Dual Vertical Phased Array

DXE-DVA-B

DXE-DVA-160B-P - Dual Vertical Array system for 160 meters
DXE-DVA-80B-P - Dual Vertical Array system for 80 meters
DXE-DVA-40B-P - Dual Vertical Array system for 40 meters

DXE-DVA-B-INS Revision 0
Introduction and General Information

Congratulations on your purchase of the DX Engineering Dual Vertical Phased Array System, custom designed and tested to offer the best directional transmitting and receiving performance in proportion to the space required. Advanced design, with a stable, clean and low-angle pattern makes the DX Engineering Dual Vertical Phased Array (DVA) the finest dual element quarter-wave monoband phased antenna system available. The DX Engineering Dual Vertical Phased Arrays are advanced vertical antenna phasing systems that set new standards in two vertical element array performance. DX Engineering Dual Vertical Phased Array system design eliminates the waste load port of previous hybrid-type two-element systems, thus increasing array efficiency. Each mono-band Dual Vertical Array system includes a sleek new Phasing Relay Unit and a new Control Console. The model number of your system corresponds to the band for which it was manufactured.

There are 3 system models available that cover the 160, 80, or 40 meter bands:
- DXE-DVA-160B-P - Dual Vertical Array - 160 meters - Phasing Relay Unit and Control Console
- DXE-DVA-80B-P - Dual Vertical Array - 80 meters - Phasing Relay Unit and Control Console
- DXE-DVA-40B-P - Dual Vertical Array - 40 meters - Phasing Relay Unit and Control Console

The Phasing Relay Unit can be ordered without the DVA Control Console:
- DXE-DVA-160B - Dual Vertical Array - 160 meters - Phasing Relay Unit Only
- DXE-DVA-80B - Dual Vertical Array - 80 meters - Phasing Relay Unit Only
- DXE-DVA-40B - Dual Vertical Array - 40 meters - Phasing Relay Unit Only

The Dual Vertical Array Control Console can be ordered without the DVA Phasing Relay Unit:
- DXE-EC-DVA - Control Console only for the Dual Vertical Array System

DX Engineering Dual Vertical Phased Array (DVA) systems produce two enhanced End-Fire Cardioid patterns and one Broadside-Omni pattern. New heavy-duty components handle 2 kW continuous RF power with array performance at low SWR over a wide bandwidth. The Dual Vertical Array end-fire directional patterns achieve a real front-to-back over 20 dB with typical array forward gain up to 3 dB over a single vertical.

Each DX Engineering Dual Vertical Phased Array’s mono-band weatherproof DVA Phasing Relay Unit includes a clamp for mounting on a mounting pipe that is positioned directly between two ground-mounted, full-size, quarter-wave resonant verticals. The antennas must be located as described in the installation section to provide switchable patterns in desired directions. The forward lobes are reasonably wide eliminating the need for precise aiming while also providing coverage of in-between directions.

The proper spacing between these user-supplied antennas is one-quarter wavelength free space, and each should be installed with 40 or more ground radials; all antenna system parts are also available from DX Engineering.

The two vertical antennas must be resonant in the desired band of operation. Each vertical element must be directly fed through 1/4-wave long 75Ω transmission lines. No additional matching components or decoupling devices may be used, like baluns or coils, between the centrally located Dual Vertical Phasing Relay Unit and the verticals, as additional transmission line lengths can reduce array performance.
DVA systems require the 75-ohm antenna feed cables to be electrically tuned to one-quarter wavelength. Offered by DX Engineering as an option, these custom built PL-259 terminated cable assemblies use the highest quality waterproof polyethylene jacket direct-burial DXE-11U low-loss foam coax. These custom length coaxial cables are frequency specific, electronically tuned and connect the DVA Phasing Relay Unit directly to each mono-band vertical antenna feed point and radial system.

The vertical antennas must be series-fed at the base, 1/4-wave long and must be resonant. DX Engineering offers vertical antennas that are well suited for this application. Above all, a properly designed and installed radial system is necessary for maximum system performance.

The included companion DXE-EC-DVA Control Console is a three-position directional pattern selector that operates on +13.8 Vdc and features a 3-position rotary switch, directional LED indicators and scratch pads on the console for the user to write in their array end fire directions. The DXE-EC-DVA Control Consoles require only a 3-conductor 20 AWG cable for connection to the DVA Phasing Relay Unit.

**DXE-DVA - Dual Vertical Array System Features**

**The Dual Vertical Array System** is a monoband two element, three direction-switchable array based on a two element end-fire/broadside combination of identical vertical elements. This antenna array system is capable of delivering pattern directional performance superior to other systems in its class.

- Custom design with stable and clean low-angle patterns
- No dump power as on other types of phased arrays so all your power goes to the antenna elements
- Power Handling: 2 kW continuous
- Directional performance - Two End Fire and one Broadside directions
- Forward Gain (approximate as compared to a single vertical): 3 dB End-Fire, 1 dB Broadside (Omni)
- Can be built with monoband verticals to cover any single band
- RF Connectors: Three SO-239 (UHF Female): Transmitter, Antenna 1, Antenna 2
- Excellent signal-to-noise ratio
- Directivity over a very wide frequency range in the band selected
- Excellent relay contact reliability
- DC powered control console allows system operation without AC power mains
- Control Cable: 3 conductors, minimum 20 AWG
- Control Wire Connections: Set screw connectors internal at the Control Console and a removable external connector at the DVA Phasing Relay Unit
- Cover on the DVA Phasing Relay Unit made from tough UV protected plastic
- Stainless steel chassis and mounting plate on Phasing Relay Unit
- DVA Control Console uses +13.8 Vdc input has three LEDs and three position rotary direction switch (Position 1, Broadside, Position 2)
- Designed, manufactured and tested in the USA by DX Engineering
Parts Included

- DXE-DVAB Dual Vertical Array Phasing Relay Unit for band specified.
- DXE-SSVC-2P Stainless Steel V-Clamp for mounting the DXE-DVA Phasing Relay Unit to a mounting post between 1" and 2" OD
- DXE-EC-DVA Dual Vertical Array Control Console
- 2.1 mm Power Plug with wires to connect to the station +12 to +13.8 Vdc filtered power supply

Additional Parts Required, Not Supplied with the DXE-DVA Systems

See the Optional Items at the back of this manual for details

- Two identical Full Size Quarter-wave Monoband Vertical Antenna Elements
- JTL-12555 - Jet Lube SS-30 Anti-Oxidant for the vertical antenna elements
- DXE-RG-11U Phasing Cables, 75-ohm, cut to the proper electrical length for the applicable dual vertical array system center frequency
- DXE-RADP-3 Radial Plate - one for each vertical element
- DXE-UHF-FDFB-KIT SecureMount™ Bulkhead Connector for a clean and quality feedline connection, one for each Radial Plate
- DXE-FP-WIRE-P Feedpoint Wire & Connector Assemblies, one for each vertical element
- DXE- RADW Radial Wire for the required vertical antenna radials
- GCL-1120-050 Copper Radial Cross Bonding Strap, 2” wide
- COM-CW3 - Three Wire Control Cable - COM-CW-3 is 3-wire, 20 AWG, stranded copper with a grey PVC jacket
- Galvanized Mounting Pipe, 1 inch minimum to 2 inches OD maximum, for mounting the Dual Vertical Array Phasing Relay Unit at the center of the array using the supplied DXE-SSVC-2P Stainless Steel V-Clamp (see text for details)
- TES-2155 3M Temflex Tape and TES-06132 Scotch Super 33 Tape for Weatherproofing the coaxial cable connections
- DXE-400MAX or DXE-213U or equivalent, 50-ohm coaxial cable for the array main feedline from the transceiver to the Phasing Relay Unit

Manual Updates

Every effort is made to supply the latest manual revision with each product. Occasionally a manual will be updated between the time your DX Engineering product is shipped and when you receive it. Please check the DX Engineering web site (www.dxengineering.com) for the latest revision manual.
Tools Required

1/2” nut driver or wrench (for the DXE-SSVC-2P V-Clamp)
Wire stripper for control lines
Small flat blade screwdriver for control line connections
Soldering Iron and Solder to join the two radial fields together where they meet

General Installation Information

The DXE-DVA Dual Vertical Array Phasing Relay Unit should be mounted to a customer supplied mounting pipe at the center of the array, halfway between the two monoband verticals.

The DXE-DVA Dual Vertical Array Phasing Relay Unit has a built-in, stainless steel, pre-drilled mounting flange to accommodate up to a 2 inch OD mounting pipe. The included DXE-SSVC-2P Stainless Steel V-Bolt Saddle Clamp is for attaching the Phasing Relay Unit to the customer supplied 1” to 2” OD mounting pipe. An optional DXE-CAVS-1P V-Bolt Saddle clamp can be used for pipe from 3/4” to 1-3/4” inches OD. The Phasing Relay Unit can also be mounted on a sturdy wooden post.

Note: JTL-12555 Jet-Lube SS-30 Anti-Seize should be used on all clamps, bolts and stainless steel threaded hardware to prevent galling and to ensure proper tightening.

The Array Phasing Relay Unit must be mounted with cover upward and the control and coaxial cable connections downward to prevent water from entering the box. The stainless steel base of the Array Phasing Relay Unit has weep holes to allow condensation that may build up inside the unit to leave. Additional weatherproofing protection may be used on the coaxial connections.

WARNING!

INSTALLATION OF ANY ANTENNAS NEAR POWER LINES IS DANGEROUS

Warning: Do not locate the antennas near overhead power lines or other electric light or power circuits, or where they can come into contact with such circuits. When installing the antennas, take extreme care not to come into contact with such circuits, because they may cause serious injury or death. Make sure when you are digging, you are not near any buried utility lines.
Overhead Power Line Safety

Before you begin working, check carefully for overhead power lines in the area you will be working. Don't assume that wires are telephone or cable lines: check with your electric utility for advice. Although overhead power lines may appear to be insulated, often these coverings are intended only to protect metal wires from weather conditions and may not protect you from electric shock.

Keep your distance! Remember the 10-foot rule: When carrying and using ladders and other long tools, keep them at least 10 feet away from all overhead lines - including any lines from the power pole to your home.

Installation

Site Selection

Select mounting locations clear from power lines and structures by a minimum of height of the monoband antennas used plus 10 feet (for the 10 foot safety rule). **Consider overhead power lines, utility cables and wires.** The monoband verticals should be mounted away from local noise sources or other metallic objects which can re-radiate noise and affect the tuning, radiation pattern and SWR. Determine the direction you want the array positioned. There should also be a clear diameter from the monoband antennas for the guying and radial systems that will extend away from the antennas.

Topographical Considerations

Flat or gradually sloped land is best. Erecting the transmitting array on steeply sloped land or uneven terrain might degrade performance. To avoid pattern degradation, antenna elements should have reasonably similar elevations. It's recommended the maximum ground height difference between any of the vertical antennas in the array should be less than 20% of the array diameter. For example, two 80 meter verticals 66 feet apart should be within 13 feet of level. Every effort should be taken to make the elements symmetrical. Elements must be similar or identical in construction and grounding. Elements should be mounted above any standing water, but as close to the ground as possible. In general, the system will not be affected by trees or foliage so long as the foliage is not near an element. The open ends or tips of the elements are particularly sensitive to close branches or foliage. There should be a reasonably clear electrical path for at least 1 wavelength in important receiving directions. The site should allow a radial system to be as evenly distributed around each of the vertical elements as possible, although perfect symmetry isn't important so long as the radial connections are good.

Most amateur radio operators in the continental United States will want the system to point toward Europe (NE) as a default (position 1). Therefore the system described in this manual will be laid out with vertical antenna elements 1 to the Northeast in a line going to antenna 2 toward the Southwest.
Note: This array, like all dual phased vertical set ups, has a fairly wide flat forward lobe. This means exact direction headings are generally not critical. We should still remember there is a difference between True North and Magnetic or Compass North. Without going into all of the details, you want your system aligned to True North. Depending on your location you can check your position using various geological, topographical or aviation maps to determine True North.

If your location has more than 10 degrees magnetic declination, you may want to correct for it. Declinations below ten degrees can be safely ignored.

If you know your longitude and latitude, you can then pinpoint yourself on an aircraft navigation or geological map. If you don't know your longitude and latitude, you can find that information on many of the map services available on the internet, or use a GPS.

**Site Selection in Relation to Noise Sources**

Since the array is generally used for both transmitting and receiving, you should listen to desired bands and identify any sources of unwanted noise. Elimination of noise sources is required for optimal receiving results. If noise sources cannot be eliminated, then locate the antenna array as far away from noise sources as possible.

Since this array is directional, locate the array so the rear of the array is pointing towards the dominant noise source. This ensures the array has maximum suppression of noise when beaming in the primary listening direction. For example, if you primarily want to work Europeans from the eastern USA (Northeast direction), try to position the array so the dominant local noise is Southwest of the array. There is no advantage at all when an array points into the noise, no matter what the array gain is.

Gain does not generally matter, only the ratio of signal response to noise response changes S/N ratio. The only way S/N ratio improves at HF is if the array nulls the noise more than it nulls the desired signal.

The second-best location for the array is when the noise source is as far as possible to either side of the array. If you look at patterns, the ideal receiving location for the array is one that places undesired noise in a deep null area.

If your location doesn’t have the usual noise sources (power lines, electric fences, etc.), locate the array so that your other transmitting antennas and buildings are off the back or side of the primary array direction.

Consider these things about noise sources:

- If noise is not evenly distributed, performance will depend on the gain difference between the desired signal direction (azimuth and elevation) and average gain in the direction of noise.
- If noise predominantly arrives from the direction and angle of desired signals (assuming polarization of signals and noise are the same) there will be no improvement in the signal-to-noise ratio.

If the noise originates in the near-field of the antenna, everything becomes unpredictable. This is a good case for the use of separate receiving antennas placed as far from noise sources (such as power lines) as possible.

**Monoband Antennas for a Dual Vertical Array System**

The following are some suggested DX Engineering and COMTEK full size quarter-wave monoband vertical antennas are an ideal match for top performance in a dual vertical array system. You'll need 2 verticals. The COM-40VA-2P is a package of two antennas. The other listed antennas are single.

<table>
<thead>
<tr>
<th></th>
<th>COM-40VA-2P</th>
<th>DXE-7580FS-VA2</th>
<th>DXE-7580FS-VA3</th>
<th>DXE-ATK65A and DXE-VE BASE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Band</strong></td>
<td>40</td>
<td>80 or 75</td>
<td>80 or 75</td>
<td>80 or 75</td>
</tr>
<tr>
<td><strong>Element Size</strong></td>
<td>2” to 1-3/8”</td>
<td>3” to 1/4”</td>
<td>4” to 1/2”</td>
<td>2” to 7/8”</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Height</strong></td>
<td>35’</td>
<td>68’</td>
<td>68’</td>
<td>64’</td>
</tr>
<tr>
<td><strong>Guying</strong></td>
<td>Suggested</td>
<td>Suggested</td>
<td>Suggested</td>
<td>Required</td>
</tr>
</tbody>
</table>

Please visit [www.DXEngineering.com](http://www.DXEngineering.com) for details on these vertical antennas.

**The Dual Monoband Vertical Antenna Layout**

The two full size quarter-wave monoband vertical antennas making up the dual vertical array system must be properly positioned. The example on the right shows a typical set up where antenna 1 is toward the NE and antenna 2 is toward the SW. You must adhere to the dimensions shown on the next page for optimum performance. The placement of the two vertical antennas in relation to each other is somewhat critical. If the dimensions are more than five percent out of specification, system performance can suffer.

The formula for determining the distance between each antenna (1/4-wavelength) is:

\[
L \text{ in Feet} = \frac{246}{\text{MHz}}
\]

Use 246 divided by the Frequency in MHz = Length in feet
Other spacing close to this value may work, but the characteristics of the main lobe will change. For optimal gain, directivity and front-to-back, time spent in laying out a symmetrical installation will pay solid dividends. The system is forgiving, but the best front-to-back is obtained when symmetry is maintained and with each element resonant on the same frequency and with each antenna base at the same elevation on flat land. Sloped land installations should not use one elevated and one ground-mounted antenna.

The plots shown to the right are for a typical 40 meter DXE-DVA Dual Vertical Phased Array pointing toward Europe (Northeast) is position number one on the DVA Control Console.

The following chart shows various calculations depending on the desired center frequency. The frequencies shown here are various CW, DX, and SSB frequencies used in the American Radio Relay League Band Plan:

<table>
<thead>
<tr>
<th>Band (Meters)</th>
<th>Typical Center Frequency (MHz)</th>
<th>Distance between antennas (1/4-wavelength) at the Center Frequency</th>
<th>Meters</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td>1.815</td>
<td>41.3</td>
<td>135.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.845</td>
<td>40.6</td>
<td>133.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.900</td>
<td>39.5</td>
<td>129.5</td>
<td></td>
</tr>
<tr>
<td>80/75</td>
<td>3.550</td>
<td>21.1</td>
<td>69.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.575</td>
<td>21.0</td>
<td>68.8</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>7.040</td>
<td>11.0</td>
<td>34.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.110</td>
<td>11.0</td>
<td>34.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.150</td>
<td>10.4</td>
<td>34.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.225</td>
<td>10.3</td>
<td>34.0</td>
<td></td>
</tr>
</tbody>
</table>

**Typical Dual Phased Vertical Antenna Spacing**
(Use the formula 246/Center Frequency in MHz for exact distances in feet)

Performance of the Dual Vertical Array can noticeably decrease if metal structures radiating even small amounts of noise or signals are within 1/2-wavelength of the array.

**Note:** The DXE-DVA -Dual Vertical Array system should be separated from transmitting or other antennas and structures (particularly metal) by at least 1/2- wavelength. Less separation may cause significant pattern distortion and the introduction of re-radiated noise into the system. This becomes apparent as reduced front-to-rear directivity in one or more directions or a higher noise level.
With so many variables involved, there is no optimum or minimum spacing for effects on pattern. The best practice is to install the array as far as possible from tall conductors or noise sources, or place potential problems in less frequently used directions. For best pattern, space the system as far as possible from conductors that might be noise sources or re-radiate unwanted signals. One wavelength or more is generally ideal, although adequate performance generally occurring at closer spacing, with one-half wavelength minimum recommended.

**Radial System Information**

The use of a radial system is a key requirement for a high performance dual phased monoband vertical antenna system. With any vertical antenna, the radials are the second half of the antenna. The radials contribute to the radiation efficiency of the entire phased vertical antenna system.

Using an optional patented DXE-RADP-3 Radial Plate greatly simplifies mounting radial wires in a vertical installation. The DXE-RADP-3 stainless steel Radial Plate contains enough stainless hardware sets to attach 20 radials. Additional 20 set radial connection hardware kits DXE-RADP-HW1K are available from DX Engineering.

**DXE-RADW** - Radial Wire Kits and Components contain everything you need to make your own radials, including steel or biodegradable lawn staples to hold the wire down, are also available.

The best way to connect the feedline to the radial plate and vertical feed point is to use an optional **DXE-FDFB-KIT** SecureMount™ bulkhead connector with the **DXE-FP-WIRE-P** Feedpoint Connection Assembly.

A **DXE-SSVC-2P** V-Clamp is needed to secure the radial plate to the 2” OD vertical monoband antenna mounting pipe.

The radial plate must be mounted to the vertical antenna’s mounting pipe prior to installing the vertical element or antenna. It should be as close to the ground as possible, while still allowing access to the radial wire hardware for tightening. A one inch ground clearance is adequate.

Optional: DXE-RADP-3 Radial Plate, DXE-FDFB-KIT SecureMount™ Bulkhead Connector and DXE-FP-WIRE-P Feedpoint Wire and Connector Assembly
The optional SecureMount™ DXE-FDFB-KIT is a high-quality bulkhead connector with silver plated outer and inner conductors and PTFE insulation. The connector has very low loss and high electrical break down. It comes with the hardware to secure it to the DX Engineering Radial Plate and ensures the radial ground system, antenna ground and the feedline shield are common. The optional DXE-FP-WIRE-P Feedpoint Wire Connector Assembly is a perfect solution to connect the feedline to the vertical element. Don't forget to weatherproof the PL-259 coaxial connections.

At a minimum, 30 radials, each 1/4-wavelength long on the array frequency should be used. Arrays using 40 to 60 radials are preferred and highly recommended. If you have very rocky or mostly sandy soil, using more longer radials may help the performance of your phased antenna system. Extra radials help overcome unknown poor-soil conditions, improve efficiency, and ensure the best performance. DXE-RADW Radial Wire, a stranded 14 gauge PVC insulated copper wire is suggested for the best results.

The 1/4-wavelength wire radials should be placed as symmetrically as possible straight from the feedpoint around each of the vertical antennas that are spaced 1/4 wavelength apart and spaced evenly, regardless of how many radials are used. Where the radial wires from one antenna cross the radials of the other antenna, cut the wires and bond them to a common wire or copper strap as shown. If you have limited space, put in as many straight radials as you can. The radials must be connected to the shield of the respective feedlines. DXE-RADP-3 Stainless Steel Radial Plates are the ideal optional items which provide an excellent system for attaching radial wires to your vertical antenna system feedpoints.

Radial wires can be laid on the roots of the grass using DXE-STPL Radial Wire Anchor Pins to hold them down. Using enough staples will ensure the wires will not be snagged by mowers, people, or animals. Grass will quickly overgrow the radials and they will be virtually impossible to see or cause trouble. An article describing this process is available the DX Engineering website www.dxengineering.com in the Tech Info section. Radials can also be buried just under the surface by using a power edger to make a slit in the soil.

Where the radial wires from one vertical element cross the radials of the other vertical element, they should be cut and bonded (soldered) together using the optional GCL-1120-050 Copper Radial Cross Bonding Strap.
**Vertical Antenna Information**

Each full size quarter-wave vertical antenna should be resonant (reactance = 0) at the target frequency for the particular band: 7.150 MHz on 40 meters for example. When the measurement is being done on one vertical antenna, the other vertical antenna should be floating (not connected to anything).

It is also expected that the impedance of a single full size quarter-wave vertical antenna should be close to 39 ohms at resonance, as in 39 + j 0 ohms. That represents the 36 ohms of a "textbook" quarter-wave vertical antenna, and a few ohms of ground loss, assuming a good ground.

When measured, one vertical with the other one floating, and the results are approximately 39 + j 0 ohms of impedance and then go to the second vertical with the first antenna now floating and again measure 39 + j 0 ohms, that's a good indication of being ready to go.

**Phasing Relay Unit Mounting Pipe**

Use a customer supplied thick-walled galvanized steel mounting pipe *36 inches to 66 inches* long. This will allow approximately 12 to 18 inches below ground and approximately 24 to 48 inches above ground. The height above ground is to allow easy access to the connection on the Phasing Relay Unit. A thick-walled steel pipe 1-3/4" OD to 2" OD *maximum* is recommended with a minimum thickness of 1/8" (1/4" preferred) should be used. The standard 1-1/2" galvanized water pipe (with a 1.9" OD) is just fine for this application and can usually be found at your local home building supply store. For permanent mounting, use a post-hole digger to make the hole deep enough to accommodate the mounting pipe and a couple inches of gravel at the bottom for drainage. Set the pipe on the gravel, use the pre-mix concrete to fill around the pipe, adding water and mixing as you fill or mix the concrete first, then pour in the hole. Fill the hole until the concrete is level with the ground around it. Use a level as you fill the hole to be sure the pipe is straight. Allow to set overnight. Your location, landscape and ground conditions may require different mounting solutions in order to have the mounting pipe in a secure position. Your ground/soil/rocky conditions may require additional mounting pipe length or method of securing.

*Note:* *Galvanized steel, rather than aluminum, is much more suitable for mounting in concrete. Aluminum will quickly corrode due to incompatibility with the materials used to make concrete.*

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Installing the DVA Phasing Relay Unit to the Mounting Pipe

Using the included **DXE-SSVC-2P** Stainless Steel V-Clamp mount the DVA Phasing Relay Unit to the previously installed mounting pipe as shown below. The use of **JTL-12555** Jet-Lube SS-30 Anti-Seize for stainless steel hardware is recommended for any stainless steel bolts and nuts to avoid galling or seizing of the stainless steel hardware.

![Diagram of DVA Phasing Relay Unit installation](image)

Dual Vertical Array Control Console

The **DXE-EC-DVA** is the 3 position controller used to control the DX Engineering Dual Vertical Array systems (**DXE-DVA** series).

The **DXE-EC-DVA** offers the following features:
- Stainless Steel Housing
- Non-Skid feet
- On-Off toggle switch
- Three green LEDs indicate position chosen
- White blocks to mark your chosen directions
- Internal automatic resettable fuse
- Includes a 2.1 mm power plug for +12 to +13.8 Vdc power connection

Front and Rear Panels

![Front panel with On/Off toggle switch and Three Green LEDs](image)

![Rear panel with Power Connection](image)
The DC Input used is +12 to +13.8 Vdc. A 2.1 mm power cord is supplied with unit. The wire with the white stripes is the +12 to +13.8 Vdc.

Outer Connection is GROUND, Center Pin is +12 to +13.8 VDC.

If station power is used, it must be +12 tp +13.8 Vdc at 1 amp (fused) minimum. An optional DXE-PSW-12D1A 120 Vac 60 Hz to 12 Vdc 1 Amp, fused wall transformer supply is an available option.

Tools Required
Phillips Head Screwdriver
Wire Stripper
Small Flat Blade Screwdriver

Overall Size

Interior Connections

1. Open the unit by removing the four (two per side) Phillips head screws to remove the cover.

2. Push the end of the cable through the control wire feed through on the rear of the unit.

3. Three wire connections for the wire are made on the green header (G-1-2). Terminal 3 is not used. Loosen each terminal screw until it is near flush with the top of the connector block as shown to the right.

4. Strip approximately 1/4” insulation from the four conductor wire ends as shown to the right.

5. Connect each wire to a terminal (G-1-2) by sliding the wire completely into the wire connection hole. Using a small flat blade screwdriver, tighten the associated screw until the wire is firmly gripped in place as shown below. Terminal 3 is not used.
Take caution to ensure just the wire is clamped in place, not the wire's insulation which would cause an open or intermittent connection. Do not over tighten the screw so much that the wire is cut instead of being firmly gripped. Use the included Ty-Wrap on the inside of the unit to hold the cable from pulling outward as shown above.

**COM-CW3** three wire control cable is a high-quality, PVC-jacketed control cable consisting of three 20 AWG stranded copper conductors. Your color code may vary.

When connecting the control cable to the DX Engineering Dual Vertical Array system, ensure your cable is wired the same way at both ends to avoid un-necessary troubleshooting (G to G, 1 to 1 and 2 to 2). Use the chart (below) to record which color wire is connected to each terminal connection.

<table>
<thead>
<tr>
<th>Connector Wire Reference Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
</tr>
</tbody>
</table>

The selected position will supply the correct BCD logic voltage as shown in the chart below. 
H = +12 Vdc output. Note that with no power, the default selection is Broadside.

<table>
<thead>
<tr>
<th>Switch Position</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H</td>
</tr>
<tr>
<td>BROADSIDE</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>H</td>
</tr>
</tbody>
</table>

The **DXE-DVA** Phasing Relay Unit uses a removable five terminal connector plug as shown below. The **DXE-DVA** connections are labeled “G 1 2 3 G”. The terminals inside the **DXE-EC-DVA** Control Console use the same connection letters and are connected G to G, 1 to 1 and 2 to 2.

**Number 3 is not used and the second G is tied to the first G internally.**

On the **DXE-DVA Phasing Relay Unit** the 5 pin green connector is a two part connector as shown below. The top part can be removed by pulling it straight off. This will allow easy wire replacement or servicing as needed. When pushing the removable connector back in place, ensure you press straight inward to fully seat the connection.
Three wire connections for the wire are made on the removable green header (G-1-2). Number 3 is not used and the second G is tied to the first G internally. Loosen each terminal screw until it is near flush with the top of the connector block as shown above.

Strip approximately 1/4” insulation from the three conductor wire ends to be used.

Connect each wire to a terminal (G-1-2) by sliding the wire completely into the wire connection hole. Refer to your color code chart to ensure the connections are 1 to 1, 2 to 2 and G to G. Using a small flat blade screwdriver, tighten the associated screw until the wire is firmly gripped in place as shown above.

**Station Feedline**

The weakest link in an antenna system is often the coaxial cable connections. All connections must be high quality and weather tight to prevent contamination and corrosion, which can cause the feedline impedance to change. This can affect the signal-to-noise ratio and the directivity of the array. If the coaxial cable is compromised the shield will then pick up unwanted signals. This is why the shield connections are most critical.

The feedline from the Transmitter to the **DXE-DVA Phasing Relay Unit** must be good quality 50 Ω coaxial cable such as the **DXE-400MAX** or **DXE-213U Coaxial Cable**. See the Optional Items for details on the coaxial cable and cable assemblies available from DX Engineering.

**Vertical Element Feedlines**

From the **DXE-DVA Phasing Relay Unit** to each antenna element use good quality 75 Ω coaxial cable cut the proper electrical length for the center frequency being used. The two feedlines from the **DXE-DVA Phasing Relay Unit** to the two vertical elements must **all be the same electrical length, velocity factor and type**. Note the orientation and numbering of the elements. Be sure the appropriate antenna element is connected to the proper **ANT** connector on the **DXE-DVA Phasing Relay Unit**. Additional weatherproofing protection can be provided when using weatherproofing tapes available from DX Engineering.
Lightning Protection

The key to lightning survival is to properly ground feedlines and equipment and to maintain the integrity of shield connections. A proper installation improves lightning protection and enhances weak signal receiving performance. Consult lightning protection and station grounding information in the ARRL handbooks, or by referring to the NEC (National Electric Code). The DX Engineering website has technical and product information listed under “Lightning Protection and Grounding”. Use lightning surge protectors for the coax feedline and control lines for the array feedline at the station end ground.

Typical EZNEC DX Engineering Dual Vertical Array Plots
**Troubleshooting**
There are several possible causes for a malfunction. Testing the system is not difficult. Directional switching and antenna phasing can each be affected by a variety of cabling, connection and or component problems. If you are troubleshooting a new system check that the wiring from the Control Console to the Array Relay Unit is correct and no damage has been done to the lines.

Here are the most common causes of malfunction, especially in a system that was previously functioning properly:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>Broken/Shorted Conductors</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>PL-259 is loose</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>Shorted/Open conductors due to water</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>RF overload</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>Damaged due to lightning</td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>Damaged by animals or insects</td>
</tr>
</tbody>
</table>

A) Broken and/or shorted conductors due to animal, weather or other damage, including chewed, punctured, stretched and broken control and power lines and/or feedlines for the system and each antenna. Also, screws in the green removable connector at the DVA Phasing Relay Unit can inadvertently be tightened onto the insulation of control or power conductors.

B) Loose PL-259 connector causing disengagement from the female pin of the SO-239 connector. This can happen on feedlines to/from the vertical elements and the DVA Phasing Relay Unit as well as the main feedline from DVA Relay Unit to the transceiver.

C) Shorted or opened conductors caused by water migration into a control line or a feedline.
Over 80% of all phased array malfunctions have been caused by the above system problems. A thorough inspection and subsequent testing of each control cable, RF cable, and their respective connections, will uncover the cause of most phased array system troubles. Here are a few other causes for malfunction:

1) Damaged Dual Vertical Array Relay unit due to lightning. This has been reported only a couple of times and is not very likely.
2) Dual Vertical Array Relay units that were damaged by animals or insects.

If necessary, the following further troubleshooting procedure may assist in finding the malfunction.

**Advanced Troubleshooting Procedure**

1) Test the **DXE-EC-DVA** Dual Vertical Array (DVA) Control Console unit, which should be connected only to the control lines of the Dual Vertical Relay Unit. When the DVA Control Console is connected to the control cable, do all three of the selected switch position LEDs light normally when rotating the directional control knob?

2) When rotating DVA Control Console switch from position 1, Broadside and 2, if all three LEDs light normally, measure BCD output voltages. Nominal +12 Vdc. Connections A and B, reference to the ground pin G as shown below. The selected position will supply the BCD logic voltage as shown in the chart below.

<table>
<thead>
<tr>
<th>Switch Position</th>
<th>G</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>H</td>
<td>0</td>
</tr>
<tr>
<td>BROADSIDE</td>
<td>GND</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>0</td>
<td>H</td>
</tr>
</tbody>
</table>

**Output Truth Table** - “H” Equals +12 Vdc

3) If the voltages are not normal, less than +10 to +18 Vdc, with the control line connected, then disconnect the control line and retest DVA Control Console. If voltages that were not correct, are now okay, that indicates a short in the control line or a problem in or beyond the Phasing Relay Unit.

4) If the DVA Control Console has only a one or two LEDs lighting up with the control cable disconnected, then it may have sustained lightning pulse damage and will need to be repaired or replaced. A new DVA Control Console (**DXE-EC-DVA**) is available from DX Engineering.

**Continue troubleshooting the array control** with a good DVA Control Console or by using a 1A fused power source.

5) Determine if the control line is intact by resistance or voltage testing each conductor for shorts with the far end of the control cable disconnected from the DVA Phasing Relay Unit.
6) With a good DVA Control Console or other power source connected, measure 1 and 2 control conductor voltages at the Phasing Relay Unit with the control cable connected, and again at the end of the control cable that is disconnected from the Phasing Relay Unit. If measured voltages are not between +10 to 18 Vdc on the selected line, a resistive, short or open circuit problem exists in the control line or in the Phasing Relay Unit. Normal voltages on the connected control line will cause relays to switch inside the Phasing Relay Unit. If switching voltages are correct, lack of system directivity may be due to antenna feedline(s) or the vertical elements.

7) Test reception of each Vertical Antenna by connecting each antenna feedline, one at a time, to an activated port on the Phasing Relay Unit. This assumes that a good port has been identified and is functioning properly. Normal reception must be confirmed from each antenna. If one or both monoband verticals produce a low or no signal, then vertical elements, connections or feedlines may need to be serviced or replaced.

8) If both vertical elements tested provide the same signal level in one port, then change switching to select the other port and try each antenna on that port one at a time, testing for the same level of reception. If one or two of the antenna ports are dead or has diminished reception, there may be a problem in the Phasing Relay Unit.

At this point, the problem in your system should have been identified.

If you need additional assistance from DX Engineering, feel free to call or write. Detailed discussions of system function, connections, and troubleshooting is best handled by telephone, Monday through Friday, 8:30 am to 4:30 pm Eastern Time, at 330-572-3200.

**Testing the Vertical Antennas without the DVA connected**

This test will determine if the vertical antenna system needs to be adjusted.

If the test results are not correct as described, one or both of the vertical antennas (or feedlines) may need to be adjusted accordingly.

If the test results are correct as described, there may be a problem with the Dual Vertical Array Relay Unit.

It is assumed that the full size quarter-wave vertical antennas are resonant (at the chosen frequency), are identical and properly installed. The radial system for both antennas must be complete and the quarter-wave feedline coaxial cables are electrically cut to the proper length for the frequency desired.

**Parts needed:**
- DXE-533-2 - UHF-T Adapter
- Antenna Analyzer or VNA: Rig Expert REU-AA-54/170/230Zoom/55Zoom, or equivalent
Testing the Vertical Antennas without the DXE-DVA connected.

Each full size quarter-wave vertical antenna should be resonant (reactance = 0) at the target frequency for the particular band: 7.150 MHz on 40 meters for example.

When the measurement is being done on one vertical antenna, the other vertical antenna should be floating (not connected to anything).

It is also expected that the impedance of a single full size quarter-wave vertical antenna should be close to 39 ohms at resonance, as in $39 + j0$ ohms. That represents the 36 ohms of a "textbook" quarter-wave vertical antenna, and a few ohms of ground loss, assuming a good ground.

When measured, one vertical with the other one floating, and the results are approximately $39 + j0$ ohms of impedance and then go to the second vertical with the first antenna now floating and again measure $39 + j0$ ohms, that's a good indication of being ready to go.

Now the pair of vertical can be tested together.

The 75 ohm 1/4-wavelength feedlines from the two vertical antennas are connected to a UHF-T (DXE-533-2) which is connected directly to an Antenna Analyzer or VNA.

**Do not use any extra coaxial cables since we are trying to measure the impedance right at the junction.**

The measured impedance at the target frequency should be very close to: $46 + j12$ ohms (in this example, the target frequency is 7.150 MHz). The values should be within a few ohms. Values that are far off may indicate a problem with one or both of the vertical antennas, cables or installation. If this occurs, then each antenna and cable should be carefully measured by themselves and adjustments made accordingly.
The following is a graph showing the impedance and reactance curves with the selected frequency of 7.150 MHz with the two antennas connected as shown above.

![Impedance and Reactance Curves](image)

The green arrows point to the readings (46 + j 12 ohms) at the selected 7.150 MHz.

The SWR of 1.3 is not the SWR dip. This is the expected value at the target frequency regardless of the band. The SWR dip well above array selected frequency is normal. **Remember, the goal is 46 n+ j 12 ohms at the desired frequency.**

The following graph shows the SWR sweep of the array connected as instructed.

![SWR Sweep](image)

The sweep shows the SWR dip above the selected frequency of 7.150 MHz.
Even though the SWR dip is high in frequency, the impedance (46 + j 12 ohms) is right on target at the selected frequency of 7.150 MHz. Do not adjust the verticals for a different result when the antenna feedlines are connected in parallel for this test.

The values should be within a few ohms. Values that are far off may indicate a problem with one or both of the vertical antennas or installation. If this occurs, then each antenna should be carefully measured by themselves and adjustments made to achieve the 39+ j 0 ohms at each antenna feedpoint.

The bottom line: If you measure an impedance of 46 + 12 j ohms using this T-adapter paralleled phasing feedline test set up with both vertical antennas, your system is good and ready to connect to the DXE-DVA Dual Vertical Array.
Technical Support

If you have questions about this product, or if you experience difficulties during the installation, contact DX Engineering at (330) 572-3200. You can also e-mail us at:

DXEngineering@DXEngineering.com

For best service, please take a few minutes to review this manual before you call.

Warranty

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