Model 3140

BiConiLog™ Antenna

MANUAL

ETS·LINDGREN™
An ESCO Technologies Company

REV C – PN 399258

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INTRODUCTION

The ETS-Lindgren EMCO brand Model 3140 is a high-field addition to the popular bow-tie/log periodic combination BiConiLog™ family, providing the highest field-to-power ratio at low frequencies of any of the BiConiLog™ antennas. The Model 3140 is designed specifically to generate the field levels required for immunity/susceptibility tests required by standards such as IEC/EN 61000-4-3 using the lowest amount of input power possible.

A BiConiLog™ antenna combines a broadband biconical-like bow-tie antenna with a standard LPDA (log periodic dipole array) to replace the traditional use of two antennas in the 26-1000 MHz EMC test frequency range. Many EMC antennas are variations of a standard tuned dipole, which must be nearly half a wavelength long to transmit or receive energy most efficiently. Thus, at 26 MHz, a tuned dipole would have to be approximately 5.3 meters long, about 4.6 meters long at 30 MHz, and 2.8 meters long at 50 MHz. Unfortunately, this is too unwieldy for many anechoic chambers and test sites. The end plates of the Model 3140 T bow-ties make the bow-tie antenna segment look like an antenna twice as long as its 1.6 meter length. The result is about a 10-dB improvement in low frequency transmit gain compared to a same-length regular bow-tie.

Although bow-ties have been used for all of the elements on some log-periodic antenna designs in the past, in EMC applications the advantage gained is an extension of the

useful low frequency range of the typical LPDA's from 100 MHz down to 26 MHz. At 26 MHz, an efficient single dipole type antenna must be over 5 meters long, whereas suitable performance is obtained here with a 1.6 meter long bow-tie. A simple wire outline bow-tie antenna is narrowband compared to a sheet bow-tie or biconical, thus struts are added to the Model 3140 bow-ties to better simulate the broadband sheet bow-tie.

The unique feature of the Model 3140 is the T bow-tie elements. A T bow-tie increases the equivalent dipole electrical length, thereby decreasing resonant frequency and increasing efficiency in the 20-60 MHz range. Similarly, a regular bow-tie has a lower resonant frequency than an equal length single-wire dipole. The T bow-tie has its first resonance at a frequency where its length is about 0.22λ, a regular bow-tie at a length of 0.3λ, and a tuned dipole at about a length of 0.48λ. Thus at 50 MHz the 1.4 m long T bow-tie of the Model 3140 behaves like a 2.8 m tuned dipole. Cross-polar radiation is minimized because current flow on one of the T end frames is almost exactly cancelled by the oppositely-phased current on the other T end.

The standard "self-balun" feed of the log-periodic also provides a matched balanced feed to the bow-tie elements. To prevent cable pickup below 100 MHz, and to improve matching to the bow-tie elements, the Model 3140 contains a "balun" transformer which acts as a common-mode choke to keep unbalanced current off the coaxial feed cable outer shield, as well as adding some additional inductance to

improve impedance matching to the bow-ties. Even though the Model 3140 is highly balanced (symmetry +/- 0.5 dB), in vertically polarized measurements cable position can effect results, so it is recommended that the cable be suspended horizontally back from the antenna at least 1 meter before any vertical drop. Below 150 MHz, bow-tie radiation dominates with a dipole-like pattern, while above 150 MHz the radiation in the plane of the elements is directional.

The antenna has dual mounting bracket and 1/4x20 UNC knob for attaching to ETS-Lindgren tripod and tower adapters. The brackets are spaced to align with the mounting holes on the Model 7-TR tripod and the ETS-Lindgren towers. Typical antenna factor data is included in Figure 11.

Note: The Model 3140 is designed only for immunity testing. The large size of the antenna makes it impractical for emissions testing where height scanning is required, and the bow-tie end plates increase the measurement uncertainty when the antenna is polarized vertically. Thus, individual calibrations are not provided for the Model 3140.

ASSEMBLY INSTRUCTIONS

The Model 3140 Antenna consists of the following (shipped unassembled):

1 ea. Boom Assembly
2 ea. Bow-tie Elements
2 ea. Long T leg Elements
2 ea. V Elements
4 ea. Diagonal Struts
2 ea. Boom adapters for ETS booms with 7/8" mount holes
2 ea. Thread inserts 7/8" to ¼"

Step 1. Attach a bow-tie element to the antenna balun box (see Figure 1). The bow-tie should be standing vertical and the antenna held horizontal and attached to it using the hand screw knob. Supporting the antenna during the assembly process will eliminate stress at the connection of the balun box and prevent damage to the connection.

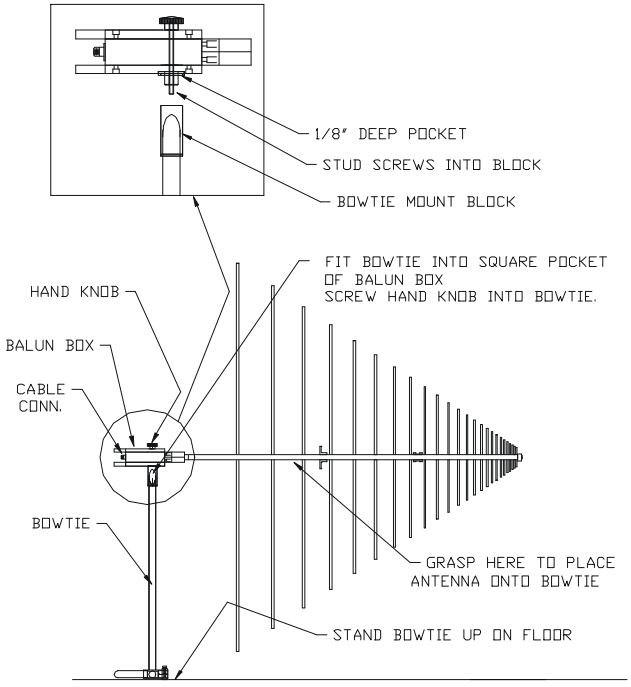

FIGURE 1 – Assembly Step 1

Step 2. Once you have attached both bow-tie elements; with both hands, rotate the antenna and bow-tie into a vertical position resting on a flat surface (see Figure 2). The antenna can now rest by itself on the feet of the balun box, and the bottom edge of the bow-tie elements.

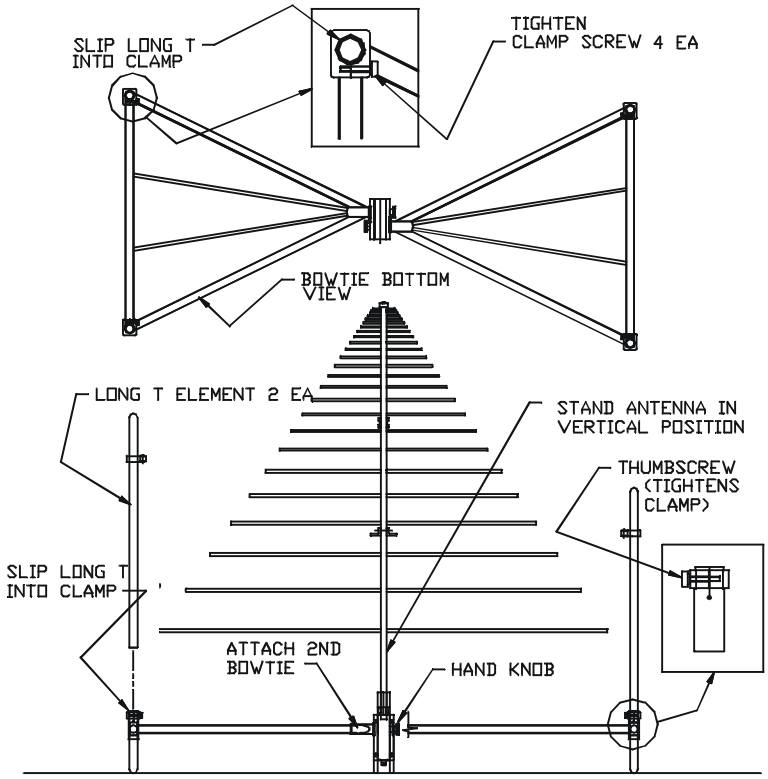

FIGURE 2 - Assembly Steps 2 through 4

Step 3. Attach the other bow-tie element to the antenna balun box (see Figure 2). The antenna should rest on the balun end and stand vertically to attach the 2nd bow-tie with the opposite hand knob.

Step 4. The long T leg elements are installed and clamped to the bow-ties (Figure 2) with the antenna standing vertical.

Step 5. The four diagonal struts should be installed. Loosen the thumbscrews at the mount on the T legs and at the boom mounts to install the strut ends. Place the pocket of the straight end facing the raised face of each mount and tighten the thumbscrew to lock in place (see Figure 3).

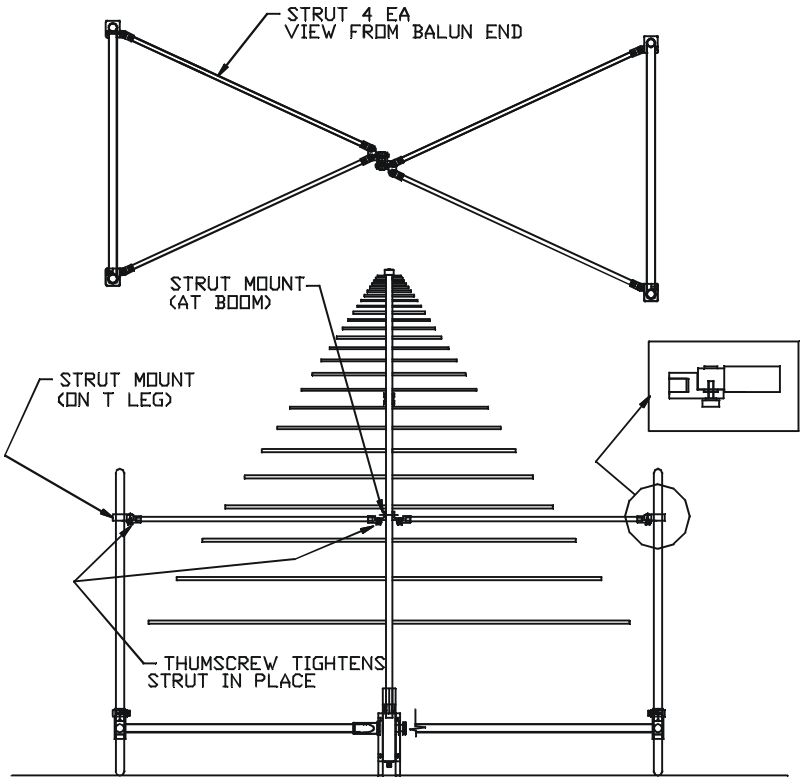

FIGURE 3 – Assembly Step 5

Step 6. The V elements should be installed and tightened using the thumbscrews through the boom (see Figure 4).

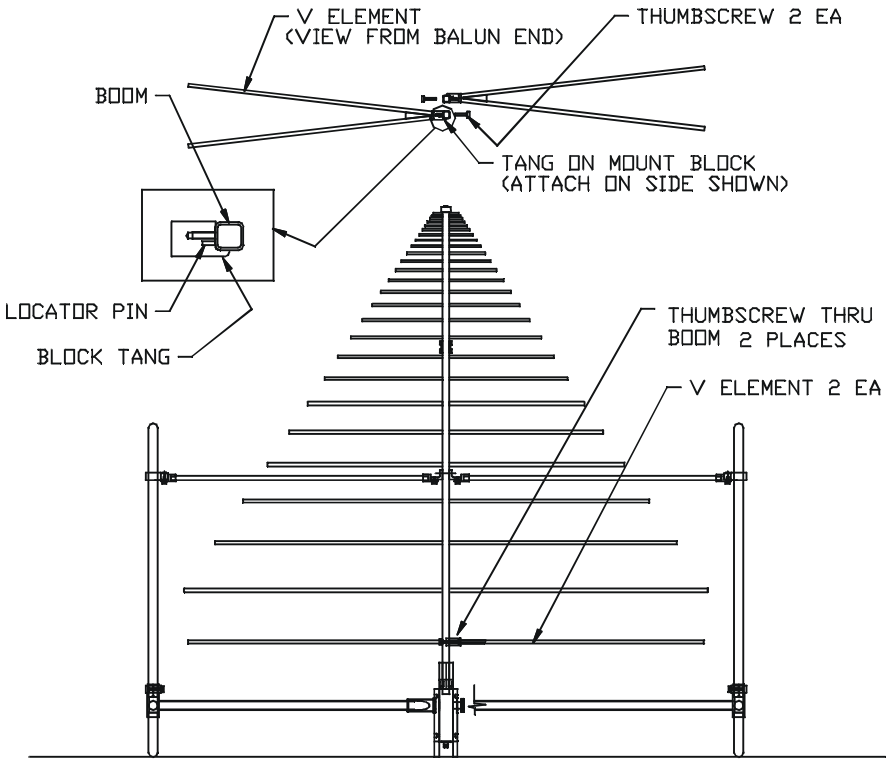

FIGURE 4 – Assembly Step 6

The antenna is now ready for mounting on a boom of a stand such as the ETS-Lindgren 7-TR or mast such as the ETS-Lindgren 2070 series. See the next section "Mounting Instructions" for more details.

MOUNTING INSTRUCTIONS

The Model 3140 boom has dual mounting brackets that are spaced 8" on center. The dual mounts make the Model 3140 very stable on a boom when polarizing and moving up and down a mast.

Step 1. Install the antenna adapters onto the two mount brackets on the antenna boom (see Figure 5). These have a 7/8" threaded hole for an ETS-Lindgren mount knob. Install the threaded insert adapter into the 7/8" hole if a ¼" thread is required on the mounting stand or mast.

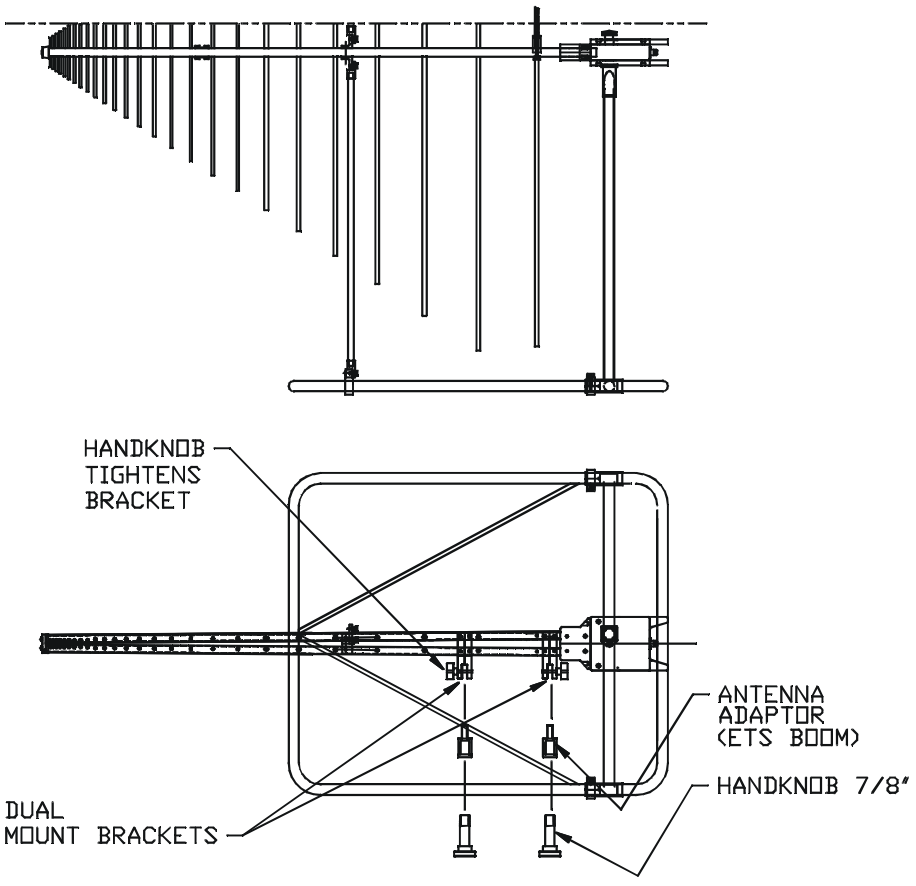

FIGURE 5 – Attachment of antenna mount adapters to Model 3140

Step 2. The antenna can be mounted on standard ETS-Lindgren perforated cross booms using two 7/8" mount knobs through the 2" square boom (see Figure 6).

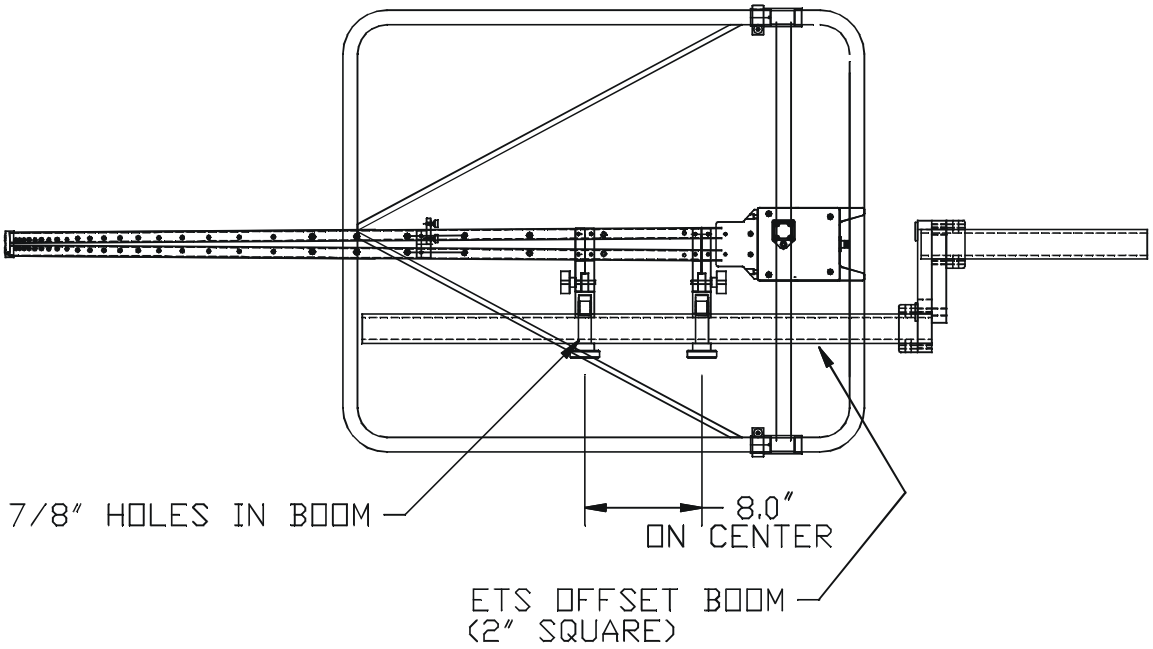

FIGURE 6 – Attachment of Model 3140 to perforated offset boom.

The antenna can be mounted to the 2" square booms of the following ETS-Lindgren products:

Model 7-TR tripod stand (see Figure 7),
Model 2075 MiniMast tower (see Figure 8),
and Model 2070/2071 towers (see Figure 9).

For other 2" square booms, two slip-on boom brackets that do not require through holes in the boom can be used to mount the antenna.

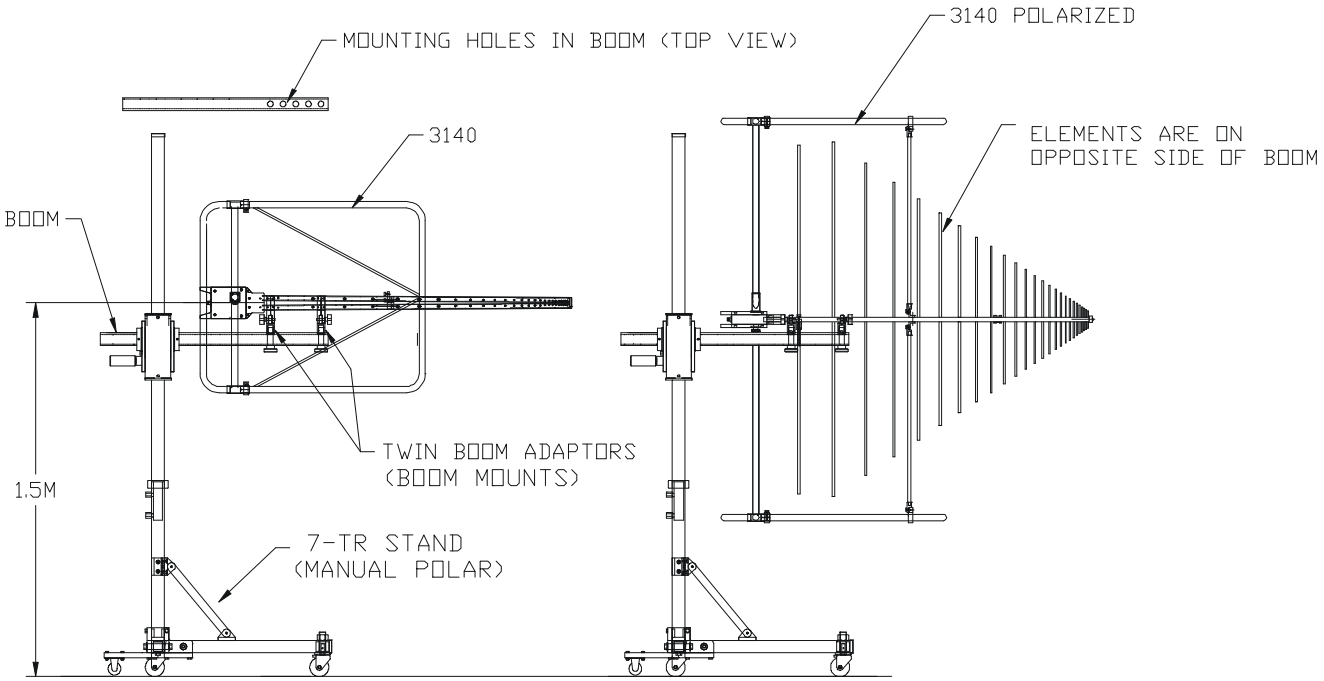

FIGURE 7 – Attachment of Model 3140 to Model 7-TR heavy duty antenna stand

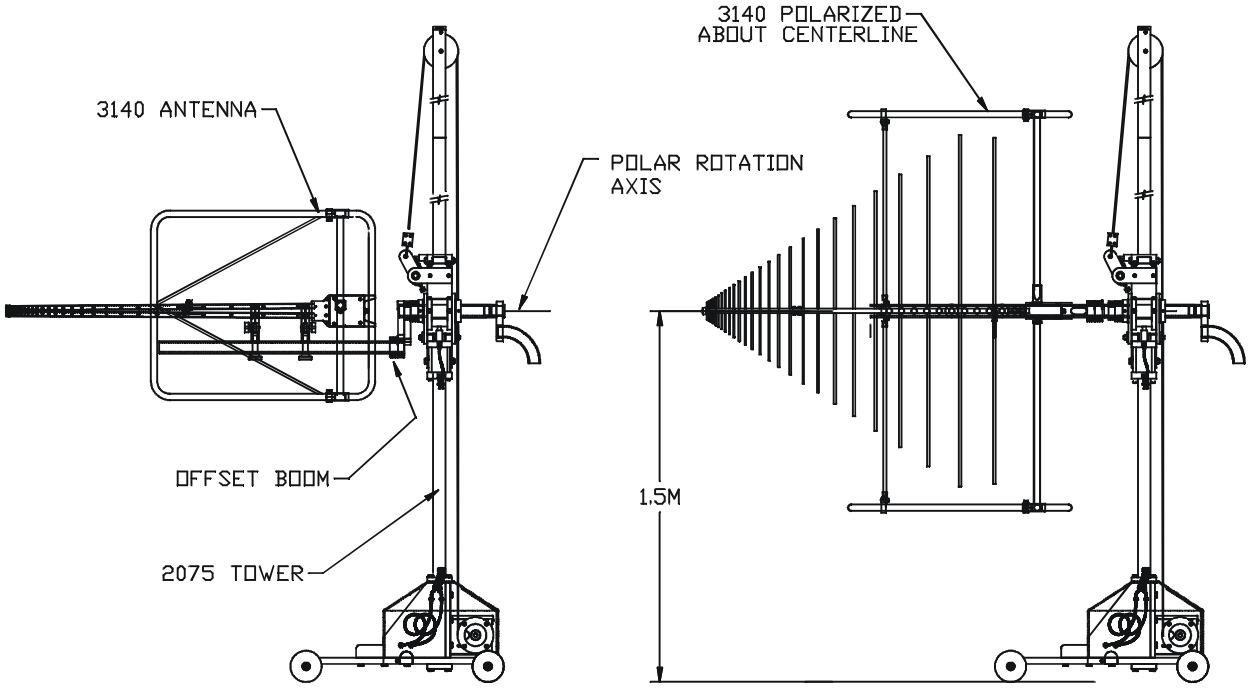

FIGURE 8 – Attachment of Model 3140 to Model 2075 MiniMast

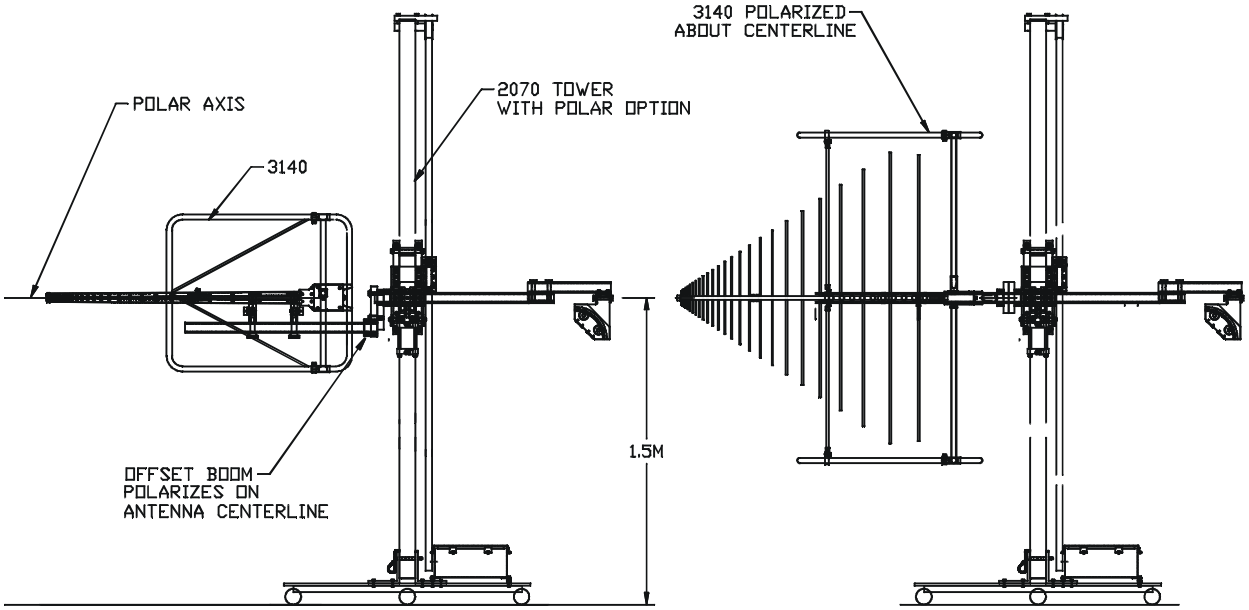

FIGURE 9 – Attachment of Model 3140 to Model 2070 or 2071 Tower

APPLICATION

Assemble and mount the Model 3140 per the instructions in the previous sections. Connect an N-type coaxial cable from the antenna connector to a signal generator or amplifier. Contact with any metal or non-metallic structure can capacitively load the antenna, which may cause unrepeatable results. Therefore, care must be taken to ensure that no part of the dipole elements or bow-ties are in contact with the tripod or tower, particularly in vertically-polarized tests. Where possible, run the feed cable straight back at least 1 meter or more from the Model 3140 before dropping vertically.

Both horizontal and vertical polarization is easily accomplished when the Model 3140 is mounted on an ETS-Lindgren tower. The Model 7-TR tripod is designed specifically for the T bow-tie BiConiLog™ antennas to allow easy polarization changes, and with the air polarization option can provide automated polarization using a Model 2090 controller. The previous section "Mounting Instructions" shows the mounting scheme for both ETS-Lindgren towers and the 7-TR tripod.

For immunity testing, the electric field strength generated at a distance *d* can be approximated by the formula

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

where *d* is in meters, *g* is the numeric gain ($10^{G[\mathrm{dB}]/10}$, see attached calibration data), and *P* is antenna net input power in Watts. An estimate of the power required for any

field strength *E* can be obtained from Figure 12 or 13 in the Typical Data section below, which shows forward power required in Watts to generate 1 V/m. Note that while the formula provided above is based on the net power (forward minus reflected) transmitted by the antenna, the gain determined from the antenna factor already contains effects due to mismatch, so the formula then predicts the required forward power rather than net power. To determine the power (in Watts) required for any other field strength not shown, multiply the power required for 1 V/m by the desired *E*-field squared, or

$$P(E \text{ V/m}) = E^2 P(1 \text{ V/m})$$

To determine the additional amplifier overhead required to handle 80% amplitude modulation, multiply the result by 3.24 (1.8^2). Actual transmitted field strength should be verified using an ETS-Lindgren Model 7200 series electric field probe or equivalent. Figures 14 and 15 show power requirements for the lower frequencies at 3 meters based on measurements using a field probe on an OATS over both conducting ground and a $(2.4\text{m})^2$ ferrite absorber field over conducting ground. For IEC 1000-4-3 type testing, the antenna tip can be placed at any distance between 1 and 3 meters from the EUT as long as the front face plane is illuminated according to the -0, +6 dB uniform field specification. In general, closer distances require less power to create a given field strength.

TYPICAL DATA

Figure 10 shows the typical VSWR for the Model 3140 in the frequency range from 26-2000 MHz. Figure 11 shows the typical horizontal antenna factors for the 3140 in the same range. The separation distance for the ANSI C63.5 3 and 10 meter calibrations is measured from the antenna midpoint, while for SAE/ARP-958 1 meter calibrations the distance is measured from the antenna tip. Midpoint is defined as half the distance between the small elements and the bow-ties, which is about 65 cm from the small end tip. Figure 12 shows the typical forward power required for 1, 3, and 10 V/m (with and without 80% amplitude modulation) at 1 meter from the tip of the antenna, while Figure 13 is for 3 meters from the antenna tip. Figures 14 and 15 show power requirements for the lower frequencies at 3 meters based on measurements using a field probe on an OATS over both conducting ground and a $(2.4m)^2$ ferrite absorber field over conducting ground. The power shown was measured with 1.5 meter transmit antenna and probe height and horizontal polarization. Horizontal polarization represents the worst-case power requirement; typically less power is required for vertical polarization. In practice, many users place ferrite tiles on the ground between the antenna and probe to reduce reflected-ray interference. For any other field strength E, multiply the power in Watts for 1 V/m by E^2.

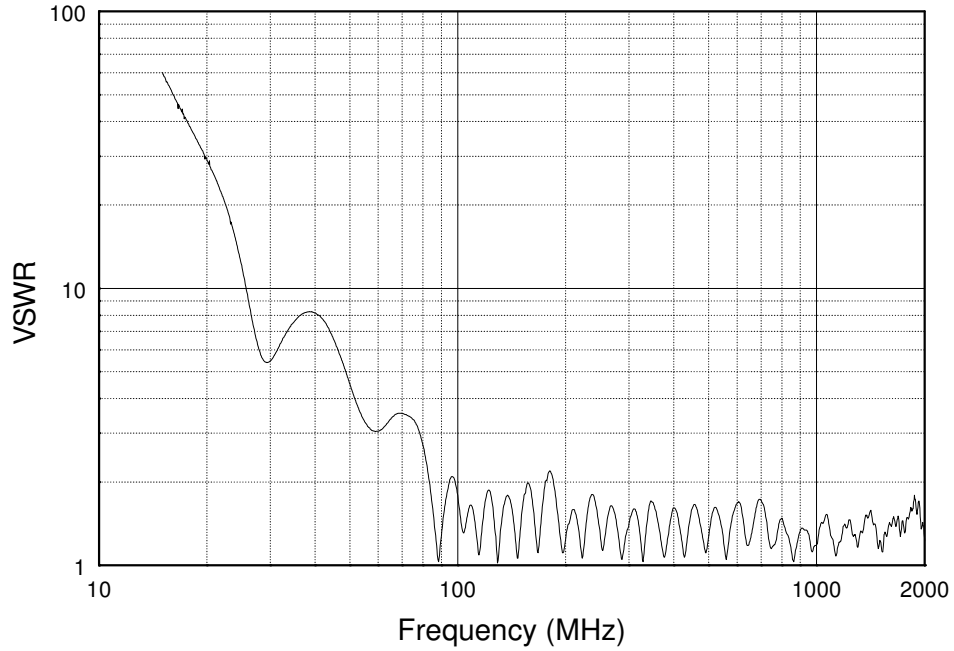

FIGURE 10 - Model 3140 typical VSWR.

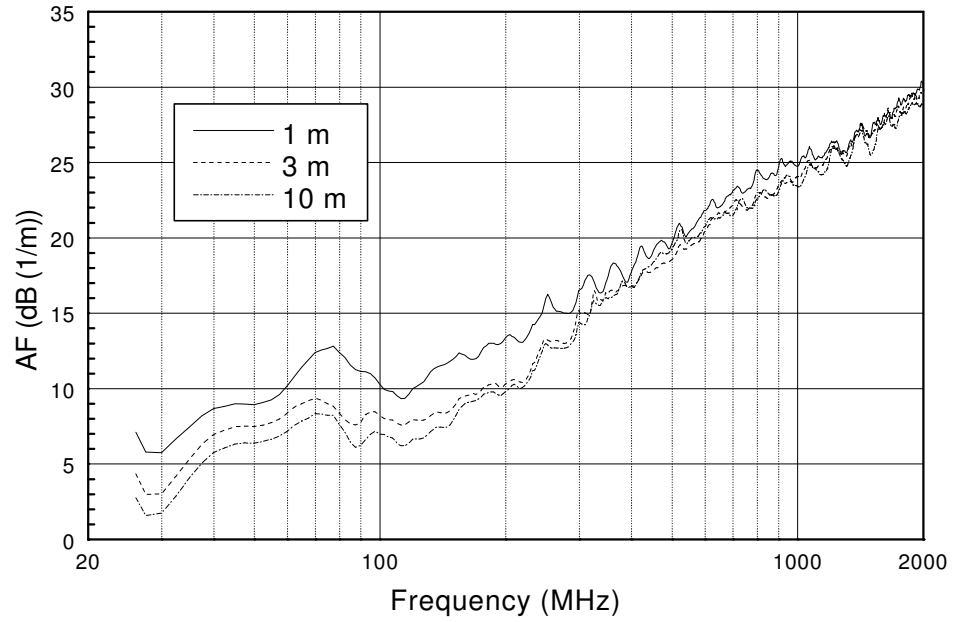

FIGURE 11 – Model 3140 typical antenna factors.

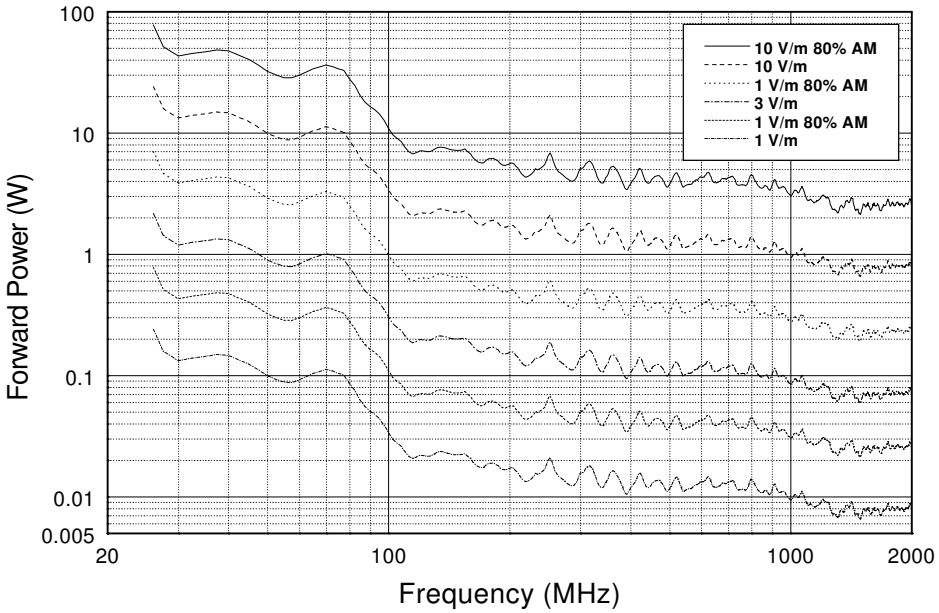

FIGURE 12 – Model 3140 typical 1 meter forward power based on 1 meter antenna factor.

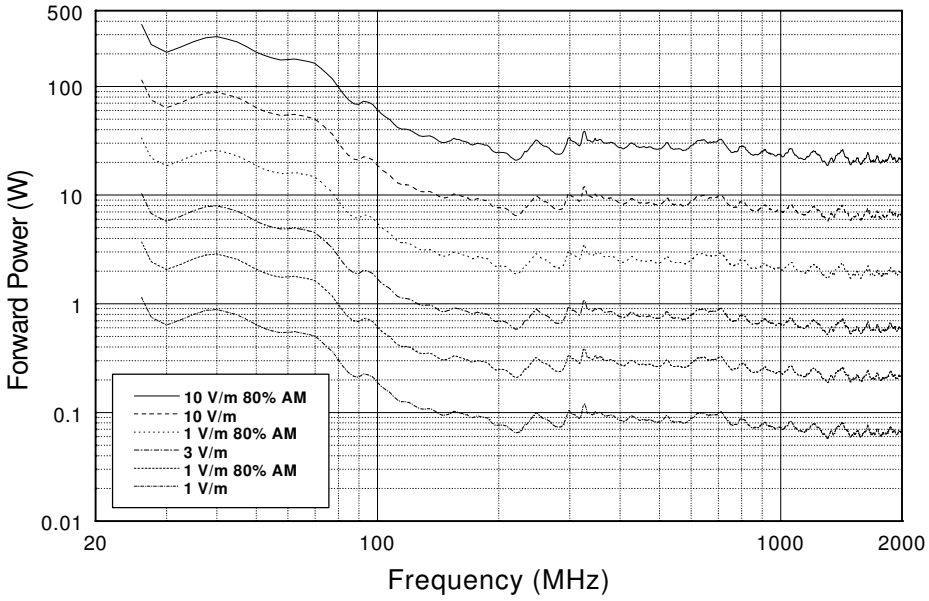

FIGURE 13– Model 3140 typical 3 meter forward power based on 3 meter antenna factor.

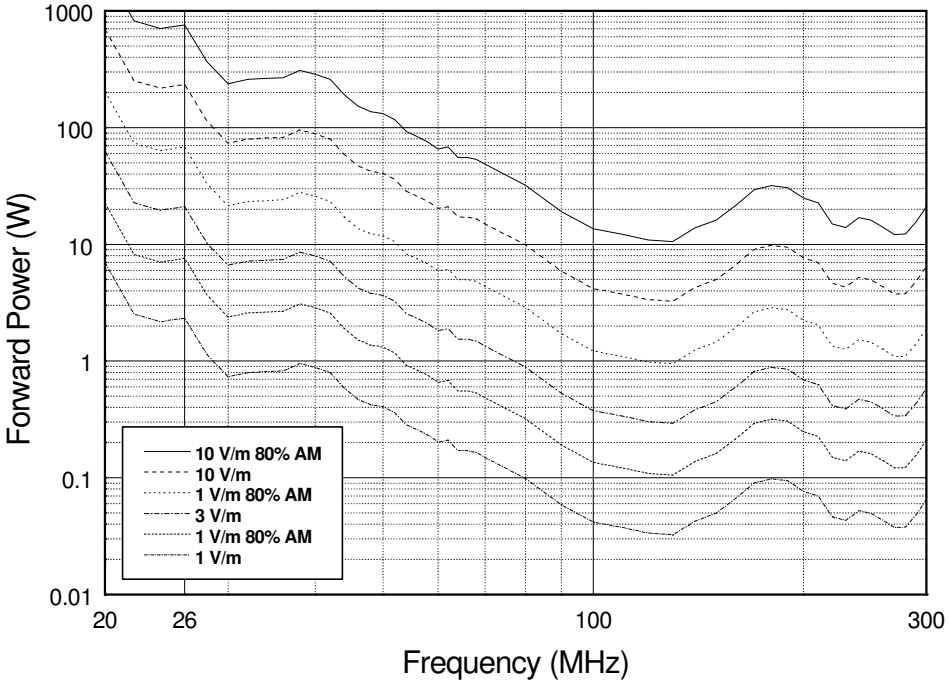

FIGURE 14 – Model 3140 typical 3 meter forward power measured over ferrite tile.

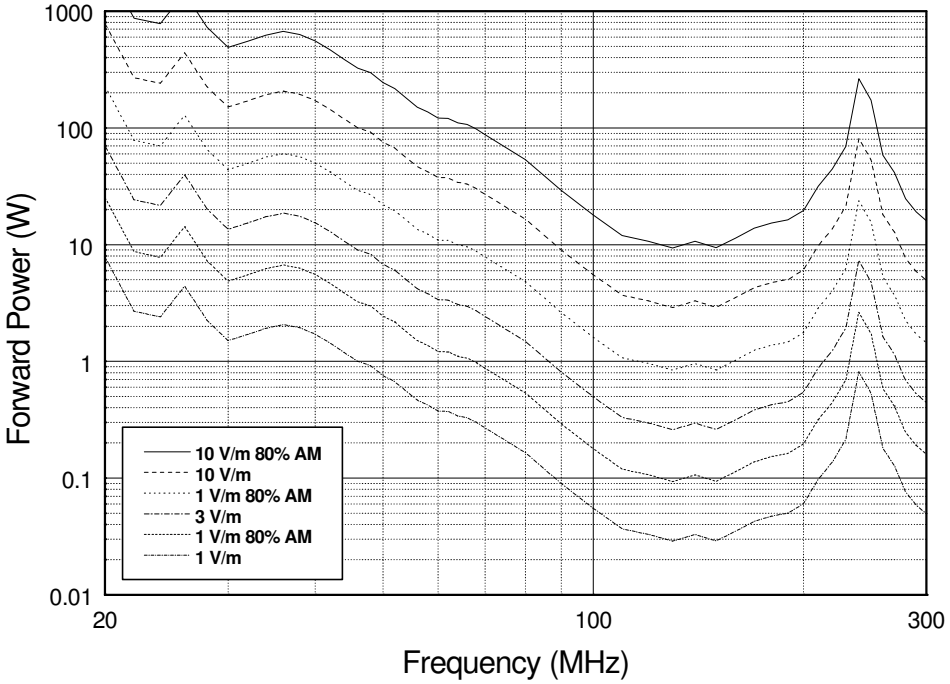

FIGURE 15 – Model 3140 typical 3 meter forward power measured over conducting ground.

SPECIFICATIONS

Electrical (nominal)

Frequency range	26 - 2000 MHz
Input impedance	50 Ω
VSWR	2:1 average
CW power	750 W
Symmetry	+/- 0.5 dB
Connector	Type N female

Physical

Height (T bow-tie)	76.65 cm 30.18 in
Width (T bow-tie)	161.5 cm 63.60 in
Depth (length)	149.3 cm 58.78 in
Weight	10 kg 22 lbs

MAINTENANCE

The ETS-Lindgren EMCO brand Model 3140 was designed to be used for Immunity testing. Because the testing is for immunity, the generated field is measured with a calibrated field probe, not the Model 3140. Thus it is not required that the Model 3140 be recalibrated regularly. If you would like to have your Model 3140 antenna verified or serviced please contact our Calibration Department.

For more information about our calibration services or to place an order for antenna calibration, visit our calibration website at http://antennacalibration.com/

WARRANTY STATEMENT

EMC Test Systems, L.P., hereinafter referred to as the Seller, warrants that standard EMCO products are free from defect in materials and workmanship for a period of two (2) years from date of shipment. Standard EMCO Products include the following:

- Antennas, Loops, Horns
- GTEM cells, TEM cells, Helmholtz Coils
- LISNs, PLISNs, Rejection cavities & Networks
- Towers, Turntables, Tripods & Controllers
- Field Probes, Current Probes, Injection Probes

If the Buyer notifies the Seller of a defect within the warranty period, the Seller will, at the Seller's option, either repair and/or replace those products that prove to be defective.

There will be no charge for warranty services performed at the location the Seller designates. The Buyer must, however, prepay inbound shipping costs and any duties or taxes. The Seller will pay outbound shipping cost for a carrier of the Seller's choice, exclusive of any duties or taxes. If the Seller determines that warranty service can only be performed at the Buyer's location, the Buyer will not be charged for the Seller's travel related costs.

This warranty does not apply to:

- Normal wear and tear of materials
- Consumable items such as fuses, batteries, etc.
- Products that have been improperly installed, maintained or used
- Products which have been operated outside the specifications
- Products which have been modified without authorization
- Calibration of products, unless necessitated by defects

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Note: Please contact the Seller's sales department for a Return Materials Authorization (RMA) number before shipping equipment to us.