Cert. No. 1152.01
Electrical (EMC)

**DATE: 13 March 2005**

# I.T.L. (PRODUCT TESTING) LTD.

# FCC Test Report

**for**

# Galcon Galil Control

**Equipment under test:**

# DC Radio Programmer

# (For Transmitter Section)

10,000

Written by: _____
D. Shidlowsky, Documentation

Approved by: _____
E. Pitt, Test Engineer

Approved by: _____
I. Raz, EMC Laboratory Manager

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This report relates only to items tested.

Cert. No. 1152.01
Electrical (EMC)

# Measurement/Technical Report for
## Galcon Galil Control

**Equipment under test:**

## DC Radio Programmer

## (For Transmitter Section)

## FCC ID: SZ810000

## DATE: 13 March 2005

This report concerns: Original Grant _x_ Class II change ___

Class B verification ___ Class A verification_____ Class I change ____

Equipment type: Radio Telemetry Transmitter
Request Issue of Grant:
__x__Immediately upon completion of review

Limits used:
CISPR 22 _____ Part 15 _x_

Measurement procedure used is ANSI C63.4-2003.


Application for Certification
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Applicant for this device:
(different from "prepared by")
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# 1. General Information

## *1.1 Administrative Information*

| | |
|---|---|
| Manufacturer: | Galcon Galil Control |
| Manufacturer's Address: | Kibbutz Kfar Blum<br>Upper Galilee<br>D.N. 12150<br>Israel<br>Tel: +972-4-690-0222<br>Fax: +972-4-690-2727 |
| Manufacturer's Representative: | Shay Shtekelmacher<br>Eitain Gabay |
| Equipment Under Test (E.U.T): | DC Radio Programmer |
| Equipment Model No.: | 10,000 |
| Equipment Serial No.: | Not designated |
| Date of Receipt of E.U.T: | 19.01.05 |
| Start of Test: | 19.01.05 |
| End of Test: | 07.02.05 |
| Test Laboratory Location: | I.T.L (Product Testing) Ltd.<br>Kfar Bin Nun,<br>ISRAEL 99780 |
| Test Specifications: | See Section 2 |

## 1.2 List of Accreditations

The EMC laboratory of I.T.L. is accredited by the following bodies:

1. The American Association for Laboratory Accreditation (A2LA) (U.S.A.), Certificate No. 1152.01.
2. The Federal Communications Commission (FCC) (U.S.A.), Registration No. 90715.
3. The Israel Ministry of the Environment (Israel), Registration No. 1104/01.
4. The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) (Japan), Registration Numbers: C-1350, R-1285.
5. Industry Canada (Canada), File No. IC 4025.
6. TUV Product Services, England, ASLLAS No. 97201.
7. Nemko (Norway), Authorization No. ELA 207.

I.T.L. Product Testing Ltd. is accredited by the American Association for Laboratory Accreditation (A2LA) and the results shown in this test report have been determined in accordance with I.T.L.'s terms of accreditation unless stated otherwise in the report.

## 1.3 Product Description

The DC Radio Programmer is part of a system used to control irrigation valves. The system comprises of a DC Radio Controller unit and DC Radio Programmer unit.

The user sets and saves irrigation programs in the Programmer using the keyboard and the LCD. The program can be sent to the Controller via the RF link. Once the Controller gets the program, the valve connected to the Controller, will be opened and closed according the received program.

The Programmer includes the following electronics circuits on three PCBs:

- LCD
- Keyboards
- CPU
- Memory
- RF Transceiver operating at 916.0 MHz
- Replaceable 4x1.5VDC AA Batteries

## 1.4 Test Methodology

Both conducted and radiated testing were performed according to the procedures in ANSI C63.4: 2003. Radiated testing was performed at an antenna to EUT distance of 3 meters.

## 1.5 Test Facility

The radiated emissions tests were performed at I.T.L.'s testing facility at Kfar Bin-Nun, Israel. This site is a FCC listed test laboratory (FCC Registration No. 90715, date of listing December 12, 2003).
I.T.L.'s EMC Laboratory is also accredited by A2LA, certificate No. 1152.01.

## 1.6 Measurement Uncertainty

Radiated Emission

The Open Site complies with the ±4 dB Normalized Site Attenuation requirements of ANSI C63.4-2003. In accordance with Paragraph 5.4.6.1 of this standard, this tolerance includes instrumentation calibration errors, measurement technique errors, and errors due to site anomalies.

# 2. Product Labeling

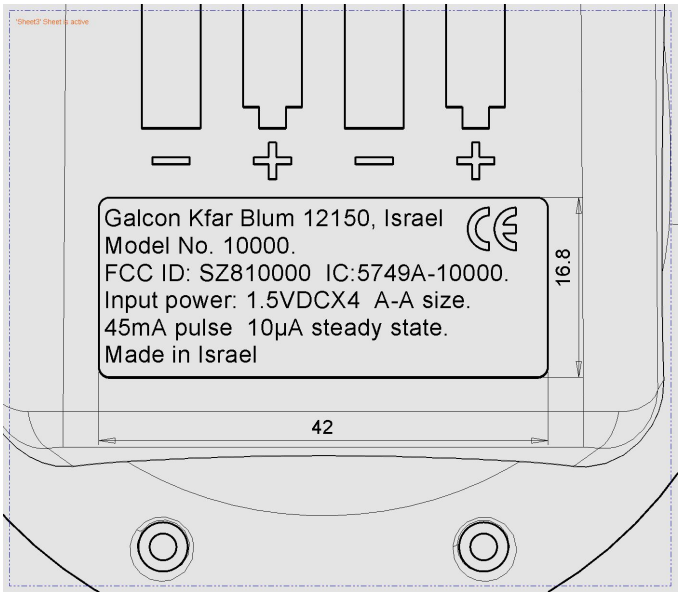


**Figure 1. FCC Label**

**Figure 2. Label Location on EUT**

# 3. System Test Configuration

## 3.1 Justification

The E.U.T. is hand held.

To determine the E.U.T. orientation for the spurious radiated emissions tests, the product carrier field level was measured in three orthogonal directions of the E.U.T. The horizontal position of the E.U.T. and vertical position of the E.U.T. antenna (E.U.T. open) was selected as the worst case final orientation position.

The Programmer was tested in the functional operation mode.

In this mode the Programmer sends a command to the Controller and waits for an answer from the Controller.

While sending the command, the Programmer acts as a transmitter for 30mSec.

While waiting for the Controller answer, the Programmer acts as a receiver for 105mSec.

In the worst case, the Controller might be out of range, so the Programmer will repeat this process, for up to 12 Sec per hour.

## 3.2 EUT Exercise Software

The Programmer SW was changed in order to demonstrate a repetitive transmitting of a command.

## 3.3 Special Accessories

No special accessories were needed to achieve compliance.

## 3.4 Equipment Modifications

No special modifications were needed to achieve compliance.

## 3.5 Configuration of Tested System

The configuration of the tested system is described below.

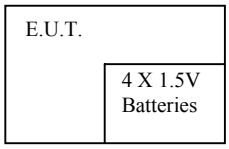


**Figure 3. Configuration of Tested System**

# 4. Block Diagram

## 4.1 Schematic Block/Connection Diagram

**Intentionally Blank for Reasons of Confidentiality**

## 4.2 Theory of Operation

The user sets and saves irrigation programs in the Programmer using the keyboard and the LCD. The program can be sent to the Controller via the RF link. Once the Controller gets the program, the valve connected to the Controller, will be opened and closed according the received program.

The user can get the Controller status via the RF link, displaying it on the Programmer LCD.

The RF Transceiver based on single chip for RF transceiver for narrow band link. The clock frequency is 14.7456 MHz, while the local oscillator is the CW (916MHz) minus 207 kHz.

# 5. Field Strength of Fundamental

## 5.1 Test Specification

F.C.C., Part 15, Subpart C, Section 15.249(a)

## 5.2 Test Procedure

The E.U.T. operation mode and test set-up are as described in Section 3.

The E.U.T. was placed on a non-conductive table, 0.8 meters above the O.A.T.S. ground plane.
The EMI receiver was set to the E.U.T. Fundamental Frequency (916.00MHz) and Peak Detection.
The turntable and antenna mast were adjusted for maximum level reading on the EMI receiver.
The measurement was performed for vertical and horizontal polarizations of the test antenna.

The final result is:

Peak Level(dBµV/m) + E.U.T. Duty Cycle Factor, in 100msec time window (dB)

## 5.3 Measured Data

JUDGEMENT: Passed by 10.15 dB

The EUT met the FCC Part 15, Subpart C, Section 15.249(a) specification requirements.

The details of the highest emissions are given in Figure 4 to Figure 5.

TEST PERSONNEL:

Tester Signature: _____ Date: 14.03.05

Typed/Printed Name: E. Pitt

# Field Strength of Fundamental

E.U.T Description DC Radio Programmer
Model Number 10,000
Serial Number: Not designated

Specification: F.C.C., Part 15, Subpart C 15.249(a)

Antenna Polarization:
Horizontal/Vertical

Test Distance: 3 meters Detector: Peak

| Freq. (MHz) | Pol. V/H | Peak Reading (dBμV/m) | Peak Specification (3) (dBμV/m) | Margin (dB) |
|---|---|---|---|---|
| 916.00 | H | 94.10 | 114.0 | -19.90 |
| 916.00 | V | 94.31 | 114.0 | -19.69 |

**Figure 4. Field Strength of Fundamental. Antenna Polarization: HORIZONTAL/VERTICAL. Detector: Peak**

Note: Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

"Peak Reading" includes "Correction Factors.

"Correction factors" = Antenna Correction Factor + Cable Loss

# Field Strength of Fundamental

E.U.T Description DC Radio Programmer
Model Number 10,000
Serial Number: Not designated

Specification: F.C.C., Part 15, Subpart C 15.249(a)

Antenna Polarization:
Horizontal/Vertical

Test Distance: 3 meters Detector: Peak

| Freq. (MHz) | Pol. V/H | Peak Reading (1) (dBμV/m) | D.C.F. (2) (dB) | Final Result (3) (dBμV/m) | AVG. Specification (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| 916.00 | H | 94.10 | -10.46 | 83.64 | 94.0 | -10.36 |
| 916.00 | V | 94.31 | -10.46 | 83.85 | 94.0 | -10.15 |

**Figure 5. Field Strength of Fundamental. Antenna Polarization: HORIZONTAL/VERTICAL. Detector: Peak**

Note: Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

(1) "Peak Amp." includes "Correction Factors.
"Correction Factors" = Antenna Correction Factor + Cable Loss.

(2) "Duty Cycle Factor (D.C.F.)= $20\log\frac{30}{100} = -10.46dB$ (See Section 4.2 of this report).

(3) "Final Result" = "Peak Reading" +D.C.F. (dB).

### 5.4 Test Instrumentation Used, Field Strength of Fundamental

| Instrument | Manufacturer | Model | Serial Number | Calibration | Period |
|---|---|---|---|---|---|
| EMI Receiver | HP | 85422E | 3411A00102 | February 28, 2004 | 1 year |
| RF Section | HP | 85420E | 3427A00103 | February 28, 2004 | 1 year |
| Antenna Log Periodic | ARA | LPD-2010/A | 1038 | March 21, 2004 | 1 year |
| Antenna Mast | ARA | AAM-4A | 1001 | N/A | N/A |
| Turntable | ARA | ART-1001/4 | 1001 | N/A | N/A |
| Mast & Table Controller | ARA | ACU-2/5 | 1001 | N/A | N/A |
| Printer | HP | ThinkJet 2225 | 2738508357.0 | N/A | N/A |

# 6. Radiated Measurement Photos

**Figure 6. Radiated Emission Test. Front**

# 7. Spurious Radiated Emission Data

## 7.1 Spurious Radiated Emission 9kHz-1000 MHz, Below 1GHz

The E.U.T. operation mode and test set-up are as described in Section 3.

A preliminary measurement to characterize the E.U.T was performed inside the shielded room at a distance of 3 meters, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The configuration tested is shown in Figure 3.1.

The frequency range 9kHz-1000 MHz was scanned, and the list of the highest emissions was verified and updated accordingly.
The emissions were measured using a computerized EMI receiver complying to CISPR 16 requirements. The specification limits and applicable correction factors are loaded to the receiver via a 3.5" floppy disk.
In the frequency range 9 kHz-30 MHz, the loop antenna was rotated on its vertical axis. The antenna height (center of loop) was 1 meter.
In the frequency range 30-1000 MHz, the readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization.
Verification of the E.U.T emissions was based on the following methods:

- Turning the E.U.T on and off.
- Using a frequency span less than 10 MHz.
- Observation of the signal level during turntable rotation. Background noise is not affected by the rotation of the E.U.T.

During this test the E.U.T. was operated in continuous transmission to enable better detection of signals.

## 7.2 *Measured Data*

JUDGEMENT: Passed by 17.5 dB

The signals in the band 9 kHz – 30 MHz were 20dB below the specification limit.

The margin between the emission level and the specification limit is 17.5 dB in the worst case at the frequency of 213.81 MHz, vertical polarization.

The EUT met the requirements of the F.C.C. Part 15, Subpart C, Section 15.249 specification.

The details of the highest emissions are given in Figure 7 to Figure 10.

TEST PERSONNEL:

Tester Signature: _____ Date: 14.03.05

Typed/Printed Name: E. Pitt

# Radiated Emission

| | |
|---|---|
| E.U.T Description | DC Radio Programmer |
| Model Number | 10,000 |
| Serial Number: | Not designated |

Specification: F.C.C., Part 15, Subpart C: Section15.249

Antenna Polarization: Horizontal
Test Distance: 3 meters

Frequency range: 30 to 1000 MHz
Detector: Peak, Quasi-peak

| Frequency (MHz) | Peak Amp (dBµV/m) | QP Amp (dBµV/m) | Correction (dB) | Specification (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 213.81 | 27.9 | 23.5 | 17.9 | 43.5 | -20.0 |
| 228.56 | 28.6 | 23.5 | 18.7 | 46.0 | -22.5 |
| 258.05 | 28.6 | 23.5 | 20.8 | 46.0 | -22.5 |
| 309.66 | 27.6 | 22.3 | 15.9 | 46.0 | -23.7 |
| 339.15 | 24.5 | 19.7 | 17.0 | 46.0 | -26.3 |
| 353.89 | 25.5 | 20.3 | 17.5 | 46.0 | -25.7 |

**Figure 7. Spurious Radiated Emission. Antenna Polarization: HORIZONTAL. Detector: Peak, Quasi-peak**

Note: Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

# Radiated Emission

| | |
|---|---|
| E.U.T Description | DC Radio Programmer |
| Model Number | 10,000 |
| Serial Number: | Not designated |

Specification: F.C.C., Part 15, Subpart C: Section15.249

Antenna Polarization: Horizontal
Test Distance: 3 meters

Frequency range: 30 to 1000 MHz
Detector: Peak, Quasi-peak

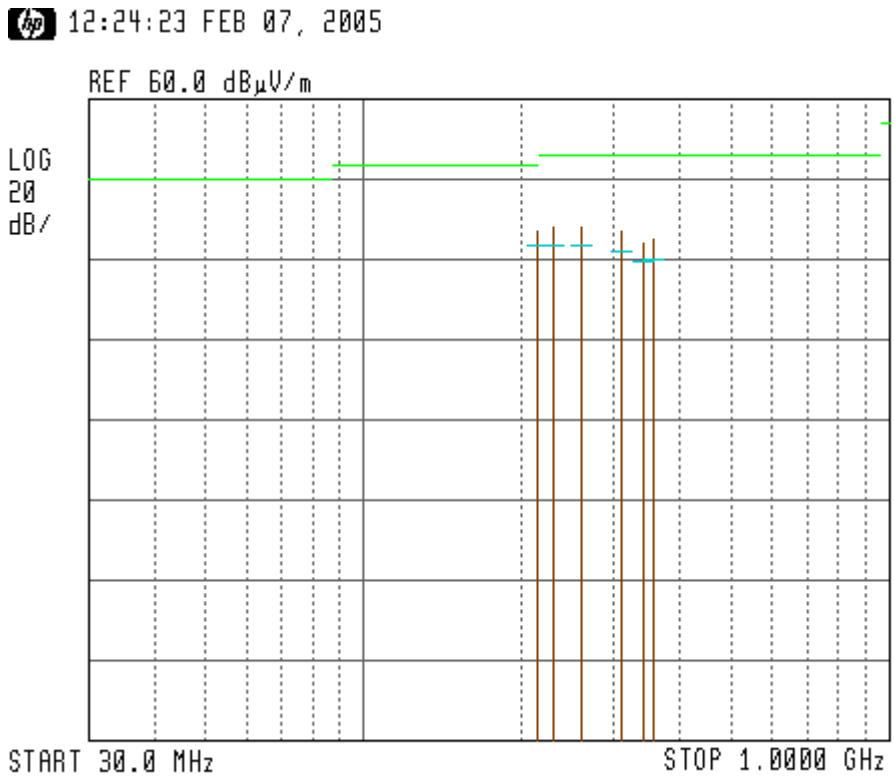


**Figure 8. Radiated Emission. Antenna Polarization: HORIZONTAL**
**Detectors: Peak, Quasi-peak**

*Note:*

1. *Horizontal axis shows logarithmic frequency scale.*
2. *The vertical axis shows amplitude (in dB µV/m).*
3. *Peak detection is designated by the top of each vertical line.*
4. *Quasi-peak detection is designated by the first dash mark (from the top) of each vertical line.*

# Radiated Emission

| | |
|---|---|
| E.U.T Description | DC Radio Programmer |
| Type | 10,000 |
| Serial Number: | Not designated |

Specification: F.C.C., Part 15, Subpart C: Section 15.249

Antenna Polarization: Vertical
Test Distance: 3 meters

Frequency range: 30 to 1000 MHz
Detector: Peak, Quasi-peak

| Frequency (MHz) | Peak Amp (dBµV/m) | QP Amp (dBµV/m) | Correction (dB) | Specification (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|
| 213.81 | 32.3 | 26.0 | 14.9 | 43.5 | -17.5 |
| 228.56 | 32.1 | 26.2 | 15.0 | 46.0 | -19.8 |
| 243.30 | 31.7 | 26.3 | 15.2 | 46.0 | -19.7 |
| 309.66 | 32.6 | 27.3 | 15.9 | 46.0 | -18.7 |
| 339.15 | 23.3 | 18.4 | 17.0 | 46.0 | -27.6 |
| 353.89 | 24.2 | 19.4 | 17.5 | 46.0 | -26.6 |

**Figure 9. Spurious Radiated Emission. Antenna Polarization: VERTICAL. Detector: Peak, Quasi-peak**

Note: Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

# Radiated Emission

| | |
|---|---|
| E.U.T Description | DC Radio Programmer |
| Model Number | 10,000 |
| Serial Number: | Not designated |

Specification: F.C.C., Part 15, Subpart C: Section15.249

Antenna Polarization: Vertical
Test Distance: 3 meters

Frequency range: 30 to 1000 MHz
Detector: Peak, Quasi-peak

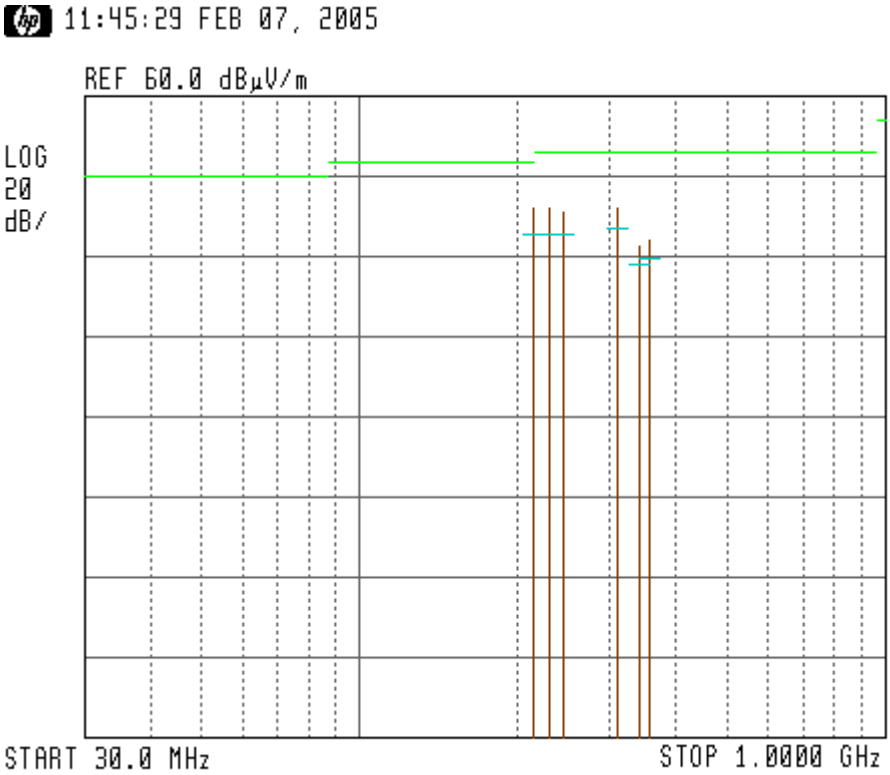


**Figure 10. Radiated Emission. Antenna Polarization: VERTICAL**
**Detectors: Peak, Quasi-peak**

*Note:*

1. *Horizontal axis shows logarithmic frequency scale.*
2. *The vertical axis shows amplitude (in dB µV/m).*
3. *Peak detection is designated by the top of each vertical line.*
4. *Quasi-peak detection is designated by the first dash mark (from the top) of each vertical line.*

### *7.3 Test Instrumentation Used, Radiated Measurements*

| Instrument | Manufacturer | Model | Serial Number | Calibration | Period |
|---|---|---|---|---|---|
| EMI Receiver | HP | 85422E | 3411A00102 | February 28, 2004 | 1 year |
| RF Section | HP | 85420E | 3427A00103 | February 28, 2004 | 1 year |
| Antenna Bioconical | ARA | BCD 235/B | 1041 | April 11, 2004 | 1 year |
| Antenna Log Periodic | ARA | LPD-2010/A | 1038 | March 21, 2004 | 1 year |
| Active Loop Antenna | EMCO | 6502 | 9506-2950 | October 17, 2004 | 1 year |
| Antenna Mast | ARA | AAM-4A | 1001 | N/A | N/A |
| Turntable | ARA | ART-1001/4 | 1001 | N/A | N/A |
| Mast & Table Controller | ARA | ACU-2/5 | 1001 | N/A | N/A |
| Printer | HP | ThinkJet 2225 | 2738508357.0 | N/A | N/A |

## 7.4 Field Strength Calculation

The field strength is calculated directly by the EMI Receiver software, and a "Correction Factors" data disk, using the following equation:

$$[dB\mu v/m]\ FS = RA + AF + CF$$

| | |
|---|---|
| FS: | Field Strength [dBμv/m] |
| RA: | Receiver Amplitude [dBμv] |
| AF: | Receiving Antenna Correction Factor [dB/m] |
| CF: | Cable Attenuation Factor [dB] |

# 8. Spurious Radiated Emission Above 1 GHz

## *8.1 Spurious Radiated Emission Above 1 GHz*

The E.U.T operation mode and test set-up are as described in Section 3.

A preliminary measurement to characterize the E.U.T was performed inside the shielded room, using peak detection mode and broadband antennas. The preliminary measurements produced a list of the highest emissions. The E.U.T was then transferred to the open site, and placed on a remote-controlled turntable. The E.U.T was placed on a non-metallic table, 0.8 meters above the ground. The configuration tested is shown in Figure 3.1.

The emission levels were compared to the requirement of Section 15.249.

In the frequency range 1-2.9 GHz, a computerized EMI receiver complying to CISPR 16 requirements and a High Pass Filter were used. The test distance was 3 meters.

In the frequency range 2.9-9.5 GHz, a spectrum analyzer including a low noise amplifier was used. The test distance was 3 meters. During peak measurements, the I.F. bandwidth was 1 MHz, and video bandwidth 3 MHz. During average measurements, the I.F. bandwidth was 1 MHz and video bandwidth was 100 Hz.

The readings were maximized by adjusting the antenna height between 1-4 meters, the turntable azimuth between 0-360°, and the antenna polarization.

Verification of the E.U.T emissions was based on the following methods: turning the E.U.T on and off; using a frequency span less than 10 MHz; observation of the signal level during turntable rotation. (Background noise is not affected by the rotation of the E.U.T.)

## 8.2 Test Data

JUDGEMENT: Passed by 15.76 dB

The margin between the emission level and the specification limit is 15.76 dB in the worst case at the frequency of 1832.00 MHz, vertical polarization.

The EUT met the requirements of the F.C.C. Part 15, Subpart C Section 15.249, specification.

The details of the highest emissions are given in Figure 11 to Figure 12.

TEST PERSONNEL:

Tester Signature: _____ Date: 14.03.05

Typed/Printed Name: E. Pitt

# Spurious Radiated Emission Above 1 GHz

| | |
|---|---|
| E.U.T Description | DC Radio Programmer |
| Type | 10,000 |
| Serial Number: | Not designated |

Specification: F.C.C., Part 15, Subpart C, 15.249

Antenna Polarization: Horizontal/Vertical

Frequency range: 1.0 GHz to 9.5 GHz

Test Distance: 3 meters

Detector: Peak

| Freq. (MHz) | Peak Reading (dBµV/m) | Polarization (H/L) | Peak. Specification (dB µV/m) | Peak. Margin (dB) |
|---|---|---|---|---|
| 1832.00 | 52.8** | H | 74.0 | -21.2 |
| 2747.00 | 51.4** | H | 74.0 | -22.6 |
| 3664.00 | 41.5* | H | 74.0 | -32.5 |
| 4580.00 | 48.3* | H | 74.0 | -25.7 |
| 1832.00 | 54.6** | V | 74.0 | -19.4 |
| 2747.00 | 50.7** | V | 74.0 | -23.3 |
| 3664.00 | 42.7* | V | 74.0 | -31.3 |
| 4580.00 | 44.4* | V | 74.0 | -29.6 |

**Figure 11. Spurious Radiated Emission. Antenna Polarization: HORIZONTAL/Vertical. Detector: Peak**

Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

"Peak Reading" includes correction factor.

* "Correction Factor" = Antenna Factor + Cable Loss- Preamplifier Gain

** "Correction Factor" = Antenna Factor + Cable Loss

# Spurious Radiated Emission Above 1 GHz

| | |
|---|---|
| E.U.T Description | DC Radio Programmer |
| Type | 10,000 |
| Serial Number: | Not designated |

Specification: F.C.C., Part 15, Subpart C, 15.249

Antenna Polarization: Horizontal/Vertical

Frequency range: 1.0 GHz to 9.5 GHz

Test Distance: 3 meters

Detector: Average

| Freq. (MHz) | Average Reading (dBµV/m) | Polarization (H/L) | Average Result (dBµV/m) | Average Specification (dB µV/m) | Average Margin (dB) |
|---|---|---|---|---|---|
| 1832.00 | 47.7** | H | 37.24 | 54.0 | -16.76 |
| 2747.00 | 43.2** | H | 32.74 | 54.0 | -21.26 |
| 3664.00 | 33.6* | H | 23.14 | 54.0 | -30.86 |
| 4580.00 | 41.6* | H | 31.14 | 54.0 | -22.86 |
| 1832.00 | 48.7** | V | 38.24 | 54.0 | -15.76 |
| 2747.00 | 43.6** | V | 33.14 | 54.0 | -20.86 |
| 3664.00 | 36.3* | V | 25.84 | 54.0 | -28.16 |
| 4580.00 | 36.8* | V | 26.34 | 54.0 | -27.66 |

**Figure 12. Spurious Radiated Emission. Antenna Polarization: HORIZONTAL/VERTICAL. Detector: Average**

Margin refers to the test results obtained minus specified requirement; thus a positive number indicates failure, and a negative result indicates that the product passes the test.

"Average Reading" includes correction factor.

*"Correction Factor" = Antenna Factor + Cable Loss- Preamplifier Gain

** "Correction Factor" = Antenna Factor + Cable Loss

"Average Result" = "Average reading" + "Average Factor (-10.46dB)"

### 8.3 Test Instrumentation Used, Spurious Radiated Measurements Above 1 GHz

| Instrument | Manufacturer | Model | Serial Number | Calibration | Period |
|---|---|---|---|---|---|
| Receiver | HP | 85422E | 3411A00102 | February 28, 2004 | 1 year |
| RF Section | HP | 85420E | 3427A00103 | February 28, 2004 | 1 year |
| Antenna Mast | ARA | AAM-4A | 1001 | N/A | N/A |
| Turntable | ARA | ART-1001/4 | 1001 | N/A | N/A |
| Mast & Table Controller | ARA | ACU-2/5 | 1001 | N/A | N/A |
| Printer | HP | ThinkJet2225 | 2738508357 | N/A | N/A |
| Antenna-Log Periodic | A.H.System | SAS-200/511 | 253 | January 31,2003 | 2 year |
| Low Noise Amplifier | DBS MICROWAVE | LNA-DBS-0411N313 | 013 | October 17, 2004 | 1 year |
| Spectrum Analyzer | HP | 8592L | 3926A01204 | February 28, 2004 | 1 year |

# 9. Photographs of Tested E.U.T.

**Figure 13 Top View**

**Figure 14 Bottom View**

**Figure 15  Rear View**

**Figure 16  Open Unit**

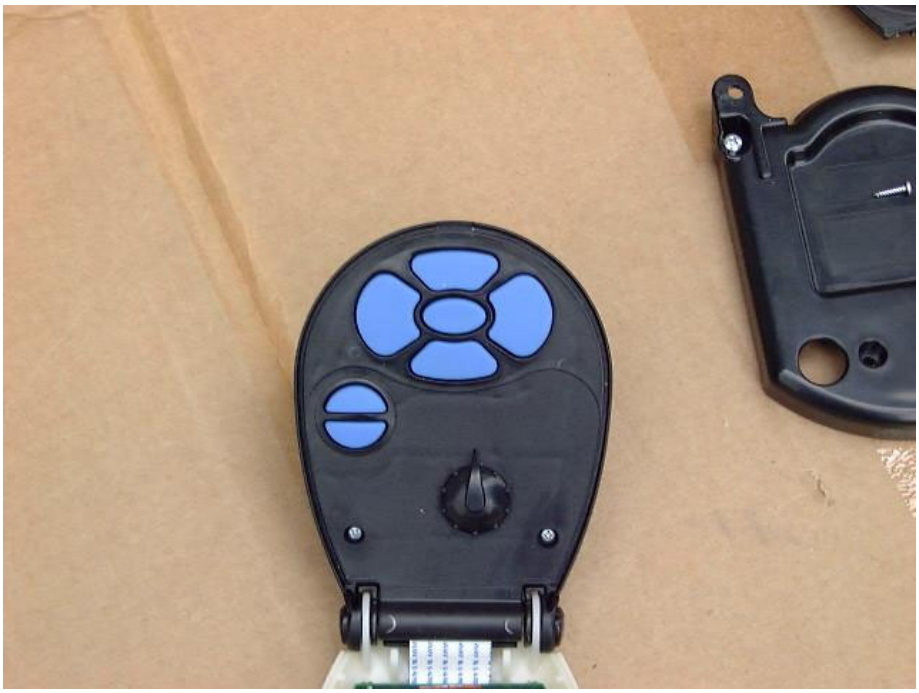

**Figure 17  Keypad**

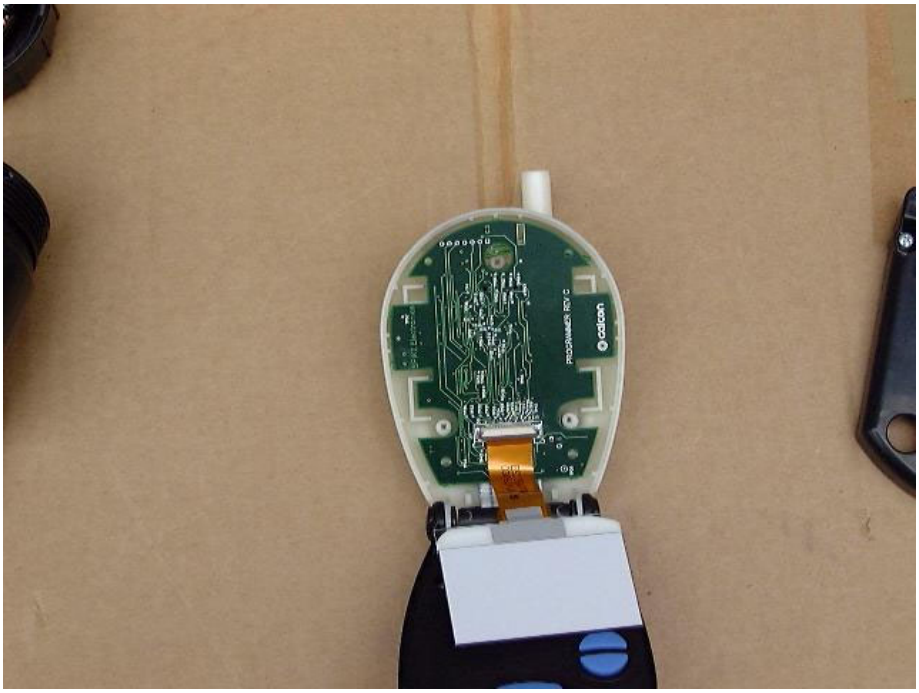

**Figure 18  PCB In Case**

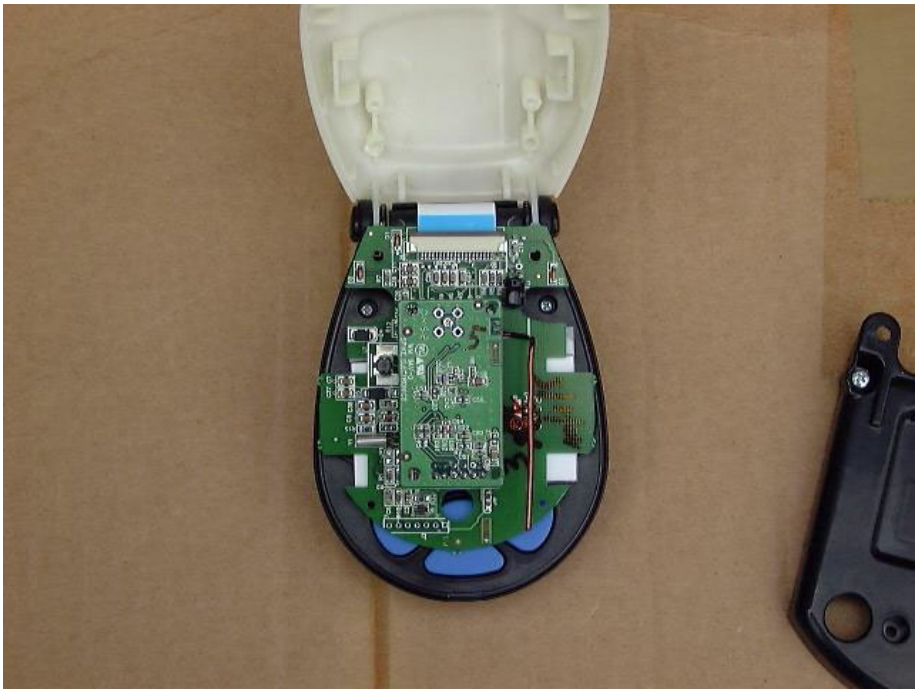

**Figure 19  PCB 1 Side 1**

**Figure 20 PCB Side 1 Side 2**

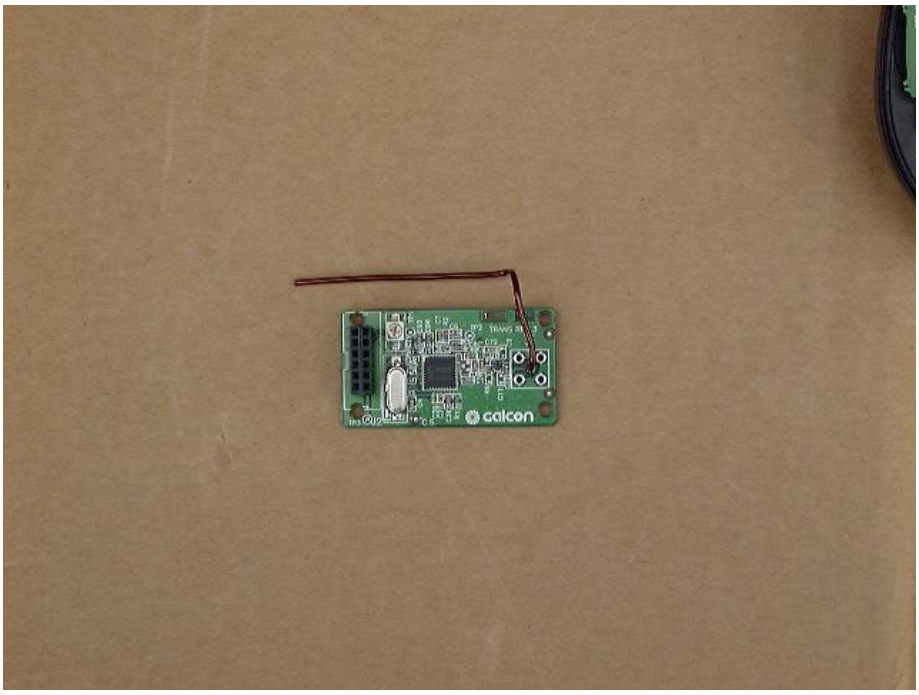


**Figure 21  PCB 2 Side 1**

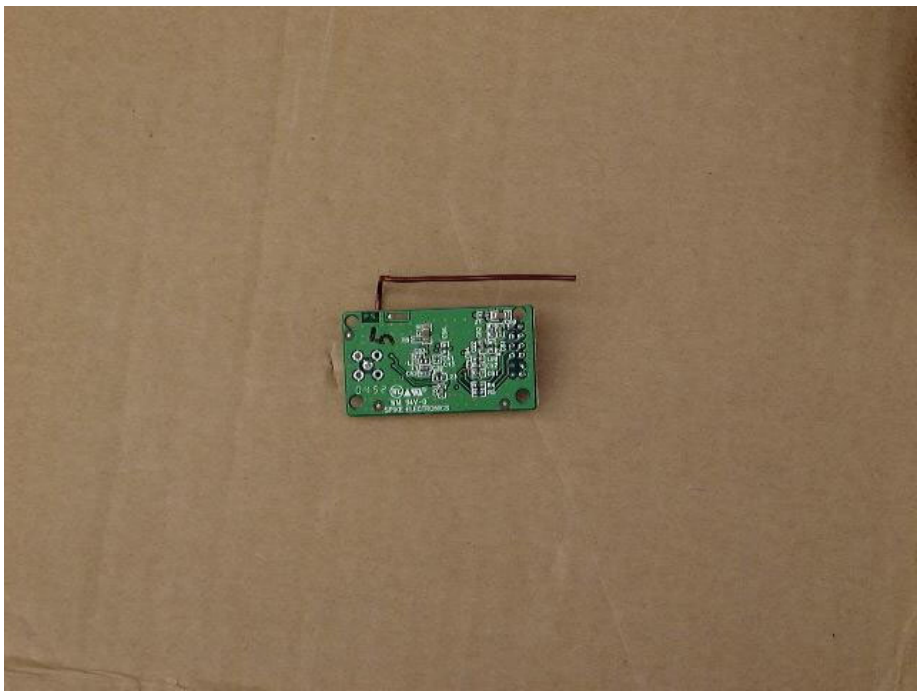

**Figure 22 PCB 2 Side 2**

# 10. APPENDIX A - CORRECTION FACTORS

## *10.1 Correction factors for CABLE*

**from EMI receiver to test antenna at 3 meter range.**

| FREQUENCY (MHz) | CORRECTION FACTOR (dB) |
|---|---|
| 10.0 | 0.3 |
| 20.0 | 0.6 |
| 30.0 | 0.8 |
| 40.0 | 0.9 |
| 50.0 | 1.1 |
| 60.0 | 1.2 |
| 70.0 | 1.3 |
| 80.0 | 1.4 |
| 90.0 | 1.6 |
| 100.0 | 1.7 |
| 150.0 | 2.0 |
| 200.0 | 2.3 |
| 250.0 | 2.7 |
| 300.0 | 3.1 |
| 350.0 | 3.4 |
| 400.0 | 3.7 |
| 450.0 | 4.0 |
| 500.0 | 4.3 |
| 600.0 | 4.7 |
| 700.0 | 5.3 |
| 800.0 | 5.9 |
| 900.0 | 6.3 |
| 1000.0 | 6.7 |

| FREQUENCY (MHz) | CORRECTION FACTOR (dB) |
|---|---|
| 1200.0 | 7.3 |
| 1400.0 | 7.8 |
| 1600.0 | 8.4 |
| 1800.0 | 9.1 |
| 2000.0 | 9.9 |
| 2300.0 | 11.2 |
| 2600.0 | 12.2 |
| 2900.0 | 13.0 |

*NOTES:*

1. *The cable type is RG-214.*
2. *The overall length of the cable is 27 meters.*
3. *The above data is located in file 27MO3MO.CBL on the disk marked "Radiated Emission Tests EMI Receiver".*

## *10.2 Correction factors for CABLE*

**from spectrum analyzer to test antenna at 3 meter range.**

| FREQUENCY (GHz) | CORRECTION FACTOR (dB) |
|---|---|
| 1.0 | 1.2 |
| 2.0 | 1.6 |
| 3.0 | 2.0 |
| 4.0 | 2.4 |
| 5.0 | 3.0 |
| 6.0 | 3.4 |
| 7.0 | 3.8 |
| 8.0 | 4.2 |
| 9.0 | 4.6 |
| 10.0 | 5.0 |
| 12.0 | 5.8 |

*NOTES:*

*1. The cable type is RG-8.*

*2. The overall length of the cable is 10 meters.*

## *10.3 Correction factors for CABLE*

**from EMI receiver to test antenna**

| FREQUENCY (MHz) | CORRECTION FACTOR (dB) |
|---|---|
| 10.0 | 0.2 |
| 20.0 | 0.2 |
| 30.0 | 0.2 |
| 40.0 | 0.2 |
| 50.0 | 0.3 |
| 60.0 | 0.4 |
| 70.0 | 0.4 |
| 80.0 | 0.4 |
| 90.0 | 0.5 |
| 100.0 | 0.5 |
| 150.0 | 0.6 |
| 200.0 | 0.6 |
| 250.0 | 0.7 |
| 300.0 | 0.8 |
| 350.0 | 0.9 |
| 400.0 | 1.0 |
| 450.0 | 1.1 |
| 500.0 | 1.2 |
| 600.0 | 1.3 |
| 700.0 | 1.4 |
| 800.0 | 4.4 |
| 900.0 | 1.5 |
| 1000.0 | 1.5 |

| FREQUENCY (MHz) | CORRECTION FACTOR (dB) |
|---|---|
| 1200.0 | 1.6 |
| 1400.0 | 1.8 |
| 1600.0 | 2.1 |
| 1800.0 | 2.2 |
| 2000.0 | 2.3 |
| 2300.0 | 2.8 |
| 2600.0 | 2.7 |
| 2900.0 | 3.1 |

*NOTES:*

*1. The cable type is RG-214.*

*2. The overall length of the cable is 5.5 meters.*

### *10.4 Correction factors for CABLE*

**from spectrum analyzer**
**to test antenna above 2.9 GHz**

| FREQUENCY (GHz) | CORRECTION FACTOR (dB) | FREQUENCY (GHz) | CORRECTION FACTOR (dB) |
|---|---|---|---|
| 1.0 | 1.9 | 14.0 | 9.1 |
| 2.0 | 2.7 | 15.0 | 9.5 |
| 3.0 | 3.5 | 16.0 | 9.9 |
| 4.0 | 4.2 | 17.0 | 10.2 |
| 5.0 | 4.9 | 18.0 | 10.4 |
| 6.0 | 5.5 | 19.0 | 10.7 |
| 7.0 | 6.0 | 20.0 | 10.9 |
| 8.0 | 6.5 | 21.0 | 11.2 |
| 9.0 | 7.0 | 22.0 | 11.6 |
| 10.0 | 7.5 | 23.0 | 11.9 |
| 11.0 | 7.9 | 24.0 | 12.3 |
| 12.0 | 8.3 | 25.0 | 12.6 |
| 13.0 | 8.7 | 26.0 | 13.0 |

*NOTES:*

*1. The cable type is SUCOFLEX 104 E manufactured by SUHNER.*

*2. The cable is used for measurements above 2.9 GHz.*

*3. The overall length of the cable is 10 meters.*

### *10.5 Correction factors for CABLE*

**from EMI receiver to test antenna at 10 meter range.**

| FREQUENCY (MHz) | CORRECTION FACTOR (dB) |
|---|---|
| 10.0 | 0.3 |
| 20.0 | 0.8 |
| 30.0 | 0.9 |
| 40.0 | 1.2 |
| 50.0 | 1.4 |
| 60.0 | 1.6 |
| 70.0 | 1.8 |
| 80.0 | 1.9 |
| 90.0 | 2.0 |
| 100.0 | 2.1 |
| 150.0 | 2.6 |
| 200.0 | 3.2 |
| 250.0 | 3.8 |
| 300.0 | 4.2 |
| 350.0 | 4.6 |
| 400.0 | 5.1 |
| 450.0 | 5.3 |
| 500.0 | 5.6 |
| 600.0 | 6.3 |
| 700.0 | 7.0 |
| 800.0 | 7.6 |
| 900.0 | 8.0 |
| 1000.0 | 8.7 |

| FREQUENCY (MHz) | CORRECTION FACTOR (dB) |
|---|---|
| 1200.0 | 9.8 |
| 1400.0 | 10.0 |
| 1600.0 | 11.3 |
| 1800.0 | 12.2 |
| 2000.0 | 13.1 |
| 2300.0 | 14.5 |
| 2600.0 | 15.9 |
| 2900.0 | 16.4 |

*NOTES:*

1. *The cable type is RG-214.*
2. *The overall length of the cable is 34 meters.*
3. *The above data is located in file 34M10MO.CBL on the disk marked "Radiated Emissions Tests EMI Receiver".*

## *10.6 Correction factors for LOG PERIODIC ANTENNA*

**Type LPD 2010/A**
**at 3 and 10 meter ranges.**

**Distance of 3 meters**

| FREQUENCY (MHz) | AFE (dB/m) |
|---|---|
| 200.0 | 9.1 |
| 250.0 | 10.2 |
| 300.0 | 11.4 |
| 400.0 | 14.5 |
| 500.0 | 15.2 |
| 600.0 | 17.3 |
| 700.0 | 19.0 |
| 850.0 | 20.1 |
| 1000.0 | 22.2 |

**Distance of 10 meters**

| FREQUENCY (MHz) | AFE (dB/m) |
|---|---|
| 200.0 | 9.0 |
| 250.0 | 10.1 |
| 300.0 | 11.2 |
| 400.0 | 14.4 |
| 500.0 | 15.2 |
| 600.0 | 17.2 |
| 700.0 | 19.0 |
| 850.0 | 20.1 |
| 1000.0 | 22.1 |

*NOTES:*

1. *Antenna serial number is 1038.*
2. *The above lists are located in file number 38M3O.ANT for a 3 meter range, and file number 38M100.ANT for a 10 meter range.*
3. *The files mentioned above are located on the disk marked "Radiated Emission Test EMI Receiver".*

## *10.7 Correction factors for BICONICAL ANTENNA*

**Type BCD-235/B,**
**at 3 meter range**

| FREQUENCY (MHz) | AFE (dB/m) |
|---|---|
| 20.0 | 19.4 |
| 30.0 | 14.8 |
| 40.0 | 11.9 |
| 50.0 | 10.2 |
| 60.0 | 9.1 |
| 70.0 | 8.5 |
| 80.0 | 8.9 |
| 90.0 | 9.6 |
| 100.0 | 10.3 |
| 110.0 | 11.0 |
| 120.0 | 11.5 |
| 130.0 | 11.7 |
| 140.0 | 12.1 |
| 150.0 | 12.6 |
| 160.0 | 12.8 |
| 170.0 | 13.0 |
| 180.0 | 13.5 |
| 190.0 | 14.0 |
| 200.0 | 14.8 |
| 210.0 | 15.3 |
| 220.0 | 15.8 |
| 230.0 | 16.2 |
| 240.0 | 16.6 |
| 250.0 | 17.6 |
| 260.0 | 18.2 |
| 270.0 | 18.4 |
| 280.0 | 18.7 |
| 290.0 | 19.2 |
| 300.0 | 19.9 |
| 310 | 20.7 |
| 320 | 21.9 |
| 330 | 23.4 |
| 340 | 25.1 |
| 350 | 27.0 |

*NOTES:*

*1. Antenna serial number is 1041.*

*2. The above list is located in file 19BC10M1.ANT on the disk marked "Radiated Emissions Tests EMI Receiver".*

### *10.8 Correction factors for ACTIVE LOOP ANTENNA*

**Model 6502**
**S/N 9506-2950**

| FREQUENCY (MHz) | Magnetic Antenna Factor (dB) | Electric Antenna Factor (dB) |
|---|---|---|
| .009 | -35.1 | 16.4 |
| .010 | -35.7 | 15.8 |
| .020 | -38.5 | 13.0 |
| .050 | -39.6 | 11.9 |
| .075 | -39.8 | 11.8 |
| .100 | -40.0 | 11.6 |
| .150 | -40.0 | 11.5 |
| .250 | -40.0 | 11.6 |
| .500 | -40.0 | 11.5 |
| .750 | -40.1 | 11.5 |
| 1.000 | -39.9 | 11.7 |
| 2.000 | -39.5 | 12.0 |
| 3.000 | -39.4 | 12.1 |
| 4.000 | -39.7 | 11.9 |
| 5.000 | -39.7 | 11.8 |
| 10.000 | 40.2 | 11.3 |
| 15.000 | -40.7 | 10.8 |
| 20.000 | -40.5 | 11.0 |
| 25.000 | -41.3 | 10.2 |
| 30.000 | 42.3 | 9.2 |

### *10.9 Correction factors for LOG PERIODIC ANTENNA*

**Type SAS-200/511**
**at 3 meter range.**

| FREQUENCY (GHz) | ANTENNA FACTOR (dB) |
|---|---|
| 1.0 | 24.9 |
| 1.5 | 27.8 |
| 2.0 | 29.9 |
| 2.5 | 31.2 |
| 3.0 | 32.8 |
| 3.5 | 33.6 |
| 4.0 | 34.3 |
| 4.5 | 35.2 |
| 5.0 | 36.2 |
| 5.5 | 36.7 |
| 6.0 | 37.2 |
| 6.5 | 38.1 |

| FREQUENCY (GHz) | ANTENNA FACTOR (dB) |
|---|---|
| 7.0 | 38.6 |
| 7.5 | 39.2 |
| 8.0 | 39.9 |
| 8.5 | 40.4 |
| 9.0 | 40.8 |
| 9.5 | 41.1 |
| 10.0 | 41.7 |
| 10.5 | 42.4 |
| 11.0 | 42.5 |
| 11.5 | 43.1 |
| 12.0 | 43.4 |
| 12.5 | 44.4 |
| 13.0 | 44.6 |

*NOTES:*

1. *Antenna serial number is 253.*
2. *The above lists are located in file number SAS3M0.ANT for a 3 meter range.*
3. *The files mentioned above are located on the disk marked "Antenna Factors".*

## *10.10 Correction factors for BICONICAL ANTENNA*

**Type 3109,**
**1.0 meter range**

| FREQUENCY (MHz) | AFE (dB/m) |
|---|---|
| 20.0 | 11.1 |
| 30.0 | 12.0 |
| 40.0 | 12.0 |
| 50.0 | 11.4 |
| 60.0 | 10.3 |
| 70.0 | 10.7 |
| 80.0 | 8.3 |
| 90.0 | 9.0 |
| 100.0 | 10.0 |
| 110.0 | 11.6 |
| 120.0 | 13.6 |
| 130.0 | 14.2 |
| 140.0 | 13.5 |
| 150.0 | 12.7 |
| 160.0 | 12.7 |
| 170.0 | 13.6 |
| 180.0 | 15.3 |
| 190.0 | 14.6 |
| 200.0 | 14.7 |
| 210.0 | 15.3 |
| 220.0 | 15.8 |
| 230.0 | 17.0 |
| 240.0 | 18.0 |
| 250.0 | 18.1 |
| 260.0 | 18.0 |
| 270.0 | 17.5 |
| 280.0 | 18.2 |
| 290.0 | 19.7 |
| 300.0 | 21.8 |

*NOTES:*

*1. Antenna serial number is 3244.*

*2. The above list is located in file 44BIC10M1.ANT on the disk marked "Radiated Emissions Tests EMI Receiver"*

### *10.11 Correction factors for BICONICAL ANTENNA*

**Type 3109,**
**3 meter range**

| FREQUENCY (MHz) | AFE (dB/m) |
|---|---|
| 20.0 | 18.4 |
| 30.0 | 14.0 |
| 40.0 | 12.3 |
| 50.0 | 10.6 |
| 60.0 | 8.3 |
| 70.0 | 8.7 |
| 80.0 | 7.2 |
| 90.0 | 8.6 |
| 100.0 | 10.1 |
| 110.0 | 11.2 |
| 120.0 | 11.8 |
| 130.0 | 12.3 |
| 140.0 | 12.7 |
| 150.0 | 12.5 |
| 160.0 | 12.4 |
| 170.0 | 12.1 |
| 180.0 | 12.2 |
| 190.0 | 12.8 |
| 200.0 | 13.7 |
| 210.0 | 14.5 |
| 220.0 | 15.4 |
| 230.0 | 15.9 |
| 240.0 | 16.3 |
| 250.0 | 16.7 |
| 260.0 | 17.1 |
| 270.0 | 17.2 |
| 280.0 | 17.5 |
| 290.0 | 18.1 |
| 300.0 | 18.9 |

*NOTES:*

*1. Antenna serial number is 3244.*

*2. The above list is located in file 44BIC3M1.ANT on the disk marked "Radiated Emissions Tests EMI Receiver"*