

October 8, 2001

Federal Communications Commission  
Authorization and Evaluation Division  
7435 Oakland Mills Road  
Columbia, MD 21046

Attention: Applications Examiner

Applicant: Nokia Networks  
6000 Connection Dr.; Irving, TX 75039

Equipment: MetroHopper  
FCC ID: PM5T55800-01

Specification: for a 47 CFR 15.255 Certification

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Dear Examiner:

The following application for Grant of Equipment Authorization is presented on behalf of Nokia Networks, Inc. for the Certification of their MetroHopper.

Enclosed, please find a complete data and documentation package demonstrating that this device complies with the technical requirements of 47 CFR 15.255 and FCC Report & Order 99-261, for millimeter wave device operating between 57.2 - 58.2 GHz..

If you have any questions, please contact the undersigned, who is authorized to act as Agent.

Sincerely,



Chris Harvey,

Director

EMC Laboratory  
MET Laboratories, Inc.

**MET Laboratories, Inc.** *Safety Certification - EMI - Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE ! BALTIMORE, MARYLAND 21230-3432 ! PHONE (410) 354-3300 ! FAX (410) 354-3313

# ENGINEERING TEST REPORT

in support of the  
Application for Grant of Equipment Authorization

**EQUIPMENT:** Model: MetroHopper

**FCC ID:** PM5T55800-01

**Specification:** 47 CFR 15.255

**On Behalf of the Applicant:** Nokia Networks.  
6000 Connection Dr.  
Irving, TX 75039

**Manufacturer:** Nokia Networks.  
6000 Connection Dr.  
Irving, TX 75039

**Manufacturer's Representative** Mr. Anthony Aird

**Test Date(s):** June 21 thru June 23, 2000

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## ENGINEERING STATEMENT

**I ATTEST:** the measurements shown in this report were made in accordance with the procedures indicated, and that the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements. On the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 15.255 of the FCC Rules under normal use and maintenance.



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Liming Xu  
EMC Engineer, MET Laboratories

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## 1.0 INTRODUCTION

The following data is presented on behalf of the Applicant, Nokia Networks, as verification of the compliance of the Nokia MetroHopper to the requirements of 47 CFR 15.255

## 2.0 TEST SITE

All testing was conducted at MET Laboratories, Inc., 914 West Patapsco Avenue, Baltimore, Maryland 21230-3493. Radiated emissions measurements were performed on a three-meter test site. A complete site description is on file with the FCC Laboratory Division as 31040/SIT/MET.

## 3.0 TEST EQUIPMENT USED

Manufacturer	Equipment	Calibration Due Date @ time of testing	Cal. Interval
Hewlett Packard	8563A Spectrum Analyzer	6/14/01	annual
EMCO	Biconical Antenna 3104	4/10/01	annual
EMCO	EMCO Log Periodic Antenna	4/10/01	annual
EMCO	Double Ridge Guided Horn	2/17/01	annual
Hewlett Packard	8594EM Analyzer	11/20/00	annual
Hewlett Packard	8591E Analyzer	8/12/00	annual
Solar	LISN	8/27/00	annual

## 4.0 EQUIPMENT UNDER TEST CONFIGURATION

The MetroHopper was configured with MetroHub providing DC power to MetroHopper via the FXC, RRI card. The MetroHub required AC power as input. An external PC was used to program the EUT to output a RF signal. The EUT with host external computer was configured for maximum signal gain and bandwidth. The EUT was operated in a manner representative of the typical usage of the equipment. During all testing, system components were manipulated within the confines of typical usage to maximize each emission.

## 5.0 TEST TYPE(S)

- 5.1 Radiated Emissions: 47 CFR 2.1053, , 15.255
- 5.2 Occupied Bandwidth: 47 CFR 2.1049
- 5.3 RF Power Output: 47 CFR 2.1046, 15.255
- 5.4 Frequency Stability over temperature variations: 47 CFR 15.255 (f)
- 5.5 Frequency Stability over variations in supply voltage: 47 CFR 15.255 (f)
- 5.6 AC Line Conducted Emissions: 47 CFR 15.107

## 6.0 TEST RESULTS

### 6.1 TEST TYPE: Radiated Emissions

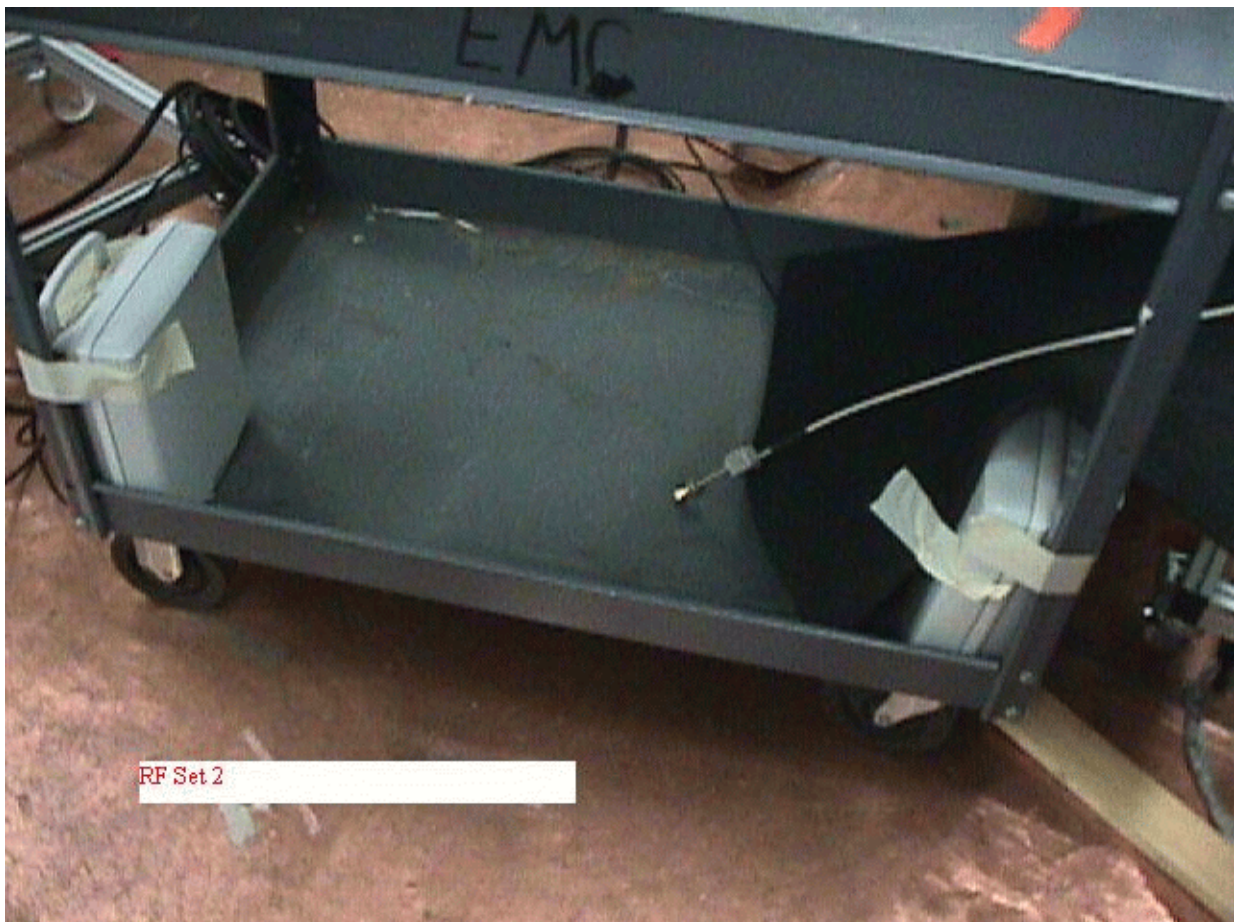
#### 6.1.1 TECHNICAL SPECIFICATION: 2.1053; 15.209

#### 6.1.2 TEST DATE(S): 6/12/00

#### 6.1.3 MEASUREMENT PROCEDURES:

As required by §2.1053, *field strength of spurious radiation measurements* were made in accordance with the general procedures of ANSI C63.4-1992 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". Preliminary radiated emission measurements were performed inside a shielded chamber. The frequency list from the preliminary measurements was used as a guide for making final measurements for frequencies below 1GHz on a 3 meter Open Area Test Site. Emissions above 1GHz were performed in an open area of the laboratory. The unit was scanned over the frequency range 30MHz to 200GHz

The photograph of the EUT test configuration



**6.1.4 RESULTS:**

Frequency (MHz)	Azimuth (ECCW-OE=EUT facing ant.)	Polarity	Height (m)	Raw Amplitude (dBuV)	Ant.Cor. Factor (db)	Cable Loss (db)	Distance Corr. 3m to 1m	Corrected Amplitude (dBuV/m)	Limit (dBuV/m) at 3 meters
* 40.500	270	H	1.5	13.25	11.19	1.17	0	25.61	40
* 40.500	270	V	1	15.52	10.09	1.17	0	26.78	40
* 74.620	270	H	1.5	13.54	7.0216	1.55	0	22.11	40
* 74.620	270	V	1	15.14	7.1456	1.55	0	23.84	40
* 159.500	270	H	1.5	13.29	14.93	2.359	0	30.58	43.5
* 159.500	270	V	1	13.17	15.27	2.359	0	30.80	43.5
* 394.000	270	H	1.5	13.15	16.58	3.884	0	33.61	46
* 394.000	270	V	1.2	13.24	16.28	3.884	0	33.40	46
* 413.500	270	H	1.5	13.63	17.14	3.99	0	34.76	46
* 413.500	270	V	1	13.51	17.215	3.99	0	34.72	46
* 566.000	270	H	1.5	13.61	19.12	4.903	0	37.63	46
* 566.000	279	V	1	13.64	18.58	4.903	0	37.12	46
4.96GHz	0	H	1	44	33.3	35	9.54	32.76	54
9.517GHz	0	H	1	49	378	35	9.54	42.26	54

Equipment meets the specifications of 2.10532; 15.209

\*— These emissions were related to the digital electronics, and thus are measured against the 47 CFR 15 Class B limit. These emissions are significantly below the limit for spurious emissions.

\*\* There is no detectable emissions between 9.517GHz and 200GHz.

**6.2 TEST TYPE:** Occupied Bandwidth

**6.2.1 TECHNICAL SPECIFICATION:** 47CFR2.1049

**6.2.2 TEST DATE(S):** 6/21/00

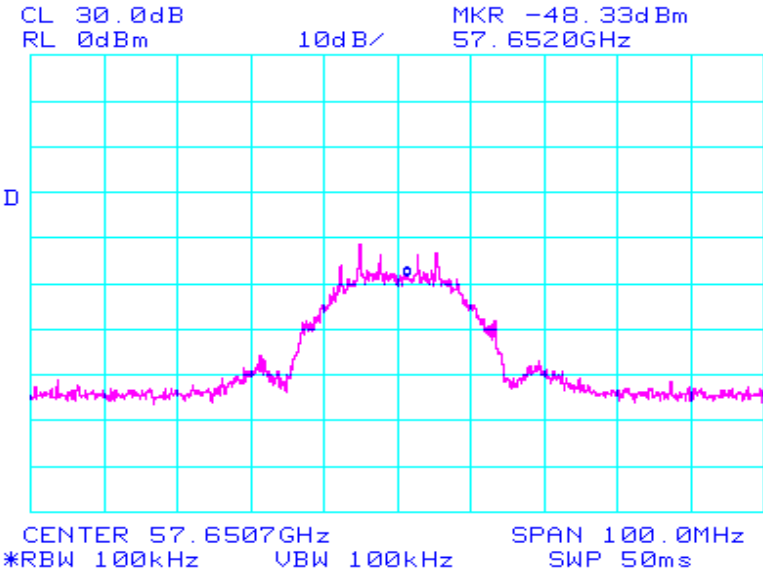
**6.2.3 MEASUREMENT PROCEDURES:**

As required by §2.1049 of CFR 47, *occupied bandwidth measurements* were made on the MetroHopper. The EUT was configured to transmit a modulated carrier signal.

**6.2.4 RESULTS:**

Equipment complies with Section 2.1049. Plots of the occupied bandwidth, :  
The emission bandwidth = 20 MHz (6 dBc EBW @ 100KHz RBW)

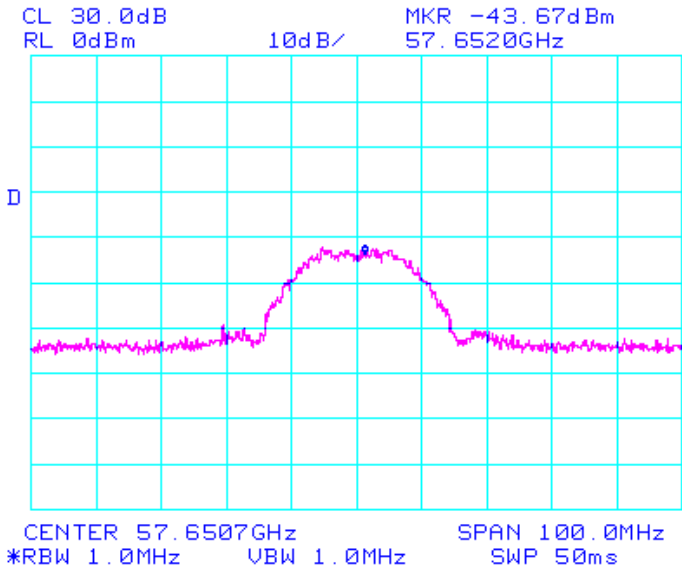
**Nokia MetroHopper emi9754**



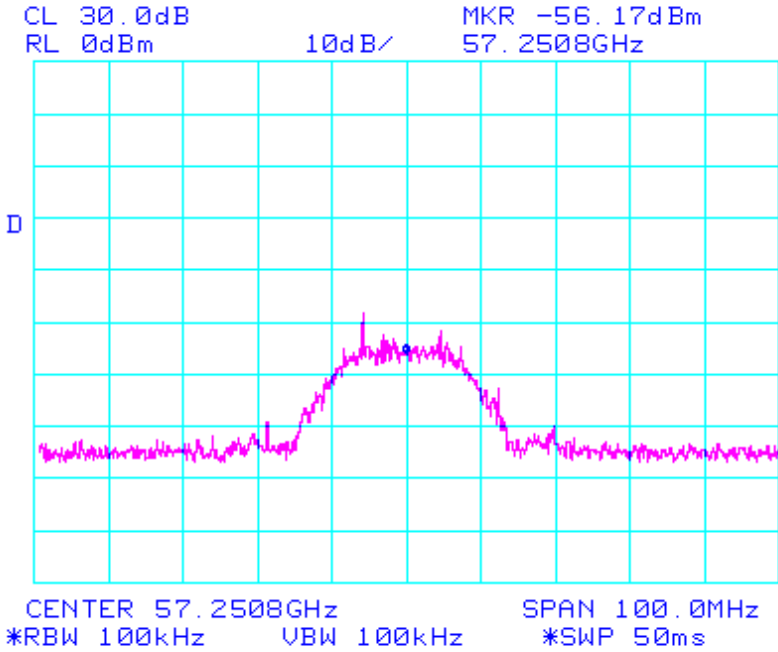
\*\* EBW<sub>6dB</sub> (6 dBc ) = 20 dBm.

\*\* EBW<sub>26dB</sub> ( 26 dBc) = 30 dBm.

emi9754

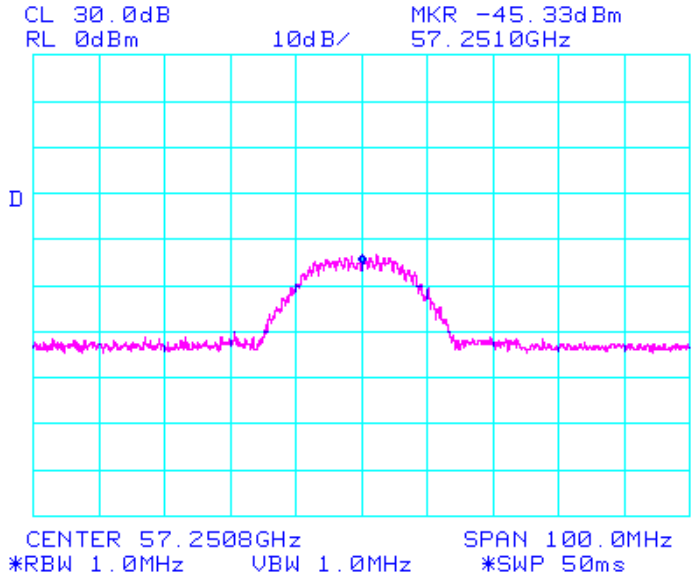


emi9754

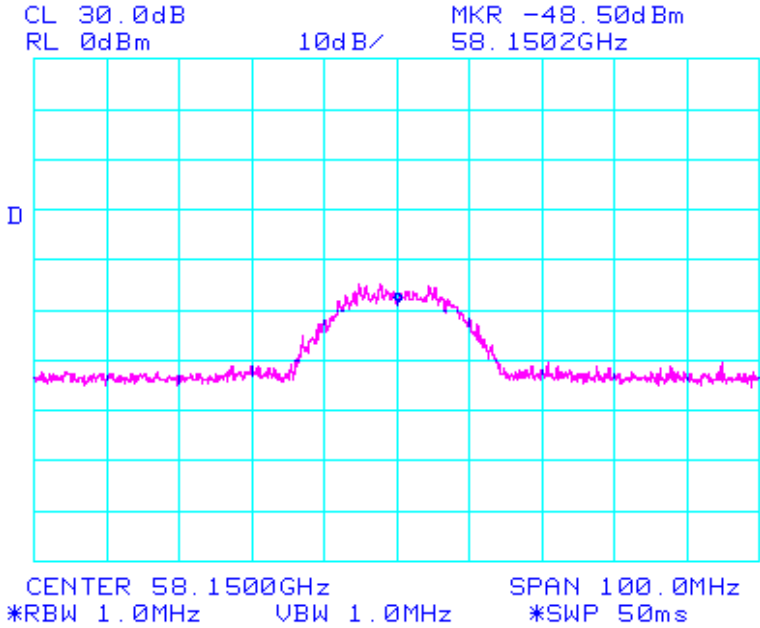




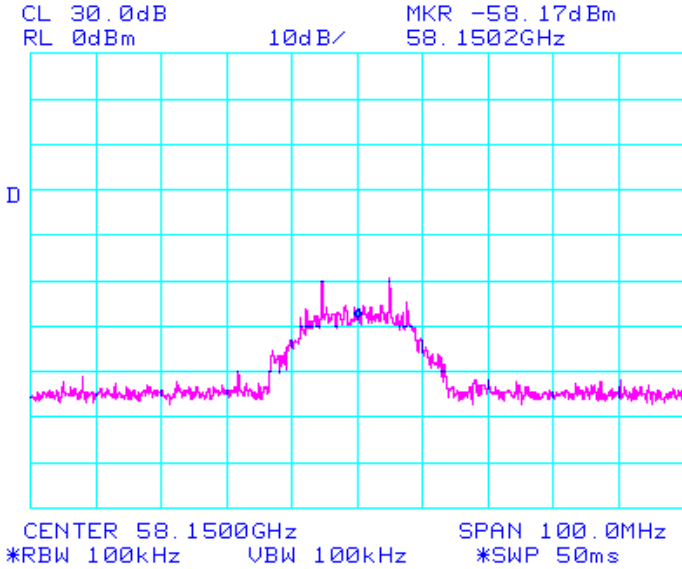
emi9754



emi9754



emi9754



**6.3 TEST TYPE:** RF Power Output**6.3.1 TECHNICAL SPECIFICATION:** 47CFR2.1046 and 15.255 (e)**6.3.2 TEST DATE(S):** 6/21/00**6.3.3 MEASUREMENT PROCEDURES:**

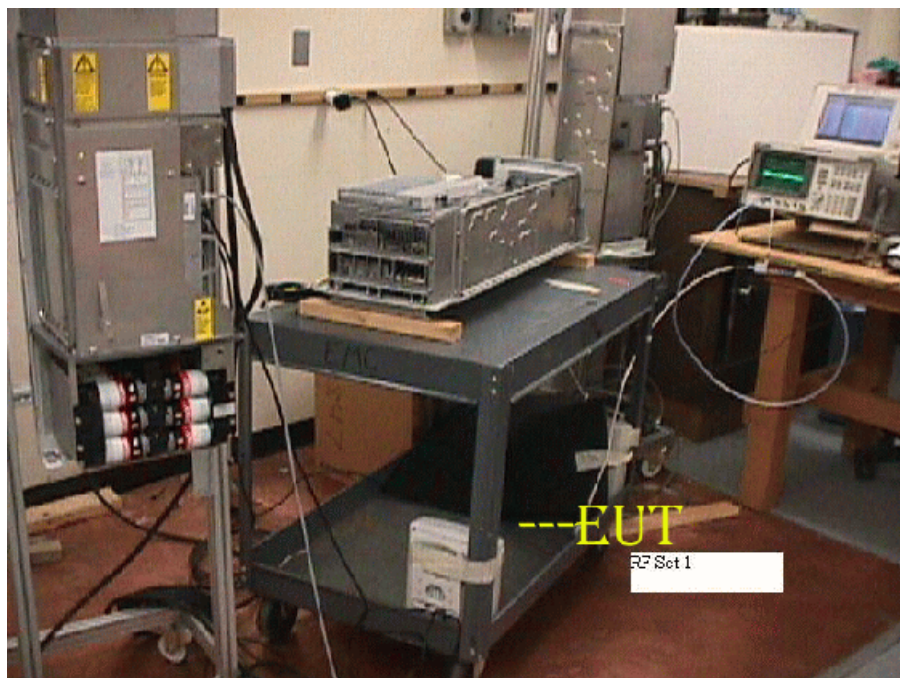
As required by §2.1046 of CFR 47, *RF power output measurements* were made at the front of antenna using an mixer and spectrum analyzer. This test was performed with carrier modulated signal.

Plots of the RF output Power level of the Digitally modulated carrier are included on the following page .

**6.3.4 RESULTS:**

Equipment complies with 47CFR 2.1046 and 15.255 (e). The MetroHopper does not exceed 500 mW ( or 27 dBm) at the carrier frequency.

Photograph of Antenna Conducted Spurious Emissions and  
RF Power Output Test Configuration



**\*\*The Peak Output Power Limit Per 15.255(e)(1):**

for emission bandwidth less than 100MHz , use the correction factor of  
 EBW (MHz)/100MHz, using 6dB EBW<sub>6dB</sub>  
 The peak output power Limit: 500 mW x 20MHz/100MHz = 100 mW.

$$\begin{aligned} E &= 50 + 10\text{dB}(\text{reference offset}) + 10 \log (\text{EBW}_{26\text{dB}}/\text{RBW}) \\ &= 50 + 10\text{dB} + 10\log(30/1) \\ &= 50 + 10 + 14.77 \text{ (dBuV/m)} \\ &= 74.77 \text{ dBuV/m} \end{aligned}$$

$$\begin{aligned} E &= 0.0057 \text{ V/m} \\ & * 70 \text{ dBuV/m is measured peak field strength @ 1 meter} \\ & * 50 \text{ dBuV/m is peak field strength @ 3 meters per 40dB/decade} \\ & * 14.77 \text{ dB is correction factor (insufficient RBW).} \\ & * 60 \text{ dBuV/m is peak field strength @ 2 meters per 40dB/decade} \end{aligned}$$

$$\begin{aligned} P &= (E*d)^2/30G \\ &= (0.0057*3)^2/30 \\ &= 0.000009747 \text{ W} \end{aligned}$$

$$P = 0.00975 \text{ mW}$$

where:

E is the measured peak field strength

d=3 meters

G=1

P is the measured peak output power of the EUT.

**The measured value of 0.00975mW complies with the limit of 100mW.**

**Per 15.255(g) : This device is installed out-doors to fixed structure. The minimum distance between the antenna and any person during normal operation will always exceed 2 meters.**

$$\begin{aligned} P_d &= E^2/ 120*\pi \\ &= ( 60 + 10 + 14.77)^2/120*\pi \\ &= ( 0.01797* 0.01797)/377 \\ &= 0.00323/377 = 0.00000856 \text{ W/m}^2 = 0.856\mu\text{W/m}^2 = 0.0856\text{nW/cm}^2 \\ & *P_d \text{ is power density in W/m}^2 \text{ and E is field strength in V/m @ 2meters} \end{aligned}$$

**The MPE limit listed in Pt.1.1311 is 1mW/m<sup>2</sup>.**

**Per 15.255(h): There is no provision for the addition of external PLL device.**

**Per 15.255(I): This device's peak output power is 0.00975 mW which is less than 0.1mW  
 Therefore Tx ID is not required.**

**6.4 TEST TYPE:** Spurious Emissions**6.4.1 TECHNICAL SPECIFICATION:** 2.1051; 15.255 ©**6.4.2 TEST DATE(S):** 6/21/00**6.4.3 MEASUREMENT PROCEDURES:**

As required by §2.1051 of CFR 47, *spurious emissions measurements* were made at the RF output (in front of antenna) using a mixer and spectrum analyzer set for a 1MHz bandwidth. This test was performed with digitally modulated carrier signals. The spectrum analyzer was investigated from 33 GHz to 210 GHz. .

**6.4.4 RESULTS:**

Equipment complies with Section 2.1051 and 15.255 ©

The following plots are included to illustrate compliance with the requirements of 47 CFR Part 15.255 (c):

The pairs of spurs in the plots are the image of the intermodulation products of the external mixer. These are not actual emissions of the EUT.

There is no detectable spurious emissions between 33 GHz to 210 GHz (out-band).

The limit (out-band) for 40 GHz to 200 GHz is  $90 \text{ pW/cm}^2 = 85.3 \text{ dBuV @ 3 m}$   
 $= -21.5 \text{ dBm @ 3 meter}$

The highest noise floor of the measurement system is -50 dBm.

There is no detectable inband spurious emissions within the 57-64 GHz band.

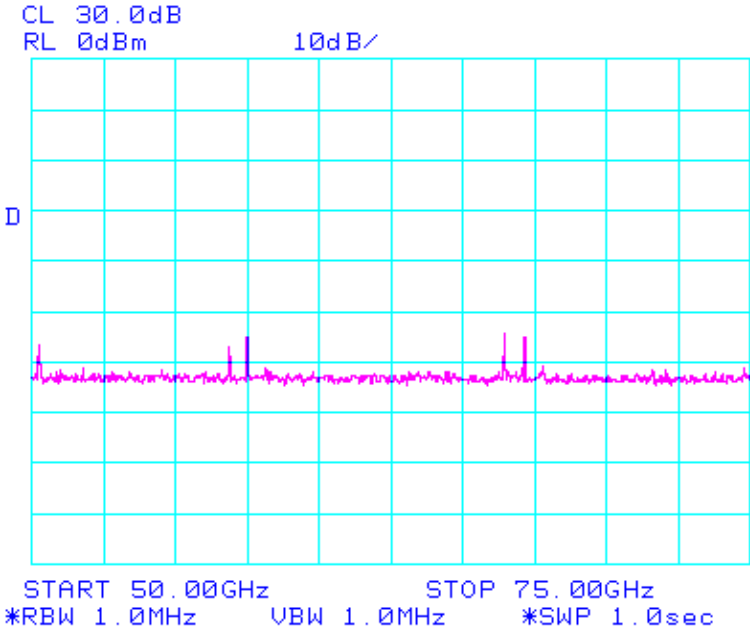
The limit for the average power density of any emissions (in-band):

$$9 \mu\text{W/cm}^2 = 9 \times 10,000/\text{m}^2 = 90 \text{ mW/m}^2 = (377 \times 0.09) \text{ ee}^{(1/2)} = 135.3 \text{ dBuV/m @ 3m}$$

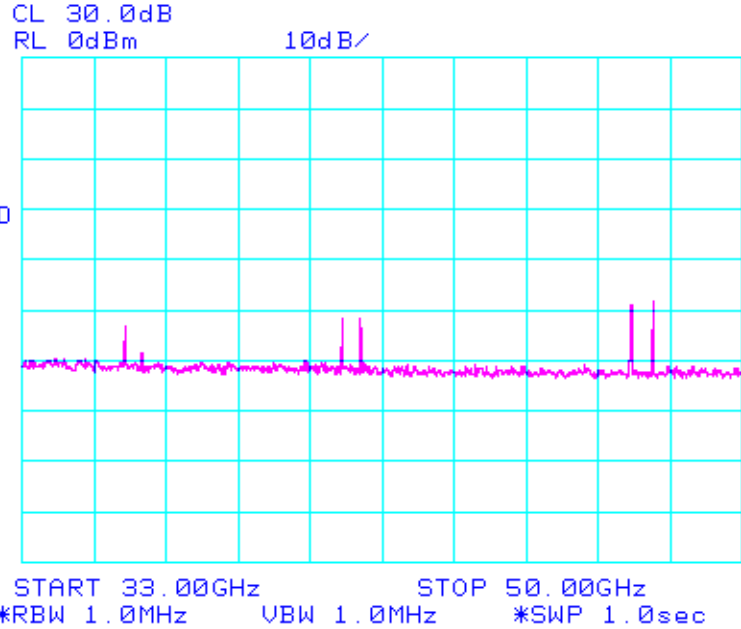
The limit for the peak power density of any emissions ( in-band):

$$18 \mu\text{W/cm}^2 = 18 \times 10,000/\text{m}^2 = 180 \text{ mW/m}^2 = (377 \times 0.18) \text{ ee}^{(1/2)} = 138.3 \text{ dBuV/m @ 3m}$$

Spur emissions emi9754



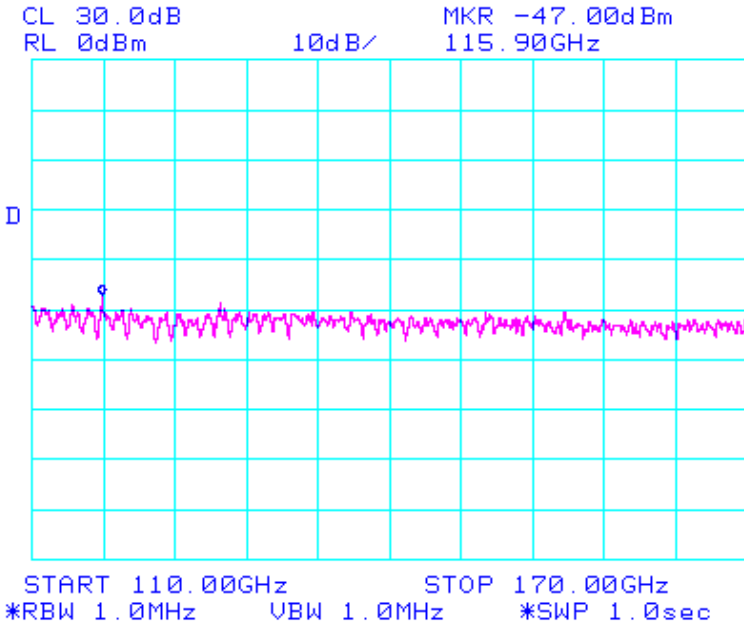
Spur emission emi9754



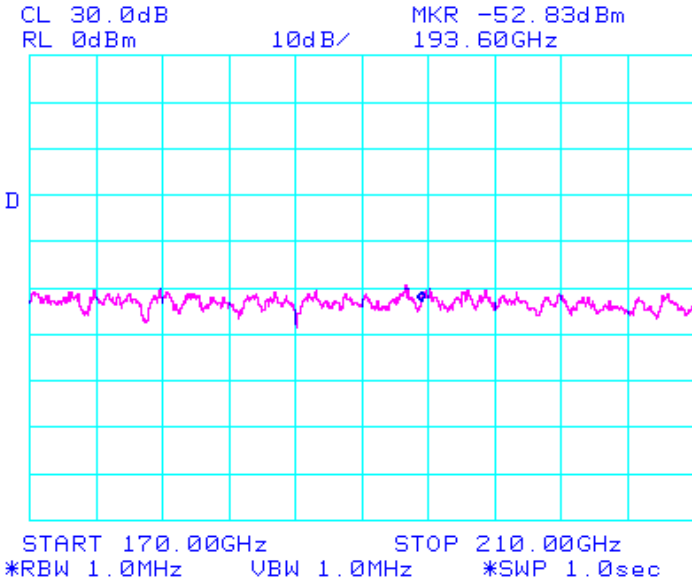




Spur emissions emi9754



Spur emissions emi9754



**6.6 TEST TYPE:** Frequency Stability over Temperature Variations**6.6.1 TECHNICAL SPECIFICATION:** 15.255 (f)**6.6.2 TEST DATE(S):** 6/21/00**6.6.3 MEASUREMENT PROCEDURES:**

As required by §15.255(f) of CFR 47, *frequency tolerance measurements* were made over the temperature range of -20EC to +50EC. The frequency measurements were made using direct input to a spectrum analyzer. Climatic control was accomplished using an environmental simulation chamber. The temperature was first lowered to -20EC and then raised hourly in 10E increments. The unit remained in the chamber during temperature transitions and during the measurement process.

**6.6.4 Results:**

Frequency tolerance of carrier signal: +/- 0.005% for a temperature variation from -20EC to +50EC at normal supply voltage. The signal is required to remain within the intended frequency band of 57.0 to 64.0GHz. This EUT operates from 57.2GHz to 58.2GHz with an emission bandwidth of only 20MHz. This EUT would need to deviate more than 180MHz in order to be considered non-compliant. The deviation measured was less than 0.006 MHz, and thus is compliant with the requirements.

**CARRIER FREQUENCY DEVIATIONS DUE TO TEMPERATURE INSTABILITY**

Temperature (EC)	Carrier Frequency (CH 661) (GHz)	Frequency Deviation (kHz)
-20	57.25017077	0.253
-10	57.25017082	0.258
0	57.25016896	0.072
+10	57.25016797	-0.027
+20	57.25016824	0
+30	57.25016600	-0.224
+40	57.25014790	-2.034
+50	57.25010427	-5.397

The unit meets the requirements of 15.255 (f)

**6.7 TEST TYPE:** Frequency Stability over Voltage Variations**6.7.1 TECHNICAL SPECIFICATION:** 15.255 (f)**6.7.2 TEST DATE(S):** 6/21/00**6.7.3 MEASUREMENT PROCEDURES:**

As required by §15.255 (f) of CFR 47, *frequency tolerance measurements* were made over changes in the supply voltage to the EUT from 85% to 115% of the nominal supply voltage using a variac to vary the AC supply. The frequency measurements were made using direct input to a spectrum analyzer.

**6.7.4 Results:**

Frequency tolerance of carrier signal:  $\pm 0.005\%$  for a variation in primary voltage from 85% to 115% of the **rated supply**.

Percentage of Rated Supply	AC Voltage (VAC @ 60 / 50 Hz)	Carrier Frequency (GHz)	Deviation (kHz)
85 %	93.5	57.250041314	0.086
100 %	110 / 230	57.250041228	0
115 %	276	57.250041659	0.413

The unit meets the requirements of 15.255(f)

**6.8 TEST TYPE:** Line Conducted Emissions**6.8.1 TECHNICAL SPECIFICATION:** 15.107(a)**6.8.2 TEST DATE(S):** 6/22/00**6.8.3 MEASUREMENT PROCEDURES:**

The measurements were performed over the frequency range of 0.45 MHz to 30 MHz using a 50 S /50  $\mu$ H LISN as the input transducer to an EMI/Field Intensity Meter. The measurements were made with the detector set for "peak", "quasi-peak", and "average" amplitude within an IF bandwidth of 9 kHz. The tests were conducted in a RF-shielded enclosure. In addition, they were tested with two different power supplies, Original(Artesyn) and Efore.

**6.8.4 RESULTS:**

Equipment complies with Section 15.107(a)

**ORIGINAL POWER SUPPLY****SUMMARY OF SPURIOUS EMISSIONS AT AC Mains Terminals (110v) - Phase**

Frequency (MHz)	Emission Quasi-Peak Level (dBuV)	Limit (dBuV)
12.290	30.4	48.0
14.337	28.5	48.0
10.719	23.6	48.0

**SUMMARY OF SPURIOUS EMISSIONS AT AC Mains Terminals (110v) - Neutral**

Frequency (MHz)	Emission Quasi-Peak Level (dBuV)	Limit (dBuV)
12.289	30.7	48.0
14.337	28.1	48.0
10.159	23.4	48.0

**EFORE POWER SUPPLY****SUMMARY OF SPURIOUS EMISSIONS AT AC Mains Terminals (110v) - Neutral**

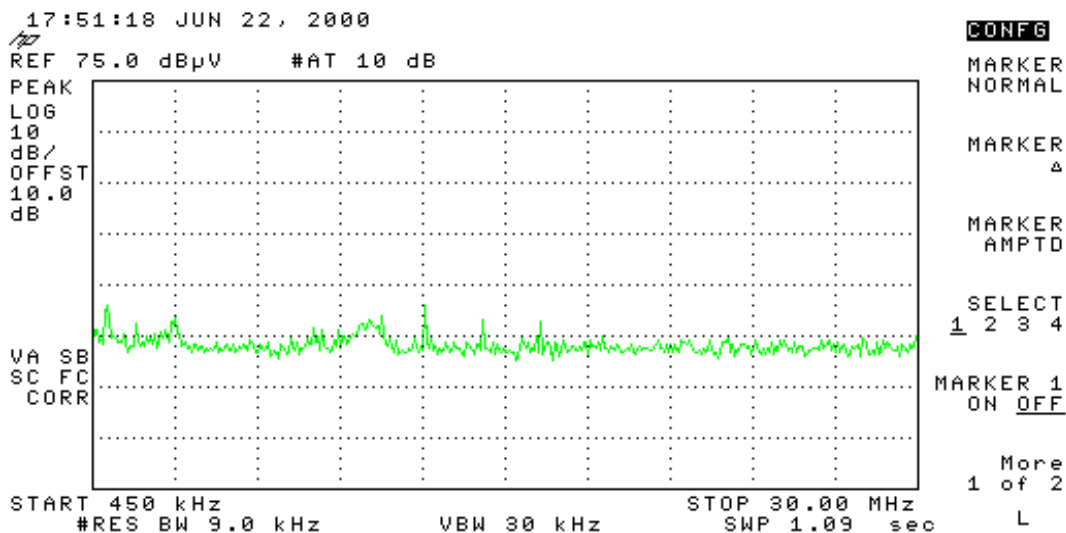
Frequency (MHz)	Emission Quasi-Peak Level (dBuV)	Limit (dBuV)
12.289	37.2	48.0
1.012	31.3	48.0
14.336	32.5	48.0

**SUMMARY OF SPURIOUS EMISSIONS AT AC Mains Terminals (110v) -Phase**

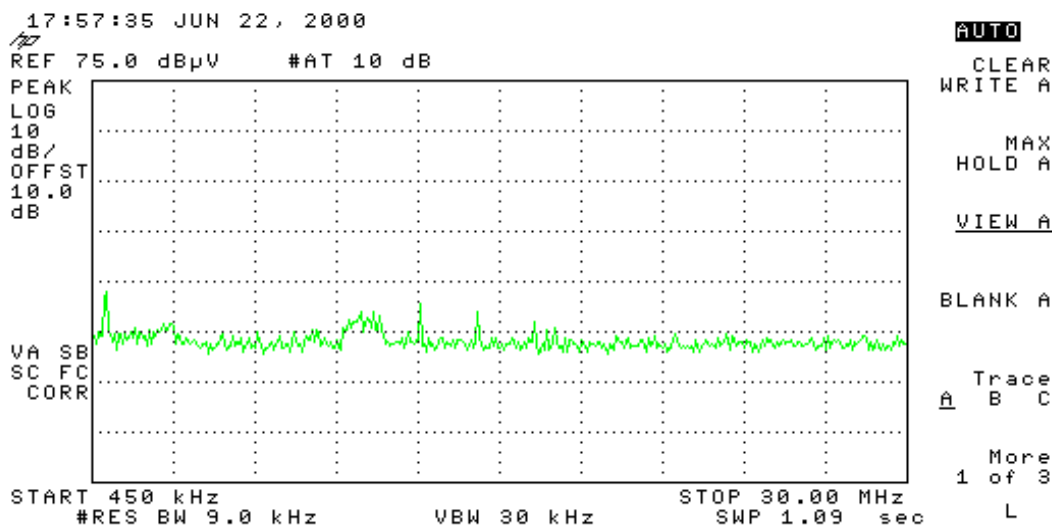
Frequency (MHz)	Emission Quasi-Peak Level (dBuV)	Limit (dBuV)
12.288	36.6	48.0
14.338	32.2	48.0
1.009	29.6	48.0

The following plots illustrate compliance with the applicable specification.

Phase emi9754 MetroHub with MetroHopper

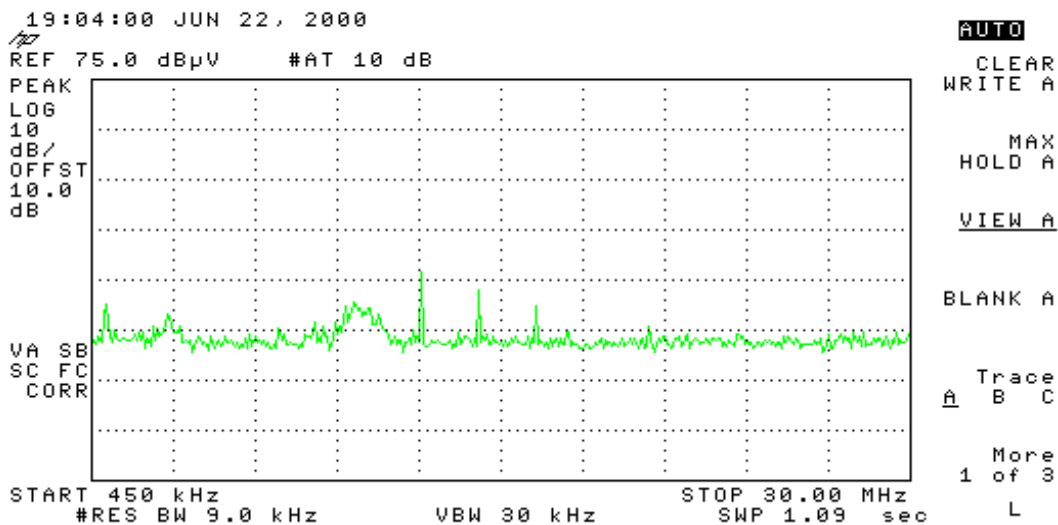


Neutral emi9754 MetroHub with MetroHopper





**Efore Phase emi9754** MetroHub with MetroHopper



**Efore Neutral emi9754** MetroHub with MetroHopper

