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7542 群

实例程序 异步串行 I/O1（UART）- LED 显示模式控制

1. 要点

本应用说明使用如下功能：

- 定时器 X（定时器模式）：主循环定时 20 毫秒；
- INT0（下降沿有效）：启动数据发送；
- 串行 I/O1（UART）：实现 MCU 之间全双工通信；
- 输出端口（$P3_0$-$P3_2$, $P0_3$）：控制 LED0，LED1，LED2，LED3。

2. 说明

该应用说明适用于以下条件：

- 采用的 MCU：7542 群
- 振荡频率：8MHz
- 存储器容量：ROM 32K，RAM 1KB

3. 操作

电路图如图 1 所示：

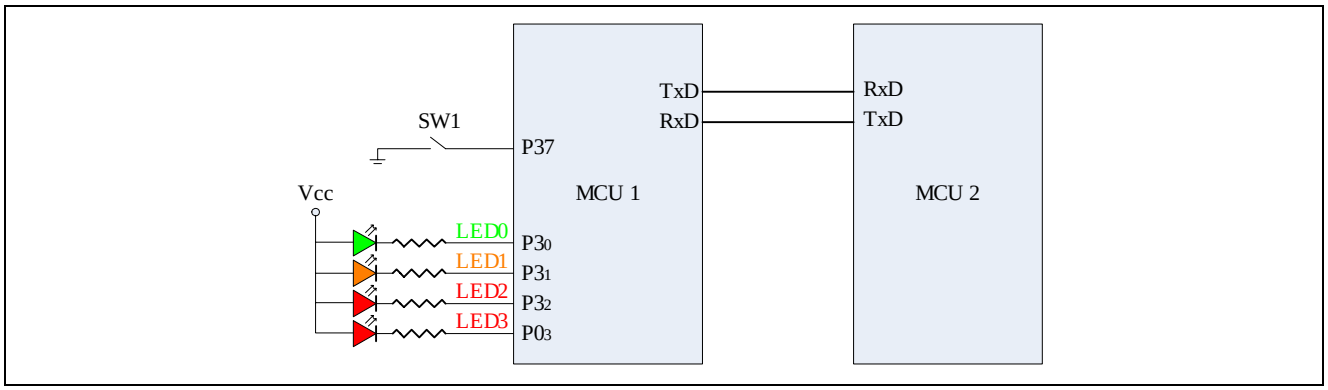


图 1　电路原理图

- 通信格式：波特率 9615bps，数据长度 8 位，1 位停止位，采用偶校验。
- 通过按键 SW1 启动数据发送，发送端的初始数据为 0x0f，每按一次键（SW1），发送数据，然后发端送的数据减 1，当发送端的数据减到 0 时，重新装载为 0x0f。
- 接收端根据接收到的数据控制 LED0-3 的点亮和关闭。接收的数据和 LED0-3 对应的显示模式如图 2 所示：

接收的数据	LED3	LED2	LED1	LED0
0x0f	●	●	●	●
0x0e	●	●	●	○
0x0d	●	●	○	●
0x0c	●	●	○	○
0x0b	●	○	●	●
0x0a	●	○	●	○
0x09	●	○	○	●
0x08	●	○	○	○
0x07	○	●	●	●
0x06	○	●	●	○
0x05	○	●	○	●
0x04	○	●	○	○
0x03	○	○	●	●
0x02	○	○	●	○
0x01	○	○	○	●
0x00	○	○	○	○

● ● ● 亮
○ 灭

图 2　显示模式

4. 寄存器的设定

4.1 程序使用的全局变量

表 1　全局变量表

变量名	初值	大小	描述	最小	最大	标志
g_mode	00H	1	发送和接收模式标志: 0 接收;1 发送	00H	01H	—
g_error	00H	1	错误标志	00H	FFH	—
g_tr_data	0FH	1	发送数据缓存单元	00H	0FH	—
g_re_data	00H	1	接收数据缓存单元	00H	FFH	—
g_key_state	00H	1	按键状态标志	00H	04H	—

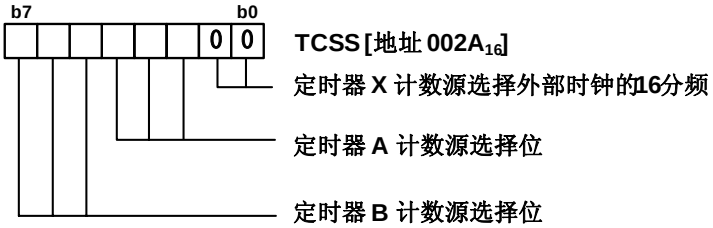
4.2 定时器 X（定时器模式）

定时器 X 选择定时器运行模式；

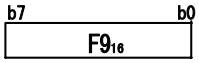
- 主循环周期为 20 毫秒；
- 禁止定时器 X 中断。

定时时间：*8MHz x f16 x 250 x 40 = 20*ms

设定定时器计数源选择寄存器

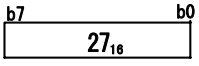


设定定时器 X 预定标器



PREX [地址 002C16]

设定定时器 X 计数寄存器



TX [地址 002D16]

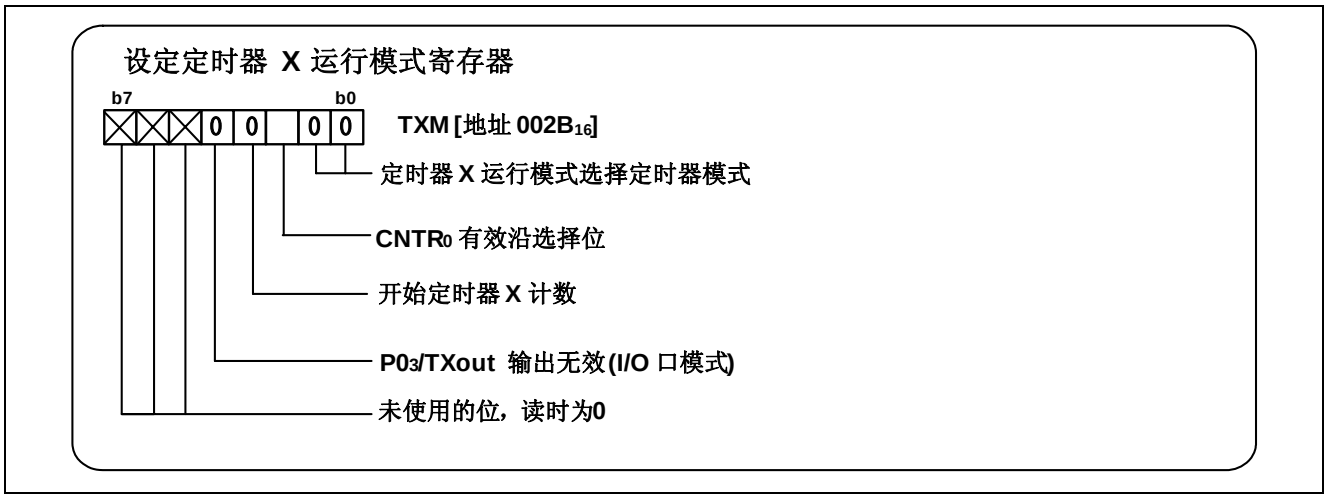


图 3　定时器 X 设置

4.3 INT0（下降沿有效）

允许 INT0 中断。有关 INT0 的设定如图 4 所示：

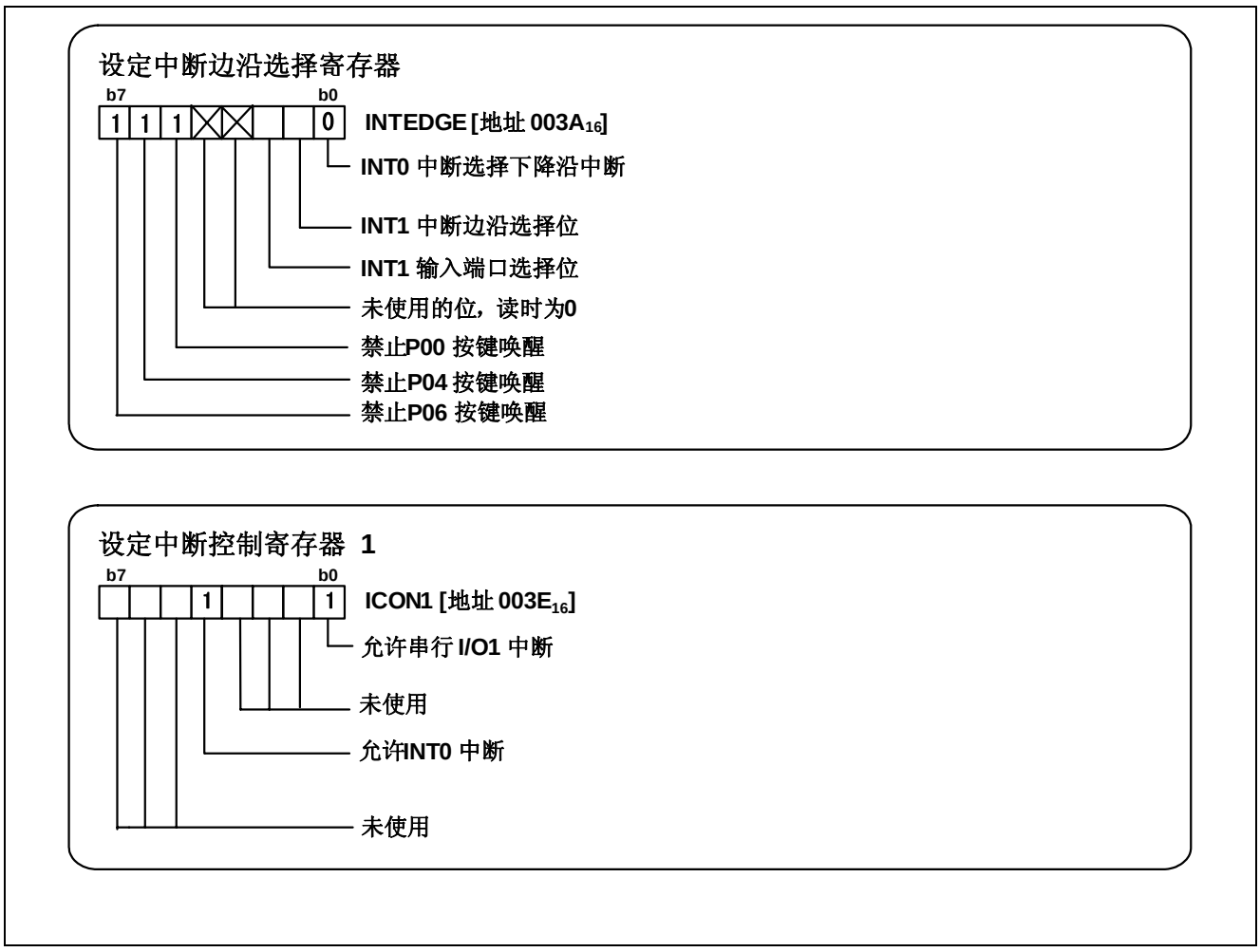


图 4　INT0 设置

4.4 串行 I/O1（UART 模式）

对于时钟异步串行 I/O1(UART)通信，发送端和接收端的波特率和数据格式要统一。当一字节数据接收完成会产生一个接收中断。

有关串行 I/O1 的设定如图 5 所示：

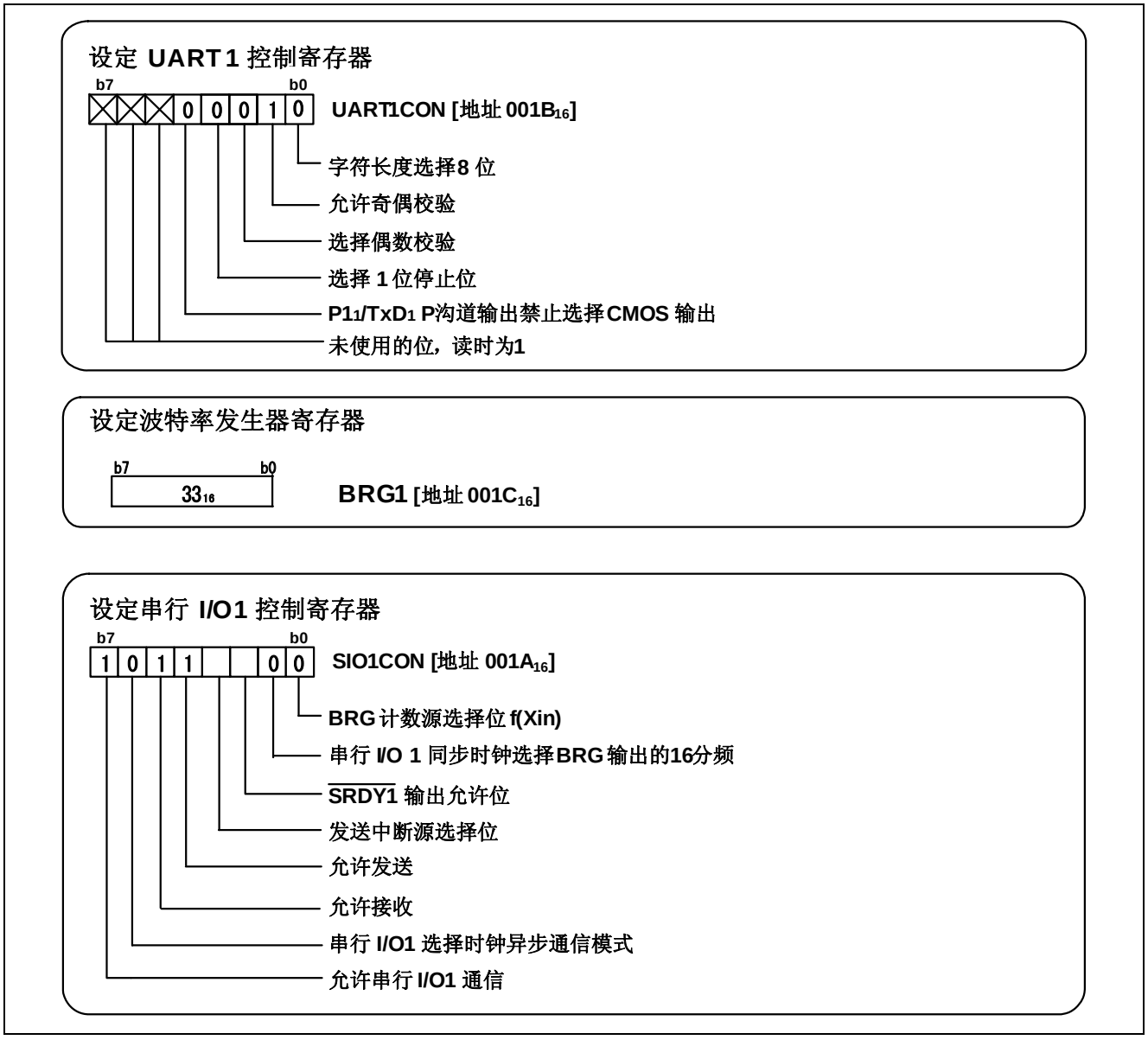


图 5　串行 I/O1 设置

4.5 输出端口(P30-P33, P03)：控制 LED 显示模式

通过 $P3_0$，$P3_1$，$P3_2$，$P0_3$ 控制 LED0，LED1，LED2，LED3 显示模式；每隔 20 毫秒根据接收到的数据改变输出端口的电平。

有关 I/O 端口的设置如图 6 所示：

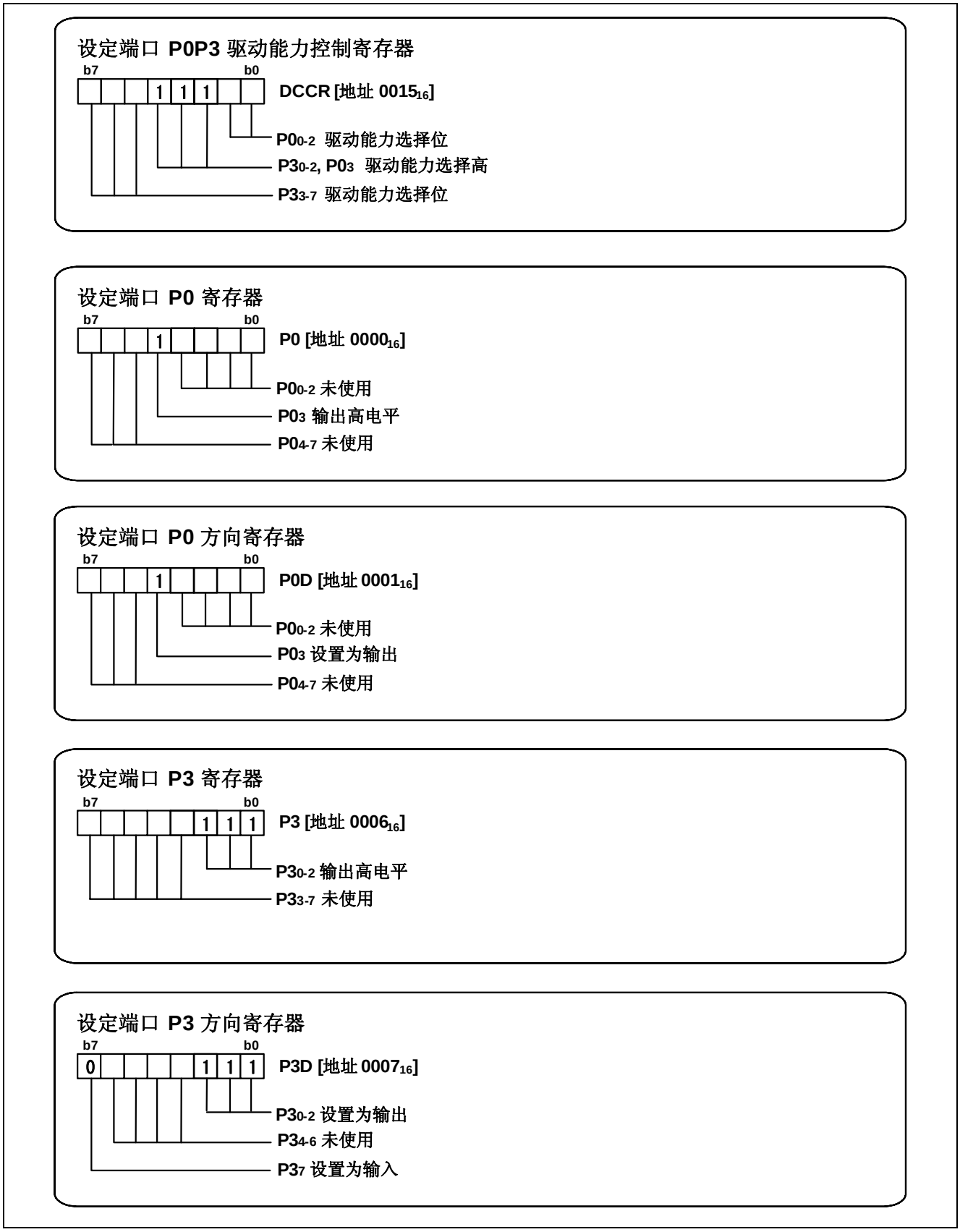

设定端口 P0P3 驱动能力控制寄存器
b7
b0
1 1 1
DCCR [地址 0015₁₆]
P0₀₋₂ 驱动能力选择位
P3₀₋₂, P0₃ 驱动能力选择高
P3₃₋₇ 驱动能力选择位
设定端口 P0 寄存器
b7
b0
1
P0 [地址 0000₁₆]
P0₀₋₂ 未使用
P0₃ 输出高电平
P0₄₋₇ 未使用
设定端口 P0 方向寄存器
b7
b0
1
P0D [地址 0001₁₆]
P0₀₋₂ 未使用
P0₃ 设置为输出
P0₄₋₇ 未使用
设定端口 P3 寄存器
b7
b0
1 1 1
P3 [地址 0006₁₆]
P3₀₋₂ 输出高电平
P3₃₋₇ 未使用
设定端口 P3 方向寄存器
b7
b0
0 1 1 1
P3D [地址 0007₁₆]
P3₀₋₂ 设置为输出
P3₄₋₆ 未使用
P3₇ 设置为输入

图 6　输出端口设置

5. 流程图

5.1 主函数

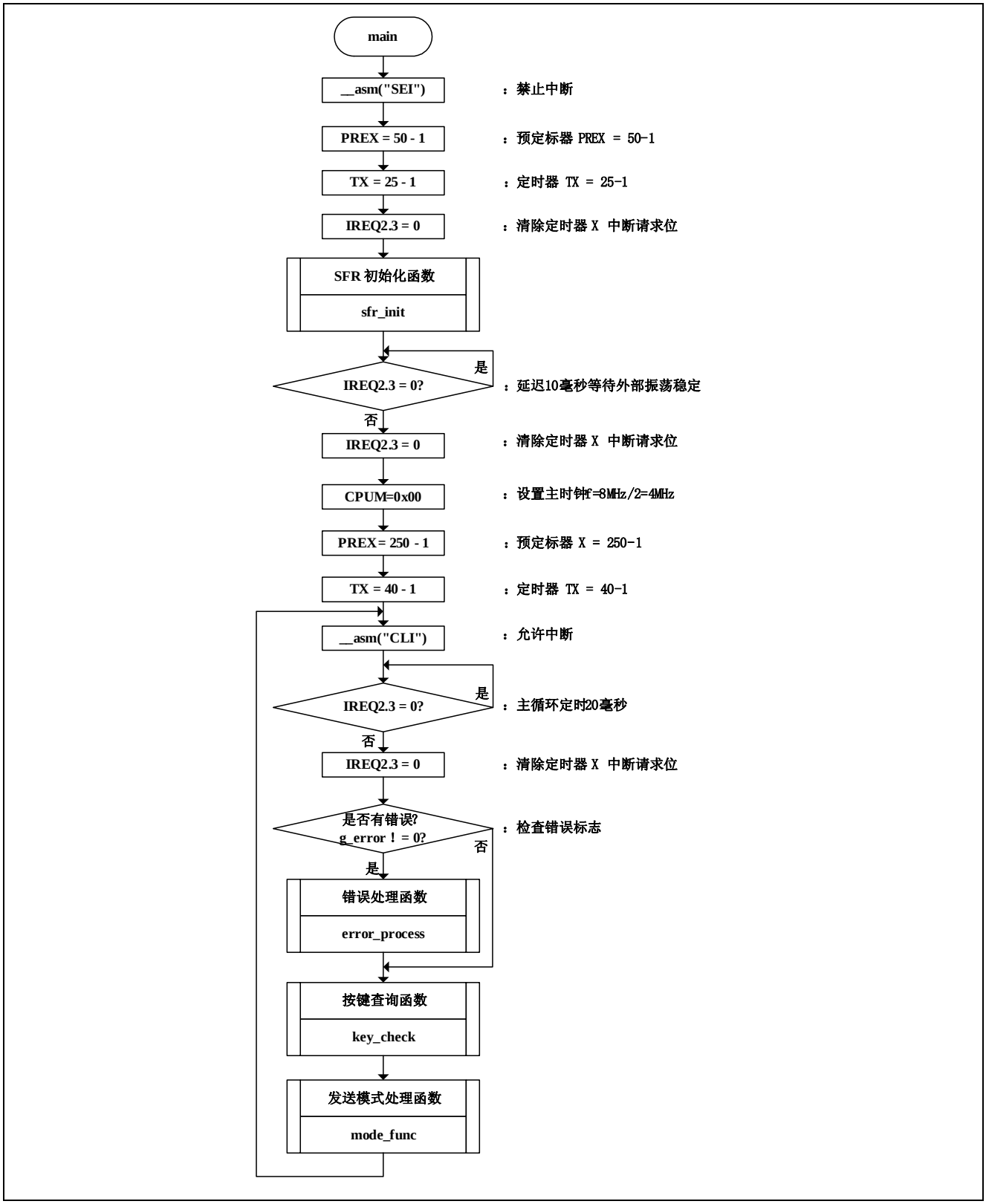


图 7　主函数流程图

5.2 SFR 初始化函数

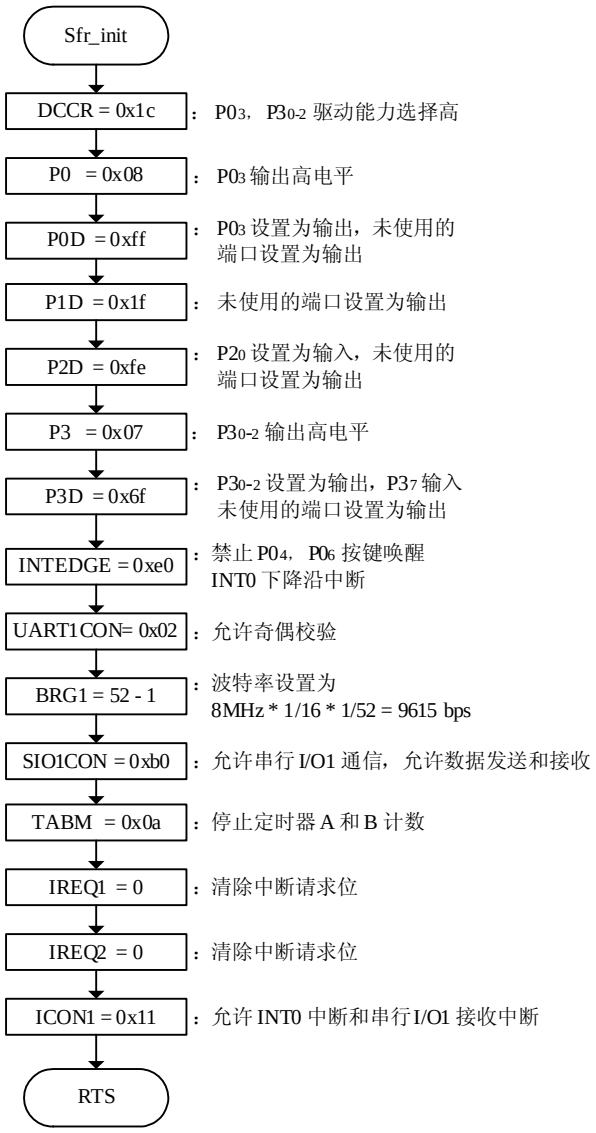


图 8　SFR 初始化函数流程图

5.3 发送模式处理函数

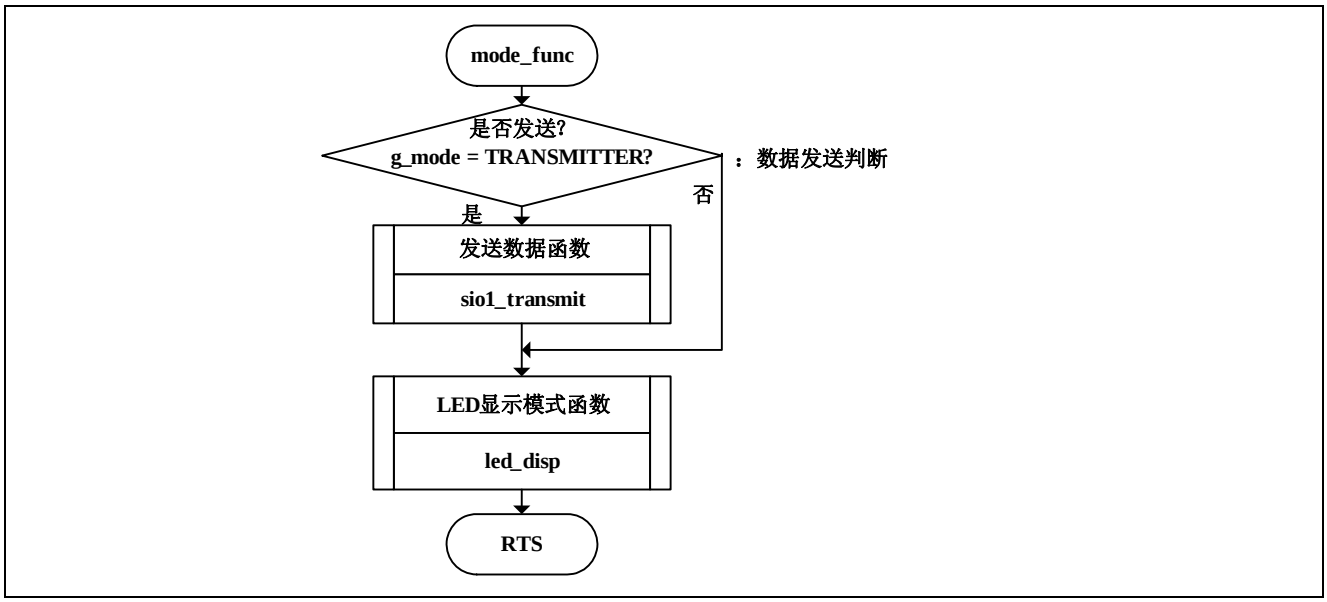


图 9　发送模式处理函数流程图

5.4 输出端口（P30-2, P03）：LED 显示模式函数

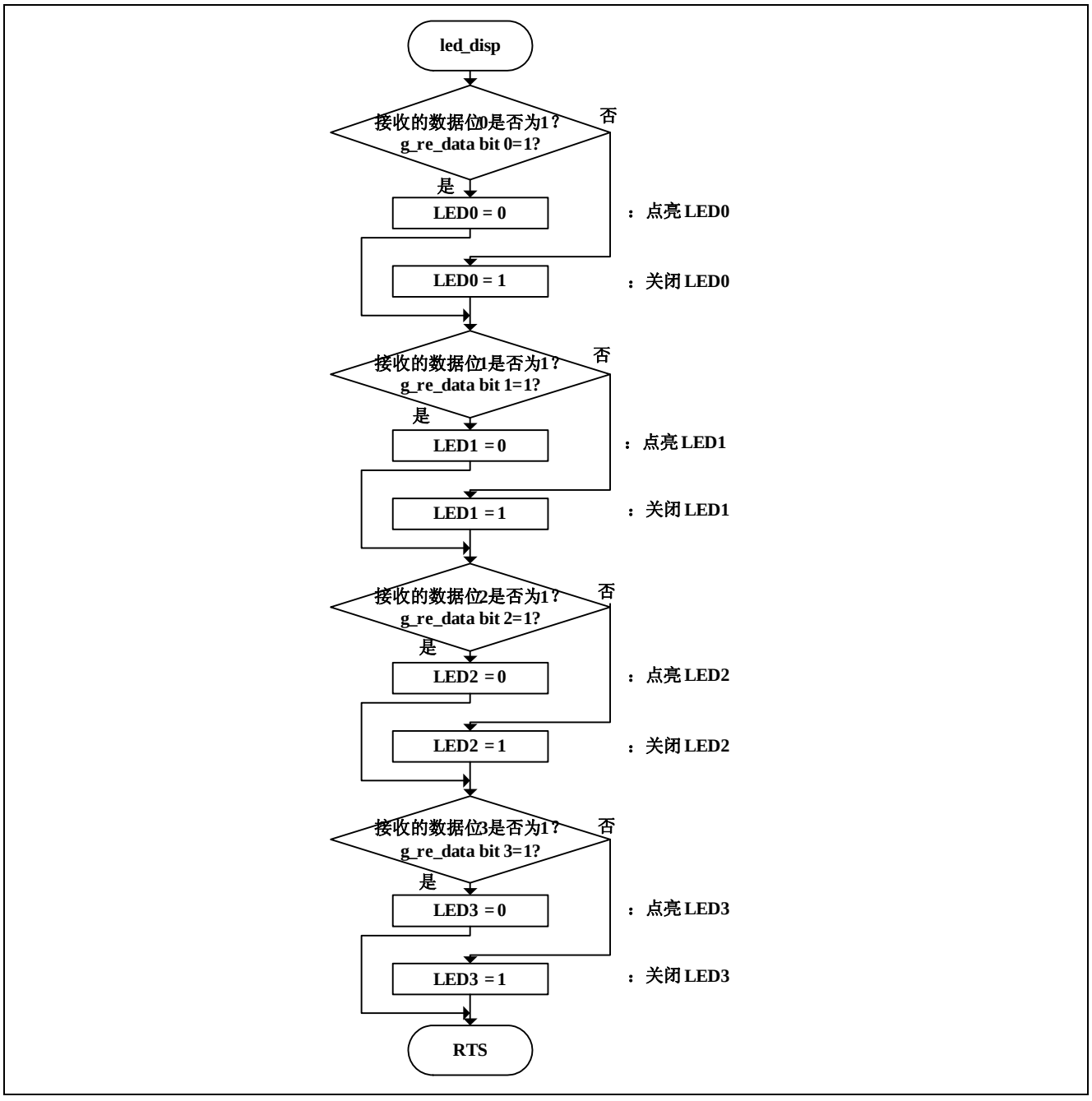


图 10　LED 显示模式函数流程图

5.5 按键查询函数

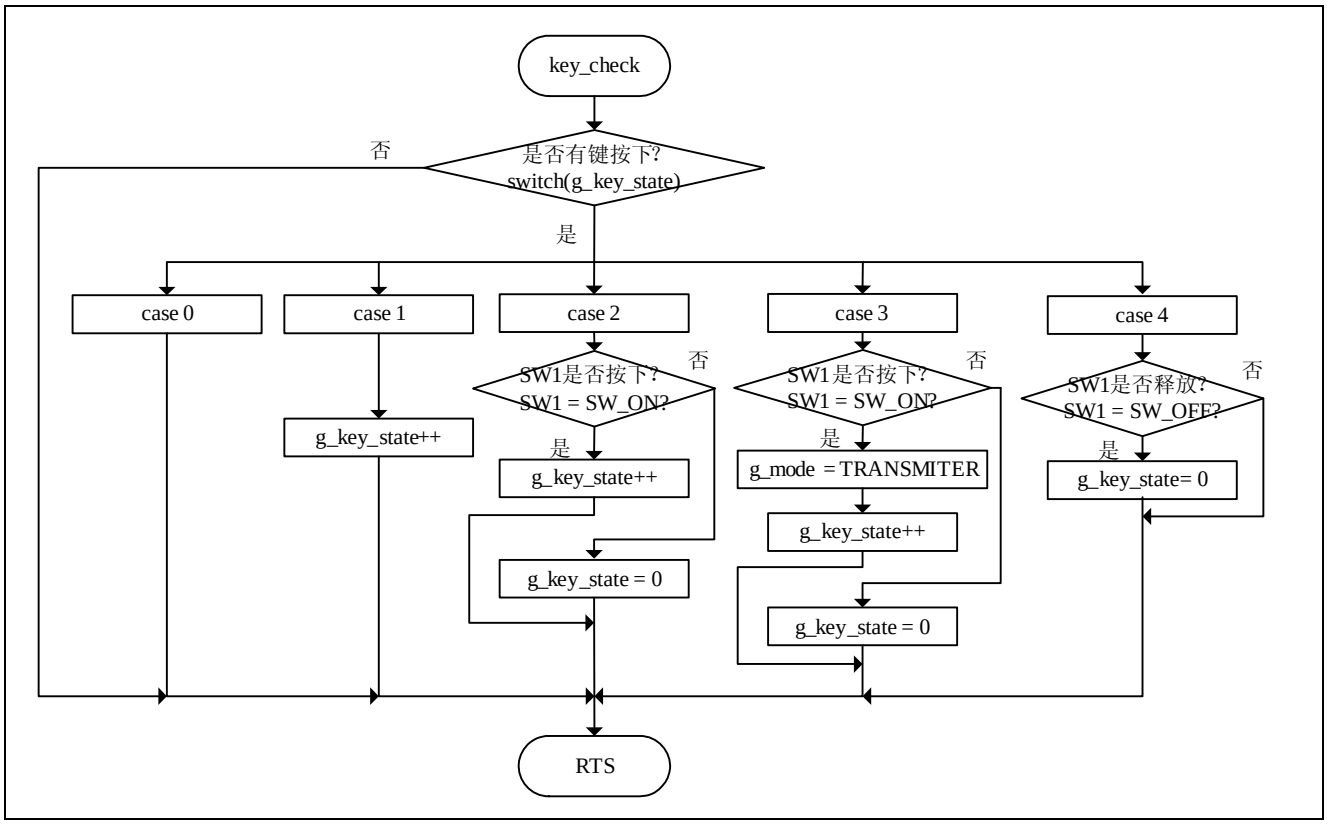


图 11　按键查询函数流程图

5.6 串行 I/O1 数据发送函数

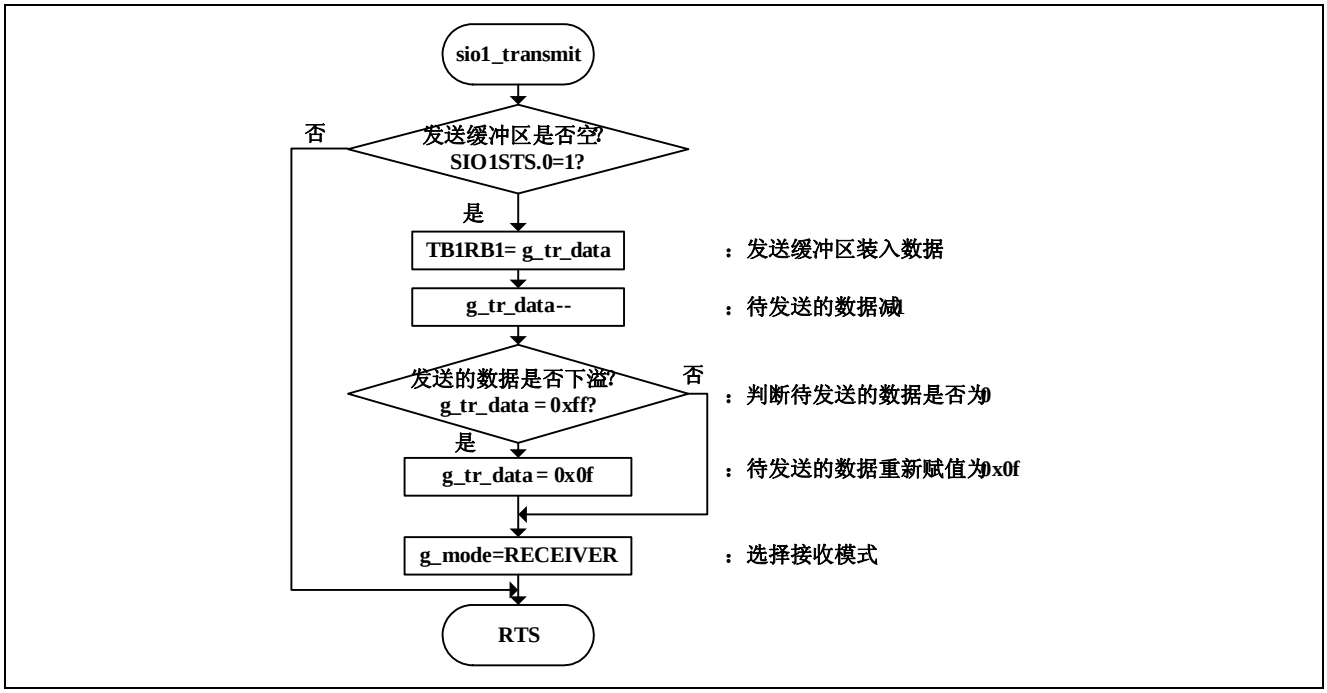


图 12　串行 I/O1 数据发送函数流程图

5.7 INT0 中断函数和串行 I/O1 接收中断函数

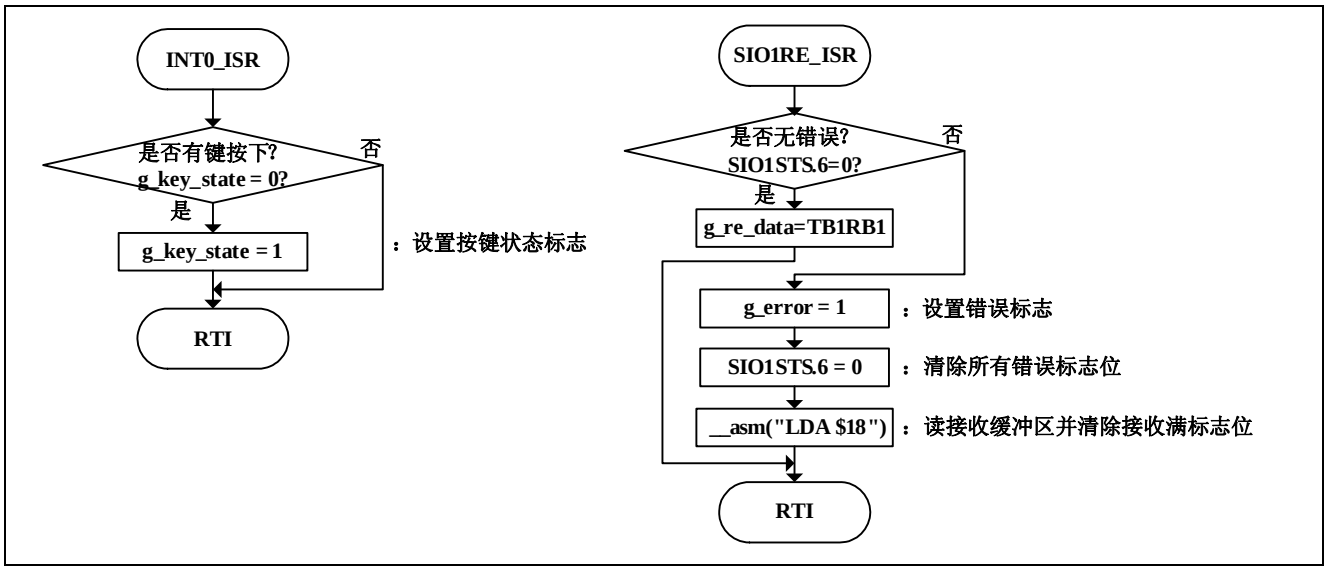


图 13　INT0 中断函数和串行 I/O1 接收中断函数流程图

5.8 错误处理函数

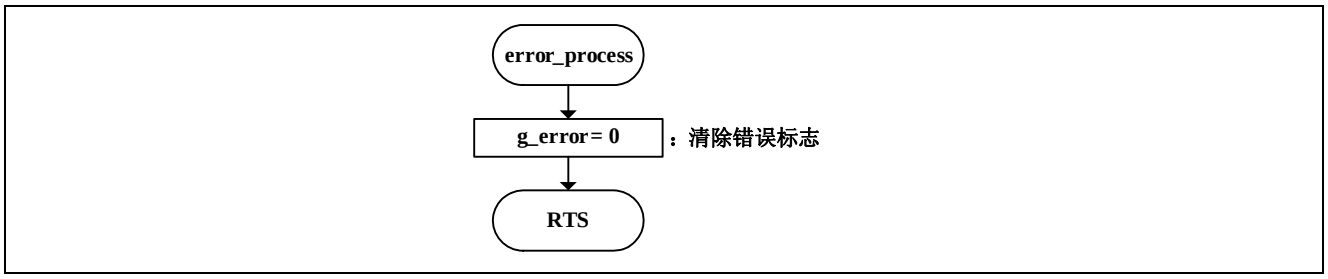


图 14　错误处理函数流程图

6. 参考程序

```
/************************************************************************
*                                                                       *
*   File Name: main.c                                                   *
*   Contents : Main program of serial I/O sample program                *
*   Copyright (C) 2006, Renesas Technology Corp. All rights reserved.   *
*                                                                       *
*   Version:    1.00                                                    *
*                                                                       *
************************************************************************/

#include "sfr_7542.h"
#include "sio.h"

void main(void)
{
   __asm("SEI");                    /* Interrupt Disable */

   /* Delay for external OSCI stabilization */
   PREX = 50 - 1;                   /* 2MHz(On-chip) * 1/16 * 1/50 * 1/25 = 10ms */
   TX = 25 - 1;
   IREQ2.3 = 0;                     /* Clear Timer X interrupt request bit */

   sfr_init();

   while (IREQ2.3 == 0){}           /* Wait for Timer X underflow */
   IREQ2.3 = 0;                     /* Clear Timer X interrupt request bit */

   CPUM = 0x00;                     /* Change to main clock */

   /* Setting main cycle timer */
   PREX = 250 - 1;                  /* 8MHz * 1/16 * 1/250 * 1/40 = 20ms */
   TX = 40 - 1;

   while(1)
   {
      __asm("CLI");                 /* Enable interrupt */

      while (IREQ2.3 == 0){}        /* Waiting for Timer X underflow */
      IREQ2.3 = 0;                  /* Clear Timer X interrupt request bit */

      if (g_error != 0)
      {
         error_process();           /* Error processing */
      }

      key_check();                  /* Check keys */
      mode_func();                  /* Mode processing */
   }
}
```

```
/*****************************************************************
; Name:         sfr_init
; Parameter:    None
; Return:       None
; Description: Initial setting of SFR registers
;*****************************************************************/

void sfr_init(void)
{
   DCCR = 0x1c;             /* P0 P3 drive capacity configuration for LED */
   P0 = 0x08;               /* P03 = H(LED3) */
   P0D = 0xff;              /* PD03 = Output(LED3), unused pins set to output */
   P1D = 0x1f;              /* Unused pins output */
   P2D = 0xfe;              /* PD20 = Input(AD0), unused pins set to output */
   P3 = 0x07;               /* P30-2 = H(LED0,1,2) */
   P3D = 0x6f;              /* P30-2 = Output(LED0,1,2), P37 = Input (SW1) */

   INTEDGE  = 0xe0;         /* P04, P06 Key-on Wakeup Disable;
                            INT0 Falling Edge Active */

   UART1CON = 0x02;         /* Even parity checking enable */
   BRG1 = 52 - 1;           /* 8MHz * 1/16 * 1/52 = 9615 bps */
   SIO1CON = 0xb0;          /* Serial I/O 1 enable;
                            Transmit enable; Receive enable */

   TABM     = 0x0a;         /* Stop Timer A and Timer B */

   IREQ1    = 0;            /* Clearing interrupt request bit */
   IREQ2    = 0;

   ICON1 = 0x11;            /* INT0 interrupt enable;
                            Serial I/O1 receive interrupt enable */
}

/*****************************************************************
; Name:         mode_func
; Parameter:    None
; Return:       None
; Description: Mode processing
;*****************************************************************/
void mode_func(void)
{
   if (g_mode == TRANSMITTER)
   {
      sio1_transmit();            /* Call transmit function */
   }

   led_disp();                    /* Call display function */
}

/*****************************************************************
; Name:         key_check
; Parameter:    None
; Return:       None
; Description: Confirm pressed key twice and change g_mode
;*****************************************************************/
void key_check(void)
```

```
{
   switch (g_key_state)
   {
   case 0:
   break;

         case 1:                    /* 20ms delay */
            g_key_state++;
            break;

         case 2:
            if (SW1 == SW_ON)       /* Confirm key state */
            {
               g_key_state++;
            }
            else
            {
               g_key_state = 0;
            }
            break;

         case 3:
            if (SW1 == SW_ON)       /* Confirm key state again */
            {
               g_mode = TRANSMITER;

               g_key_state++;
            }
            else
            {
               g_key_state = 0;
            }
            break;

         case 4:
            if (SW1 == SW_OFF)      /* If key is released */
            {
               g_key_state = 0;     /* Set to no key pushed state */
            }
            break;

         default:
            break;
   }
}

/***********************************************************************
; Name:         led_disp
; Parameter:    None
; Return:       None
; Description: Display receive data by LED
;***********************************************************************/
void led_disp(void)
{
   if (g_re_data & 0x01)
   {
      LED0 = 0;                     /* Turn on LED0 */
```

```
    }
    else
    {
       LED0 = 1;                    /* Turn off LED0 */
    }

    if (g_re_data & 0x02)
    {
       LED1 = 0;                    /* Turn on LED1 */
    }
    else
    {
       LED1 = 1;                    /* Turn off LED0 */
    }

    if (g_re_data & 0x04)
    {
       LED2 = 0;                    /* Turn on LED2 */
    }
    else
    {
       LED2 = 1;                    /* Turn off LED2 */
    }

    if (g_re_data & 0x08)
    {
       LED3 = 0;                    /* Turn on LED3 */
    }
    else
    {
       LED3 = 1;                    /* Turn on LED3 */
    }

}

/***********************************************************************
; Name:         sio1_transmit
; Parameter:    None
; Return:       None
; Description: Transmit g_tr_data by Serial I/O 1
;***********************************************************************/
void sio1_transmit(void)
{
    if (SIO1STS.0 == 1)             /* Check transmit buffer full flag */
    {
       TB1RB1 = g_tr_data;

       g_tr_data--;                 /* Reduce transmit data by 1 */
       if (g_tr_data == 0xff)
       {
          g_tr_data = 0x0f;
       }

       g_mode = RECEIVER;           /* When complete return to receive mode */
    }
}
```

```
/***********************************************************************
; Name:         error_process
; Parameter:    None
; Return:       None
; Description: Receive error processing
;***********************************************************************/
void error_process(void)
{
   /* User define */

   g_error = 0;                    /* Clear error flag */
}

/***********************************************************************
; Name:         INT0_ISR
; Parameter:    None
; Return:       None
; Description: INT0 interrupt handler
;***********************************************************************/
interrupt void INT0_ISR(void)
{
   if (g_key_state == 0)           /* If no key pressed */
   {
      g_key_state = 1;
   }
}

/***********************************************************************
; Name:         SIO1RE_ISR
; Parameter:    None
; Return:       None
; Description: Serial I/O 1 receive interrupt handler
;***********************************************************************/
interrupt void SIO1RE_ISR(void)
{
   if (SIO1STS.6 == 0)             /* Check summing error bit */
   {
      g_re_data = TB1RB1;
   }
   else
   {
      g_error = 1;                 /* Set error flag */
      IO1STS.6 = 0;                /* Clear summing error bit */
      __asm("LDA $18");            /* Read receive buffer for clearing RBF flag*/
   }
}
```

```
/***********************************************************************
*                                                                      *
*   File Name   : sio.h                                                *
*   Contents : Definition of sample program                            *
*   Copyright (C) 2006, Renesas Technology Corp. All right reserved.   *
*                                                                      *
*   Version  : 1.00                                                    *
*                                                                      *
***********************************************************************/

#ifndef SIO_H
#define SIO_H

/* Definition of globle variable */

unsigned char g_mode;                   /* Mode flag */
unsigned char g_error;                  /* Error flag */
unsigned char g_tr_data = 0x0f;         /* Transmit data buffer (Initialized as
                                        0x0f) */
unsigned char g_re_data;                /* Receive data buffer */
unsigned char g_key_state;              /* Key state */

/* Declaration of function prototype */

extern void sfr_init(void);             /* SFR initialize routine */
extern void mode_func(void);            /* Mode processing */
extern void key_check(void);            /* Check key input */
extern void led_disp(void);             /* LED control */
extern void sio1_transmit(void);        /* Transmit routine */
extern void error_process(void);        /* Error processing */

/* Definition of macros */
#define SW_ON        0
#define SW_OFF       1

#define RECEIVER     0
#define TRANSMITTER  1

#define LED0         P3_0
#define LED1         P3_1
#define LED2         P3_2
#define LED3         P0_3

#define SW1          P3_7

#endif                                  /* SIO_H */
```

7. 参考文献

硬件手册

7542 群数据手册

（最新版本请从瑞萨科技网页上取得）

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修订记录

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		页	要点
1.00	2006.04.12	—	初版发行
1.01	2008.03.17	19	增加咨询邮箱地址，修改硬件手册名称，删去版本号
		21－22	更新版权声明

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