Excellence in Compliance Testing

Modular Approval
Certification Test Report

FCC ID: SDBVPPIM
IC: 2220A-VPPIM
FCC Rule Part: CFR 47 Part 24 Subpart D, Part 101 Subpart C
ISED Canada Radio Standards Specification: RSS-119, RSS-134

ACS Report Number: 16-3057.W06.1A

Applicant: Sensus Metering Systems, Inc.
Model: VP-DALI

Test Begin Date: August 11, 2016
Test End Date: October 14, 2016

Report Issue Date: October 25, 2016

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

For The Scope of Accreditation Under Certificate Number AT-1921

This report must not be used by the client to claim product certification, approval, or endorsement by ANAB, ANSI, or any agency of the Federal Government.

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This report contains 59 pages

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1.0 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 2 Subpart J, Part 24 Subpart D and Part 101 Subpart C of the FCC's Code of Federal Regulations, and ISED Canada Radio Standards Specifications RSS-119 and RSS-134.

1.2 Product Description

The VP-DALI module is a radio control module to be used in NEMA plug-in streetlight control products that are part of the Sensus Flexnet Streetlight Control System that allows users to monitor and control streetlights.

The VP-DALI is manufactured using any one of three different TCXOs (KDS, Taiten, ILS).

Manufacturer Information:
Sensus Metering Systems, Inc.
639 Davis Drive
Morrisville, NC 27560

Test Sample Serial Numbers:

TCXO Manufacturer	TX Radiated	RF Conducted
ILSI	Not applicable	113
KDS	258	56
Taitien	Not applicable	96

Test Sample Condition: The test samples were provided in good working order with no visible defects.

1.3 Test Methodology

1.3.1 Configurations and Justification

The EUT was evaluated for radiated and RF conducted measurements for all modulations formats. Where applicable, data is provided for the unit having the worst case emissions (where the TCXO is KDS). Taitien, ILSI, and KDS brands of TCXOs were evaluated.

The evaluation for unintentional emissions is documented separately in a verification report.

The EUT module was evaluated stand alone and in three orthogonal planes (X, Y, Z) and the Y orientation was determined to be the worst case.

1.3.2 In-Band Testing Methodology

The EUT is designed to operate in multiple bands under the requirements of CFR 47 Parts 24 and 101. The following is a list of the frequency bands of operation sorted based on the FCC rule parts in which the band is associated.

CFR Title 47 Rule Part	Frequency Band of Operation (MHz)
24D	901.0 - 902.0
24D	930.0 - 931.0
24D	940.0 - 941.0
101	928.85 - 929.0
101	932.0 - 932.5
101	941.0 - 941.5
101	952.0 – 953.0
101	959.85 - 960.0

Based on the requirements set forth in accordance 47 CFR 2.1046-2.1057 as stated above, the methodology in selecting the places to test in the available bands of operation is outlined in the following table.

CFR Title 47 Rule Part	Frequency Band of Operation (MHz)	Location in the Range of Operation	Approx. Test Freq.
24D	901.0 - 902.0	Middle	901.5000
101	928.85 - 929.0	Middle	928.9250
24D	930.0 - 931.0	Middle	930.5000
101	932.0 - 932.5	Middle	932.2500
24D	940.0 - 941.0	1 near top and 1 near bottom	940.0125
101	941.0 - 941.5		941.4875
101	952.0 – 953.0	Middle	952.5000
101	959.85 – 960.0	Middle	959.9250

1.4 Emission Designators

The VP-DALI transmitter produces six distinct modulation formats. The emission designators for the modulation types used by the VP-DALI transmitter calculated using the baud rate defined in the Theory of Operation are as follows:

EMISSIONS DESIGNATORS

Mode	Emission Designator	Modulation
Normal	9K60F2D	7-FSK
Double Density	9K60F2D	13-FSK
C & I (Half Baud)	4K80F2D	7-FSK
Priority	4K80F2D	13-FSK
MPass (5 kbps)	5K90F1D	2-GFSK
MPass (10 kbps)	11K8F1D	2-GFSK

2.0 TEST FACILITIES

2.1 Location

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions, Inc.
2320 Presidential Dr. Suite 101
Durham NC 27703-8077
Phone: (919) 381-4235
www.acstestlab.com

FCC Registered Test Site Number: 637011
ISED Canada Test Site Registration Number: 20446

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS (Durham) is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board/ANAB accreditation program, and has been issued certificate number AT-1921 in recognition of this accreditation. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

2.3 Radiated & Conducted Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of an 18' x 28' x 18' shielded enclosure. The chamber is lined with Samwha Electronics Co. LTD Ferrite Absorber, model number SFA300 (HSN-1). The ferrite tile is 10cm x 10 cm and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber. On top of the ferrite tiles is DMAS HT-45 (Dutch Microwave Absorber Solutions) hybrid absorber on all walls except the wall behind the antenna mast which has a shorter DMAS HT-25 absorber.

The turntable is 1.50m in diameter and is located 150cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using short #6 copper wire. The turntable is an aluminum, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the turntable. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane.

Behind the turntable is a 2' x 6' x 1.5' deep shielded pit used for support equipment if necessary. The pit is equipped with 2 - 4" PVC chase from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3.1-1 below:

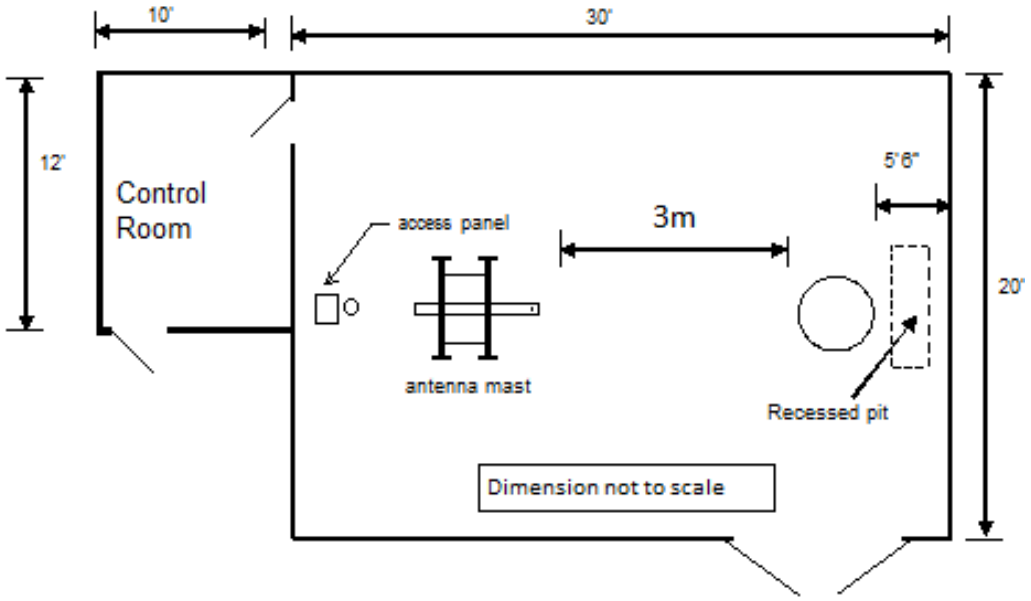

Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 10' sheet galvanized steel horizontal ground reference plane (GRP) bonded every 6" to an 8' X 8' aluminum vertical ground plane.

A diagram of the room is shown below in figure 2.3.2-1:

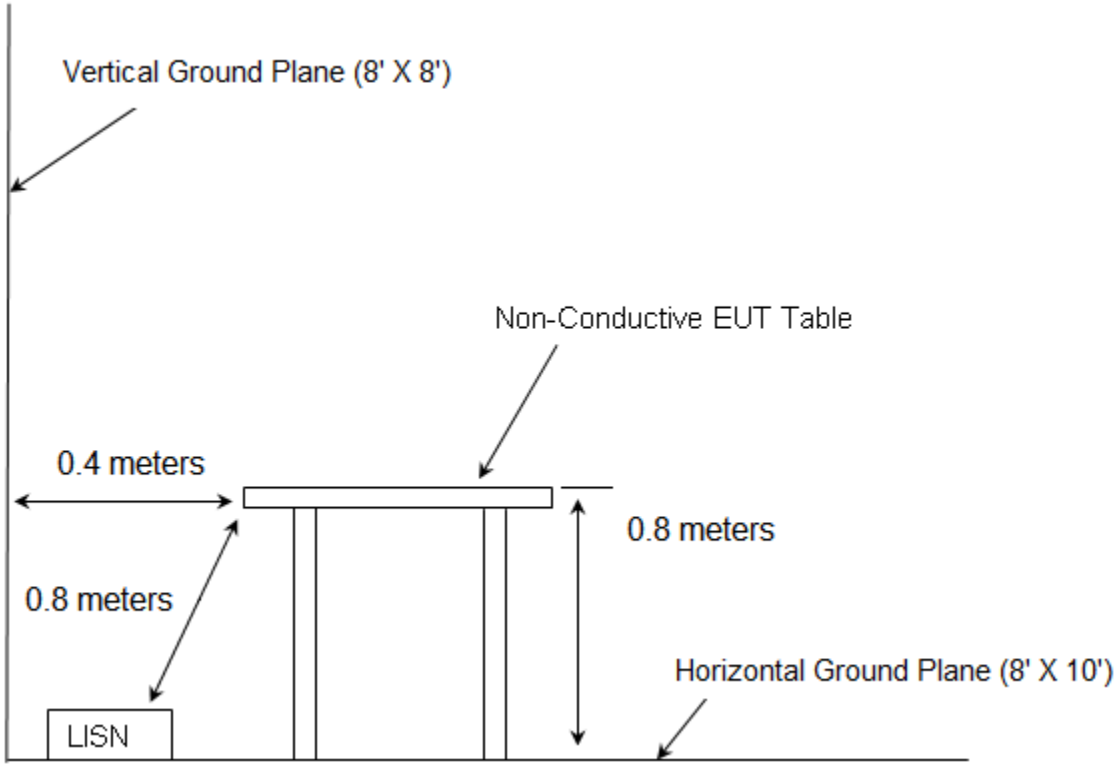

Figure 2.3.2-1: AC Mains Conducted EMI Site

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.4-2014: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9 kHz to 40GHz
- ANSI C63.26-2015: Compliance Testing of Transmitters Used in Licensed Radio Services
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures - 2016
- US Code of Federal Regulations (CFR): Title 47, Part 24, Subpart D: Personal Communications Services – 2016
- US Code of Federal Regulations (CFR): Title 47, Part 101, Subpart C: Fixed Microwave Services -2016
- TIA-603-D: Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards – 2010
- ISED Canada Radio Standards Specification: RSS-119 - Radio Transmitters and Receivers Operating in the Land Mobile and Fixed Services in the Frequency Range 27.41-960 MHz, Issue 12, May 2015
- ISED Canada Radio Standards Specification: RSS-134 - 900 MHz Narrow Band Personal Communication Service, Issue 2, February 2016
- ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 4, November 2014.

4.0 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

Table 4-1: Test Equipment

Asset ID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
277	EMCO	93146	Antennas	9904-5199	9/2/2014	9/2/2016
277	EMCO	93146	Antennas	9904-5199	9/12/2016	9/12/2018
499	EMCO	3146	Antennas	1108	5/4/2015	5/4/2017
626	EMCO	3110B	Antennas	9411-1945	2/29/2016	2/28/2017
3002	Rohde & Schwarz	ESU40	Receiver	100346	1/8/2016	1/8/2017
3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	6/29/2015	12/29/2016
3008	Rohde & Schwarz	NRP2	Meter	103131	1/28/2016	1/28/2017
3009	Rohde & Schwarz	NRP-Z81	Meter	102397	1/28/2016	1/28/2017
3012	Rohde & Schwarz	EMC32-EB	Software	100731	2/2/2016	8/2/2016
3012	Rohde & Schwarz	EMC32-EB	Software	100731	8/2/2016	2/2/2017
3013	Agilent	53132A	Freq. Counter	MY40007729	7/13/2015	1/13/2017
3014	EMCO	3115	Antennas	9901-5653	2/10/2015	2/10/2017
3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	1/26/2016	1/26/2018
3020	Rohde & Schwarz	SMB100A	Signal Generators	175943	7/14/2015	1/14/2017
3029	Micro-Tronics	HPM50108	Filter	134	12/21/2015	12/21/2016
3031	Hasco, Inc.	HLL335-S1-S1-96	Cables	3074	12/30/2015	12/30/2016
3033	Hasco, Inc.	HLL142-S1-S1-36	Cables	1435	1/7/2016	1/7/2017
3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	12/22/2015	12/22/2016
3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	12/22/2015	12/22/2016
3041	Aeroflex Inmet	18N10W-30	Cable Set	1447	1/8/2016	1/8/2017
3042	Aeroflex Inmet	18N10W-10	Cable Set	1444	1/8/2016	1/8/2017
3055	Rohde & Schwarz	3005	Cables	3055	12/30/2015	12/30/2016

When required DMAS MT-25 RF absorber material was used on the floor for all final measurements above 1 GHz.

NCR = No Calibration Required
Firmware Version: ESU40 is 4.73 SP1
Software Version: EMC32-B is 9.15

5.0 SUPPORT EQUIPMENT

5.1 Transmit Conducted

Table 5.1-1: EUT and Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Sensus Metering Systems, Inc.	VP-DALI	56, 96, 113
2	Socket fixture	Sensus Metering Systems	N/A	N/A
3	Isolation transformer	Triad	N-57MG	N/A

Table 5.1-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Power	165 cm	No	EUT to transformer
B	Power	38cm	No	Transformer to Mains

5.2 Transmit Radiated

Table 5.2-1: EUT and Support Equipment

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Sensus Metering Systems, Inc.	VP-DALI	258
2	3.6 V Power Supply	Sensus Metering Systems, Inc.	N/A	N/A

Table 5.2-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Power	1.5 m	No	EUT to Power Supply
B	Power	1.8 m	No	Power Supply to Mains

6.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

6.1 Transmit Conducted

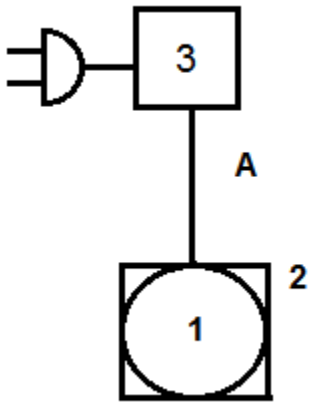

Figure 6.1-1: EUT Test Setup (TX conducted)

6.2 Transmit Radiated

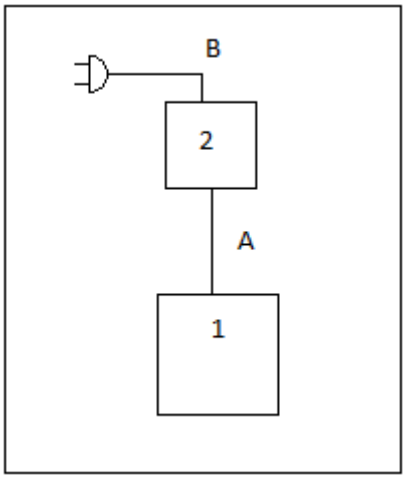

Figure 6.2-1: EUT Test Setup (TX Radiated)

7.0 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

7.1 RF Power Output

7.1.1 Measurement Procedure (ANSI 63.26: 2015 Section 5.2.3.2)

The RF output of the equipment under test was directly connected to the input of a wide band peak reading RF power meter through 30 dB of passive attenuation. The results are shown below.

Part 24.132, 101.113 (a), and ISED Canada RSS-134 4.3(a), (b) and RSS-119 5.4 – Power Output

7.1.2 Measurement Results

KDS

Table 7.1.2-1: Peak Output Power

Frequency (MHz)	FCC Rule Part	Output Power (dBm)	Output Power (Watts)
901.5000	24D	28.70	0.7413
930.5000	24D	28.01	0.6324
940.0125	24D	28.01	0.6324
928.9250	101	27.90	0.6166
932.2500	101	27.94	0.6223
941.4875	101	28.11	0.6471
952.5000	101	27.95	0.6237
959.9250	101	27.84	0.6081

7.2 Out of Band Unwanted Emissions

7.2.1 Measurement Procedure (ANSI 63.26: 2015 Section 5.7.3)

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through 30 dB of passive attenuation. The spectrum analyzer resolution and video bandwidths were set to 300 Hz and 3000 Hz respectively. The internal correction factors of the spectrum analyzer were employed to correct for any cable or attenuator losses. Results of the test are shown below for all modes of operation.

7.2.2 Measurement Results – Emission Masks

Part 24.133 a(1), a(2), ISED Canada RSS-134 4.4.1 (a), (b), 4.4.2 (a),(b) – Emission Limits

KDS

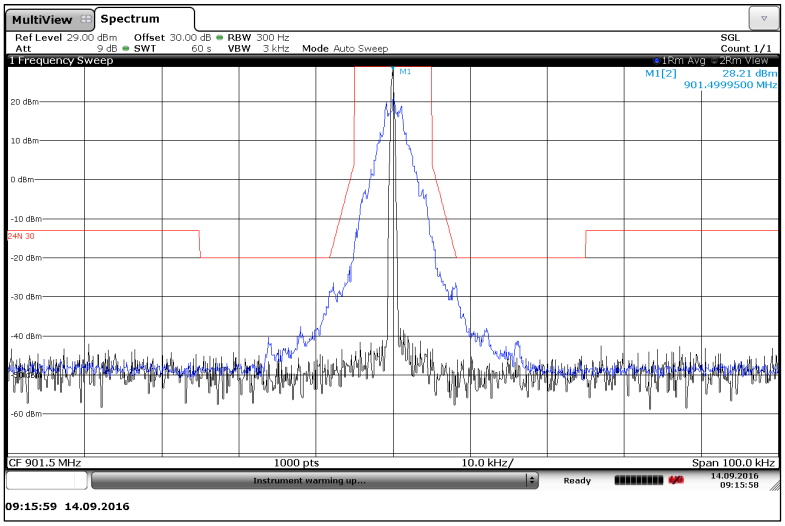

Figure 7.2.2-1: 901.5 MHz – 12.5 kHz Channel Spacing – C&I Mode

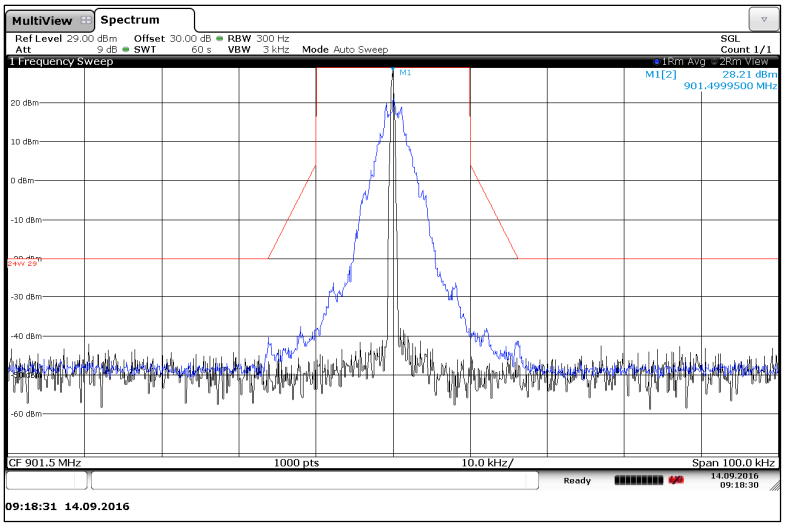

Figure 7.2.2-2: 901.5 MHz – 25 kHz Channel Spacing – C&I Mode

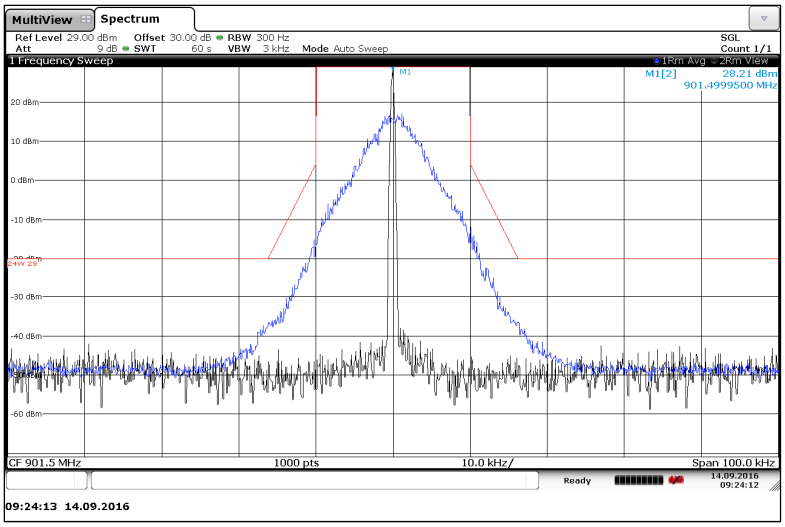

Figure 7.2.2-3: 901.5 MHz – 25 kHz Channel Spacing – Double Density Mode

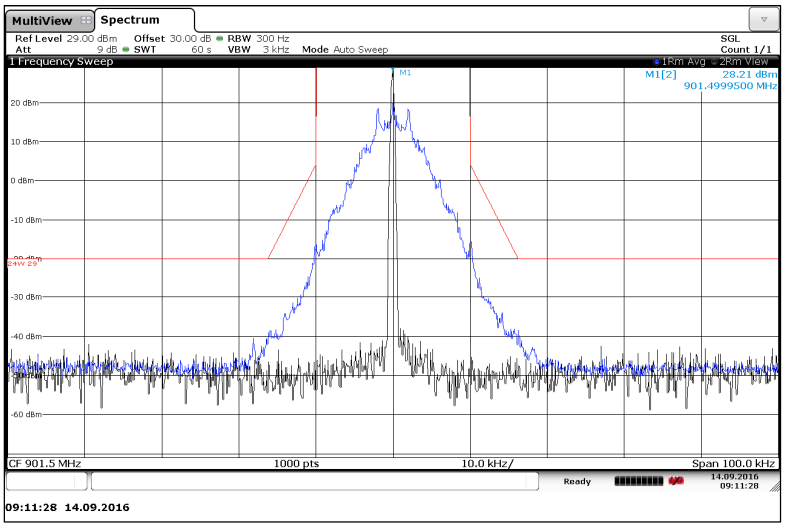

Figure 7.2.2-4: 901.5 MHz – 25 kHz Channel Spacing – Normal Mode

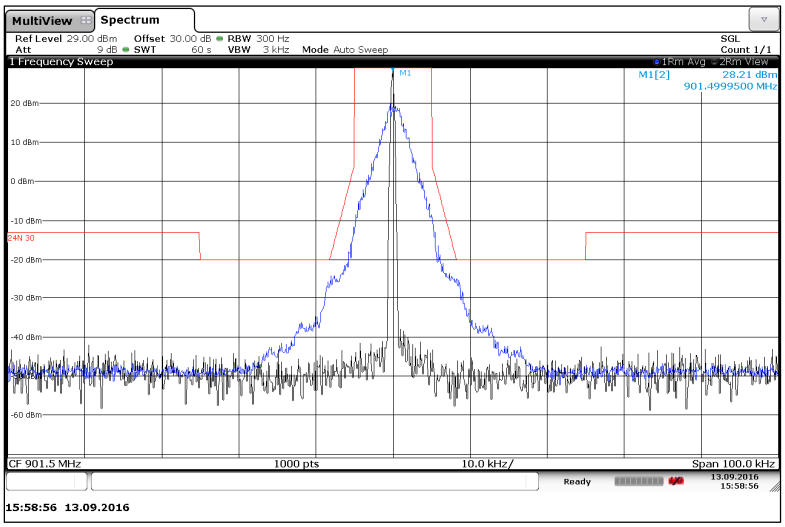

Figure 7.2.2-5: 901.5 MHz – 12.5 kHz Channel Spacing – Priority Mode

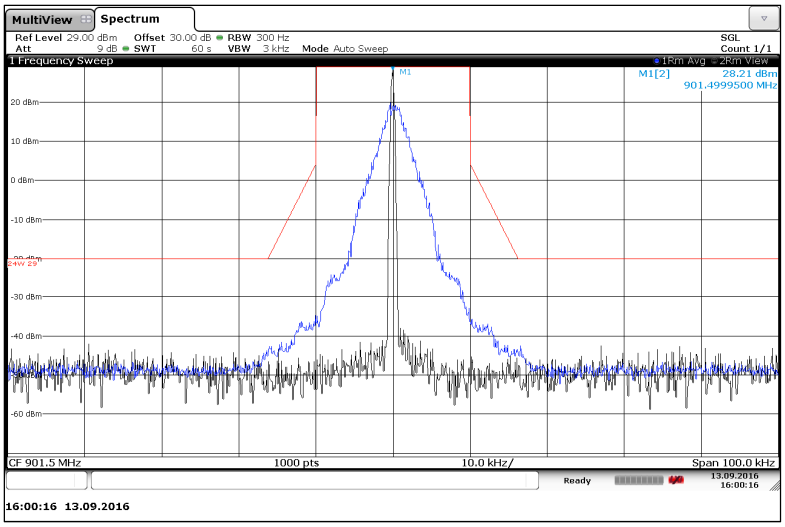

Figure 7.2.2-6: 901.5 MHz – 25 kHz Channel Spacing – Priority Mode

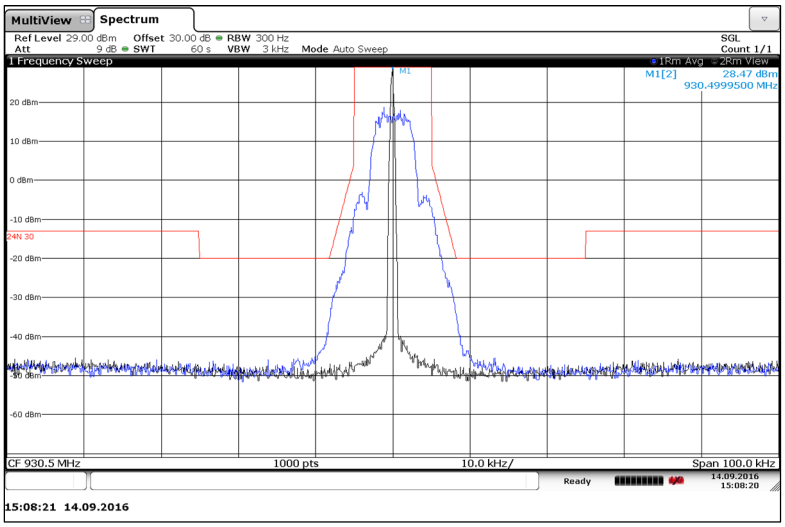

Figure 7.2.2-7: 930.5 MHz - 12.5 kHz Channel Spacing – mPass 5k Mode

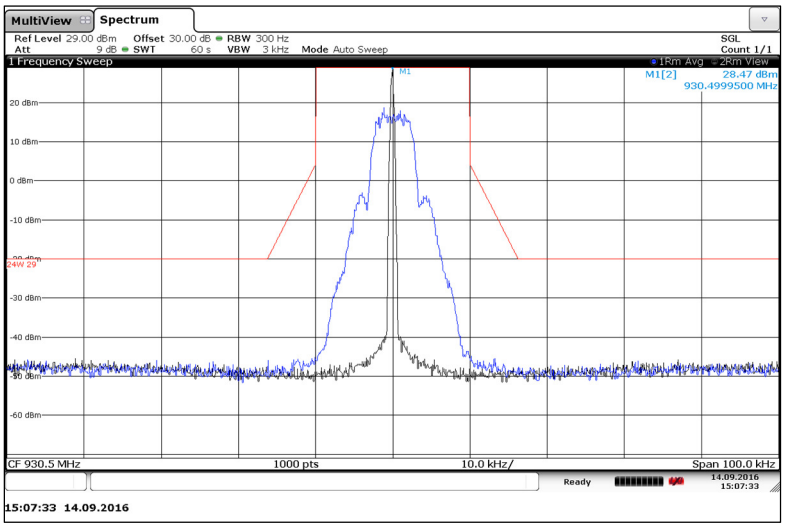

Figure 7.2.2-8: 930.5 MHz – 25 kHz Channel Spacing – mPass 5k Mode

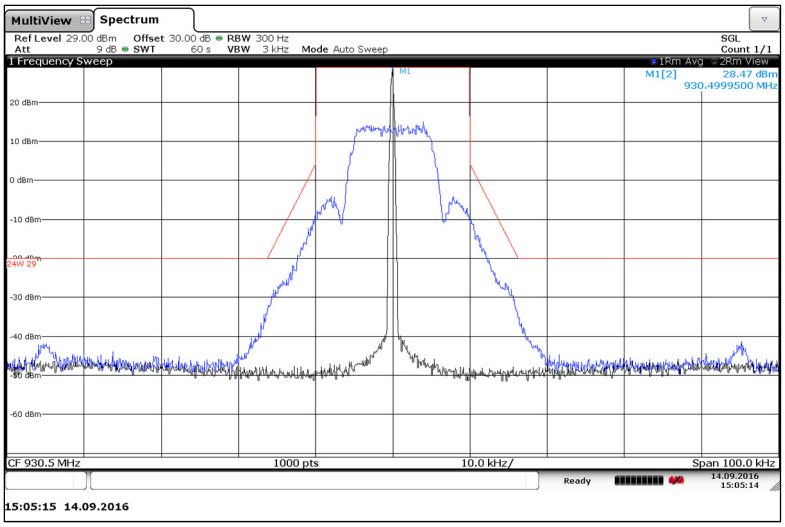

Figure 7.2.2-9: 930.5 MHz – 25 kHz Channel Spacing – mPass 10k Mode

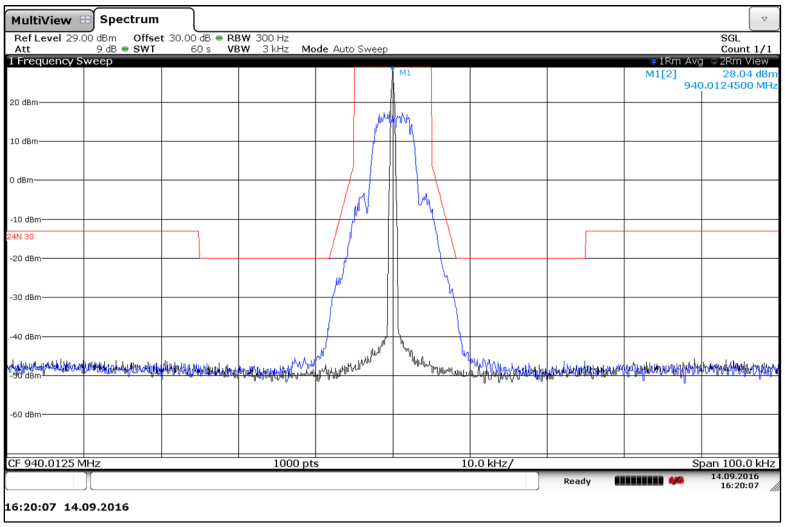

Figure 7.2.2-10: 940.0125 MHz – 12.5 kHz Channel Spacing – mPass 5k Mode

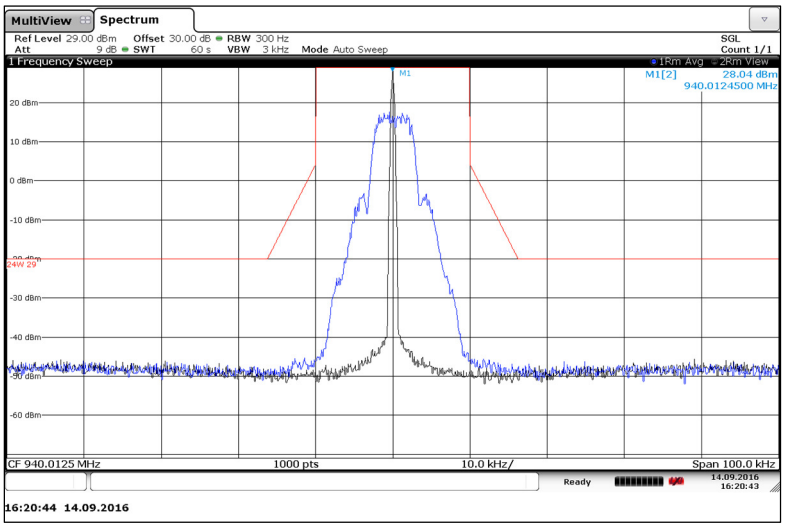

Figure 7.2.2-11: 940.0125 MHz – 25 kHz Channel Spacing – mPass 5k Mode

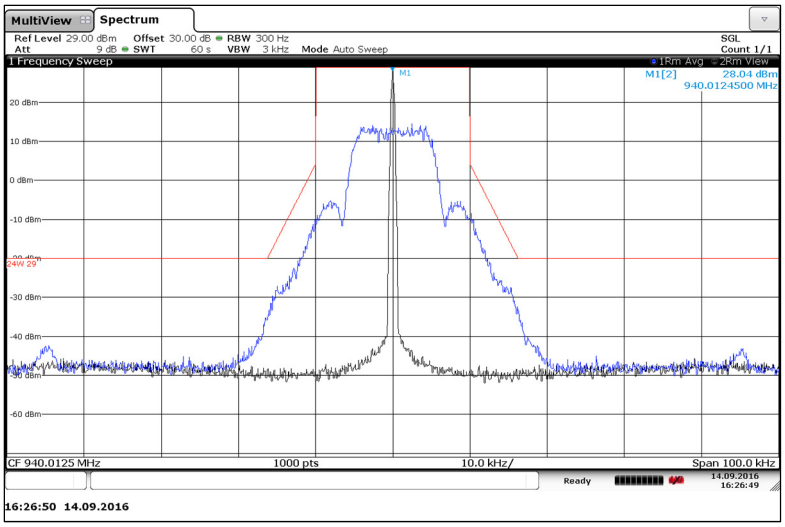

Figure 7.2.2-12: 940.0125 MHz – 25 kHz Channel Spacing – mPass 10k Mode

Part 101.111 a(6), RSS-119 5.8.6 (FCC Part 101.11a(6) provides worst case)

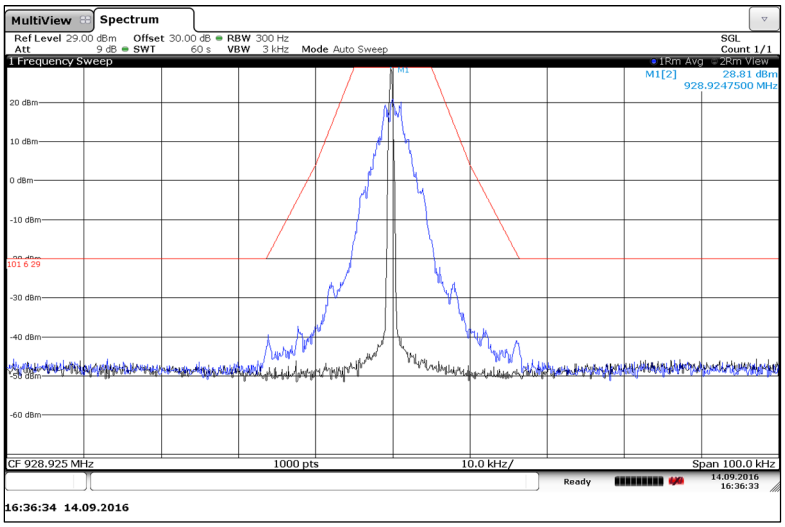

Figure 7.2.2-13: 928.925 MHz – C&I Mode

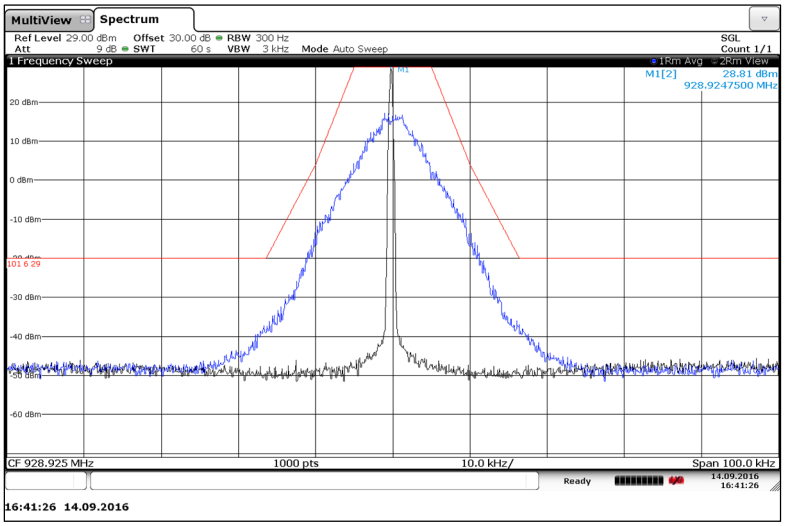

Figure 7.2.2-14: 928.925 MHz – Double Density Mode

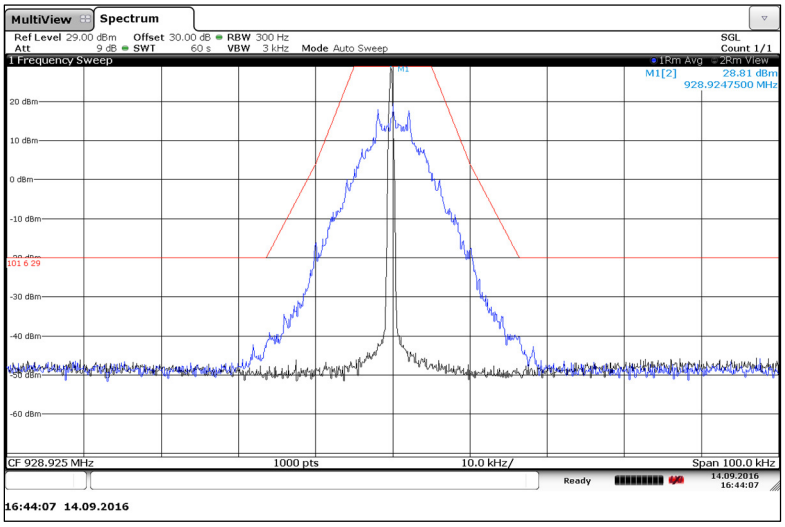

Figure 7.2.2-15: 928.925 MHz – Normal Mode

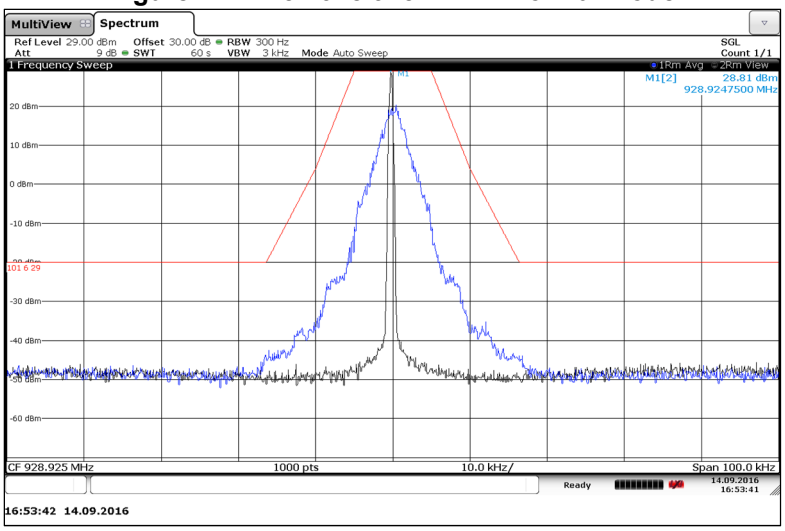

Figure 7.2.2-16: 928.925 MHz — Priority Mode

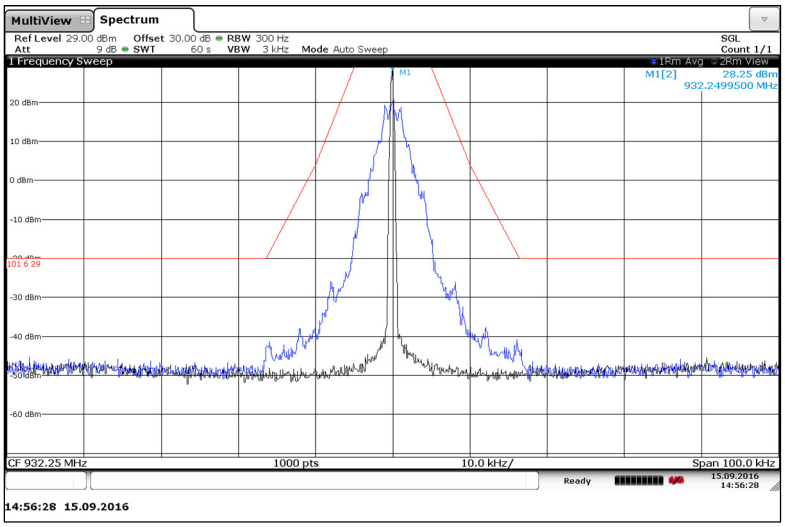

Figure 7.2.2-17: 932.25 MHz – C&I Mode

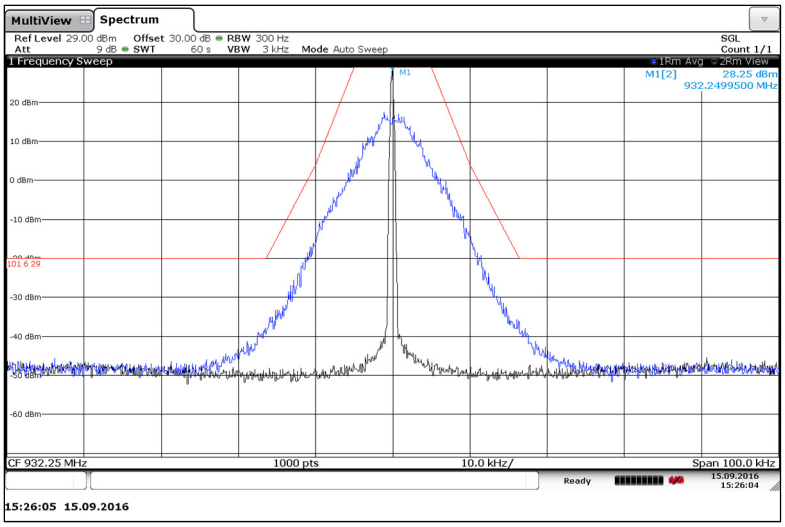

Figure 7.2.2-18: 932.25 MHz – Double Density Mode

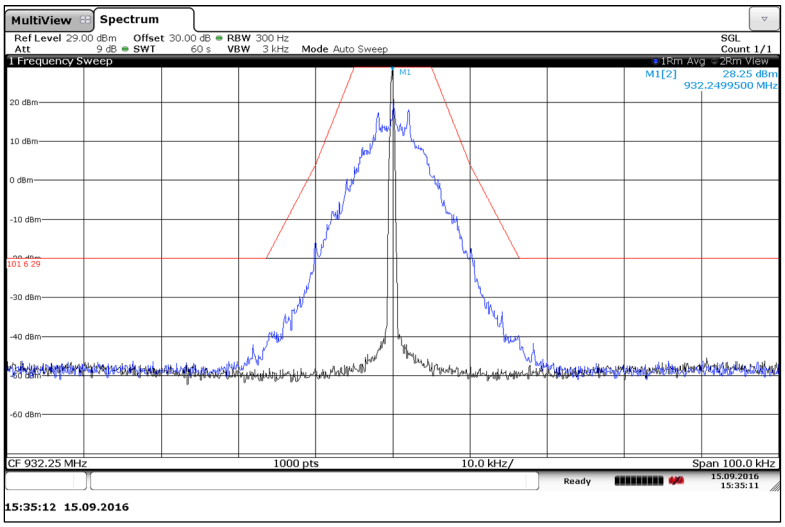

Figure 7.2.2-19: 932.25 MHz – Normal Mode

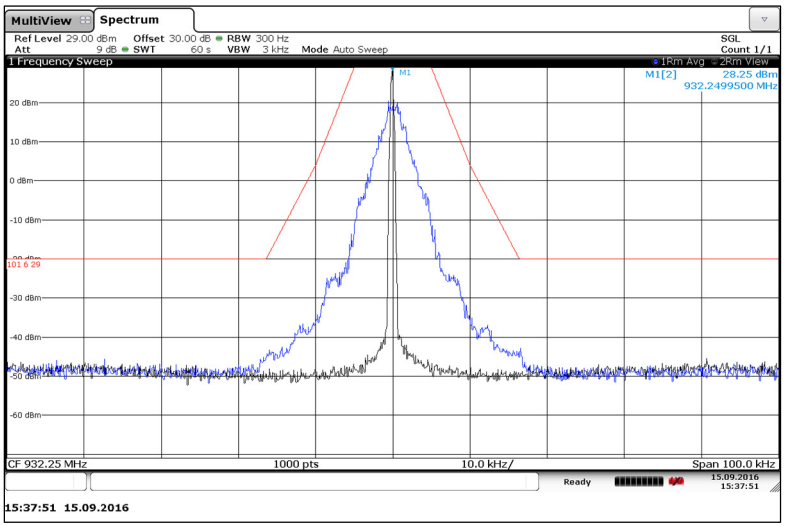

Figure 7.2.2-20: 932.25 MHz — Priority Mode

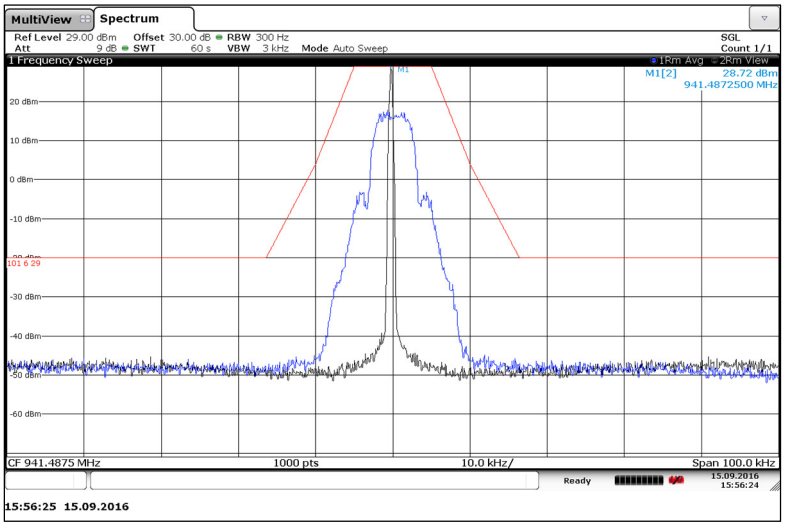

Figure 7.2.2-21: 941.4875 MHz – mPass 5k Mode

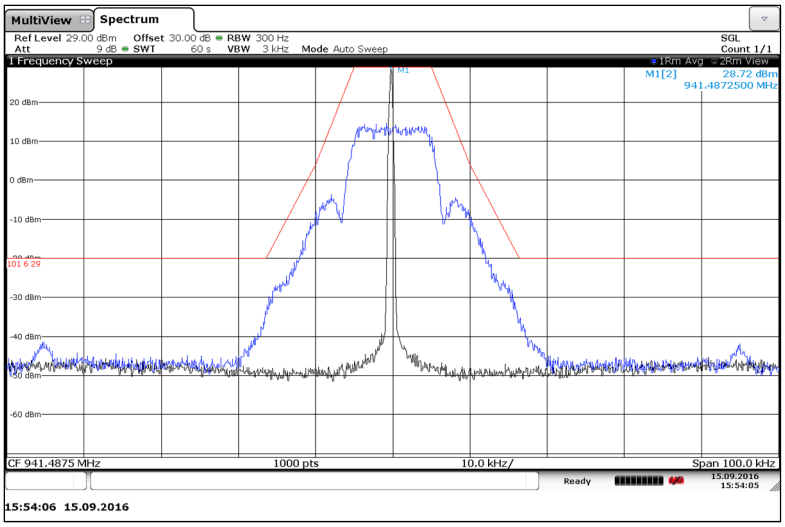

Figure 7.2.2-22: 941.4875 MHz – mPass 10k Mode

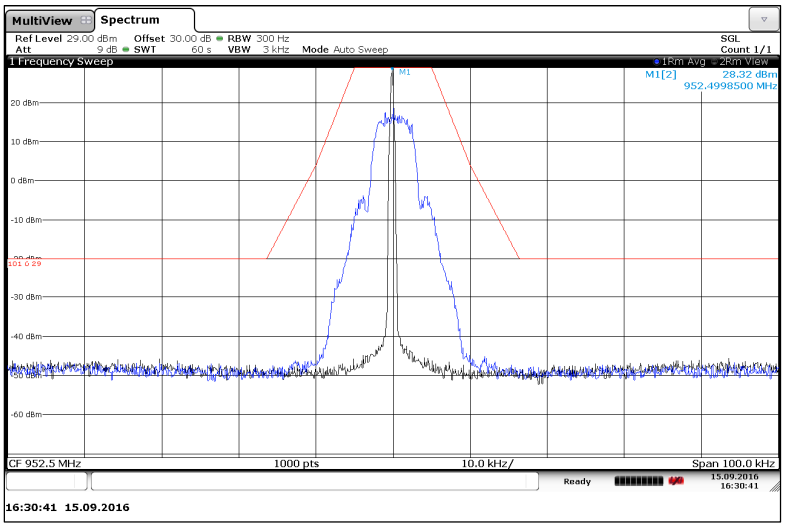

Figure 7.2.2-23: 952.5 MHz – mPass 5k Mode

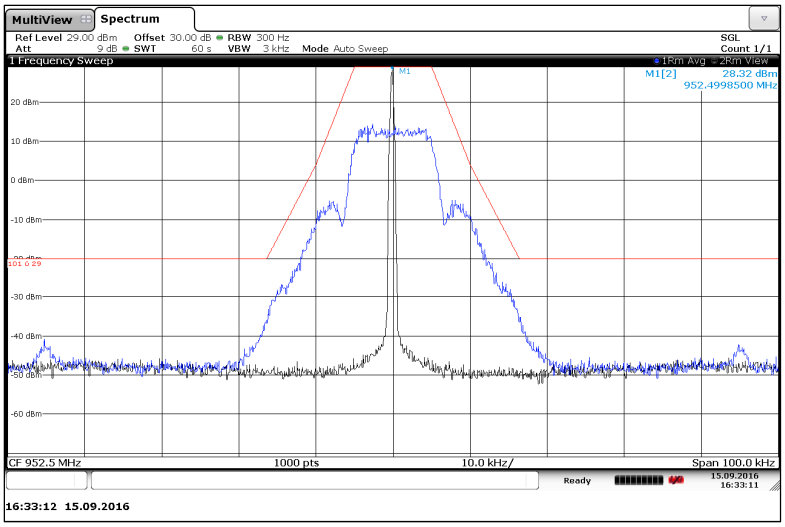

Figure 7.2.2-24: 952.5 MHz – mPass 10k Mode

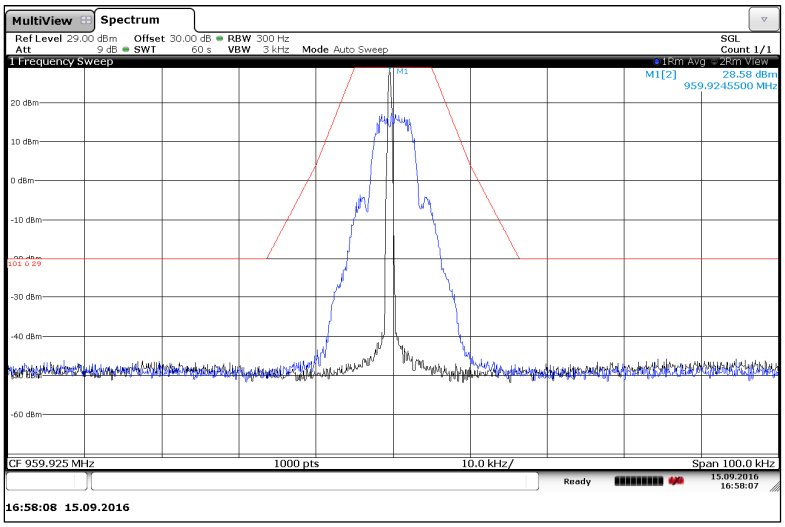

Figure 7.2.2-25: 959.925 MHz – mPass 5k Mode

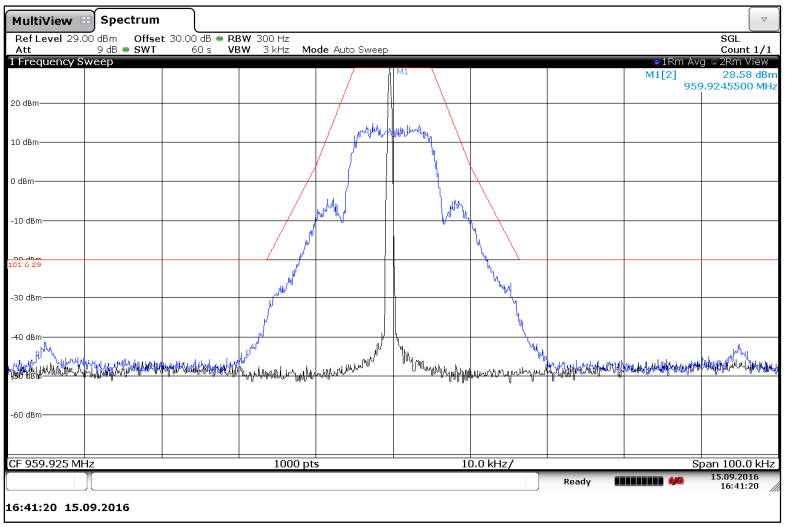

Figure 7.2.2-26: 959.925 MHz – mPass 10k Mode

7.3 99% Bandwidth

7.3.1 Measurement Procedure (ANSI 63.26: 2015 Section 5.4.4)

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through 30 dB of passive attenuation. The internal correction factors of the spectrum analyzer were employed to correct for any cable and attenuator losses.

The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts. The nominal IF filter 3 dB bandwidth (RBW) is in the range of 1% to 5% of the OBW, and the VBW was set ≥ 3 × RBW. The reference level was set to prevent the signal amplitude from exceeding the maximum spectrum analyzer input mixer level for linear operation. The measurements were made using the spectrum analyzer's 99% BW function.

7.3.2 Measurement Results

Frequency (MHz)	ISED Canada Rule Part	Mode of Operation	99% Bandwidth (kHz)
901.5000	RSS-134	C&I	5.6267
901.5000	RSS-134	Double Density	12.4000
901.5000	RSS-134	Normal	11.4333
901.5000	RSS-134	Priority	6.4667
930.5000	RSS-134	mPass 5k	5.8533
930.5000	RSS-134	mPass 10k	11.9333
940.0125	RSS-134	mPass 5k	5.8267
940.0125	RSS-134	mPass 10k	12.0667
928.9250	RSS-119	C&I	5.8267
928.9250	RSS-119	Double Density	13.0000
928.9250	RSS-119	Normal	11.5333
928.9250	RSS-119	Priority	6.6400
932.2500	RSS-119	C&I	5.8800
932.2500	RSS-119	Double Density	13.0000
932.2500	RSS-119	Normal	11.3000
932.2500	RSS-119	Priority	6.5333
941.4875	RSS-119	mPass 5k	5.8533
941.4875	RSS-119	mPass 10k	11.7667
952.5000	RSS-119	mPass 5k	5.8267
952.5000	RSS-119	mPass 10k	12.0667
959.9250	RSS-119	mPass 5k	5.8133
959.9250	RSS-119	mPass 10k	11.9000

ISED Canada RSS-GEN 6.6, ISED Canada RSS-134

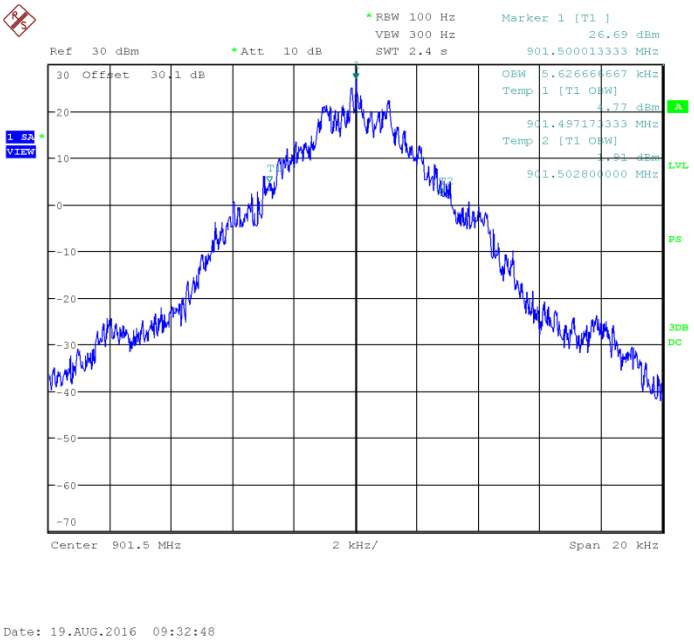

Figure 7.3.2-1: 901.5 MHz – C&I Mode

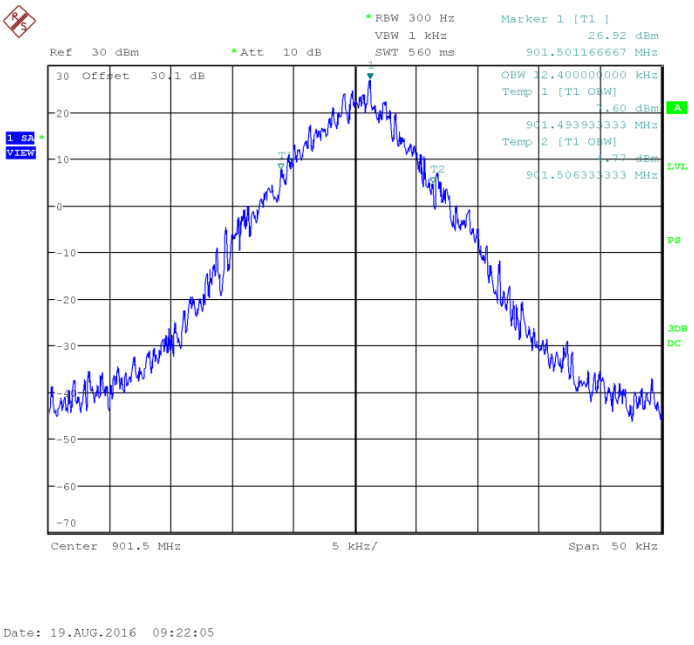

Figure 7.3.2-2: 901.5 MHz – Double Density Mode

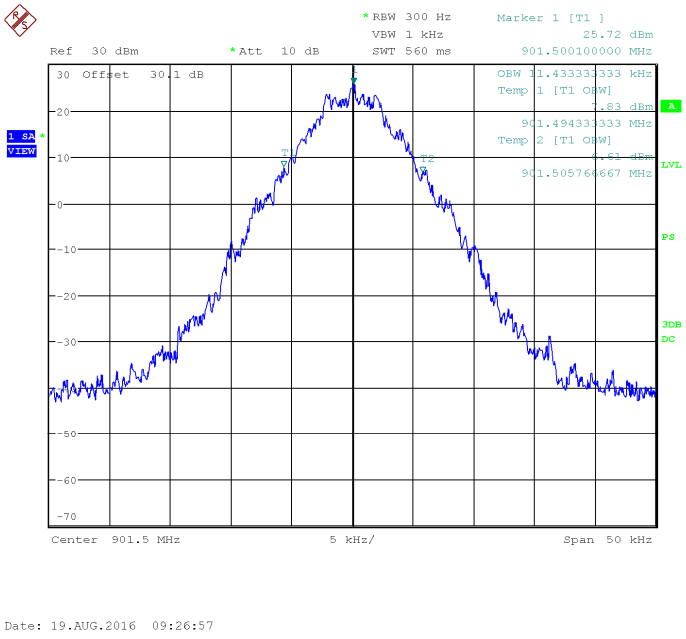

Figure 7.3.2-3: 901.5 MHz – Normal Mode

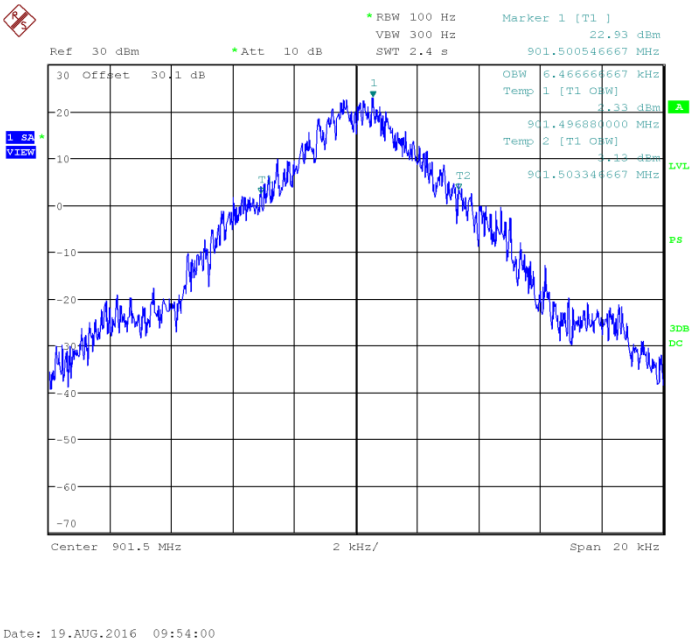

Figure 7.3.2-4: 901.5 MHz – Priority Mode

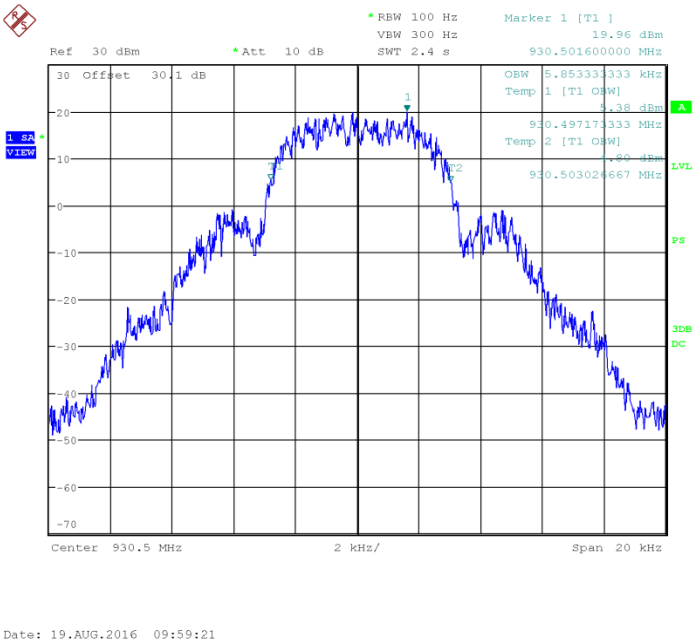

Figure 7.3.2-5: 930.5 MHz – mPass 5k Mode

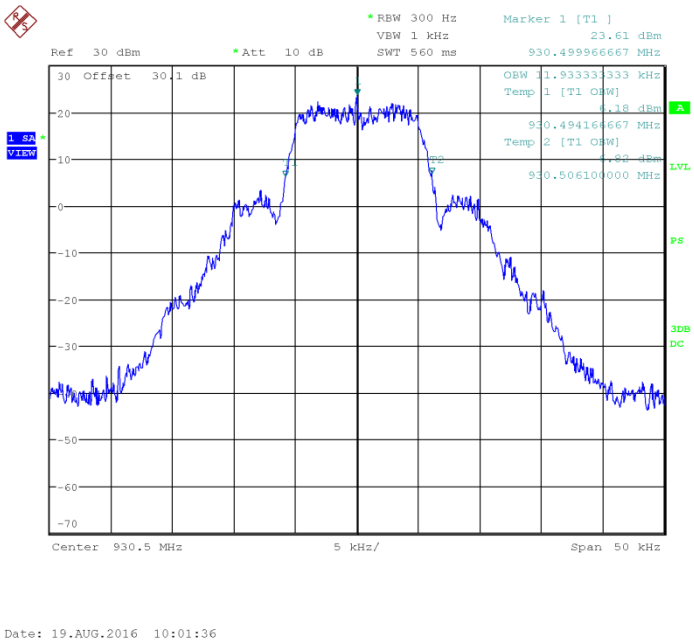

Figure 7.3.2-6: 930.5 MHz – mPass 10k Mode

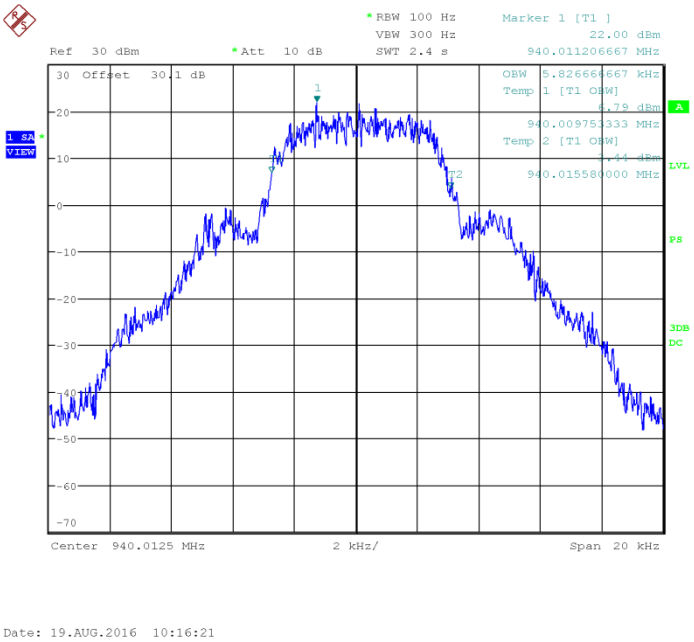

Figure 7.3.2-7: 940.0125 MHz – mPass 5k Mode

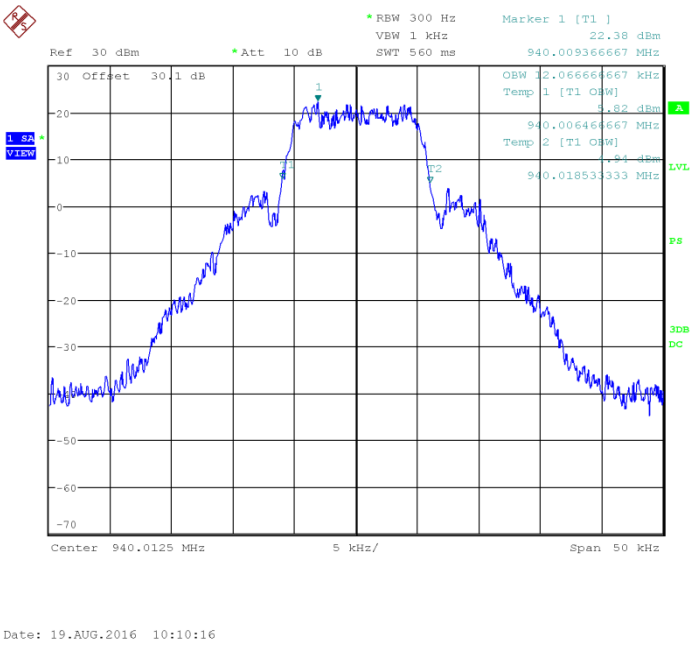

Figure 7.3.2-8: 940.0125 MHz – mPass 10k Mode

ISED Canada RSS-GEN 6.6, ISED Canada RSS-119

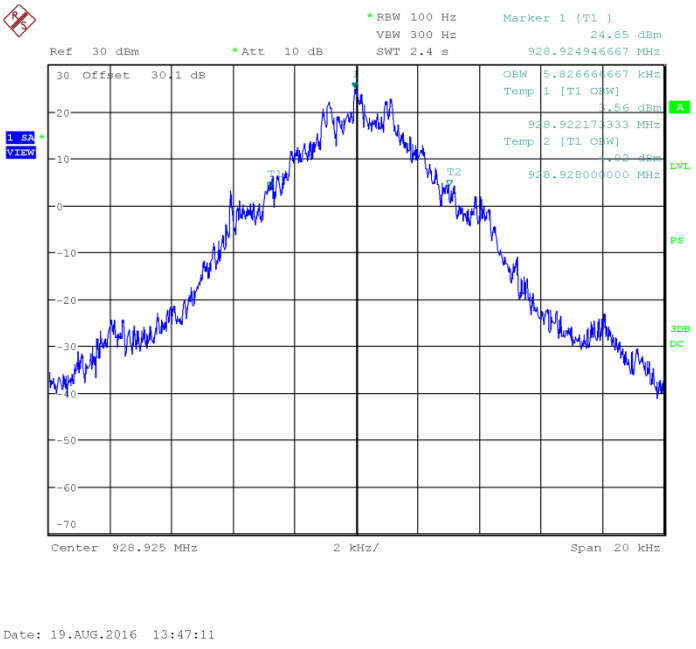

Figure 7.3.2-9: 928.925 MHz – C&I Mode

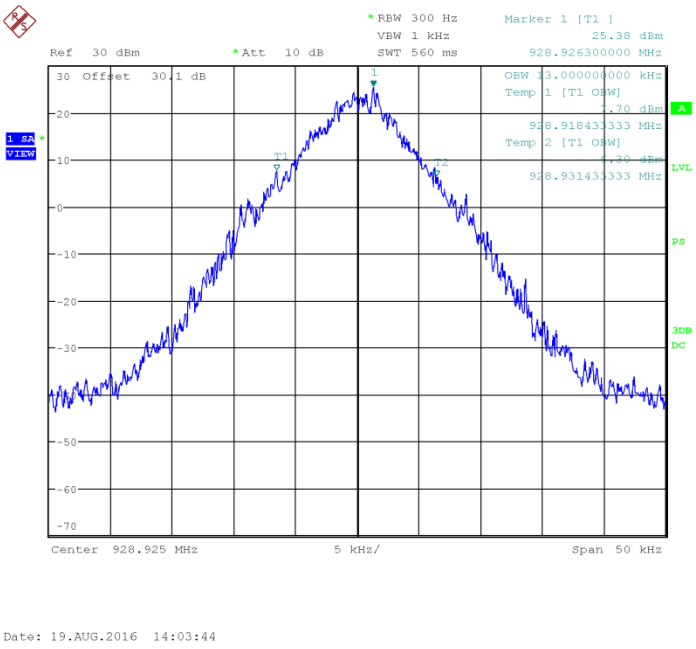

Figure 7.3.2-10: 928.925 MHz – Double Density Mode

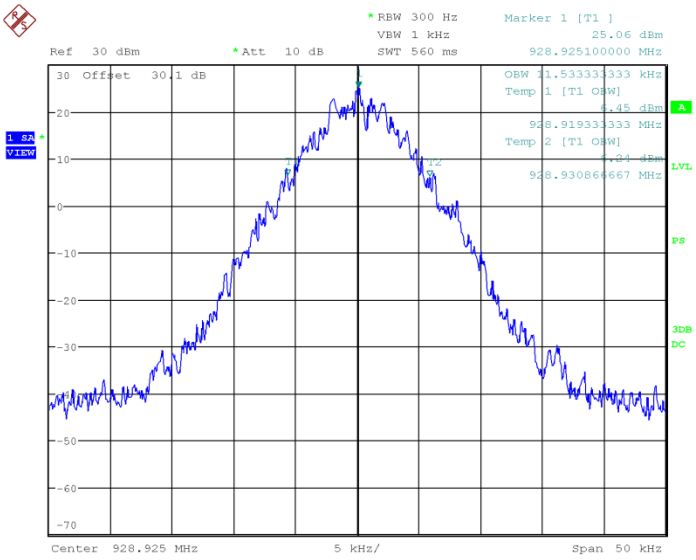

Figure 7.3.2-11: 928.925 MHz – Normal Mode

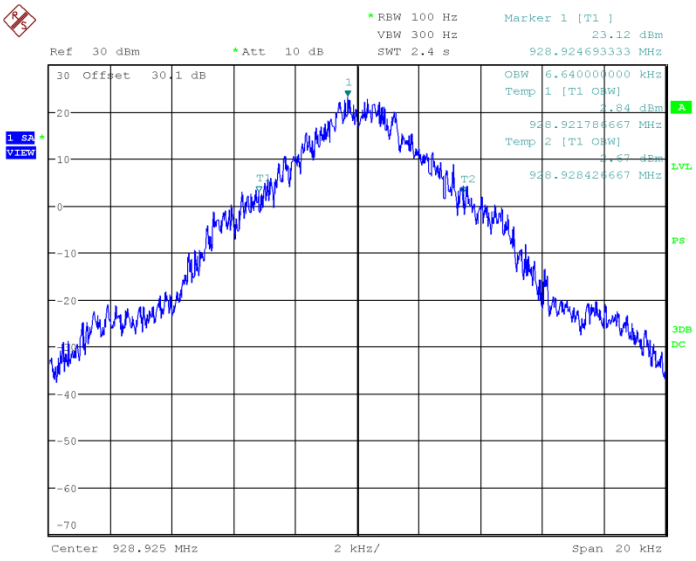

Figure 7.3.2-12: 928.925 MHz — Priority Mode

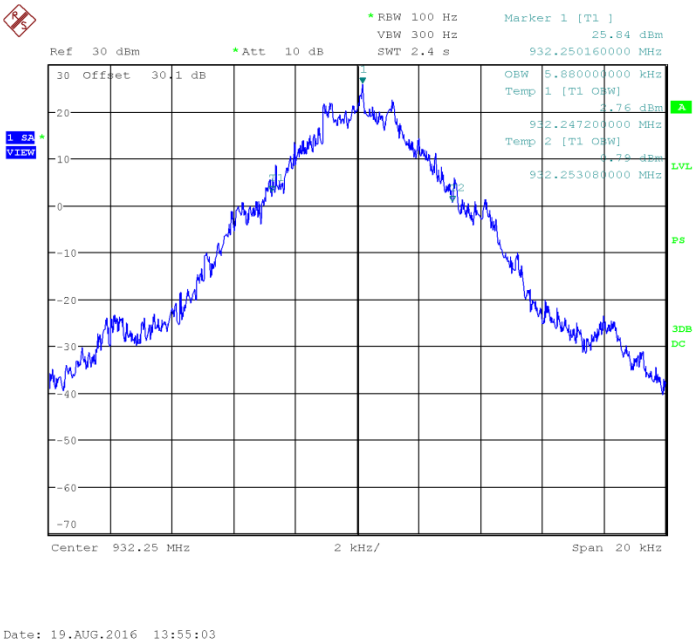

Figure 7.3.2-13: 932.25 MHz – C&I Mode

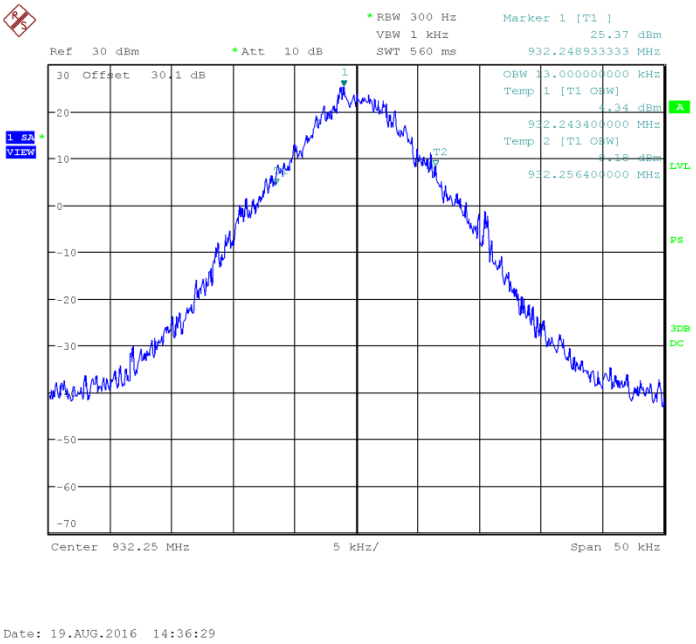

Figure 7.3.2-14: 932.25 MHz – Double Density Mode

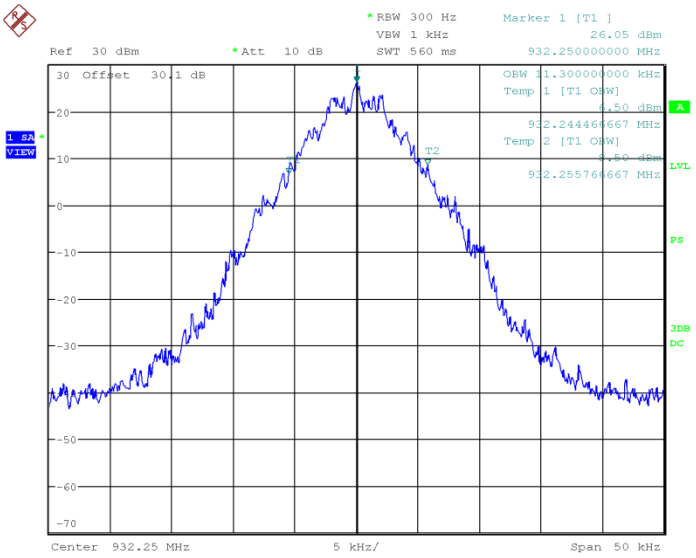

Figure 7.3.2-15: 932.25 MHz – Normal Mode

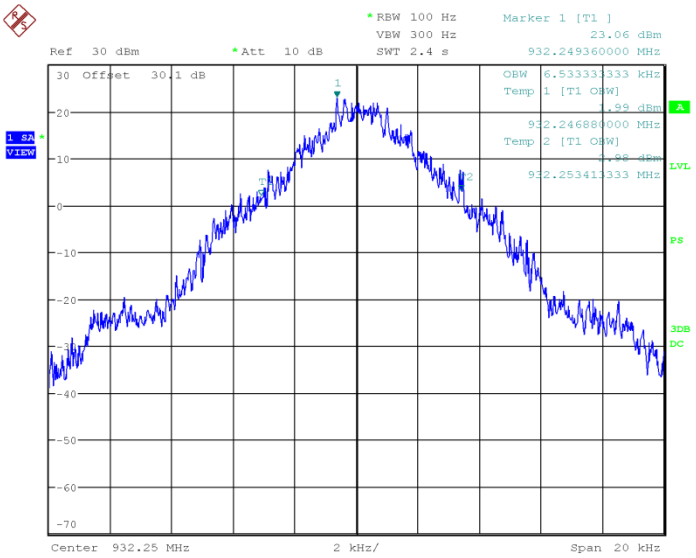

Figure 7.3.2-16: 932.25 MHz — Priority Mode

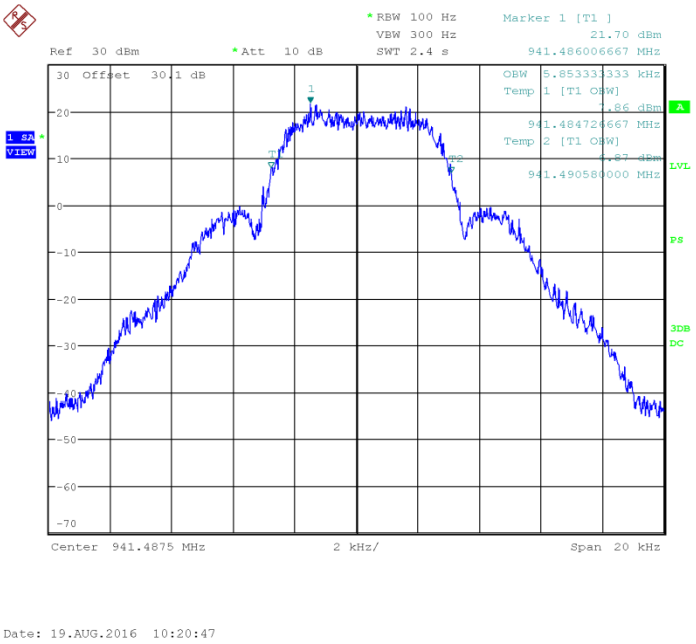

Figure 7.3.2-17: 941.4875 MHz – mPass 5k Mode

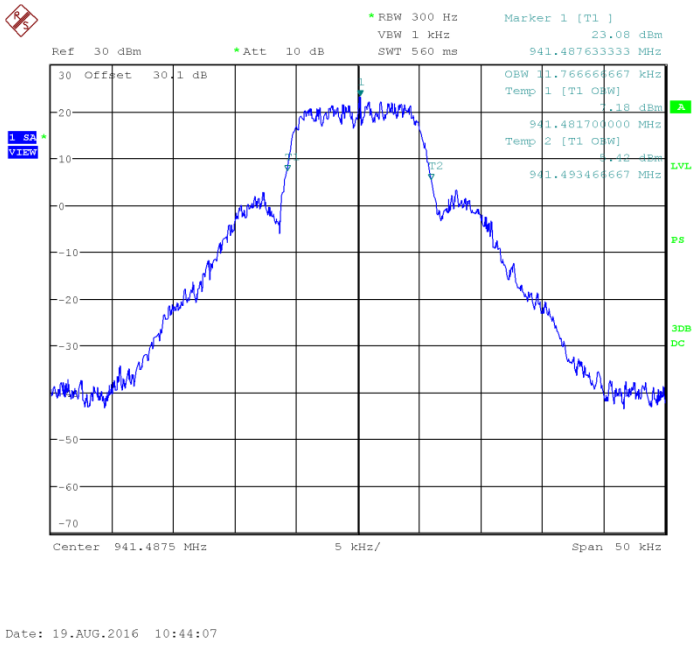

Figure 7.3.2-18: 941.4875 MHz – mPass 10k Mode

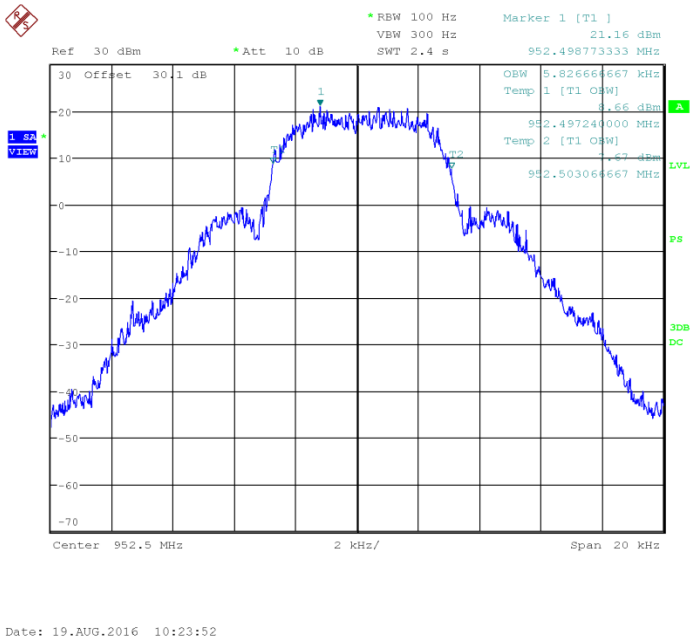

Figure 7.3.2-19: 952.5 MHz – mPass 5k Mode

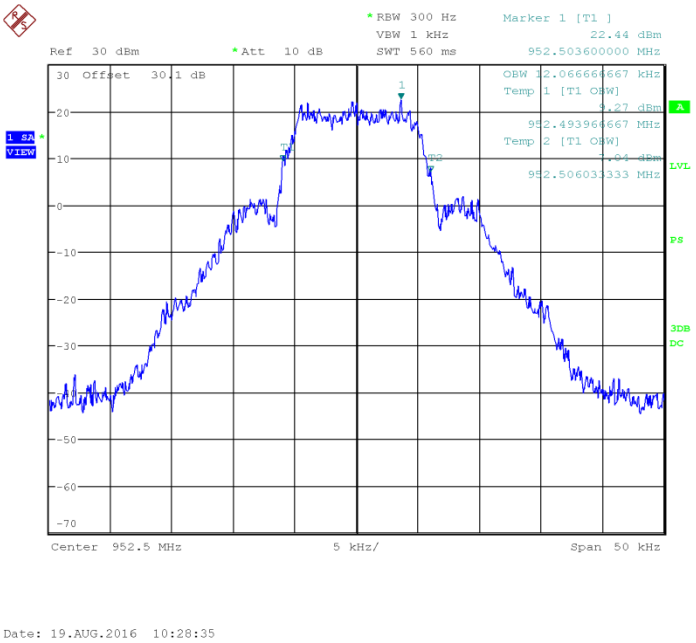

Figure 7.3.2-20: 952.5 MHz – mPass 10k Mode

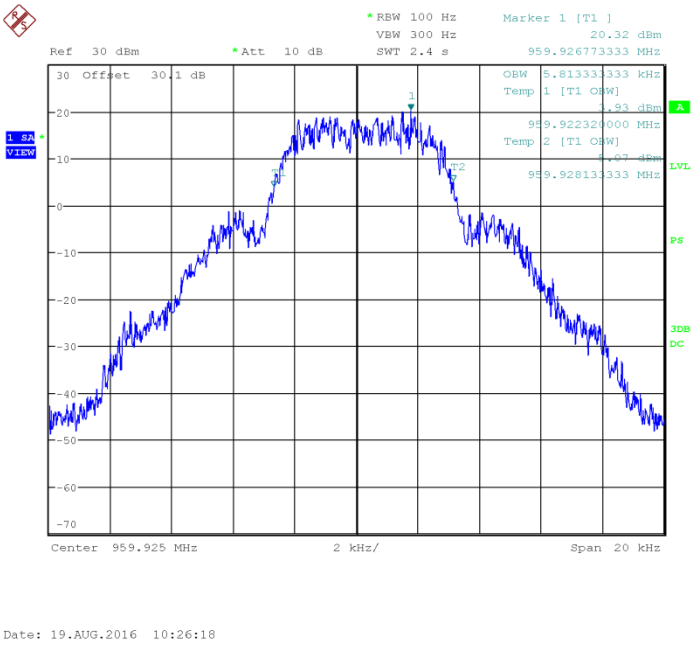

Figure 7.3.2-21: 959.925 MHz – mPass 5k Mode

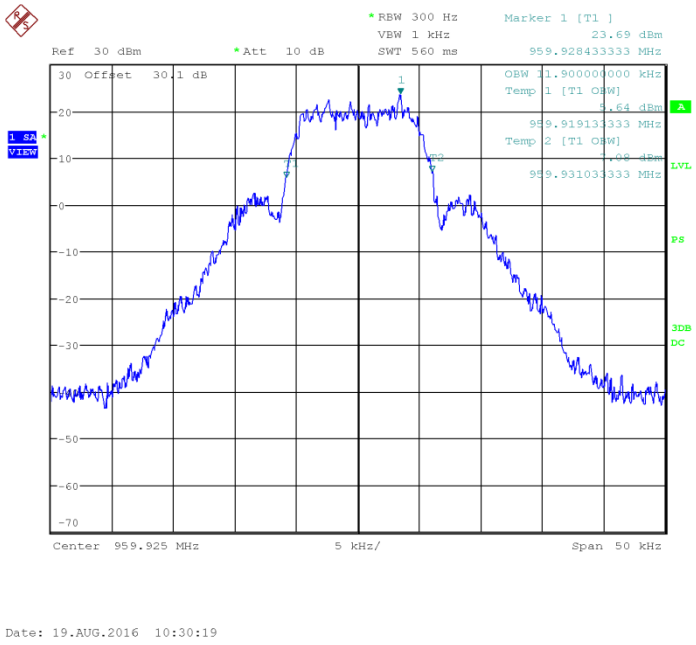

Figure 7.3.2-22: 959.925 MHz – mPass 10k Mode

7.4 Spurious Emissions at Antenna Terminals

7.4.1 Measurement Procedure (ANSI 63.26: 2015 Section 5.7.4)

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through 30 dB of passive attenuation. The spectrum analyzer resolution bandwidth was set to 100 kHz below 1000 MHz and 1 MHz above 1000 MHz. The internal correction factors of the spectrum analyzer were employed to correct for any cable, attenuator or filter losses. The spectrum was investigated in accordance to CFR 47 Part 2.1057. Results are shown below. There were no significant emissions from 9 kHz or lowest frequency generated to 30 MHz.

7.4.2 Measurement Results

Part 24.133 a(1), a(2), ISED Canada RSS-134 4.4.1 (a), (b), 4.4.2 (a), (b)

KDS

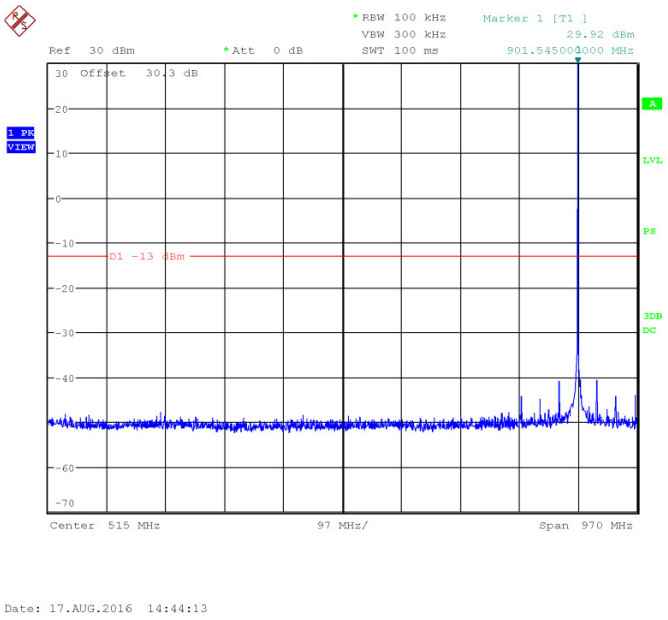

Figure 7.4.2-1: 901.5 MHz – 30MHz to 1GHz

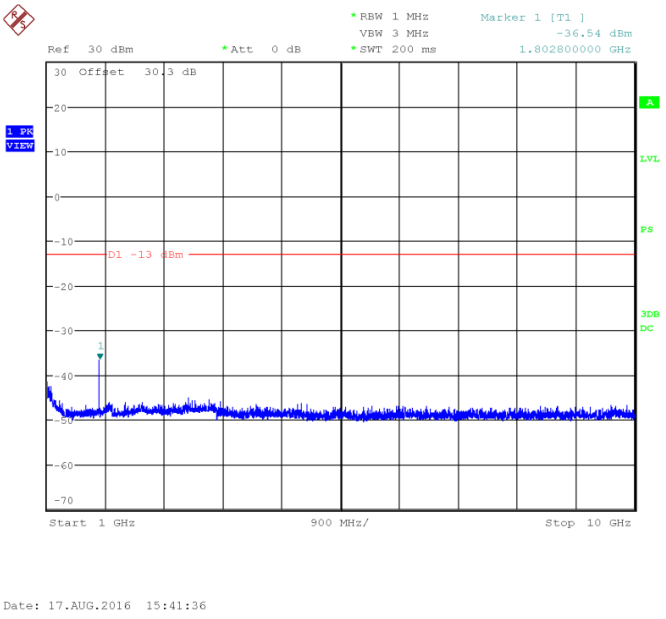

Figure 7.4.2-2: 901.5 MHz – 1GHz to 10GHz

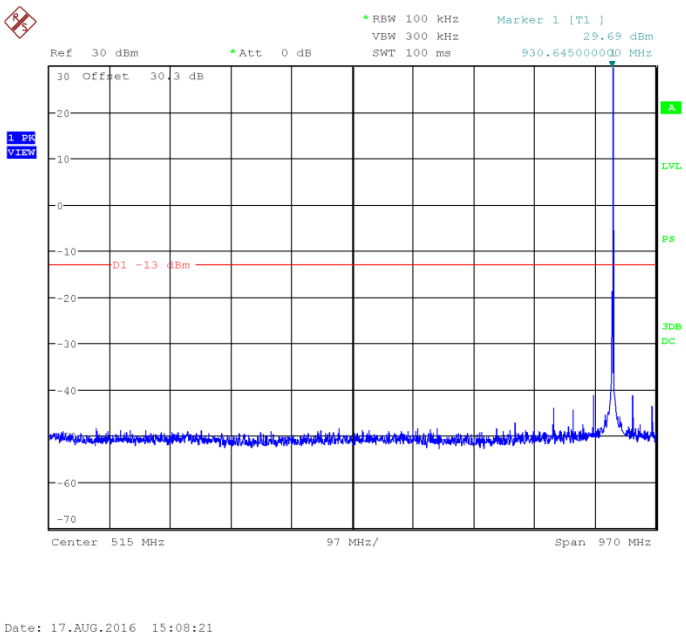

Figure 7.4.2-3: 930.5 MHz – 30MHz to 1GHz

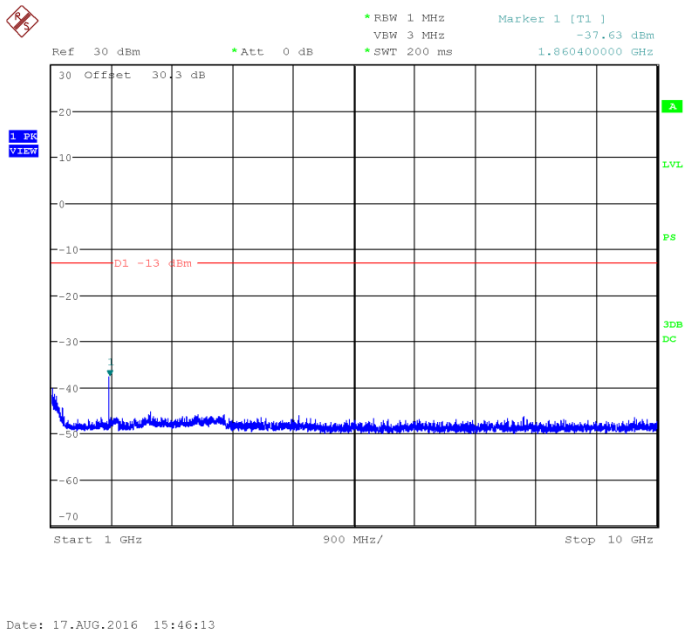

Figure 7.4.2-4: 930.5 MHz – 1GHz to 10GHz

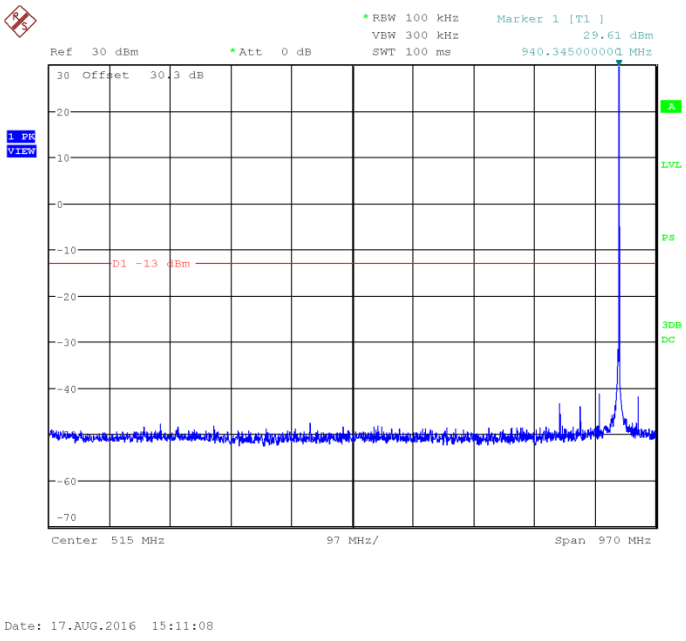

Figure 7.4.2-5: 940.0125 MHz – 30MHz to 1GHz

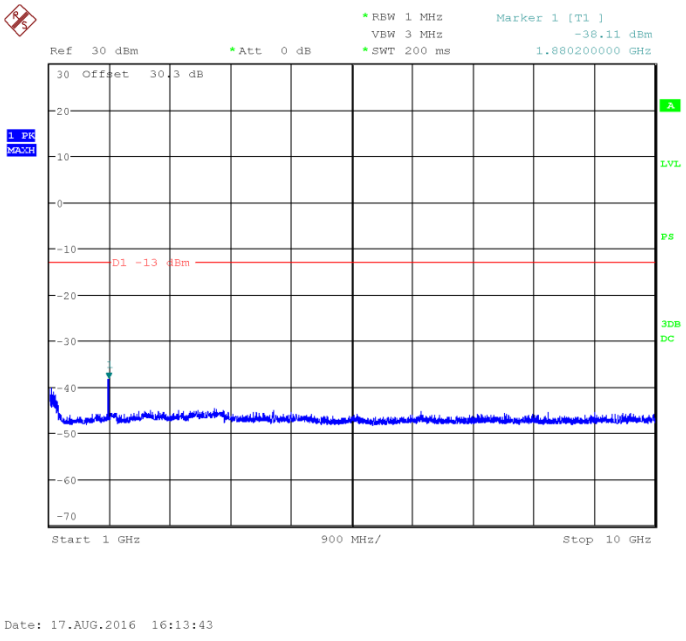

Figure 7.4.2-6: 940.0125 MHz – 1GHz to 10GHz

Part 101.111 a(6), RSS-119 5.8.6

KDS

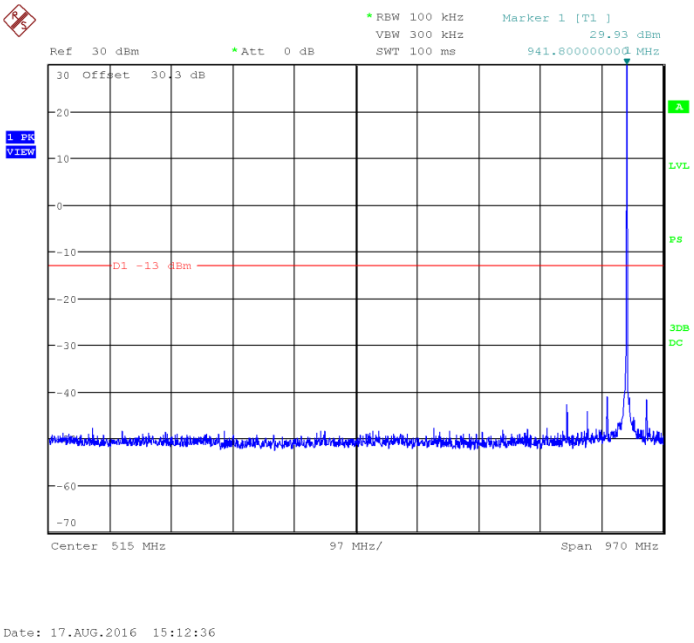

Figure 7.4.2-7: 928.925 MHz – 30MHz to 1GHz

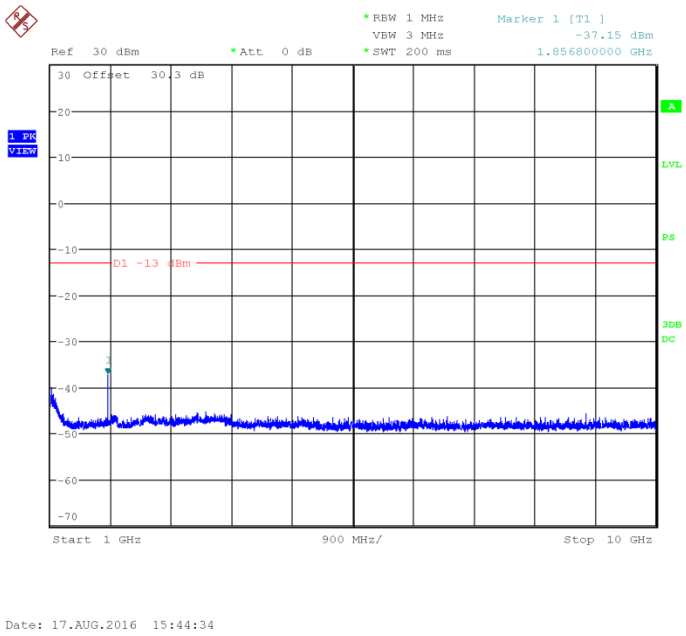

Figure 7.4.2-8: 928.925 MHz – 1GHz to 10GHz

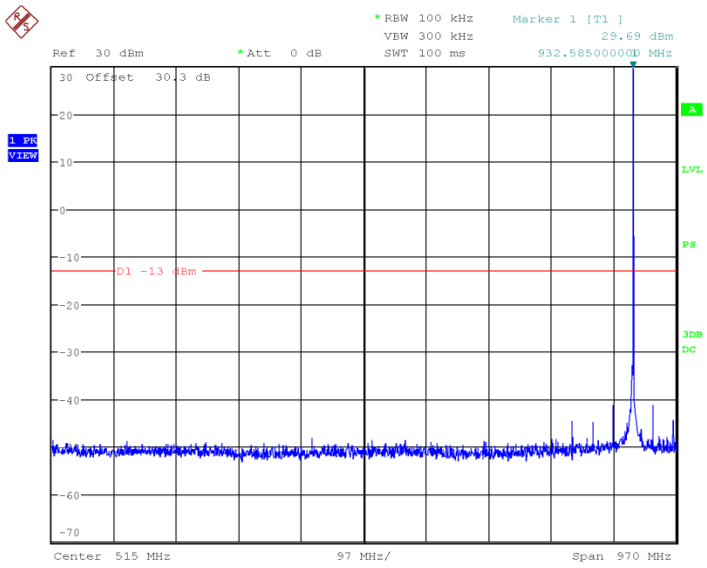

Figure 7.4.2-9: 932.25 MHz – 30MHz to 1GHz

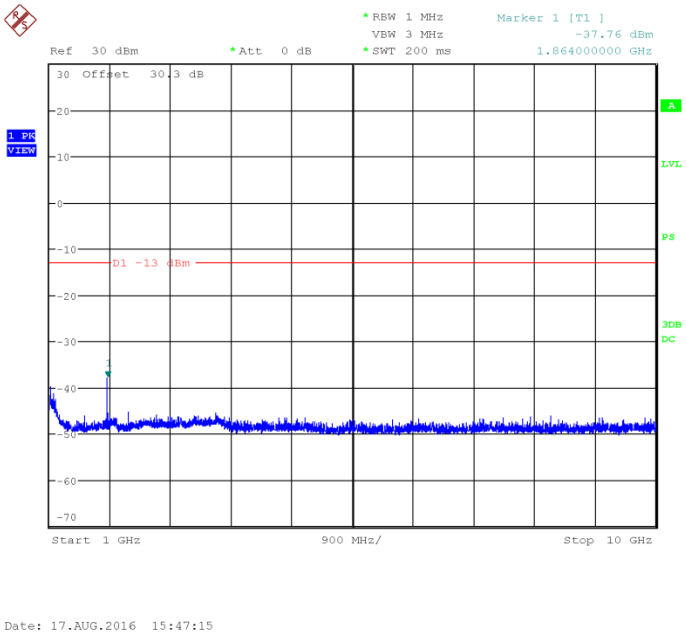

Figure 7.4.2-10: 932.25 MHz – 1GHz to 10GHz

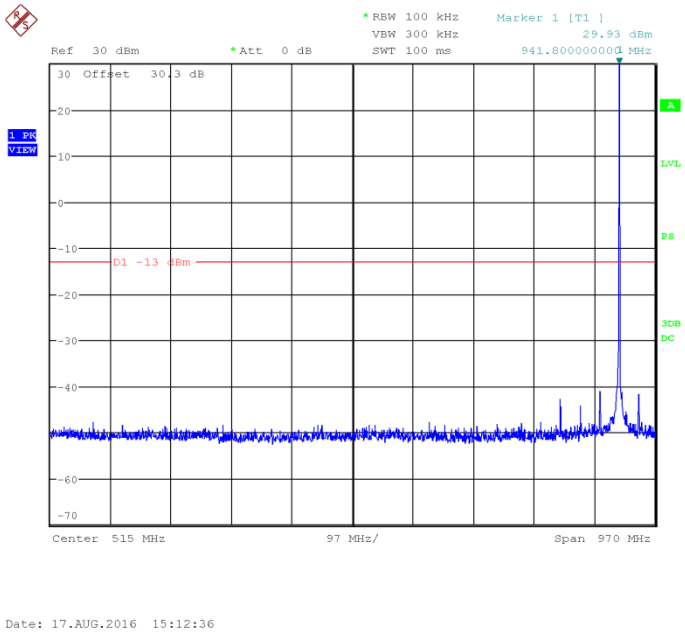

Figure 7.4.2-11: 941.4875 MHz – 30MHz to 1GHz

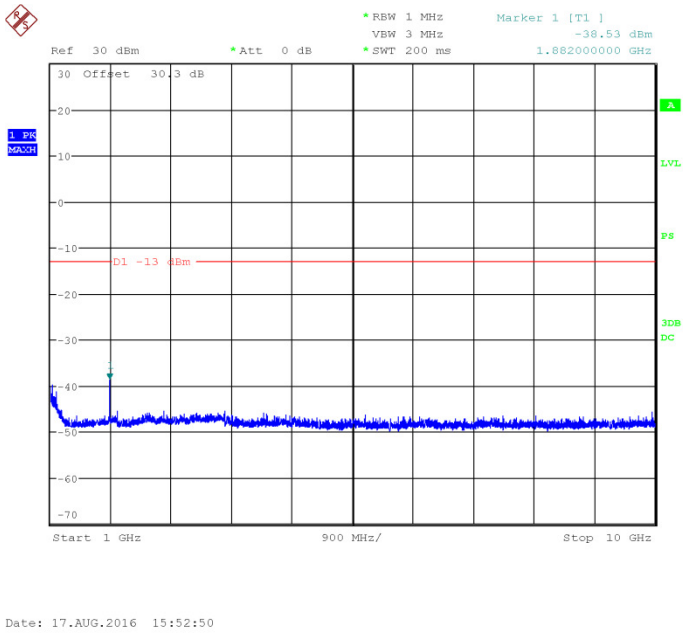

Figure 7.4.2-12: 941.4875 MHz – 1GHz to 10GHz

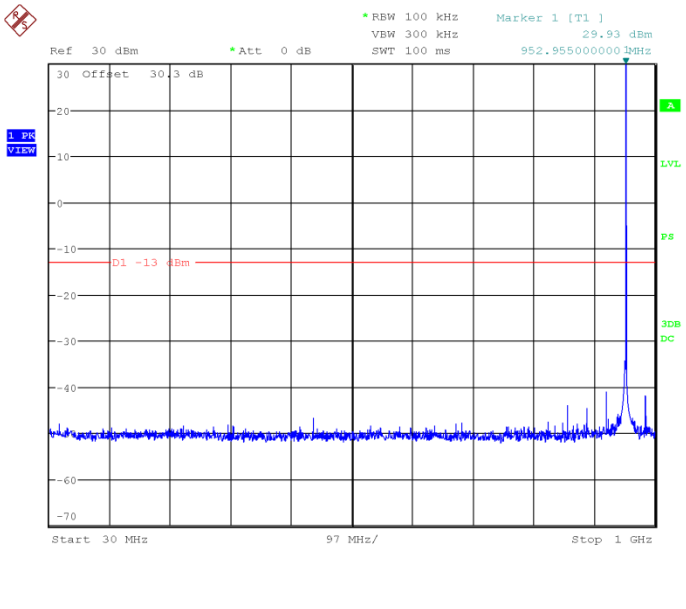

Figure 7.4.2-13: 952.5 MHz – 30MHz to 1GHz

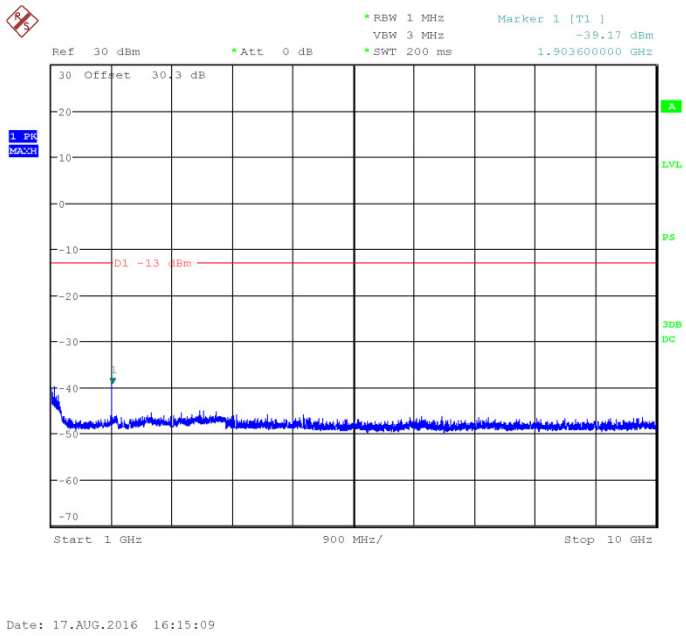

Figure 7.4.2-14: 952.5 MHz – 1GHz to 10GHz

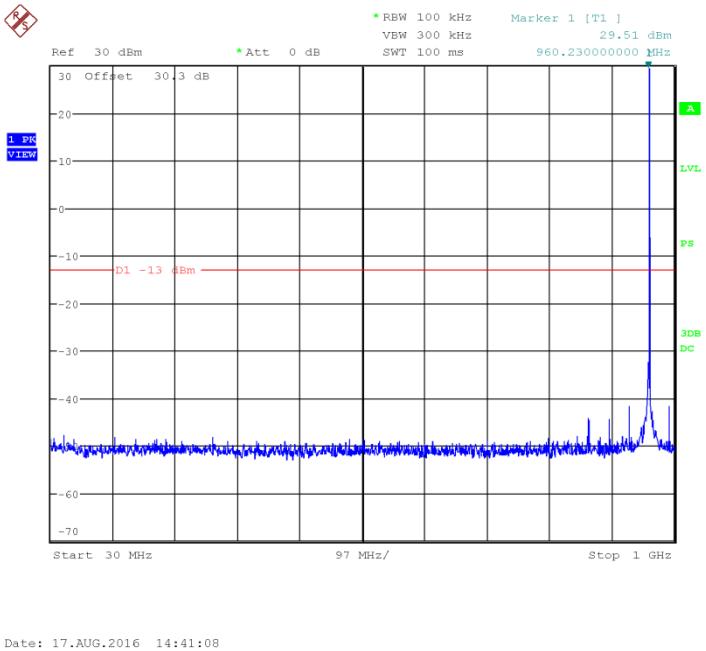

Figure 7.4.2-15: 959.925 MHz – 30MHz to 1GHz

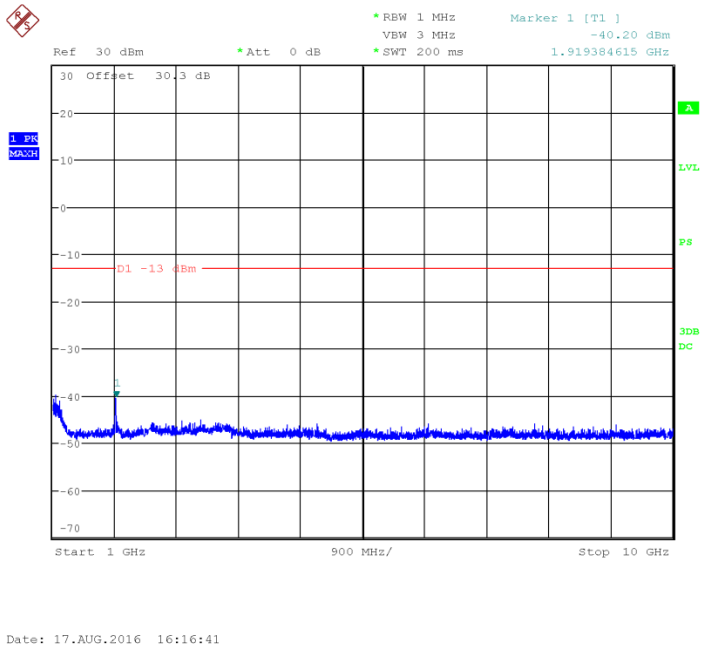

Figure 7.4.2-16: 959.925 MHz – 1GHz to 10GHz

7.5 Field Strength of Spurious Emissions

7.5.1 Measurement Procedure (ANSI 63.26: 2015 Section 5.5.2.3.1)

The equipment under test is placed in the Semi-Anechoic Chamber (described in section 2.3.1) on a table at the turntable center. Below 1 GHz the table height was 80cm and above 1 GHz the table height was 1.5m. For each spurious emission, the antenna mast is raised and lowered from one (1) to four (4) meters and the turntable is rotated 360º and the maximum reading on the spectrum analyzer is recorded. This was repeated for both horizontal and vertical polarizations of the receive antenna.

The equipment under test is then replaced with a substitution antenna fed by a signal generator. The signal generator's frequency is set to that of the spurious emission recorded from the equipment under test. The antenna mast is raised and lowered from one (1) to four (4) meters to obtain a maximum reading on the spectrum analyzer. The output of the signal generator is then adjusted until the reading on the spectrum analyzer matches that obtained from the equipment under test. The signal generator level is recorded. The power in dBm of each spurious emission is calculated by correcting the signal generator level for the cable loss and gain of the substitution antenna referenced to a dipole. The spectrum was investigated in accordance to CFR 47 Part 2.1057.

The magnitude of all spurious emissions not reported were attenuated below the noise floor of the measurement system and therefore not specified in this report. Results are shown below.

7.5.2 Measurement Results

Part 24.133 a(1), a(2), RSS-134 4.4.1 (a), (b), 4.4.2 (a), (b)

KDS

Table 7.5.2-1: Field Strength of Spurious Emissions – 901.5 MHz – Normal Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1803	55.20	H	-47.70	-13.00	34.70
1803	44.4	V	-57.20	-13.00	44.20
2704.5	68.8	H	-30.60	-13.00	17.60
2704.5	65.4	V	-34.30	-13.00	21.30
3606	46.3	H	-49.89	-13.00	36.89
3606	47	V	-51.09	-13.00	38.09
4507.5	52.2	H	-41.60	-13.00	28.60
4507.5	51.4	V	-43.70	-13.00	30.70

NOTE: All frequencies not listed were below the noise floor of the spectrum analyzer.

Table 7.5.2-2: Field Strength of Spurious Emissions – 930.5 MHz – mPass 5k Mode

Frequency (MHz)	Spectrum Analyzer Level (dBµV/m)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1861	50.90	H	-52.58	-13.00	39.58
1861	48.3	V	-54.38	-13.00	41.38
2791.5	70	H	-29.25	-13.00	16.25
2791.5	64.8	V	-34.65	-13.00	21.65
3722	47.4	H	-48.32	-13.00	35.32
3722	46.9	V	-49.52	-13.00	36.52
4652.5	53.5	H	-39.94	-13.00	26.94
4652.5	46.9	V	-48.14	-13.00	35.14

NOTE: All frequencies not listed were below the noise floor of the spectrum analyzer.

Table 7.5.2-3: Field Strength of Spurious Emissions – 940.0125 MHz – mPass 5k Mode

Frequency (MHz)	Spectrum Analyzer Level (dBµV/m)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1880.025	51.40	H	-52.18	-13.00	39.18
1880.025	45.3	V	-57.08	-13.00	44.08
2820.0375	64.7	H	-34.64	-13.00	21.64
2820.0375	59.2	V	-40.14	-13.00	27.14
3760.05	46.4	H	-48.10	-13.00	35.10
3760.05	43.2	V	-52.80	-13.00	39.80
4700.0625	46.1	H	-46.41	-13.00	33.41
4700.0625	44.6	V	-49.51	-13.00	36.51

NOTE: All frequencies not listed were below the noise floor of the spectrum analyzer.

Part 101.111 a(6), RSS-119 5.8.6

Table 7.5.2-4: Field Strength of Spurious Emissions – 928.925 MHz – Normal Mode

Frequency (MHz)	Spectrum Analyzer Level (dBµV/m)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1857.85	51.10	H	-52.19	-13.00	39.19
1857.85	47.5	V	-55.09	-13.00	42.09
2786.775	68.8	H	-30.36	-13.00	17.36
2786.775	62.5	V	-37.06	-13.00	24.06
3715.7	48.5	H	-46.33	-13.00	33.33
3715.7	44.4	V	-52.03	-13.00	39.03
4644.625	52.2	H	-41.02	-13.00	28.02
4644.625	46.6	V	-47.62	-13.00	34.62

NOTE: All frequencies not listed were below the noise floor of the spectrum analyzer.

Table 7.5.2-5: Field Strength of Spurious Emissions – 932.25 MHz – Normal Mode

Frequency (MHz)	Spectrum Analyzer Level (dBµV/m)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1864.5	51.20	H	-52.08	-13.00	39.08
1864.5	48	V	-53.98	-13.00	40.98
2796.75	69.6	H	-29.75	-13.00	16.75
2796.75	64.7	V	-34.85	-13.00	21.85
3729	48.1	H	-46.92	-13.00	33.92
3729	48.2	V	-48.22	-13.00	35.22
4661.25	51.6	H	-41.95	-13.00	28.95
4661.25	50.9	V	-44.15	-13.00	31.15

NOTE: All frequencies not listed were below the noise floor of the spectrum analyzer.

Table 7.5.2-6: Field Strength of Spurious Emissions – 941.4875 MHz – mPass 5k Mode

Frequency (MHz)	Spectrum Analyzer Level (dBµV/m)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1882.975	50.30	H	-53.18	-13.00	40.18
1882.975	46.2	V	-55.98	-13.00	42.98
2824.4625	64.3	H	-35.03	-13.00	22.03
2824.4625	63.1	V	-36.23	-13.00	23.23
3765.95	44.8	H	-50.20	-13.00	37.20
3765.95	43.4	V	-53.00	-13.00	40.00
4707.4375	49	H	-43.52	-13.00	30.52
4707.4375	48.9	V	-45.12	-13.00	32.12

NOTE: All frequencies not listed were below the noise floor of the spectrum analyzer.

Table 7.5.2-7: Field Strength of Spurious Emissions – 952.5 MHz – mPass 5k Mode

Frequency (MHz)	Spectrum Analyzer Level (dBµV/m)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1905	49.00	H	-53.48	-13.00	40.48
1905	45.4	V	-56.18	-13.00	43.18
2857.5	58.9	H	-40.52	-13.00	27.52
2857.5	56.1	V	-43.22	-13.00	30.22
3810	41.6	H	-53.77	-13.00	40.77
3810	43.3	V	-52.57	-13.00	39.57
4762.5	44.9	H	-48.01	-13.00	35.01
4762.5	44.7	V	-49.51	-13.00	36.51

NOTE: All frequencies not listed were below the noise floor of the spectrum analyzer.

Table 7.5.2-8: Field Strength of Spurious Emissions – 959.925 MHz – mPass 5k Mode

Frequency (MHz)	Spectrum Analyzer Level (dBµV/m)	Antenna Polarity (H/V)	Spurious ERP (dBm)	Limit (dBm)	Margin (dB)
1919.85	46.60	H	-53.07	-13.00	40.07
1919.85	43.1	V	-58.47	-13.00	45.47
2879.775	57.8	H	-41.60	-13.00	28.60
2879.775	51.7	V	-47.50	-13.00	34.50
3839.7	37.8	H	-46.46	-13.00	33.46
3839.7	38.3	V	-57.66	-13.00	44.66
4799.625	41.7	H	-51.27	-13.00	38.27
4799.625	41.7	V	-52.57	-13.00	39.57

NOTE: All frequencies not listed were below the noise floor of the spectrum analyzer.

7.6 Frequency Stability

7.6.1 Measurement Procedure (ANSI C63.26 Subsection 5.6.3)

The equipment under test is placed inside an environmental chamber. The RF output is directly coupled to the input of the measurement equipment and a power supply is attached to the primary supply voltage.

Frequency measurements were made at the extremes of the of temperature range -30º C to +50º C and at intervals of 10º C at normal supply voltage. A period of time sufficient to stabilize all components of the equipment was allowed at each frequency measurement. The equipment can operate at voltages from 120 to 277 Vac. The equipment under test at a temperature of 20º C the measurements were performed at +/- 15% of 120Vac and at 300Vac at the client's request. The maximum variation of frequency was recorded.

At the clients request data for all 3 TCXO manufacturers are included in the results below.

7.6.2 Measurement Results

Part 24.135, RSS-134 (4.5)

Frequency Stability

Frequency (MHz): 901.5
Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VAC)
-30 C	**901.499640**	**-0.399**	100%	120.00
-20 C	**901.499467**	**-0.591**	100%	120.00
-10 C	**901.499590**	**-0.455**	100%	120.00
0 C	**901.499715**	**-0.316**	100%	120.00
10 C	**901.499862**	**-0.153**	100%	120.00
20 C	**901.499902**	**-0.109**	100%	120.00
30 C	**901.499934**	**-0.073**	100%	120.00
40 C	**901.499945**	**-0.061**	100%	120.00
50 C	**901.499980**	**-0.022**	100%	120.00
20 C	**901.499760**	**-0.266**	85%	102.00
20 C	**901.499830**	**-0.189**	115%	138.00
20 C	**901.499780**	**-0.244**	250%	300.00

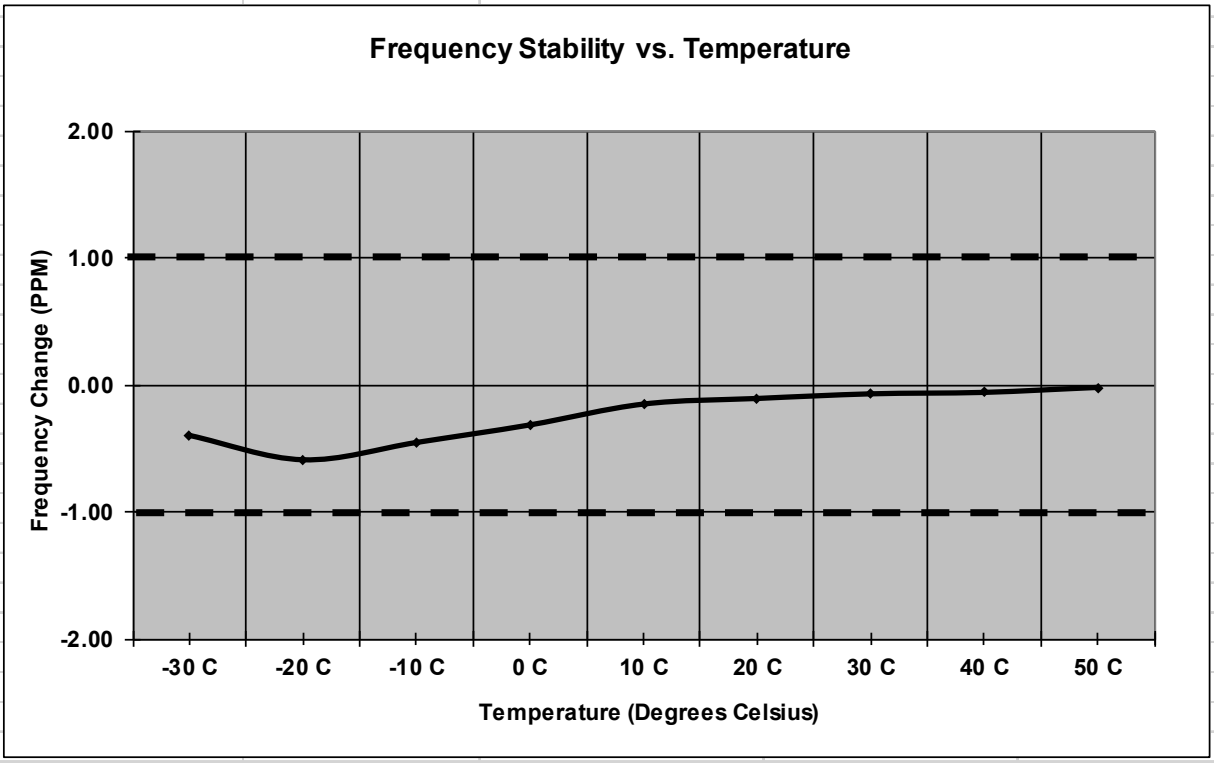

Figure 7.6.2-1: Frequency Stability – 901.5 MHz - KDS

Part 24.135, RSS-134 (4.5)

Frequency Stability

Frequency (MHz): 930.5

Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VAC)
-30 C	**930.499450**	**-0.591**	100%	120.00
-20 C	**930.499415**	**-0.629**	100%	120.00
-10 C	**930.499450**	**-0.591**	100%	120.00
0 C	**930.499550**	**-0.484**	100%	120.00
10 C	**930.499745**	**-0.274**	100%	120.00
20 C	**930.499760**	**-0.258**	100%	120.00
30 C	**930.499824**	**-0.189**	100%	120.00
40 C	**930.499896**	**-0.112**	100%	120.00
50 C	**930.499900**	**-0.107**	100%	120.00
20 C	**930.499805**	**-0.210**	85%	102.00
20 C	**930.499760**	**-0.258**	115%	138.00
20 C	**930.499780**	**-0.236**	250%	300.00

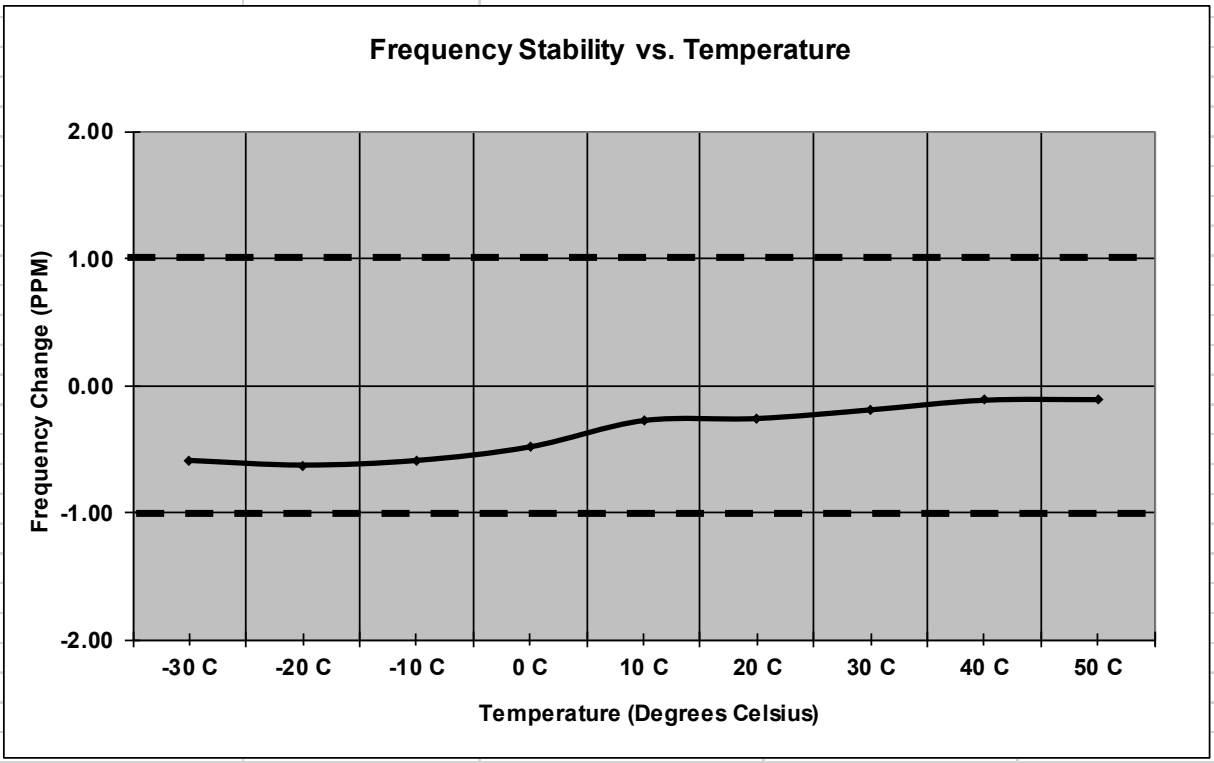

Figure 7.6.2-2: Frequency Stability – 930.5 MHz - KDS

Part 101.107, RSS-119 5.3

Frequency Stability

Frequency (MHz): 959.925

Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VAC)
-30 C	**959.924440**	**-0.583**	100%	120.00
-20 C	**959.924420**	**-0.604**	100%	120.00
-10 C	**959.924467**	**-0.555**	100%	120.00
0 C	**959.924615**	**-0.401**	100%	120.00
10 C	**959.924760**	**-0.250**	100%	120.00
20 C	**959.924785**	**-0.224**	100%	120.00
30 C	**959.924830**	**-0.177**	100%	120.00
40 C	**959.924900**	**-0.104**	100%	120.00
50 C	**959.924926**	**-0.077**	100%	120.00
20 C	**959.924795**	**-0.214**	85%	102.00
20 C	**959.924760**	**-0.250**	115%	138.00
20 C	**959.924845**	**-0.161**	250%	300.00

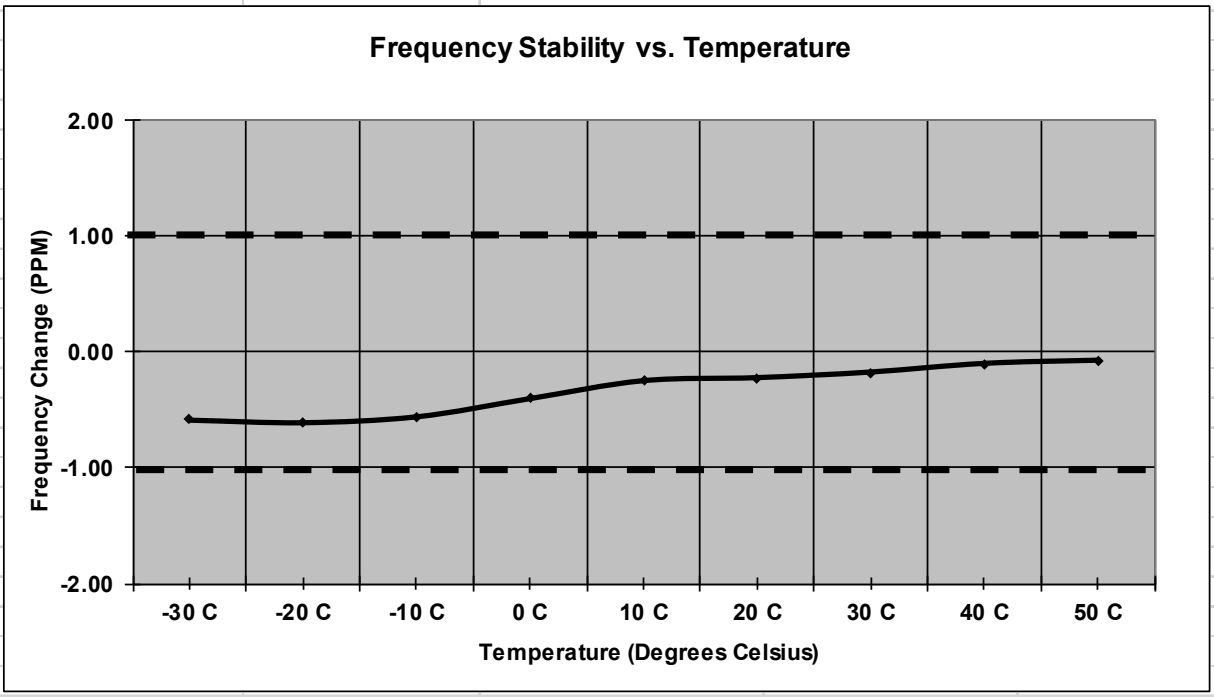

Figure 7.6.2-3: Frequency Stability – 959.925 MHz - KDS

Part 24.135, RSS-134 (4.5)

Frequency Stability

Frequency (MHz): 901.5

Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VAC)
-30 C	**901.499566**	**-0.481**	100%	120.00
-20 C	**901.499535**	**-0.516**	100%	120.00
-10 C	**901.499530**	**-0.521**	100%	120.00
0 C	**901.499527**	**-0.525**	100%	120.00
10 C	**901.499615**	**-0.427**	100%	120.00
20 C	**901.499570**	**-0.477**	100%	120.00
30 C	**901.499470**	**-0.588**	100%	120.00
40 C	**901.499505**	**-0.549**	100%	120.00
50 C	**901.499465**	**-0.593**	100%	120.00
20 C	**901.499530**	**-0.521**	85%	102.00
20 C	**901.499515**	**-0.538**	115%	138.00
20 C	**901.499515**	**-0.538**	250%	300.00

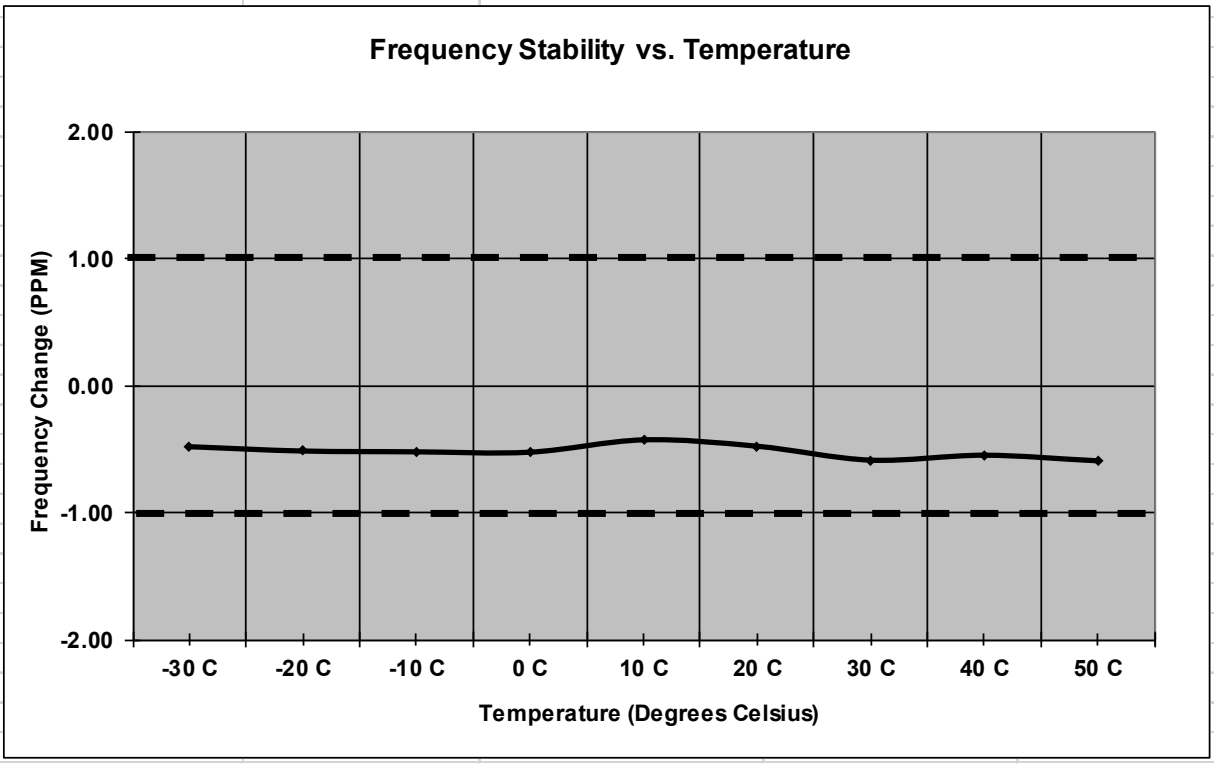

Figure 7.6.2-4: Frequency Stability – 901.5 MHz - ILSI

Part 24.135, RSS-134 (4.5)

Frequency Stability

Frequency (MHz): 930.5

Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VAC)
-30 C	**930.499545**	**-0.489**	100%	120.00
-20 C	**930.499560**	**-0.473**	100%	120.00
-10 C	**930.499505**	**-0.532**	100%	120.00
0 C	**930.499510**	**-0.527**	100%	120.00
10 C	**930.499570**	**-0.462**	100%	120.00
20 C	**930.499520**	**-0.516**	100%	120.00
30 C	**930.499515**	**-0.521**	100%	120.00
40 C	**930.499477**	**-0.562**	100%	120.00
50 C	**930.499450**	**-0.591**	100%	120.00
20 C	**930.499495**	**-0.543**	85%	102.00
20 C	**930.499480**	**-0.559**	115%	138.00
20 C	**930.499485**	**-0.553**	250%	300.00

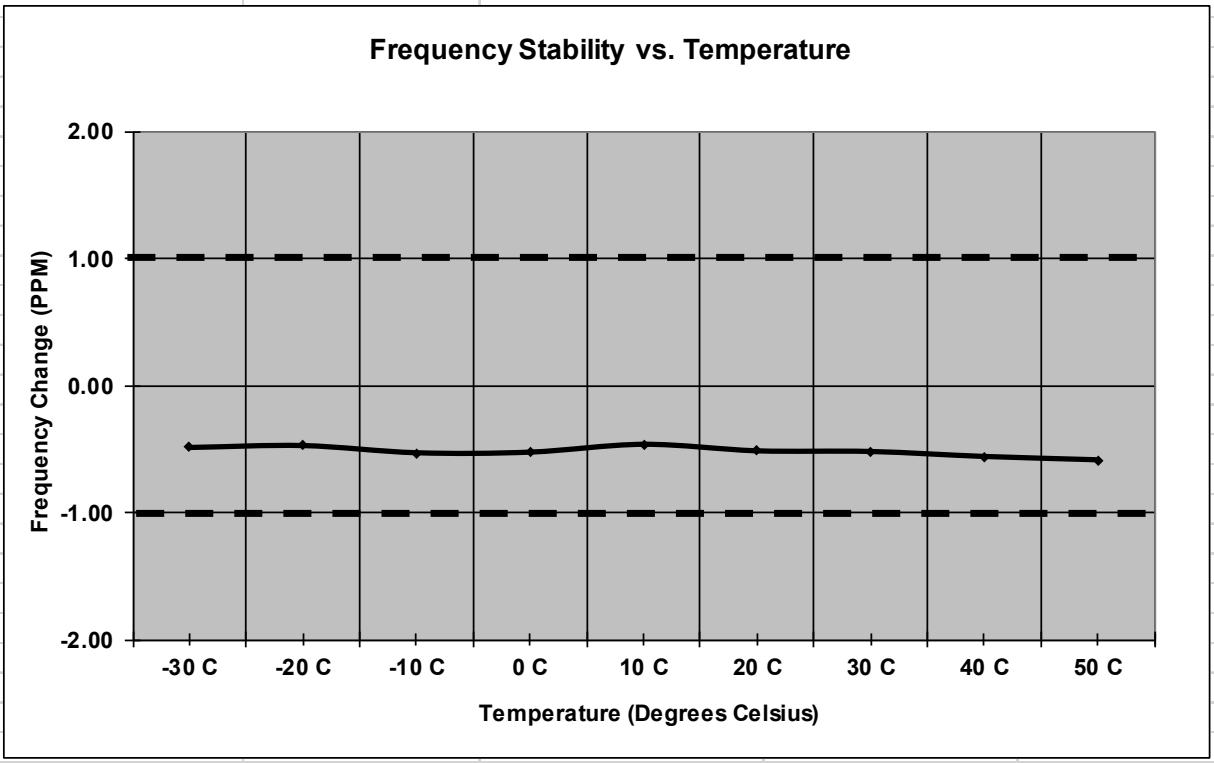

Figure 7.6.2-5: Frequency Stability – 930.5 MHz - ILSI

Part 101.107, RSS-119 5.3

Frequency Stability

Frequency (MHz): 959.925

Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VAC)
-30 C	**959.924553**	**-0.466**	100%	120.00
-20 C	**959.924508**	**-0.513**	100%	120.00
-10 C	**959.924545**	**-0.474**	100%	120.00
0 C	**959.924550**	**-0.469**	100%	120.00
10 C	**959.924590**	**-0.427**	100%	120.00
20 C	**959.924515**	**-0.505**	100%	120.00
30 C	**959.924407**	**-0.618**	100%	120.00
40 C	**959.924480**	**-0.542**	100%	120.00
50 C	**959.924450**	**-0.573**	100%	120.00
20 C	**959.924508**	**-0.513**	85%	102.00
20 C	**959.924490**	**-0.531**	115%	138.00
20 C	**959.924500**	**-0.521**	250%	300.00

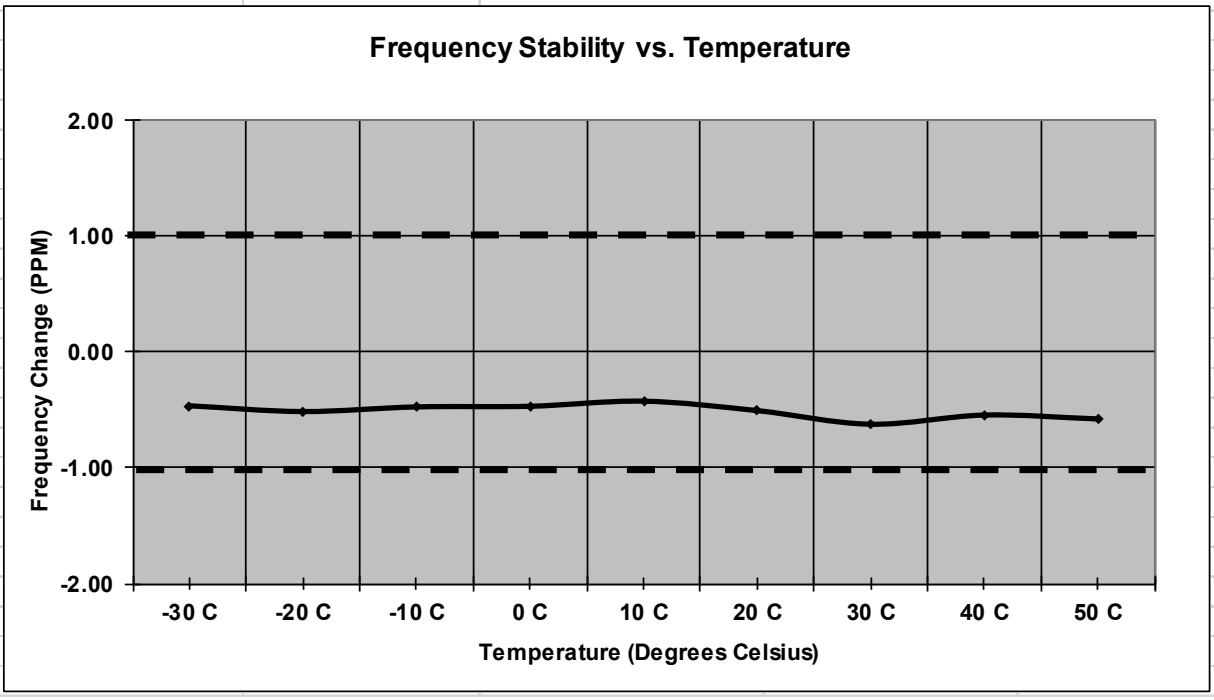

Figure 7.6.2-6: Frequency Stability – 959.925 MHz - ILSI

Part 24.135, RSS-134 (4.5)

Frequency Stability

Frequency (MHz): 901.5

Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VAC)
-30 C	**901.500400**	**0.444**	100%	120.00
-20 C	**901.500310**	**0.344**	100%	120.00
-10 C	**901.500285**	**0.316**	100%	120.00
0 C	**901.500302**	**0.335**	100%	120.00
10 C	**901.500325**	**0.361**	100%	120.00
20 C	**901.500275**	**0.305**	100%	120.00
30 C	**901.500253**	**0.281**	100%	120.00
40 C	**901.499870**	**-0.144**	100%	120.00
50 C	**901.499945**	**-0.061**	100%	120.00
20 C	**901.500270**	**0.300**	85%	102.00
20 C	**901.500271**	**0.301**	115%	138.00
20 C	**901.500262**	**0.291**	250%	300.00

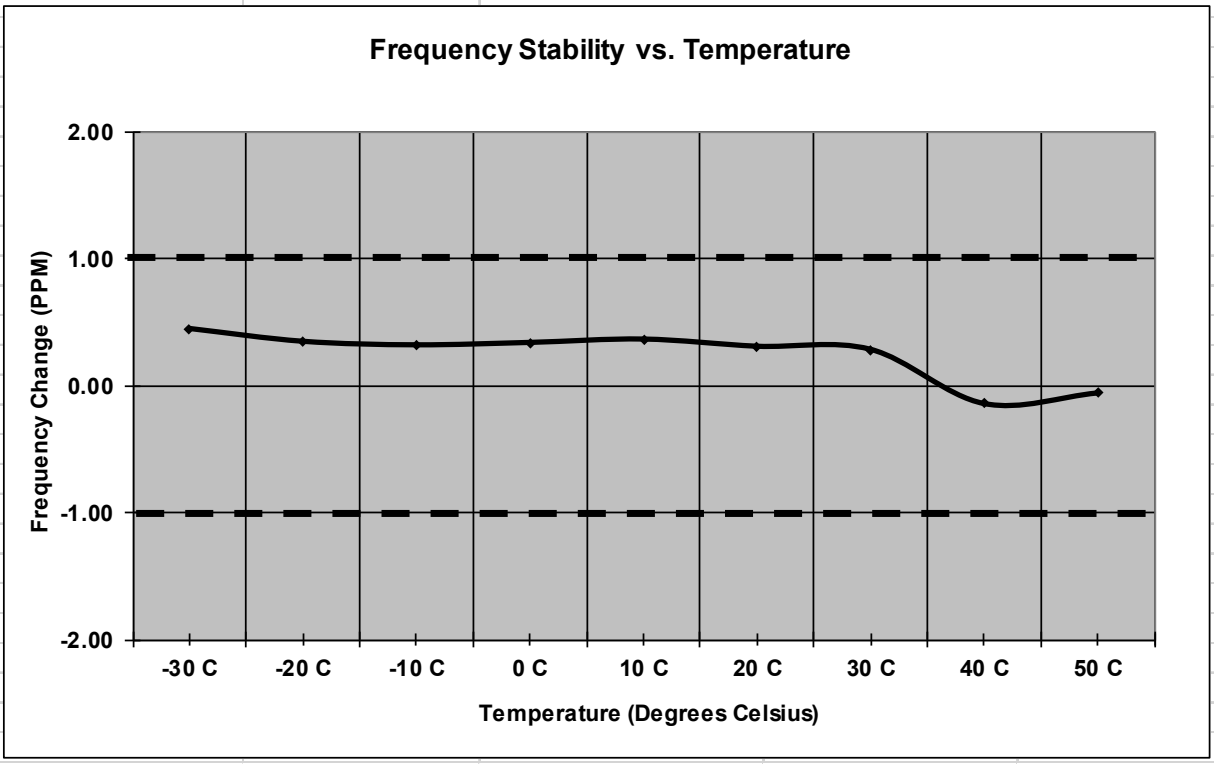

Figure 7.6.2-7: Frequency Stability – 901.5 MHz - Taitien

Part 24.135, RSS-134 (4.5)

Frequency Stability

Frequency (MHz): 930.5

Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VAC)
-30 C	**930.500325**	**0.349**	100%	120.00
-20 C	**930.500263**	**0.283**	100%	120.00
-10 C	**930.500250**	**0.269**	100%	120.00
0 C	**930.500285**	**0.306**	100%	120.00
10 C	**930.500280**	**0.301**	100%	120.00
20 C	**930.500243**	**0.261**	100%	120.00
30 C	**930.500212**	**0.228**	100%	120.00
40 C	**930.499830**	**-0.183**	100%	120.00
50 C	**930.499890**	**-0.118**	100%	120.00
20 C	**930.500238**	**0.256**	85%	102.00
20 C	**930.500231**	**0.248**	115%	138.00
20 C	**930.500232**	**0.249**	250%	300.00

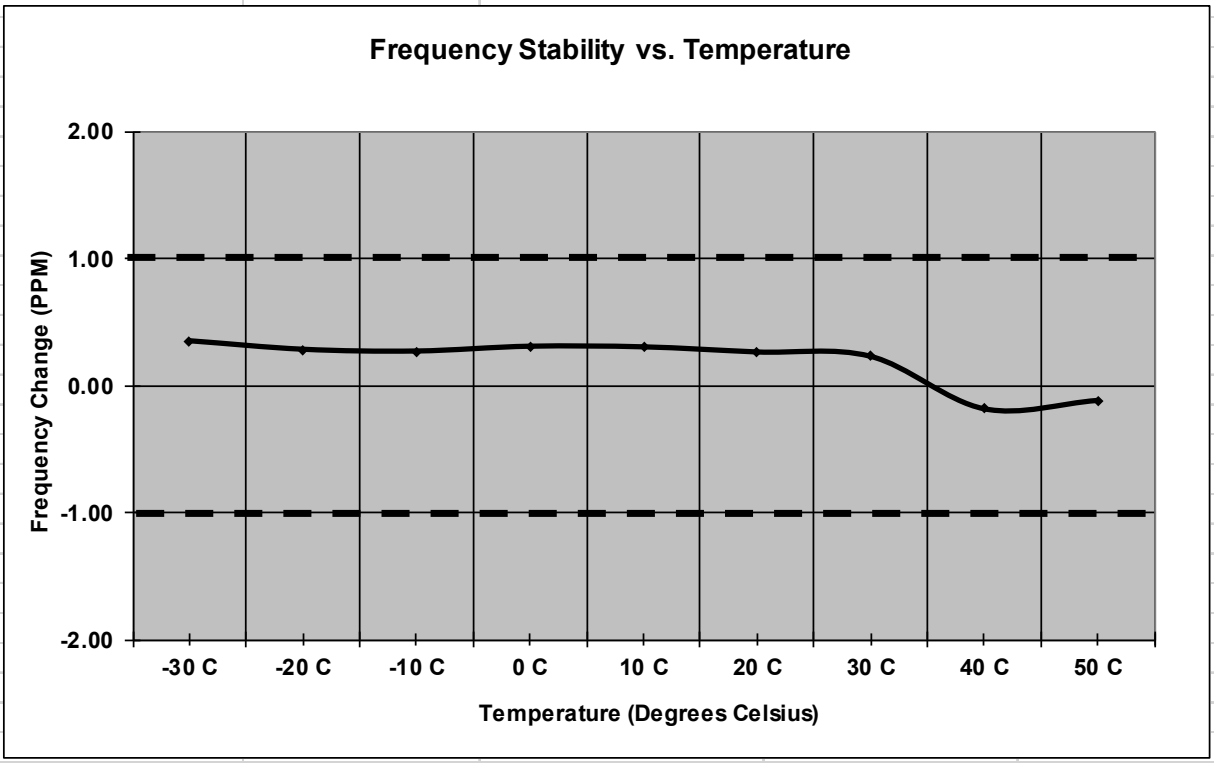

Figure 7.6.2-8: Frequency Stability – 930.5 MHz - Taitien

Part 101.107, RSS-119 5.3

Frequency Stability

Frequency (MHz): 959.925

Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VAC)
-30 C	**959.925312**	**0.325**	100%	120.00
-20 C	**959.925290**	**0.302**	100%	120.00
-10 C	**959.925230**	**0.240**	100%	120.00
0 C	**959.925280**	**0.292**	100%	120.00
10 C	**959.925265**	**0.276**	100%	120.00
20 C	**959.925237**	**0.247**	100%	120.00
30 C	**959.925204**	**0.213**	100%	120.00
40 C	**959.924834**	**-0.173**	100%	120.00
50 C	**959.924860**	**-0.146**	100%	120.00
20 C	**959.925222**	**0.231**	85%	102.00
20 C	**959.925227**	**0.236**	115%	138.00
20 C	**959.925222**	**0.231**	250%	300.00

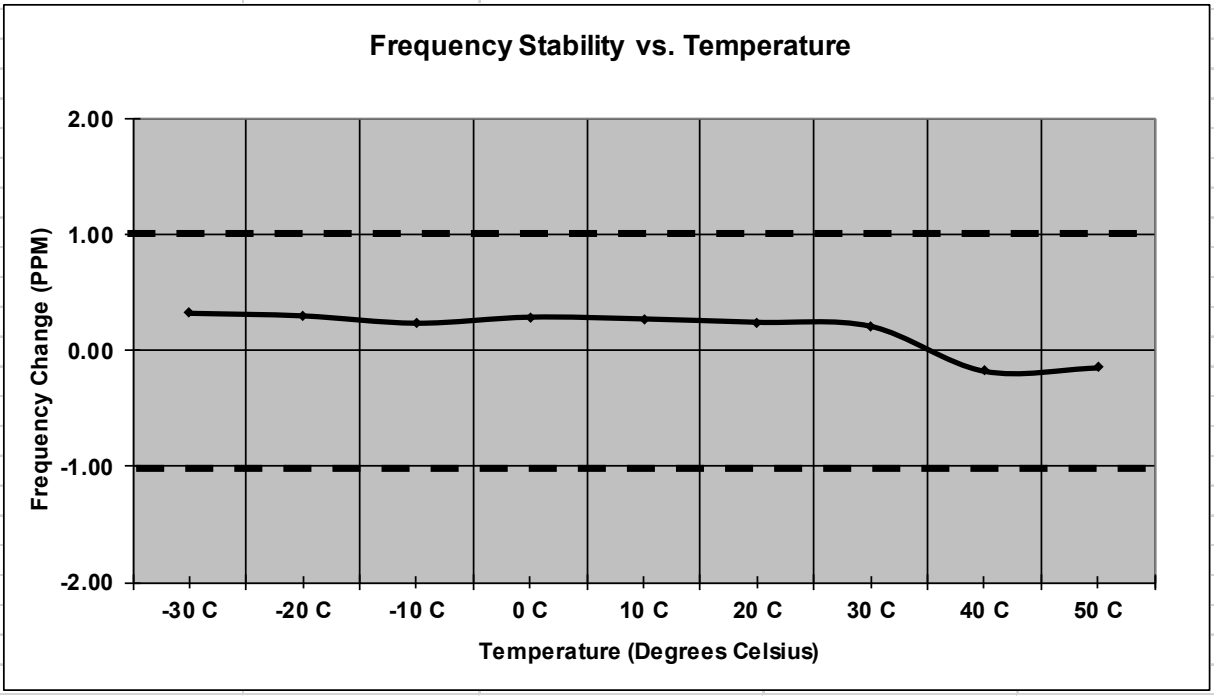

Figure 7.6.2-9: Frequency Stability – 959.925 MHz - Taitien

8.0 CONCLUSION

In the opinion of ACS, Inc. the model VP-DALI, manufactured by Sensus Metering Systems, Inc., meets all the requirements of FCC Part 24D and Part 101 as well as ISED Canada RSS-119 and RSS-134 where applicable.

End Report