

Tranzeo EMC Labs Inc.  
#2 - 11720 Stewart Crescent  
Maple Ridge, BC  
Canada V2X 9E7

## **TR-AP5A-N Test Report**

14 January 2005

Report Number: TRL140105.1



Bruce Balston, EMC Lab Manager



Andrew Marles, Technical Writer

---

---

---

## Revision History

## Table of Contents

|             |                                                       |           |
|-------------|-------------------------------------------------------|-----------|
| <b>1.0</b>  | <b>General Information .....</b>                      | <b>4</b>  |
| 1.1         | EUT Description .....                                 | 4         |
| 1.2         | Operational Description .....                         | 5         |
| 1.3         | EUT Testing Configuration .....                       | 6         |
| 1.4         | EUT Modifications .....                               | 6         |
| 1.5         | Test Facilities .....                                 | 7         |
| 1.6         | Test Equipment .....                                  | 7         |
| 1.7         | Test System Details.....                              | 7         |
| 1.8         | Test Results .....                                    | 7         |
| <b>2.0</b>  | <b>Conducted Emissions .....</b>                      | <b>8</b>  |
| 2.1         | Test Standard .....                                   | 8         |
| 2.2         | Test Limits .....                                     | 8         |
| 2.3         | Test Setup .....                                      | 8         |
| <b>3.0</b>  | <b>Peak Power Output .....</b>                        | <b>11</b> |
| 3.1         | Test Standard .....                                   | 11        |
| 3.2         | Test Limits .....                                     | 12        |
| 3.3         | Test Setup .....                                      | 12        |
| 3.4         | Test Results .....                                    | 13        |
| <b>4.0</b>  | <b>Radiated Emissions, General Requirements .....</b> | <b>15</b> |
| 4.1         | Test Standard .....                                   | 15        |
| 4.2         | Test Limits .....                                     | 15        |
| 4.3         | Test Setup .....                                      | 16        |
| 4.4         | Test Results .....                                    | 17        |
| <b>5.0</b>  | <b>Harmonic Emissions.....</b>                        | <b>18</b> |
| 5.1         | Test Standard .....                                   | 18        |
| 5.2         | Test Limits .....                                     | 18        |
| 5.3         | Test Setup – Conducted Measurements (Harmonics) ..... | 18        |
| 5.4         | Test Results .....                                    | 20        |
| 6.1         | Test Standard .....                                   | 26        |
| 6.2         | Test Limits .....                                     | 26        |
| 6.3         | Test Setup .....                                      | 27        |
| 6.4         | Test Results .....                                    | 28        |
| <b>7.0</b>  | <b>Occupied Bandwidth .....</b>                       | <b>29</b> |
| 7.1         | Test Standard .....                                   | 29        |
| 7.2         | Test Limits .....                                     | 29        |
| 7.3         | Test Setup .....                                      | 29        |
| 7.4         | Test Results .....                                    | 30        |
| <b>8.0</b>  | <b>Power Spectral Density .....</b>                   | <b>32</b> |
| 8.1         | Test Standard .....                                   | 32        |
| 8.2         | Test Limits .....                                     | 32        |
| 8.3         | Test Setup .....                                      | 32        |
| 8.4         | Test Results 15.24 - 7 5.725-5.850 GHz.....           | 33        |
| <b>9.0</b>  | <b>Peak Excursion .....</b>                           | <b>35</b> |
| 9.1         | Test Standard .....                                   | 35        |
| 9.2         | Test Limits .....                                     | 35        |
| 9.3         | Test Setup .....                                      | 35        |
| 9.4         | Test Results .....                                    | 35        |
| 9.4         | Test Results .....                                    | 35        |
| <b>10.0</b> | <b>RF Exposure Evaluation .....</b>                   | <b>37</b> |
| 9.1         | Fries Formula.....                                    | 37        |
| 9.2         | EUT Operating Condition.....                          | 37        |
| 9.3         | RF exposure evaluation distance calculation .....     | 37        |
| <b>11.0</b> | <b>Test Photos .....</b>                              | <b>39</b> |

## 1.0 General Information

### 1.1 EUT Description

|                            |                                                                                                                  |
|----------------------------|------------------------------------------------------------------------------------------------------------------|
| Product Name               | Wireless Access Point                                                                                            |
| Company Name               | Tranzeo Wireless Technologies inc.                                                                               |
| FCC ID                     | QRF-TR-AP5A-N                                                                                                    |
| Model No.                  | TR-AP5A-N                                                                                                        |
| Frequency Range            | 5250 to 5350 and 5725 MHz to 5850 MHz                                                                            |
| Number of Channels         | 9                                                                                                                |
| Transmit Rate              | 54Mbps maximum bit rate specification                                                                            |
| Type of Modulation         | OFDM modulation                                                                                                  |
| Antenna Type               | External, N-female connector                                                                                     |
| Antenna Gain               | 5250-5350: 24 dBi max<br>5725-5850: 32 dBi max                                                                   |
| Product Software           | Tranzeo/Ubicom 6.2.0                                                                                             |
| Test Software              | bandwidth test software                                                                                          |
| Operator Channel Selection | By Software                                                                                                      |
| Power Adapter              | Tranzeo Wireless Supplied SP48-181000<br>Input: AC 120V 60Hz, 25.9 W<br>Output: DC 18 V, 1000 mA<br>Serial: 0504 |

Product samples tested:

| Manufacturer     | Model No. | Serial No.      |
|------------------|-----------|-----------------|
| Tranzeo Wireless | TR-AP5A-N | TR-AP5a-N 00039 |

Frequency of each channel:

| Channel     | Frequency (MHz) |
|-------------|-----------------|
| Channel 52  | 5260            |
| Channel 56  | 5280            |
| Channel 60  | 5300            |
| Channel 64  | 5320            |
| Channel 149 | 5745            |
| Channel 153 | 5765            |
| Channel 157 | 5785            |
| Channel 161 | 5805            |
| Channel 165 | 5825            |

For compliance with the EIRP limits specified in CFR 47 Part 15, Section E, 15.407 the output power of the unit is limited by the Tranzeo supplied firmware based on the gain of the antenna used with the device.

As an IEEE 802.11a compliant wireless bridge, this device includes a 5 GHz receiving function and a 5 GHz digital modulation transmit function. The unit is fitted with an N-female connector to facilitate the use of an external antenna. There are no user serviceable parts inside the unit. It is factory sealed in a one-time use manner and inaccessible to the end user.

The tests were performed on production sample models to demonstrate compliance with FCC Part 15 Subpart B, Subpart C, and Subpart E, as well as Industry Canada RSS-210 Issue 5 for digitally modulated devices.

## 1.2 Operational Description

The TR-AP5A-N is a wireless network bridge designed specifically for outdoor applications. The device provides a bridge between IEEE802.3 wired Ethernet LANs and IEEE802.11a compliant wireless networks. It uses an external antenna coupled with a 802.11a transceiver to connect to remote wireless clients. The transceiver is connected to N-female and operates in the frequency band 5250-5350 and 5725-5850 MHz. The device transmits digital network data. The unit is mounted externally in fixed point-to-point installations. It is mounted on the exterior of a building or, typically for broadband internet access.

The type of RF modulation is OFDM. The device can transmit data at a bit rate of 54 Mbps or a real-world data rate of approximately 27 Mbps. 64/128 bit Wired Equivalent Protection (WEP) algorithm is used for secure communications. The device's standard compliance ensures that it can communicate with any 802.11a network.

The firmware used with the device prevents the use of channels outside the 5.250-5.350 and 5725-5850 MHz bands. It also limits the output power of the device, based on the antenna gain, to maintain compliance with the 15.407 EIRP limits when using the 5.250-5.350 MHz band.

In line with the IEEE 802.11a standard an OFDM physical layer (PHY) splits an information signal across 52 separate subcarriers to provide transmission of data at a rate of 6, 9, 12, 18, 24, 36, 48, or 54 Mbps. Four of the subcarriers are pilot subcarriers that the system uses as a reference to disregard frequency or phase shifts of the signal during transmission. A high speed Fast Fourier Transform (FFT)/Inverse Fast Fourier Transform (IFFT), combined with BPSK, QPSK, 16QAM and 64QAM modulation of the individual subcarriers, provides the data rates of 6, 9, 12, 18, 24, 36, 48 and 54Mbps, with rate compatible punctured convolutional coding with a coding rate of 1/2, 2/3, and 3/4.

In the 802.11a standard, a pseudo binary sequence is sent through the pilot subchannels to prevent the generation of spectral lines. In 802.11a, the remaining 48 subcarriers provide separate wireless pathways for sending the information in a parallel fashion. The resulting subcarrier frequency spacing is 0.3125 MHz (for a 20 MHz with 64 possible subcarrier frequency slots).

The OFDM PHY layer consists of two protocol functions: first a PHY convergence function, which adapts the capabilities of the Physical Medium Dependent (PMD) system to the PHY service. This function is supported by the Physical Layer Convergence Procedure (PLCP), which defines a method of mapping the IEEE 802.11 PHY Sublayer Service Data Units (PSDU) into a framing format suitable for sending and receiving user data and management information between two or more stations using the associated PMD system. Second a PMD system whose function defines the characteristics and method of transmitting and receiving data through a wireless medium between two or more stations, each using the OFDM system.

**The TR-AP5A-N product is used exclusively in a professionally installed, fixed point-to-point environment.**

---

### **1.3 EUT Testing Configuration**

The unit was tested with the largest gain antenna of each type marketed by the client. These were a 12 dBi dipole antenna; a 19 dBi sector antenna; a 24 dBi patch antenna; and a 32 dBi dish antenna. Extensive prescanning for individual tests was performed to determine worst case. Data is presented for worst case measurements only.

The EUT is mounted to a custom non-metallic stand to ease polarization changes and to best represent a typical user installation. The EUT was connected to the host PC so that it could be cycled through the various test modes and channels.

The EUT was tested in the following modes:

- 1) Standby/Receive mode: In this mode the EUT beacons at the lowest possible rate while searching for a client with which to establish communication.
- 2) Data transfer mode: In this mode the EUT is exercised with commercially available bandwidth test software. A link is established between two PCs through the unit and an access point and a transmit rate of 15 Mbps or 27 Mbps is specified reflecting the worst case data rate of the unit for specific tests.

### **1.4 EUT Modifications**

No modifications were necessary for this unit to comply with FCC Part 15 and Industry Canada RSS-210 Issue 5

Conducted output tests were performed with a modified unit. The antenna is removed and the intentional transmitter fitted with a modified production cable. The only modification to the cable is the addition of an appropriate connector that allows a direct connection to measurement equipment.

## 1.5 Test Facilities

Tranzeo EMC Labs  
 #2-11720 Stewart Cres.  
 Maple Ridge, BC Canada  
 V2X 9E7

Phone: (604) 460-6002

Fax: (604) 460-6005

FCC registration number: 960532

Industry Canada Number: 5238A

## 1.6 Test Equipment

| Manufacturer    | Model            | Description        | Serial Number | Last Cal  | Cal Due Date |
|-----------------|------------------|--------------------|---------------|-----------|--------------|
| Hewlett Packard | 8560A            | Quasi Peak Adapter | 790142        | 12-Apr-04 | 12-Apr-05    |
| Hewlett Packard | 8566B            | Spectrum Analyzer  | 2937A06114    | 06-Aug-04 | 06-Aug-06    |
| Hewlett Packard | 8568A            | Preselector        | 3010A1095     | 01-Dec-03 | 01-Dec-05    |
| Sunol Sciences  | SM46C            | Turntable          | 051204-2      | N/R       | N/R          |
| Sunol Sciences  | Custom           | Mast Motor         | TREML0001     | N/R       | N/R          |
| Sunol Sciences  | JB3              | Antenna            | A042004       | 05-May-04 | 05-May-05    |
| Sunol Sciences  | DRH-118          | Antenna            | A052804       | 02-Jun-04 | 02-Jun-05    |
| FCC             | FCC-LISN-50-25-2 | LISN               | 105           | 02-Jun-04 | 02-Jun-06    |
| Wavetek         | 8501             | Power Meter        | 45-00218      | 27-Jul-04 | 27-Jul-06    |
| Wavetek         | 17266            | Power Detector     | 1509315       | 27-Jul-04 | 27-Jul-06    |
| Hewlett Packard | 11970A           | Harmonic Mixer     | 2332A00886    | N/R       | N/R          |
| Hewlett Packard | 11975A           | Amplifier          | 2517A00949    | N/R       | N/R          |

## 1.7 Test System Details

The following auxiliary equipment and cables were used for performing the tests:

| Manufacturer | Model   | Description       | S/N         |
|--------------|---------|-------------------|-------------|
| Soyo         | PW-930S | Laptop PC         | 6188        |
| Pheenet      | SW-05P  | 5 port switch     | C0104260954 |
| Tranzeo      | POE-1   | DC injection unit | n/a         |

| Signal Cable Type | Signal Cable Description    | Length |
|-------------------|-----------------------------|--------|
| Cat 5 LAN         | EUT to DC injection unit    | 50m    |
| Cat 5 LAN         | DC Block to Ethernet switch | 2m     |

## 1.8 Test Results

The TR-AP5A-N product complies with FCC Part 15 Subparts B,C and E, as well as Industry Canada RSS-210 Issue 5.

## 2.0 Conducted Emissions

### 2.1 Test Standard

FCC Part 15 Subpart C Section 15.207a

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30MHz shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

### 2.2 Test Limits

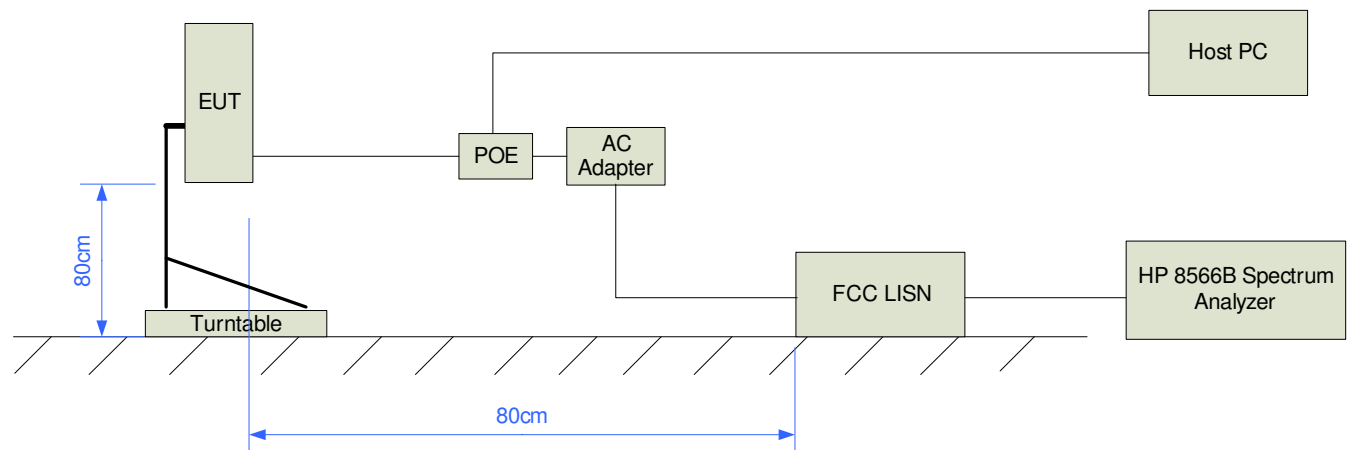
| frequency (MHz) | Maximum Level (dBuV)<br>Quasi-Peak | Maximum Level (dBuV)<br>Average |
|-----------------|------------------------------------|---------------------------------|
| 0.15-0.50       | 66-56 (Log Delta)                  | 56-46 (Log Delta)               |
| 0.50-5.00       | 56                                 | 46                              |
| 5.00-30.0       | 60                                 | 50                              |

### 2.3 Test Setup

The EUT was scanned in all modes. Testing was performed over the frequency range of 0.15 MHz to 30 MHz. Only worst case data is shown below.

The unit was exercised using bandwidth test software at a rate of 15 Mbps representing the worst case data rate. Testing was performed using channels 52, 60, 64, 149, 157 and 165.

#### 2.3.1 Test Setup Block Diagram

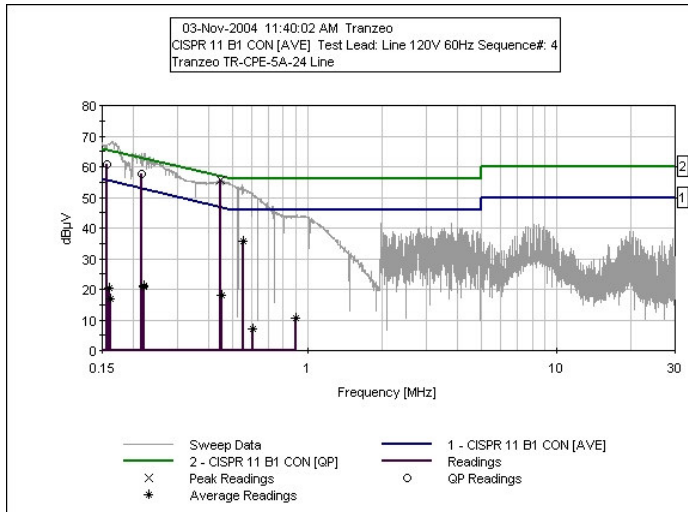


*Note: The unused LISN terminal is terminated with a 50 Ohm terminator.*

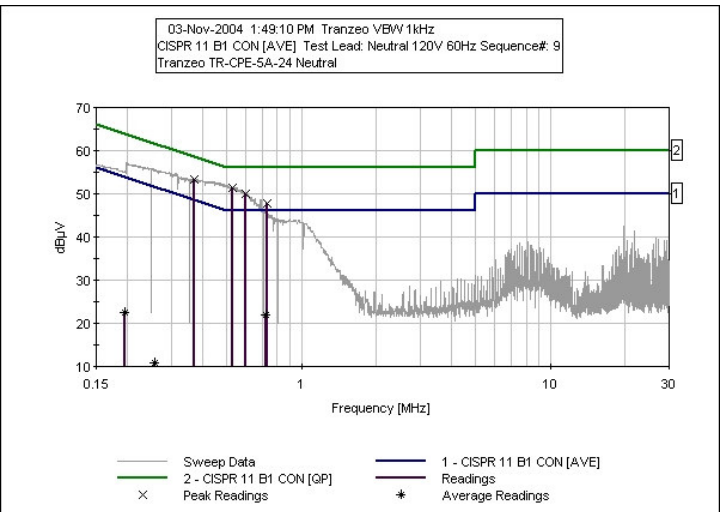
## 2.4 Test Results

### 2.5.1 Emissions Plots

#### Line



#### Neutral



### 2.5.2 Test Data

#### TR-AP5A-N - Line

| Frequency (MHz) | Reading (dBμV) | Correction (dB) | Corr Reading (dBμV) | Limit (dBμV) | Margin (dBμV) | Polarity | Reading type | Result |
|-----------------|----------------|-----------------|---------------------|--------------|---------------|----------|--------------|--------|
| 0.157           | 60.7           | -0.1            | 60.6                | 65.6         | -5.0          | Line     | QP           | PASS   |
| 0.160           | 20.5           | -0.1            | 20.4                | 55.5         | -35.1         | Line     | Ave          | PASS   |
| 0.162           | 16.8           | -0.1            | 16.7                | 55.4         | -38.7         | Line     | Ave          | PASS   |
| 0.165           | 68.3           | -0.1            | 68.2                | --           | --            | Line     | Peak         | --     |
| 0.216           | 57.8           | -0.1            | 57.7                | 63.0         | -5.3          | Line     | QP           | PASS   |
| 0.221           | 20.8           | -0.1            | 20.7                | 52.8         | -32.1         | Line     | Ave          | PASS   |
| 0.223           | 64.4           | -0.1            | 64.3                | --           | --            | Line     | Peak         | --     |
| 0.446           | 55.6           | -0.1            | 55.5                | 56.9         | -1.4          | Line     | Peak         | PASS   |
| 0.453           | 18.2           | -0.1            | 18.1                | 46.8         | -28.7         | Line     | Ave          | PASS   |
| 0.546           | 54.4           | -0.1            | 54.3                | 56.0         | -1.7          | Line     | Peak         | PASS   |
| 0.551           | 35.7           | -0.1            | 35.6                | 46.0         | -10.4         | Line     | Ave          | PASS   |
| 0.599           | 51.5           | -0.1            | 51.4                | 56.0         | -4.6          | Line     | Peak         | PASS   |
| 0.603           | 7.1            | -0.1            | 7.0                 | 46.0         | -39.0         | Line     | Ave          | PASS   |
| 0.903           | 10.5           | -0.1            | 10.4                | 46.0         | -35.6         | Line     | Ave          | PASS   |
| 0.907           | 44.3           | -0.1            | 44.2                | 56.0         | -11.8         | Line     | Peak         | PASS   |

**TR-AP5A-N -24 – Neutral**

| Frequency (MHz) | Reading (dB $\mu$ V) | Correction (dB) | Corr Reading (dB $\mu$ V) | Limit (dB $\mu$ V) | Margin (dB $\mu$ V) | Polarity | Reading type | Result |
|-----------------|----------------------|-----------------|---------------------------|--------------------|---------------------|----------|--------------|--------|
| 0.195           | 22.7                 | -0.1            | 22.6                      | 53.8               | -31.2               | Neutral  | Ave          | PASS   |
| 0.198           | 57.2                 | -0.1            | 57.1                      | 63.7               | -6.6                | Neutral  | Peak         | PASS   |
| 0.254           | 56.0                 | -0.1            | 55.9                      | 61.6               | -5.7                | Neutral  | Peak         | PASS   |
| 0.257           | 10.8                 | -0.1            | 10.7                      | 51.5               | -40.8               | Neutral  | Ave          | PASS   |
| 0.363           | 9.4                  | -0.1            | 9.3                       | 48.7               | -39.4               | Neutral  | Ave          | PASS   |
| 0.371           | 53.5                 | -0.1            | 53.4                      | 58.5               | -5.1                | Neutral  | Peak         | PASS   |
| 0.528           | 51.5                 | -0.1            | 51.4                      | 56.0               | -4.6                | Neutral  | Peak         | PASS   |
| 0.537           | 0.8                  | -0.1            | 0.7                       | 46.0               | -45.3               | Neutral  | Ave          | PASS   |
| 0.595           | 6.2                  | -0.1            | 6.1                       | 46.0               | -39.9               | Neutral  | Ave          | PASS   |
| 0.601           | 50.2                 | -0.1            | 50.1                      | 56.0               | -5.9                | Neutral  | Peak         | PASS   |
| 0.723           | 22.2                 | -0.1            | 22.1                      | 46.0               | -23.9               | Neutral  | Ave          | PASS   |
| 0.728           | 47.8                 | -0.1            | 47.7                      | 56.0               | -8.3                | Neutral  | Peak         | PASS   |

## 3.0 Peak Power Output

### 3.1 Test Standard

FCC CFR47, Part 15, Subpart B 15.247b

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(ii) Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted output power.

(iii) Fixed, point-to-point operation, as used in paragraphs (c)(4)(i) and (c)(4)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

---

**FCC CFR47, Part 15, Subpart E 15.407a****(a) Power limits**

(2) For the 5.25-5.35 and 5.47-5.735 GHz bands, the peak transmit power of the frequency bands of operation shall not exceed the lesser of 250 mW or  $11 \text{ dBm} + 10 \log B$ , where B is the 26 dB emission bandwidth in megahertz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**3.2 Test Limits**

When used exclusively for fixed, point-to-point operations in the 5.725-5.850 MHz band, the intentional radiator may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted output power. Therefore, the maximum peak power output of the intentional radiator shall be less than 1 watt = 30 dBm.

When used in the 5.25-5.35 MHz frequency band the peak transmit power shall not exceed the lesser of 250 mW or  $11 \text{ dBm} + 10 \log B$ , where B is the 26 dB emission bandwidth in megahertz. In addition, the peak transmit power must be reduced whenever antennas with greater than 6 dBi of gain are used.

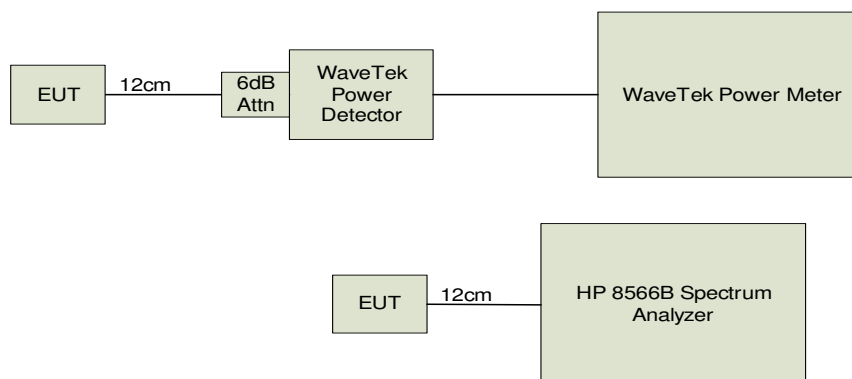
**3.3 Test Setup**

This test is performed with a modified unit. The antenna is removed and the intentional transmitter fitted with a modified production cable. The only modification to the cable is the addition of an appropriate connector that allows a direct connection to measurement equipment. The output of the EUT is connected directly to the power meter through an attenuator. Prescans using standby (beaconing) mode and data transfer mode were performed. The worst case measurements from standby mode are shown below.

The power reduction function is tested by specifying varying levels of antenna gain and measuring the conducted power output to confirm operation of the software.

This test is performed on channels 52, 60, 64, 149, 157 and 165.

### 3.3.1 Test Setup Block Diagram



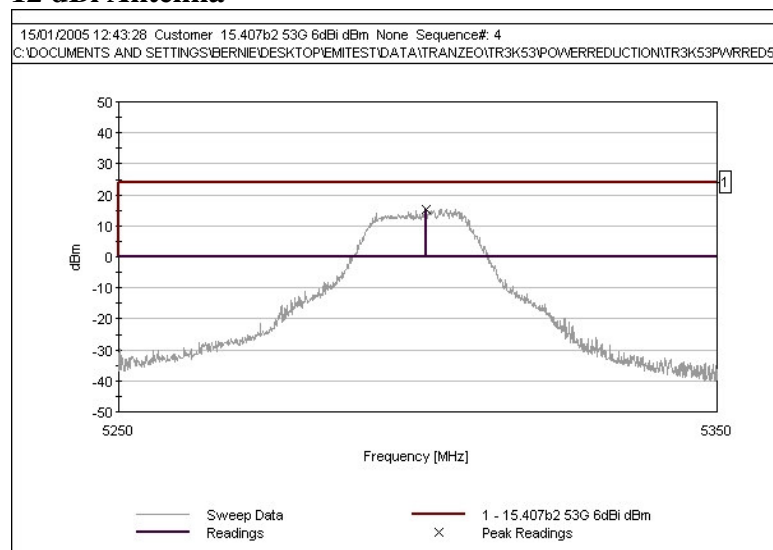
### 3.4 Test Results

#### TR-AP5A-N Beaconsing

| Channel | Frequency (MHz) | Measurement (dBm) | Limit (dBm) | Result |
|---------|-----------------|-------------------|-------------|--------|
| 52      | 5260            | 16.81             | 24.0        | PASS   |
| 60      | 5300            | 16.00             | 24.0        | PASS   |
| 64      | 5320            | 14.15             | 24.0        | PASS   |
| 149     | 5745            | 15.65             | 30.0        | PASS   |
| 157     | 5785            | 16.61             | 30.0        | PASS   |
| 165     | 5825            | 16.89             | 30.0        | PASS   |

#### TR-AP5A-N Output Power Reduction

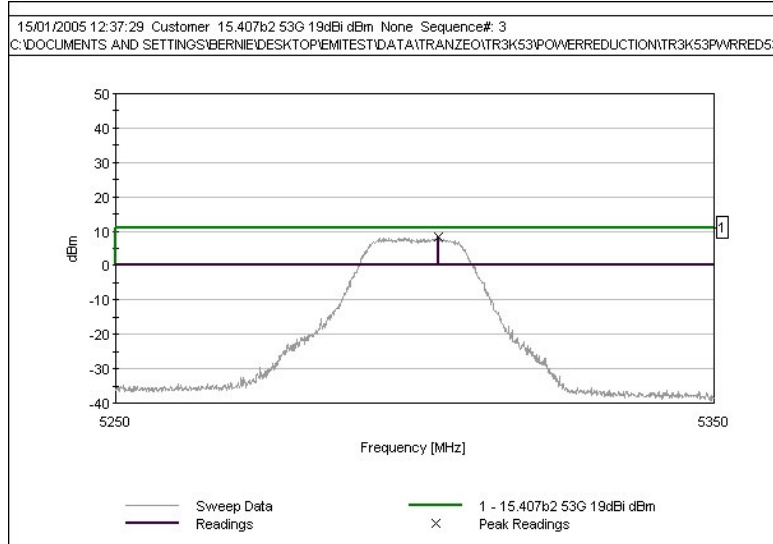
##### 12 dBi Antenna



| Frequency (MHz) | Reading (dBm) | Correction (dB) | Corrected Rdg (dBm) | Power Limit (dBm) | Margin (dB) | Result |
|-----------------|---------------|-----------------|---------------------|-------------------|-------------|--------|
| 5301.2          | 3.4           | 12              | 15.4                | 18                | -2.6        | PASS   |

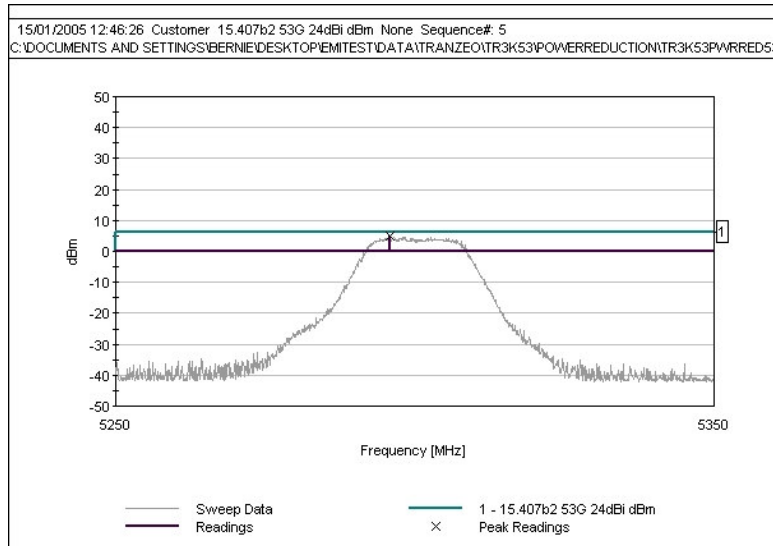
No power reduction is required to use the EUT with the 12 dBi dipole antenna.

## 19 dBi Antenna



| Frequency (MHz) | Reading (dBm) | Correction (dB) | Corrected Rdg (dBm) | Power Limit (dBm) | Margin (dB) | Result |
|-----------------|---------------|-----------------|---------------------|-------------------|-------------|--------|
| 5303.7          | -3.8          | 12              | 8.2                 | 11                | -2.8        | PASS   |

## 24 dBi Antenna



| Frequency (MHz) | Reading (dBm) | Correction (dB) | Corrected Rdg (dBm) | Power Limit (dBm) | Margin (dB) | Result |
|-----------------|---------------|-----------------|---------------------|-------------------|-------------|--------|
| 5295.700        | -7.2          | 12.0            | 4.8                 | 6.0               | -1.2        | PASS   |

## 4.0 Radiated Emissions, General Requirements.

### 4.1 Test Standard

FCC Part 15 Subpart C Section 15.209 Radiated emission limits, general requirements.

(a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequency<br>(MHz) | Field Strength<br>(microvolts/meter) | Measurement Distance<br>(meters) |
|--------------------|--------------------------------------|----------------------------------|
| 0.009 - 0.490      | 2400/F(kHz)                          | 300                              |
| 0.490 - 1.705      | 24000/F(kHz)                         | 30                               |
| 1.705 - 30.0       | 30                                   | 30                               |
| 30 - 88            | 100 **                               | 3                                |
| 88 - 216           | 150 **                               | 3                                |
| 216 - 960          | 200 **                               | 3                                |
| Above 960          | 500                                  | 3                                |

\*\* Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

(b) In the emission table above, the tighter limit applies at the band edges.

(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other Sections within this Part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

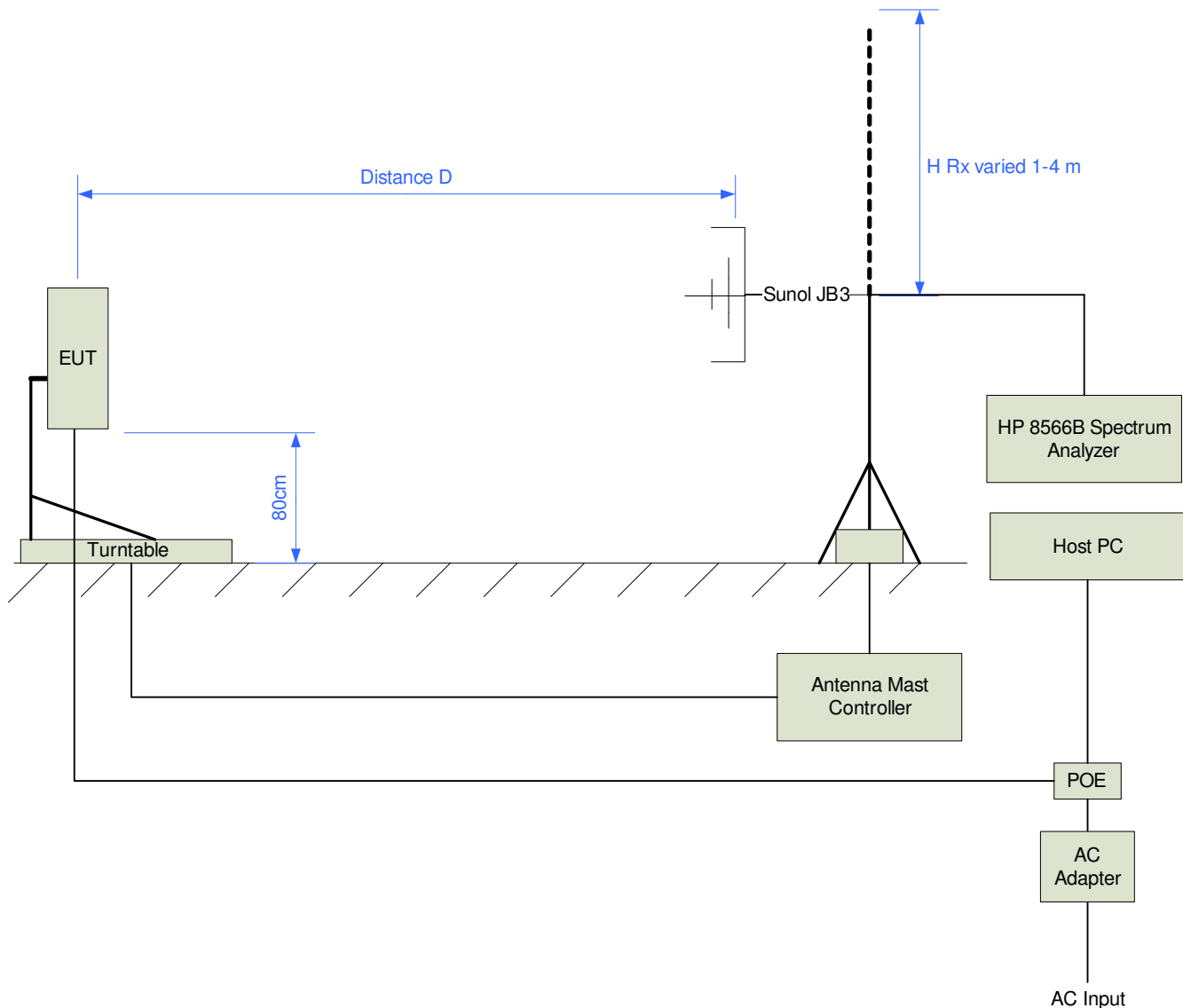
### 4.2 Test Limits

| Frequency (MHz) | Maximum Field Strength<br>(uV/m @ 3M) | Maximum Field Strength<br>(dBuV/m @ 3m) |
|-----------------|---------------------------------------|-----------------------------------------|
| 30-88           | 100                                   | 40.0                                    |
| 88-216          | 150                                   | 43.5                                    |
| 216-960         | 200                                   | 46.0                                    |
| 960-1000        | 500                                   | 54.0                                    |

### 4.3 Test Setup

The TR-AP5A-N was prescanned in both orientations and at in all frequency bands. Scans were performed with all antenna types as listed above. The EUT was exercised with bandwidth test software at a rate of 15 Mbps reflecting the worst case data-rate. The EUT was rotated 360 degrees and the receive antenna swept from 1m to 4m to determine the maximum emissions level. The measurement distance was 3m. The TR-AP5A-N in the vertical orientation with a 12 dBi dipole antenna was determined to be worst case. Only the data taken from the worst is shown below.

#### 4.3.1 Test Setup Block Diagram



Note: Measurements below 2 GHz were performed with the Sunol JB3 antenna with a measurement distance of 3m. Measurements above 2 GHz were performed with the DRH-118 at a distance of 1m.

#### 4.4 Test Results

| Frequency (MHz) | Meter (dBuV) | Correction (dBuV) | Corr Reading (dBuV) | Limit (dBuV) | Margin (dB) | Polarization | Rtype      | Result |
|-----------------|--------------|-------------------|---------------------|--------------|-------------|--------------|------------|--------|
| 30.613          | 11.5         | 21.9              | 33.4                | 40.0         | -6.6        | Vert         | Peak       | PASS   |
| 30.960          | 15.8         | 21.6              | 37.4                | 40.0         | -2.6        | Vert         | Peak       | PASS   |
| 30.623          | 14.9         | 21.8              | 36.7                | 40.0         | -3.3        | Vert         | Peak       | PASS   |
| 34.500          | 14.2         | 19.3              | 33.5                | 40.0         | -6.5        | Vert         | Peak       | PASS   |
| 39.540          | 17.7         | 15.7              | 33.4                | 40.0         | -6.6        | Vert         | Quasi Peak | PASS   |
| 42.000          | 19.0         | 14.0              | 33.0                | 40.0         | -7.0        | Vert         | Peak       | PASS   |
| 50.400          | 23.9         | 9.8               | 33.7                | 40.0         | -6.3        | Vert         | Peak       | PASS   |
| 496.020         | 15.7         | 21.7              | 37.4                | 46.0         | -8.6        | Vert         | Peak       | PASS   |
| 682.014         | 14.6         | 24.4              | 39.0                | 46.0         | -7.0        | Vert         | Peak       | PASS   |
| 744.013         | 15.6         | 25.1              | 40.7                | 46.0         | -5.3        | Vert         | Peak       | PASS   |

## 5.0 Harmonic Emissions

### 5.1 Test Standard

FCC CFR 47, Part 15, Subpart B 15.247d

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

FCC CFR 47, Part 15, Subpart E 15.407b

(b) Undesireable Emission limits: Except as shown in Paragraph (b)(6) of this section, the peak emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of  $-27$  dBm/MHz. Devices operating in the 5.25-5.35 GHz band that generate emissions in the 5.15-5.25 GHz band must meet all applicable technical requirements for operation in the 5.15-5.25 GHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of  $-27$  dBm/MHz in the 5.15-5.25 band.

### 5.2 Test Limits

5.725-5.850 GHz limits:

Fundamental Limit = 137 dBuV

Harmonics and Spurious Emissions = 20 dBc

Restricted Band Emissions = AVG 54 dBuV, PK 74dBuV

5.250-5.350 GHz limits:

All emissions outside of the 5.25-5.35 GHz band shall not exceed an EIRP of  $-27$  dBm/MHz.

Restricted Band Emissions = AVG 54 dBuV, PK 74dBuV

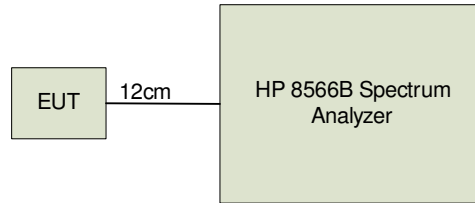
### 5.3 Test Setup – Conducted Measurements (Harmonics)

This test is performed with a modified unit. The antenna is removed and the intentional transmitter fitted with a modified production cable. The only modification to the cable is the addition of an appropriate connector that allows a direct connection to measurement equipment. The output of the EUT is connected directly to the spectrum analyzer. The unit is exercised with bandwidth test software at a rate of 15 MBps reflecting the maximum possible transmit rate. This test is performed on channels 52, 60, 64, 149, 157, and 165.

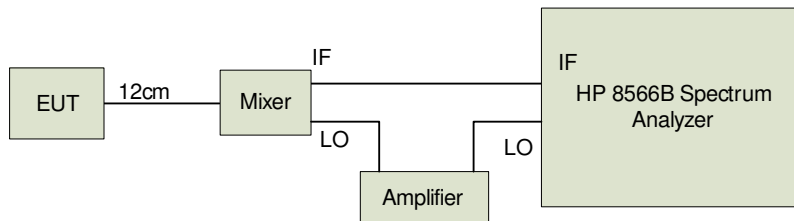
All measurements are performed conducted. To ensure compliance with the required EIRP limits, a worst case antenna gain factor is added to the measured emission level which is then converted to a radiated value.

### 5.3.1 Test Setup Block Diagram – Conducted Measurements (Harmonics)

Below 24 GHz:



Above 24 GHz:



## 5.4 Test Results

### 5.4.1 Test Results 15.247– 5.725-5.850 Harmonics -20 dBc

Channel 149

| Harmonic    | Pol  | Freq (MHz) | Peak Meas TXM (dBm) | Antenna Gain (dBi) | Total transducer Corr (dB) | Limit (dBc/dBm) | Corr Pk TXM (dBm) | Margin | Result |
|-------------|------|------------|---------------------|--------------------|----------------------------|-----------------|-------------------|--------|--------|
| Fundamental | Cond | 5745       | 2.2                 | 0.0                | 0.0                        | 30.0            | 2.2               | -27.8  | PASS   |
| 2nd         | Cond | 11490      | -61.6               | 0.0                | 0.0                        | -15.3           | -61.6             | -46.3  | PASS   |
| 3rd         | Cond | 17235      | -57.1               | 0.0                | 0.0                        | -15.3           | -57.1             | -41.8  | PASS   |
| 4th         | Cond | 22980      | -58.7               | 0.0                | 0.0                        | -15.3           | -58.7             | -43.4  | PASS   |
| 5th         | Cond | 28725      | -66.9               | 0.0                | 0.0                        | -15.3           | -66.9             | -51.6  | PASS   |
| 6th         | Cond | 34470      | -64.9               | 0.0                | 0.0                        | -15.3           | -64.9             | -49.6  | PASS   |

Channel 157

| Harmonic    | Pol  | Freq (MHz) | Peak Meas TXM (dBm) | Antenna Gain (dBi) | Total transducer Corr (dB) | Limit (dBc/dBm) | Corr Pk TXM (dBm) | Margin | Result |
|-------------|------|------------|---------------------|--------------------|----------------------------|-----------------|-------------------|--------|--------|
| Fundamental | Cond | 5785       | 2.9                 | 0.0                | 0.0                        | 30.0            | 2.9               | -27.1  | PASS   |
| 2nd         | Cond | 11570      | -61.0               | 0.0                | 0.0                        | -15.3           | -61.0             | -45.7  | PASS   |
| 3rd         | Cond | 17355      | -66.3               | 0.0                | 0.0                        | -15.3           | -66.3             | -51.0  | PASS   |
| 4th         | Cond | 23140      | -59.5               | 0.0                | 0.0                        | -15.3           | -59.5             | -44.2  | PASS   |
| 5th         | Cond | 28925      | -66.9               | 0.0                | 0.0                        | -15.3           | -66.9             | -51.6  | PASS   |
| 6th         | Cond | 34710      | -62.0               | 0.0                | 0.0                        | -15.3           | -62.0             | -46.7  | PASS   |

Channel 165

| Harmonic    | Pol  | Freq (MHz) | Peak Meas TXM (dBm) | Antenna Gain (dBi) | Total transducer Corr (dB) | Limit (dBc/dBm) | Corr Pk TXM (dBm) | Margin | Result |
|-------------|------|------------|---------------------|--------------------|----------------------------|-----------------|-------------------|--------|--------|
| Fundamental | Cond | 5825       | 4.7                 | 0.0                | 0.0                        | 30.0            | 4.7               | -25.3  | PASS   |
| 2nd         | Cond | 11650      | -71.9               | 0.0                | 0.0                        | -15.3           | -71.9             | -56.6  | PASS   |
| 3rd         | Cond | 17475      | -66.5               | 0.0                | 0.0                        | -15.3           | -66.5             | -51.2  | PASS   |
| 4th         | Cond | 23300      | -57.8               | 0.0                | 0.0                        | -15.3           | -57.8             | -42.5  | PASS   |
| 5th         | Cond | 29125      | -67.1               | 0.0                | 0.0                        | -15.3           | -67.1             | -51.8  | PASS   |
| 6th         | Cond | 34950      | -64.2               | 0.0                | 0.0                        | -15.3           | -64.2             | -48.9  | PASS   |

All conducted harmonics are at least -20 dBc

## 5.4.2 Test Results 15.407 - 5.25-5.35 Harmonics–27 dBm/MHz

Channel 52

| Harmonic    | Pol  | Freq (MHz) | Peak Meas TXM (dBm) | Antenna Gain (dBi) | Total transducer Corr (dB) | EIRP Limit (dBm) | Corr Pk TXM (dBm) | Margin | Result |
|-------------|------|------------|---------------------|--------------------|----------------------------|------------------|-------------------|--------|--------|
| Fundamental | Cond | 5260       | 4.8                 | 24.5               | 0.0                        | 30.0             | 29.3              | -0.7   | PASS   |
| 2nd         | Cond | 10520      | -71.9               | 24.5               | 0.0                        | -27.0            | -47.4             | -20.4  | PASS   |
| 3rd         | Cond | 15780      | -68.9               | 24.5               | 0.0                        | -27.0            | -44.4             | -17.4  | PASS   |
| 4th         | Cond | 21040      | -63.4               | 24.5               | 0.0                        | -27.0            | -38.9             | -11.9  | PASS   |
| 5th         | Cond | 26300      | -76.3               | 24.5               | 0.0                        | -27.0            | -51.8             | -24.8  | PASS   |
| 6th         | Cond | 31560      | -76.8               | 24.5               | 0.0                        | -27.0            | -52.3             | -25.3  | PASS   |
| 7th         | Cond | 36820      | -76.8               | 24.5               | 0.0                        | -27.0            | -52.3             | -25.3  | PASS   |

Channel 60

| Harmonic    | Pol  | Freq (MHz) | Peak Meas TXM (dBm) | Antenna Gain (dBi) | Total transducer Corr (dB) | EIRP Limit (dBm) | Corr Pk TXM (dBm) | Margin | Result |
|-------------|------|------------|---------------------|--------------------|----------------------------|------------------|-------------------|--------|--------|
| Fundamental | Cond | 5300       | 4.0                 | 24.5               | 0.0                        | 30.0             | 28.5              | -1.5   | PASS   |
| 2nd         | Cond | 10600      | -72.3               | 24.5               | 0.0                        | -27.0            | -47.8             | -20.8  | PASS   |
| 3rd         | Cond | 15900      | -68.5               | 24.5               | 0.0                        | -27.0            | -44.0             | -17.0  | PASS   |
| 4th         | Cond | 21200      | -62.9               | 24.5               | 0.0                        | -27.0            | -38.4             | -11.4  | PASS   |
| 5th         | Cond | 26500      | -75.9               | 24.5               | 0.0                        | -27.0            | -51.4             | -24.4  | PASS   |
| 6th         | Cond | 31800      | -77.0               | 24.5               | 0.0                        | -27.0            | -52.5             | -25.5  | PASS   |
| 7th         | Cond | 37100      | -77.5               | 24.5               | 0.0                        | -27.0            | -53.0             | -26.0  | PASS   |

Channel 64

| Harmonic    | Pol  | Freq (MHz) | Peak Meas TXM (dBm) | Antenna Gain (dBi) | Total transducer Corr (dB) | EIRP Limit (dBm) | Corr Pk TXM (dBm) | Margin | Result |
|-------------|------|------------|---------------------|--------------------|----------------------------|------------------|-------------------|--------|--------|
| Fundamental | Cond | 5320       | 1.8                 | 24.5               | 0.0                        | 30.0             | 26.3              | -3.7   | PASS   |
| 2nd         | Cond | 10640      | -72.1               | 24.5               | 0.0                        | -27.0            | -47.6             | -20.6  | PASS   |
| 3rd         | Cond | 15960      | -68.9               | 24.5               | 0.0                        | -27.0            | -44.4             | -17.4  | PASS   |
| 4th         | Cond | 21280      | -63.2               | 24.5               | 0.0                        | -27.0            | -38.7             | -11.7  | PASS   |
| 5th         | Cond | 26600      | -76.5               | 24.5               | 0.0                        | -27.0            | -52.0             | -25.0  | PASS   |
| 6th         | Cond | 31920      | -76.7               | 24.5               | 0.0                        | -27.0            | -52.2             | -25.2  | PASS   |
| 7th         | Cond | 37240      | -77.0               | 24.5               | 0.0                        | -27.0            | -52.5             | -25.5  | PASS   |

Including a worst case 24.5 dBi antenna factor, all harmonics are below the required EIRP of –27dBm/Mhz.

### 5.4.3 Test Results 15.247– Restricted Bands 5.725-5.850

This is a delta measurement. The dBc of each respective harmonic located in a restricted band is subtracted from the maximum radiated output power of the fundamental to determine the radiated value.

#### Channel 149

| Harmonic    | Pol  | Freq (MHz) | Peak Meas TXM (dBuV) | Total transducer Corr (dB) | EIRP Limit (dBuV) | Corr Pk TXM (dBm) | Margin | Result |
|-------------|------|------------|----------------------|----------------------------|-------------------|-------------------|--------|--------|
| Fundamental | Cond | 5260       | 109.2                | 0.0                        | 137.0             | 109.2             | -27.8  | PASS   |
| 2nd         | Cond | 10520      | 65.7                 | 0.0                        | 74.0              | 65.7              | -8.3   | PASS   |
| 4th         | Cond | 22980      | 68.6                 | 0.0                        | 74.0              | 68.6              | -5.4   | PASS   |

#### Average Measurements:

| Harmonic    | Pol  | Freq (MHz) | Ave Rdg (dBuV) | Total transducer Corr (dB) | Limit (dBuV) | Corr Ave @3m (dBuV) | Delta (dB) | Result |
|-------------|------|------------|----------------|----------------------------|--------------|---------------------|------------|--------|
| Fundamental | Cond | 5745       | 71.4           | 0.0                        | 137.0        | 71.4                | -65.6      | PASS   |
| 2nd         | Cond | 11490      | 27.9           | 0.0                        | 54.0         | 27.9                | -26.1      | PASS   |
| 4th         | Cond | 22980      | 30.8           | 0.0                        | 54.0         | 30.8                | -23.2      | PASS   |

#### Channel 157

| Harmonic    | Pol  | Freq (MHz) | Peak Rdg (dBuV) | Total transducer Corr (dB) | Limit (dBuV) | Corr Pk TXM @3m (dBuV) | Delta (dB) | Result |
|-------------|------|------------|-----------------|----------------------------|--------------|------------------------|------------|--------|
| Fundamental | Cond | 5785       | 109.9           | 0.0                        | 137.0        | 109.9                  | -27.1      | PASS   |
| 2nd         | Cond | 11570      | 66.3            | 0.0                        | 74.0         | 66.3                   | -7.7       | PASS   |

#### Average Measurements:

| Harmonic    | Pol  | Freq (MHz) | Ave Rdg (dBuV) | Total transducer Corr (dB) | Limit (dBuV) | Corr Ave @3m (dBuV) | Delta (dB) | Result |
|-------------|------|------------|----------------|----------------------------|--------------|---------------------|------------|--------|
| Fundamental | Cond | 5785       | 72.1           | 0.0                        | 137.0        | 72.1                | -64.9      | PASS   |
| 2nd         | Cond | 11570      | 28.5           | 0.0                        | 54.0         | 28.5                | -25.5      | PASS   |

#### Channel 165

| Harmonic    | Pol  | Freq (MHz) | Peak Rdg (dBuV) | Total transducer Corr (dB) | Limit (dBuV) | Corr Pk TXM @3m (dBuV) | Delta (dB) | Result |
|-------------|------|------------|-----------------|----------------------------|--------------|------------------------|------------|--------|
| Fundamental | Cond | 5845       | 111.7           | 0.0                        | 137.0        | 111.7                  | -25.3      | PASS   |
| 2nd         | Cond | 11650      | 55.4            | 0.0                        | 74.0         | 55.4                   | -18.6      | PASS   |

---

**Average Measurements:**

| Harmonic    | Pol  | Freq (MHz) | Ave<br>Rdg<br>(dBuV) | Total<br>transducer<br>Corr<br>(dB) | Limit<br>(dBuV) | Corr<br>Ave<br>@3m<br>(dBuV) | Delta<br>(dB) | Result |
|-------------|------|------------|----------------------|-------------------------------------|-----------------|------------------------------|---------------|--------|
| Fundamental | Cond | 5825       | 73.9                 | 0.0                                 | 137.0           | 73.9                         | -63.1         | PASS   |
| 2nd         | Cond | 11650      | 17.6                 | 0.0                                 | 54.0            | 17.6                         | -36.4         | PASS   |

Assuming a worst case antenna configuration, all radiated harmonics meet the required restricted band emission limits.

### 5.4.3 Test Results 15.407 – Restricted Bands 5.250-5.350

This is a conducted measurement. The gain in dBi of the antenna is added to the measured signal to give the effective radiated power.

#### Channel 52

| Harmonic    | Pol  | Freq (MHz) | Peak Meas TXM (dBuV) | Antenna Gain (dBi) | Total transducer Corr (dB) | EIRP Limit (dBuV) | Corr Pk TXM (dBm) | Margin | Result |
|-------------|------|------------|----------------------|--------------------|----------------------------|-------------------|-------------------|--------|--------|
| Fundamental | Cond | 5260       | 100.8                | 24.5               | 0.0                        | 137.0             | 125.3             | -11.7  | PASS   |
| 2nd         | Cond | 10520      | 35.1                 | 24.5               | 0.0                        | 74.0              | 59.6              | -14.4  | PASS   |
| 4th         | Cond | 21040      | 43.6                 | 24.5               | 0.0                        | 74.0              | 68.1              | -5.9   | PASS   |
| 6th         | Cond | 31560      | 30.2                 | 24.5               | 0.0                        | 74.0              | 54.7              | -19.3  | PASS   |

#### Average Measurements:

| Harmonic    | Pol  | Freq (MHz) | Ave Rdg (dBuV) | Antenna Gain (dBi) | Total transducer Corr (dB) | Limit (dBuV) | Corr Ave @3m (dBuV) | Delta (dB) | Result |
|-------------|------|------------|----------------|--------------------|----------------------------|--------------|---------------------|------------|--------|
| Fundamental | Cond | 5260       | 74.0           | 24.5               | 0.0                        | 137.0        | 98.5                | -38.5      | PASS   |
| 2nd         | Cond | 10520      | 8.3            | 24.5               | 0.0                        | 54.0         | 32.8                | -21.2      | PASS   |
| 4th         | Cond | 21040      | 16.8           | 24.5               | 0.0                        | 54.0         | 41.3                | -12.7      | PASS   |
| 6th         | Cond | 31560      | 3.4            | 24.5               | 0.0                        | 54.0         | 27.9                | -26.1      | PASS   |

#### Channel 60

| Harmonic    | Pol  | Freq (MHz) | Peak Rdg (dBuV) | Antenna Gain (dBi) | Total transducer Corr (dB) | Limit (dBuV) | Corr Pk TXM @3m (dBuV) | Delta (dB) | Result |
|-------------|------|------------|-----------------|--------------------|----------------------------|--------------|------------------------|------------|--------|
| Fundamental | Cond | 5300       | 100.0           | 24.5               | 0.0                        | 137.0        | 124.5                  | -12.5      | PASS   |
| 2nd         | Cond | 10600      | 34.7            | 24.5               | 0.0                        | 74.0         | 59.2                   | -14.8      | PASS   |
| 3rd         | Cond | 15900      | 38.5            | 24.5               | 0.0                        | 74.0         | 63.0                   | -11.0      | PASS   |
| 4th         | Cond | 21200      | 44.1            | 24.5               | 0.0                        | 74.0         | 68.6                   | -5.4       | PASS   |
| 6th         | Cond | 31800      | 30.0            | 24.5               | 0.0                        | 74.0         | 54.5                   | -19.5      | PASS   |

## Average Measurements:

| Harmonic    | Pol  | Freq (MHz) | Ave Rdg (dBuV) | Antenna Gain (dBi) | Total transducer Corr (dB) | Limit (dBuV) | Corr Ave @3m (dBuV) | Delta (dB) | Result |
|-------------|------|------------|----------------|--------------------|----------------------------|--------------|---------------------|------------|--------|
| Fundamental | Cond | 5300       | 73.2           | 24.5               | 0.0                        | 137.0        | 97.7                | -39.3      | PASS   |
| 2nd         | Cond | 10600      | 7.9            | 24.5               | 0.0                        | 54.0         | 32.4                | -21.6      | PASS   |
| 3rd         | Cond | 15900      | 11.7           | 24.5               | 0.0                        | 54.0         | 36.2                | -17.8      | PASS   |
| 4th         | Cond | 21200      | 17.3           | 24.5               | 0.0                        | 54.0         | 41.8                | -12.2      | PASS   |
| 6th         | Cond | 31800      | 3.2            | 24.5               | 0.0                        | 54.0         | 27.7                | -26.3      | PASS   |

## Channel 64

| Harmonic    | Pol  | Freq (MHz) | Peak Rdg (dBuV) | Antenna Gain (dBi) | Total transducer Corr (dB) | Limit (dBuV) | Corr Pk TXM @3m (dBuV) | Delta (dB) | Result |
|-------------|------|------------|-----------------|--------------------|----------------------------|--------------|------------------------|------------|--------|
| Fundamental | Cond | 5320       | 97.8            | 24.5               | 0                          | 137.0        | 122.3                  | -14.7      | PASS   |
| 2nd         | Cond | 10640      | 34.9            | 24.5               | 0                          | 74.0         | 59.4                   | -14.6      | PASS   |
| 3rd         | Cond | 15960      | 38.1            | 24.5               | 0                          | 74.0         | 62.6                   | -11.4      | PASS   |
| 4th         | Cond | 21280      | 43.8            | 24.5               | 0                          | 74.0         | 68.3                   | -5.7       | PASS   |

## Average Measurements:

| Harmonic    | Pol  | Freq (MHz) | Ave Rdg (dBuV) | Antenna Gain (dBi) | Total transducer Corr (dB) | Limit (dBuV) | Corr Ave @3m (dBuV) | Delta (dB) | Result |
|-------------|------|------------|----------------|--------------------|----------------------------|--------------|---------------------|------------|--------|
| Fundamental | Cond | 5320       | 71             | 24.5               | 0                          | 137.0        | 95.5                | -41.5      | PASS   |
| 2nd         | Cond | 10640      | 8.1            | 24.5               | 0                          | 54.0         | 32.6                | -21.4      | PASS   |
| 3rd         | Cond | 15960      | 11.3           | 24.5               | 0                          | 54.0         | 35.8                | -18.2      | PASS   |
| 4th         | Cond | 21280      | 18             | 24.5               | 0                          | 54.0         | 42.5                | -11.5      | PASS   |

Assuming a worst case antenna configuration, all radiated harmonics meet the required restricted band emission limits.

---

## 6.0 Band Edge

### 6.1 Test Standard

FCC CFR 47, Part 15, Subpart B 15.247d

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

FCC CFR 47, Part 15, Subpart E 15.407b

(b) Undesireable Emission limits: Except as shown in Paragraph (b)(6) of this section, the peak emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

- (2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of  $-27$  dBm/MHz. Devices operating in the 5.25-5.35 GHz band that generate emissions in the 5.15-5.25 GHz band must meet all applicable technical requirements for operation in the 5.15-5.25 GHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of  $-27$  dBm/MHz in the 5.15-5.25 band.
- (7) The provisions of Section 15.205 of this part apply to intentional radiators operating under this section.

### 6.2 Test Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Sec. 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Sec. 15.205(a), must also comply with the radiated emission limits specified in Sec. 15.209(a) (see Sec. 15.205(c)).

- (2) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of  $-27$  dBm/MHz. Devices operating in the 5.25-5.35 GHz band that generate emissions in the 5.15-5.25 GHz band must meet all applicable technical requirements for operation in the 5.15-5.25 GHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of  $-27$  dBm/MHz in the 5.15-5.25 band.

- (7) The provisions of Section 15.205 of this part apply to intentional radiators operating under this section.

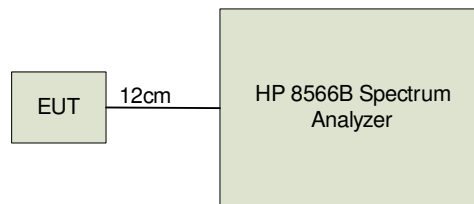
### 6.3 Test Setup

This test is performed with a modified unit. The antenna is removed and the intentional transmitter fitted with a modified production cable. The only modification to the cable is the addition of an appropriate connector that allows a direct connection to the measurement equipment. The output of the EUT is connected directly to the spectrum analyzer through an attenuator. The unit is exercised with bandwidth test software at a rate of 27 MBps reflecting the worst case transmit rate.

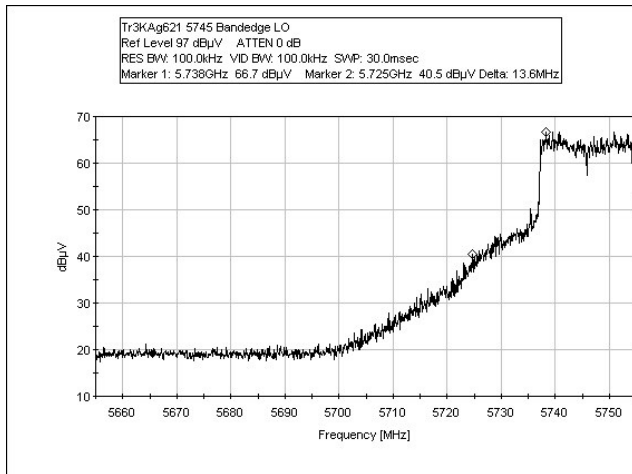
For the 15.407 requirements a worst case antenna gain factor is added to the conducted measurement.

This test is performed on channels 52, 64, 149, and 165.

#### 6.3.1 Test Setup Block Diagram

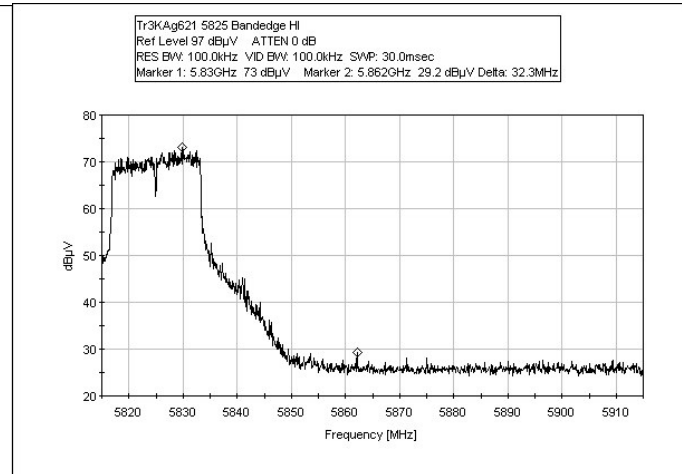


## 6.4 Test Results



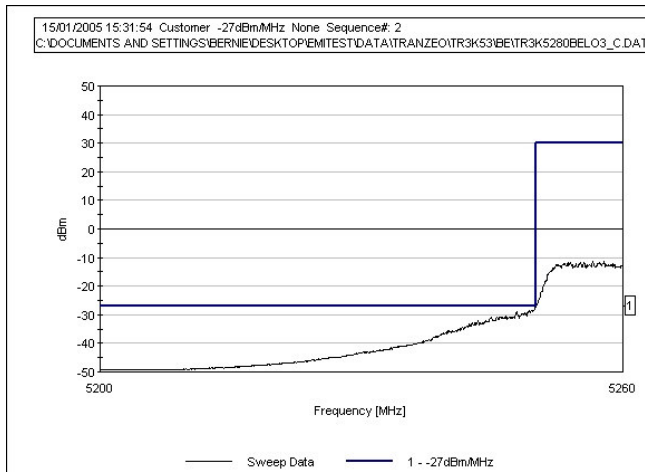
**Test result, Channel 149**

| Hi Reading (dBuV) | Lo Reading (dBuV) | Delta (dB) | Result |
|-------------------|-------------------|------------|--------|
| 66.7              | 40.5              | -26.2      | PASS   |



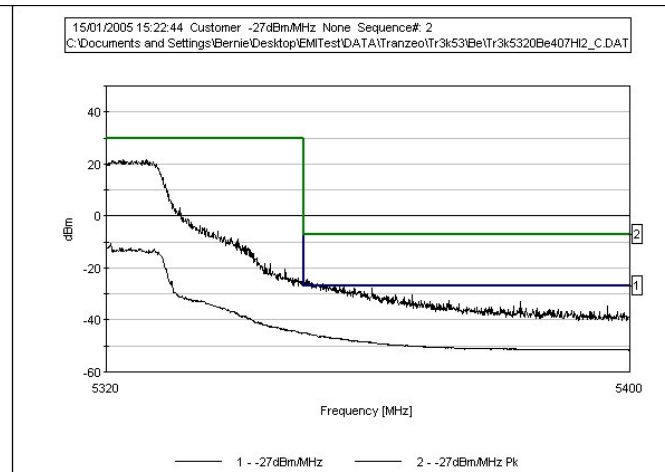
**Test result, Channel 165**

| Hi Reading (dBuV) | Lo Reading (dBuV) | Delta (dB) | Result |
|-------------------|-------------------|------------|--------|
| 73.0              | 29.2              | -43.8      | PASS   |



**Test Results, Channel 52**

| Freq (MHz) | Meter (dBm) | Factors (dB) | Corrected Reading (dBm) | Limit (dBm) | Margin (dB) |
|------------|-------------|--------------|-------------------------|-------------|-------------|
| 5249.98    | -52.7       | 25.5         | -27.2                   | -27         | -0.2        |



**Test Results, Channel 64**

| Freq (MHz) | Meter (dBm) | Factors (dB) | Corrected Reading (dBm) | Limit (dBm) | Margin (dB) |
|------------|-------------|--------------|-------------------------|-------------|-------------|
| 5349.92    | -70.5       | 25.5         | -45                     | -27         | -18         |

## 7.0 Occupied Bandwidth

### 7.1 Test Standard

FCC CFR47, Part 15, Subpart B 15.247a

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

- (3) Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

FCC CRF47, Part 15, Subpart E 15.403i

(i) Emission bandwidth. For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

### 7.2 Test Limits

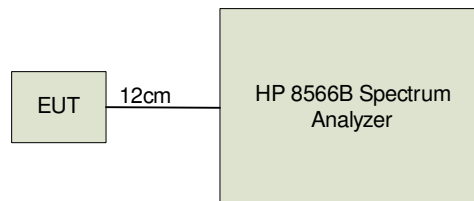
The minimum 6dB bandwidth shall be at least 500 kHz.

### 7.3 Test Setup

This test is performed with a modified unit. The antenna is removed and the intentional transmitter was fitted with a modified production cable. The only modification to the cable is the addition of an appropriate connector that allows a direct connection to the measurement equipment. The output of the EUT is connected directly to the spectrum analyzer through an attenuator. The unit is exercised with bandwidth test software at a rate of 27 MBps reflecting the worst case transmit rate.

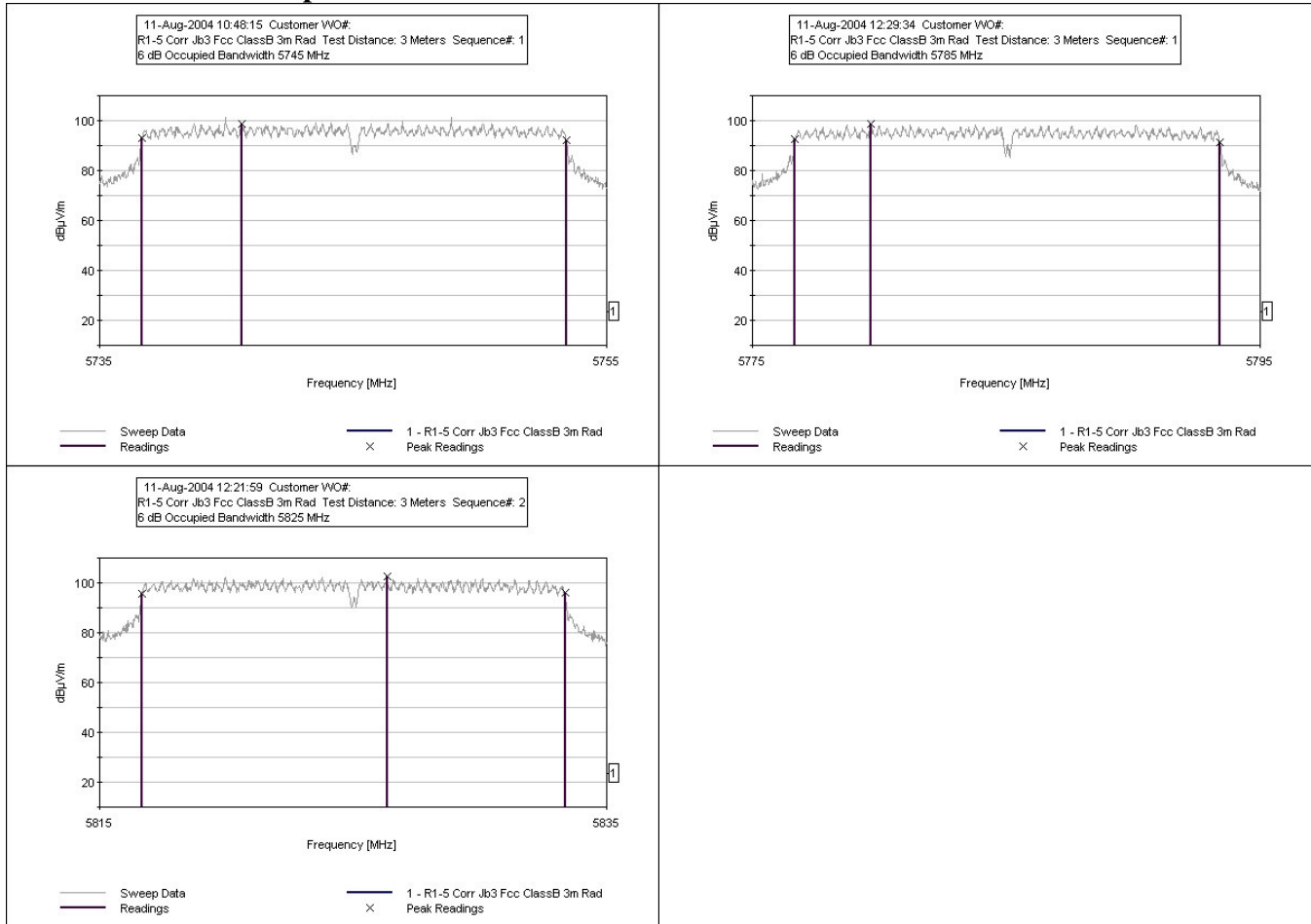
This test was performed on channels 52, 60, 64, 149, 157 and 165.

#### 7.3.1 Test Setup Block Diagram

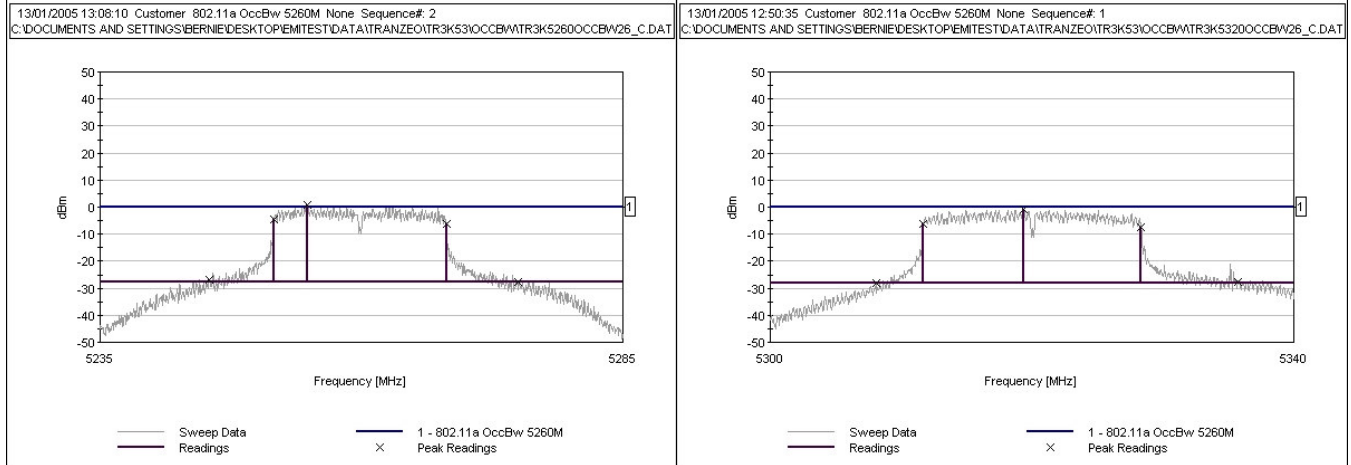


## 7.4 Test Results

### 5.725-5.850 6 dB Occupied Bandwidth



|        | Start Frequency (Mhz) | Stop Frequency (MHz) | Occupied Bandwidth (MHz) | Result |
|--------|-----------------------|----------------------|--------------------------|--------|
| CH 149 | 5736.68               | 5753.40              | <b>16.72</b>             | PASS   |
| Ch 157 | 5776.66               | 5793.40              | <b>16.74</b>             | PASS   |
| Ch 165 | 5816.66               | 5833.36              | <b>16.70</b>             | PASS   |

**5.250-5.350 26 dB Emission Bandwidth**

|       | Start<br>Frequency<br>(Mhz) | Stop<br>Frequency<br>(MHz) | Occupied<br>Bandwidth<br>(MHz) |
|-------|-----------------------------|----------------------------|--------------------------------|
| CH 52 | 5245.45                     | 5274.90                    | <b>29.45</b>                   |
| Ch 64 | 5308.12                     | 5335.72                    | <b>27.60</b>                   |

## 8.0 Power Spectral Density

### 8.1 Test Standard

FCC CFR 47, Part 15, Subpart B 15.247e

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

FCC CFR47, Part 15, Subpart E 15.407a

(2) For the 5.25-5.35 and 5.47-5.735 GHz bands, the peak transmit power of the frequency bands of operation shall not exceed the lesser of 250 mW or  $11 \text{ dBm} + 10 \log B$ , where B is the 26 dB emission bandwidth in megahertz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 8.2 Test Limits

The transmitted power density shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

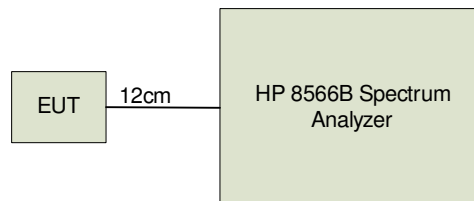
In addition, the peak power spectral density shall not exceed 11 dBm in any 1 megahertz band.

### 8.3 Test Setup

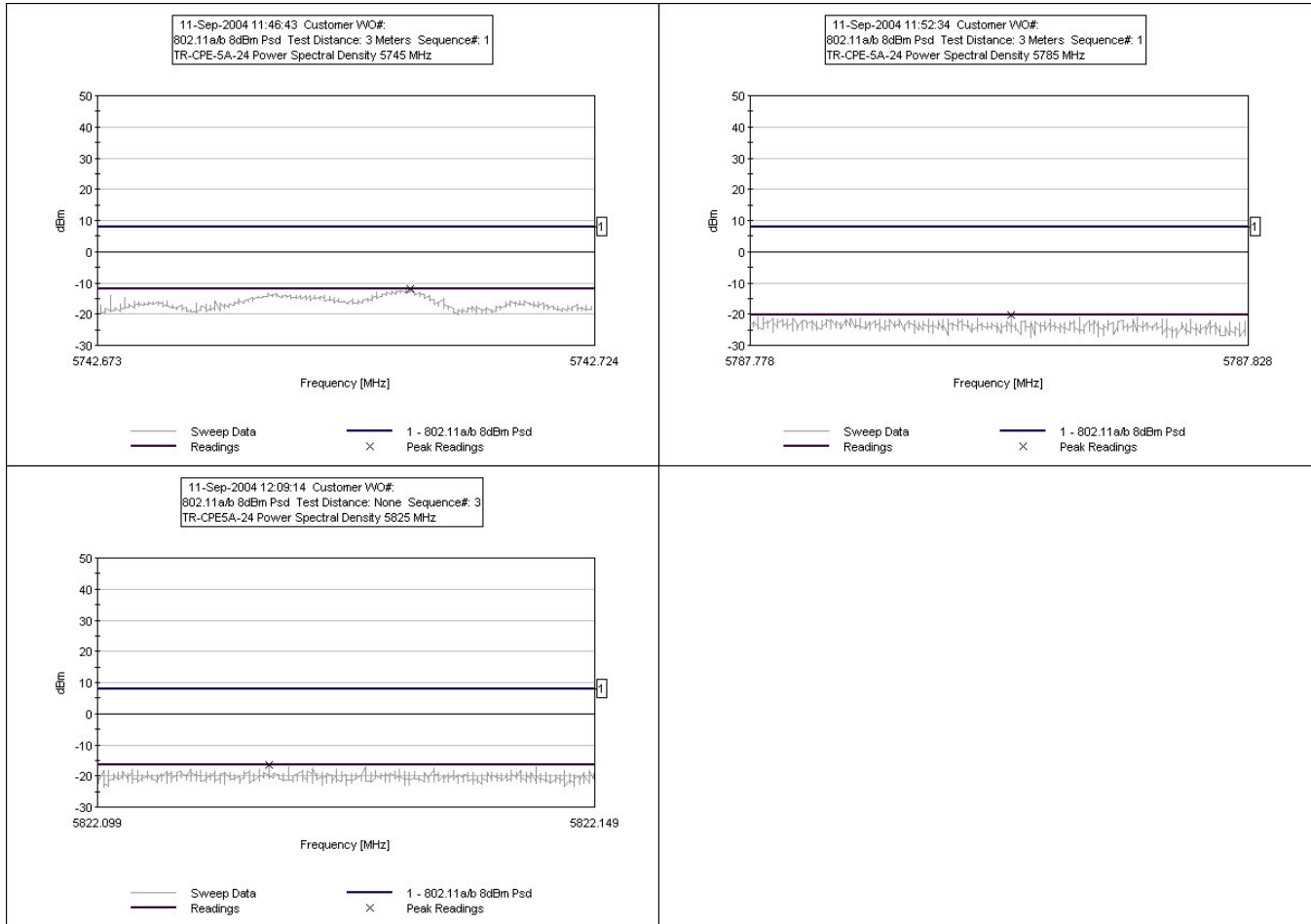
This test is performed with a modified unit. The antenna is removed and the intentional transmitter fitted with a modified production cable. The only modification to the cable is the addition of an appropriate connector that allows a direct connection to measurement equipment. The unit is exercised with bandwidth test software at a rate of 27 MBps reflecting the worst case transmit rate.

This test was performed on channels 52, 60, 64, 149, 157 and 165.

#### 8.3.1 Test Setup Block Diagram

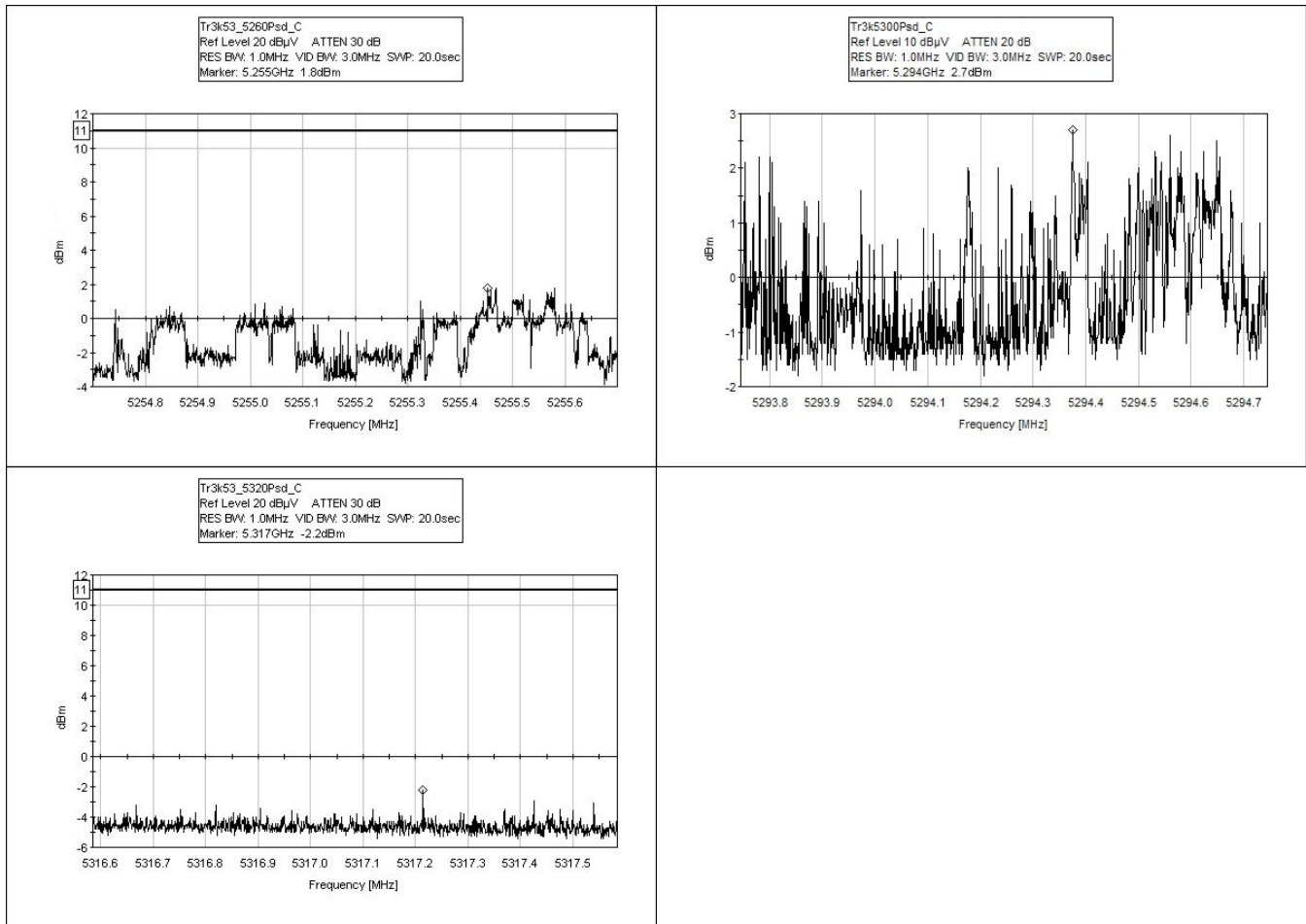


## 8.4 Test Results 15.24 - 7 5.725-5.850 GHz



| Frequency (MHz) | Measurement (dBm) | Limit (dBm) | Result |
|-----------------|-------------------|-------------|--------|
| 5742            | -21.9             | +8          | PASS   |
| 5787            | -20.3             | +8          | PASS   |
| 5822            | -16.3             | +8          | PASS   |

## Test Results 15.407 - 5.250-5.350 Ghz



| Frequency (MHz) | Measurement (dBm) | Limit (dBm) | Result |
|-----------------|-------------------|-------------|--------|
| 5260            | 1.8               | +11         | PASS   |
| 5300            | 2.7               | +11         | PASS   |
| 5320            | -2.2              | +11         | PASS   |

## 9.0 Peak Excursion

### 9.1 Test Standard

FCC CFR47, Part 15, Subpart E 15.407a

- (6) The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak ptransmit power (measured as a specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

### 9.2 Test Limits

The peak excursion ratio shall not exceed 13 dB across any 1 MHz bandwidth.

### 9.3 Test Setup

This test is performed with a modified unit. The antenna is removed and the intentional transmitter fitted with a modified production cable. The only modification to the cable is the addition of an appropriate connector that allows a direct connection to measurement equipment. The unit is exercised with bandwidth test software at a rate of 27 MBps reflecting the maximum possible transmit rate.

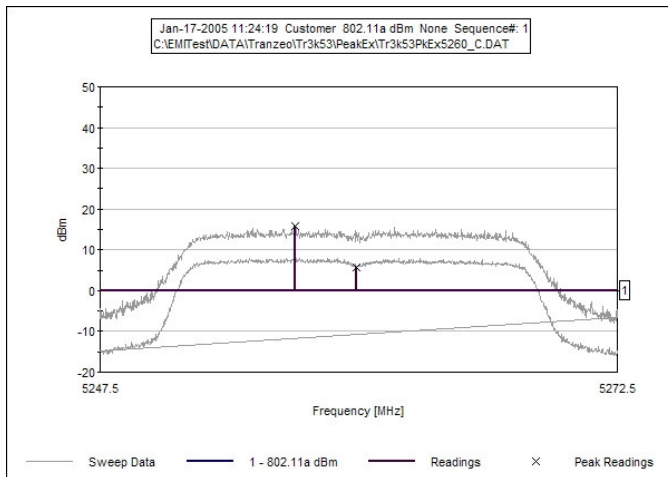
This test was performed on channel 60.

### 9.4 Test Results

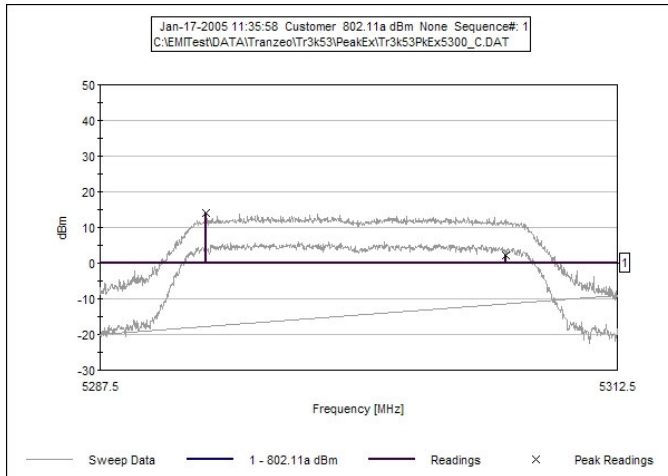
with bandwidth test software at a rate of 27 MBps reflecting the maximum possible transmit rate.

This test was performed on channels 52, 60, and 64.

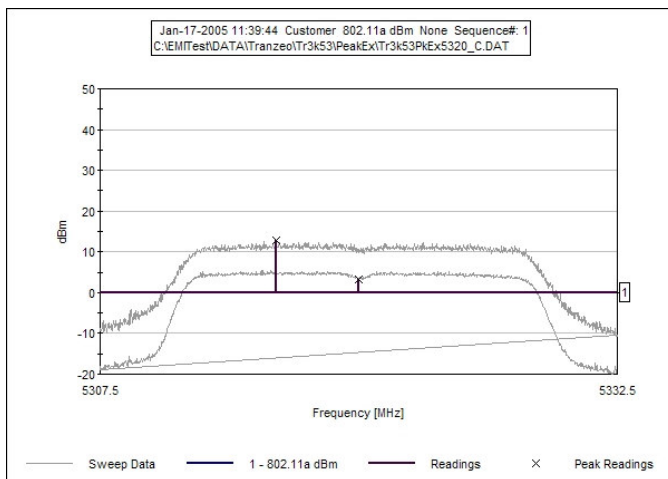
### 9.4 Test Results



| Freq (MHz) | Reading (dBm) | Correction (dB) | Corrected Reading (dBm) | Peak Excursion (dB) | Result |
|------------|---------------|-----------------|-------------------------|---------------------|--------|
| 5256.9     | 3.7           | 12              | 15.7                    | 10.0                | PASS   |
| 5259.9     | -6.3          | 12              | 5.7                     |                     |        |



| Freq (MHz) | Reading (dBm) | Correction (dB) | Corrected Reading (dBm) | Difference (dB) | Result |
|------------|---------------|-----------------|-------------------------|-----------------|--------|
| 5292.6     | 2.1           | 12              | 14.1                    | 11.3            | PASS   |
| 5307.1     | -9.7          | 12              | 2.3                     |                 |        |



| Freq (MHz) | Reading (dBm) | Correction (dB) | Corrected Reading (dBm) | Peak Excursion (dB) | Result |
|------------|---------------|-----------------|-------------------------|---------------------|--------|
| 5316.0     | 0.9           | 12.0            | 12.9                    | 9.6                 | PASS   |
| 5320.0     | -8.7          | 12.0            | 3.3                     |                     |        |

## 10.0 RF Exposure Evaluation

FCC 1.1310 states the criteria listed in the table below shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter. Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation."

| Frequency Range (MHZ)                                    | Electric Field Strength (V/m) | Magnetic Field Strength (A/M) | Power Density (mW/cm <sup>2</sup> ) | Average Time |
|----------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------------|--------------|
| (A) Limits for Occupational/Control Exposures            |                               |                               |                                     |              |
| 300-1500                                                 | --                            | --                            | F/300                               | 6            |
| 1500-100,000                                             | --                            | --                            | 5                                   | 6            |
| (B) Limits for General Population/Uncontrolled Exposures |                               |                               |                                     |              |
| 300-1500                                                 | --                            | --                            | F/1500                              | 6            |
| 1500-100,000                                             | --                            | --                            | 1                                   | 30           |

### 9.1 Fries Formula

Fries transmission formula:  $P_d = (P_{out} * G) / (4 * \pi * r^2)$  Where

$P_d$  = power density in mW/cm<sup>2</sup>

$P_{out}$  = output power to antenna in mW.

$G$  = gain of antenna in the direction of interest relative to an isotropic radiator.

$R$  = the distance between the observation point and the center of the radiator in cm.

$P_d$  is the limit of MPE, 1mW/cm<sup>2</sup>. If we know the maximum gain of the antenna and the total power input to the antenna we can calculate the distance  $r$  where the MPE limit is reached.

### 9.2 EUT Operating Condition

Software provided by the manufacturer enabled the EUT to transmit and receive data at the lowest, middle and highest channels individually.

The maximum antenna gain is 24.5 dBi for the TR-CPE5A-24 as stated by the manufacturer. The maximum antenna gain is 21.5 dBi for the TR-CPE5A-21 as stated by the manufacturer.

### 9.3 RF exposure evaluation distance calculation

#### TR-AP5A-N with 32 dBi antenna

| Chan | Freq (MHz) | Output Power to Antenna (dBm) | Output Power to Antenna (mW) | Antenna Gain (dBi) | Antenna Gain | r (cm) |
|------|------------|-------------------------------|------------------------------|--------------------|--------------|--------|
| 1    | 5745       | 15.65                         | 37                           | 33                 | 1778.279     | 50.978 |
| 6    | 5785       | 16.61                         | 46                           | 33                 | 1778.279     | 56.935 |
| 11   | 5825       | 16.89                         | 49                           | 33                 | 1778.279     | 58.800 |

As shown above, the minimum distance where the MPE limit is reached is **59** cm for the TR-AP5A-N.

## 11.0 Test Photos



**TR-AP5A-N with 12 dBi Antenna**



TR-AP5A-N with 19 dBi antenna



TR-AP5A-N with 24 dBi antenna



TR-AP5A-N with 32 dBi antenna.