Four-Square Arrays
or
Two Element Phased Arrays

ACB-4-A Series: COM-ACB-160-A, COM-ACB-80-A, COM-ACB-40-A,

COM-ACB-A-INS-Revision 1

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Congratulations! You are now the proud owner of an ACB-4 Hybrid Quadrature Phasing Coupler, based on the Collins design. COMTEK has manufactured this product to guarantee reliable communications for many years. These systems have proven to be a powerful weapon in the Contester’s and DX’ers antenna arsenal.

**ACB-4 HYBRID PHASING COUPLER FEATURES**

COMTEK uses state of the art design and technology to offer every ham the most advanced antenna systems possible.

Our Phased Array Systems are affordable, simple to install and easy to use. COMTEK makes mono-band phased array switches from 160-10 meters.

A phased array consists of two or more elements fed with a particular phase and power ratio to obtain a directional pattern. Each element of the antenna can be fed with different amounts of power and phase relationships to obtain this directional pattern, providing good gain and front-to-back and front-to-side ratios. COMTEK phased array switchboxes can be used with 2 or 4-element vertical arrays. Our 4-square vertical array provides the greatest directivity.

![Comparison of Phased Array and 4 Square Array Radiation Patterns](image)

The COMTEK ACB-4 used for a 2 element Phased Array System provides the patterns shown on the left in this diagram.

See page 18 for more information on a two element phased system.

Note the clean pattern and 25 dB of front-to-back at low angles. Gain is 4 dB over a single element using a good ground.
4-Square Array

More gain and better front-to-back and front-to-side ratios are possible using a 4-element array. Four separate verticals are arranged in a square -- a 4-square array -- one vertical at each corner of a square. The square is one quarter wavelength on a side. Its pattern is directional across each diagonal of that square. In other words, it beams across opposite corners of the square. The COMTEK ACB-4 provides the correct power and phase division between these 4 vertical elements and a switch matrix which allows rotation of the relative powers and phases allowing 4 separate directions at the flick of a switch from your operating position.

The exterior Relay Unit of the ACB-4 contains all the switching and phase and power controls using hybrid toroids. No coax cables are hanging at the switchbox. You switch 90 degrees at each of the 4 switch settings-providing a full 360 degrees of coverage.

ACB-4 HYBRID PHASING COUPLER SPECIFICATIONS
The ACB-4 is band specific. You cannot use an 80M ACB-4 for any band other than 80M. In order to meet your needs, we offer the ACB-4 for all amateur bands from 10M to 160M. If you have any special needs, or the model you are interested in is not listed, please contact us.

CONTROL CONSOLE
- Operation on 12 to 13.6 Vdc, well filtered, 2 amp minimum
- Heavy duty one amp diodes with Sprague RF bypass caps
- Current limiting resistor protection for each LED
- Chassis and cover custom manufactured to our specifications.
- LEXAN label for recording favored directions
- Compact size: 2-3/8"H x 6-1/4"W x 5-1/2" D

90 DEGREE HYBRID-RELAY MATRIX
- Fifteen amp gold plated contact relays with dust covers
- Belden TEFLON silver stranded wire over 3M Fiberglass tape wound toroids
- Sprague 5% balanced temperature, frequency and voltage stable capacitors
- Laboratory analyzed for improved performance
- Double-sided printed circuit board
- Two KW conservative rating for Amateur Radio Service
- Harris MOV's for lightning surge protection with Sprague RF bypass caps
- Size: 4"H x 6"W x 8-1/2"D
- Brushed aluminum finish Z-Chassis and Cover with riveted seams
INSTRUCTIONS

The ACB-4 consists of a control switch and the hybrid switching matrix. They are connected via a three conductor control cable. Our tests have used 1500 feet of 24 AWG wire, so for those with long runs, 18 AWG should be adequate.

The heart of a four square is the ACB-4, however, the vertical radiators themselves are vitally important. The following types of vertical antennas have been successfully used worldwide:

1) Conventional ground mounted 1/4-wave verticals - available from DX Engineering
2) 1/4-wave elevated ground plane verticals
3) 1/2-wave center-fed vertical dipoles
4) Conical monopoles (grounded verticals)
5) Inverted L

The ACB-4 contains two hybrids and the necessary switching matrix to provide correct phasing to each of the four elements 0 & -90 and -180 & -90 degrees. Two element arrays can be phased by simply using the 0 & -90 ports.

RF power division is also accomplished with the ACB-4 so that all ports get an equal power split. Due to mutual coupling within the array, each element will present different impedance; i.e. different from the impedance of a single element.

If all elements are not the same (or very similar), your system may not be symmetrical and an imbalance may result. Be careful to make each vertical radiator as identical as possible.

The physical layout of the array is also important. Elements should be symmetrical in placement, within one foot of each location.

Use of a good radial system is paramount with any high performance earth mounted vertical antenna system. With a Marconi vertical antenna system, the radials are the second half of the antenna. They also act like a screen, shielding radiation from the lossy earth below the radials. Radials greatly influence radiation efficiency of a ground-mounted vertical antenna system.

Use of the DX Engineering **DXE-RADP-3** Stainless Steel Radial Plate is an ideal solution to having a symmetric and well designed radial system. Mount a **DXE-RADP-3** to the 2” OD (maximum OD is 2”) mounting pipe at each of the vertical antennas using a **DXE-SSVC-2P** Stainless Steel V-Clamp.

For best performance, refer to **Table 1** for the radial system required for the band of operation. In most cases peak performance actually comes with as few as 20 or 30 radials. At that point the array stops rapidly increasing in field strength as radials are added. 32 radials is generally a very comfortable number when cost vs. efficiency is considered. Payback is generally only a fraction of a dB when more than 40 radials are compared to 20-30 radials. In any event, it is never necessary to use more than 50 or 60 radials. Dozens of studies have proven there is very little change in efficiency beyond 50 radials, regardless of soil type. DX Engineering **DXE-RADW** Radial Wire, a stranded copper 14 gauge relaxed PVC insulated copper wire is suggested for the best results.
<table>
<thead>
<tr>
<th>Band of Operation</th>
<th>Minimum Number of Radial Wires</th>
<th>Maximum Length of each Radial Wire</th>
<th>Minimum Length of each Radial Wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>160 Meters</td>
<td>32</td>
<td>130 Feet</td>
<td>65 Feet</td>
</tr>
<tr>
<td>80 Meters</td>
<td>32</td>
<td>65 Feet</td>
<td>32.5 Feet</td>
</tr>
<tr>
<td>75 Meters</td>
<td>32</td>
<td>65 Feet</td>
<td>32.5 Feet</td>
</tr>
<tr>
<td>40 Meters</td>
<td>32</td>
<td>33 Feet</td>
<td>16.25 Feet</td>
</tr>
</tbody>
</table>

Table 1 - Radial Wire Lengths

Not all of the radial wires will be 1/4-wavelength long. Since the four vertical antennas are spaced 1/4-wavelength apart, the radial fields would cross each other. At the point where the radial fields do cross, they can be cut and bonded together with intersecting radials from the adjacent radial fields, as shown in Fig 1.

The wire radials should placed as symmetrically as possible straight from the feedpoint around each of the vertical antennas and spaced evenly, regardless of how many radials are used. Do not run radials parallel or in bundles, and avoid bending radials to extend the length. This nullifies or reduces radial effectiveness.

If you have limited space, put in as many straight radials as you can. Radials must be connected to the antenna feedline shield. The DX Engineering DXE-RADP-3 Stainless Steel Radial Plate is an ideal optional item for making radial connections. The corrosion resistant stainless steel plate provides an excellent reliable system for attaching radial wires to your vertical antenna system feedpoint.

Radial wires can be laid in shortly mowed grass using DX Engineering DXE-STPL-100K/BD Steel or Biodegradable Radial Wire Anchor Staples to hold them down. Use enough staples to ensure the wires will not be snagged by mowers, people, or animals. Grass will quickly overgrow the radials and it will be virtually impossible to see them. An article describing this process is available on the DX Engineering website in the Tech Info section. Radials can also be buried just under the surface by using a power edger or single blade plow to make a slit in the soil.

![Figure 1 - Typical Radial Field](image)

When the radial field is set up for the four vertical antennas, copper strap or heavy solid buss wire should be used to provide cross bonding of the radials that meet each other.
The four square array is directional across its diagonals. So when laying out your array, make certain you know the difference between true north and magnetic north (using a compass) for your QTH and place the elements accordingly to true north. Remember that you will be beaming across the diagonals. Using the formula $246/f$ (MHz) should determine spacing along the sides of the square for best pattern results. This means the diagonal distance will be $1.41 \times 246/f$ (MHz).

Other spacing close to this value may work, but the characteristics of the main lobe will change 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. Use $234/f$ (MHz) for the vertical and radial length.

The ACB-4 uses a Quadrature hybrid in toroid form to obtain 90 degree phase shifts. This device is a four port hybrid and one port must be terminated with a 50-ohm dummy load. This termination is vital! When the array is working well, with all elements resonant, there is typically less than 5% power dissipated by this load. However, when an element is open, shorted, or not resonant at the same frequency as other elements, this load will dissipate power. A test for your system is to measure the power between the ACB-4 and the dummy load. The lower the power reading, the better your system is performing. Coax between the load port and the dummy load may be any convenient length of 50-ohm cable. A length of 50-ohm cable to the operating position connected to a wattmeter and the dummy load will allow simultaneous operation and monitoring the power level to the load.

Front-to-back is affected by the balance between elements. If you want good front-to-back, pay attention to the details of making each element the same and symmetrical. Using the Four-Square vertical array, you will notice the best front-to-back on low angle signals. Signals arriving at high angles see all elements in the array at the same time (no phase delay is possible) and therefore may display small front-to-back ratios. Do not worry if this happens; just wait for low angle signals to test your system.

**Tuning the radiators (use this procedure with any type element)**

1) Install one radiator and install the ground radial system. ($234/f$ (MHz))

2) Connect a 50-ohm feed line to the radiator

3) Tune quarter-wave element to lowest VSWR approximately 100 kHz lower than the desired frequency when using 1/4-wave tubing. Due to mutual coupling, the array will shift up approximately 100 kHz when all verticals are connected and fed from the ACB-4 Hybrid Coupler. Our experience has shown reduced mutual coupling with less than 1/4-wave sized elements, 1/4-wave wire elements and shortened commercial verticals. Examples: Tune for 3.550 for 3.650 mid-range coverage. Tune 7.000 for 7.100 etc.

4) Disconnect 50-ohm feed line. Make remaining radiators identical to the first radiator

5) Drive a 1-1/4" to 1-1/2" outside diameter pipe into the ground at the array center. Install hybrid with supplied U-Bolt. (If installing 1/2-wavelength dipoles, install hybrid on one tower leg.)
6) Connect all radiators with 1/4-wavelength 75-ohm FOAM coax to their respective ports on the ACB-4. (Belden 8213, JSC 3640 or equivalent).

Use supplied cable tags to identify coax from each radiator, and place several inches below connectors at the ACB-4. This will aid in properly installing the cables if disconnected for any reason.

**EXCEPTION to 75-ohm coax requirement:** Inverted L arrays present a lower impedance and require 1/4-wave 50-ohm lines such as RG-8 Foam or 3/4-wave RG-213.

7) Connect 50-ohm dummy load to load port via 50-ohm coax.

8) Connect 50-ohm feed line from ACB-4 to transmitter.

9) Connect 3 conductor cable to terminal strips inside the ACB-4 and inside the control console. Connect G to G, 1 to 1 and 2 to 2. Four conductor cable is recommended for future upgrades to DX Engineering Four Square Controllers.

Use the included Tye-Wrap on the cable to avoid accidentally pulling the cable out of the control box.

A 2.1 mm power cord is supplied with unit. The wire with the white stripes is the +12 Vdc.

![White Lines = +12 Vdc](image)

**Outer Connection is GROUND**  
**Center Pin is +12 VDC.**

Power used must be +12 Vdc, well filtered at 2 amps (fused) minimum.

**All Models Ship with the DC powered ACB-4 Control Console**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Northwest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Northeast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Southeast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Southwest</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The output of the Control Console is as follows:

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal 1</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Terminal 2</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Digital Volt Meter connected between G and each terminal as needed.
For those customers in high snowfall totals or pesky wildlife, an 8 gallon plastic trash can can be obtained and placed over the ACB-4 to prevent snow from building up to the connector ports.

We recommend you install the coax cables so position 2 on the inside control is your most favored direction. Position 2 is the default position and does not supply any voltage to the relays. This means when the control box is off, you are beaming in the direction of position 2.

**NOTES**

1) As an example, most types of RG-11 foam coax have a velocity factor of .78%.

   The formula for a specific frequency is: \(\frac{246}{f} \text{ (MHz)} \times .78 = \text{length in feet}\). This works out to 50 feet 6 inches at 3.800 before measuring for an electrical 1/4 wave. Foam coax must be used to reach the antennas.

   CATV hardline velocity factors are typically .81% or higher. Polyethylene coax with a velocity factor of .66 will not reach the antennas.

   Your VSWR should be less than 2:1 from 3.5-3.8 MHz with full size aluminum elements, with 5% or less of transmitted power "dumped" into the 50-ohm load.

2) See the ARRL Antenna Handbook chapter on "Antenna Orientation" for details on how to determine true north for your QTH. Using only a compass with no correction can cause the array to be off by as much as 30 degrees.

3) **Do not HOT SWITCH**, i.e. transmit while switching. THIS CAN DAMAGE THE RELAY. HOT SWITCHING is NOT covered under warranty.

**WARNING !**

**DO NOT INSTALL ANTENNAS NEAR POWER LINES!**
**METAL OBJECTS TOUCHING HIGH VOLTAGE LINES CAN CAUSE SERIOUS OR FATAL INJURIES!**
QUARTER-WAVE (1/4w) FEEDLINE SET-UP FOR FAVORED DIRECTION USING DEFAULT POSITION

HYBRID PORTS   #1   2   3   4
Directions:     NW   NE   SE   SW

(This is normally used by North American stations.)

The following setup directions are for other parts of the world. Remember Position 2 is the favorite direction:

<table>
<thead>
<tr>
<th></th>
<th>SW</th>
<th>NW</th>
<th>NE</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NW</td>
<td>NE</td>
<td>SW</td>
<td>NW</td>
<td></td>
</tr>
<tr>
<td>NE</td>
<td>SE</td>
<td>SW</td>
<td>NW</td>
<td></td>
</tr>
<tr>
<td>SE</td>
<td>SW</td>
<td>NW</td>
<td>NE</td>
<td></td>
</tr>
</tbody>
</table>

Position 2 is the default position, i.e., the array favors this direction when no power is applied to the relays.

Position 1 applies voltage to all three relays, which are closed.
Position 2 no voltage and all relays open
Position 3 applies voltage and closes K-1 & K-2. (K-3, far left is open.)
Position 4 applies voltage and closes K-3. (K-1 & K-2, far right & center are open.)

Facing the 3 wire terminal strip, K-1 is far right; K-2 is in the center and K-3 is far left. Again, while facing the terminal strip side.

IF any two antenna connections are not in the proper ports, the array will not function correctly and a higher SWR will result.
COMTEK SYSTEMS ACB-4  4-SQUARE SETUP DIMENSIONS

160 = 1.835
Spacing = 134 feet
Diagonal = 189 feet
Foam Coax = 104 feet 6 1/2 inches (RG-11 @ .78 to .81% VF minimum is required.)
ACB-4 to any vertical = 94 feet 6 inches  (.78% minimum figures shown)

80 = 3.500 (Favors CW Operation)
Spacing = 70 feet 3 inches
Diagonal = 99 feet
Foam Coax = 54 feet 9-1/2 inches
ACB-4 To any vertical = 49 feet 6 inches

80 = 3.650 (Favors CW & Phone Operation)
Spacing = 67 feet 4 inches
Diagonal = 95 feet
Foam Coax = 52 feet 6-1/2 inches
ACB-4 to any vertical = 47 feet 6 inches

80 = 3.775 (Favors DX Phone Window)
Spacing = 65 feet 1-3/4 inches
Diagonal = 91 feet 10 inches
Foam Coax = 50 feet 9-1/2 inches
ACB-4 to any vertical = 45 feet 11 inches

40 = 7.100
Spacing = 34 feet 7 inches
Diagonal = 48 feet 10 inches
Foam Coax = 27 feet
ACB-4 to any vertical = 24 feet 5 inches

<table>
<thead>
<tr>
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<th>Maximum Length of each Radial Wire</th>
<th>Minimum Length of each Radial Wire</th>
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</thead>
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<tr>
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<tr>
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<td>32</td>
<td>65 Feet</td>
<td>32.5 Feet</td>
</tr>
<tr>
<td>75 Meters</td>
<td>32</td>
<td>65 Feet</td>
<td>32.5 Feet</td>
</tr>
<tr>
<td>40 Meters</td>
<td>32</td>
<td>33 Feet</td>
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Radial Wire Lengths

Not all of the radial wires will be 1/4-wavelength long. Since the four vertical antennas are spaced 1/4-wavelength apart, the radial fields would cross each other. At the point where the radial fields do cross, they can be cut and bonded together with intersecting radials from the adjacent radial fields, as shown in Fig 1.

The wire radials should placed as symmetrically as possible straight from the feedpoint around each of the vertical antennas and spaced evenly, regardless of how many radials are used. Do not run radials parallel or in bundles, and avoid bending radials to extend the length. This nullifies or reduces radial effectiveness.
Comtek 4-Square typical performance

X-1  X-2

X-4  X-3

Directivity is diagonal-through each of the two sets of verticals.

Gain: 4 dB over single vertical
Beamwidth: +/- 46 degrees
Front-to-Back > 20 dB over 120 degrees
Front-to-Side > 15 dB
Rotation time: < 1 second
Directions: 4 - Across diagonals
Required Footprint: Including radials
160M (1.835) 400 X 400 feet
75/80M (3.650) 200 X 200 feet
40M (7.100) 105 X 105 feet
20M (14.200) 51 X 51 feet

Examples:

<table>
<thead>
<tr>
<th>Band</th>
<th>Freq</th>
<th>X-1 to X-2. X-2 to X-3. X-3 to X-4. X-4 to X-1</th>
<th>Diagonal X2 to X4</th>
<th>Diagonal X1 to X3</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td>1.835</td>
<td>134'</td>
<td>189'</td>
<td>189'</td>
</tr>
<tr>
<td>80</td>
<td>3.500</td>
<td>70' 3&quot;</td>
<td>99'</td>
<td>99'</td>
</tr>
<tr>
<td>80</td>
<td>3.650</td>
<td>67' 4&quot;</td>
<td>95'</td>
<td>95'</td>
</tr>
<tr>
<td>80</td>
<td>3.775</td>
<td>65' 2&quot;</td>
<td>92'</td>
<td>92'</td>
</tr>
<tr>
<td>40</td>
<td>7.100</td>
<td>34' 7&quot;</td>
<td>48' 10&quot;</td>
<td>48' 10&quot;</td>
</tr>
<tr>
<td>30</td>
<td>10.125</td>
<td>24' 3&quot;</td>
<td>34' 3&quot;</td>
<td>34' 3&quot;</td>
</tr>
<tr>
<td>20</td>
<td>14.200</td>
<td>17' 3&quot;</td>
<td>24' 5&quot;</td>
<td>24' 5&quot;</td>
</tr>
</tbody>
</table>
02-06-1998 14:16:43
Freq = 3.8 MHz

Gain: 7.388 dBi
Angle: 45 deg
Fo/B: 28.653 dB
Beamwidth: 96 deg
-3dB: 357, 93 deg
Slope: 7.388 dBi
Angle: 45 deg
F/Slope: 0.000 dB

Outer Ring = 7.387 dBi
Max. Gain = 7.388 dBi

Azimuth Plot
Elevation Angle = 20.0 deg.

02-06-1998 14:17:44
Freq = 3.8 MHz

Gain: 6.646 dBi
Takeoff: 22 deg
Beamwidth: 39 deg
-3dB: 84 deg
Slope: -11.831 dBi
Angle: 115 deg
F/Slope: 18.477 dB

Outer Ring = 6.646 dBi
Max. Gain = 6.646 dBi

Elevation Plot
Azimuth Angle = 20.0 Deg.
TROUBLESHOOTING AND MISCELLANEOUS

The supplied Cable ID Tags should be numbered 1, 2, 3, and 4, then placed on the 1/4 wave coax lines from each antenna at the hybrid coupler port end. This will prevent an out of sequence connection, which will result in poor performance. A waterproof marker used to number the tags is recommended.

TYPICAL NORTH AMERICAN EXAMPLE

<table>
<thead>
<tr>
<th>Position</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Northwest</td>
</tr>
<tr>
<td>2</td>
<td>Northeast</td>
</tr>
<tr>
<td>3</td>
<td>Southeast</td>
</tr>
<tr>
<td>4</td>
<td>Southwest</td>
</tr>
</tbody>
</table>

These are the favorite directions for North America users. Remember, Position 2 is the default position when power is off, the array will beam towards Europe (Northeast).

Insure DC power is OFF prior to connecting the 3 conductor control cable to the hybrid terminal strip. Four conductor cable is recommended for future upgrades to DX Engineering Four Square Controllers.

Initial test should be with transmitter in low power position.

Never switch relays while transmitting. “HOTSWITCHING” at HIGH power levels will damage the relays and possibly the transmitting equipment.

Hotswitching at 50 to 75 watt power levels is acceptable and will aid in the cleaning of the relay contacts by rotating the control switch from Position 1 to Position 2 then back to 1. Repeat this sequence several times.

NOTE FOR ELEVATED FEED ARRAYS INCLUDING FOUR 1/2 WAVE DIPOLES

Anytime the four 75-ohm FOAM feedlines and feedpoints are elevated above ground, it is IMPORTANT TO USE A CURRENT BALUN at the feedpoint to reduce RF currents from flowing on the coax shield (braid). RF on the braid will deteriorate performance. We do not recommend coiling the quarter-wave lines at the antenna feedpoints.

Comtek stocks two sizes of RF beads which slip over RG-11 foam or RG-59 foam coax. These beads choke RF from flowing on the shield, resulting in cleaner patterns.
SIMPLIFIED POWER MONITORING PROCEDURE
After the array is tuned, you may run a length of RG-58 or RG-8X from the Dummy Load Port to a wattmeter in the shack. Connect a short jumper from the wattmeter antenna out to the dummy load. This allows complete monitoring of the dissipated power at all times while on the air.

TOWER LEG INSTALLATIONS
Remove the sheet metal screw above the U-Bolt prior to installing the hybrid on a tower leg, as in a dipole array. This permits the cover to be removed later without removing the U-Bolt.

DEEP SNOW PROTECTION
For customers residing in areas with high snowfall amounts, one suggestion is to purchase an 8 gallon trash container and turn it upside down over the Hybrid installed on a 2 or 3 foot pipe. This will prevent snow from accumulating around the UHF connector ports. An 8 gallon size may be purchased in home supply stores. A brick or heavy block of wood can be placed on top to prevent being blown over by strong winds.

TYPES OF VERTICAL MATERIAL
The following have been successfully used in Four-Square arrays in conjunction with the COMTEK SYSTEMS ACB-4 SERIES HYBRID PHASING COUPLER:

1. Aluminum irrigation tubing. 3" to 5" OD. Typical height for 3" OD coupled is 64 feet for resonance at 3.650. Heights will vary slightly, being determined by the diameter used.

2. Rohn 20/25G tower on insulated bases for 80 meters. Rohn 25G and 45G are used on 160 meters.

3. Wires supported from nylon/dacron ropes, which are in turn tower supported. Trees offer supports for wire arrays as well, however, tree supported arrays require heavy maintenance. Wire arrays typically do not exhibit bandwidth as aluminum elements.

4. Hy-Gain Hy-Towers extended to 75 feet with all other stubs removed, for 3.650.

5. Short Top-Loaded verticals for 80 meters from 38 feet to 50 feet in height. These work well, but do not cover the entire band as full quarter wave sized aluminum elements.

6. Commercial verticals may also be used in a four-square array. DX Engineering (www.dxengineering.com) has a full line of vertical antennas that are perfect for phased array systems.

DX Engineering sells quality aluminum from 2.125 OD in 3’ and 6’ lengths. The 6’ pieces are UPS shippable. TEL: 330-572-3200 or visit their web page at www.dxengineering.com
ADDITIONAL REFERENCES

Antennas and Techniques for LOW-BAND DX'ing by ON4UN, published by ARRL,
The Amateur Radio VERTICAL ANTENNA HANDBOOK by Capt. Paul H. Lee, N6PL. This excellent book covers Conical Monopoles, an excellent vertical superior to shunt-feeding towers. All About VERTICAL ANTENNAS by William I. Orr, W6SAI & Stuart D. Cowan, W2LX.

INSTALLATION NOTES and FREQUENTLY ASKED QUESTIONS. (FAQ)

How close can I install my 4-Square to other verticals or my tower?
Unless the 4-Square will be installed on a multi-acre location, insure the array will not be beaming into towers or other objects such as buildings closer than one-half wavelength. Some installations perform well at lesser distances, but one-half wave distance is the recommended minimum.

Will a 4-Square cover the entire band?
Yes and No. Using full sized aluminum verticals, the 20, 40, and 80-meter bands can be fully covered with appropriate spacing. 160 meters can easily cover 1.800 to 1.900 using Rohn 20G/25G tower sections as the radiators. Using wire elements will not permit full coverage, unless stub switching is incorporated.

Can I install a 40 meter 4-Square inside my 80 meter 4-Square?
This is not recommended. The 40m performance will be greatly reduced due to mutual coupling. (No 20m inside a 40m; No 80m inside a 160 etc. also applies.)

If one phasing line is too short to reach a vertical, can I add a few feet? Can I make one 3/4 wave long while the other 3 are at 1/4 wavelength?
Simply stated, No. If unequal lines are used, the phase relationship is incorrect and performance will be poor. Make ALL either 1/4 or 3/4 electrical wavelengths in length.

How deep do I bury the radials?
If foot traffic is minimum, simply cut grass shorter than normal and pin radials down with wire lawn staples every 3’ to 5’ as terrain requires. Grass thatch will cover them in a few months. (Don’t forget to raise cutting level of mower!) If burial is required, slight trenching 1"-2" is sufficient.

Should I use three or four conductor control cable?
Four conductor cable is recommended for future upgrades to DX Engineering Four Square Controllers.
ACB-4 TROUBLESHOOTING

One of the most common reported problems after a new installation is lack of front-to-back or working a station opposite the normal direction. This is caused by incorrect sequence of wiring from the inside control switch or the quarter-wave coax lines, to the hybrid relay unit. The control wiring sequence From left to right is G-1-2: HOWEVER, ON THE RELAY UNIT, it is G-2-1. The following truth table indicates relay closure in selected positions, and voltages applicable to the terminals on the rear of the ACB-4 control unit. See page 8 for directional connections for the quarter-wave coax.

<table>
<thead>
<tr>
<th>POSITION</th>
<th>TERM. 1</th>
<th>TERM. 2</th>
<th>K1</th>
<th>K2</th>
<th>K3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12-14 Vdc</td>
<td>12-14 Vdc</td>
<td>Close</td>
<td>Close</td>
<td>Close</td>
</tr>
<tr>
<td>2 (Default)</td>
<td>None</td>
<td>None</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td>3</td>
<td>12-14 Vdc</td>
<td>None</td>
<td>Close</td>
<td>Close</td>
<td>Open</td>
</tr>
<tr>
<td>4</td>
<td>None</td>
<td>12-14 Vdc</td>
<td>Open</td>
<td>Open</td>
<td>Close</td>
</tr>
</tbody>
</table>

Voltage level depends on DC voltage used to power the Control Console.

REDUCED STATIC BUILDUP TIPS FOR PHASED VERTICAL ARRAYS

Comtek highly recommends the addition of quarter wave TEE-STUBS for installations in high lightning areas.

After normal 75-ohm quarter wave phasing lines have been prepared, prepare the following stubs, which may be of 50 or 75-ohm coax. Install a PL-259 connector on the stub, tune to desired frequency, i.e., the same as the RG-11 Foam phasing cable, remove the dielectric and **solder the shield to the center conductor**.

Connect a TEE connector to the antenna feed point connector.

Connect the 1/4 wave 75-ohm phasing line to one side of the TEE and to the Comtek Hybrid Port.

Connect the 1/4 wave stub to the other side of the TEE.

The purpose of the tuned stub is to bleed off static buildup and minimize lightning strikes. **THE STUB WILL NOT PREVENT A DIRECT LIGHTNING HIT**.

The stub also reduces harmonics by up to 30 dB, which Multi-Multi and Multi-Single Contest stations may find beneficial.
<table>
<thead>
<tr>
<th>Control Console Position</th>
<th>Beam Direction</th>
<th>Relative Phasing</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NW</td>
<td>-180</td>
<td>-90</td>
<td>0</td>
<td>-90</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>NE</td>
<td>-90</td>
<td>-180</td>
<td>-90</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SE</td>
<td>0</td>
<td>-90</td>
<td>-180</td>
<td>-90</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>SW</td>
<td>-90</td>
<td>0</td>
<td>-90</td>
<td>-180</td>
<td></td>
</tr>
</tbody>
</table>
THE ACB USED AS A TWO ELEMENT PHASED ARRAY

Connect the favorite antenna in Element Port 1.

Connect the second antenna in Element Port 4.

Using the ACB-4A Control Selector, select Position 2 for Port 1 and Position 3 for Port 4.

Ports 2 and 3 on the Hybrid Relay Unit remain open.

Use electrical quarter wave lines of 50-ohm RG-213 or equivalent from each antenna to the Comtek Hybrid unit. (UNLIKE the 4-Square which uses 75-ohm coaxial cables).

SHORTENED 80 Meter VERTICAL

Example of a Top-Loaded 80 meter vertical when less than 1/4 wave size can be installed. Use 234/f (MHz) and use as much aluminum as possible, making up the difference with the three Top-Loading wires. Vertical section should be a minimum of 2/3 the height of full size, however, Comtek customers are using vertical heights from as little as 38' with an increase in wire length.
The following installations have been reported to Comtek Systems by satisfied amateur radio experimenters.

**COMTEK DIPOLE 4-SQUARE ARRAY INSTALLATION NOTES:**

1. Install four pulley systems at or near the top of the tower; one for each dipole.

2. Use beads for current choke at each feedpoint.

3. Measure four (4) half-wave dipoles using 468/f (MHz) and solder to the current baluns.

4. Temporarily connect a 50-ohm coaxial cable transmission line to one of the dipoles and install all four, pulling the centers out with nylon or Dacron line. Fold the bottom legs toward the tower base.

5. Check resonant frequency of the dipole and tune all four equally if required.

6. Loosen tie off lines so dipoles can be pulled into tower and connect 75-ohm feedlines to each dipole from the hybrid.

7. Securely tie off the feedpoints and check the array.

8. If a higher than normal SWR is seen on two of the four antennas, there is a ground problem with the control line(s), or with coax lines. Recheck all connections.

9. As with aluminum verticals, the Comtek Dipole 4-Square dummy load port needs to be checked for the lowest amount of "dumped power". This is the true resonant frequency of the array.
Comtek Systems - W7DD Installation

Example of an 80 meter Dipole 4-Square array with less than optimum tall tower support.

WARNING!

DO NOT INSTALL ANTENNAS NEAR POWER LINES!
METAL OBJECTS TOUCHING HIGH VOLTAGE LINES
CAN CAUSE SERIOUS OR FATAL INJURIES!
Thank you again for purchasing a Comtek Hybrid Phasing System for your 4-square. Comtek has manufactured hybrids since 1989, and have models in use world wide by major Contest and DX stations.

*Enjoy your 4-Square array’s performance while contesting and DXing.*

73,

Comtek Systems  www.comteksystems.com

**ACCESSORIES**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM-CW3</td>
<td>3 conductor control cable</td>
</tr>
<tr>
<td>COM-CW4</td>
<td>4 Conductor wire</td>
</tr>
<tr>
<td>COM-VFA-4</td>
<td>Vertical Feedpoint Assembly</td>
</tr>
<tr>
<td>DXE-RADP-3</td>
<td>Stainless Steel Radial Plate</td>
</tr>
</tbody>
</table>
**ACB Series Part Numbers:**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM-ACB-160-A</td>
<td>160 Meter Relay Unit and Control Console</td>
</tr>
<tr>
<td>COM-ACB-80-A</td>
<td>80 Meter Relay Unit and Control Console</td>
</tr>
<tr>
<td>COM-ACB-40-A</td>
<td>40 Meter Relay Unit and Control Console</td>
</tr>
<tr>
<td>COM-ACB-30-A</td>
<td>30 Meter Relay Unit and Control Console</td>
</tr>
<tr>
<td>COM-ACB-20-A</td>
<td>20 Meter Relay Unit and Control Console</td>
</tr>
<tr>
<td>COM-ACB-15-A</td>
<td>15 Meter Relay Unit and Control Console</td>
</tr>
<tr>
<td>COM-ACB-10-A</td>
<td>10 Meter Relay Unit and Control Console</td>
</tr>
<tr>
<td>COM-ACB4A</td>
<td>Control Console</td>
</tr>
<tr>
<td>COM-ACB-160</td>
<td>160 Meter Relay Unit</td>
</tr>
<tr>
<td>COM-ACB-80</td>
<td>80 Meter Relay Unit</td>
</tr>
<tr>
<td>COM-ACB-40</td>
<td>40 Meter Relay Unit</td>
</tr>
<tr>
<td>COM-ACB-30</td>
<td>30 Meter Relay Unit</td>
</tr>
<tr>
<td>COM-ACB-20</td>
<td>20 Meter Relay Unit</td>
</tr>
<tr>
<td>COM-ACB-15</td>
<td>15 Meter Relay Unit</td>
</tr>
<tr>
<td>COM-ACB-10</td>
<td>100 Meter Relay Unit</td>
</tr>
</tbody>
</table>
Record dumped power levels at these frequencies, depending on which ACB-4 model hybrid phasing system installed. Maintain with your instructions as a reference in the event SWR or dumped power levels change.
Technical Support

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

Info@comteksystems.com

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

Warranty

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