

FCC and ISED Canada Testing of the

Esprit Model Inc.
JETIDS12US

In accordance with FCC 47 CFR part 15.247 and
ISED Canada's Radio Standards Specifications
RSS-247

Prepared for: Esprit Model Inc.
4253 Pinewood Road
Melbourne, FL 32934

FCC ID: ONTJETIDS12US
IC: 10491A-JETIDS12US

COMMERCIAL-IN-CONFIDENCE

Date: 02. December 2019

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RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Authorized Signatory	Peter Walsh	2019 -December-02	
Testing	Thierry Jean-Charles	2019-December-02	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

FCC Accreditation
Designation Number US1063 Tampa, FL Test Laboratory

Innovation, Science, and Economic Development Canada
Accreditation
Site Number 2087A-2 Tampa, FL Test Laboratory

EXECUTIVE SUMMARY

Samples of this product were tested and found to be in compliance with 15.247 and ISED Canada's RSS-247



A2LA Cert. No. 2955.15

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	2019-November-25
2	Updated product information (Section 1.4.1)	2019-December-02



1.2 Introduction

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations Section 15.247 and Innovation Science and Economic Development Canada's Radio Standards Specification RSS-247 for the tests documented herein.

Applicant	Esprit Model Inc.
Manufacturer	Esprit Model Inc.
Applicant's Email Address	zb@espritmodel.com
Model Number(s)	JETIDS12US
Serial Number(s)	1914005990 (Radiated Sample) 1914007890 (RF Conducted Sample)
FCC ID	ONTJETIDS12US
ISED Certification Number	10491A-JETIDS12US
Hardware Version(s)	DS-12-PW-3, DS-12-TFT-3
Software Version(s)	5.02
Number of Samples Tested	2
Test Specification/Issue/Date	US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2019 Innovation, Science and Economic Development Canada Radio Standards Specification: RSS-247 — Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices, Issue 2, February 2017
Test Plan/Issue/Date	2019-July-24
Order Number	72152278
Date	2019-August-13
Date of Receipt of EUT	2019-July-03
Start of Test	2019-August-16
Finish of Test	2019-November-20
Name of Engineer(s)	Thierry Jean-Charles and Jean N. Rene
Related Document(s)	ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Device. US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2019. FCC OET KDB 558074 D01 15.247 Meas Guidance v05r02: Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules.



FCC OET KDB 558074 D01 15.247 Meas Guidance v05r02:
Guidance for Compliance Measurements on Digital
Transmission System, Frequency Hopping Spread
Spectrum System, and Hybrid System Devices Operating
under Section 15.247 of the FCC Rules.



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC Part 15.247 and ISED Canada's RSS-247 is shown below.

Table 1.3-1: Test Result Summary

Test Parameter	Test Plan (Yes/No)	Test Result	FCC 47 CFR Rule Part	ISED Canada's RSS	Test Report Page No
Antenna Requirement	Yes	Pass	15.203, 15.204	-----	10
Carrier Frequency Separation	Yes	Pass	15.247(a)(1)	RSS-247 5.1(c)	11
Number of Hopping Channels	Yes	Pass	15.247(a)(1)(i)	RSS-247 5.1(c)	14
Channel Dwell Time	Yes	Pass	15.247(f)	RSS-247 5.3(a)	17
20 dB Bandwidth	Yes	Pass	15.247(a)(1)(i)	RSS-247 5.1(a)	22
99% Bandwidth	Yes	Pass	-----	RSS-GEN 6.6	27
Peak Output Power	Yes	Pass	15.247(b)(2)	RSS-247 5.4(a)	32
Band-Edge Compliance of RF Conducted Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	37
RF Conducted Spurious Emissions	Yes	Pass	15.247(d)	RSS-247 5.5	43
Radiated Spurious Emissions into Restricted Frequency Bands	Yes	Pass	15.205, 15.209	RSS-GEN 8.9, 8.10	48
Power Spectral Density	Yes	Pass	15.247(f)	RSS-247 5.3(b)	55
Power Line Conducted Emissions	Yes	Pass	15.207	RSS-GEN 8.8	60



1.4 Product Information

1.4.1 Technical Description

The EUT is a remote control. The device utilizes a 900 MHz transceiver (LoRa and FSK modes) as well as a 2.4 GHz transceiver. The radios are not capable of transmitting at the same time. The test report documents the compliance of the 900 MHz LoRa transceiver.

Technical Details

Mode of Operation: Hybrid
 Frequency Range: 902.5 MHz - 927.3 MHz
 Number of Channels: 32
 Channel Separation: 800 kHz
 Data Rate: SF=7: 5.468 kbps
 SF=6: 9.375 kbps
 Modulations: Chirp Spread Spectrum (CSS)
 Spreading Factors: 6, 7
 Antenna Type/Gain: Helical Antenna, 2 dBi
 Input Power: 3.6 VDC Battery, 12 VDC Power Supply

A full description and detailed product specification details are available from the manufacturer.

Table 1.4.1-1 – Cable Descriptions

Cable/Port	Description
Power	1.83 m, Not Shielded, 12 VDC Power Supply to EUT
Headphone Audio	1.2 m, Not Shielded, Headphone to EUT

Table 1.4.1-2 – Support Equipment Descriptions

Make/Model	Description
Esprit	12 VDC Power Supply, S/N: G1711105043036
N/A	Headphones



Declaration of Build Status

EQUIPMENT DESCRIPTION	
Model Name/Number	Jeti Duplex DS-12
Part Number	DS-12US
Hardware Version	DS-12-PW-3, DS-12-TFT-3
Software Version	5.02
FCC ID (if applicable)	ONTJETIDS12US
ISED ID (if applicable)	10491A-JETIDS12US
Technical Description (Please provide a brief description of the intended use of the equipment)	Hand held transmitter for radio controlled models

UN-INTENTIONAL RADIATOR	
Highest frequency generated or used in the device or on which the device operates or tunes	2480MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	400KHz
Class A Digital Device (Use in commercial, industrial or business environment) ☐	
Class B Digital Device (Use in residential environment only) ☒	

Power Source			
AC	Single Phase	Three Phase	Nominal Voltage
	☒	☐	110v
External DC	Nominal Voltage	Maximum Current	
	12v	0.15A	
Battery	Nominal Voltage	Battery Operating End Point Voltage	
	3.3v	4.2v	

EXTREME CONDITIONS			
Maximum temperature	+85	°C	Minimum temperature
			-40 °C

Ancillaries
Please list all ancillaries which will be used with the device.

I hereby declare that the information supplied is correct and complete.

Name: Zbyněk Hubáček

Position held: President

Date: 11-22-2019



1.4.2 Modes of Operation

The EUT was evaluated in continuous TX mode for the 900 MHz transceiver using the LoRa modulation for spreading factors 6 and 7. The test software power setting for the data reported in this document was 14.

The device was configured using the worst-case duty cycle configuration as per normal operation.

1.4.3 Monitoring of Performance

Preliminary radiated emissions measurements were performed for the EUT in three orthogonal orientations. The measurements reported in this document correspond to the worst-case configuration which was the EUT flat on the tabletop.

The EUT was configured with an U. FL. connector to facilitate the RF Conducted measurements.

The EUT powers off when connected to the AC Mains. The power line conducted emissions evaluation was performed for the EUT off in the charging mode.

1.4.4 Performance Criteria

The EUT was evaluated to the requirements of FCC 47 CFR Part 15.247 as well as ISED Canada RSS-247 for the tests documented below.

Table 1.4.4 -1: Performance Criteria

Parameter	Requirement
Antenna Requirement	FCC: Section 15.203. 15.204
Carrier Frequency Separation	FCC: Section 15.247(a)(1); ISED Canada:RSS-247 5.1(c)
Number of Hopping Channels	FCC: Section 15.247(a)(1)(i); ISED Canada: RSS-247 5.1(c)
Dwell Time	FCC; Section 15.247(f); ISED Canada: RSS-247 5.3(a)
20 dB Bandwidth	FCC: Section 15.247(a)(1)(i); ISED Canada: RSS-247 5.1(a)
99% Bandwidth	ISED Canada: RSS-GEN 6.6
Peak Output Power	FCC: Section 15.247(b)(2); ISED Canada:RSS-247 5.4(a)
Band-Edge Compliance of RF Conducted Emissions	FCC: Section 15.247(d); ISED Canada: RSS-247 5.5
RF Conducted Spurious Emissions	FCC: Section 15.247(d); ISED Canada: RSS-247 5.5
Radiated Spurious Emissions into Restricted Frequency Bands	FCC: Sections 15.205, 15.209; ISED Canada: RSS-GEN 8.9, 8.10
Power Spectral Density	FCC: Section 15.247(f); ISED Canada: RSS-247 5.3(b)
Power Line Conducted Emissions	FCC: Section 15.207; ISED Canada: RSS-GEN 8.8

1.5 Deviations from the Standard

The testing was performed without any deviation from the test requirements.



1.6 EUT Modification Record

The table below details modifications made to the EUT during the test programme. The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted

No modification was necessary to meet the radio requirements. The modifications that were implemented to meet the unintentional emissions requirements are reported in the supplier's declaration of conformity test report.

1.7 Test Location

TÜV SÜD Product Service conducted the following tests at our Tampa FL Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Battery Powered Operating		
Antenna Requirement	Thierry Jean-Charles	A2LA
Carrier Frequency Separation	Thierry Jean-Charles	A2LA
Number of Hopping Channels	Thierry Jean-Charles	A2LA
Dwell Time	Thierry Jean-Charles	A2LA
20 dB Bandwidth	Thierry Jean-Charles	A2LA
99% Bandwidth	Thierry Jean-Charles	A2LA
Peak Output Power	Thierry Jean-Charles	A2LA
Band-Edge Compliance of RF Conducted Emissions	Thierry Jean-Charles	A2LA
RF Conducted Spurious Emissions	Thierry Jean-Charles	A2LA
Radiated Spurious Emissions into Restricted Frequency Bands	Thierry Jean-Charles and Jean N. Rene	A2LA
Power Spectral Density	Thierry Jean-Charles	A2LA
Power Line Conducted Emissions	Thierry Jean-Charles	A2LA

Office Address:

TÜV SÜD America, Inc.
5610 W. Sligh Ave, Suite 100
Tampa, FL 33634
USA



2 Test Details

2.1 Antenna Requirements

2.1.1 Specification Reference

FCC: Section 15.203, 15.204

2.1.2 Equipment Under Test and Modification State

S/N: N/A

2.1.3 Date of Test

11/12/2019

2.1.4 Test Method

N/A

2.1.5 Environmental Conditions

Ambient Temperature N/A

Relative Humidity N/A

Atmospheric Pressure N/A

2.1.6 Test Results

Limit Clause FCC Sections: 15.203, 15.204

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 EUT uses a 2 dBi helical antenna that is directly soldered to the PCB. The antenna is not removable/replaceable without damaging the unit. The device meets the requirements of FCC Section 15.203.

2.1.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

As this was a visual inspection, no test equipment was used.



2.2 Carrier Frequency Separation

2.2.1 Specification Reference

FCC: Section 15.247(a)(1)
ISED Canada: RSS-247 5.1(c)

2.2.2 Equipment Under Test and Modification State

SN: 1914007890

2.2.3 Date of Test

10/7/2019

2.2.4 Test Method

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The span of the spectrum analyzer was set wide enough to capture two adjacent peaks and the RBW and VBW were set to approximately 30% of the channel spacing.

2.2.5 Environmental Conditions

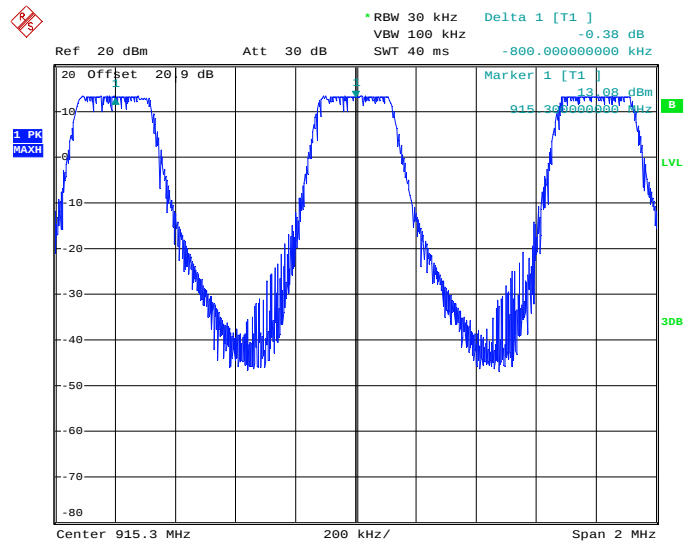
Ambient Temperature	24.0°C
Relative Humidity	48.2 %
Atmospheric Pressure	1015.2 mbar



2.2.6 Test Results

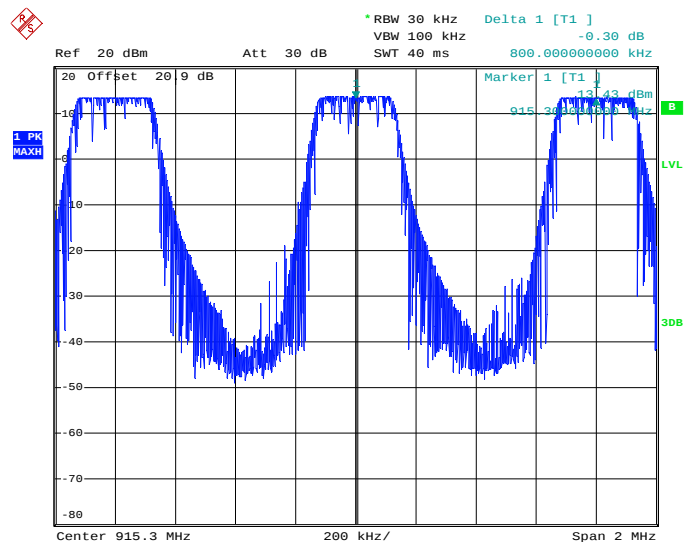
Battery Powered Operating

Limit Clause FCC Part 15.247(a)(1); ISED RSS-247 5.1 (c)



Date: 7.OCT.2019 11:40:58

Figure 2.2.6-1: Carrier Frequency Separation Test Results – SF6



Date: 7.OCT.2019 11:34:15

Figure 2.2.6-2: Carrier Frequency Separation Test Results – SF7



2.2.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



2.3 Number of Hopping Channels

2.3.1 Specification Reference

FCC: Section 15.247(a)(1)(i)
ISED Canada: RSS-247 5.1(c)

2.3.2 Equipment Under Test and Modification State

SN: 1914007890

2.3.3 Date of Test

10/7/2019

2.3.4 Test Method

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The span of the spectrum analyzer was set wide enough to capture the number of hopping channels. The peak detector max hold function was enabled for the measurements.

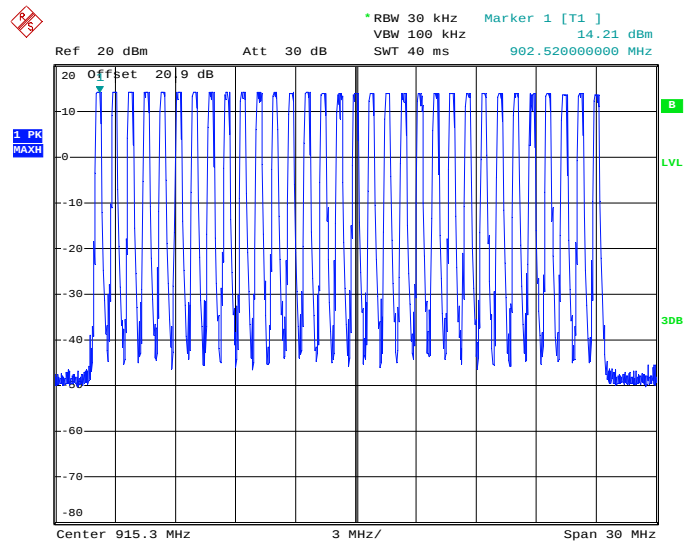
2.3.5 Environmental Conditions

Ambient Temperature	24.3°C
Relative Humidity	48.5 %
Atmospheric Pressure	1014.9 mbar

2.3.6 Test Results

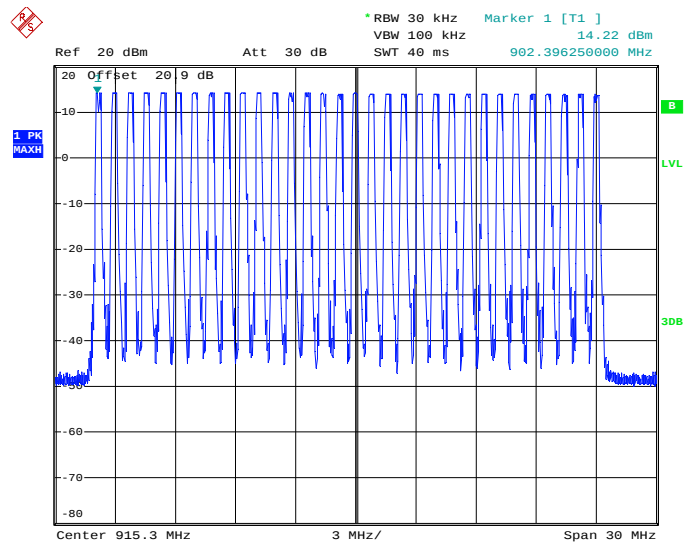
Battery Powered Operating

Limit Clause FCC Part 15.247(a)(1)(i); ISED RSS-247 5.1 (c)



Date: 7.OCT.2019 11:11:13

Figure 2.3.6-1: Number of Hopping Channels Test Results – SF 6



Date: 7.OCT.2019 11:03:28

Figure 2.3.6-2: Number of Hopping Channels Test Results – SF 7



2.3.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



2.4 Channel Dwell Time

2.4.1 Specification Reference

FCC: Section 15.247(f)
ISED Canada: RSS-247 5.3(a)

2.4.2 Equipment Under Test and Modification State

SN: 1914007890

2.4.3 Date of Test

10/7/2019 to 11/20/2019

2.4.4 Test Method

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The span of the spectrum analyzer was set 0 Hz centered on a hopping channel. The RBW was set to less than 30% of the channel spacing and the sweep time adjusted to capture the entire dwell time per channel with peak detector max hold function.

2.4.5 Environmental Conditions

Ambient Temperature 24.7°C
Relative Humidity 45.3 %
Atmospheric Pressure 1015.4 mbar

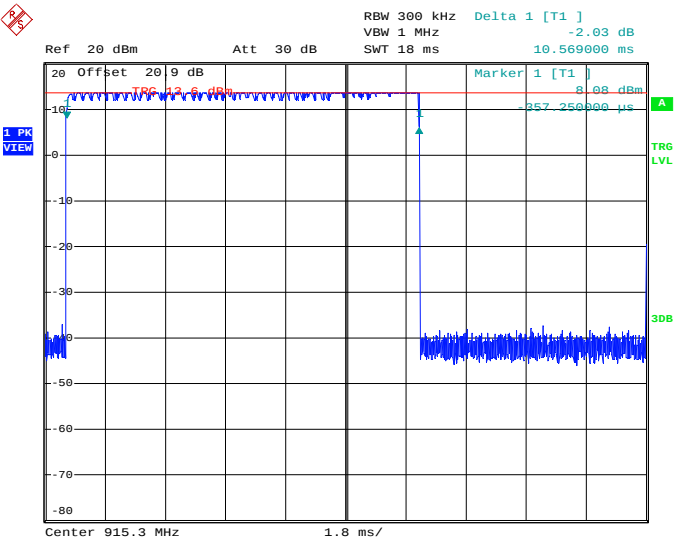
2.4.6 Test Results

Battery Powered Operating

Limit Clause FCC Part 15.247(f); ISED RSS-247 5.3 (a)

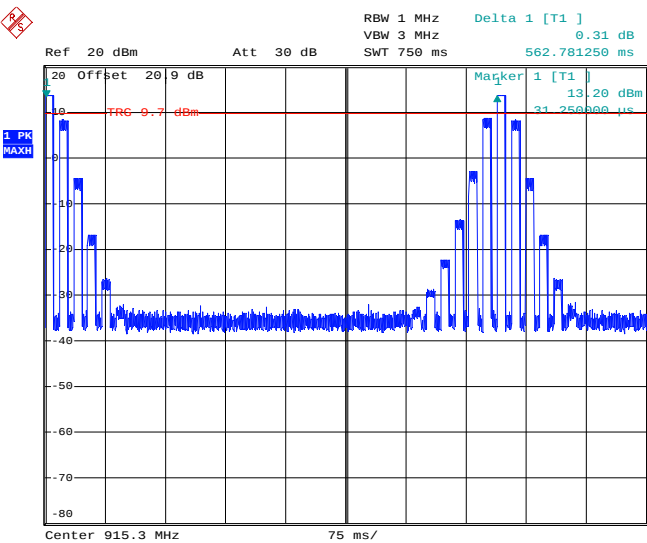
Table 2.4.6-1: Dwell Time Test Results

Spreading Factor	Number of Hops Per Sec. (NHPS)	Number of Hops per Channel Per Sec. (NHPCPS)	Number of hops on a 12.8 s Cycle (NHPC)	Measured Dwell Times (ms)	Dwell Times on a 12.8 s Cycle (ms)	Limit (ms)	Status
SF = 6	57	1.78	23	10.569	243.09	400	PASS
SF = 7	28	0.88	11	21.129	232.42	400	PASS



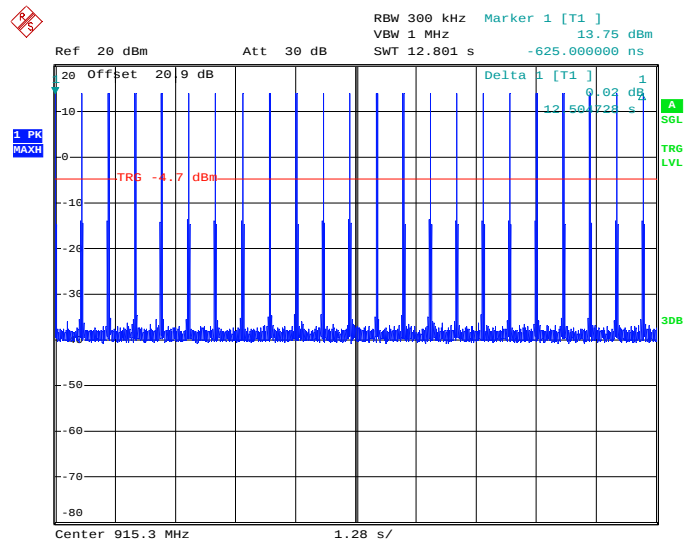
Date: 21.OCT.2019 12:30:02

Figure 2.4.6-1: Channel Dwell Time Test Results – SF6



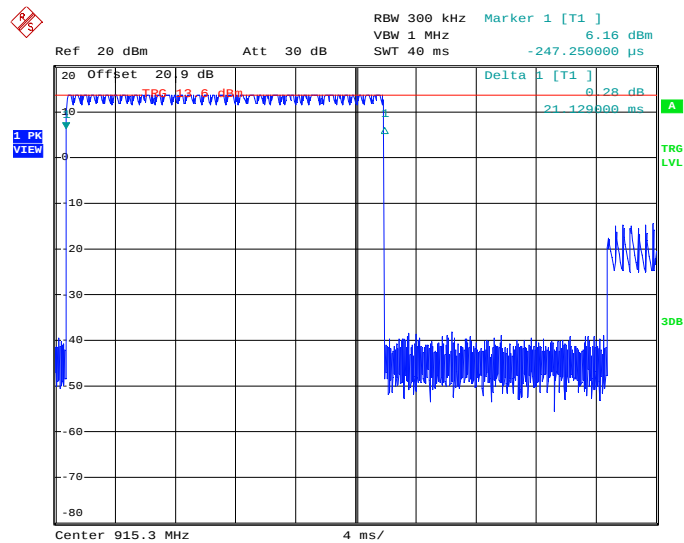
Date: 7.OCT.2019 12:32:05

Figure 2.4.6-2: Channel Dwell Time Test Results – SF6



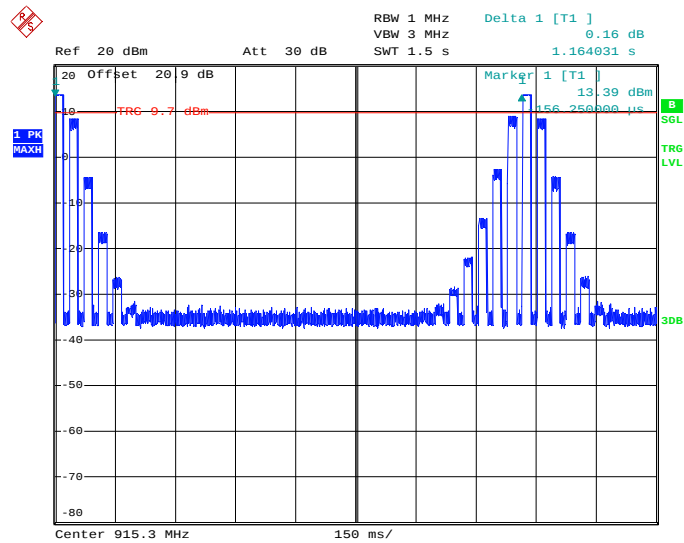
Date: 20.NOV.2019 17:21:30

Figure 2.4.6-3: Channel Dwell Time Test Results SF6



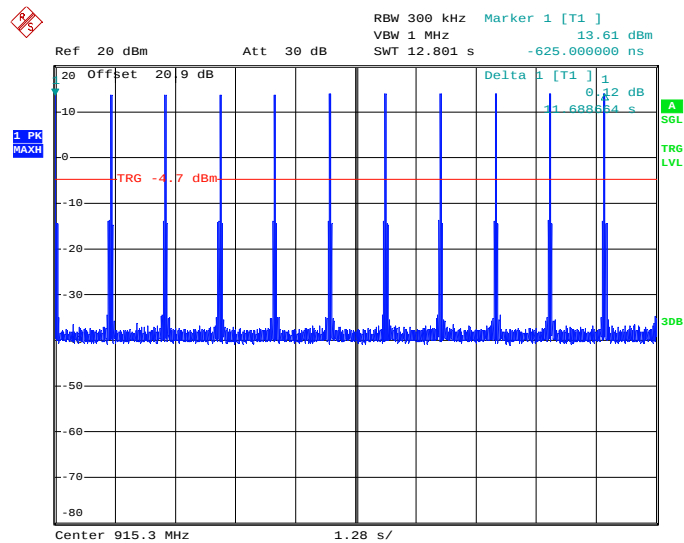
Date: 21.OCT.2019 12:31:37

Figure 2.4.6-4: Channel Dwell Time Test Results – SF7



Date: 7.OCT.2019 12:34:50

Figure 2.4.6-5: Channel Dwell Time Test Results – SF7



Date: 20.NOV.2019 17:23:13

Figure 2.4.6-6: Channel Dwell Time Test Results SF7



2.4.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



2.5 20 dB Bandwidth

2.5.1 Specification Reference

FCC: Section 15.247(a)(1)(i)
ISED Canada: RSS-247 5.1(a)

2.5.2 Equipment Under Test and Modification State

SN: 1914007890

2.5.3 Date of Test

10/3/2019 to 10/18/2019

2.5.4 Test Method

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The spectrum analyzer span was set to 2 to 5 times the estimated bandwidth of the emission. The RBW was set to 1% to 5% of the estimated emission bandwidth. The trace was recorded using the max hold function with a peak detector.

2.5.5 Environmental Conditions

Ambient Temperature 24.4°C
Relative Humidity 40.1 %
Atmospheric Pressure 1013.4 mbar

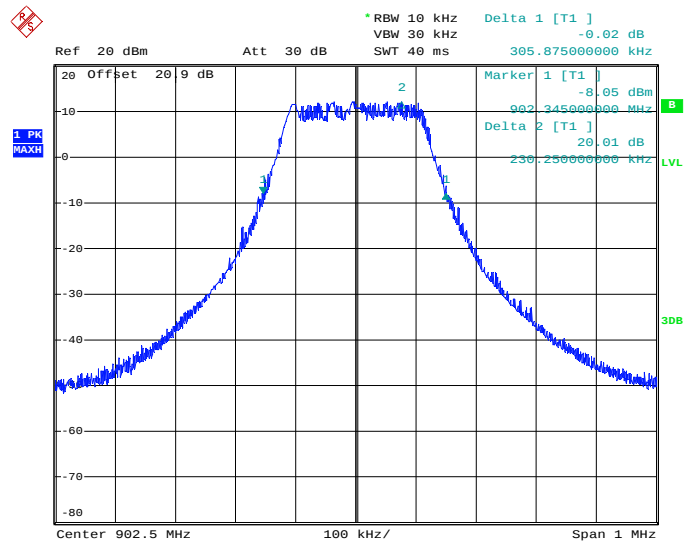
2.5.6 Test Results

Battery Powered Operating

Limit Clause FCC Part 15.247(a)(1)(i), ISED RSS-247 5.1(a)

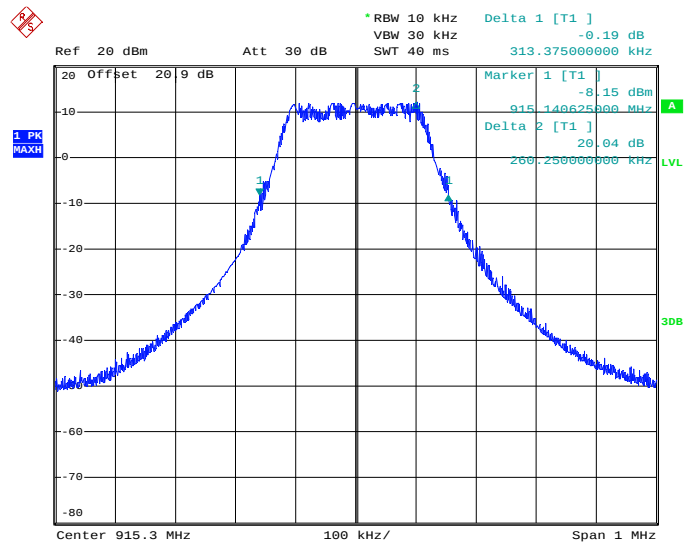
Table 2.5.6-1: 20 dB Bandwidth Test Results – SF6

Frequency (MHz)	20 dB Bandwidth (kHz)
902.5	305.875
915.3	313.375
927.3	307.000



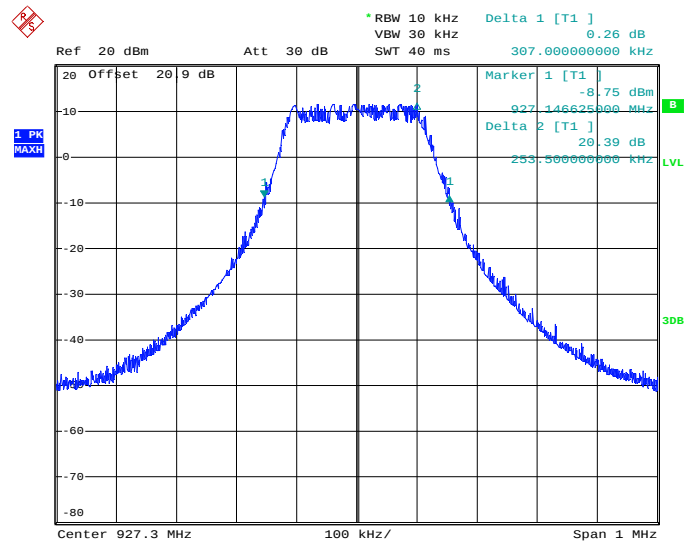
Date: 18.OCT.2019 12:22:59

Figure 2.5.6-1: 20 dB Bandwidth Test Results – Low Channel – SF6



Date: 3.OCT.2019 16:34:58

Figure 2.5.6-2: 20 dB Bandwidth Test Results – Middle Channel – SF6

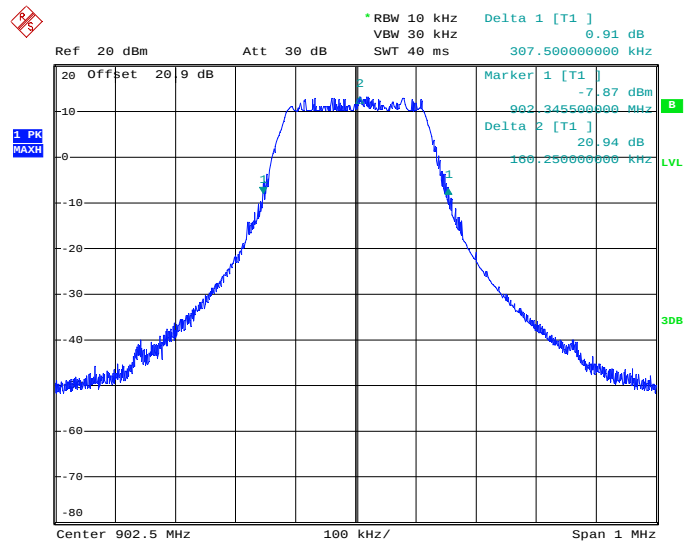


Date: 18.OCT.2019 12:11:07

Figure 2.5.6-3: 20 dB Bandwidth Test Results – High Channel – SF6

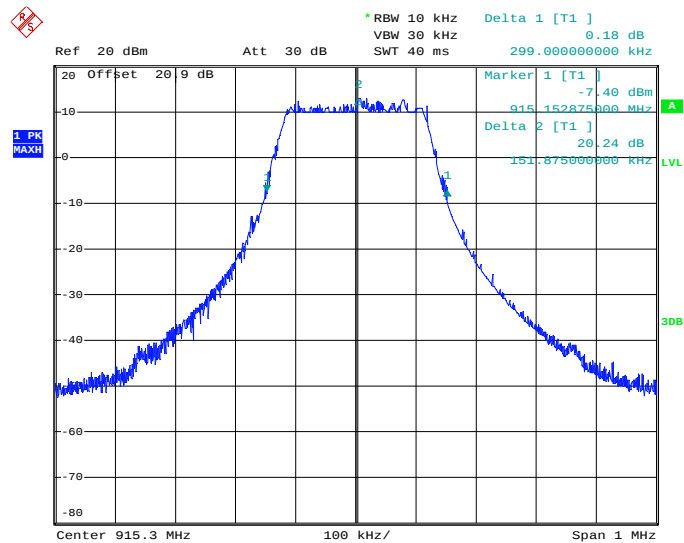
Table 2.5.6-2: 20 dB Bandwidth Test Results – SF7

Frequency (MHz)	20 dB Bandwidth (kHz)
902.5	307.500
915.3	299.000
927.3	301.000



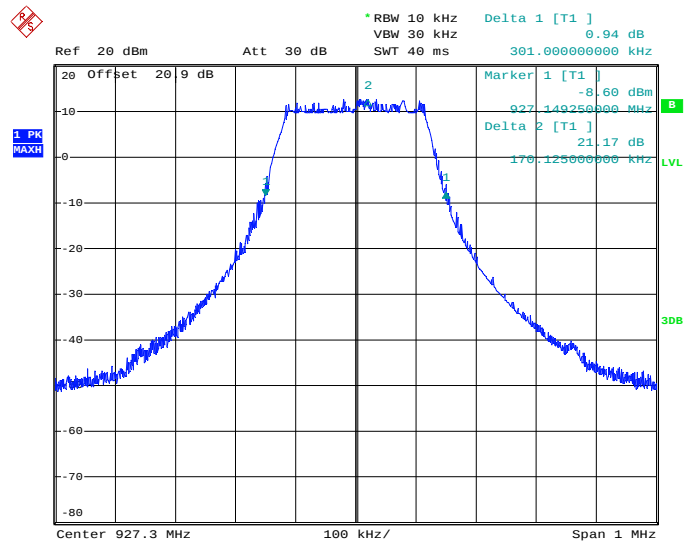
Date: 18.OCT.2019 12:29:35

Figure 2.5.6-4: 20 dB Bandwidth Test Results – Low Channel – SF7



Date: 3.OCT.2019 16:39:41

Figure 2.5.6-5: 20 dB Bandwidth Test Results – Middle Channel – SF7



Date: 18.OCT.2019 12:00:07

Figure 2.5.6-6: 20 dB Bandwidth Test Results – High Channel – SF7

2.5.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable



2.6 99% Bandwidth

2.6.1 Specification Reference

ISED Canada: RSS-GEN 6.6

2.6.2 Equipment Under Test and Modification State

SN: 1914007890

2.6.3 Date of Test

10/3/2019 to 10/18/2019

2.6.4 Test Method

The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission. The RBW was set to 1% to 5% of the approximated bandwidth. The occupied 99% bandwidth was measured by using the bandwidth measurement function of the spectrum analyzer with a peak detector.

2.6.5 Environmental Conditions

Ambient Temperature 24.6°C
Relative Humidity 40.3 %
Atmospheric Pressure 1013.8 mbar

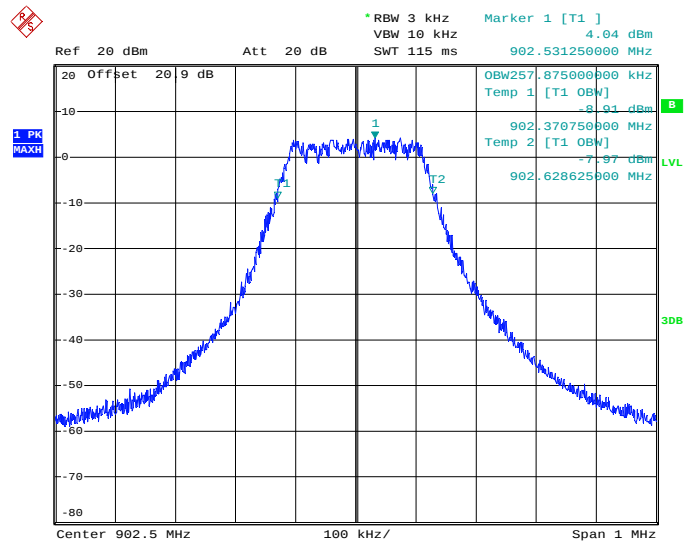
2.6.6 Test Results

Battery Powered Operating

Limit Clause ISED RSS-GEN 6.6

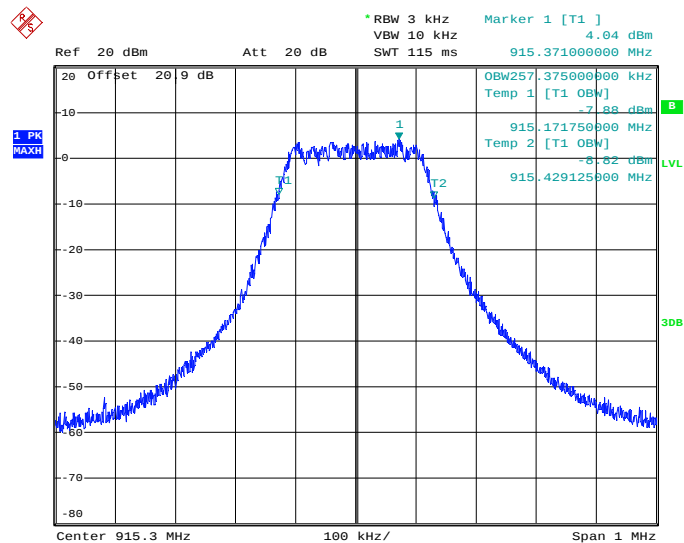
Table 2.6.6-1: 99% Bandwidth Test Results – SF6

Frequency (MHz)	99% Bandwidth (kHz)
902.5	257.875
915.3	257.375
927.3	257.500



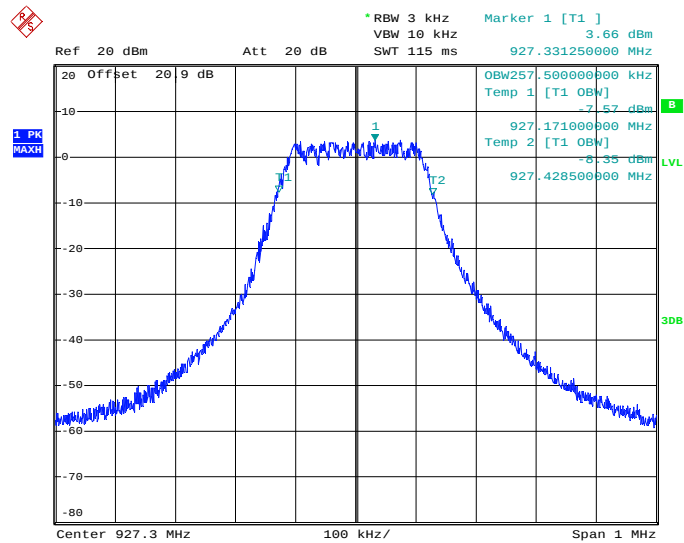
Date: 18.OCT.2019 11:16:21

Figure 2.6.6- 1: 99% Bandwidth Test Results – Low Channel – SF6



Date: 3.OCT.2019 16:10:33

Figure 2.6.6- 2: 99% Bandwidth Test Results – Middle Channel – SF6

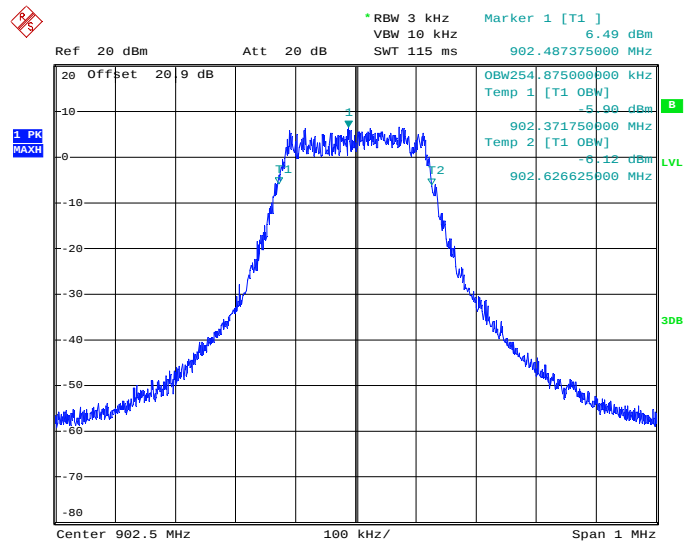


Date: 18.OCT.2019 11:45:54

Figure 2.6.6- 3: 99% Bandwidth Test Results – High Channel – SF6

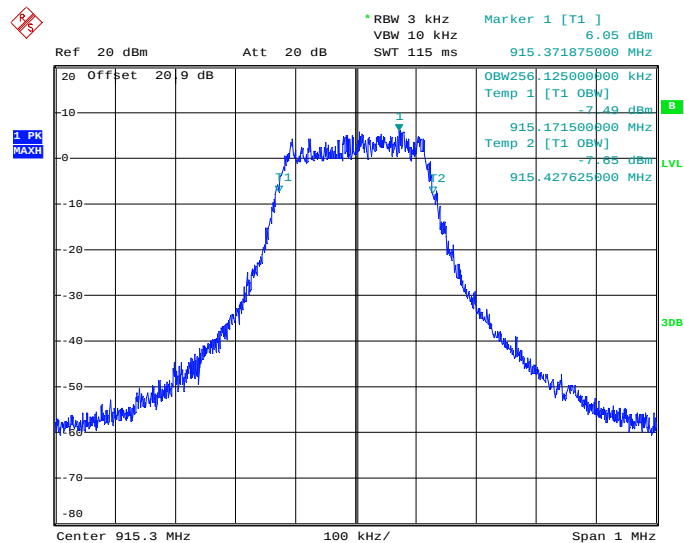
Table 2.6.6-2: 99% Bandwidth Test Results – SF7

Frequency (MHz)	99% Bandwidth (kHz)
902.5	254.875
915.3	256.125
927.3	254.000



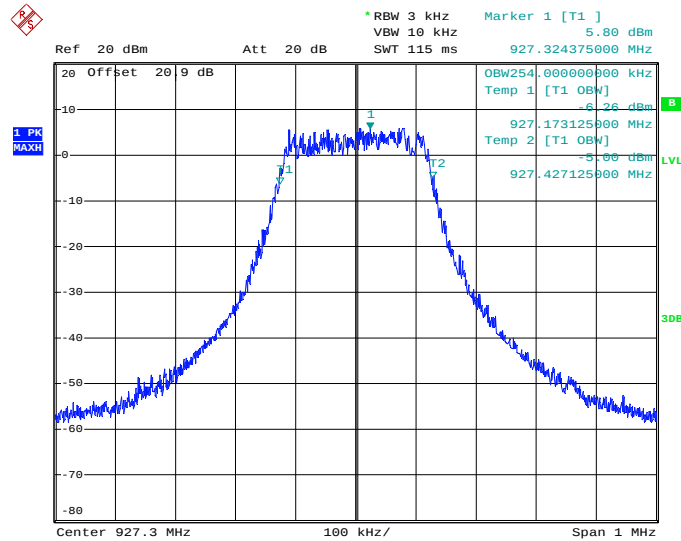
Date: 18.OCT.2019 11:20:28

Figure 2.6.6- 4: 99% Bandwidth Test Results – Low Channel – SF7



Date: 3.OCT.2019 16:07:50

Figure 2.6.6- 5: 99% Bandwidth Test Results – Middle Channel – SF7



Date: 18.OCT.2019 11:51:38

Figure 2.6.6- 6: 99% Bandwidth Test Results – High Channel – SF7

2.6.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



2.7 Peak Output Power

Specification Reference

FCC Section 15.247(b)(2)
ISED Canada: RSS-247 5.4(a)

2.7.1 Equipment Under Test and Modification State

SN: 1914007890

2.7.2 Date of Test

10/7/2019 to 10/18/2019

2.7.3 Test Method

The fundamental emission output power was measured in accordance with ANSI 63.10 Subclause 7.8.5. The RF output of the equipment under test was directly connected to the input of the spectrum analyzer through suitable attenuation.

2.7.4 Environmental Conditions

Ambient Temperature 24.5°C
Relative Humidity 39.8 %
Atmospheric Pressure 1013.1 mbar

2.7.5 Test Results

Battery Powered Operating

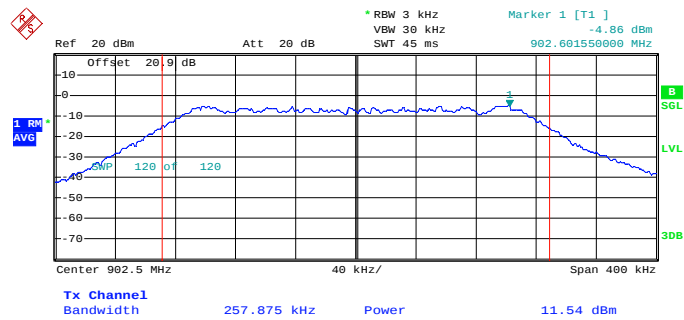
Limit Clause FCC Part 15.247(b)(2), ISED RSS-247 5.4(a)

The Maximum Output Power allowed for frequency hopping systems employing at least 50 channels is 1 Watt (30 dBm). For frequency hopping systems employing less than 50 hopping channels but at least 25 hopping channels the power limit is 0.25 watts (24 dBm).

The calculations for the duty cycle correction factor is provided in Section 2.13.

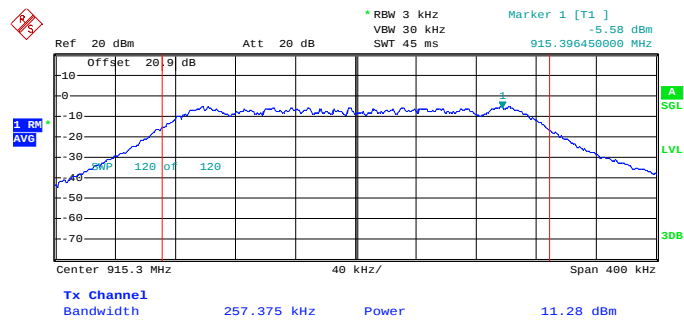
Table 2.7.6-1: Maximum Output Power Test Results – SF6

Frequency (MHz)	Measured Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Power (dBm)
902.5	11.54	2.29	13.83
915.3	11.28	2.29	13.57
927.3	11.08	2.29	13.37



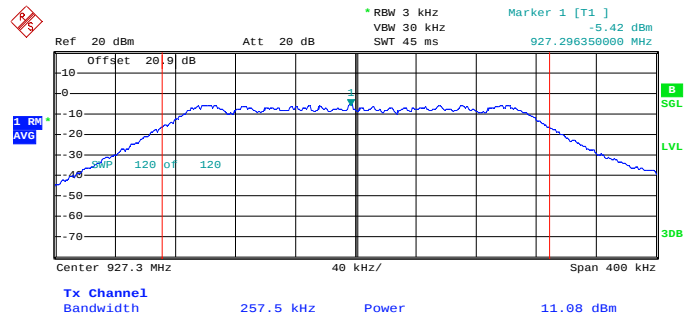
Date: 18.OCT.2019 13:04:08

Figure 2.7.6-1: Maximum Output Power Test Results – Low Channel – SF6



Date: 7.OCT.2019 10:23:28

Figure 2.7.6-2: Maximum Output Power Test Results – Middle Channel – SF6

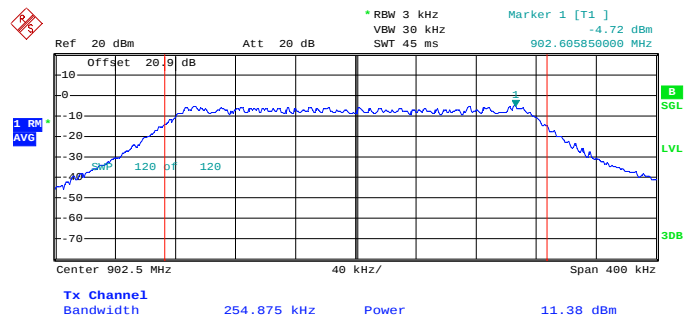


Date: 18.OCT.2019 13:07:37

Figure 2.7.6-3: Maximum Output Power Test Results – High Channel – SF6

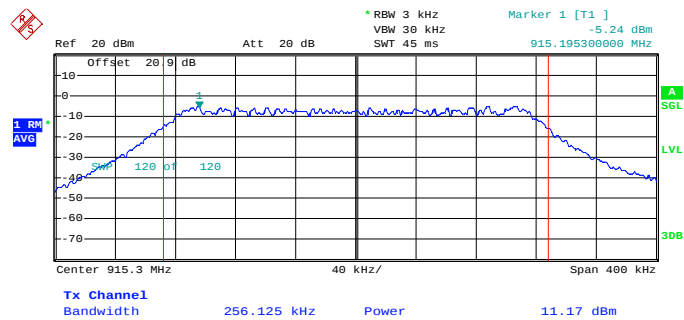
Table 2.7.6-2: Maximum Output Power Test Results – SF7

Frequency (MHz)	Measured Power (dBm)	Duty Cycle Correction Factor (dB)	Corrected Power (dBm)
902.5	11.38	2.35	13.73
915.3	11.17	2.35	13.52
927.3	11.02	2.35	13.37



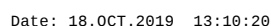
Date: 18.OCT.2019 13:01:50

Figure 2.7.6-4: Maximum Output Power Test Results – Low Channel – SF7



Date: 7.OCT.2019 10:21:02

Figure 2.7.6-5: Maximum Output Power Test Results – Middle Channel – SF7



Correct for duty cycle

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.



2.8 Band-Edge Compliance of RF Conducted Emissions

2.8.1 Specification Reference

FCC: Section 15.247(d)
ISED Canada: RSS-247 5.5

2.8.2 Equipment Under Test and Modification State

SN: 1914007890

2.8.3 Date of Test

10/14/2019

2.8.4 Test Method

The RF Conducted Emissions at the Band-Edges were measured in accordance with Subclause 7.8.6 of ANSI C63.10. The RF output port of the EUT was connected to the input of the spectrum analyzer through suitable attenuation. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 100 kHz, and the VBW was set to ≥ 300 kHz.

2.8.5 Environmental Conditions

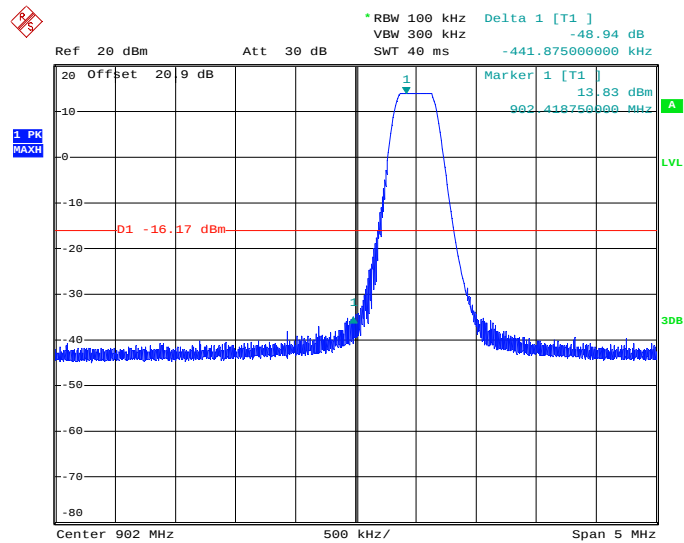
Ambient Temperature	29.3 °C
Relative Humidity	42.2 %
Atmospheric Pressure	1015.5 mbar

2.8.6 Test Results

Battery Powered Operating

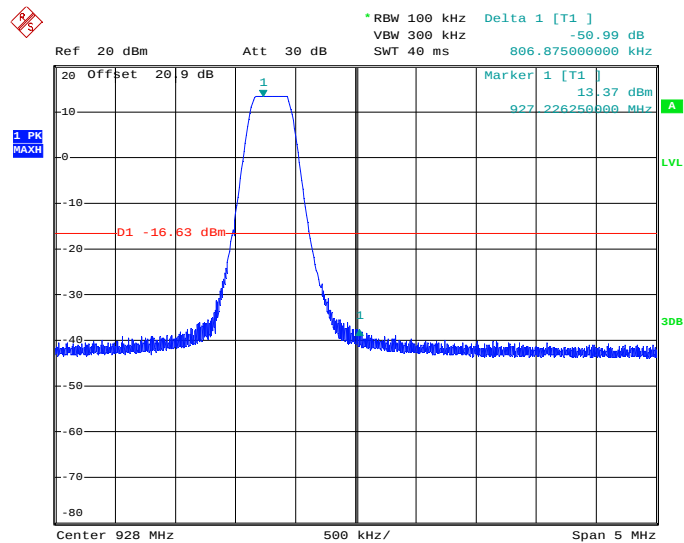
Limit Clause FCC Section 15.247(d), ISED Canada: RSS-247 5.5

In any 100 kHz bandwidth outside of the frequency band the radio frequency power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.



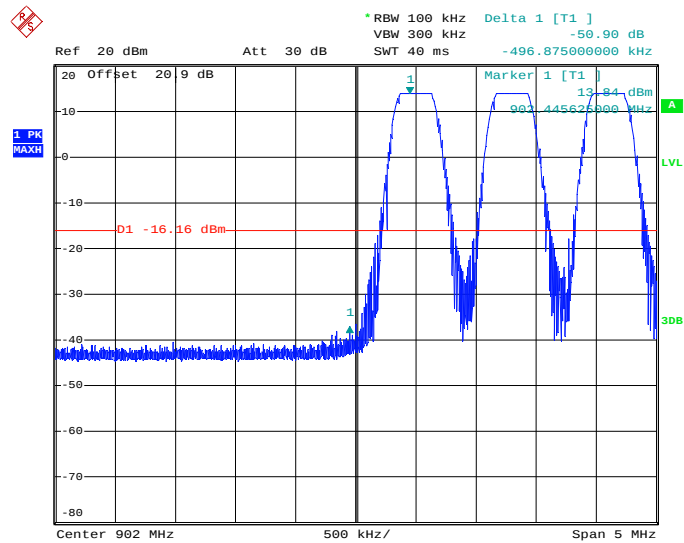
Date: 14.OCT.2019 14:06:49

Figure 2.8.6- 1: RF Conducted Band-Edge – Low Channel – SF6



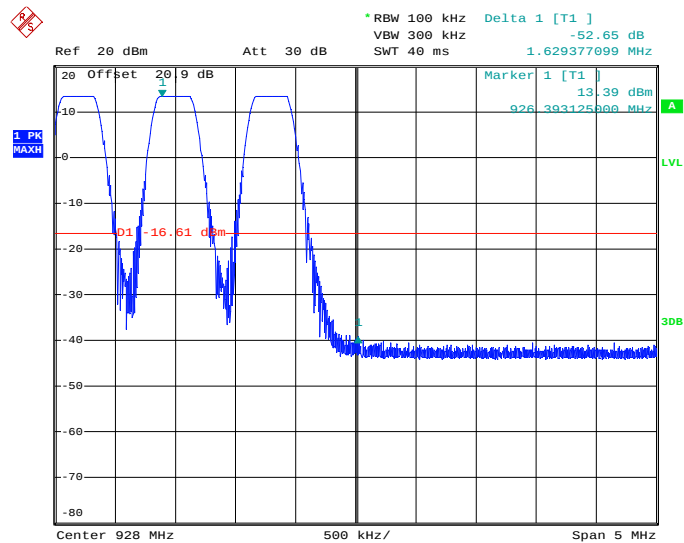
Date: 14.OCT.2019 13:55:23

Figure 2.8.6- 2: RF Conducted Band-Edge – High Channel – SF6



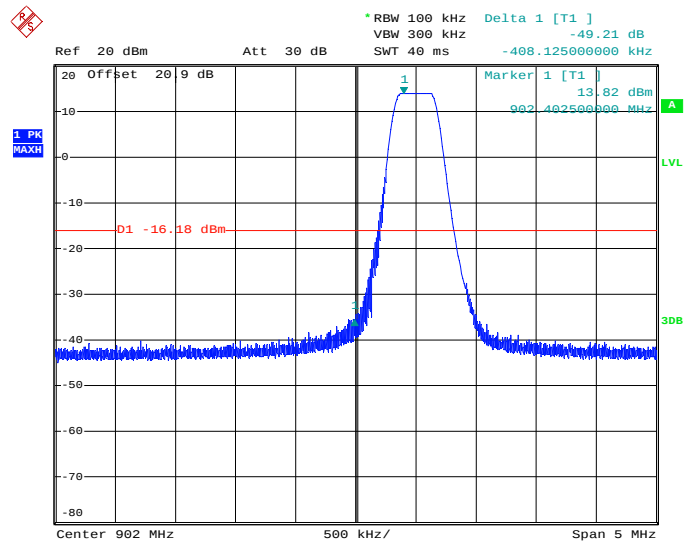
Date: 14.OCT.2019 13:18:09

Figure 2.8.6- 3: RF Conducted Band-Edge – Hopping – SF6



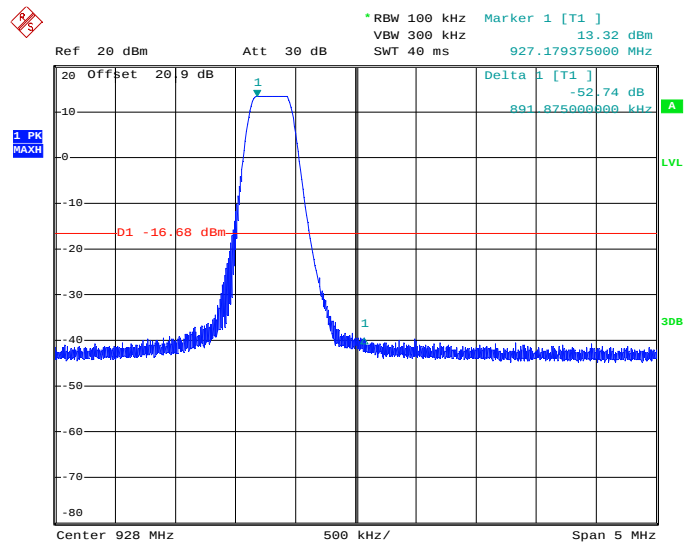
Date: 14.OCT.2019 13:34:30

Figure 2.8.6- 4: RF Conducted Band-Edge – Hopping – SF6



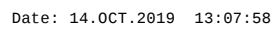
Date: 14.OCT.2019 16:12:17

Figure 2.8.6- 5: RF Conducted Band-Edge – Low Channel – SF7



Date: 14.OCT.2019 16:19:09

Figure 2.8.6- 6: RF Conducted Band-Edge – High Channel – SF7



* RBW 100 kHz Delta 1 [T1]
 VBW 300 kHz -53.24 dB
 SWT 40 ms 1.787500000 MHz

Ref 20 dBm Att 30 dB

20 Offset 20 9 dB

Marker 1 [T1]
 13.39 dBm
 928.465625000 MHz

1 PK MAXH

01 -16.61 dBm

1

Center 928 MHz 500 kHz/ Span 5 MHz

Date: 14.OCT.2019 12:57:53

Figure 2.8.6- 8: RF Conducted Band-Edge – Hopping – SF7



2.8.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



2.9 RF Conducted Spurious Emissions

2.9.1 Specification Reference

FCC: Section 15.247(d)
ISED Canada: RSS-247 5.5

2.9.2 Equipment Under Test and Modification State

SN: 1914007890

2.9.3 Date of Test

10/14/2019

2.9.4 Test Method

The RF Conducted Spurious Emissions were measured in accordance with Subclause 7.8.8 of ANSI C63.10. The RF output port of the equipment under test was directly connected to the input of the spectrum analyzer. The EUT was investigated for conducted spurious emissions from 30 MHz to 10 GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100 kHz and the VBW was set to 300 kHz. The peak Max Hold function of the analyzer was utilized.

2.9.5 Environmental Conditions

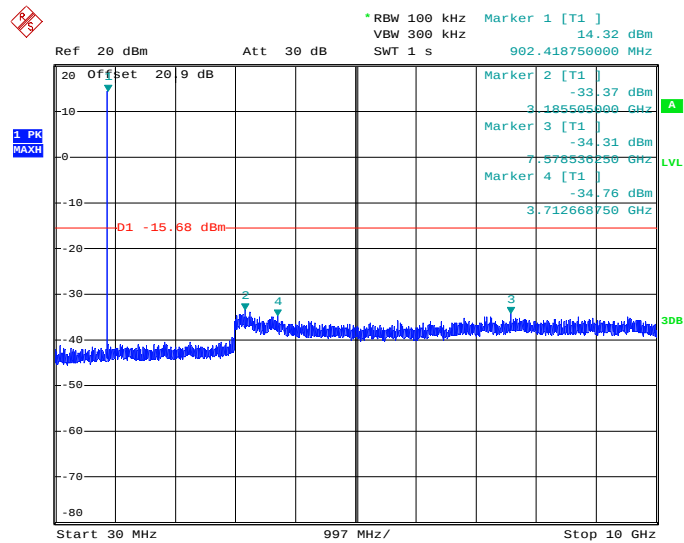
Ambient Temperature	23.9 °C
Relative Humidity	44.0 %
Atmospheric Pressure	1016.5 mbar

2.9.6 Test Results

Battery Powered Operating

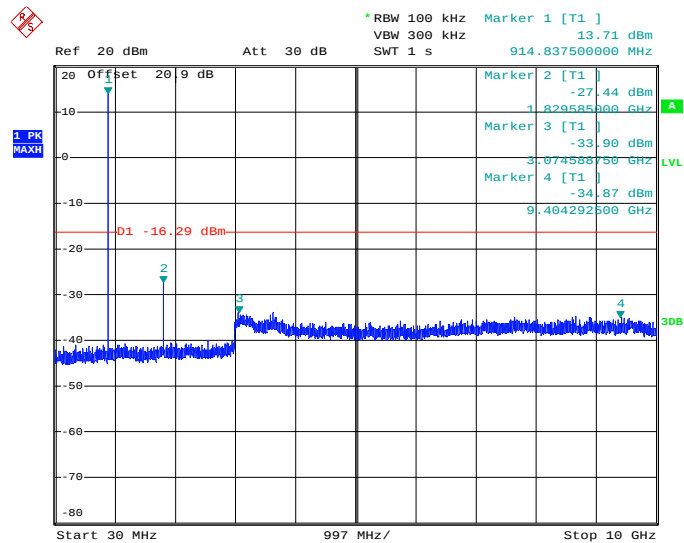
Limit Clause FCC Section 15.247(d), ISED Canada: RSS-247 5.5

In any 100 kHz bandwidth outside of the frequency band the radio frequency power shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.



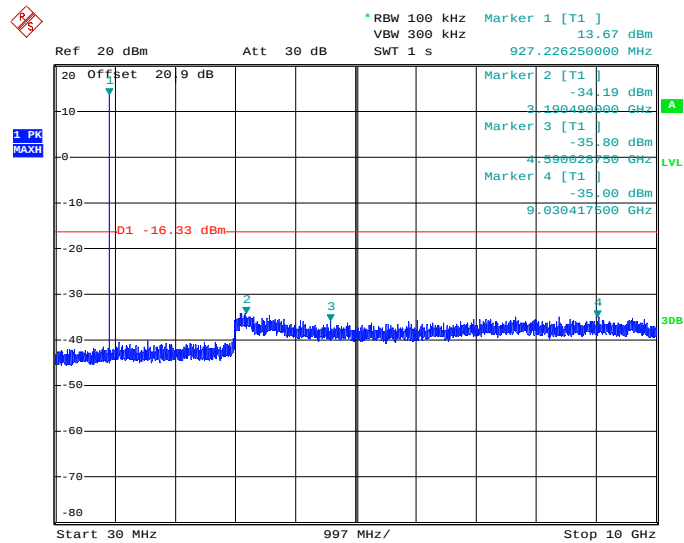
Date: 14.OCT.2019 14:12:11

Figure 2.9.6-1: Conducted Spurious Emissions – Low Channel – SF6



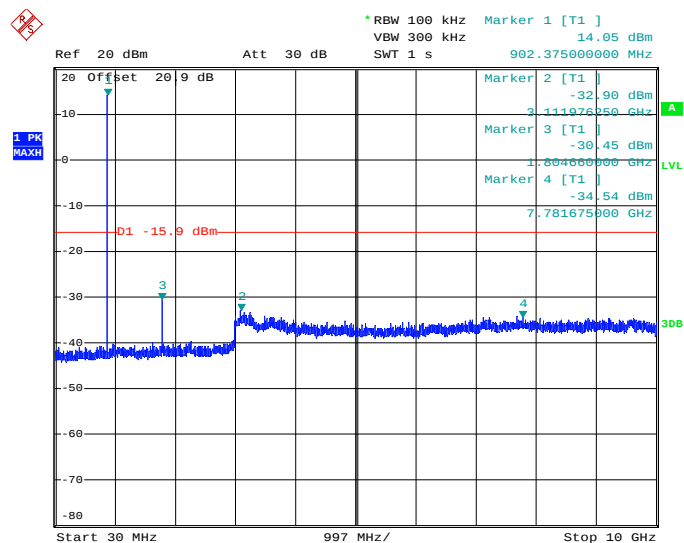
Date: 14.OCT.2019 14:18:16

Figure 2.9.6-2: Conducted Spurious Emissions – Middle Channel – SF6



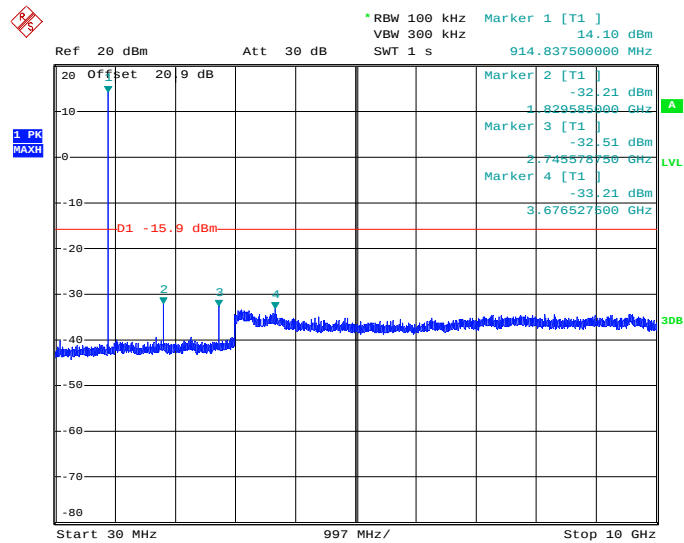
Date: 14.OCT.2019 13:59:23

Figure 2.9.6-3: Conducted Spurious Emissions – High Channel – SF6



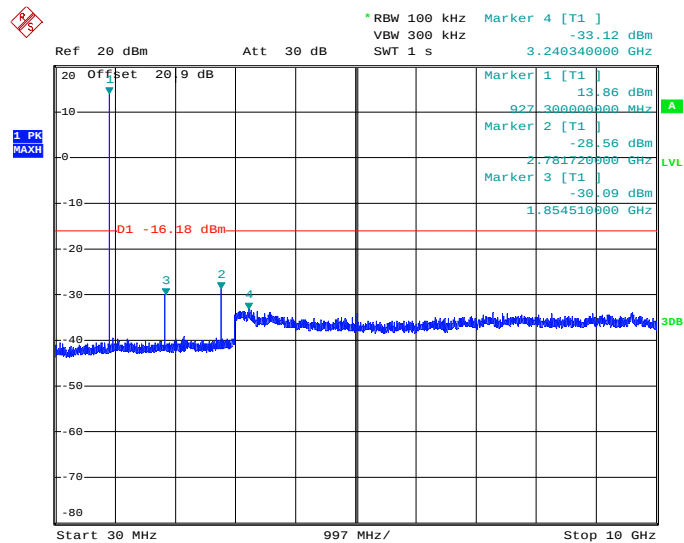
Date: 14.OCT.2019 15:46:58

Figure 2.9.6-4: Conducted Spurious Emissions – Low Channel – SF7



Date: 14.OCT.2019 15:11:02

Figure 2.9.6-5: Conducted Spurious Emissions – Middle Channel – SF7



Date: 14.OCT.2019 18:18:28

Figure 2.9.6-6: Conducted Spurious Emissions – High Channel – SF7



2.9.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



2.10 Radiated Spurious Emissions into Restricted Frequency Bands

2.10.1 Specification Reference

FCC Sections: 15.205, 15.209;
ISED Canada: RSS-GEN 8.9, 8.10

2.10.2 Equipment Under Test and Modification State

SN: 1914005990

2.10.3 Date of Test

8/19/2019 to 10/14/2019

2.10.4 Test Method

Radiated emissions tests were made over the frequency range of 9 kHz to 10 GHz, 10 times the highest fundamental frequency. Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in Section 15.209.

For measurements below 30 MHz, the receive antenna height was set to 1 m and the EUT was rotated through 360 degrees. The resolution bandwidth was set to 200 Hz below 150 kHz and to 9 kHz above 150 kHz.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000 MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak measurements are made with RBW of 1 MHz and VBW of 3 MHz. Average measurements are performed in the linear scale using VBW of 300 Hz.

2.10.5 Duty Cycle Correction

The EUT was configured to transmit at 100% duty cycle during the evaluation. No Duty Cycle Correction factor was used during the evaluation.

2.10.6 Environmental Conditions

Ambient Temperature	23.5 °C
Relative Humidity	40.1 %
Atmospheric Pressure	1005 mbar



2.10.7 Test Results

Battery Powered Operating

Limit Clause FCC Sections 15.205, 15.209, ISED Canada: RSS-GEN 8.9, 8.10

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.4090-1.705	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



Table 2.10.7-1: TX Radiated Spurious Emissions Results

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
2707.5	57.40	34.45	H	-0.92	56.48	33.53	74.0	54.0	17.5	20.5
2707.5	55.75	34.27	V	-0.92	54.83	33.35	74.0	54.0	19.2	20.7
3610	41.95	31.13	H	0.58	42.53	31.71	74.0	54.0	31.5	22.3
3610	41.69	30.80	V	0.58	42.27	31.38	74.0	54.0	31.7	22.6
4512.5	43.01	30.17	H	3.45	46.46	33.62	74.0	54.0	27.5	20.4
4512.5	46.34	32.40	V	3.45	49.79	35.85	74.0	54.0	24.2	18.1
5415	40.61	32.55	H	5.78	46.39	38.33	74.0	54.0	27.6	15.7
5415	40.38	31.51	V	5.78	46.16	37.29	74.0	54.0	27.8	16.7
8122.5	38.01	24.64	H	10.93	48.94	35.57	74.0	54.0	25.1	18.4
8122.5	41.44	26.84	V	10.93	52.37	37.77	74.0	54.0	21.6	16.2
9025	37.83	24.30	V	12.06	49.89	36.36	74.0	54.0	24.1	17.6
Middle Channel										
2745.9	55.37	37.87	H	-0.82	54.55	37.05	74.0	54.0	19.4	16.9
2745.9	54.35	37.84	V	-0.82	53.53	37.02	74.0	54.0	20.5	17.0
3661.2	41.43	31.94	H	0.73	42.16	32.67	74.0	54.0	31.8	21.3
3661.2	42.30	32.17	V	0.73	43.03	32.90	74.0	54.0	31.0	21.1
4576.5	45.04	36.49	H	3.62	48.66	40.11	74.0	54.0	25.3	13.9
4576.5	47.34	38.92	V	3.62	50.96	42.54	74.0	54.0	23.0	11.5
7322.4	39.51	26.51	H	9.53	49.04	36.04	74.0	54.0	25.0	18.0
7322.4	41.89	30.10	V	9.53	51.42	39.63	74.0	54.0	22.6	14.4
8237.7	39.06	27.27	H	11.12	50.18	38.39	74.0	54.0	23.8	15.6
8237.7	43.73	35.42	V	11.12	54.85	46.54	74.0	54.0	19.2	7.5
9153	37.98	24.14	H	11.97	49.95	36.11	74.0	54.0	24.1	17.9
9153	39.18	26.78	V	11.97	51.15	38.75	74.0	54.0	22.9	15.3
High Channel										
2781.9	50.76	40.57	H	-0.71	50.05	39.86	74.0	54.0	24.0	14.1
2781.9	49.42	39.54	V	-0.71	48.71	38.83	74.0	54.0	25.3	15.2
3709.2	44.67	37.74	H	0.87	45.54	38.61	74.0	54.0	28.5	15.4
3709.2	44.34	37.56	V	0.87	45.21	38.43	74.0	54.0	28.8	15.6
4636.5	46.69	41.90	H	3.77	50.46	45.67	74.0	54.0	23.5	8.3
4636.5	47.83	43.01	V	3.77	51.60	46.78	74.0	54.0	22.4	7.2
7418.4	38.08	24.51	H	9.65	47.73	34.16	74.0	54.0	26.3	19.8
7418.4	39.78	28.15	V	9.65	49.43	37.80	74.0	54.0	24.6	16.2
8345.7	40.15	29.24	H	11.29	51.44	40.53	74.0	54.0	22.6	13.5
8345.7	44.54	36.89	V	11.29	55.83	48.18	74.0	54.0	18.2	5.8

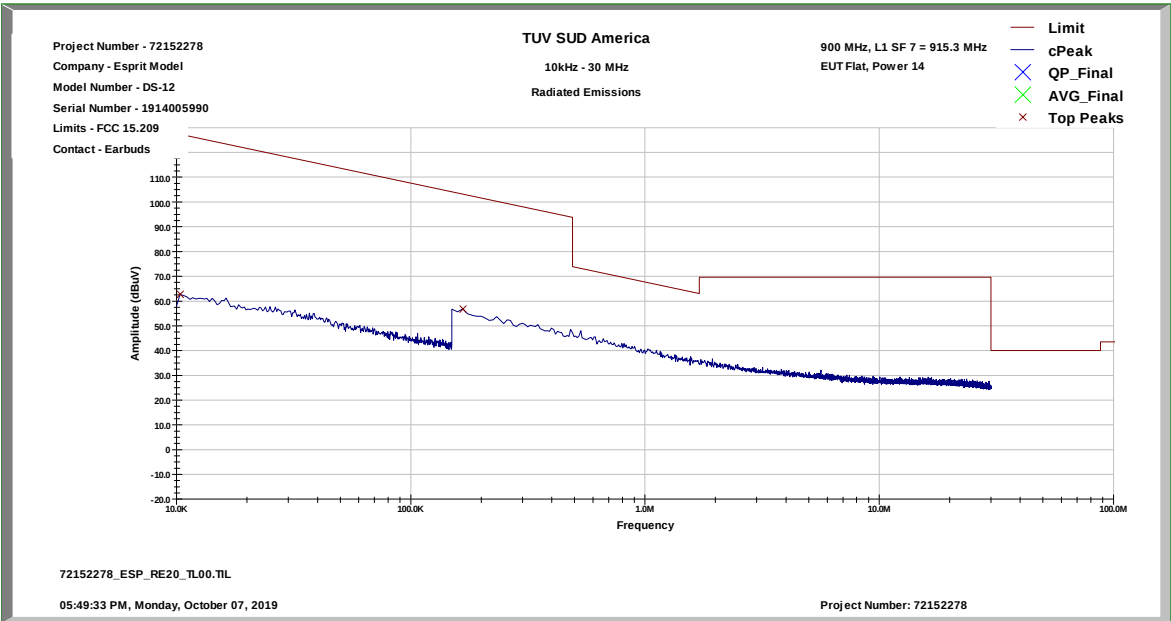


Figure 2.10.7-1: TX Radiated Spurious Emissions – Pre-Scan Plot below 30 MHz

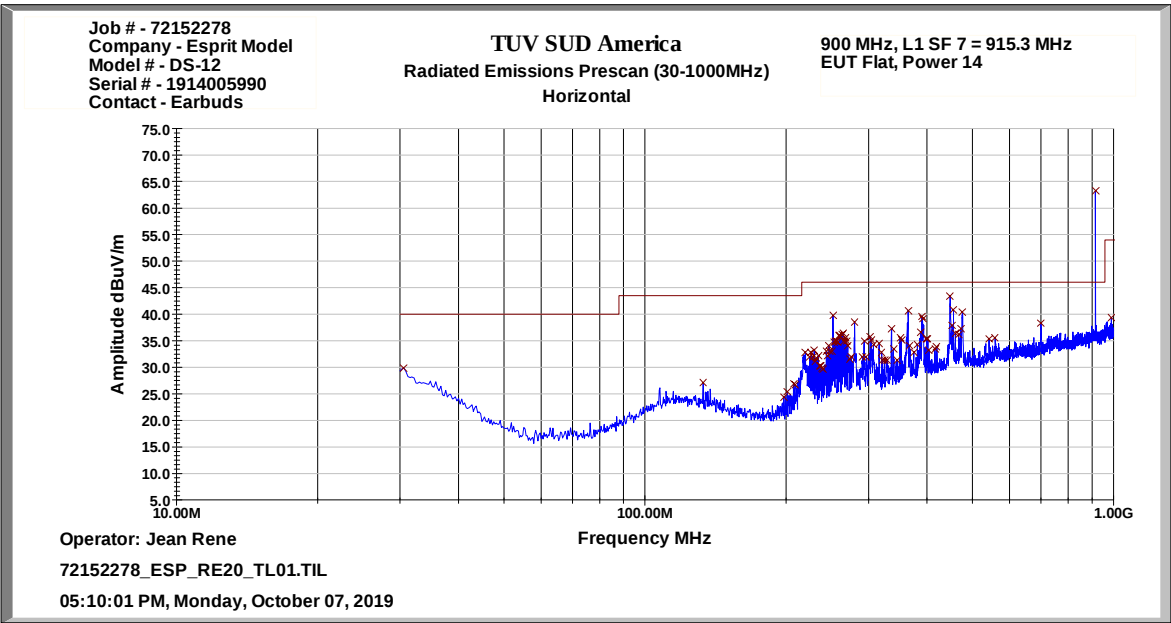


Figure 2.10.7-2: TX Radiated Spurious Emissions – Pre-Scan Plot 30 MHz – 1 GHz – Horizontal Polarization

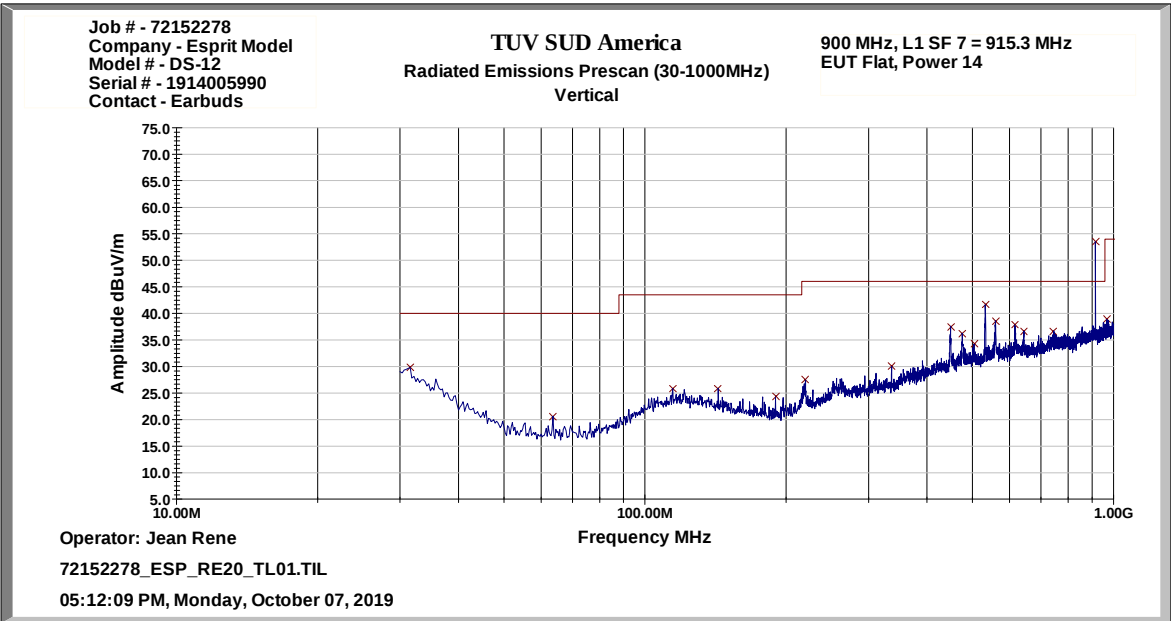


Figure 2.10.7-3: TX Radiated Spurious Emissions – Pre-Scan Plot 30 MHz – Vertical Polarization

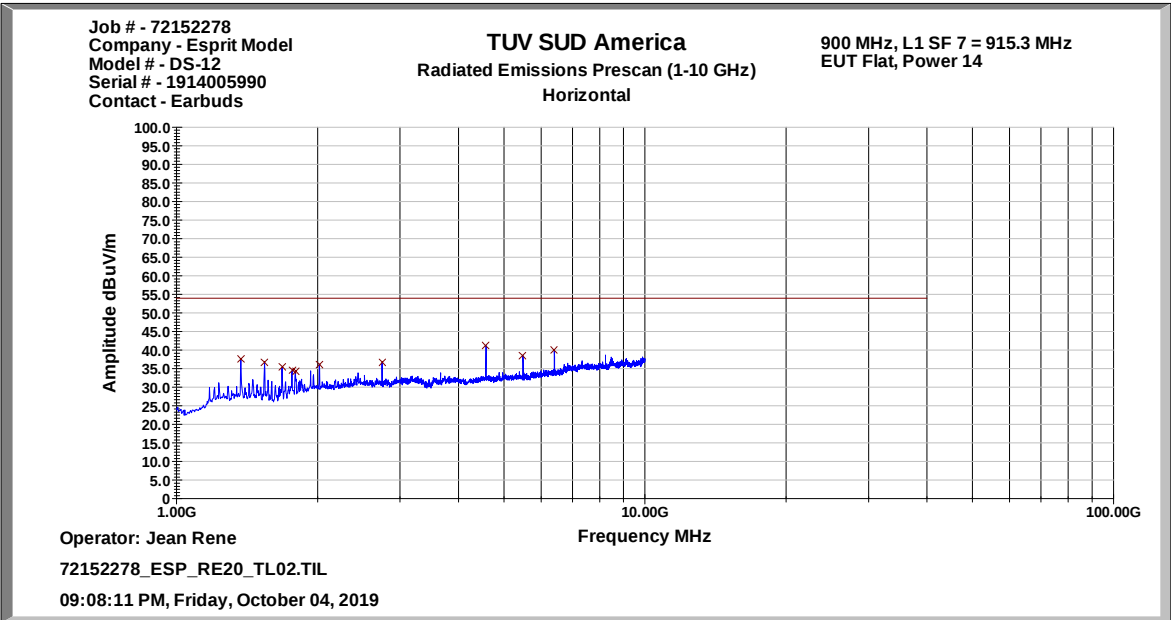


Figure 2.10.7-4: TX Radiated Spurious Emissions – Pre-Scan Plot 1 GHz- 10 GHz – Horizontal Polarization

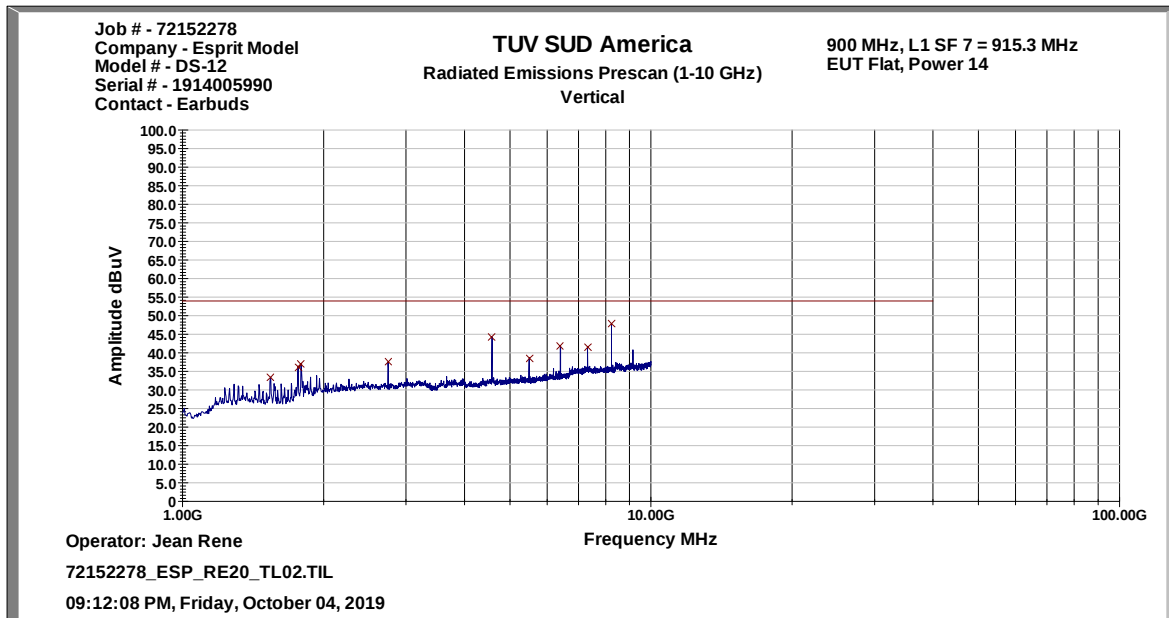


Figure 2.10.7-5: TX Radiated Spurious Emissions – Pre-Scan Plot 1 GHz – 10 GHz – Vertical Polarization

2.10.8 Sample Calculations

$$R_C = R_U + CF_T$$

Where:

CF_T	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
R_U	=	Uncorrected Reading
R_C	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

Example Calculation: Peak

Corrected Level: $57.4 + (-0.92) = 56.48 \text{ dB}\mu\text{V/m}$

Margin: $74 \text{ dB}\mu\text{V/m} - 56.48 \text{ dB}\mu\text{V/m} = 17.52 \text{ dB}$

Example Calculation: Average

Corrected Level: $34.45 + (-0.92) - 0 = 33.53 \text{ dB}\mu\text{V/m}$

Margin: $54 \text{ dB}\mu\text{V/m} - 33.53 \text{ dB}\mu\text{V/m} = 20.47 \text{ dB}$



Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Active Loop Antenna	EMCO	6502	BEMC00078	N/A	24	09-May-2020
9kHz-26.5GHz EMC analyzer/HYZ	Agilent	E7405A	BEMC00523	A.14.06	24	27-Nov-2020
10dB Attenuator	Merrimac	FAN-6-10K	BEMC02086	N/A	12	12-Oct-2020
Tile Automation Software	ETS Lindgren	TILE4! - Version 4.2.A	BEMC02095	4.2A	N/A	NCR
BI LOG PERIODIC, ANTENNA	Schaffner	CBL6112B	TEMC00005	N/A	24	19-Dec-2019
Horn Antenna	Schwarzbeck	BBHA-9170	TEMC00029	N/A	60	23-Aug-2021
EMC Chamber	Panasheild	N/A	TEMC00031	N/A	24	28-Jan-2020
Double Ridge Guide Horn	ETS Lindgren	3117	TEMC00061	N/A	24	13-Feb-2020
18 GHz-40 GHz Microwave Preamplifier	COM-power	PAM-840A	TEMC00147	N/A	24	30-May-2020
PAM-118A	Com-Power Corporatio	PAM-118A	TEMC00160	N/A	12	27-Apr-2020
4A & 4B Test Cables	MegaPhase, LLC	1GVT4	TEMC00171	N/A	24	30-May-2020
2.4 GHz Notch Filter	Micro-Tronics	BRM50702-01	TEMC00176	N/A	12	10-Apr-2020
Radiated Cable Set 30 MHz - 1 GHz	TUV SUD Tampa	Cable 2	TEMC00179	N/A	12	07-May-2020
Radiated Cable Set 9 kHz - 30 MHz	TUV SUD Tampa	Cable 2	TEMC00186	N/A	12	08-May-2020

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



2.11 Power Spectral Density

2.11.1 Specification Reference

FCC: Section 15.247(f)
ISED Canada: RSS-247 5.3(b)

2.11.2 Equipment Under Test and Modification State

SN: 1914005990

2.11.3 Date of Test

10/18/2019

2.11.4 Test Method

The power spectral density was measured in accordance with ANSI C63.10 Subclause 11.10.5 Method AVGPSD-2. The RF output port of the EUT was directly connected to the input of the spectrum analyzer. Offset values were input for cable and external attenuation. The spectrum analyzer RBW was set to 3 kHz and VBW to 10 kHz. The Span was adjusted to 1.5 times the OBW bandwidth and the sweep time was set to auto. The measurements were performed using an RMS detector.

2.11.5 Environmental Conditions

Ambient Temperature 24.4 °C
Relative Humidity 40.1 %
Atmospheric Pressure 1013.3 mbar

2.11.6 Test Results

DC Powered Operating

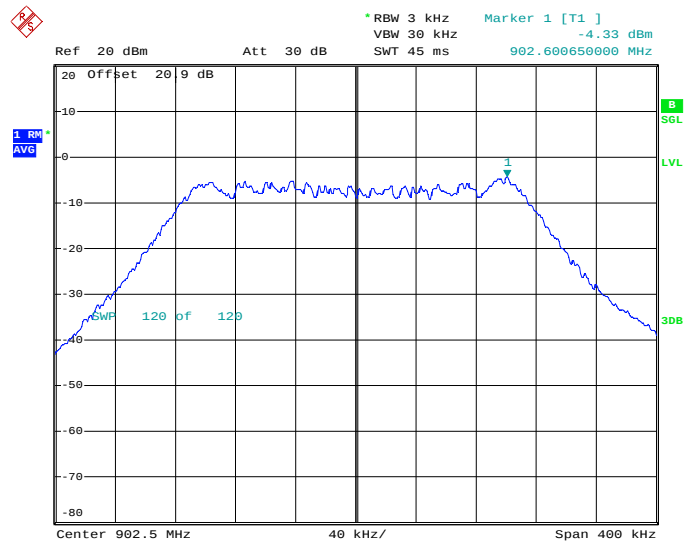
Limit FCC: Section 15.247(f), ISED Canada: RSS-247 5.3(b)

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time of continuous transmission.

The calculations for the duty cycle correction factor is provided in Section 2.13.

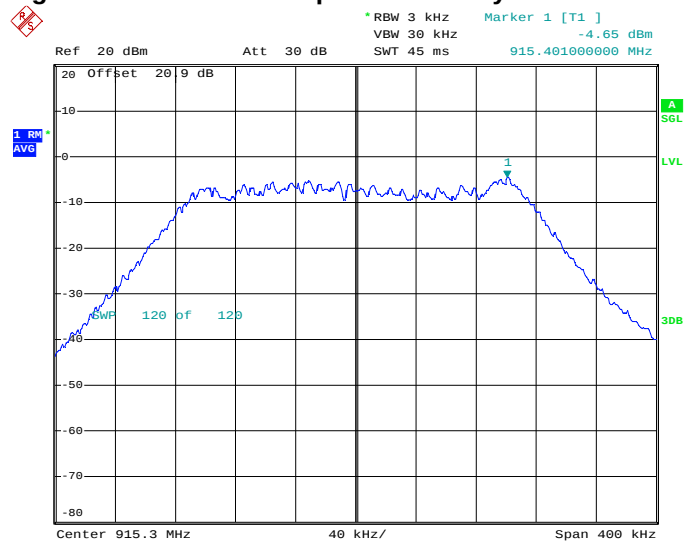
Table 2.11.6-1: Power Spectral Density – SF6

Frequency (MHz)	Measured Level (dBm)	Duty Cycle Correction Factor (dB)	Corrected Average PSD (dBm)
902.5	-4.33	2.29	-2.04
915.3	-4.65	2.29	-2.36
927.3	-5.15	2.29	-2.86



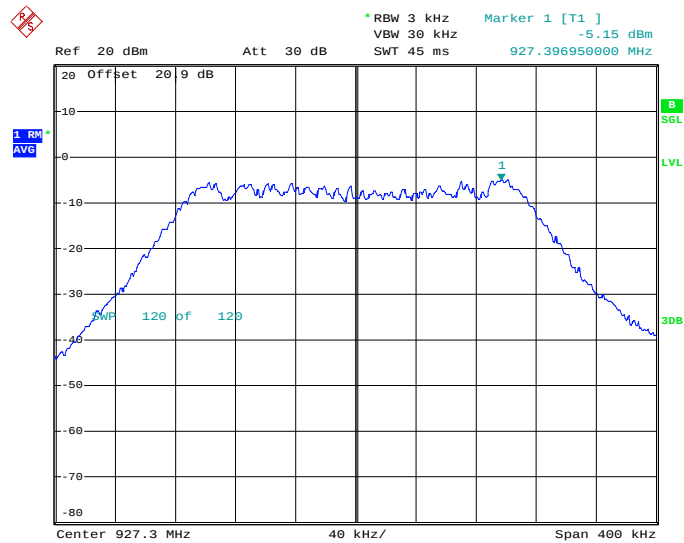
Date: 18.OCT.2019 12:52:39

Figure 2.11.6-1: Power Spectral Density – Low Channel – SF6



Date: 7.OCT.2019 10:33:14

Figure 2.11.6-2: Power Spectral Density – Middle Channel – SF6

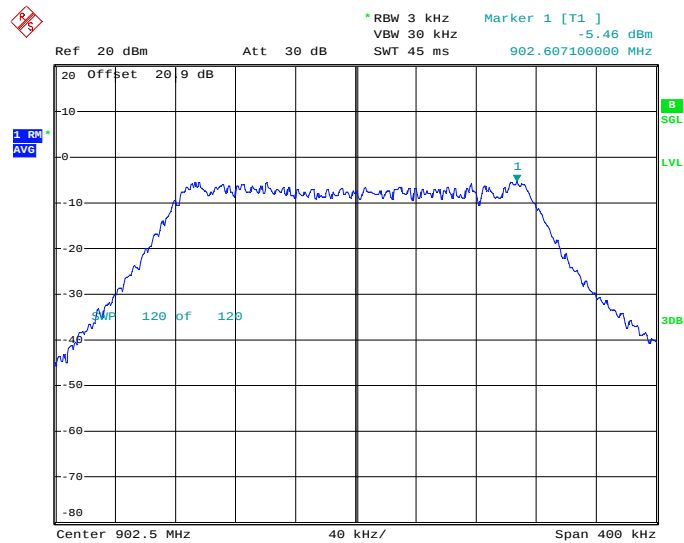


Date: 18.OCT.2019 12:51:09

Figure 2.11.6-3: Power Spectral Density – High Channel – SF6

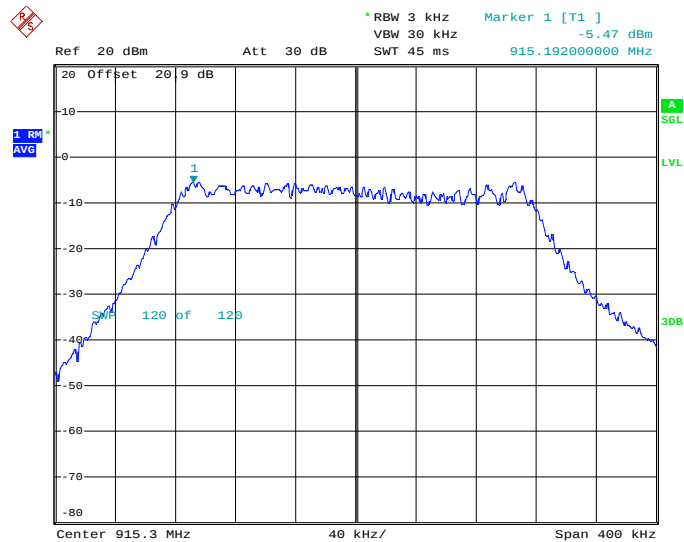
Table 2.11.6-2: Power Spectral Density – SF7

Frequency (MHz)	Measured Level (dBm)	Duty Cycle Correction Factor (dB)	Corrected Average PSD (dBm)
902.5	-5.46	2.35	-3.11
915.3	-5.47	2.35	-3.12
927.3	-5.64	2.35	-3.29



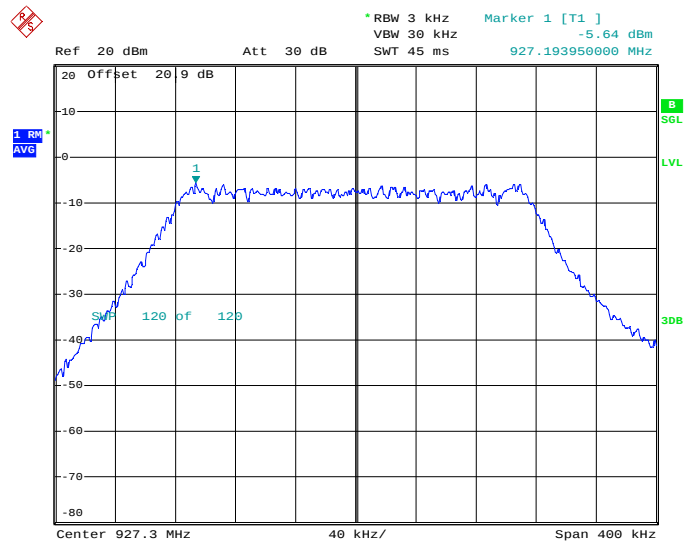
Date: 18.OCT.2019 12:54:42

Figure 2.11.6-4: Power Spectral Density – Low Channel – SF7



Date: 7.OCT.2019 10:45:52

Figure 2.11.6-5: Power Spectral Density – Middle Channel – SF7



Date: 18.OCT.2019 12:49:45

Figure 2.11.6-6: Power Spectral Density – High Channel – SF7

2.11.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled
O/P MON - Traceability Unscheduled
N/A - Not Applicable



2.12 Power Line Conducted Emissions

2.12.1 Specification Reference

FCC: Section 15.207
ISED Canada: RSS-GEN 8.8

2.12.2 Equipment Under Test and Modification State

SN: 1914005990

2.12.3 Date of Test

8/16/2019

2.12.4 Test Method

ANSI C63.10 section 6.2 was the guiding document for this evaluation. Conducted emissions were performed from 150 kHz to 30 MHz with the spectrum analyzer's resolution bandwidth set to 9 kHz and the video bandwidth set to 30 kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

2.12.5 Environmental Conditions

Ambient Temperature 24.5 °C
Relative Humidity 45.2 %
Atmospheric Pressure 1018.3 mbar

2.12.6 Test Results

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.

**Table 2.12.6-1: Power Line Conducted Emissions – Quasi-Peak Detector Results**

Frequency (MHz)	Quasi-peak (dBμV)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	47.98	N	10.1	18.02	66.00
0.402000	34.69	N	10.0	23.12	57.81
0.465000	27.88	N	10.0	28.72	56.60
1.153500	24.54	L1	10.1	31.46	56.00
1.500000	25.19	L1	10.2	30.81	56.00
1.671000	25.14	L1	10.2	30.86	56.00
2.008500	24.74	L1	10.2	31.26	56.00
2.206500	24.30	L1	10.2	31.70	56.00
4.906500	22.85	L1	10.4	33.15	56.00
6.985500	27.55	L1	10.7	32.45	60.00

Table 2.12.6-2: Power Line Conducted Emissions – Average Detector Results

Frequency (MHz)	Average (dBμV)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.168000	30.84	N	10.0	24.22	55.06
0.222000	26.52	N	10.0	26.22	52.74
0.388500	27.40	N	10.0	20.70	48.10
0.411000	23.83	N	10.0	23.80	47.63
0.442500	20.32	N	10.0	26.70	47.02
1.153500	17.10	L1	10.1	28.90	46.00
1.482000	19.05	L1	10.2	26.95	46.00
2.202000	17.81	L1	10.2	28.19	46.00
4.884000	16.11	L1	10.4	29.89	46.00
6.787500	22.02	L1	10.7	27.98	50.00

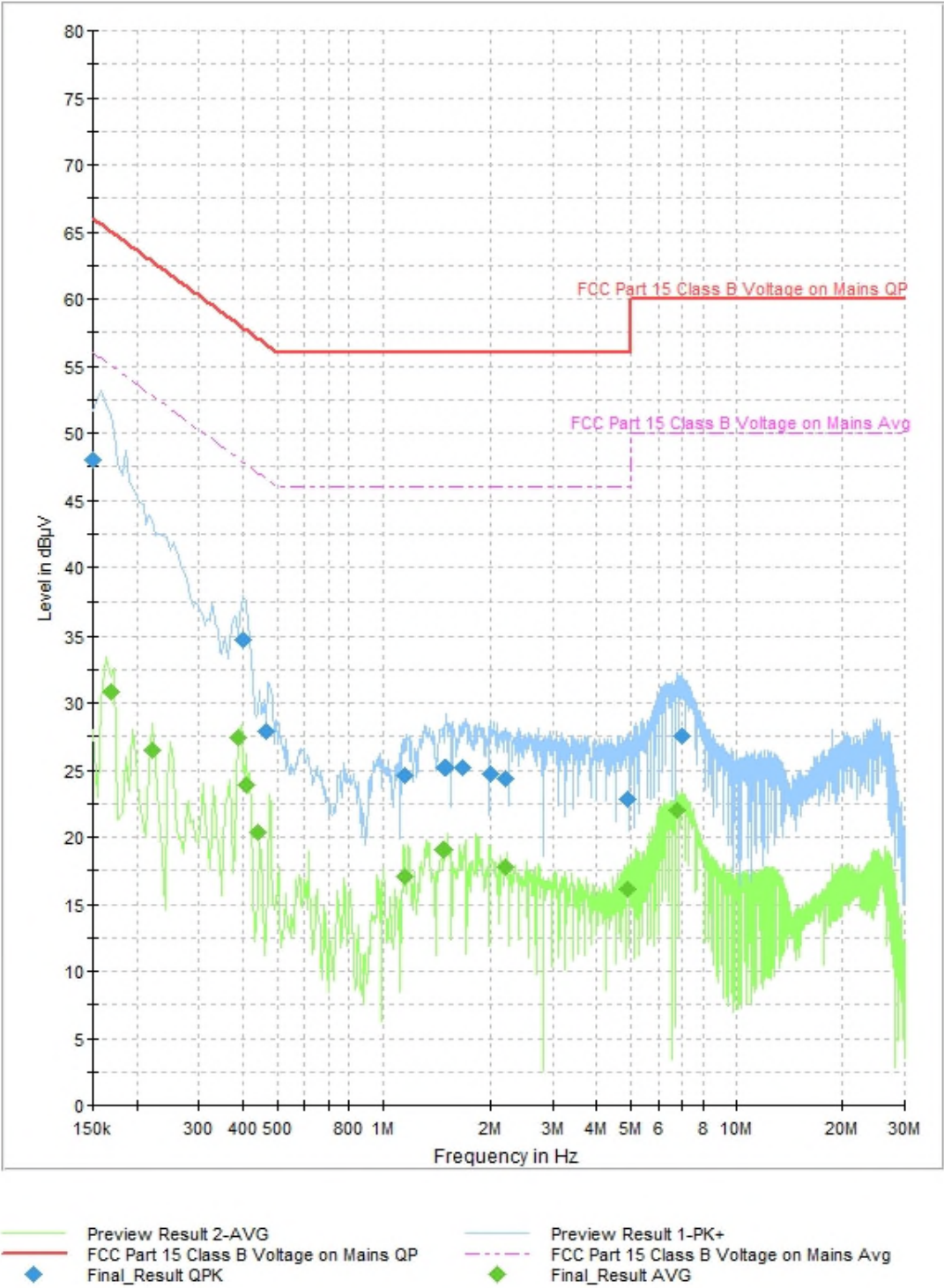


Figure 2.12.6-1: Graphical Results – AC Mains Composite Line and Neutral Plots



2.12.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
LISN	Rohde & Schwarz	ESH3-Z5	TEMC00002	N/A	24	30-Sep-2021
EMI Test Receiver	Rohde & Schwarz	ESCS30	TEMC00011	2.3002.0102.36	24	17-Nov-2019
RFI/EMI Shielded Enclosure	UNIVERSAL SHIELDING CORP.	N/A	TEMC00100	N/A	N/A	NCR
Test Software	Rohde & Schwarz	EMC32	TEMC00184	10.50.00	N/A	NCR

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



2.13 Duty Cycle Correction Factor

2.13.1 Specification Reference

FCC: N/A
ISED Canada: N/A

2.13.2 Equipment Under Test and Modification State

SN: 1914005990

2.13.3 Date of Test

10/3/2019

2.13.4 Test Method

The transmitter duty cycle was measured in accordance with FCC KDB 558074 D01 15.247 Meas Guidance v05r02. The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The reference level of the measuring equipment was offset to account for the insertion loss of the measurement cable and external attenuation. The spectrum analyzer RBW was set to the largest value. The measurements were performed using a Peak detector.

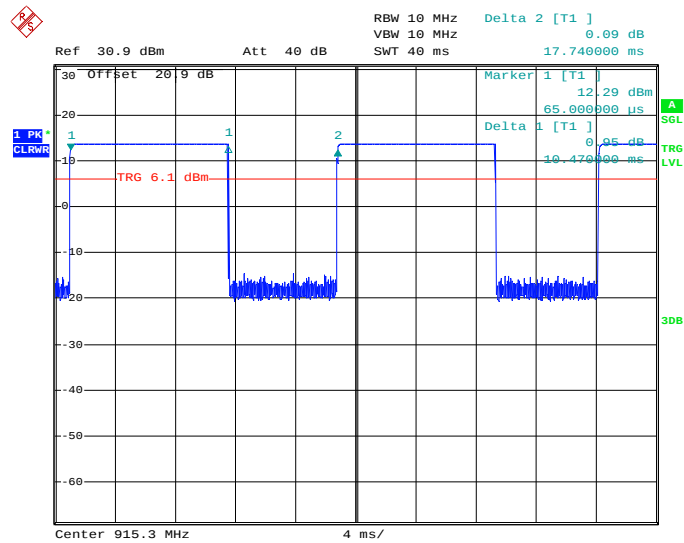
2.13.5 Environmental Conditions

Ambient Temperature 24.5 °C
Relative Humidity 48.5 %
Atmospheric Pressure 1014.1 mbar

2.13.6 Test Results

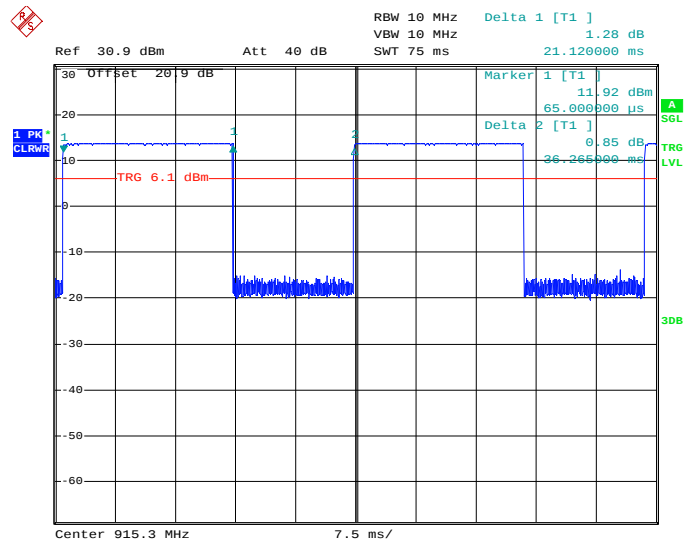
Table 2.11.6-3: Duty Cycle Correction Factor

Spreading Factor	Tx On (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
SF=6	10.47	17.74	59.02	2.29
SF=7	21.12	36.265	58.24	2.35



Date: 3.OCT.2019 15:44:48

Figure 2.13.6-1: Duty Cycle – SF6



Date: 3.OCT.2019 15:52:51

Figure 2.13.6-2: Duty Cycle – SF7



2.13.7 Test Location and Test Equipment Used

This test was carried out in TÜV SÜD America, Inc., 5610 W. Sligh Ave, Suite 100, Tampa, FL 33634, USA.

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



3 Test Equipment Information

3.1 General Test Equipment Used

Instrument	Manufacturer	Type No	TE No	Software / Firmware Revision	Calibration Period (months)	Calibration Due
Active Loop Antenna	EMCO	6502	BEMC00078	N/A	24	09-May-2020
9kHz-26.5GHz EMC analyzer/HYZ	Agilent	E7405A	BEMC00523	A.14.06	24	27-Nov-2020
10dB Attenuator	Merrimac	FAN-6-10K	BEMC02086	N/A	12	12-Oct-2020
Tile Automation Software	ETS Lindgren	TILE4! - Version 4.2.A	BEMC02095	4.2A	N/A	NCR
BI LOG PERIODIC, ANTENNA	Schaffner	CBL6112B	TEMC00005	N/A	24	19-Dec-2019
Horn Antenna	Schwarzbeck	BBHA-9170	TEMC00029	N/A	60	23-Aug-2021
EMC Chamber	Panasheild	N/A	TEMC00031	N/A	24	28-Jan-2020
Double Ridge Guide Horn	ETS Lindgren	3117	TEMC00061	N/A	24	13-Feb-2020
18 GHz-40 GHz Microwave Preamp	COM-power	PAM-840A	TEMC00147	N/A	24	30-May-2020
PAM-118A	Com-Power Corporatio	PAM-118A	TEMC00160	N/A	12	27-Apr-2020
4A & 4B Test Cables	MegaPhase, LLC	1GVT4	TEMC00171	N/A	24	30-May-2020
2.4 GHz Notch Filter	Micro-Tronics	BRM50702-01	TEMC00176	N/A	12	10-Apr-2020
Radiated Cable Set 30 MHz - 1 GHz	TUV SUD Tampa	Cable 2	TEMC00179	N/A	12	07-May-2020
Radiated Cable Set 9 kHz - 30 MHz	TUV SUD Tampa	Cable 2	TEMC00186	N/A	12	08-May-2020
LISN	Rohde & Schwarz	ESH3-Z5	TEMC00002	N/A	24	30-Sep-2021
EMI Test Receiver	Rohde & Schwarz	ESCS30	TEMC00011	2.3002.0102.36	24	17-Nov-2019
RFI/EMI Shielded Enclosure	UNIVERSAL SHIELDING CORP.	N/A	TEMC00100	N/A	N/A	NCR
Test Software	Rohde & Schwarz	EMC32	TEMC00184	10.50.00	N/A	NCR
Spectrum Analyzer	Rohde & Schwarz	FSP40	BEMC00283	4.50 SP5	24	28-Nov-2019
Attenuator 20dB, 2.9 mm-M/F, DC-40GHz 2 W	Aeroflex Inmet	40AH2W-20	BEMC02111	N/A	12	27-Jul-2020
Duratest High Frequency Cable Max. frequency 26.5GHz	Teledyne Storm Products	921-0101-036	BEMC02112	N/A	12	12-Oct-2020

TU - Traceability Unscheduled

O/P MON - Traceability Unscheduled

N/A - Not Applicable



4 **Diagram of Test Set-ups**

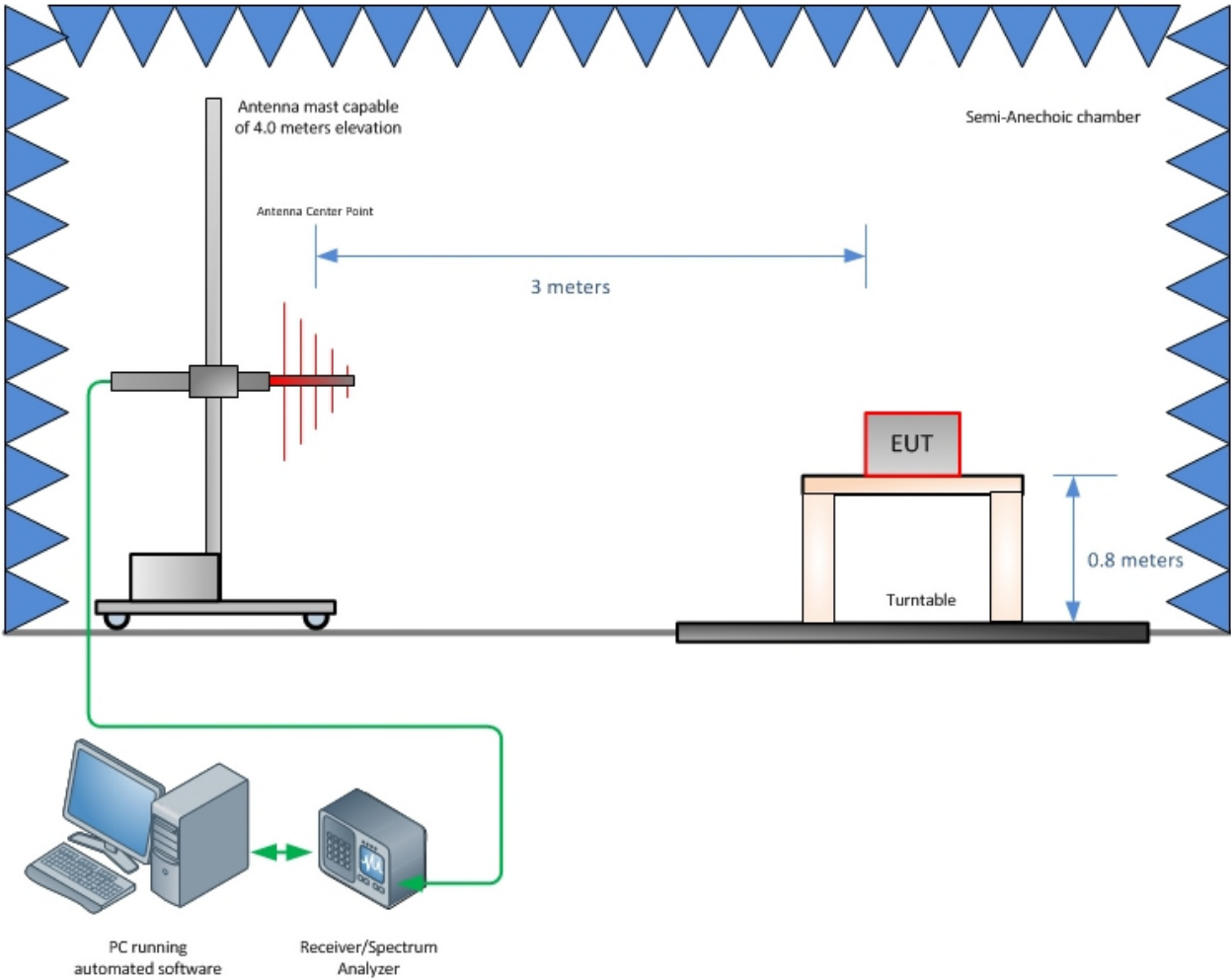


Figure 4-1 - Radiated Emissions Test Setup up to 1 GHz

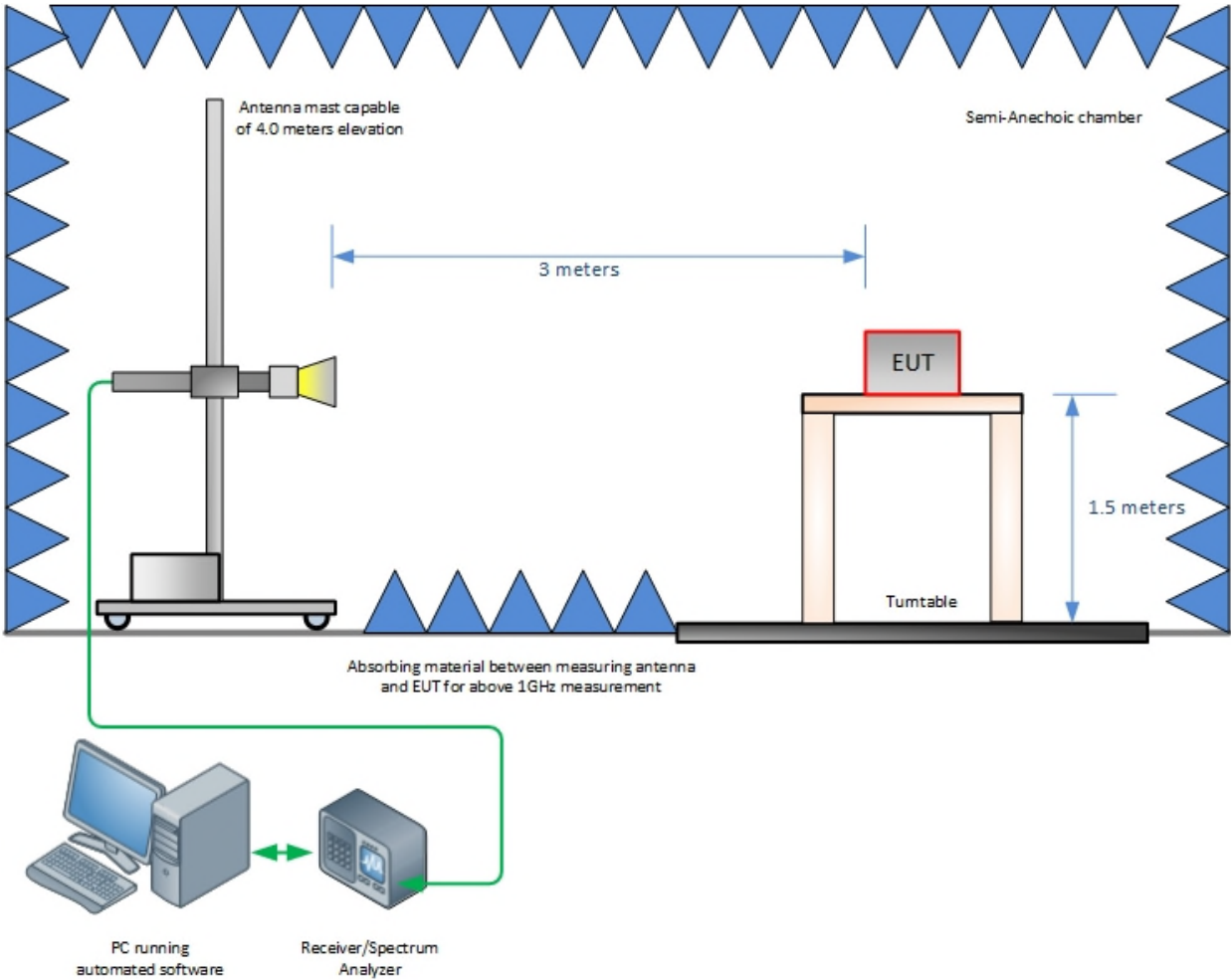


Figure 4-2 - Radiated Emissions Test Setup above 1 GHz

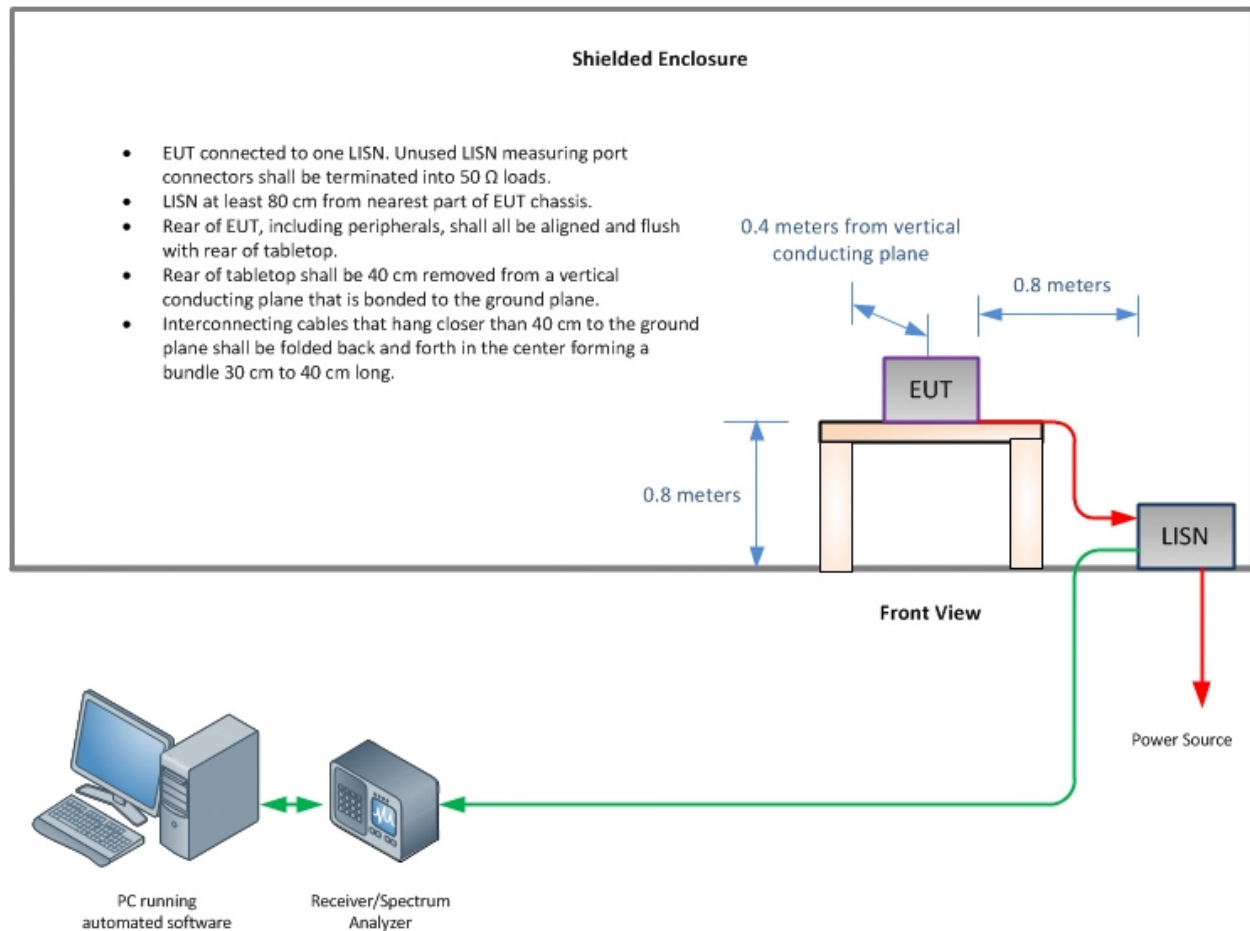


Figure 4-3 – Conducted Emissions Test Setup



5 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Table 6-1 - Values of U_{CISPR} and U_{Lab}

Measurement	U_{CISPR}	U_{Lab}
Conducted disturbance (mains port) (9 kHz – 150 kHz) (150 kHz – 30 MHz)	3.8 dB 3.4 dB	3.71 dB 3.31 dB
Conducted disturbance (telecom port) (150 kHz – 30 MHz 55 dB LCL) (150 kHz – 30 MHz 65 dB LCL) (150 kHz – 30 MHz 75 dB LCL)	5.0 dB 5.0 dB 5.0 dB	4.11 dB 4.50 dB 4.94 dB
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1 000 MHz) (1 – 6 GHz) (6-18 GHz)	6.3 dB 5.2 dB 5.5 dB	5.85 dB 4.48 dB 4.48 dB

Notes:

U_{CISPR} resembles a value of measurement uncertainty for a specific test, which was determined by considering uncertainties associated with the quantities listed in CISPR 16-4-2:2011.



6 Accreditation, Disclaimers and Copyright

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