FCC Part 15
(Subpart C – Intentional Radiators)

Test Report

Prepared For:

Hitachi Keiyo Engineering and Systems, Ltd
7chome-1-1 Higashinarashino
Narashino-shi, Chiba-ken
275-0001, Japan

Model:
PC5NR3

Prepared by:

EMCE Engineering, Inc.
44366 S. Grimmer Blvd.
Fremont, CA 94538
USA

CONTENTS

1. CUSTOMER INFORMATION……..…3
2. EUT AND ACCESSORY INFORMATION……..4
   2.1 EUT DESCRIPTION…….4
   2.2 EUT AND ACCESSORIES…….4
   2.3 SOFTWARE…….4
3. SUMMARY OF TEST RESULTS……..5
4. STANDARDS AND MEASUREMENT METHODS…….6
   4.1 SELECTION OF OPERATION MODE FOR TESTS…….6
5. TEST SETUPS……..…6
   5.1 SETUP A (CONDUCTED MEASUREMENTS)……..…….6
      5.1.1 Operational description……6
      5.1.2 Test Set up Photo……7
   5.2 SETUP B (CONDUCTED MEASUREMENTS)……..…….8
      5.2.1 Operational description……8
      5.2.2 Test Setup Photo: Setup B……8
   5.3 SETUP C (POWER OUTPUT)……..9
      5.3.1 Test Condition and Setup…….9
6. TEST RESULTS……..10
   6.1 PEAK OUTPUT POWER (§15.247b1)……10
      6.1.1 EUT operation mode……..…..10
      6.1.2 Limits and results……10
      6.1.3 Screen shots……..11-13
   6.2 POWER DENSITY (FCC REPORT & ORDER97-114)……..14
      6.2.1 Limits and results……14
      6.2.2 Screen Shots……..14-16
   6.3 6dB BANDWIDTH……..……17
      6.3.1 Limits and results……...17
      6.3.2 Screen shots……..17-19
   6.4 BAND-EDGE COMPLIANCE OF RF RADIATED EMISSIONS (§15.247c1)……..19
      6.4.1 EUT operation mode……..19
      6.4.2 Limits and results……..20
      6.4.3 Screen Shots……. 20-21
   6.5 RESTRICTED BAND RADIATED EMISSIONS (§15.247c)……22
      6.5.1 EUT operation mode……22
      6.5.2 Limits and results……..22
      6.5.3 Screen Shots……. 22-23
   6.6 SPURIOUS RADIATED EMISSIONS (§15.247c)……24
      6.6.1 Screen Shots……..24-28
      6.6.2 Line Conducted Measurement Procedure……29
      6.6.3 Radiated Measurement Procedure……29-30
      6.6.4 EUT operation mode……..31
      6.6.5 Emission Measurement Data 30MHz-1GHz ……32
      6.6.6 Line Conducted Measurement Data……33
7. TEST EQUIPMENT……..34

1 CUSTOMER INFORMATION

Test Laboratory: FCC registration number	EMCE Engineering 44366 S. Grimmer Blvd. Fremont, CA 94538 USA Tel: 510-490-4307 Fax: 510-490-3441 bob@universalcompliance.com 0007-1981-20
Customer:	Hitachi Keiyo Engineering and Systems, Ltd 7chome-1-1 Higashinarashino Narashino-shi, Chiba-ken Japan Tel: 408-970-7706 Fax: 408-327-3422
Contact Person:	Sam law
Receipt of EUT:	6/5/03
Test plan reference:	FCC Part 2, 15 (15.247)
Date of testing:	6/5/03-6/10/03
Date of Report:	7/2/03

The tests listed in this report have been done to demonstrate compliance to the CFR 47 Section 15.247.

Contents approved:

Name: Bob Cole Title: President	Name Title

2 EUT AND ACCESSORY INFORMATION

2.1 EUT description

The EUT is a Hitachi PC5NR3 Tablet Computer utilizing an Agere 802.11B Wireless LAN Card.

Equipment Type	Tablet PC with Wireless LAN Transceiver
Frequency Band	2400-2483.5 MHz
Frequency Operation	2412-2462 MHz
Type of Modulation	CCK, DBPSK, DQPSK
Channel Spacing	5 MHz
Emission Designation	
Channel Access Protocol	
Mode of Operation	Simplex
Antenna Type	Board mounted (soldered)
Antenna Connector Type	See separate exhibit
Reference Standard (Radio)	802.11B
Method of Frequency Generation	Crystal and Synthesizer

2.2 EUT and accessories

The table below lists all EUTs and accessories used in the tests.

2.3 Software

The computers were equipped with test software provided by the customer. The software was used to control the EUT in the tests.

	Name	Type	S/N	Number
EUT	PC5NR3	Tablet Computer with 802.11B Wireless LAN Card	T317-000071	E0001
Accessories				
Software	Agere	Wireless Client Manager	N/A	N/A

3 SUMMARY OF TEST RESULTS

	Section in CFR 47	Results
15.245 (b)(1)	Peak output power (Radiated Emissions)	PASSED
R&O 97-114	Power Density	PASSED
15.247 (a)(2)	6 dB Bandwidth	PASSED
15.247, c	Band-edge compliance of RF Radiated emissions	PASSED
15.247, (4)(c)	Restricted Band (Radiated Emissions)	PASSED
15.247,c	Spurious radiated emissions	PASSED

PASS The EUT passed that particular test.
FAIL The EUT failed that particular test.

4 STANDARDS AND MEASUREMENT METHODS

The tests were performed in guidance of CFR 47 section 15.247, FCC Public Notice DA 00-705 (March 30, 2000), FCC Report & Order 97-114 (April 10, 1997),and ANSI C63.4 (1992). Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method". For the test equipment, see device list in the end of this test.

4.1 Selection of operation mode for tests

Before tests, several operation modes, and modulation patterns were tried. The worst case, 11 MB/s, was selected for each test and those results reported.

5 TEST SETUPS

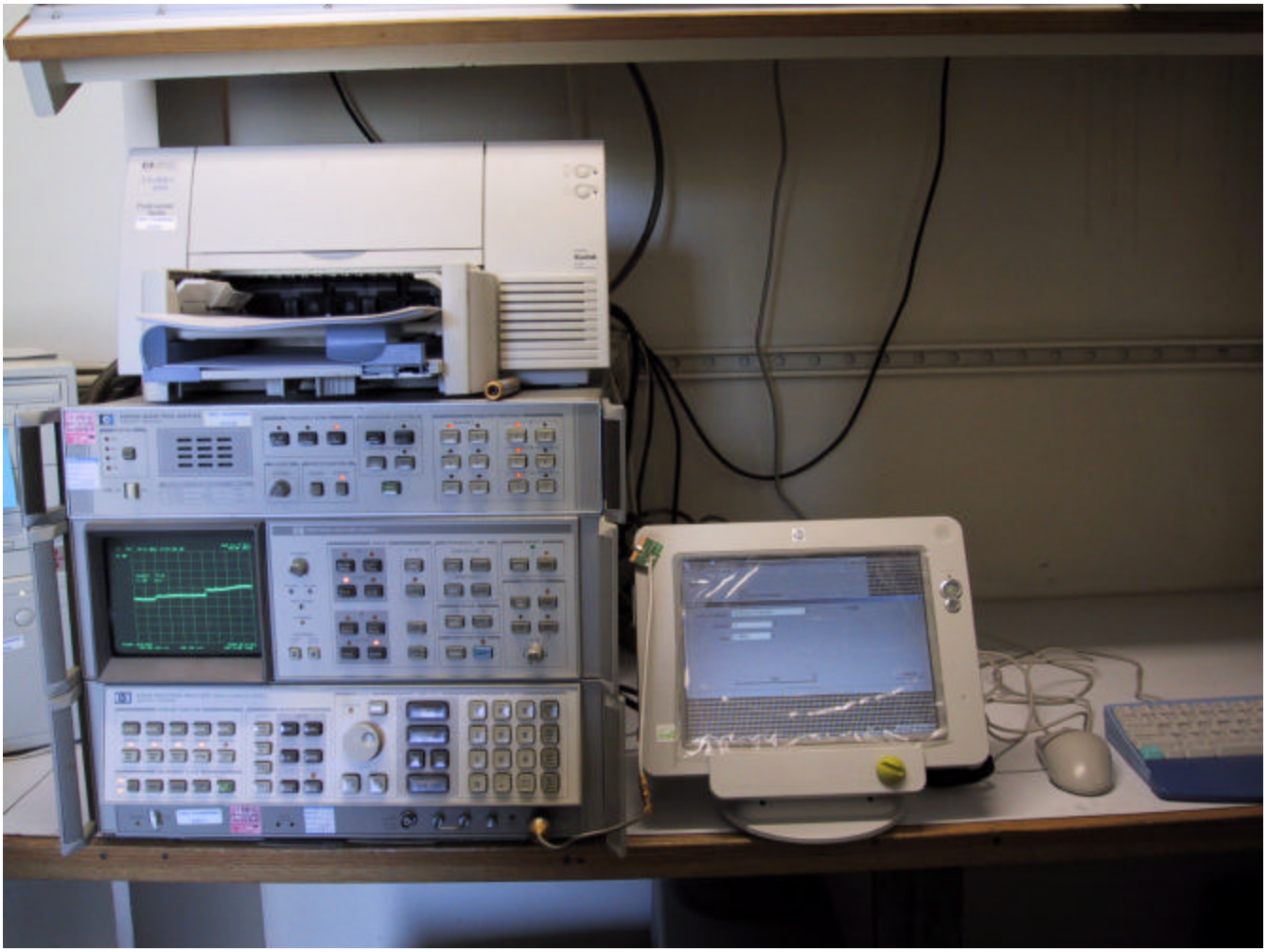
To fulfill all requirements for the testing, total of two different test setups were used. One EUT was used, unmodified for radiated tests and for conductive measurements.

5.1 Setup A (conducted measurements, Inquiry Mode)

5.1.1 Operational description

- This setup was used in conducted measurements with EUT performing the INQUIRY function. The EUT was connected to the Laptop Computer through the serial port (COM1), the antenna bypassed and the SMA Cable connected to the Spectrum Analyzer. This setup was used for the ***Power Density, Peak Power Output, 6 dB Bandwidth, Band-edge Compliance, and Restricted Band*** measurements.

5.1.2 Test Setup Photo, Setup A (conducted measurements)

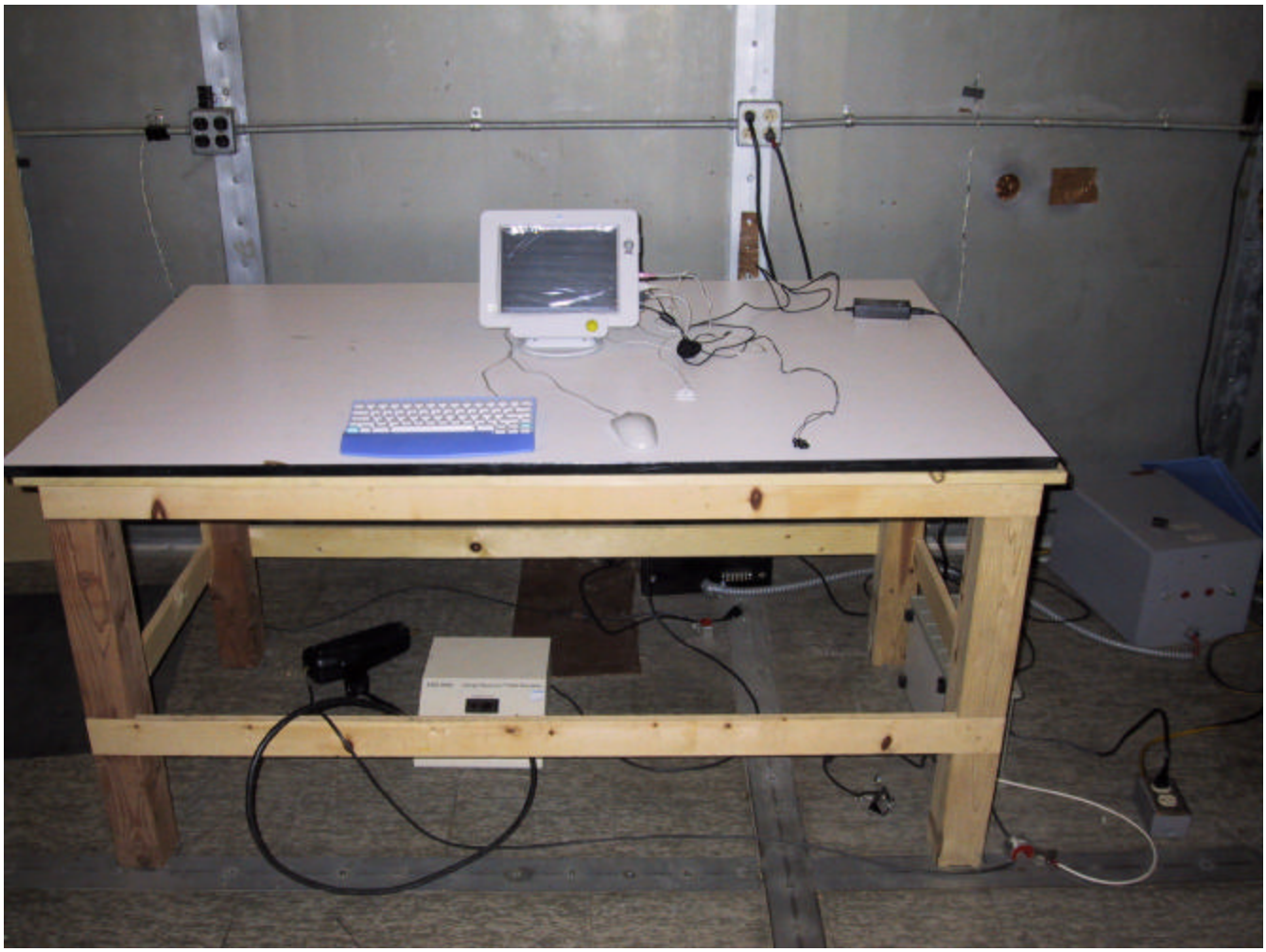


5.2 Setup B (Line Conducted measurements)

5.2.1 Operational description

This setup was used in radiated measurements. THIS SETUP USED FOR ***Line Conducted Emissions***

5.2.2 Test Setup Photo, (Line Conducted measurements)

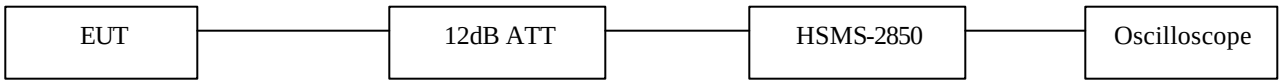


5.3 Setup C (Power Output)

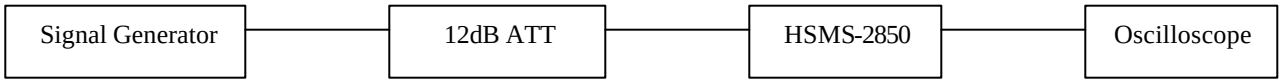
5.3.1 Test Condition and Setup

This setup is used for ***Peak Power*** Measurements.

A:



B:



1. The output of the transmitter thought 12dB attenuator an terminated by Schottkey Detector Diode (Hewlett Packard HSMS-2850)
2. The output of the Schottkey Diode Detector connected to the vertical channel of an oscilloscope. The observed trace of the oscilloscope shall be recorded as “a”.
3. The combination of the diode detector and the oscilloscope capable of faithfully reproducing the envelop peaks and the duty cycle of the transmitter and output signal.
4. The transmitter replaced by the signal generator. The output frequency of the signal made equal to the center of the frequency range occupied by the transmitter and unmodulated.
5. The output of the signal generator raised to reach the peak of trace “A” named X.
6. The signal generator output level X(mW) is the transmitter output peak power. Recording the following.

6 TEST RESULTS

The measurement results were adjusted with the attenuation of the cable between the LISN and receiver.

6.1 Peak Output Power [CFR 47, 15.247(b)(1)]

EUT	Hitachi PC5NR3
Test setup	C (conducted)
Temp, Humidity, Air Pressure	56º F, 29.96
Date of Measurement	6/9/03
Measured by	Bob Cole
Result	PASSED

6.1.1 EUT operation mode

EUT operation mode	Data Rate –11MB/s
EUT channel	1, 6, 11
EUT TX power level	Nominal
Operation voltage	3.3 VDC

6.1.2 Limits and results

Peak output power

EUT Channel	Limit (dBm)	Test results (dBm)
1	</= 30.0	13.4
6	</= 30.0	13.9
11	</= 30.0	15.3

Note: dBm to dBuV conversion is 0 dBm = 107 dBuV

6.1.3 Screen shots

Plot 1: Peak output power 2412 MHz

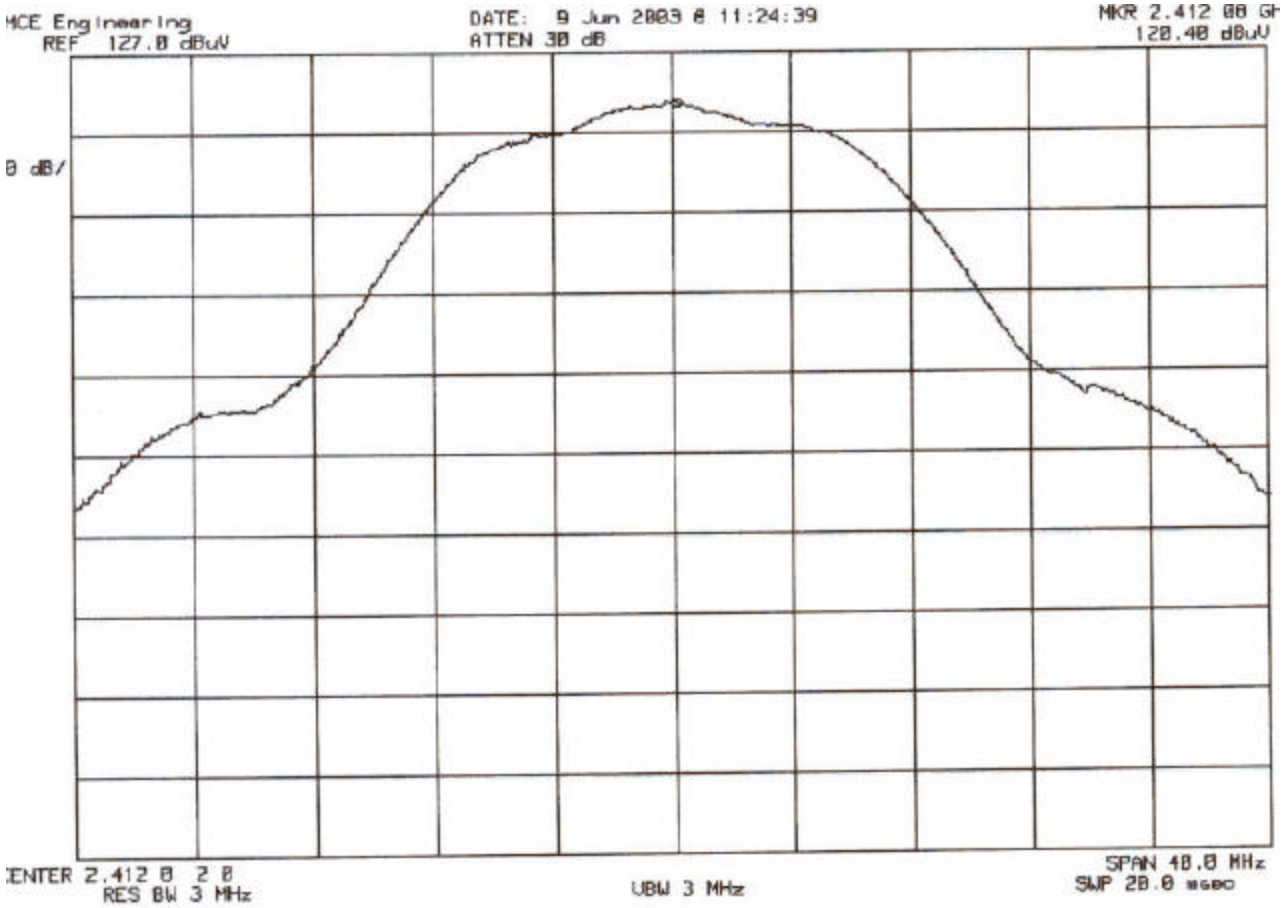


FIGURE PEAK POWER

Plot 2: Peak output power 2437 MHz

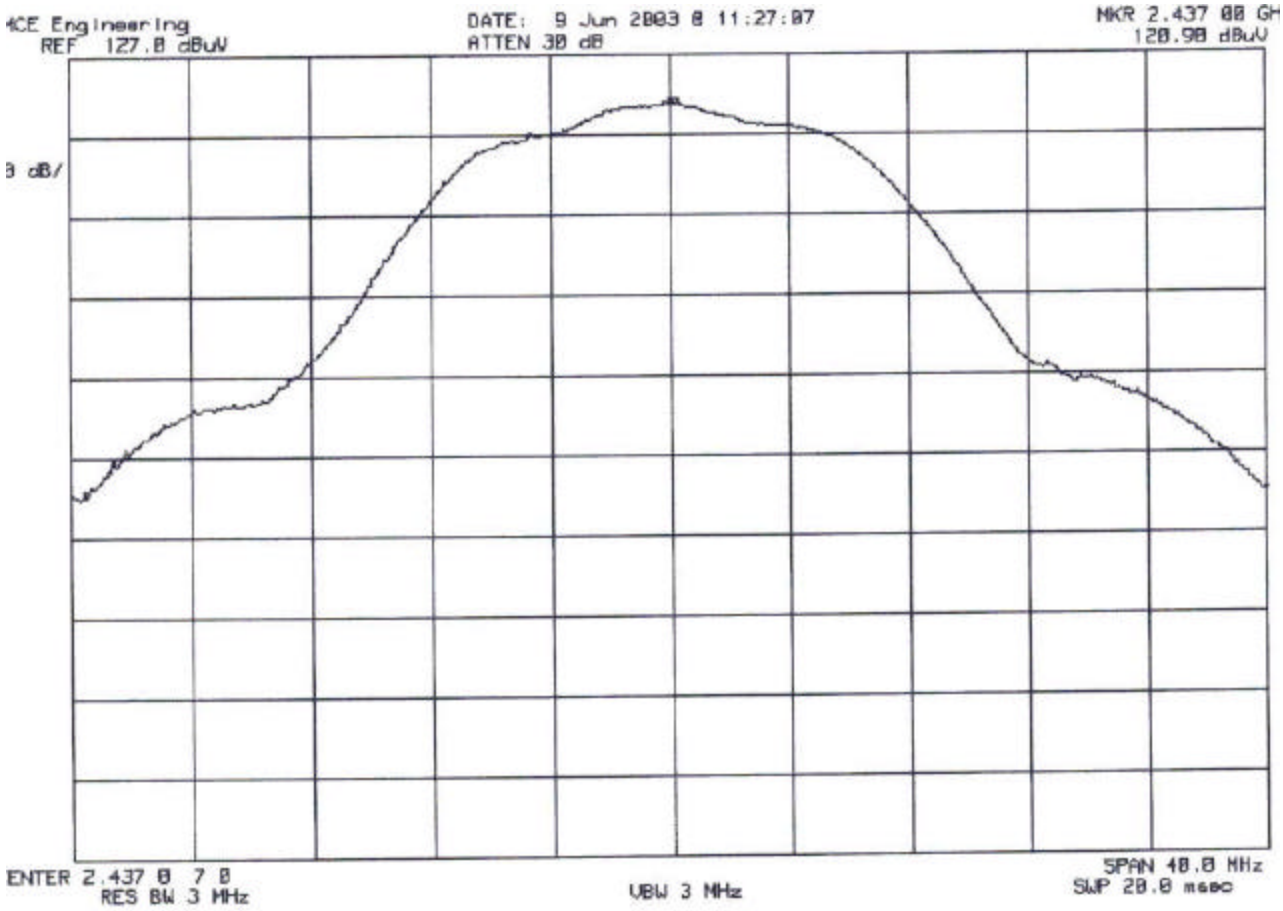


FIGURE PEAK POWER

Plot 3: Peak output power 2462 MHz

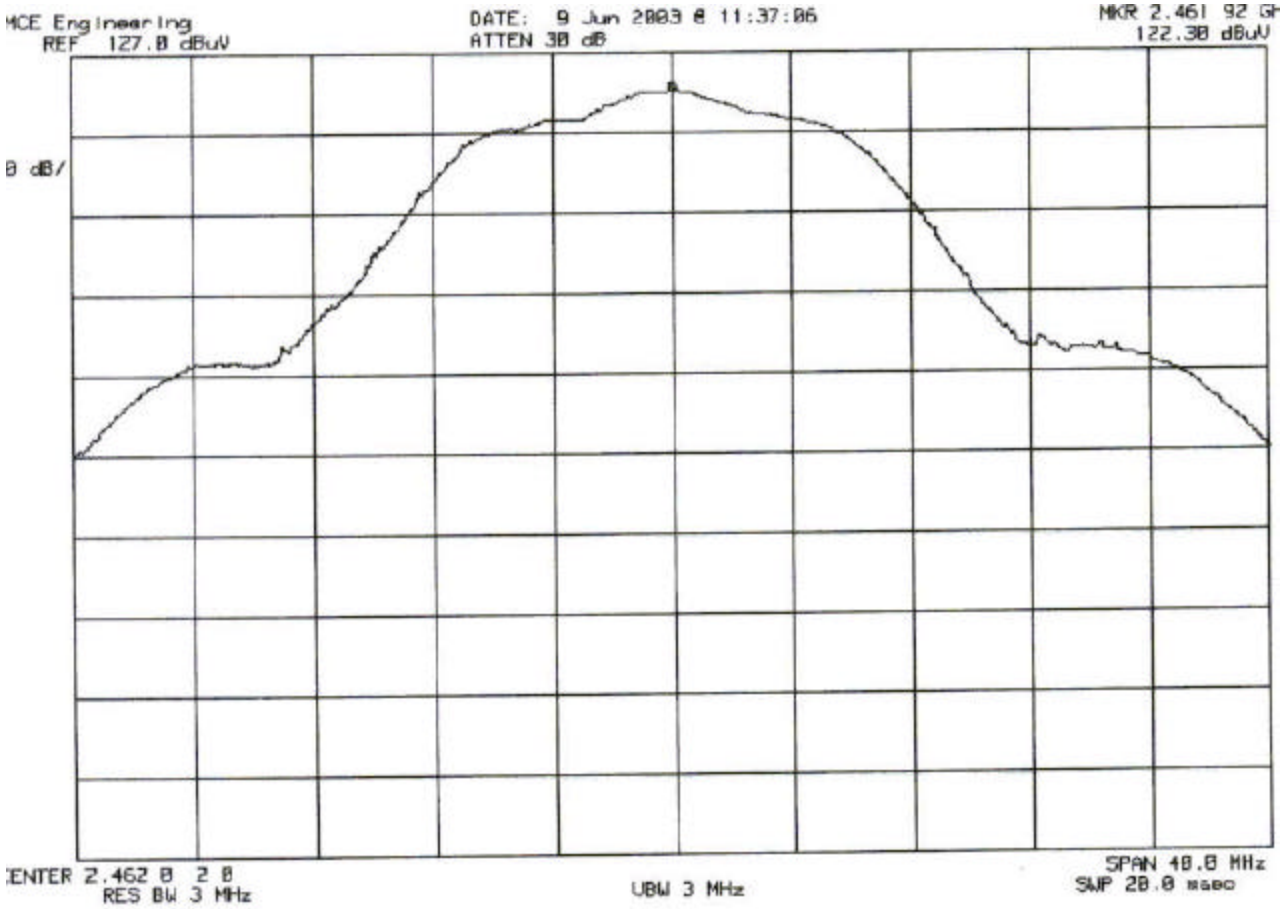


FIGURE PEAK POWER

6.2 Power Density [FCC Report & Order 97-114]

EUT	Hitachi PC5NR3
Test setup	C (conducted)
Temp, Humidity, Air Pressure	56º F, 29.96
Date of Measurement	6/9/03
Measured by	Bob Cole
Result	PASSED

6.2.1 Limits and results

Peak output power

EUT Channel	Limit (dBm/3 kHz)	Test results (dBm)
1	</= 8.0	-14.0
6	</= 8.0	-14.4
11	</= 8.0	-14.6

Note: dBm to dBuV conversion is 0 dBm = 107 dBuV

6.2.2 Screen shots

Plot 4: Power Density 2412 MHz

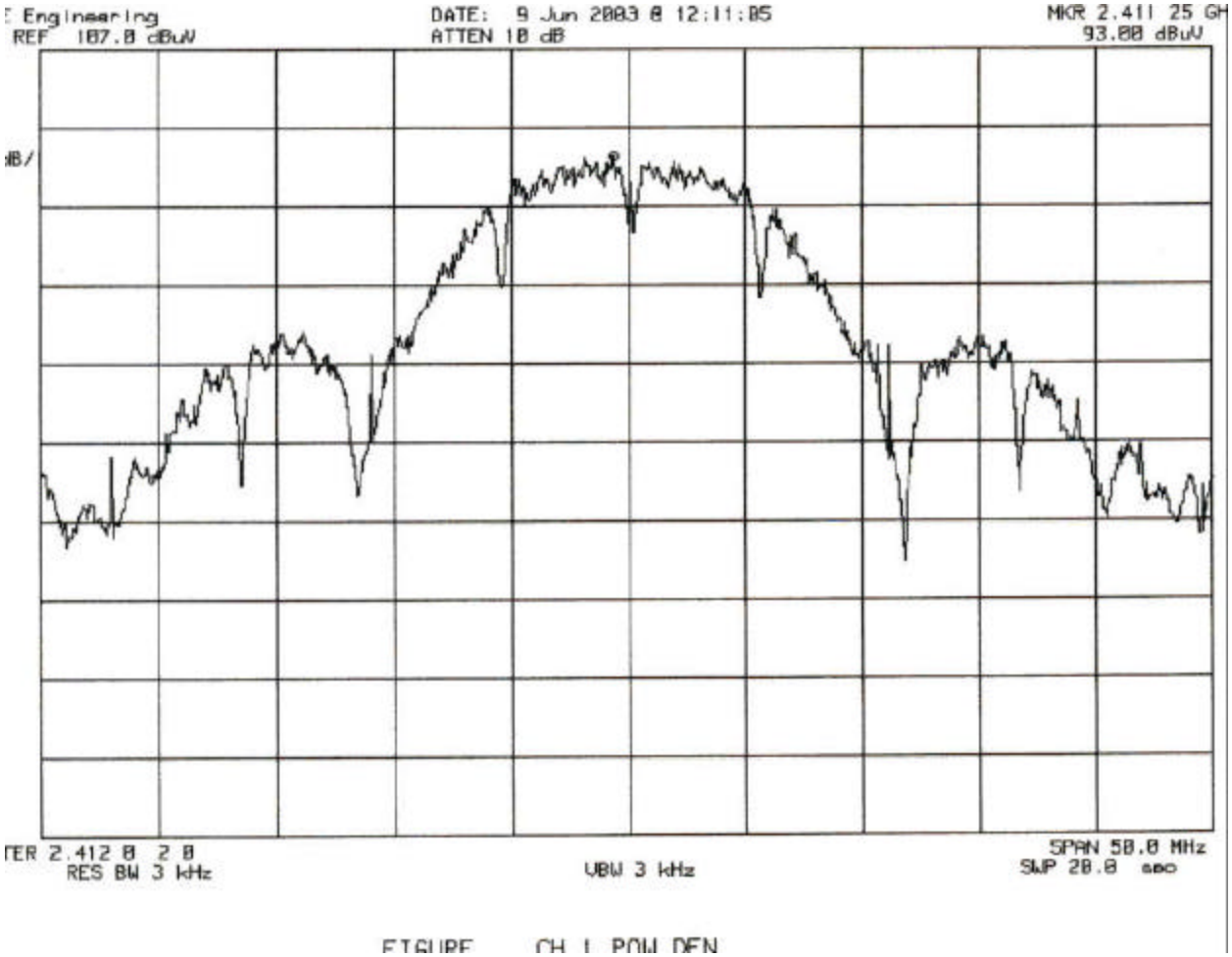
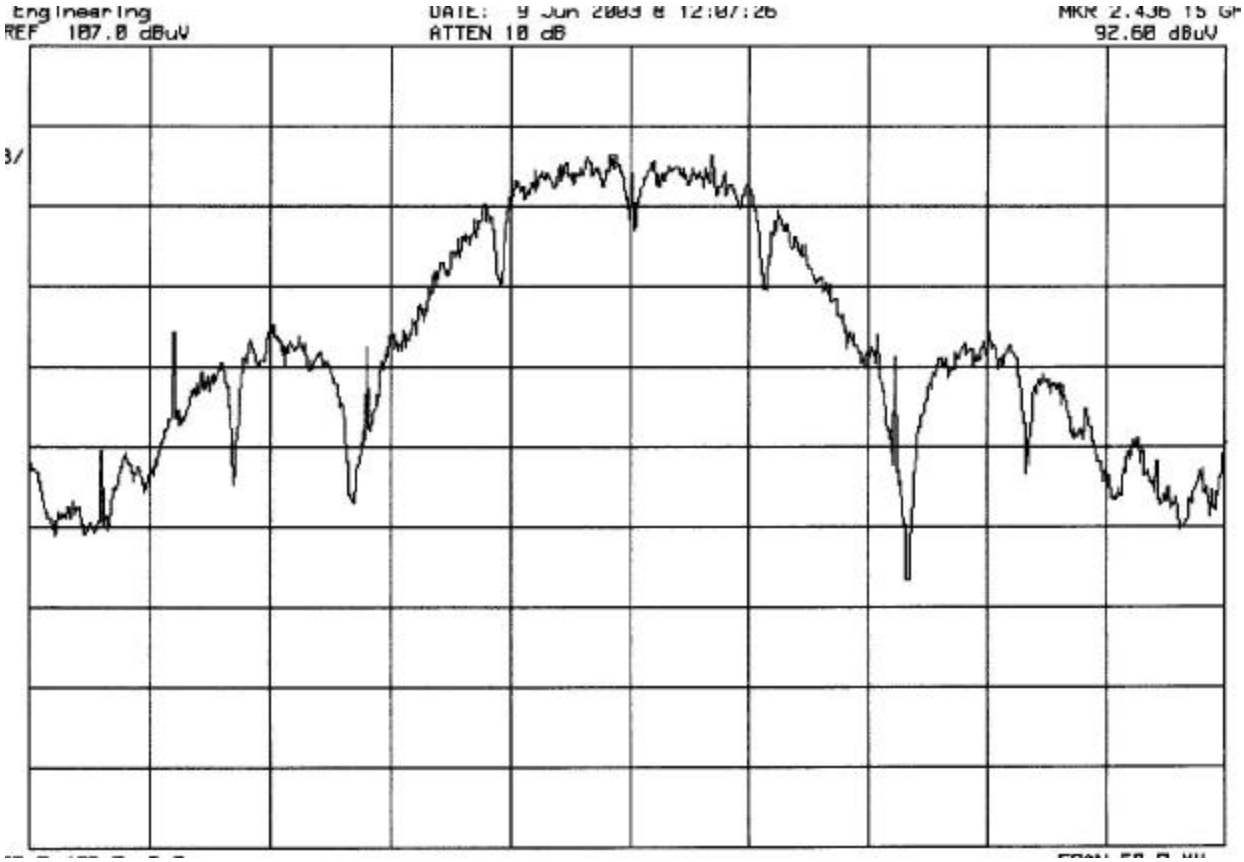


FIGURE CH 1 POW DEN

Plot 5: Power Density 2437 MHz



Plot 6: Power Density 2462 MHz

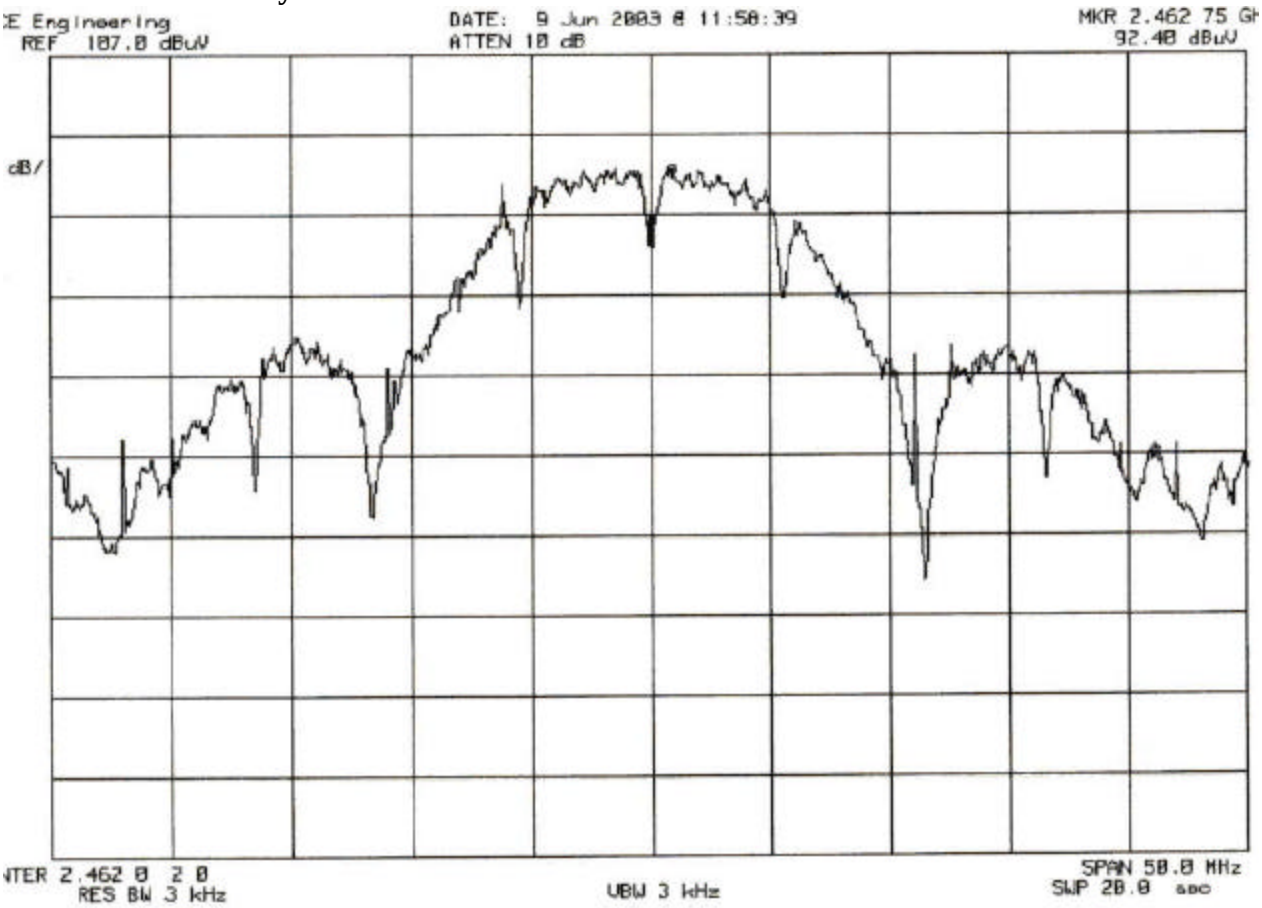


FIGURE CH11 POW DEN

6.3 6 dB Bandwidth

EUT	Hitachi PC5NR3
Test setup	C (conducted)
Temp, Humidity, Air Pressure	56º F, 29.96
Date of Measurement	6/9/03
Measured by	Bob Cole
Result	PASSED

6.3.1 Limits and Results

EUT Channel	Limit (kHz)	Test results (kHz)
1	>/= 500	1034
6	>/= 500	1008
11	>/= 500	1020

6.3.2 Screen Shots

Plot 10: 6 dB BW 2412 MHz

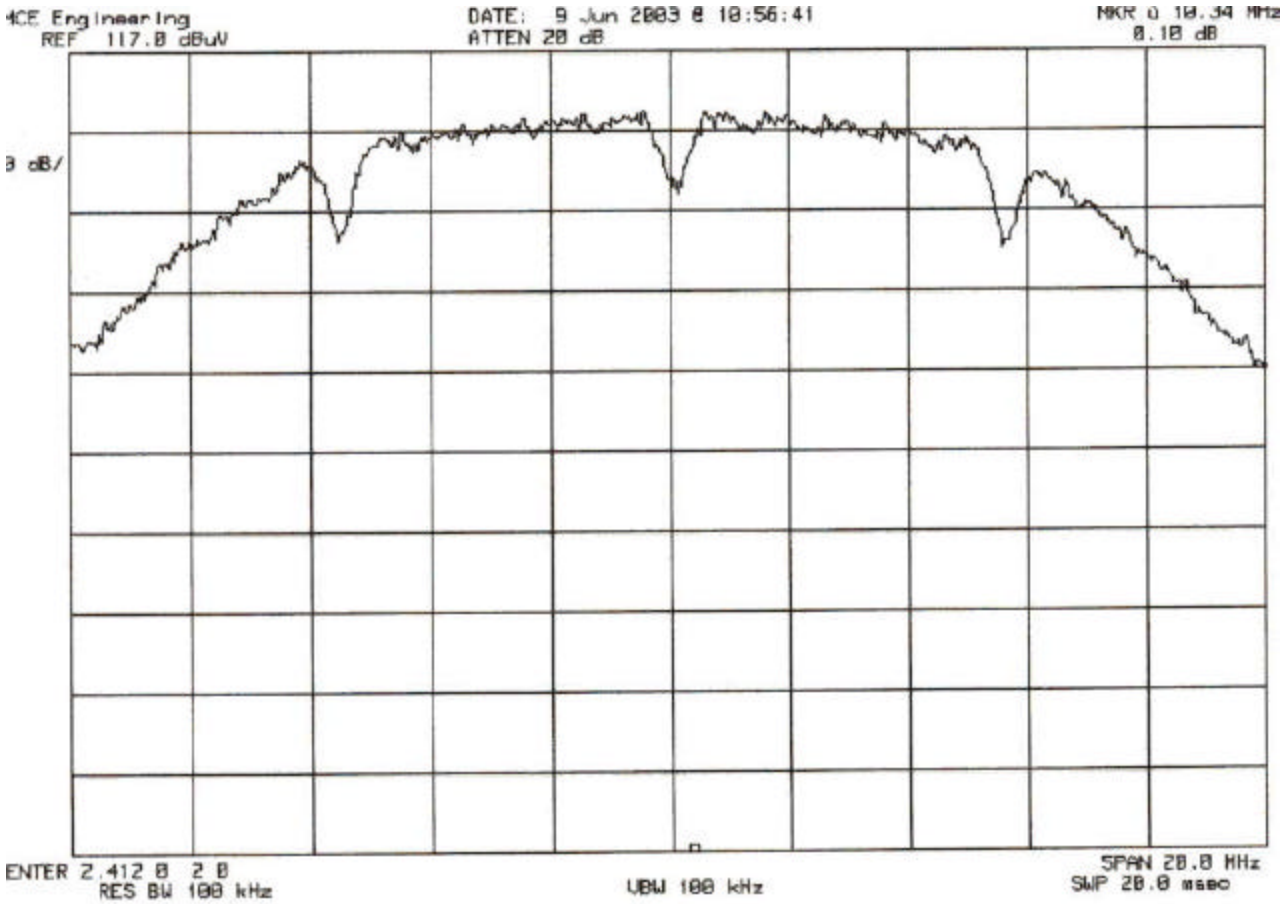


FIGURE CH 1 6 DB

Plot 11: 6 dB BW 2437 MHz

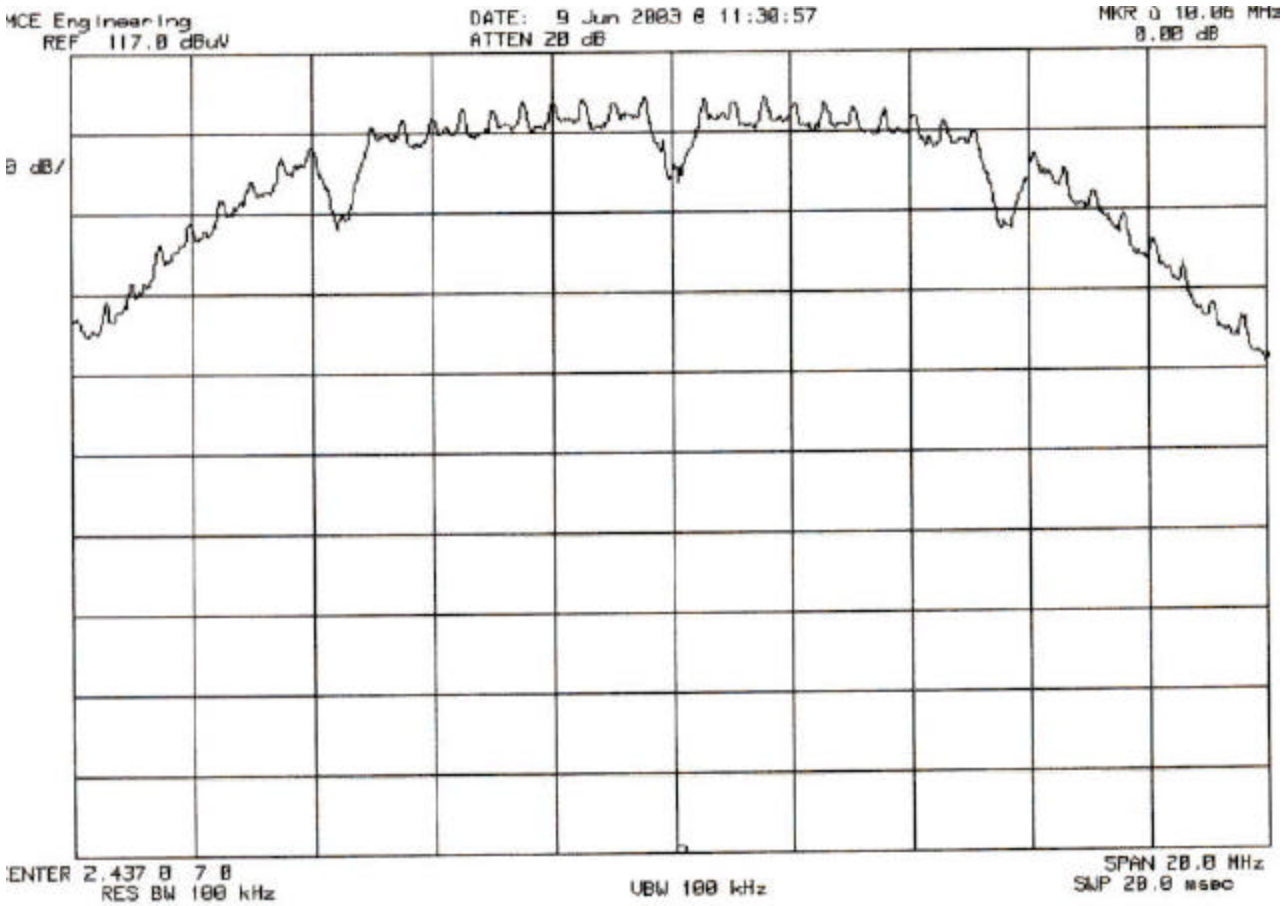


FIGURE CH 6 6 DB

Plot 12: 6 dB BW 2462 MHz

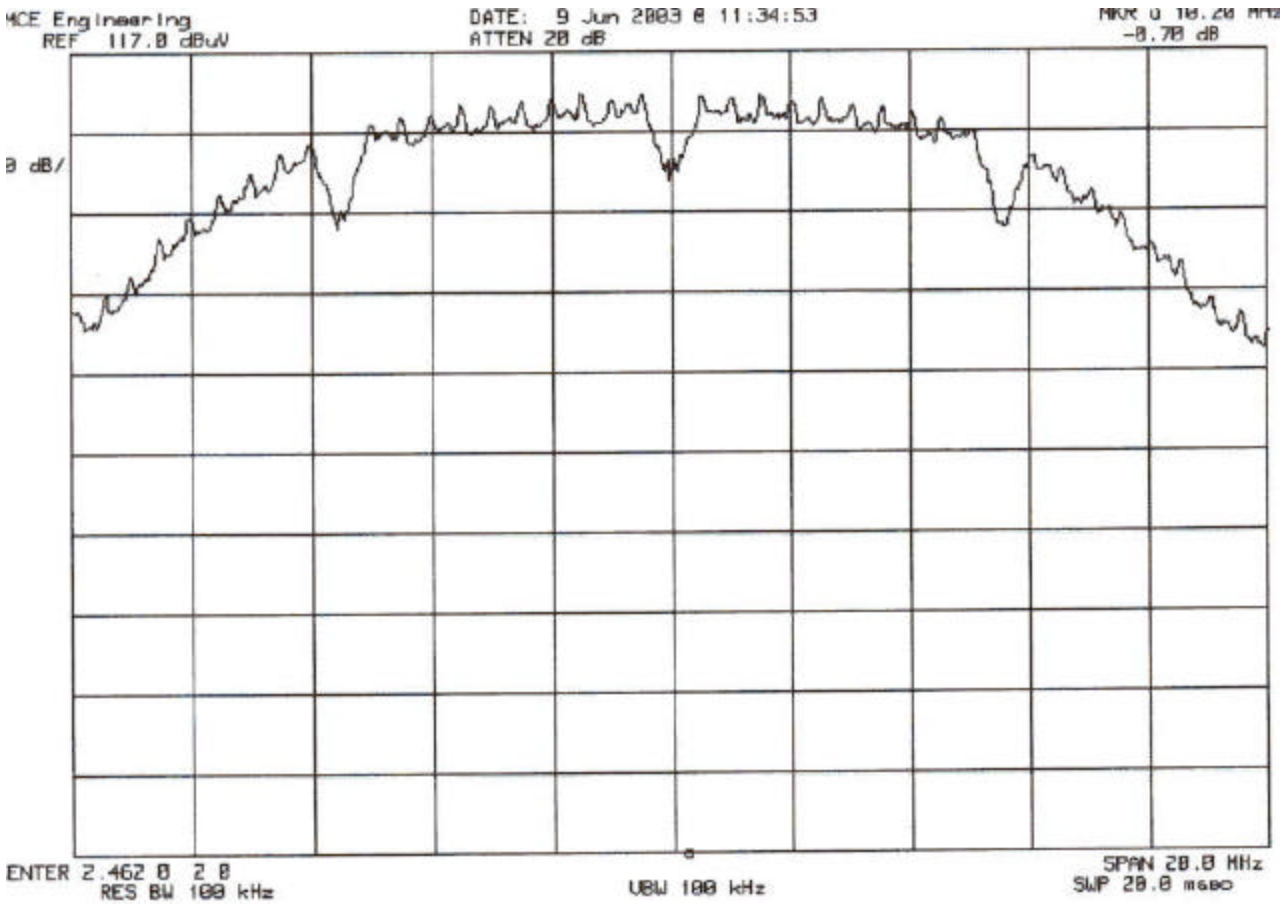


FIGURE CH 11 6 DB

6.4 Band-edge compliance of RF Radiated emissions [CFR 47, 15.247c(1)]

EUT	Hitachi PC5NR3
Test setup	C (conducted)
Temp, Humidity, Air Pressure	56º F, 29.96
Date of Measurement	6/9/03
Measured by	Bob Cole
Result	PASSED

6.4.1 EUT operation mode

EUT operation mode	Data Rate- 11MB/s
EUT channel	1, 11
EUT TX power level	Maximum

6.4.2 Limits and results

Band-edge compliance

Channel	Limit (dBm)	Results (dBm)
2	-6.0	-74.00
80	-6.0	-76.20

6.4.3 Screen shots:

Plot 13: Band-edge Compliance, (Lower Band-edge)

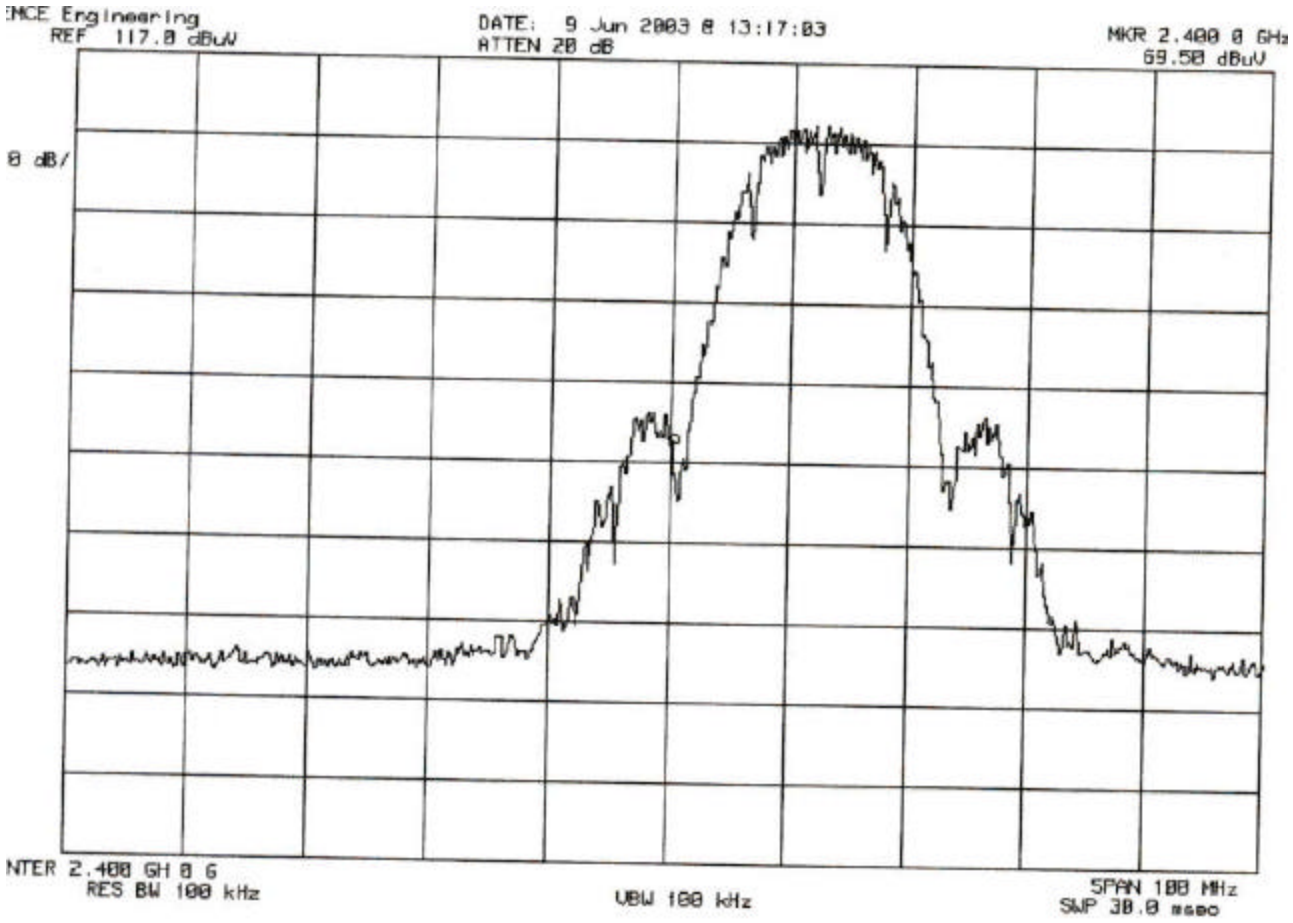


FIGURE BAND EDGE

Plot 14: Band-edge compliance, (Upper Band-edge)

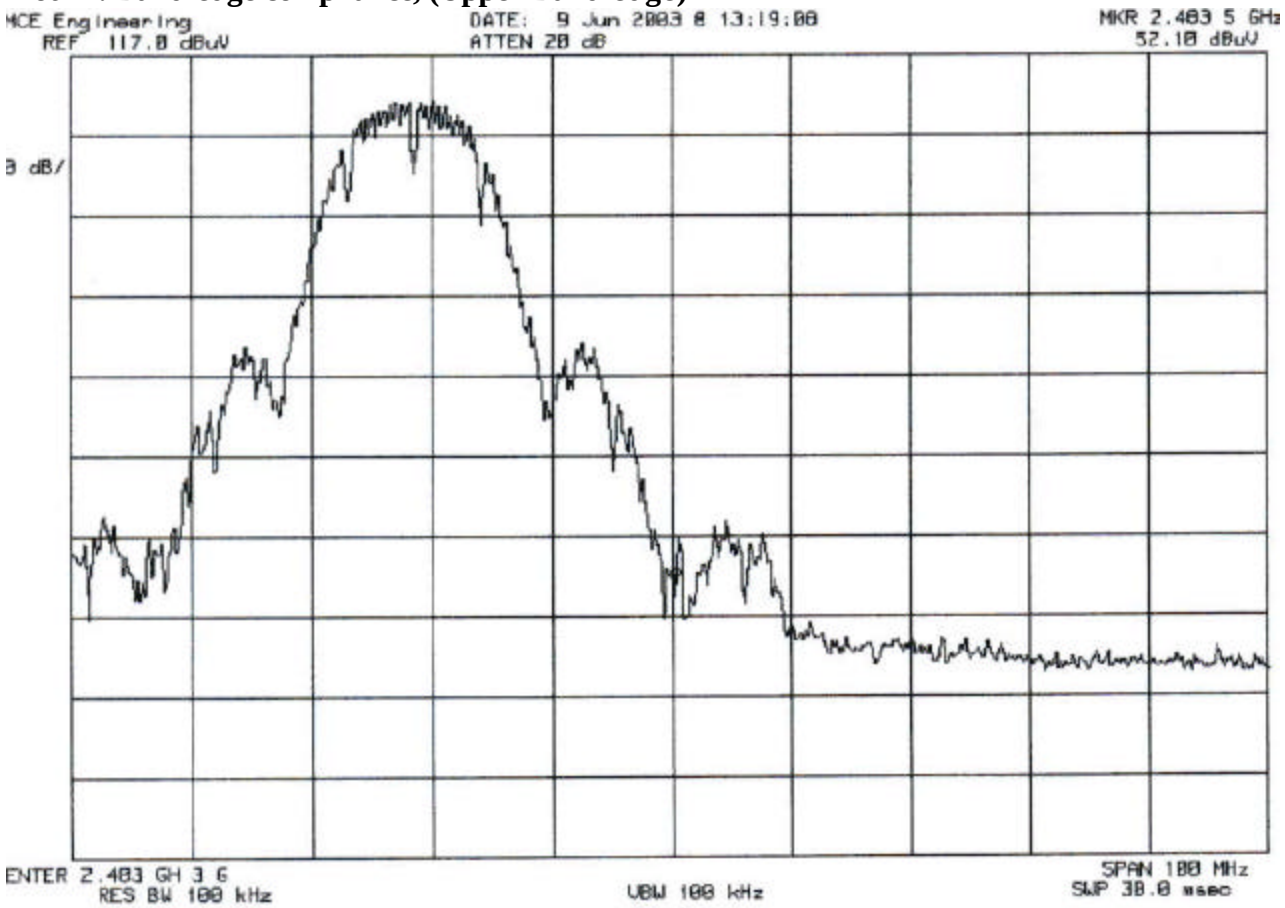


FIGURE BAND EDGE

6.5 Restricted Band Measurements

EUT	Hitachi PC5NR3
Test setup	C (conducted)
Temp, Humidity, Air Pressure	56º F, 29.96
Date of Measurement	2/19/03
Measured by	Bob Cole
Result	PASSED

6.8.1 EUT Operation Mode

EUT operation mode	Data Rate-11MB/s
EUT channel	N/A
EUT TX power level	Maximum

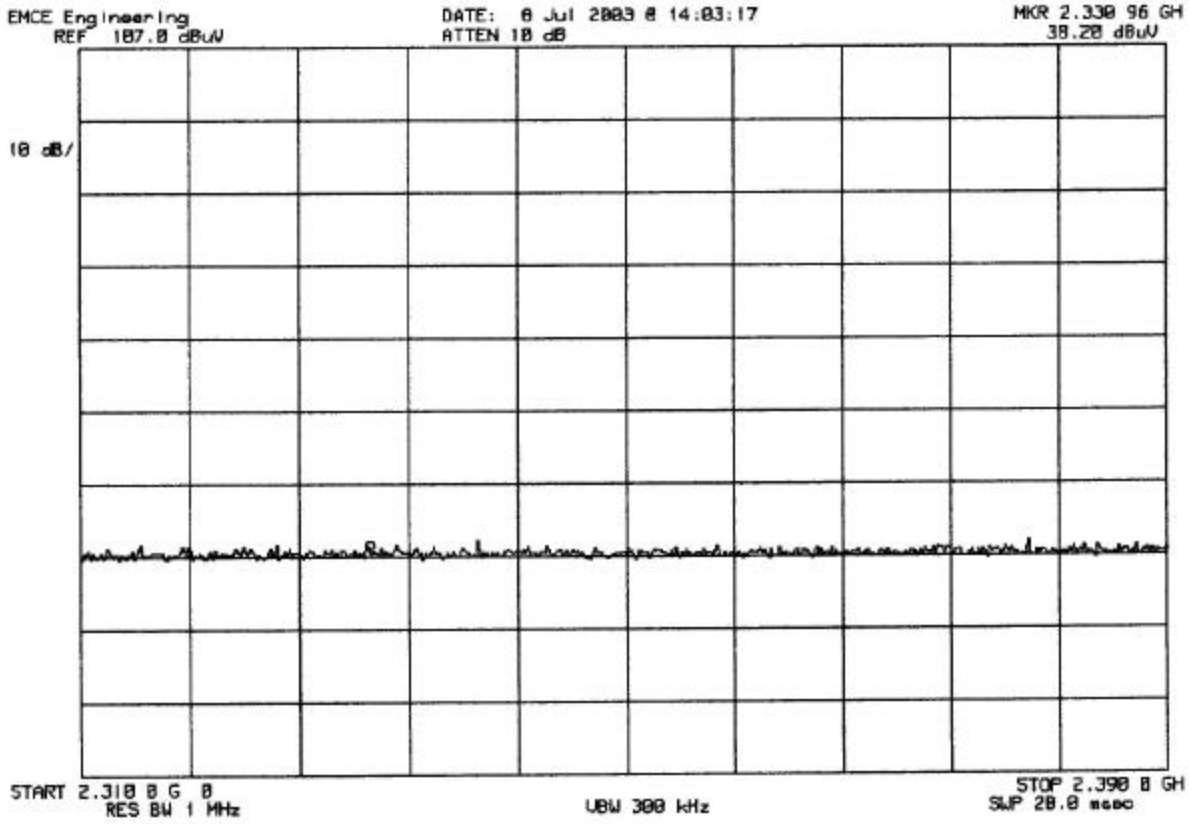
6.5.2 Limits and results

Restricted Bands

Frequency (MHz)	Limit (dBm)	Results (dBm)
2310-2390	-6.0	-68.8
2483.5-2500	-6.0	-69.0

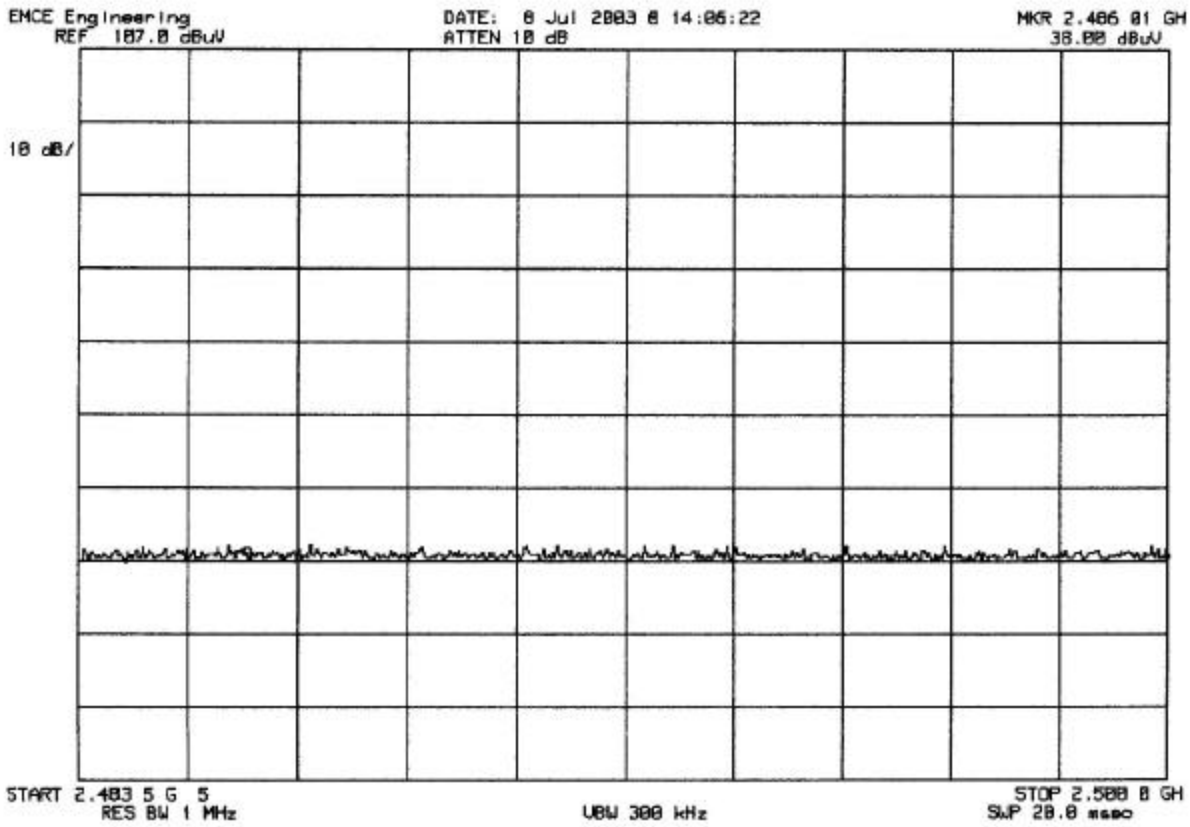
6.5.3 Screen Shots:

Plot 15: 2310-2390 MHz Restricted Band



[redacted]

Plot 16: 2483.5-2500 MHz Restricted Band



[redacted]

6.6 Spurious RF Radiated Emissions [CFR 47, 15.247c1)

EUT	Hitachi PC5NR3
Test setup	C (conducted)
Temp, Humidity, Air Pressure	56º F, 29.96
Date of Measurement	6/9/03
Measured by	Bob Cole
Result	PASSED

Plot # 17 : Spurious Emissions, 30 MHz-1 GHz

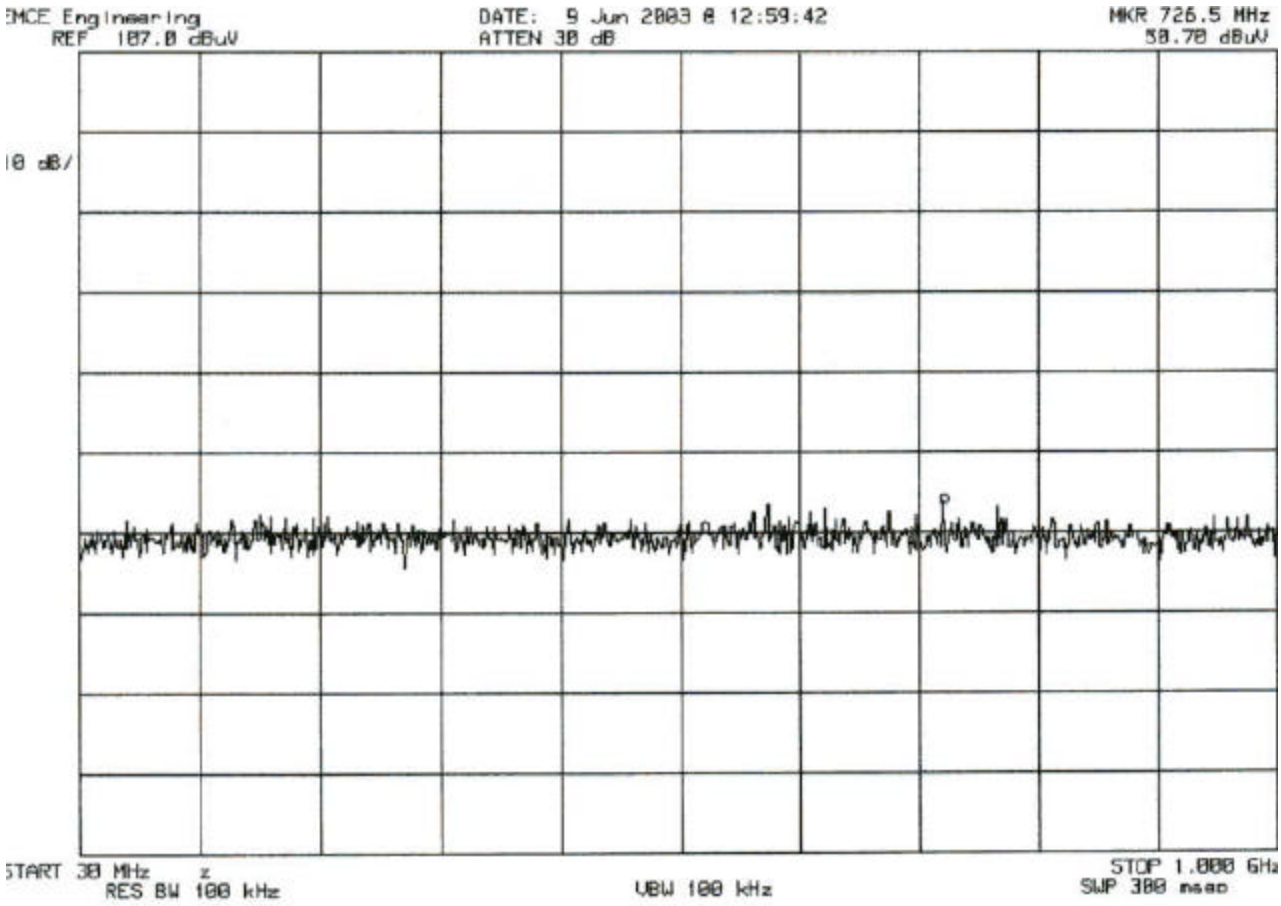


FIGURE CH11 SPURIOUS

Plot # 18 : Spurious Emissions, 1 – 2.5 GHz

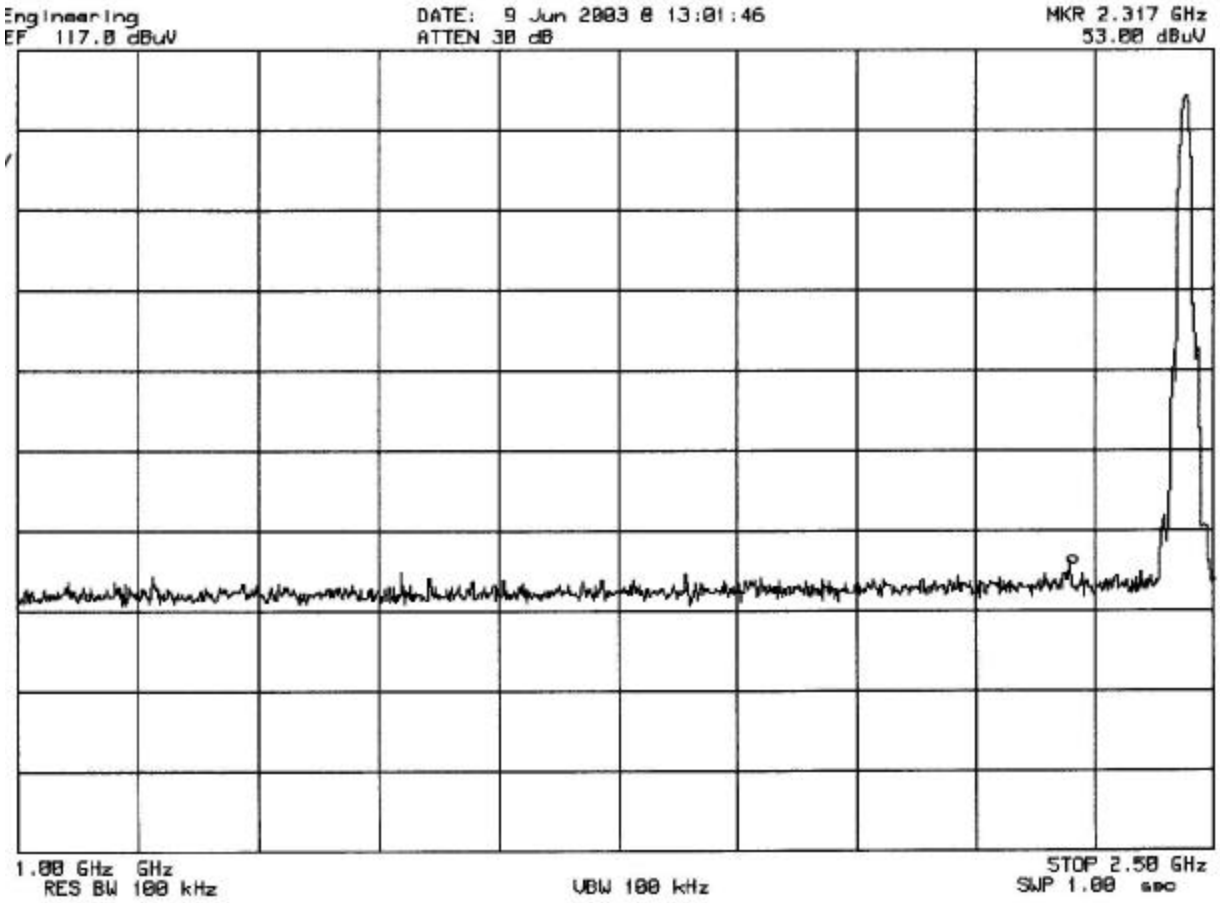


FIGURE CH11 SPURIOUS

Plot # 19: Spurious Emissions, 2.5 – 5 GHz

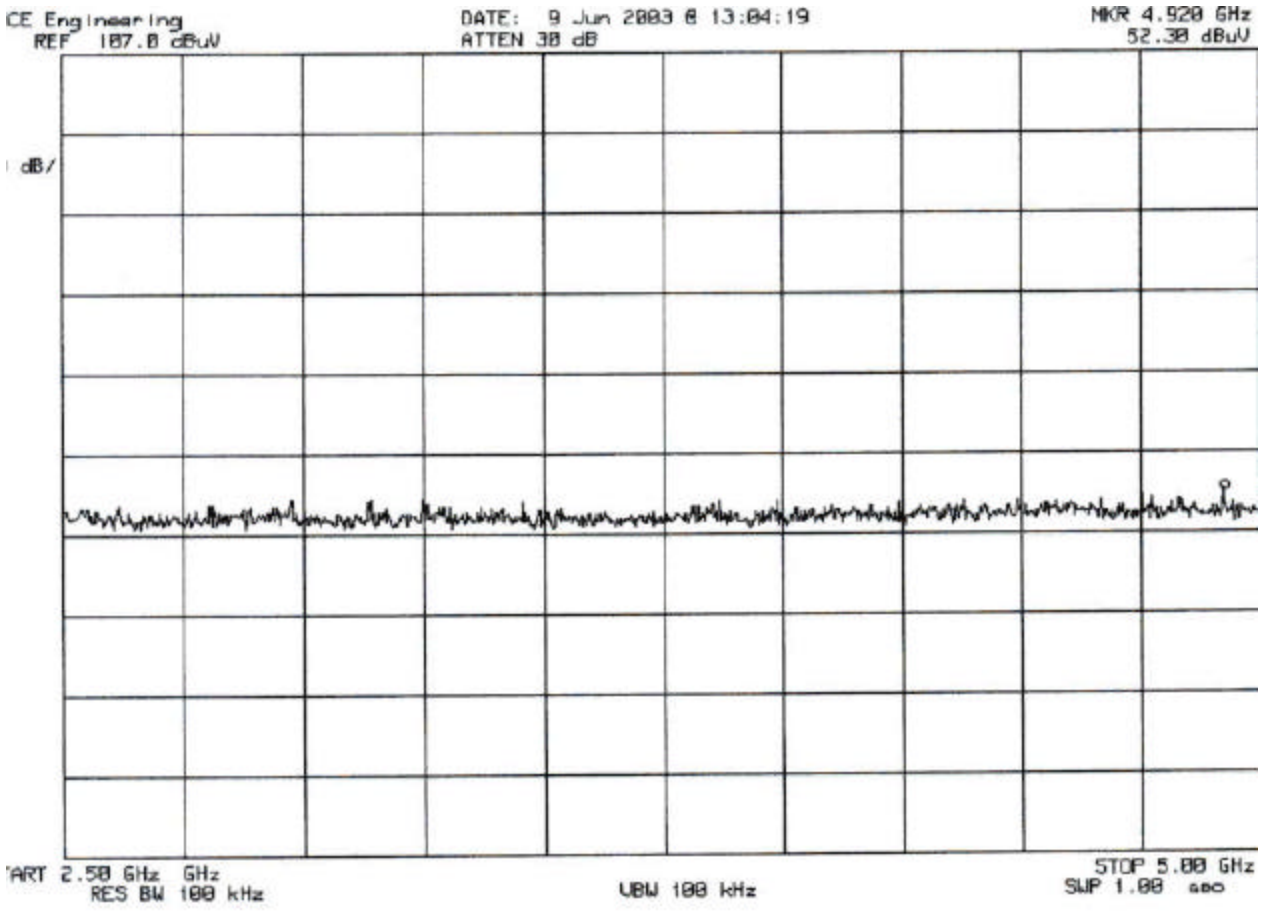


FIGURE CH11 SPURIOUS

Plot#20: Spurious Emissions, 5 – 10 GHz

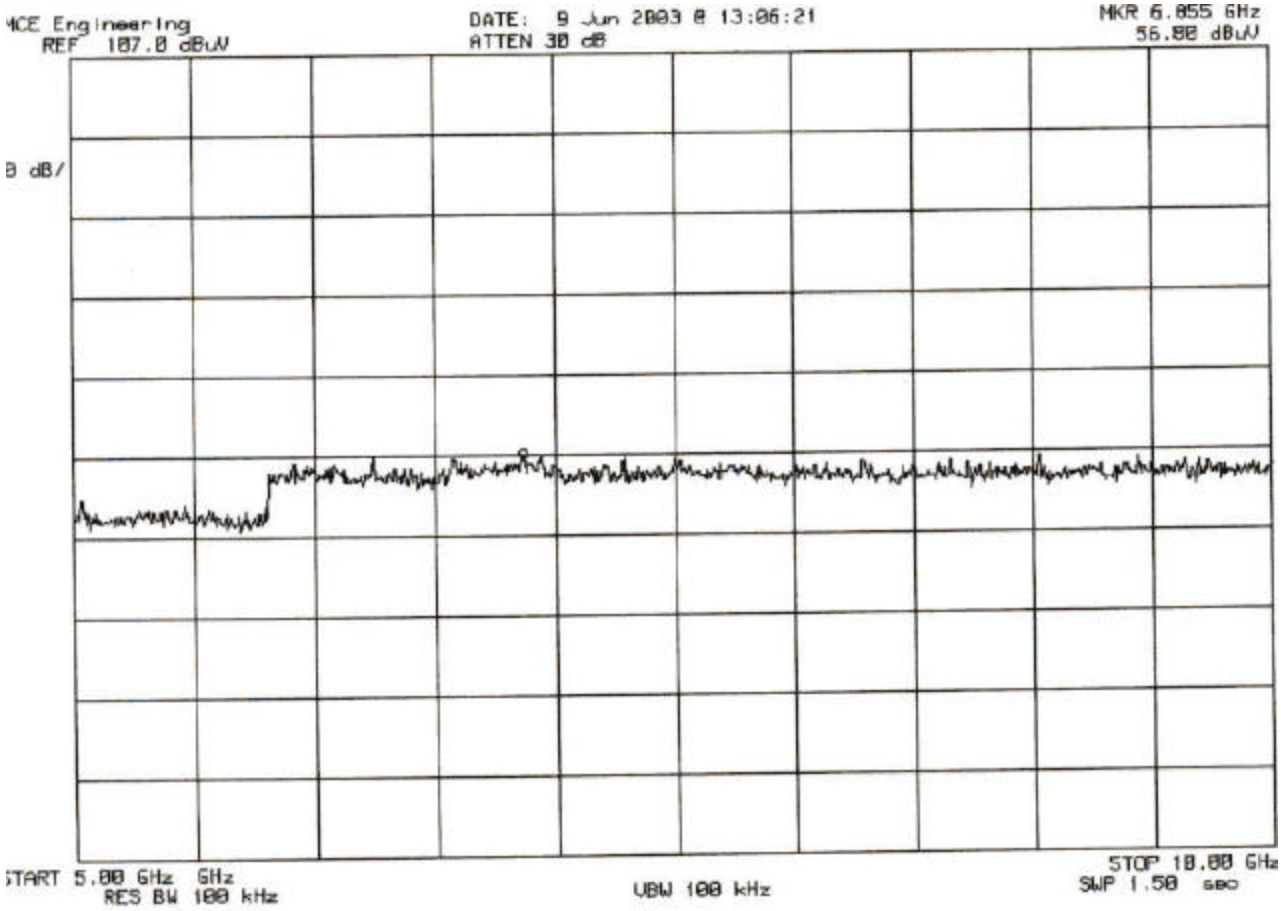


FIGURE CH11 SPURIOUS

Plot #21: Spurious Emissions, 10 – 14 GHz

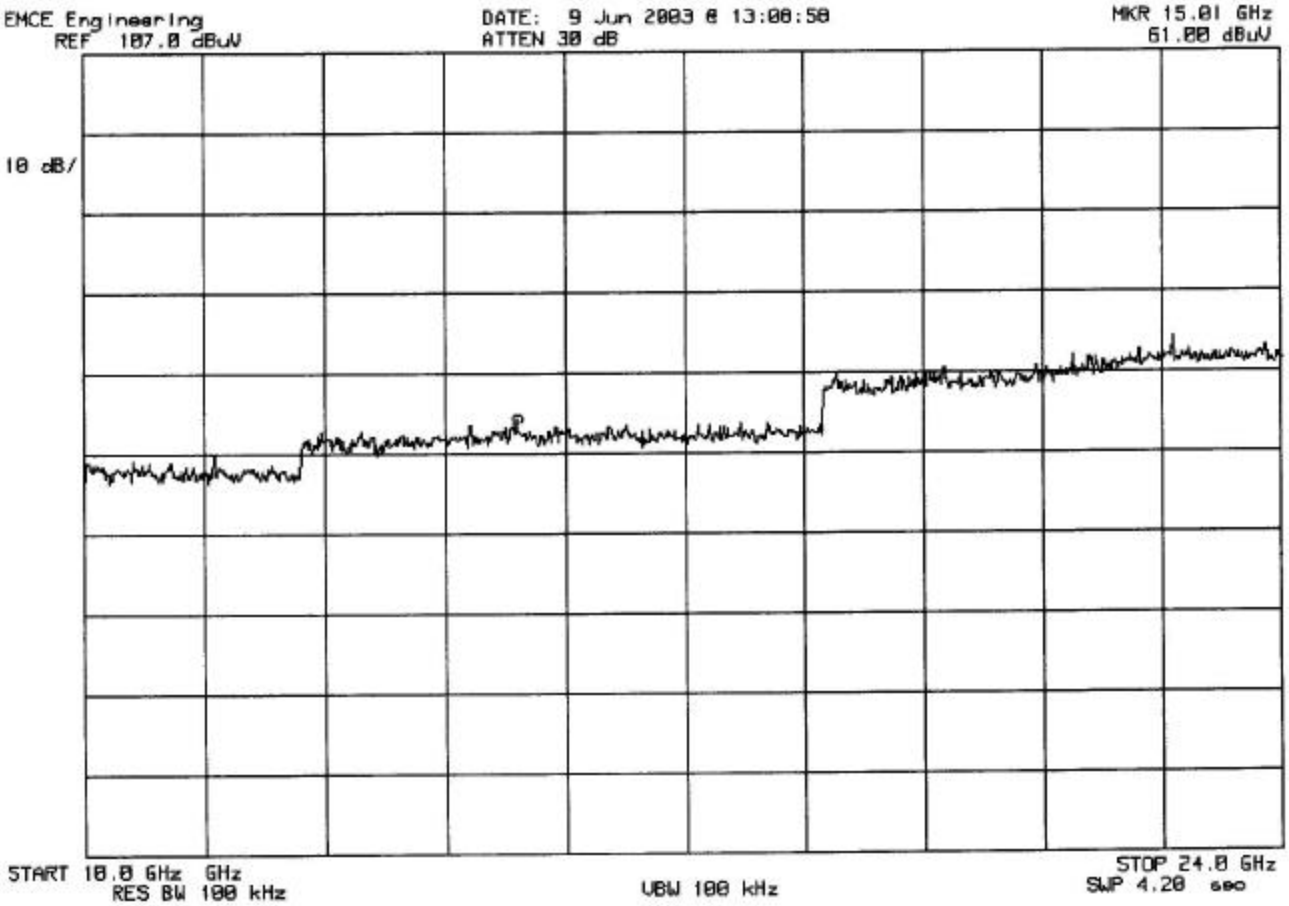


FIGURE CH11 SPURIOUS

6.6.2 AC Line Conducted Emissions Measurement Procedure 450 kHz – 30 MHz

Line conducted Emissions Test Procedure:

1. **SET UP EUT ON TURNTABLE PER ANSI 63.4 FIGURE 11:** Be careful to maintain proper spacing between peripheral devices. Bundle excessive lengths of I/O cable to achieve 1 meter cable length, make sure I/O cables are at least 40 cm from ground plane. Power up the system and initialize any software necessary to exercise the EUT.

2. **SET UP SPECTRUM ANALYZER:** Per instrument settings in Appendix A of this document.

3. **BEGIN MEASUREMENT SEQUENCE:**

   a) **<Start Freq> <450> <kHz>, <Stop Freq> <5> <MHz>;** Start Sweep #1 as defined in Appendix A by starting a single sweep **<Single>** from 450 kHz to 5 MHz.

   b) **<Start Freq> <5> <MHz>, <Stop Freq> <15> <MHz>;** Start Sweep #2 as defined in Appendix A by starting a single sweep **<Single>** from 5 MHz to 15 MHz.

   c) **<Start Freq> <15> <MHz>, <Stop Freq> <30> <MHz>;** Start Sweep #3 as defined in Appendix A by starting a single sweep **<Single>** from 15 MHz to 30 MHz.

   d) For any emissions within 10 dB of the limit; reduce Frequency Span to 1 MHz **<Frequency Span> <1> <MHz>**, set sweep time to 200 **seconds <Sweep Time> <200> <Sec>**, a perform a single sweep **<Single>** to attain a final measurement. Record this measurement on the measurement spreadsheet.

4. CABLE MANIPULATION TO MAXIMIZE EMISSIONS: The effect of cable position on the line conducted emissions must be fully investigated. Experiment with various positions of the I/O cables and power cords to determine if there is any interaction between cables. Repeat step 3 to re-measure emissions after each cable manipulation.

6.6.3 Radiated emissions Measuremetn Procedure, 30 MHz – 18GHz

Radiated Emissions Test Procedure:

1. **Setup EUT on turntable per ANSI 63.4 Figure 11:** Be careful to maintain proper spacing between peripheral devices. Bundle excessive lengths of I/O cable to achieve 1 meter cable length, make sure I/O cables are at least 40 cm from ground plane. Power up the system and initialize any software necessary to exercise the EUT.

2. Place the biconical antenna in vertical polarization on antenna mast.

3. **INITIAL SCAN:** Record signals from 30 - 300 MHz, vary the size of the frequency span (and corresponding Center Frequency Step Size) displayed on the analyzer depending on the number of signals present. Decrease the span to 5 MHz or 1 MHz to clearly identify signals in crowded areas of the spectrum.

4. **IDENTIFICATION OF AMBIENT SIGNALS:** In order to identify ambient signals, turn off power to the turntable and recheck the spectrum from 30 - 300 MHz. Any signals still present are ambient signals. Remove these datapoints from the measurement spreadsheet.

5. **MAXIMIZATION OF SIGNAL STRENGTH:** With the ambient signals eliminated from consideration, it is time to maximize the emissions from the EUT to record the final measurements. Apply power to the EUT.

a) **Identify worst case angle:** Center the spectrum analyzer display on the first recorded frequency. Set the frequency span to 1 MHz. With Trace A in **MAX HOLD**, rotate the turntable 360 degrees. Observe the display during turntable rotation. Trace A will record the maximum field strength, while Trace B (still in **Clear/Write** mode) will vary during the rotation. Return the turntable to the location where Trace B is at the same amplitude as Trace A. This is the worst case angle for this frequency.

b) **Identify worst case antenna height:** Now vary the antenna height from 1 to 4 meters, again with Trace A on MAX HOLD and Trace B on Clear/Write. Return the antenna to the height where Trace B is the same amplitude as Trace A. This is the worst case height for this frequency.

c) **Cable Manipulation:** It is essential to vary I/O cable and power cord positions to identify the maximum emission level from the EUT. With the turntable and mast still at the worst case positions, leave Trace A in MAX HOLD and vary the cable locations as much as they could reasonably be expected to vary in normal use of the EUT. For example, it is not necessary to lift any I/O cable or power cord to a position above the turntable height. Be careful to explore any possibilities for cable interactions which might increase emissions.

d) **Quasi-Peak Measurements:** Certain signals will exhibit a lower amplitude when measured in quasi-peak mode. When the amplitude is lower is quasi-peak mode than in peak detection mode the quasi-peak measurement shall be recorded as the final measurement (note: quasi-peak detection is valid from 9 kHz to 1 GHz, above 1GHz average mode is required). Quasi-peak measurement procedure is as follows:

1) Center the signal being measured on the analyzer display.
2) Narrow the span to 100 Hz and re-center the signal.
3) Narrow the span to 10 Hz and re-center the signal.
4) Set the Frequency Span to 0 Hz.
5) Adjust the Reference Level until the trace is near the top of the display.
6) Put the analyzer in Linear Mode **<LIN>**
7) Re-adjust the Reference Level until the signal is near the top of the display.
8) Set the analyzer to single sweep mode **<Single>**
9) Set the sweep time to 5 seconds **<Sweep Time> <5> <Sec>**
10) Turn Trace B off **<Off>**
11) Set Trace A to max hold **<Max Hold>**
12) Turn the quasi-peak adapter on **<On>**
13) Hit **<Single>** to start measurement
14) Use marker **<Normal>** to find highest reading
15) Convert measurement to dB uV/m using the equation 20 Log (amplitude in microvolts)
16) Record measurement if lower than peak measurement.

6. **COMPLETE THE SCAN:**

a) Repeat steps 3 - 5 with the biconical antenna in the horizontal position. Perform the initial scan (step 3) with the antenna height at 2 meters.

b) Repeat steps 3 - 5 utilizing the log-periodic antenna in the vertical polarization to explore the frequency range from 300 MHz to 1 GHz.

c) Repeat steps 3 - 5 utilizing the log-periodic antenna in the horizontal polarization to explore the frequency range from 300 MHz to 1 GHz. Perform the initial scan with the log-periodic antenna positioned at 1 meter antenna height.

a) Phase g was repeated with vertical antenna polarization.
b) Obtained values were recorded.

Class B limit (3m measuring distance)

Frequency Band (MHz)	Limit (dBµV/m)	Detector
30-88	40	Q-Peak
88-230	43.5	Q-Peak
230-960	47	Q-Peak
960-1000	54	Q-Peak
1000-25000	54	Average

6.6.4 EUT operation mode

EUT operation mode	Data Rate – 11MB/s
EUT channel	N/A
EUT TX power level	Maximum
EUT operation voltage	3.3 VDC

6.6.5 Radiated emission measurement data, 30 MHz – 1GHz

The measurement results were obtained as described below.

$$E[uV/m] - U_{RX} + A_{CABLE} + AF - G_{PREAMP}$$

Where:

U_{RX}	receiver reading
A_{CABLE}	Attenuation of the cable
AF	Antenna Factor
G_{PREAMP}	Gain of the preamplifier

Freq [Max] [Mhz]	[QP] EMI [dBµV/m]	Limit [dBµV/m]	QP Marg [dB]	Azimuth [deg]	Twr Ht [meters]	Pol.
36.00	37.32	40	-2.68	0	1.15	Vertical
48.00	36.97	40	-3.03	15	1.10	Vertical
210.00	39.75	43.5	-3.75	92	1.20	Vertical
240.00	44.86	47	-2.14	0	1.00	Vertical
360.00	40.80	47	-6.20	279	1.12	Horizontal
416.00	40.69	47	-6.31	0	1.00	Vertical

Table 1. Highest emissions, 30-1000 MHz

6.6.6 Line Conducted Emissions measurement data

Line/Detection Mode	Freq [Mhz]	Amplitude [µV]	Amplitude [dBµV]	Limiter Attenuation [dB]	Class B Limit	Margin [dBµV]
Hot/Quasi Peak	0.195	89.092	39.00	10.00	65.00	-16.00
Hot/Quasi Peak	1.470	12.006	21.59	10.00	56.00	-24.41
Hot/Quasi Peak	3.240	7.046	16.96	10.00	56.00	-29.04
Hot/Quasi Peak	5.370	7.733	17.77	10.00	60.00	-32.23
Hot/Quasi Peak	10.830	13.663	22.71	10.00	60.00	-27.29
Hot/Quasi Peak	23.270	7.458	17.45	10.00	60.00	-32.55

Line/Detection Mode	Freq [Mhz]	Amplitude [µV]	Amplitude [dBµV]	Limiter Attenuation [dB]	Class B Limit	Margin [dBµV]
Neutral/Quasi Peak	0.202	87.299	38.82	10.00	65.00	-16.18
Neutral/Quasi Peak	1.432	11.207	20.99	10.00	56.00	-25.01
Neutral/Quasi Peak	4.865	7.508	17.51	10.00	56.00	-28.49
Neutral/Quasi Peak	5.340	8.754	18.84	10.00	60.00	-31.16
Neutral/Quasi Peak	10.850	14.232	23.07	10.00	60.00	-26.93
Neutral/Quasi Peak	24.030	6.453	16.20	10.00	60.00	-33.80

7 TEST EQUIPMENT

Conducted Measurements:

Equipment	Type	Manufacturer	Device Number
EMI Analyzer	84125B	Hewlett-Packard	15921-12
Coaxial cable	SMA Male – Reverse SMA Male (Length = 1 ft.)	Own	C1

Spurious RF radiated emissions:

Equipment	Type	Manufacturer	Device Number
EMI Analyzer System	84125B	Hewlett-Packard	15921-12
Pre-Amp	83051A	Hewlett-Packard	15921-12
Pre-Amp	83017A	Hewlett-Packard	15921-12
High Pass Filter	9701	CMT	15921-12
Horn Antenna	3115	EMCO	15921-12
Cable		Hewlett Packard	15921-12

Note: The HP 84125B EMC Analyzer System is calibrated as a system, including the analyzer, pre-amps, filters, and cable.

CFR47, 15.207 (AC powerline conducted emissions)

Equipment	Type	Manufacturer	Device number
EMI Analyzer System	84125B	Hewlett-Packard	15921-12
LISN	EMCO		ACL-001
Coaxial cable	SMA – BNC (5 Meters)	Own	C2