



Project: 03CA18244
File: MC1884
Report: 030218
Date: July 12, 2003
Model: 9320 Release 1
RFID Reader
(FCC ID: QRKHI46320)

Test Report

For

FCC/Canada Compliance

Samsys Technologies, Inc.

Durham, NC USA

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Test Report Details:

Tests Performed By:	Underwriters Laboratories Inc. 12 Laboratory Drive Research Triangle Park, NC 27709
Tests Performed For:	Samsys Technologies, Inc. 2525 Meridian Parkway Lake Level Suite 60 Durham, NC 27713 USA
Applicant Contact:	Mr. Marv Baker (919) 281-1549
Test Report Number:	030218
Test Report Date:	July 12, 2003
Product Type:	RFID tag reader
Model Number:	9320 Release 1
Sample Serial Number:	Production Sample
Sample Tag Number:	S03LB25441
EUT Category:	Transmitter - Low Powered
EUT Type:	Wall Mounted
Sample Receive Date:	June 17, 2003
Testing Start Date:	June 24, 2003
Date Testing Complete:	July 7, 2003

Underwriters Laboratories Inc. reports apply only to the specific samples tested under stated test conditions. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. Underwriters Laboratories Inc. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from Underwriters Laboratories Inc. issued reports. This report shall not be used to claim, constitute or imply product certification, approval, or endorsement by NVLAP, A2LA, or any agency of the US government.

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Summary of Testing:

Test #	Test Name Test Requirement/Specification	Comply	Does Not Comply	See Remark
1	Conducted Emissions - Conducted Power 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C - Section 15.247	X	-	
2	Conducted Emissions - Spurious Emissions 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C - Section 15.247	X	-	
3	Radiated Emissions - Spurious Emissions and Restricted Bands 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C Sections 15.247 and 15.209	X	-	
4	Radiated Disturbance Emissions - Occupied Bandwidth, Channel Spacing, etc 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C, Section 15.247	X	-	
5	Radiated Disturbance Emissions - 30 to 1000 MHz Electric Field 47 CFR Part 15, Subpart B / 47 CFR Part 15, Subpart B, Class A	X	-	
6	Conducted Disturbance Emissions - Voltage 47 CFR Part 15, Subpart B / 47 CFR Part 15, Subpart B, Class A 47 CFR Part 15, Subpart C / 47 CFR Part 15, Subpart C, Part 15.207	X	-	
7	Radiated Disturbance Emissions - 1 to 40 GHz Electric Field 47 CFR Part 15, Subpart B / 47 CFR Part 15, Subpart B, Class A	X	-	
8	Maximum Permissible Exposure 47 CFR Part 1 / 47 CFR Part 1.1307	X	-	

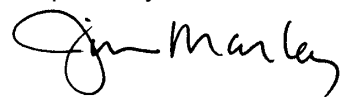
Remarks:

- 1) Test Methods followed are consistent with ANSI C63.4:2001 where applicable
- 2) Modifications Required to Comply: None.
- 3) This unit is required to be professionally installed. Output power is determined during installation to compensate for antenna gain and cable loss. Antenna does not require unique antenna connectors because it is professionally installed.
- 4) Device is found to comply with FCC rules for a frequency hopping spread spectrum transmitter/receiver in Part 15.247.
- 5) Device is found to comply with Restricted Band rules in Part 15.209.
- 6) Compliance with Maximum Permissible Exposure requirements, OET Bulletin 65 Supplement C. Device is capable of power density in excess of FCC limits in the uncontrolled/general environment. Installation instructions specify minimum spacing for the actual EIRP of the installation.
- 7) EMC Sensitive components: Ferrite molded onto power cable (between AC-to-DC adapter and transmitter).
- 8) This report also satisfies requirements of the following similar Canadian standards:
 - a. RSS-210 Low-Powered Unlicensed Radio Equipment
 - b. RSS-102 RF Exposure Rules
 - c. ICES-003 Interference from Digital Apparatus
- 9) Canadian Emissions Designator is determined to be: L1DBT101K.

Conclusion:

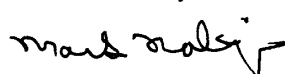
The tests listed in the Summary of Testing section of this report have been performed and the results recorded by Underwriters Laboratories Inc. in accordance with the procedures stated in each test requirement and specification. The test list was determined by the Applicant as being applicable to the Equipment Under Test. As a result, the subject product has been verified to comply or not comply as noted in the Summary of Testing with each test specification. The test results relate only to the items tested.

Prepared By:



Jim Marley
NARTE Certified EMC Engineer
EMC-002278-NE
(919) 549-1408

Reviewed By:



Mark Nolting
NARTE Certified EMC Test Lab Engineer
ATL-0340-E
(919) 549-1584

Test Facilities:

Test Location A) 10-Meter Anechoic Chamber (Industry Canada - IC 2953, NVLAP - 200246-0, VCCI - R-722)

Constructed by Lindgren RF Enclosures, this room consists of a 17.9 by 12 by 8.3 m (inside clearance) shielded room lined with TDK absorber material. The walls, floor (conducting ground plane) and ceiling are constructed of double sided galvanized sheet steel supported by 19 mm thick particle board. The interior walls and ceiling are covered with 10 by 10 cm, 4.6 mm thick ferrite tiles and partially covered with polystyrene absorber cones. Removable floor tiles and cones covering the floor between the EUT and antenna are provided when RF immunity testing is performed.

Room is provided with a 4.0 m diameter embedded turntable and a 1.2 by 2.1 m and 2.4 by 2.4 m double knife edge doors for access. Also, the room is fed electrical EUT power via permanently installed filters and is provided with a permanently mounted video surveillance camera. A remotely controllable antenna mast is located in the room for positioning the measuring antenna from 1 to 4 m above the ground plane.

Test Location B) Compact Anechoic Chamber

Constructed by Lindgren RF Enclosures, this room consists of a 6 by 3 by 2.9 m (inside clearance) shielded room lined with TDK absorber material. The walls, floor (conducting ground plane) and ceiling are constructed of double sided galvanized sheet steel supported by 19 mm thick particle board. The interior walls and ceiling are covered with 10 by 10 cm, 4.6 mm thick ferrite tiles and partially covered with polystyrene absorber cones. Removable floor tiles and cones covering the floor between the EUT and antenna are provided when RF immunity testing is performed.

Room is provided with a 1.5 m diameter embedded turntable and a 1.2 by 2.1 m double knife edge door for access. Also, the room is fed electrical EUT power via permanently installed filters and is provided with a video camera.

Test Location C) RF Shielded Room (VCCI - C-744, NVLAP - 200246-0)

Constructed by Lindgren RF Enclosures, this room consists of a 7.3 by 4.3 by 2.7 m (inside clearance) shielded room. The walls, floor (conducting ground plane) and ceiling are constructed of double sided galvanized sheet steel supported by 19 mm thick particle board. Room is provided with a 1.2 by 2.1 m double knife edge door for access. Also, the room is fed electrical EUT power via permanently installed filters and is provided with a portable video surveillance camera.

Test Location D) Ground Reference Plane # 1 (VCCI - C-742, NVLAP - 200246-0)

Horizontal floor ground reference plane constructed of double sided galvanized sheet steel supported by 19 mm particle board and measures 3.6 by 3.0 m. It is located and bonded next to one vertical wall of the Control Room and is, therefore, provided with a 3.0 by 3.6 m vertical ground reference plane constructed of the same material. Power filters and LISNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

Test Location E) Ground Reference Plane # 2 (VCCI - C-743, NVLAP - 200246-0)

Horizontal floor ground reference plane constructed of double sided galvanized sheet steel supported by 19 mm particle board and measures 4.3 by 5.2 m. It is located and bonded next to one vertical wall of the RFD Shielded Room and is, therefore, provided with a 4.3 by 2.8 m vertical ground reference plane constructed of the same material. Power filters and LISNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

Test Location F) Ground Reference Plane # 3

Horizontal floor ground reference plane constructed of galvanized sheet steel measuring 3.0 by 3.6 m x 2.5 mm thick. CDNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

Test Location G) Ground Reference Plane # 4 (Automotive)

Horizontal floor ground reference plane constructed of double-sided galvanized sheet steel supported by 19 mm particle board and measures 3.6 by 3.0 m.

Test Location I) Harmonic Current Test Area - Located in front of Standard Source Impedance Power Supply.

Test Location J) Magnetic Field Ground Reference Plane

Horizontal floor ground reference plane constructed of 1.5 mm thick aluminum measuring 3.6 by 2.4 m.

Test Location P) Ground Reference Plane # 5

Horizontal floor ground reference plane constructed of double-sided galvanized sheet steel supported by 19 mm particle board and measures 3.6 by 3.0 m.

Test Location R) Ground Reference Plane # 6

Ground reference plane constructed of galvanized sheet steel measuring 3.0 m x 3.6 m x 2.5 mm thick. CDNs, when required, are placed on top of and bonded to the horizontal floor ground reference plane.

Test Location X) Other - As described in the Comments Section of Test Results.

EUT Information:

Equipment Used During Test:

Use*	Product Type	Manufacturer	Model	Comments
EUT	Tag Reader	SAMSys	9320 (FCC)	
ACC	Antenna	-	-	
SIM	Load	-	-	50-ohm matched load

* Use = EUT - Equipment Under Test, ACC - Accessory (Not Subjected to Test), or SIM - Simulator (Not Subjected to Test)

Input/Output Ports:

Port #	Name	Type*	Cable Max. >3m	Cable Shielded	Comments
0	Enclosure	N/E	No	No	
1	AC Mains	AC	No	No	
2	Antenna	I/O	No	No	Four Identical Ports (Single Output multiplexed to four connectors)
3	RS-232	I/O	Yes	Yes	Device is connected with a PC located outside test area
4	RS-485/Digital I/O	I/O	Yes	Yes	Device is cabled with attaching cable during testing

* AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
I/O = Signal Input or Output Port (Not Involved in Process Control)
PMC = Process Measurement and Control Port

EUT Internal Operating Frequencies:

Frequency (MHz)*	Description
902 - 928	902 to 928 MHz Frequency Hopping Spread Spectrum
5	Internal Digital Clock

Power Interface:

Mode #	Voltage (V)	Current (A)	Power (W)	Frequency (DC/AC-Hz)	Phases (#)	Comments
1	120	-	-	60	1	

EUT Operation Modes:

Mode #	Description
1	Operating at Lower Channel (904.1 MHz).
2	Operating at Middle Channel. (915.1 MHz).
3	Operating at Higher Channel (925.9 MHz).
4	Operating while hopping normally.
5	As described in test section.

EUT Configuration Modes:

Mode #	Description
1	RFID Reader connected to power. Serial port connected to personal computer. Antenna ports populated with matched loads (50-ohm).
2	RFID Reader connected to power. Serial port connected to personal computer. Antenna port under test (Port 1) populated with representative antenna (8 dBi gain). Output power at antenna connector was set to full power (unreduced to compensate for antenna gain > 6dB) for spurious testing.

Environmental Conditions:

All tests were performed indoors in typical office conditions. The environment is verified to be within the following bounds before testing:

Temperature: 20°C to 25°C
Relative Humidity: 30% to 60%
Atmospheric Pressure: 98 to 102 kPa

Discrete Data:

Transmitter Description

This RFID tag reader operates in the 902 to 928 MHz ISM band as a frequency hopping spread spectrum device. It complies with the rules set forth in FCC Part 15.247 for spread spectrum devices. This device operates as follows:

Number of antennas: Four multiplexed antenna ports are provided. One to four antennas may be used. If more than one antenna is used, then output power is switched between antennas such that no more than one antenna may be active at any time. Antenna port #1 is used for all measurements in the report.

Antenna Port connectors: Antennas use an SMA 3.5 standard connector. As this device is required to be professionally installed, there is no requirement for a unique connector design. The user of this device may select among commercially available patch antennas for this device.

Output Power: The output of the device is 35dBm maximum. This is limited to 30 dBm in the United States per 15.247 and is detailed as such in the setup instructions. Instructions are provided to further reduce power if an antenna with a gain exceeding 6 dBi is used. See the installation instructions for further information.

Number of Channels: 120 channels operating on 200 kHz centers. The lowest channel is 903.1 MHz and the highest channel is at 926.9 MHz.

Hopping duration/algorithm: Hopping occurs in a pseudo-random sequence. Additional information regarding the hopping method for both transmitter and receiver are provided. The hopping duration for each channel is 233.3 ms per hop. The hopping algorithm is explained in further detail in an accompanying document.

RF Exposure: This device is considered as a fixed installation device. A calculation of Maximum Personnel Exposure is presented as item "Test 8".

Test 1: Conducted Emissions - Conducted Power

Test Requirement: 47 CFR Part 15, Subpart C

Test Specification: 47 CFR Part 15, Subpart C - Section 15.247

Test Procedure:

The test was performed in accordance with the Test Requirement and Specification and configured as noted in the Test Setup. Output Power was set to maximum. A notch filter was installed for spurious measurements below 4 GHz. A high-pass filter was installed for spurious measurements above 4 GHz. A 30 dB attenuator was installed for transmit frequency measurements. Correction factors were included for each device.

Radiated Disturbance Limits for Frequency Hopping Spread Spectrum Transmitters - Section 15.247

Fundamental Frequency (MHz)	Hopping Channels	Permissible Output Power (milliwatts)	Permissible Output Power (dBm)	Permissible Spurious Emissions (milliwatts)	Permissible Spurious Emissions (dBm)
902 – 928	25 to 49	250	24	25	14
	50 or more	1000	30	100	20
	Digital Modulation	1000	30	100	20
2400 – 2483	15 to 74	125	21	12.5	11
	75 or more	1000	30	100	20
	Digital Modulation	1000	30	100	20
5725 – 5850	75 or more	1000	30	100	20
	Digital Modulation	1000	30	100	20

Other than fixed point-to-point applications, power adjustment for antenna gain are as follows:

Gain of 6 dBi or less

No reduction is required

Gain greater than 6 dBi

Reduce the maximum output power by 1 dB for each 1 dB of antenna gain above 6 dBi

Test Deviations:

None

Test Setup: Only the following ports were tested. See EUT Information for details.

Test Item	Port #	Port Name	EUT Operation Mode	EUT Configuration	Power Interface
A	2	Antenna	1 (Low Channel)	1 (Terminated by Receiver)	1
B	2	Antenna	2 (Mid Channel)	1 (Terminated by Receiver)	1
C	2	Antenna	3 (High Channel)	1 (Terminated by Receiver)	1

Test 1 - Results: Conducted Emissions - Conducted Power and Spurious Emissions

Test Results Summary:

Test Item	Test Location	Pass/Fail (P/F)	Date Completed	Comment #
A	E	P	6/19/03	
B	E	P	6/19/03	
C	E	P	6/19/03	

The EUT was considered to **Pass** the Requirements.

Output Power and Antenna Cable Loss

Because the installation of this device may involve long lengths of cable attaching the transmitter to the antenna, the unit is designed to transmit with as much as +35 dBm power. This permits the output to compensate for up to 5 dB of cable loss to the antenna. During installation (professional installation is required) the output power is set to ensure that no more than +30 dBm is present at the end of the attaching cable to the antenna. As the power supplied to the antenna is considered the net output power, this device complies with the +30 dBm power limit.

Maximum Output Power Setting vs. Attaching cable loss and Antenna Gain.

The maximum output power setting is set using the following formula:

Transmitter Output Power (max) = 30 dBm + Cable Loss (dB) – (Antenna gain exceeding 6 dBi)

Results

The peak output power (conducted) was measured to be 33.64 dBm (2.31 Watts) at the antenna port at the highest frequency measured. The average output power (conducted) was measured to be 32.14 dBm (1.60 Watts) at the antenna port using 1.5 dB peak-to-average reduction at the highest frequency measured. **This will be limited to 1 Watt at the antenna input by professional installation procedure.**

Comments:

Comment #	Description

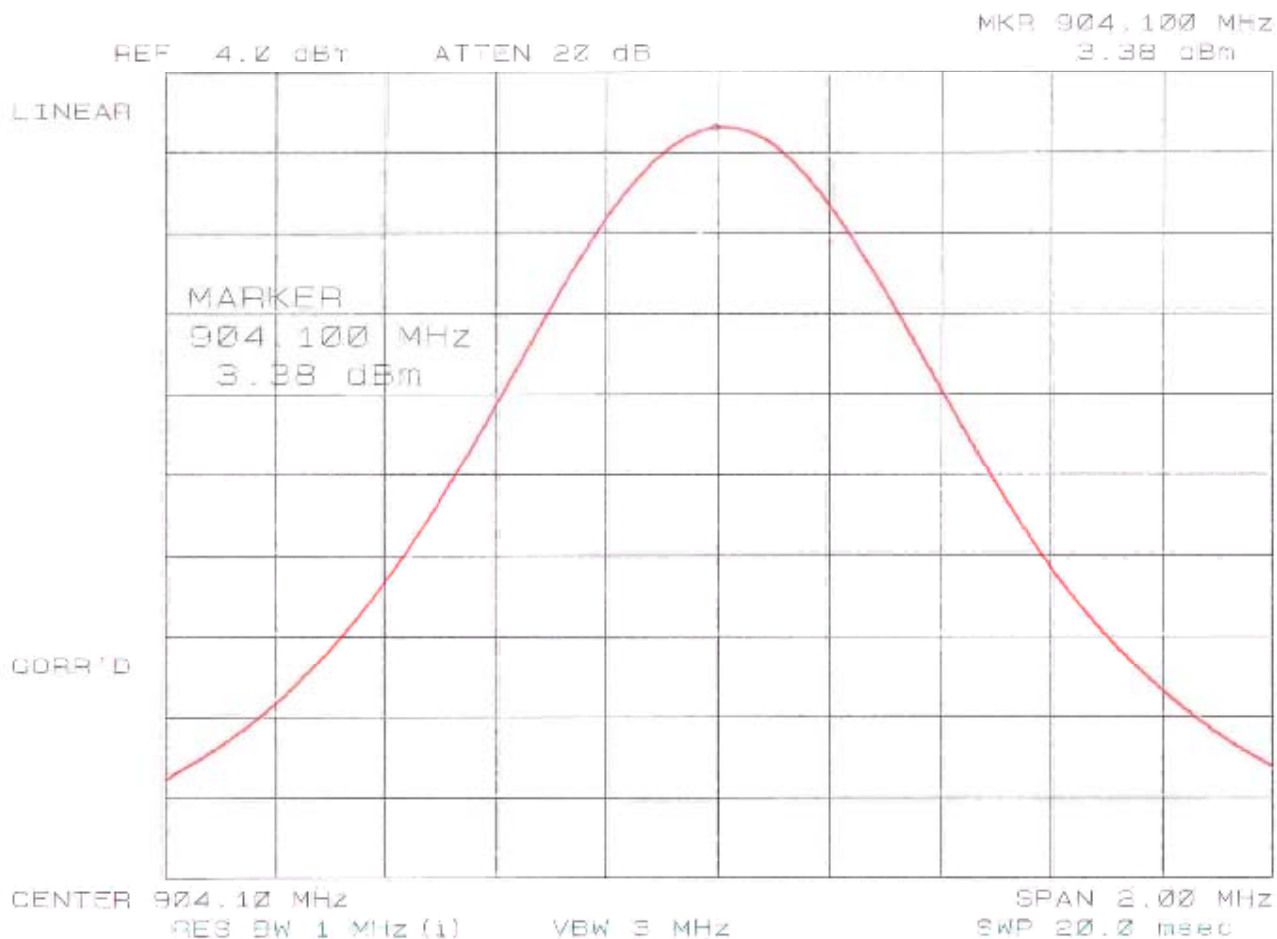
Test Equipment Used:

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
ATA152	27 ft. N male - N male low loss cable	Micro-coax	UFB293C-0-3149-50504	2/25/03	8/31/03
HI0042	Environmental Indicator	Cole-Palmer	99760-00	10/2/02	10/31/03
SAR001	Spectrum Analyzer / Receiver	Hewlett-Packard	8572A	1/31/03	1/31/04
ATA160	RF Attenuator, 30 dB, 50 Watt	Std N-connector	-	9/30/02	9/30/03

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NCSS Z540-1-1994.

Test 1, Item A (35 dBm Nominal) - Peak Plot (Amplitude in dBm):

Conducted Power at Maximum Power Level – Low Channel



Conducted Power (Peak) is measured

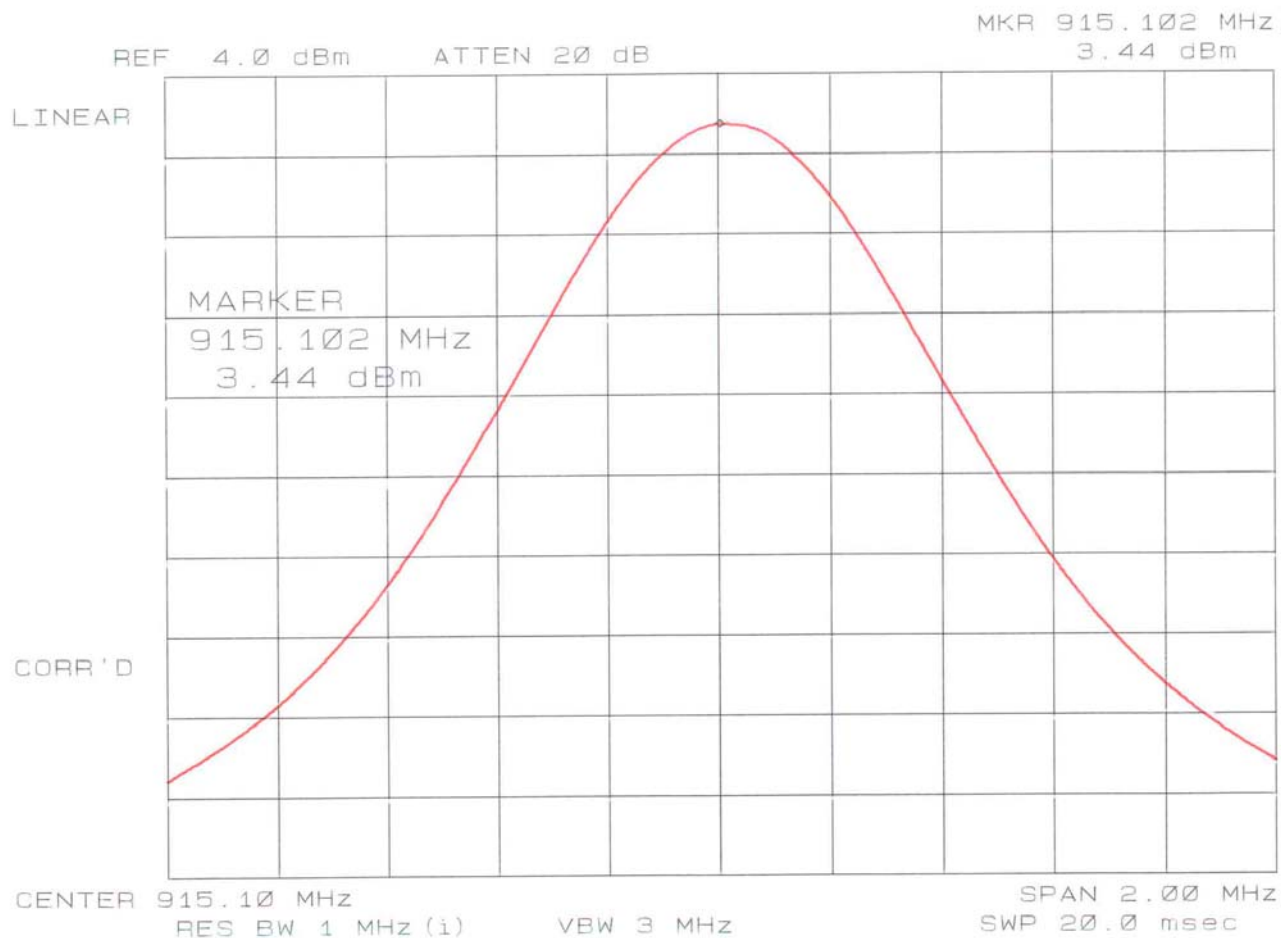
Peak Power (measured) = 3.38 dBm

Attenuator = 30.2 dBm

Total Peak Power = 33.58 dBm

Test 1, Item A (35 dBm Nominal) - Peak Plot (Amplitude in dBm):

Conducted Power at Maximum Power Level – Mid Channel



Conducted Power (Peak) is measured

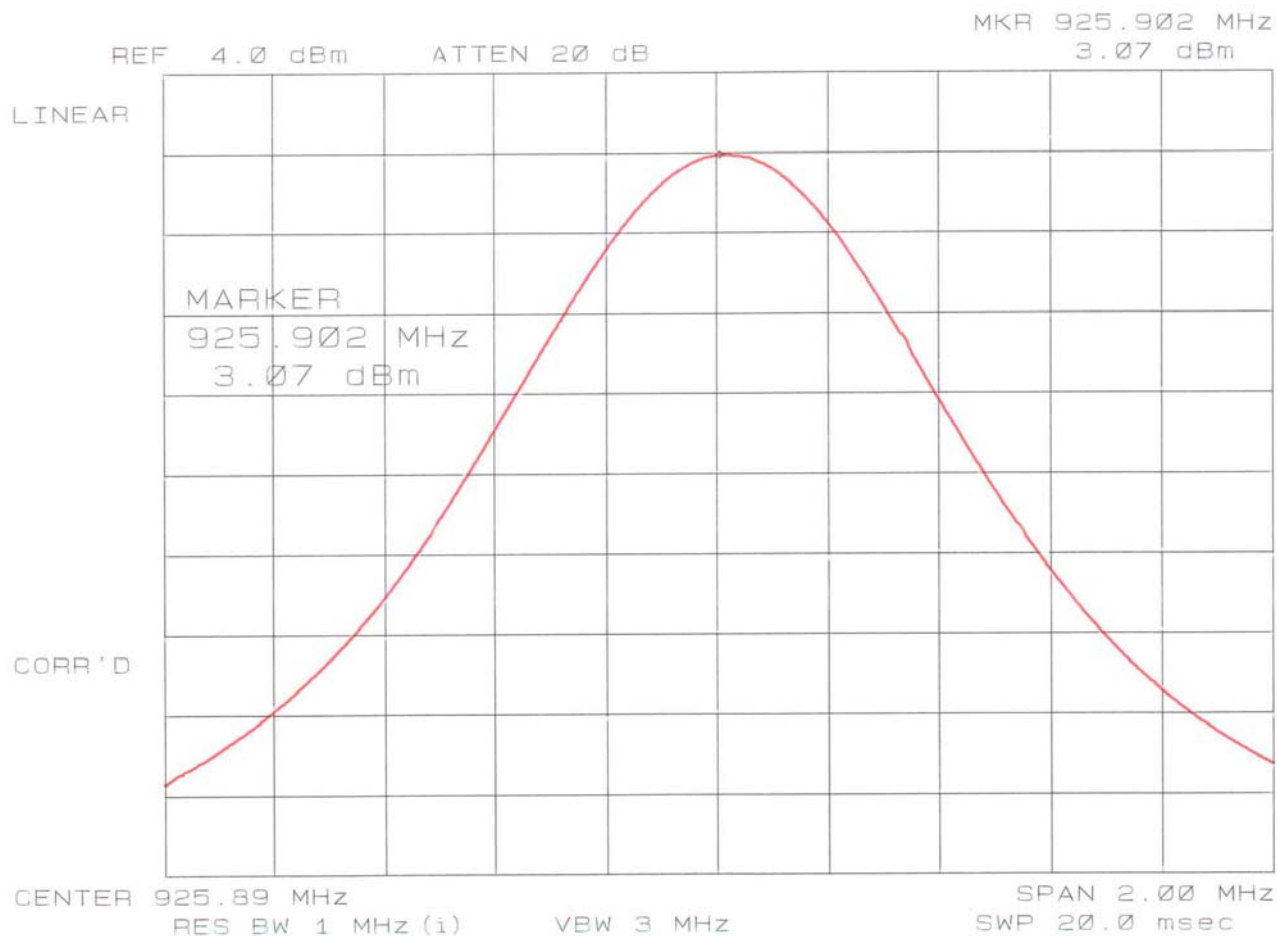
Peak Power (measured) = 3.44 dBm

Attenuator = 30.2 dBm

Total Peak Power = 33.64 dBm

Test 1, Item A (35 dBm Nominal) - Peak Plot (Amplitude in dBm):

Conducted Power at Maximum Power Level – High Channel



Conducted Power (Peak) is measured

Peak Power (measured) = 3.07 dBm

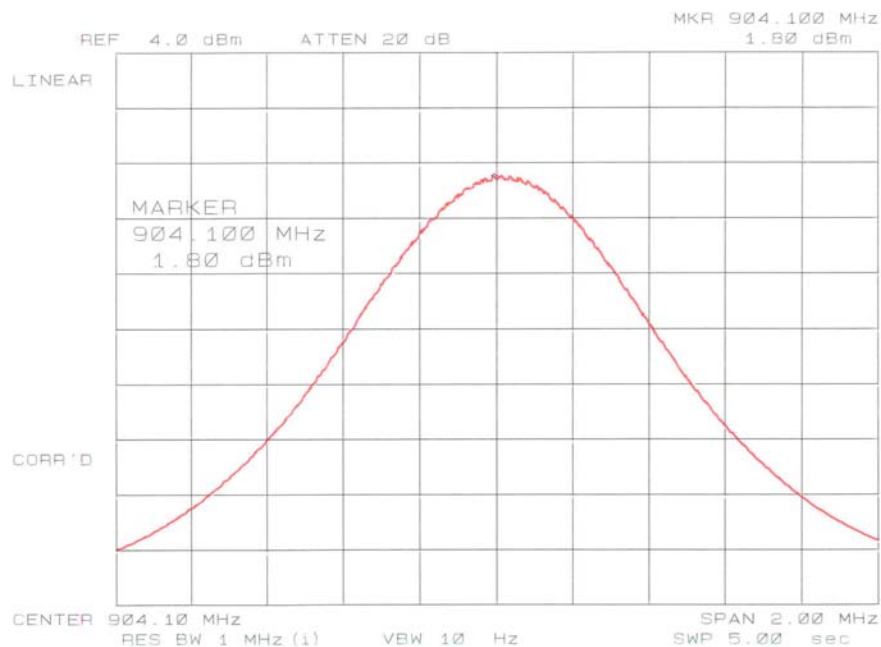
Attenuator = 30.2 dBm

Total Peak Power = 33.27 dBm

Test 1, Item A – Peak-to-Average Ratio:

Measured

The peak-to-average ratio is determined via reduced video bandwidth method. The initial (peak) measurement is performed at 1 MHz Resolution Bandwidth and 3 MHz Video Bandwidth. The average measurement is performed at 1 MHz Resolution Bandwidth and 10 Hz Video Bandwidth.



Test 1 Peak-to-Average Ratio (cont):

Measured (cont)

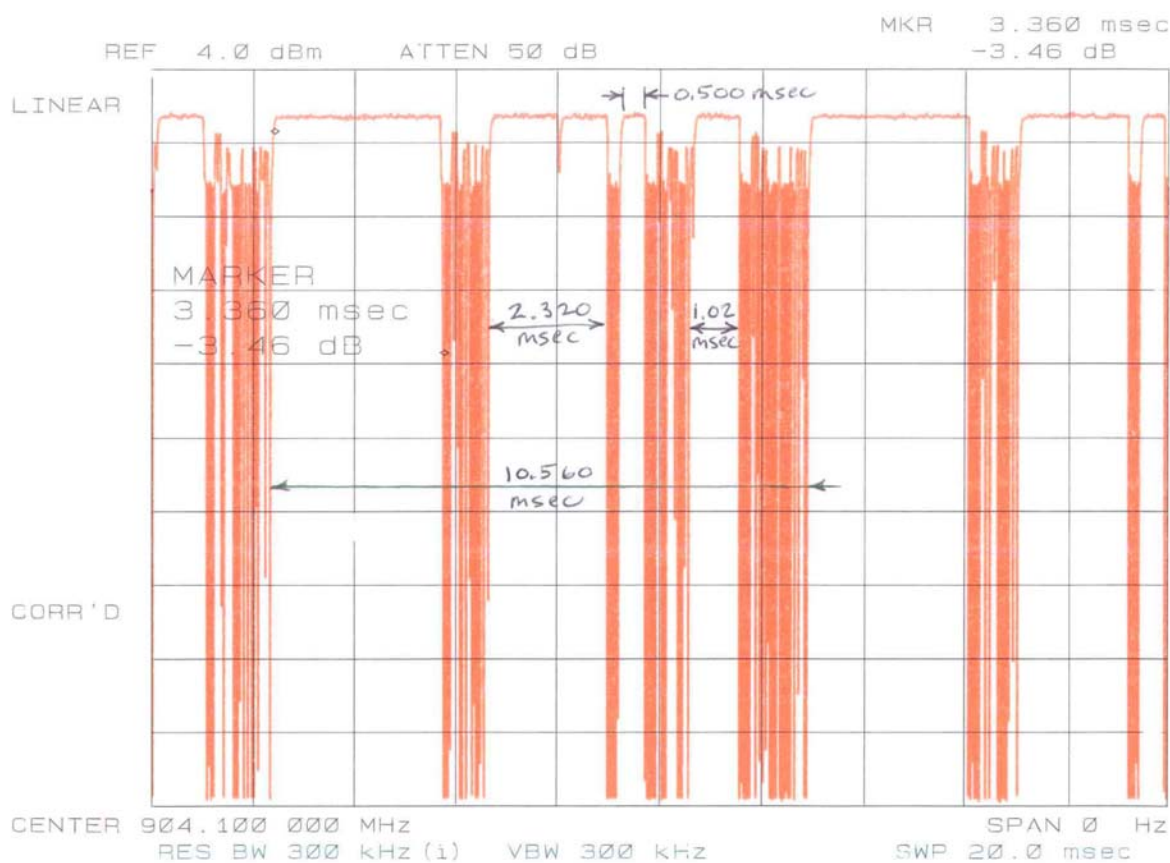
Peak Power (measured) = 3.38 dBm
Attenuator = 30.2 dBm
Total Peak Power = 33.58 dBm

Average Power (measured) = 1.80 dBm
Attenuator = 30.2 dBm
Total Peak Power = 32.0 dBm

Peak-to-Average Ratio (measured) = **1.58 dB**

Calculated

The Peak-to-Average Ratio is verified by a duty cycle analysis of the transmission pattern.



Total Cycle = 10.6 msec

On time = 3.36 ms + 2.32 ms + 0.5 ms + 1.02 ms = 7.2 ms

Remainder of cycle may be approximated by 50% duty cycle, or 1/2 times 3.4 ms. These cycles were too fast to be captured by the HP 8449B set to zero span and minimum sweep time.

Total On Time = 7.2 ms + 1/2(3.4 ms) = 8.9 ms

Total Cycle = 10.6 ms

Duty Cycle = (Total On Time) / (Total Cycle) = 8.9 / 10.6 = 83.96%

Peak-to-Average Ratio (calculated) = **1.52 dB**

1.5 dB will be applied as peak-to-average ratio.

Test 2: Conducted Emissions - Spurious Emissions

Test Requirement: 47 CFR Part 15, Subpart C

Test Specification: 47 CFR Part 15, Subpart C - Section 15.247

Test Procedure:

The test was performed in accordance with the Test Requirement and Specification and configured as noted in the Test Setup. Output Power was set to maximum. A notch filter was installed for spurious measurements below 4 GHz. A high-pass filter was installed for spurious measurements above 4 GHz. A 30 dB attenuator was installed for transmit frequency measurements. Correction factors were included for each device. Resolution bandwidth and Video Bandwidth is set to 1 MHz.

Radiated Disturbance Limits for Frequency Hopping Spread Spectrum Transmitters - Section 15.247

Fundamental Frequency (MHz)	Hopping Channels	Permissible Output Power		Permissible Spurious Emissions	
		(milliwatts)	(dBm)	(milliwatts)	(dBm)
902 – 928	25 to 49	250	24	25	14
	50 or more	1000	30	100	20
	Digital Modulation	1000	30	100	20
2400 – 2483	15 to 74	125	21	12.5	11
	75 or more	1000	30	100	20
	Digital Modulation	1000	30	100	20
5725 – 5850	75 or more	1000	30	100	20
	Digital Modulation	1000	30	100	20

Other than fixed point-to-point applications, power adjustment for antenna gain are as follows:

Gain of 6 dBi or less

No reduction is required

Gain greater than 6 dBi

Reduce the maximum output power by 1 dB for each 1 dB of antenna gain above 6 dBi

Test Deviations:

None

Test Setup: Only the following ports were tested. See EUT Information for details.

Test Item	Port #	Port Name	EUT Operation Mode	EUT Configuration	Power Interface
A	2	Antenna	1 (Low Channel)	1 (Receiver Terminated)	1
B	2	Antenna	2 (Mid Channel)	1 (Receiver Terminated)	1
C	2	Antenna	3 (High Channel)	1 (Receiver Terminated)	1

Test 2 - Results: Conducted Emissions - Conducted Power and Spurious Emissions

Test Results Summary:

Test Item	Test Location	Pass/Fail (P/F)	Date Completed	Comment #
A	E	P	6/19/03	
B	E	P	6/19/03	
C	E	P	6/19/03	

The EUT was considered to **Pass** the Requirements.

All spurious were observed to be below the applicable limit of +20 dBm (100 mW). Restricted Band compliance is considered in the radiated spurious test section in this report.

Comments:

Comment #	Description

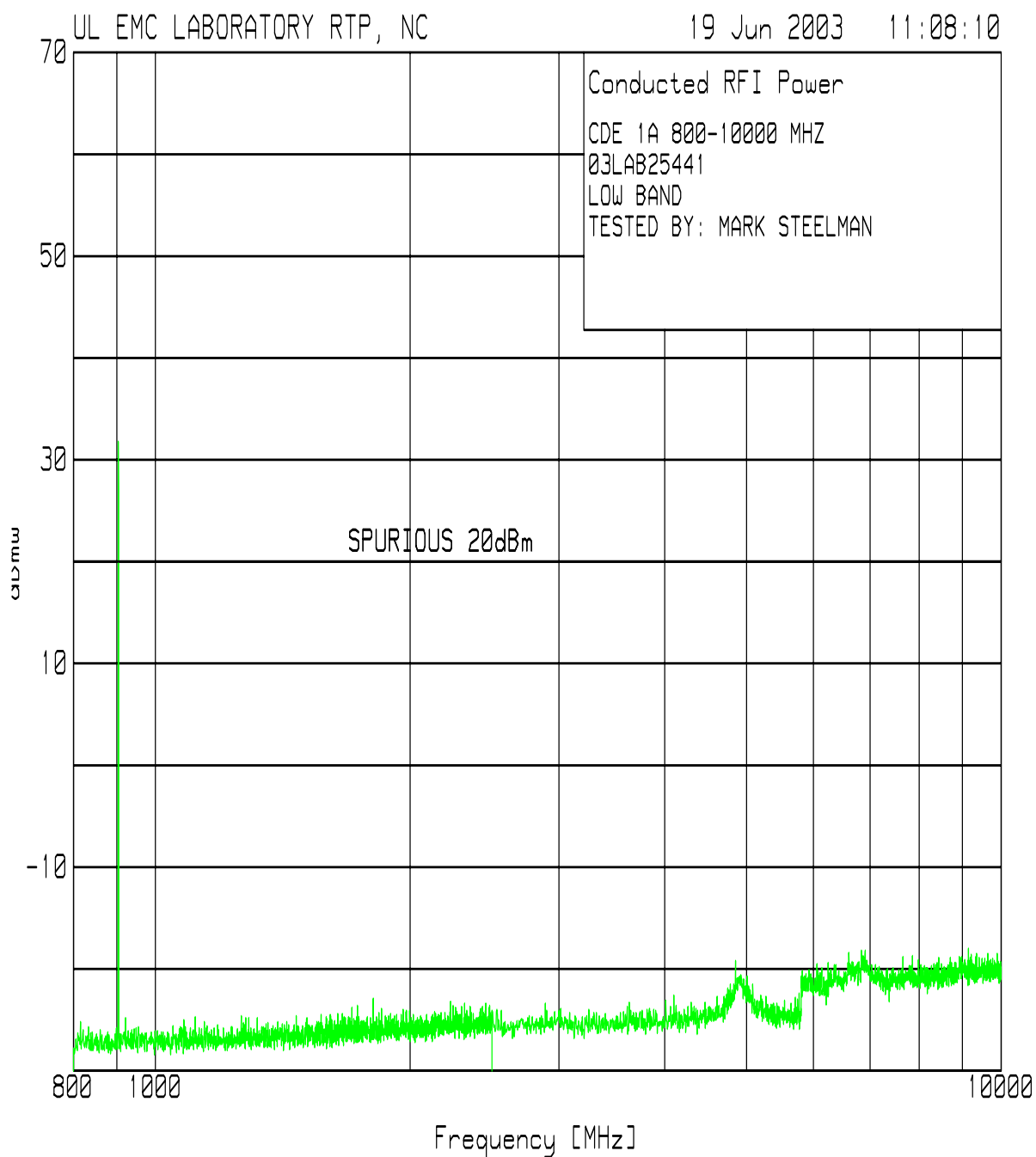
Test Equipment Used:

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
ATA152	27 ft. N male - N male low loss cable	Micro-coax	UFB293C-0-3149-50504	2/25/03	8/31/03
HI0042	Environmental Indicator	Cole-Palmer	99760-00	10/2/02	10/31/03
SAR001	Spectrum Analyzer / Receiver	Hewlett-Packard	8572A	1/31/03	1/31/04
ATA160	RF Attenuator, 30 dB	Weinshel	47-30-43	9/5/02	9/30/03

The above equipment has been calibrated and is within the manufacturer's published limit of error. Calibration is traceable to the National Institute of Standards & Technology(NIST) and conforms to ANSI/NCSL Z540-1-1994.

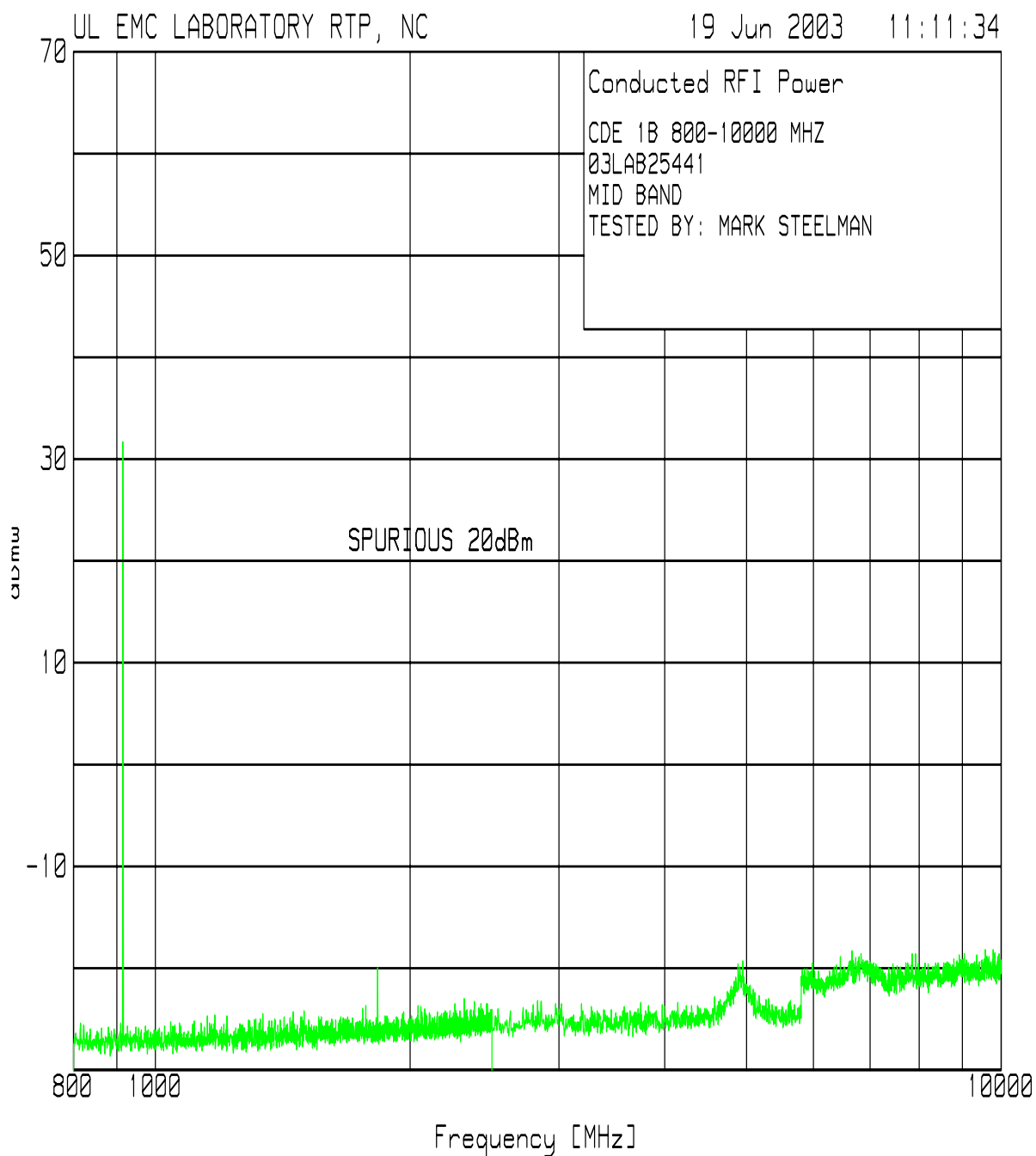
Test 2, Item A (Low Channel) - Peak Plot (Amplitude in dBm):

Conducted Emissions - Conducted Spurious Emissions



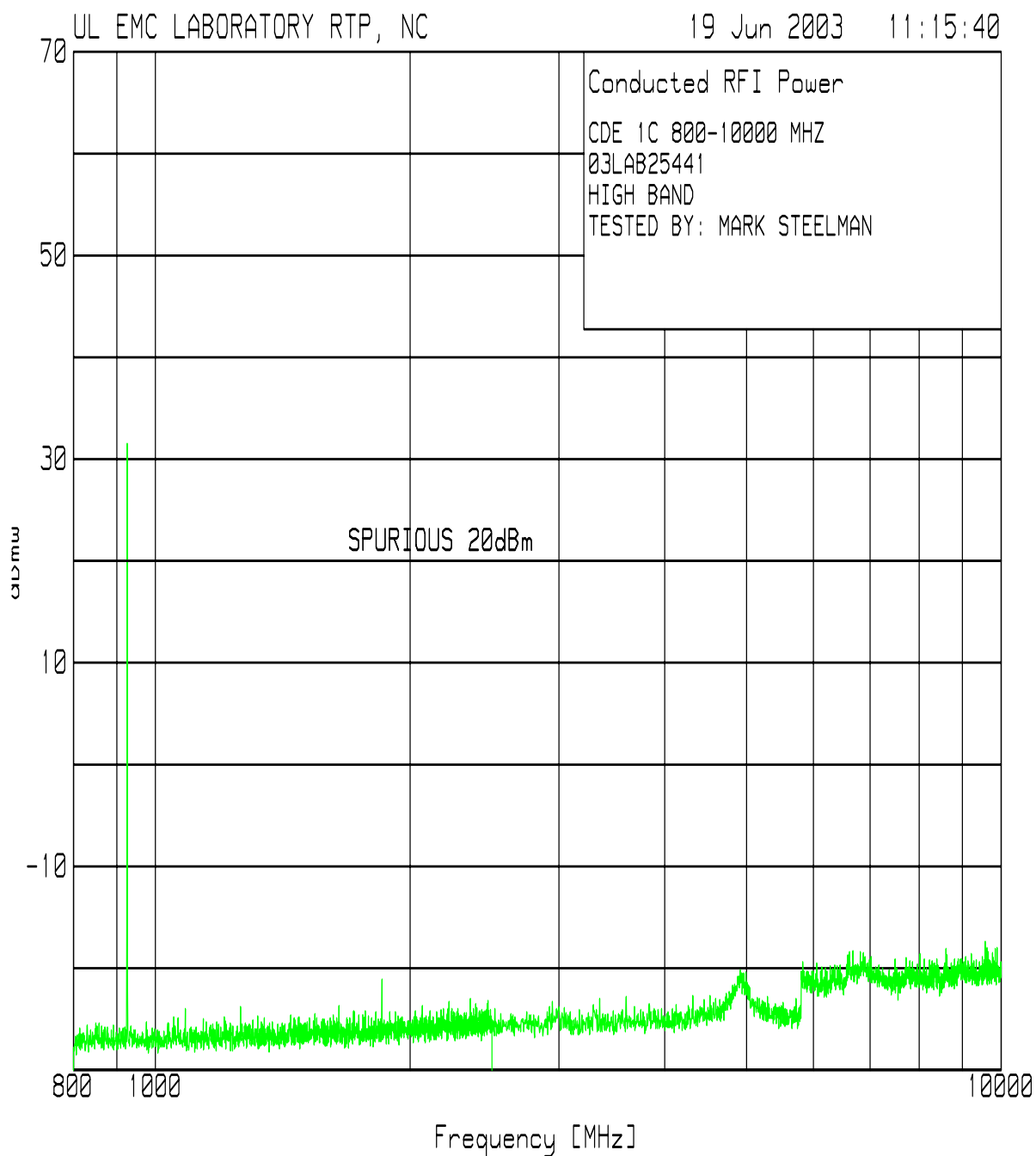
Test 2, Item B (Mid Channel) - Peak Plot (Amplitude in dBm):

Conducted Emissions - Conducted Spurious Emissions



Test 2, Item C (High Channel) - Peak Plot (Amplitude in dBm):

Conducted Emissions - Conducted Spurious Emissions



Test 2, All Items - Discrete Data: Conducted Emissions - Conducted Power and Spurious Emissions

Test Item (A-Z)	Detector Type* (P/Q/A)	Measured Conductor (Name)	Measured Frequency (MHz)	Measured Value (dBuV)	Attenuator Loss (dB)	Units Conversion (dBm/dBuV)	Corrected Value (dBm)	Specified Limit (dBm)	Spec Margin (dB)	See Comment (#)**
B	P	Antenna Port	1831.3800	54.8	32.2	-107.0	-20.0	20.0	-40.0	

* P = Peak, Q = Quasi-Peak, A = Average.

** # = See Comment Number Under This Test's Comments Section.

Sample Calculation: Corrected Value = Measured Value (dBuV) + Attenuator Loss (dB)

Note:

Only the second harmonic was viewable above the measurement noise floor. The measurement was recorded while operating at the center channel, because the emission was highest at this frequency. All other harmonics were more than 35 dB below the +20 dBm limit.