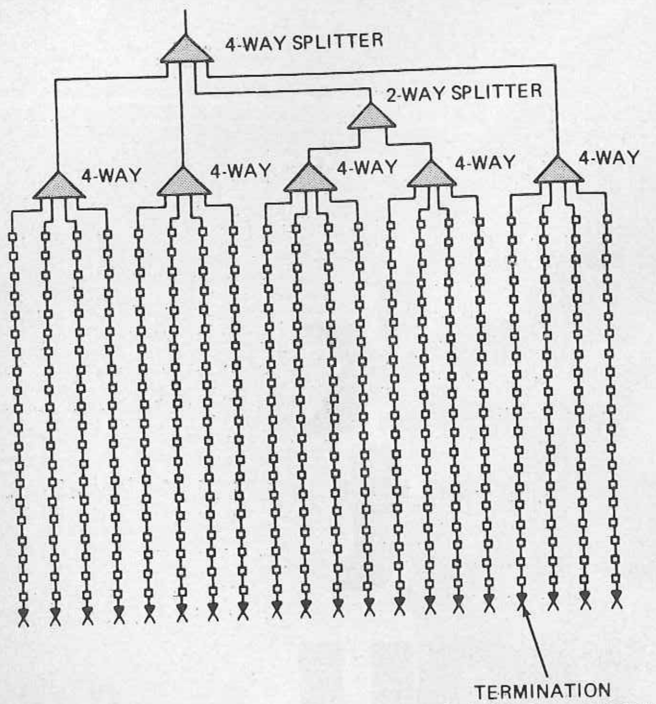


FIG. 5—CABLE AND TAP-OFF LAYOUT in a typical high-rise apartment building. Feeders run vertically from top to bottom.

we can get the right signal levels at the outputs of all the other taps.

To calculate losses, start at the last tapoff in the line, in this case tapoff A.

Going through tapoff A, we immediately encounter 12 dB of isolation. Then, we hit the thru line loss of each of six tapoffs. While thru line loss varies with isolation, we can use an average figure of 1 dB per tapoff, for a total of 6 dB. Next, we encounter the loss of a four-way splitter (8 dB) and the loss of a two-way splitter (4 dB). Finally, we have to add in the loss of the length of cable between the last set in the line and the output of the head end. As indicated in Fig. 4, this cable is about 150 feet.

Cable loss, of course, varies with frequency, as well as the type of cable used. The most commonly used MATV coaxial cables have copper or copper-plated steel center conductors, foam polyethylene dielectric, and aluminum tape shield, covered either by drain wires or aluminum braid. The jackets are generally black polyvinylchloride (PVC).

Three sizes of cable are commonly used, and they have attenuation characteristics approximately as follows:

CABLE	ATTENUATION IN dB/100' CH. 13	CH. 57
RG-59	4.3	7.8
RG-6	3.2	5.6
RG-11	2.5	4.3

RG-59 is used for economy. For most applications, RG-6 is preferred, while RG-11 is used for very long runs. Let's assume that we use RG-6 throughout the remainder of this article.

If it's a vhf-only system, cable loss is always calculated for Channel 13. Even if Channel 9 is the highest channel in the area, it's usually a good idea to design for 13. However, cable loss is a bigger factor at uhf, so we generally design uhf systems for Channel 57, rather than Channel 83, since 90% of all uhf channels in use today are below Channel 57.

The cable attenuation in our example, then, would be 150 feet @ 5.6 dB/100' or 8.4 dB. Let's put all the losses together:

Tapoff Isolation	12 dB
Tapoff Thru Loss (6 x 1.0 dB)	6 dB
4-way Splitter Loss	8 dB
2-way Splitter Loss	4 dB
150' Cable Loss (1.5 x 5.6 dB/100')	8.4 dB
TOTAL DISTRIBUTION LOSS	38.4 dB

We call this sum the *total distribution loss* because it is the amount of loss the head end must be able to overcome. This calculation will help us to choose our head-end amplifier. Using similar calculations, we would determine that the total distribution loss of Fig. 3 is:

Tapoff Isolation	12 dB
Tapoff Thru Loss (12 x 1.0 dB)	12 dB
4-way Splitter Loss	8 dB
2-way Splitter Loss	4 dB
150' Cable Loss (1.5 x 5.6 dB/100')	8.4 dB
TOTAL DISTRIBUTION LOSS	44.4 dB

In a system as large as Fig. 5, it is not cost effective to distribute uhf *on Channel*. UHF channels are converted at the head end to unused vhf channels. Therefore, this system would be calculated at Channel 13 as follows.

Tapoff Isolation	15 dB
Insertion Loss (20 x .6 dB)	12 dB
4-way Splitter Loss	7.0 dB
2-way Splitter Loss	3.5 dB
4-way Splitter Loss	7.0 dB
250' Cable (2.5 x 3.2 dB/100')	8.0 dB
TOTAL DISTRIBUTION LOSS	52.5 dB

Head ends

The job of the head end is to pick up TV signals, remove interference and provide enough signal output to overcome the total distribution loss. This brings us to the question, "How much signal does a TV receiver need?" The answer, of course, varies with the TV receiver. A set with a "hot" front end can get along with less signal than an old set with weak tuner tubes. More signal is required for color than for black and white. The MATV industry has pretty much decided on 1000 millivolts across 75 ohms as the standard *minimum* signal. This minimum can also be expressed as 0 decibel millivolts, abbreviated to 0 dBmV. 0 dBmV is equal to 1000 microvolts.

The head end must supply enough signal voltage to deliver *at least* 0 dBmV of signal on every channel to every set connected to the system. Fig. 6 shows the simplest type of head end, consisting of a broadband antenna and a broadband amplifier. This type of head end will fit many installations. If all channels are broadcast from the same direction, at about the same power, this type of installation is convenient and economical.

All you have to do is to decide what antenna and what amplifier to use. Some installers use ordinary home TV antennas for small MATV systems, but this is not recommended. Use heavy-duty, professional-quality antennas. Much more rugged than home antennas, they deliver better picture quality over a longer period of time.

In choosing a head-end amplifier, two specifications are vitally important: output capability and gain.

The desired output capability of the amplifier is determined by the total distribution loss. For example, if you have a system like Fig. 4 with total distribution loss of 38.4 dB, you need an amplifier that can put out at least 38.4 dBmV without distortion. (38 dBmV means 38 dB above 1 millivolt, or approximately 80 millivolts *per channel*).

Amplifier gain required is determined by the difference

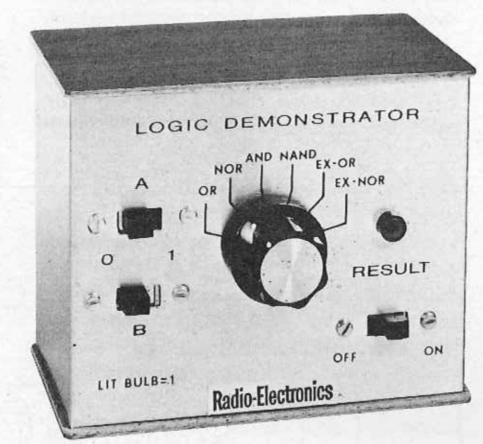
(continued on page 97)

BUILD R-E'S LOGIC DEMONSTRATOR

Simple demonstrator shows how the six most common logic functions operate

by DON LANCASTER

HERE'S A SIMPLE PROJECT THAT SHOWS you the basics of OR, NOR, AND, NAND, EXCLUSIVE OR and EXCLUSIVE NOR logic functions. You can use this as a personal study aide, as a teaching demonstrator, as a science fair project, or as a school lab project. It's also a dandy first TTL (Transistor-Transistor Logic) project, showing you the basics of mounting, supplying, decoupling, and visually indicating states with TTL. Kits for this project are commercially available.



About logic

Logic is the fundamental language of the digital world of computers, calculators, digital instruments, and digital electronics in general. It is one way machines have of talking with each other or with humans, and it is the way they are taught to provide the correct responses for a given set of input situations.

The most common logic in use today has two possible conditions or *states.* These states are ON or OFF, YES or NO, or, in digital language, a **1** or a **0**. Logic is simply a set of rules of what a circuit, called a *logic block,* will do. A logic block will provide either a **1** or a **0** in predetermined response to a specified collection of **1**'s and **0**'s at its inputs. Enough logic blocks taken together provide the memory for a computer, the answer for a calculator, or the counting for a digital voltmeter.

The *Logic Demonstrator* uses a TTL integrated circuit. When using TTL, it is common to call a **0** a voltage very near ground or 0 volts and a **1** any voltage between +2.4 and +5 volts. This is called a *positive logic convention* and is often, but not always, used with TTL.

A TTL logic block *accepts* **1**'s and **0**'s at its inputs and then *provides* new **1**'s and **0**'s at its outputs in response to a predetermined set of logic rules it has been trained to respond to.

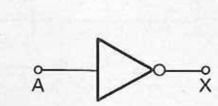
One-input logic blocks

The simplest useful logic block would have one input and one output. The output could be taught to do any of *four* possible things: It could *ignore* the input and always put a **1** out; it could *ignore* the input and always put a **0** out; it could *follow* the input and put a **1** out when the input is **1** and a **0** out when the input is **0**; or it could *complement* the input, and put a **1** out when the input is **0** and a **0** out when the input is a **1**.

The first two possibilities are patently worthless, while the third would be useful only if we were increasing the drive capability or something else rather special. Thus only the fourth possibility is genuinely useful. We call a one input, one output logic block that complements its input an *inverter.*

Logic people have a way of building up a little chart that lists what a logic block will do. This chart is called a *Truth Table,* and it lists the output response you will get for every possible combination of every possible input. With an inverter, there is only one input, and it can only be a **1** or a **0**. The truth table looks like this:

INVERTER	
A	X
0	1
1	0



Inverters are used whenever we want to generate the complement of a logic signal. They are sometimes also used to increase the drive capability of a logic system.

Two-input logic blocks

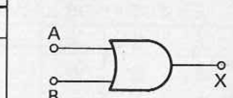
Logic blocks with two inputs and one output are far more versatile than single inverters, for they may be used in combination to build up *any* logic function, however complex, from the simplest NAND gate to the biggest computer memory. With the two-input logic block, there are four possible input conditions—**00**, **01**, **10**, and **11**. The output can be anything we teach the block to do, with a **1** or a **0** cropping up in any of the four output slots.

Some thought will tell you there are *sixteen* different ways we can teach or program the logic block. Of these, six ignore at least one input and thus are essentially worthless. Four others are rather specialized and thus see little use. The remaining six logic block programs, called the OR, NOR, AND, NAND, EXCLUSIVE OR, and EXCLUSIVE NOR blocks are the workhorses of digital logic, and, together with the inverter, give you a stock of seven basic logic blocks with which any digital machine can be built up.

OR function

The OR function gives you a **1** out for a **1** in on *either or both* inputs:

OR		
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

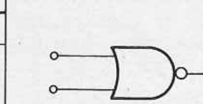


It is used any time we want to verify the presence of a **1** on any input.

NOR function

The NOR gives you a **0** out for a **1** in on either or both inputs. One way to build it is to follow an OR gate with an inverter. Its truth table looks like this:

NOR		
A	B	X
0	0	1
0	1	0
1	0	0
1	1	0



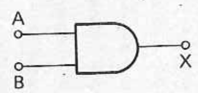
It's usually used anytime we want to stop something from happening if a **1** shows up on any input.

AND and NAND

The AND function needs a **1** on *both* inputs to get you a **1** out, while a NAND is a AND plus inverter that gives you a zero out for **1**'s coincident on the input. The truth tables look like this:

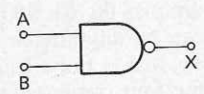
AND

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1



NAND

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0



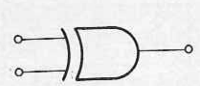
The AND is used to detect a *coincidence* of **1**'s at its inputs; NAND is used to stop something from happening at the coincidence of input ones. Two NAND gates back-to-back form a set–reset flip-flop, or the most basic digital storage element.

EXCLUSIVE OR and NOR

The EXCLUSIVE OR gives you a **1** out if *one but not both* inputs have a **1** on them, while the EXCLUSIVE NOR gives you a **0** for one but not both inputs being a **1**. Looking at it another way, the EXCLUSIVE NOR gives you a **1** out if the inputs are *identical* and a **0** if they are *different*:

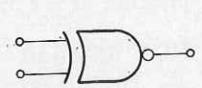
EXCLUSIVE OR

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0



EXCLUSIVE NOR

A	B	X
0	0	1
0	1	0
1	0	0
1	1	1

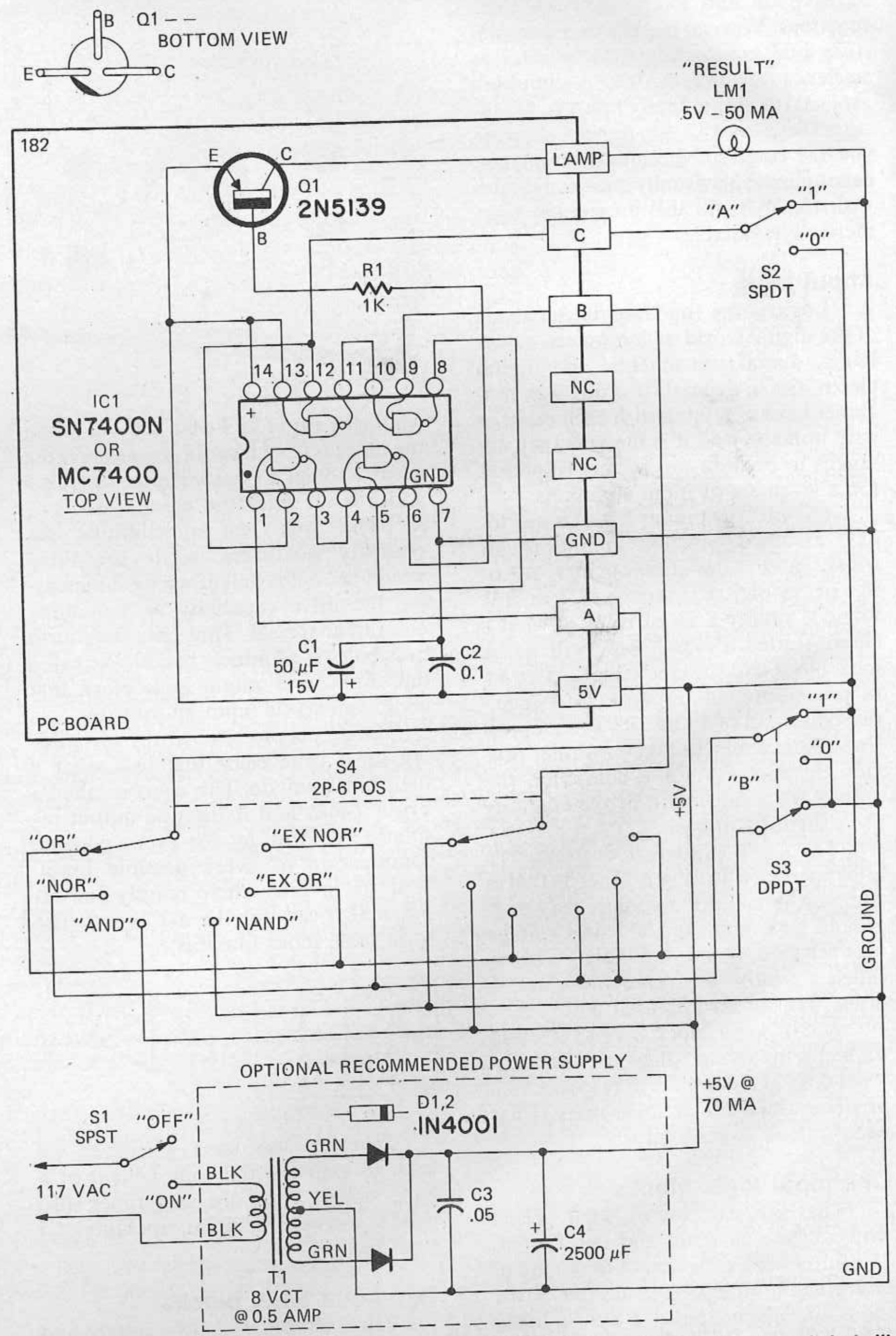


The EXCLUSIVE OR circuit is used to perform binary arithmetic. When doing this, it goes by the name of a HALF ADDER. Two half adders and an inverter can perform binary addition, and thus EXCLUSIVE OR circuits are the cornerstone to digital computation. The EXCLUSIVE NOR is also called a COMPARATOR, for it lets you *test* to see if inputs are identical or different. It is used in coincidence and counter circuits.

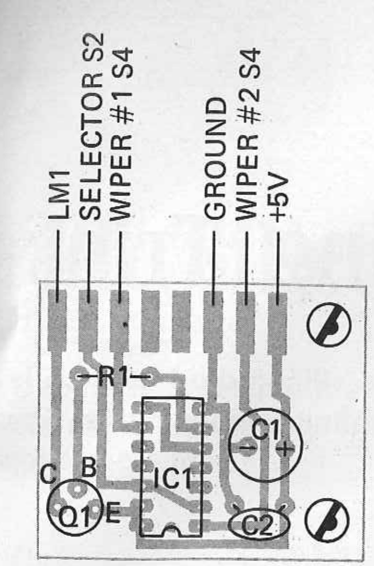
PARTS LIST

C1—50 μF, 15V, electrolytic
C2—0.1 μF, 10V, disc ceramic
*C3—.05 μF, mylar or disc ceramic
*C4—2500 μF, 10V, electrolytic
*D1,D2—1 amp, 50 PIV, power diode: 1N4001 or equal
IC1—SN7400 or MC7400 TTL Quad Two-Input Gate
LM1—5V, 50 mA, pilot lamp assembly
Q1—2N5139
R1—1000 ohms, ¼ watt
S1—spst slide
S2—spdt slide
S3—dpdt slide
S4—2-pole 6-position non-shorting selector switch (Mallory 3226J or equal)
*T1—primary, 117Vac; secondary, 8Vct, 0.5A transformer
MISC—1⅜″ x 1⅝″ PC Board (see text); PC Mounting brackets; switch hardware; ¾″ knob; walnut and gold colored case, bottomplate and endplate assembly, prepunched and prefinished; mounting feet (4); wire; solder; line cord and strain relief*; terminal strip*; power supply hardware*; wire nut*; etc. . . .

NOTE: The following parts are available from Southwest Technical Products, 219 W. Rapsody, San Antonio, Texas, 78216: Etched and drilled PC Board No. 182, $3.00 Complete kit of all parts less power supply No. 182K, $8.25 Power supply components (* above) No. 182PS $4.25 postpaid in US.



COMPLETE SCHEMATIC OF THE LOGIC DEMONSTRATOR. You will note that the unit is built around a single IC and its functions are switch selected.



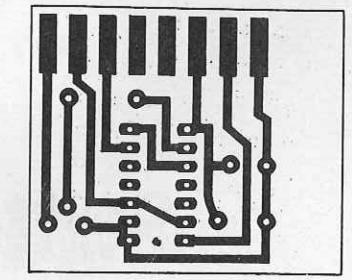


FIG. 2—FULL-SIZE FOIL PATTERN above is the circuit board you need for your own logic demonstrator. Use this pattern as is.

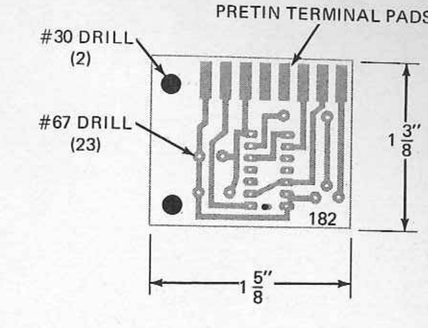


FIG. 3—DRILLING GUIDE (top right) shows drill bit sizes to make proper size holes in the circuit board.

FIG. 4—PARTS LAYOUT (left) on the circuit board. All connections are shown actual size.

Build a demonstrator

The schematic is shown in Fig. 1. A small printed circuit board is recommended to support the TTL logic gate and lamp driver transistor. You can buy this item commercially, or you can build one following the layout of Fig. 2 and the drilling guide of Fig. 3. Components are located per Fig. 4. Watch the polarity on C1 and the IC, and be sure to use a small soldering iron and fine solder for assembly.

The photos and Fig. 1 should serve as an assembly guide. The PC board mounts on two brackets above S2, and interconnections are soldered directly to the terminal pads on the PC board.

It is best to check the circuit out function by function as you progressively wire S4 to prevent any possible switch wiring errors. Use the truth tables to verify operation.

The circuit may be powered by a 4½ volt battery, a 5 volt, 100 mA bench supply, or the recommended power supply shown in Fig. 1. The recommended supply may be assembled inside the bottom of the case for trouble free line operation. **R-E**

makeshift ac wattmeter

Just the thing for ac power measurements when accuracy and convenience do not warrant a lab wattmeter.

by George Lennie

In the March 1971 issue, Jack Darr presented valuable information on using a wattmeter when servicing home appliances. I have a makeshift wattmeter that was originally made up to check the current consumption of an automobile block heater. Its basic operation is illustrated in Fig. 1.

A low-resistance power resistor (R) is inserted in series with the line and the load. By measuring the voltage drop across R, we calculate the load current from I = V1/R and load wattage from W = I x V2. The wattage calculation is approximate—neither impedance nor power factor have been considered—but is sufficient to indicate whether power consumption is much out of line.

A 1-ohm, 25-watt resistor was mounted in a surface-type outlet box along with a parallel-ground duplex receptacle. Leads from the ends of the resistor are brought out to a terminal strip as in Fig. 2. (Both meter terminals are "hot" to ground and present a shock hazard. Insulated binding posts or jacks in the side of the outlet box will be safer.—*Editor*) A 3-wire cable and plug complete the wattmeter adapter. A Heathkit audio voltmeter is used since it can indicate very low ac voltages. The line voltage drop due to the resistor is small and can be ignored in most instances. **R-E**

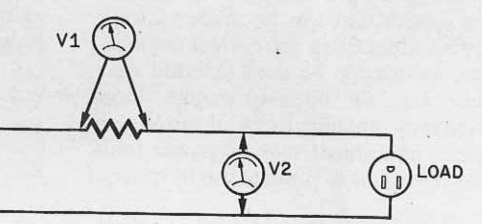


FIG. 1

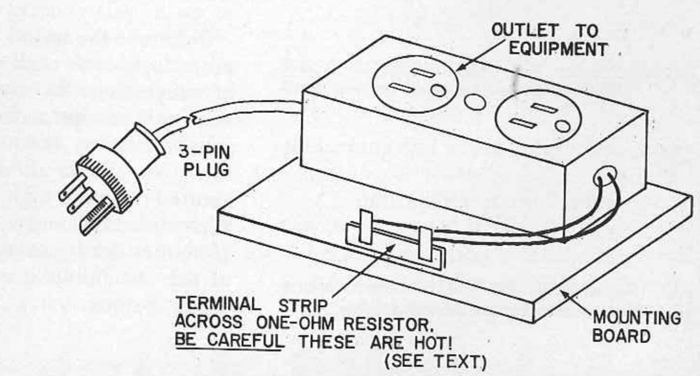


FIG. 2