Transmitter Certification

Test Report

FCC ID: SDBELS

FCC Rule Part: CFR 47 Part 24 Subpart D, Part 90 Subpart I, Part 101 Subpart C

ACS Report Number: 05-0268-LD

Manufacturer: Advanced Metering Data Systems, LLC
Equipment Type: Electricity Meter Transmitter
Model: AMDSELS

Test Begin Date: August 24, 2005
Test End Date: August 29, 2005

Report Issue Date: September 09, 2005

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612

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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, Part 90 Subpart I, and Part 101 Subpart C of the FCC's Code of Federal Regulations.

1.2 Product Description

The AMDS Elster Transceiver is a printed circuit board that provides wireless communication capability to the Elster family of electric utility meters. The device mounts into existing Elster meters and acts as the "Integrated Communications Device".

The device monitors meter reading and diagnostic information via an interface to the Elster display and metrology boards and communicates via the AMDS fixed wireless telemetry network to provide electric meter readings and diagnostic data from the meter to the utility provider via a two-way radio link.

The device permanently attaches to a printed, external antenna through a coaxial cable that is soldered on both ends, that is not accessible to the end user.

The AMDS Elster Transceiver utilizes a PCB printed antenna that connects to the RF PCB via a coaxial cable permanently soldered to both circuit boards.

The PCB antenna is a dual helix antenna with a gain of 0 dBi.

The AMDS Elster Transceiver operates on 901-902 MHz, 930-931 MHz, and 940-941 MHz in accordance to Part 24 Narrowband PCS; on 896-901 MHz and 935-940 MHz in accordance to Part 90; and on 928.85-929 MHz, 932-932.5 MHz, 941-941.5 MHz, and 959.85-960 MHz in accordance to Part 101.

Detailed photographs of the EUT are filed separately with this filing.

1.3 Emission Designators

The AMDS Elster Transceiver produces four distinct modulation formats.

The emissions designators for the four modulation types used by the AMDS Elster Transceiver are as follows:

EMISSIONS DESIGNATORS:

Normal Mode:	9K60F2D
Half-Baudrate Mode:	4K80F2D
Boost Mode:	1K10F2D
MPass Mode:	5K90F1D

2.0 TEST FACILITIES

2.1 Location

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

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment. In addition, ACS is compliant to ISO 17025 as certified by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program. The following certification numbers have been issued in recognition of these accreditations and certifications:

FCC Registration Number: 89450
Industry Canada Lab Code: IC 4175
VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

NVLAP Lab Code: 200612

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20’ x 30’ x 18’ shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm 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 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25’ from the range. 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 during operation.

Behind the turntable is a 3’ x 6’ x 4’ deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4” PVC chases 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 below:

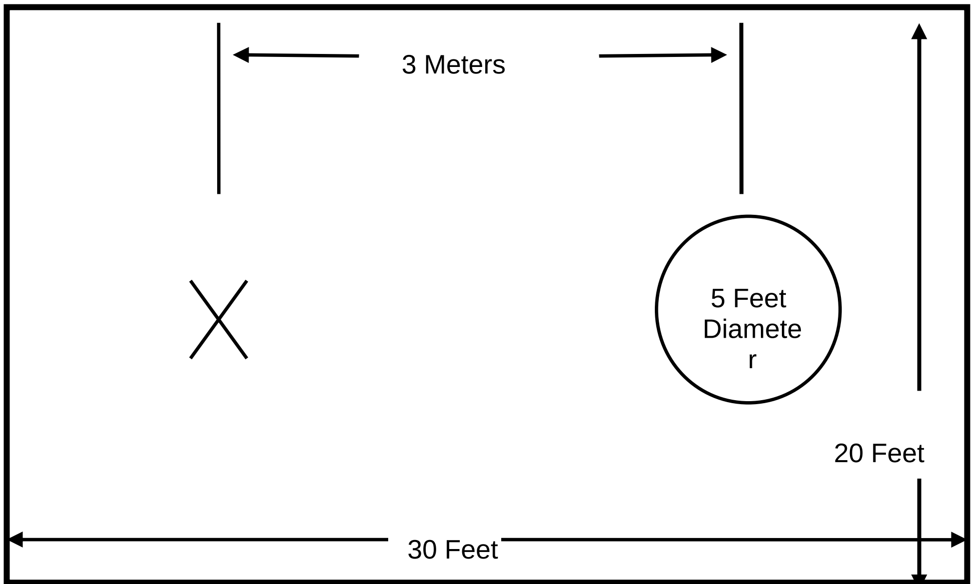

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. 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 during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room 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. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

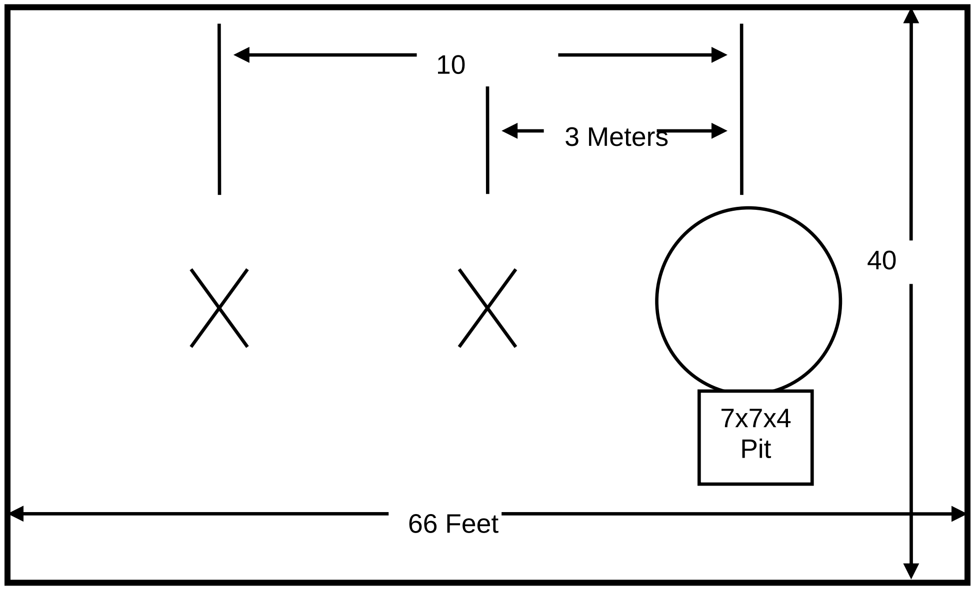

Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is a shielded room with the following dimensions:

- Height: 3.0 Meters
- Width: 3.6 Meters
- Length: 4.9 Meters

The room is manufactured by Rayproof Corporation and installed by Panashield, Inc. Earth ground is provided to the room via an 8' copper ground rod. Each panel of the room is connected electrically at intervals of 4".

Power to the room is filtered to prevent ambient noise from coupling to the EUT and measurement equipment. Filters are models 1B42-60P manufactured by Rayproof Corporation.

The room is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 2.4-1:

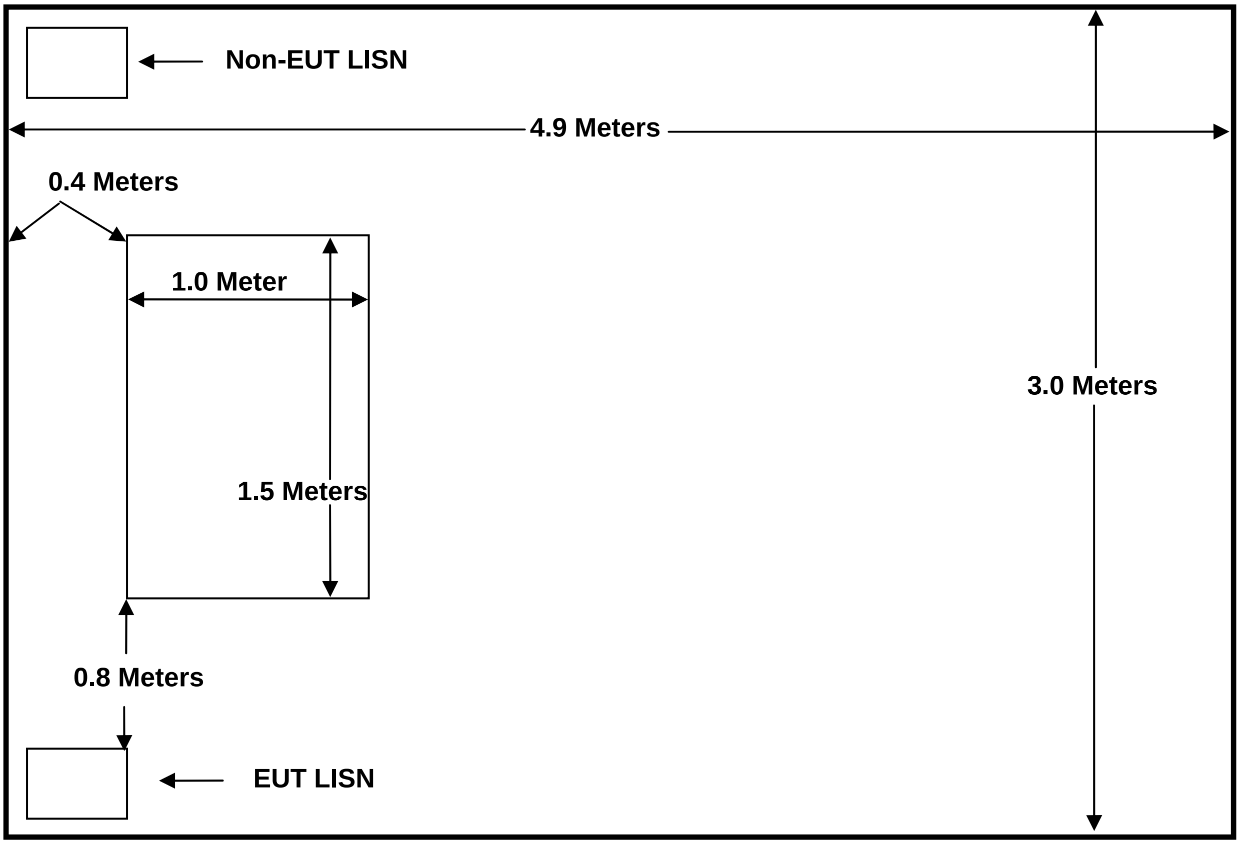

Figure 2.4-1: AC Mains Conducted EMI Site

3.0 APPLICABLE STANDARD REFERENCES

The following standards were used:

1 - ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9KHz to 40GHz
2 - US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures (October 2004)
3 - US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart B: Radio Frequency Devices, Unintentional Radiators (October 2004)
4 - US Code of Federal Regulations (CFR): Title 47, Part 24, Subpart D: Personal Communication Service (October 2004)
5 - US Code of Federal Regulations (CFR): Title 47, Part 90, Subpart I: Private Land Mobile Radio Services (October 2004)
6 - US Code of Federal Regulations (CFR): Title 47, Part 101, Subpart C: Fixed Microwave Services (October 2004)

4.0 LIST OF TEST EQUIPMENT

All test equipment used for regulatory testing is calibrated yearly or according to manufacturer's specifications.

Table 4-1: Test Equipment

Equipment Calibration Information					
ACS#	**Mfg.**	**Eq. type**	**Model**	**S/N**	**Cal. Due**
26	Chase	Bi-Log Antenna	CBL6111	1044	10/05/05
152	EMCO	LISN	3825/2	9111-1905	01/18/06
153	EMCO	LISN	3825/2	9411-2268	12/20/05
193	ACS	OATS Cable Set	RG8	193	01/07/06
225	Andrew	OATS RF cable	Heliax	225	01/06/06
165	ACS	Conducted EMI Cable Set	RG8	165	01/06/06
22	Agilent	Pre-Amplifier	8449B	3008A00526	05/06/06
73	Agilent	Pre-Amplifier	8447D	272A05624	05/18/06
30	Spectrum Technologies	Horn Antenna	DRH-0118	970102	05/09/06
105	Microwave Circuits	High Pass Filter	H1G810G1	2123-01 DC0225	06/09/06
209	Microwave Circuits	High Pass Filters	H3G020G2	4382-01 DC0421	06/09/06
1	Rohde & Schwarz	Receiver	804.8932.52	833771/007	02/26/06
2	Rohde & Schwarz	Receiver	1032.5640.53	839587/003	02/26/06
3	Rohde & Schwarz	ESMI Receiver	804.8932.52	839379/011	12/15/05
4	Rohde & Schwarz	ESMI Receiver	1032.5640.53	833827/003	12/15/05
168	Hewlett Packard	Pulse Limiter	11947A	3107A02268	01/06/06
93	Chase	EM Clamp	CIC 8101	65	01/06/06
204	ACS	Cable	RG8	204	12/29/05
6	Harbour Industries	HF RF Cable	LL-335	00006	03/16/06
7	Harbour Industries	HF RF Cable	LL-335	00007	03/16/06
208	Harbour Industries	HF RF Cable	LL142	00208	06/24/06
237	Gigatronics	Signal Generator	900	282706	01/03/06
176	Weinschel	30 dB Attenuator	46-30-34	BN4922	1/10/2006
N/A	Termaline	Coaxial Resistor 100W	8164	7655	N/A
167	ACS	Chamber EMI Cable Set	RG6	167	12/29/05
204	ACS	Chamber EMI RF cable	RG8	204	01/07/06

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Diagram #	Manufacturer	Equipment Type	Model Number	Serial Number	FCC ID
1	AMDS	EUT	AMDSELS Transceiver	None	SDBELS
2	Hewlett Packard	DC Power Supply	6286A	2109A-06095	None
3	OK Industries	DC Power Supply	PS73C	36095	None
4	Dell	Laptop PC	Latitude D505 - PP10L	CN-OH2049-48643-46F-1251	QDS-BRCM1005-D

6.0 EQUIPMENT UNDER TEST SETUP AND BLOCK DIAGRAM

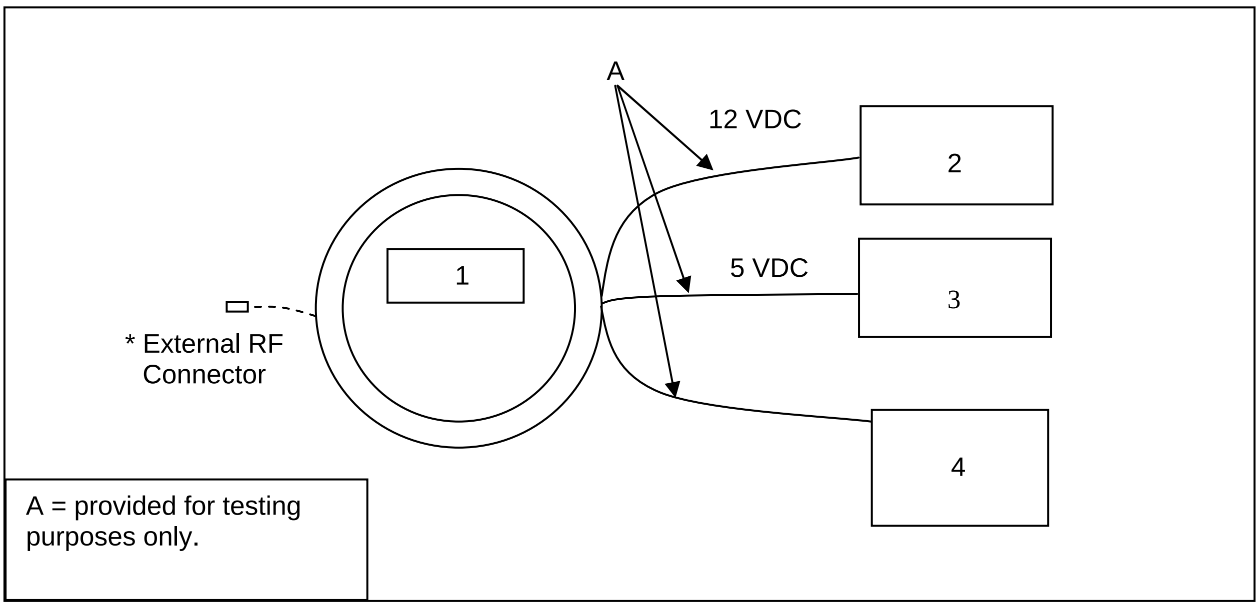

Figure 6-1: EUT Test Setup

For testing the transceiver characteristics the EUT was power by two external DC power supplies as shown above. The DB9 connector was used to connect to a PC for programming the EUT test modes. The PC was removed prior to testing radiated emissions.

* For RF conducted measurements the AMDS Elster Transceiver was modified with an external RF connector to the PCB. The AMDS Elster Transceiver utilizes a printed antenna integral to the transceiver PCB for normal operation but for testing purposes a 50-Ohm test point is available on the PCB. The test point provides proper power level measurements only when the antenna is disconnected and a 50-Ohm test cable is soldered (with the appropriate ground connection) to the PCB. The EUT test cable was connected to non-radiating 50 Ohm load for radiated measurements.

For the purpose of testing to Part 15 for unintentional radiators, the EUT was test as installed in electricity meters with the integral antenna connected. Two separate configurations were evaluated for the purpose of this report. The EUT was tested as installed in a 120VAC meter box and powered by 120VAC. The second configuration was with the EUT installed in a 240 VAC 3 phase meter box and powered by 240 VAC 3 phase power.

7.0 SUMMARY OF TESTS

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document. The most stringent limit from all rule parts indicated in this report is used to show compliance. For example if the spurious emission limit for one rule part is -13 dBm and is -20 dBm for another, the -20 dBm limit is used for spurious emissions for all data points.

7.1 RF Power Output - FCC Section 2.1046

7.1.1 Measurement Procedure

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through a 30 dB passive attenuator. The resolution and video bandwidths of the spectrum analyzer were set at sufficient levels, >> signal bandwidth, to produce accurate results. The internal correction factors of the spectrum analyzer were employed to correct for any cable or attenuator losses. Results are shown below in Table 7.1.1-2 and Figure 7.1.1-1 through 7.1.1-11.

7.1.2 Measurement Results

Table 7.1.1-1: Peak Output Power

Frequency (MHz)	FCC Rule Part	Output Power (dBm)
901.1125	24	29.95
930.1125	24	29.26
940.1125	24	29.09
896.0500	90	30.08
900.9875	90	29.95
935.0125	90	29.24
939.9875	90	29.01
928.93125	101	29.42
932.23125	101	29.24
941.23125	101	29.03
959.93125	101	28.45

Part 24

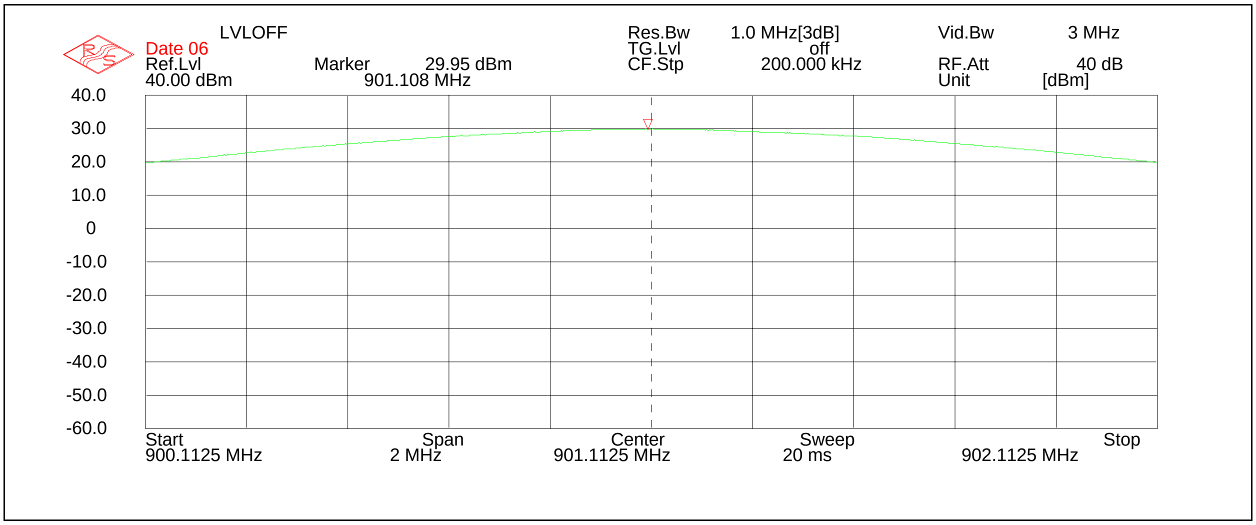

Figure 7.1.2-1: Peak Output Power 901.1125 MHz

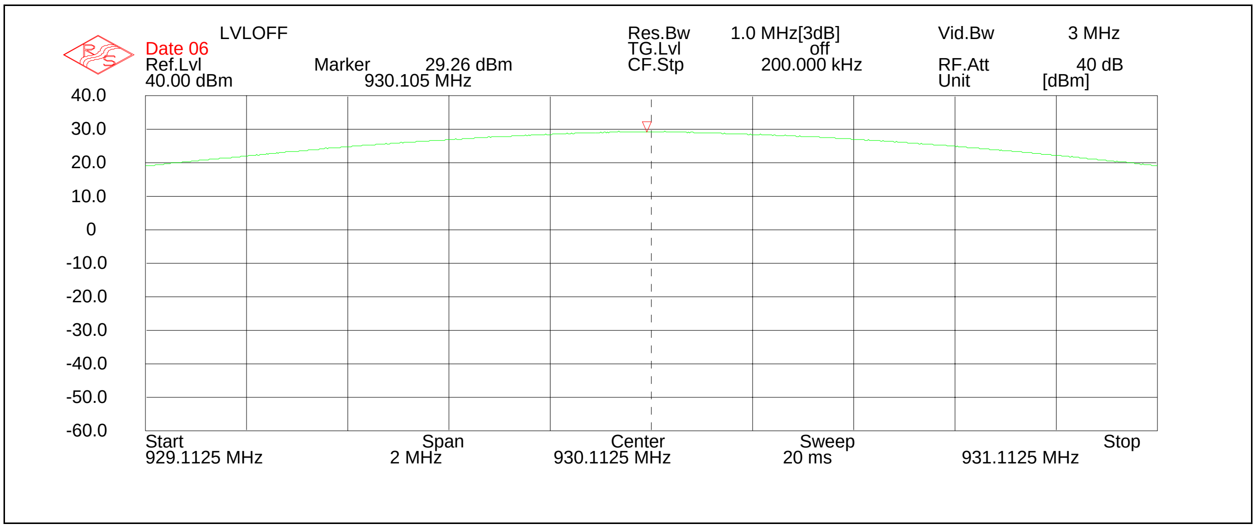

Figure 7.1.2-2: Peak Output Power 930.1125 MHz

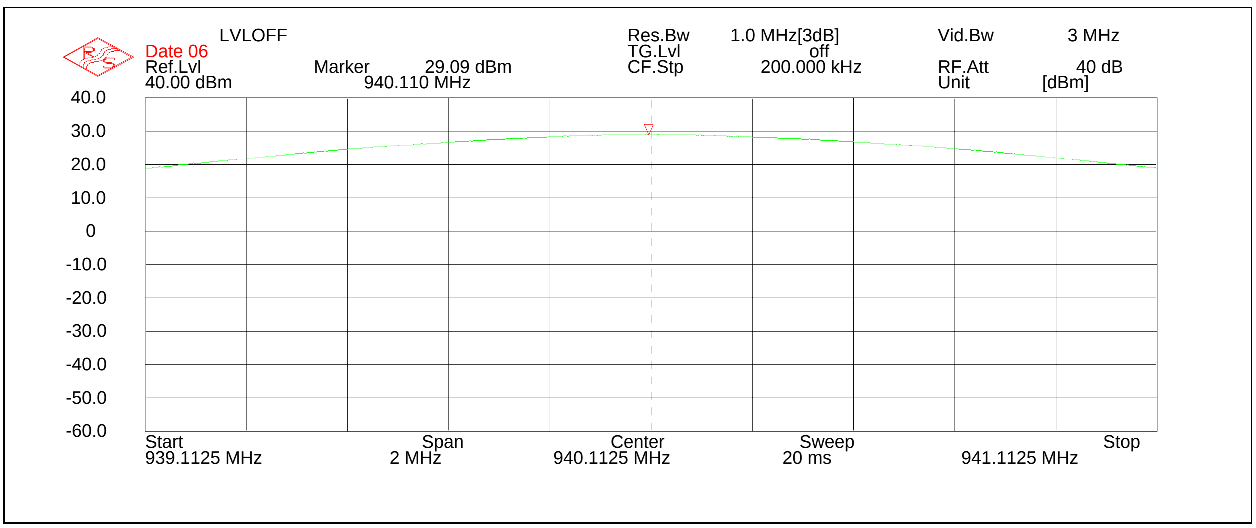

Figure 7.1.2-3: Peak Output Power 940.1125 MHz

Part 90

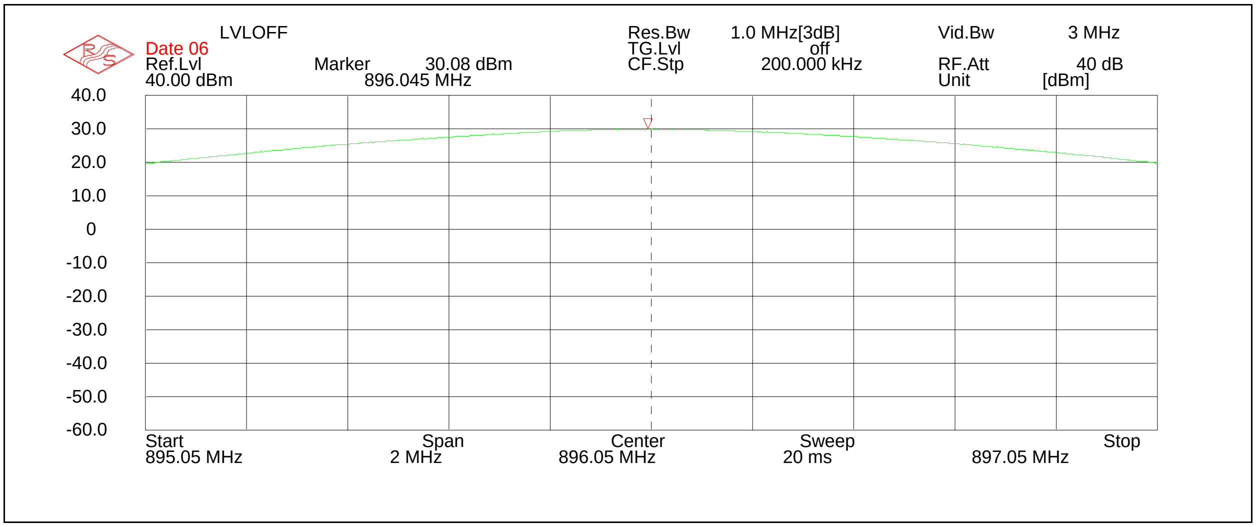

Figure 7.1.2-4: Peak Output Power 896.0500 MHz

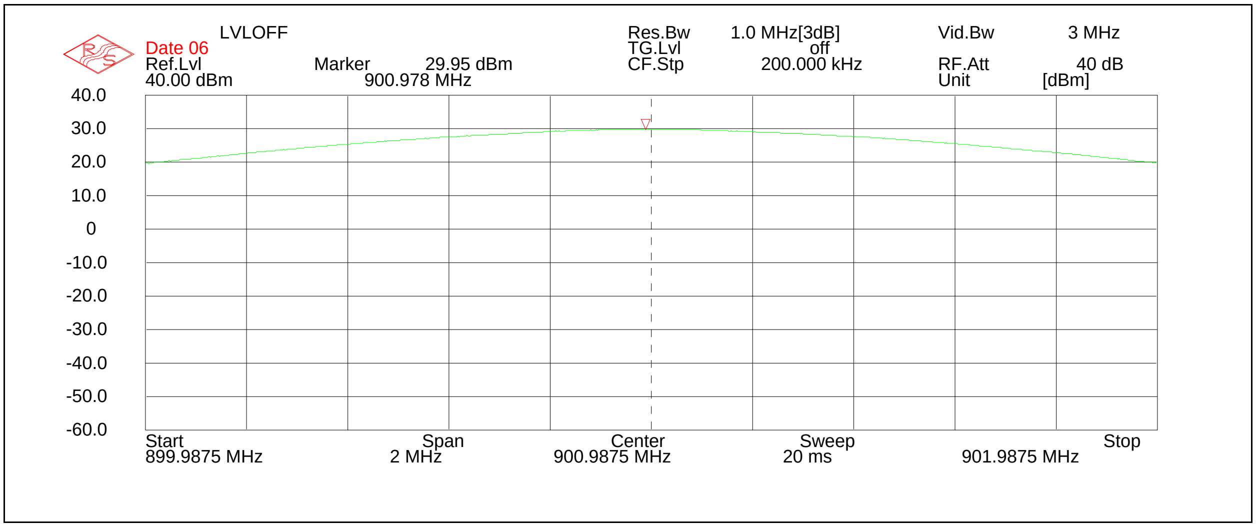

Figure 7.1.2-5: Peak Output Power 900.9875 MHz

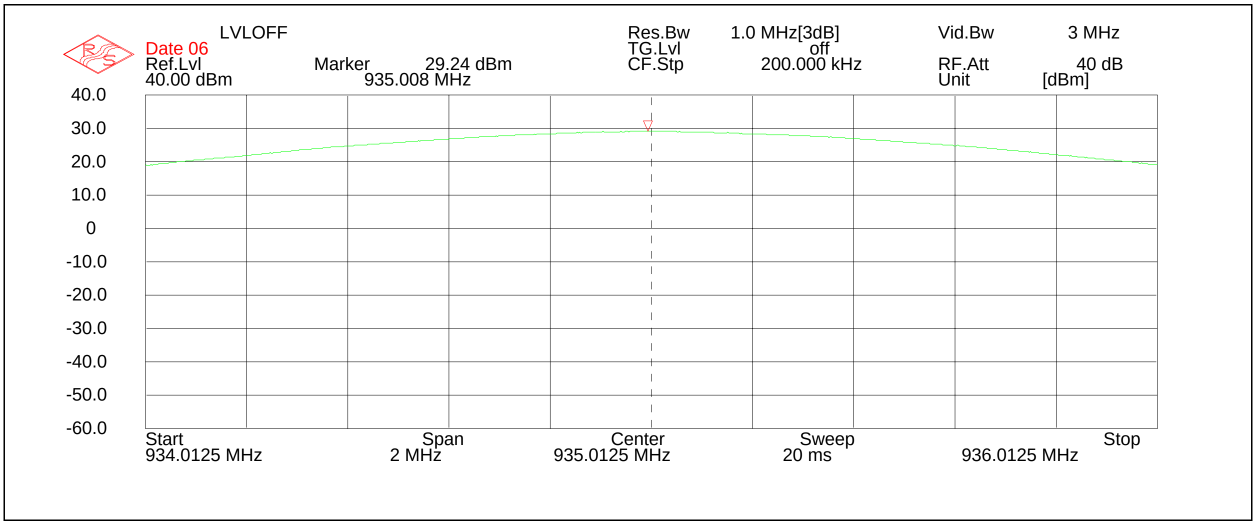

Figure 7.1.2-6: Peak Output Power 935.0125 MHz

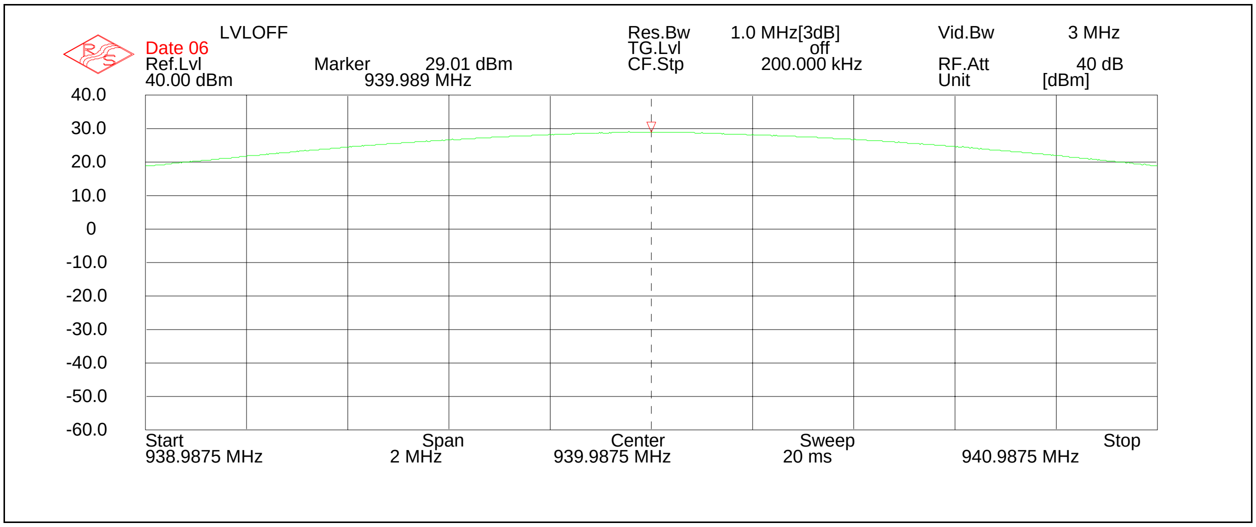

Figure 7.1.2-7: Peak Output Power 939.9875 MHz

Part 101

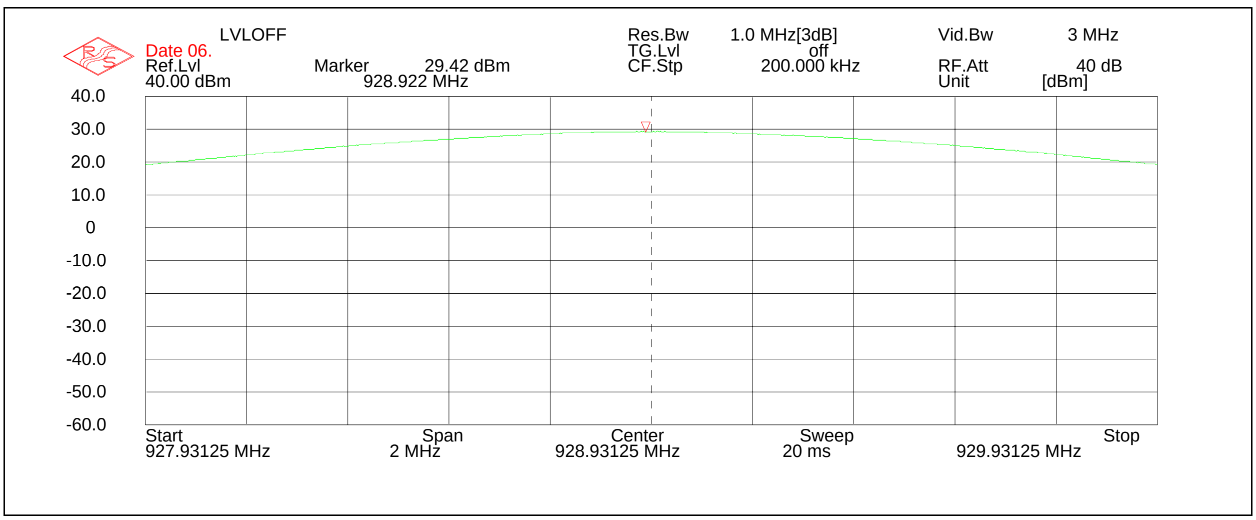

Figure 7.1.2-8: Peak Output Power 928.93125 MHz

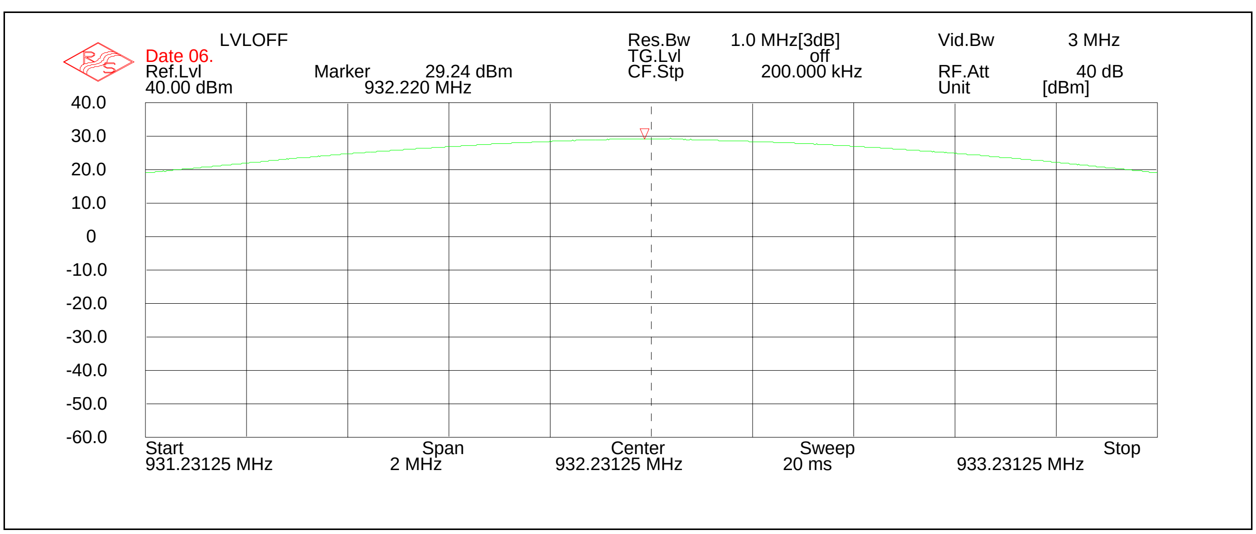

Figure 7.1.2-9: Peak Output Power 932.23125 MHz

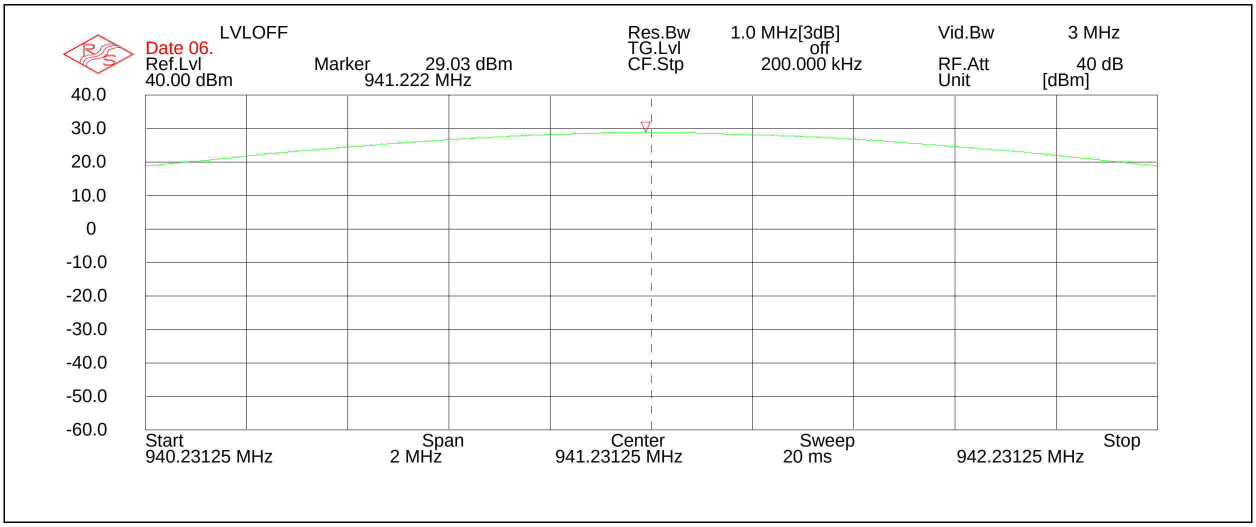

Figure 7.1.2-10: Peak Output Power 941.23125 MHz

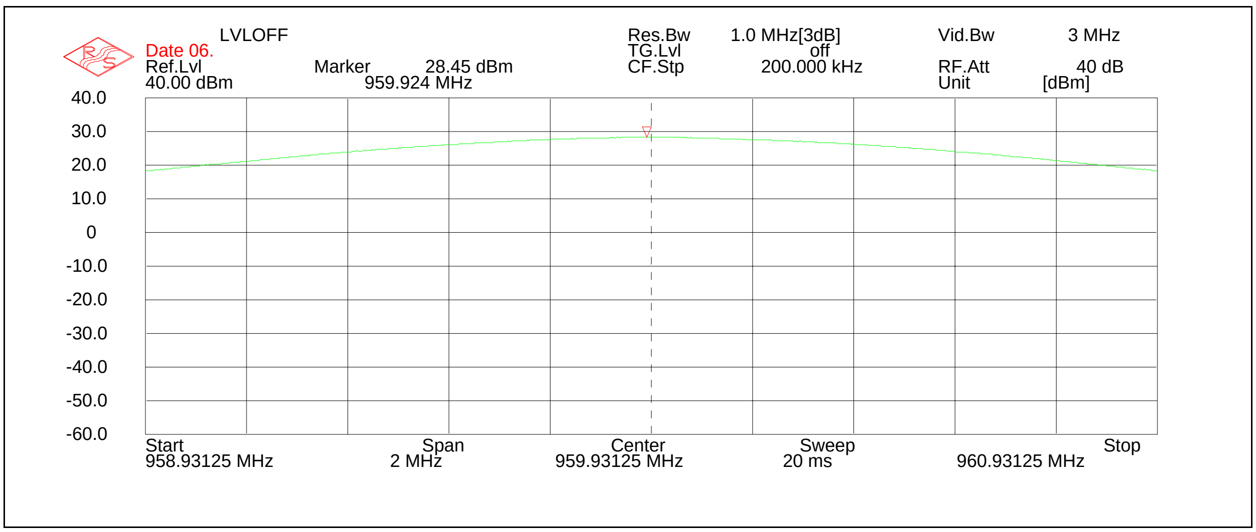

Figure 7.1.2-11: Peak Output Power 959.93125 MHz

7.2 Occupied Bandwidth (Emission Limits) - FCC Section 2.1049

7.2.1 Measurement Procedure

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through a 30 dB passive attenuator. The spectrum analyzer resolution and video bandwidths were set to 300 Hz. 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 in for all modes of operation.

7.2.2 Measurement Results – Part 24.133 a(1), a(2)

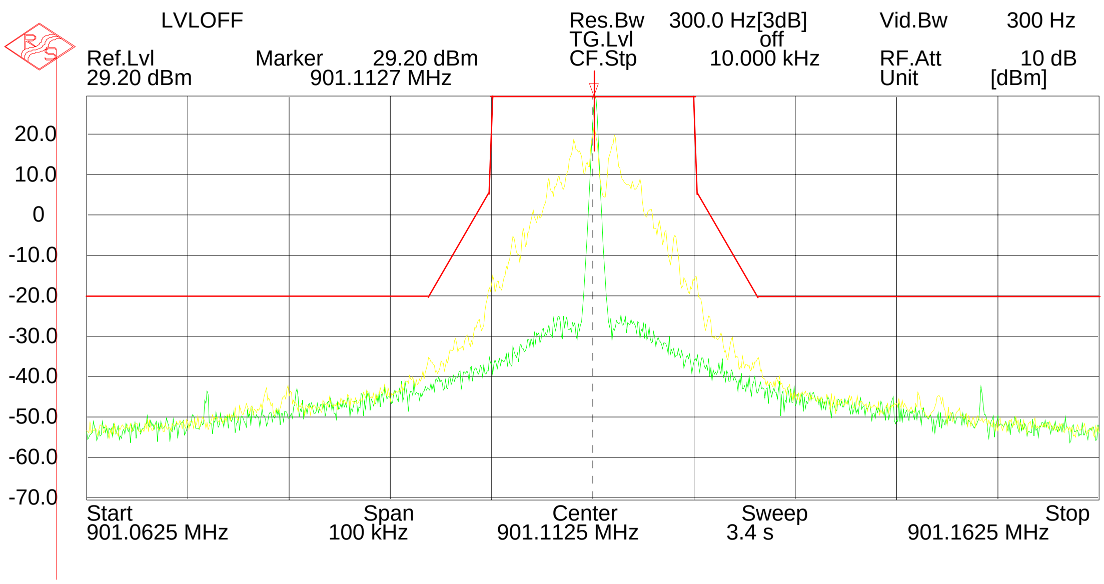

Figure 7.2.2-1: Normal Mode – 901.1125 MHz – 25 kHz Channel

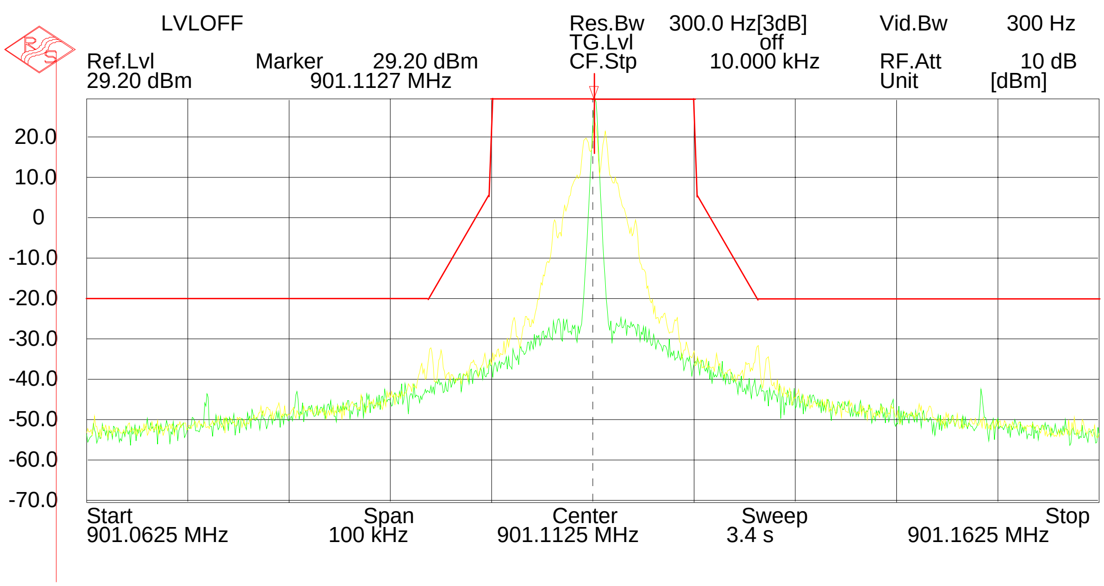

Figure 7.2.2-2: Half-Baud Rate Mode – 901.1125 MHz – 25 kHz Channel

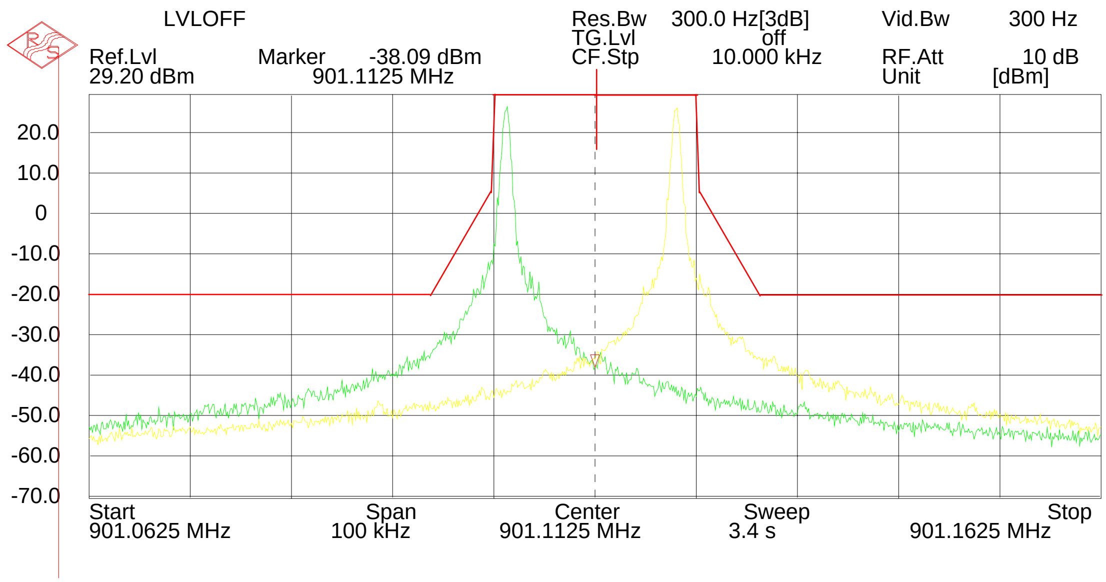

Figure 7.2.2-3: Boost Mode – 901.1125 MHz – 25 kHz Channel
Offset Channel of +/- 14 (+/- 8400 Hz)

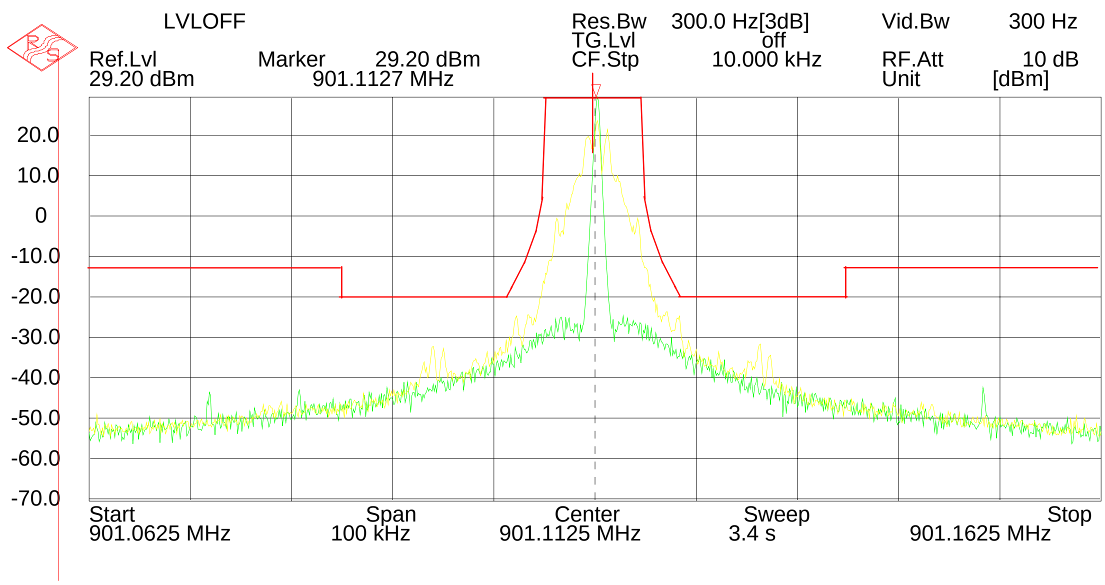

Figure 7.2.2-4: Half-Baud Rate – 901.1125 MHz – 12.5 kHz Channel

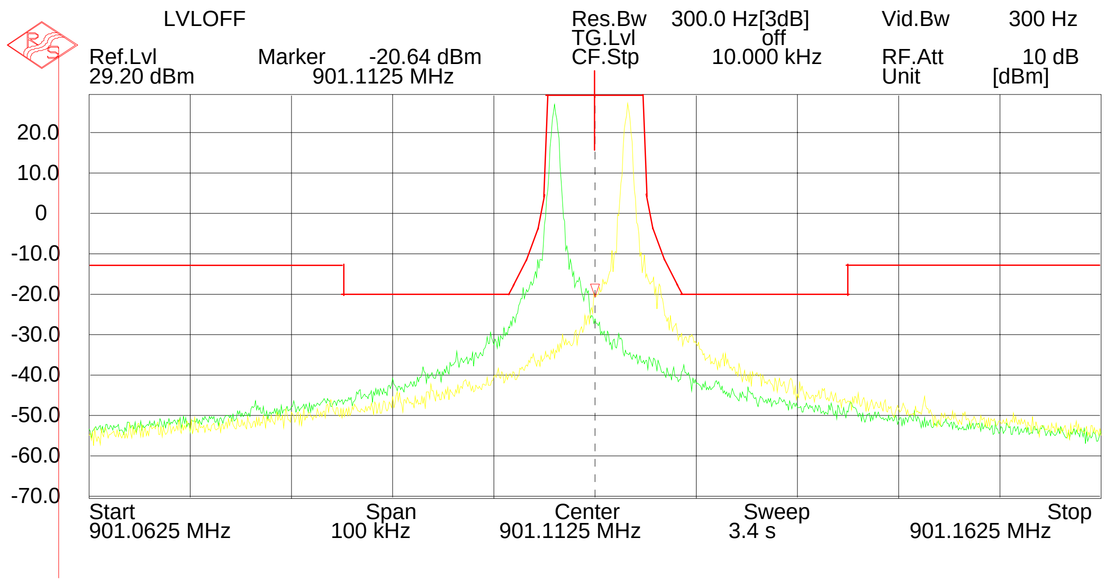

Figure 7.2.2-5: Boost Mode – 901.1125 MHz – 12.5 kHz Channel
Offset Channel of +/- 6 (+/- 3600 Hz)

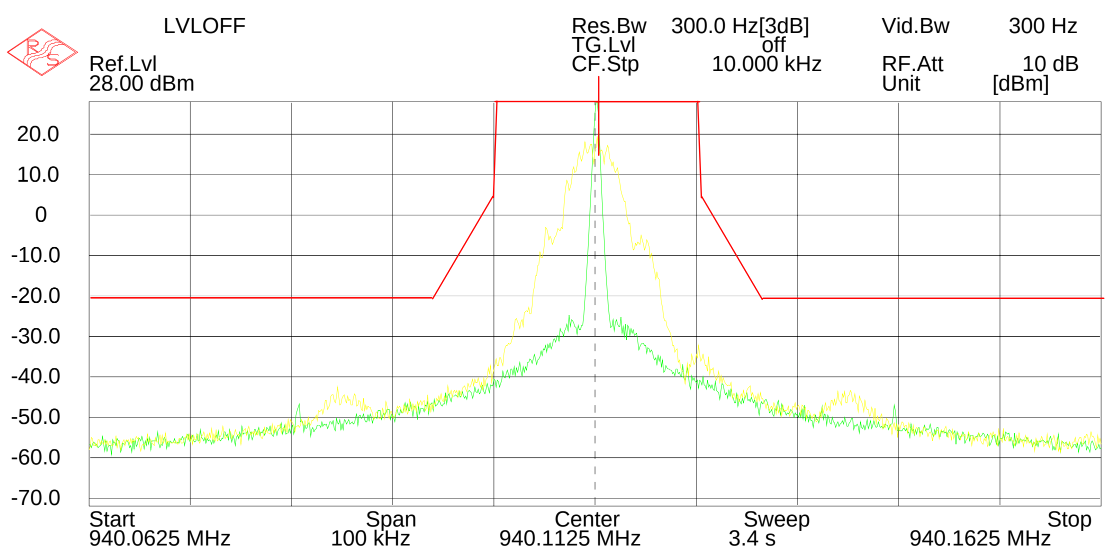

Figure 7.2.2-6: MPass Mode – 940.1125 MHz – 25 kHz Channel

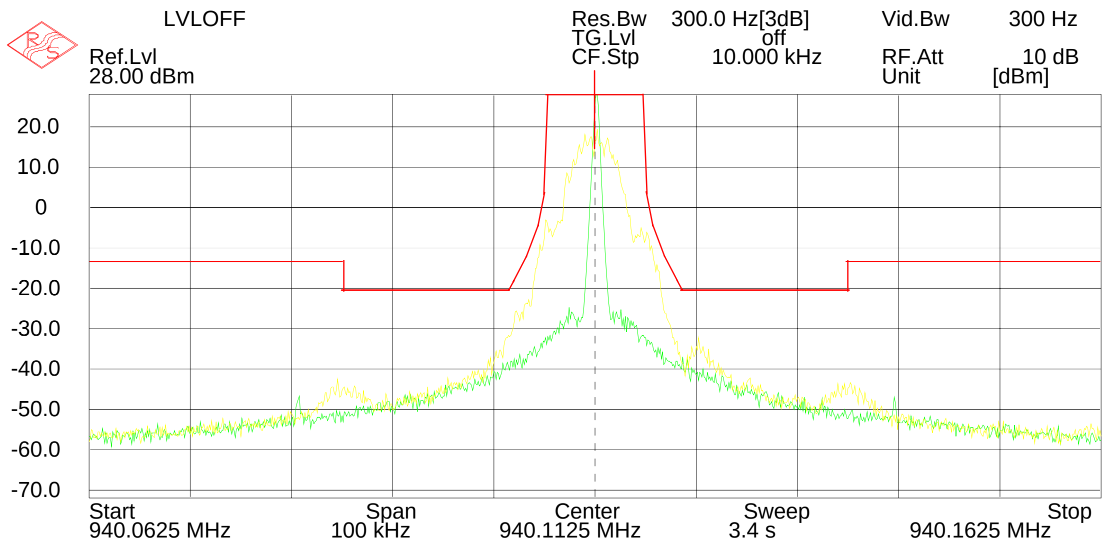

Figure 7.2.2-7: MPass Mode – 940.1125 MHz – 12.5 kHz Channel

7.2.3 Measurement Results – Part 90.210 (j)

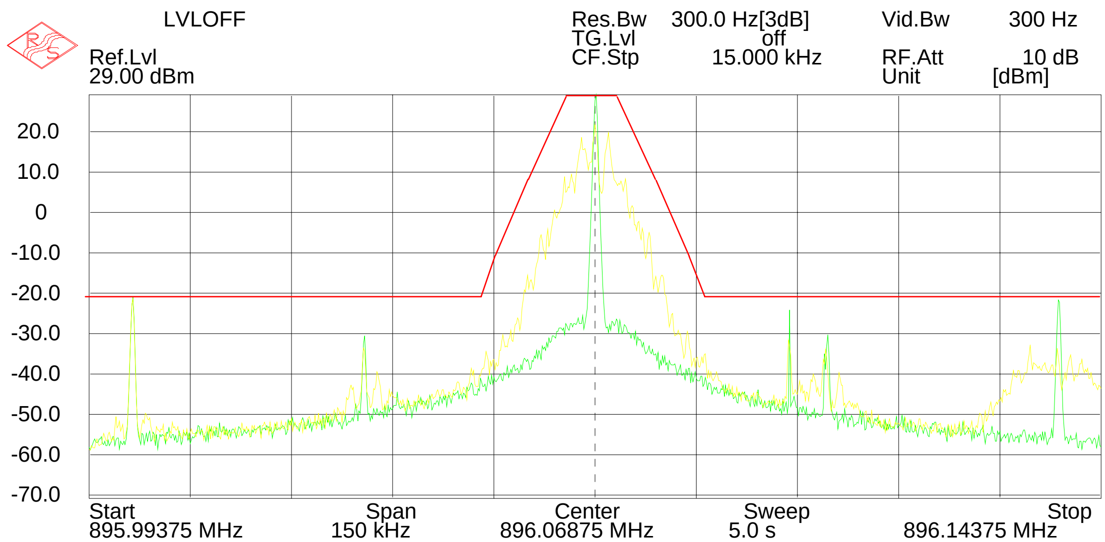

Figure 7.2.3-1: Normal Mode – 896.06875 MHz

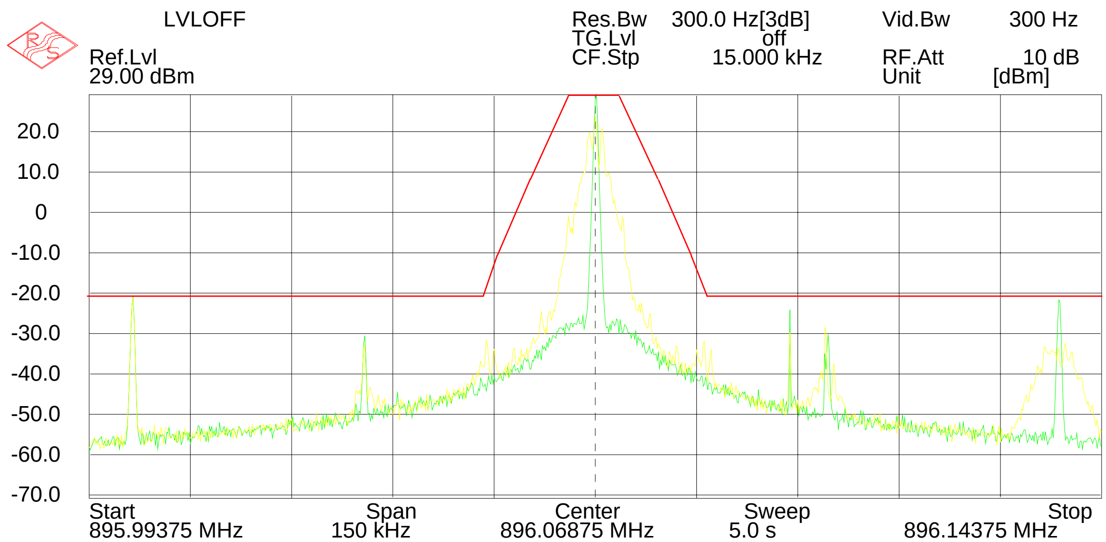

Figure 7.2.3-2: Half-Baud Rate Mode – 896.06875 MHz

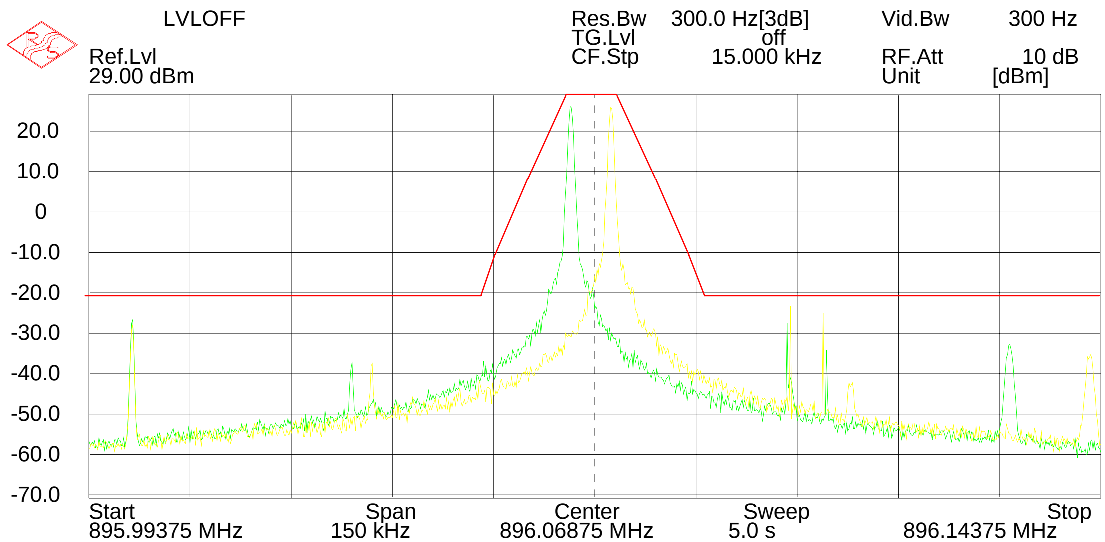

Figure 7.2.3-3: Boost Mode – 896.06875 MHz
Offset Channel of +/- 5 (+/- 3000 Hz)

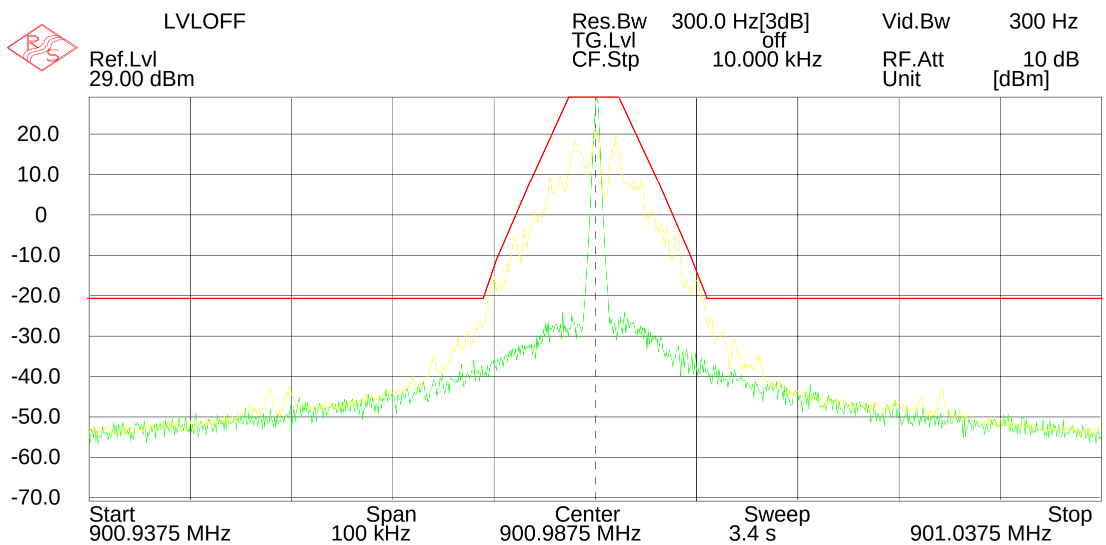

Figure 7.2.3-4: Normal Mode – 900.9875 MHz

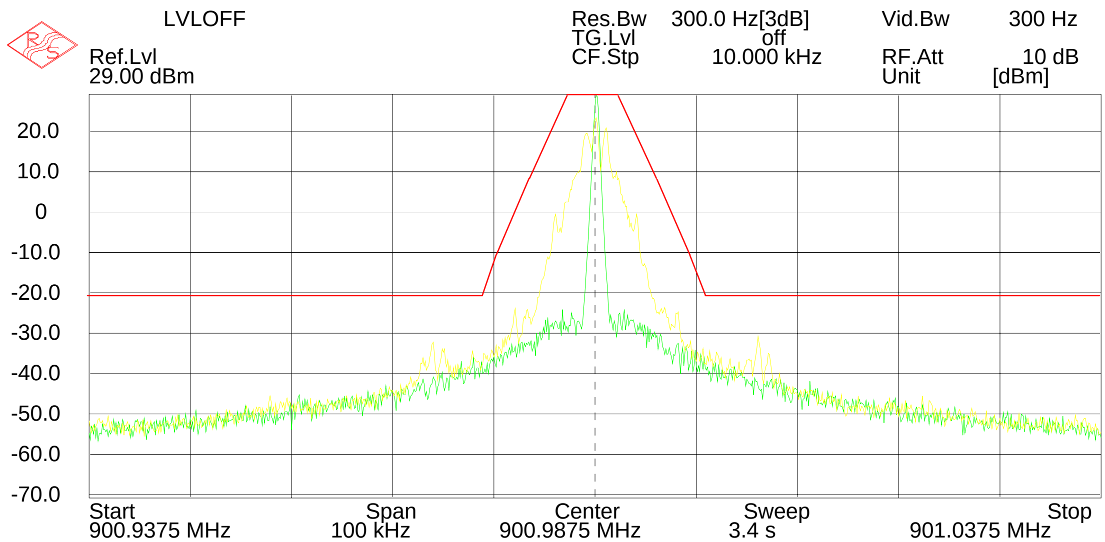

Figure 7.2.3-5: Half-Baud Rate Mode – 900.9875 MHz

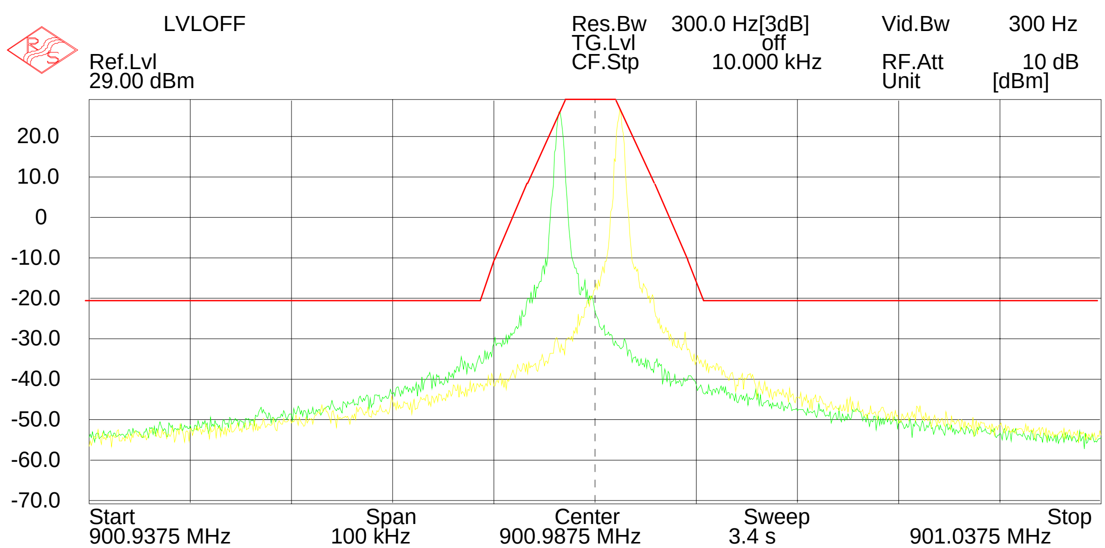

Figure 7.2.3-6: Boost Mode – 900.9875 MHz
Offset Channel of +/- 5 (+/- 3000 Hz)

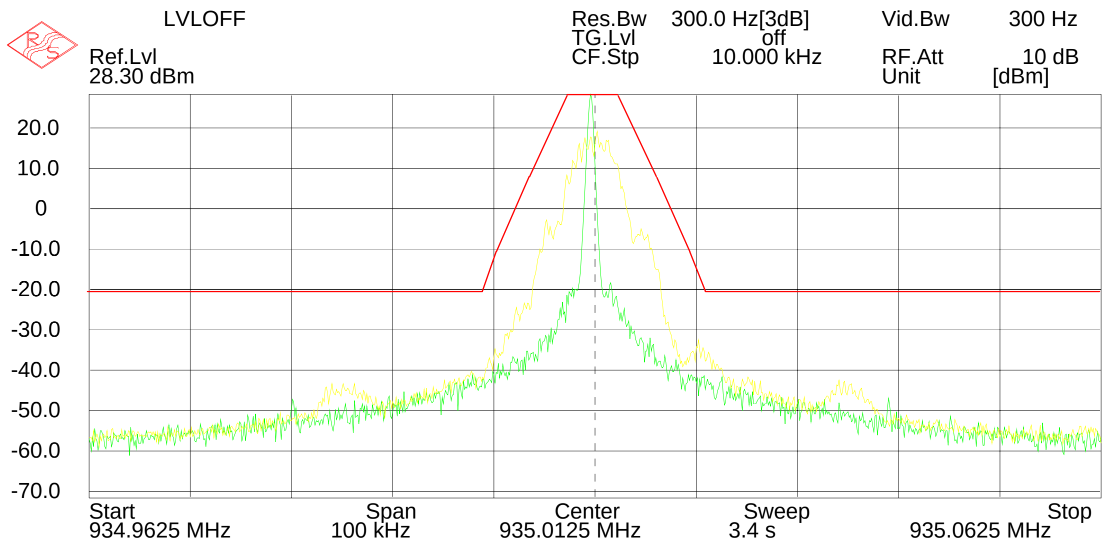

Figure 7.2.3-7: Mpass Mode – 935.0125 MHz

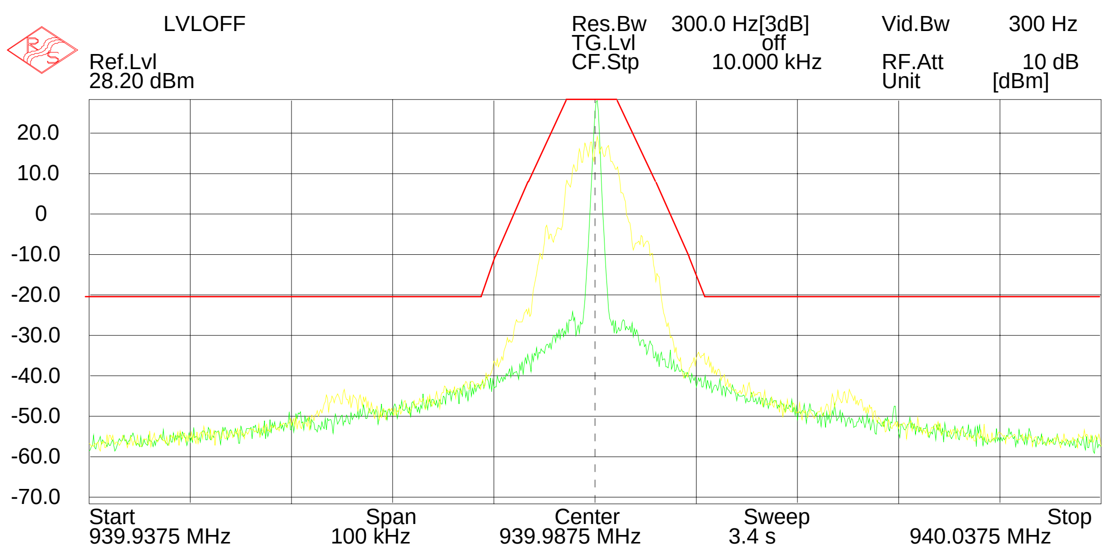

Figure 7.2.3-8: Mpass Mode – 939.9875 MHz

7.2.4 Measurement Results – Part 101.111 a(6)

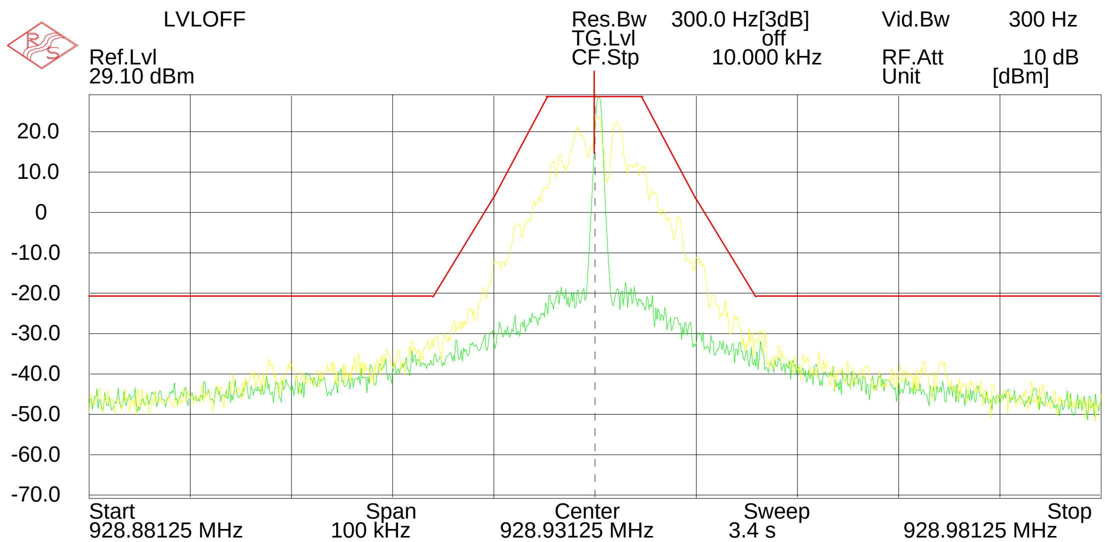

Figure 7.2.4-1: Normal Mode – 928.93125 MHz

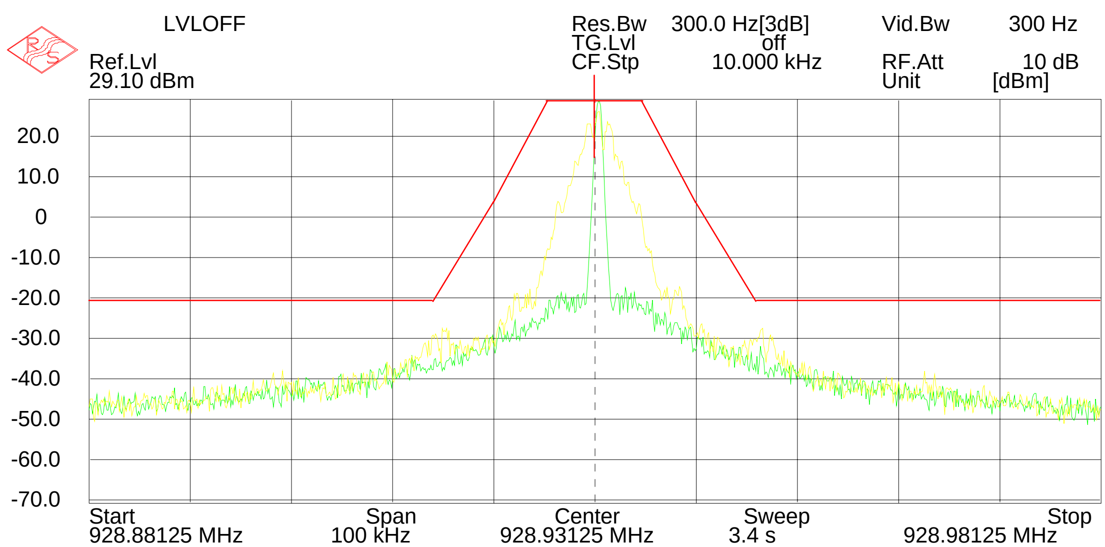

Figure 7.2.4-2: Half-Baud Rate Mode – 928.93125 MHz

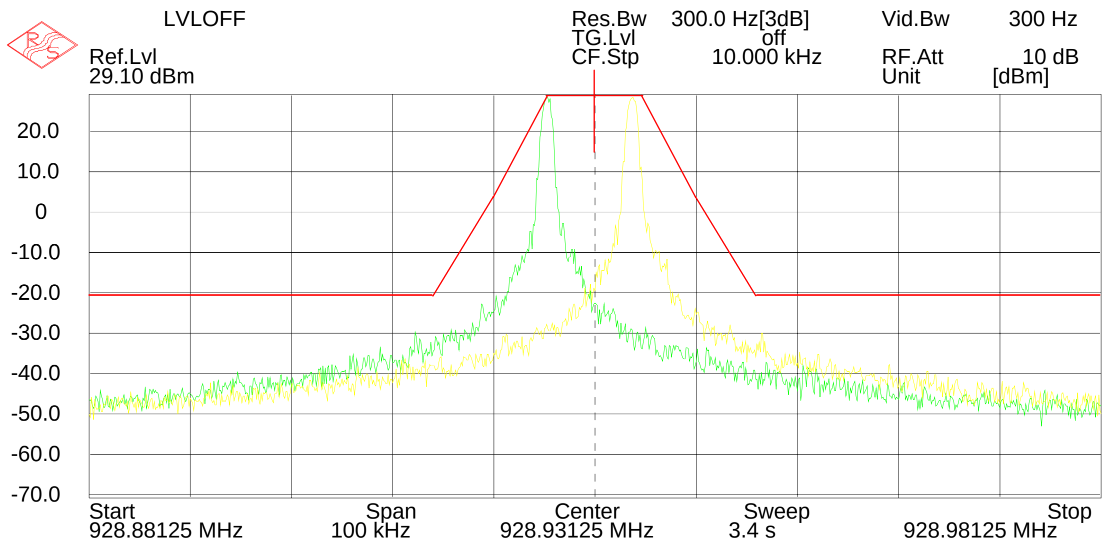

Figure 7.2.4-3: Boost Mode – 928.93125 MHz
Offset Channel of +/- 7 (+/- 4200 Hz)

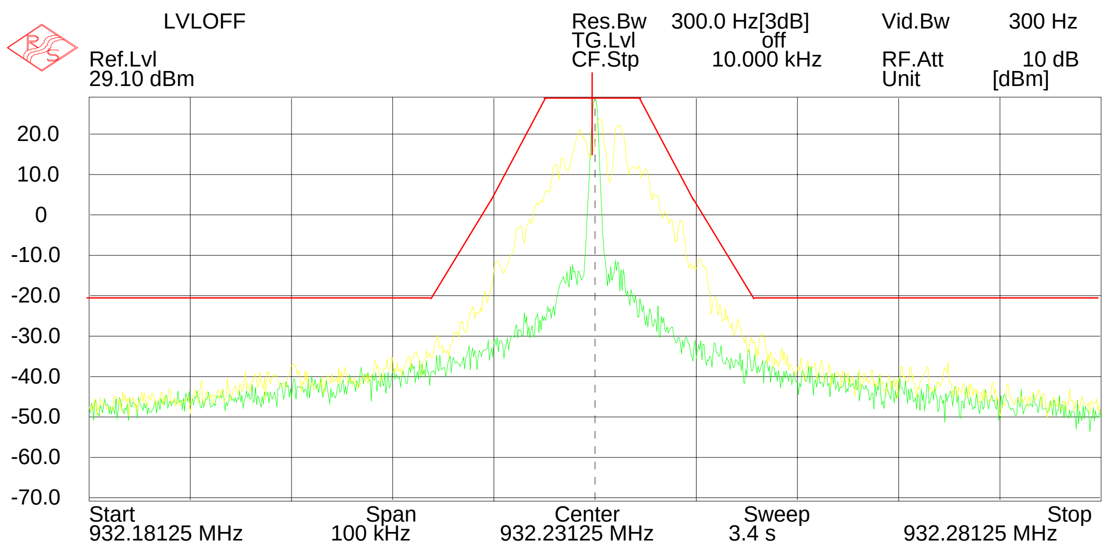

Figure 7.2.4-4: Normal Mode – 932.23125 MHz

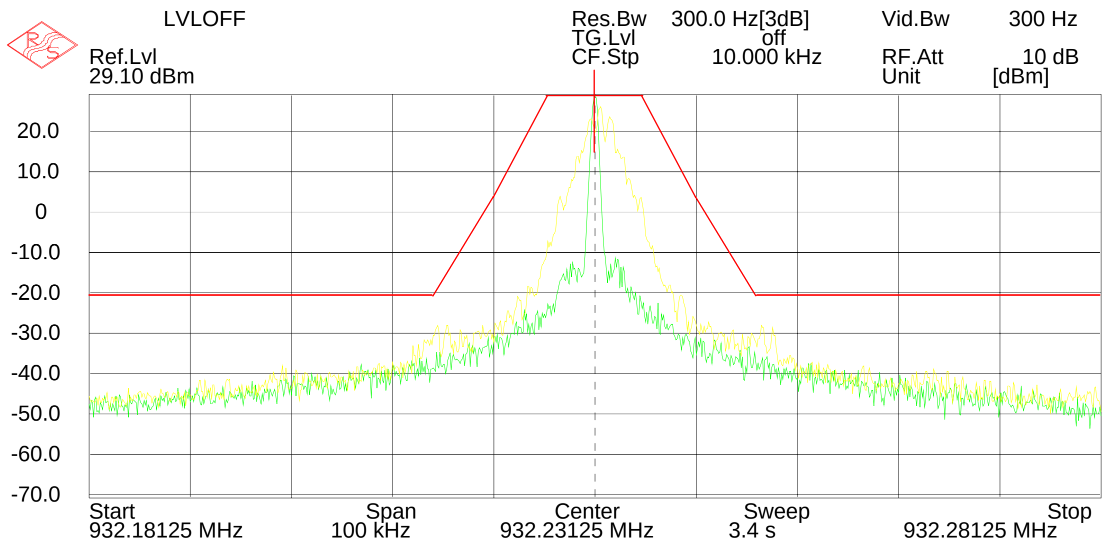

Figure 7.2.4-5: Half-Baud Rate Mode – 932.23125 MHz

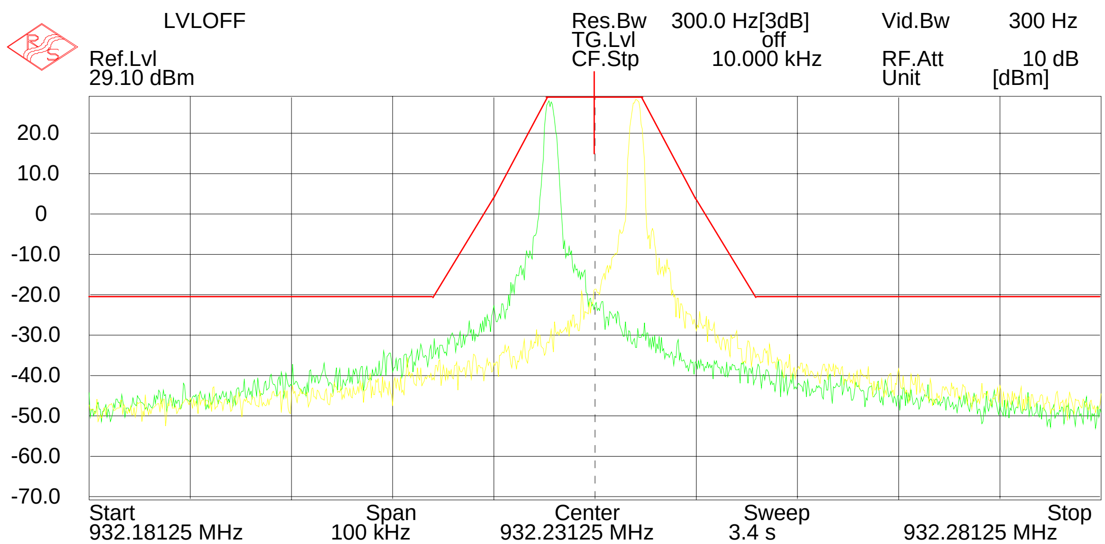

Figure 7.2.4-6: Boost Mode – 932.23125 MHz
Offset Channel of +/- 7 (+/- 4200 Hz)

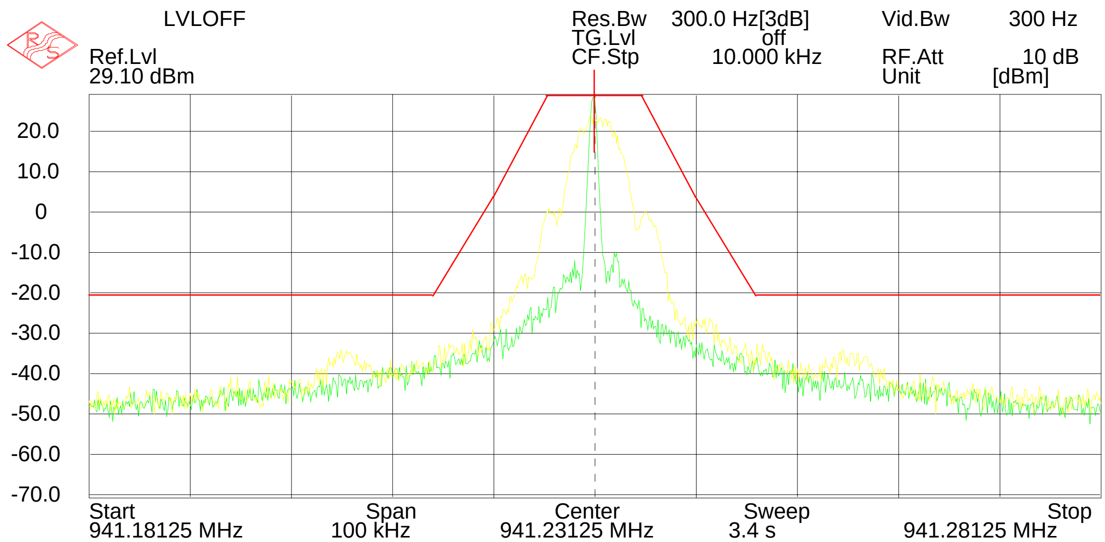

Figure 7.2.4-7: Mpass Mode – 941.23125 MHz

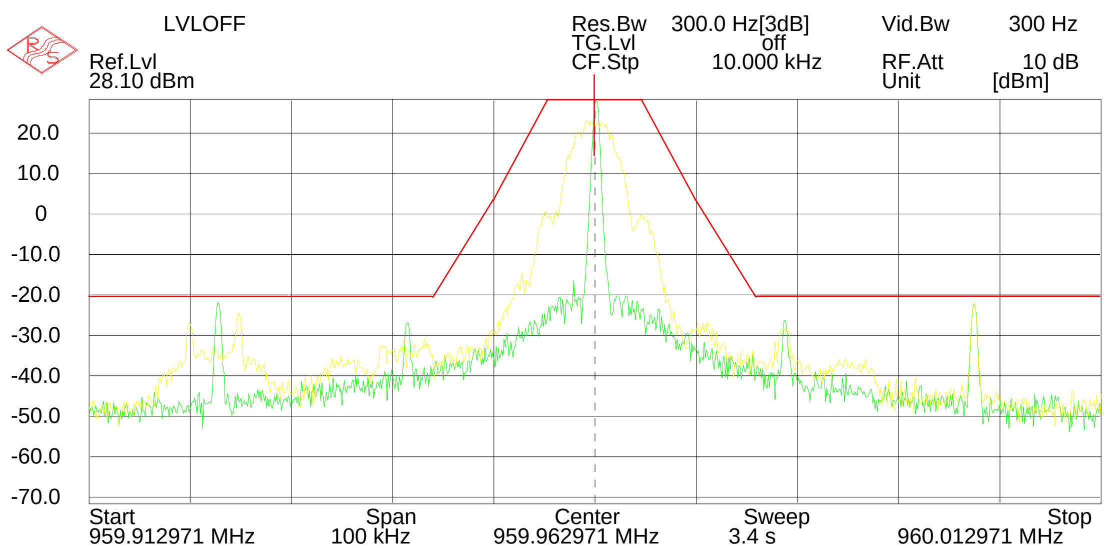

Figure 7.2.4-8: Mpass Mode – 959.96250 MHz

7.3 Spurious Emissions at Antenna Terminals - FCC Section 2.1051, 101.111 a (6)

7.3.1 Measurement Procedure

The RF output of the equipment under test was directly connected to the input of the Spectrum Analyzer through a 30 dB passive attenuator. The spectrum analyzer resolution bandwidth was set to 30 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 or attenuator losses. The spectrum was investigated in accordance to CFR 47 Part 2.1057.

7.3.2 Measurement Results

The magnitude of all spurious emissions were attenuated more than 20 dB below the permissible value and therefore not specified in this report (2.1051). Data was collected at the low, middle, and high end of the operating range of the device in the mode that produced the worst case emissions. Plots are supplied in Figure 7.3.2-1 through 7.3.2.6.

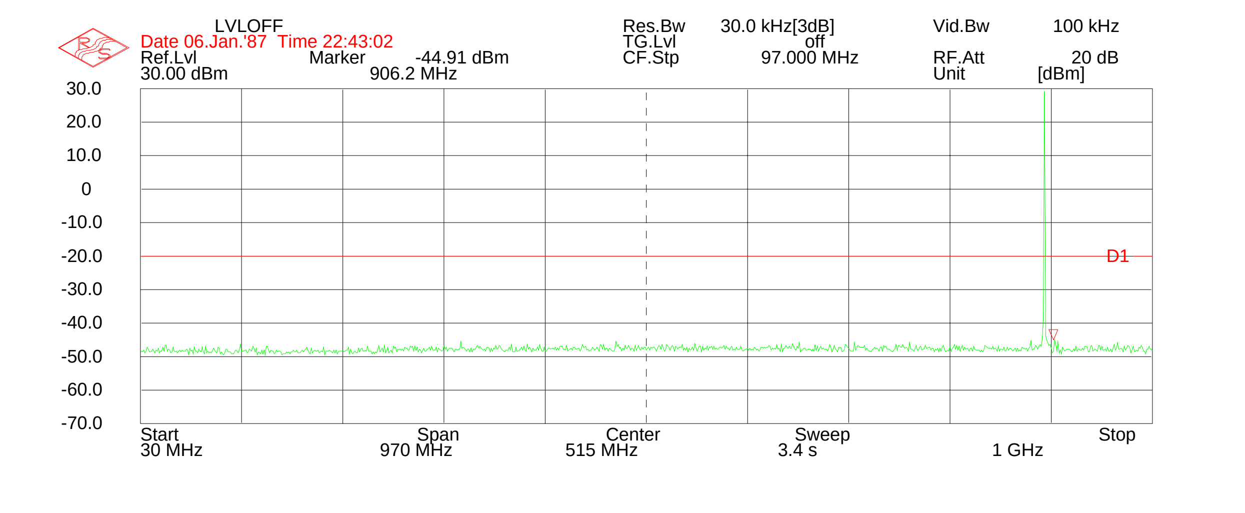

Figure 7.3.2-1: Normal Mode – 896.06875 MHz

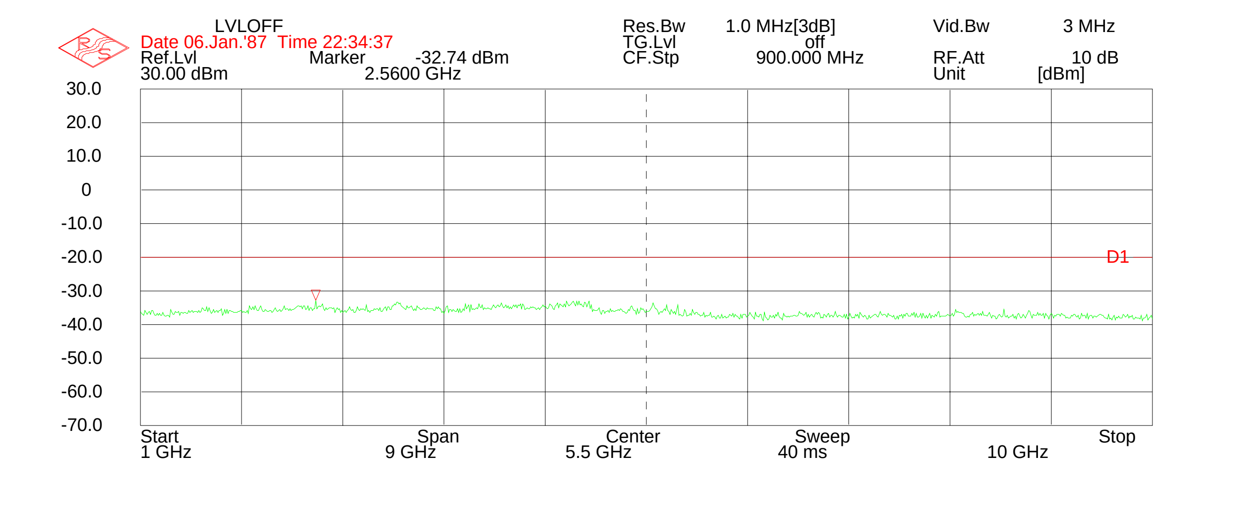

Figure 7.3.2-2: Normal Mode – 896.06875 MHz

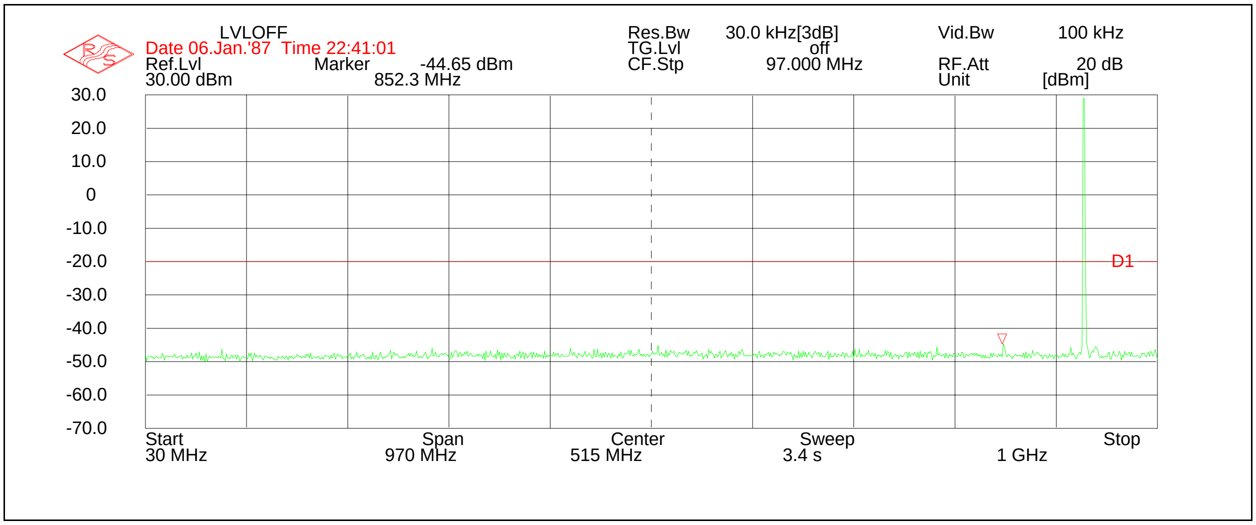

Figure 7.3.2-3: Normal Mode – 928.93125 MHz

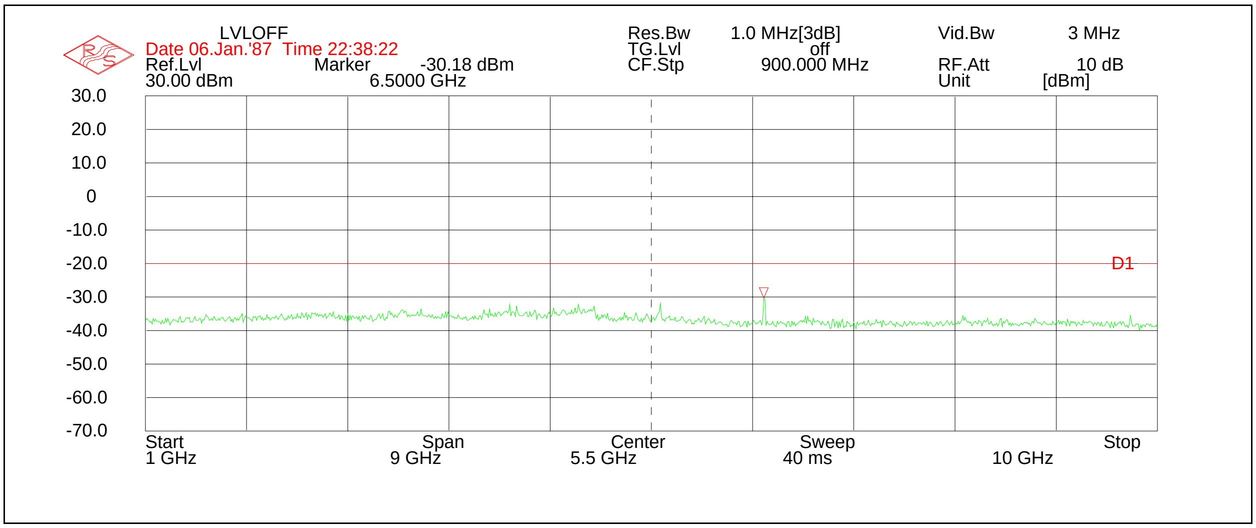

Figure 7.3.2-4: Normal Mode – 928.93125 MHz

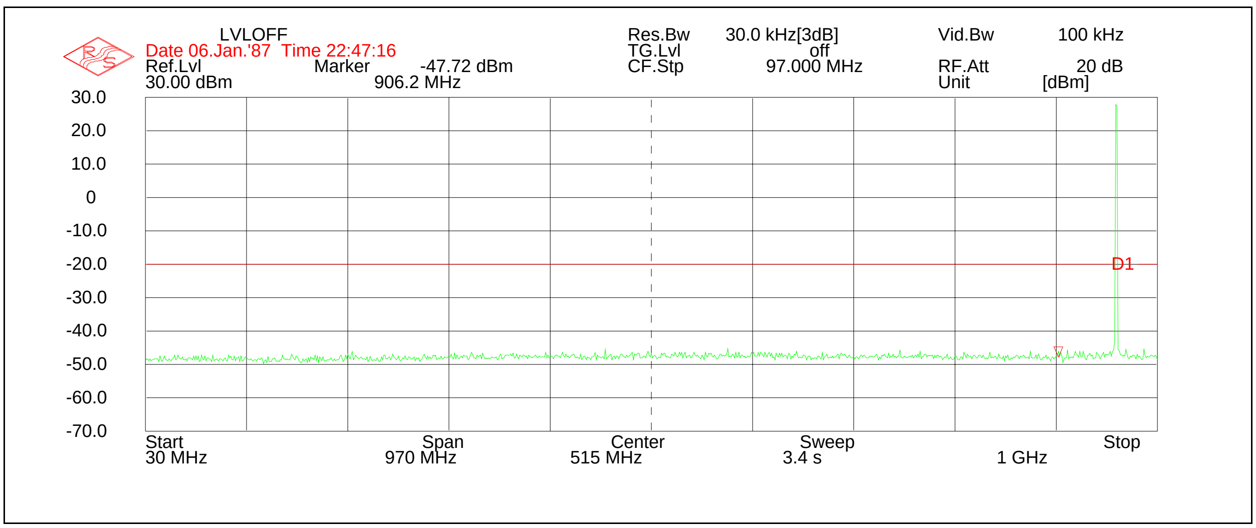

Figure 7.3.2-5: Normal Mode – 959.96250 MHz

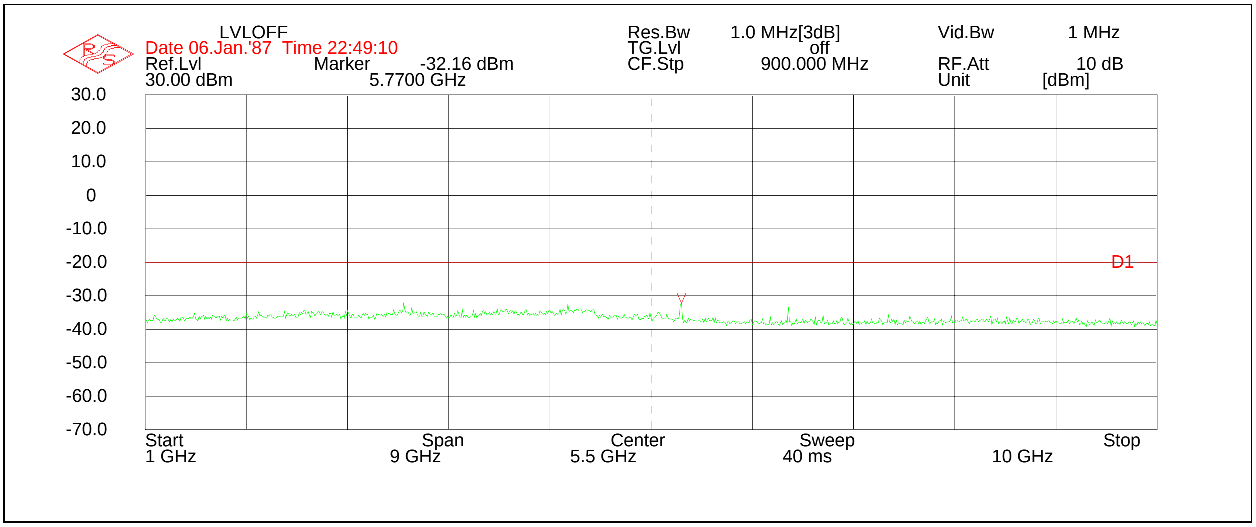

Figure 7.3.2-6: Normal Mode – 959.96250 MHz

7.4 Field Strength of Spurious Emissions - FCC Section 2.1053, 24.133, 90.210, and 101.111

7.4.1 Measurement Procedure

The equipment under test is placed on the Open Area Test Site (described in section 2.1) on a wooden table at the turntable center. 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 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.

Data was collected at the low, middle, and high end of the operating range of the device. Results of the test are shown below in Table 7.4.2-1 and 7.4.2-3. 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.

7.4.2 Measurement Results

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1792.15	-56.18	-60	H	5.41	-54.59	-20.00	34.59
1792.15	-51.99	-53	V	5.41	-47.59	-20.00	27.59
2688.225	-50.09	-49	H	5.71	-43.29	-20.00	23.29
2688.225	-49.73	-48	V	5.71	-42.29	-20.00	22.29
3584.3	-57.12	-54	H	5.95	-48.05	-20.00	28.05
3584.3	-54.23	-49	V	5.95	-43.05	-20.00	23.05
4480.375	-45.54	-38	H	6.67	-31.33	-20.00	11.33
4480.375	-46.94	-39	V	6.67	-32.33	-20.00	12.33
5376.45	-58.95	-49	H	6.02	-42.98	-20.00	22.98
5376.45	-57.76	-47	V	6.02	-40.98	-20.00	20.98
6272.525	-59.3	-51	H	6.27	-44.73	-20.00	24.73
6272.525	-57.98	-46	V	6.27	-39.73	-20.00	19.73
7168.6	-56.33	-45	H	5.08	-39.92	-20.00	19.92
7168.6	-56.87	-46	V	5.08	-40.92	-20.00	20.92
8064.675	-59.41	-48	V	6.17	-41.83	-20.00	21.83

Table 7.4.2-1: Field Strength of Spurious Emissions – 896.06875 MHz – Normal Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1860.225	-54.61	-57	H	5.42	-51.58	-20.00	31.58
1860.225	-54.15	-56	V	5.42	-50.58	-20.00	30.58
2790.3375	-47.95	-46	H	5.77	-40.23	-20.00	20.23
2790.3375	-46.4	-43	V	5.77	-37.23	-20.00	17.23
3720.45	-51.8	-46	H	5.82	-40.18	-20.00	20.18
3720.45	-52.35	-45	V	5.82	-39.18	-20.00	19.18
4650.5625	-45.9	-37	H	6.50	-30.50	-20.00	10.50
4650.5625	-48.33	-40	V	6.50	-33.50	-20.00	13.50
5580.675	-55.72	-44	H	6.06	-37.94	-20.00	17.94
5580.675	-55.04	-43	V	6.06	-36.94	-20.00	16.94
6510.7875	-53.54	-45	H	6.24	-38.76	-20.00	18.76
6510.7875	-54.96	-43	V	6.24	-36.76	-20.00	16.76
7440.9	-55.85	-42	H	5.46	-36.54	-20.00	16.54
7440.9	-56.74	-44	V	5.46	-38.54	-20.00	18.54

Table 7.4.2-2: Field Strength of Spurious Emissions – 930.1125 MHz – mPass Mode

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Generator Level (dBm)	Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBm)	Limit (dBm)	Margin (dB)
1919.925	-51.05	-52.00	H	5.43	-46.57	-20.00	26.57
1919.925	-51.25	-52	V	5.43	-46.57	-20.00	26.57
2879.8875	-48.36	-46	H	5.82	-40.18	-20.00	20.18
2879.8875	-50.57	-47	V	5.82	-41.18	-20.00	21.18
4799.8125	-49.15	-40	H	6.29	-33.71	-20.00	13.71
4799.8125	-53.21	-44	V	6.29	-37.71	-20.00	17.71
5759.775	-56.76	-46	H	6.16	-39.84	-20.00	19.84
5759.775	-58.03	-48	V	6.16	-41.84	-20.00	21.84

Table 7.4.2-3: Field Strength of Spurious Emissions – 959.96250 MHz – mPass Mode

7.5 Frequency Stability - FCC Section 2.1055, 24.135, 90.213, 101.107

7.5.1 Measurement Procedure

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. At a temperature 20º C the supply voltage was varied from 85% to 115% from the normal. The maximum variation of frequency was recorded.

Data was collected at the low and high end of the operating range of the device. Results of the test are shown below in Table 7.5.2-1 through 7.5.2-2.

7.5.2 Measurement Results

Frequency Stability

Frequency (MHz): 901.1125
Deviation Limit (PPM): 1.0ppm

Temperature C	Frequency MHz	Frequency Error (PPM)	Voltage (%)	Voltage (VDC)
-30 C	**901.112795**	**0.327**	100%	12.00
-20 C	**901.112398**	**-0.113**	100%	12.00
-10 C	**901.112605**	**0.117**	100%	12.00
0 C	**901.112649**	**0.165**	100%	12.00
10 C	**901.112574**	**0.082**	100%	12.00
20 C	**901.112340**	**-0.178**	100%	12.00
30 C	**901.112406**	**-0.104**	100%	12.00
40 C	**901.112301**	**-0.221**	100%	12.00
50 C	**901.112272**	**-0.253**	100%	12.00
20 C	**901.112527**	**0.030**	85%	10.20
20 C	**901.112461**	**-0.043**	100%	13.80

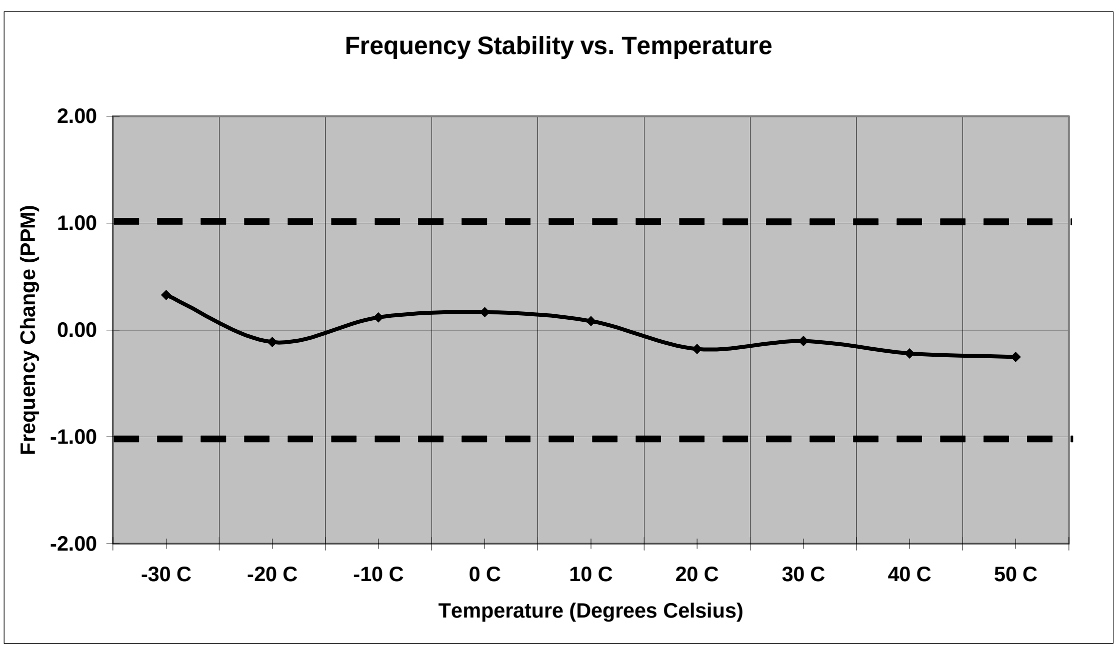

Table 7.5.2-1: Frequency Stability

Frequency Stability

Frequency (MHz): 959.93125
Deviation Limit (PPM): 1.0ppm

Temperature	Frequency	Frequency Error	Voltage	Voltage
C	MHz	(PPM)	(%)	(VDC)
-30 C	**959.931537**	**0.299**	100%	12.00
-20 C	**959.930846**	**-0.421**	100%	12.00
-10 C	**959.931424**	**0.181**	100%	12.00
0 C	**959.931456**	**0.215**	100%	12.00
10 C	**959.931368**	**0.123**	100%	12.00
20 C	**959.931229**	**-0.022**	100%	12.00
30 C	**959.931154**	**-0.100**	100%	12.00
40 C	**959.931059**	**-0.199**	100%	12.00
50 C	**959.931019**	**-0.241**	100%	12.00
20 C	**959.931219**	**-0.032**	85%	10.20
20 C	**959.931143**	**-0.111**	100%	13.80

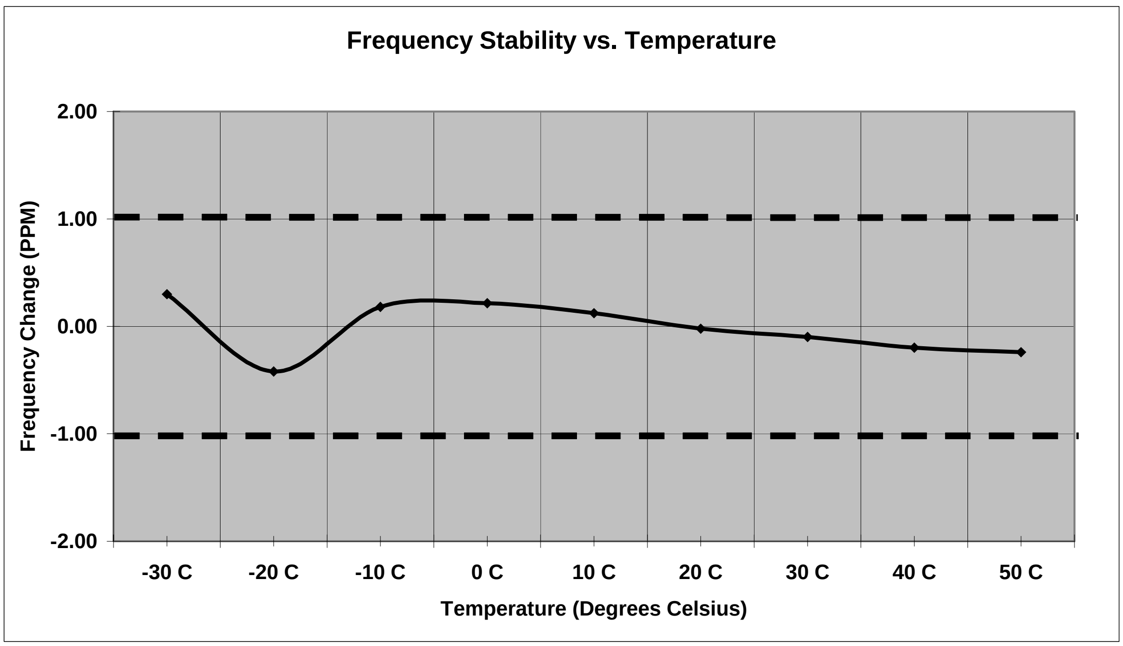

Table 7.5.2-2: Frequency Stability

7.6 Radiated Emissions (Unintentional Radiators) - FCC Section 15.109

7.6.1 Measurement Procedure

The equipment under test is placed on the Open Area Test Site (described in section 2.1) on a wooden table at the turntable center. For each radiated emission, the antenna mast is raised and lowered from one (1) to four (4) meters and the turntable is rotated 360º to obtain a maximum peak reading on the spectrum analyzer. The radiated emissions are then measured using an EMI receiver employing a CISPR quasi-peak detector for frequencies below 1000 MHz and an Average detector function for frequencies above 1000 MHz. This repeated for both horizontal and vertical polarizations of the receive antenna.

The field strength of each radiated emission is calculated by correcting the EMI receiver level for cable loss, amplifier gain, and antenna correction factors.

Field Strength (dBuV/m) = EMI Receiver Level (dBuV) + Cable Loss (dB) – Amplifier Gain (dB) + Antenna Correction Factor (1/m)

Results of the test are shown below in Table 7.6.2-1 and Table 7.6.2-2.

7.6.2 Measurement Results

120 VAC Configuration

Table 7.6.2-1: Radiated Emissions Tabulated Data

Frequency (MHz)	Polarization (H/V)	Height (cm)	Azimuth (deg)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.00	VERTICAL	110	47	11.9	40.0	28.1
42.32	VERTICAL	110	35	4.2	40.0	35.8
85.68	HORIZONTAL	190	77	2.0	40.0	38.0
97.12	VERTICAL	118	13	10.2	43.5	33.3
127.92	HORIZONTAL	189	257	7.5	43.5	36.0
207.36	VERTICAL	229	7	5.9	43.5	37.6
341.36	HORIZONTAL	190	79	11.4	46.0	34.6
484.64	VERTICAL	170	12	17.2	46.0	28.8
642.96	VERTICAL	270	45	20.4	46.0	25.6
955.44	VERTICAL	290	0	25.5	46.0	20.5

240 VAC Configuration

Table 7.6.2-2: Radiated Emissions Tabulated Data

Frequency (MHz)	Polarisation	Height (cm)	Azimuth (deg)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.00	VERTICAL	225	58	13.8	40.0	26.3
96.82	HORIZONTAL	325	324	11.2	43.5	32.3
106.52	HORIZONTAL	375	229	8.6	43.5	34.9
484.82	VERTICAL	206	249	18.0	46.0	28.0
591.52	VERTICAL	391	208	19.5	46.0	26.5
596.91	VERTICAL	375	172	20.0	46.0	26.0
863.12	HORIZONTAL	275	0	23.6	46.0	22.4
929.94	HORIZONTAL	225	49	24.7	46.0	21.3
937.49	HORIZONTAL	333	159	25.0	46.0	21.0
941.80	HORIZONTAL	275	171	25.5	46.0	20.5

7.7 Power Line Conducted Emissions - FCC Section 15.107

7.7.1 Measurement Procedure

Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

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

Results of the test are shown below in and Tables 7.7.2-1 through 7.7.2-12 and Figure 7.7.2-1 through 7.7.2-6

7.7.2 Measurement Results

120 VAC Configuration

Table 7.7.2-1: Line 1 Conducted EMI Results (Quasi-Peak)

Frequency MHz	Level dBμV	Transducer dB	Limit dBμV	Margin dB	Line	PE
0.210	31.5	9.9	63.2	31.6	L1	GND
0.354	30.8	9.9	58.8	28.0	L1	GND
0.546	28.6	9.9	56	27.3	L1	GND
0.846	28.2	10.0	56	27.7	L1	GND
1.512	28.3	10.0	56	27.6	L1	GND
3.216	28.0	10.0	56	27.9	L1	GND
4.536	29.4	10.0	56	26.5	L1	GND
5.982	35.6	10.1	60	24.3	L1	GND
6.096	34.0	10.1	60	25.9	L1	GND
11.154	24.3	10.1	60	35.6	L1	GND

Table 7.7.2-2: Line 1 Conducted EMI Results (Average)

Frequency MHz	Level dBμV	Transducer dB	Limit dBμV	Margin dB	Line	PE
0.210	33.3	9.9	53.2	19.8	L1	GND
0.354	32.0	9.9	48.8	16.7	L1	GND
0.534	26.9	9.9	46	19.0	L1	GND
0.846	29.2	10.0	46	16.7	L1	GND
1.506	25.0	10.0	46	20.9	L1	GND
3.216	24.4	10.0	46	21.5	L1	GND
4.518	26.0	10.0	46	19.9	L1	GND
5.982	32.8	10.1	50	17.1	L1	GND
6.144	32.6	10.1	50	17.3	L1	GND
11.16	23.1	10.1	50	26.9	L1	GND

Table 7.7.2-3: Line 2 Conducted EMI Results (Quasi-Peak)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.282	31.5	9.9	60.7	29.2	L2	GND
0.348	30.4	9.9	59	28.5	L2	GND
0.492	24.3	9.9	56.1	31.7	L2	GND
0.558	17.2	9.9	56	38.7	L2	GND
0.768	27.1	9.9	56	28.8	L2	GND
0.978	27.8	9.9	56	28.1	L2	GND
1.266	21.3	10.0	56	34.7	L2	GND
2.220	11.5	10.0	56	44.4	L2	GND
3.102	7.9	10.0	56	48.0	L2	GND
3.738	17.9	10.0	56	38.0	L2	GND

Table 7.7.2-4: Line 2 Conducted EMI Results (Average)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.282	33.2	9.9	50.7	17.4	L2	GND
0.348	31.6	9.9	49	17.3	L2	GND
0.492	26.3	9.9	46.1	19.7	L2	GND
0.606	10.9	9.9	46	35.0	L2	GND
0.768	27.9	9.9	46	18.0	L2	GND
0.978	28.3	9.9	46	17.6	L2	GND
1.266	22.1	10	46	23.8	L2	GND
2.196	10.2	10	46	35.8	L2	GND
3.102	12.4	10	46	33.5	L2	GND
3.720	11.4	10	46	34.5	L2	GND

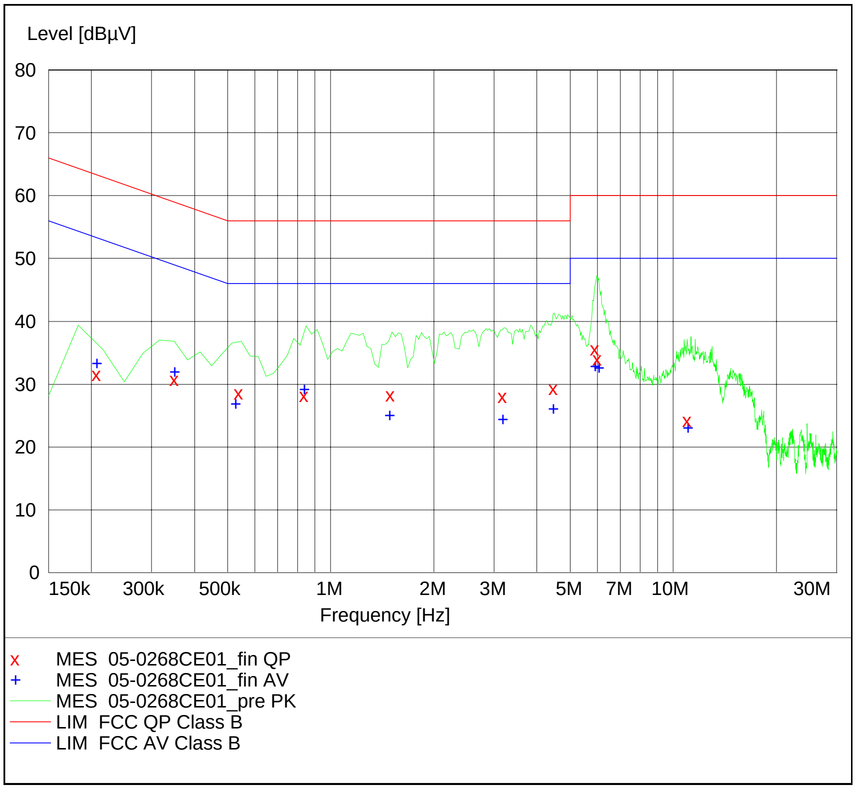

Figure 7.7.2-1: Conducted Emissions Graph – Line 1

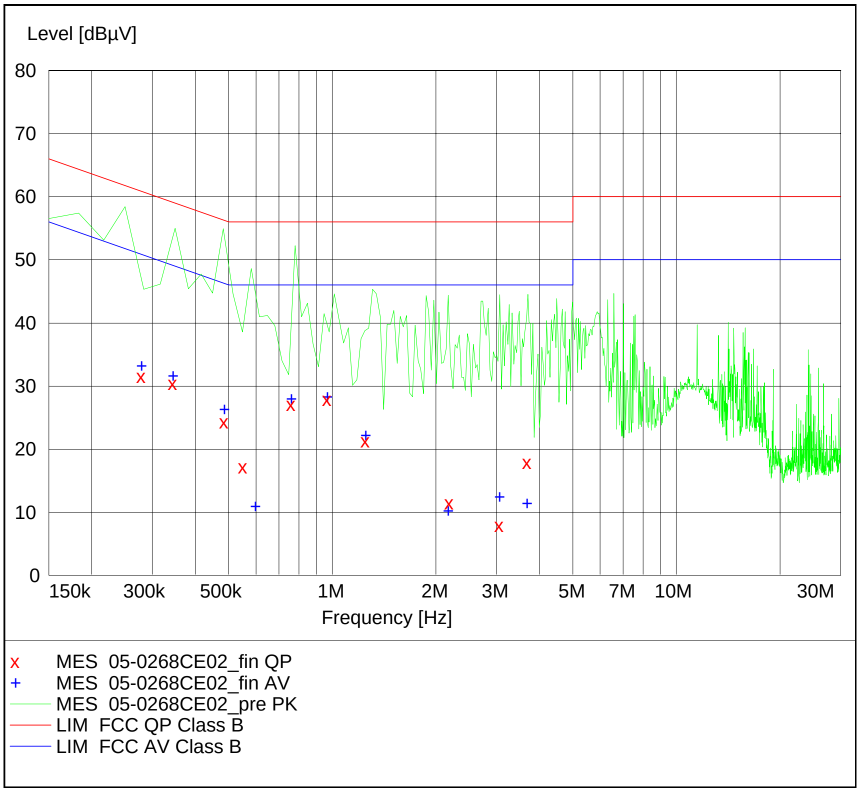

Figure 7.7.2-2: Conducted Emissions Graph – Line 2

240 VAC 3 Phase Configuration

Table 7.7.2-5: Line 1 Conducted EMI Results (Quasi-Peak)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.210	36.7	9.9	63.2	26.4	L1	GND
0.282	35.9	9.9	60.7	24.8	L1	GND
0.492	29.3	9.9	56.1	26.8	L1	GND
0.762	26.0	9.9	56	29.9	L1	GND
1.416	20.9	10.0	56	35.0	L1	GND
13.206	14.9	10.2	60	45.0	L1	GND
13.986	16.2	10.2	60	43.7	L1	GND
14.184	16.2	10.2	60	43.7	L1	GND
14.352	16.4	10.2	60	43.5	L1	GND
14.892	14.6	10.2	60	45.3	L1	GND

Table 7.7.2-6: Line 1 Conducted EMI Results (Average)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.210	36.8	9.9	53.2	16.3	L1	GND
0.282	35.4	9.9	50.7	15.3	L1	GND
0.498	29.1	9.9	46	16.9	L1	GND
0.786	26.1	10.0	46	19.8	L1	GND
1.362	21.2	10.0	46	24.7	L1	GND
13.182	15.7	10.2	50	34.2	L1	GND
13.800	17.3	10.2	50	32.6	L1	GND
14.262	17.3	10.2	50	32.6	L1	GND
14.394	17.1	10.2	50	32.8	L1	GND
15.078	15.3	10.2	50	34.6	L1	GND

Table 7.7.2-7: Line 2 Conducted EMI Results (Quasi-Peak)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.426	14.6	9.9	57.3	42.6	L2	GND
0.642	13.1	9.9	56	42.8	L2	GND
1.146	16.7	10.0	56	39.2	L2	GND
2.076	17.2	10.0	56	38.7	L2	GND
2.142	16.8	10.0	56	39.1	L2	GND
3.726	14.6	10.0	56	41.3	L2	GND
6.150	10.6	10.1	60	49.3	L2	GND
12.846	22.0	10.2	60	37.9	L2	GND
17.586	13.5	10.2	60	46.5	L2	GND
25.002	3.8	10.4	60	56.1	L2	GND

Table 7.7.2-8: Line 2 Conducted EMI Results (Average)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.420	15.1	9.9	47.4	32.3	L2	GND
0.642	15.6	9.9	46	30.3	L2	GND
1.104	13.9	10.0	46	32.0	L2	GND
2.058	14.7	10.0	46	31.2	L2	GND
2.118	15.2	10.0	46	30.7	L2	GND
3.786	13.8	10.0	46	32.1	L2	GND
6.144	12.2	10.1	50	37.7	L2	GND
12.780	22.0	10.2	50	27.9	L2	GND
17.604	14.6	10.2	50	35.3	L2	GND
25.002	9.5	10.4	50	40.4	L2	GND

Table 7.7.2-9: Line 3 Conducted EMI Results (Quasi-Peak)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.282	15.6	9.9	60.7	45.1	L3	GND
0.426	15.1	9.9	57.3	42.1	L3	GND
0.576	14.6	9.9	56	41.3	L3	GND
0.852	15.4	10.0	56	40.5	L3	GND
1.788	15.7	10.0	56	40.2	L3	GND
3.060	13.4	10.0	56	42.5	L3	GND
4.320	10.2	10.0	56	45.7	L3	GND
11.982	19.0	10.2	60	40.9	L3	GND
17.490	13.8	10.2	60	46.1	L3	GND
24.570	16.3	10.4	60	43.6	L3	GND

Table 7.7.2-10: Line 3 Conducted EMI Results (Average)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.282	17.1	9.9	50.7	33.6	L3	GND
0.426	15.8	9.9	47.3	31.4	L3	GND
0.576	16.3	9.9	46	29.7	L3	GND
0.852	16.1	10.0	46	29.8	L3	GND
1.776	15.0	10.0	46	31.0	L3	GND
3.078	12.7	10.0	46	33.2	L3	GND
4.368	12.4	10.0	46	33.5	L3	GND
12.072	19.0	10.2	50	30.9	L3	GND
17.580	15.4	10.2	50	34.5	L3	GND
24.570	18.4	10.4	50	31.6	L3	GND

Table 7.7.2-11: Neutral Line Conducted EMI Results (Quasi-Peak)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.210	39.7	9.9	63.2	23.4	N	GND
0.426	36.0	9.9	57.3	21.2	N	GND
0.498	36.0	9.9	56	19.9	N	GND
0.852	33.0	10.0	56	22.9	N	GND
1.422	32.5	10.0	56	23.5	N	GND
2.094	29.7	10.0	56	26.2	N	GND
3.648	24.6	10.0	56	31.3	N	GND
6.144	21.3	10.1	60	38.6	N	GND
13.014	22.0	10.2	60	37.9	N	GND
24.576	22.5	10.4	60	37.4	N	GND

Table 7.7.2-12: Neutral Line Conducted EMI Results (Average)

Frequency MHz	Level dBµV	Transducer dB	Limit dBµV	Margin dB	Line	PE
0.210	40.5	9.9	53.2	12.7	N	GND
0.426	35.6	9.9	47.3	11.6	N	GND
0.498	34.6	9.9	46	11.4	N	GND
0.852	32.1	10.0	46	13.8	N	GND
1.422	29.7	10.0	46	16.2	N	GND
2.124	26.0	10.0	46	19.9	N	GND
3.636	20.9	10.0	46	25.0	N	GND
6.144	21.1	10.1	50	28.8	N	GND
12.888	22.0	10.2	50	27.9	N	GND
24.576	25.0	10.4	50	25.0	N	GND

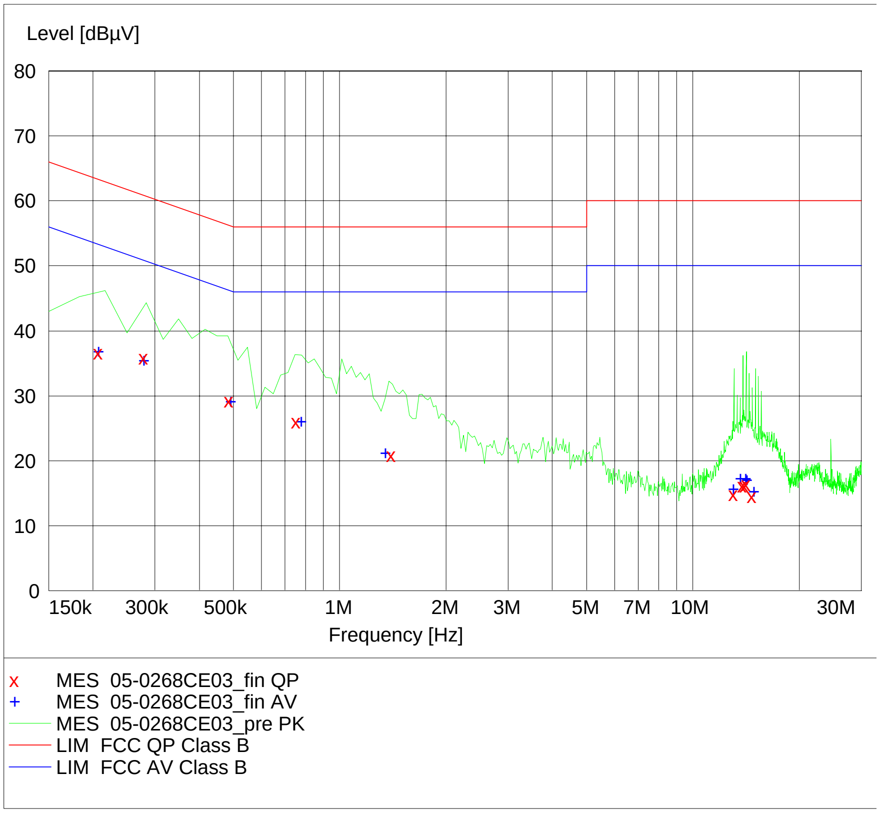

Figure 7.7.2-3: Conducted Emissions Graph – Line 1

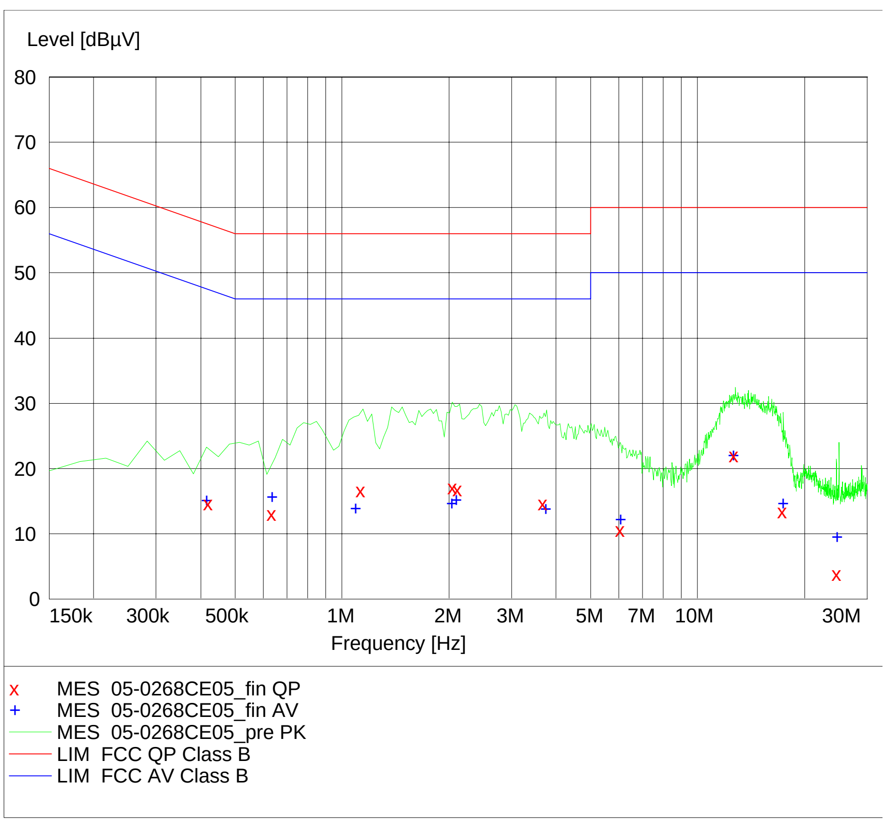

Figure 7.7.2-4: Conducted Emissions Graph – Line 2

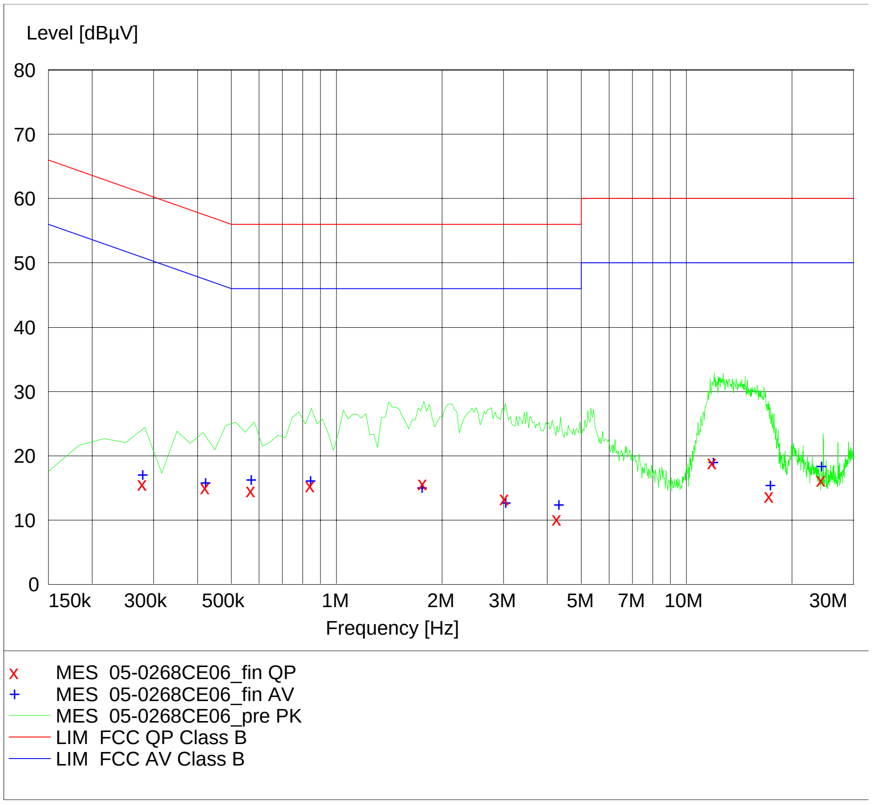

Figure 7.7.2-5: Conducted Emissions Graph – Line 3

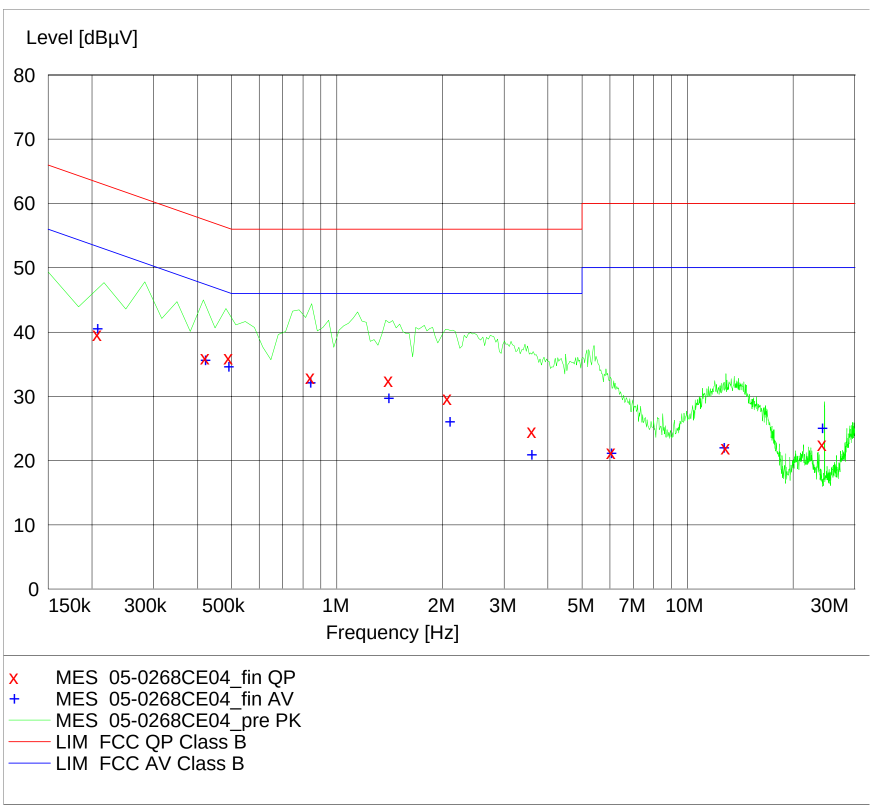

Figure 7.7.2-6: Conducted Emissions Graph – Neutral Line

End Report