SMITH ELECTRONICS, INC.
ELECTROMAGNETIC COMPATIBILITY LABORATORIES

Radio Frequency Interference Report

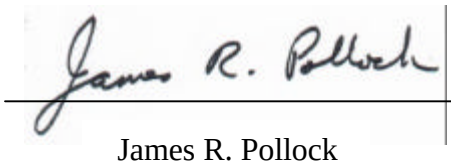
on the
Gorman-Redlich

Weather Radio Receiver

Model CRW-S

May 20, 2004

Prepared by:



James R. Pollock

Prepared for:

Gorman-Redlich
257 Union Street
Athens, OH 45701

Smith Electronics, Inc.
8200 Snowville Road
Brecksville, OH 44141
Phone: (440) 526-4386
Fax: (440) 526-9205

TEST REPORT

OBJECTIVE

Measurements were performed on May 14 & 18, 2004, to determine if the Gorman-Redlich CRW-S weather receiver was in compliance with the FCC emissions requirements of 15.107, 15.109 and 15.111 for a digital device and a receiver.

SUMMARY

The Gorman-Redlich CRW-S weather receiver was found to be in compliance with the conducted and radiated radio frequency emissions requirement of the FCC for a digital device and a receiver.

The CRW-S would be considered a Class A digital device but was found to meet the more stringent Class B requirements which are the same requirements as for the receiver.

GENERAL INFORMATION

MANUFACTURER	Gorman-Redlich 257 Union Street Athens, OH 45701
TEST DATES	May 14 & 18, 2004
EQUIPMENT UNDER TEST	Model CRW-S Weather Radio Receiver FCC ID: MVZCRW-S
SPECIFICATION	FCC Part 15 15.107(a); 15.109(a)(b), 15.111(a)

INTRODUCTION

The Gorman-Redlich CRW-S receiver is a receiver capable of tuning the seven weather band channels. Tuning is performed by setting DIP-switches on the back panel of the receiver. With a rack-mount design, it would probably be installed in a radio-room or equipment room rather than in an office location. Back panel connectors do provide for remote audio outputs, a flashing LED, remote relay closure and reset, and remote replay and mute/de-mute. Digital I/O ports are also provided for receiver programming and outputting a digital signal to a message board.

A 15 VDC wall power pack, or a stand-by battery source generally powers the receiver. The antenna port is a standard "F" connector. The CWR-S also contains the digital circuitry necessary for proper operation and digital signal processing, and is thus a Class A digital device as well as a receiver

The receiver is to tune between 162.40 MHz and 162.55 MHz and is a dual-conversion receiver with a first IF frequency of 21.4 MHz and a second IF of 455 kHz. The local oscillator (LO) of the system operates 21.4 MHz below the tuned frequency. This report describes the tests performed on the receiver in support of an application for certification.

MEASUREMENTS PERFORMED

The AC line input to the 15 VDC power pack was examined for conducted RF emissions with the receiver powered.

The antenna input port was examined for any spurious emissions that might feed back from the receiver into the antenna system.

The receiver chassis, with its external wiring and cabling was examined for spurious emissions that might be radiated from the chassis or its external connections.

All measurements were taken following the procedures outlined in ANSI C63.4-1992, with the results being compared to limits provided in sections 15.107(a), 15.109(a)(b) and 15.111(a) of the FCC Rules. All measurements were made with the receiver tuned to the middle of the weather band at 162.475 MHz. Photographs of the test set-ups are found in the Pictorials.

The receiver as examined has been determined to comply with these sections and the data determining compliance is presented in this report.

.

LINE CONDUCTED EMISSIONS

Conducted emissions were measured at the 50 Ohm termination points of the LISN with the receiver's power pack plugged directly into the LISN AC output. The receiver was placed on a non-conducting table in the shielded room. The receiver was positioned 0.4 m from the room wall, which served as the ground plane. It was at least 0.8 m from other conducting planes. The detected emissions were recorded on a plotter from the spectrum analyzer. The FCC Class B limit of 250 uV or 48 dBuV is drawn on the plots for comparison.

Figure 1 shows the conducted emissions detected at the LISN from the receiver between 450 kHz and 3 MHz. The upper plot, using peak detection, shows broadband emissions near the limit at 450 kHz. The lower plot of Fig. 1 covers the range from 400 kHz – 1.4 MHz using the quasi-peak detector and shows that the emissions are about 4 dB below the limit. The emissions data between 3 MHz and 30 MHz is found in Fig. 2. This also is peak data. Data for both hot and neutral sides of the line are overlaid on each plot.

In viewing the plots of Figs. 1 & 2, it appears that the line conducted emissions are comfortably below the Class B limit for receivers.

ANTENNA POWER CONDUCTION EMISSIONS

Emissions from the antenna port of a receiver are required to be 2 nW or less if the antenna is not defined. Two nanowatts is equivalent to –57 dBm. The antenna port of the weather receiver was attached to the spectrum analyzer input port with a 0.5 meter length of RG-58. The loss in this length of cable ranges from less than 0.1 dB at 100 MHz to less than 0.2 dB at 1 GHz. The emissions over the frequency range of 0 to 1 GHz were measured in one analyzer scan which is seen in Fig. 3. The –57 dB level is shown on the scan. The four highest antenna port emissions are seen in Table 1. All other antenna emissions were more than 10 dB below the limit.

Table 1
Antenna Conducted Power Levels

Frequency	Conducted Power	dB from Limit
141.1 MHz	-62.5 dBm	-5.5
160.0 MHz	-66.2 dBm	-9.2
282.1 MHz	-62.6 dBm	-5.6
705.4 MHz	-66.3 dBm	-9.3

RADIATED EMISSIONS

The radiated emissions from the receiver were initially examined in the shielded room. The absence of RF noise in the shielded room allows for easy measurement of the emissions generated by the system. Measurements performed in the shielded room have unwanted perturbations caused by reflections and resonances. However, shielded room measurements are useful in determining the emissions profile, as well as identifying specific frequencies of interest for investigation on the open field site.

All radiated emissions measured in the shielded room were measured at an antenna distance of one meter. All spectral plots made of the detected emissions have FCC Class B limits drawn on them for reference. The FCC Class B limits for radiated emissions from FCC Part 15.109(a) are as follows:

Frequency (MHz)	Linearly Scaled FCC Class B Limit @ 1 Meter (uV/m)	(dBuV/m)	FCC Class B Limit @ 3 Meters (uV/m)	(dBuV/m)
30-88	300	49.5	100	40.0
> 88-216	450	53.0	150	43.5
>216-960	600	55.6	200	46.0
>960	1500	63.5	500	54.0

To transfer the scaled one-meter FCC limits to the spectral plots taken in the shielded room, the following relationship was used:

$$L = FCC - AF - CP + P \qquad \text{(Eq. 1)}$$

Where:
- L = Corrected limit on plot in dBuV
- FCC = Scaled FCC limit (1 m) at frequency of interest in dBuV/m
- AF = Antenna factor in dB at frequency of interest
- C = Coax loss in dB at frequency of interest
- P = Gain of preamplifier (26 dB)

To determine compliance with FCC limits on the open field site, the following equation was used:

$$Q = S + AF - C - FCC \qquad \text{(Eq. 2)}$$

Where:
- Q = Magnitude in dB above/below the FCC limit
- S = Measured signal strength of interference in dBuV
- AF = Antenna factor in dB at frequency of interest
- C = Coax loss in dB at frequency of interest
- FCC = FCC Class B limit (3 m) in dBuV/m at frequency of interest

The antenna and coax factors used are found in Table 2

The shielded room measurements were performed using linearly polarized broadband antennas. A biconical antenna was used for measurements between 30-200 MHz, and a log periodic antenna was used between 200-1000 MHz.. Measurements were made in both the vertical and horizontal antenna polarizations with the detected emissions recorded on a common spectral plot.

Figure 4 shows the measurements made in the shielded room between 30 MHz and 1000 MHz with the Class B limit drawn on the plots. While it appears that all emissions are well below the limit, the open field measurements found in Table 2, indicate the some of the emissions were relatively close to the limit,

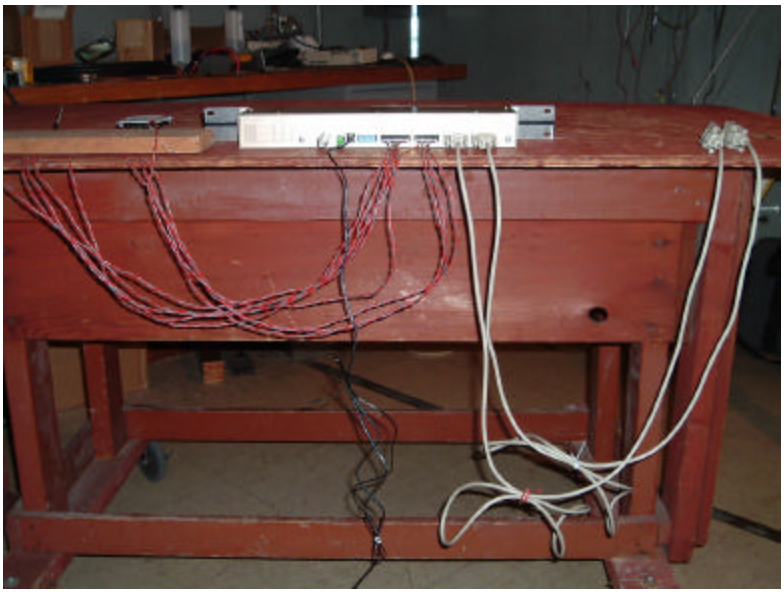
The final radiated emissions tests were performed on the three-meter open field site located in Brecksville, Ohio. Information regarding this site is on file with the FCC. The receiver was set up on the rotary platform three meters distant from the receiving antenna (see Pictorials). These measurements were made with a 50 Ohm dummy load on the antenna port of the receiver. The same antennas were used on the open field site as for the shielded room measurements.

With the receiver powered, the frequency range of interest between 30-1000 MHz was manually searched. The system was rotated on its axis and the receiver antenna height was repeatedly adjusted to maximize the field intensity of the detected emissions. The maximum signal level, frequency, and antenna polarizations were recorded tabularly. The detected signal closest to the limit was at 564.3 MHz and is a harmonic of the local oscillator.

CONCLUSION

Based on the information shown in Figs. 1 – 3 and Tables 1, it appears that the Gorman-Redlich Model CRW-S weather receiver is capable of compliance with the FCC Rules and Regulation in regard to conducted and radiated emissions as found in 15.107(a) and 15.109(a). As shown in Fig. 4 and Table 1, it also complies with the regulation regarding antenna power conducted limits found in 15.111(a), and therefore qualifies for Certification.

Front View



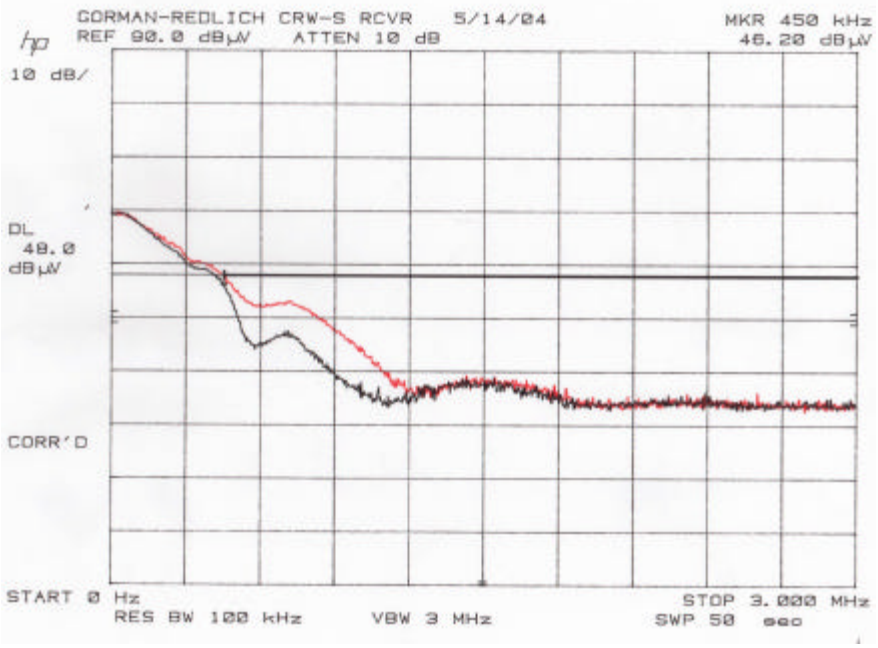
Rear View
(Moved away from wall for visibility)

Pictorial 1
Conducted Emissions
CRW-S Weather Radio
Test Set-Up

Front View

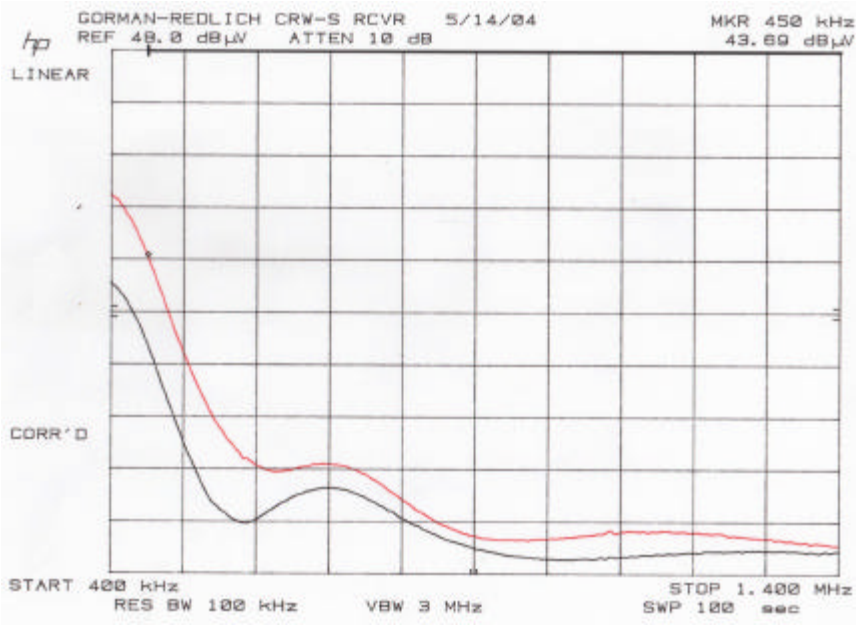
Rear View

Pictorial 2
Radiated Emissions
CRW-S Weather Radio
Test Set-Up



Peak

Class B Limit

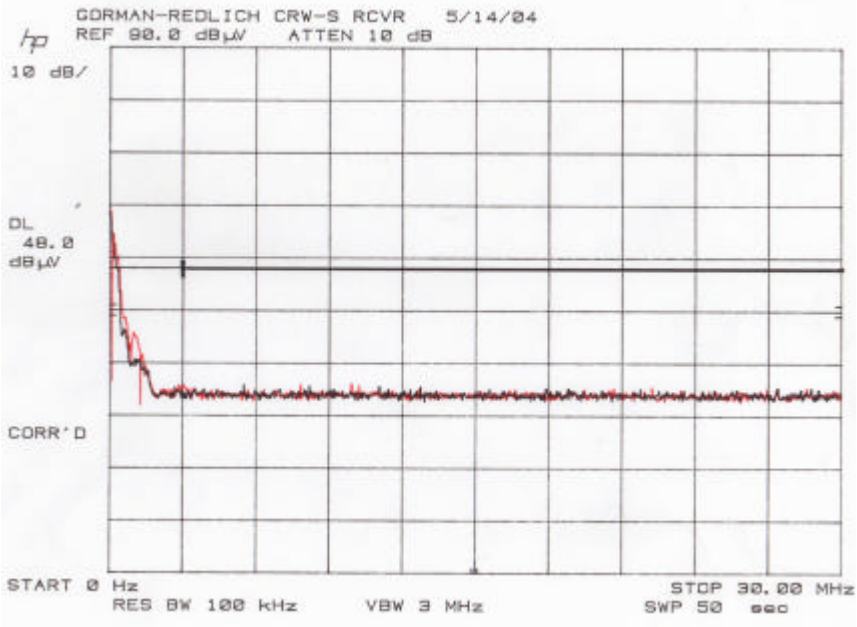


Class B Limit

Quasi-Peak

Red = Neutral
Black = Line

Fig. 1
Conducted Emissions
CRW-S Weather Receiver
450 kHz – 3.0 MHz

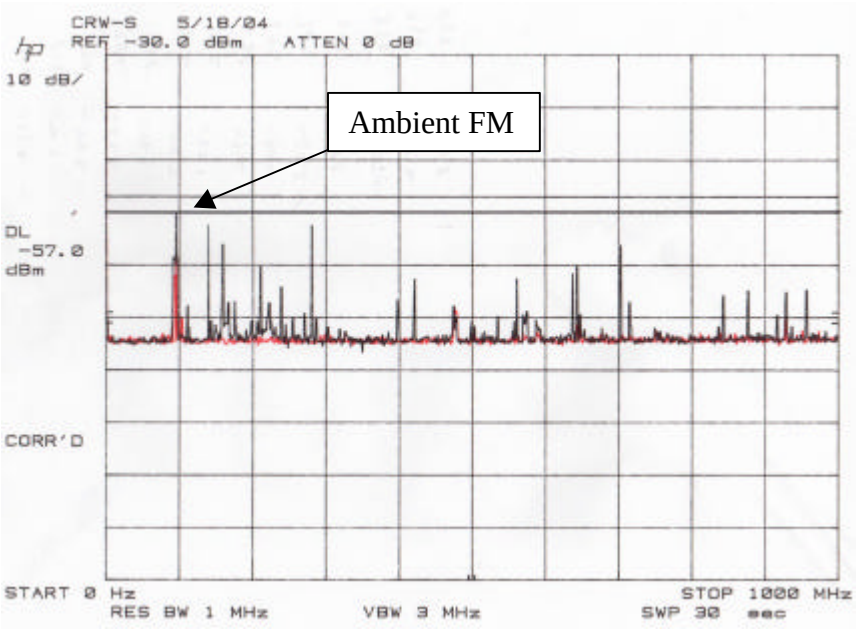


Peak

250 uV

Red = Neutral Lead
Black = Hot Lead

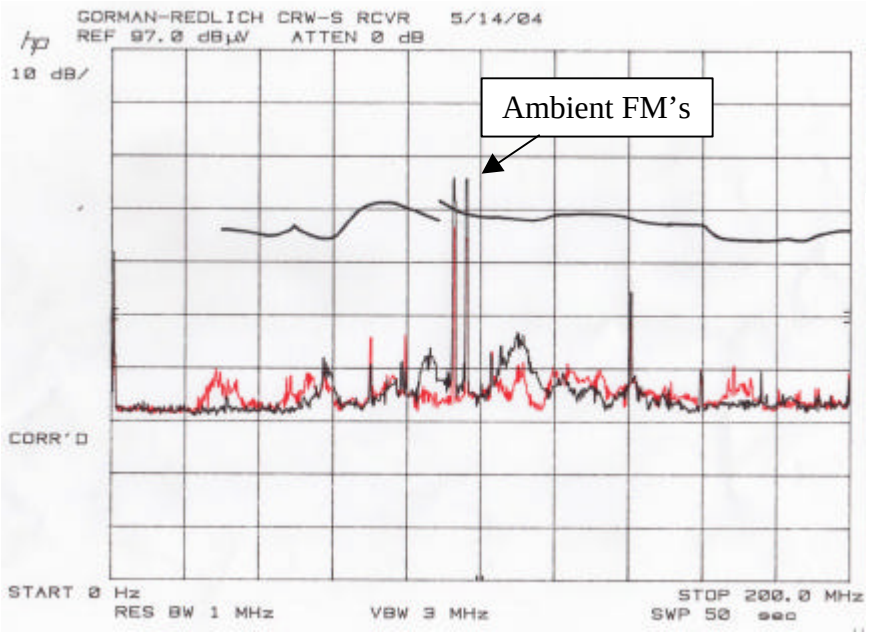
Fig. 2
Conducted Emissions
CRW-S Weather Receiver
3 MHz – 30 MHz



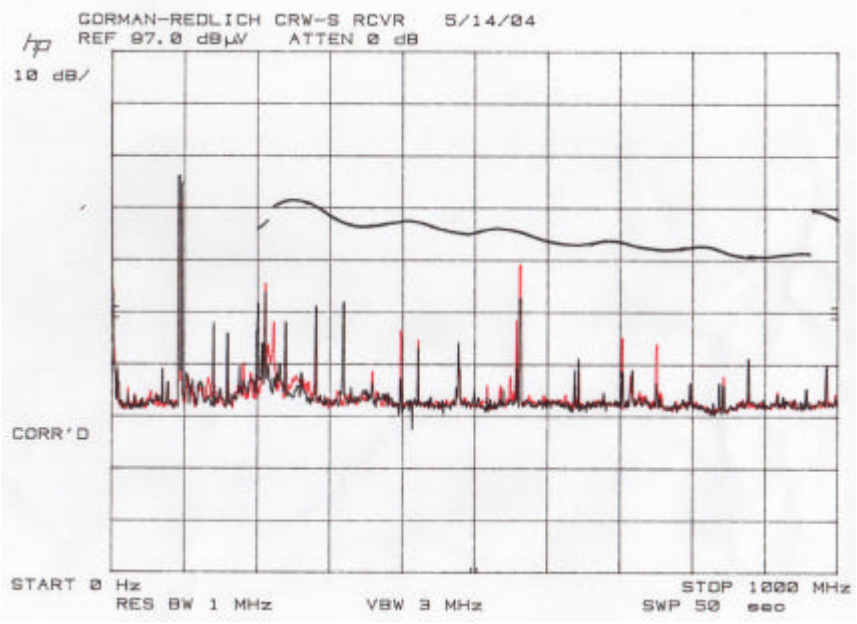
2 nW

Red = Ambient
Black = Active

Fig. 3
Antenna Terminal Power
CRW-S Weather Receiver
0 – 1000 MHz



Class B Limit



Class B Limit

Red = Neutral
Black = Line

Fig. 4
Preliminary Radiated Emissions
CRW-S Weather Receiver
30 MHz – 1000 MHz

Table 1
Open Field Test Summary, Radiated Emissions
Groman-Redlich Model CRW-S Weather Receiver
Test Date May 14, 2004
Measurement Distance, 3 meters

Freq. MHz	Signal dBuV	Antenna Factor	Coax Factor	E UV/m	dB vs. FCC A	dB vs. FCC B	Antenna Type
141.1	12.0	10.7	1.1	15.5	-30.2	-19.7	BICON V
141.1	19.0	10.7	1.1	34.7	-23.2	-12.7	BICON H
160.0	17.0	12.3	1.2	33.3	-23.5	-13.1	BICON V
160.0	19.0	12.3	1.2	41.9	-21.5	-11.1	BICON H
211.6	12.0	12.2	1.4	19.0	-28.4	-17.9	LOGP V
211.6	18.0	12.2	1.4	38.0	-22.4	-11.9	LOGP H
224.0	5.0	10.8	1.4	7.3	-39.7	-28.8	LOGP V
224.0	4.0	10.8	1.4	6.5	-40.7	-29.8	LOGP H
240.0	1.0	11.5	1.5	5.0	-42.9	-32.0	LOGP V
240.0	8.0	11.5	1.5	11.3	-35.9	-25.0	LOGP H
282.0	7.0	14.7	1.6	14.8	-33.5	-22.6	LOGP V
282.0	17.0	14.7	1.6	46.6	-23.5	-12.6	LOGP H
320.0	12.0	14.1	1.8	24.8	-29.0	-18.1	LOGP V
320.0	16.0	14.1	1.8	39.3	-25.0	-14.1	LOGP H
360.0	3.0	15.9	1.9	11.0	-36.1	-25.2	LOGP V
360.0	4.0	15.9	1.9	12.4	-35.1	-24.2	LOGP H
400.0	8.0	15.1	2.0	18.1	-31.7	-20.9	LOGP V
400.0	12.0	15.1	2.0	28.7	-27.7	-16.9	LOGP.H
423.2	7.0	16.8	2.1	19.8	-31.0	-20.1	LOGP V
423.2	7.0	16.8	2.1	19.8	-31.0	-20.1	LOGP H
564.3	21.0	18.4	2.5	124.3	-15.0	-4.1	LOGP V
564.3	20.0	18.4	2.5	110.8	-16.0	-5.1	LOGP H
987.5	5.0	24.1	3.6	43.4	-27.3	-21.2	LOGP H

EUT EXTERNAL CABLING

Port	Attached Cables
Standby/Battery	Empty
15 VDC	Shoeyo 120VAC/15VDC Adapter Model CRW-S Weather Radio w/2m cord
10-pin connector	1 m twisted pairs 1-2 550 Ohm 3-4 550 Ohm 5-6 Open 7-8 Open 9-10 Open
8-pin connector	1 m twisted pairs 11-12 Speaker 13-14 Open 15-16 Open 17-18 Open
PC Port	2 m unterminated DB-9 cable bundled to 1 m
Aux Port	2 m unterminated DB-9 cable bundled to 1 m

MEASUREMENT EQUIPMENT

Spectrum Analyzer	Hewlett Packard Type 8568B with 85680A RF Spectrum Analyzer section SN: 2216A02120 85662A display section SN: 2152A03683 Cal Due: 6/04
Quasi-Peak Adapter	Hewlett Packard Model: 85650A SN: 2043A00350 Cal Due: 6/04 QP adapter provides CISPR Bandwidths Freq. Range — 6 dB BW 10-150 kHz — 200 Hz 0.15-30 MHz — 9 kHz 30-1000 MHz — 120 kHz
Interference Receiver	Singer Instrumentation Model: NM-37/57 SN: 0366-06168 Cal Due: 6/04 (Open field Measurements)
Preamplifier	Hewlett Packard Type 8447D SN: 1726A01282 Gain: 26 dB
Vector Plotter	Hewlett Packard Type 7407A SN: 2308A39494
LISN's	50 uH LISN's per ANSI C63.4-1992
Biconical Antenna	EMCO Model: 3104 SN: 2660 Cal Due: 12/04 Frequency Range: 30-200 MHz
Log Periodic Antenna	EMCO Model: 3146 SN: 1236 Cal Due: 12/04 Frequency Range: 200-1000 MHz
Coaxial Cable	Type RG-214/U 12.2 m length (open field) RG-58 0.5 m length (Antenna Power)