TDS-535
Tuned Dipole Set
Operation Manual

TABLE OF CONTENTS

INTRODUCTION

CONTENTS – TUNED DIPOLE SET, TV

QTY	Model Number	Part Number	Description
1	TSC-535	2454	Transit Storage Case
2	N/A	N/A	Keys
1	FCC-1	2311	Tuned Dipole Antenna (25 MHz – 70 MHz)
1	FCC-2	2312	Tuned Dipole Antenna (65 MHz – 180 MHz)
1	FCC-3	2313	Tuned Dipole Antenna (170 MHz – 340 MHz)
1	FCC-4	2314	Tuned Dipole Antenna (325 MHz – 1000 MHz)
4	N/A	2336	Extension Elements
2	N/A	2337-2	Telescoping Elements
1	SAC-213-10	2111	3 Meter Cable, N(m) to N(m)
1	ABC-TD	2332-1	Clamp
1	N/A	2346	Tape Measurer

INTENDED PURPOSES

This equipment is intended for general laboratory use in a wide variety of industrial and scientific applications, and designed to be used in the process of generating, controlling and measuring high levels of electromagnetic Radio Frequency (RF) energy. It is the responsibility of the user to assure that the device is operated in a location which will control the radiated energy such that it will not cause injury and will not violate regulatory levels of electromagnetic interference.

RANGE OF ENVIRONMENTAL CONDITIONS

This equipment is designed to be safe under the following environmental conditions:

Indoor use

Altitude up to 2000M

Temperature of 5°C to 40°C

Maximum relative humidity 80 % for temperatures up to 31°C. Decreasing linearly to 50% at 40°C

Pollution degree 2: Normally non-conductive with occasional condensation.

While the equipment will not cause hazardous condition over this environmental range, performance may vary.

GENERAL INFORMATION

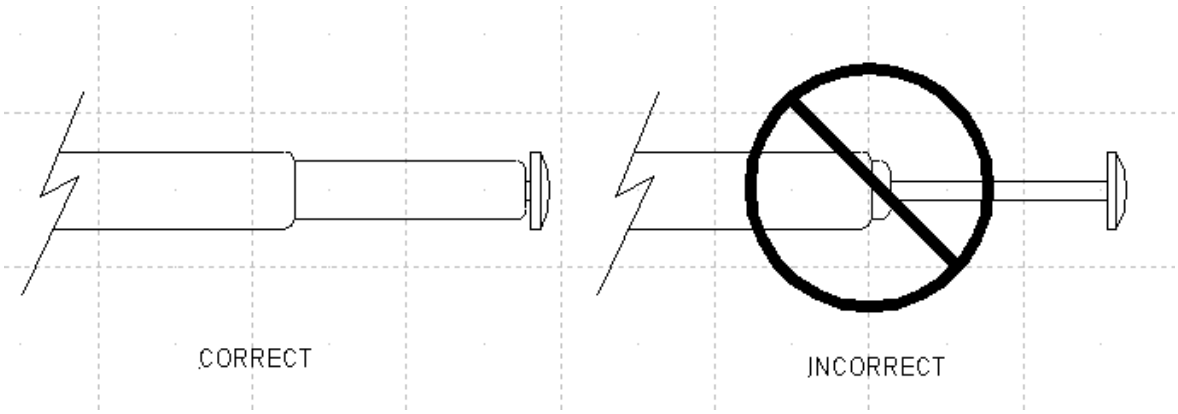
GENERAL DESCRIPTION

The A.H. Systems TDS-535 Tuned Dipole Antenna Set is manufactured per ANSI C63.5 (Willmar Roberts design) and covers the 25 MHz – 1 GHz Frequency Range. This half wave dipole set provides an accurate standard for precise EMI testing and site attenuation measurements (per EN55022 and ANSI C63.4), and should be considered as a standard reference antenna for frequencies below 1000 MHz.

The tuned dipole antenna set is designed for radiated emissions and site attenuation measurements over the 25 MHz – 1 GHz frequency range. The Tuned Dipole Antenna Set is contained in a rugged, lightweight storage case and includes four Baluns, Element extension rods, telescoping Elements, 10 Meter Cable, Tape Measure and a antenna balun clamp with a ¼-20 thread for mounting the baluns to a tripod. Each set is individually calibrated per ANSI C63.5 at 3 and 10 meters (three antenna technique) using NIST traceable test equipment. Two Dipole Sets in one case (TDS-535-2) is available as an option. Review this manual and become familiar with all safety markings and instructions. Verify that the equipment impedance is compatible with the receiver impedance.

Using your antennas

To use your antennas, you must set them up either on a tripod for informal testing or on a mast for site attenuation and/or compliance testing. The telescoping elements should be adjusted to the resonant frequency. When adjusting the elements make sure that the largest OD is exposed.



When adjusting the elements for frequency in-between those data points provided, linear extrapolation can be used. The output of the antennas should be plugged into a 50 ohm receiver or spectrum analyzer.

The ANSI C63.5 derived a theoretical curve for the predicted site attenuation for frequencies between 30 MHz and 1 GHz. In order to make the calculation simple, it was assumed that the antenna could be raised and lowered to achieve a height where the transmitted signal from the transmitting antenna arrived at the receiving antenna in phase with the signal bouncing off the ground plane. The receiving antenna therefore receives two signals, a direct wave and reflected wave. Raising and lowering the antenna finds the height where these two waves reinforce and yield maximum received signal strength.

ANTENNA SPECIFICATIONS

The FCC-1 Dipole Antenna specifications:

Frequency Range .....25 MHz - 70 MHz
Maximum Continuos Power .....300 Watts
Antenna Factor (dBm) .....-2 to 6
Gain (dBi) .....2 dB
Balun Loss .....< 0.5 dB
Average VSWR .....< 1.5:1
Impedance .....50 Ω
Connector Type.....N-type Female
Weight .....1.2 lbs.
Size (W x H x D)..... ……192 X 23.7 X 1.5 (inches)

The FCC-2 Dipole Antenna specifications:

Frequency Range .....65 MHz - 180 MHz
Maximum Continuos Power .....200 Watts
Antenna Factor (dBm) .....4 to 14
Gain (dBi) .....2 dB
Balun Loss .....< 0.5 dB
Average VSWR .....< 1.5:1
Impedance .....50 Ω
Connector Type.....N-type Female
Weight .....0.7 lbs.
Size (W x H x D)..... ……93 X 21.7 X 1.5 (inches)

The FCC-3 Dipole Antenna specifications:

Frequency Range .....170 MHz - 340 MHz
Maximum Continuos Power .....90 Watts
Antenna Factor (dBm) .....13 to 20
Gain (dBi) .....2 dB
Balun Loss .....< 0.5 dB
Average VSWR .....< 1.5:1
Impedance .....50 Ω
Connector Type.....N-type Female
Weight .....0.5 lbs.
Size (W x H x D)..... ……32.25 X 12.5 X 1.5 (inches)

The FCC-4 Dipole Antenna specifications:

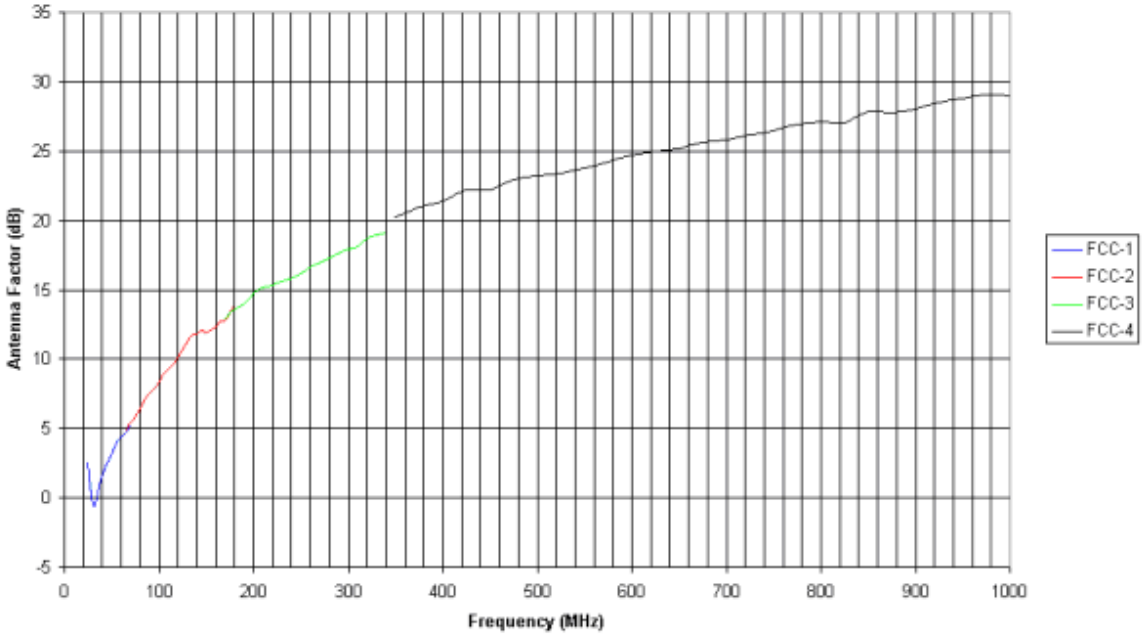
Frequency Range .....325 MHz - 1000 MHz
Maximum Continuos Power .....60 Watts
Antenna Factor (dBm) .....19 to 29
Gain (dBi) .....2 dB
Balun Loss .....< 0.5 dB
Average VSWR .....< 1.5:1
Impedance .....50 W
Connector Type.....N-type Female
Weight .....0.4 lbs.
Size (W x H x D).....16 X 9.0 X 1.5 (inches)

TYPICAL DATA

A.H. Systems Inc.
9710 Cozycroft Ave. Chatsworth, CA 91311
Phone (818) 998-0223 Fax (818) 998-6892
E-mail: Info@AHSystems.com
Web site: http://www.AHSystems.com

Antenna Factor
Tuned Dipole Set - 3 m.
TDS-200/535

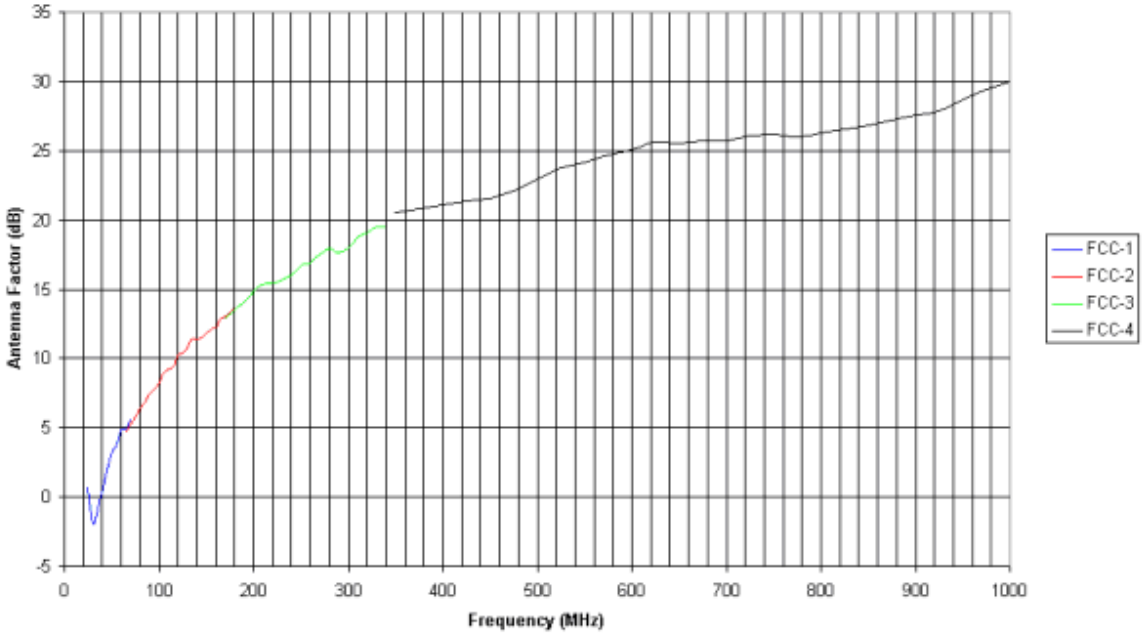
Conversion of meter reading
to field strength:
dBuV/m = dBuV + AF + cable loss



A.H. Systems Inc.
9710 Cozycroft Ave. Chatsworth, CA 91311
Phone (818) 998-0223 Fax (818) 998-6892
E-mail: Info@AHSystems.com
Web site: http://www.AHSystems.com

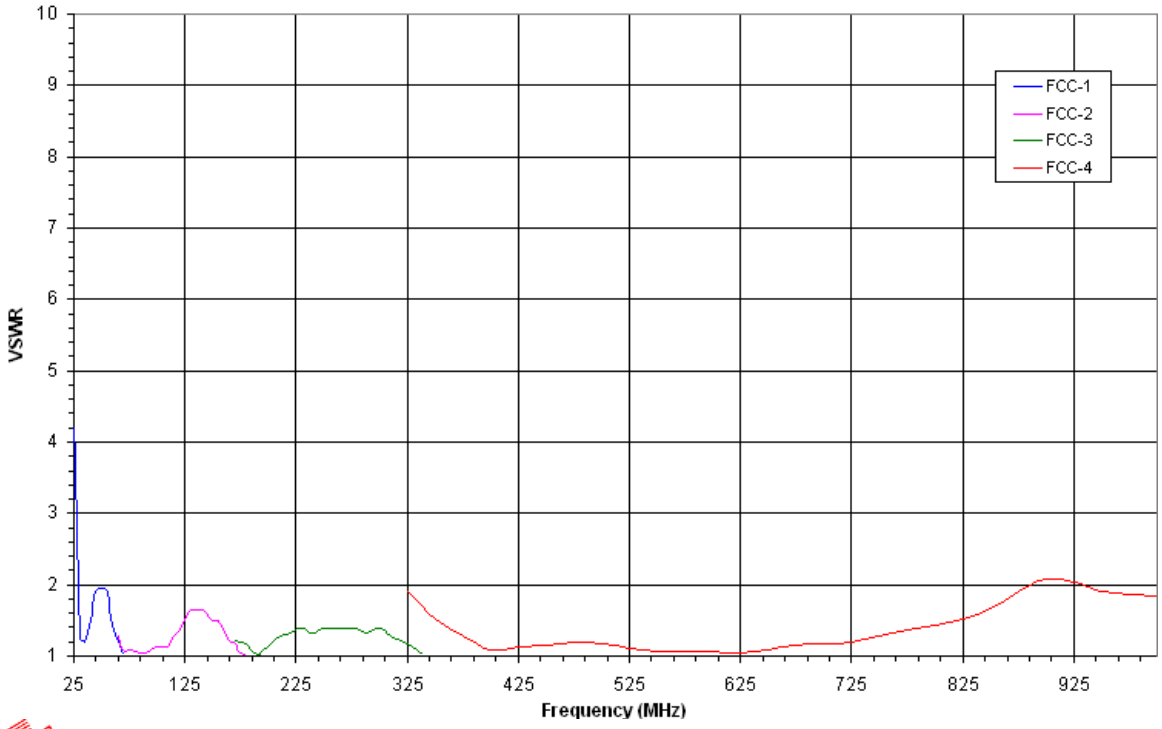
Antenna Factor
Tuned Dipole Set - 10 m.
TDS-200/535

Conversion of meter reading
to field strength:
dBuV/m = dBuV + AF + cable loss



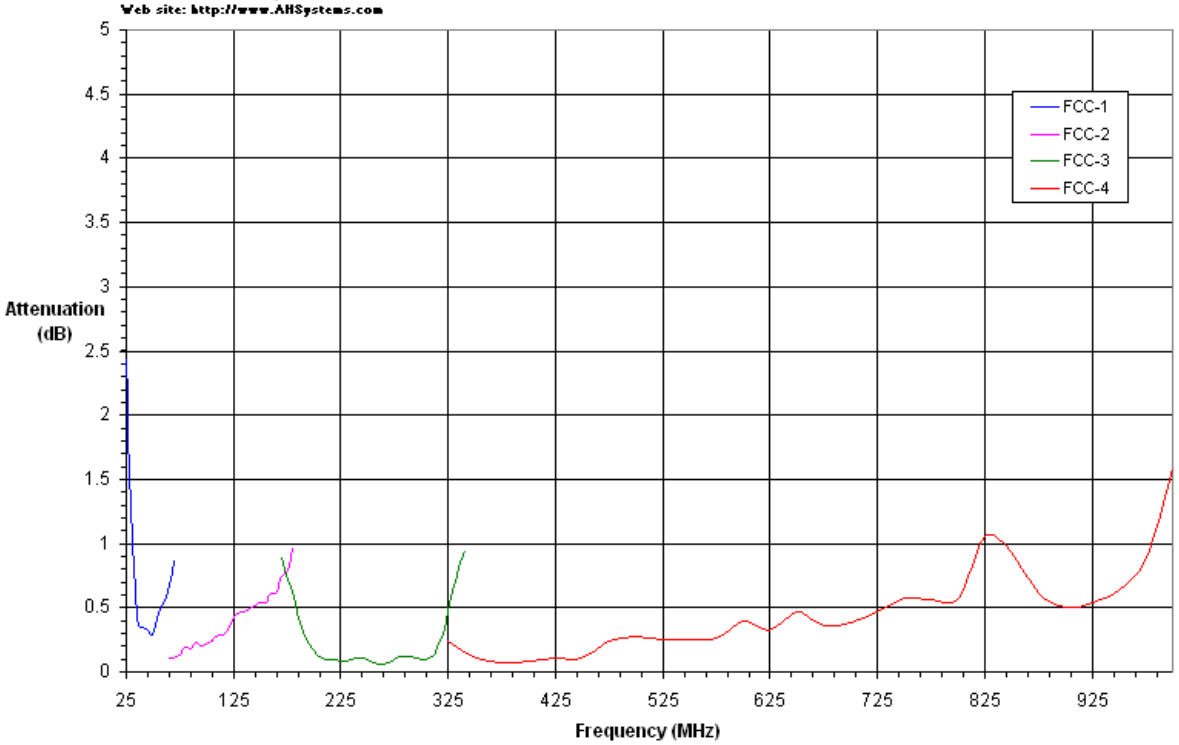
A.H. Systems Inc.
9710 Cozycroft Ave. Chatsworth, CA 91311
Phone (818) 998-0223 Fax (818) 998-6892
E-mail: Info@AHSystems.com
Web site: http://www.AHSystems.com

VSWR
Tuned Dipole Antennas



A.H. Systems Inc.
9710 Cozycroft Ave. Chatsworth, CA 91311
Phone (818) 998-0223 Fax (818) 998-6892
E-mail: Info@AHSystems.com
Web site: http://www.AHSystems.com

Balun Loss
Tuned Dipole Antennas



OPERATING INSTRUCTIONS

ASSEMBLY INSTRUCTIONS

To prepare the antenna for operation, attach the appropriate elements to the balun, which covers the frequency of desired operation. See the table below for details. Screw elements on opposite ends of the top portion of the balun to make a symmetrical dipole. Attach the supplied 50-ohm cable from any receiver to the balun.

Dipole Antenna	Frequency	Elements	Length
FCC-1	25 MHz – 70 MHz	4 Extension Elements 2 detachable elements	Adjustable 8” to 96”
FCC-2	65 MHz – 180 MHz	2 detachable elements	Adjustable 8” to 48”
FCC-3	170 MHz – 340 MHz	2 detachable elements	Adjustable 8” to 48”
FCC-4	325 MHz – 1000 MHz	2 fixed elements	Adjustable 3” to 8”

MOUNTING INSTRUCTIONS

Mount the ABC-TD to any ¼-20 screw. Insert the balun into the balun clamp and tighten the ¼-20 wing nut.

GENERAL USE INSTRUCTIONS

The tuned dipole antenna has two quarter wavelength elements for a total of λ/2. Each dipole balun covers a specific frequency range and the elements must be tuned to the desired frequency. The theoretical element length is (300/FMhz /2), however we provide slightly different lengths that are tuned to the maximum Return loss. The calibration tables that follow in this manual provide a list of the frequencies of operation for each antenna. Listed next to each frequency is the antenna factor, gain (dBi) and the tuned element length (L/2) for each frequency.

The “L/2” lengths given in the data tables are the half length of the dipole at each frequency. “L/2” is the length measured from the notch in the center of the antenna to each tip of the two elements. The overall tip to tip dipole element length will be 2 X “L/2” in length.

> NOTE: Due to the finite diameter of the antenna elements, the optimum or tuned length of the dipole is found to be slightly less than the half-wavelength determined by calculations.

When making a measurement, mount the antenna on an appropriate mast or tripod. Point the main lobe of the dipole toward the transmission source.

ELEMENT LENGTHS

Frequency (MHz)	Element Length
FCC-I	
25	96
30	96
35	82
40	71 1/2
45	63 3/4
50	57
55	54 1/2
60	47 1/4
65	45
70	41
FCC-2	
65	46 1/4
70	43
75	39 7/8
80	36 3/4
85	33 3/4
90	32 5/8
95	30 5/8
100	28 3/4
105	27 1/4
110	25 7/8
115	24 5/8
120	23 3/8
125	22 3/8
130	21 1/2
135	20 3/4
140	20 1/8
145	19 3/8
150	18 3/4
155	18
160	17 1/4
165	16 5/8
170	16 1/8
175	15 5/8
180	15 3/16
FCC-3	
170	16 1/8
180	15 3/16
190	14 5/16
200	13 5/8
210	12 7/8

Frequency (MHz)	Element Length
220	12 1/4
230	11 9/16
240	11 1/8
250	10 5/8
260	10 1/4
270	9 15/16
280	9 11/16
290	9 3/16
300	8 3/4
310	8 5/16
320	8
330	7 13/16
340	7 11/16
FCC-4	
325	8 1/8
350	7 3/4
375	7 1/2
400	7 1/8
425	6 9/16
450	6 1/8
475	5 5/8
500	5 1/4
525	4 15/16
550	4 3/4
575	4 1/2
600	4 3/8
625	4 1/8
650	4
675	3 13/16
700	3 11/16
725	3 7/16
750	3 1/4
775	3 1/8
800	3
825	2 15/16
850	2 7/8
875	2 11/16
900	2 5/8
925	2 5/8
950	2 5/8
975	2 5/8
1000	2 5/8

CALCULATIONS

EMISSIONS TESTING

Individual calibration data for the Tuned Dipole Antennas is supplied at appropriate distances (3, and 10 meter) to comply with various emissions test requirements. For emissions measurements, add antenna factor plus cable loss to receiver reading in dBμV to convert to field strength in dBμV/m.

FS = Field Strength in dBμV/m

$$FS\ (dB\mu V/m) = SA\ (dB\mu V) + AF(dB) + CL\ (dB)$$

SA = Spectrum Analyzer or Receiver voltage reading

AF = Antenna Correction Factor

CL = Cable Loss in dB

IMMUNITY TESTING

For Immunity measurements, the generated electric field strength can be calculated by:

FS = Approximate Field Strength in (V/m)

$$FS\ (V/m) = \frac{\sqrt{30Pg}}{d}$$

P = Power in watts
g = Numeric Gain
d = Distance in meters

TYPICAL CONVERSION FORMULAS

LOG -> LINEAR VOLTAGE

dBµV to Volts	$V = 10^{((dB\mu V - 120) / 20)}$
Volts to dBµV	$dB\mu V = 20 \log(V) + 120$
dBV to Volts	$V = 10^{(dBV / 20)}$
Volts to dBV	$dBV = 20\log(V)$
dBV to dBµV	$dB\mu V = dBV + 120$
dBµV to dBV	$dBV = dB\mu V - 120$

LOG -> LINEAR CURRENT

dBµA to uA	$\mu A = 10^{(dB\mu A / 20)}$
µA to dBµA	$dB\mu A = 20 \log(\mu A)$
dBA to A	$A = 10^{(dBA / 20)}$
A to dBA	$dBA = 20\log(A)$
dBA to dBµA	$dB\mu A = dBA + 120$
dBµA to dBA	$dBA = dB\mu A - 120$

LOG -> LINEAR POWER

dBm to Watts	$W = 10^{((dBm - 30)/10)}$
Watts to dBm	$dBm = 10\log(W) + 30$
dBW to Watts	$W = 10^{(dBW / 10)}$
Watts to dBW	$dBW = 10\log(W)$
dBW to dBm	$dBm = dBW + 30$
dBm to dBW	$dBW = dBm - 30$

TERM CONVERSIONS

dBm to dBµV	$dB\mu V = dBm + 107$ (50Ω) *$dB\mu V = dBm + 10\log(Z) + 90$*
dBµV to dBm	$dBm = dB\mu V - 107$ (50Ω) *$dBm = dB\mu V - 10\log(Z) - 90$*
dBm to dBµA	$dB\mu A = dBm - 73$ (50Ω) *$dB\mu A = dBm - 10\log(Z) + 90$*
dBµA to dBm	$dBm = dB\mu A + 73$ (50Ω) *$dBm = dB\mu A + 10\log(Z) - 90$*
dBµA to dBµV	$dB\mu V = dB\mu A + 34$ (50Ω) *$dB\mu V = dB\mu A + 20\log(Z)$*
dBµV to dBµA	$dB\mu A = dB\mu V - 34$ (50Ω) *$dB\mu A = dB\mu V - 20\log(Z)$*

FIELD STRENGTH & POWER DENSITY

dBµV/m to V/m	$V/m = 10\ (((dB\mu V/m) - 120) / 20)$
V/m to dBµV/m	$dB\mu V/m = 20 \log(V/m) + 120$
dBµV/m to dBmW/m²	$dBmW/m^2 = dB\mu V/m - 115.8$
dBmW/m² to dBµV/m	$dB\mu V/m = dBmW/m^2 + 115.8$
dBµV/m to dBµA/m	$dB\mu A/m = dB\mu V/m - 51.5$
dBµA/m to dBµV/m	$dB\mu V/m = dB\mu A + 51.5$
dBµA/m to dBpT	$DBpT = dB\mu A/m + 2$
dBpT to dBµA/m	$dB\mu A/m = dBpT - 2$
W/m² to V/m	$V/m = SQRT(W/m^2 * 377)$
V/m to W/m²	$W/m^2 = (V/m)^2 / 377$
µT to A/m	$A/m = \mu T / 1.25$
A/m to µT	$\mu T = 1.25 * A/m$

E-FIELD ANTENNAS

Correction Factor	$dB\mu V/m = dB\mu V + AF$
Field Strength	$V/m = \sqrt{\frac{30 * watts * Gain_{numeric}}{meters}}$
Required Power	$Watts = \frac{(V/m * meters)^2}{30 * Gain_{numeric}}$

LOOP ANTENNAS

Correction Factors	$dB\mu A/m = dB\mu V + AF$
Assumed E-field for shielded loops	$dB\mu V/m = dB\mu A/m + 51.5$
	$dBpT = dB\mu V + dBpT/\mu V$

CURRENT PROBES

Correction Factor	$dB\mu A = dB\mu V - dB_{(ohm)}$

Power needed for injection probe given voltage(V) into 50Ω load and Probe Insertion Loss (I_L)

$$Watts = 10^{((I_L + 10\log(V^2/50))/10)}$$

MAINTENANCE

MAINTENANCE PROCEDURES

Proper antenna maintenance should include:

- Visual inspection of RF connectors
- Check for bent and loose elements
- ♦ Check for loose or missing hardware
- Corrosion near the element joints

At least once a month it is a good idea to wipe down the antenna with a damp rag.

ANNUAL CALIBRATION

To ensure reliable and repeatable long-term performance, annual re-calibration of your antennas, preamplifiers and current probes by A.H. Systems experienced technicians is recommended. Our staff can calibrate almost any type or brand of antenna.

It is always up to the user to determine the appropriate interval for calibration certification based on the requirements of the end users specific test/application. The calibration of EMC antennas is important for those conforming to compatibility standard. Radiated emissions testing for electromagnetic compatibility (EMC) requires the measurement of electric field (E-field) strength, which is compared with a limit level. The output voltage of an antenna is converted to E-field strength via its antenna factor, the measurement of which must include the uncertainty components related to that particular antenna, taking into consideration the environment in which the antenna is to be used for the testing. Most standards will specify the appropriate interval for re-calibration of your EMC antenna.

In some cases these antennas are used for a manufacturers pre-compliance testing, field monitoring, surveillance and/or other applications where the exact field intensity of the received signal is not of importance. For those customers a yearly re-calibration is not necessary, however it is recommended that an interval for maintenance be performed.

For more information about our calibration services or to place an order for antenna calibration visit our website at http://www.AHSystems.com or call 1(818) 998-0223.

WARRANTY INFORMATION

A.H. Systems Inc., warrants that our Antennas, Sensors and Probes will be free from defects in materials and workmanship for a period of three (3) years. All other products delivered under contract will be warranted for a period of two (2) years. A.H. Systems' obligation under this warranty shall be limited to repairing or replacing, F.O.B. Chatsworth, California, each part of the product which is defective, provided that the buyer gives A.H. Systems notice of such defect within the warranty period commencing with the delivery of the product by A.H. Systems.

The remedy set forth herein shall be the only remedy available to the buyer, and in no event shall A.H. Systems be liable for direct, indirect, incidental or consequential damages.

This warranty shall not apply to any part of the product which, without fault of A.H. Systems has been subject to alteration, failure caused by a part not supplied by A.H. Systems, accident, fire or other casualty, negligence, misuse or normal wear of materials.

Except for the warranty set forth above, there are no other warranties, expressed or implied, with respect to the condition of the product or it's suitability for the use intended for them by the buyer.

For prompt service, please contact our service department for a Return Material Authorization Number before shipping equipment back to us.