Pro-Stack Broadband  
Two Antenna Phasing System  

DXE-PS-2B-P  

DXE-PS-2B-P-INS Revision 2a

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1200 Southeast Ave. - Tallmadge, OH 44278  
Phone: (800) 777-0703 · Tech Support and International: (330) 572-3200  
Fax: (330) 572-3279 · E-mail: DXEngineering@DXEngineering.com

RoHS
Introduction

The DXE-PS-2B-P Pro-Stack Broadband Two Antenna Phasing System is primarily designed to combine two identical Yagi, log periodic or vertical antennas in a phasing arrangement. The DXE-PS-2B-P is a frequency independent broadband phasing system that operates with two mono-band antennas on any band, from 160 through 10 meters. It is a 50Ω system that is switched by applying 12 to 15 volts dc to three control wires. The unit can be used for other applications requiring the following four basic antenna feed selections:

- Both antenna ports in-phase
- Both antenna ports out-of-phase
- Antenna port 1 only
- Antenna port 2 only

Default is both antenna ports in-phase. To ensure lowest SWR, impedance matching automatically changes when any antenna is disabled.

Information on the appropriate distances for the separation between the two stacked Yagis, to create a versatile, high performance array, is discussed fully in the “ARRL Antenna Book”, 20th Edition. Generally, stacked Yagi antennas are separated vertically greater than 1/2-wavelength, free space. The bottom antenna should generally be as high above ground as the stack spacing distance. Optimum spacing is generally around one wavelength.

Features

- Power Handling up to 5 kW
- Broad band coverage on 160-10 meters
- Proven DX Engineering RF Relays - high performance
- Safe 12 volt dc relay operation
- MOV surge protection on control lines
- RoHS compliant assembly
- High-RF tolerant, silver - PTFE UHF connectors

Using Antenna Pattern to your Advantage

Signals arrive at your antenna from different azimuth directions and different elevation angles, depending on many variables. The ability to steer the major lobe of an antenna (or array of antennas) in both planes moves the major lobe and nulls, not just the major lobe. Typically two dB or slightly more is gained by stacking a second antenna. The largest advantage is not necessarily additional gain, but the ability to move harmful pattern nulls away from primary signal arrival angles. While gain makes a marginal improvement, moving a null can be a phenomenal change,
sometimes the difference between barely readable and having a strong signal which can provide the performance edge needed to work rare DX and win contests.

It is therefore desirable to not only change azimuthal direction by rotating the antenna, but also elevation angle by switching between antennas at different heights above ground and/or changing the phase relationship between multiple antennas. The old standard system in stacks was to activate or disable specific antennas in the stack to change pattern. In general, gain remains higher when all antennas are driven and phase is changed. This system allows either phase inversion or completely disabling any antenna.

The **DXE-PS-2B-P** Pro-Stack Broadband Two Antenna Phasing System provides the greatest flexibility from two identical antennas. This system contains a broad-bandwidth high-power 2:1 impedance matching transformer. This eliminates common requirements of using mixtures of 75Ω and 50 Ω cables for impedance matching.

A central stack-box location is best. Feedlines to each antenna from any stack-box should match the antenna system impedance and have the same electrical length. Feedlines need only be long enough to reach comfortably from each antenna to the stack-box. While it is best to have feedlines equal electrical lengths, total errors of twenty electrical degrees or less have only a minor impact on system performance. With such wide tolerances in cable lengths, cutting similar cables to equal lengths will suffice. There is no need to closely phase-match cables.

**Larger Array Building Blocks**

The **DXE-PS-2B-P** Pro-Stack Broadband Two Antenna Phasing System control box works in conjunction with identical boxes, or in combinations with 3-stack boxes, to build larger stacked arrays. For example, four antennas are stacked using three **DXE-PS-2B-P** boxes. In this example, two **PS-2B**s would be centrally located; one between the upper and lower antenna pairs, and each antenna would be fed through equal length cables. A single **PS-2B** located in the middle of the stack feeds the upper and lower boxes through equal lengths cables. This would allow the user to take any antenna or combination of antennas off-line, or feed any antenna or combination of antennas out-of-phase. Keep in mind out-of-phase systems generally have more gain than systems that disable antennas.

The best arrangement for larger stacked systems is feeding antennas in pairs, with the pairs fed from other stacking boxes. This is a distributed or branched feed system. All cables at any branch level should be equal length. While it is best to avoid length errors, accumulated errors totaling 20-degrees or less have a minimal affect on gain and positioning of lobes. With such wide tolerances in cable lengths, cutting similar cables to equal lengths will suffice. There is no need to closely phase-match cables.

Multiple antenna arrays require modeling with software such as “**EZNEC**” by W7EL to examine the multiple patterns possible by reversing phase and dropping antennas in a large system.
This unit is **RoHS** (Reduction of Hazardous Substances) compliant. The components, including the solder used are all lead free. If you decide to do any modifications or internal repairs, you should use only lead free solder and lead free soldering tools. Lead free solder melts approximately 100 degrees (F) higher than the old leaded solder, so you may need to upgrade your current soldering system.

**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](http://www.dxengineering.com)) for the latest revision manual.

**Additional Material Needed but not Supplied:**

- **JTL-12555 - Jet-Lube SS-30** anti-seize compound - used on the threads of Stainless Steel Hardware to prevent galling and aid in proper tightening torque.

- Two electrically equal length 50 Ω coaxial cables to run from the **DXE-PS-2B** to each of the identical Yagi antennas.

- 4-Wire Control Cable - **COM-CW4** Control Cable is ideal.

- **LCT-37534** Dielectric Grease
1 - Stacking Yagis

In-phase

- The greatest gain increase comes from the first pair of antennas.
- Optimum spacing is usually around one-wavelength stack spacing.
- Lower heights produce a cleaner pattern. Avoiding nulls in the middle of useful propagation angles is often more important than a small gain improvement.

Note that increased heights result in maximum stack gain improvement (maximum gain still occurs at about 1 wavelength antenna-to-antenna spacing) and lower wave angles. The lowest antenna should generally be significantly higher than the antenna-to-antenna spacing above ground for maximum stacking gain. Greatly increased height produces more minor lobes and stronger minor lobes.

Neglecting feedline losses, over medium soil two stacked Hy-Gain model 205CA 20 meter antennas have the following in-phase gain improvement:

![Figure 1](image)

70 feet = 1 wavelength

<table>
<thead>
<tr>
<th>Height</th>
<th>35+70 ft</th>
<th>52+104 ft</th>
<th>70+140 Optimum</th>
<th>87.5+175</th>
<th>110+180ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain / angle</td>
<td>15.41dBi @ 15 deg</td>
<td>16.89 dBi @ 11 deg</td>
<td>17.27dBi @ 8 deg</td>
<td>17.17 @ 7 deg</td>
<td>17.87 dBi @ 6 deg</td>
</tr>
<tr>
<td>Stack spacing</td>
<td>0.5 wave</td>
<td>.75 wave</td>
<td>1 wave</td>
<td>1.25 wave</td>
<td>1 wave</td>
</tr>
<tr>
<td>Reference Figures</td>
<td></td>
<td></td>
<td><strong>Figure 1</strong></td>
<td><strong>Figure 2</strong></td>
<td><strong>Figure 3</strong></td>
</tr>
</tbody>
</table>
Figure 2 - Maximum gain at 8 degree elevation

Figure 3 - Maximum gain at 6 degree elevation
Switching Out One Antenna

Dropping one antenna is useful to change patterns and fill null areas, even if it results in a loss of overall gain. It is also useful for reducing or elimination precipitation static during inclement weather by disconnecting the upper antenna. Pattern would depend on the type of antenna and antenna height.

Out-of-Phase

Out-of-phase stacking is more effective at raising wave angle than dropping one antenna. Here is the typical pattern of a maximum gain stack of Hy-Gain 205CA 20 meter antennas fed out-of-phase:

Figure 4 - Maximum gain at 28 degree elevation
Overlaying the two patterns of in-phase and out-of-phase:

![Figure 5](image)

If signals arrive in a null of the in-phase pattern, changing to out-of-phase can result in almost 40 dB increase in field strength.

In the pattern above, Blue is out-of-phase. Red is in-phase. This pattern demonstrates why the real advantage is filling of nulls. Note the blue trace is 2 to 3 dB down from the in-phase gain, so it primarily fills nulls.
2 - Phased Verticals

The stacking box can be used to feed three vertical antennas in a four pattern array. In this arrangement the three antennas are each individually 1/4-wave resonant antennas. The center #2 passive element must be directly grounded to a good ground system at all times. Elements #1 and #3 are then fed in various phase relationships. The following patterns are for three 1/4-wave elements over perfect ground. Figure 7 shows the proper radial system for three verticals with the radial systems bonded together where they would intersect.

Elements 1 and 3 out-of-phase (in this special case middle element has no current):

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**Figure 6**

**Figure 7**

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**Figure 8**

**EZNEC+ ver. 5.0**

--------- SOURCE DATA ---------

Frequency = 7.1 MHz

**Source 1**

Voltage = 190.7 V at 18.03 deg.
Current = 4.136 A at 0.0 deg.
Impedance = 43.84 + J 14.27 ohms
Power = 750 watts
SWR (50 ohm system) = 1.392 (75 ohm system) = 1.802

**Source 2**

Voltage = 190.7 V at -161.97 deg.
Current = 4.136 A at 180.0 deg.
Impedance = 43.84 + J 14.27 ohms
Power = 750 watts
SWR (50 ohm system) = 1.392 (75 ohm system) = 1.802

Total applied power = 1500 watts

---
Element one or three only (pattern can reverse):

![Diagram of antenna radiation pattern]

**Figure 9**

 EZNEC+ ver. 5.0

---------- SOURCE DATA ----------

**Frequency** = 7.1 MHz

**Source 1**
- Voltage = 252.1 V at 32.82 deg.
- Current = 7.08 A at 0.0 deg.
- Impedance = 29.93 + J 19.3 ohms
- Power = 1500 watts
- SWR (50 ohm system) = 2.024 (75 ohm system) = 2.701
The next band above the design-spacing band, such as 20 meters with 40 meter optimized spacing, can have some use if elements are trap verticals.

With vertical arrays, spacing errors limit available gain and directivity on bands below the optimum spacing band. Although trap antennas would still work and produce a little gain, patterns on bands below the optimum-spacing band show very modest directivity.
Installation

Before installing the **DXE-PS-2B-P** Relay Unit with control cable onto the tower, connection of the entire length of four (4) conductor control line between the **EC-PS2** Control Console and the **PS2B** Relay Unit for testing purposes is recommended.

Following installation of the two equal length coaxial cables (**PS2B** Relay Unit to antennas) on the Relay Unit during testing take continuity measurements to insure the system is functioning properly. Any trouble found during testing may be addressed before the **EC-PS2** and **PS2B** are installed into their operating positions.

Open the **EC-PS2** control console by removing the four (two per side) Phillips head screws to remove the cover.

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

Connections for the wire are made on the green header. Loosen each terminal screw until it is near flush with the top of the connector block as shown to the right.

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

Connect each wire to a terminal 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. The four-conductor control cable goes between the **PS2B** Relay Unit and the **EC-PS Control Console**. Either "G" is ground. Terminals G, 1, 2 and 3 are used. **COM-CW4** four conductor cable is available by the foot for your installation requirements.

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. Your color code may vary.

Input power should be +12 Vdc, well filtered at 2 amps (fused) minimum. A 2.1 mm power cord is supplied with unit. The wire with the white stripes is the +12 Vdc.

**Outer Connection** is GROUND ——— ——— ——— ——— ——— ———

**Center Pin** is +12 VDC.
The green connector on the **PS-2B** is in two parts and the top part can be removed by pulling it straight off. This will allow easier wire replacement or servicing as needed. When pushing the connector back in place, ensure you press straight inward.

Connect the 4 control wires to this plug as you did with the green connector in the **EC-PS2** Control Box. Selected output measures +12 Vdc between selected terminal (1, 2 or 3) and G.

Control lines (usually BCD) can normally use good quality CAT5e cable (4 twisted pairs of 24 AWG wire) for runs up to 1000 feet. Typical DX Engineering BCD control lines requirements are +12 VDC at 25 milliamps.

Depending on the number of control lines needed (usually 3 or 4) you can double up the twisted pairs of CAT5e cable, or use control wire that is at least 22 AWG, allowing runs up to 1500 feet. If you use a cable with more conductors, it is a good idea to tie the unused conductors to ground.

For longer runs of control cable, use a line loss calculator to ensure you supply the proper control levels needed.

Approximate BCD Control Line Lengths.

<table>
<thead>
<tr>
<th>Minimum Copper Wire Gage (AWG)</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>1,000 feet</td>
</tr>
<tr>
<td>22</td>
<td>1,500 feet</td>
</tr>
<tr>
<td>20</td>
<td>2,000 feet</td>
</tr>
</tbody>
</table>
Secure the **DXE-PS-2B-P** to the tower between the two stacked antennas using the included **DXE-SSVC-2P** V Saddle Clamp.

Use Jet-Lube SS-30 Anti-Seize on all stainless steel hardware to prevent galling.

Install the **DXE-PS-2B-P** with the connectors facing down.

The coaxial cable from the **upper** Yagi is connected to **ANT 2**. The coaxial cable from the **lower** Yagi is connected to **ANT 1**. The feedline from the **transmitter** is connected to **INPUT**.

Fasten all cables to the tower to relieve strain, and gently droop the cables to form a drip loop (do not use tight bends with coaxial cable).

**Note:** Do not seal the green connector! The connector is recessed inside a drip edge that prevents water from getting into connector. The cover-to-connector plate junction is not sealed so the unit can “breathe” and eliminate condensation.

The following table designates the sequence of antenna ports selected when using the **EC-PS2** Switch Console.

<table>
<thead>
<tr>
<th><strong>EC-PS2 LED ON</strong></th>
<th><strong>Activated Antenna(s)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 + 2</td>
<td>BOTH Yagi Antennas Activated, In Phase</td>
</tr>
<tr>
<td>1 + 2</td>
<td>BOTH Yagi Antennas Activated, Out of Phase</td>
</tr>
<tr>
<td>1</td>
<td>LOWER Yagi Antenna only</td>
</tr>
<tr>
<td>2</td>
<td>UPPER Yagi Antenna only</td>
</tr>
</tbody>
</table>
Optional Accessory Items

**JTL-12555 Jet-Lube™ SS-30 Pure Copper Anti-Seize 12555**

Jet-Lube™ SS-30 Pure Copper Anti-Seize is the top choice of engineers and technicians in government, industry and leading Amateur Radio contest stations, for protecting mechanical assemblies of aluminum tubing, general hardware and copper grounding systems. On bonded metal surfaces Jet-Lube™ SS-30 assures electrical and RF conductivity while preventing oxidation and corrosion. Surpassing the capabilities of other aluminum anti-oxidants, the wide temperature range of Jet-Lube™ SS-30 prevents long-term drying and caking, and allows easy disassembly and effortless cleaning of parts. An environmentally preferred thread lubricant and conductive termination compound, Jet-Lube™ SS-30 helps keep your equipment in serviceable condition. It contains a high concentration of copper flakes, a requirement for heavy loads or compression; controlled frictional characteristics allow the surfaces of nuts and bolts to be tightened to their design torque specifications. This anti-seize product assures full hydraulic efficiency by allowing the metal surfaces to slide over each other without damaging metal-to-metal contact. Jet-Lube™ SS-30 is also designed to work as a similar and dissimilar component between two metal surfaces to prevent seizing and galvanic action. The SS-30 compound formula improves conductivity and ground continuity - and will not melt in high temperatures.

Jet-Lube™ SS-30 Pure Copper Anti-Seize Features include:

* Meets MIL-PRF-907E spec
* K-factor: 0.13
* Service rating: -65 degrees F (-54 degrees C) to 1800 degrees F (820 degrees C)
* SS-30 Resistivity (ohm-CM x 108) 5

**DX Engineering DXE-213U an RG-213/U Coax Assembly**

These DX Engineering cable assemblies use high quality DXE-213U coaxial cable and include Silver/PTFE PL-259 (UHF) or male N connectors installed at each end. DXE-213U cable is protected by a non-contaminating PVC jacket and is normally recommended for both indoor and outdoor applications. The UV stabilized jacket assures long life where ultraviolet contamination is a concern. Manufactured to MIL-spec (MIL-C-17, M17/163-00001), you can always be sure of getting the highest quality cable. The coax has a flexible 12.5 gauge stranded copper center, Poly dielectric, 96% coverage bare copper shield and a non-contaminating PVC jacket. The PL-259 connector is Silver/PTFE with a silver plated center conductor. The N connector is Silver/PTFE with a gold center conductor. Connectors are soldered rather than crimped and an adhesive lined shrink tubing is used to form a weather-resistant bond between the connector body and the coax. Each assembly is then 100% Hi-Pot tested to guarantee a quality cable assembly you can count on.

*Custom Lengths Available, Call DX Engineering for Details*

**50Ω Coax Cable Prep Tools**

The UT-8213 (red tool) simplifies the preparation of RG-8 or RG-213 coax to accept PL-259 UHF style or 2-piece Type N connectors. The UT-808X (green tool) is specifically designed for stripping RG-8X/Belden 9258 cable. The CNL-911 cutters have specially designed blades to cut the cable without crushing it - leaving the end cleanly cut and ready for stripping and connector assembly. The UT-80P or UT-80N allows mechanical assembly of the PL-259 or 2-piece Type N connector body to the cable without shredding it with pliers. All DX Engineering Cable Prep Tools are designed and selected to provide better results, with greater ease of use.

<table>
<thead>
<tr>
<th>DXE Part Number</th>
<th>Part Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>DXE-UT-8213</td>
<td>Coax Cable Stripper for RG-213, RG-8, 9913F7, LMR-400 etc.</td>
</tr>
<tr>
<td>DXE-UT-808X</td>
<td>Coax Cable Stripper for RG-8X, Belden 9258, LMR-240</td>
</tr>
<tr>
<td>DXE-UT-RB-HD</td>
<td>Premium Replacement Blades for DX Engineering and Cablematic Strippers</td>
</tr>
<tr>
<td>DXE-UT-80P</td>
<td>Connector Assembly Tool for PL-259/RG-213-size Cable</td>
</tr>
<tr>
<td>CNL-911</td>
<td>Coax Cable Cutter</td>
</tr>
<tr>
<td>DXE-170M</td>
<td>Precision Shear Side Cutters</td>
</tr>
</tbody>
</table>

**TES-2155 - 3M Temflex™ 2155 Rubber Splicing Tape.**

Conformable self-fusing rubber electrical insulating tape. Designed for low voltage electrical insulating and moisture sealing applications. For outdoor use, it should be protected from UV deterioration with an overwrap of TES-06132

**TES-06132 - Scotch® Super 33+.**

Highly conformable super stretchy tape for all weather applications. This tape provides flexibility and easy handling for all around performance. It also combines PVC backing with excellent electrical insulating properties to provide primary electrical insulation for splices up to 600V and protective jacketing.
DXE-IS-RCT DC Shunt Control Line Protector

DX Engineering Rotator Control Line Protector is a custom made surge protector designed for use on rotator cables - up to 8 conductors. Also ideal for control lines of remote antenna switches and any low voltage control system where voltages are normally below 60 Vdc or ac.

DXE-IS-RCT features include:
* Weatherproof metal enclosure with cover, mounting stud and terminal gaskets to deter water from entering the enclosure.
* Terminal strips to connect up to eight rotator control wires
* 1/4 in. x 20 mounting stud allowing multiple mounting configurations
* Each line connection has an individual shunt MOV for maximum surge protection
* Voltage spikes exceeding 82 Vdc (in either polarity) will be shunted to ground
* RoHS compliant construction

DXE-CW9S - Shielded Control Wire, 9 conductor stranded, per foot

DXE-CW9S is a high quality shielded outdoor cable. It features 9 #24 AWG stranded conductors with aluminum foil shielding plus a #24 stranded tinned copper drain wire. This gives you 8 switch positions plus common ground - plus the separate shield. It has a gray PVC jacket. This cable is ideal for DX Engineering Remote Antenna Switches and Four Square arrays, and should be considered for any low-current custom remote switching application you have - such as receiving antenna arrays. Order by the foot in the length you require. Price shown is per foot. A nice feature is the "rip cord", which allows for easy stripping of the heavy jacket without worry about nicking or accidentally cutting the conductors.

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.

This unit is RoHS (Reduction of Hazardous Substances) compliant. The components, including the solder used are all lead free. If you decide to do any modifications or internal repairs, you should use only lead free solder and lead free soldering tools. Lead free solder melts approximately 100 degrees higher than the old leaded solder, so you may need to upgrade your current soldering system.

Warranty

All products manufactured by DX Engineering are warranted to be free from defects in material and workmanship for a period of one (1) year from date of shipment. DX Engineering’s sole obligation under these warranties shall be to issue credit, repair or replace any item or part thereof which is proved to be other than as warranted; no allowance shall be made for any labor charges of Buyer for replacement of parts, adjustment or repairs, or any other work, unless such charges are authorized in advance by DX Engineering. If DX Engineering’s products are claimed to be defective in material or workmanship, DX Engineering shall, upon prompt notice thereof, issue shipping instructions for return to DX Engineering (transportation-charges prepaid by Buyer). Every such claim for breach of these warranties shall be deemed to be waived by Buyer unless made in writing. The above warranties shall not extend to any products or parts thereof which have been subjected to any misuse or neglect, damaged by accident, rendered defective by reason of improper installation, damaged from severe weather including floods, or abnormal environmental conditions such as prolonged exposure to corrosives or power surges, or by the performance of repairs or alterations outside of our plant, and shall not apply to any goods or parts thereof furnished by Buyer or acquired from others at Buyer’s specifications. In addition, DX Engineering’s warranties do not extend to other equipment and parts manufactured by others except to the extent of the original manufacturer’s warranty to DX Engineering. The obligations under the foregoing warranties are limited to the precise terms thereof. These warranties provide exclusive remedies, expressly in lieu of all other remedies including claims for special or consequential damages. SELLER NEITHER MAKES NOR ASSUMES ANY OTHER WARRANTY WHATSOEVER, WHETHER EXPRESS, STATUTORY, OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS, AND NO PERSON IS AUTHORIZED TO ASSUME FOR DX ENGINEERING ANY OBLIGATION OR LIABILITY NOT STRICTLY IN ACCORDANCE WITH THE FOREGOING.

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