

LWA Memo 225: LWA Antenna Field Assembly Instructions Ver. 2

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Introduction

This memo is to serve as a guide to Long Wavelength Array antenna construction in the field and is an adapted version based upon *Complete Guide to Antenna Assembly LWA Engineering Memo ARR0005 (2011)*, *Field Manual for LWA Deployment (2015)*, and LWA-North Arm construction. This document is arranged such that antennas can be build with as few as 2 people, or broken up into many small groups in an assembly-line fashion with each team having their own set of instructions. A few prerequisite tasks are assumed to have been already completed which are shown below. The resulting site should have cabled antenna masts ready to be fully constructed following the order of build phases or document chapters equivalently.

Prerequisite Tasks

- LWA Site Survey
- Installation of Oz-Posts, Masts, and Junction Boxes
- Trenching of Array
- Laying of cable and conduit for each antenna
- Backfilling of trenches (can be done in tandem with antenna construction)

Build Phases (Table of Contents)

1. Ground Screen Fabrication
2. Fiberglass Support Assembly

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3. Hub and Antenna Arm Installation
4. Final Antenna Alignment
5. Front End Electronics Installation

1 Ground Screen

People Required: 2

Tools Required	Materials Required
Medium Gauge Wire Cutter Tape Measure Nicopress	Bulk Roll of Ground Screen (4"x4" S.S. Mesh Fencing) Tent Stakes S.S. Nicopress sleeves

Procedure:

1. Unroll 10 ft. of ground screen material and cut it off using the wire cutters to form one half of the ground screen (approximately 30 squares worth for 4 in. mesh).
2. Find the approximate center of the ground screen section using either a tape measure at 5 ft. or by counting 15 mesh squares from one end.
3. Make two cuts on both sides of a wire running the *width* of the ground screen section using wire cutters. Then fold each of the three cut ends so they point upward and set aside.
4. Roll out another 10 ft. section of ground screen material and again find the center mark around 5 ft.
5. Next make three cuts at the first intersection from the edge and fold all four cut ends upward such that the remaining cavity is an 8 in. square. (see diagrams)
6. Overlap the two sections of ground screen by one square and intertwine the cut pieces of wire into the rest of the ground screen. This should secure the two sections of screen together leaving an 8 in. square in the center for installation.
7. Install 2 or more nicos along the seam of the two sections to create a secure bond. If nicos are not available then make cuts in ground screen and intertwine wires at two or more places along the seam.
8. Place completed ground screen over mast, oriented roughly in the N-S direction, and fasten to the ground using stakes.

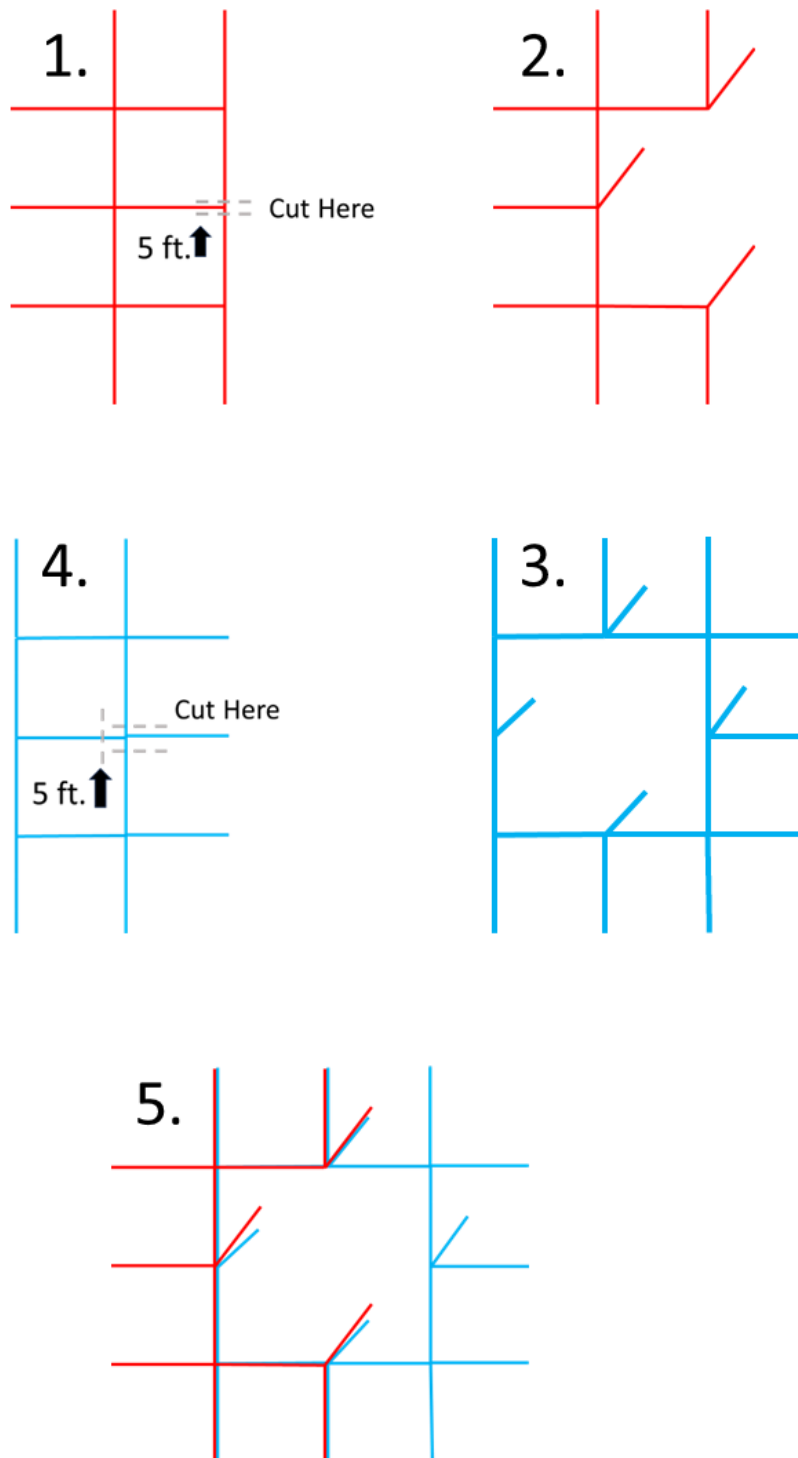


Figure 1: Diagram illustrating the steps outlined in the Ground Screen Fabrication Section. Dashed lines indicate where to make cuts on the ground screen roll for overlapping each half successfully.

2 Fiberglass Supports

People Required: 1-2

Tools Required	Materials Required
5/16" Socket or Drill 5/32" Hexkey	Mount Flange (4) Fiberglass triangle supports (8) 1-1/4" 10-32 UNF Hex SEM Screws, 18-8 S.S. (3) 1/2" 5/16-18 UNC Hex Set Screws, 18-8 S.S.

Procedure:

1. Set mounting flange flat-side up and arrange the 4x supports around it in a cross shape. The corner with two screw holes should be arranged on top of the corresponding holes on the flat side of the flange, and the other corners should have the angled side facing up.
2. Install two screws in each support to fasten them to the center flange. Take care not to over tighten the screws as they will embed in the plastic of the support making them impossible to disassemble.
3. Install the set screws in the three holes on the narrow end of the flange but do not tighten completely.
4. Slide entire assembly, flat-side up as before, over a constructed mast ***with ground screen already in place***. Gently rest this assembly on top of the antenna junction box.



Figure 2: Completed fiberglass support assembly resting on a partially completed antenna from LWA1 construction. This image illustrates the final state after completion of the *Fiberglass Supports* instruction section. Note the orientation of the of the support triangles as described in the steps above. In this image the flexible conduit is not fully installed in this image, rather at this step expect the conduit to be fixed to the junction box and running under the ground screen into the trenches.

3 Hub and Antenna Arms

People Required: 2

Tools Required	Materials Required
7/16" Socket and/or Drill 5/32" Hexkey	FEE Hub Base Size-12 Hose Clamp (4) Antenna Arms (8) 1-1/4" 10-32 UNF Hex SEM Screws, 18-8 S.S. (4) 1/4-20 Flange Nuts, 18-8 S.S.

Procedure:

1. Slide Hose clamp over mast and rest on top of support assembly, then place the FEE hub base on top of the mast. Tighten the hose clamp around the neck of the hub base such that the clamp holds its position but the hub can freely rotate.
2. Antenna arms have a tongue with a single screw hole on the top and two additional holes near the central crossbar. One person will take one of the antenna wings, with the tongue at the top, and slide it onto the screws protruding from the bottom of the hub base. While holding the wing in place, a second person will install one fastening nut and tighten it with a socket wrench. Gently releasing the fastened antenna arm should slightly bend at the tongue and settle, leave it this way for now.
3. Repeat step 2 until all 4 wings have been installed in place.
4. Once all 4 arms are in place, lift the support assembly until it's corner holes roughly align with those on the antenna arms. Then tighten the set screws so this support structure stays in place.
5. Next take the 8x mounting screws, passing them through the holes midway up the antenna arms, and partially screw them into the angled part of the support structure. After all screws are in place, then tighten each fully into place.
6. Lastly loosen the support assembly set screws so that the arms, hub base, and supports can freely rotate on the mast. Allowing for final orientation of the antenna structure.



(i) Top View



(ii) Bottom View

Figure 3: Top and Bottom view of the LWA antenna Hub Base. Antenna arms mount on the underside of the hub's threaded rods that also hold the antenna FEE.



Figure 4: Junction of the antenna arm with the fiberglass support structure. The angle of the support and antenna arm should match, as seen here, and screw in without difficulty.

4 Final Antenna Alignment

People Required: 1-2

Tools Required	Materials Required
5/16" Socket and/or Drill	FEE Hub Cover
5/32" Hexkey	LWA FEE
Hub Alignment Jig	(4) 1/4-20 flange nuts
Torque Wrench	(2) 1/2" 10-14 S.S. Plastite Screws

Procedure:

1. Locate a station reference object to align all the antennas to. For LWA-NA this was the VLA antenna barn. In previous station builds, we have used a reference object that is at least 10 km away from the center of the array, and aligned the reference with a sighting tool that fits in the antenna hub to align the antennas with North. Choosing a reference object at 10 km results in residual parallax errors of $\sim 0.5^\circ$ from one side of the array to the other, but this is improved for more distant objects.

Alternatively, if the view surrounding the array is obstructed by foliage, you could use a compass to align each antenna. The antennas must be aligned with **Geometric North**, not magnetic North, so aligning antennas using a compass requires knowledge of the proper correction to magnetic North for the arrays position on Earth. This information is available online through the NOAA Geomagnetic Tools. For standard 256-element LWA stations it is possible that the density of antennas near the center of the array can affect the sensitivity of a regular compass, so as a substitute one could use a cell phone compass application to perform this alignment. Cell phones now have accurate GPS positioning, and most compass applications come with an automatic conversion tool from Magnetic to Geometric North to aid in this process, but using a cell phone to align a full LWA station has not yet been fully tested.

2. Place compass or alignment jig onto threaded posts where a front end would normally be installed. *If using a cell phone, ensure that the device is placed flat on the antenna hub with the plastic white post of the Hub assembly located near the top right of the screen, and parallel to the sides of the Hub.*
3. Rotate the entire hub, arms, and support assembly until the antenna structure is aligned with the reference object or points toward **Geometric North**. After alignment the plastic white post on the Hub assembly should be in the NE corner.
4. Using the hexkey, tighten the set screws on the fiberglass support structure to hold the antenna in place.
5. Slide the hose clamp up the mast and tighten it around the base of the hub neck using the socket or drill.

5 Front End Electronics Installation

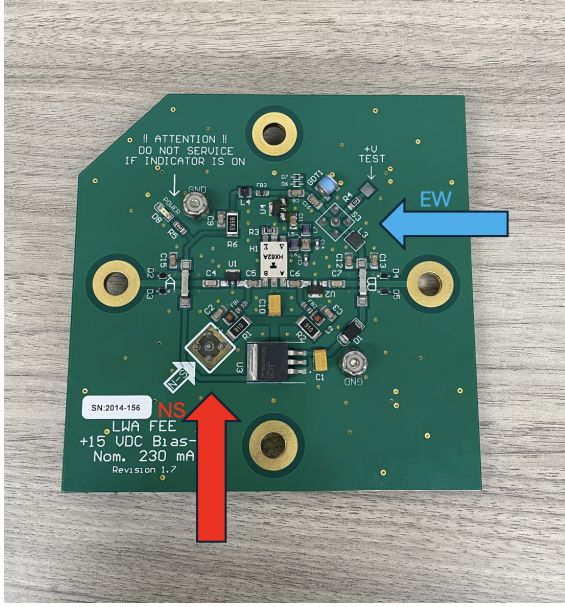
The FEE board is a sandwich of two nearly identical printed circuit boards, but there is an easy way to recognize the top from the bottom, and to know which SMA connector corresponds to which polarization. It is important to connect the correct cable input to its associated terminal to avoid errors in station calibration and extra labor to rectify incorrectly installed dipoles. The top of the board is the flat side of the FEE that will face toward the sky, that does not have input connectors. The bottom of the board is the side where the SMA connectors stick out, and where you can see the Phillips head of the ground (GRD) screws.

- **Top of the board:** You see an arrow labeled N-S directly on the board; Although the "N-S" stands for "Next-Side" this is the NS polarization. See Figure 5i.
- **Bottom of the board:** The EW polarization board is identified from the bottom, where the SMA connectors stick out. On this board, you will also see the arrow with N-S, in this case it belongs to the EW polarization. See Figure 5ii.

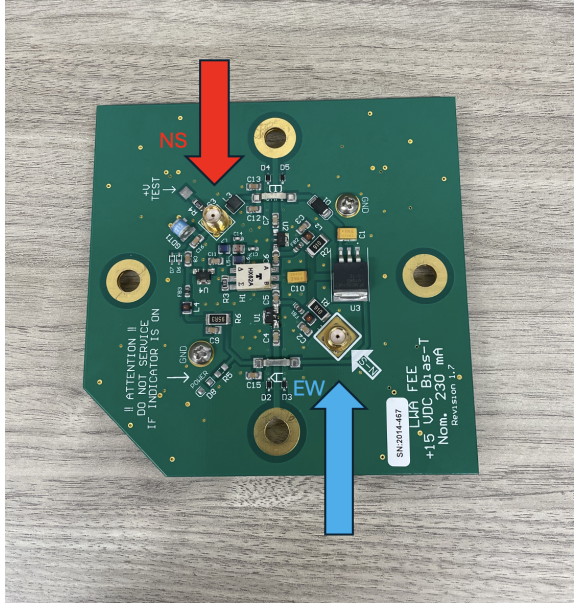
For completeness, we have provided pictures of the FEE board installed on an antenna in Figure 6, and with the NS polarization connected in Figure 7 and in Figure 8.

5.1 Installation Instructions

1. Take the cables protruding from the top of the antenna mast and, with your fingers, connect the cable labeled '**XX**' to the **East-West** terminal on the FEE as described above, and shown in the example figures.
2. Next connect the cable labelled '**YY**' to the **North-South** terminal on the FEE until finger tight.
3. After both cables are connected, use the torque wrench to finish tightening the SMA connectors on each polarization, but **DO NOT OVER TIGHTEN**. Using excessive pressure could break off the SMA connector from the FEE and require repairs. The torque wrench will buckle when the proper pressure is reached.
4. Slide the Connected FEE onto the threaded rods (FEE only fits one way), and install the 4 nuts onto the mounting rods finger tight to hold the FEE in place and maintain electrical connection.
5. Fasten the hub cover into place using the two to four 1/2" screws.
6. Adjust the ground screen as needed to align with the antenna arms, such that the ground screen is also squared to the cardinal directions.
7. Place 4-6 stakes around perimeter of ground screen to firmly hold it to the ground.

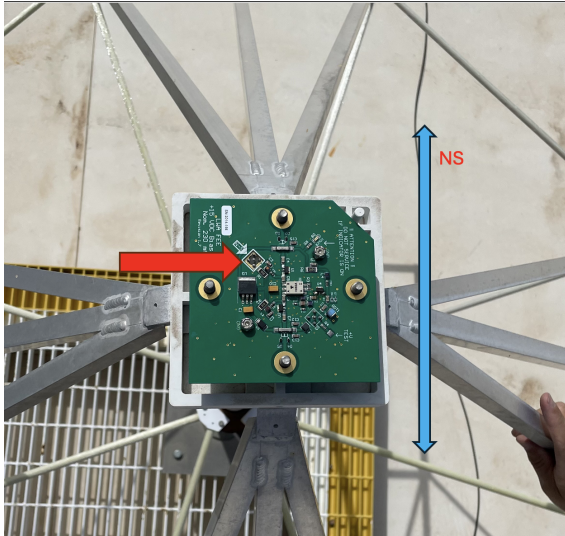


(i) FEE board Top View

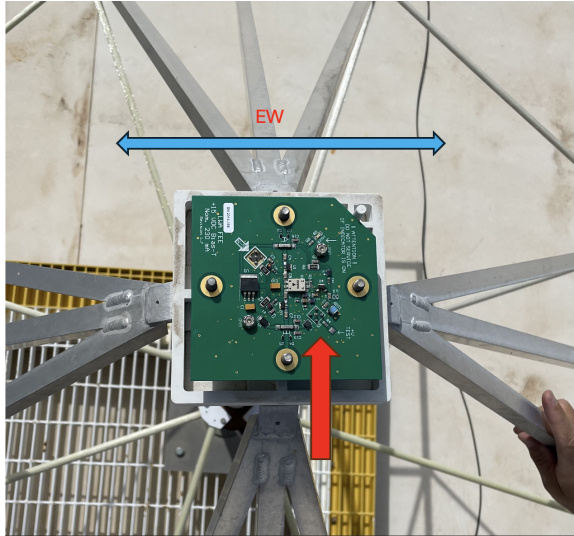


(ii) FEE board Bottom View

Figure 5: Top and Bottom view of the FEE boards. Both polarization connectors are specified on both sides. The red arrows are NS polarization and the blue ones are EW polarization.



(i) NS polarization



(ii) EW polarization

Figure 6: FEE board installed on top of the antenna, the blue arrow indicates the polarization direction and the red arrow indicates the polarization connector.

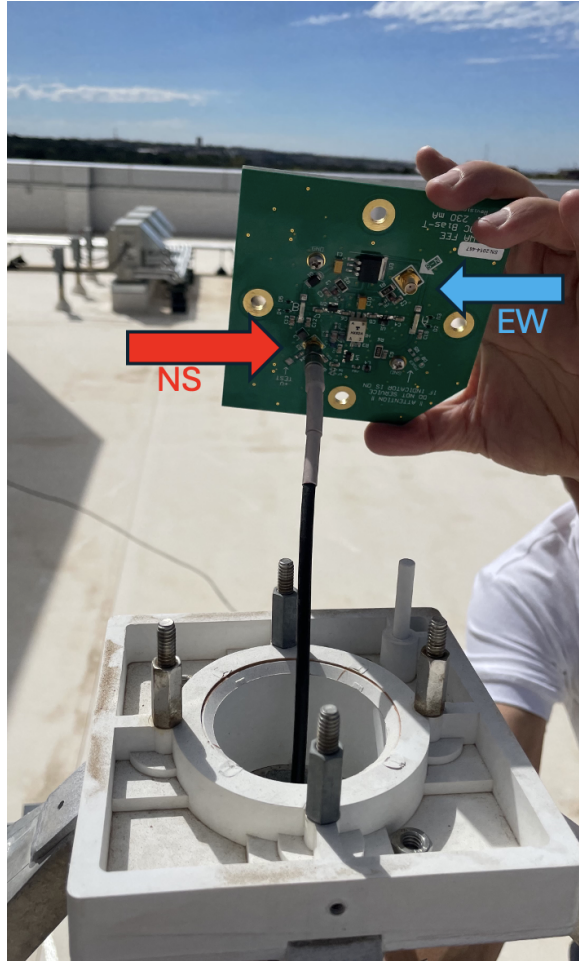


Figure 7: FEE board with NS polarization cable connected. The arrows show where the cables need to be connected for both NS and EW polarizations. Here the NS cable has been connected.

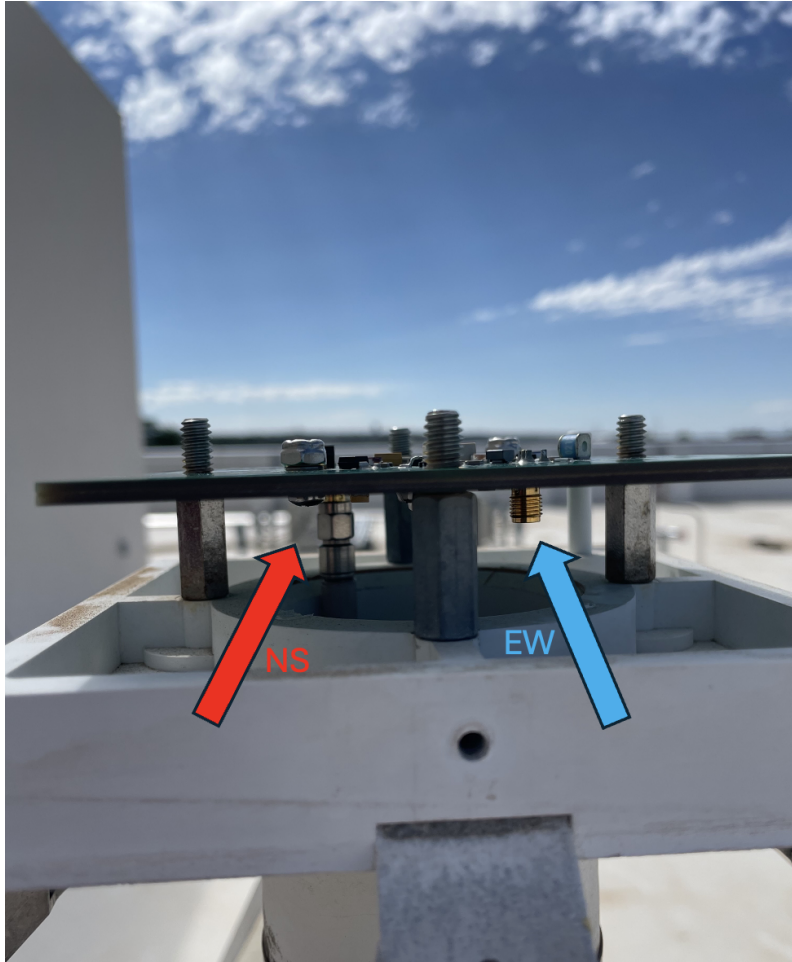


Figure 8: FEE board with NS polarization cable connected and placed on antenna.

6 Document History

- Version 2 (Oct 6, 2025): Updated to improve clarity on the process to orient dipole stands in the array and proper installation of Front End Electronics in the antenna hub.
- Version 1 (Nov 6, 2023): First version.

References

- [1] Day, Cherie. *Field Manual for LWA Deployment*. 20 Feb 2015.
- [2] Tremblay, S. , Tremblay, S., and Craig, J. *Complete Guide to Antenna Assembly*. LWA Enginnering Memo ARR0005, 21 May, 2011.