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SIMPLE EEPROM PROGRAMMER

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Anyone who deals with computerized equipment will, sooner or later, come up against Read Only Memory (ROM) ICs. Nowadays, Electrically-Erasable Programmable Read-Only Memory (EEPROM) is replacing the older Ultra Violet-Erasable Programable Read-Only Memory (EPROM) and many of the new ICs are "drop-in compatible" with older types. For example, the 2Kx8 2816 used here matches the popular 2716 EPROM pin for pin. Except during programming, the 2816 needs only a single 5-volt supply.

The EEPROM is a significant improvement over the ultra violet-erasable device. First, it can be erased quickly without an expensive UV source (or waiting for a long, sunny day, *hi*). Second, single bytes can be erased selectively without disturbing the rest of the ROM's contents.

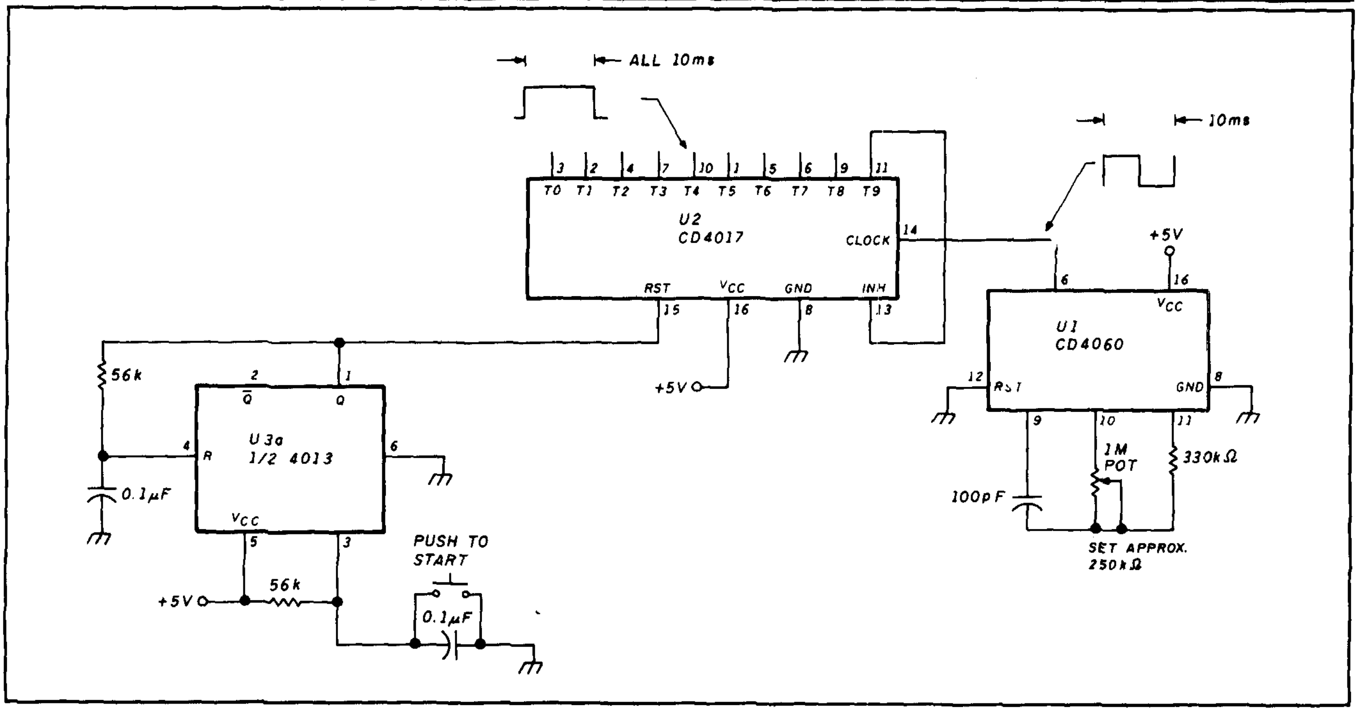
This EEPROM programmer lets you do both erasing and simple, manual programming. It's described as a "stand-alone" device assembled on a prototyping block, but it can just as easily be incorporated into your equipment using the EEPROM. As shown here, the programmer can't be computer driven or operated automatically. You can add these features, but it will cost more in terms of both time and money.

The electrical characteristics for programming show only two *critical parameters*. The programming voltage (V_{pp}) write pulse duration must be between 9 and 15 ms, and the V_{pp} rise time must be between 0.45 and 0.75 ms. Because all other timing parameters are given as minima expressed in nanoseconds or microseconds, I timed everything around the V_{pp} pulse width of 10 ms to keep things simple.

How it works

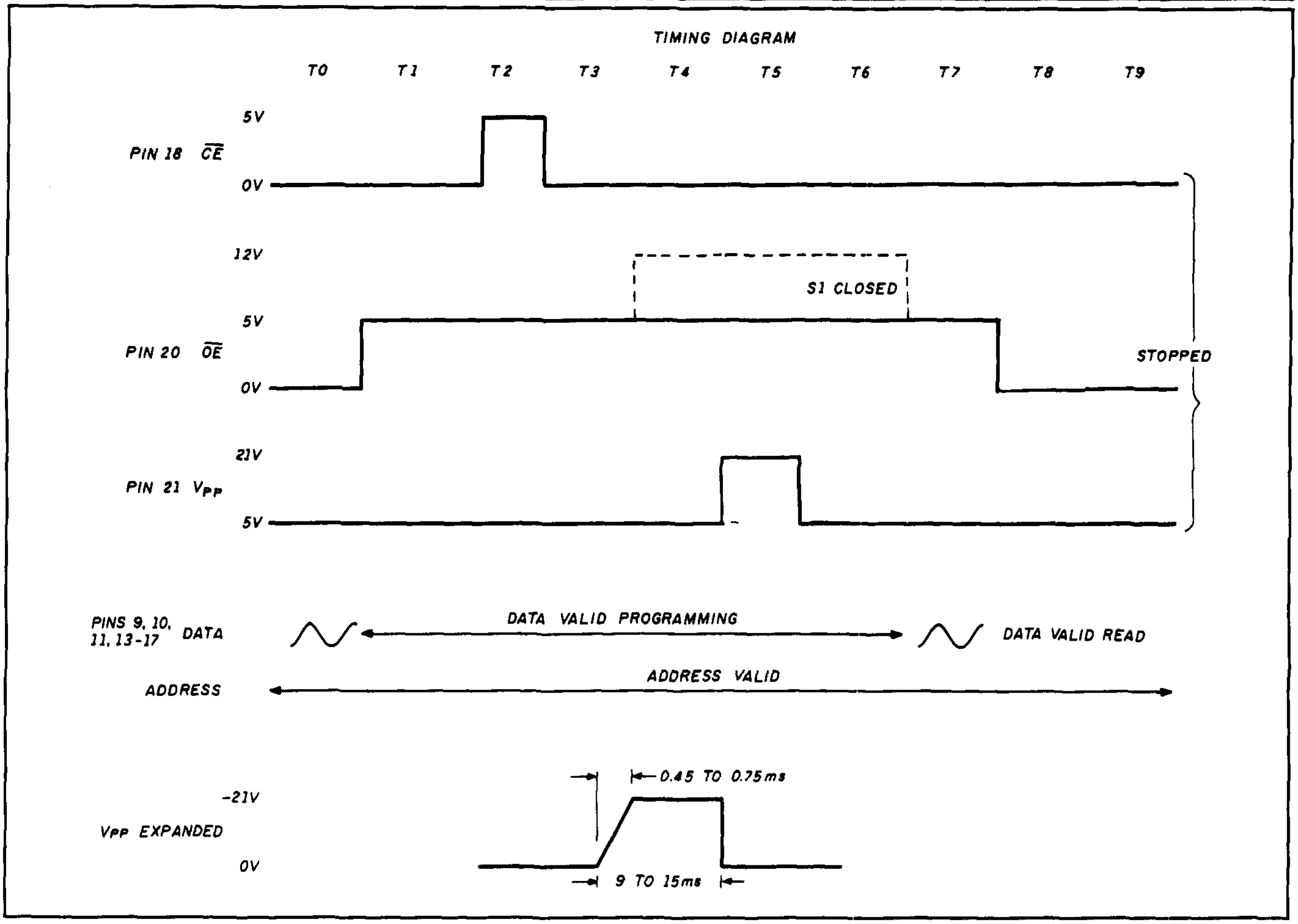
The 4060 oscillator/pulse generator (U1) in **Figure 1** is an oscillator/divider combination. The 1-meg pot adjusts the oscillator frequency to 12.8 kHz. This is divided by 128 to

FIGURE 1



Oscillator/pulse generator.

FIGURE 2



Timing diagram.

give a 100-Hz output at pin 6, pulsing the input of pin 14 of the CD4017 (U2), a decade counter which produces sequential 10-ms pulses from the 100-Hz clock input. The pulses appear in order from T0 to T9. When output T9 goes high it activates inhibit, pin 13, stopping all activity. When you press the START switch it resets the 4017, causing T9 to go low and the program to run from T0 to T9 again. Flip-flop U3A is a debounce circuit.

Flip-flop U3B has already been reset when the counter arrives at T9, causing the outputs of the 4503 analog multiplexer/demultiplexers (U4 and U5) to float. The inputs to the 4049 hex inverting buffers (U6 and U7) from the EEPROM socket cause the LEDs to display the value of data being read from the EEPROM. Refer to the timing diagram in **Figure 2**. When you push START, T0 goes high for 10 ms and then goes low. Next, T1 goes high and sets flip flops U3B and U8B causing the value of the data thumbwheel switches (shown in **Figure 3**) to be applied to the I/O pins of the EEPROM. Also, $\overline{OE}$ (**Figure 4**) pin 20 goes to 5 volts. T2 then applies a 10-ms pulse to pin 18 of the EEPROM. T4 sets flip-flop U8A to apply a 12-volt pulse to pin 20. This pulse is used for chip erase. Leave the 26-volt switch S1 open for a byte erase and the pulse will remain at 5 volts, as indicated by the solid section of the timing diagram in **Figure 2**, EEPROM $\overline{OE}$. The LM317 voltage regulator (U10) normally supplies 5 volts to the V_{pp} pin. The 1 and 4.4-k resistors are in parallel because T5 is still low. The bottom of the 1-k resistor is effectively at ground. When T5 goes high, LM317 voltage regulator U10 is allowed to rise to 21 volts. The time constant of the 1-k resistor and 0.02-μF capacitor produces a rise time of about 0.6 ms, which should improve device reliability. After T5 the process reverses itself, and the circuit comes to a stop at T9. The address pins are connected directly to the thumbwheel switches in **Figure 5** and you must enter the correct address before any byte erase/write takes place. The resistors at the bottom of the data and address switches terminate the CMOS inputs of IC 4503 and the address pins A0 to A10.

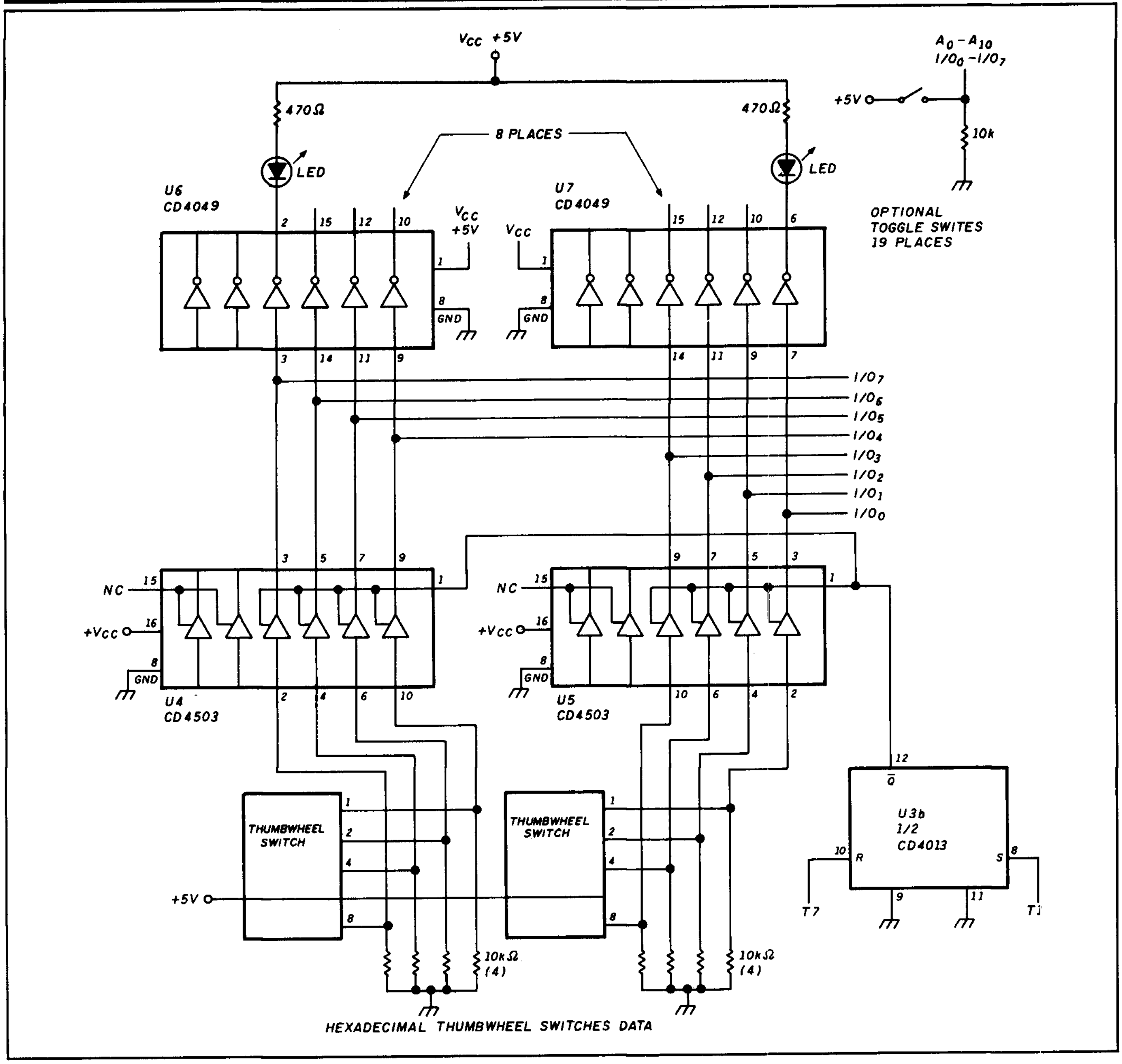
Power supply

I didn't build a power supply for this project. I have several 1 to 15-volt regulated supplies with floating outputs. I connected two of them in series to obtain 26 volts. The current drain is very small, around 20 mA maximum. The 5-volt supply uses about 200 mA.

Adjustments

Temporarily disconnect pin 11 of the 4017 and ground pin 13. This causes the counter to run constantly. Apply

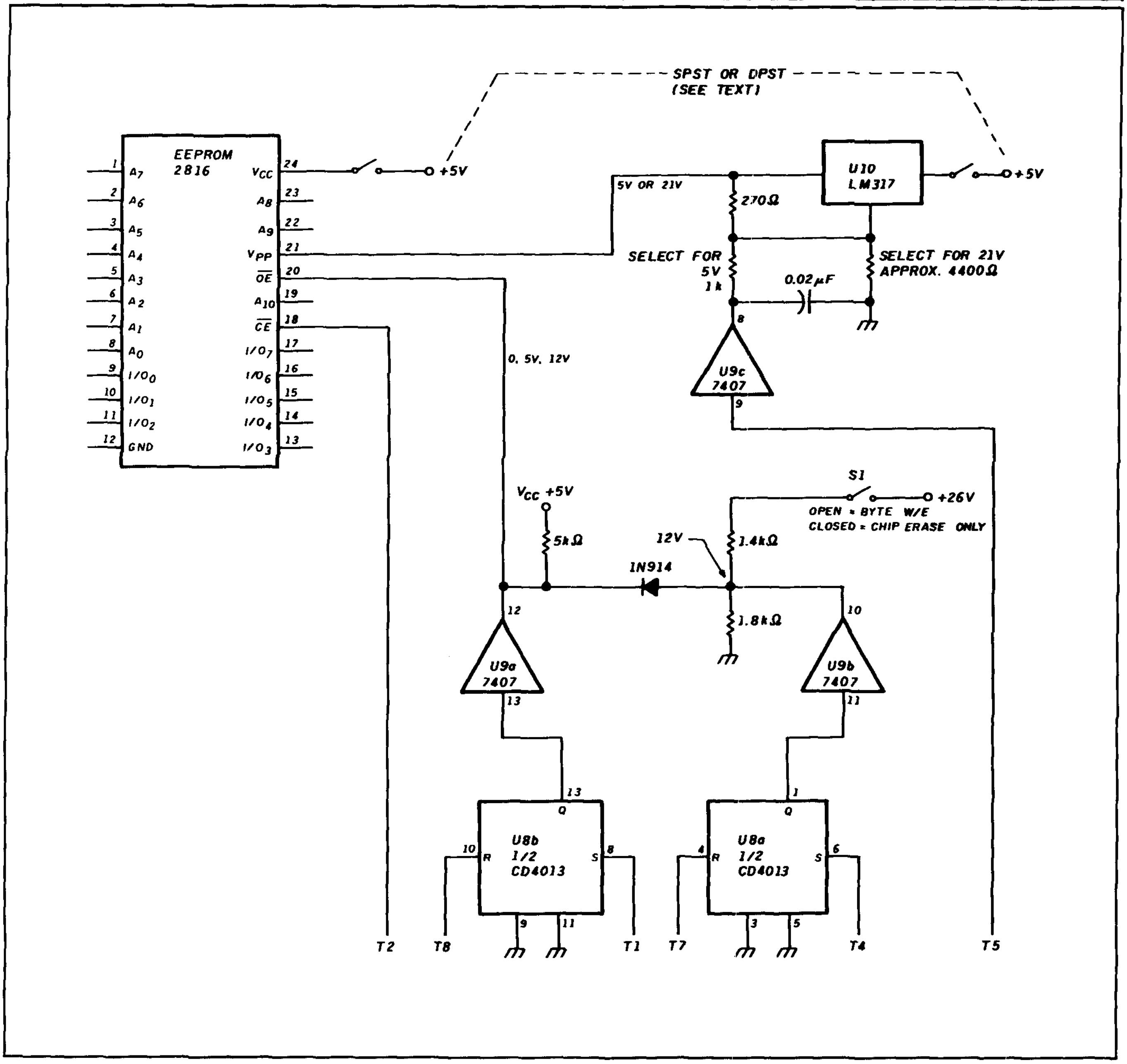
FIGURE 3



Data setup and readout.

power to all circuits with the EEPROM removed from its socket. Using a scope, sync on T0 (U2 pin 3) and adjust the 1-meg pot on IC 4060 for a pulse width of 10 ms. Keep sync on T0 and adjust the scope sweep speed for 10 ms/cm. T0 to T9 are now each represented by centimeters across the screen. Refer to the timing diagram and observe $\overline{CE}$, pin 18 of the EEPROM socket. The pulse should be at T2. $\overline{OE}$ pin 20 should appear as a 5-volt pulse. Closing S1 causes a 9 to 15-volt pulse to be superimposed on the 5-volt pulse as indicated by the dotted lines. The 1.4 and 1.8-k resistors establish this voltage. V_{pp} pin 21 should start out at 5 volts (adjust the 1-k resistor if necessary). The pulse then goes to 21 volts. Adjust the 4.4-k resistor for 21 volts $\pm$1 volt. Next, expand the trace speed to x10 and observe the rise time of the 21-volt pulse; it should be between 0.45 and 0.75 ms. Adjust the 0.02-μF capacitor if necessary. The pulse should be between 9 and 15 ms long, so go back and tweek the 1-meg pot if necessary. Now return to normal sweep. Check the I/O pins by observing the waveforms. If you touch the probe tip you should see a 60-cycle hum, indicating that the outputs of IC 4503 are floating. The solid line from T1 to T7 should be either low or high depending on the setting of the data switches. Next, check each address pin to see if you're getting good highs and lows. Remove the ground on IC 4017 pin 13 and reconnect pin 11; the counter should stop. Push START; one cycle should pass

FIGURE 4



Programming control.

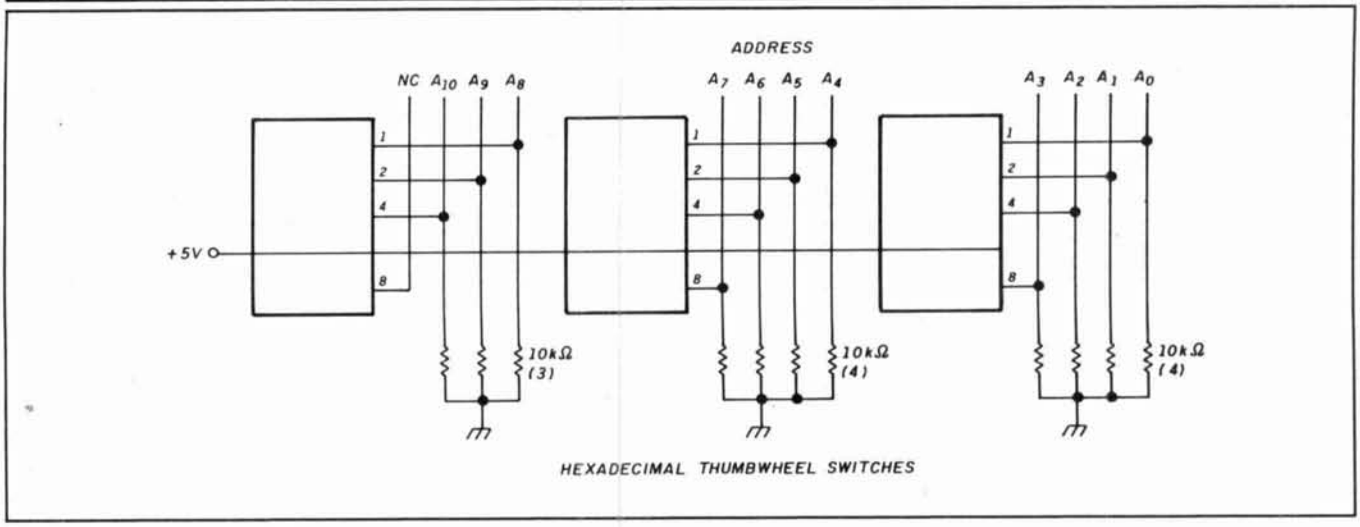
and stop at T9. If two or more cycles pass, you may have to adjust the debounce flip-flop for a longer time constant.

Using the circuit

This circuit can power up at any point from T0 to T9, applying unwanted pulses. To prevent this, I've placed a toggle switch to inhibit the EEPROM's V_{CC} 5-volt and 26-volt, which inhibits V_{PP}. First insert the 2816 into its socket and turn on the main power to the rest of the ICs. Push START once or twice to reset all flip-flops. If you're using an SPST switch, apply 5-volt V_{CC} power first — then apply the 26-volt power. If you have a DPST switch, both V_{CC} and V_{PP} will be applied simultaneously. Power down in the reverse order when removing the 2816 from its socket.

The EEPROM should be in read mode after power up. A new EEPROM should show all highs (LEDs lit) for the erased condition. The LEDs and LED drivers can be eliminated if you don't mind touching each I/O pin with a VOM to determine the logic level. Place the address switches at 000 or any desired address. If the data byte you're looking at has been erased already (all highs), enter the value of data you want at that address and push START. The LEDs should show the same value entered on your data switches because you're reading the 2816 at T9. If data is already present and you want to change it, first erase that location by writing all "1"s (FF_H), then enter the correct data and push START again. To erase the entire 2K of memory, close S1 and push START. The entire chip will be erased. I've

FIGURE 5



Address selection.

found that the address and data settings aren't important when you're doing a chip erase using the SEEQ device. However, another 2816 by EXEL requires the data value FF for a chip erase as well as a byte erase. I suggest you obtain data sheets for any EEPROMs you buy to determine if there are any special procedures to follow.

Conclusion

I built the programmer on a protoboard so I could change the circuitry to accommodate other PROMs. You may want to try using the EEPROM to decode binary values into seven-segment readouts including the characters A to F. Circuits with the 2716 UV EPROM can be modified using the 2816. You can program eight outputs with varying pulse widths to control other circuits by hooking a binary counter up to the address pins. I used three EEPROMs with their addresses in parallel for a total of 24 control lines. Those 24 lines let me program a single chip microcomputer with its own UV EPROM. I have since replaced the EEPROMs with a single chip microcomputer which programs other PROMs. You can purchase all of the ICs used in this project from Jameco, 1355 Shoreway Road, Belmont, California 94007. hr