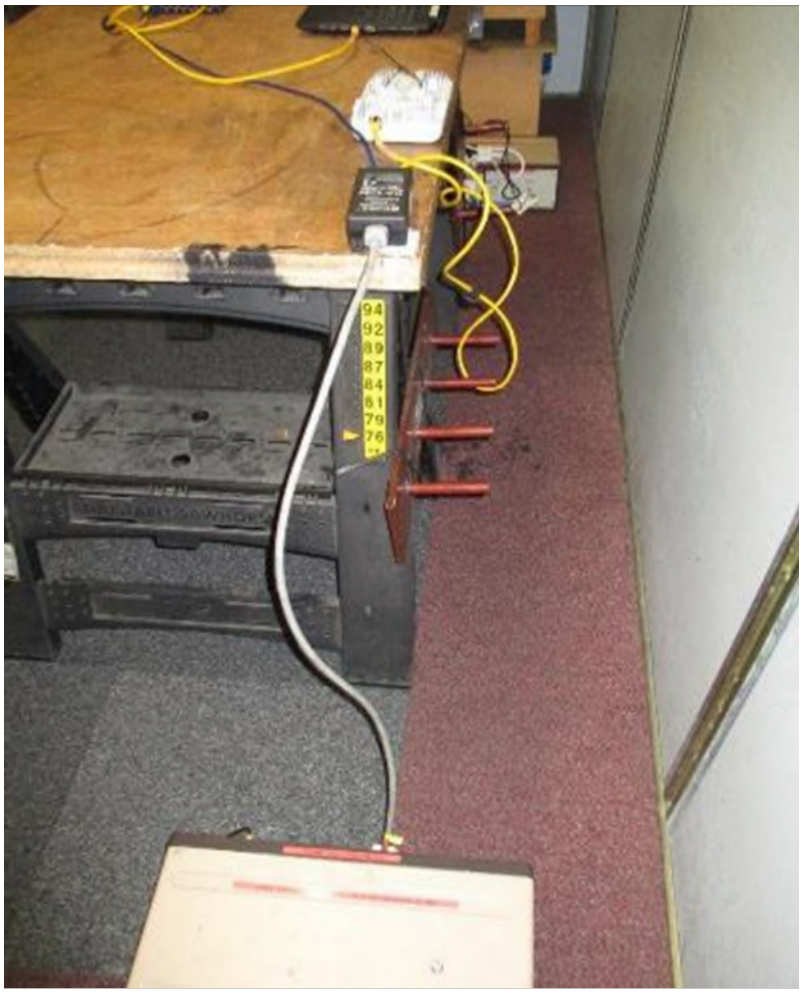
8.7 EUT Internal photos

Photos not included due to confidentiality of internal photos

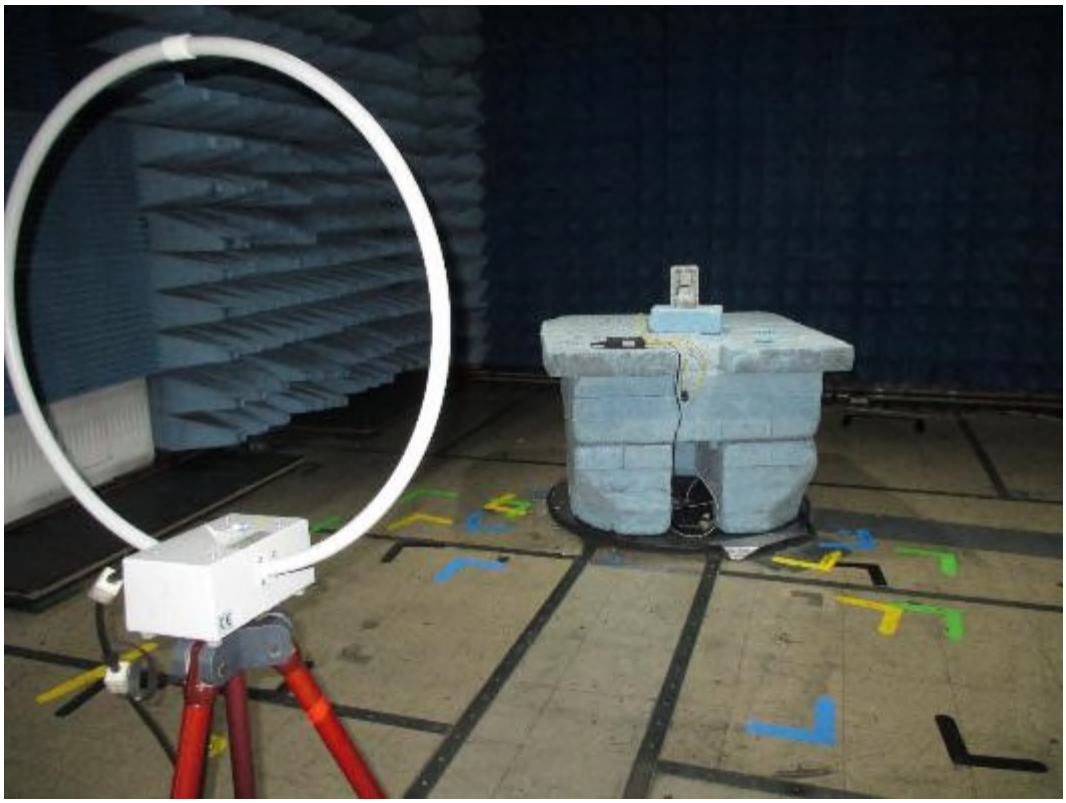
8.8 EUT ID Label

8.9 AC power line conducted emissions

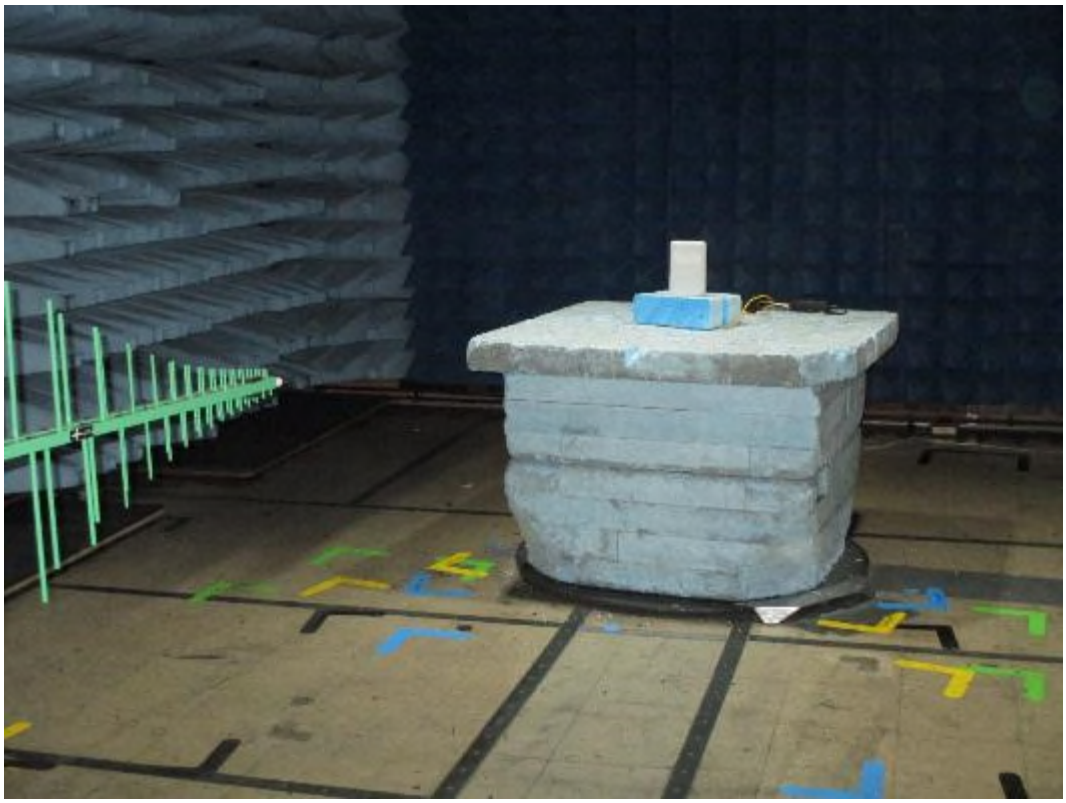




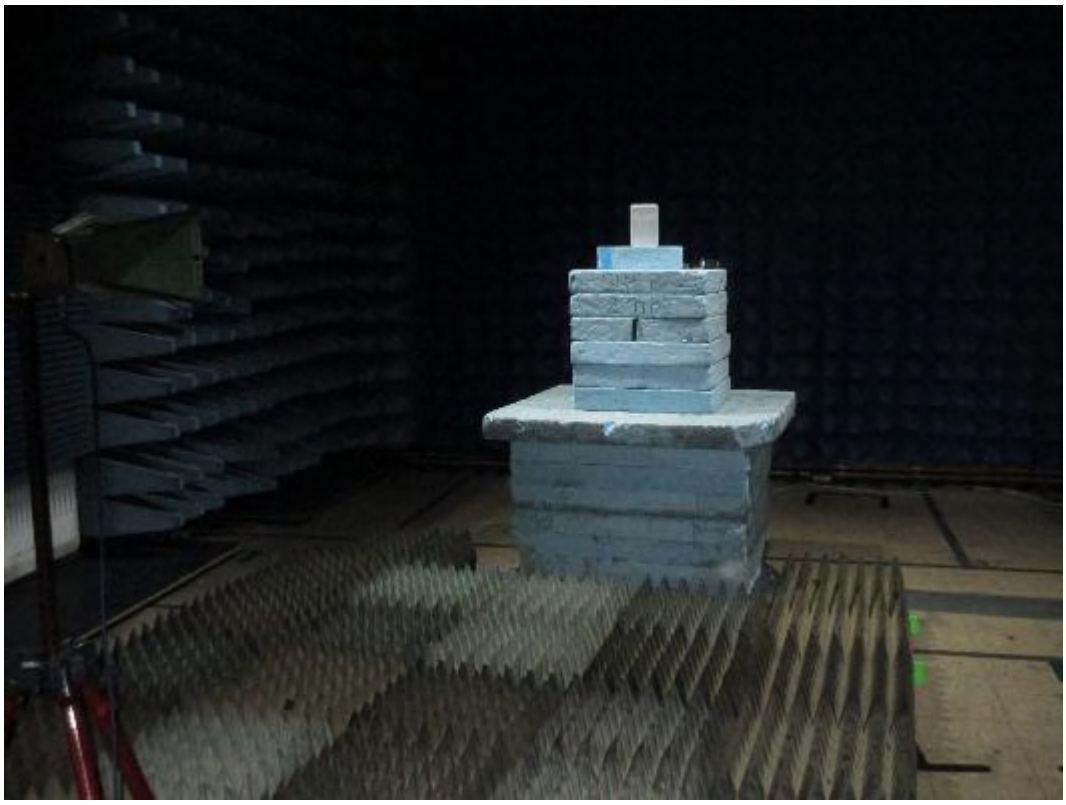
8.10 Radiated emissions 150 kHz - 30 MHz

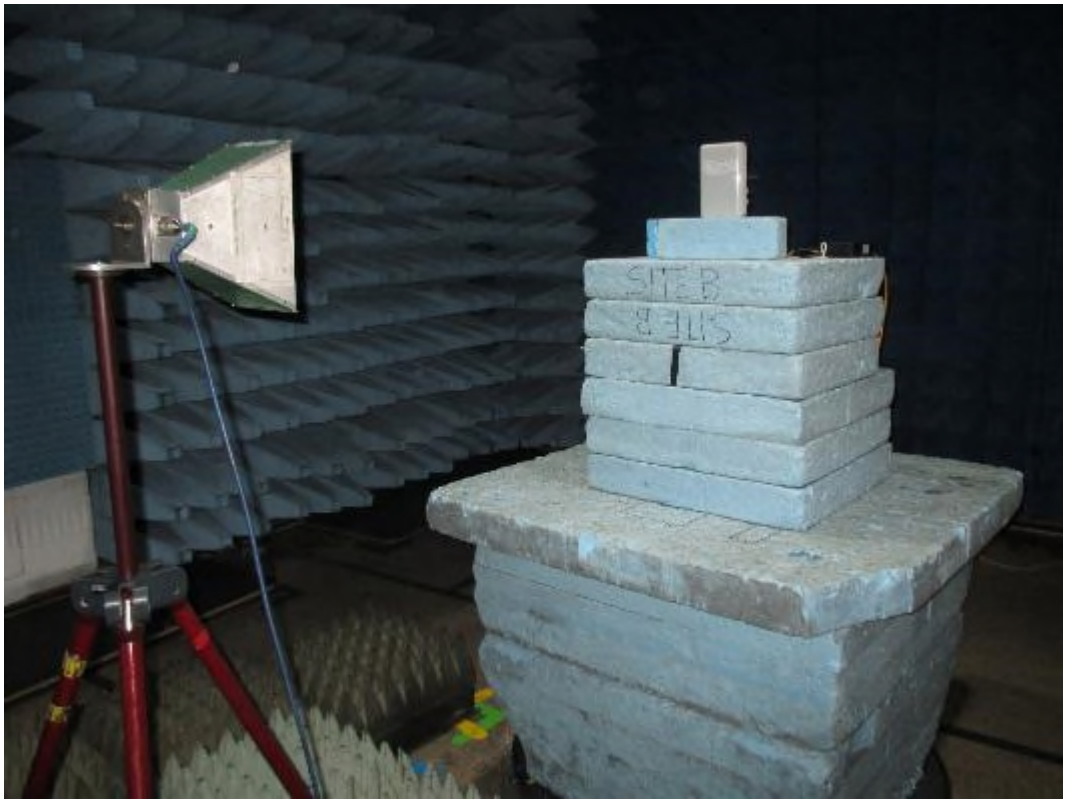


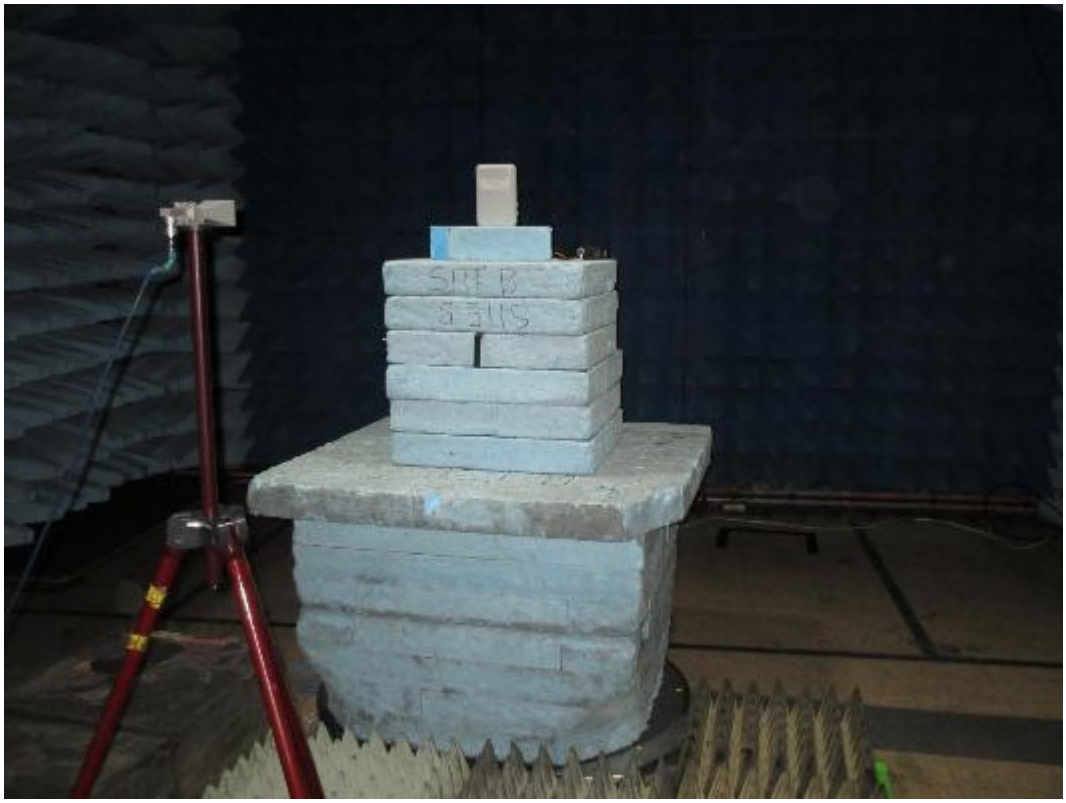
8.11 Radiated emissions 30 MHz -1 GHz



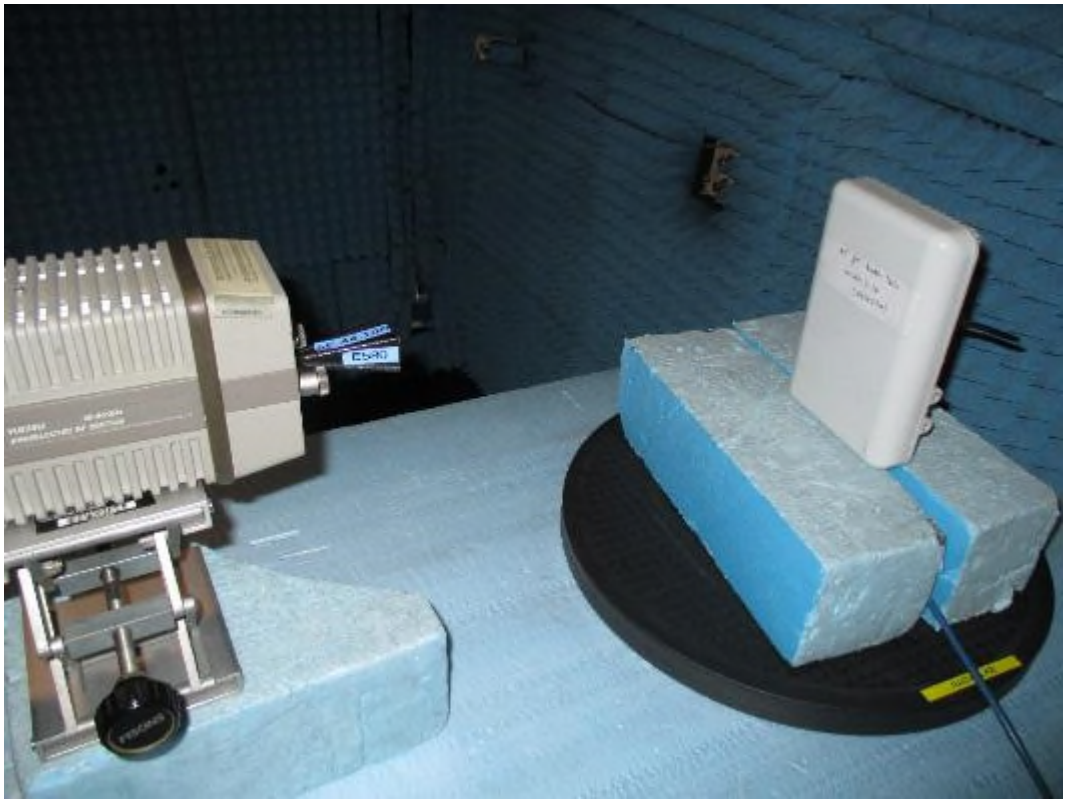
8.12 Radiated emissions above 1 GHz

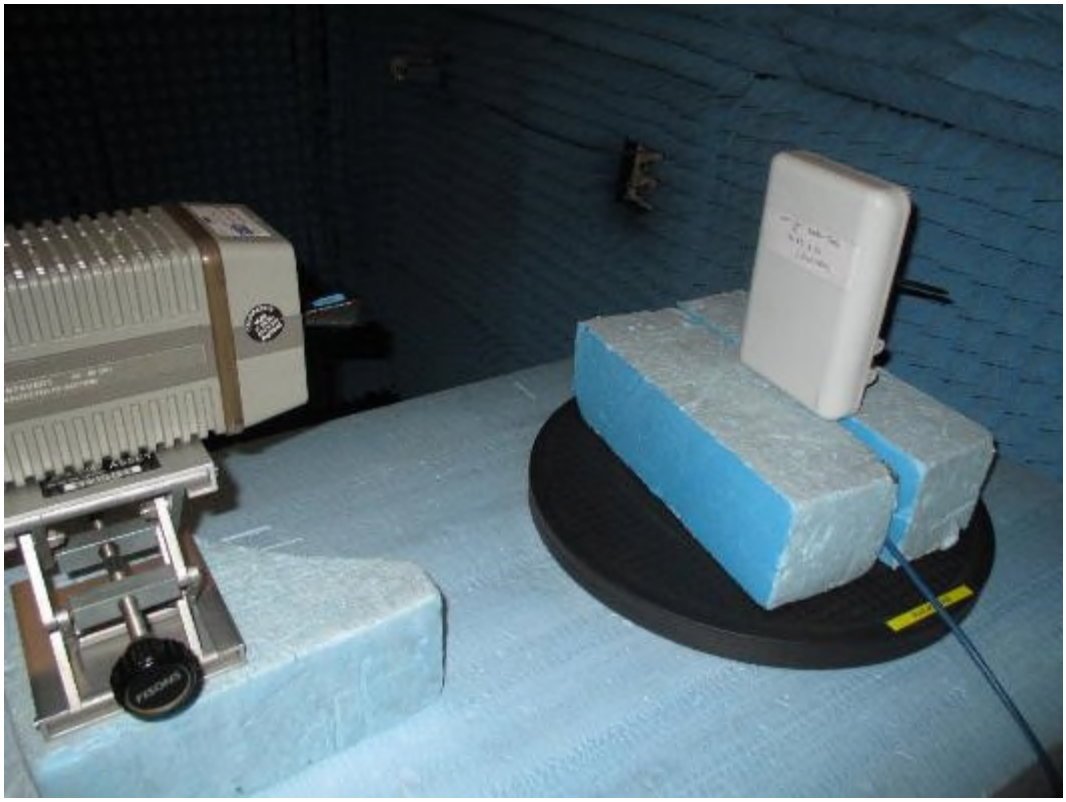





SITE B


SITE B





8.13 Radiated emission diagrams

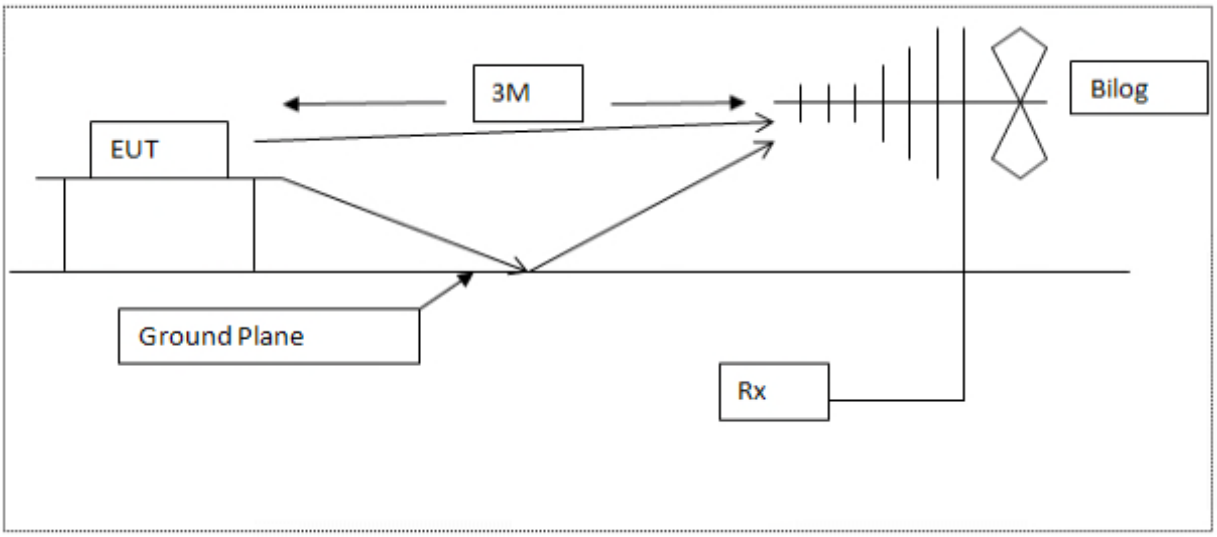


Diagram of the radiated emissions test setup 30 - 1000 MHz

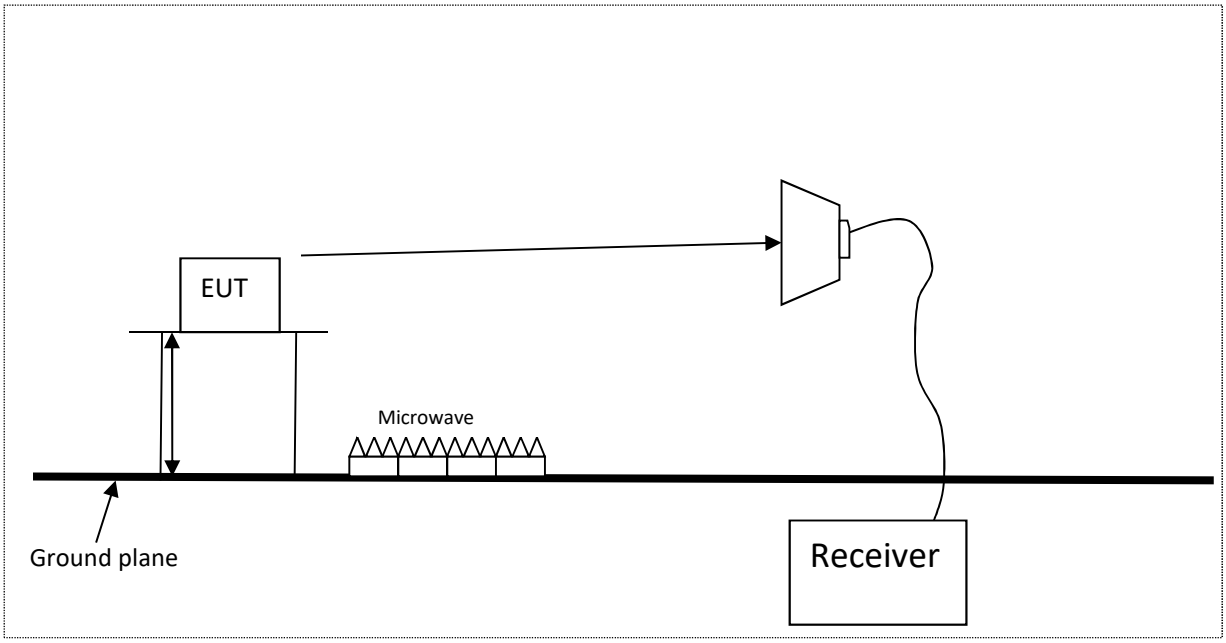


Diagram of the radiated emissions test setup above 1GHz

8.14 AC powerline conducted emission diagram

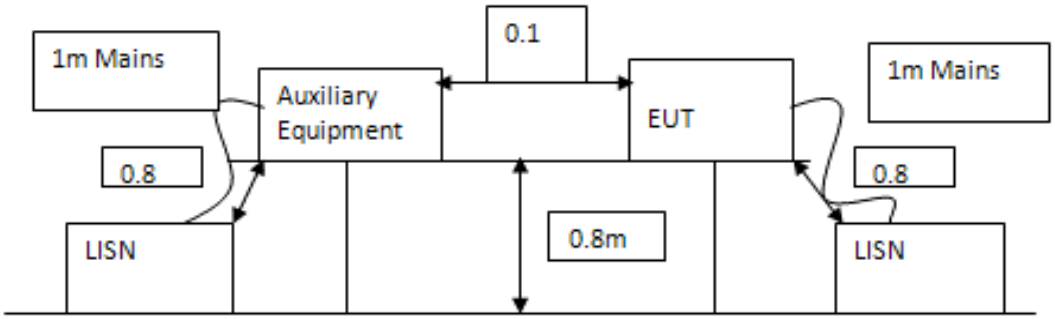


Diagram of the AC conducted emissions test setup

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
E035	11947A	Transient Limiter 9kHz - 200MHz	Hewlett Packard	16-Dec-2019	12 months
E136	3105	Horn Antenna 1-12.5GHz	EMCO	30-Apr-2020	12 months
E150	MN2050	LISN 13A	Chase	22-Apr-2020	12 months
E187	84534.01	Variac 0-290VAC, 4A, 50Hz	Marconi Instruments	N/A	N/A
E296-2	11970A	Harmonic Mixer 26.5-40GHz	Hewlett Packard	02-Jan-2020	12 months
E296-6	11970W	Harmonic Mixer 75-110GHz WR10	Hewlett Packard	08-Dec-2017	36 months
E330	2224-20	Horn Antenna 26.5-40GHz	Flann (FMI)	28-Apr-2020	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	#11-Jul-2020	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	#30-Jun-2020	24 months
E434	G3RUH	10MHz GPS Disciplined Oscillator	G3RUH - James Miller	03-Mar-2020	6 months
E465	PCR2000LA	AC Power Source 2kVA	Kikusui	15-Jul-2019	12 months
E485	11974-60028	Preselector PSU	Agilent Technologies	13-Mar-2020	12 months
E487	11974U	Preselect Mixer 40 - 60GHz	Agilent Technologies	12-Sep-2018	24 months
E503	2524-20	Horn Antenna 50-75GHz	Flann (FMI)	28-Apr-2020	12 months
E577	2511	Attenuator 50-76GHz Rotary	Flann (FMI)	14-Apr-2020	12 months
E579	27240	Horn Std Gain 75GHz - 110GHz	Flann (FMI)	28-Apr-2020	12 months
E580	24240	Horn Std Gain 40GHz - 60GHz	Flann (FMI)	28-Apr-2020	12 months
E599	ML4803A	Power Meter	Anritsu	03-Sep-2019	12 months
E600	MA4002B, MP716A4	Power Sensor 50GHz - 75GHz Waveguide	Anritsu	03-Sep-2019	12 months
E602	MG3692A	Signal Generator 10MHz - 20GHz	Anritsu	04-Feb-2019	24 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	07-Mar-2020	24 months
E627	DSO5052A	Oscilloscope 500MHz 2CH 4GSa/s	Agilent Technologies	#29-Jun-2020	12 months
E638	11974VE01	Preselected Mixer 50 - 80GHz	Agilent Technologies	21-Feb-2019	24 months
E714	PM 140_3_1	Frequency Tripler 110-170GHz	Teratech Components Ltd	17-Feb-2020	36 months
E717		Horn Std Gain 50-75GHz		28-Apr-2020	12 months
E720	28240	Horn Std Gain 90-140GHz	Flann (FMI)	#24-Jun-2020	12 months
E722	861G/387	Horn Std Gain 140-220GHz	Alpha Industries Inc	#20-Jul-2020	12 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	07-Feb-2020	12 months
E755	N9030B	PXA 3Hz to 50GHz	Keysight Technologies	14-May-2020	12 months
E760	M05HWDX	Mixer 140-220GHz	OML Inc	25-Jun-2019	24 months
E771	861G/387	Horn Std Gain 140-220GHz WR5	Alpha	28-Apr-2020	12 months
E777	MG3695B	Signal Generator 8MHz - 50GHz	Anritsu	19-Jun-2020	12 months
E781	MX4-15-F	Multiplier 50 - 75GHz X4 WR15	MMWave Group (Quantum)	10-Sep-2019	12 months
E851	47324H-1211	Detector Broadband 50-75GHz	Millitech	#10-Jun-2020	24 months
E852	LPF10	Filter 10MHz Low Pass	G4HUP	17-Mar-2020	12 months
E908	00365-60004	Isolator 50-75GHz WR15	Hewlett Packard	#23-Jun-2020	24 months
E920	FTL 6541	Mixer 60 - 90GHz	Farran Technology	14-Dec-2019	12 months
E941	M08HWDX	Mixer 90-140GHz	OML Inc	08-Jul-2019	24 months
E942	-	Cable SMA - SMA ~1m Blue	OML Inc	08-Jul-2019	24 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	07-Mar-2020	24 months
N579	71043	Frequency Standard Distribution	-	26-Nov-2019	12 months
NSA-M	NSA - M	NSA - Site M	RN Electronics	09-Jan-2019	36 months
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	N/A	N/A
TMS57	PM2534	Digital Multimeter	Philips	20-Mar-2019	24 months
TMS78	3160-08	Horn Std Gain 12.4-18 GHz	ETS Systems	#25-Aug-2020	12 months
TMS79	3160-09	Horn Std Gain 18-26.5 GHz	ETS Systems	#25-Aug-2020	12 months
TMS80	206-3722	Digital Thermometer & K Probe	RS Components Ltd	20-Nov-2019	12 months
TMS81	6502	Antenna Active Loop	EMCO	24-Jun-2019	24 months

TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	18-Dec-2019	12 months
TMS937	CCN1000	Mains Flicker	Schaffner	08-Aug-2018	24 months
TMS938	NSG1007	AC Power Source 3kVA	Schaffner	08-Aug-2018	24 months
ZSW1	V2.4	Measurement Software Suite	RN Electronics	Not Applicable	

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

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	POE29U-1AT(PL)	56 V DC PoE	Phihong	P193903153A2
2	GS108E	Gigabit network switch	Netgear	2LM1223P515FE
3	Satellite Pro	Laptop and psu	Toshiba	CCSLT71-RFLab02

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
P276	D30 4	PSU 30V 4A	Farnell power supply	179

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 Laboratory and Anechoic Chamber

Site B Semi-Anechoic Chamber and Control Room
FCC Registration No. 293246, IC Registration No. 5612A-4

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)

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 Transient Laboratory

Site K Screened Room (Control Room for Site M)

Site M 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 293246, IC Registration No. 5612A-3

Site N Radio Laboratory

Site Q Fully-Anechoic Chamber

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

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

RN Electronics CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002
RN Electronics CAB identifier as issued by FCC is UK0015

13 Abbreviations and units

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