Produkte
Products

TÜVRheinland®

Prüfbericht - Nr.: *Test Report No.:*	**50274553 001**	**Seite 1 von 53** *Page 1 of 53*

Auftraggeber: *Client:*	**Panasonic Corporation** 600 Saedo-cho, Tsuzuki-ku Yokohama-shi, Kanagawa 224-8539 JAPAN
Gegenstand der Prüfung: *Test Item:*	**DSRC On-Board Unit**

Bezeichnung: *Identification:*	**PVX-U01**	**Serien-Nr.:** *Serial No.:*	**001**
Wareneingangs-Nr.: *Receipt No.:*	**A000971853**	**Eingangsdatum:** *Date of Receipt:*	**2019-08-08**

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of Test Item at Delivery:*	**Good**
Prüfort: *Testing Location:*	**TÜV Rheinland Japan Ltd. – Global Technology Assessment Center** 4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan
Prüfgrundlage: *Test Specification:*	**FCC 47 CFR Part 95, Subpart L** **FCC 47 CFR Part 2, Subpart J** ANSI C63.26-2015 ASTM E2213-03
Prüfergebnis: *Test Result:*	**Der Prüfgegenstand entspricht oben genannter Prüfgrundlage(n).** *The test item passed the test specification(s).*
Prüflaboratorium: *Testing Laboratory:*	**TÜV Rheinland Japan Ltd. – Global Technology Assessment Center** 4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan

geprüft/ *tested by:*

Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*
2019-10-11	Akira Abe / Inspector	a. abe

kontrolliert/ *reviewed by:*

Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*
2019-10-11	Pin Zhang / Reviewer	P. Zhang

Sonstiges / *Other Aspects:*

Abkürzungen:	***P(ass)***	***=***	***entspricht Prüfgrundlage***	***Abbreviations:***	***P(ass)***	***=***	***passed***
	F(ail)	***=***	***entspricht nicht Prüfgrundlage***		***F(ail)***	***=***	***failed***
	N/A	***=***	***nicht anwendbar***		***N/A***	***=***	***not applicable***
	N/T	***=***	***nicht getestet***		***N/T***	***=***	***not tested***

TEST SUMMARY

5.1.1 MAXIMUM TRANSMITTER POWER
RESULT: PASS

5.1.2 DUTY CYCLE

5.1.3 OCCUPIED BANDWIDTH

5.1.4 TRANSMIT SPECTRUM MASK
RESULT: PASS

5.1.5 TRANSMIT CONDUCTED SPURIOUS EMISSIONS
RESULT: PASS

5.1.6 FREQUENCY TOLERANCE
RESULT: PASS

5.2.1 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER
RESULT: PASS

Contents

1. General Remarks

1.1 Complementary Materials

There is no attachment to this test report.

2. Test Sites

2.1 Test Facilities

TÜV Rheinland Japan Ltd. – Global Technology Assessment Center
4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan

The used test equipment is in accordance with CISPR 16 for measurement of radio interference.

The test facility is accredited according to ISO/IEC 17025:2005 by VLAC (member of ILAC) under number VLAC-017.

The test facility is recognized by the Federal Communications Commission (FCC) as a Conformity Assessment Body under designation number JP0017 and test firm registration number 386498.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Serial Number	Equip. ID	Cal. Interval	Cal. Date	Next Cal.
For Antenna Port Conducted Emission							
EMI Receiver	Rohde & Schwarz	ESU 40	100029	RF-0021	1 year	2019-08-05	2020-08-05
EMI Receiver	Rohde & Schwarz	ESW 26	101316	RF-0812	1 year	2019-01-20	2020-01-20
10dB Attenuator	Huber + Suhner	6610_SK-50-1/199_NE	-/-	RF-0766	1 year	2019-03-22	2020-03-22
Temperature Chamber	Voetsch	VT 4018	58566025 090010	BT-8012	1 year	2019-06-18	2020-06-18
For Radiated Emission (RE)							
Radiated Emission Measurement Soft-ware (above 30MHz)	Toyo Corporation	EP7/RE	Ver. 7.4.30	RF-0026	1 year	2019-02-25	2020-02-25
EMI Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	1 year	2019-04-09	2020-04-09
EMI Receiver	Rohde & Schwarz	ESU 40	100029	RF-0021	1 year	2019-08-05	2020-08-05
EMI Receiver	Rohde & Schwarz	ESW 26	101316	RF-0812	1 year	2019-01-20	2020-01-20
RF Selector (10m Chamber)	Toyo Corporation	NS4900	0703-182	RF-0029	1 year	2019-02-25	2020-02-25
Trilog Antenna No. 2, 30-1000MHz	Schwarzbeck	VULB 9168	9168-475	RF-0462	1 year	2019-05-07	2020-05-07
5dB Attenuator	Pasternack	PE7047-5	-/-	RF-0731	1 year	2019-05-07	2020-05-07
Biconical Antenna, 30-300MHz	Schwarzbeck	BBA9106-VHBB912	00235-00963	RF-0784	1 year	2019-03-18	2020-03-18
5dB Attenuator	Pasternack	PE7047-5	-/-	RF-0732	1 year	2019-03-18	2020-03-18
Low Noise Preamplifier, 9kHz-1GHz	TSJ	MLA-10K01-B01-35	1370750	RF-0253	1 year	2019-01-22	2020-01-22
Low Pass Filter, DC-1GHz	R&K	LP1000CH 3	12104001	RF-0515	1 year	2019-01-22	2020-01-22
Horn Antenna, 1-8GHz	Schwarzbeck	BBHA 9120 D	1059	RF-0553	1 year	2019-05-25	2020-05-25
Microwave Preamplifier, 1-8GHz	Toyo Corporation	TPA0108-40	0634	RF-0052	1 year	2019-01-21	2020-01-21
Band Reject Filter, 1-8GHz	Nitsuki	NF-49BT	027	RF-0131	1 year	2019-01-21	2020-01-21
Horn Antenna with Preamplifier, 8-18GHz (RX)	Toyo Corporation	HAP06-18W	00000025	RF-0065	1 year	2019-05-25	2020-05-25
High Pass Filter, 8-18GHz	Micro-Tronics	HPM50107	006	RF-0334	1 year	2019-05-25	2020-05-25
Horn Antenna with Preamplifier, 18-26.5GHz (RX)	Toyo Corporation	HAP18-26N	00000010	RF-0070	1 year	2019-05-25	2020-05-25

Kind of Equipment	Manufacturer	Model Name	Serial Number	Equip. ID	Cal. Interval	Cal. Date	Next Cal.
Horn Antenna with Preamplifier, 26.5 -40GHz (RX)	Toyo Corporation	HAP26-40N	00000007	RF-0069	1 year	2019-05-25	2020-05-25
Preamplifier, 26.5-40GHz	Toyo Corporation	HAP2640-S	-/-	RF-0258	1 year	2019-03-22	2020-03-22
Constant Voltage Constant Frequency Stabilizers and Power Accessories							
CVCF (10m Chamber)	NF Corporation	ES2000U	9067307	RF-0212	1 year	2019-03-22	2020-03-22
CVCF Booster (10m Chamber)	NF Corporation	ES2000B	9074408	RF-0213	1 year	2019-03-22	2020-03-22
DC Power Supply	Agilent	E3646A	MY50350007	RF-0412	N/A	N/A	N/A
True RMS Multimeter	Fluke	87V	97680450	RF-0282	1 year	2019-03-07	2020-03-07
True RMS Multimeter	Fluke	87V	16110176	RF-0414	1 year	2019-06-19	2020-06-19

Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025:2005 has been confirmed before testing.

2.3 Measurement Uncertainty

Table 2: Emission Measurement Uncertainty

Measurement Type	Frequency	Uncertainty
Antenna Port Conducted Emission	20Hz - 40GHz	±1.5dB
Radiated Emission	150kHz - 30MHz	±4.7dB
	30MHz - 1GHz	±4.8dB
	> 1GHz	±3.8dB

3. General Product Information

3.1 Product Function and Intended Use

The **EUT** (**E**quipment **U**nder **T**est) PVX-U01 is an **OBU** (**O**n-**B**oard **U**nit) and is a **DSRC** (**D**edicated **S**hort **R**ange **C**ommunications) transceiver system that is vehicle-mounted. It has also GNSS feature such as GPS to acquire an exact position of a vehicle.

3.2 System Details

Radio standard:	IEEE 802.11p
Application of the DSRC	Private OBU
Specified output power:	19.05dBm **(*)**
DSRC device class	Device Class C
Antenna gain:	+6.0dBi
Antenna type:	Rod
Antenna mounting type:	External
Antenna cable length:	3.0m
Frequency range:	5860MHz **(**)**
Number of channels:	1 **(**)**
Channel spacing:	10MHz
Modulation type:	OFDM coupled with QPSK
Transmit speed	6 Mbps **(**)**
FCC classification:	TNB
Emission designator:	8M26W7W

Note:
(*) This power is defined as “antenna input power” as per the standard of ASTM E2213-03 §8.9.1. Above listed power is the maximum antenna input power of the EUT.
(**) These parameters are specified (limited) by the customer.

Rated voltage:	DC +12V
Rated current:	1.0A
Protection class:	III

Test voltage:	DC +12V DC + 10.2V, DC + 13.8V for Frequency Tolerance measurement (i.e. 85% or 115% of rated voltage)

3.3 Clock Frequencies

The highest frequency generated or used by the EUT is 600MHz for the digital interface.

3.4 Noise Suppressing Parts

Refer to schematics.

4. Test Set-up and Operation Modes

4.1 Test Methodology

The test methodology used is based on the requirements of 47 CFR Part 95.

The test methods, which have been used, are based on ANSI C63.26.

For details, see under each test item.

4.2 Operation Modes

Testing was performed at the operating frequency (5860MHz).

The basic operation mode used for testing is:

A. EUT transmits (TX mode), with full power, at the specific channel (5860MHz), a continuous modulated signal streaming with highest available duty cycle.

Configuration:

1. QPSK, both RF output ports are operating (simultaneous Tx)
2. QPSK, RF output port 1 is only operating (single Tx)

Note: OFDM is coupled with QPSK modulation.

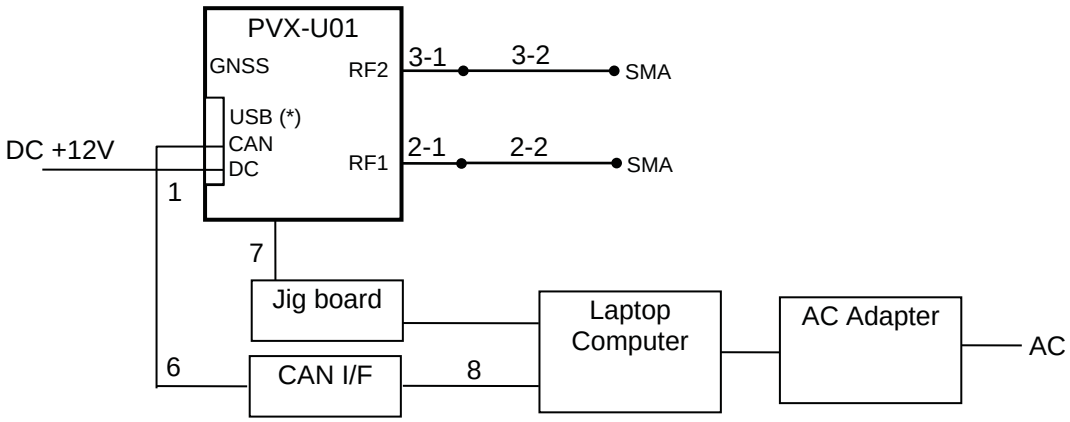
4.3 Physical Configuration for Testing

The test system was configured in a typical fashion (as a customer would normally use it).

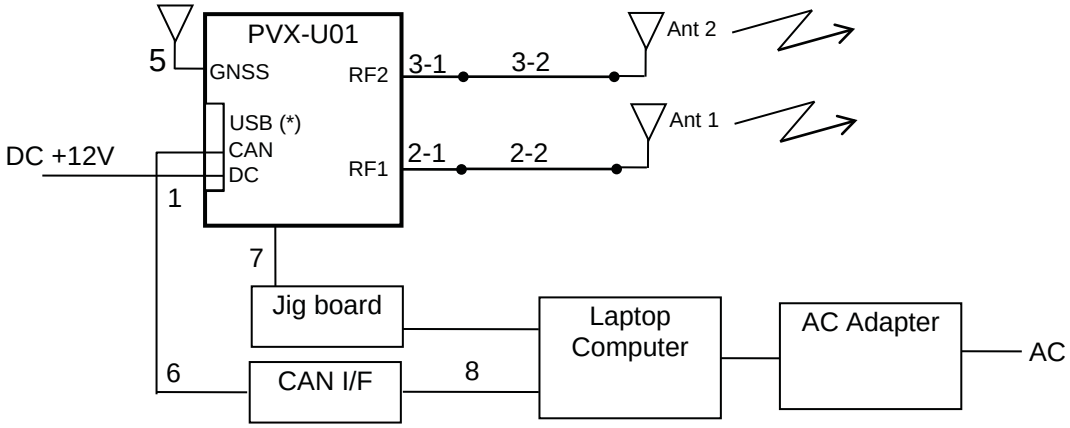
The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.26.

Figure 1: Block Diagram

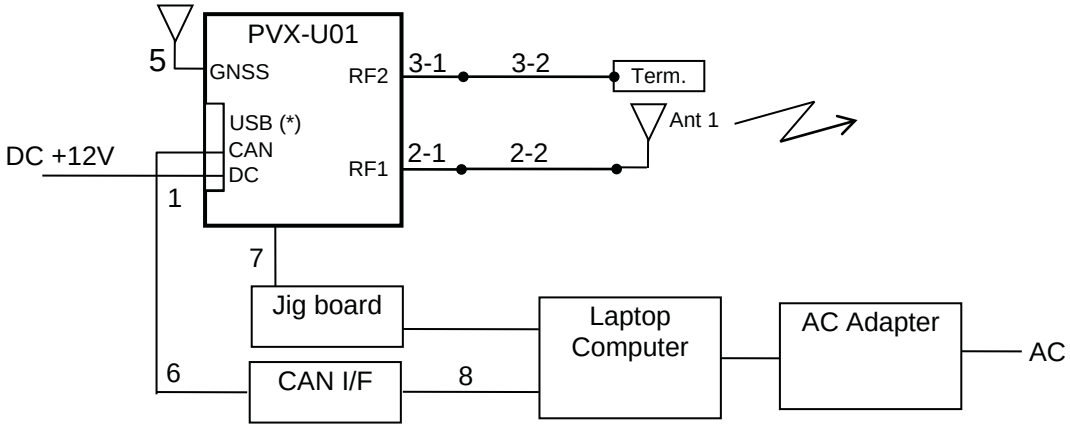
1) Antenna Conducted Measurements



2) Radiated Spurious Emission Measurements (Configuration 1)



3) Radiated Spurious Emission Measurements (Configuration 2)



Note:
(*) USB Interface port does **not** intend to be used by end users. Therefore, this port keeps open during testing.

Table 3: Interfaces present on the EUT

No.	Interface	Cable Length for Testing, Shielding	Interface Classification
1.	DC Input	2m, Un-shielded	DC Power Line
2.	RF Out 2-1	5cm, Un-shielded	RF Out
	RF Out 2-2	3m, Un-shielded	RF Out
3.	RF Out 3-1	5cm, Un-shielded	RF Out
	RF Out 3-2	3m, Un-shielded	RF Out
4.	USB **(*)**	n/a	Signal Line
5.	GNSS	5m, Un-shielded	Signal Line
6.	CAN #1	1m, Un-shielded	Signal Line
7.	Flat Cable **(**)**	0.1m, Un-shielded	Signal Line
8.	USB for CAN I/F **(**)**	1m, Shielded	Signal Line

Note:

(*) USB Interface does **not** intend to be used by end users. Therefore, it kept opened during testing.

(**) This interface cable was used for testing purpose only.

For more details, refer to section: Photographs of the Test Set-Up.

4.4 Test Software

The EUT was provided by the manufacturer with suitable software to allow operation in all the required modes.

Software used for testing:Tera term version 4.95 by T. Teranishi.

This software was running on the laptop computer connected to the EUT. It was used to enable the test operation modes listed in section 4.2 as appropriate.

4.5 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

1. Product: CAN Interface
   Manufacturer: VECTOR
   Model: VN1610
   Rated Voltage: DC 5V
   Input Current: Un-specified
   Protection Class: III
   Serial Number: 007150-040293

2. Product: Laptop PC
   Manufacturer: Panasonic Corporation
   Model: CF-SZ6
   Rated Voltage: DC 16V
   Input Current: Un-specified
   Protection Class: III
   Serial Number: 7DKSA57571

3. Product: AC Adaptor for Laptop PC
   Manufacturer: Panasonic Corporation
   Model: CF-AA64L2C M1
   Rated Voltage: AC 100V–240V
   Input Current: 1.6A-0.9A
   Frequency: 50-60Hz
   Protection Class: II
   Serial Number: 64L2CM117231257A

4. Product: Jig board (**See section 6**)
   Manufacturer: Panasonic Corporation
   Model: Un-specified
   Rated Voltage: DC 5V (USB Bus-powered)
   Input Current: Un-specified
   Protection Class: III
   Serial Number: Un-specified

4.6 Countermeasures to achieve Compliance

No additional measures were employed to achieve compliance.

5. Test Results RADIO

5.1 Conducted Measurements at Antenna Port

5.1.1 Maximum Transmitter Power

RESULT: **PASS**

Date of testing:	2019-08-29
Ambient temperature:	25°C
Relative humidity:	62%
Atmospheric pressure:	1002hPa

Requirements:

FCC §95.3189, §2.1046 and ASTM E2213-03 §8.9.1

Private OBU operates in Channel 172 shall not exceed 28.8dBm at the antenna input power and not exceed 33dBm E.I.R.P.

Test procedure:

ANSI C63.26-2015 §5.2.4.

The maximum average output power was measured at the antenna input port with a spectrum analyzer using an rms detector. The resolution bandwidth was set to 10MHz and the video bandwidth were set to 40MHz.

The readings of the measurements take into account an attenuation by an attenuator to protect a RF port of the spectrum analyzer.

The measurement was performed at the highest output power for the 802.11p radio for each configuration. The results given here below show that the worst case output power.

As the EUT cannot be configured to transmit continuously (i.e., duty cycle < 98%), but the spectrum analyzer (ESW 26, R&S, Equipment ID: RF-0812) has a capability of signal triggering function. Then, this measurement was performed at the highest available duty cycle of the EUT. See the next section of 5.1.2 for details.

Table 4: Conducted Antenna Input Power, Mode A (5860MHz)

Conf.	Freq. [MHz]	Conducted average Power				Summation of average Power		Limit	Margin
		[dBm]		[mW]					
		RF out 1	RF out 2	RF out 1	RF out 2	[mW]	[dBm]	[dBm]	[dBm]
Conf. 1	5860	15.26	16.22	33.573	41.879	75.453	**18.78**	28.8	10.02
Conf. 2	5860	**19.05**	-/-	80.352	-/-	-/-	-/-	28.8	9.75

Note: At configuration 1, the measure-and-sum technique was used as per the section 6.4.3 of ANSI C63.26-2015.

Table 5: E.I.R.P., Mode A (5860MHz)

Conf.	Freq. [MHz]	Max. Cond. Power	Antenna Gain	E.I.R.P.	Limit	Margin
		[dBm]	[dBi]	[dBm]	[dBm]	[dBm]
Conf. 1	5860	18.78	6.0	24.78	33.0	8.22
Conf. 2	5860	19.05	6.0	25.05	33.0	7.95

Figure 2: Conducted Output Power, Mode A (5860MHz) Configuration 1, RF output port 1

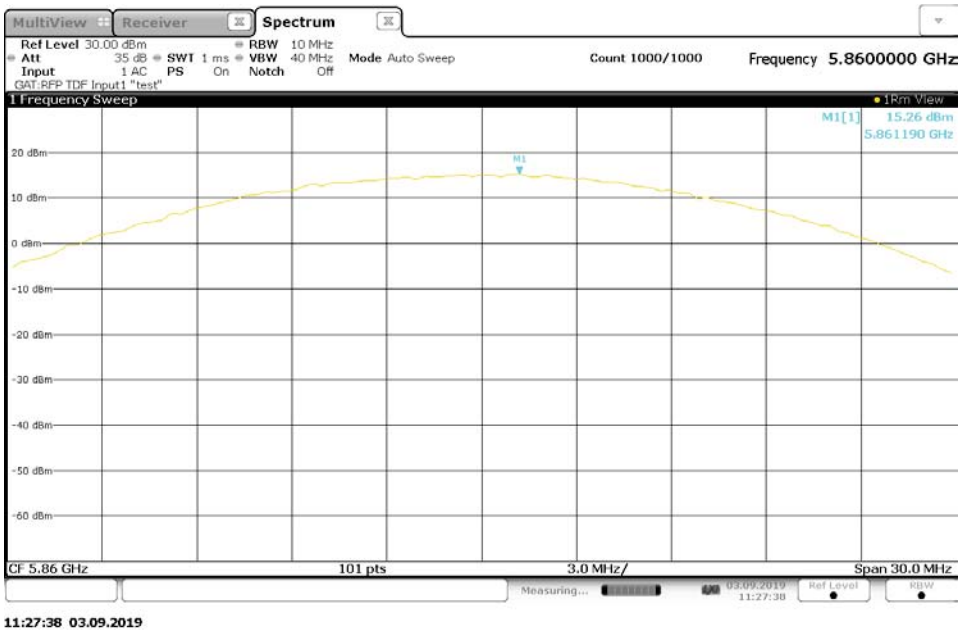


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Figure 3: Conducted Output Power, Mode A (5860MHz) Configuration 1, RF output port 2

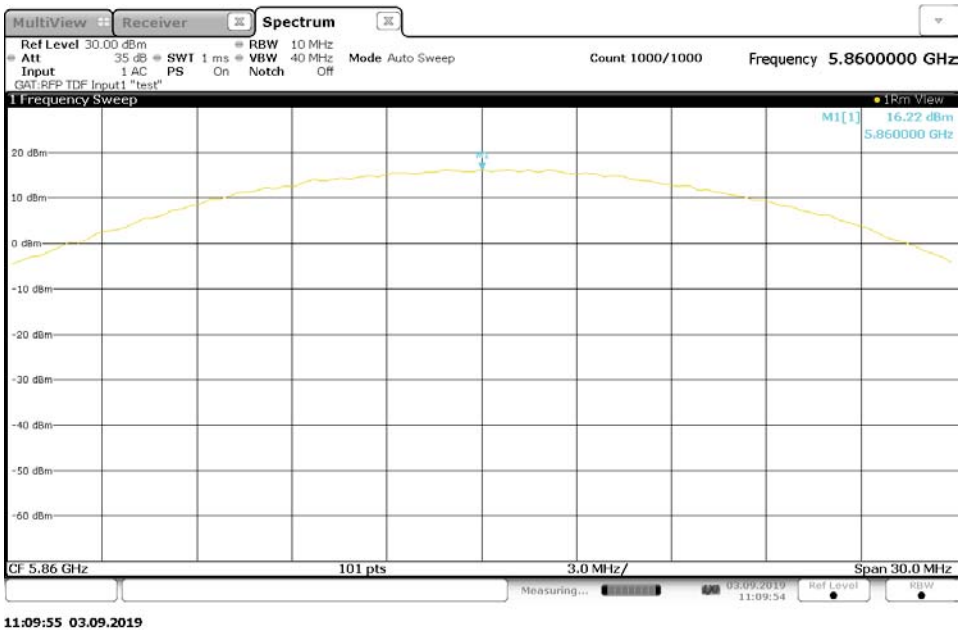
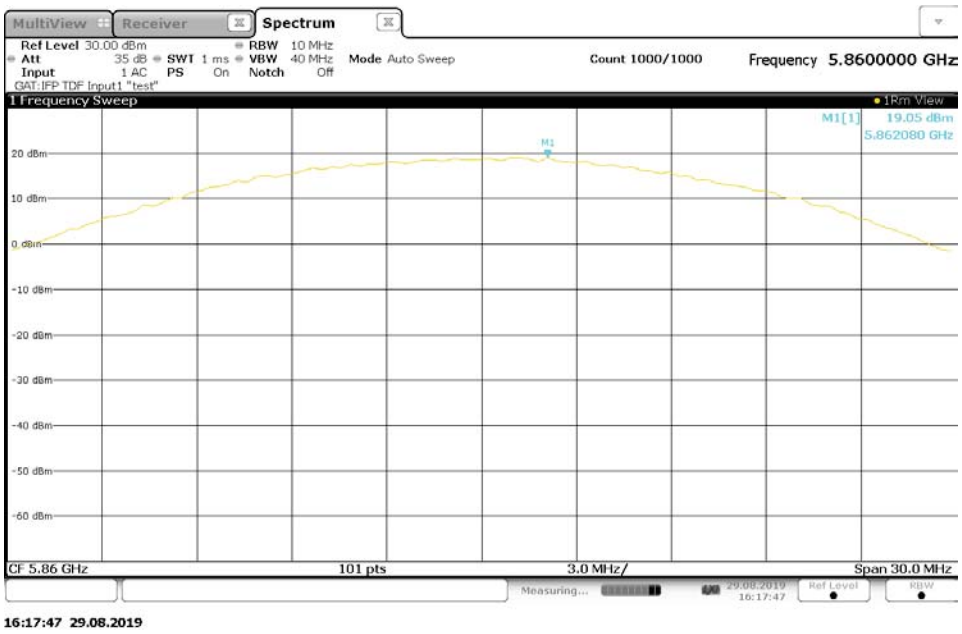


Figure 4: Conducted Output Power, Mode A (5860MHz) Configuration 2, RF output port 2



5.1.2 Duty Cycle

Date of testing: 2019-08-19

Ambient temperature: 25°C
Relative humidity: 68%
Atmospheric pressure: 1007hPa

Requirements:

N/A, this test item was performed as reference.

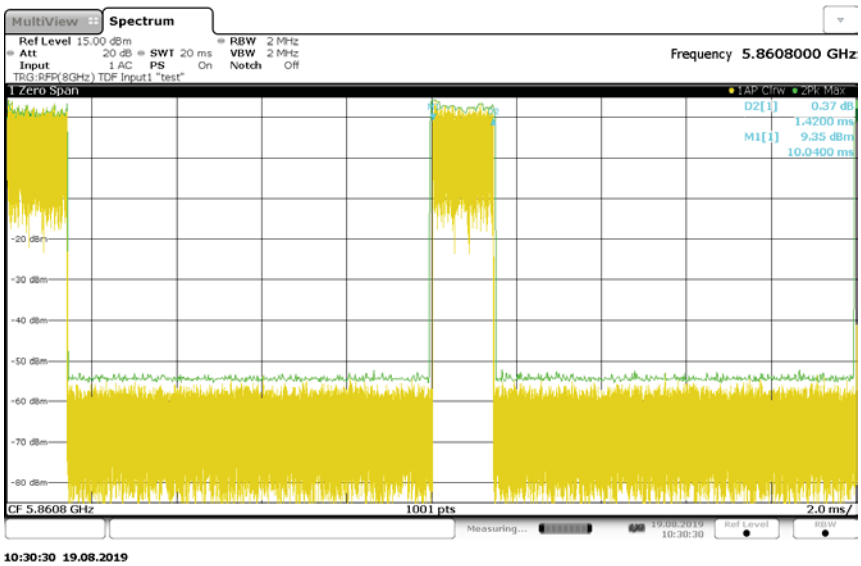
Test procedure:

ANSI C63.26-2015

Table 6: Duty Cycle

Operating Frequency [MHz]	On Time Duration [ms]	Period of the Pulse Train [ms]	Total On Time [%]
5860	1.42	10.0400	14.14

Figure 5: Conducted Output Power, Mode A (5860MHz) Configuration 2, RF output port 1



5.1.3 Occupied Bandwidth

Date of testing:	2019-08-29, 2019-09-03
Ambient temperature:	25, 25°C
Relative humidity:	62, 60%
Atmospheric pressure:	1002, 1013hPa

Requirements:

FCC §2.1049

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

Test procedure:

ANSI C63.26-2015 §5.4

The 99% bandwidth was measured at the each antenna port with a spectrum analyzer using a peak detector and the trace mode to max-hold. The resolution bandwidth was set to in the range of 1% to 5% of the anticipated occupied bandwidth (OBW). And the video bandwidth shall be approximately 3 × RBW. The 99% OBW was measured by using the OBW function of the analyzer with a 99% coverage setting.

Table 7: 99% Occupied Bandwidth

Conf./ Port	Operating Frequency [MHz]	OBW [MHz]	RBW [kHz]	RBW/OBW [%]
Conf. 1 RF port 1	5860	8.237684726	100	1.21
Conf. 1 RF port 2	5860	8.186375612	100	1.22
Conf. 2 RF port 1	5860	8.263190776	100	1.21

Note: RBW was set within a range from 1 to 5% of the observed OBW.

Figure 6: 99% Bandwidth, Mode A (5860MHz) Configuration 1, RF output port 1

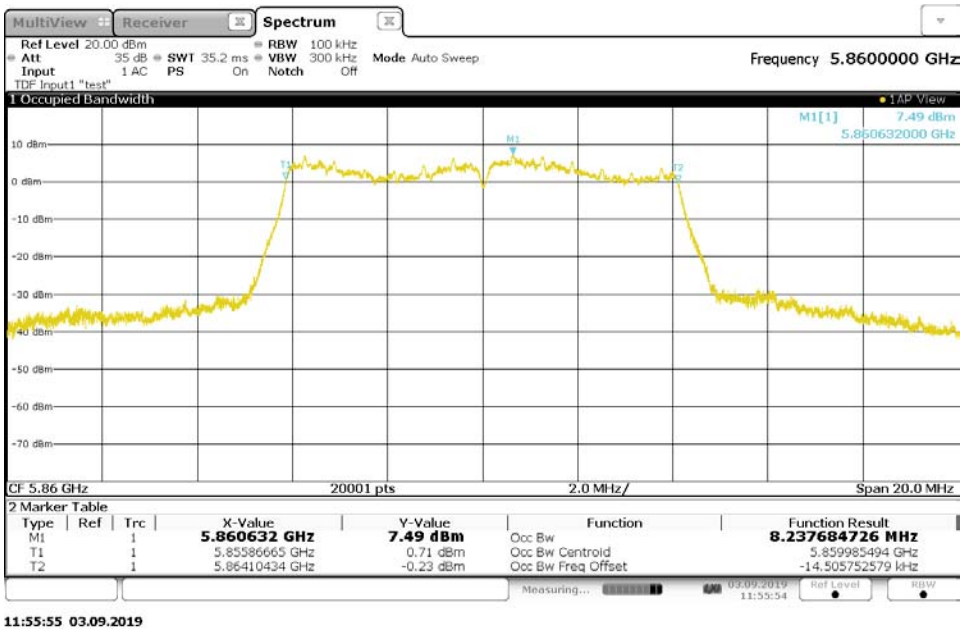
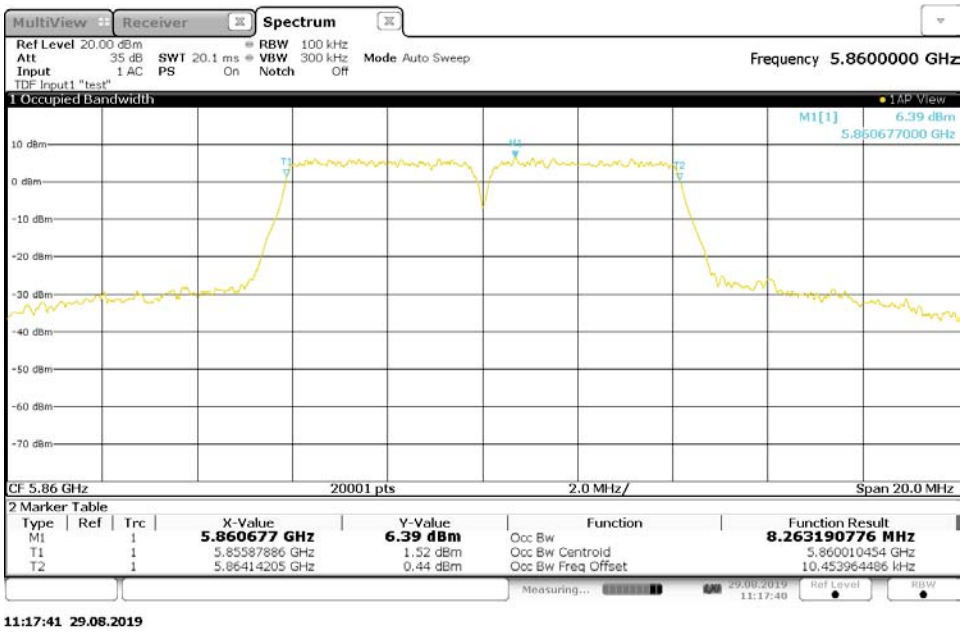


Figure 7: 99% Bandwidth, Mode A (5860MHz) Configuration 1, RF output port 2

Figure 8: 99% Bandwidth, Mode A (5860MHz) Configuration 2, RF output port 1



5.1.4 Transmit Spectrum Mask

RESULT: **PASS**

Date of testing:	2019-09-03
Ambient temperature:	25°C
Relative humidity:	60%
Atmospheric pressure:	1013hPa

Requirements:

FCC §95.3189 and ASTM E2213-03 clause 8.9.2

The transmit spectrum mask is relative to the device class of operation. This EUT belongs to the class C.

Test procedure:

ANSI C63.26-2015 clause 5.7

The transmit spectrum mask was measured at the antenna port with a spectrum analyzer using an rms detector.
The resolution bandwidth was set to 100kHz and the video bandwidth was set to 30kHz as required at the clause 8.9.2 of ASTM E2213-03.

Figure 9: Transmit Spectrum Mask, Mode A (5860MHz) Configuration 1, RF output port 1

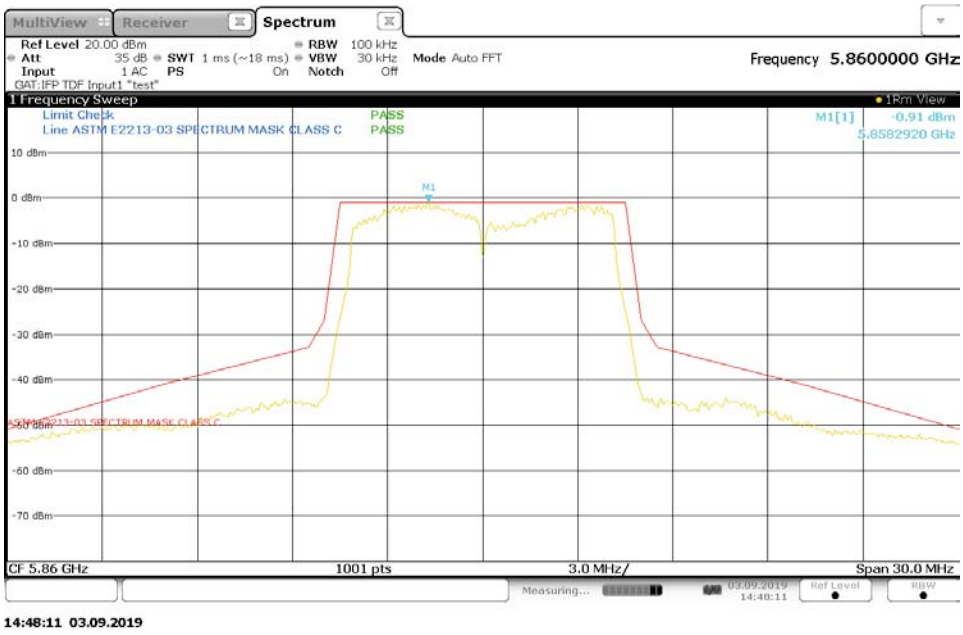


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Figure 10: Transmit Spectrum Mask, Mode A (5860MHz) Configuration 1, RF output port 2

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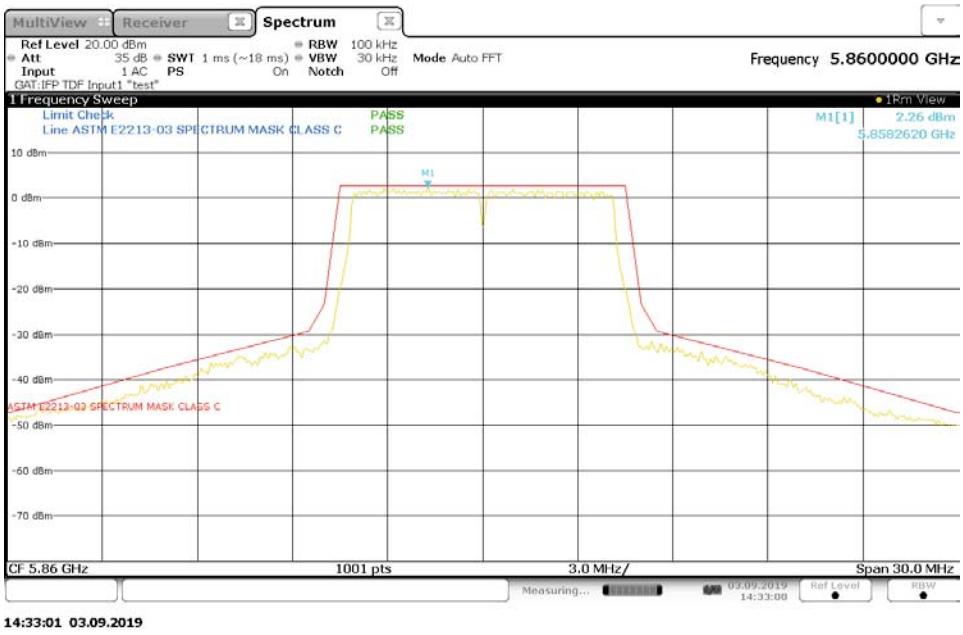
Figure 11: Transmit Spectrum Mask, Mode A (5860MHz) Configuration 2, RF output port 1



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5.1.5 Transmit Conducted Spurious Emissions

RESULT: **PASS**

Date of testing:	2019-08-29, 2019-09-03
Ambient temperature:	25, 25°C
Relative humidity:	62, 60%
Atmospheric pressure:	1002, 1013hPa
Frequency range:	9kHz - 40GHz

Requirements:

FCC §2.1051, §95.3189 and ASTM E2213-03 §8.9.2

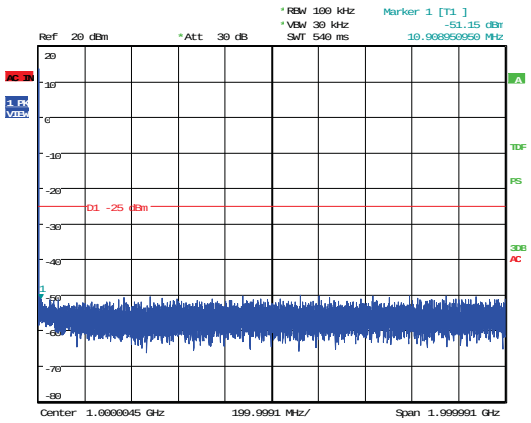
Transmit conducted spurious emissions shall be -25dBm or less within 100kHz outside all channel and band edges.

Test procedure:

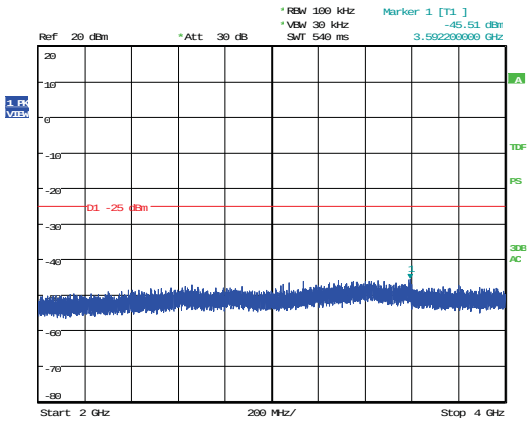
ASTM E2213-03 §8.9.2 and ANSI C63.26-2015 §5.7 and §5.1.1.

The conducted spurious emissions were measured at the antenna port with a spectrum analyzer using a peak detector instead of rms detector. The resolution bandwidth was set to 100kHz and the video bandwidth was set to 30kHz. Measurements were performed from 9kHz to 40GHz.

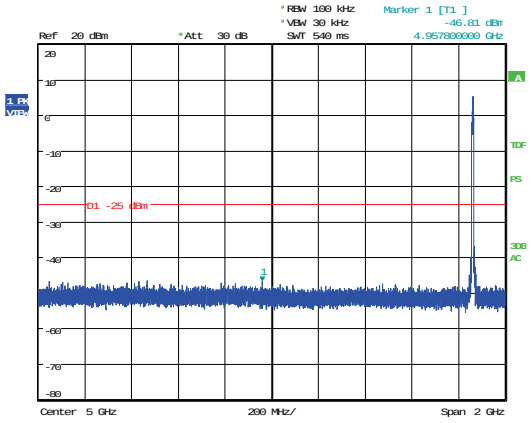
Figure 12: Conducted Spurious Emissions, 9kHz - 12GHz, Mode A (5860MHz) Configuration 1, RF output port 1



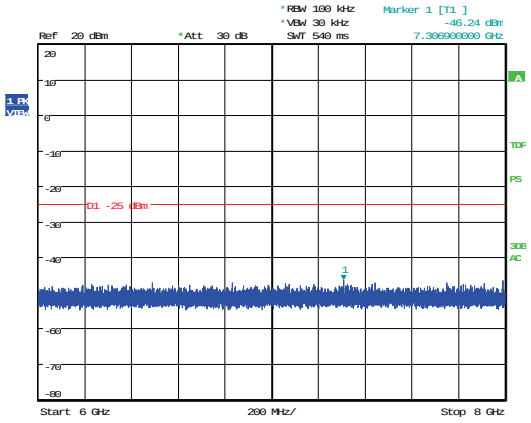
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:52:55



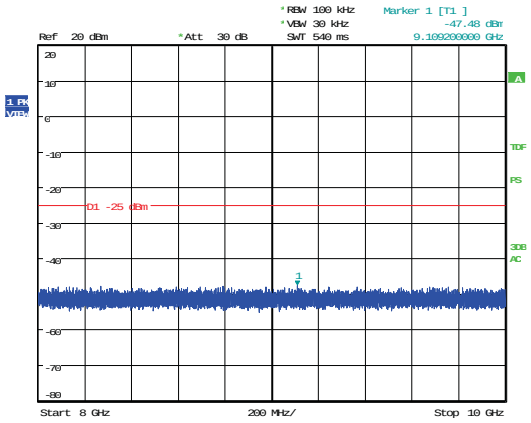
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:53:27



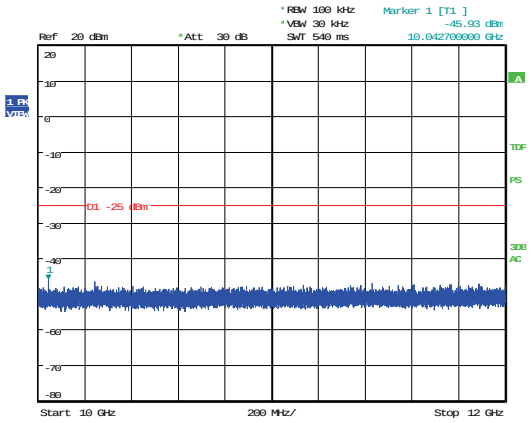
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:54:16



Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:54:43

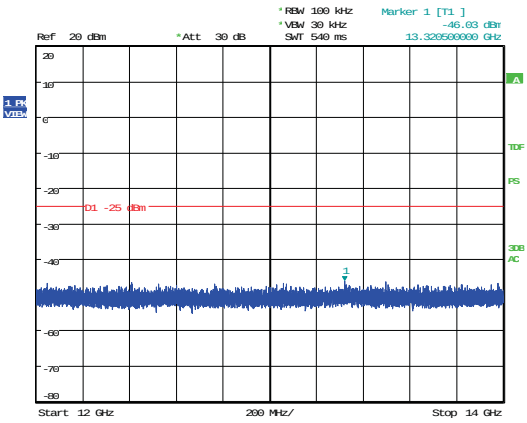


Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:55:02

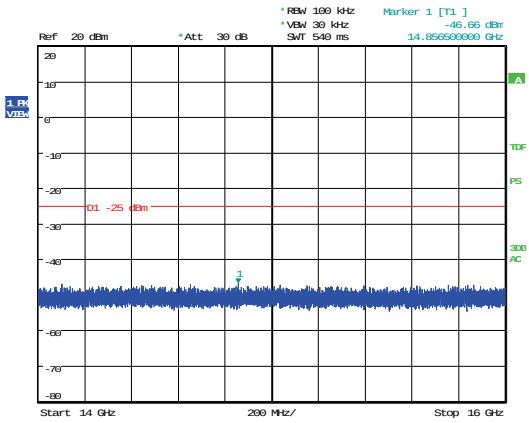


Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:55:38

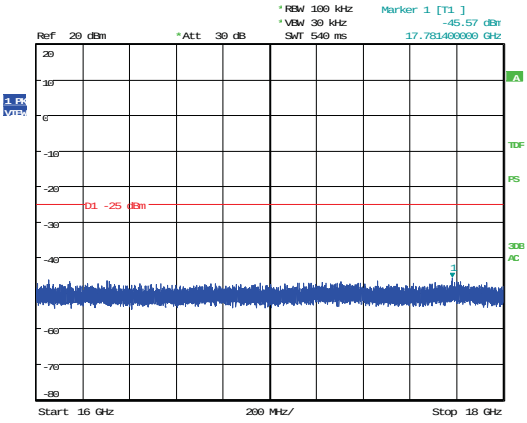
Figure 13: Conducted Spurious Emissions, 12 - 24GHz, Mode A (5860MHz) Configuration 1, RF output port 1



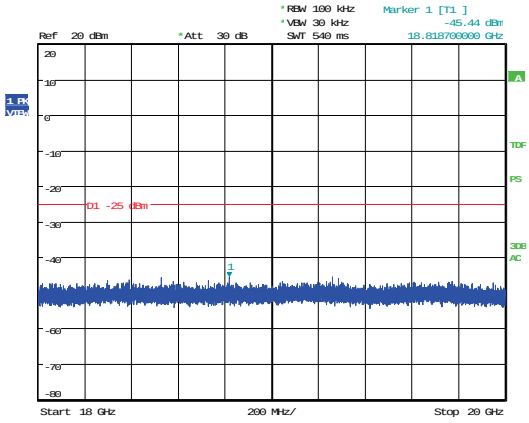
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:55:58



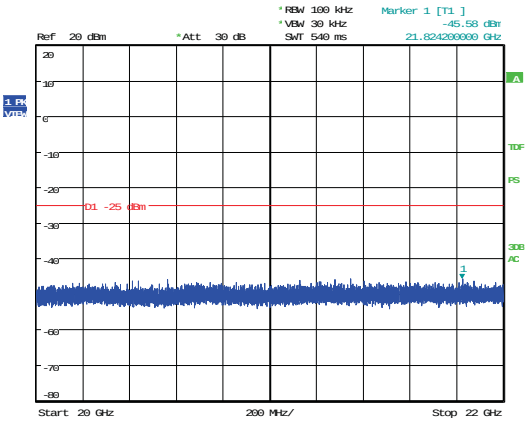
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:56:20



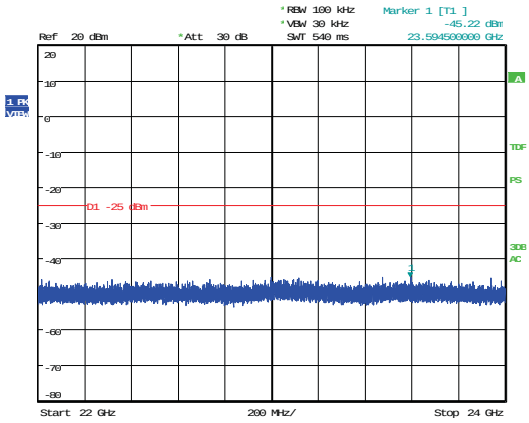
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:56:47



Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:57:22

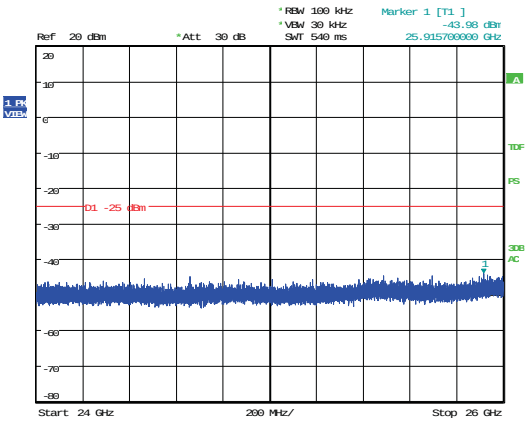


Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:57:51

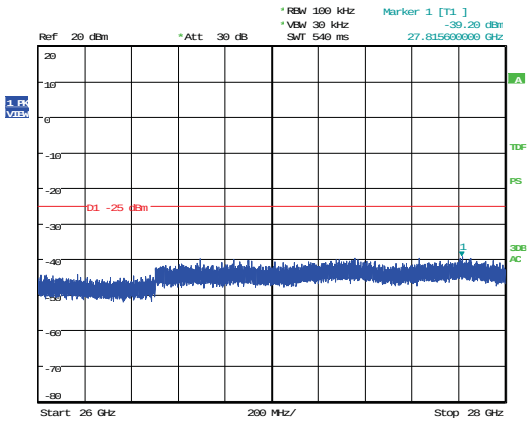


Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:58:11

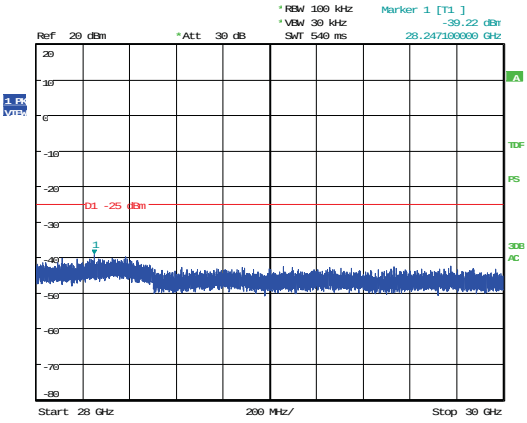
Figure 14: Conducted Spurious Emissions, 24 - 36GHz, Mode A (5860MHz) Configuration 1, RF output port 1



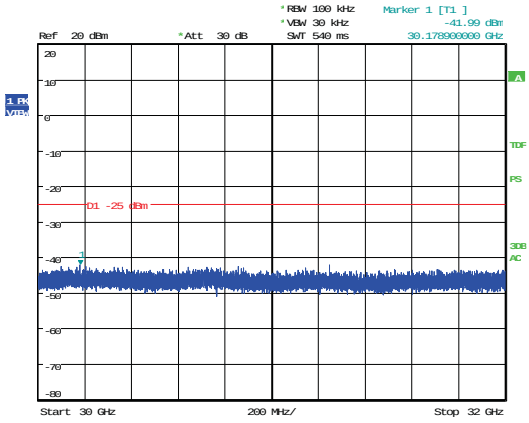
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:58:45



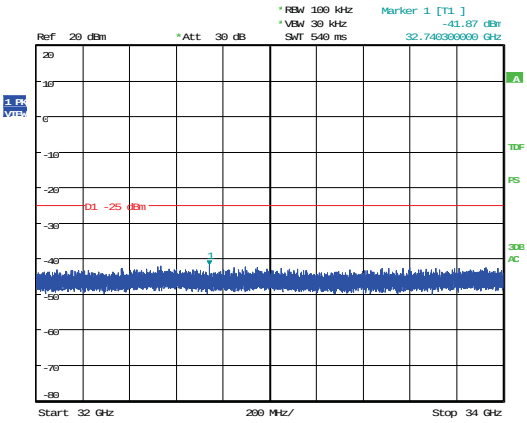
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:59:13



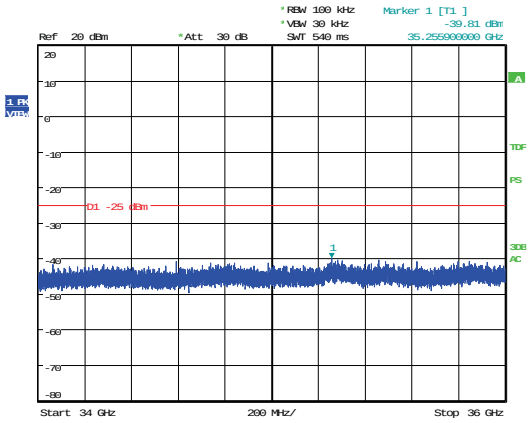
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:59:36



Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:59:57

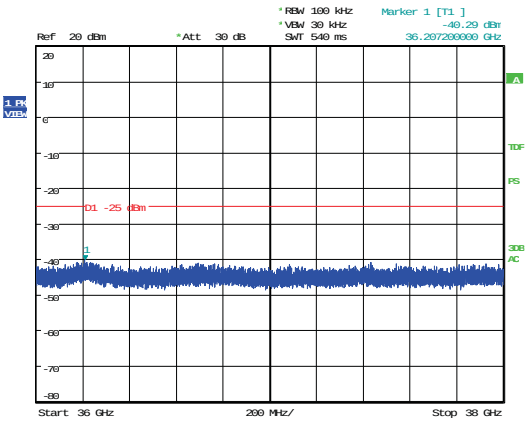


Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 11:00:15

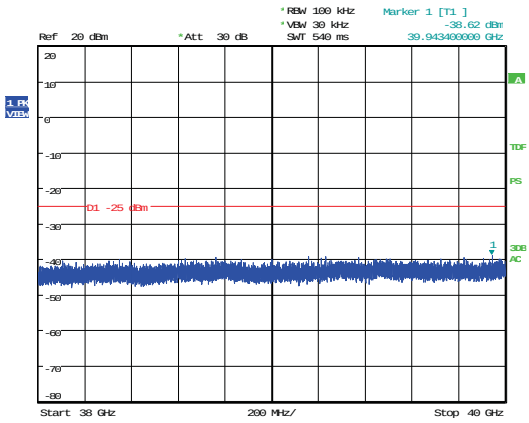


Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 11:00:35

Figure 15: Conducted Spurious Emissions, 36 - 40GHz, Mode A (5860MHz) Configuration 1, RF output port 1

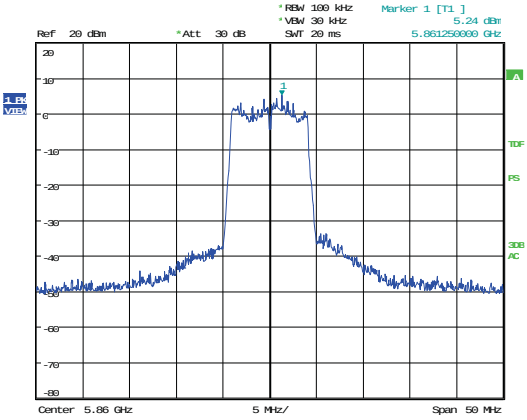


Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 11:00:58



Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 11:01:27

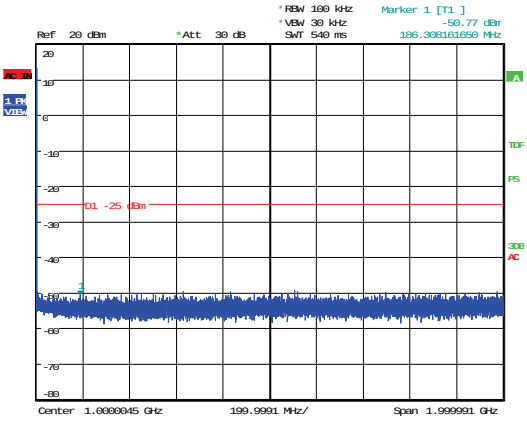
Figure 16: Conducted Spurious Emissions, Fundamental, Mode A (5860MHz) Configuration 1, RF output port 1



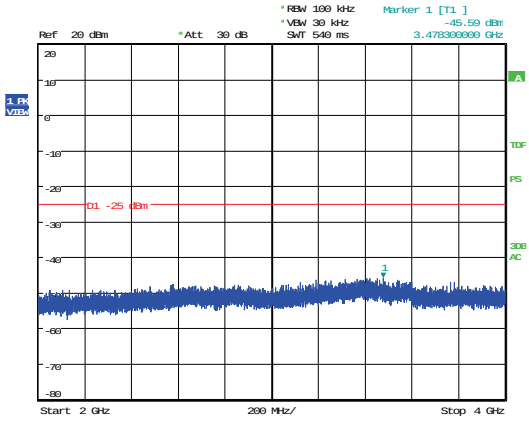
Conducted spurious emissions, mode A1 ANT0
Date: 3.SEP.2019 10:51:33

Note: This spectra was taken as reference plot.

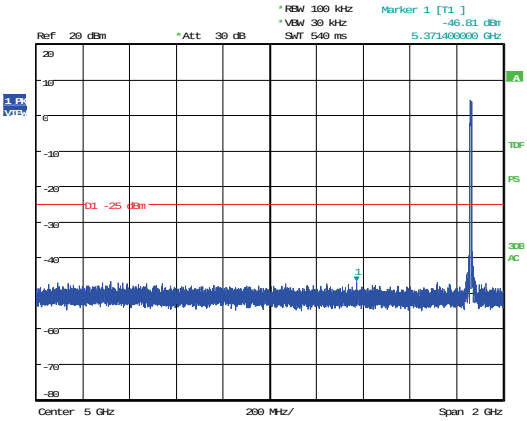
Figure 17: Conducted Spurious Emissions, 9kHz - 12GHz, Mode A (5860MHz) Configuration 1, RF output port 2



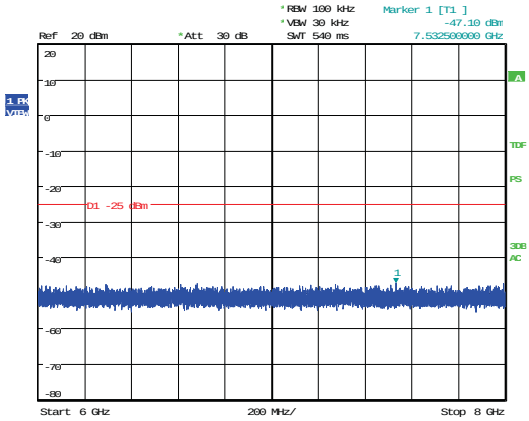
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:14:38



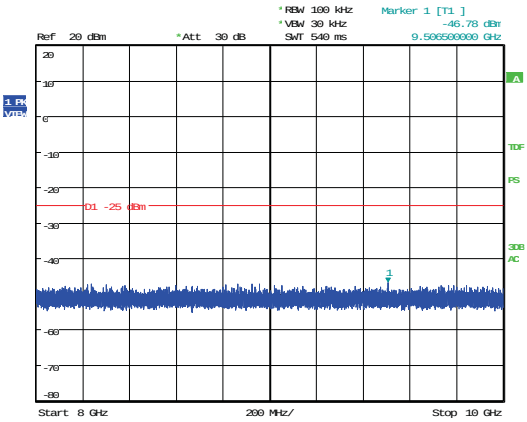
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:15:05



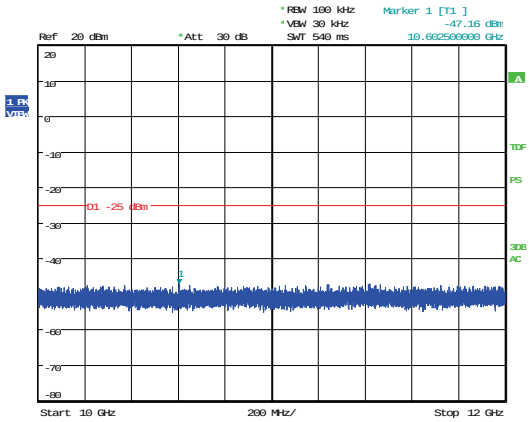
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:15:59



Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:16:40

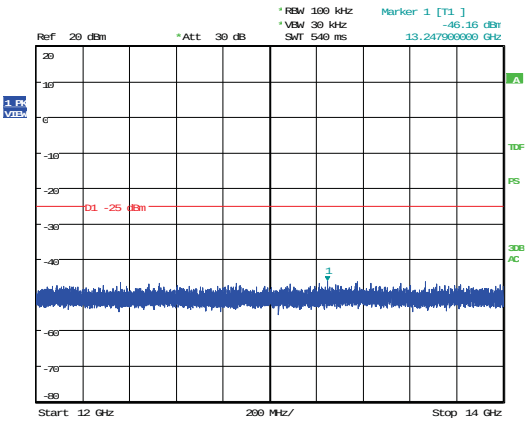


Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:17:11

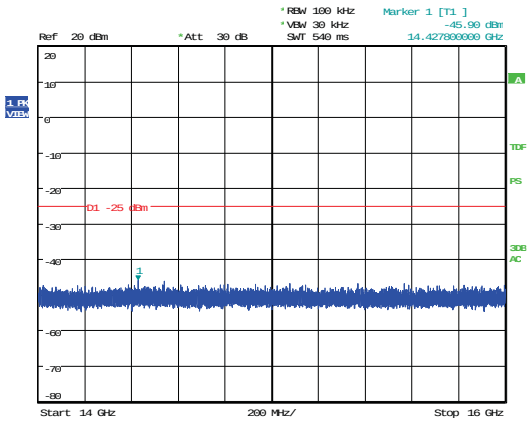


Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:18:02

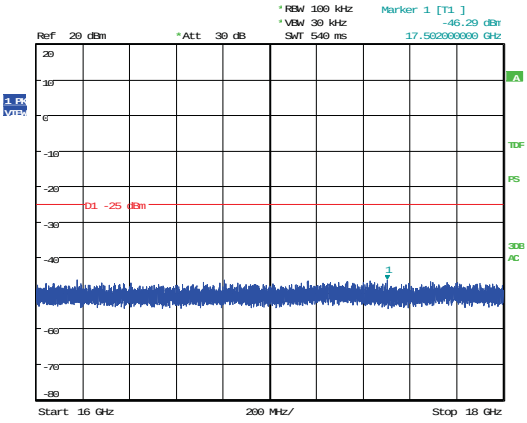
Figure 18: Conducted Spurious Emissions, 12 - 24GHz, Mode A (5860MHz) Configuration 1, RF output port 2



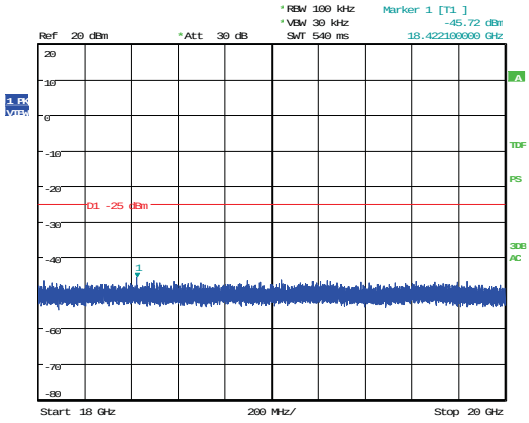
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:18:44



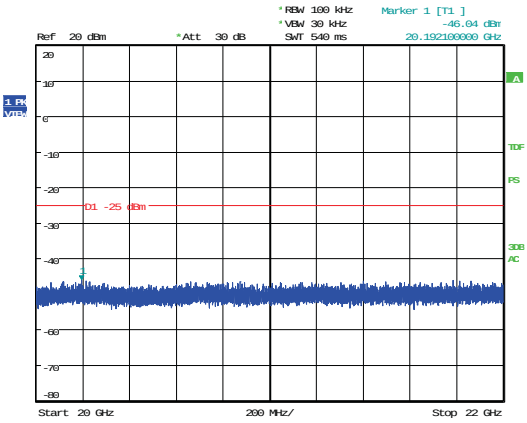
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:19:14



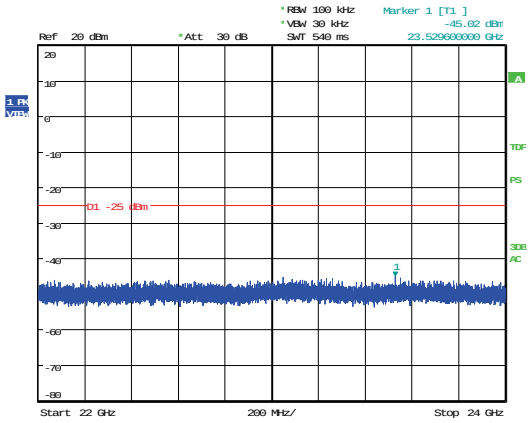
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:19:32



Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:19:57

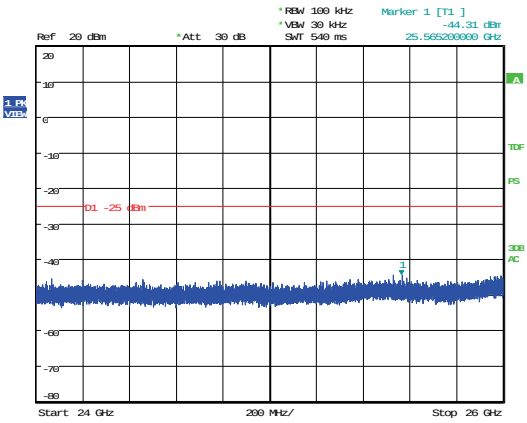


Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:20:21

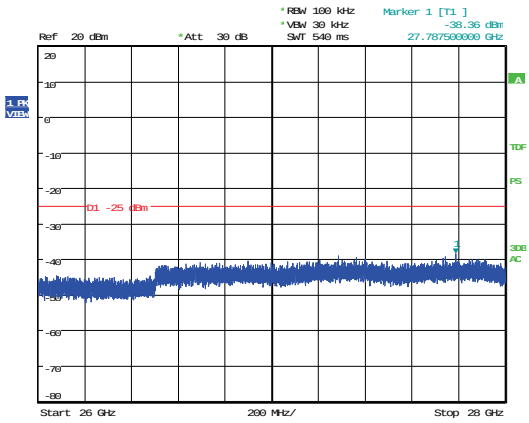


Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:20:47

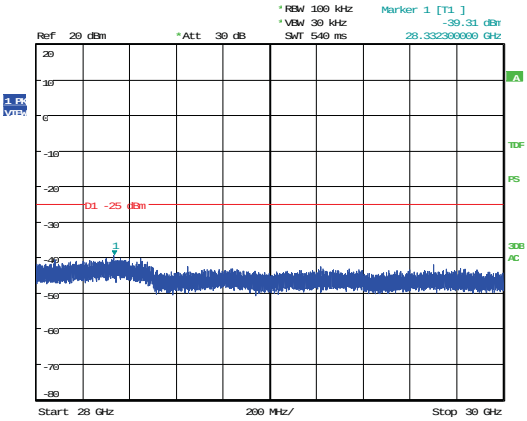
Figure 19: Conducted Spurious Emissions, 24 - 36GHz, Mode A (5860MHz) Configuration 1, RF output port 2



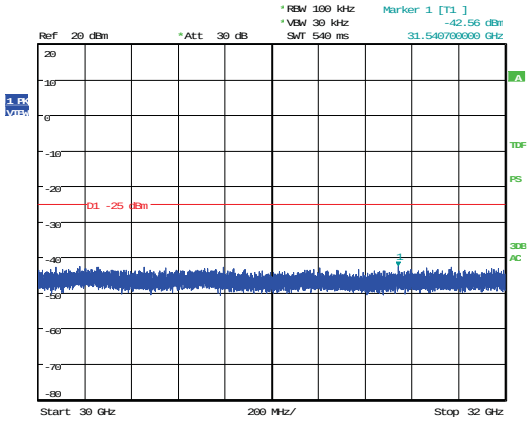
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:21:14



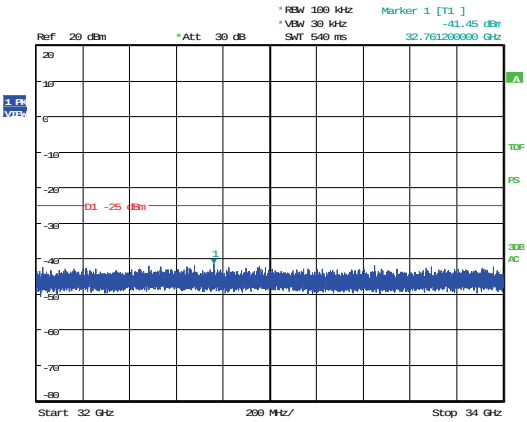
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:21:39



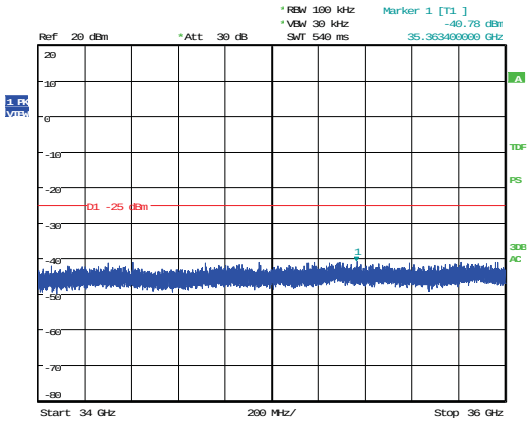
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:22:06



Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:22:43

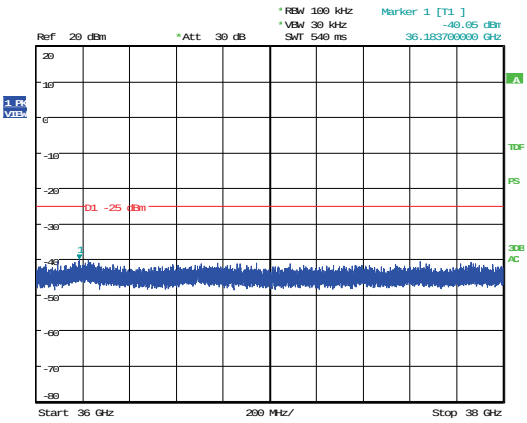


Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:23:03

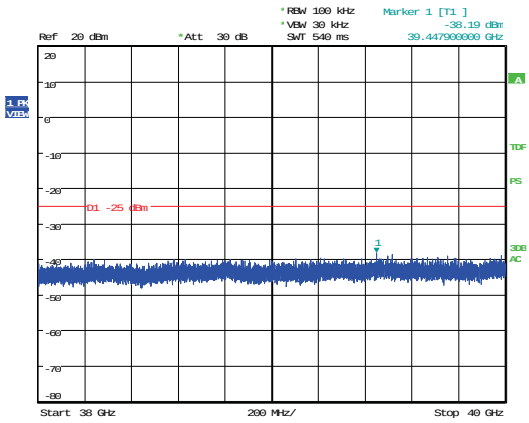


Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:23:27

Figure 20: Conducted Spurious Emissions, 36 - 40GHz, Mode A (5860MHz) Configuration 1, RF output port 2

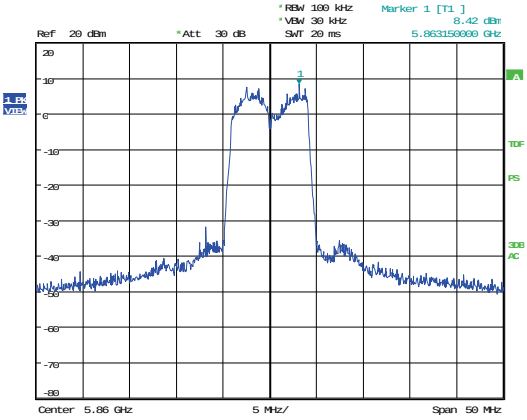


Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:23:52



Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:24:22

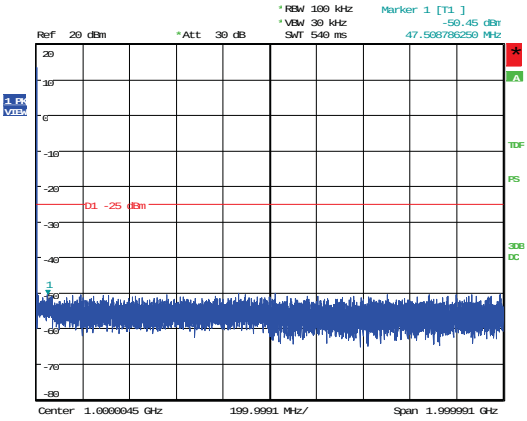
Figure 21: Conducted Spurious Emissions, Fundamental, Mode A (5860MHz) Configuration 1, RF output port 2



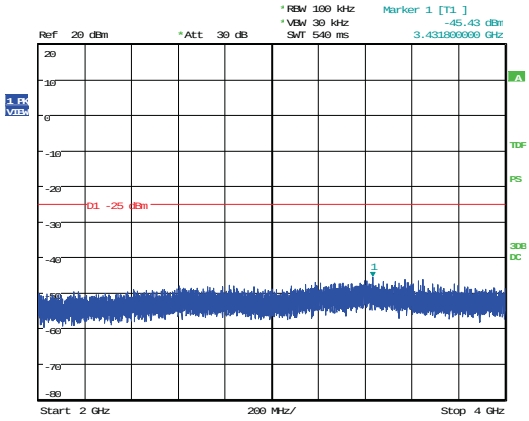
Conducted spurious emissions, mode A1 ANT1
Date: 3.SEP.2019 11:13:50

Note: This spectra was taken as reference plot.

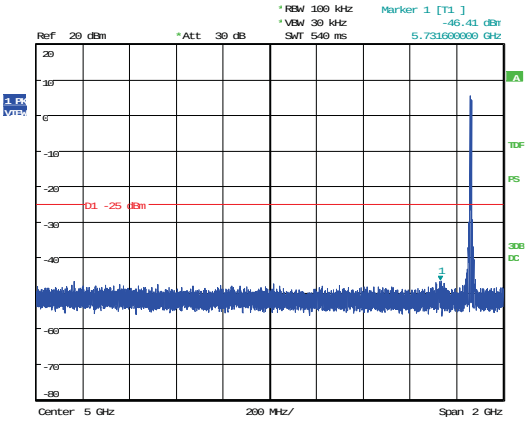
Figure 22: Conducted Spurious Emissions, 9kHz - 12GHz, Mode A (5860MHz) Configuration 2, RF output port 1



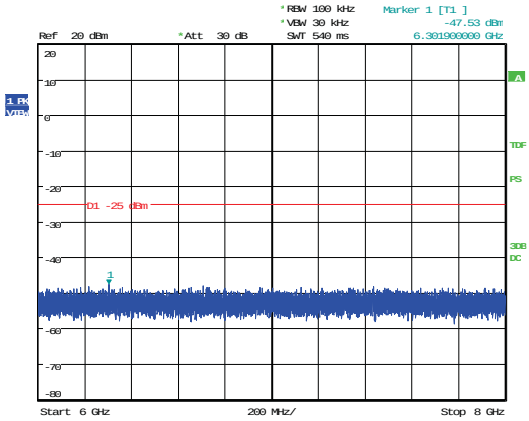
Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:21:01



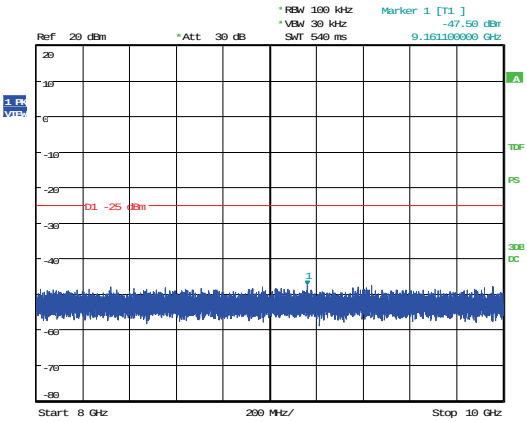
Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:21:15



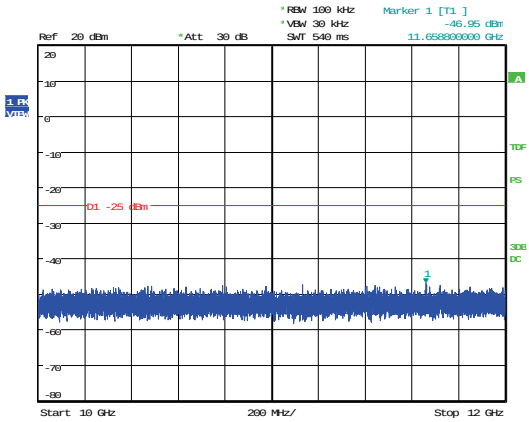
Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:22:07



Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:22:36

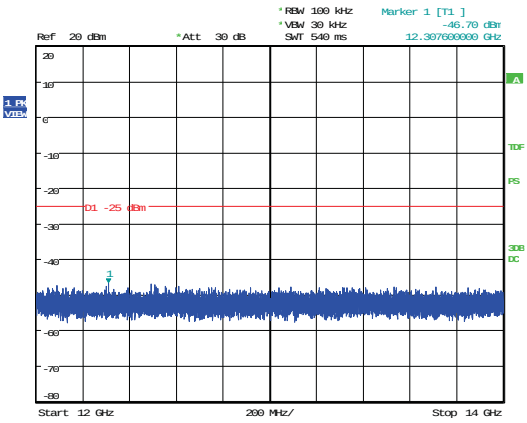


Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:22:48

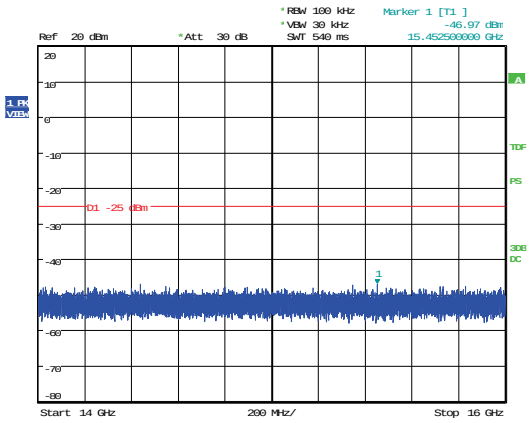


Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:23:04

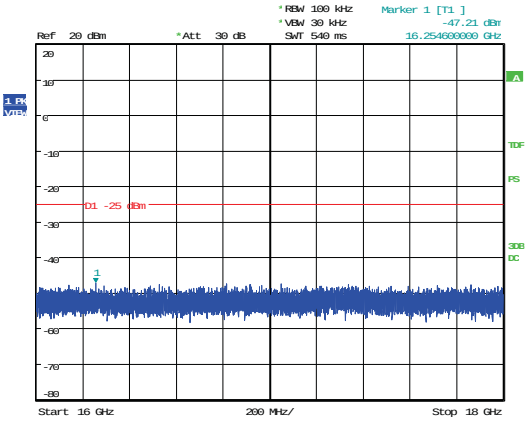
Figure 23: Conducted Spurious Emissions, 12 - 24GHz, Mode A (5860MHz) Configuration 2, RF output port 1



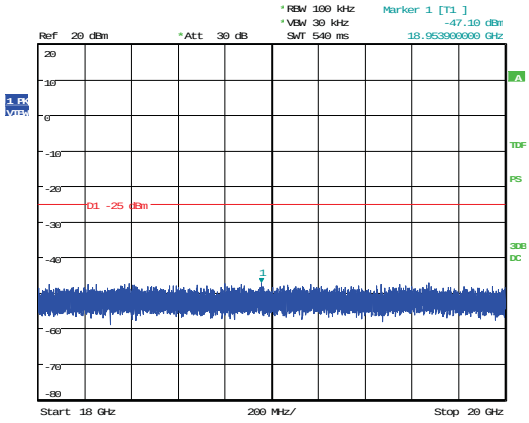
Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:23:18



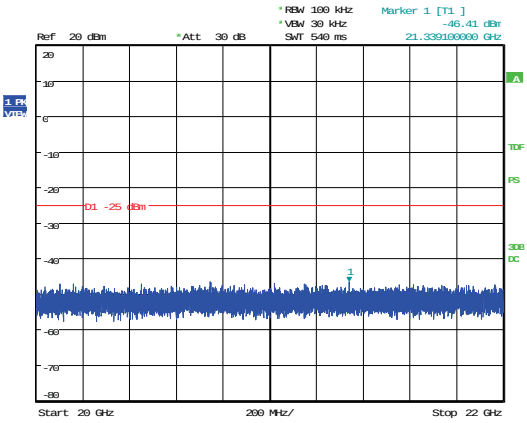
Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:23:30



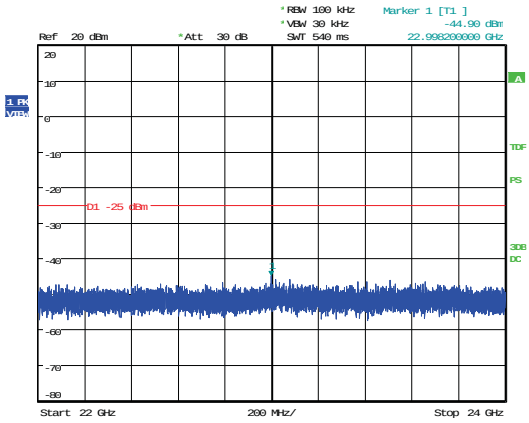
Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:23:42



Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:23:56

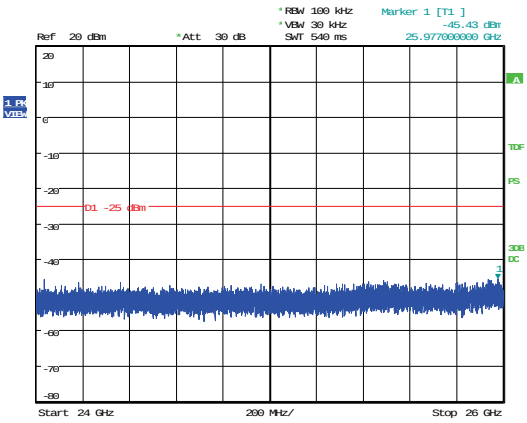


Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:24:09

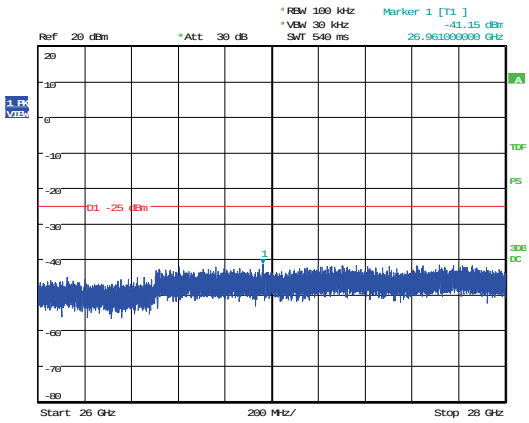


Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:24:20

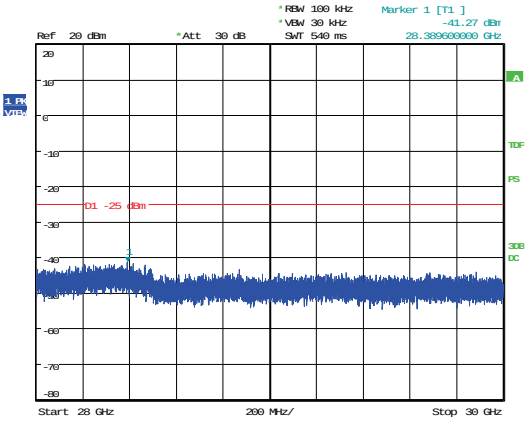
Figure 24: Conducted Spurious Emissions, 24 - 36GHz, Mode A (5860MHz) Configuration 2, RF output port 1



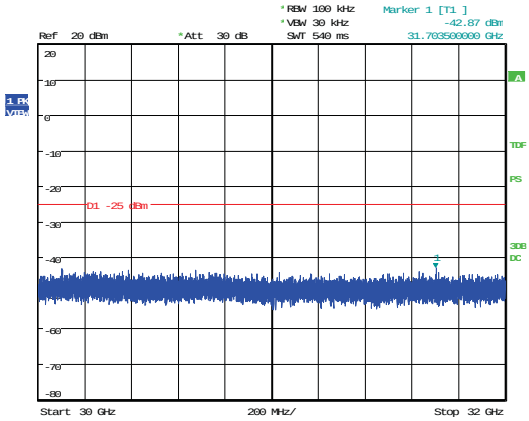
Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:24:42



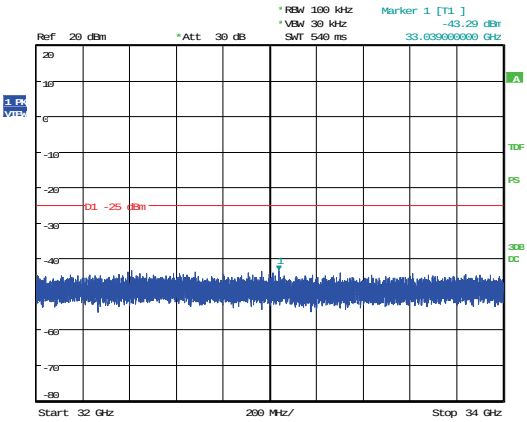
Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:24:57



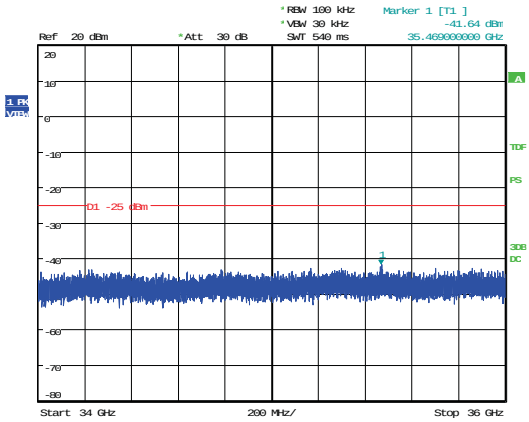
Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:25:12



Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:25:25

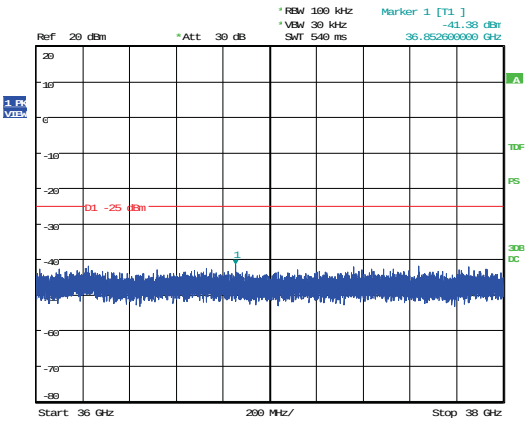


Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:25:42

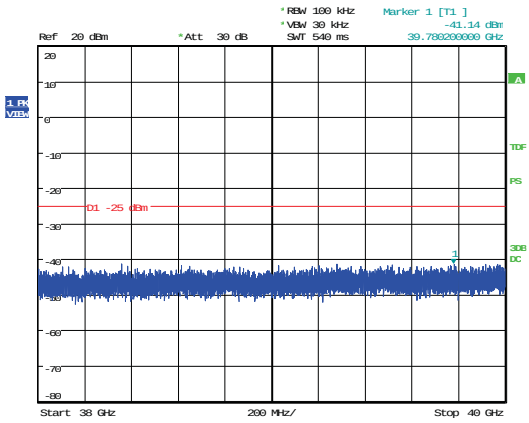


Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:25:53

Figure 25: Conducted Spurious Emissions, 36 - 40GHz, Mode A (5860MHz) Configuration 2, RF output port 1

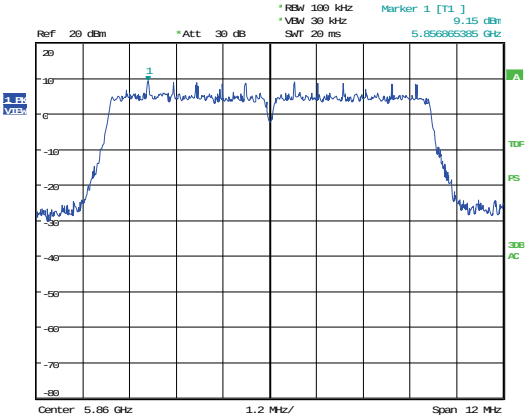


Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:26:11



Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:26:32

Figure 26: Conducted Spurious Emissions, Fundamental, Mode A (5860MHz) Configuration 2, RF output port 1



Conducted spurious emissions, mode A2
Date: 29.AUG.2019 18:20:08

Note: This spectra was taken as reference plot.

5.1.6 Frequency Tolerance

RESULT: **PASS**

Date of testing:	2019-09-10
Ambient temperature:	27°C
Relative humidity:	57%
Atmospheric pressure:	1007hPa

Requirements:

FCC §2.1055 and ASTM E2213-03 clause 8.9.4

Temperature range:	Type 4, -40 to +85°C
Temperature step:	10°C
Voltage variations:	85%, DC +10.2V 115%, DC +13.8V

Test procedure:

ANSI C63.26-2015 §5.6

With the transmitter installed in an environment test chamber, the fundamental frequency shall be measured under the conditions specified above.

As an unmodulated carrier was not available at the EUT, modulated signal was measured by 99% OBW measurement function. Its lower (F_L) and upper (F_U) frequencies were measured and recorded at each test condition. Then it was manually calculated for its center carrier frequency.

Table 8: Frequency Tolerance, Mode A (5860MHz), Configuration 2, RF port 1

Temperature [°C]	Voltage [V]	Nominal Center Frequency [MHz]	Measured Frequency F_L [MHz]	Measured Frequency F_U [MHz]	Calculated Center Frequency [MHz]	Deviation [ppm]	Limit [ppm]
85	12.0	5860	5855.89502	5864.12331	5860.00917	1.56	±10
80	12.0	5860	5855.87933	5864.12948	5860.00441	0.75	±10
70	12.0	5860	5855.87773	5864.12958	5860.00366	0.62	±10
60	12.0	5860	5855.88087	5864.13070	5860.00579	0.99	±10
50	12.0	5860	5855.88446	5864.12965	5860.00706	1.20	±10
40	12.0	5860	5855.88636	5864.13082	5860.00859	1.47	±10
30	12.0	5860	5855.88277	5864.13148	5860.00713	1.22	±10
20	12.0	5860	5855.88359	5864.12844	5860.00602	1.03	±10
20	10.2	5860	5855.88345	5864.12884	5860.00615	1.05	±10
20	13.8	5860	5855.88185	5864.12917	5860.00551	0.94	±10
10	12.0	5860	5855.88165	5864.12759	5860.00462	0.79	±10
0	12.0	5860	5855.88294	5864.12842	5860.00568	0.97	±10
-10	12.0	5860	5855.88380	5864.12872	5860.00626	1.07	±10
-20	12.0	5860	5855.88236	5864.12863	5860.00550	0.94	±10
-30	12.0	5860	5855.88066	5864.12871	5860.00469	0.80	±10
-40	12.0	5860	5855.87993	5864.12742	5860.00368	0.63	±10

Note:
Center Frequency was calculated by the following;
Center Frequency = $(F_H-F_L)/2 + F_L$
Grey shading area shows the highest power in the test result.

5.2 Radiated Measurements

5.2.1 Radiated Spurious Emissions of Transmitter

RESULT: **PASS**

Date of testing:	2019-08-19, 2019-08-20, 2019-08-21 2019-08-28
Ambient temperature:	20, 20, 21, 20°C
Relative humidity:	67, 68, 69, 65%
Atmospheric pressure:	1007, 1007, 1006, 1003hPa
Frequency range:	30MHz - 40GHz
Measurement distance:	3m
Kind of test site:	Semi Anechoic Chamber

Requirements:

FCC §2.1053, §95.3189 and ASTM E2213-03 clause 8.9.2

Radiated emissions outside frequency bands of operation shall be -25dBm or less within 100kHz outside all channel and band edges.

The power limit of -25dBm was converted to the corresponding field strength limit of 70.2dBuV/m at 3m distance by the formula defined by the Annex C.2 of ANSI C63.26-2015.

Test procedure:

ANSI C63.26-2015 §5.5, §5.2.7 and §5.1.1

The EUT was placed on a nonconductive turntable. The table height was 0.8m for measurements below 1GHz or was 1.5m for measurements above 1GHz. Before final measurements of radiated emissions were performed, the EUT was scanned to determine its emission spectrum profile. The physical arrangement of the test system, the associated cabling and the EUT orientation (X, Y and Z) were varied in order to ensure that maximum emission amplitudes were attained.

The spectrum was examined from 30MHz to 40GHz as per the section 5.1.1 of ANSI C63.26-2015. Final radiated emission measurements were made at 3m distance.

At each frequency where a spurious emission was found, the EUT was rotated 360° and the antenna was raised and lowered from 1 to 4m in order to determine the emission's maximum level. Measurements were taken using both horizontal and vertical antenna polarizations.

For the emissions, measurements were performed with a spectrum analyzer using the settings RBW = 100kHz & VBW 30kHz as per ASTM E2213-03 clause 8.9.2.

Absorbers have been placed on the floor between the EUT and the measuring antenna for testing above 1GHz.

The highest emission amplitudes relative to the appropriate limit were recorded in this report. Emissions other than those mentioned are small or not detectable.

No spurious emission less than or equal to 20dB within the limit of 70.2 dBuV/m was found below 1GHz. However, further measurement was conducted and the general limit of §15.209 was applied for reference. For emissions between 30MHz and 1GHz, measurements were performed with a test receiver operating in the CISPR quasi-peak detection mode with a 6dB bandwidth set to 120kHz.

Table 9: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode A (5860MHz) Configuration 1

Frequency [MHz]	EUT / Antenna Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP [dBµV/m]	Limit (*) [dBµV/m]	Margin QP [dB]	Height [cm]	Angle [°]
47.851	X/V	35.7	-21.9	13.8	40.0	26.2	105	186
53.647	X/V	44.5	-21.9	22.6	40.0	17.4	100	217
65.556	X/V	53.1	-23.3	29.8	40.0	10.2	100	108
71.753	X/V	40.3	-24.1	16.2	40.0	23.8	100	187
76.369	X/V	49.3	-24.7	24.6	40.0	15.4	100	359
181.405	X/H	42.3	-22.3	20.0	43.5	23.5	181	134
320.004	X/H	53.6	-19.2	34.4	46.0	11.6	100	294
352.619	X/H	37.7	-18.0	19.7	46.0	26.3	209	168

Note: Level QP = Reading QP + Factor

(*) The general limit of §15.209 was applied instead of the limit of -25dBm.

Table 10: Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (5860MHz) Configuration 1

Freq. [MHz]	EUT / Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1340.347	X/V	40.0	-16.1	23.9	70.2	46.3	154	340
1587.532	X/V	54.1	-16.5	37.6	70.2	32.6	193	14
2993.507	X/V	40.1	-13.7	26.4	70.2	43.8	175	43
5047.844	X/H	38.8	-7.4	31.4	70.2	38.8	160	323
7167.688	X/V	39.2	-1.7	37.5	70.2	32.7	155	215
11719.962	X/V	49.6	-5.9	43.7	70.2	26.5	153	7
17575.560	X/H	37.0	-4.0	33.0	70.2	37.2	119	106
19306.224	X/H	38.8	-11.7	27.1	70.2	43.1	159	35
23440.054	X/H	40.7	-11.5	29.2	70.2	41.0	172	7
29238.524	X/V	52.8	-22.8	30.0	70.2	40.2	167	325
35212.292	X/H	54.1	-22.6	31.5	70.2	38.7	154	41

Note: Level AV = Reading AV + Factor

Table 11: Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (5860MHz) Configuration 1

Freq. [MHz]	EUT / Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit (*) [dBµV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1340.347	X/V	54.1	-16.1	38.0	70.2	36.0	154	340
1587.532	X/V	58.8	-16.5	42.3	70.2	31.7	193	14
2993.507	X/V	58.1	-13.7	44.4	70.2	29.6	175	43
5047.844	X/H	52.7	-7.4	45.3	70.2	28.7	160	323
7167.688	X/V	53.3	-1.7	51.7	70.2	22.3	155	215
11719.962	X/V	51.6	-5.9	45.7	70.2	28.3	153	7
17575.560	X/H	38.7	-4.0	34.7	70.2	39.3	119	106
19306.224	X/H	52.4	-11.7	40.7	70.2	33.3	159	35
23440.054	X/H	54.0	-11.5	42.5	70.2	31.5	172	7
29238.524	X/V	66.9	-22.8	44.1	70.2	29.9	167	325
35212.292	X/H	68.6	-22.6	46.0	70.2	28.0	154	41

Note: Level PK = Reading PK + Factor

(*) Limit is defined as Average limit, however, Peak measurements were additionally performed.

Table 12: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode A (5860MHz) Configuration 2

Freq. [MHz]	EUT / Antenna Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP [dBµV/m]	Limit (*) [dBµV/m]	Margin QP [dB]	Height [cm]	Angle [°]
48.002	X/V	35.4	-24.9	10.5	40.0	29.5	105	116
53.627	X/V	57.6	-25.2	32.4	40.0	7.6	116	159
71.925	X/V	38.0	-25.4	12.6	40.0	27.4	110	205
162.919	X/H	48.9	-21.5	27.4	43.5	16.1	210	79
266.661	X/H	50.7	-16.6	34.1	46.0	11.9	133	68
363.823	X/H	47.6	-17.7	29.9	46.0	16.1	116	154
377.227	X/V	41.7	-17.1	24.6	46.0	21.4	110	6
932.472	X/H	30.9	-7.4	23.5	46.0	22.5	342	275

Note: Level QP = Reading QP + Factor

(*) The general limit of §15.209 was applied instead of the limit of -25dBm.

Table 13: Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (5860MHz) Configuration 2

Freq. [MHz]	EUT / Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1571.653	V	61.7	-16.4	45.3	70.2	24.9	163	23
2996.375	V	69.3	-13.7	55.6	70.2	14.6	201	335
7454.270	V	52.8	-0.8	52.0	70.2	18.2	160	22
7934.283	V	52.9	-0.4	52.5	70.2	17.7	167	138
11720.201	V	51.8	-5.9	45.9	70.2	24.3	150	256
17581.624	V	40.1	-3.9	36.2	70.2	34.0	156	186
19326.014	V	38.7	-11.7	27.0	70.2	43.2	175	172
23396.836	H	37.8	-11.5	26.3	70.2	43.9	192	346
29312.424	H	53.2	-23.0	30.2	70.2	40.0	153	71
35049.008	H	50.5	-22.7	27.8	70.2	42.4	160	148

Note: Level AV = Reading AV + Factor

Table 14: Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (5860MHz) Configuration 2

Freq. [MHz]	EUT / Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit (*) [dBµV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1571.653	V	61.7	-16.4	45.3	70.2	24.9	163	23
2996.375	V	69.3	-13.7	55.6	70.2	14.6	201	335
7454.270	V	52.8	-0.8	52.0	70.2	18.2	160	22
7934.283	V	52.9	-0.4	52.5	70.2	17.7	167	138
11720.201	V	55.3	-5.9	49.4	70.2	20.8	150	256
17581.624	V	41.6	-3.9	37.7	70.2	32.5	156	186
19326.014	V	52.9	-11.7	41.2	70.2	29.0	175	172
23396.836	H	51.9	-11.5	40.4	70.2	29.8	192	346
29312.424	H	67.4	-23.0	44.4	70.2	25.8	153	71
35049.008	H	64.2	-22.7	41.5	70.2	28.7	160	148

Note: Level PK = Reading PK + Factor

(*) Limit is defined as Average limit, however, Peak measurements were additionally performed.

7. List of Tables

8. List of Figures

9. List of Photographs