Designer's casebook

Logic-function generator needs no power supply

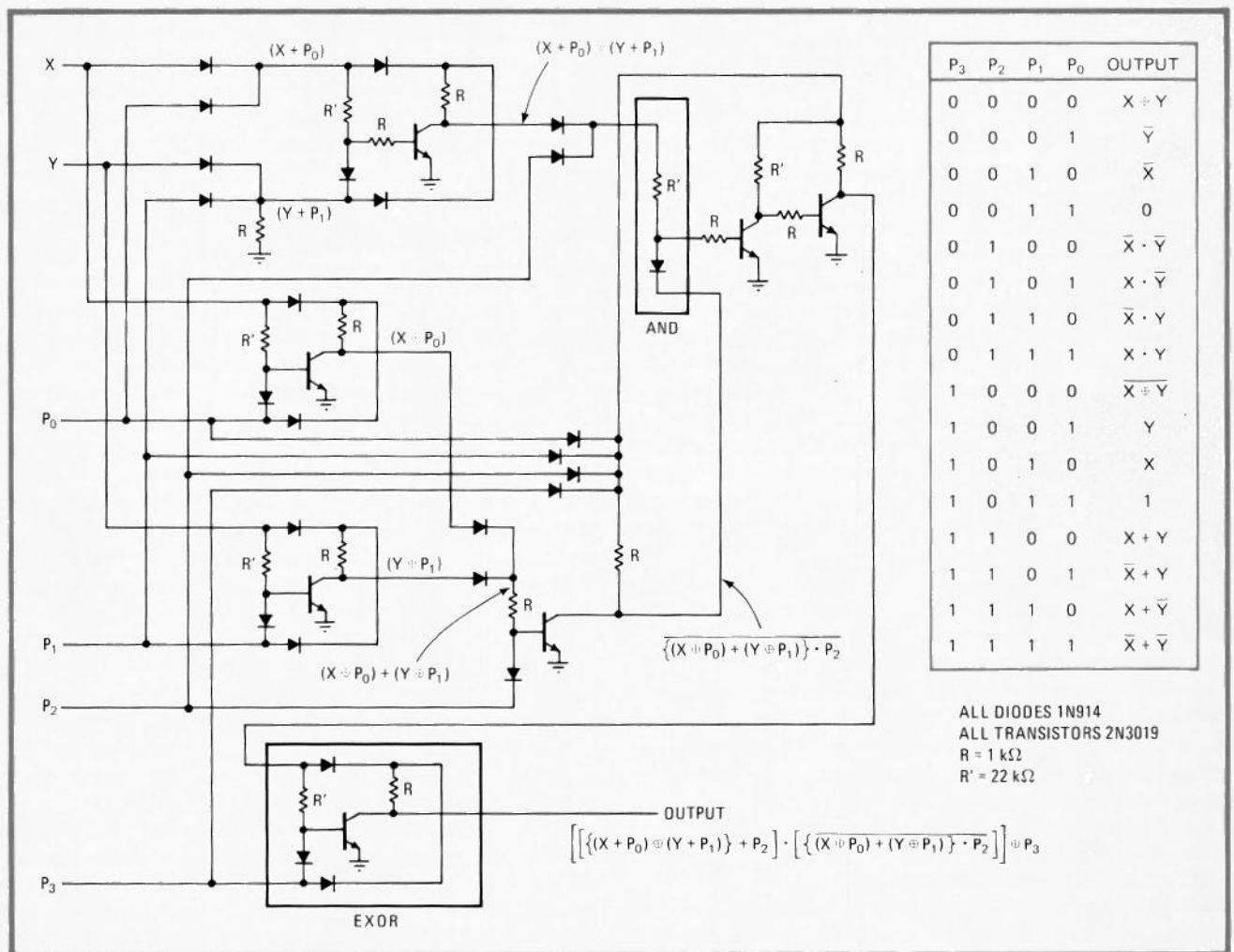by P. R. K. Chetty, *Department of Electrical Engineering, California Institute of Technology, Pasadena*

When the same logic and control signals that drive this generator are also used to power it, 14 functions of two input variables are generated without the benefit of a bona fide supply. Consequently, dc power is conserved, and the physical size of the generator is also reduced. It is only necessary that each input signal be able to provide a minimum average current of 15 milliamperes at 5 volts to energize the generator.

Given input variables X and Y, the generator (see figure) will derive most of the popular logic functions of both when ordered by control inputs P_0–P_3. A logic 0 and logic 1 output can also be generated.

The X and Y signals are applied to one or more of three exclusive-OR gates and directly combined with three of the P lines, as shown. Each of the exclusive-OR gate outputs is combined in various ways with the aid of one AND and one OR gate so that the general logic function appearing at the output of the fourth exclusive-OR gate is denoted by the Boolean expression shown. By suitable choice of the logic value of the P_i terms (see table), the desired logic function will be generated.

Although discrete transistors, resistors, and diodes are used, the circuit can easily be condensed into a four-chip device using a transistor array, such as the CA3081, resistor arrays (Beckman 898-3) and a diode package (LM3039). In either case, the circuit will be compatible with TTL, although the unit will accept and generate a wide range of voltages, corresponding to the magnitude of the driving signals. □

P_3	P_2	P_1	P_0	OUTPUT
0	0	0	0	$X \div Y$
0	0	0	1	$\bar{Y}$
0	0	1	0	$\bar{X}$
0	0	1	1	0
0	1	0	0	$\bar{X} \cdot \bar{Y}$
0	1	0	1	$X \cdot \bar{Y}$
0	1	1	0	$\bar{X} \cdot Y$
0	1	1	1	$X \cdot Y$
1	0	0	0	$\overline{X \div Y}$
1	0	0	1	Y
1	0	1	0	X
1	0	1	1	1
1	1	0	0	$X + Y$
1	1	0	1	$\bar{X} + Y$
1	1	1	0	$X + \bar{Y}$
1	1	1	1	$\bar{X} + \bar{Y}$

ALL DIODES 1N914
ALL TRANSISTORS 2N3019
R = 1 kΩ
R' = 22 kΩ

Signal power. X-Y driving logic, and control signals that select 1 of 16 possible outputs (see table) simultaneously provide power for function generator. All inputs should be capable of providing at least 15 mA to circuit, which uses wired-AND, OR, and EXOR gates throughout.