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DATE: 06 June 2014

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

FCC Radio Test Report

for

Colibri Spindles Ltd.

Equipment under test:

HSM Jet Spindle/Spinjet/Typhoon RPM Receiver (Display Unit)

TJS TSD

Written by: _____
R. Pinchuck, Documentation

Approved by: _____
A. Sharabi, Test Engineer

Approved by: _____
I. Raz, EMC Laboratory Manager

Measurement/Technical Report for
Colibri Spindles Ltd.

Equipment under test:

HSM Jet Spindle/Spinjet/Typhoon

RPM Receiver (Display Unit)

TJS TSD

FCC ID: 2ACJNTJSTSD

This report concerns:	Original Grant: x Class I change: Class II change:
Equipment type:	Digital Transmission System
Limits used:	47CFR15 Section 15.249 (a-b)

Measurement procedure used is KDB 558074 D01, April 1, 2013 and ANSI C63.4-2003.

Application for Certification
prepared by:
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Applicant for this device:
(different from "prepared by")
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TABLE OF CONTENTS

1. General Information

1.1 Administrative Information

Manufacturer:	Colibri Spindles Ltd.
Manufacturer's Address:	Industrial Park Lavon, Building 1, M.P. Bikat Bet Hakerem, 2011800 Israel
Manufacturer's Representative:	Alex Grouzer
Equipment Under Test (E.U.T):	HSM Jet Spindle/Spinjet/Typhoon RPM Receiver (Display Unit)
Equipment Model No.:	TJS TSD
Equipment Serial No.:	Not Designated
Date of Receipt of E.U.T:	15.05.14
Start of Test:	15.05.14
End of Test:	19.05.14
Test Laboratory Location:	I.T.L (Product Testing) Ltd. Kfar Bin Nun, ISRAEL 99780
Test Specifications:	FCC Part 15, Subpart C, Section 15.249

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), IC File No.: 46405-4025; Site No. IC 4025B-1.

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 Colibri 2.4 System intends to monitor the rotating speed of Colibri spindles. The system has 2 units (Display, TagSensor). The Display unit receives the speed data from the TagSensor which is mounted on the rotating spindle.

The system allows to register multiple tags to one receiver by placing the tag close to the receiver. After the tag is registered with the receiver, the receiver will be aware of the tag and display the rotating speed of spindle once the spindle start rotating. The speed data is sent every 0.5 seconds and the receiver updates the display any time new data arrives.

When the spindle stops to rotate the tag will stop transmitting data until the spindle rotates again.

1.4 Test Methodology

Both conducted and radiated testing were performed according to the procedures in KDB 558074 D01, April 9, 2013 and 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 September 3, 2009).
I.T.L.'s EMC Laboratory is also accredited by A2LA, certificate No. 1152.01.

1.6 Measurement Uncertainty

Conducted Emission

Conducted Emission (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4) 0.15 – 30 MHz:

Expanded Uncertainty (95% Confidence, K=2):

± 3.44 dB

Radiated Emission

Radiated Emission (CISPR 11, EN 55011, CISPR 22, EN 55022, ANSI C63.4) for open site 30-1000MHz:

Expanded Uncertainty (95% Confidence, K=2):

± 4.96 dB

2. System Test Configuration

2.1 Justification

Unit was tested in installation position, transmitting continuously at 2480MHz

2.2 EUT Exercise Software

No special exercise software was needed to achieve compliance.

2.3 Special Accessories

No special exercise software was needed to achieve compliance.

2.4 Equipment Modifications

No equipment modifications were needed to achieve compliance.

2.5 Configuration of Tested System

The configuration of the tested system is described below.

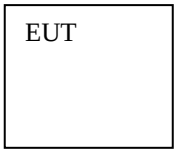


Figure 1. Configuration of Tested System

3. Conducted and Radiated Measurement Test Set-up Photo

Figure 2. Conducted Emission Test

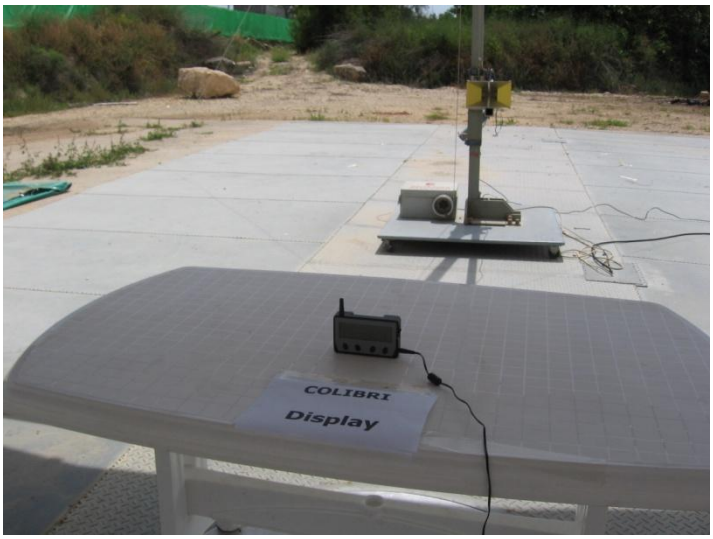


Figure 3. Radiated Emission Test

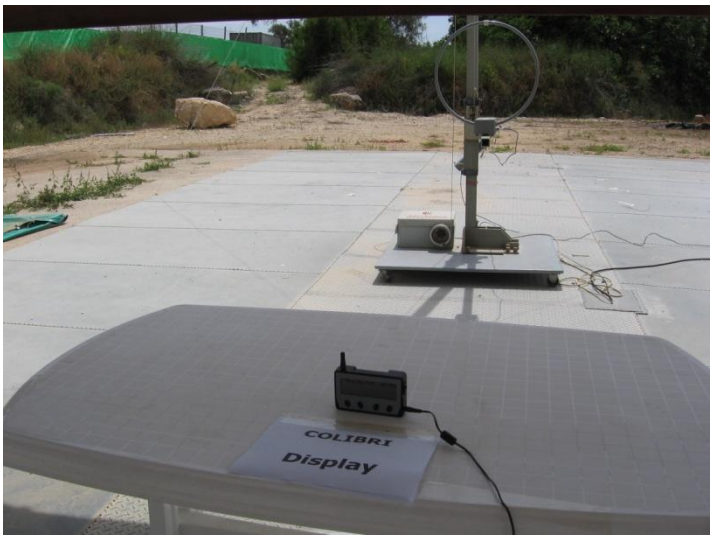


Figure 4. Radiated Emission Test

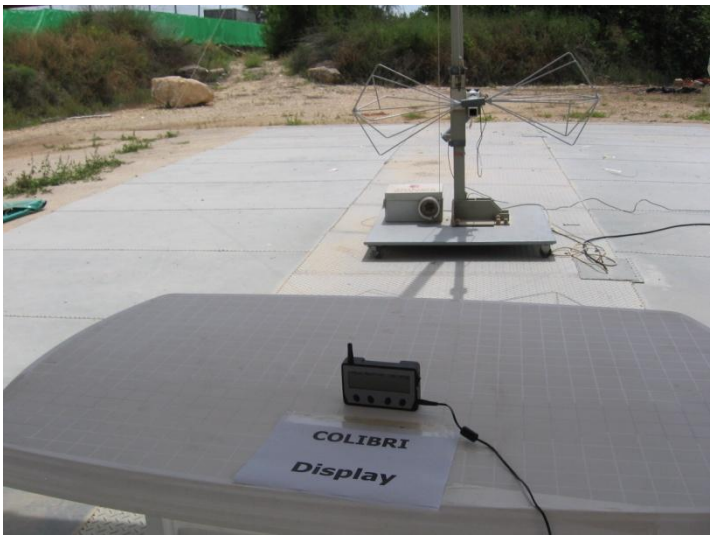


Figure 5. Radiated Emission Test

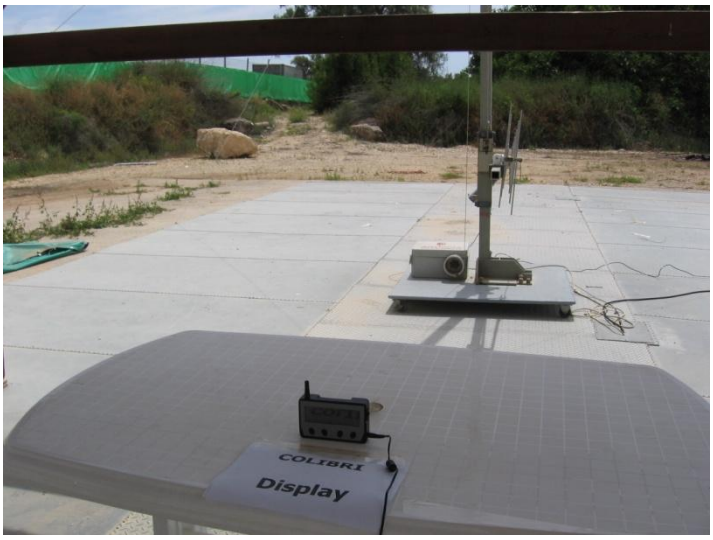


Figure 6. Radiated Emission Test

4. Conducted Emission

4.1 Test Specification

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

4.2 Test Procedure

The E.U.T operation mode and test set-up are as described in Section 3.1. In order to minimize background noise interference, the conducted emission testing was performed inside a shielded room, with the E.U.T placed on an 0.8 meter high wooden table, 0.4 meter from the room's vertical wall.

The E.U.T was powered from 115 V AC / 60 Hz via a 50 Ohm / 50 µHn Line Impedance Stabilization Network (LISN) on the phase and neutral lines. The LISN's were grounded to the shielded room ground plane (floor), and were kept at least 0.8 meters from the nearest boundary of the E.U.T

The center of the E.U.T AC cable was folded back and forth, in order to form a bundle less than 0.40 meters and a total cable length of 1 meter.

The emission voltages at the LISN's outputs were measured using a computerized receiver, complying with CISPR 16 requirements. The specification limits are loaded to the receiver via a 3.5" floppy disk and are displayed on the receiver's spectrum display.

A frequency scan between 0.15 and 30 MHz was performed at 9 kHz I.F. band width, and using peak detection.

The spectral components having the highest level on each line were measured using a quasi-peak and average detector.

4.3 Measured Data

JUDGEMENT: Passed by 24.7 dB

The margin between the emission levels and the specification limit is, in the worst case, 26.8 dB for the phase line at 0.49 MHz and 24.7 dB at 0.41 MHz for the neutral line.

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

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

TEST PERSONNEL:

Tester Signature: _____ Date: 23.06.14

Typed/Printed Name: A. Sharabi

Conducted Emission

E.U.T Description	HSM Jet Spindle/Spinjet/Typhoon RPM Receiver (Display Unit)
Type	**TJS TSD**
Serial Number:	Not Designated

Specification:	F.C.C., Part 15, Subpart C
Lead:	Phase
Detectors:	Quasi-peak, Average

EDIT PEAK LIST (Final Measurement Results)

Trace1: CE22BQP
Trace2: CE22BAP
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	198 kHz	35.24	-28.45
2	Average	202 kHz	22.51	-31.01
2	Average	414 kHz	18.67	-28.89
1	Quasi Peak	422 kHz	28.57	-28.83
1	Quasi Peak	494 kHz	29.31	-26.78
2	Average	502 kHz	17.99	-28.00
2	Average	1.106 MHz	14.00	-31.99
1	Quasi Peak	1.182 MHz	24.91	-31.08
2	Average	1.774 MHz	14.70	-31.30
1	Quasi Peak	1.81 MHz	24.94	-31.06
1	Quasi Peak	2.266 MHz	25.58	-30.41
2	Average	2.29 MHz	13.37	-32.62
2	Average	5.614 MHz	20.19	-29.80
1	Quasi Peak	5.906 MHz	31.77	-28.22
1	Quasi Peak	6.402 MHz	32.72	-27.27
2	Average	6.698 MHz	21.11	-28.88
2	Average	11.022 MHz	16.29	-33.70
1	Quasi Peak	13.242 MHz	30.33	-29.67
1	Quasi Peak	29.962 MHz	17.77	-42.22
2	Average	29.966 MHz	9.98	-40.01

Date: 1.JUN.2014 10:13:27

Figure 7. Detectors: Quasi-peak, Average

Note: DELTA LIMIT 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.

Conducted Emission

E.U.T Description	HSM Jet Spindle/Spinjet/Typhoon RPM Receiver (Display Unit)
Type	TJS TSD
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C, Class **B**
Lead:	Phase
Detectors:	Quasi-peak, Average

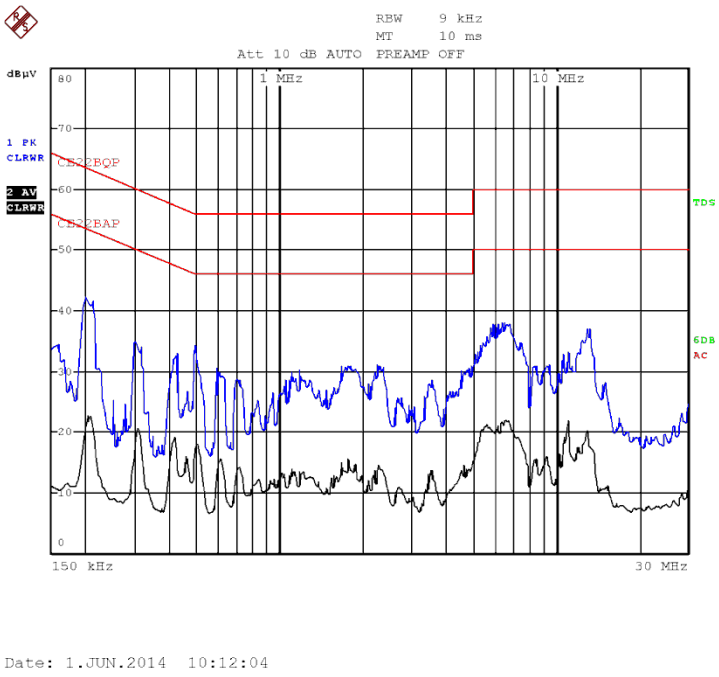
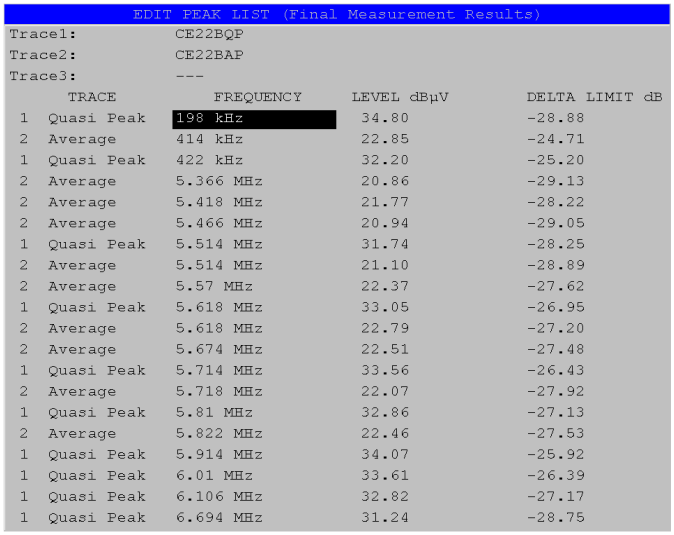


Figure 8 Detectors: Quasi-peak, Average

Conducted Emission

E.U.T Description	HSM Jet Spindle/Spinjet/Typhoon RPM Receiver (Display Unit)
Type	TJS TSD
Serial Number:	Not Designated

Specification:	FCC Part 15, Subpart C, Class **B**
Lead:	Neutral
Detectors:	Quasi-peak, Average



EDIT PEAK LIST (Final Measurement Results)

Trace1: CE22BQP
Trace2: CE22BAP
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	198 kHz	34.80	-28.88
2	Average	414 kHz	22.85	-24.71
1	Quasi Peak	422 kHz	32.20	-25.20
2	Average	5.366 MHz	20.86	-29.13
2	Average	5.418 MHz	21.77	-28.22
2	Average	5.466 MHz	20.94	-29.05
1	Quasi Peak	5.514 MHz	31.74	-28.25
2	Average	5.514 MHz	21.10	-28.89
2	Average	5.57 MHz	22.37	-27.62
1	Quasi Peak	5.618 MHz	33.05	-26.95
2	Average	5.618 MHz	22.79	-27.20
2	Average	5.674 MHz	22.51	-27.48
1	Quasi Peak	5.714 MHz	33.56	-26.43
2	Average	5.718 MHz	22.07	-27.92
1	Quasi Peak	5.81 MHz	32.86	-27.13
2	Average	5.822 MHz	22.46	-27.53
1	Quasi Peak	5.914 MHz	34.07	-25.92
1	Quasi Peak	6.01 MHz	33.61	-26.39
1	Quasi Peak	6.106 MHz	32.82	-27.17
1	Quasi Peak	6.694 MHz	31.24	-28.75

Date: 1.JUN.2014 10:18:30

Figure 9. Detectors: Quasi-peak, Average

Note: DELTA LIMIT 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.

Conducted Emission

E.U.T Description	HSM Jet Spindle/Spinjet/Typhoon RPM Receiver (Display Unit)
Type	TJS TSD
Serial Number:	Not Designated

Specification: FCC Part 15, Subpart B, Class **B**
Lead: Neutral
Detectors: Quasi-peak, Average

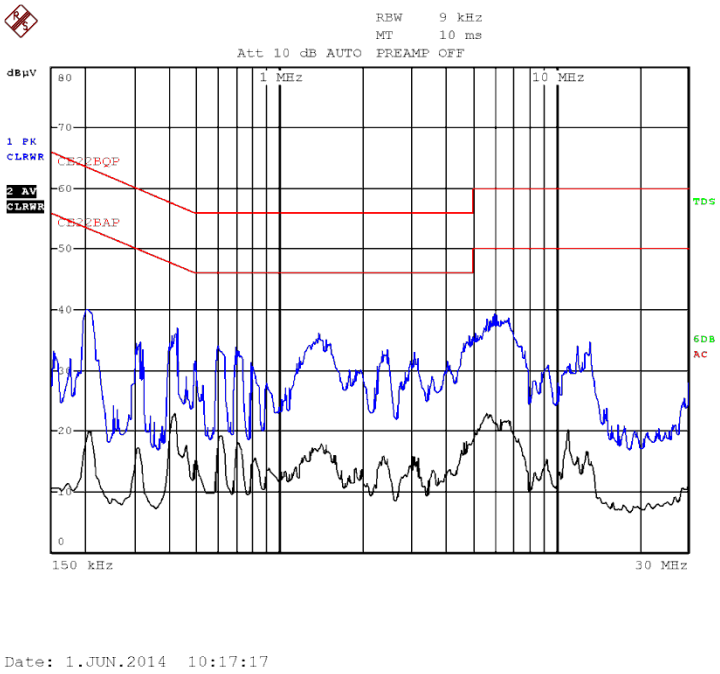


Figure 10 Detectors: Quasi-peak, Average

4.4 Test Instrumentation Used, Conducted Measurement

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Period
LISN	Fischer	FCC-LISN-2A	127	January 1, 2014	1 Year
EMI Receiver	HP	85422E	3906A00276	January 15, 2014	1Year
RF Filter Section	HP	85420E	3705A00248	January 15, 2014	1Year
Printer	HP	LaserJet 2200	JPKGC19982	N/A	N/A

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 (low, mid and high) 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.

5.3 Measured Data

JUDGEMENT: Passed by 47.56 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 11*.

TEST PERSONNEL:

Tester Signature: _____ Date: 23.06.14

Typed/Printed Name: A. Sharabi

Field Strength of Fundamental

E.U.T Description	HSM Jet Spindle/Spinjet/Typhoon RPM Receiver (Display Unit)
Model Number	**TJS TSD**
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.	Pol.	Peak Reading	Specification	Avg. Factor	Avg. Result	Specification	Margin
(MHz)	V/H	(dBµV/m)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV/m)	(dB)
2480.0	H	87.87	114.0	-44.4	43.47	94.0	-50.53
2480.0	V	90.84	114.0	-44.4	46.44	94.0	-47.56

Figure 11. 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 Amp." includes "Correction Factors.

"Correction Factors" = Antenna Correction Factor + Cable Loss.

Field Strength of Fundamental

E.U.T Description	HSM Jet Spindle/Spinjet/Typhoon RPM Receiver (Display Unit)
Model Number	TJS TSD
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

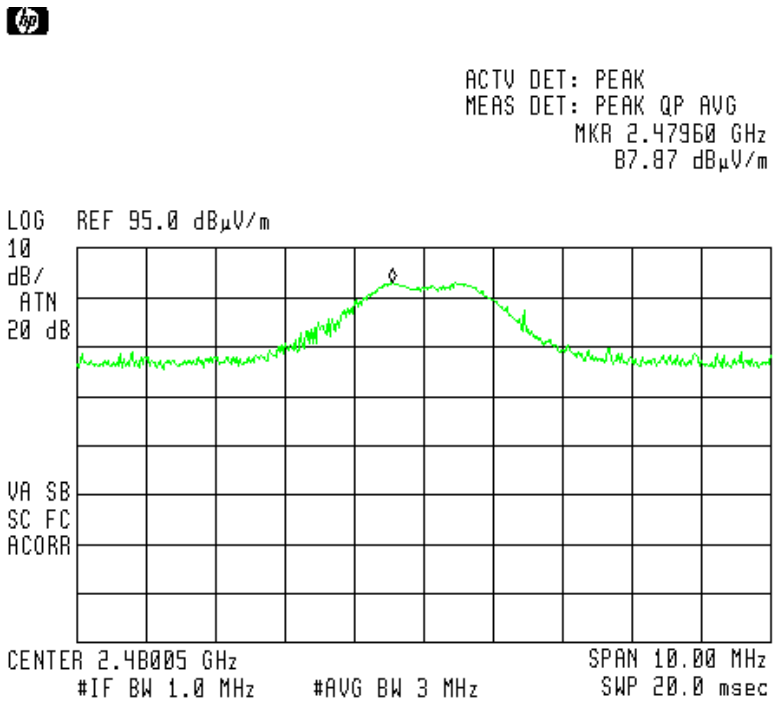


Figure 12. Field Strength of Fundamental. Antenna Polarization: HORIZONTAL Channel: n/a

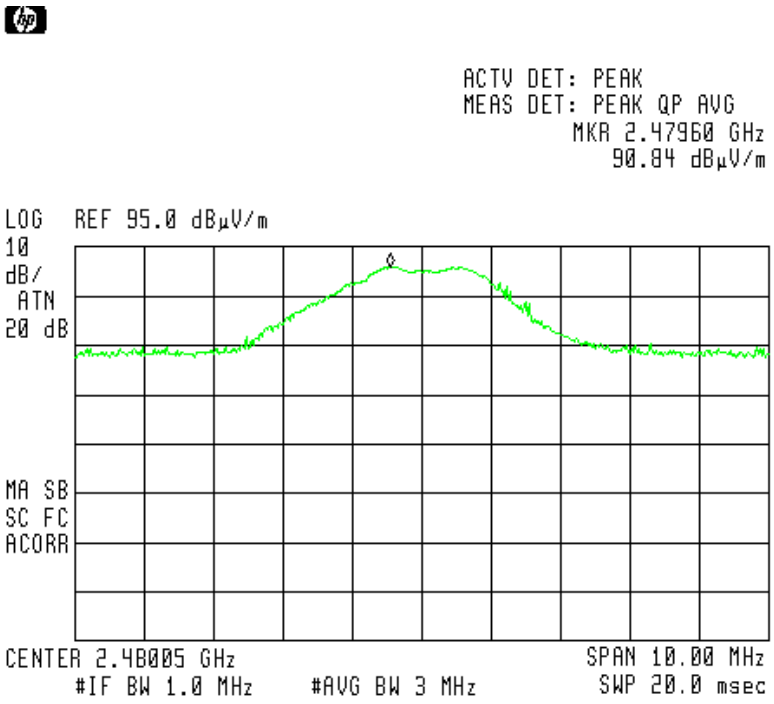


Figure 13. Field Strength of Fundamental. Antenna Polarization: VERTICAL Channel: n/a

5.4 Test Instrumentation Used, Field Strength of Fundamental

Instrument	Manufacturer	Model	Serial Number	Calibration	Period
EMI Receiver	HP	85422E	3906A00276	January 15, 2014	1 year
RF Section	HP	85420E	3705A00248	January 15, 2014	1 year
Horn Antenna	ETS	3115	6142	March 14, 2012	3 Years
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

6. Radiated Emission, 9 kHz – 30 MHz

6.1 Test Specification

9 kHz-30 MHz, FCC, Part 15, Subpart C, Section 209

6.2 Test Procedure

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 9 kHz-30 MHz was scanned.

The emissions were measured using a computerized EMI receiver complying with 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-30MHz, the loop antenna was rotated on its vertical axis. The antenna height (center of loop) was 1 meter at a distance of 3 meters.

The E.U.T. was operated at the frequency of 25 GHz. This frequency was measured using a peak detector.

6.3 Measured Data

JUDGEMENT: Passed

The EUT met the requirements of the F.C.C. Part 15, Subpart C, Section 209 specification. No results were detected in the range of 9kHz-30MHZ.

TEST PERSONNEL:

Tester Signature: _____ Date: 23.06.14

Typed/Printed Name: A. Sharabi

6.4 Test Instrumentation Used, Radiated Measurements

Instrument	Manufacturer	Model	Serial Number	Calibration	Period
EMI Receiver	HP	85422E	3906A00276	January 15, 2014	1 year
RF Section	HP	85420E	3705A00248	January 15, 2014	1 year
Active Loop Antenna	EMCO	6502	9506-2950	November 4, 2013	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	LaserJet 2200	JPKGC19982	N/A	N/A

6.5 Field Strength Calculation

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

$$FS = RA + AF + CF$$

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

Example: FS = 30.7 dBµV (RA) + 14.0 dB (AF) + 0.9 dB (CF) = 45.6 dBµV

No external pre-amplifiers are used.

7. Spurious Radiated Emission 30 MHz - 25GHz

7.1 Test Specification

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

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

See Section 3.1 Justification of the System Test Configuration concerning the E.U.T. orientation for this test.

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 1*.

The frequency range 30 MHz-1000 MHz was scanned and the list of the highest emissions was verified and updated accordingly.

The levels of the emissions within the frequency ranges of the restricted bands (Section 15.205 of FCC Part 15) were compared to the limits of the table in Section 15.209 (a), General Requirements.

In the frequency range 30 MHz – 2.9 GHz, the emissions were measured using a computerized EMI receiver complying with 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 2.9 - 25 GHz, a spectrum analyzer including a low noise amplifier was used. During average measurements, the IF bandwidth was 1 MHz and the video bandwidth was 100Hz. During peak measurements, the IF bandwidth was 1 MHz and the video bandwidth was 3 MHz.
The test distance was 3 meters.
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.)

7.2 Measured Data

JUDGEMENT: Passed

The margin between the emission level and the specification limit was 7.3 dB in the worst case at the frequency of 4960.0 MHz, vertical polarization.

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

TEST PERSONNEL:

Tester Signature: _____ Date: 23.06.14

Typed/Printed Name: A. Sharabi

Radiated Emission Above 1.0 GHz

E.U.T Description	HSM Jet Spindle/Spinjet /Typhoon RPM Receiver (Display Unit)
Type	TJS TSD
Serial Number:	Not Designated

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical
Frequency range: 1.0 GHz to 25.0 GHz
Test Distance: 3 meters
Detector: Peak
Operation Frequency: Low/Mid/High

Freq. (MHz)	Polarity (H/V)	Peak Amp (dBµV/m)	Peak. Specification (dB µV/m)	Peak. Margin (dB)
2390.0	H	44.0	74.0	-30.0
2390.0	V	45.0	74.0	-29.0
4960.0	H	59.2	74.0	-14.8
4960.0	V	66.7	74.0	-7.3
2483.5	H	64.6	74.0	-9.4
2483.5	V	65.0	74.0	-9.0

Figure 14. 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 Amp" includes correction factor.

* "Correction Factor" = Antenna Factor + Cable Loss- Low Noise Amplifier Gain

Radiated Emission Above 1.0 GHz

E.U.T Description	HSM Jet Spindle/Spinjet /Typhoon RPM Receiver (Display Unit)
Type	TJS TSD
Serial Number:	Not Designated

Specification: FCC, Part 15, Subpart C

Antenna Polarization: Horizontal/Vertical
Frequency range: 1.0 GHz to 25.0 GHz
Test Distance: 3 meters
Detector: Average
Operation Frequency: Low/Mid/High

Freq. (MHz)	Polarity (H/V)	Avg Factor (dB)	Average Amp (dBµV/m)	Average Specification (dB µV/m)	Peak. Margin (dB)
2390.0	H	-44.4	0.4	54.0	-53.6
2390.0	V	-44.4	0.6	54.0	-53.4
4960.0	H	-44.4	14.8	54.0	-39.2
4960.0	V	-44.4	22.3	54.0	-31.7
2483.5	H	-44.4	20.2	54.0	-33.8
2483.5	V	-44.4	20.6	54.0	-33.4

Figure 15. Radiated Emission. Antenna Polarization: HORIZONTAL / VERTICAL. Detector: Average

Notes:

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 Amp" includes correction factor.

* Correction Factor = Antenna Factor + Cable Loss- Low Noise Amplifier Gain

**Avg. Factor calculation:

1. Pulse period = 1 (worst scenario)*
2. Pulse duration = 1 (worst scenario)*
3. Burst duration = 0.6msec
4. Time between bursts = 500msec
5. $$\text{Average Factor} = 20\log\left[\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{burst duration}}{100\text{msec}} \times \text{Num of burst within } 100\text{msec}\right]$$

$$\text{Average Factor} = 20\log\left[\frac{0.6}{100}\right] = -44.4dB$$

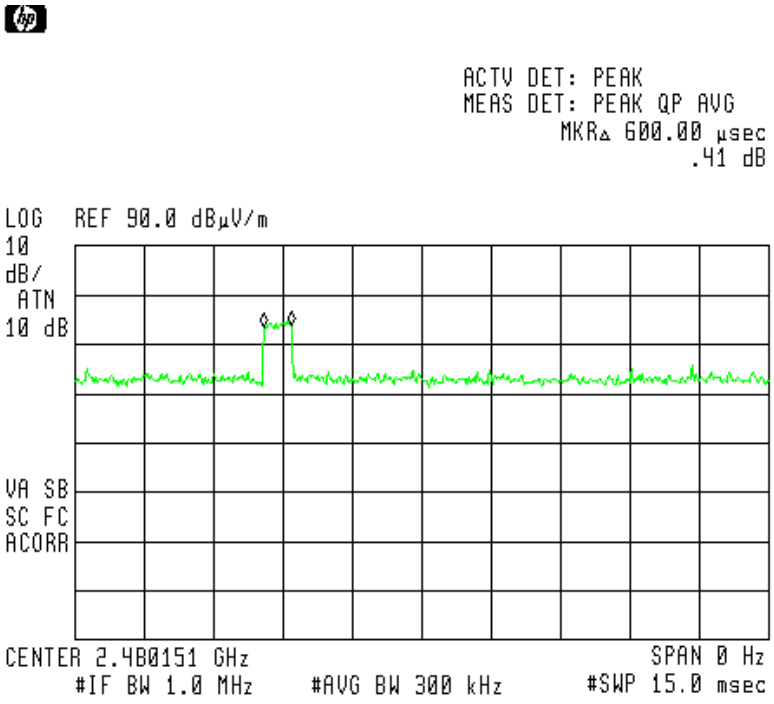


Figure 16. Transmission Burst Duration = 0.6 msec

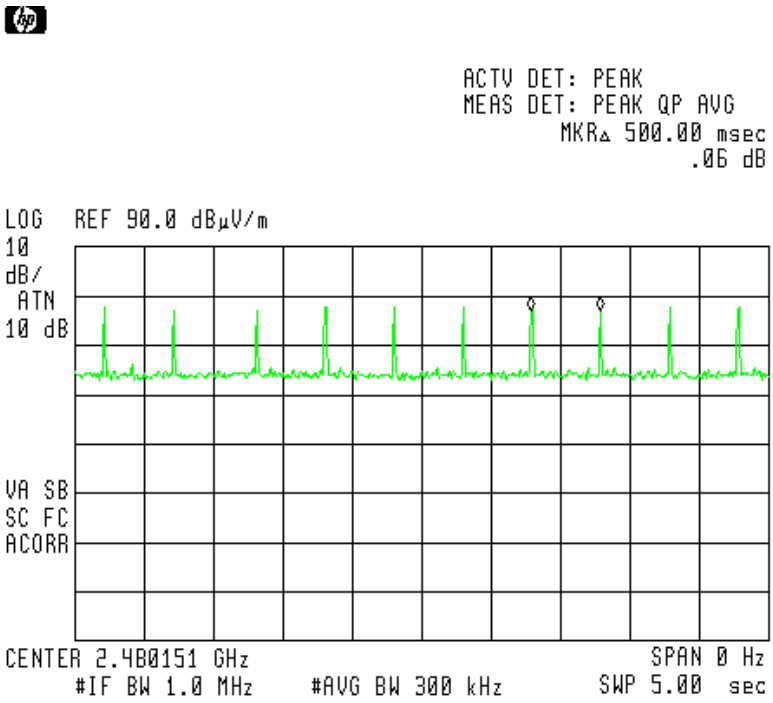


Figure 17. Time between Transmissions 500 msec

7.3 Test Instrumentation Used

Instrument	Manufacturer	Model	Serial No.	Last Calibration Date	Period
EMI Receiver	HP	85422E	3906A00276	January 15, 2014	1Year
RF Filter Section	HP	85420E	3705A00248	January 15, 2014	1Year
Antenna Biconical	EMCO	3104	2606	August 30, 2012	2Years
Antenna Log Periodic	ARA	LPD-2010/A	1038	April 2, 2013	2 Years
Double Ridged Waveguide Horn Antenna	EMCO	3115	29845	March 14, 2012	3 Years
Horn Antenna	ARA	SWH-28	1007	March 30, 2014	3 Years
Low Noise Amplifier	DBS MICROWAVE	LNA-DBS-0411N313	013	August 21, 2013	1 Year
Low Noise Amplifier	Sophia Wireless	LNA 28-B	232	August 28, 2013	1 Year
Spectrum Analyzer	HP	8592L	3826A01204	February 28, 2014	1 Year
Spectrum Analyzer	HP	8564E	3442A00275	March 2, 2014	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	LaserJet 2200	JPKGC19982	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. Antenna Gain/Information

The antenna gain is -1.9 dBi

ANT-2.4-PW-LP

Data Sheet

Product Description

The LP Series antennas utilize a helical element which greatly reduces the antenna's size while allowing favorable performance characteristics. These compact antennas are cosmetically attractive and inexpensive, making them ideal for volume applications. The LP Series mounts directly to a PCB with a single screw, eliminating the expense of a connector while meeting FCC Part 15 requirements.

Features

- Very low cost
- Compact housing
- Excellent performance
- Omni-directional pattern
- Weather-resistant
- Screw-mount
- Use with plastic* or metal enclosures

* Requires proximity ground plane

Electrical Specifications

Center frequency:	2.45GHz
Bandwidth:	200MHz
Wavelength:	¼-wave
VSWR:	≤ 1.9 typical
Peak Gain:	–1.9dBi
Impedance:	50-ohms
Connection:	Screw-mount
Oper. Temp. Range:	–20°C to +85°C

Electrical specifications and plots measured with a 3.81 cm x 8.38 cm (1.5" x 3.3") reference ground plane

9. R.F Exposure/Safety

Typical use of the E.U.T. is in a Tag designed to be used for real time location systems.

The typical placement of the E.U.T. is in inside a variety of equipment, such as medical devices, containers, manufacturing equipment and vehicles. The typical distance between the E.U.T. and the user in the worst case application, is 20 cm.

Calculation of Maximum Permissible Exposure (MPE)

Based on Section 1.1310 Requirements

(a) FCC limits at 2480 MHz is: $1\frac{mW}{cm^2}$

Using table 1 of Section 1.1310 limit for general population/uncontrolled exposures, the above level is an average over 30 minutes.

(b) The power density produced by the E.U.T. is

$$S = \frac{P_t G_t}{4\pi R^2}$$

P_t- Transmitted Power 90.84 dBµV/m (Peak) = 0.366mW

G_T- Antenna Gain, -1.9 dBi = 0.65 numeric

R- Distance from Transmitter using 20 cm worst case

(c) The peak power density is:

$$S_p = \frac{0.366 \times 0.65}{4\pi(20)^2} = 4.74 \times 10^{-5} \frac{mW}{cm^2}$$

(e) This is below the FCC limit.

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 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.

8.4 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	12.5
400.0	15.4
500.0	16.1
600.0	19.2
700.0	19.4
800.0	19.9
900.0	21.2
1000.0	23.5

Distance of 10 meters

FREQUENCY (MHz)	AFE (dB/m)
200.0	9.0
250.0	10.1
300.0	11.8
400.0	15.3
500.0	15.6
600.0	18.7
700.0	19.1
800.0	20.2
900.0	21.1
1000.0	23.2

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".*

10.5 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".*

10.6 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".

10.7 Correction factors for Double-Ridged Waveguide Horn

Model: 3115, S/N 29845
at 3 meter range.

FREQUENCY (GHz)	ANTENNA FACTOR (dB 1/m)	ANTENNA Gain (dBi)	FREQUENCY (GHz)	ANTENNA FACTOR (dB 1/m)	ANTENNA Gain (dBi)
1.0	24.8	5.4	10.0	38.8	11.4
1.5	26.1	7.6	10.5	38.9	11.8
2.0	28.6	7.7	11.0	39.0	12.1
2.5	29.8	8.4	11.5	39.6	11.8
3.0	31.4	8.4	12.0	39.8	12.0
3.5	32.4	8.7	12.5	39.6	12.5
4.0	33.7	8.6	13.0	40.0	12.5
4.5	33.4	9.9	13.5	39.8	13.0
5.0	34.5	9.7	14.0	40.2	13.0
5.5	35.1	9.9	14.5	40.6	12.9
6.0	35.4	10.4	15.0	41.3	12.4
6.5	35.6	10.8	15.5	39.5	14.6
7.0	36.2	10.9	16.0	38.8	15.5
7.5	37.3	10.4	16.5	40.0	14.6
8.0	37.7	10.6	17.0	41.4	13.4
8.5	38.3	10.5	17.5	44.8	10.3
9.0	38.5	10.8	18.0	47.2	8.1
9.5	38.7	11.1			

10.8 Correction factors for Horn Antenna

Model: SWH-28
at 1 meter range.

FREQUENCY (GHz)	AFE (dB /m)	Gain (dB1)
18.0	40.3	16.1
19.0	40.3	16.3
20.0	40.3	16.1
21.0	40.3	16.3
22.0	40.4	16.8
23.0	40.5	16.4
24.0	40.5	16.6
25.0	40.5	16.7
26.0	40.6	16.4

10.9 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