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H8/300L Super Low Power（SLP）系列

对于 LCD 和串行端口的 printf 函数

内容

本应用说明叙述 printf 函数的写法，说明从库函数调用的方法和用户建立的方法。另外，也说明将信息的输出目标设定为 SIM IO 窗口、LCD 和串行端口的方法。

要点

和具有标准输入（键盘）和标准输出（显示器）设备的 PC 不同，嵌入式系统需要开发者定义输入源和输出目标。

以 printf 函数为例，嵌入式系统开发者必须定义此函数的输出目标。作为被广泛使用的输出，有 LCD 显示屏和 PC 的超级终端（经由设备的串行端口）。

本应用说明使用 5 个 HEW2.1 工程文件，说明面向 SLP H8/38024F 的以下 5 类例子。操作例是使用 SLP CPU 电路板（ALE300L）和应用电路板的例子。

1. Simulated I/O
2. LCD 显示屏的 printf（使用标准库函数）
3. 串行端口的 printf（使用标准库函数）
4. LCD 显示屏的基本的 printf（使用用户建立的程序）
5. 串行端口的基本的 printf（使用用户建立的程序）

动作确认器件

H8/38024

目录

1. printf 函数的使用方法

printf 是嵌入式系统开发者广泛使用的函数，具有将信息输出到外部的功能，主要的使用方法有以下两种：

(1) 提供用户界面（例：通过血压仪在 LCD 显示屏显示血压值）

(2) 提供调试手段（例：将实际的 ADC 值从串行端口发送到 PC 的超级终端）

【注】 以下的例子是使用 HEW2.1（H8 TINY/Super Low Power 工具链）创建的。不能用以前版本的 HEW 存取在此使用的工程文件。如果所使用的版本不同，最简单的方法就是通过所使用的 HEW 建立新的工程，并在该新工程目录中替换需要的 C 程序和头文件。

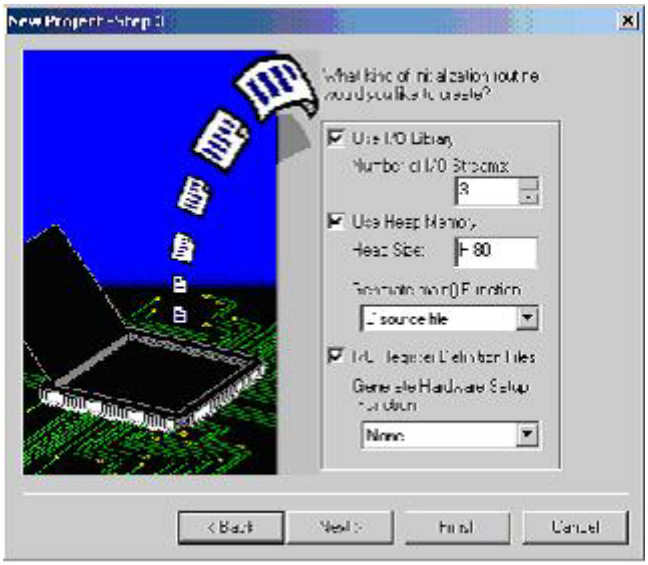
2. Simulated I/O

在硬件准备完毕之前，能通过 HEW 仿真器开始工作。为了进一步提高调试环境的效率，HEW 仿真器导入了 Simulated I/O。Simulated I/O 能使开发者将结果（调试信息）输出到 HEW 的调试（SIM IO）窗口。即 printf 函数能将信息显示在此窗口。

HEW 工程生成程序自动进行 SIM I/O 功能的设定（在此例中，使用 H8S、 H8/300 标准工具链创建工程）。免费的 H8 TINY/Super Low Power 工具链没有仿真器功能。

确认 Simulated I/O 结果的方法如下所示：

(1) 在工程生成的步骤 3，选择 **Use I/O Library** 选项和 **Use heap memory** 选项，I/O 流数为 3 不变。



(2) 由此，生成和更改了以下的文件：

a. Lowsrc.c（低级标准输入/输出功能）

b. Lowlev.src（包含 charget 和 charput 的输出目标– PC SIM IO 窗口）

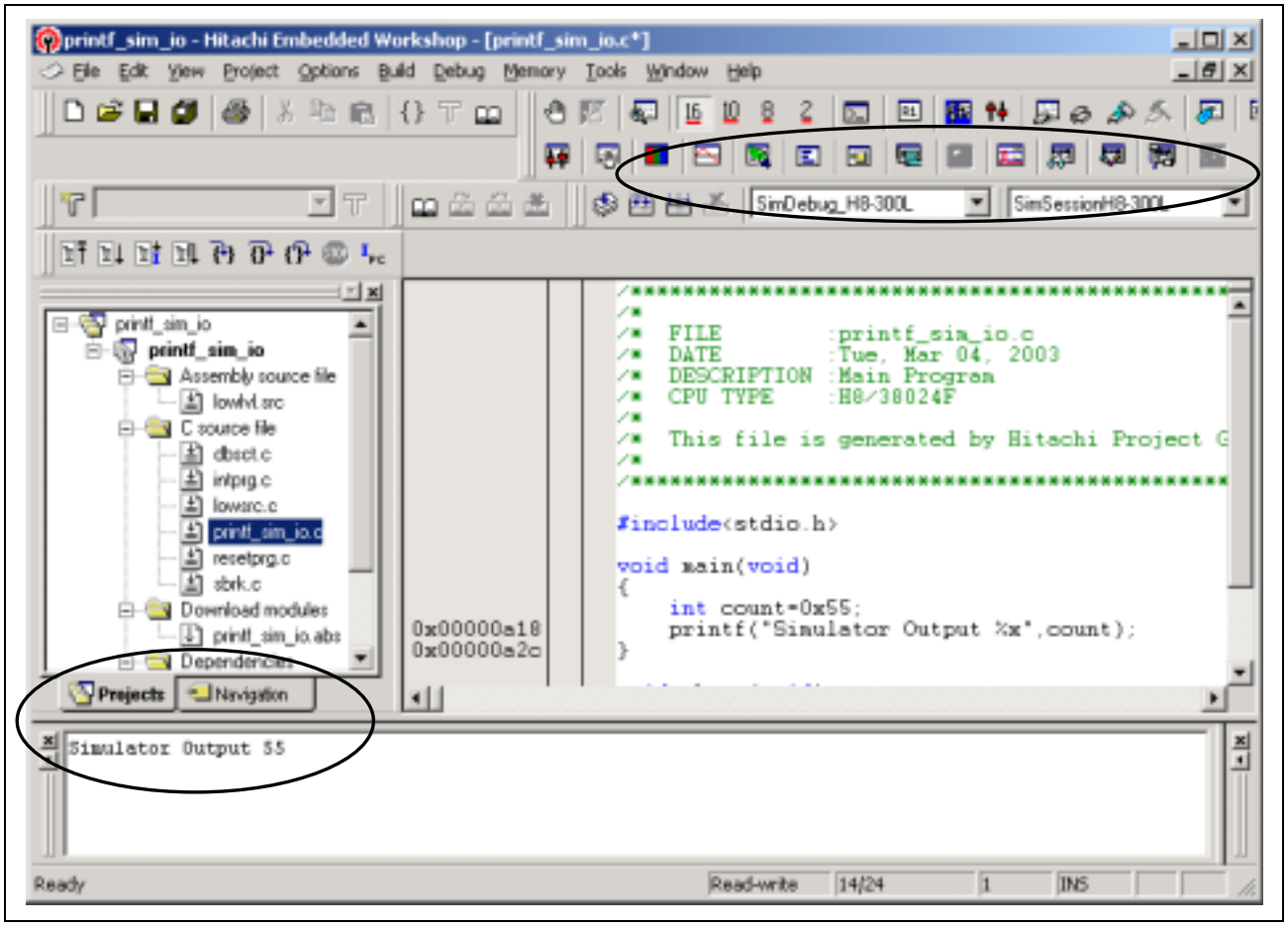
c. Resetprg.c（追加函数_INIT_IOLIB()和_CLOSEALL()的调用，初始化标准 I/O）

d. Sbrk.c（分配堆存储器）

(3) 将 printf()追加到主程序（必须追加#include <stdio.h>）。
(4) 将调试会话的默认值从“Debug”更改为“SimDebug_H8-300L”。
(5) **创建**工程（F7）。
(6) 打开 Option/**Debug Setting** 窗口，如果将会话设定为“SimSessionH8-300L”，就自动设定以下内容：
   a. 将目标设定为“H8/300L Simulator”
   b. 将调试格式的默认值设定为“Elf/Dwarf2”
   c. 作为在步骤 v 的编译文件，追加下载模块

(7) 将会话更改为“SimSession H8-300L”。
(8) 打开 Option/ simulator/ **Simulator Memory Resources**。
   a. 通过存储器映像，指定可读/可写，追加能使用的存储器。作为系统内存资源，显示所分配的资源（HEW 自动设定）。

(9) 打开 Option/ simulator/ **Simulator System**，将系统调用地址设定为允许（HEW 自动设定）。
(10) 打开 Debug/**Download Modules**，装入文件（Debug setting 预先设定的文件）。
(11) 打开 View/ **Simulated IO**。
(12) 点击 Debug/**Reset Go**。
(13) 确认 Simulated I/O 窗口的信息。



详细步骤和说明请参照 HEW 的在线用户手册。

HEW 生成的复位例程如下所示：

```
__entry(vect=0) void PowerON_Reset(void)
{
     set_imask_ccr(1);
    _INITSCT();
//  _CALL_INIT();    // Remove the comment when you use global class object
    _INIT_IOLIB();   // Use SIM I/O
//  errno=0;      // Remove the comment when you use errno
//  srand(1);     // Remove the comment when you use rand()
//  _s1ptr=NULL;      // Remove the comment when you use strtok()
//  HardwareSetup(); // Remove the comment when you use Hardware Setup
    set_imask_ccr(0);

    main();

    _CLOSEALL();     // Use SIM I/O
//  _CALL_END();     // Remove the comment when you use global class object
    sleep();
}
```

HEW 生成的 Lowlev.src 如下所示，将字符发送到 SIM IO。

```
        .EXPORT    _charput
        .EXPORT    _charget

SIM_IO:  .EQU      H'0000

        .SECTION   P,CODE,ALIGN=2
;---------------------------------------------------------------------
;  _charput:
;---------------------------------------------------------------------
_charput:
        MOV.B      R0L,@IO_BUF
        MOV.W      #H'0102,R0
        MOV.W      #IO_BUF,R1
        MOV.W      R1,@PARM
        MOV.W      #PARM,R1
        JSR        @SIM_IO
        RTS
;---------------------------------------------------------------------
;  _charget:
;---------------------------------------------------------------------
_charget:
        MOV.W      #H'0101,R0
        MOV.W      #IO_BUF,R1
        MOV.W      R1,@PARM
        MOV.W      #PARM,R1
        JSR        @SIM_IO
        MOV.B      @IO_BUF,R0L
        RTS
;---------------------------------------------------------------------
;  I/O Buffer
;---------------------------------------------------------------------
        .SECTION   B,DATA,ALIGN=2
PARM:    .RES.W     1
IO_BUF:  .RES.B     1
        .END
```

3. charput 函数和 charget 函数的变更

由上例可知， printf()将信息输出到 SIM IO 窗口时所需的函数全部由 HEW 函数生成程序生成。要将信息输出到串行端口和 LCD 等其他设备时，更改 lowsrc.src 文件的 charput 函数。能将这 2 个函数用 C 语言记述并且包含于其他的.c 文件中。

举例说明以下 2 种输出手段：

(1) 串行端口

(2) LCD

3.1 输出到串行端口的 printf

3.1.1 程序的说明

说明使用 SLP 应用电路板的串行端口 3（SCI-3）的例子。

main 例程初始化通用 I/O 和 SCI-3，其次 printf 函数使用 charput 函数输出一连串的字符，最后 charput 函数经由串行端口输出数据。

“no_float.h”必须声明在“stdio.h”前，由此缩小 printf 函数的程序大小（不使用浮点格式的情况）。

```
#include <no_float.h>
#include <stdio.h>
#include "iodefine.h"
#include <machine.h>

static const char string[] = {"¥n¥n¥rCan putstr too!"};

void main(void)
{
    int count=0;

    init_io();
    init_sci();

    printf("¥n¥n¥n¥rDemonstration of printf function");
    printf("¥n¥rCounting = ");

    for (count=0;count<10;count++)
        printf(" %d",count);

    PutStr((char *)string);
}
```

以下详细说明 main 函数调用的 3 个函数：

1. void init_io(void); //通用初始化程序

```
void init_io(void)
{
    P_IO.PCR3.BYTE = 0x00;     //P37..P31 : inputs
    P_IO.PUCR3.BYTE = 0x00;    //Turn off the MOS pull-up

    //PMR3 : |AEVL|AEVH|---|---|---|TMOFH|TMOFL|---|
    //AEVL = 0 : P37 as I/O
    //AEVH = 0 : P36 as I/O
    //TMOFH = 0: P32 as I/O
    //TMOFL = 0: P31 as I/O
    P_IO.PMR3.BYTE = 0x00;

    P_IO.PCR4.BYTE = 0xF8;     //P40 is connected to keypad 0

    //PMR2 : |---|---|POF1|---|---|---|---|IRQ0| : |1|1|0|1|1|0|0|1|
    //Bits 7, 6, 4 and 3 are reserved and always read as 1 and cannot be
    //modified
    //POF1 = 0 (initial value)
    //Only 0 can be written to reserved bits 2 & 1.
    //IRQ0 = 1 : functions as IRQ0_N input pin
    P_IO.PMR2.BYTE = 0xD9;

    //PMR9 : |---|---|---|---|PIOFF|---|PWM2|PWM1|
    //PIOFF = 0 : large-current port step-up circuit is turned on
    //PWM1 = PWM2 = 0 : P90 and P91 functions as P_IO output pin
    P_IO.PMR9.BYTE = 0xF0;

    //PMRB : |---|---|---|---|IRQ1|---|---|---|
    //IRQ1 = 0 : PB3 functions as I/O or AN3
    //Bits 7 to 4 and 2 to 0 are reserved and always read as 1.
    P_IO.PMRB.BYTE = 0xF7;

#if ALE300L_38024||ALE300L_3802
    init_sci();
#endif
```

```
    //IEGR : |---|---|---|---|---|---|IEG1|IEG0| : |1|1|1|0|0|0|0|0|
    //Bits 7 to 5 are reserved; they are always read as 1 and cannot be
   //modified
    //Bits 4 to 2 are reserved; only 0 can be written to these bits
    //IEG0 = 0 : Falling edge of IRQ0_N is detected
    P_SYSCR.IEGR.BYTE = 0xE0;

    //IENR1 : |IENTA|---|IENWP|---|---|IENEC2|IEN1|IEN0| : |0|0|0|0|0|
    //IENTA = 0 : Disable Timer A interrupt request
    //Bit 6 is reserved; only 0 can be written to it
    //IENWP = 0 : Disable WKP7_N TO WKP0_N interrupt requests
    //Bits 4 and 3 are reserved; only 0 can be written to these bits
    //IENEC2 = 0 : Disable IRQAEC interrupt request
    //IEN1 = 0 : Disable interrupt request from IRQ1_N
    //IEN0 = 1 : Enable interrupt request from IRQ0_N
    P_SYSCR.IENR1.BYTE = 0x01;
    P_SYSCR.IENR2.BYTE = 0x10;
    set_imask_ccr(0);
}
```

2. void init_sci(void); // 将 SCI-3 初始化为 2400bps、8 位、1 个停止位、无奇偶校验

```
void init_sci(void)
{   unsigned char temp = 0;

    //SCR3 : |TIE|RIE|TE|RE|MPIE|TEIE|CKE1|CKE0|
    //TIE : Transmit interrupt enable
    //RIE : Receive interrupt enable
    //TE  : Transmit enable
    //RE  : Receive enable
    //MPIE : Multiprocessor interrupt enable
    //TEIE : Transmit end interrupt enable
    //CKE1 : Clock enable 1
    //CKE0 : Clock enable 0
    //CKE1 = CKE0 = 0
    //asynchronous mode, internal clock source, SCK32 functions as I/O port
    P_SCI3.SCR3.BYTE = 0x30;

    //SMR : |COM|CHR|PE|PM|STOP|MP|CKS1|CKS0| : |0|0|0|0|0|0|0|0|
    //COM : Communication Mode  : 0 : asynchronous mode
    //CHR : Character Length    : 0 : character length = 8 bits
    //PE : Parity Enable     : 0 : parity bit addition and checking disabled
    //PM  : Parity Mode  : 0 : even parity (no effect since parity is already
   //disabled)
    //STOP: Stop Bit Length     : 0 : 1 stop bit
    //MP  : Multiprocessor Mode : 0 : multiprocessor communication function
   //disabled
    //|CKS1|CKS0| : Clock Select: |0|0| : clock source for baud rate generator
   //= clk
    P_SCI3.SMR.BYTE = 0x00;

    //Bit rate = 19200 bps, n = 0, N = 64 // MODIFY TO 2400bps
    P_SCI3.BRR = 64;

    //SPCR : |---|---|SPC32|---|SCINV3|SCINV2|---|---| : |1|1|1|0|0|0|0|0|
    //SPC32 = 1 : P42 functions as TXD32 output pin
    //need to set TE bit in SCR3 after setting this bit to 1
    //SCINV3 = 0 : TXD32 output data is not inverted
    //SCINV2= 0 : RXD32 input data is not inverted
    //Bits 7 and 6 are reserved and always read as 1
    //Bits 4, 1 and 0 are reserved and only 0 can be written to these bits
    P_SCI3.SPCR.BYTE = 0xE0;

   //SSR  : |TDRE|RDRF|OER|FER|PER|TEND|MPBR|MPBT|
    //TDRE : transmit data register empty
    //RDRF : receive data register full
    //OER  : overrun error
    //FER  : framing error
    //PER  : parity error
    //TEND : transmit end
    //MPBR : Multiprocessor bit receive
    //MPBT : Multiprocessor bit transfer
    P_SCI3.SSR.BYTE = 0x84;             //Initialise upon reset to 0x84
}
```

3. void charput(char outputchar) //将数据输出到串行端口 3

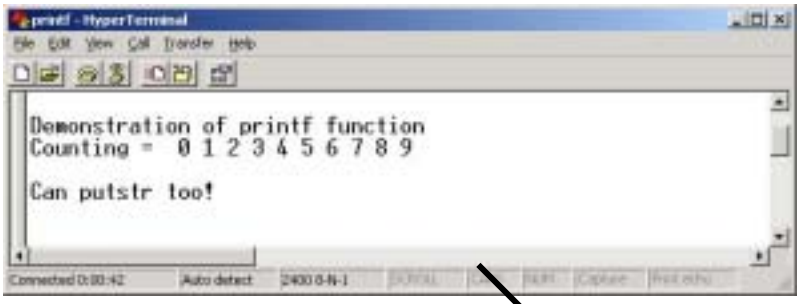
```
void charput(char OutputChar)            //Serial Port
{
  while ((P_SCI3.SSR.BIT.TDRE) == 0);

  P_SCI3.TDR = OutputChar;
  P_SCI3.SSR.BIT.TDRE = 0;
}
```

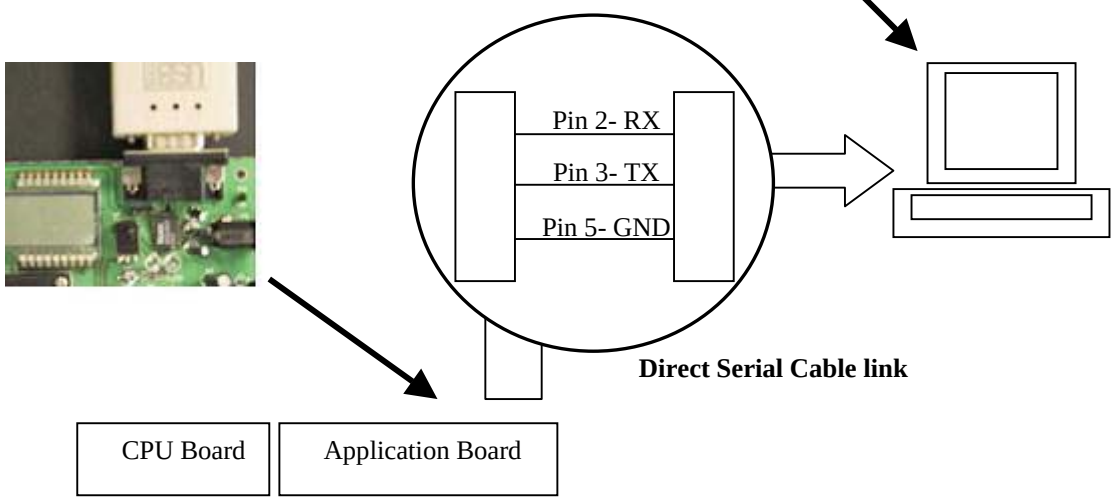
3.1.2 硬件的设定

能设定 PC 窗口超级终端，显示此信息。使用串行电缆（直接连接型电缆）连接应用电路板和 PC 串行端口。超级终端的设定如下图所示：

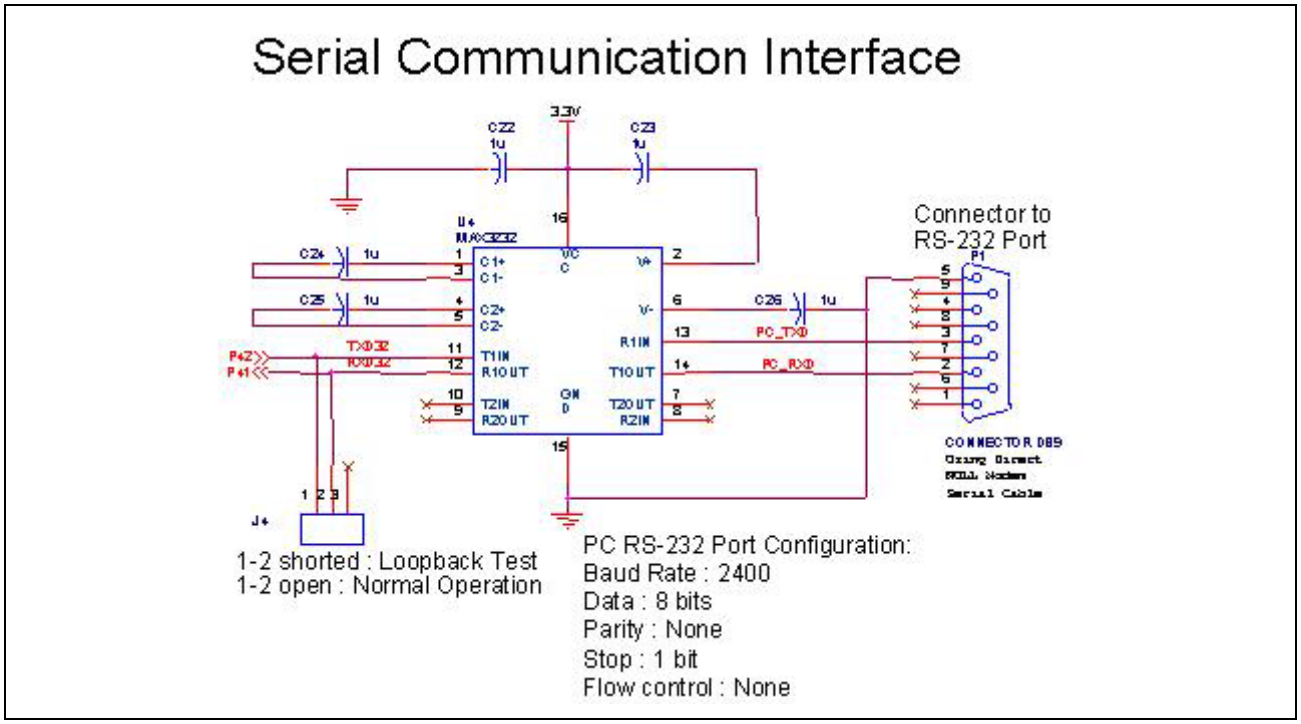
信息的输出如下图所示：



硬件设定如下：



为了取得 MCU 和 PC 的接口，应用电路板需要 RS232 驱动器：



3.2 输出到 LCD 的 printf

3.2.1 程序的说明

说明使用 SLP 应用电路板的 LCD 的例子。

main 例程能在初始化通用 I/O 和 LCD 后调用标准库的 printf 函数。此时，charput 函数将字符输出到 LCD（1 行×7 个字符）到。全局变量 *position* 决定显示在 LCD 的字符位置。

```
#include <no_float.h>
#include <stdio.h>

#include "iodefine.h"
#include "printf_lcd.h"
#include <machine.h>

unsigned int position=7;

void main(void)
{
  char temp1 ='e';
  int  temp2 =15; //0xF

  init_io();
  init_lcd();

  printf("HI %c %x", (BYTE)temp1, (DWORD)temp2);
 }
```

程序例使用 4 个主要函数：

1. void init_io(void); //通用初始化例程（同 3.1 章的函数）

2. void init_lcd(void) //LCD 的初始化

```
void init_lcd(void)
{
    unsigned char temp_a;
    unsigned char *dest;

    //clear LCD RAM
    dest = (unsigned char *)0xF740;
    for (temp_a = 0 ; temp_a < 16 ; temp_a++)
    {
        *dest++ = 0;
    }

    //LPCR : |DTS1|DTS0|CMX|---|SGS3|SGS2|SGS1|SGS0| : |1|1|0|0|0|1|1|0|
    //|DTS1|DTS0| = |1|1| : 1/4 duty
    //|CMX | = 0
    //Bit 4 is reserved; only 0 can be written to this bit
    //|SGS3|SGS2|SGS1|SGS0| = |1|0|0|0| : Use SEG1 to SEG32
    P_LCD.LPCR.BYTE = 0xC8;    //1/4 duty cycle

    //LCR : |---|PSW|ACT|DISP|CKS3|CKS2|CKS1|CKS0| : |1|1|1|1|1|1|1|1|
    //Bit 7 is reserved; always read as 1 and cannot be modified
    //PSW = 1 : LCD drive power supply on
    //ACT = 1 : LCD controller/driver operates
    //DISP = 1 : LCD RAM data is displayed
    P_LCD.LCR.BYTE = 0xFF;     //display is faint

    //LCR2 : |LCDAB|---|---|---|---|---|---|---|
    //LCDAB : 0 : drive using A waveform
    //Bits 6 and 5 are reserved; always read as 1 and cannot be modified
    //Bits 4 to 0 are reserved; only 0 can be written to these bits
    P_LCD.LCR2.BYTE = 0x60;
}
```

3. void Display_number(…) // 在 LCD 显示数值，LCD 只能显示 7 个字符。

```
void display_number(unsigned char digit, unsigned char number, unsigned char decimal_point)
{
    unsigned short   *dest;

    switch(digit)
    {
        case 0:       dest = (unsigned short *)0xF740;
                  break;
        case 1:       dest = (unsigned short *)0xF742;
                  break;
        case 2:       dest = (unsigned short *)0xF744;
                  break;
        case 3:       dest = (unsigned short *)0xF746;
                  break;
        case 4:       dest = (unsigned short *)0xF748;
                  break;
        case 5:       dest = (unsigned short *)0xF74A;
                  break;
        case 6:       dest = (unsigned short *)0xF74C;
                  break;
        case 7:       dest = (unsigned short *)0xF74E;
                  break;
        default:      break;
    }

    if (decimal_point)
        *dest = (unsigned short)(lcd_number_data[number] | 0x0800);
    else
        *dest = lcd_number_data[number];
}
```

4. void charput(char outputchar)　　//调用 display_number()，显示字符。

```
void charput(char OutputChar)
{
    display_number(position, OutputChar, 0);
    position--;
}
```

5. printf_lcd.h // 搜索转换显示在 LCD 的字符表。

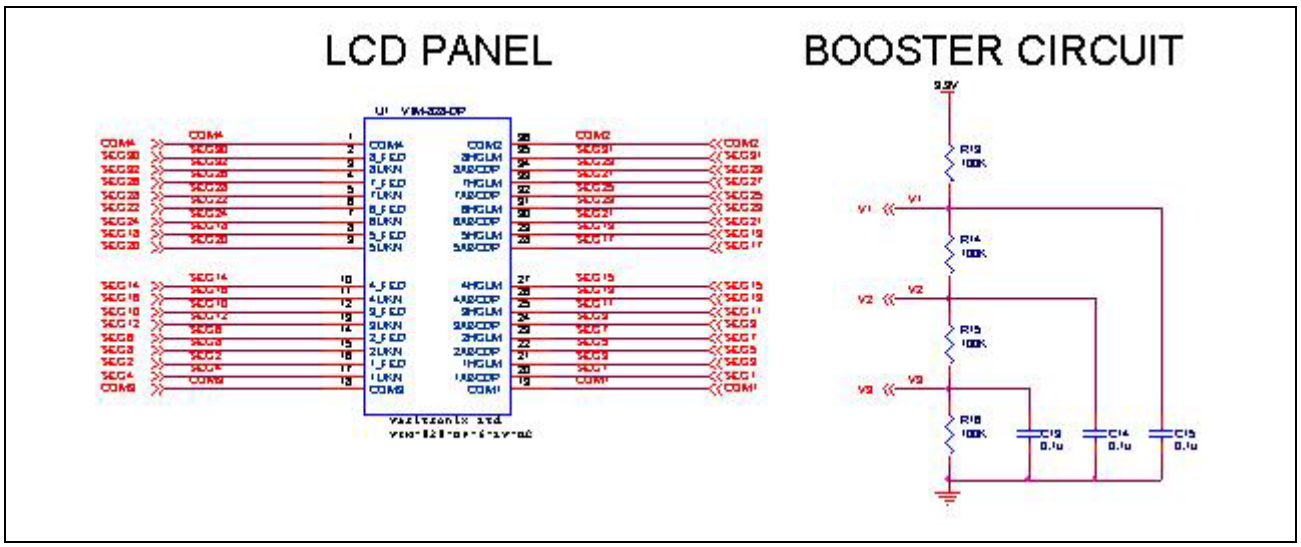
```
//for 1/4 duty cycle
const unsigned shortlcd_number_data[128]
= {               //ASCII
                  0x0039,     //  00.   'NUL'    :Display
                  0x0039,     //  01.   'SOH'    :Display
                  0x0039,     //  02.   'STX'    :Display
                  0x0039,     //  03.   'ETX'    :Display
                  0x0039,     //  04.   'EOT'    :Display
                  0x0039,     //  05.   'ENQ'    :Display
                  0x0039,     //  06.   'ACK'    :Display
                  0x0039,     //  07.   'BEL'    :Display
                  0x0039,     //  08.   'BS'     :Display
                  0x0039,     //  09.   'HT'     :Display
                  0x0039,     //  0A.   'LF'     :Display
                  0x0039,     //  0B    'VT'     :Display
                  0x0039,     //  0C.   'FF'     :Display
                  0x0039,     //  0D.   'CR'     :Display
                  0x0039,     //  0E.   'SO'     :Display
                  0x0039,     //  0F.   'SI'     :Display
                  0x0039,     //  10.   'DLE'    :Display
                  0x0039,     //  11.   'DC1'    :Display
                  0x0039,     //  12.   'DC2'    :Display
                  0x0039,     //  13.   'DC3'    :Display
                  0x0039,     //  14.   'DC4'    :Display
                  0x0039,     //  15.   'NAK'    :Display
                  0x0039,     //  16.   'SYN'    :Display
                  0x0039,     //  17.   'ETB'    :Display
                  0x0039,     //  18.   'CAN'    :Display
                  0x0039,     //  19.   'EM'     :Display
                  0x0039,     //  1A.   'SUB'    :Display
                  0x0039,     //  1B.   'ESC'    :Display
                  0x0039,     //  1C.   'FS'     :Display
                  0x0039,     //  1D.   'GS'     :Display
                  0x0039,     //  1E.   'RS'     :Display
                  0x0039,     //  1F.   'US'     :Display
                  0x0000,     //  20.   'SP'     :Space, all segment off
                  0x0039,     //  21.   '!'      :Display
                  0x2200,     //  22.   '"'      :"
                  0x0039,     //  23.   '#'      :Display
                  0xA55A,     //  24.   '$'      :$
                  0x0039,     //  25.   '%'      :Display
                  0x0039,     //  26.   '&'      :Display
                  0x0010,     //  27.   '''      :'
                  0x0039,     //  28.   '('      :Display
                  0x0039,     //  29.   ')'      :Display
                  0x00E7,     //  2A.   '*'      :*
                  0x005A,     //  2B.   '+'      :+
                  0x0039,     //  2C.   ','      :Display
                  0x0042,     //  2D.   '-'      :-
                  0x0800,     //  2E.   '.'      :.
                  0x0024,     //  2F.   '/'      :/
```

```
 0xE724,     //  30.   '0'      :0
0x0600,      //  31.   '1'      :1
0xC342,      //  32.   '2'      :2
0x8742,      //  33.   '3'      :3
0x2642,      //  34.   '4'      :4
0xA542,      //  35.   '5'      :5
0xE542,      //  36.   '6'      :6
0x0700,      //  37.   '7'      :7
0xE742,      //  38.   '8'      :8
0x2742,      //  39.   '9'      :9
0x0039,      //  3A.   ':'      :Display
0x0039,      //  3B.   ';'      :Display
0x00A0,      //  3C.   '<'      :<
0x8100,      //  3D.   '='      :=
0x0005,      //  3E.   '>'      :>
0x0039,      //  3F.   '?'      :Display
0x0039,      //  40.   '@'      :Display
0x6742,      //  41.   'A'      :A
0xE442,      //  42    'B'      :b
0xE100,      //  43.   'C'      :C
0xC642,      //  44.   'D'      :D
0xE142,      //  45.   'E'      :E
0x6142,      //  46.   'F'      :F
0xE540,      //  47.   'G'      :G
0x6642,      //  48.   'H'      :H
0x8118,      //  49.   'I'      :I
0xC600,      //  4A.   'J'      :J
0x60A2,      //  4B.   'K'      :K
0xE000,      //  4C.   'L'      :L
0x6621,      //  4D.   'M'      :M
0x6681,      //  4E.   'N'      :N
0xE700,      //  4F.   'O'      :O
0x6342,      //  50.   'P'      :P
0xE780,      //  51.   'Q'      :Q
0x63C2,      //  52.   'R'      :R
0xA542,      //  53.   'S'      :S
0x0118,      //  54.   'T'      :T
0xE600,      //  55.   'U'      :U
0x0681,      //  56.   'V'      :V
0x6684,      //  57.   'W'      :W
0x00A5,      //  58.   'X'      :x
0x0029,      //  59.   'Y'      :Y
0x8124,      //  5A.   'Z'      :Z
0xE100,      //  5B.   '['      :[
0x0081,      /*  5C.   '¥'      :¥     */
0x8700,      //  5D    ']'      :]
0x0084,      //  5E.   '^'      :^
0x0000,      //  5F.   ' '      :
0x0001,      //  60.   '`'      :`
0xC742,      //  61.   'a'      :a
0xE442,      //  62    'b'      :b
0xC042,      //  63.   'c'      :c
0xC642,      //  64.   'd'      :d
```

```
                0xE142,     //  65.   'e'      :E
                0x6142,     //  66.   'f'      :F
                0xE540,     //  67.   'g'      :G
                0x6442,     //  68.   'h'      :h
                0x8118,     //  69.   'i'      :I
                0xC600,     //  6A.   'j'      :J
                0x60A2,     //  6B.   'k'      :K
                0xE000,     //  6C.   'l'      :L
                0x444A,     //  6D.   'm'      :m
                0x4442,     //  6E.   'n'      :n
                0xC442,     //  6F.   'o'      :o
                0x6342,     //  70.   'p'      :P
                0xE780,     //  71.   'q'      :Q
                0x63C2,     //  72.   'r'      :R
                0xA542,     //  73.   's'      :S
                0x0118,     //  74.   't'      :T
                0xE600,     //  75.   'u'      :U
                0x0681,     //  76.   'v'      :V
                0x6684,     //  77.   'w'      :W
                0x00A5,     //  78.   'x'      :x
                0x0025,     //  79.   'y'      :Y
                0x8124,     //  7A.   'z'      :Z
                0x0039,     //  7B.   '{'      :Display
                0x0018,     //  7C.   '|'      :|
                0x0039,     //  7D.   '}'      :Display
                0x0039,     //  7E.   '~'      :Display
                0x0039,     //  7F.   'DEL'    :Display
};
```

3.2.2 硬件的设定

将 LCD 显示屏直接连接到 SLP MCU：



应用电路板的 LCD 显示如下所示：

```
char k='e';
int j =15;

printf("Hi %c%x",(BYTE)k,(DWORD)j);
```

4. printf()库函数的缺点

printf()虽然好用，却是很复杂的库函数（关于函数的详细内容，请参照 H8 编译程序用户手册）。在 SLP MCU 使用时有以下缺点：

4.1 ROM 容量

因为 printf()函数必须处理 I/O 流、堆和许多参数，所以需要大量的 ROM 区（详细的比较请参照第 6 章）。

【注】 SLP H8/38024 的 ROM 容量最大为 32K 字节。

4.2 RAM 容量

因为 printf()需要使用堆存储器，所以只 printf 就被分配了 H’80 字节（不使用其他目的的堆的情况）。

【注】 SLP H8/38024 的 RAM 容量最大为 1K 字节。

5. 用户建立的 printf 函数 – Bprintf()

为解决上述问题，需要用户建立函数。本应用说明建立基本的 printf (Bprintf)函数，能根据应用的需要自定义此例。

和 2～3 章中说明的例子相比，Bprintf 函数不需要以下内容：

(1) Lowsrc.c
(2) Lowlev.src
(3) Resetprg.c 中的_INIT_IOLIB()和_CLOSEALL()函数调用
(4) sbrk.c

换言之，就是不需要 I/O 流和堆存储器，这正是用户建立函数的优点。

5.1 函数的使用方法

函数的原型如下：

```
BYTE Bprintf(const char *fmt, BYTE arg1, DWORD arg2);
```

此函数一般能和通常的 printf 函数一样调用，但是有如下限制：

(1) 显示字符数（20）
(2) 参数只有 2 个
(3) 第 1 参数是 BYTE 型，第 2 参数是 DWORD 型
(4) 支持的参数格式是%x、%c、%u

使用例：

(1) Bprintf(“Hello world”,0,0);
(2) Bprntf(“¥n¥rGet data = %x from address %x”, (BYTE)data, (DWORD)address);

5.2 函数的说明

和库的 printf()不同，Bprintf()是 printf 函数的简略版本，有以下限制：

(1) MAXCHARS ：指定字符串的长度，也是决定使用的堆栈深度的主要因素。
(2) 有 3 个 case 条件语句：参数的格式限制为%x、%c、%u 3 个。
(3) 变量 num ：参数的数量限制在 2 个。

Bprintf()函数调用 charput 函数，将信息发送到输出目标。

```
#define MAXCHARS      20
#define LEN   9

BYTE Bprintf(const char *fmt, BYTE arg1, DWORD arg2);
void itoab(char **buf, DWORD i, unsigned int base);


BYTE Bprintf(const char *fmt, BYTE arg1, DWORD arg2)
{
   DWORD u;
   BYTE num=0;                          // argument index
   BYTE index=0;                        // string index
   char buf[MAXCHARS];
   char *buf_ptr;

    buf_ptr = buf;

    // Rearranging output strings
   while (*fmt && index<(MAXCHARS-1))
   {    if (*fmt != '%')
           *buf_ptr++ = *fmt++;         // store string into buf
      else
      {   switch (*++fmt)               // if %, check what type
          {
              case 'x':                 // %x, hexadecimal unsigned number
                  if (num == 0)
                     u = (DWORD)arg1;
                  else if (num == 1)
                         u = (DWORD)arg2;
                     else
                         break;         //ignore > 2 arg
                     num++;
                  *buf_ptr++ = '0';
                  *buf_ptr++ = 'x';
                  b_itoab((char **)&buf_ptr, u, (unsigned int)16);
                  break;



               case 'u':                // %u, decimal unsigned number
                  if (num == 0)
                     u = (DWORD)arg1;
                  else if (num == 1)
                         u = (DWORD)arg2;
                     else
                         break;         //ignore > 2 arg
                     num++;
                  b_itoab((char **)&buf_ptr, u, (unsigned int)10);
                  break;
```

```
                case 'c':               // %c, a single character
                    if (num==0)
                        *buf_ptr++ = (char)arg1;
                    else if (num == 1)
                        *buf_ptr++ = (char)arg2;
                        else
                            break;      //ignore > 2 arg
                        num++;
                        break;

                default:
                        break;
                }// end switch
                fmt++;
            }// end else
        } //end while

        *buf_ptr = 0;                   // end of string indicator

        // Output rearranged string
        buf_ptr = buf;
        for (index = 0 ; *buf_ptr != (char)0 & index < MAXCHARS ; index++)
            charput(*buf_ptr++);        // output

        return(index);
    }
```

b_itoab()函数将整数转换为 ASCII 码，整数限于 16 进制或者 10 进制。

```
void b_itoab(char **buf, DWORD i, unsigned int base)
{
    BYTE index=0;
    DWORD rem;
    char conv[LEN];

    if (i == 0)
    {
        (*buf)[0] = '0';
        ++(*buf);
        return;
    }
    conv[index++] = 0;
    while (i)
    {
      rem = i % base;
      if (base == 10)
           conv[index++] = rem + '0';
      else if (base == 16)
      {
           if (rem < 10)
               conv[index++] = rem + '0';
           else
               conv[index++] = rem + 'A'- 0xA;
       }
       i /= base;
    }
    while (conv[--index])
    {
        (*buf)[0] = conv[index];
        ++(*buf);
    }
}
```

还能自定义 Bprintf()函数：

(1) 增加字符串的长度
(2) 追加参数的其他格式：%f、%3d、%o 等
(3) 增加参数的数量
(4) 增加或减小参数的长度（BYTE, WORD, DWORD）

6. 比较

为了比较程序大小，生成以下工程的映像文件（使用 Option/ Link Library/List）。为了简化比较，使用段 P 的大小评价函数的大小。在优化时，使用 debug 和 release 两者的设定。

	Debug	Release
printf LCD（不包含<no_float.h>）	20.4K 字节	14.9K 字节
printf LCD（包含<no_float.h>）	7.4K 字节	5.6K 字节
Bprintf LCD.	1.1K 字节	0.8K 字节

printf()的程序大小在使用浮点格式时约为 20.4K 字节；包含<no_float.h>时，被缩小到约 7.4K 字节。而用户建立函数时，程序大小进一步被缩小到 1.1K 字节，为 7 分之 1。必须再次注意 SLP 的最大 ROM 容量只有 32K 字节。

对于 RAM 容量，用户建立的 Bprintf()函数使用约 30 字节的堆栈（当 MAXCHAR=20 时），而库的 printf()函数使用 128（H’80）字节的堆存储器。

7. 总结

因为 SLP 的 ROM 容量小，并且在大部分目标应用程序中不需要复杂的 I/O 流，所以库的 printf()函数效率不高。因此推荐用户自定义 printf()函数。

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