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April 1st, 2010
Renesas Electronics Corporation

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Application Note

µPD780058 Subseries

8-bit Single-Chip Microcontrollers

DA Converter in Real Time Output Mode

µPD780053

µPD780054

µPD780055

µPD780056

µPD780058B

µPD78F0058

Document No. U16521EE1V0AN00 (1st edition)
Date Published December 2002

[MEMO]

NOTES FOR CMOS DEVICES

1. PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

2. HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to VDD or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

3. STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note:

Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

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Contents

(A) Features of the DA Converter

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.

(B) Program Description

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.

(C) Program Specifications

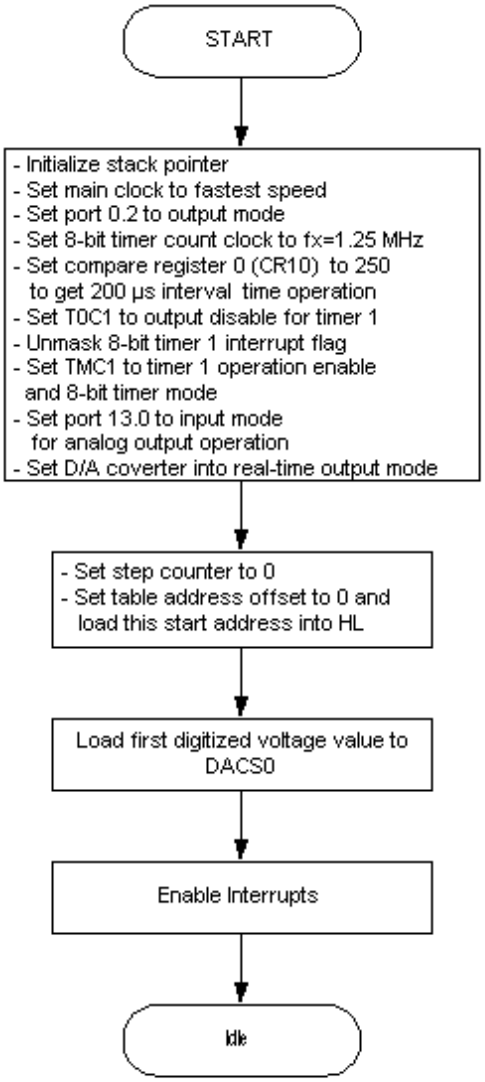
- D/A converter channel 0 in real-time mode
- D/A output triggered every 200 µs by timer 1 interrupt
- D/A outputs analog voltages form 0 to 5 volts in 1-volt steps

(D) Used pins

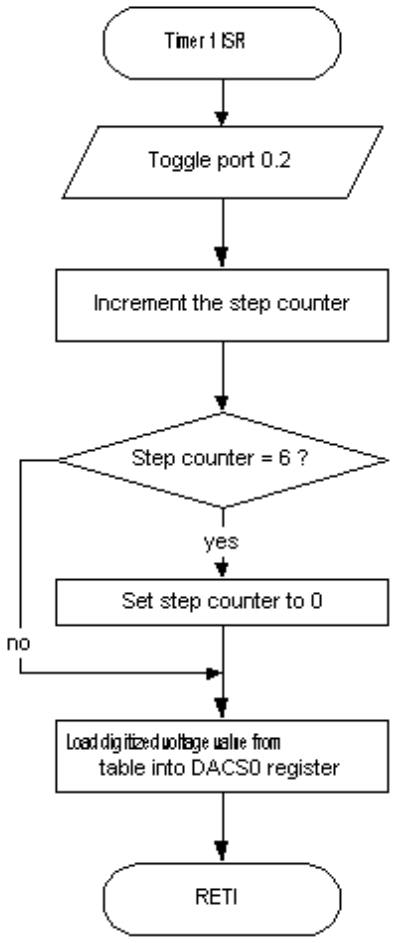
- P02/INTP2: toggles every 200 µs
- ANO0/P130: outputs analog voltage from D/A converter

(E) Software Flow Chart

Flowchart - Main Program



Interrupt Service



(F) Software Listing

```
/***********************************************************************
; Date:       11/15/2002
;
; Parameters:    - CPU clock;              (fx = 5 MHz; 1 CPU clock cycle = 200 ns)
;                - 8-bit D/A channel 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
;***********************************************************************/

/*=======================================
; Include Files
;=======================================*/
#include <in78000.h>
#include "DF0058.h"

/*======================================
;=        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               =
;=====================================*/

interrupt[INTTM1_vect] 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 */
}
```

[MEMO]

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