SPECIAL ISSUE: STEREO-4-CHANNEL-HI-FI

75c ■ OCT. 1974

Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

EXCLUSIVE!
BUILD 3-IC SQ DECODER
Full Logic & Wavematching

CD-4 REPORT
How It Works

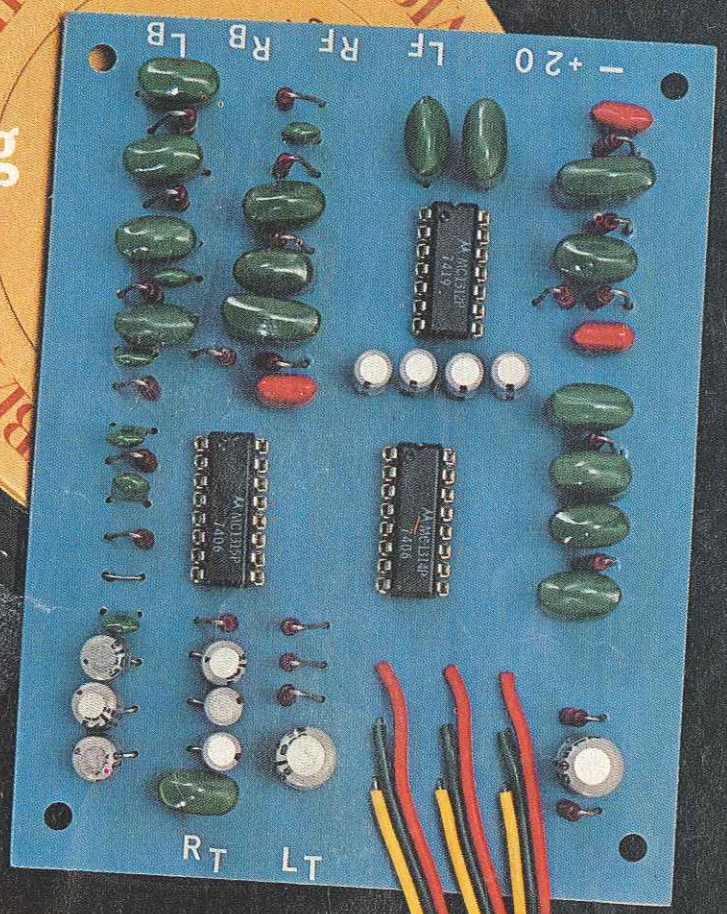
MANY ROADS TO 4-CHANNEL
Which Way Is Best?

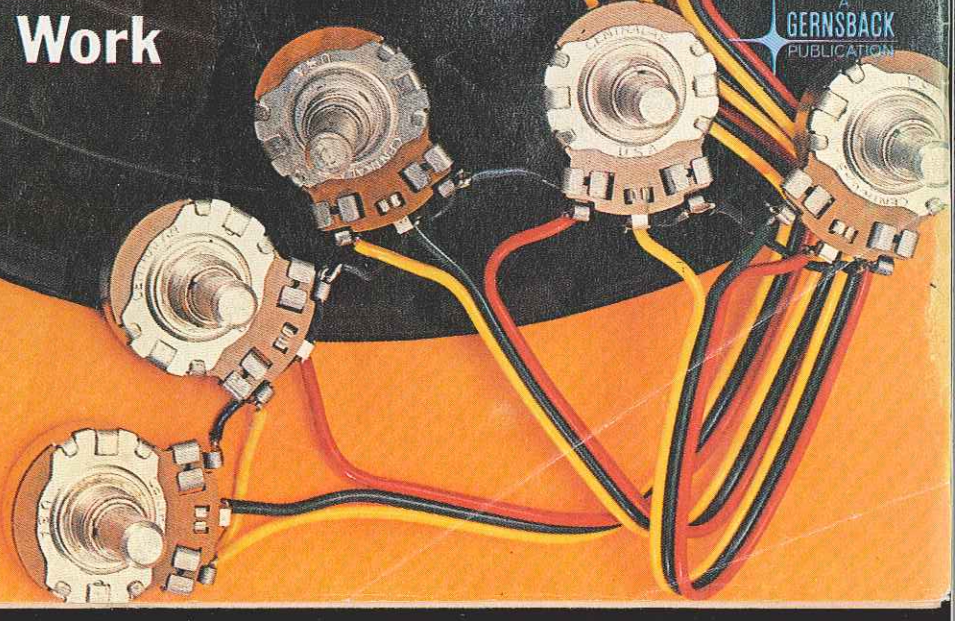
4-CHANNEL SOFTWARE
Who Makes What

LOW NOISE FM STEREO
New Techniques That Work

4-CHANNEL RECORD REVIEWS

R-C COUPLING
In Audio Amplifiers





A GERNSBACK PUBLICATION

4-Channel Software
who makes what?

by HARRY E. MAYNARD

TODAY OVER 50 RECORDING COMPANIES in the U.S. and abroad are producing quadriphonic discs, Q-8 cartridges, and some reel-to-reel tapes. As of June 1 there was a worldwide total of 576 CD-4 discs, 618 QS discs, and 500 SQ discs. Added to this was more than 400 Q-8 cartridges and approximately 100 reel tapes. To buy all this software would cost you well over $10,000. But if you are a typical consumer perhaps the best reason for buying a four-channel system is the considerable increment of improvement you'll get when you play your stereo records, or decode a stereo FM broadcast through any one of the better matrix decoders.

Most buyers of hi-fi equipment on the average invest three to five times as much money in recordings as they do in hi-fi equipment, so no matter how fast sales of quadriphonic equipment grows it will be years before the larger percentage of software available to you and I will be recorded in the quadriphonic mode. Remember it has been 20 years since stereo equipment was first introduced commercially (1954); but after the first four years of stereo there were only 650 stereo tapes and no discs. It was only in the early 60's that stereo discs started to hit the market place from most of the major companies.

In the U.S. the SQ decoded discs leads the pack with over 300 releases from the CBS group, and 17 other licensees of the SQ system. SQ leads in number of releases in the U.S. and also in the commercial popularity of their artists. Available also from Columbia and SQ licensees are 210 Q-8 cartridges. A total of 15 companies have released over 200 titles.

Reel to reel tapes need to be treated separately since they do not have the wide distribution of the disc or Q-8 cartridge. Often sold by direct mail by the manufacturer, sub-distributor or a large tape catalogue house such as Ampex who sells directly to the consumer and acts as a sub-distributor for many companies.

For those dealers and hi-fi buffs who like to make comparisons between various type of quadriphonic discs Project 3 is the single record company that allows you to do so. Project 3 produces many of its discs in two and often three formats, SQ, CD-4, QS. **R-E**

SQ

Columbia Recording Group	Discs	Q-8 Cartridges
Columbia Records	159	133
Epic	17	17
Barnaby	2	2
Monument	5	4
Philadelphia International	7	7
Stax	1	1
Blue Sky	1	1
T-Neck	1	1
A & M Records	1	
Golden Crest Recordings	10	
Capitol Records	7	
Vanguard Recording Society	40	
Ampex Records	2	44
Connoiseur Society	11	
Creative World	4	
Project 3	18	
C.I.T.	6	
Stanyan Records	8	
Audio Fidelity	1	

In Japan and Europe 18 companies have released 200 records. for a worldwide total of 500 SQ discs with considerable box office fire power from these companies:

Japan
Canyon
CBS/Sony
Toshiba
Tro
WB Pioneer

U.K.
CBS Records
EMI

France
Pathe Marconi

The Netherlands
CBS-Artone

Germany
CBS-Schallplatten
Electrola
Ariola
Bellaphon
BASF

Italy
CBS-Sugar

Spain
Iberofon

Czechoslovakia
Supraphon

QS (Regular Matrix)

Over 40 record companies in the U.S. and abroad have released a total of 618 discs, with a total of 334 in the U.S.

	Discs
ABC-Dunhill	100
Black Jazz	10
Audio Treasury	2
Blue Thumb	1
Kilmarnock	1
Longines	60
Ode	4
Ovation	30
Project 3	37
Quad Spectrum	20
RTV	1
Telecast Marketing	7
Alshire	24
BASF	2
Tumbleweed	1
Blueseway	4
Vox	6
Everest	24

Currently there are 49 QS records distributed in Europe from Decca-France and Pye-England.

In Japan 249 QS discs have been distributed by: Techiku, Crown, Nippon Columbia, Toho, King, Polydor Japan, Toshiba, Minruphone.

CD-4

A total of 130 CD-4 discs have been released in the U.S.

	Discs	Q-8 Cartridges
RCA	52	128
Warner Group		
Reprise	2	2
Warner	18	18
Mobil	3	3
Atlantic	8	8
Altco	2	2
Elektra	11	11
Nonesuch	9	
Project 3	23	46
Team Electronic	1	
Mirror Records	1	

JVC has also released for limited distribution in the US via K & M publishing in New York City (142 West 57th St., N.Y., N.Y. 10019) for direct sale in the New York Metropolitan area 59 CD-4 discs. In Japan a total of 303 discs have been released from these companies:

Victor Musical	Toshiba-EMI
Teichiku	Nippon Phonograph
Polydor	(Philips)
Trio-Kenwood	Warner Pioneer

Tapes

Ampex Music Division 2201 Lunt Ave. Elkgrove Village, Ill. 60007	4
Project 3 1133 Avenue of Americas New York, N.Y. 10036	42
Ambiphon Records One Riverdale Avenue Bronx, N.Y. 10463	4
WEA Warner Communication 15 Columbus Circle New York, N.Y. 10023	16

40 PROJECTS

Using COSMOS Digital IC's

Are you up on COSMOS, the latest in solid-state technology? If not, you can learn what it's all about by building these simple circuits yourself. They are useful as well as educational

by R. M. MARSTON

Last month, in part one of this series, we discussed the COSMOS family of digital ICs' and explored its operating characteristics. RCA's CD4001 was introduced as an example of a versatile COSMOS digital IC.

This month we will discuss some practical applications of the CD4001 and look at some bistable multivibrator projects.

Inverters and gates

We have already seen that a NOR gate can be made to function as a simple inverter or pulse amplifier by merely connecting its input terminals together as shown in Fig. 8-a. Note that since only one of the four available gates is used in this application, the input terminals of the remaining three unused gates are strapped directly to ground.

All four gates can be used as inverters, if required, by using the connections shown in the quad pulse amplifier/inverter circuit of Fig. 8-b.

Figure 9-a shows how a CD4001 can be connected as a simple pulse-disabling gate. Here, the signal input is applied to pin 1 and the gating input is applied to pin 2: the output signal is available at pin 3. Normally, with a zero or logic 0 gating input applied, the circuit acts as a simple pulse amplifier and produces an inverted version of the input signal at output pin 3. When, however, a logic 1 gate input is applied to pin 2, the circuit acts like a gate and its output is driven to logic level 0, so the input signal no longer reaches the output. The gate is thus "disabled."

The pulse-disabling gate of Fig. 9-a is intended to work with signal inputs that fluctuate fully between the logic 0 and logic 1 levels. The circuit can be modified for use with low-level input signals by interposing a direct-coupled transistor amplifier between the input signal and the input of the gate as shown in Fig. 9-b. This particular circuit can be used with input signal pulses that vary alternately from less than 200 mV to greater than 1 volt.

Note in the Figs. 9-a and 9-b that only one of the four available CD4001 gates is used and that all input terminals of the remaining three unused gates are strapped to ground.

All four gates can be used as pulse disablers, if required, by using the connections

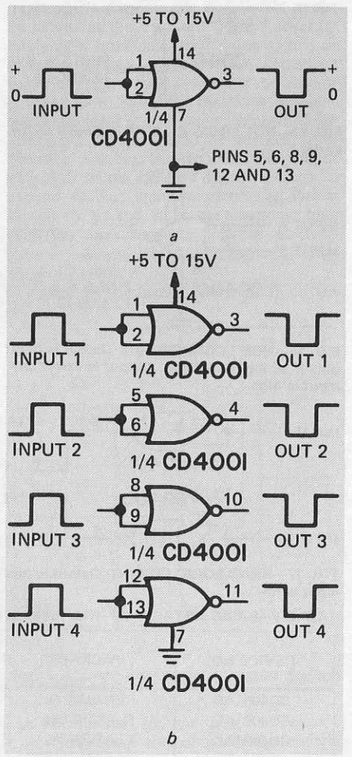


FIG. 8-a—SIMPLE PULSE amplifier/inverter. b—QUAD PULSE amplifier/inverter.

shown in the quad pulse-disabling gate circuit of Fig. 9-c.

The pulse-disabling gate can readily be converted into a pulse-enabling gate which passes signals only when the gating input signal is high or at logic level 1 by simply interposing an inverter stage between the gating input signal and the gate input pin of the disabling gate as shown in Fig. 10. Note that two of these pulse-enabling gate circuits can be built from a single CD4001.

The pulse-enabling gate of Fig. 10 can be converted to an electronically or manually triggered START/STOP gate which starts passing signals at a START command and stops passing them on a separate STOP command by feeding the command signals to the circuit's gate input terminal via a simple bistable multivibrator element. Figure 11 shows the electronically triggered version of such a circuit and Fig. 12 shows the manually triggered version.

The two circuits operate in the same basic way and use the two left-hand gates as a bistable multivibrator and the two right-hand gates as a conventional pulse-enabling network. Normally, the output of the bistable is low or at logic 0, so the pulse-enabling circuit's output is grounded and none of the input signal reaches the output terminal. When the START command is given, the bistable changes state and locks in this new state even when the command signal is subsequently removed.

As the bistable changes state, its output goes to logic 1 so the enabling gate opens and passes the input signals to its output. These signals continue to flow until a STOP command is given, at which point the bistable flips back to its original "logic 0 output" condition and the enabling gate turns off; the input signals then cease to reach the output again. Note that since four gate elements are needed to make a single START/STOP gate, only a single circuit of this type can be built from each CD4001.

A practical application of the START/STOP gate is in a sports-event timer. In this appli-

cation, the signl input is derived from an accurate 1-kHz crystal-controlled oscillator and the gate's output is taken to an electronic counter. The START command signal can be derived from the race starter's gun and the STOP signal can be derived from the photocell of a light beam unit projected across the finishing tape. As soon as the starter's gun is fired, the gate opens and starts feeding 1-kHz pulses to the counter. As soon as the winner reaches the finishing tape and breaks the light beam, the gate closes and the 1-kHz pulses stop reaching the counter. Thus, the number of pulses registered on the counter from the 1-kHz oscillator are equal to the duration of the race to the nearest millisecond. For longer races, the oscillator can be a 1-Hz type, in which case the counter will register the race time in seconds.

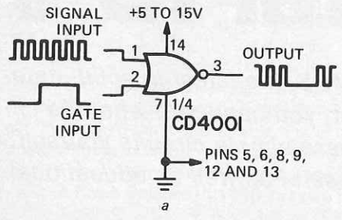


FIG. 9-a—PULSE-DISABLING GATE. b—SAME GATE ADAPTER for use with low-level signal input. c—QUAD PULSE-DISABLING gate.

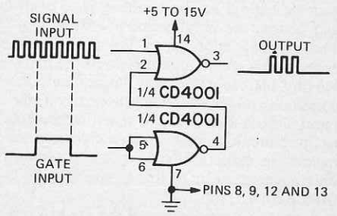


FIG. 10—PULSE-ENABLING GATE.

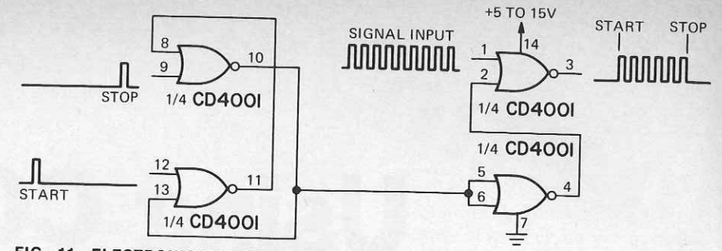


FIG. 11—ELECTRONICALLY TRIGGERED start/stop gate.

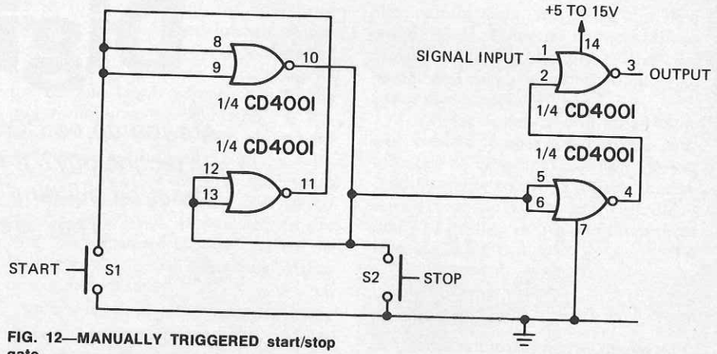


FIG. 12—MANUALLY TRIGGERED start/stop gate.

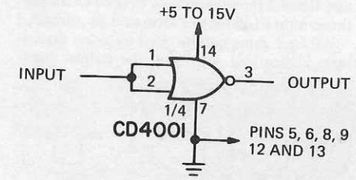


FIG. 13—NOT LOGIC CIRCUIT is simply an inverter.

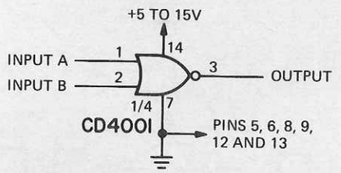


FIG. 14—NOR LOGIC CIRCUIT. Output is high only if all inputs are low. Output is low if any input is high.

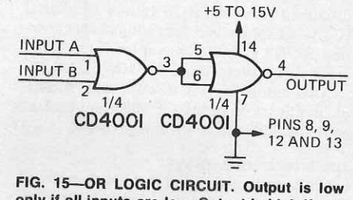


FIG. 15—OR LOGIC CIRCUIT. Output is low only if all inputs are low. Output is high if any input is high.

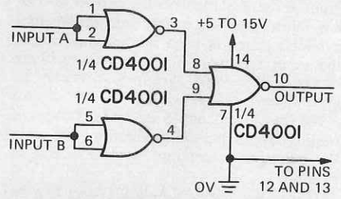


FIG. 16—AND LOGIC CIRCUIT. Output is high only if all inputs are high. Output is low if any input is low.

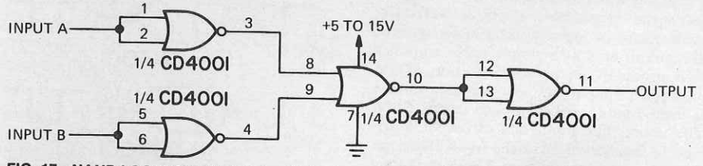


FIG. 17—NAND LOGIC CIRCUIT. Output is low only if all inputs are high. Output is high if any input is low.

TABLE I—BASIC DETAILS OF THE FIVE AVAILABLE TYPES OF CD4001 COSMOS IC

DEVICE NO.	PACKAGE	OPERATING VOLTAGE RANGE	OPERATING TEMPERATURE RANGE
CD4001AD	CERAMIC DIL	3 TO 15V	-55 TO +125°C
CD4001AE	PLASTIC DIL	3 TO 15V	-40 TO +85°C
CD4001AK	FLAT PACK	3 TO 15V	-55 TO +125°C
CD4001D	CERAMIC DIL	5 TO 15V	-55 TO +125°C
CD4001E	PLASTIC DIL	5 TO 15V	-40 TO +85°C

Logic circuits

The CD4001 can be made to function as any one of five basic types of logic circuit. Figure 13 shows how one of the IC's gates can be connected so that it functions as a NOT logic circuit or pulse inverter by simply shorting its two input terminals together as described earlier. Four NOT gates can be built from each CD4001.

Figure 14 shows the connections for making a NOR logic circuit from one quarter of the CD4001. The action of the circuit is such that the output goes high or to logic 1 only when both inputs are low or at logic 0: the output goes low if any input is high. Four NOR logic elements are available from each CD4001.

An OR logic circuit can be obtained from a NOR logic element by simply inverting the output of the NOR element as shown in Fig. 15. The action of this circuit is such that its output is low only when all inputs are low: the output goes high if any input is high. Two OR logic circuits can be made from each CD4001.

Figure 16 shows how an AND logic circuit can be made by inverting each of the two inputs of a NOR logic element. The action of the circuit is such that its output is high only when both inputs are high. The output is low if either input is low. Note that only one AND gate can be made from each CD4001, but that a spare gate element is available as a NOT or NOR logic element.

Finally, Fig. 17 shows how a NAND logic circuit can be made by simply inverting the output of an AND logic element. The action of the circuit is such that its output is low only when all inputs are high: the output goes high if any input is low. Only one NAND circuit can be built from each CD4001.

Bistable multivibrator projects

A simple bistable multivibrator circuit can be made by cross-coupling the inputs and outputs of a pair of NOT or NOR logic gates. Figure 18 shows the practical connections for making an electronically triggered bistable from two NOR gates.

Here, the output of gate A is direct-coupled to one of the input terminals of gate B, and the output of gate B is direct-coupled to one of the input terminals of gate A. The 'spare' input terminal of each gate accommodates an input command signal, and both are normally low or at logic level 0.

To understand the circuit operation, assume initially that the output of the circuit, taken from the output terminal of gate A, is at the low or logic 0 level. In this case, both inputs of gate B are also at logic level 0, so the output of gate B is at logic level 1. Since the output of gate B is direct-coupled to one of the input terminals of gate A, the output of gate A is driven to logic level 0. The output of gate A is thus locked in the logic 0 state by the cross-coupling under this condition.

Suppose now that a positive trigger pulse is applied to the 'set 1' input terminal of the circuit. In this case, the output of gate B drops to logic 0 for the duration of the pulse and under this condition both input terminals of gate A are held at logic level 0, so its output goes to logic 1.

Since the output of gate A is direct-coupled to one input terminal of gate B, the output of gate A is locked in the logic 0 condition. Consequently, the output of the circuit goes to logic 1 as soon as the input 'set 1' pulse is applied, and the circuit then locks into this condition and stays there even when the input pulse ceases to be applied.

Finally, suppose that a positive trigger pulse is now applied to the 'set 0' input terminal of the circuit. In this case, the output of gate A drops to logic 0 for the duration of the pulse and under this condition, both input terminals of gate B are held at logic level 0, so the output of gate B goes to logic level 1. Since the output of gate B is direct-coupled to the input terminal of gate A, the circuit is then locked in this condition, and its output remains at the logic 0 level.

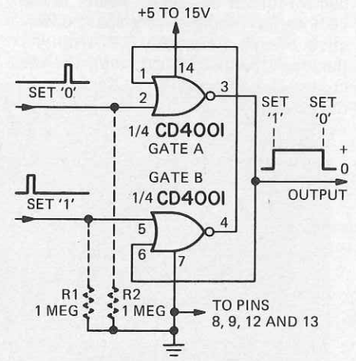


FIG. 18—BISTABLE MULTIVIBRATOR or memory unit.

Thus, the output of the Fig. 18 circuit can be locked at the logic 0 or logic 1 level by applying a brief command pulse to one or other of the two input terminals. Note that these command signals should be direct-coupled from a source that switches between the logic 0 and logic 1 levels: If the command signals are to be derived from 'floating' sources, the pin 2 and pin 5 input terminals of the bistable must be taken to ground via high value resistors, as shown dotted by R_1 and R_2 in the diagram. Also note that two complete bistable multivibrator or memory circuits can be built from a single CD4001.

Figure 19 shows how the Fig. 18 circuit

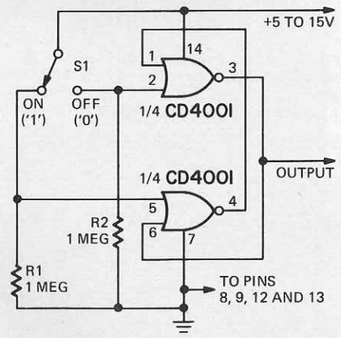


FIG. 19—"NOISELESS" ON/OFF Switch

can be modified for use as a "noiseless" ON/OFF switch. A normal mechanical switch generates a good deal of noise (caused by point bounce, dirty contacts, etc.) when it is used to switch voltage or current, and this noise appears in the form of a series of high-amplitude voltage spikes at the start or end of the basic switching waveform.

If a mechanical switch is coupled directly into a sensitive section of a high-speed pulse generating or counting circuit, therefore, this noise can cause the sensitive circuit to malfunction. This snag can be overcome by using the Fig. 19 circuit to process the normal switching signals. The circuit's state is unaffected by noise, since its state is changed by the first noise pulse that occurs from the mechanical switching action, and cross-coupling then causes the circuit to self-latch and be immune to following noise pulses.

Finally, Fig. 20 shows how a manually triggered bistable can be made by cross-coupling two NOT gates. The operation of the circuit is basically similar to that of Fig. 18: The output of the circuit sets to the logic 1 state when S_1 is momentarily closed, and resets at the logic 0 level when S_2 is momentarily closed. Note that, since both input terminals of each gate are direct-coupled to the output terminals of their opposing gates, the input terminals can be allowed to 'float' without having to be tied to ground via separate resistors.

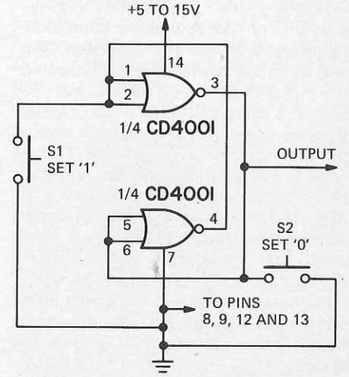
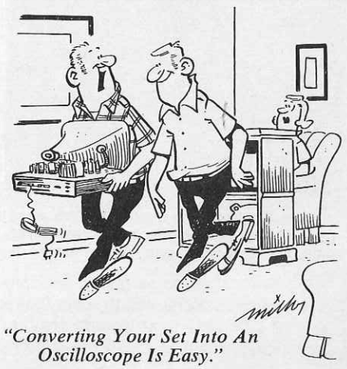


FIG. 20—MANUALLY TRIGGERED bistable multivibrator.

In this second part of this series we discussed some practical applications of the CD4001 IC and looked at bistable multivibrator projects.

Next month we will show the monostable and astable projects, using the CD4001 IC. **R-E**



"Converting Your Set Into An Oscilloscope Is Easy."