NEC

D/A Converter in Real-Time Output Mode

On-Chip Peripheral Program Example August 1999

Description

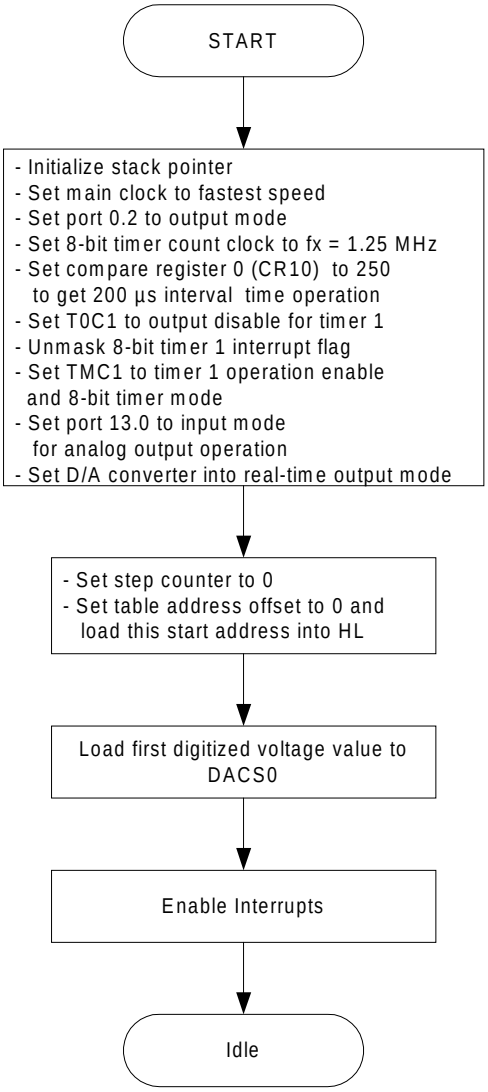
The 8-bit D/A converter in the μPD7805x/78005x subseries can be used in the normal output mode or the real-time output mode.

This program demonstrates the D/A converter in real-time output mode. Every 200 μs, an interrupt toggles port 0.2 and outputs a voltage step at pin ANO0/P130. The 0-, 1-, 2-, 3-, 4-, and 5-volt steps are predefined in a lookup table. After reaching the 5-volt step, the program starts outputting from 0 volts again.

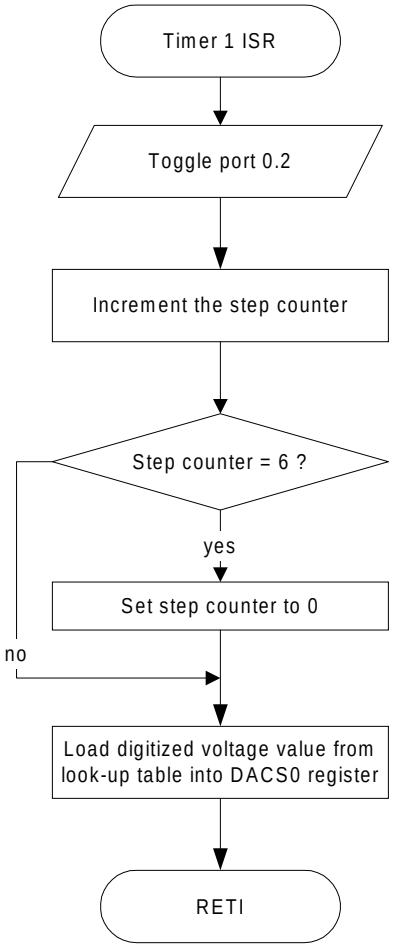
Program Specifications

- D/A converter channel 0 in real-time mode
- D/A output triggered every 200 μs by timer 1 interrupt
- D/A outputs analog voltages form 0 to 5 volts in 1-volt steps
- Pins used in program:
  - P02/INTP2: toggles every 200 μs
  - ANO0/P130: outputs analog voltage from D/A converter

Flowchart


START
- Initialize stack pointer
- Set main clock to fastest speed
- Set port 0.2 to output mode
- Set 8-bit timer count clock to fx = 1.25 MHz
- Set compare register 0 (CR10) to 250
to get 200 µs interval time operation
- Set T0C1 to output disable for timer 1
- Unmask 8-bit timer 1 interrupt flag
- Set TMC1 to timer 1 operation enable
and 8-bit timer mode
- Set port 13.0 to input mode
for analog output operation
- Set D/A converter into real-time output mode
- Set step counter to 0
- Set table address offset to 0 and
load this start address into HL
Load first digitized voltage value to
DACS0
Enable Interrupts
Idle

Flowchart ISR



Assembly Language Program

```
;*************************************************************************
; Date:       08/27/1999
;
; Parameters: - fastest CPU clock
;               (fx = 5 MHz; 1 CPU clock cycle = 200 ns)
;             - 8-bit D/A channel 0 (ANO0)
;             - Real-time output operation mode
;             - Timer 1 as output trigger
;             - Output ladder voltage:         0 V, 1 V, 2 V, 3 V, 4 V, 5 V
;             - Output ladder frequency:       5 kHz (200 µs steps)
;             - Reference voltage:             5 V (must be attached to Vref1 pin)
;             - Output port:                   Port 0.2 toggles every 200 µs
;*************************************************************************

;=======================================
;=      Digitized voltage values        =
;=======================================

VoltageTable:      db 0 * 255 /Vref1           ; 0 volt
                   db 1 * 255 /Vref1           ; 1 volt
                   db 2 * 255 /Vref1           ; 2 volt
                   db 3 * 255 /Vref1           ; 3 volt
                   db 4 * 255 /Vref1           ; 4 volt
                   db 5 * 255 /Vref1           ; 5 volt

;=======================================
;=      Constants/Variables             =
;=======================================

Vref1           equ         5                  ; Reference voltage value
TableSize       equ         $ - VoltageTable

;=======================================
;=      Data Segment                     =
;=======================================

Data               DSEG     saddr
StepCounter:       ds       1         ; Voltage step counter

;=======================================
;=       Specify Interrupt Vectors     =
;=======================================

Res_Vec   CSEG AT 0000h               ; Set main program start vector
          DW       Start
Tmr_Vec   CSEG AT 0024h               ; Set interrupt vector for 8-bit timer 1
          DW       TM1_ISR

;=======================================
;=       Main Program                   =
;=======================================

MAIN      CSEG
Start:    DI                          ; Disable interrupts
          MOVW     AX, #0FE20h        ; Load SP address
          MOVW     SP, AX             ; Set stack pointer
```

```
          MOV       OSMS,#01h          ; Don't use scaler
          MOV       PCC, #00h          ; Main system clock at fastest setting
          CLR1      P0.2               ; Latch port 0.2 low
          CLR1      PM0.2              ; Set port 0.2 to output mode
          MOV       TCL1,#07h          ; Select counter clock to fx = 1.25 MHz
          MOV       CR10,#250          ; Set Compare register to 250
                                       ;  200 µs interval
          MOV       TOC1,#00h          ; Disable output function
          MOV       TMC1,#01h          ; Set timer 1 operation enable
                                       ;  and 8-bit timer mode
          CLR1      TMMK1              ; Unmask the 8-bit timer 1 interrupt
          CLR1      PM13.1             ; Set port 13.1 to output mode
          CLR1      P13.1              ; Latch port 13.1 to low
          SET1      PM13.0             ; Set port 13.0 to input mode
                                       ;  (analog output)
          MOV       DAM,#11h           ; D/A channel 0 conversion enable
                                       ;  in real-time output mode
          MOV       StepCounter,#0     ; Set voltage output step counter to 0
          MOV       C,#0               ; Set address offset to 0
          MOVW      HL,#VoltageTable   ; Load look-up table start address
          MOV       A,[HL+C]           ; Read digital value of the voltage
          MOV       DACS0,A            ;  and write value to DAC register
          EI                           ; Enable interrupts
Loop:     BR        Loop               ; Endless loop
;=======================================
;=      8-bit timer 1 ISR               =
;=======================================
ISR       CSEG
TM1_ISR:
          XOR       P0, #04h                    ; Toggle port 0.2
          INC       StepCounter                 ; Increment step counter
          CMP       StepCounter,#TableSize      ; Compare step counter with
                                                ;   size of table
          BNZ       $ISR10                      ; Branch if step counter is not 6
          MOV       StepCounter,#0              ; Clear step counter
ISR10:    MOV       A,StepCounter               ; Load step counter to A register
          MOV       C,A                         ;  to store in C register
          MOVW      HL,#VoltageTable            ; Load look-up table start address
          MOV       A,[HL+C]                    ; Read digital value of the voltage
          MOV       DACS0,A                     ; and write value to DAC register
          RETI                                  ; Return from interrupt
          END
```

C Language Program

```
/************************************************************************
; Date:       08/27/1999
;
; Parameters: - fastest CPU clock
;               (fx = 5 MHz; 1 CPU clock cycle = 200 ns)
;             - 8-bit D/A channel 0 (ANO0)
;             - Real-time output operation mode
;             - Timer 1 as output trigger
;             - Output ladder voltage:         0 V, 1 V, 2 V, 3 V, 4 V, 5 V
;             - Output ladder frequency:       5 kHz (200 µs steps)
;             - Reference voltage:             5 V (must be attached to Vref1 pin)
;             - Output port:                   Port 0.2 toggles every 200 µs
;************************************************************************/

/* extension functions in K0/K0S compiler */
#pragma sfr        /* key word to allow SFR names in C code */
#pragma asm        /* key word to allow ASM statements in C code */
#pragma EI         /* key word for EI instruction in C code */

/*====================================
;=      Specify Interrupt Vectors      =
;====================================*/
#pragma interrupt INTTM1 TM1_ISR              /* TM1 interval timer vector */

/*====================================
;=      Constants/Variables            =
;====================================*/
#define  TRUE               1
#define  FALSE              0
#define  Vref1              5                 /* Reference voltage */
#define  Volts(n)           255 * n / Vref1
unsigned char               StepCounter;      /* Voltage output step index */

/*====================================
;=      Digitized voltage values       =
;====================================*/
const unsigned char VoltageTable[] =
  {
         Volts(0),                            /* 0 Volt */
         Volts(1),                            /* 1 Volt */
         Volts(2),                            /* 2 Volt */
         Volts(3),                            /* 3 Volt */
         Volts(4),                            /* 4 Volt */
         Volts(5)                             /* 5 Volt */
  };

/*====================================
;=      Main Program                   =
;====================================*/
void main(void)
{
         OSMS = 0x01;               /* Don't use scaler */
         PCC = 0x00;                /* Main system clock at fastest setting */
         P0.2 = 0;                  /* Latch port 0.2 low */
         PM0.2 = 0;                 /* Set port 0.2 to output  mode */
         TCL1 = 0x07;               /* Select counter clock to fx = 1.25 MHz */
```

```
        CR10 = 250;                 /* Set compare register to 250 for
                                        200 µs interval */
        TOC1 = 0x00;                /* Disable output function */
        TMC1 = 0x01;                /* Set timer 1 operation enable
                                              and 8-bit timer mode */
        TMMK1= 0;                   /* Unmask the 8-bit timer 1 interrupt */
        PM13.1 = 0;                 /* Set port 13.1 to output mode */
        P13.1  = 0;                 /* Latch port 13.1 to low */
        PM13.0 = 1;                 /* Set port 13.0 to input mode
                                              (analog output) */
        DAM = 0x11;                 /* D/A channel 0  conversion enable
                                        in real time output mode */
        StepCounter = 0;            /* Set voltage output step counter to 0 */
        DACS0 = VoltageTable[0];    /* Write digital value to DAC register */
        EI();                       /* Enable interrupts */
        while(TRUE);                /* Endless loop */
 }                                  /* End of function main */

/*=====================================
;=      8-bit timer 1 ISR              =
;=====================================*/
void TM1_ISR(void)
{
        P0 ^= 0x04;                                 /* Toggle port 0.2 */
        StepCounter++;                              /* Increment step counter */
        if(StepCounter == sizeof VoltageTable )     /* Step counter equal 6 ? */
                StepCounter = 0;                    /* Clear step counter */
        DACS0 = VoltageTable[StepCounter];          /* Write value to DAC register */
}
```

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