

# TEST REPORT FROM RFI GLOBAL SERVICES LTD

Test of: Multi-Tech Systems Inc.  
MTS2BTSMI Transceiver

To: FCC Part 15.247: 2004 (Subpart C)

**Test Report Serial No:**  
RFI\MPTE1\RP46786JD07A

**This Test Report Is Issued Under The Authority  
Of Andrew Brown, Operations Manager:**

  
pp

<b>Tested By:</b> Steven Wong	<b>Checked By:</b> Nigel Davison
	
<b>Report Copy No:</b> PDF01	
<b>Issue Date:</b> 14 June 2005	<b>Test Dates:</b> 09 February 2005 to 19 May 2005

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The results in this report apply only to the sample(s) tested.

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## **1. Client Information**

<b>Company Name:</b>	Multi-Tech Systems Inc
<b>Address:</b>	2205 Woodale Drive Mounds View MN USA 55112
<b>Contact Name:</b>	Mr M Sundeen

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## **2. Equipment Under Test (EUT)**

The following information (with the exception of the Date of Receipt) has been supplied by the client:

### **2.1. Identification of Equipment Under Test (EUT)**

<b>Brand Name:</b>	Multi-Tech
<b>Model Name or Number:</b>	MTS2BTSMI
<b>Unique Type Identification:</b>	MTS2BTSMI
<b>Serial Number:</b>	0X00a0960cd88b
<b>FCC ID Number:</b>	AU792U05A28780
<b>Country of Manufacture:</b>	USA
<b>Date of Receipt:</b>	09 February 2005

<b>Brand Name:</b>	Multi-Tech
<b>Model Name or Number:</b>	MTS2BTA
<b>Unique Type Identification:</b>	MTS2BTA
<b>Serial Number:</b>	Rev A 73001900
<b>FCC ID Number:</b>	AU792U05A28780
<b>Country of Manufacture:</b>	USA
<b>Date of Receipt:</b>	09 February 2005

### **2.2. Description of EUT**

The equipment under test is a *Bluetooth*® module incorporated onto a test circuit board. Since the *Bluetooth* module cannot be removed from the host test circuit board, limited modular approval testing was performed.

### **2.3. Modifications Incorporated in EUT**

During the course of testing the EUT was not modified.

"The *Bluetooth*® word mark and logos are owned by the Bluetooth SIG, Inc. and any use of such marks by RFI Global Services Ltd. is under license. Other trademarks and trade names are those of their respective owners."

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#### **2.4. Additional Information Related to Testing**

<b>Power Supply Requirement:</b>	9 V DC sourced from a nominal 115 V 60Hz AC Mains adaptor.		
<b>Intended Operating Environment:</b>	Residential, Commercial and Light Industry		
<b>Equipment Category:</b>	Short Range (Low Power)		
<b>Type of Unit:</b>	Modular device (attached to test board)		
<b>Transmit Frequency Range:</b>	2402 MHz to 2480 MHz		
<b>Transmit Channels Tested:</b>	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	1	2402
	Middle	40	2441
	Top	79	2480
<b>Receive Frequency Range:</b>	2402 MHz to 2480 MHz		
<b>Receive Channels Tested:</b>	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	1	2402
	Middle	40	2441
	Top	79	2480
<b>Maximum Power Output (EIRP)</b>	18.7 dBm		

#### **2.5. Port Identification**

Port	Description	Type/Length	Applicable
1	Enclosure	-	Y
2	RS232 Interface Port	-	Y
3	Antennal/RF Port	SMA cable / 12cm	Y
4	Power Supply Interface	2 wire core / 10cm	Y

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## **2.6. Support Equipment**

The following support equipment was used to exercise the EUT during testing:

<b>Description:</b>	AC Adaptor
<b>Brand Name:</b>	GlobTek
<b>Model Name or Number:</b>	GT-21089-0909-T3
<b>Serial Number:</b>	None Stated
<b>Cable Length and Type:</b>	2 Core Wire
<b>Connected to Port:</b>	DC Supply Interface

<b>Description:</b>	Laptop DC
<b>Brand Name:</b>	Dell
<b>Model Name or Number:</b>	PP01X
<b>Serial Number:</b>	CN-03J010-12961-2AQ-5411
<b>Cable Length and Type:</b>	Serial Cable
<b>Connected to Port:</b>	RS232 Port

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### **3. Test Results**

<b>Reference:</b>	FCC Part 15.247: 2004 Subpart C
<b>Title:</b>	Code of Federal Regulations, Part 15.247 (47CFR22) (Intentional Radiators operating within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz)

#### **3.1. Methods and Procedures**

The methods and procedures used were as detailed in:

ANSI C63.2 (1987)

Title: American National Standard for Instrumentation - Electromagnetic noise and field strength.

ANSI C63.4 (2003)

Title: American National Standard Methods of Measurement of Electromagnetic Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.5 (1988)

Title: American National Standard for the Calibration of antennas used for Radiated Emission measurements in Electromagnetic Interference (EMI) control.

ANSI C63.7 (1988)

Title: American National Standard Guide for Construction of Open Area Test Sites for performing Radiated Emission Measurements.

CISPR 16-1: (1999)

Title: Specification For Radio Disturbance and Immunity Measuring Apparatus and Methods. Part 1: Radio Disturbance and Immunity Measuring Apparatus.

DA00-705 (2000)

Title: Filing and Frequency Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

#### **3.2. Definition of Measurement Equipment**

The measurement equipment used complied with the requirements of the standards referenced in the methods & procedures section above. Appendix 1 contains a list of the test equipment used.

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**4. Deviations from the Test Specification**

None.

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## **5. Operation of the EUT during Testing**

### **5.1. Operating Modes**

The EUT was tested in the following operating modes, unless otherwise stated.

For all transmit mode measurements the *Bluetooth* test mode was active and set to transmit on top, middle and bottom channels and hopping on all channels as necessary with the longest data packet size.

### **5.2. Configuration and Peripherals**

The EUT was tested in the following configuration:

The EUT is comprised of a *Bluetooth* module with a short cable attached to the antenna port. The radiated emissions AC conducted emissions was performed with the antenna port terminated, the RS232 port terminated with a serial cable and the unit was powered by 9 volts DC taken from a 110 V AC mains supply via an AC adaptor.

All antenna port conducted emissions were performed with the EUT RS232 port connected to a laptop PC and powered via an external DC supply.

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## **6. Summary of Test Results**

Range of Measurements	Specification Reference	Port Type	Compliance Status
Idle Mode AC Conducted Emissions (150 kHz to 30 MHz)	C.F.R. 47 FCC Part 15: 2004 Section 15.107	AC Mains	Complied
Idle Mode Radiated Spurious Emissions	C.F.R. 47 FCC Part 15: 2004 Section 15.109	Antenna	Complied
Transmitter AC Conducted Emissions (150 kHz to 30 MHz)	C.F.R. 47 FCC Part 15: 2004 Section 15.207	AC Mains	Complied
Transmitter 20 dB Bandwidth	C.F.R. 47 FCC Part 15: 2004 Section 15.247(a)(1)	Antenna Terminals	Complied
Transmitter Carrier Frequency Separation	C.F.R. 47 FCC Part 15: 2004 Section 15.247(a)(1)	Antenna Terminals	Complied
Transmitter Average Time of Occupancy	C.F.R. 47 FCC Part 15: 2004 Section 15.247(a)(1)(iii)	Antenna Terminals	Complied
Transmitter Maximum Peak Output Power	C.F.R. 47 FCC Part 15: 2004 Section 15.247(b)(1)	Antenna Terminals	Complied
Transmitter Conducted Emissions	C.F.R. 47 FCC Part 15: 2004 Section 15.247 (d)	Antenna Terminals	Complied
Transmitter Radiated Emissions	C.F.R. 47 FCC Part 15: 2004 Sections 15.247(d) & 15.209(a)	Antenna	Complied
Transmitter Band Edge Conducted Emissions	C.F.R. 47 FCC Part 15: 2004 Section 15.247(d)	Antenna Terminals	Complied

### **6.1. Location of Tests**

All the measurements described in this report were performed at the premises of RFI Global Services Ltd, Ewhurst Park, Ramsdell, Basingstoke, Hampshire, RG26 5RQ, England.

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## **7. Measurements, Examinations and Derived Results**

### **7.1. General Comments**

This section contains test results only.

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to section 8 for details of measurement uncertainties.

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## **7.2. Test Results**

### **7.2.1. Idle Mode AC Conducted Spurious Emissions: Section 15.107**

The EUT was configured as for ac conducted emission measurements as described in section 9 of this report.

Tests were performed to identify the maximum emission levels present on the ac mains line of the EUT.

#### **Results:**

##### **Quasi-Peak Detector Measurements on Live and Neutral Lines**

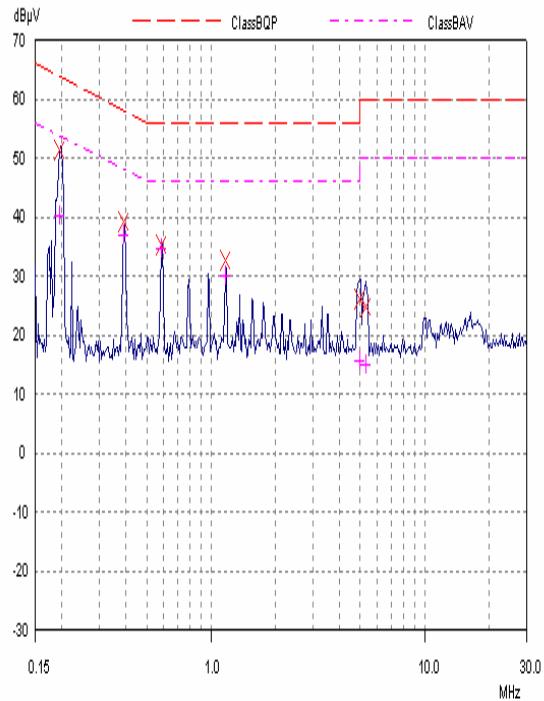
Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.19624	Live	51.3	63.8	12.5	Complied
0.39400	Live	39.0	58.0	19.0	Complied
0.58714	Live	35.3	56.0	20.7	Complied
1.17218	Live	32.6	56.0	23.4	Complied
5.01732	Live	26.1	60.0	33.9	Complied
5.33311	Live	24.9	60.0	35.1	Complied

##### **Average Detector Measurements on Live and Neutral Lines**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.19624	Live	40.3	53.8	13.5	Complied
0.39400	Live	37.1	48.0	10.9	Complied
0.58714	Live	34.8	46.0	11.2	Complied
1.17218	Live	29.9	46.0	16.1	Complied
5.01732	Live	15.8	50.0	34.2	Complied
5.33311	Neutral	15.0	50.0	35.0	Complied

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**Idle Mode AC Conducted Spurious Emissions: Section 15.107 (Continued)**

*Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying tables.*

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**7.2.2. Idle Mode Radiated Spurious Emissions: Section 15.109 - Electric Field Strength Measurements (Frequency Range: 30 to 1000 MHz)**

The EUT was configured as for radiated emission testing as described in section 9 of this report.

Tests were performed to identify the maximum receiver or standby radiated emission levels.

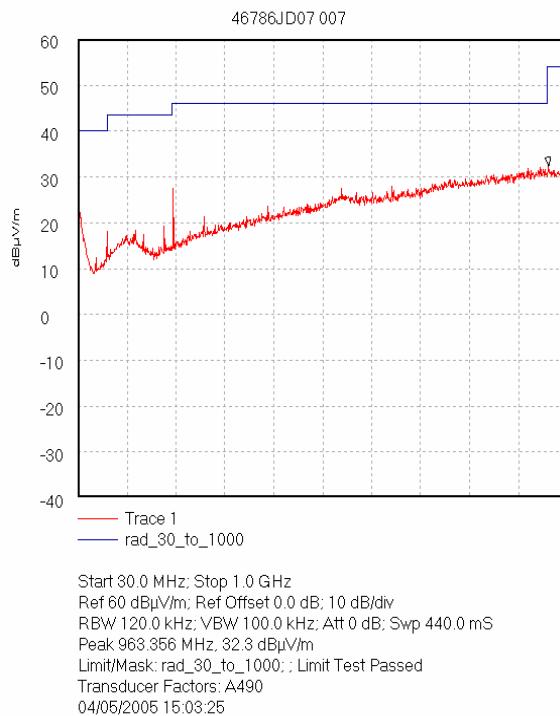
**Results:**

Frequency (MHz)	Antenna Polarity	Q-P Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
215.998	Vert	38.8	43.5	4.7	Complied

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**Idle Mode Radiated Spurious Emissions: Section 15.109 - Electric Field Strength**  
**Measurements (Frequency Range: 30 to 1000 MHz) (Continued)**



*Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying tables.*

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**7.2.3. Idle Mode Radiated Spurious Emissions: Section 15.109 - Electric Field Strength Measurements (Frequency Range: 1 to 12.5 GHz)**

**Results:**

**Highest Peak Level:**

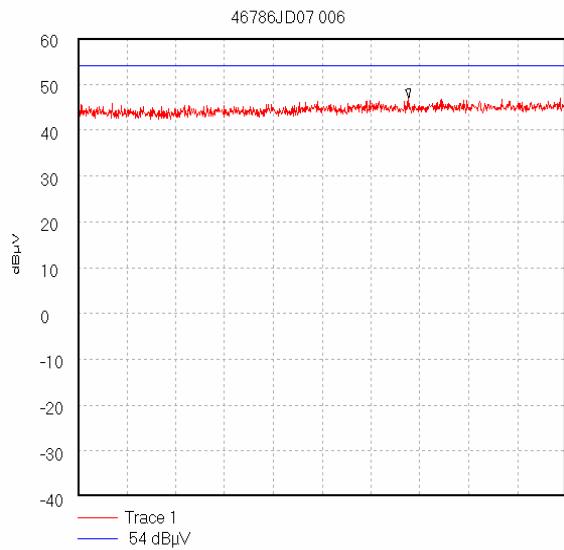
Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
9.757882	Vert	10.8	30.5	1.9	43.2	74.0	30.8	Complied

**Highest Average Level:**

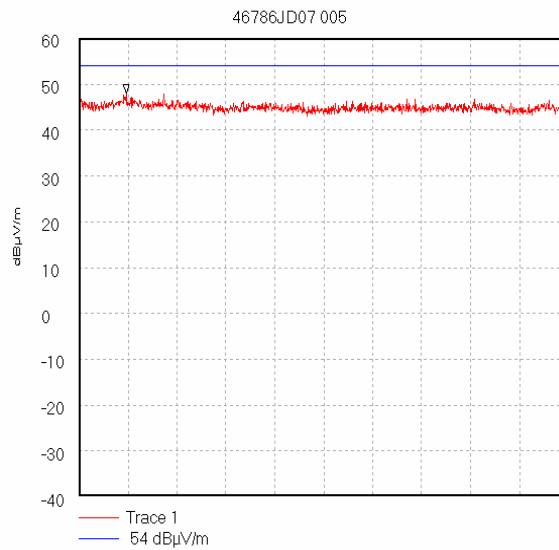
Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
9.757882	Vert	7.8	30.5	1.9	40.2	54.0	13.8	Complied

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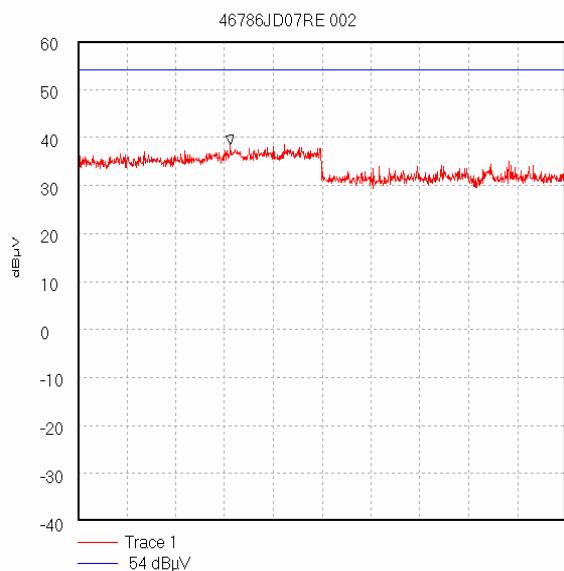
**Idle Mode Radiated Spurious Emissions: Section 15.109 - Electric Field Strength Measurements (Frequency Range: 1 to 12.5 GHz) (Continued)**



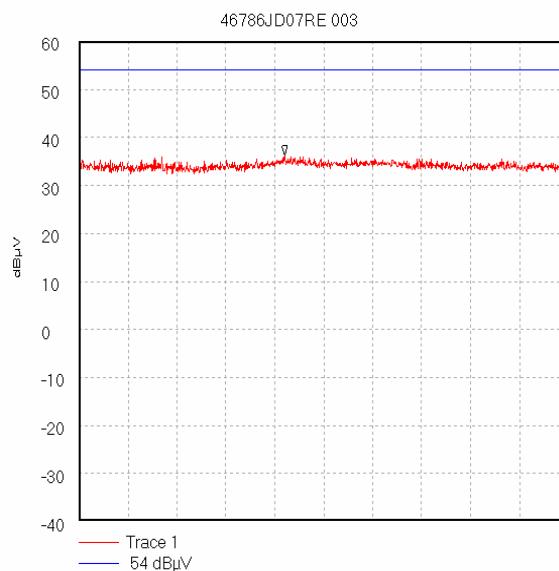
Start 1.0 GHz; Stop 2.0 GHz  
 Ref 60 dB $\mu$ V; Ref Offset 0.0 dB; 10 dB/div  
 RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS  
 Peak 1.677 GHz, 47.13 dB $\mu$ V  
 Display Line: 54 dB $\mu$ V;  
 Transducer Factors: 1 to 2  
 04/05/2005 14:55:16



Start 2.0 GHz; Stop 4.0 GHz  
 Ref 60 dB $\mu$ V/m; Ref Offset 0.0 dB; 10 dB/div  
 RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS  
 Peak 2.193 GHz, 47.94 dB $\mu$ V/m  
 Display Line: 54 dB $\mu$ V/m;  
 Transducer Factors: 2 to 4  
 04/05/2005 14:49:18



Start 4.0 GHz; Stop 6.0 GHz  
 Ref 60 dB $\mu$ V; Ref Offset 0.0 dB; 10 dB/div  
 RBW 1000.0 kHz; VBW 3.0 MHz; Att 0 dB; Swp 20.0 mS  
 Peak 4.624444 GHz, 38.57 dB $\mu$ V  
 Display Line: 54 dB $\mu$ V; ; Limit Test Passed  
 10/05/2005 18:30:33

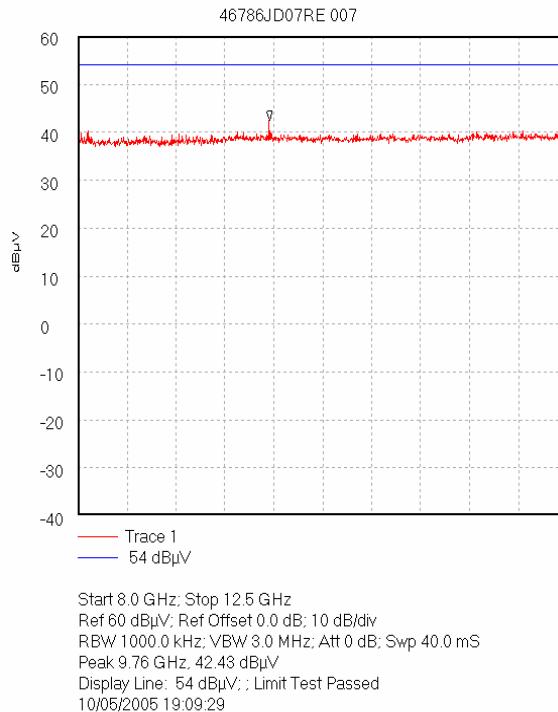


Start 6.0 GHz; Stop 8.0 GHz  
 Ref 60 dB $\mu$ V; Ref Offset 0.0 dB; 10 dB/div  
 RBW 1000.0 kHz; VBW 3.0 MHz; Att 0 dB; Swp 20.0 mS  
 Peak 6.842222 GHz, 36.26 dB $\mu$ V  
 Display Line: 54 dB $\mu$ V; ; Limit Test Passed  
 10/05/2005 18:38:46

*Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

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**Idle Mode Radiated Spurious Emissions: Section 15.109 - Electric Field Strength Measurements (Frequency Range: 1 to 12.5 GHz) (Continued)**



*Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying tables.*

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#### **7.2.4. Transmitter AC Conducted Spurious Emissions: Section 15.207**

The EUT was configured for ac conducted emission measurements as described in section 9 of this report.

Tests were performed to identify the maximum emission levels present on the ac mains line of the EUT.

##### **Results: Top Channel**

##### **Quasi-Peak Detector Measurements on Live and Neutral Lines**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.15020	Neutral	53.9	66.0	12.1	Complied
0.15616	Neutral	52.6	65.7	13.1	Complied
0.16482	Live	51.0	65.2	14.2	Complied
0.27075	Live	39.6	61.1	21.5	Complied
0.33335	Live	36.7	59.4	22.7	Complied
4.98623	Live	26.2	56.0	29.8	Complied

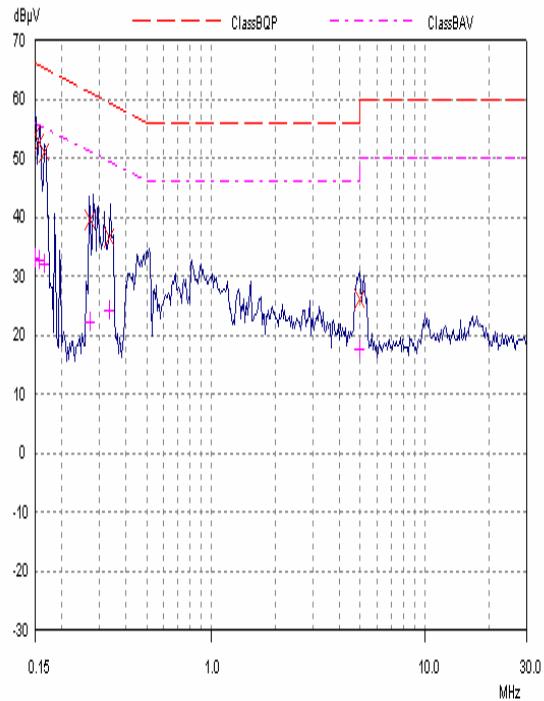
##### **Average Detector Measurements on Live and Neutral Lines**

Frequency (MHz)	Line	Level (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Result
0.15020	Live	32.9	56.0	23.1	Complied
0.15616	Live	32.7	55.7	23.0	Complied
0.16482	Live	32.1	55.2	23.1	Complied
0.27075	Live	22.0	51.1	29.1	Complied
0.33335	Live	24.3	49.4	25.1	Complied
4.98623	Live	17.7	46.0	28.3	Complied

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**Transmitter AC Conducted Spurious Emissions: Section 15.207 (Continued)**



*Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying tables.*

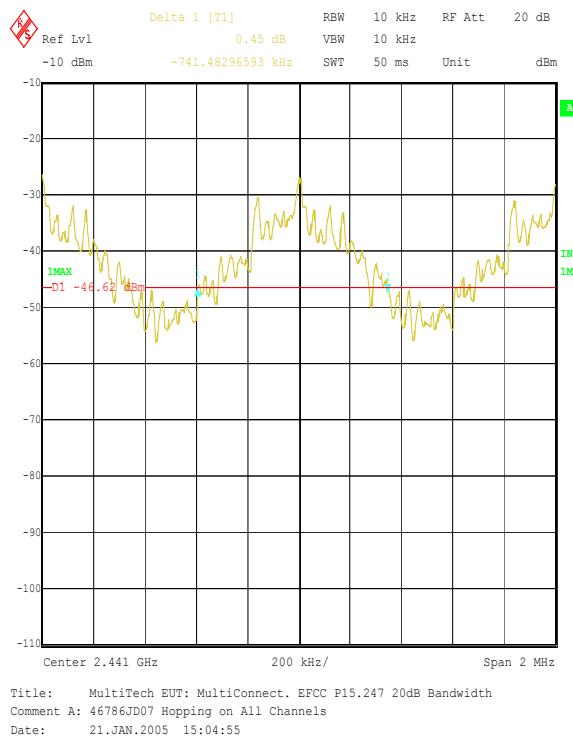
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**7.2.5. Transmitter 20 dB Bandwidth: Section 15.247(a)(1)**

The EUT was configured for 20 dB bandwidth measurements as described in section 9 of this report. Tests were performed to identify the 20 dB bandwidth.

**Results:**

Transmitter 20 dB Bandwidth (kHz)	Limit (kHz)
741.48297	None specified



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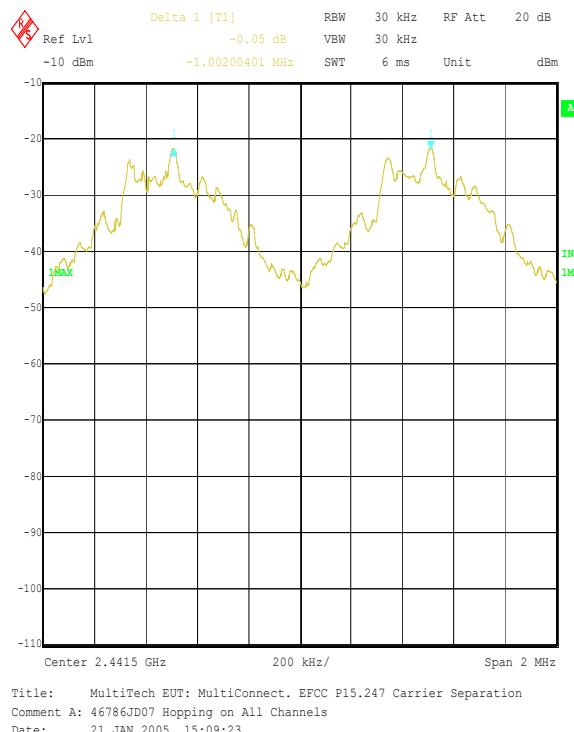
**7.2.6. Transmitter Carrier Frequency Separation: Section 15.247(a)(1)**

The EUT was configured for carrier frequency separation measurements as described in section 9 of this report.

Tests were performed to identify the carrier frequency separation.

**Results:**

Transmitter Carrier Frequency Separation (kHz)	Limit (> 20 dB or $\frac{2}{3}$ of 20 dB BW) (kHz)	Margin (kHz)	Result
1002.00401	741.48297	260.52104	Complied



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**7.2.7. Transmitter Average Time of Occupancy: Section 15.247(a)(1)(iii)**

The EUT was configured for average time of occupancy measurements as described in section 9 of this report.

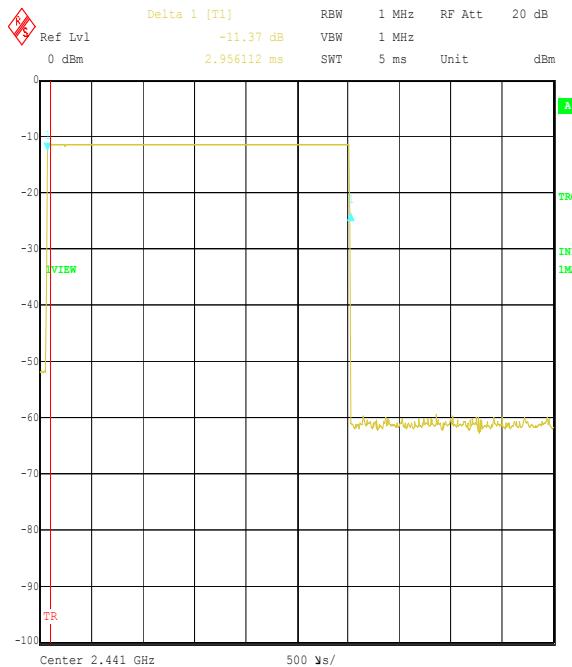
Tests were performed to identify the average time of occupancy in number of channels (79) x 0.4 seconds. The calculated period is 31.6 seconds.

**Results:**

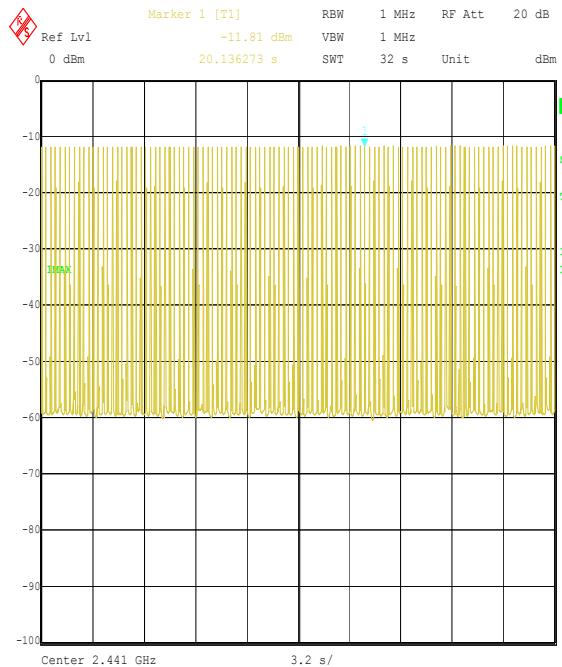
Emission Width (μs)	Number of Hops in 31.6 Seconds	Average Time of Occupancy (s)	Limit (s)	Margin (s)	Result
2956.112	112	0.331	0.4	0.069	Complied

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**Transmitter Average Time of Occupancy: Section 15.247(a)(1)(iii) (Continued)**



Title: MultiTech EUT: MultiConnect. EFCC P15.247 Emission Width  
 Comment A: 46786JD07 Hopping on All Channels  
 Date: 21.JAN.2005 15:24:35



Title: MultiTech EUT: MultiConnect. EFCC P15.247 Emissions in 32s  
 Comment A: 46786JD07 Hopping on All Channels  
 Date: 21.JAN.2005 15:26:19



Title: MultiTech EUT: MultiConnect. EFCC P15.247 Number of Channels  
 Comment A: 46786JD07 Hopping on All Channels  
 Date: 21.JAN.2005 15:18:02

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**7.2.8. Transmitter Maximum Peak Output Power: Section 15.247(b)(1)**

The EUT was configured for transmitter peak output power measurements as described in section 9 of this report.

Tests were performed to identify the transmitter maximum peak output power (ERP) of the EUT.

**Results:**

**AC Powered Devices**

Channel	Input Voltage (DC)	Conducted RF O/P Power (dBm)	Stated Antenna Gain (dB)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Result
Bottom	7.65	13.2	5.0	18.2	30.0	11.8	Complied
Bottom	9.0	13.2	5.0	18.2	30.0	11.8	Complied
Bottom	10.35	13.2	5.0	18.2	30.0	11.8	Complied
Middle	7.65	13.7	5.0	18.7	30.0	11.3	Complied
Middle	9.0	13.7	5.0	18.7	30.0	11.3	Complied
Middle	10.35	13.7	5.0	18.7	30.0	11.3	Complied
Top	7.65	13.7	5.0	18.7	30.0	11.3	Complied
Top	9.0	13.7	5.0	18.7	30.0	11.3	Complied
Top	10.35	13.7	5.0	18.7	30.0	11.3	Complied

**Note(s):**

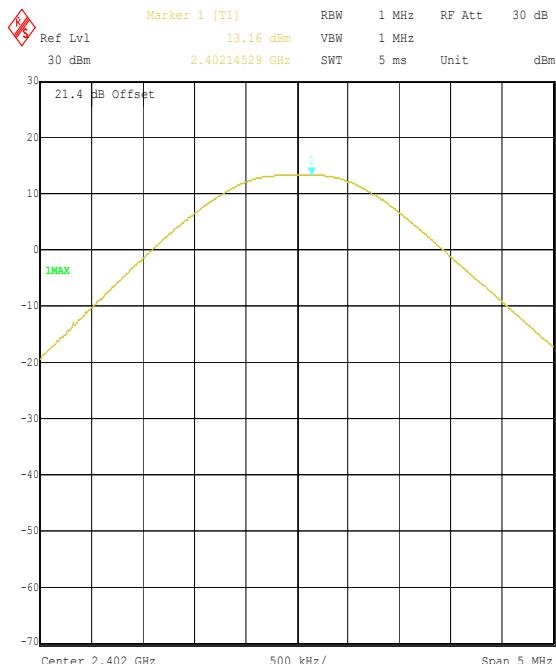
1. As per the requirements of Public Notice DA 00-705, the manufacturer stated the highest possible antenna gain that can be used with the EUT is 5.0dBi (the antenna is not apart of the EUT for approved testing which, when added to the highest (worst case) measured conducted peak output power of 18.7 dBm (from the table above) gives the de facto EIRP..

**Test of:** **Multi-Tech Systems Inc.**  
**MTS2BTSMI Transceiver**  
**To:** **FCC Part 15.247: 2004 (Subpart C)**

**Transmitter Maximum Peak Output Power: Section 15.247(b)(1) (Continued)**



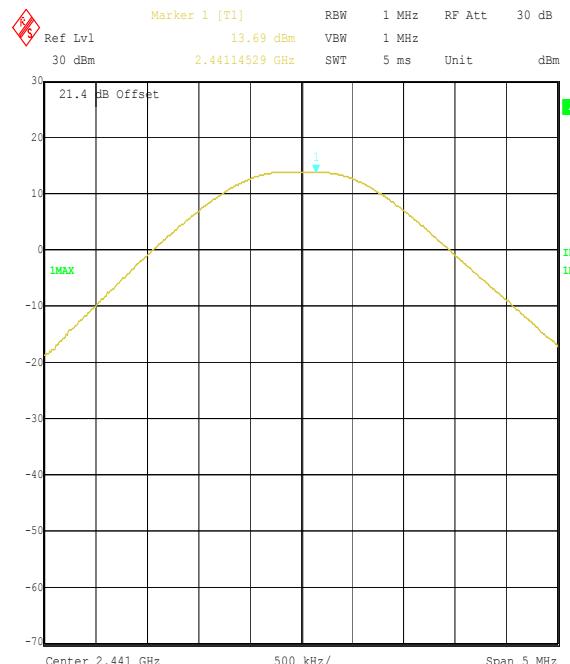
Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Output Power  
Comment A: 46786JD07 Bottom Channel (Conducted) Low Voltage  
Date: 9.MAY.2005 20:03:08



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Output Power  
Comment A: 46786JD07 Bottom Channel (Conducted) High Voltage  
Date: 9.MAY.2005 20:03:26



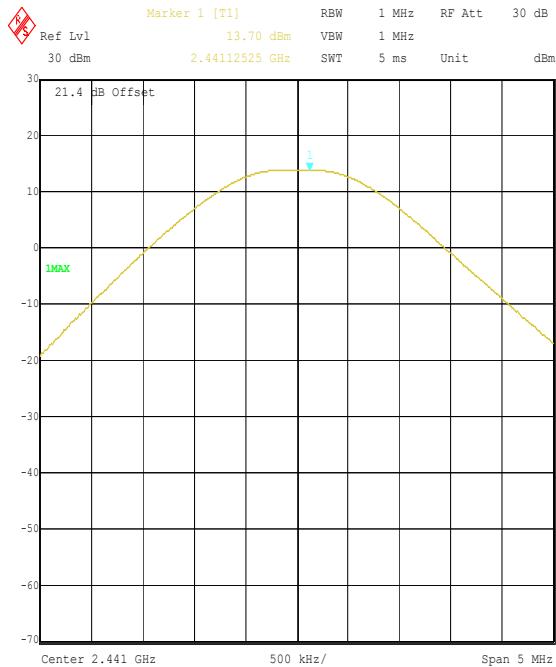
Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Output Power  
Comment A: 46786JD07 Bottom Channel (Conducted)  
Date: 9.MAY.2005 20:02:39



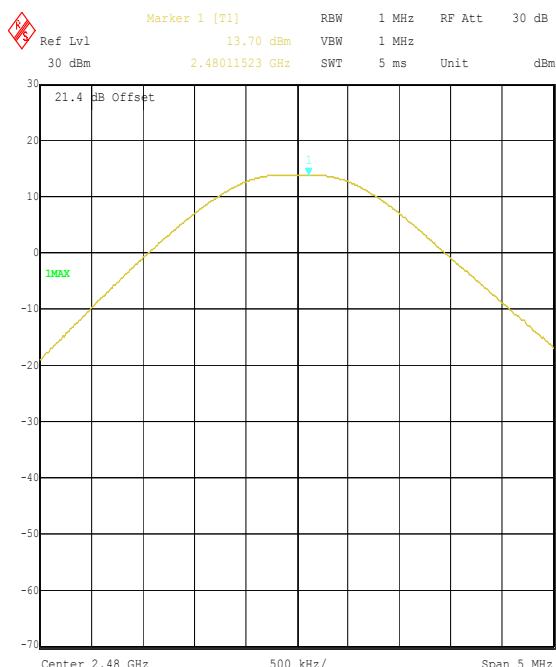
Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Output Power  
Comment A: 46786JD07 Middle Channel (Conducted) Low Voltage  
Date: 9.MAY.2005 20:04:33

**Test of:** Multi-Tech Systems Inc.  
 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

**Transmitter Maximum Peak Output Power: Section 15.247(b)(1) (Continued)**



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Output Power  
 Comment A: 46786JD07 Middle Channel (Conducted)  
 Date: 9.MAY.2005 20:04:18



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Output Power  
 Comment A: 46786JD07 Top Channel (Conducted) Low Voltage  
 Date: 9.MAY.2005 20:05:30



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Output Power  
 Comment A: 46786JD07 Middle Channel (Conducted) High Voltage  
 Date: 9.MAY.2005 20:04:04

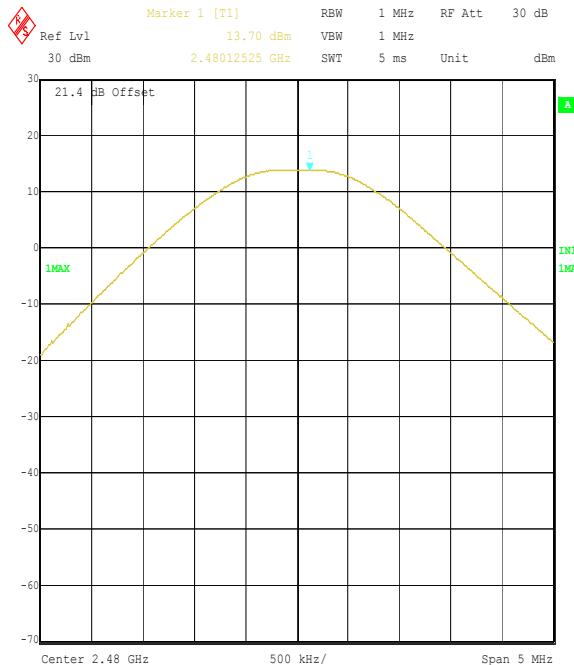


Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Output Power  
 Comment A: 46786JD07 Top Channel (Conducted)  
 Date: 9.MAY.2005 20:06:01

Test of: **Multi-Tech Systems Inc.**  
**MTS2BTSMI Transceiver**  
To: **FCC Part 15.247: 2004 (Subpart C)**

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**Transmitter Maximum Peak Output Power: Section 15.247(b)(1) (Continued)**



Test of: **Multi-Tech Systems Inc.**  
**MTS2BTSMI Transceiver**  
To: **FCC Part 15.247: 2004 (Subpart C)**

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#### **7.2.9. Transmitter Conducted Emissions: Section 15.247(d)**

The EUT was configured for transmitter conducted emission measurements as described in section 9 of this report.

The limit lines shown in the plots below are set to a level 20 dB below the measured highest fundamental peak power with a 100 kHz bandwidth.

#### **Results:**

##### **Bottom Channel**

Frequency (MHz)	Peak Emission Level (dBm)	Peak Emission Level (dBc)	Limit (dBc)	Margin (dB)	Result
4803.981	-45.7	-58.7	-20.0	38.7	Complied

##### **Middle Channel**

Frequency (MHz)	Peak Emission Level (dBm)	Peak Emission Level (dBc)	Limit (dBc)	Margin (dB)	Result
4881.974	-46.0	-59.5	-20.0	39.5	Complied

Test of: **Multi-Tech Systems Inc.**  
**MTS2BTSMI Transceiver**  
To: **FCC Part 15.247: 2004 (Subpart C)**

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**Transmitter Conducted Emissions: Section 15.247(d) (Continued)**

**Top Channel**

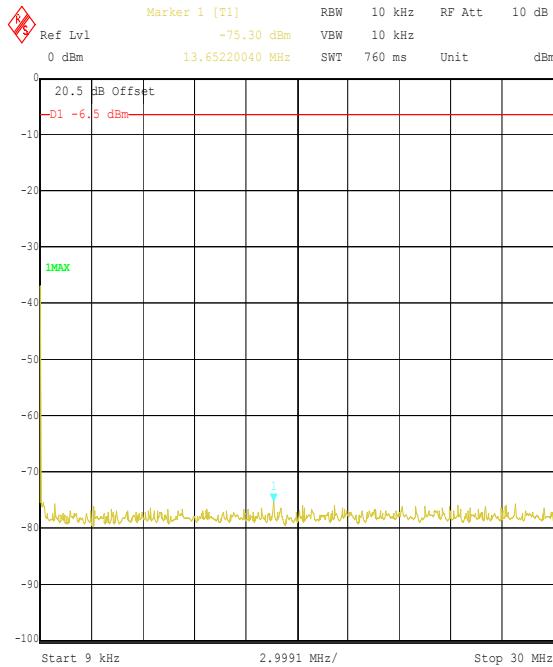
Frequency (MHz)	Peak Emission Level (dBm)	Peak Emission Level (dBc)	Limit (dBc)	Margin (dB)	Result
4959.988	-47.9	-61.4	-20.0	41.4	Complied

**Hopping Channel**

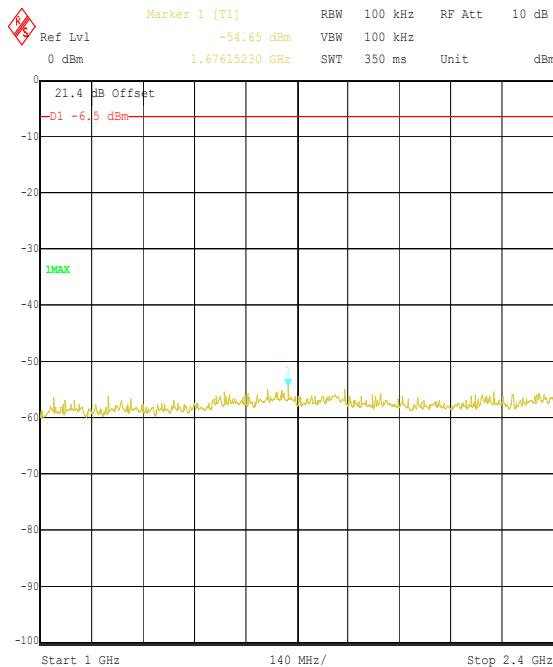
Frequency (MHz)	Peak Emission Level (dBm)	Peak Emission Level (dBc)	Limit (dBc)	Margin (dB)	Result
4833.987	-46.1	-59.6	-20.0	39.6	Complied

**Test of:** Multi-Tech Systems Inc.  
 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

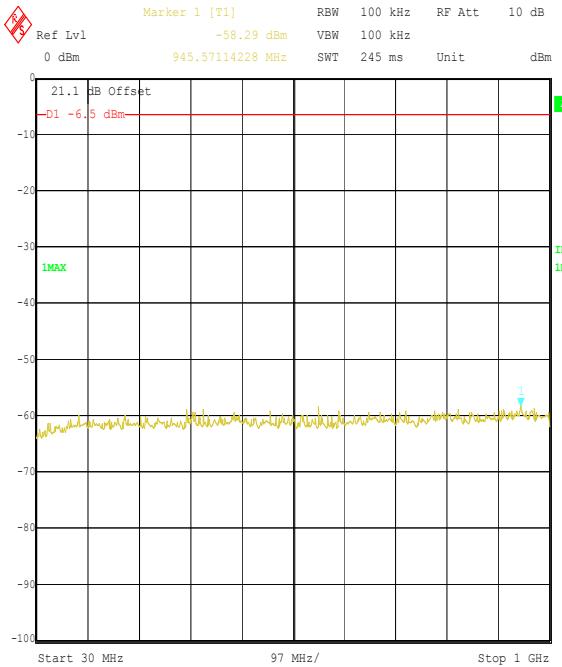
**Transmitter Conducted Emissions: Section 15.247(d) (Continued)**



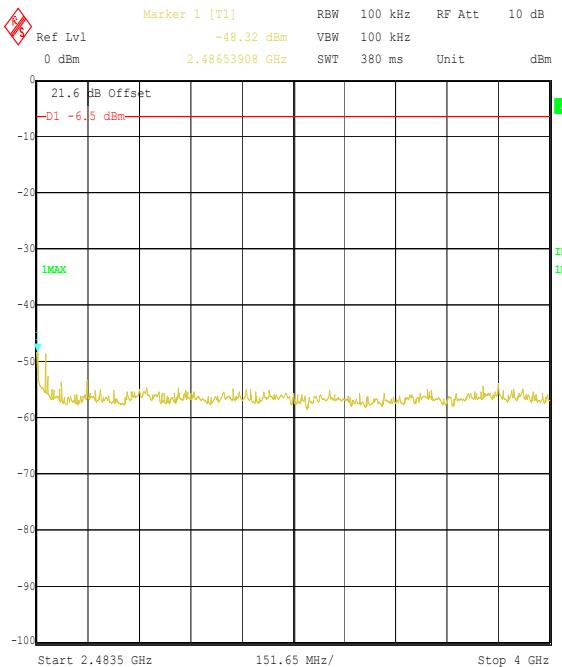
Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Emissions  
 Comment A: 46786JD07 Top Channel (Conducted)  
 Date: 9.MAY.2005 20:33:06



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Emissions  
 Comment A: 46786JD07 Top Channel (Conducted)  
 Date: 9.MAY.2005 20:33:54



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Emissions  
 Comment A: 46786JD07 Top Channel (Conducted)  
 Date: 9.MAY.2005 20:33:32

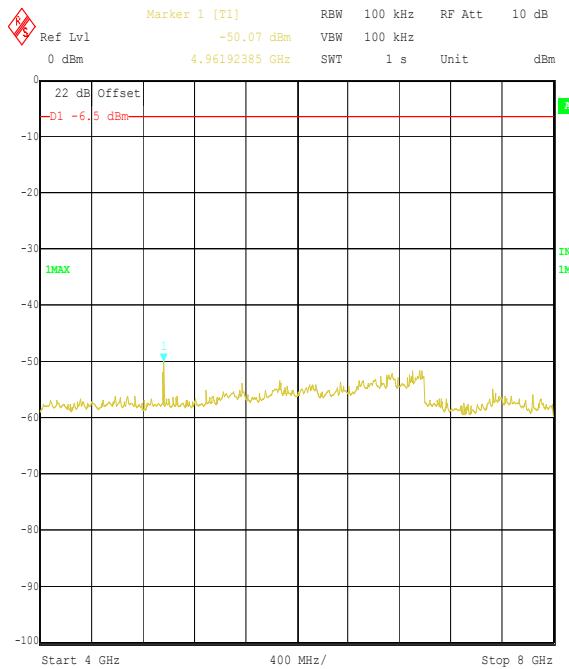


Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Emissions  
 Comment A: 46786JD07 Top Channel (Conducted)  
 Date: 9.MAY.2005 20:34:24

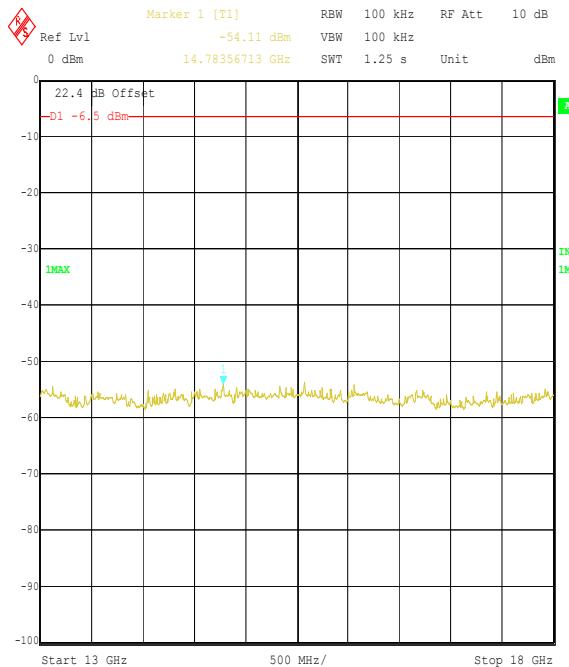
*Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

**Test of:** **Multi-Tech Systems Inc.**  
**MTS2BTSMI Transceiver**  
**To:** **FCC Part 15.247: 2004 (Subpart C)**

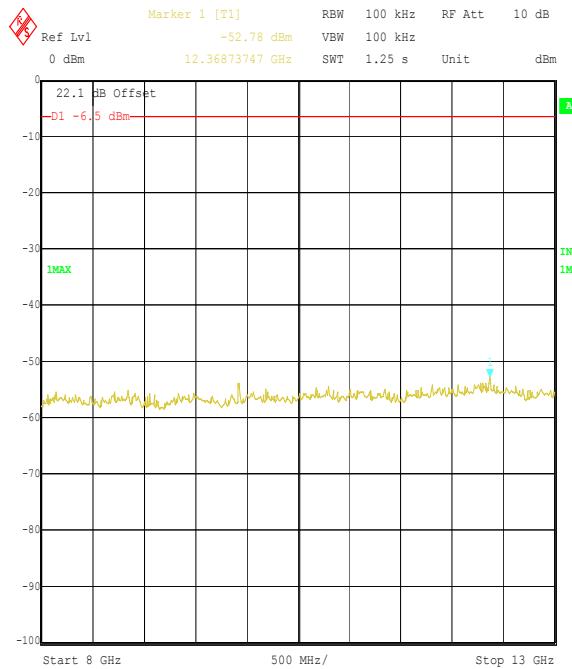
**Transmitter Conducted Emissions: Section 15.247(d) (Continued)**



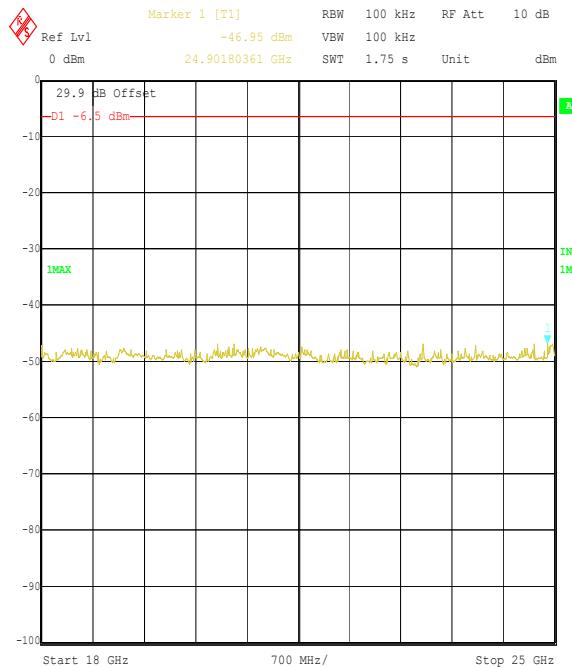
Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Emissions  
Comment A: 46786JD07 Top Channel (Conducted)  
Date: 9.MAY.2005 20:34:52



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Emissions  
Comment A: 46786JD07 Top Channel (Conducted)  
Date: 9.MAY.2005 20:36:02



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Emissions  
Comment A: 46786JD07 Top Channel (Conducted)  
Date: 9.MAY.2005 20:35:36



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Emissions  
Comment A: 46786JD07 Top Channel (Conducted)  
Date: 9.MAY.2005 20:36:29

Test of: Multi-Tech Systems Inc.  
MTS2BTSMI Transceiver  
To: FCC Part 15.247: 2004 (Subpart C)

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**7.2.10. Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) - Electric Field Strength Measurements: 30 to 1000 MHz (emissions outside the restricted bands)**

The EUT was configured for radiated emission testing as described in section 9 of this report.

Tests were performed to identify the maximum transmitter radiated emission levels.

**Results:**

**Top Channel**

Frequency (MHz)	Antenna Polarity	Peak Level (dB $\mu$ V/m)	-20 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
215.984	Vert	38.4	88.7	50.3	Complied

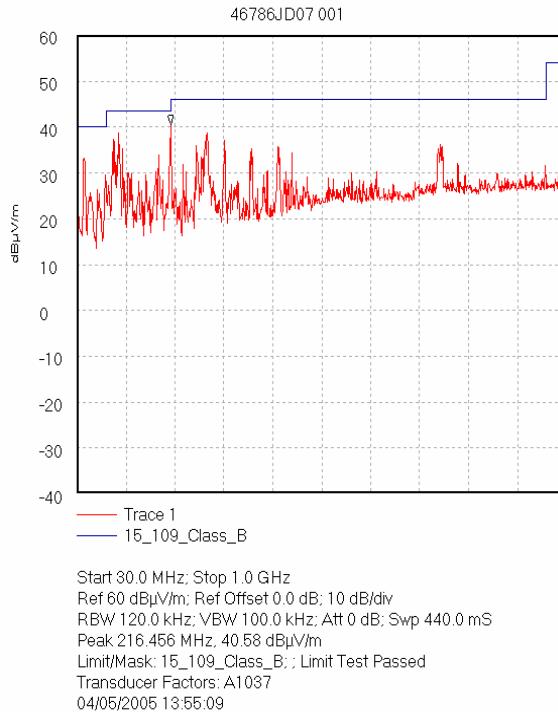
**Note(s):**

1. *The preliminary scans showed similar emission levels for each mode below 1 GHz, therefore final radiated emissions measurements were performed with the EUT set to the top channel only.*

Test of: **Multi-Tech Systems Inc.**  
**MTS2BTSMI Transceiver**  
To: **FCC Part 15.247: 2004 (Subpart C)**

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**7.2.11. Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) - Electric Field Strength Measurements: 30 to 1000 MHz (emissions occurring in the restricted bands)**  
**(Continued)**



*Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

**Test of:** Multi-Tech Systems Inc.  
 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

**7.2.12. Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) - Electric Field Strength Measurements (Frequency Range: 1 to 25.0 GHz) (emissions occurring in the restricted bands)**

The EUT was configured for radiated emission testing as described in section 9 of this report.

Tests were performed to identify the maximum transmitter radiated emission levels.

**Results:**

**Highest Peak Level: Bottom Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1.060565	Vert	26.0	21.5	0.5	48.0	74.0	26.0	Complied
1.204246	Vert	18.9	21.5	0.6	41.0	74.0	33.0	Complied
1.601390	Vert	14.7	21.6	0.7	37.0	74.0	37.0	Complied
1.618898	Vert	15.0	21.6	0.7	37.3	74.0	36.7	Complied
4.804310	Horiz	37.4	24.2	1.3	62.9	74.0	11.1	Complied

**Highest Average Level: Bottom Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1.060565	Vert	4.8	21.5	0.5	26.8	54.0	27.2	Complied
1.204246	Vert	-3.8	21.5	0.6	18.3	54.0	35.7	Complied
1.601390	Vert	-1.8	21.6	0.7	20.5	54.0	33.5	Complied
1.618898	Vert	-1.6	21.6	0.7	20.7	54.0	33.3	Complied
4.804310	Horiz	27.5	24.2	1.3	53.0	54.0	1.0	Complied

**Highest Peak Level: Middle Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1.060565	Vert	26.0	21.5	0.5	48.0	74.0	26.0	Complied
1.204246	Vert	18.9	21.5	0.6	41.0	74.0	33.0	Complied
1.601390	Vert	14.7	21.6	0.7	37.0	74.0	37.0	Complied
1.618898	Vert	15.0	21.6	0.7	37.3	74.0	36.7	Complied
4.804310	Horiz	37.8	24.2	1.3	63.3	74.0	10.7	Complied
7.323320	Horiz	26.7	26.9	1.6	55.2	74.0	18.8	Complied

**Test of:** Multi-Tech Systems Inc.  
 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

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**Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) - Electric Field Strength Measurements (Frequency Range: 1 to 25.0 GHz) (emissions occurring in the restricted bands) (Continued)**

**Highest Average Level: Middle Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1.060565	Vert	4.8	21.5	0.5	26.8	54.0	27.2	Complied
1.204246	Vert	-3.8	21.5	0.6	18.3	54.0	35.7	Complied
1.604390	Vert	-1.8	21.6	0.7	20.5	54.0	33.5	Complied
1.618898	Vert	-1.6	21.6	0.7	20.7	54.0	33.3	Complied
4.882186	Horiz	28.3	24.2	1.3	53.8	54.0	0.2	Complied
7.323320	Horiz	15.6	26.9	1.6	44.1	54.0	9.9	Complied

**Highest Peak Level: Top Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1.060565	Vert	26.0	21.5	0.5	48.0	74.0	26.0	Complied
1.204246	Vert	18.9	21.5	0.6	41.0	74.0	33.0	Complied
1.604390	Vert	14.7	21.6	0.7	37.0	74.0	37.0	Complied
1.618898	Vert	15.0	21.6	0.7	37.3	74.0	36.7	Complied
4.882186	Horiz	35.1	24.2	1.3	60.6	74.0	13.4	Complied
7.323320	Horiz	27.2	26.9	1.6	55.7	74.0	18.3	Complied

**Highest Average Level: Top Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1.060565	Vert	4.8	21.5	0.5	26.8	54.0	27.2	Complied
1.204246	Vert	-3.8	21.5	0.6	18.3	54.0	35.7	Complied
1.604390	Vert	-1.8	21.6	0.7	20.5	54.0	33.5	Complied
1.618898	Vert	-1.6	21.6	0.7	20.7	54.0	33.3	Complied
4.882186	Horiz	26.4	24.2	1.3	51.9	54.0	2.1	Complied
7.323320	Horiz	16.2	26.9	1.6	44.7	54.0	9.3	Complied

**Test of:** Multi-Tech Systems Inc.  
 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

**Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) - Electric Field Strength Measurements (Frequency Range: 1 to 25.0 GHz) (emissions occurring in the restricted bands) (Continued)**

**Highest Peak Level: Hopping Mode**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1.060565	Vert	26.0	21.5	0.5	48.0	74.0	26.0	Complied
1.204246	Vert	18.9	21.5	0.6	41.0	74.0	33.0	Complied
1.604390	Vert	14.7	21.6	0.7	37.0	74.0	37.0	Complied
1.618898	Vert	15.0	21.6	0.7	37.3	74.0	36.7	Complied
4.882186	Horiz	37.5	24.2	1.3	63.0	74.0	11.0	Complied
7.323320	Horiz	26.6	26.9	1.6	55.1	74.0	18.9	Complied

**Highest Average Level: Hopping Mode**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Result
1.060565	Vert	4.8	21.5	0.5	26.8	54.0	27.2	Complied
1.204246	Vert	-3.8	21.5	0.6	18.3	54.0	35.7	Complied
1.604390	Vert	-1.8	21.6	0.7	20.5	54.0	33.5	Complied
1.618898	Vert	-1.6	21.6	0.7	20.7	54.0	33.3	Complied
4.882186	Horiz	28.1	24.2	1.3	53.6	54.0	0.4	Complied
7.323320	Horiz	15.6	26.9	1.6	44.1	54.0	9.9	Complied

**Test of:** Multi-Tech Systems Inc.  
 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

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**7.2.13. Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) - Electric Field Strength Measurements (Frequency Range: 1 to 25.0 GHz)**

The EUT was configured for radiated emission testing as described in section 9 of this report. Tests were performed to identify the maximum transmitter radiated emission levels.

**Results:**

**Highest Peak Level: Bottom Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	-20 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
7.206293	Horiz	22.0	26.9	1.6	50.5	88.2	37.7	Complied
9.608470	Vert	25.1	30.4	1.8	57.3	88.2	30.9	Complied
16.812866	Horiz	4.7	33.8	2.1	40.6	88.2	47.6	Complied

**Highest Peak Level: Middle Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	-20 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
9.764460	Vert	25.5	30.5	1.9	57.9	88.7	30.8	Complied
17.087866	Horiz	4.9	33.9	2.1	40.9	88.7	47.8	Complied

**Highest Peak Level: Top Channel**

Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	-20 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
9.920403	Vert	25.6	30.5	1.9	58.0	88.7	30.7	Complied
17.360940	Horiz	4.9	33.9	2.1	39.0	88.7	49.7	Complied

Test of: Multi-Tech Systems Inc.  
MTS2BTSMI Transceiver  
To: FCC Part 15.247: 2004 (Subpart C)

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**Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) - Electric Field Strength Measurements (Frequency Range: 1 to 25.0 GHz) (Continued)**

**Highest Peak Level: Hopping Mode**

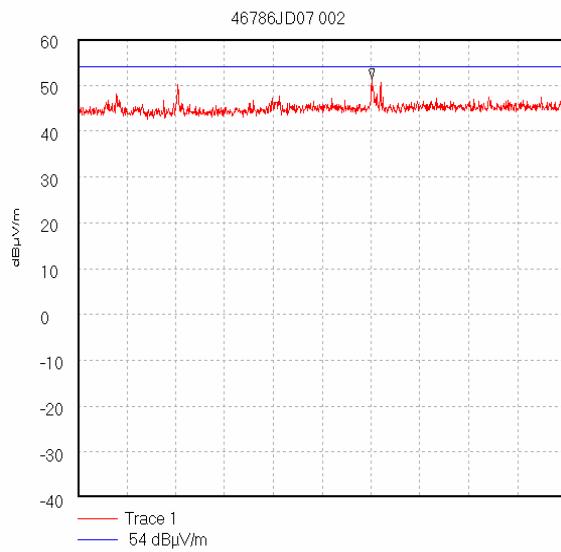
Frequency (GHz)	Antenna Polarity	Detector Level (dB $\mu$ V)	Antenna Factor (dB)	Cable Loss (dB)	Actual Level (dB $\mu$ V/m)	-20 dBc Limit (dB $\mu$ V/m)	Margin (dB)	Result
9.712460	Vert	25.6	30.5	1.9	58.0	88.7	30.7	Complied
17.150923	Horiz	4.8	33.9	2.1	40.8	88.7	47.9	Complied

**Note(s):**

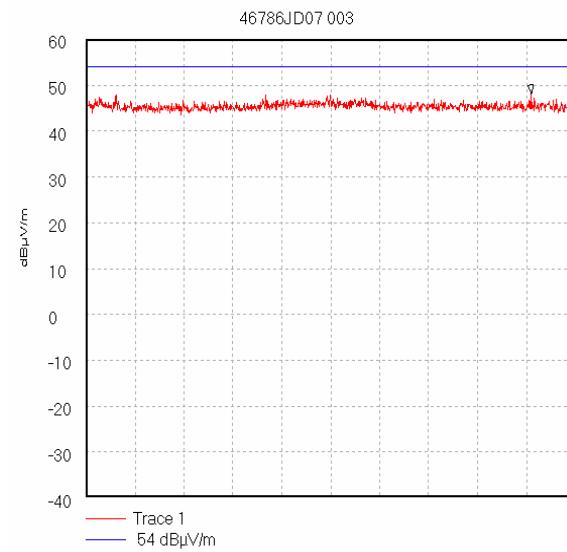
1. *The start frequency on plot 46786JD07 004 is incorrectly shown due to rounding errors in the test software. The start frequency should be shown as 2.4835 GHz..*
2. *It is confirmed that the measurement was made at the actual band edge frequency 2.4835 GHz.*

**Test of:** Multi-Tech Systems Inc.  
 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

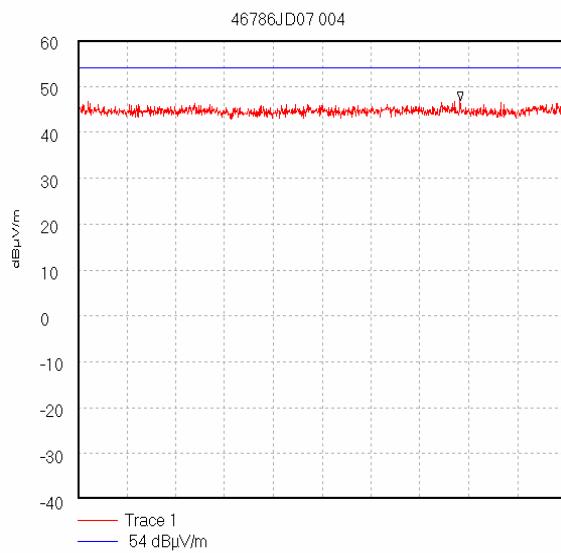
**Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) - Electric Field Strength Measurements (Frequency Range: 1 to 25.0 GHz) (Continued)**



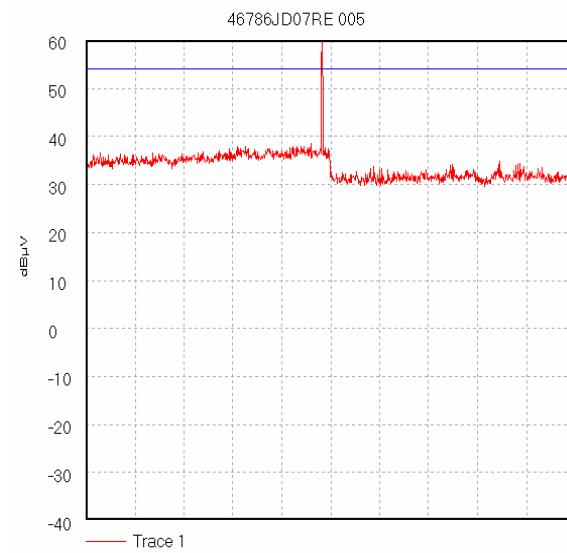
Start 1.0 GHz; Stop 2.0 GHz  
 Ref 60 dB $\mu$ V/m; Ref Offset 0.0 dB; 10 dB/div  
 RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS  
 Peak 1.602 GHz, 51.52 dB $\mu$ V/m  
 Display Line: 54 dB $\mu$ V/m;  
 Transducer Factors: 1 to 2  
 04/05/2005 14:10:10



Start 2.0 GHz; Stop 2.4 GHz  
 Ref 60 dB $\mu$ V/m; Ref Offset 0.0 dB; 10 dB/div  
 RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS  
 Peak 2.364 GHz, 48.12 dB $\mu$ V/m  
 Display Line: 54 dB $\mu$ V/m;  
 Transducer Factors: 2 to 4  
 04/05/2005 14:31:22



Start 2.484 GHz; Stop 4.0 GHz  
 Ref 60 dB $\mu$ V/m; Ref Offset 0.0 dB; 10 dB/div  
 RBW 1.0 MHz; VBW 1.0 MHz; Att 0 dB; Swp 20.0 mS  
 Peak 3.671 GHz, 46.88 dB $\mu$ V/m  
 Display Line: 54 dB $\mu$ V/m;  
 Transducer Factors: 2 to 4  
 04/05/2005 14:31:55

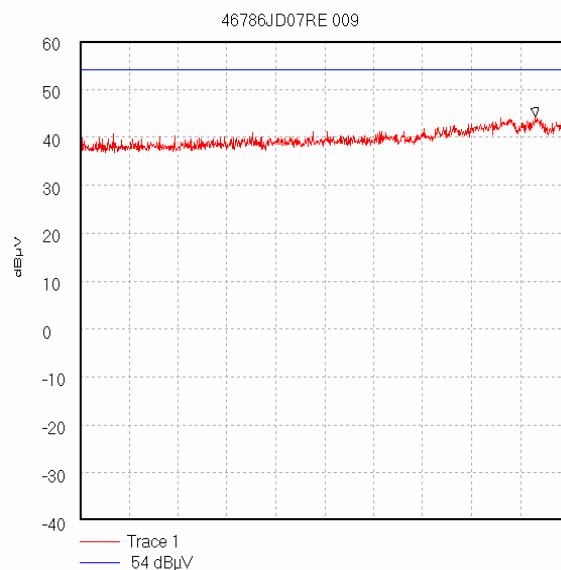
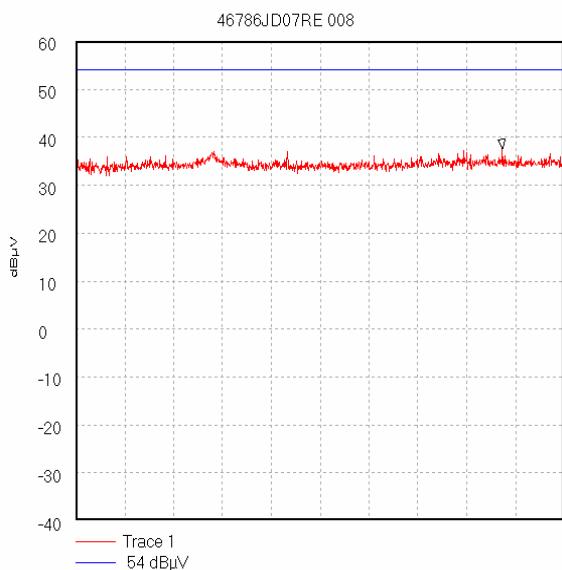
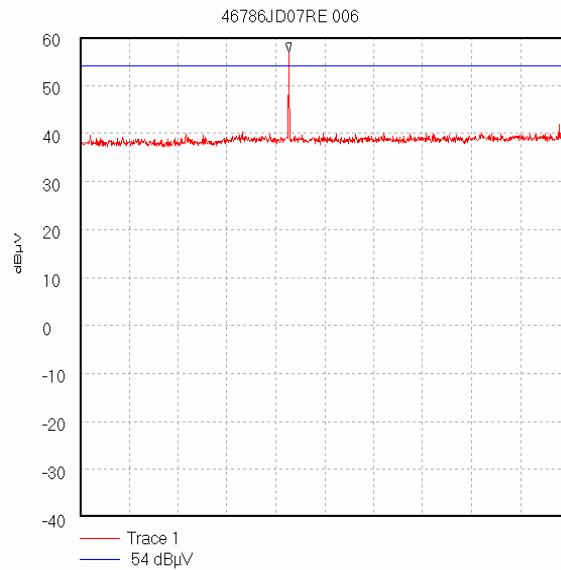
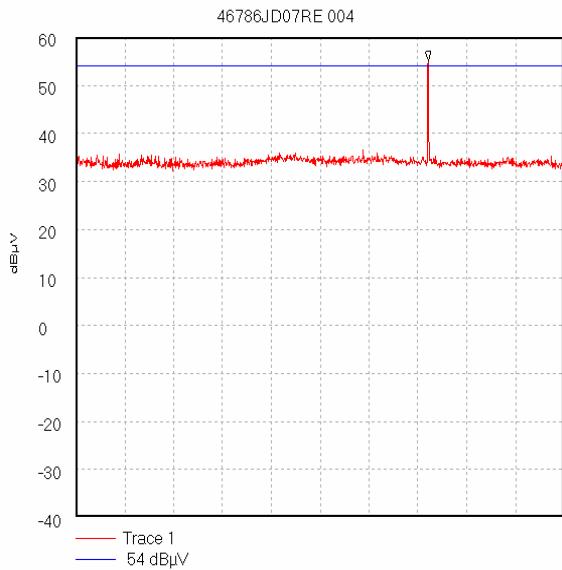


Start 4.0 GHz; Stop 6.0 GHz  
 Ref 60 dB $\mu$ V; Ref Offset 0.0 dB; 10 dB/div  
 RBW 1000.0 kHz; VBW 3.0 MHz; Att 0 dB; Swp 20.0 mS  
 Peak 4.964444 GHz, 60.93 dB $\mu$ V  
 Display Line: 54 dB $\mu$ V; ; Limit Test Failed  
 10/05/2005 18:43:06

*Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

**Test of:** Multi-Tech Systems Inc.  
 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

**Transmitter Radiated Emissions: Section 15.247(d) and 15.209(a) - Electric Field Strength Measurements (Frequency Range: 1 to 25.0 GHz) (Continued)**



*Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.*

**Test of:** Multi-Tech Systems Inc.  
 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

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**7.2.14. Transmitter Band Edge Conducted Emissions: Section 15.247(d)**

The EUT was configured for transmitter conducted emissions measurements as described in section 9 of this report.

Tests were performed to identify the maximum conducted band edge emission levels.

The limit lines shown in the hopping mode plots below are set to a level 20 dB below the measured conducted fundamental peak power of the highest power level contained within the band in a 100 kHz bandwidth.

The limit lines shown in the static mode plots below are set to a level 20 dB below the measured conducted fundamental peak power of the channels closest to the lower and upper band edge in a 100 kHz bandwidth.

**Results:**

**Peak Power Level Hopping Mode:**

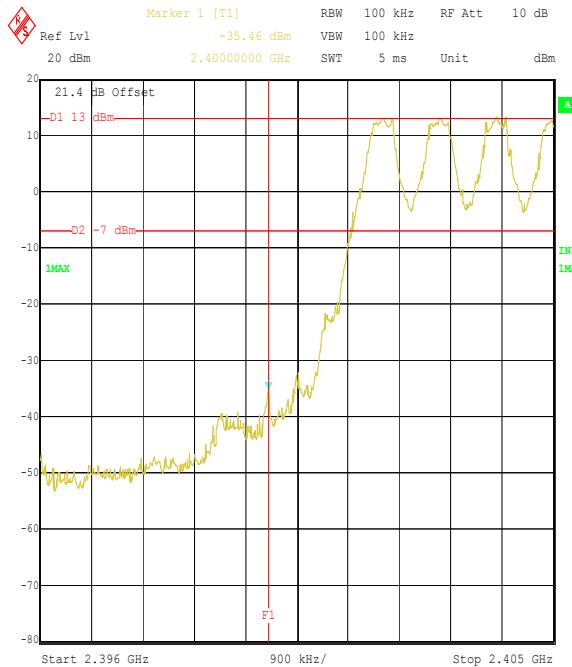
Frequency (MHz)	Peak Emission Level (dBm)	Peak Emission Level (dBc)	Limit (dBc)	Margin (dB)	Result
2400	-35.5	-48.5	-20.0	28.5	Complied
2483.5	-46.1	-59.6	-20.0	39.6	Complied

**Peak Power Level Static Mode:**

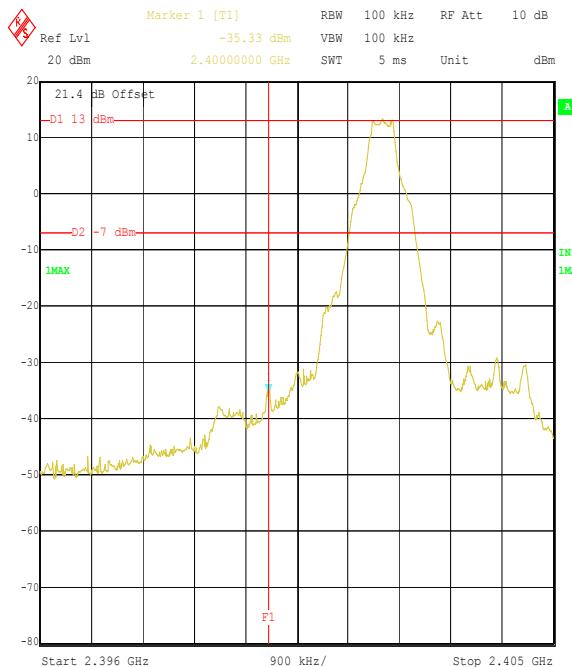
Frequency (MHz)	Peak Emission Level (dBm)	Peak Emission Level (dBc)	Limit (dBc)	Margin (dB)	Result
2400	-35.3	-43.3	-20.0	28.3	Complied
2483.5	-47.7	-61.2	-20.0	41.2	Complied

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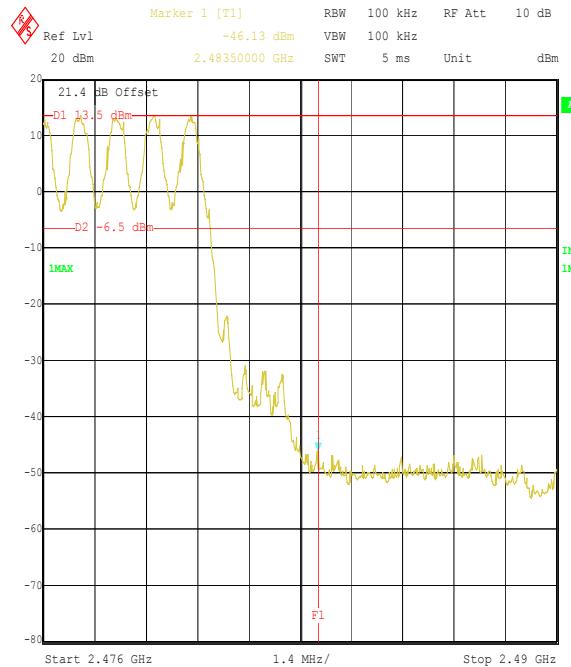
**Transmitter Band Edge Conducted Emissions: Section 15.247(d) (Continued)**



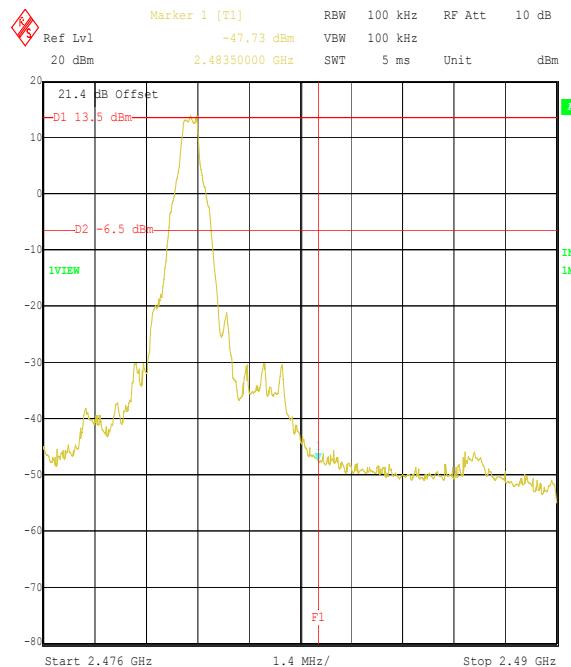
Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Band Edge  
 Comment A: 46786JD07 Hopping on All Channels (Conducted)  
 Date: 9.MAY.2005 20:49:25



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Band Edge  
 Comment A: 46786JD07 Bottom Channel (Conducted)  
 Date: 9.MAY.2005 20:46:17



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Band Edge  
 Comment A: 46786JD07 Hopping on All Channels (Conducted)  
 Date: 9.MAY.2005 20:52:50



Title: MultiTech EUT:Bluetooth Socket Modem. 15.247 Band Edge  
 Comment A: 46786JD07 Top Channel (Conducted)  
 Date: 9.MAY.2005 20:54:06

**Test of:** **Multi-Tech Systems Inc.**  
**MTS2BTSMI Transceiver**  
**To:** **FCC Part 15.247: 2004 (Subpart C)**

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## **8. Measurement Uncertainty**

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently, the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor, such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

<b>Measurement Type</b>	<b>Range</b>	<b>Confidence Level (%)</b>	<b>Calculated Uncertainty</b>
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±3.25 dB
Transmitter Maximum Peak Output Power	Not applicable	95%	±0.46 dB
Conducted Emissions Antenna Port	30 MHz to 40 GHz	95%	±1.2 dB
Transmitter Carrier Frequency Separation	Not applicable	95%	±0.01 ppm
Transmitter Average Time of Occupancy	Not applicable	95%	±10 %
20 dB Bandwidth	Not applicable	95%	± 0.12 %
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	± 5.26 dB
Radiated Spurious Emissions	1 GHz to 40 GHz	95%	±3.03 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty, the published guidance of the appropriate accreditation body is followed.

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 MTS2BTSMI Transceiver  
**To:** FCC Part 15.247: 2004 (Subpart C)

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## **9. Measurement Methods**

### **9.1. AC Mains Conducted Emissions**

AC mains conducted emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

The test was performed in a shielded enclosure with the equipment arranged as detailed in the standard on a wooden bench using the floor of the screened enclosure as the ground reference plane. The EUT was powered with 110V 60 Hz ac mains supplied via a line impedance stabilisation network (LISN).

Initial measurements in the form of swept scans covering the entire measurement band were performed in order to identify frequencies on which the EUT was generating interference. In order to minimise the time taken for these swept measurements, a peak detector was used in conjunction with the appropriate detector IF measuring bandwidths (see table below). Repetitive scans were performed to allow for emissions with low repetition rates, and the duty cycle of the EUT. The test configuration was the same for the initial scans as for the final measurements.

Following the initial scans, a graph was produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. A tolerance line was set 6 dB below the specification limit and levels above the tolerance line were re-tested (at individual frequencies) using the appropriate detector function.

The test equipment settings for conducted emissions measurements were as follows:

<b>Receiver Function</b>	<b>Initial Scan</b>	<b>Final Measurements</b>
Detector Type:	Peak	Quasi-Peak (CISPR)/Average
Mode:	Max Hold	Not applicable
Bandwidth:	10 kHz	9 kHz
Amplitude Range:	60 dB	20 dB
Measurement Time:	Not applicable	>1 s
Observation Time:	Not applicable	>15 s
Step Size:	Continuous sweep	Not applicable
Sweep Time:	Coupled	Not applicable

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## **9.2. Radiated Emissions**

Radiated emissions measurements were performed in accordance with the standard, against appropriate limits for each detector function.

Initial measurements covering the entire measurement band in the form of swept scans in a shielded enclosure were performed in order to identify frequencies on which the EUT was generating interference. This determined the frequencies on which the EUT should be re-measured in full on the open area test site. In order to minimise the time taken for the swept measurements, a peak detector was used in conjunction with the appropriate detector IF measuring bandwidth (see table below). Repetitive scans were performed to allow for emissions with low repetition rates.

The initial scans were performed using an antenna height of 1.5 m and a measurement distance of 3 m. Following the initial scans, graphs were produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. Any emission within 20 dB of the limit were then measured on the open area test site, except in cases where the noise floor was within 20 dB of the limit, in these cases the highest point of the noise floor was measured.

Where an emission fell inside a restricted band, measurements were made at the appropriate test distance using a measuring receiver with a quasi peak detector for measurements below 1000 MHz and an average and peak detector for measurements above 1000 MHz. A peak detector was used for all other measurements.

For the final measurements the EUT was arranged on a non-conducting turn table on a standard test site compliant with ANSI C63.4 – 2003 Clause 5.4.

All measurements on the open area test site were performed using broadband antennas in both vertical and horizontal polarisations.

On the open area test site, at each frequency where a signal was to be measured, the trace was maximised by rotating a turntable through 360°. The angle at which the maximum signal was observed was locked out. For frequencies below 1000 MHz the test antenna was varied in height between 1 m and 4 m in order to further maximise the target emission.

For frequencies above 1000 MHz where a horn antenna was used, height searching was performed to locate the optimal height of the horn with respect to the EUT. At this point the horn was locked off and the turntable was again rotated through 360° to maximise the target signal. It should be noted that the received signal from the EUT would diminish very quickly after it exits the beam width of the horn antenna, for this reason it may not be necessary to fully height search with the horns.

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**Radiated Emissions (Continued)**

At this point, any signals found to be between the limit and a level 6 dB below it were further maximised by changing the configuration of the EUT, e.g. re-routing cables to peripherals and moving peripherals with respect to the EUT.

Scans were performed to the upper frequency limits as stated in section 15.33

The final field strength was determined as the indicated level in dB $\mu$ V plus cable loss and antenna factor.

The test equipment settings for radiated emissions measurements were as follows:

Receiver Function	Initial Scan	Final Measurements <1 GHz	Final Measurements $\geq$ 1 GHz
Detector Type:	Peak	Quasi-Peak (CISPR)	Peak / Average
Mode:	Max Hold	Not applicable	Max Hold
Bandwidth:	(120 kHz <1 GHz) (1 MHz $\geq$ 1 GHz)	120 kHz	1 MHz
Amplitude Range:	100 dB	100 dB	100 dB
Step Size:	Continuous sweep	Not applicable	Not applicable
Sweep Time:	Coupled	Not applicable	Not applicable

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### **9.3. Conducted Antenna Port Emissions**

Conducted antenna port emissions measurements were performed using a 100 kHz bandwidth in accordance with the standard against the appropriate limits.

Prior to testing being performed a suitable RF attenuator and cable, were calibrated for the required frequency range. For each measurement range the calibrated level of the attenuator and cable were entered as an offset into the spectrum analyser to compensate for the losses in the measurement set up.

Initial measurements covering the entire measurement band in the form of swept scans were performed in order to identify frequencies on which the EUT was generating interference. This determined the frequencies on which final measurements were necessary. To make the final measurements a peak detector was used in conjunction with the appropriate detector IF measuring bandwidth.

Repetitive scans were performed to allow for emissions with low repetition rates.

Scans were performed to the upper frequency limits as stated in 15.33(a)(1)

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#### **9.4. Carrier Frequency Separation / 20 dB Bandwidth**

The EUT and spectrum analyser was configured as for conducted antenna port measurements, and as per FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

To determine the bandwidth and separation of each transmission channel the measurement analyser was configured to measure two adjacent channels whilst the EUT was in hopping mode. The spectrum analyser was configured with a resolution bandwidth and video bandwidth greater than 1% of the frequency span.

The analyser was set for a maximum hold scan to capture the profile of the signal. The peak points on the two adjacent channels were noted and the separation between them recorded.

To determine the occupied bandwidth, a resolution bandwidth of 10 kHz was used, which is greater than 1% of the 20 dB bandwidth. A video bandwidth of, at least, the same value was used.

The analyser was set for a maximum hold scan to capture the profile of the signal. The peak level was then determined, and a reference line was drawn 20 dB below the peak level.

The bandwidth was determined at the points where the 20 dB reference line intercepted the power envelope of the emission.

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### **9.5. Average Time of Occupancy**

The EUT and spectrum analyser was configured as for conducted antenna port measurements, and as per FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

First the maximum packet length was determined on the centre channel.

The measurement analyser was configured to the time domain mode by setting the span to zero with a sweep time sufficiently wide enough to measure one pulse.

The EUT was configured to operate in normal mode of operation. The pulse width of one transmission was then recorded. The measurement analyser was then configured in zero span i.e. in the time domain and the sweep time was set to 32 seconds (the closest allowable setting to 31.6 seconds). This 31.6 second period was determined by multiplying the number of channels the device operates over (79) by 0.4 seconds.

The number of transmissions within this period was noted and multiplied by the pulse width recorded earlier. This gives the maximum occupancy over 31.6 seconds.

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### **9.6. Peak Output Power**

The EUT and spectrum analyser were configured as for conducted antenna port measurements and as per FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

Prior to testing being performed a suitable RF attenuator and cable, were calibrated for the required frequencies. For each frequency to be measured, the calibrated level of the attenuator and cable were entered as an offset into a spectrum analyser to compensate for the measurement set up.

To determine the transmitter output power, the EUT was operated at maximum power and a result was obtained from the spectrum analyser using peak detector and trace max hold.

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### **9.7. Effective Isotropic Radiated Power (EIRP)**

EIRP measurements were performed in accordance with the standard, against appropriate limits.

The EIRP was measured with the EUT arranged on a non-conducting turn table on a standard test site compliant with ANSI C63.4 – 2003 Clause 5.4. The transmitter was fitted with an integral antenna; therefore all radiated tests were performed with the unit operating into the integral antenna.

The level of the EIRP was measured using a spectrum analyser.

The test antenna was positioned in the horizontal plane. The EUT was oriented in the X plane. The test antenna was then raised and lowered until a maximum peak was observed. The turntable was then rotated through 360 degrees and the maximum peak reading obtained. The height search was then repeated to take into consideration the new angular position of the turntable. The maximum reading observed was then recorded. This procedure was then repeated with the EUT oriented in the Y and Z planes. The highest reading taken in all 3 planes was recorded. The entire procedure was then repeated with the test antenna set in the vertical polarity.

Once the final amplitude (maximised) had been obtained, the EUT was substituted with a horn antenna. The centre of the substitution antenna was set to approximately the same centre location as the EUT. The substitution antenna was set to the horizontal polarity. The substitution antenna was matched into a signal generator using a 6 dB or greater attenuator. The signal generator was tuned to the EUT's frequency under test.

The test antenna was then raised and lowered to obtain a maximum reading on the spectrum analyser. The level of the signal generator output was then adjusted until the maximum recorded EUT level was observed. The signal generator level was noted. This procedure was repeated with both test antenna and substitution antenna vertically polarised. The EIRP was calculated as:-

$$\text{EIRP} = \text{Signal Generator Level} - \text{Cable Loss} + \text{Antenna Gain}$$

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**Effective Isotropic Radiated Power (EIRP) (Continued)**

Circumstances where the signal generator could not produce the desired a power substitution was performed with the signal generator set to 0 dBm. The radiated signal was maximised as previously described. The level indicated on the measuring receiver was noted. The delta between this level and the maximum level for the EUT was calculated and also noted. The EIRP of the signal generator was calculated using the above formulae. The recorded delta was added to the calculated EIRP to obtain the substituted EUT EIRP.

Delta (dB) = EUT – SG

where :

EUT = spectrum analyser indicated EUT raw level

SG = spectrum analyser indicated signal generator raw level

The signal generator actual EIRP is calculated as:

EIRP SG= Signal Generator Level - Cable Loss + Antenna Gain

The EUT EIRP is calculated as:

EIRP EUT = EIRP SG + Delta.

The test equipment settings for EIRP measurements were as follows:

Receiver Function	Setting
Detector Type:	Peak
Mode:	Not applicable
Bandwidth:	1 MHz
Amplitude Range:	100 dB
Sweep Time:	Coupled

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### **9.8. Band Edge Compliance of RF Radiated Emissions**

The EUT and spectrum analyser were configured as for radiated measurements and as per FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

To determine band edge compliance, the analyser resolution bandwidth was set to  $\geq 1\%$  of the analyser span. The video bandwidth was set to be  $\geq$  to the resolution bandwidth. The sweep was set to auto and the detector to peak. The trace was set to max hold and a trace was produced.

A plot of the lower band edge of the allocated frequency band was produced. A marker was set to the level of the highest in band emission with a limit line set to 20 dB below this. The marker was then placed on the highest out of band emission (the specification states that either the band edge level must be measured or the highest out of band emission, whichever is the greater). The plots show that the highest out of band emission complies with the -20 dBc limit.

The above procedure was then repeated for the upper band edge except that, as the upper band edge fell on a restricted band edge (as defined in section 15.205(a)), the limit for the restricted band was applied instead of the -20 dBc limit i.e. the general limits defined in section 15.209(a).

Final measurements were performed on the worst-case configuration as described in Part 15.31(i).

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## **Appendix 1. Test Equipment Used**

RFI No.	Instrument	Manufacturer	Type No.	Serial No.
A028	Horn Antenna	Eaton	91888-2	304
A031	2 to 4 GHz Eaton Horn Antenna	Eaton	91889-2	557
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002
A1361	ESH3-Z2 Pulse Limiter	Rohde & Schwarz	ESH3-Z2	A1361-20112003
A1362	Eaton	Stoddart Aircraft Radio Co., Inc.	91889-1	N/A
A1392	HUBER + SUHNER AG	HUBER + SUHNER AG	757456	6820.17.B
A201	WG 20 Horn Antenna	Flann Microwave Ltd	20240-20	266
A253	WG 12 Microwave Horn	Flann Microwave	12240-20	128
A254	WG 14 Microwave Horn	Flann Microwave	14240-20	139
A259	Bilog Antenna	Chase	CBL6111	1513
A288	Bilog Antenna	Chase	CBL6111A	1589
A427	WG 14 horn	Flann	14240-20	150
A428	WG 12 horn	Flann	12240-20	134
A429	WG 16 horn	Flann	16240-20	561
A430	WG 18 horn	Flann	18240-20	425
A458	HP RF Limiter	Hewlett Packard	11867A	04421
C323	Cable	Rosenberger	UFA 210A-1-0788-50x50	96A0121
C347	Cable	Rosenberger	UFA210A-1-1181-70x70	3007
C363	BNC Cable	Rosenberger	RG142	None

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**Test Equipment Used (Continued)**

RFI No.	Instrument	Manufacturer	Type No.	Serial No.
C374	Cable	Rosenberger	RG400	None
C499	Cable	Rosenberger	FA210A1020M 30309	001
C565	C565-N-3	Rosenberger	UFA 210A-1- 1181-70x70	96 L 0703
C573	C573-N-N-2	Rosenberger	UFA210A-1- 788-50x50	97E0936
G085	Generator	Hewlett Packard	83650L	3614A00104
M003	Spectrum Monitor	Rohde & Schwarz	EZM	883 580/008
M044	ESVP Receiver	Rohde & Schwarz	ESVP	891 845/026
M069	ESMI Spectrum Analyser / Receiver	Rohde & Schwarz	ESMI	829 808/007 (DU) / 827 063/008 (RU)
M1124	Rohde & Schwarz	Rohde & Schwarz	ESIB26	100046K
M128	Fluke 76 DVM	Fluke	76	65340273
M281	Power Meter	Hewlett Packard	E4418A (EPM441A)	GB37170210-01
M283	Power Sensor	Hewlett Packard	8487A	3318A03241
M505	Analyser Display Unit	Rohde & Schwarz	ESAI-D	825316/010
M506	RF unit	Rohde & Schwarz	ESBI-RF	827060/004
S011	D.C. PSU	INSTEK	PR-3010H	9401270
S201	Site 1	RFI	1	
S202	Site 2	RFI	2	S202-15011990
S209	Site 9	RFI	9	

**NB** In accordance with UKAS requirements, all the measurement equipment is on a calibration schedule.

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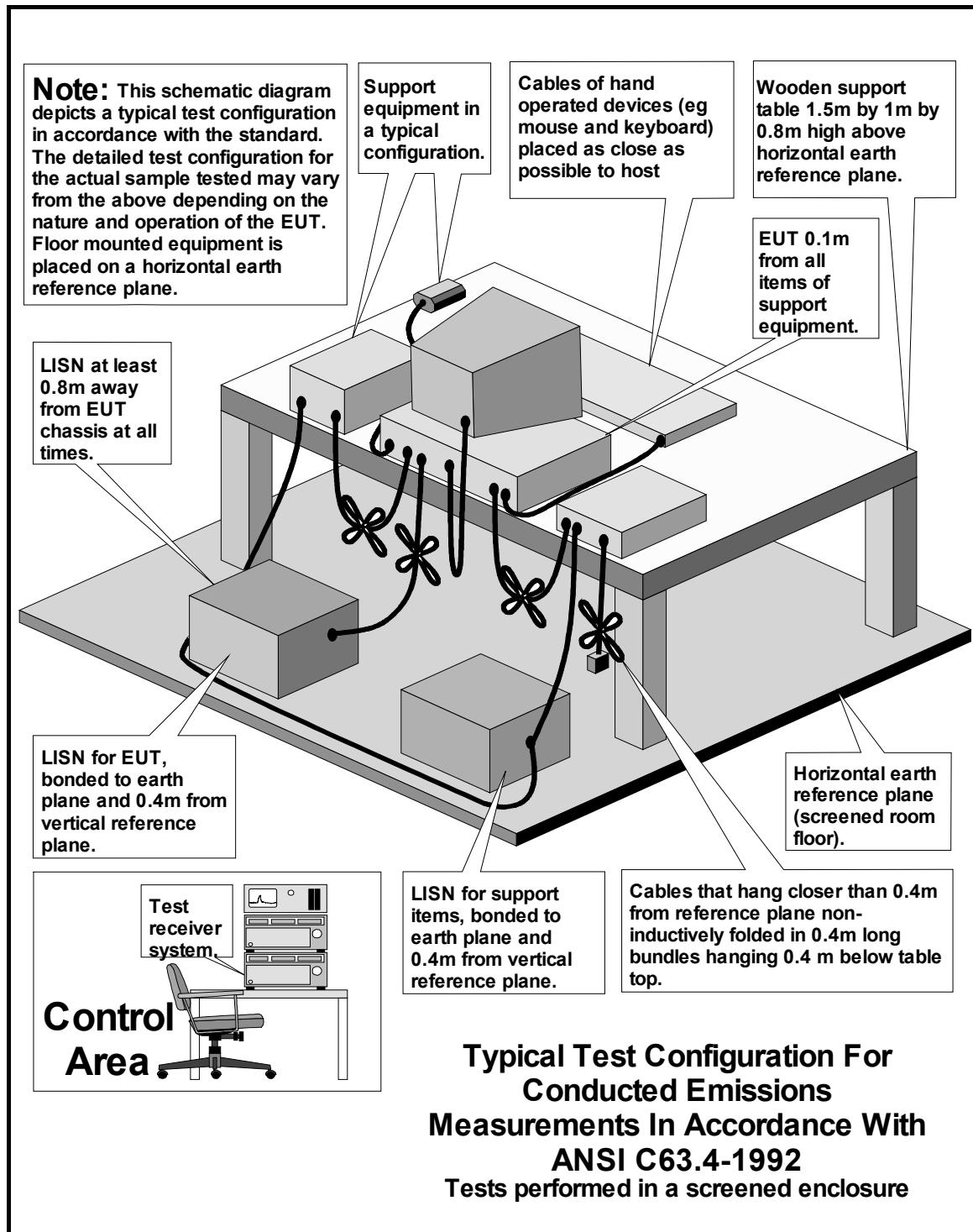
## **Appendix 2. Test Configuration Drawings**

This appendix contains the following drawings:

Drawing Reference Number	Title
DRG\46786JD07\EMICON	Test configuration for measurement of conducted emissions.
DRG\46786JD07\EMIRAD	Test configuration for measurement of radiated emissions.

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DRG\46786JD07\EMICON



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DRG\46786JD07\EMIRAD

