QUIZMASTER

Indicates who presses button first.

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LOOKING through the advertisements and brochures of the various electronic component suppliers, one cannot fail to notice the wide availability of logic i.c.s' especially TTL types. For the beginner these can be rather confusing, as the terms used tell the uninitiated little or nothing about the devices, and their functions.

Most of these have been designed for very specialised applications in the computer industry, such as frequency dividers and digital display drivers, and so do not find a very wide use in amateur electronics.

There is however, a family of logic circuits known as "gates", which are more simple than the majority of logic i.c.s, and are suitable for more general use in various switching applications. Because these i.c.s are manufactured in large numbers for use in industry, they are available at very low prices, and thus usually have a cost advantage over alternative types of circuit.

TYPES OF GATE

One factor in common with all types of gate is that they have two or more inputs, and a single output. Both the inputs and the output can be in one of two stable states. Either "high", at a potential of about 3 to 4 volts (often called logic 1), or "low", at a potential of about 0 to 0·5 volts (logic 0). Which of these two states the output assumes is dictated by the combination of states at the inputs, and the type of gate used.

There are four basic types of gate which are known as NAND, NOR, AND, and OR gates.

To show what output state a given combination of inputs will produce for any particular type of gate can be accertained by reference to the relevant truth table. This is merely a table showing the output states of a gate for all the possible input combinations, Tables 1 (a-d) give a truth table for each of the four basic types of gate. These tables are for the more simple type of gate having only two inputs.

The way in which the names of the gates are derived is quite straightforward. For instance, an AND gate is so called as the output is only high when input 1 AND input 2 are high.

A NAND gate is the same as an AND gate, except that with input 1 and 2 high, a low or Negative output is obtained. An OR gate will have a high output with either input 1 OR input 2 high. A NOR gate will have a low (Negative) output with either input 1 OR input 2 high.

These gates are all prefixed with the word "positive", as, with an AND gate for instance, it is when both inputs are positive that a high output is obtained. A negative AND gate has a low output when both inputs are negative. This last complication can be ignored to a certain extent, since one would not normally specify a

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Table I (a): Positive 2-input AND

Input I	Input 2	Output
LOW	LOW	LOW
LOW	HIGH	LOW
HIGH	LOW	LOW
HIGH	HIGH	HIGH

Table I (b): Positive 2-input NAND

Input I	Input 2	Output
LOW	LOW	HIGH
LOW	HIGH	HIGH
HIGH	LOW	HIGH
HIGH	HIGH	LOW

Table I (c): Positive 2-input OR

Input I	Input 2	Output
LOW	LOW	LOW
LOW	HIGH	HIGH
HIGH	LOW	HIGH
HIGH	HIGH	HIGH

Table I (d): Positive 2-input NOR

Input I	Input 2	Output
LOW	LOW	HIGH
LOW	HIGH	LOW
HIGH	LOW	LOW
HIGH	HIGH	LOW

negative gate for a circuit, as if, for example, a truth table were drawn for a negative AND gate, this would be the same as one for a positive OR gate.

Thus the output is low when input 1 AND input 2 are low, and the output is high when input 1 OR input 2 are high. Thus in order to avoid confusion gates are often just termed NOR, NAND, etc., and it is a positive type that is referred to.

Table 2: Positive 3-input NOR gate

Input I	Input 2	Input 3	Output
LOW	LOW	LOW	HIGH
LOW	HIGH	LOW	LOW
LOW	LOW	HIGH	LOW
HIGH	HIGH	LOW	LOW
HIGH	LOW	HIGH	LOW
HIGH	LOW	LOW	LOW
LOW	HIGH	HIGH	LOW
HIGH	HIGH	HIGH	LOW

MULTI-INPUTS

A gate can have any number of inputs, and truth tables can be drawn for multi-input gates. These can be derived in much the same way as for a two input gate.

A three-input positive NOR gate will have a low output if input 1, OR input 2, OR input 3 are high. All three must therefore be low in order to obtain a high output. The resultant truth table is shown in Table 2. Similar truth tables for the other types of gate are not shown as it should be possible (and is a good exercise) for the reader to calculate these for himself.

CIRCUIT DESCRIPTION

The circuit diagram of the Quizmaster (a precedence switching indicator) is shown in Fig. 1. This type of device is used in many television quizzes, where it is necessary to know who was the first person to press a button to indicate that they wish to answer a question.

Such a device consists of a push-button switch

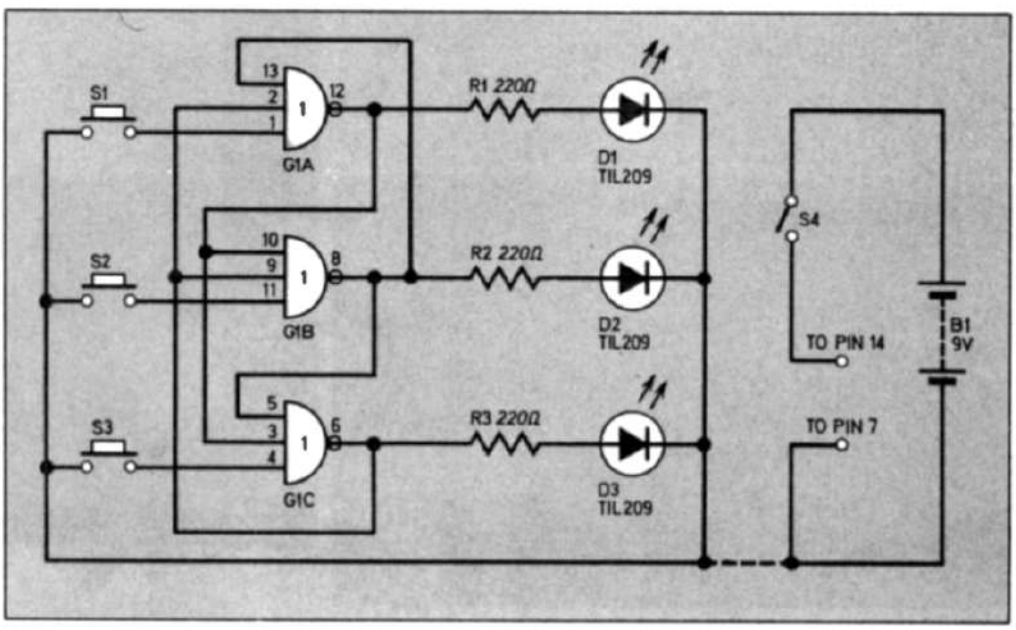


Fig. 1. The complete circuit diagram of the Quizmaster. The three gates, GIA, GIB and GIC are all contained in one package, SN7427.

QUIZMASTER

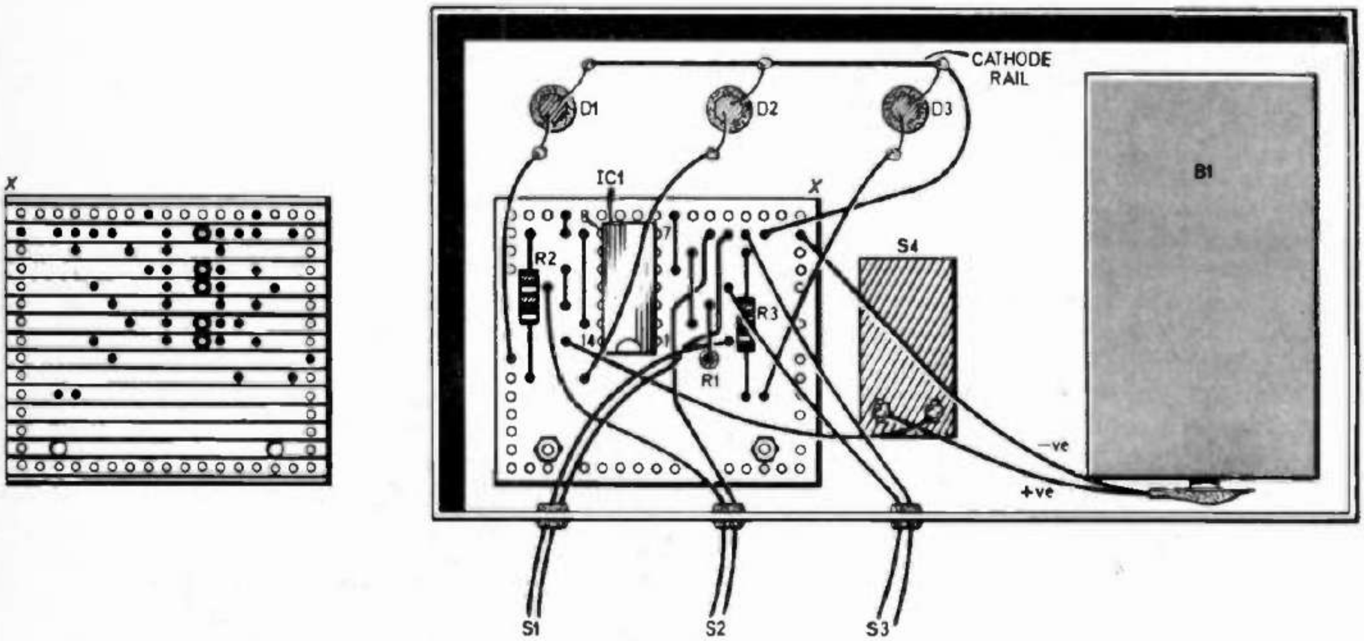
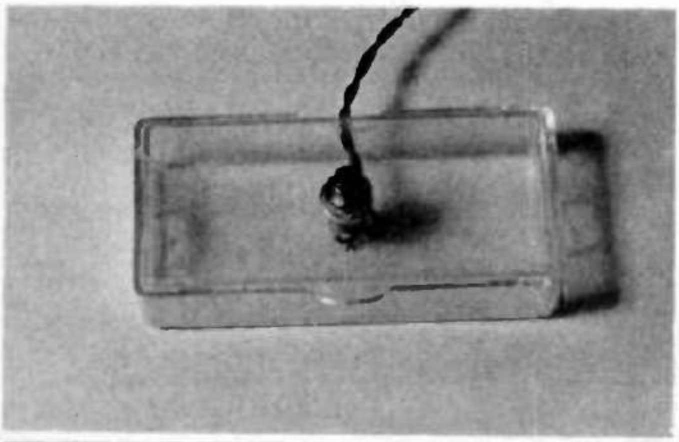
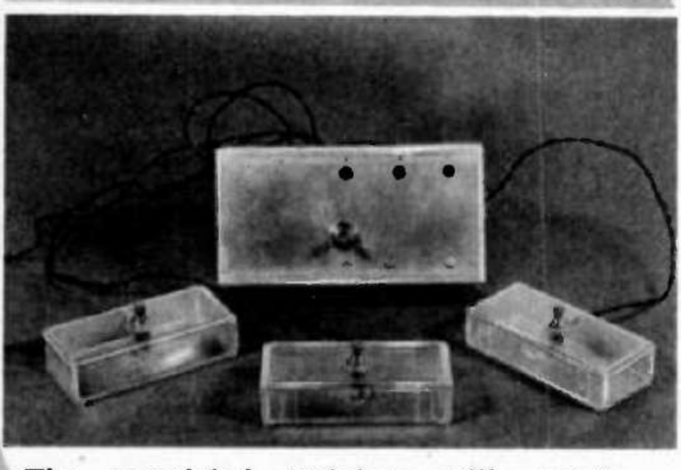


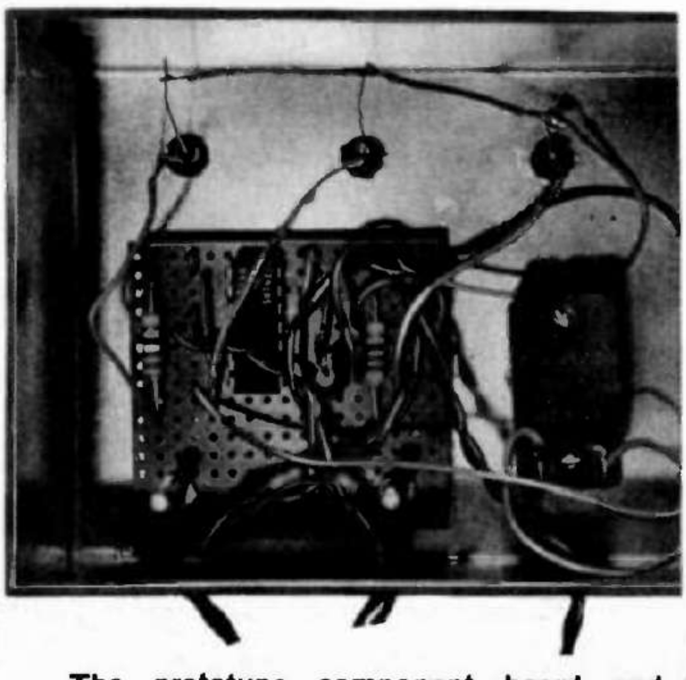
Fig. 2 (above). The layout of the components on the Veroboard and the breaks to be made on the underside. Also shows wiring up details.



Left. Photograph of one of the prototype remote switch boxes.



The completed prototype with remote switches.



The prototype component board and wiring up details.

for each person, each button operating an indicator lamp when pressed. The circuit is arranged so that when one lamp is lit, the others are blocked, and cannot be illuminated by pressing the appropriate switch.

The circuit uses three 3-input NOR gates which are all contained in a single integrated circuit package type SN7427. The output of each gate is taken via a current limiting resistor to a light emitting diode. These diodes are used as the indicator lamps, and will light when the output of the gate which drives them is high.

One input of each gate is connected to a push button switch, one switch per gate. These are operated by the players, and when closed, earth the input to which they are connected. The other two inputs of each gate go one to each output of the other two gates.

When the on/off switch, S4, is closed, the inputs connecting to S1, S2, and S3 will tend to drift to the high state, due to the type of circuitry used in the i.c. This means that all the outputs will be low (see Table 2). The gates now each have one input high, and two which are low, as they are connected to the outputs of the other gates, which are all low.

If one of the switches, say S1, is closed, all the inputs of gate 1 will be low, and the output will go high, causing the lamp to light. This will cause one input of each of the other gates to go high, and even if S1, and S2 are now closed, one input of these gates will still be high, and the lamps will not light. The circuit is not latching, and the lamp will only light while S1 is closed. Therefore to restart the cycle S1 is merely released.

It is worth noting that although a positive NOR gate is specified, and the 7427 i.c. will be advertised as such, this is in fact being used as a negative NAND gate, as a lamp can only light when input 1, and input 2, and input 3 of its gate are low.

Components....

Resistors
R1 220Ω
R2 220Ω
R3 220Ω
All ¼ watt ±10%

SEE SHOP TALK

Semiconductors
IC1 SN7427 triple 3-input NOR gates
D1, 2, 3 TIL209 l.e.d. (with fixing clips) (3 off)

Miscellaneous
S1, 2, 3 push-to-make release-to-break type (3 off)
S4 s.p.s.t. toggle
B1 9V PP3
Veroboard: 0·1in. matrix 17 holes × 15 strips; aluminium case type AB7 or similar; 14 pin d.i.l. socket to suit IC1; battery connectors for PP3; three small cases for remote switches.

CONSTRUCTION

Some of the components are mounted on a piece of 0·1in. matrix Veroboard size 15 strips by 17 holes, the layout is shown in Fig. 2 together with the breaks to be made on the underside.

Begin by making these breaks and drilling the two fixing holes and then position and solder the components to the board as detailed not forgetting the link wires. Ensure that the i.c. is put in the correct way round; there is an indentation between pins 1 and 14. In the prototype no i.c. holder was used but it is strongly recommended that one is used so as to avoid overheating by the soldering iron.

The prototype used a commercially available aluminium case type AB7 size 135×70×40mm with a removable base, although any size and material will do. Prepare the case to accept the components and then secure the latter in position.

The l.e.d.s. used had a grommet-like fixing that is fitted through a hole drilled in the case and the l.e.d. then pushed in. Do not treat the l.e.d.s. as ordinary bulbs, these must be connected with the correct polarity or they will not light and may be damaged. The case is usually marked with a small dot near the cathode (+ve) terminal.

Solder the flying leads to the component board and then wire up to the case mounted components. Attach suitable lengths of wire to the board that are to go to the push button switches S1, 2 and 3 and pass these out through the case in pairs via small grommets.

The component board is mounted by two 6BA nuts and bolts, and spacers are used to keep the copper strips clear of the case.

REMOTE SWITCHES

The three push button switches (push-to-make release-to-break) should now be mounted in suitable size cases of any material but should be robust enough to stand up to a fair amount of handling from excited contestants. Transparent plastic cases were used in the prototype since they were readily available.

Now wire up the three pairs of wires from the master unit, one to each remote switch, passing the wires through a small hole in the side of each case.

TESTING

Thoroughly check out the construction and when satisfied connect the battery and switch on at S4. None of the l.e.d.s. should be illuminated. Press down one of the remote switches and one l.e.d. should light up. With this switch held down depressing the other two should have no effect. Repeat this procedure with the other two switches to obtain the same result. Each l.e.d. should now be labelled the same as the remote switch that turns it on and the unit is ready to use. ▣