EMI – TEST REPORT

- FCC Part 15.255, RSS210 -

Type / Model Name	:	BSW200200 Series
Product Description	:	FMCW radar
Applicant	:	Symeo GmbH
Address	:	Professor-Messerschmitt-Straße 3
		85579 NEUBIBERG, GERMANY
Manufacturer	:	Symeo GmbH
Address	:	Professor-Messerschmitt-Straße 3
		85579 NEUBIBERG, GERMANY
Licence holder	:	Symeo GmbH
Address	:	Professor-Messerschmitt-Straße 3
		85579 NEUBIBERG, GERMANY

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Test Report No. : T43516-00-02HS	25. January 2019 Date of issue

Deutsche Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2018)

Part 15, Subpart A, Section 15.31	Measurement standards

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September, 2018)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.255	Operation within the band 57-71 GHz.
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
ETSI TR 100 028 V1.3.1: 2001-03	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2

2 EQUIPMENT UNDER TEST

2.1 Photo documentation of the EUT – Detailed photos see attachment A

2.2 Equipment category

The EUT is a distance measurement system.

2.3 Short description of the equipment under test (EUT)

The EUT is a distance measurement system with frequency emissions in customer settable ranges the operating band of 57.5 GHz to 63.5 GHz.

Number of tested samples: 1
Serial number: D44AH40023
Firmware ID: V0.10.0

EUT configuration:
(The CDF filled by the applicant can be viewed at the test laboratory.)

2.4 Variants of the EUT

There are the following variants of the EUT:

Device type	Software functionality		
	Primary radar	Secondary radar	Debugging
BSW200200	x	x	x
BSW200220	x	-	-
BSW200240	-	x	-
BSW200260	-	x	-
BSW200281	-	x	-
BSW200290	x	x	-

2.5 Operation frequency and channel plan

The operating frequency is 57.0 GHz to 64.0 GHz.

Channel block	Bandwidth mode	Frequency range (GHz)	Guard (MHz)	Channel number
0	R&D	57.0 - 64.0	-	0 - 199
1	0.5 GHz	57.0 - 57.5	10	200 - 299
2	0.5 GHz	57.5 - 58.0	10	300 - 399
3	0.5 GHz	58.0 - 58.5	10	400 - 499
4	0.5 GHz	58.5 - 59.0	10	500 - 599
5	0.5 GHz	59.0 - 59.5	10	600 - 699
6	0.5 GHz	59.5 - 60.0	10	700 - 799
7	0.5 GHz	60.0 - 60.5	10	800 - 899
8	0.5 GHz	60.5 - 61.0	10	900 - 999
9	0.5 GHz	61.0 - 61.5	10	1000 - 1099
10	0.5 GHz	61.5 - 62.0	10	1100 - 1199
11	0.5 GHz	62.0 - 62.5	10	1200 - 1299
12	0.5 GHz	62.5 - 63.0	10	1300 - 1399
13	0.5 GHz	63.0 - 63.5	10	1400 - 1499
14	0.5 GHz	63.5 - 64.0	10	1500 - 1599
15	1 GHz	57.5 - 58.5	10	1600 - 1799
16	1 GHz	58.5 - 59.5	10	1800 - 1999
17	1 GHz	59.5 - 60.5	10	2000 - 2199
18	1 GHz	60.5 - 59.5	10	2200 - 2399
19	1 GHz	61.5 - 62.5	10	2400 - 2599
20	1 GHz	62.5 - 63.5	10	2600 - 2799
21	2 GHz	57.5 - 59.5	10	2800 - 3199
22	2 GHz	59.5 - 61.5	10	3200 - 3599
23	2 GHz	61.5 - 63.5	10	3600 - 3999
24	3 GHz	57.5 - 60.5	20	4000 - 4399
25	3 GHz	60.5 - 63.5	20	4400 - 4799
26	4 GHz	59.5 - 63.5	20	4800 - 5199
27	5 GHz	58.5 - 63.5	40	5200 - 5599
28	6 GHz	57.5 - 63.5	40	5600 - 5999
29	7 GHz	57.0 - 64.0	40	6000 - 6399

Note. The marked frequencies are disabled ba firmware.

2.6 Transmit operating modes

As soon as the equipment is powered on, TX starts operating independent of a possible connected PC in last operation mode was set before the devices switched off.

Two operation modes are available:
Stand alone:
Primary radar 0.5, 1, 2, 3, 4, 5, 6 GHz OBW
Secondary radar 0.5, 1, 2, 3, 4, 5, 6 GHz OBW
Co-located:
Primary radar 0.5, 1, 2, 3, 4, 5, 6 GHz OBW

2.7 Antenna

The following integrated antennas are used with the EUT:

- Integrated linear polarised strip patch array antenna, gain 8.5 dBi additional lens antenna 20 dBi, effective gain 28.5 dBi. The patch antenna and the lens means one unit. No use with patch antenna only.

The antennas cannot be unattached by the user.

2.8 Power supply system utilised

Power supply voltage : 115 VAC, (DC-Input 11 - 36 VDC)

2.9 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- DC power cable, 2 m Model : Self-made
- LAN cable, 2 m Model : Self-made
- - Model : -

2.10 Determination of worst case conditions for final measurement

Exploratory measurements have been made in all three orthogonal axes and the settings of the EUT are changed to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement, the EUT is set in flat position.

As worst case, the following channels and test modes are selected for the final test:

Due to the need of FCC 15.31 c), the sweep has to be stopped for measurement, 3 frequencies are selected for measurement:

Frequency	Tested Channel block	Power setting	Modulation	Modulation type
57.5 GHz	9	VGA63	CW	-
60.5 GHz	2	VGA63	CW	-
63.5 GHz	13	VGA63	CW	-

2.10.1 Test jig

No test jig is used.

2.10.2 Test software

For test mode TX CW a test software is needed.

3 TEST RESULT SUMMARY

Operating in the 57 GHz – 71 GHz band:

FCC Rule Part	RSS Rule Part	Description	Result
15.203	RSS-Gen 6.7	Antenna requirement	passed
15.205(a)	RSS-Gen 8.10	Emissions in restricted bands	passed
15.207(a)	RSS-Gen 8.8	AC power line conducted emissions	passed
15.209(a)	RSS-Gen 8.9	Radiated emission limits; general requirements	passed
15.255(c)(2)	RSS210 J.2.2	EIRP	passed
15.255(d)	RSS210 J.3	Spurious emissions	passed
15.255(e)	RSS210 J.4	Peak conducted output power	passed
15.255(f)	RSS210 J.6	Frequency stability	passed

The mentioned RSS Rule Parts in the above table are related to:
RSS Gen, Issue 5, April 2018
RSS 210, Issue 9, August 2016

3.1 Final assessment

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 19 October 2018

Testing concluded on : 08 November 2018

Checked by:

Klaus Gegenfurtner
I confirm the correctness and integrity of this document.
2019.01.25 11:56:06 +01'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Hermann Smetana
I am the author of this document.
2019.01.25 11:42:57 +01'00'

Hermann Smetana
Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
Output power ERP, radiated	40000 MHz to 110000 MHz	95%	± 5.41 dB
Field strength of the fundamental	1000 MHz to 40000 MHz	95%	± 2.34 dB
Field strength of the fundamental	40000 MHz to 110000 MHz	95%	± 5.41 dB
Power spectral density	40000 MHz to 110000 MHz	95%	± 5.41 dB
Spurious Emissions, conducted	9 kHz to 10000 MHz	95%	± 2.15 dB
Spurious Emissions, conducted	10000 MHz to 40000 MHz	95%	± 3.47 dB
Spurious Emissions, radiated	9 kHz to 30 MHz	95%	± 3.53 dB
Spurious Emissions, radiated	30 MHz to 1000 MHz	95%	± 4.44 dB
Spurious Emissions, radiated	1000 MHz to 40000 MHz	95%	± 2.89 dB
Spurious Emissions, radiated	40000 MHz to 60000 MHz	95%	± 5.04 dB
Spurious Emissions, radiated	60000 MHz to 90000 MHz	95%	± 5.04 dB
Spurious Emissions, radiated	75000 MHz to 110000 MHz	95%	± 5.04 dB
Spurious Emissions, radiated	110000 MHz to 170000 MHz	95%	± 5.04 dB
Spurious Emissions, radiated	140000 MHz to 220000 MHz	95%	± 5.04 dB

4.4 Measurement protocol for FCC and ISED

4.4.1 General information

4.4.1.1 Test methodology

The Open Area test site is a listed Open Site under the Canadian Test-Sites File-No:

IC 3009A-1

The Anechoic chamber is a listed test site under the Canadian Test-Sites File-No:

IC 3009A-2

In compliance with RSS 247 testing for RSS compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.4.1.2 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

5 TEST CONDITIONS AND RESULTS

5.1 AC power line conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

5.1.1 Description of the test location

Test location: AREA4

5.1.2 Photo documentation of the test set-up – Please see attachment B

5.1.3 Applicable standard

According to FCC Part 15, Section 15.207(a):
Except as shown in paragraphs (b) and (c) of this Section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the given limits.

5.1.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10 described under item 4.4.3. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin 10.6 dB at 0.318 MHz

Limit according to FCC Part 15, Section 15.207(a):

Frequency of Emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

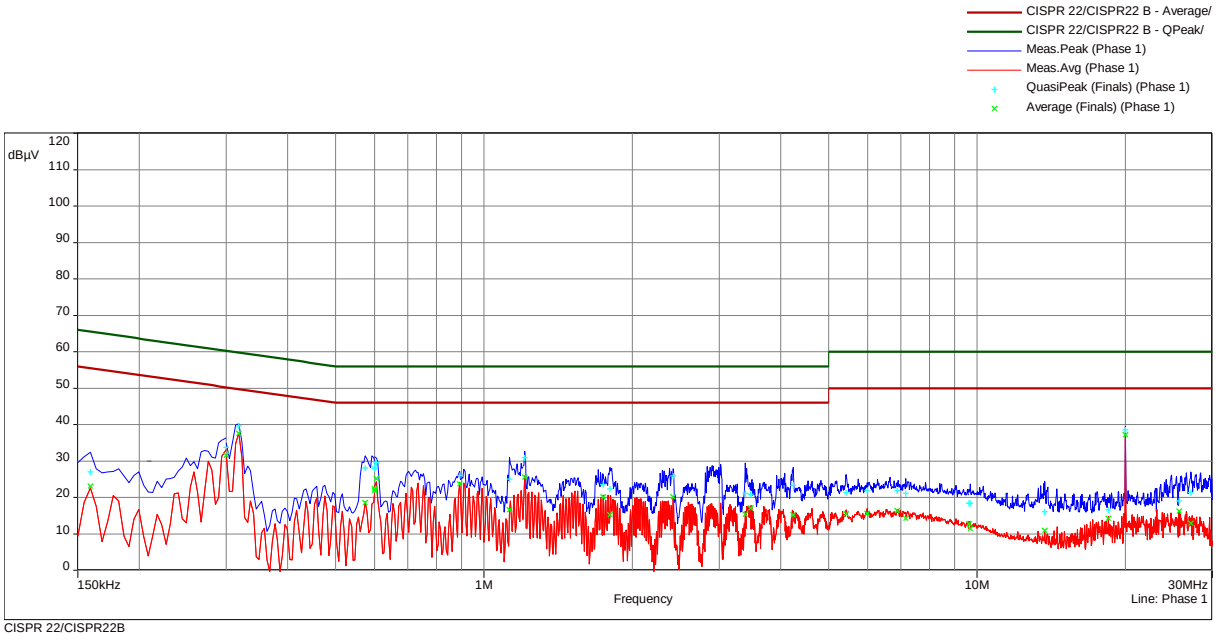
* Decreases with the logarithm of the frequency

The requirements are **FULFILLED.**

Remarks: For detailed test result please refer to following test protocols.

5.1.6 Test protocol

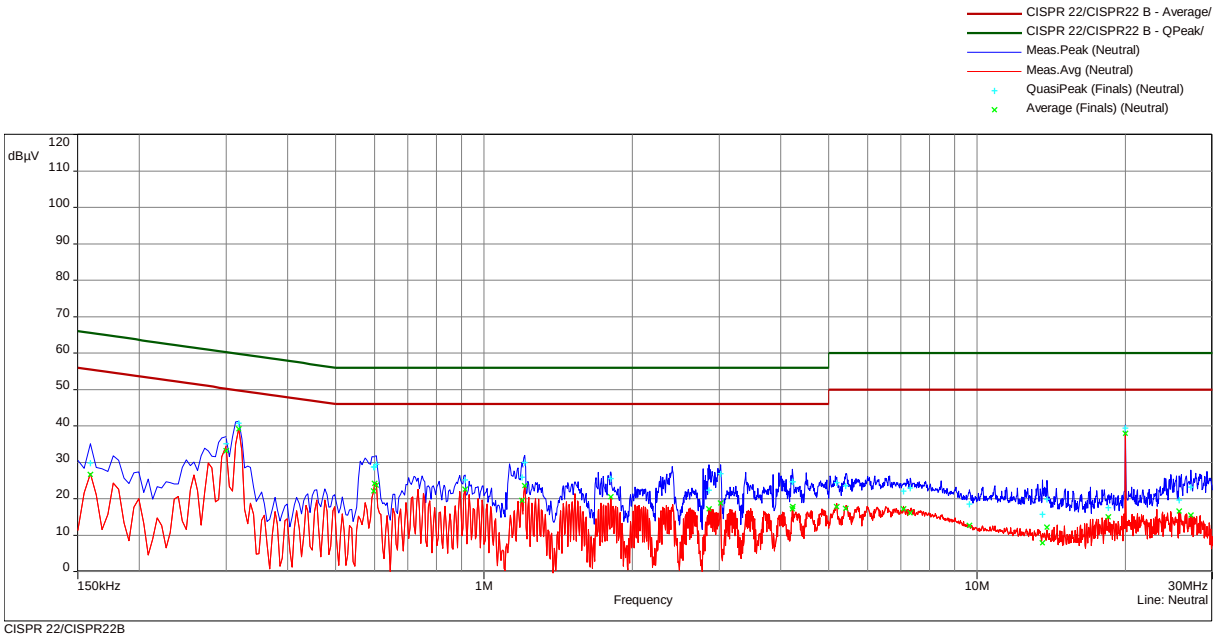
Test point L1 Result: passed
Operation mode: TX
Remarks:



freq	SR	QP	margin	limit	AV	margin	limit	line	corr
MHz		dB(µV)	dB	dB	dB(µV)	dB	dB		dB
0.159	1	27.0	38.6	65.5	23.1	32.4	55.5	Phase 1	10.08
0.300	1	33.7	26.5	60.2	31.6	18.7	50.2	Phase 1	10.12
0.318	2	39.6	20.1	59.8	37.6	12.2	49.8	Phase 1	10.13
0.575	2	28.1	27.9	56.0	18.6	27.5	46.0	Phase 1	10.15
0.600	2	28.0	28.0	56.0	21.8	24.2	46.0	Phase 1	10.15
0.600	3	28.4	27.6	56.0	22.4	23.7	46.0	Phase 1	10.15
0.605	3	29.6	26.4	56.0	25.1	20.9	46.0	Phase 1	10.16
0.893	3	26.0	30.0	56.0	23.7	22.3	46.0	Phase 1	10.18
1.127	3	25.1	30.9	56.0	16.5	29.5	46.0	Phase 1	10.21
1.209	4	30.9	25.1	56.0	25.5	20.5	46.0	Phase 1	10.22
1.745	4	23.6	32.4	56.0	20.1	25.9	46.0	Phase 1	10.27
1.799	4	22.3	33.7	56.0	15.2	30.8	46.0	Phase 1	10.26
2.418	5	25.9	30.1	56.0	20.1	25.9	46.0	Phase 1	10.31
3.390	5	21.2	34.8	56.0	15.3	30.7	46.0	Phase 1	10.35
3.471	5	20.9	35.1	56.0	17.1	28.9	46.0	Phase 1	10.35
4.236	5	23.3	32.7	56.0	15.2	30.8	46.0	Phase 1	10.42
5.430	6	21.4	38.6	60.0	15.5	34.5	50.0	Phase 1	10.49
5.993	6	21.9	38.1	60.0	15.6	34.4	50.0	Phase 1	10.53
6.893	6	21.9	38.1	60.0	16.3	33.7	50.0	Phase 1	10.6
7.163	6	21.1	38.9	60.0	14.2	35.8	50.0	Phase 1	10.62
9.632	7	18.4	41.6	60.0	12.7	37.3	50.0	Phase 1	10.72
9.681	7	18.4	41.6	60.0	11.4	38.6	50.0	Phase 1	10.73
13.709	7	16.1	43.9	60.0	10.9	39.1	50.0	Phase 1	11.07
18.443	7	16.6	43.4	60.0	14.2	35.8	50.0	Phase 1	11.38
20.001	8	38.6	21.4	60.0	37.1	12.9	50.0	Phase 1	11.46
25.689	8	19.1	41.0	60.0	16.3	33.8	50.0	Phase 1	11.69
27.161	8	21.4	38.6	60.0	12.9	37.1	50.0	Phase 1	11.7

Test point: N
Operation mode: TX
Remarks:

Result: passed



CISPR 22/CISPR22B

freq	SR	QP	margin	limit	AV	margin	limit	line	corr
MHz		dB(µV)	dB	dB	dB(µV)	dB	dB		dB
0.159	9	29.8	35.7	65.5	26.6	28.9	55.5	Neutral	10.08
0.300	9	35.1	25.2	60.2	33.1	17.2	50.2	Neutral	10.12
0.318	10	40.8	19.0	59.8	39.1	10.6	49.8	Neutral	10.13
0.597	10	28.8	27.3	56.0	22.1	23.9	46.0	Neutral	10.15
0.600	10	28.7	27.3	56.0	24.1	21.9	46.0	Neutral	10.15
0.605	11	29.4	26.6	56.0	23.7	22.3	46.0	Neutral	10.16
0.915	11	25.1	30.9	56.0	22.6	23.4	46.0	Neutral	10.18
1.194	11	25.9	30.2	56.0	19.5	26.5	46.0	Neutral	10.22
1.209	12	30.0	26.0	56.0	23.6	22.4	46.0	Neutral	10.22
1.808	12	25.5	30.5	56.0	20.5	25.5	46.0	Neutral	10.26
2.859	13	22.4	33.7	56.0	17.2	28.8	46.0	Neutral	10.34
3.017	13	26.9	29.1	56.0	18.8	27.2	46.0	Neutral	10.34
4.223	13	24.7	31.3	56.0	17.2	28.8	46.0	Neutral	10.41
4.227	13	24.7	31.3	56.0	17.9	28.1	46.0	Neutral	10.41
5.187	14	24.5	35.6	60.0	17.8	32.3	50.0	Neutral	10.45
5.417	14	23.5	36.5	60.0	17.3	32.7	50.0	Neutral	10.48
7.100	14	22.1	37.9	60.0	17.2	32.8	50.0	Neutral	10.58
7.316	14	23.0	37.0	60.0	16.0	34.0	50.0	Neutral	10.59
9.645	15	18.5	41.5	60.0	12.7	37.3	50.0	Neutral	10.66
13.574	15	15.7	44.3	60.0	7.9	42.1	50.0	Neutral	10.91
13.866	15	19.9	40.1	60.0	12.1	37.9	50.0	Neutral	10.93
18.443	15	17.5	42.5	60.0	15.0	35.0	50.0	Neutral	11.18
20.001	16	39.4	20.6	60.0	37.9	12.1	50.0	Neutral	11.25
25.689	16	19.6	40.4	60.0	16.6	33.4	50.0	Neutral	11.24
27.152	16	23.3	36.8	60.0	15.4	34.6	50.0	Neutral	11.19

5.2 EIRP

For test instruments and accessories used see section 6 Part **CPR 3**.

5.2.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.2.2 Applicable standard

According to FCC Part 15C, Section 15.255(c)(1)(i):
The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm.

5.2.3 Photo documentation of the test set-up – Please see attachment B

5.2.4 Description of Measurement

The radiated emission of the fundamental wave from the EUT is measured using a spectrum analyser and appropriate linear polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 9.11. The EUT is measured in TX continuous unmodulated under normal conditions.

Analyser settings:

PK measurement:	RBW: 1 MHz	VBW: 3 MHz	Detector: PK	Trace. Max hold
AV measurement:	RBW: 10 MHz	VBW: 28 MHz	Detector: RMS	Trace. Max hold

ANSI C63.10, 2013, Item 9.11 f) 1):
For radiated measurements:

1) Calculate the maximum peak and average field strength of the emission at the measurement distance, using Equation (19) and the peak and average (respectively) substitution power at the output of the test antenna (input to the instrumentation system) as recorded in step e).

Example:
Equation (19): $E = 126.8 - 20\log(\lambda) + P - G$
λ (60.5 GHz) = 0.00495; $20\log(\lambda) = -46.1$;
G = 24 dBi;
P (measured) (Pk) = -28.8 dBm;
P (measured) (AVG) = -29.0 dBm;

E (Pk) = 126.8 + 46.1 - 28.8 - 24 = 120.1 dBµV/m;
E (AVG) = 126.8 + 46.1 - 29.0 - 24 = 119.9 dBµV/m;

2) Calculate the peak and average EIRP from the measured peak and average (respectively) field strength using Equation (22), and then convert to linear form using Equation (24).

Example:
Equation (22): $EIRP = EMeas + 20\log(d_{Meas}) - 104.7$;
d_{Meas} = 3 m;

EIRP (Pk) = 120.1 + 9.5 – 104.7 = 24.9 dBm;
EIRP (AVG) = 119.9 + 9.5 – 104.7 = 24.7 dBm;
Equation (24): $EIRPLinear = 10^{[(EIRPLog - 30)\ 10]}$;
EIRP (Pk) = 0.309 W;
EIRP (AVG) = 0.295 W;

3) For peak measurements, calculate the peak conducted output power from the peak EIRP using Equation (27).

Example:
Equation (27): $P_{cond} = EIRPl_{in} / G_{EUT}$;
G_{EUT} = 28.5 dBi; 707.9

P_{cond} = 0.309 / 707.9 = 0.436 mW ;

5.2.5 Test result

Frequency	Power set	Level PK	Limit PK	Margin PK	Level AV	Limit AV	Margin AV
GHz	VGA	(dBm)	(dBm)	(dB)	(dBm)	(dBm)	(dB)
57.5	63	20.2	43.0	-22.8	20.0	40.0	-20.0
60.5	63	24.9	43.0	-18.1	24.7	40.0	-15.3
63.5	63	24.1	43.0	-18.9	24.0	40.0	-16.0

EIRP limit according to FCC Part 15C, Section 15.255(c)(1)(i):

The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm.

The requirements are **FULFILLED.**

Remarks: _____

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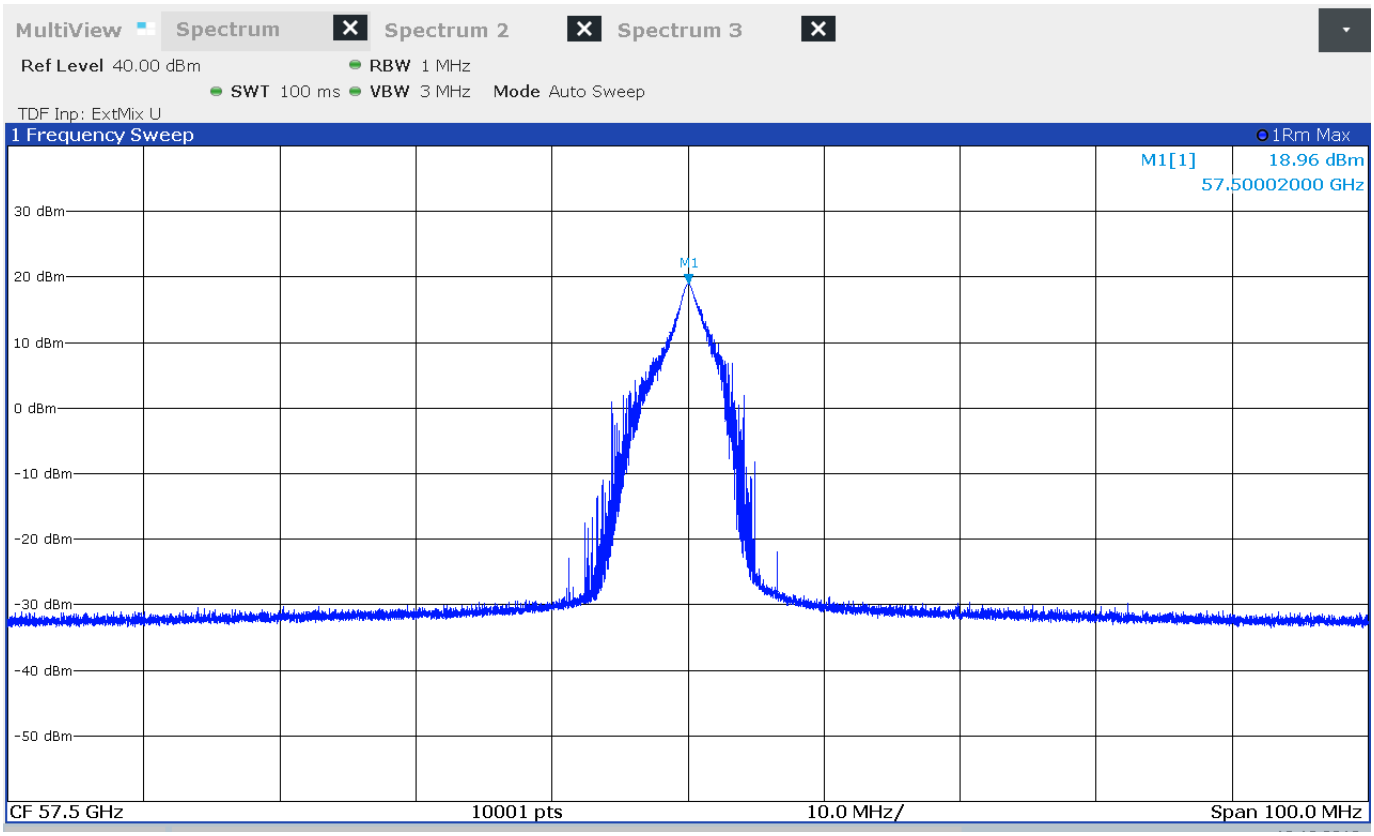
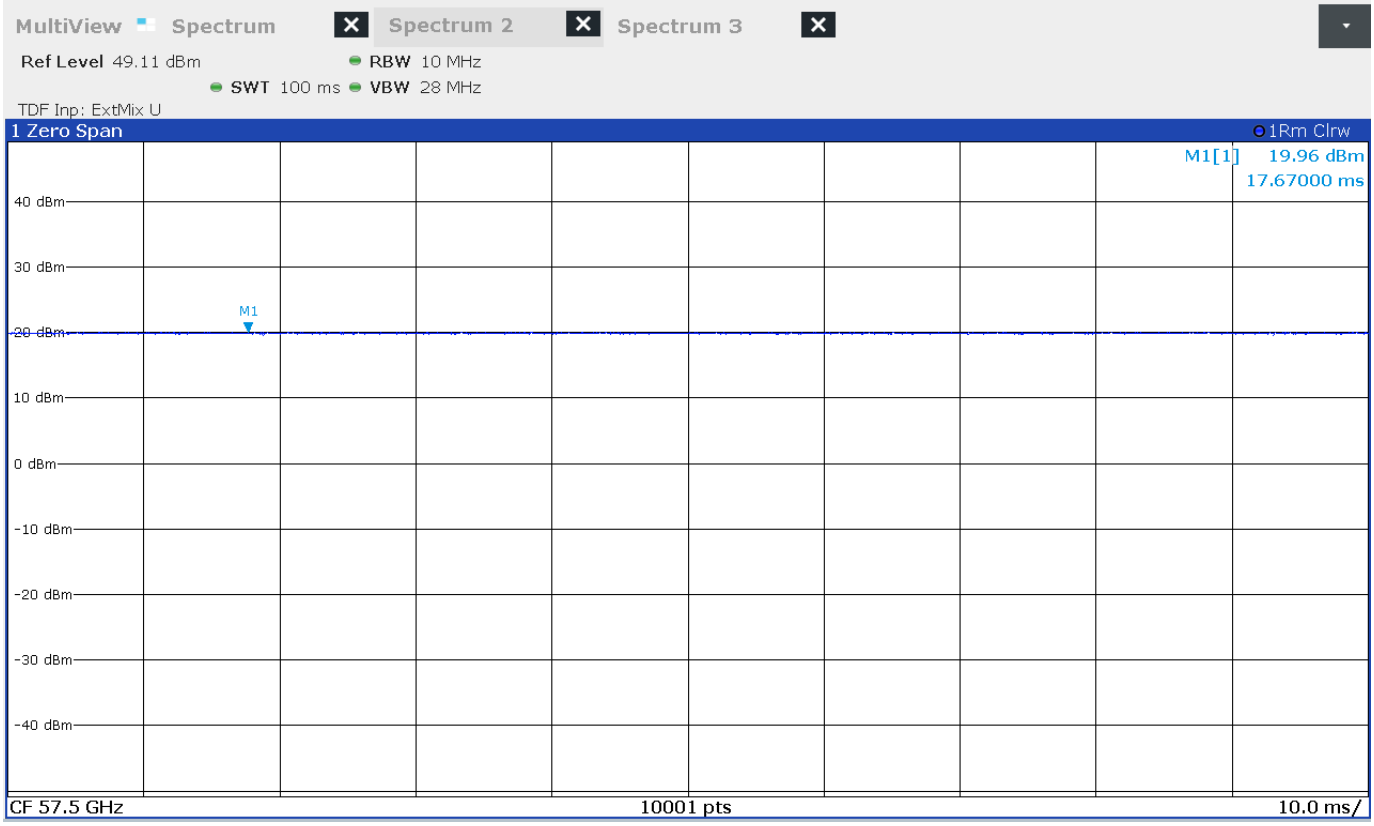
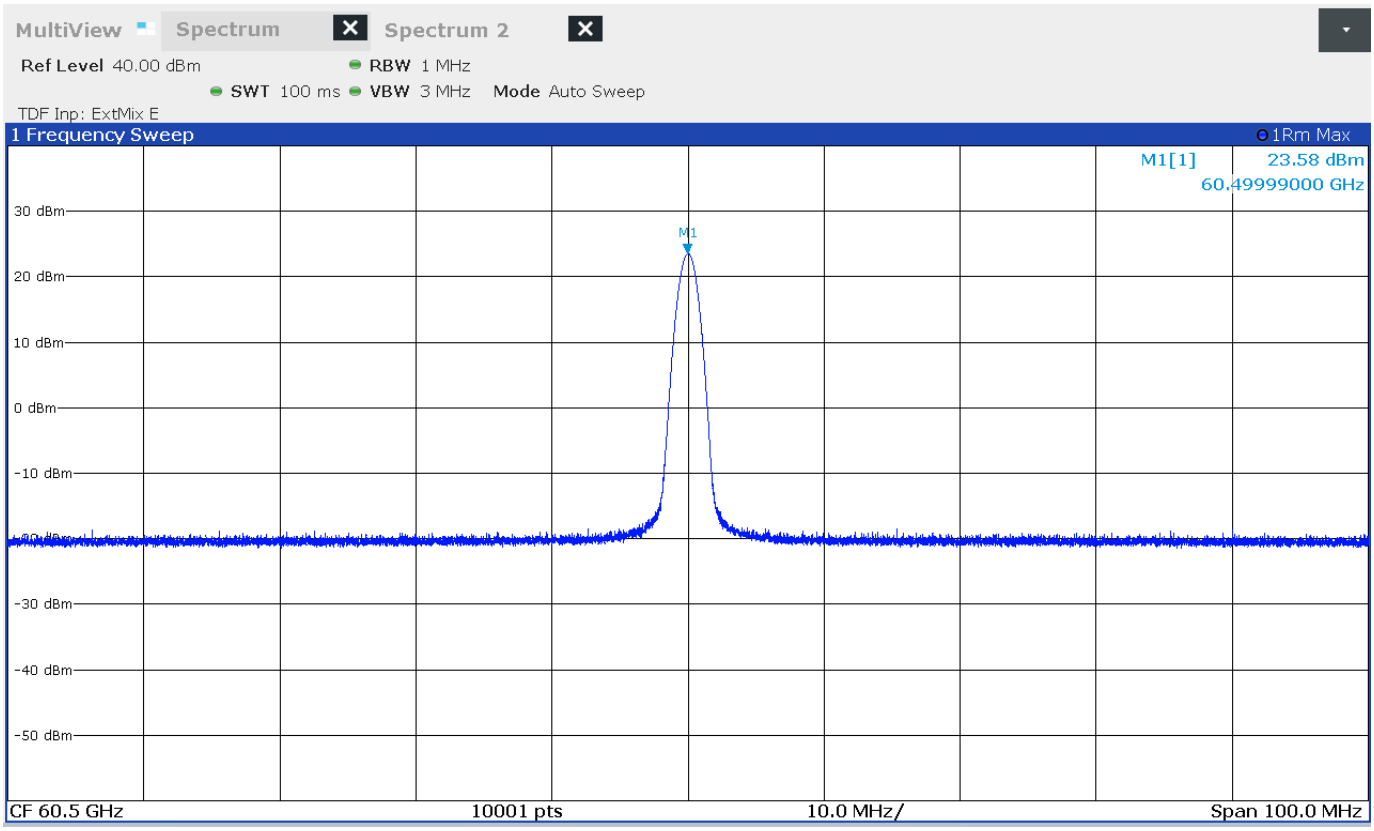
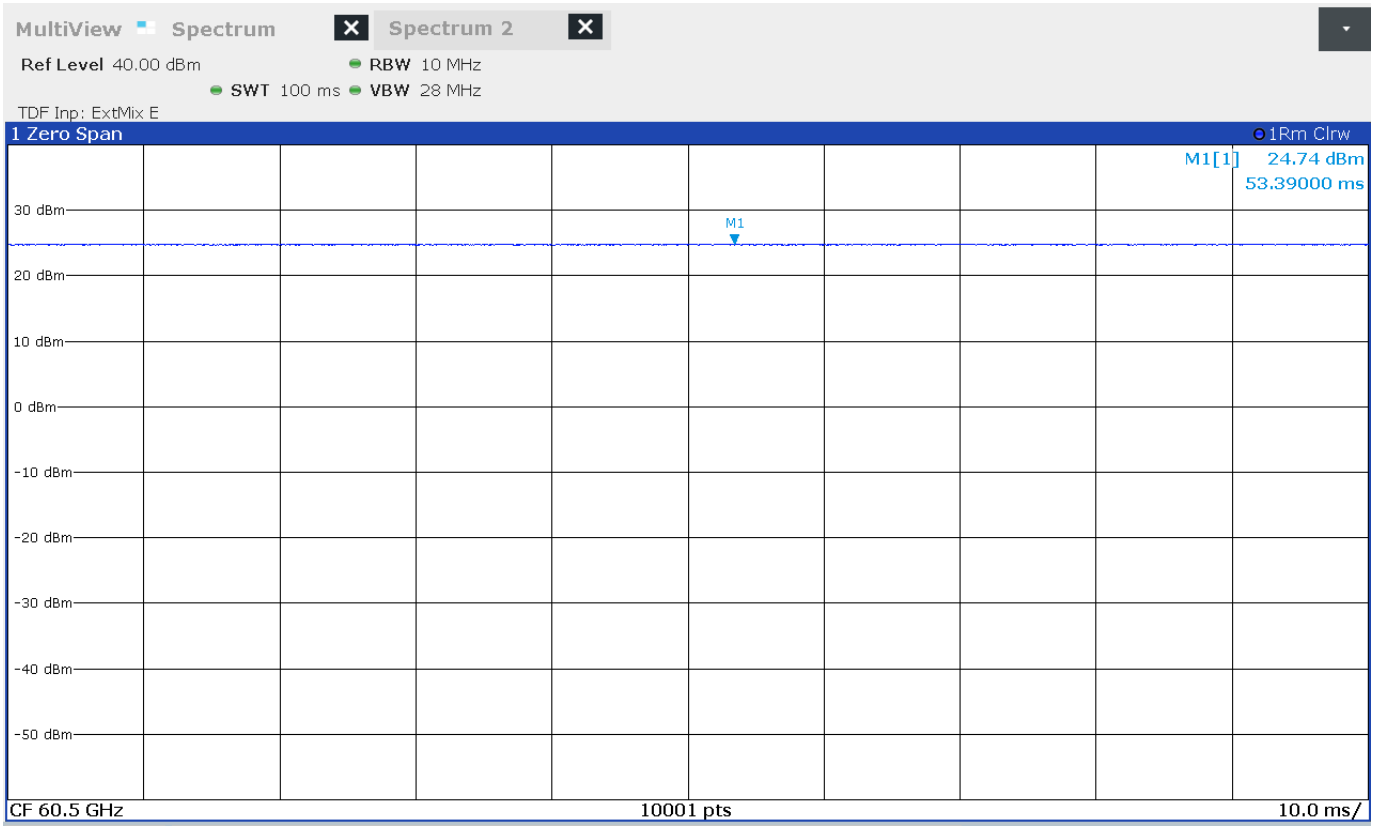
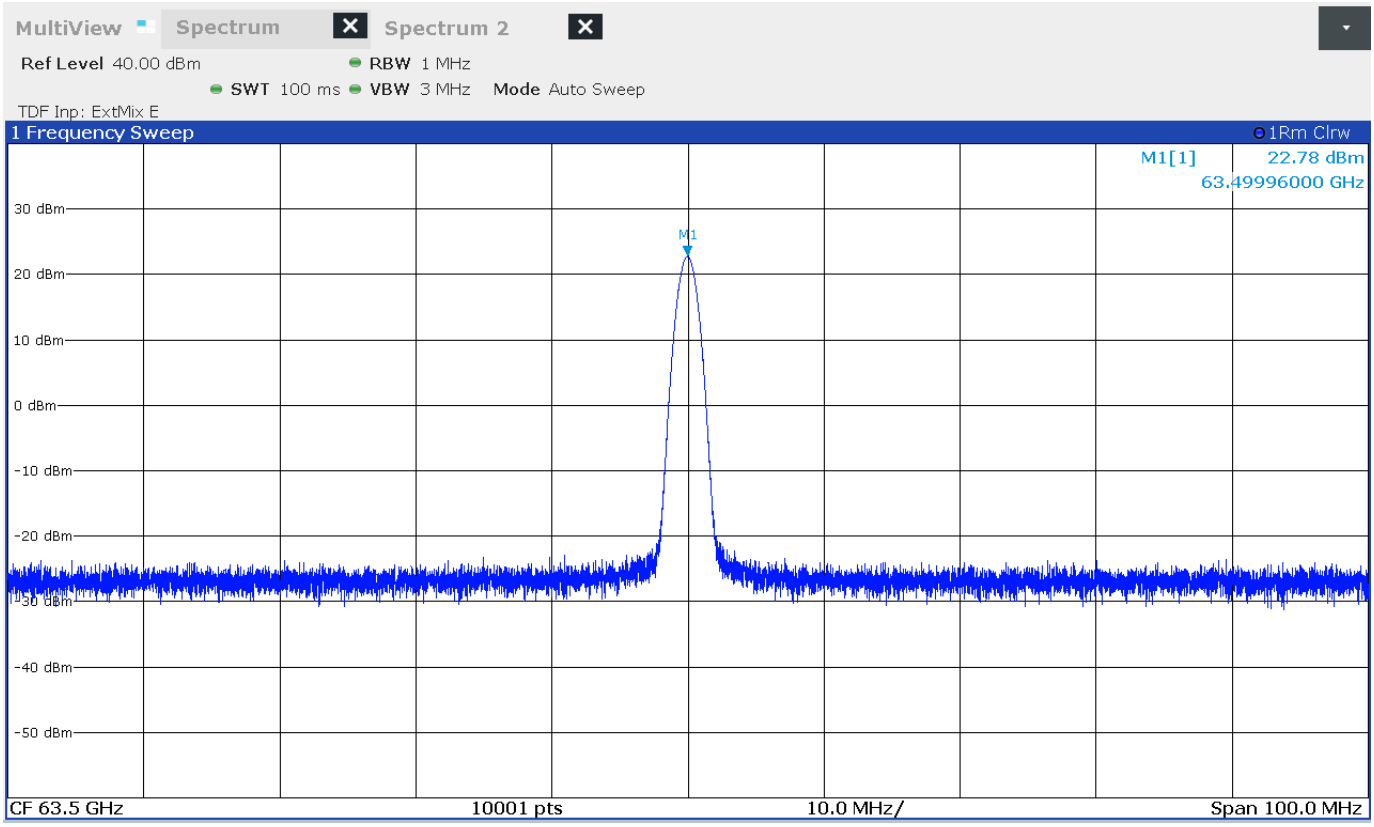
5.2.6 Test protocols AVG

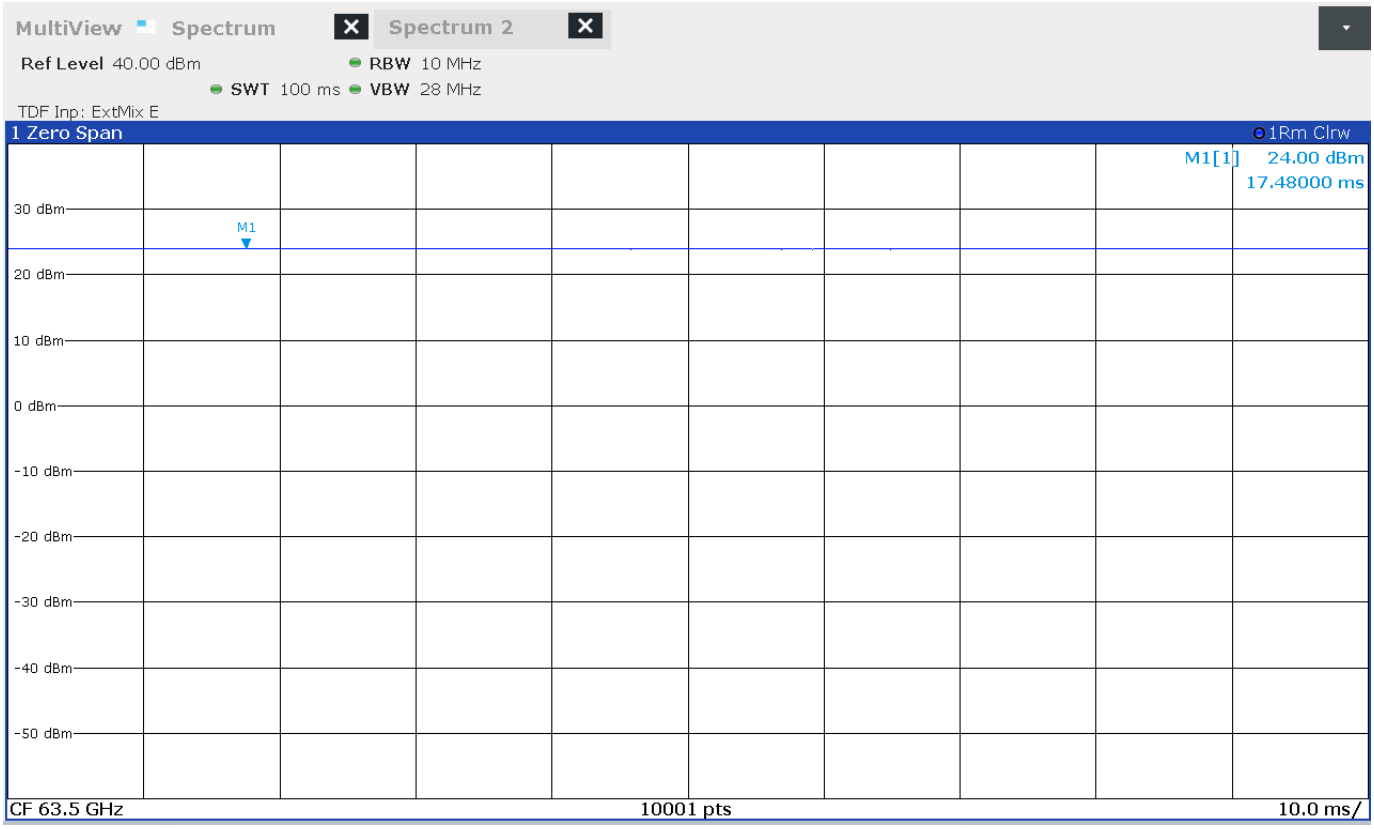





MultiView
Spectrum
Spectrum 2
Ref Level 40.00 dBm
RBW 1 MHz
SWT 100 ms VBW 3 MHz Mode Auto Sweep
TDF Inp: ExtMix E
1 Frequency Sweep
1Rm Max
M1[1] 23.58 dBm
60.49999000 GHz
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-30 dBm
-40 dBm
-50 dBm
M1
CF 60.5 GHz
10001 pts
10.0 MHz/
Span 100.0 MHz


MultiView
Spectrum
Spectrum 2
Ref Level 40.00 dBm
RBW 10 MHz
SWT 100 ms VBW 28 MHz
TDF Inp: ExtMix E
1 Zero Span
1Rm Clrw
M1[1] 24.74 dBm
53.39000 ms
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
M1
CF 60.5 GHz
10001 pts
10.0 ms/


MultiView
Spectrum
Spectrum 2
Ref Level 40.00 dBm
RBW 1 MHz
SWT 100 ms VBW 3 MHz Mode Auto Sweep
TDF Inp: ExtMix E
1 Frequency Sweep
1Rm Clrw
M1[1] 22.78 dBm
63.49996000 GHz
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
M1
CF 63.5 GHz
10001 pts
10.0 MHz/
Span 100.0 MHz


MultiView
Spectrum
Spectrum 2
Ref Level 40.00 dBm
RBW 10 MHz
SWT 100 ms VBW 28 MHz
TDF Inp: ExtMix E
1 Zero Span
1Rm Clrw
M1[1] 24.00 dBm
17.48000 ms
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
M1
CF 63.5 GHz
10001 pts
10.0 ms/

5.3 Peak conducted output power

For test instruments and accessories used see section 6 Part **CPR 3**.

5.3.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.3.2 Applicable standard

According to FCC Part 15C, Section 15.255(e):
Except as specified paragraph (e)(1) of this section, the peak transmitter conducted output power shall not exceed 500 mW. Depending on the gain of the antenna, it may be necessary to operate the intentional radiator using a lower peak transmitter output power in order to comply with the EIRP limits specified in paragraph (c) of this section.

5.3.3 Photo documentation of the test set-up – Please see attachment B

5.3.4 Description of Measurement

The radiated emission of the fundamental wave from the EUT is measured using a spectrum analyser and appropriate linear polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 9.11. The EUT is measured in TX continuous unmodulated under normal conditions.

Analyser settings:

PK measurement:	RBW: 1 MHz	VBW: 3 MHz	Detector: PK	Trace. Max hold
AV measurement:	RBW: 10 MHz	VBW: 28 MHz	Detector: RMS	Trace. Max hold

5.3.5 Test result

The conducted output power is calculated because it can not be measured.
The calculation is based on the following formula:
Conducted peak level = Peak EIRP – Antenna gain;
Example: Conducted peak level = 20.2 dBm – 28.5 dBi = -8.3 dBm

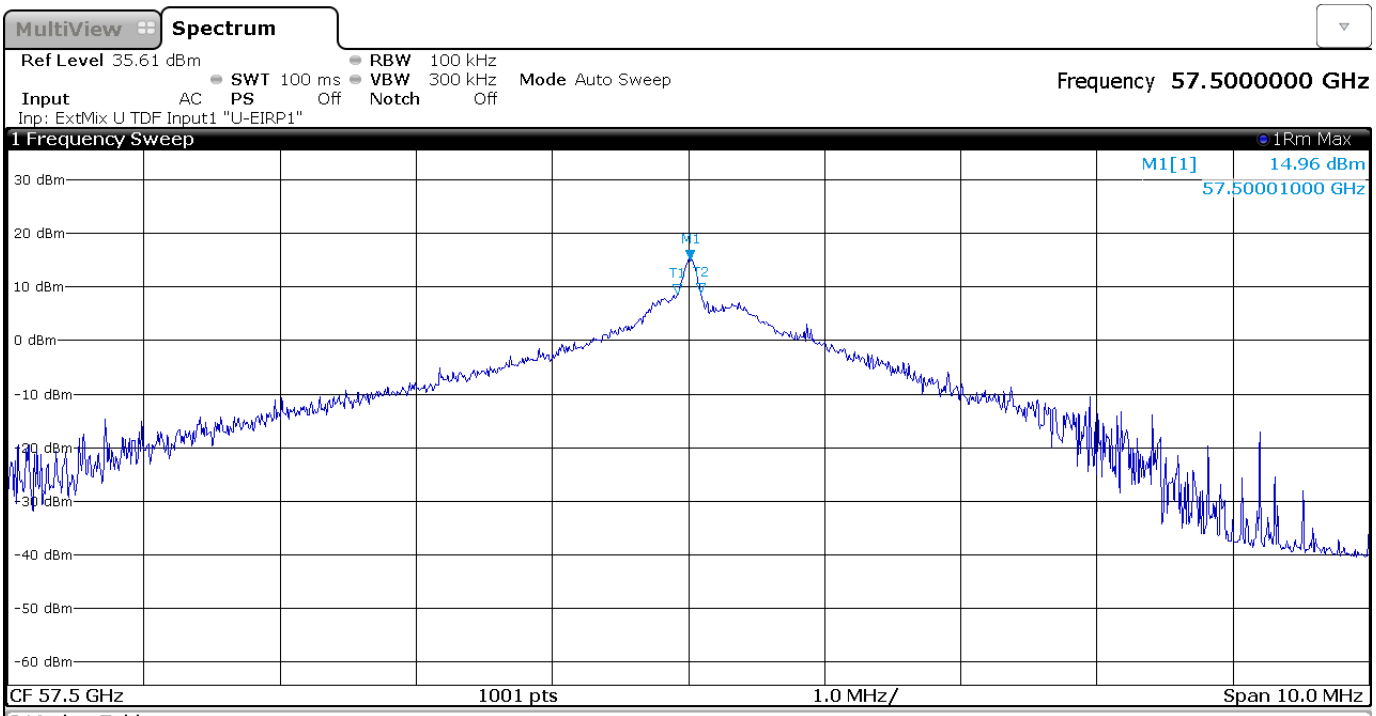
Frequency	Power set	Level EIRP PK	Antenna gain	Conducted level PK	Limit	Margin
GHz	VGA	(dBm)	(dBi)	(dBm)	(dBm)	(dB)
57.5	63	20.2	28.5	-8.3	-0.7	-7.6
60.5	63	24.9	28.5	-3.6	-1.5	-2.1
63.5	63	24.1	28.5	-4.4	-1.5	-2.9

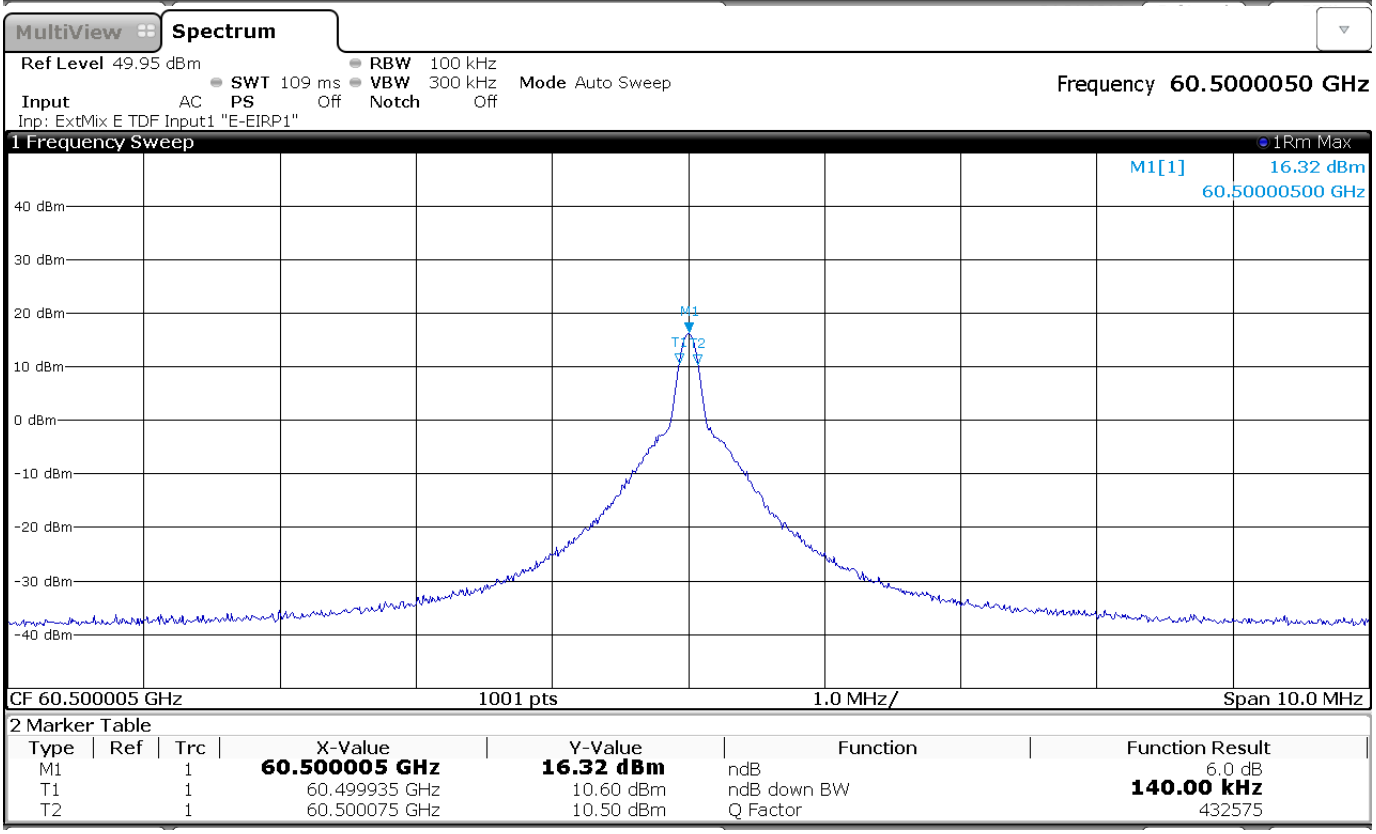
EIRP limit according to FCC Part 15C, Section 15.255(e):

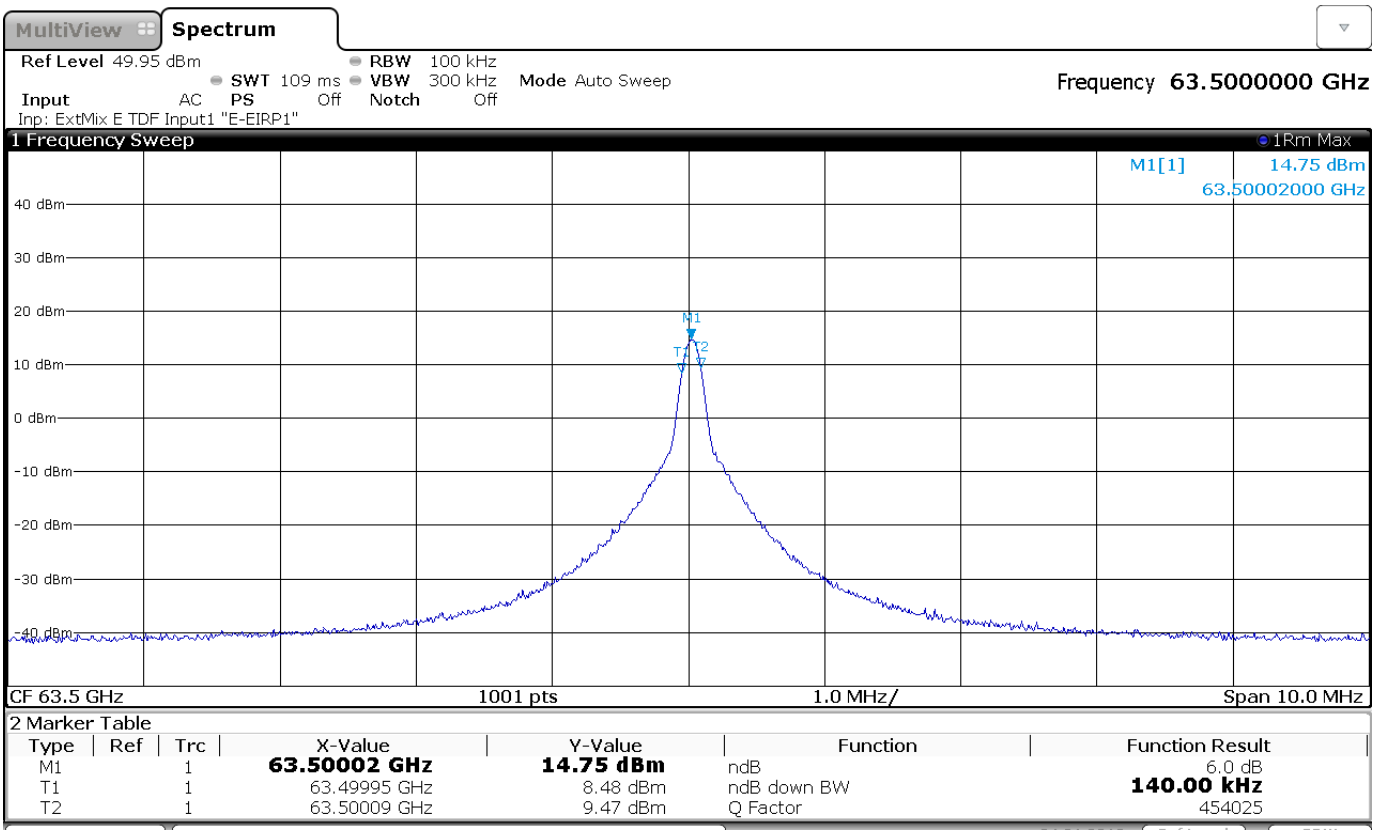
Except as specified paragraph (e)(1) of this section, the peak transmitter conducted output power shall not exceed 500 mW. Depending on the gain of the antenna, it may be necessary to operate the intentional radiator using a lower peak transmitter output power in order to comply with the EIRP limits specified in paragraph (c) of this section.
(1) Transmitters with an emission bandwidth of less than 100 MHz must limit their peak transmitter conducted output power to the product of 500 mW times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer.

The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).

Determination of the limit:







The limit is given as 500 mW * EBW 6 dB (100 kHz RBW) / 100 MHz;

For 57.5 GHz band: EBW = 170 KHz;
Limit = 500 mW * 170 kHz / 100 MHz = **0.85 mW**
For 60.5 GHz band: EBW = 140 KHz;
Limit = 500 mW * 140 kHz / 100 MHz = **0.7 mW**
For 63.5 GHz band: EBW = 140 KHz;
Limit = 500 mW * 140 kHz / 100 MHz = **0.7 mW**

The requirements are **FULFILLED.**

Remarks: _____

_____

5.4 Spurious emissions

For test instruments and accessories used see section 6 Part **SER 2, SER 3**.

5.4.1 Description of the test location

Test location: OATS 1
Test location: Anechoic chamber 2

Test distance: 3 m

5.4.2 Photo documentation of the test set-up – Please see attachment B

5.4.3 Applicable standard

According to FCC Part 15C, Section 15.255 (d):
(1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.
(2) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.
(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm2 at a distance of 3 meters.
(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

5.4.4 Description of Measurement

The radiated emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 9. In the frequency range above 1 GHz a spectrum analyser is used with appropriate linear polarized antennas. If the emission level in peak mode complies with the average limit testing is stopped and peak values will be reported, otherwise, the emission is measured in average mode again and reported. The EUT is measured in TX continuous mode under normal conditions.

Instrument settings:
30 MHz – 1000 MHz: RBW: 120 kHz;
1000 MHz – 200 GHz RBW: 1 MHz, VBW: 3 MHz;

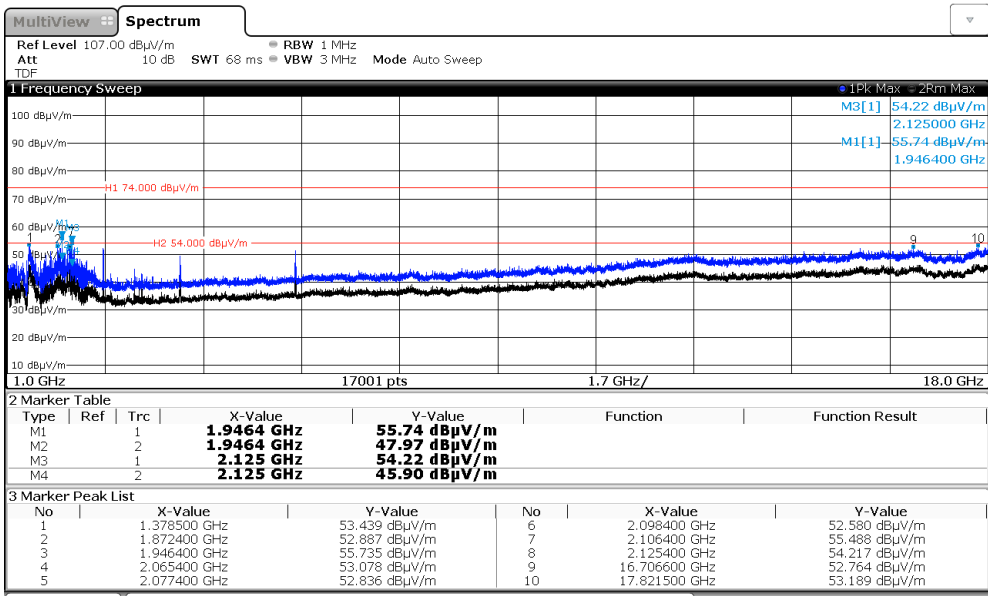
5.4.5 Test result f < 1 GHz

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
40.00	13.8	0.2	13.7	12.4	27.5	12.6	40.0	-12.5
71.23	20.2	8.9	12.8	12.2	33.0	21.1	40.0	-7.0
134.50	-2.0	2.1	12.4	13.2	10.4	15.3	43.5	-28.2
189.20	14.1	16.2	11.5	12.2	25.6	28.4	43.5	-15.1
270.00	24.0	23.0	14.1	14.0	38.1	37.0	46.0	-7.9
311.25	16.7	24.7	16.2	15.8	32.9	40.5	46.0	-5.5
680.00	16.0	12.5	25.3	24.9	41.3	37.4	46.0	-4.7
880.00	13.1	15.8	28.8	28.3	41.9	44.1	46.0	-1.9

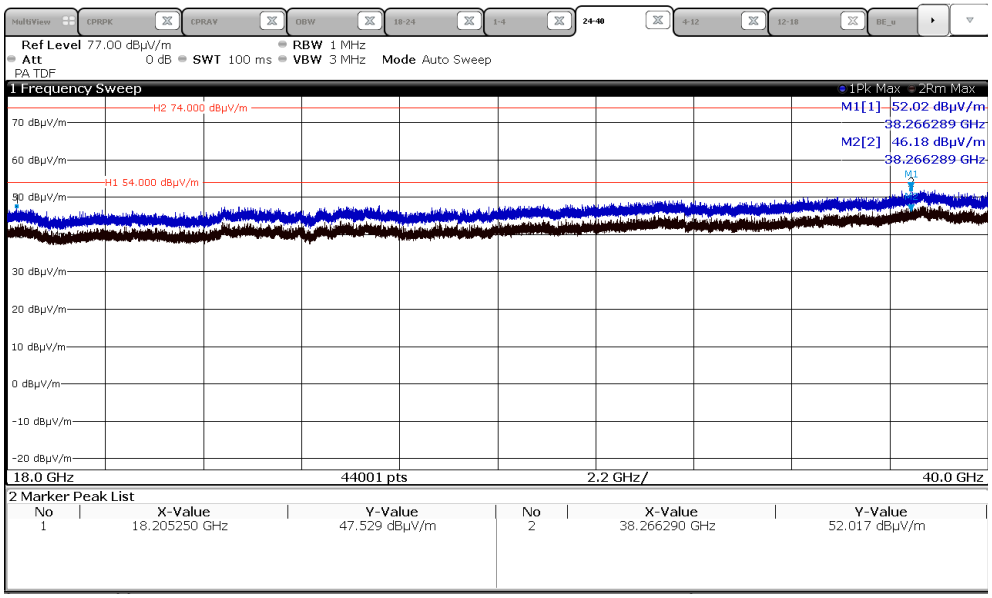
Note: For frequencies < 1 GHz the general radiated limits has been applied.

5.4.6 Test result f > 1 GHz

Frequency 57.5 GHz:



Frequency (MHz)	Level peak (dBµV/m)	Limit Peak (dBµV/m)	Margin (dB)	Level AVG (dBµV/m)	Limit AVG (dBµV/m)	Margin (dB)
1946.4	55.7	74.0	-18.3	48.0	54.0	-6.0
2106.4	55.5	74.0	-18.5	46.1	54.0	-7.9
2125.4	54.2	74.0	-19.8	45.9	54.0	-8.1



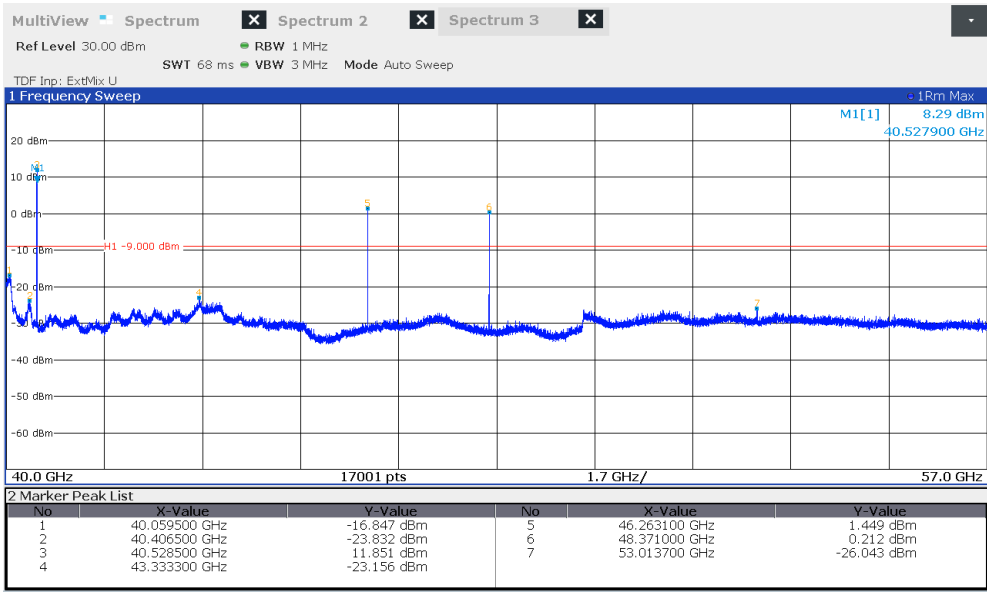
Note: For frequencies < 40 GHz the general radiated limits has been applied.

Determination of the EIRP emission limit for > 40 GHz:
For calculation the limit the friis formula is used.

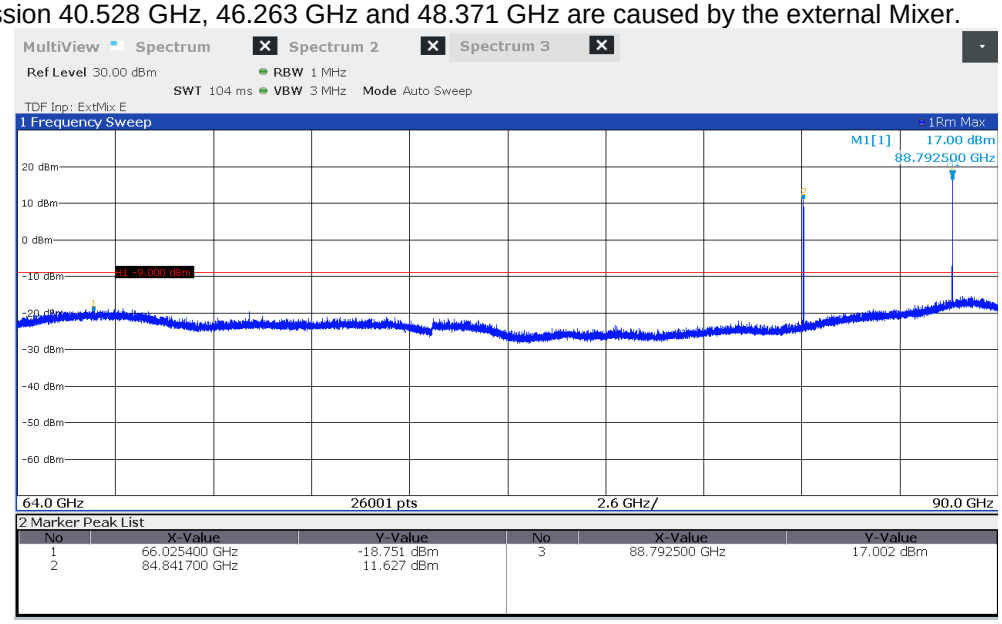
$$P_d = \frac{P_{out} * G}{4 * \Pi * r^2}$$

Pout * G = EIRP;
Therefore $EIRP = P_d * 4 * \pi * r^2$
$EIRP = -9.9$ dBm

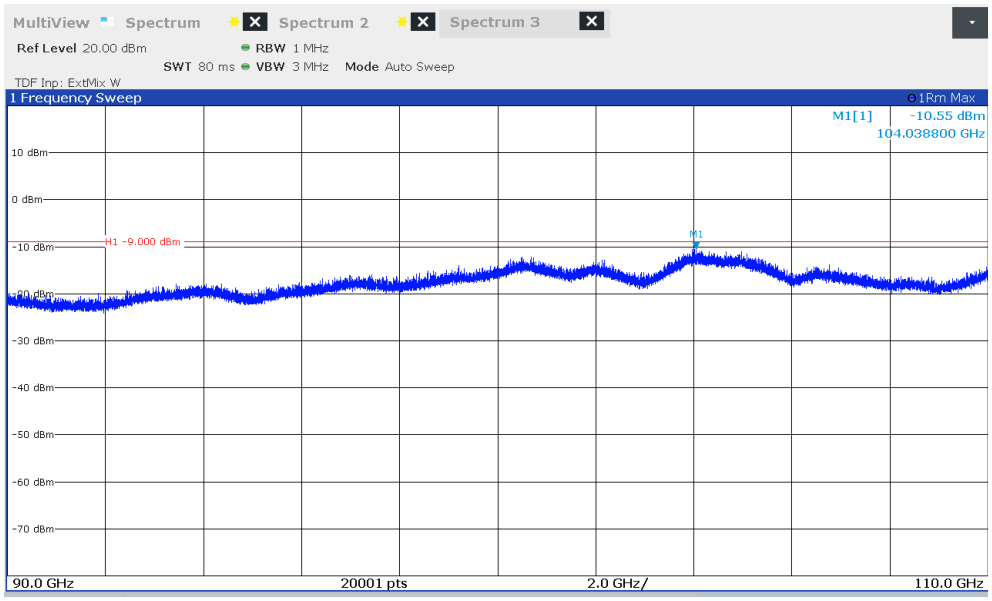
where
r is the measurement distance (3 m)
P_d is the emission density (90 pW/cm^2

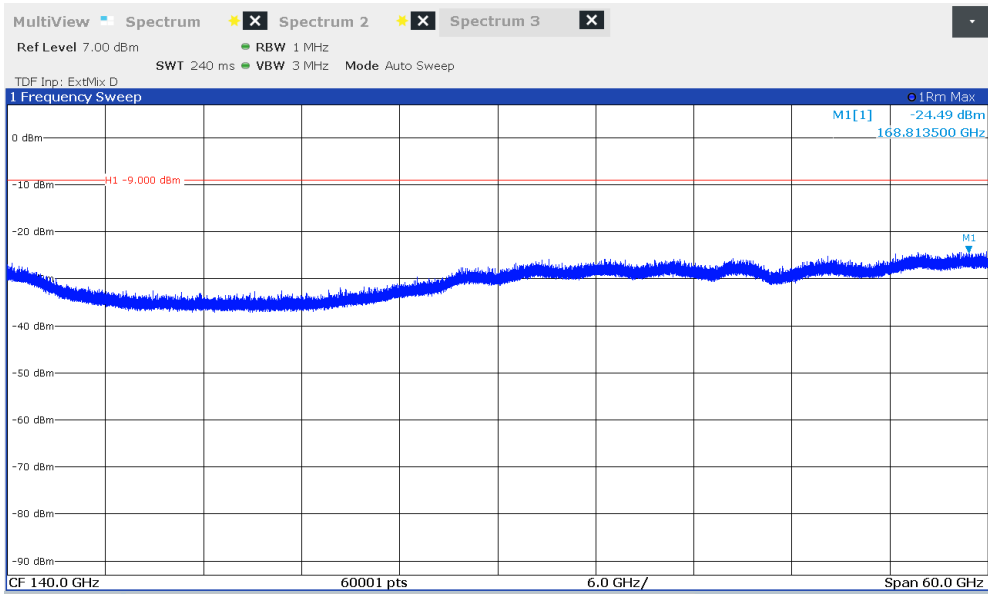


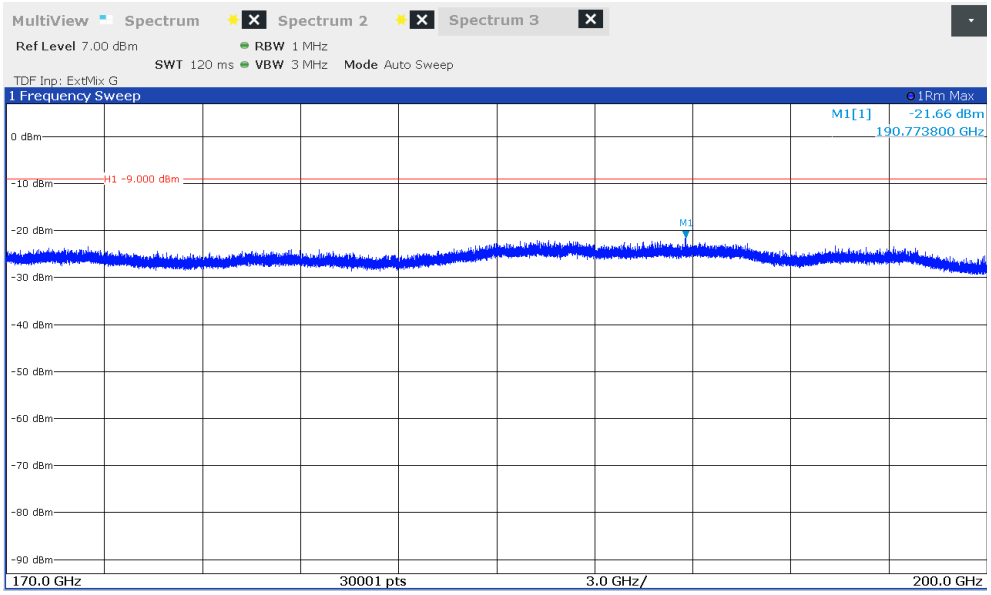
Note: The emission 40.528 GHz, 46.263 GHz and 48.371 GHz are caused by the external Mixer.



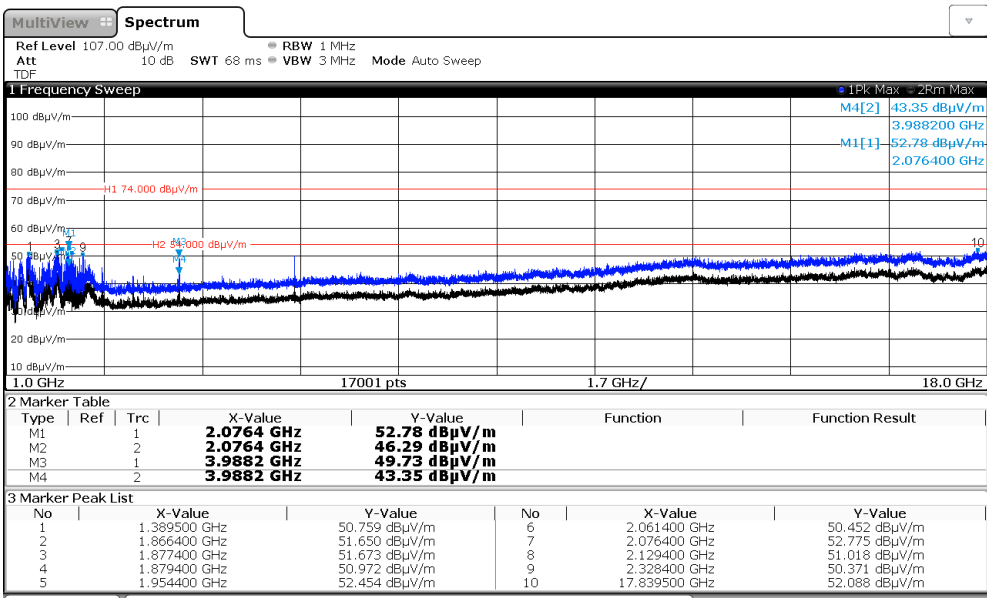
Note: The emission 84.841 GHz and 88.792 GHz are caused by the external Mixer.

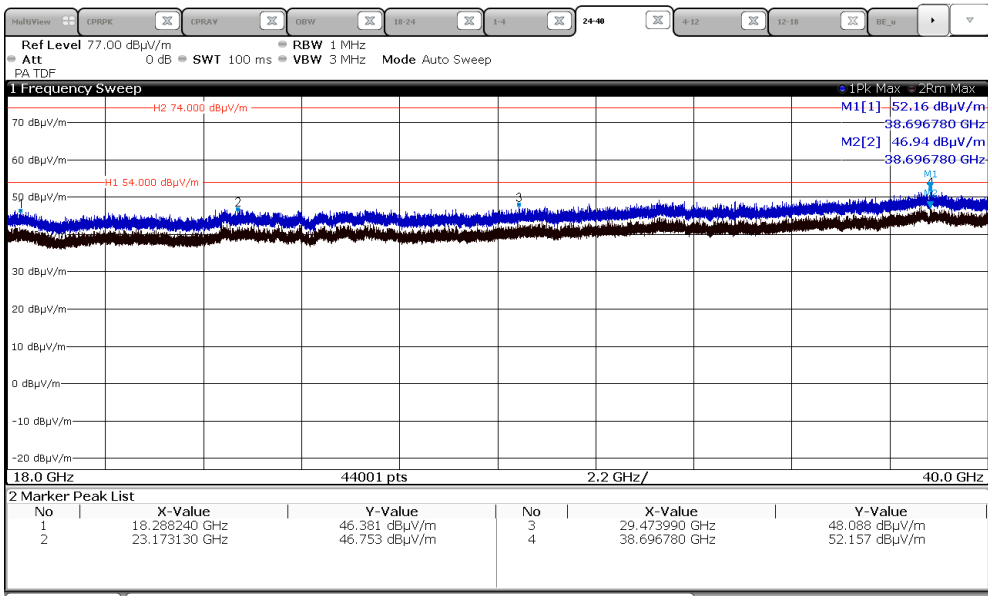

MultiView
Spectrum
Spectrum 2
Spectrum 3
Ref Level 20.00 dBm
RBW 1 MHz
SWT 80 ms
VBW 3 MHz
Mode Auto Sweep
TDF Inp: ExtMix W
1 Frequency Sweep
1Rm Max
M1[1]
-10.55 dBm
104.038800 GHz
10 dBm
0 dBm
H1 -9.000 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
90.0 GHz
20001 pts
2.0 GHz/
110.0 GHz

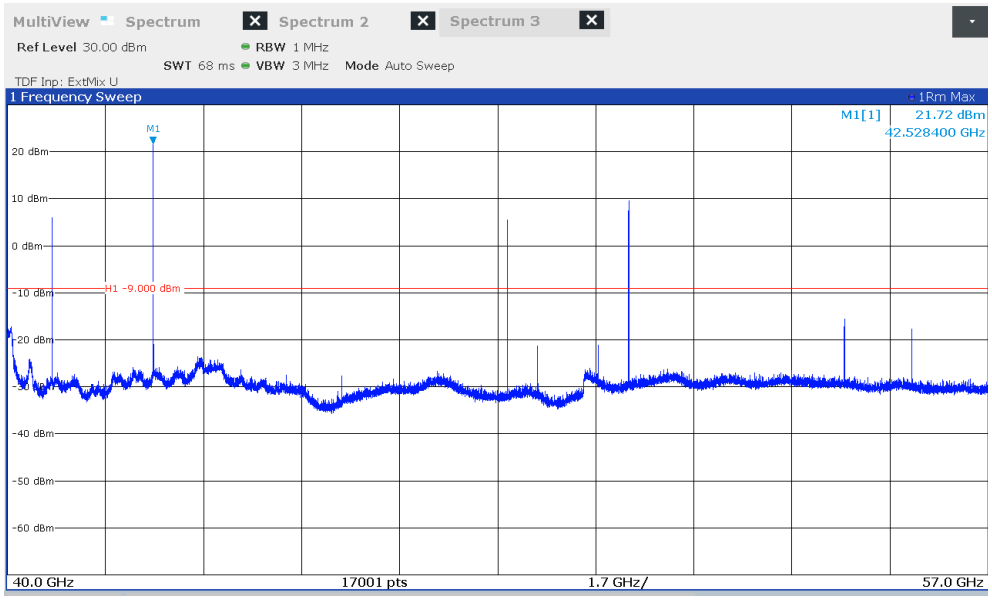

MultiView
Spectrum
Spectrum 2
Spectrum 3
Ref Level 7.00 dBm
RBW 1 MHz
SWT 240 ms
VBW 3 MHz
Mode Auto Sweep
TDF Inp: ExtMix D
1 Frequency Sweep
1Rm Max
M1[1]
-24.49 dBm
168.813500 GHz
0 dBm
H1 -9.000 dBm
-10 dBm
-20 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
M1
CF 140.0 GHz
60001 pts
6.0 GHz/
Span 60.0 GHz


MultiView
Spectrum
Spectrum 2
Spectrum 3
Ref Level 7.00 dBm
RBW 1 MHz
SWT 120 ms
VBW 3 MHz
Mode Auto Sweep
TDF Inp: ExtMix G
1 Frequency Sweep
1Rm Max
M1[1] -21.66 dBm
190.773800 GHz
H1 -9.000 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
170.0 GHz
30001 pts
3.0 GHz/
200.0 GHz

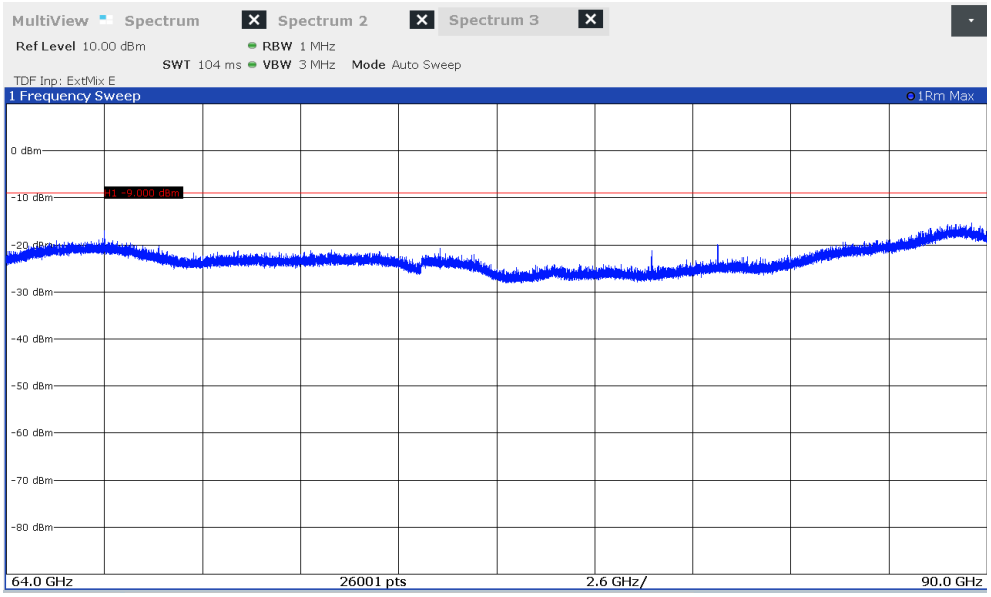
60.5 GHz:

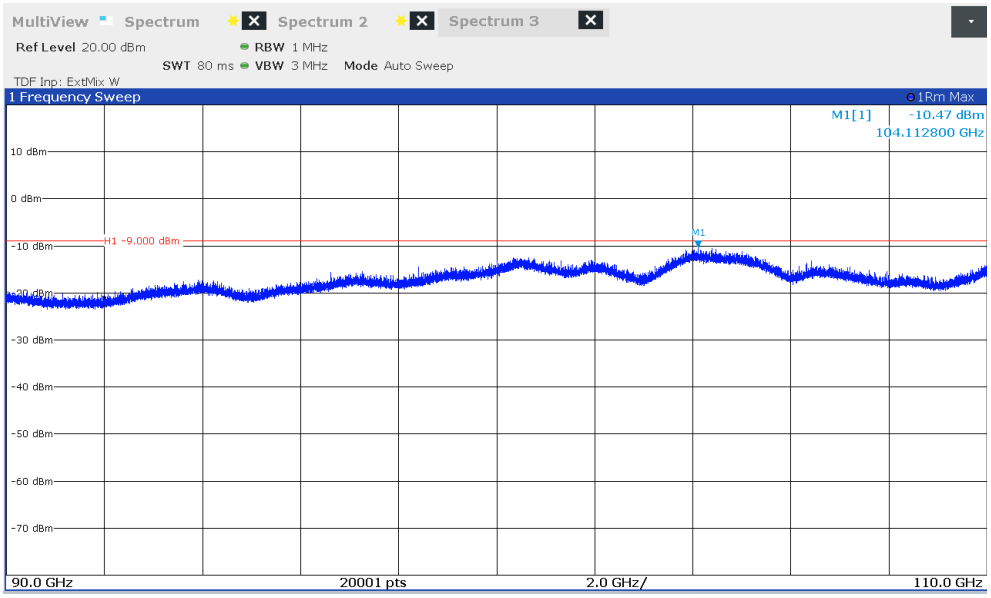

MultiView
Spectrum
Ref Level 107.00 dBµV/m
RBW 1 MHz
Att 10 dB
SWT 68 ms
VBW 3 MHz
Mode Auto Sweep
TDF
1 Frequency Sweep
1Pk Max
2Rm Max
M4[2] 43.35 dBµV/m
3.988200 GHz
M1[1] 52.78 dBµV/m
2.076400 GHz
H1 74.000 dBµV/m
H2 54.000 dBµV/m
100 dBµV/m
90 dBµV/m
80 dBµV/m
70 dBµV/m
60 dBµV/m
50 dBµV/m
40 dBµV/m
30 dBµV/m
20 dBµV/m
10 dBµV/m
1.0 GHz
17001 pts
1.7 GHz/
18.0 GHz
2 Marker Table
Type Ref Trc X-Value Y-Value Function Function Result
M1 1 2.0764 GHz 52.78 dBµV/m
M2 2 2.0764 GHz 46.29 dBµV/m
M3 1 3.9882 GHz 49.73 dBµV/m
M4 2 3.9882 GHz 43.35 dBµV/m
3 Marker Peak List
No X-Value Y-Value No X-Value Y-Value
1 1.389500 GHz 50.759 dBµV/m 6 2.061400 GHz 50.452 dBµV/m
2 1.866400 GHz 51.650 dBµV/m 7 2.076400 GHz 52.775 dBµV/m
3 1.877400 GHz 51.673 dBµV/m 8 2.129400 GHz 51.018 dBµV/m
4 1.879400 GHz 50.972 dBµV/m 9 2.328400 GHz 50.371 dBµV/m
5 1.954400 GHz 52.454 dBµV/m 10 17.839500 GHz 52.088 dBµV/m

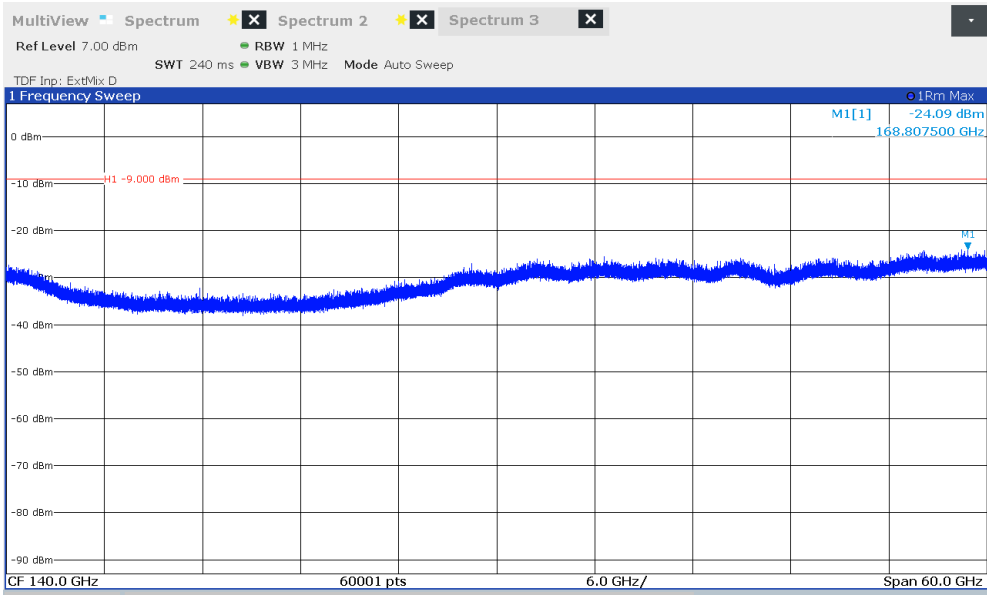


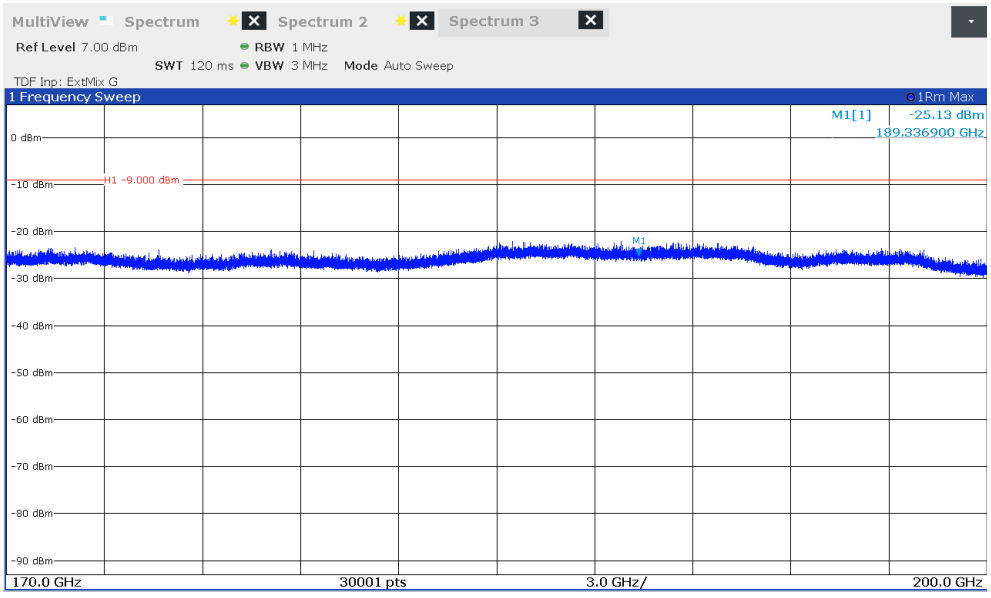


Note: The emission 40.906 GHz, 42.528 GHz, 48.871 and 50.996 GHz are caused by the external Mixer.

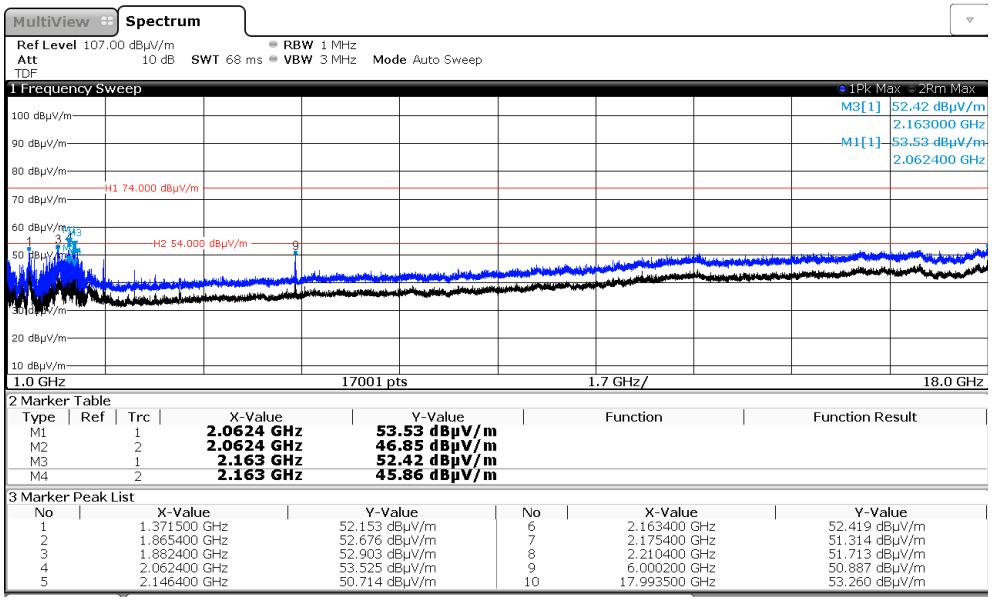

MultiView
Spectrum
Spectrum 2
Spectrum 3
Ref Level 10.00 dBm
RBW 1 MHz
SWT 104 ms
VBW 3 MHz
Mode Auto Sweep
TDF Inp: ExtMix E
1 Frequency Sweep
1Rm Max
H1 -9.000 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
64.0 GHz
26001 pts
2.6 GHz/
90.0 GHz

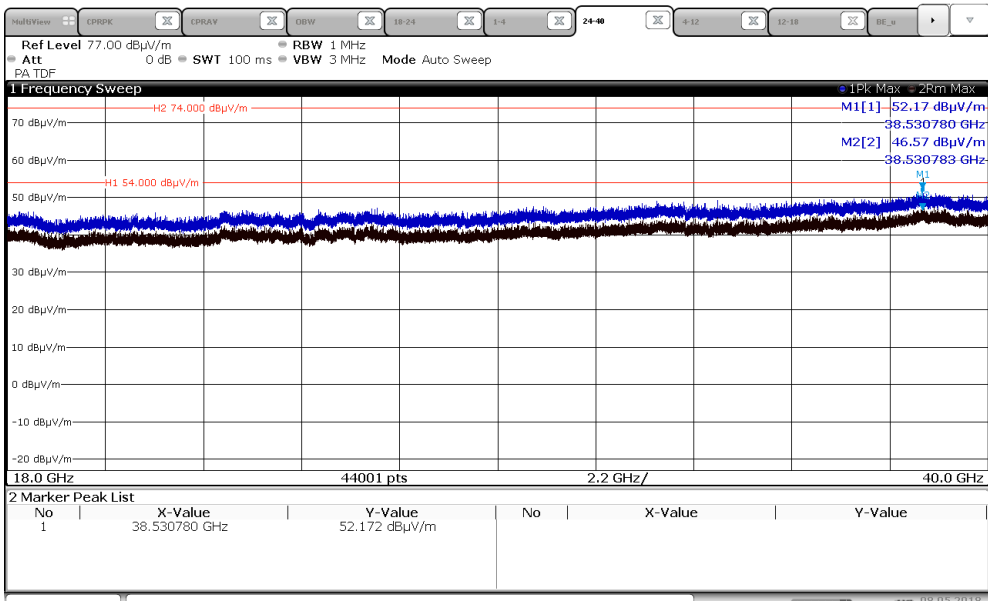

MultiView
Spectrum
Spectrum 2
Spectrum 3
Ref Level 20.00 dBm
RBW 1 MHz
SWT 80 ms
VBW 3 MHz
Mode Auto Sweep
TDF Inp: ExtMix W
1 Frequency Sweep
1Rm Max
M1[1]
-10.47 dBm
104.112800 GHz
H1 -9.000 dBm
M1
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
90.0 GHz
20001 pts
2.0 GHz/
110.0 GHz

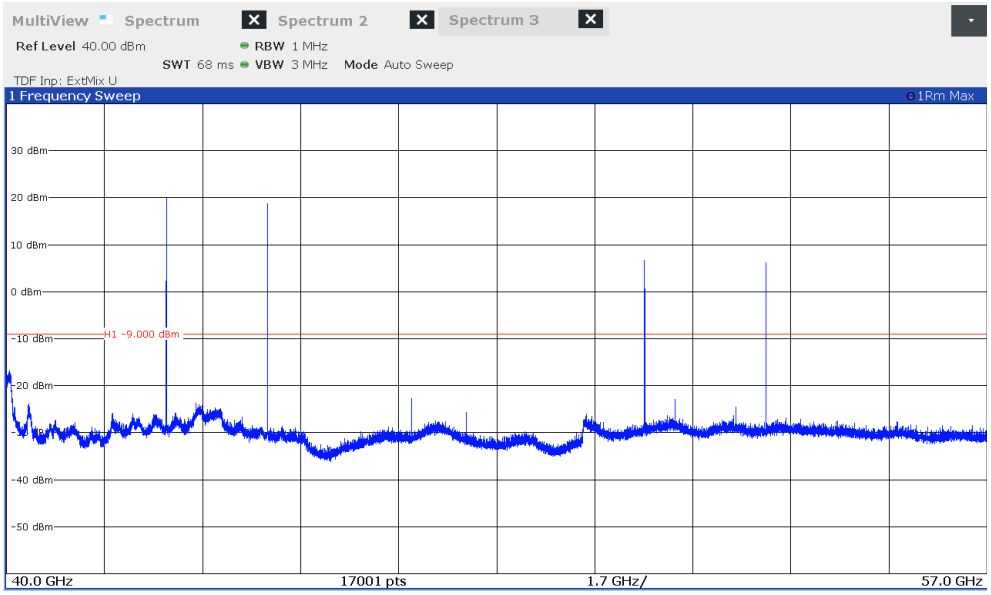

MultiView
Spectrum
Spectrum 2
Spectrum 3
Ref Level 7.00 dBm
RBW 1 MHz
SWT 240 ms
VBW 3 MHz
Mode Auto Sweep
TDF Inp: ExtMix D
1 Frequency Sweep
1Rm Max
M1[1]
-24.09 dBm
168.807500 GHz
H1 -9.000 dBm
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
CF 140.0 GHz
60001 pts
6.0 GHz/
Span 60.0 GHz


MultiView
Spectrum
Spectrum 2
Spectrum 3
Ref Level 7.00 dBm
RBW 1 MHz
SWT 120 ms
VBW 3 MHz
Mode Auto Sweep
TDF Inp: ExtMix G
1 Frequency Sweep
1Rm Max
M1[1]
-25.13 dBm
189.336900 GHz
H1 -9.000 dBm
M1
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
170.0 GHz
30001 pts
3.0 GHz/
200.0 GHz

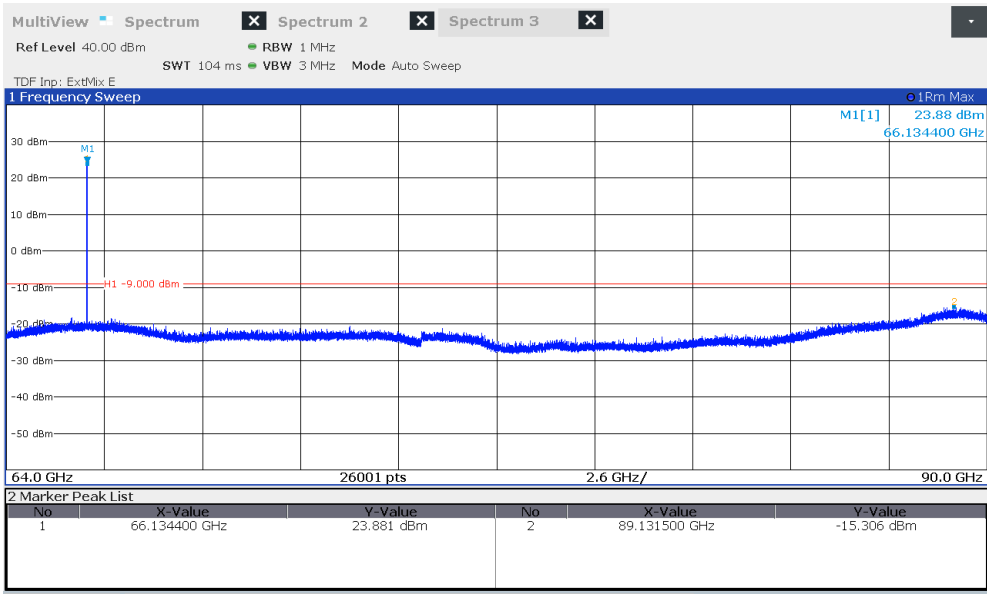
Frequency range 63.5 GHz:



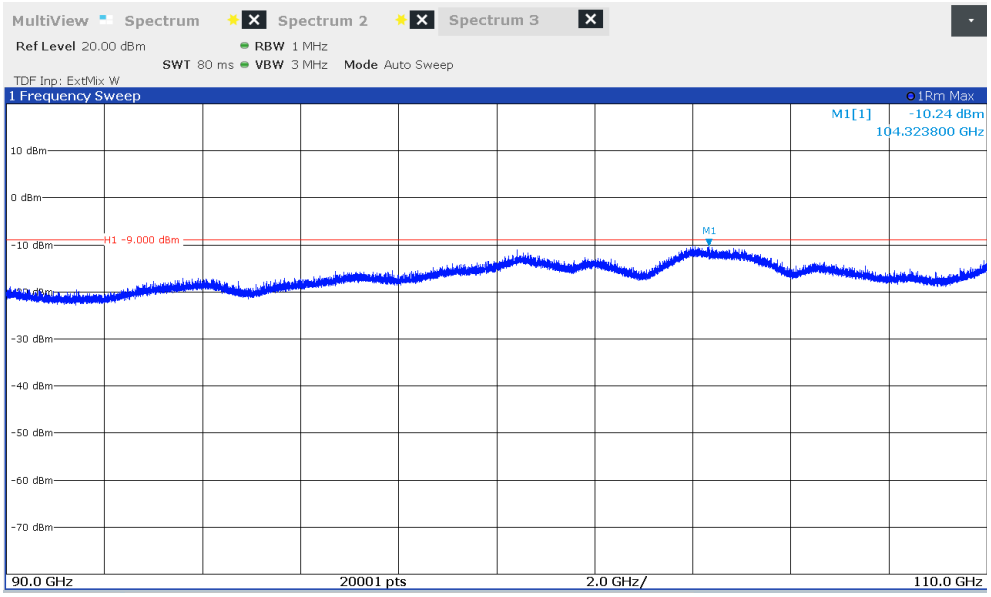


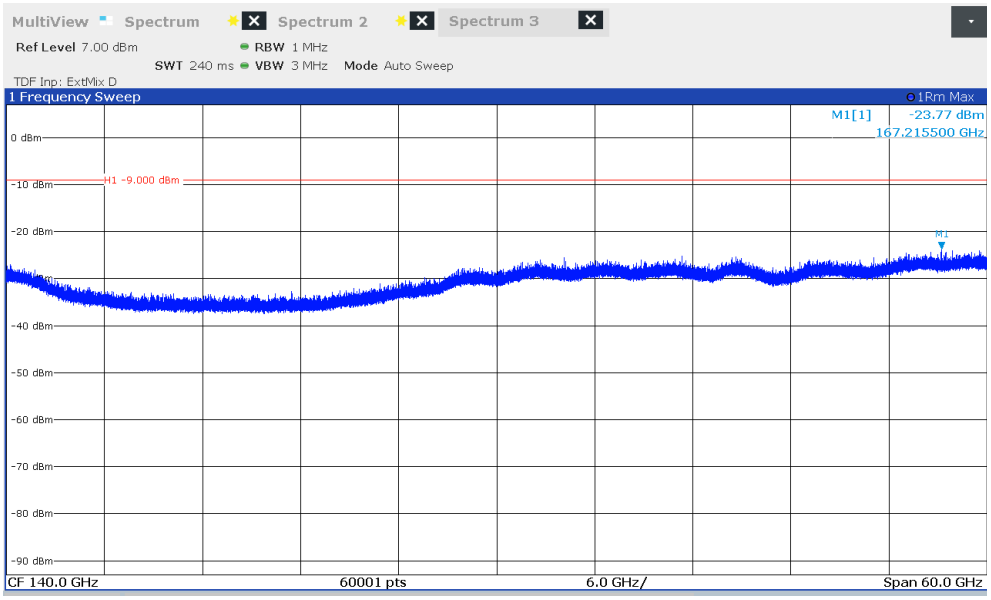


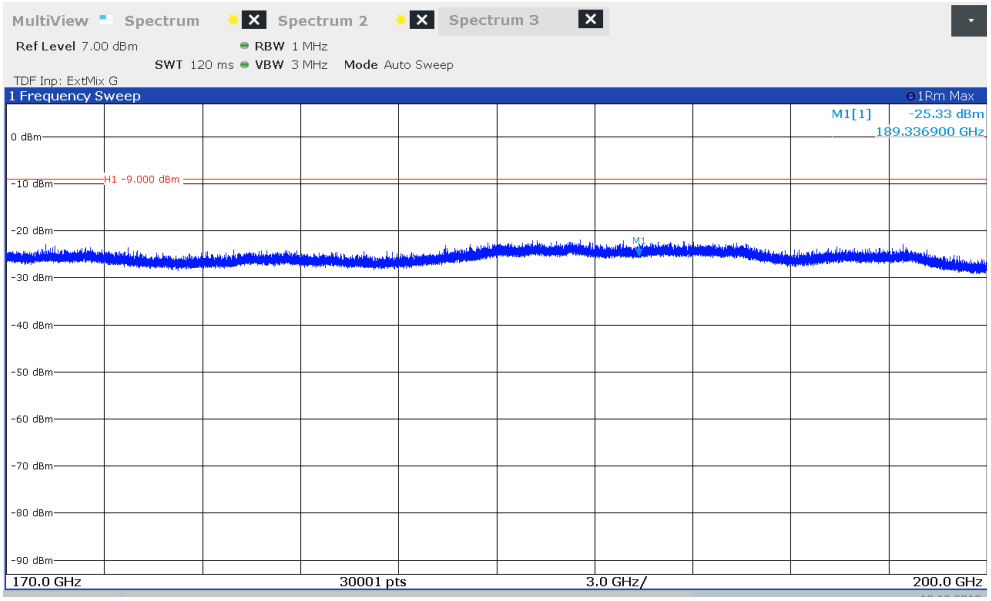
Note: The emission 42.722 GHz, 44.515 GHz, 50.957 and 53.082 GHz are caused by the external Mixer.



Note: The emission 66.134 GHz is caused by the external Mixer.


MultiView
Spectrum
Spectrum 2
Spectrum 3
Ref Level 20.00 dBm
RBW 1 MHz
SWT 80 ms
VBW 3 MHz
Mode Auto Sweep
TDF Inp: ExtMix W
1 Frequency Sweep
1Rm Max
M1[1]
-10.24 dBm
104.323800 GHz
10 dBm
0 dBm
H1 -9.000 dBm
-10 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
90.0 GHz
20001 pts
2.0 GHz/
110.0 GHz


MultiView
Spectrum
Spectrum 2
Spectrum 3
Ref Level 7.00 dBm
RBW 1 MHz
SWT 240 ms
VBW 3 MHz
Mode Auto Sweep
TDF Inp: ExtMix D
1 Frequency Sweep
1Rm Max
M1[1]
-23.77 dBm
167.215500 GHz
0 dBm
H1 -9.000 dBm
-10 dBm
-20 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
M1
CF 140.0 GHz
60001 pts
6.0 GHz/
Span 60.0 GHz



Average limit according to FCC Part 15C, Section 15.255(d):

(1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.
(2) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.
(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm^2 at a distance of 3 meters.
(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

General radiated limit according to FCC Part 15C, Section 15.209:

Frequency (MHz)	15.209 Limits (µV/m)	Measurement distance (m)
0.009 - -0.49	2400/f(kHz)	300
0.49 – 1.705	24000/f(kHz)	30
1.705 – 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

The requirements are **FULFILLED.**

Remarks: The measurement was performed up to 200 GHz.

5.5 Frequency stability

For test instruments and accessories used see section 6 Part **MB**.

5.5.1 Description of the test location

Test location: AREA4

5.5.2 Photo documentation of the test set-up – Please see attachment B

5.5.3 Applicable standard

According to FCC Part 15C, Section 15.255(f):

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

5.5.4 Description of Measurement

The frequency stability is measured with the spectrum analyser. The sweep points are set to maximum for higher the frequency resolution or the function “frequency counter” is used. The signal is unmodulated; the marker of the analyser is set to maximum amplitude at normal temperature, the frequency is recorded. Then the maximum supply voltage is set and the marker of the analyser is set to maximum amplitude. This procedure is done again for the minimum supply voltage. The EUT is now driven at normal supply voltage but in the climatic chamber to range the temperature from -40 °C to +75 °C in steps of 10 degrees. The drifting carrier is measured by setting the marker at the analyser.

5.5.5 Result

Test conditions		Test result
		Frequency (GHz)
T_{min} (-40)°C	V_{nom}	61.250254687
T (-30)°C	V_{nom}	61.250245838
T (-20)°C	V_{nom}	61.250149493
T (-10)°C	V_{nom}	61.250100595
T (0)°C	V_{nom}	61.250000000
T (10)°C	V_{nom}	61.250000000
T_{nom} (20)°C	V_{min} (11.0 V)	61.250005510
T_{nom} (20)°C	V_{nom} (24 V)	61.249998150
T_{nom} (20)°C	V_{max} (41.4 V)	61.249990100
T (30)°C	V_{nom}	61.249928104
T (40)°C	V_{nom}	61.249886456
T (50)°C	V_{nom}	61.249830708
T (60)°C	V_{nom}	61.249769312
T (70)°C	V_{nom}	61.249699965
T_{max} (75)°C	V_{nom}	61.250062897

Carrier frequency f_c	61.249998150	GHz
Max tolerance	no limit	
Highest frequency f_h	61.25014949	GHz
Lowest frequency f_l	61.24983071	GHz
Negative tolerance $f_l - f_c$	-167.442	kHz
Positive tolerance $f_h - f_c$	151.343	kHz

61.0 -61.5 GHz Range:

Channel block	Centre frequency	20 dB EBW fu	20 dB EBW fo	20 dB EBW
	(GHz)	(GHz)	(GHz)	(MHz)
9	61.25	61.006660	61.479850	473.190000

fu - drift	61.006493	
fo + drift		61.480001
Range limit	61.000000	61.500000

57-71 GHz Range:

Channel block	Centre frequency	20 dB EBW fu	20 dB EBW fo	20 dB EBW
	(GHz)	(GHz)	(GHz)	(MHz)
2	57.75	57.505080	57.980170	475.090000
13	60.75	63.006660	63.480350	473.690000

fu - drift	63.006660	
fo + drift		63.480350
Range limit	57.000000	71.000000

Limit according to FCC Part 15C, Section 15.255(f):

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

The requirements are **FULFILLED.**

Remarks: Manufacturer requirement -40°C to 75°C

5.6 Antenna requirement

5.6.1 Applicable standard

According to FCC Part 15C, Section 15.203:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

The EUT has an integrated antenna. No other antenna can be used with the device.

The supplied antenna meets the requirements of part 15.203 and 15.204.

Remarks: No power reduction results from the defacto limit.

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
A 4	BAT-EMC 3.16.0.73	01-02/68-13-001				
	ESCI	02-02/03-15-001	31/05/2018	31/05/2017		
	ESH 2 - Z 5	02-02/20-05-004	25/10/2019	25/10/2017	30/10/2018	30/04/2018
	EMV D 30000/PAS	02-02/30-05-006	21/02/2020	21/02/2017	20/02/2019	20/02/2018
	N-4000-BNC	02-02/50-05-138				
	N-1500-N	02-02/50-05-140				
	ESH 3 - Z 2	02-02/50-05-155	18/11/2019	18/11/2016	07/11/2018	07/05/2018
CPR 3	FS-Z60	02-02/11-14-001	21/03/2019	21/03/2018	21/09/2018	21/03/2018
	FS-Z90	02-02/11-14-003	26/03/2019	26/03/2018	26/09/2018	26/03/2018
	FSW43	02-02/11-15-001	19/03/2019	19/03/2018		
	QWH-UPRR00/WR-19/40-60	02-02/24-14-001				
	QWH-EPRR00/WR-12/60-90	02-02/24-14-004				
	VLP-1602 PRO	02-02/50-10-015				
MB	FS-Z60	02-02/11-14-001	21/03/2019	21/03/2018	21/09/2018	21/03/2018
	FS-Z90	02-02/11-14-003	26/03/2019	26/03/2018	26/09/2018	26/03/2018
	FSW43	02-02/11-15-001	19/03/2019	19/03/2018		
	QWH-UPRR00/WR-19/40-60	02-02/24-14-001				
	QWH-EPRR00/WR-12/60-90	02-02/24-14-004				
	VLP-1602 PRO	02-02/50-10-015				
SER 2	ESVS 30	02-02/03-05-006	03/07/2018	03/07/2017		
	VULB 9168	02-02/24-05-005	18/04/2019	18/04/2018	21/09/2018	21/03/2018
	NW-2000-NB	02-02/50-05-113				
	VLP-1602 PRO	02-02/50-10-015				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 3	FS-Z60	02-02/11-14-001	21/03/2019	21/03/2018	21/09/2018	21/03/2018
	FS-Z110	02-02/11-14-002	21/03/2019	21/03/2018	21/09/2018	21/03/2018
	FS-Z90	02-02/11-14-003	26/03/2019	26/03/2018	26/09/2018	26/03/2018
	FSW43	02-02/11-15-001	19/03/2019	19/03/2018		
	RPG FS-Z170	02-02/11-17-001	22/03/2019	22/03/2018		
	RPG FS-Z220	02-02/11-17-002	22/03/2019	22/03/2018		
	JS4-18004000-30-5A	02-02/17-05-017				
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	08/05/2019	08/05/2018		
	BBHA 9170	02-02/24-05-014	02/06/2018	02/06/2015	26/10/2018	26/10/2017
	QWH-UPRR00/WR-19/40-60	02-02/24-14-001				
	QWH-EPRR00/WR-12/60-90	02-02/24-14-004				
	QWH-WPRR00/WR-10/75-11	02-02/24-14-006				
	FH-SG-170	02-02/24-17-002				
	05-HA25	02-02/24-17-004				
	VLP-1602 PRO	02-02/50-10-015				
	KMS102-0.2 m	02-02/50-11-020				
	NMS111-GL200SC01-NMS1	02-02/50-16-040				
	18N-20	02-02/50-17-003				
	NMS111-GL200SC01-NMS11	02-02/50-17-012				
	Bandpass Filter	02-02/50-17-019				