CIRCUIT CIRCUS

More Diode Circuits

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In our last visit, we were deep into circuit applications using the diode when we ran out of space. So we'll continue this month with even more diode circuits. Just because the diode seems like such a simple component, don't let its usefulness pass you by. Electronics as we know it would be crippled greatly if it were not for the versatile semiconductor diode.

CLAMPING CIRCUITS

Our first two diode circuits, shown in Fig. 1, each use a single 1N914 silicon diode to clamp either the positive

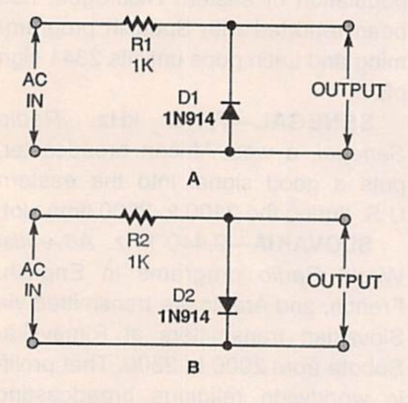

Fig. 1. The circuit in A clamps the negative half of an AC waveform to zero, leaving only the positive half cycles. The circuit in B does the same, except it clamps the positive half cycles.

or negative portion of an AC signal. The negative half is clamped to ground in Fig. 1A and the positive half in Fig. 1B.

PROTECTIVE CIRCUIT

In our next two circuits, shown in Fig. 2, the diode is used as an electronic guard to protect equipment or circuitry from reverse-voltage damage. Here's where a buck spent for a power diode can save mega bucks in equipment repair. The circuit in Fig. 2A connects between a negative-ground DC power source and its load. Unlike the case where a power diode is placed in series, this circuit does not produce a

PARTS LIST FOR THE CLAMPING CIRCUITS (Fig. 1)

D1, D2—1N914 silicon diode
R1, R2—1000-ohm, ¼-watt, 5% resistor
Wire, solder, etc.

forward voltage drop and the full voltage is fed to the load. If for some reason the voltage is reversed D1 will conduct, blowing F1 and protecting the load circuitry. The circuit in Fig. 2B is

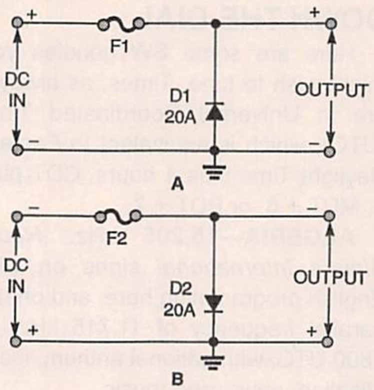

Fig. 2. Use these circuits to protect against damage due to reverse polarity. The circuit in A is for a negative ground; the one in B for a positive ground.

similar to the one in Fig. 2A, except that it is used to protect a positive-ground circuit. The diodes used for D1 and D2 are not critical, but should be rated for at least 20 amps and 100 volts.

METER GUARD

Continuing in the protective mode, the circuit in Fig. 3 will help a meter keep its cool and its needle true and straight. Diodes D1 and D2 are connected back-to-back to limit the maximum voltage that can reach the meter.

PARTS LIST FOR THE PROTECTIVE CIRCUITS (Fig. 2)

D1, D2—20-amp, 100-volt, silicon diode, see text
F1, F2—10- to 15-amp fuse
Wire, solder, etc.

D1 protects the meter from a normal-polarity overvoltage input and D2 keeps a reverse input voltage from rapping the meter's needle in the reverse direction.

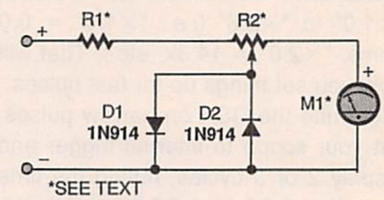

Fig. 3. This circuit uses a couple of inexpensive diodes to protect a more expensive meter.

Note that when a meter is connected in a circuit to measure voltage, a single resistor is usually connected in series to set the maximum meter current to indicate a full-scale reading at the desired full-scale input voltage. For the diodes to protect the meter, that resistor will need to be split into two separate units as shown in Fig. 3.

The values of the resistor, R1, and the potentiometer, R2, will depend on the meter and the application, though the following guidelines will help you make the appropriate selection: The

PARTS LIST FOR THE METER GUARD (Fig. 3)

R1, R2—See text
D1, D2—1N914 silicon diode
M1—Meter, see text
Wire, solder, etc.

value of the potentiometer, R2, must be large enough to produce about a 1-volt drop across it when the meter reads full scale. The total resistance value of R1 plus R2 should be selected to let the meter read full scale at its rated input voltage.

Adjusting the protection circuit is easy. Set R2's wiper for maximum resistance and connect the circuit to a variable DC power source. Raise the input voltage until the meter reads full

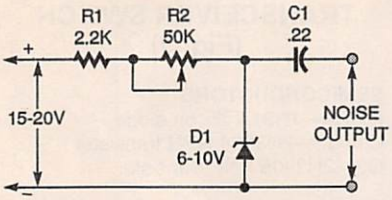

Fig. 4. Zener diodes have lots of applications, but here one is used in an uncommon way—as a noise generator.

scale. Now increase the input voltage about 10% to 20% above the full-scale reading; the meter's needle should then be against the peg. Reduce the resistance of R2 until the meter's needle just comes off of the peg and you are all set.

NOISE GENERATOR

Our next entry, see Fig. 4, uses a Zener diode in a noise-generator circuit. While that's not their usual application, Zeners generate a broadband

PARTS LIST FOR THE NOISE GENERATOR (Fig. 4)

D1—Zener diode, 6 to 10 volt, see text
C1—0.22-μF, ceramic-disc capacitor
R1—2200-ohm, ¼-watt, 5% resistor
R2—50,000-ohm potentiometer
Wire, solder, etc

noise signal under certain situations. Potentiometer R2 adjusts the noise generator for the desired output. Just about any 6- to 10-volt Zener can be used for D1. If you have a number of junk-box Zeners try each in the circuit until you find the one that produces the maximum noise output.

SYMMETRY MONITOR

An AC-waveform symmetry-monitor circuit is shown in Fig. 5. Here

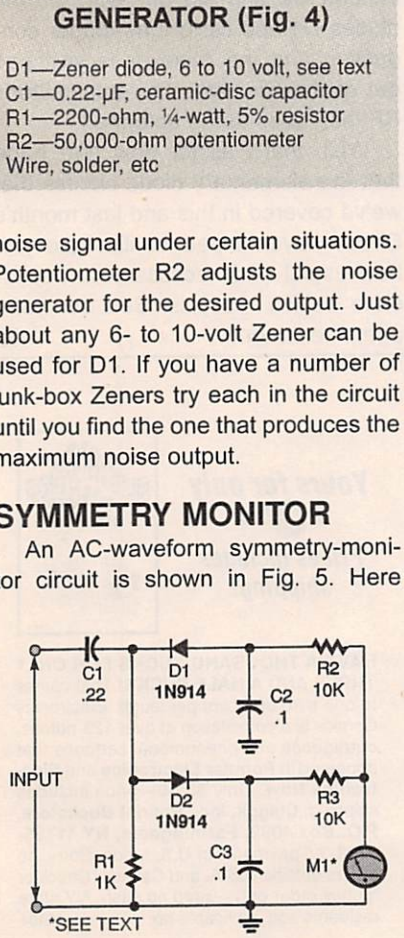

Fig. 5. This simple circuit can be used to monitor the symmetry of an AC waveform.

diodes D1 and D2 are operating as rectifiers with opposing outputs feeding a zero-center, 100-μA meter. Capacitor C1 removes any DC content from the input signal source.

PARTS LIST FOR THE SYMMETRY MONITOR (Fig. 5)

D1, D2—1N914 silicon diode
C1—0.22-μF, ceramic-disc capacitor
C2, C3—0 .1-μF, ceramic-disc capacitor
R1—1000-ohm, ¼-watt, 5% resistor
R2, R3—10,000-ohm, ¼-watt, 5% resistor
M1—100-0-100-μA, center-zero, meter
Wire, solder, etc.

When a symmetrical waveform is fed to the circuit the output voltage of both rectifiers will be the same but opposite in polarity. Under those conditions the meter will read zero, or center scale. If the signal is non-symmetrical, the meter will read off zero by the polarity and the amount of error in the symmetry of the waveform.

AMPLIFIED NOISE GENERATOR

Our second noise generator, shown in Fig. 6, adds a single-stage transistor amplifier to the Zener circuit to increase the output noise level.

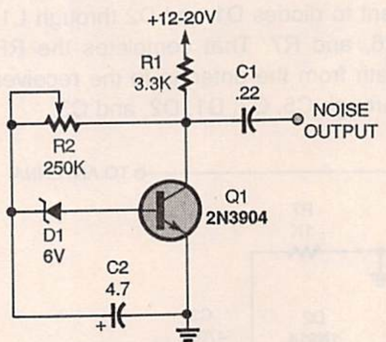

Fig. 6. For even more noise, use this amplified version of the Zener-based noise generator.

Depending on which Zener you select, the output can be as much as ten volts peak-to-peak. Once again, R2 is used to set the noise output level.

RF SWITCHING CIRCUIT

Figure 7 shows a simple diode-based RF switching circuit. When switch S1 is closed, the circuit feeds

PARTS LIST FOR THE AMPLIFIED NOISE GENERATOR (Fig. 6)

D1—Zener diode, 6-volt, see text
Q1—2N3904 NPN transistor
C1—0.22-μF, ceramic-disc capacitor
C2—4.7-μF, 16-WVDC, electrolytic capacitor
R1—3300-ohm, ¼-watt, 5% resistor
R2—250,000-ohm potentiometer
Wire, solder, etc.

the RF output of a transmitter to an antenna through the two forward-biased diodes. The DC current path that causes D1 to conduct flows through S1, R1, L2, and L1. Diode D2's current flows through S1, R1, L2, and L3. In that condition the two diodes look like a closed switch to the RF signal, allowing it to pass on to the antenna with almost no power loss. When S1 is open, both diodes are in the off state, allowing no RF to flow

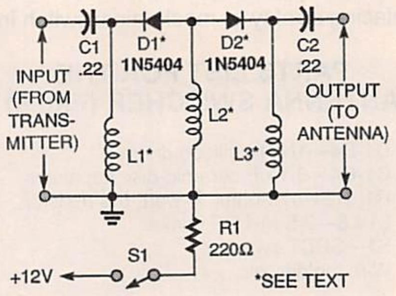

Fig. 7. Closing switch S1 lets the input signal (from a transmitter) to reach the output and be fed to an antenna.

through to the antenna.

The values of the RF chokes, L1-L3, are not critical but should be selected for the frequency range used. The inductive reactance of the chokes

PARTS LIST FOR THE RF SWITCHER (Fig. 7)

D1, D2—1N5404 or similar 2-amp, 400-volt silicon diode
C1, C2—0.22-μF, ceramic-disc capacitor
R1—220-ohm, 1-watt, 10% resistor
L1-L3—100- to 250-μH RF choke, see text
S1—SPST switch
Wire, solder, etc.

should be at least ten-times greater than the circuit's 50-ohm input/output impedance. If the reactance is too low, some of the output power will be dissipated in the chokes and will not make

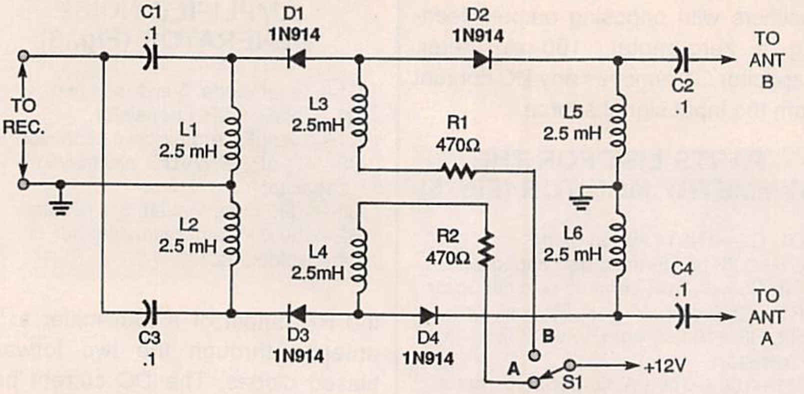

Fig. 8. This antenna switch lets the user select whether antenna A or B is connected to a receiver.

it to the antenna. The diodes should be rated for 2 amps and 400 volts.

ANTENNA SWITCHER

Our next diode switching circuit, shown in Fig. 8, builds on the principles of the previous circuit to create an antenna switcher that operates without placing a relay or mechanical switch in the RF path. With S1 in the A position, diodes D3 and D4 are biased on through R2, L1, L4, and L6 to allow signals from antenna A to reach the receiver. When S1 is in position B, current flows through R1, L1, L3, and L5, turning D1 and D2 on and allowing the receiver to use antenna B.

PARTS LIST FOR THE ANTENNA SWITCHER (Fig. 8)

D1-D4—1N914 silicon diode
C1-C4—0.1-µF ceramic-disc capacitor
R1, R2—470-ohm, ¼-watt, 5% resistor
L1-L6—2.5-mH RF choke
S1—SPDT switch
Wire, solder, etc.

TRANSCEIVER SWITCH

Our next diode-based RF switching circuit, and our last circuit for this visit, is shown in Fig.9. That circuit switches both the transmitter and receiver circuitry to the antenna at the proper time for high-speed transmit/receive operation. In the receive state, transistor Q1 receives no forward bias and is turned off with its collector high, allowing Q2 to be biased on. Transistor Q2's collector is pulled low and Q3, a PNP transistor, is turned on supplying current to diodes D1 and D2 through L1, R6, and R7. That completes the RF path from the antenna to the receiver through C5, C2, D1, D2, and C3.

PARTS LIST FOR THE TRANSCEIVER SWITCH (Fig. 9)

SEMICONDUCTORS
D1-D4—1N914 silicon diode
Q1, Q2—2N3904 NPN transistor
Q3—2N3905 PNP transistor

RESISTORS
(All resistors are ¼-watt, 5% units.)
R1, R3, R5—4700-ohm
R2—3300-ohm
R4—2200-ohm
R6, R7—1000 ohm

CAPACITORS
C1—47-pF, ceramic-disc
C2, C3—470-pF, ceramic-disc
C4—1000-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS
L1—200-µH choke
Wire, solder, etc.

When the transmitter kicks in, diodes D3 and D4 receive a sample of the RF through C1, producing a positive voltage at the base of Q1 turning it on and Q2 and Q3 off. With Q3 off, diodes D1 and D2 are no longer conducting and the receiver is switched out of the RF path. The transmitter's RF then goes to the antenna.

Well, that's all for now. We hope that the elementary diode circuits that we've covered in this and last month's Circus have helped to illustrate just how useful and necessary that solid-state device really is. See everyone again next month. ■

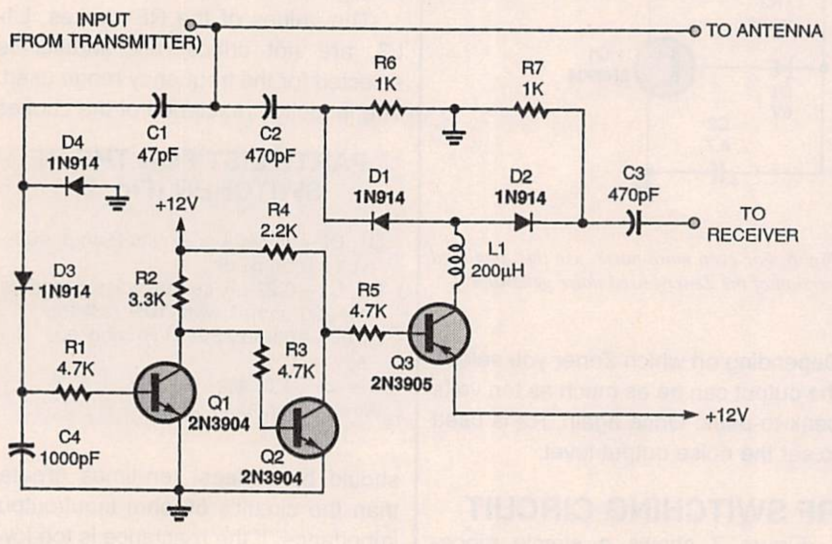

Fig. 9. This switching circuit automatically routes the antenna to either the receiver or transmitter as appropriate.