

Solid State

By Lou Garner

THE GOODFLASHER—PART II

WHEN a motion picture is a box-office smash, there's a fine opportunity for a sequel. For example, the resounding success of "The Godfather" resulted in "The Godfather, Part II." But, whereas a few motion picture sequels are planned before the initial film is released, I truly planned—and promised—to present additional applications for the amazingly versatile LM3909 LED flasher/oscillator first discussed in this column last July. (That was a smash hit!)

In fulfillment of that promise, "Solid-State Productions" proudly presents another super-colossal epic in breathtaking black and white: "Goodflasher, Part II," starring LM3909. As customary in Show Biz, credits are in order. I am indebted to Mr. Peter Lefferts, an engineer with the National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051), who designed, bench-tested and contributed the circuits shown in Figs. 1 through 4.

The LM3909, you may recall, is a monolithic oscillator specifically designed to flash light emitting diodes. Consisting of one pnp double collector and three npn transistors, a zener diode, and nine resistors, the device is packaged in an 8-lead plastic mini-DIP. With a maximum power dissipation rating of 500 mW and a maximum supply rating of 6.4

volts, the LM3909 can deliver current pulses of up to 200 mA. It is available through franchised National Semiconductor electronic components distributors and from some mail order supply houses.

Designed to demonstrate the LM3909's high efficiency and low power requirements, the solar powered oscillator circuit in Fig. 1A may be used as part of a science fair display, as an interesting lab experiment, or simply as a "fun" project. In direct sunlight, the oscillator will deliver a piercing screech, while average daylight will produce a more moderate tone. A low buzz is emitted when the circuit is activated by a 75-watt incandescent bulb placed two or three feet from the solar-cell power supply. With practice, one may be able to "guesstimate" light intensity by the tone of the output signal.

In addition to the LM3909 (IC1), the circuit requires two ¼- or ½-watt resistors (R1 and R2) and a low-voltage, 15- μ F electrolytic capacitor (C1). The output device is a standard PM loudspeaker with a 25-ohm (or more) voice coil, while the power supply consists of four to six single-junction silicon solar cells (PC1 to PC4), connected in series.

A simple AM broadcast band receiver circuit featuring the LM3909 is illustrated in Fig. 1B. Here, the IC serves as a detector/amplifier rather than in its customary role as a pulse oscillator. Suitable for listening to stronger local stations, the receiver has better sensitivity and greater power output than conventional crystal sets but, of course, can not be compared to multistage superheterodyne designs. It is an excellent project for the novice, however, who has tried crystal and one or two transistor circuits and wants to experiment with IC devices.

Operating power is supplied by a single penlight or flashlight cell (B1), controlled by a spst toggle, slide, or rotary switch (S1). The PM loudspeaker should have a 40-ohm (or better) voice coil. (If you have trouble finding one, use a 4- or 8-ohm coil and a step-down impedance transformer.) Capacitors C2 and C3 may be ceramics, plastic film, or tubular paper types. The single tuned circuit consists of a standard ferrite core broadcast band antenna coil (L1) and a matching variable capacitor (C1).

If desired, a short antenna can be connected to the "high" end of the coil, as shown. Overall sensitivity and selectivity will be improved with a longer antenna, but this should be connected to a tap near L1's "cold" (ground) terminal. If the coil used does not have a separate antenna tap, simply wind a few turns of fine-gauge enamelled wire around the lower end of the coil, attaching one end to ground and the other to the long antenna.

Requiring fewer components than an equivalent UJT configuration, the triac trigger circuit illustrated in Fig. 2A is designed as an interface between TTL logic circuitry and a

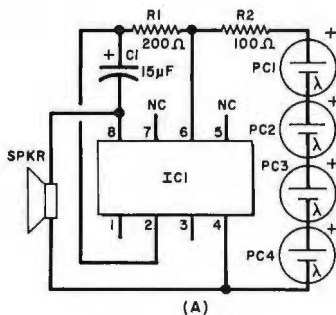
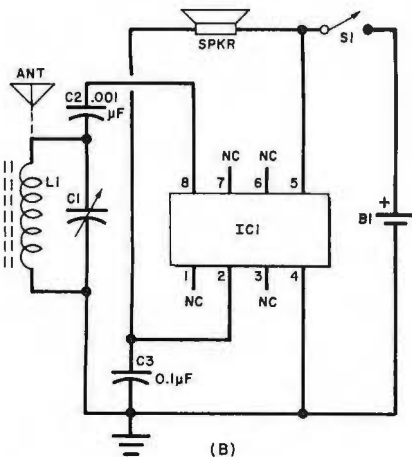
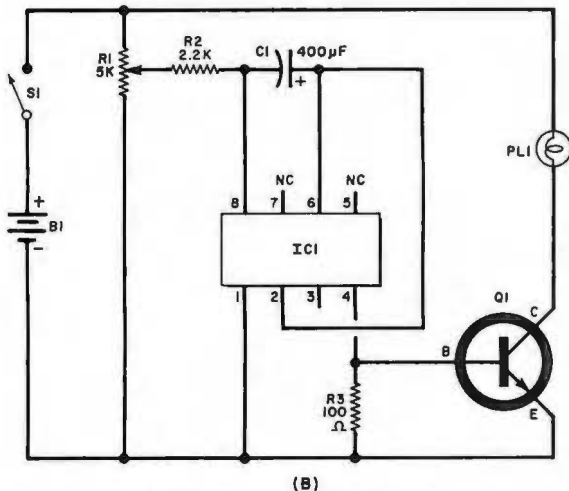
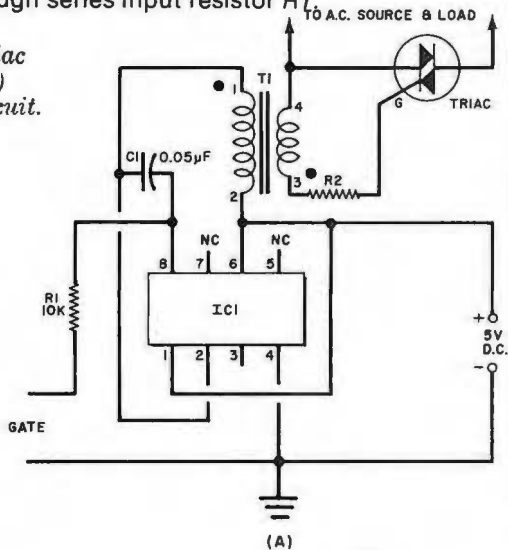


Fig. 1. Applications for LM3909: (A) solar powered oscillator; (B) AM broadcast band receiver.



power triac. The circuit delivers a train of 7-kHz, high-current pulses to the triac's gate through isolation transformer $T1$ when its input is driven "low" by a lightly loaded TTL gate through series input resistor $R1$.

Fig. 2. (A) Triac trigger and (B) ministrobe circuit.



Other than the LM3909 ($IC1$), the circuit requires a standard pulse transformer, $T1$ (Sprague 11Z2003), a small 0.05- μ F ceramic or plastic film capacitor ($C1$) and a $\frac{1}{2}$ -watt resistor ($R1$) at 10,000 ohms or less. A $\frac{1}{2}$ -watt gate current limiting resistor ($R2$) will be needed for low-to-medium-power triacs, with its value determined by the device's maximum gate current specification. If a high-power triac capable of handling a 200-mA gate current is used, $R2$ will be 1 ohm or less (or can be omitted). As indicated, the circuit is designed for operation on a standard 5-volt dc supply.

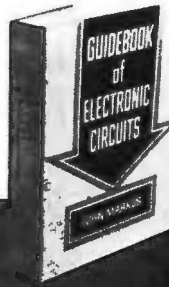
Battery operated and thus shockfree, the mini-strobe circuit given in Fig. 2B is ideal for a youngster's toy, but also could be used for advertising displays or caution and warning signal applications. With an effective flashing rate of up to 7 Hz, the unit can provide a strobeflike "flicker" effect in a darkened room. The rate control, $R1$, has a range from "off" to beyond the response time of the incandescent lamp bulb, $PL1$, causing it to appear "on" continuously.

For optimum results, the lamp, a type 1767 bulb (chosen for its rapid response characteristic), should be provided with a reflector. Control $R1$ is a 5,000-ohm linear potentiometer. Timing capacitor $C1$ is a 3-volt electrolytic. The lamp driver ($Q1$) is a National Semiconductor type U01 npn transistor or similar general-purpose device. Operating

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power is supplied by two series-connected flashlight cells, B1, furnishing 3 volts, controlled by S1.

Delivering a rapidly rising wail when activated, followed by a slower "coasting down" when its control button is released, the fire siren shown in Fig. 3A may be used in toys or as a sound effects generator. As in the previous circuits, the active device is an LM3909. The capacitors are low-voltage electrolytics. A momentary contact, NO, spst push-button type is used as the control switch, S2. A single flashlight cell (B1) serves as the power source. The PM loudspeaker should have at least a 25-ohm voice coil. If the operator prefers that the output tone stop sometime after the pushbutton is released, an 18,000-ohm, ½-watt resistor should be connected between IC pins 6 and 8.

A whooper siren circuit is illustrated in Fig. 3B. Generating a sound similar to that of the electronic sirens used on many ambulances, police cars and rescue trucks, the de-

sign employs a pair of LM3909's. In operation, IC1 produces a high-pitched signal which is modulated at a low rate by a sawtooth waveform developed by IC2. Again, a high-impedance (25-ohm or more) loudspeaker (or transformer) is used. The capacitors are low-voltage electrolytics, and a single flashlight cell serves as the power source. Diode D1 is type 1N4002. Since this circuit provides continuous operation, a single control switch is adequate.

Suitable for operation at distances of up to 200 feet when used with standard 22-gauge intercom or hookup wire, the dual-station code practice set shown in Fig. 4A is a dandy project for beginners or even for old-timers wishing to improve their skills at "pounding the brass." The two units may be operated room-to-room, room-to-garage or basement; apartment-to-apartment, or even house-to-house in some suburban areas. In addition to its obvious application for code practice, the system could be used in lieu of an intercom for simple communication by means of a pre-established private code. For example, one short buzz could mean "dinner's ready," a long and short "you're wanted on the phone," and so on.

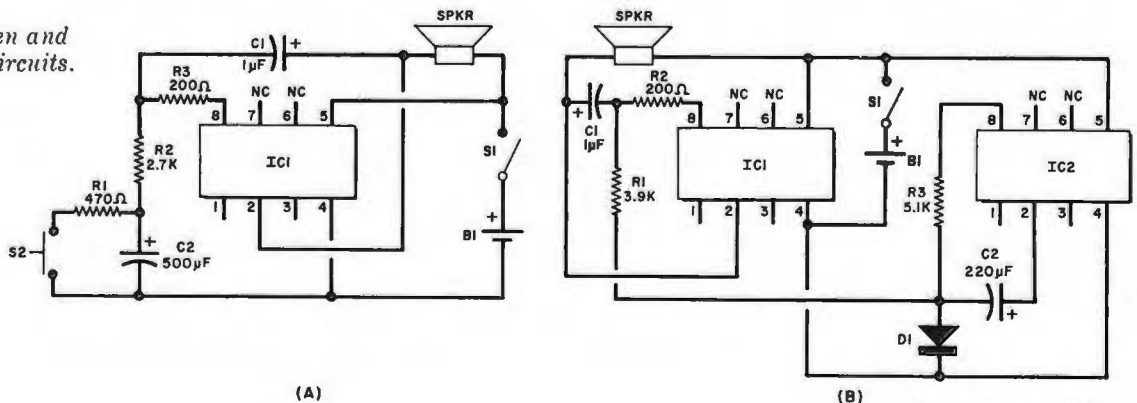
In operation, the LM3909 serves as a simple relaxation oscillator to drive both loudspeakers, which are effectively in series. Its normal narrow pulse output is modified by series resistor R2, lengthening capacitor C1's discharge time and developing a rectangular waveform.

With the two loudspeaker voice coils in series electrically, inexpensive 8-ohm types may be used in this application. The capacitor is a low-voltage electrolytic. Either a penlight or flashlight cell may be used as the power source. On-off switch S1 is optional, for the battery drain is virtually nil until one of the handkeys is closed.

For maximum audio output at minimum current drain, the entire system can be operated in a resonant mode. This may be accomplished by adjusting both the oscillator output frequency and the acoustic characteristics of the enclosures (or cases) to match the natural resonant frequencies of the loudspeakers. The oscillator output frequency may be changed by selecting different values for timing capacitor C1. The acoustic characteristics of the cases may be modified by adding additional holes (other than the openings for the speaker grill). Both hole size and capacitor value must be determined experimentally for maximum output and stability.

Another interesting linear application for the LM3909 is given in Fig. 4B—a low power unidirectional intercom or "remote listener." Here, the device serves as a simple audio amplifier between a remote microphone and a local loudspeaker. Although the circuit's overall gain and audio output are relatively low, so is the power drain, assuring long battery life, even under continuous operating conditions.

Fig. 3. (A) Fire siren and (B) whooper siren circuits.



Referring to the schematic, the remote microphone consists of a 3.2-ohm PM loudspeaker and a 3.2-ohm-to-15K matching transformer, *T1*. This can be a small tube-type output transformer used "in reverse." The microphone assembly is connected to the amplifier, *IC1*, through a standard twisted pair up to 50-feet in length. The local loudspeaker should have a high impedance (40-ohm) voice coil (or use a transformer). Capacitors *C1* and *C2* are small ceramic or plastic film types. Operating power is supplied by a single flashlight cell, *B1*.

The additional circuits we've reviewed (Figs. 1 through 4) will hopefully spark your imagination, leading to even more exciting applications in the future.

Reader's Circuit. In a letter commenting on the LED flasher circuits discussed in a previous column, reader Edwin C. Hadden (Oakland Park, FL) asks if I know of a circuit capable of flashing two LED's at different rates.

A suitable circuit is illustrated in Fig. 5. Featuring discrete devices, this design was developed several years ago, long before inexpensive timer and flasher IC's, such as the 555, 556, and LM3909, were introduced. Despite the limitations imposed by its early design, the circuit requires but four transistors, four resistors, and two capacitors in addition to its dc power source, yet is capable of flashing two

LED's at widely different rates and includes an optional circuit interlock.

Transistors *Q1* and *Q2* form a complementary relaxation oscillator, with *LED1* serving as *Q2*'s collector load and capacitor *C1* providing the feedback needed to start and sustain oscillation. The circuit's operating rate (frequency) depends upon a number of factors, including the dc source voltage and individual transistor characteristics, but principally upon the *R1-C1* time constant. Similarly, *Q3* and *Q4* form a second complementary relaxation oscillator, with feedback provided by *C2*, and *LED2* serving as *Q3*'s collector load. Operating power is furnished by a common dc source, *B1*, controlled by *S1*. Series resistor *R3* serves a dual role, acting to limit current and thus to protect the LED's. It also introduces a common source impedance to "interlock" the two complementary oscillators.

Different flashing rates for the two LED's may be achieved simply by establishing different operating frequencies for the complementary oscillators, using different values for either the feedback capacitors (*C1* and *C2*) or the corresponding base bias resistors (*R1* and *R4*). If a variable flashing rate is needed, either base bias resistor can be replaced with a fixed resistor in series with a suitable potentiometer. Typically, *R1* could be replaced by a 100K resistor in series with a 500K potentiometer.

The circuit interlock feature provided by *R3* is most effective when one

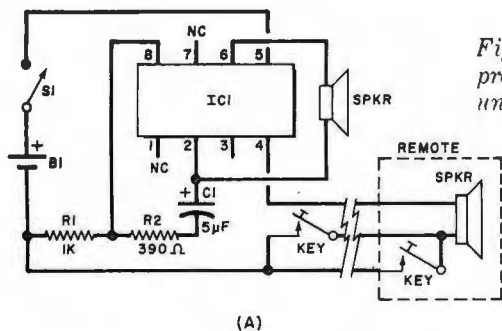
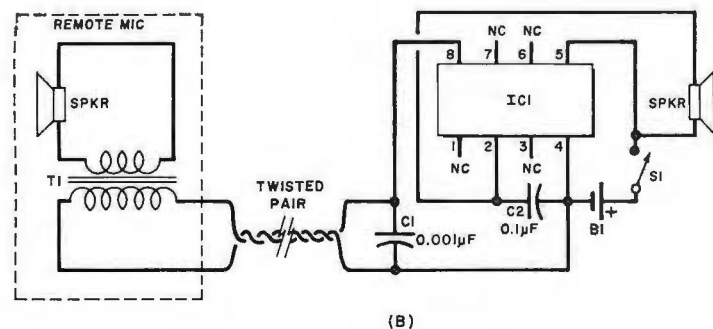
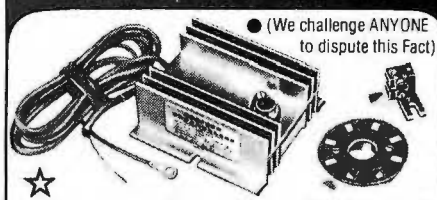


Fig. 4. (A) Dual-station code practice set and (B) unidirectional intercom circuit.



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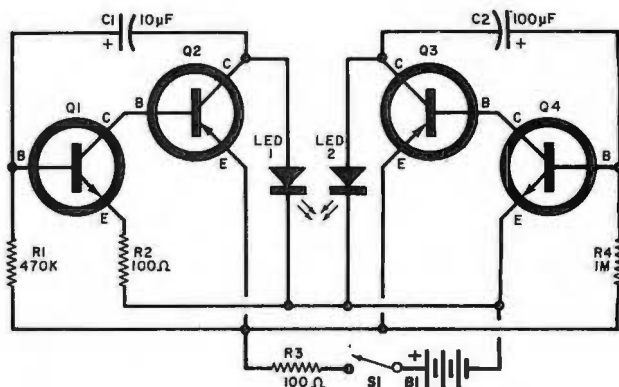
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Fig. 5. Simple
double-flasher
circuit design.



LED is flashed at a rate which is a multiple of the other. With the values specified in Fig. 5, LED1 is flashed at (approximately) a 1-Hz rate. Then LED2 flashes at a 0.1-Hz rate—once in ten seconds. If the interlock feature is not needed, R3 may be omitted, but fixed small resistors should be connected in series with each LED to limit their respective maximum currents.

While the design is not overly critical, best results are obtained when low-leakage, moderate- to high-gain transistors are used. Small-signal (low-power) types are adequate. In the original model, the npn types, Q1 and Q4, were similar to type 2N170, while the pnp devices, Q2 and Q3, were equivalent to the 2N109. Both LED's were type MV50. The two capacitors were 10-volt electrolytics. A standard 9-volt transistor battery was used.

The double-flasher circuit may be assembled using perf board, point-to-point wiring, or a suitably designed PC board, as preferred, for neither layout nor lead dress are critical. However, some experimentation with component values may be needed to achieve optimum performance and to establish desired flashing rates due to component tolerances and differences in transistor characteristics.

Device/Product News. RCA's Solid State Division (Box 3200, Somerville, NJ 08876) has introduced a number of new IC's which are said to offer the performance and reliability characteristics of hermetically sealed devices in low-cost plastic packages. Identified by a "G" suffix, a number of standard circuits are now available in the new "hermetic-in-plastic" packages, including the CA741CG and CA747G op amps, the CA324G quad op amp, the CA339G quad voltage comparator, and the CA3724G and CA3725G high-current npn transistor arrays.

Also from RCA comes news of sub-

stantial price reductions of from 15 to 40 percent on over 100 types of IC's in the firm's extensive COS/MOS line and the addition of 30 new modules, IC's and power devices to the popular "SK" general replacement line. The new "SK" devices include four hi-fi audio modules ranging from 10 to 20 watts, a Darlington preamp, some 16 linear IC's designed for AM and FM radio, stereo, and TV receiver applications, power transistors, op amps, and SCR's.

A family of solid-state current sensors designed to protect highly sensitive electronic equipment against over-current conditions has been announced by the Micro Switch division of Honeywell (11 W. Spring St., Freeport, IL 61032). Designated type ES, the devices use coils which have resistances of a few milliohms to operate Hall-effect sensors. The solid-state sensor is triggered when coil current exceeds a specified level in the 1-to-3 amp range, producing a logic-level digital output signal which, in turn, can be used to actuate "crowbar" circuits or other protective devices. The sensors are designed to respond to over-current conditions in approximately 100 µs, independently of ambient temperature conditions and pre-existing current levels.

Suitable for use in a variety of timing, control and logic applications, a new series of pulse generator modules has been introduced by the Engineered Components Company (3580 Sacramento Drive, San Luis Obispo, CA 93401). Designed to provide precise output pulse widths when triggered by variable width inputs, the new devices are supplied in standard 16-pin DIP's. Twelve models are available, supplying output pulse widths from 5 ns to 100 ns at maximum pulse rates of from 100 MHz (for the 5-ns version) to 5 MHz (for the 100-ns model). All twelve devices operate on a standard 5-volt dc power supply. ♦