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Test & Consulting Services for Commercial, Military, International Compliance
P.O. Box 1086
El Granada CA 94018

CERTIFICATION TEST REPORT FOR A 2400-2483.5 MHz DSSS TRANSCEIVER

Applicant: Utilicom Inc.

FCC ID: LFO-LR2050

Operating Frequency: 2407.780 - 2476.900 MHz

RF Output Power: 0-28 dBm

FCC Rule Part: 15.247

Used For: Data link

Power Source: 120 AC

Test Location: Compliance Consulting Services
951F Monterey Road
Morgan Hill, CA 95087

All tests were performed by me or under my supervision. The LFO-LR2050 meets all emissions and modulation requirements specified under Parts 2 and 15 of the Commission's Rules, as well as those specified in RSS-210 and RSP-100 for operation in Canada.

THOMAS N. COKENIAS

23 September 1998

EXHIBITS

EXHIBIT A: Test Configurations and Rationale

EXHIBIT B: Circuit Information (Confidentiality Requested per Rule section 0.459)

B1: Schematics

B2: Block Diagrams

B3: Theory of Operation

EXHIBIT C: Product Photographs

EXHIBIT D: User Manual and FCC ID Label

EXHIBIT E: Channel Frequency Assignment List

EXHIBIT F: Description of Antennas and Antenna Connector Per 15.203

EXHIBIT G: Report of Measurements

EXHIBIT A: Test Configurations and Rationale

TEST CONFIGURATIONS AND RATIONALE

The maximum allowed output power depended on data rate and antenna type being used. Limiting factors were power spectral density (PSD) at a given output power setting, on antenna gain, and on the amplitude of emission bandedge energy in restricted bands starting at 2483.5 MHz and 2390 MHz.

Tests were performed using the following antennas:

Antenna Type	Make and Model	Gain
omni rod	Mobilmark OD9-2400-24	8 dBi
yagi	Cushcraft PC2415	15 dBi
dish reflector	Cal Amp dish 130094, feed 1300135	24 dBi

SUMMARY OF MAXIMUM ALLOWED TRANSMITTER SETTINGS

	8 dBi	17 dBi	25 dBi	LR2050	Rule Ref.
				Power level	
				Setting	
	P2P/P2MP	P2P/P2MP	P2P/P2MP	P2P/P2MP	
Ch 5	30 dBm/28dBm	27 dBm/19dBm	24 dBm/11 dBm	6	15.205
Ch 6				7	
Ch 7				7	
Ch 8				INVALID	
Ch 9				INVALID	
Ch10				7	
Ch 11				7	
Ch 12				7	
Ch 13				8	
Ch 22	30 dBm/28dBm	27 dBm/19dBm	24 dBm/11 dBm	15	15.247(b)3
Ch 40				11	
Ch 41				10	
Ch 42				10	
Ch 43				10	
Ch 44				8	
Ch 45				7	
Ch 46				7	
Ch 47				6	
Ch 48				6	
Ch 49				-	
Ch 50	30 dBm/28dBm	27 dBm/19dBm	24 dBm/11 dBm	-	15.205

These radios are all professionally installed and maintained, they are not sold to the general public or to hobbyists.

EXHIBIT B: Circuit Information (Confidentiality Requested)

B1: Schematics

B2: Block Diagrams

B3: Theory of Operation

B1: Schematics

B2: Block Diagrams

EXHIBIT C: Theory of Operation

EXHIBIT C: Product Photographs

EXHIBIT D: User Manual and FCC ID Label

EXHIBIT E: Channel Frequency Assignment List
(from page 18 of User Manual)

Channel Frequency Correspondence

Channel	Frequency (KHz)	Channel	Frequency (KHz)	Channel	Frequency (KHz)
5	2,407,780	21	2,432,356	37	2,456,932
6	2,409,316	22	2,433,892	38	2,458,468
7	2,410,852	23	2,435,428	39	2,460,004
8	2,412,388	24	2,436,964	40	2,461,540
9	2,413,924	25	2,438,500	41	2,463,076
10	2,415,460	26	2,440,036	42	2,464,612
11	2,416,996	27	2,441,572	43	2,466,148
12	2,418,532	28	2,443,108	44	2,467,684
13	2,420,068	29	2,444,644	45	2,469,220
14	2,421,604	30	2,446,180	46	2,470,756
15	2,423,140	31	2,447,716	47	2,472,292
16	2,424,676	32	2,449,252	48	2,473,828
17	2,426,212	33	2,450,788	49	2,475,364
18	2,427,748	34	2,452,324	50	2,476,900
19	2,429,284	35	2,453,860		
20	2,430,820	36	2,455,396		

Number of Non-Overlapping Channels	Suggested Channel Allocation	Frequency Separation
3	5, 27, 49	33,792
4	5, 20, 35, 50	23,040
5	5, 16, 27, 38, 49	16, 896
6	5, 14, 23, 32, 41, 50	13,824

EXHIBIT F: Description of Antennas and Antenna Connector

Per FCC Rule Para. 15.203

Note: EUT is professionally installed, therefore standard N-type antenna and cable connectors are used. Power levels are also set by the installer.

Antenna Type	Make and Model	Gain
omni rod	Mobilmark OD9-2400-24	8 dBi
yagi	Cushcraft PC2415	15 dBi
dish reflector	Cal Amp dish 130094, feed 1300135	24 dBi

EXHIBIT G: Report of Measurements

EMISSIONS TEST REPORT FOR A LOW POWER TRANSMITTER

I. GENERAL INFORMATION

Requirement: FCC: 47CFR, Parts 2 and 15
Industry Canada: RSS-210 and RSP-100

Applicant: Utilicom Inc.
323 Love Place
Goleta, CA 93117

Product ID: U.S.: FCC ID: LFO-LR2050

Model Numbers: LR2050, LR2040

II. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

The Utilicom radios are 2400 - 2483.5 MHz direct sequence spread spectrum (DSSS) transceiver links for data transmission.

III. TEST LOCATION

All emissions tests were performed at:

Compliance Consulting Services
561F Monterey Road
Morgan Hill, CA 95087
Phone: 408-752-8166 Fax: 408-752-8168

CCS has site descriptions on file with the FCC for 30 m, 10m and 3m site configurations. CCS is a NVLAP accredited facility.

Radiated emissions from the digital portion of the EUT were performed on site B, one of the 3m/10 m sites.

IV. TEST PROCEDURES

Radiated Emissions

Test Requirement: FCC: 15.205, 15.209

Industry Canada: RSS-210, 6.3

Measurement Equipment Used:

HP 8563E Spectrum Analyzer

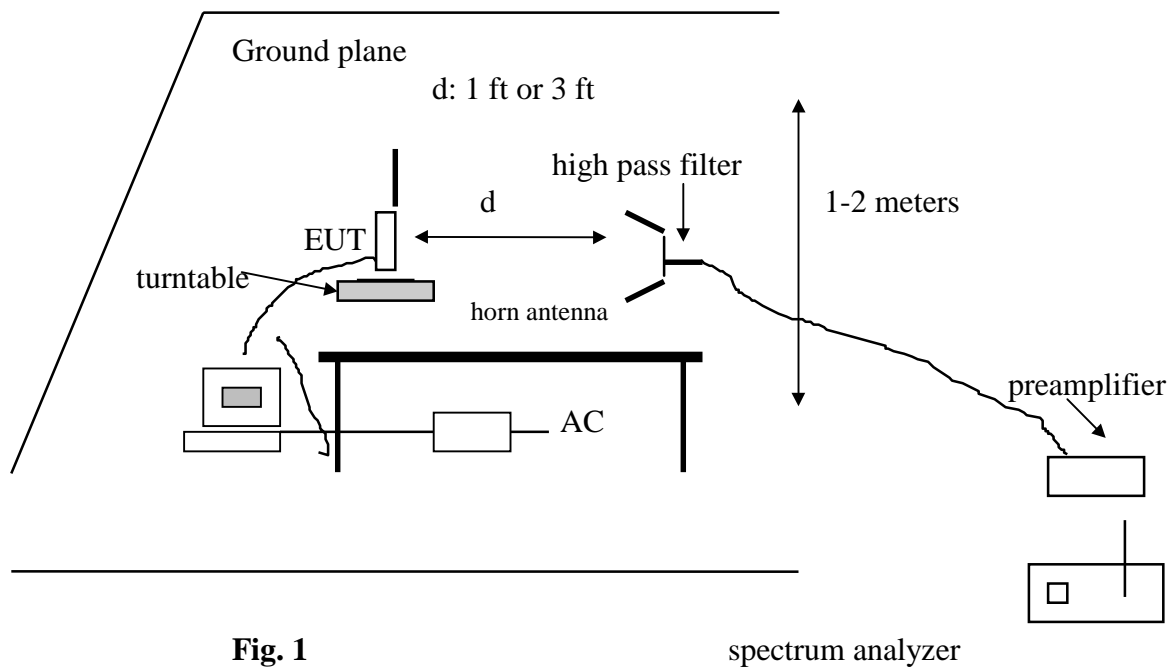
HP 8449 B Preamplifier, 1-26 GHz

ARA DRG-118/A Double Ridged Horn antenna, 1 - 18 GHz

Flexco low loss cable, 9 ft (loss: 0.85 dB/ft@ 26 GHz)

FSY high pass filter ($f_o = 1800$ MHz)

Test Set-Up



Test Procedures

1. For each radio model, the EUT was set to LOW channel and was placed on a wooden table on the outdoor ground plane. The search antenna was placed 3 ft from the EUT. The EUT antenna was mounted vertically as per normal installation.

2. The turntable was slowly rotated to locate the direction of maximum emission at each emission falling in the restricted bands of 15.205.
3. Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded in the data listed below.
4. Steps 1 - 3 were repeated for MID and HIGH channels.

Test Results: Refer to attached tabular data sheets

AC Line Conducted Emissions

Test Requirement: FCC: 15.107, 15.207

Industry Canada: RSS-210, 6.6

Measurement Equipment Used:

Rohde & Schwarz EMI Receiver ESHS-20

Fischer Custom Communication LISN, FCC-LISN-50/250-25-2

Test Set-up

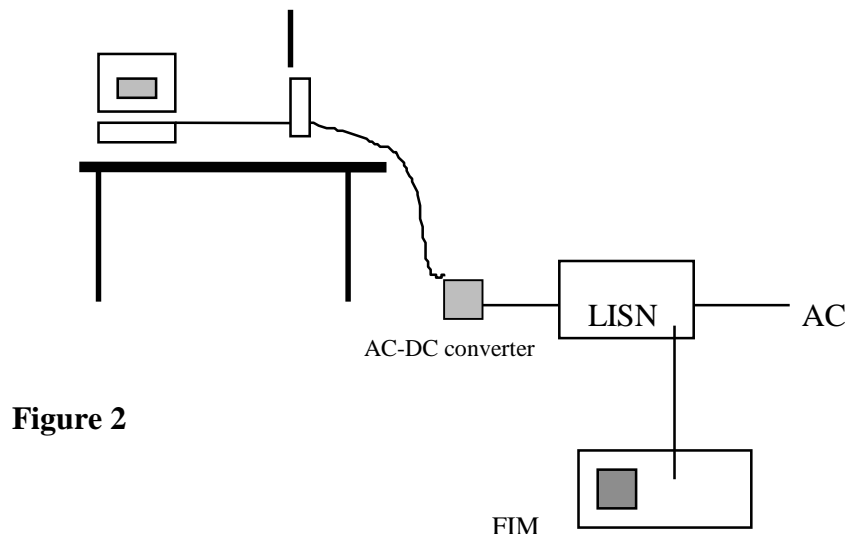


Figure 2

Test Procedure

1. For each radio model, the EUT was placed on a wooden table 40 cm from a vertical ground plane and approximately 80 cm above the horizontal ground plane on the floor. The EUT was set to transmit on MID channel.

2. Line conducted data was recorded for both NEUTRAL and HOT lines.

Test Results

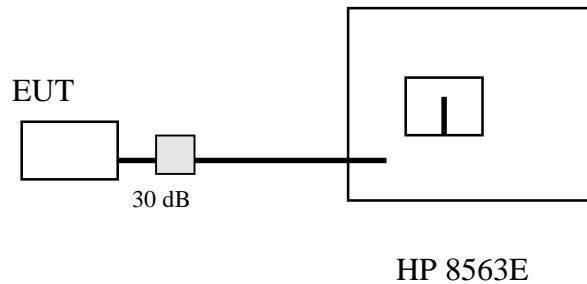
Refer to attached graph and tabular data sheet.

Minimum 6 dB Bandwidth for DSSS**Test Requirement: FCC: 15.247(a)2****Measurement Equipment Used:**

HP 8563E Spectrum Analyzer

Narda Coaxial attenuator, 30 dB, DC-12.6 GHz

Flexco low loss cable, 3ft (loss: 0.85 dB/ft@ 26 GHz)

Test Set-up**Figure 3****Test Procedures**

1. For each radio model the EUT was configured on a test bench as shown in Figure 3. The transmitter was set to a MID channel. While the transmitter broadcast a steady stream of digital data, the analyzer MAX HOLD function was used to capture the envelope of the transmission occupied bandwidth.
2. The process in (1) was repeated for LOW and HIGH channels.

Test Results: Refer to attached spectrum analyzer charts.

RF Power Output**Test Requirement: FCC: 15.247(b)****Industry Canada: RSS-210, 6.2.2(o)(b)(3)****Measurement Equipment Used:**

HP 435B RF Power Meter

HP 8481A RF Power Sensor

Test Procedures

1. For each radio model the EUT was configured on a test bench and the sensor of the power meter was connected directly to the antenna port.. The EUT was set to transmit on LOW channel. While the transmitter broadcast a steady stream of digital data, the maximum power level was recorded.
2. The process in (1) was repeated for MID and HIGH channel.

Test Results

Channel	Frequency, MHz	Output Power, dBm
5	2407.78	24.5
22	2433.89	25.8
50	2476.90	22.0

Out of Band Measurements

Test Requirement: **FCC: 15.247(c)**
 Industry Canada: RSS-210, 6.2.2(o)(a)4

Measurement Equipment Used:

HP 8563E Spectrum Analyzer
Narda coaxial attenuator, 30dB, DC-12.6 GHz
Flexco low loss cable, 3ft (loss: 0.85 dB/ft@ 26 GHz)

Test Set-up

Refer to Figure 3.

Test Procedure

1. For each radio model the EUT was set to transmit continuously at LOW channel.
2. Spectrum analyzer RES BW was set to 100 kHz, the MAX HOLD function was engaged. While the EUT was transmitting, the range 1 MHz - 248350 MHz was scanned continuously to capture all out-of-band transmitter emissions and compare their levels in relation to a display line placed 20 dB below the maximum amplitude of the transmitter.
3. The procedure was repeated for MID and HIGH channels.

Test Results

Refer to attached spectrum analyzer graphs.

Power Spectral Density Measurement**Test Requirement: FCC: 15.247(d)****Industry Canada: RSS-210, 6.2.2(o)(b)1****Measurement Equipment Used:**

Measurement Equipment Used:

HP 8563E Spectrum Analyzer

Narda coaxial attenuator, 30dB

Flexco low loss cable, 3ft (loss: 0.85 dB/ft@ 26 GHz)

Test Set-up

Refer to Figure 3.

Test Procedure

For each radio model the EUT was set to transmit on LOW channel. The center frequency of the spectrum analyzer was set to the frequency at which the peak of the output power envelope was located. The SPAN was decreased to 300 kHz, while making sure that the peak of the output power envelope was still at screen center. The RES BW and VID BW were set to 3 kHz, the SWEEP was set to 100 seconds, and the resultant trace was recorded and compared to a display line set to the 8 dBm limit.

The test was repeated for MID and HIGH channels.

Test Results

Refer to attached spectrum analyzer graphs.

Process Gain Measurement

Test Requirement: **FCC: 15.247(e)**
 Industry Canada: RSS-210, 6.2.2(o)(b)2

Performed by manufacturer. Refer to attachment.

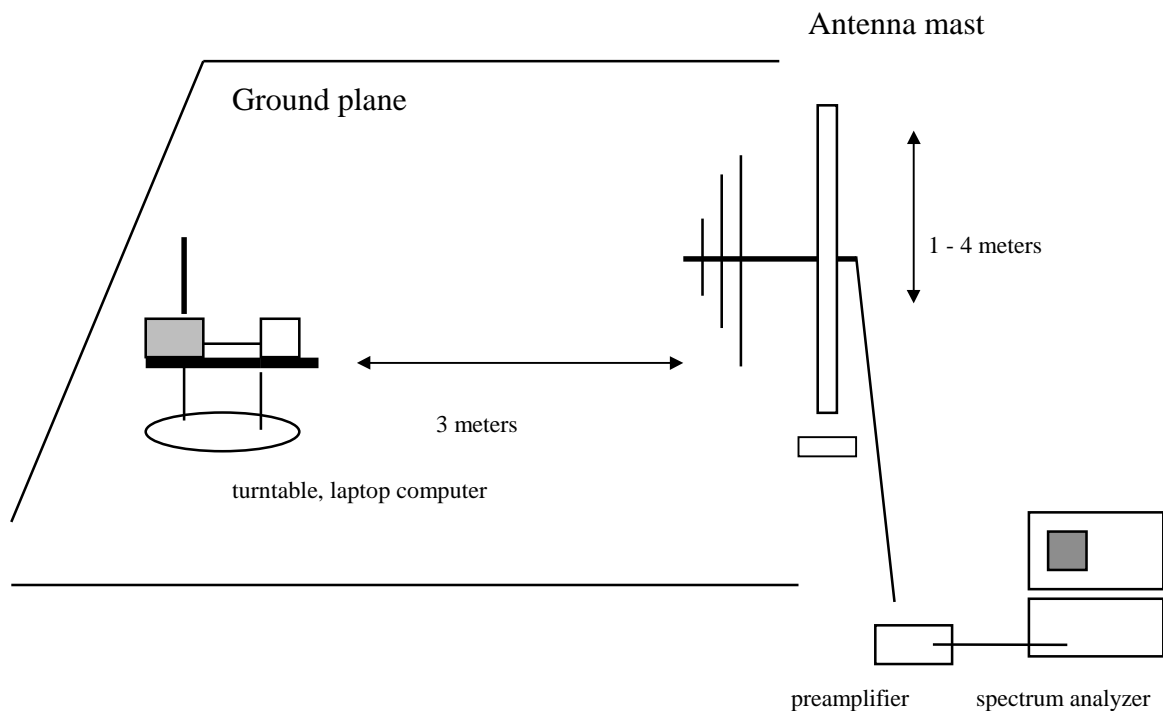
Radiated Emissions from ITE Portion of EUT**Test Requirement:****FCC: 15.109****Industry Canada: ICES-003, 5.3****Measurement Equipment Used:**

HP 8568A Spectrum Analyzer

HP 8447D Preamplifier

Eaton 94456-1 Biconical Antenna, 20 - 200 MHz

EMCO 3146 Log Periodic Antenna, 200 - 1000 MHz

Test Set-up**Fig. 5****Test Procedure**

The EUT was set to RECEIVE mode. Radiation emissions from the digital portion of the EUT were measured according to the dictates of EN55022, class B limits.

Test Results

Refer to tabulated data sheet.

V. CERTIFICATION OF DATA

All radiated and conducted measurements described in this report were performed by, or were witnessed and supervised by, the undersigned. To the best of his knowledge and belief, test equipment calibrations, test procedures, and test data were accurate and as reported here.

T.N. COKENIAS

23 September 1998

SET-UP PHOTOGRAPHS, DATA SHEETS, CHARTS, AND GRAPHS

RADIATED EMISSIONS, RESTRICTED BANDS - SET-UP PHOTOS

- see separate attachments-

RADIATED EMISSIONS, RESTRICTED BANDS - SET-UP PHOTOS

- see separate attachments-

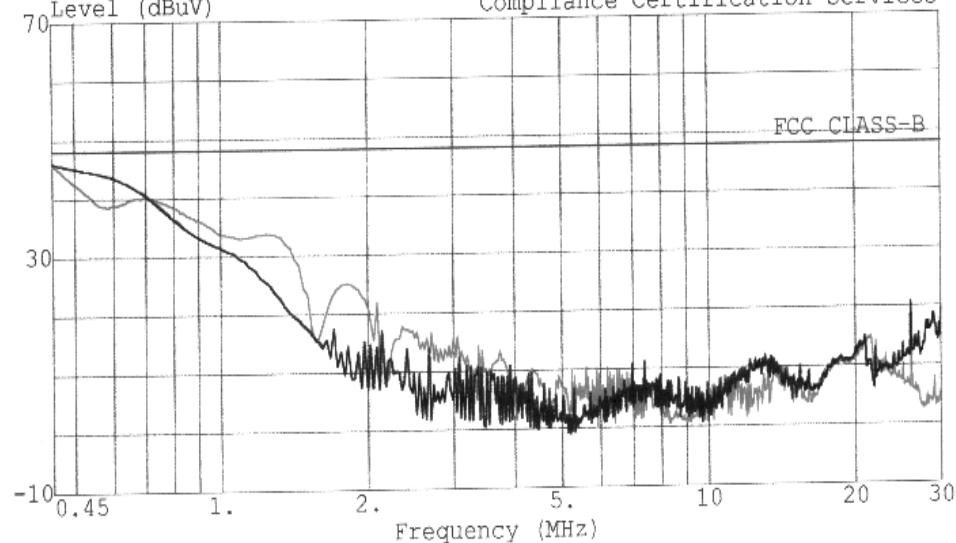
RADIATED EMISSIONS, RESTRICTED BANDS - SPREAD SHEETS

- see separate attachments-

CONDUCTED EMISSIONS - DATA SHEETS AND GRAPHS

1366 Bordeaux Dr.
Sunnyvale, CA 94089-1005 USA
Tel: (408) 752-8166
Fax: (408) 752-8168

Data#: 12 File#: 99U0510.EMI Date: 08-24-1999 Time: 09:12:20
Level (dBuV) Compliance Certification Services



Trace: 5
Project No. : 99U0510-1
Report No. : 990823LC
Test Engr : Jesse Saldivar Jr. *JS*
Company : Utilicom
EUT : LR2050
Test Config.: EUT/Laptop/Indoor Long Ranger 2050
Type of Test: FCC 15.247
Mode of Op. : TX/RX
Mode of Op. : QUASI-PEAK: L1 (Green), L2 (Black)
: 110VAC 60Hz

Ref Trace:

Utilicom Line Conducted Emissions:

Preliminary Conducted Emission Test			
Mode of operation	Date	Data Report/Plot No.	Worst Mode
NORMAL	8/24/99	990824	<input checked="" type="checkbox"/>

Final Conducted Emission Test:

Conducted Room	Plot No. 990824	Date 8/24/99	Tested By: JESSE SALDIVAR JR
Six Highest Conducted Emission Readings			

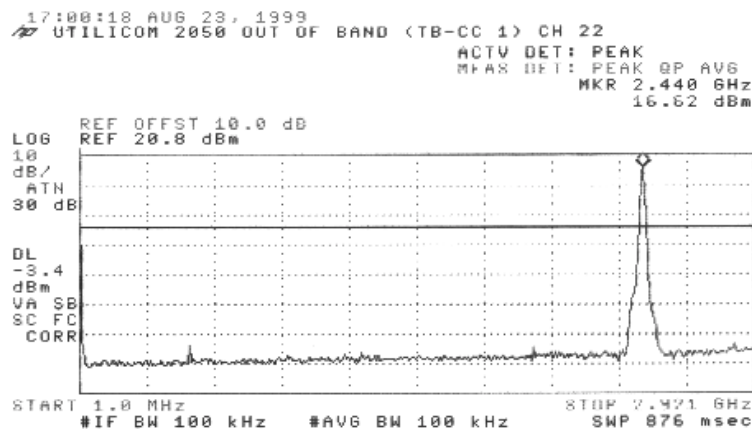
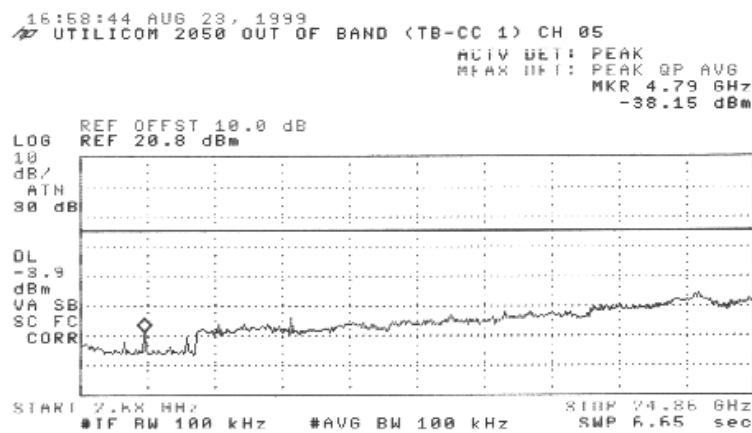
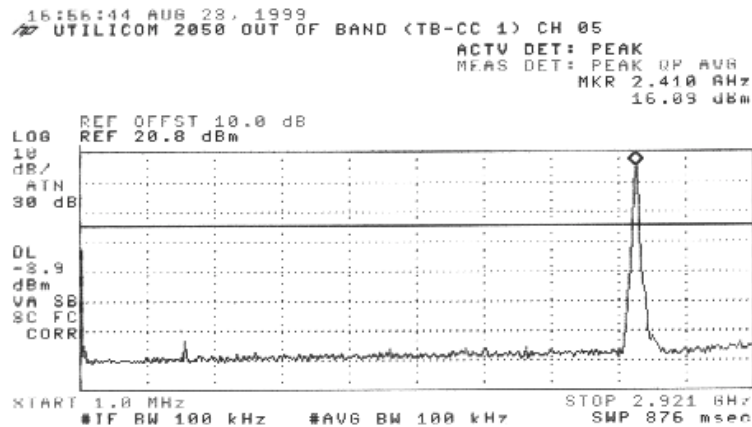
Freq. (MHz)	Reading (dBuV)	C.F, (dB)	Reading (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Type (P/Q/A)	Line (L1/L2)
0.45	45.62	0	45.62	48	-2.38	P	L1
0.696	40.07	0	40.07	48	-7.93	P	L1
1.24	33.7	0	33.7	48	-14.3	P	L1
0.45	46.02	0	46.02	48	-1.98	P	L2
0.614	43.3	0	43.3	48	-4.7	P	L2
1.04	30.72	0	30.72	48	-17.28	P	L2

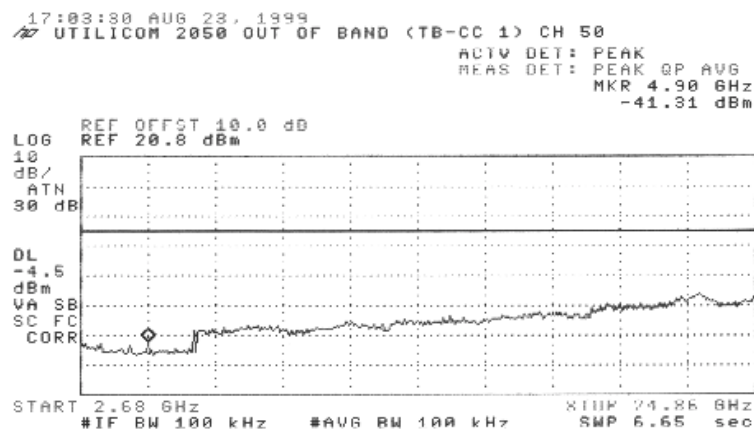
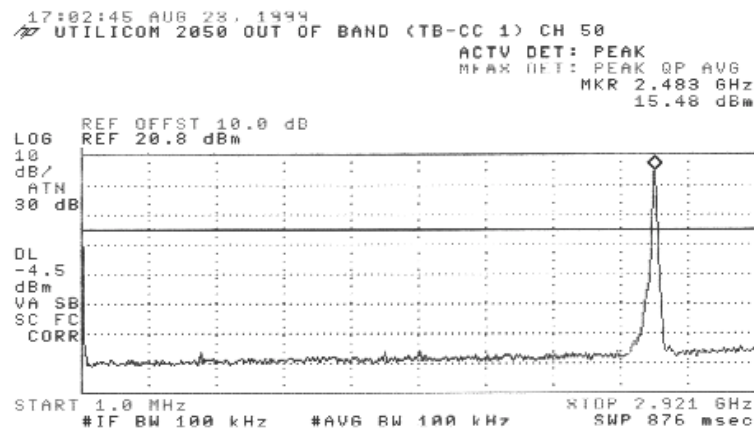
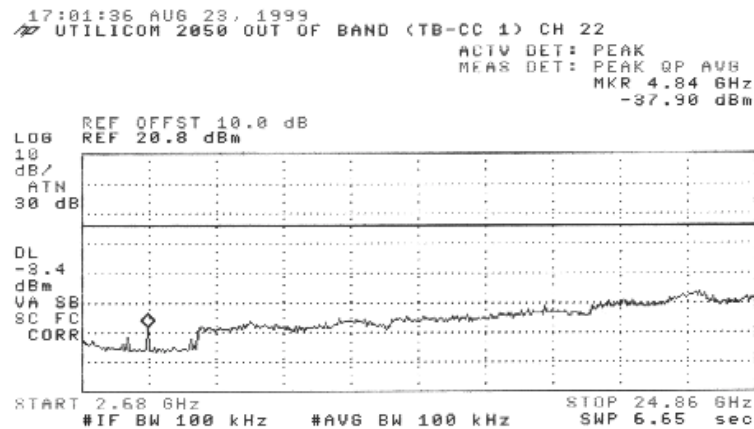
COMMENTS: N/A

MAXIMUM 6 dB BANDWIDTH

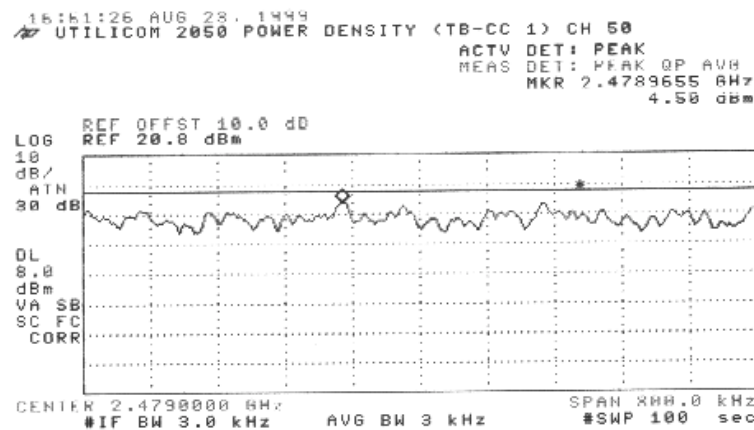
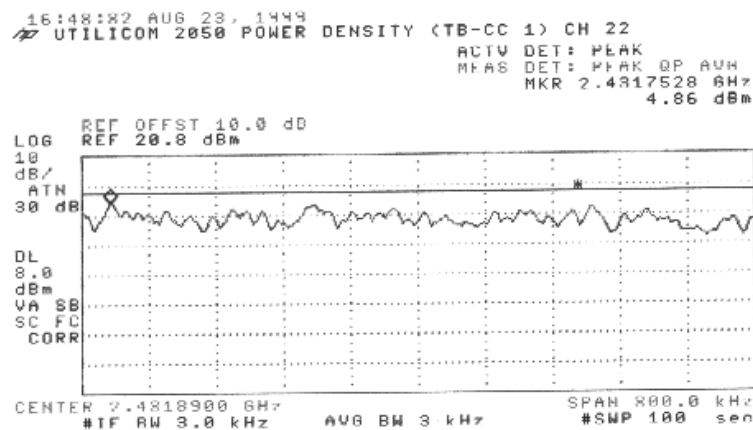
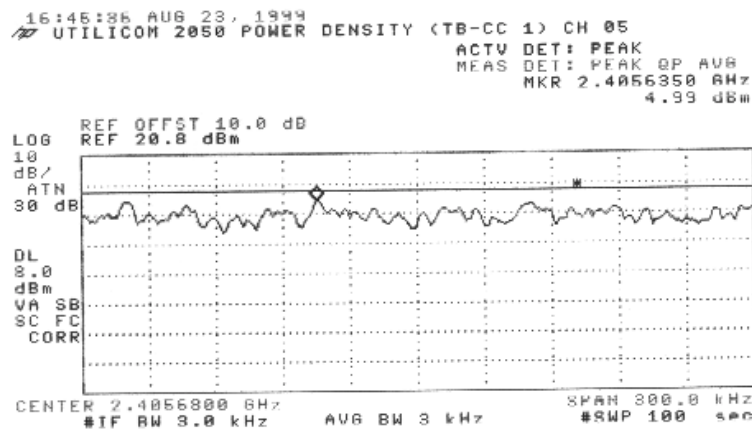
- see separate attachments-

OUT OF BAND MEASUREMENTS





POWER DENSITY MEASUREMENTS



PROCESSING GAIN

Testing performed, results supplied by the manufacturer.

See separate attachments

RADIATED EMISSIONS FOR ITE PORTION OF EUT

Compliance Engineering Services Inc.

Project No. : 99U0510

Report No. : 990826C1

Date : 08/26/1999

Time : 16:31

Test Engr : JESSE

>> 3 M RADIATED EMISSION DATA <<

Company : UTILICOM
Equipment Under Test : LR2050
Test Configuration : EUT/LAPTOP PC
Type of Test : FCC CLASS B
Mode of Operation : NORMAL

Freq.	dBuV	PreAmp	Ant	Cable	dBuV/m	Limit	Margin	Pol	Hgt (m)	Az
Biconical 1214 ; Pre-pamp = 8447D-P5 2944A06550:										
80.00	49.90	-27.34	8.83	1.14	32.53	40.00	-7.47	V	1.0	180
LP 9107-3163 ; Pre-pamp = 8447D-P5 2944A06550:										
225.00	47.32	-26.74	12.03	1.94	34.56	46.00	-11.44	V	1.0	180
480.00	49.50	-27.74	16.96	2.99	41.71	46.00	-4.29	V	1.0	180
225.00	53.00	-26.74	12.12	1.94	40.33	46.00	-5.67	H	1.0	180
250.00	51.40	-26.59	12.48	2.06	39.35	46.00	-6.65	H	1.0	180
300.00	52.00	-26.60	14.64	2.33	42.37	46.00	-3.63	H	1.0	180

COMPLETED SCAN FROM 30MHz TO 1GHz IN VERTICAL AND HORIZONTAL POLARIZATIONS.

Total # of data 6
V. c2.2