



Micro-Professor Application Note

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MPF-I AS A TRAFFIC LIGHT CONTROLLER

An Application Example of Z80-PIO.



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Purpose: Use PIO for traffic light control

Required Equipment: A PIO chip, a 75492, three LED lamps (one in green, one in red, and one in yellow), three resistors, and some wire.

You are required to use the necessary devices to make the hardware connections in accordance with the diagram shown below:

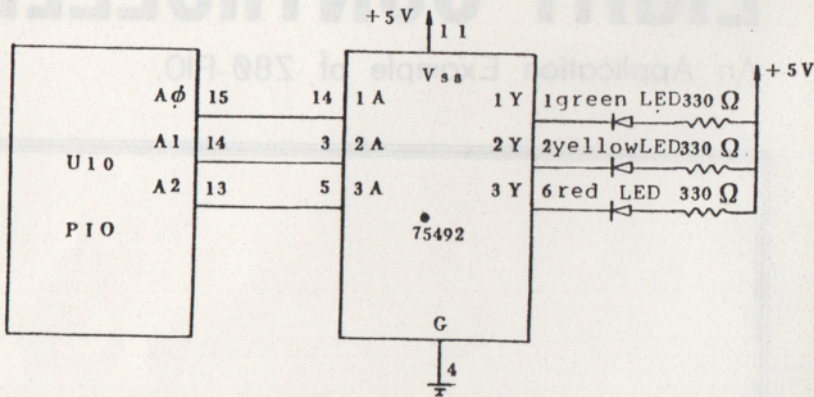


fig A

Experiment Explanation:

1. The PIO is a 40-pin large-scale integrated circuit (LSI) especially designed to provide TTL compatible interface between peripheral devices and the Z80 CPU. The CPU can configure the Z80-PIO to interface with a wide range of peripheral devices with no other external logic required. Typical peripheral devices that are fully compatible with the Z80-CPU include most keyboard, paper tape readers and punches, printers, and PROM programmers, etc. It is programmable. The PIO has two I/O ports--port A and port B. Each port is connected to eight pins. The addresses of the PIO are from 80 to 83 (in hexadecimal). In this experiment, port A will be used. For detailed description of the PIO and its operation, refer to "Z80 Microprocessor Programming and Interfacing, Book 2" by Nichols, Rony, published by Black-sburg; or Z80 Handbook.

2. Each of the two ports of the PIO has four modes of operation; namely, byte output, byte input, byte bidirectional bus, and bit control mode. The mode of operation must be established by writing a control word to the PIO in the following format:

		mode of operation
<u>D7</u>	<u>D6</u>	
ϕ	ϕ	Byte output
ϕ	1	Byte input
1	ϕ	Byte bidirectional
1	1	Bit control

fig B

We can change the contents of bit D7 and D6 to form a control word in order to change the mode of operation of port A.

3. In this experiment, the mode of operation of port A is byte output. Thus, the contents of bit D7 and D6 should be zero, and the contents of bit D3 through bit D0 should be one. The contents of bit D5 and D4 make no difference to the control word.

D7	D6	D5	D4	D3	D2	D1	D0
M1	M0	x	x	1	1	1	1

control word

4. Of the four addresses of PIO, two addresses are assigned to port A--80H is used as the data port of port A, and 82H is used as the control port of port A. Since we use port A in its byte output mode, the control word is set 00001111(binary) (or 0FH). The value of the control word should be sent to the control port of Port A to set Port A to its byte output mode.

5. We use the bit 0 (A0) of Port A to control the green light, A1 to control the yellow light, and A2 to control the red light. To illuminate the red light, the value 01 should be sent to the data port of PIO (whose address is 80H). By sending 01H to the data port of PIO, the eight bits on the Port A will become

A7 A6 A5 A4 A3 A2 A1 A0

0 0 0 0 0 0 0 1

The 75492 will convert the input from A0 to low, so the output at pin 1Y of 75492 is low. This will cause the electrical current to flow from the resistor to the green LED lamp.

To illuminate the yellow LED, the byte (02H) should be sent to the data port of the PIO. This byte will cause the A1 high and 2Y low. To illuminate the red lamp, the byte (04H) is sent to the data port of the PIO.

6. For how long will a lamp be illuminated? This is controlled by time delay subroutines--DELAY, DELAY1, and DELAY2.

Since the MPF-I operates at 1.79MHz, a T state is 0.56 micro-seconds. Therefore, the time delay achieved by the DELAY subroutine is

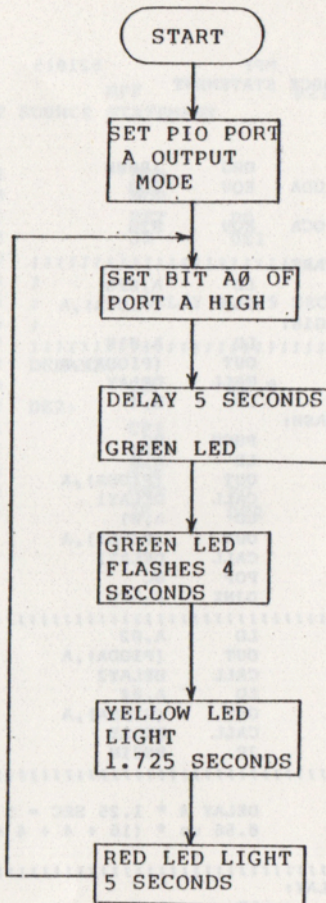
$$0.56 \text{ micro-seconds} \times \{7+4[10+(16+4+4+10) \times 65536+4+12]-5+10\}=4.9912867 \text{ sec}$$

And the time delay for DELAY1 is

$$0.56 \times [10+(16+4+4+11+12) \times 19000]=0.5000856 \text{ sec}$$

The time delay for DELAY2 is

$$0.56 \times [10+(16+4+4+11+12) \times 65536]=1.7249131 \text{ sec}$$



```

1
2
1800 3
3   PIODA   ORG   1800H
4   EQU     EQU     80H           ;DATA PORT OF PIO
                                   CHANNEL A
5   PIOCA   EQU     82H           ;CONTROL PORT OF PIO
                                   CHANNEL A
6   START:
7   LD      A,0FH
8   OUT     (PIODA),A           ;PIO PORT A OUTPUT MODE
9   BEGIN:
10  LD      A,01H
11  OUT     (PIODA),A           ;GREEN LED LIGHT
12  CALL    DELAY               ;DELAY 5 SEC
13  LD      B,4
14  FLASH:
15  PUSH    BC
16  LD      A,0
17  OUT     (PIODA),A           ;FLASH 4 SEC
18  CALL    DELAY1
19  LD      A,01
20  OUT     (PIODA),A
21  CALL    DELAY1
22  POP     BC
23  DJNZ    FLASH
24  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
25  LD      A,02
26  OUT     (PIODA),A           ;YELLOW LED LIGHT
27  CALL    DELAY2               ;1.725 SEC
28  LD      A,04
29  OUT     (PIODA),A           ;RED LED LIGHT
30  CALL    DELAY               ;5 SEC
31  JP      BEGIN
32  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
33  ;      DELAY 4 * 1.25 SEC = 5 SEC  SUBROUTINE
34  ;      0.56 us * (16 + 4 + 4 + 10 ) * 65536 =1.25 SEC
35  ;
36  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
37  DELAY:
1830 1604 38   LD      D,4           ; 7T
39   DELX:
1832 010000 40  LD      BC,0           ; 10T
41   DE0:
1835 EDA1 42   CPI           ; 16T
1837 00 43   NOP           ; 4T
1838 00 44   NOP           ; 4T
1839 EA3518 45  JP      PE,DE0       ; 10T
183C 15 46   DEC      D
183D 20F3 47   JR      NZ,DELX
183F C9 48   RET
49  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
50  ;
51  ;      DELAY 0.5 SEC SUBROUTINE
52  ;      0.56 us * (16 + 4 + 4 + 11 + 12 ) * 19000 =0.5 SEC
53  ;
54  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
55  DELAY1:
1840 01384A 56  LD      BC,4A38H
57   DEL:
1843 EDA1 58  CPI

```


LOC OBJ CODE M STMT SOURCE STATEMENT

MPF

821015

PAGE 2
ASM 5.8

1845	00	59	NOP	
1846	00	60	NOP	
1847	E0	61	RET	PO
1848	18F9	62	JR	DE1
		63	////////////////////	
		64	;	
		65	; DELAY 1.725 SEC SUBROUTINE	
		66	;	
		67	////////////////////	
		68	DELAY2:	
184A	010000	69	LD	BC,0
		70	DE2:	
184D	EDA1	71	CPI	
184F	00	72	NOP	
1850	00	73	NOP	
1851	E0	74	RET	PO
1852	18F9	75	JR	DE2