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, á 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:

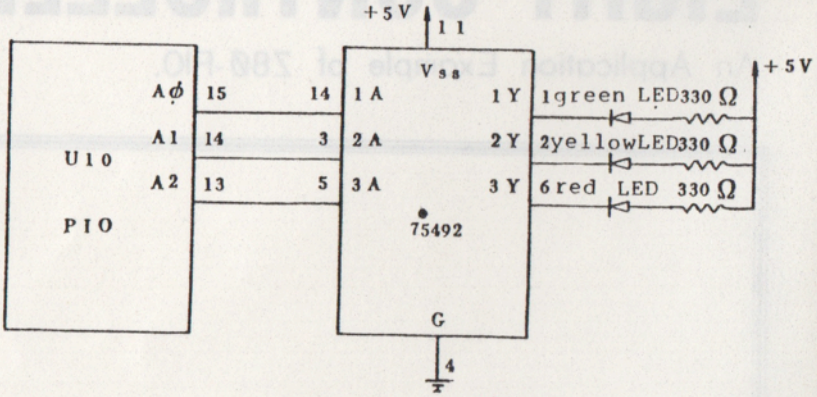


fig A

Expriment 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:

D7	D6	mode of operation
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 DØ should be one. The contents of bit D5 and D4 make no difference to the control word.

D7	D6	D5	D4	D3	D2	D1	Dϕ
M1	Mϕ	×	×	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 Ø (AØ) 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 Ø1 should be sent to the data port of PIO (whose address is 8ØH). By sending ØlH to the data port of PIO, the eight bits on the Port A will become

A7 A6 A5 A4 A3 A2 A1 AØ

Ø Ø Ø Ø Ø Ø Ø 1

The 75492 will convert the input from AØ 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 (Ø2H) 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 (Ø4H) 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 Ø.56 micro-seconds. Therefore, the time delay achieved by the DELAY subroutine is

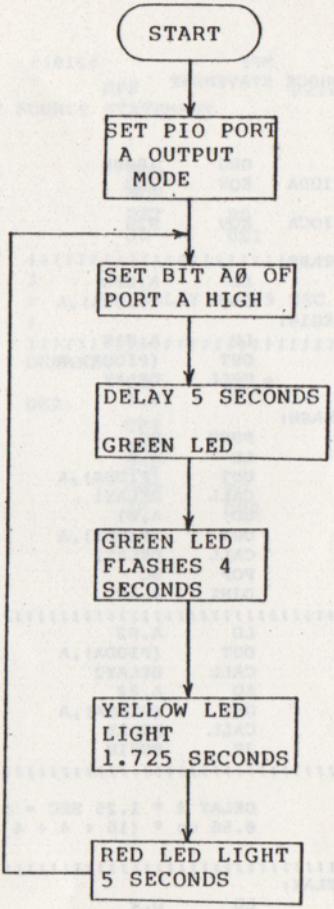
Ø.56 micro-seconds x {7+4[1Ø+(16+4+4+1Ø)x65536+4+12]-5+1Ø}=4.9912867 sec

And the time delay for DELAY1 is

Ø.56 x [1Ø+(16+4+4+11+12)x19ØØØ]=Ø.5ØØØ856 sec

The time delay for DELAY2 is

Ø.56 x [1Ø+(16+4+4+11+12)x65536]=1.7249131 sec


START
SET PIO PORT A OUTPUT MODE
SET BIT A0 OF PORT A HIGH
DELAY 5 SECONDS
GREEN LED
GREEN LED FLASHES 4 SECONDS
YELLOW LED LIGHT 1.725 SECONDS
RED LED LIGHT 5 SECONDS

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LOC   OBJ CODE M STMT SOURCE STATEMENT                          ASM 5.8

                  1
18ØØ              2           ORG    18ØØH
                  3   PIODA   EQU    8ØH             ;DATA PORT OF PIO
                                                      CHANNEL A
                  4   PIOCA   EQU    82H             ;CONTROL PORT OF PIO
                                                      CHANNEL A
                  5   START:
18ØØ  3EØF        6           LD     A,ØFH
18Ø2  D382        7           OUT    (PIOCA),A       ;PIO PORT A OUTPUT MODE
                  8   BEGIN:
18Ø4  3EØ1        9           LD     A,Ø1H
18Ø6  D38Ø       1Ø           OUT    (PIODA),A       ;GREEN LED LIGHT
18Ø8  CD3Ø18     11           CALL   DELAY           ;DELAY 5 SEC
18ØB  Ø6Ø4       12           LD     B,4
                 13   FLASH:
18ØD  C5         14           PUSH   BC
18ØE  3EØØ       15           LD     A,Ø
181Ø  D38Ø       16           OUT    (PIODA),A       ;FLASH 4 SEC
1812  CD4Ø18     17           CALL   DELAY1
1815  3EØ1       18           LD     A,Ø1
1817  D38Ø       19           OUT    (PIODA),A
1819  CD4Ø18     2Ø           CALL   DELAY1
181C  C1         21           POP    BC
181D  1ØEE       22           DJNZ   FLASH
                 23   ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
181F  3EØ2       24           LD     A,Ø2
1821  D38Ø       25           OUT    (PIODA),A       ;YELLOW LED LIGHT
1823  CD4A18     26           CALL   DELAY2          ;1.725 SEC
1826  3EØ4       27           LD     A,Ø4
1828  D38Ø       28           OUT    (PIODA),A       ;RED LED LIGHT
182A  CD3Ø18     29           CALL   DELAY           ;5 SEC
182D  C3Ø418     3Ø           JP     BEGIN .
                 31   ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                 32   ;
                 33   ;       DELAY 4 * 1.25 SEC = 5 SEC  SUBROUTINE
                 34   ;       Ø.56 us * (16 + 4 + 4 + 1Ø ) * 65536 =1.25 SEC
                 35   ;
                 36   ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                 37   DELAY:
183Ø  16Ø4       38           LD     D,4             ; 7T
                 39   DELX:
1832  Ø1ØØØØ     4Ø           LD     BC,Ø            ; 1ØT
                 41   DEØ:
1835  EDA1       42           CPI                    ; 16T
1837  ØØ         43           NOP                    ; 4T
1838  ØØ         44           NOP                    ; 4T
1839  EA3518     45           JP     PE,DEØ          ; 1ØT
183C  15         46           DEC    D
183D  2ØF3       47           JR     NZ,DELX
183F  C9         48           RET
                 49   ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                 5Ø   ;
                 51   ;       DELAY Ø.5 SEC SUBROUTINE
                 52   ;       Ø.56 us * (16 + 4 + 4 + 11 + 12 ) * 19ØØØ =Ø.5 SEC
                 53   ;
                 54   ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                 55   DELAY1:
184Ø  Ø1384A     56           LD     BC,4A38H
                 57   DE1:
1843  EDA1       58           CPI
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1845  ØØ          59          NOP
1846  ØØ          6Ø          NOP
1847  EØ          61          RET     PO
1848  18F9        62          JR      DE1
                  63  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                  64  ;
                  65  ;         DELAY 1.725 SEC SUBROUTINE
                  66  ;
                  67  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                  68  DELAY2:
184A  Ø1ØØØØ     69          LD      BC,Ø
                  7Ø  DE2:
184D  EDA1        71          CPI
184F  ØØ          72          NOP
185Ø  ØØ          73          NOP
1851  EØ          74          RET     PO
1852  18F9        75          JR      DE2
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