PMU Driver Sample Code Reference Guide

V1.00.001

Publication Release Date: Sep. 2011

Support Chips:

ISD9160

Support Platforms:

NuvotonPlatform_Keil

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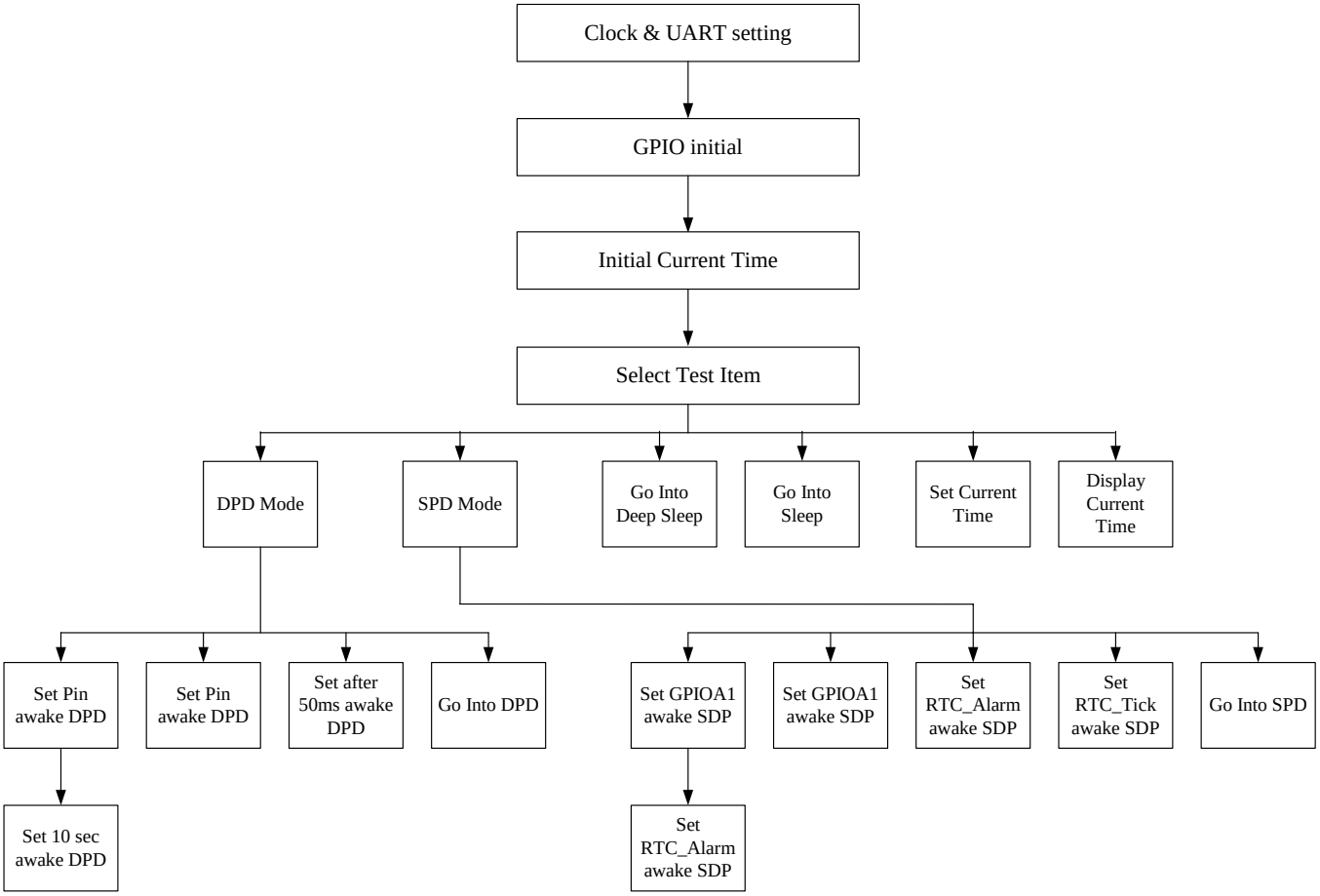
1. PMU Driver Introduction

This sample code will demo PMU IP on ISD9160 chip.

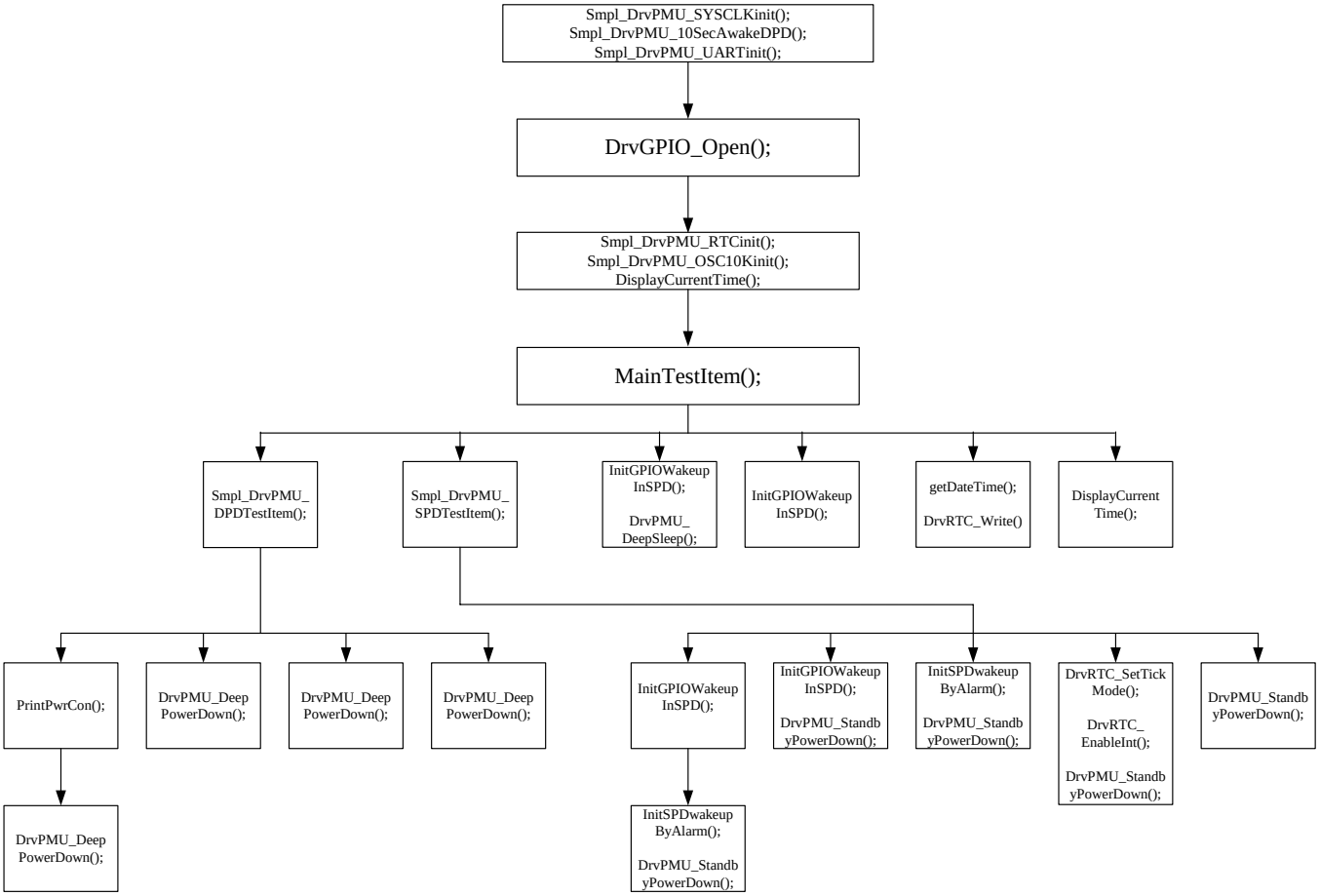
1.1 Feature

- Using Pin and 10sec awake ISD9160 when the chip enters in DPD.
- Using Pin awakes ISD9160 when the chip enters in DPD.
- After 50ms awakes ISD9160 when the chip enters in DPD.
- Directly enters into DPD.
- Using GPIOA1 pin and RTC Alarm awake ISD9160 when the chip enters in SPD.
- Using GPIOA1 pin awakes ISD9160 when the chip enters in SPD.
- Using RTC Alarm awakes ISD9160 when the chip enters in SPD.
- Using RTC Tick awakes ISD9160 when the chip enters in SPD.
- Directly enters into SPD.
- Directly enters into Deep Sleep.
- Directly enters into Sleep.
- Set current time.
- 11. Display current time.

2. Block Diagram



3. Calling Sequence



4. Code Section –Smpl_DrvPMU.c

```
/*---------------------------------------------------------------------------------------------------------*/
/*
*/
/* Copyright(c) 2011 Nuvoton Technology Corp. All rights reserved.
*/
/*
*/
/*---------------------------------------------------------------------------------------------------------*/
#include <stdio.h>
#include "Driver\DrvUART.h"
#include "Driver\DrvGPIO.h"
#include "Driver\DrvRTC.h"
#include "Driver\DrvOSC.h"
#include "Driver\DrvPMU.h"
#include "Driver\DrvPWM.h"
#include "Driver\DrvI2S.h"
#include "ISD9xx.h"

/*---------------------------------------------------------------------------------------------------------*/
/* Global variables
*/
/*---------------------------------------------------------------------------------------------------------*/

/*---------------------------------------------------------------------------------------------------------*/
/* Define functions prototype
*/
/*---------------------------------------------------------------------------------------------------------*/


void SysTimerDelay(uint32_t us)
{
    SysTick->LOAD = us * 22; /* Assume the internal 22MHz RC used */
    SysTick->VAL   =   (0x00);
    SysTick->CTRL = (1 << SYSTICK_CLKSOURCE) | (1<<SYSTICK_ENABLE);

    /* Waiting for down-count to zero */
    while((SysTick->CTRL & (1 << 16)) == 0);
}
```

```
void Smpl_DrvPMU_SYSCLKinit(void)
{
	UNLOCKREG();
	SYSCLK->CLKSEL0.HCLK_S = 0; /* Select HCLK source as OSC48 */
	SYSCLK->CLKDIV.HCLK_N    = 9;   /* Select no division                  */
	SYSCLK->CLKSEL0.OSCFSel = 1;    /* 1= 32MHz, 0=48MHz */
	SYSCLK->PWRCON.XTL32K_EN = 1;
	SYSCLK->PWRCON.OSC10K_EN = 1;
	/* Enable RTC Clock */
	SYSCLK->APBCLK.RTC_EN =1;
	SYSCLK->APBCLK.I2S_EN     = 1;
	SYSCLK->APBCLK.ANA_EN     = 1;
	LOCKREG();
}

void Smpl_DrvPMU_10SecAwakeDPD(void)
{
	if(SYSCLK->DPDSTATE.DPD_STATE_RD != 0){
		// We have state from DPD, increment until 100 then exit
		if(SYSCLK->DPDSTATE.DPD_STATE_RD != 100){
			SYSCLK->DPDSTATE.DPD_STATE_WR =
SYSCLK->DPDSTATE.DPD_STATE_RD + 1;

	DrvPMU_DeepPowerDown(DPDWAKEUPMODE_PINOSC10KWAKEUP,DPDWAKETIME_
100ms);
		}
	}
}

void Smpl_DrvPMU_UARTinit(void)
{
	STR_UART_T sParam;
	/* Set UART Pin */
	DrvGPIO_InitFunction(FUNC_UART0);

	/* UART Setting */
	sParam.u32BaudRate        = 115200;
	sParam.u8cDataBits        = DRVUART_DATABITS_8;
	sParam.u8cStopBits        = DRVUART_STOPBITS_1;
	sParam.u8cParity          = DRVUART_PARITY_NONE;
	sParam.u8cRxTriggerLevel= DRVUART_FIFO_1BYTES;

	DrvUART_Open(UART_PORT0,&sParam);
}
```

```
void Smpl_DrvPMU_RTCinit(void)
{
    uiTmp = RTC->INIR;
    if(    RTC->INIR == 0){
        /* RTC Initialize if it is a "cold" boot (i.e. not from SPD) */
        DrvRTC_Init();
       uiTmp = RTC->INIR;
    }

    // Clear interrupt sources: If we have been in SPD mode, WIC is preserved.
    GPIOA->ISRC = GPIOA->ISRC;
    RTC->RIIR.AI            = 1;
    RTC->RIIR.TI            = 1;
    RTC->RIER.TIER              = 0;
    RTC->RIER.AIER              = 0;
}

void Smpl_DrvPMU_OSC10Kinit(void)
{
    SYS->OSC10K.TM_REG = 0x0;
    SYS->OSC10K.TRIM_CLK =0;
    SYS->OSC10K.TRIM_CLK =1;
    SYS->OSC10K.TRIM_CLK =0;
    printf ("TM_REG %x\n", SYS->OSC10K.TM_REG);
}

void PrintPwrCon(void)
{
    printf("ICER register %08X\n",    NVIC->ICER[0]);
    printf("PFLAG register %02X\n", M32(&SYSCLK->PFLAGCON));
    M32(&SYSCLK->PFLAGCON) = 0xff;
    printf("RSTSRC register %02X\n", M32(&SYS->RSTSRC));
    M32(&SYS->RSTSRC) = 0xff;
    printf("PWRCON register %08X\n", M32(&SYSCLK->PWRCON));
    printf("XTLEN=%d, OSC49=%d OSC10=%d STOP=%d SBPD=%d DPD=%d\n",
            SYSCLK->PWRCON.XTL32K_EN,
            SYSCLK->PWRCON.OSC49M_EN,
            SYSCLK->PWRCON.OSC10K_EN,
            SYSCLK->PWRCON.STOP,
            SYSCLK->PWRCON.STANDBY_PD,
            SYSCLK->PWRCON.DEEP_PD);

    printf("PIN_ENB=%d, DPD_10K=%d TIMER=%d PIN_WAKE=%d TIMER_WAKE=%d
POI_WAKE=%d TIMER=%d\n",
```

```
                SYSCLK->PWRCON.PIN_ENB,
                SYSCLK->PWRCON.OSC10K_ENB,
                SYSCLK->PWRCON.TIMER_SEL,
                SYSCLK->PWRCON.PIN_WAKE,
                SYSCLK->PWRCON.TIMER_WAKE,
                SYSCLK->PWRCON.POI_WAKE,
                SYSCLK->PWRCON.TIMER_SEL_RD);

}

static void MainTestItem (void)
{
    printf("\n\n");
    PrintPwrCon();
    printf("+------------------------------------------------------------+\n");
    printf("|                  PMU Sample Program                        |\n");
    printf("+------------------------------------------------------------+\n");
    printf("| [0] Deep Power Down Mode                                   |\n");
    printf("| [1] Standby Power Down Mode                                |\n");
    printf("| [2] Deep Sleep                                             |\n");
    printf("| [3] Sleep                                                  |\n");
    printf("| [4] Set Current Time                                       |\n");
    printf("| [5] Display Current                                        |\n");
    printf("+------------------------------------------------------------+\n");
    printf("Select Test Item : \n>");
}

void Smpl_DrvPMU_DPDTestItem(void)
{
    uint8_t u8Option;

    while(1)
    {
        printf("\n\n");
        printf("+-----------------------------------------------------------------+\n");
        printf("|              Deep Power Down Test Item                          |\n");
        printf("+-----------------------------------------------------------------+\n");
        printf("| [0] Deep Power Down (pin or wake in 10 sec)                     |\n");
        printf("| [1] Deep Power Down can wakeup by WAKEUP-PIN                    |\n");
        printf("| [2] Deep Power Down can wakeup by OSC10K:50ms                   |\n");
        printf("| [3] Deep Power Down can only wakeup by POR                      |\n");
        printf("| [4] Exit to Main Menu                                           |\n");
        printf("+-----------------------------------------------------------------+\n");
        printf("Select Test Item : \n>");
        u8Option = getchar();
        printf("    [%c]\n",u8Option);
```

```
            switch(u8Option)
            {
                case '0': //Deep Power Down
                    PrintPwrCon();
                    printf("Going into DPD wake by pin or in 10 sec\n");
                    SYSCLK->DPDSTATE.DPD_STATE_WR = 1;
                    while(UART0->FSR.TE != 1);
                    DrvPMU_DeepPowerDown(DPDWAKEUPMODE_PINOSC10KWAKEUP,
                    DPDWAKETIME_100ms);
                  break;

                case '1': //DPD wakeup by PIN&POR
                    printf("Going into DPD, wake by pin\n");
                    while(UART0->FSR.TE != 1);
                    DrvPMU_DeepPowerDown(DPDWAKEUPMODE_PINWAKEUP,
                    DPDWAKETIME_100ms);
                  break;

                case '2': //DPD wakeup by OSC10kHz:50ms & POR
                    printf("Going into DPD for 50msec\n");
                    while(UART0->FSR.TE != 1);
                    DrvPMU_DeepPowerDown(DPDWAKEUPMODE_OSC10KWAKEUP,
                    DPDWAKETIME_50ms);
                  break;

                case '3': //DPD only wakeup by POR
                    printf("Going into DPD\n");
                    while(UART0->FSR.TE != 1);
                    DrvPMU_DeepPowerDown(DPDWAKEUPMODE_ONLYPORWAKEUP,
                    DPDWAKETIME_100ms);
                  break;

                case '4':
                    return;

                default:
                    printf("Wrong Item\n");
                  break;
            }
        }
}
```

```
void Smpl_DrvPMU_SPDTestItem(void)
{
    uint8_t u8Option;

    while(1)
    {
        printf("\n\n");
        printf("+-------------------------------------------------------------------------+\n");
        printf("|                      Standby Power Down Test Item                       |\n");
        printf("+-------------------------------------------------------------------------+\n");
        printf("| [0] SPD can wakeup by GPIOA[1]    &    RTC:ALARM      |\n");
        printf("| [1] Standby Power Down can wakeup by GPIOA[1]            |\n");
        printf("| [2] Standby Power Down can wakeup by RTC:ALARM           |\n");
        printf("| [3] Standby Power Down can wakeup by RTC:TICK            |\n");
        printf("| [4] Standby Power Down can only wakeup by POR            |\n");
        printf("| [5] Exit to Main Menu                                    |\n");
        printf("+-------------------------------------------------------------------------+\n");
        printf("Select Test Item : \n>");
        u8Option = getchar();
        printf("    [%c]\n",u8Option);

        switch(u8Option)
        {
            case '0': //SPD can wakeup by GPIOA[1]    &    RTC:ALARM    &    POR
                InitGPIOWakeupInSPD();
                ///////////////Call from RTC driver
                InitSPDwakeupByAlarm();
                while(UART0->FSR.TE != 1);
                DrvPMU_StandbyPowerDown();
               break;

            case '1': //SPD can awakeup by GPIO & POR
                InitGPIOWakeupInSPD();
                while(UART0->FSR.TE != 1);
                DrvPMU_StandbyPowerDown();
            break;

           case '2': //SPD wakeup by RTC Alarm & POR
                ///////////////Call from RTC driver
                InitSPDwakeupByAlarm();
                while(UART0->FSR.TE != 1);
                DrvPMU_StandbyPowerDown();
               break;
```

```
                case '3': //SPD wakeup by RTC Tick & POR
                    //Set Tick setting
                    DrvRTC_SetTickMode(DRVRTC_TICK_1_SEC);
                    //Enable RTC Tick Interrupt and install tick call back function
                    DrvRTC_EnableInt(DRVRTC_TICK_INT, Smpl_DrvPMU_TickISR);
                    DrvPMU_StandbyPowerDown();
                  break;

                case '4': //SPD only wakeup POR
                    DrvPMU_StandbyPowerDown();
                  break;

                case '5':
                    return;

                default:
                    printf("Wrong Item\n");
                  break;
            }
        }
}

void Smpl_DrvPMU_SPDGPABCallback(uint32_t u32GpaStatus, uint32_t u32GpbStatus)
{
    //DrvGPIO_DisableInt(GPA, 1);
    printf("GPIO Wake up from Standby-Power-Down Mode\n");

}

void InitGPIOWakeupInSPD(void)
{
    // Clear interrupts.
    GPIOA->ISRC = GPIOA->ISRC;
    ////INT from GPA pin1 as an example wake up
    DrvGPIO_Open(GPA, 1, IO_INPUT);
    DrvGPIO_SetIntCallback(Smpl_DrvPMU_SPDGPABCallback);
    DrvGPIO_SetDebounceTime(3, DBCLKSRC_HCLK);
    DrvGPIO_EnableDebounce(GPA, 1);
    DrvGPIO_EnableInt(GPA, 1, IO_BOTH_EDGE, MODE_EDGE);
}
```

```
/*_-----------------------------------------*/
/*     define date and time                */
/*-----------------------------------------*/
S_DRVRTC_TIME_DATA_T getDateTime()
{
        S_DRVRTC_TIME_DATA_T sInitTime;

        printf ("enter year :\n ");
        scanf    ("%d",&sInitTime.u32Year );
        printf ("year = %d\n", sInitTime.u32Year);

        printf ("enter month (1-12) :\n ");
        scanf    ("%d", &sInitTime.u32cMonth);
        printf ("month = %d\n", sInitTime.u32cMonth);

        printf ("enter day (1-31) :\n ");
        scanf    ("%d", &sInitTime.u32cDay );
        printf ("day = %d\n", sInitTime.u32cDay);

        printf ("enter hour (0-23) : \n");
        scanf    ("%d", &sInitTime.u32cHour );
        printf ("hour = %d\n", sInitTime.u32cHour);

        printf ("enter minute (0-59) : \n");
        scanf    ("%d", &sInitTime.u32cMinute );
        printf ("minute = %d\n", sInitTime.u32cMinute);

        printf ("enter second (0-59) : \n");
        scanf    ("%d", &sInitTime.u32cSecond );
        printf ("second = %d\n", sInitTime.u32cSecond);

        printf ("enter day of week (0-6) : \n");
        scanf    ("%d", &sInitTime.u32cDayOfWeek );
        printf ("day = %d\n", sInitTime.u32cDayOfWeek);

        sInitTime.u8cClockDisplay = DRVRTC_CLOCK_24;

        return sInitTime;
}
```

```
void DisplayCurrentTime(E_DRVRTC_TIME_SELECT eTime)
{
    S_DRVRTC_TIME_DATA_T sCurTime;

    /* Get the currnet time */
    DrvRTC_Read(eTime, &sCurTime);
    printf("Time:%d/%02d/%02d
%02d:%02d:%02d\n",sCurTime.u32Year,sCurTime.u32cMonth,sCurTime.u32cDay,sCurTime.u32cH
our,sCurTime.u32cMinute,sCurTime.u32cSecond);
}

void Smpl_DrvPMU_AlarmISR(void)
{
    S_DRVRTC_TIME_DATA_T sCurTime;

    /* Get the currnet time */
    DrvRTC_Read(DRVRTC_CURRENT_TIME, &sCurTime);
    printf("Current Time:%d/%02d/%02d %02d:%02d:%02d
",sCurTime.u32Year,sCurTime.u32cMonth,sCurTime.u32cDay,sCurTime.u32cHour,sCurTime.u32c
Minute,sCurTime.u32cSecond);
    printf("Alarm!\n");
}

void InitSPDwakeupByAlarm(void)
{
    S_DRVRTC_TIME_DATA_T sInitTime;

    DisplayCurrentTime(DRVRTC_CURRENT_TIME);
  check_time:
    DrvRTC_Read(DRVRTC_CURRENT_TIME, &sInitTime);
    // Set alaram to wakeup in 10 seconds.
    if(sInitTime.u32cSecond < 49)
        sInitTime.u32cSecond += 10;
    else{
        sInitTime.u32cSecond = sInitTime.u32cSecond + 10 - 60;
        if( sInitTime.u32cMinute < 59 )
            sInitTime.u32cMinute += 1;
        else
            // Too lazy, wait a few seconds...
            goto check_time;
    }
    DrvRTC_Write(DRVRTC_ALARM_TIME,&sInitTime);
    printf("Alarm ");
    DisplayCurrentTime(DRVRTC_ALARM_TIME);
    DrvRTC_EnableInt(DRVRTC_ALARM_INT, Smpl_DrvPMU_AlarmISR);
}
```

```
void Smpl_DrvPMU_TickISR(void)
{
    printf("Tick Int!\n");
    /* Disable RTC Tick Interrupt */
    DrvRTC_DisableInt(DRVRTC_TICK_INT);
}


/*---------------------------------------------------------------------------*/
/* Using UART for testing PMU Samples                                        */
/* Test Item                                                                 */
/* It sends the messages to HyperTerminal.                                   */
/*---------------------------------------------------------------------------*/

int32_t main(void)
{
    uint8_t u8Item;
    S_DRVRTC_TIME_DATA_T sInitcTime;
    uint32_t uiTmp;

    // Initial SYSCLK
    Smpl_DrvPMU_SYSCLKinit();

    // Timer for 10 Second awake DPD if function has been enabled
    Smpl_DrvPMU_10SecAwakeDPD();

    //Initial UART
    Smpl_DrvPMU_UARTinit();

    printf("\nBOOT\n");

    // Set GPA1 to input
    DrvGPIO_Open(GPA, 1, IO_INPUT);


    //Initial RTC
    Smpl_DrvPMU_RTCinit();
```

```
    if((M32(&SYSCLK->PFLAGCON)==0) && (M32(&SYS->RSTSRC)==0x43)){
        // Indicates a Boot from DPD or POI rather than SPD
        if(SYSCLK->PWRCON.POI_WAKE)
            printf("DPD WakeUp of device was requested with a power-on reset.\n");
        if(SYSCLK->PWRCON.TIMER_WAKE)
            printf("DPD WakeUp of device was requested with Timer count of the 10KHz
oscillator.\n");
        if(SYSCLK->PWRCON.PIN_WAKE)
            printf("DPD WakeUp of device was requested with WAKEUP-PIN.\n");
    }
    PrintPwrCon();

    // Only enable clocks we need in SLEEP modes
    M32(&SYSCLK->CLKSLEEP)=0x20 + 0x01;

    Smpl_DrvPMU_OSC10Kinit();

    DisplayCurrentTime(DRVRTC_CURRENT_TIME);

    while(1)
    {
        MainTestItem();
        u8Item = getchar();
        switch(u8Item)
        {
            case '0':
                Smpl_DrvPMU_DPDTestItem();
              break;

            case '1':
                Smpl_DrvPMU_SPDTestItem();
              break;

            case '2': //Deep sleep
                InitGPIOWakeupInSPD();
                SYSCLK->CLKSEL0.HCLK_S = 0;
                SYSCLK->PWRCON.OSC49M_EN =0;
                SysTimerDelay(5000);
                DrvPMU_DeepSleep();
              break;

            case '3': //Sleep
                InitGPIOWakeupInSPD();
                SCB->SCR = 0;
                __wfi();
              break;
```

```
                case '4':
                    printf("Please Input Current time\n");
                    sInitcTime = getDateTime();
                    DrvRTC_Write(DRVRTC_CURRENT_TIME,&sInitcTime);
                  break;

                case '5':
                    DisplayCurrentTime(DRVRTC_CURRENT_TIME);
                  break;

                default:
                    printf("Wrong Item\n");
                  break;

            }
        }
}
```

5. Execution Environment Setup and Result

- Prepare a ISD9160 board.
- Compile the sample code.
- Console window show result of ACMP.

6. Revision History

Version	Date	Description
V1.00.01	Sep. 2011	Created