RPA-2 HF Modular Receive Preamplifier

DXE-RPA-2

DXE-RPA-2-INS Rev 1

U.S. Patent No. 7,319,435

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Introduction

The DX Engineering **DXE-RPA-2** Modular Receive Preamplifier is a high-performance broadband LF through HF receiver preamplifier that features exceptional immunity to overload. It also has an excellent noise figure and a low input SWR, optimized for the 300 kHz to 35 MHz range. Meticulous craftsmanship and durable, robust components allow this 50-ohm preamplifier to withstand high signal levels while providing superior dynamic range and third-order intercept performance that equals or exceeds most receiver and transceiver front-ends. Unlike other external preamplifiers and many transceiver internal preamplifiers, the RPA-2 enhances the readability of weak signals without artificially increasing the noise. On low bands and beyond, weak signals become more intelligible using this preamplifier in conjunction with proper adjustment of the RF Gain and Attenuator in the transceiver.

The RPA-2 is a combination of a redesigned aluminum shielded enclosure chassis with the **DXE-RPA-2-PM** Receive Preamplifier Plug-in Module factory installed. The **DXE-RPA-2-PM** module retains the essential characteristics of the milestone product, the original DX Engineering RPA-1.

Featuring one internal optional module slot, the RPA-2 allows the use of the optional **DXE-IT-PM** 75 to 50-ohm Impedance Transformer Plug-in Module or the optional **DXE-RG5000HD-PM** Receiver Guard Plug-in Module or optional filter. See DX Engineering Receive Filters.

While many other common preamplifiers suffer from harmonic distortion, the **DXE-RPA-2** low-noise preamplifier features an advanced push-pull design that eliminates harmonic distortion. High quiescent current increases its ability to handle strong signals without distortion or overload. This high performance device must be powered with a well filtered and regulated DC power supply and offers maximum performance at +13.8 Vdc to +18 Vdc input. Never use an inexpensive, poorly performing wall transformer to power this top-of-the-line preamplifier.

Features

- Internal circuit impedance of 50-ohms for direct connection to 50-ohm receive systems and antenna feedline BNC connectors with no transformer required
- Internal slot accommodates the optional 75 to 50-ohm Impedance Transformer Module to accomplish transition from a typical F connector 75-ohm receive antenna feedline to 50-ohm equipment, without losses
- Input and output connectors BNC and F types, prevent accidental connection to transmitting devices
- Automatic RF bypass relay also turns the preamp off when the dc power is removed
- Green LED indicates when DC power is present and the preamplifier circuit is engaged
- An ingenious positive-capture threaded-sleeve 2.1 mm power connector that ensures the DC power cannot be accidently disconnected from the RPA-2
- A simple internal jumper allows the RPA-2 to be powered by DC on the feedline for use on antenna types that require a preamplifier at the antenna such as Pennants, Flags or K9AY Loops

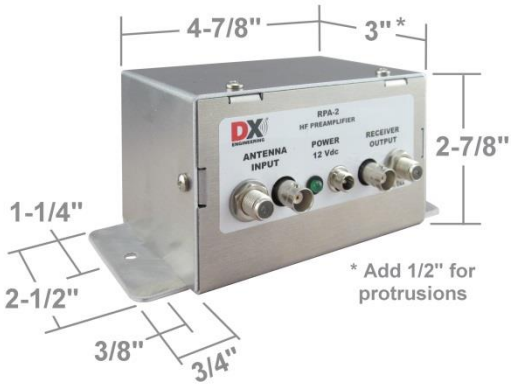
Additional Requirements

Please note you will need to consider the following requirements (parts not included in this package) to install and operate the RPA-2 HF Preamplifier:

The RPA-2 requires a well-filtered, negative ground, +13.8 to +18 Vdc @140 mA power source. Depending on the supply current, you should use an inline fuse. Alternatively, powering the RPA-2 through the coax feedline requires a voltage injector circuit (not included) and an internal jumper (HD5) change. See the section "*Powering Through the Coaxial Cable*".

Installation outdoors at the antenna is not normally needed or recommended. However, some antenna types such as Pennants, Flags or K9AY Loops require a preamplifier at the antenna. If you are mounting the unit outdoors, you will also need to mount the RPA-2 in such a manner as to prevent moisture entering the unit.

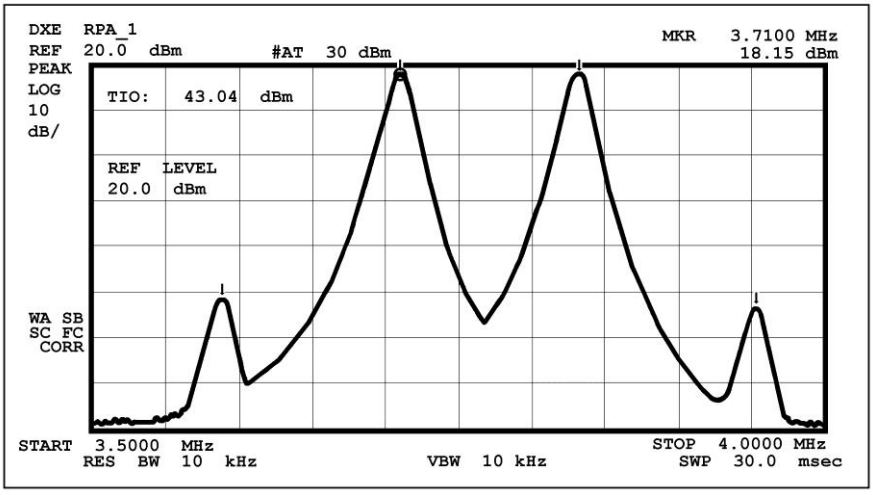
Specifications of the **DXE-RPA-2** Receive Preamplifier:



- **Input and Output Connectors, female**: BNC and F
- **Frequency Range**: 300 kHz to 35 MHz
- **Gain**: 16 dB, +/- 1.5 dB (over entire frequency range)
- **Output Third Order Intercept**: 43 dBm
- **Noise Figure**: 3.5 dB
- **One dB Compression Point**: +26 dBm (400 mW output)
- **Dynamic Range, IM3**: 110 dB or greater (500 kHz BW)
- **Power Requirement**: +13.8 to +18 Vdc, 140 mA max.
- **Operating Temperature Range**: -10°F (-23°C) to 150°F (65°C), non-condensing

The following are simplified explanations of information highlighted above.

Third Order Intercept - A standard measure of how well a receiving system performs in the presence of strong nearby signals. The higher the third order intercept (TOI), the less likely adjacent strong signals will cause interference. The RPA-2 offers substantially improved TOI over competitive preamplifiers and communication receivers. The figure to the right illustrates a typical RPA-2 output third order intercept measurement. The RPA-2 is significantly more immune to overload than the best commercial amateur receivers. Third order products are 50 dB below +18 dBm output.



Noise Figure - The ratio of equivalent noise power developed at the input to that generated by thermal noise in the source resistance, usually expressed in decibels. If it were possible, a perfect amplifier would have a noise figure of 0 dB. The RPA-2 is extremely quiet, and does not contribute noticeable noise to receiving systems. Almost all HF antenna systems receive an ambient noise level that is greater than the noise floor of the RPA-2.

Dynamic range - The ratio of the faintest signal detected to the loudest signal amplified without significant distortion, typically expressed in decibels. The RPA-2 allows you to hear faint signals in the presence of adjacent strong signals.

Gain - The ratio of signal input to output. The RPA-2 features a modest gain that may be bypassed when not needed by removing power to the unit.

ATTENTION: Never transmit through the RPA-2.
The unit can be damaged by direct application of transmitter power.

Installation Location Considerations

Optimum electrical location of the RPA-2 varies with antenna system background noise level. A good receiving system requires the antenna to establish system noise, not the preamplifier. A common myth is that a preamplifier must be mounted at or near antennas to be effective. This is not true at low VHF, HF and lower frequencies. A preamplifier is needed at the antenna only when feedline loss is high and the antenna has very low background noise. Low band antennas rarely suffer from feedline losses, so the preamplifier can normally be used at the radio. Another common misconception is that mounting the preamplifier at the antenna feedpoint reduces feedline noise pickup. The location of the preamplifier rarely makes a difference in feedline noise. Most feedline noise couples back to the antenna at the antenna terminals, it does not leak directly into the feedline. The RPA-2 prevents signal leakage when used at an antenna.

Normal Mounting Indoors

For typical indoor installations, mount the RPA-2 near the receive antenna input of receiver or transceiver. For best results, use the RPA-2 in a well-ventilated indoor area away from direct sunlight and moisture. Operation outside of the specified temperature range of -10°F (-23°C) to 150°F (65°C), non-condensing, will shorten the life of the RPA-2, and should be avoided.

Mounting at the Antenna

Ordinarily, the preamplifier should be mounted indoors at the operating position, rather than at the antenna. There are few exceptions which include Pennants, Flags, and K9AY Loops. These antennas have relatively low sensitivity and will not provide much background noise to the system when they are installed in quiet locations. If the feedline loss is high, performance might improve with the preamplifier mounted near the antenna.

The RPA-2 may be mounted at or near the receive antenna under a cover or in a weather-protected enclosure. Operation outside of the specified temperature range of -10°F (-23°C) to 150°F (65°C), non-condensing, will shorten the life of the RPA-2, and should be avoided. Make certain that the enclosure is vented to prevent moisture from collecting in the unit that would accelerate corrosion

and failures. A remote power source of +13.8 Vdc minimum may be used. Alternatively, the RPA-2 may be powered over the coax. See "*Powering Through the Coaxial Cable*".

Power Connection

The RPA-2 requires a well-filtered +13.8 to +18 Vdc @ 140 mA source with a negative ground. Many inexpensive wall mounted transformer DC supplies are not 'clean' and have RF noise components on their DC output. Place the fuse at the power supply, rather than at the RPA-2.

The RPA-2 power connector uses a positive locking threaded 2.1 mm barrel type plug (included). When plugged in, tighten the connector by turning clockwise. This prevents the power connector from coming loose. To remove, turn the connector counterclockwise. You should use a well regulated +13.8 Vdc supply. Another well regulated source can be used as long as it supplies +13.8 to +18 Vdc, negative ground, the power plug center is connected to positive and has an inline 1A fuse. When power is applied to the RPA-2, the green LED will illuminate. A standard 2.1 mm power connector with center positive and +13.8 Vdc supply may be used. Do NOT use a wall transformer, they are inherently noisy.

ATTENTION! *Be sure the power supply polarity and voltage level are correct.*

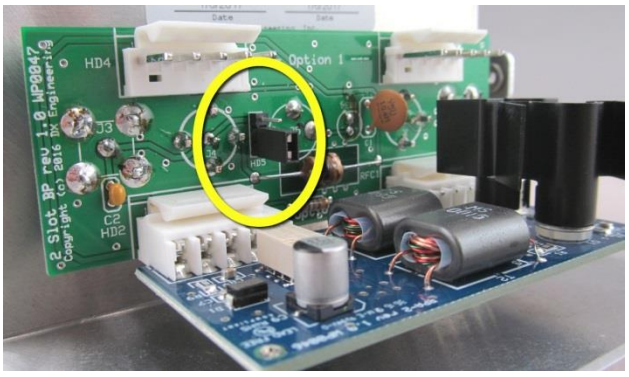
Opening the RPA-2 unit

To open the RPA-2 unit, remove the six Phillips head screws and the case will come off exposing the interior printed circuit boards. The top slot has a By-Pass Module installed and the bottom slot has the RPA Printed Circuit Board installed.

View looking from the rear of the RPA-2 with the cover removed.

Powering Through the Coaxial Cable

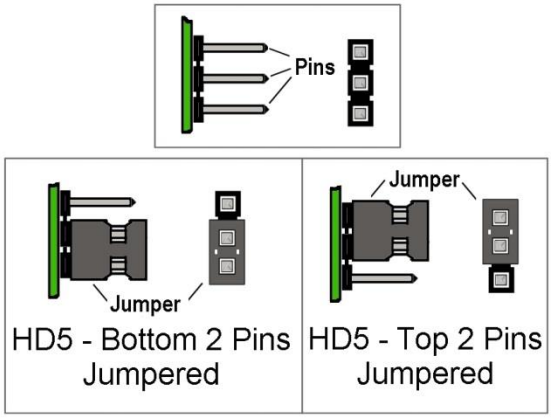
The RPA-2 has a three-pin internal jumper header labeled **HD5**. The **factory default** (as shown) **has the jumper installed onto the lower two pins of HD5**.



With **HD5** in the factory default position, the DC power connected from the units 2.1 mm connector labeled "**POWER 12 Vdc**" feeds the internal RPA-2-PM Receive Preamplifier Plug-In Module and another optional board, as needed.

Alternatively, if the RPA-2 is to be located at the receive antenna, the unit may be powered from DC on the feedline that is connected to the "**RECEIVER OUTPUT**" connectors. This requires a user supplied bias-tee or feedline voltage inserter used at the operating position, providing the properly filtered and regulated (center-positive) +13.8 Vdc, 140 mA minimum.

To enable powering the RPA-2 via the coaxial cable, move the HD5 jumper to the top two pins.



RPA-2 Powered by 2.1 mm Connector (default) | **RPA-2 Power from Coax Cable**

NOTE: The ability of the RPA-2 to be powered on the "**RECEIVE OUTPUT**" coaxial cable cannot be extended to the antenna feedline. In other words, when the RPA-2 is powered on the coax, any active devices used on the "**ANTENNA INPUT**" side of the preamplifier will require separate power connections.

Information on Gain for the RPA-2

The DXE-RPA-2 Preamplifier and the DXE-RPA-2-PM Preamplifier Plug-in Module do not have a gain adjustment control. All specifications are optimized for 16 - 17 dB gain as set by the circuit components. If signals are overloading your receiver or if background noise is excessively high, here are two gain reduction solutions.

The first and simplest gain reduction solution is to use an attenuator. The simultaneous use of the pre-amplification of DXE-RPA-2 *and* the step attenuator in the transceiver or receiver, along with fine adjustment of the RF Gain control, is an extremely effective technique for improving intelligibility of weak signals. Using the step attenuator built into your radio is essentially the same as using an inline attenuator pad on the RPA-2 output. This increases the receiver's overload threshold, while preserving the preamplifier's specified performance, including input intercept* and noise figure, which remain essentially unchanged. Conversely, adding a conventional inline attenuator on the input of the RPA-2 will reduce its noise figure roughly by the amount of the attenuation. This is usually not a problem with modest antenna efficiency. With a decrease in noise figure the input intercept and overload limit increase. As a general rule, reduction of gain with an attenuator pad at either the input or output of this preamp will not compromise system performance. This is because the RPA-2 design has a very large performance margin in both noise figure and intercept.

The second gain reduction solution, if desired, is a "permanent" reduction of gain level by modification of RPA-2 surface mount devices (SMD) in the FET push-pull circuit.

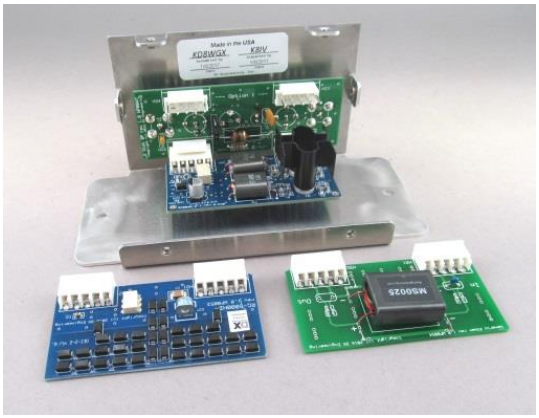
Please Note: The following is an advanced modification that should be performed by electronics technicians familiar with SMD PC board soldering techniques.

Reduction of the RPA-2 gain by about 3 dB is accomplished by removing two capacitors, C3 *and* C6, from the push-pull circuit. Additional gain reduction of about 4 dB is achieved by soldering one

1,500 ohm 0.25 watt resistor (SMD 1206 package) in parallel with R1 and another in parallel with R6. Be aware that gain reduction modifications will cause the performance of the RPA-2 to diminish above 15 MHz. Modifications, if done incorrectly as described, are not covered by warranty.

*For more information on receiver and receive preamplifier performance measurements, including third order intercept, see *The ARRL Handbook for Radio Communications*.

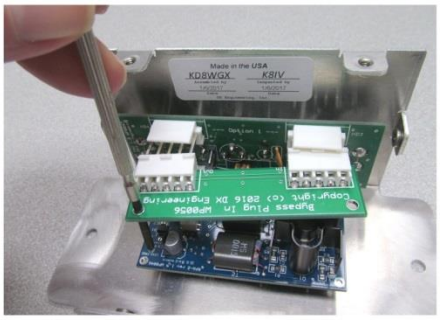
Installing an Optional Plug-in Module



The RPA-2 has an internal open slot that will accommodate either the optional **DXE-RG5000HD-PM** Receiver Guard or the optional **DXE-IT-PM** 75 to 50-ohm Impedance Transformer.

The Bypass Module will have to be removed to allow installation of the chosen optional board.

With the RPA-2 opened, use a round screwdriver to gently pry the bypass module as shown below. Do one side at a time and the module will come out. When installing the chosen optional module, align the pins and press both ends of the module equally until the chosen option module is fully seated.



Lightning

While most amateur radio installations rarely suffer damage from lightning (even though they never disconnect their equipment); the best protection is to disconnect electrical devices during storms. The key to proper lightning survival is proper grounding of feedlines and equipment, and maintaining integrity of shield connections. A proper installation improves lightning protection and enhances weak-signal receiving performance. The **DXE-RLP-75FF** Lightning Protector, 75-ohm, DC Pass, Type F Connectors is one optional device that could be used. Consult lightning protection and station grounding information in the ARRL handbooks, the National Association of Broadcasters (NAB) handbook or other reliable sources.

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-ohms unbalanced
output = 50-ohms unbalanced

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

This highly effective and inexpensive receive RF limiter prevents 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

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

Manual Updates

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

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