

INSTRUCTION MANUAL
for
**ACTIVE DOUBLE RIDGE
HORN ANTENNA**

Model: AHA-840
18 GHz to 40 GHz

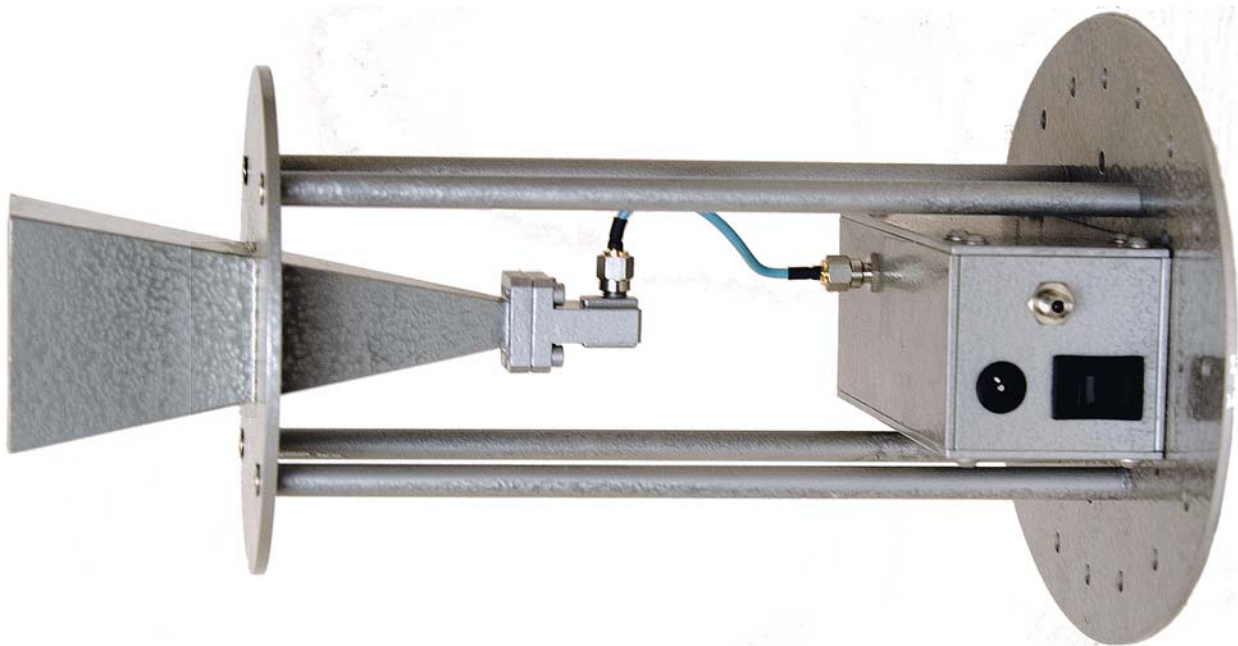


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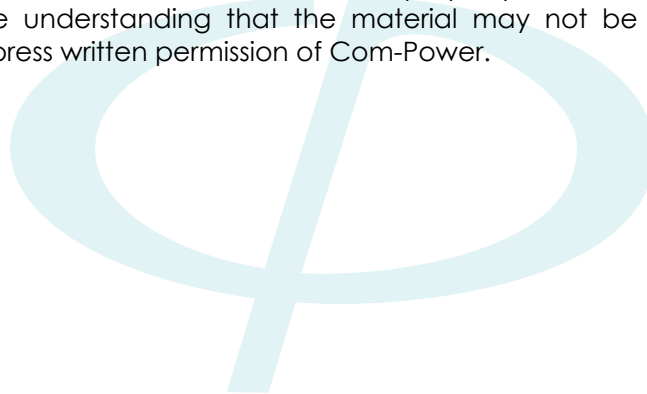
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1.0 Introduction

This manual includes product specifications, safety precautions, warranty information, guidelines and instructions for appropriately configuring the AHA-840 for different applications, along with general instructions for its proper usage.

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2.0 Products Available from Com-Power



Antennas



Antenna Kits



Absorbing Clamps



*Coupling/Decoupling
Networks (CDN)*



Comb Generators



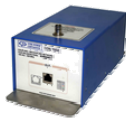
Current Probes



*Emissions Test
Systems*



*Conducted Immunity
Test Systems*



*Impedance Stabilization
Networks (ISN)*



*Line Impedance Stabilization
Networks (LISN)*



Antenna Masts



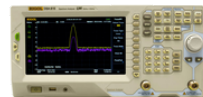
*Near-Field
Probe Sets*



Preamplifiers



Power Amplifiers



Spectrum Analyzers



*Product Safety Test
Equipment*



Transient Limiters



Turntables



Antenna Tripods



*Telecom Test
Systems*

www.com-power.com

3.0 Product Information

3.1 Product Handling – ESD SENSITIVE DEVICE



WARNING – This product contains semiconductors that can be damaged by electrostatic discharge (ESD). Care must be taken so that the devices are not damaged. Damage due to inappropriate handling is not covered by the warranty.

Prior to handling product at any time, discharge yourself by touching a grounded bare metal surface, such as an uncovered metal floor or wall of a shielded enclosure (test chamber); or ground plane on an Open Area Test Site (OATS).

3.2 Incoming Inspection

WARNING – To avoid possibility of electrical shock, do not apply power to the Com-Power AHA-840 if there is any evidence of shipping damage to the antenna assembly or to the AC power adapter.

Please check the contents of the shipment against the package inventory in section 3.3 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.

3.3 Package Inventory

- ✓ AHA-840 Active Double Ridge Horn Antenna
- ✓ Coaxial Jumper Cable (3.5")
2.92 mm (male) to 2.92 mm (male)
(may be connected to horn antenna)
- ✓ **6 V_{DC} (unregulated), 500 mA, AC Power Adapter**
- ✓ **Calibration Certificate and Data**

3.4 Product Connections/Controls

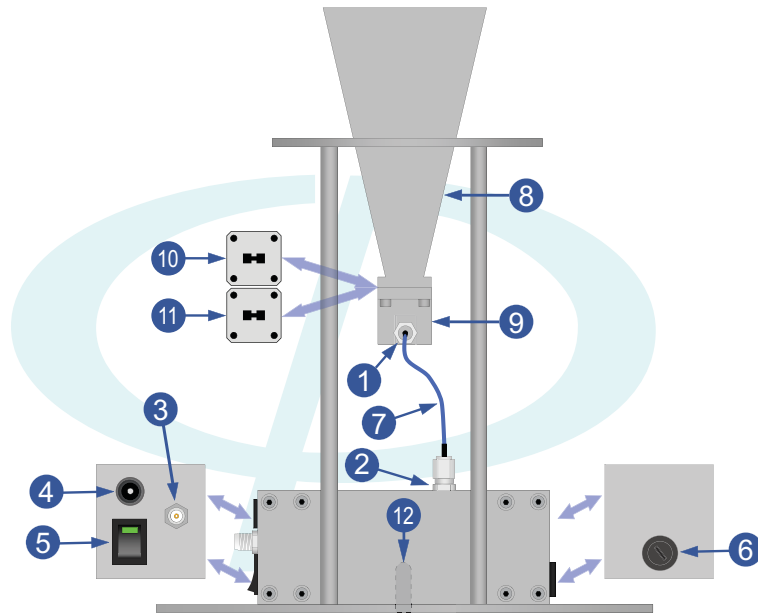


FIGURE 1 - Product Connections/Controls Diagram

- 1 Coaxial Port of Waveguide to Coaxial Adapter**
This is the antenna's coaxial output port, located on the waveguide to coaxial adapter.
- 2 Preamplifier Input Port**
Input port of Preamplifier (used in ACTIVE modes only)
- 3 Preamplifier Output Port**
Output Port of Preamplifier (used in ACTIVE modes only)
- 4 DC Power Input Port**
Receptacle for output plug of provided AC adapter for preamplifier power in ACTIVE mode
- 5 Preamplifier Power Switch**
Turns on/off power for preamplifier (used in ACTIVE modes only)
- 6 Fuse Mounting Assembly**
To replace the fuse, insert a flat-blade screw driver, coin or similar into the slot and rotate one-eighth turn counter-clockwise to release.
- 7 Coaxial Jumper Cable**
For connecting the antenna output to the preamplifier input. (ACTIVE modes only)
- 8 Horn Antenna Waveguide Flange**
Double Ridge Horn Antenna Waveguide Flange (actual antenna portion of assembly)
- 9 Waveguide to Coaxial Adapter**
Converts the waveguide transmission line into a coaxial transmission line
- 10 Waveguide Antenna Port**
This is the antenna's waveguide port, an integral part of the antenna flange
- 11 Waveguide Port of Waveguide to Coaxial Adapter**
Connects directly to waveguide port of antenna flange.
- 12 1/4" x 20 Threaded Mounting Hole**
Provides the means by which the antenna assembly can be mounted.

3.5 Product Specifications

Technical

Frequency Range	18 GHz to 40 GHz
Polarization	Linear
Nominal Impedance	50Ω
Power Handling - Waveguide	200W (waveguide), 10W (coaxial)
Preamplifier Gain	37 to 43 dB (linear slope ± 3.5 dB)
P_{OUT} @ 1 dB Compression	>10 dBm
Antenna Factors	-5 to 3.5 dB/m (ACTIVE Modes) 35 to 45 dB/m (NON-ACTIVE Modes)
Isotropic Gain	54 to 64 dBi (ACTIVE Modes) 17 to 24 dBi (NON-ACTIVE Modes)
VSWR (antenna port)	1.18 to 1.71 (average 1.37):1

Electrical

DC Power Input	6 V_{DC}, 245 mA
AC to DC Power Adapter	6 V_{DC} (unregulated), 500 mA

RF Connectors

Waveguide Antenna Flange	WRD180C24
Waveguide to Coaxial Adapter	WRD180C24 to 2.92 mm [K-type] (female)
Preamplifier Input Connector	2.92 mm [K-type] (female)
Preamplifier Output Connector	2.92 mm [K-type] (female)
Coaxial Jumper Cable	(2) 2.92 mm [K-type] (male)

Mechanical

Dimensions (H)x(W)x(D)	5.9" x 8.7" x 10.4" (15 x 22 x 26.5 cm)
Weight	1.5 lbs (0.68 kg)

Environmental

Operating Temperature	40°F to 104°F (5°C to 40°C)
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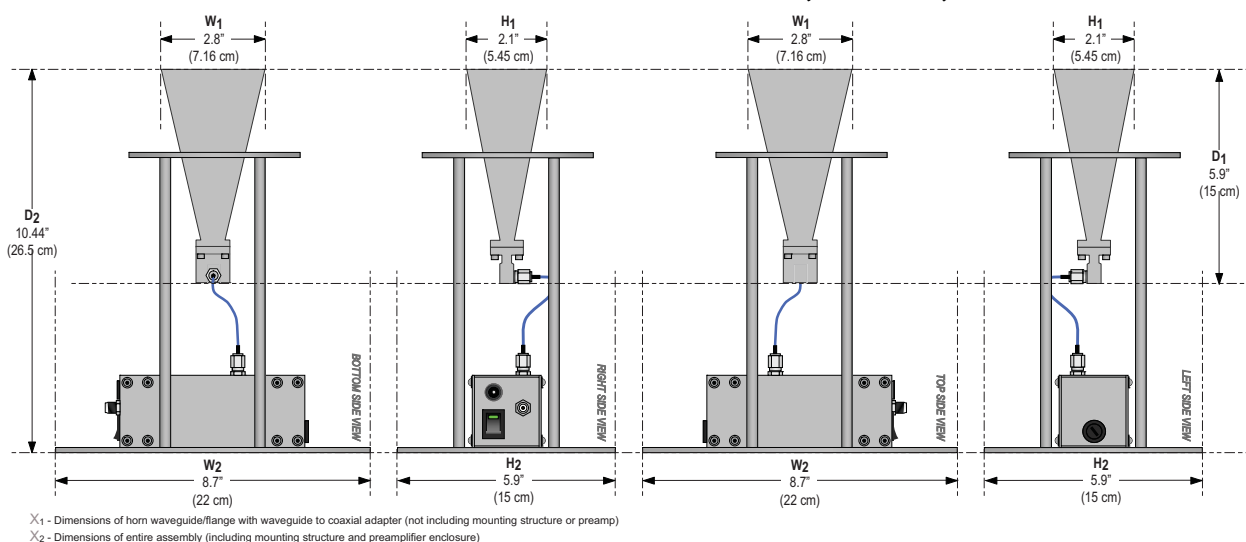


FIGURE 2 - Product Dimensions

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,**
- 3) Insertion Loss Factors**

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

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 *EVERY TIME YOU RUN A TEST* until such time that you notice the mistake, or until you recalibrate and enter the new factors. It is a good idea to check and even double-check your entries.

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)).”

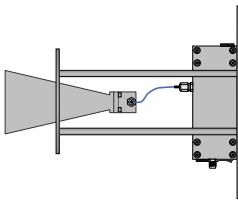
Put more simplistically, the antenna factor represents the difference (in dB) between:

- 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:

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

4.1.1 Active Antenna Factors

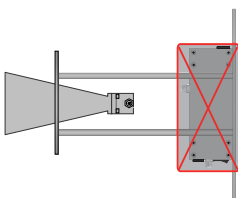


The provided *ACTIVE* Antenna Factors include all gain/loss factors for the assembly (pictured), up to and including the preamplifier output port connector. It includes the factor of the antenna, the insertion loss of the coaxial jumper cable and the preamplifier gain, calibrated as a system (not separately as individual components).

NOTE: As the Active Factor includes the gain factor of the preamplifier, its value at certain frequencies may be negative. Therefore, it is critical that the sign of the factor be included in any calculations; the field strength formula shown above remains true.

Refer to section 5 for guidance on selecting the appropriate antenna configuration.

4.1.2 Non-Active Antenna Factors



The provided *NON-ACTIVE* Antenna Factors include only the antenna factor.

NON-ACTIVE FACTORS DO NOT INCLUDE THE INSERTION LOSS FOR THE COAXIAL JUMPER CABLE OR GAIN FACTORS FOR THE PREAMPLIFIER.

Refer to section 5 for guidance on selecting the appropriate antenna configuration.

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:

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

NOTE: When using the AHA-840 antenna in the ACTIVE-Rx modes (see section 5), you will apply the ACTIVE factors, which already include the preamplifier gain. So, our field strength formula in this case becomes:

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

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, 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:

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

NOTE: When using the AHA-840 antenna in the ACTIVE-Rx mode (see section 5), you will apply the ACTIVE factors, which already include the insertion loss of the coaxial jumper cable.

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.

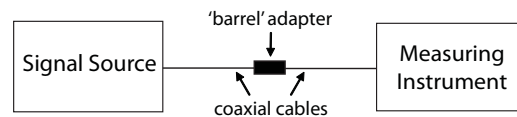


FIGURE 3 - Setup for Reference Measurements (R)

- 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.

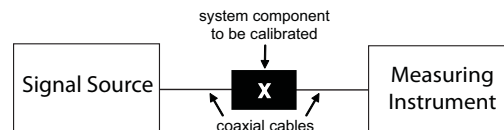


FIGURE 4 - Setup for Insertion Loss Measurements (I)

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

$$\text{Insertion Loss Factor} = \text{(R) minus (I)}$$

5.0 Antenna Configurations (Modes of Operation)

Defined within this section are the four prescribed operational configurations (modes of operation) in which the antenna can be utilized, examples of respective applications for each, along with guidance for measurement corrections.

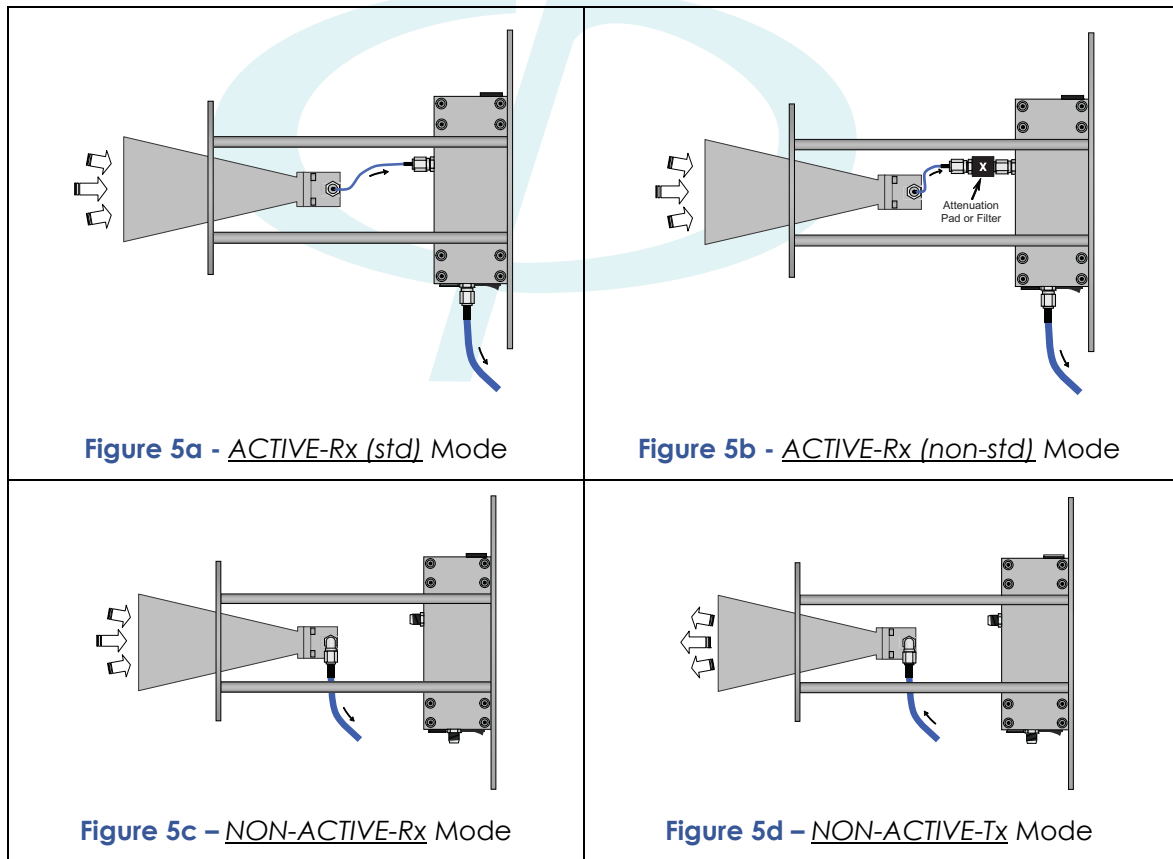


FIGURE 5 - Antenna Configurations (Modes of Operation)

It is important to select the appropriate antenna configuration based on the type of test to be performed as well as the type of device that is to be tested. Some devices, especially intentional radiators, depending on output power and frequency of operation, may saturate the input of the preamplifier, which can lead to inaccurate test results. Refer to the following sections for guidance on selecting the appropriate antenna configuration.

5.1 ACTIVE-Rx (std) CONFIGURATION

Illustrated in Figure 6 is the AHA-840 Active Double Ridge Horn Antenna in its ACTIVE-Rx (std) configuration. As shown, the coaxial jumper cable is used to connect the antenna port to the preamplifier input port directly. Illustrated in Figure 7 is a typical measurement system arrangement for this antenna configuration, with the AHA-840 preamplifier output port connected directly to the input port of the measuring instrument (usually located in a separate, nearby area) using a coaxial cable of sufficient length.

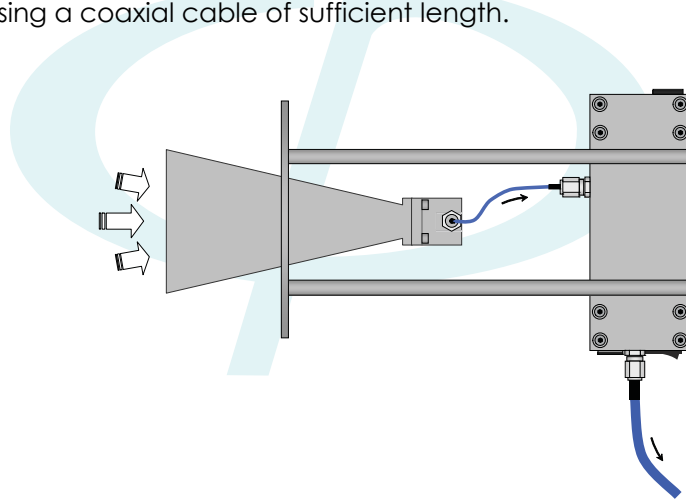


FIGURE 6 - AHA-840 - ACTIVE-Rx (std) Configuration

This configuration is ideal for the measurement of low-level signals; as it provides the best overall measurement sensitivity and highest signal to noise ratio. This is the most common configuration for regulatory compliance measurements of most types of products.

This antenna configuration is commonly utilized for the following types of spurious radiated emissions tests:

- o spurious radiated emissions of unintentional radiators; or,
- o spurious radiated emissions tests of intentional radiators;

where:

- the fundamental (transmit) frequency is $\ll 18$ GHz, or
- the fundamental (transmit) frequency is $\gg 40$ GHz;

or,

- the amplitude of the fundamental (transmit) frequency, or any other signal (or combination of signals) does not saturate the input of the preamplifier

(REFER TO SECTION 5.1.2 FOR GUIDANCE)

NOTE: THE *ACTIVE* ANTENNA FACTORS MUST BE APPLIED FOR MEASUREMENTS MADE IN THIS CONFIGURATION. SEE SECTION 5.1.1.

5.1.1 Field Strength Measurement Calculations

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

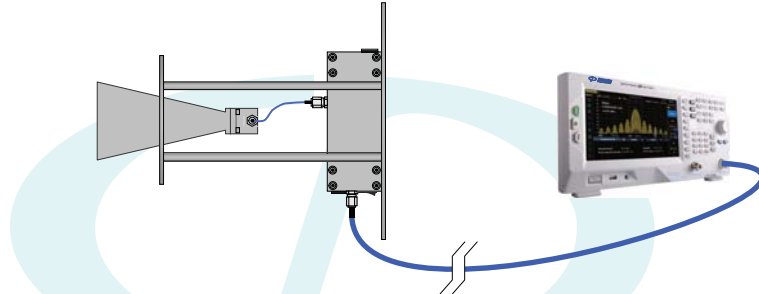


FIGURE 7 - Typical setup for ACTIVE-Rx (Std) mode

Let's go through one exercise of converting an uncorrected voltage measurement into an actual field strength value for comparison to the FCC Part 15 Limit of $500 \mu\text{V}/\text{m}$ ($54 \text{ dB}\mu\text{V}/\text{m}$) using the following example.

EXAMPLE:

We'll use the measurement system shown in Figure 7, and assume a 3-meter separation distance between the source and the antenna. We observe a signal at 20 GHz using the spectrum analyzer, and its [uncorrected] amplitude is exactly $40 \text{ dB}\mu\text{V}$.

For the system shown above, there are two (2) correction factors needed:

- 1) The AHA-840 ACTIVE Antenna Factor (which includes the insertion loss of the coaxial jumper cable, as well as the preamp gain)
- 2) The Insertion Loss Factor for the long cable connecting the AHA-840 to the measuring instrument

We'll assume that the insertion loss of the cable at 20 GHz is 15 dB. And, by referring to the typical antenna factor tables in Section 8, we see that the ACTIVE Antenna Factor for the AHA-840 is $-2.74 \text{ dB}/\text{m}$ (in practice, you will use your actual calibrated factors rather than the typical factors). So our calculation will be as follows:

Measured amplitude @ 20 GHz,	40 dB μ V
with a 3-meter separation distance =	
ACTIVE Antenna Factor @ 20 GHz =	-2.74 dB/m
Insertion Loss of Long Coaxial Cable @ 20 GHz =	15 dB
$\begin{aligned} &\text{Measured Value (dB}\mu\text{V)} \\ &+ \\ \text{Field Strength (dB}\mu\text{V}/\text{m)} &= \text{Active Antenna Factor (dB/m)} \\ &+ \\ &\text{Insertion Loss Factors (dB)} \end{aligned}$	52.26 dBμV/m @ 3 meters
FCC Part 15 Field Strength Limit @ 3 meters =	54 dB μ V/m
Limit Δ (margin) =	-1.74 dB

5.1.2 Avoiding Preampifier 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 coaxial jumper cable from the preamplifier input connector of the antenna. Attach an appropriately rated coaxial attenuator (at least 10 dB) to the preamplifier input port, and connect the coaxial jumper cable to the attenuator input (see Figure 8). 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.

5.2 ACTIVE-Rx (non-std) CONFIGURATION

Illustrated in Figure 8 is the AHA-840 Active Double Ridge Horn Antenna in its ACTIVE-Rx (non-std) configuration. As shown, the coaxial jumper cable connects directly to the antenna port, and the other end of the jumper cable is connected to an addition device, such as an attenuation pad or an RF filter (band-pass or notch), which is connected to the preamplifier input port. For discussion purposes, we will call this device the 'X-device'.

Illustrated in Figure 9 is a typical measurement system arrangement for this antenna configuration, with the AHA-840 preamplifier output port connected directly to the input port of the measuring instrument, which is usually located in a separate, nearby area) using a coaxial cable of sufficient length.

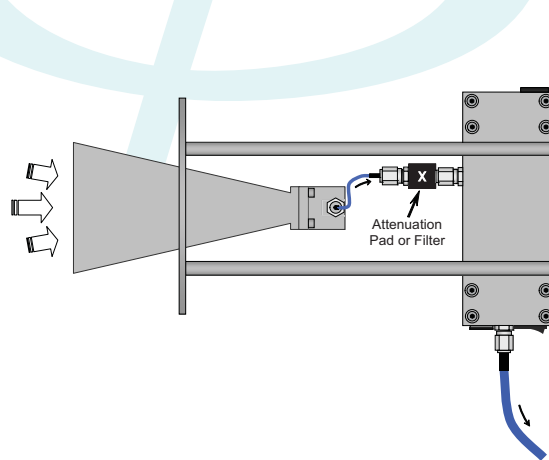


FIGURE 8 - AHA-840 - ACTIVE-Rx (non-std) Configuration

This configuration is used in situations where there are high signal levels which will (or may) saturate the input to the preamplifier. The 'X-device', whether it be 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 5.1.2.

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.

NOTE: THE **ACTIVE** ANTENNA FACTORS MUST BE APPLIED FOR MEASUREMENTS MADE IN THIS CONFIGURATION. IN ADDITION, THE INSERTION LOSS FACTORS FOR THE 'X-DEVICE' MUST ALSO BE ACCOUNTED FOR. SEE SECTION 5.2.1.

5.2.1 Field Strength Measurement Calculations

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

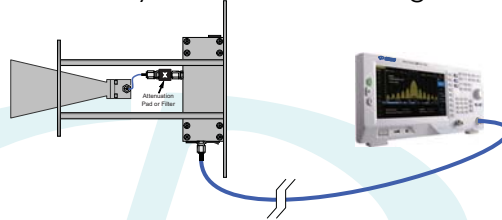


FIGURE 9 - Typical setup for ACTIVE-Rx (non-std) mode

Let's go through one exercise of converting an uncorrected voltage measurement into an actual field strength value for comparison to the FCC Part 15 Limit of $500 \mu\text{V}/\text{m}$ ($54 \text{ dB}\mu\text{V}/\text{m}$) using the following example.

EXAMPLE:

We'll use the measurement system shown in Figure 9, and assume a 3-meter separation distance between the source and the antenna. The 'X-device' is a 10 dB attenuation pad. We observe a signal at 20 GHz using the spectrum analyzer, and its [uncorrected] amplitude is exactly 30 dB μV .

For the system shown above, there are three (3) correction factors needed:

- 1) The AHA-840 ACTIVE Antenna Factor (which includes the insertion loss of the coaxial jumper cable, as preamp gain)
- 2) The Insertion Loss Factor for the long cable connecting the AHA-840 to the measuring instrument
- 3) The Insertion Loss Factor for the 10 dB attenuation pad

We'll assume that the insertion loss of the cable at 20 GHz is 15 dB. And, by referring to the typical antenna factor tables in Section 8, we see that the ACTIVE Antenna Factor for the AHA-840 is $-2.74 \text{ dB}/\text{m}$ (you'll use the actual factor in practice). And, obviously, our 10 dB attenuation pad has 10 dB insertion loss (I checked). So our calculation will be as follows:

Measured amplitude @ 20 GHz,		30 dB μV												
with a 3-meter separation distance =														
Active Antenna Factor @ 20 GHz =		-2.74 dB/m												
Insertion Loss of Long Coaxial Cable @ 20 GHz =		15 dB												
Insertion Loss of 10 dB Attenuation Pad =		10 dB												
<table style="margin: auto; border: none;"> <tr> <td style="padding: 0 5px;">Measured Value (dBμV)</td> <td style="text-align: center; padding: 0 5px;">+</td> <td style="padding: 0 5px;">Field Strength (dB$\mu\text{V}/\text{m}$) =</td> <td style="text-align: center; padding: 0 5px;">Active Antenna Factor (dB/m)</td> <td style="text-align: center; padding: 0 5px;">=</td> <td style="padding: 0 5px;">52.26 dB$\mu\text{V}/\text{m}$</td> </tr> <tr> <td></td> <td style="text-align: center;">+</td> <td></td> <td style="text-align: center;">Insertion Loss Factors (dB)</td> <td></td> <td style="text-align: center;">@ 3 meters</td> </tr> </table>			Measured Value (dB μV)	+	Field Strength (dB $\mu\text{V}/\text{m}$) =	Active Antenna Factor (dB/m)	=	52.26 dB $\mu\text{V}/\text{m}$		+		Insertion Loss Factors (dB)		@ 3 meters
Measured Value (dB μV)	+	Field Strength (dB $\mu\text{V}/\text{m}$) =	Active Antenna Factor (dB/m)	=	52.26 dB $\mu\text{V}/\text{m}$									
	+		Insertion Loss Factors (dB)		@ 3 meters									
FCC Part 15 Field Strength Limit @ 3 meters =		54 dB $\mu\text{V}/\text{m}$												
Limit Δ (margin) =		-1.74 dB												

5.3 **NON-ACTIVE-Rx CONFIGURATION**

Illustrated in Figure 10 is the AHA-840 Active Double Ridge Horn Antenna in its NON-ACTIVE-Rx configuration. As shown, there is no connection to the preamplifier input/output ports. Illustrated in Figure 11 is a typical measurement system arrangement for this antenna configuration, with the antenna port connected directly to the input port of the measuring instrument (usually located in a separate, nearby area) using a coaxial cable of sufficient length.

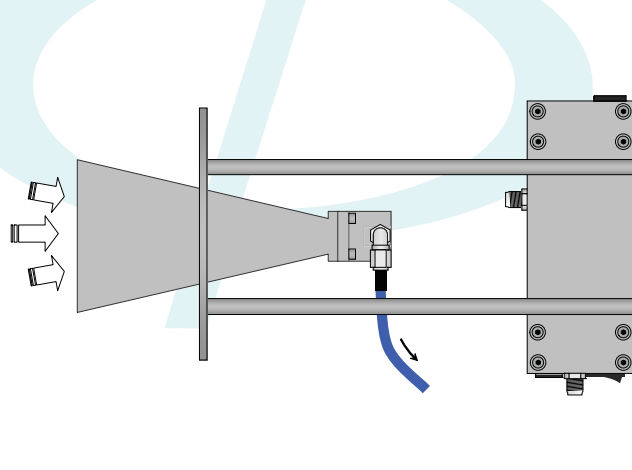


FIGURE 10 - AHA-840 – NON-ACTIVE-Rx Configuration

This configuration is used in situations where:

- no preamplification is needed; or,
- the internal preamplifier of the measuring instrument is used instead of using external preamplification.

NOTE: THE **NON-ACTIVE** ANTENNA FACTORS MUST BE APPLIED FOR MEASUREMENTS MADE IN THIS CONFIGURATION. SEE SECTION 5.3.1.

5.3.1 Field Strength Measurement Calculations

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

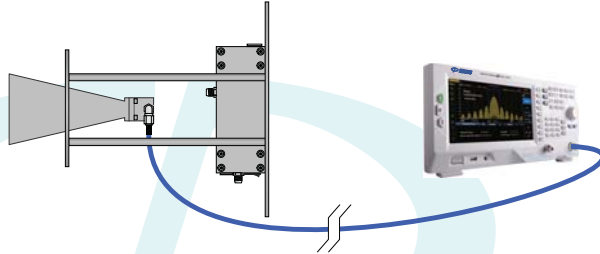


FIGURE 11 - Typical setup for NON-ACTIVE-Rx mode

Let's go through one exercise of converting an uncorrected voltage measurement into an actual field strength value for comparison to the FCC Part 15 Limit of $500 \mu\text{V}/\text{m}$ ($54 \text{ dB}\mu\text{V}/\text{m}$) using the following example.

EXAMPLE:

We'll use the measurement system shown in Figure 11, and assume a 3-meter separation distance between the source and the antenna. We observe a signal at 20 GHz using the spectrum analyzer, and its [uncorrected] amplitude is $0.65 \text{ dB}\mu\text{V}$.

For the system shown above, there are two (2) correction factors needed:

- 1) The AHA-840 NON-ACTIVE Antenna Factor
- 2) The Insertion Loss Factor for the long cable connecting the AHA-840 to the measuring instrument

NOTE: The measuring instrument will automatically account for the gain factor of its internal preamplifier, when it is in use.

We'll assume that the insertion loss of the cable at 20 GHz is 15 dB. And, by referring to the typical antenna factor tables in Section 8, we see that the NON-ACTIVE Antenna Factor for the AHA-840 is $36.61 \text{ dB}/\text{m}$ (you'll use the actual factor in practice). So our calculation will be as follows:

Measured amplitude @ 20 GHz,	0.65 dBμV
with a 3-meter separation distance =	
Non-Active Antenna Factor @ 20 GHz =	36.61 dB/m
Insertion Loss of Long Coaxial Cable @ 20 GHz =	15 dB
Field Strength (dBμV/m) =	52.26 dBμV/m
	@ 3 meters
FCC Part 15 Field Strength Limit @ 3 meters =	54 dBμV/m
Limit Δ (margin) =	-1.74 dB

5.4 NON-ACTIVE-Tx CONFIGURATION

Illustrated in Figure 12 is the AHA-840 Active Double Ridge Horn Antenna in its NON-ACTIVE-Tx configuration. As shown, there is no connection to the preamplifier input/output ports. Illustrated in Figure 13 is a typical measurement 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 application.

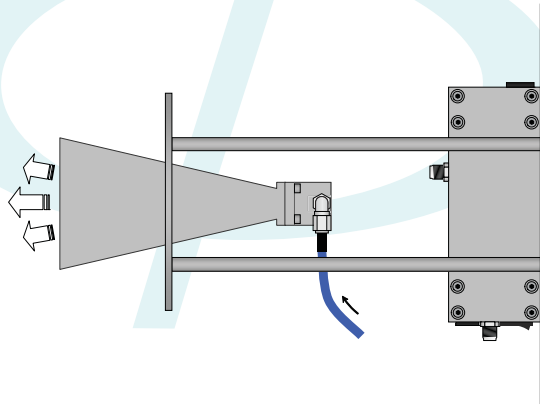


FIGURE 12 - AHA-840 - ACTIVE-Rx (Std) Configuration

In this configuration, the AHA-840 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 shown in section 5.4.1.

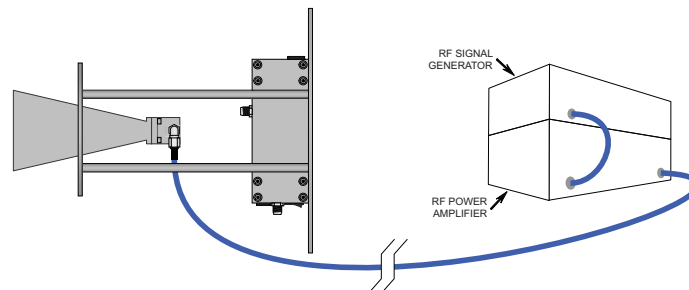


FIGURE 13 - Typical test setup for ACTIVE-Tx Configuration

5.4.1 Field Strength Calculations

The graph shown in Figure 14 shows the calculated maximum field strengths (based on typical gain factors) able to be achieved with the AHA-840 at 1-meter and 3-meter distances with input levels of 10 and 200 watts.

The waveguide to coaxial adapter has a power limit of 10 watts. For power levels in excess of 10 watts, the waveguide to coaxial adapter can be removed, and the antenna flange waveguide can be directly connected to a power amplifier equipped with a WRD180C24 waveguide output connection.

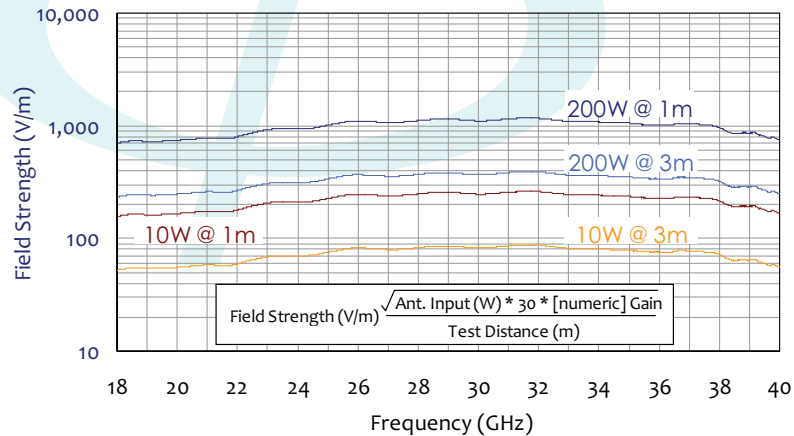


FIGURE 14 - Radiated field strength with 10W & 200W input power

The graph shown in Figure 15 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.

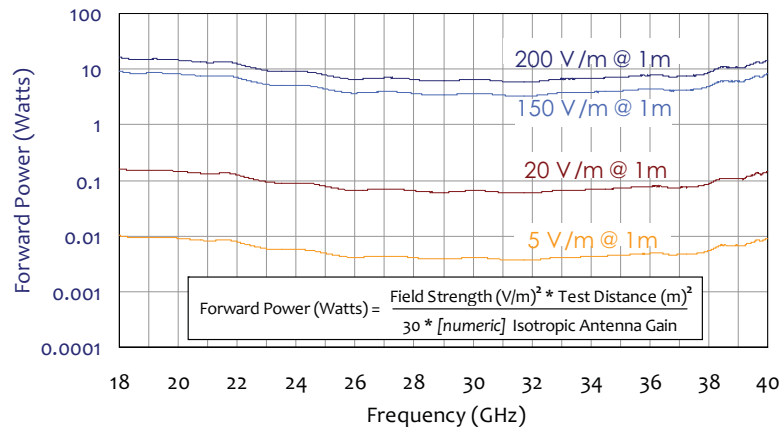


FIGURE 15 - Power requirements for various fields strengths/distances

6.0 Calibration and Re-Calibration

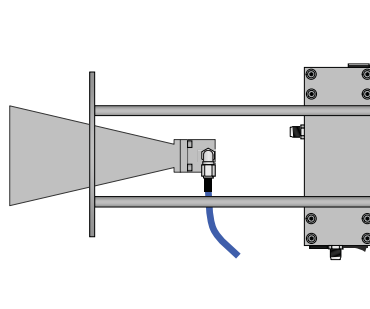
Your AHA-840 Active Double Ridge Horn Antenna has been individually calibrated for both *ACTIVE* and *NON-ACTIVE* configurations, and the data has been provided.

Periodic re-calibration of your AHA-840 is recommended. 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; however, if you choose another vendor to perform the calibration of your AHA-840, or if the calibration is to be performed in-house, we *highly recommend* the following approach in order to ensure the accuracy of the factors, as well as your measurement results when the factors are used during testing:

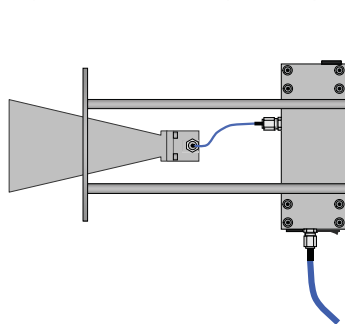
PERFORM TWO SEPARATE ANTENNA CALIBRATIONS AS FOLLOWS:

- 1) Perform calibration in the *NON-ACTIVE* mode (shown below), as would be done for any standard, passive horn antenna;



and additionally,

- 2) Perform a separate calibration in *ACTIVE* mode (shown below) with the coaxial jumper cable in place and the preamplifier turned on.



By calibrating the *ACTIVE* mode as a system, rather than calibrating the antenna, cable and preamplifier individually, any mismatches that occur between components are accounted for in the antenna factor. This system level approach yields much more accurate results (factors) than those achieved through individual calibration of the components.

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 shipped 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.

If you feel that the product is not working as intended, or is malfunctioning, please contact Com-Power for assistance. If the product must be returned to Com-Power, a Return Merchandise Authorization (RMA) number will be supplied to you. 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.

8.0 Typical Performance Data



E-Field Antenna Factors (AFE)
ACTIVE mode

Equipment:		Active Double Ridge Horn Antenna (ACTIVE mode - with Preamp)			
Model:		AHA-840			
Serial Number:		xxxxxxx			
Calibration Date:		xx-xx-xxxx			
Antenna Polarization:		Horizontal			
Calibration Distance:		3 meter(s)			
Frequency (GHz)	Isotropic Gain (dBi)	Active AFE (dB/m)	Frequency (GHz)	Isotropic Gain (dBi)	Active AFE (dB/m)
18	54.59	0.73	29.5	62.61	-3.00
18.5	55.80	-0.25	30	62.33	-2.58
19	57.26	-1.48	30.5	62.00	-2.11
19.5	58.48	-2.47	31	61.57	-1.53
20	58.97	-2.74	31.5	61.78	-1.61
20.5	59.14	-2.70	32	62.33	-2.01
21	60.01	-3.36	32.5	62.64	-2.20
21.5	60.70	-3.84	33	62.77	-2.19
22	61.25	-4.19	33.5	62.78	-2.07
22.5	61.07	-3.82	34	62.49	-1.65
23	61.37	-3.93	34.5	62.93	-1.97
23.5	61.71	-4.08	35	62.35	-1.26
24	62.09	-4.28	35.5	62.46	-1.25
24.5	62.46	-4.47	36	63.00	-1.67
25	62.30	-4.13	36.5	63.19	-1.74
25.5	62.09	-3.75	37	63.36	-1.79
26	61.95	-3.44	37.5	63.53	-1.84
26.5	62.38	-3.70	38	61.27	0.53
27	62.32	-3.48	38.5	59.04	2.88
27.5	61.96	-2.97	39	59.74	2.29
28	61.67	-2.52	39.5	60.62	1.52
28.5	61.94	-2.63	40	60.59	1.66
29	62.12	-2.67			

Calibration performed per:
 ANSI C63.5: 2006

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

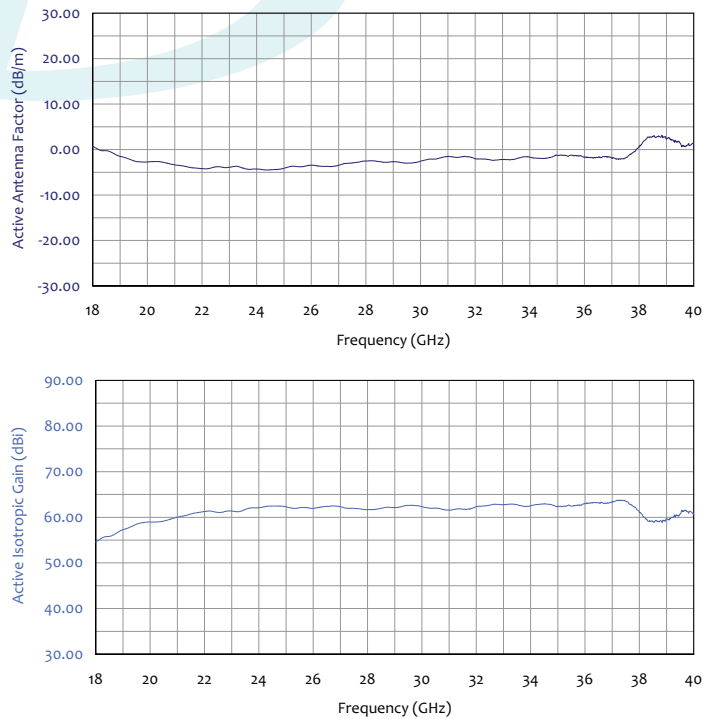


FIGURE 16 - Typical ACTIVE Antenna Factors/Gain Values

COM-POWER CORPORATION
E-Field Antenna Factors (AFE)
NON-ACTIVE mode

Equipment:		Active Double Ridge Horn Antenna (NON-ACTIVE mode - Preamp Bypassed)			
Mode:		AHA-840			
Serial Number:		xxxxxxx			
Calibration Date:		xx-xx-xxxx			
Antenna Polarization:		Horizontal			
Calibration Distance:		3 meter(s)			
Frequency (GHz)	Isotropic Gain (dBi)	Non-Active AFE (dB/m)	Frequency (GHz)	Isotropic Gain (dBi)	Non-Active AFE (dB/m)
18	17.97	37.35	29.5	23.26	36.34
18.5	18.52	37.03	30	23.28	36.47
19	19.13	36.65	30.5	23.37	36.52
19.5	19.67	36.34	31	22.74	37.30
20	19.62	36.61	31.5	22.76	37.41
20.5	19.26	37.18	32	22.72	37.59
21	19.83	36.82	32.5	22.64	37.81
21.5	20.40	36.46	33	22.42	38.16
22	20.90	36.15	33.5	22.34	38.37
22.5	20.71	36.55	34	21.81	39.02
23	20.93	36.51	34.5	22.03	38.94
23.5	21.09	36.54	35	21.32	39.77
24	21.40	36.41	35.5	21.36	39.85
24.5	21.80	36.19	36	21.72	39.62
25	21.78	36.39	36.5	21.41	40.04
25.5	21.82	36.51	37	20.95	40.62
26	21.92	36.58	37.5	21.37	40.32
26.5	22.61	36.07	38	20.34	41.46
27	23.01	35.83	38.5	19.28	42.64
27.5	22.87	36.12	39	19.54	42.49
28	22.59	36.57	39.5	19.01	43.13
28.5	22.60	36.70	40	18.14	44.11
29	22.76	36.69			

Calibration performed per:
ANSI C63.5: 2006

Corrected Reading (dBμV/m) = Meter Reading (dBμV) + Non-Active AFE(dB/m)

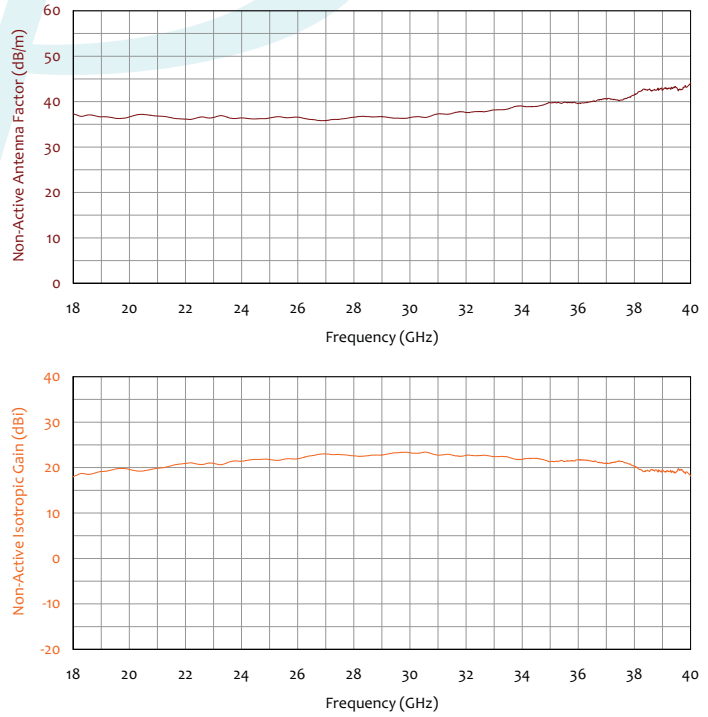


FIGURE 17 - Typical NON-ACTIVE Antenna Factors/Gain Values

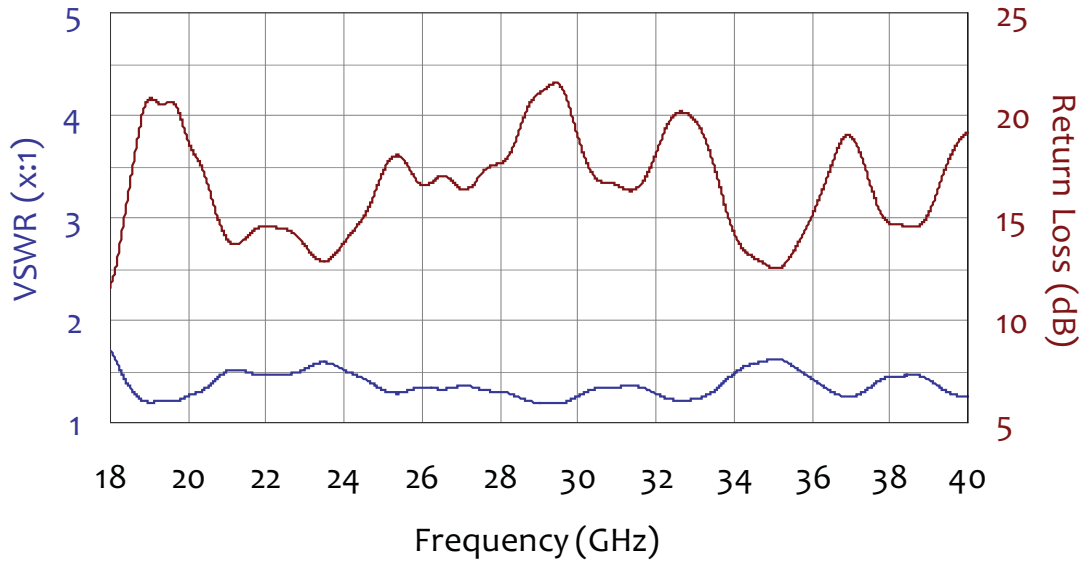


FIGURE 18 - Typical VSWR/Return Loss at Coaxial Antenna Port

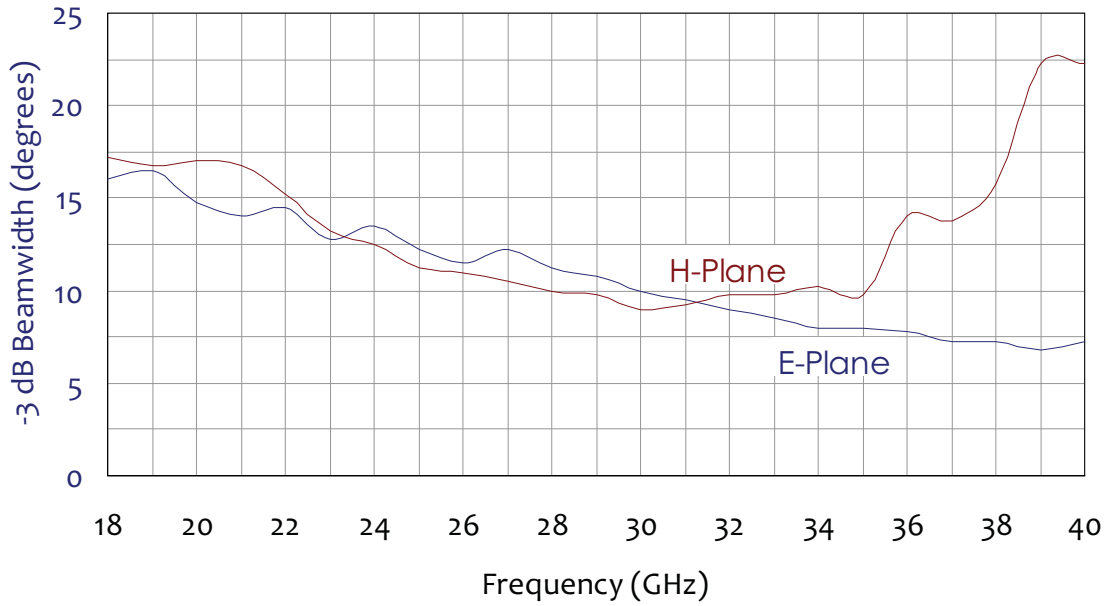


FIGURE 19 - Typical -3 dB Beamwidth