Gottlieb ON TARGET

TECHNICAL NEWSLETTER VOLUME 3, ISSUE 1 DECEMBER 1981/JANUARY 1982

SWITCH MATRIX (PART ONE)

The switch matrix of a pinball (flipper) game is a network of switches that allow the control board to monitor the conditions of sixty-four (64) switch positions while only using sixteen strobe and return lines, (See Figure 1).

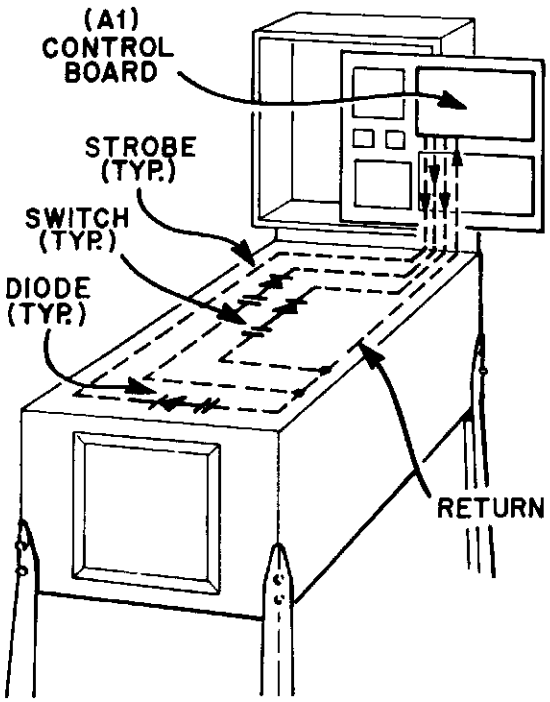

Figure 1.

All gold-plated playfield switches (except the pop-bumper cup switch; see volume 2, issue 2, Feb. 1981), the front door switches (except the slam switch), and the tilt switches make up the switch matrix. All switches in the matrix are normally open.

Eight of the sixteen signal lines from the A1 control board are called strobe (STR) lines. The remaining eight are called return (RTN) lines. Let's examine the operation of a single strobe and single return line. (See Figure 2). The A1 control board places a negative pulse

on the STR Ø line. If the switch is open, the negative strobe signal from the control board does not have a complete conducting path to the RTN Ø line. (Note: the isolation diode will be discussed later). The control board examines the RTN Ø line and detects no logic level change (RTN Ø remains at a logic high). Consequently, no action by the control board is taken. However, close the switch and a complete path for the negative pulse from STR Ø to RTN Ø is made. RTN Ø is pulled to a logic low

for the pulse duration. The control board now responds to the RTN Ø signal change.

(continued on p. 2)

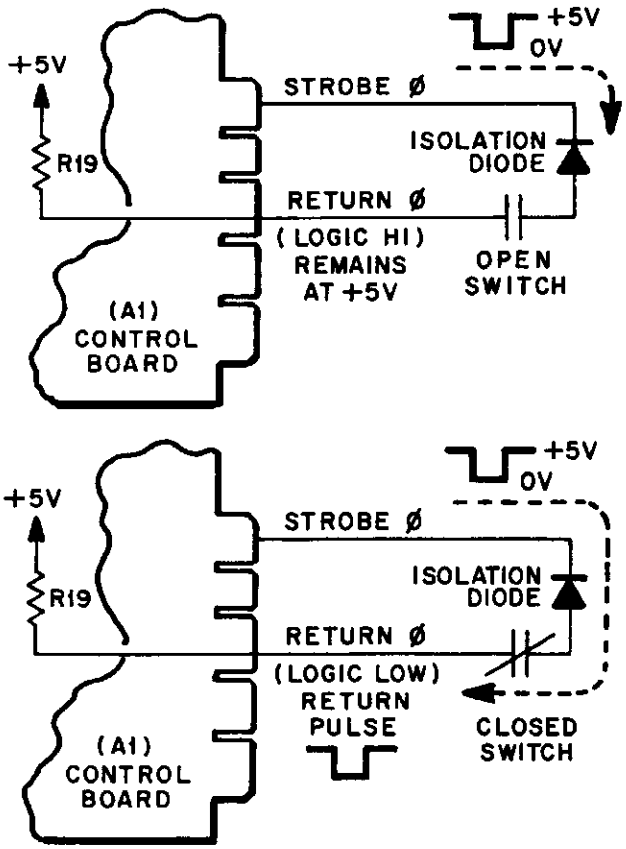

Figure 2.

SWITCH MATRIX (PART ONE)

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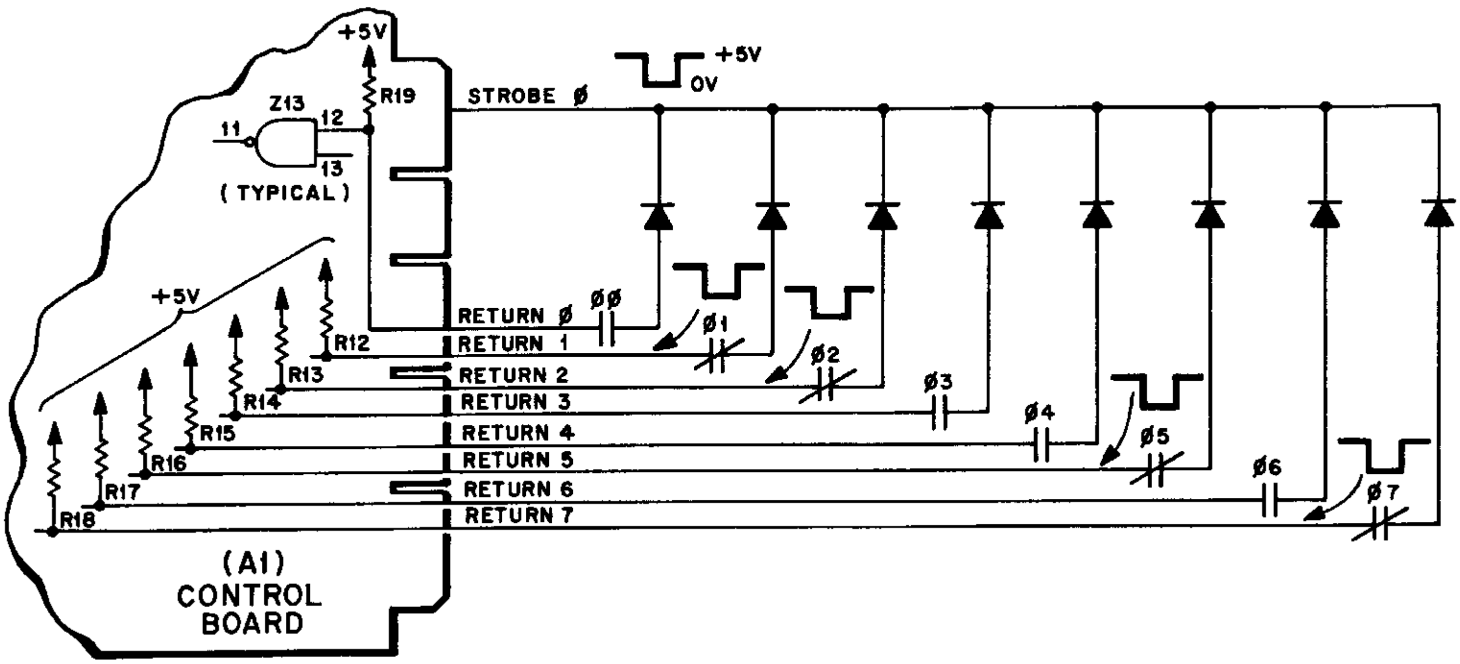

Figure 3.

Now let's add seven more switches to the STR Ø line as in Figure 3. The other end of each switch is attached to a different return line. When STR Ø pulses low, eight switches are "looked at" by the control board at the return line inputs. Here, switches Ø1, Ø2, Ø5 and Ø7 are closed. Return lines 1, 2, 5 and 7 change logic state. The control board will accept all return line data simultaneously, store it, and then process each data bit (return line information) in programmed sequence.

Finally, let's examine the switch matrix in its entirety, (See Figure 4). Note that eight switches are attached to each strobe and return line, a total of sixty-four (64). Also observe, that each switch is assigned a two digit number. The left digit designates the strobe number and the right digit designates the return line number. So, switch number 23 is connected to STR 2 and RTN 3 and so on.

This number is important for several reasons. The game manual references each switch in the matrix with this number on the switch matrix schematic and the playboard switch assignment diagram. Most important, though, these switch numbers are displayed on the game status display (4 digit) during the switch test (step #18 of self-test). This powerful test will be discussed later.

Notice

The Pinball/Video Service Hotlines are now the same. Call 800-323-9121, in Illinois 800-942-1620 from 8:00 a.m. to 4:30 p.m. CST for any Gottlieb pinball or video game assistance.

MAILING LIST: Get ON TARGET every month by sending your name and mailing address to:

ON TARGET
GOTTLIEB AMUSEMENT GAMES
165 W. LAKE STREET
NORTHLAKE, IL 60164

FLASHBACK

D. Gottlieb experienced its first flop game early in its history. In the mid-1930s a game was made called PLUS and MINUS. Supposedly reflecting the current times, it had certain holes which would subtract score from the player. However, Americans in the trough of the Depression could find better ways of spending a nickel than for the privilege of having score points taken away from them. The lesson of PLUS and MINUS was well taken; from then on no Gottlieb game has ever taken away anything already won by the player.

SWITCH MATRIX (PART ONE)

(continued from p. 2)

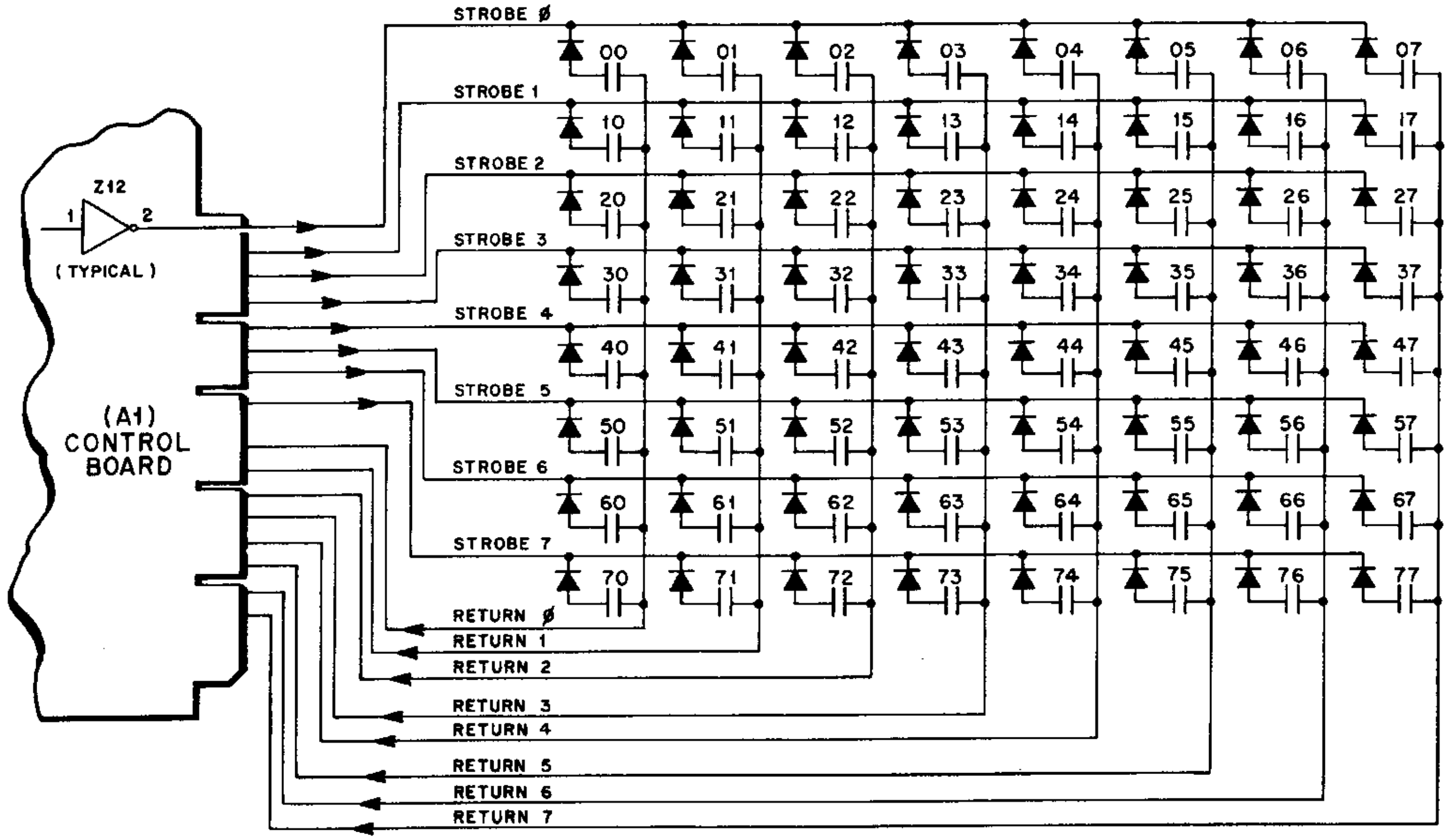

Figure 4.

Through programming, a switch's function or assignment is defined by what return line changes state when a particular strobe line is pulsed. For example, in Figure 4, let's say that switch Ø2 (STR Ø, RTN 2) is a drop target switch scoring 5000 points, when closed.

The control board computer knows that it must score 5000 points if STR Ø is pulsed and RTN 2 changes its logic state (from hi to lo). Consequently, every switch position in the matrix can be assigned a specific function. The self test switch, the coin switches, and replay switch on the front door are assigned switch matrix numbers. (Note: the slam switch is not part of the switch matrix.)

These switch numbers define the switches' position in the matrix, and ultimately, their function.

Strobe Sequencing

Strobe lines are not pulsed at the same time. Each strobe line is sequentially pulsed from STR Ø to STR 7. (See Figure 5). All strobe lines are pulsed fast enough so that no switch closures anywhere in the matrix are missed. All switches are examined by the control board in 10 milli-seconds. A strobe pulse width is 1.25 milliseconds. Switch debounce is handled by the system software. No debounce capacitors across switches are found on Gottlieb's pin games.

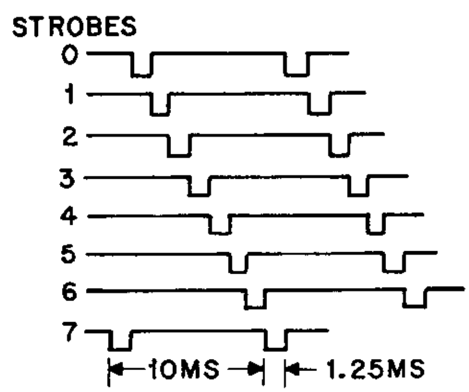

Figure 5.

Next Month:

The Switch Matrix Part Two: Isolating and solving matrix related problems.

SWITCH MATRIX (PART ONE)

(continued from p. 3)

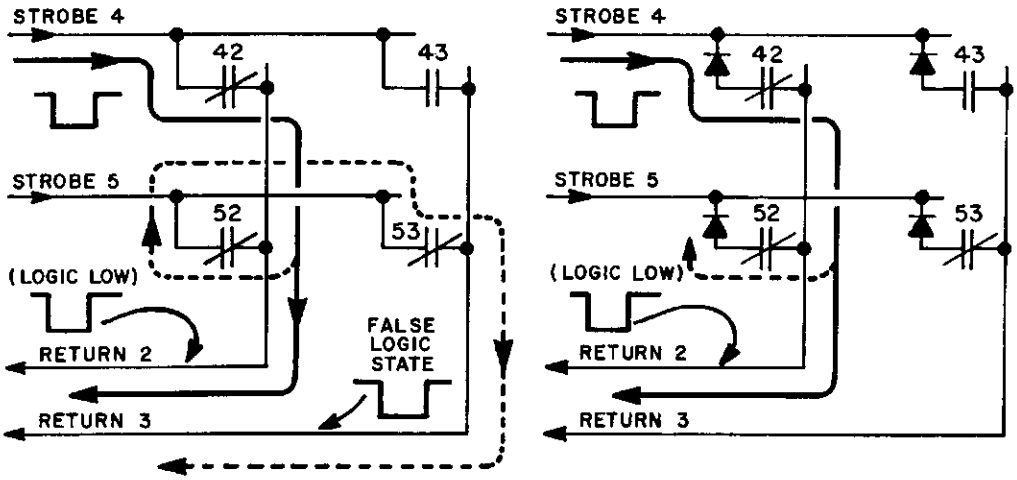

Figure 6.

Isolation Diodes

Switch matrix isolation diodes give the matrix its integrity. If all diodes are removed as shown in Figure 6, false switch closures will be sensed by the control board. For example, let's say that switches 42, 52 and 53 are closed. A conductive path is made not only for RTN 2 but for RTN 3 as well. When STR 4 is pulsed, RTN 2 and RTN 3 lines will both change logic state. But notice switch 43. Its open, and yet the control board will process a changed logic state as if it were closed.

If a coin switch was assigned to the 43 switch position, a credit was just given without inserting a coin.

Now let's place the diodes back into the circuit. STR 4 pulses low, but because the diode becomes reversed biased, no completed circuit to the RTN 3 is possible. With the diodes, no combination of switch closures will cause false signals.

The diodes used are 1N270 germanium type. Using silicon diodes will not guarantee valid logic states when a switch matrix uses a negative strobe system. Do not replace these germanium diodes with silicon diodes. Do not use 1N4148 or 1N4004 diodes. They are silicon diodes.

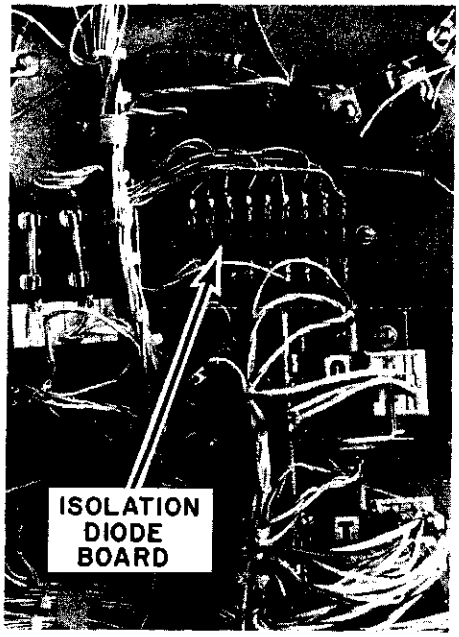

Figure 7.

Switch isolation diodes are located on the playboard underside. (See Figure 7.) They are physically mounted on diode boards instead of soldered to the individual switches.

ON TARGET

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