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Test report

363662 - 1TRFWL

Date of issue: November 20, 2018

Applicant:

SOLiD

Product:

Amplifier for the Alliance LROU

Model:

RDU_220

FCC ID: W6U220

Specification:

- FCC 47 CFR Part 90

Private Land Mobile Radio Services

- FCC 47 CFR Part 2

Frequency Allocations and Radio Treaty Matters General Rules and Regulations

Lab and test locations

Company name	Nemko USA Inc.
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State	California
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Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
Site number	FCC: US5058

Tested by	Martha Espinoza, Wireless Engineer
Tester signature	
Reviewed by	Chip Fleury, Wireless and Certification Supervisor
Review date	November 22, 2018
Reviewer signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko USA's ISO/IEC 17025 accreditation.

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	SOLiD
Address	10, 9th Floor, SOLiD Space, Pangyoyeok-ro 220
City	Seongnam-si, Gyeonggi-do
State	N/A
Postal/Zip code	463-400
Country	Korea

1.2 Test specifications

FCC 47 CFR Part 90	Private land mobile radio services
KDB 935210 D05 Indus Booster Meas v01r02	Measurements guidance for industrial and non-consumer signal booster, repeater and amplifier devices

1.3 Test method

ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
363662-1TRFWL	Original report issued
363662-1TRFWL	Changes to pages 2,4,5,6,12,17,20,23

Table 1.5-1: *Test report revision history*

Section 2. Summary of test results

2.1 FCC Part 90 Subpart T Regulations Governing Licensing and Use of Frequencies in the 220-222 MHz Band and Subpart I—General Technical Standards / Test results

Part	Test description	Verdict
90.203(k)	Frequency Bands	Verified
§90.205,	Power and antenna height limits.	Pass
§90.207	Types of emissions.	Pass
§90.209	Bandwidth limitations.	Pass
§90.210	Emission masks	Pass
§90.212	Provisions relating to the use of scrambling devices and digital voice modulation[1]	Not applicable
§90.213	Frequency stability.	Not applicable
§90.214	Transient frequency behavior.	Not applicable
§90.215	Transmitter measurements.	Not applicable
§90.219	Use of Signal Boosters	Pass
§90.221	Adjacent channel power limits.	Not applicable

Notes:

[1]EUT is a Signal Booster set to produce a constant output at 24dBm when the input signal ranges from -20 to +10dB and transmits in the 220 - 222 MHz range and does not alter the input signal in any way.

Table 2.1-1: *FCC Part 90, Subpart I results summary*

2.2 FCC Part 90.219 Subpart I—Signal boosters

Part	Test description	Verdict
90.219 (d) (1) – (7)	Deployment rules	See Letter
90.219 (e) (1)	Device specifications output power	Pass
90.219 (e) (2)	Noise Figure	Not applicable
90.219 (e) (3)	Spurious Emission	Pass
90.219 (e) (4)	Input/output power and amplifier/booster gain comparison	Pass
90.219 (e) (5)	Label	See Label

2.3 KDB935210 D05—General Requirements, PLMRS/PSRS REPEATER/AMPLIFIER AND INDUSTRIAL BOOSTER DEVICES

Part	Test description	Verdict
§ 4.1	General[1]	Not applicable
§4.2	Measuring AGC threshold.	Pass
§4.3	Out-of-band rejection.	Pass
§4.4	Input-versus-output signal comparison	Pass
§4.5	Input/output power and amplifier/booster gain.	Pass
§4.6	Noise figure measurements.	Pass
§4.7.1 /4.7.2	Measuring out-of-band/out-of-block (including intermodulation) and spurious emissions[2]	Not applicable
§4.7.3	EUT Spurious emissions conducted measurements.	Pass
§4.8	Frequency stability measurements. [3]	Not applicable
§4.9	Spurious emissions radiated measurements	Pass

Notes:

[1]The test signals used to cover table 1 of KDB935210 D05 came from the Auxiliary device.

[2] The system is a single channel system therefore there are no intermodulation products to measure

[3]the amplifier, booster, or repeater does not alter the input signal in any way, so a frequency stability test is not required

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	11/05/2018
Nemko sample ID number	363662

3.2 EUT information

Product name	Remote Drive Unit (RDU)
Model	RDU_220
Serial number	52202918800002

3.3 Technical information

Operating band	220-222 MHz
Modulation type	DQPSK
Power requirements	+/- 48 VDC
Emission designator	B9B, Part 90 Class B Industrial Booster (non-SMR)
Gain	37±0.5 (Downlink signal), 53±0.5 dB (Uplink signal). Complete system gain declared by manufacturer.
Antenna information	N/A
Equipment Class	Amplifier

3.4 Product description and theory of operation

EUT is a 24dBm Signal Booster working in the 220-222 MHz band (bi-directional mode).

3.5 EUT exercise details

The EUT was configured in several ways according to the test under interest. A DQPSK modulated signal was introduced into the system. It can be introduced by a transmission port or reception port.

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3.6 EUT setup diagram

Table 3.6-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
Power Supply	SOLiD	Internal Part (ROU module)	N/A
RCPU	SOLiD	Internal Part (ROU module)	N/A
R-Optic	SOLiD	Internal Part (ROU module)	N/A
Multiplexer	SOLiD	Internal Part (ROU module)	N/A

Note: All these parts are inside a module called ROU

Table 3.6-2: EUT interface ports

Description	Qty.
SMA Port	2
Dock Port	2
DC Port	1

Table 3.6-3: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop Computer	Dell	Inspiron 15-5548	9K84J22	-
DC Adapter	Dell	LA90PE1-01	J622H3	-
Base Station Interface Unit	SOLiD	SMDR-NH124: BIU	09C00005	02
Optical Distribution Unit	SOLiD	SMDR-NH124: ODU	15600316500270	-
Power supply	SOLiD	SMDR-NH124: RMP-480	N/A	-

Table 3.6-4: Inter-connection cables

Cable description	From	To	Length (m)
Fiber optic cable	ODU	R-Optic	2.0
SMA Cable	ODU	BIU	0.5
Serial Cable	ODU	BIU	0.5
Dock Station	ROU	BIU	-
Serial Cable	BIU	Laptop	1.0
SMA Cable (Tx/Rx)	RDU_220	In/Out	0.5

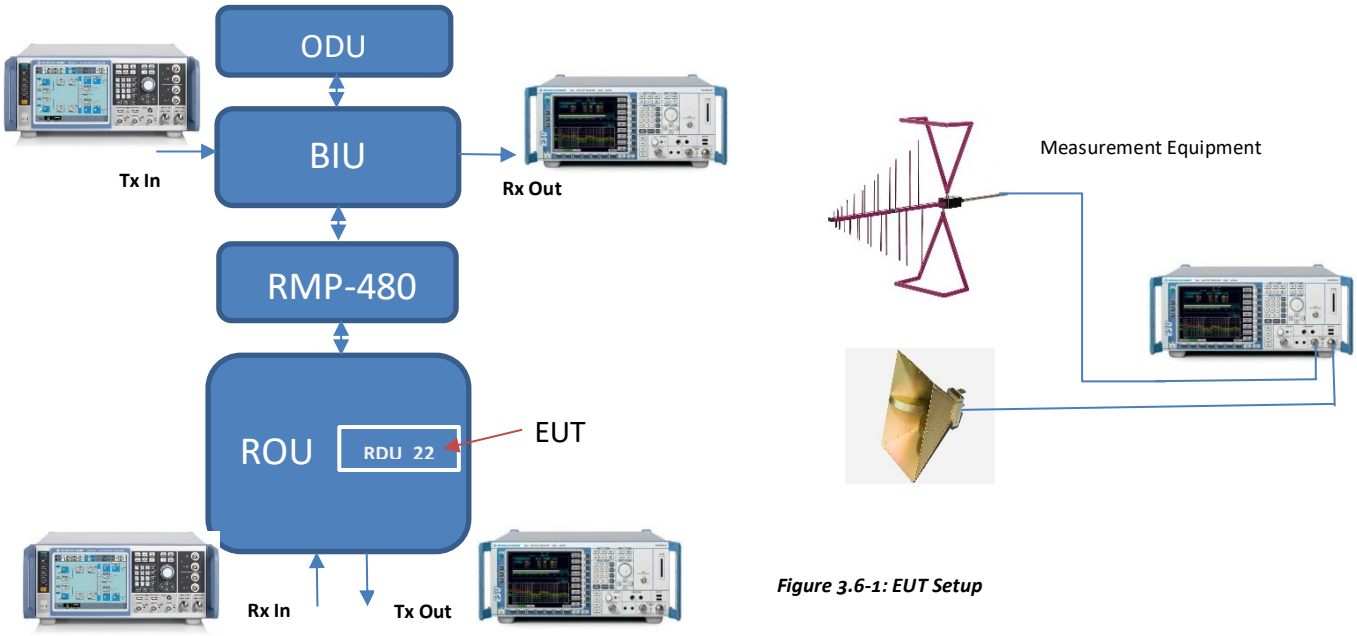


Figure 3.6-1: EUT Setup

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Nemko USA Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 “Uncertainty in EMC measurements.” Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Table 6.1-1: *Uncertainty of measurement*

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Conducted disturbance at mains port equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Test Receiver 9kHz to 7GHz	Rohde & Schwarz	ESCI 7	E1767	1 Year	02/21/2019
Two Line V-Network	Rohde & Schwarz	ENV216	E1019	1 Year	07/24/2019

Notes: None

Table 7.1-2: Radiated disturbance equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1121	1 Year	04/28/2019
Antenna, Bilog	Schaffner-Chase	CBL6111C	E1763	2 Years	11/28/2018
Antenna, Horn	ETS	3117-PA	E1139	2 Years	01/26/2020

Notes: None

Table 7.1-3: Radiated/Conducted disturbance test software details

Manufacturer of Software	Details
R&S	EMC32 V10.00.00

Notes: None

Table 7.1-4: Other equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Vector signal generator	Rohde & Schwarz	SMW200A	E1156	2 Years	10/04/2020
Signal analyzer	Rohde & Schwarz	FSV40	E1120	1 Year	08/24/2019

Notes: None

Section 8. Testing data

8.1 FCC §90.219(e)(1), §90.729(a), Per KDB935210 D05 § 4.5: Input - Output Power

8.1.1 Definitions and limits

FCC §90.219

(1) Signal boosters must be deployed such that the radiated power of each retransmitted channel, on the forward link and on the reverse link, does not exceed 5 Watts effective radiated power (ERP).

FCC §90.729

(a) The permissible effective radiated power (ERP) with respect to antenna heights for land mobile, paging, or fixed stations transmitting on frequencies in the 220-221 MHz band shall be determined from the following Table. These are maximum values and applicants are required to justify power levels requested.

ERP vs. Antenna Height Table[2]

Antenna height above average terrain (HAAT), meters	Effective radiated power, watts[1]
Up to 150	500
150 to 225	250
225 to 300	125
300 to 450	60
450 to 600	30
600 to 750	20
750 to 900	15
900 to 1050	10
Above 1050	5

[1]Transmitter PEP shall be used to determine ERP.

[2]These power levels apply to stations used for land mobile, paging, and fixed operations.

8.1.2 Test summary

Test date	November 12, 2018	Temperature	22 °C
Test engineer	Martha Espinoza, Wireless Engineer	Air pressure	1011 mbar
Verdict	Pass	Relative humidity	15 %

8.1.3 Observations, settings and special notes

The output of the RDU does not exceed 24dBm and the total transmitter power will not exceed 5W ERP (39 dBm)

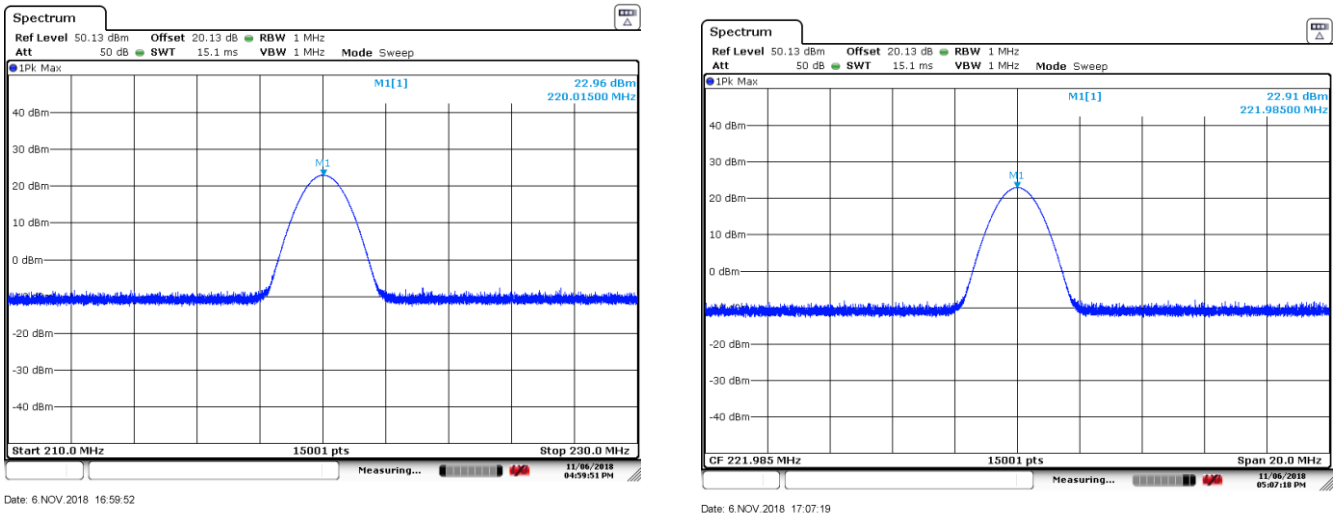
8.1.4 Test data RF Output power

Frequency (MHz)	Input (dBm)	Output (dBm)	Output (W)	ERP Limit (W)	Margin (W)	Gain	Max Ant Gain (dBi)[2]
220.015	-20	23.62	0.2302	5	4.7698	43.62	15.38
221.985	-20	23.70	0.2345	5	4.7655	43.70	15.3
220.015	-15	23.45	0.2214	5	4.7786	38.45	15.55
221.985	-15	23.39	0.2183	5	4.7817	38.39	15.61
220.015	-13	23.37	0.2173	5	4.7827	36.37	15.63
221.985	-13	23.36	0.2168	5	4.7832	36.36	15.64
220.015	-10	23.75	0.2372	5	4.7628	33.75	15.25
221.985	-10	23.71	0.2350	5	4.7650	33.71	15.29
220.015	**-5**	**23.78**	**0.2388**	**5**	**4.7612**	**28.78**	**15.22**
221.985	-5	23.31	0.2143	5	4.7857	28.31	15.69
220.015	0	23.31	0.2143	5	4.7857	23.31	15.69
221.985	0	23.70	0.2345	5	4.7655	23.70	15.3
220.015	+5	23.34	0.2158	5	4.7842	18.34	15.66
221.985	+5	23.27	0.2124	5	4.7876	18.27	15.73
220.015	+10	22.96	0.1977	5	4.8023	12.96	16.04
221.985	+10	22.91	0.1955	5	4.8045	12.91	16.09

Note: [1]AGC was activated automatically for controlling the gain at +24 dBm. The input signal was in carrier wave mode.

[2]Calculated Maximum antenna gain and remain compliant to the 5W limit is 15.22 dBi at 220.015 MHz

Table 8.1-1: Input – Output, power results



Note: An offset of 20.13 was used for this testing. It included the attenuator and cable loss.

Figure 8.1-1: Input – Sample plots of Output, power results. Input signal: +10 dBm

8.2 FCC §90.209 Bandwidth limitations.

8.2.1 Definitions and limits

(a) Each authorization issued to a station licensed under this part will show an emission designator representing the class of emission authorized. The designator will be prefixed by a specified necessary bandwidth. This number does not necessarily indicate the bandwidth occupied by the emission at any instant. In those cases where §2.202 of this chapter does not provide a formula for the computation of necessary bandwidth, the occupied bandwidth, as defined in part 2 of this chapter, may be used in lieu of the necessary bandwidth.

(b) The maximum authorized single channel bandwidth of emission corresponding to the type of emission specified in §90.207 is as follows:
(5) Unless specified elsewhere, channel spacings and bandwidths that will be authorized in the following frequency bands are given in the following table.

STANDARD CHANNEL SPACING/BANDWIDTH

Frequency band (MHz)	Channel spacing (kHz)	Authorized bandwidth (kHz)
Below 25[2]		
25-50	20	20
72-76	20	20
150-174	[1]7.5	[1 3]20/11.25/6
216-220[5]	6.25	20/11.25/6
220-222	5	4
406-512[2]	[1]6.25	[136]20/11.25/6
806-809/851-854	12.5	20
809-824/854-869	25	[6]20
896-901/935-940	12.5	13.6
902-928[4]		
929-930	25	20
1427-1432[5]	12.5	12.5
[3]2450-2483.5[2]		
Above 2500[2]		

8.2.2 Test summary

Test date	November 13, 2018	Temperature	24°C
Test engineer	Martha Espinoza, Wireless Engineer	Air pressure	1013 mbar
Verdict	Pass	Relative humidity	18 %

8.2.3 Observations, settings and special notes

The Bandwidth is based on the transmission of a DQPSK 25kHz single output from the RDU-220 amplifier.

8.2.4 Test data .

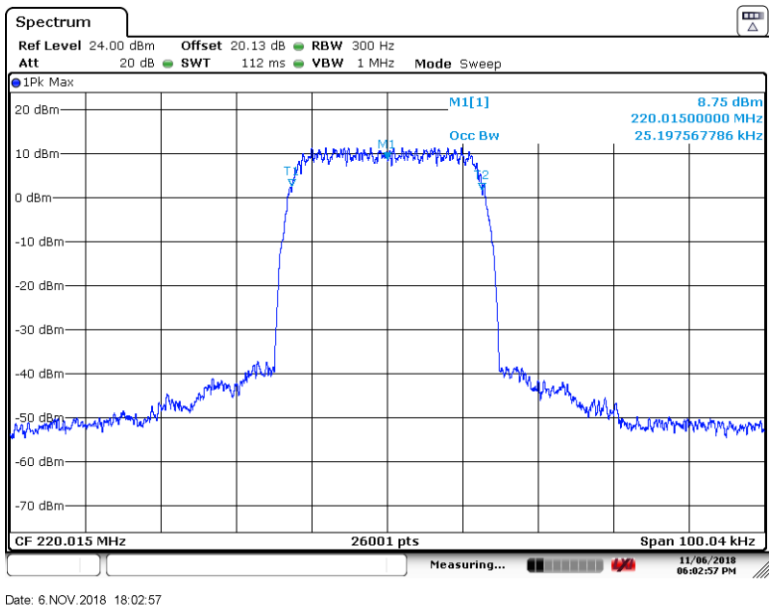
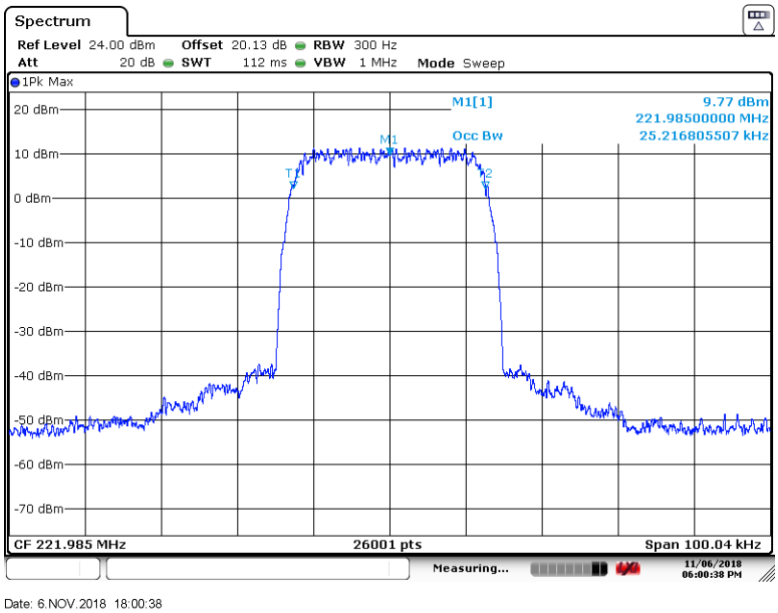


Figure 8.2-1: *Bandwidth plot, input power +10 dBm at 220.015 MHz*



Note: An offset of 20.13 was used for this testing. It included the attenuator and cable loss

Figure 8.2-2: *Bandwidth plot, input power +10 dBm at 221.985 MHz*

Frequency (MHz)	Bandwidth (kHz)
220.015	25.198
221.985	25.217

Table 8.2-1: *Bandwidth results summary*

8.3 90.219(d)(7), Part 90.205(f), Part 90.729 Per KDB935210 §4.3, Out of band rejection/passband of the RDU-220

8.3.1 Definitions and limits

(a) Each authorization issued to a station licensed under this part will show an emission designator representing the class of emission authorized.

90.219(d)(7) Signal booster passbands are limited to the service band or bands for which the operator is authorized. In general, signal boosters should utilize the minimum passband that is sufficient to accomplish the purpose. Except for distributed antenna systems (DAS) installed in buildings, the passband of a Class B booster should not encompass both commercial services (such as ESMR and Cellular Radiotelephone) and part 90 Land Mobile and Public Safety Services.

8.3.2 Test summary

Test date	November 12, 2018	Temperature	22°C
Test engineer	Martha Espinoza, Wireless Engineer	Air pressure	1011 mbar
Verdict	Pass	Relative humidity	15 %

8.3.3 Observations, settings and special notes

The operating range to be evaluated is 220 to 222MHz. The RDU-220 has a passband from 217 to 222MHz. the 217 to 220MHz passband may be utilized in future applications. For this application the manufacturer is declaring a frequency range from 220 to 222 MHz.

The declared operating range is 220 MHz to 222 MHz = a 2 MHz passband as demonstrated by M1 and M2 below.

Result: Class B equipment

8.3.4 Test data out of band rejection

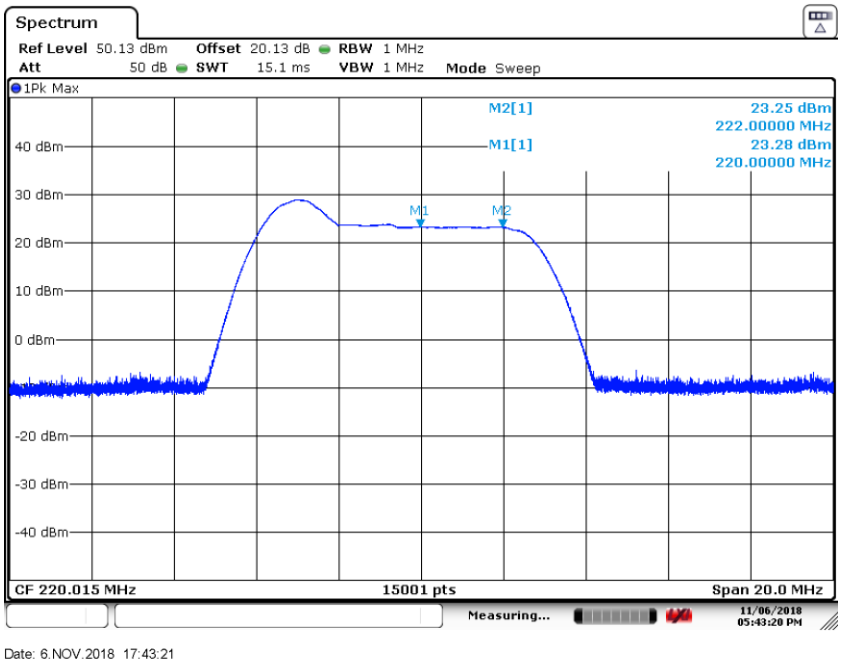


Figure 8.3-1: *Pass band response sweeping from 210 to 230 MHz*

Note: An offset of 20.13 was used for this testing. It included the attenuator and cable loss.

Operating range = 220 MHz to 222 MHz

8.4 KDB935210 §4.2: AGC Threshold

8.4.1 Definitions and limits

4.2 Measuring AGC threshold (applying procedure of 3.2 Measuring AGC threshold Level)

The AGC threshold is to be determined as follows.[3]

In the case of fiber-optic distribution systems, the RF input port of the equipment under test (EUT) refers to the RF input of the supporting equipment RF to optical convertor; see also descriptions and diagrams for typical DAS booster systems in KDB Publication 935210 D02 [R7].

Devices intended to be directly connected to an RF source (donor port) only need to be evaluated for any over-the-air transmit paths.

a) Connect a signal generator to the input of the EUT.
b) Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation as necessary.
c) The signal generator should initially be configured to produce either of the required test signals (i.e., broadband or narrowband).
d) Set the signal generator frequency to the center frequency of the EUT operating band.
e) While monitoring the output power of the EUT, measured using the methods of 3.5.3 or 3.5.4, increase the input level until a 1 dB increase in the input signal power no longer causes a 1 dB increase in the output signal power.
f) Record this level as the AGC threshold level.
g) Repeat the procedure with the remaining test signal.

8.4.2 Test summary

Test date	November 12, 2018	Temperature	22°C
Test engineer	Martha Espinoza, Wireless Engineer	Air pressure	1011 mbar
Verdict	Pass	Relative humidity	15 %

8.4.3 Observations, settings and special notes

This was for reporting only to demonstrate the operation of the AGC and to verify the maximum test levels.

Analysis of plots 8.4-1 and 8.4-2, is the AGC is functioning as intended. In the frequency range of 220 to 222MHz the threshold level can be defined as -15 dBm.

8.4.4 Test data AGC Threshold

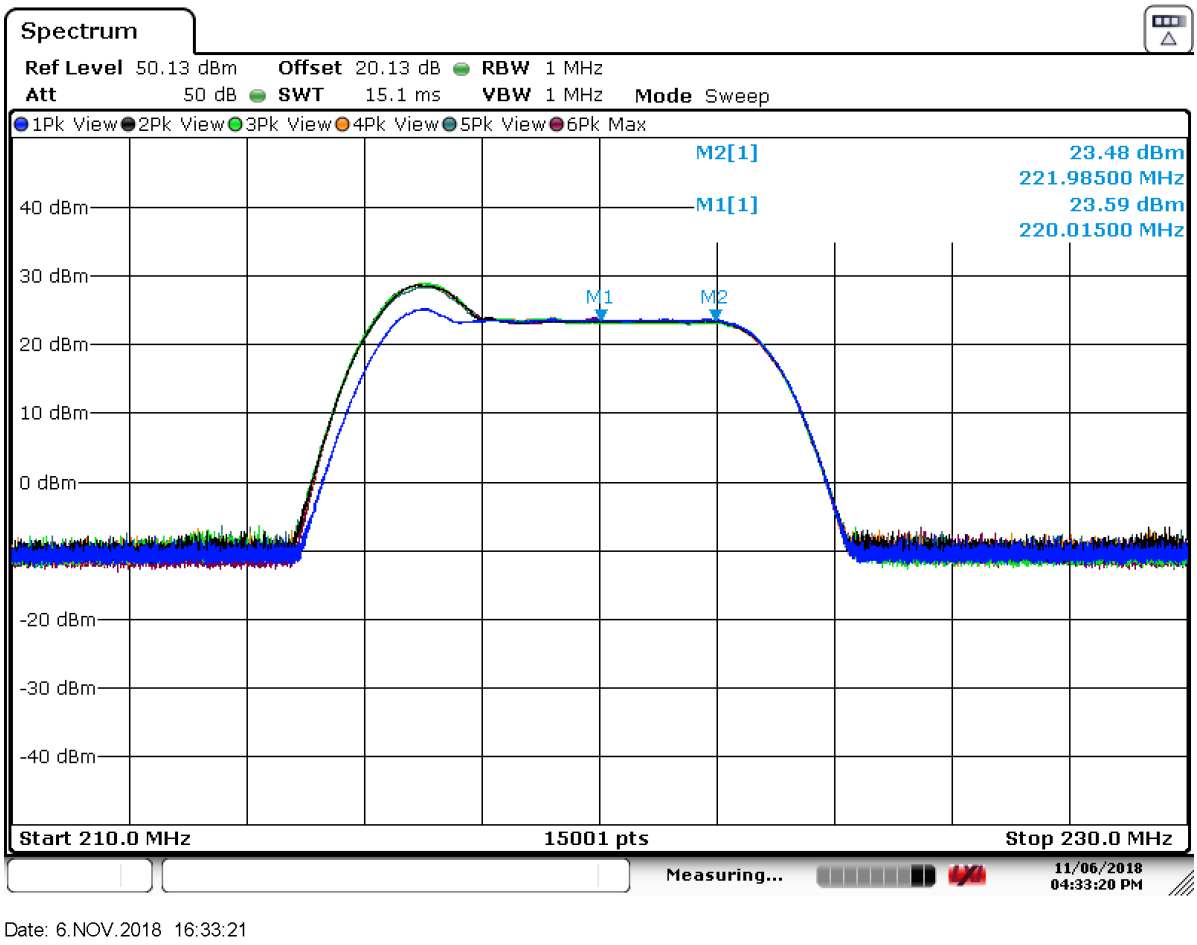


Figure 8.4-1: *Gain measuring increasing the input power from -20 dBm to +5 dBm.*

For this test the input power started at -20 dBm, going up until +5 dBm. When a -20 dBm input power level is applying, the response is a little different to the other cases (blue plot). However, in the frequency range of interest (transmission frequencies) the output power is very close in any input power level.

Note: An offset of 20.13 was used for this testing. It included the attenuator and cable loss.

.

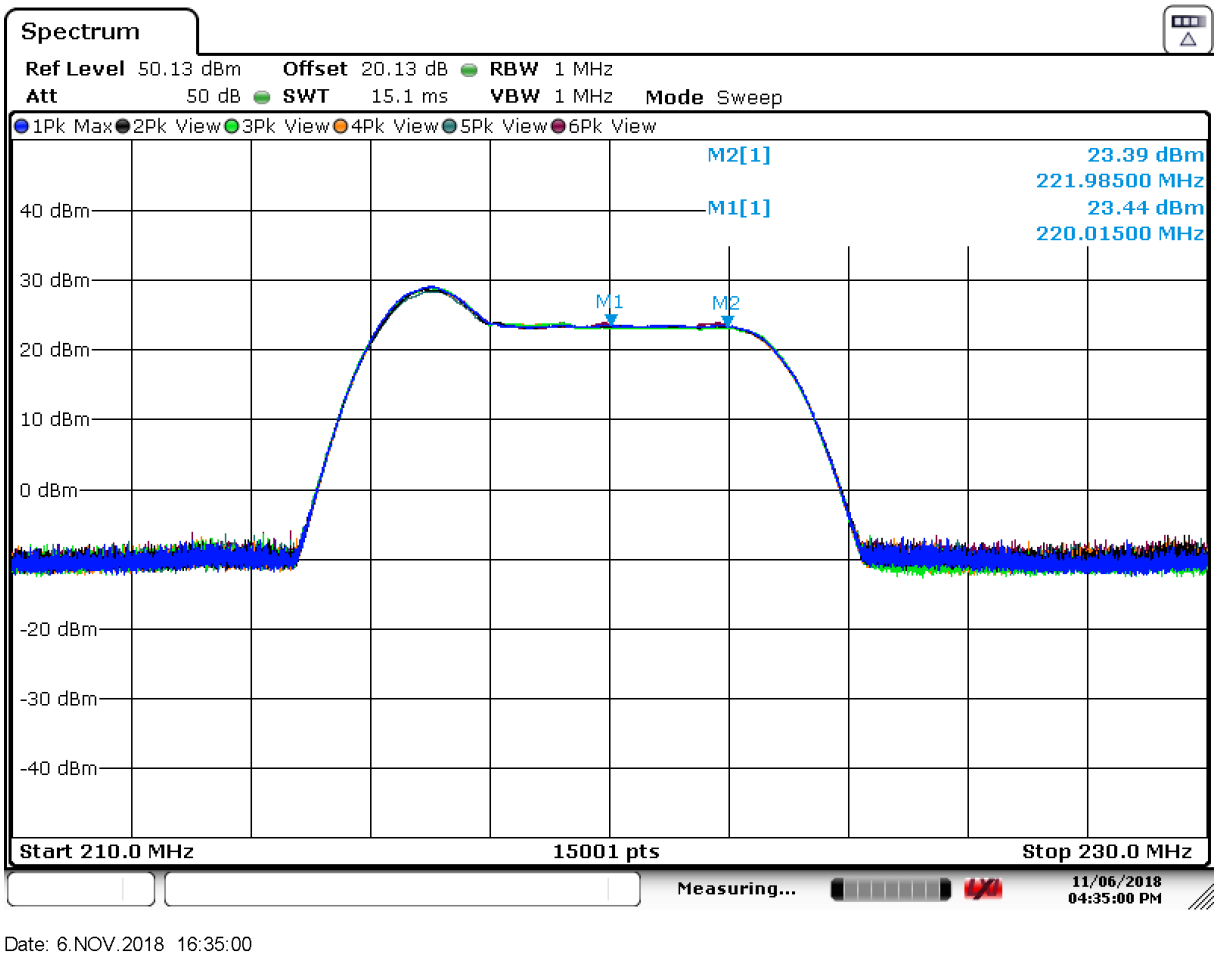


Figure 8.4-2: *Gain measuring increasing the input power from -15 dBm to +10 dBm.*

Note: An offset of 20.13 was used for this testing. It included the attenuator and cable loss.

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AGC THRESHOLD = -15 dBm Input Power

8.5 FCC § 90.210(f), FCC 90.219 (e)(4) and KDB 935210 § 4.4: Emission mask, Device Specifications and Input-versus-output signal comparison

8.5.1 Definitions and limits

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (o) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating under this part.

APPLICABLE EMISSION MASKS

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25[1]	A or B	A or C
25-50	B	C
72-76	B	C
150-174[2]	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512[2 5]	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854[6]	B	H
809-824/854-869[3 5]	B	G
896-901/935-940	I	J
902-928	K	K
929-930	B	G
4940-4990 MHz	L or M	L or M
5850-5925[4]		
All other bands	B	C

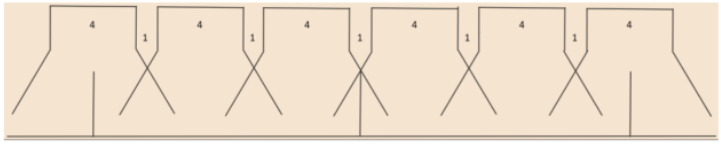
(f) *Emission Mask F.* For transmitters operating in the 220-222 MHz frequency band, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

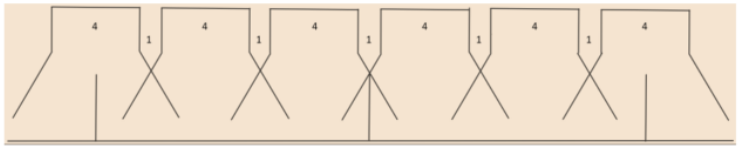
(1) On any frequency from the center of the authorized bandwidth f_o to the edge of the authorized bandwidth f_e: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 2 kHz up to and including 3.75 kHz: 30 + 20(f_d – 2) dB or 55 + 10 log (P), or 65 dB, whichever is the lesser attenuation.

(3) On any frequency beyond 3.75 kHz removed from the center of the authorized bandwidth f_d: At least 55 + 10 log (P) dB.

Below are the aggregated channels used with Emissions Mask F for low and High operating frequencies in the 220 to 222 MHz band.





Part 90.219 (e)(4)

(e) *Device Specifications.* In addition to the general rules for equipment certification in §90.203(a)(2) and part 2, subpart J of this chapter, a signal booster must also meet the rules in this paragraph.

(4) A signal booster must be designed such that all signals that it retransmits meet the following requirements:

(i) The signals are retransmitted on the same channels as received. Minor departures from the exact provider or reference frequencies of the input signals are allowed, *provided that* the retransmitted signals meet the requirements of §90.213.

(ii) There is no change in the occupied bandwidth of the retransmitted signals.

(iii) The retransmitted signals continue to meet the unwanted emissions limits of §90.210 applicable to the corresponding received signals (assuming that these received signals meet the applicable unwanted emissions limits by a reasonable margin).

Input-vesus-output signal comparison was tested per KDB 935210 D05 v01r02 clause 4.4

8.5.2 Test summary

Test date	November 13, 2018	Temperature	24°C
Test engineer	Martha Espinoza, Wireless Engineer	Air pressure	1013 mbar
Verdict	Pass	Relative humidity	18 %

8.5.3 Observations, settings and special notes

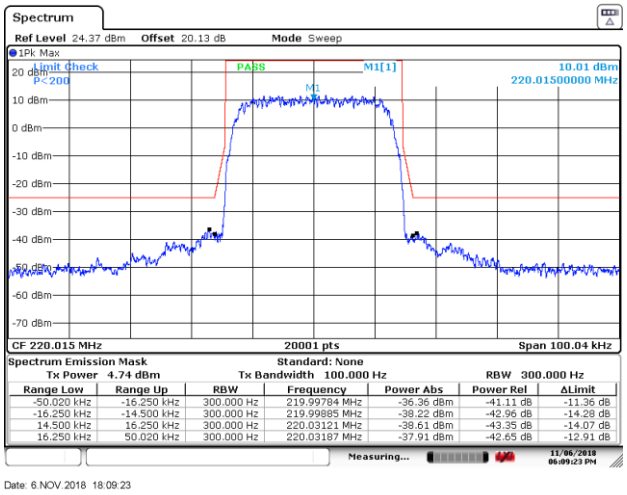
Low and High channels were investigated.
Spectrum Analyzer settings were:

Emissions Mask: The plots below on the left demonstrates compliance to the required emissions mask

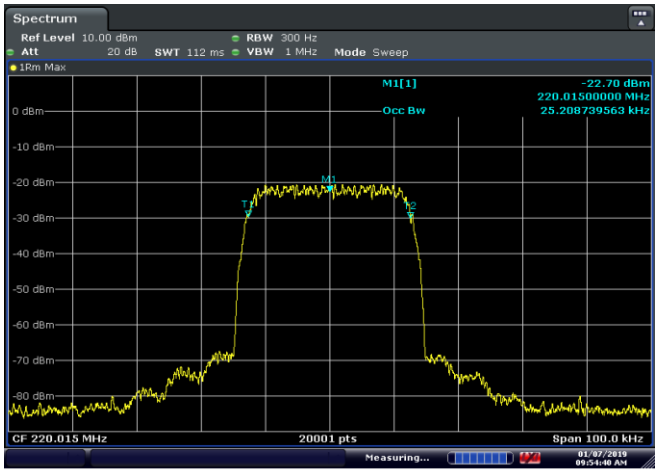
Input vs output signal: Signal Generator output and RDU220 output shown in Figures 8.5-1 and 8.5-2 demonstrates the RDU-220 output does not change the frequency, bandwidth or the shape of the input DQPSK signal. The only notable difference it amplitude.

Span	100KHz
Detector mode	Peak
Resolution bandwidth	300 Hz
Video bandwidth	3X RBW
Trace mode	A sufficient number of sweeps were measured to ensure that the emission profile is developed and within limits.

8.5.4 Test Data, Emission mask, Input-versus-output signal comparison



Date: 6.NOV.2018 18:09:23



Date: 7.JAN.2019 09:54:41

Figure 8.5-1: *Emission mask and input vs output comparison, input power +10 dBm at 220.015*
(Right side plot Signal Generator, Left side plot output of RDU220)

Note: An offset of 20.13 was used for this testing. It included the attenuator and cable loss.

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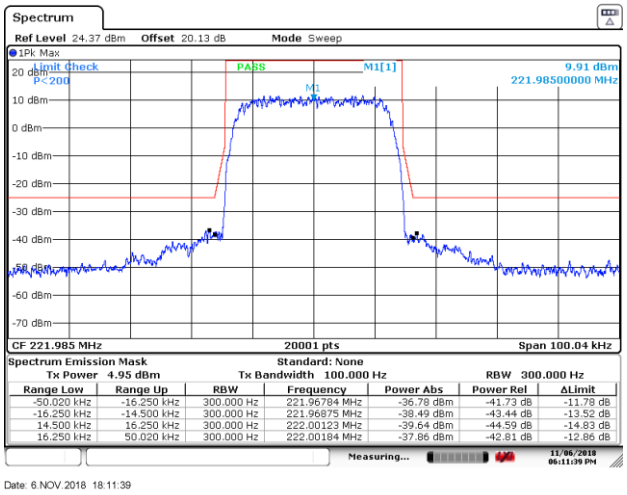
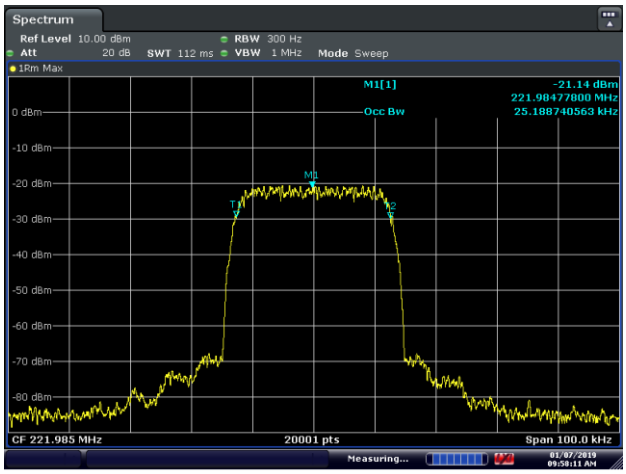
8.5.4 Test Data, Emission mask, Input-versus-output signal comparison, continued



Date: 6.NOV.2018 18:11:39



Date: 7.JAN.2019 09:58:11

Figure 8.5-2: *Emission mask and input vs output comparison, input power +10 dBm at 221.985 MHz*
(Right side plot Signal Generator, Left side plot output of RDU220)

Note: An offset of 20.13 was used for this testing. It included the attenuator and cable loss.

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8.6 FCC §90.219, KDB 935210-D05: Noise Figure

8.6.1 Definitions and limits

Section 90.219(e)(2) limits the noise figure of a signal booster to ≤ 9 dB in either direction. The following discussion provides guidance for demonstrating compliance with this requirement.

Several widely recognized methods for performing noise figure measurements are available. Some require the use of specialized equipment, such as a noise figure analyzer and/or an excess noise ratio (ENR) calibrated noise source, while others involve the use of conventional measurement instrumentation such as a spectrum analyzer. Methods that require use of a noise figure analyzer are generally accepted as producing the most accurate results, and are considered to be the reference method within this document, while others are considered to be acceptable alternative methods. Consult the relevant instrumentation application notes for detailed guidance regarding the selection and application of an appropriate methodology for performing noise figure measurements. Note also that noise figure measurements require that any AGC circuitry be disabled over the duration of the measurement.

8.6.2 Test summary

Test date	N/A	Temperature	N/A
Test engineer	Martha Espinoza, Wireless Engineer	Air pressure	N/A
Verdict	Pass	Relative humidity	N/A

8.6.3 Observations, settings and special notes

The RDU-220 Amplifier/Signal booster is part of a larger system for SOLiD and not available otherwise therefore the NF requirements is not applicable. The manufacturers declared noise figure is given below.

8.6.4 Test Data, Noise Figure

Noise figure	Limit	Margin
≤ 6 dB[1]	NF ≤ 9 dB	At least 3 dB

[1]Important note: The results of this test are based on the manufacturer declare.

8.7 FCC §90.219(e)(3), Per KDB 935210 § 4.9: Conducted Port Spurious Emissions

8.7.1 Definitions and limits

(e) Device Specifications. In addition to the general rules for equipment certification in §90.203(a)(2) and part 2, subpart J of this chapter, a signal booster must also meet the rules in this paragraph.

(3) Spurious emissions from a signal booster must not exceed −13 dBm within any 100 kHz measurement bandwidth.

8.7.2 Test summary

Test date	November 13, 2018	Temperature/	24 °C/1013 mbar/18 %
	November 14, 2018	Air pressure/	24 °C/1008 mbar/19 %
	November 16, 2018	Relative humidity	23 °C/1003 mbar/33 %
Test engineer	Martha Espinoza, Wireless Engineer		
Verdict	Pass		

8.7.3 Observations, settings and special notes

Complies

8.7.4 Test Data, Conducted and Spurious Emission

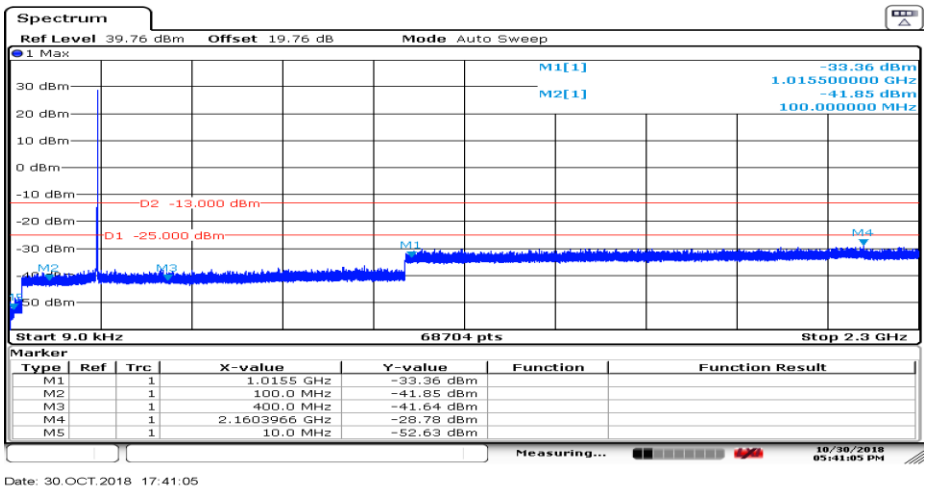
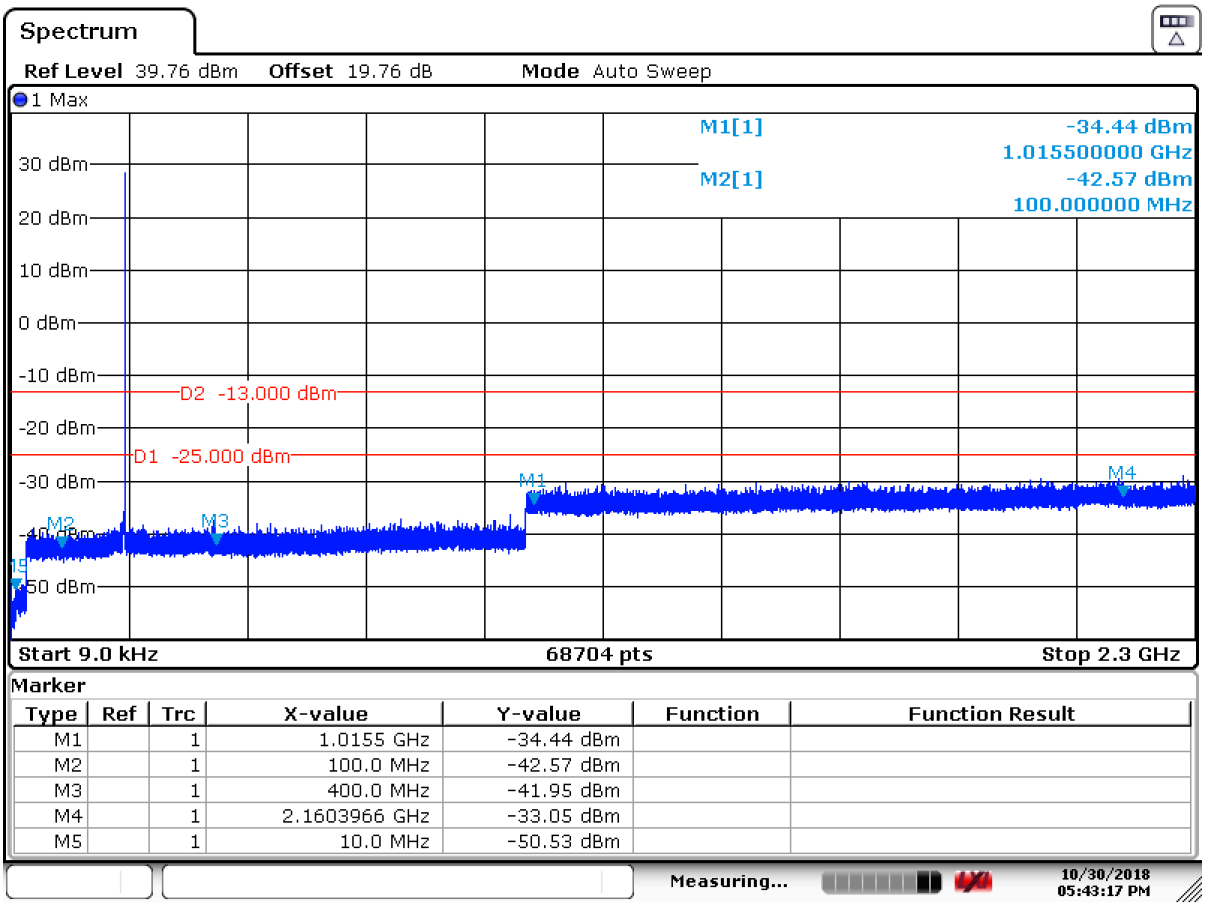


Figure 8.7-1: Conducted spurious plot, signal transmitted at 220.015 MHz

Note: An offset of 19.76 was used for this testing. It included the attenuator and cable loss.

Frequency	RE Spurious	Margin (-13 dBm)	Margin (-25 dBm)
10 MHz	-52.63 dBm	39.63 dBm	27.63 dBm
100 MHz	-41.85 dBm	28.85 dBm	16.85 dBm
400 MHz	-41.64 dBm	28.64 dBm	16.64 dBm
1.015 GHz	-33.36 dBm	20.36 dBm	8.36 dBm
2.160 GHz	-28.78 dBm	15.78 dBm	3.78 dBm

Table 8.7-1: Conducted spurious results, signal transmitted at 220.015 MHz



Date: 30.OCT.2018 17:43:17

Figure 8.7-2: Conducted spurious plot, signal transmitted at 221.985 MHz

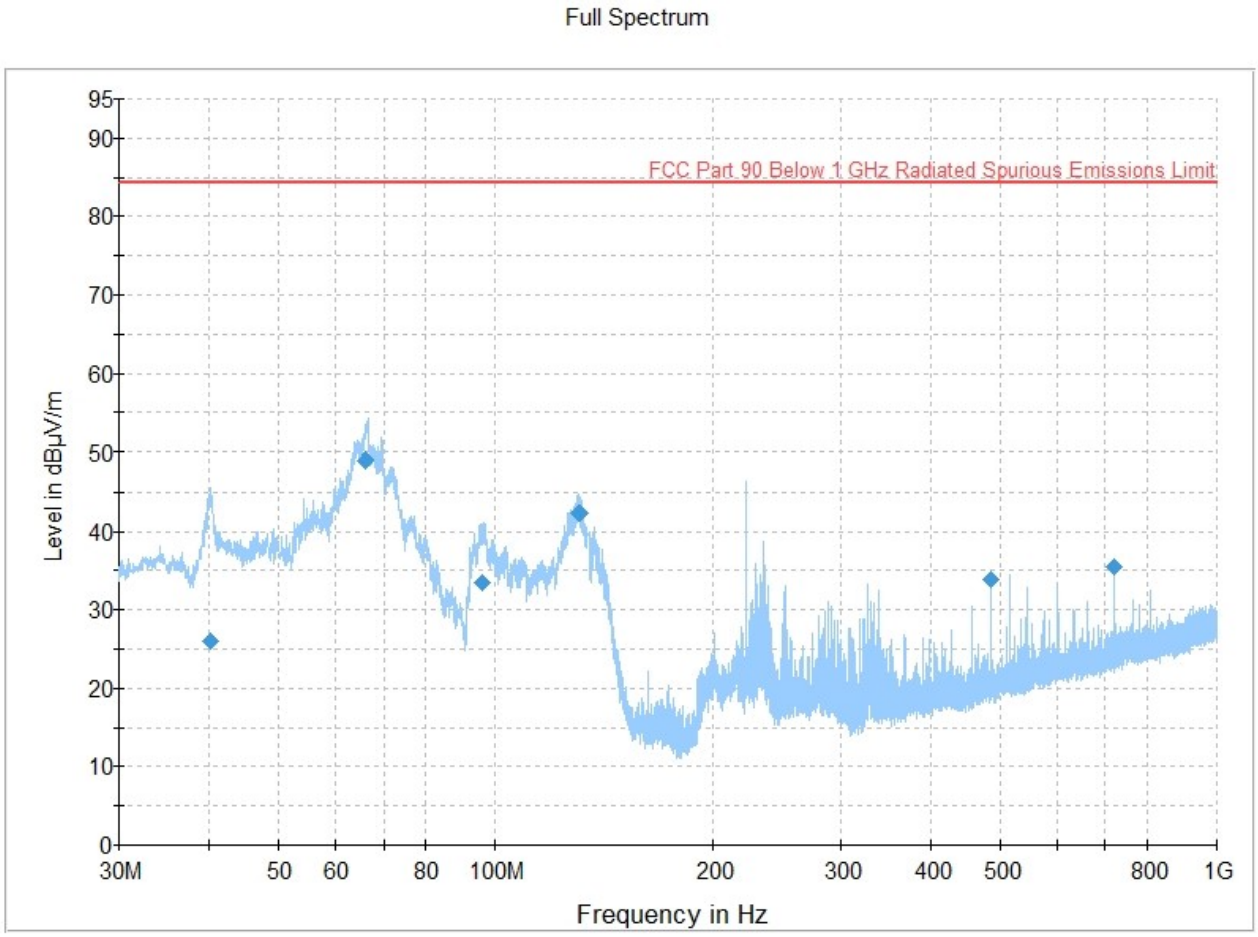
Note: An offset of 20.13 was used for this testing. It included the attenuator and cable loss.

Frequency	RE Spurious	Margin (-13 dBm)	Margin (-25 dBm)
10 MHz	-50.53 dBm	37.53 dBm	25.53 dBm
100 MHz	-42.57 dBm	29.57 dBm	17.57 dBm
400 MHz	-41.95 dBm	28.95 dBm	16.95 dBm
1.015 GHz	-34.44 dBm	21.44 dBm	9.44 dBm
2.160 GHz	-33.05 dBm	20.05 dBm	8.05 dBm

Table 8.7-2: Conducted spurious results, signal transmitted at 221.985 MHz

8.8 Conducted and Radiated Emissions

8.8.1 Test Data, Conducted and Radiated Emissions



The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.

Figure 8.7-3: Radiated spurious plot, signal transmitted at 221.985 MHz. Setup from 30 MHz to 1000 MHz

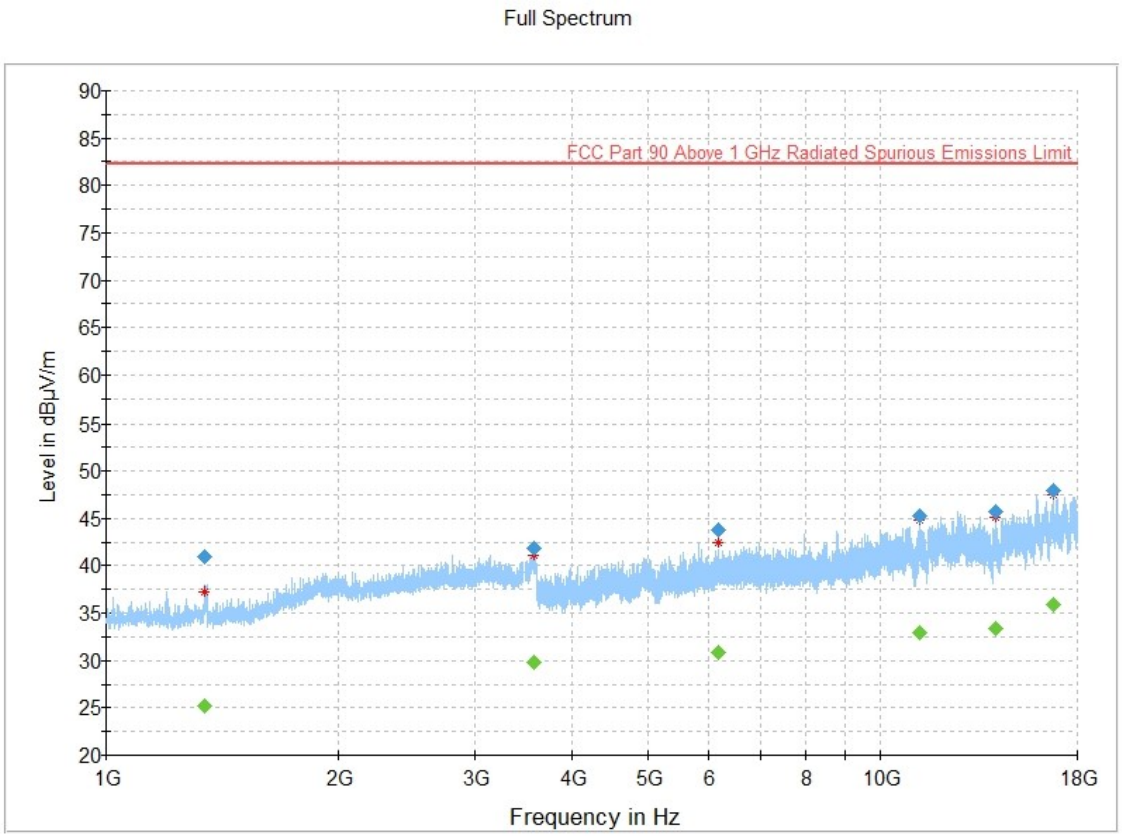
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
40.194333	25.98	84.38	58.40	1000.0	120.000	156.0	H	185.0	14.9
65.849000	49.00	84.38	35.38	1000.0	120.000	246.0	H	87.0	7.1
95.917333	33.44	84.38	50.94	1000.0	120.000	250.0	H	115.0	11.4
130.265667	42.30	84.38	42.08	1000.0	120.000	154.0	H	249.0	13.7
486.611333	33.82	84.38	50.56	1000.0	120.000	150.0	H	176.0	20.8
719.985667	35.60	84.38	48.78	1000.0	120.000	102.0	H	85.0	24.8

Table 8.7-3: Radiated spurious results, signal transmitted at 221.985 MHz. Setup from 30 MHz to 1000 MHz

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[3] An inverse proportionality factor of 20 dB per decade (20 log (10/3) = 10.5 dB) has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

[4]The maximum measured value observed over a period of 15 seconds was recorded.

8.8.2 Test Data, Conducted and Radiated Emissions



The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.

Figure 8.7-4: Radiated spurious results, signal transmitted at 221.985 MHz. Setup from 1 MHz to 18 GHz

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1342.400000	---	25.24	82.23	56.99	5000.0	1000.000	155.0	V	270.0	-14.3
1342.400000	41.01	---	82.23	41.22	5000.0	1000.000	155.0	V	270.0	-14.3
3560.800000	41.82	---	82.23	40.41	5000.0	1000.000	134.0	H	119.0	-6.3
3560.800000	---	29.78	82.23	52.45	5000.0	1000.000	134.0	H	119.0	-6.3
6168.100000	43.78	---	82.23	38.45	5000.0	1000.000	169.0	V	180.0	-1.8
6168.100000	---	30.81	82.23	51.42	5000.0	1000.000	169.0	V	180.0	-1.8
11260.066667	---	32.98	82.23	49.25	5000.0	1000.000	113.0	V	61.0	3.3
11260.066667	45.30	---	82.23	36.93	5000.0	1000.000	113.0	V	61.0	3.3
14101.300000	45.76	---	82.23	36.47	5000.0	1000.000	119.0	V	82.0	6.4
14101.300000	---	33.38	82.23	48.85	5000.0	1000.000	119.0	V	82.0	6.4
16767.500000	47.98	---	82.23	34.25	5000.0	1000.000	201.0	H	10.0	10.6
16767.500000	---	35.88	82.23	46.35	5000.0	1000.000	201.0	H	10.0	10.6

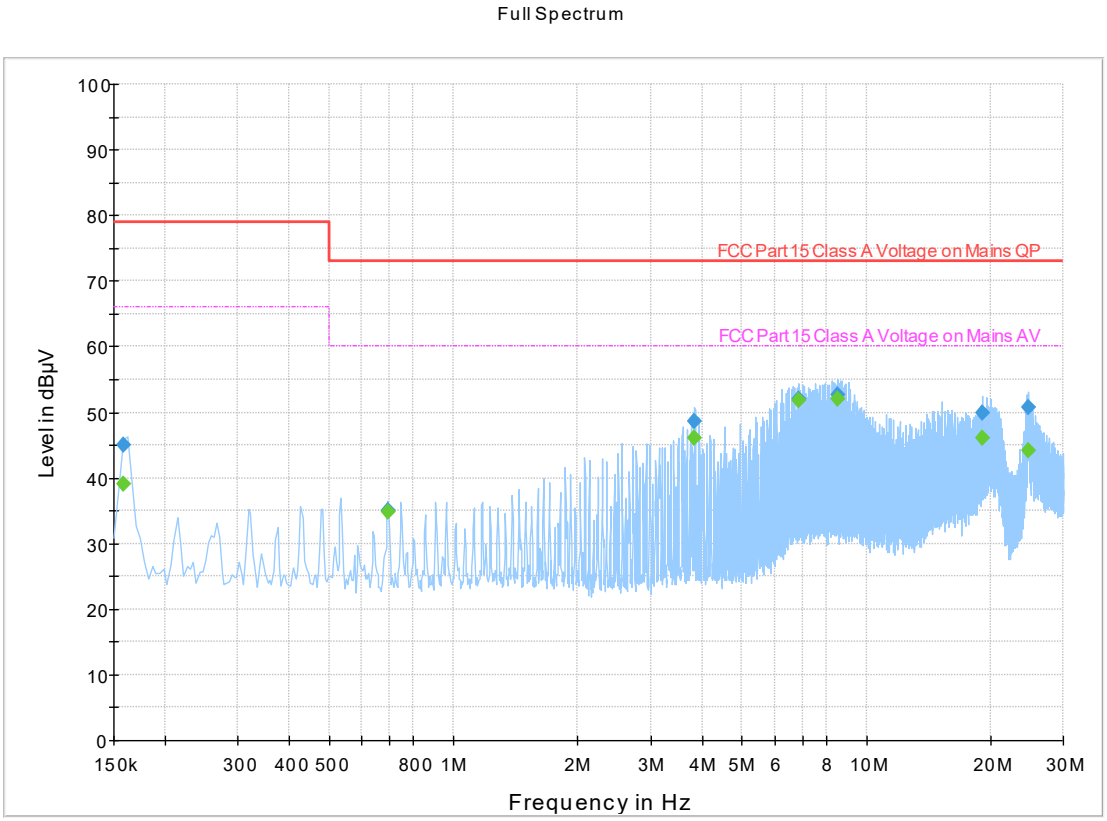
Table 8.7-4: Radiated spurious results, signal transmitted at 221.985 MHz. Setup from 1 MHz to 18 GHz

Notes:

[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)

[3]An inverse proportionality factor of 20 dB per decade (20 log (10/3) = 10.5 dB) has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.
[4]The maximum measured value observed over a period of 15 seconds was recorded

8.8.3 Test Data, Conducted and Radiated Emissions



The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.

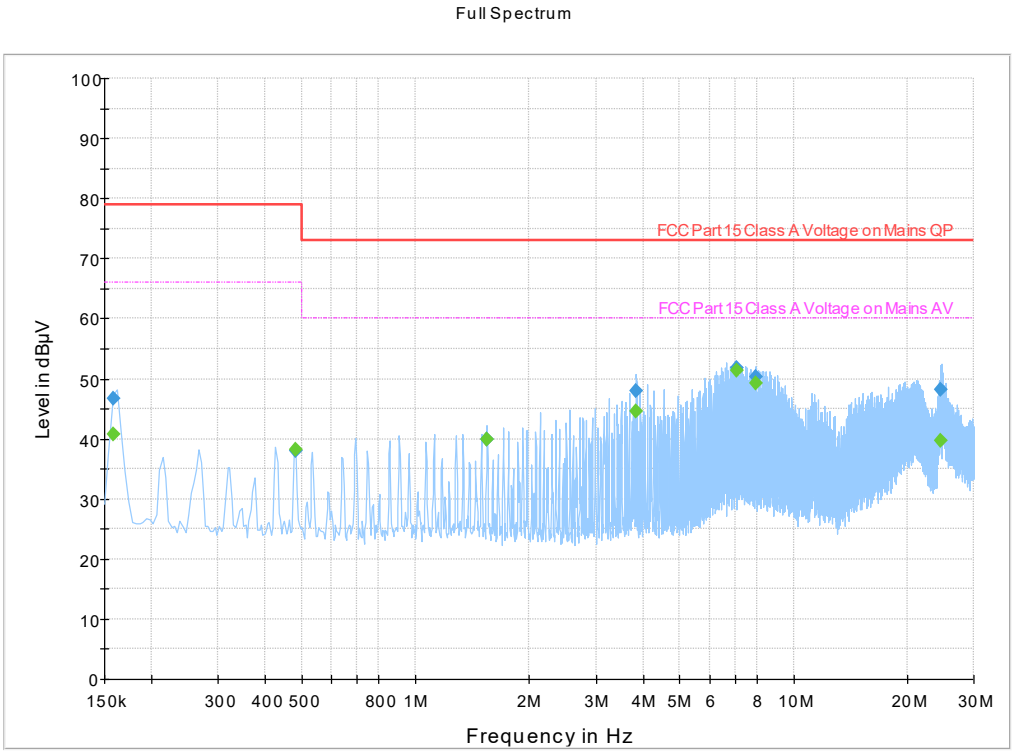
Figure 8.7-5: Conducted emissions plot, signal transmitted at 221.985 MHz. Setup from 150 KHz to 30 MHz, LISN Line at 120V 60HZ

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.158000	---	39.16	66.00	26.84	5000.0	9.000	L1	ON	19.5
0.158000	45.08	---	79.00	33.92	5000.0	9.000	L1	ON	19.5
0.692500	---	34.92	60.00	25.08	5000.0	9.000	L1	ON	19.5
0.692500	34.99	---	73.00	38.01	5000.0	9.000	L1	ON	19.5
3.840500	---	46.03	60.00	13.97	5000.0	9.000	L1	ON	19.5
3.840500	48.60	---	73.00	24.40	5000.0	9.000	L1	ON	19.5
6.872500	---	51.90	60.00	8.10	5000.0	9.000	L1	ON	19.6
6.872500	52.08	---	73.00	20.92	5000.0	9.000	L1	ON	19.6
8.524500	---	51.92	60.00	8.08	5000.0	9.000	L1	ON	19.6
8.524500	52.66	---	73.00	20.34	5000.0	9.000	L1	ON	19.6
19.132500	---	46.04	60.00	13.96	5000.0	9.000	L1	ON	19.8
19.132500	49.91	---	73.00	23.09	5000.0	9.000	L1	ON	19.8
24.780500	---	44.19	60.00	15.81	5000.0	9.000	L1	ON	19.9
24.780500	50.81	---	73.00	22.19	5000.0	9.000	L1	ON	19.9

Table 8.7-5: Conducted emissions plot, signal transmitted at 221.985 MHz. Setup from 150 KHz to 30 MHz, LISN Line at 120V 60HZ

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[3] An inverse proportionality factor of 20 dB per decade (20 log (10/3) = 10.5 dB) has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.
[4] The maximum measured value observed over a period of 15 seconds was recorded.

8.8.4 Test Data, Conducted and Spurious Emission, continued



The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators.

Figure 8.7-6: Conducted emissions plot, signal transmitted at 221.985 MHz. Setup from 150 KHz to 30 MHz, LISN Neutral at 120V 60HZ

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.158000	---	40.83	66.00	25.17	5000.0	9.000	L1	ON	19.5
0.158000	46.73	---	79.00	32.27	5000.0	9.000	L1	ON	19.5
0.480500	---	38.13	66.00	27.87	5000.0	9.000	L1	ON	19.5
0.480500	38.04	---	79.00	40.96	5000.0	9.000	L1	ON	19.5
1.544500	---	39.84	60.00	20.16	5000.0	9.000	L1	ON	19.5
1.544500	39.98	---	73.00	33.02	5000.0	9.000	L1	ON	19.5
3.840500	---	44.54	60.00	15.46	5000.0	9.000	L1	ON	19.5
3.840500	48.01	---	73.00	24.99	5000.0	9.000	L1	ON	19.5
7.088500	---	51.47	60.00	8.53	5000.0	9.000	L1	ON	19.6
7.088500	51.82	---	73.00	21.18	5000.0	9.000	L1	ON	19.6
7.940500	---	49.26	60.00	10.74	5000.0	9.000	L1	ON	19.6
7.940500	50.22	---	73.00	22.78	5000.0	9.000	L1	ON	19.6
24.532500	---	39.64	60.00	20.36	5000.0	9.000	L1	ON	19.9
24.532500	48.30	---	73.00	24.70	5000.0	9.000	L1	ON	19.9

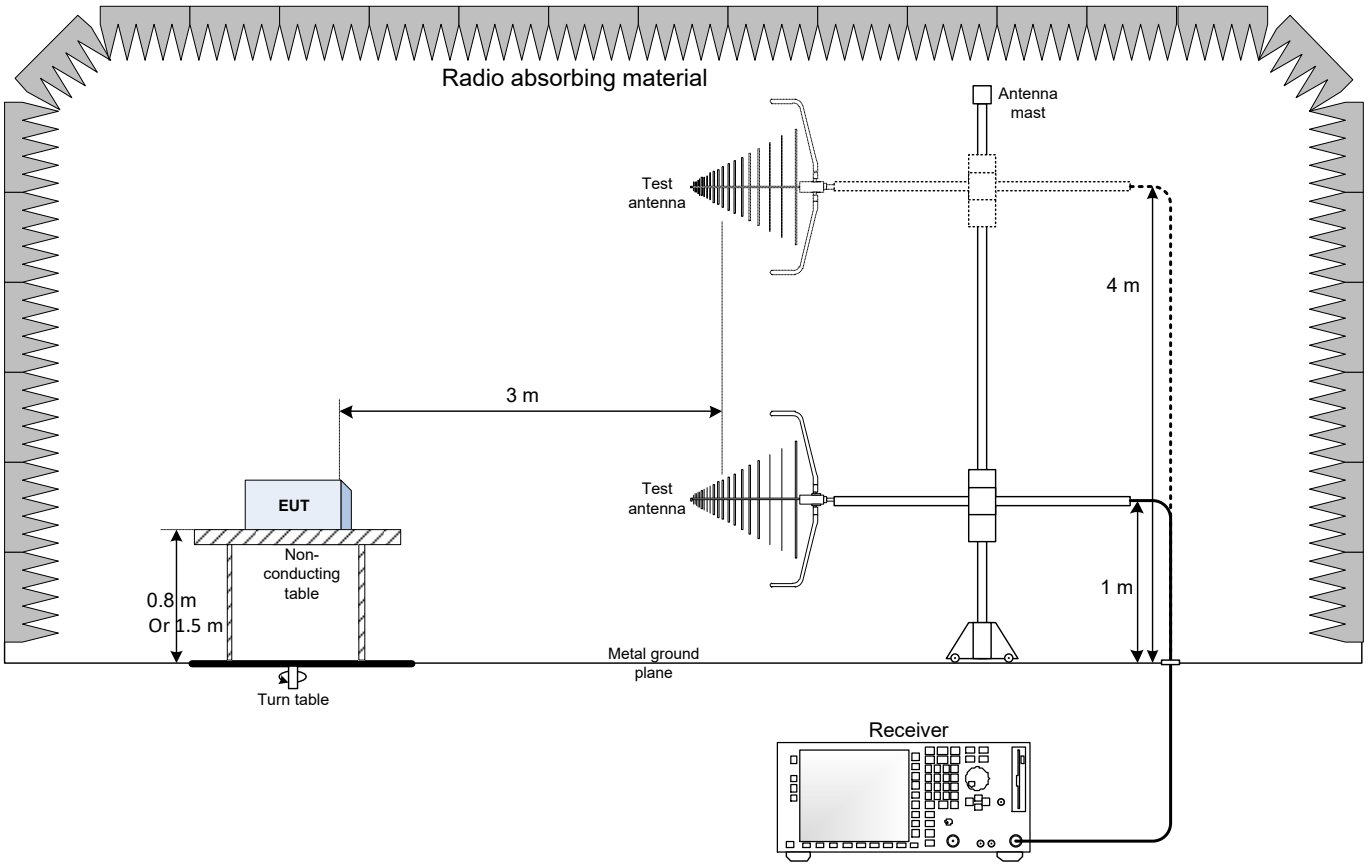
Table 8.7-6: Conducted emissions plot results, signal transmitted at 221.985 MHz. Setup from 150 KHz to 30 MHz, LISN Neutral at 120V 60Hz

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[3]An inverse proportionality factor of 20 dB per decade (20 log (10/3) = 10.5 dB) has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.
[4]The maximum measured value observed over a period of 15 seconds was recorded.

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



Note.- Per ANSI C63.26-2015 for radiated emissions measurements performed at frequencies less than or equal to 1 GHz, the EUT shall be placed on a RF-transparent table or support at a nominal height of 80 cm above the reference ground plane and for radiated measurements performed at frequencies above 1 GHz, the EUT shall be placed on an RF transparent table or support at a nominal height of 1.5 m above the ground plane.

Thank you for choosing