



Micro-Professor Application Note

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MPF-I AS A FREQUENCY COUNTER

An Application Example of Z80-CTC.



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US\$1.00

DATE	TIME	LOCATION	STATUS	REMARKS
1941	1200	STATION	ARRIVED	FROM NEW YORK
1941	1300	STATION	DEPARTED	FOR PHOENIX
1941	1400	STATION	ARRIVED	FROM PHOENIX
1941	1500	STATION	DEPARTED	FOR LOS ANGELES
1941	1600	STATION	ARRIVED	FROM LOS ANGELES
1941	1700	STATION	DEPARTED	FOR SAN FRANCISCO
1941	1800	STATION	ARRIVED	FROM SAN FRANCISCO
1941	1900	STATION	DEPARTED	FOR SEATTLE
1941	2000	STATION	ARRIVED	FROM SEATTLE
1941	2100	STATION	DEPARTED	FOR PORTLAND
1941	2200	STATION	ARRIVED	FROM PORTLAND
1941	2300	STATION	DEPARTED	FOR OREGON
1941	0000	STATION	ARRIVED	FROM OREGON
1941	0100	STATION	DEPARTED	FOR CALIFORNIA
1941	0200	STATION	ARRIVED	FROM CALIFORNIA
1941	0300	STATION	DEPARTED	FOR ARIZONA
1941	0400	STATION	ARRIVED	FROM ARIZONA
1941	0500	STATION	DEPARTED	FOR NEW YORK
1941	0600	STATION	ARRIVED	FROM NEW YORK
1941	0700	STATION	DEPARTED	FOR PHOENIX
1941	0800	STATION	ARRIVED	FROM PHOENIX
1941	0900	STATION	DEPARTED	FOR LOS ANGELES
1941	1000	STATION	ARRIVED	FROM LOS ANGELES
1941	1100	STATION	DEPARTED	FOR SAN FRANCISCO
1941	1200	STATION	ARRIVED	FROM SAN FRANCISCO
1941	1300	STATION	DEPARTED	FOR SEATTLE
1941	1400	STATION	ARRIVED	FROM SEATTLE
1941	1500	STATION	DEPARTED	FOR PORTLAND
1941	1600	STATION	ARRIVED	FROM PORTLAND
1941	1700	STATION	DEPARTED	FOR OREGON
1941	1800	STATION	ARRIVED	FROM OREGON
1941	1900	STATION	DEPARTED	FOR CALIFORNIA
1941	2000	STATION	ARRIVED	FROM CALIFORNIA
1941	2100	STATION	DEPARTED	FOR ARIZONA
1941	2200	STATION	ARRIVED	FROM ARIZONA
1941	2300	STATION	DEPARTED	FOR NEW YORK
1941	0000	STATION	ARRIVED	FROM NEW YORK

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.

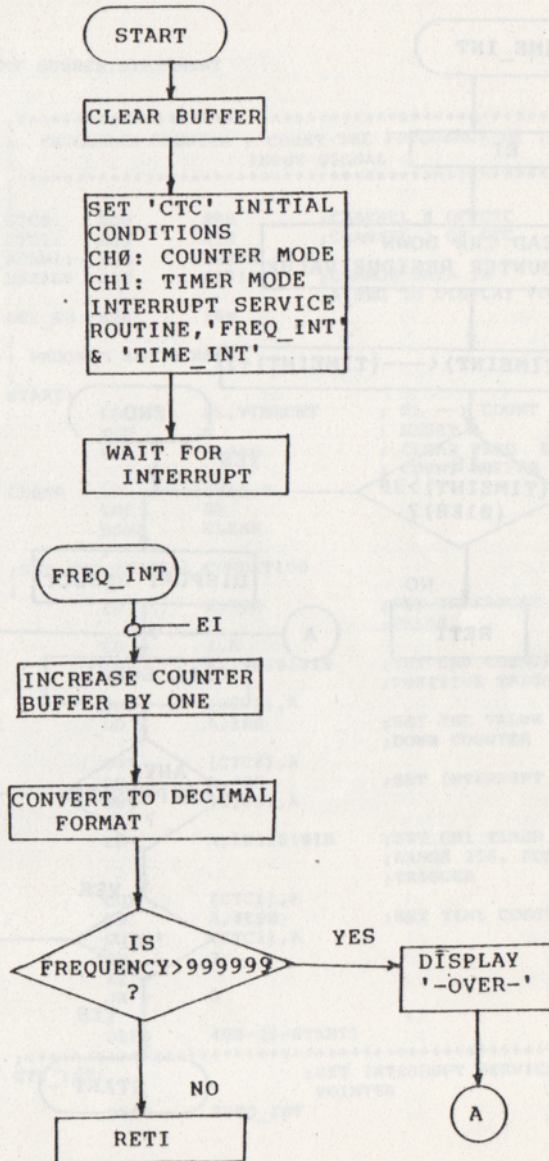
OUTPUT LOW VOLTAGE: 0.4V

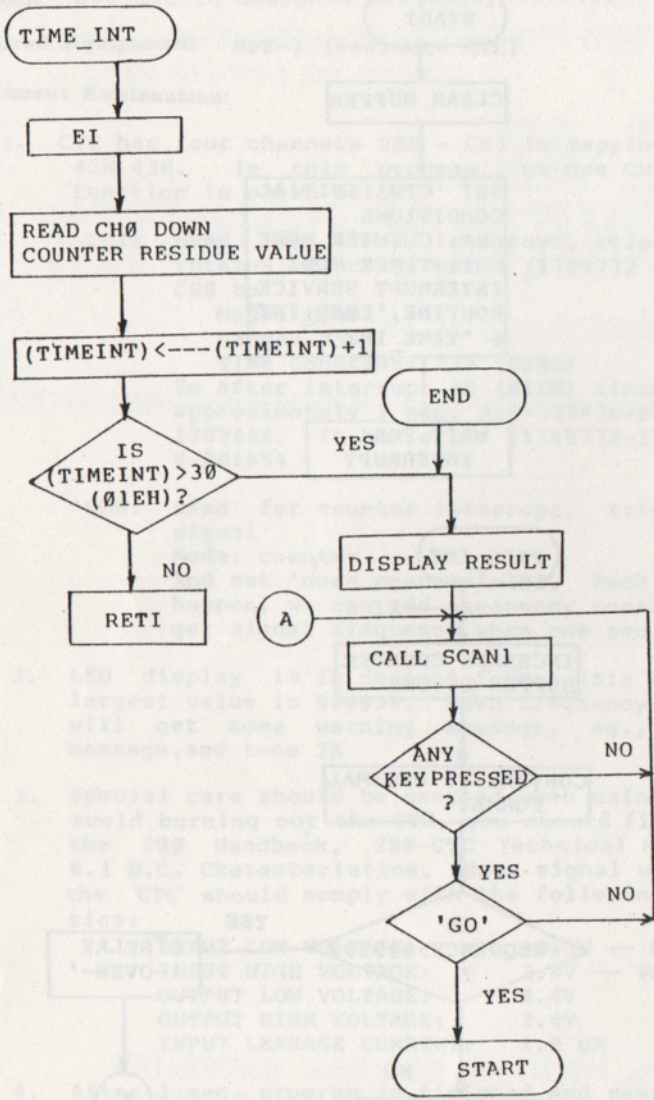
OUTPUT HIGH VOLTAGE: 2.4V

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 18 CLEAR LD (HL),A
1803 AF 16 XOR A
1804 060A 17 LD B,0AH
; CLEAR FREQ & TIMER
; COUNT BUFFER
1806 77 18 CLEAR LD (HL),A
1807 23 19 INC HL
1808 10FC 20 DJNZ CLEAR
21 ;
22 ;SET CTC INITIAL CONDITION
23 ;
180A 3E20 24 LD A,20H ;SET INTERRUPT REGISTER
;VALUE
180C ED47 25 LD I,A
180E 3ED5 26 LD A,11010101B ;SET CH0 COUNTER MODE,
;POSITIVE TRIGGER
1810 D340 27 OUT (CTC0),A
1812 3E64 28 LD A,100 ;SET THE VALUE OF
;DOWN COUNTER
1814 D340 29 OUT (CTC0),A
1816 3E40 30 LD A,40H ;SET INTERRUPT VECTOR
1818 D340 31 OUT (CTC0),A
32 ;
181A 3EB5 33 LD A,10110101B ;SET CH1 TIMER CODE,
;RANGE 256, POSITIVE
;TRIGGER
181C D341 34 OUT (CTC1),A
181E 3EE9 35 LD A,0E9H ;SET TIME CONSTANT
1820 D341 36 OUT (CTC1),A
1822 ED5E 37 IM 2
1824 FB 38 EI
1825 18FE 39 JR $
40 ;
1827 41 DEFS 40H-($-START)
42 ;+++++;
43 CTC_INT: ;SET INTERRUPT SERVICE ROUTINE
POINTER
1840 4400 44 DEFW FREQ_INT

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1842 5D00      45      DEFW      TIME_INT
          46      ;
          47      ;+++++
48      ;FREQ INT:
          49      ;FREQUENCY COUNTER INTERRUPT SERVICE ROUTINE
          50      ;INCREASE COUNTER AND CONVERT TO DECIMAL FORMAT
          51      ;
1844  FB      52      EI              ;WHEN CPU ENTER THIS INTERRUPT
          ;SERVICE
          53      ;ROUTINE, IT WILL DISABLE
          ;ANOTHER INTERRUPT
          54      ;SO "EI" CAN LET COUNT_INT
          ;HAPPEN
1845  21A700   55      LD              HL,FREQCNT+1
1848  0602     56      LD              B,2          ;SET FREQUENCY BUFFER
          ;COUNTER
          57      ADDONE:
184A  FB      58      EI              ;
184B  7E      59      LD              A,(HL)
184C  C601   60      ADD             A,1          ;INCREASE COUNT BY ONE
184E  27      61      DAA             ;CHANGE TO DECIMAL FORMAT
184F  77      62      LD              (HL),A    ;RESTORE VALUE
1850  3009   63      JR              NC,NOTOVER ;NOT OVER 99
1852  23      64      INC             HL        ;OVER,MUST INCREASE HIGH
          ;ORDER BUE ONE
1853  10F5   65      DJNZ          ADDONE
1855  DD21AF00 66      LD              IX,OVER    ;FREQUENCY LARGER THEN
          ;999999 DISPLAY '-OVER-'
1859  183B   67      JR              DISPLAY
          68      NOTOVER:
185B  ED4D   69      RETI
          70      ;
          71      ;+++++
          72      TIME INT:
          73      ;CH1 (TIMER MODE) INTERRUPT SERVICE ROUTINE
          74      ;CH1: TRIGGERED BY 'MPF-1' CLOCK(1789772HZ)
          75      ;EVERY 256*233 HZ, THIS SERVICE ROUTINE WILL DO AGAIN
          76      ;UNTIL 30 TIMES (--1 SEC),PROGRAM HALT AND SIGNAL
          ;FREQUENCY GET
185D  FB      77      EI              ;LET ANOTHER INTERRUPT
          ;CAN HAPPEN ANYTIME
185E  DB40   78      IN              A,(CTC0)    ;GET CH0 GOWN COUNTER
          ;RESIDUE VALUE
1860  D664   79      SUB             100
1862  ED44   80      NEG
1864  32A600  81      LD              (FREQCNT),A    ;SAVE THIS TO BUFFER
          82      ;
1867  21A500  83      LD              HL,TIMECNT    ;INCREASE TIME COUNTER BY
          ;ONE
186A  7E      84      LD              A,(HL)
186B  3C      85      INC             A
186C  77      86      LD              (HL),A    ;RESTORE VALUE
186D  FE1E   87      CP              01EH        ;CHECK ONE SEC ?
186F  3002   88      JR              NC,END      ;YES
1871  ED4D   89      RETI

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```

90
91 ;*****
92 END:
1873 F3 93 DI
1874 0602 94 LD B,2 ;CHANGE LOWER BYTE
;OF FREQUENCY COUNTER
;TO DECIMAL FORMAT
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
102 ;
1883 0603 103 LD B,3
1885 11A600 104 LD DE,FREQCNT ;CHANGE FREQ TO DISPLAY
;PATTERN
1888 21A900 105 LD HL,OUTBUF
106 CONVERT:
188B 1A 107 LD A,(DE)
188C 13 108 INC DE
188D CD7406 109 CALL DATADP+3
1890 10F9 110 DJNZ CONVERT
111 ;
1892 DD21A900 112 LD IX,OUTBUF ;DISPLAY DATA TO LED
1896 CD2406 113 DISPLAY:CALL SCAN1
1899 38FB 114 JR C,DISPLAY ;NO KEY PRESSED,SCAN
;AGAIN
;PRESSED 'GO' ?
;NO
;RETURN TO PROGRAM
;STRTING ADDR. &
;COUNT FREQUENCY AGAIN
18A2 E3 118 EX (SP),HL
18A3 ED4D 119 RETI
120 ;
121 ;
18A5 122 TIMECNT DEFS 1 ;TIMER COUNT BUFFER
18A6 123 FREQCNT DEFS 3 ;FREQUENCY COUNT BUFFER
18A9 124 OUTBUF DEFS 6 ;DISPLAY BUFFER
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 ;'- '

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DATE	TIME	TYPE	CLASS	STATUS	REMARKS
1941	0800	A	101	OK	
1941	0810	A	101	OK	
1941	0820	A	101	OK	
1941	0830	A	101	OK	
1941	0840	A	101	OK	
1941	0850	A	101	OK	
1941	0900	A	101	OK	
1941	0910	A	101	OK	
1941	0920	A	101	OK	
1941	0930	A	101	OK	
1941	0940	A	101	OK	
1941	0950	A	101	OK	
1941	1000	A	101	OK	
1941	1010	A	101	OK	
1941	1020	A	101	OK	
1941	1030	A	101	OK	
1941	1040	A	101	OK	
1941	1050	A	101	OK	
1941	1100	A	101	OK	
1941	1110	A	101	OK	
1941	1120	A	101	OK	
1941	1130	A	101	OK	
1941	1140	A	101	OK	
1941	1150	A	101	OK	
1941	1200	A	101	OK	
1941	1210	A	101	OK	
1941	1220	A	101	OK	
1941	1230	A	101	OK	
1941	1240	A	101	OK	
1941	1250	A	101	OK	
1941	1300	A	101	OK	
1941	1310	A	101	OK	
1941	1320	A	101	OK	
1941	1330	A	101	OK	
1941	1340	A	101	OK	
1941	1350	A	101	OK	
1941	1400	A	101	OK	
1941	1410	A	101	OK	
1941	1420	A	101	OK	
1941	1430	A	101	OK	
1941	1440	A	101	OK	
1941	1450	A	101	OK	
1941	1500	A	101	OK	
1941	1510	A	101	OK	
1941	1520	A	101	OK	
1941	1530	A	101	OK	
1941	1540	A	101	OK	
1941	1550	A	101	OK	
1941	1600	A	101	OK	
1941	1610	A	101	OK	
1941	1620	A	101	OK	
1941	1630	A	101	OK	
1941	1640	A	101	OK	
1941	1650	A	101	OK	
1941	1700	A	101	OK	
1941	1710	A	101	OK	
1941	1720	A	101	OK	
1941	1730	A	101	OK	
1941	1740	A	101	OK	
1941	1750	A	101	OK	
1941	1800	A	101	OK	
1941	1810	A	101	OK	
1941	1820	A	101	OK	
1941	1830	A	101	OK	
1941	1840	A	101	OK	
1941	1850	A	101	OK	
1941	1900	A	101	OK	
1941	1910	A	101	OK	
1941	1920	A	101	OK	
1941	1930	A	101	OK	
1941	1940	A	101	OK	
1941	1950	A	101	OK	
1941	2000	A	101	OK	
1941	2010	A	101	OK	
1941	2020	A	101	OK	
1941	2030	A	101	OK	
1941	2040	A	101	OK	
1941	2050	A	101	OK	
1941	2100	A	101	OK	
1941	2110	A	101	OK	
1941	2120	A	101	OK	
1941	2130	A	101	OK	
1941	2140	A	101	OK	
1941	2150	A	101	OK	
1941	2200	A	101	OK	
1941	2210	A	101	OK	
1941	2220	A	101	OK	
1941	2230	A	101	OK	
1941	2240	A	101	OK	
1941	2250	A	101	OK	
1941	2300	A	101	OK	
1941	2310	A	101	OK	
1941	2320	A	101	OK	
1941	2330	A	101	OK	
1941	2340	A	101	OK	
1941	2350	A	101	OK	
1941	0000	A	101	OK	

DATE	TIME	LOCATION	STATUS	REMARKS
1941	12:00	STATION	ARRIVED	FROM NEW YORK
1941	12:15	STATION	DEPARTED	FOR PHOENIX
1941	12:30	STATION	ARRIVED	FROM PHOENIX
1941	12:45	STATION	DEPARTED	FOR LOS ANGELES
1941	13:00	STATION	ARRIVED	FROM LOS ANGELES
1941	13:15	STATION	DEPARTED	FOR SAN FRANCISCO
1941	13:30	STATION	ARRIVED	FROM SAN FRANCISCO
1941	13:45	STATION	DEPARTED	FOR PORTLAND
1941	14:00	STATION	ARRIVED	FROM PORTLAND
1941	14:15	STATION	DEPARTED	FOR SEASIDE
1941	14:30	STATION	ARRIVED	FROM SEASIDE
1941	14:45	STATION	DEPARTED	FOR OAKLAND
1941	15:00	STATION	ARRIVED	FROM OAKLAND
1941	15:15	STATION	DEPARTED	FOR SACRAMENTO
1941	15:30	STATION	ARRIVED	FROM SACRAMENTO
1941	15:45	STATION	DEPARTED	FOR STOCKTON
1941	16:00	STATION	ARRIVED	FROM STOCKTON
1941	16:15	STATION	DEPARTED	FOR YUBA CITY
1941	16:30	STATION	ARRIVED	FROM YUBA CITY
1941	16:45	STATION	DEPARTED	FOR COLUSA
1941	17:00	STATION	ARRIVED	FROM COLUSA
1941	17:15	STATION	DEPARTED	FOR BUTTE
1941	17:30	STATION	ARRIVED	FROM BUTTE
1941	17:45	STATION	DEPARTED	FOR YUBA
1941	18:00	STATION	ARRIVED	FROM YUBA
1941	18:15	STATION	DEPARTED	FOR SUTTER
1941	18:30	STATION	ARRIVED	FROM SUTTER
1941	18:45	STATION	DEPARTED	FOR YUBA
1941	19:00	STATION	ARRIVED	FROM YUBA
1941	19:15	STATION	DEPARTED	FOR SUTTER
1941	19:30	STATION	ARRIVED	FROM SUTTER
1941	19:45	STATION	DEPARTED	FOR YUBA
1941	20:00	STATION	ARRIVED	FROM YUBA
1941	20:15	STATION	DEPARTED	FOR SUTTER
1941	20:30	STATION	ARRIVED	FROM SUTTER
1941	20:45	STATION	DEPARTED	FOR YUBA
1941	21:00	STATION	ARRIVED	FROM YUBA
1941	21:15	STATION	DEPARTED	FOR SUTTER
1941	21:30	STATION	ARRIVED	FROM SUTTER
1941	21:45	STATION	DEPARTED	FOR YUBA
1941	22:00	STATION	ARRIVED	FROM YUBA
1941	22:15	STATION	DEPARTED	FOR SUTTER
1941	22:30	STATION	ARRIVED	FROM SUTTER
1941	22:45	STATION	DEPARTED	FOR YUBA
1941	23:00	STATION	ARRIVED	FROM YUBA