Reaction Timer

Actually two projects demonstrating high-speed logic techniques.

By Owen Bishop

Circuits built using integrated circuits have several advantages over circuits built from separate transistors, resistors and other components. They occupy less space, they are simpler to assemble and often cost less too. Another advantage is that most ICs are designed to operate at high speed.

All of these advantages explain why the arrival of low-cost home computers depended upon the availability of ICs. This month we have two projects that depend upon the high speed operation of ICs. The ICs used are not the fastest available but, even so, are more than adequate for the purpose.

Project One – Reaction Timer

The circuit diagram shown in Fig. 1 allows you to measure your reaction time to the nearest tenth of a second. It is an oscillator followed by a counting chain. The difference here is that this circuit is stopped and started under the control of a bistable. In the non-running state the bistable holds the reset input of the 555 timer (IC2) low, so it does not oscillate.

The 7493 binary counter IC3 is first reset by pressing switch S3. All lamps go out. Now your friend presses the "start" button (S1). Instantly the bistable changes state. The reset of the 555 goes high and it begins to produce 10 pulses a second. These are counted by the 7493.

At the same time as counting begins, the light emitting diode (LED) D6 comes on. You should be watching for this and *as soon as you see it come on,* you press the "Stop" button (S2). When you press this, the state of the bistable is reversed, the counter stops counting and D6 goes out.

The count indicated by LEDs D1 to D5 tell you how many tenths of a second elapsed between the instant when your friend pressed the Start button and the instant you pressed the "Stop" button. This is a measure of

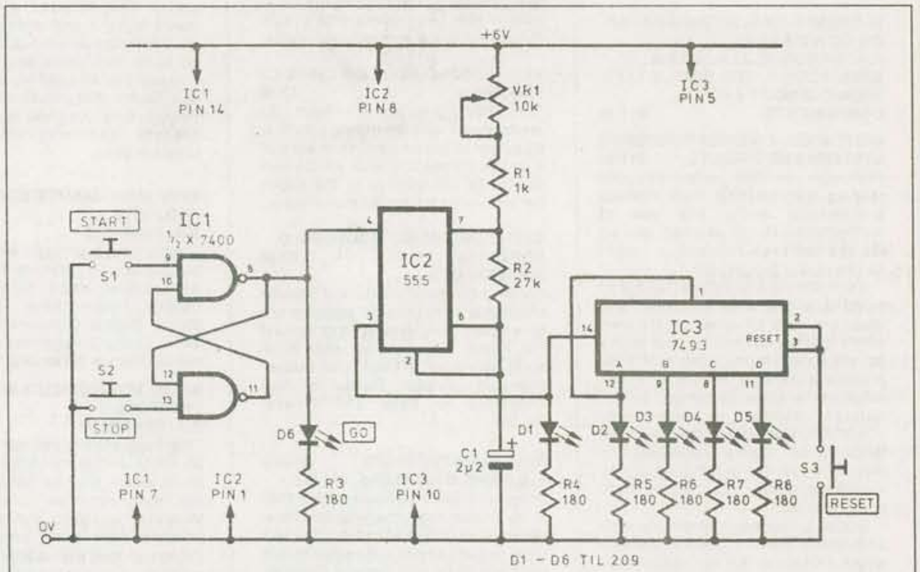


Fig. 1. Circuit diagram for the Reaction Tester using the 555 timer IC.

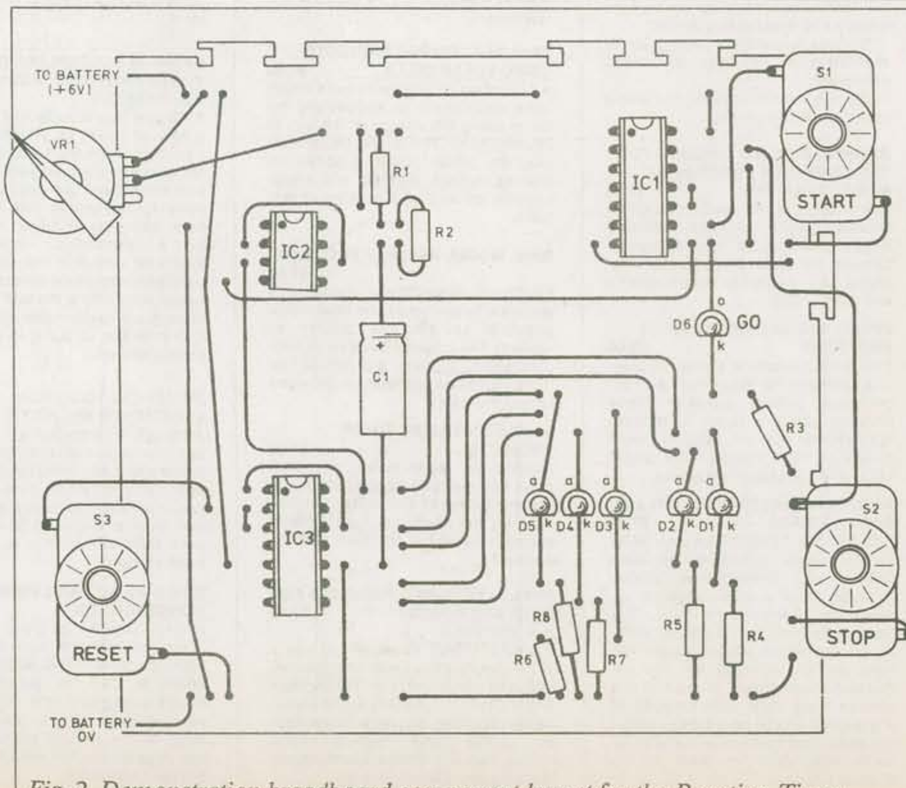
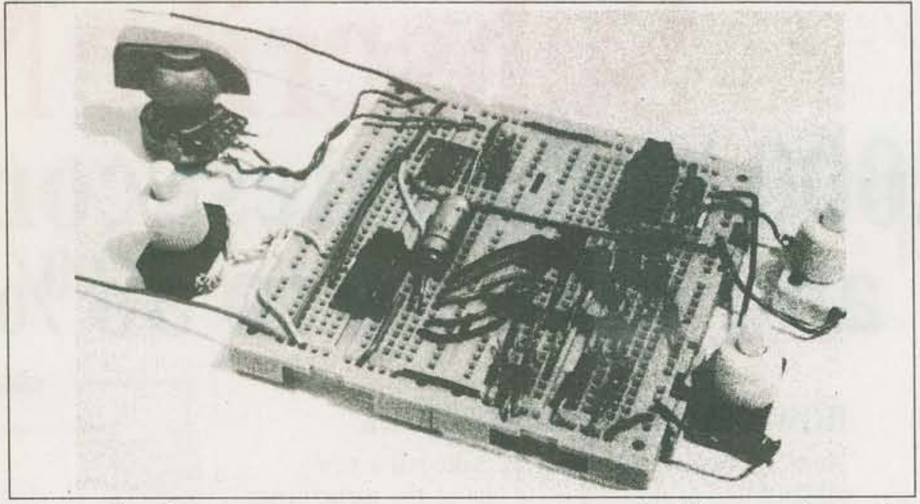


Fig. 2. Demonstration breadboard component layout for the Reaction Timer.



your reaction time.

Construction

The demonstration breadboard component layout for the Reaction Timer is shown in Fig. 2. If possible, place the start button out of sight, so that you can not tell when your friend is about to press it. When the circuit is assembled, let it run steadily and watch the final LED of the sequence. This should go out every 3.2 seconds.

You will need to adjust potentiometer VR1 to make the 555 timer run at the correct frequency. The easiest way is to watch the fifth LED as it goes out. Measure how long it takes to go out 10 times; this should be 32 seconds exactly. Then you know that the count indicated on the LEDs is your reaction time in tenths of a second.

Variation

Here is a problem for you to work on. How can you adapt the timer circuit so that it can be used as a lap-timer for races, for example with model racing cars?

Project Two – Who Was First?

It is all too easy to disagree about who did something first. With the circuit diagrams shown in Fig. 3 there can be no argument – even when one person is only 25 seconds before the other.

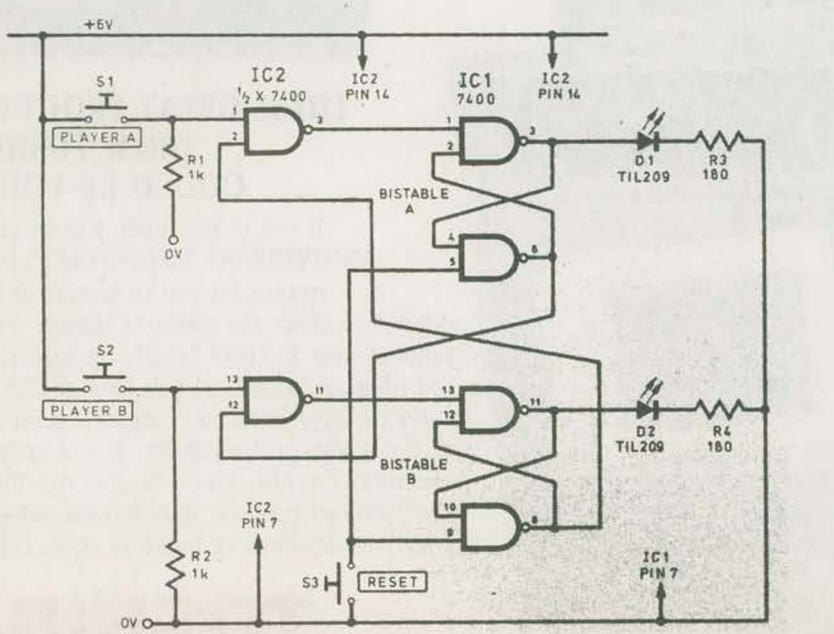


Fig. 3. Circuit diagram for a simple Who Was First using the 7400 quad NAND.

Parts List

Reaction Timer

Resistors
R1 .... 10k
R2 .... 27k
R3-R8 180
All 0.25W 5% carbon

Potentiometer
VR1 10k linear, carbon track potentiometer

Capacitors
C1 .... 2u2 electrolytic

Semiconductors
D1-D6 TIL 209 (or similar) LED
IC1 7400 quad 2-input NAND gate
IC2 555 timer
IC3 7493 4-bit binary counter

Miscellaneous
S1-S3 .... Push-to-make

Breadboard (2 small or 1 large); connecting wire; knob for VR1 and 5V to 6V supply

Who Was First?

Resistors
R1, R2 .... 1k
R3, R4 180

Semiconductors
D1, D2 TIL209 (or similar) LED.
IC1-IC2 7400 quad 2-input NAND gate

Miscellaneous
S1-S3 Push-to-make push-button switch

Breadboard (e.g. Verobloc); connecting wire and 5V to 6V supply.

Since a nano second is only a thousand-millionth of a second, most close ties can be decided easily.

The circuit (Fig. 3) is triggered by push-buttons operated by two players – perhaps they are playing "Snap" or some other game in which it is necessary to know who was first. It could instead be triggered by two phototransistor light sensors and be used in deciding which model car was first to cross the finishing line. For each player there is a bistable, which operates an LED. When the circuit is reset (press S3) and ready for action, both LEDs are out.

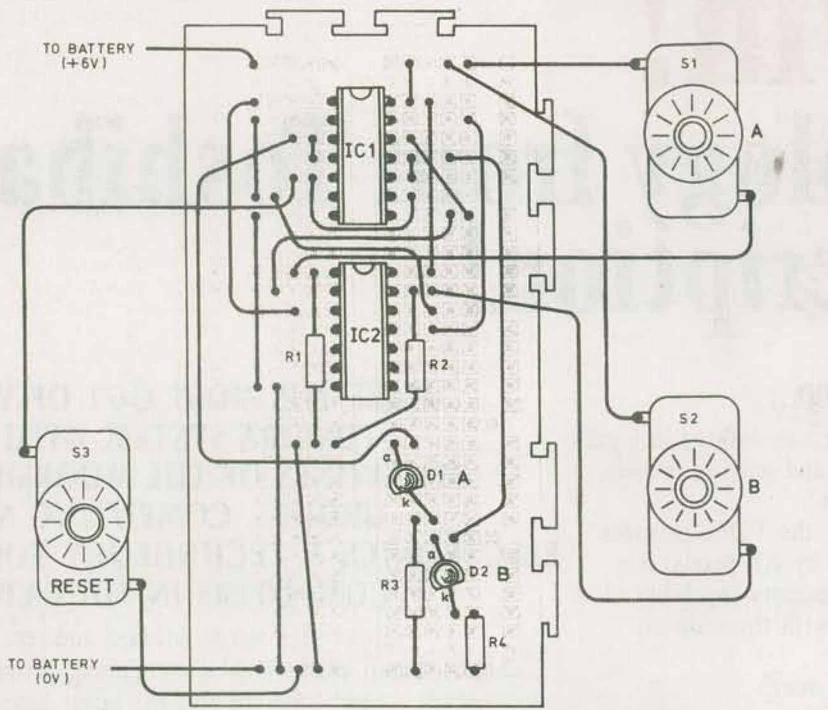


Fig. 4. Demonstration breadboard for the Who Was First circuit.

Between each push-button and the corresponding bistable is a NAND gate. One input to the gate comes from the player's push-button. The other input comes from the bistable *of the opposing player.* Each bistable feeds a "high" input to the NAND gates, so that if the other input is made high, by pressing the button, the output of the gate goes low. This triggers the bistable.

Suppose that player –A changes state and the lamp comes on, to indicate the winner. At the same time a "low" input is fed to the NAND gate belonging to player –B. Now it makes no difference if *B* presses the button or not. The output of that NAND gate is bound to be "high" whatever *B* does and it is impossible for B's bistable to be triggered. If *B* had pressed the button first, then the opposite would apply and *A* would be unable to trigger the bistable. So the lamp lights for whoever was first, and stays lit until the whole circuit is reset.

The demonstration breadboard component layout for the Who Was First? circuit is shown in Fig. 4. Commence construction by inserting all the link wires followed by the on-board components. Finally insert the switch and battery leads. ■