Tail-biting one-shot keeps car-door light on

by B. D. Redmile
Salisbury, Rhodesia

A one-shot multivibrator that drives the same line it is sensing is useful for such applications as burglar alarms and switch-action delays because it can be fitted at any point in the circuit. Full reliability of the original circuit is retained, since connection of the one-shot across it does not break it. In the arrangement shown in the schematic, a 555 timer keeps the interior light of a car turned on for 10 seconds after the car doors are closed.

In the idle condition (door closed, light off), the 12-volt line charges capacitor C_1 and supplies power to the 555. The current drain is only about 10 milliamperes, so the light does not go on. The threshold terminal of the 555 is held high by R_3, so its output is low and all the rest of the circuit is off. When a door is opened, the light goes on in the usual way and the power to the one-shot is removed. Capacitor C_1 then discharges rapidly through D_2 and R_1.

When the door is closed and the lamp starts to turn off, power flows to the 555. With C_1 discharged, the threshold terminal is at low voltage, so the output goes high. This turns on transistors Q_1, Q_2, and Q_3. Q_2 maintains power to the 555 while Q_1 furnishes a path for current to flow to keep the light on. After a delay set by C_1 charging through R_3, the 555 output goes low, restoring the circuit to its idle state.

The combination of C_2 and R_4 prevents transients on the battery supply from damaging the 555 or prematurely terminating the one-shot high output pulse. □

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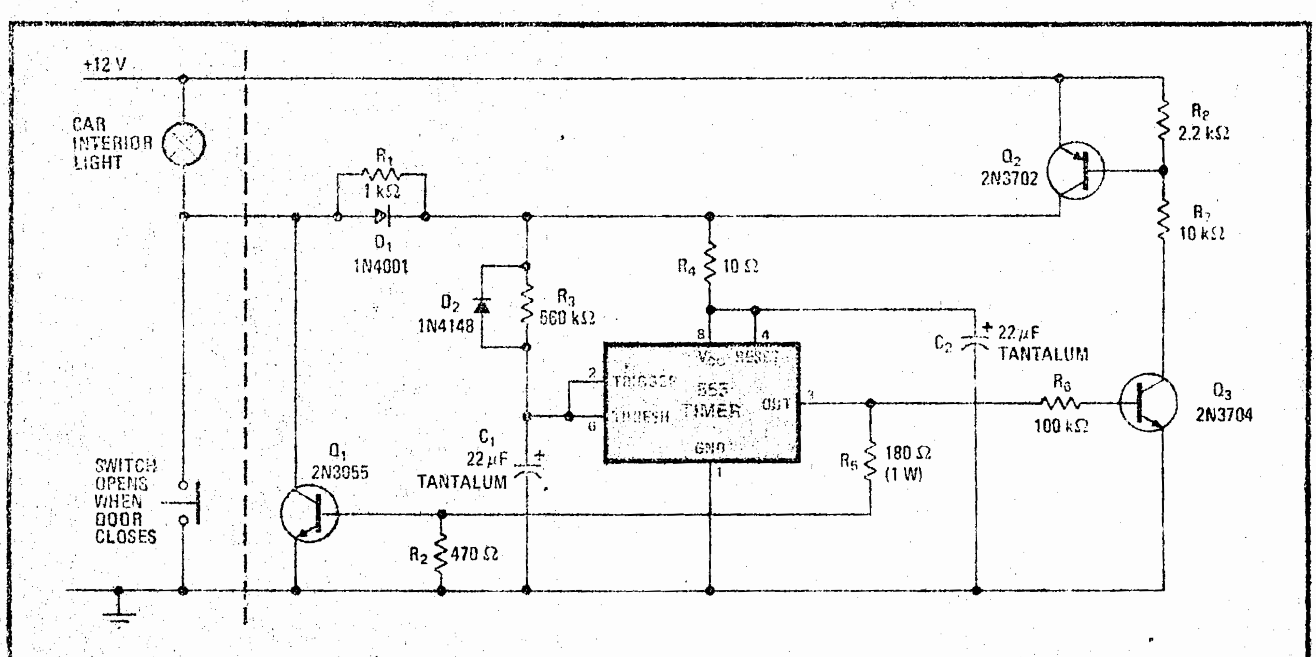


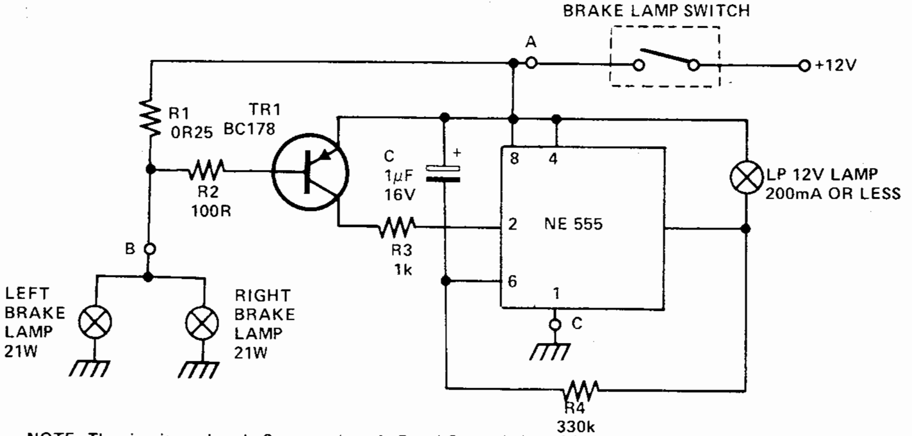
Holds the light. When car door closes, output current pulse from 555 timer turns on transistor Q_1 to keep interior light on for about 10 seconds. This type of one-shot arrangement, driving the line that is sensed, can be added at any point in the circuit. It is useful in alarm systems, process controls, automatic machinery, safety circuits, and convenience circuits such as this one.

BRAKE LAMP FAILURE INDICATOR

Here is yet another application for the NE555 timer.

If both brake lamps are working the lamp LP lights but if one or both are open circuit the lamp will flash at 2Hz, alerting the driver.

When both lamps are good the current through R1 turns on TR1 preventing C from charging, and keeping pins 2 and 6 at rail potential. Under these circumstances pin 3 is low and LP is on, however if one or both lamps are faulty TR is not turned on and the NE555 time oscillates freely at 2Hz, flashing LP.



NOTE: The circuit needs only 3 connections A, B and C to existing wiring.

R1 is calculated on the basis of two 21W brake lamps (42W total). If a different total wattage is used, use the formula:

R1=10.5/P where P is the total wattage of two lamps.

Darlington-switched relays link car and trailer signal lights

by M. E. Gilmore, and C. W. Snipes
Florence, Ala.

New cars with separate turn and brake signals—a safety feature—require a special circuit to properly drive the combination turn-and-brake lights on a trailer; otherwise, if the trailer lights are connected to the brake command, the turn signal will not work, and connecting the lights to the turn command will not yield a brake signal. But two relays and low-cost transistors will combine the signals onto a common bus again, ensuring that the trailer's lights respond to both commands.

As shown in the figure, the brake-command line is normally connected to the trailer lights through relays K_1 and K_2 during normal operation. However, a left- or right-turn command will turn on the respective Darlington amplifier, Q_1Q_2 or Q_3Q_4, thus activating K_1 or K_2. The turn signal is then routed to the lights.

Capacitors C_1 and C_2 charge to the peak amplitude of the turn signal, which flashes at one to two times per second. C_1 and C_2 should therefore be selected to hold the relay closed between these flash intervals (0.5 to 1.0 second), but no longer. If the capacitance is too large, the brake signal cannot immediately activate the trailer lights after the turn signal is canceled. Diodes D_1 and D_2 prevent capacitor discharge through the left or right turn-signal lines, respectively. □

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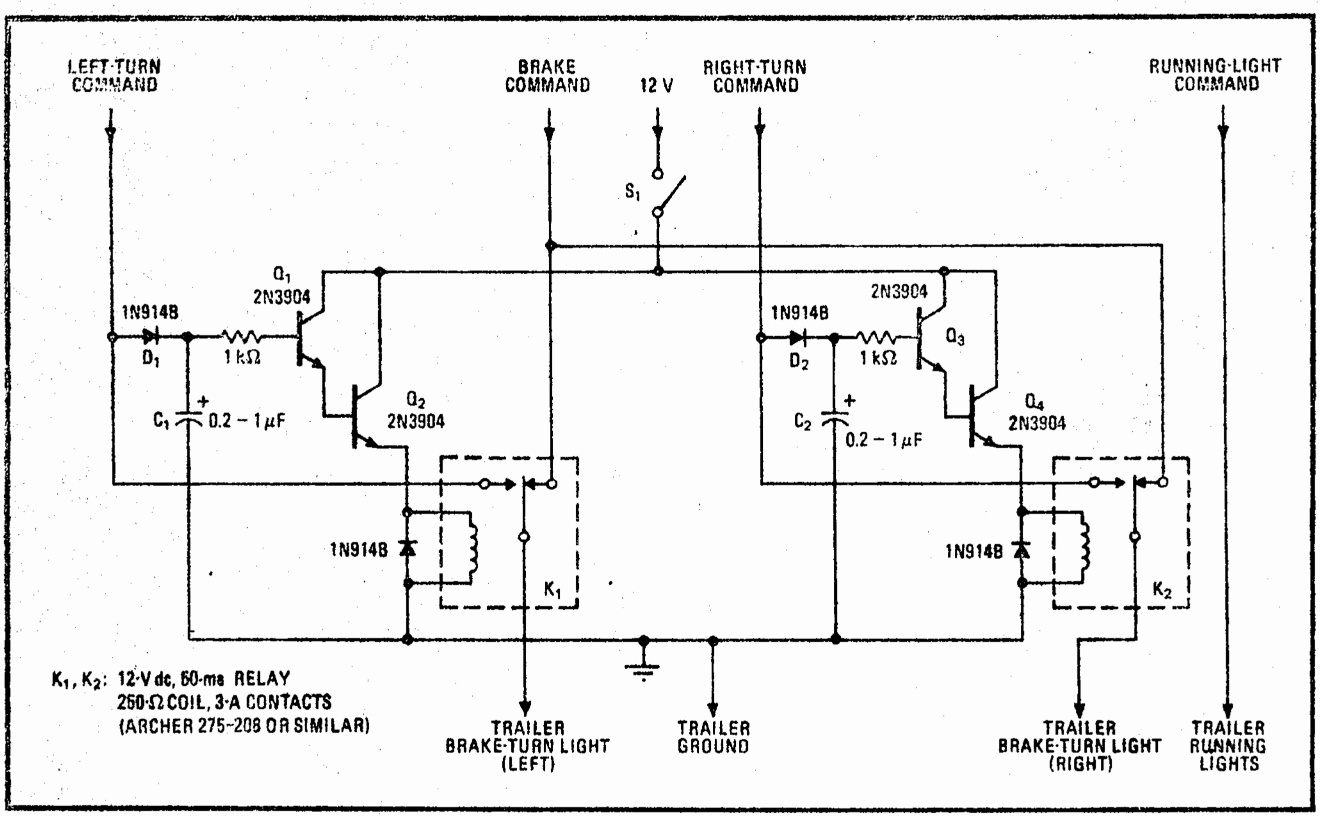

Auto-to-trailer interface. Relays multiplex brake and turn commands onto common bus line, permit control of brake-turn lights on trailer. Darlington amplifiers provide high command-line isolation and sufficient drive for the relays.

Tri-level indicator monitors automobile's electrical system

by S. K. Wong
Torrance, California

The battery voltage of a car in operation indicates a great deal about the condition of the alternator, the voltage regulator, and the battery itself. Expensive sports cars are routinely equipped with gages to monitor voltage. Sedans may be optionally equipped with these voltmeters, but a good gage usually costs more than $30, and its size may make it difficult to install on the instrument panel.

Fortunately, exact voltage readings are not necessary to indicate the condition of the electrical system, even if a precise value could be read while the car is running. An instrument that shows three levels of voltage can give enough information to indicate that (1) a major component of the electrical system is faulty; (2) the battery voltage is fairly low, and the electrical system should be checked; or (3) the battery voltage is adequate for efficient functioning of the system.

A solid-state tri-level voltage indicator that uses light-emitting diodes to show three voltage ranges can be built for $5 to $10, depending on the quality of the parts used, and it is a bargain for the purpose it serves. The circuit shown in the diagram uses, in addition to the three LEDs of different colors, three npn switching transistors, two zener diodes, one blocking diode, and a handful of 0.5-watt resistors. The red and yellow combination indicates a battery voltage of less than 11.7 V, yellow shows 11.7 to 12.7 V, and the green light shows that the battery voltage is 12.7 V or more.

If the battery voltage is below 11.7 V, all of the transistors are turned off. Diode D_4 blocks the current path through green LED D_3, the base and collector of Q_2, D_2, and D_1, so that current flows only through R_2, D_2, and D_1. The red and yellow LEDs light up to indicate that the battery, voltage regulator, alternator, or any combination of the three, is bad.

If the voltage is between 11.7 and 12.7 V, transistors Q_2 and Q_3 are still turned off, but zener ZD_1 conducts and lets Q_1 turn on to shunt out the red LED. Thus only the yellow LED lights up, warning the driver of a fairly low battery voltage. Unless this low-voltage situation improves after a few miles of driving, the electrical system of the car should be inspected for faults or high contact resistances.

If the battery voltage quickly reaches 12.7 V or more after the car is started, Q_3 also turns on. Current through Q_3 lights the green LED and also turns on Q_2 to shunt out the yellow LED. The resulting green light assures the driver of a functioning electrical power system in his car.

The user may choose zener diodes with somewhat different breakdown voltages if he wants to shift the three indication levels to fit his own requirements. □

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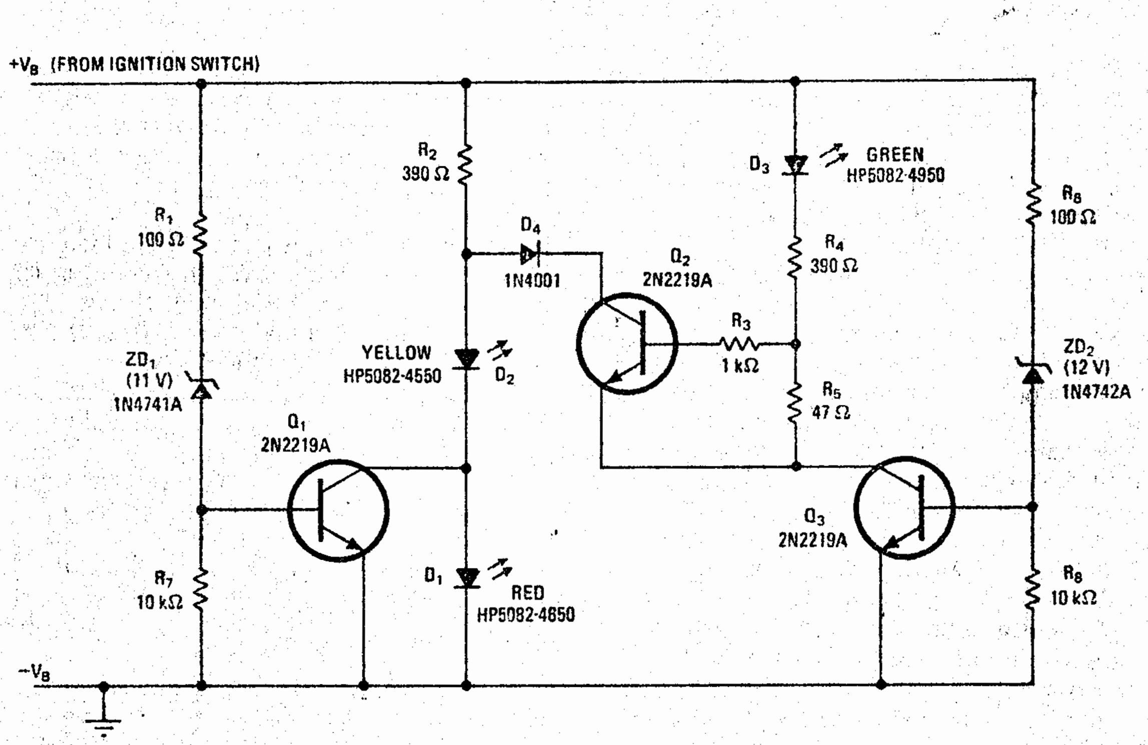
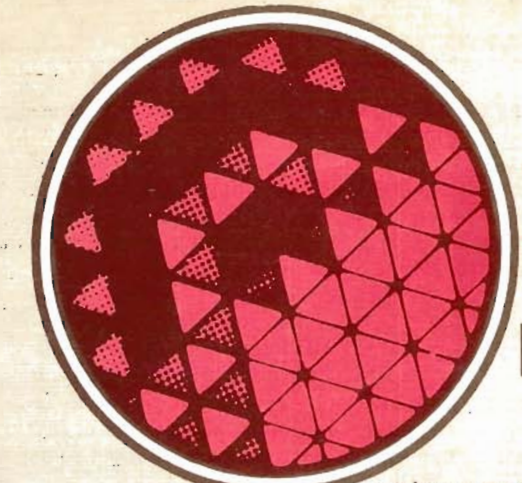


BATTERY VOLTAGE	LEDs LIGHTED
$V_B \leq 11.7$ V	RED AND YELLOW
$11.7 \text{ V} \leq V_B < 12.7$ V	YELLOW
$V_B \geq 12.7$ V	GREEN

Battery-voltage indicator. Colored LEDs indicate three ranges of battery voltage in car. A weak battery turns on red and yellow, a stronger battery breaks down 11-V zener to light only yellow, and a strong battery turns on green as both zeners conduct. Resistors R_7 and R_8 provide high-temperature stability. This unit can warn of need for corrective maintenance of car's electrical system.



BY IMRE GORGENYI

TURN/BRAKE INDICATOR FOR TRAILERS

Simple solid-state circuit permits use of 3-wire systems on older trailers with 4-wire systems on new cars

ON AUTOMOBILES manufactured after 1977, the turn-indicator and brake lights are independent. This may present a problem when one wants to haul a trailer that is equipped with the older 3-wire system in which turning and braking are indicated by the same rear light.

The interface circuit shown here permits coupling the old 3-wire system to a modern car. The circuit for only one side is shown so it must be duplicated for the other side. When using this circuit, the car light flasher does not have to be replaced with a heavy-duty version as in some trailer systems. As a further advantage, there are no moving or electromechanical parts such as relays that can be affected by moisture or vibration encountered on the highway.

Operation. Each time the vehicle turn signal is operated, its line alternately goes high and low as determined by the flasher. When the line goes high, diode *D1* is forward-biased, turning on the *Q3/Q4* combination and causing the common turn-brake lamp to glow. When this line goes low, the transistor pair is turned off and the turn/brake lamp is extinguished. Thus, the turn/brake lamp glows in step with the lamp flasher.

When the brake is applied, that line goes high and forward biases *D2*. The transistor pair is turned on and the turn/brake lamp glows. Since the brake line remains high as long as the brake is depressed, the lamp remains lit.

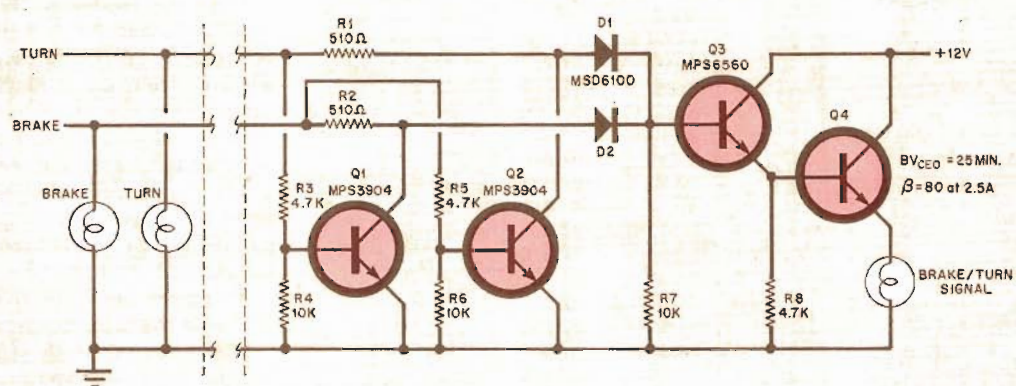
Now let us consider what happens when the turn indicator level is actuated and the brake is applied at the same time. Initially, the turn signal drives the *Q3/Q4* pair through *R1* and *D1* with the base voltage for *Q3* developed across *R7*. Each positive voltage signal on the turn line causes the lamp to go on. Note that the pulsating signal on the turn line is also applied to the base of *Q1* through *R3* and *R4*. This signal does nothing to *Q1* since the brake line (collector source of power) is low, and reverse-biased *D2* keeps the positive voltage across resistor *R7* from appearing on the turn line.

When the brake line goes high, the transistor pair is driven through *R2* and *D2* with the base voltage for *Q3* developed across *R7*. Transistor *Q2* is also turned on by the positive voltage applied to its base through *R5* and *R6*, making *Q2* draw current through *R1* each time the line goes high, thus bringing the *D1/R1* connection effectively to ground. In essence, this action shuts off the turn signal input to *Q3/Q4*. But then *Q1* takes over. Driven by the "turn" line, it alternately releases and pulls down the "brake" voltage at its collector. Therefore, one trailer light flashes but it is 180 degrees out of phase with the car's orange light. The other is on steadily, indicating that the brakes are on.

Construction. Since the circuit is relatively insensitive, it can be fabricated in any desired fashion. Two identical systems should be made, one for each side of the trailer. The turn signal is taken from the appropriate line, while the common brake signal is used.

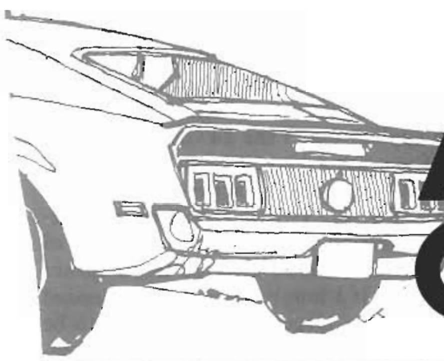
A power Darlington can be substituted for the *Q3/Q4* combination as long as you make sure that the output transistor in the last stage can carry the current required by the lamp.

The circuit can be mounted in the car with the two lamp wires, battery wire and ground fed to the trailer. Taking the taillight wire, electric brake, and back-up light connection into account, we should use a seven-pole connector. ◇



The conversion circuit above must be built twice—one for each side of the car.

TRANSIENT PROTECTION FOR AUTOMOBILE CIRCUITS



BY ROBERT PEASE
National Semiconductor

ˈafeguards for solid-state circuits in your car

˚T CAN be very frustrating to have a ˌnew circuit you built for your car ılfunction when the engine is being ırted or even running smoothly—espe-ːlly when it checked out fine with the ˉ parked. What went wrong? Chances are the problem is at the power source.

A 12-volt battery by itself is a very well-behaved power supply. But when the engine runs and the alternator charges the battery, a variety of things can happen to upset electronic circuitry.

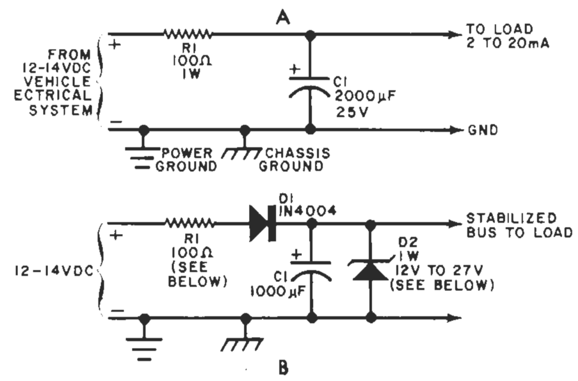


Fig. 1. The simple R-C filter at A will provide adequate protection against transients for low-power applications. For better protection, the circuit at B is recommended. Ratings for D2 and R1 are determined from the Table as described in the text.

VALUES FOR D2 AND R1

D2			R1	Rated
ɔlts	Watts	Type	Ohms	Output Current
2	1/2	1N759 or 1N963	300	8 mA
ˈ	1/2	1N971A or 1N5254	150	15 mA
2	1	1N4742	150	15 mA
7	1	1N4750	75	30 mA
2	5	1N5349A	27	75 mA
27	5	1N5361A	15	150 mA
2 or 27	50	1N2810A or 1N3311A	1.5	1.5 A
27	75	Motorola MR2525	1	2 A

For example, transients measuring 1 to 10 volts P-P are commonly found in the 12-volt automotive power-supply. These will not usually harm semiconductor circuits, but they can cause severe noise and instability problems and false-triggering of sensitive logic circuits.

Larger transients that can cause damage also appear at various times, as when a battery is temporarily disconnected or when battery terminals become corroded. These transients, sometimes known as "load dump," can reach +60 to +80 volts for a few-hundred milliseconds. When the engine is running, and the alternator is delivering power to the battery, the voltage regulator holds the output to about 13.8 V. When the battery (load) is removed, the output overshoots until the voltage regulator can reduce the alternator field, which takes time to decay, and re-establish the correct output voltage. Another severe transient, which usually occurs when the ignition is turned off, can go to −50 volts for 100 milliseconds. This

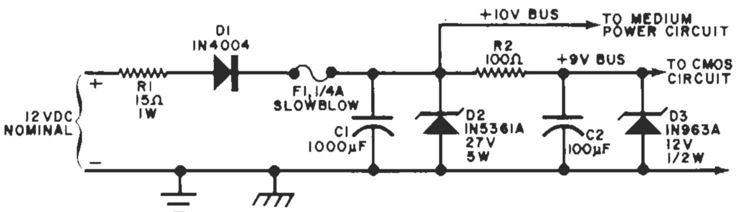


Fig.2. Sometimes, if your circuit contains parts requiring protection at different levels (such as CMOS components), it can be partitioned. Double protection is actually provided for the CMOS.

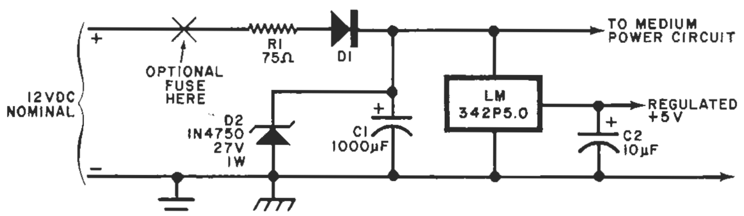


Fig. 3. CMOS components can be protected along with medium-power circuits by using a three-terminal regulator to provide separation.

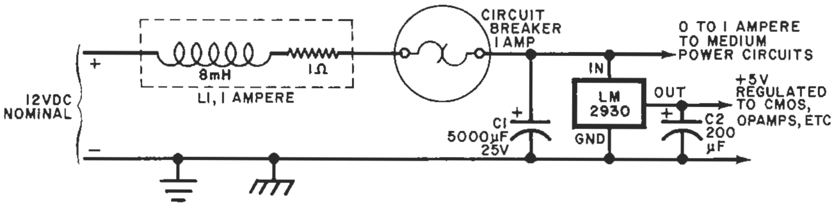


Fig. 4. The tops in decoupling and regulation provided by an inductor, circuit breaker, capacitors and regulator.

"field decay" results as the excitation in the alternator field dies away.

Other random transients can reach ± 200 to 400 volts for a few microseconds. Such peaks can be reached when inductive elements connected to the vehicle power bus are switched on or off, thus producing rather large back-emf spikes. No ordinary solid-state circuits can survive this kind of transient onslaught without protection. As a prime example, popular CMOS circuits, which are ideal for low-power designs, can be destroyed by supply voltages outside the range of +15 and −1 volt. Obviously, some form of protection is required to keep electronic equipment operating reliably in a car. But what kind? And how much?

Levels of Protection. One criterion for deciding how well protected a circuit should be is its importance to the system. The inconvenience caused by an inoperative car stereo system is of a different order from that caused by the untimely discovery—when you are miles from the nearest telephone—of a failure in a newly installed solid-state ignition system. It would make sense to protect the latter circuit more rigorously than the former.

Manufacturers, too, have reason to be concerned about intercepting transients before they cause trouble. How much immunity should be provided for a run of 10,000 radar detectors? What will warranty repairs cost if they are needed? And what about microprocessor-controlled systems to be installed in 3 million cars? An epidemic of malfunctions here could be calamitous. Clearly, protective systems in which you can place a high degree of confidence are called for in these situations.

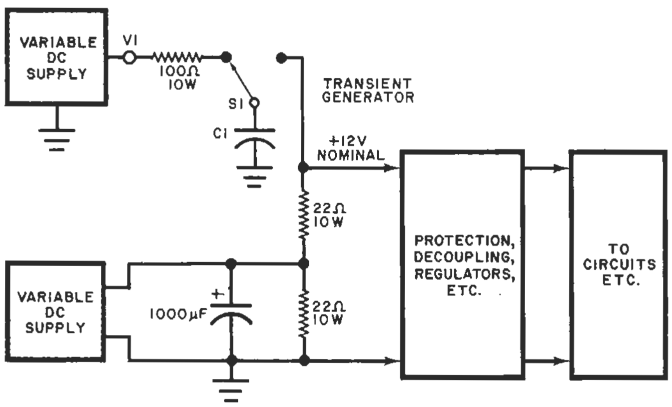
Trapping the Spikes. Now, let's discuss several circuit approaches for protecting a hobbyist's circuits and/or store-bought hardware. The first technique is simple decoupling and bypassing. There are many low-power circuits which will run reliably and well in a car if you simply add a large R-C filter in the supply line. As the cost of a 2000-μF capacitor is very reasonable, circuit A of Fig. 1 is a good basic scheme. All the positive and negative transients mentioned above will be heavily attenuated by the simple *R1C1* filter. For low-power applications, Fig. 1A provides adequate protection. But the circuit in Fig. 1B is better and costs little more.

In Fig. 1B, diode *D1* will provide full tolerance of negative transients on the 12-volt bus; and positive transients will cause less ripple, too. Also, this diode will guard against inadvertently reversed supply connections. Zener diode *D2* prevents the stabilized bus from rising too high. If you use a 27-volt zener, this circuit will be highly resistant to any short-term 60-volt transients on the input. It will also withstand connection of a 24-volt battery, which some mechanics use for emergency starting. (Obviously, placing 24 volts on a 12-volt system can damage any electrical or electronic elements connected to the bus. For safety sake, *all* circuit elements other than those necessary to start the vehicle should be switched off during the application of the 24 volts.)

If you use a 12-volt zener to limit output voltage, use a larger-valued resistance for *R1*. This is recommended because during fault conditions, most of the current will be diverted to *D2* rather than *C1*. If a lower value of *R1* is needed to permit a larger output current to be drawn, the dissipation rating of the zener diode should be increased accordingly. (See Table.) In normal operation, a low-power zener will never get warm but it can be destroyed by a load-dum transient if the value of *R1* is too low For good reliability, therefore, the resis tor values in the Table should be treate as the lower limits.

The use of a 27-volt zener presume your circuit can tolerate a +30-volt sup ply. What if your circuit includ CMOS components that are rated f +16 volts absolute maximum? Yo might be able to partition your circuit. the high-current portion can tolerat +27 volts briefly, and the CMOS is, c course, drawing only a small curren then the circuit of Fig. 2 will do nicel The path to the CMOS circuitry is no doubly protected.

Note that a fuse has been added t



V1	C1
+60 to +80V	2,000 to 10,000μF, 100V
−50V	1,000 to 5,000μF, 60V
+200V	1μF, 400V
−200V	1μF, 400V
+400V	0.1μF, 600V
−400V	0.1μF, 600V

Fig. 5. Circuit to be used in testing your transient protection system. Throwing the switch provides transients on the regular supply. Be sure the polarity and rating of the capacitor agree with those of the transient voltage.