Cert. No. 1152.01
Electrical (EMC)

DATE: 06 April 2005

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

FCC EMC Test Report

for

Galcon Galil Control

Equipment under test:

DC Radio Controller

(For Transmitter Section)

10,001

Written by: _____
D. Shidlowsky, Documentation

Approved by: _____
E. Pitt, Test Engineer

Approved by: _____
I. Raz, EMC Laboratory Manager

This report must not be reproduced, except in full, without the written permission of I.T.L. (Product Testing) Ltd.
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 Controller

(For Transmitter Section)

FCC ID: SZ810001

DATE: 06 April 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
prepared by:
Ishaiahou Raz
ITL (Product Testing) Ltd.
POB 211
Or Yehuda 60251
Israel
Tel: +972-3-533-9022
Fax: +972-3-533-9019
Email: sraz@itl.co.il

Applicant for this device:
(different from "prepared by")
Shay Shtekelmacher
Galcon Galil Control
Kibbutz Kfar Blum
D.N. 12150
Israel
Tel: +972-4-690-0222
Fax: +972-4-690-2727
Email: shaysc@galcon.co.il

TABLE OF CONTENTS

1. GENERAL INFORMATION ---------- 5
- 1.1 Administrative Information 5
- 1.2 List of Accreditations 6
- 1.3 Product Description 7
- 1.4 Test Methodology 7
- 1.5 Test Facility 7
- 1.6 Measurement Uncertainty 7

2. PRODUCT LABELING ---------- 8

3. SYSTEM TEST CONFIGURATION ---------- 9
- 3.1 Justification 9
- 3.2 EUT Exercise Software 9
- 3.3 Special Accessories 9
- 3.4 Equipment Modifications 9
- 3.5 Configuration of Tested System 9

4. BLOCK DIAGRAM ---------- 10
- 4.1 Schematic Block/Connection Diagram 10
- 4.2 Theory of Operation 10

5. FIELD STRENGTH OF FUNDAMENTAL ---------- 11
- 5.1 Test Specification 11
- 5.2 Test Procedure 11
- 5.3 Measured Data 11
- 5.4 Test Instrumentation Used, Field Strength of Fundamental 14

6. RADIATED MEASUREMENT PHOTOS ---------- 15

7. SPURIOUS RADIATED EMISSION DATA ---------- 16
- 7.1 Spurious Radiated Emission 9kHz-1000 MHz, Below 1GHz 16
- 7.2 Measured Data 17
- 7.3 Test Instrumentation Used, Radiated Measurements 22
- 7.4 Field Strength Calculation 23

8. SPURIOUS RADIATED EMISSION ABOVE 1 GHZ ---------- 24
- 8.1 Spurious Radiated Emission Above 1 GHz 24
- 8.2 Test Data 25
- 8.3 Test Instrumentation Used, Spurious Radiated Measurements Above 1 GHz 28

9. PHOTOGRAPHS OF TESTED E.U.T. ---------- 29

10. APPENDIX A - CORRECTION FACTORS ---------- 34
- 10.1 Correction factors for CABLE 34
- 10.2 Correction factors for CABLE 35
- 10.3 Correction factors for CABLE 36
- 10.4 Correction factors for CABLE 37
- 10.5 Correction factors for CABLE 38
- 10.6 Correction factors for LOG PERIODIC ANTENNA 39
- 10.7 Correction factors for BICONICAL ANTENNA 40
- 10.8 Correction factors for ACTIVE LOOP ANTENNA 41
- 10.9 Correction factors for LOG PERIODIC ANTENNA 42
- 10.10 Correction factors for BICONICAL ANTENNA 43
- 10.11 Correction factors for BICONICAL ANTENNA 44

11. APPENDIX B – TEST RESULTS FOR CONTROLLER USING ANTENNA WITH COAX CONNECTING CABLE ----------45

12. SPURIOUS RADIATED EMISSION DATA ----------46

12.1 Spurious Radiated Emission 9kHz-1000 MHz, Below 1GHz.....46
12.2 Measured Data.....47
12.3 Test Instrumentation Used, Radiated Measurements 52
12.4 Field Strength Calculation 53

13. SPURIOUS RADIATED EMISSION ABOVE 1 GHZ ----------54

13.1 Spurious Radiated Emission Above 1 GHz 54
13.2 Test Data.....54
13.3 Test Instrumentation Used, Spurious Radiated Measurements Above 1 GHz 55

14. RADIATED MEASUREMENT PHOTOS ----------56

15. PHOTOGRAPHS OF TESTED E.U.T. ----------57

1. General Information

1.1 Administrative Information

Manufacturer:	Galcon Galil Control
Manufacturer's Address:	Kibbutz Kfar Blum D.N. 12150 Israel Tel: +972-4-690-0222 Fax: +972-4-690-2727
Manufacturer's Representative:	Shay Shtekelmacher Eitain Gabay
Equipment Under Test (E.U.T):	DC Radio Controller
Equipment Model No.:	10,001
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. Kfar Bin Nun, 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 Controller 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 Controller includes the following electronics circuits on two PCBs:

Valves Drivers circuit

CPU

Memory

RF Transceiver

Replaceable 2x1.5VDC C 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

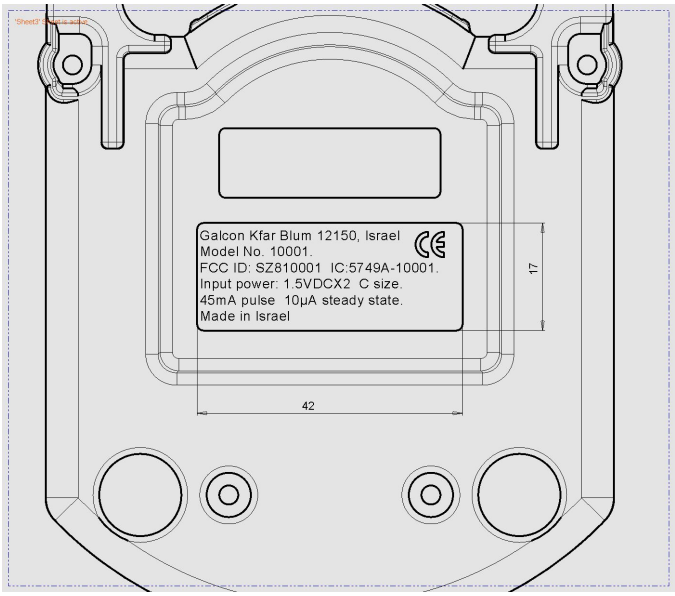

Figure 1. FCC Label

Figure 2. Label Location on EUT

3. System Test Configuration

3.1 Justification

The E.U.T. is typically mounted vertically on a valve although it can also be wall mounted.. The E.U.T.'s antenna can be rotated in different directions.

To determine the E.U.T. antenna orientation for the spurious radiated emissions tests, the product carrier field level was measured with the E.U.T. antenna in various directions/positions. The vertical position of the E.U.T. antenna was selected as the worst case final orientation position.

The Controller was tested in the functional operation mode.

In this mode the Controller send an answer to the Programmer.

While sending the answer, the Controller acts as a transmitter for 50mSec. There is only one transmission in 100mSec.

While waiting for the Programmer command, the Controller acts as a receiver until a command is received.

3.2 EUT Exercise Software

The Controller SW was changed in order to demonstrate a repetitive transmitting of an answer.

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.

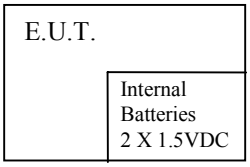

Figure 3. Configuration of Tested System

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 (916.005MHz) 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 5.3 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: 06.04.05

Typed/Printed Name: E. Pitt

Field Strength of Fundamental

E.U.T Description	DC Radio Controller
Model Number	10,001
Serial Number:	Not designated

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

Antenna Polarization: Horizontal

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	94.75	114.0	-19.25
916.00	V	91.66	114.0	-22.34

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 Controller
Model Number 10,001
Serial Number: Not designated

Specification: F.C.C., Part 15, Subpart C 15.49(a)

Antenna Polarization: Horizontal
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	94.75	-6.0	88.75	94.0	-5.25
916.00	V	91.66	-6.0	85.66	94.0	-8.34

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.)= $20\log\frac{50}{100} = -6.0dB$ (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.

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 17.9 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 17.9 dB in the worst case at the frequency of 36.03 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: 06.04.05

Typed/Printed Name: E. Pitt

Radiated Emission

E.U.T Description DC Radio Controller
Model Number 10,001
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)
110.59	31.1	25.5	14.3	43.5	-18.0
243.30	32.7	26.5	15.2	46.0	-19.5
309.66	26.0	20.9	15.9	46.0	-25.1
324.40	26.3	21.5	16.5	46.0	-24.5
353.90	26.4	21.7	17.5	46.0	-24.3
457.11	27.0	22.1	19.8	46.0	-23.9
575.08	30.4	25.0	23.0	46.0	-21.0

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 Controller
Model Number	10,001
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

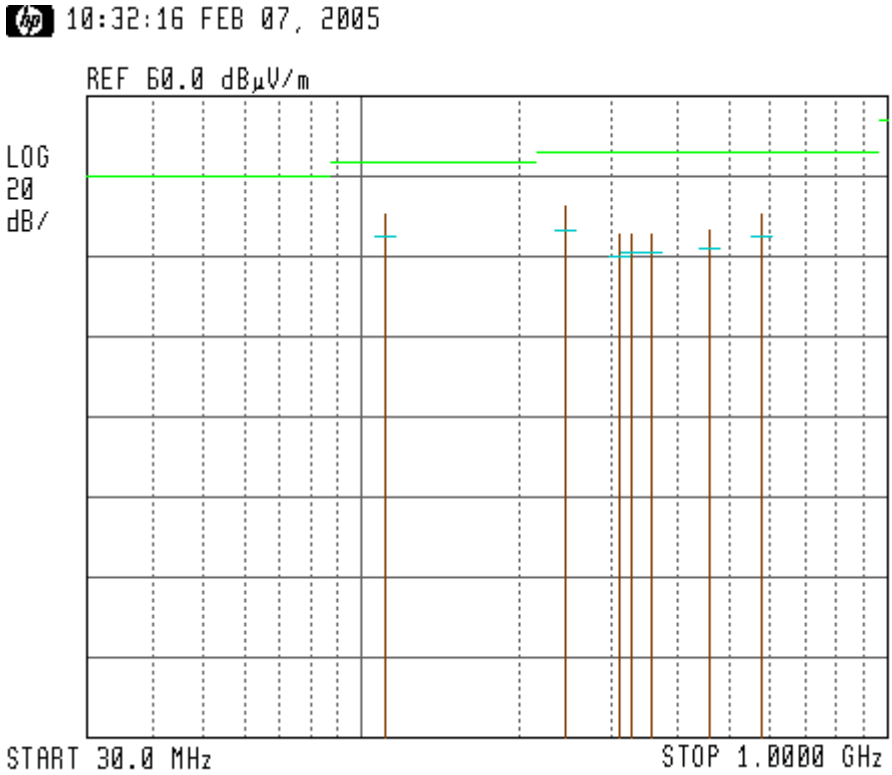

Figure 8. Radiated Emission. Antenna Polarization: HORIZONTAL
Detectors: Peak, Quasi-peak

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 Controller
Model Number	10,001
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)
36.03	26.2	22.1	13.9	40.0	-17.9
110.59	19.2	14.1	12.8	43.5	-29.4
221.18	26.6	20.8	18.3	46.0	-25.2
294.91	29.6	23.7	22.6	46.0	-22.3
324.40	23.4	18.0	16.5	46.0	-28.0
353.89	25.6	19.8	17.5	46.0	-26.2

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 Controller
Model Number	10,001
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

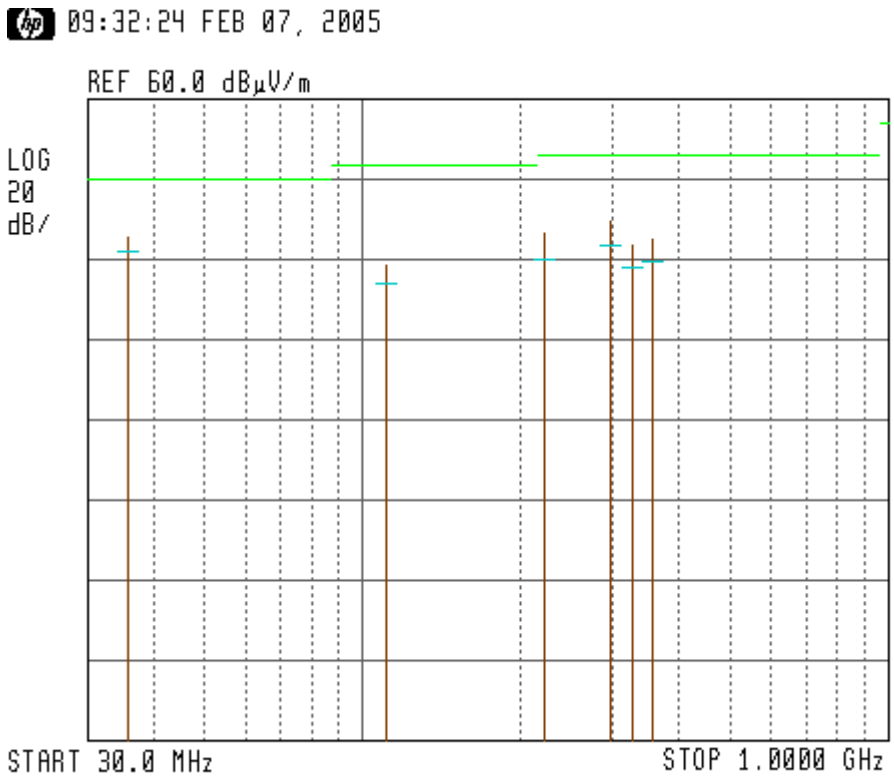

Figure 10. Radiated Emission. Antenna Polarization: HORIZONTAL
Detectors: Peak, Quasi-peak

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.*

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.

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 was 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 6.8 dB

The margin between the emission level and the specification limit is 6.8 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: 06.04.05

Typed/Printed Name: E. Pitt

Spurious Radiated Emission Above 1 GHz

E.U.T Description	DC Radio Controller
Model Number	10,001
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	56.5**	H	74.0	-17.5
2747.00	53.4**	H	74.0	-20.6
3664.00	41.3*	H	74.0	-32.7
4580.00	44.1*	H	74.0	-29.9
1832.00	56.2**	V	74.0	-17.8
2747.00	52.4**	V	74.0	-21.6
3664.00	42.2*	V	74.0	-31.8
4580.00	41.8*	V	74.0	-32.2

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 Controller
Model Number	10,001
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	52.2**	H	46.2	54.0	-7.8
2747.00	42.3**	H	36.3	54.0	-17.7
3664.00	33.7*	H	27.7	54.0	-26.3
4580.00	36.8*	H	30.8	54.0	-23.2
1832.00	53.2**	V	47.2	54.0	-6.8
2747.00	42.3**	V	36.3	54.0	-17.7
3664.00	32.2*	V	26.2	54.0	-27.8
4580.00	34.2*	V	28.2	54.0	-25.8

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 (-6.0dB)"

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 Front View

Figure 16 Rear View

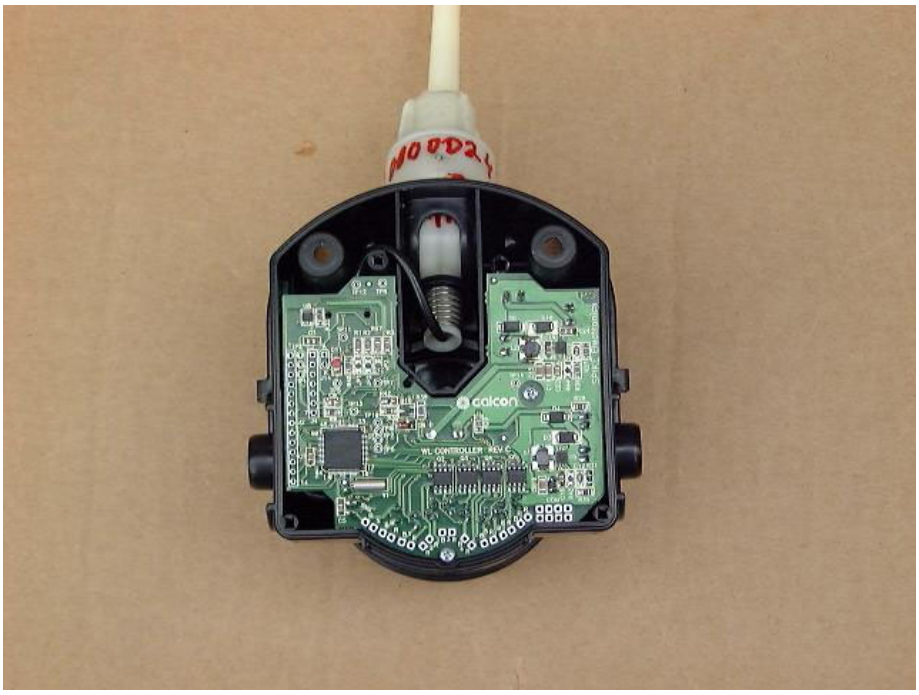

Figure 17 PCB In Case

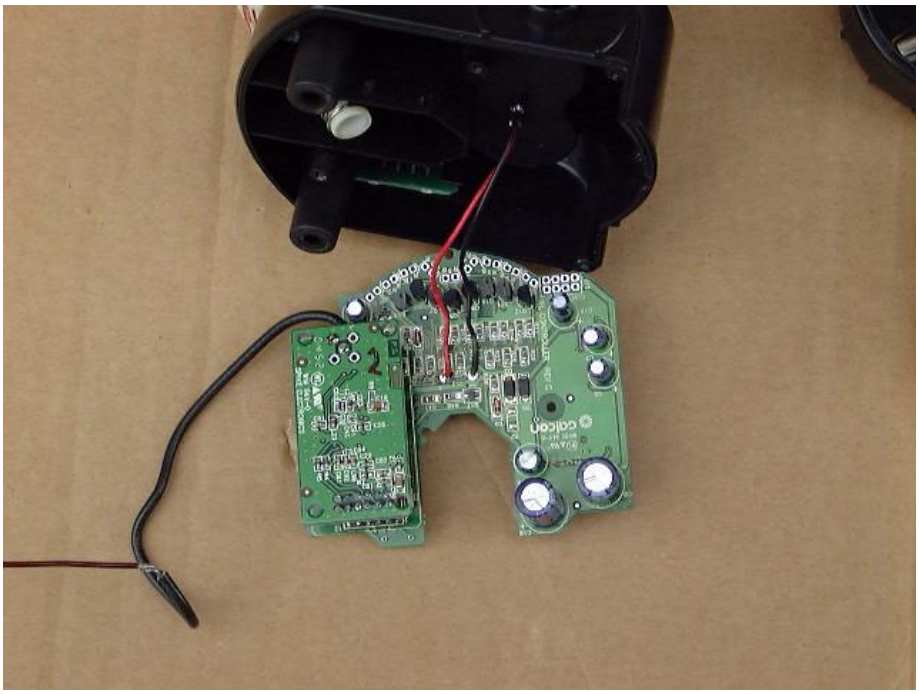

Figure 18 PCB 1 Side 1

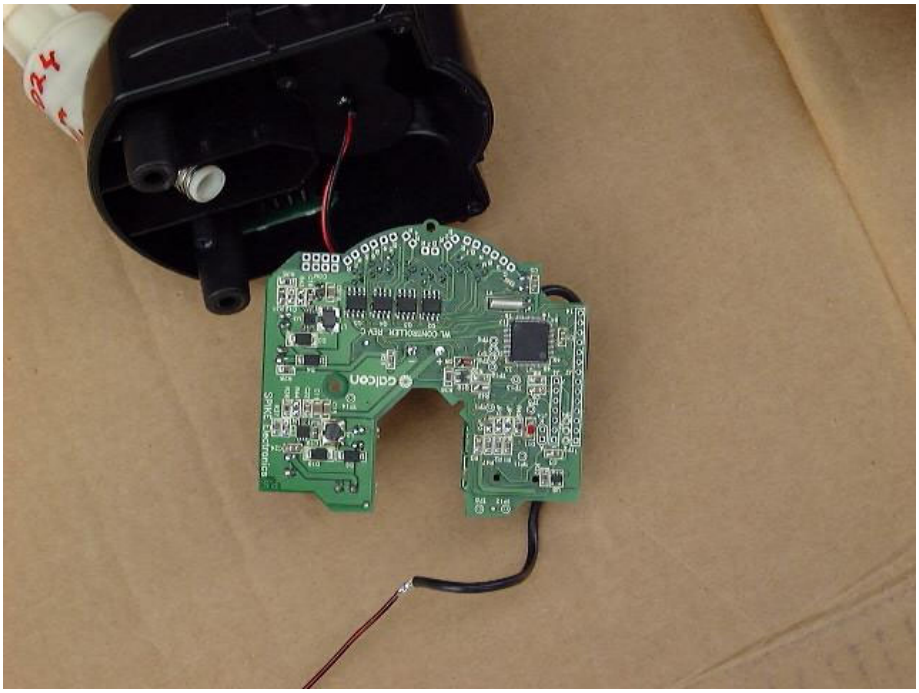

Figure 19 PCB 1 Side 2

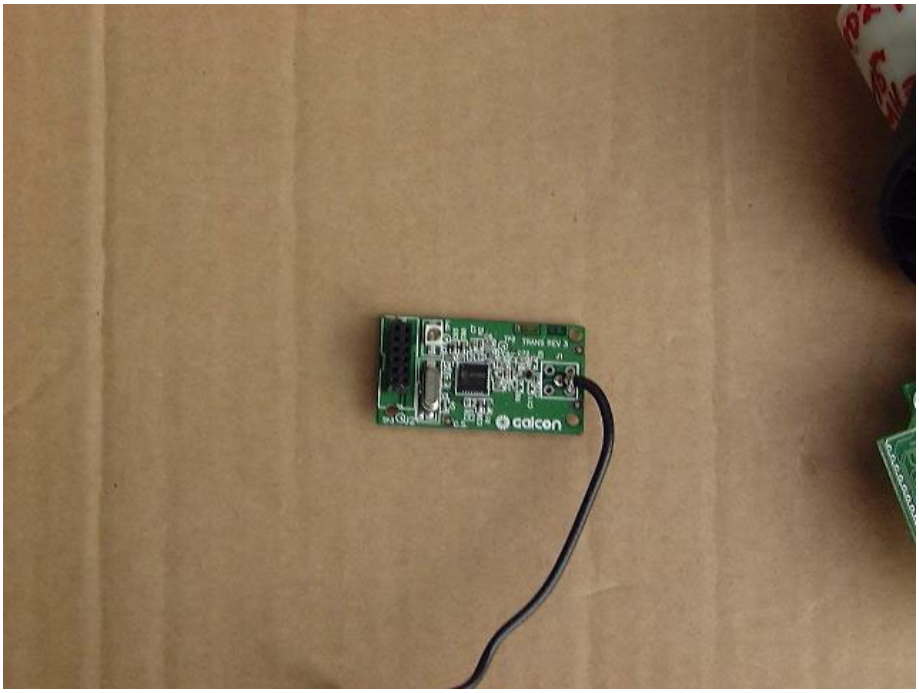

Figure 20 PCB 2 Side 1

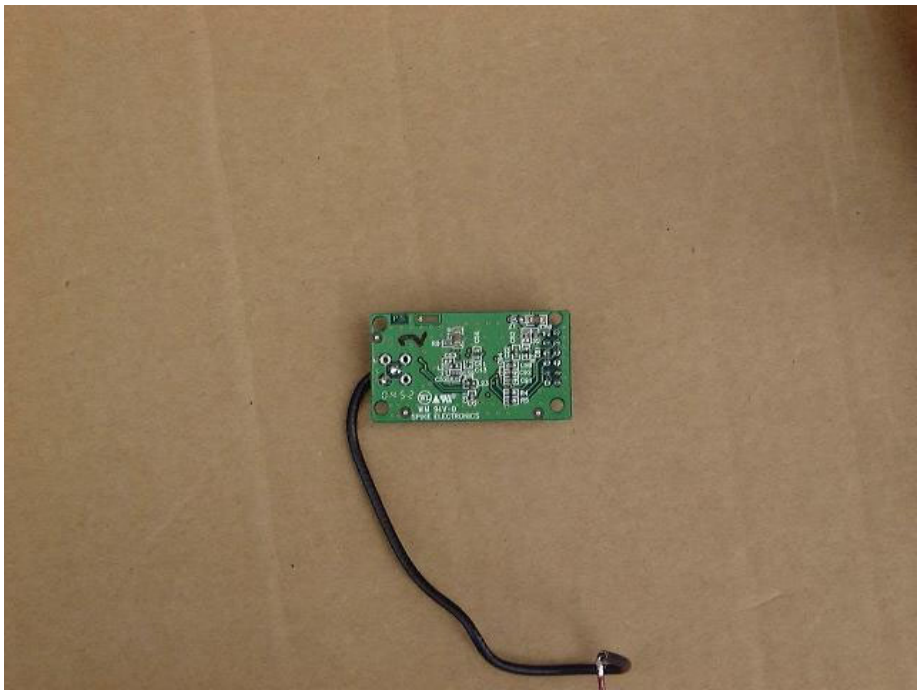

Figure 21 PCB 2 Side 2

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 EMI receiver 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"

11. APPENDIX B – Test Results for Controller Using Antenna With Coax Connecting Cable

12. Spurious Radiated Emission Data

12.1 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.

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.

The E.U.T. was operated in both Rx and Tx modes.

12.2 Measured Data

JUDGEMENT: Passed by 4.7 dB

The results for both Rx and Tx modes were the same.

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 4.7 dB in the worst case at the frequency of 458.89 MHz, horizontal 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 22 to Figure 25.

TEST PERSONNEL:

Tester Signature: _____ Date: 06.04.05

Typed/Printed Name: E. Pitt

Radiated Emission

E.U.T Description	DC Radio Controller
Type	10501-6
Serial Number:	Not designated

Specification: FCC Part 15, Subpart B, Class B

Antenna Polarization: Horizontal
Antenna: 3 meters distance

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

Frequency (MHz)	Peak Amp (dBµV/m)	QP Amp (dBµV/m)	Correction (dB)	Specification (dBµV/m)	Margin (dB)
110.59	32.7	27.9	12.8	43.5	-15.6
140.08	32.0	26.8	14.0	43.5	-16.7
213.81	35.3	30.5	17.9	43.5	-13.0
228.56	36.7	31.8	18.7	46.0	-14.2
457.11	37.6	33.2	19.8	46.0	-12.8
458.89	43.1	41.3	19.9	46.0	-4.7

Figure 22. Radiated Emission. Antenna Polarization: HORIZONTAL. Detectors: 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 Controller
Type	10501-6
Serial Number:	Not designated

Specification: FCC Part 15, Subpart B, Class B

Antenna Polarization: Horizontal
Antenna: 3 meters distance

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

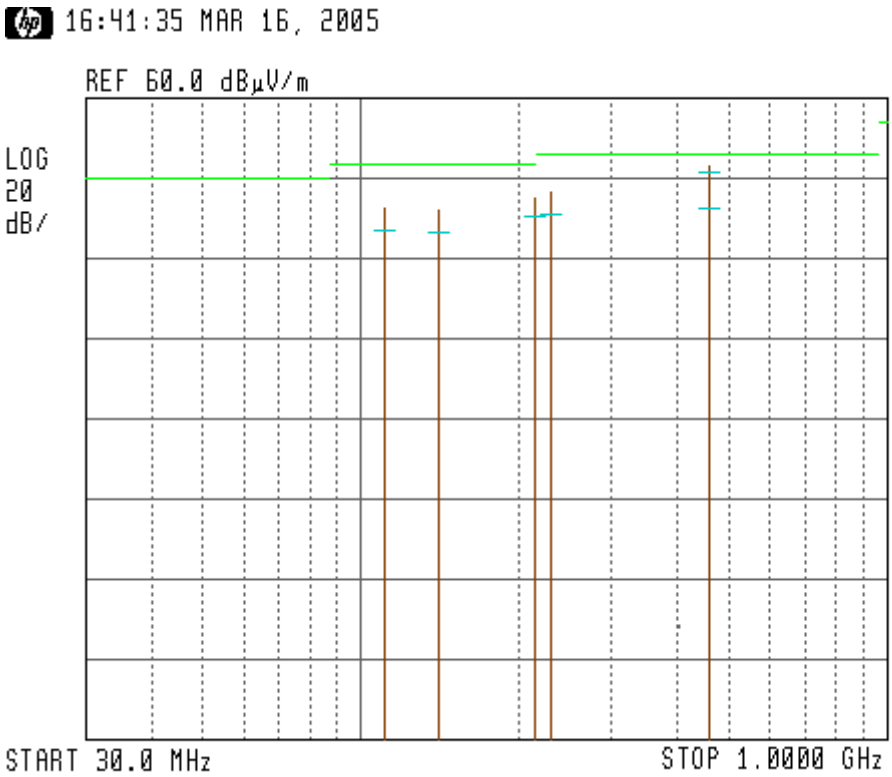

Figure 23. Radiated Emission. Antenna Polarization: HORIZONTAL
Detectors: Peak, Quasi-peak

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 Controller
Type	10501-6
Serial Number:	Not designated

Specification: FCC Part 15, Subpart B, Class B

Antenna Polarization: Vertical
Antenna: 3 meters distance

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

Frequency (MHz)	Peak Amp (dBµV/m)	QP Amp (dBµV/m)	Correction (dB)	Specification (dBµV/m)	Margin (dB)
35.95	29.2	25.0	13.9	40.0	-15.0
110.54	48.0	24.4	12.8	43.5	-19.1
228.56	26.9	22.9	18.7	46.0	-23.1
324.40	24.0	19.0	16.5	46.0	-27.0
353.89	24.8	19.4	17.5	46.0	-26.6
458.89	38.3	36.4	19.9	46.0	-9.6

Figure 24. Radiated Emission. Antenna Polarization: VERTICAL. Detectors: 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 Controller
Type	10501-6
Serial Number:	Not designated

Specification: FCC Part 15, Subpart B, Class B

Antenna Polarization: Vertical
Antenna: 3 meters distance

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

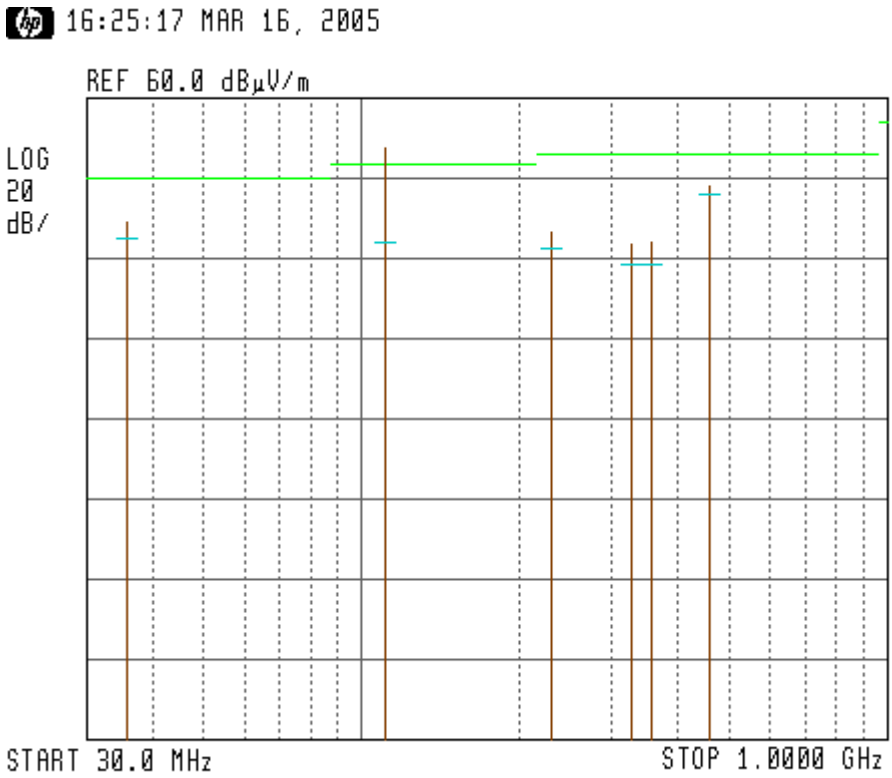

Figure 25. Radiated Emission. Antenna Polarization: VERTICAL
Detectors: Peak, Quasi-peak

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.*

12.3 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

12.4 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]

13. Spurious Radiated Emission Above 1 GHz

13.1 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.

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 was 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.).

13.2 Test Data

JUDGEMENT: Passed

The results were the same as for the short antenna.

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

TEST PERSONNEL:

Tester Signature: _____ Date: 06.04.05

Typed/Printed Name: E. Pitt

13.3 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

14. Radiated Measurement Photos

Figure 26. Radiated Emission Test. Front

15. Photographs of Tested E.U.T.

Figure 27 Front View

Figure 28 Rear View