



Intertek Testing Services
ETL SEMKO

TEST REPORT

Report Number: 303882162
Project Number: 30388216
Report Date: March 16, 2003

Testing performed on the
CardioNet ECG Monitor With Arrhythmia Detection
Model: CardioNet Monitor
FCC ID: QBI-1005

to
FCC Parts 22 and 24

for
Cardionet, Inc.



A2LA Certificate Number: 1755-01

Test Performed by:

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3/31/03

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1.0 Introduction

1.1 Test Summary

FCC RULE	DESCRIPTION OF TEST	RESULT	PAGE
2.1046	RF Power Output	Complies 23.5 dBm - average	7
22.913, 24.232	ERP, EIRP	Complies	14
2.1053	Field Strength of Spurious Radiation	Complies	20
15.109	Radiated Emissions from digital parts and receiver	Complies	-
15.207	AC Line Conducted Emissions	Complies	-
2.1091	RF Exposure	Complies	*

* See separate SAR report

Note: The CardioNet Monitor contains the certified module - CDMA modem SB555 from Sierra Wireless, FCC ID: N7NSB555.

Therefore, the following tests were not performed as the module is used with no modification.

FCC Rule	Description of Test	Comment
2.1049	Occupied Bandwidth. Emission Designator	See Report/Application FCC ID: N7NSB555
2.1051, 22.901(d) 22.917(f), 24.238(a)	Out of Band Emissions at Antenna Terminal. Mobile Emissions In Base Frequency Range	See Report/Application FCC ID: N7NSB555
2.1055	Frequency Stability vs. Temperature	See Report/Application FCC ID: N7NSB555
2.1055	Frequency Stability vs. Voltage	See Report/Application FCC ID: N7NSB555

The Cardionet ECG Monitor also contains a low power (~ 1 mW) transmitter operating in 902-928 MHz band.

This radio is also certified under FCC Part 15.249, FCC ID: QBI-1002, and therefore was not tested.

1.2 Product Description

The CardioNet Monitoring System consists of two devices - the CardioNet Sensor and the CardioNet Monitor.

The CardioNet Monitor communicates with the CardioNet Sensor at 902 - 928 MHz (ISM band) and also communicates with CardioNet Patient Service Center in cellular band (824 – 848 MHz) and/or PCS band (1850 – 1910 MHz). The CardioNet Monitor transmitter operating at ISM band is very low power transmitter (1 mW), The Cellular/ PCS bands transmitter operates at 224 mW power in CDMA mode.

The CardioNet Monitor constantly monitors patient's heartbeat and sends information to the CardioNet Patient Service Center. When a patient is away from home it uses wireless communication throughout Cellular/ PCS CDMA modem manufactured by Sierra Wireless (SB555 model, FCC ID: N7NSB555).

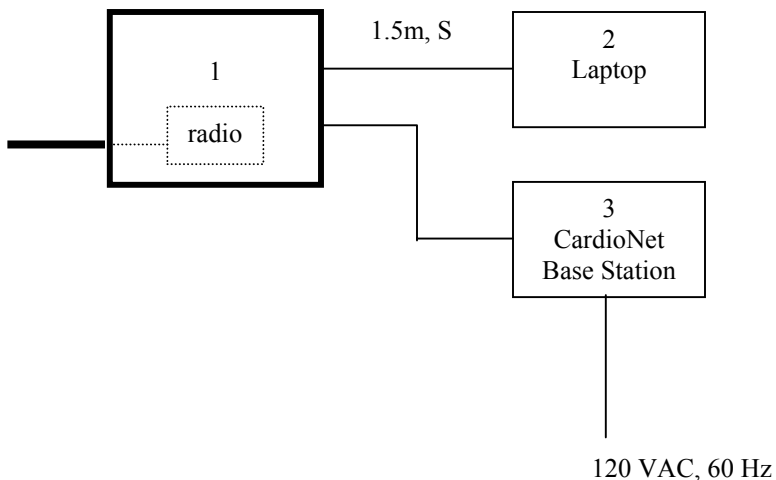
For more information, please refer to the attached product description.

Use of Product	Communication throughout Cellular/ PCS
Whether quantity (>1) production is planned	[X] Yes, [] No
Cellular Phone standards	CDMA
Type(s) of Emission	1M25F9W
RF Output Power	824-849 MHz: 23.5 dBm (Average) 1850-1910 MHz: 23.5 dBm (Average)
Frequency Range	824 - 849 MHz, 1850 - 1910 MHz
Antenna(e) & Gain	0.3 to -2.4 dBi
Detachable antenna ?	No
Receiver frequency	869 – 894 MHz, 1930 – 1990 MHz
External input	Digital Data

The prototype version of the EUT was received on February 18, 2003 in good operating condition. As declared by the Applicant, it is identical to the production units.

Note: The CardioNet Sensor (with the 900 MHz radio), as well as CardioNet Monitor (as mentioned above), both are granted, FCC IDs: QBI-1001 and QBI-1002 accordingly.

1.3 Test Configuration



Notes: The Laptop is used to setup the radio; after setup it was disconnected
There is no physical cable between the Monitor and Base station

Item #	Description	Make	Model No.	Serial No.
1	EUT	CardioNet, Inc.	CardioNet Monitor	Not labeled
2	Laptop	Compaq	Armada 1750	6333/T/6400/D/M/1
3	Base Station	CardioNet, Inc.	-	-

1.4 Related Submittal(s) Grants

FCC ID: QBI-1002, granted on 08/20/2002 – 900 MHz radio module, monitor
FCC ID: QBI-1001, granted on 08/06/2002 – 900 MHz radio module, sensor
FCC ID: N7NSB555, granted on 11/25/2002 – Cellular radio module, monitor

2.0 RF Power Output FCC 2.1046

2.1 Test Procedure

The transmitter output was connected to the Average Power Meter. The output power was adjusted to 23.5 dBm. The transmitter output was connected to a calibrated coaxial attenuator, the other end of which was connected to a spectrum analyzer. The resolution and video bandwidths of the spectrum analyzer were set to 30 kHz and 300 Hz accordingly. The average power at the transmitter output was determined by adding the value of the attenuator and cable loss to the spectrum analyzer reading. Tests were performed at three frequencies (low, middle, and high channels) in Cellular in PCS bands.

2.2 Test Equipment

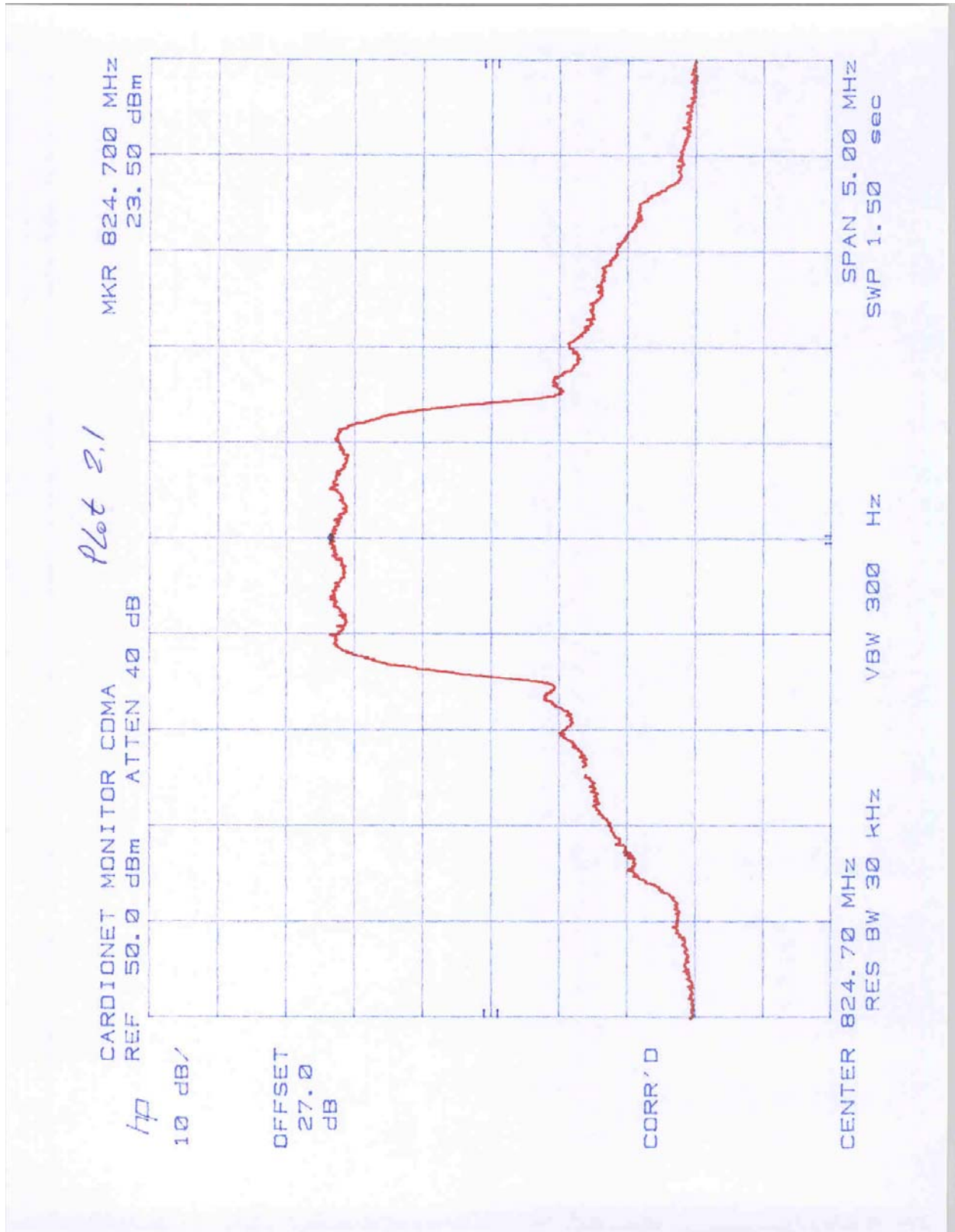
HP 8566B Spectrum Analyzer
10 dB Attenuator

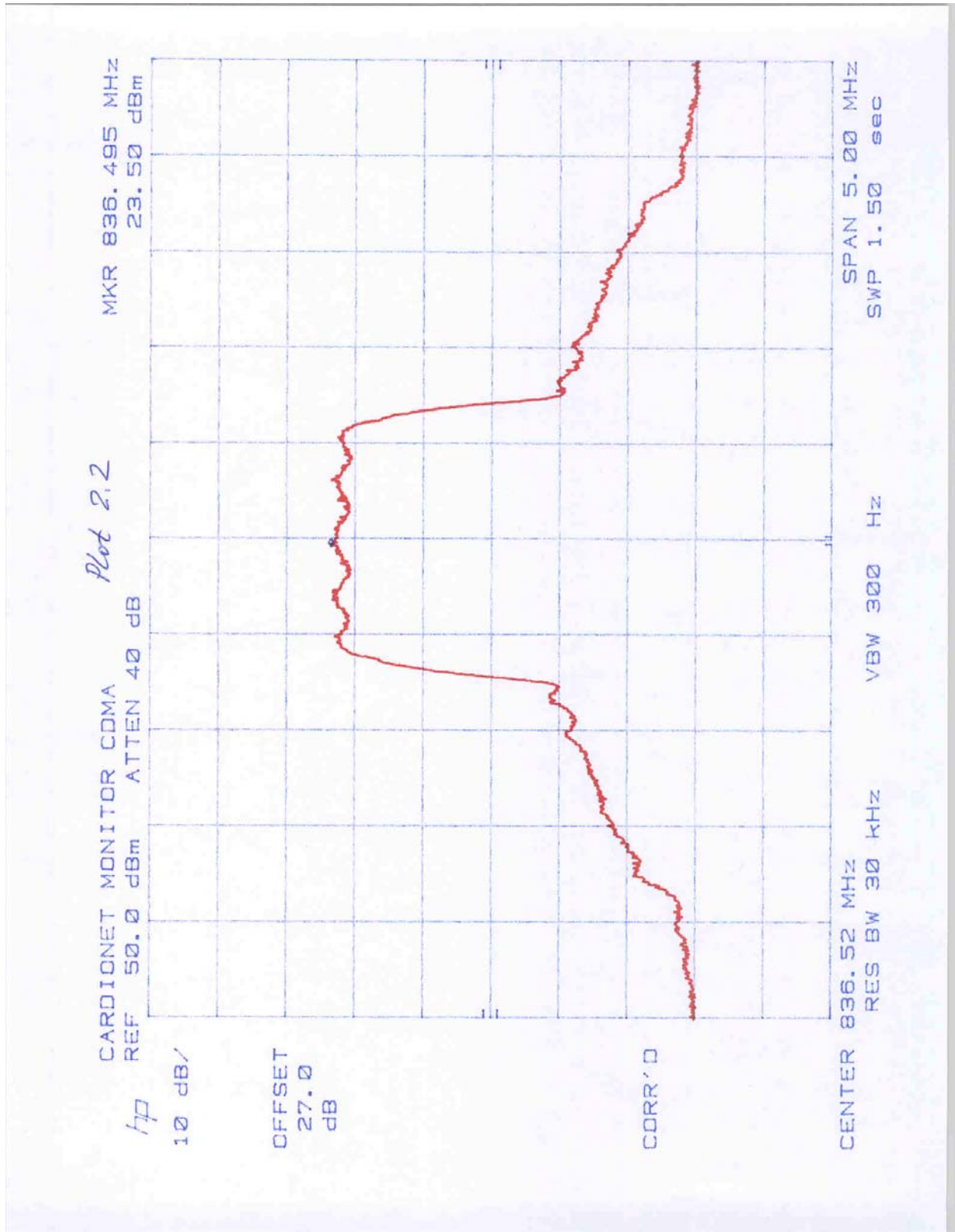
2.3 Test Results

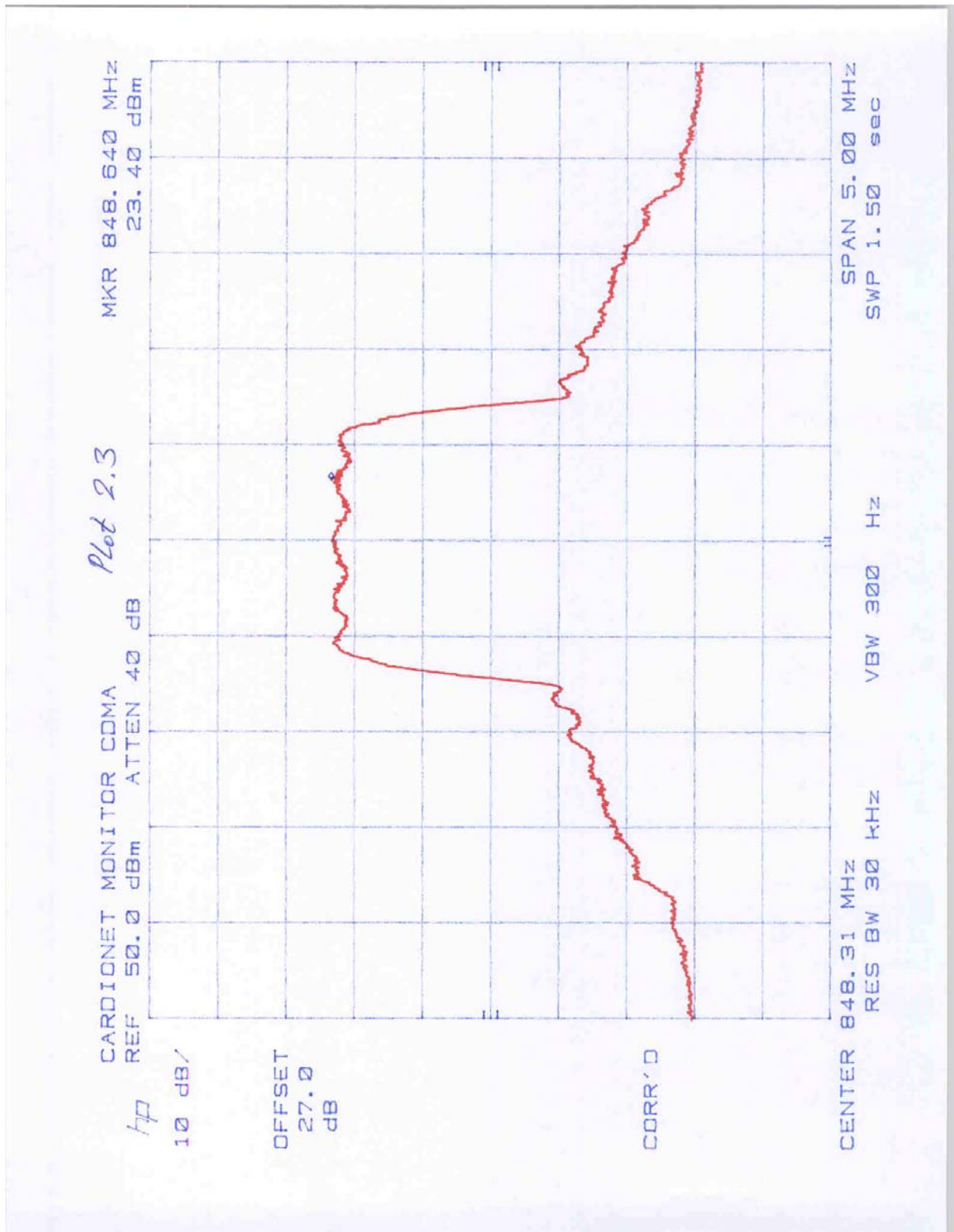
Frequency (MHz)	Average Power (dBm)	Plot
824.7	23.5	2.1
836.52	23.5	2.2
848.3	23.4	2.3
1851.25	23.5	2.4
1880.00	23.4	2.5
1908.75	23.6	2.6

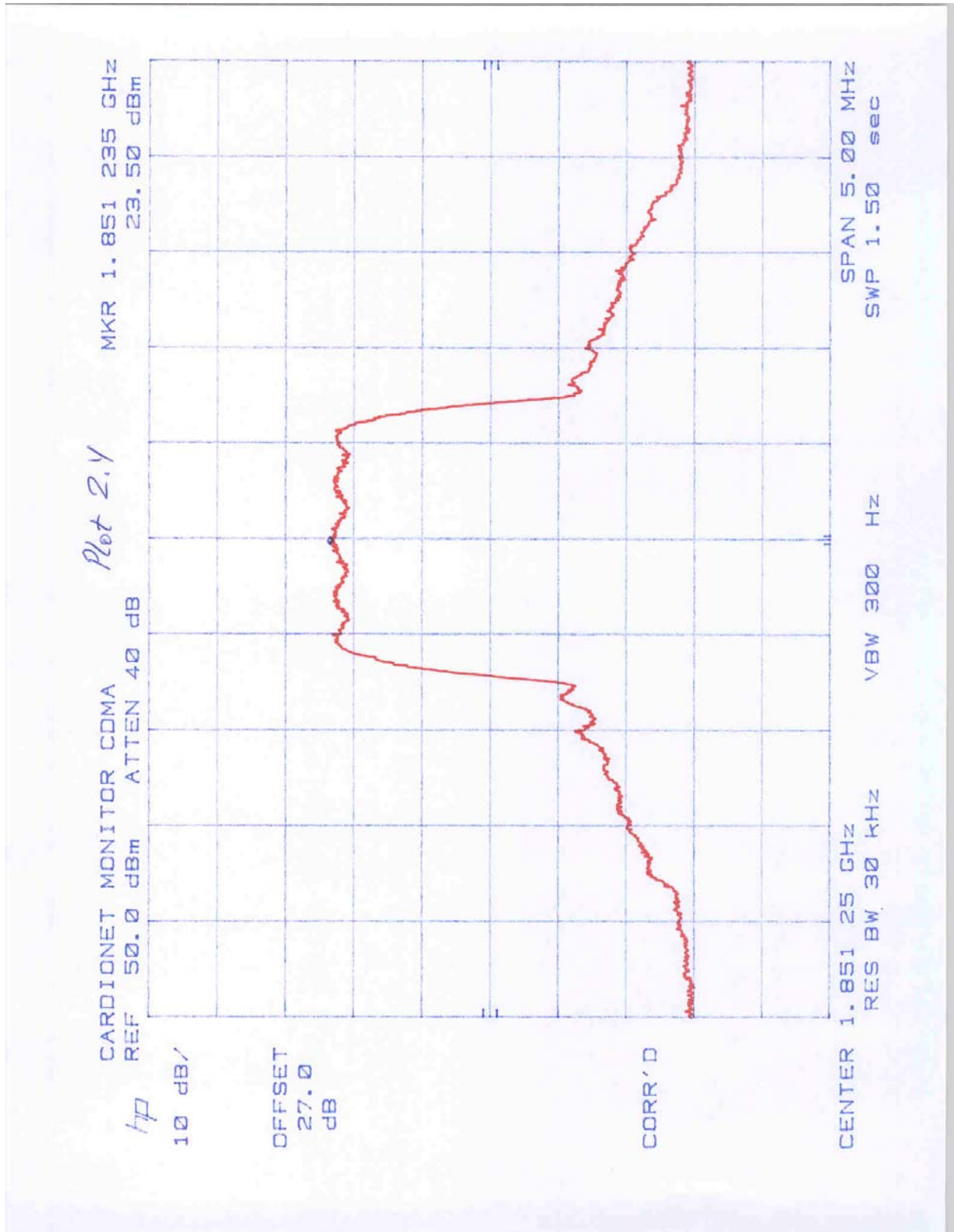
For more details refer to the attached plots. On this plots the OFFSET level equals 27 dB comes from:
10 dB – external attenuator,
0.8 dB – cable loss,
16.2 dB – bandwidth correction factor equals $10\log(1250/30)=16.2$ dB, where 1250 kHz is the CDMA signal bandwidth.

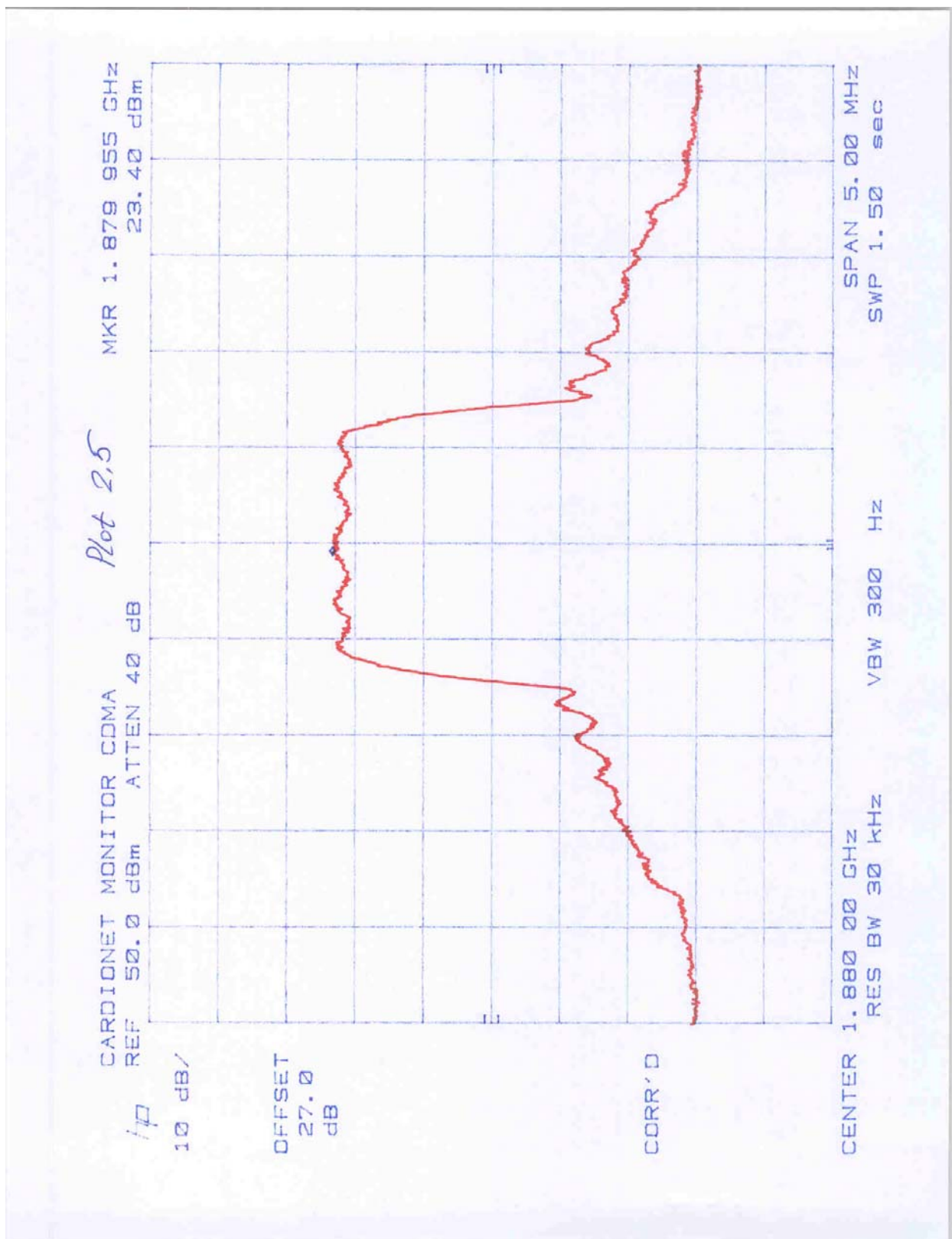
Cellular Band (CDMA Mode)	
Plot Number	Description
2.1	Low Channel
2.2	Middle Channel
2.3	High Channel
PCS Band (CDMA Mode)	
Plot Number	Description
2.4	Low Channel
2.5	Middle Channel
2.6	High Channel

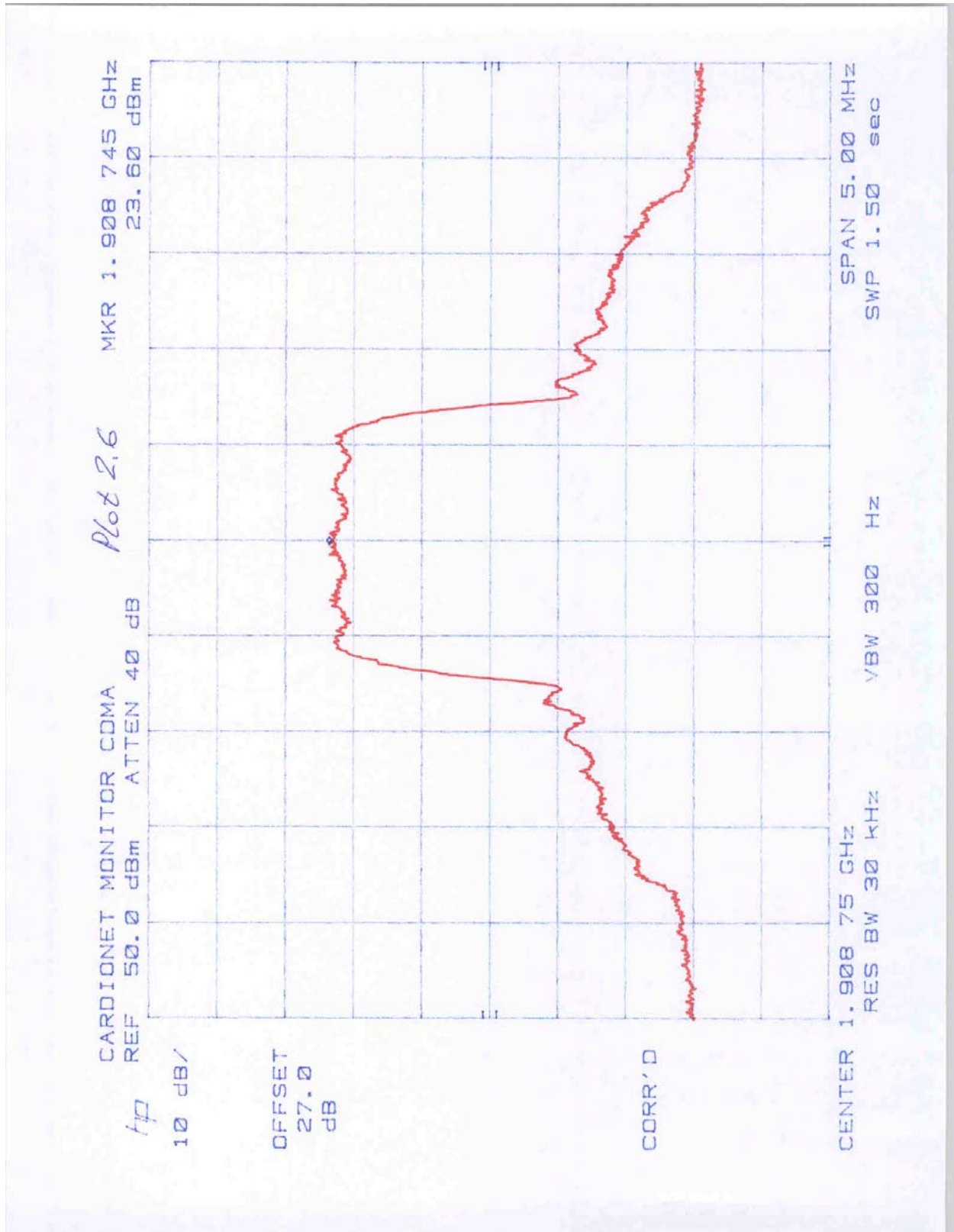












3.0 Radiated Power
FCC 22.913

The Effective Radiated Power (ERP) of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

FCC 24.232

The Equivalent Isotropic Radiated Power (EIRP) must not exceed 2 Watts.

3.1 Test Procedure

The EUT was positioned on a non-conductive turntable, 0.8m above the ground plane in a 10m semi-anechoic chamber.

The radiated emission at the fundamental frequency was measured at 3m distance with a test antenna and spectrum analyzer. During the measurement, the resolution and video bandwidths of the spectrum analyzer were set to: 100 kHz - for frequencies below 1 GHz, 1 MHz – for frequencies above 1 GHz.

Worst-case emission was recorded with the rotation of the turntable and the raising and lowering of the test antenna. Maximization was performed for three orthogonal position of the EUT on the turntable. The spectrum analyzer reading in dB(μV) was recorded.

ERP/EIRP was measured using a substitution method. The EUT was replaced by a half-wave dipole (for frequencies below 1 GHz) or horn antenna (frequencies above 1 GHz) connected to a signal generator. The spectrum analyzer reading was recorded and ERP/EIRP was calculated as follows:

$$\text{ERP} = V_1 - V_2 + V_g ; \text{EIRP} = V_1 - V_2 + V_g + G$$

Where V_1 & V_2 are spectrum analyzer readings in dB(μV) when measured field strength from EUT & generator accordingly; V_g is the generator output in dBm, G is the gain of the substitution antenna in dBi.

3.2 Test Result

**Effective Radiated Power
(Measured by Substitution Method)
Cellular Band**

Frequency MHz	Antenna Polariz.	SA Reading (EUT) dB(μV)	SA Reading (Sig. Gen. +Tuned Dipole) dB(μV)	Signal Generator Output dBm	ERP dBm
AMPS/TDMA Mode					
824.70	V	92.7	70.7	0	22.0
836.52	H	92.0	68.8	0	23.2
848.30	V	92.1	70.6	0	21.5

**Effective Radiated Power
(Measured by Substitution Method)
PCS Band**

Frequency MHz	Antenna Polariz.	SA Reading (EUT) dB(μV)	SA Reading (Sig. Gen. +Horn Antenna) dB(μV)	Signal Generator Output dBm	EIRP dBm
TDMA Mode					
1851.25	H	83.5	69.3	0	21.7
1880.00	H	82.8	69.2	0	21.1
1908.75	H	81.7	67.7	0	21.5

Note: Antenna gain G=7.5 dBi

Complies

4.0 Field Strength of Spurious Radiation FCC 2.1053, 22.901(d), 24.238(a)

4.1 Test Procedure

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT.

As the EUT can be powered from a battery and from AC power line (by setup on the base station which is AC powered), radiated emissions were measured in both configurations. The worst-case result was reported. When powered from the battery, the EUT was tested by placing on the turntable on three orthogonal axis. The worst-case emissions was reported.

The frequency range up to tenth harmonic of each of the three fundamental frequency (low, middle, and high channels) for each band (cellular and PCS) was investigated.

For spurious emissions attenuation, the substitution method was used. On each frequency where the Field Strength was found above 63.4 dBuV/m (which corresponds to ERP = -33 dBm), the EUT was substituted by a reference antenna (half-wave dipole - below 1 GHz, or Horn antenna - above 1GHz), connected to a signal generator. The signal generator output was adjusted to obtain the same reading as from EUT. The ERP (for cellular band) or EIRP (for PCS band) at the spurious emissions frequency was calculated by adding the antenna gain in dBd (for cellular band) or dBi (for PCS band)) to the signal generator output level in dBm.

The spurious emissions attenuation was calculated as the difference between ERP/EIRP at the fundamental frequency (see section 3) and at the spurious emissions frequency.

4.2 Test Equipment

EMCO 3115 Horn Antennas
HP 8566B Spectrum Analyzer
Low Pass Filter
Preamplifiers

4.3 Test Results

For the Field Strength of spurious emissions, see data in Appendix A. As the field strength exceed the level of 63.4 dB(uV/m) at 3 m on the second harmonic only, the radiated power measurements by the substitution method were performed only on the second harmonic.

Frequency	Antenna	SA Reading	Signal Generator Power	ERP	EIRP	Spurious emission
		(EUT)	Required for the same SA reading	(EUT)	(EUT)	attenuation
MHz	H/V	dB(uV)	dBm	dBm	dBm	dB
Cellular Band						
1649.4	V	68.7	-38.9	-32.1		54.1
1673.0	V	72.5	-35.6	-28.8		52.0
1696.6	V	74.2	-32.7	-25.9		47.4
PCS Band						
3702.5	H	39.2	-30.0		-21.9	43.6
3760.0	V	38.7	-27.1		-19.0	40.1
3817.5	V	35.3	-29.2		-21.1	42.6

Note: Limit for Spurious emission attenuation is $[43 + 10\text{Log}(P)] = 36.5 \text{ dB}$

Complies	Passed by 3.6 dB
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5.0 Radiated Emissions from digital part
FCC 15.109

Test Procedure

The test procedures, as described in American National Standards Institute C63.4-1992, were employed. The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. As the EUT can be powered from a battery and from AC power line (by setup on the base station which is AC powered), radiated emissions were measured in both configurations. The worst-case result was reported.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength in dB(μ V/m)

RA = Receiver Amplitude (including preamplifier) in dB(μ V)

CF = Cable Attenuation Factor in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dB(μ V) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29.0 dB is subtracted, giving field strength of 32 dB(μ V/m). This value in dB(μ V/m) is converted to its corresponding level in μ V/m.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}$$

$$CF = 1.6 \text{ dB}$$

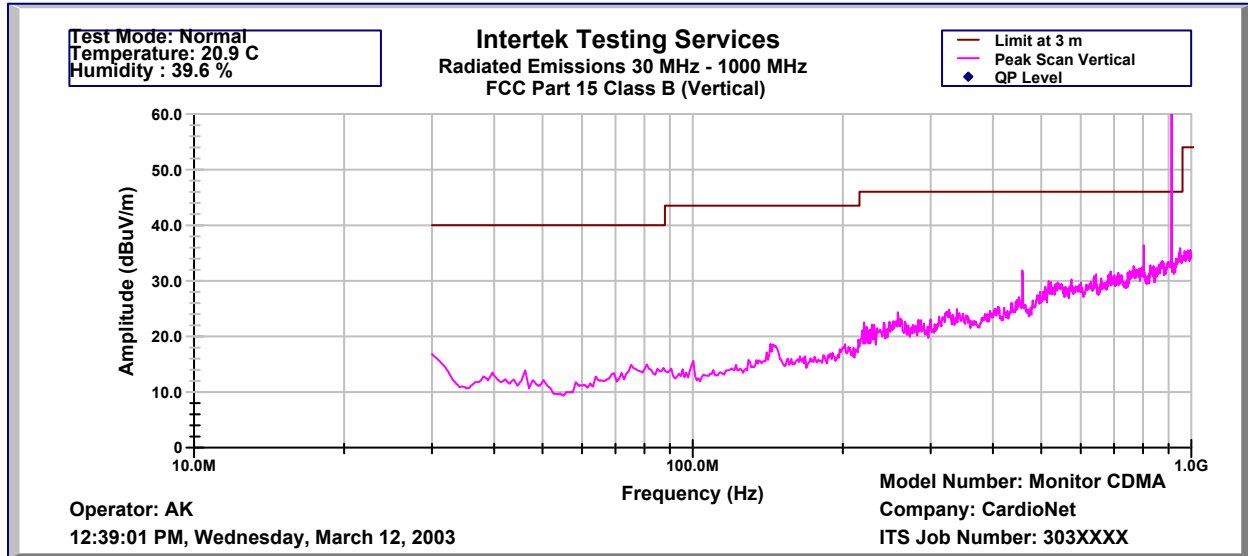
$$AG = 29.0 \text{ dB}$$

$$FS = 52.0 + 7.4 + 1.6 - 29.0 = 32 \text{ dB}(\mu\text{V/m})$$

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(32 \text{ dB}\mu\text{V/m})/20] = 39.8 \mu\text{V/m}$$

Test Results

The results on the following page(s) were obtained when the device was tested in the condition described in Section 1.3.



Intertek Testing Services
Radiated Emissions 30 MHz- 1000 MHz
FCC Part 15 Class B (Pk-Vertical)

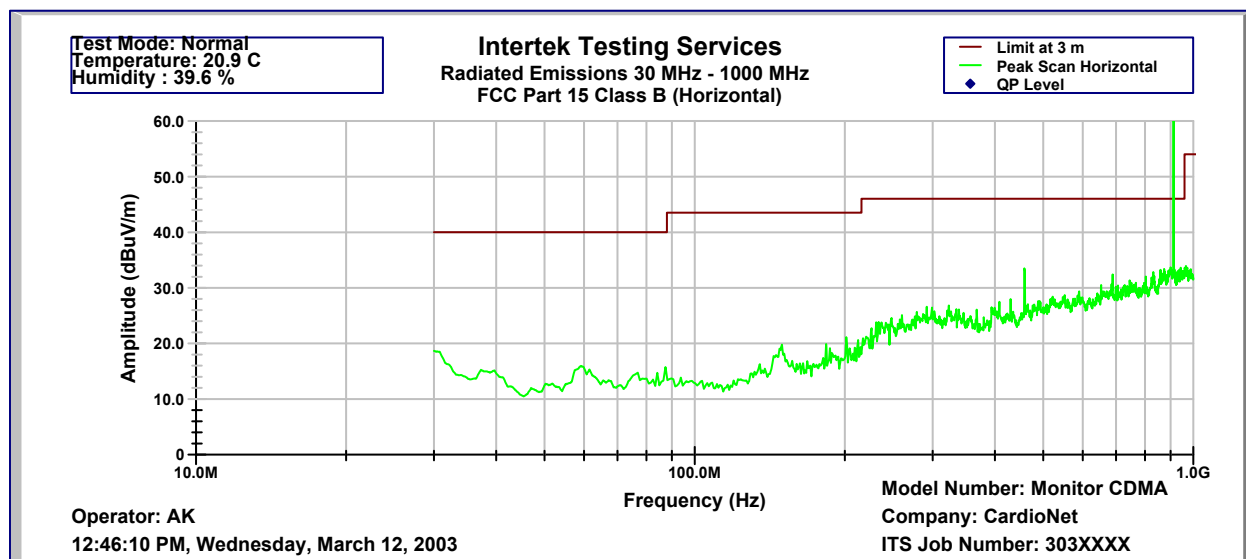
Operator: AK
ITS Job Number: 3038816
Mon Mar 31 14:31:35 2003

Model Number: CardioNet Monitor
Company: CardioNet

Frequency	Peak FS	Limit@3m	Margin	RA	CF	AG	DCF	AF
(MHz)	dB(uV/m)	dB(uV/m)	dB	db(uV)	dB	dB	dB	dB(1/m)
458.41	31.8	46.0	-14.2	29.9	5.8	32.3	10.5	17.9
802.76	36.4	46.0	-9.6	29.8	7.1	32.4	10.5	21.4

Note: The signal on 912 MHz is a signal from Spread Spectrum transmitter.

Test Mode: powered from the base station
Temperature: 20.9 C
Humidity : 39.6 %



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (Pk-Horizontal)

Operator: AK

Model Number: CardioNet Monitor

ITS Job Number: 3038816

Mon Mar 31 14:28:59 2003

Company: CardioNet

Frequency	Peak FS	Limit@3m	Margin	RA	CF	AG	DCF	AF
(MHz)	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)
458.41	33.5	46.0	-12.5	32.0	5.8	32.3	10.5	17.4

Note: The signal on 912 MHz is a signal from Spread Spectrum transmitter.

Test Mode: powered from the base station
Temperature: 20.9 C
Humidity : 39.6 %

6.0 AC Line Conducted Emissions
FCC 15.207

6.1 Test Procedure

Test procedure described in the ANSI C63.4 Standard was employed. The Cardionet Monitor was connected to the AC line through the LISNs. Both HOT and NEUTRAL leads were tested.

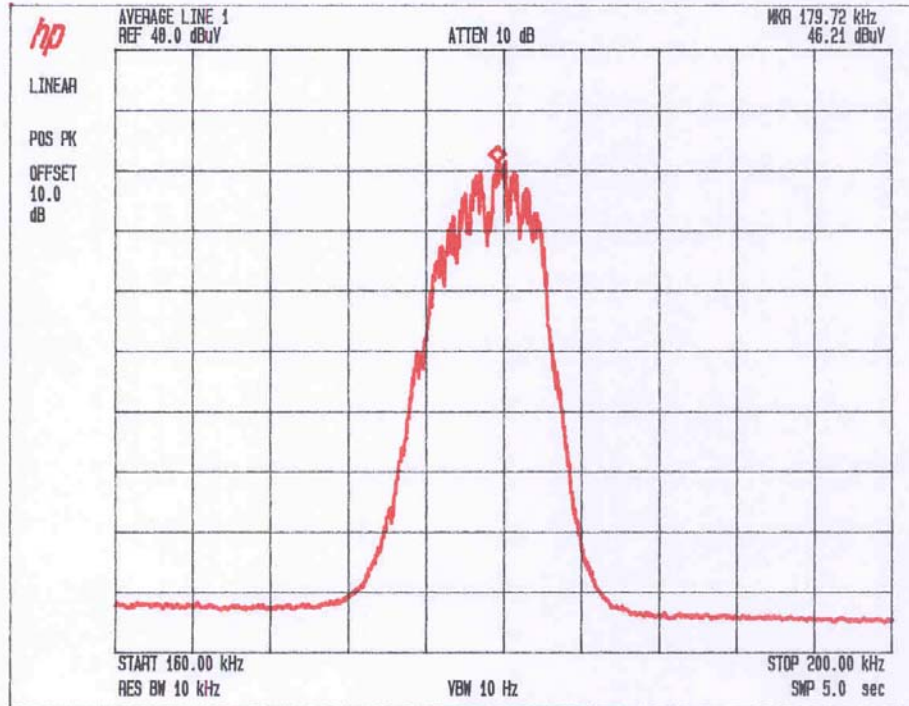
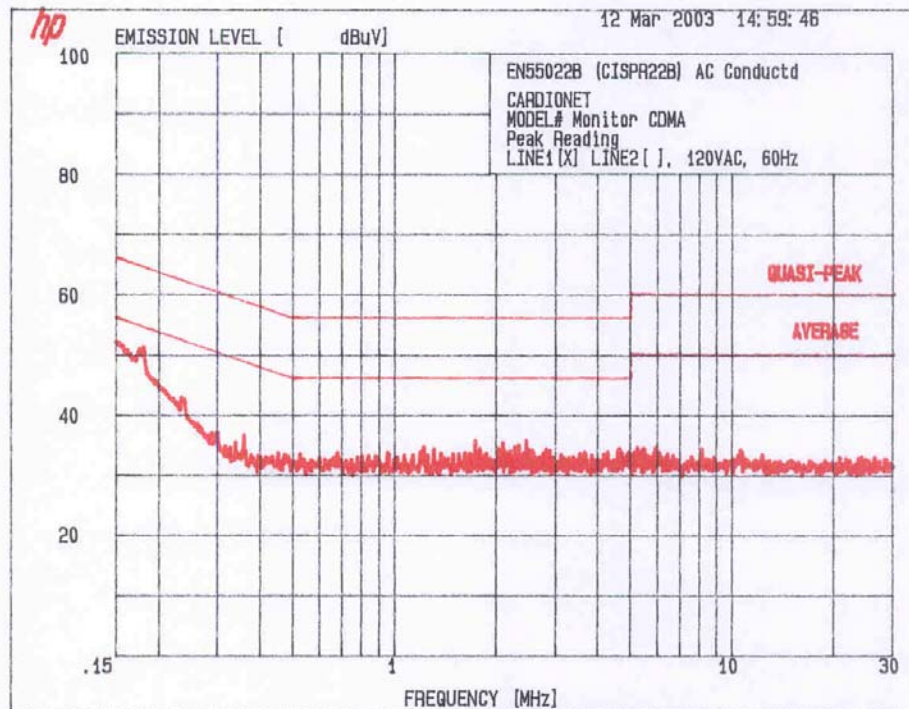
6.2 Test Equipment

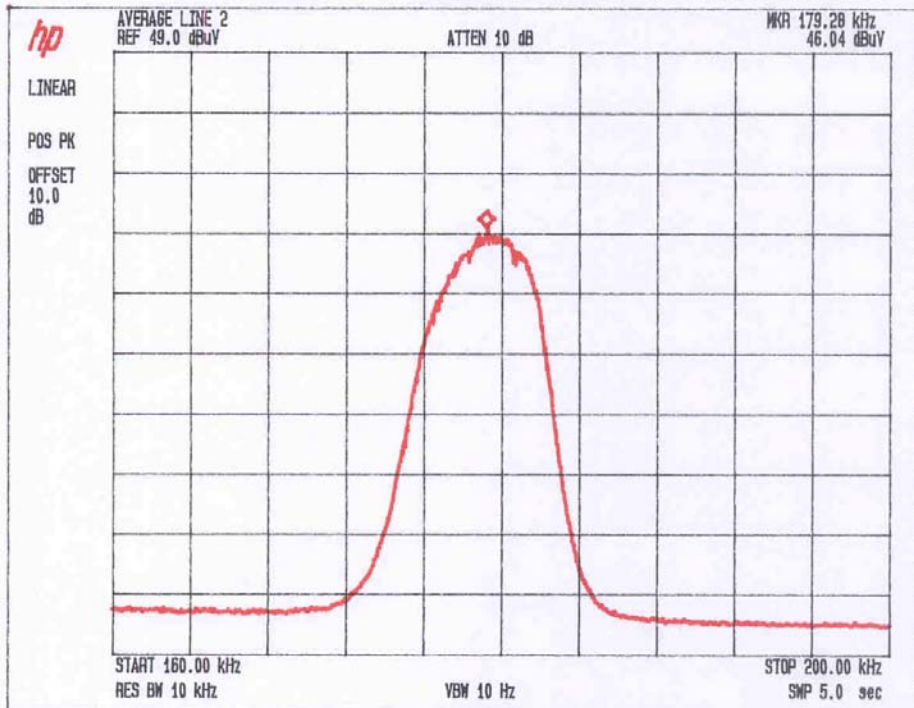
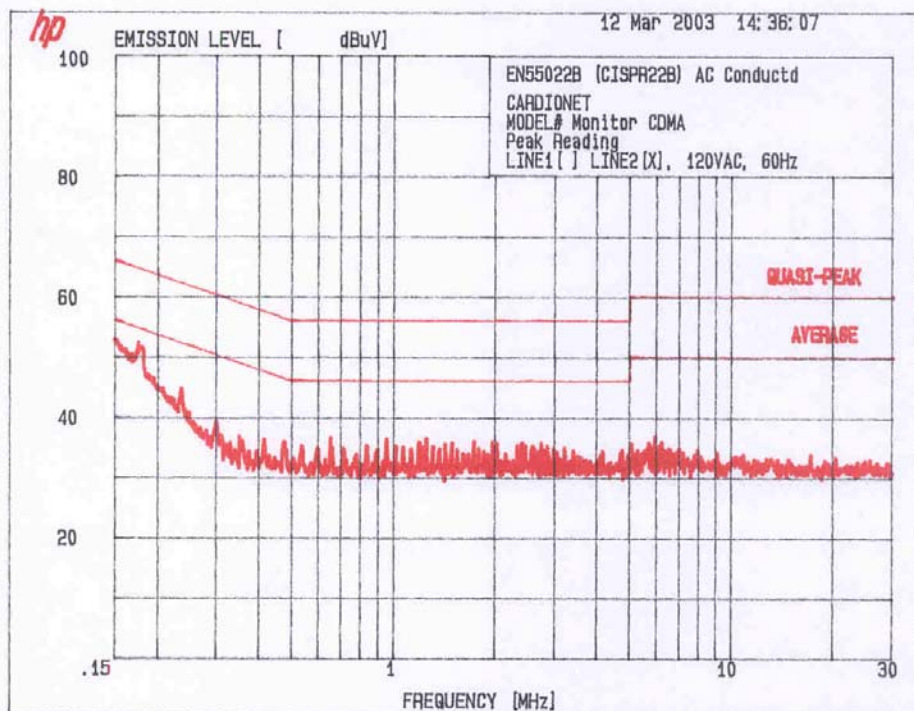
HP8568A Spectrum Analyzer with 85650 Quasi-peak adapter
Fisher Custom Communications, FCC-LISN-50-50-M-H

6.3 Test Results

For the test result, see attached plots.

EUT complies by 8 dB.





7.0 List of test Equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

Equipment	Manufacturer	Model/Type	Serial #	Cal Int	Cal Due
BI-Log Antenna	EMCO	3143	9509-1160	12	9/19/03
Horn Antenna #8	EMCO	3115	9170-3712	12	6/02/03
Horn Antenna	EMCO	3160-09	ITS51	#	#
Horn Antenna	EMCO	3160-10	ITS52	#	#
Pre-Amplifier	Miteq	AMF-4D-001180-24-10P	799159	12	4/05/03
Pre-Amplifier	CTT	ACO/400	47526	12	5/28/03
Pre-Amplifier	ITS	ITSPA-1	44156	12	5/16/03
RF Filter Section	Hewlett Packard	85460A	3448A00267	12	7/16/03
EMI Receiver	Hewlett Packard	8546A	3710A00373	12	7/16/03
Spectrum Analyzer	Tektronix	2784	B3020108	12	8/08/03
LISN	FCC	FCC-LISN-50-50-M-H	2011	12	2/08/04
Attenuator	Narda	757C	00433	12	3/16/04

No Calibration Required

8.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 / 3038816	DC	March 16, 2003	Original document

9.0 Appendix A

Test Result						
February 19-21 and March 10-11, 2003						
Test Mode: Tx, 824.7 MHz.			FCC Part 22 (Radiated Emission, Harmonics)			
Temperature: 21.0 C			CARDIONET INC.			
Humidity:51.0 %			Model: CARDIONET MONITOR			
Frequency MHz	Polarity	Spectrum analyzer reading dB(uV)	Cable loss (dB)	Pre-amplif. Gain dB	Ant.factor dB(1/m)	FS Level dB(uV/m)
1649.50	V	68.7	4.1	36.5	27.6	63.7
2474.25	V	39.2	5.2	36.5	30.6	38.5
3299.00	H	27.8	6.6	36.4	32.2	30.2
4123.75	V	25.5	6.7	36.3	34.1	30.0
4948.50	V	18.3	10.1	35.8	35.0	27.7
5773.25	V	20.8	8.3	35.3	36.3	30.2
6598.00	V	22.3	12.6	35.3	36.1	36.1
7422.75	V	24.7	10.0	35.4	37.8	37.1
8247.50	V	23.5	10.2	35.5	37.8	36.1

Test Result						
February 19-21 and March 10-11, 2003						
Test Mode: Tx, 836.5 MHz.			FCC Part 22 (Radiated Emission, Harmonics)			
Temperature: 21.0 C			CARDIONET INC.			
Humidity:51.0 %			Model: CARDIONET MONITOR			
Frequency MHz	Polarity	Spectrum analyzer reading dB(uV)	Cable loss (dB)	Pre-amplif. Gain dB	Ant.factor dB(1/m)	FS Level dB(uV/m)
1673.0	V	72.5	4.1	36.5	27.7	67.8
2509.5	H	52.5	5.2	36.5	30.7	51.9
3346.0	H	39.5	6.9	36.4	32.3	42.3
4182.5	H	44.7	6.7	36.3	34.0	49.1
5019.0	V	36.3	10.5	35.8	35.1	46.3
5855.5	V	25.5	8.4	35.3	36.4	35.0
6692.0	V	21.2	11.7	35.3	36.3	34.2
7528.5	V	28.7	10.2	35.4	38.0	41.5
8365.0	V	23.7	10.1	35.4	37.8	36.2

Test Result						
February 19-21 and March 10-11, 2003						
Test Mode: Tx, 848.3			FCC Part 22 (Radiated Emission, Harmonics)			
Temperature: 21.0 C			CARDIONET INC.			
Humidity:51.0 %			Model: CARDIONET MONITOR			
Frequency MHz	Polarity	Spectrum analyzer reading dB(uV)	Cable loss (dB)	Pre-amplif. Gain dB	Ant.factor dB(1/m)	FS Level dB(uV/m)
1696.60	V	74.2	4.0	36.5	27.8	69.3
2543.25	V	53.5	5.2	36.5	30.8	53.0
3391.00	H	39.5	7.2	36.4	32.5	42.8
4238.75	H	53.5	6.8	36.3	34.0	58.1
5086.50	H	35.5	9.9	35.7	35.2	44.9
5934.25	V	22.7	8.4	35.2	36.5	32.4
6782.00	V	25.8	10.7	35.3	36.5	38.0
7629.75	V	24.2	10.4	35.4	37.9	37.1
8477.50	V	23.2	10.3	35.4	37.9	35.9

Test Result							
February 19-21 and March 10-11, 2003							
Test Mode: Tx, 1851.25 MHz.				FCC Part 24 (Radiated Emission, Harmonics)			
Temperature: 21.0 C				CARDIONET INC.			
Humidity:51.0 %				Model: CARDIONET MONITOR			
Frequency MHz	Spectrum analyzer reading dB(uV)	Polarity	Cable loss (dB)	Pre-amplif. Gain dB	Ant.factor dB(1/m)	Distance Factor dB	FS Level dB(uV/m)
3702.0	39.2	H	6.4	0.0	33.4	0.0	79.0
5553.0	36.2	V	8.3	35.5	36.0	0.0	45.2
7404.0	30.2	V	9.9	35.4	37.8	0.0	42.5
9255.0	23.0	V	11.4	35.3	39.4	0.0	38.6
11106.0	26.2	V	5.0	36.3	40.2	0.0	35.0
12957.0	29.3	H	5.6	36.9	40.4	0.0	38.4
14808.0	23.5	V	6.0	36.6	40.4	0.0	33.3
16659.0	21.8	V	6.9	35.6	41.3	0.0	34.4
18510.0	22.0	V	9.6	35.6	40.2	0.0	36.2

Test Result							
February 19-21 and March 10-11, 2003							
Test Mode: Tx, 1880 MHz.				FCC Part 24 (Radiated Emission, Harmonics)			
Temperature: 21.0 C				CARDIONET INC.			
Humidity:51.0 %				Model: CARDIONET MONITOR			
Frequency MHz	Spectrum analyzer reading dB(uV)	Polarity	Cable loss (dB)	Pre-amplif. Gain dB	Ant.factor dB(1/m)	Distance Factor dB	FS Level dB(uV/m)
3760.0	38.7	V	6.4	0.0	33.5	0.0	68.6
5640.0	40.2	V	8.3	35.4	36.1	0.0	49.3
7520.0	24.2	V	10.2	35.4	38.0	0.0	36.9
9400.0	21.3	V	10.9	35.3	39.0	0.0	36.0
11280.0	32.2	H	5.0	36.5	40.4	0.0	41.1
13160.0	28.7	H	5.7	36.9	40.2	0.0	37.7
15040.0	23.5	H	6.3	36.1	42.2	0.0	35.9
16920.0	21.3	V	7.0	35.6	41.8	0.0	34.5
18800.0	22.1	V	9.6	35.6	40.2	0.0	36.3

Test Result							
February 19-21 and March 10-11, 2003							
Test Mode: Tx, 1908.75 MHz				FCC Part 24 (Radiated Emission, Harmonics)			
Temperature: 21.0 C				CARDIONET INC.			
Humidity:51.0 %				Model: CARDIONET MONITOR			
Frequency MHz	Spectrum analyzer reading dB(uV)	Polarity	Cable loss (dB)	Pre-amplif. Gain dB	Ant.factor dB(1/m)	Distance Factor dB	FS Level dB(uV/m)
3817.5	35.3	V	6.4	0.0	33.7	0.0	75.4
5725.5	39.8	V	8.3	35.4	36.2	0.0	49.1
7634.0	24.2	H	10.5	35.4	37.9	0.0	37.1
9542.5	20.7	V	11.3	35.3	38.8	0.0	35.6
11451.0	37.2	H	5.1	36.7	40.6	0.0	46.2
13359.5	27.2	H	5.7	36.8	40.1	0.0	36.2
15268.0	26.0	H	6.4	36.0	42.0	0.0	38.4
17176.5	21.7	H	7.0	35.6	43.0	0.0	36.2
19085.0	22.0	H	9.8	35.6	40.2	0.0	36.4