NVLAP TESTING
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BACL Bay Area Compliance Labs Corp.

# FCC PART 90

# TEST REPORT

For

# Hytera Communications Corporation Limited

Hytera Tower, Hi-Tech Industrial Park North, 9108# Beihuan Road, Nanshan District, Shenzhen, 518057
China

## FCC ID: YAMRD98XSIU5

| **Report Type:** | **Product Type:** |
|---|---|
| Original Report | Digital Repeater |

**Report Number:** RDG171207020-00A

**Report Date:** 2018-03-17

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**Note:** This report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP* or any agency of the Federal Government. * This report may contain data that are not covered by the NVLAP accreditation and are marked with an asterisk "*".

# TABLE OF CONTENTS

**GENERAL INFORMATION** ..... **3**
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) ..... 3
OBJECTIVE ..... 3
RELATED SUBMITTAL(S)/GRANT(S) ..... 3
TEST METHODOLOGY ..... 3
MEASUREMENT UNCERTAINTY ..... 4
TEST FACILITY ..... 4
**SYSTEM TEST CONFIGURATION** ..... **5**
DESCRIPTION OF TEST CONFIGURATION ..... 5
EUT EXERCISE SOFTWARE ..... 5
SPECIAL ACCESSORIES ..... 5
EQUIPMENT MODIFICATIONS ..... 5
SUPPORT EQUIPMENT LIST AND DETAILS ..... 5
EXTERNAL I/O CABLE ..... 5
BLOCK DIAGRAM OF TEST SETUP ..... 6
**SUMMARY OF TEST RESULTS** ..... **7**
**TEST EQUIPMENT LIST** ..... **8**
**FCC §1.1307 (b) (1) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)** ..... **9**
APPLICABLE STANDARD ..... 9
RESULT ..... 9
**FCC §2.1046 & §90.205 - RF OUTPUT POWER** ..... **10**
APPLICABLE STANDARD ..... 10
TEST PROCEDURE ..... 10
TEST DATA ..... 10
**FCC §2.1047 & §90.207 - MODULATION CHARACTERISTIC** ..... **12**
APPLICABLE STANDARD ..... 12
TEST PROCEDURE ..... 12
TEST DATA ..... 12
**FCC §2.1049 & §90.210 – OCCUPIED BANDWIDTH & EMISSION MASK** ..... **28**
APPLICABLE STANDARD ..... 28
TEST PROCEDURE ..... 28
TEST DATA ..... 29
**FCC §2.1051 & §90.210 - SPURIOUS EMISSIONS AT ANTENNA TERMINALS** ..... **47**
APPLICABLE STANDARD ..... 47
TEST PROCEDURE ..... 47
TEST DATA ..... 47
**FCC §2.1053 & §90.210 - RADIATED SPURIOUS EMISSIONS** ..... **56**
APPLICABLE STANDARD ..... 56
TEST PROCEDURE ..... 56
TEST DATA ..... 56
**FCC §2.1055 & §90.213 - FREQUENCY STABILITY** ..... **60**
APPLICABLE STANDARD ..... 60
TEST PROCEDURE ..... 60
TEST DATA ..... 60

# GENERAL INFORMATION

## Product Description for Equipment under Test (EUT)

The *Hytera Communications Corporation Limited's* product, model number: *RD982Si U(5)* *(FCC ID: YAMRD98XSIU5)* in this report is a *Digital Repeater*, which was measured approximately: 366 mm (L) x 483 mm (W) x 88 mm (H), rated input voltage: DC 13.6 V.

*Notes: This series products model: RD985Si U(5), RD986Si U(5), RD988Si U(5) and RD982Si U(5) are identical schematics, and only are different for model number. Model RD982Si U(5) was selected for fully testing, the detailed information can be referred to the declaration which was stated and guaranteed by the applicant.*

** All measurement and test data in this report was gathered from production sample serial number: 171207020 (Assigned by BACL, Shenzhen). The EUT supplied by the applicant was received on 2017-12-07.*

## Objective

This test report is prepared on behalf of *Hytera Communications Corporation Limited* in accordance with Part 2, and Part 90 of the Federal Communication Commissions rules.

## Related Submittal(s)/Grant(s)

No Related Submittal(s)/Grant(s).

## Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of federal Regulations Title 47 Part 2, Sub-part J as well as the following individual parts:

Part 90 – Private Land Mobile Radio Service

Applicable Standards: TIA 603-D.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

## Measurement Uncertainty

| Parameter | | uncertainty |
|---|---|---|
| Occupied Channel Bandwidth | | ±5% |
| RF output power, conducted | | ±1.5dB |
| Unwanted Emission, conducted | | ±1.5dB |
| Emissions, Radiated | Below 1GHz | ±4.75dB |
| | Above 1GHz | ±4.88dB |
| Temperature | | ±1℃ |
| Supply voltages | | ±0.4% |

## Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 382179, the FCC Designation No.: CN5001.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

# SYSTEM TEST CONFIGURATION

## Description of Test Configuration

The system was configured for testing in a test mode which has been done in the factory.

## EUT Exercise Software

No exercise software was used.

## Special Accessories

No special accessory was used.

## Equipment Modifications

No modification was made to the EUT tested.

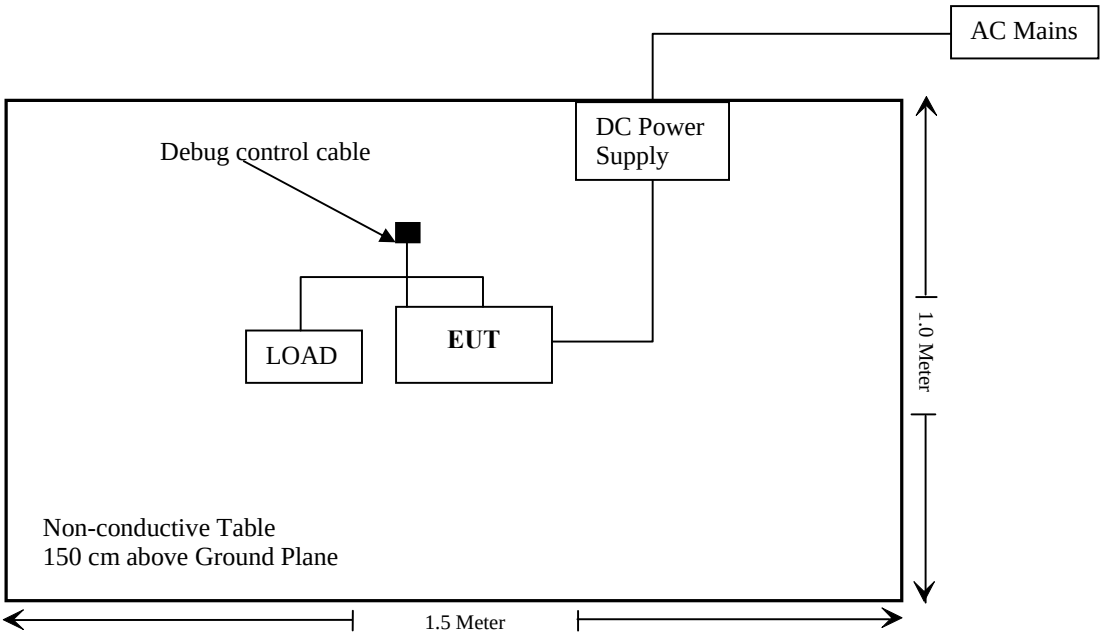
## Support Equipment List and Details

| Manufacturer | Description | Model | Serial Number |
|---|---|---|---|
| N/A | Load | 100W/50Ohm | N/A |
| TDK-Lambda | DC Power Supply | Z60-14-L-C | N/A |
| Hytera | Debug control cable | N/A | N/A |

## External I/O Cable

| Cable Description | Length (m) | From Port | To |
|---|---|---|---|
| Un-shileding Detachable DC Cable | 2.5 | EUT | DC Power Supply |
| Shielding RF Conducted Cable | 1.0 | EUT | Load |

## Block Diagram of Test Setup



# SUMMARY OF TEST RESULTS

| FCC Rules | Description of Test | Results |
|---|---|---|
| §1.1307(b), §2.1091 | Maximum Permissible exposure (MPE) | Compliance |
| §2.1046; §90.205 | RF Output Power | Compliance |
| §2.1047; §90.207 | Modulation Characteristic | Compliance |
| §2.1049; §90.210 | Occupied Bandwidth & Emission Mask | Compliance |
| §2.1051;§90.210 | Spurious Emission at Antenna Terminal | Compliance |
| §2.1053;§90.210 | Spurious Radiated Emissions | Compliance |
| §2.1055;§90.213 | Frequency Stability | Compliance |

# TEST EQUIPMENT LIST

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| **Radiated Emission Test** | | | | | |
| Sunol Sciences | Horn Antenna | DRH-118 | A052604 | 2017-12-28 | 2020-12-27 |
| Rohde & Schwarz | Signal Analyzer | FSIQ26 | 8386001028 | 2017-04-24 | 2018-04-24 |
| Sunol Sciences | Bi-log Antenna | JB1 | A040904-2 | 2017-12-17 | 2020-12-16 |
| Mini | Pre-amplifier | ZVA-183-S+ | 5969001149 | 2017-02-14 | 2018-02-14 |
| HP | Amplifier | HP8447E | 1937A01046 | 2017-11-19 | 2018-05-17 |
| Anritsu | Signal Generator | 68369B | 004114 | 2017-12-05 | 2018-12-05 |
| Rohde & Schwarz | EMI Test Receiver | ESCI | 101120 | 2017-12-07 | 2018-12-07 |
| COM POWER | Dipole Antenna | AD-100 | 041000 | NCR | NCR |
| A.H. System | Horn Antenna | SAS-200/571 | 135 | 2015-08-18 | 2018-08-17 |
| Ducommun technologies | RF Cable | UFA210A-1-4724-30050U | MFR64369 223410-001 | 2017-11-19 | 2018-05-17 |
| Ducommun technologies | RF Cable | 104PEA | 218124002 | 2017-11-19 | 2018-05-17 |
| Ducommun technologies | RF Cable | RG-214 | 1 | 2017-11-19 | 2018-05-17 |
| Ducommun technologies | RF Cable | RG-214 | 2 | 2017-11-22 | 2018-05-22 |
| **RF Conducted Test** | | | | | |
| Rohde & Schwarz | SPECTRUM ANALYZER | FSU26 | 200120 | 2017-12-05 | 2018-12-05 |
| Rohde & Schwarz | Signal Analyzer | FSIQ26 | 837405/023 | 2017-04-24 | 2018-04-24 |
| ESPEC | Temperature & Humidity Chamber | EL-10KA | 09107726 | 2017-11-22 | 2018-11-22 |
| Long Wei | DC Power Supply | TPR-6420D | 398363 | NCR | NCR |
| HP Agilent | RF Communication Test Set | HP8920 | 3325U00859 | 2017-05-07 | 2018-05-07 |
| Ducommun technologies | RF Cable | RG-214 | 3 | 2017-11-22 | 2018-05-22 |
| WEINSCHEL | 30dB Attenuator | 53-30-43 | PG633 | 2017-11-22 | 2018-05-22 |

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

# FCC §1.1307 (b) (1) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

## Applicable Standard

According to subpart 1.1307 (b)(1), 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

**Limits for Occupational/Controlled Exposure**

| Limits for occupational/Controlled Exposure | | | | |
|---|---|---|---|---|
| **Frequency Range (MHz)** | **Electric Field Strength (V/m)** | **Magnetic Field Strength (A/m)** | **Power Density ($mW/cm^2$)** | **Averaging Time (Minutes)** |
| 0.3-1.34 | 614 | 1.63 | *(100) | 6 |
| 1.34-30 | 1842/f | 4.89/f | *($900/f^2$) | 6 |
| 30-300 | 61.4 | 0.163 | 1.0 | 6 |
| 300-1500 | / | / | f/300 | 6 |
| 1500-100,000 | / | / | 5.0 | 6 |

f = frequency in MHz
* = Plane-wave equivalent power density

## Result

### Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. $mW/cm^2$)
P = power input to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For worst case:

| Frequency (MHz) | Antenna Gain | | Max average output power | Evaluation Distance (cm) | Power Density ($mW/cm^2$) | MPE Limit ($mW/cm^2$) |
|---|---|---|---|---|---|---|
| | (dBi) | (numeric) | (mW) | | | |
| 851-869 | 5.5 | 3.55 | 19905.5 | 45 | 2.78 | 2.83 |
| 935-940 | 5.5 | 3.55 | 19905.5 | 45 | 2.78 | 3.11 |

Note: Max tune-up output power is 46dBm (39811 mW), and PMR radio 4FSK mode, the duty cycle is 50%. So the average power is 19905.5 mW

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 45cm from nearby persons.

**Result: Compliance**

# FCC §2.1046 & §90.205 - RF OUTPUT POWER

## Applicable Standard

FCC §2.1046 and §90.205

## Test Procedure

Conducted RF Output Power:

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

Spectrum Analyzer Setting:

| R B/W | Video B/W |
|---|---|
| 100 kHz | 300 kHz |

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Rocky Kang on 2017-12-30.*

*Test Mode: Transmitting*

**Test Result:** Compliance. Please refer to following table.

| Modulation | Channel Separation (kHz) | Frequency (MHz) | Power Level | Output Power (dBm) | Output Power (W) |
|---|---|---|---|---|---|
| Analog | 12.5 | 851.0125 | High | 45.73 | 37.41 |
| | | | Low | 37.31 | 5.38 |
| | 12.5 | 868.9875 | High | 45.86 | 38.55 |
| | | | Low | 37.36 | 5.45 |
| | 12.5 | 935.0125 | High | 45.18 | 32.96 |
| | | | Low | 37.52 | 5.65 |
| | 12.5 | 939.9875 | High | 45.14 | 32.66 |
| | | | Low | 37.41 | 5.51 |

| Modulation | Channel Separation (kHz) | Frequency (MHz) | Power Level | Output Power (dBm) | Output Power (W) |
|---|---|---|---|---|---|
| Analog | 25 | 851.0125 | High | 45.70 | 37.15 |
| | | | Low | 37.35 | 5.43 |
| | 25 | 868.9875 | High | 45.83 | 38.28 |
| | | | Low | 37.29 | 5.36 |

| Modulation | Channel Separation (kHz) | Frequency (MHz) | Power Level | Output Power (dBm) | Output Power (W) |
|---|---|---|---|---|---|
| Digital | 12.5 | 851.0125 | High | 45.68 | 36.98 |
| | | | Low | 37.34 | 5.42 |
| | 12.5 | 868.9875 | High | 45.86 | 38.55 |
| | | | Low | 37.29 | 5.36 |
| | 12.5 | 935.0125 | High | 45.21 | 33.19 |
| | | | Low | 37.45 | 5.56 |
| | 12.5 | 939.9875 | High | 45.16 | 32.81 |
| | | | Low | 37.54 | 5.68 |

Note: The rated high power is 35W. The limit of the high output power is 28W-42W.
The rated low power is 5W. The limit of the low output power is 4W-6W.

# FCC §2.1047 & §90.207 - MODULATION CHARACTERISTIC

## Applicable Standard

FCC§2.1047 and §90.207:

(a) Equipment which utilizes voice modulated communication shall show the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz. for equipment which is required to have a low pass filter, the frequency response of the filter, or all of the circuitry installed between the modulation limited and the modulated stage shall be supplied.
(b) Equipment which employs modulation limiting, a curve showing the percentage of modulation versus the modulation input voltage shall be supplied.

## Test Procedure

Test Method: TIA/EIA-603-D

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Rocky Kang on 2017-12-30.*

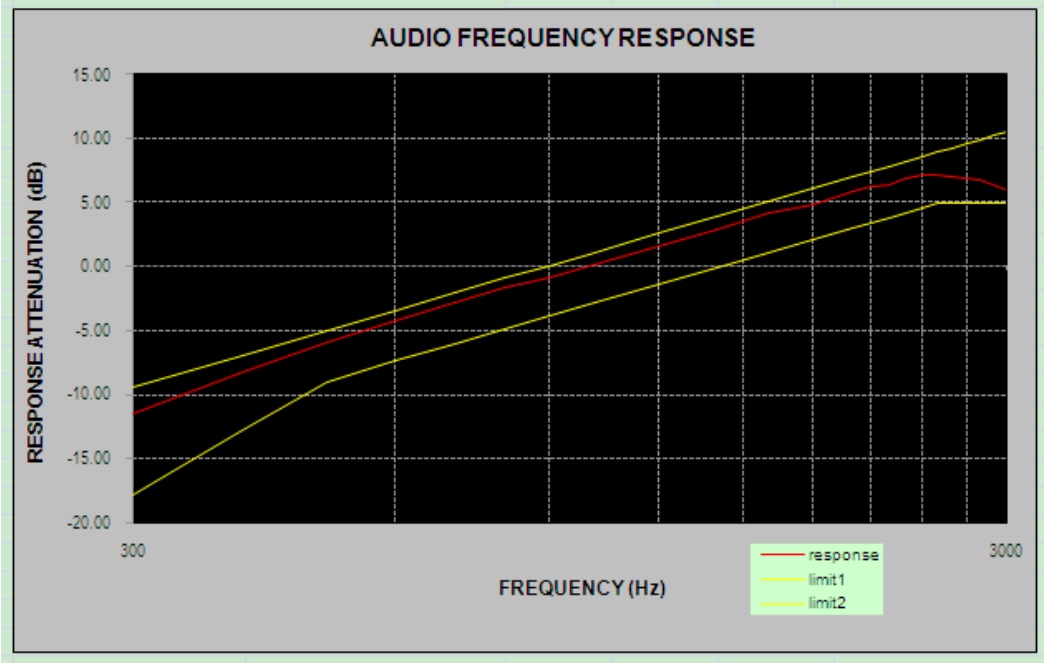
*Test Mode: Transmitting*

Please refer to the following tables and plots.

**Audio Frequency Response**

Carrier Frequency: 851.0125 MHz, Channel spacing=12.5 kHz

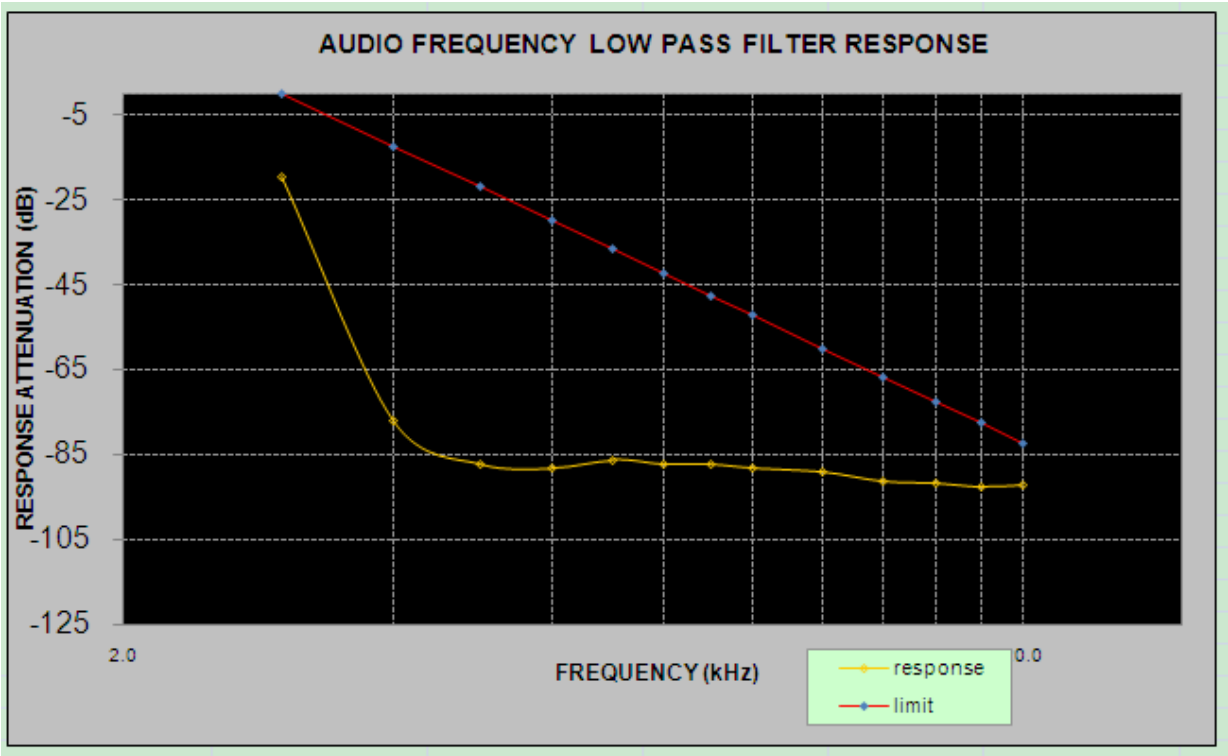
| Audio Frequency (Hz) | Response Attenuation (dB) |
|---|---|
| 300 | -11.57 |
| 400 | -8.31 |
| 500 | -5.99 |
| 600 | -4.29 |
| 700 | -2.83 |
| 800 | -1.68 |
| 900 | -0.88 |
| 1000 | 0 |
| 1200 | 1.60 |
| 1400 | 2.90 |
| 1600 | 4.15 |
| 1800 | 4.83 |
| 2000 | 5.80 |
| 2100 | 6.20 |
| 2200 | 6.43 |
| 2300 | 6.86 |
| 2400 | 7.17 |
| 2500 | 7.22 |
| 2600 | 7.01 |
| 2700 | 6.95 |
| 2800 | 6.73 |
| 2900 | 6.40 |
| 3000 | 6.00 |


AUDIO FREQUENCY RESPONSE
RESPONSE ATTENUATION (dB)
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
300
3000
FREQUENCY (Hz)
response
limit1
limit2

**Audio frequency lows pass filter response**

Carrier Frequency: 851.0125 MHz, Channel spacing=12.5 kHz

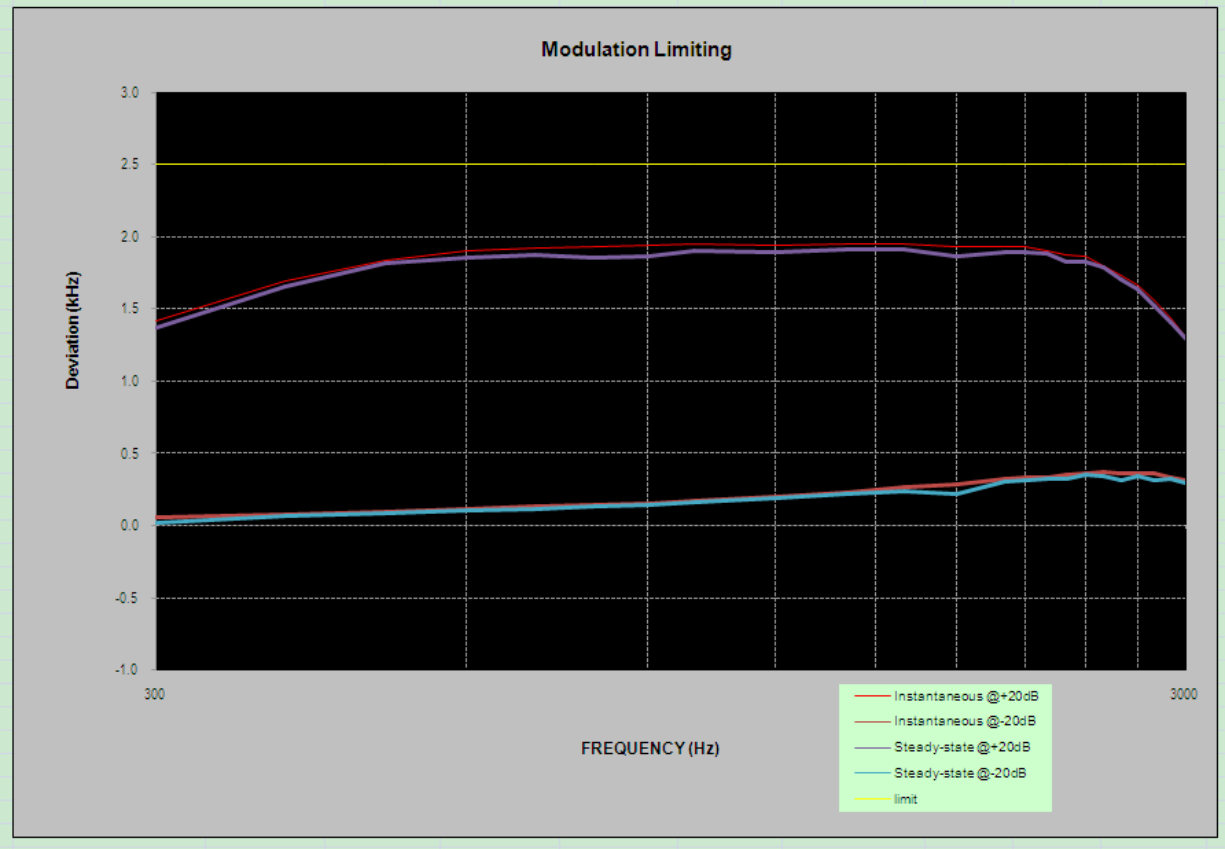
| Audio Frequency (kHz) | Response Attenuation (dB) | Limit (dB) |
|---|---|---|
| 1.0 | 0 | / |
| 3.0 | -19.6 | 0 |
| 4.0 | -77.3 | -12.5 |
| 5.0 | -87.2 | -22.2 |
| 6.0 | -88.2 | -30.1 |
| 7.0 | -86.4 | -36.8 |
| 8.0 | -87.4 | -42.6 |
| 9.0 | -87.5 | -47.7 |
| 10.0 | -88.3 | -52.3 |
| 12.0 | -89.4 | -60.2 |
| 14.0 | -91.4 | -66.9 |
| 16.0 | -91.8 | -72.7 |
| 18.0 | -92.6 | -77.8 |
| 20.0 | -92.3 | -82.5 |



## MODULATION LIMITING

Carrier Frequency: 851.0125 MHz, Channel spacing=12.5 kHz

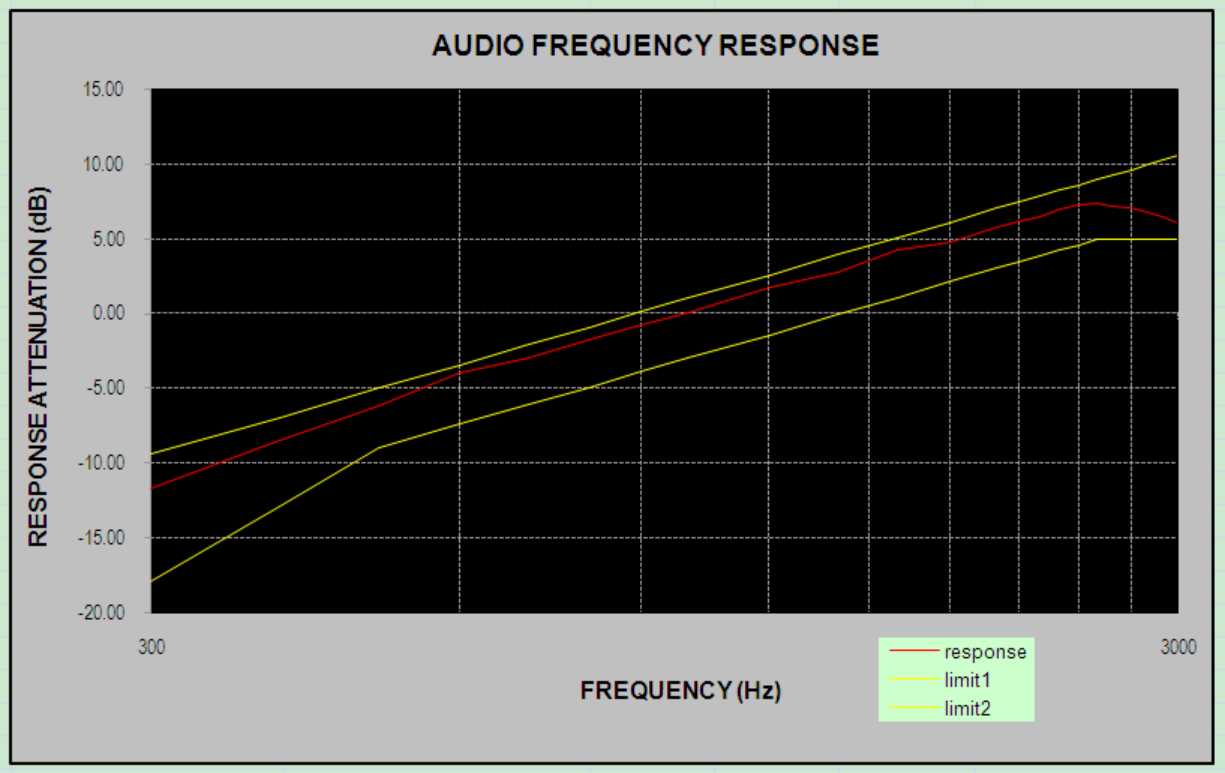
| Audio Frequency (Hz) | Instantaneous | | Steady-state | | FCC Limit [kHz] |
|---|---|---|---|---|---|
| | DEVIATION (@+20dB) [kHz] | DEVIATION (@-20dB) [kHz] | DEVIATION (@+20dB) [kHz] | DEVIATION (@-20dB) [kHz] | |
| 300 | 1.416 | 0.058 | 1.369 | 0.021 | 2.500 |
| 400 | 1.695 | 0.078 | 1.653 | 0.068 | 2.500 |
| 500 | 1.836 | 0.098 | 1.821 | 0.086 | 2.500 |
| 600 | 1.902 | 0.113 | 1.856 | 0.102 | 2.500 |
| 700 | 1.921 | 0.133 | 1.879 | 0.112 | 2.500 |
| 800 | 1.935 | 0.143 | 1.856 | 0.135 | 2.500 |
| 900 | 1.945 | 0.156 | 1.869 | 0.142 | 2.500 |
| 1000 | 1.950 | 0.171 | 1.902 | 0.163 | 2.500 |
| 1200 | 1.938 | 0.198 | 1.893 | 0.187 | 2.500 |
| 1400 | 1.948 | 0.233 | 1.912 | 0.215 | 2.500 |
| 1600 | 1.952 | 0.269 | 1.914 | 0.239 | 2.500 |
| 1800 | 1.936 | 0.284 | 1.868 | 0.218 | 2.500 |
| 2000 | 1.936 | 0.321 | 1.898 | 0.301 | 2.500 |
| 2100 | 1.936 | 0.332 | 1.897 | 0.312 | 2.500 |
| 2200 | 1.902 | 0.336 | 1.882 | 0.321 | 2.500 |
| 2300 | 1.879 | 0.354 | 1.825 | 0.324 | 2.500 |
| 2400 | 1.862 | 0.363 | 1.831 | 0.352 | 2.500 |
| 2500 | 1.801 | 0.368 | 1.785 | 0.347 | 2.500 |
| 2600 | 1.733 | 0.366 | 1.702 | 0.316 | 2.500 |
| 2700 | 1.665 | 0.357 | 1.635 | 0.347 | 2.500 |
| 2800 | 1.562 | 0.358 | 1.526 | 0.312 | 2.500 |
| 2900 | 1.437 | 0.336 | 1.411 | 0.321 | 2.500 |
| 3000 | 1.303 | 0.313 | 1.296 | 0.296 | 2.500 |


Modulation Limiting
Deviation (kHz)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
300
3000
FREQUENCY (Hz)
Instantaneous @+20dB
Instantaneous @-20dB
Steady-state @+20dB
Steady-state @-20dB
limit

**Audio Frequency Response**

Carrier Frequency: 935.0125 MHz, Channel spacing=12.5 kHz

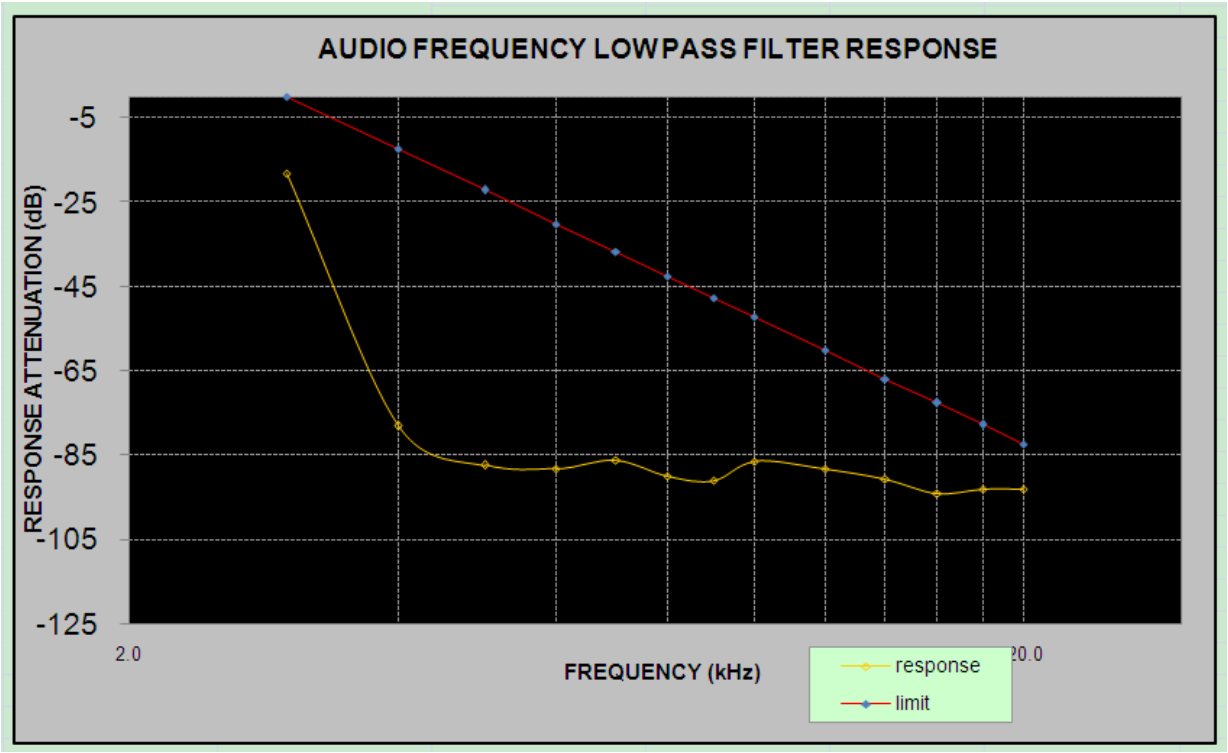
| Audio Frequency (Hz) | Response Attenuation (dB) |
|---|---|
| 300 | -11.63 |
| 400 | -8.45 |
| 500 | -6.16 |
| 600 | -4.01 |
| 700 | -2.95 |
| 800 | -1.77 |
| 900 | -0.78 |
| 1000 | 0 |
| 1200 | 1.76 |
| 1400 | 2.76 |
| 1600 | 4.21 |
| 1800 | 4.76 |
| 2000 | 5.78 |
| 2100 | 6.16 |
| 2200 | 6.46 |
| 2300 | 6.90 |
| 2400 | 7.22 |
| 2500 | 7.34 |
| 2600 | 7.11 |
| 2700 | 7.09 |
| 2800 | 6.79 |
| 2900 | 6.41 |
| 3000 | 6.05 |


AUDIO FREQUENCY RESPONSE
RESPONSE ATTENUATION (dB)
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
300
3000
FREQUENCY (Hz)
response
limit1
limit2

**Audio frequency lows pass filter response**

Carrier Frequency: 935.0125 MHz, Channel spacing=12.5 kHz

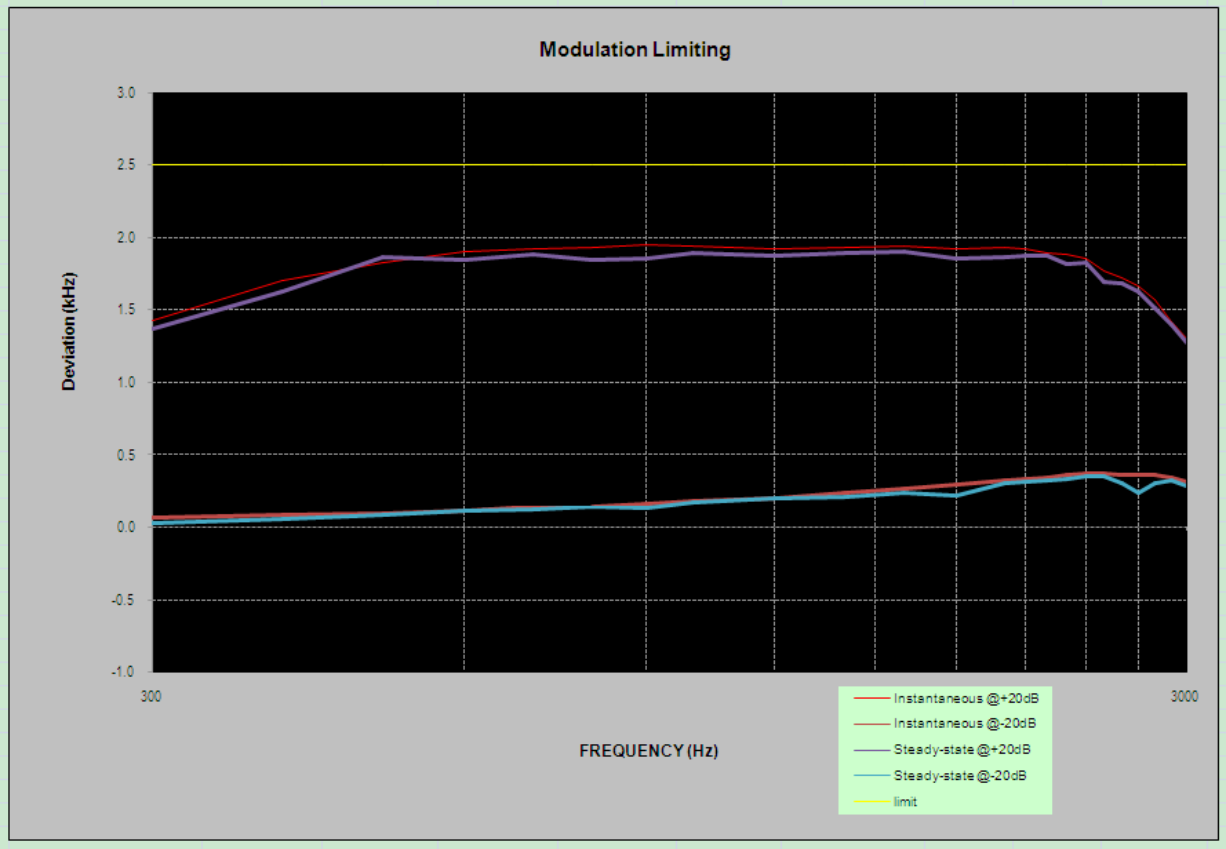
| Audio Frequency (kHz) | Response Attenuation (dB) | Limit (dB) |
|---|---|---|
| 1.0 | 0 | / |
| 3.0 | -18.1 | 0 |
| 4.0 | -78.2 | -12.5 |
| 5.0 | -87.5 | -22.2 |
| 6.0 | -88.3 | -30.1 |
| 7.0 | -86.2 | -36.8 |
| 8.0 | -90.1 | -42.6 |
| 9.0 | -91.2 | -47.7 |
| 10.0 | -86.5 | -52.3 |
| 12.0 | -88.4 | -60.2 |
| 14.0 | -90.7 | -66.9 |
| 16.0 | -94.2 | -72.7 |
| 18.0 | -93.1 | -77.8 |
| 20.0 | -93.1 | -82.5 |



## MODULATION LIMITING

Carrier Frequency: 935.0125 MHz, Channel spacing=12.5 kHz

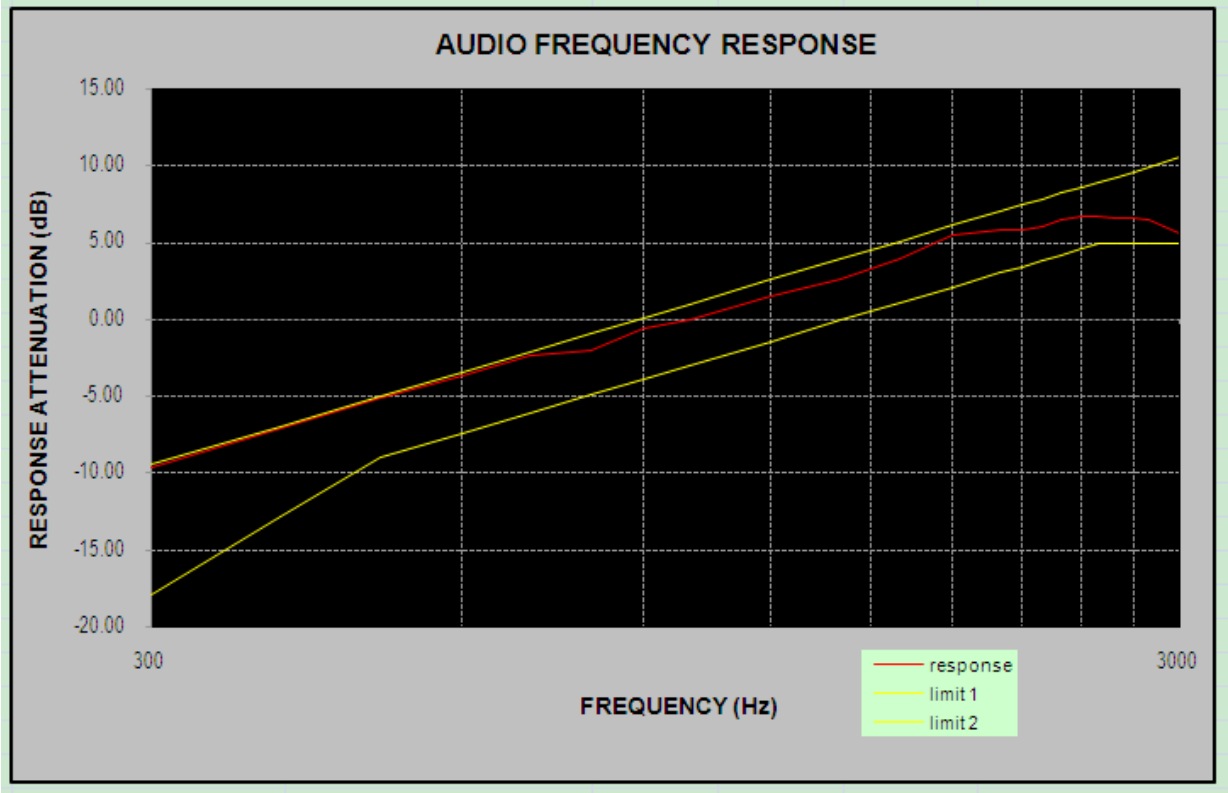
| Audio Frequency (Hz) | Instantaneous | | Steady-state | | FCC Limit [kHz] |
|---|---|---|---|---|---|
| | DEVIATION (@+20dB) [kHz] | DEVIATION (@-20dB) [kHz] | DEVIATION (@+20dB) [kHz] | DEVIATION (@-20dB) [kHz] | |
| 300 | 1.425 | 0.063 | 1.371 | 0.031 | 2.500 |
| 400 | 1.701 | 0.085 | 1.628 | 0.059 | 2.500 |
| 500 | 1.824 | 0.096 | 1.869 | 0.086 | 2.500 |
| 600 | 1.901 | 0.118 | 1.845 | 0.112 | 2.500 |
| 700 | 1.918 | 0.139 | 1.881 | 0.124 | 2.500 |
| 800 | 1.929 | 0.144 | 1.842 | 0.139 | 2.500 |
| 900 | 1.951 | 0.158 | 1.859 | 0.137 | 2.500 |
| 1000 | 1.946 | 0.178 | 1.897 | 0.172 | 2.500 |
| 1200 | 1.925 | 0.201 | 1.876 | 0.198 | 2.500 |
| 1400 | 1.935 | 0.234 | 1.893 | 0.208 | 2.500 |
| 1600 | 1.946 | 0.271 | 1.902 | 0.236 | 2.500 |
| 1800 | 1.926 | 0.291 | 1.852 | 0.215 | 2.500 |
| 2000 | 1.934 | 0.328 | 1.862 | 0.305 | 2.500 |
| 2100 | 1.925 | 0.336 | 1.875 | 0.315 | 2.500 |
| 2200 | 1.896 | 0.342 | 1.879 | 0.326 | 2.500 |
| 2300 | 1.887 | 0.362 | 1.815 | 0.332 | 2.500 |
| 2400 | 1.852 | 0.368 | 1.824 | 0.349 | 2.500 |
| 2500 | 1.768 | 0.371 | 1.693 | 0.348 | 2.500 |
| 2600 | 1.721 | 0.359 | 1.689 | 0.301 | 2.500 |
| 2700 | 1.668 | 0.358 | 1.629 | 0.239 | 2.500 |
| 2800 | 1.568 | 0.362 | 1.512 | 0.308 | 2.500 |
| 2900 | 1.421 | 0.342 | 1.396 | 0.321 | 2.500 |
| 3000 | 1.308 | 0.316 | 1.278 | 0.287 | 2.500 |


Modulation Limiting
Deviation (kHz)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
300
3000
FREQUENCY (Hz)
Instantaneous @+20dB
Instantaneous @-20dB
Steady-state @+20dB
Steady-state @-20dB
limit

**Audio Frequency Response**

Carrier Frequency: 851.0125 MHz, Channel spacing=25 kHz

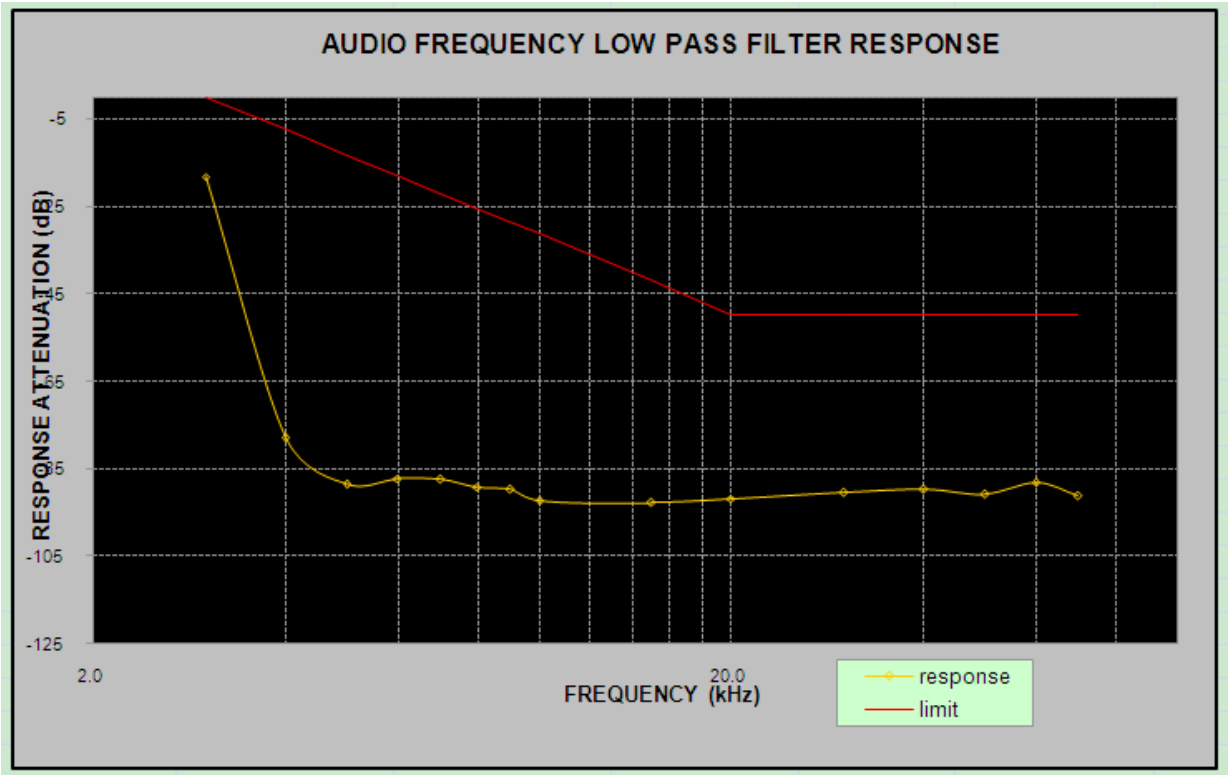
| Audio Frequency (Hz) | Response Attenuation (dB) |
|---|---|
| 300 | -9.68 |
| 400 | -7.11 |
| 500 | -5.07 |
| 600 | -3.70 |
| 700 | -2.35 |
| 800 | -2.07 |
| 900 | -0.61 |
| 1000 | 0 |
| 1200 | 1.54 |
| 1400 | 2.64 |
| 1600 | 3.94 |
| 1800 | 5.43 |
| 2000 | 5.78 |
| 2100 | 5.82 |
| 2200 | 5.99 |
| 2300 | 6.48 |
| 2400 | 6.70 |
| 2500 | 6.71 |
| 2600 | 6.62 |
| 2700 | 6.58 |
| 2800 | 6.46 |
| 2900 | 5.99 |
| 3000 | 5.58 |


AUDIO FREQUENCY RESPONSE
RESPONSE ATTENUATION (dB)
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
300
3000
FREQUENCY (Hz)
response
limit 1
limit 2

**Audio frequency lows pass filter response**

Carrier Frequency: 851.0125 MHz, Channel spacing=25 kHz

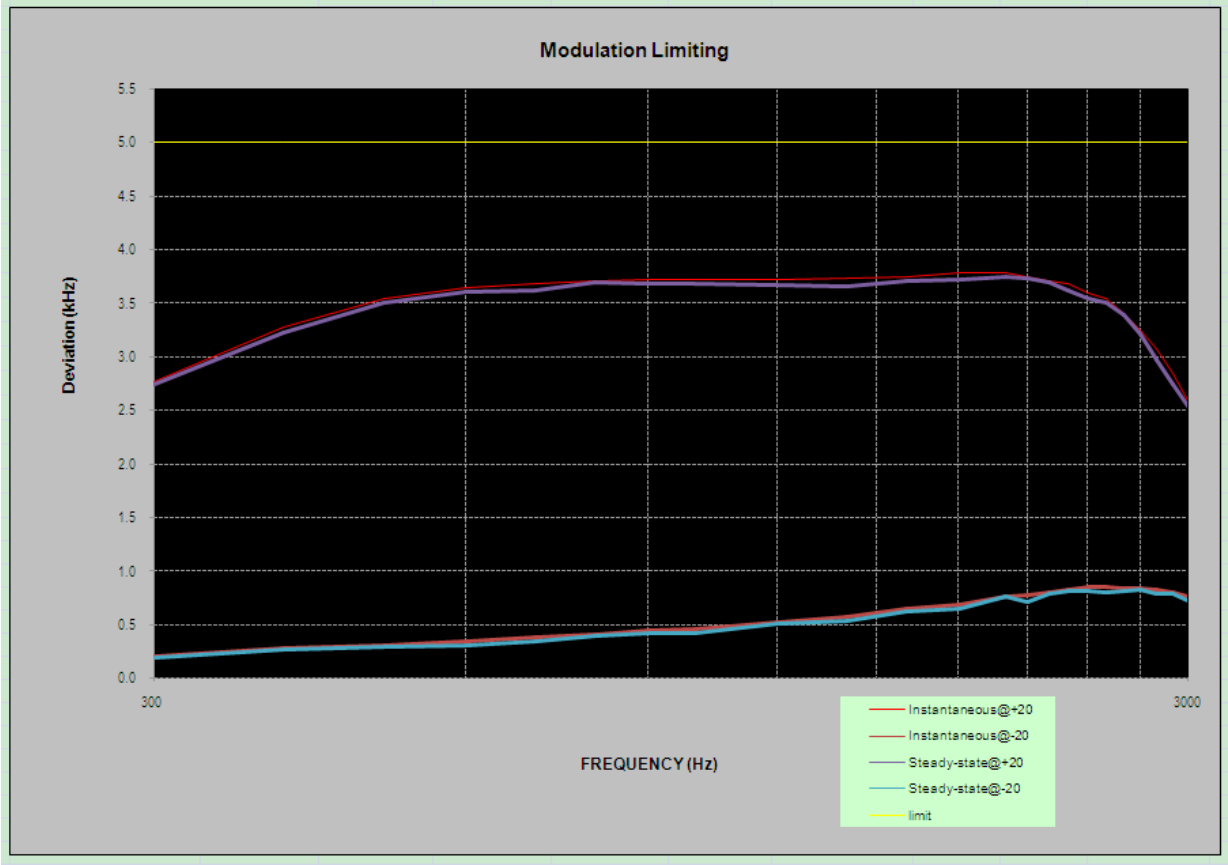
| Audio Frequency (kHz) | Response Attenuation (dB) | Limit (dB) |
|---|---|---|
| 1.0 | 0 | / |
| 3.0 | -18.2 | 0 |
| 4.0 | -77.9 | -7.5 |
| 5.0 | -88.6 | -13.3 |
| 6.0 | -87.3 | -18.1 |
| 7.0 | -87.5 | -22.1 |
| 8.0 | -89.1 | -25.6 |
| 9.0 | -89.7 | -28.6 |
| 10.0 | -92.4 | -31.4 |
| 15.0 | -92.8 | -41.9 |
| 20.0 | -91.9 | -50.0 |
| 30.0 | -90.5 | -50.0 |
| 40.0 | -89.7 | -50.0 |
| 50.0 | -90.8 | -50.0 |



## MODULATION LIMITING

Carrier Frequency: 851.0125 MHz, Channel spacing=25 kHz

| Audio Frequency (Hz) | Instantaneous | | Steady-state | | FCC Limit [kHz] |
|---|---|---|---|---|---|
| | DEVIATION (@+20dB) [kHz] | DEVIATION (@-20dB) [kHz] | DEVIATION (@+20dB) [kHz] | DEVIATION (@-20dB) [kHz] | |
| 300 | 2.768 | 0.214 | 2.745 | 0.199 | 5.000 |
| 400 | 3.275 | 0.283 | 3.221 | 0.272 | 5.000 |
| 500 | 3.547 | 0.312 | 3.502 | 0.293 | 5.000 |
| 600 | 3.642 | 0.351 | 3.612 | 0.313 | 5.000 |
| 700 | 3.684 | 0.381 | 3.621 | 0.351 | 5.000 |
| 800 | 3.715 | 0.411 | 3.693 | 0.396 | 5.000 |
| 900 | 3.717 | 0.443 | 3.689 | 0.422 | 5.000 |
| 1000 | 3.721 | 0.458 | 3.689 | 0.421 | 5.000 |
| 1200 | 3.728 | 0.527 | 3.675 | 0.517 | 5.000 |
| 1400 | 3.739 | 0.573 | 3.658 | 0.537 | 5.000 |
| 1600 | 3.751 | 0.654 | 3.712 | 0.624 | 5.000 |
| 1800 | 3.781 | 0.689 | 3.724 | 0.658 | 5.000 |
| 2000 | 3.779 | 0.762 | 3.752 | 0.762 | 5.000 |
| 2100 | 3.753 | 0.782 | 3.731 | 0.714 | 5.000 |
| 2200 | 3.712 | 0.805 | 3.699 | 0.795 | 5.000 |
| 2300 | 3.687 | 0.832 | 3.625 | 0.821 | 5.000 |
| 2400 | 3.591 | 0.858 | 3.547 | 0.813 | 5.000 |
| 2500 | 3.541 | 0.853 | 3.512 | 0.808 | 5.000 |
| 2600 | 3.401 | 0.848 | 3.396 | 0.816 | 5.000 |
| 2700 | 3.258 | 0.846 | 3.210 | 0.825 | 5.000 |
| 2800 | 3.078 | 0.825 | 2.968 | 0.786 | 5.000 |
| 2900 | 2.845 | 0.802 | 2.745 | 0.793 | 5.000 |
| 3000 | 2.594 | 0.762 | 2.538 | 0.724 | 5.000 |


Modulation Limiting
Deviation (kHz)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
300
3000
FREQUENCY (Hz)
Instantaneous@+20
Instantaneous@-20
Steady-state@+20
Steady-state@-20
limit

# FCC §2.1049 & §90.210 – OCCUPIED BANDWIDTH & EMISSION MASK

## Applicable Standard

FCC §2.1049 and §90.210

Emission Mask B - 25 kHz channel bandwidth equipment. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) 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.

(2) 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.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

Emission Mask I. For transmitters that are equipped with an audio low pass filter, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 6.8 kHz, but no more than 9.0 kHz: At least 25 dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 9.0 kHz, but no more than 15 kHz: At least 35 dB;

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 15 kHz: At least 43 + 10 log (P) dB, or 70 dB, whichever is the lesser attenuation.

## Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set at 100 Hz and the spectrum was recorded in the frequency band ±50 kHz from the carrier frequency.

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 22-25 ℃ |
| **Relative Humidity:** | 54-62 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Rocky Kang on 2017-12-30 and 2018-03-17.*

*Test mode: transimitting*

| Modulation | Channel Separation (kHz) | Frequency (MHz) | Power Level | 99% Occupied Bandwidth (kHz) | 26 dB Emissions Bandwidth (kHz) |
|---|---|---|---|---|---|
| Analog | 12.5 | 851.0125 | High | 9.856 | 10.176 |
| | | | Low | 9.776 | 10.176 |
| | 12.5 | 868.9875 | High | 5.288 | 10.176 |
| | | | Low | 5.288 | 10.176 |
| | 12.5 | 935.0125 | High | 9.936 | 10.176 |
| | | | Low | 9.856 | 10.176 |
| Digital | 12.5 | 851.0125 | High | 7.372 | 8.974 |
| | | | Low | 7.853 | 9.696 |
| | 12.5 | 868.9875 | High | 7.853 | 9.375 |
| | | | Low | 7.612 | 9.455 |
| | 12.5 | 935.0125 | High | 7.692 | 10.417 |
| | | | Low | 8.093 | 9.776 |

*Note: Emission bandwidth was based on calculation method instead of measurement.*

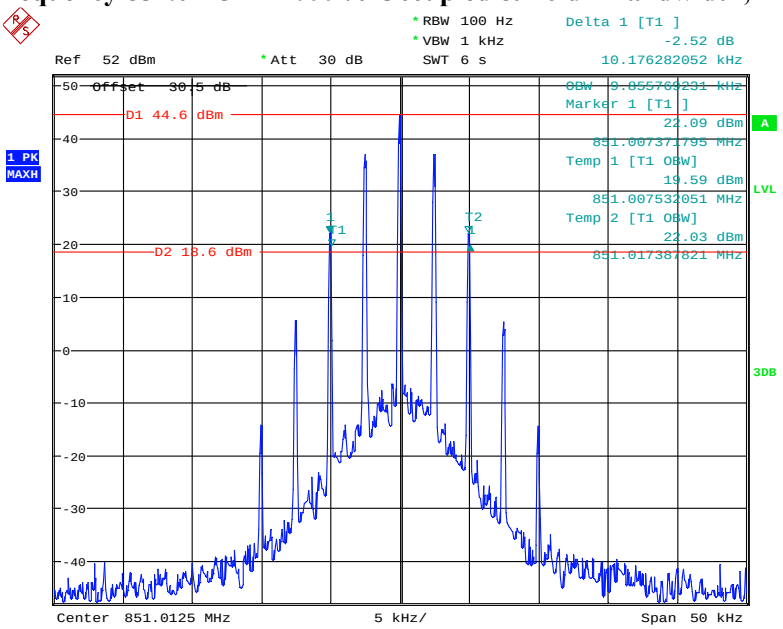
Emission Designator Per CFR 47 §2.201& §2.202&, Bn = 2M + 2D

**For FM Mode (Channel Spacing: 12.5 kHz)**
Emission Designator 11K0F3E In this case, the maximum modulating frequency is 3.0 kHz with a 2.5 kHz deviation. BW = 2(M+D) = 2*(3.0 kHz + 2.5 kHz) = 11 kHz → 11K0
F3E portion of the designator represents an FM voice transmission Therefore, the entire designator for 12.5 kHz channel spacing FM mode is 11K0F3E.

For Digital Mode (Channel Spacing: 12.5 kHz)
Emission Designator 7K60F1D and 7K60F1E
The 99% energy rule (title 47CFR 2.1049) was used for digital mode. It basically states that 99% of the modulation energy falls within X kHz, in this case, 7.60 kHz. The emission mask was obtained from 47CFR 90.210(d).
F1D and F1E portion of the designator indicates digital information.
Therefore, the entire designator for 12.5 kHz channel spacing digital mode is 7K60F1D and 7K60F1E.

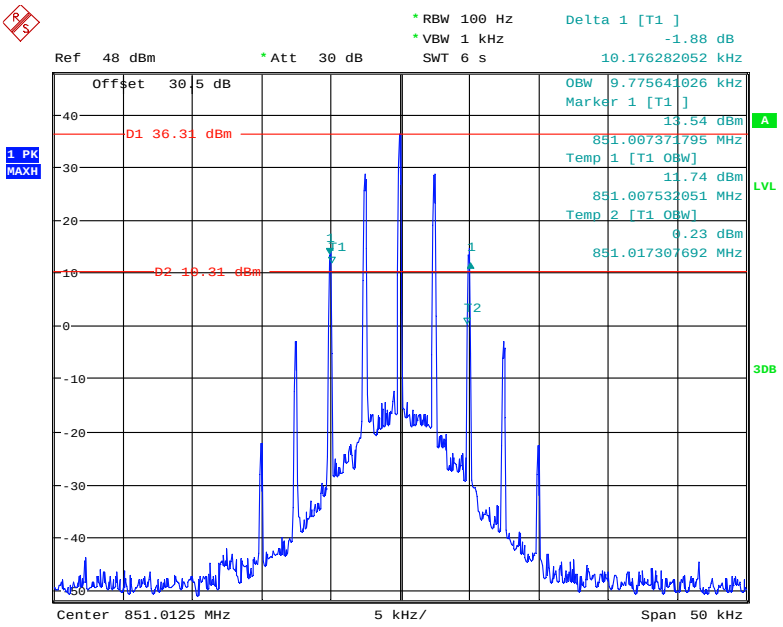
**Analog Modulation:**

**Frequency 851.0125 MHz: 99% Occupied & 26 dB Bandwidth, High Power**



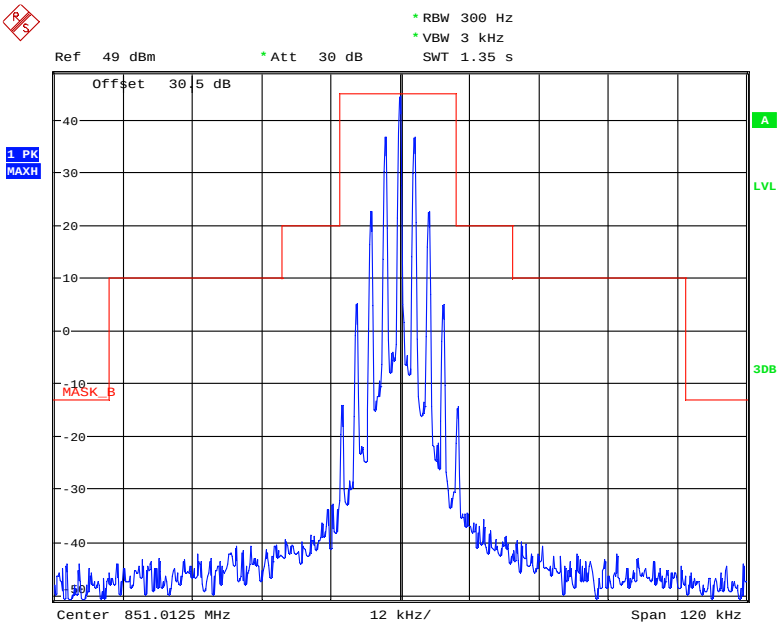

Date: 30.DEC.2017 10:58:54

**Frequency 851.0125 MHz: 99% Occupied & 26 dB Bandwidth, Low Power**



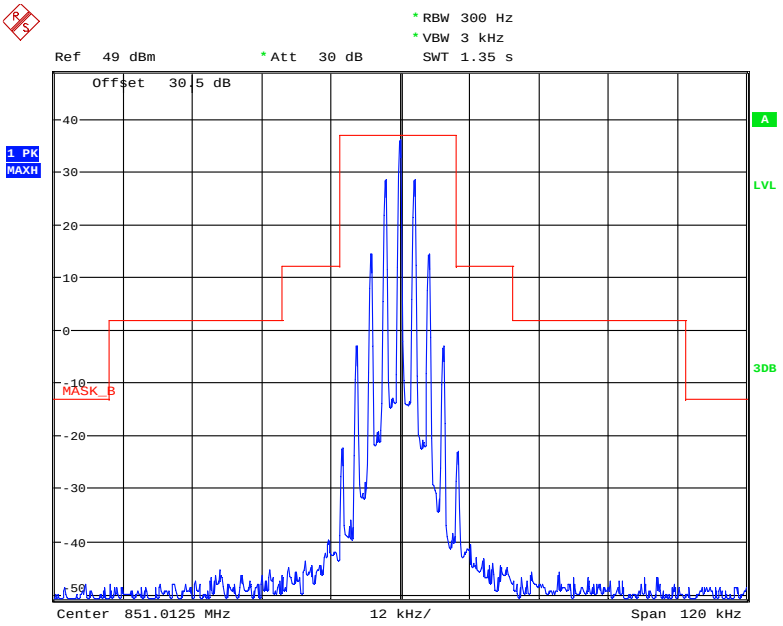

Date: 30.DEC.2017 10:53:43

## Frequency 851.0125 MHz: Emission Mask B, High Power



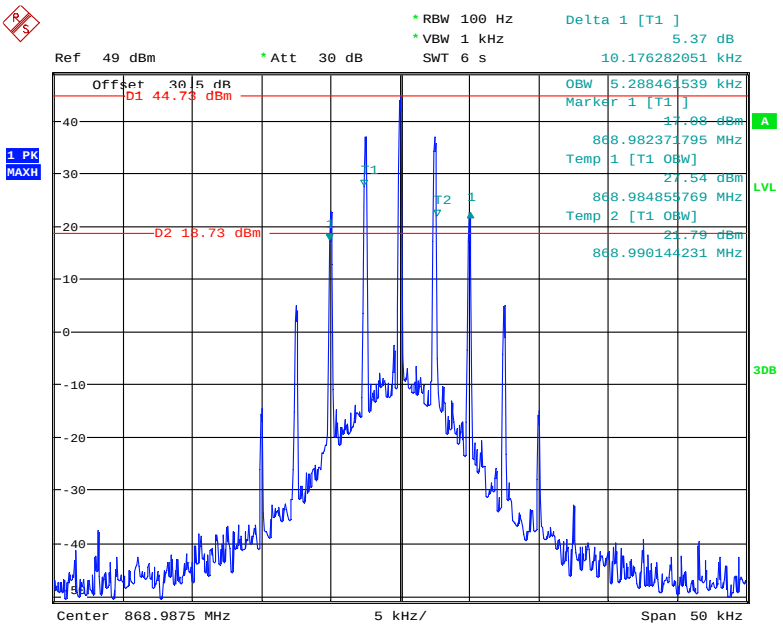

Date: 30.DEC.2017 13:33:20

## Frequency 851.0125 MHz: Emission Mask B, Low Power



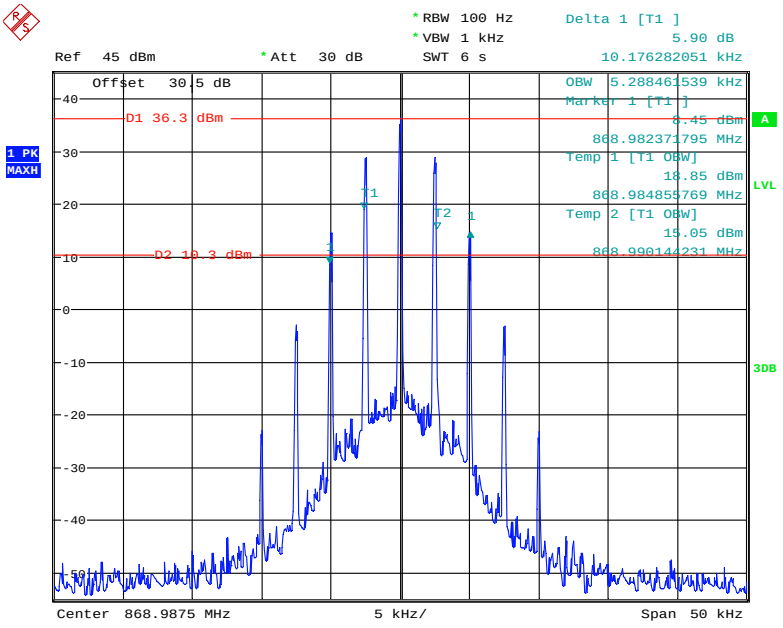

Date: 30.DEC.2017 13:30:42

## Frequency 868.9875 MHz: 99% Occupied & 26 dB Bandwidth, High Power



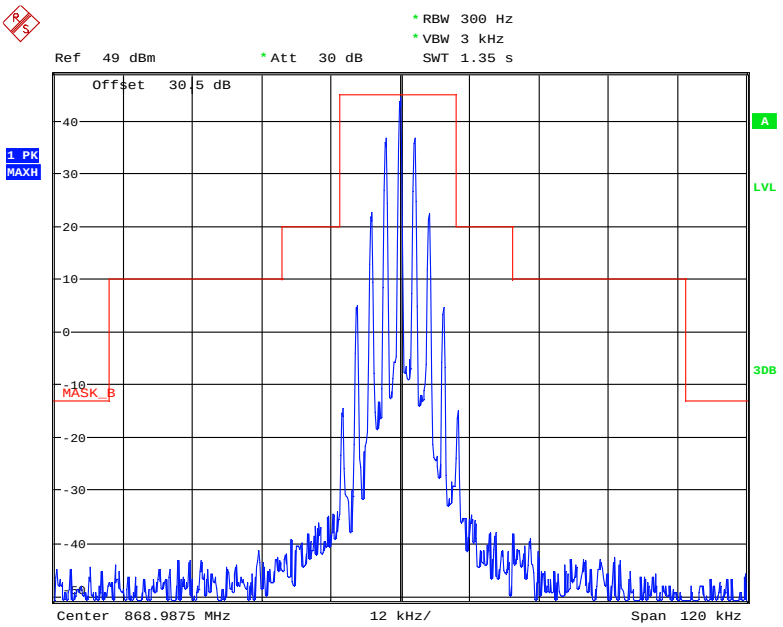

Date: 30.DEC.2017 11:09:20

## Frequency 868.9875 MHz: 99% Occupied & 26 dB Bandwidth, Low Power



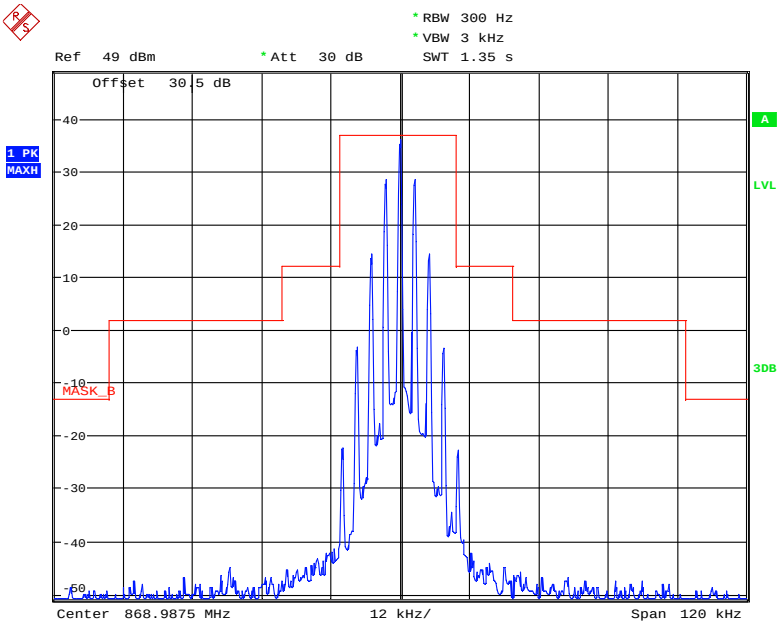

Date: 30.DEC.2017 11:08:10

## Frequency 868.9875 MHz: Emission Mask B, High Power



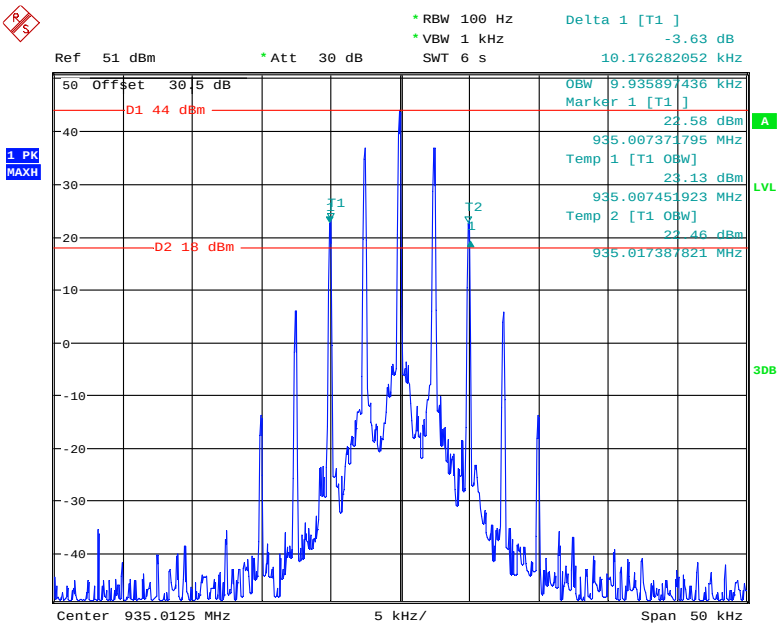

Date: 30.DEC.2017 13:34:54

## Frequency 868.9875 MHz: Emission Mask B, Low Power



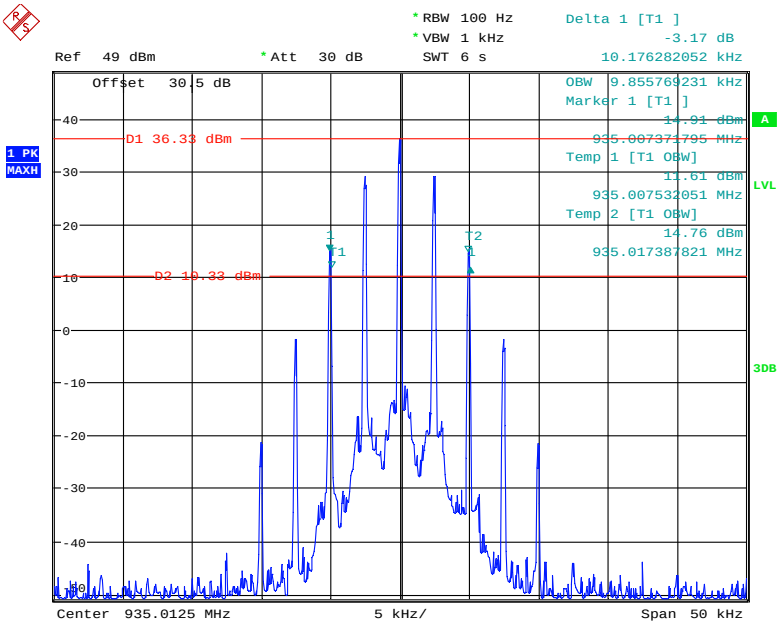

Date: 30.DEC.2017 13:37:14

## Frequency 935.0125 MHz: 99% Occupied & 26 dB Bandwidth, High Power



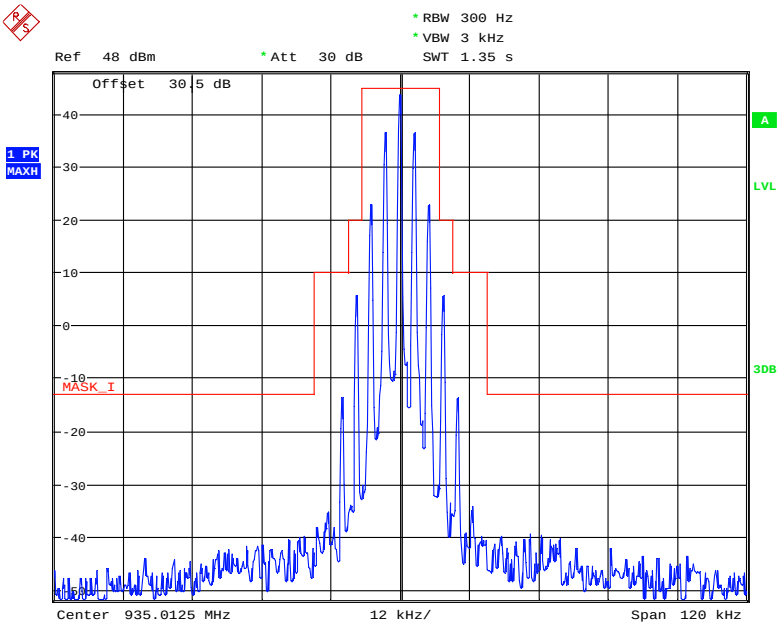

Date: 30.DEC.2017 11:12:27

## Frequency 935.0125 MHz: 99% Occupied & 26 dB Bandwidth, Low Power



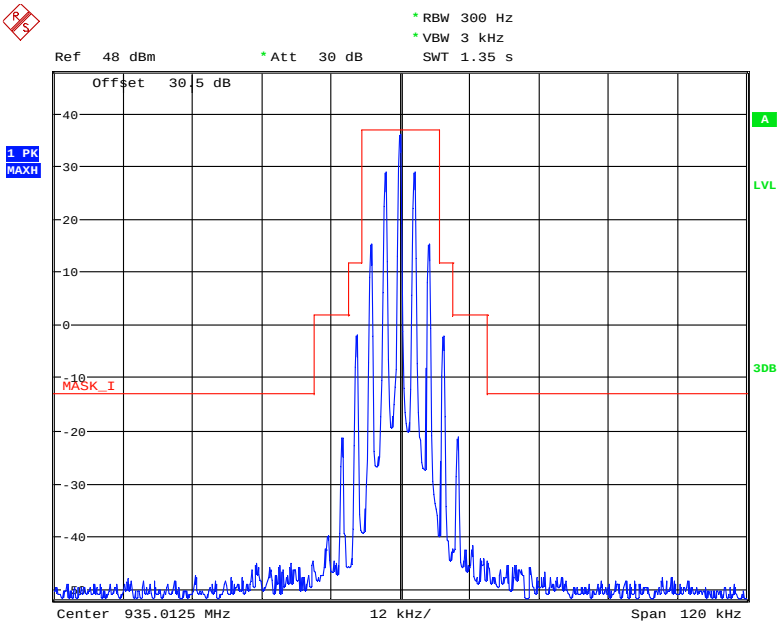

Date: 30.DEC.2017 11:10:55

## Frequency 935.0125 MHz: Emission Mask I, High Power




Date: 30.DEC.2017 13:53:24

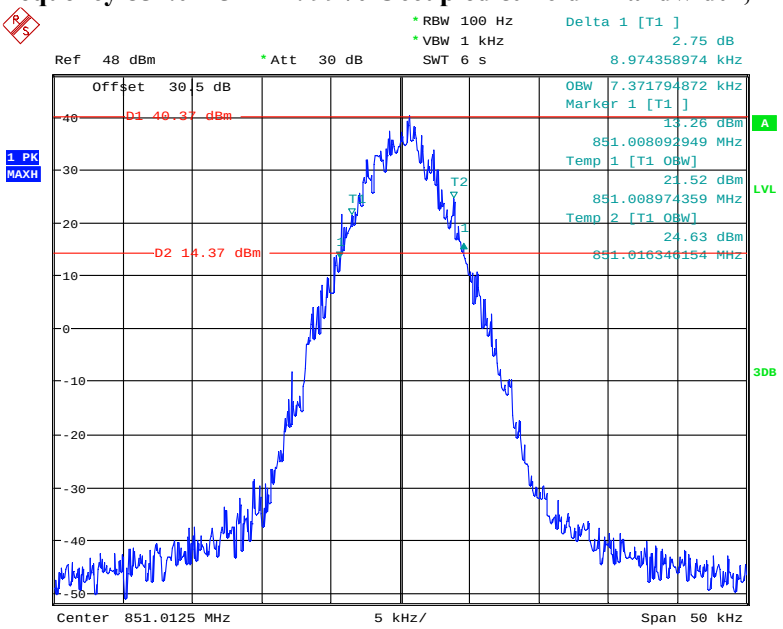
## Frequency 935.0125 MHz: Emission Mask I, Low Power




Date: 30.DEC.2017 13:51:26

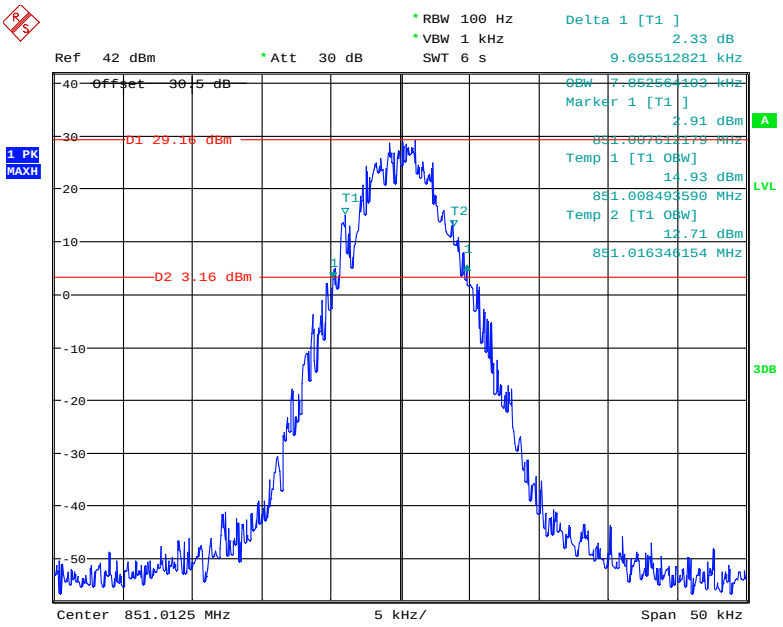
**Digital Modulation:**

**Frequency 851.0125 MHz: 99% Occupied & 26 dB Bandwidth, High Power**



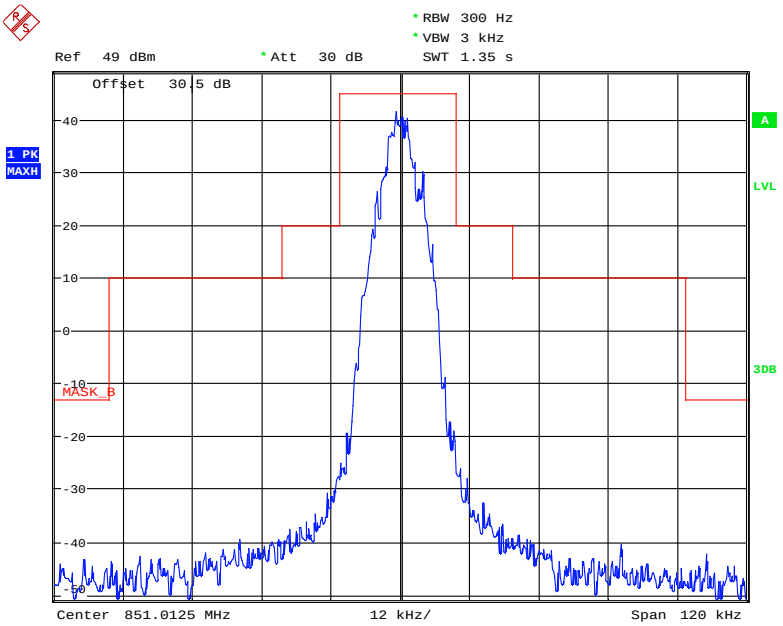

Date: 30.DEC.2017 10:39:51

**Frequency 851.0125 MHz: 99% Occupied & 26 dB Bandwidth, Low Power**



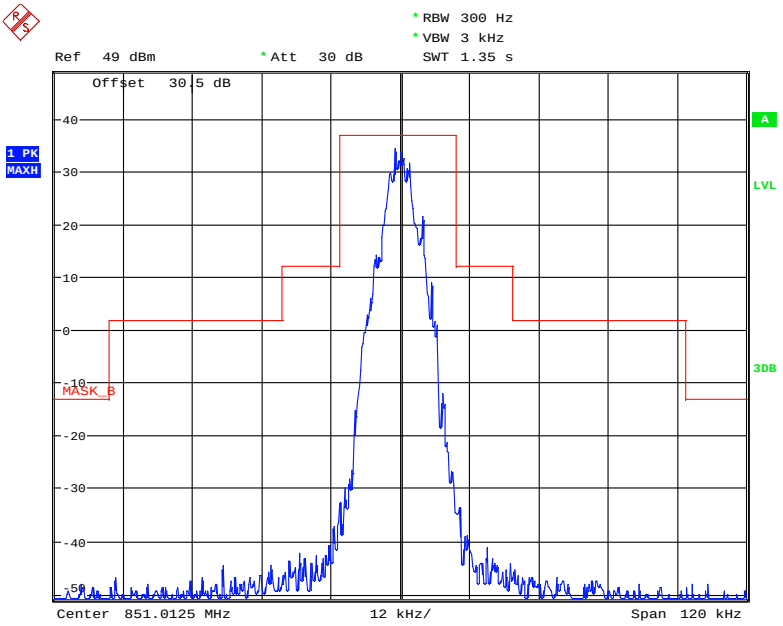

Date: 30.DEC.2017 10:37:52

## Frequency 851.0125 MHz: Emission Mask B, High Power



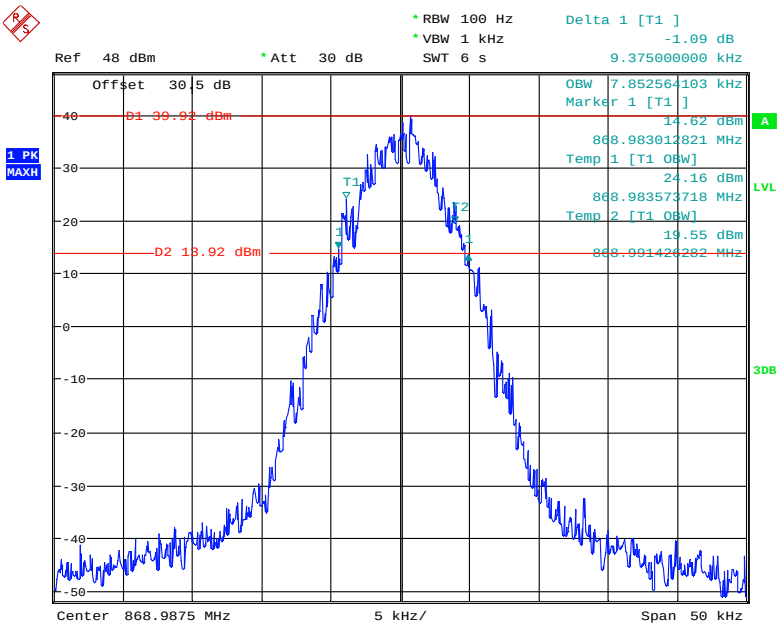

Date: 30.DEC.2017 13:33:00

## Frequency 851.0125 MHz: Emission Mask B, Low Power



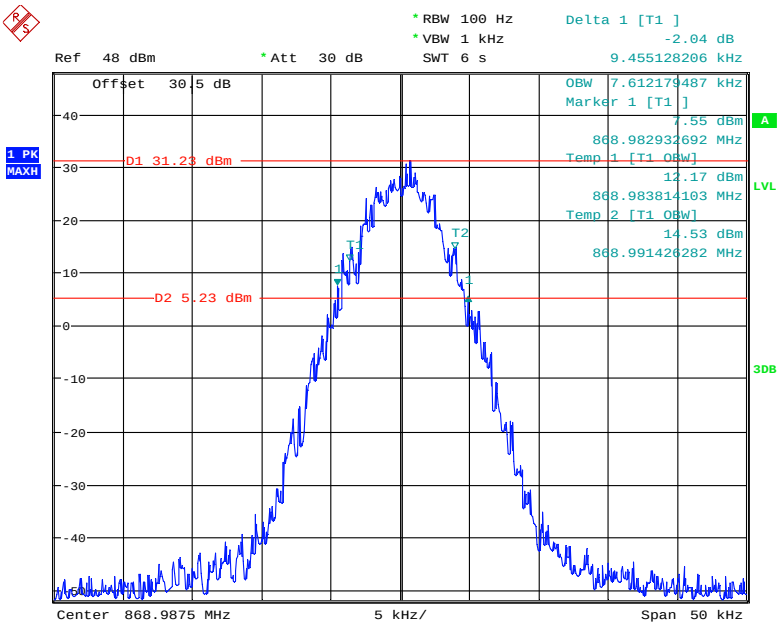

Date: 30.DEC.2017 13:31:56

## Frequency 868.9875 MHz: 99% Occupied & 26 dB Bandwidth, High Power



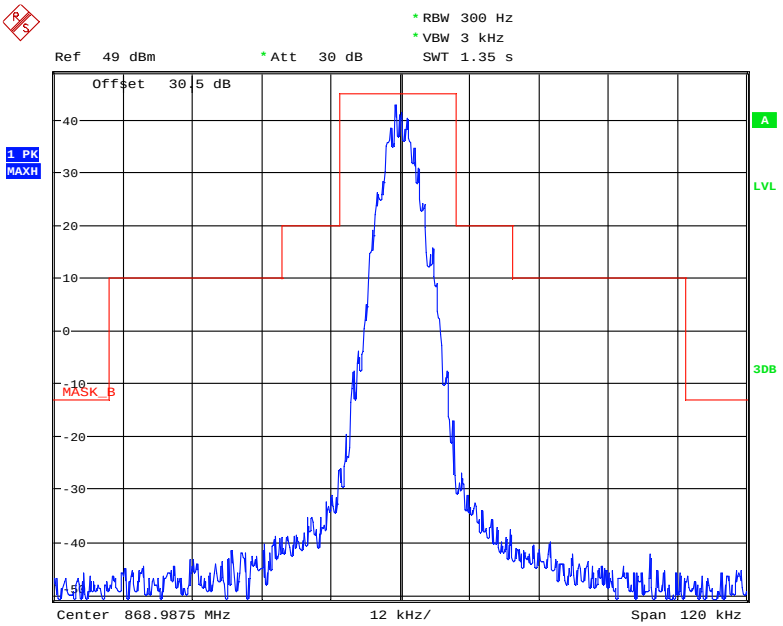

Date: 30.DEC.2017 10:42:20

## Frequency 868.9875 MHz: 99% Occupied & 26 dB Bandwidth, Low Power



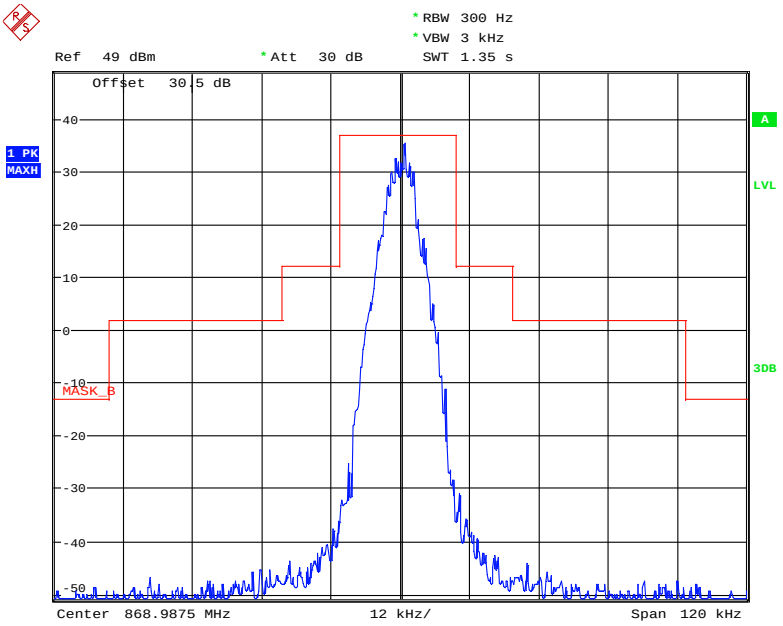

Date: 30.DEC.2017 10:41:11

## Frequency 868.9875 MHz: Emission Mask B, High Power



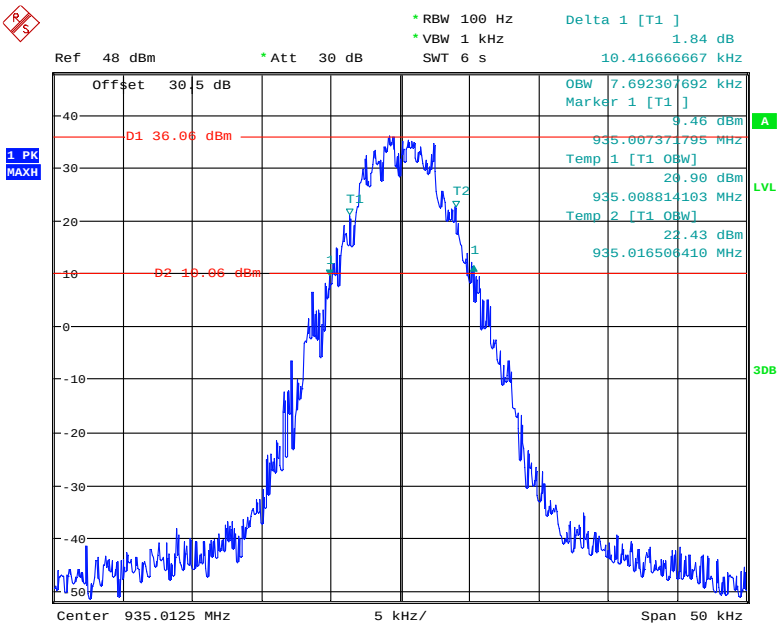

Date: 30.DEC.2017 13:35:51

## Frequency 868.9875 MHz: Emission Mask B, Low Power



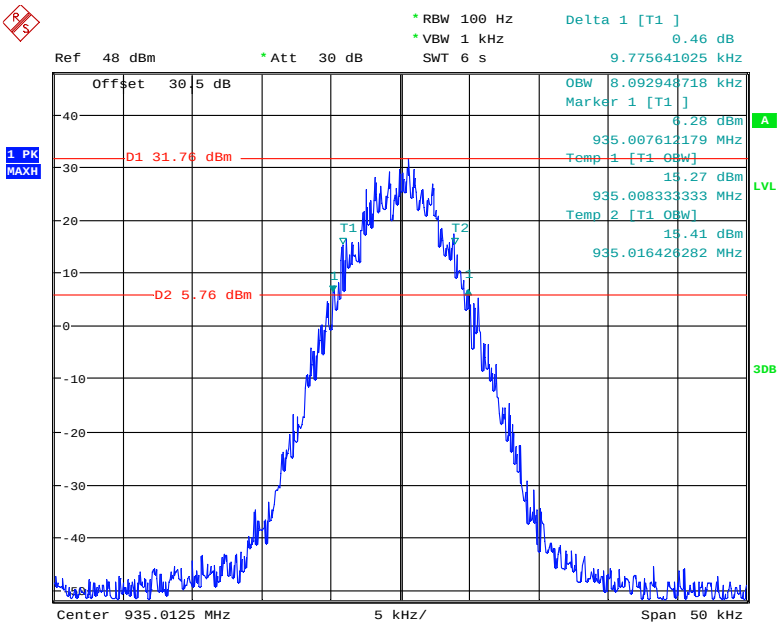

Date: 30.DEC.2017 13:36:47

## Frequency 935.0125 MHz: 99% Occupied & 26 dB Bandwidth, High Power



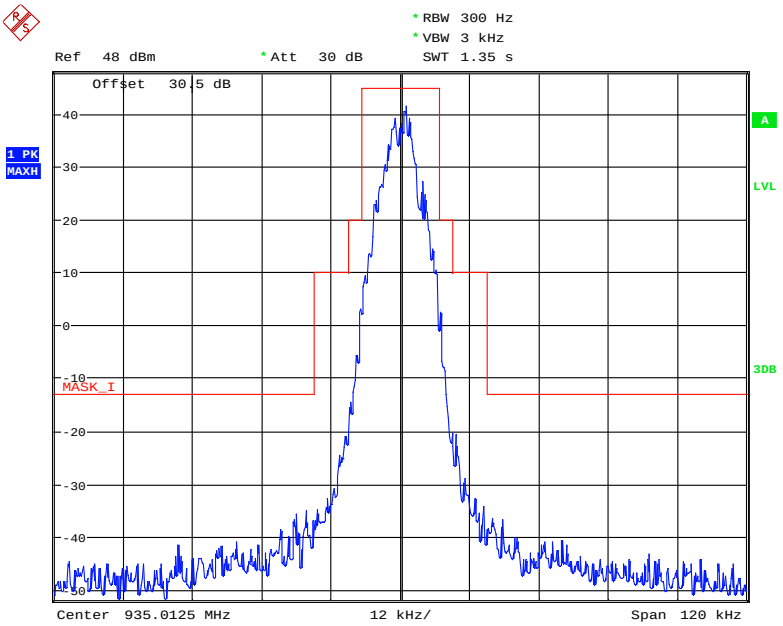

Date: 30.DEC.2017 10:43:39

## Frequency 935.0125 MHz: 99% Occupied & 26 dB Bandwidth, Low Power



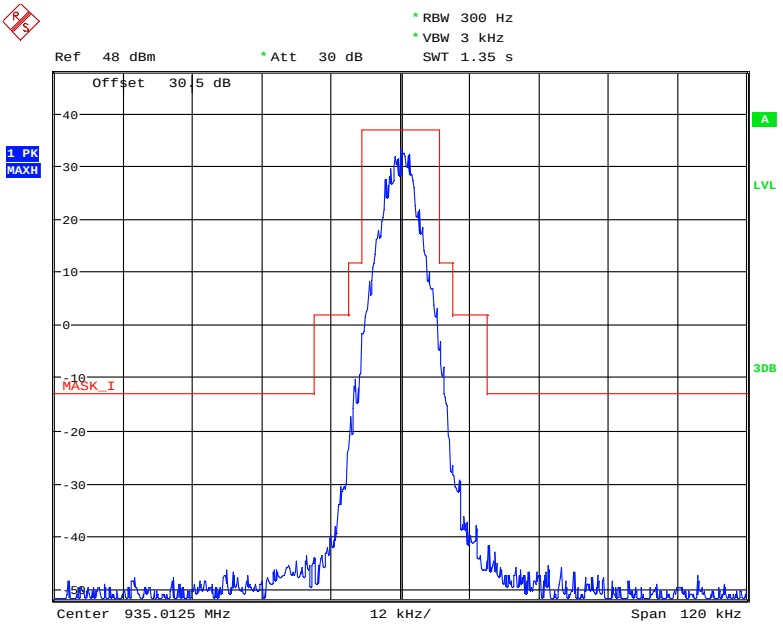

Date: 30.DEC.2017 10:44:53

## Frequency 935.0125 MHz: Emission Mask I, High Power




Date: 30.DEC.2017 13:53:05

## Frequency 935.0125 MHz: Emission Mask I, Low Power




Date: 30.DEC.2017 13:52:07

| Modulation | Channel Separation (kHz) | Frequency (MHz) | Power Level | 99% Occupied Bandwidth (kHz) | 26 dB Emissions Bandwidth (kHz) |
|---|---|---|---|---|---|
| Analog | 25 | 851.0125 | High | 14.90 | 15.58 |
| | 25 | | Low | 14.90 | 15.58 |
| | 25 | 868.9875 | High | 14.81 | 15.67 |
| | 25 | | Low | 14.81 | 15.67 |

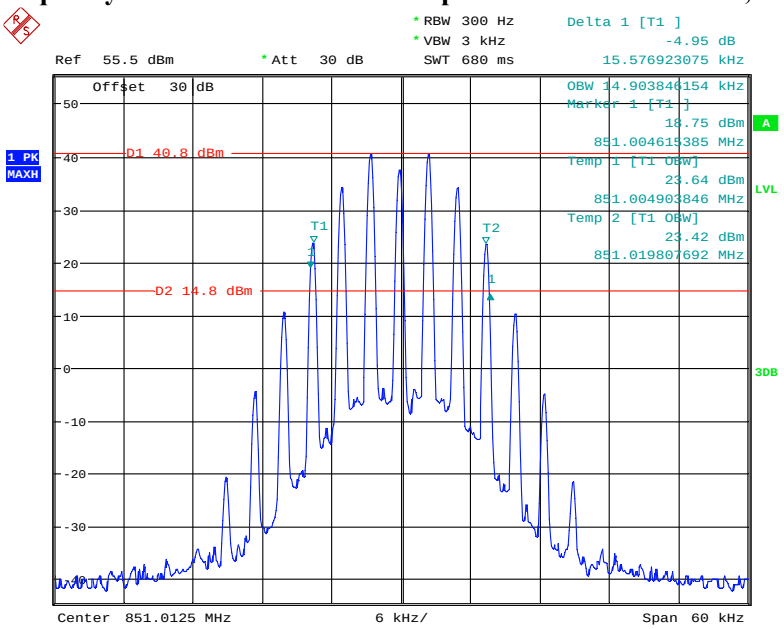
*Emission Designator Per CFR 47 §2.201& §2.202&, Bn = 2M + 2D*

***For FM Mode (Channel Spacing: 25 kHz)***

*Emission Designator 16K0F3E In this case, the maximum modulating frequency is 5.0 kHz with a 3 kHz deviation. BW = 2(M+D) = 2*(5 kHz + 3 kHz) = 16 kHz → 16K0*
*F3E portion of the designator represents an FM voice transmission Therefore, the entire designator for 25 kHz channel spacing FM mode is 16K0F3E.*

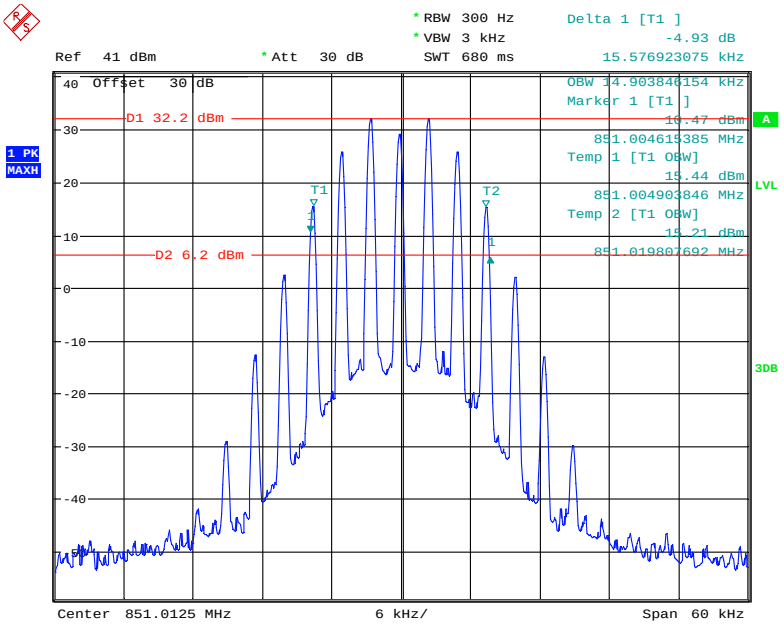
## Analog Modulation

### Frequency 851.0125 MHz: 99% Occupied & 26 dB Bandwidth, High Power



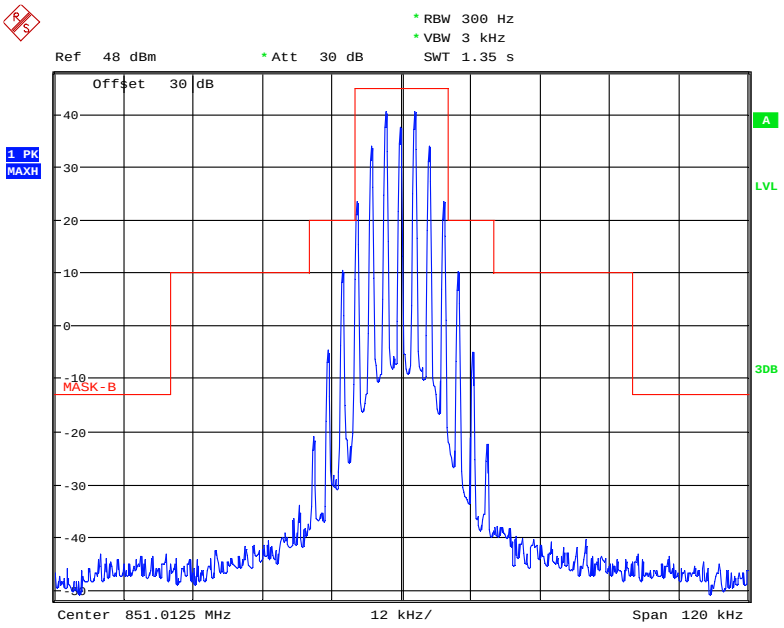

Date: 17.MAR.2018 14:13:56

### Frequency 851.0125 MHz: 99% Occupied & 26 dB Bandwidth, Low Power



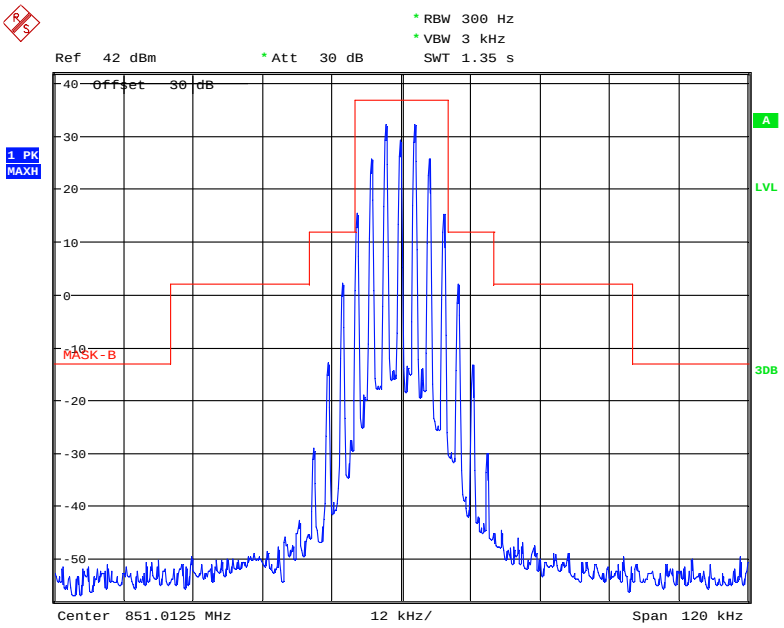

Date: 17.MAR.2018 14:15:15

## Frequency 851.0125 MHz: Emission Mask B, High Power



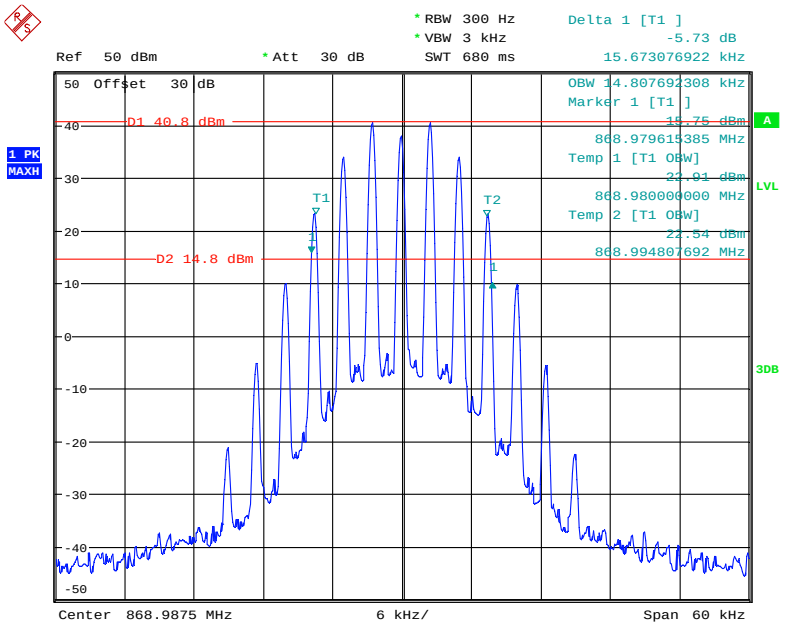

Date: 17.MAR.2018 14:25:17

## Frequency 851.0125 MHz: Emission Mask B, Low Power



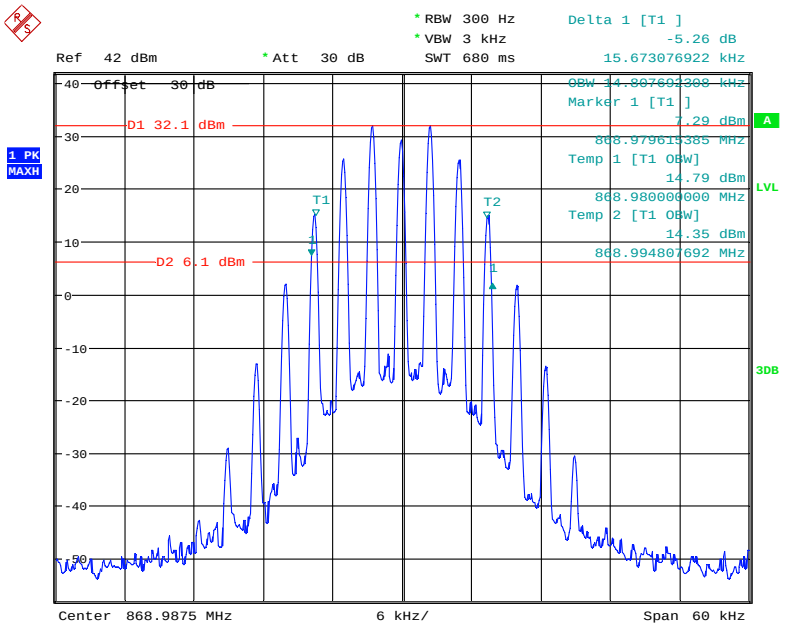

Date: 17.MAR.2018 14:27:06

## Frequency 868.9875 MHz: 99% Occupied & 26 dB Bandwidth, High Power



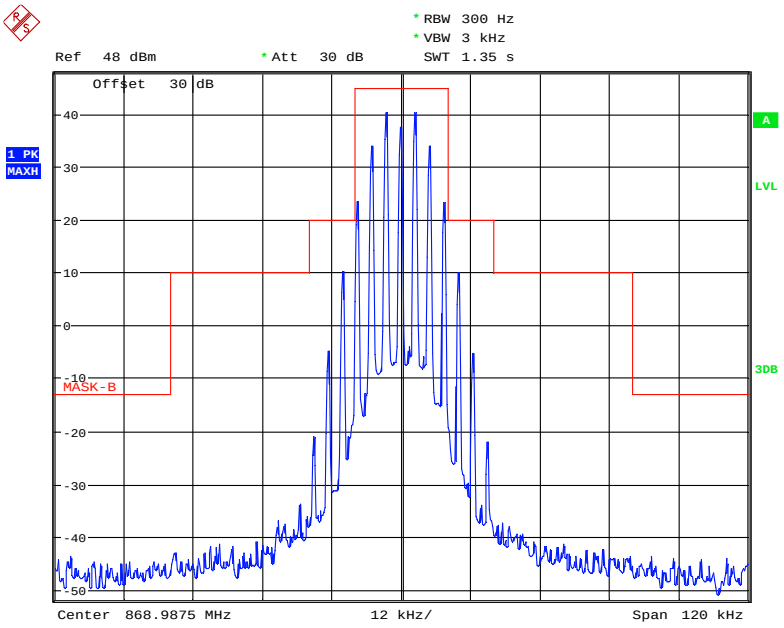

Date: 17.MAR.2018 14:16:23

## Frequency 868.9875 MHz: 99% Occupied & 26 dB Bandwidth, Low Power



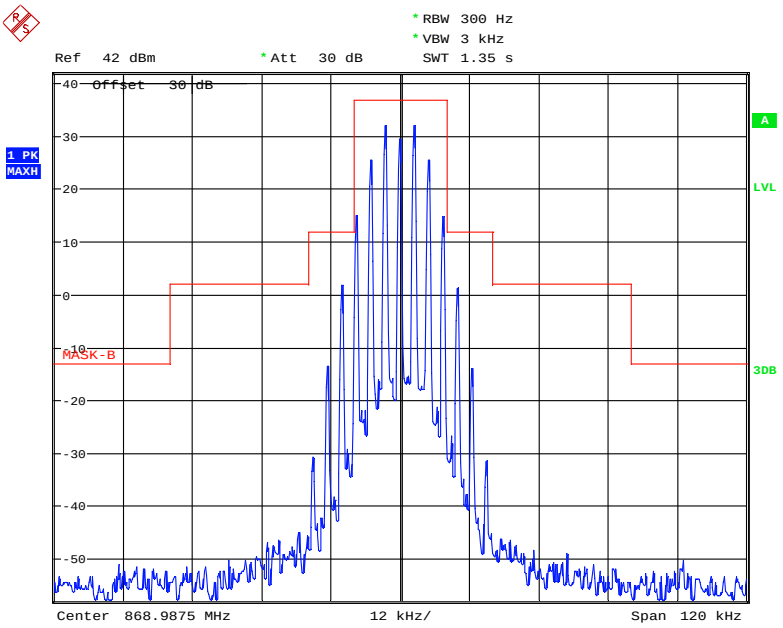

Date: 17.MAR.2018 14:17:14

## Frequency 868.9875 MHz: Emission Mask B, High Power




Date: 17.MAR.2018 14:23:46

## Frequency 868.9875 MHz: Emission Mask B, Low Power




Date: 17.MAR.2018 14:21:10

# FCC §2.1051 & §90.210 - SPURIOUS EMISSIONS AT ANTENNA TERMINALS

## Applicable Standard

Emission Mask B. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

1) 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.

2) 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.

3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

Emission Mask I. For transmitters that are equipped with an audio low pass filter, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) as follows:

1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 6.8 kHz, but no more than 9.0 kHz: At least 25 dB;

2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 9.0 kHz, but no more than 15 kHz: At least 35 dB;

3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency of more than 15 kHz: At least 43 + 10 log (P) dB, or 70 dB, whichever is the lesser attenuation.

## Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100kHz for below 1GHz, and 1MHz for above 1GHz. Sufficient scans were taken to show any out of band emissions up to $10^{th}$ harmonic.

## Test Data

### Environmental Conditions

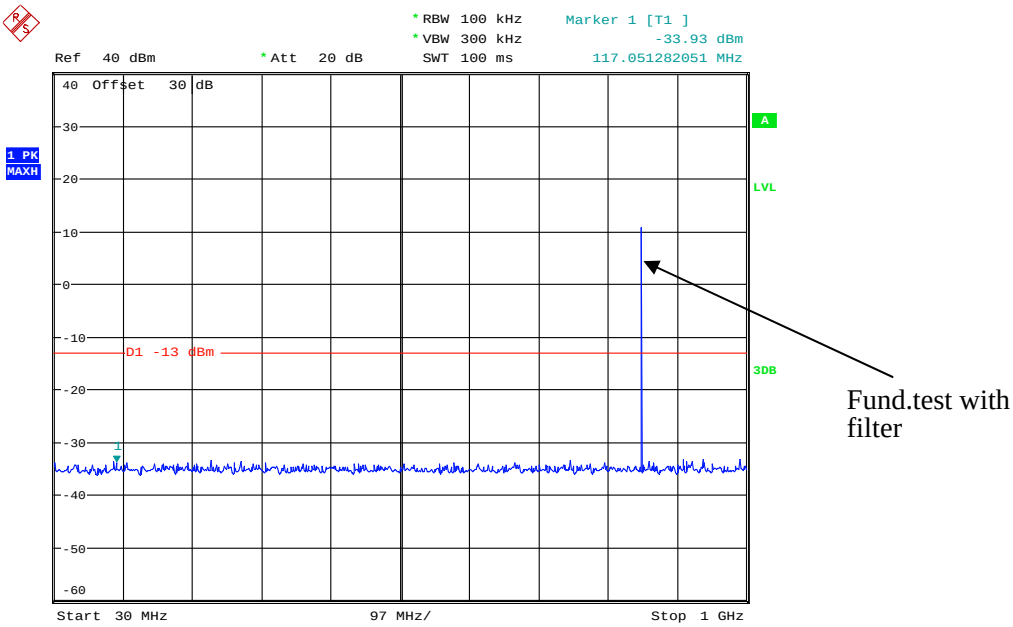
| | |
|---|---|
| **Temperature:** | 23 ℃ |
| **Relative Humidity:** | 54 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Rocky Kang on 2018-01-05.*

*Test Mode: Transmitting, please refer to the following plots.*

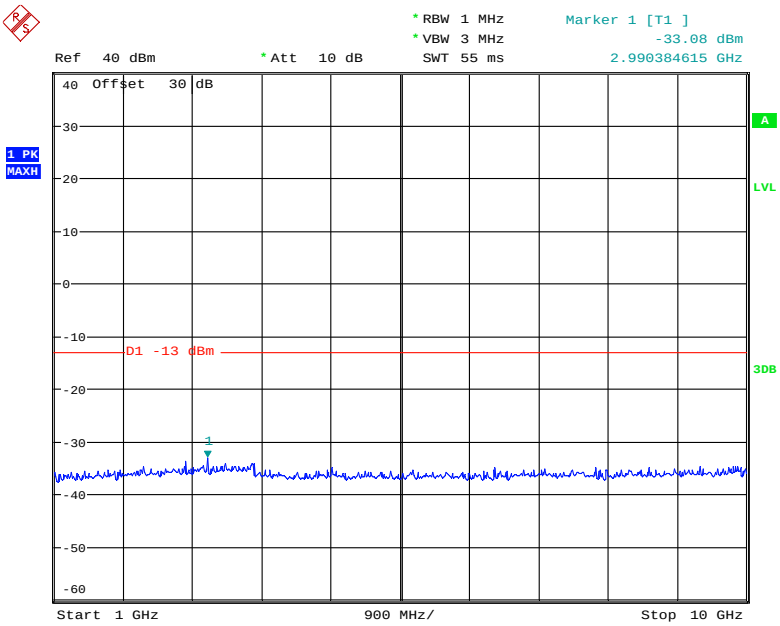
**Analog Modulation:**

**30MHz – 1 GHz, Channel Spacing 12.5 kHz, 851.0125 MHz**



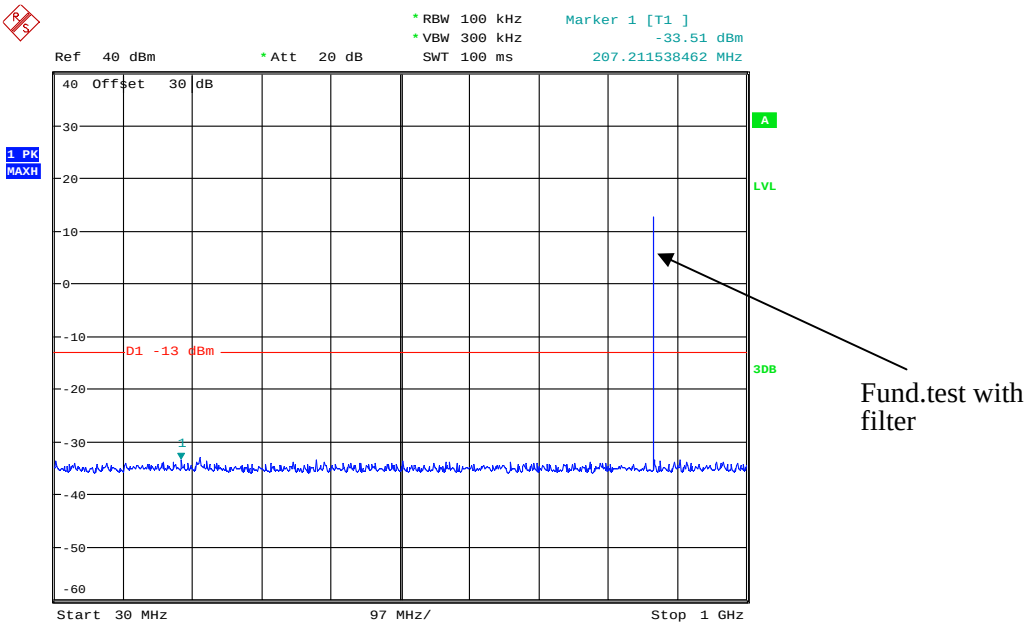

Date: 5.JAN.2018 16:22:11

**1 GHz – 10 GHz, Channel Spacing 12.5 kHz, 851.0125 MHz**



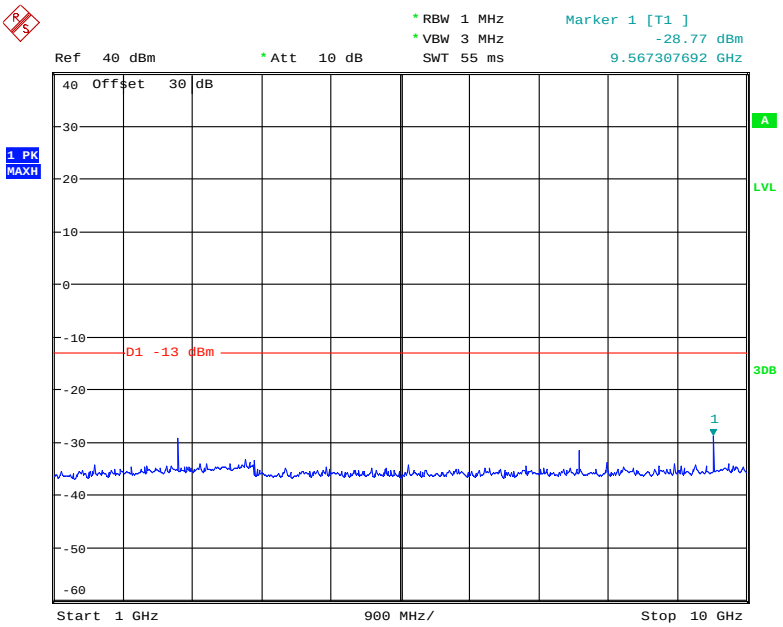

Date: 5.JAN.2018 16:19:40

## 30MHz – 1 GHz, Channel Spacing 12.5 kHz, 868.9875 MHz



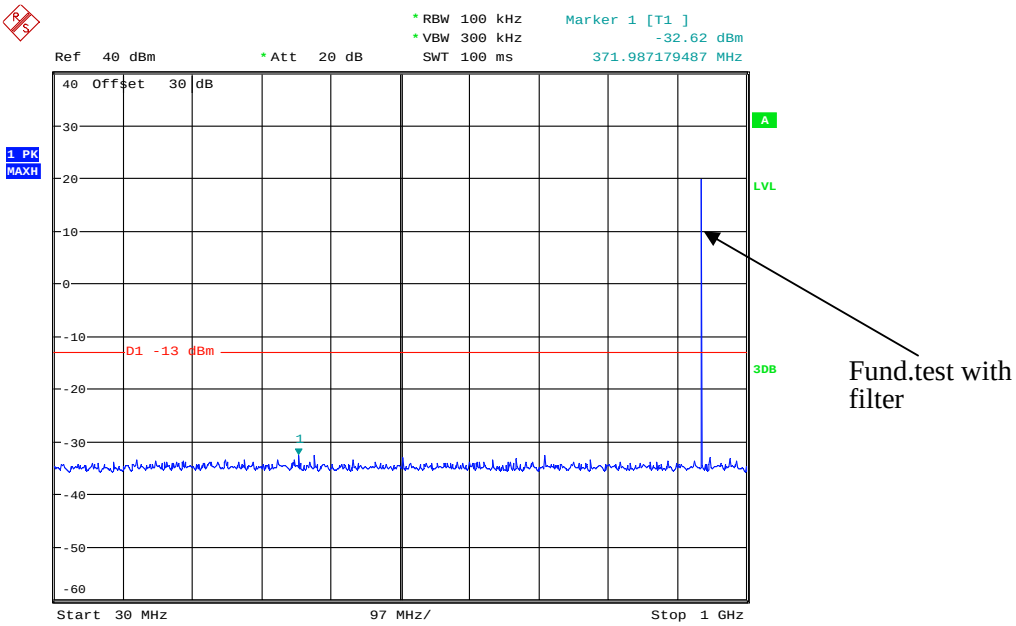

Date: 5.JAN.2018 16:24:09

## 1 GHz – 10 GHz, Channel Spacing 12.5 kHz, 868.9875 MHz



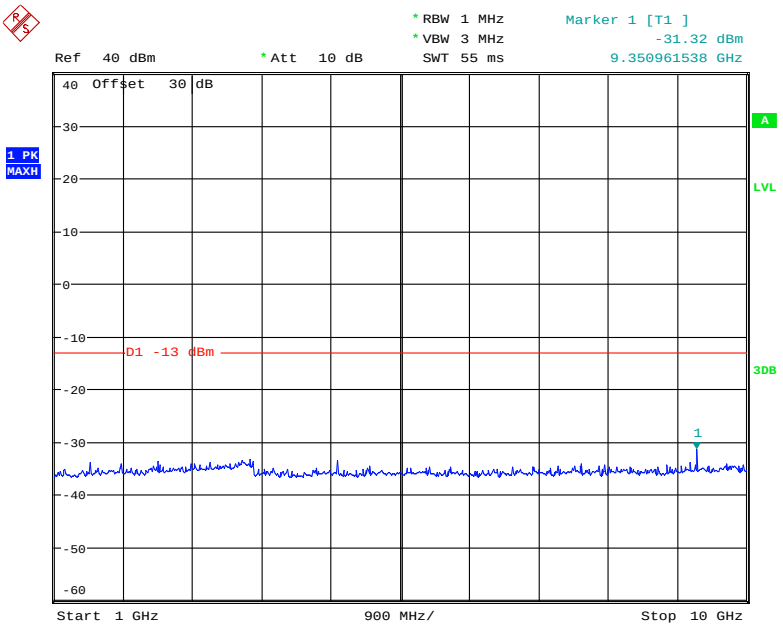

Date: 5.JAN.2018 16:26:03

## 30MHz – 1 GHz, Channel Spacing 12.5 kHz, 935.0125 MHz



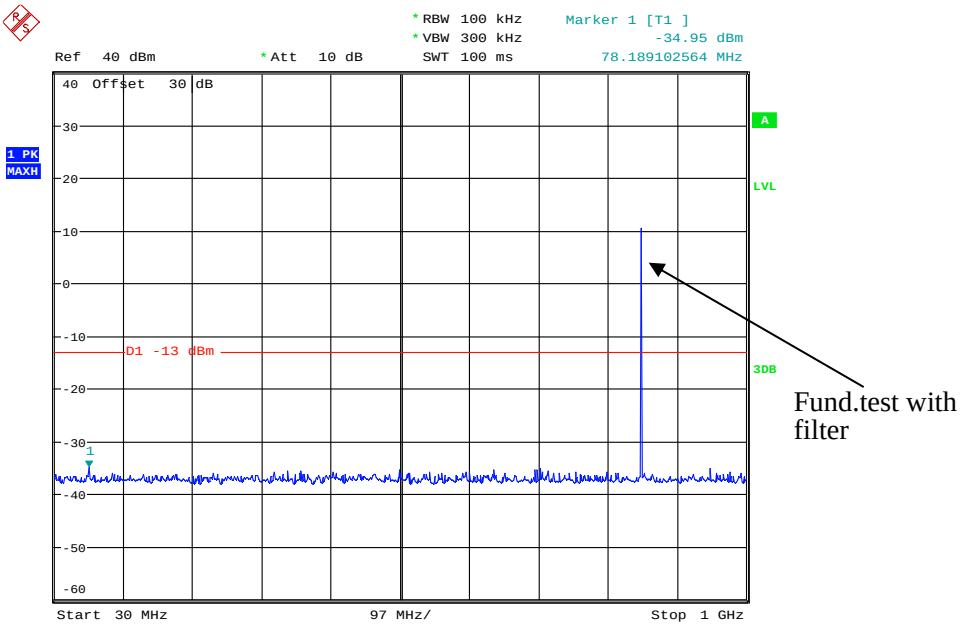

Date: 5.JAN.2018 16:31:22

## 1 GHz – 10 GHz, Channel Spacing 12.5 kHz, 935.0125 MHz



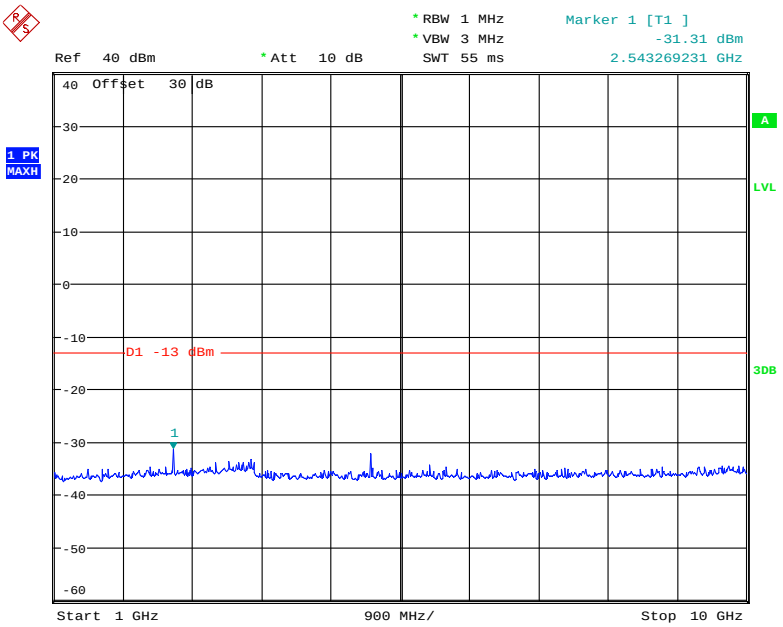

Date: 5.JAN.2018 16:28:26

## 30MHz – 1 GHz, Channel Spacing 25 kHz, 851.0125 MHz



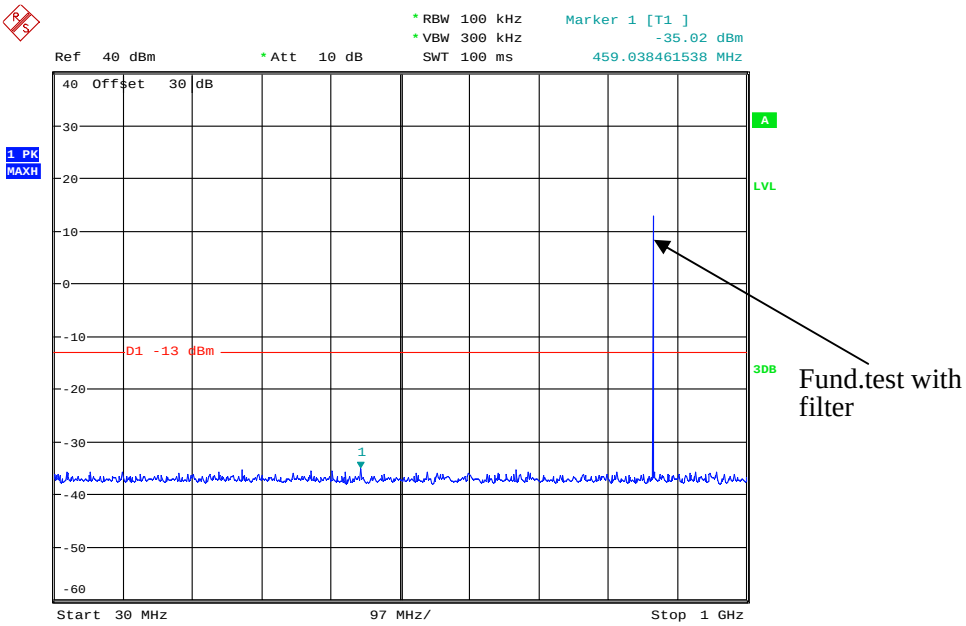

Date: 5.JAN.2018 16:40:17

## 1 GHz – 10 GHz, Channel Spacing 25 kHz, 851.0125 MHz



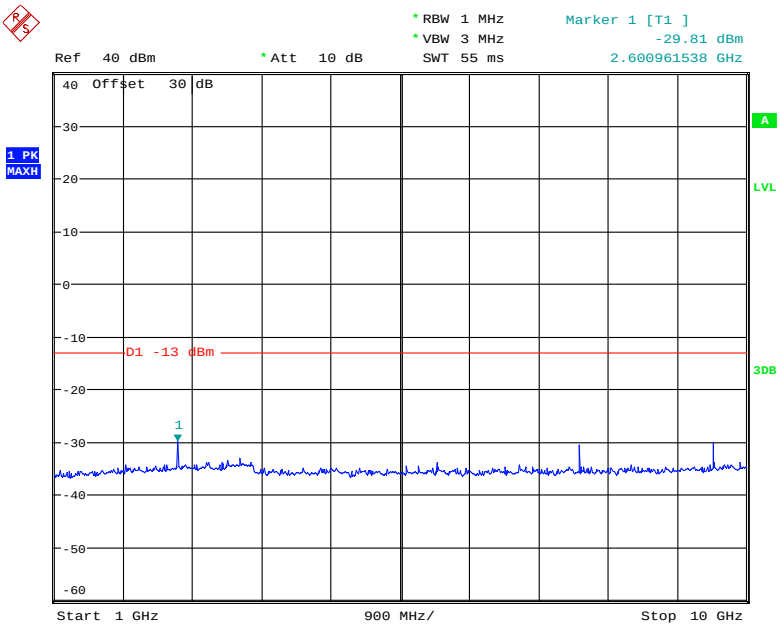

Date: 5.JAN.2018 16:38:12

## 30MHz – 1 GHz, Channel Spacing 25 kHz, 868.9875 MHz




Date: 5.JAN.2018 16:42:11

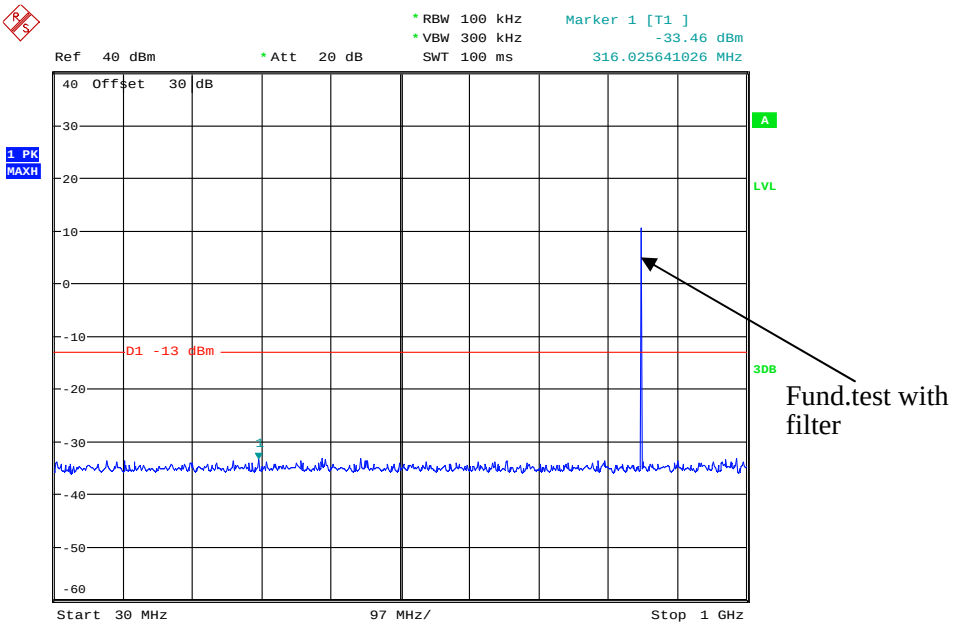
## 1 GHz – 10 GHz, Channel Spacing 25 kHz, 868.9875 MHz




Date: 5.JAN.2018 16:45:59

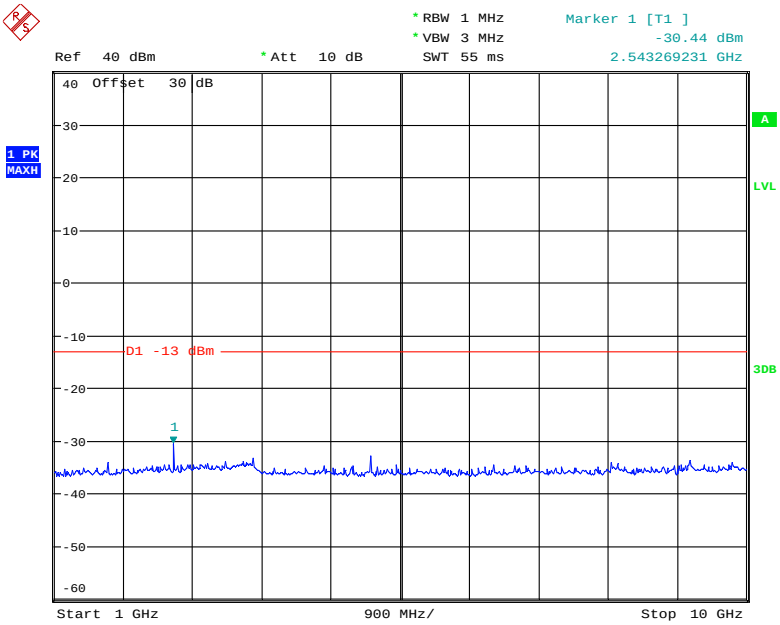
**Digital Modulation:**

**30MHz – 1 GHz, Channel Spacing 12.5 kHz, 851.0125 MHz**



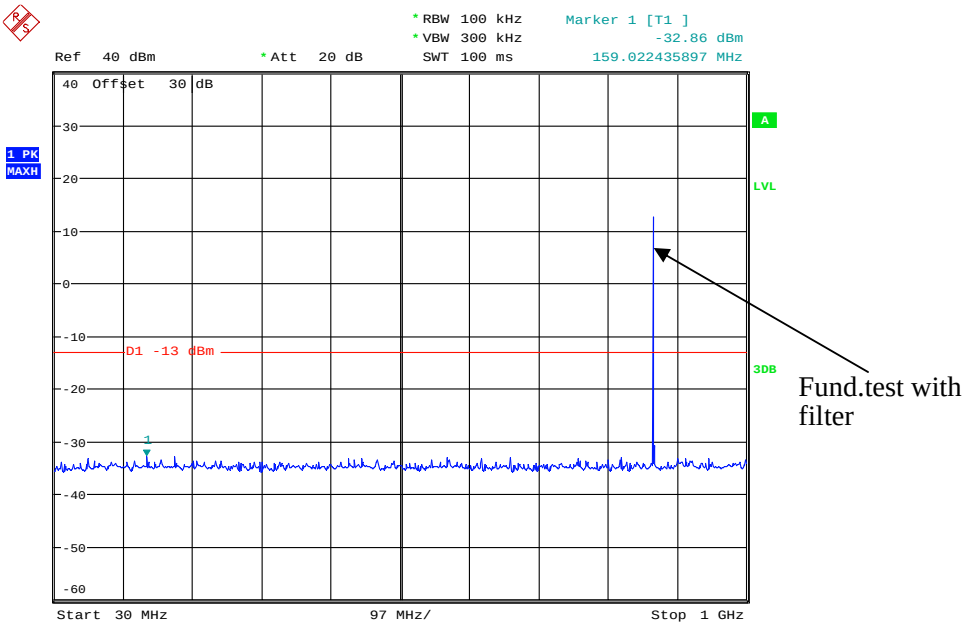

Date: 5.JAN.2018 16:50:05

**1 GHz – 10 GHz, Channel Spacing 12.5 kHz, 851.0125 MHz**



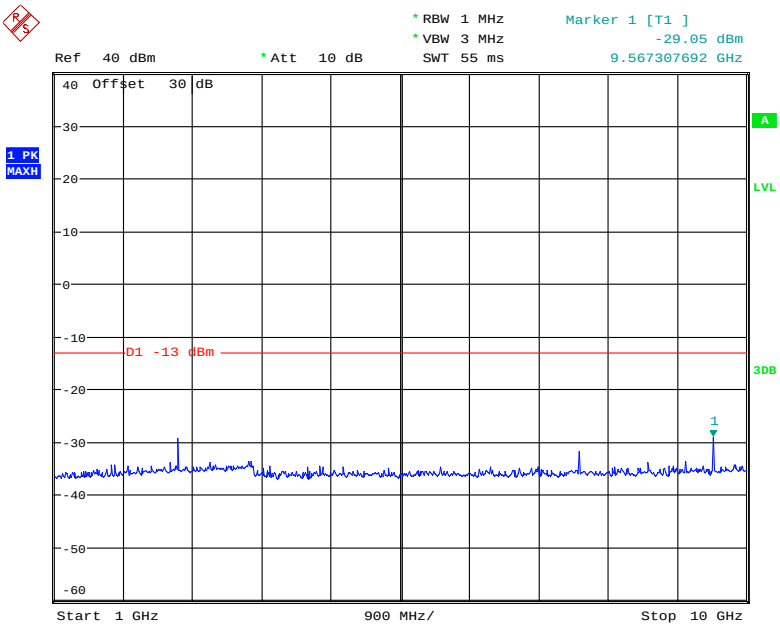

Date: 5.JAN.2018 16:47:57

## 30MHz – 1 GHz, Channel Spacing 12.5 kHz, 868.9875 MHz



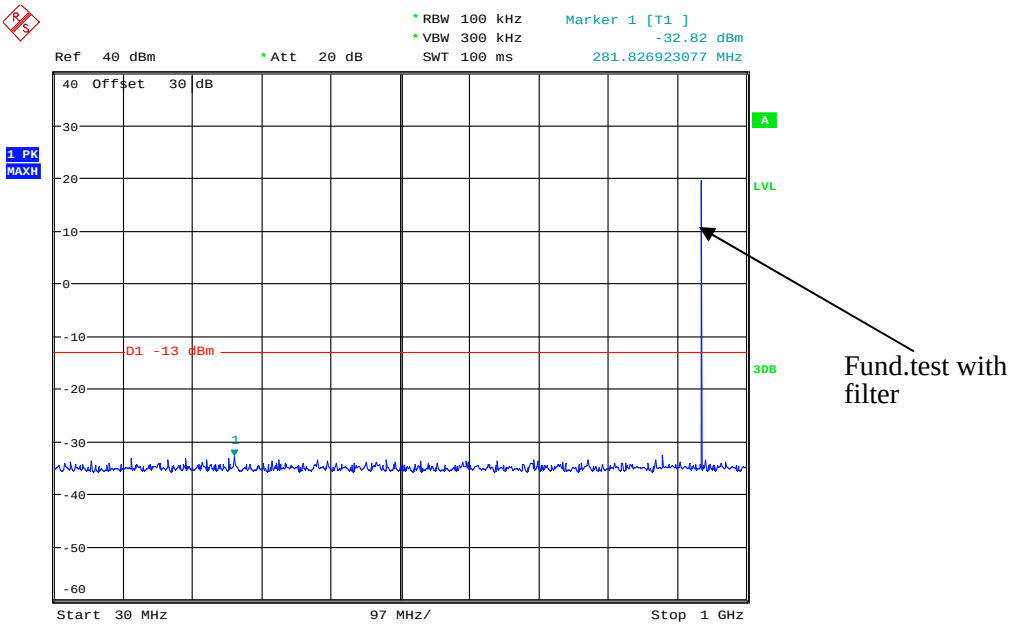

Date: 5.JAN.2018 16:54:03

## 1 GHz – 10 GHz, Channel Spacing 12.5 kHz, 868.9875 MHz



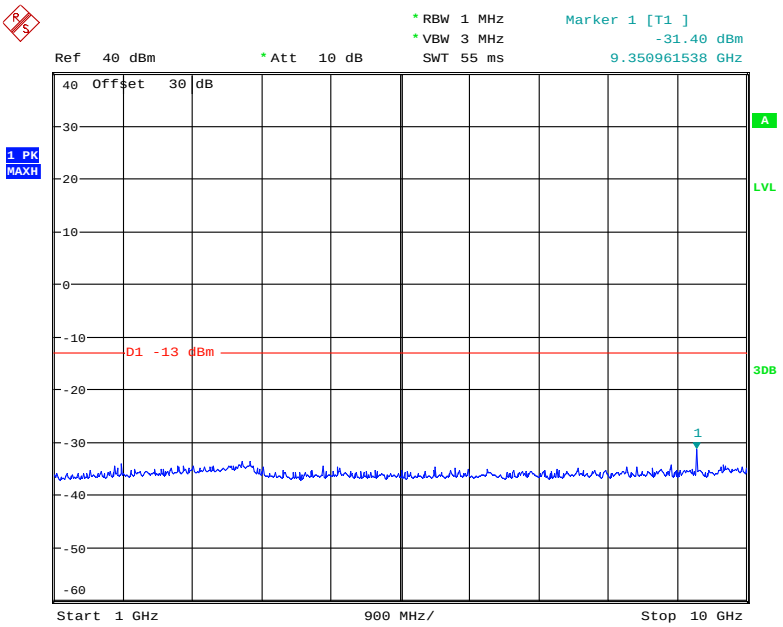

Date: 5.JAN.2018 16:55:55

## 30MHz – 1 GHz, Channel Spacing 12.5 kHz, 935.0125 MHz




Date: 5.JAN.2018 17:00:33

## 1 GHz – 10 GHz, Channel Spacing 12.5 kHz, 935.0125 MHz




Date: 5.JAN.2018 16:58:06

# FCC §2.1053 & §90.210 - RADIATED SPURIOUS EMISSIONS

## Applicable Standard

FCC §2.1053 and §90.210

## Test Procedure

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load, which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT .The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to teeth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB =10 1g (TXpwr in Watts/0.001)-the absolute level

Spurious attenuation limit in dB =43+10 $Log_{10}$ (power out in Watts) for EUT.

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Rocky Kang on 2017-12-30.*

*Test Mode: Transmitting*

**30MHz - 10GHz:**

| Frequency (MHz) | Receiver Reading (dBµV) | Turn Table Angle Degree | Rx Antenna | | Substituted | | | Absolute Level (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Height (m) | Polar (H/V) | Level (dBm) | Cable Loss (dB) | Antenna Gain (dB) | | | |
| Analog Modulation 851.0125 MHz-12.5 kHz | | | | | | | | | | |
| 886.489 | 40.25 | 191 | 2.0 | H | -54.8 | 0.70 | 0 | -55.50 | -13 | 42.50 |
| 886.489 | 41.06 | 288 | 1.2 | V | -52.9 | 0.70 | 0 | -53.60 | -13 | 40.60 |
| 1702.03 | 54.76 | 115 | 1.3 | H | -52.3 | 1.30 | 9.10 | -44.50 | -13 | 31.5 |
| 1702.03 | 54.29 | 12 | 1.4 | V | -52.2 | 1.30 | 9.10 | -44.40 | -13 | 31.4 |
| 2553.04 | 57.11 | 9 | 2.4 | H | -46.6 | 2.20 | 9.40 | -39.40 | -13 | 26.4 |
| 2553.04 | 58.79 | 215 | 2.2 | V | -44.6 | 2.20 | 9.40 | -37.40 | -13 | 24.4 |
| 3404.05 | 46.8 | 300 | 2.2 | H | -53.8 | 1.40 | 9.70 | -45.50 | -13 | 32.5 |
| 3404.05 | 48.97 | 224 | 1.2 | V | -51.5 | 1.40 | 9.70 | -43.20 | -13 | 30.2 |
| Analog Modulation 868.9875 MHz-12.5 kHz | | | | | | | | | | |
| 886.489 | 41.36 | 194 | 1.9 | H | -53.6 | 0.70 | 0 | -54.30 | -13 | 41.30 |
| 886.489 | 40.58 | 103 | 2.4 | V | -53.4 | 0.70 | 0 | -54.10 | -13 | 41.10 |
| 1737.98 | 56.71 | 247 | 1.3 | H | -50.4 | 1.30 | 9.10 | -42.60 | -13 | 29.6 |
| 1737.98 | 55.26 | 52 | 2.2 | V | -51.2 | 1.30 | 9.10 | -43.40 | -13 | 30.4 |
| 2606.96 | 59.05 | 187 | 1.7 | H | -44.7 | 2.20 | 9.40 | -37.50 | -13 | 24.5 |
| 2606.96 | 61.27 | 32 | 1.1 | V | -42.1 | 2.20 | 9.40 | -34.90 | -13 | 21.9 |
| 3475.95 | 46.59 | 214 | 1.4 | H | -53.9 | 1.50 | 9.70 | -45.70 | -13 | 32.7 |
| 3475.95 | 48.66 | 219 | 1.9 | V | -52.6 | 1.50 | 9.70 | -44.40 | -13 | 31.4 |
| Analog Modulation 935.0125 MHz-12.5 kHz | | | | | | | | | | |
| 886.489 | 40.36 | 318 | 1.0 | H | -54.6 | 0.70 | 0 | -55.30 | -13 | 42.30 |
| 886.489 | 41.26 | 59 | 1.5 | V | -52.7 | 0.70 | 0 | -53.40 | -13 | 40.40 |
| 1870.03 | 60.67 | 173 | 2.1 | H | -43.6 | 1.30 | 8.50 | -36.40 | -13 | 23.4 |
| 1870.03 | 61.25 | 97 | 2.3 | V | -43.2 | 1.30 | 8.50 | -36.00 | -13 | 23 |
| 2805.04 | 53.46 | 207 | 1.0 | H | -50.3 | 1.80 | 9.70 | -42.40 | -13 | 29.4 |
| 2805.04 | 52.84 | 268 | 1.5 | V | -50.6 | 1.80 | 9.70 | -42.70 | -13 | 29.7 |
| 3740.05 | 47.27 | 317 | 2.1 | H | -54.1 | 1.60 | 9.80 | -45.90 | -13 | 32.9 |
| 3740.05 | 49.21 | 105 | 2.1 | V | -51.6 | 1.60 | 9.80 | -43.40 | -13 | 30.4 |

| Frequency (MHz) | Receiver Reading (dBµV) | Turn Table Angle Degree | Rx Antenna | | Substituted | | | Absolute Level (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Height (m) | Polar (H/V) | Level (dBm) | Cable Loss (dB) | Antenna Gain (dB) | | | |
| Analog Modulation 851.0125 MHz-25 kHz | | | | | | | | | | |
| 886.489 | 41.34 | 50 | 2.0 | H | -53.7 | 0.70 | 0 | -54.40 | -13 | 41.40 |
| 886.489 | 42.37 | 135 | 1.3 | V | -51.6 | 0.70 | 0 | -52.30 | -13 | 39.30 |
| 1702.03 | 55.47 | 194 | 1.0 | H | -51.6 | 1.30 | 9.10 | -43.80 | -13 | 30.80 |
| 1702.03 | 53.92 | 338 | 1.9 | V | -52.6 | 1.30 | 9.10 | -44.80 | -13 | 31.80 |
| 2553.04 | 57.04 | 24 | 2.4 | H | -46.7 | 2.20 | 9.40 | -39.50 | -13 | 26.50 |
| 2553.04 | 58.14 | 27 | 1.4 | V | -45.2 | 2.20 | 9.40 | -38.00 | -13 | 25.00 |
| 3404.05 | 46.6 | 140 | 1.7 | H | -54.0 | 1.40 | 9.70 | -45.70 | -13 | 32.70 |
| 3404.05 | 49.59 | 249 | 1.6 | V | -50.9 | 1.40 | 9.70 | -42.60 | -13 | 29.60 |
| Analog Modulation 868.9875 MHz-25 kHz | | | | | | | | | | |
| 886.489 | 40.36 | 71 | 2.2 | H | -54.6 | 0.70 | 0 | -55.30 | -13 | 42.30 |
| 886.489 | 42.69 | 138 | 1.9 | V | -51.3 | 0.70 | 0 | -52.00 | -13 | 39.00 |
| 1737.98 | 57.11 | 50 | 1.4 | H | -50.0 | 1.30 | 9.10 | -42.20 | -13 | 29.20 |
| 1737.98 | 55.13 | 303 | 1.6 | V | -51.3 | 1.30 | 9.10 | -43.50 | -13 | 30.50 |
| 2606.96 | 59.05 | 318 | 2.1 | H | -44.7 | 2.20 | 9.40 | -37.50 | -13 | 24.50 |
| 2606.96 | 60.97 | 65 | 1.9 | V | -42.4 | 2.20 | 9.40 | -35.20 | -13 | 22.20 |
| 3475.95 | 46.44 | 57 | 1.9 | H | -54.1 | 1.50 | 9.70 | -45.90 | -13 | 32.90 |
| 3475.95 | 48.41 | 240 | 2.5 | V | -52.9 | 1.50 | 9.70 | -44.70 | -13 | 31.70 |
| Digital Modulation 851.0125 MHz-12.5 kHz | | | | | | | | | | |
| 886.489 | 39.86 | 225 | 2.3 | H | -55.1 | 0.70 | 0 | -55.80 | -13 | 42.80 |
| 886.489 | 40.12 | 61 | 1.8 | V | -53.9 | 0.70 | 0 | -54.60 | -13 | 41.60 |
| 1702.03 | 53.44 | 296 | 2.0 | H | -53.6 | 1.30 | 9.10 | -45.80 | -13 | 32.8 |
| 1702.03 | 52.8 | 325 | 2.0 | V | -53.7 | 1.30 | 9.10 | -45.90 | -13 | 32.9 |
| 2553.04 | 56.72 | 153 | 1.1 | H | -47.0 | 2.20 | 9.40 | -39.80 | -13 | 26.8 |
| 2553.04 | 58.09 | 33 | 1.1 | V | -45.3 | 2.20 | 9.40 | -38.10 | -13 | 25.1 |
| 3404.05 | 46.52 | 20 | 1.6 | H | -54.1 | 1.40 | 9.70 | -45.80 | -13 | 32.8 |
| 3404.05 | 48.04 | 278 | 1.3 | V | -52.4 | 1.40 | 9.70 | -44.10 | -13 | 31.1 |

| Frequency (MHz) | Receiver Reading (dBµV) | Turn Table Angle Degree | Rx Antenna | | Substituted | | | Absolute Level (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Height (m) | Polar (H/V) | Level (dBm) | Cable Loss (dB) | Antenna Gain (dB) | | | |
| Digital Modulation 868.9875 MHz-12.5 kHz | | | | | | | | | | |
| 886.489 | 40.82 | 43 | 1.0 | H | -54.2 | 0.70 | 0 | -54.90 | -13 | 41.90 |
| 886.489 | 41.32 | 120 | 1.8 | V | -52.7 | 0.70 | 0 | -53.40 | -13 | 40.40 |
| 1737.98 | 52.39 | 240 | 2.0 | H | -54.7 | 1.30 | 9.10 | -46.90 | -13 | 33.9 |
| 1737.98 | 53.76 | 140 | 2.0 | V | -52.7 | 1.30 | 9.10 | -44.90 | -13 | 31.9 |
| 2606.96 | 57.42 | 75 | 1.1 | H | -46.3 | 2.20 | 9.40 | -39.10 | -13 | 26.1 |
| 2606.96 | 56.66 | 28 | 1.3 | V | -46.7 | 2.20 | 9.40 | -39.50 | -13 | 26.5 |
| 3475.95 | 47.41 | 306 | 1.5 | H | -53.1 | 1.50 | 9.70 | -44.90 | -13 | 31.9 |
| 3475.95 | 46.41 | 260 | 2.4 | V | -54.9 | 1.50 | 9.70 | -46.70 | -13 | 33.7 |
| Digital Modulation 935.0125 MHz-12.5 kHz | | | | | | | | | | |
| 886.489 | 41.95 | 20 | 2.4 | H | -53.1 | 0.70 | 0 | -53.80 | -13 | 40.80 |
| 886.489 | 40.16 | 237 | 1.4 | V | -53.8 | 0.70 | 0 | -54.50 | -13 | 41.50 |
| 1870.03 | 63.41 | 311 | 1.8 | H | -40.9 | 1.30 | 8.50 | -33.70 | -13 | 20.7 |
| 1870.03 | 61.68 | 166 | 1.9 | V | -42.8 | 1.30 | 8.50 | -35.60 | -13 | 22.6 |
| 2805.04 | 51.92 | 73 | 2.1 | H | -51.9 | 1.80 | 9.70 | -44.00 | -13 | 31 |
| 2805.04 | 51.22 | 41 | 1.1 | V | -52.2 | 1.80 | 9.70 | -44.30 | -13 | 31.3 |
| 3740.05 | 46.98 | 340 | 1.3 | H | -54.4 | 1.60 | 9.80 | -46.20 | -13 | 33.2 |
| 3740.05 | 47.69 | 213 | 2.1 | V | -53.1 | 1.60 | 9.80 | -44.90 | -13 | 31.9 |

**Note:**
Absolute Level = Substituted Level - Cable loss + Antenna Gain
Margin = Limit- Absolute Level

# FCC §2.1055 & §90.213 - FREQUENCY STABILITY

## Applicable Standard

FCC §2.1055 and §90.213

## Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feed-through attenuators. The EUT was placed inside the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the counter.

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 56 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Rocky Kang on 2017-12-30.*

*Test Mode: Transmitting*

**For 12.5 kHz:**

| Analog Modulation, Reference Frequency: 851.0125 MHz, Limit: ±1.0 ppm | | | |
|---|---|---|---|
| Test Environment | | Frequency Measure with Time Elapsed | |
| Temperature (℃) | Voltage Supplied ($V_{DC}$) | Measured Frequency (MHz) | Frequency Error (ppm) |
| Frequency Stability versus Input Temperature | | | |
| 50 | 13.60 | 851.012486 | -0.0165 |
| 40 | 13.60 | 851.012476 | -0.0282 |
| 30 | 13.60 | 851.012469 | -0.0364 |
| 20 | 13.60 | 851.012476 | -0.0282 |
| 10 | 13.60 | 851.012469 | -0.0364 |
| 0 | 13.60 | 851.012453 | -0.0552 |
| -10 | 13.60 | 851.012477 | -0.0270 |
| -20 | 13.60 | 851.012469 | -0.0364 |
| -30 | 13.60 | 851.012469 | -0.0364 |
| Frequency Stability versus Input Voltage | | | |
| 20 | 15.64 | 851.012458 | -0.0494 |
| 20 | 11.56 | 851.012462 | -0.0447 |

| Digital Modulation, Reference Frequency: 851.0125 MHz, Limit: ±1.0 ppm | | | |
|---|---|---|---|
| Test Environment | | Frequency Measure with Time Elapsed | |
| Temperature (℃) | Voltage Supplied ($V_{DC}$) | Measured Frequency (MHz) | Frequency Error (ppm) |
| Frequency Stability versus Input Temperature | | | |
| 50 | 13.60 | 851.012484 | -0.0188 |
| 40 | 13.60 | 851.012475 | -0.0294 |
| 30 | 13.60 | 851.012468 | -0.0376 |
| 20 | 13.60 | 851.012476 | -0.0282 |
| 10 | 13.60 | 851.012464 | -0.0423 |
| 0 | 13.60 | 851.012453 | -0.0552 |
| -10 | 13.60 | 851.012474 | -0.0306 |
| -20 | 13.60 | 851.012462 | -0.0447 |
| -30 | 13.60 | 851.012467 | -0.0388 |
| Frequency Stability versus Input Voltage | | | |
| 20 | 15.64 | 851.012452 | -0.0564 |
| 20 | 11.56 | 851.012445 | -0.0646 |

| Analog Modulation, Reference Frequency: 868.9875 MHz, Limit: ±1.5 ppm | | | |
|---|---|---|---|
| Test Environment | | Frequency Measure with Time Elapsed | |
| Temperature (℃) | Voltage Supplied ($V_{DC}$) | Measured Frequency (MHz) | Frequency Error (ppm) |
| Frequency Stability versus Input Temperature | | | |
| 50 | 13.60 | 868.987481 | -0.0219 |
| 40 | 13.60 | 868.987495 | -0.0058 |
| 30 | 13.60 | 868.987435 | -0.0748 |
| 20 | 13.60 | 868.987465 | -0.0403 |
| 10 | 13.60 | 868.987418 | -0.0944 |
| 0 | 13.60 | 868.987459 | -0.0472 |
| -10 | 13.60 | 868.987484 | -0.0184 |
| -20 | 13.60 | 868.987438 | -0.0713 |
| -30 | 13.60 | 868.987465 | -0.0403 |
| Frequency Stability versus Input Voltage | | | |
| 20 | 15.64 | 868.987451 | -0.0564 |
| 20 | 11.56 | 868.987447 | -0.0610 |

| Digital Modulation, Reference Frequency: 868.9875 MHz, Limit: ±1.5 ppm | | | |
|---|---|---|---|
| Test Environment | | Frequency Measure with Time Elapsed | |
| Temperature (℃) | Voltage Supplied ($V_{DC}$) | Measured Frequency (MHz) | Frequency Error (ppm) |
| Frequency Stability versus Input Temperature | | | |
| 50 | 13.60 | 868.987477 | -0.0265 |
| 40 | 13.60 | 868.987487 | -0.0150 |
| 30 | 13.60 | 868.987465 | -0.0403 |
| 20 | 13.60 | 868.987444 | -0.0644 |
| 10 | 13.60 | 868.987412 | -0.1013 |
| 0 | 13.60 | 868.987454 | -0.0529 |
| -10 | 13.60 | 868.987483 | -0.0196 |
| -20 | 13.60 | 868.987438 | -0.0713 |
| -30 | 13.60 | 868.987464 | -0.0414 |
| Frequency Stability versus Input Voltage | | | |
| 20 | 15.64 | 868.987449 | -0.0587 |
| 20 | 11.56 | 868.987456 | -0.0506 |

| Analog Modulation, Reference Frequency: 935.0125 MHz, Limit: ±0.1 ppm | | | |
|---|---|---|---|
| **Test Environment** | | **Frequency Measure with Time Elapsed** | |
| **Temperature (℃)** | **Voltage Supplied ($V_{DC}$)** | **Measured Frequency (MHz)** | **Frequency Error (ppm)** |
| Frequency Stability versus Input Temperature | | | |
| 50 | 13.60 | 935.012475 | -0.0267 |
| 40 | 13.60 | 935.012475 | -0.0267 |
| 30 | 13.60 | 935.012468 | -0.0342 |
| 20 | 13.60 | 935.012467 | -0.0353 |
| 10 | 13.60 | 935.012448 | -0.0556 |
| 0 | 13.60 | 935.012477 | -0.0246 |
| -10 | 13.60 | 935.012469 | -0.0332 |
| -20 | 13.60 | 935.012477 | -0.0246 |
| -30 | 13.60 | 935.012474 | -0.0278 |
| Frequency Stability versus Input Voltage | | | |
| 20 | 15.64 | 935.012470 | -0.0321 |
| 20 | 11.56 | 935.012463 | -0.0396 |

| Digital Modulation, Reference Frequency: 935.0125 MHz, Limit: ±0.1 ppm | | | |
|---|---|---|---|
| **Test Environment** | | **Frequency Measure with Time Elapsed** | |
| **Temperature (℃)** | **Voltage Supplied ($V_{DC}$)** | **Measured Frequency (MHz)** | **Frequency Error (ppm)** |
| Frequency Stability versus Input Temperature | | | |
| 50 | 13.60 | 935.012457 | -0.0460 |
| 40 | 13.60 | 935.012472 | -0.0299 |
| 30 | 13.60 | 935.012447 | -0.0567 |
| 20 | 13.60 | 935.012475 | -0.0267 |
| 10 | 13.60 | 935.012452 | -0.0513 |
| 0 | 13.60 | 935.012471 | -0.0310 |
| -10 | 13.60 | 935.012464 | -0.0385 |
| -20 | 13.60 | 935.012472 | -0.0299 |
| -30 | 13.60 | 935.012471 | -0.0310 |
| Frequency Stability versus Input Voltage | | | |
| 20 | 15.64 | 935.012443 | -0.0610 |
| 20 | 11.56 | 935.012456 | -0.0471 |

**For 25 kHz:**

| Analog Modulation, Reference Frequency: 851.0125 MHz, Limit: ±1.0 ppm | | | |
|---|---|---|---|
| Test Environment | | Frequency Measure with Time Elapsed | |
| Temperature (℃) | Voltage Supplied ($V_{DC}$) | Measured Frequency (MHz) | Frequency Error (ppm) |
| Frequency Stability versus Input Temperature | | | |
| 50 | 13.60 | 851.012476 | -0.0188 |
| 40 | 13.60 | 851.012467 | -0.0294 |
| 30 | 13.60 | 851.012469 | -0.0376 |
| 20 | 13.60 | 851.012466 | -0.0282 |
| 10 | 13.60 | 851.012475 | -0.0423 |
| 0 | 13.60 | 851.012469 | -0.0552 |
| -10 | 13.60 | 851.012439 | -0.0306 |
| -20 | 13.60 | 851.012477 | -0.0564 |
| -30 | 13.60 | 851.012476 | -0.0646 |
| Frequency Stability versus Input Voltage | | | |
| 20 | 15.64 | 851.012449 | -0.0599 |
| 20 | 11.56 | 851.012436 | -0.0752 |

| Analog Modulation, Reference Frequency: 868.9875 MHz, Limit: ±1.5 ppm | | | |
|---|---|---|---|
| Test Environment | | Frequency Measure with Time Elapsed | |
| Temperature (℃) | Voltage Supplied ($V_{DC}$) | Measured Frequency (MHz) | Frequency Error (ppm) |
| Frequency Stability versus Input Temperature | | | |
| 50 | 13.60 | 868.987439 | -0.0702 |
| 40 | 13.60 | 868.987453 | -0.0541 |
| 30 | 13.60 | 868.987459 | -0.0472 |
| 20 | 13.60 | 868.987468 | -0.0368 |
| 10 | 13.60 | 868.987469 | -0.0357 |
| 0 | 13.60 | 868.987457 | -0.0495 |
| -10 | 13.60 | 868.987466 | -0.0391 |
| -20 | 13.60 | 868.987459 | -0.0472 |
| -30 | 13.60 | 868.987418 | -0.0944 |
| Frequency Stability versus Input Voltage | | | |
| 20 | 15.64 | 868.987451 | -0.0564 |
| 20 | 11.56 | 868.987457 | -0.0495 |

******* END OF REPORT *******