| | |
|---|---|
| **Nemko Test Report:** | 2L0092RUS1 |
| **Applicant:** | Internet Telemetry<br>5311 S.122nd East Avenue<br>Tulsa, OK 74146 |
| **Equipment Under Test: (E.U.T.)** | Model TIM 15 Version G4 |
| **In Accordance With:** | **FCC Part 15, Subpart C, 15.247**<br>Frequency Hopping Transmitters |
| **Tested By:** | Nemko Dallas Inc.<br>802 N. Kealy<br>Lewisville, Texas 75057-3136 |
| **Authorized By:** |  <br>David Light, Wireless Lab Supervisor |
| **Date:** | 6/25/02 |
| **Total Number of Pages:** | 41 |

# Table of Contents

## Section 1. Summary of Test Results

Manufacturer: Internet Telemetry

Model No.: Model TIM 15 Version G4

Serial No.: None

General: **All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C, Paragraph 15.247 for Frequency Hopping Spread Spectrum devices. Radiated tests were conducted is accordance with ANSI C63.4-1992. Radiated emissions below 1 GHz are made on an open area test site. A description of the test facility is on file with the FCC.

| | | | |
|---|---|---|---|
| ☒ | New Submission | ☐ | Production Unit |
| ☐ | Class II Permissive Change | ☒ | Pre-Production Unit |
| ☐ | Family Listing | | |

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.
See " Summary of Test Data".

NVLAP

**NVLAP LAB CODE: 100426-0**

TESTED BY: Tom Tidwell DATE: 5/19/2002

## Summary Of Test Data

| NAME OF TEST | PARA. NO. | SPEC. | RESULT |
|---|---|---|---|
| Powerline Conducted Emissions | 15.207(a) | 48 dBμV | Complies |
| Channel Separation | 15.247(a)(1) | Greater of 25 kHz or 20 dB Bandwidth | Complies |
| Pseudorandom Hopping Algorithm | 15.247(a)(1) | | Complies |
| Time of Occupancy | 15.247(a)(1)(ii) | ≤ 0.4 sec in 30 sec | Complies |
| 20 dB Occupied Bandwidth | 15.247(a)(1) | ≤ 1 MHz | Complies |
| Peak Power Output | 15.247(b) | <1 Watt | Complies |
| Spurious Emissions (Antenna Conducted) | 15.247(c) | -20 dBc | Complies |
| Spurious Emissions (Radiated) | 15.247(c) | Table 15.209(a) | Complies |

**Footnotes:**

This device is battery powered. Since the device is also intended to be an OEM module, powerline conducted emissions were measured using an off-the-shelf AC/DC adapter.

# Section 2. Equipment Under Test (E.U.T.)

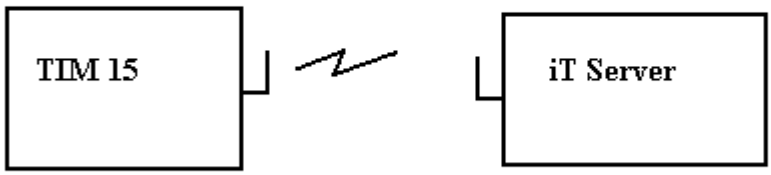
## General Equipment Information

| | |
|---|---|
| **Frequency Band:** | ☒ 902 – 928 MHz<br>☐ 2400 – 2483.5 MHz |
| **Number of Channels:** | 50 |
| **Channel Spacing:** | 125 kHz |
| **20 dB Bandwidth:** | 50.8 kHz |
| **User Frequency Adjustment:** | Software controlled |

## Theory of Operation

The Telemetry Interface Module (TIM) is a data-collection-wireless-transceiver module.

## System Diagram



## Section 3. Powerline Conducted Emissions

| | |
|---|---|
| NAME OF TEST: Powerline Conducted Emissions | PARA. NO.: 15.207(a) |
| TESTED BY: | DATE: |

**Test Results:** Complies.

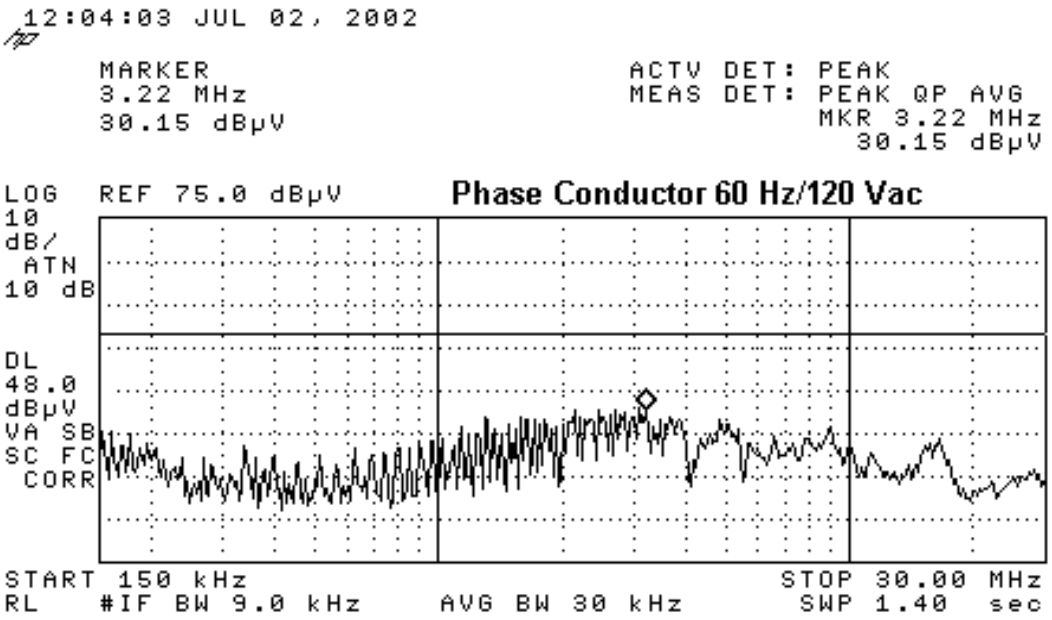
**Measurement Data:** See attached plots.

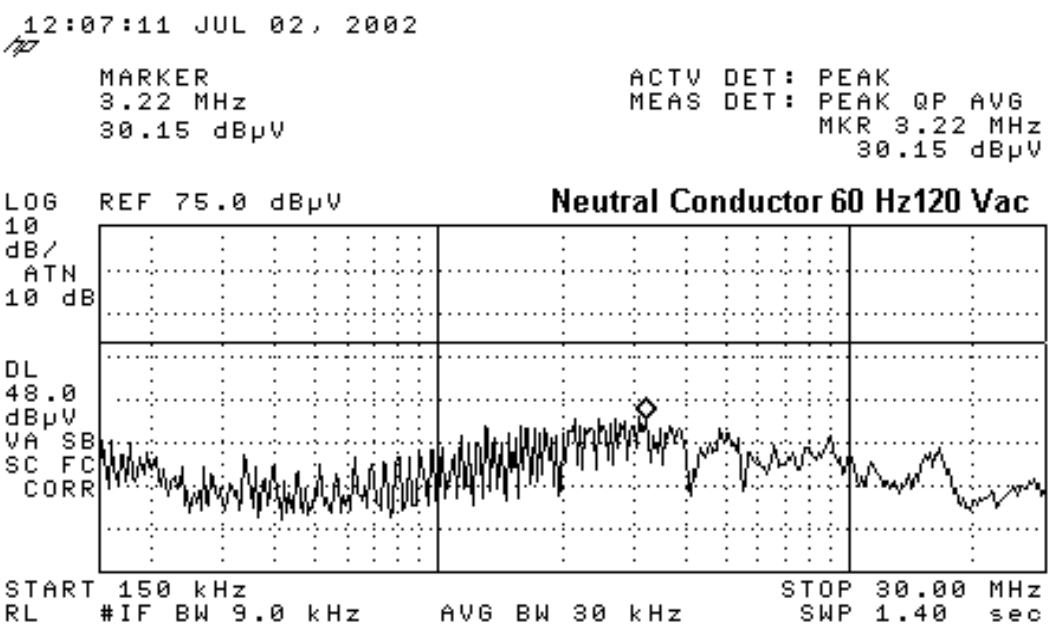
**Equipment Used:**

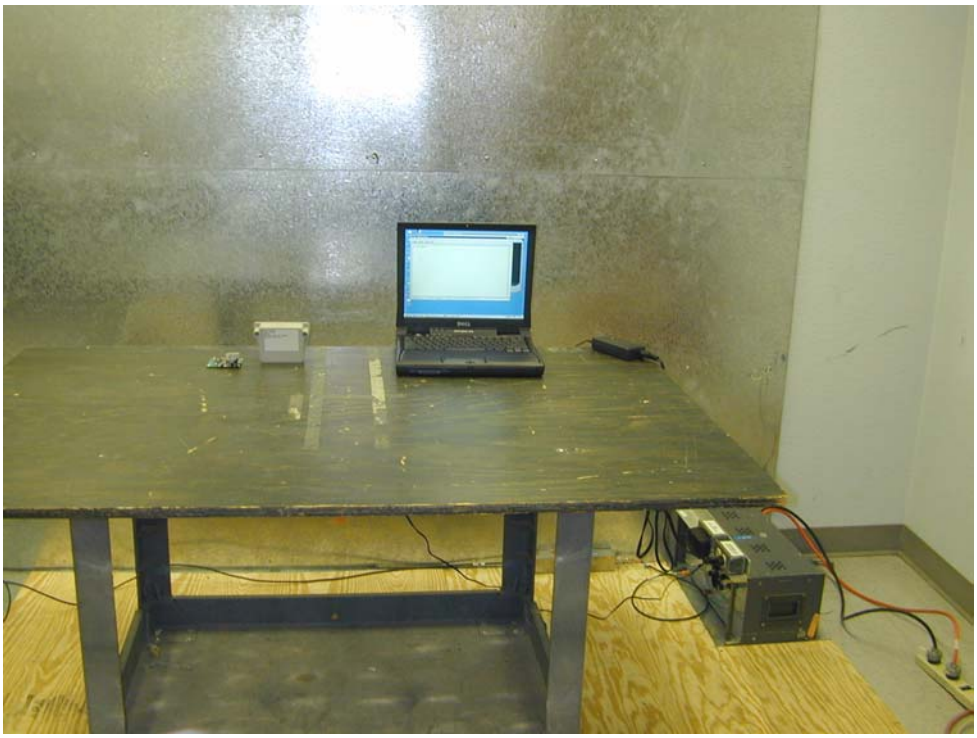
**Measurement Uncertainty:** +/- 0.7 dB

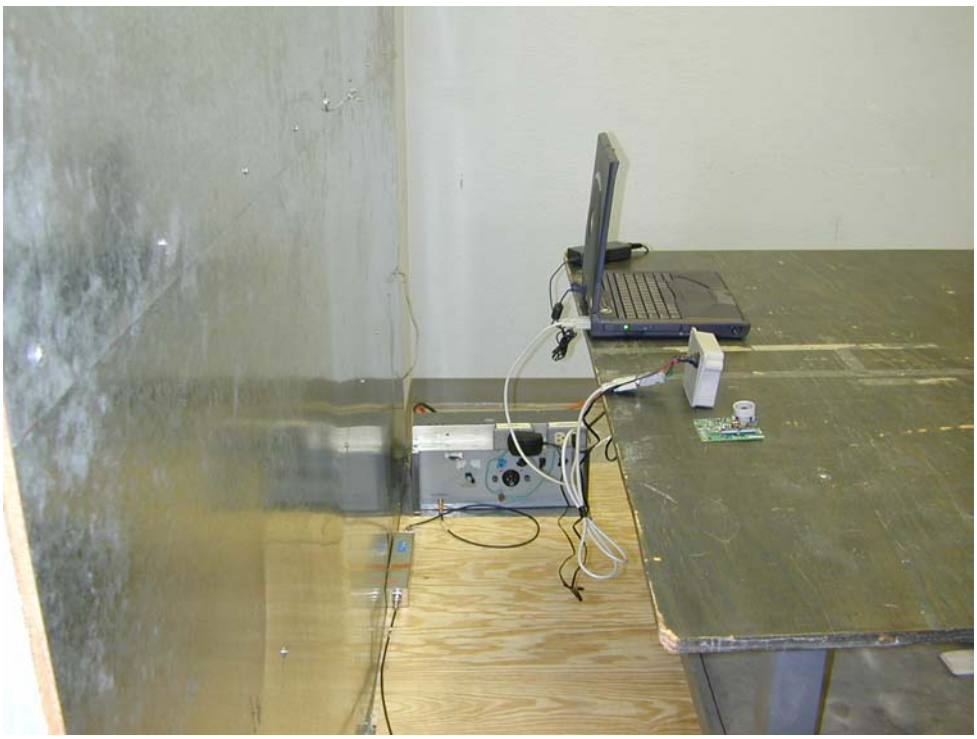
**Temperature:** °C

**Relative Humidity:** %


12:04:03 JUL 02, 2002
MARKER
3.22 MHz
30.15 dBµV
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 3.22 MHz
30.15 dBµV
LOG 10 dB/ ATN 10 dB
REF 75.0 dBµV
Phase Conductor 60 Hz/120 Vac
DL 48.0 dBµV
VA SB
SC FC CORR
START 150 kHz
RL #IF BW 9.0 kHz
AVG BW 30 kHz
STOP 30.00 MHz
SWP 1.40 sec


12:07:11 JUL 02, 2002
MARKER
3.22 MHz
30.15 dBµV
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 3.22 MHz
30.15 dBµV
LOG 10 dB/ ATN 10 dB
REF 75.0 dBµV
Neutral Conductor 60 Hz120 Vac
DL 48.0 dBµV
VA SB
SC FC CORR
START 150 kHz
RL #IF BW 9.0 kHz
AVG BW 30 kHz
STOP 30.00 MHz
SWP 1.40 sec





## Section 4. Channel Separation

| | |
|---|---|
| NAME OF TEST: Channel Separation | PARA. NO.: 15.247(a)(1) |
| TESTED BY: Tom Tidwell | DATE: 5/19/02 |

**Test Results:** Complies.

**Measurement Data:** See 20 dB BW plot
Measured 20 dB bandwidth: 42 kHz
Channel Separation: 125 kHz

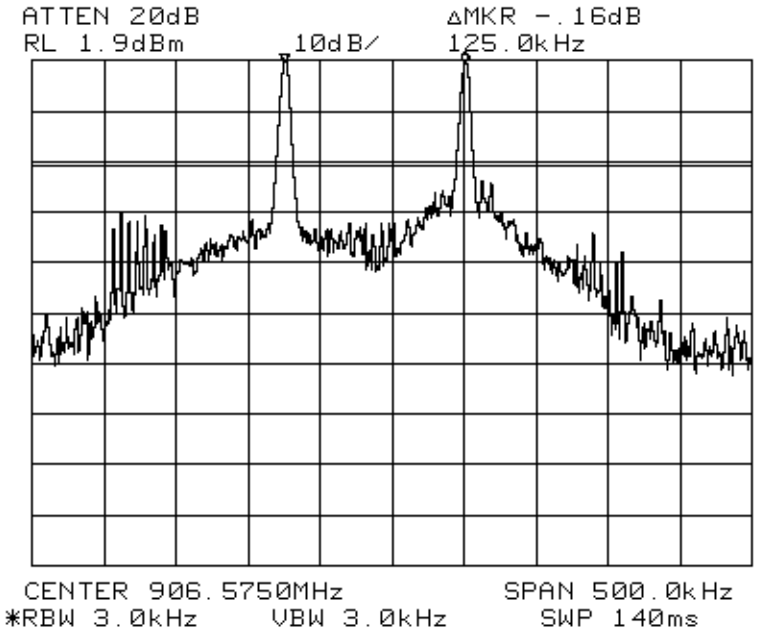
**Equipment Used:** 1464-1484-1485-1304

**Measurement Uncertainty:** +/- 0.7 dB

**Temperature:** 22 °C

**Relative Humidity:** 50 %

## Test Plot – Channel Separation




**Channel Separation**

## Section 5. Pseudorandom Hopping Algorithm

| NAME OF TEST: Pseudorandom Hopping Algorithm | PARA. NO.: 15.247(a)(1) |
|---|---|

**Test Results:** Complies.

**Measurement Data:** See sample hopping sequence.
Number of Hopping Frequencies: 50
Number of Hopping Patterns: 6

All hopping patterns contain the same number of channels (50).

**Refer to separate attachment.**

## Section 6. Time of Occupancy

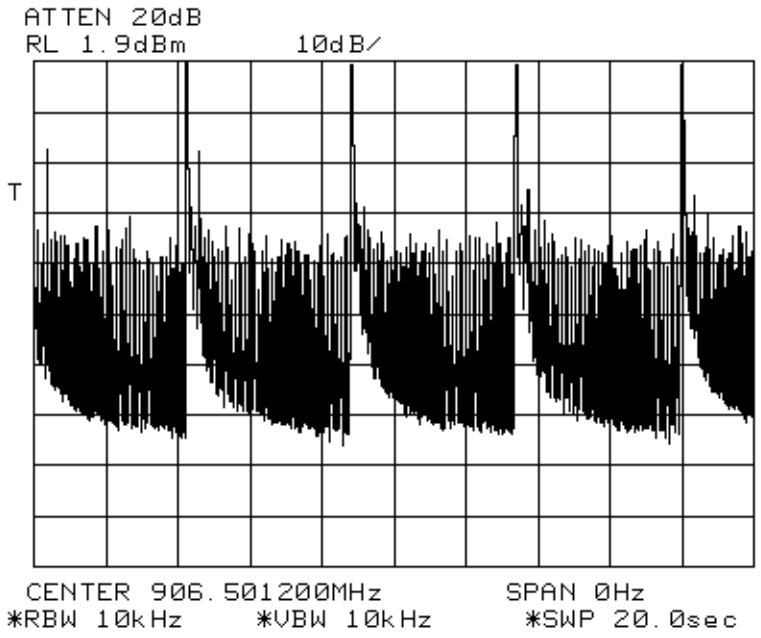
| | |
|---|---|
| NAME OF TEST: Time of Occupancy | PARA. NO.: 15.247(a)(1) |
| TESTED BY: Tom Tidwell | DATE: 5/19/2002 |

**Test Results:** Complies.

**Measurement Data:**

Maximum Dwell Time On Any Channel: 0.24 S/20 seconds

### Test Plot – Time of Occupancy




**Dwell Time**
**worst-case dwell = 4 dwells of 60 ms./dwell in 20 sec.**

## Section 7. Occupied Bandwidth

| | |
|---|---|
| NAME OF TEST: Occupied Bandwidth | PARA. NO.: 15.247(a)(1)(i) |
| TESTED BY: Tom Tidwell | DATE: 5/19/2002 |

**Test Results:** Complies.

**Measurement Data:** See attached plots.

**Equipment Used:** 1464-1484-1485-1304

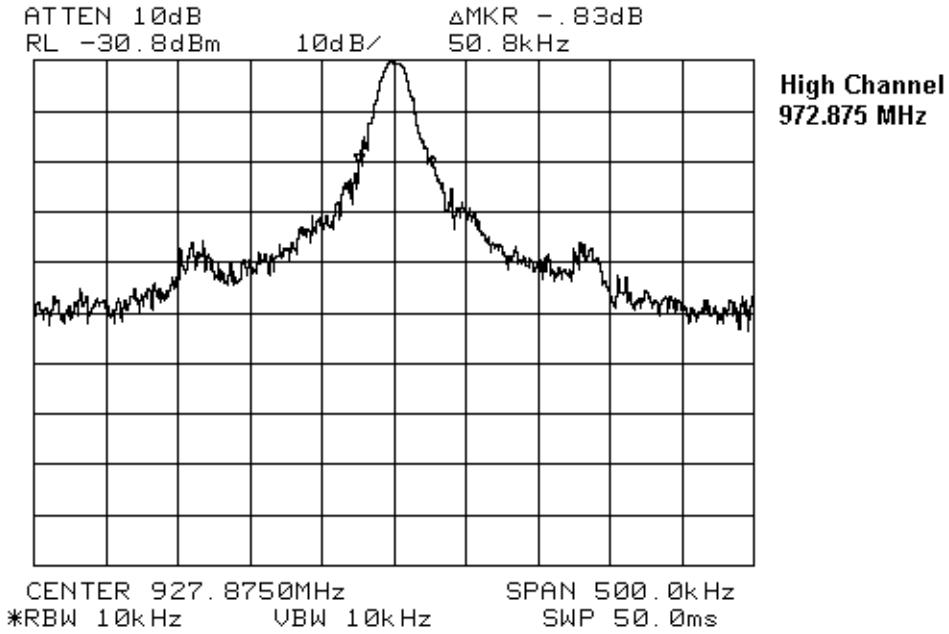
**Measurement Uncertainty:** +/- 0.7 dB

**Temperature:** 22 °C

**Relative Humidity:** 50 %

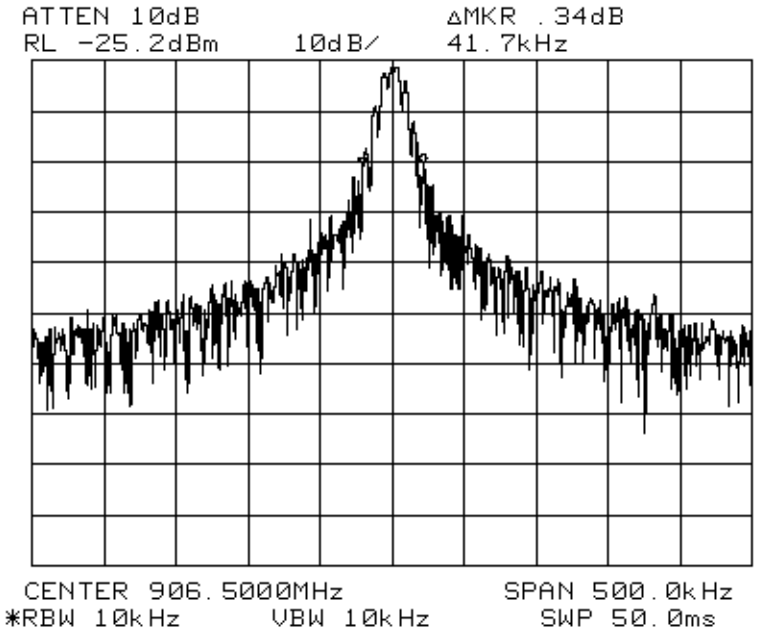
**The device was tested with a fully charged battery**

### Test Plots – Occupied Bandwidth

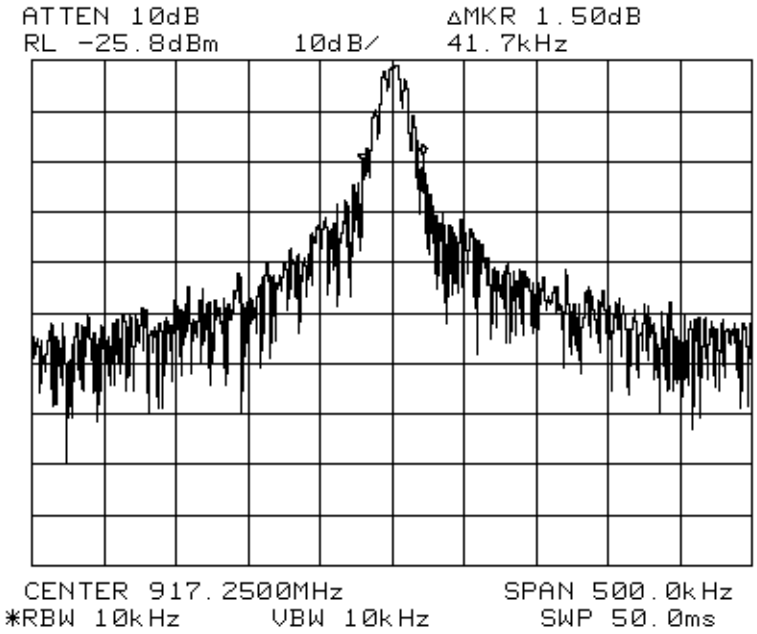



**High Channel**
**972.875 MHz**

## Test Plots – Occupied Bandwidth




**Low Channel**
**906.5 MHz**




**Mid Channel**
**917.25 MHz**

## Section 8. Peak Power Output

| NAME OF TEST: Peak Power Output | PARA. NO.: 15.247 (b) |
|---|---|
| TESTED BY: Tom Tidwell | DATE:5/19/2002 |

**Test Results:** Complies.

**Measurement Data:**

Detachable antenna? ☒ Yes ☒ No
If yes, state the type of non-standard connector used: Hirose MS-147

**Antennas:** (1) Integral monopole
(2) Larsen YA6 900, 6dBi 3-element Yagi

| Antenna | Type | **E.I.R.P. (dBm)** |
|---|---|---|
| 906.5 MHz (Integral) | Monopole | 18 dBm eirp |
| 917.25 MHz (Integral) | Monopole | 18.5 dBm eirp |
| 927.875 MHz (Integral) | Monopole | 18.8 dBm eirp |
| External | Yagi | 22.8dBm + 6 dBi = 28.8 dBm |
| External | Yagi | 23.1dBm + 6 dBi = 29.1 dBm |
| External | Yagi | 22.9dBm + 6 dBi = 28.9 dBm |

See attached data sheets.
The rf power output was determined with the integral antenna by calculating the e.i.r.p. from the received signal strength. An antenna gain of 0 dBi was used for these calculations. This is the rated gain of the integral antenna. According to the test results, the integral antenna exhibits slightly less than 0 dBi gain.

The rf output for the external antenna was determined using a peak power meter and measuring the rf power output at the external antenna port via a special adapter provided by the client(Hirose MS-147 to SMA). A gain of 6 dBi is added.

**Equipment Used:** 1484-1485-1464-1304-1029

**Measurement Uncertainty:** +/- 0.7 dB

**Temperature:** 22 °C

**Relative Humidity:** 50 %

## Field Strength of Spurious Emissions

Page 1 of | Complete X
Job No.: 2L0092R | Date: 5/18/02 | Preliminary
Specification: | Temperature(°C): 21
Tested By: Tom Tidwell | Relative Humidity(%) 45
E.U.T.: TIM15 Version G4
Configuration: Internal Antenna
Sample Number: S01
Location: AC 3 | RBW: 1 MHz | Measurement Distance 3 m
Detector Type: Average | VBW: 1 MHz

**Test Equipment Used**

| | | | |
|---|---|---|---|
| Antenna: | 759 | Directional Coupler: | #N/A |
| Pre-Amp: | #N/A | Cable #1: | 1484 |
| Filter: | #N/A | Cable #2: | 1485 |
| Receiver: | 1464 | Cable #3: | #N/A |
| Attenuator #1 | #N/A | Cable #4: | #N/A |
| Attenuator #2: | #N/A | Mixer: | #N/A |

Additional equipment used:
Measurement Uncertainty: +/-2.6 dB

| Frequency (GHz) | Meter Reading (dBm) | Antenna Factor (dB) | Cable Loss (dB) | Pre-Amp Gain (dB) | Conversion Factor | Corrected Reading (dBuV/m) | ERP (mW) | EIRP (dBm) | Polarity | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 906.500 | 85.2 | 22.5 | 5.5 | 0 | 0.0 | 113 | 62.68 | 17.97 | H | |
| 906.5 | 80 | 22.5 | 5.5 | 0 | 0.0 | 108 | 18.93 | 12.77 | V | |
| | | | | | | | | | | |
| 917.25 | 85.7 | 22.5 | 5.5 | 0 | 0.0 | 114 | 70.33 | 18.47 | H | |
| 917.25 | 80.1 | 22.5 | 5.5 | 0 | 0.0 | 108 | 19.37 | 12.87 | V | |
| | | | | | | | | | | |
| 927.875 | 86.0 | 22.5 | 5.5 | 0 | 0.0 | 114 | 75.36 | 18.77 | H | |
| 927.875 | 79.2 | 22.5 | 5.5 | 0 | 0.0 | 107 | 15.74 | 11.97 | V | |
| | | | | | | | | | | |
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Notes: EIRP was calculated from the measured field strength by using a gain factor of 0 dBi for the integral antenna.

## Section 9. Spurious Emissions (Antenna Conducted)

| | |
|---|---|
| NAME OF TEST: Spurious Emissions (Antenna Conducted) | PARA. NO.: 15.247(c) |
| TESTED BY: Tom Tidwell | DATE:5/19/2002 |

**Test Results:** Complies.

**Measurement Data:** See attached plots.

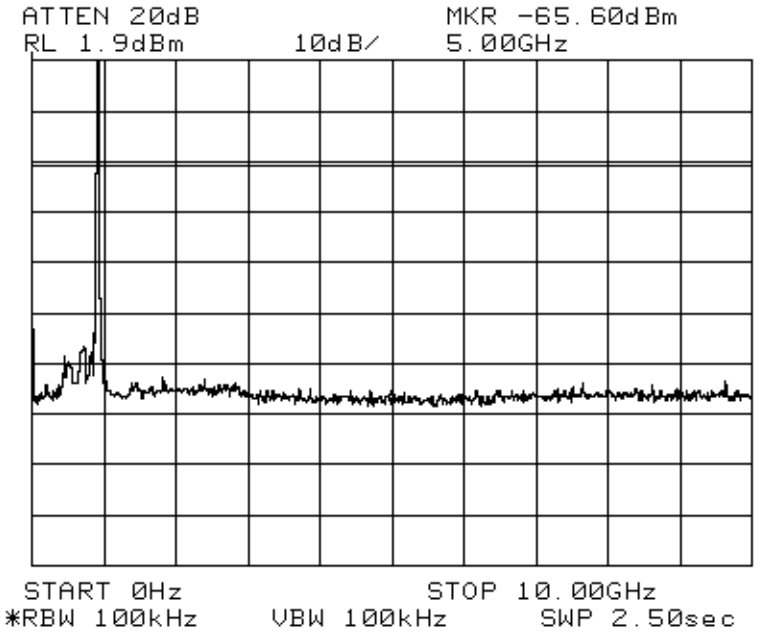
**Equipment Used:** 1464-1629

**Measurement Uncertainty:** +/- 0.7 dB

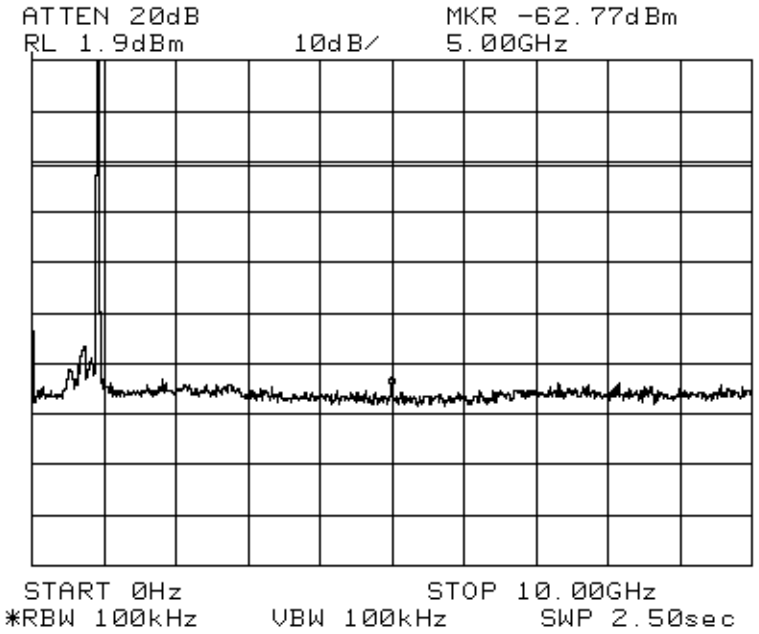
**Temperature:** 20 °C

**Relative Humidity:** 50 %

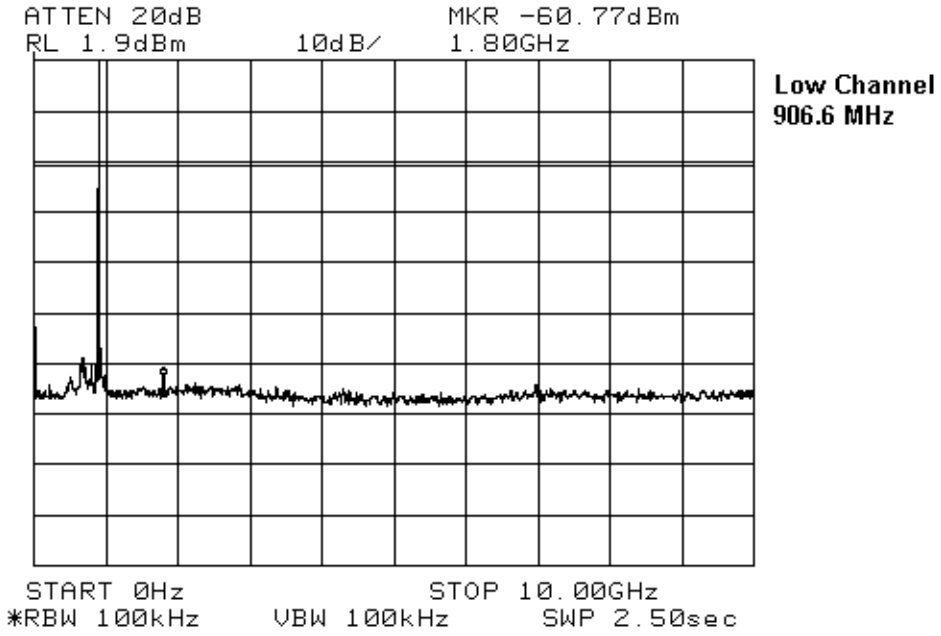
## Test Plots – Spurious Emissions at Antenna Terminals




**High Channel**
**927.875 MHz**




**Mid Channel**
**917.25 MHz**




**Low Channel**
**906.6 MHz**

## Section 10. Spurious Emissions (Radiated)

| | |
|---|---|
| NAME OF TEST: Spurious Emissions (Radiated) | PARA. NO.: 15.247(c) |
| TESTED BY: Tom Tidwell / Kevin Rose | DATE:5/19/2002 |

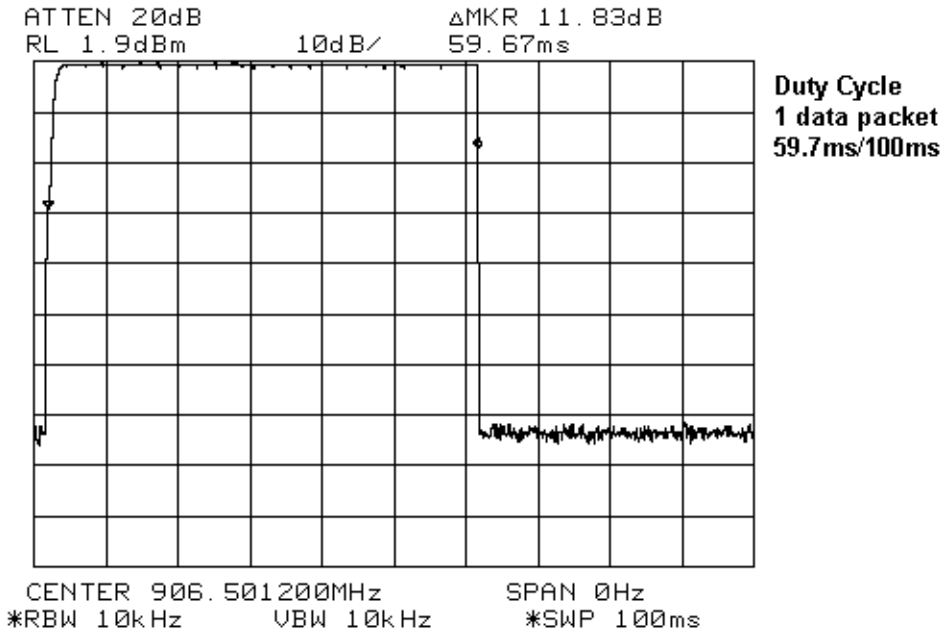
**Test Results:** Complies.

**Measurement Data:** See attached table.

**Duty Cycle Calculation:**

Duty Cycle correction factor(dB) = 20 log ($rf_{ON}$ in ms/100ms)

20 log (59.7/100) = -4.48 dB




**Measurement Uncertainty:** +/- 0.7 dB

**Temperature:** °C

**Relative Humidity:** %

## Test Data - Radiated Emissions – Low Channel (Integral Antenna)

Nemko Dallas, Inc.

**Dallas Headquarters:**
802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

**Radiated Emissions**

Page 1 of 1

Job No.: 2L0092R Date: 5/18/02
Specification: 15.247 Temperature(°C): 20
Tested By: Tom Tidwell Relative Humidity(%) 50
E.U.T.: TIM 15G3/4
Configuration:
Sample Number:
Location: AC 3 RBW: 1 MHz
Detector Type: Average VBW: 1 MHz Peak
Peak VBW: 10 Hz Average

**Test Equipment Used**

Antenna: 1304 Directional Coupler: #N/A
Pre-Amp: 1016 Cable #1: 1484
Filter: 1481 Cable #2: 1485
Receiver: 1464 Cable #3: #N/A
Attenuator #1 #N/A Cable #4: #N/A
Attenuator #2: #N/A Mixer: #N/A
Measurement Uncertainty: +/-3.6

| Frequency (GHz) | Meter Reading (dBuV) | Antenna Factor (dB) | Cable Loss (dB) | Pre-Amp Gain (dB) | Duty Cycle Factor (dB) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Delta (dB) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| 2.720 | 52 | 28.2 | 3.7 | 33.5 | | 50.4 | 74 | -23.6 | Horizontal(Peak) |
| 2.720 | 45.8 | 28.2 | 3.7 | 33.5 | -4 | 40.2 | 54 | -13.8 | Horizontal(Average) |
| 2.720 | 51 | 28.2 | 3.7 | 33.5 | | 49.4 | 74 | -24.6 | Vertical(Peak) |
| 2.720 | 46.3 | 28.2 | 3.7 | 33.5 | -4 | 40.7 | 54 | -13.3 | Vertical(Average) |
| | | | | | | | | | |
| 3.626 | 48.2 | 30.3 | 3.5 | 33.6 | | 48.4 | 74 | -25.6 | Horizontal(NF) |
| 3.626 | 40 | 30.3 | 3.5 | 33.6 | -4 | 36.2 | 54 | -17.8 | Horizontal |
| 3.626 | 50.1 | 30.3 | 3.5 | 33.6 | | 50.3 | 74 | -23.7 | Vertical |
| 3.626 | 43.8 | 30.3 | 3.5 | 33.6 | -4 | 40.0 | 54 | -14.0 | Vertical |
| | | | | | | | | | |
| 4.533 | 56.5 | 32.0 | 3.7 | 33.8 | | 58.4 | 74 | -15.6 | Vertical |
| 4.533 | 54 | 32.0 | 3.7 | 33.8 | -4 | 51.9 | 54 | -2.1 | Vertical |
| 4.533 | 51.7 | 32.0 | 3.7 | 33.8 | | 53.6 | 74 | -20.4 | Horizontal |
| 4.533 | 47 | 32.0 | 3.7 | 33.8 | -4 | 44.9 | 54 | -9.1 | Horizontal(NF) |
| | | | | | | | | | |
| 8.159 | 49 | 37.5 | 4.6 | 34 | | 57.1 | 74 | -16.9 | Vertical |
| 8.159 | 43.2 | 37.5 | 4.6 | 34 | -4 | 47.3 | 54 | -6.7 | Vertical |
| 8.159 | 47.7 | 37.5 | 4.6 | 34 | | 55.8 | 74 | -18.2 | Horizontal |
| 8.159 | 40.5 | 37.5 | 4.6 | 34 | -4 | 44.6 | 54 | -9.4 | Horizontal |
| | | | | | | | | | |
| 9.066 | 50.7 | 37.0 | 5.8 | 34.8 | | 58.7 | 74 | -15.3 | Vertical |
| 9.066 | 42.8 | 37.0 | 5.8 | 34.8 | -4 | 46.8 | 54 | -7.2 | Vertical |
| 9.066 | 46 | 37.0 | 5.8 | 34.8 | | 54.0 | 74 | -20.0 | Horizontal |
| 9.066 | 38.1 | 37.0 | 5.8 | 34.8 | -4 | 42.1 | 54 | -11.9 | Horizontal |
| | | | | | | | | | |

Notes: 906.6 MHz Carrier

## Test Data - Radiated Emissions – Mid Channel (Integral Antenna)

| Frequency (GHz) | Meter Reading (dBuV) | Antenna Factor (dB) | Cable Loss (dB) | Pre-Amp Gain (dB) | Duty Cycle Factor (dB) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Delta (dB) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| 2.764 | 52 | 28.2 | 3.7 | 33.5 | | 50.4 | 74 | -23.6 | Horizontal(Peak) |
| 2.764 | 45.8 | 28.2 | 3.7 | 33.5 | -4 | 40.2 | 54 | -13.8 | Horizontal(Average) |
| 2.764 | 51 | 28.2 | 3.7 | 33.5 | | 49.4 | 74 | -24.6 | Vertical(Peak) |
| 2.764 | 46.3 | 28.2 | 3.7 | 33.5 | -4 | 40.7 | 54 | -13.3 | Vertical(Average) |
| | | | | | | | | | |
| 3.685 | 48.2 | 30.3 | 3.5 | 33.6 | | 48.4 | 74 | -25.6 | Horizontal(NF) |
| 3.685 | 40 | 30.3 | 3.5 | 33.6 | -4 | 36.2 | 54 | -17.8 | Horizontal |
| 3.685 | 50.1 | 30.3 | 3.5 | 33.6 | | 50.3 | 74 | -23.7 | Vertical |
| 3.685 | 43.8 | 30.3 | 3.5 | 33.6 | -4 | 40.0 | 54 | -14.0 | Vertical |
| | | | | | | | | | |
| 4.606 | 56.5 | 32.0 | 3.7 | 33.8 | | 58.4 | 74 | -15.6 | Vertical |
| 4.606 | 54 | 32.0 | 3.7 | 33.8 | -4 | 51.9 | 54 | -2.1 | Vertical |
| 4.606 | 51.7 | 32.0 | 3.7 | 33.8 | | 53.6 | 74 | -20.4 | Horizontal |
| 4.606 | 47 | 32.0 | 3.7 | 33.8 | -4 | 44.9 | 54 | -9.1 | Horizontal(NF) |
| | | | | | | | | | |
| 8.291 | 49 | 37.5 | 4.6 | 34 | | 57.1 | 74 | -16.9 | Vertical |
| 8.291 | 43.2 | 37.5 | 4.6 | 34 | -4 | 47.3 | 54 | -6.7 | Vertical |
| 8.291 | 47.7 | 37.5 | 4.6 | 34 | | 55.8 | 74 | -18.2 | Horizontal |
| 8.291 | 40.5 | 37.5 | 4.6 | 34 | -4 | 44.6 | 54 | -9.4 | Horizontal |
| | | | | | | | | | |
| 9.211 | 50.7 | 37.0 | 5.8 | 34.8 | | 58.7 | 74 | -15.3 | Vertical |
| 9.211 | 42.8 | 37.0 | 5.8 | 34.8 | -4 | 46.8 | 54 | -7.2 | Vertical |
| 9.211 | 46 | 37.0 | 5.8 | 34.8 | | 54.0 | 74 | -20.0 | Horizontal |
| 9.211 | 38.1 | 37.0 | 5.8 | 34.8 | -4 | 42.1 | 54 | -11.9 | Horizontal |
| | | | | | | | | | |

Notes: 921.125 MHz Carrier

## Test Data – Radiated Emissions – High Channel (Integral Antenna)

| Frequency (GHz) | Meter Reading (dBuV) | Antenna Factor (dB) | Cable Loss (dB) | Pre-Amp Gain (dB) | Duty Cycle Factor (dB) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Delta (dB) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| 2.784 | 52 | 28.2 | 3.7 | 33.5 | | 50.4 | 74 | -23.6 | Horizontal(Peak) |
| 2.784 | 45.8 | 28.2 | 3.7 | 33.5 | -4 | 40.2 | 54 | -13.8 | Horizontal(Average) |
| 2.784 | 47.6 | 28.2 | 3.7 | 33.5 | | 46.0 | 74 | -28.0 | Vertical(Peak) |
| 2.784 | 41 | 28.2 | 3.7 | 33.5 | -4 | 35.4 | 54 | -18.6 | Vertical(Average) |
| | | | | | | | | | |
| 3.712 | 50 | 30.3 | 3.5 | 33.6 | | 50.2 | 74 | -23.8 | Horizontal(NF) |
| 3.712 | 46.5 | 30.3 | 3.5 | 33.6 | -4 | 42.7 | 54 | -11.3 | Horizontal |
| 3.712 | 55 | 30.3 | 3.5 | 33.6 | | 55.2 | 74 | -18.8 | Vertical |
| 3.712 | 53.7 | 30.3 | 3.5 | 33.6 | -4 | 49.9 | 54 | -4.1 | Vertical |
| | | | | | | | | | |
| 4.640 | 52 | 32.0 | 3.7 | 33.8 | | 53.9 | 74 | -20.1 | Vertical |
| 4.640 | 47.8 | 32.0 | 3.7 | 33.8 | -4 | 45.7 | 54 | -8.3 | Vertical |
| 4.640 | 49.2 | 32.0 | 3.7 | 33.8 | | 51.1 | 74 | -22.9 | Horizontal |
| 4.640 | 45.8 | 32.0 | 3.7 | 33.8 | -4 | 43.7 | 54 | -10.3 | Horizontal |
| | | | | | | | | | |
| 8.351 | 42 | 37.5 | 4.6 | 34 | | 50.1 | 74 | -23.9 | Vertical |
| 8.351 | 32 | 37.5 | 4.6 | 34 | -4 | 36.1 | 54 | -17.9 | Vertical |
| 8.351 | 42 | 37.5 | 4.6 | 34 | | 50.1 | 74 | -23.9 | Horizontal |
| 8.351 | 32.2 | 37.5 | 4.6 | 34 | -4 | 36.3 | 54 | -17.7 | Horizontal |
| | | | | | | | | | |
| 9.279 | 42 | 37.0 | 5.8 | 34.8 | | 50.0 | 74 | -24.0 | Vertical |
| 9.279 | 32 | 37.0 | 5.8 | 34.8 | -4 | 36.0 | 54 | -18.0 | Vertical |
| 9.279 | 42 | 37.0 | 5.8 | 34.8 | | 50.0 | 74 | -24.0 | Horizontal |
| 9.279 | 32 | 37.0 | 5.8 | 34.8 | -4 | 36.0 | 54 | -18.0 | Horizontal |
| | | | | | | | | | |

Notes: 927.875 MHz Carrier

## Test Data – Radiated Emissions – Low Channel (Yagi Antenna)

Nemko Dallas, Inc.

**Dallas Headquarters:**
802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

**Radiated Emissions**

Page 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| Job No.: | 2L0092R | Date: | 5/28/02 | | |
| Specification: | 15.247 | Temperature(°C): | 20 | | |
| Tested By: | Kevin Rose | Relative Humidity(%) | 50 | | |
| E.U.T.: | TIM 1500 Rev G4 | | | | |
| Configuration: | low channel transmit external antenna | | | | |
| Sample Number: | 3 | | | | |
| Location: | AC 3 | RBW: | 1 MHz | | |
| Detector Type: | Average | VBW: | 1 MHz | Peak | |
| | Peak | VBW: | 10 Hz | Average | |

**Test Equipment Used**

| | | | |
|---|---|---|---|
| Antenna: | 1304 | Directional Coupler: | #N/A |
| Pre-Amp: | 1016 | Cable #1: | 1484 |
| Filter: | 1481 | Cable #2: | 1485 |
| Receiver: | 1464 | Cable #3: | #N/A |
| Attenuator #1 | #N/A | Cable #4: | #N/A |
| Attenuator #2: | #N/A | Mixer: | #N/A |
| Measurement Uncertainty: | +/-3.6 | | |

| Frequency (GHz) | Meter Reading (dBuV) | Antenna Factor (dB) | Cable Loss (dB) | Pre-Amp Gain (dB) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Delta (dB) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 2.720 | 48.7 | 28.2 | 3.7 | 33.5 | 47.1 | 74 | -26.9 | Horizontal(Peak) |
| 2.720 | 31.7 | 28.2 | 3.7 | 33.5 | 30.1 | 54 | -23.9 | Horizontal(Average) |
| 2.720 | 47 | 28.2 | 3.7 | 33.5 | 45.4 | 74 | -28.6 | Vertical(Peak) |
| 2.720 | 31.5 | 28.2 | 3.7 | 33.5 | 29.9 | 54 | -24.1 | Vertical(Average) |
| | | | | | | | | |
| 3.626 | 48.7 | 30.3 | 3.5 | 33.6 | 48.9 | 74 | -25.1 | Horizontal |
| 3.626 | 33 | 30.3 | 3.5 | 33.6 | 33.2 | 54 | -20.8 | Horizontal |
| 3.626 | 51.2 | 30.3 | 3.5 | 33.6 | 51.4 | 74 | -22.6 | Vertical |
| 3.626 | 40.5 | 30.3 | 3.5 | 33.6 | 40.7 | 54 | -13.3 | Vertical |
| | | | | | | | | |
| 4.533 | 47.3 | 32.0 | 3.7 | 33.8 | 49.2 | 74 | -24.8 | Vertical |
| 4.533 | 30 | 32.0 | 3.7 | 33.8 | 31.9 | 54 | -22.1 | Vertical |
| 4.533 | 47.2 | 32.0 | 3.7 | 33.8 | 49.1 | 74 | -24.9 | Horizontal |
| 4.533 | 30.2 | 32.0 | 3.7 | 33.8 | 32.1 | 54 | -21.9 | Horizontal(nosie floor) |
| | | | | | | | | |
| 8.159 | 47 | 37.5 | 4.6 | 34 | 55.1 | 74 | -18.9 | Vertical |
| 8.159 | 29.5 | 37.5 | 4.6 | 34 | 37.6 | 54 | -16.4 | Vertical |
| 8.159 | 47.3 | 37.5 | 4.6 | 34 | 55.4 | 74 | -18.6 | Horizontal |
| 8.159 | 30 | 37.5 | 4.6 | 34 | 38.1 | 54 | -15.9 | Horizontal |
| | | | | | | | | |
| 9.066 | 48 | 37.0 | 5.8 | 34.8 | 56.0 | 74 | -18.0 | Vertical |
| 9.066 | 30.5 | 37.0 | 5.8 | 34.8 | 38.5 | 54 | -15.5 | Vertical |
| 9.066 | 48.7 | 37.0 | 5.8 | 34.8 | 56.7 | 74 | -17.3 | Horizontal |
| 9.066 | 30.5 | 37.0 | 5.8 | 34.8 | 38.5 | 54 | -15.5 | Horizontal |
| | | | | | | | | |

Notes: 906.6 MHz Carrier 6dbi antenna power level 255 regular
4dB duty cycle adjustment on the Average Measurements

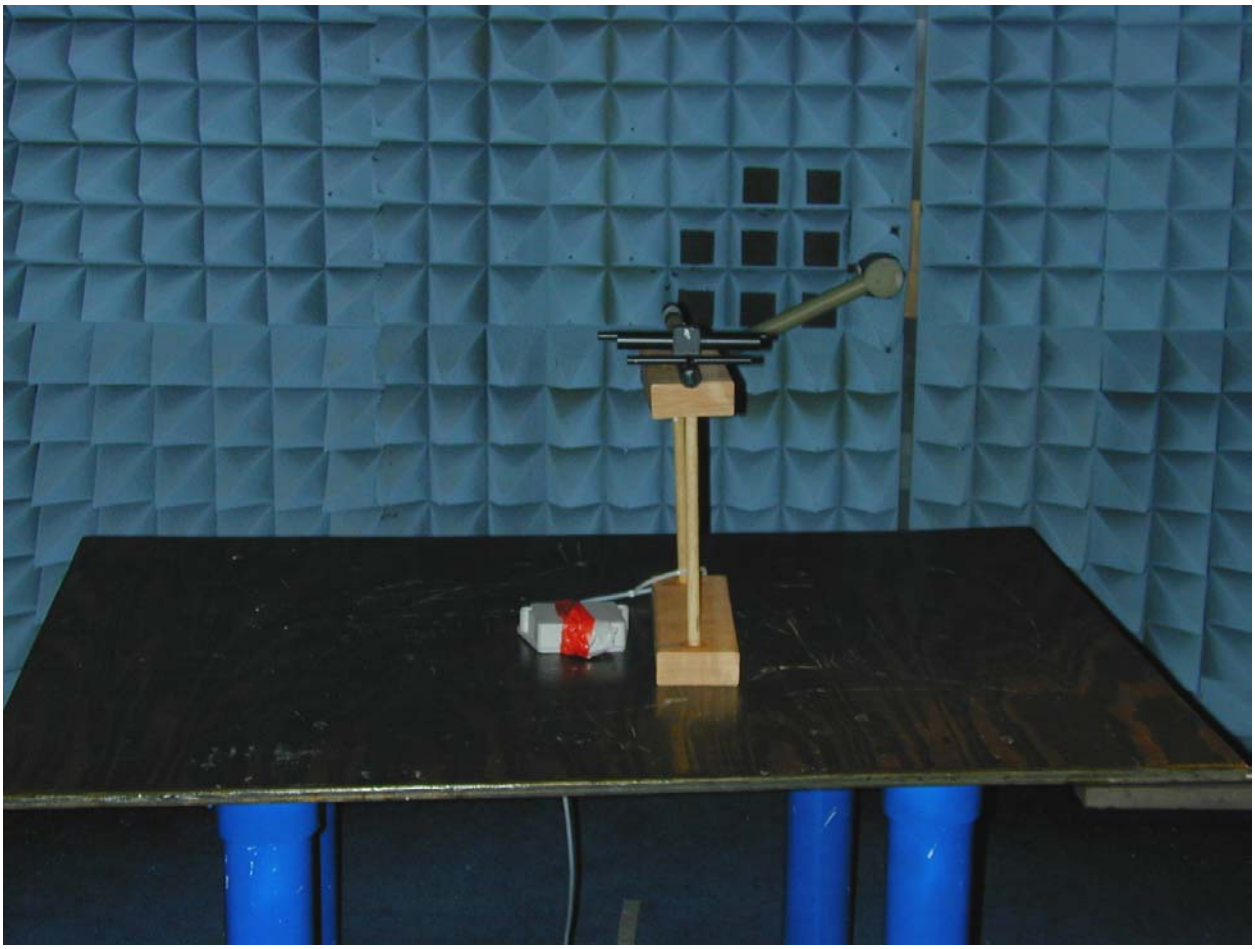
## Test Data – Radiated Emissions – Mid Channel (Yagi Antenna)

| Frequency (GHz) | Meter Reading (dBuV) | Antenna Factor (dB) | Cable Loss (dB) | Pre-Amp Gain (dB) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Delta (dB) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 2.751 | 48.8 | 28.2 | 3.7 | 33.5 | 47.2 | 74 | -26.8 | Horizontal(Peak) |
| 2.751 | 31.3 | 28.2 | 3.7 | 33.5 | 29.7 | 54 | -24.3 | Horizontal(Average) |
| 2.751 | 49.3 | 28.2 | 3.7 | 33.5 | 47.7 | 74 | -26.3 | Vertical(Peak) |
| 2.751 | 31.8 | 28.2 | 3.7 | 33.5 | 30.2 | 54 | -23.8 | Vertical(Average) |
| | | | | | | | | |
| 3.669 | 48.2 | 30.3 | 3.5 | 33.6 | 48.4 | 74 | -25.6 | Horizontal |
| 3.669 | 33.8 | 30.3 | 3.5 | 33.6 | 34.0 | 54 | -20.0 | Horizontal |
| 3.669 | 50 | 30.3 | 3.5 | 33.6 | 50.2 | 74 | -23.8 | Vertical |
| 3.669 | 39 | 30.3 | 3.5 | 33.6 | 39.2 | 54 | -14.8 | Vertical |
| | | | | | | | | |
| 4.586 | 47.6 | 32.0 | 3.7 | 33.8 | 49.5 | 74 | -24.5 | Vertical |
| 4.586 | 30.5 | 32.0 | 3.7 | 33.8 | 32.4 | 54 | -21.6 | Vertical |
| 4.586 | 47 | 32.0 | 3.7 | 33.8 | 48.9 | 74 | -25.1 | Horizontal |
| 4.586 | 30.8 | 32.0 | 3.7 | 33.8 | 32.7 | 54 | -21.3 | Horizontal(nosie floor) |
| | | | | | | | | |
| 8.254 | 48.2 | 37.5 | 4.6 | 34 | 56.3 | 74 | -17.7 | Vertical |
| 8.254 | 32 | 37.5 | 4.6 | 34 | 40.1 | 54 | -13.9 | Vertical |
| 8.254 | 46.7 | 37.5 | 4.6 | 34 | 54.8 | 74 | -19.2 | Horizontal |
| 8.254 | 30.3 | 37.5 | 4.6 | 34 | 38.4 | 54 | -15.6 | Horizontal |
| | | | | | | | | |
| 9.17125 | 47.2 | 37.0 | 5.8 | 34.8 | 55.2 | 74 | -18.8 | Vertical |
| 9.17125 | 31 | 37.0 | 5.8 | 34.8 | 39.0 | 54 | -15.0 | Vertical |
| 9.17125 | 46.5 | 37.0 | 5.8 | 34.8 | 54.5 | 74 | -19.5 | Horizontal |
| 9.17125 | 30.8 | 37.0 | 5.8 | 34.8 | 38.8 | 54 | -15.2 | Horizontal |
| | | | | | | | | |
| Notes: | 917.125 MHz Carrier 6dbi antenna power level 255 regular | | | | | | | |
| | 4dB duty cycle adjustment on the Average Measurements | | | | | | | |

## Test Data – Radiated Emissions – High Channel (Yagi Antenna)

| Frequency (GHz) | Meter Reading (dBuV) | Antenna Factor (dB) | Cable Loss (dB) | Pre-Amp Gain (dB) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Delta (dB) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 2.784 | 48.8 | 28.2 | 3.7 | 33.5 | 47.2 | 74 | -26.8 | Horizontal(Peak) |
| 2.784 | 31.3 | 28.2 | 3.7 | 33.5 | 29.7 | 54 | -24.3 | Horizontal(Average) |
| 2.784 | 49.2 | 28.2 | 3.7 | 33.5 | 47.6 | 74 | -26.4 | Vertical(Peak) |
| 2.784 | 33.2 | 28.2 | 3.7 | 33.5 | 31.6 | 54 | -22.4 | Vertical(Average) |
| | | | | | | | | |
| 3.712 | 49 | 30.3 | 3.5 | 33.6 | 49.2 | 74 | -24.8 | Horizontal |
| 3.712 | 34.8 | 30.3 | 3.5 | 33.6 | 35.0 | 54 | -19.0 | Horizontal |
| 3.712 | 50.8 | 30.3 | 3.5 | 33.6 | 51.0 | 74 | -23.0 | Vertical |
| 3.712 | 40.5 | 30.3 | 3.5 | 33.6 | 40.7 | 54 | -13.3 | Vertical |
| | | | | | | | | |
| 4.639 | 47.3 | 32.0 | 3.7 | 33.8 | 49.2 | 74 | -24.8 | Vertical |
| 4.639 | 30.5 | 32.0 | 3.7 | 33.8 | 32.4 | 54 | -21.6 | Vertical |
| 4.639 | 46.8 | 32.0 | 3.7 | 33.8 | 48.7 | 74 | -25.3 | Horizontal |
| 4.639 | 29.5 | 32.0 | 3.7 | 33.8 | 31.4 | 54 | -22.6 | Horizontal(nosie floor) |
| | | | | | | | | |
| 8.351 | 47.2 | 37.5 | 4.6 | 34 | 55.3 | 74 | -18.7 | Vertical |
| 8.351 | 30 | 37.5 | 4.6 | 34 | 38.1 | 54 | -15.9 | Vertical |
| 8.351 | 47.5 | 37.5 | 4.6 | 34 | 55.6 | 74 | -18.4 | Horizontal |
| 8.351 | 29.8 | 37.5 | 4.6 | 34 | 37.9 | 54 | -16.1 | Horizontal |
| | | | | | | | | |
| 9.27875 | 47.3 | 37.0 | 5.8 | 34.8 | 55.3 | 74 | -18.7 | Vertical |
| 9.27875 | 30.3 | 37.0 | 5.8 | 34.8 | 38.3 | 54 | -15.7 | Vertical |
| 9.27875 | 47.2 | 37.0 | 5.8 | 34.8 | 55.2 | 74 | -18.8 | Horizontal |
| 9.27875 | 29.7 | 37.0 | 5.8 | 34.8 | 37.7 | 54 | -16.3 | Horizontal |
| | | | | | | | | |
| Notes: | 927.875 MHz Carrier 6dbi antenna power level 255 regular | | | | | | | |
| | 4dB duty cycle adjustment on the Average Measurements | | | | | | | |

**Radiated Photographs**



## Section 11. Test Equipment List

| Nemko ID | Description | Manufacturer Model Number | Serial Number | Calibration Date | Calibration Due |
|---|---|---|---|---|---|
| 969 | LISN | Schwarzbeck 8120 | 8120281 | 07/18/01 | 07/18/02 |
| 1553 | CABLE 1m | KTL RG223 | N/A | 08/06/01 | 08/06/02 |
| 1555 | Filter high pass 5KHz | Solar Electronics 7930-5.0 | 933125 | 06/06/02 | 06/06/03 |
| 1114 | CABLE, 7m | KTL RG223 | N/A | 06/06/02 | 06/06/03 |
| 1603 | LIMITER | FISCHER FCC-450-1.25-N | 447 | 01/17/02 | 01/17/03 |
| 718 | HP SPECTRUM ANALYZER | HEWLETT PACKARD 8591EM | 3639A00980 | 12/17/01 | 12/17/02 |
| 1029 | PEAK POWER METER | HP 8900D | 3303U0012 | 04/04/02 | 04/04/03 |
| 1030 | PEAK POWER SENSOR | HP 84811A | 2539A03573 | 04/04/02 | 04/04/03 |
| 1484 | Cable 2.0-18.0 Ghz | Storm PR90-010-072 | N/A | 06/01/02 | 06/01/03 |
| 1485 | Cable 2.0-18.0 Ghz | Storm PR90-010-216 | N/A | 06/01/02 | 06/01/03 |
| 1016 | Pre-Amp | HEWLETT PACKARD 8449A | 2749A00159 | 05/30/02 | 05/30/03 |
| 1304 | HORN ANTENNA | ELECTRO METRICS RGA-60 | 6151 | 07/30/01 | 07/30/03 |
| 1629 | CABLE, 6 ft | MEGAPHASE 10311 1GVT4 | N/A | CBU | CPU |
| 1481 | Microwave Highpass Filter | K & L 3DH1-2000/T8000-0/0 | 4 | CBU | CBU |

CBU = Calibrate Before Use

# ANNEX A - TEST DETAILS

| NAME OF TEST: Powerline Conducted Emissions | PARA. NO.: 15.207(a) |
|---|---|

**Minimum Standard:** The R.F. that is conducted back onto the AC power line on any frequency within the band 0.45 to 30 MHz shall not exceed 250μV (48 dBμV) across 50 ohms.

| NAME OF TEST: Channel Separation | PARA. NO.: 15.247(a)(1) |
|---|---|

**Minimum Standard:** Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

| NAME OF TEST: Pseudorandom Hopping Algorithm | PARA. NO.: 15.247(a)(1) |
|---|---|

**Minimum Standard:** The system shall hop to channel frequencies that are selected from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their transmitters and shall shift frequencies in synchronization with the transmitted signals.

| NAME OF TEST: Time of Occupancy | PARA. NO.: 15.247(a)(1)(ii) |
|---|---|

**Minimum Standard:**

| Frequency Band (MHz) | 20 dB Bandwidth | No. of Hopping Channels | Average Time of Occupancy |
|---|---|---|---|
| 902 - 928 | <250 kHz | 50 | =<0.4 sec. in 20 sec. |
| 902 – 928 | =>250 kHz | 25 | =<0.4 sec. in 10 sec. |
| 2400 – 2483.5 | ----- | 75 | =<0.4 sec. in 30 sec. |
| 5725 – 5850 | ----- | 75 | =<0.4 sec. in 30 sec. |

**Method Of Measurement:**

The spectrum analyzer is set as follows:

RBW: 1 MHz
VBW: = RBW
Span: 0 Hz
LOG dB/div.: 10 dB
Sweep: Sufficient to see one hop time sequence.
Trigger: Video

The occupancy time of one hop is measured as above. The average time of occupancy is calculated over the appropriate period of time from above table (10, 20, or 30 seconds).

Avg. time of occupancy = (period from table/duration of one hop)/no. of channels multiplied by the duration of one hop.

For instance:

If a 2.4 GHz system has a measured hop duration time of 1 msec. and uses 75 channels, then the average time of occupancy would be:

(30 sec./.001 sec.)/75 chan. = 400 x 1 msec. = 400 msec. or 0.4 sec. in 30 sec.

| NAME OF TEST: Occupied Bandwidth | PARA. NO.: 15.247(a)(2) |
|---|---|

**Minimum Standard:**

| Frequency Band (MHz) | Maximum 20 dB Bandwidth |
|---|---|
| 902 - 928 | 500 kHz |
| 2400 – 2483.5 | 1 MHz |
| 5725 – 5850 | 1 MHz |

**Method Of Measurement:**

The spectrum analyzer is set as follows:

RBW: At least 1% of span/div.
VBW: >RBW
Span: Sufficient to display 20 dB bandwidth
LOG dB/div.: 10 dB
Sweep: Auto

Number of channels tested:

| Tuning range | Number of channels tested | Channel location in band |
|---|---|---|
| 1 MHz or less | 1 | middle |
| 1 to 10 MHz | 2 | top and bottom |
| more than 10 MHz | 3 | top, middle, bottom |

| NAME OF TEST: Peak Power Output | PARA. NO.: 15.247(b) |
|---|---|

**Minimum Standard:**

| Frequency Band (MHz) | No. of Hopping Channels | Maximum Peak Power Output at Antenna Port |
|---|---|---|
| 902 - 928 | at least 50 | 1 watt |
| 902 – 928 | 25 - 49 | 0.25 watts |
| 2400 – 2483.5 | 75 | 1 watt |
| 5725 – 5850 | 75 | 1 watt |

If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point to point operation may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceed 6 dBi.

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

**Direct Measurement Method For Detachable Antennas:**
If the antenna is detachable, a peak power meter is used to measure the power output with the transmitter operating into a 50 ohm load. The dBi gain of the antenna(s) employed shall be reported.

**Measurement of EIRP For Integral Antenna:**
If the antenna is not detachable from the circuit then the field strength of the fundamental emission is measured. The equivalent isotropic radiated power is then determined using the plane wave formula:

$P = V^2R^2/30G$

Where:

P = power
V = Field Strength
R = Test distance
G = Gain of the TX antenna over isotropic.

The RBW of the spectrum analyzer shall be set to a value greater than the measured 20 dB occupied bandwidth of the E.U.T.

Number of channels tested:

| Tuning range | Number of channels tested | Channel location in band |
|---|---|---|
| 1 MHz or less | 1 | middle |
| 1 to 10 MHz | 2 | top and bottom |
| more than 10 MHz | 3 | top, middle, bottom |

NAME OF TEST: Spurious Emissions at Antenna Terminals PARA. NO.: 15.247(c)

**Minimum Standard:** In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits. Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:

| Frequency (MHz) | Field Strength (μV/m @ 3m) | Field Strength (dB @ 3m) |
|---|---|---|
| 30 - 88 | 100 | 40.0 |
| 88 - 216 | 150 | 43.5 |
| 216 - 960 | 200 | 46.0 |
| Above 960 | 500 | 54.0 |

**THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC**

**Method Of Measurement:**

30 MHz - 10th harmonic plot
RBW: 100 kHz
VBW: 300 kHz
Sweep: Auto
Display line: -20 dBc

Lower Band Edge
RBW: At least 1% of span/div.
VBW: >RBW
Span: As necessary to display any spurious at band edge.
Sweep: Auto
Center Frequency: 902 MHz, 2400 MHz, or 5725 MHz
Marker: Peak of fundamental emission
Marker Δ: Peak of highest spurious level below center frequency.

Upper Band Edge
RBW: At least 1% of span/div.
VBW: >RBW
Span: As necessary to display any spurious at band edge.
Sweep: Auto
Center Frequency: 928 MHz, 2483.5 MHz, or 5850 MHz
Marker: Peak of fundamental emission
Marker Δ: Peak of highest spurious level above center frequency.

Number of channels tested:

| Tuning range | Number of channels tested | Channel location in band |
|---|---|---|
| 1 MHz or less | 1 | middle |
| 1 to 10 MHz | 2 | top and bottom |
| more than 10 MHz | 3 | top, middle, bottom |

NAME OF TEST: Radiated Spurious Emissions PARA. NO.: 15.247(c)

**Minimum Standard:** In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits:

**Emissions falling in the restricted bands of 15.205 shall not exceed the following field strength limits:**

| Frequency (MHz) | Field Strength (μV/m @ 3m) | Field Strength (dB @ 3m) |
|---|---|---|
| 30 - 88 | 100 | 40.0 |
| 88 - 216 | 150 | 43.5 |
| 216 - 960 | 200 | 46.0 |
| Above 960 | 500 | 54.0 |

***THE SPECTRUM WAS SEARCHED TO THE 10th HARMONIC***

**15.205 Restricted Bands**

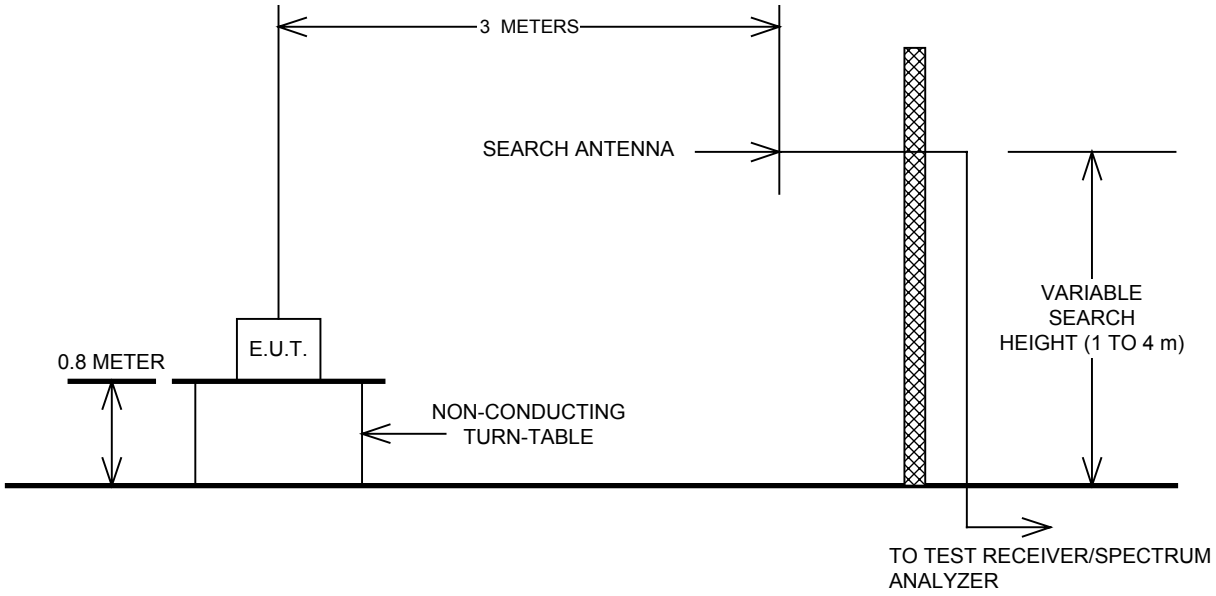
| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.09-0.11 | 16.42-16.423 | 399.9-410 | 4.5-5.25 |
| 0.495-0.505 | 16.69475-16.69525 | 608-614 | 5.35-5.46 |
| 2.1735-2.1905 | 16.80425-16.80475 | 960-1240 | 7.25-7.75 |
| 4.125-4.128 | 25.5-25.67 | 1300-1427 | 8.025-8.5 |
| 4.17725-4.17775 | 37.5-38.25 | 1435-1626.5 | 9.0-9.2 |
| 4.20725-4.20775 | 73-74.6 | 1645.5-1646.5 | 9.3-9.5 |
| 6.125-6.218 | 74.8-75.2 | 1660-1710 | 10.6-12.7 |
| 6.26775-6.26825 | 108-121.94 | 1718.8-1722.2 | 13.25-13.4 |
| 6.31175-6.31225 | 123-138 | 2200-2300 | 14.47-14.5 |
| 8.291-8.294 | 149.9-150.05 | 2310-2390 | 15.35-16.2 |
| 8.362-8.366 | 156.52475-156.52525 | 2483.5-2500 | 17.7-21.4 |
| 8.37625-8.38675 | 156.7-156.9 | 2655-2900 | 22.01-23.12 |
| 8.41425-8.41475 | 162.0125-167.17 | 3260-3267 | 23.6-24.0 |
| 12.29-12.293 | 167.72-173.2 | 3332-3339 | 31.2-31.8 |
| 12.51975-12.52025 | 240-285 | 3345.8-3358 | 36.43-36.5 |
| 12.57675-12.57725 | 322-335.4 | 3600-4400 | Above 38.6 |
| 13.36-13.41 | 1718 | | |

Number of channels tested:

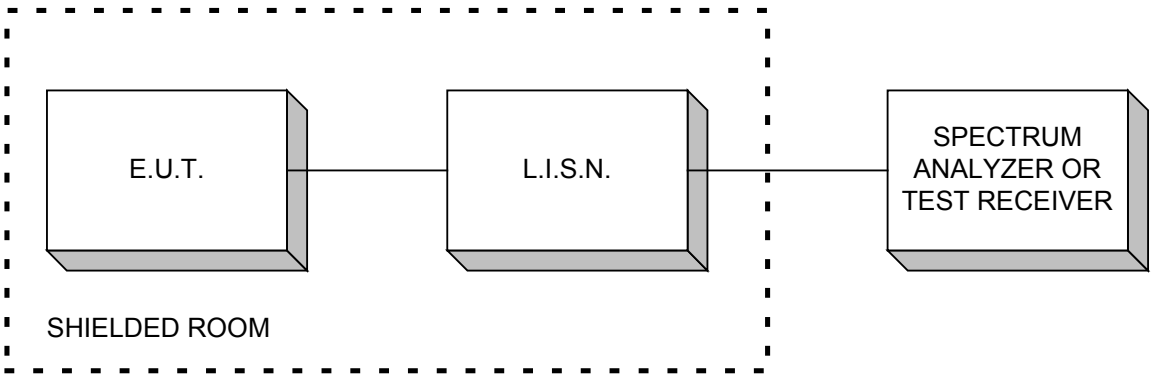
| Tuning range | Number of channels tested | Channel location in band |
|---|---|---|
| 1 MHz or less | 1 | middle |
| 1 to 10 MHz | 2 | top and bottom |
| more than 10 MHz | 3 | top, middle, bottom |

# ANNEX B - TEST DIAGRAMS

## Test Site For Radiated Emissions




## Conducted Emissions



**Peak Power At Antenna Terminals**