International Compliance Laboratories

FCC Part 15 Subpart C
Transmitter Certification Test Report

ICL Report # 2775 Rev3
FCC ID: 2A3P5HIFIS1

Test Specification: FCC Rule Part: 15.247

Manufacturer: SMT Engineering, LLC
Model Name: High Impedance Fault Isolator
Model Number: HIFIS
Serial Number: ASM-0718-06-R03-02

Test Start Date: 12/7/2021
Test End Date: 6/17/2022

Report Issue Date: 2/8/2022
Report Revision Date: 6/21/2022

Test Result: Meets Requirements

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Reviewed By:

Ronald W. Zimmerman
ICL President and NCE

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1.0 Purpose

The purpose of this report is to demonstrate compliance with FCC CFR Title 47, Part 15, Subpart C.

This Report revises and replaces ICL Report #2775 Rev2. The following revisions were made:

- Section 19: Added receiver disabled test data. Updated test data for the receiver enabled portion for direct comparison to the receiver disabled test data.

2.0 Summary of Testing

Test Description	Regulation	Result
Antenna Requirement	FCC CFR 47 Part 15.203 FCC CFR 47 Part 15.247(b)	MEETs Requirement
DTS Bandwidth	FCC CFR 47 Part 15.247(a)(2)	MEETs Requirement
Occupied Bandwidth	FCC CFR 47 Part 15.247(b)(3) ANSI C63.10 Section 11.9.2	No Requirement, Record only
Maximum Conducted (average) Output Power	FCC CFR 47 Part 15.247(b)(3)	MEETs Requirements
Power Spectral Density	FCC CFR 47 Part 15.247(e)	MEETs Requirement
Band Edge	FCC CFR 47 Part 15.215(c) FCC CFR 47 Part 15.247(d)	MEETs Requirements
Antenna Port Conducted Emissions	FCC CFR 47 Part 15.247(d)	MEETs Requirement
Emissions in Restricted Frequency Bands (Radiated Emissions)	FCC CFR 47 Part 15.209 FCC CFR 47 Part 15.247(d)	MEETs Requirement (with Modification)[1]
Unintentional Radiator Radiated Emissions (Receiver Mode)	FCC CFR 47 Part 15.109	MEETs Requirement
AC Power Line Conducted Emissions (Intentional Radiator)	FCC CFR 47 Part 15.207(a)	MEETs Requirement
AC Power Line Conducted Emissions (Receiver Mode)	FCC CFR 47 Part 15.107	MEETs Requirement
Fundamental Power with Line Voltage Variation	FCC CFR 47 Part 15.31(e)	MEETs Requirement
Maximum Permissible Exposure	FCC CFR 47 Part 15.247(i) FCC CFR 47 Part 1.1307	MEETs Requirement

Table 2-1 – Summary of Testing

[1] Modifications made to the EUT were implemented exclusively for meeting restricted band radiated emissions requirements. However, modifications implemented for radiated emissions were present for all testing covered by this report. See section 4.17 for details.

3.0 Reference Documents

US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart B: *Radio Frequency Devices, Unintentional Radiators*

US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: *Radio Frequency Devices, Intentional Radiators*

US Code of Federal Regulations (CFR): Title 47, Part 1, Subpart I: *Procedures Implementing the National Environmental Policy Act of 1969*

ANSI C63.4-2014: *American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9kHz to 40GHz*

ANSI C63.10-2013: *American National Standard for Methods of Measurement of Procedures for Compliance Testing of Unlicensed Wireless Devices*

4.0 General Information

4.1 EUT FCC-ID

2A3P5HIFIS1

4.2 EUT Product Name

High Impedance Fault Isolator

4.3 EUT Model Number

HIFIS1

4.4 EUT Description

The High Impedance Fault Isolation System (HIFIS) is intended to prevent catastrophic events related to downed overhead high voltage primary power lines, by deenergizing downed power lines that have insufficient fault current to operate overcurrent systems, under high impedance fault conditions.

4.5 EUT Serial Number

ASM-0718-06-R03-02

4.6 EUT Printed Circuit Board Information (Main PCB)

The main PCB was etched with the PCB number/assembly number ASM-0718-06-R03. Additionally, a label was placed on the silk-screened marked area “Label 1” with the serial/assembly number ASM-0718-06-R03-02.

Firmware Version: 1.02.03.

4.7 EUT Transmitter Device Type

DTS, Fixed

4.8 EUT Transmitter Peak Power

19 dBm (0.0794 Watts)

4.9 EUT Transmitter Frequency of Operation

The full transmitter range of operation is 9 discrete channels (channel 1 through 9) from 908 to 924 MHz.

4.10 Other EUT Internal Frequencies

PWM Controller: 90 kHz, Buck switching regulator: 1 to 2.25 MHz, Crystal: 16 MHz, Low frequency crystal/tuning fork: 32.768 kHz, Band Crystal: 38.4 MHz

4.11 EUT Transmitter Modulation

2FSK, 90 kHz deviation

4.12 EUT Power Source

The EUT was powered by 120V 60Hz AC line.

EUT Nominal Voltage: 120V, EUT Specified voltage range: 70 to 126V ac

4.13 EUT Transmitter Modules

The EUT was submitted with 6 transmitter modules for testing. The transmitter modules were identical to one another and representative of final production. The modules were configured for 3 different frequencies/channels, with each channel configured for 2 different duty cycles.[2] The EUT channel and duty cycle setting were set as needed throughout testing by changing the transmitter module.

Transmitter Module Frequency & Duty Cycle Configurations			
Module Serial Number	**Channel / Frequency**	**Duty Cycle**	**Firmware**
ASM-0718-07-R02-07	1 / 908 MHz	80%	3.06.01
ASM-0718-07-R02-04	5 / 916 MHz	80%	3.06.01
ASM-0718-07-R02-04	9 / 924 MHz	80%	3.06.01
ASM-0718-07-R02-05	1 / 908 MHz	3%	3.06.01
ASM-0718-07-R02-03	5 / 916 MHz	3%	3.06.01
ASM-0718-07-R01-52	9 / 924 MHz	3%	3.06.01

Table 4-1 - Transmitter module configurations

4.14 EUT Antenna Connector

N-Type

[2] See section 10.0 for more information regarding duty cycle.

4.15 EUT Antennas

Two antennas were submitted with the EUT. Both antennas are manufactured by L-Com:

- HGV-906U (6 dBi gain)
- HGV-903U (3 dBi gain)

Both antennas are N-Type, omnidirectional, vertical polarity antennas with identical radiation patterns. Therefore, for testing covered by this report, the HGV-906U antenna was used for all emissions testing where antenna installation was required.

See the antenna data sheets in the accompanying exhibits for more information.

4.16 Selected Test Frequencies

Low Channel: 908 MHz, Middle Channel: 916 MHz, High Channel: 924 MHz

4.17 Test Conditions

Temperature: 21 – 23 ºC, Relative Humidity: 14 – 27 %RH, Air Pressure: 96 – 99 kPa

5.0 Modifications

Modifications were made during testing at International Compliance Laboratories, LLC. (ICL) during radiated emissions testing. These modifications were necessary for the EUT to meet requirements. It should be noted that while the modifications shown here were exclusively for the purpose of meeting radiated emissions testing requirements, all modifications listed below were present for all testing covered by this report. Photos of the modifications are included in a separate exhibit.

1. Fair-Rite 0431164181 (2631102002 solid core equivalent) ferrite added to AC power input harness (all 3 conductors, double passthrough). Ferrite position right at the point of enclosure entry.

2. Fair-Rite 0431164281 (2631540002 solid core equivalent) ferrite added to added to each LED annunciator harness. A single ferrite clamped on both LED wires in a single passthrough configuration. Ferrite was position closest to the PCB connector end of the LED harness.

6.0 Auxiliary Equipment

No auxiliary equipment was needed for EUT operation.

7.0 Customer Information

Electrical Materials Co.
145 Elizabeth Lane,
Genoa City, WI 53128

Contact: Timothy J. O'Regan
Phone: 262-279-3812
Email: tim@rvpedestal.com

8.0 Test Facilities

8.1 Location

The test site used for all testing covered by this report is located at the following address:

International Compliance Laboratories, LLC
1057 Tullar Court
Neenah, WI 54956
Phone: (920) 720-5555
Fax: (920) 720-5556

8.2 Laboratory Accreditations

Accredited Laboratory

A2LA has accredited

INTERNATIONAL COMPLIANCE LABORATORIES, LLC

Neenah, WI

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 29th day of January 2021.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2599.01
Valid to April 30, 2022

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

INTERNATIONAL COMPLIANCE LABORATORIES, LLC
1057 Tullar Court
Neenah, WI 54956
Ronald W. Zimmerman Phone: 920 720 5555

ELECTRICAL (EMC)

Valid to: April 30, 2022 Certificate Number: 2599.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following electromagnetic compatibility and product safety tests:

Test Technology:	Test Method(s) [1]:
Emissions	
RF (Radiated and Conducted) (*up to 26 GHz*)	CFR 47 FCC, Part 15B (using ANSI C63.4:2014); CFR 47 FCC, Part 15C (using ANSI C63.10:2013); CFR 47 FCC, Part 18 (using MP-5:1986); CISPR 11; EN 55011; CISPR 14-1; EN 55014-1; CISPR 15 (*clause 8 only*); EN 55015 (*clause 8 only*); CISPR 22; EN 55022; CISPR 32; EN 55032; ICES-001; ICES-003
Harmonic Current Emissions	IEC 61000-3-2; EN 61000-3-2
Voltage Fluctuations and Flicker	IEC 61000-3-3; EN 61000-3-3
Immunity	
Electrostatic Discharge (ESD)	IEC 61000-4-2
Radiated Immunity	IEC 61000-4-3 (*up to 2.7 GHz & 10V/m*)
Electrical Fast Transients (EFT)/Burst	IEC 61000-4-4; IEC 61000-4-4:2004
Electrical Surge	IEC 61000-4-5; IEC 61000-1-3:2005
Conducted Immunity	IEC 61000-4-6; IEC 61000-4-6:2008
Power Frequency and Magnetic Field	IEC 61000-4-8 (*excluding short duration mode*)
Voltage Dip, Interruptions, and Variations	IEC 61000-4-11

Test Technology:	**Test Method(s) [1]:**
Generic and Product Specific EMC Standards	
Generic Immunity Residential	IEC 61000-6-1; EN 61000-6-1
Generic Immunity Industrial	IEC 61000-6-2; EN 61000-6-2
Generic Emissions Residential	IEC 61000-6-3 (*up to 16A*); EN 61000-6-3 (*up to 16A*)
Generic Emissions Industrial	IEC 61000-6-4; EN 61000-6-4
Laboratory Equipment	IEC 61326-1; EN 61326-1 (*up to 16A*)
Medical Equipment	IEC 60601-1-2:2001; IEC 60601-1-2:2007; IEC 60601-1-2
Information Technology Equipment	CISPR 24; EN 55024 (*excluding Annex A, CISPR 20*)
Household Appliances and Similar	CISPR 14-2; EN 55014-2 (*excluding IEC 61000-4-22*)
Industry Canada Radio Tests	RSS-GEN; RSS-210 (*up to 26 GHz*)
Automotive Component EMC	
Emissions	CISPR 25; SAE J1113-41
Bulk Current Injection (BCI)	SAE J1113-4; ISO 11452-4
Electrostatic Discharge (ESD)	SAE J1113-13; ISO 10605
Radiated RF Immunity	SAE J1113-21; ISO 11452-2
Electrical Transients	SAE J1113-11; ISO 7637-2; ISO 16750-2 (sections 4.4, 4.6.3, & 4.6.4)
Harley Davidson Component EMC	
Engineering Guideline	EG-812-22614
United Nations UNECE	
Emissions	E/ECE/324 Addendum 9: Regulation 10, Annexes 7 and 8
Immunity	E/ECE/324 Addendum 9: Regulation 10, Annex 9 (*except Appendix 2*)

On the following products or types of products:
Light Industrial, Commercial, Residential, Heavy Industrial, Scientific, Medical, Portable Test and Measurement Equipment, Information Technology Equipment, Telecom, Automotive, and other Electrical and Electronic Equipment

[2]When the date, edition, version, etc. is not identified in the scope of accreditation, laboratories may use the version that immediately precedes the current version for a period of one year from the date of publication of the standard measurement method, per part C., Section 1 of A2LA *R101 - General Requirements-Accreditation of ISO-IEC 17025 Laboratories.*

Testing Activities Performed in Support of FCC Certification in Accordance with 47 Code of Federal Regulations and FCC KDB 974614, Appendix A, Table A.1 [2]:

Rule Subpart/Technology	Test Method	Maximum Frequency (MHz)
Unintentional Radiators Part 15B	ANSI C63.4:2014	26000
Industrial, Scientific, and Medical Equipment Part 18	FCC MP-5 (February 1986)	26000
Intentional Radiators Part 15C	ANSI C63.10:2013	26000

[2]Accreditation does not imply acceptance to the FCC equipment authorization program. Please see the FCC website (https://apps.fcc.gov/oetcf/eas/) for a listing of FCC approved laboratories.

9.0 Test Equipment List

Calibrated Equipment List						
ICL No.	Manufacturer	Equipment Type	Model	Serial	Last Calibrated	Cal Interval
1001	HP	EMI Receiver	8546A	3746A00414	4/21/2021	1 year
1017	Agilent/HP	RF Filter Section	85460A	3704A00360	4/21/2021	1 year
1029	ETS Rayproof	EMC Chamber	Series 81	n/a	n/a[a]	n/a
1052	EMCO	Biconilog Antenna	3141	9706-1052	4/8/2020	3 year
1162	Rohde & Schwarz	EMI Test Receiver	ESIB 26	100040	8/16/2021	1 year
1169	Agilent/HP	Preamplifier	8449B	3008A00151	12/12/2019	3 year
1179	Pasternack	Low Noise Preamplifier	PE1524	0081	12/12/2019	3 year
1180	Micro-Tronics	High Pass Filter	HPM50111	041	n/a[b]	n/a
1189	EMCO	Horn Antenna	3115	6217	3/4/2020	3 year
1217	Com-Power	Loop Antenna	AL-130	121016	5/6/2020	3 year
1247	Com-Power	LISN	LIN-115	241118	6/8/2020	2 year
1312	Micro-Tronics	High Pass Filter	HPM50108	G251	n/a[b]	n/a
1321	Mini-Circuits	Attenuator	UNAT-5+	n/a	n/a[b]	n/a
1322	Mini-Circuits	Attenuator	UNAT-5+	n/a	n/a[b]	n/a
1356	Keysight	EMI Receiver	N9038A	MY55330009	6/29/2021	1 year
1446	Pasternack	Attenuator	PE7087-3	n/a	n/a[b]	n/a
1447	Pasternack	Attenuator	PE7087-3	n/a	n/a[a]	n/a
1436	Braden Shielding	EMC Chamber	5 Meter	A67631	n/a[b]	n/a
1360	Pacific Power	AC Power Source	360-AMX	1648	12/9/2021	1 year
1431	Rohde & Schwarz	EMI Receiver	ESIB 40	100047	11/17/2021	1 year

[a] Verified in a calibrated system by ICL during NSA process and checked by A2LA during ISO 17025 laboratory assessment. Refer to A2LA accreditation in section 8.2.

[b] Correction factors charted and verified in a NIST traceable calibration system prior to use.

Table 9-1 – List of Test Equipment

10.0 Duty Cycle Plots

10.1 Conducted Antenna Port Measurement Duty Cycle Plots

Note: These duty cycle screen captures are for reference only. Where applicable, antenna port conducted RF measurements were captured using ANSI C63.10 AVGSA-1 and AVGPSD-1 methods utilizing sweep triggering. Therefore, no duty cycle corrections were applied to the conducted antenna port measurements provided in this report. See the applicable measurement section regarding test method and more information.

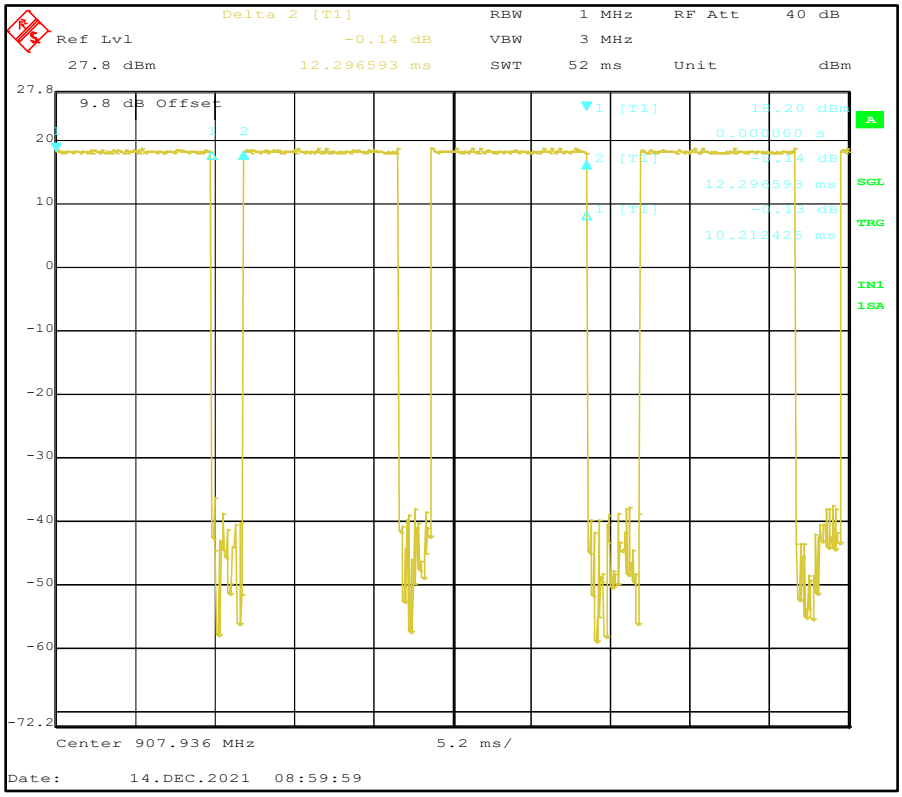


Figure 10-1 - Duty Cycle, Low Channel

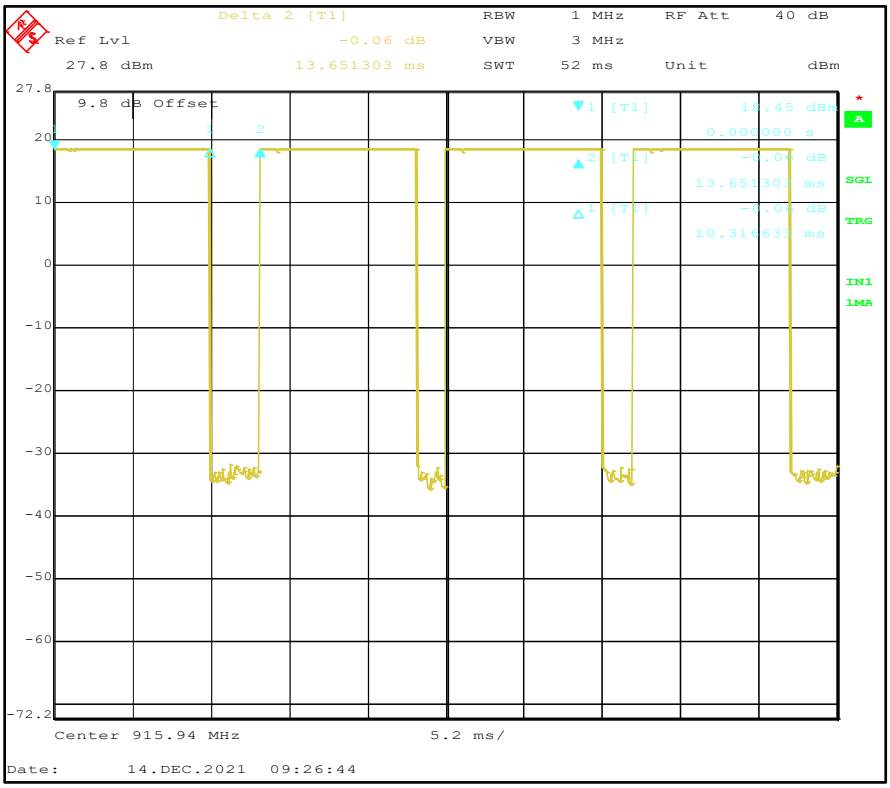


Figure 10-2 - Duty Cycle, Middle Channel

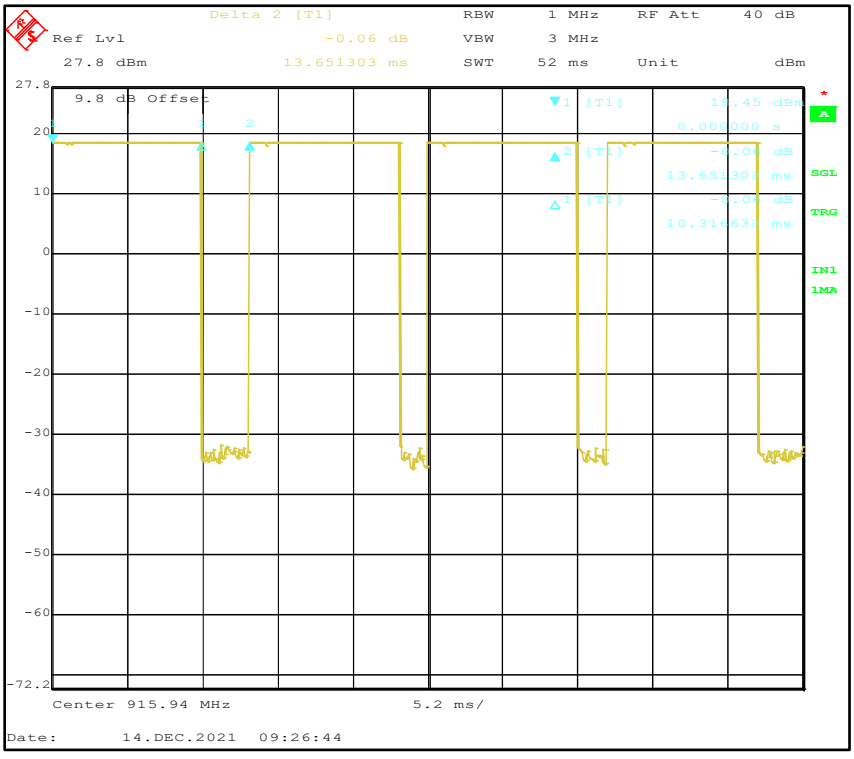


Figure 10-3 - Duty Cycle, High Channel

10.2 Emissions Duty Cycle Plots

Note: These duty cycle plots reflect the maximum supported (worst case scenario) duty cycle for normal EUT transmitter operation. This duty cycle was used for all radiated and conducted AC line emissions testing. When the transmitter was programmed for the maximum achievable duty cycle (~80%), the load would drive emissions, generated by the EUT digital electronics, over the limit in the restricted frequency bands. Given this was an unrealistic representation of end use, worst case operational duty cycle was applied for all emissions testing. The duty cycle configuration is locked out from end use and cannot be field configured.

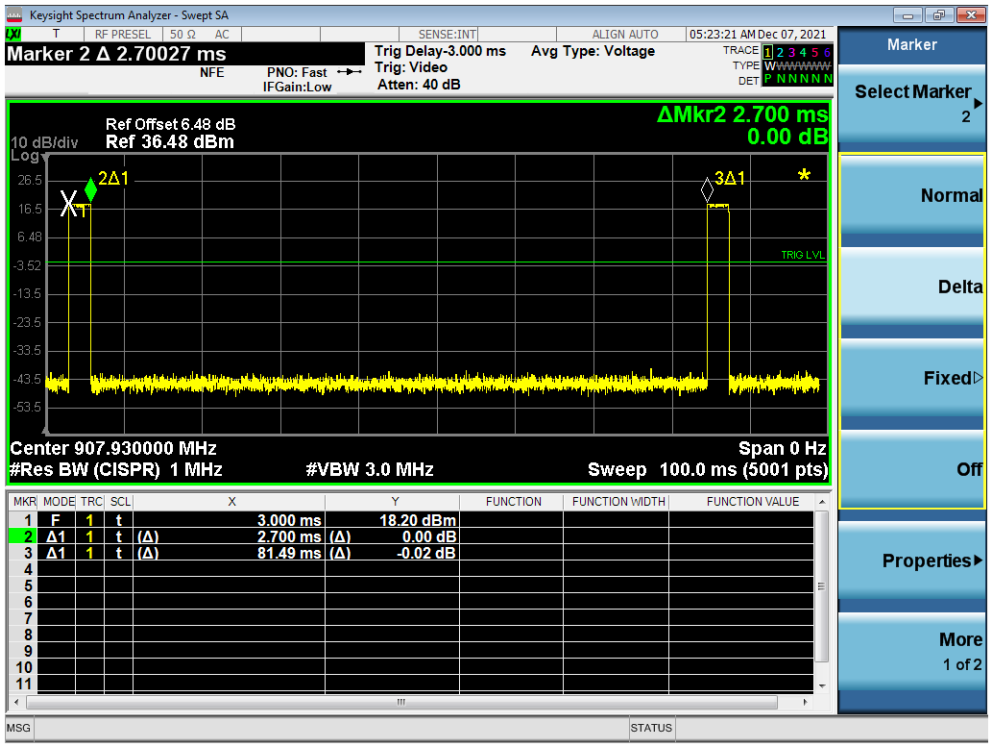


Figure 10-4 - Duty Cycle, Low Channel

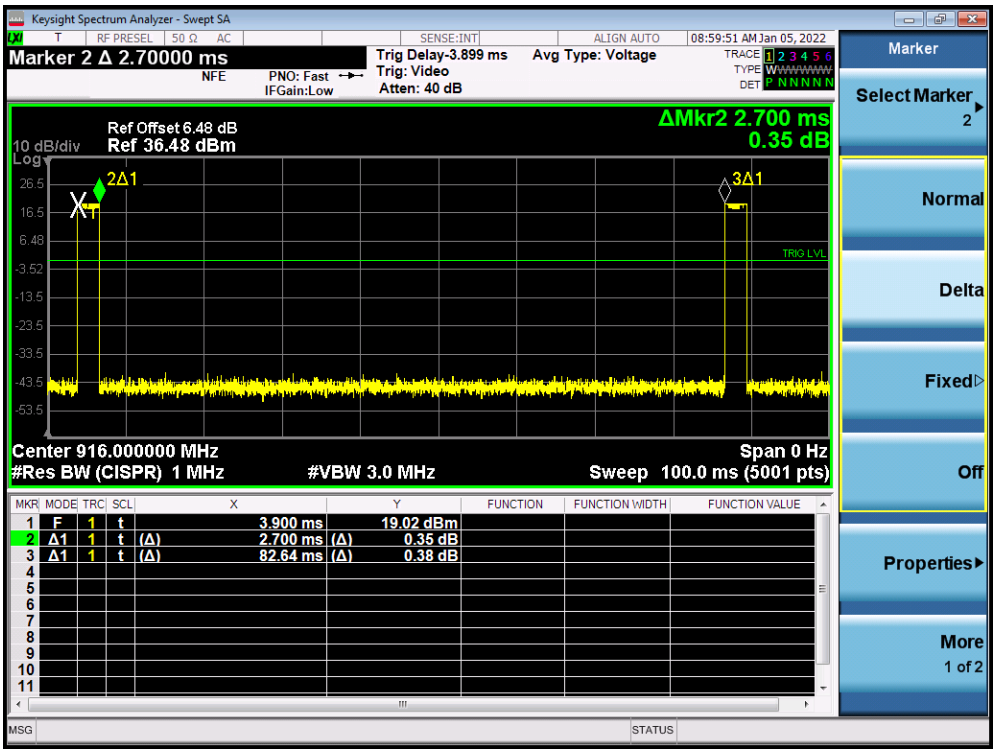


Figure 10-5 - Duty Cycle, Middle Channel

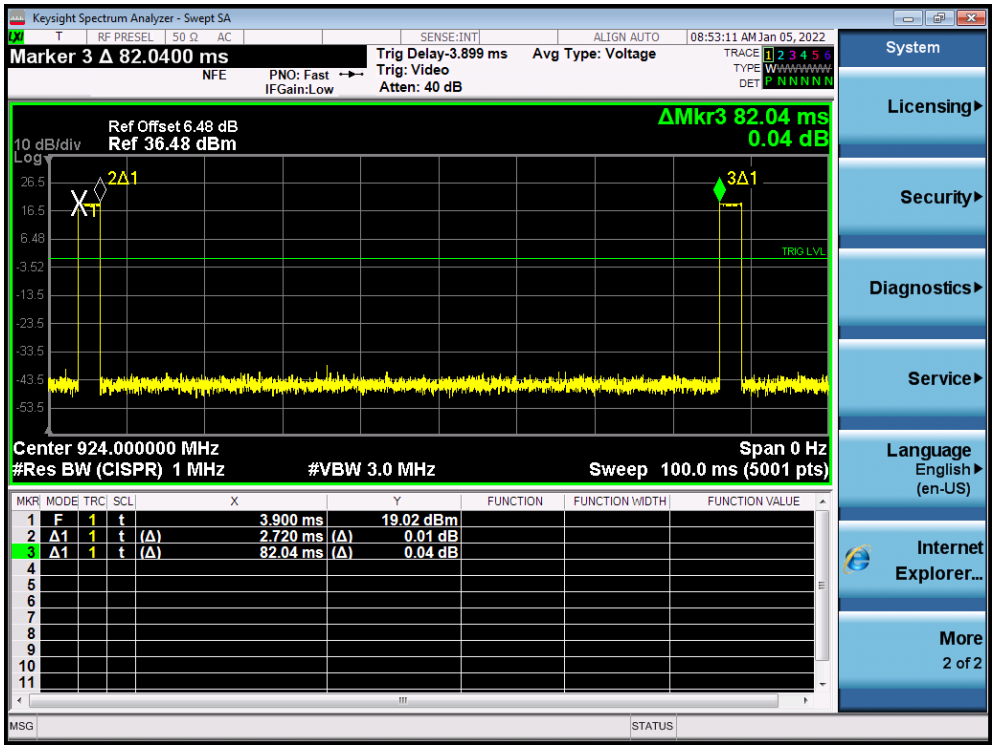


Figure 10-6 - Duty Cycle, High Channel

11.0 Antenna Requirement

11.1 Regulation

FCC CFR 47 Part 15.203 and 15.247(b)

11.2 Requirement

An intentional radiator shall be designed to ensure that no antenna other that furnished by the responsible party shall be used with the device. The use of permanently attached antennas or antennas with unique coupling to the intentional radiator shall be considered sufficient. The manufacture may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed.

Additionally, transmitting antennas of directional gain greater than 6dBi, the transmitter power shall be reduced by the amount of dB that the directional gain of the antenna exceeds 6dBi.

11.3 Evaluation

The EUT application was evaluated to determine compliance to part 15.203. The EUT employs a standard N-type connection for the antenna. However, the customer has attested that the EUT must be professionally installed and that the EUT is not a commercially available device. A letter of attestation describing the specific nature of the professional installation can be found in the exhibits accompanying this report.

The maximum antenna gain from the antennas for which the EUT is intended to operate with is 6dBi meeting the requirements of 15.247(b) without the need to reduce transmitter output power.

11.4 Results

Meets Requirements

12.0 DTS Bandwidth

12.1 Regulation

FCC CFR 47 Part 15.247(a)(2)

12.2 Requirement

Systems using digital modulation in the 902-928 MHz band, the minimum 6 dB bandwidth shall be at least 500 kHz

12.3 Setup

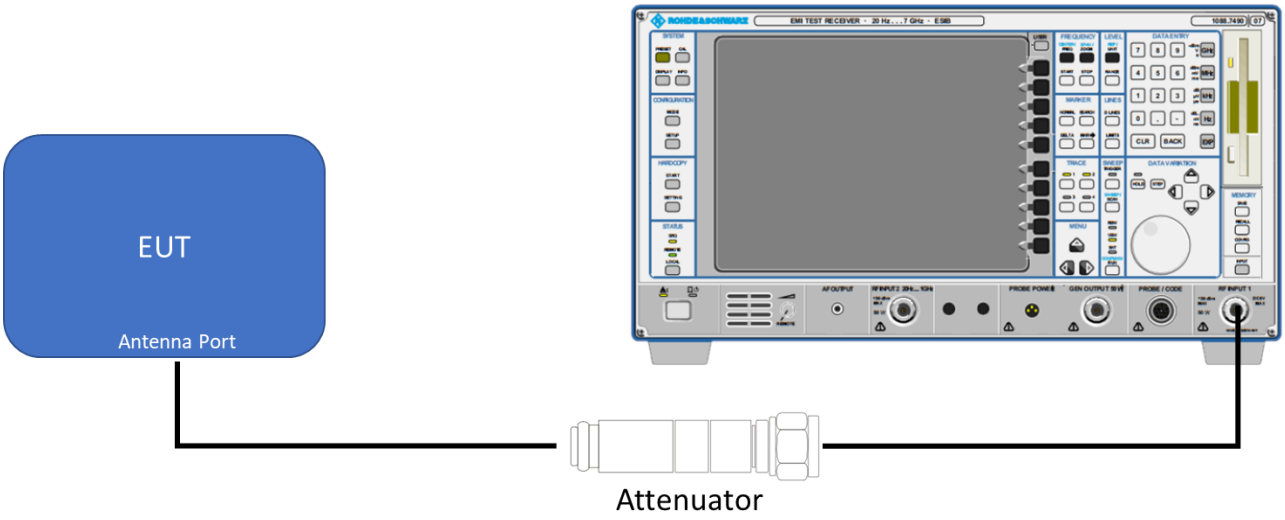


Figure 12-1 - DTS Bandwidth Setup

12.4 Test Method

ANSI C63.10-2013, Clause 11.8.2 (Option 2)

The automatic bandwidth method of the analyzer was used with the “n dB down” points set to 6 dB. It was observed that intermediate power nulls were not impeding the automatic measurement feature of the analyzer.

The cable and attenuator(s) total loss were calculated and programed into the analyzer’s reference level offset feature. The following screen captures reflect the actual EUT output amplitude at the time of measurement.

12.5 Results

Frequency/Channel (MHz)	Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
908	530	≥ 500	30	Meets Requirement
916	530	≥ 500	30	Meets Requirement
924	526	≥ 500	26	Meets Requirement

Table 12-1 - DTS Bandwidth Results

12.6 Plots

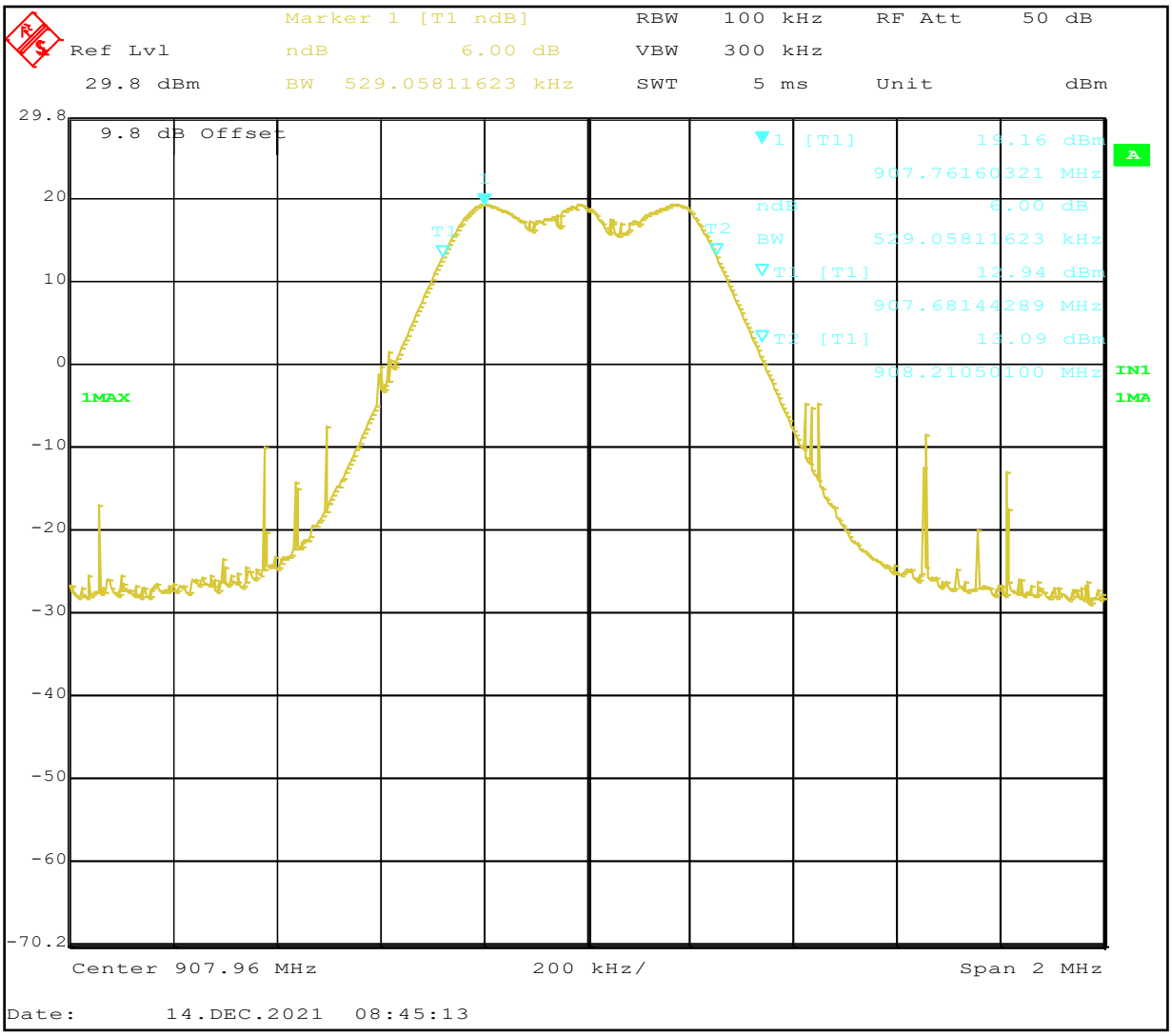


Figure 12-2 - DTS Bandwidth, Low Channel

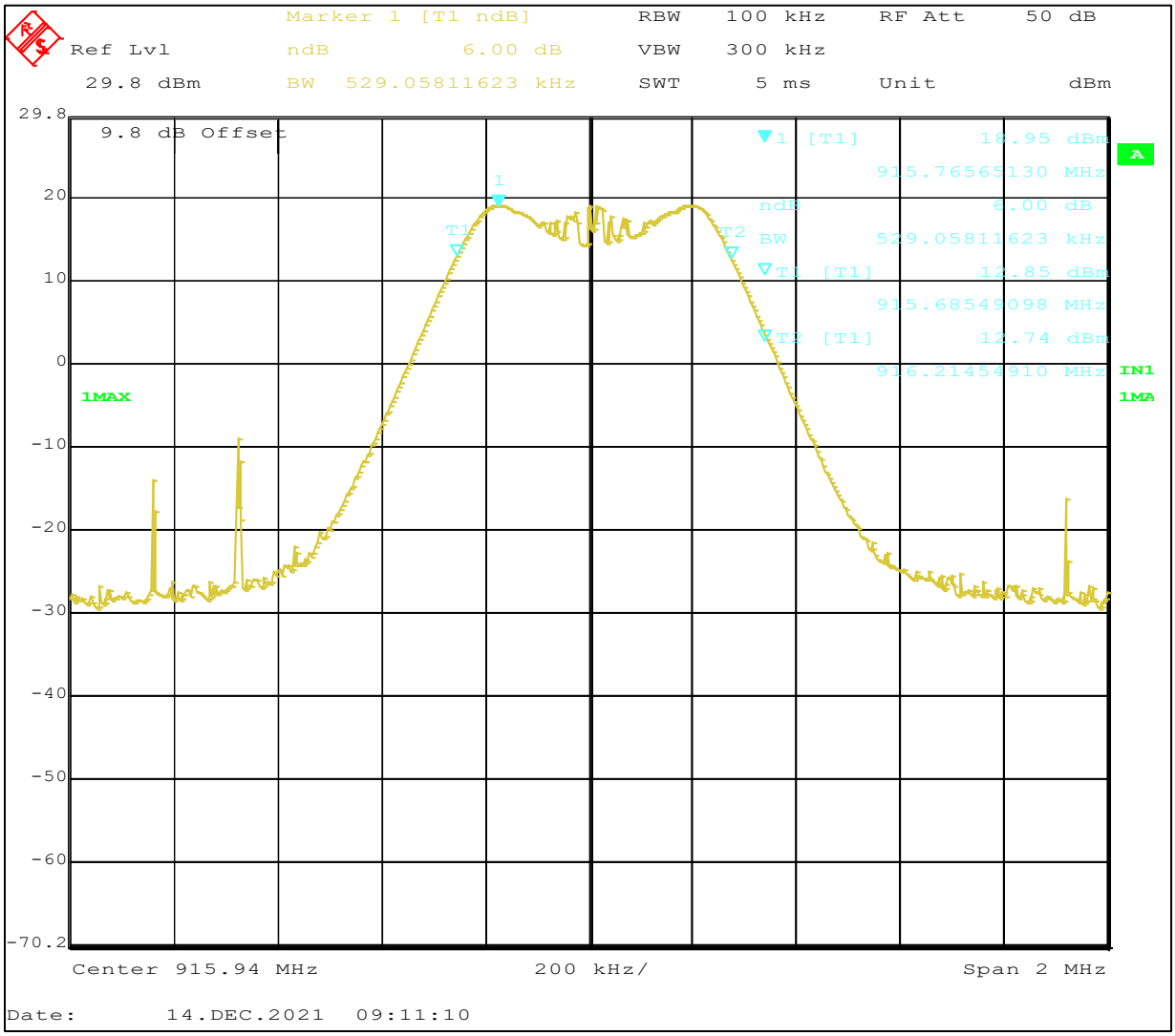


Figure 12-3 - DTS Bandwidth, Middle Channel

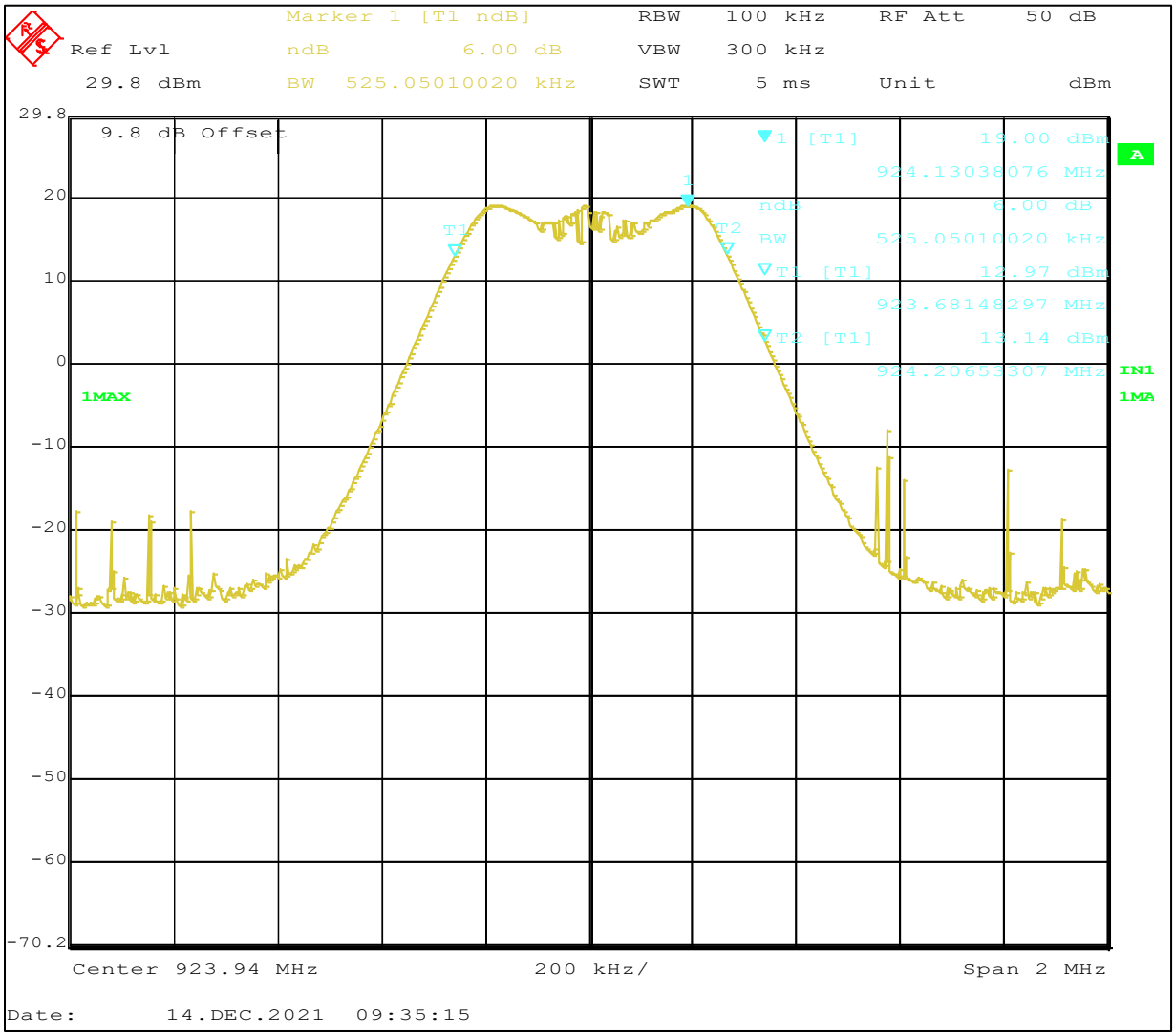


Figure 12-4 - DTS Bandwidth, High Channel

13.0 Occupied Bandwidth (OBW)

13.1 Regulation

FCC CFR 47 Part 15.247(b)(3) and ANSI C63.10 Clause 11.9.2

13.2 Requirement

When maximum conducted (average) output power measurement is used to determine compliance to the limit, the power is to be referenced to the OBW.

13.3 Setup

Refer to Figure 12-1 - DTS Bandwidth Setup for a diagram of the test setup.

13.4 Test Method

ANSI C63.10 Clause 6.9.3 (Power Bandwidth (99%) measurement procedure)

The analyzer's 99% power bandwidth measurement function was used to facilitate the measurement.

The cable and attenuator(s) total loss were calculated and programed into the analyzer's reference level offset feature. The following screen captures reflect the actual EUT output amplitude at the time of measurement.

13.5 Results

Frequency/Channel (MHz)	Occupied Bandwidth (99%) (kHz)
908	468.9
916	468.9
924	465.9

Table 13-1 - OBW Results

13.6 Plots

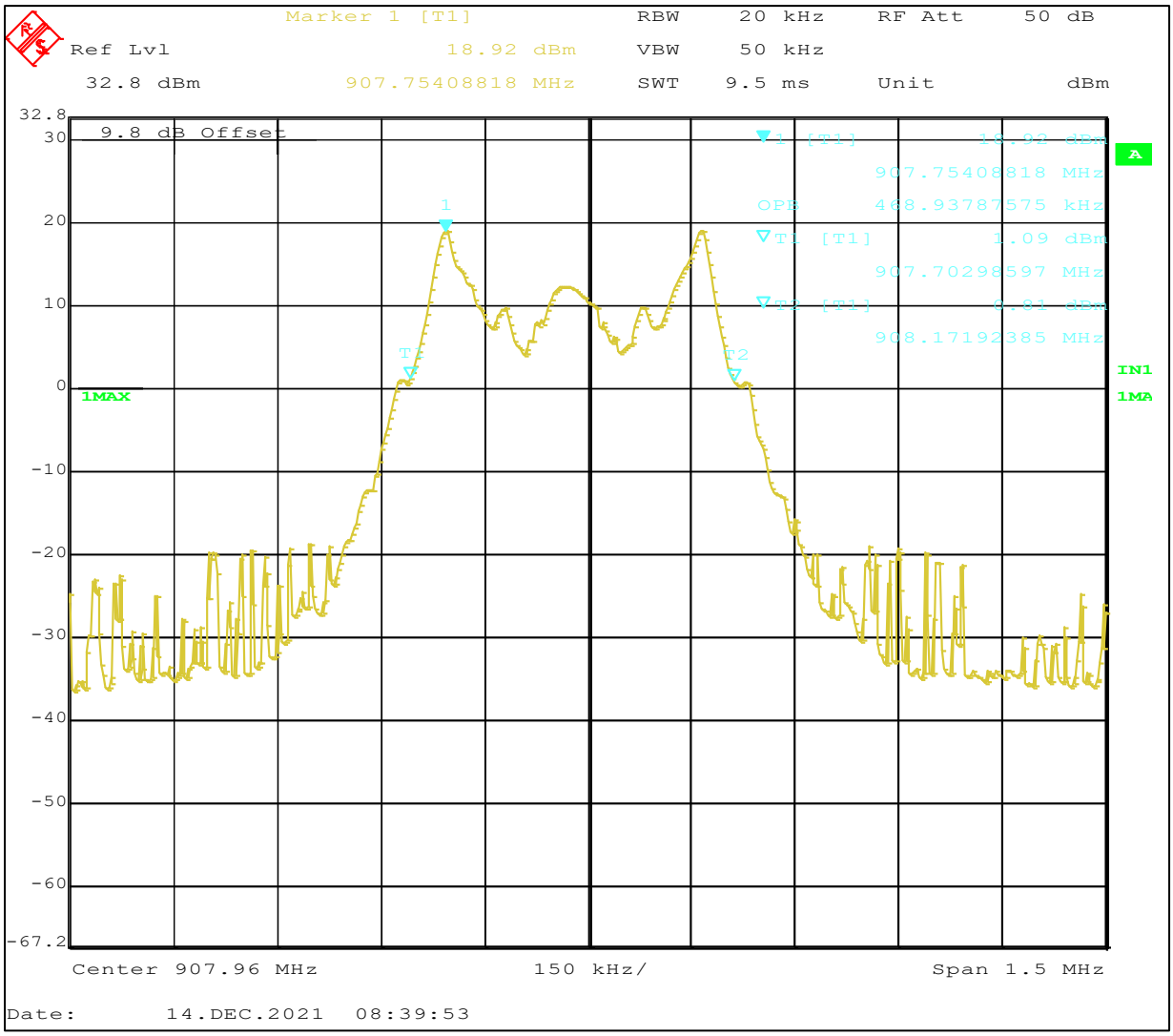


Figure 13-1 - OBW, Low Channel

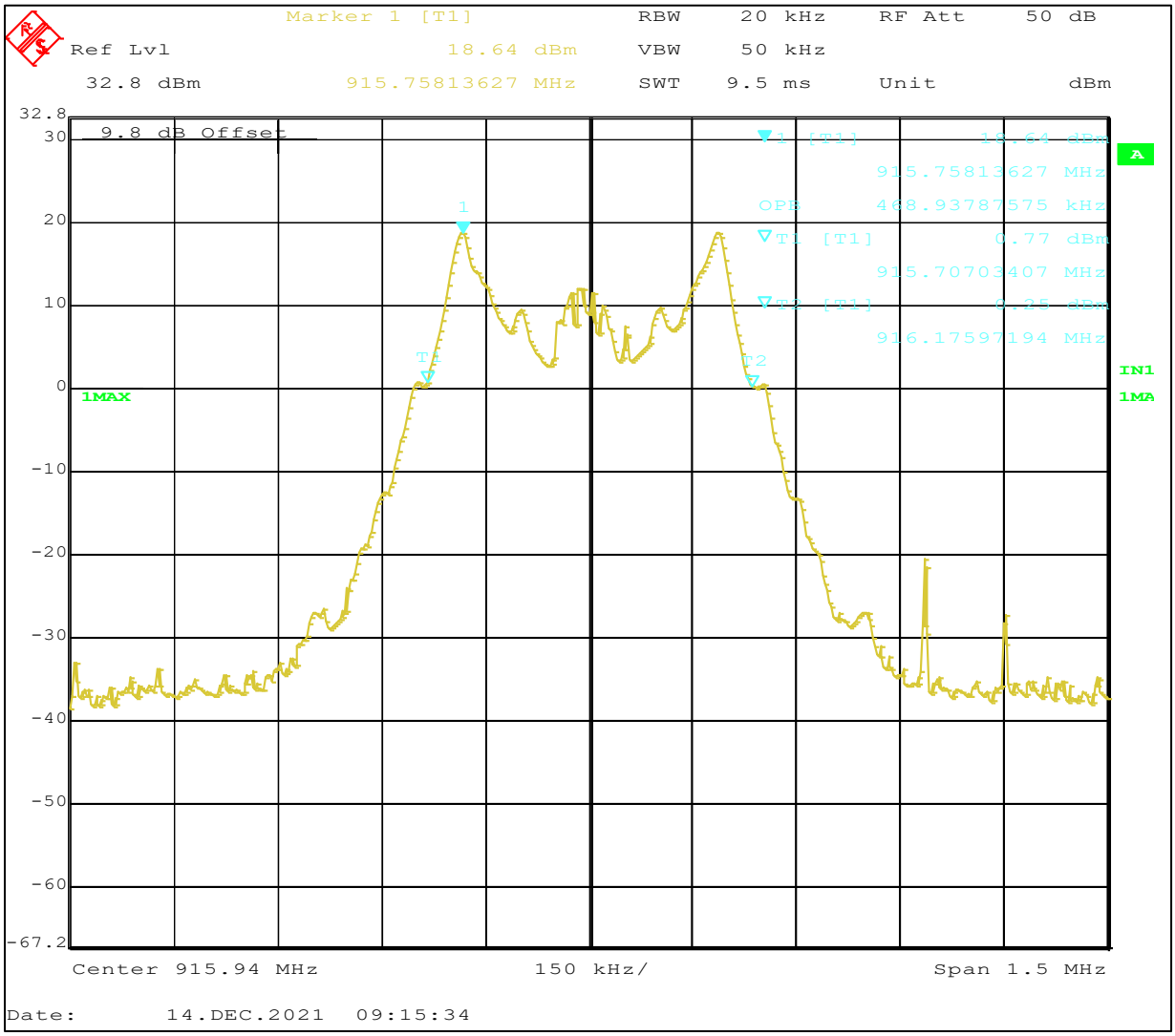


Figure 13-2 - OBW, Middle Channel

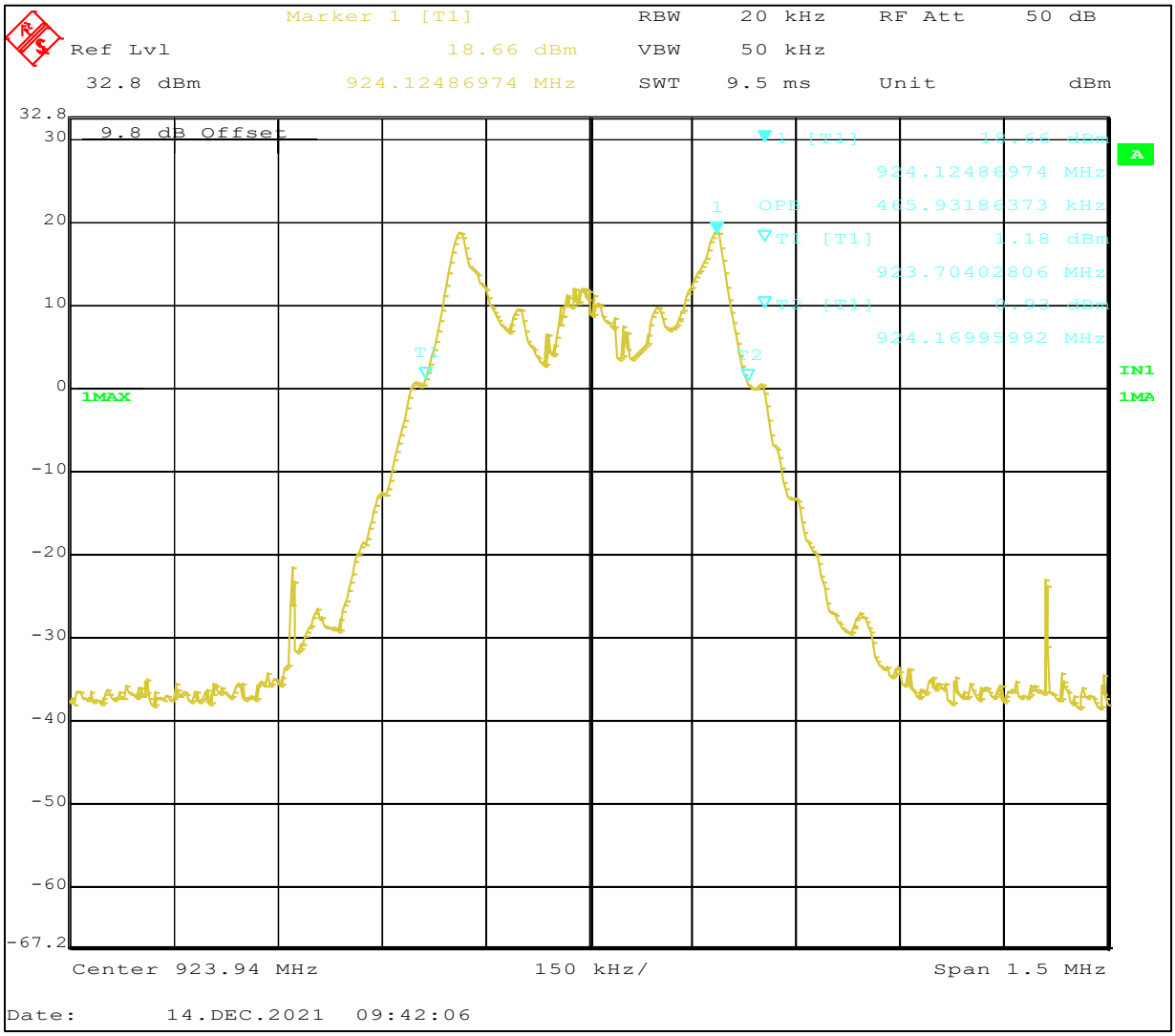


Figure 13-3 - OBW, High Channel

14.0 Maximum Conducted (average) Output Power

14.1 Regulation

FCC CFR 47 part 15.247(b)(3)

14.2 Requirement

Systems using digital modulation in the 902-928 MHz band, the maximum peak conducted output power of the intentional radiator shall not exceed 1-watt. Alternatively, the 1-watt limit can be based on a measurement of the maximum conducted (average) output power.

14.3 Test Setup

Refer to Figure 12-1 - DTS Bandwidth Setup for a diagram of the test setup.

14.4 Test Method

ANSI C63.10-2013, Clause 11.9.2.2.2 (AVGSA-1).

Sweep triggering was implemented since the EUT transmitter could not be programmed to a duty cycle ≥ 98%. The analyzer was set to trigger on the transmitter RF power and the gate duration was adjusted so that measurement evaluation was only performed when the EUT was transmitting at full power (no transmitter off time was evaluated during trace averaging). Trace averaging was set to average 100 traces.

The analyzer's channel power measurement function with the rms detector was used to perform the maximum conducted (average) output power measurements. The respective channels OBW recorded in Table 13-1 was used as the channel power bandwidth parameter for this measurement.

The cable and attenuator(s) total loss were calculated and programed into the analyzer's reference level offset feature. The following screen captures reflect the actual EUT output amplitude at the time of measurement.

14.5 Results

Frequency/Channel (MHz)	Average Conducted Measured (dBm)	Average Conducted Measured (W)	Limit (W)	Margin (W)	Result
908	16.10	0.04074	1.00000	0.95926	Meets Requirement
916	15.97	0.03954	1.00000	0.96046	Meets Requirement
924	15.85	0.03846	1.00000	0.96154	Meets Requirement

Table 14-1 - Maximum Conducted Power Results

14.6 Plots

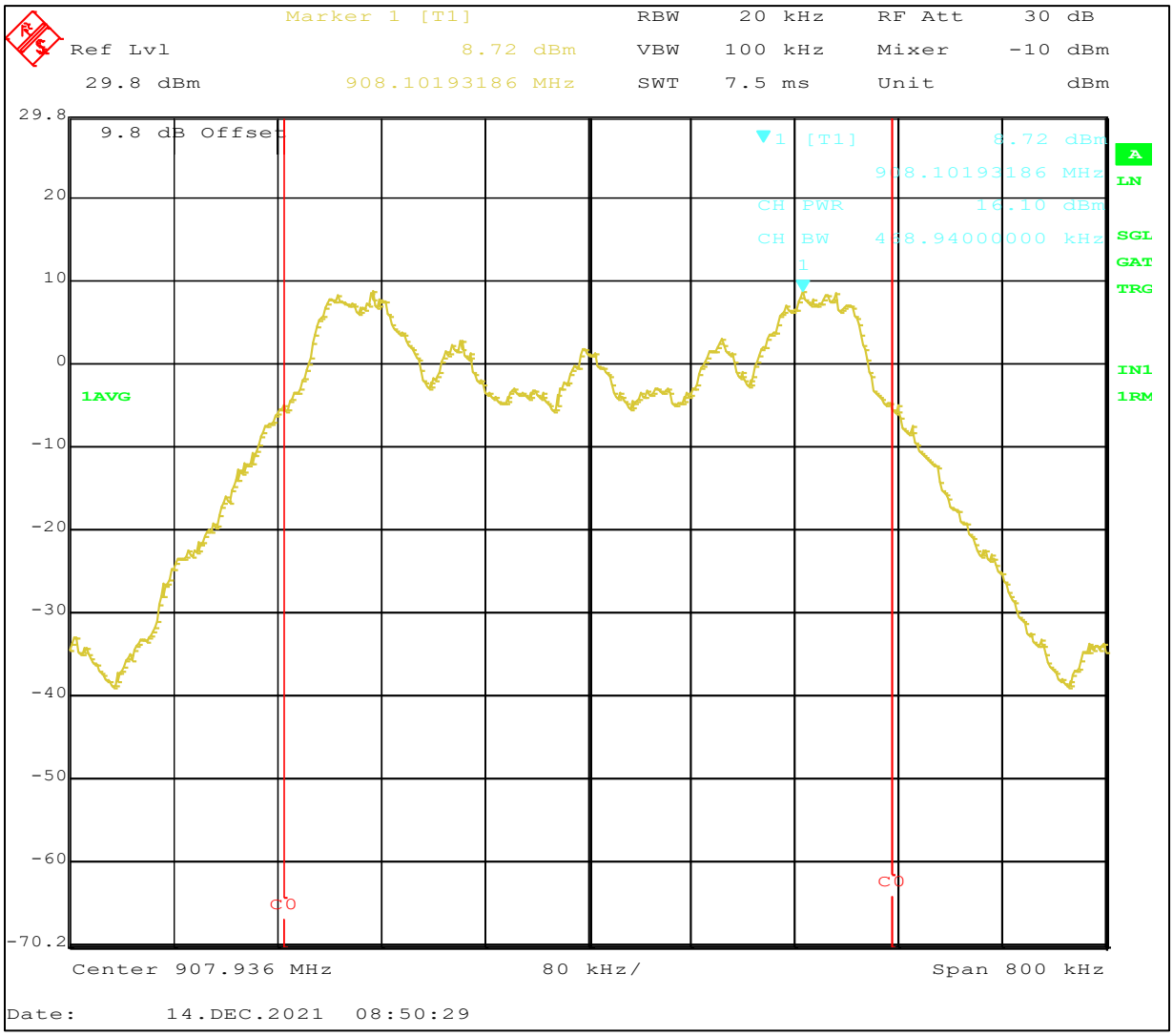


Figure 14-1 - Maximum Conducted Output Power, Low Channel

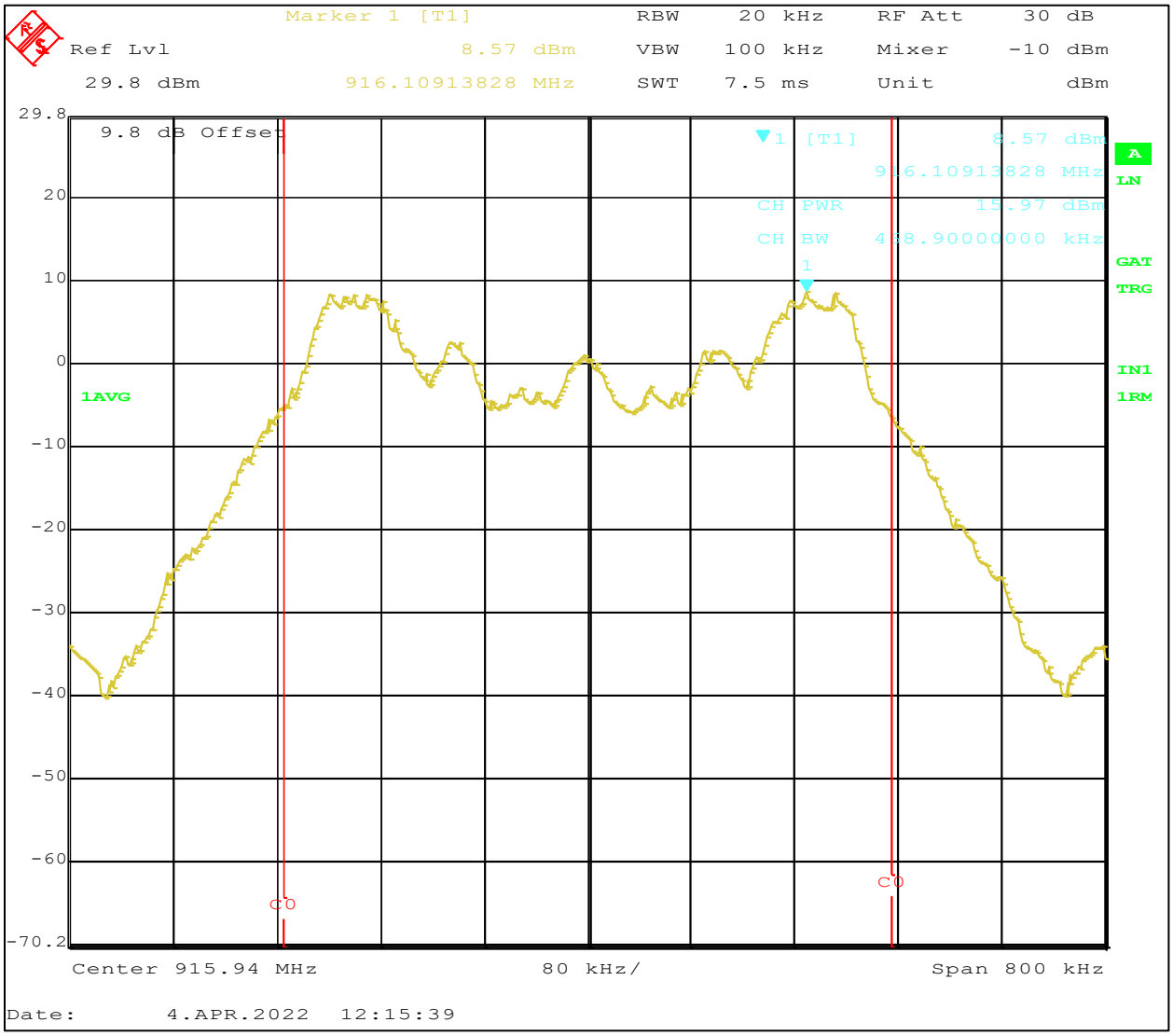


Figure 14-2 - Maximum Conducted Output Power, Middle Channel

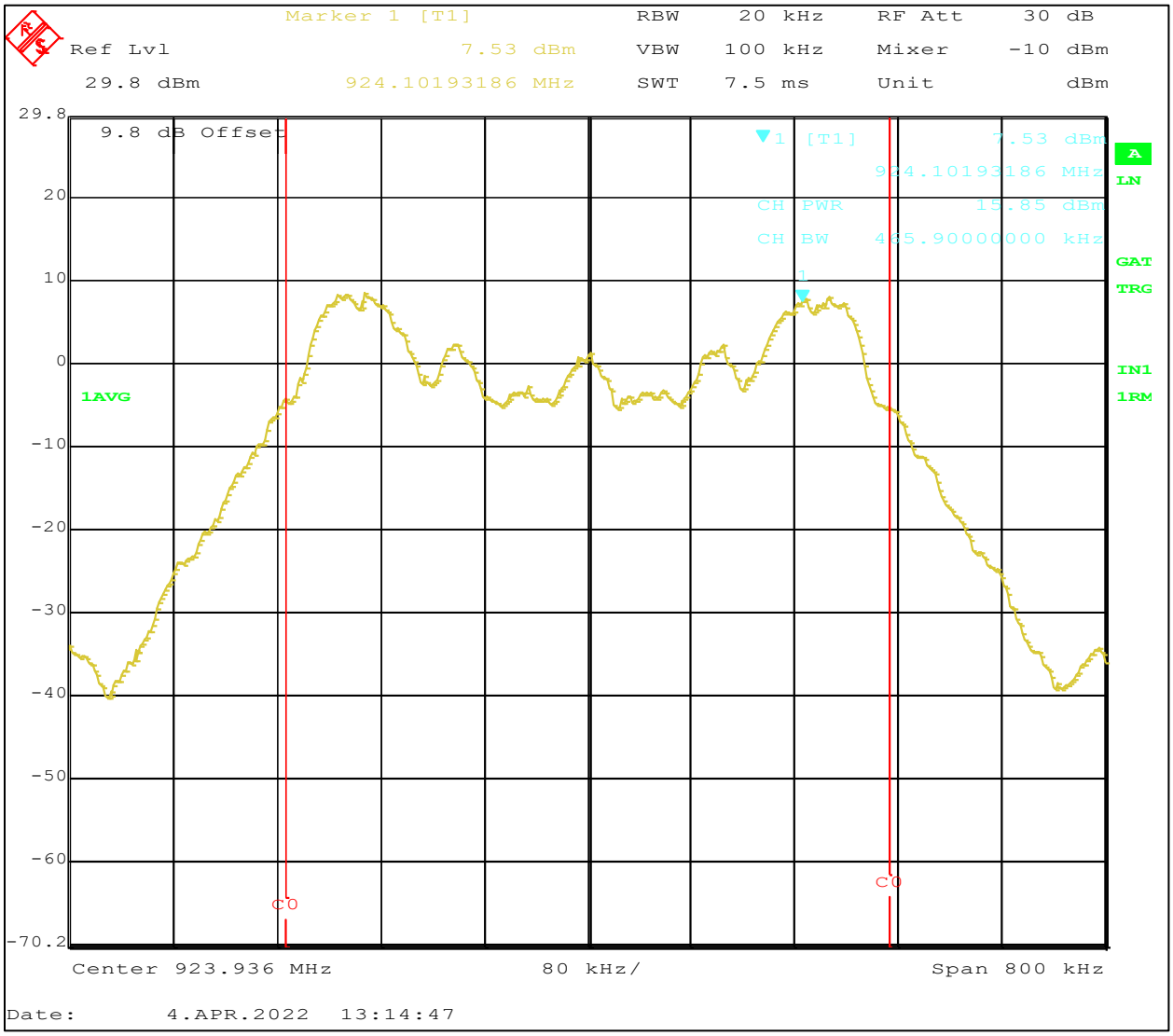


Figure 14-3 - Maximum Conducted Output Power, High Channel

15.0 Power Spectral Density (PSD)

15.1 Regulation

FCC CFR 47 Part 15.247(e)

15.2 Requirement

For digitally modulated system, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. The same method of determining the conducted output power shall be used to determine the power spectral density.

15.3 Setup

Refer to Figure 12-1 - DTS Bandwidth Setup for a diagram of the test setup.

15.4 Test Method

ANSI C63.10-2013, Clause 11.10.3 (AVGPSD-1)

Sweep triggering was implemented since the EUT transmitter could not be programmed to a duty cycle ≥ 98%. The analyzer was set to trigger on the transmitter RF power and the gate duration was adjusted so that measurement evaluation was only performed when the EUT was transmitting at full power (no transmitter off time was evaluated during trace averaging). Trace averaging was set to average 100 traces.

The analyzer's rms detector was used to perform the PSD measurement. The span was reduced on the analyzer as needed to ensure the number of points in the sweep was greater than [2 x span / RBW], while maintaining a span of at least 1.5 times the OBW recorded in Table 13-1.

The cable and attenuator(s) total loss were calculated and programed into the analyzer's reference level offset feature. The following screen captures reflect the actual EUT output amplitude at the time of measurement.

15.5 Results

Frequency/Channel (MHz)	PSD Conducted Measured (dBm)	Limit (dBm/3kHz)	Margin (dB)	Result
908	3.28	≤8	4.72	Meets Requirement
916	3.17	≤8	4.83	Meets Requirement
924	3.20	≤8	4.80	Meets Requirement

Table 15-1 - PSD Results

15.6 Plots

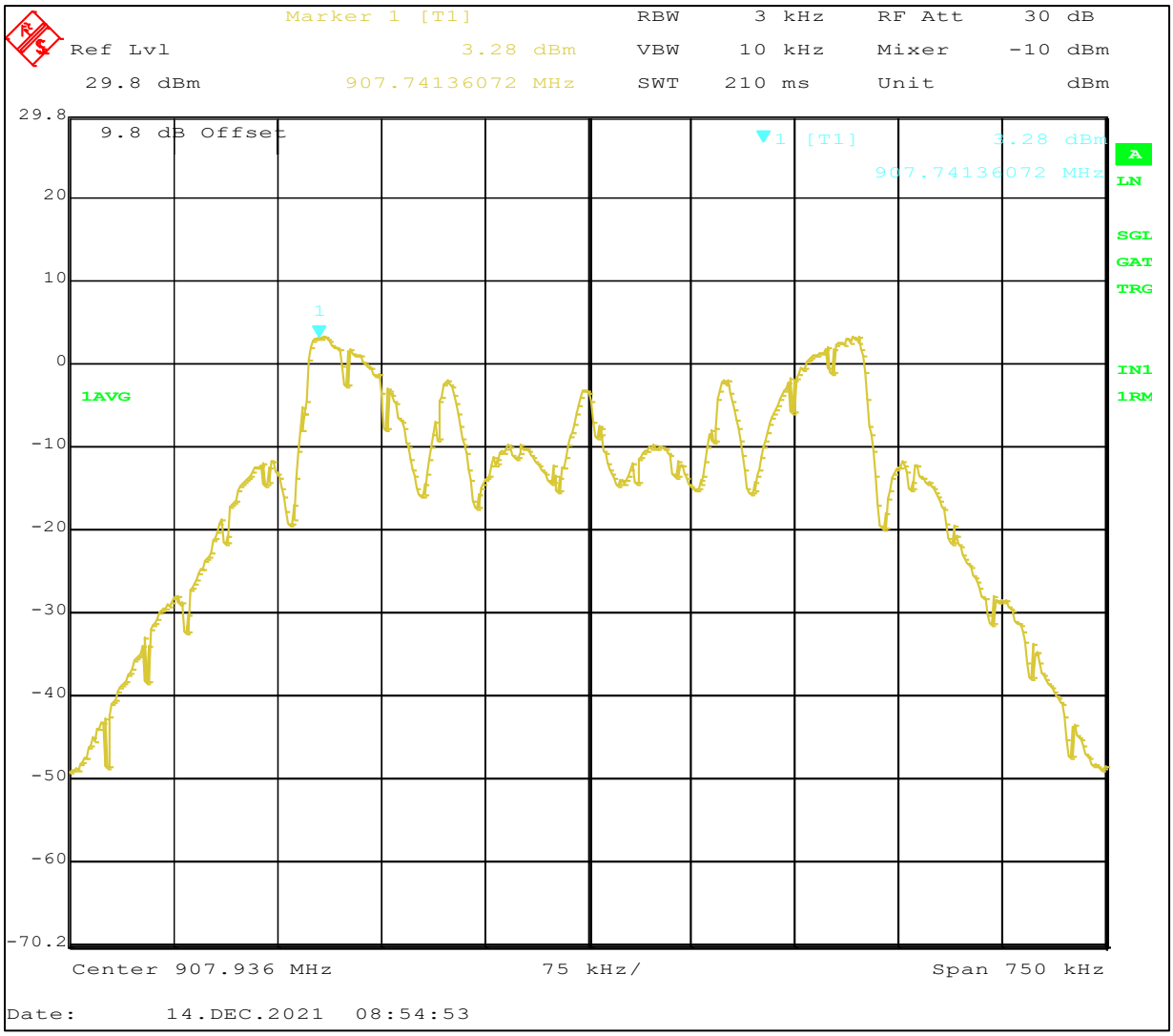


Figure 15-1 - PSD, Low Channel

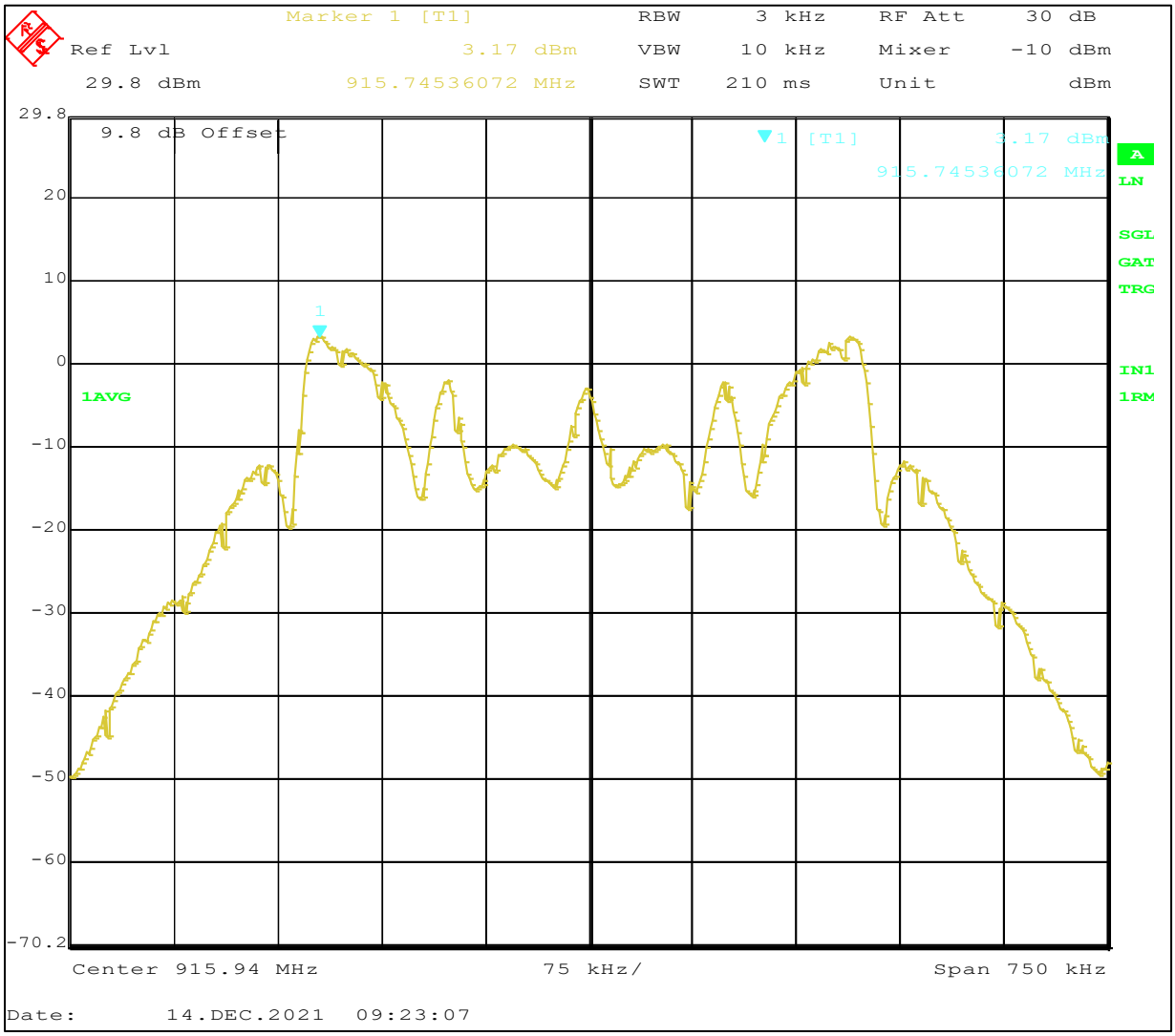


Figure 15-2 - PSD, Middle Channel

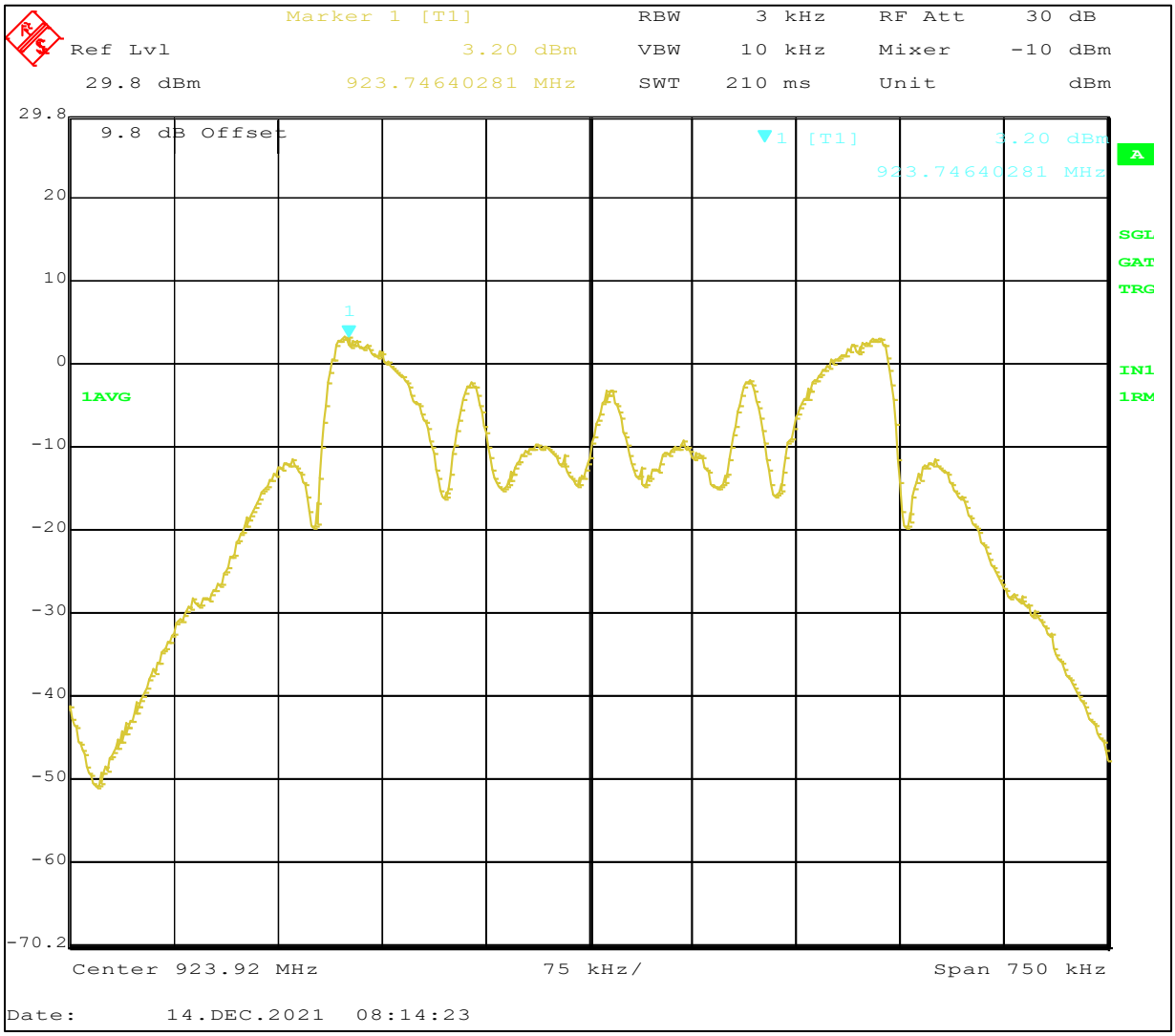


Figure 15-3 - PSD, High Channel

16.0 Band Edges

16.1 Regulation

FCC CFR 47 Part 15.215(c), FCC CFR 47 Part 15.247(d)

16.2 Requirement

Intentional radiators must be designed to ensure the 20 dB bandwidth of the emission is contained within the frequency band designated. Also, in any 100 kHz bandwidth outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of power (when maximum conducted (average) output power measurement is used to determine compliance to the limit).

16.3 Setup

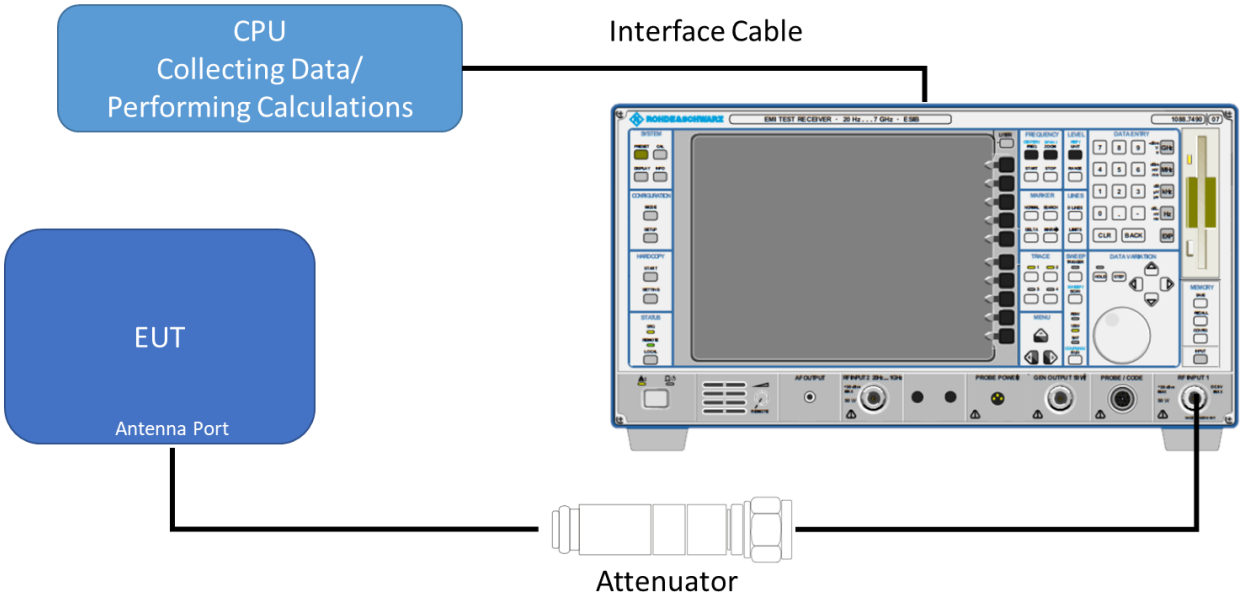


Figure 16-1 - Band Edge Setup

16.4 Test Method

ANSI C63.10-2013 Clause 6.10.4, as specified in clause 11.13.1.

The analyzer was setup according to ANSI C63.10-2013 Clause 6.10.4, and a sweep performed from 30MHz to 10GHz. A trace capture was performed using automated software (Tile 7.5.7.6).

The cable and attenuator(s) factors were loaded into the software. The software calculated the total correction and applied it to the uncorrected analyzer data using the formula:

Corrected Reading = Analyzer Reading + Attenuator Loss + Cable Loss

The test plots and results below reflect the corrected data. For reference, the plots also show a display line showing the 30dBc limit.

16.5 Results

Frequency/Channel (MHz)	Maximum Band Edge Emission (dBc)	Limit (dBc)	Margin (dB)	Result
908	49.14	≥ 30	19.14	Meets Requirement
924	47.59	≥ 30	17.59	Meets Requirement

Table 16-1 - Band Edge Results

16.6 Plots

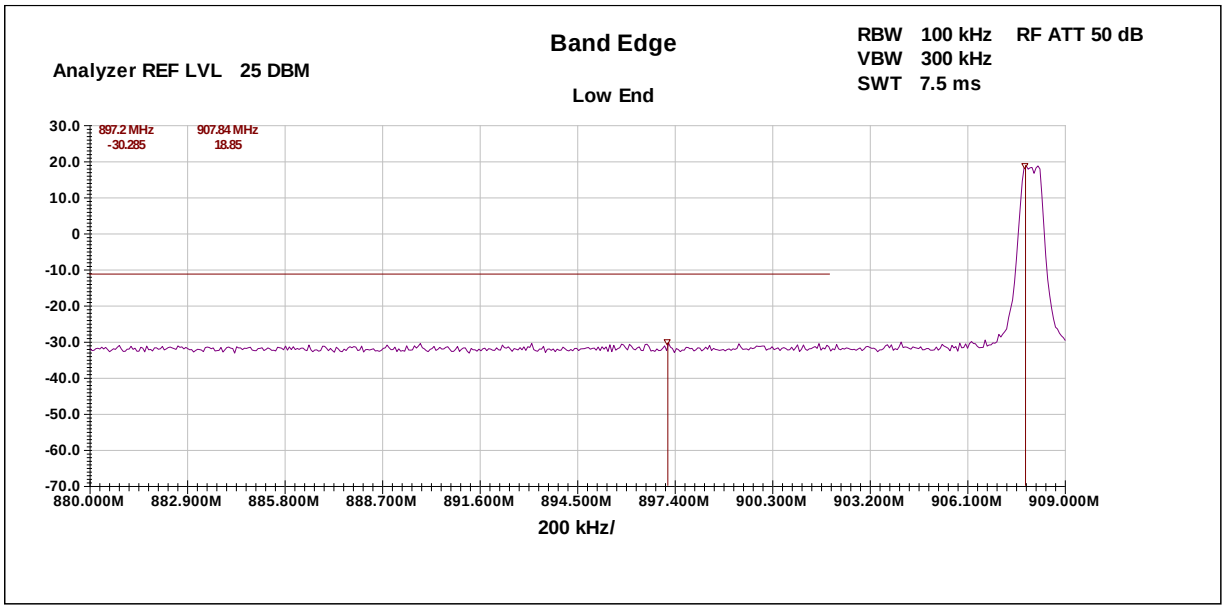


Figure 16-2 - Band Edge Lower Channel

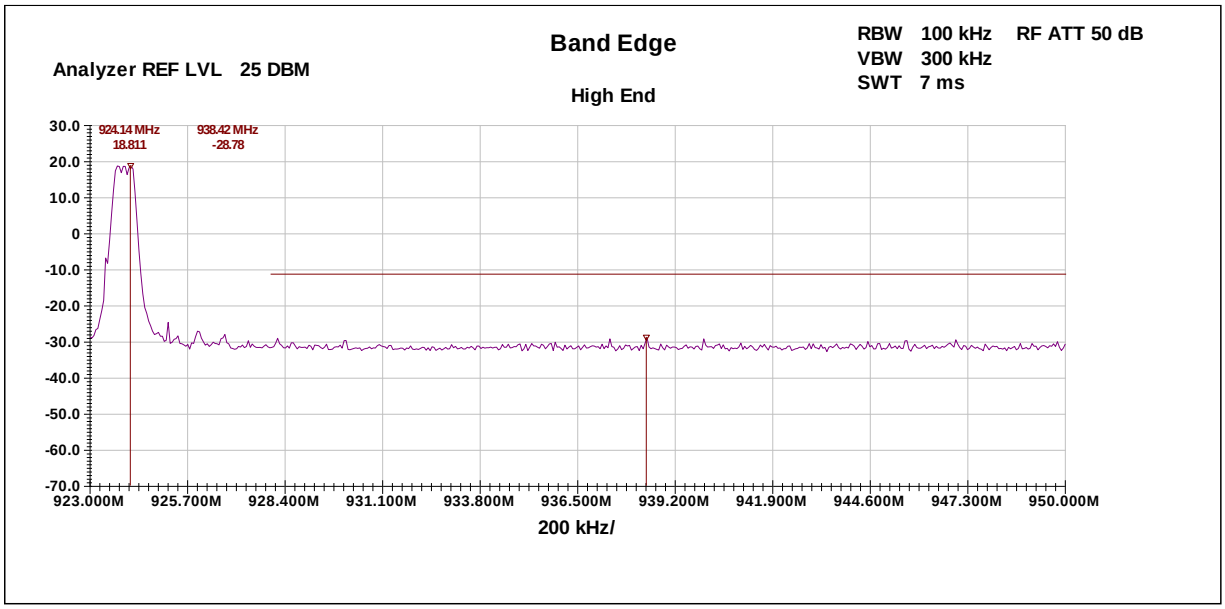


Figure 16-3 - Band Edge, Upper Channel

17.0 Antenna Port Conducted Spurious Emissions

17.1 Regulation

FCC DFR 47 part 15.247(d).

17.2 Requirement

In any 100 kHz bandwidth outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of power (when maximum conducted (average) output power measurement is used to determine compliance to the limit).

17.3 Test Setup

Refer to Figure 16-1 - Band Edge Setup for a diagram of the test setup.

17.4 Test Method

ANSI C63.10-2013, Clause 11.11 (Emissions in nonrestricted frequency bands).

A reference level measurement was performed by setting the EUT to the channel with the highest PSD obtained from section 15.5. The analyzer was setup according to ANSI C63.10-2013 Clause 11.11.2 and a sweep performed capturing the channel fundamental frequency. A trace capture was performed using automated software (Tile 7.5.7.6) and stored for later calculations.

Then, emissions level measurements were made for each channel by setting up the analyzer as needed, according to ANSI C63.10-2013 Clause 11.11.3. For each channel to be measured, a sweep was performed with the analyzer followed by a trace capture using the automated software. The software was used to mark any significant peaks (or the worst-case noise floor emission if no peaks were observed) and to perform the necessary attenuation calculation. Additionally, the software calculated and displayed a limit line showing the 30dB attenuation limit from the previously stored reference level.

For all measurements, the cable and attenuator(s) factors were loaded into the software. The software calculated the total correction and applied it to the uncorrected analyzer data using the formula:

Corrected Reading = Analyzer Reading + Attenuator Loss + Cable Loss

17.5 Results

Frequency/Channel (MHz)	Fundamental Reference Level (dB)[a]	Maximum Spurious Emission (dBc)	Limit (dBc)	Margin (dB)	Result
908	18.89	40.15	≥ 30	10.15	Meets Requirement
916	18.89	39.69	≥ 30	9.69	Meets Requirement
924	18.89	47.67	≥ 30	17.67	Meets Requirement
[a] Maximum PSD Channel used as the fundamental reference for all channels.					

Table 17-1 - Antenna Port Spurious Emissions Results

17.6 Plots

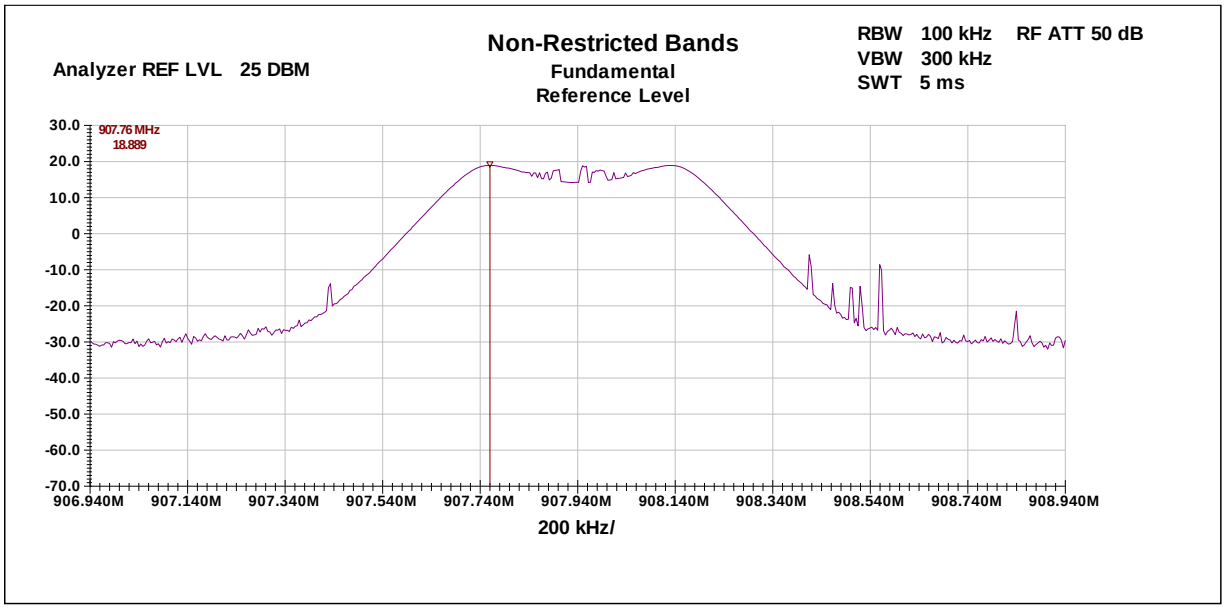


Figure 17-1 - 100kHz Spurious Reference (Maximum PSD = Low Channel)

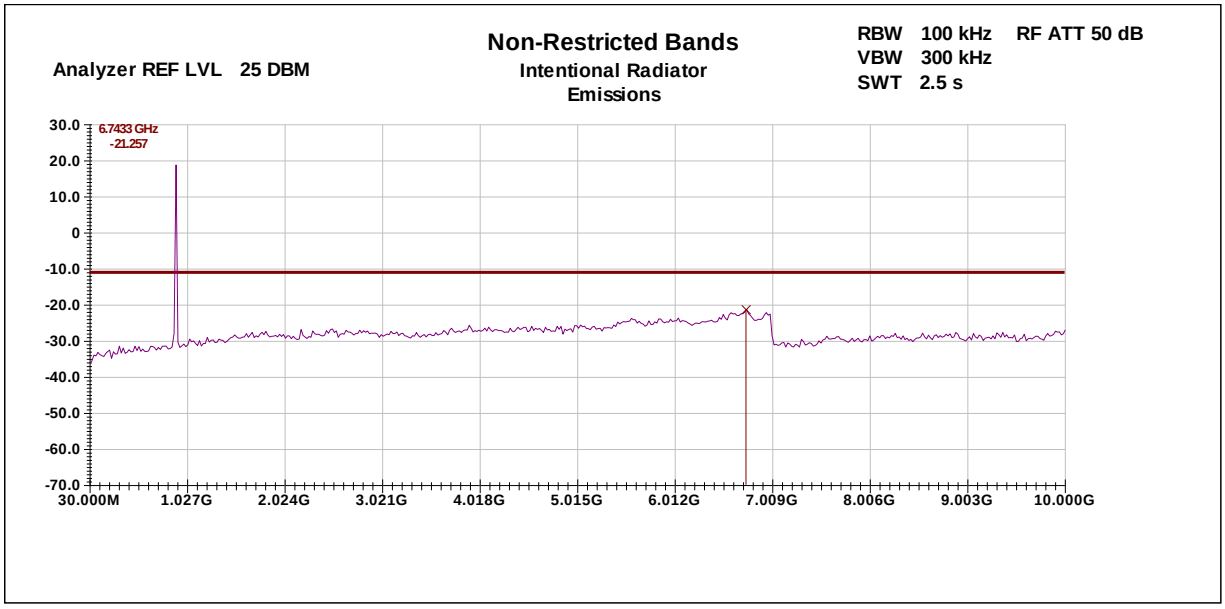


Figure 17-2 - 100kHz Spurious Emissions, Low Channel

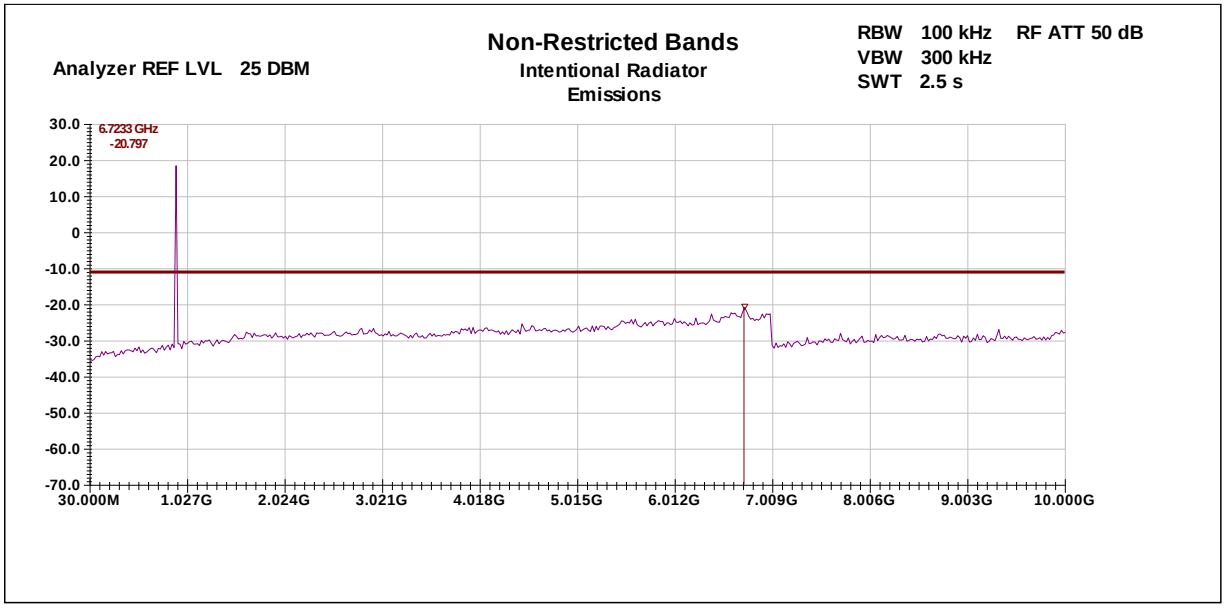


Figure 17-3 - 100kHz Spurious Emissions, Middle Channel

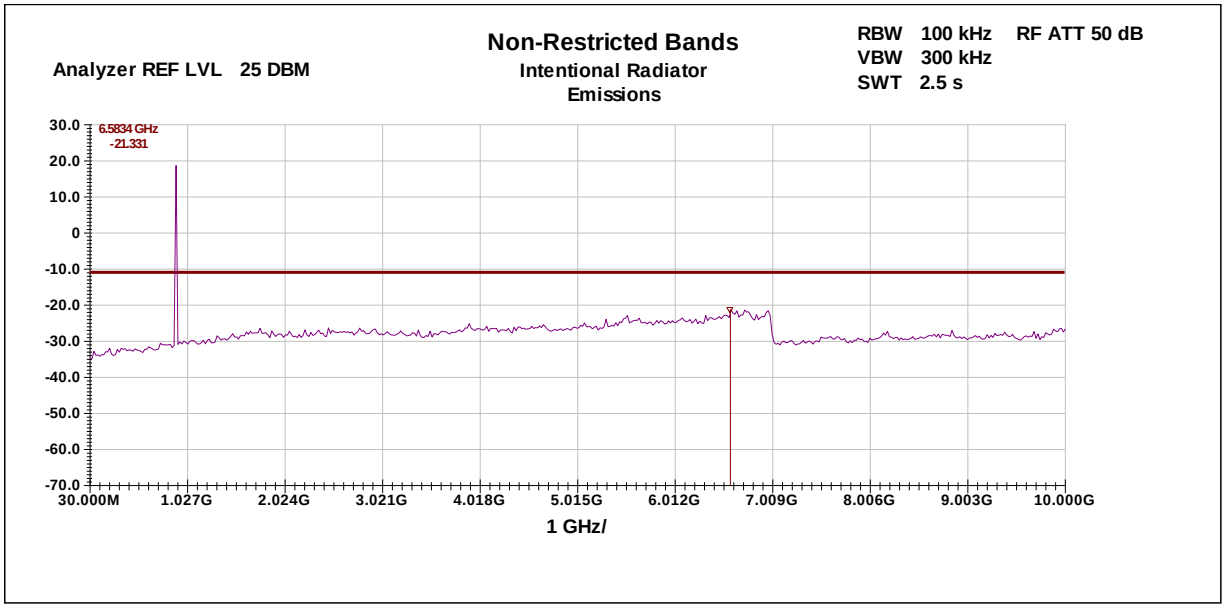


Figure 17-4 - 100kHz Spurious Emissions, High Channel

18.0 Spurious Emissions within Restricted Bands

18.1 Regulation

FCC CFR 47 Part 15.209, FCC CFR 47 part 15.247(d).

18.2 Requirement

Radiated emissions that fall within restricted bands, as defined in 15.205(a), must comply with the radiated emission limits specified in 15.209(a).

18.3 Test Setup

18.3.1 Below 30MHz

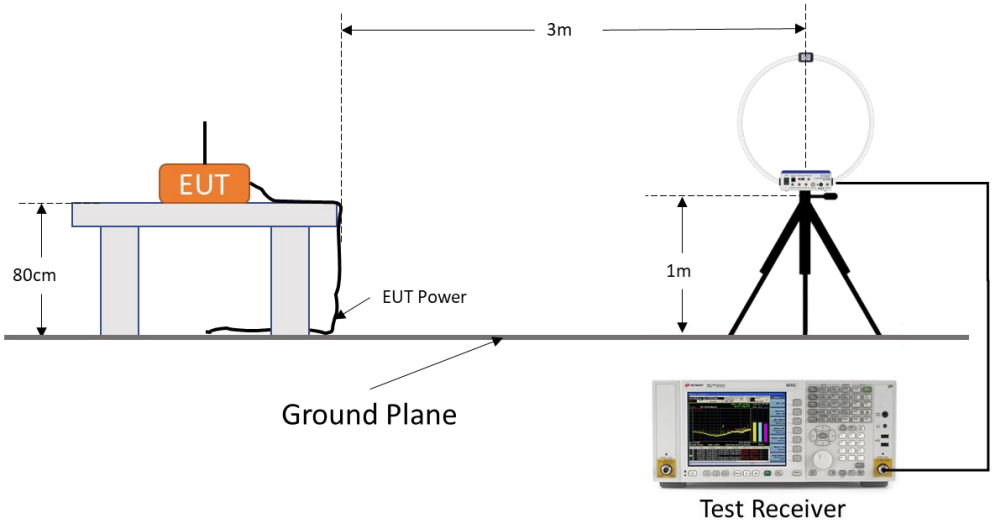


Figure 18-1 - Radiated Emissions Setup, below 30MHz

18.3.2 30MHz to 1GHz

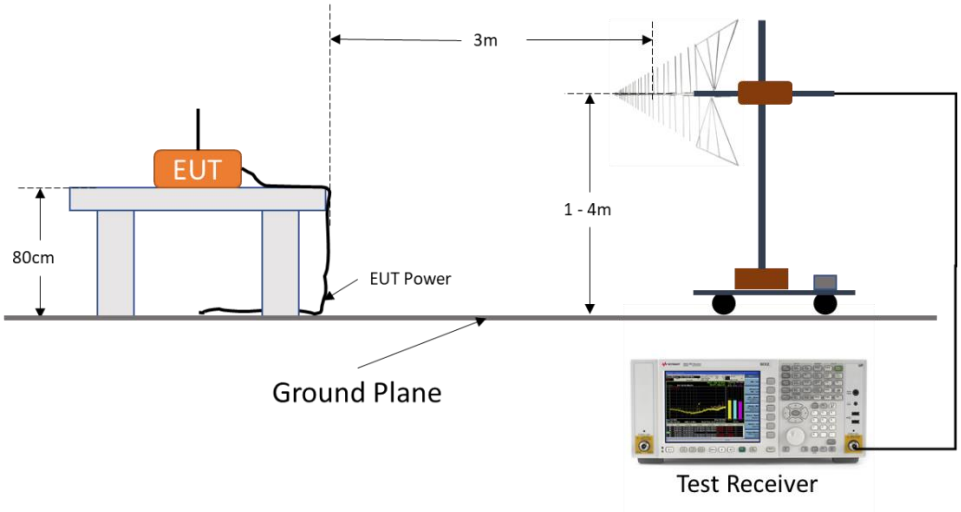


Figure 18-2 - Radiated Emissions Setup, 30MHz to 1GHz

18.3.3 Above 1GHz

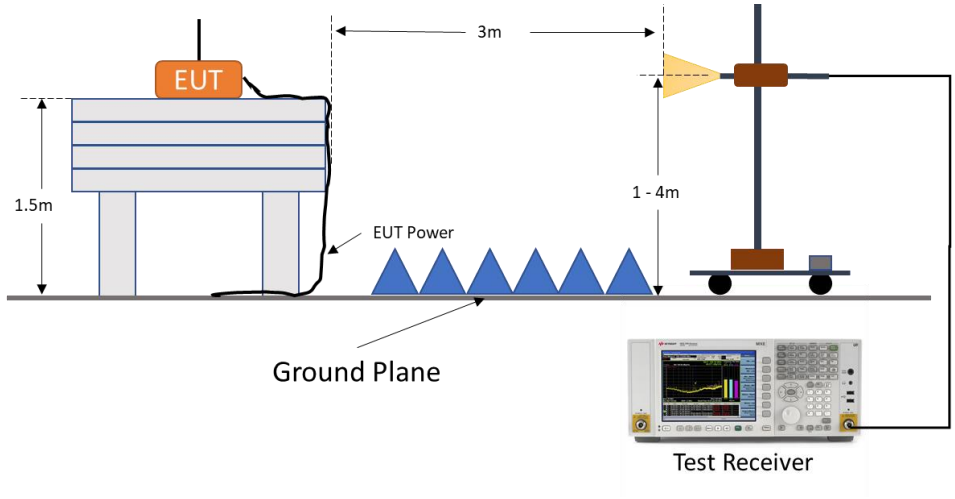


Figure 18-3 - Radiated Emissions Setup, Above 1GHz

18.4 Test Method

18.4.1 General

ANSI C63.10, Clause 6.2

For all radiated emissions testing, the EUT was explored for the maximum radiated emission levels during the pre-scan/exploratory measurements. The EUT only has one overall operational mode and is automatically set after power up. The EUT will enter a “monitoring” mode in which it monitors the state of the AC line also used to power the EUT. During this monitoring state, the EUT wirelessly broadcasts AC line information. Therefore, maximization was exclusively a function of the EUT channel being tested and tower/turntable positioning.

The antenna was directly coupled to the EUT with an adapter, representing the lowest “cable loss” scenario. The EUT can be used with various lengths of antenna cable, depending on environment, however, in all cases the antenna is mounted vertically above the EUT.

All radiated measurements were made with the EUT set to the worst-case operational duty cycle. This duty cycle is illustrated in section 10.2 of this report and is the highest duty cycle used in normal operation. The 80% duty cycle (test mode) would drive the emissions, generated by the EUT digital electronics, over the limit in the restricted frequency bands and was therefore not used in radiated measurements. The duty cycle configuration is locked out from end use and cannot be field configured.

Analyzer measurement, antenna tower position, and azimuth rotation times were setup as such so that several full power/maximum transmission pulses were properly observed throughout each frequency range and EUT position.

For all radiated measurements, automated software (Tile 7.5.7.6) was used to setup and control the measurement and positional instrumentation. The software was also loaded with the appropriate calibration factors (for the cables, attenuator, preamps, etc…) and performed the corrections after gathering the raw uncorrected measurement instrument data. The software also provides the data presented in this report. Sample calculations used in the software are shown in the sections that follow.

Corrected data collected by the software was then compared to the general radiated limits specified in FCC CFR 47 Part 15.209 and used for margin calculations. A Summary limit table is provided in Table 18-1 for reference.

Frequency	Limit (uV/m) @ Distance	Limit (dBuV/m)	Distance Correction
9kHz – 490kHz	2400/F(kHz) @ 300m	48.5 – 13.8 @ 300m	300m to 3m = 80dB
490kHz – 1.705MHz	24000/F(kHz) @ 30m	33.8 – 22.97@ 30m	30m to 3m = 40dB
1.705MHz – 30MHz	30 @ 30m	29.54 @ 30m	30m to 3m = 40dB
30MHz – 88MHz	100 @ 3m	40.0 @ 3m	n/a
88MHz – 216MHz	150 @ 3m	43.5 @ 3m	n/a
216MHz – 960MHz	200 @ 3m	46.0 @ 3m	n/a
960MHz – 40GHz	500 @ 3m	54.0 @ 3m	n/a

Table 18-1 - FCC General Radiated Emission Limits

18.4.2 Below 30MHz

ANSI C63.10, Clause 6.4

A loop antenna was used to measure frequencies below 30MHz. The EUT was tested with the measuring loop antenna placed in 3 positions: 1) aligning the antenna along the site axis, 2) orthogonal to the site axis, and 3) horizontal to the ground plane.

Pre-Scan measurements were made rotating the EUT through 360º with the receive antenna at 1-meter height. The peak detector was used with analyzer set to 9kHz resolution bandwidth and a 30kHz video bandwidth. Any peak emissions within 20dB of the respective QP or Average limit were then selected for final evaluation and re-maximization using a measuring receiver and the appropriate QP or Average detector as defined in the following table:

Measurement Receiver Settings Below 30MHz			
Frequency Range	**RBW**	**VBW**	**Detector**
9 kHz to 90kHz	9 kHz	30 kHz	Average
90kHz to 110kHz	9 kHz	30 kHz	Quasi-Peak
110kHz to 490kHz	9 kHz	30 kHz	Average
490kHz to 30MHz	9 kHz	30 kHz	Quasi-Peak

Table 18-2 - Receiver Setting, Below 30MHz

All measurements were performed at a 3-meter distance from the EUT to the measurement antenna. Where applicable, measurement data was extrapolated to the specified distance by conservatively presuming a field strength decay of 40 dB/decade per ANSI C63.10-2013, clause 6.4.4.1 where the limits were specified for distances other than 3-meters. Table 18-1 shows the distance correction factors to apply for the applicable frequency ranges.

Sample calculation carried out in the software are as follows:

- **Corrected Reading = Analyzer Reading + Cable Loss + Active Antenna Factor – Distance Correction factor**
- **Margin = Applicable Limit – Corrected Reading**

18.4.3 30MHz to 1GHz

A Biconilog antenna was used to measure frequencies from 30MHz to 1GHz. The EUT was tested with the measuring antenna in both the horizontal and vertical polarities.

Due to the broad band noise observed over the limit during preliminary exploratory measurements with a peak detector, full Pre-Scan measurements were made with a Time Domain scanning receiver and a QP detector. The EUT turntable was rotated in 24 fixed 15-degree increments, scanning the full frequency range at each angle. This was repeated for 4 antenna heights from 1 to 2.5-meters. The receiver was set to 120 kHz resolution bandwidth. At a minimum, the top 6 emissions within 20dB of the limit were then selected for final evaluation and re-maximization. All emissions selected for final evaluation were performed with antenna heigh scans from 1 to 4 meters.

Sample calculations carried out in the software are as follows:

- **Corrected Reading = Analyzer Reading + Cable Loss + Antenna Factor**
- **Margin = Applicable Limit – Corrected Reading**

18.4.4 Above 1GHz

A Horn antenna was used to measure frequencies above 1GHz. The EUT was tested with the measuring antenna in both the horizontal and vertical polarities.

Pre-Scan measurements were made rotating the EUT through 360º with the receive antenna at 1.5-meter height. A Time Domain scanning receiver with both peak and average detectors was used. The EUT turntable was rotated in 24 fixed 15-degree increments, scanning the full frequency range at each angle. The receiver was set to 1 MHz resolution bandwidth. If any peaks were observed, at least the top 6 emissions within 20dB of the limit were then selected for final evaluation and re-maximization. All emissions selected for final evaluation were performed with antenna heigh scans from 1 to 4 meters.

Sample calculations carried out in the software are as follows:

- **Corrected Reading = Analyzer Reading + Cable Loss + Antenna Factor – Amplifier Gain**
- **Margin = Applicable Limit – Corrected Reading**

18.5 Results

18.5.1 9kHz to 30MHz

All emissions measured with a peak detector were greater than 20dB below the FCC peak limit for restricted bands. All emissions measured with a QP detector were greater than 20dB below the FCC QP limit for restricted bands.

18.5.2 30MHz to 1GHz

The data below shows the worst-case emissions within 20dB of the limit for all 3 frequencies/channels.

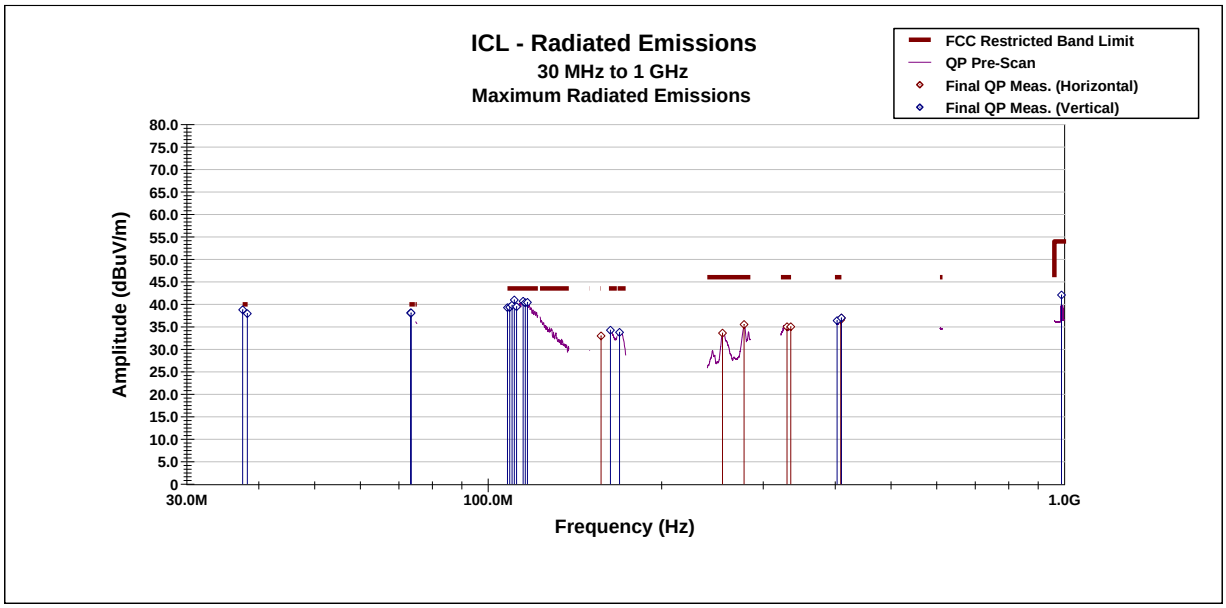


Figure 18-4 - Maximum Radiated Emissions (over all 3 channels, both polarities), Quasi-Peak Detector

Final Radiated Emissions FCC Restricted Bands							
Channel Frequency	Emission Frequency	QP Meas.	QP Limit	QP Margin	Turn Table	Ant. Height	Ant. Polarity
(MHz)	(MHz)	(dBuV/m)	(dBuV/m)	(dB)	(deg)	(cm)	(V/H)
908	109.32	40.09	43.52	3.43	0	99.8	V
908	110.13	39.96	43.52	3.56	0	99.8	V
908	111.9	39.62	43.52	3.90	195	99.8	V
908	115.17	40.84	43.52	2.68	180	99.8	V
908	156.79	33.12	43.52	10.40	105	199.8	H
908	255.15	33.71	46.02	12.31	30	30.1	H
908	402.87	36.50	46.02	9.52	90	150.1	V
916	37.5	38.78	40.00	1.22	210	149.6	V
916	38.2	37.93	40.00	2.07	210	149.6	V
916	108.42	39.96	43.52	3.56	0	99.8	V
916	110.67	40.97	43.52	2.55	355	101.6	V
916	115.86	40.38	43.52	3.14	210	99.4	V
916	116.82	40.19	43.52	3.33	210	99.4	V
916	278.25	35.58	46.02	10.44	0	0.3	H
916	987.69	42.07	53.98	11.91	52	271.9	V
924	73.39	38.09	40.00	1.91	195	99.8	V
924	73.42	38.08	40.00	1.92	195	99.8	V
924	73.48	38.07	40.00	1.93	195	99.8	V
924	162.78	34.25	43.52	9.27	2	101.1	V
924	169.23	33.94	43.52	9.58	315	250.2	V
924	329.62	35.15	46.02	10.87	210	99.4	H
924	334.66	35.26	46.02	10.76	210	99.4	H
924	409.38	36.80	46.02	9.22	0	-0.2	H
924	409.77	37.16	46.02	8.86	300	150.0	V
924	409.89	37.21	46.02	8.81	0	-0.2	H

Negative margin indicates measurements ABOVE the limit.
Positive margin indicates measurements BELOW the limit.

Table 18-3 - Final Radiated Emissions Measurements, 30MHz - 1GHz, Quasi-Peak Detector

18.5.3 Above 1GHz

All emissions measured with a peak detector were greater than 20dB below the FCC peak limit for restricted bands.

19.0 Unintentional Radiator Radiated Emissions (Receiver Mode)

19.1 Regulation

FCC CFR 47 Part 15.109.

19.2 Requirement

The field strength of radiated emissions from unintentional radiators shall not exceed the limits specified in 15.109(a).

19.3 Test Setup

19.3.1 30MHz to 1GHz

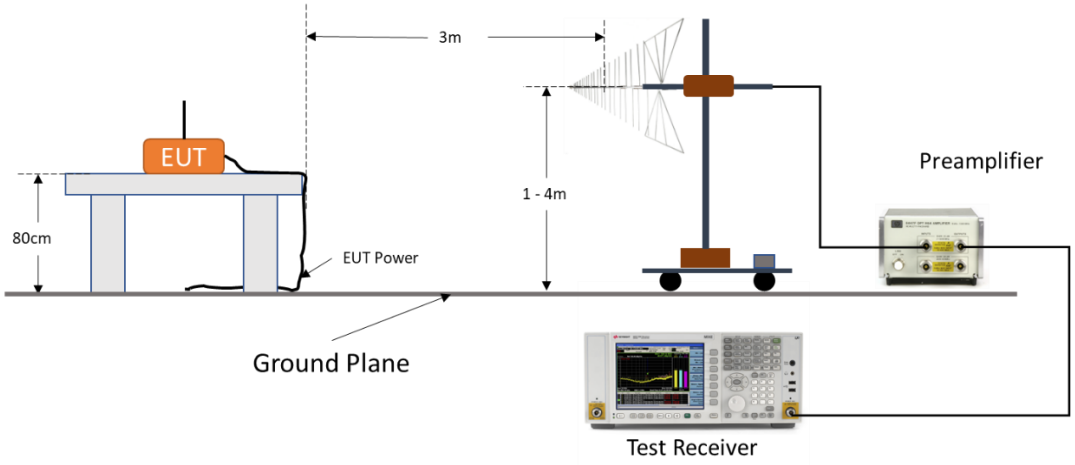


Figure 19-1 - Radiated Emissions Setup, 30MHz to 1GHz

19.3.2 Above 1GHz

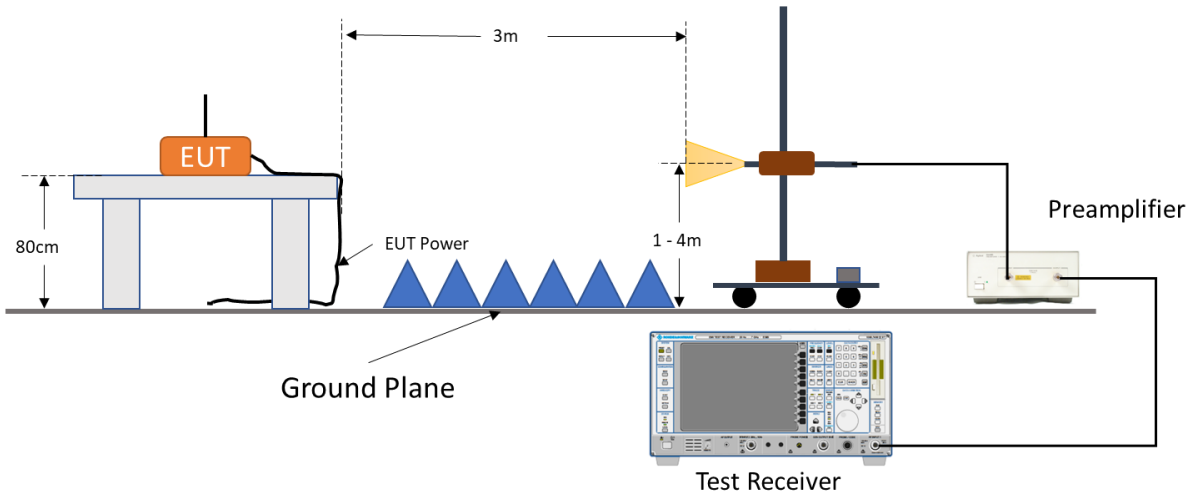


Figure 19-2 - Radiated Emissions Setup, Above 1GHz

19.4 Test Method

19.4.1 General

ANSI C63.4, Clause 8

For all radiated emissions testing, the EUT was explored for the maximum radiated emission levels during the pre-scan/exploratory measurements. The EUT only has one overall operational mode and is automatically set after power up. The EUT will enter a "monitoring" mode in which it monitors the state of the AC line also used to power the EUT. During this monitoring state, the EUT wirelessly broadcasts AC line information. For unintentional radiator and receiver mode only testing, the EUT's transmitter was disabled. The customer provided a transmitter module that had the transmitter disabled via firmware.

Other than the disabling of the transmitter, the EUT was setup and configured for typical use.

For all radiated measurements, automated software (Tile 7.5.7.6) was used to setup and control the measurement and positional instrumentation. The software was also loaded with the appropriate calibration factors (for the cables, attenuator, preamps, etc…) and performed the corrections after gathering the raw uncorrected measurement instrument data. The software also provides the data presented in this report. Sample calculations used in the software are shown in the sections that follow.

Corrected data collected by the software was then compared to the class A radiated limits specified in FCC CFR 47 Part 15.109 and used for margin calculations. A Summary limit table is provided in Table 19-1 for reference.

Frequency Range	Quasi-Peak Limits [a]	Average Limits [a]	Peak Limits [a]
(MHz)	(dBuV/m)	(dBuV/m)	(dBuV/m)
30 to 88	49.54	n/a	n/a
88 to 216	53.98	n/a	n/a
216 to 960	56.90	n/a	n/a
960 to 1,000	60.00	n/a	n/a
1,000 to 5,000	n/a	60.00	80.00

[a] Radiated emissions limits were extrapolated to a 3-meter test distance as described in FCC 15.31(f)(1)

Table 19-1 – FCC Radiated Limits for Class A devices

19.4.2 30MHz to 1GHz

A Biconilog antenna was used to measure frequencies from 30MHz to 1GHz. The EUT was tested with the measuring antenna in both the horizontal and vertical polarities.

The EUT is classified as a Class A digital device for commercial/industrial applications with respect to the digital electronics. However, the receiver portion of the transmitter module is considered a Class B device and must meet the limits specified for class B devices in FCC

15.109 Subpart B. For this reason, the emissions measurements were performed twice, once with the transmitter module receiver mode only enabled (transmitters disabled), and then again with the receiver portion disabled. These two emission plots were then compared to ensure the transmitter module's receiver was not contributing to the emissions exceeding the FCC B limit.

Due to the broad band digital noise observed over the FCC class B limit during preliminary exploratory measurements with a peak detector, and to assist in receiver enabled vs. disabled comparisons, full Pre-Scan measurements were made with a Time Domain scanning receiver and a QP detector. The EUT turntable was rotated in 24 fixed 15-degree increments, scanning the full frequency range at each angle. This was repeated for 4 antenna heights from 1 to 2.5-meters. The receiver was set to 120 kHz resolution bandwidth. At a minimum, the top 6 emissions within 20dB of the limit were then selected for final evaluation and re-maximization. All emissions selected for final evaluation were maximized with full turntable rotations and with continuous antenna heigh scans from 1 to 4 meters and the results were recorded.

Sample calculations carried out in the software are as follows:

- **Corrected Reading = Analyzer Reading + Cable Loss + Antenna Factor – Preamp gain**
- **Margin = Applicable Limit – Corrected Reading**

19.4.3 Above 1GHz

A Horn antenna was used to measure frequencies above 1GHz. The EUT was tested with the measuring antenna in both the horizontal and vertical polarities.

Swept pre-scan measurements were made continuously rotating the EUT through 360º with the receive antenna at 1-meter height. The EMI receiver was set to spectrum analyzer mode with both peak and average detectors enabled and set to a 1MHz resolution bandwidth and 3MHz video bandwidth, for the pre-scan measurements. If any peaks were observed, at least the top 6 emissions within 20dB of the limit were then selected for final evaluation and re-maximization with a CISPR compliant average detector with the EMI receiver set to receiver mode. Final evaluation was performed at a 1MHz resolution bandwidth. All emissions selected for final evaluation were performed with antenna height scans from 1 to 4 meters.

Sample calculations carried out in the software are as follows:

- **Corrected Reading = Analyzer Reading + Cable Loss + Antenna Factor – Amplifier Gain**
- **Margin = Applicable Limit – Corrected Reading**

19.5 Results

19.5.1 30MHz to 1GHz

The data below shows the worst-case maximized emissions within 20dB of the limit for both antenna polarities.

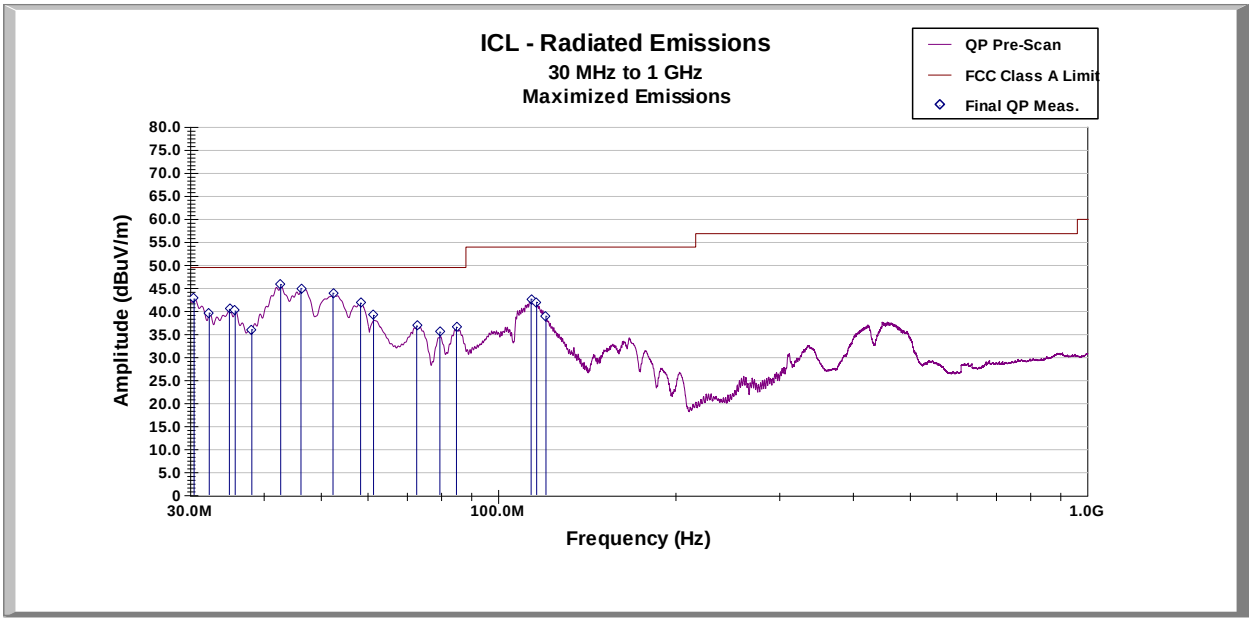


Figure 19-3 - Maximum Radiated Emissions, Receiver Mode Enabled, Quasi-Peak Detector

Final Radiated Emissions FCC Class A Limits						
Emission Frequency	QP Meas.	QP Limit	QP Margin	Turn Table	Ant. Height	Ant. Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	(deg)	(cm)	(V/H)
30.51	42.66	49.54	6.88	240	100	V
32.37	39.60	49.54	9.94	225	100	V
35.01	40.40	49.54	9.14	225	100	V
35.82	40.03	49.54	9.51	345	100	V
38.22	36.01	49.54	13.53	15	100	V
42.78	45.82	49.54	3.72	274	101	V
46.32	44.95	49.54	4.59	195	100	V
52.5	43.92	49.54	5.62	30	170	V
58.47	41.76	49.54	7.78	187	101	V
61.5	39.09	49.54	10.45	180	100	V
72.81	36.80	49.54	12.74	264	101	V
79.71	35.47	49.54	14.07	167	101	V
85.05	36.54	49.54	13.00	51	102	V
113.88	42.64	53.98	11.34	220	102	V
116.37	41.94	53.98	12.04	30	170	V
120.66	38.92	53.98	15.06	357	102	V

Negative margin indicates measurements ABOVE the limit.
Positive margin indicates measurements BELOW the limit.

Table 19-4 - Final Radiated Emissions, 30MHz - 1GHz, Receiver Mode Enabled, Quasi-Peak Detector

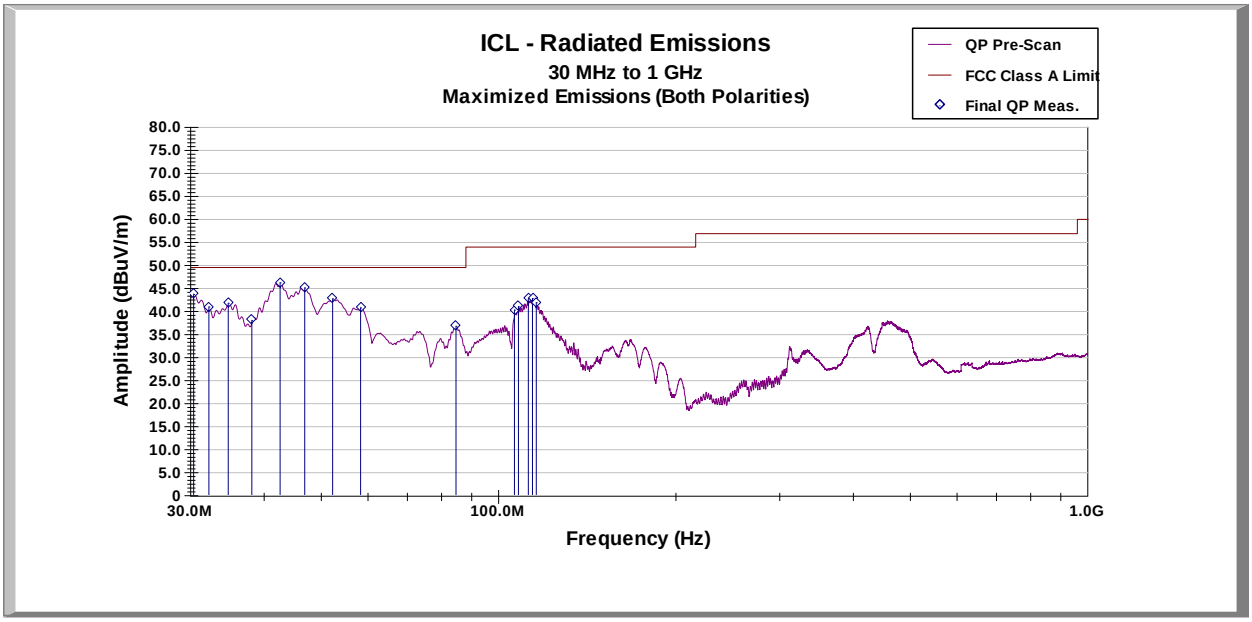


Figure 19-5 – Maximum Radiated Emissions, Receiver Mode Disabled, Quasi-Peak Detector

Final Radiated Emissions FCC Class A Limits						
Emission Frequency	QP Meas.	QP Limit	QP Margin	Turn Table	Ant. Height	Ant. Polarity
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	(deg)	(cm)	(V/H)
30.45	43.69	49.54	5.85	285	100	V
32.31	40.97	49.54	8.57	210	100	V
34.86	41.76	49.54	7.78	240	100	V
35.73	41.46	49.54	8.08	1	100	V
38.22	38.01	49.54	11.53	330	100	V
42.69	46.22	49.54	3.32	29	100	V
47.01	45.09	49.54	4.45	210	100	V
52.41	42.72	49.54	6.82	165	100	V
58.47	40.75	49.54	8.79	176	101	V
84.9	36.77	49.54	12.77	165	100	V
106.68	40.28	53.98	13.70	180	100	V
108.36	41.01	53.98	12.97	180	100	V
112.65	42.78	53.98	11.20	177	101	V
114.45	42.76	53.98	11.22	182	102	V
116.19	41.90	53.98	12.08	187	102	V

Negative margin indicates measurements ABOVE the limit.
Positive margin indicates measurements BELOW the limit.

Figure 19-6 - Final Radiated Emissions, 30Mhz - 1GHz, Reciever Mode Disabled, Quasi-Peak Detector

19.5.2 Above 1GHz

All emissions measured with a peak detector were greater than 20dB below the FCC peak limit for Class A digital devices.

20.0 AC Power Line Conducted Emissions (Intentional Radiator)

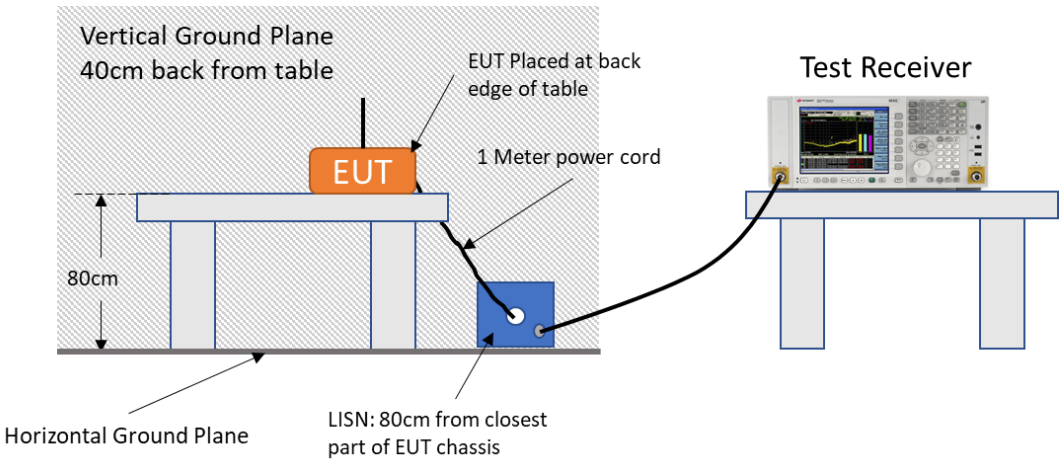
20.1 Regulation

FCC CFR 47 part 15.207(a)

20.2 Requirement

Intentional radiators designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back on to the AC power line on any frequency, within the band of 150 kHz to 30 MHz, shall not exceed the limits defined in 15.207(a).

20.3 Test Setup



20.4 Test Method

ANSI C63.10-2013, Clause 6.2

Measurements were taken from 150kHz to 30MHz with the EMI test receiver's resolution bandwidth set to 9kHz. The measuring receiver was used in the Time Domain mode with both QP and Average detectors enabled. The calculation for the power line conducted emissions is as follows:

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

Since the end application power cord length is unknown and/or could be a fixed hard line, the EUT was affixed with a 1-meter flexible cord for testing purposes.

The EUT only has one overall operational mode and is automatically set after power up. The EUT will enter a "monitoring" mode in which it monitors the state of the AC line also used to power the EUT. During this monitoring state, the EUT wirelessly broadcasts AC line information. Therefore, maximization was exclusively a function of the EUT channel being tested. All 3 channels were tested with maximum emissions for each channel provided below.

20.5 Result

Final Measurements Conducted Line Emissions - 150kHz to 30MHz Maximum Emissions Relative to the Limit						
Channel Frequency (MHz)	Conductor	Emission Frequency (MHz)	Detector	Meas (dBuV)	Limit (dBuV)	Margin (dB)
908	L1	0.350	QP	48.28	58.96	10.68
908	L1	0.526	QP	47.81	56.00	8.19
908	L1	0.701	QP	47.43	56.00	8.57
908	L1	0.877	QP	46.05	56.00	9.95
908	L1	1.754	QP	44.33	56.00	11.67
908	L1	1.930	QP	43.84	56.00	12.16
908	L2	0.526	QP	46.05	56.00	9.95
908	L2	0.701	QP	46.23	56.00	9.77
908	L2	0.877	QP	45.13	56.00	10.87
908	L2	0.965	QP	44.60	56.00	11.40
908	L2	1.754	QP	45.07	56.00	10.93
908	L2	1.930	QP	45.13	56.00	10.87
916	L1	0.352	QP	49.32	58.90	9.58
916	L1	0.528	QP	48.15	56.00	7.85
916	L1	0.704	QP	47.65	56.00	8.35
916	L1	0.791	QP	46.81	56.00	9.19
916	L1	0.879	QP	48.92	56.00	7.08
916	L1	1.756	QP	45.40	56.00	10.60
916	L2	0.528	QP	45.84	56.00	10.16
916	L2	0.704	QP	45.08	56.00	10.92
916	L2	0.791	QP	44.17	56.00	11.83
916	L2	0.879	QP	45.49	56.00	10.51
916	L2	1.756	QP	44.73	56.00	11.27
916	L2	1.932	QP	44.78	56.00	11.22
924	L1	0.35	QP	47.73	58.96	11.23
924	L1	0.526	QP	46.60	56.00	9.40
924	L1	0.701	QP	46.10	56.00	9.90
924	L1	0.877	QP	44.96	56.00	11.04
924	L1	1.756	QP	44.11	56.00	11.89
924	L1	1.932	QP	43.46	56.00	12.54
924	L2	0.528	QP	44.90	56.00	11.10
924	L2	0.704	QP	46.34	56.00	9.66
924	L2	0.879	QP	44.24	56.00	11.76
924	L2	0.967	QP	44.06	56.00	11.94
924	L2	1.756	QP	44.80	56.00	11.20
924	L2	1.932	QP	44.91	56.00	11.09

Negative margin indicates measurements ABOVE the limit.
Positive margin indicates measurements BELOW the limit.

Table 20-1 - Final Conducted Emissions Measurements, 150kHz - 30MHz

20.6 Plots

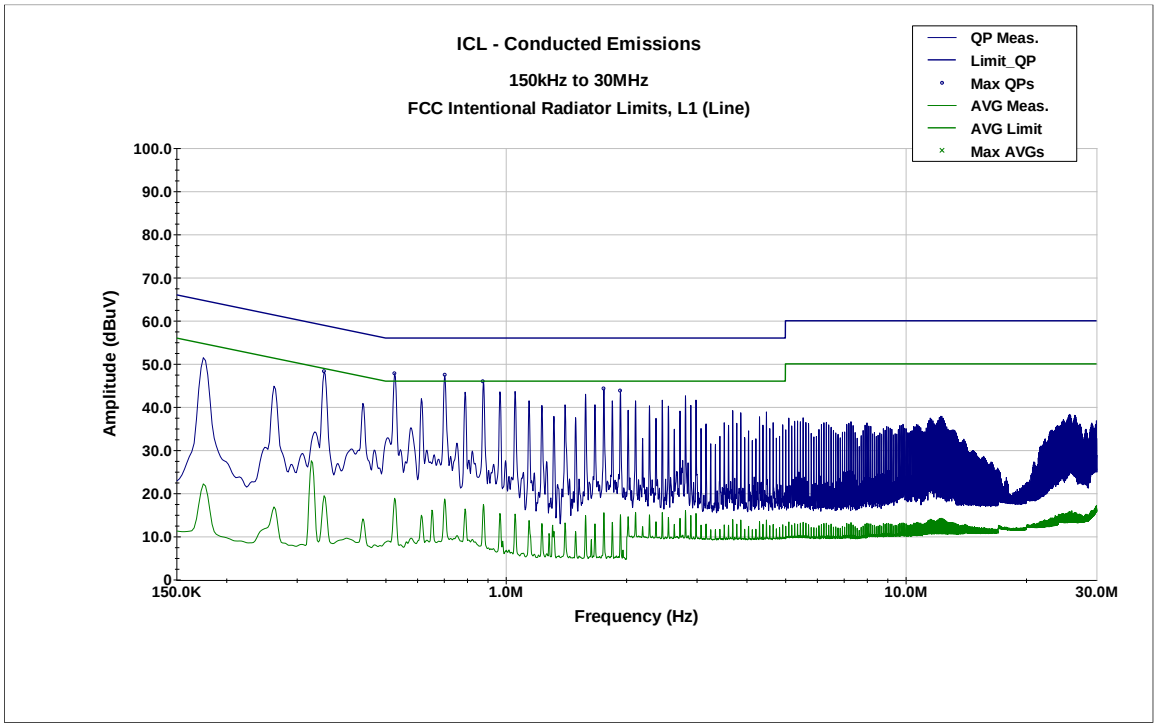


Figure 20-1 - Final Quasi-Peak and Average Measurements, 150kHz to 30MHz, Line, Low Channel

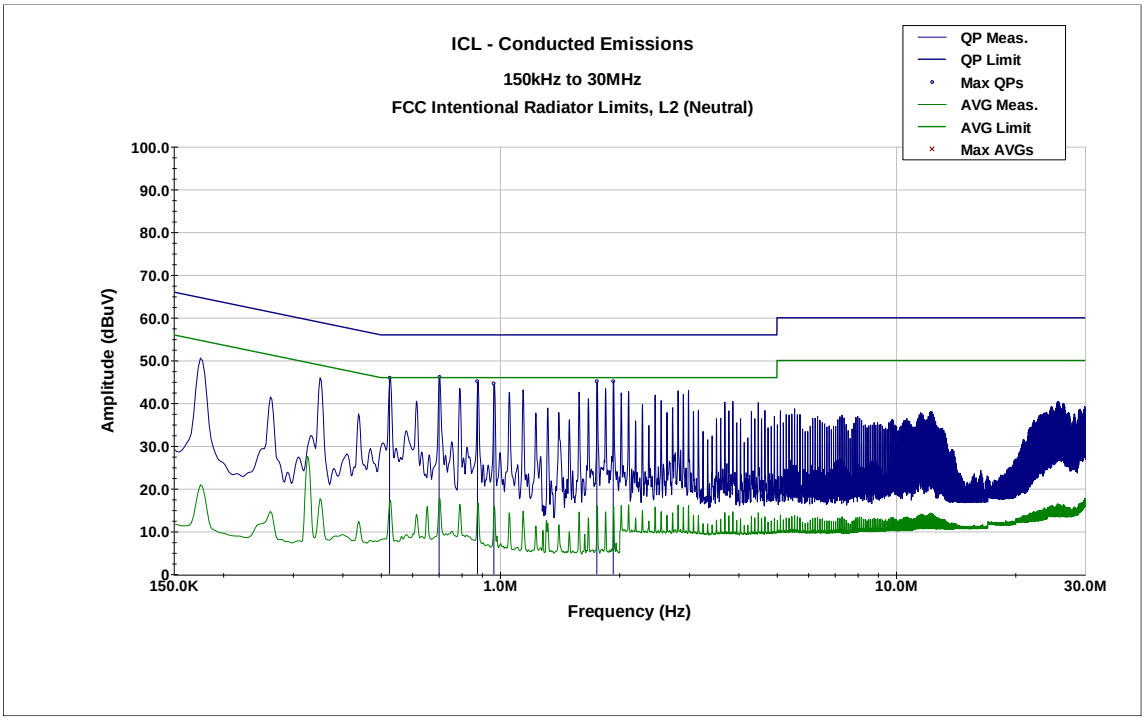


Figure 20-2 - Final Quasi-Peak and Average Measurements, 150kHz to 30MHz, Line 2, Low Channel

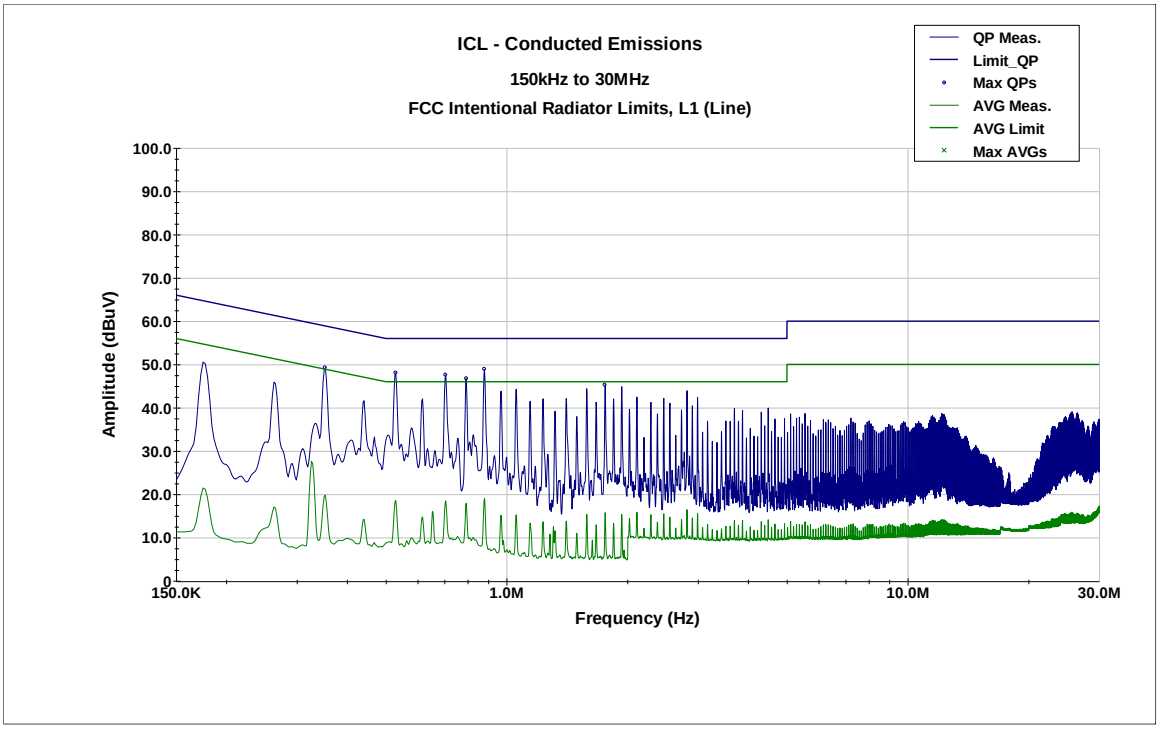


Figure 20-3 - Final Quasi-Peak and Average Measurements, 150kHz to 30MHz, Line, Middle Channel

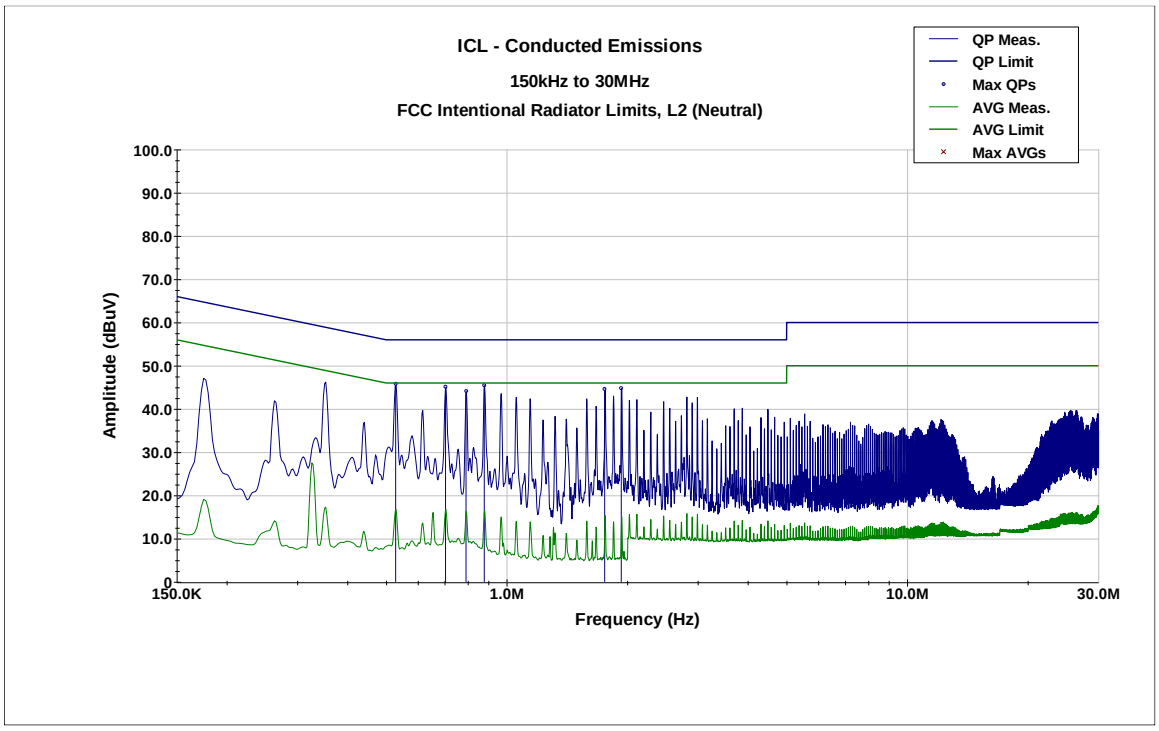


Figure 20-4 - Final Quasi-Peak and Average Measurements, 150kHz to 30MHz, Line 2, Middle Channel

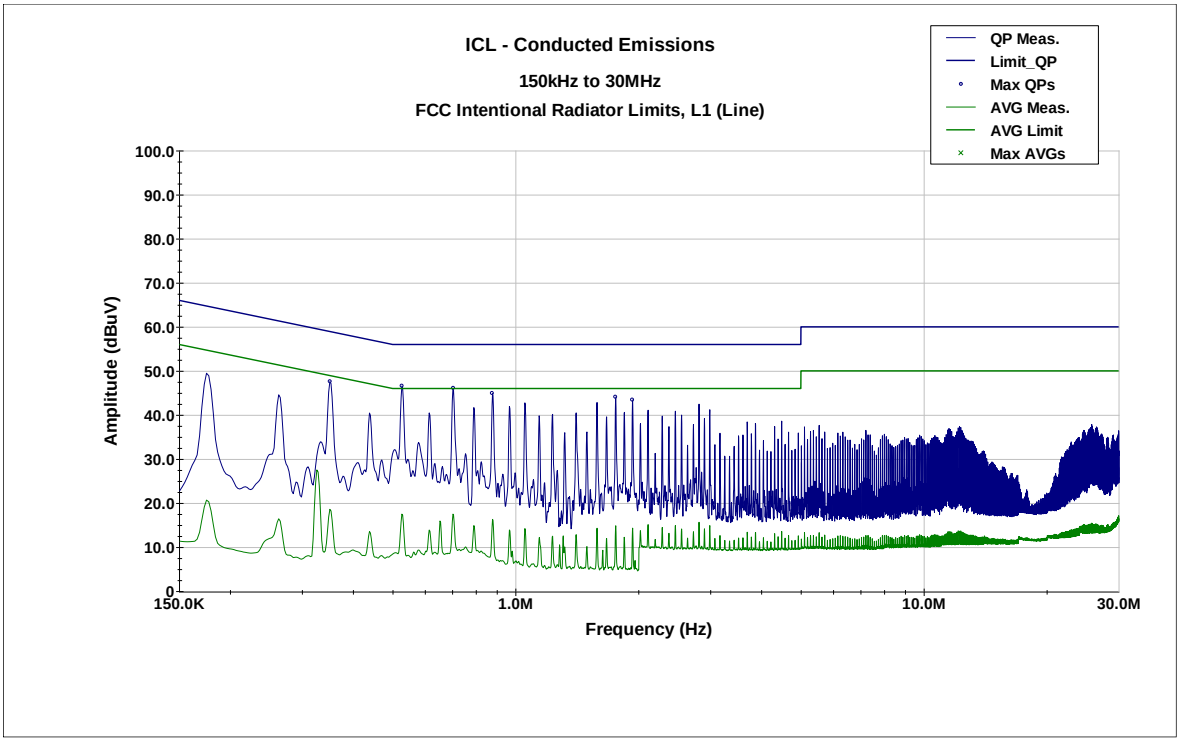


Figure 20-5 - Final Quasi-Peak and Average Measurements, 150kHz to 30MHz, Line, High Channel

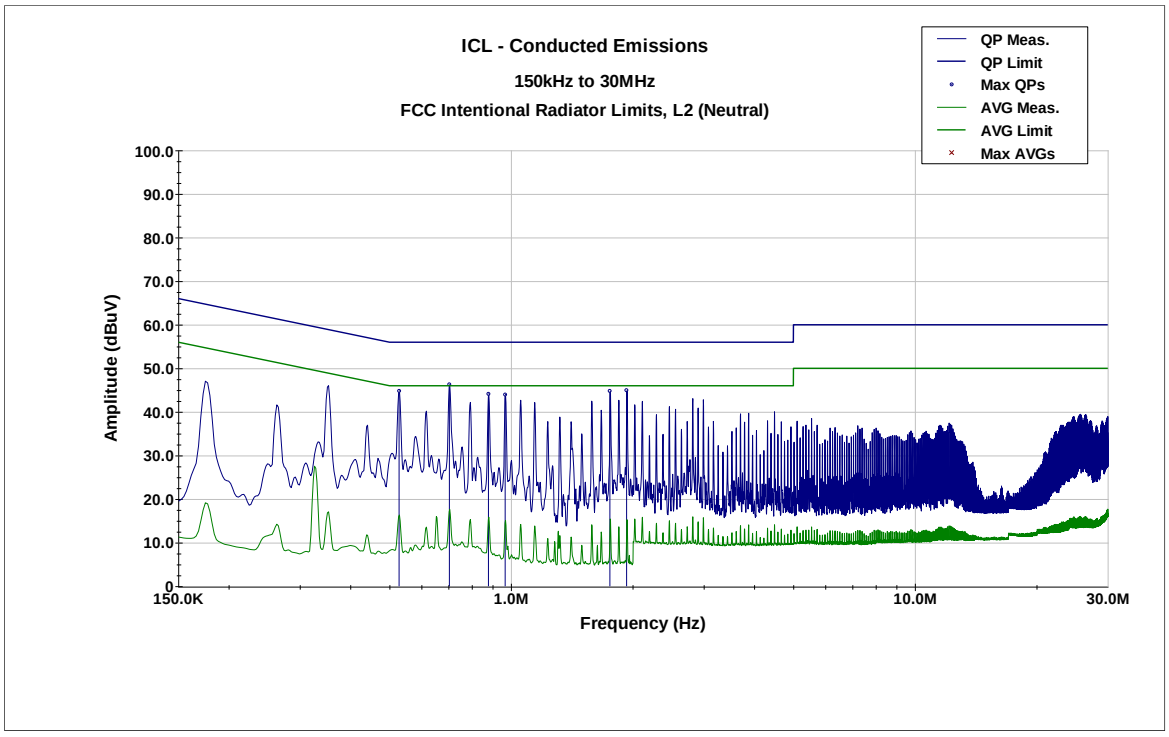


Figure 20-6 - Final Quasi-Peak and Average Measurements, 150kHz to 30MHz, Line 2, High Channel

21.0 AC Power Line Conducted Emissions (Receiver Mode)

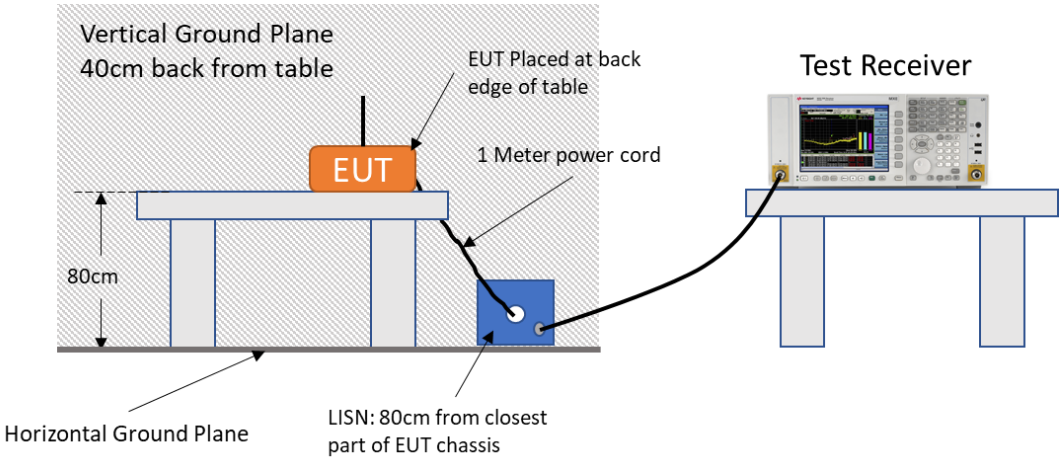
21.1 Regulation

FCC CFR 47 part 15.107

21.2 Requirement

For Class A digital devices, equipment designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back on to the AC power line on any frequency, within the band of 150 kHz to 30 MHz, shall not exceed the limits defined in 15.207(b).

21.3 Test Setup



21.4 Test Method

ANSI C63.4, Clause 7

Measurements were taken from 150kHz to 30MHz with the EMI test receiver's resolution bandwidth set to 9kHz. The measuring receiver was used in the Time Domain mode with both QP and Average detectors enabled.

Since the end application power cord length is unknown and/or could be a fixed hard line, the EUT was affixed with a 1-meter flexible cord for testing purposes.

The EUT only has one overall operational mode and is automatically set after power up. The EUT will enter a "monitoring" mode in which it monitors the state of the AC line also used to power the EUT. During this monitoring state, the EUT wirelessly broadcasts AC line information. For unintentional radiator and receiver mode only testing, the EUT's transmitter was disabled. The customer provided a transmitter module that had the transmitter disabled via firmware.

Automated software (Tile 7.5.7.6) was used to setup and control the measurement instrumentation. The software was also loaded with the appropriate calibration factors (for the cables, limiters, LISN's, etc…) and performed the corrections after gathering the raw

uncorrected measurement instrument data. The software also provides the data presented in this report. Sample calculations used in the software are shown in the sections that follow

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

Corrected data collected by the software was then compared to the Class A conducted limits specified in FCC CFR 47 Part 15.109 and used for margin calculations. A Summary limit table is provided in Table 21-1 for reference.

Frequency Range	Quasi-Peak Limits	Average Limits
(MHz)	(dBuV)	(dBuV)
0.15 to 0.50	79	66
0.50 to 30	73	60

Table 21-1 – FCC Conducted Class A Limits

21.5 Result

All emissions measured with a QP detector were greater than 20dB below the FCC QP limit for Class A digital devices. All emissions measured with an average detector were greater than 20dB below the FCC average limit for Class A digital devices.

21.6 Plots

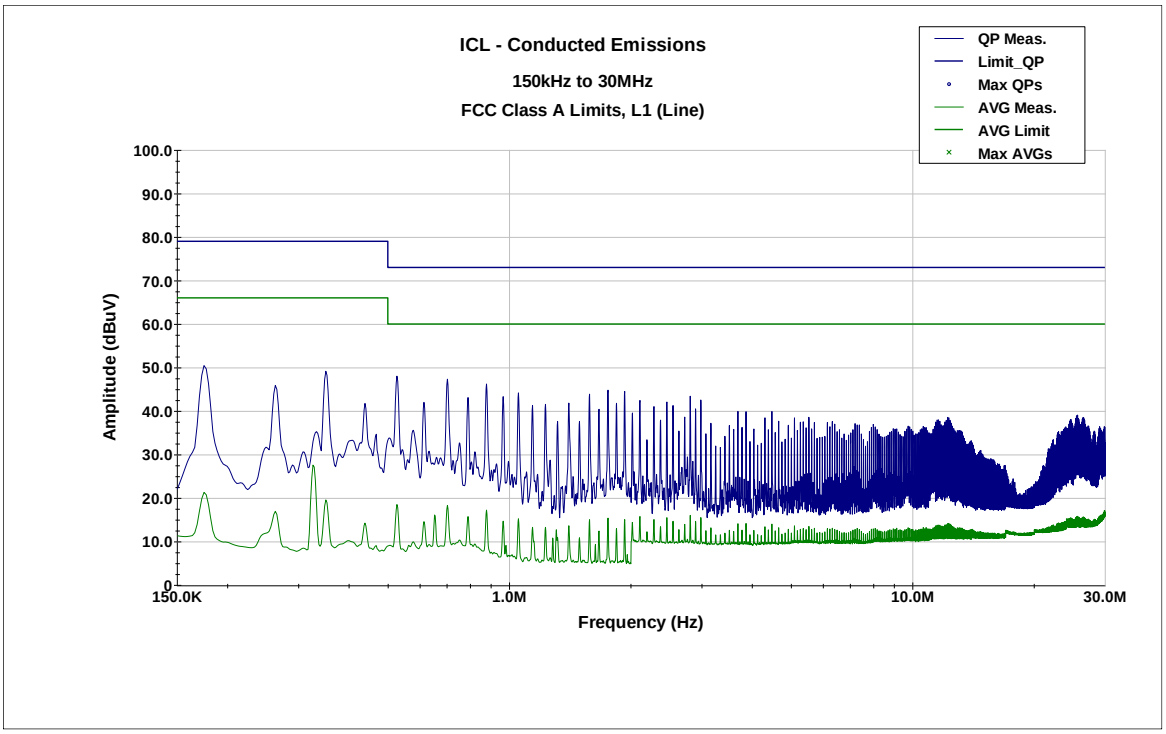


Figure 21-1 - Final Quasi-Peak and Average Measurements, 150kHz to 30MHz, Line, Receiver Mode

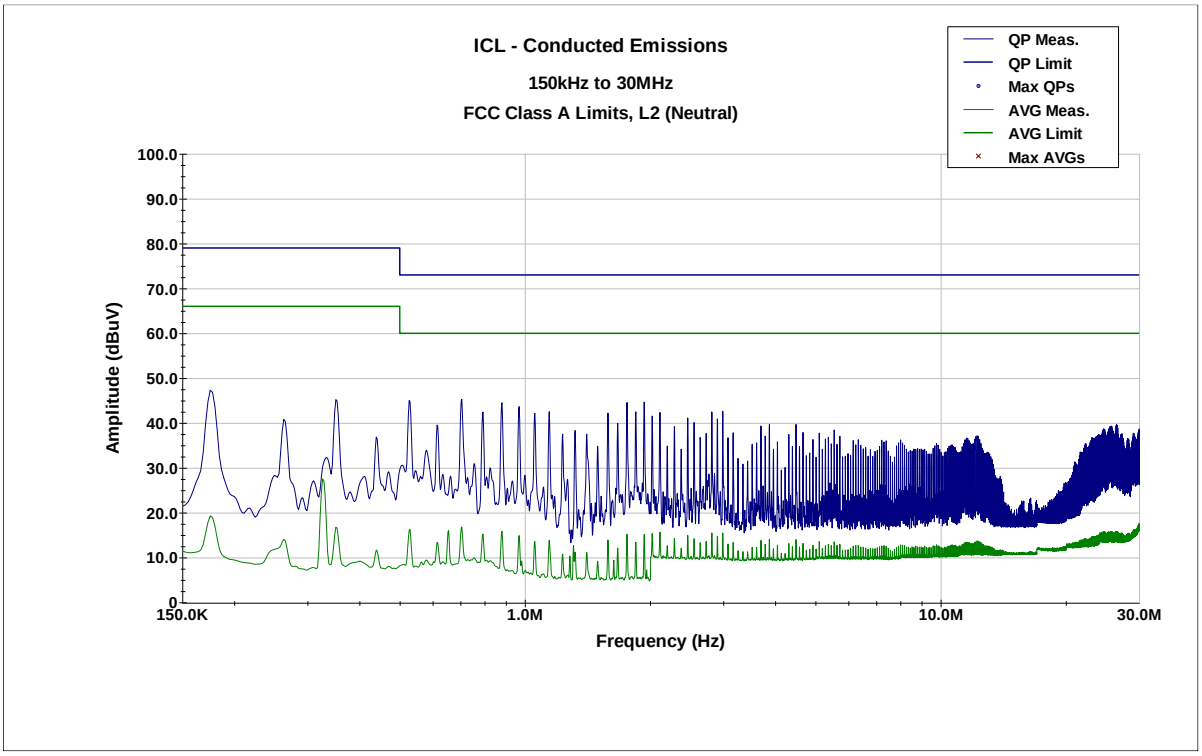


Figure 21-2 - Final Quasi-Peak and Average Measurements, 150kHz to 30MHz, Line, Receiver Mode

22.0 Fundamental Power with Line Voltage Variation

22.1 Regulation

FCC CFR 47 Part 15.31(e), FCC CFR 47 Part 15.247

22.2 Requirement

For intentional radiators, measurements of the variation of the radiated signal level of the fundamental frequency component of the emission shall be performed with the supply voltage varied between 85% and 115% of the rated supply voltage.

22.3 Test Setup

The test setup for measuring the fundamental was the same setup for measuring radiated emissions as outlined in section 18.3.2. Additionally, the EUT was powered with a variable AC power source, supplied through the chamber filters.

22.4 Test Method

ANSI C63.10, Clause 5.13, Clause 6.8, and Clause 11.9.1.1

The EUT fundamental emission was maximized with the AC power supply initially set to the nominal rated voltage of 120V ac. A final fundamental peak power measurement, with the EUT powered at 120V, was performed, and recorded. This served as the reference measurement for the subsequent voltage variation tests.

The AC power supply was then set to the lowest and highest specified operating AC line voltage for the EUT. Fundamental peak power measurements were performed at each level and compared to the 120V reference to check for deviation. At each voltage setting, the actual AC line voltage at the EUT plug were measured with a digital multimeter.

The procedure for the actual voltage variation test followed ANSI C63.10 Clause 6.8, substituting the considerations as specified in clause 5.13.

The actual specified line voltage range of the EUT was 70 to 126V ac, therefore testing at 85 and 115% of the stated nominal voltage (120V ac) was not possible. Taking guidance from ANSI C63.10 Clause 5.13(b), the EUT was then tested at the minimum and maximum allowable voltage as specified by the manufacturer. Refer to section 4.12 for EUT voltage specifications.

22.5 Result

The EUT fundamental amplitude did not change when the AC input line voltage was varied between the EUT stated minimum and maximum voltages. This is considered to MEET the requirements.

23.0 Maximum Permissible Exposure

23.1 Regulation

FCC CFR 47 Part 15.247(i), Part 1.1307, and Part 1.1310

23.2 Requirement

According to part 15.247, products operating under this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

According to the FCC's definition as given in Part 1.1307, the EUT is classified as a fixed RF source. Additionally, since this type of fixed equipment does not fall into any of the categories listed in 1.1307 table 1 or clause 1.1307(b)(2), it is categorically excluded from routine environmental evaluation for RF exposure. However, it should still be demonstrated that the EUT complies with the RF exposure limits in part 1.1310.

23.3 MPE Calculation

The MPE calculations shown below assume the worst case programable power available to the EUT. Actual peak power output of the EUT is a little less than the programmed setting. The MPE calculations were performed in a separate spreadsheet and submitted as an exhibit with this report. Refer to the SAR exclusion and MPE calculation spreadsheet exhibit for calculation details.

Plots of the actual measured peak power output have been provided for reference.

23.4 Result

Freq. (MHz)	Antenna Gain (dBi)	Antenna Gain (numeric)	Peak Output Power (dBm)	Peak Output Power (mW)	Power Density(S) (mW/cm^2)	Limit of Power Density (S) (mW/cm^2)	Result
908	6	3.98107	19	40.738	0.062912	0.605	Pass
916	6	3.98107	19	40.458	0.062912	0.611	Pass
924	6	3.98107	19	38.548	0.062912	0.616	Pass

Table 23-1 - MPE Exposure Calculations (actual measured values)

23.5 Plots

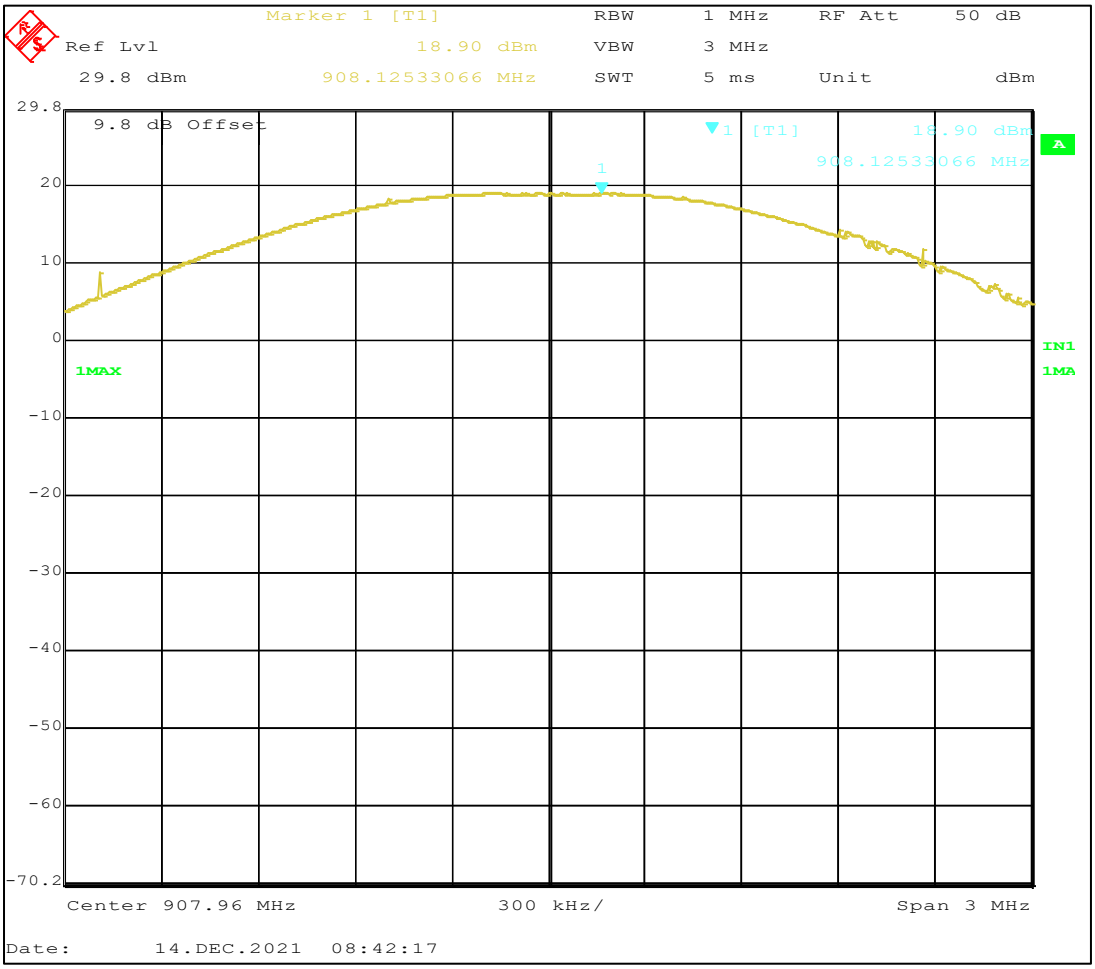


Figure 23-2 - Max Peak Power, Low Channel

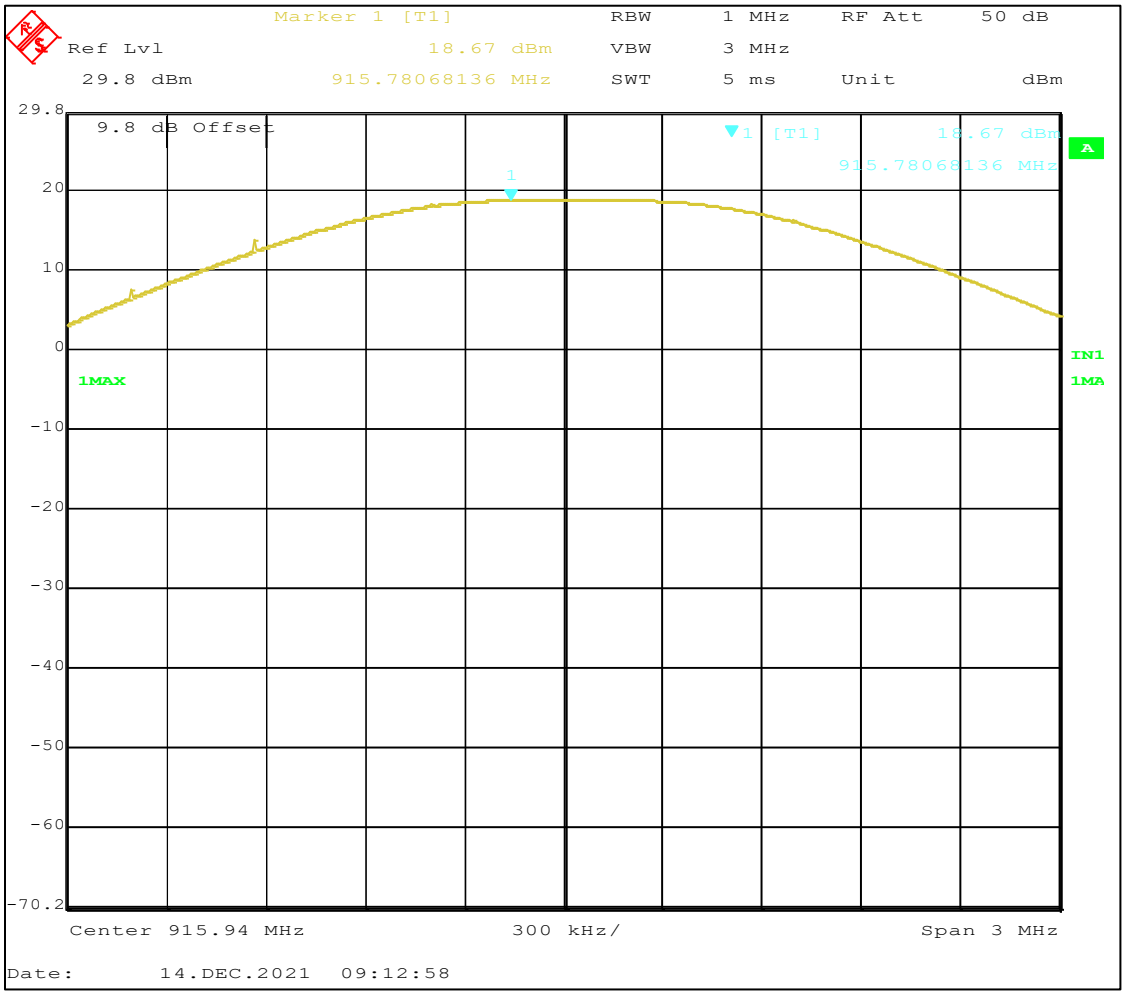


Figure 23-3 - Max Peak Power, Middle Channel

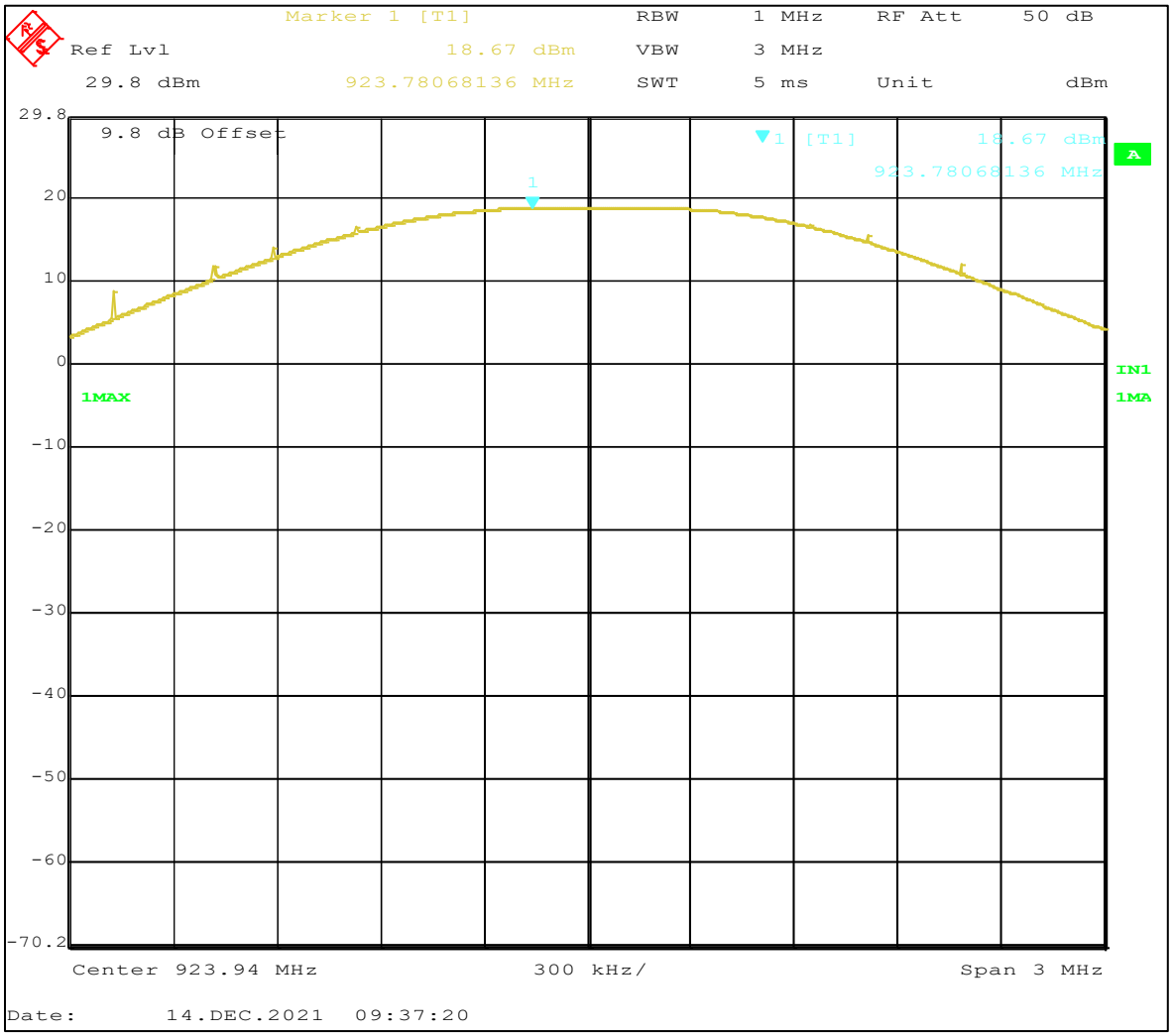


Figure 23-4 - Max Peak Power, High Channel

24.0 Conclusion

The High Impedance Fault Isolator, Model# HIFIS1, was found to **Meet** the requirements of the CFR47, Parts 15.203, 15.207, 15.215 & 15.247 for operating within the 902-928 MHz Band. See Section 0 of this report for a summary of tests.

Appendix A: Uncertainty

ANSI C63.10-2013, Clause 1.3 details the following decision rule:

> *The results of measurements of emissions from an unlicensed wireless device shall include measurement instrumentation uncertainty considerations contained in ETSI TR 100 028-2001. Determining compliance shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.*

Statements of conformity (e.g. Pass/Fail) to specifications are made in this report without taking measurement uncertainty into account. Where statements of conformity are made in this report, the following decision rules are applied:

PASS – Results within limits/specifications
FAIL – Results exceed limits/specifications

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level, using a coverage factor of k=2.

Measurement Type	Site/Equipment Configuration	Uncertainty Values
Radiated Emissions	3-meter chamber, 9kHz - 30MHz, LAS measurements	3.1 dB
Radiated Emissions	3-meter chamber, 30-1000MHz, BiConiLog horizontal antenna polarity, foam table-top	5.1 dB
Radiated Emissions	3-meter chamber, 30-1000MHz, BiConiLog vertical antenna polarity, foam table-top	6.2 dB
Radiated Emissions	3-meter chamber, 1-6GHz, foam table-top	6.1 dB
Radiated Emissions	3-meter chamber, 6-18GHz, foam table-top	6.3 dB
Conducted Emissions	ICL conducted emissions test area, Keysight MXE Receiver, AMN 150kHz – 30MHz	3.4 dB
Conducted RF Antenna Port Measurement	DTS/Occupied Bandwidth	2.26 kHz
Conducted RF Antenna Port Measurement	Maximum Conducted (average) Output Power	1.04 dB
Conducted RF Antenna Port Measurement	Power Spectral Density	0.9 dB
Conducted RF Antenna Port Measurement	Band Edge and Spurious Emissions ≤ 1GHz	0.7 dB
Conducted RF Antenna Port Measurement	Spurious Emissions 1GHz to 7GHz	1.2 dB
Conducted RF Antenna Port Measurement	Spurious Emissions > 7GHz	2.3 dB

Table A-1, ICL's Table of Expanded Uncertainty Values (k=2)
for Specific Types of Measurements

Appendix B: Test Setup Photos

All photos have been removed from this report for confidentiality purposes. EUT and test setup photos are available as separate exhibits.