

TEST REPORT


| | | |
|---|--|---|
| KOSTEC Co., Ltd. 28(175-20, Annyeong-dong) 406-gil sejaro, Hwaseong-si, Gyeonggi-do, Korea Tel:031-222-4251, Fax:031-222-4252 | Report No.: KST-FCR-180001(2) |  KOSTEC Co., Ltd. http://www.kostec.org |
| 1. Applicant <ul style="list-style-type: none">• Name : SamYoungCeletra. Co.,Ltd.• Address : 110, Geomdan-ro, Seo-gu, Incheon, South Korea | | |
| 2. Test Item <ul style="list-style-type: none">• Product Name: UHF TRANSCEIVER• Model Name: CT405• Brand: -• FCC ID: 2AJRJ-CT405 | | |
| 3. Manufacturer <ul style="list-style-type: none">• Name : SamYoungCeletra. Co.,Ltd.• Address : 110, Geomdan-ro, Seo-gu, Incheon, South Korea | | |
| 4. Date of Test : 2017. 12. 26. ~ 2017. 12. 29. | | |
| 5. Test Method Used : FCC CFR 47, Part 90, ANSI/TIA-603-D-2010 | | |
| 6. Test Result : Compliance | | |
| 7. Note: None | | |
| Supplementary Information <p>The device bearing the brand name and FCC ID specified above has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with measurement procedures specified in ANSI/TIA-603-D-2010</p> <p>We attest to the accuracy of data and all measurements reported herein were performed by KOSTEC Co., Ltd. and were made under Chief Engineer's supervision. We assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.</p> | | |
| The results shown in this test report refer only to the sample(s) tested unless otherwise stated. | | |
| Affirmation | Tested by Name : Lee, Mi-Young (Signature) | Technical Manager Name : Park, Gyeong-Hyeon (Signature) |
| 2018. 02.07. | | |
| KOSTEC Co., Ltd. | | |

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1. GENERAL INFORMATION

1.1 Test Facility

Test laboratory and address

KOSTEC Co., Ltd.

128(175-20,Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea

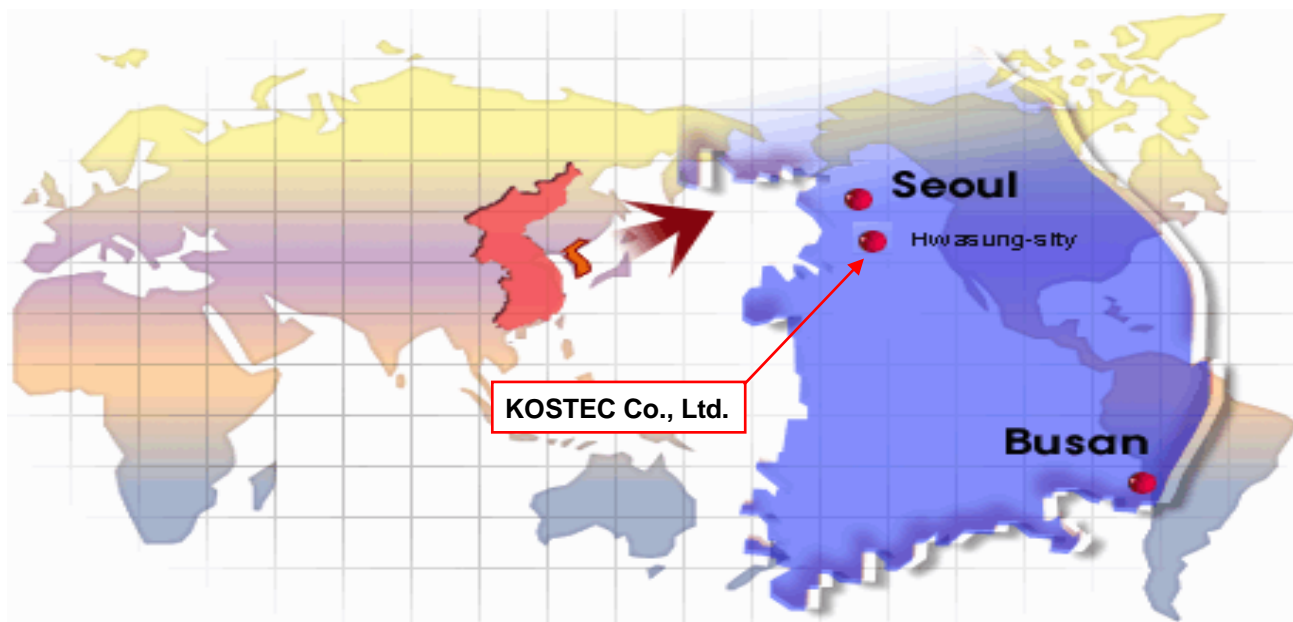
Registration information

KOLAS No. : 232

FCC Designation No. : KR0041

IC Registration Site No. : 8305A

1.2 Location



1.3 Revision History of test report

| Rev. | Revisions | Effect page | Reviewed | Date |
|------|---|-------------|--------------------|---------------|
| - | Initial issue | All | Gyeong Hyeon, Park | 2018. 01. 15. |
| 1 | Revised the error of output power and marked the frequency deviation mask in the plots of transmitter frequency behavior. | 11,15,27,37 | Gyeong Hyeon, Park | 2018. 02.02 |
| 2 | Add the frequency deviation limit on the mask | 37 | Gyeong Hyeon, Park | 2018. 02.07. |

2. EQUIPMENT DESCRIPTION

The product specification described herein was declared by manufacturer. And refer to user's manual for the details.

| | |
|--------------------------------|--|
| Equipment Name | UHF Transceiver |
| Model No | CT405 |
| Type of Equipment | Licensed Non-Broadcast Transmitter Held to Face |
| Intended Operating Environment | Restricted to Occupational Use only |
| Serial Number | Prototype |
| Primary User Functions of EUT | 2-Way Wireless Voice & Data Communication |
| RF Output Power Rating | 5 Watt (High) / 2 Watt (Low) |
| Assigned Frequency Range | 400 ~ 470 MHz |
| Operating Frequency Range | 406.125 ~469.975 MHz |
| RF Output Impedance | 50 Ω |
| Channel Spacing | 12.5 kHz |
| Modulation | FM for analog voice 4FSK for digital Voice and data |
| Occupied Bandwidth (99%) | 5.51 kHz (for 12.5 kHz Channel Spacing / Analog) 7.85 kHz (for 12.5 kHz Channel Spacing / Digital) |
| Emission Designation | 5K51F3E, 7K85F1D, 7K85F1E |
| Power Source | Li-ion battery / 7.2 Vdc nominal / 2.600 mAh |
| Antenna Description | HW-423W-CT405 Whip antenna, max 1.5 dBi |
| FCC ID | 2AJRJ-CT405 |
| Remark | The above DUT's information was declared by manufacturer. Please refer to the specifications or user manual for more detailed description. |

3. SYSTEM CONFIGURATION FOR TEST

3.1 Characteristics of equipment

The Equipment Under Test (EUT) use for UHF transceiver.

3.2 Used peripherals list

| Description | Model No. | Serial No. | Manufacture | Remark |
|---------------|----------------|--------------|---------------------------------------|--------|
| AC/DC adaptor | BX18W-1201000A | None | SHENZHEN BOSHENGGAO TECHNOLOGY CO.Ltd | |
| Charger | CDC-200 | SC1550001239 | SamYoungCeletra | |
| Battery | SB-2600 | SB1748002358 | SamYoungCeletra | |
| Tube.ear/mic | WEP-100 | None | JEIL INNOTEL | |

3.3 Product Modification

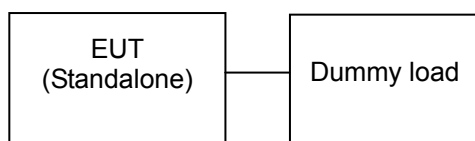
N/A

3.4 Operating Mode

Constantly transmitting with a modulated carrier at maximum power on the low, middle and high channels.
Radiated emissions tests were performed with antenna ports terminated.

3.5 Test Setup of EUT

The measurements were taken in continuous transmit mode.



3.6 Table for Carrier Frequencies

| Modulation Type | Tested Channel | Channel separation (kHz) | Test freq. (MHz) |
|-----------------|----------------|-----------------------------|---------------------|
| Analog | Low | 12.5 | 406.125 |
| | Mid | | 435.000 |
| | High | | 469.975 |
| Digital | Low | 12.5 | 406.125 |
| | Mid | | 435.000 |
| | High | | 469.975 |

3.8 Used Test Equipment List

| No. | Instrument | Model | S/N | Manufacturer | Due to cal date | Cal interval | used |
|-----|-------------------------------|----------------------------------|--------------|-----------------------------|-----------------|--------------|-------------------------------------|
| 1 | T & H Chamber | EY-101 | 90E14260 | TABAI ESPEC | 2018.09.06 | 1 year | <input checked="" type="checkbox"/> |
| 2 | T & H Chamber | RCT-V-THC-403-1(H) | 20030210 | R.C.T | 2018.09.06 | 1 year | <input type="checkbox"/> |
| 3 | Spectrum Analyzer | 8593E | 3710A02859 | Agilent Technology | 2018.02.02 | 1 year | <input type="checkbox"/> |
| 4 | Spectrum Analyzer | FSV30 | 20-353063 | Rohde & Schwarz | 2018.02.01 | 1 year | <input checked="" type="checkbox"/> |
| 5 | Signal Analyzer | N9010A | MY56070441 | Agilent Technologies | 2018.05.15 | 1 year | <input type="checkbox"/> |
| 6 | EMI Test Receiver | ESCI7 | 100823 | Rohde & Schwarz | 2018.01.31 | 1 year | <input type="checkbox"/> |
| 7 | EMI Test Receiver | ESI | 837514/004 | Rohde & Schwarz | 2018.09.05 | 1 year | <input type="checkbox"/> |
| 8 | Vector Signal Analyzer | 89441A | 3416A02620 | Agilent Technology | 2018.02.03 | 1 year | <input type="checkbox"/> |
| 9 | Network Analyzer | 8753ES | US39172348 | AGILENT | 2018.09.04 | 1 year | <input type="checkbox"/> |
| 10 | EPM Series Power meter | E4418B | GB39512547 | Agilent Technology | 2018.02.01 | 1 year | <input type="checkbox"/> |
| 11 | RF Power Sensor | E9300A | MY41496631 | Agilent Technology | 2018.02.01 | 1 year | <input type="checkbox"/> |
| 12 | Microwave Frequency Counter | 5352B | 2908A00480 | Agilent Technology | 2018.02.01 | 1 year | <input type="checkbox"/> |
| 13 | Modulation Analyzer | 8901A | 3041A05716 | Agilent Technology | 2018.01.31 | 1 year | <input checked="" type="checkbox"/> |
| 14 | Audio Analyzer | 8903B | 3514A16919 | Agilent Technology | 2018.01.31 | 1 year | <input checked="" type="checkbox"/> |
| 15 | Audio Telephone Analyzer | DD-5601CID | 520010281 | CREDIX | 2018.02.02 | 1 year | <input type="checkbox"/> |
| 16 | Digital storage Oscilloscope | TDS3052 | B015962 | Tektronix | 2018.09.04 | 1 year | <input checked="" type="checkbox"/> |
| 17 | ESG-D Series Signal Generator | E4436B | US39260458 | Agilent Technology | 2018.02.02 | 1 year | <input checked="" type="checkbox"/> |
| 18 | Vector Signal Generator | SMBV100A | 257557 | Rohde & Schwarz | 2018.02.02 | 1 year | <input checked="" type="checkbox"/> |
| 19 | Signal Generator | SMB100A | 179628 | Rohde & Schwarz | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 20 | Tracking Source | 85645A | 070521-A1 | Agilent Technology | 2018.02.03 | 1 year | <input type="checkbox"/> |
| 21 | SLIDAC | None | 0207-4 | Myoung sung Ele. | 2018.01.31 | 1 year | <input type="checkbox"/> |
| 22 | DC Power supply | DRP-5030 | 9028029 | Digital Electronic Co.,Ltd | 2018.02.01 | 1 year | <input type="checkbox"/> |
| 23 | DC Power supply | 6038A | 3440A12674 | Agilent Technology | 2018.01.31 | 1 year | <input checked="" type="checkbox"/> |
| 24 | DC Power supply | E3610A | KR24104505 | Agilent Technology | 2018.01.31 | 1 year | <input type="checkbox"/> |
| 25 | DC Power supply | UP-3005T | 68 | Unicon Co.,Ltd | 2018.01.31 | 1 year | <input type="checkbox"/> |
| 26 | DC Power Supply | SM 3004-D | 114701000117 | DELTAELEKTRONIKA | 2018.01.31 | 1 year | <input type="checkbox"/> |
| 27 | Attenuator | 24-30-34 | BX5630 | Aeroflex / Weinschel | 2018.12.15 | 1 year | <input type="checkbox"/> |
| 28 | Attenuator | 8498A | 3318A09485 | HP | 2018.02.01 | 1 year | <input type="checkbox"/> |
| 29 | Step Attenuator | 8494B | 3308A32809 | HP | 2018.02.02 | 1 year | <input type="checkbox"/> |
| 30 | Attenuator | 18B50W-20F | 64671 | INMET | 2018.02.02 | 1 year | <input type="checkbox"/> |
| 31 | Attenuator | 10 dB | 1 | Rohde & Schwarz | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 32 | Attenuator | 10 dB | 2 | Rohde & Schwarz | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 33 | Attenuator | 10 dB | 3 | Rohde & Schwarz | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 34 | Attenuator | 10 dB | 4 | Rohde & Schwarz | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 35 | Attenuator | 54A-10 | 74564 | WEINSCHTEL | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 36 | Attenuator | 56-10 | 66920 | WEINSCHTEL | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 37 | RF termination | 1432-3 | QR946 | AEROFLEX/WEINSCHTEL | 2018.07.20 | 1 year | <input checked="" type="checkbox"/> |
| 38 | Power divider | 11636B | 51212 | HP | 2018.02.01 | 1 year | <input checked="" type="checkbox"/> |
| 39 | 3Way Power divider | KPDSU3W | 00070365 | KMW | 2018.09.04 | 1 year | <input type="checkbox"/> |
| 40 | 4Way Power divider | 70052651 | 173834 | KRYTAR | 2018.02.01 | 1 year | <input type="checkbox"/> |
| 41 | 3Way Power divider | 1580 | SQ361 | WEINSCHTEL | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 42 | OSP | OSP120 | 101577 | Rohde & Schwarz | 2018.05.19 | 1 year | <input type="checkbox"/> |
| 43 | White noise audio filter | ST31EQ | 101902 | SoundTech | 2018.09.04 | 1 year | <input type="checkbox"/> |
| 44 | Dual directional coupler | 778D | 17693 | HEWLETT PACKARD | 2018.02.02 | 1 year | <input type="checkbox"/> |
| 45 | Dual directional coupler | 772D | 2839A00924 | HEWLETT PACKARD | 2018.02.02 | 1 year | <input type="checkbox"/> |
| 46 | Band rejection filter | 3TNF-0006 | 26 | DOVER Tech | 2018.02.03 | 1 year | <input type="checkbox"/> |
| 47 | Band rejection filter | 3TNF-0007 | 311 | DOVER Tech | 2018.02.03 | 1 year | <input type="checkbox"/> |
| 48 | Band rejection filter | WTR-BRF2442-84NN | 09020001 | WAVE TECH Co.,LTD | 2018.02.02 | 1 year | <input type="checkbox"/> |
| 49 | Band rejection filter | WRCJV12-5695-5725-5825-5855-50SS | 1 | Wainwright Instruments GmbH | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 50 | Band rejection filter | WRCJV12-5120-5150-5350-5380-40SS | 4 | Wainwright Instruments GmbH | 2018.05.18 | 1 year | <input type="checkbox"/> |

| No. | Instrument | Model | S/N | Manufacturer | Due to cal date | Cal interval | used |
|-----|-------------------------------------|----------------------------------|-------------|-----------------------------|-----------------|--------------|-------------------------------------|
| 51 | Band rejection filter | WRCGV10-2360-2400-2500-2540-50SS | 2 | Wainwright Instruments GmbH | 2018.05.18 | 1 year | <input type="checkbox"/> |
| 52 | Highpass Filter | WHJS1100-10EF | 1 | WAINWRIGHT | 2018.02.02 | 1 year | <input type="checkbox"/> |
| 53 | Highpass Filter | WHJS3000-10EF | 1 | WAINWRIGHT | 2018.02.02 | 1 year | <input type="checkbox"/> |
| 54 | Highpass Filter | WHNX6-5530-3000-26500-40CC | 2 | Wainwright Instruments GmbH | 2018.05.19 | 1 year | <input type="checkbox"/> |
| 55 | Highpass Filter | WHNX6-2370-7000-26500-40CC | 4 | Wainwright Instruments GmbH | 2018.05.19 | 1 year | <input type="checkbox"/> |
| 56 | WideBand Radio Communication Tester | CMW500 | 102276 | Rohde & Schwarz | 2018.02.03 | 1 year | <input type="checkbox"/> |
| 57 | Radio Communication Tester | CMU 200 | 112026 | Rohde & Schwarz | 2018.02.03 | 1 year | <input type="checkbox"/> |
| 58 | Bluetooth Tester | TC-3000B | 3000B6A0166 | TESCOM CO., LTD. | 2018.02.03 | 1 year | <input type="checkbox"/> |
| 59 | Loop Antenna | 6502 | 9203-0493 | EMCO | 2019.05.29 | 2 year | <input type="checkbox"/> |
| 60 | BiconiLog Antenna | 3142B | 9910-1432 | EMCO | 2018.04.25 | 2 year | <input checked="" type="checkbox"/> |
| 61 | Trilog-Broadband Antenna | VULB 9168 | 9168-606 | SCHWARZBECK | 2018.09.09 | 2 year | <input type="checkbox"/> |
| 62 | Horn Antenna | 3115 | 2996 | EMCO | 2018.02.11 | 2 year | <input checked="" type="checkbox"/> |
| 63 | Horn Antenna | BBHA9170 | BBHA9170152 | SCHWARZBECK | 2019.04.25 | 2 year | <input type="checkbox"/> |
| 64 | Antenna Master(3) | AT13 | None | AUDIX | N/A | N/A | <input type="checkbox"/> |
| 65 | Turn Table(3) | None | None | AUDIX | N/A | N/A | <input type="checkbox"/> |
| 66 | PREAMPLIFIER(3) | 8449B | 3008A02577 | Agilent | 2018.02.01 | 1 year | <input type="checkbox"/> |
| 67 | Antenna Master(10) | MA4000-EP | None | inno systems GmbH | N/A | N/A | <input checked="" type="checkbox"/> |
| 68 | Turn Table(10) | None | None | inno systems GmbH | N/A | N/A | <input checked="" type="checkbox"/> |
| 69 | AMPLIFIER(10) | TK-PA6S | 120009 | TESTEK | 2018.01.31 | 1 year | <input checked="" type="checkbox"/> |
| 70 | AMPLIFIER | 8447D | 2944A07881 | H.P | 2018.01.31 | 1 year | <input type="checkbox"/> |
| 71 | Antenna Mast | MA2000-EP | None | inno systems GmbH | N/A | N/A | <input type="checkbox"/> |
| 72 | Turn Device | DE3700-RH | None | inno systems GmbH | N/A | N/A | <input type="checkbox"/> |

4. SUMMARY TEST RESULTS

| Description of Test | FCC Rule | Reference Clause | Used | Test Result |
|--|---------------------------------|------------------|-------------------------------------|-------------|
| RF Output Power | Part 90.205 | Clause 5.1 | <input checked="" type="checkbox"/> | Compliance |
| Modulation Characteristics | Part 2.1047(a), 90.242(b)(8) | Clause 5.2 | <input checked="" type="checkbox"/> | Compliance |
| Occupied Bandwidth | Part 90.209 | Clause 5.3 | <input checked="" type="checkbox"/> | Compliance |
| Emission Mask | Part 90.210 | Clause 5.4 | <input checked="" type="checkbox"/> | Compliance |
| Frequency Stability | Part 90.213 | Clause 5.5 | <input checked="" type="checkbox"/> | Compliance |
| Spurious Emission On Antenna Port | Part 90.210 | Clause 5.6 | <input checked="" type="checkbox"/> | Compliance |
| Transmitter Radiated Unwanted Emissions | Part 90.210 | Clause 5.7 | <input checked="" type="checkbox"/> | Compliance |
| Transmitter Frequency Behavior | Part 90.214 | Clause 5.8 | <input checked="" type="checkbox"/> | Compliance |
| Compliance/pass : The EUT complies with the essential requirements in the standard. Not Compliance : The EUT does not comply with the essential requirements in the standard. N/A : The test was not applicable in the standard. | | | | |

Procedure Reference

FCC CFR 47, Part 90

ANSI/TIA-603-D-2010

5. MEASUREMENT RESULTS

5.1 RF Output Power

5.1.1 Standard Applicable [FCC §90.205 & 2.1046]

Applicants for licenses must request and use no more power than the actual power necessary for satisfactory operation.

The output power shall not exceed by more than 20 percent either the output power shown in the Radio Equipment List for transmitters included in this list or when not so listed, the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

5.1.2 Test Environment conditions

- Ambient temperature : (21 - 22) °C • Relative Humidity : (48 - 50) % R.H.

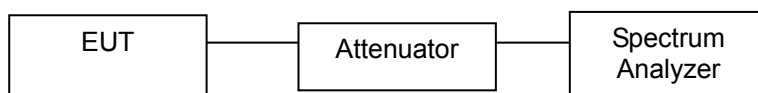
5.1.3 Measurement Procedure

The transmitter output was connected to the spectrum analyzer with an attenuator. The power output shall be monitored and recorded and no adjustment shall be made to the transmitter after the test has begun, except as noted below: If the power output is adjustable, measurements shall be made for the highest and lowest power levels.

The spectrum analyzer is set to the as follows :

- RBW : 30 kHz
- VBW : 100 kHz

5.1.4 Test setup



5.1.5 Measurement Result

| Modulation | Frequency [MHz] | Power Level | Conducted output Power [dBm] | Conducted output Power [W] | Limit [dBm] | Test Results |
|------------|-----------------|-------------|------------------------------|----------------------------|-------------|--------------|
| Analog | 406.125 | Low | 33.66 | 2.32 | 1.6 - 2.4 W | Compliance |
| | 435.000 | Low | 33.54 | 2.26 | | Compliance |
| | 469.975 | Low | 33.34 | 2.16 | | Compliance |
| | 406.125 | High | 37.36 | 5.45 | 4 - 6 W | Compliance |
| | 435.000 | High | 37.46 | 5.57 | | Compliance |
| | 469.975 | High | 37.69 | 5.87 | | Compliance |
| Digital | 406.125 | Low | 33.62 | 2.30 | 1.6 - 2.4 W | Compliance |
| | 435.000 | Low | 33.45 | 2.21 | | Compliance |
| | 469.975 | Low | 33.39 | 2.18 | | Compliance |
| | 406.125 | High | 36.82 | 4.81 | 4 - 6 W | Compliance |
| | 435.000 | High | 36.80 | 4.79 | | Compliance |
| | 469.975 | High | 36.79 | 4.78 | | Compliance |

5.2 Modulation Characteristics

5.2.1 Standard Applicable [FCC §Part 2.1047(a)]

2.1047(b): Equipment which employs modulation limiting. A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

Recommended frequency deviation characteristics are given below:

| CH spacing | Frequency deviation |
|------------|---------------------|
| 12.5 kHz | 2.5 kHz |

Part 2.1047(a) A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

90.242(b)(8) Recommended audio filter attenuation characteristics are given below:

| Audio freq. | Minimum Attenuation Rel. to 1 kHz Attenuation |
|-------------|---|
| 3 - 20 kHz | 60 log ₁₀ (f/3) dB where f is in kHz |
| 20 - 30 kHz | 50 dB |

5.2.2 Test Environment conditions

- Ambient temperature : (21 - 22) °C • Relative Humidity : (48 - 50) % R.H.

5.2.3 Measurement Procedure

- Modulation Limit

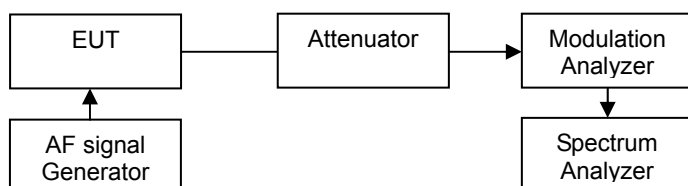
The carrier frequency deviation was measured with the tone adjust the audio input for 60 % of rated system deviation at 1 kHz using this level as a reference (0 dB) and vary the input level from -20 to +20 dB. Record the frequency deviation obtained as a function of the input level at frequencies 0.1, 0.5, 1.0, 3.0 and 5.0 kHz. The maximum deviation was recorded at each test condition.

- Audio frequency response

The audio input level needed for a particular percentage of modulation was measured in accordance with ANSI/TIA 603-D: 2010. The audio input curves versus modulation are shown below. Curves are provided for audio input frequencies of 300, 1000, and 3000 Hz.

- Test freq: Mid

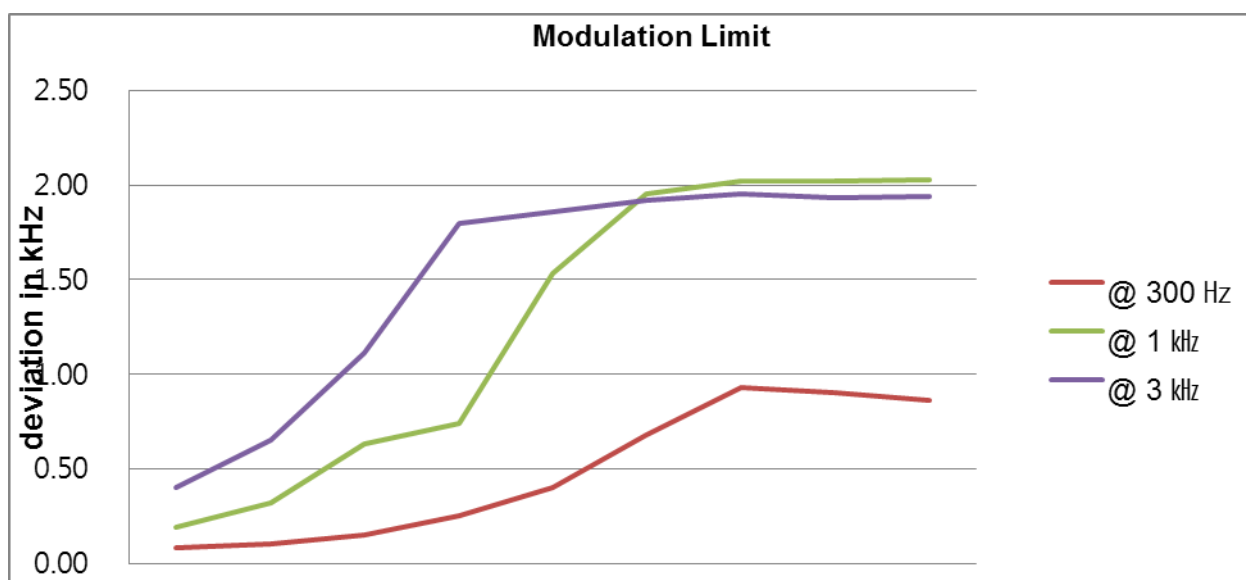
5.2.4 Test setup



5.2.5 Measurement Result

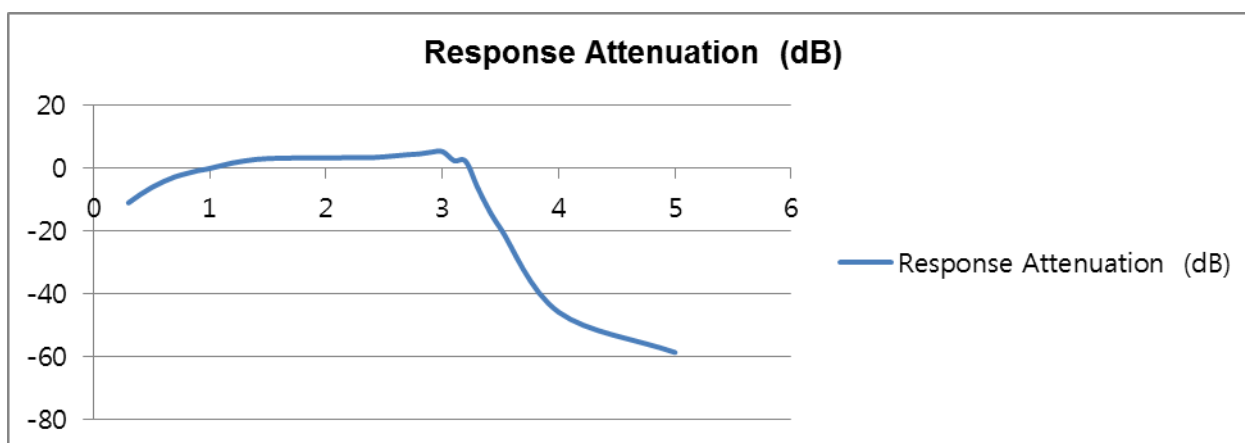
• Modulation Limit

| Audio input Level (dB) | Frequency Deviation (kHz) | | | Limit (kHz) |
|---------------------------|---------------------------|---------|---------|----------------|
| | @ 300 Hz | @ 1 kHz | @ 3 kHz | |
| -20 | 0.09 | 0.19 | 0.40 | 2.5 |
| -15 | 0.10 | 0.32 | 0.65 | 2.5 |
| -10 | 0.15 | 0.63 | 1.11 | 2.5 |
| -5 | 0.26 | 0.74 | 1.80 | 2.5 |
| 0 | 0.40 | 1.53 | 1.86 | 2.5 |
| 5 | 0.68 | 1.95 | 1.92 | 2.5 |
| 10 | 0.93 | 2.02 | 1.95 | 2.5 |
| 15 | 0.90 | 2.02 | 1.93 | 2.5 |
| 20 | 0.86 | 2.03 | 1.94 | 2.5 |



• Audio frequency response

| Audio Frequency (Hz) | Response Attenuation (dB) | Audio Frequency (Hz) | Response Attenuation (dB) |
|----------------------|---------------------------|----------------------|---------------------------|
| 300 | -11 | 2 800 | 4.58 |
| 400 | -8.38 | 2 900 | 5.13 |
| 500 | -6.11 | 3 000 | 5.33 |
| 600 | -4.25 | 3 100 | 2.46 |
| 700 | -2.71 | 3 200 | 2.22 |
| 800 | -1.65 | 3 300 | -5.96 |
| 900 | -0.72 | 3 400 | -13.32 |
| 1 000 | -0.02 | 3 500 | -19.22 |
| 1 200 | 1.73 | 4 000 | -45.86 |
| 1 400 | 2.86 | 5 000 | -58.67 |
| 1 600 | 3.22 | | |
| 1 800 | 3.26 | | |
| 2 000 | 3.28 | | |
| 2 100 | 3.35 | | |
| 2 200 | 3.41 | | |
| 2 300 | 3.45 | | |
| 2 400 | 3.43 | | |
| 2 500 | 3.67 | | |
| 2 600 | 4.01 | | |
| 2 700 | 4.33 | | |



5.3 Occupied Bandwidth & 26 dB Bandwidth

5.3.1 Standard Applicable [FCC §90.209 & 2.1049]

According to FCC Part 90 Section 90.209: The authorized bandwidth shall be 11.25 kHz for 12.5 kHz channel separation and 6 kHz for 6.25 kHz channel separation.

5.3.2 Test Environment conditions

- Ambient temperature : (21 - 22) °C • Relative Humidity : (48 - 50) % R.H.

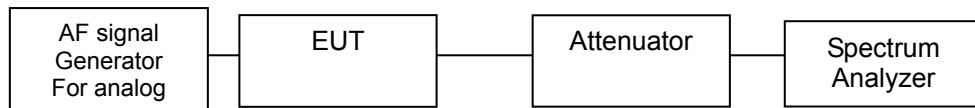
5.3.3 Measurement Procedure

1. The EUT was modulated by 2.5 kHz Sine wave audio signal, The level of the audio signal employed is 16 dB greater than that necessary to produce 50 % of rated system deviation. Rated system deviation is 2.5 kHz (12.5 kHz channel spacing).
2. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
3. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. The 99 % occupied bandwidth is the frequency bandwidth of the signal power at the 99 % channel power of occupied bandwidth.

The spectrum analyzer is set to the as follows :

- RBW : 300 Hz
- VBW : >3 x RBW
- Detector function : peak
- Trace : max hold

5.3.4 Test setup



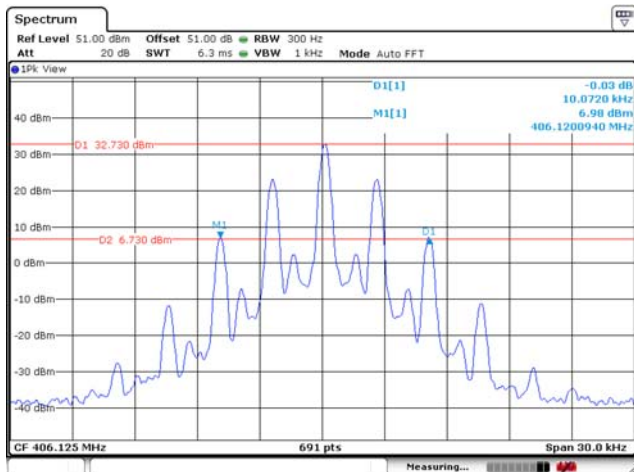
5.3.5 Measurement Result

| Modulation | Frequency [MHz] | Power Level | 99 % Bandwidth [KHz] | 26 dB Bandwidth [kHz] | Limit [kHz] | Test Results |
|--------------------------|-----------------|-------------|----------------------|-----------------------|-------------|--------------|
| Analog | 406.125 | Low | 5.47 | 10.07 | ≤ 11.25 | Compliance |
| | 435.000 | Low | 5.47 | 10.07 | | Compliance |
| | 469.975 | Low | 5.51 | 10.07 | | Compliance |
| | 406.125 | High | 5.47 | 10.07 | ≤ 11.25 | Compliance |
| | 435.000 | High | 5.47 | 9.99 | | Compliance |
| | 469.975 | High | 5.51 | 9.99 | | Compliance |
| Digital (Voice and Data) | 406.125 | Low | 7.86 | 10.07 | ≤ 11.25 | Compliance |
| | 435.000 | Low | 7.68 | 9.94 | | Compliance |
| | 469.975 | Low | 7.60 | 10.07 | | Compliance |
| | 406.125 | High | 7.73 | 9.94 | ≤ 11.25 | Compliance |
| | 435.000 | High | 7.64 | 9.94 | | Compliance |
| | 469.975 | High | 7.64 | 9.90 | | Compliance |

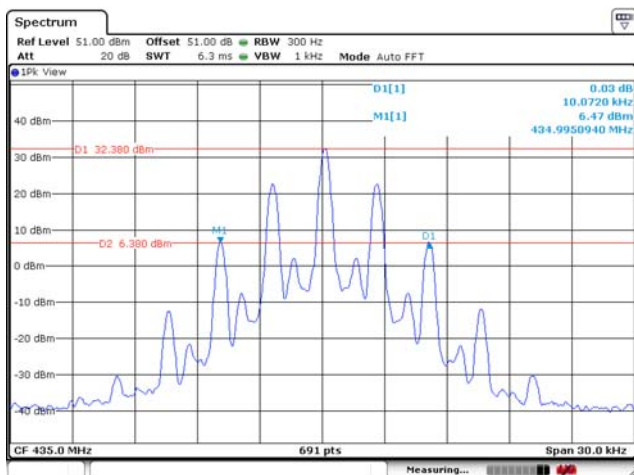
5.3.6 Test Plot (26 dB band width for analog)

Power level: Low

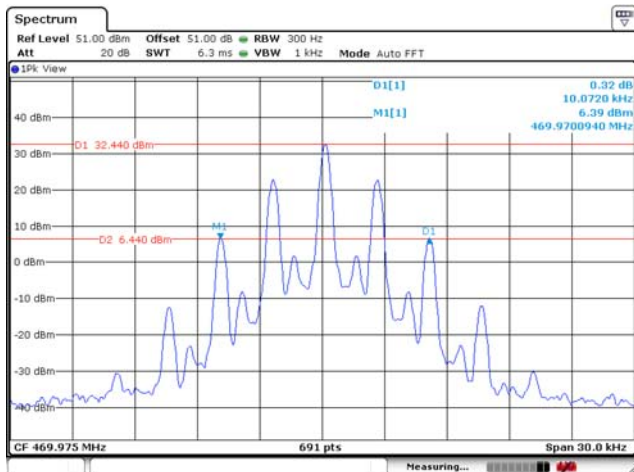
CH Low



CH Middle

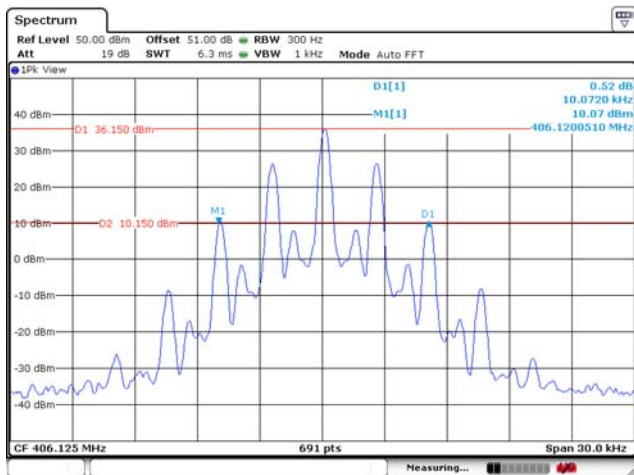


CH High

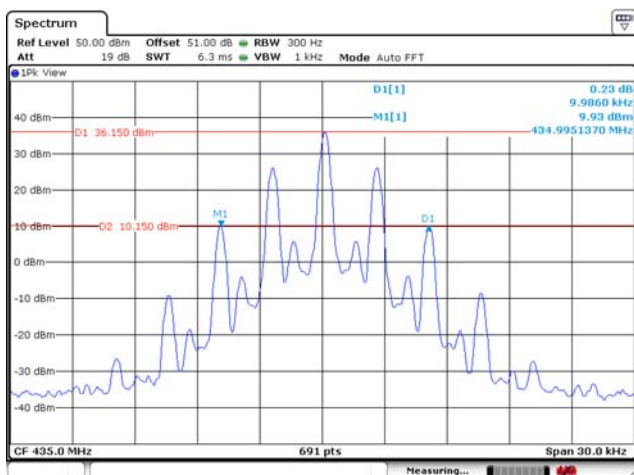


Power level: High

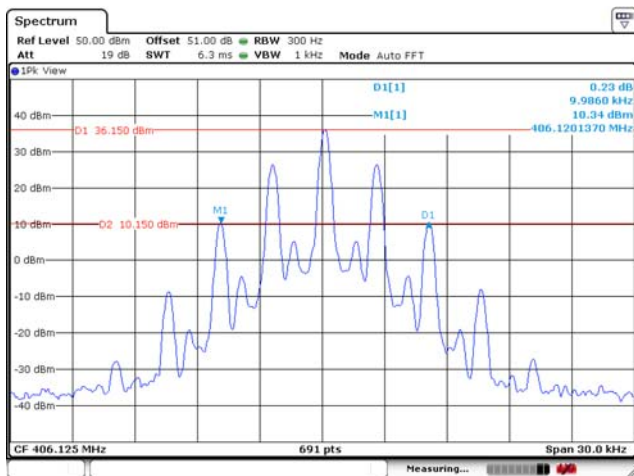
CH Low



CH Middle



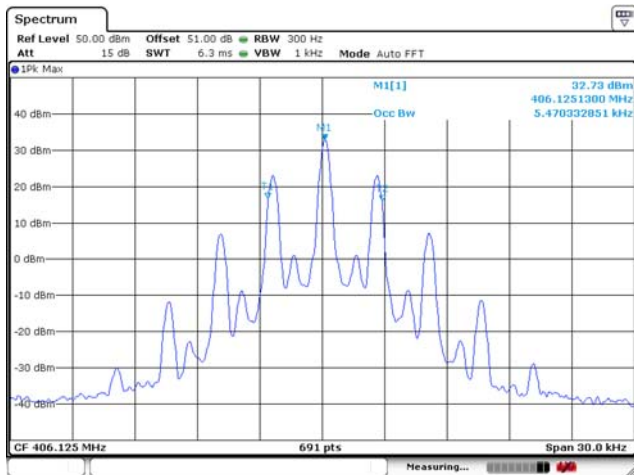
CH High



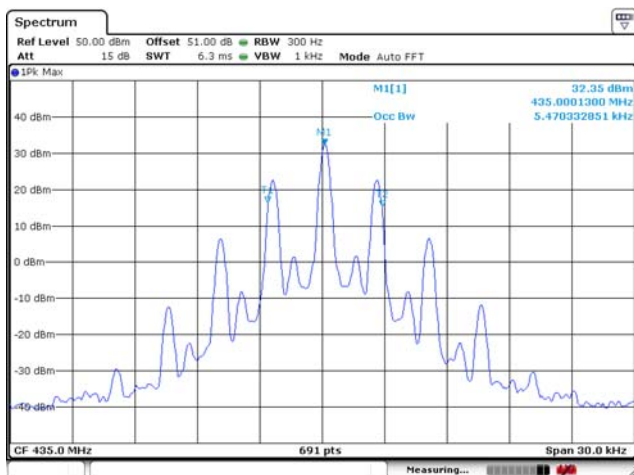
Test Plot (99 % band width for analog)

Power level: Low

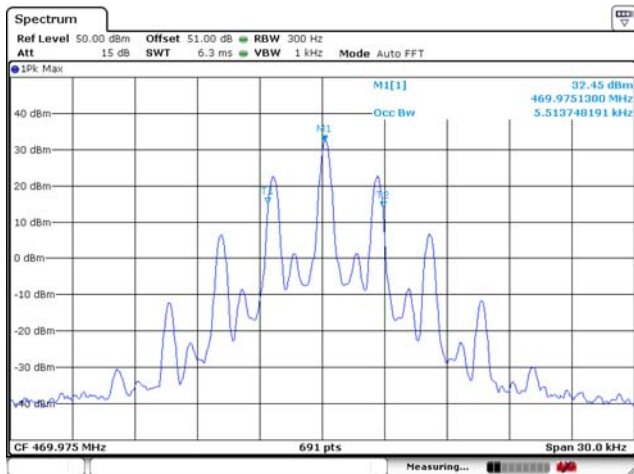
CH Low



CH Middle

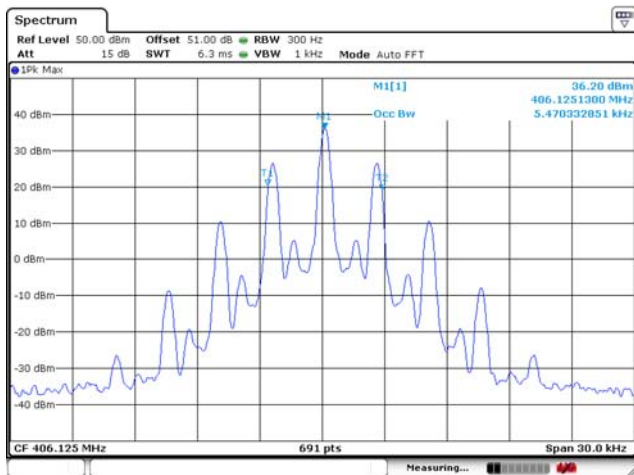


CH High

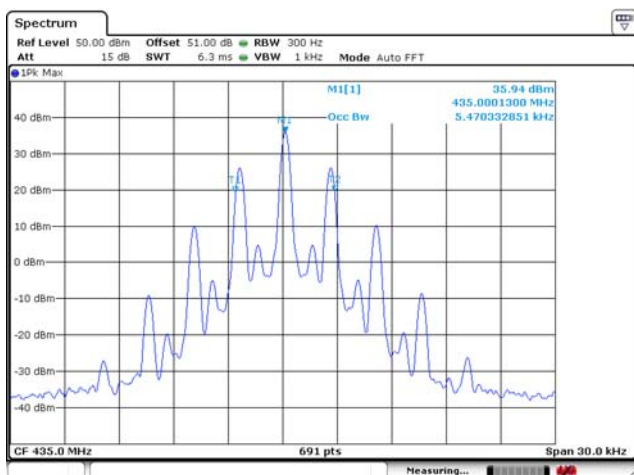


Power level: High

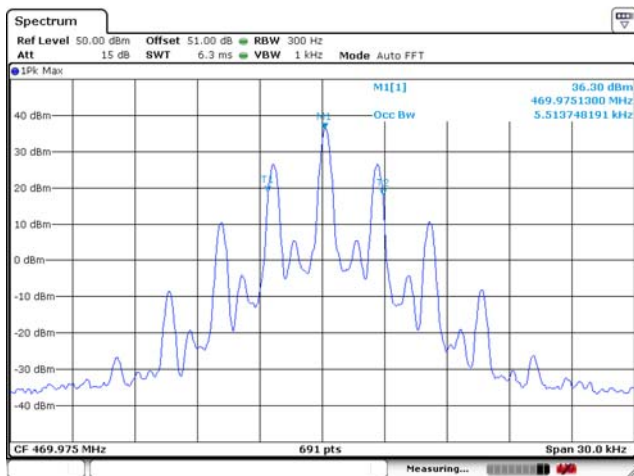
CH Low



CH Middle



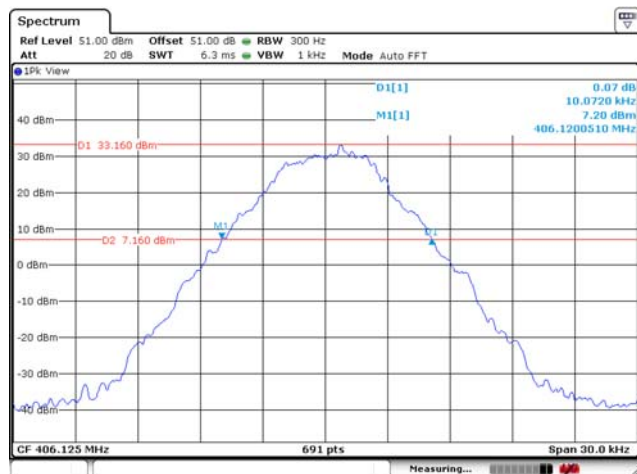
CH High



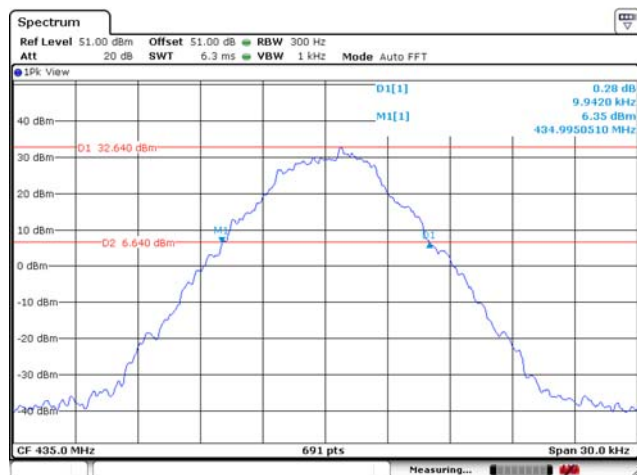
Test Plot (26 dB band width for digital)

Power level: Low

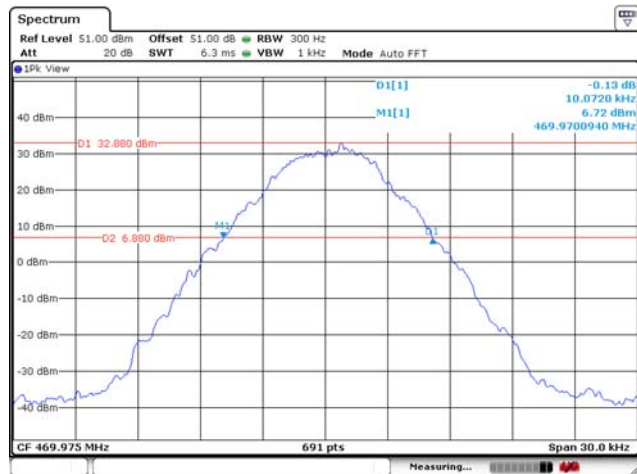
CH Low



CH Middle

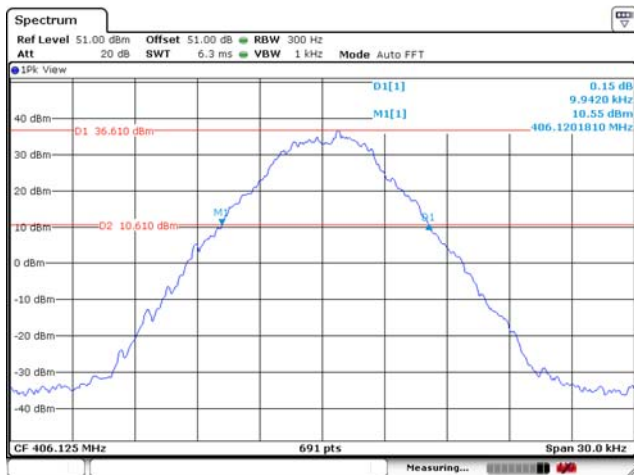


CH High

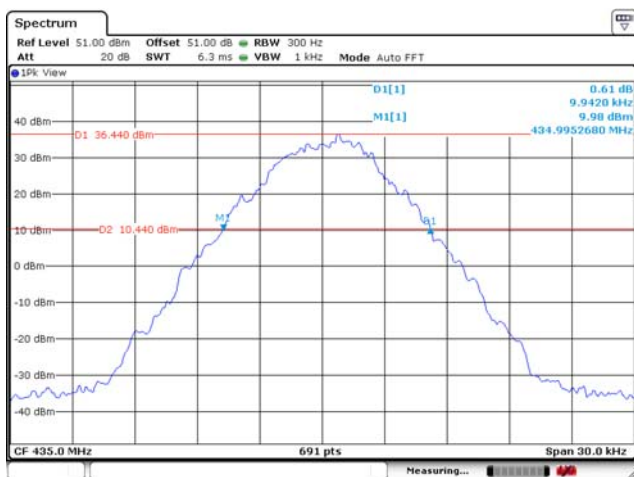


Power level: High

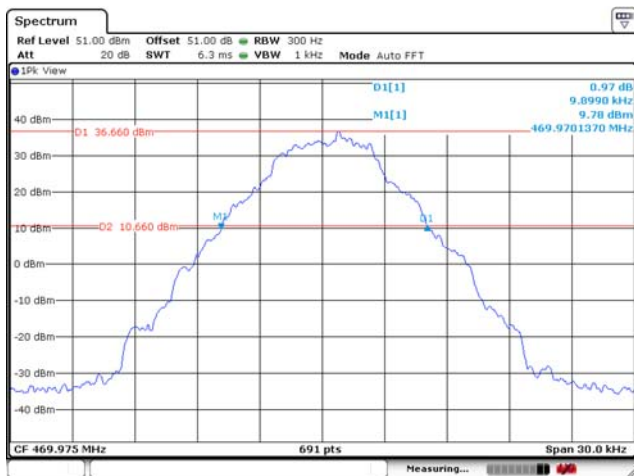
CH Low



CH Middle



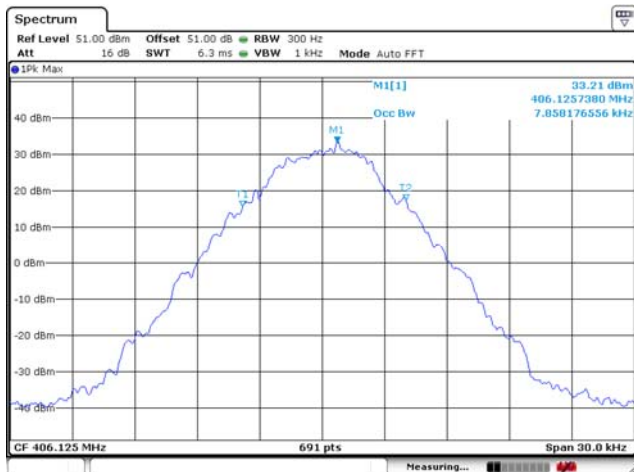
CH High



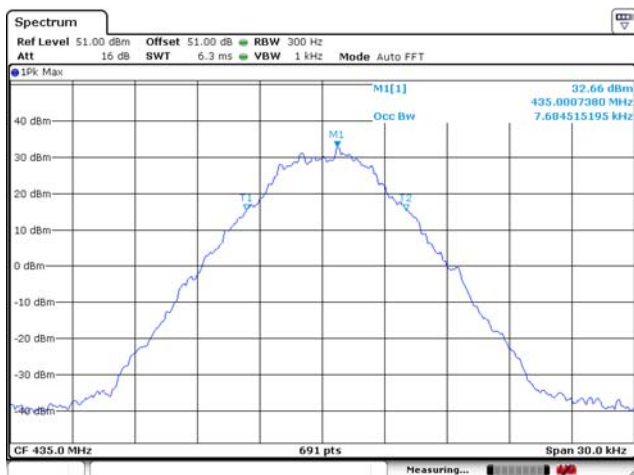
Test Plot (99 % band width for digital)

Power level: Low

CH Low



CH Middle



CH High

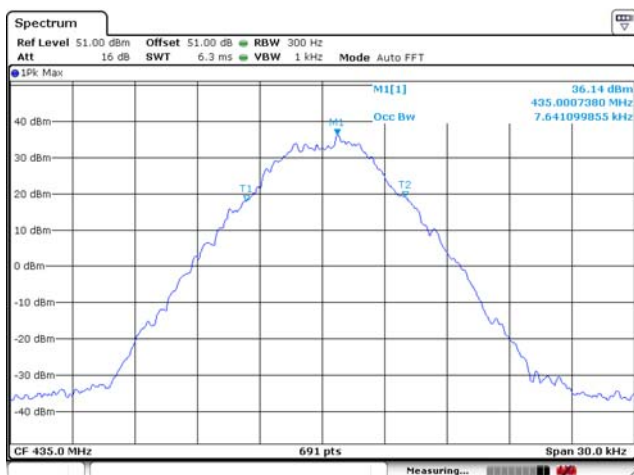


Power level: High

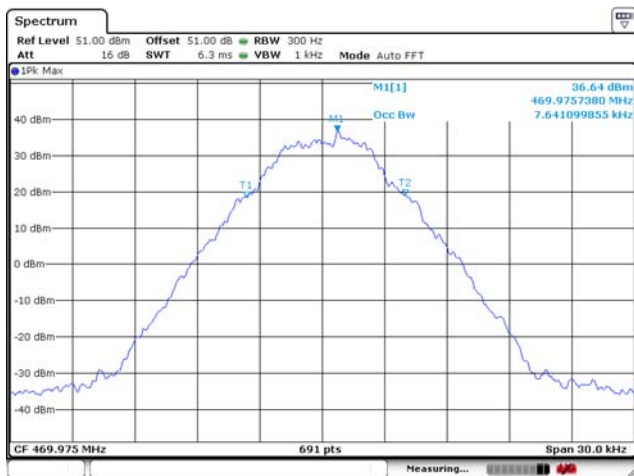
CH Low



CH Middle



CH High



5.4 Emission Mask

5.4.1 Standard Applicable [FCC §90.210]

Emission mask D: For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

- (1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0 : Zero dB.
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least $7.27(f_d - 2.88 \text{ kHz})$ dB.
- (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least $50 + 10 \log (P)$ dB or 70 dB, whichever is the lesser attenuation.

5.4.2 Test Environment conditions

- Ambient temperature : (21 - 22) °C • Relative Humidity : (48 - 50) % R.H.

5.4.3 Measurement Procedure

• Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(i)

The transmitter was modulated by a 2.5 kHz tone signal at an input level 16 dB greater than that required to produce 50 % modulation (e.g.: ± 2.5 kHz peak deviation at 1 kHz modulating frequency). The input level was established at the frequency of maximum response of the audio modulating circuit.

• Digital Modulation Through a Data Input Port @ 2.1049(h):

Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the Emission Masks shall be shown for operation with any devices used for modifying the spectrum when such devices are operational at the discretion of the user.

The following EMI Receiver bandwidth shall be used for measurement of Emission Mask/Out-of-Band Emission Measurements:

The spectrum analyzer is set to the as follows

- For 25 kHz Channel Spacing: RBW = 300 Hz
- For 12.5 kHz or 6.25 kHz Channel Spacings: RBW = 100 Hz
- The all cases are set "VBW: >3xRBW"

5.4.4 Test setup

Please refer 5.3.4

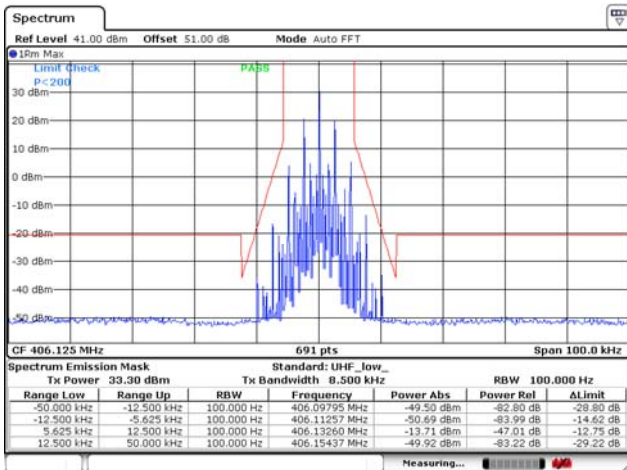
5.4.5 Measurement Result

Compliance: please refer 5.4.6 for details

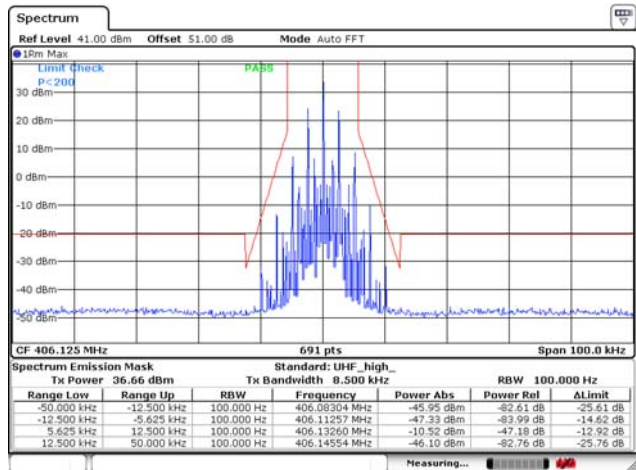
5.4.6 Test Plot

■ Analog

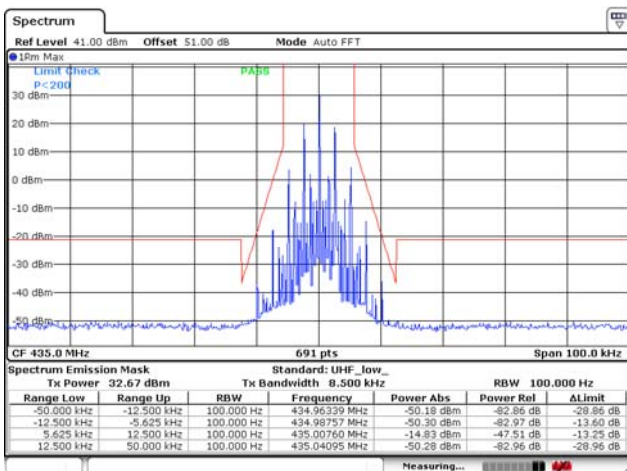
CH Low / Low power



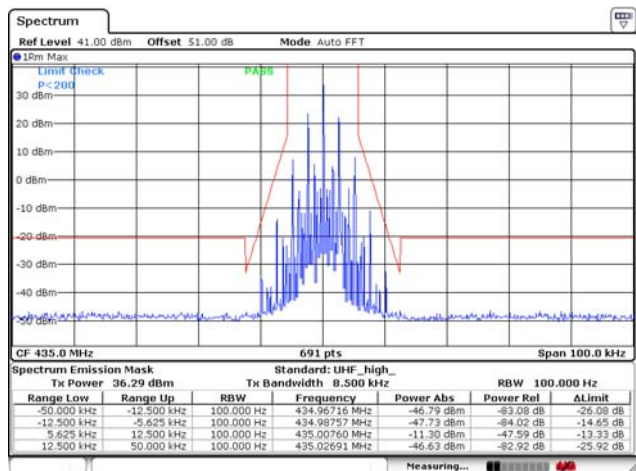
CH Low / High power



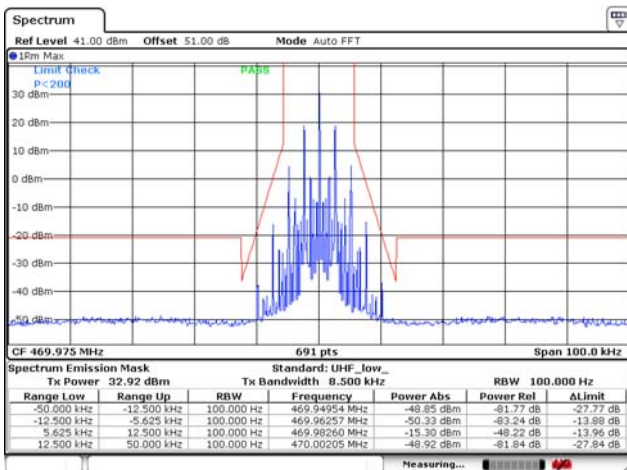
CH Middle / Low power



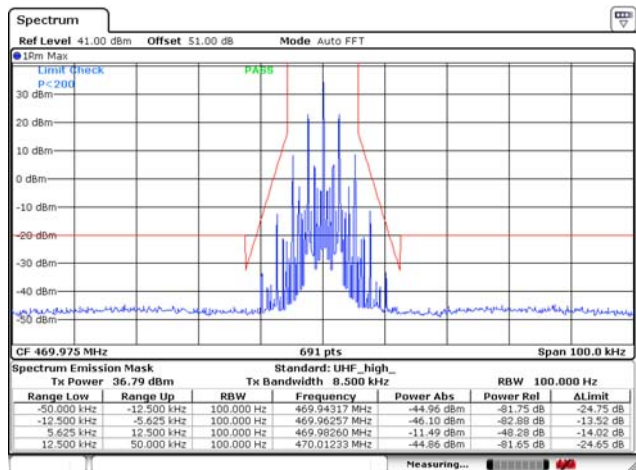
CH Middle / High power



CH High / Low power

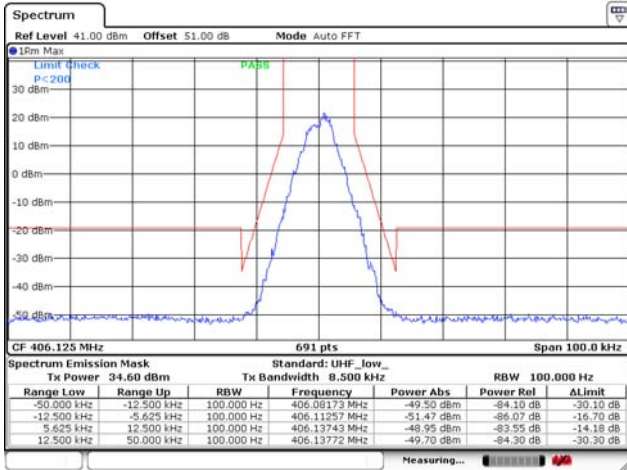


CH High / High power

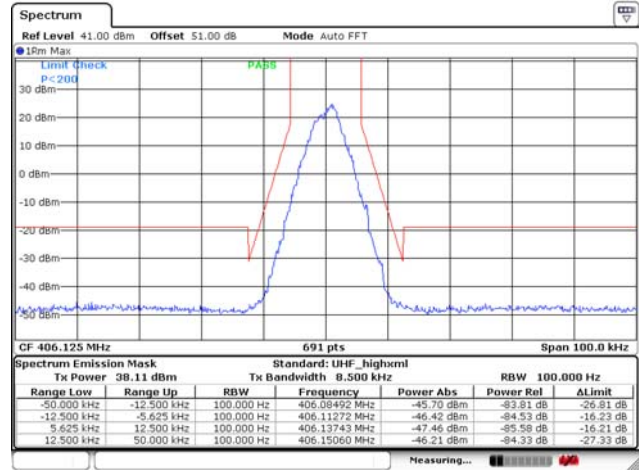


■ Digital (Voice and Data)

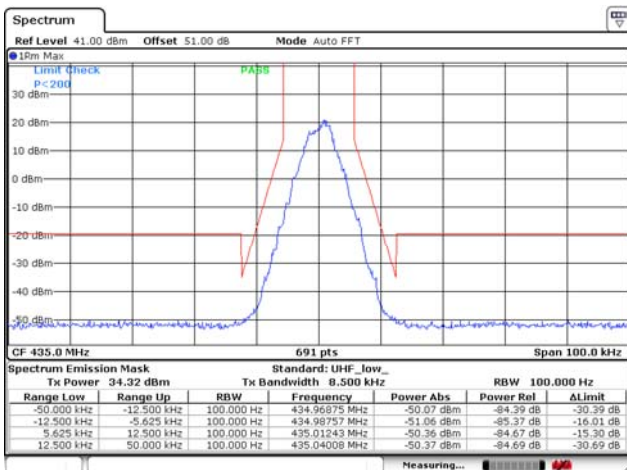
CH Low / Low power



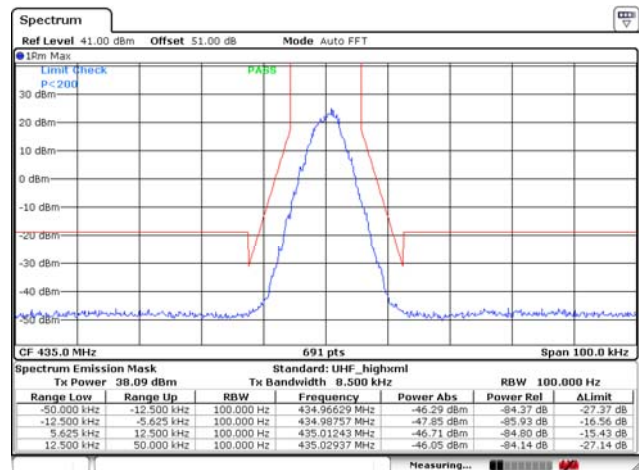
CH Low / High power



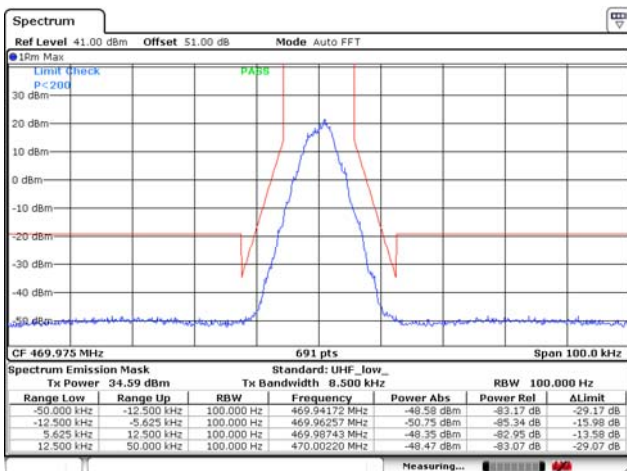
CH Middle / Low power



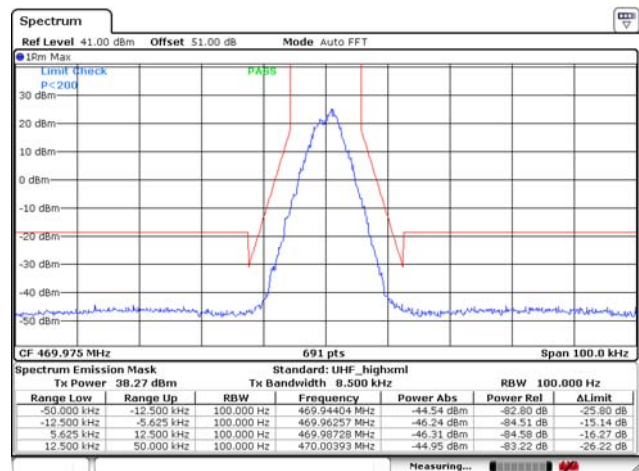
CH Middle / High power



CH High / Low power



CH High / High power



5.5 Spurious Emission On Antenna Port

5.5.1 Standard Applicable [FCC §90.210(d)]

Emission Mask D: 12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

- 1) For any frequency removed from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0 , 0 dB.
- 2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.626 kHz but no more than 12.5 kHz, at least 7.27 ($f_d - 2.88$ kHz) dB.
- 3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least $50 + 10 \log(P)$ dB or 70 dB, whichever is the lesser attenuation.

5.5.2 Test Environment conditions

- Ambient temperature : (21 - 22) °C • Relative Humidity : (48 - 50) % R.H.

5.5.3 Measurement Procedure

The carrier was modulated 100 % using a 2 500 Hz tone. The spectrum was scanned from the lowest frequency generated to at least the 10th harmonic of the fundamental. The measurements were made in accordance with standard ANSI/TIA 603-D: 2010. The RBW = 100 kHz, VBW = 300 kHz and the span set to 10.0 MHz and the spectrum was scanned from 30 MHz to the 10th harmonic of the fundamental. Above 1 GHz the resolution bandwidth was 1 MHz and the VBW = 3 MHz and the span to 50 MHz.

5.5.4 Test setup

Refer 5.3.4

5.5.5 Measurement Result

Analog / 406.125 MHz / Low power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 249.4 | 62.35 | 9.35 | 53 | Compliance |
| 429.2 | 53.61 | 0.61 | 53 | Compliance |

Analog / 435.000 MHz / Low power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 285.3 | 63.52 | 10.52 | 53 | Compliance |

Analog / 469.975 MHz / Low power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 422.0 | 54.59 | 1.59 | 53 | Compliance |

Analog / 406.125 MHz / High power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 249.37 | 61.30 | 4.30 | 57 | Compliance |
| 810.38 | 63.41 | 6.41 | 57 | Compliance |

Analog / 435.000 MHz / High power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 867.90 | 64.67 | 7.67 | 57 | Compliance |

Analog / 469.975 MHz / High power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 429.2 | 57.79 | 0.79 | 57 | Compliance |
| 939.8 | 65.14 | 8.14 | 57 | Compliance |

Digital / 406.125 MHz / Low power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 249.4 | 60.80 | 7.80 | 53 | Compliance |
| 429.2 | 54.63 | 1.63 | 53 | Compliance |

Digital / 435.000 MHz / Low power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 788.8 | 61.98 | 8.98 | 53 | Compliance |

Digital / 469.975 MHz / Low power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 422.0 | 55.02 | 2.02 | 53 | Compliance |

Digital / 406.125 MHz / High power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 249.4 | 61.13 | 4.13 | 57 | Compliance |
| 436.4 | 62.23 | 5.23 | 57 | Compliance |
| 810.4 | 62.94 | 5.94 | 57 | Compliance |

Digital / 435.000 MHz / High power

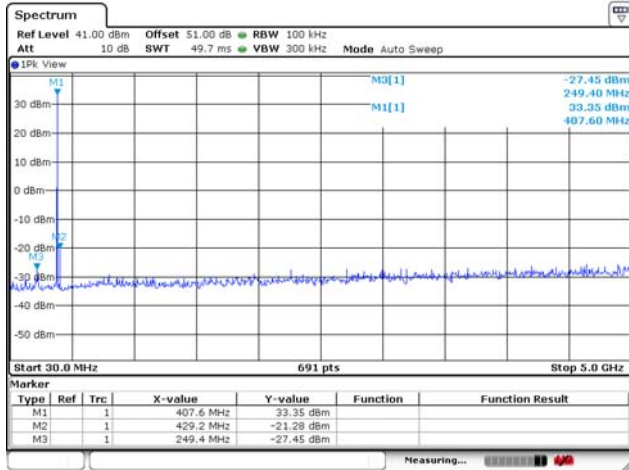
| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 867.9 | 64.84 | 7.84 | 57 | Compliance |

Digital / 469.975 MHz / High power

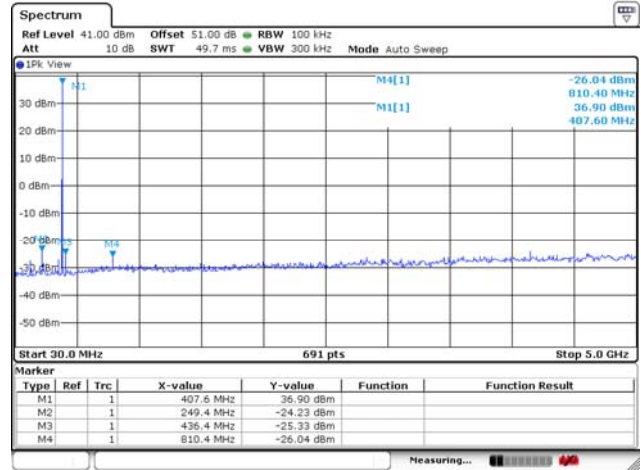
| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 429.2 | 58 | 1.00 | 57 | Compliance |
| 939.8 | 66.13 | 9.13 | 57 | Compliance |

■ Digital (Voice and Data)

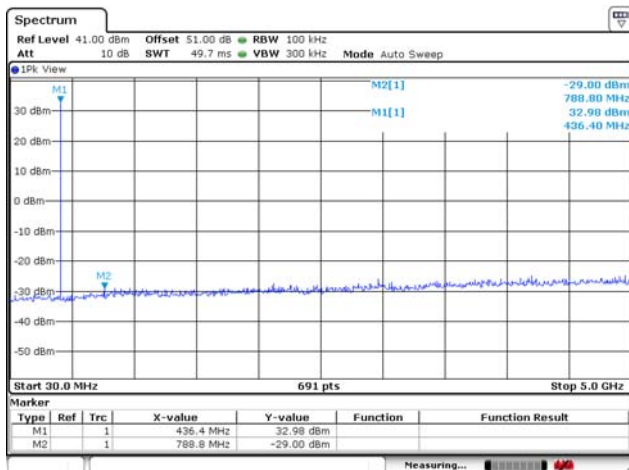
CH Low / Low power



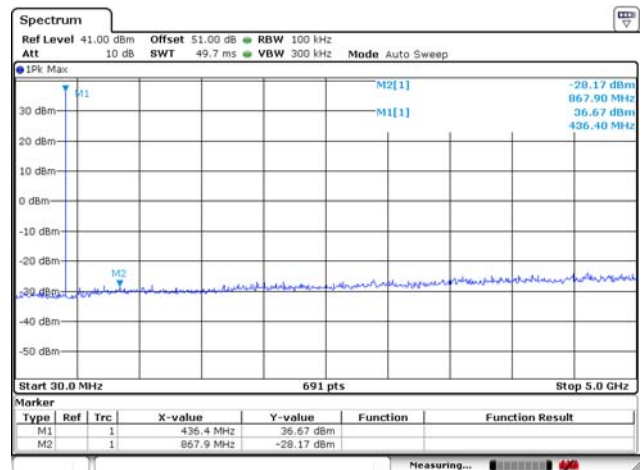
CH Low / High power



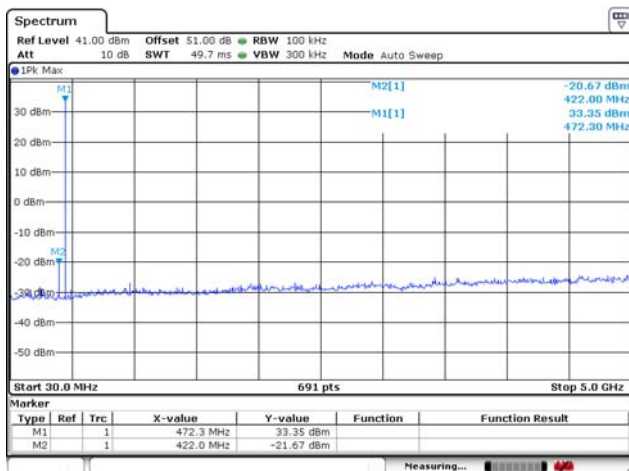
CH Middle / Low power



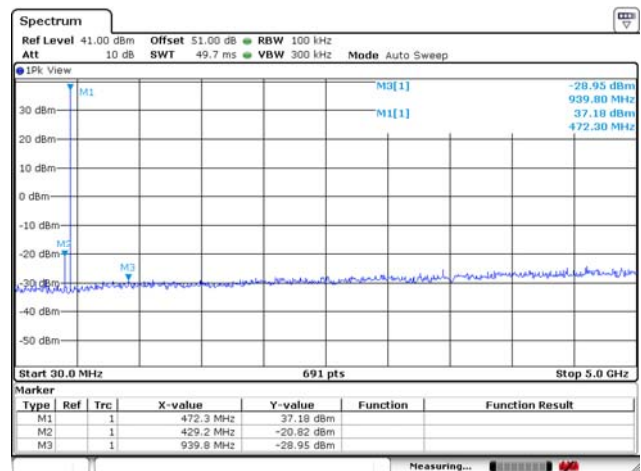
CH Middle / High power



CH High / Low power



CH High / High power



5.6 Transmitter Radiated Unwanted Emissions

5.6.1 Standard Applicable [FCC §90.210(d) & 2.1053]

The power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $[50 + 10 \log (P)]$ (e.i.r.p. -20 dBm)

5.6.2 Test Environment conditions

- Ambient temperature : (21 - 22) °C • Relative Humidity : (48 - 50) % R.H.

5.6.3 Measurement Procedure

The EUT was setup according to ANSI/TIA 603D:2010 for compliance to FCC 47CFR part 90 requirements.

As a below test procedure (①~⑬), The result value of measurement is performed to condition of the below; The EUT will operate in continuous transmission mode during the time necessary to perform the measured of the frequency. Substitution method was performed to determine the actual P_{erp} (or P_{eirp}) emission levels of the EUT.

The following test procedure as below;

The test is performed in a fully pyramidal chamber to determine the accurate frequencies, after maximum emissions level will be checked on a test chamber and measuring distance is 3 m from EUT to test antenna.

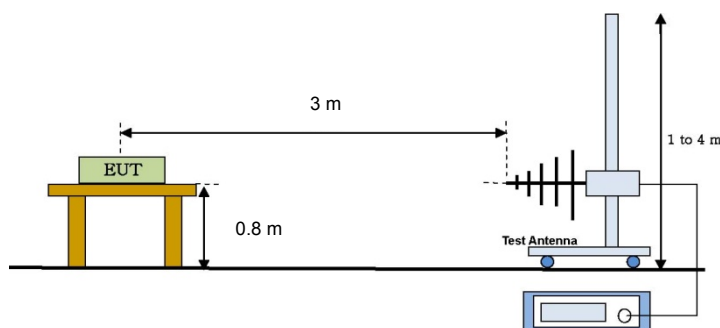
- ① The EUT was set on with continuous transmission mode and placed on a 0.8 meter high non-conductive table on the chamber.
- ② The test antenna is used on Bi-Log antenna at above 30 MHz, and used on Horn antenna at 1 GHz and then the measurements are repeated with the test antenna for vertical and horizontal polarization. The output of the test antenna will be connected to a measuring receiver, and it is set to tuned over the required standard measuring frequency range.
- ③ At each frequency at which a relevant spurious component is detected, the test antenna will be raised and lowered through the specified range of heights until an maximum signal level is detected on the measuring receiver.
- ④ The EUT is position x, y, z axis on rotating through 360 degrees in the horizontal plane, until the Max. signal level is detected by the measuring receiver.
- ⑤ The receiver is scanned from requested measuring frequency band and then the maximum meter reading is recorded. The radiated emissions were measured with requested standard specification (detector and resolution bandwidth etc.)
- ⑥ The EUT was then removed and replaced with substitution antenna .The center of the antenna was approximately at the same location as the center of the EUT, and calibrated for the frequency of the spurious component detected.
- ⑦ Signal generator output port connected with substitution antenna input port. If necessary, may use shield cable between signal generator and substitution antenna
- ⑧ The frequency of the calibrated signal generator is set to frequency of the spurious component detected, and the input attenuator setting of the measuring receiver was adjust in order to increase the sensitivity of the measuring receiver, if necessary
- ⑨ The test antenna was raised and lowered through the specified range of heights to ensure that maximum signal is received.
- ⑩ The input signal to the substitution antenna was be adjusted until an equal or a known related level to that

detected from the transmitter is obtained on the measuring receiver.

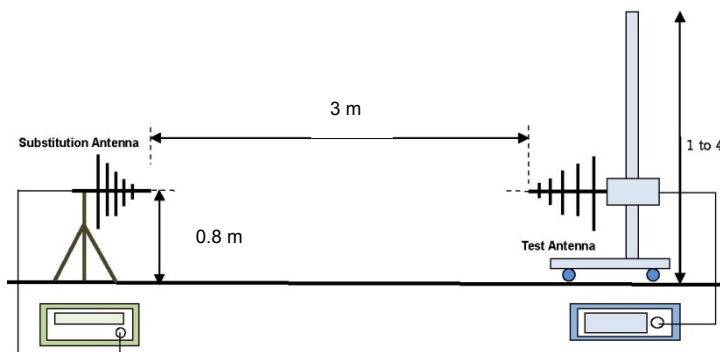
- ⑪ The input signal to the substitution antenna was be recorded as a power level and corrected for any change of input attenuator setting of the measuring receiver
 - ⑫ The measure of P_{erp} (or P_{eirp}) the spurious components is the larger of the two power levels recorded for each spurious component at the input to the substitution antenna, corrected for the gain of the substitution antenna, if necessary.
 - ⑬ It is correction to signal generator's offset value. In this case of P_{erp} (or P_{eirp}) shall calculated as follow as formula ;
- P_{erp} (or P_{eirp}) = Signal generator level (dBm) – Cable loss (dB)

The measurement frequency range from 30 MHz - 10th Harmonic of fundamental was investigated.

5.6.5 Test Setup



[Radiated measurement setup_Below than 1 GHz]



[Effective Radiated Power measurement setup]

※ Above the test antenna is used on Horn antenna at above 1 GHz.

Measurement Uncertainty

All measurements involve certain levels of uncertainties. The factors contributing to uncertainties are test receiver, Cable loss, Antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, Antenna frequency interpolation, measurement distance variation, Site imperfection, mismatch, and system repeatability based on NIS 80,81.

Radiated Emission measurement: Below 1 GHz: 3.66 dB (CL: Approx 95 %, k=2)
 Above 1 GHz: 4.04 dB (CL: Approx 95 %, k=2)

5.6.6 Measurement Result

The following frequencies were selected based on the antenna conducted results, the worst case for each mode are presented.

Analog / 406.125 MHz / Low power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 249.5 | 64.74 | 11.74 | 53 | Compliance |
| 429.2 | 56.32 | 3.32 | 53 | Compliance |
| 1 847 | 65.58 | 12.58 | 53 | Compliance |

Note: The formula for limit is below;
 $50 + 10 \log(P)$ where, P = EUT's output power in W
 Therefore $50 + 10 \log(2.16) = 53$

Digital / 469.975 MHz / High power

| Emission Frequency [MHz] | Level below Carrier [dBc] | Margin [dB] | Limit [dBc] | Test Results |
|--------------------------|---------------------------|-------------|-------------|--------------|
| 429.2 | 60.11 | 3.11 | 57 | Compliance |
| 939.8 | 69.13 | 12.13 | 57 | Compliance |
| 1 411 | 68.86 | 11.86 | 57 | Compliance |

Note: The formula for limit is below;
 $50 + 10 \log(P)$ where, P = EUT's output power in W
 Therefore $50 + 10 \log(5.22) = 57$

5.7 Frequency Stability

5.7.1 Standard Applicable [FCC §90.213 & 2.1055]

The EUT is placed in a temperature chamber, the EUT is allowed to soak at room temperature for 20 minutes and a reference frequency is read. The temperature is then lowered to -30 C and stepped up to 50 C soaking 20 minutes at each temperature then a frequency is read. According to §90.213, the frequency stability limit is 2.5 ppm for 12.5 kHz channel separation.

5.7.2 Test Environment conditions

- Ambient temperature : (21 - 22) °C • Relative Humidity : (48 - 50) % R.H.

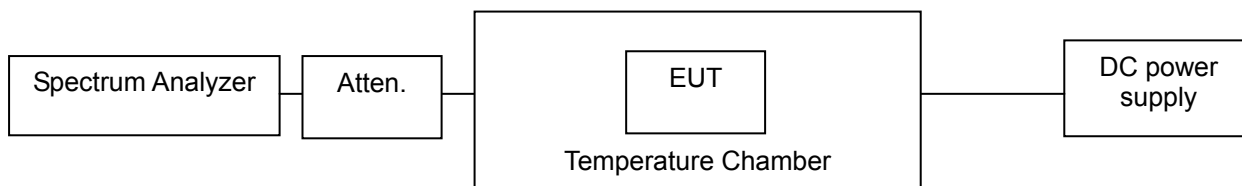
5.6.3 Measurement Procedure

EUT connect to Spectrum analyzer, test is performed in T&H chamber.

These measurements shall also be performed at normal and extreme test conditions.

- Test Method : ANSI/TIA-603-D-2010, clause 3.2.2 for frequency stability tests
 - Frequency stability with respect to ambient temperature
 - Frequency stability when varying supply voltage

5.7.4 Test setup



5.7.5 Measurement Result

Analog

| Temp(°C) | Power Supply | Measured Freq(MHz) | Freq Drift(ppm) |
|-----------------|---------------|--------------------|-----------------|
| 50 | DC 7.4 (Vnom) | 435.000161 | 0.37 |
| 40 | DC 7.4 (Vnom) | 435.000141 | 0.32 |
| 30 | DC 7.4 (Vnom) | 435.000138 | 0.32 |
| 20 | DC 7.4 (Vnom) | 435.000135 | 0.31 |
| 10 | DC 7.4 (Vnom) | 435.000088 | 0.20 |
| 0 | DC 7.4 (Vnom) | 435.000075 | 0.17 |
| -10 | DC 7.4 (Vnom) | 435.000051 | 0.12 |
| -20 | DC 7.4 (Vnom) | 435.000062 | 0.14 |
| -30 | DC 7.4 (Vnom) | 435.000053 | 0.12 |
| Nom Temperature | DC 6.3 (Vmin) | 435.000136 | 0.31 |
| Nom Temperature | DC 8.5 (Vmax) | 435.000139 | 0.32 |



Digital (Voice and Data)

| Temp(℃) | Power Supply | Measured Freq(MHz) | Freq Drift(ppm) |
|-----------------|---------------|--------------------|-----------------|
| 50 | DC 7.4 (Vnom) | 435.000272 | 0.63 |
| 40 | DC 7.4 (Vnom) | 435.000271 | 0.62 |
| 30 | DC 7.4 (Vnom) | 435.000266 | 0.61 |
| 20 | DC 7.4 (Vnom) | 435.000268 | 0.62 |
| 10 | DC 7.4 (Vnom) | 435.000211 | 0.49 |
| 0 | DC 7.4 (Vnom) | 435.000188 | 0.43 |
| -10 | DC 7.4 (Vnom) | 435.000174 | 0.40 |
| -20 | DC 7.4 (Vnom) | 435.000168 | 0.39 |
| -30 | DC 7.4 (Vnom) | 435.000180 | 0.41 |
| | | | |
| Nom Temperature | DC 6.3 (Vmin) | 435.000270 | 0.62 |
| Nom Temperature | DC 8.5 (Vmax) | 435.000269 | 0.62 |

5.8 Transmitter Frequency Behavior

5.8.1 Standard Applicable [FCC §90.214]

Transient frequencies must be within the maximum frequency difference limits during the time intervals indicated:

| Time Intervals | Maximum frequency difference | All equipment (421 to 512 MHz) |
|---|------------------------------|--------------------------------|
| Transient Frequency Behavior for Equipment Designed to operate on the 12.5 kHz Channels | | |
| t_1^4 | ± 12.5 kHz | 10 ms |
| t_2 | ± 6.25 kHz | 25 ms |
| t_3^4 | ± 12.5 kHz | 10 ms |

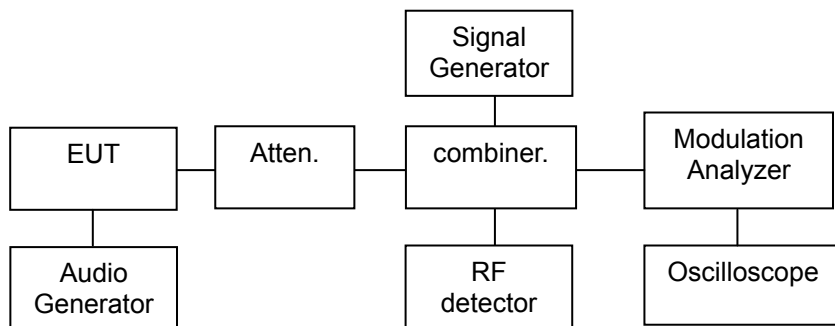
5.8.2 Test Environment conditions

- Ambient temperature : (21 - 22) °C • Relative Humidity : (48 - 50) % R.H.

5.8.3 Measurement Procedure

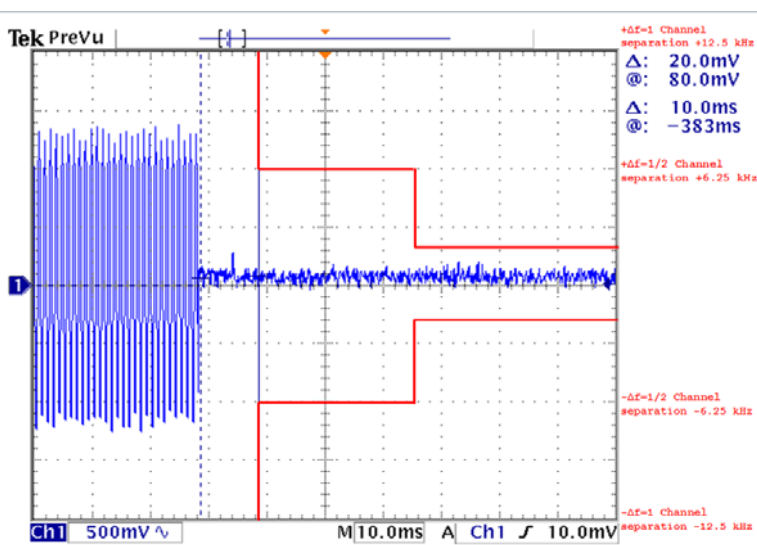
- Connect the EUT and test equipment as shown on the following test setup diagram.
- Set the Spectrum Analyzer to measure FM deviation, and tune the RF frequency to the transmitter assigned frequency.
- Set the signal generator to the assigned transmitter frequency and modulate it with a 1 kHz tone at ± 12.5 kHz deviation and set its output level to -100 dBm.
- Turn on the transmitter.
- Supply sufficient attenuation via the RF attenuator to provide an input level to the Spectrum Analyzer that is 40 dB below the maximum allowed input power when the transmitter is operating at its rated power level. Note this power level on the Spectrum Analyzer as P0.
- Turn off the transmitter.
- Adjust the RF level of the signal generator to provide RF power equal to P0. This signal generator RF level shall be maintained throughout the rest of the measurement.
- Remove the attenuation 1, so the input power to the Spectrum Analyzer is increased by 30 dB when the transmitter is turned on.
- Adjust the vertical amplitude control of the spectrum analyzer to display the 1000 Hz at ± 4 divisions vertically centered on the display. Set trigger mode of the Spectrum Analyzer to "Video", and tune the "trigger level" on suitable level. Then set the "trigger offset" to -10ms for turn on and -15 ms for turn off.
- Turn on the transmitter and the transient wave will be captured on the screen of Spectrum Analyzer. Observe the stored display. The instant when the 1 kHz test signal is completely suppressed is considered to be ton. The trace should be maintained within the allowed divisions during the period t_1 and t_2 .

5.8.4 Test setup



5.8.5 Measurement Result

OFF - ON



ON - OFF

