CIRCUIT CIRCUS

By Charles D. Rakes

Detector Circuits, And More

This time around, we'd like to share with you a number of unrelated circuits that can be fun to build and may prove useful in some upcoming project. In any case, drag out the junkbox, heat up the iron, and get ready for some circuit fun.

PRESSURE DETECTOR

Our first entry, see Fig. 1, uses a piezo transducer as a sensor in a circuit that responds to changes in air pressure. A piezo transducer is mounted in one end of a plastic tube facing out toward the open end. By blowing into the tube opening, the pressure increases, causing the piezo element to bend slightly, producing a small output signal.

A 0.1-µF capacitor, C1, is connected across the piezo element to help filter out high-frequency sounds and allows only very low frequency, air-pressure signals to pass. Half an LM1458 dual op-amp, U1-a, is configured as a low-frequency, high-gain amplifier, which is used to boost the transducer's output.

A second high-gain, low-frequency amplifier, formed around U1-b, increases the output of U1-a to several volts, with the exact output depending on the air-pressure variations at the transducer. Diodes D1 and D2, and capacitors C4 and C5, convert the amplifier's output to a DC pulse that's used to turn Q1 on, thereby causing piezo buzzer BZ2 to sound for each change in air pressure.

The pulsed DC output, at the cathode of D2, can also be used to drive a voltage-controlled oscillator. Such a circuit could be made into an electronic whistle to produce a varying output tone in relation to the air pressure applied to the transducer.

PARTS LIST FOR THE PRESSURE DETECTOR

SEMICONDUCTORS

U1—LM1458 dual op-amp, integrated circuit
Q1—2N3904 general-purpose NPN silicon transistor
D1, D2—1N914 general-purpose small-signal silicon diode

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1, R2—10,000-ohm
R3, R4—100,000-ohm
R5—220,000-ohm
R6—4700-ohm

CAPACITORS

C1—0.1-µF, ceramic-disc
C2, C3—0.47-µF, ceramic-disc
C4—0.27-µF, ceramic-disc
C5—10-µF, 16-WVDC, electrolytic
C6—47-µF, 16-WVDC, electrolytic
C7—470-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

BZ1—Piezoelectric buzzer (without internal oscillator)
BZ2—Piezoelectric buzzer (with internal oscillator)
Perfboard materials, enclosure, plastic tube, IC socket, 9-volt power source, wire, solder, hardware, etc.

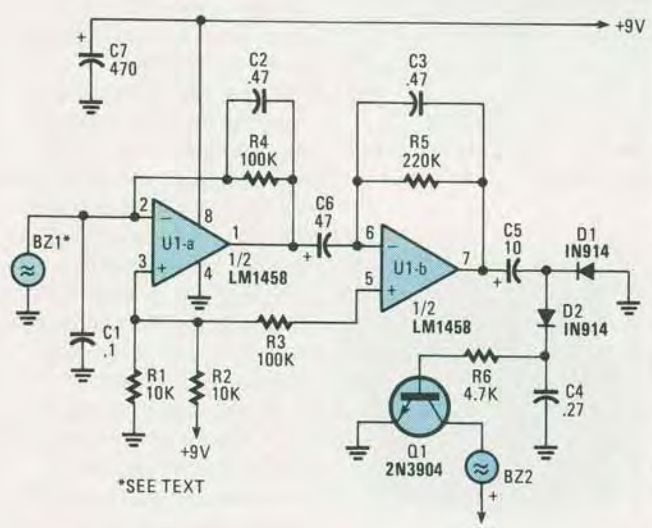

Fig. 1. In this circuit, a piezo transducer (BZ1) is used as an air-pressure sensor. The circuit responds to changes in air pressure by sounding a buzzer (BZ2).

VCO

The circuit in Fig. 2 is a simple, voltage-controlled oscillator that can be connected to the output of the circuit in Fig. 1. A single 4093BE quad 2-input NAND Schmitt trigger is connected in a simple RC audio-oscillator circuit. An MPF102 FET operates like a voltage-variable resistor, shifting the oscillator's frequency as its gate voltage is varied. Without a DC input, the oscillator's feedback path is open, due to the near-infinite resistance between the FET's drain and source, so no output tone is produced.

As the FET's gate voltage rises, the drain-to-source resistance decreases sufficiently to start the oscillator. The oscillator starts out with a very low frequency tone that increases in pitch as the input voltage rises. The third gate drives a piezo buzzer, which produces a low-level tone output.

The oscillator's frequency range can be changed by increasing the value of C1 for a lower-frequency range or by decreasing the value for a higher-frequency range. To connect the pressure-sensor circuit to the VCO, just remove Q1, R6, and BZ2 from the circuit in Fig. 1, and connect a wire from the junction of D2 and C4 to R3 in Fig. 2. Also connect the two ground circuits together.

RF DETECTOR

Our next circuit, see Fig. 3, uses half of an LM1458 dual op-amp in a sensitive, wide frequency range, RF-detector circuit. The circuit can detect milliwatt levels of RF energy from below the standard broadcast band to frequencies beyond the FM broadcast band.

A small pull-up antenna (ANT1) collects the RF signal and sends it to a broadband RF detector made up of L1 and D1, a germanium diode. The diode converts the sampled RF to a DC signal that's fed to the negative input of U1-a. A 50-µA meter is used to indicate the approximate strength of the RF signal. The circuit is powered from a standard 9-volt transistor battery.

CURRENT SENSOR

The circuit in Fig. 4, built around a single 2N3904 general-purpose silicon transistor configured as an RF oscillator, can be used as a DC current sensor. Inductor L1—which is connected in the oscillator's tank circuit—is a hand-wound coil consisting of 36 turns of #26 enamel-covered copper wire wound evenly spaced on a donut-shaped Amidon (Amidon Associates, Inc., PO Box 965, Torrance, CA 90508; Tel. 818-760-4429) FT50-43 ferrite core. The sense wire (designated L2) is simply a length of number 16 insulated copper wire looped

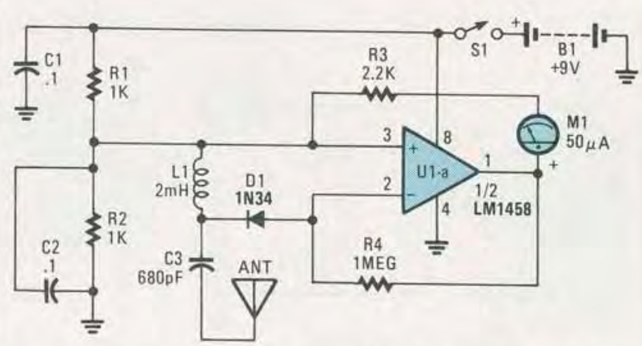

Fig. 3. This circuit uses half of an LM1458 dual op-amp to form a sensitive wide-range RF detector that's capable uncovering RF signals in the milliwatt region.

PARTS LIST FOR THE RF DETECTOR

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1, R2—1000-ohm
R3—2200-ohm
R4—1-megohm

ADDITIONAL PARTS AND MATERIALS
U1—LM1458 dual op-amp, integrated circuit
D1—1N34 germanium diode
C1, C2—0.1-µF, ceramic-disc capacitor
C3—680-pF ceramic-disc capacitor
L1—2-mH choke
S1—SPST switch
B1—9-volt transistor-radio battery
M1—50-mA meter
ANT1—Small telescoping antenna
Perfboard materials, enclosure, IC socket, wire, solder, hardware, etc.

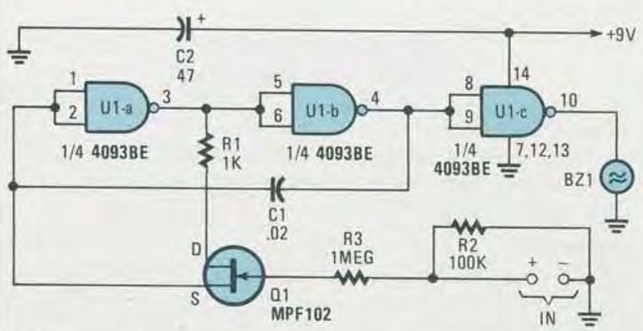

Fig. 2. Here a 4093BE quad 2-input NAND Schmitt trigger is configured as a simple voltage-controlled audio oscillator. The MPF102 FET (Q1) operates like a voltage-variable resistor, shifting the oscillator's frequency as its gate voltage is varied.

PARTS LIST FOR THE VCO

U1—4093BE quad 2-input NAND Schmitt trigger, integrated circuit
Q1—MPF102 N-channel FET
R1, R2—100K ¼-watt, 5% resistor
R3—1-megohm, ¼-watt, 5% resistor
C1—.02-µF, ceramic-disc capacitor
C2—47-µF, 16-WVDC, electrolytic capacitor
BZ1—Piezoelectric buzzer (without internal oscillator)
Perfboard materials, enclosure, IC socket, 9-volt power source, wire, solder, hardware, etc.

through the center of L1's core. When power is applied to the circuit, it begins to oscillate at a fixed frequency of about 180 kHz.

The application of DC power causes current to flow through L2, changing the core's permeability, which, in turn, causes the oscillator's frequency to shift. Resistor R3, a 20-ohm, 25-watt unit, limits current in the sensing circuit, thereby protecting the power supply and keeping L2 from acting like a shorted turn in the oscillator's tank circuit. A frequency counter can be connected as shown to monitor the oscillator's frequency shift.

The circuit will respond to currents from as low as a few milliamps to over 1 amp. With a current flow of 50 mA, the frequency will increase by about 1 kHz; and when the current is increased to 100 mA, the frequency will increase by about 2.5 kHz. With 1 amp of current, the frequency will increase to about 238 kHz. A potentiometer can be substituted for R3, allowing the current though the sense loop to be varied, and by extension, the operating frequency of the oscillator.

CURRENT SENSOR MODIFICATION

By using the coil/potentiometer combination shown in Fig. 5, the current sensing circuit can be made to respond linearly to relatively low levels of current, ranging from 1 to 50 mA, at a rate of about 100-Hz-per-milliamp. The 33-mH choke (L3) completely removes

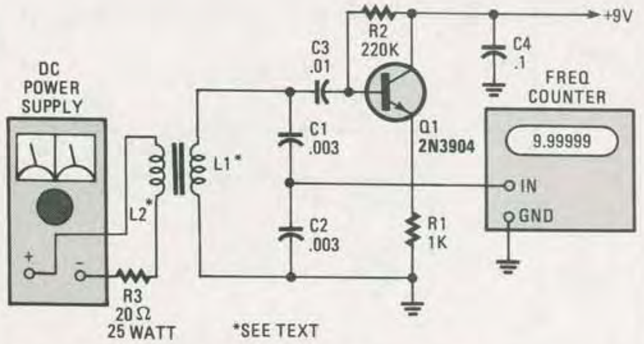

Fig. 4. Here a single transistor, configured as an RF oscillator, is used to detect changes in current flow.

PARTS LIST FOR THE CURRENT SENSOR

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—1000-ohm
R2—220,000-ohm
R3—20-ohm, 25-watt, see text

CAPACITORS

C1, C2—.003-µF, ceramic-disc
C3—.01-µF, ceramic-disc
C4—0.1-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

Q1—2N3904 general-purpose NPN silicon transistor
L1—See text
L2—See text
Perfboard materials, enclosure, DC supply, frequency counter, Amidon FT50-43 ferrite toroidal core (see text), wire, solder, hardware, etc.

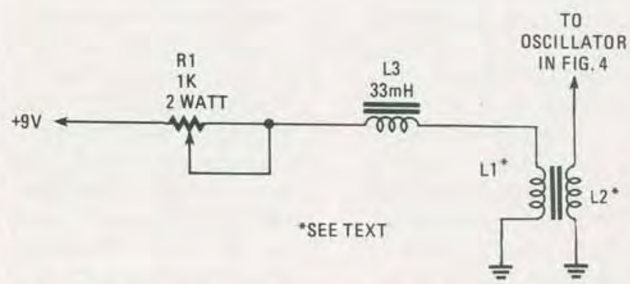

Fig. 5. The current sensing circuit in Fig. 4 can be modified (through the coil/potentiometer combination shown here) to respond linearly to relatively small current changes; the frequency of oscillation will shift at a rate of about 100 Hz per milliamp.

PARTS LIST FOR THE CURRENT-SENSOR MODIFICATIONS

R1—1000-ohm, 2-watt potentiometer
L1—5-turns #26 copper wire, see text
L2—36-turns #26 copper wire, see text
L3—33-mH choke (Mouser, part 43LH333)
Perfboard materials, enclosure, 9-volt power source, wire, solder, hardware, etc.

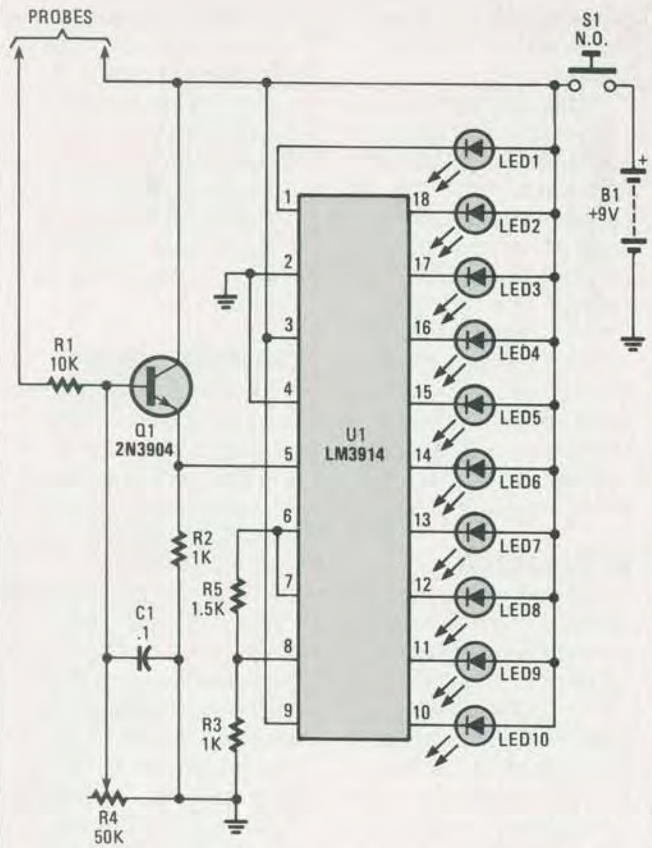

Fig. 6. The moisture detector is built around a 2N3904 general-purpose NPN transistor (configured as an emitter folower), an LM3914 dot/bar display driver, and a few support components.

PARTS LIST FOR THE MOISTURE MONITOR

SEMICONDUCTORS

U1—LM3914 dot/bar-display driver, integrated circuit
Q1—2N3904 general-purpose NPN silicon transistor
LED1–LED10—Jumbo light-emitting diode (any color)

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—10,000-ohm
R2, R3—1000-ohm
R4—50,000-ohm, potentiometer
R5—1500-ohm

ADDITIONAL PARTS AND MATERIALS

C1—0.1-µF, ceramic-disc capacitor
B1—9-volt transistor-radio battery
S1—Normally-open pushbutton switch
Perfboard materials, enclosure, 18-pin IC socket, probe material (see text), 9-volt battery connector, wire, solder, hardware, etc.

the shorted turn effect of the current sensor. The five turns used in Fig. 5 for L2 increases the circuit's sensitivity. The number of turns on L2 may be varied to increase or decrease the circuit's sensitivity to current changes. Adding turns to L2 will increase sensitivity and reducing the number of turns will reduce the sensitivity.

The oscillator's frequency range may also be

(Continued on page 88)

CIRCUIT CIRCUS

(Continued from page 76)

changed by decreasing or increasing the number of turns in L1. For higher frequency operation, reduce the number of turns. For lower frequency operation, increase the number of turns.

The values of C1 and C2, in Fig. 4, also may be varied to shift the oscillator's frequency. To lower the oscillator's frequency, increase the value of C1 and C2, and for a higher frequency operation decrease their values.

A carbon microphone can be used in place of R1 in Fig. 5, turning the oscillator into a low-power FM transmitter. The carbon microphone's internal resistance varies in step with the audio, causing the current flow through L1 to vary in a like manner. The varying current through L1 frequency modulates the oscillator.

MOISTURE MONITOR

Our last entry for this month is ideally suited to the horticulturist in your family. If the majority of the plants that you have end up like specimens from the petrified forest, or like drowning rats in a flash flood, it's probably due to improper watering. Too much or too little moisture can end the life of even the most hardy plant.

The moisture monitor shown in Fig. 6 will help keep the plant life around you green and healthy. The circuit is built around a 2N3904 general-purpose NPN transistor (configured as an emitter follower), an LM3914 dot/bar display driver, and a few support components. The probes and the emitter follower (Q1) sample the current flow through the soil. Current flow through the soil causes Q1 to turn on—the degree to which Q1 turns on is determined by the amount of moisture detected in the soil. That causes a voltage to be developed at the emitter of Q1. That voltage is fed to the input of U1 (the bar/dot display driver). The ten LED's, connected in the bar configuration, light up to indicate the soil's approximate moisture content.

The best material for the probes is stainless steel, but almost any metal will do as long as it is kept clean. A simple way to calibrate the circuit is to short the probes together and adjust R4 until all of the LED's light. That, of course, indicates too much moisture. Now take your moisture meter to an expert gardener and check out a number of plants to get an idea how many LED's should light when the soil has the proper moisture content. ■

COMPUTER BITS

(Continued from page 71)

of, and are supported directly by the respective companies.

The Mylex and Hauppauge boards are produced domestically and are of the highest quality. They are normally sold through dealers, although Hauppauge indicated a willingness to sell directly to end users. Pioneer sells only through dealers.

In general, since I began the process of evaluating these boards, prices of boards at all performance levels have nosedived, and the trend will continue. It seems that no matter when you buy, you can make a better deal six months later. However, that's the nature of this business. Spend a little bit more now and your investment will last a little bit longer. ■

HOBBY CORNER

Help from our readers

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THIS MONTH SEEMS TO BE A GOOD TIME TO pause and thank those of you who have written to offer help to others. Your answers and suggestions are appreciated. It is a good time, too, to pass along some of your helpful hints to those who may have experienced similar problems.

Little shocker

Ernest Worley of Irvine, CA went to the trouble of analyzing the "Little Shocker" circuit that appeared in the this column in the August 1981 issue. Among several improvements he suggested are two of special interest.

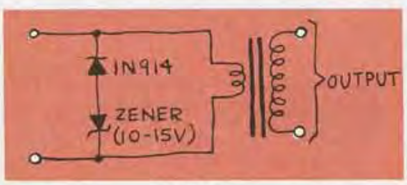

FIG. 1

The most significant change is shown in Fig. 1. If you compare it with the original circuit, you will see that Ernest has added a 12-volt Zener diode in series with the 1N914 across the primary of the output transformer. The Zener allows the transformer to make a more complete recovery with each pulse while still protecting the transistor from breakdown.

In addition, Ernest adjusted the values of the capacitor and resistors to increase the frequency to about 350 Hz and to bring the duty cycle to 50%. The end result is to give the shocker a bit more "zing" and, more importantly, to conserve battery life. You may recall that short battery-life was a characteristic of the original circuit, and the changes help get rid of that problem.

I am not calling Ernest's changes to your attention so much because the shocker circuit is especially deserving, but rather because the addition of the Zener diode across the primary of the transformer can be applied to other situations.

Often you will run across designs that couple transistor outputs through a transformer. If it is not a circuit like an audio amplifier, where fidelity is important, give the Zener a try. It may improve circuit efficiency and conserve battery power.

Thanks, Ernest, for sharing the battery-saving-Zener with us.

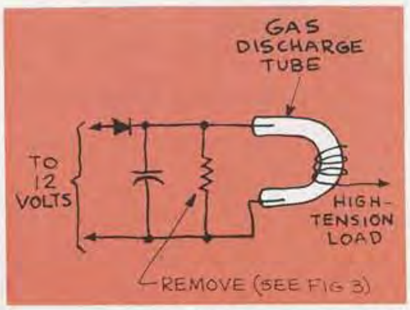

FIG. 2

Induction timing-light

David Reading of Marshfield, WI offers a good solution to James McDaniel's desire to change his timing light to the induction pick-up variety (April 1982). Careful selection of the few extra parts required—especially the triggering transformer—will allow you to fit it all into the original light case.

Figure 2 shows a basic high-tension timing-light circuit. Figure 3 shows a circuit with David's added parts (note that the resistor shown in Fig. 2 has been removed). He says any 4-kV trigger transformer will work fine and suggests one sold by Mouser Electronics (11433 Woodside Ave., Santee, CA 92071) as their stock number 42FM401.

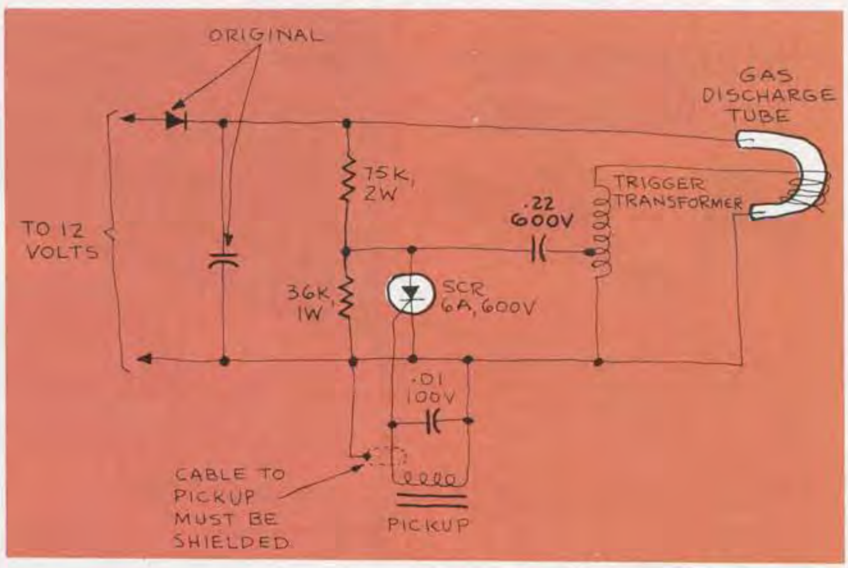

FIG. 3

David has tried several different styles of induction pickups. All had three to five turns of wire around the core and they all worked fine. He cautions that the SCR must not be rated any lower than six amps at 600 volts.

Many thanks, David. Now all of us can give new life to those old timing lights.

AN INVITATION

To better meet your needs, "Hobby Corner" will undergo a change in direction. It will be changed to a question-and-answer form in the near future. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in "Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

Hobby Corner
Radio-Electronics
200 Park Ave. South
New York, NY 10003

Bullet velocity

Randolph Richter (Schenectady, NY), J.A. Keys (Long Beach, CA) and others were quite helpful with the problem of measuring bullet velocity (December 1981). The solution, of course, is to measure the time it takes the bullet to travel over a known distance as accurately as possible.

The usual approach is to place two wires a given distance apart and then break them with the bullet. I acknowledge that the most difficult part of that procedure, at least to me, would be to hit the two wires! The experts tell me, however, that it isn't too hard to do provided that the wires are close and the rifle (or pistol) is supported by sand bags.

In any case, it is easy enough to measure the distance between the wires. Now, if you only knew the length of time between the breaking of the first wire and the breaking of the second one, finding the velocity would be easy.

Everyone seemed to go about timing the breaks in just about the same way. A counter circuit counts the pulses from a fast clock. The clock is triggered by the breaking of the wires—the first one starts it when broken, and the second one stops it. Knowing the clock rate and the number of counts, it is simple to figure the time that has elapsed between the breaking of the two wires.

After you know both the distance and the time, you can divide the first by the second to get the velocity. Let's now look at the actual techniques our readers used.

J.A. and Randolph use different circuits to measure the time. J.A. uses an internally triggered commercial counter that's enabled by an EXCLUSIVE-OR gate. The two wires are, of course, connected to the gate inputs. When one is broken the counter starts; it stops when the second wire is broken.

Randolph, on the other hand, built his gear from designs in Radio Shack's *Engineer's Notebook*. His circuit also consists of counters and a clock, but the triggering setup he uses is a little different. In that setup, he has the clock running before he fires and uses the breaking of the first wire to start the counter.

Breaking the second wire stops the clock by turning off its power. When the clock stops, there are no more pulses for the counter to count and the display freezes, showing the number of pulses that were counted between the wire breaks. Neat!

If you are thinking of measuring bullet velocities, I should tell you that almost every response to this problem that I received included one piece of advice: OBSERVE FIREARM SAFETY PROCEDURES! That is very important and only a fool thinks it is "silly" to repeatedly go through a safety checklist when conducting tests like this.

Forgetting about guns for the moment, you can measure the speed of almost anything with the system described here. It will completely eliminate errors due to human reaction-time, as well as errors (real or imagined) that might be due to favoritism.

Certainly, anything slower than a bullet will present no difficulty. All you have to do is to slow down the clock to a rate that is appropriate to the event you are measuring.

Mosquitoes again

Summer is an interesting time of the year. Many of you become involved in warm-weather activities and electronics experimenting receives less attention than it does in other seasons. Your outside activities bring to mind (and body) the problem of mosquitoes, and what can be done about them.

Last summer was no exception. Several readers wrote to ask for information or a circuit for a mosquito repeller. If you have a problem with those infernal pests, you may wish to refer to "Hobby Corner" in the March 1980 and February 1981 issues of **Radio-Electronics.** There you will find a circuit and some comments about its value.

It may be helpful to summarize the comments I have received over the last couple of years. Before you plunge into building a repeller, you should know that the number of readers who think it is great is about equalled by the number who think it is of no value at all! Until there is more information, I wouldn't recommend that you build one except on an experimental basis.

I am beginning to think that the effectiveness of a mosquito repeller is, like beauty, in the eye of the beholder. Certainly, there is no consensus of opinion on the question.

It occurs to me that, in addition to the psychological aspects of your reactions, there is the probability that certain components in the circuitry are critical. The speaker, for instance, could make a considerable difference in the unit's effectiveness. (Has anyone tried using one of those inexpensive piezo-element tweeters?) In addition, I have been led to believe that the frequency of the oscillator is critical.

It would be nice to resolve the question once and for all. If you have any information on the effect of sound on mosquitoes (or other insects), how about sharing it with the rest of us? If you have built a repeller that seems to work, let us know the exact parts you used and the oscillator frequency, as close as you can measure it. If you have done any actual experimenting with sound and the little beasties, tell us about your results.

Because of the continuing interest, I'll start a "mosquito" file and share its contents from time to time. If you have anything to contribute to that file please write in and share it with us. **R-E**

CIRCUIT CIRCUS

By Charles D. Rakes

Something for Just About Everyone

This month I've worked up a number of assorted circuits to share with you that, with any luck, are bound to inspire you to create your own electronic project. The first of this month's circuits came about when a friend asked if there was any way that he could generate about 30 to 36 volts DC from a 12-volt transformer without spending a bundle on parts.

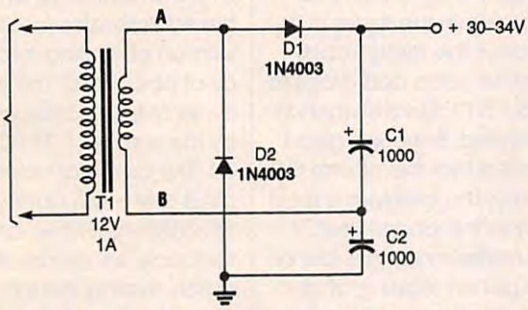

Fig. 1. The voltage doubler is built around a pair of diodes (D1 and D2) and a pair of capacitors (C1 and C2) that are fed from, in this case, a 12-volt, 1-amp step-down transformer (T1).

Since he didn't need a regulated source, I figured that a full-wave voltage doubler would fill the bill.

VOLTAGE DOUBLER

The voltage doubler (see Fig. 1) is built around a pair of diodes (D1 and D2) and a pair of capacitors (C1 and C2) that are fed from the aforementioned 12-volt transformer (T1, a 1-amp unit). One leg of T1's secondary winding is connected between the anode/cathode junction of D1 and D2. The other leg is connected at the junction of C1 and C2. When the transformer's "A" lead goes positive, D1 conducts, charging C1 to about 16 volts; that's about equal to the peak AC voltage minus the diode's forward drop.

During the following half-cycle, the polarity is reversed with the "A" lead going negative, charging C2 through D2 to about 16 volts. Since the two capacitors are in series, the voltage across the two units add, providing about 30–34 volts at the output of the circuit. The actual DC output voltage depends on the AC input voltage and the load connected to the output of the power supply.

STEPPED-UP DUAL-VOLTAGE SUPPLY

Our next circuit, see Fig. 2, follows a similar course to produce a simple dual (±) 15-volt unregulated power supply. Diodes D1 and D2 are connected to the output of the 24-volt, center-tapped transformer to produce a positive output across capacitor C1. Diodes D3 and D4 are connected to the transformer's output in the reverse direction, producing a negative output across C2.

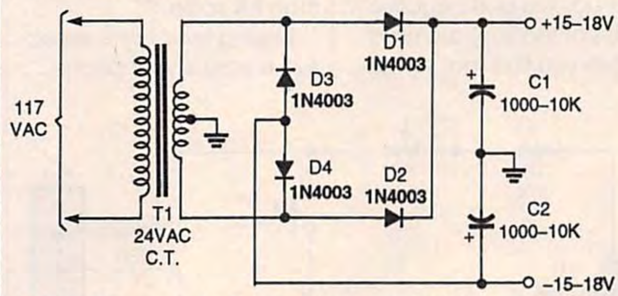

Fig. 2. The stepped-up dual-voltage supply follows a similar course to that in Fig. 1 to produce a ±15-volt unregulated power supply.

PARTS LIST FOR THE STEPPED-UP DUAL VOLTAGE SUPPLY

D1–D4—1N4003 1-amp, 200-PIV, general-purpose, silicon rectifier diode
C1, C2—1000- to 10,000-µF, 35-WVDC, electrolytic capacitor
T1—24-volt, center-tapped power transformer
Perfboard materials, enclosure, molded AC power plug with line cord, wire, solder, hardware, etc.

PARTS LIST FOR THE VOLTAGE DOUBLER

D1, D2—1N4003 1-amp, 200-PIV, general-purpose, silicon rectifier diode
C1, C2—1000-µF, 35-WVDC, electrolytic capacitor
T1—12-volt, 1-amp power transformer
Perfboard materials, molded AC power plug with line cord, wire, solder, hardware, etc.

The supply's unloaded output voltages will be somewhere between ±15 and ±18 volts DC. For light loads, the two filter capacitors may be as small as 1000 µF, but for heavy loads, the capacitors should be as large as possible.

TELEPHONE-LINE TESTER

If you have ever had problems with your telephone and ended up paying an exorbitant price for a service call, then look at the simple phone-line tester shown in Fig. 3.

The line tester consists of a meter that is used to measure the line voltage with the telephone in the on-hook or off-hook state. Those two simple checks can, in most cases, tell you where your phone problem lies. The tester—with its built-in off-hook load resistor—is wired to a modular telephone connector, which has become the phone standard in just about all locations.

The standard phone system usually uses a four-wire cable; in most cases, only the green and red wires (respectively, designated as the positive and negative sides of the line) are used. Often you find that someone has wired the line backwards (the red positive, and the green to negative). If the meter's needle pegs to the left (reverse), check the wiring at the wall jack to see if some misguided soul has been tampering with the phone line.

The line tester requires only one simple calibration; the meter must be calibrated for a full-scale reading of 50 volts. For that, you'll need a digital multimeter set to read 50 or more DC volts. Connect the DMM to the red and green wires of the tester, and then plug the tester into a phone jack; the meter should read about 48 volts. If the voltage is much lower than 48 volts, check to see that all the extension phones on the line are in the on-hook condition. Once that is done, adjust R2 for a meter reading that's slightly less than full scale.

Playing telephone detective is easy. If your phone appears dead (no dial tone), unplug the phone and plug in the tester in its place. If the meter reads near full scale and drops to about 5 to 10 volts when S1 is pressed, there is a good chance that the phone line is okay. The problem is most likely in the phone itself. If the meter reading is low or you get no reading at all and all phones on the line are unplugged, the problem is probably located in the central office or in the phone line between your location and the central office (although it is also possible that the problem is with the wiring inside your home).

Believe me, I've saved a bundle in service charges over the years by making the same simple tests before contacting the phone company.

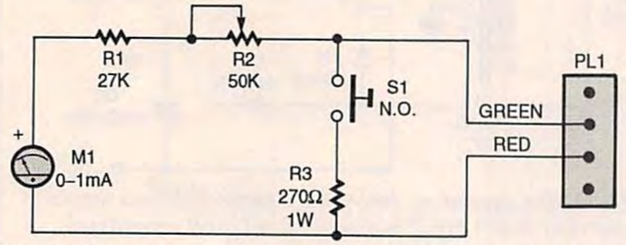

Fig. 3. The telephone-line tester consists of nothing more than a meter (that's used to measure line voltage in the on- or off-hook state), three resistors (one of which is variable), a pushbutton switch, and a modular telephone connector. When the circuit is connected to the telephone line, a meter reading of 5 to 10 volts when S1 is pressed indicates that the line is okay.

PARTS LIST FOR THE TELEPHONE-LINE TESTER

RESISTORS

(All fixed resistors are ¼-watt, 5% units unless otherwise indicated.)
R1—27,000-ohm
R2—50,000-ohm, potentiometer
R3—270-ohm, 1-watt

ADDITIONAL PARTS AND MATERIALS

M1—0-to 1-mA D'Arsonval meter movement
S1—Normally open pushbutton switch
PL1—Modular telephone plug
Perfboard materials, enclosure, wire, solder, hardware, etc.

HEADLIGHT FLASHER

Our next circuit came about when an outdoors buddy of mine ask if I could come up with an inexpensive circuit to make the add-on headlights for his off-road four-wheeler flash. That request was easily handled by the simple 555 oscillator/timer-based circuit (U1) shown in Fig. 4.

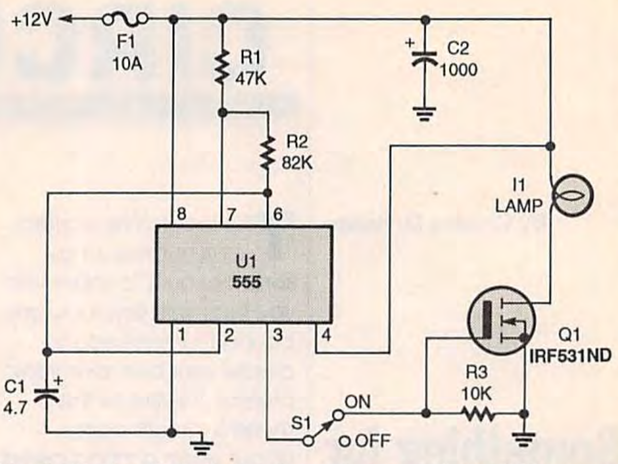

Fig. 4. The headlight flasher is nothing more than a 555 oscillator/timer that's configured as an astable multivibrator (oscillator), whose output is used to drive the gate of an IRF531ND hexFET, which, in turn, acts like an on/off switch, turning the lamp on and off at the oscillating frequency (1 Hz).

In a the headlight flasher, U1 is configured as an astable multivibrator (oscillator) with an operating frequency of about 1 Hz. The duty cycle of the oscillator is set by the values of R1, R2, and C1. The oscillator's output at pin 3 drives the gate of an IRF531ND hexFET, which, in turn, acts like an on/off switch, turning the lamp on and off at the oscillating frequency (1 Hz).

Switch S1 is used to turn the circuit on or off without breaking the high-current lamp circuit, allowing the circuit to be controlled with a low-current, low-cost switch.

FIELD-STRENGTH METER

Our next circuit, a field-strength meter (see Fig. 5), provides a cheap and fast way to monitor an amateur-radio or CB transmitter for maximum output; it can also be used to check out a new antenna system.

The circuit is no more than a simple untuned, crystal radio receiver that feeds a metering circuit. A 19-inch pull-up antenna is connected between a 2-mH choke and the anode of a 1N34A germanium diode. Capacitor C1 removes

PARTS LIST FOR THE HEADLIGHT FLASHER

SEMICONDUCTORS
U1—555 oscillator/timer, integrated circuit
Q1—IRF53IND hexFET

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—47,000-ohm
R2—82,000-ohm
R3—10,000-ohm

CAPACITORS
C1—4.7-µF, 16-WVDC, electrolytic
C2—1000-µF, 35-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
F1—10-amp fuse
L1—12-volt headlamp
S1—SPST toggle switch
Perfboard materials, enclosure, IC socket, fuse holder, wire, solder, hardware, etc.

PARTS LIST FOR THE SAMPLE AND HOLD CIRCUIT

U1—LF351 FET-input op-amp, integrated circuit
C1—0.05-µF polystyrene capacitor
S1—SP3T switch
S2—DPDT toggle switch
M1—Digital voltmeter
Perfboard materials, enclosure, IC socket, 5–9-volt power source, wire, solder, hardware, etc.

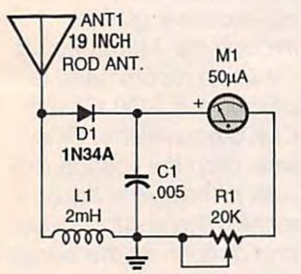

Fig. 5. This simple field-strength meter provides a cheap way to monitor an amateur radio or CB transmitter (or even an antenna system) for maximum output.

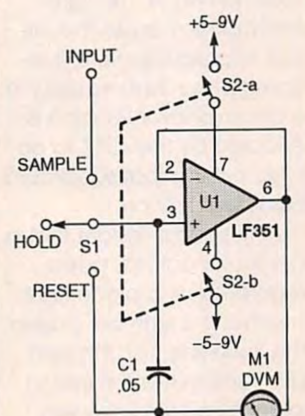

Fig. 6. In this sample-and-hold circuit, a FET input op-amp (U1) is configured as a voltage follower.

the RF from the DC signal that feeds the 50-µA meter (M1), while a potentiometer sets the circuit's sensitivity. The circuit can be mounted inside of a small aluminum enclosure with the circuit ground tied to the case.

SAMPLE-AND-HOLD CIRCUIT

Our next entry came about when we needed to make a remote reading of an instantaneous voltage and hold that reading for a short period of time. After some experimenting, we came up with the sample-and-hold circuit shown in Fig. 6.

(Continued on page 90)

CIRCUIT CIRCUS

(Continued from page 73)

In that circuit, a FET input op-amp is configured as a voltage follower, and its output is connected to a digital voltmeter. The op-amp's positive input is tied to a .05-µF, high-quality, low-loss polystyrene capacitor and to the wiper of a three-position switch.

With S1 in the reset position, the op-amp's input is taken to ground and the meter reads zero. When the switch is moved to the sample position, the capacitor charges to the input voltage level and the op-amp produces the same voltage at its output, which is then applied to the meter.

When the switch is returned to the hold position, the charge on the capacitor remains and the op-amp supplies the same voltage to the meter. A quality capacitor will hold the charge for a long time, and with the high input impedance of the FET-input op-amp, the circuit will hold the reading for several minutes with little loss.

CMOS LAMP DRIVER

The majority of CMOS IC's are capable of sinking enough current to light a single LED indicator. But, if you need a bright light, CMOS IC's just aren't designed to handle that much current.

With the aid of the circuit in Fig. 7, a CMOS chip can be used to control an incandescent lamp. The input drive power required by the gate of the hexFET is almost zero, so the circuit can be used to control just about any lamp (or another load, like a motor) as long as the current and voltage limits of the hexFET are not exceeded. ■

PARTS LIST FOR THE FIELD-STRENGTH METER

D1—1N34A general-purpose germanium diode
R1—20,000-ohm, potentiometer
C1—0.005-µF, 50-volt, ceramic-disc capacitor
L1—2-mH RF choke
M1—50-µA D'Arsonval meter movement
ANT1—19-inch telescoping antenna
Perfboard materials, metal enclosure, wire, solder, hardware, etc.

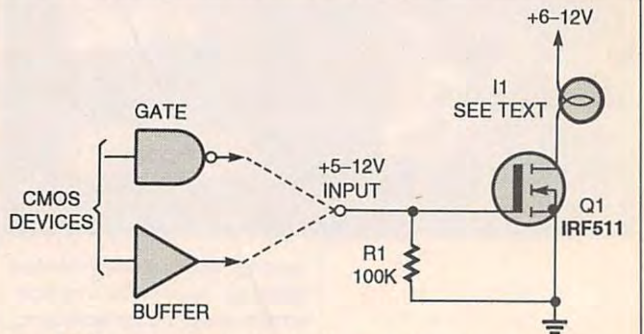

Fig. 7. The lamp-driver circuit allows an incandescent lamp to be controlled by CMOS logic gates, which aren't designed to handle that much current.

PARTS LIST FOR THE CMOS LAMP DRIVER

Q1—IRF511ND hexFET
R1—100,000-ohm, ¼-watt, 5% resistor
I1—See text
Perfboard materials, enclosure, 6–12-volt power source, wire, solder, hardware, etc.