DESIGNER'S NOTEBOOK

A simple solution to switch debouncing

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SOME OF THE BIGGEST HEADACHES that show up in circuit design have absolutely nothing to do with electronics. That is, after you've spent all kinds of energy in taming electrons, the time comes when you have to connect the circuit to the outside world, and that's when the real trouble begins! Mechanical switching of electronic circuits is always an "iffy" business; and any designer who doesn't know that couldn't possibly recognize the symptoms, much less, solve the problem.

The most common causes of circuit "insanity" is what the data books refer to as *input-signal conditioning* or what the rest of the world calls debouncing. No mechanical switch is perfect, no matter how well it's made. As a result, pushing down on that little red button is going to generate more than one pulse. Any circuitry that's being triggered by that pulse is going to do exactly what it was designed to do—respond to each pulse it "sees."

There are all sorts of schemes to handle the problem. For one, you can use more expensive non-mechanical switches, or simply redesign the front-end of your circuit to respond to only one pulse. But the easiest way is to debounce the switch. There are dedicated IC's that can be used for that purpose but, as with most other things, there's an easier way.

Debouncing circuits

The basic idea behind all switch debouncers is to put some type of isolating circuit between the switch and the circuit being triggered. The job of the extra circuit is to output one (and only one) pulse no matter how many bounces it "sees" from the switch. You can use anything from a flip-flop to a 555 timer (set up as a one-shot), but the problem can be handled a lot easier with inverters.

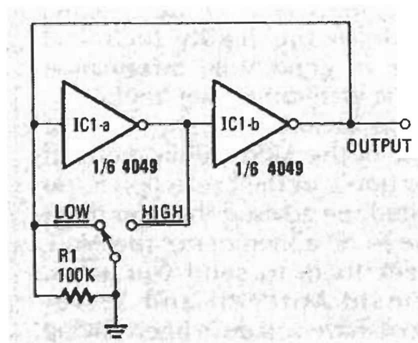

FIG. 1

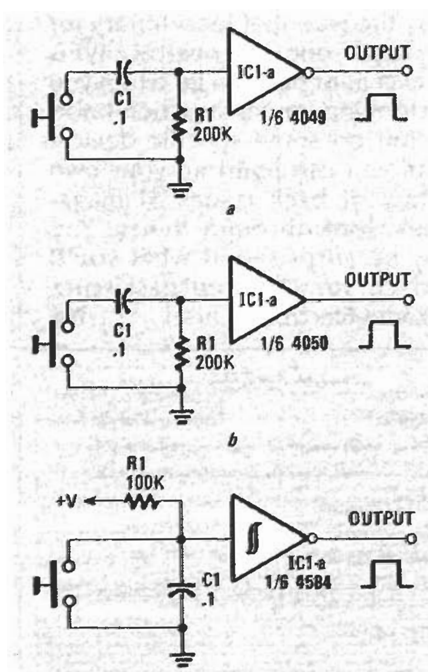

FIG. 2

The most straightforward approach is to build a simple latch like the one in Fig. 1. Throwing switch S1 one way or the other will change the state of the output. Since there's always some period of time during which no connection is made, resistor R1 is added to keep the circuit from glitching when the switch is thrown. That circuit is ideal for applications where you want to switch from one state to another. Even the noisiest single-pole, double-throw switch can be used because the resistor acts as a temporary storage device while the switch is being thrown.

The real problem appears when you want to use momentary (push-button) switches. That's because those switches are notoriously noisy, and if you don't take several precautions, they can screw up the operation of any circuit—no matter how well it's designed. Fortunately, there are two simple circuits that can take care of the problem.

The circuits in Fig. 2 are *half monostables* or edge detectors made from a single gate. The only difference between Figs. 2-a and 2-b are the gates: One is inverting and the other non-inverting. (We'll get to Fig. 2-c in a moment.)

As you can see, the way the circuit responds depends on which end of the supply rail is tied to the resistor. The capacitor integrates the incoming switch bounces and causes the gate to change states. The capacitor then starts to discharge through resistor R1, and the gate (IC1) doesn't change back until its threshold voltage has been reached.

If you're still in the design stage of your circuit, you can add an ex-

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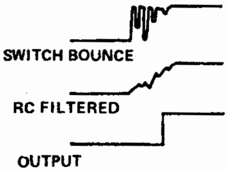
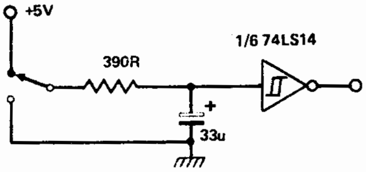
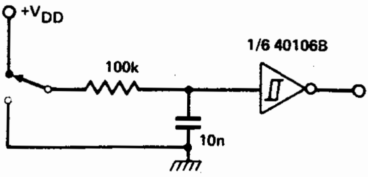
Switch Debouncing Using Schmitt Triggers







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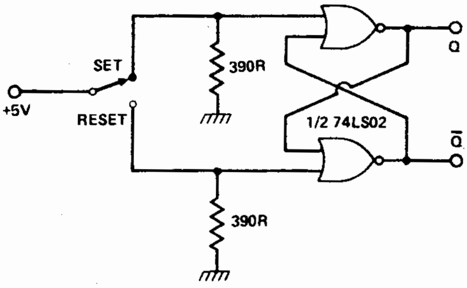
Switch Debouncing Using Flip-flops

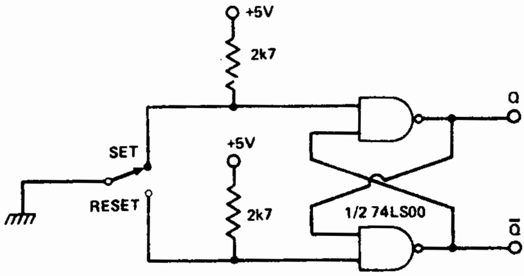
Flip-flop using NOR gates

S	R	Q	$\overline{Q}$
1	0	0	1
0	1	1	1

Flip-flop using NAND gates

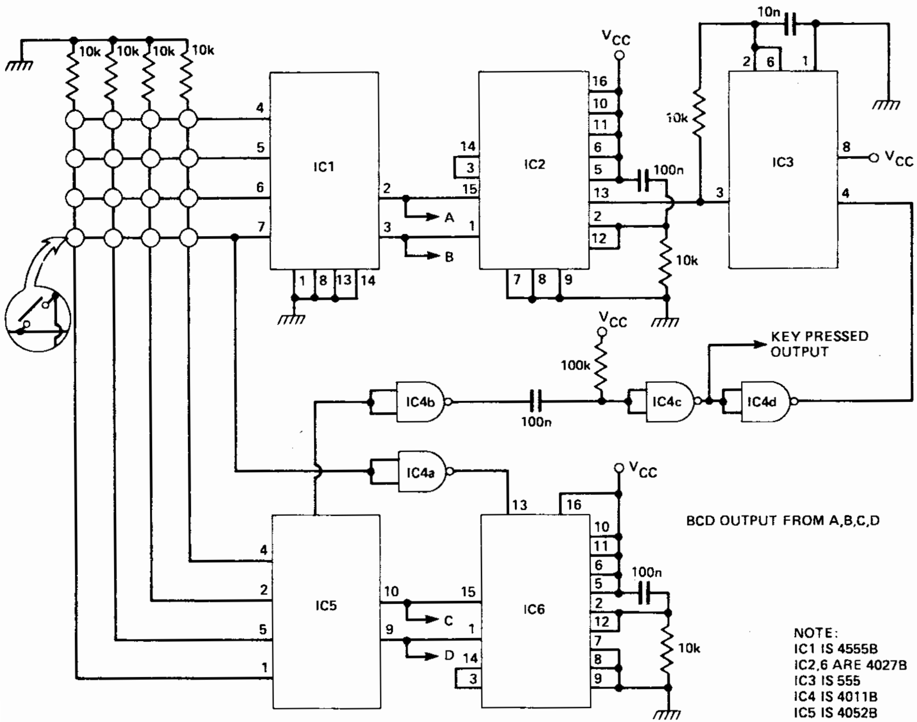
S	R	Q	$\overline{Q}$
0	1	1	0
1	0	0	1





Fully Debounced Keyboard

Graham Kyte



This circuit produces a debounced output whenever a key is pressed. Each matrix point is scanned in turn and the output of the 4052 data distributor goes high when a pressed key is detected. This stops the scanning oscillator (555) for about 10 mS and a 'key pressed' output is produced, thus enabling the BCD output to be stored in a latch or otherwise made use of. The use of CMOS ICs enables current consumption to be minimised, making the circuit suitable for operation in a car. The circuit is easily modified for a larger number of keys by using an eight-way data distributor (with relevent counter made from three j-K flip-flops rather than the two as used here).