BUILD THIS BRAKE LAMP FLASHER

Add this safety feature to your car

Automatic brake lamp flasher

What's the best way to avoid a rear-end collision while braking? According to recent tests among Sydney taxi-drivers, the best way is to have an additional flashing stop-lamp installed on the parcel shelf. This project fulfils that requirement.

by COLIN DAWSON

The circuit described here will flash a set of accessory lamps three times each time the brakes are applied and hold them on after that while ever the brake pedal remains depressed.

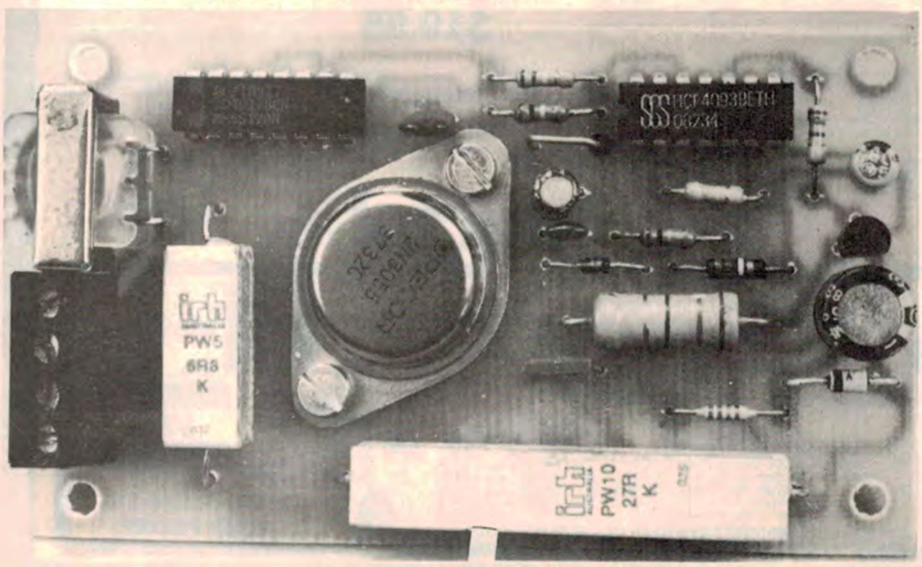
Installation is easy. Only two connections are required to the existing wiring — one to the brake lamp line and the other to the chassis.

Except for the accessory lamps, the project is completely self contained on a small printed circuit board. This could easily be mounted under the rear parcel shelf of a sedan — even most hatchback cars would have some suitable "nook".

We are, of course, aware of various other schemes for flashing accessory brake lamps. Most simply flash the lamps continuously while ever the brakes are in use, although at least one has the added refinement of altering the flash rate in proportion to braking effort. The problem with this arrangement is that following motorists only need the first few flashes to attract their attention. After that, the device only serves to irritate, and an irritated driver can easily become an aggressive one.

Our circuit overcomes this problem by including a "delay" feature. This effectively causes the circuit to wait five seconds after the brakes have been released before it is re-armed. Any brake application during this period will cause the accessory lamps to operate without flashing. For bumper-to-bumper driving where brake release may only last for a few seconds, the accessory lamps will function just the same as ordinary brake lamps.

Below is a larger-than-life size of the assembled PCB.



The project could, in fact, be used without any additional brake lamps. For cars with two pairs of brake lamps such as Commodores and Falcons, one pair could be modified to flash. This may not be as effective as fitting eye level lamps, but it would be cheaper.

The circuit

The main components in the circuit are a 4093 quad NAND gate with Schmitt trigger inputs, a 4017 decade counter and three transistors. These components may be considered as three main functional elements: a clock, a counter (incorporating the delay) and the lamp driver section.

The circuit basically works as follows. When the brake pedal is pressed, the circuit is energised. This starts the clock which drives the transistor lamp driver section, flashing the accessory lamps on and off. This continues until the counter section counts up to four, after which the accessory lamps are turned on continuously, as long as the brake pedal is depressed.

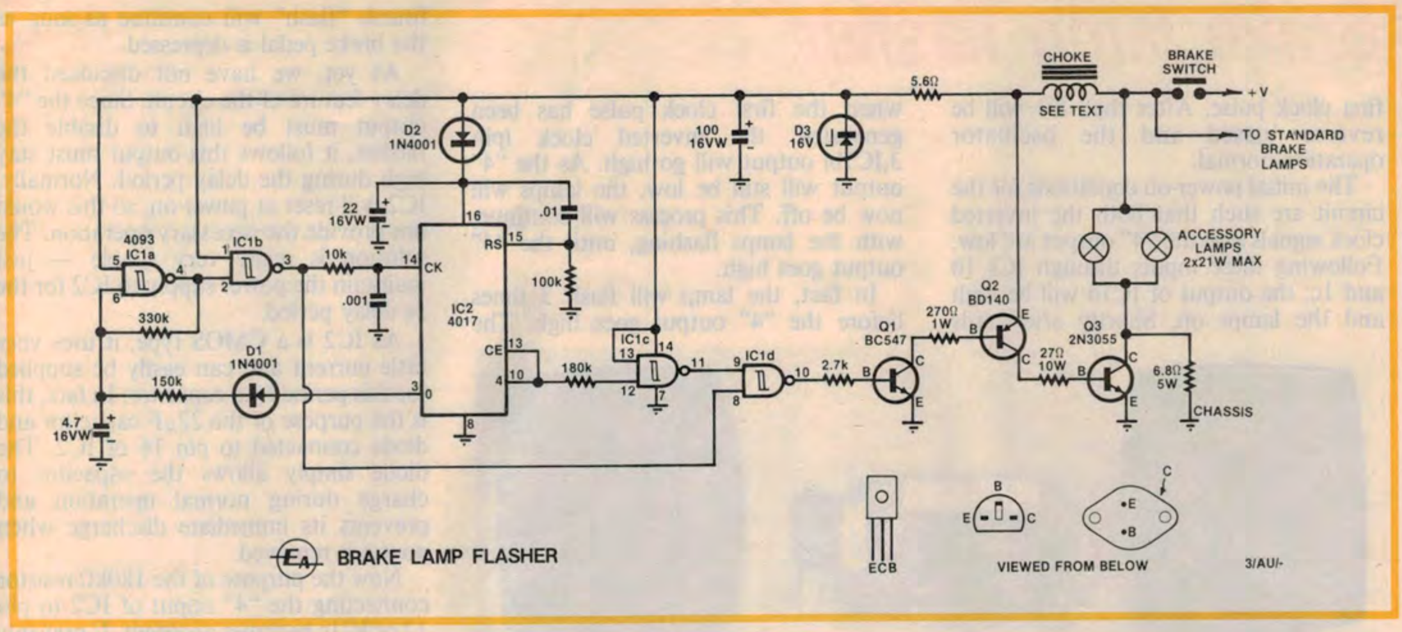
To gain a better understanding of the circuit, let's look more closely at what the 4017 does.

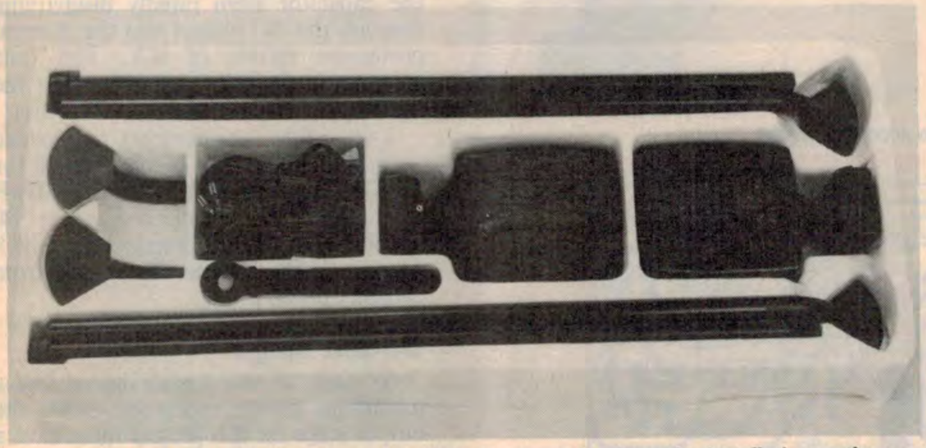
A 4017 decade counter is a device with ten outputs, numbered 0 to 9. Normally, each output goes high, in sequence, for one complete clock cycle. This mode of operation can be overridden by either Clock Enable (CE, pin 13) or Reset (RS, pin 15). CE

We estimate the current cost of parts for this project to be approximately

$16-20

This includes sales tax, but not the cost of accessory brake lamps.





This accessory brake lamp kit comes with all the necesssary hardware for installation on the rear parcel shelf. It cost us less than $20 (from BBC Hardware).

prevents further counting when it is taken to logic high and RS sets the counter outputs to zero when it is taken high.

Notice that the Reset pin has a 100kΩ resistor and a .01μF capacitor connected to it. These two components form a power-on reset circuit. Whenever power is applied to the IC, it automatically resets to the zero count. Notice also that the "4" output (pin 10) is connected to the Clock Enable input (pin 13). This means counting ceases once the "4" output goes high.

The "4" output of IC2 is also connected to pin 12 of IC1c by means of a 180kΩ resistor. For the moment, ignore the resistor and assume that the connection is direct. IC1c simply functions as an inverter so that its output (pin 11) is low only after the "4" count has been reached.

Pin 11 of IC1c is connected to pin 9, one of the inputs of IC1d. Pin 9 acts as a control for this gate — whenever it is low, the output (pin 10) will be high. While ever this condition prevails, the lamps will be permanently on.

Until the "4" output (and hence pin 9 of IC1d) goes high, the output of IC1d will be determined by the logic state of it's other input, pin 8. As pin 8 of IC1d is connected back to the inverted clock output (pin 3, IC1b), it now becomes necessary to examine the operation of the clock in detail.

The frequency of the oscillator based on IC1a is set by the 4.7μF capacitor and 330kΩ resistor at about 1.5Hz. During normal operation, the charge on the 4.7μF capacitor will swing over a range equal to the hysteresis voltage. This might typically be between + 6V and +8.5V for a 4093 made by National Semiconductor.

Unfortunately, when the circuit is first powered up, the 4.7μF capacitor must charge from 0V to the normal operating range. This, of course, would mean that the first clock cycle takes much longer than normal.

As we want the accessory lamps to begin flashing as soon as the brakes are used, an extended first clock cycle is undesirable. As a means of preventing it, the capacitor is "fast charged" by an auxiliary circuit. This consists of D1 and the 150kΩ resistor connected to the "0" output of IC2.

When power is first applied the "0" output is high and D1 permits current to flow into the capacitor. Remember, the "0" output will only be high until the

PARTS LIST

1 PCB, code 84au9, 101 × 60mm
1 4-way PCB-mounting terminal block
1 Automotive noise suppression choke (DSE Cat. L-1900)
2 21W automotive stop lamps (see text)

Semiconductors

1 4017 decade counter IC
1 4093 quad Schmitt NAND IC
1 BC547 NPN transistor
1 BD140 PNP transistor
1 2N3055 NPN transistor
2 1N4001 diodes
1 16V/1W zener diode

Capacitors

1 100μF/16V electrolytic
1 22μF/16V electrolytic
1 4.7μF/16V electrolytic
1 .01μF metallized polyester (greencap)
1 .001μF greencap

Resistors (5%, ¼W unless noted)
1 × 330kΩ, 1 × 180kΩ, 1 × 150kΩ, 1 × 100kΩ, 1 × 10kΩ, 1 × 2.7kΩ, 1 × 270Ω/1W, 1 × 27Ω/10W, 1 × 6.8Ω/5W, 1 × 5.6Ω

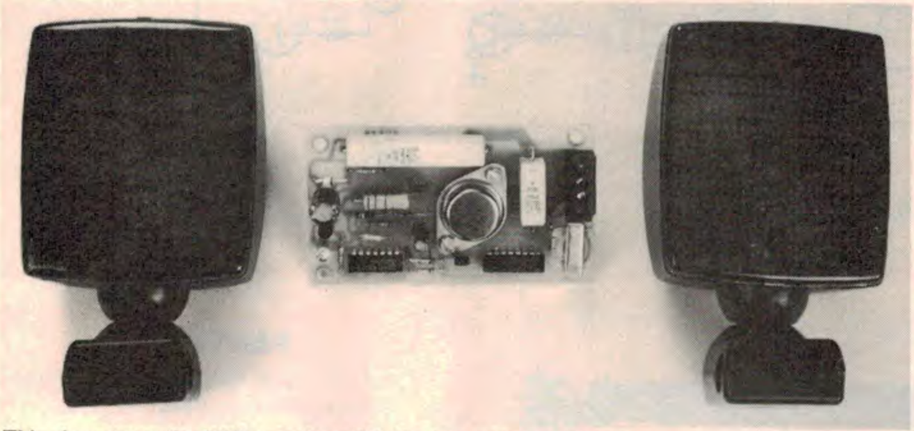
Miscellaneous

Machine screws and nuts, automotive hookup wire, solder etc.

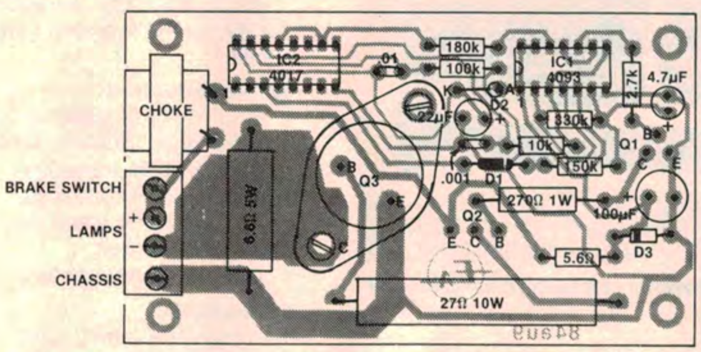
first clock pulse. After that, D1 will be reverse biased and the oscillator operation normal.

The initial power-on conditions for the circuit are such that both the inverted clock signals and the "4" output are low. Following these inputs through ICs 1b and 1c, the output of IC1d will be high and the lamps on. Shortly afterwards when the first clock pulse has been generated, the inverted clock (pin 3,IC1b) output will go high. As the "4" output will still be low, the lamps will now be off. This process will continue, with the lamps flashing, until the "4" output goes high.

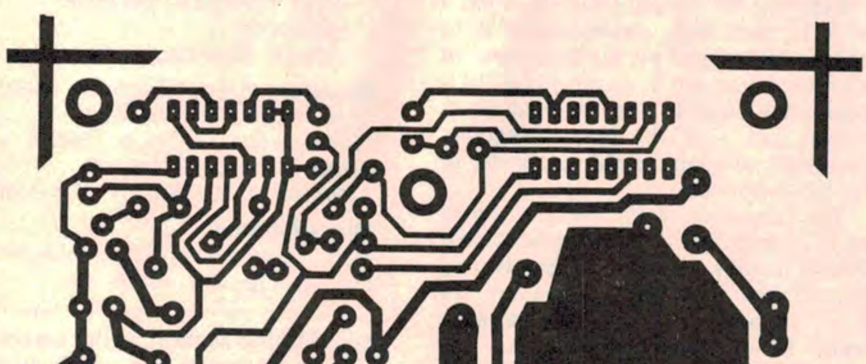
In fact, the lamp will flash 3 times before the "4" output goes high. The fourth "flash" will continue as long as the brake pedal is depressed.



This view shows the PCB together with the two accessory lamps.



Follow this parts placement diagram when wiring up the Brake Lamp Flasher. The suppression choke should be secured to the PCB using epoxy adhesive.



Above is an actual size reproduction of the printed circuit artwork.

As yet, we have not discussed the delay feature of the circuit. Since the "4" output must be high to disable the flasher, it follows this output must stay high during the delay period. Normally, IC2 will reset at power-on, so this would not provide the necessary operation. The solution is really very simple — just maintain the power supply to IC2 for the 5s delay period.

As IC2 is a CMOS type, it uses very little current and can easily be supplied for this period by a capacitor. In fact, this is the purpose of the 22µF capacitor and diode connected to pin 16 of IC2. The diode simply allows the capacitor to charge during normal operation and prevents its immediate discharge when power is removed.

Now the purpose of the 180kΩ resistor connecting the "4" ouput of IC2 to pin 12 of IC1c becomes apparent. It prevents the capacitor from rapidly discharging through the "4" output and the internal protection diodes of IC1. The time constant is virtually determined by the 22µF capacitor and the 180kΩ resistor.

Two other components associated with IC2 should also be mentioned: the 10kΩ resistor and shunt .001µF capacitor at the clock input, pin 14. These are filter components which prevent hash on the clock line from causing mis-counting.

Output stage

As each of the flasher lamps has a maximum power rating of 21W, the output stage for this project must have a nominal current rating of nearly four amps. To achieve this level of drive from the CMOS output, three stages of current gain are needed. The first consists of an NPN BC547 transistor (Q1). This drives a PNP BD140 (Q2) which drives the final stage, an NPN 2N3055.

Current through the 270Ω base resistor of Q2 is about 45mA, which means that this resistor must have a power rating of 1W. Similarly, the 450mA base current of Q3 dictates that its base resistor must have a 10W rating. For periods of extended brake usage, this resistor will become quite hot.

There is another power resistor in the circuit — a 6.8Ω/5W resistor connected across Q3. This is simply a "heater" for the lamps. It maintains a filament current of about 750mA per lamp in the period between flashes. Whenever the lamps are fully on, most of the current flows through Q3 and the 6.8Ω resistor has very little effect.

To prevent ignition and alternator noise from upsetting the logic, we found it necessary to include a noise suppression choke. This is included in the brake switch line to the circuit.

In the event that this choke should fail to suppress some high voltage spikes sufficiently, a 16V zener diode in conjunction with a 5.6Ω resistor will protect the circuit from the damage.

Construction

In contrast to most automotive projects, this one is quite simple to construct and install. We have not mounted the project in a box, so construction simply amounts to soldering the printed circuit board components in place. The PCB measures 101 × 60mm and is coded 84au9.

Location of the board will depend on the type of car, although it should be somewhere towards the rear of the vehicle. This will be close to both existing brake light wiring and the new lights.

Begin soldering with the smaller components, then move on to the larger devices. The suppression choke should be held in place with some epoxy adhesive once its leads have been soldered.

Note that the accessory brake lamps must connect back through the appropriate terminal on the PCB — they cannot simply be connected to the vehicle chassis.

On Commodores and Falcons, where one pair of standard brake lamps can be used as "flashers", a small amount of modification to the vehicle wiring will be necessary. Usually, one pair of lamps will be dual filament — one filament for the tail light and one for the brake light. The other bulb(s) will usually only be single filament types. These are the ones to use with the flasher.

The chassis connection to the single filament bulbs must be broken. A Commodore which we inspected had the single filament brake lamps mounted on a plastic "card" with pressed wiring. This card was shared with the reversing lamp. To use the brake lamp as a flasher, the pressed wiring track will have to be cut. Make sure that the chassis return to the reversing lamp is not broken — you may have to make a new connection after cutting the track.

Once the chassis connection to the single filament bulb has been broken, make a new connection from the bulb to the flasher "Bulb -ve" output on the PCB. The "Bulb +ve" output of the flasher PCB need not be used as +V will be supplied to the bulb by the brake lamp switch in the normal manner.

Testing this project is simply a matter of operating it normally. Due to components tolerances, the flash rate might not be ideal. This can easily be altered by changing the value of the 330kΩ resistor associated with IC1a. Should the initial flash be of incorrect duration, alter the value of the 150kΩ resistor connected to D1.