# Engineering Test Report
# for the SDR-T-001 UHF 403-477 MHz
# 0.4W Exciter Modules for the BDP4 Digital Base Station

**Report Number:** 156-90000-920

**Apparatus:** SDR-T-001 UHF 403-477 MHz exciter module

**Model Number:** SDR-T-001-403

**Support Equipment:** P4 base station controller/modem module (BSC2)
P4_PD+ base data link controller/modem module (BDLCslim)

**Applicant:**
CalAmp Corporation
5540 Ferrier Street, Suite 101
Town of Mount Royal, QC
H4P 1M2, Canada

**IC ID:** EOTBDP4-EXCT403

**Test Specification:** Title 47 - Telecommunication
Part 90 - Private Land Mobile Radio Services
Subpart I - General Technical Standards

**Prepard by:**
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H4P 1M2, Canada

**Submitted by:** Richard Vallée
_____
**Richard Vallée:** Senior Hardware Engineer

**Approved by:**
_____
**Pierre Olivier:** R/D Engineering Manager

## Section A0: General

All applicable test data according to:

- Part 2: 2.1046, 2.1047, 2.1049 and 2.1057
- Part 90, Subpart I: 90.205, 90.207, 90.209, 90.213 and 90.214

are provided in this report, while other applicable test data according to Part 2.1051, 2.1053 and Part 90.210 (d)(3) are provided in another report, as shown below:

| **Section-# of Pages** | **Data Contents** | **FCC parts** | **Laboratory** |
|---|---|---|---|
| A0-1 | General. | | |
| A1-3 | Transmitter Rated Power Output | 2.1046 (a) (c), 90.205 | CalAmp Corp, Montreal R&D |
| A1-2 | Frequency Stability vs Variation in Supply Voltage | 2.1055 (d)(1), 90.213 | CalAmp Corp, Montreal R&D |
| A1-2 | Frequency Stability vs Variation in Ambient Temperature | 2.1055 (a) (b), 90.213 | CalAmp Corp, Montreal R&D |
| A2-3 | P4 BSC2 Modulation Source: Modulation Characteristics - Digital Modulation Techniques - Spectrum Efficiency | 2.1047, 90.207 - 2.1033 (c)(13) - 90.203 (j)(3) | CalAmp Corp, Montreal R&D |
| A3-3 | P4_PD+ BDLCslim Modulation Source: Modulation Characteristics - Digital Modulation Techniques - Spectrum Efficiency | 2.1047, 90.207 - 2.1033 (c)(13) - 90.203 (j)(3) | CalAmp Corp, Montreal R&D |
| A4-28 | P4 BSC2 and P4_PD+ BDLCslim Modulation Sources: Occupied bandwidth – Emission Designator – Mask Compliance | 2.201, 2.202, 2.1033(c) (14), 2.1041, 2.1049 (h), 90.209 (b)(5), 90.210 (c)(d) | CalAmp Corp, Montreal R&D |
| A5- 5 | Transient Frequency Behavior | 90.214 | CalAmp Corp, Montreal R&D |
| B1-24 | Transmitter Unwanted Emissions | 2.1051, 90.210 (d)(3) 2.1053, 90.210 (d)(3) | Nemko Canada Inc, Ottawa Laboratories |
| **71** | **Total number of report pages** | | |

## Section A1: Transmitter Power and Frequency Stability

# Summary

These tests were conducted on a sample of equipment for the purpose of demonstrating compliance with the restrictions related to the RF power and the frequency stability of the equipment operating in the 406.1-512 MHz range, as defined by the rules found in FCC Part 90. These tests were performed in accordance with ANSI TIA-603 B.

The assessment summary is:

EQUIPMENT UNDER TEST: SDR-T-001UHF 403-477MHz exciter module (model name SDR-T-001-403)

SERIAL NUMBER (S): Pre-production sample

SUPPORT EQUIPMENT: P4 base station controller/modem module, pre-production sample (model name BSC2)

SPECIFICATIONS: FCC Part 90 Private Land Mobile Radio Services

COMPLIANCE STATUS: **Compliant**

EXCLUSIONS: None

NON-COMPLIANCES: None

TEST RESULTS SUMMARY:

| Test name | Page No | Worst case data | Margin | Assessment |
|---|---|---|---|---|
| Transmitter Rated Output Power | | 400mW | NA | Pass |
| Frequency Stability over voltage | | 101Hz or 0.22ppm | 1.28ppm | Pass |
| Frequency stability over temperature | | 400Hz or 0.96 ppm | 0.54ppm | Pass |

The technical data included in this report has been accumulated through tests that were performed by me or under my direction. To the best of my knowledge, all of the data is true and correct

PERFORMED BY: Richard Vallée DATE: 13/04/10

Richard Vallée

NAME OF TEST: Transmitter Rated Power Output

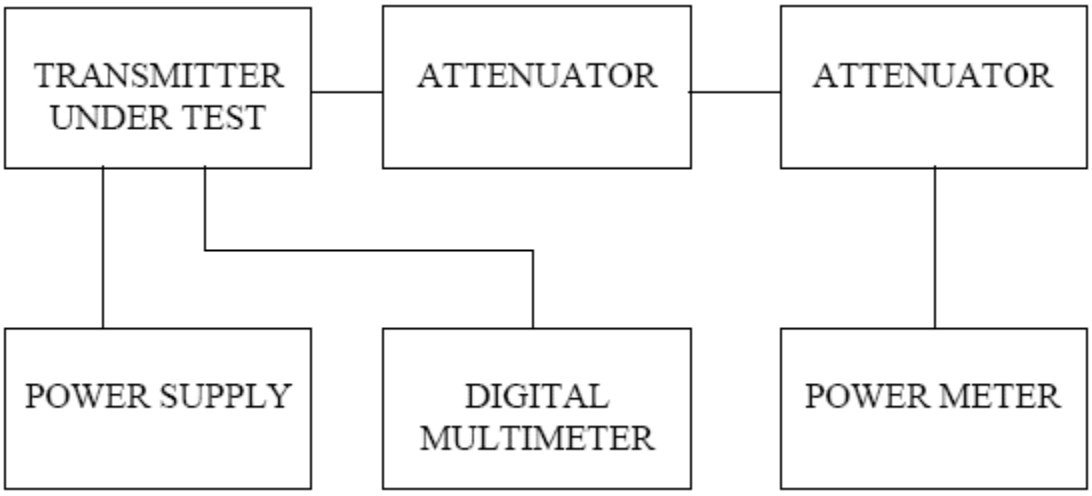
RULE PART NUMBER: FCC 2.1046 (a) (c), 90.205

TEST RESULTS: 0.4W adjustable down to 4mW see data below

TEST CONDITIONS: Standard Test Conditions

TEST EQUIPMENT: 50-Ohm Attenuators, 30dB 150W, Bird Model 150-A-MFN-30
50-Ohm Attenuators, 6dB 50W, Bird Model 50-A-MFN-06
Variable DC Power Supply, Astron VS-20M
Power Meter, IFR COM-120B Comm. Monitor, DR612B
Digital Voltmeter, Fluke 77 series II multimeter
True RMS Clamp multimeter, Extech model 380947

TEST SET-UP:




PERFORMED BY: Richard Vallée Date: 05/04/10

TEST RESULTS:

| Band | Frequency (MHz) | DC Voltage at Exciter (Vdc) | DC Current into Exciter (Adc) | DC Power into Exciter (W) | RF Power Output (mW) |
|---|---|---|---|---|---|
| **UHF LOW** | 406.05 | 13.8 | 1.1 | 15.18 | 387 |
| | 418.05 | 13.8 | 0.4 | 5.52 | 0 |
| | 418.05 | 13.8 | 1 | 13.8 | 4 |
| | 418.05 | 13.8 | 1.11 | 15.32 | 388 |
| | 429.9875 | 13.8 | 1.1 | 15.18 | 397 |
| **UHF MID** | 450.0125 | 13.8 | 1.1 | 15.18 | 394 |
| | 460 | 13.8 | 1.11 | 15.32 | 400 |
| | 469.9875 | 13.8 | 1.11 | 15.32 | 390 |

NAME OF TEST: Frequency Stability with Variation in Supply Voltage

RULE PART NUMBER: FCC 2.1055 (d)(1), 90.213

MINIMUM STANDARD: For 12.5KHz channel bandwidths, shall not exceed ± 0.000150 % from test frequency, or ±1.50 ppm for ± 15% change in supply voltage.

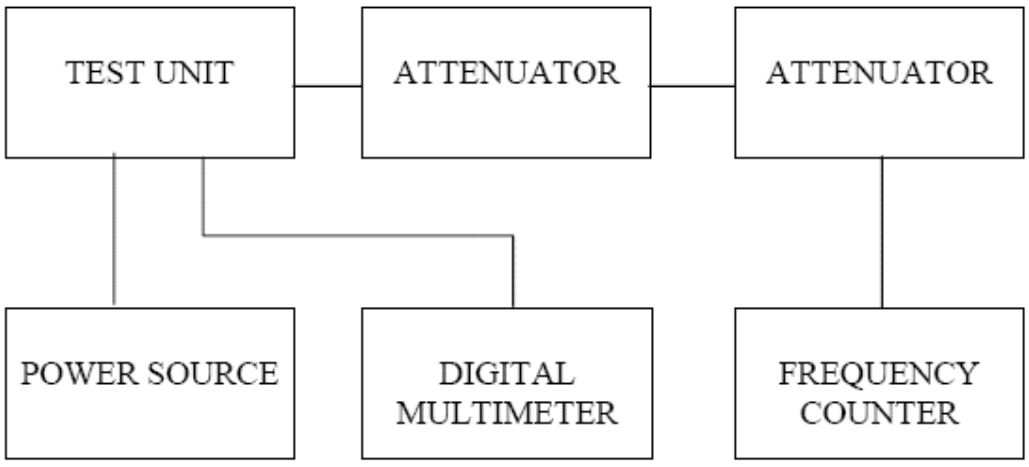
TEST RESULTS: Meets minimum standard, see data on following page

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT: 50-Ohm Attenuators, 30dB 150W, Bird Model 150-A-MFN-30
50-Ohm Attenuators, 6dB 50W, Bird Model 50-A-MFN-06
Variable DC Power Supply, Astron VS-20M
Frequency meter, IFR COM-120B, DR612B
Digital Voltmeter, Fluke 77 series II multimeter

PERFORMED BY: Richard Vallée _____ Date: 05/04/10

TEST SET-UP:




TEST SET-UP

**UHF LOW:**

Channel Frequency: 418.05000 MHz
Power level: 0.4W
Highest Variation: 0.22

| Input Voltage ( Vdc ) | Frequency ( MHz ) | Delta Freq ( Hz ) | Ppm from assigned Frequency |
|---|---|---|---|
| 11.7 | 418.050090 | 90 | 0.22 |
| 13.8 | 418.050082 | 82 | 0.20 |
| 15.9 | 418.050064 | 64 | 0.15 |

Spec. limit ±1.50 ppm

**UHF MID:**

Channel Frequency: 460.00000 MHz
Power level: 0.4W
Highest Variation: 0.22

| Input Voltage ( Vdc ) | Frequency ( MHz ) | Delta Freq ( Hz ) | Ppm from assigned Frequency |
|---|---|---|---|
| 11.7 | 460.000098 | 98 | 0.21 |
| 13.8 | 460.000101 | 101 | 0.22 |
| 15.9 | 460.000091 | 91 | 0.2 |

Spec. limit ±1.50 ppm

NAME OF TEST: Frequency Stability with Variation in Ambient Temperature

RULE PART NUMBER: FCC 2.1055 (a) (b), 90.213

MINIMUM STANDARD: For 12.5KHz channel bandwidths, shall not exceed ± 0.000150 % from test frequency, or ±1.50 ppm

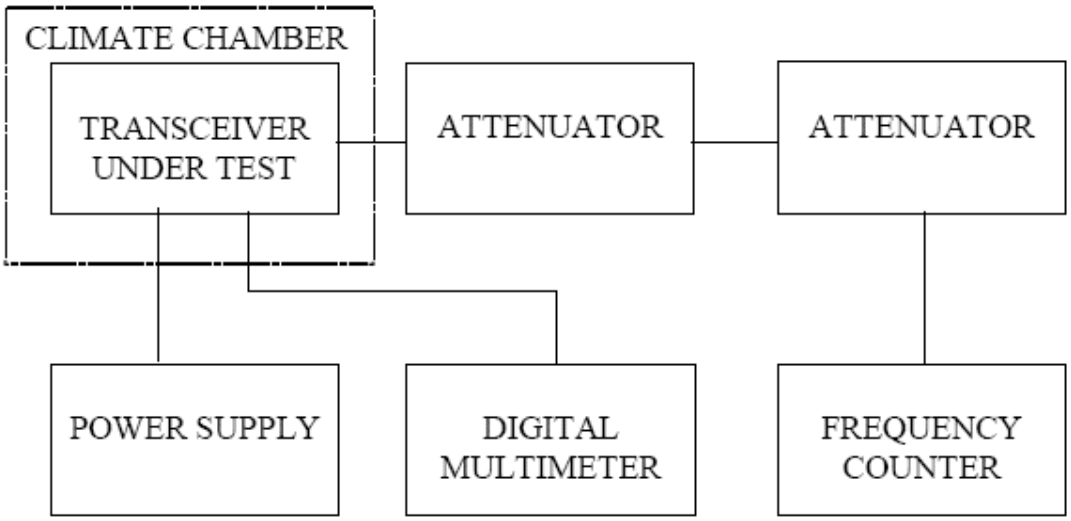
TEST RESULTS: Meets minimum standard, see data on following page

TEST CONDITIONS: Standard Test Conditions

TEST EQUIPMENT: 50-Ohm Attenuators, 30dB 150W, Bird Model 150-A-MFN-30
50-Ohm Attenuators, 6dB 50W, Bird Model 50-A-MFN-06
Variable DC Power Supply, Astron VS-20M
Frequency meter, IFR COM-120B, DR612B
Digital Voltmeter, Fluke 77 series II multimeter
Climate Chamber, TempGard III, Tenney Jr.

PERFORMED BY: Richard Vallée _____ Date: 07/04/10

TEST SET-UP:



UHF LOW

Channel Frequency: 418.0500MHz
Voltage & Power Level: 13.8V @ 0.4 Watts
Highest Variation (ppm) 0.957

| Temperature (Deg C) | Measured Frequency (Mhz) | Frequency Error (Hz) | Frequency Error (ppm) |
|---|---|---|---|
| -30 | 418.05029 | 290 | 0.694 |
| -20 | 418.05035 | 350 | 0.837 |
| -10 | 418.05010 | 100 | 0.239 |
| 0 | 418.05007 | 70 | 0.167 |
| 10 | 418.05003 | 30 | 0.072 |
| 20 | 418.04998 | -20 | -0.048 |
| 30 | 418.04989 | -110 | -0.263 |
| 40 | 418.04979 | -210 | -0.502 |
| 50 | 418.04972 | -280 | -0.670 |
| 60 | 418.04960 | -400 | -0.957 |

Spec. limit ±1.50 ppm

UHF MID

Channel Frequency: 460.0000MHz
Voltabe & Power Level: 13.8V @ 0.4 Watts
Highest Variation (ppm) 0.834

| Temperature (Deg C) | Measured Frequency (Mhz) | Frequency Error (Hz) | Frequency Error (ppm) |
|---|---|---|---|
| -30 | 460.00027 | 270 | 0.587 |
| -20 | 460.00032 | 320 | 0.696 |
| -10 | 460.00008 | 80 | 0.174 |
| 0 | 460.00005 | 50 | 0.109 |
| 10 | 460.00004 | 40 | 0.087 |
| 20 | 460.00000 | 0 | 0 |
| 30 | 459.99992 | -80 | -0.174 |
| 40 | 459.99981 | -190 | -0.413 |
| 50 | 459.99975 | -250 | -0.543 |
| 60 | 459.99962 | -380 | -0.826 |

Spec. limit ±1.50 ppm

## Section A2 P4 BSC2 Modulation Source: Modulation Characteristics - Digital Modulation Techniques – Spectrum Efficiency

This section contains the following required data:

- **Modulation Characteristic** FCC 2.1047 (d)
- **Digital Modulation Techniques** FCC 2.1033 (c)(13)
- **Spectrum Efficiency Standard** FCC 90.203 (j)(3)

**MODULATION CHARACTERISTIC** FCC 2.1047 (d)

Other types of equipment: this equipment is not provided with hardware audio low-pass filters, the filtering is entirely the result of the DSP-based digital filter controlled by firmware in the modulation source.

**DIGITAL MODULATION TECHNIQUES** FCC 2.1033 (c)(13)

The Paragon 4 digital base station comprises the controller/modem (BSC2) which generates a digitized multi-level frequency shift keying modulating signal. This digital modulation scheme is produced by the main PowerPC central processing unit (CPU) in conjunction with a DSP processor, and the resulting analog differential output signals are DC-coupled to the baseband differential inputs of the SDR-001-T-UHF exciter.

This modulation scheme is used in conjunction with the Dataradio Next Generation high-efficiency Enhanced DBA over-the-air protocol. The protocol has provisions to have the 16FSK modulation scheme use only a subset of the 16 levels to generate 8FSK or 4FSK subsets, reducing the bit rate to ¾ or ½ of the full 16FSK bit rate while keeping the baud (signalling) rate and deviation setting constant. Reducing the number of signalling levels allows the data rate to be traded off for increased decode sensitivity (range) without changing the transmitter emission. Because only intermediate signalling levels are deleted, the overall emission bandwidth is virtually unchanged.

In detail, the main CPU processes incoming data to comply with data-link layer requirements, then feeds this binary stream to the DSP which performs Forward Error Correction (FEC) coding, interleaving and scrambling, then generates an NRZ stream for encoding and pulse shaping. The digital processing computes the binary differential and maps the binary bit stream into a symbol (baud) stream. The result is processed as stream of symbols of multiple-bits as required by the multiple-level FSK type of modulation. The number of levels of the digital symbol stream corresponds to the numbers of levels (N) of NFSK modulation.

The DSP processes the digital symbol stream using a Squared Root Raised Cosine filter (SRRC) whose coefficients determine the filter characteristic and its 3dB cutoff frequency. The equation trim factor, which for the SRRC family is the cosine weight "α", is set according to the bit/baudrate rate selected and channel bandwidth. For each bit rate, the filter coefficients are obtained from a Inverse Fourier Transform of the desired SRRC filter response curve. The three proposed baud rates and their corresponding bit rates (16FSK, 8FSK and 4FSK) are shown in the following table:

| Chn. BW (KHz) | Bit rate (Kbps) | Symbol rate (baud) | FSK levels | Pulse shape and modulation type | Acronyms / factor / 3dBcutoff freq. |
|---|---|---|---|---|---|
| 12.5 | 32 | 8000 | 16 | SRRC 16-lvl FSK | SRRC16FSK, α=0.4, 4000Hz |
| | 24 | 8000 | 8 | SRRC 8-lvl FSK | SRRC8FSK, α=0.4, 4000Hz |
| | 16 | 8000 | 4 | SRRC 4-lvl FSK | SRRC4FSK, α=0.4, 4000Hz |
| 25 | 64 | 16000 | 16 | SRRC 16-lvl FSK | SRRC16FSK, α=0.4, 8000Hz |
| | 48 | 16000 | 8 | SRRC 8-lvl FSK | SRRC8FSK, α=0.4, 8000Hz |
| | 43.2 | 14400 | 8 | SRRC 8-lvl FSK | SRRC8FSK, α=0.4, 7200Hz |
| | 32 | 16000 | 4 | SRRC 4-lvl FSK | SRRC4FSK, α=0.4, 8000Hz |

The pulse-shaped signal is then subject to an amplification constant to adjust the transmitter deviation level, then fed to the CODEC for digital-to-analog conversion. The transmitter deviation level and digital filter cutoff frequency are set according to the bit rate selected and channel bandwidth as follows:

| Chn. BW (KHz) | Bit Rate (Kbps) | Modulation type / trim factor / 3dB cutoff freq. | Reference deviation for 1kHz tone (Hz) | Maximum Digital Deviation (Hz) | Occupied Bandwidth (Hz) | Emission designator |
|---|---|---|---|---|---|---|
| 12.5 | 32 | SRRC16FSK, α=0.4, 4000Hz | 2200 | 2700 | 8167 | 8K30F1D |
| | 24 | SRRC8FSK, α=0.4, 4000Hz | 2100 | 2700 | 8167 | 8K30F1D |
| | 16 | SRRC4FSK, α=0.4, 4000Hz | 1500 | 2000 | 7667 | 7K80F1D |
| 25 | 64 | SRRC16FSK, α=0.4, 8000Hz | 4200 | 5300 | 16000 | 16K1F1D |
| | 48 | SRRC8FSK, α=0.4, 8000Hz | 4100 | 5200 | 15670 | 15K8F1D |
| | 43.2 | SRRC8FSK, α=0.4, 7200Hz | 4200 | 5400 | 15670 | 15K8F1D |
| | 32 | SRRC4FSK, α=0.4, 8000Hz | 3500 | 4700 | 16000 | 16K1F1D |

The resulting wave shape is applied to the analog-to-digital I & Q FM modulator inside the exciter, which will then produce a compact RF spectrum, which when using the correct frequency

deviation, fits within the restrictive limits inherent to the intended channel bandwidth. The receiver performs the same processes in reverse to demodulate the received symbols into a digital data stream

**SPECTRUM EFFICIENCY STANDARD DATA** FCC 90.203 (j)(3)

The Paragon 4 SRRC16FSK modulation source transmits 64000 bps in 25 kHz channel bandwidth. This represents more than 4800*4=19200bps required for 6.25*4=25kHz channel bandwidth
The Paragon 4 16FSK modulation source transmits 32000 bps in 12.5 kHz channel bandwidth.
This represents more than 4800*2=9600bps required for 6.25*2=12.5kHz channel bandwidth

## Section A3 P4_PD+ BDLCslim Modulation Source: Modulation Characteristics – Digital Modulation Techniques – Spectrum Efficiency

This section contains the following required data:

- **Modulation Characteristic** FCC 2.1047 (d)
- **Digital Modulation Techniques** FCC 2.1033 (c)(13)
- **Spectrum Efficiency Standard** FCC 90.203 (j)(3)

**MODULATION CHARACTERISTIC** FCC 2.1047 (d)

Other types of equipment: this equipment is not provided with hardware audio low-pass filters, the filtering is entirely the result of the DSP-based digital filter controlled by firmware in the modulation source.

**DIGITAL MODULATION TECHNIQUES** FCC 2.1033 (c)(13)

The Paragon 4 PD+ digital base station supports DBA (Dynamic Bandwidth Allocation), a Calamp proprietary protocol. DBA is a 5:1 TDMA protocol optimized for public utilities and public safety markets.

The controller part of the BDLCslim module generates the digital stream characteristic of this wireless network protocol. Its frame sizes and block format are not dependent of the network speed. Each frame consists of a frame recognition pattern and a data packet (block). DBA protocol requires transmission of the frame recognition pattern from the base to maintain the synchronization at the mobile end of the network. The system transmits "idle" packets as message terminators to schedule mobile acknowledgements. Both "idle" and "data " packets undergo FEC encoding and scrambling by the CPU to preserve the characteristics of random data.

The slot recognition pattern for frames are ¼ network symbol rate filtered data symbols. The idle packet slots follow an idle pattern. This pattern is generated by the internal software using the polynomial $X^{11}+X^{9}+1$ form and a 12-bit shift register. Initial value of the register is 111111111110 (FFE hex). The 2047 bit sequence is repeated thereafter as long is necessary to complete the idle duration . This pattern is applied to the DSP processor data input for encoding and pulse shaping.

The modem part of the BDLCslim module generates N-level filtered FSK type modulation signals. The N-level voltages and the filtering control are a DSP implementation which establishes the modulation limits and is not subject to aging or drift. The hardware-based low-pass filtering has been replaced by the DSP filtering and complies with the RF mask compliance requirements found in FCC Part 90.210 (c) for mask C and D.

The DBA protocol as described above is implemented using various digital modulation schemes. The measurement in this report concerns the 2, 4 and 8-level FSK schemes combined with one of the three following pulse shaping filters:

- Square Root Raised Cosine (SRRC) with an α = 0.4 for cut-off frequency.
- Raised Cosine (RC) with an α = 04 for cut-off frequency.
- Gaussian filter (DGMSK) with a BT = 0.3 for cut-off frequency.
  Note: The term DGMSK, differential gaussian minimum shift keying, is loosely used here and throughout the industry to represent the generic modulation scheme DGFSK.

The DSP processes the digital symbol stream using one of these pulse shaping filters whose coefficients determine the filter characteristic and its 3dB cutoff frequency. The equation trim factor, which for the SRRC and RC families is the cosine weight "α", is set according to the bit/baudrate rate selected and channel bandwidth. For each bit rate, the filter coefficients are obtained from a Inverse Fourier Transform of the desired SRRC or RC filter response curve. Similarly for the gaussian filter, the filter characteristic and 3dB cutoff frequency is set by the "BT" value and the bit rate.

The various bit rates and filtered FSK modulation schemes proposed for 12.5 and 25KHz channels BWs are shown in the following table:

| Chn. BW (KHz) | Bit Rate (Kbps) | Symbol rate (baud) | FSK levels | Pulse shape filter | Acronyms / factor / 3dBcutoff freq. |
|---|---|---|---|---|---|
| 12.5 | 21.6 | 7200 | 8 | SRRC | SRRC8FSK, α=0.4, 3600Hz |
| | 16 | 8000 | 4 | SRRC | SRRC8FSK, α=0.4, 4000Hz |
| | 14.4 | 7200 | 4 | SRRC | SRRC8FSK, α=0.4, 3600Hz |
| | 9.6 | 9600 | 2 | DGMSK | DGMSK2FSK, BT = 0.3, 2880Hz |
| | 8 | 8000 | 2 | DGMSK | DGMSK2FSK, BT = 0.4, 3200Hz |
| 25 | 43.2 | 14400 | 8 | SRRC | SRRC8FSK, α=0.4, 7200Hz |
| | 32 | 16000 | 4 | RC | RC4FSK, α=0.4, 8000Hz |
| | 25.6 | 12800 | 4 | SRRC | SRRC8FSK, α=0.4, 6400Hz |
| | 19.2 | 9600 | 4 | SRRC | SRRC8FSK, α=0.4, 4800Hz |
| | 19.2 | 19200 | 2 | DGMSK | DGMSK2FSK, BT = 0.3, 5760Hz |
| | 9.6 | 9600 | 2 | DGMSK | DGMSK2FSK, BT = 0.3, 2880Hz |

Both network speed and digital modulation scheme are produced by the main CPU in conjunction with the DSP. The main CPU processes incoming binary data to make it fit the DBA protocol as described above. Then the process continues on the DBA formatted data applying Forward Error Correction (FEC), interleaving and scrambling, and from it generates an NRZ signal that is fed to the DSP processor for encoding and pulse shaping at network speed. The DSP processor assigns to every incoming bit/ 2-bit/ 3-bit set, a symbol recorded in a level of frequency shift. The mapping follows a differential encoding scheme for DGMSK2FSK and a Gray encoding scheme for RC4FSK, SRRC4FSK and SRRC8FSK modulation types.

The pulse-shaped signal is then subject to an amplification constant to adjust the transmitter deviation level, then fed to the CODEC for digital-to-analog conversion. The transmitter deviation level and digital filter cutoff frequency are set according to the bit rate selected and channel bandwidth as follows:

| Chn. BW (KHz) | Bit Rate (Kbps) | Modulation type / trim factor / 3dB cutoff freq. | Reference deviation for 1kHz tone (Hz) | Maximum Data Deviation (Hz) | Occupied Bandwidth (Hz) | Emission designator |
|---|---|---|---|---|---|---|
| 12.5 | 21.6 | SRRC8FSK, α=0.4, 3600Hz | 2200 | 2700 | 8000 | 8K10F1D |
| | 16 | SRRC8FSK, α=0.4, 4000Hz | 1900 | 2200 | 7333 | 7K50F1D |
| | 14.4 | SRRC8FSK, α=0.4, 3600Hz | 2300 | 2900 | 8000 | 8K10F1D |
| | 9.6 | DGMSK2FSK, BT = 0.3, 2880Hz | 2000 | 2200 | 8000 | 8K10F1D |
| | 8 | DGMSK2FSK, BT = 0.4, 3200Hz | 2100 | 2300 | 8167 | 8K30F1D |
| 25 | 43.2 | SRRC8FSK, α=0.4, 7200Hz | 4300 | 5300 | 15843 | 16K0F1D |
| | 32 | RC4FSK, α=0.4, 8000Hz | 4300 | 5200 | 15456 | 15K6F1D |
| | 25.6 | SRRC8FSK, α=0.4, 6400Hz | 3900 | 4400 | 14588 | 14K7F1D |
| | 19.2 | SRRC8FSK, α=0.4, 4800Hz | 4300 | 5500 | 15799 | 15K9F1D |
| | 19.2 | DGMSK2FSK, BT = 0.3, 5760Hz | 3700 | 3800 | 14443 | 14K6F1D |
| | 9.6 | DGMSK2FSK, BT = 0.3, 2880Hz | 4200 | 4300 | 13613 | 13K8F1D |

The resulting wave shape is applied to the analog-to-digital I& Q FM modulator inside the exciter, which will then produce a compact RF spectrum, which when using the correct frequency deviation, fits within the restrictive limits inherent to the intended channel bandwidth. The receiver performs the same processes in reverse to demodulate the received symbols into a digital data stream

**SPECTRUM EFFICIENCY STANDARD DATA** FCC 90.203 (j)(3)

The Paragon 4 PD+'s SRRC8FSK modulation source transmits 43200 bps in 25 kHz channel bandwidth.
This represents more than 4800*4 = 19200 bps required for 6.25*4 = 25kHz channel bandwidth.
The Paragon 4 PD+'s SRRC8FSK modulation source transmits 21600 bps in 12.5 kHz channel bandwidth.
This represents more than 4800*2 = 9600 bps required for 6.25*2 = 12.5kHz channel bandwidth.

Section A4: Occupied bandwidth - Emission Designator – Mask Compliance

## Summary

These tests were conducted on a sample of equipment for the purpose of demonstrating compliance with the occupied bandwidth and the RF spectrum mask restrictions of the 12.5 KHz and 25.0 KHz channels in the 406.1-512 MHz range, as defined in the rules of FCC Part 90 at the testing date. The tests were performed in accordance with ANSI TIA-603 B.

The assessment summary is:

EQUIPMENT UNDER TEST: SDR-T-001UHF 403-477MHz exciter module (model name SDR-T-001-403)

SERIAL NUMBER (S): Pre-production sample

SUPPORT EQUIPMENT: P4 base station controller/modem module, pre-production sample (model name BSC2)

P4_PD+ base data link controller/modem module, pre-production sample (model name BDLCslim)

SPECIFICATIONS: FCC Part 90 Private Land Mobile Radio Services

COMPLIANCE STATUS: **Compliant**

EXCLUSIONS: None

NON-COMPLIANCES: None

TEST RESULTS SUMMARY: For the BSC2 module, the modulation's pulse shaping filter is a square-root raised cosine (SRRC) related to the symbol rate. There are 4, 8 and 16-Level FSK options for the symbol rates, 8000 and 16000 baud, and only the 8-Level FSK option for the symbol rate 14400 baud.

| Chn. BW (KHz) | Bit rate (Kbps) | Symbol rate (baud) | Pulse shape and modulation type | Occupied Bandwidth (Hz) | Emission designator | Limit mask | Result |
|---|---|---|---|---|---|---|---|
| 12.5 | 32 | 8000 | SRRC 16-lvl FSK | 8167 | 8K30F1D | D | Pass |
| | 24 | 8000 | SRRC 8-lvl FSK | 8167 | 8K30F1D | D | Pass |
| | 16 | 8000 | SRRC 4-lvl FSK | 7667 | 7K80F1D | D | Pass |
| 25 | 64 | 16000 | SRRC 16-lvl FSK | 16000 | 16K1F1D | C | Pass |
| | 48 | 16000 | SRRC 8-lvl FSK | 15670 | 15K8F1D | C | Pass |
| | 43.2 | 14400 | SRRC 8-lvl FSK | 15670 | 15K8F1D | C | Pass |
| | 32 | 16000 | SRRC 4-lvl FSK | 15670 | 15K8F1D | C | Pass |

For the BDLCslim module, there are three types of pulse shaping filters used in the Paragon 4 PD+ modem. The square-root raised cosine (SRRC) pulse shaping filter is used on all speeds with 4 and 8-level FSK modulation, except for the 32Kbps speed, which uses a raised cosine (RC) pulse shaping filter. The differential gaussian minimum shift keing (DGMSK) pulse shaping filter is used on all speeds with 2-level FSK modulation.

| Chn. BW (KHz) | Bit rate (Kbps) | Symbol rate (baud) | Pulse shape and modulation type | Occupied Bandwidth (Hz) | Emission designator | Limit mask | Result |
|---|---|---|---|---|---|---|---|
| 12.5 | 21.6 | 7200 | SRRC 8-lvl FSK | 8000 | 8K10F1D | D | Pass |
| | 16 | 8000 | SRRC 4-lvl FSK | 7333 | 7K50F1D | D | Pass |
| | 14.4 | 7200 | SRRC 4-lvl FSK | 8000 | 8K10F1D | D | Pass |
| | 9.6 | 9600 | DGMSK 2-lvl FSK | 8000 | 8K10F1D | D | Pass |
| | 8 | 8000 | DGMSK 2-lvl FSK | 8167 | 8K30F1D | D | Pass |
| 25 | 43.2 | 14400 | SRRC 8-lvl FSK | 15843 | 16K0F1D | C | Pass |
| | 32 | 16000 | RC 4-lvl FSK | 15456 | 15K6F1D | C | Pass |
| | 25.6 | 12800 | SRRC 4-lvl FSK | 14588 | 14K7F1D | C | Pass |
| | 19.2 | 9600 | SRRC 4-lvl FSK | 15799 | 15K9F1D | C | Pass |
| | 19.2 | 19200 | DGMSK 2-lvl FSK | 14443 | 14K6F1D | C | Pass |
| | 9.6 | 9600 | DGMSK 2-lvl FSK | 13613 | 13K8F1D | C | Pass |

ATTESTATION: The technical data included in this report has been accumulated through tests that were performed by me or under my direction. To the best of my knowledge, all of the data is true and correct

Richard Vallée

PERFORMED BY: _____ DATE: 21/04/10

Richard Vallée

**NAME OF TEST: Emission Designator for the BSC2 Modulation Source**

RULE PART NUMBER: FCC 2.201, 2.202, 2.1033 c (14), 2.1041, 2.1049 (h), 90.207, 90.209(b)(5)

For the SRRC N-level FSK type of emissions, a Paragon 4 base station controller/modem module (BSC2) was the source of the digital modulation signals. The random signal generator passes the test sequence through a DSP-based digital SRRC filter to feed the FM modulator. The necessary bandwidth calculation for this type of modulation (SRRC16FSK) is not covered by paragraphs (1), (2) or (3) from 2.202(c), the result exceeding by far the real necessary bandwidth obtained through measurement of the 99% of the occupied bandwidth.

Therefore, the approach outlined in (2.202(c)(4)) is applicable in this case.

**Necessary Bandwidth Measurement** (90.209.(b))
The results of 99% Occupied Bandwidth measurement are:

| Channel BW (KHz) | Bit Rate (Kbps) | Pulse shape and modulation type | Reference deviation for 1kHz tone (Hz) | Maximum Digital Deviation (Hz) | Occupied Bandwidth (Hz)[1)] | Emission designator |
|---|---|---|---|---|---|---|
| 12.5 | 32 | SRRC 16-lvl FSK | 2200 | 2700 | 8167 | 8K30F1D |
| | 24 | SRRC 8-lvl FSK | 2100 | 2700 | 8167 | 8K30F1D |
| | 16 | SRRC 4-lvl FSK | 1500 | 2000 | 7667 | 7K80F1D |
| 25 | 64 | SRRC 16-lvl FSK | 4200 | 5300 | 16000 | 16K1F1D |
| | 48 | SRRC 8-lvl FSK | 4100 | 5200 | 15670 | 15K8F1D |
| | 43.2 | SRRC 8-lvl FSK | 4200 | 5400 | 15670 | 15K8F1D |
| | 32 | SRRC 4-lvl FSK | 3500 | 4700 | 15670 | 15K8F1D |

[1)] – Supporting plots for these values are shown in the mask compliance test to follow. The deviation meter has an IF filter bandwidth of 30kHz. The measurement setup is explained below.

**Occupied Bandwidth Measurement**

The Occupied Bandwidth measurement option of the instrument (8563EC spectrum analyzer from Agilent) calculates and provides the values used above for the emission designator.

The percentage setting of the measurement has been set to 99% following the definition of the ***Occupied Bandwidth*** as "the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission" (FCC 2.202) .

The measurement has been performed during the tests for compliance with mask C or D, the highest resulting value was recorded for the Occupied Bandwidth. The measurement set-up is detailed along with mask compliance test reports.

**TX Data Test Pattern:**

The transmit "test data" pattern command produces an 8,388,607 bit pseudo- random pattern. This pattern is generated by the DSP using the polynomial X23+X5+1 form and a 23-bit shift register with an initial

value of 1. The 8,388,607 bit sequence is repeated thereafter as long is necessary to complete the test duration. This pattern is applied to the DSP modulator for mapping to 16-FSK (8-FSK or 4-FSK) with a Squared Root Raised Cosine pulse shaping with $\alpha = 0.4$.

**NAME OF TEST: Emission Designator for the BDLCslim Modulation Source**

RULE PART NUMBER: FCC 2.201, 2.202, 2.1033 c (14), 2.1041, 2.1049 (h), 90.207, 90.209(b)(5)

For the N-level FSK type of emissions, a PD+ base data link controller/modem module (BDLCslim) was the source of the digital modulation signals. The test data pattern passes through a DSP-based digital low-pass/pulse shaping filters to feed the FM modulator. The necessary bandwidth calculation for this type of modulation (SRRC8FSK) is not covered by paragraphs (1), (2) or (3) from 2.202(c), the result exceeding by far the real necessary bandwidth obtained through measurement of the 99% of the occupied bandwidth.

Therefore, the approach outlined in (2.202(c)(4)) is applicable in this case.

**Necessary Bandwidth Measurement** (90.209.(b))
The results of 99% Occupied Bandwidth measurement are:

| Chn. BW (KHz) | Bit Rate (Kbps) | Pulse shape and modulation type | Reference deviation for 1kHz tone (Hz) | Maximum Digital Deviation (Hz) | Occupied Bandwidth (Hz)[1)] | Emission designator |
|---|---|---|---|---|---|---|
| 12.5 | 21.6 | SRRC 8-lvl FSK | 2200 | 2700 | 8000 | 8K10F1D |
| | 16 | SRRC 4-lvl FSK | 1900 | 2200 | 7333 | 7K50F1D |
| | 14.4 | SRRC 4-lvl FSK | 2300 | 2900 | 8000 | 8K10F1D |
| | 9.6 | DGMSK 2-lvl FSK | 2000 | 2200 | 8000 | 8K10F1D |
| | 8 | DGMSK 2-lvl FSK | 2100 | 2300 | 8167 | 8K30F1D |
| 25 | 43.2 | SRRC 8-lvl FSK | 4300 | 5300 | 15843 | 16K0F1D |
| | 32 | RC 4-lvl FSK | 4300 | 5200 | 15456 | 15K6F1D |
| | 25.6 | SRRC 4-lvl FSK | 3900 | 4400 | 14588 | 14K7F1D |
| | 19.2 | SRRC 4-lvl FSK | 4300 | 5500 | 15799 | 15K9F1D |
| | 19.2 | DGMSK 2-lvl FSK | 3700 | 3800 | 14443 | 14K6F1D |
| | 9.6 | DGMSK 2-lvl FSK | 4200 | 4300 | 13613 | 13K8F1D |

[1)] – Supporting plots for these values are shown in the mask compliance test to follow. The deviation meter has an IF filter bandwidth of 30kHz. The measurement setup is explained below.

**Occupied Bandwidth Measurement**

The Occupied Bandwidth measurement option of the instrument (8563EC or E4401B spectrum analyzer from Agilent) calculates and provides the values used above for the emission designator.

The percentage setting of the measurement has been set to 99% following the definition of the ***Occupied Bandwidth*** as "the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission" (FCC 2.202) .

The measurement has been performed during the tests for compliance with mask C or D, the highest resulting value was recorded for the Occupied Bandwidth. The measurement set-up is detailed along with mask compliance test reports.

**TX Data Test Pattern:**

The transmit data pattern is DBA protocol- type of "idle" packets data pattern as described in Annex A "Digital Modulation Techniques" of this application. After this data follows the modulation process described, the resulting base band signal feeds the modulator's input of the Exciter.

**NAME OF TEST:** **Mask compliance data**

NAME OF TEST: Mask Compliance data for Paragon4 BSC2 Modem

Mask compliance data in support of 8000 baud 4/8/16-FSK for mask D, 16000 baud 4/8/16-FSK and 14400 baud 8-FSK for mask C.

RULE PART NUMBER: FCC 2.201, 2.202, 2.1033(c) (14), 2.1041, 2.1049 (h), 90.209 (b)(5), 90.210 (c)(d)
IC RSS-Gen section 4.6.1, RSS 119 section 5.5

MINIMUM STANDARD: Mask D
Sidebands and Spurious [Rule FCC 90.210 (d) & IC RSS 119 (5.8.3)]
Authorized Bandwidth = 11.25 kHz [Rule 90.209(b) (5) & IC RSS 119 (5.5)]

| | |
|---|---|
| Fo to 5.625 kHz | Attenuation = 0 dB |
| >5.625 kHz to 12.5 kHz | Attenuation= 7.27($f_d$ -2.88kHz) dB |
| >12.5kHz | Lesser of 50 + 10*log(P) dB or 70dB |
| **Corner Points:** | |
| Fo to 5.625 kHz | Attenuation = 0 dB |
| >5.625 kHz to 12.5 kHz | Attenuation=20 dB to 70 dB |
| >12.5 kHz | Attenuation =70dB (100W) |

Mask C
Sidebands and Spurious [Rule 90.210 (c) & IC RSS 119 (5.8.2)]
Authorized Bandwidth = 20 kHz [Rule 90.209(b) (5) & IC RSS 119 (5.5)]

| | |
|---|---|
| Fo to 5.0 kHz | Attenuation = 0 dB |
| >5.0 kHz to 10.0 kHz | Attenuation= 83*log($f_d$ KHz /5) dB |
| >10.0 kHz to 250% Auth BW | Attenuation = Lesser of: 50dB or 29 log (fd2/11)dB, |
| 250% Auth BW | 43 + 10*log(P) |
| **Corner Points:** | |
| $f_0$ to 5.0 kHz | Attenuation = 0 dB |
| >5.0 kHz to 10.0 kHz | Attenuation= 0 dB to 25 dB |
| >10.0 kHz to 15.0 KHz | Attenuation = 27.8 dB to 38 dB |
| >15.0 kHz to 20.0 KHz | Attenuation = 38 dB to 45.2 dB |
| >20.0 kHz to 24.0 KHz | Attenuation = 45.2 dB to 50 dB |
| >24.0 kHz to 50.0 KHz | Attenuation = 50 dB |
| >250% Auth BW | Attenuation = min. 63 dB (100 W) |

TEST RESULTS: Meets minimum standard (see data on the following pages)

TEST CONDITIONS:

The test ran in standard environmental test conditions, at $22^0$C, 30-50% RH.

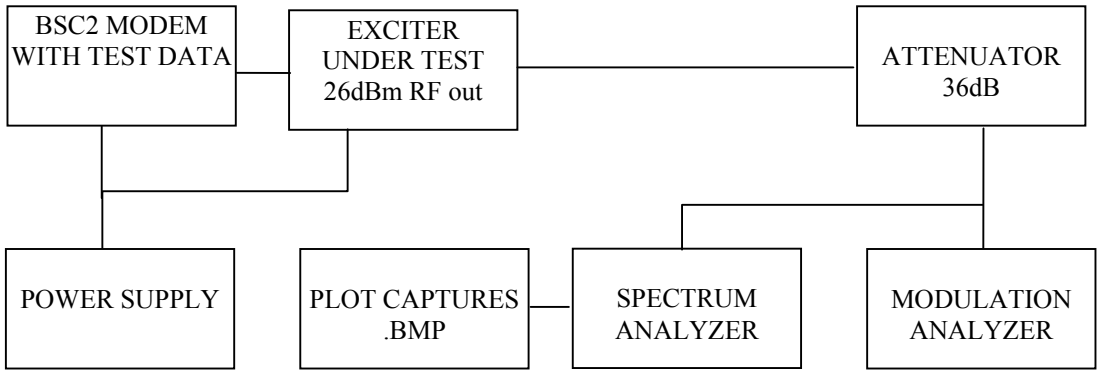
TEST EQUIPMENT:

| Equipment | Manufacturer | Model | Asset # | Last cal | Next Cal |
|---|---|---|---|---|---|
| P4 Base Station Controller/modem | Calamp | BSC2 | RD pilot unit | COU | - |
| Variable DC Power supply | Astron | VS-20M | S/N:970 10044 | COU | - |
| Modulation meter | IFR | COM-120B | DR612 | 10/2009 | 10/2010 |
| Spectrum Analyzer | Agilent | 8563EC | DR231 | 03/2010 | 03/2011 |
| Fixed Attenuator 6dB 10W | Pasternack | PE7015-6 | - | COU | - |
| Fixed Attenuator 30dB 10W | Pasternack | PE7015-30 | - | COU | - |

COU = Calibrate On Use

PERFORMED BY: Richard Vallée DATE: 21/04/10

TEST SET-UP:

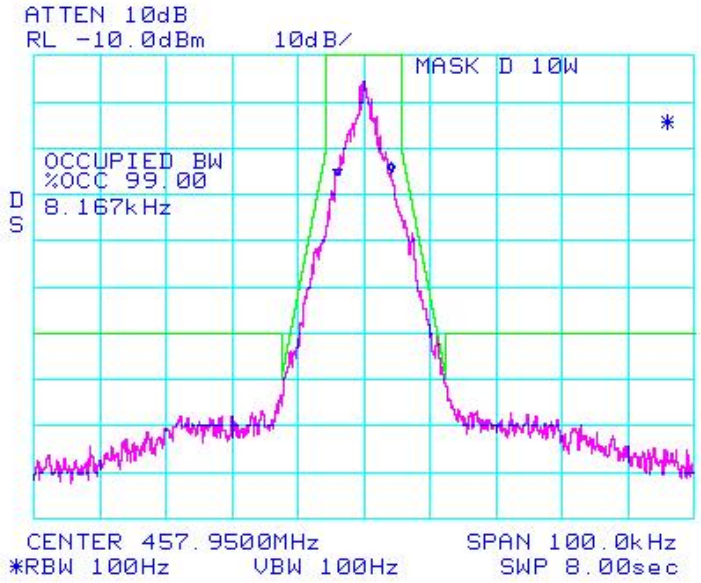


NAME OF TEST: Mask compliance data (Continued)
Paragon4 Modem at 32000 bps 16FSK

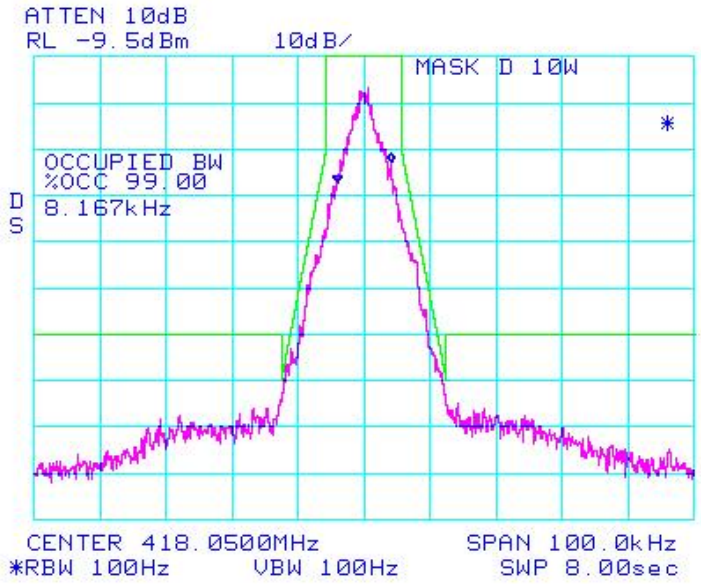
MASK: D, 8000baud, 2.2KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
32000 bps, 16 level FSK
PEAK DEVIATION = 2700 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

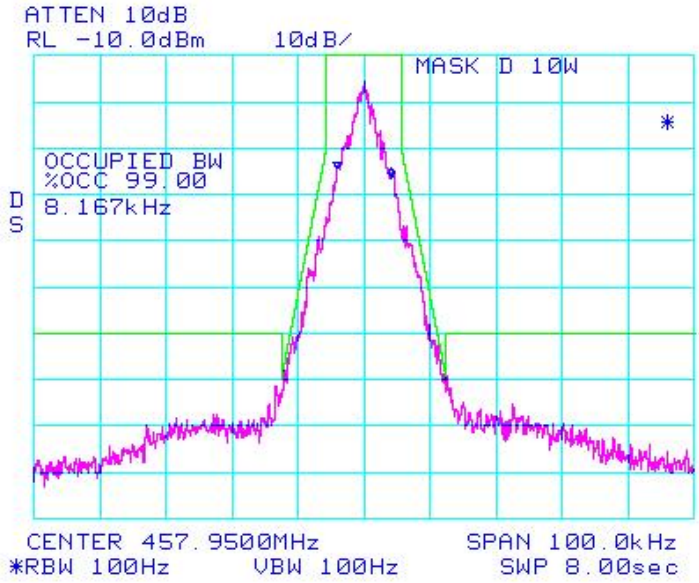


NAME OF TEST: Mask compliance data (Continued)
Paragon4 Modem at 24000 bps 8FSK

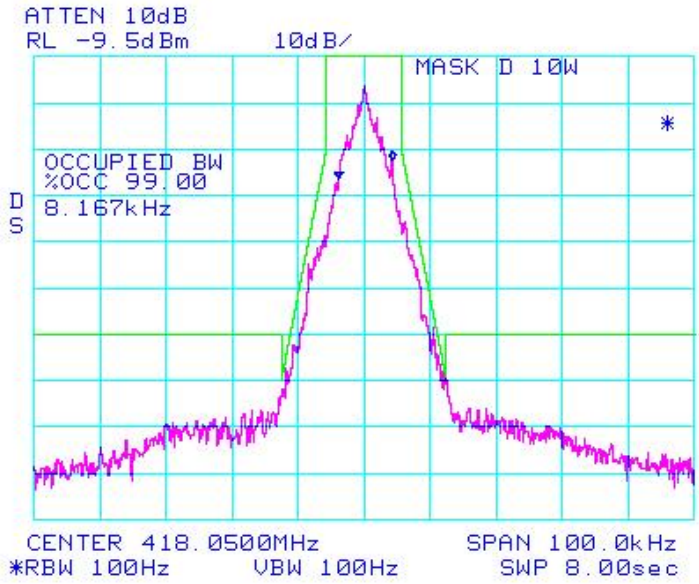
MASK: D, 8000baud, 2.1KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
24000 bps, 8 level FSK
PEAK DEVIATION = 2700 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

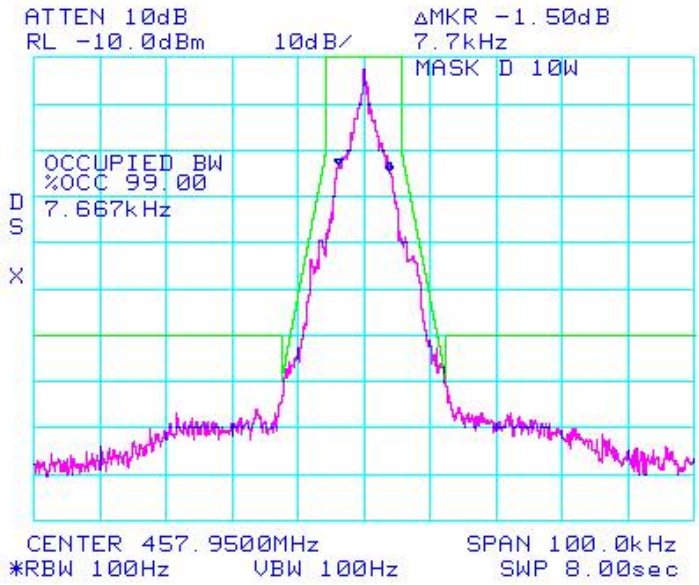


NAME OF TEST: Mask compliance data (Continued)
Paragon4 Modem at 16000 bps 4FSK

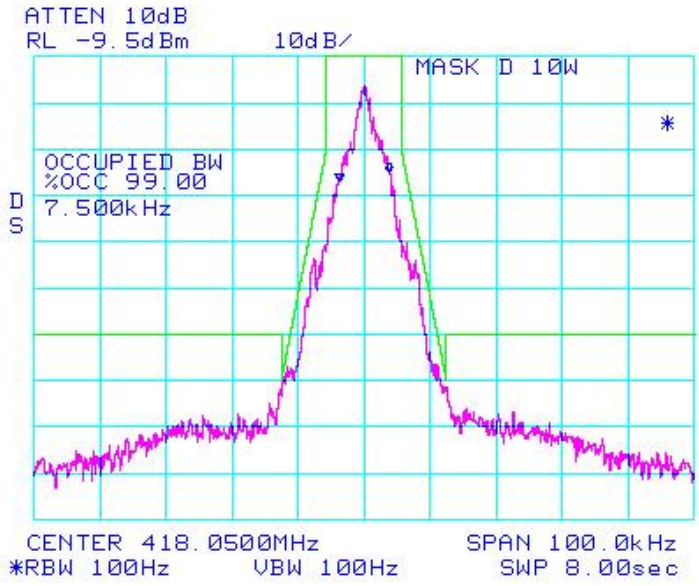
MASK: D, 8000baud, 1.5KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
16000 bps, 4 level FSK
PEAK DEVIATION = 2000 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

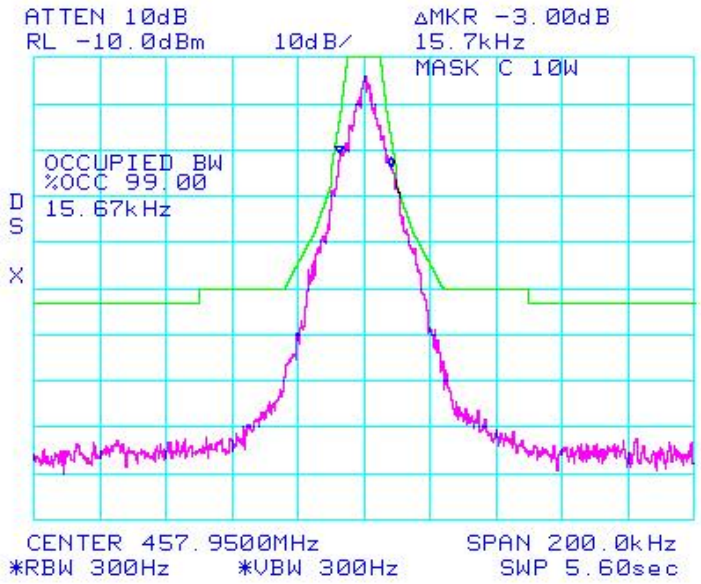


NAME OF TEST: Mask compliance data (Continued)
Paragon4 Modem at 43200 bps 8FSK

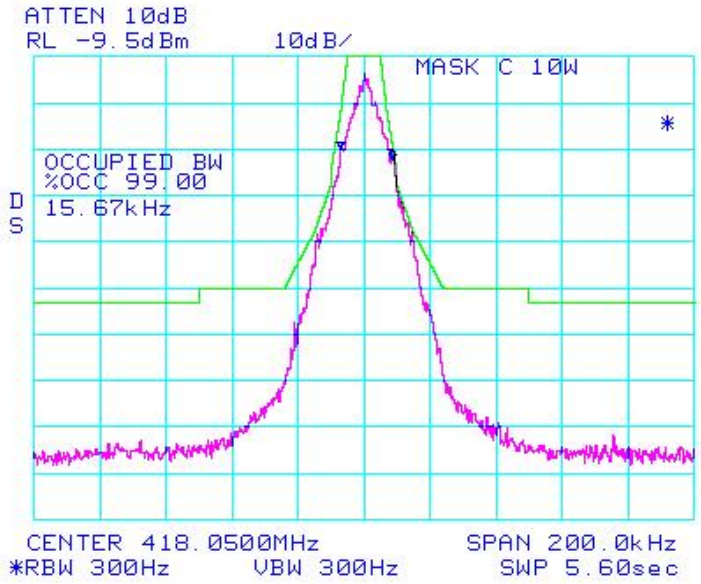
MASK: C, 14400baud, 4.2KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
43200 bps, 8 level FSK
PEAK DEVIATION = 5400 Hz
SPAN = 200 KHz

**UHF MID:**




**UHF LOW:**

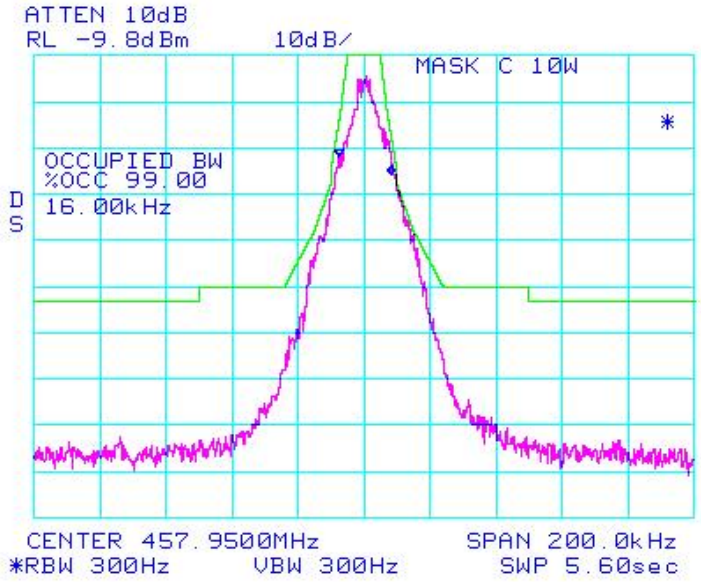


NAME OF TEST: Mask compliance data (Continued)
Paragon4 Modem at 64000 bps 16FSK

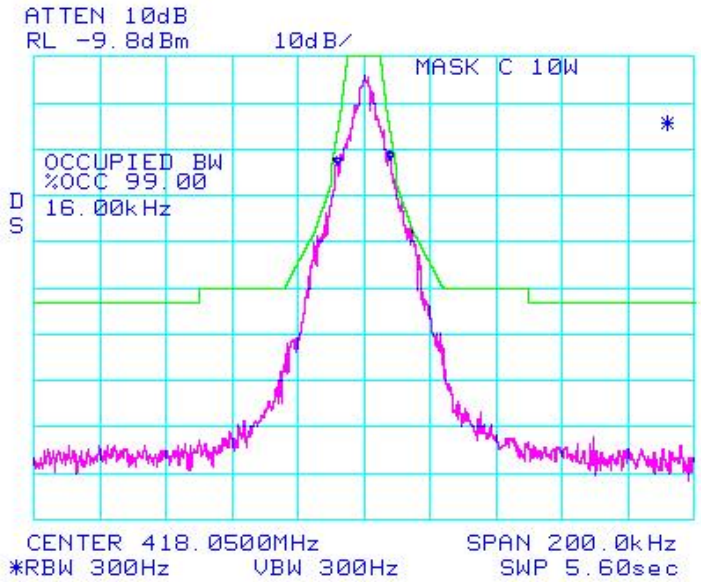
MASK: C, 16000baud, 4.2KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
64000 bps, 16 level FSK
PEAK DEVIATION = 5300 Hz
SPAN = 200 KHz

**UHF MID:**




**UHF LOW:**

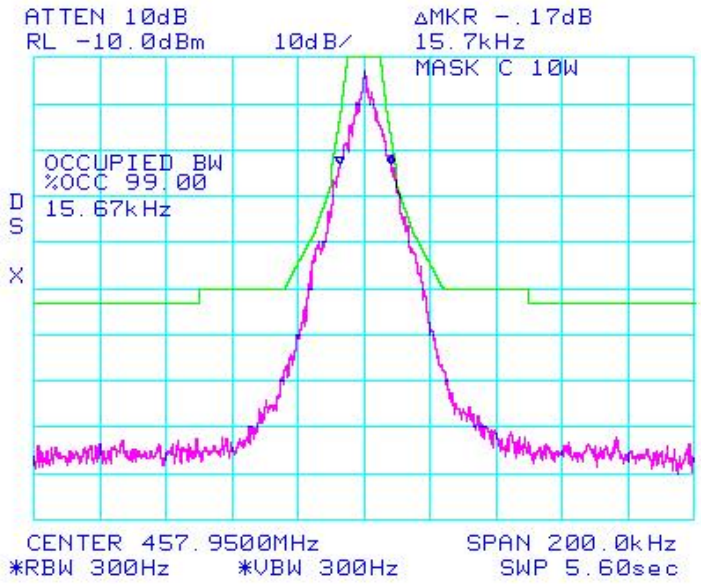


NAME OF TEST: Mask compliance data (Continued)
Paragon4 Modem at 48000 bps 8FSK

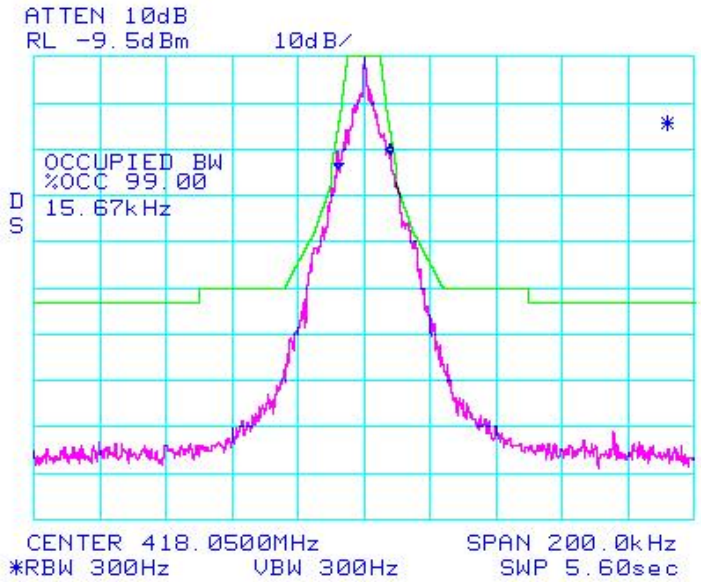
MASK: C, 16000baud, 4.1KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
48000 bps, 8 level FSK
PEAK DEVIATION = 5200 Hz
SPAN = 200 KHz

**UHF MID:**




**UHF LOW:**

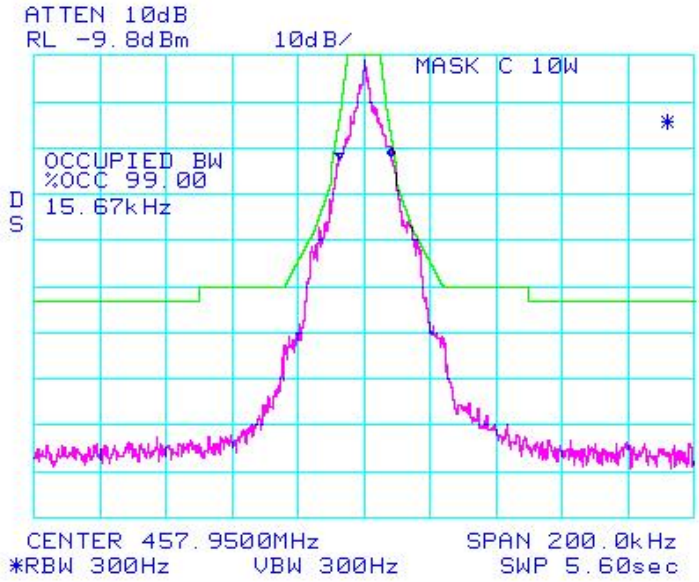


NAME OF TEST: Mask compliance data (Continued)
Paragon4 Modem at 32000 bps 4FSK

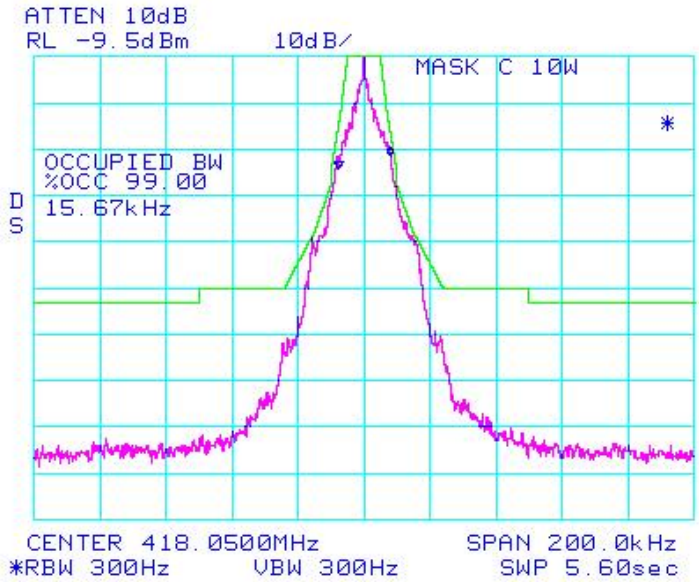
MASK: C, 16000baud, 3.5KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
32000 bps, 4 level FSK
PEAK DEVIATION = 4700 Hz
SPAN = 200 KHz

**UHF MID:**




**UHF LOW:**



NAME OF TEST: Mask Compliance data for Paragon4 PD+ BDLCslim Modem

Mask compliance data in support of 7200 baud 4/8-FSK, 8000 baud 2/4-FSK and 9600 baud 2-FSK for mask D. Mask compliance data in support of 9600 baud 2/4-FSK, 12800 baud 4-FSK, 14400 baud 8-FSK, 16000 baud 4-FSK and 19200 baud 4-FSK for mask C.

RULE PART NUMBER: FCC 2.201, 2.202, 2.1033(c) (14), 2.1041, 2.1049 (h), 90.209 (b)(5), 90.210 (c)(d)
IC RSS-Gen section 4.6.1, RSS 119 section 5.5

MINIMUM STANDARD: Mask D
Sidebands and Spurious [Rule 90.210 (d) & IC RSS 119 (5.8.3)]
Authorized Bandwidth = 11.25 kHz [Rule 90.209(b) (5) & IC RSS 119 (5.5)]

| | |
|---|---|
| Fo to 5.625 kHz | Attenuation = 0 dB |
| >5.625 kHz to 12.5 kHz | Attenuation= 7.27($f_d$ -2.88kHz) dB |
| >12.5kHz | Lesser of 50 + 10*log(P) dB or |
| 70dB | |
| **Corner Points:** | |
| Fo to 5.625 kHz | Attenuation = 0 dB |
| >5.625 kHz to 12.5 kHz | Attenuation=20 dB to 70 dB |
| >12.5 kHz | Attenuation =70dB (100W) |

Mask C
Sidebands and Spurious [Rule 90.210 (c) & IC RSS 119 (5.8.2)]
Authorized Bandwidth = 20 kHz [Rule 90.209(b) (5) & IC RSS 119 (5.5)]

| | |
|---|---|
| Fo to 5.0 kHz | Attenuation = 0 dB |
| >5.0 kHz to 10.0 kHz | Attenuation= 83*log($f_d$ KHz /5) dB |
| >10.0 kHz to 250% Auth BW | Attenuation = Lesser of: 50dB or 29 log (fd2/11)dB, |
| 250% Auth BW | 43 + 10*log(P) |
| **Corner Points:** | |
| $f_0$ to 5.0 kHz | Attenuation = 0 dB |
| >5.0 kHz to 10.0 kHz | Attenuation= 0 dB to 25 dB |
| >10.0 kHz to 15.0 KHz | Attenuation = 27.8 dB to 38 dB |
| >15.0 kHz to 20.0 KHz | Attenuation = 38 dB to 45.2 dB |
| >20.0 kHz to 24.0 KHz | Attenuation = 45.2 dB to 50 dB |
| >24.0 kHz to 50.0 KHz | Attenuation = 50 dB |
| >250% Auth BW | Attenuation = min. 63 dB (100 W) |

TEST RESULTS: Meets minimum standard (see data on the following pages)

TEST CONDITIONS:

The test ran in standard environmental test conditions, at $22^0$C, 30-50% RH.

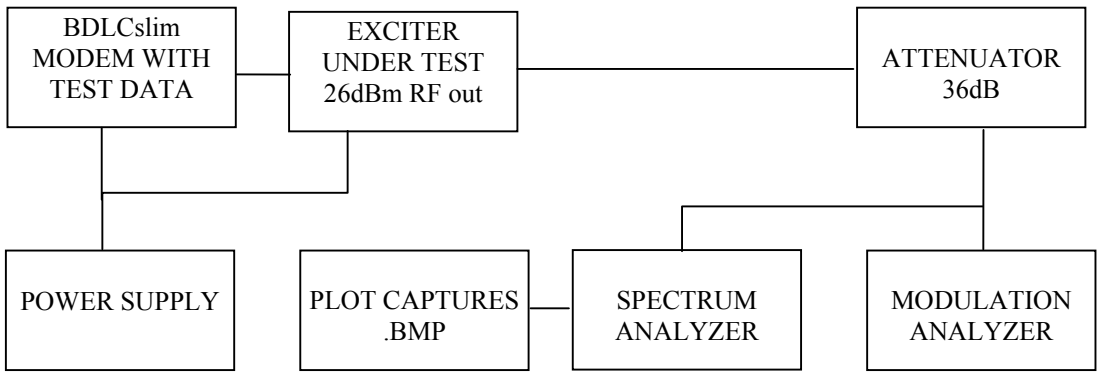
TEST EQUIPMENT:

| Equipment | Manufacturer | Model | Asset # | Last cal | Next Cal |
|---|---|---|---|---|---|
| PD+ Base DataLink Controller/Modem | Calamp | BDLCslim | RD pilot unit | COU | - |
| Variable DC Power supply | Astron | VS-20M | S/N:97010044 | COU | - |
| Modulation meter | IFR | COM-120B | DR612 | 10/2009 | 10/2010 |
| Spectrum Analyzer | Agilent | 8563EC | DR231 | 03/2010 | 03/2011 |
| Spectrum Analyzer | Agilent | E4401B | DR624 | 03/2010 | 03/2011 |
| Fixed Attenuator 6dB 10W | Pasternack | PE7015-6 | - | COU | COU |
| Fixed Attenuator 30dB 10W | Pasternack | PE7015-30 | - | COU | COU |

COU = Calibrate On Use

PERFORMED BY: Richard Vallée DATE: 22/04/10

TEST SET-UP:

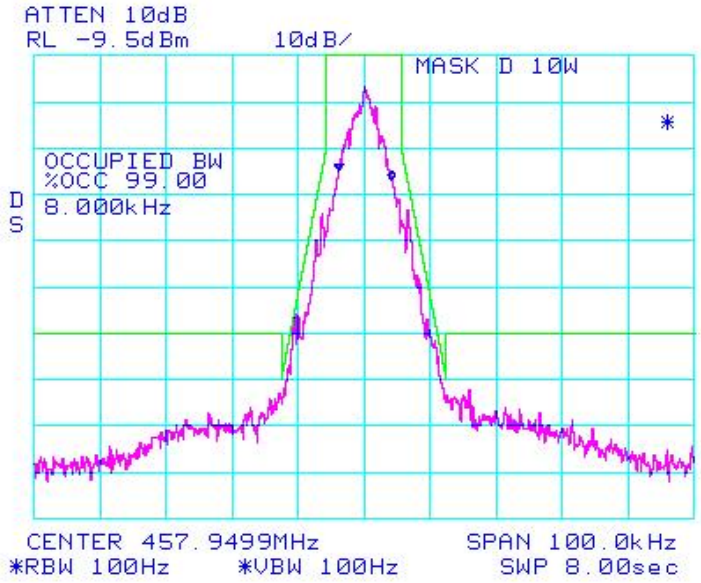


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 21600 bps 8FSK

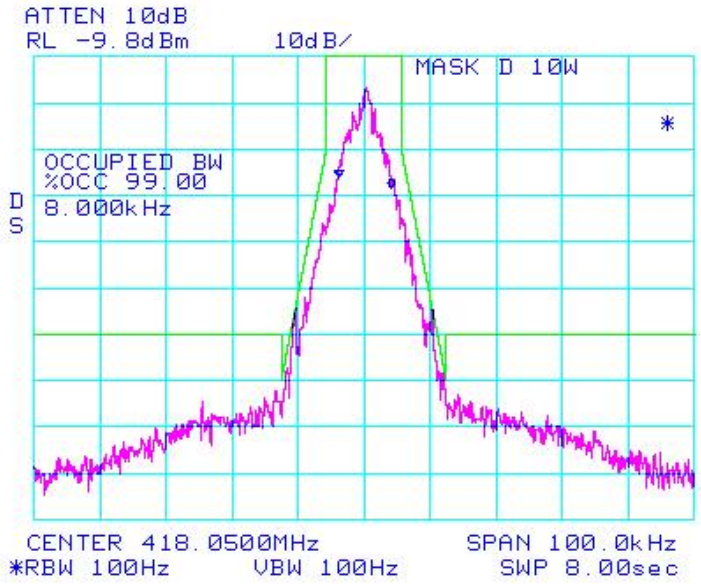
MASK: D, 7200 baud, 2.2KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
21600 bps, 8 level FSK
PEAK DEVIATION = 2700 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

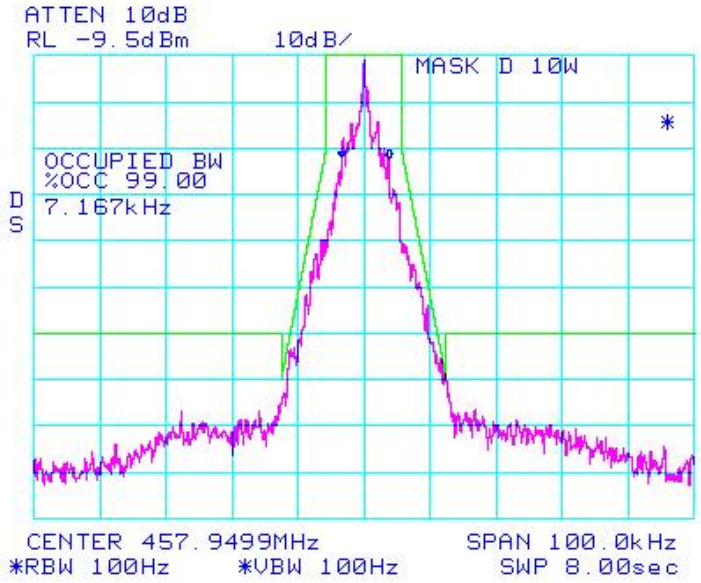


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 16000 bps 4FSK

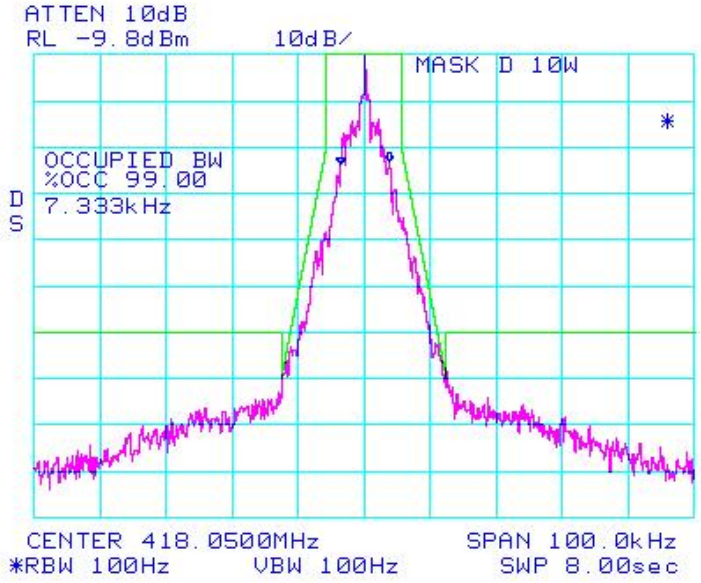
MASK: D, 8000 baud, 1.9KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
16000 bps, 4 level FSK
PEAK DEVIATION = 2200 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

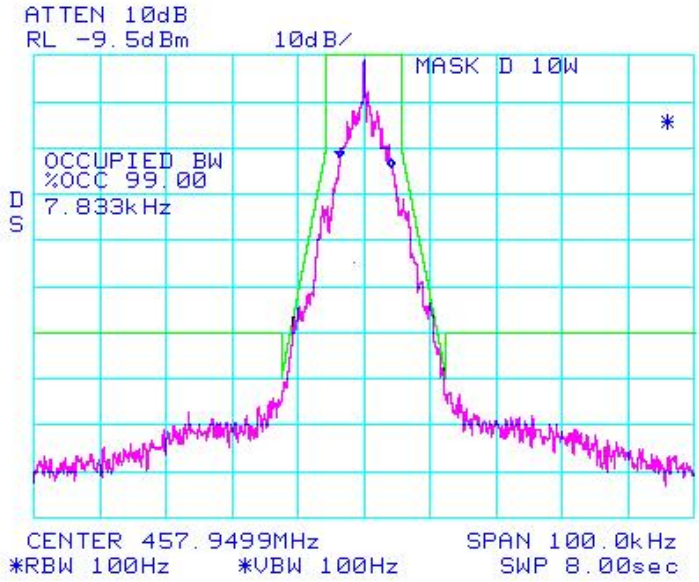


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 14400 bps 4FSK

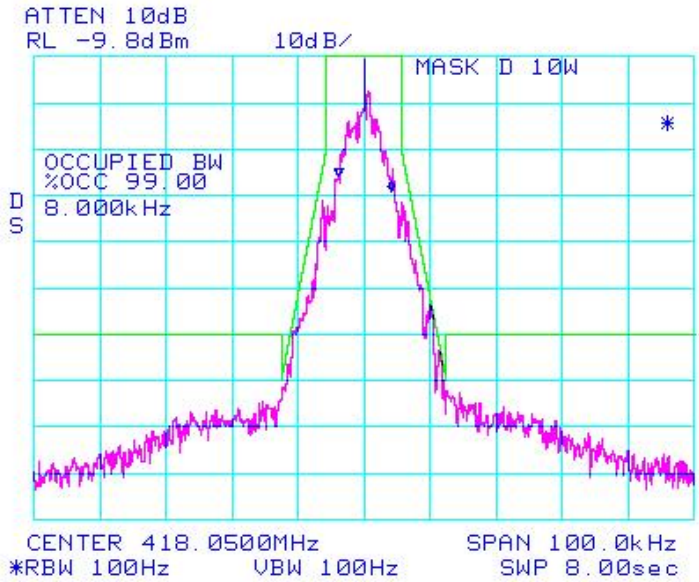
MASK: D, 7200 baud, 2.3KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
14400 bps, 4 level FSK
PEAK DEVIATION = 2900 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

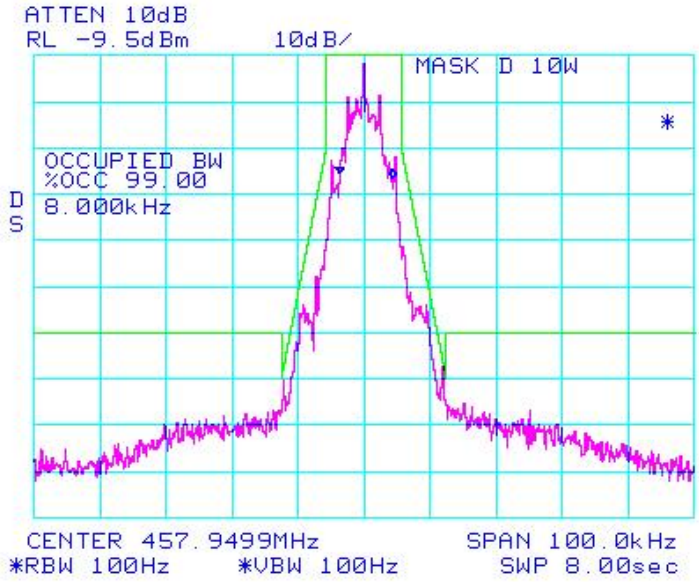


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 9600 bps 2FSK

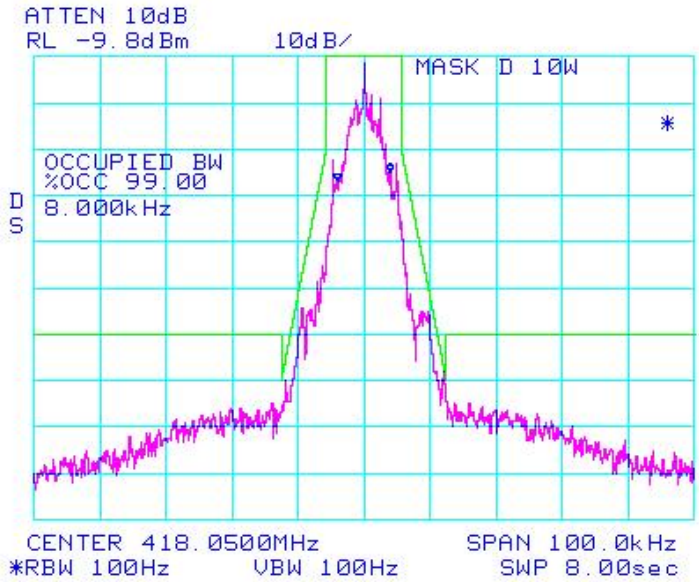
MASK: D, 9600 baud, 2.0KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
9600 bps, 2 level FSK
PEAK DEVIATION = 2200 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

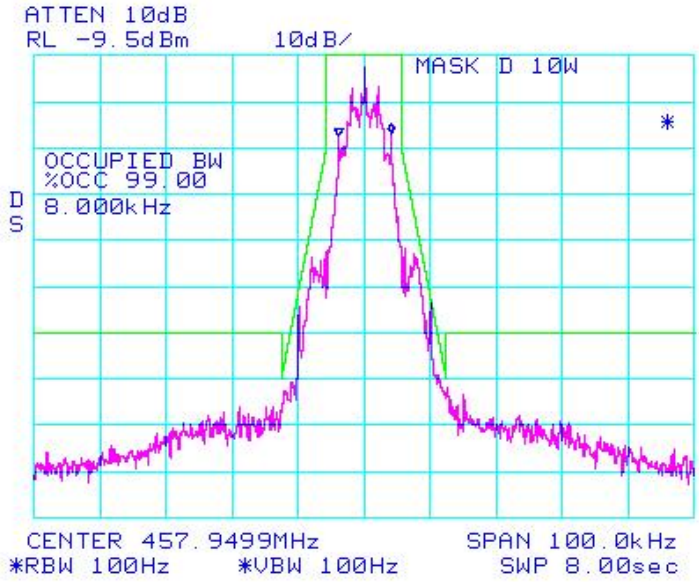


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 8000 bps 2FSK

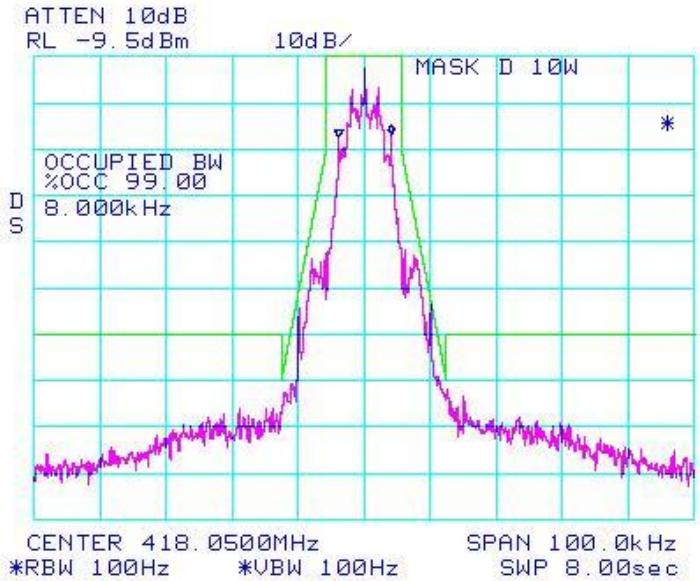
MASK: D, 8000 baud, 2.1KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
8000 bps, 2 level FSK
PEAK DEVIATION = 2300 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

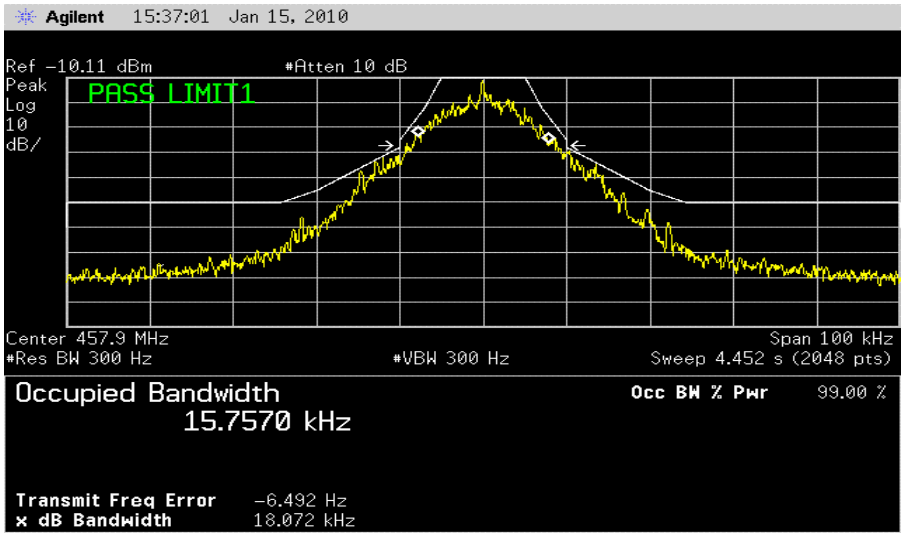


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 43200 bps 8FSK

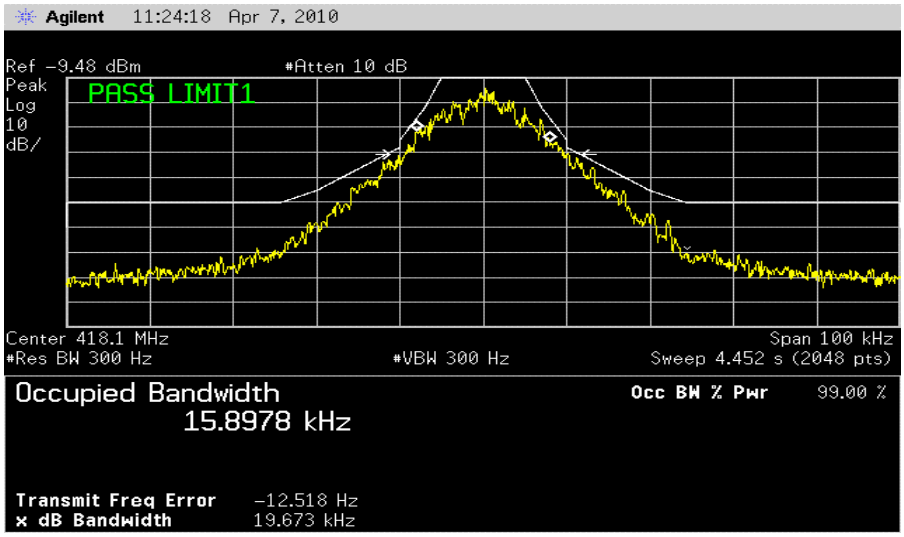
MASK: C, 14400 baud, 4.3KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
43200 bps, 8 level FSK
PEAK DEVIATION = 5300 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

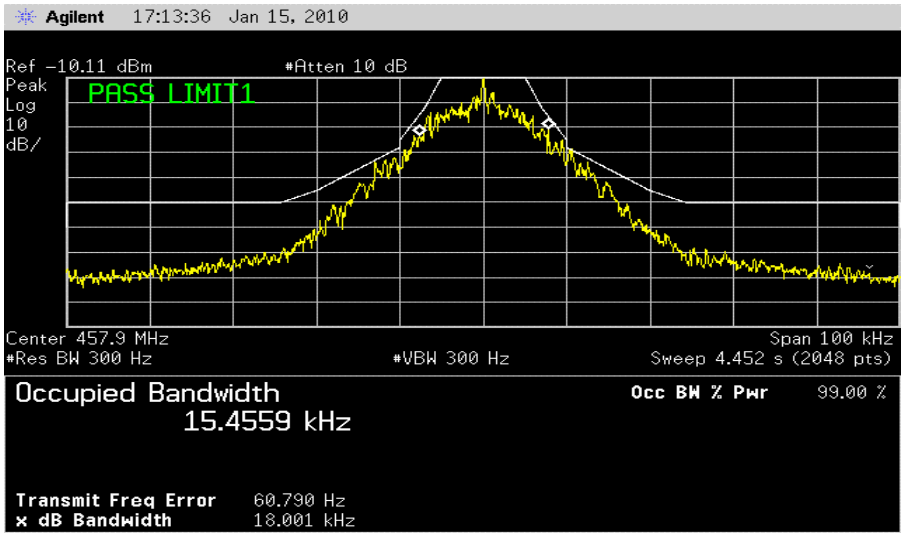


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 32000 bps 4FSK

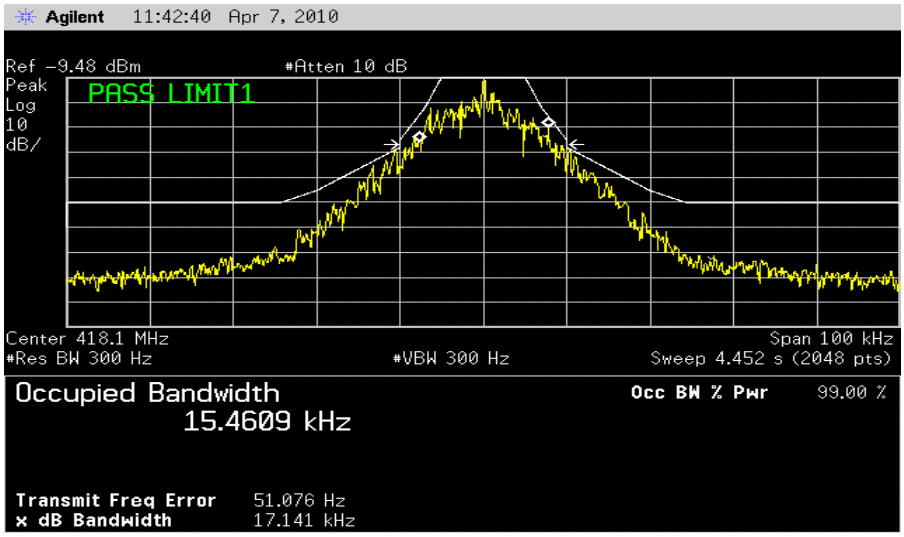
MASK: C, 16000baud, 4.3KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
32000 bps, 4 level FSK
PEAK DEVIATION = 5200 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

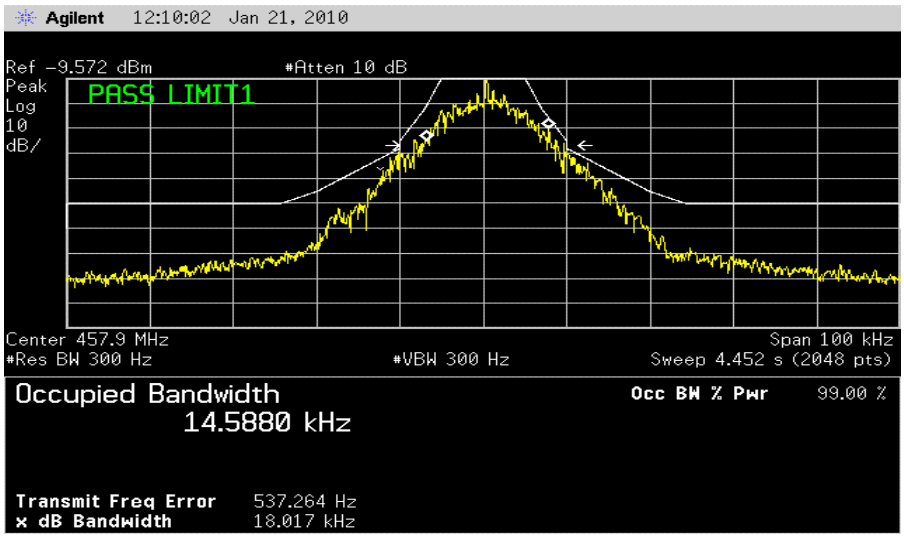


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 25600 bps 4FSK

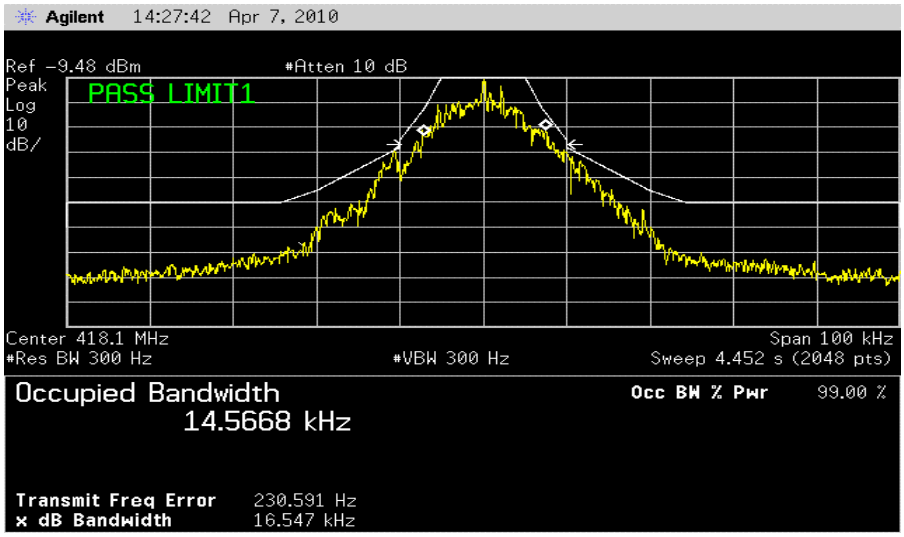
MASK: C, 12800baud, 3.9KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
25600 bps, 4 level FSK
PEAK DEVIATION = 4400 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

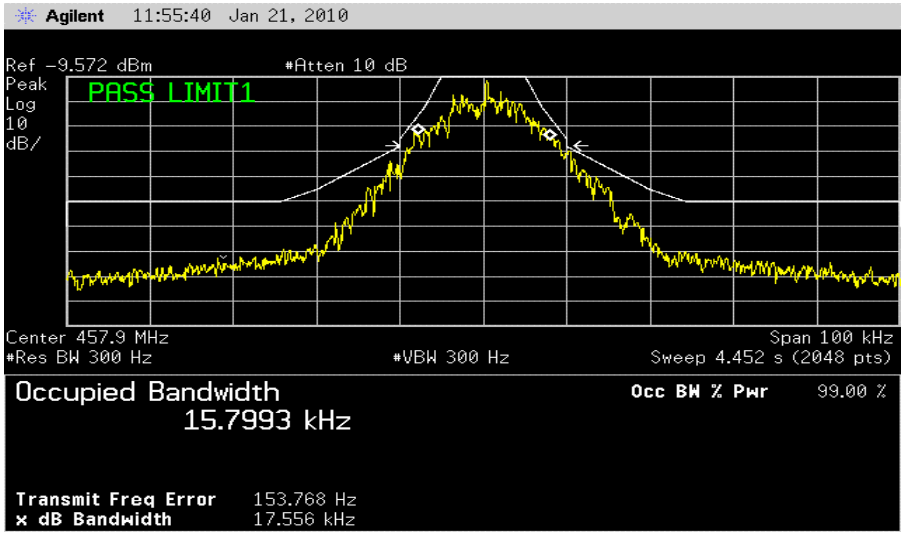


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 19200 bps 4FSK

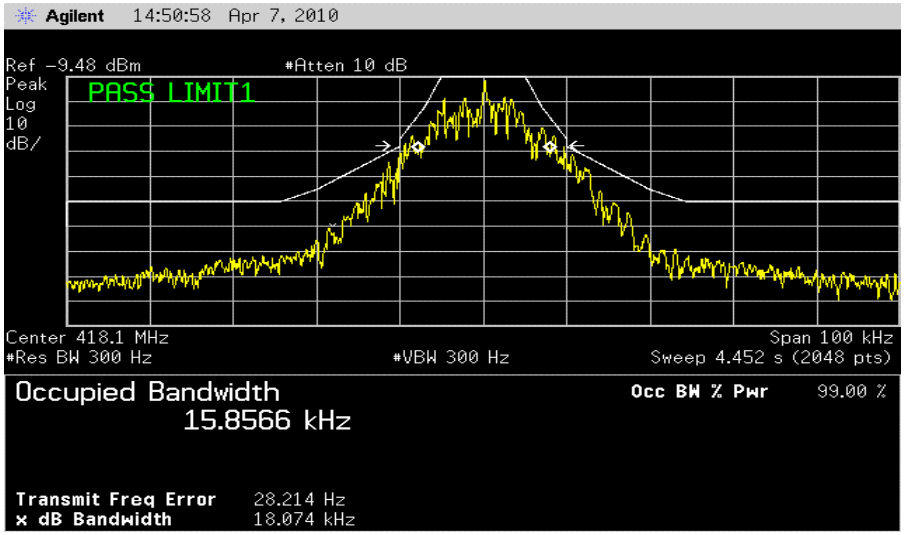
MASK: C, 9600baud, 4.3KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
19200 bps, 4 level FSK
PEAK DEVIATION = 5500 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

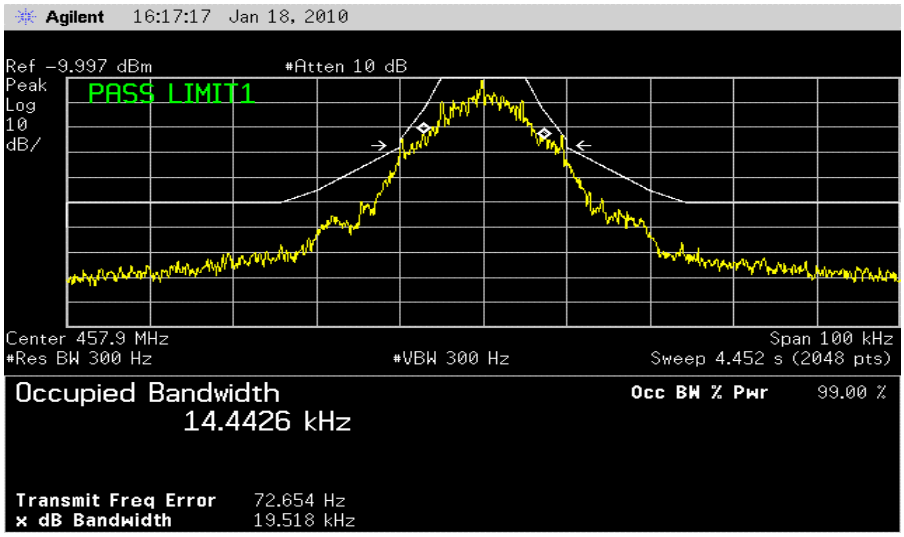


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 19200 bps 2FSK

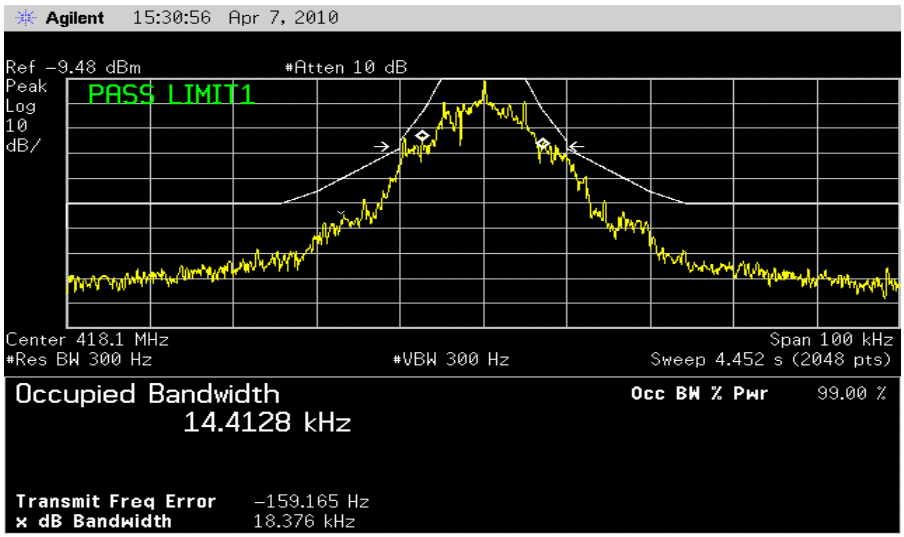
MASK: C, 19200baud, 3.7KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
19200 bps, 2 level FSK
PEAK DEVIATION = 3800 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**

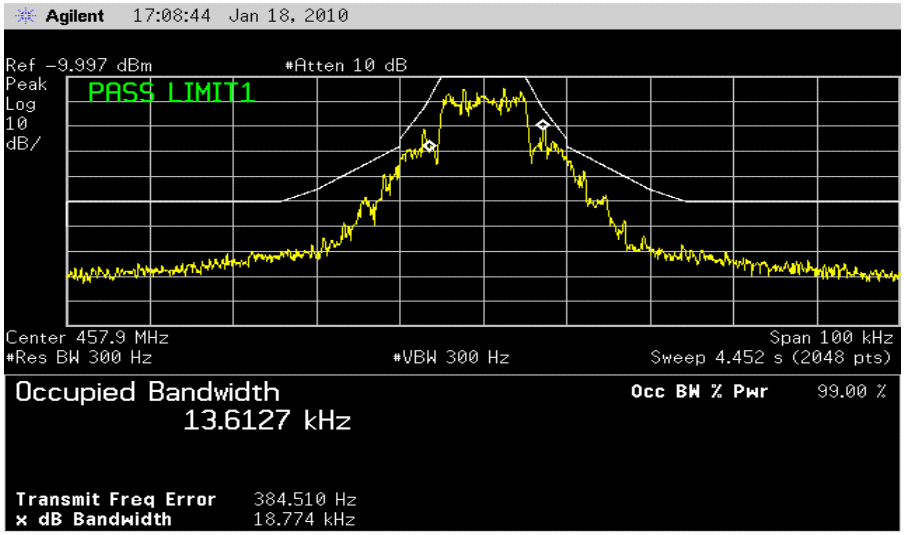


NAME OF TEST: Mask compliance data (Continued)
Paragon4 PD+ Modem at 9600 bps 2FSK

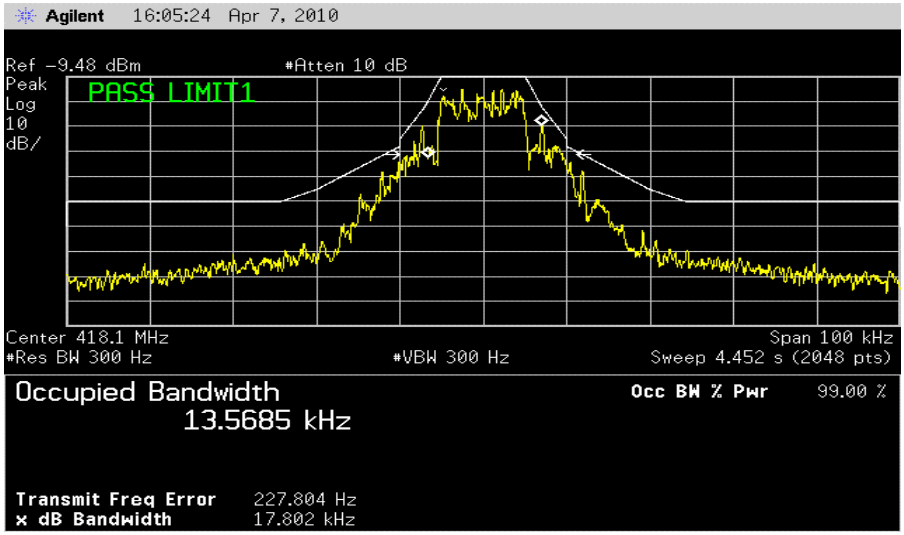
MASK: C, 9600baud, 4.2KHz reference deviation on 1000Hz tone

OUTPUT POWER: 400mWatts
9600 bps, 2 level FSK
PEAK DEVIATION = 4300 Hz
SPAN = 100 KHz

**UHF MID:**




**UHF LOW:**



Section A5: Transmitter Frequency Behavior

## Summary

These tests were conducted on a sample of equipment for the purpose of demonstrating its compliance with the restrictions for the transient frequency behavior of the transmitter in both the turned on and turned off cases. This test is required for equipment operating in the 406.1-512 MHz range, as defined by the rules found in FCC Part 90. These tests were performed in accordance with ANSI TIA-603 B.

The assessment summary is:

| | |
|---|---|
| EQUIPMENT UNDER TEST: | SDR-T-001UHF 403-477MHz exciter module (model name SDR-T-001-403) |
| SERIAL NUMBER (S): | Pre-production sample |
| SUPPORT EQUIPMENT: | P4 base station controller/modem module, pre-production sample (model name BSC2) |
| SPECIFICATIONS: | FCC Part 90 Private Land Mobile Radio Services |
| COMPLIANCE STATUS: | **Compliant** |
| EXCLUSIONS: | None |
| NON-COMPLIANCES: | None |
| TEST RESULTS SUMMARY: | Pass |

The technical data included in this report has been accumulated through tests that were performed by me or under my direction. To the best of my knowledge, all of the data is true and correct

PERFORMED BY: Richard Vallée DATE: 17/10/09

NAME OF TEST: Transient Frequency Behavior

RULE PART NUMBER: FCC Part 90.214

MINIMUM STANDARD: **12.5 kHz channel** (used worst case numbers from 406.1 to 477 MHz)
**25 kHz channel** (used worst case numbers from 406.1 to 477 MHz)

NOTE: The following plots were done using method TIA/EIA 603-B, 2.2.19. The transient time duration and frequency difference limits shown in these plots are for a 12.5KHz channel minimum standard.. The 25KHz channel minimum standard is also met, since the 12.5KHz channel minimum standard is the more strict standard.

| TIME INTERVAL | MAX FREQ DIFFERENCE (KHz) | MAX FREQ DIFFERENCE (KHz) | TIME (mSec) |
|---|---|---|---|
| | 12.5KHz CHN | 25 kHz CHN | |
| T1 | +/- 12.5 | +/- 25 | 10 |
| T2 | +/- 6.25 | +/- 12.5 | 25 |
| T3 | +/- 12.5 | +/- 25 | 10 |
| T2 to T3 | +/-1.5ppm of fc (MHz) | +/-2.5ppm of fc (MHz) | - |

TEST RESULTS: Meets minimum standards, see data on following pages

TEST CONDITIONS: RF Power Level = 400mWatts and 4mWatts (see following plots)
The test ran in standard environmental test conditions at $22^0$C, 30-50% RH.

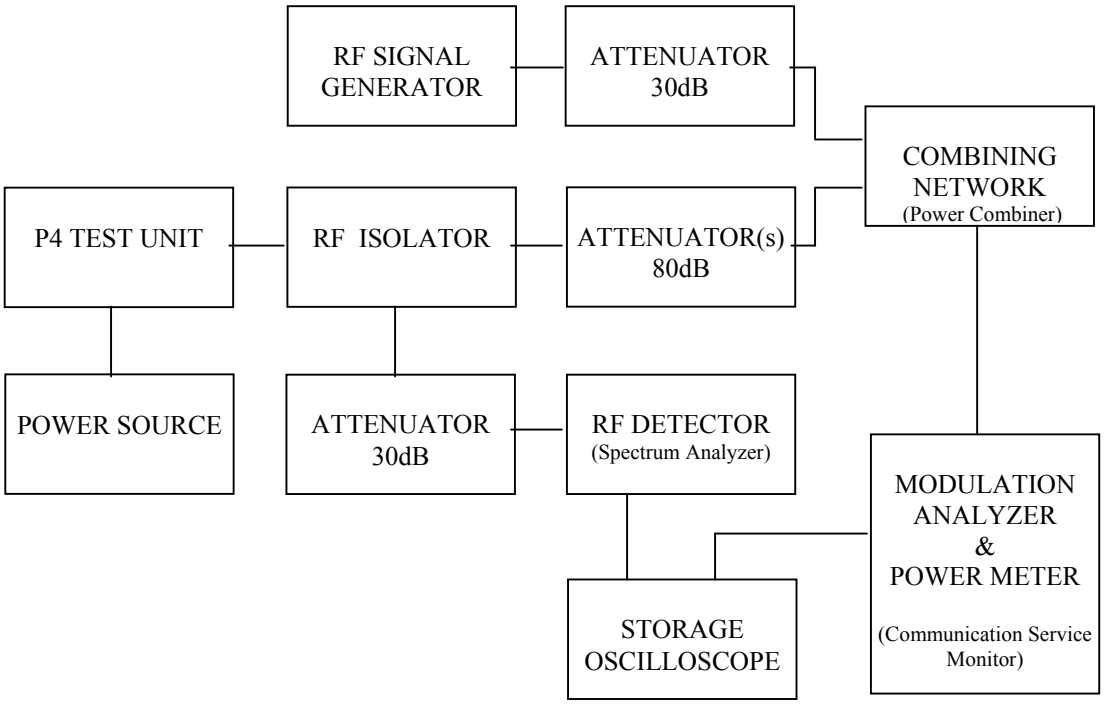
TEST PROCEDURE: TIA/EIA - 603, 2.2.19

TEST EQUIPMENT:

| Equipment | Manufacturer | Model | Asset # | Last cal | Next Cal |
|---|---|---|---|---|---|
| P4 Base Station Controller/modem | Calamp | BSC2 | RD pilot unit | COU | - |
| Variable DC Power supply | Astron | VS-20M | DR1402 | COU | - |
| Comm. Monitor: Modulation Analyzer & Power Meter | IFR | COM-120B | DR612B | 10/2009 | 10/2010 |
| Spectrum Analyzer: RF Detector | Agilent | 8563EC | DR231 | 03/2010 | 03/2011 |
| RF Signal Generator | Hewlett Packard | HP8642A | DR326 | COU | - |
| Storage Oscilloscope | Hewlett Packard | HP54645D | DR223 | COU | - |
| RF Isolator | EMC Corp | 7550/4A | - | COU | - |
| Power Combiner | Mini-Circuits | ZAPD-1 | - | NCR | - |
| Fixed Attenuator 20dB 10W | Pasternack | PE7015-20 | - | NCR | - |
| Fixed Attenuators 30dB 10W | Pasternack | PE7015-30 | - | NCR | - |

COU = Calibrate On Use, NCR = No Calibration Required

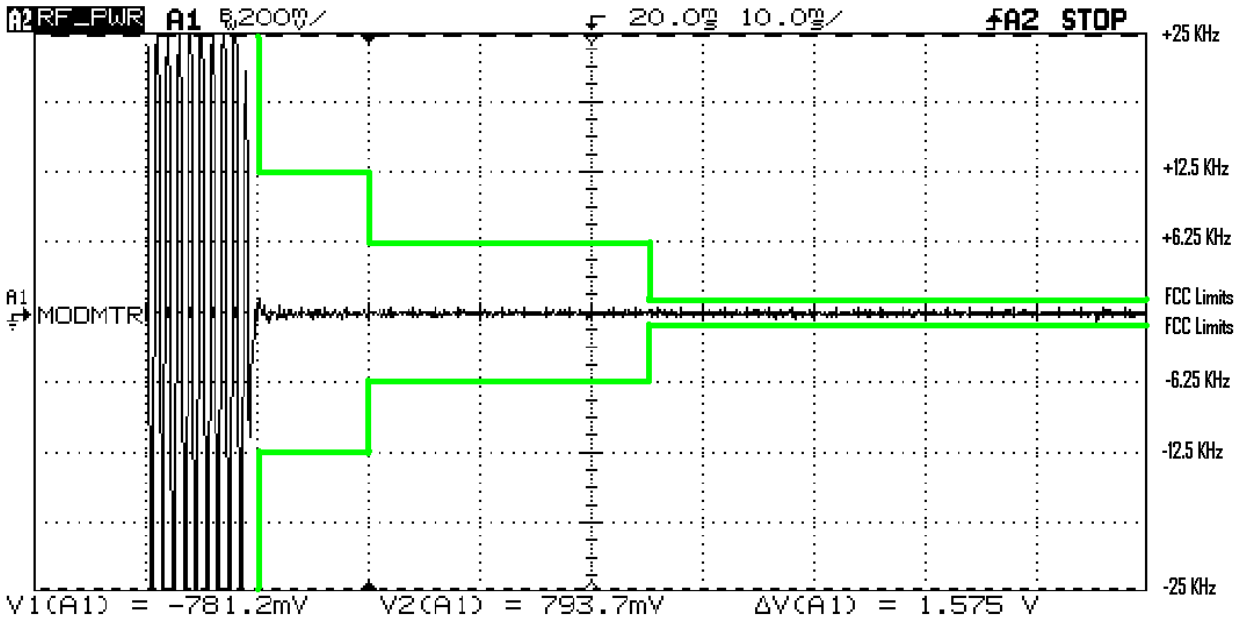
TEST SET-UP:



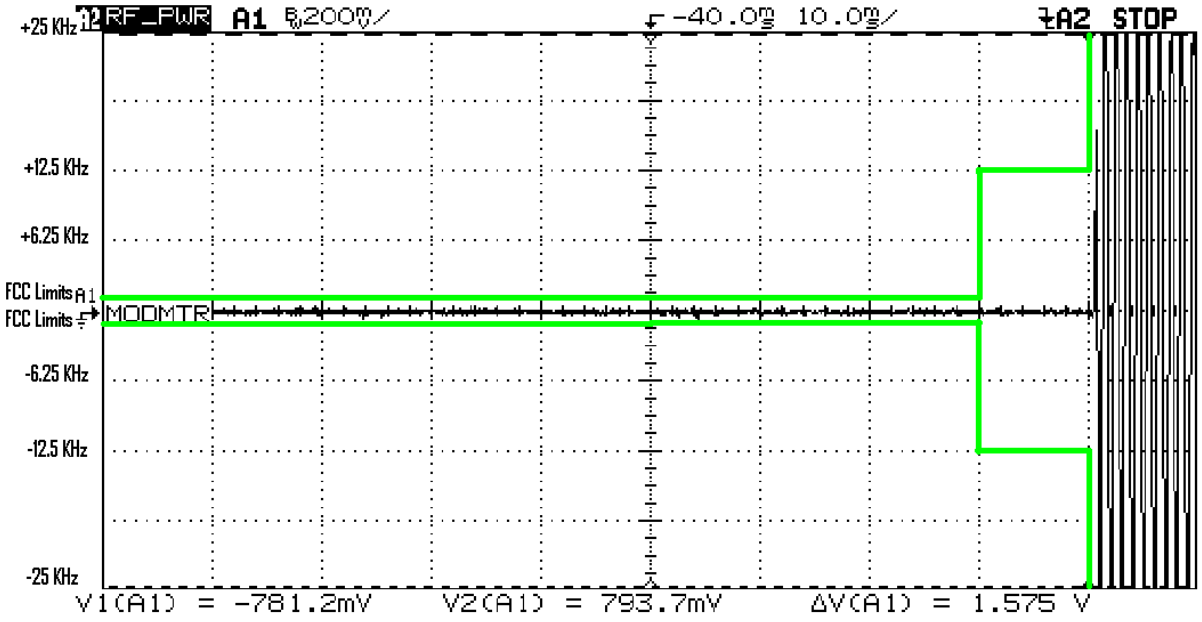

PERFORMED BY: Richard Vallée DATE:17/10/09

TRANSIENT FREQUENCY RESPONSE
UHF LOW Exciter : Unmodulated 400 mWatts

KEY UP

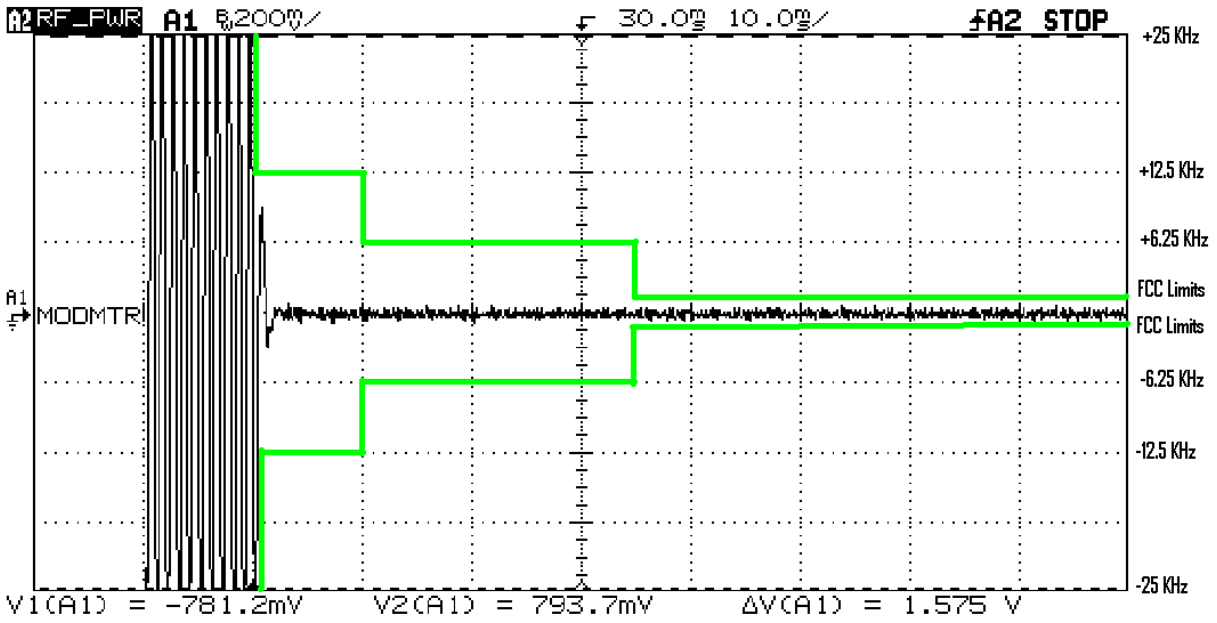



KEY DOWN



TRANSIENT FREQUENCY RESPONSE
UHF LOW Exciter : Unmodulated 4 mWatts

KEY UP




KEY DOWN