



Micro-Professor Application Note

—DOC. NO. MPF-I-01-210A —

MPF-I AS A FREQUENCY COUNTER

An Application Example of Z80-CTC.



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 CTC to design a frequency counter

Required Equipment: MPF-1 (included CTC)

Experiment Explanation:

1. CTC has four channels CH0 - CH3 is mapping to 40H, 41H, 42H, 43H. In this program, we use CH0 & CH1. The function is shown below.

CH1: used for timer interrupt, triggered by the internal clock of MPF-1 (1789772 Hz), we set CH0 to

Mode: timer

Range: 256

Time constant: 233 (0E9H)

So after interrupt 30 (01EH) times. It will be approximately 1 sec, $256 * 233 * 30 = 0FFH * 0E9H * 01EH = 1789440$. It has error $(1789772 - 1789440) / 1789772 = 0.00185\%$

CH0: used for counter interrupt, triggered by user signal

Mode: counter

And set 'down counter' = 100. Each time interrupts happen, we can add frequency counter by 1. We can get signal frequency when one sec is up.

2. LED display is in decimal format (six digit). So the largest value is 999999. When frequency is over this it will get some warning message, eg., display 'over' message, and tone 2K
3. Special care should be exerted when using the CTC. To avoid burning out the CTC, you should first refer to the Z80 Handbook, Z80-CTC Technical Manual, section 8.1 D.C. Characteristics. User signal used to trigger the CTC should comply with the following characteristics:

INPUT LOW VOLTAGE: -0.3V -- 0.8V

INPUT HIGH VOLTAGE: 2.0V -- Vcc.

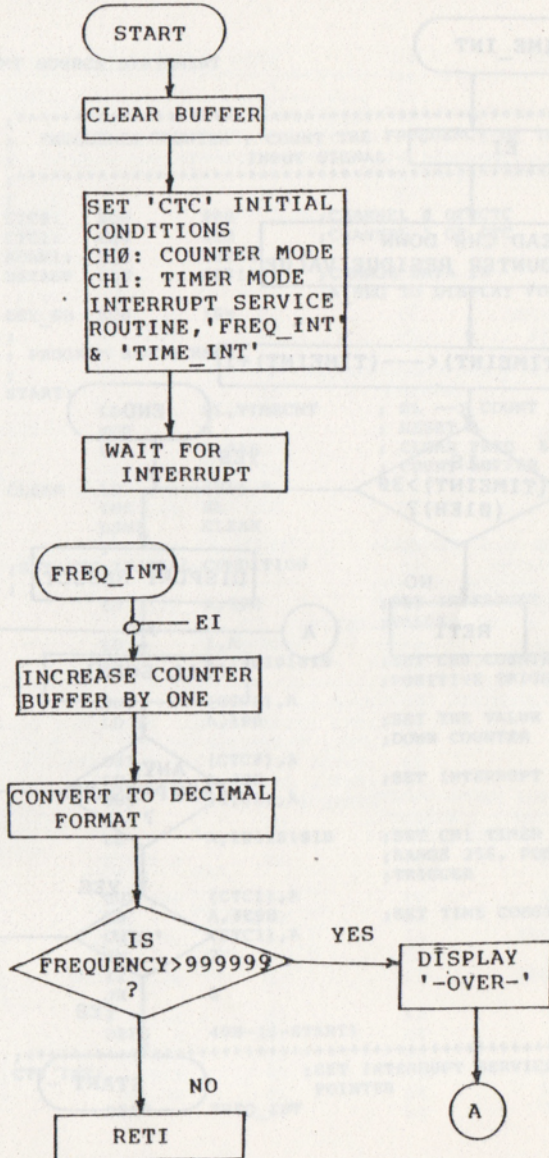
OUTPUT LOW VOLTAGE: 0.4V

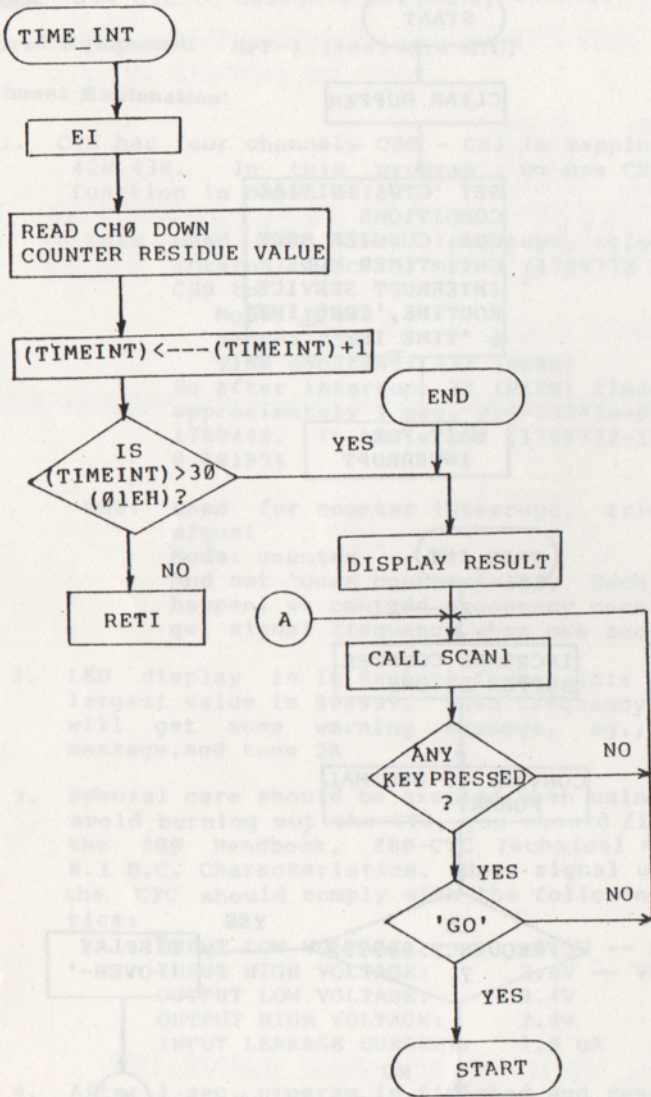
OUTPUT HIGH VOLTAGE: 2.4V

INPUT LEAKAGE CURRENT: 1.0 uA

4. After 1 sec, program is finished and result will display at LED. If user want to count again, you can pressed key 'GO' then it will count again. Othersize, it will continue to display data.

Flowchart:





LOC OBJ CODE M STMT SOURCE STATEMENT

```

1 ;*****
2 ; FREQUENCY COUNTER : COUNT THE FREQUENCY OF THE*
3 ; INPUT SIGNAL *
4 ;*****
5 ;
6 CTC0: EQU 40H ;CHANNEL 0 OF CTC
7 CTC1: EQU 41H ;CHANNEL 1 OF CTC
8 SCAN1: EQU 0624H
9 DATADP EQU 0671H ;CHANGE DATA IN
;A_REG TO DISPLAY FORMAT
10 DEY_GO EQU 16H
11 ;
12 ; PROGRAM BEGIN HERE!
13 ;
14 START:
15 LD HL,TIMECNT ; HL --> COUNT BUFFER
16 XOR A ; RESET A
17 LD B,0AH ; CLEAR FREQ & TIMER
; COUNT BUFFER
1800 21A500 15
1803 AF 16
1804 060A 17
1806 77 18 CLEAR LD (HL),A
1807 23 19 INC HL
1808 10FC 20 DJNZ CLEAR
21 ;
22 ;SET CTC INITIAL CONDITION
23 ;
24 LD A,20H ;SET INTERRUPT REGISTER
;VALUE
180A 3E20 24
25 LD I,A
26 LD A,11010101B ;SET CH0 COUNTER MODE,
;POSITIVE TRIGGER
180C ED47 25
180E 3ED5 26
27 OUT (CTC0),A
28 LD A,100 ;SET THE VALUE OF
;DOWN COUNTER
1810 D340 27
1812 3E64 28
29 OUT (CTC0),A
30 LD A,40H ;SET INTERRUPT VECTOR
31 OUT (CTC0),A
32 ;
33 LD A,10110101B ;SET CH1 TIMER CODE,
;RANGE 256, POSITIVE
;TRIGGER
1814 D340 29
1816 3E40 30
1818 D340 31
32 ;
33 LD A,10110101B ;SET CH1 TIMER CODE,
;RANGE 256, POSITIVE
;TRIGGER
181A 3EB5 33
34 OUT (CTC1),A
35 LD A,0E9H ;SET TIME CONSTANT
36 OUT (CTC1),A
37 IM 2
38 EI
39 JR $
40 ;
41 DEFS 40H-($-START)
1827 42
43 ;+++++++
CTC_INT: ;SET INTERRUPT SERVICE ROUTINE
; POINTER
1840 4400 44 DEFW FREQ_INT

```

```

1842 5D00      45      DEFW      TIME_INT
1843           46      ;
1844           47      ;+++++
1845           48      FREQ_INT:
1846           49      ;FREQUENCY COUNTER INTERRUPT SERVICE ROUTINE
1847           50      ;INCREASE COUNTER AND CONVERT TO DECIMAL FORMAT
1848           51      ;
1849           52      EI                      ;WHEN CPU ENTER THIS INTERRUPT
1850           53      ;SERVICE
1851           54      ;ROUTINE, IT WILL DISABLE
1852           55      ;ANOTHER INTERRUPT
1853           56      ;SO "EI" CAN LET COUNT_INT
1854           57      ;HAPPEN
1855           58      LD      HL,FREQCNT+1
1856           59      LD      B,2          ;SET FREQUENCY BUFFER
1857           60      ;COUNTERR
1858           61      ADDONE:
1859           62      EI
1860           63      LD      A,(HL)
1861           64      ADD      A,1          ;INCREASE COUNT BY ONE
1862           65      DAA              ;CHANGE TO DECIMAL FORMAT
1863           66      LD      (HL),A      ;RESTORE VALUE
1864           67      JR      NC,NOTOVER  ;NOT OVER 99
1865           68      INC      HL         ;OVER,MUST INCREASE HIGH
1866           69      ;ORDER BUE ONE
1867           70      DJNZ     ADDONE
1868           71      LD      IX,OVER     ;FREQUENCY LARGER THEN
1869           72      ;999999 DISPLAY '-OVER-'
1870           73      JR      DISPLAY
1871           74      NOTOVER:
1872           75      RETI
1873           76      ;
1874           77      ;+++++
1875           78      TIME_INT:
1876           79      ;CH1 (TIMER MODE) INTERRUPT SERVICE ROUTINE
1877           80      ;CH1: TRIGGERED BY 'MPF-1' CLOCK(1789772HZ)
1878           81      ;EVERY 256*233 HZ, THIS SERVICE ROUTINE WILL DO AGAIN
1879           82      ;UNTIL 30 TIMES (--1 SEC),PROGRAM HALT AND SIGNAL
1880           83      ;FREQUENCY GET
1881           84      EI                      ;LET ANOTHER INTERRUPT
1882           85      IN      A,(CTC0)      ;CAN HAPPEN ANYTIME
1883           86      SUB      100         ;GET CH0 GOWN COUNTER
1884           87      NEG      A          ;RESIDUE VALUE
1885           88      LD      (FREQCNT),A  ;SAVE THIS TO BUFFER
1886           89      ;
1887           90      LD      HL,TIMECNT   ;INCREASE TIME COUNTER BY
1888           91      ;ONE
1889           92      LD      A,(HL)
1890           93      INC      A
1891           94      LD      (HL),A      ;RESTORE VALUE
1892           95      CP      01EH        ;CHECK ONE SEC ?
1893           96      JR      NC,END      ;YES
1894           97      RETI

```

```

90
91 ;*****
92 END:
93
94         DI
        LD         B,2           ;CHANGE LOWER BYTE
                                   ;OF FREQUENCY COUNTER
                                   ;TO DECIMAL FORMAT
1873      F3
1874      0602
1876      AF           95         XOR         A
1877      21A600       96         LD         HL,FREQCNT
187A      ED67         97         CHANGE: RRD
187C      CE00         98         ADC         A,0
187E      27           99         DAA
187F      10F9        100        DJNZ        CHANGE
1881      ED67        101        RRD
1883      0603        102        ;
1885      11A600      103        LD         B,3
1886                        104        LD         DE,FREQCNT ;CHANGE FREQ TO DISPLAY
                                   ;PATTERN
1888      21A900      105        LD         HL,OUTBUF
188B      1A           106        CONVERT:
188C      13           107        LD         A,(DE)
188D      CD7406      108        INC         DE
1890      10F9        109        CALL        DATADP+3
1891                        110        DJNZ        CONVERT
1892      DD21A900    111        ;
1896      CD2406      112        LD         IX,OUTBUF ;DISPLAY DATA TO LED
1899      38FB        113        DISPLAY:CALL SCAN1
189A                        114        JR         C,DISPLAY ;NO KEY PRESSED,SCAN
                                   ;AGAIN
189B      FE16        115        CP         KEY_GO ;PRESSED 'GO' ?
189D      20F7        116        JR         NZ,DISPLAY ;NO
189F      210000      117        LD         HL,START ;RETURN TO PROGRAM
                                   ;STRTING ADDR. &
                                   ;COUNT FREQUENCY AGAIN
18A2      E3           118        EX         (SP),HL
18A3      ED4D        119        RETI
18A4                        120        ;
18A5                        121        ;
18A6      122        122        TIMECNT DEFS 1 ;TIMER COUNT BUFFER
18A7      123        123        FREQCNT DEFS 3 ;FREQUENCY COUNT BUFFER
18A8      124        124        OUTBUF  DEFS 6 ;DISPLAY BUFFER
18A9      125        125        OVER:
18AF      02          126        DEFB        02H ; '-'
18B0      03          127        DEFB        03H ; 'R'
18B1      8F          128        DEFB        08FH ; 'E'
18B2      B7          129        DEFB        0B7H ; 'V'
18B3      A3          130        DEFB        0A3H ; 'O'
18B4      02          131        DEFB        02H ; '-'

```