



Compliance Certification Services (Kunshan) Inc.

CCSEM-TRF-001 Rev. 02 Sep 01, 2023

Report No.: KSCR240500097002

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TEST REPORT

Application No.: KSCR2405000970AT
FCC ID: 2AEJ4R22208
Applicant: Sunwave Communications Co., Ltd.
Address of Applicant: 581 Houju Avenue, Binjiang District, Hangzhou, China
Manufacturer: Sunwave Communications Co., Ltd.
Address of Manufacturer: 581 Houju Avenue, Binjiang District, Hangzhou, China
Factory: Sunwave Communications Co., Ltd.
Address of Factory: 581 Houju Avenue, Binjiang District, Hangzhou, China
Equipment Under Test (EUT):
EUT Name: Remote Unit
Model No.: PS-R222
Trade mark: CROSSFIRE
Standard(s) : 47 CFR Part 2
47 CFR Part 90
Date of Receipt: 2024-05-30
Date of Test: 2024-06-26 to 2024-08-13
Date of Issue: 2024-08-13

Test Result:	Pass*
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* In the configuration tested, the EUT complied with the standards specified above.

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<i>Revision Record</i>			
<i>Version</i>	<i>Description</i>	<i>Date</i>	<i>Remark</i>
00	Original	2024-08-13	/

Authorized for issue by:			
Tested By		<i>Damon Zhou</i>	
		<hr/> Damon Zhou /Project Engineer	
Approved By		<i>Terry Hou</i>	
		<hr/> Terry Hou /Reviewer	



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2 Test Summary

2.1 862MHz-869MHz for FCC Part 90 subpart S

Test Item	Reference	Result
RF Output Power, Amplifier Gain and Peak to Average Ratio	§90.635	PASS
Conducted Spurious Emissions	§90.691	PASS
Out-of-band/out-of-block (including intermodulation) Emissions	§90.691	PASS
Radiated Spurious Emissions	§90.691	PASS
Input-versus-output signal comparison	§2.1049(h)	PASS
Frequency Stability	§90.213	PASS
Emission Mask	§90.210	PASS
Noise Figure	§90.219	PASS
<p>Remark:</p> <p>EUT: In this whole report EUT means Equipment Under Test.</p> <p>Tx: In this whole report Tx (or tx) means Transmitter.</p> <p>Rx: In this whole report Rx (or rx) means Receiver.</p> <p>All modes have been tested and only record the worst test result.</p> <p>This product has two power supply modules, one is AC power supply module, the other is DC power supply module. We evaluated and tested all power supply modules. The worst mode is AC power supply module. This report only record the worst mode.</p> <p>Test method standard:</p> <p>ANSI C63.26-2015</p> <p>KDB 935210 D05 Indus Booster Basic Meas v01r04</p> <p>KDB 935210 D02 Signal Booster Certification v04r02</p>		



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4 General Information

4.1 Details of E.U.T.

Product Name:	Remote Unit
Device type	Booster
Model No.:	PS-R222
Antenna Type:	External
Antenna Gain:	0dBi (Provided by manufacturer)
Power Supply:	AC :100-240V~ 3A 50/60Hz DC: -48VDC 6.5A
Type of Modulation	TETRA/P25/DMR/CQPSK/FM
Frequency Band:	862MHz to 869MHz,
Temperature Range:	-40°C to 55°C
Antenna Delivery:	SISO

4.2 Description of Support Units

Description	Manufacture	Model No.	S/N
Notebook	ThinkPad	K27	/

4.3 Measurement Uncertainty

No.	Item	Measurement Uncertainty
1	Radio Frequency	8.4×10^{-8}
2	Timeout	2s
3	Duty Cycle	0.37%
4	Occupied Bandwidth	3%
5	RF Conducted Power	0.6dB
6	RF Power Density	2.9dB
7	Conducted Spurious Emissions	0.75dB
8	RF Radiated Power	5.2dB (Below 1GHz)
		5.9dB (Above 1GHz)
9	Radiated Spurious Emission Test	4.2dB (Below 30MHz)
		4.5dB (30MHz-1GHz)
		5.1dB (1GHz-18GHz)
		5.4dB (Above 18GHz)
10	Temperature Test	1°C
11	Humidity Test	3%
12	Supply Voltages	1.5%
13	Time	3%

Note: The measurement uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

4.4 Test Location

All tests were performed at:

Compliance Certification Services (Kunshan) Inc.

No.10 Weiye Rd, Innovation park, Eco&Tec, Development Zone, Kunshan City, Jiangsu, China.

Tel: +86 512 5735 5888 Fax: +86 512 5737 0818

No tests were sub-contracted.

Note:

1.SGS is not responsible for wrong test results due to incorrect information (e.g., max. internal working frequency, antenna gain, cable loss, etc) is provided by the applicant. (If applicable).

2.SGS is not responsible for the authenticity, integrity and the validity of the conclusion based on results of the data provided by applicant. (If applicable).

3. Sample source: sent by customer.

4.5 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **A2LA**

Compliance Certification Services (Kunshan) Inc. is accredited by the American Association for Laboratory Accreditation (A2LA). Certificate No. 2541.01.

- **FCC**

Compliance Certification Services (Kunshan) Inc. has been recognized as an accredited testing laboratory. Designation Number: CN1172.

- **ISED**

Compliance Certification Services (Kunshan) Inc. has been recognized by Innovation, Science and Economic Development Canada (ISED) as an accredited testing laboratory. Company Number: 2324E

- **VCCI**

The 3m and 10m Semi-anechoic chamber and Shielded Room of Compliance Certification Services (Kunshan) Inc. has been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: R-20134, R-11600, C-11707, T-11499, G-10216 respectively.

4.6 Deviation from Standards

None

4.7 Abnormalities from Standard Conditions

None



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5 Equipment List

Item	Equipment	Manufacturer	Model	Inventory No	Cal Date	Cal. Due Date
RF Conducted Test						
1	Spectrum Analyzer	Keysight	N9020A	KUS1911E004-2	08/24/2023	08/23/2024
2	Spectrum Analyzer	Keysight	N9020A	KUS2001M001-2	08/24/2023	08/23/2024
3	Spectrum Analyzer	Keysight	N9030B	KSEM021-1	01/15/2024	01/14/2025
4	Signal Generator	R&S	SMBV100B	KSEM032	03/19/2024	03/18/2025
5	Signal Generator	R&S	SMW200A	KSEM020-1	08/24/2023	08/23/2024
6	Signal Generator	Agilent	N5182A	KUS2001M001-1	08/24/2023	08/23/2024
7	Radio Communication Test Station	Anritsu	MT8000A	KSEM001-1	08/24/2023	08/23/2024
8	Radio Communication Analyzer	Anritsu	MT8821C	KSEM002-1	03/19/2024	03/18/2025
9	Universal Radio Communication Tester	R&S	CMW500	KUS1911E004-1	08/24/2023	08/23/2024
10	Switcher	TST	FY562	KUS2001M001-4	01/15/2024	01/14/2025
11	AC Power Source	EXTECH	6605	KS301178	N.C.R	N.C.R
12	DC Power Supply	Agilent	E3632A	KS301180	N.C.R	N.C.R
13	Conducted Test Cable	Thermax	RF01-RF04	CZ301111-CZ301120	01/15/2024	01/14/2025
14	Temp. / Humidity Chamber	TERCHY	MHK-120AK	KS301190	08/24/2023	08/23/2024
15	Temperature & Humidity Recorder	Renke Control	RS-WS-N01-6J	KSEM024-5	03/19/2024	03/18/2025
16	Software	BST	TST-PASS	/	NCR	NCR
RF Radiated Test						
1	Spectrum Analyzer	R&S	FSV40	KUS1806E003	08/24/2023	08/23/2024
2	Universal Radio Communication Tester	R&S	CMW500	KSEM009-1	03/19/2024	03/18/2025
3	Signal Generator	Agilent	E8257C	KS301066	08/24/2023	08/23/2024
4	Loop Antenna	COM-POWER	AL-130R	KUS1806E001	03/18/2023	03/17/2025
5	Bilog Antenna	TESEQ	CBL 6112D	KUS1806E005	06/29/2023	06/28/2025
6	Bilog Antenna	TESEQ	CBL 6112D	KUS1806E006	03/19/2024	03/18/2025
7	Horn-antenna(1-18GHz)	Schwarzbeck	BBHA9120D	KS301079	08/24/2023	08/23/2024
8	Horn-antenna(1-18GHz)	ETS-LINDGREN	3117	KS301186	04/07/2023	04/06/2025
9	Horn Antenna(18-40GHz)	Schwarzbeck	BBHA9170	CZ301058	01/07/2024	01/06/2026
10	Amplifier(30MHz~18GHz)	PANSHAN TECHNOLOGY	LNA:1~18G	KSEM010-1	01/15/2024	01/14/2025
11	Amplifier(18~40GHz)	PANSHAN TECHNOLOGY	LNA180400G40	KSEM038	08/24/2023	08/23/2024
12	RE Test Cable	REBES MICROWAVE	/	CZ301097	08/24/2023	08/23/2024
13	Temperature & Humidity Recorder	Renke Control	RS-WS-N01-6J	KSEM024-4	03/19/2024	03/18/2025
14	Software	Faratronic	EZ EMC-v 3A1	/	NCR	NCR
15	Software	ESE	E3_V 6.111221a	/	NCR	NCR

6 Test Results

6.1 Test conditions

Input voltage:	AC 120V/60Hz	
Test voltage	Normal	AC 120V/60Hz
	Extreme	AC 102V-AC138V
Operating Environment:		
Test Temperature:	Normal	22°C~26°C
	Extreme	-40~55° C
Humidity:	46%~56% RH	
Atmospheric Pressure:	990~1005mbar	
Test Requirement:	<p>The RF output power of the EUT was measured at the antenna port, by adjusting the input power of signal generator to drive the EUT to get to maximum output power point and keep the EUT at maximum gain setting for all tests. The device should be tested on downlink.</p> <p>For detail test Modulation and Frequency, please refer to 7.2.</p>	

Remark:

FIBER-OPTIC AND OTHER SIMILAR RF DISTRIBUTION SYSTEMS

Fiber-optic distribution systems are a type of in-building radiation system that receives RF signals from an antenna, distributes the signal over fiber-optic cable, and then retransmits at another location for example within a building or tunnel. Most fiber-optic systems are signal boosters; however, some may be boosters. These systems generally have two enclosures typically called host (or local or donor unit) and remote. Some systems may also have an optional expander box for fan-out to multiple remotes. The system transmits downlink signals from the remote unit to handsets, portables, or clients, and transmits uplink signals via from the host unit. Usually but not always the uplink goes through an intermediate amplifier to a “donor” antenna. Therefore both uplink and downlink must be tested, unless filing effectively documents how connection of uplink to donor antenna with or without an intermediate amplifier will be prevented, such as for always only a cabled connection to a base station. Fiber-optic systems are not amplifiers (AMP equipment class) – they are equipment class TNB or PCB. The same approval procedures also apply for multiple-enclosure systems connected by coax cable.

Synonyms and related terms: in-building radiation system, coverage enhancer, distributed antenna system, fiber-optic distribution system, converter, donor antenna

Typical in-building or distributed antenna systems can consist of five different components (enclosures), not counting antennas:

1) host unit

- a) transmits uplink to base station via antenna thru coax, **passive interface unit**, or **active interface unit** (amplifier)
- b) sends base-station downlink via fiber-optic or coax to **remote**
- c) receives handset uplink via fiber-optic or coax from **remote**
- d) optional connection to **expansion unit** via fiber-optic
- e) separate FCC ID from **remote**, unless electrically identical

f) non-transmitting host unit

- i) connects directly to a base station via coax cable but does not connect to antenna or amplifier
- ii) Part 15 digital device subject to Verification, no FCC ID

2) remote unit



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- a) receives base-station downlink via fiber-optic or coax from **host**, transmits via antenna to handsets
- b) returns handset uplink via fiber-optic or coax to **host**
- c) separate FCC ID from **remote**, unless electrically identical

3) fiber-optic expansion unit

- a) fiber-optic or coax from **host**
- b) fiber-optic or coax fan-out to **remote(s)**
- c) Part 15 digital device subject to Verification, no FCC ID

4) RF expansion unit

- a) internal or external device used to add band(s) and/or transmit mode(s) to a **remote**
- b) operates only when connected to a **remote unit** as part of a booster system
- c) contains signal-processing functions to convert baseband signal into modulated RF signal
- d) use equipment class PCB or TNB for an **RF expansion unit** (the associated **remote** uses an equipment class Bxx per **Table C.1** of this document, e.g., B2I)

5) passive interface unit

- a) contains attenuators, splitters, combiners
- b) coax cable connection between **host** and base-station
- c) passive device, no FCC ID

6) active interface unit

- a) amplifies uplink signal from **host unit** for transmit by donor antenna
- b) attenuates downlink from donor antenna
- c) coax cable connection between **host** and **active interface unit**
- d) usually has separate FCC ID; in some cases could be combined/included with **host** as one enclosure

GENERAL DEFINITIONS FOR CERTIFICATION PURPOSES:

The following three general definitions follow from those stated in the Part 90 rule sections as listed above. Two of the definitions replace previous EAB internal definitions given for booster, booster and extender. The general term “extender” is the same as booster, but booster should be used rather than extender. The general term “translator” is the same as booster, but booster should be used rather than translator.

External radio frequency power amplifier (ERFPA) - any device which, (1) when used in conjunction with a radio transmitter signal source, is capable of amplification of that signal, and (2) is not an integral part of a radio transmitter as manufactured. The EAS equipment class AMP is used only for an ERFPA device inserted between a transmitter (TNB/PCB) and an antenna (has only one antenna port) **Booster** is a device that automatically reradiates signals from base transmitters without channel translation, for the purpose of improving the reliability of existing service by increasing the signal strength in dead spots. An “in-building radiation system” is a signal booster. These devices are not intended to extend the size of coverage from the originating base station. A booster can be either single or multiple channels.

Booster is a device that retransmits the signals of other stations. Boosters are different from boosters in that they can include frequency translation and can extend coverage beyond the design of the original base station. A booster is typically single channel but can also be multiple channels.

ERFPA (AMP) and boosters/boosters (TNB/PCB) can generally be authorized for all rule parts except 15 and 18.

Tests should be done with each typical signal. e.g., for F3E emissions use 2500 Hz with 2.5 or 5 kHz deviation. Use of CW signal for some tests is acceptable in lieu of actual emission, in some cases when CW signal gives worst case.

6.2 Test Procedure & Measurement Data

6.2.1 RF Output Power and Amplifier Gain

Test Requirement:	§90.635
Test Method:	KDB 935210 D05 Indus Booster Basic Meas v01r04
EUT Operation:	
Status:	Drive the EUT to maximum output power.
Conditions:	Normal conditions
Application:	Cellular Band RF output ports
Test Configuration:	

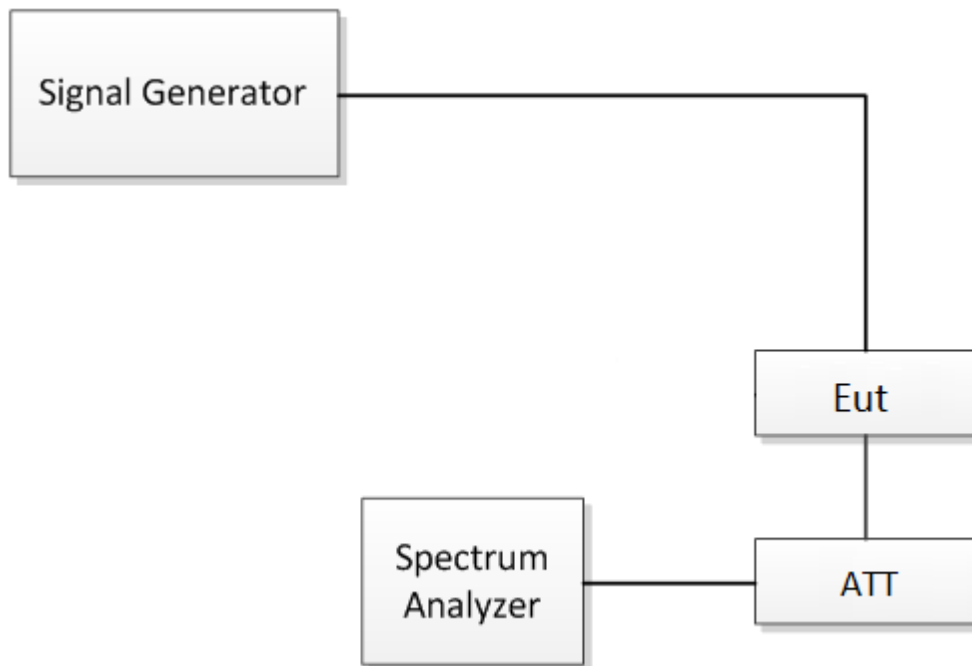


Fig.1 RF Output Power test configuration

Test Procedure: RF output power test procedure:

- 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.

Amplifier gain test procedure:

After the mean input and output power levels have been measured as described in the preceding subclauses, the mean gain of the EUT can be determined from:

Gain (dB) = output power (dBm) - input power (dBm).

Peak to Average Ratio:

Please according to KDB 971168 D01 clause 5.7.

Remark: The system continuously monitors the input power.

6.2.1.1 Measurement Record:

Please refer to Appendix B for KSCR240500097002.

6.2.2 Conducted Spurious Emissions

Test Requirement:	§90.691
Test Method:	KDB 935210 D05 Indus Booster Basic Meas v01r04
EUT Operation:	
Status:	Drive the EUT to maximum output power.
Conditions:	Normal conditions
Application:	Cellular Band RF output ports
Test Configuration:	

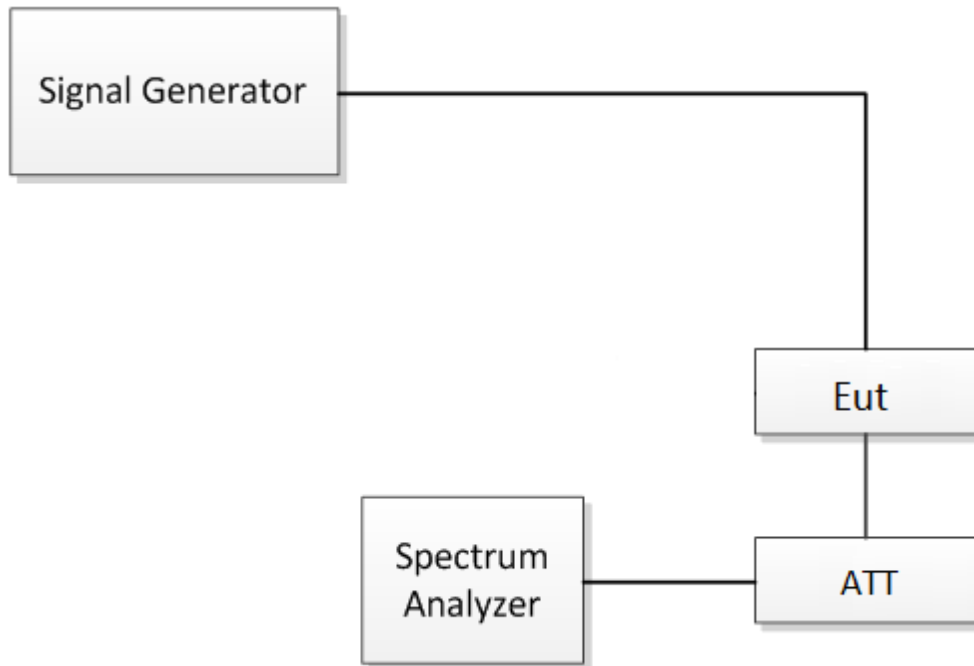


Fig.2. Conducted Spurious Emissions test configuration

- Test Procedure: Conducted Emissions test procedure:
- 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.

6.2.2.1 Measurement Record:

Please refer to Appendix B for KSCR240500097002.

6.2.3 Out-of-band/out-of-block emissions

Test Requirement: KDB 935210 D05 Indus Booster Basic Meas v01r04
 Test Method: KDB 935210 D05 Indus Booster Basic Meas v01r04
 EUT Operation:
 Status: Drive the EUT to maximum output power.
 Conditions: Normal conditions
 Application: Cellular Band RF output ports
 Test Configuration:

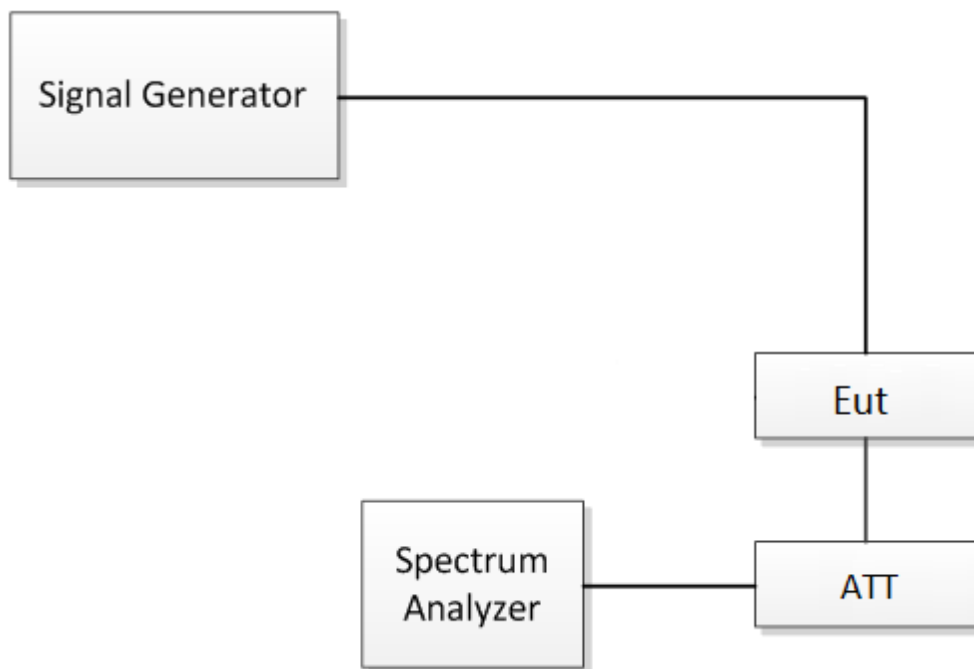


Fig.3. Band edge test configuration

Test Procedure:

Out-of-band/out-of-block emissions test procedure:
 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 [R8], 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 [R8].
 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.

Remark:

- At maximum drive level, for each modulation: two tests (high-, low-band edge) with two tones
- Limit usually is -13dBm conducted.
- Not needed for Single Channel systems.

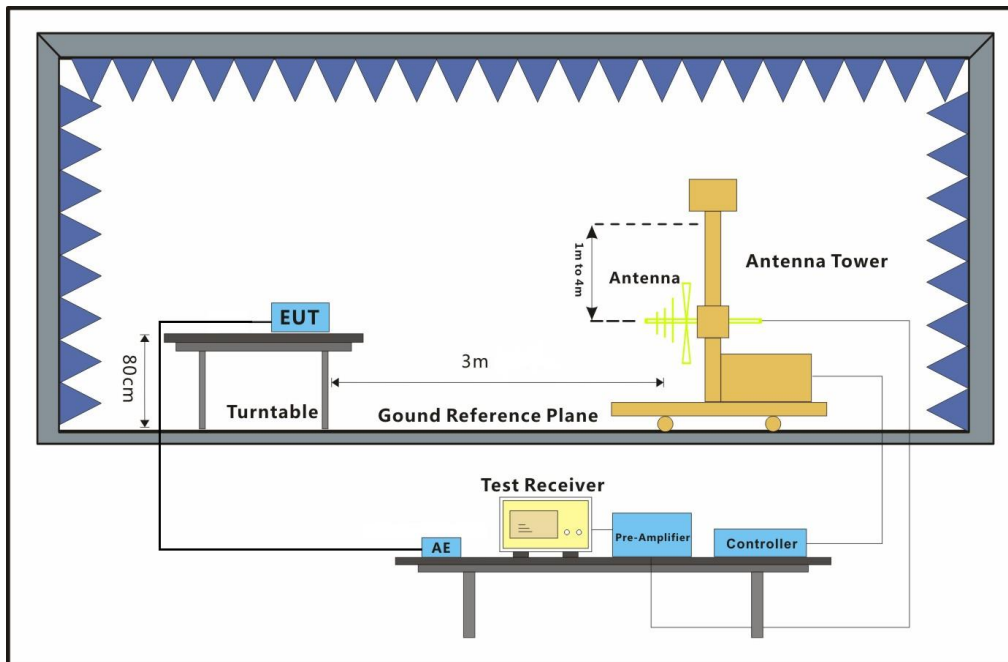
Test have been done with two modulated carriers and single modulated carriers, all modes have been tested and we only record the worst test result with two modulated carriers

6.2.3.1 Measurement Record:

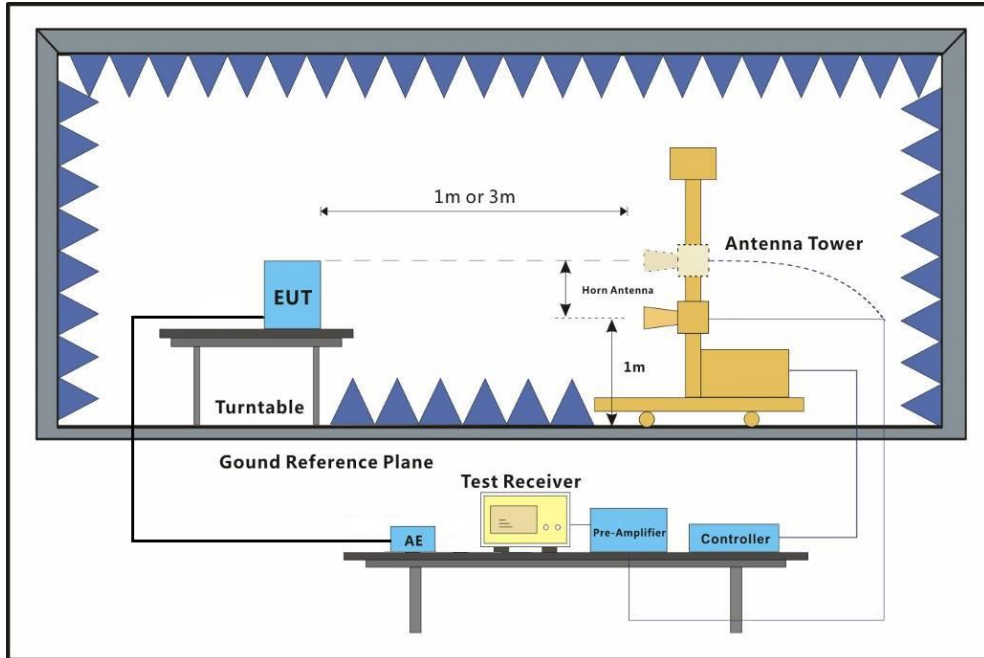
Please refer to Appendix B for KSCR240500097002.

6.2.4 Radiated Spurious Emissions

- Test Requirement: §90.691
- Test Method: KDB 935210 D05 Indus Booster Basic Meas v01r04
- EUT Operation:
 - Status: Drive the EUT to maximum output power.
 - Conditions: Normal conditions
 - Application: Enclosure
- Test Configuration:
 - 30MHz to 1GHz emissions:



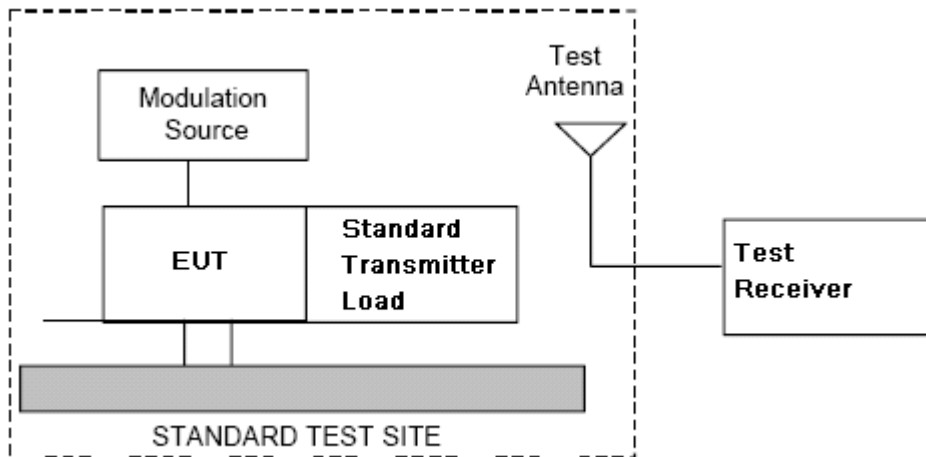
1GHz to 40GHz emissions:



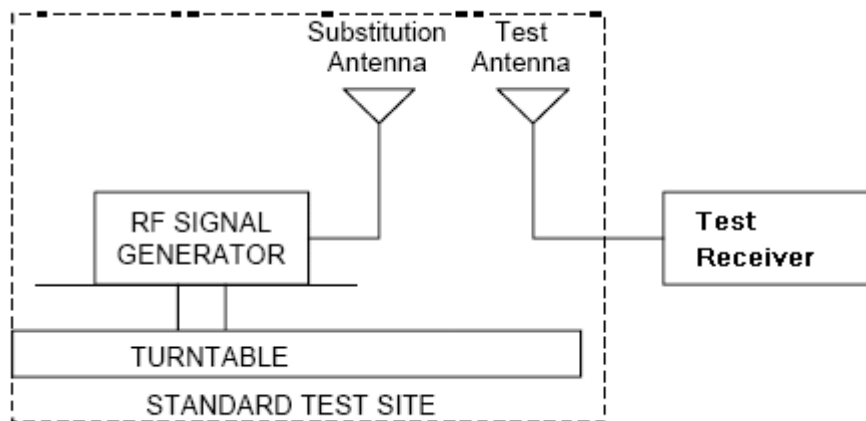
Test Procedure:

1. Test the background noise level with all the test facilities;
2. Keep one transmitting path, all other connectors shall be connected by normal power or RF leads;
3. Select the suitable RF notch filter to avoid the test receiver or spectrum analyzer produce unwanted spurious emissions;
4. Keep the EUT continuously transmitting in max power;
5. Read the radiated emissions of the EUT enclosure.

Radiated Emissions Test Procedure:



- a) Connect the equipment as illustrated.
- b) Adjust the spectrum analyzer for the following settings:
 - 1) Resolution Bandwidth = 100 kHz for spurious emissions below 1 GHz, and 1 MHz for spurious emissions above 1GHz.
 - 2) Video Bandwidth = 300 kHz for spurious emissions below 1 GHz, and 3 MHz for spurious emissions above 1 GHz.
 - 3) Sweep Speed slow enough to maintain measurement calibration.
 - 4) Detector Mode = Positive Peak.
- c) Place the transmitter to be tested on the turntable in the standard test site, The transmitter is transmitting into a no radiating load that is placed on the turntable. The RF cable to this load should be of minimum length.
- d) Measurements shall be made from 30MHz to 10 times of fundamental carrier, except for the region close to the carrier equal to \pm the carrier bandwidth.
- e) Key the transmitter without modulation or normal modulation base the standard.
- f) For each spurious frequency, raise and lower the test antenna from 1 m to 4 m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Then the turntable should be rotated 360° to determine the maximum reading. Repeat this procedure to obtain the highest possible reading. Record this maximum reading.
- g) Repeat step f) for each spurious frequency with the test antenna polarized vertically.



- h) Reconnect the equipment as illustrated.
- i) Keep the spectrum analyzer adjusted as in step b).
- j) Remove the transmitter and replace it with a substitution antenna (the antenna should be half-wavelength for each frequency involved). The center of the substitution antenna should be approximately at the same location as the center of the transmitter. At the lower frequencies, where the substitution antenna is very long, this will be impossible to achieve when the antenna is polarized vertically. In such case the lower end of the antenna should be 0.3 m above the ground.
- k) Feed the substitution antenna at the transmitter end with a signal generator connected to the antenna by means of a non-radiating cable. With the antennas at both ends horizontally polarized, and with the signal generator tuned to a particular spurious frequency, raise and lower the test antenna to obtain a maximum reading at the spectrum analyzer. Adjust the level of the signal generator output until the previously recorded maximum reading for this set of conditions is obtained. This should be done carefully repeating the adjustment of the test antenna and generator output.
- l) Repeat step k) with both antennas vertically polarized for each spurious frequency.
- m) Calculate power in dBm into a reference ideal half-wave dipole antenna by reducing the readings obtained in steps k) and l) by the power loss in the cable between the generator and the antenna, and further corrected for the gain of the substitution antenna used relative to an ideal half-wave dipole antenna by the following formula:

$$Pd(\text{dBm}) = Pg(\text{dBm}) - \text{cable loss (dB)} + \text{antenna gain (dB)}$$

where:

Pd is the dipole equivalent power and

Pg is the generator output power into the substitution antenna.

NOTE:

- 1) It is permissible to use other antennas provided they can be referenced to a dipole.
- 2) For below 1GHz signal, the *antenna gain* (dB) is dBd, and for above 1GHz signal, the *antenna gain* (dB) is dBi
- 3) Effective radiated power (e.r.p) refers to the radiation of a half wave tuned dipole instead of an isotropic antenna. There is a constant difference of 2.15 dB between e.i.r.p. and e.r.p.
 $e.r.p (\text{dBm}) = e.i.r.p. (\text{dBm}) - 2.15$
- 4) For this test, the AU and EU are put outside of the chamber; connect to the RU through the optical fiber

6.2.4.1 Measurement Record:

Please refer to Appendix B for KSCR240500097002.

6.2.5 Occupied bandwidth and Input-versus-output signal comparison

Test Requirement:	§2.1049
	The spectral shape of the output should look similar to input for all modulations.
EUT Operation:	
Status:	Drive the EUT to maximum output power. .
Conditions:	Normal conditions
Application:	Cellular Band RF output ports
Test Configuration:	

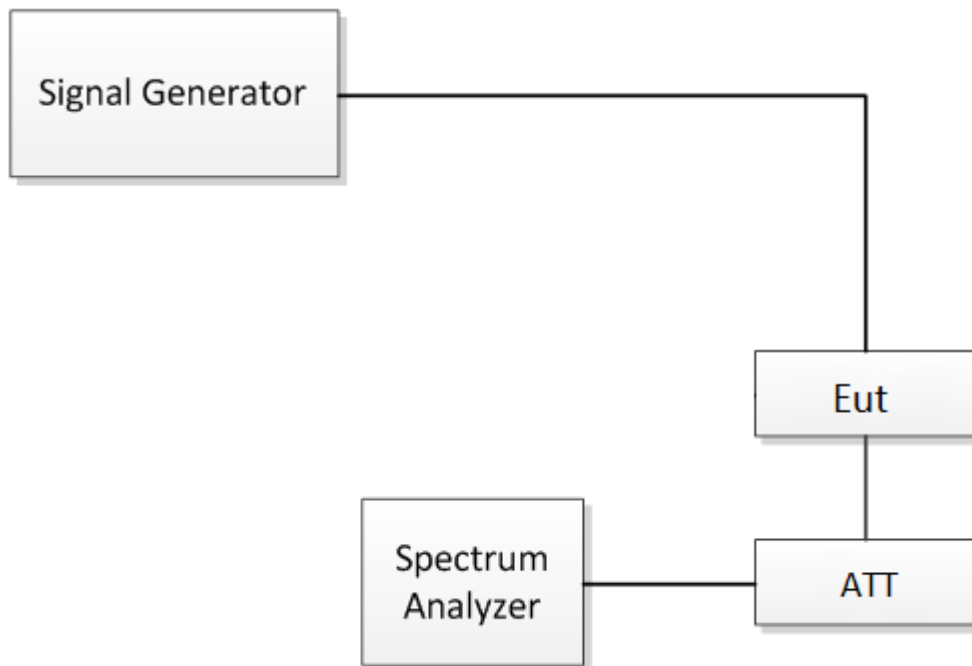


Fig.4. Occupied bandwidth test configuration

Test Procedure:

- 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 $\geq 3 \times$ 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 $[10 \log (OBW / RBW)]$ 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.

6.2.5.1 Measurement Record:

Please refer to Appendix B for KSCR240500097002.

6.2.6 Out of Band Rejection

Test Requirement: Section 4.3 of KDB 935210 D05 Indus Booster Basic Meas v01r04
 Test for rejection of out of band signals. Filter freq. response plots are acceptable.

Test Method: KDB 935210 D05 Indus Booster Basic Meas v01r04

EUT Operation:

Status: Drive the EUT to maximum output power. .

Conditions: Normal conditions

Application: Cellular Band RF output ports

Test Configuration:

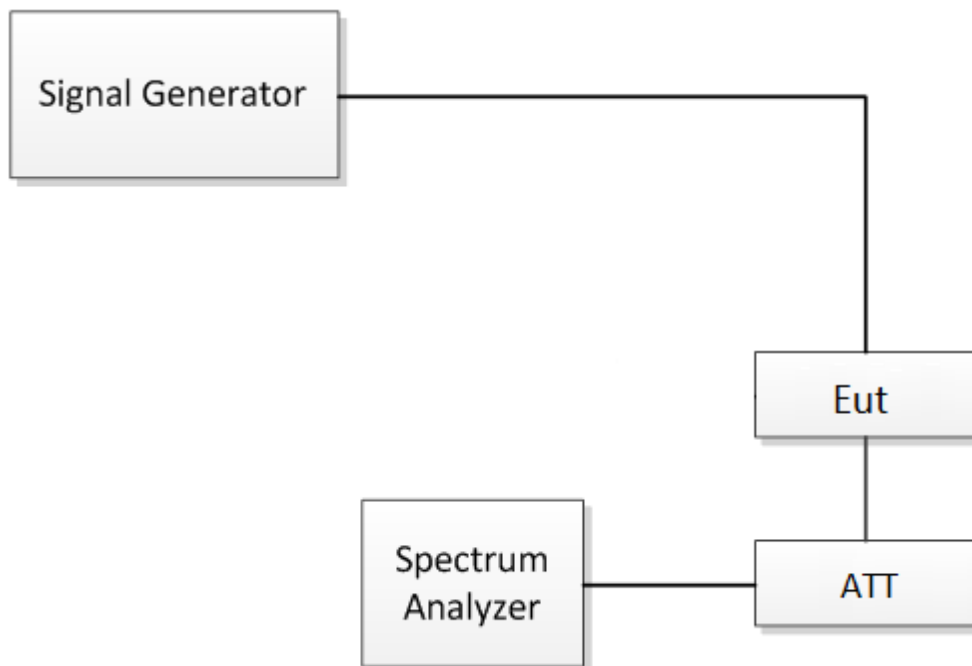


Fig.5. Out of Band rejection test configuration

- Test Procedure:**
- a) Connect a signal generator to the input of the EUT.
 - b) Configure a swept CW signal with the following parameters:
 - 1) Frequency range = $\pm 250\%$ of the passband, for each applicable CMRS band (see also KDB Publication 935210 D02 [R7] and KDB Publication 634817 [R5] about selection of frequencies for testing and for grant listings).
 - 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 = approximately 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 (RBW) of the spectrum analyzer to be 1 % to 5 % of the EUT passband, and the video bandwidth (VBW) shall be set to $\geq 3 \times \text{RBW}$.



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- 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 20dB bandwidth.
- i) Capture the frequency response of the EUT.
- j) Repeat for all frequency bands applicable for use by the EUT.

6.2.6.1 Measurement Record:

Please refer to Appendix B for KSCR240500097002.

6.2.7 Frequency Stability

Test Requirement: §90.213

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

EUT Operation:

Status: Drive the EUT to maximum output power.

Conditions: Temperature conditions, voltage conditions

Application: Cellular Band RF output ports

Test Procedure:

1. Temperature conditions:
 - a) The RF output port of the EUT was connected to Frequency Meter;
 - b) Set the working Frequency in the middle channel;
 - c) record the 20°C and nominal voltage frequency value as reference point;
 - d) vary the temperature from -40°C to 55°C with step 10°C
 - e) when reach a temperature point, keep the temperature balance at least 1 hour to make the product working in this status;
 - f) read the frequency at the relative temperature.
2. Voltage conditions:
 - a) record the 20°C and nominal voltage frequency value as reference point;
 - b) vary the voltage from -15% nominal voltage to +15% voltage;
 - c) read the frequency at the relative voltage.

6.2.7.1 Measurement Record:

Please refer to Appendix B for KSCR240500097002.

6.2.8 Emission Mask

Test Requirement:	§90.210 The spectral shape of the output should look similar to input for all modulations.
EUT Operation:	
Status:	Drive the EUT to maximum output power. .
Conditions:	Normal conditions
Application:	Cellular Band RF output ports
Test Configuration:	

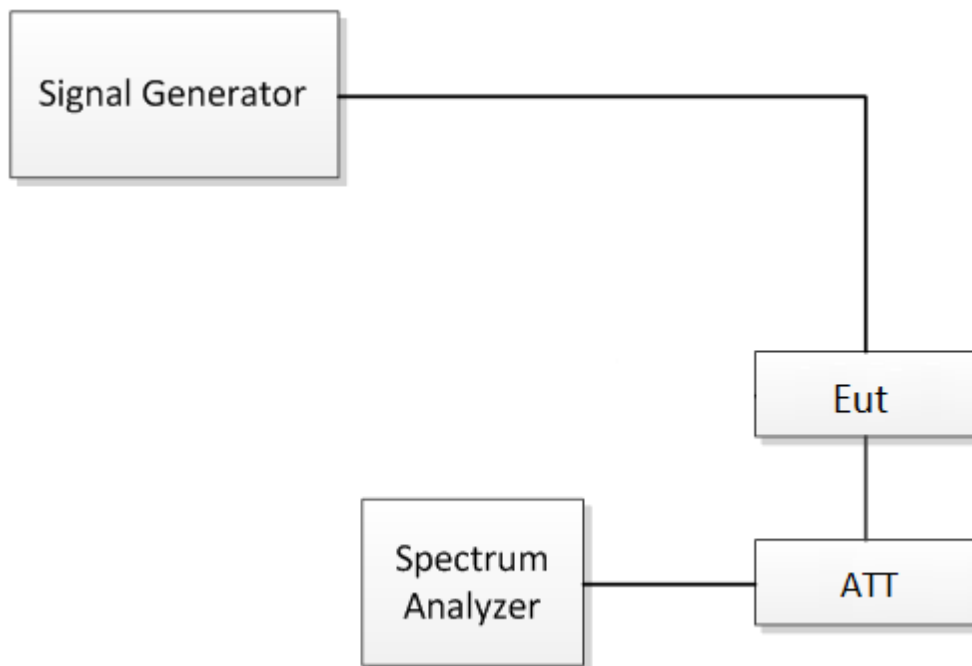


Fig.4. Emission mask test configuration

- Test Procedure:
- 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) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB..
 - g) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB..
 - h) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB..
 - i) Repeat steps b) to i) with the narrowband test signal.



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6.2.8.1 Measurement Record:

Please refer to Appendix B for KSCR240500097002.

6.2.9 Noise Figure

Test Requirement:	§90.219
Test Method:	KDB 935210 D05 Indus Booster Basic Meas v01r04 Clause 4.6
EUT Operation:	
Status:	Drive the EUT to maximum output power. .
Conditions:	Normal conditions
Application:	Cellular Band RF output ports
Test Configuration:	

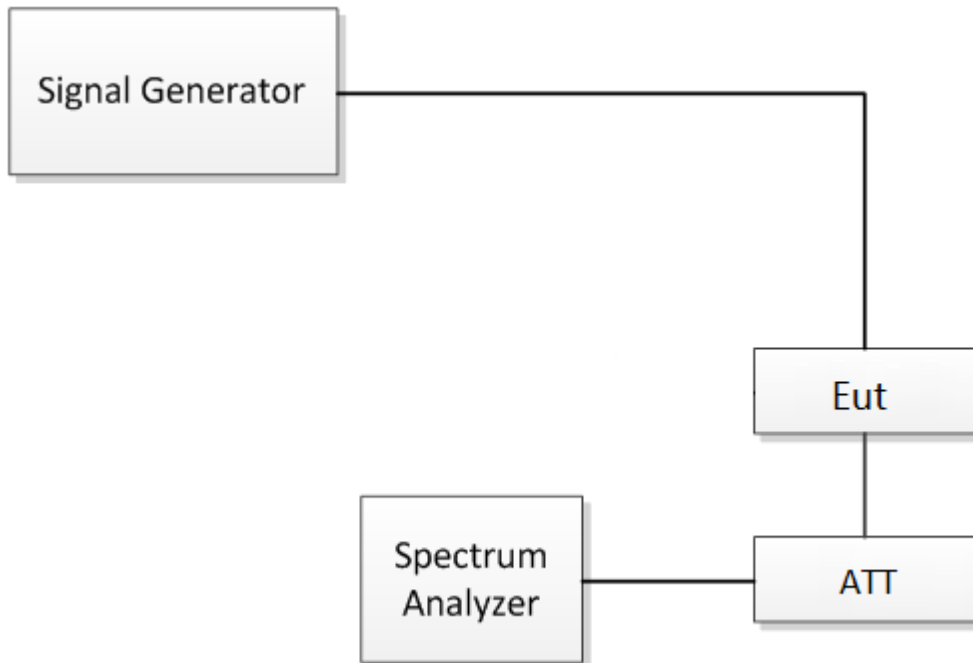


Fig.5. Noise Figure

Test Procedure:

Several widely recognized methods for performing noise figure measurements are available. Some require the use of specialized equipment, such as a noise figure analyzer and/or an excess noise ratio (ENR) calibrated noise source, while others involve the use of conventional measurement instrumentation such as a spectrum analyzer. Methods that require use of a noise figure analyzer are generally accepted as producing the most accurate results and are considered to be the reference method within this document, while others are considered to be acceptable alternative methods.

Consult the relevant instrumentation application notes for detailed guidance regarding the selection and application of an appropriate methodology for performing noise figure measurements. Note also that noise figure measurements require that any AGC circuitry be disabled over the duration of the measurement.



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6.2.9.1 Measurement Record:

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7 Photographs - Test Setup

Please refer to test setup photo

8 Photographs - EUT Constructional Details

Please refer to external and internal photo

--The End of Report--