



Micro-Professor Application Note

—DOC. NO. MPF-I-02-210A —

MPF-I AS A TRAFFIC LIGHT CONTROLLER

An Application Example of Z80-PIO.



MULTITECH INDUSTRIAL CORPORATION

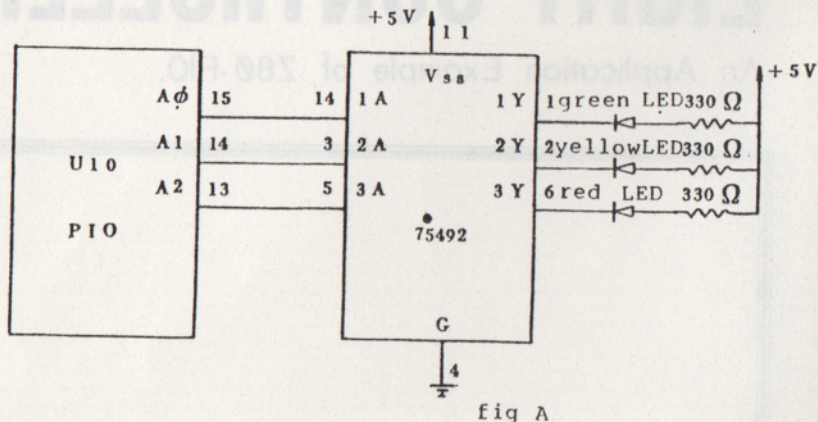
OFFICE : 977, MIN SHEN E. ROAD, TAIPEI, 105, TAIWAN, R.O.C.
TEL: (02)769-1225 (10 LINES) TELEX: 23756 MULTIC
FACTORY: 5, TECHNOLOGY ROAD III
HSINCHU SCIENCE-BASED INDUSTRIAL PARK.
HSINCHU, TAIWAN, 300, R.O.C.
TEL: (035)775102 (3 LINES)

US\$1.00

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:



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 Blackburg; 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
D7	D6	
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

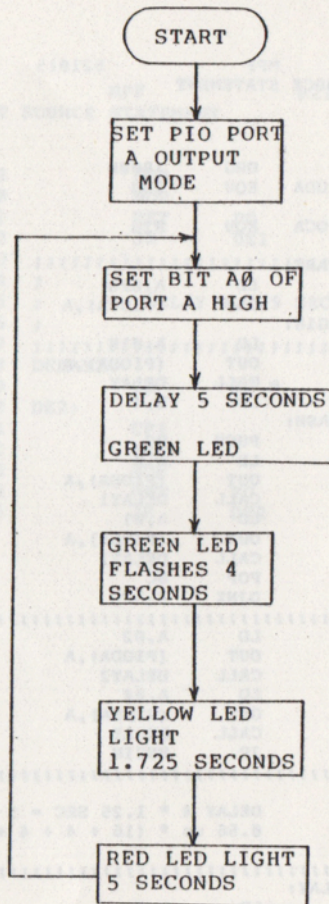
$$0.56 \text{ micro-seconds} \times [7+4[10+(16+4+4+10) \times 65536+4+12]-5+10]=4.9912867 \text{ sec}$$

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

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




```

1800      1
          2      ORG      1800H
          3      PIODA   EQU      80H      ;DATA PORT OF PIO
                                         ;CHANNEL A
          4      PIOCA   EQU      82H      ;CONTROL PORT OF PIO
                                         ;CHANNEL A
          5      START:
          6      LD      A,0FH
          7      OUT     (PIOCA),A      ;PIO PORT A OUTPUT MODE
          8      BEGIN:
          9      LD      A,01H
         10      OUT     (PIODA),A      ;GREEN LED LIGHT
         11      CALL    DELAY          ;DELAY 5 SEC
         12      LD      B,4
         13      FLASH:
         14      PUSH    BC
         15      LD      A,0
         16      OUT     (PIODA),A      ;FLASH 4 SEC
         17      CALL    DELAY1
         18      LD      A,01
         19      OUT     (PIODA),A
         20      CALL    DELAY1
         21      POP     BC
         22      DJNZ    FLASH
         23      ;
         24      LD      A,02
         25      OUT     (PIODA),A      ;YELLOW LED LIGHT
         26      CALL    DELAY2          ;1.725 SEC
         27      LD      A,04
         28      OUT     (PIODA),A      ;RED LED LIGHT
         29      CALL    DELAY          ;5 SEC
         30      JP      BEGIN
         31      ;
         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:
         38      LD      D,4      ; 7T
         39      DELX:
         40      LD      BC,0      ; 10T
         41      DE0:
         42      CPI
         43      NOP      ; 16T
         44      NOP      ; 4T
         45      JP      PE,DE0      ; 4T
         46      DEC     D      ; 10T
         47      JR      NZ,DELX
         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:
         56      LD      BC,4A38H
         57      DE1:
         58      CPI

```

MPF

821015

PAGE 2
ASM 5.8

LOC	OBJ CODE M	STMT	SOURCE	STATEMENT
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

