Product Review Column from *QST* Magazine

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MFJ-931 Artificial RF Ground

Reviewed by Doug DeMaw, W1FB

Martin F. Jue, who heads MFJ Enterprises, is known for developing clever and unique Amateur Radio products. The MFJ-931 is no exception. It's the first example I have seen of a commercially made network for removing unwanted RF energy from hot mics, rigs and keyers. I developed and used a small Transmatch in the 1960s for solving the same problem. I lived on the second floor of an apartment, and getting an effective earth ground was impossible without canceling the reactance in the two-story water pipe that I used for the station ground. Without tuning the ground lead to the water pipe, my station equipment was too hot to touch, especially when I was transmitting on 20, 15 and 10 meters. After using my Transmatch to cancel the reactance of the ground system, things became rather pleasant in my ham shack!

The name "artificial ground" is a misnomer, in my view. You do not create a ground with a network of L and C. Rather, you make an existing poor ground more effective.[1] I have been asked by a number of hams if the MFJ-931 will, for example, take the place of a ground-radial system or above-ground counterpoise. The answer is a definite *no*! Nothing will replace a proper ground screen for a vertical antenna, unless it has equivalent conductive mass and dimensions. It's important that you understand the function and purpose of the MFJ-931.

A Look at the Circuit

Since MFJ does not supply a schematic diagram with the unit, I took the time to trace the circuit to help show what the MFJ-931 actually does. See Fig 1. C1 and L1 comprise a series LC network. S1 has 12 positions and permits the selection of various inductance values from 0.9 to 43 μH, as measured on my Boonton Q meter. C1 measures 25 to 225 pF on my digital capacitance meter. C1 is a receiving-type capacitor with fairly close plate spacing.

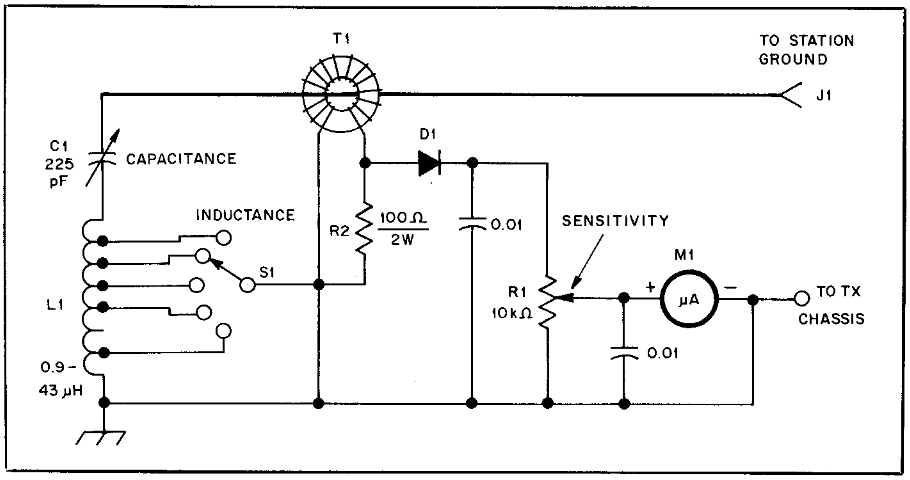

Fig 1—Schematic diagram of the MFJ-931 artificial ground. See text.

The main lead for the station ground is attached to J1, a binding-post connector. RF current along the ground lead is sampled by toroidal transformer T1; this configuration is used in a number of SWR bridges. We are interested only in *forward current* in the ground lead, so there is no need to measure reflected power.

The sampled RF current is rectified by D1 across a 100-ohm load resistor, R2. The resultant dc voltage registers on M1, which appears to be a microammeter. R1, the SENSITIVITY control, is used to keep the meter needle from pinning.

S1 and C1 are adjusted alternately for the highest meter reading at M1. As the reactance is tuned out of the ground system, the forward power through T1 increases to cause the highest attainable reading at M1.

Practical Tests

I first tried the '931 with my FT-101E transceiver, which resides permanently in my lab as a piece of test equipment. I have no earth ground for the rig, so I threw a random length of no. 18 hookup wire on the floor and routed it out the door into the yard. Overall wire length was roughly 24 feet. I then operated the '101E into a

[1] In effect, the MFJ-931 "improves" a ground by shifting an unwanted RF voltage loop (maximum) away from the station equipment by means of a series-resonant LC circuit. Because of this, one or more high-RF-voltage points can exist somewhere in the "artificial ground" system provided by an MFJ-931. *Wherever* an RF voltage maximum appears in an antenna system, *there is a shock or fire hazard.* So, play it safe: *Treat the tuned ground wire as an antenna wire.* Be sure that the tuned ground wire cannot be touched by children or pets, and that there is adequate spacing between the wire and combustible materials.

Table 1

MFJ-931 Artificial RF Ground

Dimensions (HWD): 3.5 × 7 × 7.5 in.
Weight: 2 pounds.
Color: Case, dull black. Panel, black with brushed-aluminum labels and outer trim.

trap 20/40-meter dipole above my lab. I attached the probe for my Tektronix 453-A scope to the cabinet of the FT-101E to provide a visual indication of the RF voltage on the main frame of the transmitter. Indeed, there was RF voltage on the rig cabinet during 40-meter operation, as noted on the scope display. I adjusted INDUCTANCE and CAPACITANCE controls on the '931 (C1 and L1 of Fig 1) until I had a flat trace on the scope (maximum deflection sensitivity). I observed that this coincided with maximum meter reading on the MFJ-931 tuner. After changing the operating frequency from 7000 kHz to 7300 kHz, I found it necessary to slightly readjust the '931. I repeated the tests at 20 meters and obtained similar results.

I next created a condition of high SWR by connecting only the center conductor of the RG-58 feeder to the antenna jack on the '101E. The chassis and mic became *very* hot with RF voltage. When I adjusted the '931, I was able to make the random-length ground wire act like a ¼-wavelength counterpoise, and the chassis "cooled off."

I brought the MFJ-931 tuner into my house and connected it in series with the main ground lead to my radial system in the field where my antennas are located. I tested the unit by generating RF power with my FT-102 transceiver and AL-80A amplifier. I could find no evidence of an inferior ground until I reached 15 meters. There was not enough RF on the equipment cases to feel a tingle upon touching the cabinets, but the MFJ unit did show a peak in meter reading as I adjusted the tuner controls. I did note, however, some interaction between the settings of the '931 and my station Transmatch. I found it necessary to touch up my Transmatch setting for an SWR of 1:1 after tuning the station ground for maximum indicated current on the '931 meter. The interaction would be more pronounced when using an inferior ground, such as I employed during my first round of tests.

Conclusions

I would have enjoyed using the MFJ-931 during some of my DXpeditions. Second- and third-floor accommodations in the West Indies generally afford a poor RF ground. Plastic plumbing is used extensively there (to avoid corrosion from the salt air), so nothing conductive goes to ground from the station site! I have dangled wires off verandas and laid wire along walls on the floor, hoping to simulate an earth ground. This worked on some bands, but on others it was a wasted effort. The MFJ-931 would have solved my problem.

The '931's components appear to be of high quality. The only annoyance I experienced was when hand capacitance reared its head during '931 adjustments on the higher frequencies. C1 of Fig 1 is floating above chassis ground, as shown. It is panel-mounted by means of fiber insulating washers. This brings the RF-active tuning shaft out of the case, insulated from your hand only by the tuning knob. You will discover that, under some conditions, you can set the '931 for maximum meter reading, but when you remove your hand from the C1 knob, the reading will change. It's not a serious problem, but an annoying one. This would not occur if C1 were set back into the cabinet on insulators. An insulated shaft coupler could then be used to make the control accessible from the front panel.

The MFJ-931 is available from MFJ Enterprises, Inc, Box 494, Mississippi State, MS 39762, tel 800-647-1800. Price class: $80.

AMECO PT-3 1.8-54 MHz PREAMPLIFIER

Reviewed by Mark Wilson, AA2Z

The PT-3 is Ameco's latest outboard preamplifier, replacing the very popular PT-2 preamplifier that found its way into many ham shacks over the years. I still remember the first time I saw a PT-2 and heard it magically improve signal copy on an old National NCX-5 transceiver. Even with today's hottest transceivers, serious DXers and contest operators still use external preamplifiers. Although today's rigs have plenty of sensitivity for casual use, a preamplifier is a big help when using low-noise Beverage or loop receiving antennas on 160 and 80 meters. In addition, sometimes a preamp comes in handy for copying weak signals on 10, 12 and 15 meters.

Features

The PT-3 is designed for use with transceivers. There are two SO-239 jacks on the rear panel, one for connection to the antenna (ANTENNA) and one for connection to the antenna jack of your transceiver (TRANS.). TR switching—to take the preamp out of the line during transmit—is built in. A sensing circuit detects the presence of RF at the TRANS. jack and switches the built-in antenna relay to bypass the preamp. The sensing circuit in the review unit switches reliably when 400 mW or more RF is applied to the TRANS. jack. The built-in relay can handle up to 350 W, which is more than adequate for most transceivers. If you use a high-power amplifier, place the PT-3 between the transceiver and amplifier input. Insertion loss through the PT-3 relay won't be noticed through 30 MHz, but it exceeds 1 dB at 6 meters. See Table 2.

I spent some time listening on a separate receiver to signals transmitted through the PT-3 with the preamp in and out of the line. The RF-sensed relay switching attack time is very fast. I could hear a slight shortening of the first dot in a CW transmission, but I found that the semi-break-in circuit in the test transceiver produces a much more noticeable shortening of the first dot.

A front-panel DELAY control varies the amount of time that the relay stays closed after you stop transmitting. This helps prevent excessive relay chatter during SSB operation or semi-break-in CW operation. I found it convenient to adjust the DELAY control for approximately the same dropout time as the VOX delay in my transceiver. Use of the PT-3 during QSK CW operation is impractical because relay response time is not fast enough.

When the front-panel PREAMP IN/OUT switch is set to OUT, signals are routed directly through the double-pole, double-throw TR relay to the TRANS. jack. When the preamp is in line, signals are routed to a singly tuned band-pass filter and then to the 40673 dual-gate FET RF amplifier.

Front-panel BAND and TUNE controls adjust the band-pass filter. The BAND switch changes inductors, while the TUNE control adjusts a variable capacitor. There is some overlap among the ranges. Table 2 shows the actual ranges measured in the ARRL lab for the four BAND switch settings. Tuning is fairly sharp, but it is not difficult to find a definite peak by listening to the received signal or watching the S meter.

Table 2

Ameco PT-3 1.8-54 MHz Preamplifier

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Gain: Greater than 20 dB.	See below.
Power requirement: 12 V dc.	12 V at 75 mA.
Insertion loss: Not specified.	See below.
1-dB compression point: Not specified.	See below.
Transmitter power handling: 350 W max.	As specified.
Size (height, width, depth): 2.5 × 8.75 × 6.5 inches.	
Weight: 2.4 pounds.	
Color: Black.	

ARRL Lab Measurements

Frequency (MHz)	*Gain (dB)*	*Insertion Loss of the TR Relay (dB)*	*1-dB Compression Point (input, dBm)*
1.8	28.0	0.10	−37.5
3.5	28.0	0.10	−37.0
7	23.0	0.11	−31.5
10	20.0	0.12	−28.0
14	19.0	0.10	−27.0
18	18.5	0.14	−27.0
21	18.0	0.16	−25.5
24	16.0	0.26	−24.5
28	16.0	0.29	−24.5
50	14.5	1.22	−19.5
54	12.0	1.22	−17.0

Band Switch Setting (MHz)	*Actual Frequency Range (MHz)*
1.8- 4.0	1.495- 4.022
4.0-10.0	3.499- 9.313
10.0-23.0	8.270-21.776
23.0-54.0	18.625-51.670

The GAIN control adjusts the source bias on the 40673. By varying this control, you can adjust the PT-3 gain from approximately −10 dB to the maximum available. Maximum gain varies from band to band—see Table 2. It's good to be able to reduce preamp gain, especially when there are a lot of strong signals on the band.

Hookup and Operation

There isn't much to hooking up the PT-3. Connect it to an antenna, your transceiver, and a 12 V dc source, and you're on the air. The review unit was equipped with Ameco's optional P-12T wall transformer. It is possible to wire the PT-3 for use with a second receiver or a separate receiving antenna (such as a Beverage). Information on these modifications is not in the manual, but is available from the factory.

It is easy to hear the improvement that the PT-3 makes when trying to copy weak 10-meter signals on an older tube-type transceiver. In the first 10 minutes of listening one winter evening, I found a half dozen weak signals that went from the ESP level[2] to easy copy with a touch of the PREAMP IN switch. I found similar results on 15 meters.

The test transceiver had adequate sensitivity on 80-20 meters, and using the PT-3 made no difference in signal copy. In fact, I found that the PT-3 overloaded the rig on 40 meters, making copy impossible because of receiver-generated spurious signals.

Overall, I find the PT-3 to be a useful addition to my station. Used wisely, it's a big help with weaker signals on 10, 12 and 15 meters, and it would be useful at times with a low-noise receiving antenna for the low bands. Manufacturer: Ameco Equipment Co, 220 E Jericho Tpk, Mineola, NY 11501, tel 516-741-5030. Price class: PT-3, $110; P-12T power supply, $9.

[2]The extrasensory perception level at which the contact is largely telepathic instead of telegraphic.

RF CONCEPTS RFC 3-312 220-MHz AMPLIFIER

Reviewed by Bruce Hale, KB1MW and Mark Wilson, AA2Z

So you say your new 220-MHz transceiver is a wonderful thing, but you'd like a bit more "smoke" at the antenna? Here's a deal for you! The RF Concepts RFC 2-317 amplifier will take that 25-W transceiver and turn it into a 120-W powerhouse—and add a 20-dB-gain receive preamplifier at no extra charge! Before you conclude that we're applying for jobs writing advertising for RF Concepts, let's look at the inside details of this amplifier.

Circuit Highlights

The power amplifier in the RFC 3-312 uses a pair of parallel-connected SRF-3883 bipolar transistors. The receive preamp uses the same circuit found in the 144-MHz version of the amplifier—a CF300 GaAsFET drives a U309 JFET. Relay switching is handled by four more small bipolar transistors and a handful of diodes. There's really not a whole lot to this amplifier, but simplicity is a good idea when you want a device that just sits there and *works.*

Like the 144-MHz RFC 2-317 reviewed in October 1987 *QST*, the 3-312 always operates linearly, even in the FM mode. The only difference between FM and SSB modes is the TR relay turnaround time. The delay is lengthened for SSB operation to avoid relay chatter between words in the transmission. Turnaround time can be adjusted by tweaking a small potentiometer accessed through a hole in the side of the amp.

There are two ways to switch the amp from receive to transmit. RF-sensed switching is standard, but there is also a key jack that can be used to switch the amplifier. The keying polarity can be changed with a jumper so that the amplifier is either switched by grounding the key jack or by applying +3 to 12 V dc at the jack. This external keying feature can be handy for SSB operation; with the keying externally switched, you don't have to worry about the amplifier switching to receive if you pause during a transmission.

Back at the ad copy desk, you should know that it's practically impossible to hurt this amplifier. The amplifier has built-in SWR sensing circuitry that shuts down if the reflected power exceeds 30 W. If this circuitry is activated, the SWR LED on the front panel lights, and the amplifier must be switched off to reset the circuit. Overheating protection is provided by an internal thermostat. If the heat sink temperature exceeds 175 °F, the amplifier shuts down; it resets itself when the heat sink cools down. Power-supply reverse polarity protection is provided by a diode across the power-supply connections. (Connecting the power supply incorrectly will cause the 35-A fuse to blow.) Finally, there are two diodes at the input of the preamp to protect it from strong signals.

Controls and Indicators

There are three switches and four LEDs on the front panel of the 3-312. The

Table 3
RF Concepts RFC 3-312 220-MHz Amplifier, Serial no. 3-3012

Manufacturer's Claimed Specifications	*Measured in the ARRL Lab*
Frequency range: 220 to 225 MHz.	As specified.
Modes of operation: FM, CW, SSB.	As specified. Also works on packet radio.
Power output: 120 W (±0.75 dB) for 30-W drive. Input power: 0.2 to 40 W.	38-W output for 5-W drive; 70-W output for 10-W drive; 108-W output for 20-W drive; 127-W output for 28-W drive.
Spurious signal and harmonic suppression: Not specified.	See Fig 2.
Receive preamp: 18 dB gain with 1.25 dB noise figure.	20.54 dB gain, 1.27 dB noise figure at 220 MHz.
Receive preamp 1-dB compression point: Not specified.	+1 dBm output.
Power requirement: 13.8 V dc at 20 A.	13.8 V dc at 21.5 A required at full output.
Color: Black	
Size (height, width, depth): 3 × 6 × 11.5 inches.	
Weight: 5 pounds.	

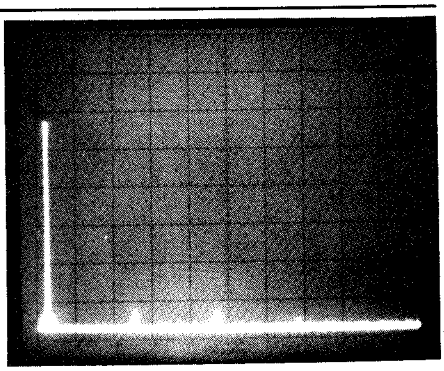

Fig 2—Spectral display of the RFC 3-312. Horizontal divisions are each 100 MHz; vertical divisions are each 10 dB. Output power is approximately 127 W at 222 MHz. The fundamental has been reduced in amplitude approximately 22 dB by means of notch cavities to prevent analyzer overload. All harmonics and spurious emissions are at least 72 dB below peak fundamental output. The RFC 3-312 complies with current FCC specifications for spectral purity.

POWER switch controls the power amplifier, and lights the POWER LED. The PREAMP ON/OFF switch controls the preamplifier and lights the PREAMP LED. It is possible to use the preamp without switching on the main power switch. The SSB/FM switch controls the TR turnaround delay. The TX LED lights when the amplifier switches to the transmit mode, and the SWR LED lights when the protective circuitry shuts down the amplifier.

SO-239 connectors for RADIO and ANTENNA are located on the rear panel of the amplifier. The rear panel also supports the external key jack, a four-pin Jones plug for applying 13.8 V dc to the amplifier and the fuse holder for the 35-A fuse. The front-panel switches can also be controlled through a five-pin DIN jack located on the rear panel. RF Concepts does not supply a remote-control head, but the manual clearly indicates how to hook up the DIN jack; the only parts required are three switches and a 10-μF capacitor.

Testing and Operation

Initial ARRL Lab tests indicated that the second harmonic of the review amplifier was suppressed by 56 dB—4 dB shy of the FCC spectral purity requirements. We returned the amplifier to the factory, where the customer service folks found that our unit was from an early production run. RF Concepts had redesigned the output filter for better performance since the time our unit was built, and they upgraded our amplifier at no charge. Service was prompt and friendly. With the new filter, amplifier harmonics are well below the FCC-specified level.

Hookup is simplicity itself (who let that advertising hype in here again?). Connect power and RF cables, and you're ready to go. During the review period, the amp was in use at AA2Z with an IC-375A (see Product Review, March 1988). The amplifier worked flawlessly. It also saw service at a multiop January VHF Sweepstakes effort at WA2OMY. Although it was primarily used on FM during the contest, we also used the RFC 3-312 on SSB and CW for a while after our high-power tube-type amplifier failed. Good thing that the RF Concepts brick is reliable! We made more than 140 contacts on 220 MHz during the contest, and the RFC 3-312 amplifier made a lot of those contacts easier.

The RF Concepts amplifier is a fine addition to any 220-MHz station—FM or weak signal—where you need some additional oomph. The preamp is helpful in many cases, too. Similar models requiring 2 W and 10 W drive are available. Price class: $264. Manufacturer: RF Concepts, 2000 Humboldt St, Reno, NV 89509, tel 702-827-0133. QST