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## Power MOSFETs

The schematic shown in Figure 1 shows how a power MOSFET is configured as a high-side switch. Also, note the difference between the "P" channel device and an "N" channel device. The use of a "P" channel power MOSFET allows the designer to cut the number of discrete components because a charge pump circuit will not be required. On the other hand, the use of a "P" channel power MOSFET,

## Low Power Operation

with its higher RDS(on), will generate more heat and thus diminish operating efficiency. It then becomes a trade-off in the number of extra parts needed for the gate driver (voltage pump) or the loss of efficiency with the "P" channel device. Even the best "P" channel power MOSFET on the market has a rather high RDS(on) of an ohm or two.

You can use the power MOSFET as a simple switch. I have used them to replace a switching transistor in some projects. A common example is to use a transistor switch to operate a relay for T/R control. As shown in Figure 2, a power MOSFET will work

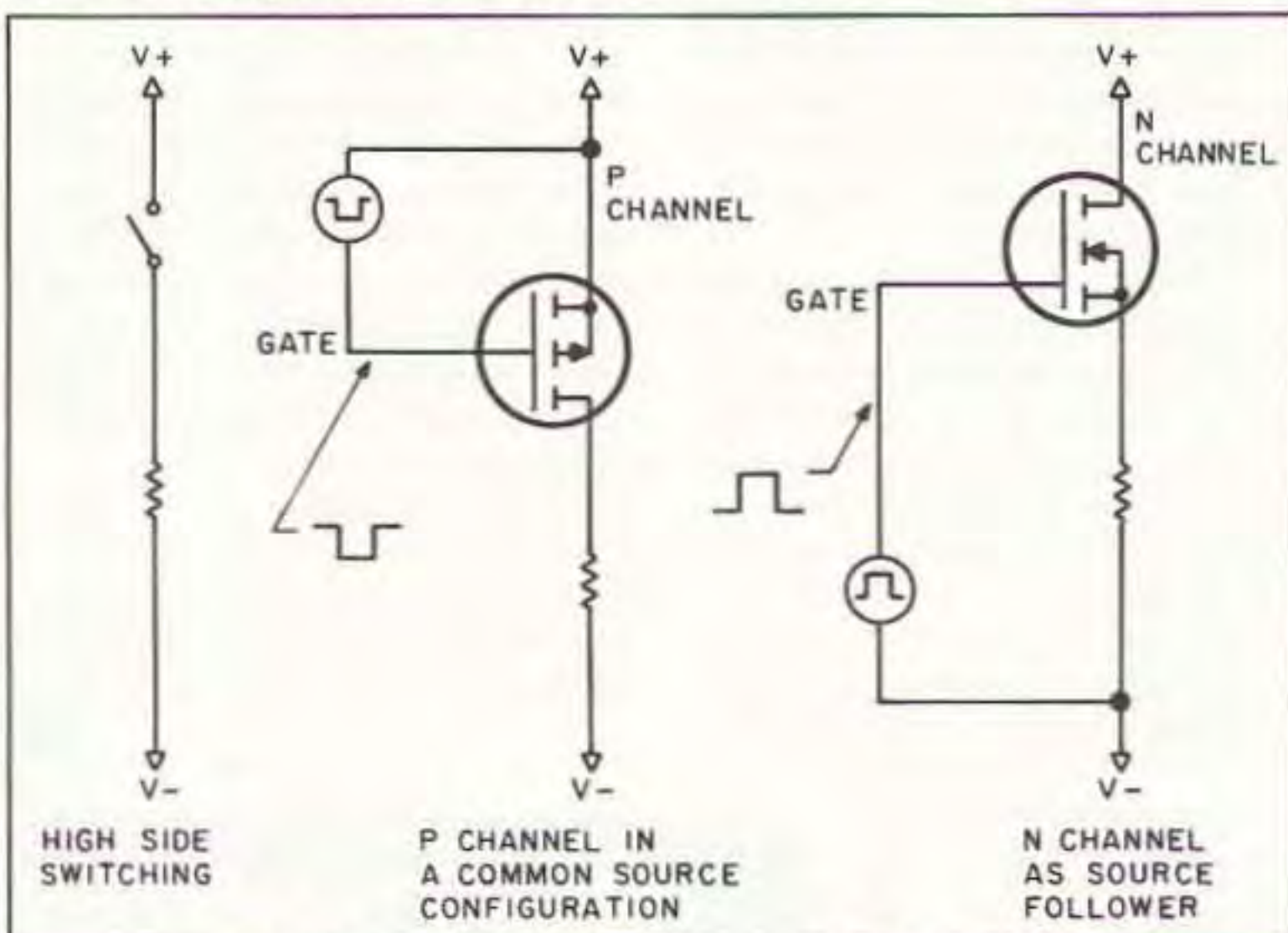


Figure 1. The power MOSFET configured as a high-side switch.

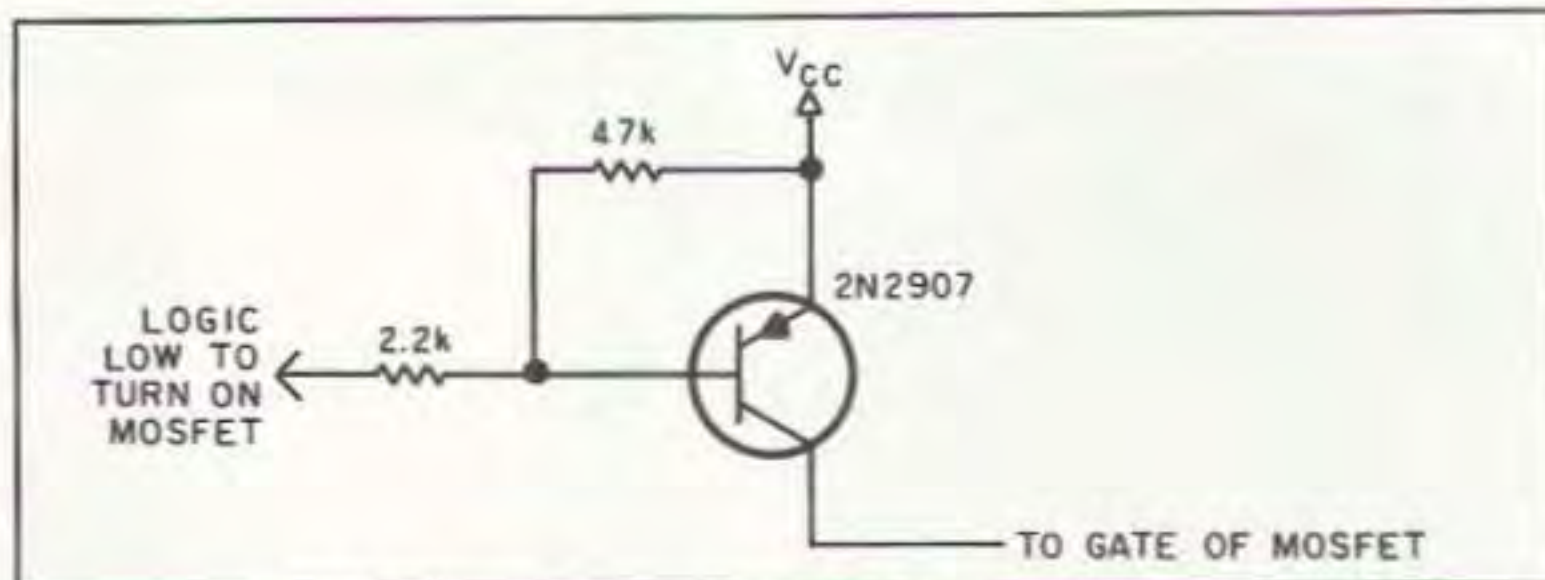


Figure 3. Using a transistor switch to supply the gate drive.

quite nicely in this configuration. The only requirements will be the proper gate voltage and, of course, the amount of current the relay will draw. This is normally not a problem with a power MOSFET; a drain current of several amps is common.

The power MOSFET is turned on by applying +10 volts to the gate. This requirement is easily handled by using a CMOS gate since the output of the CMOS gate is usually over 10 volts when operating with a 12-volt VCC line. Depending on the MOSFET, gate capacitance may cause some distortion when rapidly switching the MOSFET. In the case of our T/R relay, the distortion will never be noticed. Capacitance of several pF to several thousand pF is common, depending on die size. In some cases, paralleling CMOS gates together will help overcome the difficulty in driving the power MOSFET directly from a CMOS IC.

With the extra gate capacitance, the turn-off time may be too long. A transistor switch may be added to reduce the on time after the gate drive has been removed.

Using TTL logic will increase the drive current, but the normal VCC of TTL logic, just +5 volts, will not drive

the power MOSFET fully on. In this case, a transistor switch may be employed to supply the gate drive. Such a circuit is shown in Figure 3. Notice the use of a PNP transistor. When the base of the transistor is pulled low, the transistor is turned on and voltage appears on the collector. This voltage then turns on the power MOSFET. Again, this circuit will work up to several kHz before the switching distortion becomes troublesome.

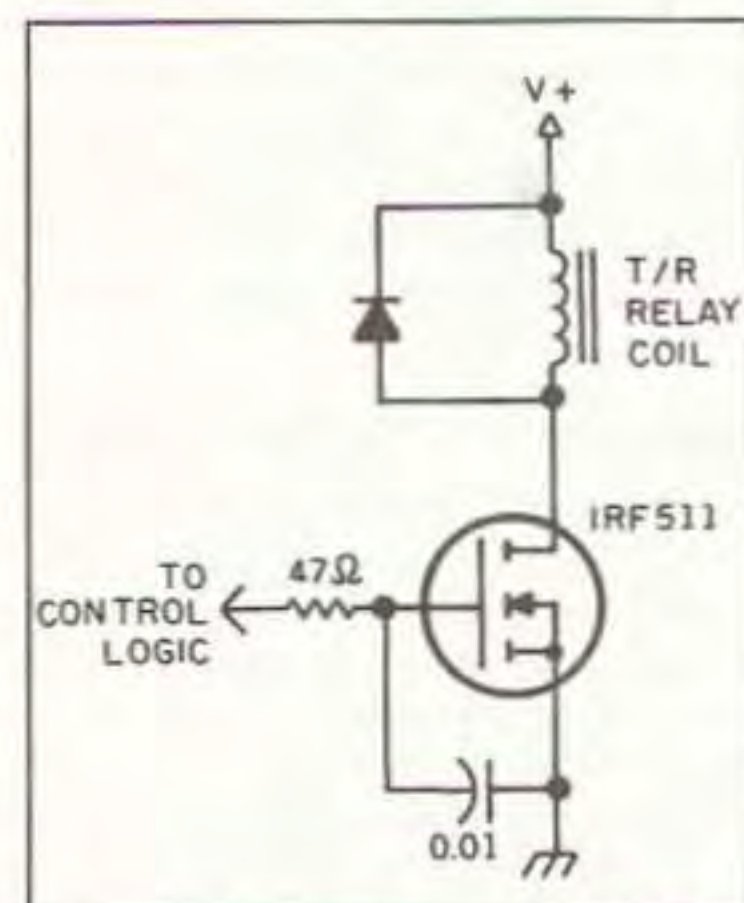


Figure 2. Using a power MOSFET to operate a relay for T/R control.

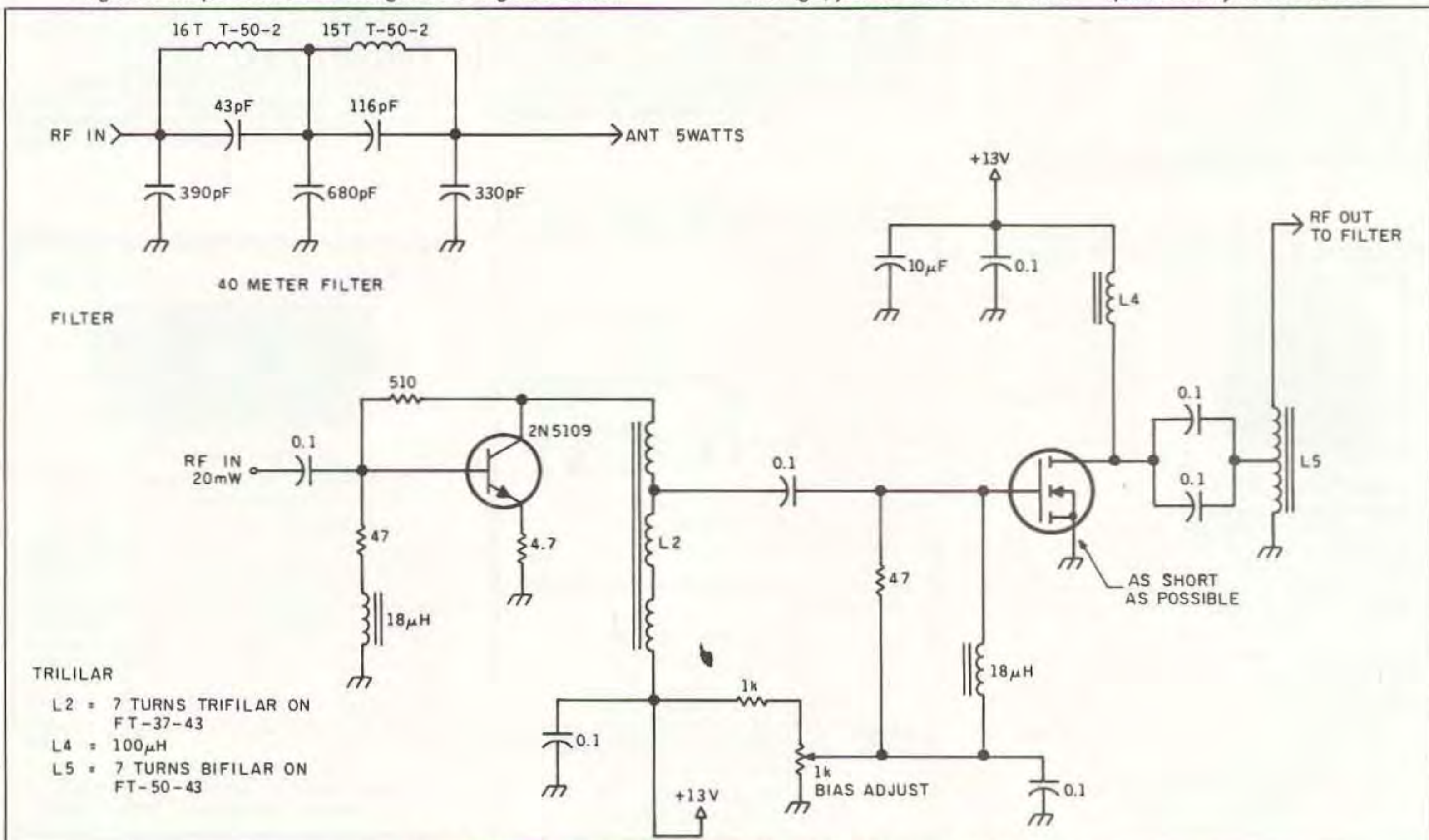


Figure 4. An RF amplifier using a single transistor and a power MOSFET.



## RF Amplifier Circuit

Only now are we seeing designs using power MOSFETs in RF applications. Figure 4 is a simple RF amplifier using a single transistor and a power MOSFET. I did not design the circuit—credit for it goes to Bruce Franklin KG7CR. The circuit originally came from the NorthWest QRP club newsletter, June 1992. Bruce kindly gave me permission to present it here to you. I have not had the time to build the circuit myself, therefore I can't comment on its performance. Bruce says the circuit will produce 5 watts of RF with only 20 milliwatts of drive. Bruce's original schematic contained some fancy band-switching features using reed relays and a 4015 IC. This schematic shows only the driver and the MOSFET PA components, along with one section of the output filters. The output filter values are for the 40 meter band.

You can use the amplifier for SSB, too! All you have to do is set the bias to about 50 mA with no drive. If you're a CW-only person, then a much lower bias will do. Bias is set by R5, the 1k trimmer.

Suitable sources of RF drive may be VFO, VXO or even the output of a mixer such as the NE602. In the case of the VFO, an extra stage of buffering may be needed if you notice pulling of the VFO frequency.

Also notice that the VCC for the amplifier is only +12 volts. It would be

possible to get better efficiency at a higher voltage, but then you would need to re-compute the values of the LC networks. Of course, you would have to split the circuit in half as the +28 volts would be too much for the bipolar transistor used as a driver.

Bruce uses the IRF510. The IRF511 is available from Radio Shack for under \$2. If you can't find it, an IRF531 would be a good substitute to try.

A very good application of a power MOSFET used as an RF amplifier is described in the November 1990 issue of *73 Amateur Radio Today*, page 36: "The MOuSe-FeET," by Bill Heishman N5HNN. I had the good fortune to work on this amplifier and can say that it works first-class all the way.

As shown in the original article, the filter values are for the 40 meter band. The values for the 20 meter band are as follows:

L1	6T x 1/2
L2	3T x 1/4
L3	9T x 1/2
L8	6.8 $\mu$ H
C1	1000 pF
C2	Not used
C3	1360 pF (2 x 680 pF or 2 x 500 + 270 pF)
C4	250 pF

All coils are 20-gauge copper magnet wire air wound on 3/8" form and spread to proper length.

With my HW-8 on 40 meters and running both the amplifier and the

HW-8 on a 12.6 volt supply, I had 20+ watts (my QRP wattmeter only goes to 20 watts and the needle was pegged) going into the dummy load. I know had I increased the supply voltage to 13.8 volts, my output power would have been close to 30+ watts. The heat sink became rather warm with the 20 watts and more than likely a larger hunk of aluminum is necessary at higher power. My aluminum heat sink measured the same size as the PC board and was 1/8" thick. The relay-less QSK keying is a real pleasure to use, too. If someone really wanted to, a band-switching model could be constructed

to give multiband performance. Operation on 10 meters may result in slightly lower output as noted in the original text. Circuit boards for the amplifier are available from Far Circuits, 18N640 Field Court, Dundee IL 60118.

### Toroids and the Wattmeter

Several months ago when discussing the directional wattmeter, I mentioned the cores used as being "special." That's true and I still

don't know what kind of material is used for the core. I mentioned I'd try a T-50-6 core as a start. Several readers wrote to tell me that's the wrong type of material for use in this type of project. I mentioned the T-50-6 core primarily because the ones used in the project are yellow, just as a T-50-6 core is. Hold up a T-50-6 core beside the one in the wattmeter and you'll have a hell of a time trying to tell the difference. That is why I made the suggestion. The core should be of ferrite material instead of the powdered iron material used in the T-50-6 core.

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