



# Modular Receive Antenna Interface for Transceivers

## DXE-RTR-2

*U.S. Patent 8,175,546*

DXE-RTR-2-INS Revision 0b



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## Introduction

The DX Engineering **DXE-RTR-2 Modular Receive Transmit Interface** is an innovative, multi-purpose relay unit that automatically switches the RF output connector on any HF transceiver between a receiving antenna system and a standard transmitting antenna. A front panel mode switch allows the operator to listen to either antenna system. It provides the safest and most versatile method of connecting a receive antenna to any general coverage receiver, but it most often used with HF transceivers that do not have a separate receive antenna input.

The **DXE-RTR-2** has a new design that features three internal slots for optional accessory modules to improve receive system connections, provide receiver front-end protection and to dramatically enhance low-signal receive antenna performance.

- 75 to 50 ohm Impedance Transformer Plug-in Module, **DXE-IT-PM**
- Receiver Guard Plug-in Module, **DXE-RG5000HD-PM**
- Receive Preamp Plug-in Module, **DXE-RPA-2-PM**



The **DXE-RTR-2** is a very useful antenna relay unit for many applications, such as adding our low-noise, high dynamic range receive preamplifier to any transceiver or receiver, as requested by Amateurs and SWLs. Or, add failsafe receiver protection for stations with close-spaced transmit and receive antennas. This unit protects and safely connects any transceiver to any antenna that can be used for receiving, including Beverage, Pennant, Flag, a passive loop or a sophisticated Receive Array. Plus, it supplies keyed, bias-

tee voltage on the receive antenna input for all types of powered receive antennas including the Active Receive Vertical, **DXE-ARAV3-1P** and the Active Magnetic Loop, **DXE-RF-PRO-1B**.

One of the most important features of the **DXE-RTR-2** is its unique, failsafe relay system that protects the unit, the plug-in modules, and the receive antenna equipment from transceiver RF output damage. The receive antenna mode (RX ANT) is only allowed when the dual-purpose keying line from the transceiver is connected, carrying the special RX ENABLE output signal on the keying line shield to the transceiver chassis. This is the failsafe interlock. Then, as soon as the transceiver is keyed (*or* the unit loses power), the RF output from the transceiver is automatically diverted to the transmit antenna connection. The very fast acting relay (about 4 ms) in the RTR-2 diverts the transceiver output (up to 200 watts CW) fast enough for QSK, full break-in CW (use partial break-in CW operation when using Bias Tee powered active receive antennas), while listening to a receive antenna. It prevents the hot switching and timing errors that are common on other transmit/receive relays, especially dangerous RF sense circuits.

For normal operation, the RTR-2 requires the **RADIO PTT – RX ENABLE** keying cable to be installed. It can be as simple as a common RCA patch cable connection on transceivers that have a keying connector RCA shell at chassis ground. Most other transceivers' keying common is tied to the transceiver chassis. The exception is most Kenwood transceiver keying relays with floating common. To facilitate connections to most Kenwood 7-pin DIN Remote connectors, a new keying line cable is available from DX Engineering, the **DXE-KWD-RTR**. This special cable assembly allows proper operation of a Kenwood transceiver with the RTR-2. See more details in manual sections entitled “*RTR-2 Technical Description and Functional*” and “*More on Radio PTT – RX Enable Failsafe Feature.*”

**Note:** Every radio manufacturer's accessory interconnection scheme is different. Consult your radio manufacturer's manual for details and requirements for receive signal inputs, outputs and switching voltages.

### **Features of the DXE-RTR-2 Receive Transmit Interface:**

- Attractive and heavy stainless steel enclosure
- Multi-Color Status Indicating LEDs for **Power, Option Power and Mode**
- Safe switching - automatically connects radio to transmit antenna when dc power is off
- Hot switching lockout – disconnects receive antenna during transmit mode
- Adds protection and antenna switching flexibility, even for transceivers with receive ports
- Connects transmit antenna to second receiver (**MAIN ANT OUT**) when transceiver is listening to receive antenna
- Handles up to 200 watts (CW) of transmit RF
- Fast relay supports QSK, full break-in CW (use partial break-in CW operation when using Bias Tee powered active receive antennas)
- Transceiver amplifier keying line input RCA female, **RADIO PTT** with **RX Enable** output supports **RTR-2** failsafe
- Accessory keying line output RCA female (**ACC PTT**) ‘ground on transmit’ Schottky diode isolated pass-through from **RADIO PTT** transceiver amp keying for Amplifier or Accessory
- Three internal option slots for Plug-In Modules
- Internal 50 ohm impedance – rear panel SO-239 for **RADIO** and **MAIN ANT**
- Receive Antenna Input – BNC for 50 ohm and F connector for 75 ohm feedlines (use 75 to 50 ohm Impedance Transformer Plug-In Module - **DXE-IT-PM**)
- Internal jumpers to enable and lock bias-tee DC power injection onto receive feedline for Active Vertical or Magnetic Loop Antennas and to lock receive mode (disable failsafe)
- Screw-on version of the DC power connector is provided to prevent accidental power cable pull-out (standard type 2.1 mm DC power connector may be used)

Operates on +13.8 Vdc nominal, accepts and operates on any voltage from +13 to +21 Vdc input to power the RTR-2 and Active antennas connected (voltage may have to be higher for long feedlines). DX Engineering Active Magnetic Loops require +21 Vdc and DX Engineering Active Receive Verticals require +13.8 Vdc minimum.

## The Amateur Radio Dilemma and the DX Engineering RTR-2 Solution

The benefits of using separate receiving antennas for “low-band” HF operations have been known for many years. Low band enthusiasts know that typical transmitting antennas collect too much noise for reception, especially for DXing on the 160 and 80 meter bands. But, affordable HF transceivers have been designed without any provision for a receive antenna connection. Otherwise very capable transceivers, even brand new models, lack a built-in receive antenna port and relay system. Unfortunately, only the most expensive HF transceivers have a separate receive antenna input. Even many “high-end” radios do not provide adequate switching between the receive antenna and the default transmit antenna, or they do not interrupt the receive antenna input during transmit. To obtain a separate receive antenna input, certain models required optional equipment or modules which are no longer available.

Now, with the **DXE-RTR-2** Receive Transmit Interface, the joy of low-noise, low-band reception with a separate receive antenna is available to all transceiver and receiver owners. This unit offers a special receive antenna connection solution, with RF overload protection and improved preamplification, which incorporates safeguards and switching flexibility. Typical homebrew and commercial transmit/receive (T/R) relays and other receive switching solutions offer little or no protection to the receive antenna equipment. The **DXE-RTR-2** allows instantaneous receive comparisons between the receive antenna and the transmit antenna, with a convenient three-position front panel switch. Multi-color Status LEDs on the front panel allow the user to determine at a glance if the unit is connected to power, turned on, if the keying cable is properly connected, when a receive or transmit antenna is selected for reception and when the unit is keyed for transmission.

## RTR-2 Technical Description and Functions

The DX Engineering **RTR-2** Modular Receive Transmit Interface is an indispensable accessory for the radio enthusiast and is useful for any Amateur to expand the capabilities of their transceiver or receiver. It is a specialized multi-port relay unit with one RF transmit capable input and output and one receive antenna input, and a special purpose output. Here is a detailed description of specific technical aspects and functions of the **RTR-2**.

### Internal Option Slots

The BNC and F connectors at **RX ANT IN** are in parallel and are connected directly to the **RTR-2** Option Slots. Bypass Plug-In boards are in place to carry input RF directly to the RTR relay. The DX Engineering Plug-In Modules function exclusively for the receive antenna input operational protection and enhancements. There are three slots for the following order of option installation:

- **Option 1** – the top slot is intended for the 75 to 50 ohm Impedance Transformer (**DXE-IT-PM**) when the receive antenna 75 ohm feedline is connected to either the F connector or the BNC connector **RX ANT IN**. Without the transformer, either input is 50 ohms, which is the internal impedance of the RTR-2.

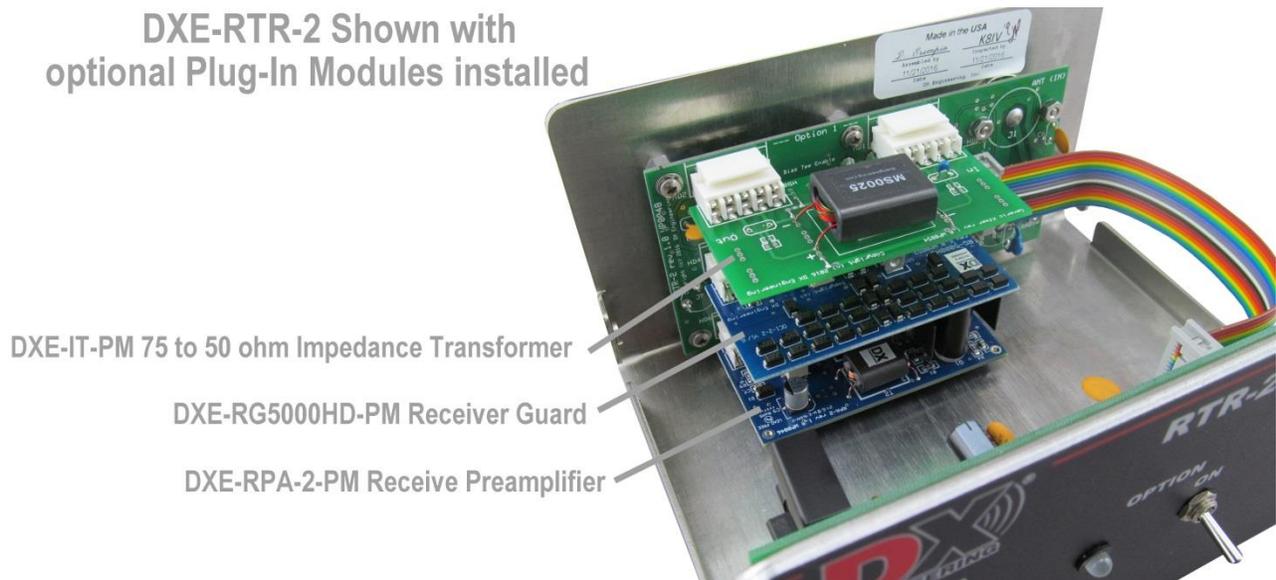


- **Option 2** – middle slot may be used for the Receiver Guard Plug-In Module (**DXE-RG5000HD-PM**) when high RF signal levels are anticipated to occur on the receive antenna input.
- **Option 3** – bottom slot, switched and powered is reserved for Receive Preamplifier Plug-In Modules (**DXE-RPA-2-PM**) as controlled by the Option Power switch. When the RTR-2 is used with passive receive antennas or an Active Receive Vertical (**DXE-ARAV3-1P**), the installation of the RPA-2 plug-in modules is highly recommended to enhance low signal levels due to propagation and atmospheric conditions.



See the section on *Removing Bypass Plug-in Boards* and the section on *Installing Optional Modules*

### DXE-RTR-2 Shown with optional Plug-In Modules installed



## Internal Relay Connections and Functions

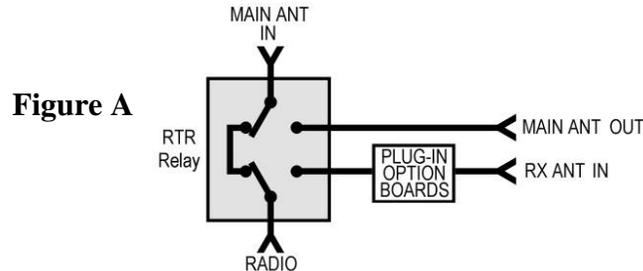
The RTR-2 high-speed relay toggles the **MAIN ANT IN** and **RADIO** connectors simultaneously. This is a reverse-logic relay which prevents the **RADIO** connection to the optional modules and **RX ANT IN** receive signal unless certain connections are met, to prevent the transmitted RF from causing damage.

In **Figure A**, the RTR-2 is in **MAIN ANT** transmit mode. **MAIN ANT IN** is internally connected to the **RADIO** when the power is turned **Off**.

The RTR-2 stays in the transmit mode and the mode LED changes to Red when:

- An antenna is connected to **MAIN ANT IN**
- A coaxial cable is connected from the transceiver RF output to **RADIO** (or from transceiver **RX ANT IN**)
- The **Power** switch is set to **On**

- The **RTR mode** switch is in **Main Ant** momentary or **On** position (not center position)
- The keying line cable **is** installed from the transceiver to the **RADIO PTT – RX ENABLE** connector. Even when the RTR-2 is turned **On** the mode LED (**MAIN AT/RXANT/MAIN ANT LED**) will be dark when no keying cable is connected. This is a reminder to install the required keying cable.



**NOTE: No reception of the RX ANT IN and receive signals through the optional modules is possible when the keying line is not connected. Exception\* - See next page.**

When the RTR-2 is in the **MAIN ANT** transmit mode, and even when independently jumper enabled, RTR-2 input DC voltage (+13.8 to +21 Vdc) is **NOT** fed onto the **RX ANT IN** connector to operate Active antenna(s) – See section on **Internal Jumpers**.

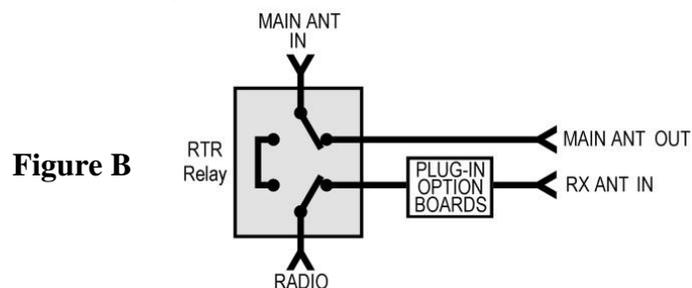
## Receive Antenna Mode

In **Figure B**, the RTR-2 is in **RX ANT** receive mode, the mode LED turns to BLUE, and the **RADIO** is connected to the optional modules and **RX ANT IN** receive signal. This receive-enabled condition depends upon all of these items:

- A coaxial cable is connected from the transceiver RF output to **RADIO** (or from transceiver **RX ANT IN**)
- The **Power** switch is set to **On**
- The mode switch is set to the **RX ANT** position
- The transceiver amp keying line is connected to **RADIO PTT/RX ENABLE**, shield to transceiver chassis, center NOT grounded
- The properly connected transceiver is **NOT** in the transmit mode

When the **RTR-2** is in **RX ANT** mode, the receive signals from the **RX ANT** and optional modules are sent to the transceiver connected to **RADIO**. Also in **RX ANT** mode, these conditions are enabled, as shown in **Fig B**.

- The **MAIN ANT IN** signal is connected to the **MAIN ANT OUT**.
- When independently jumper enabled, RTR-2 input DC voltage (+13.8 to +21 Vdc) is fed onto the **RX ANT IN** to operate Active antenna(s)



**IMPORTANT NOTE** - There are two typical uses of the RTR-2 **MAIN ANT OUT**:

1. When using the RTR-2 to send the transmit antenna received signal to a second receiver only while the RADIO is listening to the RX ANT.
2. When using the RTR-2 **MAIN ANT OUT** to send the transmit antenna received signal to an external splitter in order to share it between a second receiver or SDR spectrum display and the **RX ANT IN**.

**As shown on Figure B, the MAIN ANT OUT has no internal connection to option slots.**

See the section *System Connection Diagrams* for details

**Warning:** When **RX ANT IN** is used in this manner, **DO NOT** short the “**BIAS TEE ENABLE**” jumper on RTR-2 PBC.

See section entitled *Internal Jumpers*.

The RTR-2 immediately reverts to **MAIN ANT** transmit mode, **Figure A, RADIO to MAIN ANT IN** as soon as:

- The transceiver is keyed to transmit, with a ground on transmit on the keying line center conductor
- The keying line is removed from the **RADIO PTT-RX ENABLE** connector
- The **POWER** is turned **Off**

The **MAIN ANT** transmit mode cannot occur when the **Exception\*** condition exists.

**\*Exception:** The RTR-2 **failsafe**, which requires the installation of a keying cable, can be **disabled** with the **Force Ground** internal jumper. **Force Ground** is provided for RTR-2 applications when **ONLY receive antennas** are used, such as SWL or AM DX operations. **MAIN ANT IN** may also be used for a receive antenna, if RADIO connection to a transceiver RF output is **NEVER** to be made.

The **Force Ground** internal jumper **disables the failsafe** provided by requirement of the keying cable connection to **RADIO PTT-RX ENABLE**. See the *Internal Jumpers* section.

**WARNING:** When the **Force Ground** jumper is used to disable RTR-2 failsafe, and when unit is in **RX ANT** mode, any RF transmitted into the **RADIO** connector will cause internal damage, especially to optional Plug-In Modules, and may damage externally connected receive equipment.

**Damage caused by misuse of the “Force Ground” jumper is not covered under warranty.**

## DXE-RTR-2 Front Panel

**PWR ON:** Toggle Switch - RTR-2 power ON and off. +13.8 Vdc power is supplied via the rear panel center positive connector.

**PWR LED indicator:** LED (Light Emitting Diode) illuminates Green to indicate the RTR-2 **POWER ON** is turned on. With power connected to the unit, when the **POWER ON** toggle switch is turned off, the LED will illuminate yellow.

**OPTION:** Green LED. Illuminates green when **OPTION** toggle switch is turned ON

**OPTION ON:** Toggle Switch turns power on for the internal **Option 3** slot. Option 3 slot is for the optional **DXE-RPA-2PM** Receive Preamp Plug-in Module.

**RX ANT:** Mode - Two color LED (Red, Blue, or off) indicator illuminates Blue to indicate the RTR-2 is in the receive mode (and there is a keying cable connected). When the LED is red, it indicates you are in the **MAIN ANT** transmit mode. This LED extinguishes when the keying cable is not connected or when the unit is turned off.

**MAIN ANT - RX ANT - MAIN ANT:** Three-position toggle switch provides manual control of the RTR-2- antenna selections:

**MAIN ANT (up)** - Manually switches **RADIO** to the **MAIN ANT** for receiving with the transmitting antenna. **RADIO** remains connected to **MAIN ANT** during transmit. Mode LED is red when keying cable is connected and **POWER** is ON.

**RX ANT (center)** - Switches the **RADIO** to the **RX ANT** for receive mode and allows automatic switching of the **RADIO** to the **MAIN ANT** during transmit. Mode LED is blue.

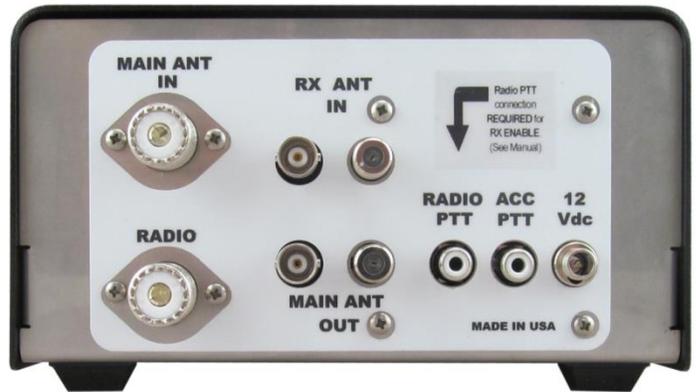
**MAIN ANT (momentary on when pressed down)** - Manually switches **RADIO** to **MAIN ANT** momentary for a fast check of reception on the transmitting **MAIN ANT** (mode LED is red).

For those that want a slightly larger switch handle on the RTR three-position toggle switch, a black switch cap has been included with the RTR-2. Push this cap fully in place as shown.



## DXE-RTR-2 Rear Panel

**MAIN ANT IN:** SO-239 connector - RF connection to a suitable transmit antenna or load. Connected to the **RADIO** connector when the RTR-2 is not powered or the **MAIN ANT/RX ANT** switch in the **MAIN ANT** position. When the unit is in the **RX ANT** mode, **MAIN ANT IN** is connected to **MAIN OUT** to monitor transmit antenna. Details in **Figure B** and text. While compatible with high power amateur radio stations, the RTR-2 can never be connected to the output of a high power amplifier. The **MAIN ANT IN** port must always connect to the input of any linear amplifier or directly to the transmitting antenna system if no amplifier is in use.



**RADIO:** SO-239 connector - Transmit and receive RF connection to the transceiver or connection to the transceiver RX antenna input. Maximum 200 Watts transmit with **MAIN ANT** connected to a suitable antenna or load. Connected to the **MAIN ANT IN** connector when the RTR-2 is not powered or the **MAIN ANT/RX ANT** switch in the **MAIN ANT** position.

**RX ANT IN:** BNC female connector and F-Connector (in parallel) - Input for receive only antenna, or from a receive only device.

**MAIN ANT OUT:** BNC female connector and F-Connector (in parallel) - Output for special applications, receive only connection of **MAIN ANT** during receive mode only. Used for transmit antenna monitoring and pre-amplification or sharing purposes only. Disconnected during transmit or when unit is switched to **MAIN ANT**. This port is never connected to options. This port is active only in the **RX ANT** receive mode, when **POWER** is **ON** and the “**RX ANT ACTIVE**” Blue LED is fully illuminated.

**RADIO PTT RX ENABLE:** RCA female connector - The transmitter amplifier keying line input connection from transceiver or sequencer (ground on transmit). This two-conductor connection to the transceiver keying output **MUST BE CONNECTED** to enable **RADIO** reception of receive antenna. This connection is master to the **ACC PTT**. See section *More on Radio PTT-RX ENABLE*

**ACC PTT:** RCA female connector - Keying line pass-through output connection for amplifier or accessory (grounding keying line only) for automatic relay switching of an accessory. This connection is a diode protected pass through of the ground on transmit from the **RADIO PTT** and is **NOT INTERCHANGEABLE** with **RADIO PTT**. There is no delay in this signal. See section *More on Radio PTT-RX ENABLE and Caution*

**12 Vdc:** The RTR-2 operates on +13.8 Vdc 2A and accepts well-filtered, +13.8 to +21 Vdc for normal operation. A 2.1 mm screw on plug, center positive power plug is included with the RTR-2 which is intended to prevent accidental disconnection (a standard 2.1 mm plug will also work). Supports external active antennas that require higher feedline voltage from the RTR-2. The RTR-2 will accept up to 21 Vdc input. *The use of some switching power supplies is discouraged due to the presence of RF noise in their output.*

## More On RADIO PTT – RX ENABLE Failsafe Feature

The proven design of the **RADIO PTT-RX ENABLE** failsafe feature used in the RTR-1 is now improved for the NCC-2 and the RTR-2.

In the RTR-2, the purpose of the failsafe circuit is to allow the transceiver to listen to a receive antenna while reducing, to nearly zero, the chances of accidentally transmitting into the option modules and RX ANT IN. Therefore, the RTR-2 relay is wired so that when the unit is turned off, the transceiver (**RADIO**) is connected to the transmit antenna or amplifier (**MAIN ANT IN**). When the unit is off, you can use your station normally. See **Figure A** on page 7.



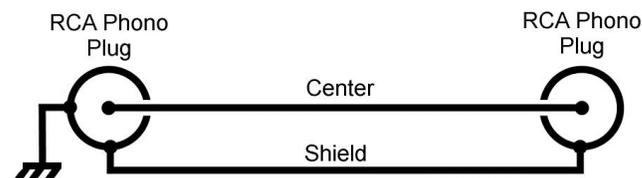
When we turn the RTR-2 on, we still want the same connections, the **RADIO** to **MAIN ANT IN**, when the transceiver is keyed to transmit, or when we want to listen only to the transmit antenna (**MAIN ANT**). Okay, let's tell the RTR-2 when it is safe to switch to receive mode. Well, unfortunately, we can't because transceivers don't put out an "Okay to Receive" signal, they only send out a "Hey, I'm transmitting signal" on the amplifier keying line (which we connect to **RADIO PTT**).

So when we want to switch the RTR-2 to the receive mode (**RX ANT**), so that the **RADIO** is connected to the Option Modules and the RX ANT IN (**Figure B** on page 7), we have to be absolutely certain that the transceiver keying signal, which automatically switches the **RADIO** back to the **MAIN ANT**, is always there, **OR ELSE!** That transceiver amplifier keying cable **MUST** be installed. But, how can the NCC-2 know that it is safe to go to the receive mode? It does it with the **RX ENABLE** signal, which is sent on the **shield** of the **RADIO PTT** keying cable to the chassis of the transceiver, and back on the RF coaxial cable shield. **No keying cable? No receive! Only transmit.**

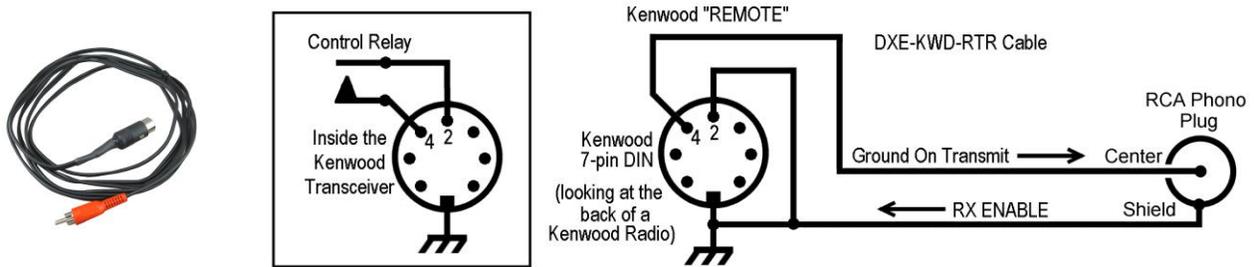
How can that work? Simple; the **shell** of the **RADIO PTT** connector is **NOT** at RTR-2 chassis ground. It carries the **RX ENABLE** voltage that is looking for the chassis ground. The keying cable **MUST** be there. **This is the failsafe interlock.**

Let us say it another way: The **RX ENABLE** signal travels from the **RADIO PTT** on the shield of the keying cable to the transceiver chassis ground. The transceiver amplifier keying signal on the center conductor takes the RTR-2 out of the receive mode, sending the **RADIO** back to the **MAIN ANT IN**. Of course, the amplifier keying signal is sent on to your amplifier without delay, through a Schottky-diode for isolation, via the **ACC PTT** connector. (See the caution on the next page).

The **RADIO PTT – RX ENABLE** keying cable can be as simple as a common RCA audio patch cable connection from certain transceivers that have an RCA keying connector that has its shell at chassis ground.



Most other transceivers' keying common is tied to the transceiver chassis. The exception is that most Kenwood transceiver keying relays have a floating common. To facilitate connections to Kenwood 7-pin DIN Remote connectors, a new keying line cable is available from DX Engineering, the **DXE-KWD-RTR**. This special cable assembly adds the shield to the chassis ground connection on the 7-pin DIN shell to allow proper operation of a Kenwood transceiver with the RTR-2.



With this special cable wiring for Kenwood transceivers, Ground On Transmit and RX ENABLE are functional for the RTR-2, NCC-2 and RTR-1 units.

Note: The **DXE-KWD-RTR** cable does not provide an ALC line due to its lack of use.

The following Kenwood radios are known to have the 7-pin DIN REMOTE connector for amplifier keying line connection and can use the **DXE-KWD-RTR** cable:

TS-120, TS-130, TS-140S, TS-2000, TS-2000X, TS-B2000, TS-430S, TS-440S, TS-450S, TS-50S, TS-530S, TS-570D, TS-570DG, TS-570S, TS-570SG, TS-590S, TS-590SG, TS-680S, TS-690, TS-690S, TS-850S, TS-870S, TS-930S (Some early unmodified TS-930 models are not supported), TS-950S, TS-950SDX, TS-990S

**KEYING LINE CONNECTION WARNING:**

**MAKE ABSOLUTELY CERTAIN that the KEYING LINE from the TRANSCEIVER is connected ONLY to the RTR-2 RADIO PTT connector. The keying line to the amplifier must be connected ONLY to ACC PTT output.**

**Do Not reverse the RADIO PTT and ACC PTT keying line connectors. These connections are NOT interchangeable.**

**When the RTR-2 RADIO connector is used to carry transmitted RF, if these keying connectors are accidentally reversed, PERMANENT INTERNAL DAMAGE will occur to the RTR-2 and potentially to other receive antenna devices.**

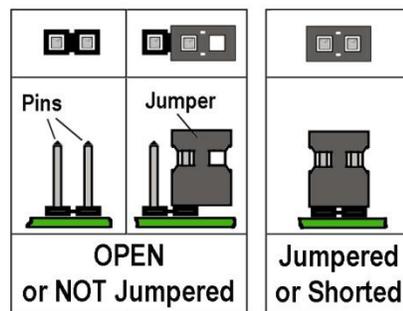
**INTERNAL DAMAGE TO THE RTR-2, PLUG-IN MODULES and external equipment DUE TO REVERSAL OF KEYING LINES IS NOT COVERED UNDER WARRANTY.**

## Internal Jumpers

The **RTR-2** has internal jumpers that configure the placement of DC power (Bias Tee) onto the **RX ANT IN** to power an active receive antenna. As delivered from DX Engineering, the RTR-2 internal jumpers are set for normal operation with no DC power on the antenna input connectors.

With the unit unplugged and no power connected, remove the two screws on each side of the cover and lift the cover off.

The jumpers are small plugs that fit over and connect two of the pins on the associated header that is soldered to the printed circuit board. The jumper is removed by pulling straight out and installed by aligning with two pins and pushing straight in to fully seat the jumper. When a jumper is not used and to avoid losing it, push it on so it only connects to one pin.



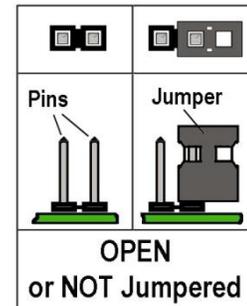
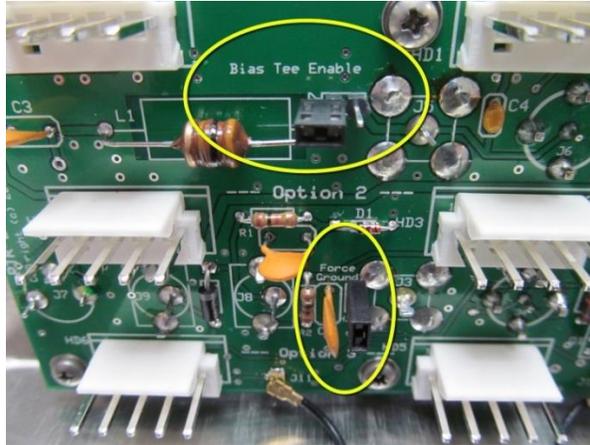
Looking inside the RTR-2 toward the rear of the unit is a printed circuit board.



Remove the Option 1 and Option 2 By-Pass Plug In boards to have a clear view and easily check/change the jumpers. Refer to "*Removing Bypass Plug-in Boards*" for removal or installation of these boards.

## Bias Tee Enable

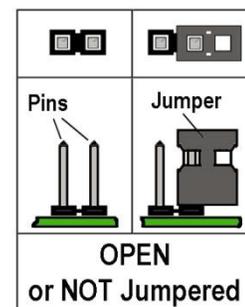
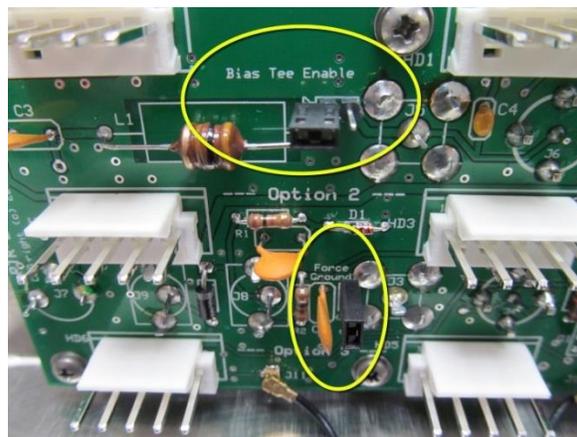
In between the Option 1 and Option 2 plug in boards on the printed circuit board (PCB) there is a jumper labeled “**Bias Tee Enable**”. The factory default for this jumper is open (pins are **NOT** jumpered together).



When the “Bias Tee Enable” jumper is in place (both pins connected), the bias tee voltage is connected to the **RX ANT IN** receiver antenna input connectors (BNC and F). This voltage is toggled on when in the RX ANT mode. Exception: *See Bias Tee Always On*

## Force Ground

On the rear internal PCB between the Option 2 and Option 3 By-Pass Plug In boards there is one jumper called “**Force Ground**”. This jumper is normally left open (factory default).



**NOTE: If this jumper is installed (pins are jumpered) the internal safety mechanism is defeated. This safety mechanism is intended to protect the RTR-2 from transmit energy. DO NOT use this jumper for typical amateur radio transmit functions.**

This jumper is only used for applications where the RTR-2 is going to be used only with receive antennas and any transceiver RF output is never connected to the RTR-2. **Never use with any type of TRANSMIT antennas when the “Force Ground” jumper is installed.**

The RTR-2 **failsafe** requires the installation of a keying cable. It is **disabled** with the **Force Ground** internal jumper. **Force Ground** is provided for RTR-2 applications when **ONLY receive antennas** are used, such as SWL or AM DX operations. **MAIN ANT IN** may also be used for a receive antenna, if RADIO connection to a transceiver RF output is **NEVER** to be made.

The **Force Ground** internal jumper **disables the failsafe** provided by requirement of the keying cable connection to **RADIO PTT-RX ENABLE**. See the *Internal Jumpers* section.

**WARNING:** When the **Force Ground** jumper is used to disable RTR-2 failsafe, and when unit is in **RX ANT** mode, any RF transmitted into the **RADIO** connector will cause internal damage, especially to optional Plug-In Modules, and may damage externally connected receive equipment.

**Damage caused by misuse of the “Force Ground” jumper is not covered under warranty.**

## Bias Tee Always On

The PCB mounted on the RTR-2 front panel has one jumper labeled “**Bias Tee Always On**” as shown below. The factory default for this jumper is open - pins NOT connected together).



When this jumper is connected (both pins shorted together), bias tee voltage is present regardless of transmit and receive keying. This jumper should only be installed for non-RTR, receive only use of the RTR-2. Keyed bias tee voltage on the receive feedlines is normally desired.

## Removing Bypass Plug-in Boards

The RTR-2 has Bypass Plug-In Boards installed at the factory. When making changes to the internal jumpers or installing the optional modules, the Bypass Plug-In boards must be removed.

Remove the cover from the RTR-2. Looking at the rear of the unit from the inside, you will see the three Bypass Plug-In boards installed as shown below.



To remove the Bypass Plug-In board, use a small diameter Phillips Screw Driver. Put the screw driver through the hole on the corner of the board to be removed and gently pry it slightly outward. Move the screw driver to the other corner of the board to be removed and repeat the prying action. The board will come loose from the board connectors and be able to be easily removed. Repeat the same sequence for the other Bypass Plug-In boards See the photos below.



## Installing Internal Option Modules

The RTR-2 has positions for optional modules:

- 75 to 50 ohm Impedance Transformer Plug-in Module, **DXE-IT-PM**
- Receiver Guard Plug-in Module, **DXE-RG5000HD-PM**
- Receive Preampifier Plug-in Module, **DXE-RPA-2-PM**

Remove the cover from the RTR-2. Looking at the rear of the unit from the inside, you will see the three Bypass Plug-In boards installed as shown below. When an optional board or boards are not installed, the jumper boards (labeled as “Bypass Plug In”) must be in place as shown below.



- Option 1 - The Top position is where the 50-75 ohm Transformer Module **DXE-IT-PM** is installed.  
Option 2 - The Middle position is where the Receiver Guard **DXE-RG5000HD-PM** is installed.  
Option 3 - The Bottom position is where the Receive Preampifier **DXE-RPA-2-PM** is installed.

### DXE-RTR-2 Shown with optional Plug-In Modules installed

DXE-IT-PM 75 to 50 ohm Impedance Transformer

DXE-RG5000HD-PM Receiver Guard

DXE-RPA-2-PM Receive Preampifier



Note: Because of the power and switching requirements, the Receive Preampifier **DXE-RPA-2-PM** must be installed in only the Bottom position. When installing an optional module or a Bypass board, ensure the pins are properly aligned and push the board fully in place.

## RTR-2 Installation

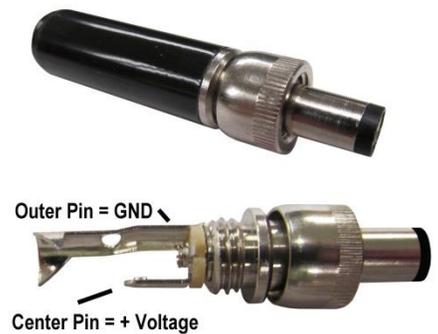
*Please read the following section carefully.*

The best location for this unit is at the operating position with easy access to the controls since you will be using the S-Meter and listening to your receiver while operating the **RTR-2** mode switch.

### Connections

Make connections to the **RTR-2** as follows:

- Connect a well filtered and fused power source of +13.8 to +21 Vdc 2A minimum to the 2.1 mm center (positive) **MAIN PWR** jack using the included 2.1 mm screw-in plug. A standard 2.1 mm plug will also work. Well filtered and fused station power is recommended. For most operations (no loops or special receive antennas) using your shack power of +13.8 Vdc is fine. **Be aware that any voltage used as an input to the RTR-2 (+13.8 to +21 Vdc) will be fed by the bias tee circuitry onto the RX ANT port.** Some active antennas may require specific voltage levels to work properly. You have to account for line loss over long distances as well. Depending on your installation, you may need to use an external voltage inserter (Bias Tee) to provide different feedline voltage.
- Connect a receiving antenna to the **RX ANT IN** BNC or F connector.
- Connect a standard shielded RCA male patch cable between the **RADIO PTT** Phono connector and a transceiver. For Kenwood transceivers, use the optional **DXE-KWD-RTR** cable.
- Connect the **RADIO** jack to a transceiver antenna jack for use on radios that lack a **RX ANT IN** or the transceiver receive-only antenna port, or receiver antenna input.



Once all connections have been made and double checked, with DC power turned on, and connected (with the RTR-2 turned off, the **POWER LED** will be yellow. Turning **POWER ON**, the **POWER ON LED** will change to green.

The three position **MAIN ON - RX ANT - MAIN ON** toggle switch for manual control of the **DXE-RTR-2** antenna selections.

#### **MAIN ANT** (toggle switch up)

Manually switches the transceiver (**RADIO**) to the **MAIN ANT** for receiving with the transmitting antenna. The transceiver will remain connected to **MAIN ANT** during transmit. The mode LED will illuminate red.

**RX ANT** (toggle switch center)

Place the switch in this position for reception with a receive antenna. This position connects the **RADIO** to the **RX ANT** for receive mode on a receive antenna and allows automatic switching of the **RADIO** to the **MAIN ANT** during transmit. The mode LED will illuminate blue only during receive with the receive antenna and will change to red when the transceiver keying switches the RTR-2 to transmit mode.

**MAIN ANT** (toggle switch momentary down)

Manually switches **RADIO** to **MAIN ANT** momentarily for a fast check of reception on the transmitting **MAIN ANT**. The mode LED changes to red.

## Receiving Antenna Spacing Guidelines

The overall benefits that receiving antenna offer is less noise. Weak signals can be heard on a dedicated receive antenna because it rejects noise and strong stations by virtue of its design, size, directivity and lower sensitivity.

Therefore, placement of a receiving antenna is very important. Normally, excellent results are achieved by placing a receive antenna in a low noise environment. If possible, receive antennas should be located at least 1/2-wavelength away from noise sources and noise re-radiating antennas. Houses, other metal or structures containing metal, metal fencing, towers and transmitting antennas can introduce noise into a receive antenna by proximity which may reduce the effectiveness of a receive antenna.

However, in many cases, the physical space required for the ideal receive antenna installation is not available in the average back yard. In the *Connection Diagrams* section there are typical and special system configurations showing absolute minimum spacing between transmitting and DX Engineering Active Receive Antennas. For optimal performance, greater spacing is recommended for better reception results.

## Typical System Configurations

In most cases, the operator will purchase the RTR-2 because they want to use a receive antenna on a transceiver which lacks a receive antenna input. See the text below and use Diagram 1B for an example using the RTR-2 with a transceiver having a Receive Input and Output.

All transceivers under 200 watts output may be connected to the RTR-2 as is shown in **Diagram One**, and all other diagrams, even if it has a receive antenna input.

**Diagram 1** illustrates the positions and connections to a standard transceiver with optional receive enhancement products from DX Engineering. A simple Beverage antenna or receiving wire loop antenna may be connected directly to the **RX ANT** connector on the RTR-2. A single **DXE-ARAV3-1P** Active Receive Vertical uses DC power, enabled by the internal Bias Tee jumper, on the **RX ANT** input.

**Diagram 2** illustrates how to connect the RTR-2 to a transceiver using available receive input and output connectors. For informational example purposes, here is a partial listing of the transceivers that can benefit from connections with the RTR-2: Yaesu FT-1000 series, FT-1000MP/ MKV series, FT-2000/5000/9000 series; Icom IC-7851, IC-7800, IC-7700, IC-7600, IC-765, IC-761 and IC-781.

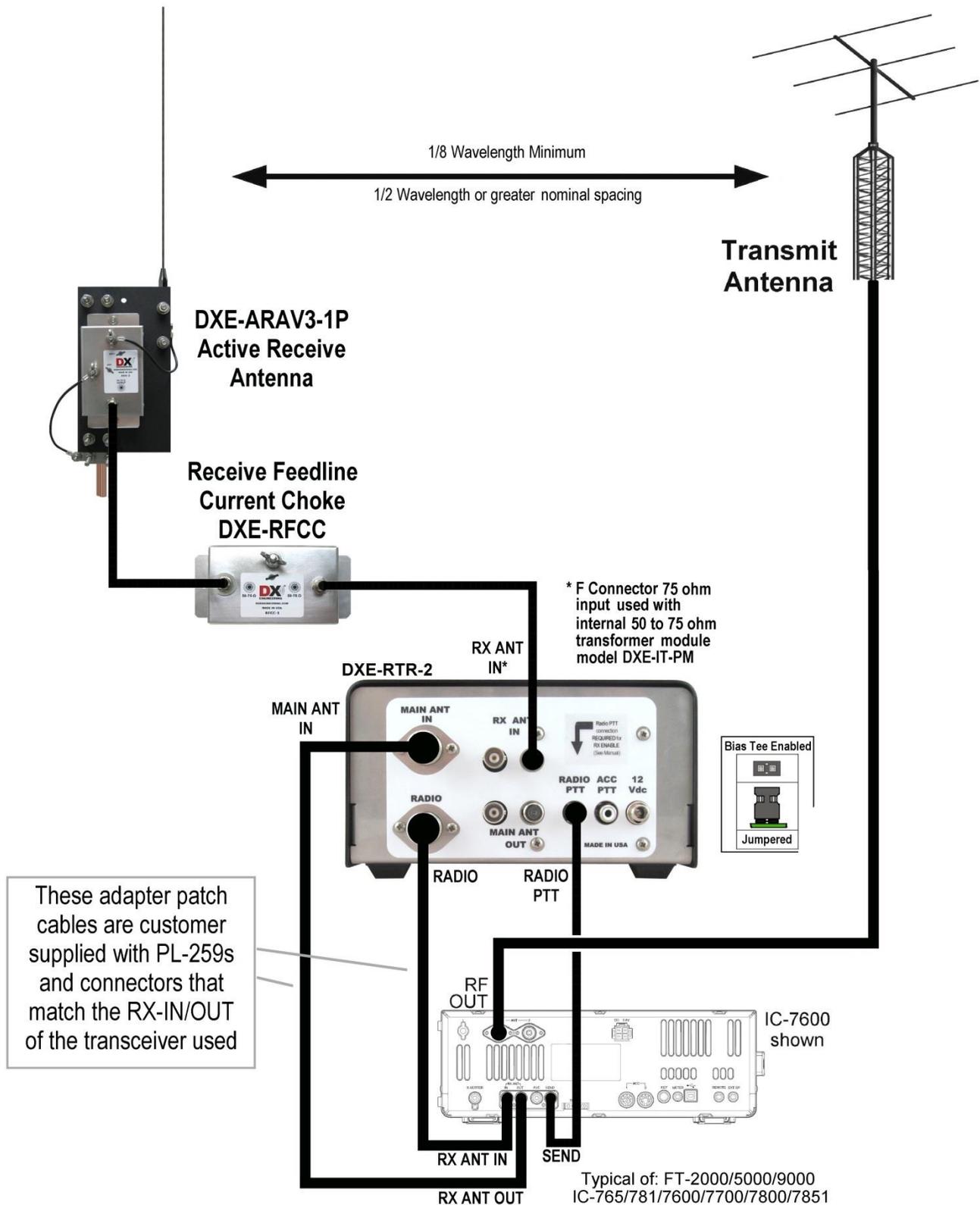
Most high-end transceivers, old and new, offer a receive antenna input that DOES NOT interrupt or switch off during transmit even though the receiver is muted. Also, on many transceivers, connection of a receive antenna to the RX IN port means that the RX OUT to RX IN jumper patch cord must be removed. Then the transmit antenna cannot be heard. For operators of these high-end transceivers, the RTR-2 offers two benefits. First and foremost, it can protect the front end with automatic disconnection of the receive input, preserving QSK, full break-in CW (use partial break-in CW operation when using Bias Tee powered active receive antennas) with 4 ms response. Second, the RTR-2 offers a simple and handy way to toggle between listening to receive and transmit antennas with a front panel switch. The RTR-2 option slot for the **DXE-RG5000HD-PM** Receiver Guard plug-in module will help protect your receiver from damage due to strong received signals.

The RTR-2 **RX ANT** connector is used for the receive antenna system signals. The transceiver RF output is connected to the transmit antenna or amplifier. The transceiver amplifier keying line must be connected to the RTR-2 **RADIO PTT** connector to enable reception of the receive antenna signal. Customer supplied RF patch cords must be used to connect to the SO-239 **RADIO** and **MAIN ANT IN** ports on the RTR-2 to the RX IN and OUT ports on a transceiver, respectively, replacing the existing jumper patch cable. In most cases these are simply two patch cords with PL-259s on one end and male RCA phono plugs on the other end. This connection will never allow transmitted RF into the front end of the transceiver. Since the RX OUT carries only the received transmit antenna signals, the RTR-2 will allow monitoring of either receive, or transmit antenna as described in this manual. This connection scheme is applicable for the radios listed above, as well as others not listed, which offer RX IN and OUT. This transceiver connection scheme may also be adapted for use with any of the diagramed system configurations. If your transceiver has only a receive antenna input but no RX OUT, use the standard connection methods depicted in the diagrams.

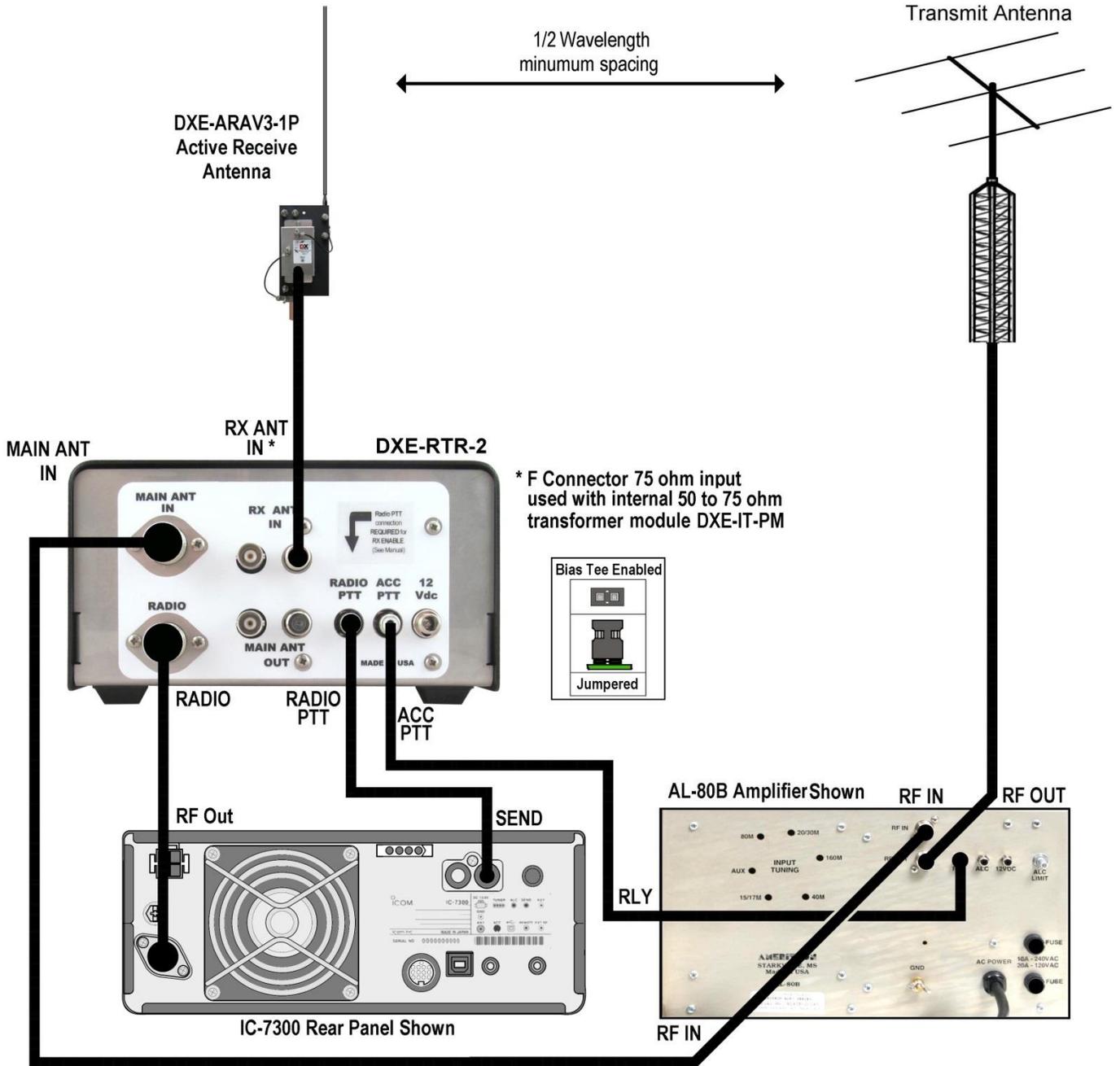
**Diagram 3** shows a typical system which connects a standard transceiver to the RTR-2 for operation with a receive antenna and an HF amplifier.



**Diagram 2** - Active Receive to a transceiver equipped with RX Inputs and Output ports. Allows use of an active or passive receive antenna with added receive signal strength using the **DXE-RPA-2-PM** Preamplifier Plug-In Module.



**Diagram 3** - Active Receive Antenna and Transmit Antenna using High Power. Allows use of an active or passive receive antenna with the optional RTR-2 preamplifier for increased receive signal strength.



## Additional System Configurations

**Diagram 4** shows the legacy receiving application which is similar to the NCC-2 with active receive antennas. The **DXE-RTR-2** Receive Antenna Interface for Transceivers now allows owners of transceivers which lack a receive antenna input to use a phased receive antenna array. This diagram shows the connections for use of the **DXE-AAPS3-1P** Electronically Rotatable Receive Antenna System, which consists of two active receive vertical antennas and the **DXE-NCC-1** Receive Antenna Variable Phasing Controller using the **DXE-RTR-2** Receive Transmit Relay.

**Diagram 5** includes the exceptional **DXE-RPA-2-PM** Receive Preamplifier Plug-In Module with the main (transmit) antenna. For many years Amateurs have been requesting a method to employ a receiving device on their transceivers which lack a built-in preamplifier. The **DXE-RTR-2** provides this connection option. Instantaneous receive comparisons between 'preamplifier in' and 'preamplifier out' are easily accomplished using the **DXE-RTR-2 MAIN ANT - RX ANT - MAIN ANT** toggle switch.

**Diagram 6** demonstrates another common use for the **DXE-RTR-2** and the connections required for use of a two direction **DXE-RBSA-1P** Reversible Beverage Antenna System.

**Diagram 7** shows how a **DXE-RFS-SYS-4P** Complete Receive Four Square Array Package connected to a transceiver that does not offer a receive antenna input.

**Diagram 8** demonstrates how the **DXE-RTR-2** may be used in a classic T/R relay application with an added bonus! The popular optional accessory for older receivers, the DX Engineering Receive Preamplifier model **DXE-RPA-2**, may be used externally, for improving older receiver sensitivity of the transmit antenna, especially on higher frequencies. When the pre-amp is not required, it may be internally bypassed by removing the DC power to it. (The RTR-2 option slots are not used).

Set the **MAIN ANT - RX ANT - MAIN ANT** toggle switch to the **RX ANT** (center) position to connect the **MAIN ANT** to your receiver. When you key the transmitter, the **DXE-RTR-2**'s automatic 4 ms changeover from receive to transmit switches the **MAIN ANT** to the transmitter. Manually switching the toggle switch to the **MAIN ANT** (up) position connects the **MAIN ANT** to the transmitter, if desired for tune up operations. *The power limit for the transmitter is 200 watts.*

The keying line from the transmitter must be a Ground-On-Transmit type, as the **DXE-RTR-2** cannot accept any keying voltage. If the only keying line from the transmitter is a positive or negative voltage type, then a KD9SV Products **SVP-SV-KR** must be used in the transmitter keying line, as shown in **Diagram 8**.

A muting line from the transmitter which may provide a ground for an older receiver, cannot be shared with the **DXE-RTR-1A**, as many old receivers\* require the grounding of a high voltage for muting. However, use the RTR-2 **ACC PTT** line, and an extra relay if necessary, for receiver mute.

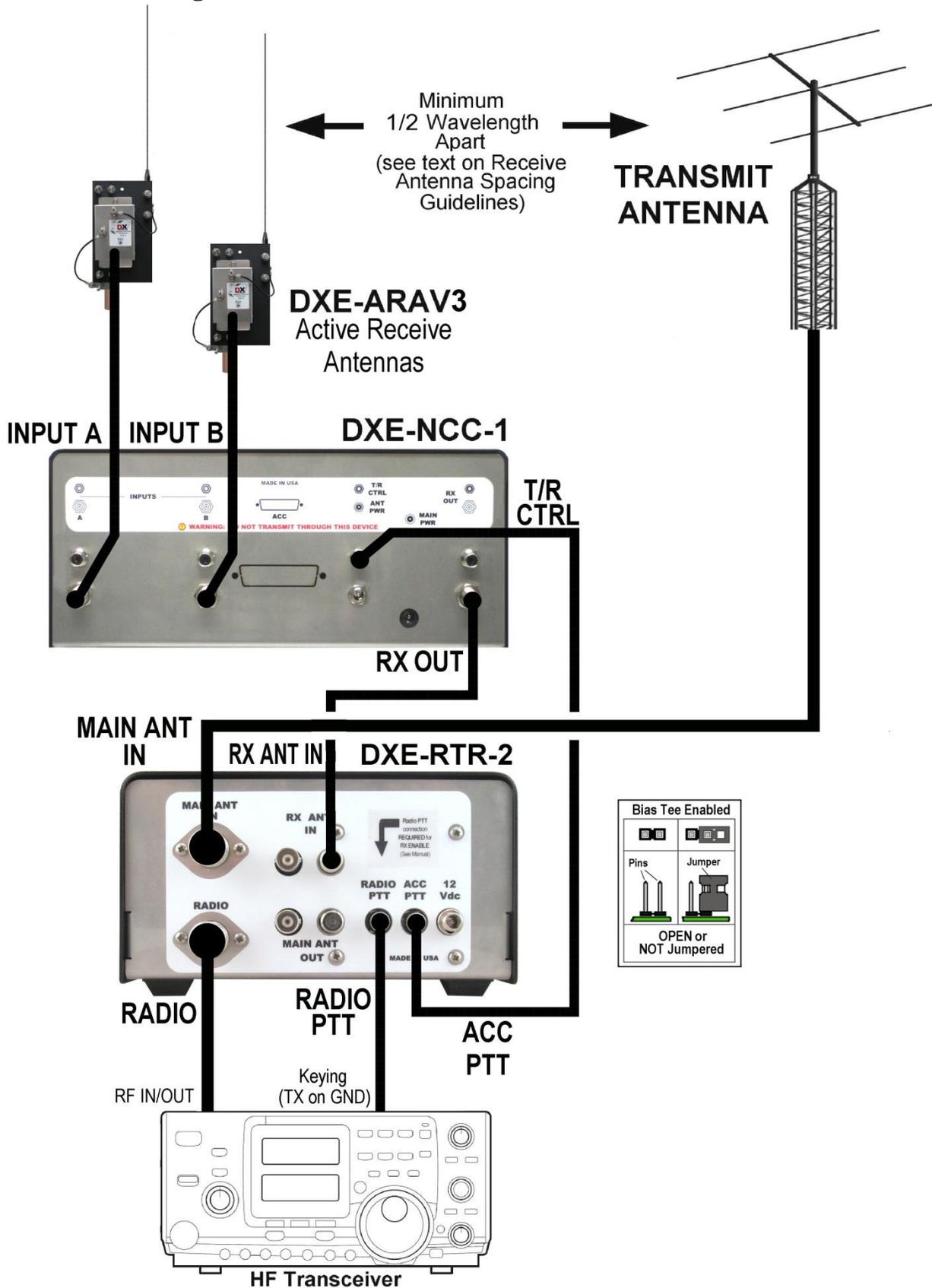
**Diagram 9** illustrates a special application with no receive antenna connections, using the **DXE-RTR-2** with an optional **DXE-RSC-2** Two-Port Splitter/Combiner to allow one transmitting antenna to be shared for simultaneous receive on two transceivers or with one transceiver and one receiver. The second radio (SDR spectrum display) is isolated from transmit energy by the **DXE-**

**RTR-2.** An external Receiver Guard **DXE-RG5000HD** is recommended. Only the main transceiver may be used to transmit. The second transceiver that is connected to one of the **DXE-RSC-2** outputs must be transmit inhibited using either the radio's menu settings or power output controls set to zero to prevent system damage.

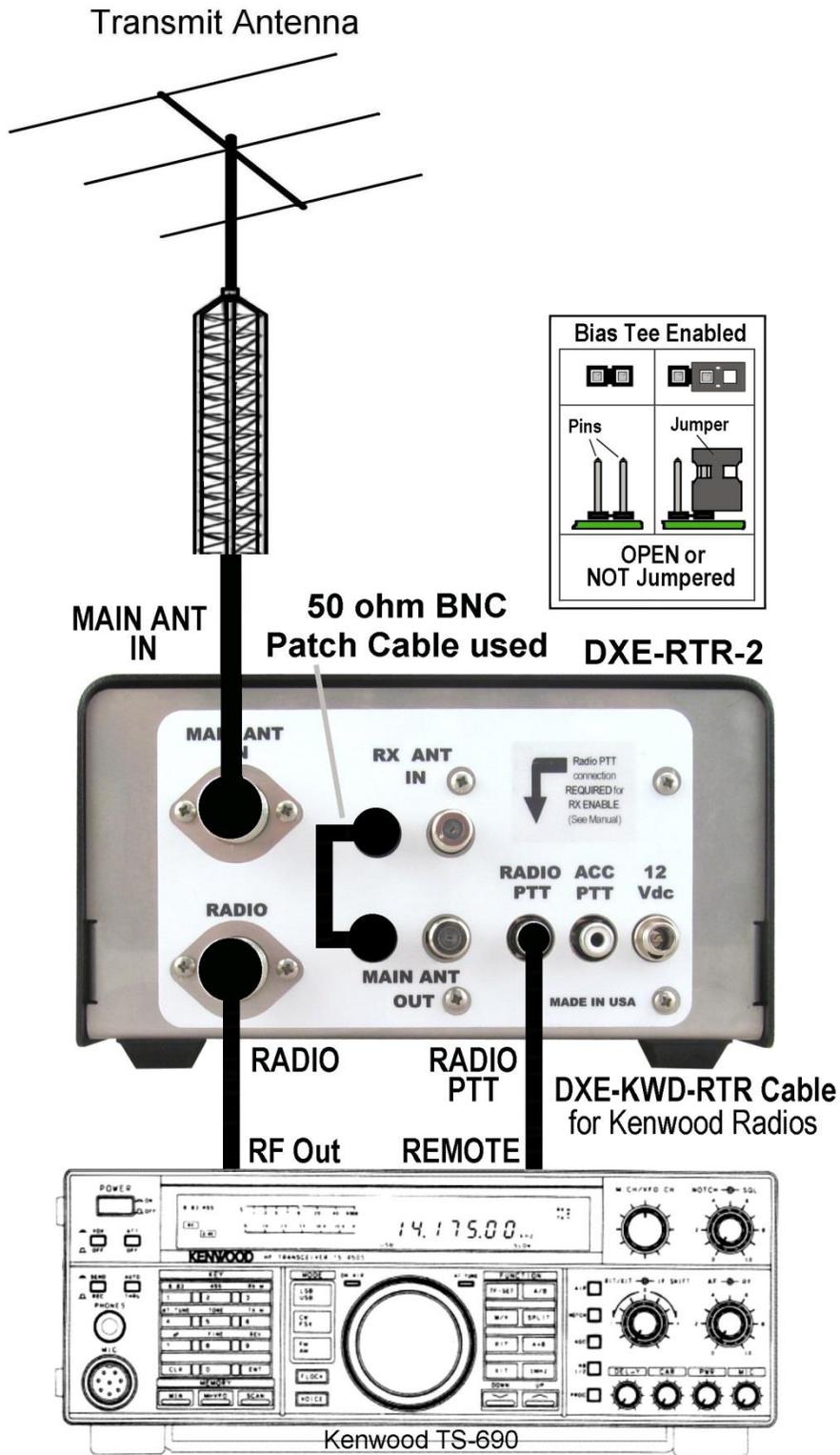
Set the **MAIN ANT - RX ANT - MAIN ANT** toggle switch to the **RX ANT** (center) position to connect the **MAIN ANT** to both radios for simultaneous reception. When you key the main transmitter, the **DXE-RTR-2** automatically changes from receive on both radios to transmit on the **MAIN ANT** in about 4 ms. The strong signal heard by the second radio is at a level that cannot damage it's front end. An external relay may be required to mute the second receiver supported on the **RTR-2 ACC PTT**. Manually switching the toggle switch to the **MAIN ANT** (up) position connects the **MAIN ANT** to the main transceiver, if desired for tune up operations, or for normal operations without the second radio. *The power limit for the radio transmit is 200 watts.*

**Diagram 10** illustrates how to share the transmit antenna with two radios such as a Kenwood transceiver and an SDR with a spectrum display. Similar to Diagram 9, using the **DXE-KWD-RTR** Keying Cable. Addition of an external Receiver Guard **DXE-RG5000HD** to protect the second receiver is left to the discretion of the user. Any **RTR-2** internal optional Plug-in Modules are 'seen' only by the Kenwood transceiver (in this diagram) connected to **RADIO**. Use the **ACC PTT** (and external relay if needed) for the second receiver mute during transmit,

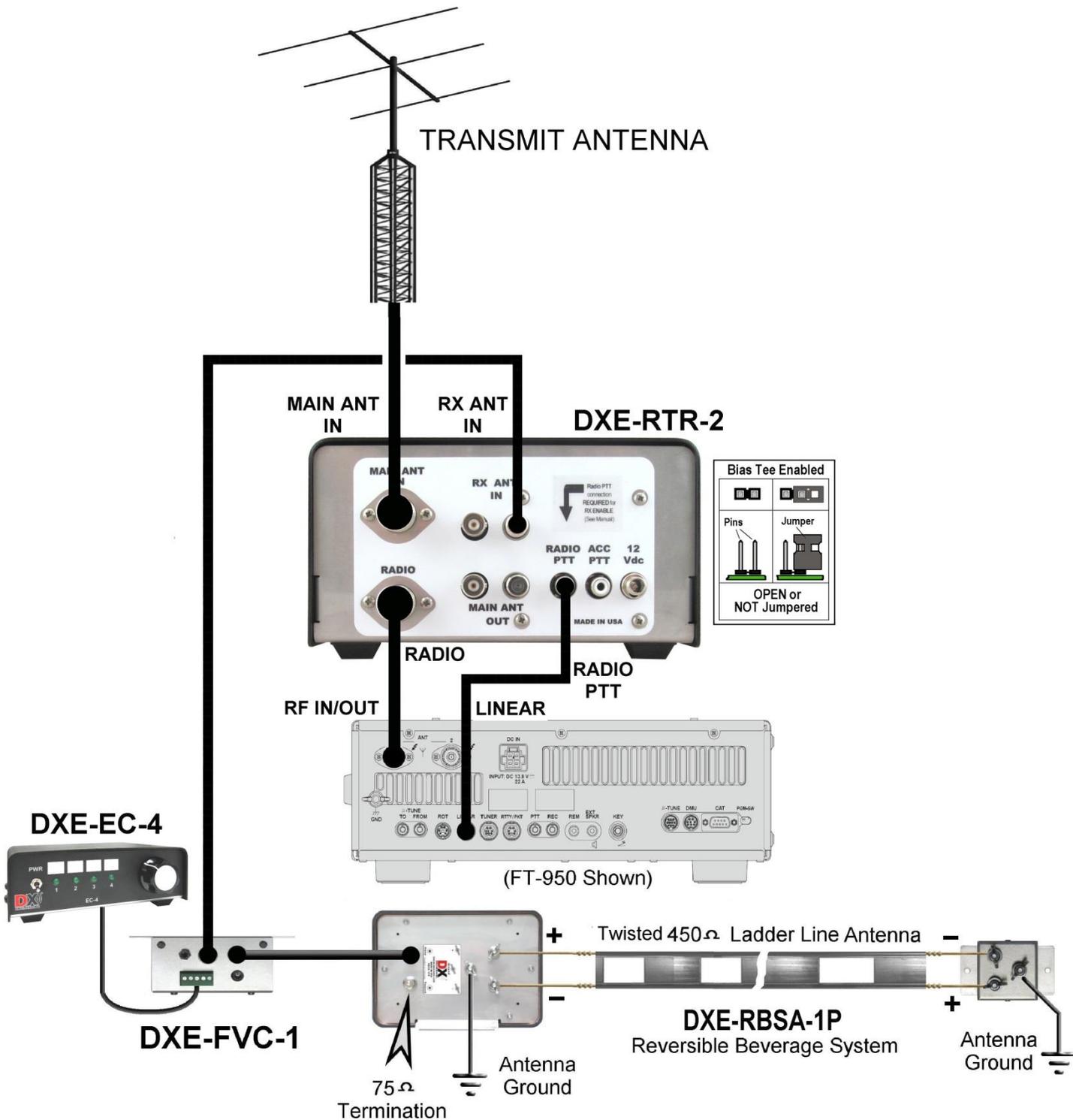
**Diagram 4 - Connections of Active Antenna Phasing System to Standard Transceiver using the DXE-RTR-2.**



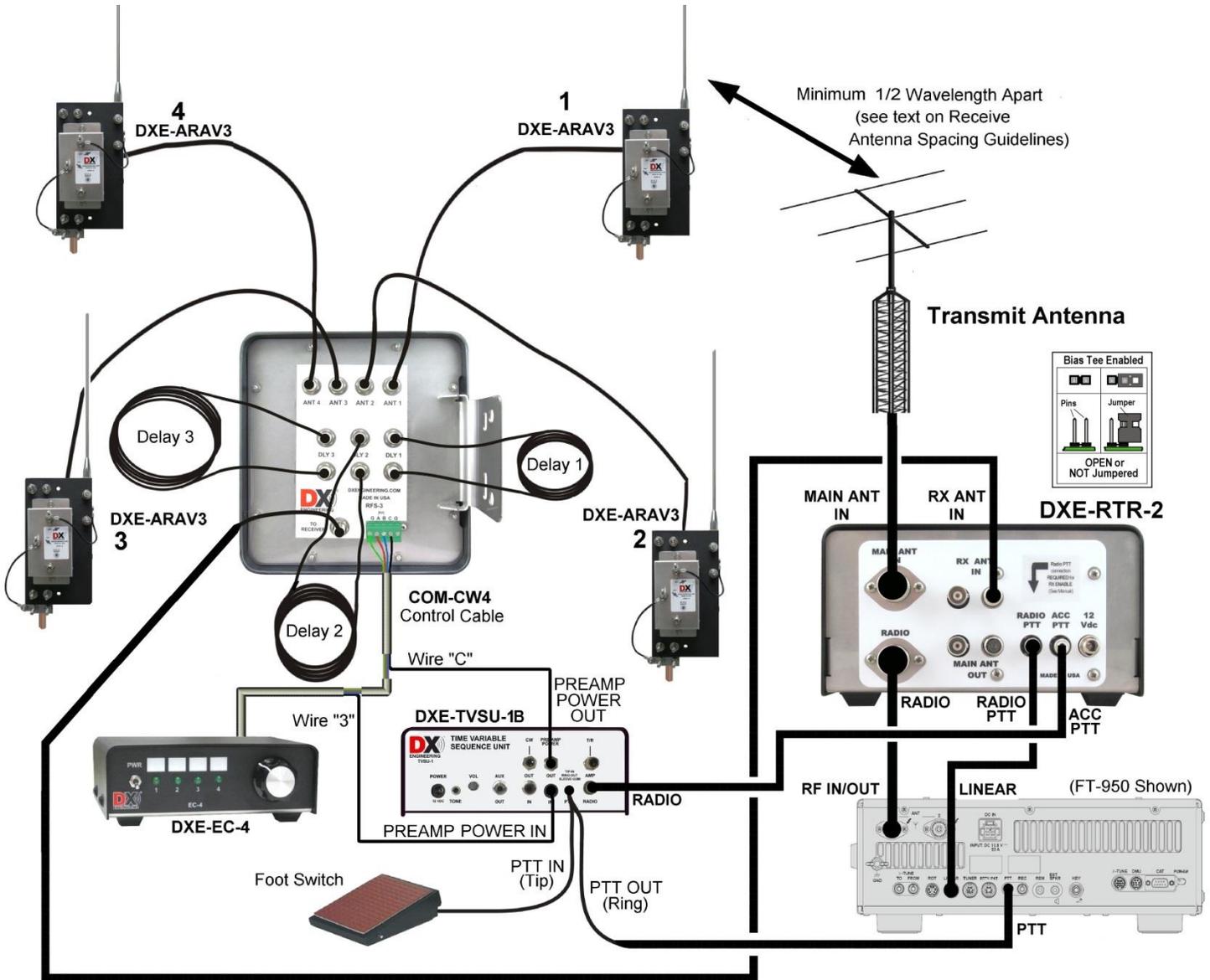
**Diagram 5 - Adding the DXE-RPA-2-PM Receive Preamp Plug-in Module to the RTR-2 provides exceptional receive improvement for older transceivers and receivers.**



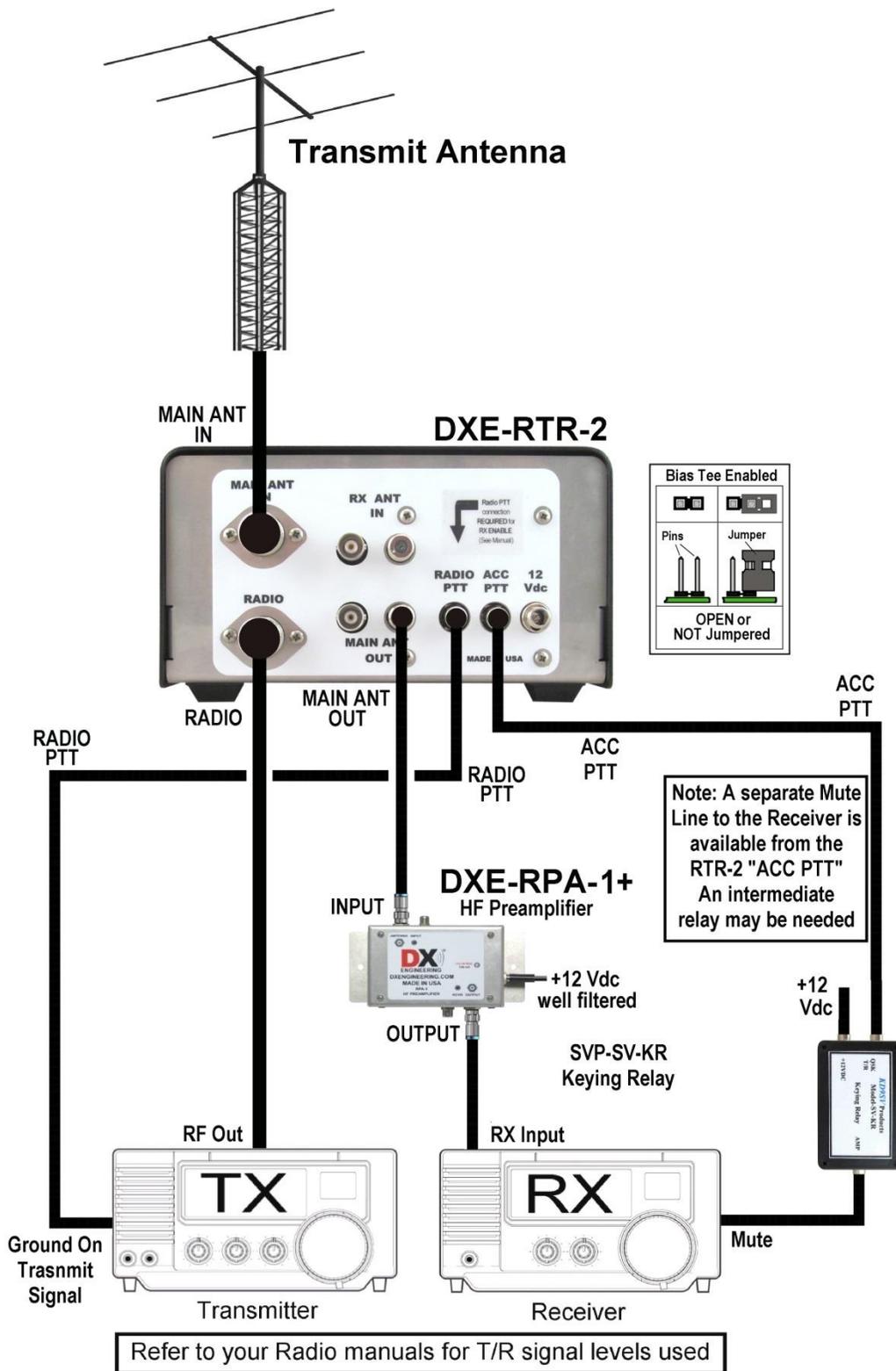
**Diagram 6 - Connections for a standard transceiver to a Reversible Beverage System DXE-RSBA-1P. See the full description in the DXE-RBSA-1P manual available at DXEngineering.com**



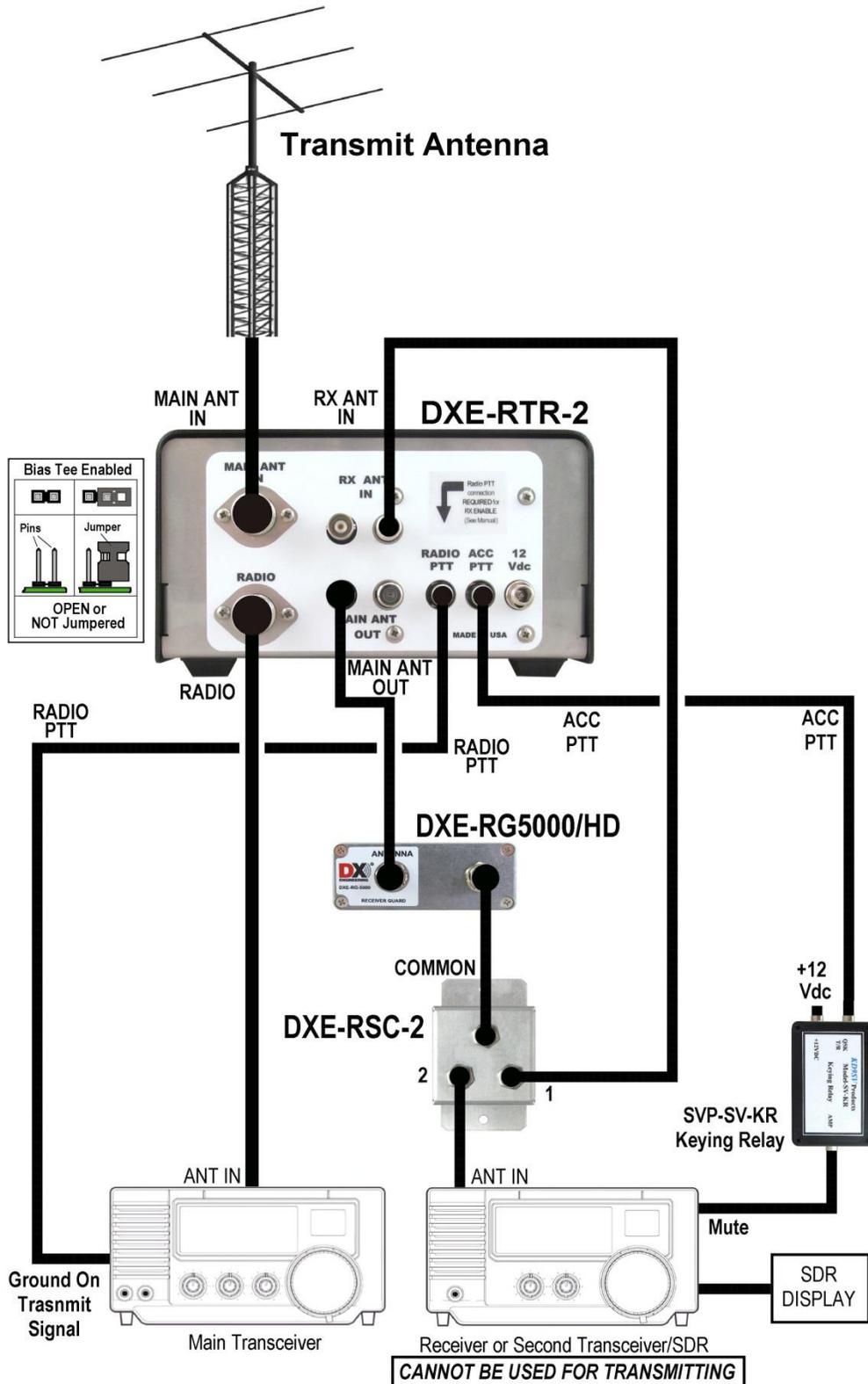
**Diagram 7 - Connections for a standard transceiver to the Receive Four-Square Complete Array Package DXE-RFS-SYS-4P. For details, refer to the DXE-RFS-SYS-4P manual available at DXEngineering.com**



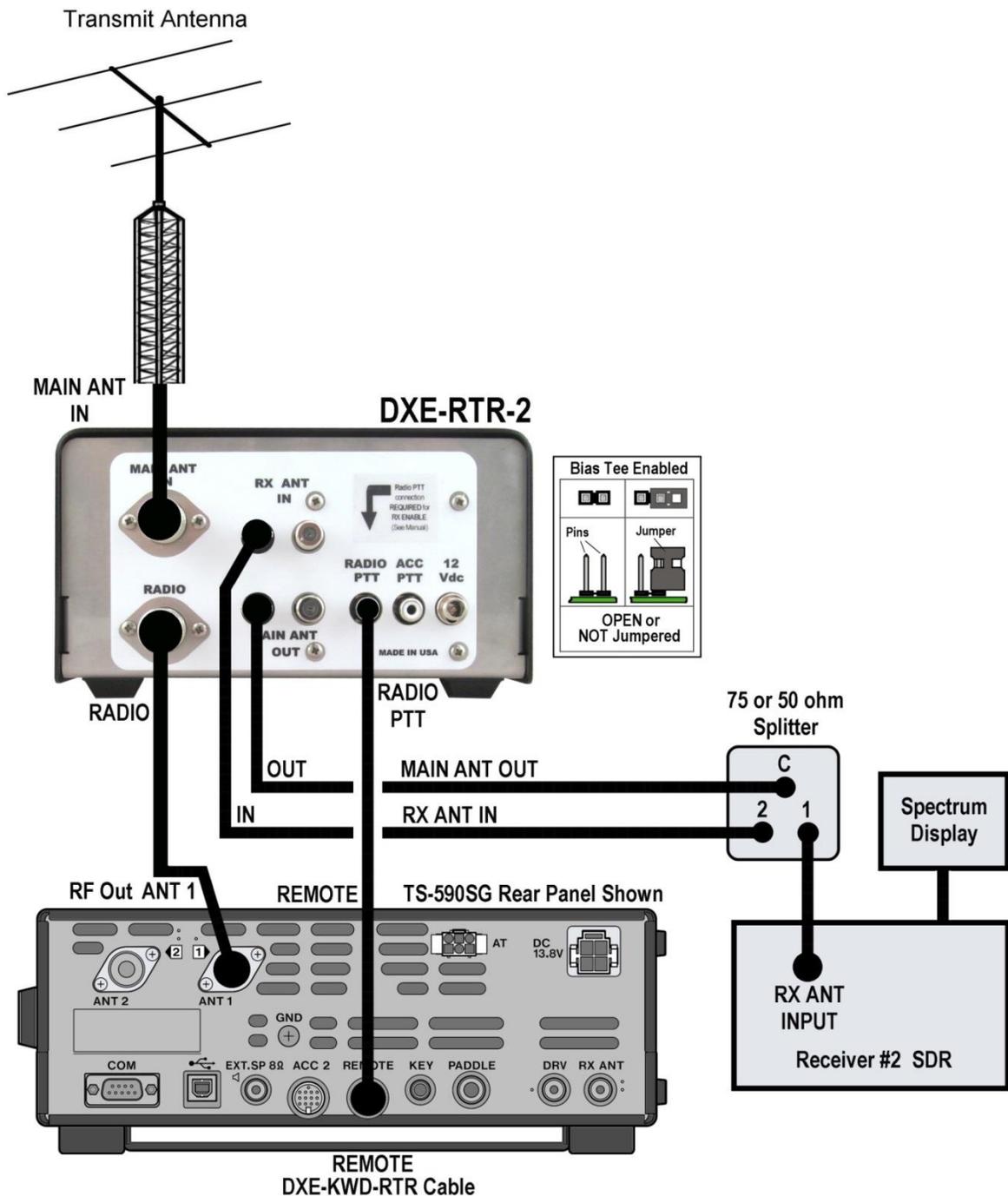
**Diagram 8 - Classic T/R Relay application with the RTR-2 to safely switch a transmit antenna between a transmitter and a receiver. An external Receive Preamp can improve aged receiver performance. Due to keying from older radio equipment, an external relay may be required. Internal optional modules are not used in the RTR-2.**



**Diagram 9 - Connections to share a transmit antenna between two radios for simultaneous reception and safe transmit switching. Supports the addition of an SDR spectrum display to a standard transceiver. External mute relay may be required. External Receiver Guard DXE-RG-5000HD is recommended.**



**Diagram 10 - Connections to share a transmit antenna between two radios for simultaneous reception and safe switch over to transmit. The main RADIO in this example is shown as a Kenwood transceiver, making use of the special Kenwood Keying Cable DXE-KWD-RTR. See section *More On RADIO PTT-RX Enable*. Supports the addition of an SDR spectrum display to a standard transceiver. External options may be desired. RTR-2 Plug-In Modules are effective only for main RADIO.**



## RTR-2 Specifications

Frequency Range	1.8 MHz to 54 MHz
Insertion Loss	Less than 0.1 dB RADIO to MAIN ANT. Less than 0.5 dB RADIO to RX ANT (no options)
Maximum RF Power	200 Watts CW/SSB
Power Input	+13.8 Vdc 1A nominal. Accepts +13.8 to +21 Vdc for operation of an active receive antenna with internal Bias Tee enabled.



## Optional Plug-in Module Descriptions and Specifications

### 75 to 50 ohm Impedance Transformer Plug-in Module (DXE-IT-PM)

A perfect match for changing the line impedance between 50 and 75 ohm systems

Frequency Range	500 kHz through 30 MHz
Insertion Loss	<0.1 dB at 15 MHz, <0.2 dB at 30 MHz
Power Handling	over 30 dBm
Impedance	input = 75 ohm unbalanced output = 50 ohms unbalanced



### Receiver Guard Plug-In Module (DXE-RG5000HD-PM)

These highly effective and inexpensive receive RF limiters prevent front-end damage due to high RF levels that can result in costly radio repairs.

Frequency Range:	0.5 through 150 MHz
Insertion Loss:	< 0.15 dB at 50 MHz, < 0.3 dB 50 MHz up to 150 MHz
VSWR:	< 1.2:1
Max Output Level:	+14 dBm at 10 W input.
Maximum Power Handling:	10 W CCS (Continuous Commercial Service)
System Impedance:	50 ohms, unbalanced



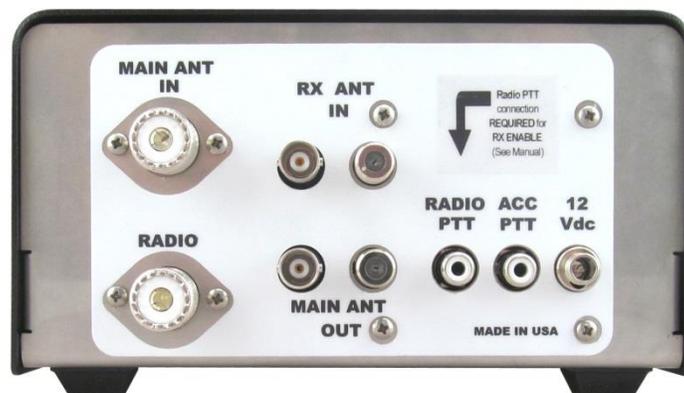
### Receive Preamplicator Plug-In Module (DXE-RPA-2-PM)

Optimized for 0.3-35 MHz operating range. The push-pull amplifier design and robust components enable it to withstand high signal levels and operate when you need it most. The dynamic range is better than most receivers.

Output TOI (Third Order Intercept):	+43 dBm @ 13 Vdc
Noise figure:	3.5 dB
One dB Compression:	+26 dBm (~.4 watts output)
Gain:	16 dB from 300 kHz - 35 MHz (+1.5 to -1.5 dB over this range)
500 Hz BW IM3 Dynamic range:	110 dB or greater



**User Diagram** - Use this to page to document your connections for future reference.



## 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](mailto:DXEngineering@DXEngineering.com)

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

## Manual Updates

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

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