Keyboard Interfacing

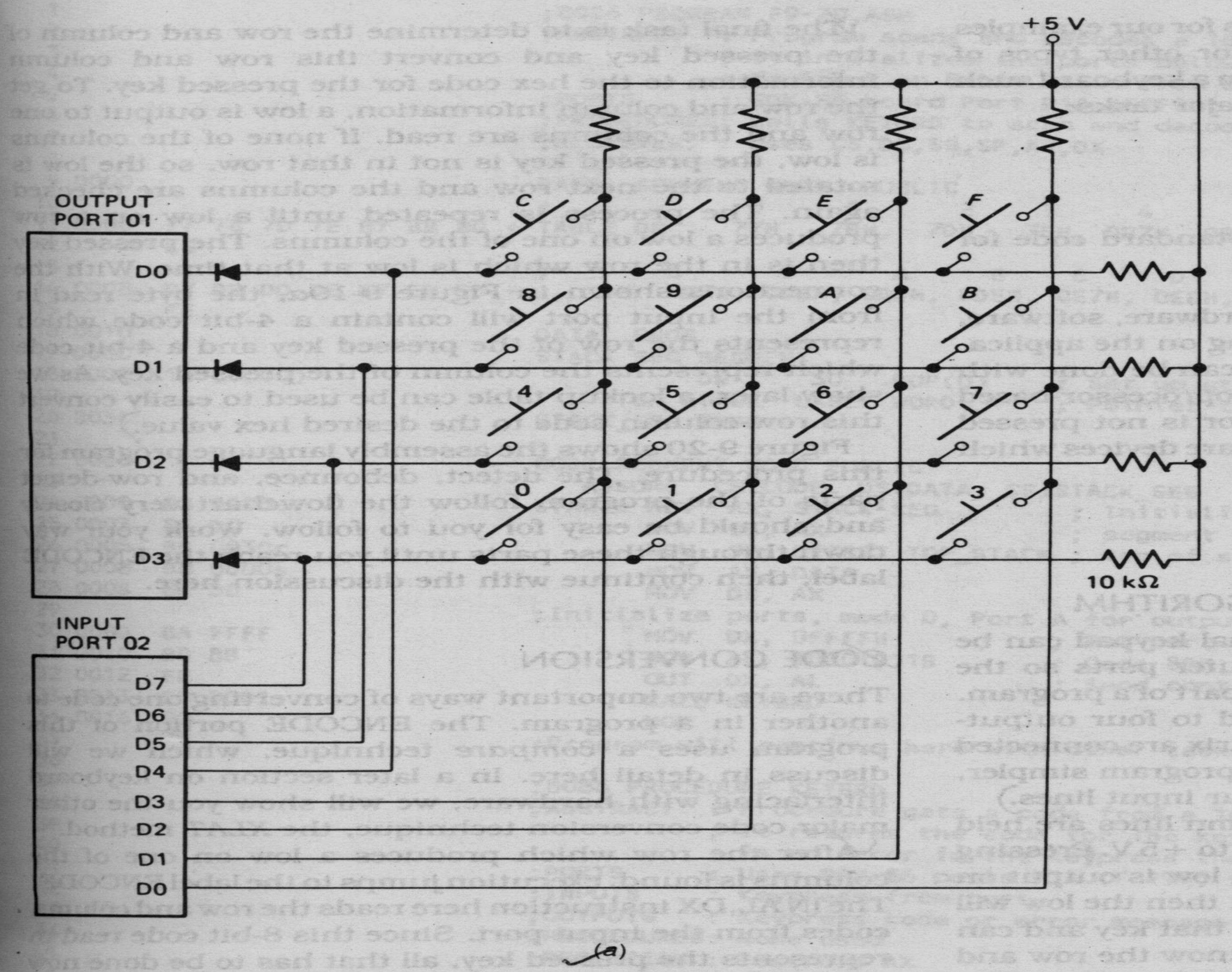
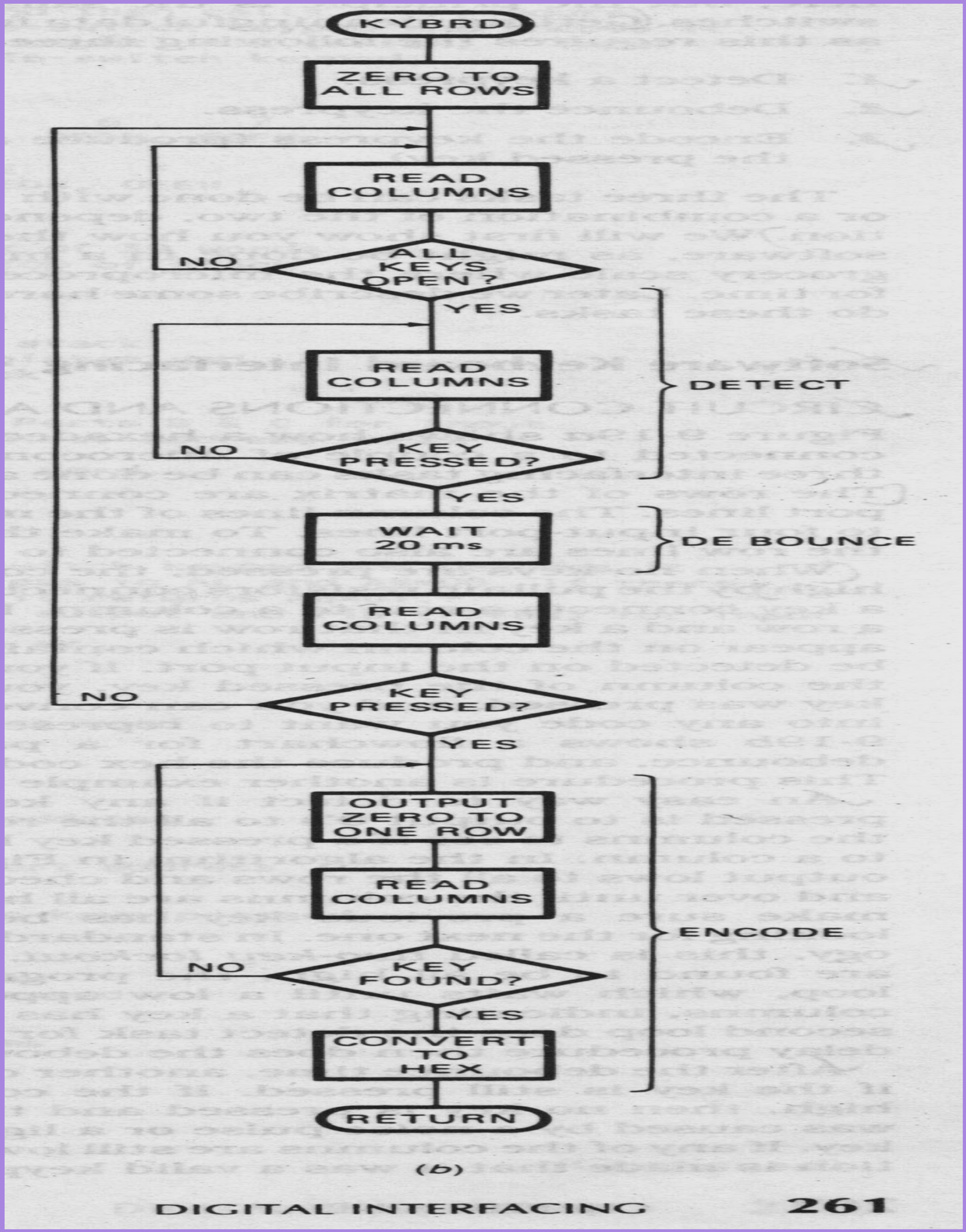


FIGURE 9-19 Detecting a matrix keyboard keypress, debouncing it, and encoding it with a microcomputer. (a) Port connections. (b) Flowchart for procedure.

- Key switches are connected in a matrix of rows and columns, as shown in Fig. 9-19a - Hexadecimal Keypad
- The rows of the matrix are connected to the four output port lines.
- The column lines of the matrix are connected to four input port lines.
- When no keys are pressed, the column lines are kept high.

- Pressing a key connects a row to a column.
- If a low is output on a row and a key in that row is pressed, then the low will appear on the column which contains that key and can be detected on the input port.
- The row and column information of a pressed key is read from the input port by the microcomputer.

Key Press Detection



- At first we output lows to all the rows and check the columns over and over until the columns are all high. This is done to make sure that a previous key has been released before looking for the next one.
- Once the columns are found to be all high, the program enters for another loop, which waits until a low appears on one of the columns, indicating that a key has been pressed.
- A simple 20 ms delay procedure then does the debounce task.

- After the debounce time another check is made to see if the key is still pressed.
- If all the columns are now high, then no key is pressed and the initial detection was caused by a noise pulse or a light brushing past a key.
- If one of the columns are still low, then the assumption is made that it was a valid keypress.

- Now, a row is kept low and check all the columns. If none of the columns is low, the pressed key is not in that row.
- So, low is rotated to the next row and all the columns are checked again.
- This process continues until low on a row produces low on a column and thus a valid row and column combination is detected.

Interfacing to Alphanumeric Display

- Digit oriented display
- Used for small amount of data display
- 7 Segment LED display – used for only numbers and hexadecimal letters.
- 16 or 18 Segment Display – used for displaying a number of letters of the alphabet, numbers and other symbols
- Dot Matrix Display – Provides higher resolution and desired curve shapes
- LCD displays

- Different Alphanumeric Displays

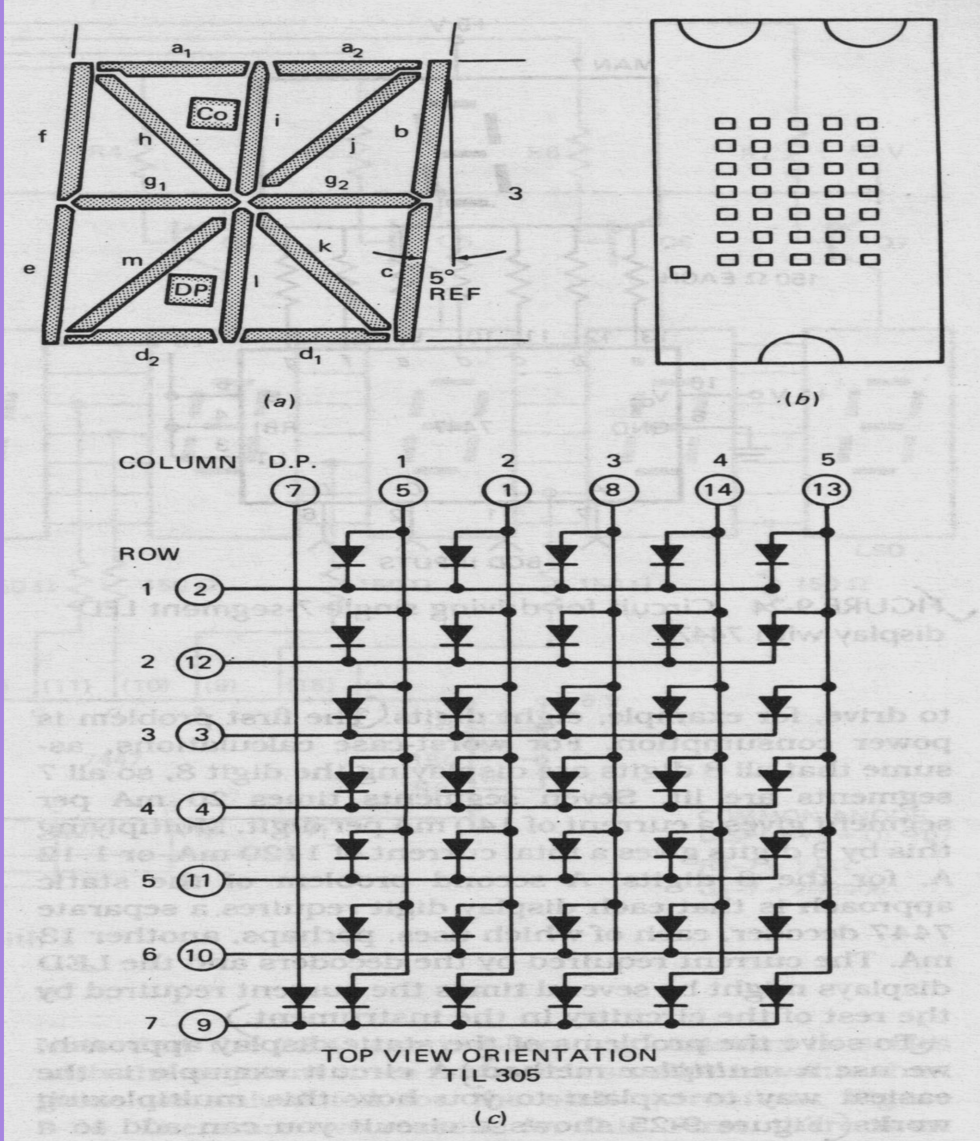


FIGURE 9-23 Eighteen-segment and 5 by 7 matrix LED displays. (a) 18-segment display. (b) 5 by 7 dot-matrix display format. (c) 5 by 7 dot-matrix circuit connections.

7 Segment LED Display

- Single 7 Segment, common anode display – connection with parallel port
- A segment is turned on by applying a logic low to it.
- The 7447 converts a BCD code applied to its inputs to the pattern of lows required to display the number represented by the BCD code.

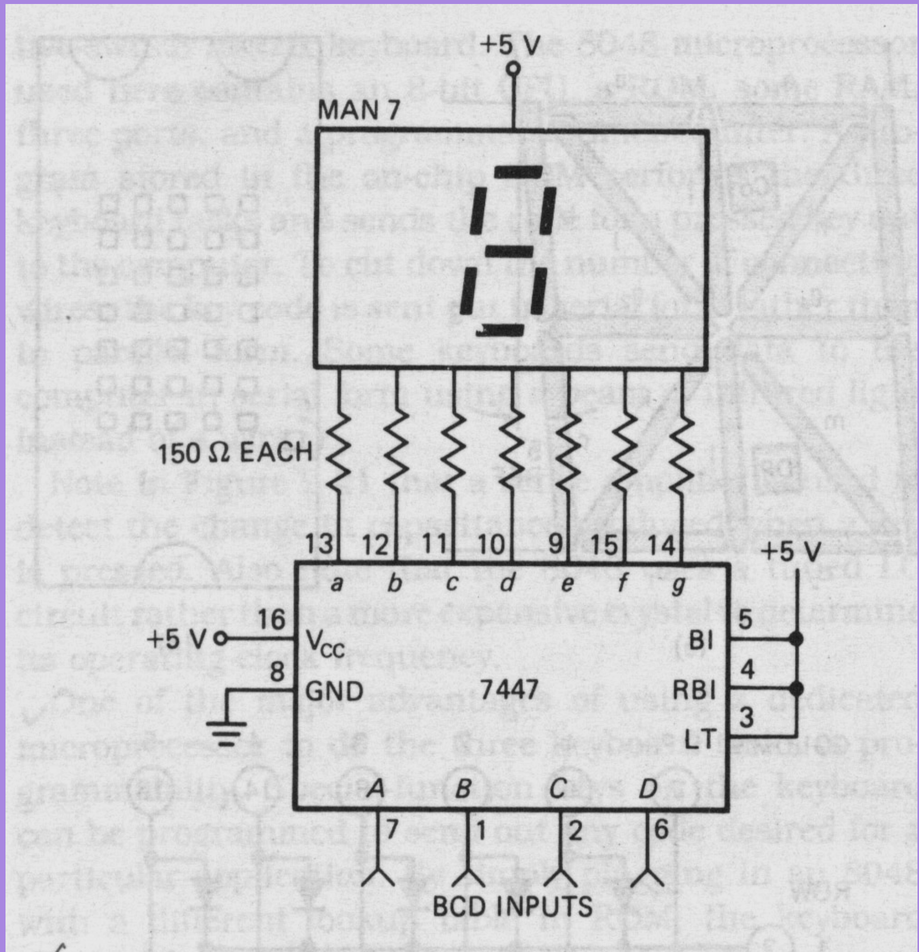


FIGURE 9-24 Circuit for driving single 7-segment LED display with 7447.

- Static Display – The current is being passed through the display all the time.
- Current per segment – 5 to 30 mA. (20mA)
- Voltage drop across LED (lit) – 1.5v
- The low o/p voltage for the 7447 is a maximum of 0.2V at 20mA
- Voltage drop across current limiting register: 5V – (1.5V + 0.2V) = 3.3V
- Value of Current Limiting Reg. Becomes around 165 ohm

Limitations of Static Display Approach

- For Multi Digit LED display
- More Power Consumption
- Current = 20 * 7 * 8 = 1120mA = 1.12A for 8 digit display
- More 7447 will be required

Multiplexing 7-Segment Display

- Multiplexing
- Turn of a single digit is 1 or 2 ms
- With 8 digits and 2ms per digit, 1 digit will lit 60 times a second.

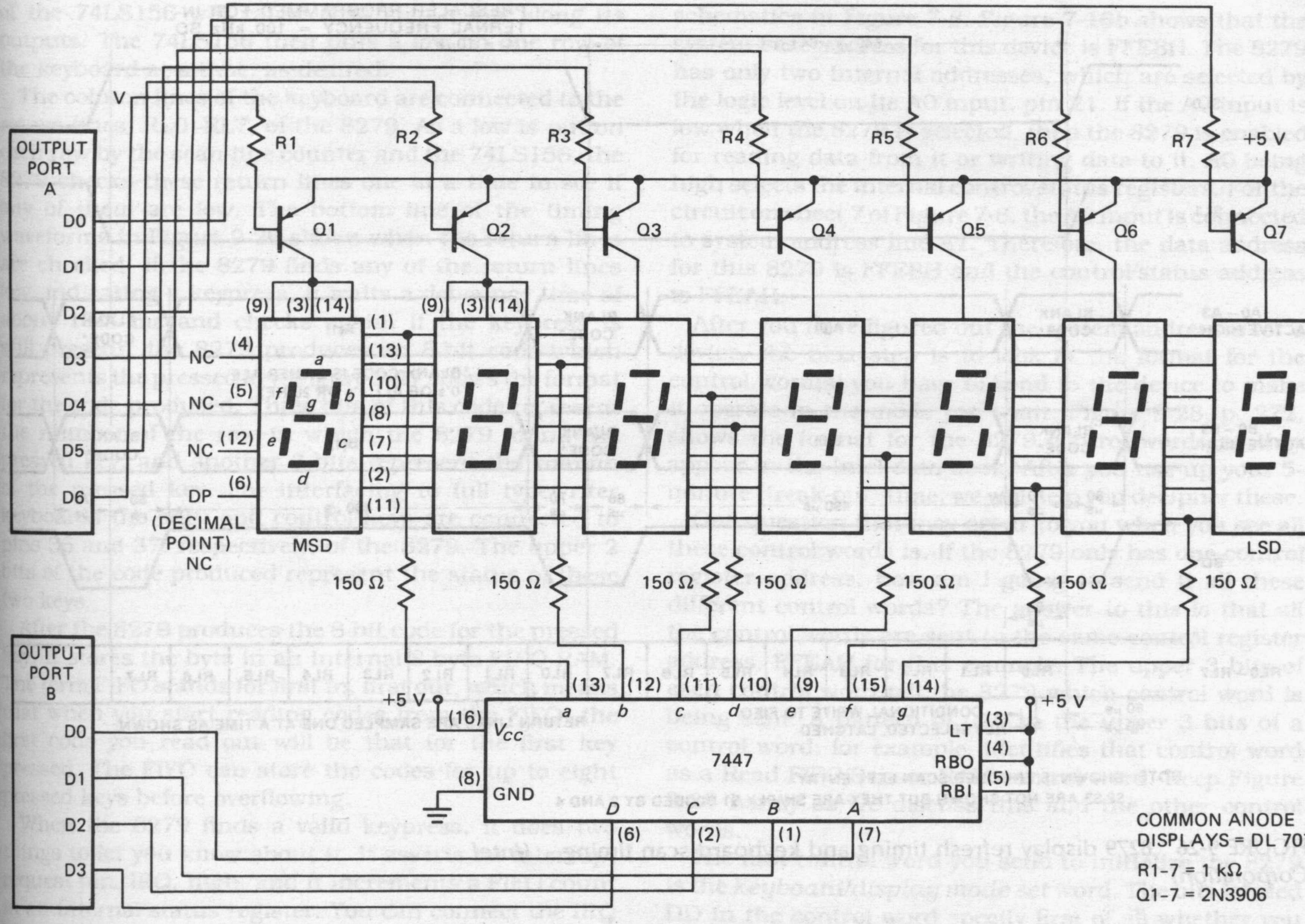


FIGURE 9-25 Circuit for multiplexing 7-segment displays with a microcomputer.

Optical Motor Shaft Encoders

- In order to control machines in electronic factories, the microcomputers in these machines often need information about position,direction and speed of rotations of motor shafts.
- Microcomputers need these information in digital form.
- An optical shaft encoder is a device that converts motion into a sequence of digital pulses. By counting a single bit or by decoding a set of bits, the pulses can be converted to relative or absolute position measurements
- There are two types of encoders :

Absolute shaft encoder & incremental encoder.

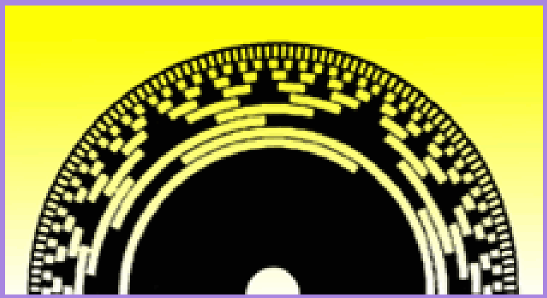
The **absolute encoder** where a unique digital word corresponds to each rotational position of the shaft,

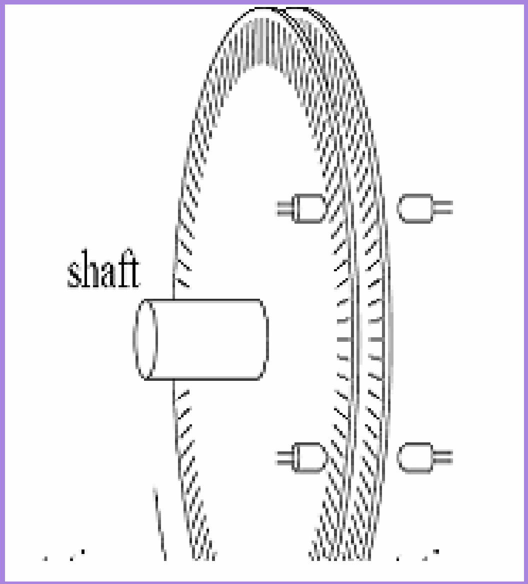
The **incremental encoder**, which produces digital pulses as the shaft rotates, allowing measurement of relative position of shaft.

Absolute Encoders

- Most encoders are composed of a glass or plastic slotted disk.
- An LED is mounted on one side of each track and a phototransistor is mounted on the other side of each track,

  opposite the LED.
- As radial lines in each track interrupt the beam between a photoemitter-detector pair digital pulses are produced.
- Outputs from the phototransistors will produce one of the codes.
- The most common types of numerical encoding used in the absolute encoder are gray and binary codes.
- Each code represents an absolute angular position of the shaft in its rotation.





Absolute Encoders

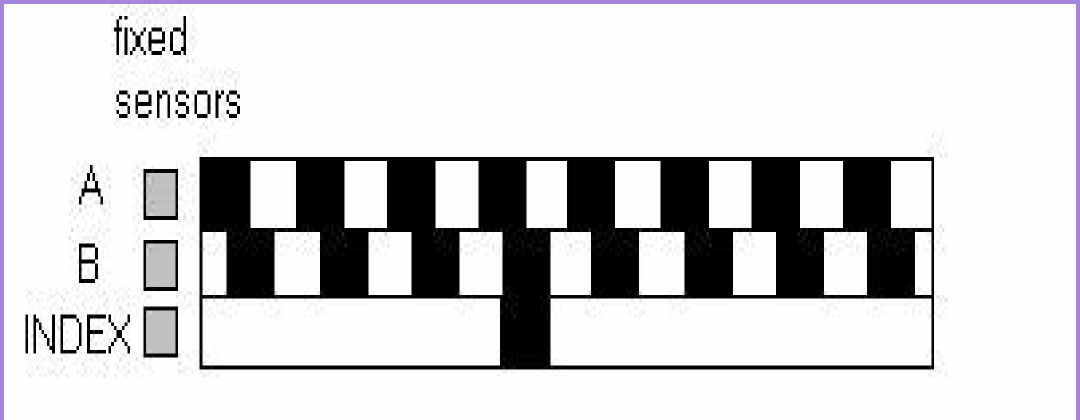
- For example, if there are 8 tracks (8 bits), the encoder is capable of producing 256 distinct positions or an angular resolution of 1.406 (360/256) degrees.
- if there are 4 tracks (4 bits), the encoder is capable of producing 16 distinct positions or an angular resolution of 22.5 (360/16) degrees.
- The most common types of numerical encoding used in the absolute encoder are gray and binary codes.
- The gray code is designed so that only one track (one bit) will change state for each count transition, unlike the binary code where multiple tracks (bits) change at certain count transitions. For the gray code, the uncertainty during a transition is only one count, unlike with the binary code, where the uncertainty could be multiple counts.
- Since the gray code provides data with the least uncertainty but the natural binary code is the preferred choice for direct interface to computers and other digital devices, a circuit to convert from gray to binary code is desirable. Figure 4 shows a simple circuit that utilizes exclusive OR gates (XOR) to perform this function.For a gray code to binary code conversion of any number of bits N, the most significant bits (MSB) of the binary and gray code are always identical, and for each other bit, the binary bit is the exlcusive OR (XOR) combination of adjacent gray code bits.

Absolute Encoders

- For example, let us assume that binary-coded disk was used and the disk was rotating from position 7 (0111) to position 8 (1000).
- Now if the detectors pick the changes on the 3 least significant bits but fails to pick the change of msb , then the output code will be 0000 instead of 1000.
- But the Gray code for 7 is 0100 and 8 is 1100 (only one bit changes during transition). So if the detector fails to pick the new bit,it will be the previous position

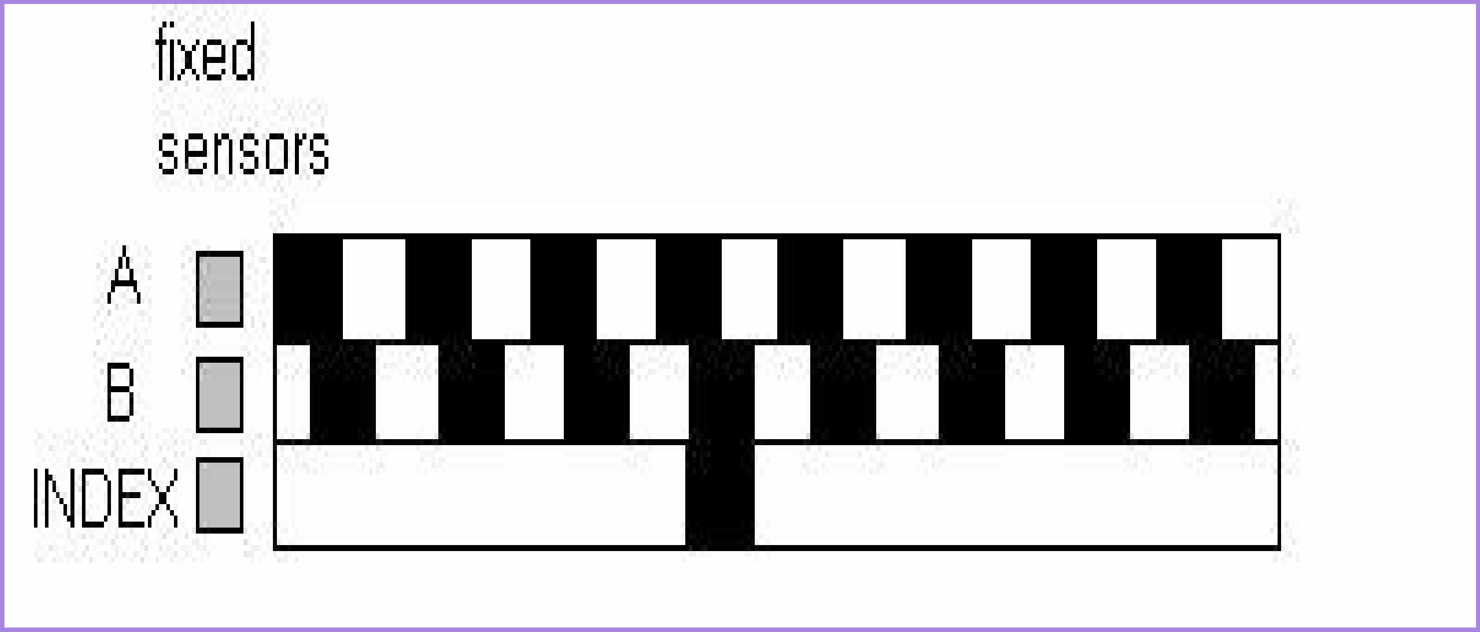
Incremental Encoders

- The incremental encoder, sometimes called a relative encoder, is simpler in design than the absolute encoder.
- It consists of two tracks of slotted holes ,an LED is mounted on one side of each track of holes and two sensors on the other side of the disk whose outputs are called channels A and B.
- As the shaft rotates, pulse trains occur on these channels at a frequency proportional to the shaft speed, and the phase relationship between the signals yields the direction of rotation.
- The two tracks of slotted holes are 90° out of phase with each other so as the disk is rotated.

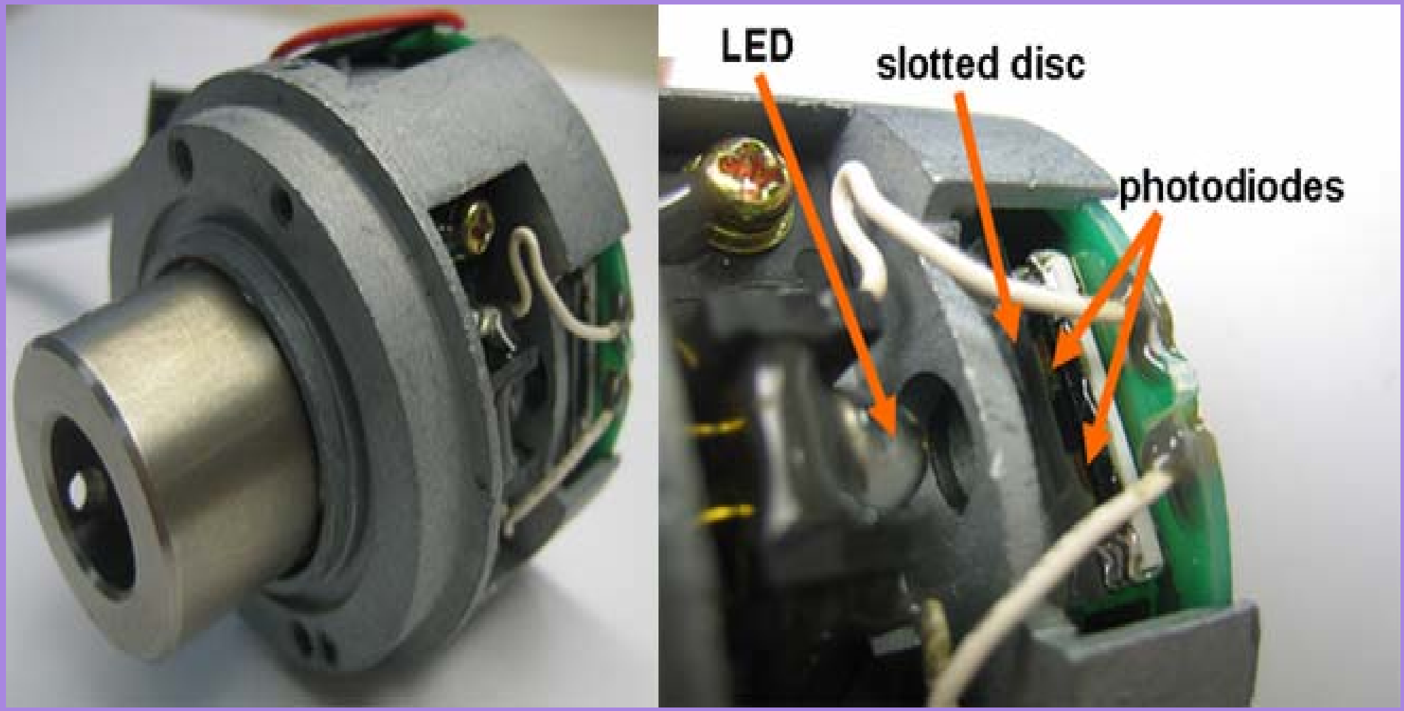


Incremental Encoders

- The following waveform is produced by the sensors as the shaft is rotated in a direction.
- In the opposite direction B waveform leads A waveform by 90° instead of lagging it by 90°.
- the speed of the rotation can be measured by counting the pulses of one detector in a fixed time interval.



0	0-22.5	0000	0000
1	22.5-45	0001	0001
2	45-67.5	0010	0011
3	67.5-90	0011	0010
4	90-112.5	0100	0110
5	112.5-135	0101	0111
6	135-157.5	0110	0101
7	15.75-180	0111	0100
8	180-202.5	1000	1100
9	202.5-225	1001	1101
10	225-247.5	1010	1111
11	247.5-270	1011	1110
12	270-292.5	1100	1010
13	292.5-315	1101	1011
14	315-337.5	1110	1001
15	337.5-360	1111	1000


LED
slotted disc
photodiodes