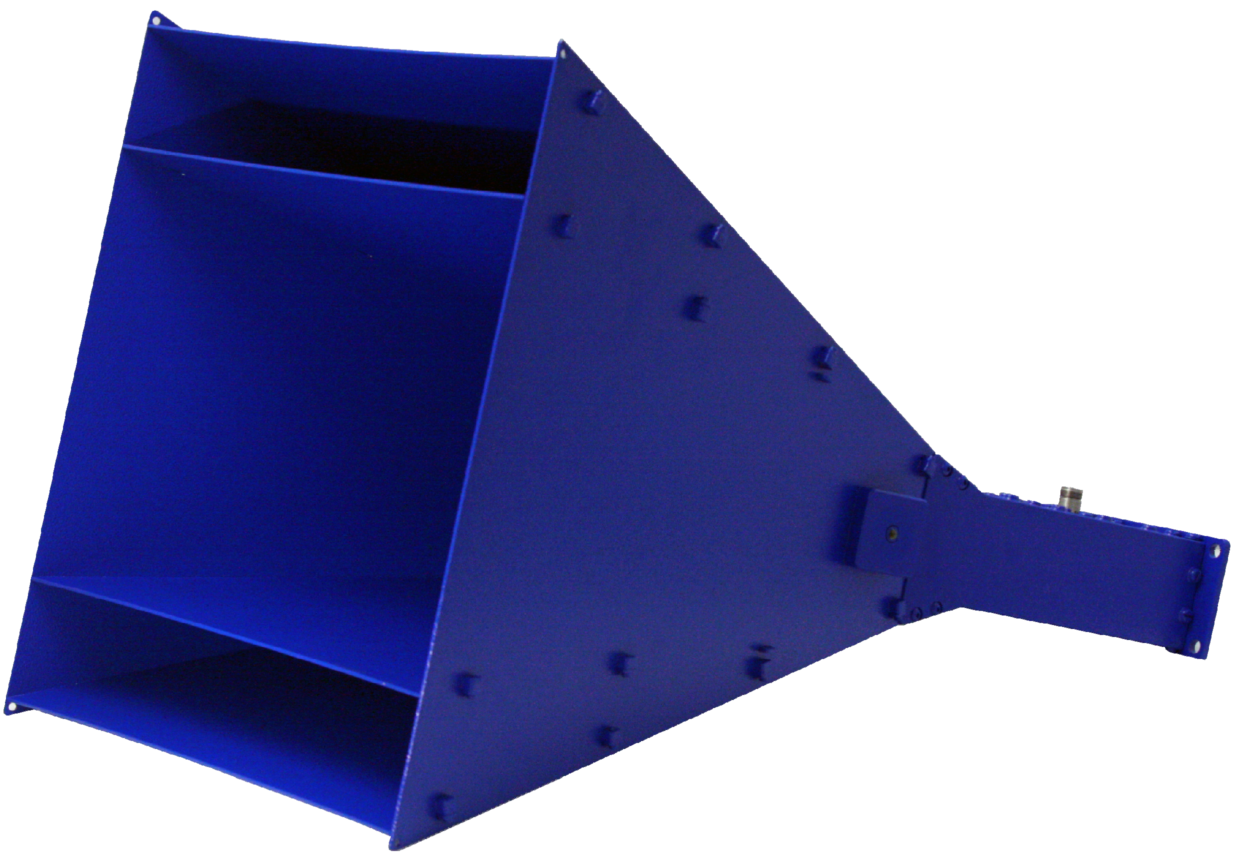
INSTRUCTION MANUAL
for

HIGH GAIN HORN ANTENNA

Model: AH-8055
800 MHz to 5 GHz
(useable up to 6.5 GHz)



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1.0 Introduction

This manual includes product specifications, safety precautions, warranty information, guidelines and usage instructions for the AH-8055 for different applications.

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2.0 Products Available from Com-Power


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Line Impedance Stabilization Networks (LISN)


Antenna Masts


Near-Field Probe Sets


Preamplifiers


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Spectrum Analyzers


Product Safety Test Equipment


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Antenna Tripods


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3.0 Product Information

3.1 Incoming Inspection

Please check the contents of the shipment against the package inventory in section 3.2 to ensure that you have received all applicable items.

If shipping damage to the product or any of the accessories is suspected, or if the package contents are not complete, contact Com-Power or your Com-Power distributor.

3.2 Package Inventory

- ✓ AH-8055 High Gain Horn Antenna
- ✓ Calibration Certificate and Data

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3.3 Product Connections

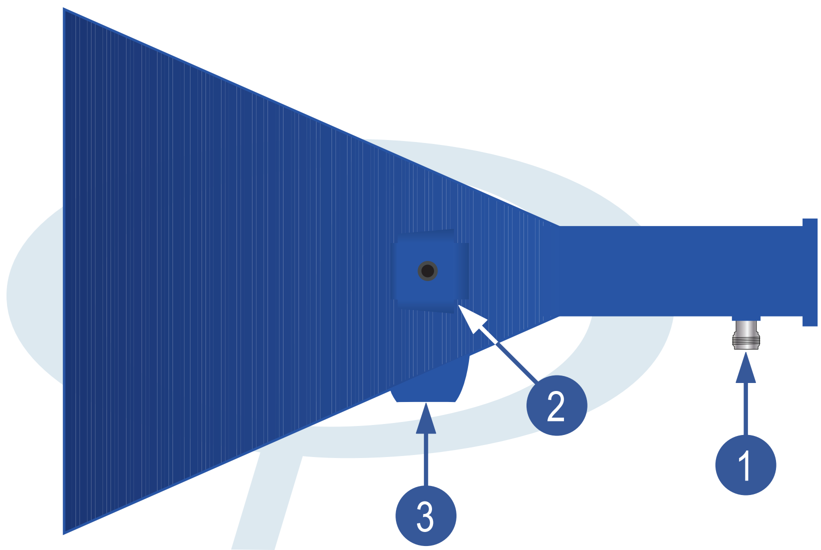

Figure 1 – Product Connections

1 **Antenna Port (input/output)**
Antenna port is a precision, female N-type connector. When used as a receiving antenna, this port is the antenna output port. Conversely, when used as a transmitting antenna, it is the antenna input port.

2 **Mounting Hole for Horizontal Polarization**
This is a ¼" x 20 threads mounting hole for the horizontal antenna polarization.

3 **Mounting Hole for Vertical Polarization**
This is a ¼" x 20 threads mounting hole for the vertical antenna polarization.

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3.4 Product Specifications

Technical	
Frequency Range	**800 MHz to 5 GHz** *(useable up to 6.5 GHz)*
Polarization	**Linear**
Nominal Impedance	**50Ω**
Power Handling	**450 Watts** *(continuous)*
Antenna Factors	**13.8 to 24.2** (average: 19.7) **dB/m**
Isotropic Gain	**10.6 to 23.1 dBi**
VSWR (antenna port)	**1.17 to 2.88** (average 1.69)**:1**
Return Loss (antenna port)	**6.3 to 22** (average: 13) **dB**
RF Connector	
Antenna Port Connector	**Precision N-type** *(female)*
Mechanical	
Dimensions (H)x(W)x(D)	**17.2" x 18" x 27.2"** (43.7 x 45.7 x 69.1 cm)
Weight	**20.5 lbs** (9.3 kg)

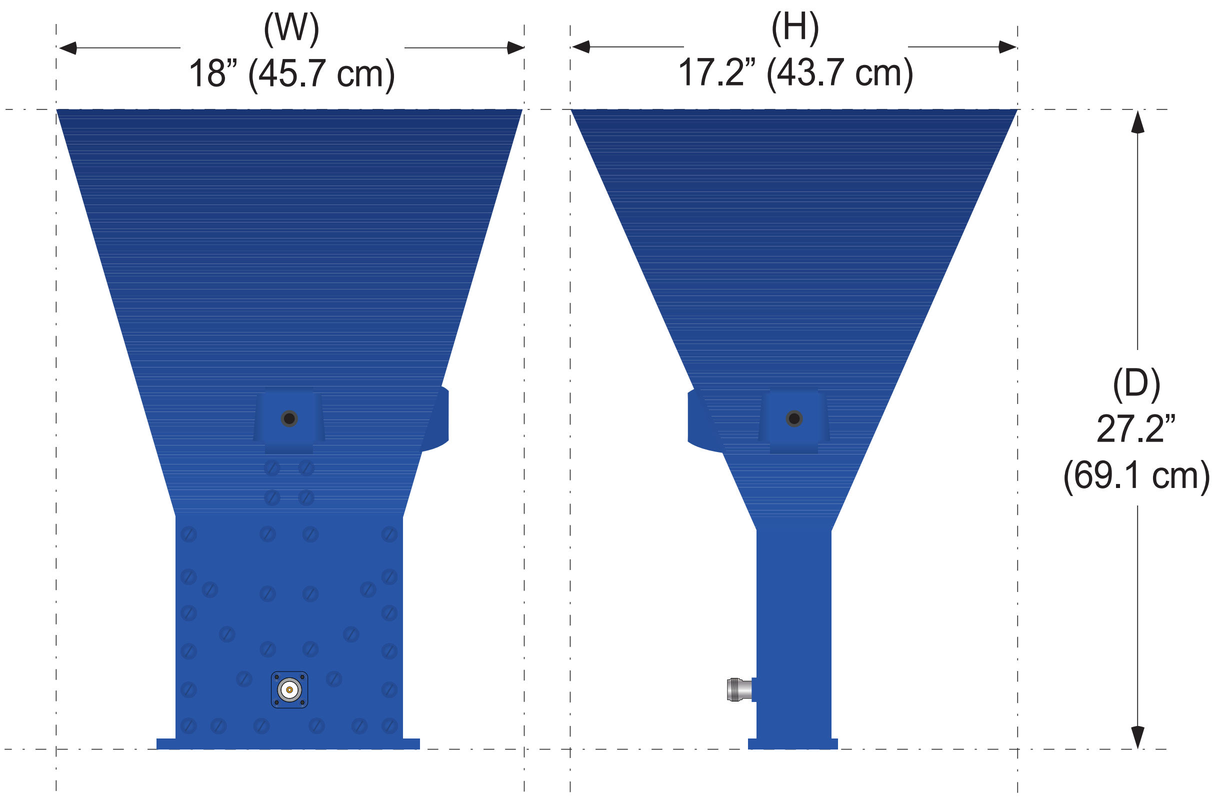

Figure 2 – Product Dimensions

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4.0 Measurement Correction Factors

Anyone familiar with EMI radiated emissions measurements understands that 'uncorrected' values measured on your spectrum analyzer or EMI receiver are essentially meaningless without the appropriate 'correction' factors for the individual components of your measurement system.

A typical radiated emissions measurement system can include any combination of the following components, all of which have a quantifiable effect value on the measured voltage; and therefore must be accounted for to accurately 'correct' your reading:

- **Receiving antenna(s)**
- **Preamplifier(s)**
- **Coaxial measurement cable(s)**
- **Attenuation Pad(s)**
- **Connecting Adapter(s)**
- **Low-Pass, High-Pass or Notch Filter(s)**
- **DC Block(s)**
- **Other similar measurement components**

We can separate the factors associated with the above components into three basic categories:

1) **Antenna (or transducer) Factors,**
2) **Gain Factors (for preamplifiers); and,**

the cables, attenuators, adapters, filters, etc., can all be lumped into one general category…

3) **Insertion Loss Factors**

These three categories of correction factors are discussed in the following sections.

Most of today's spectrum analyzers and EMI receivers allow entry of these factors directly into the instrument. You can then group the factors into factor sets, so that the appropriate cables factors are used with the correct antennas, preamplifiers, etc. This makes things very convenient, and allows the instrument to display/output test results as the corrected values, with no further correction necessary. These newer instruments will also allow you to enter the specification limits, so that PASS/FAIL can be determined instantaneously.

Older instruments, however, do not have this capability, so manual correction, or correction through data acquisition PC software (or other means) is needed.

Whatever the case may be, applying the *CORRECT* correction factors is obviously key to achieving accurate results. A simple typo when entering factors into your instrument or PC software will give you incorrect data until such time that you notice the mistake, or until you recalibrate and enter the new factors. It is a good idea to check your entries.

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4.1 Antenna Factors

Antennas used for EMI tests for frequencies above 30 MHz are typically provided with electric field antenna factors (AFE). These factors are almost always provided in logarithmic units in dB per meter (dB/m) or ($dB_{m^{-1}}$), and their values tend to vary with respect to frequency.

Antenna factor is defined as the "ratio of the electric field in the polarization direction of the antenna to the voltage induced across the load connected to the antenna and expressed in decibel form (20 log (E/V_o))."

Put more simplistically, the antenna factor represents the difference (in dB) between:

A) the voltage present across the output port of the antenna (measured on an instrument with a 50Ω input impedance), and;

B) the electric field strength (V/m) present at the mid-point of the antenna's elements, or in the case of a horn antenna, at the front plane of its aperture (opening).

As any antenna is less than 100% efficient (without amplification), the voltage present across the antenna output port will always be less than that present in the measured field, so the antenna factor can be considered a loss, and is added to the measured value to obtain the field strength:

$$\text{Field Strength (dB}\mu\text{V/m)} = \begin{array}{c}\text{Measured Value (dB}\mu\text{V)} \\ + \\ \text{Antenna Factor (dB/m)}\end{array}$$

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4.2 Preamplifier Gain Factors

Our second category of correction factors are gain factors for preamplifiers. Preamplifiers are used to increase measurement sensitivity by increasing signal to noise ratio. This is necessary when measuring low signal levels which would otherwise be buried below the inherent noise floor of the measuring instrument, typically a spectrum analyzer or EMI receiver. Ideally, input signals levels are increased proportionate to the preamp's gain, without significantly increasing the overall system noise level.

Since the amplitude of the measured signal has been increased by the gain of the preamplifier, the gain value must then be subtracted from the measured value in order to obtain the 'corrected' value. Hence, our field strength formula is modified as follows:

$$\text{Field Strength (dB}\mu\text{V/m)} = \begin{array}{c}\text{Measured Value (dB}\mu\text{V)}\\ + \\ \text{Antenna Factor (dB/m)}\\ - \\ \text{Preamp Gain Factor (dB)}\end{array}$$

4.3 Insertion Loss Factors

As discussed previously, our third category of correction factors is insertion loss factors. These factors can include the insertion loss values of coaxial cables, band-pass or notch filters, attenuation pads, connecting adapters, etc. Basically, it includes any measurement system component (cable, adapter, combiner, divider or any other device) installed in-line with your measurement path having inherent insertion loss over the frequency range of the measurements, intentionally or unintentionally, beyond that which is considered to be negligible.

If the exact insertion loss factors (or values) are unknown for one or more component(s) of your measurement system, refer to section 4.3.1.

Insertion loss factors (or values) must be added to the measured values in order to obtain the 'corrected' values. So, we can update our field strength calculation formula as follows:

$$\text{Field Strength (dB}\mu\text{V/m)} = \begin{array}{c}\text{Measured Value (dB}\mu\text{V)}\\ + \\ \text{Antenna Factor (dB/m)}\\ + \\ \text{Insertion Loss Factors (dB)}\\ - \\ \text{Preamp Gain Factor (dB)}\end{array}$$

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4.3.1 Insertion Loss Measurement

Insertion Loss values for coaxial cables and most measurement system components having a single coaxial input and output, such as attenuators, filters, dc blocks, etc., can be easily determined through a simple calibration process.

All that is typically needed is the following:

- ✓ (2) short coaxial cables and ‘barrel’ adapter to connect them together; and,

either:

- ✓ a network analyzer or measuring instrument (spectrum analyzer or EMI receiver) with tracking generator;

or:

- ✓ a measuring instrument (spectrum analyzer or EMI receiver); and,
- ✓ a stable signal source with the appropriate frequency capabilities, such as a signal generator, function generator, or even a Com-Power Comb Generator.

4.3.1.1 Insertion Loss Measurement Procedure

1) REFERENCE MEASUREMENTS **(R)** - With the equipment set up as shown in Figure 3, measure and record the signal level *(in dBµV)* at several frequencies over the frequency range to be calibrated.

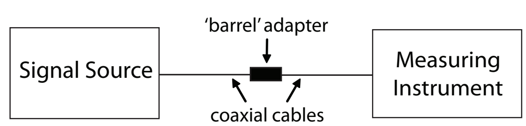

Figure 3 – Setup for Reference Measurements **(R)**

2) INSERTION LOSS MEASUREMENTS **(I)** – Without changing any equipment settings, and with the equipment set up as shown in Figure 4, measure and record the signal level *(in dBµV)* at the same frequencies used in Step 1.

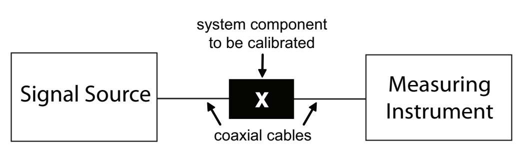

Figure 4 – Setup for Insertion Loss Measurements **(I)**

3) Calculate the insertion loss factor for each frequency using the following formula:

Insertion Loss Factor = (R) minus (I)

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5.0 Antenna Configurations (Modes of Operation)

The AH-8055 high gain horn antenna, while designed primarily for use as a transmitting antenna, may also be used as a receiving antenna.

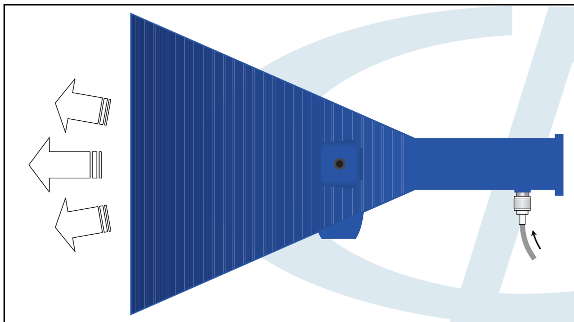

Figure 5a – *Transmit Mode*

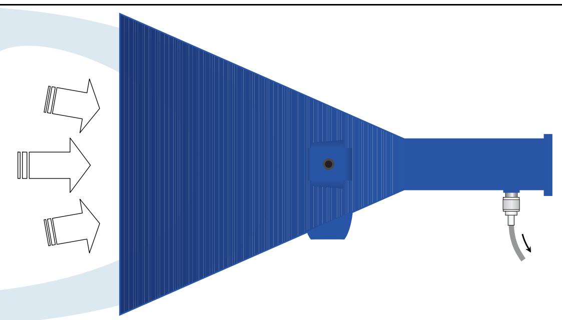

Figure 5d – *Receive Mode*

Figure 5 – Antenna Configurations (Modes of Operation)

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5.1 AH-8055 as a Transmitting Antenna

Illustrated in Figure 6 is the AH-8055 High Gain Horn Antenna configured for use as a transmitting antenna. Illustrated in Figure 7 is a typical system arrangement for this antenna configuration, with the antenna port connected directly to the output port of a power amplifier. In practice, a power amplifier may or may not be used, depending on the desired magnitude of the generated field.

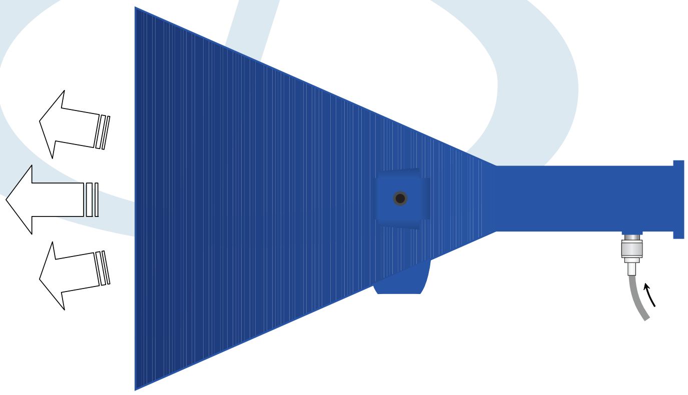

Figure 6 – AH-8055 as a Transmitting Antenna

In this configuration, the AH-8055 is used as a transmitting antenna. Some examples of these applications are listed below:

- Site Validation tests, such as the reciprocal S_{VSWR} procedure described in CISPR 16-1-4
- Radiated RF Immunity (or susceptibility) testing, such as that described in IEC 61000-4-3, MIL-STD 461x, DO-160, etc.
- Antenna Calibrations per ANSI C63.5, ARP 958, etc.

For applications such as those listed above, the isotropic gain factors have importance, rather than the antenna factors, as described in section 5.1.1.

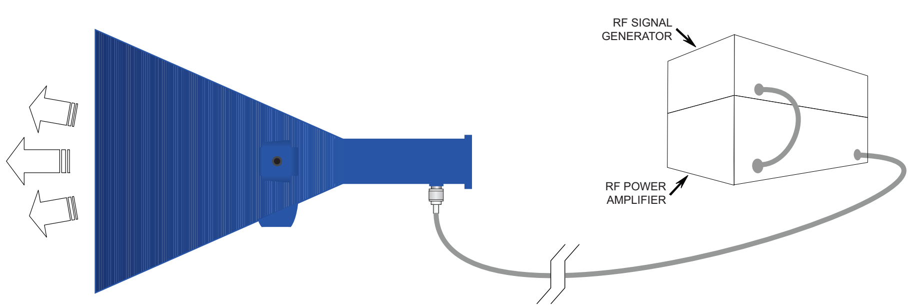

Figure 7 – Typical Equipment Arrangement for Transmitting Applications

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5.1.1 Field Strength Calculations

The graph shown in Figure 8 shows the calculated maximum field strengths (based on typical gain factors) able to be achieved using the AH-8055 High Gain Horn Antenna with 450 watts input power at both one and three meter distances, as well as the formula used for the calculations.

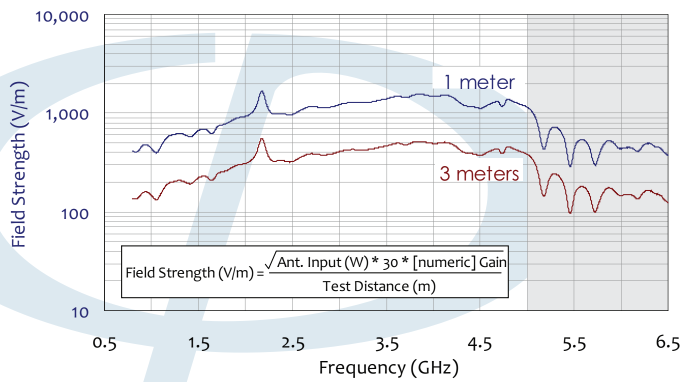

Figure 8 – Calculated Field Strength with 450W input power

The graph shown in Figure 9 shows the calculated power requirements (based on typical factors) for various field strength levels at various test distances, as well as the formula used for the calculations.

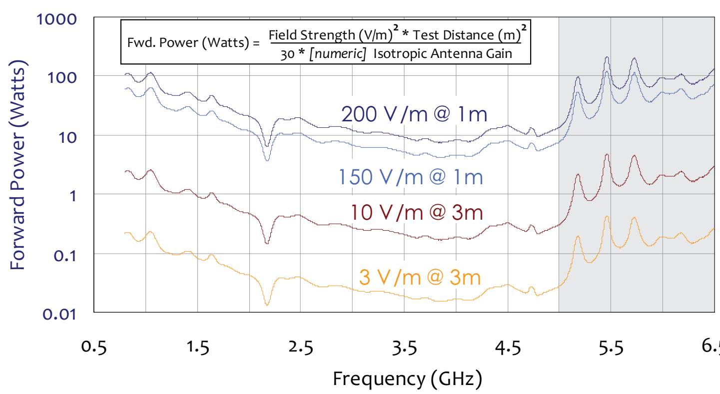

Figure 9 – Power requirements for various fields strengths/distances

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5.2 AH-8055 as a Receiving Antenna

Illustrated in Figure 10 is the AH-8055 High Gain Horn Antenna configured for use as a receiving antenna. Illustrated in Figure 11 is a typical system arrangement for this antenna configuration, with the antenna port connected to the input of a preamplifier, and the preamplifier connected to the input of a spectrum analyzer. In practice, a preamplifier may or may not be used, depending on the magnitude of the signals(s) being measured.

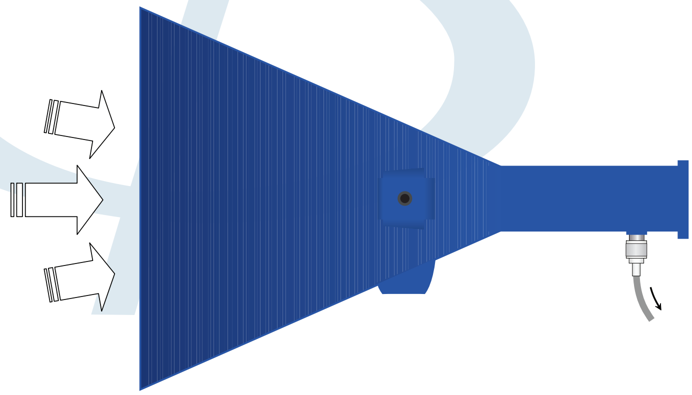

Figure 10 – AH-8055 as a Receiving Antenna

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5.2.1 Field Strength Measurements and Example Calculations

As discussed in section 4, the measured values must be corrected for antenna factor, preamplifier gain and any losses incurred along the measurement path.

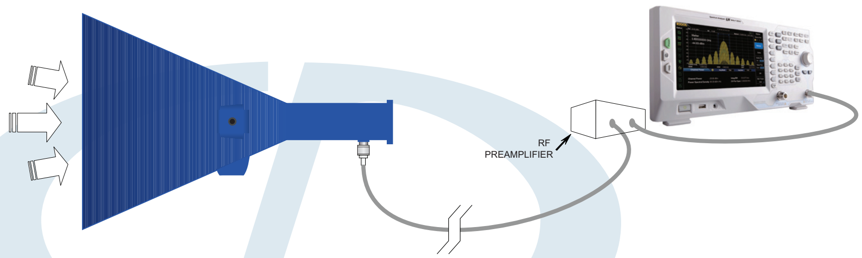

Figure 11 – Typical Equipment Arrangement for Receiving Applications

EXAMPLE:

Using measurement system shown in Figure 11, a signal at 2 GHz is observed using the spectrum analyzer, and its [uncorrected] amplitude is exactly 60 dBµV. The field strength limit at this frequency is assumed to be *500 µV/m* (54 dBµV/m).

For the system shown above, there are four (4) correction factors needed:

1) The AH-8055 Antenna Factor
2) The Insertion Loss Factor for the cable connecting the AH-8055 to the preamplifier (Cable #1)
3) The Insertion Loss Factor for the cable connecting the preamplifier to the spectrum analyzer (Cable #2)
4) The gain of the RF preamplifier.

We'll assume that the insertion loss of the Cables #1 & #2 at 2 GHz is 8 dB and 2 dB, respectively. The preamplifier gain is 40 dB; and, by referring to the typical antenna factor tables in Section 8, we see that the Antenna Factor for the AH-8055 at 2 GHz is 20.82 dB/m (in practice, you will use your actual calibrated factors rather than the typical factors). So our calculation will be as follows:

Measured amplitude @ 2 GHz, with a 3-meter separation distance =	60 dBµV
AH-8055 Antenna Factor @ 2 GHz =	20.82 dB/m
Insertion Loss of Cable #1 @ 2 GHz =	8 dB
Insertion Loss of Cable #2 @ 2 GHz =	2 dB
Preamplifier Gain @ 2 GHz =	40 dB
Field Strength (dBµV/m) = Measured Value (dBµV) + Antenna Factor (dB/m) + Insertion Loss Factors (dB) - Preamp Gain Factor (dB) =	**50.82 dBµV/m**
FCC Part 15 Field Strength Limit @ 3 meters =	54 dBµV/m
Limit ∆ (margin) =	**-3.18 dB**

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5.2.2 Avoiding Preamplifier Saturation

When testing in the presence of high amplitude signals, whether they are generated by the device under test, or from external sources such as radio towers, cellular repeaters or otherwise, it is always advisable to check for overload of your preamplifier, in order to avoid inaccurate test results.

The following procedure will usually be sufficient to detect an overload condition of your preamplifier:

1) Tune your measuring instrument to the frequency of the offending (or possibly offending) signal. Adjust the frequency span to be wide enough to view the entire envelope of the waveform. Maximize the emission level by rotating your turntable and scanning the antenna height, as needed, so that the maximum level is shown on the display. Note the height of the antenna for the maximum level.
2) Use the max-hold/view trace functions to store the outline of the signal on the analyzer screen, or simply note the signal amplitude level.
3) Disconnect the cable connecting the antenna to your preamplifier. Connect an appropriately rated coaxial attenuator (at least 10 dB) to the preamplifier input port, and connect the antenna cable to the attenuator input. Reposition (if necessary) the antenna to the height noted in Step 1.
4) Re-measure the amplitude of the signal, and compare it to the amplitude determined in Step 1. The amplitude reduction should be equal to the attenuator value. If the amplitude reduction of the signal is not equal to the attenuator value, then it is likely that the amplifier is saturated. If this is the case, refer to section 5.2.

In situations where there are high signal levels which are saturating the input to the preamplifier an attenuation pad or RF filter is installed in order to avoid preamplifier saturation.

Attenuation pad(s) are often used temporarily for saturation checks, as discussed in section previously.

Attenuation pad(s) may also be used for tests performed in high ambient conditions. Using attenuators for this purpose will sacrifice system sensitivity and signal to noise to noise ratio performance, which is obviously not desirable.

Custom Low-Pass, High-Pass or Notch Filters are commonly used for tests performed on intentional radiators. The filter attenuates a specific frequency range to suppress the amplitude of the fundamental emission in order to avoid saturation. Outside of the cutoff band, these filters usually have very low insertion loss factors, so that the overall sensitivity and signal to noise ratio of the measurement system is not compromised.

The insertion loss value of the attenuation pad and/or filter must be considered when correcting your measured values (see section 4.3).

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6.0 Calibration and Re-Calibration

Your AH-8055 High Gain Horn Antenna has been individually calibrated and the data has been provided.

Periodic re-calibration of your AH-8055 is recommended when it is used as a receiving antenna. Calibration intervals is left to your discretion, but should be chosen based on the frequency with which it is used, and/or as allowed for by your internal quality control system (if applicable). Com-Power does offer NIST traceable calibration services

For transmitting applications, re-calibration of the antenna is not typically necessary, as the field generated by the antenna is typically measured using a calibrated field probe.

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7.0 Warranty

Com-Power warrants to its Customers that the products it manufactures will be free from defects in materials and workmanship for a period of three (3) years. This warranty shall not apply to:

- Transport damages during shipment from your plant.
- Damages due to poor packaging.
- Products operated outside their specifications.
- Products Improperly maintained or modified.
- Consumable items such as fuses, power cords, cables, etc.
- Normal wear
- Calibration
- Products transported outside the United States without the prior knowledge of Com-Power.

In addition, Com-Power shall not be obliged to provide service under this warranty to repair damage resulting from attempts to install, repair, service or modify the instrument by personnel other than Com-Power service representatives.

Under no circumstances does Com-Power recognize or assume liability for any loss, damage or expense arising, either directly or indirectly, from the use or handling of this product, or any inability to use this product separately or in combination with any other equipment.

When requesting warranty services, it is recommended that the original packaging material be used for shipping. Damage due to improper packaging will void warranty.

In the case of repair or complaint, Please visit our website www.com-power.com and fill out the RMA form (http://com-power.com/repairservicereq.asp). Our technical assistance personnel will contact you with RMA number. The RMA number should be displayed in a prominent location on the packaging and on the product, along with a description of the problem, and your contact information.

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8.0 Typical Performance Data

COM-POWER CORPORATION

Typical E-Field Antenna Factors & Isotropic Gain Values

Equipment:	**High Gain Horn Antenna**
Model:	**AH-8055**
Serial Number:	
Calibration Date:	
Antenna Polarization:	**Horizontal**
Calibration Distance:	**1 meter**

Frequency (GHz)	Gain (dBi)	AFE (dB/m)	Frequency (GHz)	Gain (dBi)	AFE (dB/m)
800	10.93	**17.34**	2800	19.81	**19.34**
850	10.92	**17.87**	2900	19.89	**19.56**
900	12.02	**17.27**	3000	20.42	**19.32**
950	12.26	**17.50**	3100	20.79	**19.24**
1000	11.54	**18.66**	3200	20.80	**19.51**
1100	11.84	**19.19**	3300	20.82	**19.75**
1200	14.16	**17.63**	3400	21.18	**19.65**
1300	14.62	**17.86**	3500	21.58	**19.50**
1400	13.96	**19.16**	3600	22.10	**19.23**
1500	15.16	**18.56**	3700	21.82	**19.75**
1600	15.20	**19.08**	3800	22.40	**19.40**
1700	15.86	**18.95**	3900	22.44	**19.59**
1800	16.60	**18.70**	4000	22.09	**20.16**
1900	17.60	**18.17**	4250	21.37	**21.41**
2000	18.03	**18.19**	4500	19.65	**23.62**
2100	19.40	**17.24**	4750	20.21	**23.53**
2200	22.50	**14.55**	5000	19.94	**24.24**
2300	18.47	**18.97**	5250	15.36	**29.25**
2400	18.58	**19.23**	5500	11.14	**33.87**
2500	18.43	**19.74**	5750	9.10	**36.30**
2600	19.40	**19.11**	6000	11.54	**34.23**
2700	20.03	**18.81**	6500	10.12	**36.35**

Calibration performed per:

SAE ARP 958, Revision D, Section 4 - 1-meter Gain Calibration (Section 4)

Corrected Reading (dBμV/m) = **Meter Reading** (dBμV) + **AFE**(dB/m)

Figure 12 – Typical Antenna Factors and Isotropic Gain Values

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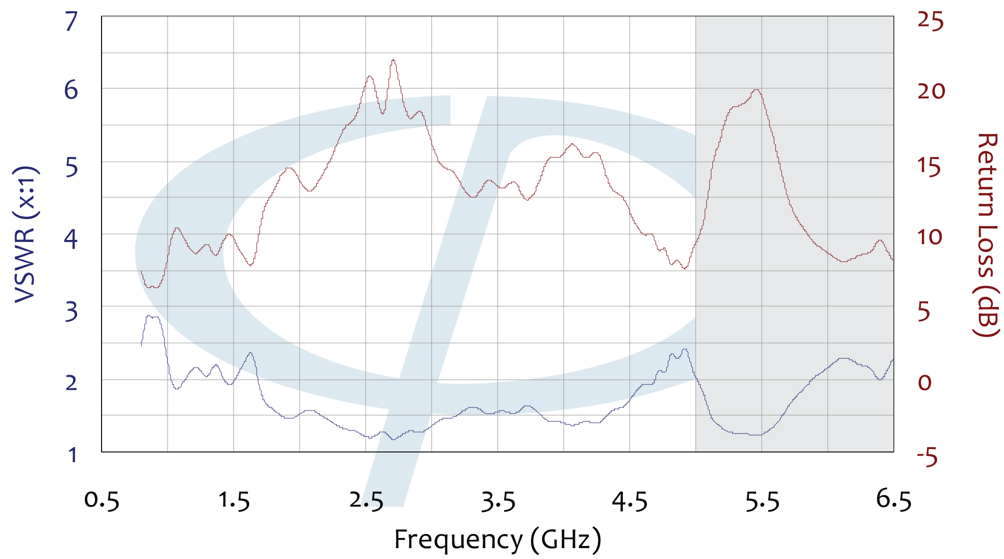

Figure 13 – Typical VSWR/Return Loss

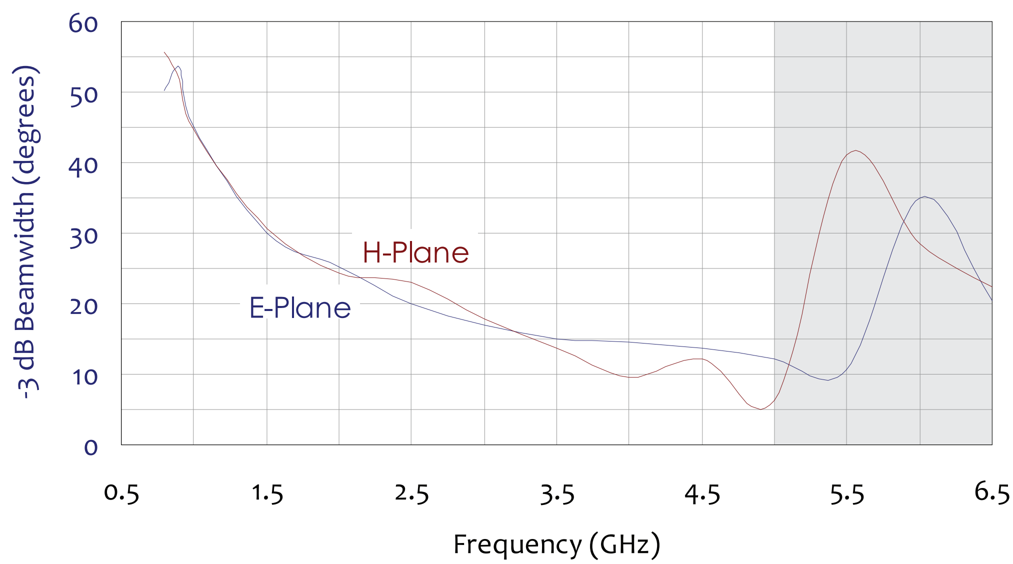

Figure 14 – Typical 3 dB Beamwidth

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