

FCC REPORT

Certification

Applicant Name:
GS Instech Co., Ltd.

Date of Issue:
May 02, 2018

Address:
70, Gilpa-ro 71beon-gil, Nam-gu, Inchen, Korea

Location of test lab:
HCT CO., LTD.,
74, Seoicheon-ro 578beon-gil, Majang-myeon,
Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA

Report No.: HCT-RF-1805-FC005

FCC ID: U88-EZDASS-A39

APPLICANT: GS Instech Co., Ltd.

Model: EZ-DASS-A39
EUT Type: Analog Optic DAS
Frequency Range: 2 110 MHz ~ 2 180 MHz (DL)
Tx Output Power: 39 dBm (8 W)
Date of Test: April 10, 2018 ~ May 02, 2018
FCC Rule Part(s): CFR 47 Part 2, Part 27

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules under normal use and maintenance.



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Approved by : Jong Seok Lee
Manager of telecommunication testing center

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Version

| TEST REPORT NO. | DATE | DESCRIPTION |
|-------------------|--------------|-------------------------|
| HCT-RF-1805-FC005 | May 02, 2018 | - First Approval Report |
| | | |
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1. GENERAL INFORMATION

1.1. APPLICANT INFORMATION

| | |
|-----------------|--|
| Company Name | GS Instech Co., Ltd. |
| Company Address | 70, Gilpa-ro 71beon-gil, Nam-gu, Inchen, Korea |

1.2. PRODUCT INFORMATION

| | |
|-------------------------|---|
| EUT Type | Analog Optic DAS |
| Power Supply | AC 110 V ~ 240 V |
| Frequency Range | 2 110 MHz ~ 2 180 MHz (DL) |
| Tx Output Power | 39 dBm (8 W) |
| Supporting Technologies | LTE 10 MHz |
| Antenna Specification | Manufacturer does not provide an antenna. |

1.3. TEST INFORMATION

| | |
|-----------------------|--|
| FCC Rule Parts | CFR 47 Part 2, Part 27 |
| Measurement standards | ANSI C63.26-2015, KDB 971168 D01 v03r01, KDB 935210 D05 v01r02 |
| Place of Test | HCT CO., LTD. 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA |

2. FACILITIES AND ACCREDITATIONS

2.1. FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA. The site is constructed in conformance with the requirements of ANSI C63.4 (Version: 2014) and CISPR Publication 22. Detailed description of test facility was submitted to the Commission and accepted dated July 07, 2015 (Registration Number: 90661).

2.2. EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

3. TEST SPECIFICATIONS

3.1. STANDARDS

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 2, Part 27

| Description | Reference | Results |
|------------------------------|-----------------------|-----------|
| RF Output Power | §2.1046, §27.50 | Compliant |
| Occupied Bandwidth | §2.1049 | Compliant |
| Out of Band Rejection | KDB 935210 D05 v01r02 | Compliant |
| Unwanted Conducted Emissions | §2.1051, §27.53 | Compliant |
| Radiated Emissions | §2.1053, §27.53 | Compliant |
| Frequency Stability | §2.1055, §27.54 | Compliant |

3.2. MODE OF OPERATION DURING THE TEST

The EUT was operated in a manner representative of the typical usage of the equipment.

During all testing, system components were manipulated within the confines of typical usage to maximize each emission.

The device does not supply antenna(s) with the system, so the dummy loads were connected to the RF output ports for radiated spurious emission testing.

* The test was carried out in conjunction with DU module (EZ-DASD-A23) provided by applicant.

* The tests results in plots are already including the actual value of loss for the attenuator and cable combination. Please check correction factors below table.

■ Correction Factor

| Freq(MHz) | Factor(dB) |
|-----------|------------|
| 30 | 30.015 |
| 100 | 28.826 |
| 200 | 29.218 |
| 300 | 29.281 |
| 400 | 26.649 |
| 500 | 29.775 |
| 600 | 29.874 |
| 700 | 29.896 |
| 800 | 29.996 |
| 900 | 30.159 |
| 1000 | 30.272 |
| 2000 | 31.154 |
| 3000 | 31.848 |
| 4000 | 32.447 |
| 5000 | 33.234 |
| 6000 | 33.586 |
| 7000 | 34.840 |
| 8000 | 33.689 |
| 9000 | 34.850 |
| 10000 | 36.207 |
| 20000 | 44.683 |
| 26000 | 49.206 |

3.3. MAXIMUM MEASUREMENT UNCERTAINTY

The value of the measurement uncertainty for the measurement of each parameter.

Coverage factor $k = 2$, Confidence levels of 95 %

| Description | Condition | Uncertainty |
|------------------------------|-------------------------------|---------------------------------|
| RF Output Power | - | ± 0.72 dB |
| Occupied Bandwidth | OBW \leq 20 MHz | ± 52 kHz |
| Out of Band Rejection | Gain 20 dB bandwidth | ± 0.89 dB ± 0.58 MHz |
| Unwanted Conducted Emissions | - | ± 1.08 dB |
| Radiated Emissions | $f \leq 1$ GHz $f > 1$ GHz | ± 4.80 dB ± 6.07 dB |
| Frequency Stability | - | $\pm 1.22 \times 10^{-6}$ |

3.4. STANDARDS ENVIRONMENTAL TEST CONDITIONS

| | |
|--------------------|------------------------|
| Temperature : | +15 °C to +35 °C |
| Relative humidity: | 30 % to 60 % |
| Air pressure | 860 mbar to 1 060 mbar |

4. TEST EQUIPMENTS

| Manufacturer | Model / Equipment | Calibration Date | Calibration Interval | Serial No. |
|------------------------|--|------------------|----------------------|----------------|
| Agilent | N9020A / Spectrum Analyzer | 09/15/2017 | Annual | MY46471250 |
| Agilent | N5128A / Signal Generator | 03/05/2018 | Annual | MY50141649 |
| Agilent | N5128A / Signal Generator | 02/17/2018 | Annual | MY46240523 |
| Weinschel | WA67-30-33/ Fixed Attenuator | 09/14/2017 | Annual | WA67-30-33-2 |
| Agilent | 11636A / Power Divider | 08/01/2018 | Annual | 09109 |
| DEAYOUNG ENT | DFSS60 / AC Power Supply | 04/05/2018 | Annual | 1003030-1 |
| NANGYEUL CO., LTD. | NY-THR18750 / Temperature and Humidity Chamber | 10/21/2017 | Annual | NY-2009012201A |
| Innco system | CO3000 / Controller(Antenna mast) | N/A | N/A | CO3000-4p |
| Innco system | MA4640/800-XP-EP / Antenna Position Tower | N/A | N/A | N/A |
| Emco | 2090 / Controller | N/A | N/A | 060520 |
| Ets | Turn Table | N/A | N/A | N/A |
| Rohde & Schwarz | Loop Antenna | 04/19/2017 | Biennial | 1513-175 |
| Schwarzbeck | VULB 9168 / Hybrid Antenna | 04/06/2017 | Biennial | 760 |
| Schwarzbeck | BBHA 9120D / Horn Antenna | 06/30/2017 | Biennial | 9120D-1300 |
| Schwarzbeck | BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz) | 04/25/2017 | Biennial | BBHA9170124 |
| Rohde & Schwarz | FSP / Spectrum Analyzer | 09/21/2017 | Annual | 836650/016 |
| Wainwright Instruments | WHKX10-900-1000-15000-40SS | 07/21/2017 | Annual | 5 |
| Wainwright Instruments | WHKX10-2700-3000-18000-40SS / High Pass Filter | 08/01/2017 | Annual | 4 |
| CERNEX | CBLU1183540 / Power Amplifier | 01/03/2018 | Annual | 24613 |
| CERNEX | CBL06185030 / Power Amplifier | 01/03/2018 | Annual | 24615 |
| CERNEX | CBL18265035 / Power Amplifier | 01/10/2018 | Annual | 22966 |

5. RF OUTPUT POWER

FCC Rules

Test Requirements:

§ 2.1046 Measurements required: RF power output.

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in §2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

(b) For single sideband, independent sideband, and single channel, controlled carrier radiotelephone transmitters the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as specified and applicable in § 2.1046 (b) (1-5). In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

(c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

§ 27.50 Power limits and duty cycle.

(d) The following power and antenna height requirements apply to stations transmitting in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz and 2180-2200 MHz bands:

(1) The power of each fixed or base station transmitting in the 1995-2000 MHz, 2110-2155 MHz, 2155-2180 MHz or 2180-2200 MHz band and located in any county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, is limited to:

- (i) An equivalent isotropically radiated power (EIRP) of 3280 watts when transmitting with an emission bandwidth of 1 MHz or less;
- (ii) An EIRP of 3280 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.

(2) The power of each fixed or base station transmitting in the 1995-2000 MHz, the 2110-2155 MHz 2155-2180 MHz band, or 2180-2200 MHz band and situated in any geographic location other than that described in paragraph (d)(1) of this section is limited to:

- (i) An equivalent isotropically radiated power (EIRP) of 1640 watts when transmitting with an emission bandwidth of 1 MHz or less;
 - (ii) An EIRP of 1640 watts/MHz when transmitting with an emission bandwidth greater than 1 MHz.
- (3) A licensee operating a base or fixed station in the 2110-2155 MHz band utilizing a power greater than 1640 watts EIRP and greater than 1640 watts/MHz EIRP must coordinate such operations in advance with all Government and non-Government satellite entities in the 2025-2110 MHz band. A licensee operating a base or fixed station in the 2110-2180 MHz band utilizing power greater than 1640 watts EIRP and greater than 1640 watts/MHz EIRP must be coordinated in advance with the following licensees authorized to operate within 120 kilometers (75 miles) of the base or fixed station operating in this band: All Broadband Radio Service (BRS) licensees authorized under this part in the 2155-2160 MHz band and all advanced wireless services (AWS) licensees authorized to operate on adjacent frequency blocks in the 2110-2180 MHz band.
- (4) Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP. Fixed stations operating in the 1710-1755 MHz band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in these bands must employ a means for limiting power to the minimum necessary for successful communications.
- (5) Equipment employed must be authorized in accordance with the provisions of §24.51. Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (d)(6) of this section. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.
- (6) Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

Test Procedures:

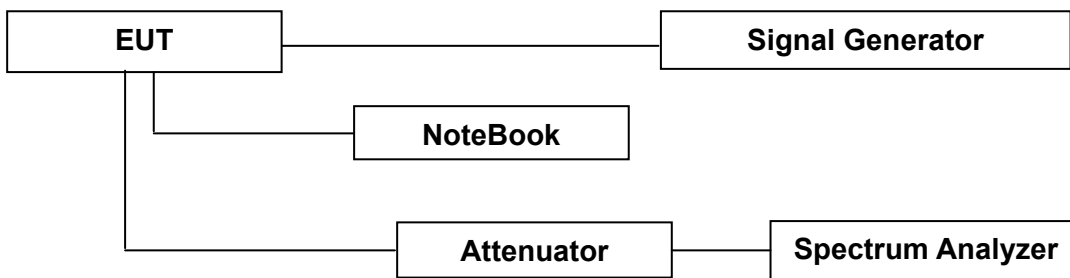
Measurements were in accordance with the test methods section 3.5.2 of KDB 935210 D05 v01r02.

- a) Connect a signal generator to the input of the EUT.
- b) Configure to generate the AWGN (broadband) test signal.
- c) The frequency of the signal generator shall be set to the frequency f_0 as determined from 3.3.

- d) Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation as necessary.
- e) Set the signal generator output power to a level that produces an EUT output level that is just below the AGC threshold (see 3.2), but not more than 0.5 dB below.
- f) Measure and record the output power of the EUT; use 3.5.3 or 3.5.4 for power measurement.
- g) Remove the EUT from the measurement setup. Using the same signal generator settings, repeat the power measurement at the signal generator port, which was used as the input signal to the EUT, and record as the input power. EUT gain may be calculated as described in 3.5.5.
- h) Repeat steps f) and g) with input signal amplitude set to 3 dB above the AGC threshold level.
- i) Repeat steps e) to h) with the narrowband test signal.
- j) Repeat steps e) to i) for all frequency bands authorized for use by the EUT.

Power measurement Method:

Guidance for performing input/output power measurements using a spectrum or signal analyzer is provided in 5.2 of KDB Publication 971168 D01 v03r01.



Block Diagram 1. RF Power Output Test Setup

Test Results:

| Input Signal | Input Level (dBm) | Maximum Amp Gain (dB) |
|--------------|-------------------|-----------------------|
| 2 100 | -58 | 97 |

* Due to EUT’s ALC function (Auto Level Control), even if input signal is increased, the same output power is transmit.

* Amp gain is the result of combination with DU module (EZ-DASD-A23)

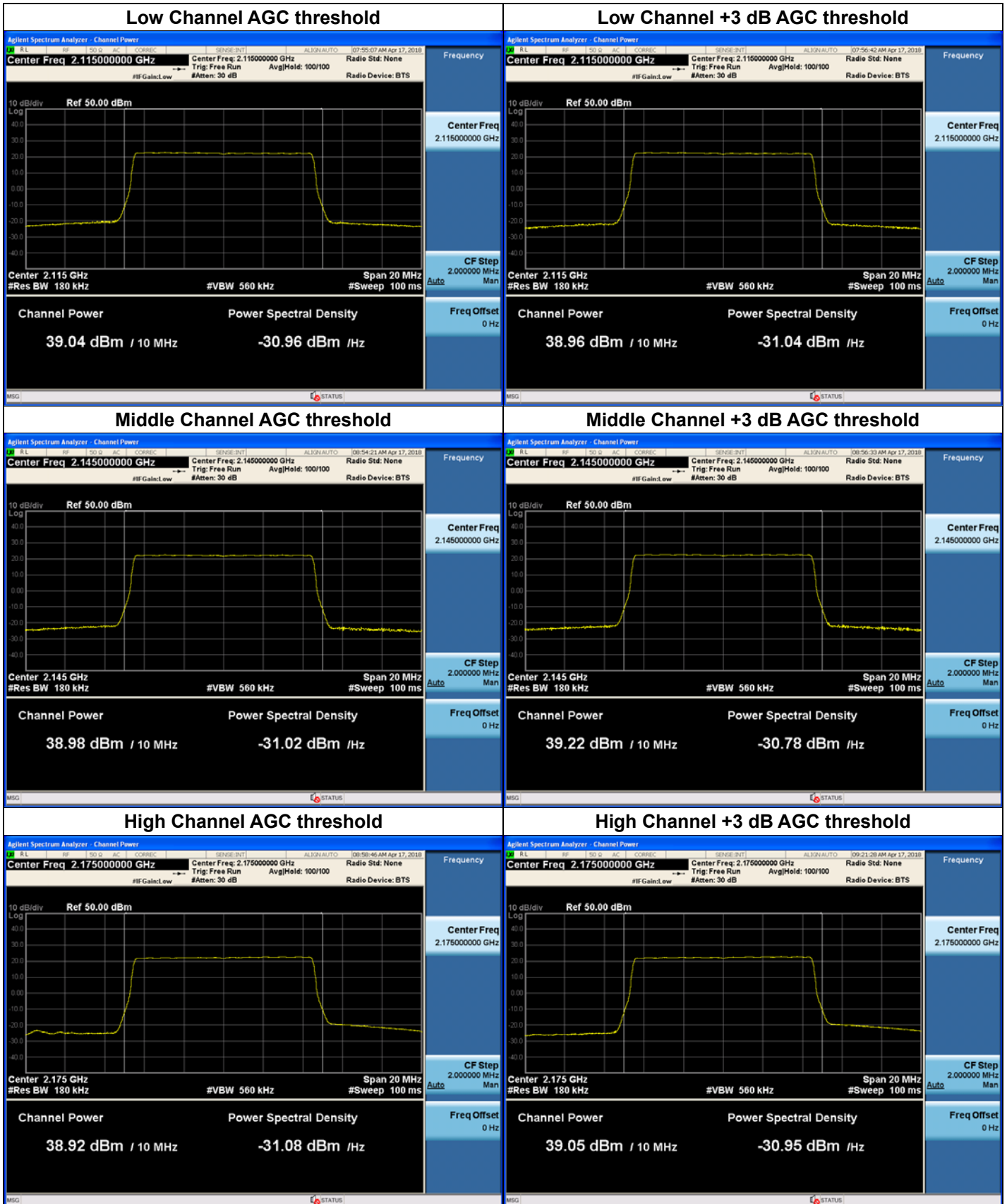
Data of Output Power

| | Channel | Frequency (MHz) | Measured Output Power | |
|--|---------|-----------------|-----------------------|-------|
| | | | (dBm) | (W) |
| LTE 10 MHz AGC threshold | Low | 2115.00 | 39.04 | 8.017 |
| | Middle | 2145.00 | 38.98 | 7.907 |
| | High | 2175.00 | 38.92 | 7.798 |
| LTE 10 MHz +3 dB above the AGC threshold | Low | 2115.00 | 38.96 | 7.870 |
| | Middle | 2145.00 | 39.22 | 8.356 |
| | High | 2175.00 | 39.05 | 8.035 |

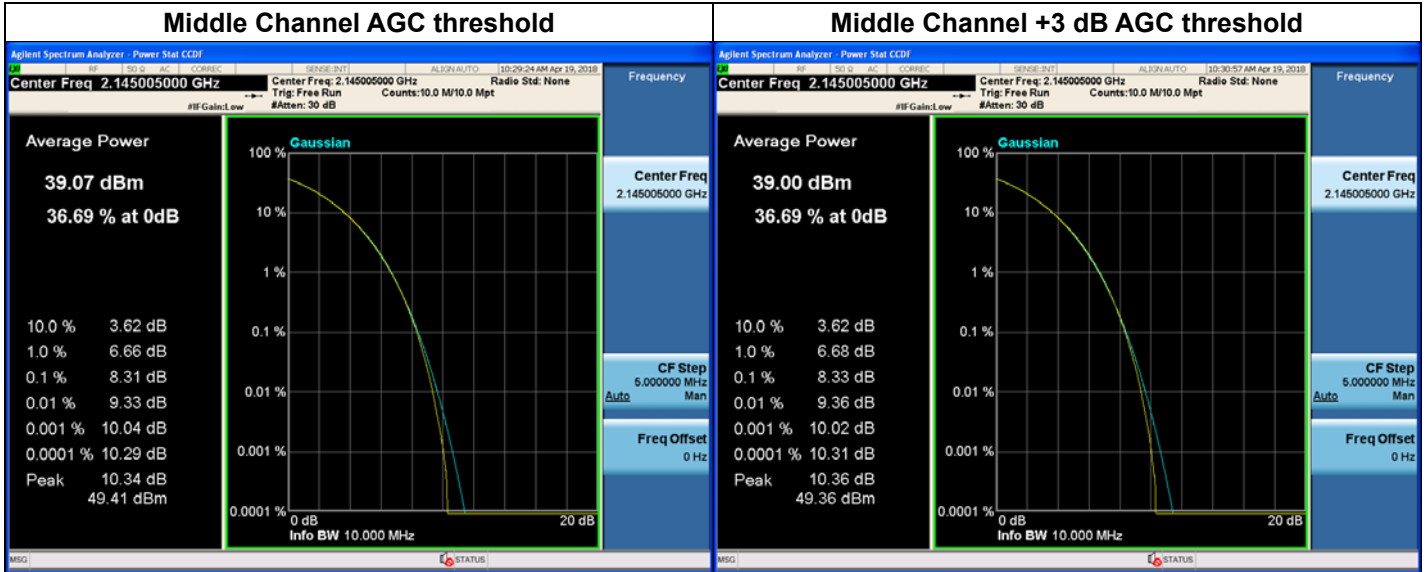
Data of Peak-to-Average Ratio (PAR)

| | Channel | Frequency (MHz) | Measured PAR (dB) |
|--|---------|-----------------|-------------------|
| LTE 10 MHz AGC threshold | Middle | 2145.00 | 8.31 |
| LTE 10 MHz +3 dB above the AGC threshold | | | 8.33 |

Plot of Output Power for LTE 10 MHz



Plot of PAR for LTE 10 MHz



6. OCCUPIED BANDWIDTH

FCC Rules

Test Requirements:

§ 2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the specified conditions of § 2.1049 (a) through (i) as applicable.

Test Procedures:

Measurements were in accordance with the test methods section 3.4 of KDB 935210 D05 v01r02 and section 4.2 of KDB 971168 D01 v03r01.

Test is 99% OBW measured and used.

- a) Connect a signal generator to the input of the EUT.
- b) Configure the signal generator to transmit the AWGN signal.
- c) Configure the signal amplitude to be just below the AGC threshold level (see 3.2), but not more than 0.5 dB below.
- d) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
- e) Set the spectrum analyzer center frequency to the center frequency of the operational band under test. The span range of the spectrum analyzer shall be between 2 times to 5 times the emission bandwidth (EBW) or alternatively, the OBW.
- f) The nominal RBW shall be in the range of 1 % to 5 % of the anticipated OBW, and the VBW shall be $\geq 3 \times \text{RBW}$.
- g) Set the reference level of the instrument as required to preclude the signal from exceeding the maximum spectrum analyzer input mixer level for linear operation. In general, the peak of the spectral envelope must be more than $[10 \log (\text{OBW} / \text{RBW})]$ below the reference level. Steps f) and g) may require iteration to enable adjustments within the specified tolerances.
- h) The noise floor of the spectrum analyzer at the selected RBW shall be at least 36 dB below the reference level.
- i) Set spectrum analyzer detection function to positive peak.
- j) Set the trace mode to max hold.
- k) Determine the reference value: Allow the trace to stabilize. Set the spectrum analyzer marker to the highest amplitude level of the displayed trace (this is the reference value) and record the associated frequency as f_0 .
- l) Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the -26 dB down amplitude. The 26 dB EBW (alternatively OBW) is the positive frequency difference between the two

markers. If the spectral envelope crosses the -26 dB down amplitude at multiple points, the lowest or highest frequency shall be selected as the frequencies that are the furthest removed from the center frequency at which the spectral envelope crosses the -26 dB down amplitude point.

m) Repeat steps e) to l) with the input signal connected directly to the spectrum analyzer (i.e., input signal measurement).

n) Compare the spectral plot of the input signal (determined from step m) to the output signal (determined from step l) to affirm that they are similar (in passband and rolloff characteristic features and relative spectral locations), and include plot(s) and descriptions in test report.

o) Repeat the procedure [steps e) to n)] with the input signal amplitude set to 3 dB above the AGC threshold.

p) Repeat steps e) to o) with the signal generator set to the narrowband signal.

q) Repeat steps e) to p) for all frequency bands authorized for use by the EUT.

Test Results:

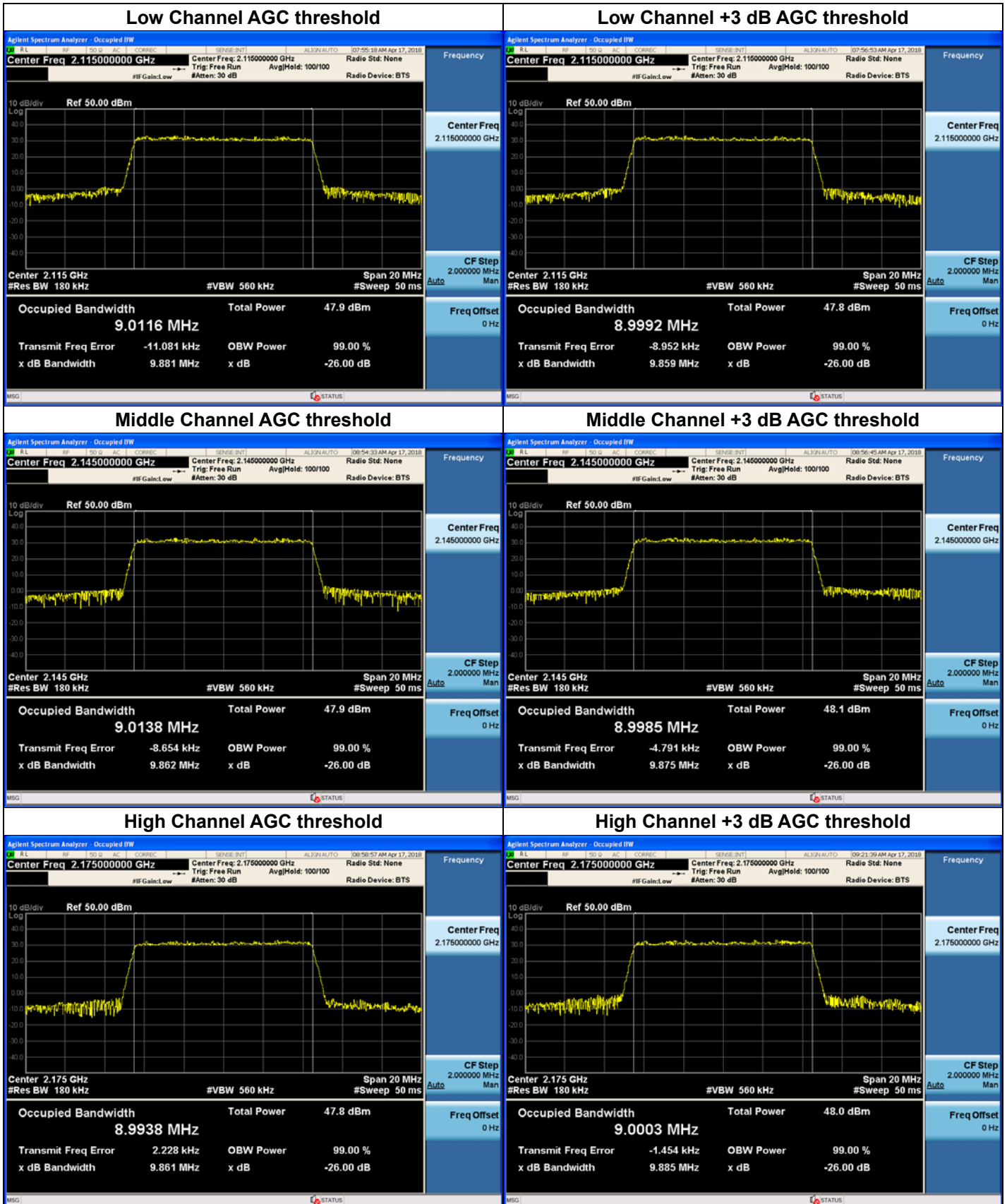
Data of Output Occupied bandwidth

| | Channel | Frequency (MHz) | Measured OBW (MHz) |
|--|---------|-----------------|--------------------|
| LTE 10 MHz AGC threshold | Low | 2115.00 | 9.0116 |
| | Middle | 2145.00 | 9.0138 |
| | High | 2175.00 | 8.9938 |
| LTE 10 MHz +3 dB above the AGC threshold | Low | 2115.00 | 8.9992 |
| | Middle | 2145.00 | 8.9985 |
| | High | 2175.00 | 9.0003 |

Data of Input Occupied bandwidth

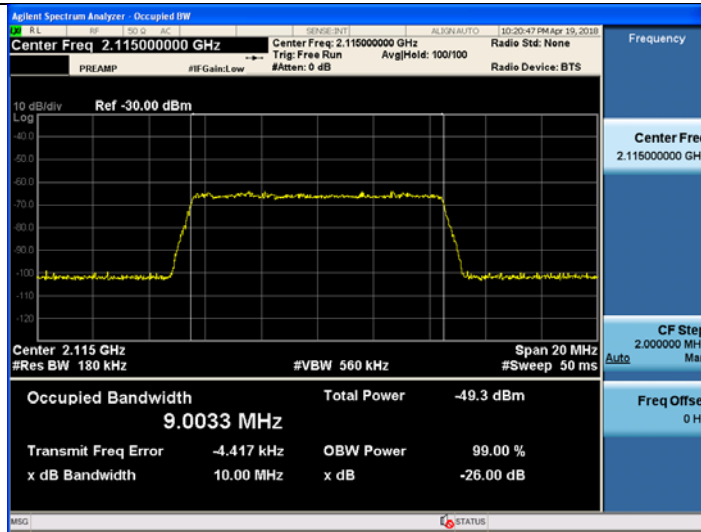
| | Channel | Frequency (MHz) | Measured OBW (MHz) |
|-----------------------------|---------|-----------------|--------------------|
| LTE 10 MHz AGC threshold | Low | 2115.00 | 9.0033 |
| | Middle | 2145.00 | 9.0011 |
| | High | 2175.00 | 9.0028 |

Plot of Output Occupied Bandwidth for LTE 10 MHz

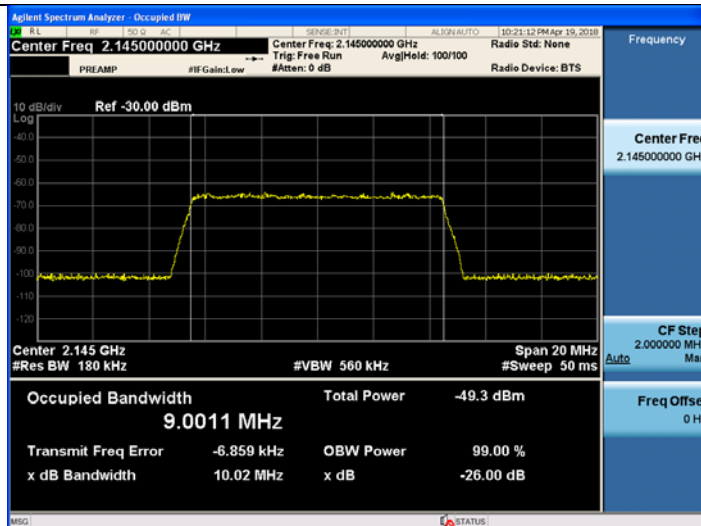


Plot of Input Occupied Bandwidth for LTE 10 MHz

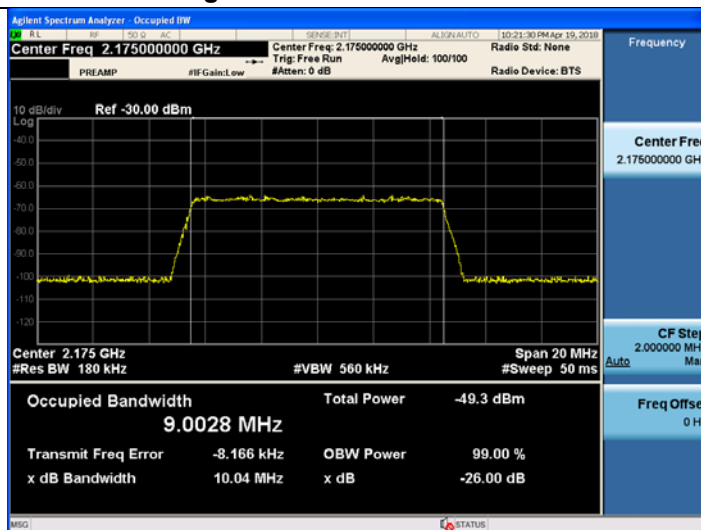
Low Channel AGC threshold



Middle Channel AGC threshold



High Channel AGC threshold



7. OUT OF BAND REJECTION

FCC Rules

Test Requirement(s):

KDB 935210 D05 v01r02

Out of Band Rejection – Test for rejection of out of band signals. Filter freq. response plots are acceptable.

Test Procedures:

Measurements were in accordance with the test methods section 3.3, 4.3 of KDB 935210 D05 v01r02.

3.3 EUT out-of-band rejection

- a) Connect a signal generator to the input of the EUT.
- b) Configure a swept CW signal with the following parameters:
 - 1) Frequency range = ± 250 % of the passband from the center of the passband.
 - 2) Level = a sufficient level to affirm that the out-of-band rejection is > 20 dB above the noise floor and will not engage the AGC during the entire sweep.
 - 3) Dwell time = approx. 10 ms.
 - 4) Number of points = $\text{SPAN}/(\text{RBW}/2)$.
- c) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
- d) Set the span of the spectrum analyzer to the same as the frequency range of the signal generator.
- e) Set the resolution bandwidth of the spectrum analyzer to be 1 % to 5 % of the passband and the video bandwidth shall be set to $\geq 3 \times \text{RBW}$.
- f) Set the detector to Peak Max-Hold and wait for the spectrum analyzer's spectral display to fill.
- g) Place a marker to the peak of the frequency response and record this frequency as f_0 .
- h) Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display such that each marker is at or slightly below the -20 dB down amplitude to determine the 20 dB bandwidth. Capture the frequency response of the EUT.

4.3 PLMRS device out-of-band rejection

Adjust the internal gain control of the equipment under test to the maximum gain for which equipment certification is sought.

- a) Connect a signal generator to the input of the EUT.
- b) Configure a swept CW signal with the following parameters:
- c) Frequency range = ± 250 % of the manufacturer's pass band.
- d) The CW amplitude will be 3 dB below the AGC threshold (see 4.2) and but not activate the AGC threshold throughout the test.

- e) Dwell time = approx. 10 ms.
- f) Frequency step = 50 kHz.
- g) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
- h) Set the resolution bandwidth of the spectrum analyzer between 1 % and 5 % of the manufacturer's pass band with the video bandwidth set to $3 \times \text{RBW}$.
- i) Set the detector to Peak and the trace to Max-Hold.
- j) After the trace is completely filled, place a marker at the peak amplitude, which is designated as f_0 , and with two additional markers (use the marker-delta method) at the 20 dB bandwidth (i.e., at the points where the gain has fallen by 20 dB).
- k) Capture the frequency response plot and for inclusion in the test report.

Test Results:

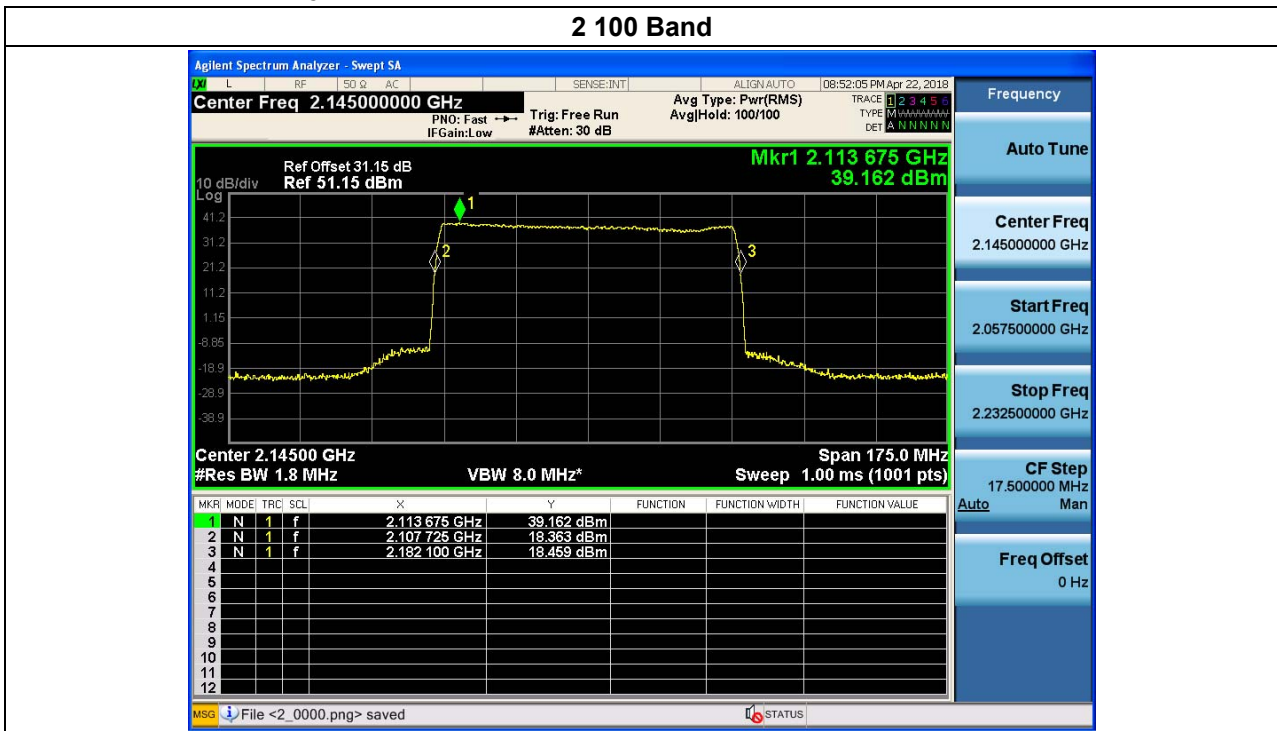
| Input Signal | Input Level (dBm) | Maximum Amp Gain (dB) |
|--------------|-------------------|-----------------------|
| Sinusoidal | -58 | 97 |

* Amp gain is the result of combination with DU module (EZ-DASD-A23)

Data of Out of Band Rejection

| | point of 20 dB below (GHz) | | Output power (dBm) | Gain (dB) |
|------------|----------------------------|-----------|--------------------|-----------|
| 2 100 Band | Left | 2.107 725 | 39.162 | 97.162 |
| | Right | 2.182 100 | | |

Plot of Out of Band Rejection



8. UNWANTED CONDUCTED EMISSIONS

FCC Rules

Test Requirements:

§ 2.1051 Measurements required: Spurious emissions at antenna terminals.

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 27.53 Emission limits

(h) AWS emission limits

(1) *General protection levels* Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10} (P)$ dB.

(3) Measurement procedure.

(i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(ii) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.

(iii) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

Test Procedures:

Measurements were in accordance with the test methods section 3.6 and 4.7 of KDB 935210 D05 v01r02.

3.6.1 General

Refer to the applicable rule part(s) for specified limits on unwanted (out-of-band/out-of-block and spurious) emissions.

Spurious emissions shall be measured using a single test signal sequentially tuned to the low, middle, and high channels or frequencies within each authorized frequency band of operation.

Out-of-band/out-of-block emissions (including intermodulation products) shall be measured under each of the following two stimulus conditions:

- a) two adjacent test signals sequentially tuned to the lower and upper frequency band/block edges;
- b) a single test signal, sequentially tuned to the lowest and highest frequencies or channels within the frequency band/block under examination.

NOTE—Single-channel boosters that cannot accommodate two simultaneous signals within the passband may be excluded from the test stipulated in step a).

3.6.2 Out-of-band/out-of-block emissions conducted measurements

- a) Connect a signal generator to the input of the EUT.

If the signal generator is not capable of generating two modulated carriers simultaneously, then two discrete signal generators can be connected with an appropriate combining network to support this two-signal test.

- b) Set the signal generator to produce two AWGN signals as previously described (e.g., 4.1 MHz OBW).
- c) Set the center frequencies such that the AWGN signals occupy adjacent channels, as defined by industry standards such as 3GPP or 3GPP2, at the upper edge of the frequency band or block under test.
- d) Set the composite power levels such that the input signal is just below the AGC threshold (see 3.2), but not more than 0.5 dB below. The composite power can be measured using the procedures provided in KDB Publication 971168, but it will be necessary to expand the power integration bandwidth so as to include both of the transmit channels. Alternatively, the composite power can be measured using an average power meter as described in KDB Publication 971168.
- e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.
- f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band (typically 1 % of the EBW or 100 kHz or 1 MHz)
- g) Set the VBW = 3 × RBW.
- h) Set the detector to power averaging (rms) detector.
- i) Set the Sweep time = auto-couple.

- j) Set the spectrum analyzer start frequency to the upper block edge frequency, and the stop frequency to the upper block edge frequency plus 300 kHz or 3 MHz, for frequencies below and above 1 GHz, respectively.
- k) Trace average at least 100 traces in power averaging (rms) mode.
- l) Use the marker function to find the maximum power level.
- m) Capture the spectrum analyzer trace of the power level for inclusion in the test report.
- n) Repeat steps k) to m) with the composite input power level set to 3 dB above the AGC threshold.
- o) Reset the frequencies of the input signals to the lower edge of the frequency block or band under test.
- p) Reset the spectrum analyzer start frequency to the lower block edge frequency minus 300 kHz or 3 MHz, for frequencies below and above 1 GHz, respectively, and the stop frequency to the lower band or block edge frequency.
- q) Repeat steps k) to n).
- r) Repeat steps a) to q) with the signal generator configured for a single test signal tuned as close as possible to the block edges.
- s) Repeat steps a) to r) with the narrowband test signal.
- t) Repeat steps a) to s) for all authorized frequency bands or blocks used by the EUT.

3.6.3 Spurious emissions conducted measurements

- a) Connect a signal generator to the input of the EUT.
- b) Set the signal generator to produce the broadband test signal as previously described (i.e., 4.1 MHz OBW AWGN).
- c) Set the center frequency of the test signal to the lowest available channel within the frequency band or block.
- d) Set the EUT input power to a level that is just below the AGC threshold (see 3.2), but not more than 0.5 dB below.
- e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.
- f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band of operation (e.g., reference bandwidth is typically 100 kHz or 1 MHz).
- g) Set the VBW $\geq 3 \times$ RBW.
- h) Set the Sweep time = auto-couple.
- i) Set the spectrum analyzer start frequency to the lowest RF signal generated in the equipment, without going below 9 kHz, and the stop frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as specified in the applicable rule part.

The number of measurement points in each sweep must be $\geq (2 \times \text{span}/\text{RBW})$, which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.2

- j) Select the power averaging (rms) detector function.
- k) Trace average at least 10 traces in power averaging (rms) mode.
- l) Use the peak marker function to identify the highest amplitude level over each measured frequency range. Record the frequency and amplitude and capture a plot for inclusion in the test report.
- m) Reset the spectrum analyzer start frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, as specified in the applicable rule part, and the spectrum analyzer stop frequency to 10 times the highest frequency of the fundamental emission (see § 2.1057). The number of measurement points in each sweep must be $\geq (2 \times \text{span}/\text{RBW})$, which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.
- n) Trace average at least 10 traces in power averaging (rms) mode.
- o) Use the peak marker function to identify the highest amplitude level over each of the measured frequency ranges. Record the frequency and amplitude and capture a plot for inclusion in the test report; also provide tabular data, if required.
- p) Repeat steps i) to o) with the input test signals firstly tuned to a middle band/block frequency/channel, and then tuned to a high band/block frequency/channel.
- q) Repeat steps b) to p) with the narrowband test signal.
- r) Repeat steps b) to q) for all authorized frequency bands/blocks used by the EUT.

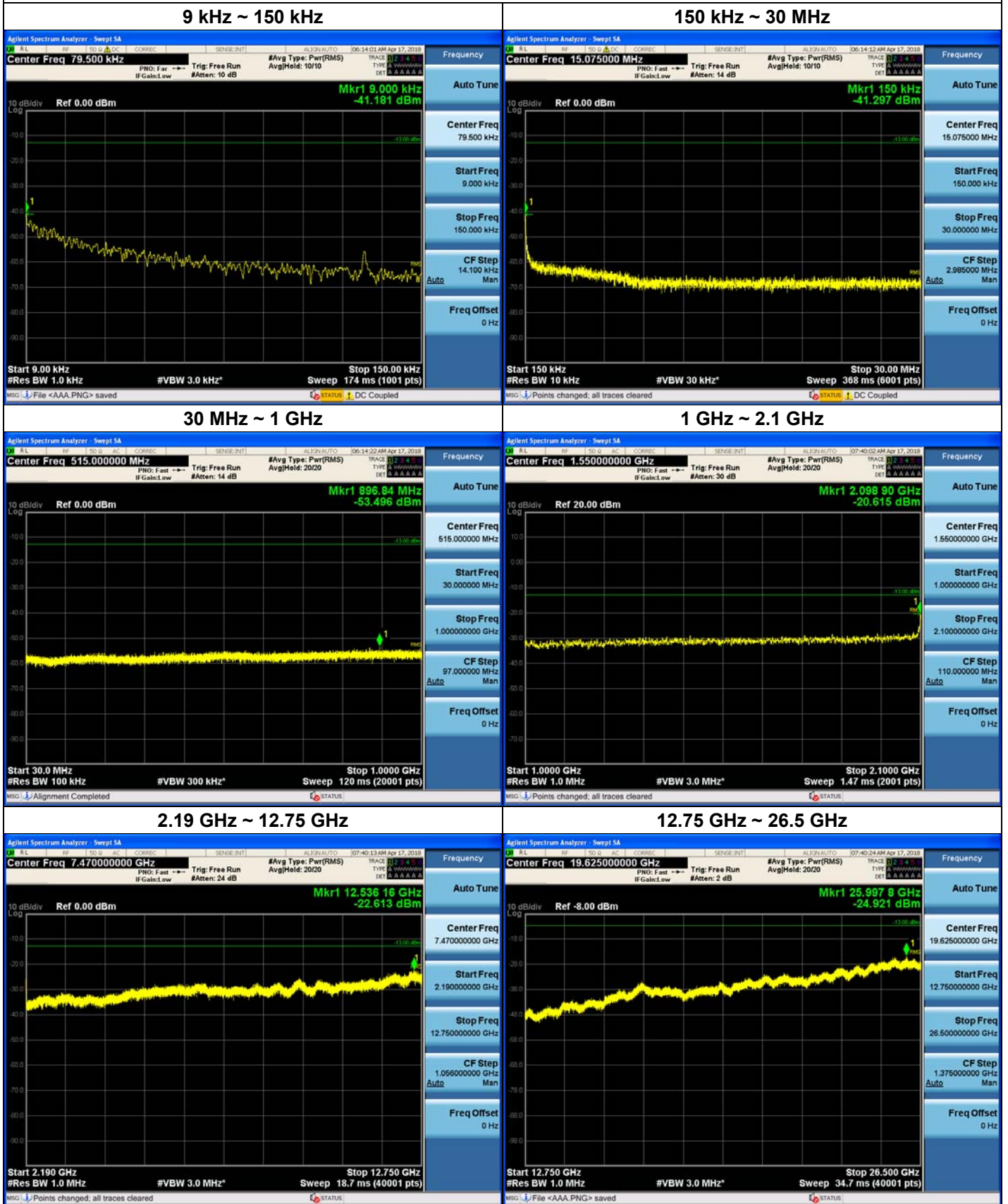
Note:

- 1) In 9 kHz to 150 kHz and 150 kHz to 30 MHz bands, RBW was reduced to 1 % and 10 % of the reference bandwidth for measuring unwanted emission level (typically, 100 kHz if the authorized frequency band is below 1 GHz) and power was integrated. (1 % = +20 dB, 10 % = +10 dB)

Test Results:

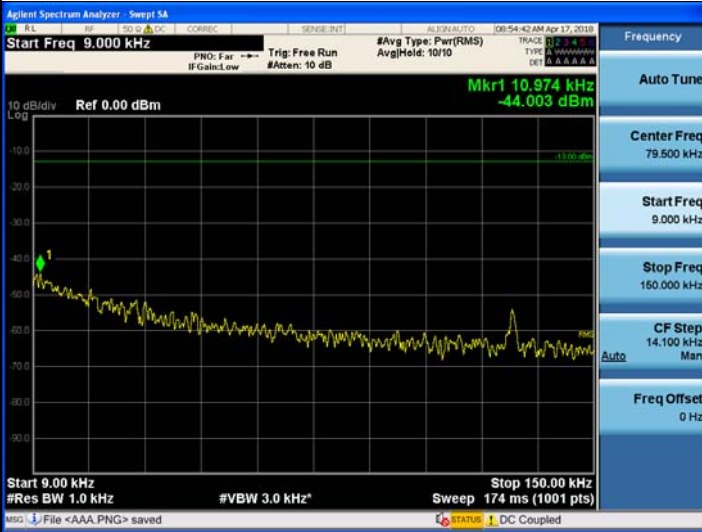
Plot of Unwanted Conducted Emissions for LTE 10 MHz

Low Channel

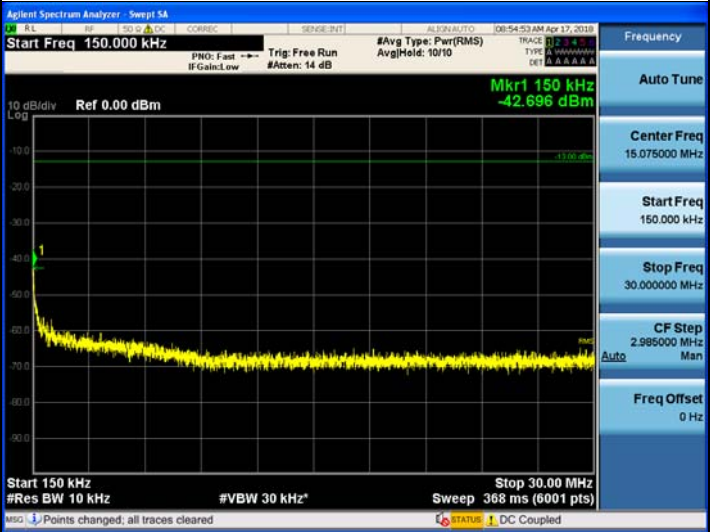


Middle Channel

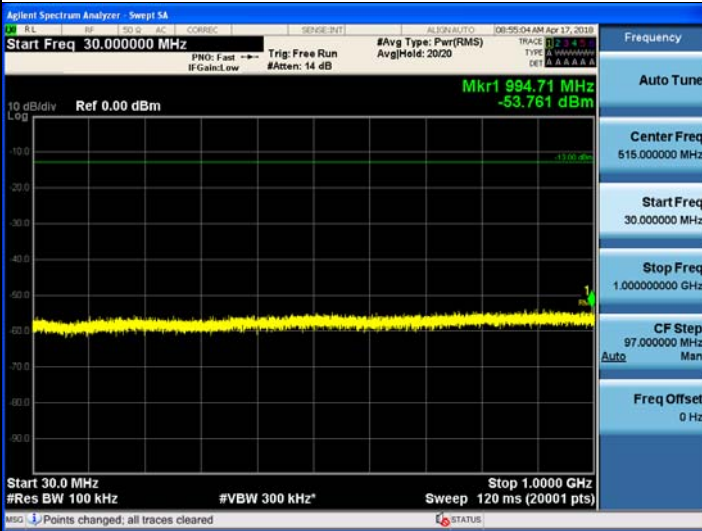
9 kHz ~ 150 kHz



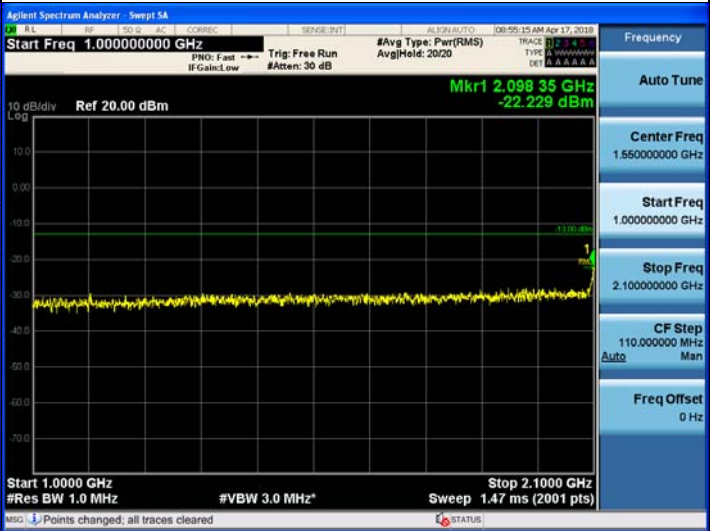
150 kHz ~ 30 MHz



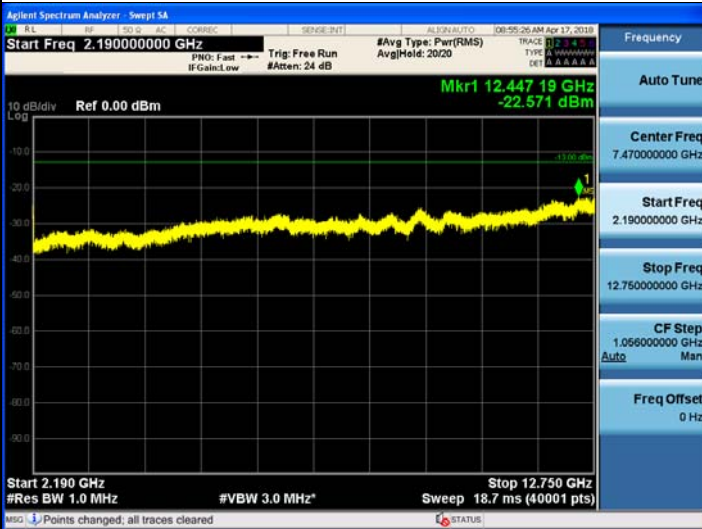
30 MHz ~ 1 GHz



1 GHz ~ 2.1 GHz



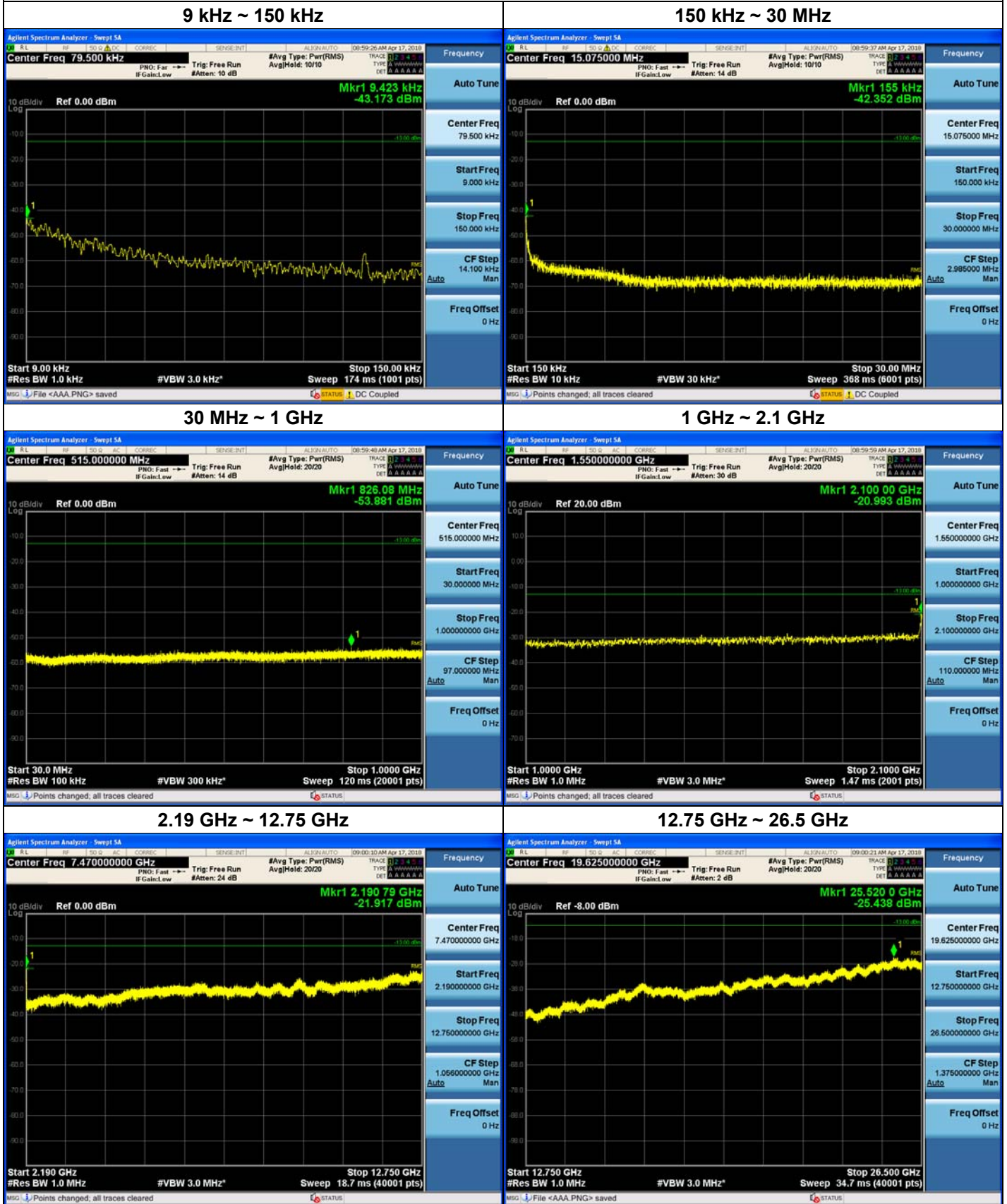
2.19 GHz ~ 12.75 GHz



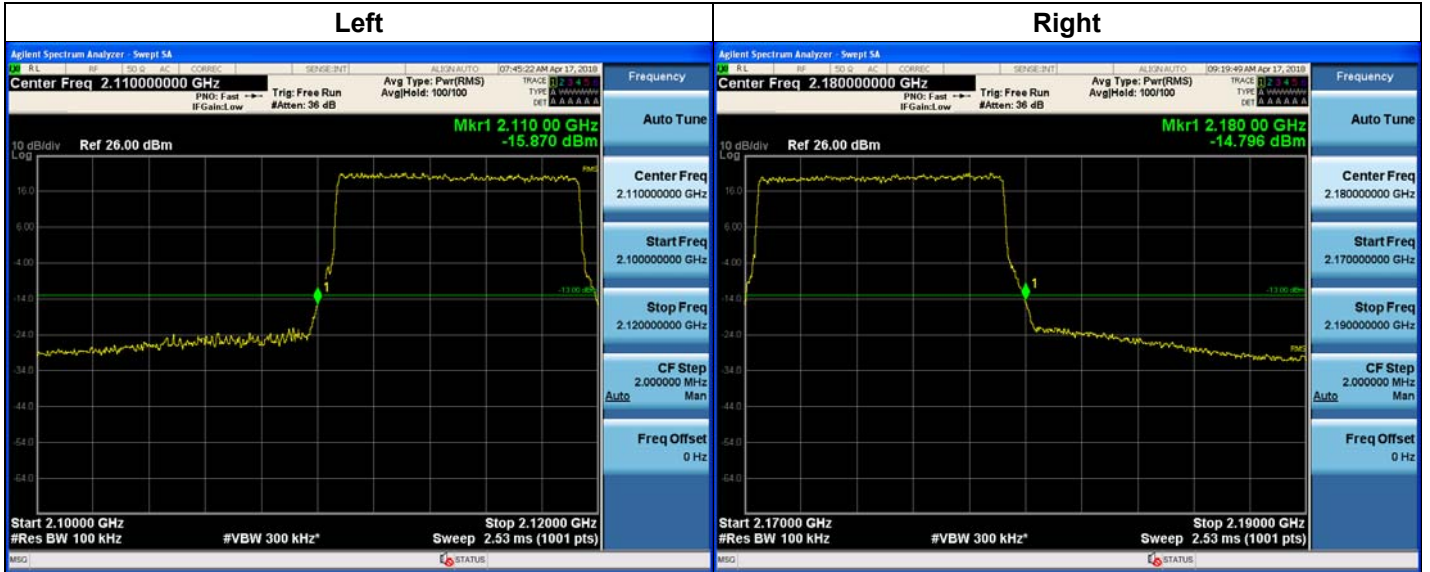
12.75 GHz ~ 26.5 GHz



High Channel



Plot of Band Edge for LTE 10 MHz



Plot of Intermodulation for LTE 10 MHz



9. RADIATED EMISSIONS

FCC Rules

Test Requirements:

§ 2.1053 Measurements required: Field strength of spurious radiation.

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.

(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

- (1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
- (2) All equipment operating on frequencies higher than 25 MHz.
- (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
- (4) Other types of equipment as required, when deemed necessary by the Commission.

Test Procedures:

The measurement is performed in accordance with Section 5.5.3.2 of ANSI C63.26.

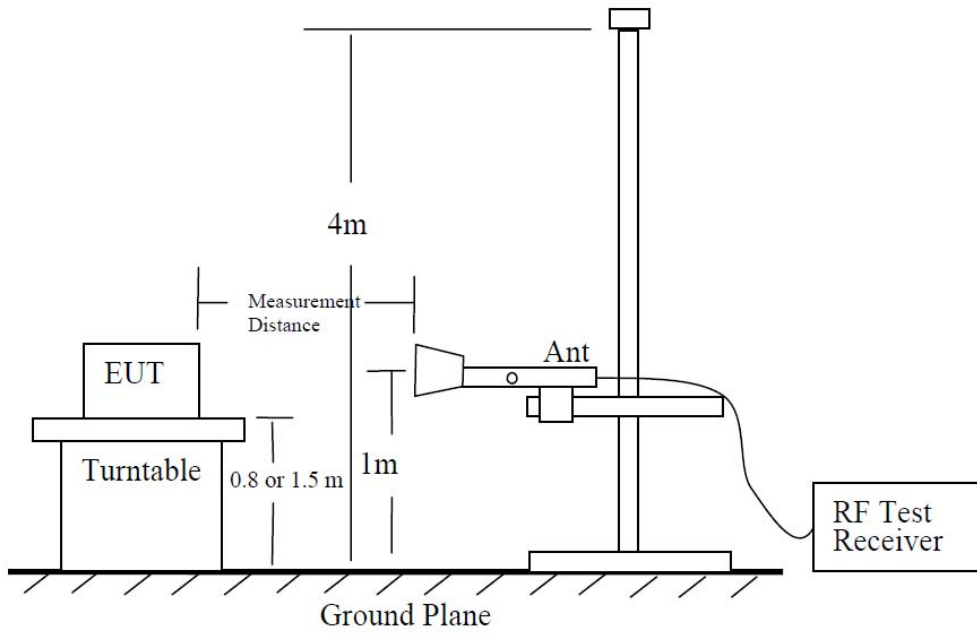
a) Place the EUT in the center of the turntable. The EUT shall be configured to transmit into the standard non-radiating load (for measuring radiated spurious emissions), connected with cables of minimal length unless specified otherwise. If the EUT uses an adjustable antenna, the antenna shall be positioned to the length that produces the worst case emission at the fundamental operating frequency.

b) Each emission under consideration shall be evaluated:

- 1) Raise and lower the measurement antenna in accordance 5.5.2, as necessary to enable

- detection of the maximum emission amplitude relative to measurement antenna height.
- 2) Rotate the EUT through 360° to determine the maximum emission level relative to the axial position.
 - 3) Return the turntable to the azimuth where the highest emission amplitude level was observed.
 - 4) Vary the measurement antenna height again through 1 m to 4 m again to find the height associated with the maximum emission amplitude.
 - 5) Record the measured emission amplitude level and frequency using the appropriate RBW.
- c) Repeat step b) for each emission frequency with the measurement antenna oriented in both the horizontal and vertical polarizations to determine the orientation that gives the maximum emissions amplitude.
- d) ~ j) Omitted
- k) Provide the complete measurement results as a part of the test report.

Test Setup:



Note:

- 1) According to SVSWR requirement in ANSI 63.4 (2014), we performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor (reference distance: 3 m).
- 2) Distance extrapolation factor = $20 \log (\text{test distance} / \text{specific distance})$ (dB)
- 3) Position of EUT for testing below 1 GHz test is 80 cm, and above 1 GHz is 1.5 m

Test Result:

| Ch. | Frequency (MHz) | Measured Level (dBuV/m) | Measured Power (dBm) | Ant. Factor (dB/m) | C.L (dB) | A.G. (dB) | D.F. (dB) | Pol. | Result (dBm) |
|-------------------------|-----------------|-------------------------|----------------------|--------------------|----------|-----------|-----------|------|--------------|
| No Critical Peaks Found | | | | | | | | | |

* C.L.: Cable Loss / A.G.: Ant. Gain / D.F.: Distance Factor (3.75 m)

10. FREQUENCY STABILITY

FCC Rules

Test Requirements:

§ 2.1055 Measurements required: Frequency stability.

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

- (1) From -30° to $+50^{\circ}$ centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

§ 27.54 Frequency stability.

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

Test Procedures:

The measurement is performed in accordance with Section 5.6.4 and 5.6.5 of ANSI C63.26.

5.6.4 Frequency stability over variations in temperature

- a) Supply the EUT with a nominal 60 Hz ac voltage, dc voltage, or install a new or fully charged battery in the EUT.
- b) If possible a dummy load should be connected to the EUT because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible.
- c) Turn on the EUT, and tune it to the center frequency of the operating band.
- d) Couple the transmitter output to the measuring instrument through a suitable attenuator and coaxial cable. If connection to the EUT output is not possible, make the measurement by connecting an antenna to the measuring instrument with a suitable length of coaxial cable and placing the measuring antenna near the EUT (e.g., 15 cm away).

NOTE—An instrument that has an adequate level of accuracy as specified by the procuring or regulatory authority is the recommended measuring instrument.

- e) Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT). Adjust the detector bandwidth and span settings to achieve a resolution capable of accurate frequency measurements over the applicable frequency stability limits.
- f) Turn the EUT off, and place it inside the environmental temperature chamber. For devices that have oscillator heaters, energize only the heater circuit.
- g) Set the temperature control on the chamber to the highest temperature specified in the regulatory requirements for the type of device, and allow the oscillator heater and the chamber

temperature to stabilize. Unless otherwise instructed by the regulatory authority, this temperature should be 50 °C.

h) While maintaining a constant temperature inside the environmental chamber, turn on the EUT and allow sufficient time for the EUT temperature to stabilize.

i) Measure the frequency.

j) Switch off the EUT, but do not switch off the oscillator heater.

k) Lower the chamber temperature to the next level that is required by the standard and allow the temperature inside the chamber to stabilize. Unless otherwise instructed by the regulators, this temperature step should be 10 °C.

l) Repeat step h) through step k) down to the lowest specified temperature. Unless otherwise instructed by the regulators, this temperature should be -30 °C. When the frequency stability limit is stated as being sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point shall be established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the lowest and highest channel of operation shall be identified as f_L and f_H respectively. The worst-case frequency offset determined in the above methods shall be added or subtracted from the values of f_L and f_H and the resulting frequencies must remain within the band.

m) Omitted

5.6.5 Frequency stability when varying supply voltage

a) Couple the transmitter output to the measuring instrument through a suitable attenuator and coaxial cable. If connection to the EUT output is not possible make the measurement by connecting an antenna to the measuring instrument with a suitable length of coaxial cable and placing the measuring antenna near the EUT (e.g., 15 cm away)

b) Supply the EUT with nominal ac or dc voltage. The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

c) Turn on the EUT, and couple its output to a frequency counter or other frequency-measuring instrument.

d) Tune the EUT to the center frequency of the operating band. Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT). Adjust the detector bandwidth and span settings to achieve a resolution capable of accurate frequency measurements over the applicable frequency stability limits.

NOTE—An instrument that has an adequate level of accuracy as specified by the procuring or regulatory authority is the recommended measuring instrument.

e) Measure the frequency.

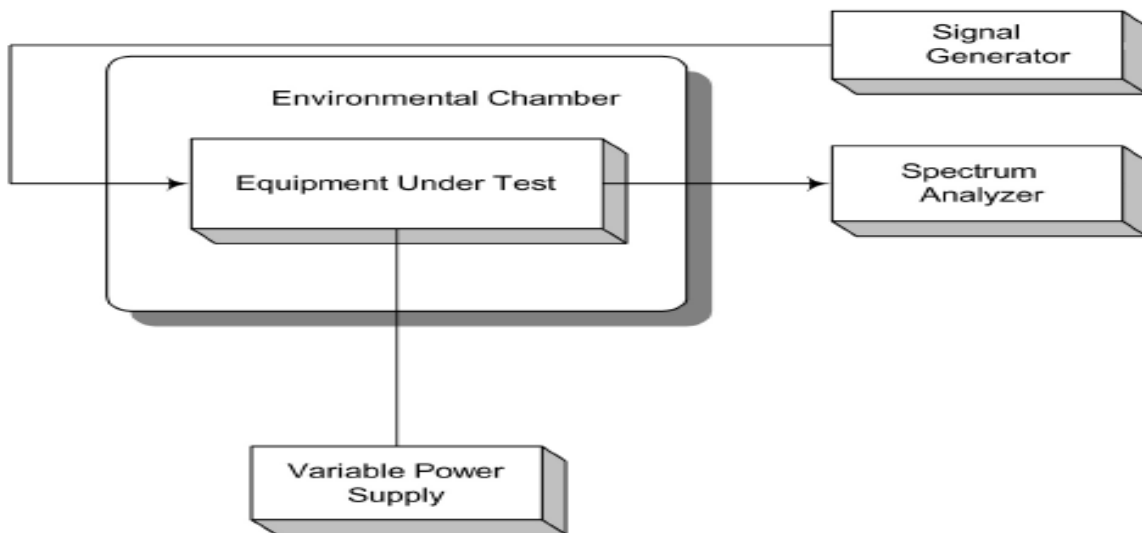
f) Unless otherwise specified, vary primary supply voltage from 85% to 115% of the nominal value for other than hand carried battery equipment.

g) For hand carried, battery powered equipment, reduce the primary ac or dc supply voltage to the battery operating end point, which shall be specified by the manufacturer.

h) Repeat the frequency measurement.

NOTE—For band-edge compliance, it can be required to make these measurements at the low and high channel of the operating band.

Test Setup:



Note:

- 1) The results of the frequency stability test shown above the frequency deviation measured values are very small and similar trend for each port, so we are attached only the worst case data.

Test Results:

Reference: voltage = -48 Vdc at 20°C, frequency = 2 145 MHz

| Voltage (%) | Temp.(°C) | Frequency (Hz) | Frequency Error (Hz) | Deviation (Hz) | ppm |
|-------------|-----------|----------------|----------------------|----------------|----------|
| 100% | +20(Ref) | 2145 000 000 | 0.184 | 0.000 | 0.00000 |
| | -30 | 2145 000 001 | 0.601 | 0.417 | 0.00019 |
| | -20 | 2144 999 999 | -0.542 | -0.725 | -0.00034 |
| | -10 | 2145 000 000 | 0.197 | 0.013 | 0.00001 |
| | 0 | 2145 000 000 | 0.018 | 0.166 | 0.00008 |
| | +10 | 2145 000 000 | 0.294 | 0.110 | 0.00005 |
| | +30 | 2144 999 999 | -0.574 | -0.758 | -0.00035 |
| | +40 | 2145 000 001 | 0.910 | 0.726 | 0.00034 |
| | +50 | 2144 999 999 | -0.780 | -0.963 | -0.00045 |
| 115% | +20 | 2144 999 999 | -0.931 | -1.115 | -0.00052 |
| 85% | +20 | 2145 000 000 | -0.341 | -0.525 | -0.00024 |