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Radio Test Report
Class II Permissive Change

FCC Part 90 and RSS-119
(435 MHz to 470 MHz)

Model: LRS455A

ISED CERTIFICATION #:	2329B-LRS455A
FCC ID:	KNYLRS455A
COMPANY:	FreeWave 5395 Pearl Parkway, Suite 100 Boulder, CO 80301
TEST SITE(S):	National Technical Systems 41039 Boyce Road. Fremont, CA. 94538-2435
PROJECT NUMBER:	PR151710
REPORT DATE:	January 13, 2022
FINAL TEST DATES:	December 28, 29 and 30, 2021 and January 10 and 11, 2022
TOTAL NUMBER OF PAGES:	50

ACCREDITED
Testing Cert #0214.26

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SCOPE

Tests have been performed on the FreeWave model LRS455A, pursuant to the relevant requirements of the following standard(s) in order to obtain device certification against the regulatory requirements of the Federal Communications Commission and Innovation Science and Economic Development Canada.

- Code of Federal Regulations (CFR) Title 47 Part 2
- RSS-Gen Issue 5, April 2018
- CFR 47 Part 90 (Private Land Mobile Radio Service) Subpart I
- RSS-119, Issue 12, May 2015 (Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz)

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems test procedures:

ANSI C63.26:2015
ANSI TIA-603-E
FCC KDB 971168 Licensed Digital Transmitters

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Innovation Science and Economic Development Canada performance and procedural standards.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

National Technical Systems is accredited by the A2LA, certificate number 0214.26, to perform the test(s) listed in this report, except where noted otherwise.

The test results recorded herein are based on a single type test of the FreeWave model LRS455A and therefore apply only to the tested sample. The sample was selected and prepared by Michael Drake of FreeWave.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, the device requires certification. Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of FreeWave model LRS455A complied with the requirements of the standards and frequency bands declared in the scope of this test report.

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS

FCC Part 90 and RSS-119

FCC	Canada	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics					
§2.1033 (c) (5) § 90.35		Frequency range(s)	435-470 MHz	435-470 MHz	Pass
	RSS-119	Frequency range(s)	450-470 MHz	450 – 470 MHz	Pass
§2.1033 (c) (6) §2.1033 (c) (7) § 2.1046 § 90.205	RSS-119	RF power output at the antenna terminals	33.0 dBm	57 dBm ERP	Pass
§2.1033 (c) (6) §2.1033 (c) (7) § 2.1046 § 90.205	RSS-119	EIRP / ERP	Max 44.5 W ERP	57 dBm ERP	Pass
§2.1033 (c) (4) § 2.1047 § 90.210	RSS-119	Emission types	F1D	-	-
		Emission mask	Mask D	Within Mask	Pass
§ 2.1049 § 90.209	RSS-GEN 6.7 RSS-119	Occupied Bandwidth	8.85 kHz (2-level GFSK) 7.74 kHz (4-level GFSK)	11.25 kHz	Pass
§ 90.214	RSS-119	Transient Frequency Behaviour	Within Limits	Refer to standard	Pass
Transmitter spurious emissions					
§ 2.1051 § 2.1057	RSS-119	At the antenna terminals	-37.0 dBm @ 939.8 MHz	-20 dBm	Pass
§ 2.1053 § 2.1057	RSS-119	Field strength (ERP)	-44.9 dBm @ 1897.8 MHz	-20 dBm	Pass
Other details					
§ 2.1055 § 90.213	RSS-119	Frequency stability	1.1 ppm	1.5 ppm	Pass
§ 2.1093	RSS-102	RF Exposure	No change from original filing	Warning to user	Pass
§2.1033 (c) (8)		Final radio frequency amplifying circuit's dc voltages and currents for normal operation over the power range	5.5V and 1000mA	-	-
-	-	Antenna Gain	Maximum 9.25 dBi	-	-
Note 1 Pass/Fail criteria defined by standards listed above.					

EXTREME CONDITIONS

Frequency stability is determined over extremes of temperature and voltage. The extremes of voltage were 85 to 115 percent of the nominal value.

The extremes of temperature were -30°C to +50°C as specified in FCC §2.1055(a)(1).

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2) and were calculated in accordance with NAMAS document NIS 81 and M3003.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF frequency	Hz	25 to 7,000 MHz	1.7×10^{-7}
RF power, conducted	dBm	25 to 7,000 MHz	± 0.52 dB
Conducted emission of transmitter	dBm	25 to 40,000 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 40,000 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 40,000 MHz	± 2.5 dB
Radiated emission (field strength)	dBμV/m	25 to 1,000 MHz 1 to 40 GHz	± 3.6 dB ± 6.0 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The FreeWave model LRS455A is a licensed radio module which is designed to operate in the 435-470 MHz bands. Since the host unit could be placed in any position during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 12VDC, 0.8 Amps.

The sample was received on December 28, 2021 and tested on December 28, 29 and 30, 2021 and January 10 and 11, 2022. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
FreeWave Technologies, Inc.	LRS455A-C	Licensed radio module	4613252	KNYLRS455A

OTHER EUT DETAILS

The following EUT details should be noted: A smaller footprint VCTCXO from a different vendor has been used from the original certified product. The trace layout was modified slightly to accommodate the smaller footprint.

ENCLOSURE

The EUT does not have an enclosure. It measures approximately 6 cm wide by 13 cm long.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at National Technical Systems.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Company	Model	Description	Serial Number	FCC ID
PK Power	KSAS012100080HU	AC/DC Adapter	-	DoC

No remote support equipment was used during testing.

The laptop was used to configure the radio for different modulations, power setting and transmit or receive mode as needed for testing and then disconnected.

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
10 pin connector	Serial DB9, Power, Reset Button	Multiwire	Unshielded	1.2
Serial DB9	Laptop USB	Multiwire	Shielded	1.8
Power	AC/DC Adapter	two wire	Unshielded	1.4
Antenna	Termination	Coax	Shielded	0.1

EUT OPERATION

During emissions testing the EUT was set to transmit a continuous modulated signal at maximum power on the selected frequency for tests.

TESTING

GENERAL INFORMATION

Antenna port measurements were taken at the National Technical Systems test site located at 41039 Boyce Road, Fremont, CA 94538-2435.

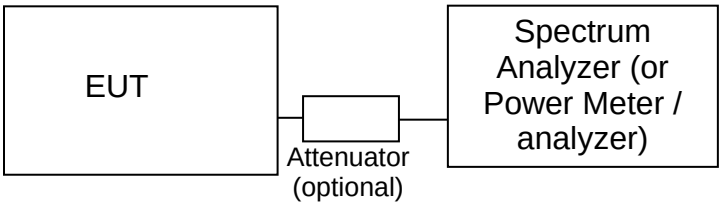
Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 6.2 of RSS-GEN, NTS has been recognized as an accredited test laboratory by the Commission and Innovation, Science and Economic Development Canada. A description of the facilities employed for testing is maintained by NTS.

Site	Company / Registration Numbers		Location
	FCC	Canada	
Chamber 5 & 7	US1031	2845B (Wireless test lab #US0027)	41039 Boyce Road Fremont, CA 94538-2435

ANSI C63.4 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Results from testing performed in this chamber have been correlated with results from an open area test site. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4.

RF PORT MEASUREMENT PROCEDURES

Conducted measurements are performed with the EUT's rf input/output connected to the input of a spectrum analyzer, power meter or modulation analyzer. When required an attenuator, filter and/or dc block is placed between the EUT and the spectrum analyzer to avoid overloading the front end of the measurement device. Measurements are corrected for the insertion loss of the attenuators and cables inserted between the rf port of the EUT and the measurement equipment.



Test Configuration for Antenna Port Measurements

For devices with an integral antenna the output power and spurious emissions are measured as a field strength at a test distance of (typically) 3m and then converted to an eirp using a substitution measurement (refer to RADIATED EMISSIONS MEASUREMENTS). All other measurements are made as detailed below but with the test equipment connected to a measurement antenna directed at the EUT.

OUTPUT POWER

Output power is measured using a power meter and an average sensor head, a spectrum analyzer or a power meter and peak power sensor head as required by the relevant rule part(s). Where necessary measurements are gated to ensure power is only measured over periods that the device is transmitting.

Power measurements made directly on the rf power port are, when appropriate, converted to an EIRP by adding the gain of the highest gain antenna that can be used with the device under test, as specified by the manufacturer.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS-GEN. The measurement bandwidth is set to be at least 1% of the instrument's frequency span.

CONDUCTED SPURIOUS EMISSIONS

Initial scans are made using a peak detector (RBW=VBW) and using scan rates to ensure that the EUT transmits before the sweep moves out of each resolution bandwidth (for transmit mode measurements). Where the limits are expressed as an average power the spectrum analyzer is tunes to that frequency with a narrow span (wide enough to capture the emission and its sidebands) and the resolution and video bandwidths are adjusted as required by the reference measurement standards. For transmitter measurements the appropriate detector (average, peak, normal ,sample, quasi-peak) is used when making measurements for licensed devices. For receiver conducted spurious measurements the detector is set to peak.

TRANSMITTER MASK MEASUREMENTS

The transmitter mask measurements are made using resolution bandwidths as specified in the pertinent rule part(s). Where narrower bandwidths are used the measurement is corrected to account for the reduced bandwidth by either using the adjacent channel power function of the spectrum analyzer to sum the power across the required measurement bandwidth. The frequency span of the analyzer is set to ensure the fundamental signal and all significant sidebands are displayed.

The top of the mask may be set by the total output power of the signal, the power of the unmodulated signal or the peak value of the signal in the reference bandwidth being used for the mask measurement.

FREQUENCY STABILITY

The EUT is placed inside a temperature chamber with all support and test equipment located outside of the chamber. The temperature is varied across the specified frequency range in 10 degree increments with frequency measurements made at each temperature step. The EUT is allowed enough time to stabilize at each temperature variation.

The spectrum analyzer is configured to give a 5- or 6-digit display for the marker-frequency function. The spectrum analyzer's built-in frequency counter is used to measure the maximum deviation of the fundamental frequency at each temperature. Where possible the device is set to transmit an unmodulated signal. Where this is not possible the frequency drift is determined by finding a stable point on the signal (e.g. the null at the centre of an OFDM signal) or by calculating a centre frequency based on the upper and lower XdB points (where X is typically 6dB or 10dB) on the signal’s skirts.

TRANSIENT FREQUENCY BEHAVIOR:

The TIA/EIA 603 procedure is used to determine compliance with transient frequency timing requirements as the radio is keyed on and off.

The EUTs rf output is connected via a combiner/splitter to the test receiver/spectrum analyzer and to a diode detector. The test receiver or spectrum analyzer video output is connected to an oscilloscope, which is triggered by the output from the diode detector.

Plots showing Ton, T1, and T2 are made when turning on the transmitter and showing T3 when turning off the transmitter.

RADIATED EMISSIONS MEASUREMENTS

Transmitter radiated spurious emissions are initially measured as a field strength. The eirp or erp limit as specified in the relevant rule part(s) is converted to a field strength at the test distance and the emissions from the EUT are then compared to that limit. Emissions within 20dB of this limit are the subjected to a substitution measurement.

All radiated emissions measurements are performed in two phases. A preliminary scan of emissions is conducted in either an anechoic chamber or on an OATS during which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed across the complete frequency range of interest and at each operating frequency identified in the reference standard. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. Initial scans are made using a peak detector (RBW=VBW) and using scan rates to ensure that the EUT transmits before the sweep moves out of each resolution bandwidth (for transmit mode).

During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit. For transmitter spurious emissions, where the limit is expressed as an effective radiated power, the eirp or erp is converted to a field strength limit.

Final measurements are made on an OATS or in a semi-anechoic chamber at the significant frequencies observed during the preliminary scan(s) using the same process of rotating the EUT and raising/lowering the measurement antenna to find the highest level of the emission. The field strength is recorded and, for receiver spurious emissions, compared to the field strength limit. For the final measurement the appropriate detectors (average, peak, normal, sample, quasi-peak) are used. For receiver measurements below 1GHz the detector is a Quasi-Peak detector, above 1GHz a peak detector is used and the peak value (RB=VB=1MHz) and average value (RB=1MHz, VB=10Hz) are recorded.

For transmitter spurious emissions, the radiated power of all emissions within 20dB of the calculated field strength limit are determined using a substitution measurement. The substitution measurement is made by replacing the EUT with an antenna of known gain (typically a dipole antenna or a double-ridged horn antenna), connected to a signal source. The output power of the signal generator is adjusted until the maximum field strength from the substitution antenna is similar to the field strength recorded from the EUT. The erp of the EUT is then calculated.

INSTRUMENTATION

An EMI receiver as specified in CISPR 16-1-1 is used for radiated emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 7000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary.

For measurements above the frequency range of the receivers and for all conducted measurements a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis.

Measurement bandwidths for the test instruments are set in accordance with the requirements of the standards referenced in this document.

Software control is used to correct the measurements for transducer factors (e.g. antenna) and the insertion loss of cables, attenuators and other series elements to obtain the final measurement value. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are exported in a graphic and/or tabular format, as appropriate.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the EUT antenna port or receiving antenna and the test receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A combination of biconical, log periodic or bi-log antennas are used to cover the range from 30 MHz to 1000 MHz. Broadband antennas or tuned dipole antennas are used over the entire 25 to 1000 MHz frequency range as the reference antenna for substitution measurements.

Above 1000 MHz, a dual-ridge guide horn antenna or octave horn antenna are used as reference and measurement antennas.

The antenna calibration factors are included in site factors that are programmed into the test receivers and instrument control software when measuring the radiated field strength.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

Table mounted devices are placed on a non-conductive table at a height of 80 centimeters above the floor. Floor mounted equipment is placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. The EUT is positioned on a motorized turntable to allow it to be rotated during testing to determine the angel with the highest level of emissions.

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS - CONDUCTED SPURIOUS EMISSIONS

Measurements are compared directly to the conducted emissions specification limit (decibel form). The calculation is as follows:

$$R_r - S = M$$

where:

R_r = Measured value in dBm
S = Specification Limit in dBm
M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH

Measurements of radiated field strength are compared directly to the specification limit (decibel form). The receiver and/or control software corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor is sued when measurements are made at a test distance that is different to the specified limit distance by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10}(D_m/D_s)$$

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS –RADIATED POWER

The erp/eirp limits for transmitter spurious measurements are converted to a field strength in free space using the following formula:

$$E = \frac{\sqrt{30\,P\,G}}{d}$$

where:

E = Field Strength in V/m
P = Power in Watts
G = Gain of isotropic antenna (numeric gain) = 1
D = measurement distance in meters

The field strength limit is then converted to decibel form (dBuV/m) and the margin of a given emission peak relative to the limit is calculated (refer to *SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH*).

When substitution measurements are required (all signals with less than 20dB of margin relative to the calculated field strength limit) the eirp of the spurious emission is calculated using:

$$P_{EUT} = P_S - (E_S - E_{EUT})$$

and

$$P_S = G + P_{in}$$

where:

P_S = effective isotropic radiated power of the substitution antenna (dBm)
P_{in} = power input to the substitution antenna (dBm)
G = gain of the substitution antenna (dBi)
E_S = field strength the substitution antenna (dBm) at eirp P_S
E_{EUT} = field strength measured from the EUT

Where necessary the effective isotropic radiated power is converted to effective radiated power by subtracting the gain of a dipole (2.2dBi) from the eirp value.

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Radiated Emissions, 30 - 5,000 MHz, 29-Dec-21					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	
ETS-Lindgren	EMC Chamber #7, Inner Dimensions (LxWxH): 24' x 38' x 20'	CH 7 (FACT-5)	WC055569	9/15/2019	9/15/2022
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	WC064454	6/7/2021	9/22/2023
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	WC064463	7/7/2020	7/7/2022
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	WC064574	3/2/2021	3/2/2022
Com-Power	Comb Gen, 1-34 GHz, 1000 MHz Step	CGO-51000	WC064663	1/19/2021	1/19/2022
Rohde & Schwarz	EMI Test Receiver, 20Hz-40GHz	ESI	WC068000	6/23/2021	6/23/2022
Radio Antenna Port (Power and Spurious Emissions), 29-Dec-21					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	
National Technical Systems	NTS Mask Software (rev 3.9)	N/A	WC022701	N/A	
National Technical Systems	NTS Capture Analyzer Software (rev 4.0)	N/A	WC022706	N/A	
ETS-Lindgren	EMC Chamber #7, Inner Dimensions (LxWxH): 24' x 38' x 20'	CH 7 (FACT-5)	WC055569	9/15/2019	9/15/2022
Agilent Technologies	PSA Spectrum Analyzer	E4446A	WC055650	8/27/2021	8/27/2022
Rohde & Schwarz	Peak Power Sensor 100 uW - 2 Watts (w/ 20 dB attenuator, SN BJ5155)	NRV-Z32	WC064459	6/17/2021	6/17/2022
Rohde & Schwarz	Power Meter, Dual Channel	NRVD	WC064499	6/18/2021	6/18/2022
Radio Antenna Port (Power and Spurious Emissions), 30-Dec-21					
National Technical Systems	EMC Lab #3	None	WC055573	N/A	
Agilent Technologies	PSA Spectrum Analyzer	E4446A	WC055650	8/27/2021	8/27/2022
Watlow	Environmental Chamber Controller	F4	WC066185	5/17/2021	5/31/2022
Watlow	Limit Controller	Limit 97	WC071533	N/A	
Envirotronics	EMC Chamber #10 (Lab #3)	SH16C	WC071534	N/A	
Radiated Emissions, 30 kHz - 30 MHz, 10-Jan-22					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
ETS-Lindgren	EMC Chamber #4, Inner Dimensions (LxWxH): 24' x 38' x 20'	CH4 (FACT-5)	WC055566	8/3/2019	8/3/2022
Rhode & Schwarz	Loop Antenna	HFH2-Z2	WC062457	1/23/2020	1/23/2022
Rohde & Schwarz	EMI Test Receiver, 20Hz-7GHz	ESIB 7	WC064989	12/20/2021	12/20/2022
Radio Antenna Port (Rx Spurious Emissions), 10-Jan-22					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	
Rohde & Schwarz	EMI Test Receiver, 20Hz-7GHz	ESIB 7	WC064989	12/20/2021	12/20/2022
Transient Frequency Behaviour, 11-Jan-22					
Tektronix	500MHz, 2CH, 5GS/s OscilloScope	TDS5052B	WC064544	12/13/2021	12/13/2022
Rohde & Schwarz	EMI Test Receiver, 20Hz-7GHz	ESIB 7	WC064989	12/20/2021	12/20/2022
Keysight Technologies	Signal Generator 250k - 6GHz (Vector) (ESG)	E4438C	WC068186	4/21/2021	4/21/2022

Appendix B Test Data

TL151710-RA Pages 23 – 49

Client:	Freewave	PR Number:	PR151710
Product	LRS455A	T-Log Number:	TL151710-RA
System Configuration:	-	Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Emissions Standard(s):	FCC Parts 15 & 90, RSS-119	Class:	-
Immunity Standard(s):	-	Environment:	Radio

EMC Test Data

For The

Freewave

Product

LRS455A

Date of Last Test: 1/11/2022

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

RSS 119 and FCC Part 90

Power, Occupied Bandwidth, Frequency Stability and Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

With the exception of the radiated spurious emissions tests, all measurements are made with the EUT's rf port connected to the measurement instrument via an attenuator or dc-block if necessary. All amplitude measurements are adjusted to account for the attenuation between EUT and measuring instrument. For frequency stability measurements the EUT was placed inside an environmental chamber.

Radiated measurements are made with the EUT located on a non-conductive table, 3m from the measurement antenna.

Radiated emissions tests above 1 GHz to FCC Part 90 were performed with floor absorbers in place in accordance with the test methods of ANSI C63.4 and CISPR 16-1-4.

Ambient Conditions:

Temperature: 18-20 °C

Rel. Humidity: 48-50 %

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Summary of Results

Run #		Test Performed	Limit	Pass / Fail	Result / Margin
1		Output Power	500W ERP	Pass	33.0 dBm (Max 44.5 W ERP)
2		Spectral Mask	Within Mask	Pass	Within Mask
3		99% or Occupied Bandwidth	11.25 kHz	Pass	8.85 kHz (2-level GFSK) 7.74 kHz (4-level GFSK)
4		Spurious Emissions (conducted)	-20dBm	Pass	-37.0 dBm @ 939.8 MHz (Margin: -17.0 dB)
5		Spurious emissions (radiated)	-20dBm	Pass	48.2 dBµV/m @ 1897.8 MHz (Margin: -29.3 dB)
6		Transient Frequency Behavior	t_1: 10ms t_2: 25ms t_3:10ms	Pass	Within Limits
7		Modulation limitation	N/A	-	-
8		Frequency Stability	2.5 ppm / 1.5 ppm	Pass	1.1 ppm

Test Notes

RSS-119 and SRSP-501 only allow operation from 450-470 MHz. FCC §2.106 pages 28 and 29 and Part 90 allow operation over the full 435-470 MHz band.

EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #1: Output Power

Date of Test: 12/29/2021
Test Engineer: M.Birgani
Test Location: Fremont Chamber #5

Config. Used: 1
Config Change: None
EUT Voltage: 12 VDC

Cable Loss: 0.0 dB Attenuator: 20.0 dB Total Loss: 20.0 dB

Power Setting[2]	Frequency (MHz)	Output Power (dBm) [1]	Output Power mW	Max Ant Gain (dBi)	Result	ERP dBm	ERP W
10	435	32.4	1737.8	9.25	Pass	43.9	24.266
10	450	32.9	1949.8	9.25	Pass	44.4	27.227
10	460	32.9	1949.8	9.25	Pass	44.4	27.227
10	470	33.0	1995.3	9.25	Pass	44.5	27.861

Note 1:	Output power measured using a peak power meter
Note 2:	Power setting - the software power setting used during testing, included for reference only
Note 3:	435 MHz not used in Canada

Run #2: Spectral Mask, FCC Part 90/RSS-119 Mask D

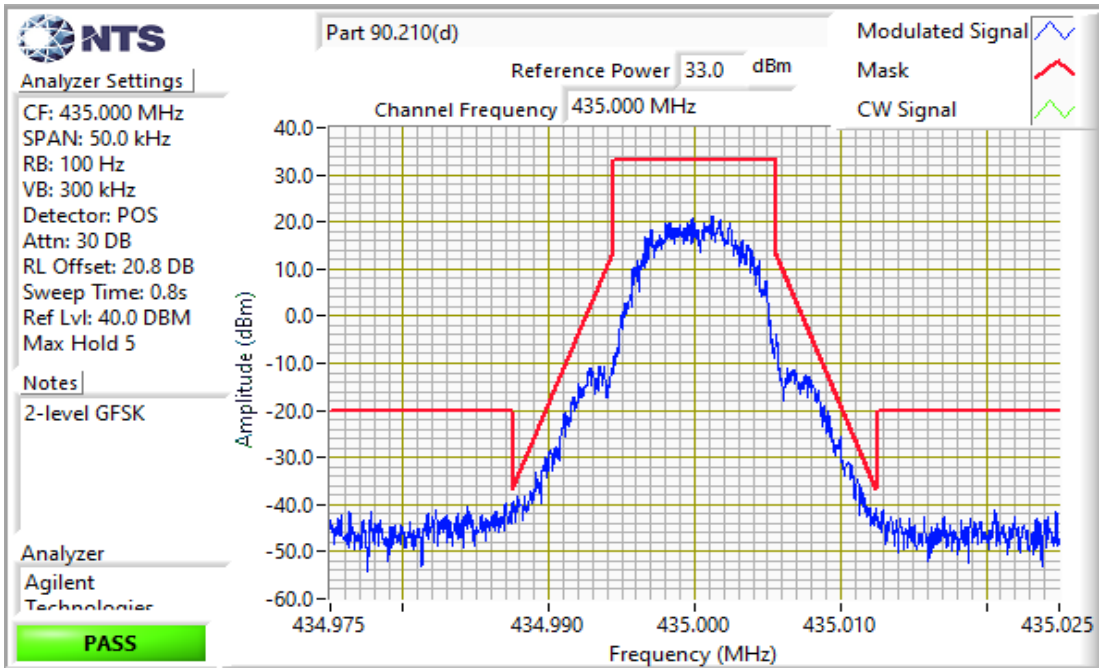
Date of Test: 12/29/2021
Test Engineer: M. Birgani
Test Location: Chamber #7

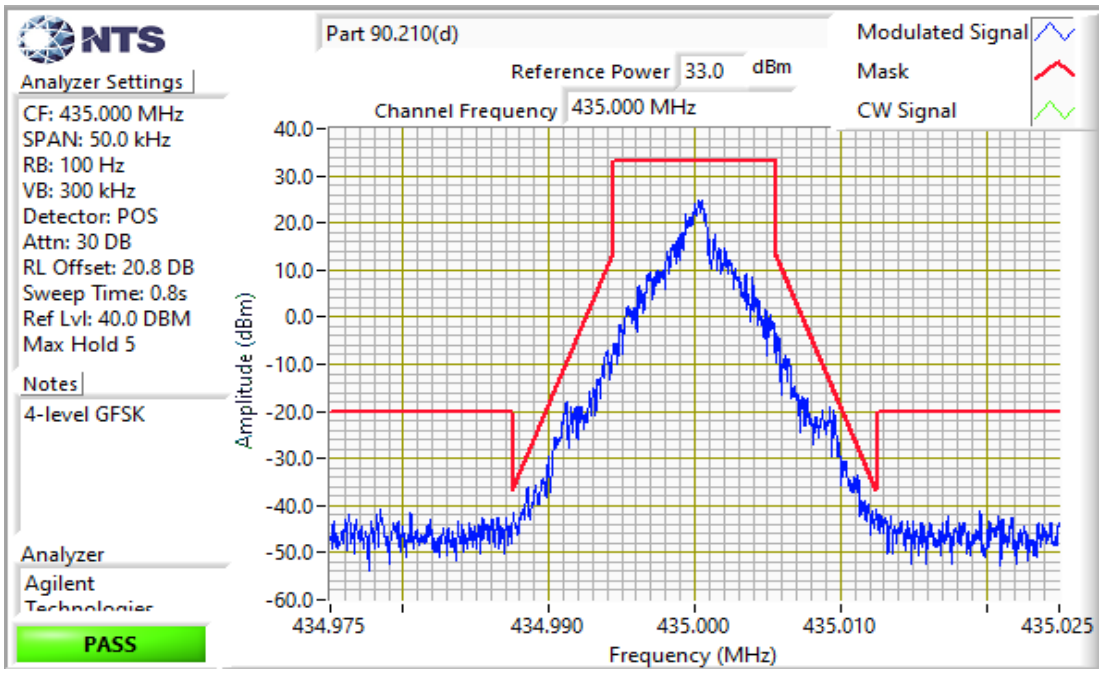
Config. Used: 1
Config Change: None
EUT Voltage: 12 VDC

Note 1:	Reference level for Mask is equal to maximim peak power from Run 1
Note 2:	435 MHz not used in Canada

EMC Test Data

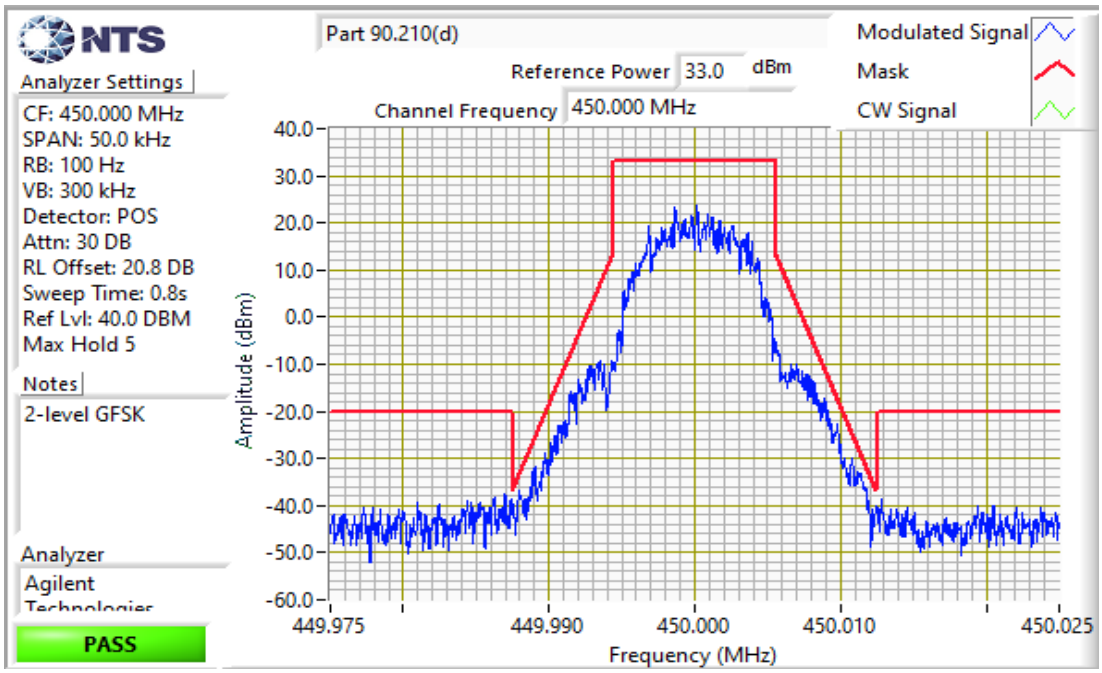
Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

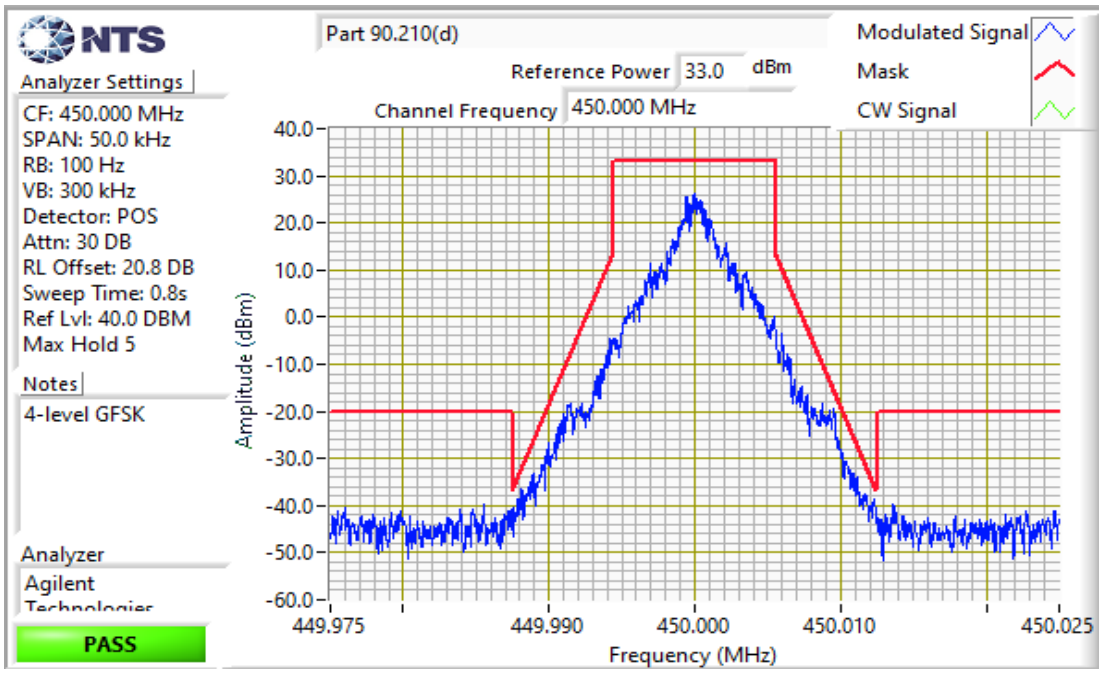




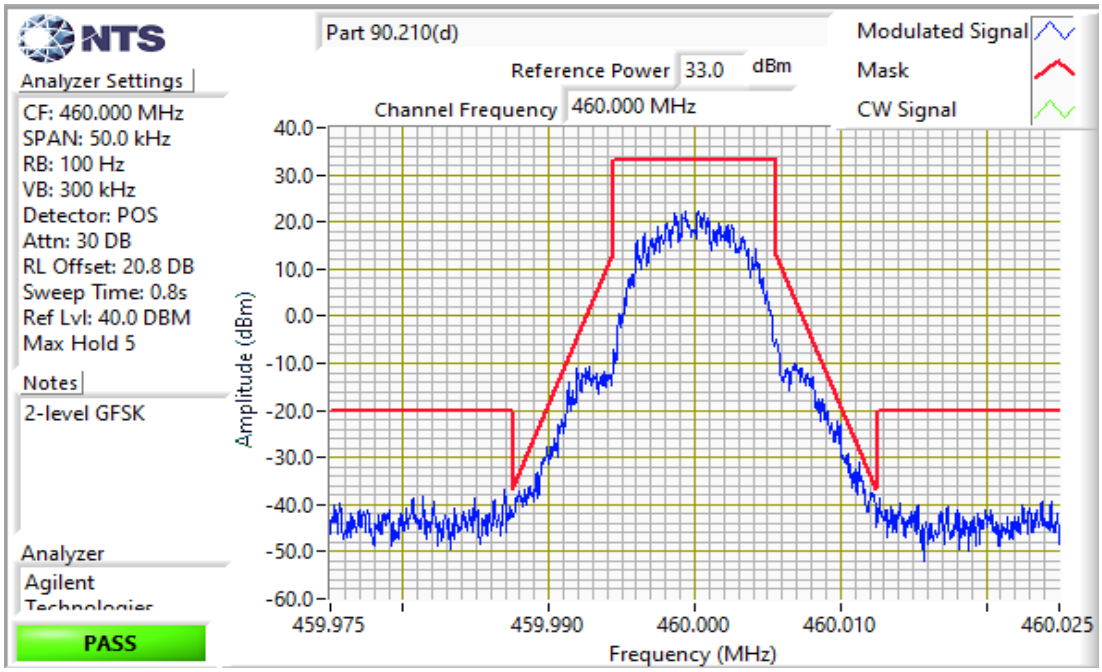
EMC Test Data

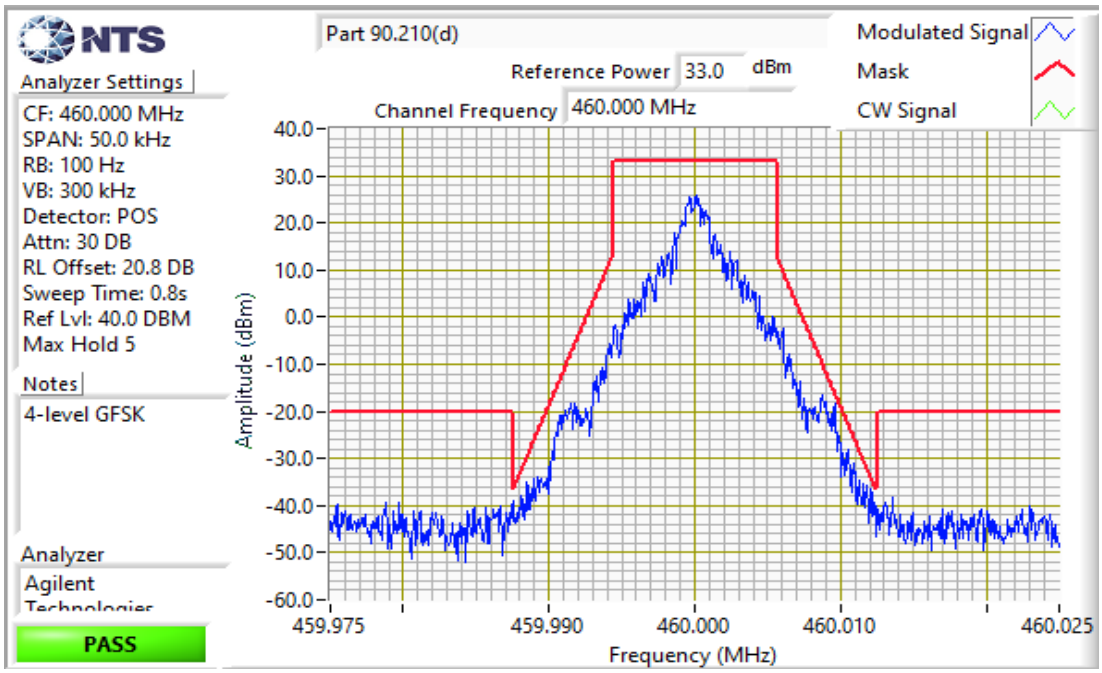
Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-



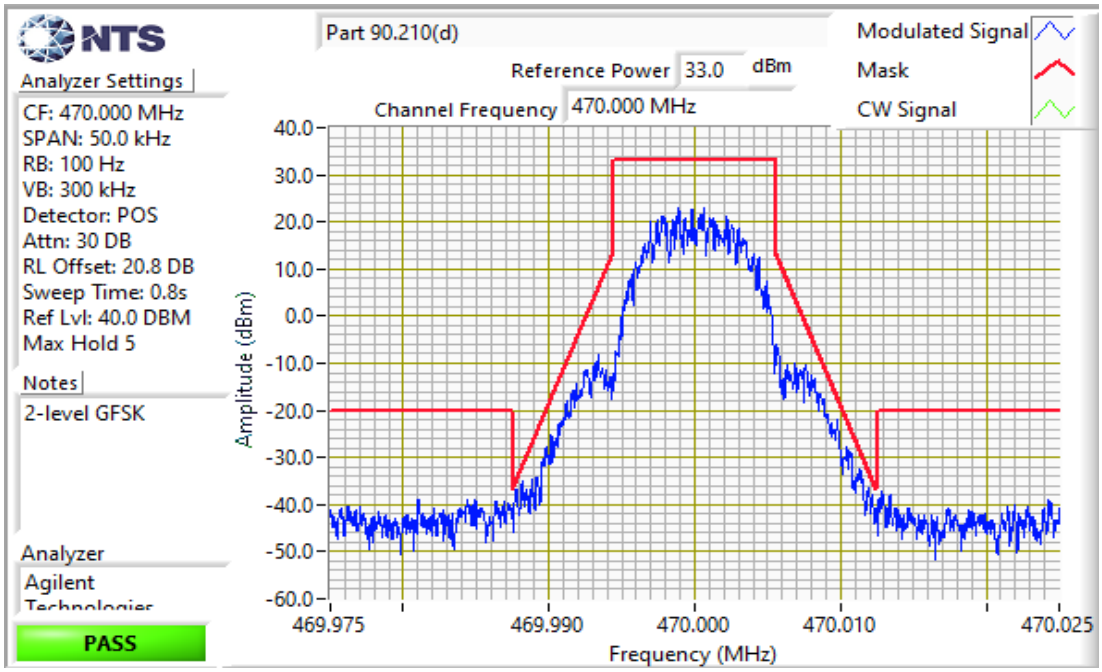


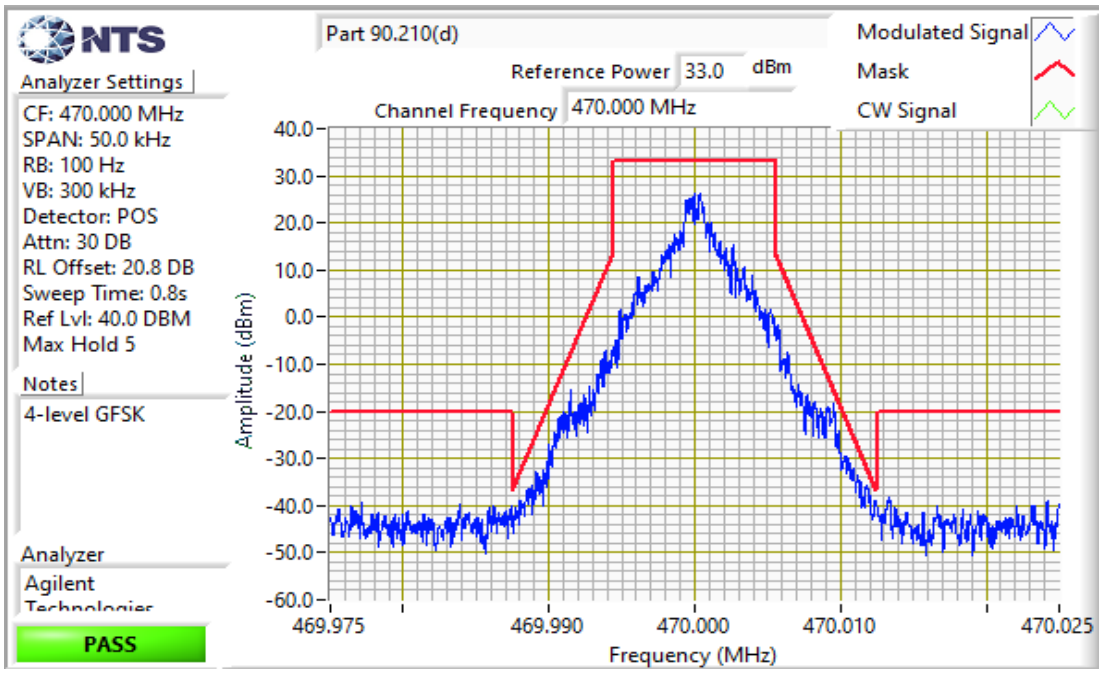
Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-





Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-





EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #3: Signal Bandwidth

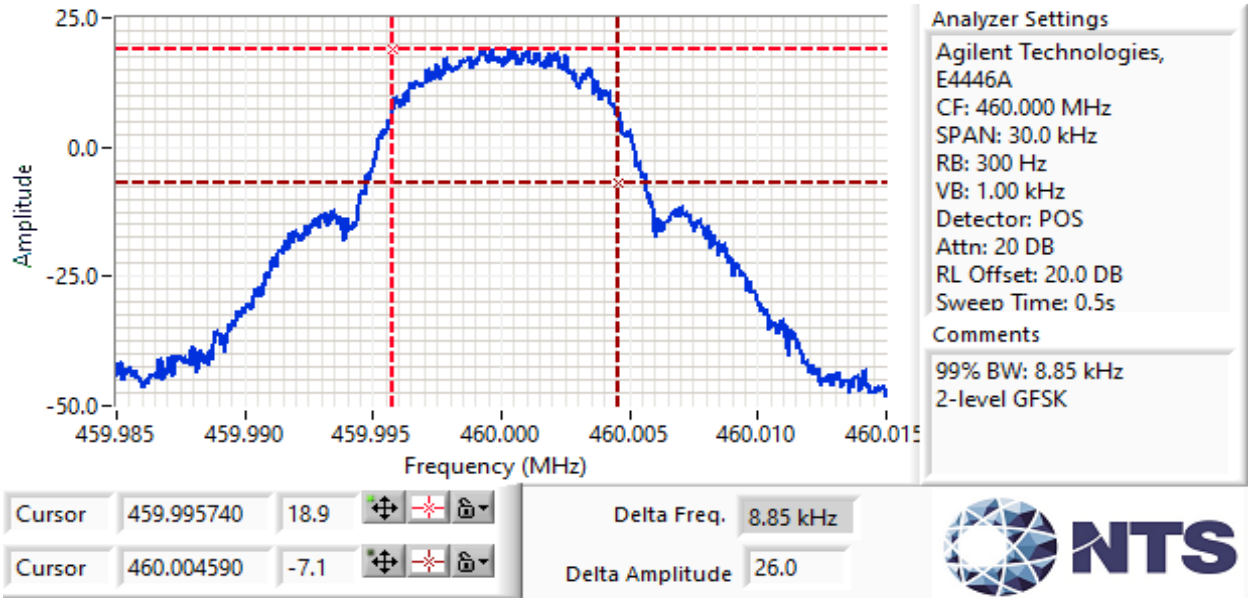
Date of Test: 12/29/2021
Test Engineer: M. Birgani
Test Location: Chamber #7

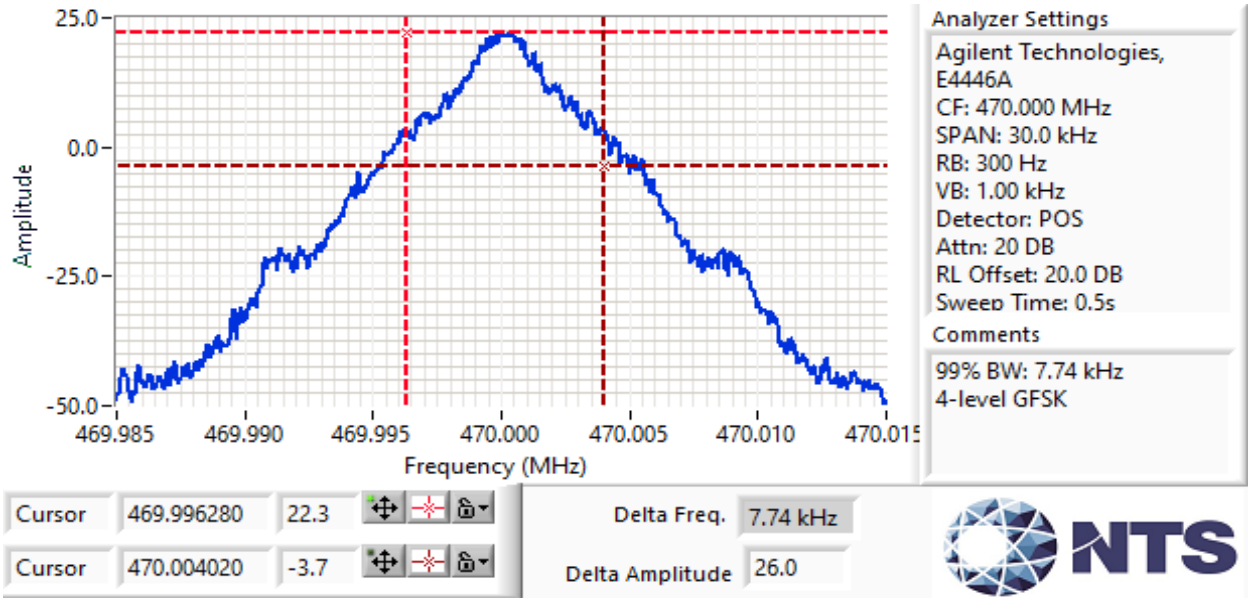
Config. Used: 1
Config Change: None
EUT Voltage: 12 VDC

Power Setting	Frequency (MHz)	Resolution Bandwidth	Bandwidth (kHz)		
				99%	
10	435	300 Hz		8.85	2-level GFSK
10	450	300 Hz		8.79	2-level GFSK
10	460	300 Hz		8.85	2-level GFSK
10	470	300 Hz		8.91	2-level GFSK
10	435	300 Hz		7.68	4-level GFSK
10	450	300 Hz		7.68	4-level GFSK
10	460	300 Hz		7.74	4-level GFSK
10	470	300 Hz		7.74	4-level GFSK

Note 1:	99% bandwidth measured in accordance with ANSI C63.10, with RB between 1% and 5% of the measured bandwidth and VB ≥ 3*RB and Span ≥ 1.5% and ≤ 5% of measured bandwidth.
Note 2:	435 MHz not used in Canada

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-





EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #4: Out of Band Spurious Emissions, Conducted

Date of Test: 6/5/2020
Test Engineer: David Bare
Test Location: Fremont Chamber #5

Config. Used: 1
Config Change: None
EUT Voltage: 12 VDC

Frequency (MHz)	Limit	Result
435	-20 dBm	Pass
450	-20 dBm	Pass
460	-20 dBm	Pass
470	-20 dBm	Pass

The limit is taken from FCC Part 90 Mask D.
Plots 20 Mhz wide centered on the signal frequency also provided for each channel bandwidth/spacing.

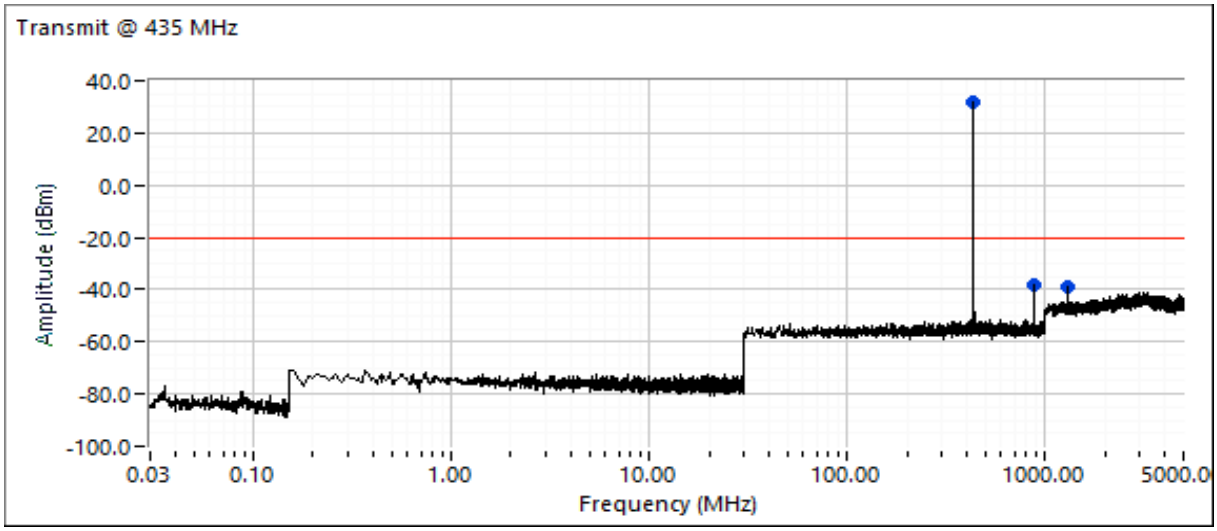
Final peak readings

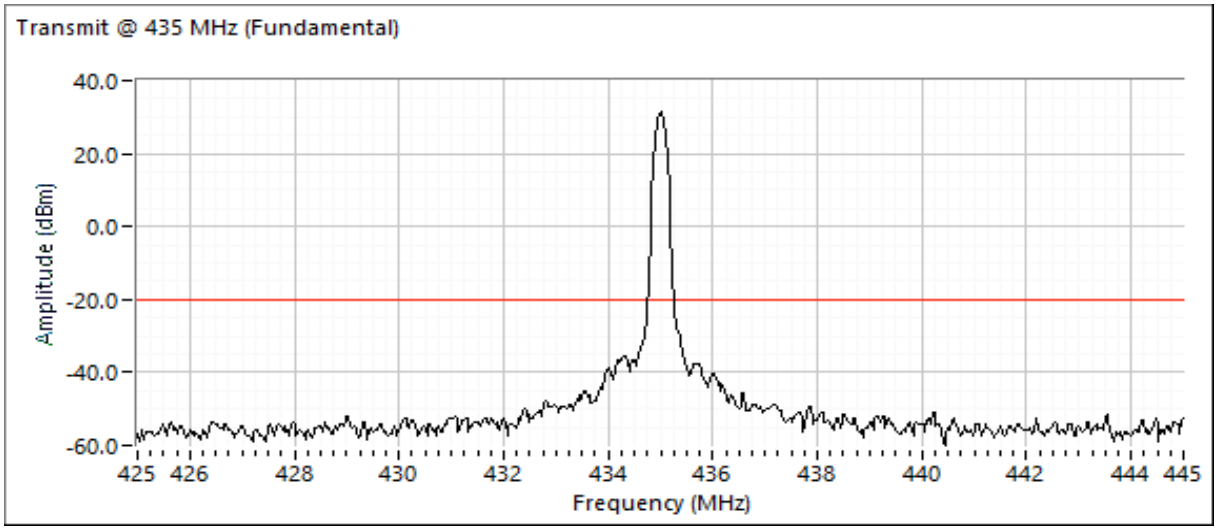
Frequency MHz	Level dBm	Port	FCC 90.210 Limit	FCC 90.210 Margin	Detector	Comments	
434.948	31.6	RF Port	-	-	PK	Fundamental	435 MHz
869.977	-37.9	RF Port	-20.0	-17.9	PK	PK (CISPR)-RB 120 kHz; VB: 1 MHz	435 MHz
1305.440	-39.0	RF Port	-20.0	-19.0	PK	PK (CISPR)-RB 1 MHz; VB: 3 MHz	435 MHz
449.827	32.0	RF Port	-	-	PK	Fundamental	450 MHz
900.057	-37.6	RF Port	-20.0	-17.6	PK	PK (CISPR)-RB 120 kHz; VB: 1 MHz	450 MHz
1349.450	-38.4	RF Port	-20.0	-18.4	PK	PK (CISPR)-RB 1 MHz; VB: 3 MHz	450 MHz
459.853	32.4	RF Port	-	-	PK	Fundamental	450 MHz
920.110	-37.4	RF Port	-20.0	-17.4	PK	PK (CISPR)-RB 120 kHz; VB: 1 MHz	450 MHz
1380.130	-38.4	RF Port	-20.0	-18.4	PK	PK (CISPR)-RB 1 MHz; VB: 3 MHz	450 MHz
459.853	32.4	RF Port	-	-	PK	Fundamental	460 MHz
920.110	-37.4	RF Port	-20.0	-17.4	PK	PK (CISPR)-RB 120 kHz; VB: 1 MHz	460 MHz
1380.130	-38.4	RF Port	-20.0	-18.4	PK	PK (CISPR)-RB 1 MHz; VB: 3 MHz	460 MHz
469.880	32.7	RF Port	-	-	PK	Fundamental	470 MHz
939.840	-37.0	RF Port	-20.0	-17.0	PK	PK (CISPR)-RB 120 kHz; VB: 1 MHz	470 MHz
1410.800	-37.5	RF Port	-20.0	-17.5	PK	PK (CISPR)-RB 1 MHz; VB: 3 MHz	470 MHz

Note 1:	435 MHz not used in Canada

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

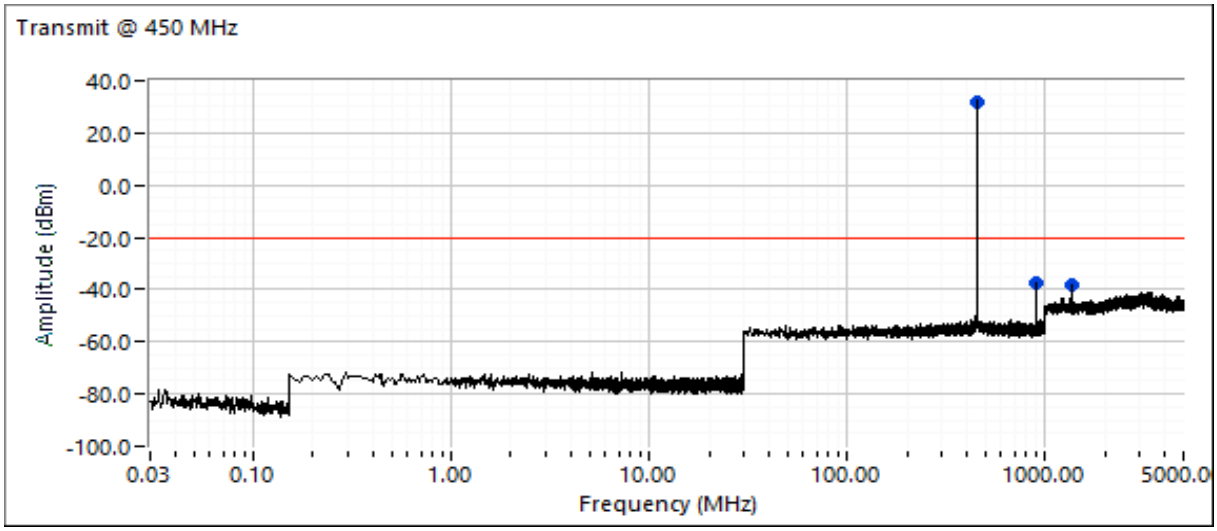
Plots for low channel, power setting(s) = 10

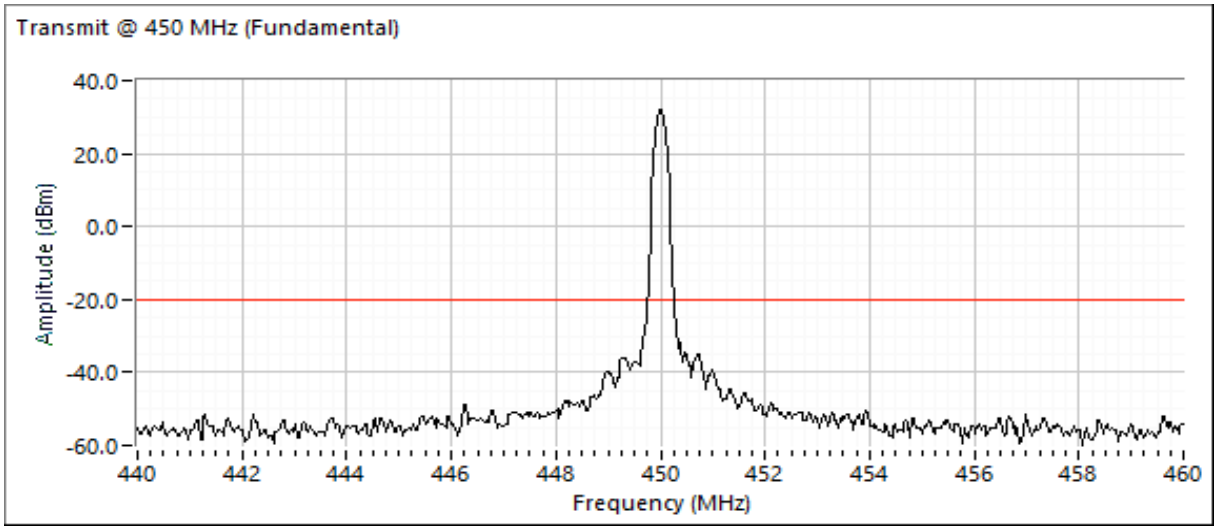




Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

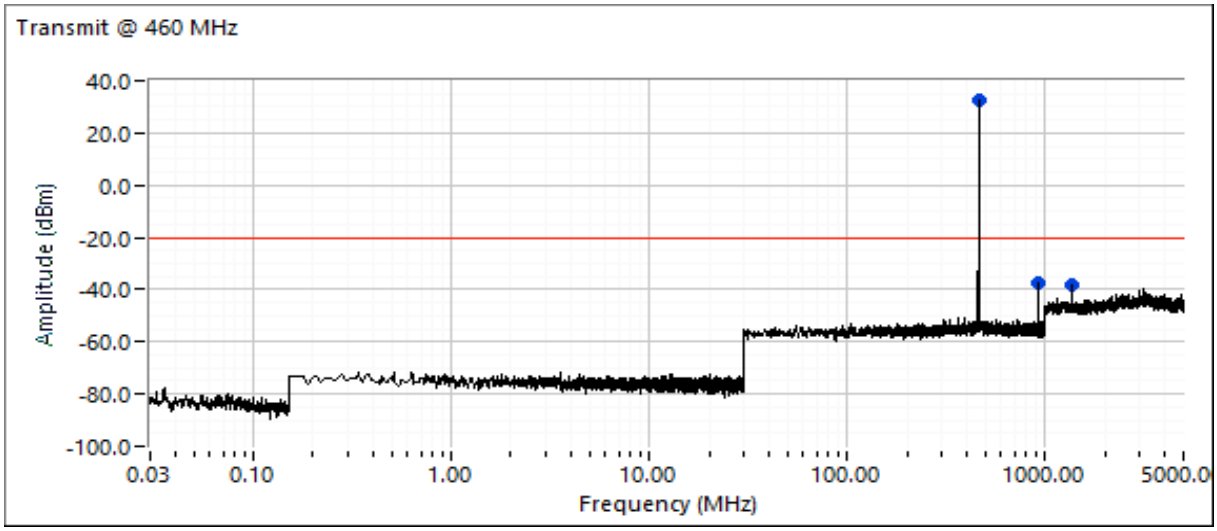
Plots for center channel, power setting(s) = 10

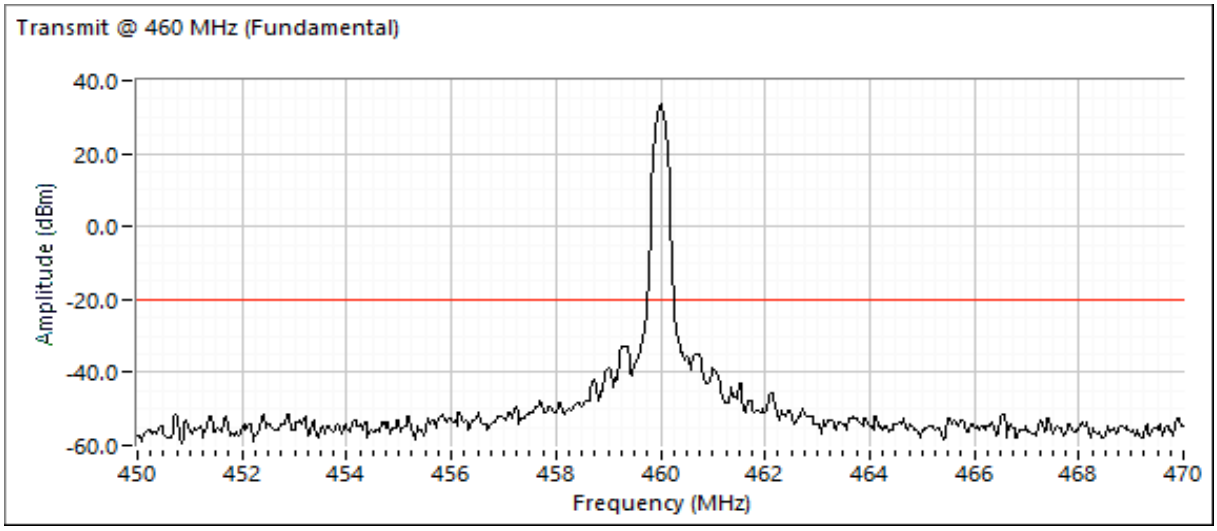




Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

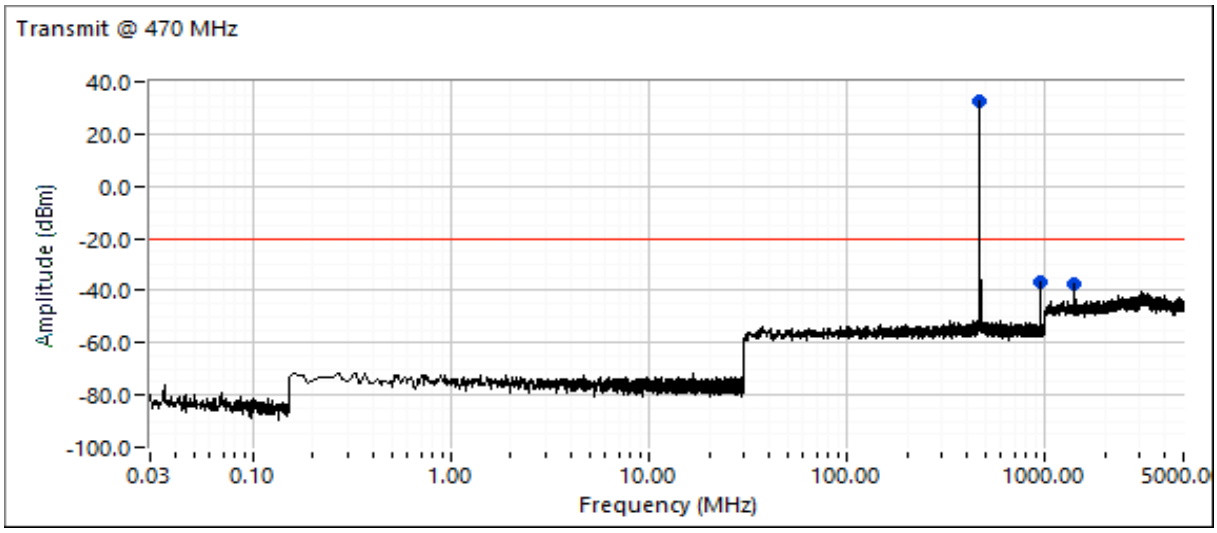
Plots for center channel, power setting(s) = 10

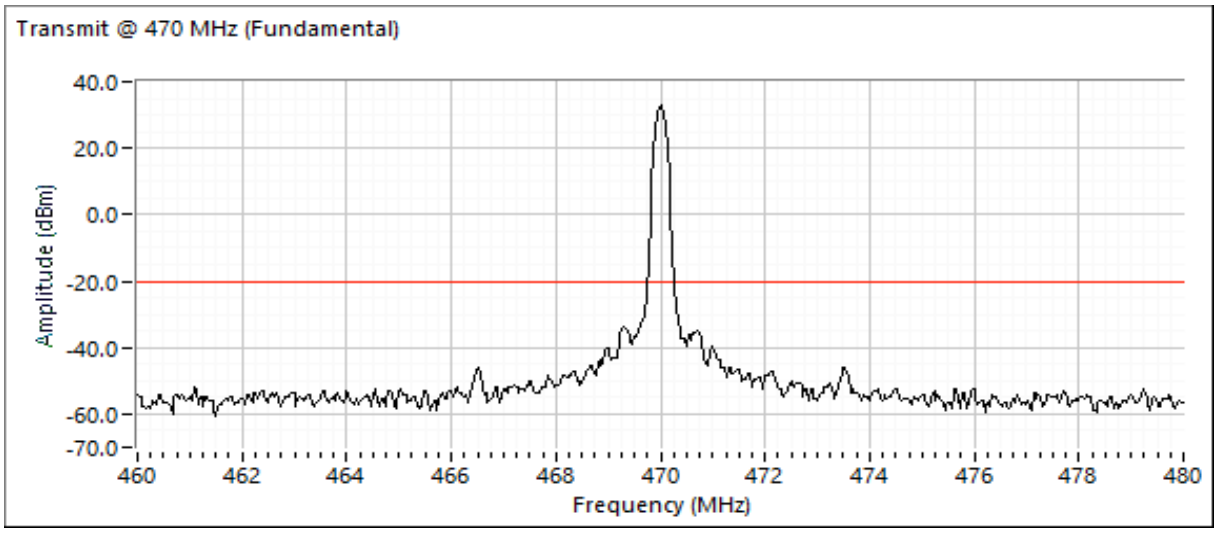




Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Plots for high channel, power setting(s) = 10





EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #5: Out of Band Spurious Emissions, Radiated

Conducted limit (dBm): -20.0
Approximate field strength limit @ 3m: 75.3

The limit is taken from FCC Part 90 Mask D

Run #5a - Preliminary measurements

Date of Test: 12/28/2021
Test Engineer: M. Birgani
Test Location: Chamber #7

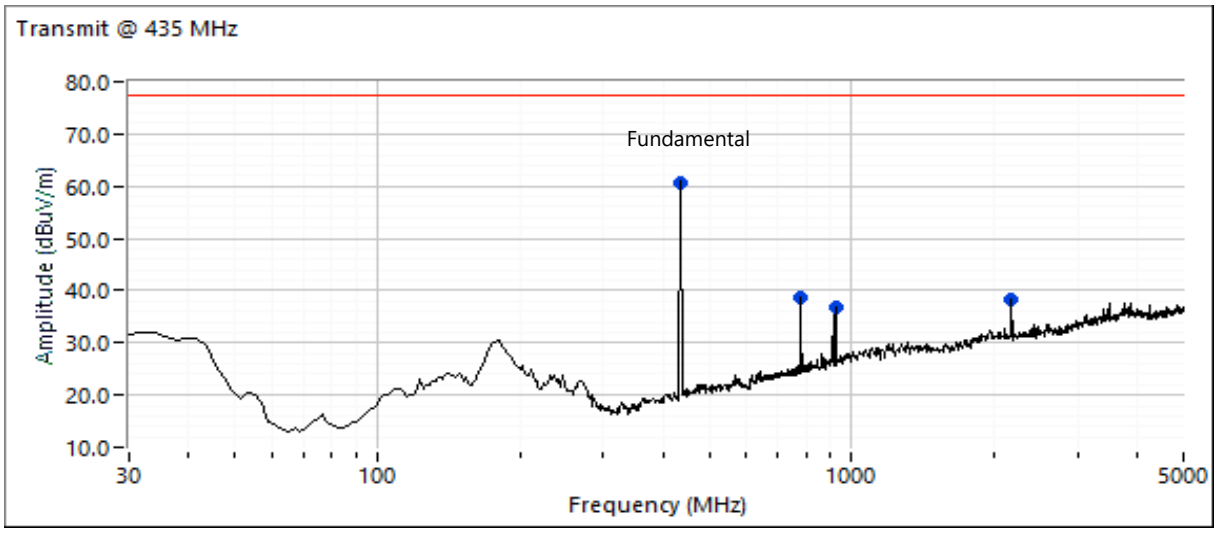
Config. Used: 1
Config Change: None
EUT Voltage: 12VDC

Frequency	Level	Pol	FCC Part 90		Detector	Azimuth	Height	Comments	Channel
MHz	dBμV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters		
436.273	60.7	H	-	-	Peak	184	1.0	Fundamental	435 MHz
778.397	38.6	V	77.5	-38.9	Peak	112	4.0		435 MHz
924.188	36.7	V	77.5	-40.8	Peak	6	2.0		435 MHz
2170.340	38.2	H	77.5	-39.3	Peak	269	2.0		435 MHz
1905.810	35.0	H	77.5	-42.5	Peak	204	2.0		450 MHz
460.329	61.8	H	-	-	Peak	258	2.5	Fundamental	460 MHz
908.637	40.3	V	77.5	-37.2	Peak	157	2.5		460 MHz
1897.800	50.2	V	77.5	-27.3	Peak	278	1.0		460 MHz
2466.930	40.4	V	77.5	-37.1	Peak	268	1.0		460 MHz
470.100	67.9	H	-	-	Peak	14	2.0	Fundamental	470 MHz
920.301	34.8	V	77.5	-42.7	Peak	301	2.0		470 MHz
2450.900	41.3	V	77.5	-36.2	Peak	66	2.0		470 MHz

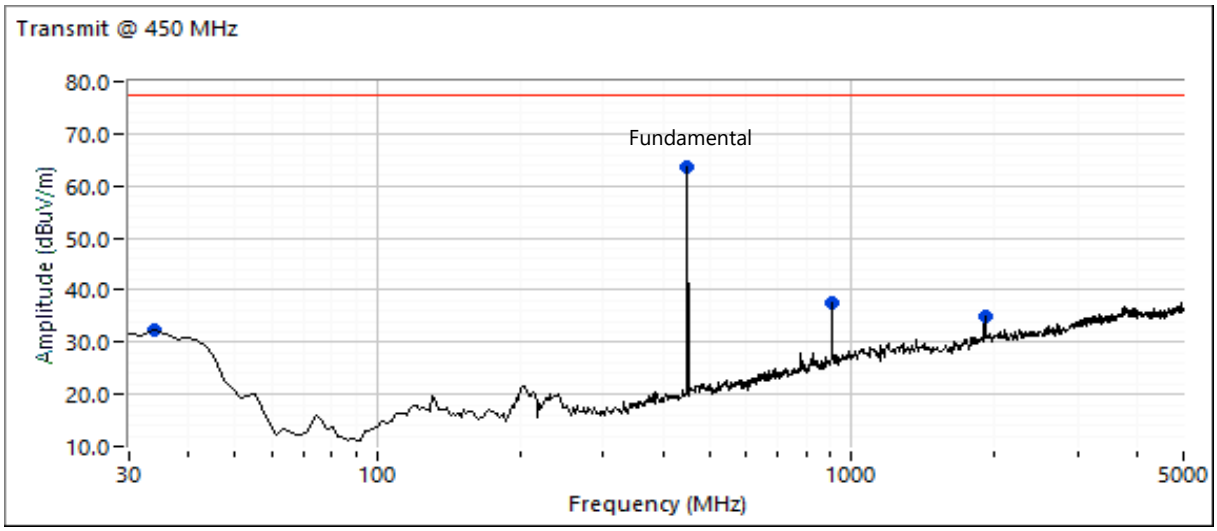
Note 1:	The field strength limit in the tables above was calculated from the erp/eirp limit detailed in the standard using the free space propagation equation: E=√(30PG)/d. This limit is conservative - it does not consider the presence of the ground plane and, for erp limits, the dipole gain (2.2dBi) has not been included. The erp or eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.
Note 2:	Measurements are made with the antenna port terminated.

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

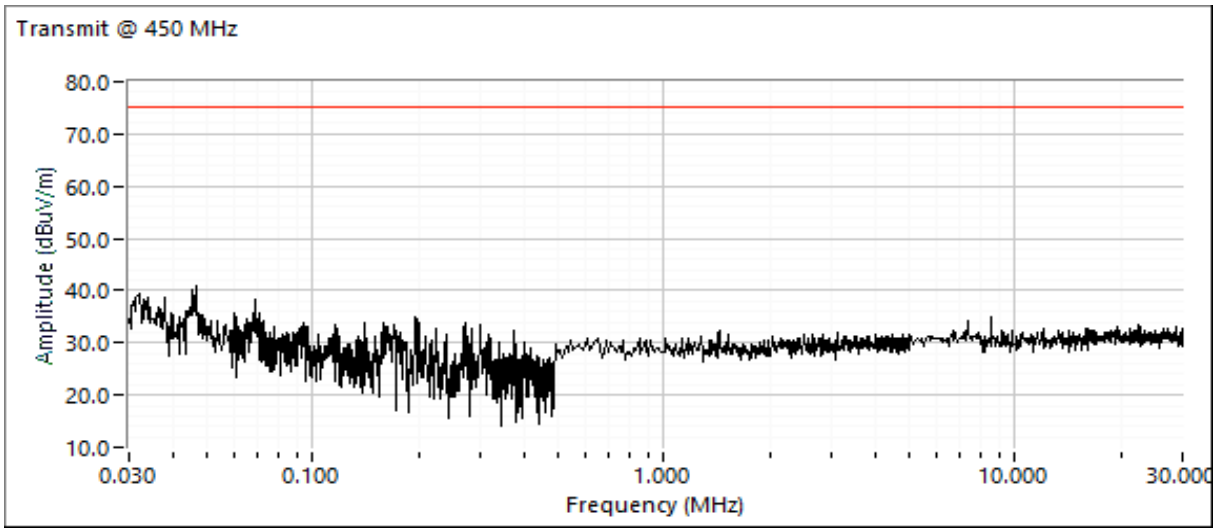
Plots for low channel, power setting(s) = 10



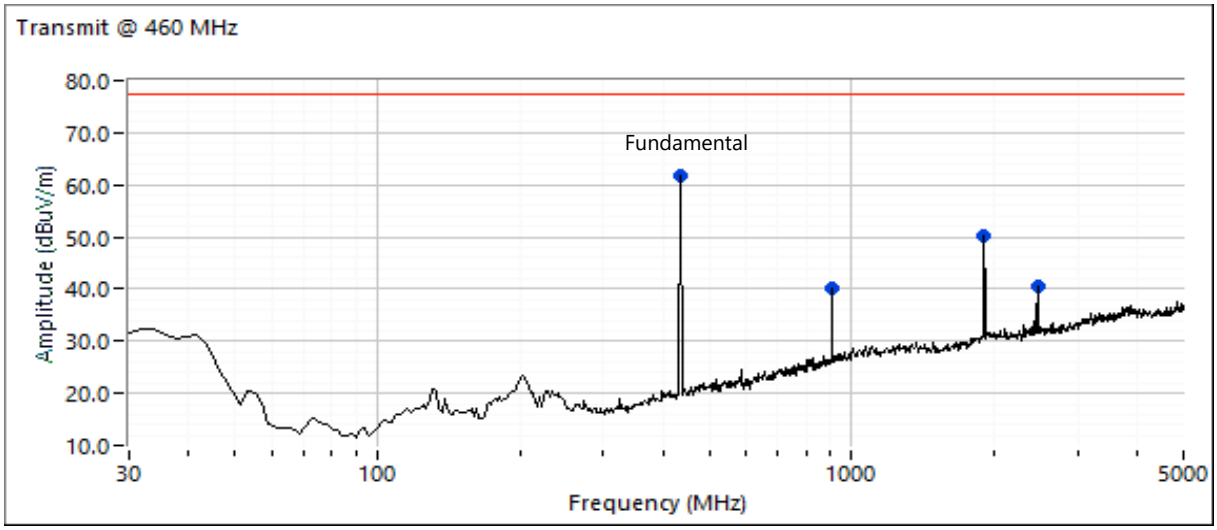
Plots for center channel, power setting(s) = 10



Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

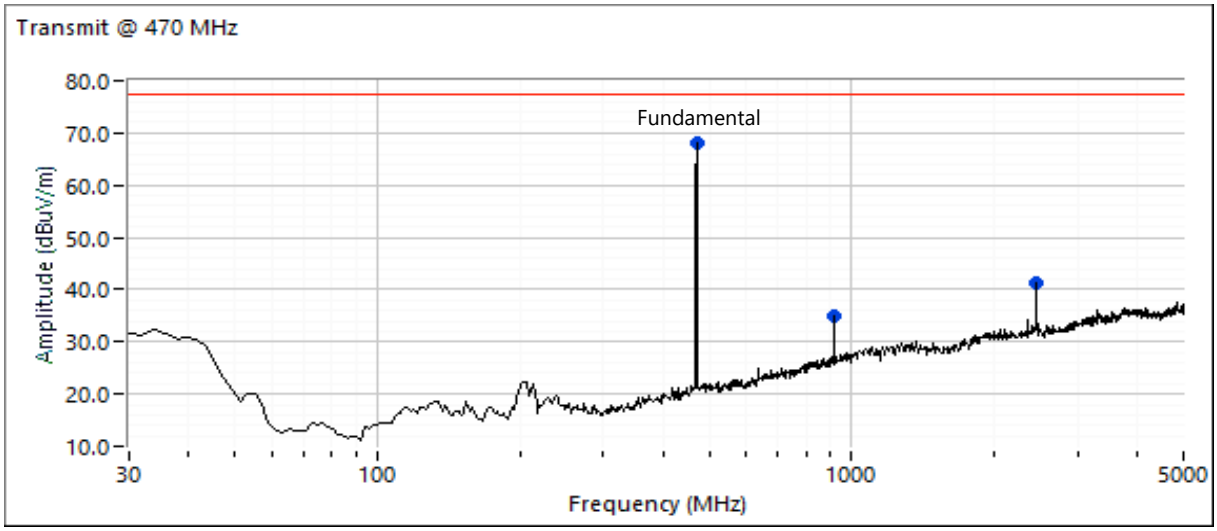


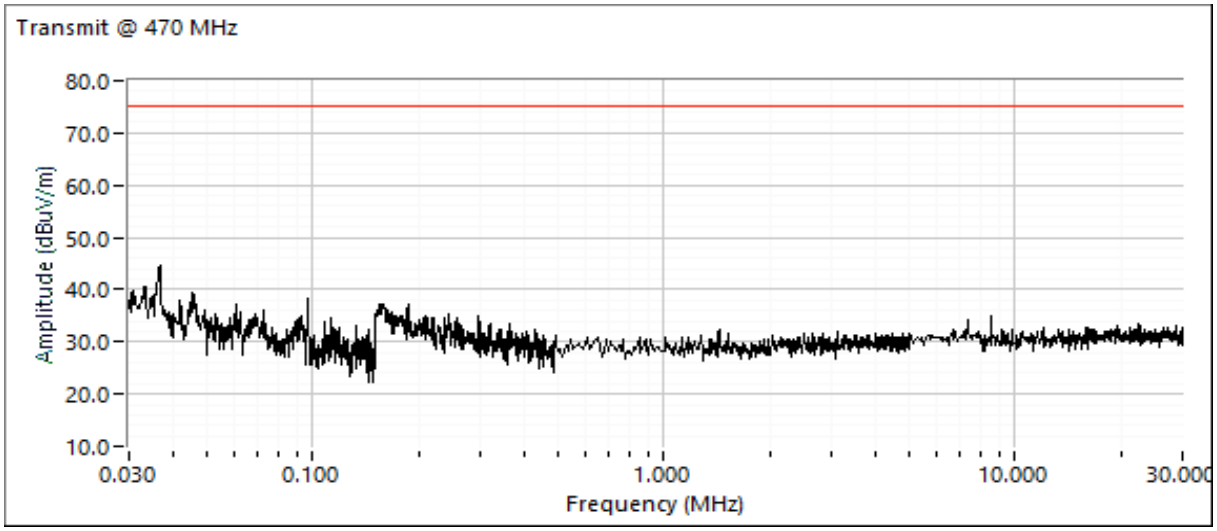
Plots for center channel, power setting(s) = 10



Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Plots for high channel, power setting(s) = 10





Note:	Since no emisisons were observed above the noise floor at 450 and 470 MHz additional measurements at other frequencies were not considered necessary.

EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #5b: - Final Field Strength Measurements and Substitution Measurements

Date of Test: 12/28/2021 Config. Used: 1
Test Engineer: M. Birgani Config Change: None
Test Location: Chamber #7 EUT Voltage: 12VDC

EUT Field Strength

Frequency	Level	Pol	FCC Part 90		Detector	Azimuth	Height	Comments	Channel
MHz	dBμV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters		
775.742	24.4	V	77.5	-53.1	PK	112	4.0	PK (0.10s)	435 MHz
924.154	36.9	V	77.5	-40.6	PK	6	2.0	PK (0.10s)	435 MHz
2170.340	38.2	H	77.5	-39.3	PK	269	2.0	PK (0.10s)	435 MHz
33.766	30.1	V	77.5	-47.4	PK	326	1.0	PK (0.10s)	450 MHz
908.765	26.1	V	77.5	-51.4	PK	267	2.5	PK (0.10s)	450 MHz
1905.810	36.2	H	77.5	-41.3	PK	204	2.0	PK (0.10s)	450 MHz
908.611	26.5	V	77.5	-51.0	PK	157	2.5	PK (0.10s)	460 MHz
1897.800	48.2	V	77.5	-29.3	PK	278	1.0	PK (0.10s)	460 MHz
2466.930	42.3	V	77.5	-35.2	PK	268	1.0	PK (0.10s)	460 MHz
918.868	26.1	V	77.5	-51.4	PK	301	2.0	PK (0.10s)	470 MHz
2451.210	37.9	V	77.5	-39.6	PK	66	2.0	PK (0.10s)	470 MHz

Note 1:	The field strength limit in the tables above was calculated from the erp/eirp limit detailed in the standard using the free space propagation equation: E=√(30PG)/d. This limit is conservative - it does not consider the presence of the ground plane and, for erp limits, the dipole gain (2.2dBi) has not been included. The erp or eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.
Note 2:	Measurements are made with the antenna port terminated.

Substitution measurements

Note 1:	As none of the emissions were within 20 dB of the calculated field strength limit, no substitution measurements are required.

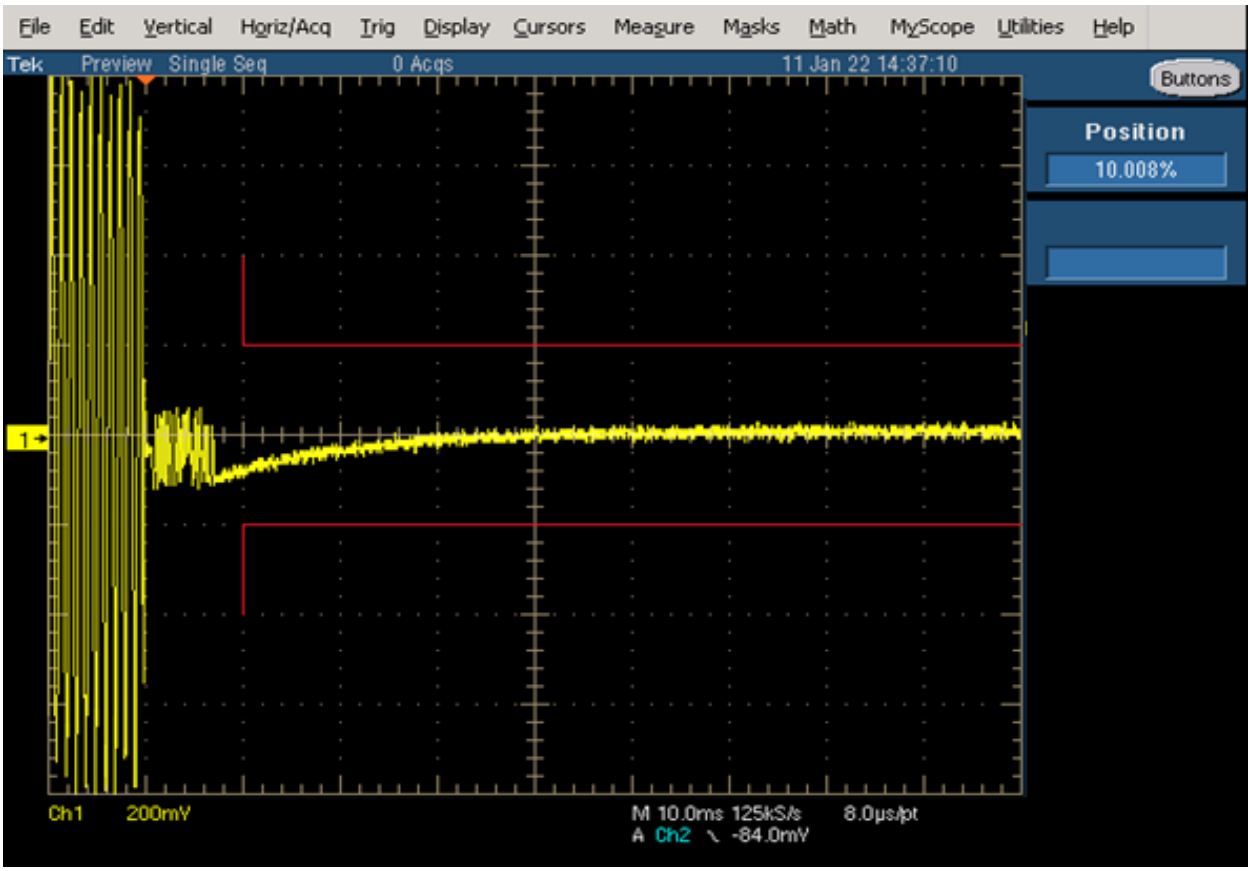
Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #6: Transient Frequency Behavior

Date of Test: 1/11/2022
Test Engineer: David Bare
Test Location: Fremotn Chamber #2

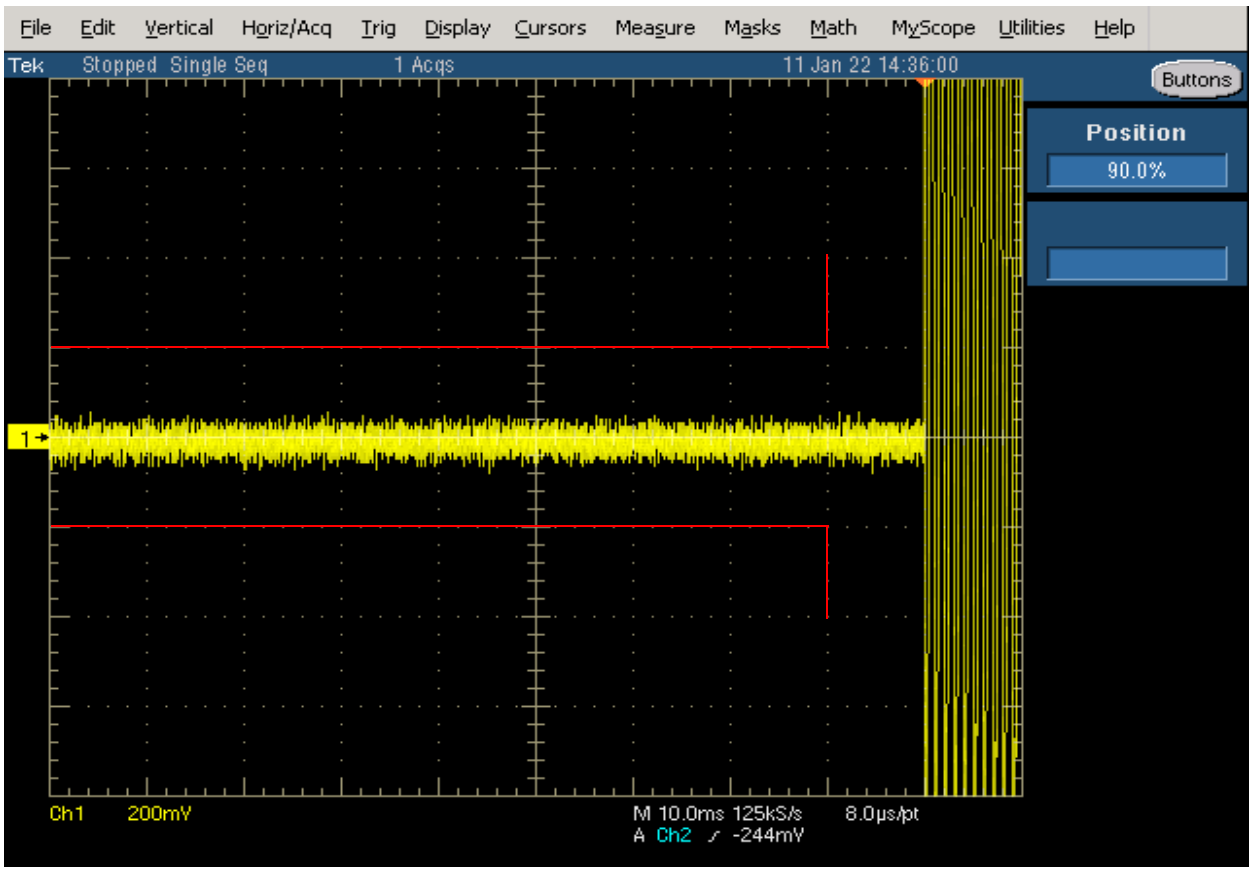
Config. Used: 1
Config Change: None
EUT Voltage: 12 VDC

Run #6a
Carrier Frequency: 450 MHz
Channel Spacing: 12.5 kHz
Modulation: 2-level GFSK
Description: Switch on condition ton, t1, and t2
Top of display: +25kHz, Bottom of display: -25kHz



Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #6b
Carrier Frequency: 450 MHz
Channel Spacing: 12.5 kHz
Modulation: 2-level GFSK
Description: Switch off condition t3 and toff
Top of display: +25kHz, Bottom of display: -25kHz



EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #8: Frequency Stability

Date of Test: 12/30/2021
Test Engineer: M. Birgani
Test Location: Fremont EMC Lab #3

Config. Used: 1
Config Change: None
EUT Voltage: 12 VDC

Nominal Frequency: 449.9985 MHz

Frequency Stability Over Temperature

The EUT was soaked at each temperature for a minimum of 30 minutes prior to making the measurements to ensure the EUT and chamber had stabilized at that temperature.

Temperature	Frequency Measured	Drift	
(Celsius)	(MHz)	(Hz)	(ppm)
-30	449.997991	510	1.1
-20	449.998254	247	0.5
-10	449.998291	210	0.5
0	449.998391	110	0.2
10	449.998431	70	0.2
20	449.998501	0	0.0
30	449.998618	-117	0.3
40	449.998554	-53	0.1
50	449.998374	127	0.3
	Worst case:	510	1.1

Frequency Stability Over Input Voltage

Nominal Voltage is 12Vdc.

Voltage	Frequency Measured	Drift	
(DC)	(MHz)	(Hz)	(ppm)
85%	449.998478	23	0.1
115%	449.998488	13	0.0
	Worst case:	23	0.1

EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Radiated Emissions

(NTS Silicon Valley, Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 12/29/2021 & 1/10/2022
Test Engineer: M. Birgani
Test Location: Chamber #7

Config. Used: 1
Config Change: None
EUT Voltage: 12VDC

General Test Configuration

The EUT and any local support equipment were located on the turntable for radiated emissions testing.
Radiated emissions tests above 1 GHz to FCC Part 15 were performed with floor absorbers in place in accordance with the test methods of ANSI C63.4 and CISPR 16-1-4.
The test distance and extrapolation factor (if applicable) are detailed under each run description.
Note, preliminary testing indicates that the emissions were maximized by orientation of the EUT and elevation of the measurement antenna. Maximized testing indicated that the emissions were maximized by orientation of the EUT, elevation of the measurement antenna, and manipulation of the EUT's interface cables.

Ambient Conditions:

Temperature: 18-20 °C
Rel. Humidity: 43-45 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
2	30 - 1,500 MHz - Receiver Radiated Spurious Emissions	FCC Part 15.109	Pass	31.6 dBµV/m @ 30.00 MHz (Margin: -8.4 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

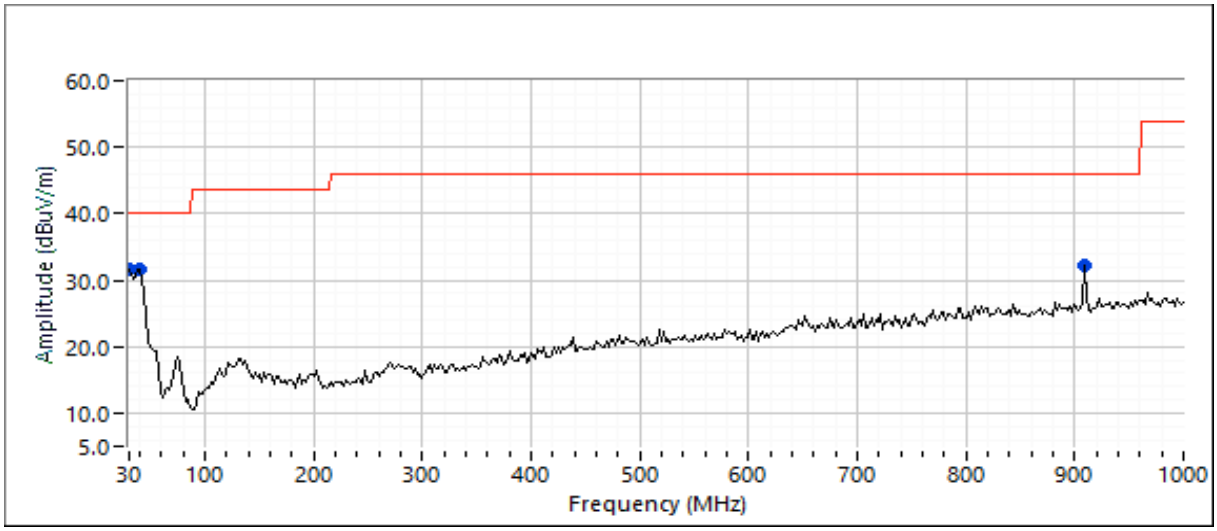
No deviations were made from the requirements of the standard.

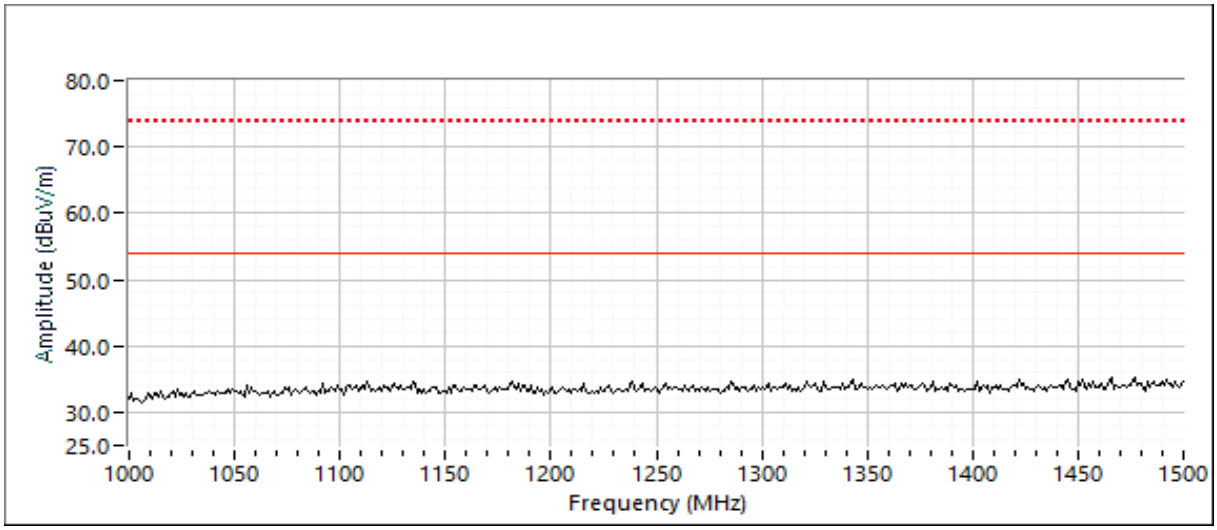
EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #1: Receiver Radiated Spurious Emissions, 30 - 1,500 MHz

Frequency	Level	Pol	15.109 / RSS GEN		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
30.000	31.6	V	40.0	-8.4	Peak	29	1.0	
39.719	31.5	V	40.0	-8.5	Peak	276	1.0	
908.637	32.2	V	46.0	-13.8	Peak	335	3.0	





EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Conducted Emissions

(NTS Silicon Valley, Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 1/10/2022
Test Engineer: David Bare
Test Location: Fremont Chamber #5

Config. Used: 1
Config Change: None
EUTt Voltage 12VDC

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN. A second LISN was used for all local support equipment. Remote support equipment was located outside of the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

Ambient Conditions:

Temperature: 19 °C
Rel. Humidity: 44 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, Antenna Port (Receive)	FCC 15.111	Pass	-79.1 dBm @ 1067.0 MHz (-22.1 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

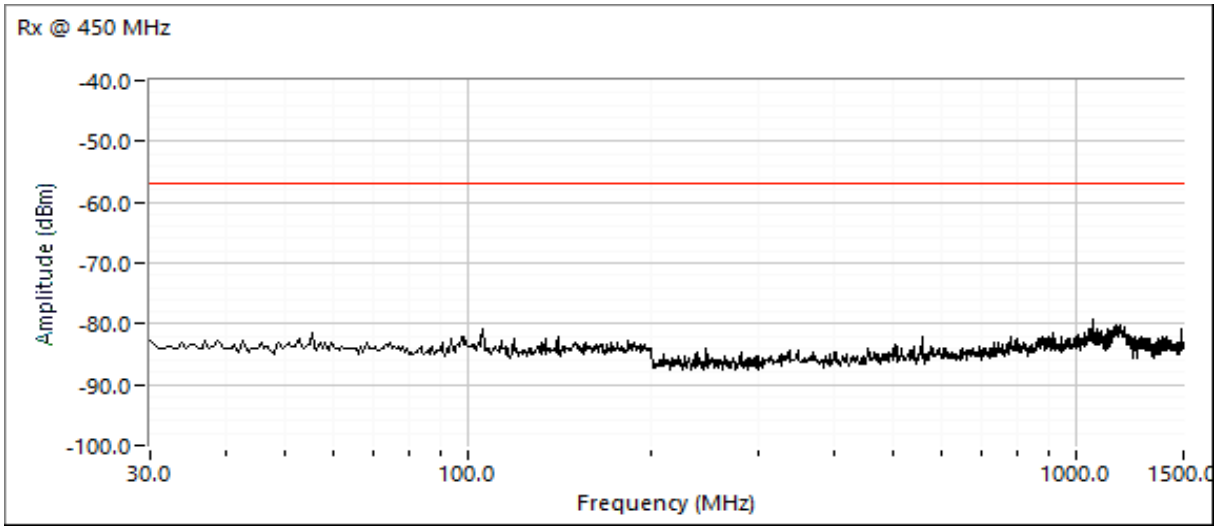
Deviations From The Standard

No deviations were made from the requirements of the standard.

EMC Test Data

Client:	Freewave	PR Number:	PR151710
Model:	LRS455A	T-Log Number:	TL151710-RA
		Project Manager:	Deepa Shetty
Contact:	Michael Drake	Project Engineer:	David Bare
Standard:	FCC Parts 15 & 90, RSS-119	Class:	-

Run #1: Antenna Port Conducted Emissions, 30 - 1,500 MHz



Final peak readings, center channel @ 450MHz

Frequency MHz	Level dBm	Port	FCC 15.111 Limit	Margin	Detector QP/Ave	Comments
1067.030	-79.1	RF Port	-57.0	-22.1	Peak	

Note 1:	As there were no emissions from the EUT above the noise floor, additional tests at other receive frequency were unnecessary.

End of Report

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