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H8/300L SLP 系列

使用 I/O 端口的 SCI 仿真（SCI 端口）

要点

根据应用，需要与各种外部设备的多通道通信。能通过使用串行端口的方法很容易地实现。但是，由于能使用的串行端口受限制，所以需要进行使用 I/O 端口的通信。

在本应用说明中使用 2 条 I/O 线进行异步方式通信，与 PC 进行发送和接收的波特率设定为 9600bps。

动作确认器件

H8/38024 SLP

目录

1. 原理

1.1 概要

为了容易移植，用 C 语言编写仿真串行通信接口的软件。本应用说明通过 H8/38024 进行了动作确认。

本应用说明使用的 UART 协议是 1 个起始位、8 个数据位、无奇偶校验位和 1 个停止位，如下所示：

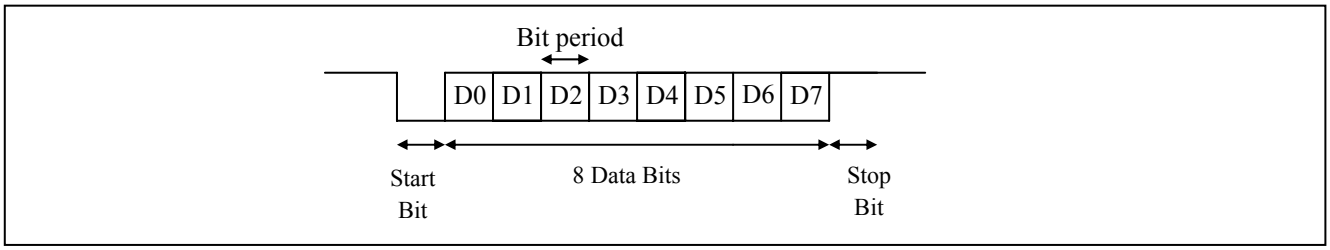

图 1 UART 协议

为了正确发送和接收数据，位周期必须正确。即使略有变动，一旦被积累，就会发生时序错误，并且数据被错误解码。位周期的计算如下：

位周期=1/波特率

在 9600bps 波特率的情况下，位周期为：

位周期=1/9600=104.167μs

为了生成此位周期，使用定时器功能或者 for 循环。对于定时器寄存器值和 for 循环，必须使用正确的值。

在发送时，将输出端口管脚上拉为 High 电平。作为起始位发送“0”，然后继续发送 8 位数据（最初发送 LSB（D0）），最后作为停止位发送“1”。

接收端口管脚也同样，上拉为 High 电平。如果信号电平为 Low，就发生起始位的接收或者因不需要的噪声而降低了电压电平。因此，将采样点延迟½个位周期，进行起始位“0”的检证。

1.2 运行

本应用说明使用 H8/38024F 的 CPU 端口。端口 1 的管脚 6（P16）用于发送通道，管脚 4（P14）用于接收来自外部的串行数据。使用的晶体振荡器频率为 9.8304MHz、波特率为 9600bps。为了满足用户的需求，能在 C 程序中容易地更改它们。

在发送时，P16 作为 MOS 上拉，设定为输出，用于发送。通过调用发送子程序发送数据。

P14 作为 MOS 上拉，用于输入。此 I/O 管脚也用于 IRQ4 中断的输入。

在开始接收数据前，将 P14 设定为用于外部中断 IRQ4 的接收。IRQ4 中断的初始设定为由 High 电平到 Low 电平的边沿触发。因此，在接收起始位后，如果 P14 从 High 电平变化到 Low 电平，就发生中断，开始执行接收运行的 IRQ4 中断服务程序。

在中断服务程序中，将 P14 设定为连续接收数据的输入端口。如果发生 IRQ4 中断，软件就等待½个位周期，然后采样起始位。在检测到起始位后，接收子程序等待 1 个位周期，分别采样 8 位的数据。此处理如图 2 所示。

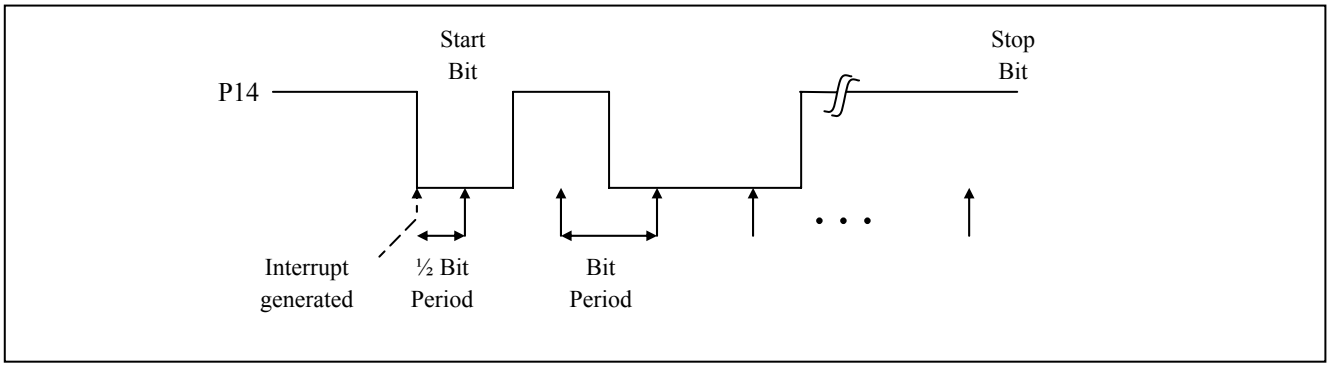

图 2　采样周期

定时器 F 用于位周期的等待。将定时器 F 初始设定为 16 位定时器，如果发生比较匹配，就产生中断。在 1.3 节中说明输出比较寄存器值的计算。

1.3　输出比较寄存器值的计算

定时器 F 是内置输出比较寄存器功能的自由运行计算器。被初始设定为：如果发生比较匹配，就产生中断。即定时器控制寄存器 F（TCRF）让值递增，如果定时器控制寄存器 F 的值和输出比较寄存器 FH（OCRFH）的值一致，就发生中断。

通过设定定时器控制寄存器 F 的位 2～0，如表 1 的粗体字所示，将内部时钟设定为 Ø/4。

表 1　定时器 F 的时钟选择

位 2 CKSL2	位 1 CKSL1	位 0 CKSL0	说明
0	0	0	在上升/下降沿，对外部事件（TMIF）进行计数
0	0	1	
0	1	0	
0	1	1	禁止使用
1	0	0	内部时钟：用 ø/32 进行计数
1	0	1	内部时钟：用 ø/16 进行计数
1	**1**	**0**	**内部时钟：用 ø/4 进行计数**
1	1	1	内部时钟：用 øw/4 进行计数

输出比较寄存器值的计算如下：

位周期=1/波特率
Ø=晶体振荡器的频率/2
内部时钟=Ø/4
d=输出比较寄存器值
d×内部时钟周期=需要的位周期

$$D\times\frac{1}{\frac{\text{晶体振荡器的频率}}{2\times 4}}=\frac{1}{\text{位周期}}$$

$$d=\frac{\text{晶体振荡器的频率}}{8\times\text{波特率}}$$

定时器 F 在初始化后到开始递增 16 位定时器计数器 TCF 的值为止，大约需要 25μs 时间。由于更长位周期的原因，值需要偏移量。在使用 9.3204MHz 的晶体振荡器时，需要 49 的偏移量。

因此，被装入到 OCRFH 的值是 d – 49。

注意：初始设定时的定时器 F 的延迟取决于使用的振荡器的值。在使用不同的晶体振荡器时，用户需要更改偏移值。

1.4 其它解决方案

- 起始位的查询

为了检测起始位，用户不使用中断而能使用查询方法。为了等待接收起始位，用户连续读取接收管脚的 P14。代码的例子如下：

```
while(1)
{
   if (RX == 0)
       receive();
}
```

但是，由于用户需要连续检测接受管脚，所以只能在主程序不执行任何指令的情况下使用此方法。

- 使用 for 循环的延迟

为了进行位周期所需的延迟，能使用 for 循环代替定时器 F。用户需要给 for 循环设定适当的延迟值，延迟子程序的例子如下所示：

```
void delay (unsigned short d)
{
  for (i = 0; i < d; i ++)
}
```

2. 运行说明

2.1 硬件的设定

为了与外部设备进行通信，必须设定 RS-232C 驱动器的连接。为了调整单片机和外部设备之间的信号电平，需要设定简易串行驱动器。必须用 10kΩ的电阻将 I/O 管脚上拉为 High 电平。

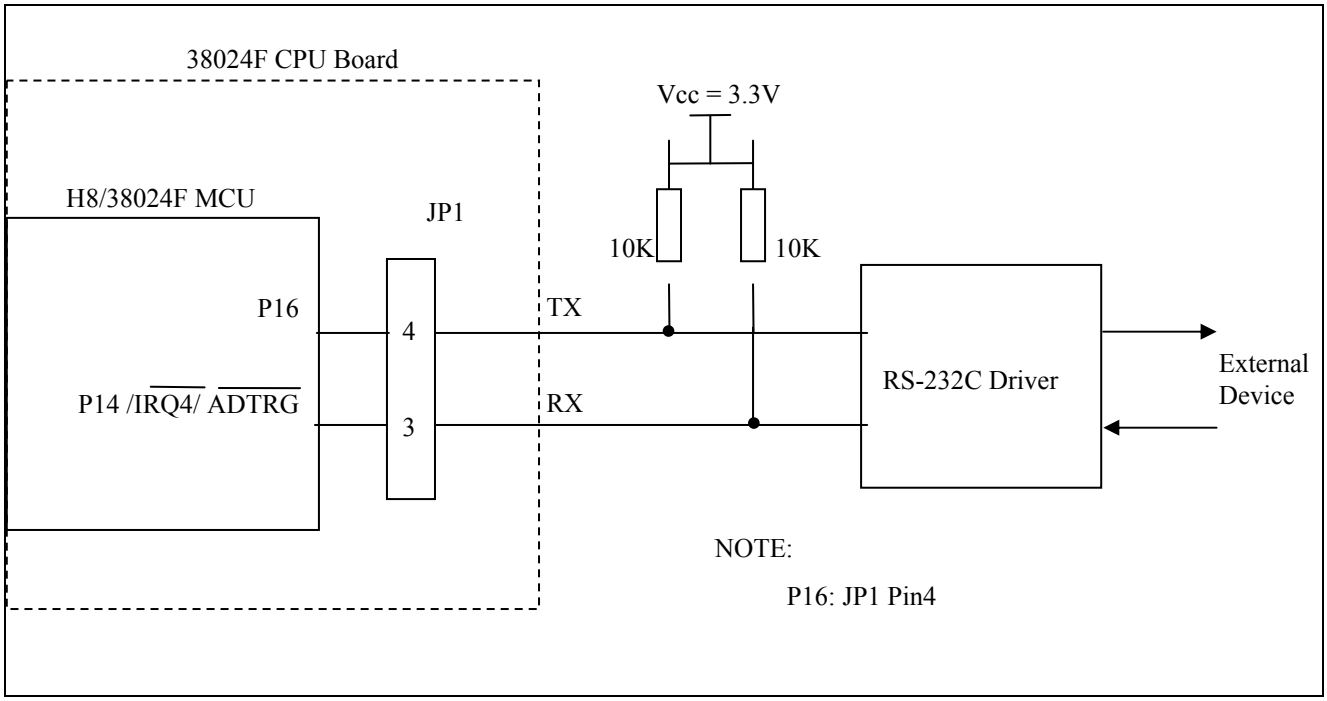

图 3 RS－232C 串行驱动器和单片机的设定

有关 RS－232C 驱动器的电路图如**图 4** 所示。

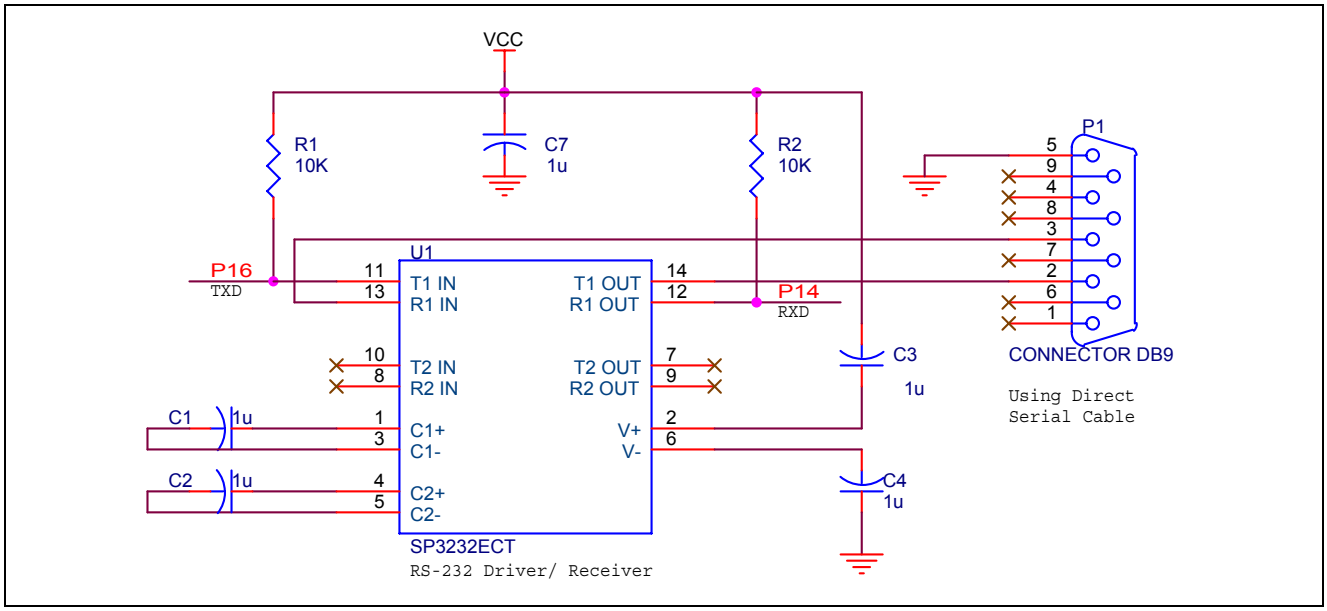

图 4　RS-232C 串行驱动器

2.2　超级终端的设定

当用户在使用单片机和超级终端的 PC 之间设定通信时，需要按照用于 UART 协议和程序的波特率设定 COM 端口。

在 9600bps 波特率的情况下，需要对连接到 RS-232 驱动器的 COM 端口进行如下设定。在超级终端窗口的 File 菜单中选择 Properties 并单击 Configure…，更改端口设定。

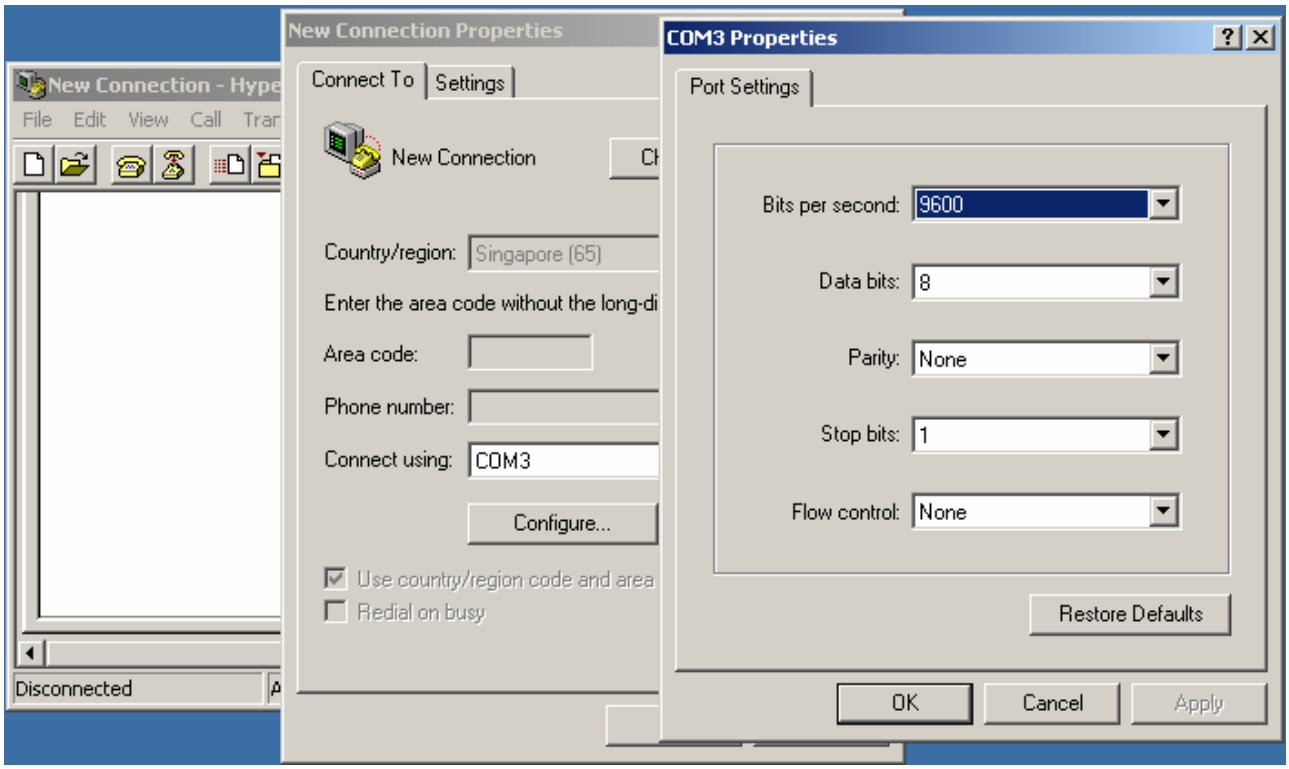

图 5　PC 超级终端的设定

其次，为了在超级终端窗口显示用户输入的字符，设定超级终端。单击设定选项卡的 *ASCII Setup…*，如图 6 所示，请单击 *Echo typed characters locally* 的复选框。

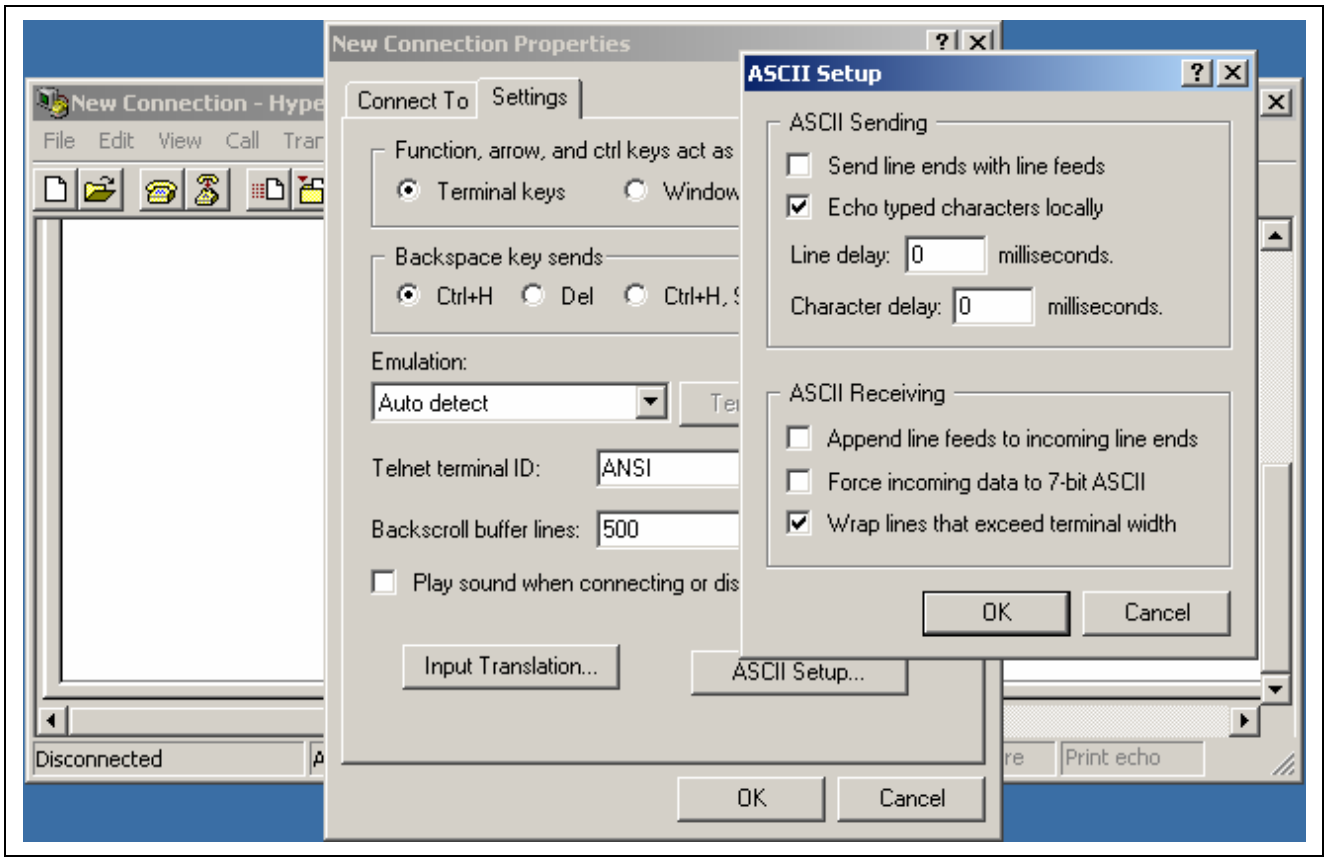

图 6　ASCII 的设定

如果设定了正确的波特率，字符 Test 就将显示在超级终端。用户能将任意字符输入到超级终端，为了确认，再次将被解码的字符发送到超级终端窗口。超级终端窗口的例子如**图 7** 所示。如果字符被错误解码 （检测不到停止位的情况），**Er** 就被发送，并显示在超级终端窗口。

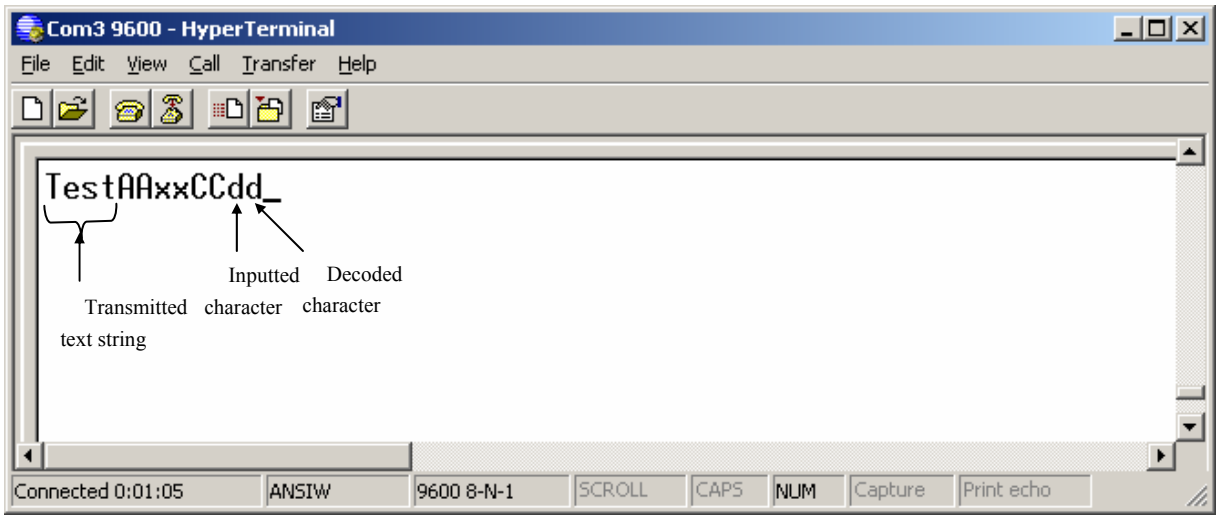

图 7　PC 超级终端窗口的显示例子

3. 程序清单

使用以 H8/38024 单片机为对象的 HEW 工程生成程序建立本应用说明的以下程序清单，使用的工具链是 SLP/TINY 工具链。

为了解说主功能，使用户更加理解，还建立了流程图。

注意：为了程序正常运行，必须将优化设定为 off。

```
/************************************************************************/
/*                                                                      */
/*  FILE       :Emulate_SCI.c                                           */
/*  DATE       :Wed, Sep 10, 2003                                       */
/*  DESCRIPTION :Main Program                                           */
/*  CPU TYPE    :H8/38024F                                              */
/*                                                                      */
/*  This file is generated by Renesas Project Generator (Ver.2.1).     */
/*                                                                      */
/************************************************************************/

//include 38024F IO define header file
#include "iodefine.h"

#include <machine.h>
#include <_h_c_lib.h>

//include additional flag define header file
#include "flagdefine.h"

void initialize (void);
void transmit (unsigned char);
void receive (void);
void transmit_string (void);
void delay (unsigned short);

char *buff_ptr;
static const char TX_buffer[] = "Test";          // Transmit buffer
char RX_buffer;                                  // Receive buffer
unsigned int i =0;

//--------------- Main Program ----------------//
void main(void)
{
   initialize();

   transmit_string();

   while(1);
}

//--------- Initialization of Port 1, Timer F & IRQ4 ---------//
void initialize (void)
{
// Initialize Port 1
   P_IO.PUCR1.BIT.PUCR16 = 1;       // P16 MOS pull-up
   TX = 1;
   P_IO.PCR1.BIT.PCR16 = 1;         // P16 as output (TX)

// Initialize IRQ4
   P_SYSCR.IEGR.BIT.IEG4 = 0;       // Interrupt generated at falling edge of //IRQ4

   P_SYSCR.IENR1.BIT.IEN4 = 1;            // Enables IRQ4
   P_IO.PMR1.BIT.IRQ4 = 1;                // P14 used as IRQ4

// Initialize Timer F
```

```
    P_TMRF.TCRF.BYTE = 0x8E;          // Set TMOFH pin output level to HIGH and //internal
clock of o/4
    P_TMRF.TCSRF.BIT.CCLRH = 1;             //TCF cleared when TCF and OCRF match

}

//--------------- Transmit a character ----------------//

void transmit (unsigned char a)
{
    int i;
    MON_RAM.TX_CHAR.BYTE = a;

// start bit
    TX = 0;
    delay(bit_period);

// 8 data bits
    for (i=0; i<8; i++)
    {
        if (MON_RAM.TX_CHAR.BIT.bit0 == 0)
            TX = 0;

        else
            TX = 1;

        delay(bit_period);
        MON_RAM.TX_CHAR.BYTE = MON_RAM.TX_CHAR.BYTE >> 1;
    }

// stop bit
    TX = 1;
    delay(bit_period);
}

//--------------- Transmit characters in Transmit Buffer ----------------//
void transmit_string (void)
{
    buff_ptr = (char *)&TX_buffer;

    while (   *buff_ptr != 0)
    {
        MON_RAM.TX_CHAR.BYTE = (*buff_ptr++);
        transmit(MON_RAM.TX_CHAR.BYTE);            // call transmit subroutine to
tansmit //each character
    }
}

//--------------- Store characters in RX_CHAR ----------------//
void receive (void)
{
    int j;
    RX_buffer = 0;

// Receive data bits
    for (j=0; j<8; j++)
    {
```

```
        delay(bit_period);
        if (RX == 1)
           MON_RAM.RX_CHAR.BYTE = MON_RAM.RX_CHAR.BYTE | (0x01 << j);

        else
           MON_RAM.RX_CHAR.BYTE = MON_RAM.RX_CHAR.BYTE & rotlc(j,0xFE);
    }

// Receive stop bit
    delay(bit_period);
    if (RX != 1)
    {
       transmit('E');                              // error if sampled stop bit='0',
transmit 'Er'
       transmit('r');
    }
    else
    {
       RX_buffer = MON_RAM.RX_CHAR.BYTE ;   // save character in receive //buffer
       transmit(RX_buffer);                        // transmit character in receive
//buffer
    }

    P_IO.PMR1.BIT.IRQ4 = 1;                              // P14 used as IRQ4
}

//--------------- Delay function using Timer F ----------------//
void delay (unsigned short d)
{
    d = d-49;                          // decrease d to offset for delay during setup of
timer

    P_TMRF.OCRF.BYTE.H = d<<8;              // save count (d) in output compare register
    P_TMRF.OCRF.BYTE.L = d;

    P_TMRF.TCSRF.BIT.CMFH = 0;              // Clear compare match flag
    P_TMRF.TCF.BYTE.H = 0;                        // Clear counter and start the timer
F
    P_TMRF.TCF.BYTE.L = 0;

    while (P_TMRF.TCSRF.BIT.CMFH == 0);     // Loop until a compare match occurs

    P_TMRF.TCSRF.BIT.CMFH = 0;              // Clear compare match flag
}
```

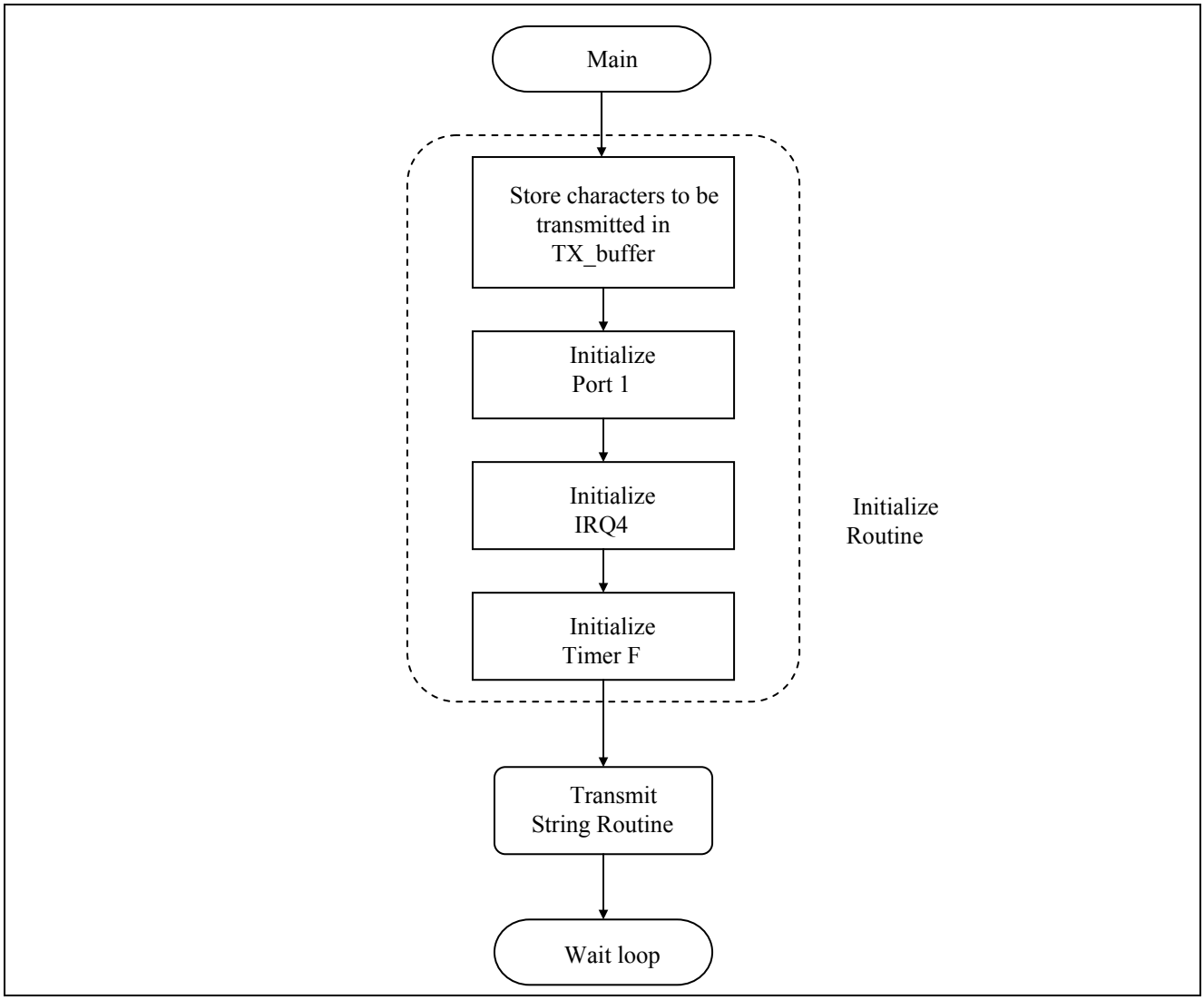
Main
Store characters to be transmitted in TX_buffer
Initialize Port 1
Initialize IRQ4
Initialize Timer F
Initialize Routine
Transmit String Routine
Wait loop

图 8　主程序

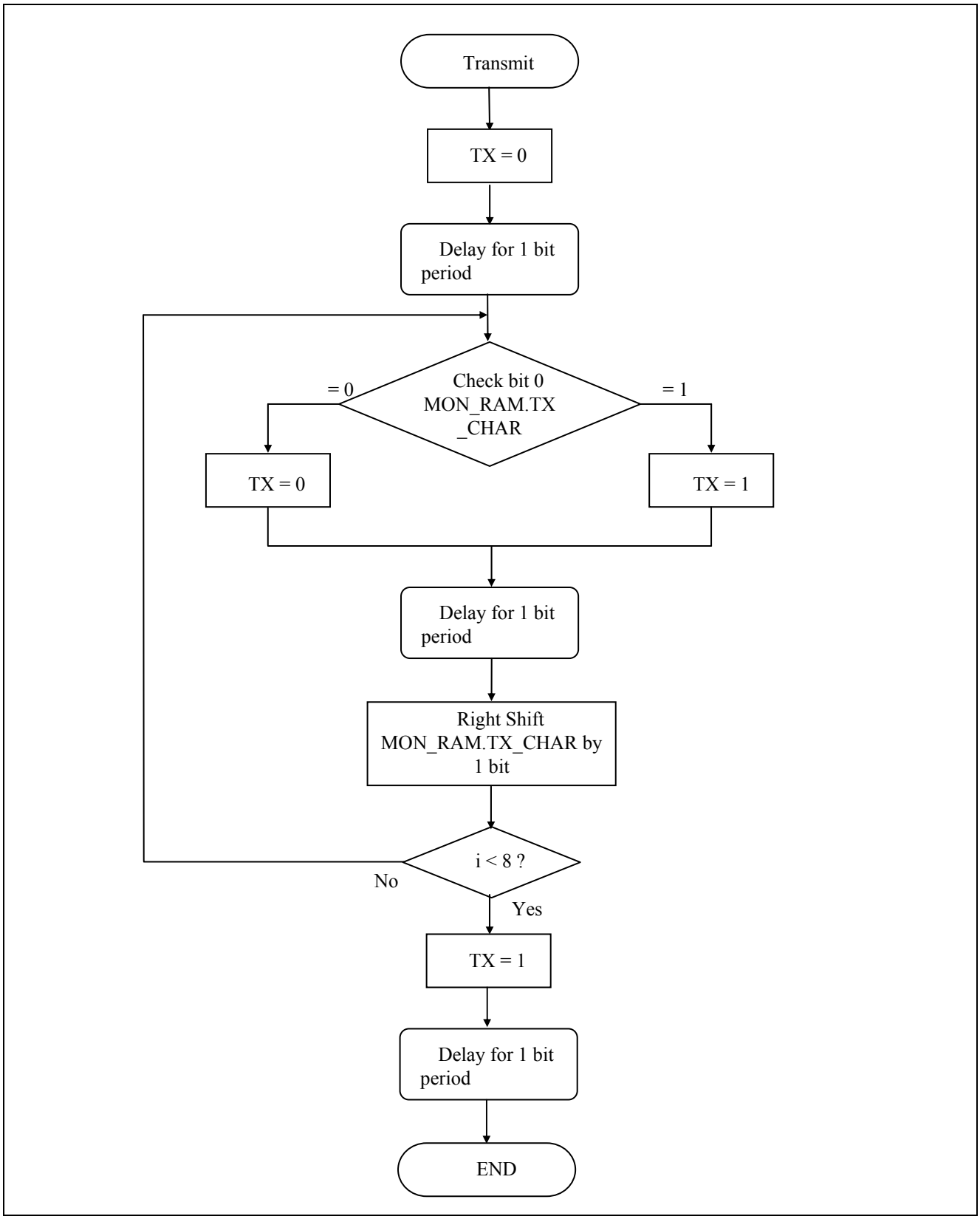
Transmit
TX = 0
Delay for 1 bit period
Check bit 0 MON_RAM.TX _CHAR
= 0
= 1
TX = 0
TX = 1
Delay for 1 bit period
Right Shift MON_RAM.TX_CHAR by 1 bit
i < 8 ?
No
Yes
TX = 1
Delay for 1 bit period
END

图 9　发送程序

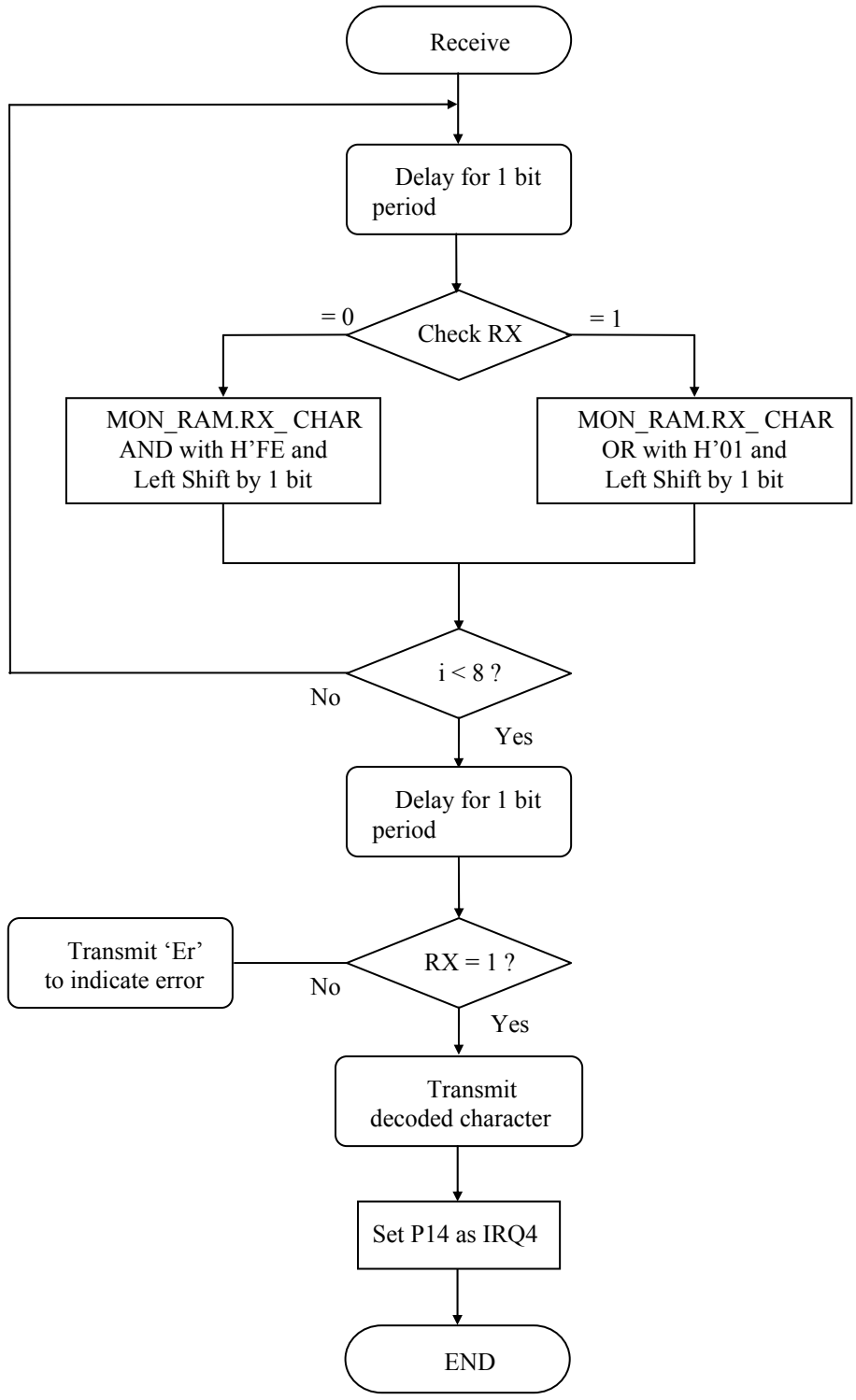
Receive
Delay for 1 bit period
Check RX
= 0
= 1
MON_RAM.RX_ CHAR AND with H'FE and Left Shift by 1 bit
MON_RAM.RX_ CHAR OR with H'01 and Left Shift by 1 bit
i < 8 ?
No
Yes
Delay for 1 bit period
Transmit 'Er' to indicate error
RX = 1 ?
No
Yes
Transmit decoded character
Set P14 as IRQ4
END

图 10　接收程序

```
/*********************************************************************/
/*  FILE       :flagdefine.h                                         */
/*  DATE       :Tue, Aug 19, 2003                                     */
/*  DESCRIPTION :Definition of flag                                   */
/*  CPU TYPE    :H8/38024                                             */
/*  Additional header file                                                */
/*                                                                 */
/*********************************************************************/

#define XTAL       9830400L          // for crystal frequency of 9.83204Mhz

#define   BAUD         9600L               // for baud rate of 9600

#define   bit_period   (XTAL / (8*BAUD))    // for internal clk = Ø /4
                                            // NOTE: Ø = XTAL/2
#define   sample    ((bit_period) / 2L)

#define   TX           P_IO.PDR1.BIT.P16    // Port 1 pin 6 as transmit pin
#define   RX           P_IO.PDR1.BIT.P14    // Port 1 pin 4 as receive pin

/*********************************************************************/
/*     H8/38024 Flag Definition File                    Ver 1.0     */
/*********************************************************************/
struct MON                                              /*struct MON_RAM*/
{                                               /*            */
          union {                               /*            */
               unsigned char BYTE;                      /*  Byte Access */
               struct {                         /*  Bit  Access */
                     unsigned char bit7:1;              /*            */
                     unsigned char bit6:1;              /*            */
                     unsigned char bit5:1;              /*            */
                     unsigned char bit4:1;              /*            */
                     unsigned char bit3:1;      /*            */
                    unsigned char bit2:1;                   /*            */
                    unsigned char bit1:1;                   /*            */
                     unsigned char bit0:1;              /*               */
                     }     BIT;                 /*              */
               } TX_CHAR;                               /*            */
          union {                               /*            */
               unsigned char BYTE;                      /*  Byte Access */
               struct {                         /*  Bit  Access */
                     unsigned char bit7:1;              /*            */
                     unsigned char bit6:1;              /*            */
                     unsigned char bit5:1;              /*            */
                     unsigned char bit4:1;              /*            */
                     unsigned char bit3:1;      /*            */
                    unsigned char bit2:1;                   /*            */
                    unsigned char bit1:1;                   /*            */
                     unsigned char bit0:1;              /*               */
                     }     BIT;                 /*              */
               } RX_CHAR;                               /*            */
};                                              /*            */
#define MON_RAM    (*(volatile struct MON    *)0xFD20)   /* MON_RAM Addr */

/*********************************************************************/
/*                                                                 */
/*  FILE       :intprg.c                                             */
```

```
/*  DATE       :Mon, Aug 25, 2003                                    */
/*  DESCRIPTION :Interrupt Program                                    */
/*  CPU TYPE    :H8/38024F                                           */
/*                                                                  */
/*  This file is generated by Renesas Project Generator (Ver.2.1).    */
/*                                                                  */
/********************************************************************/

// include 38024F IO define header file
#include "iodefine.h"

#include <machine.h>

// include additional flag define  header file
#include "flagdefine.h"

extern void delay (unsigned short);
extern void receive (void);
```

NOTE: Add the following in the IRQ4 vector

```
void INT_IRQ4(void)
{
   set_imask_ccr(1);                // Disable interrupts

   P_IO.PMR1.BIT.IRQ4 = 0;          // P14 used as i/o pin

   P_IO.PCR1.BIT.PCR14 = 0;         // P14 as Input (RX)
   P_IO.PUCR1.BIT.PUCR14 = 1; // P14 MOS pull-up

// start bit
    delay(sample);     // delay half a bit period to sample at the middle // of each
                              bit

   if (RX == 0)       // Start receive sequence if sampled start bit equals '0'
      receive();

   P_SYSCR.IRR1.BIT.IRRI4 = 0;      // clear interrupt request flag
}
```

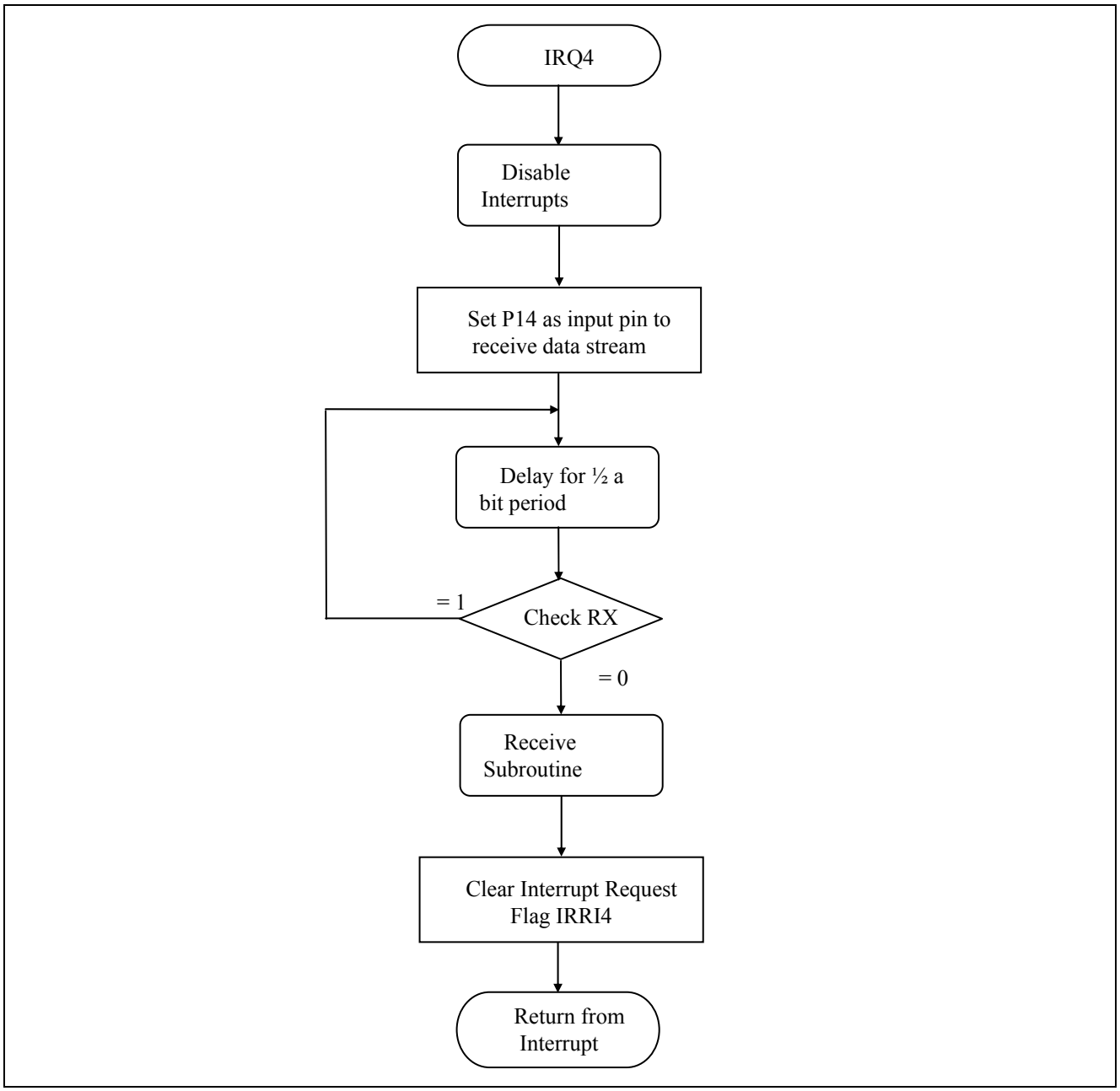

图 11　中断服务程序 4（IRQ4）

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修订记录

Rev.	发行日	修订内容	
		页	修订要点
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