Receive Four Square System

for 160, 80, 40 Meters

DXE-RFS-SYS-3P

U.S. Patent No. 7,423,588

DXE-RFS-SYS-3P-INS Revision 1a

P.O. Box 1491 · Akron, OH 44309-1491
Phone: (800) 777-0703 · Tech Support and International: (330) 572-3200
Fax: (330) 572-3279 · E-mail: DXEngineering@DXEngineering.com

Introduction

The **DXE-RFS-SYS-3P Receive Four Square 160/80/40m Electronics Package** is for the advanced amateur radio operator who wants to build an active receive antenna system with vertical antenna elements of their own design using the highly sophisticated DX Engineering receive four square control system.

The **DXE-RFS-SYS-3P Receive Four Square 160/80/40m Electronics Package** is a packaged system which includes:

- **DXE-EC4** Four position BCD Control Console
- **DXE-RFS** Receive Four Square Array Controller
- **DXE-AVA-2** (four) Active Matching units with Internal Disconnect Relays (the heart of the **DXE-ARAV3-1P** Receive Antenna Active Vertical antennas)
- **DXE-RPA-1** Receiver Preamplifier is also included to assure adequate signal level when short passive antennas are used
- **Three Custom Delay Lines** - The three delay lines included are based on a 70 foot square physical layout for 160, 80 and 40 meter performance

Just add your own short vertical whips - or your four monoband passive verticals - to create a four-direction receiving array. It allows the system designer unprecedented freedom to build a complete custom receiving system.

This patented (*US Patent Number 7,423,588*) system array configuration embodies unique phase and time shifted combining for stable broadband performance.

The **DXE-RFS-SYS-3P** is a sophisticated receiving system that is designed to be used with four identical vertical symmetrically spaced elements to provide switching for a 4-direction receiving antenna system. The system uses time delay phasing rather than the conventional narrow-band, frequency dependent phasing systems. The time delay phasing is directivity-optimized to produce wider and deeper rear nulls and a narrower main lobe. The result is that noise and undesirable signals are greatly reduced for a superior front-to-rear ratio (F/R). Better control of phase and currents provides a cleaner pattern than found on available transmit four square arrays.

This system offers greater reliability in receiving applications. The **DXE-RFS-SYS-3P** uses sealed relays sized for receiving applications with silver contacts to prevent oxidation and contamination. Most transmitting four square switches use large open-frame relays where the contacts are exposed to air which can lead to contamination. Relays with brass contacts can oxidize leading to poor conductivity.

Advantages of the RFS-SYS Receive Four Square Antenna System over other small or medium-size receiving arrays include:

- Reduced susceptibility to high angle signals compared to EWE, Flag, Pennant, and K9AY antennas
- Excellent directivity in a small space for better signal-to-noise ratio
- Switchable in four 90 degree spaced directions

- Directivity over a very wide frequency range when using DX Engineering Active Matching unit equipped vertical elements
- Less physical space and maintenance required than a Beverage antenna and active elements need only a minimal ground system
- Enhanced relay contact reliability
- Low current DC powered control console allows system operation without AC power mains

This system uses a 70 foot square layout which provides excellent directivity and high front to back ratio for best signal to noise ratio and reduction of interference from undesired directions across the 160, 80 and 40 meter bands.

Failure to make quality feedline or delay line connections might result in an array that does not work or performs poorly.

For a turnkey package including the active antennas, 1000 ft of F6 direct burial flooded cable, connectors, tools and the **DXE-TVSU-1** Time Variable Sequencer Unit, see the **DXE-RFS-SYS-4P** Complete System Package.

Additional Parts Required, Not Supplied with the DXE-RFS-SYS-3P

Four identical vertical antenna elements. This may consist of four vertical antennas, each 8-24 feet tall, with an accompanying radial system, or four 102" vertical whip elements such as the **DXE-WP-102** or **DXE-WP-102E**.

Four-Conductor Power and Control Cable for RFS-2

Four conductor cable (3 plus ground), 22 gauge minimum. Economically priced **COM-CW-4** is a four conductor control wire which may be used.

DXE-CAVS-1P or DXE-SSVC-2P Mounting Clamp for RFS-2

Pre-drilled mounting bracket accepts pipe OD sizes from 1/2 inch to 2 inches.

75 Ω Coaxial Cable, with F Connectors

When calculating cable length, include connections from the phasing unit to each active matching unit element, plus the distance to the operating position. You must use 75 Ω coaxial cable with a known velocity factor (VF) for all connections.

We recommend using a high quality, 75 Ω "flooded" F6 type coaxial cable, such as DX Engineering part number **DXE-F6-1000**. Flooded-style cables automatically seal small accidental cuts or lacerations in the cable jacket. Flooded cables also prevent shield contamination and can be direct-buried.

***Note**: The **DXE-CPT-659** stripping tool prepares F6 style cable for connectors in one easy and clean operation and comes with an extra cutting cartridge.*

Feedline connections must have good integrity and be weather resistant. We recommend cable assemblies with Snap-N-Seal type F connectors. The complete **DXE-RFS-SYS-3P**

system, including feedline connections, requires sixteen type F connectors. **DXE-SNS6-25** contains 25 Snap-N-Seal F connectors, enough for the entire array plus spare connectors. The three delay lines included with the **DXE-RFS-SYS-3** are already measured to the proper lengths and have six Snap-N-Seal F connectors installed.

Snap-N-Seal connectors cannot be installed with normal crimping tools or pliers. The **DXE-SNS-CT1** is an essential tool for proper connector installation.

Note: ***DO NOT*** *use pliers or other tools to tighten the type F connectors; they do not require high torque to make a good connection. Damage to the various units may result and is not covered under warranty. Use a tool such as the* ***DXE-CIT-1*** *F Connector Tightening Tool*

Example of Array Performance

Dedicated receive antennas have better signal-to-noise ratios. Directing the antenna away from noise sources or toward the desired signal path is the primary benefit. Antenna gain is a secondary advantage. As frequency increases, the fixed array size becomes electrically larger in terms of wavelength. The increased electrical spacing produces higher sensitivity (average gain) even though front-to-rear ratio only changes slightly. On the low bands, once the receiving system limits on external noise, antenna directivity (F/R) is the only thing that affects the signal-to-noise ratio.

An average Beverage antenna exhibits about -6 dB gain. You would need two reversible Beverage systems to obtain 4-direction selectivity and you still would be limited to one or two bands. The **DXE-RFS-SYS-3P** system occupies far less space, is much easier to install and mantain, is less conspicuous and operates over a wider frequency range with similar or better performance.

Note: The **DXE-RFS-SYS-3P** Receiving system must 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.

If the receive four square will be less than 1/2-wavelength from transmitting antennas, the **DXE-TVSU-1** Time Variable Sequencer Unit will be required.

The **DXE-RFS-SYS-3P** system can be positioned as close as 1/10-wavelength to transmitting antennas. The **DXE-ARAV2** Active Matching Units are bypassed to ground when power is turned off. An optional programmable sequencer, such as the **DXE-TVSU-1A,** is required for close spacing to a transmit antenna. The **DXE-TVSU-1A** is included in the **DXE-RFS-SYS-4P** complete Receive Four Square Array Package.

Significant pattern distortion or coupling may result from close spacing. To prevent pattern degradation or reception of re-radiated electrical noise or other interference, separation of 1/2-wavelength (at the lowest operating frequency) is ideal. See **Figure 1**. The goal is to do the best you can by balancing all the factors.

1/10-wavelength is the ***minimum*** distance to any transmitting antenna from the Four Square perimeter. Greater than 1/2-wavelength is the distance to prevent coupling to other antennas and the introduction of broadband noise into the receive system.

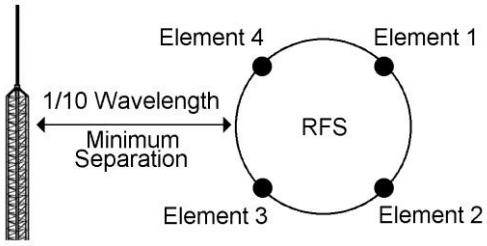


Figure 1 - Site Selection Clear Distance

Proximity to Transmitting Antennas

The **DXE-AVA-2** Active Matching Units with customer supplied vertical elements, or the **DXE-ARAV3-1P** Receive Antenna Active Vertical with Relay active elements and your transmitting antenna need only minimal physical separation to maintain safe power levels when the **DXE-TVSU-1A** Time Variable Sequencer Unit is used. With 1500 watts output and a unity gain (0 dB) antenna, the closest active element can be 1/10-wavelength from the transmitting antenna at the lowest transmitting frequency. Doubling the protection distance quadruples safe power levels. See **Table 1**.

Band	Unity (0 dB) Gain	3 dB Gain (2x)	6 dB Gain (4x)
160m (1.8 MHz)	55 ft	110 ft	220 ft
80m (3.5 MHz)	28 ft	56 ft	112 ft
40m (7.0 MHz)	15 ft	30 ft	60 ft

Table 1 - Array Safety Distance Minimums at 1500 watts

Table 1 indicates minimum safe distances for the sequenced active array from transmitting antennas with 0 dB, 3 dB and 6 dB gain (ERP) using a 1500 watt transmitter. Your actual system may vary according to location and proximity to various objects.

For example, transmitting legal-limit power output (1500 watts) into an ideal transmitting four square array produces about 6,000 watts ERP (6 dB gain). Because of the increased radiated power level, nearly 1/2-wavelength minimum spacing between the transmitting and receiving antenna arrays is required even when using the **DXE-TVSU-1A** Time Variable Sequencer Unit to remove power from the active receive antennas used in the receive four square array.

Topographical Considerations

Flat land is best. Erecting the receiving array on sloped land or steep hills may degrade performance. To avoid pattern degradation, antenna elements must have reasonably similar elevations. It's recommended the ground height difference between any element in the array be less than 10% of the array diameter. For example, a 70 foot diameter array should be within six feet of level. Every effort should be taken to make the elements symmetrical. Elements should all be identical in construction and grounding, and should be mounted above any standing water line but as close to the ground as possible. In general, the system will not be affected by trees or foliage as long as the foliage does not contact the element. Ideally, in important receiving directions, there should be a clear electrical path for at least 1 -wavelength. The site should allow a ground system to be evenly distributed around the antenna, if one is required.

Site Selection in Relation to Noise Sources

Because the array is directional across its corners, use this example as a guide: If you have a noise source and if your primary listening area is northeast, locate the array northeast of the dominant noise source. This ensures the array is looking away from the source of noise when beaming in the primary listening direction. The second-best location for the array is when the noise source is as far as possible from either side of the array. If you look at patterns, the ideal 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 transmitting antennas and buildings are off the back or side of the receiving array.

Noise that limits the ability to hear a weak signal on the lower bands is generally a mixture of local ground wave and ionosphere propagated noise sources. Some installations suffer from a dominant noise source located close to the antennas. Noise level differences between urban and rural locations can be more than 30 dB during the daytime on 160 meters. Nighttime can bring a dramatic increase in the overall noise level as noise propagates via the ionosphere from multiple distant sources. Since the noise is external to the antenna, directivity can reduce noise intensity.
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 placing receiving antennas as far from noise sources (such as power lines) as possible.

Ground System

Your vertical elements with the Active Matching units work well with just a single copper ground rod placed as close as possible to the mounting pipe. The mounting pipe can be used as the system ground if the pipe is an adequate ground. It is recommended that a 3/4" or larger rigid copper water pipe, although conventional copper coated steel rods may also work. Depending on soil conductivity, you can expect better performance with multiple ground rods spaced a few feet apart. Increasing ground rod depth beyond 5 ft rarely improves RF grounding because skin effect in the soil prevents current from flowing deep in the soil. Avoid ground rods less than 5/8" O.D. A good ground system improves the array performance and enhances lightning survivability. It is important that each ground system be the same for each active antenna in the array.

You can test ground quality by listening to a steady local signal. Attach 15 ft of wire laid in a straight line (away from the coaxial feedline) to the initial 4 ft to 6 ft ground rod. If you observe a change in signal or noise level, you need to improve the ground. A second rod spaced a few feet away from the first one may correct the problem or 10 to 12 ground radials, each 15 ft long, should

provide a sufficient ground system for most soil conditions. If a good ground cannot be established, use an optional **DXE-RFCC-1** Receive Feedline Current Choke that will further decouple the feedline from the antenna and reduce common mode current and associated noise from the feedline.

Lightning Protection

While amateur radio installations rarely suffer damage from lightning, the best protection is to disconnect electrical devices during storms. 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 also has technical and product information listed under "Lightning Protection and Grounding." Use lightning surge protectors for the coaxial feedline and control lines.

Four Square Layout

The four array antenna elements should be arranged in a 70 foot square for this multi-band system. The diagonal corners of the square should point in the most desirable receiving directions. Element 1 is the default forward element, Element 3 is the rear or null element. Position 1 in the **EC-4** Controller would switch the four square array to the North East toward Europe (preferred direction for use in North America).

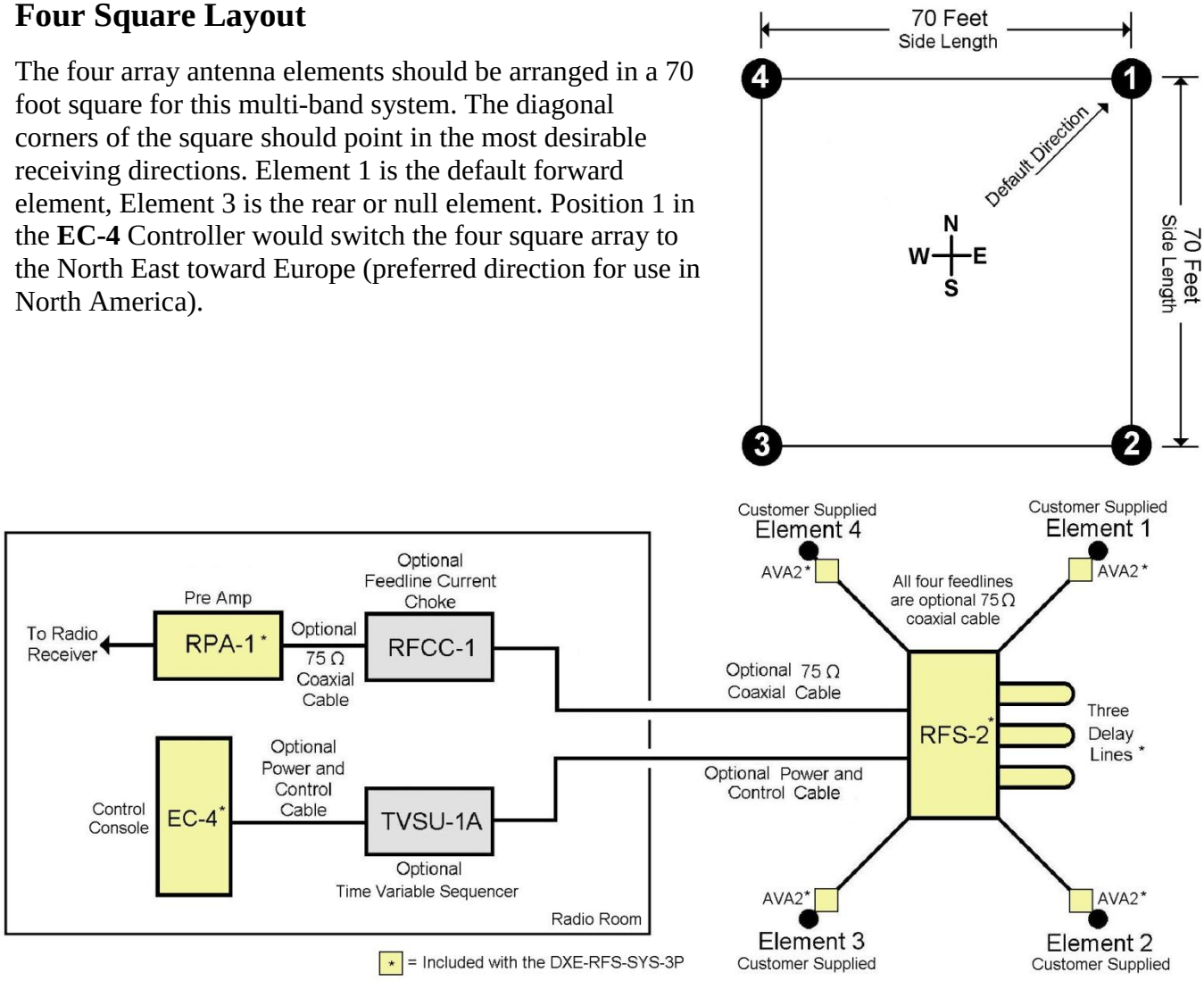


Figure 2 - Layout of the DXE-RFS-SYS-3P Receive Four Square System

- Performance of the RFS-2 can noticeably decrease if structures radiating even small amounts of noise or signals are within 1-wavelength of the array
- Measure side-to-side and then corner-to-corner to ensure the element locations are square.
- Normally the **RFS-2** phasing unit is installed near the center of the four array elements, above any standing water or snow line, with the connector side facing down. The placement of the **RFS-2** unit is not critical, however, the feedlines to each of the active elements must be equal.
- If you mount the **RFS-2** on a wood post, it should be grounded to a separate ground rod.

System Operational Overview

The **DXE-RFS-SYS-3P** system is comprised of the **DXE-EC-4** BCD Control Console and the **DXE-RFS-2** Control Unit. These units interconnect and work together.

The **DXE-EC-4** BCD Control Console supplies the nominal +12 Vdc operational voltage as well as the +12 Vdc BCD control voltage. The operational voltage powers the **DXE-RFS-2** Control Unit which subsequently powers the active receive elements. The BCD switching voltages cause the **DXE-RFS-2** to change the receiving direction of the array. The DXE-EC-4 needs a +12 Vdc, 1A, fused power input which may be supplied by your power supply or the optional **DXE-PSW-12D1A** - AC Adapter 12 Vdc/1000 mA.

The **DXE-RFS-2** distributes the operating power to the active elements through the individual element feedlines. The active elements do not work without power. Cutting power to the **DXE-RFS-2** also cuts power to the active elements which causes the **AVA2** to ground the vertical element.

Installation

The **DXE-RFS-2** Control Unit can be mounted to a galvanized pipe driven into the ground. The **DXE-RFS-2** unit has been pre-drilled to accommodate up to a 2 inch OD pipe using an appropriate clamp. If pipe mounting is desired, the optional **DXE-CAVS-1P** V-Bolt Saddle clamp for pipe from 3/4" to 1-3/4" inches OD is recommended, or **DXE-SSVC-2P** Stainless Steel V-Bolt Saddle Clamp for 1" to 2" OD pipe. The controller can also be mounted on a sturdy wooden post, but provision for grounding the **DXE-RFS-2** unit must be made. Note: **UMI-81343** Never-Seez or **DXE-NSBT8** Anti-Seize should be used on all clamps, bolts and stainless steel threaded hardware to prevent galling and to ensure proper tightening.

The **DXE-RFS-2** is designed to be used with the DX Engineering Active Vertical Antennas or may be used with passive elements. The active elements should be installed as close to the ground as possible but above any standing water line. **Ground the ANT– (negative) terminal to an adequate ground.**

Active Antenna Elements

If you are planning to use the array on 160m, a jumper in all of the **AVA2** Active Matching units should be changed. Placing a jumper on L1MF will peak the array sensitivity response for use on 160m, with little effect on 80m. When doing this the sensitivity for the AM broadcast band will be reduced. All four **AVA2** Active Matching units in the array must have identical jumper settings.

For access to the jumpers in the **AVA2** Active Matching units, remove the 2 screws on each side of the case and remove the bottom. The circuit board and jumper headers will be visible as shown in **Figure 3**. By default, there are no jumpers across any pins. Place a jumper across L1MF. Do not jumper any other positions. See the **DXE-ARAV3-1P** Receive Antenna Active Vertical w/Relay User Manual for more information about additional peak response jumper settings.

Figure 3 - Active Element L1MF Jumper Locations

Station Feedline, Active Antenna Feedline and Delay Lines

The weakest link in an antenna system, such as the **DXE-RFS-SYS-3P**, 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.

The **DXE-RFS-2** may use the shield as a ground return path for the active element power.

Note: The total loop resistance of the ground path must be under 30 Ω *for reliable operation.*

If the resistance of the shield increases due to contamination, the active elements may not function properly. Any splices (splices are not recommended) in the feedline should be high quality and entirely weather tight. The **DXE-RFS-3P** system has been designed to use only 75 Ω coaxial cable.

High quality, flooded 75 Ω CATV F6 type coaxial cable is recommended and is available from DX Engineering. **DXE-F6-1000** Flooded coaxial cables automatically seal small accidental cuts or lacerations in the jacket. Flooded coaxial cable also prevents shield contamination and can be direct-buried.

DX Engineering offers an inexpensive preparation tool, part number **DXE-CPT-659,** that readies the coaxial cable for connectors in one operation and comes with an extra cutting cartridge. To ensure weather tight connections, use **DXE-SNS6-25** Snap-N-Seal compression style connectors. **DXE-SNS6-25** contains 25 Snap-N-Seal connectors, enough for the entire array plus some spares. The Snap-N-Seal connectors cannot be installed with normal crimping tools or pliers, so you must use an installation tool like the **DXE-SNS-CT1**, available from DX Engineering, for proper connector installation.

Active Antenna Feedlines

Use 75 Ω coaxial cable from each **AVA2** Active Matching unit to the **DXE-RFS-2**. The four feedlines from the **DXE-RFS-2** phasing unit to the **AVA2** Active Matching units can be any length needed to accommodate the size of the array, but must all be the same length, velocity factor and type. Note the orientation and numbering of the elements by using **Figure 2**. Be sure the appropriate vertical antenna element is connected to the proper ANT connector on the phasing unit. The default (zero control voltage) forward direction is towards Element 1. Element 3 is the rear or null direction.

Delay Lines

The **DXE-RFS-2** uses a time delay system, not a traditional phasing system. Delay line lengths are dictated by array dimensions rather than operating frequency. This results in phase being correct for a rearward null at any frequency. This system is especially effective when used with DX Engineering **AVA2** Active Matching units. User-supplied passive elements can also provide exceptional performance for single or dual band operation where high dynamic range is required.

The **DXE-RFS-SYS-3P** includes three sets of custom made delay lines. Made for array side spacing of 70 feet, their electrical length is critical and careful measurements were made when manufacturing these delay lines using high quality 75 Ω coaxial cable with a known Velocity Factor (VF) which is a very important factor. To avoid performance degradation due to inconsistent coaxial cable construction, all three of the delay line coaxial cable assemblies are manufactured from the same spool.

Delay lines DLY1 and DLY2 are half the length of DLY3.

Delay line cables can be neatly coiled in a 1.5 ft diameter coil. Support the weight of the cables by taping or securing them to the support pole or mast rather than allowing them to hang from the connectors.

It is important to use 75 Ω feedline to the operating position from the **DXE-RFS-2**. Do not use amplifiers, combiners, filters or splitters that are not optimized for 75 Ω systems.

Control and Power Connections

The **DXE-RFS-SYS-3P** system, with the **DXE-EC-4** Control Console, no other equipment is needed for powering the **DXE-RFS-2**, the active elements or controlling the receive direction.

J12 is the 5-terminal connector plug on the front panel of the **DXE-RFS-2**. It is labeled **G A B C G**.

The **DXE-RFS-2** uses a two part green connector 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.

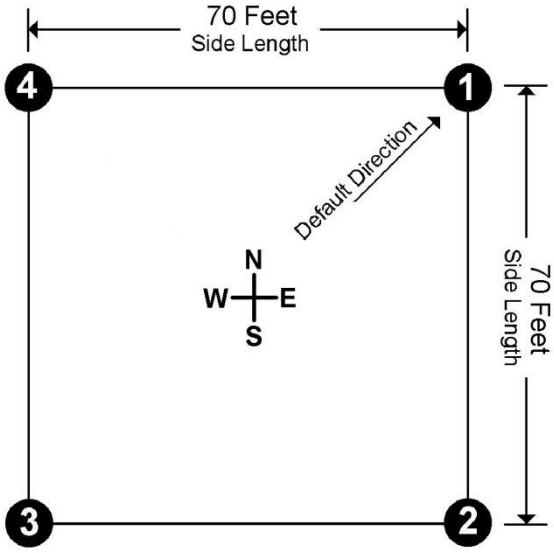
The **DXE-EC4** BCD Control Console uses an internal terminal plug labeled “G 1 2 3”.

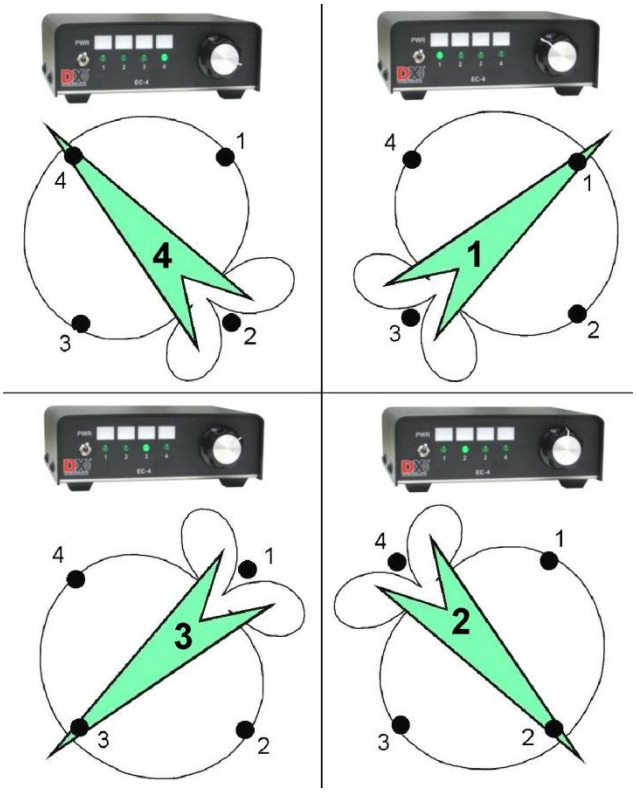
DXE-EC-4		DXE-RFS-2
G	to	G
1	to	A
2	to	B
3	to	C

Wire connections between the DXE-EC-4 and DXE-RFS-2

The switch position on the **DXE-EC-4** BCB controls the directivity of the received signal in the **DXE-RFS-SYS-3P**.

Position 1 favors the NE, position 2 favors the SE, position 3 favors the SW and position 4 favors the NW when the array is positioned as shown.





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.

Minimum Copper Wire Gage (AWG)	Length
24	1,000 feet
22	1,500 feet
20	2,000 feet

Active antenna circuitry needs a good voltage supply to operate properly. When supplying power to an active antenna, you want to have +12 VDC, 60 milliamps at each active (under load).

CAT5e cable is not recommended when making long runs to power an active antenna since the line loss in CAT5e cable may not supply the proper operational voltages required for active antennas.

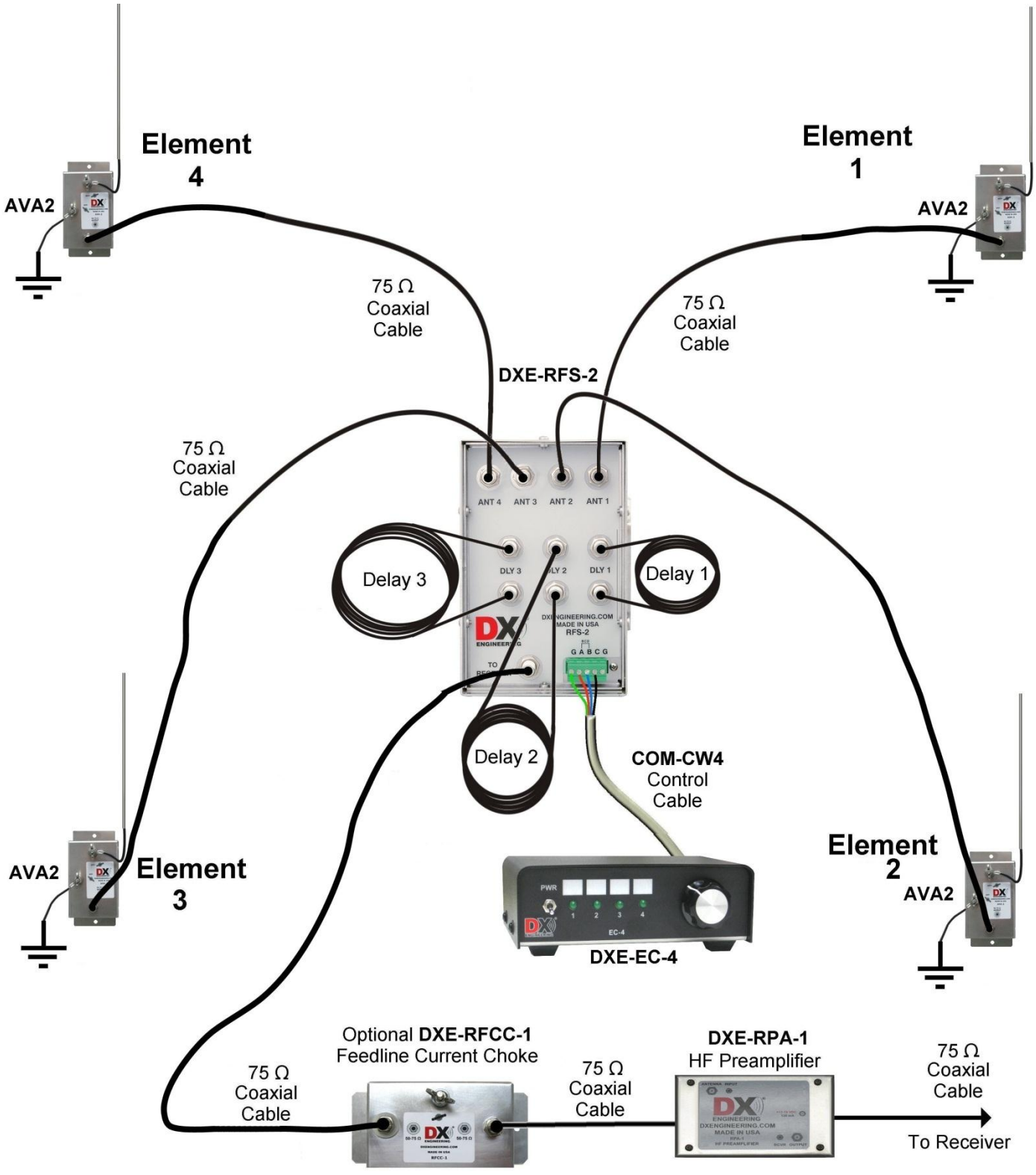
Depending on the required length of your power wire, you will want to use a line loss calculator (voltage drop with various wire gages) to ensure your power supply (normally +13.6 well filtered DC) will supply a minimum of +12 VDC, 60 milliamps at each active antenna (under load).

A DX Engineering 4 Square or 8 Circle will require approximately 250 milliamps (only 4 actives are powered at any one time).

When calculating line length, take into consideration the total number of active antennas being powered at any one time in your line length calculations.

Approximate Active Antenna Power Line Lengths (4 active antennas on at any one time).

Minimum Copper Wire Gage (AWG)	Length
18	300 Feet
16	500 feet
12	1,200 feet
10	2,000 feet



DXE-RFS-SYS-3P Connection Diagram

Shown with optional **DXE-RFCC-1** Feedline Current Choke, Control Cable, Coaxial Cables and Customer supplied vertical antenna elements

Internal Jumper Selection

To access the **DXE-RFS-2** jumper blocks, remove the 6 screws holding the connector plate of the **DXE-RFS-2** unit to the enclosure. Pull on the plate to separate it from the enclosure. The jumper blocks should be visible and oriented as shown in **Figure 5**.

> ***Important Note:*** *You cannot use the coaxial cable with the provided items for voltage control functions. Use the default configuration shown on the previous page.*

Default Jumper Configuration Settings

Figure 5 shows the default (mandatory) jumper settings for the **DXE-RFS-2**. For JMP1 & JMP2 the center and top pins of both are shorted. For JMP3 & JMP4, the center and bottom pins of both are shorted.

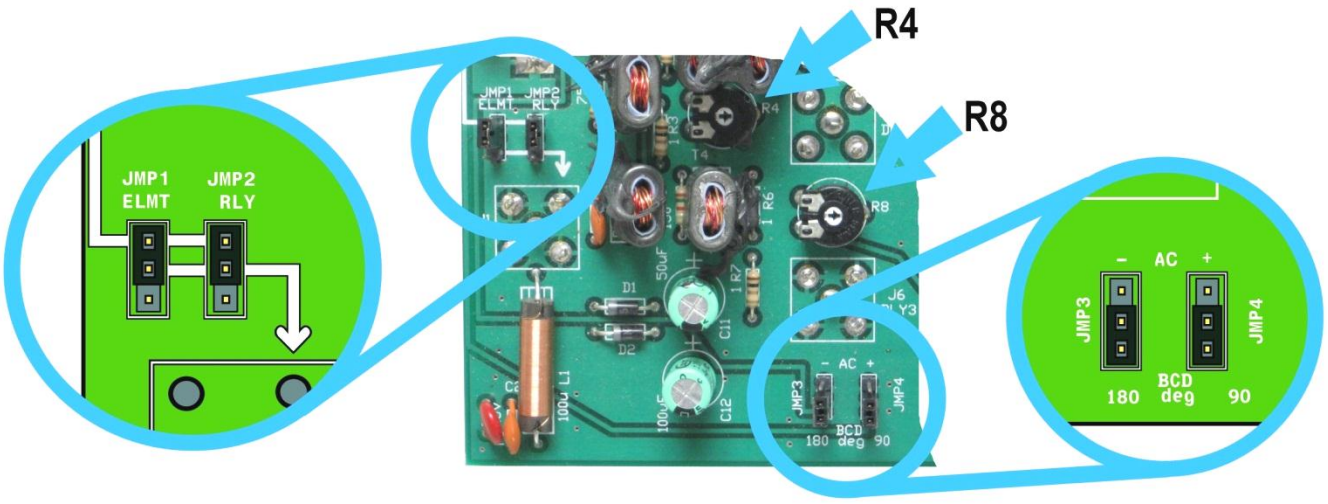


Figure 5 - Jumper Locations showing Default Settings

JMP1 Selects Power Voltage Source: Coax or J12 - Shown in default position, voltage from J12

JMP2 Selects Direction Voltage Source: Coax or J12 - Shown in default position, voltage from J12

JMP3 and **JMP4** Select Directional Voltage Configuration, either Differential or BCD.
Both Jumpers must be set the same. - Shown in default position for BCD

Optimizing the Array

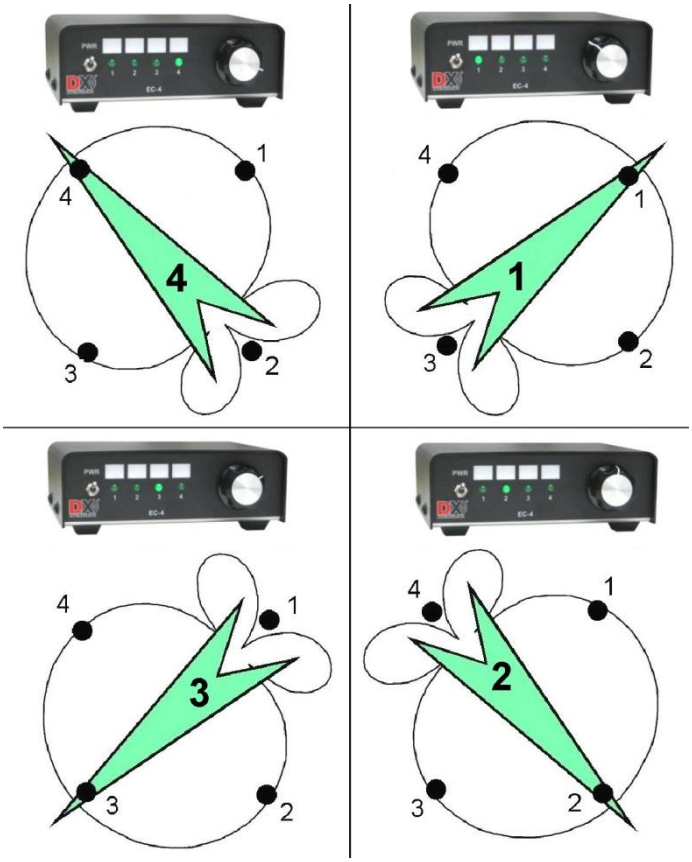
To determine if the antenna system output level is the limiting factor, tune the receiver to the lowest band at the quietest operating time. This is usually when propagation is poor but some signals are heard. Disconnect the antenna and set the receiver to the narrowest selectivity you expect to use. Receiver noise power is directly proportional to receiver bandwidth (going from 2.5 kHz selectivity to 250 Hz selectivity reduces noise by 10 dB). Connecting the antenna should result in a noticeable increase in noise. If so, the array signal level is sufficient and further optimization or amplification may not be needed.

If the array is used on 160m or below, the Active Antenna internal jumper should be set as shown in the Installation Section of this manual. If the array still lacks sensitivity on the lower bands, then a preamplifier with high dynamic range should be used to compensate for the low signal level. Using a preamplifier when sufficient signal is already present may result in amplification of the noise along with the signal. **It is always best to use the least gain possible**. Depending on conditions, a preamplifier can cause receiver overload; this may require an attenuator or bypassing the preamplifier.

The **DXE-RPA-1** HF Preamplifier has better dynamic range than most receivers and can be used to compensate for the decrease in array signal output. The **DXE-RPA-1** preamplifier is automatically bypassed when power is removed.

Front-to-Rear (Null) Optimizing

The **DXE-RFS-2** is factory adjusted to the correct settings for most coaxial cables. In some cases, the null depth may need to be adjusted to compensate for inaccurate delay line lengths. To adjust the null depth, tune to a strong steady signal off the back of the antenna's selected direction and adjust R4 and R8 for the deepest null (weakest signal off the back). Use **Figure 5** to locate R4 and R8 near the center of the circuit board.



Operation

When using the **DXE-RFS-2**, positions 1 though 4 on the **EC-4** BCD Control Box will phase the appropriate active vertical elements to give you excellent receiving capabilities.

The front to back signal to noise ratio of the active vertical elements in the four phase array allow you to not only enhance the desired received signal, but also to decrease an unwanted receive signal by selecting a position that will drastically reduce or eliminate it.

Normal Receive Four Square Operation

When the Receive Four Square system is functioning properly, low or medium power daytime AM Broadcast ground wave signals should be alternately attenuated or improved with directional switching. However, strong sky wave signals arriving at high angles of propagation will show very little signal level change as different directions are selected on the Receive Four Square.

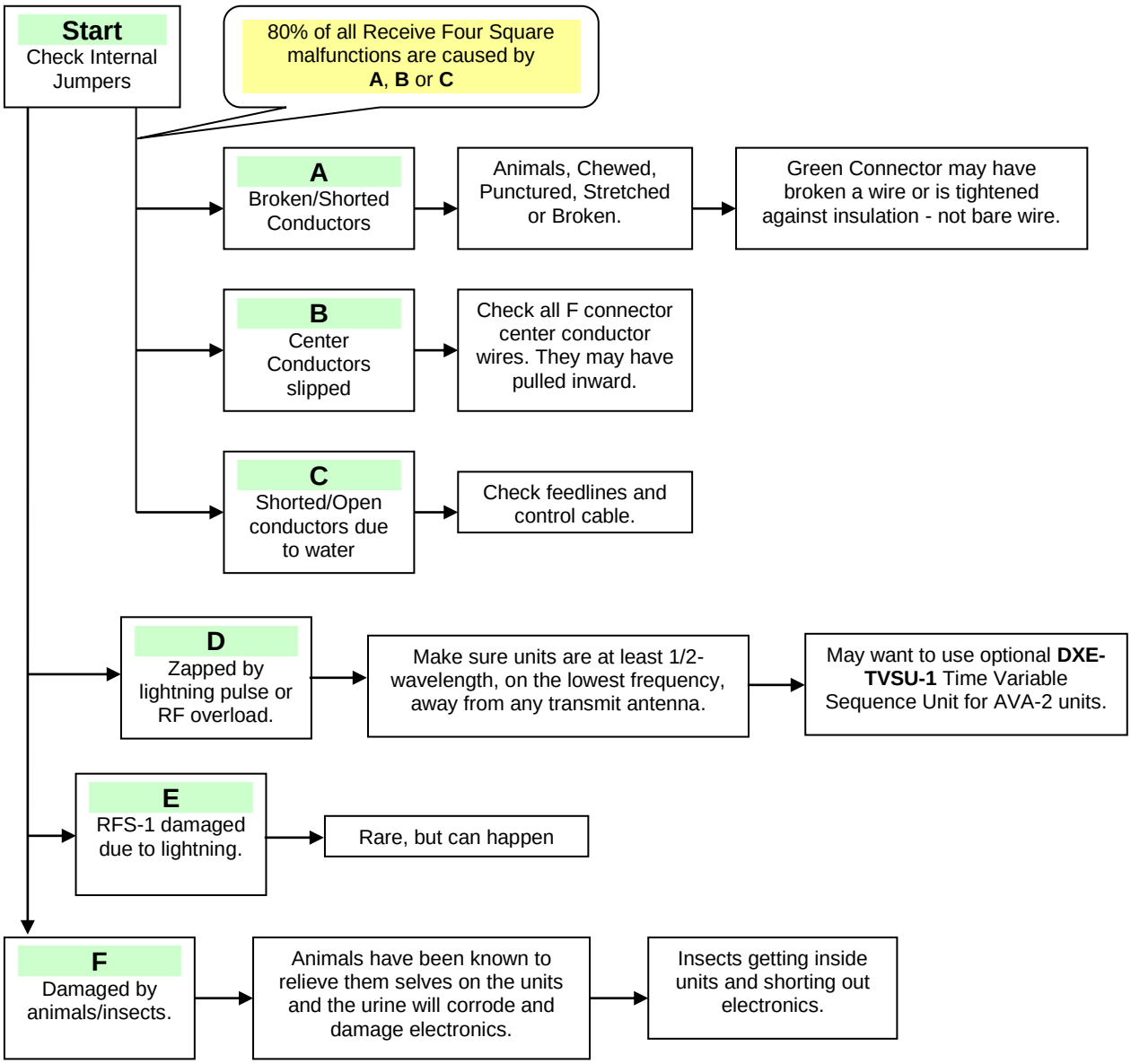
Although some low band signals may be received at very low levels, they are heard more easily due to far less noise received by the non-resonant array. Use the **DXE-RPA-1**, **Receiver Preamplifier -** an in-shack pre-amplifier with exceptionally low-noise and high dynamic range characteristics. The **DXE-RPA-1** will enhance the intelligibility of the weak DX signals, without adding the noise that plagues many of the pre-amps that are built into modern transceivers.

The Receive Four Square array pattern is designed to enhance forward low angle signals, and reject rearward and high angle signals. The Receive Four Square system provides superior signal-to-noise results that allow you to hear signals that are impossible to copy on much noisier transmit antennas, for greatly improved weak signal DX operations.

Receive Four Square Troubleshooting

There are several possible causes for a malfunction of a DX Engineering Receive Four Square System. Testing the system is not difficult and can be completed in an hour or so. Separate circuits for directional switching, Active Vertical Antenna power, and antenna phasing can each be affected by a variety of cabling, connection and or component problems. If you are troubleshooting a new system or using a replacement **RFS-2** unit, check that the internal jumpers are set correctly for your system control and voltage configuration.

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



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 connectors can inadvertently be tightened onto the insulation of control or power conductors.

B) Regressed center conductors in the feedlines causing disengagement from the female center capture pin of the F connector. This can happen in delay lines as well as in antenna or main feedline connections. Many times a compression F connector that seems to have a long enough center conductor when it was made, has regressed to the point that it is not long enough to make proper contact. A properly installed F connector should have the center conductor protruding 1/4 inch beyond the shell when viewed from the side. Check all F connectors!

C) Shorted or opened conductors caused by water migration into a control line or a feedline.

Over 80% of all Receive Four Square 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 RFS troubles. Here are a few other causes for RFS malfunction:

D) One or more burned out Active Vertical Antenna units model AVA-2 or AVA-1, due to lightning pulse or high power RF overload. One-half wavelength on the lowest frequency is the minimum distance between the Active antennas and any transmit antennas. If that distance is less and high power is used, then the Time Variable Sequence Unit, model DXE-TVSU-1A must be used to interrupt power to the AVA-2 units.

E) Damaged RFS-2 unit due to lightning. This has been reported only a couple of times and is not very likely.

F) Active units that were damaged by animals. Once we received actives damaged by an animal that relieved themselves on the antenna whips and AVA units, as if they were "trees".

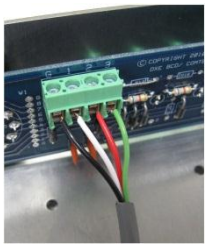
The above items are the most common failure points in the system that need to be checked.

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

Receive Four Square Control - Troubleshooting Procedure

1) Test the **DXE-EC-4** BCD Control Console unit, which should be connected only to the control lines of the Receive Four Square System. When the **EC-4** is connected to the control cable, do all of the selected switch position LEDs light normally?

2) When rotating the Control Console switch from position 1, 2, 3 and 4, if all LEDs light normally, measure BCD output voltages. Normally, +12 for the EC-4 is output on the green connector terminals located inside the unit. Connections 1, 2 and 3, reference to the ground pin G as shown below. The selected position will supply the BCD logic voltage as shown in the chart below.



Forward Direction	EC-4 Switch Position	BCD Termial			EC-4 LED Illuminated
		1	2	3	
Element 1 (Default)	1	**0**	**0**	**1**	# 1
Element 2	2	**1**	**0**	**1**	# 2
Element 3	3	**0**	**1**	**1**	# 3
Element 4	4	**1**	**1**	**1**	# 4

BCD Directional Control Matrix, "1" Equals +12 Vdc (Default)

The numbered terminals of the 4-pin green connector correspond to the numbers in the table above, with voltage measured as referenced to the G ground terminal.

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 the 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 **RFS-2** Receive Four Square relay unit.

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

Continue troubleshooting the array control with a good **EC-4** 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 **RFS-2** unit.

6) With a good **EC-4** or other power source connected, measure A, B and C control conductor voltages at the **RFS** relay unit with the control cable connected, and again at the end of the control cable that is disconnected from the **RFS** 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 **RFS** relay unit or antenna feedlines. Normal voltages on the connected control line will cause relays to switch inside the **RFS** unit. If switching voltages are correct, lack of system directivity or gaps in reception may be due to antenna, feedline or delay line issues.

7) Test the Active Antennas by feeding a voltage on the tested control line A and/or B conductor(s) to select one direction of **RFS** unit operation. Simultaneously feed normal operating voltage on the tested conductor that powers the Active Verticals for reception. If a low value fuse blows, then a short circuit may be isolated by disconnecting antennas and reconnecting them one at a time.

   If no fuses have blown and connected voltages stay near the nominal +12 Vdc levels, then:

8) Test for active operating voltage at the end of each antenna feedline. If all are good, proceed. If not, repair feedlines and/or connectors. If voltage is present on the power line to the **RFS** relay unit, but is not measured at the end of good feedlines, inspect inside **RFS-2** relay unit to determine if there is an obvious reason that Active Vertical Antenna power is not making it out the antenna ports. A bad connection outside of the **RFS** relay unit is usually the problem, and rarely has a component failure inside the **RFS** relay unit been discovered. If the system previously functioned properly, then the internal jumpers would have been previously set in their proper positions for your system configuration. If you are troubleshooting a new system or using a replacement unit, check that the internal jumpers in the **RFS-2** unit are set correctly for your system control and voltage configuration.

   Proper Receive Four Square phasing requires that each Active Vertical Antenna, and its respective equal length feedline, actually provides the <u>same signal level</u> to the RFS unit. Use a steady, non-fading ground wave signal from a low or medium power daytime AM

Broadcast station that is over 10 miles away, on a frequency high in the band, or another constant signal source on 160 or 80 meters, well away from the array, to test that each Active Vertical receives the same signal level. Do not use sky wave or night signals for these signal level tests.

9) Test reception of each Active Vertical Antenna by connecting each antenna feedline, one at a time, to an activated port on the **RFS-2**. This assumes that a good port has been identified and is functioning properly. Normal reception must be confirmed from each antenna. If any antenna is not providing the proper RF signal level, move the AVA unit to a known good feedline position to rule out the possibility that a bad feedline is attenuating the RF. If one or more Active Receive Verticals produce a low or no signal, then the AVA unit at the base of that antenna may not be receiving power. Retest for DC power at the antenna end of that feedline. If + 10 to 18 Vdc is found, then the Active unit may need to be serviced or replaced. New **DXE-AVA-2** units are available separately by calling DX Engineering.

10) If all Active Verticals tested provide the same signal level, then change switching voltages to activate the other ports, one at a time, and test each **RFS** unit port, using one of the good antennas, testing for the same level of reception. If one or more ports is dead or has diminished reception, there may be a problem in a delay line or in the **RFS** unit.

11) Using tested or replaced delay lines and connectors, if one or more ports is dead or has diminished reception, the **RFS** unit may require service or replacement.

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

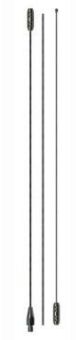
If you need additional assistance from DX Engineering, feel free to call or write. Detailed discussions of system function, connections, and troubleshooting is best handled by telephone, Monday through Friday, 8:30 am to 4:30 pm Eastern Time, at 330-572-3200.

Optional Items

DXE-WP-102 - 102 inch Stainless Steel Whip
This 102" whip antenna is made from the finest 17-7 ph tapered stainless steel which resists bending and kinking. This material is so tough it can be bent 180 degrees and will spring back to its original shape. Dissipation tip to reduce unwanted static buildup. Fits all 3/8 x 24 threaded mounts.

- Can be bent 180 degrees and will spring back to its original shape
- Resist bending and kinking
- Excellent for all off-road terrain

DXE-WP-102E - 102 inch Stainless Steel Whip, 3-piece, export version
This 102" whip antenna is made from the finest 17-7 ph tapered stainless steel which resists bending and kinking. This model is supplied in three pieces, joined by stainless steel adapters for inexpensive international shipping and easy handling. Dissipation tip to reduce unwanted static buildup. Fits all 3/8 x 24 threaded mounts. May be broken down into three easily transportable pieces for portable operation. Secure set screw connections provide noise-free operation for sensitive receiving applications, unlike potentially intermittent telescopic whips.



- 3-piece design allows inexpensive international postal shipping
- Resist bending and kinking
- Ideal for Active Receive Antenna systems

DXE-CAVS-1P - V-Bolt Saddle Clamp, 1/2 in. to 1-3/4 in. OD Applications

This V-Clamp is made in one size that fits tubing from 1/2 to 1-3/4" OD as used in antenna construction. The supplied V-bolt is long enough to attach tubing to thick plates and is made with anti-corrosive properties. The cast rippled surface of the saddle will clamp the tubing securely to a flat surface; however, for high-torque applications please use our standard U-Bolt Saddle Clamps.

- Used to clamp 1/2 to 1-3/4" (OD) tubing
- Designed for attachments that don't require resistance to torque
- V-bolt made from high-strength 18-8* stainless steel
- V-saddle cast from 535 aluminum with rippled surface

The use of an Anti-Seize compound is HIGHLY recommended to achieve proper torque and prevent galling.

DXE-SSVC-2P - Stainless Steel V-Clamp for 1 to 2 inch OD steel pipe

This V-Clamp is made in one size that fits Steel tubing or pipe from 1 to 2" OD as used in antenna construction. The supplied V-bolt is long enough to attach tubing to thick plates and is made with anti-corrosive properties. The special Stainless Steel saddle has serrated teeth will clamp to the pipe securely by biting into the surface. For this reason, it is not recommended for softer aluminum tubing or pipe. Ideal for fastening a radial plate and antenna mounting to a steel pipe.

V-Bolt thread dimensions: 5/16"-18 x 2.0"

- Used to clamp 1 to 2" (OD) steel tubing or pipe
- Designed for attachment to round steel support members
- V-bolt and saddle made from high-strength 18-8* stainless steel

The use of an Anti-Seize compound is HIGHLY recommended to achieve proper torque and prevent galling.

UMI-81343, DXE-NSBT8 - Anti-Seize & Never-Seez

An Anti-seize compound MUST be used on any Stainless Steel nuts, bolts, clamps or other hardware to prevent galling and thread seizure. Any of these products can be used for this purpose.

***UMI-81343**	Anti-Seize, 1 oz. Squeeze Tube
***UMI-81464**	Anti-Seize, 8.5 oz. Aerosol Can
***DXE-NSBT8**	Never-Seez, 8 oz. Brush Top
***DXE-NMBT8**	Never-Seez, 8 oz. Brush Top, Marine Grade

*** These products are limited to domestic <u>UPS Ground</u> shipping only**

DXE-F6-1000 - 75 Ω F-6 Style Direct Bury Coax, 1000 ft. Spool Hi Quality "Flooded" Coax

Sold by the spool, or as Custom Cable Assemblies

Center Conductor: 18 AWG Copper-Clad Steel , Nominal Diameter: 0.040 in.
Dielectric: Gas Expanded Polyethylene, Nominal Diameter Over Dielectric: 0.180 in.
Shield: <u>1st Shield:</u> Aluminum-Polypropylene-Aluminum, Laminated Tape with overlap Bonded to the Dielectric, Nominal Diameter Over Tape: 0.187 in.
<u>2nd Shield:</u> 34 AWG Aluminum Braid Wire, 60% Coverage
Jacket: PE (Flooded for Underground), Nominal Diameter Over Jacket: 0.272 in. , Nominal Jacket Thickness: 0.030 in.
Electrical Properties: Impedance: 75.0 +/- 3.0 Ωs, Velocity of Propagation: 85.0% Nominal
We recommend the use of Snap-N-Seal connectors to ensure a high quality and weather resistant feedline connection. The proper tool must be used to install these connectors.

DXE-CPT-659 - Coax Cable Stripper for CATV F-6, RG-6 and RG-59 coaxial cable

Prepares CATV F-6, RG-6 and RG-59 coaxial cable for the installation of an "F" type connector.

- One-step cutting motion
- Precision cut
- No nicks or scratches to conductor
- Includes 1 replacement blade

DXE-SNS6-25 - Watertight Coaxial Cable Connector, Snap-N-Seal for CATV F-6 Cable, 25 pieces

Snap-N-Seal is an environmentally sealed CATV F coaxial connector system for harsh environments. The connectors have a unique, 360 degree radial compression system that offers the signal leakage protection required for high performance receive systems.

- Quad sealed system prevents moisture from migrating into the connection
- 360 degree radial compression provides superior RF integrity (-95 dB typical, 60% bonded foil cable)
- Easy cable preparation
- Connector to cable retention of 40 lbs minimum
- Superb impedance match to 1 GHz
- Manufactured of high quality 360 brass, cadmium plated with yellow chromate coating for maximum corrosion resistance
- UV-resistant plastic and O-rings provide a reliable environmentally sealed connector

An installation tool, such as the **DXE-SNS-CT1**, is required to install the connectors. Normal crimping tools or pliers will not work.

DXE-SNS-CT1 - Compression Tool for Snap-N-Seal 75 Ω Coaxial Connectors

Ratchet compression tool for installing Snap-N-Seal 75 Ω Coaxial connectors. Ordinary pliers will not install these connectors properly.

Cable, 4 Conductor, Sold per Foot - COM-CW4

A high quality, PVC jacketed 4-wire control cable, COM-CW4 consists of 4 #20 AWG conductors. It may be used in a mulititude of control cable applications, such as remote switching and antenna rotators.

Sold by the foot - order the length you need.

SUM-900031 - Automatic Wire Stripper/Crimper/Cutter, 24-10 Ga.

Our DX Engineering wire stripper uses a spring-loaded design to make quick work of wires ranging from 24 to 10 gauge. Just insert the wire, squeeze the handle, and listen for the click. That's the sound of another perfect wire stripping job performed in about 2 seconds- a fraction of the time it takes your pocket knife to do the same job. An adjustable wire length guide helps you make uniform strips, and a built-in wire cutter and crimper helps you complete your wiring job.

- Spring-loaded design
- Strips wires ranging from 24 to 10 gauge
- built-in wire cutter and crimper

KLE-11055 - Klein-Kurve Wire Stripper / Cutter 11055, 18-22 AWG

Klein Tools Klein-Kurve wire strippers are ideal for stripping solid (10-18 AWG) and stranded (12-20 AWG) wire cleanly and easily. The 7 1/8 in. strippers also have precise shear-type blades to cut copper wire nicely, easy-to-read markings on both sides, and extra-soft grips and curved handles for comfort.

DXE-CIT-1 - F Connector Tightening Tool

The CIT-1 installs and removes F connectors in high density and hard to reach locations, and is the only tool that works with bent coax. Only finger force is required. Provides enough leverage to achieve a 30 in/lb tightening force by hand. Helps insure proper connections thereby reducing the potential of loose connector related service calls.

DXE-PSW-12D1A - AC Adapter 12 Vdc/1000 mA

The DXE-PSW-12D1A is an AC Wall Transformer Adapter to furnish 12 Volts DC at 1000 mA from 120 Vac 60 Hz input, fused output. It features a standard 2.1 mm plug connection for 12 Vdc. Outer connection is GROUND Center Pin is input for +12 VDC. Ideal separate power source for DX Engineering EC-4 BCD Switch

Time Variable Sequencer Unit - DXE-TVSU-1A

The DX Engineering TVSU-1A **Time Variable Sequencer Unit** is a microprocessor-based transmit / receive control-signal delay unit. It provides 0-30 ms of delay, programmable in 2 ms increments, to as many as five outputs tied to the CW keying or push-to-talk (PTT) lines. By controlling the receive-to-transmit (and back) timing of linear amplifiers, preamplifiers, and other sensitive equipment, damage caused by improper switching can be eliminated. This sequencer improves CW performance by eliminating annoying leading edge chopping or truncating of Morse characters. This is especially important in contests or pileups where sending accuracy is critical.

Now RoHS compliant, the TVSU-1A can also control external devices such as preamps, active antennas, or external relays that need to have power removed during transmit. Separate power-in and power-out jacks on the front panel are used to control external power in this type of application. Two 2.1 mm power plugs and two 3.5 mm stereo plugs are provided.

Benefits

- Control timing of PTT turn-on, hang delay of PTT, amplifier hang delay, external antenna relay hang delay and turn-on delay of auxiliary output
- Dip switch settable delays of 0-30 milliseconds in 2 millisecond steps
- Side tone generator that follows input of keyer or hand key not transmitter
- Side tone pitch can be programmed from 300 to 1000 Hz in 50 Hz steps, front panel headphone jack with adjustable volume
- Supports CW full break in
- Can control external power to our Active Receive Antennas and permit operation in closer proximity to transmit antennas

DXE-RFCC-1 - Receive Feedline Current Choke, 50 to 75 Ω 300 kHz to 30 MHz

If you wish to reduce feedline radiation and improve reception, a Feedline Current Choke is recommended if your SWR is already low. Adding a DX Engineering Feedline Current Choke at the point where the feedline exits the area of the antenna will substantially reduce unwanted feedline radiation or reception without the need for improved station grounding.

The advantages of using an FCC:

- Prevents unwanted RFI by eliminating feedline current and radiation
- All power goes to the antenna, improving efficiency
- Reduces noise or unwanted signals picked-up by the feedline
- Overcome a less than optimal ground system

The DX Engineering RFCC-1 receive feedline common-mode choke is the most effective solution to common-mode noise or unwanted signal ingress available to date. The DX Engineering RFCC provides thousands of ohms isolation between the input and output coaxial shield connections while passing desired signals, including dc or low frequency ac control signals. The RFCC has extremely high isolation impedance which effectively blocks common-mode noise or unwanted signals, even in the presence of very poor grounding. Low noise receive antennas are traditionally located away from electrical wiring and other noise sources. Unfortunately, noise and other unwanted signals have a direct path to your low-noise antenna through the feedline shield connections between the station equipment and antenna. Unwanted signals can also energize the outside of the feedline shield, and this undesired signal energy can be conducted directly to the receiving antenna. This can reduce antenna directivity. Unless you have a perfect zero-resistance RF ground at the antenna, some of the common-mode noise or unwanted signals from the feedline shield will make it into the antenna.The RFCC is effective from 300 kHz to 30 MHz. It comes with standard CATV type "F" female connectors, although it can be used in any 50 to 75 Ω receiving system. The RFCC is a passive device, therefore requires no power to operate.

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

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.

Specifications subject to change without notice.