Array Solutions AS-RXFEP Receiver Front End Protector

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Many serious lower band operators employ a separate low noise receive antenna to provide an enhanced receive signal-to-noise ratio (SNR) as compared to their higher efficiency, but often noisier, transmit antenna. These antennas, such as Beverages, small loops, short vertical arrays, and others generally provide weak signals that require considerable amplification, but still result in improved SNR. (For example, see the review of the Array Solutions Shared Apex Loop Array by Carl Luetzelschwab, K9LA, in the April 2014 issue of *QST*. That review includes a discussion of the effects of noise and the SNR improvement offered by dedicated receive antennas.[4]) The Array Solutions AS-RXFEP is designed to protect the receiver input circuitry associated with this function.

Why Do We Need a Protector?

In the typical amateur station in which a transceiver uses the same antenna for transmitting and receiving, the transceiver's transmit-receive (TR) switching circuitry switches the antenna port away from the receiver during transmission, and so receiver protection is not necessary. An exception is a multitransmitter environment, such as a contest station or ARRL Field Day. In that case, special precautions are often required to avoid receiver front-end damage from nearby high power transmitters and high-gain antennas in close proximity to each other. In multitransmitter environments, the other transmitters are usually on different frequencies and thus sharp band-pass filters can be used to greatly reduce the strength of the strong local signals.

In the case of a transceiver with a separate receive-only antenna port, the protection from TR switching does not occur. The receive antenna is always connected to the receive antenna input and it is possible for the receive input circuitry to suffer damage from a nearby transmitting antenna.

Some transceivers do provide a measure of protection, but the ones I'm aware of do so by reducing gain or inserting attenuation. While this can help avoid damage, it also tends to defeat the purpose of having the separate receive antenna. There must be a better way.

Enter the AS-RXFEP Receiver Front End Protector

The RXFEP uses multiple devices to soft limit input signals starting at –1 dBm and outputting a specified maximum signal level of +10 dBm to the receiver input. While manufacturers do not generally specify the maximum safe input levels for their equipment, it is worth noting that ARRL Lab receiver dynamic range tests include input signals as high as +10 dBm, and we haven't lost one yet.

While the box looks like it could be installed in either direction, it is not quite symmetrical. In order to work properly, the antenna must be connected to the port labeled ANTENNA. (RADIO and ANTENNA are in small print on the main label — I would add an extra marking near the connector to avoid accidentally hooking it up backward.)

The input signal first encounters a miniature gas discharge tube (mainly for lightning protection) and is then applied through a capacitor and series resistor to a wideband transformer that is designed to saturate at high inputs. The transformer increases the voltage level to allow limiting by a pair of back-to-back diodes and then another transformer matches the output to a 50 Ω receiver input. Figure 3 shows the circuit layout.

Figure 3 — View of unit with snap-on cover removed. The miniature gas discharge tube at the antenna input is clearly visible on the right side.

[4]C. Luetzelschwab, K9LA, "Array Solutions AS-SAL-20 Shared Apex Loop Array Receiving Antenna," Product Review, *QST*, Apr 2014, pp 55 – 58.

Bottom Line

The Array Solutions AS-RXFEP provides solid protection for your transceiver's receive input circuitry for those who use a separate receive antenna. The cost is low, in terms of both price and impact on performance.

Table 4
Array Solutions AS-RXFEP

Manufacturer's Specifications	Measured in ARRL Lab
Frequency range: 1 to 150 MHz.	As specified.
Insertion loss: Typically 1 dB, 1 – 75 MHz.	14 MHz, 1.2 dB; 28 MHz, 1.4 dB; 50 MHz, 1.6 dB; 70 MHz, 1.9 dB; 144 MHz, 3.1 dB.
Maximum output level: +10 dBm.	Measured at 14 MHz: *Input level (dBm)* / *Output level (dBm)* –10 (0.1 mW) / –11.2 0 (1 mW) / –2.7 +10 (10 mW) / +7.0 +20 (100 mW) / +10 +30 (1 W) / +11 +40 (10 W) / +11.7
1 dB compression point: Not specified.	+7 dBm
Size (height, width, depth): 2.1 × 5.2 × 2.2 inches. including protrusions; weight: 5 oz.	
Price: $55.	

ARRL Lab Two-Tone IMD Testing

Testing a recent Product Review transceiver with and without AS-RXFEP to determine dynamic range degradation (500 Hz bandwidth, 500 Hz roofing filter, 20 kHz spacing).

	Desired Input Signal	IMD Input Signal	IMD DR	IP3
Without RXFEP	–128 dBm	–16 dBm	112 dB	+40.0 dBm
With RXFEP	–128 dBm	–16 dBm	112 dB	+40.0 dBm
Without RXFEP	–120 dBm	–14 dBm		+39.0 dBm
With RXFEP	–120 dBm	–15 dBm		+37.5 dBm
Without RXFEP	–110 dBm	–11 dBm		38.5 dBm
With RXFEP	–110 dBm	–13 dBm		35.5 dBm
Without RXFEP	–107 dBm	–8 dBm		41.5 dBm
With RXFEP	–107 dBm	–11 dBm		37.0 dBm
Without RXFEP	–94 dBm	–3 dBm		+44.0 dBm
With RXFEP	–94 dBm	–10 dBm		+33.5 dBm

The manufacturer states that the unit can handle a minimum of 10 W ICAS input. The frequency response is specified as from 1 to 150 MHz with a typical insertion loss of 1 dB from 1 to 75 MHz. Testing in the ARRL Lab (see Table 4) resulted in the values shown — close to the manufacturer's specified typical values.

As described in the manual, the user can change the value of the series resistor to adjust the soft limiting point for lower insertion loss, but the maximum power to the receiver will increase. I don't find the little bit of insertion loss to be an issue.

In addition, a limiting device such as this could negatively impact the dynamic range of a connected receiver. We performed our usual Product Review third-order IMD dynamic range tests on a recently tested high performance transceiver with and without the AS-RXFEP in the line to the receiver. The results are summarized in Table 4.

We found that the AS-RXFEP did not degrade the dynamic range of the receiver at all for interfering signals lower in strength than –16 dBm. As shown in Table 4, there is some degradation in intercept point at higher signal levels, but it is not particularly significant until the undesired signals reach –10 dBm (S-9 +63 dB on a calibrated S meter). Whether or not this will be an issue will depend on the desired signal levels expected from your receive antenna, which are often lower than those from the usual transmit antenna. You can't beat the laws of physics here. Just as with overloading of a receiver front end, limiting naturally results in IMD. You can be sure, however, that any performance degradation is not as severe as burning up your front end.

Where to Put It

An obvious place to install this device is at the RECEIVE ONLY ANTENNA port of a receiver. By having it as close to the receiver as possible, any pickup on the cable between the device and the receiver is minimized. There is another potential application in some installations, however. Some receive-only antennas include a remote preamplifier at the antenna termination. A protector at the remote preamp input would also be appropriate, although consideration should be given to the preamp input impedance, with a transformation to 50 Ω, if needed. If there is a long coax run from the remote preamp to the receiver, a second protector could be used at the receiver in case of loose coax connectors or other shield impairments.

It should be obvious, but I'll say it anyway. This unit cannot be used on any antenna feed that is also used for transmitting. Damage to both the unit and the transmitter would be likely consequences.

On the Air at W1ZR

My Elecraft K3 transceiver setup includes the optional KXV3A RX board that provides a transverter interface, an IF OUTPUT port for a panadapter and a RECEIVE ONLY ANTENNA jack, so I was able to test it out in real life. I don't generally operate using a separate receive antenna, although I do have both horizontal and vertical 80 meter antennas, so I put them to use. I should note that with this configuration, I don't have the excessive receive RF problem that this unit is designed to deal with, but I easily could.

My impressions were entirely positive. I could copy an AM broadcast station that measured 60 dB over S-9 on the calibrated K3 S meter (–13 dBm) with no indication of distortion. While I can't measure the insertion loss to the same level that the ARRL can, using my LP-Pan panadapter with a steady broadcast band carrier, I could see that it was close to 1 dB, as predicted.

In my opinion, if you are using a separate receive antenna and suspect that you may exceed the safe input of your receiver when transmitting with a nearby antenna, this seems to be a very reasonable insurance policy to save your transceiver at a relatively low cost.

Manufacturer: Array Solutions, 2611 N Belt Line Rd, Suite #109, Sunnyvale, TX 75182; tel (214) 954-7140; **www.arraysolutions.com**.