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2010年4月1日
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R8C/10群

定时器X运行 （脉冲宽度测定模式）

1. 概要

本资料说明了定时器X脉冲宽度测定模式的使用例。脉冲宽度测定模式的选择功能如**表1**所示。在此，对选择了**表1**所示的○符号后内容运行时的运行进行说明。

表1 脉冲宽度测定模式的选择功能

设定项目	设定内容	
CNTR0极性切换	○	“H”电平宽度测定 （下降沿中断）
		“L”电平宽度测定 （上升沿中断）

2. 前言

在本资料中说明的应用例，适合以下单片机在下列条件下使用。

单片机 ：R8C/10、 R8C/11、 R8C/12、 R8C/13群

主时钟输入振荡频率 ：16MHz

和R8C/10群有相同SFR（外围设备控制寄存器）的其它的R8C/Tiny系列，也可以使用本程序。但有时会因增加一部分功能等情况而有所改变，所以必须通过手册进行确认。在使用本应用说明时必须进行充分的评价。

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3. 脉冲宽度测定模式的运行

对选择了**表1**所示的○符号后内容时的运行进行说明。

（1）如果将计数开始标志置 “1”，那么，在从CNTR0引脚输入的外部信号为 “H”电平期间，计数器对计数源进行递减计数。
外部信号变为 “L”电平 （脉冲宽度测定结束）时，产生$\overline{\text{INT1}}$中断请求。
此时，如果保持计数器的值，并且外部信号再次变为测定电平，就继续计数。
（2）下溢时，重新装入再装入寄存器的内容，然后继续计数。同时，定时器X中断请求位变为 “1”。
（3）如果将计数开始标志清 “0”，计数器则保持计数值并停止。

脉冲宽度测定模式运行时序如**图1**所示。

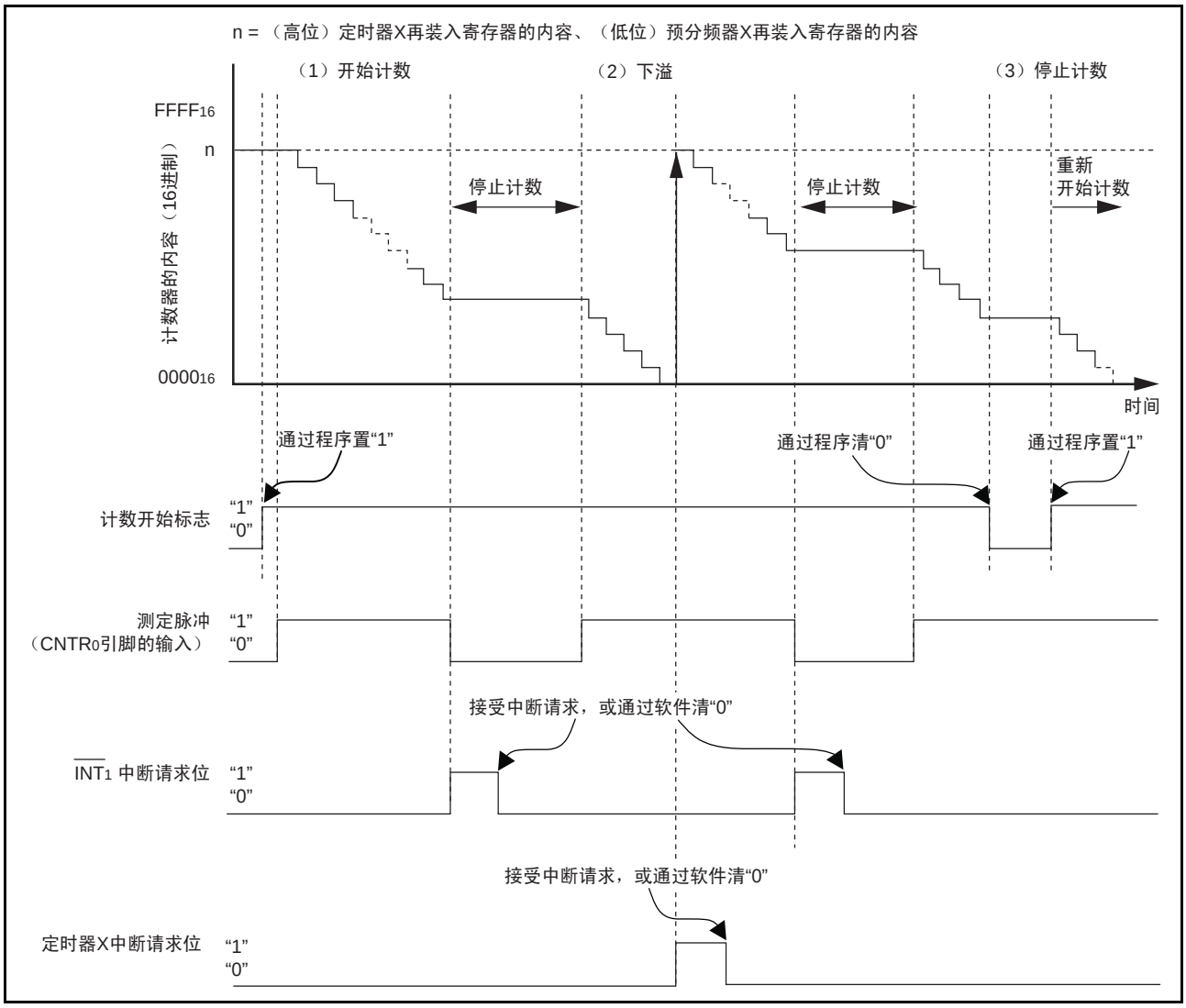


图1 脉冲宽度测定模式运行时序

4. 应用例

4.1 应用例的说明

（1）如果按下SW2键，则点亮LED灯，开始测定脉冲宽度。
端口P10/$\overline{KI0}$用于键输入。端口P11～P14用于LED输出。

（2）通过$\overline{INT1}$中断 （脉冲宽度测定结束），读取定时器X和预分频器X的值。

通过主程序计算脉冲宽度，并保存到RAM。
脉冲宽度 = （前一次的定时器X和预分频器X的值）－（本次的定时器X和预分频器X的值）

在本例中，选择f1为计数源，设定FFh为预分频器X， 3Fh为定时器X。
因此，可以计数的范围为0～3FFFh，每1.024ms产生一次下溢。
1.024ms = （1/ f1） ×（预分频器X + 1） ×（定时器X + 1）
= 62.5ns × (255+1) × (63+1)

产生$\overline{INT1}$中断请求时，在产生定时器X中断请求 （产生下溢）的情况下，通过将前一次的计数值加4000h后的结果来计算脉冲宽度。
用LED显示计算的脉冲宽度的低4位。

（3）如果再次按下SW2键，则中止测定，熄灭LED灯，等待下一次的SW2输入。以后重复 （1）～ （3）的操作。

使用的引脚如图2所示。

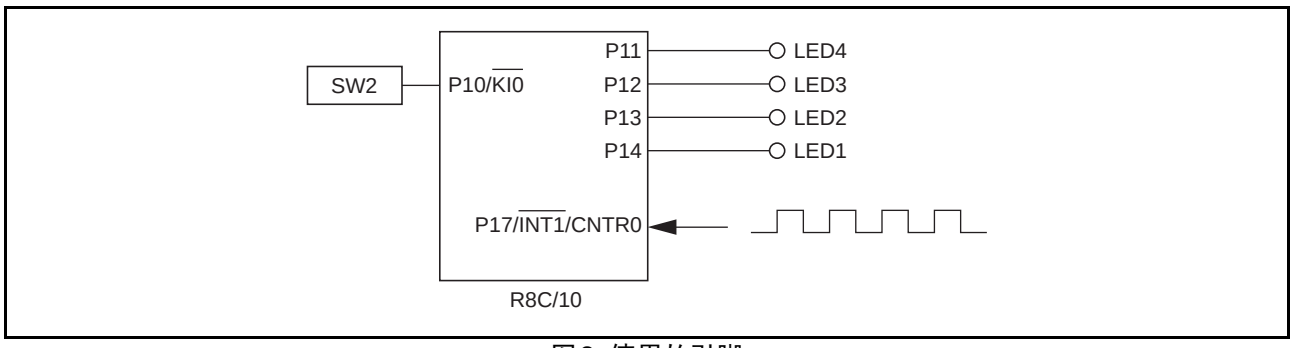
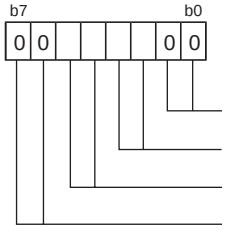


图2 使用的引脚

另外，本样本程序在SFR的位分配的情况下，有可能对不使用的功能位进行操作。这些设定值请根据用户系统的使用情况进行设定。

4.2 主要寄存器的设定

定时器计数源设定寄存器的设定



定时器计数源设定寄存器 【008E16地址】 TCSS

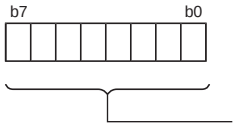
定时器X计数源选择位
定时器Y计数源选择位
定时器Z计数源选择位
保留位

定时器X计数源选择位

b1 b0
0 0 : f1
0 1 : f8
1 0 : f32
1 1 : f2

b1	b0	计数源	计数源的周期 f(XIN)：16MHz时
0	0	f1	62.5ns
0	1	f8	500ns
1	0	f32	2μs
1	1	f2	125ns

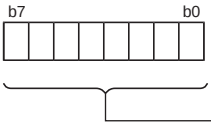
预分频器X寄存器的设定



预分频器X寄存器 【008C16地址】 PREX

设定为255

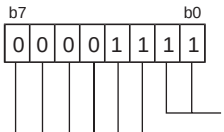
定时器X寄存器的设定



定时器X寄存器 【008D16地址】 TX

设定为63

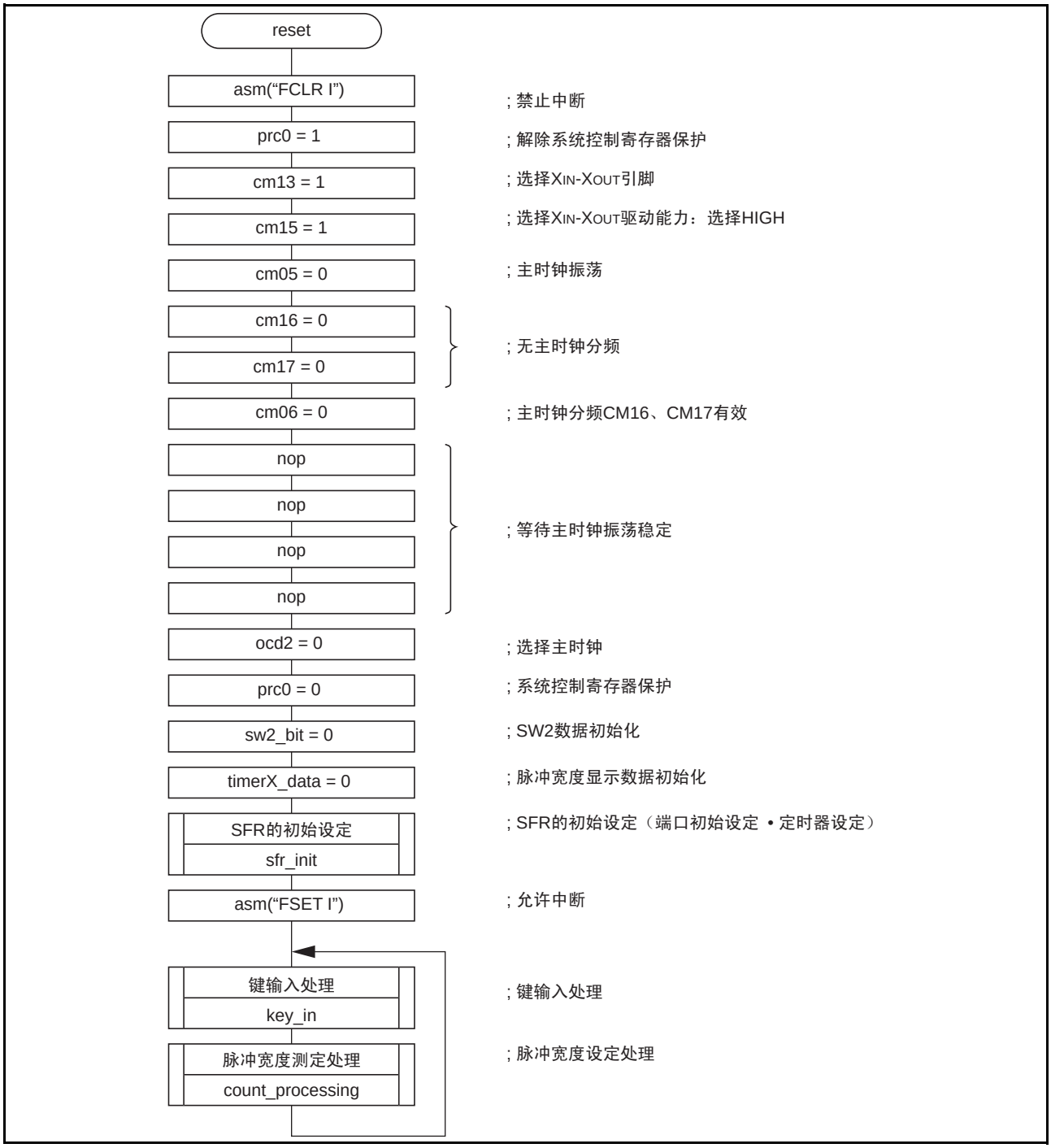
定时器X模式寄存器的设定

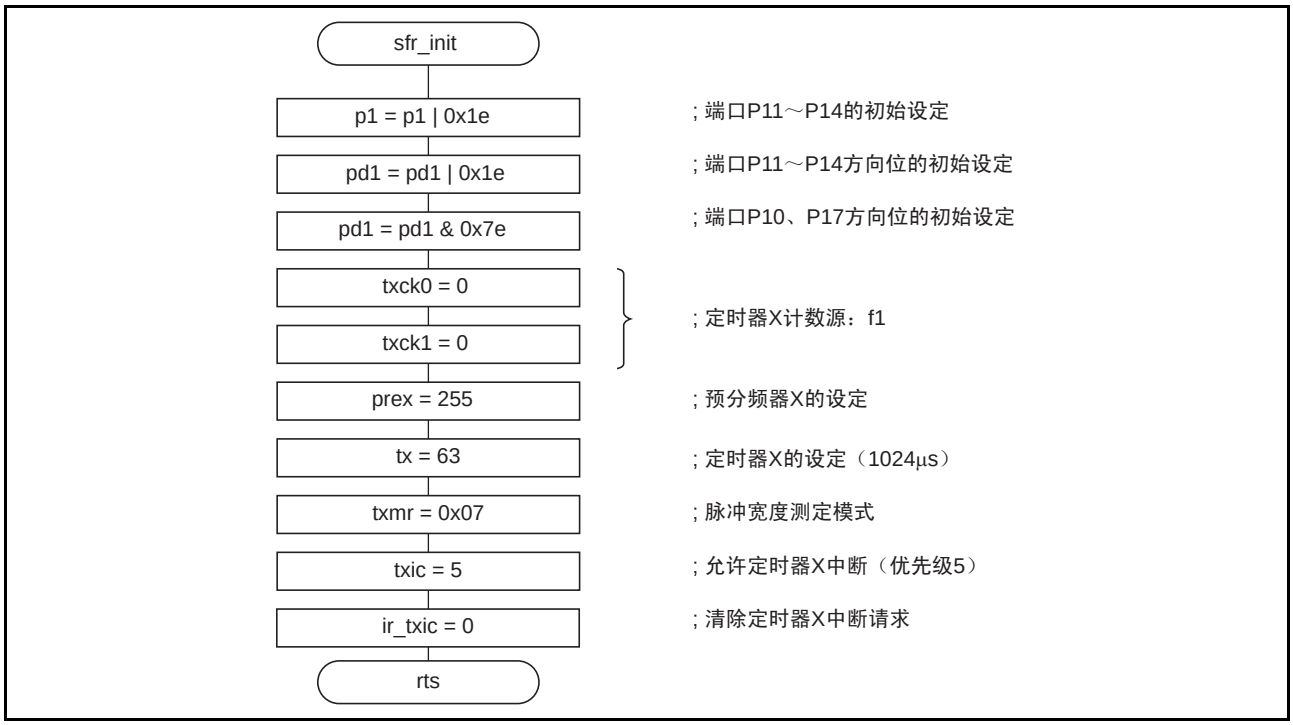


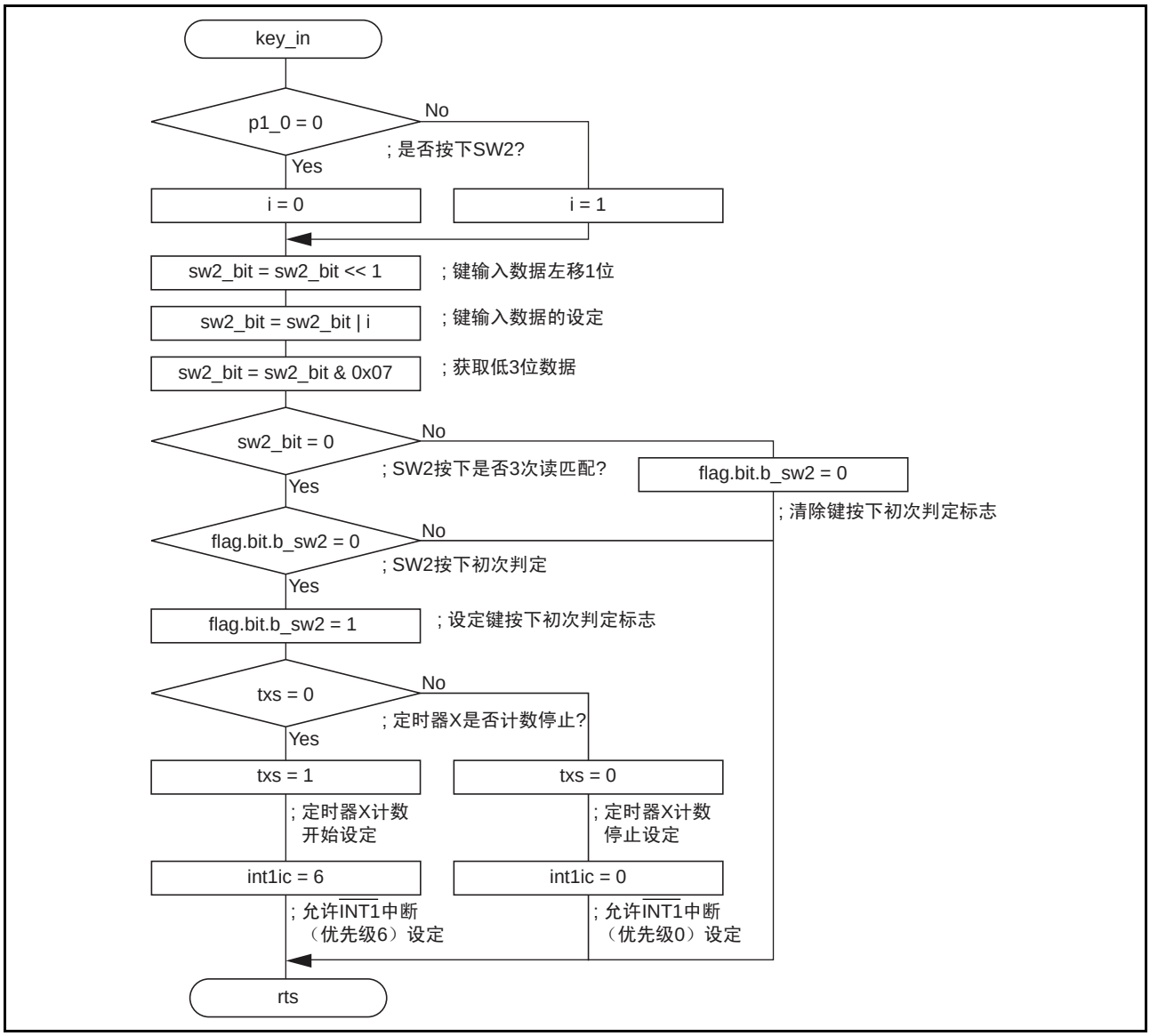
定时器X模式寄存器 【008B16地址】 TXMR

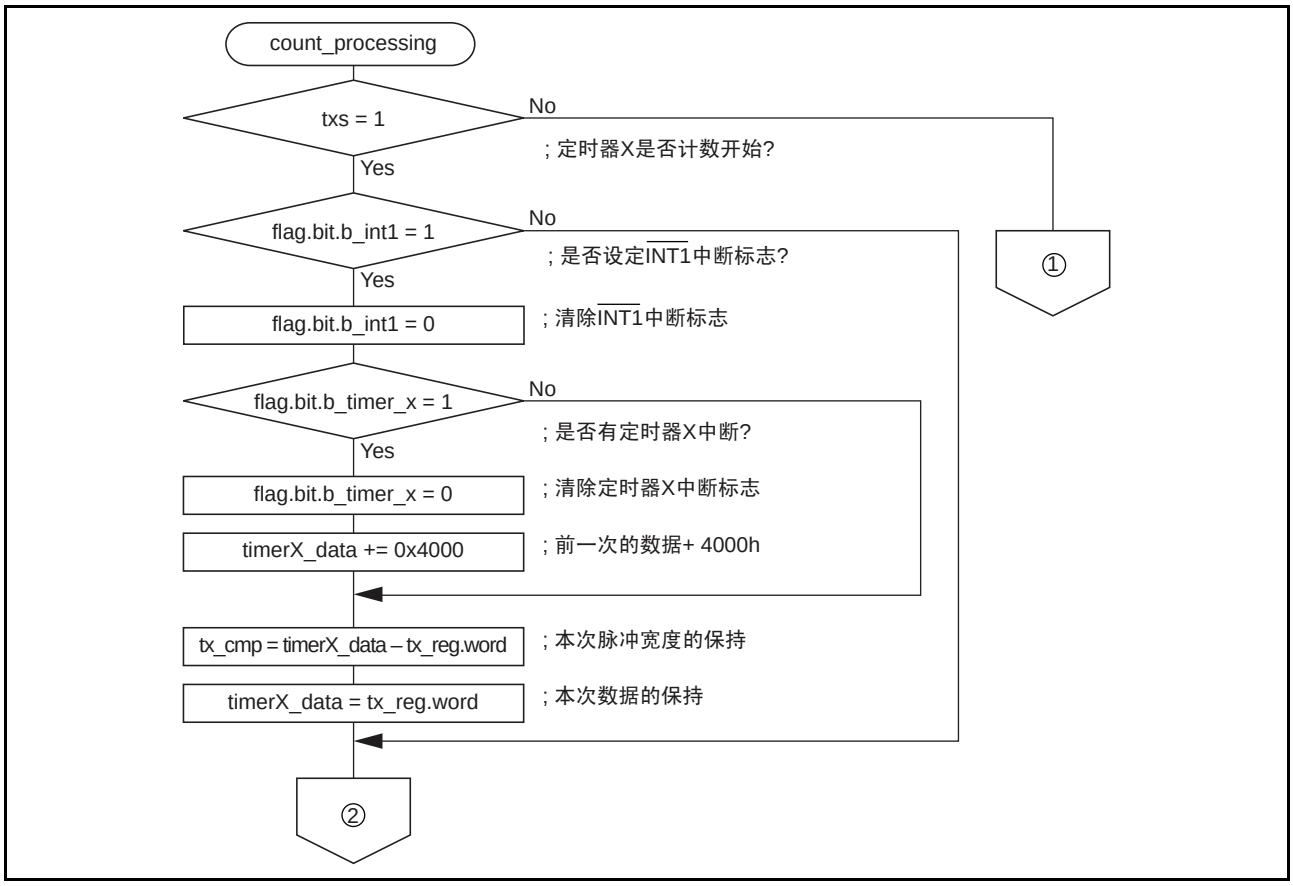
脉冲宽度测定模式的选择
$\overline{\text{INT1}}$/CNTR0极性切换位　　1：“H”电平宽度测定
定时器X计数开始标志　　计数开始时设定为“1”
在脉冲宽度测定模式下，必须清“0”。

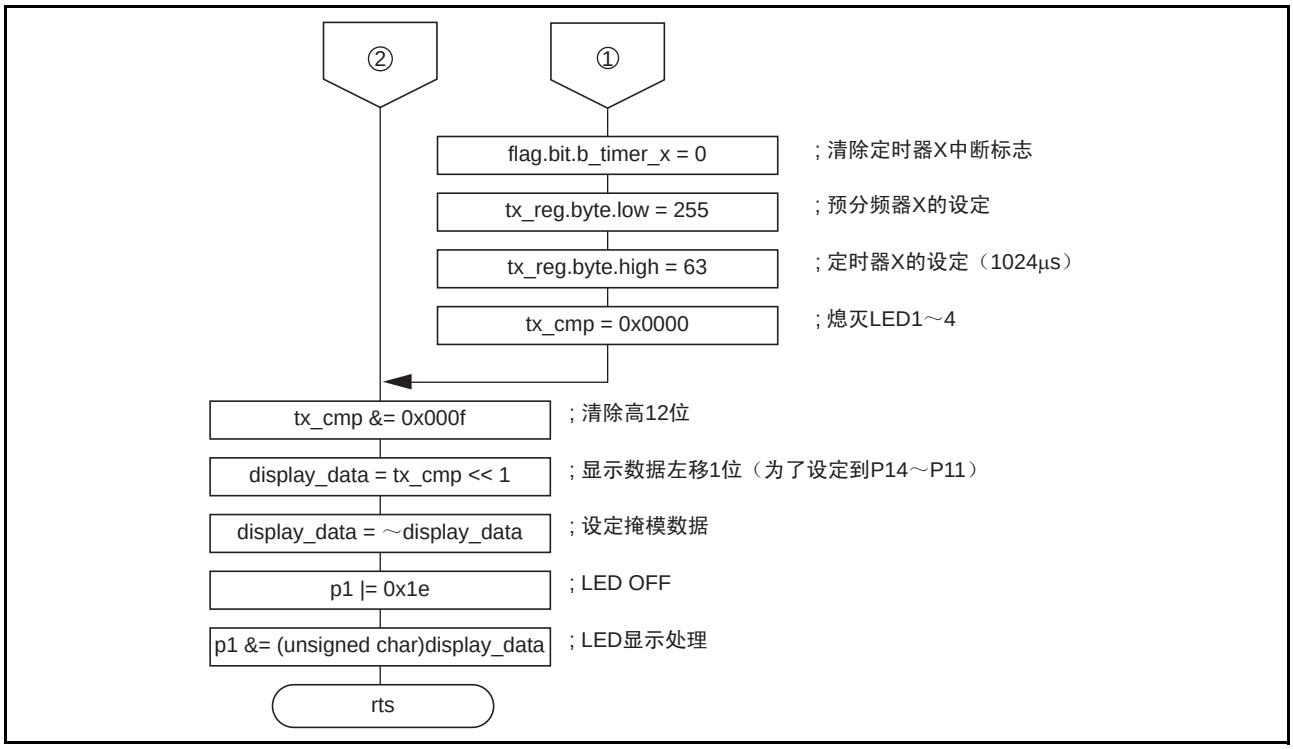
4.3 流程图

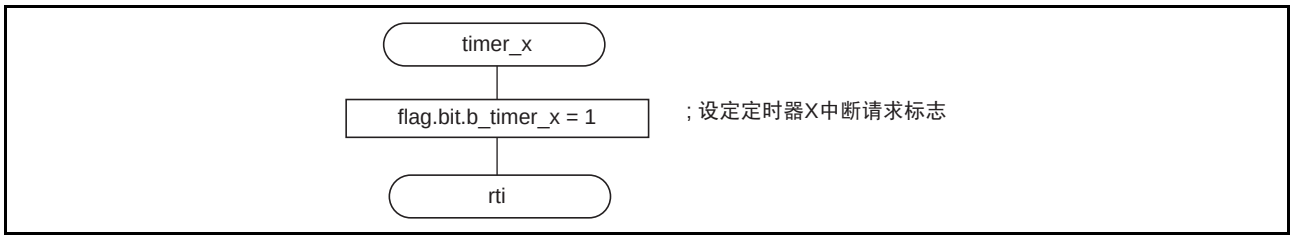

reset
asm(“FCLR I”)
; 禁止中断
prc0 = 1
; 解除系统控制寄存器保护
cm13 = 1
; 选择XIN-XOUT引脚
cm15 = 1
; 选择XIN-XOUT驱动能力：选择HIGH
cm05 = 0
; 主时钟振荡
cm16 = 0
cm17 = 0
; 无主时钟分频
cm06 = 0
; 主时钟分频CM16、CM17有效
nop
nop
nop
nop
; 等待主时钟振荡稳定
ocd2 = 0
; 选择主时钟
prc0 = 0
; 系统控制寄存器保护
sw2_bit = 0
; SW2数据初始化
timerX_data = 0
; 脉冲宽度显示数据初始化
SFR的初始设定
sfr_init
; SFR的初始设定（端口初始设定 • 定时器设定）
asm(“FSET I”)
; 允许中断
键输入处理
key_in
; 键输入处理
脉冲宽度测定处理
count_processing
; 脉冲宽度设定处理

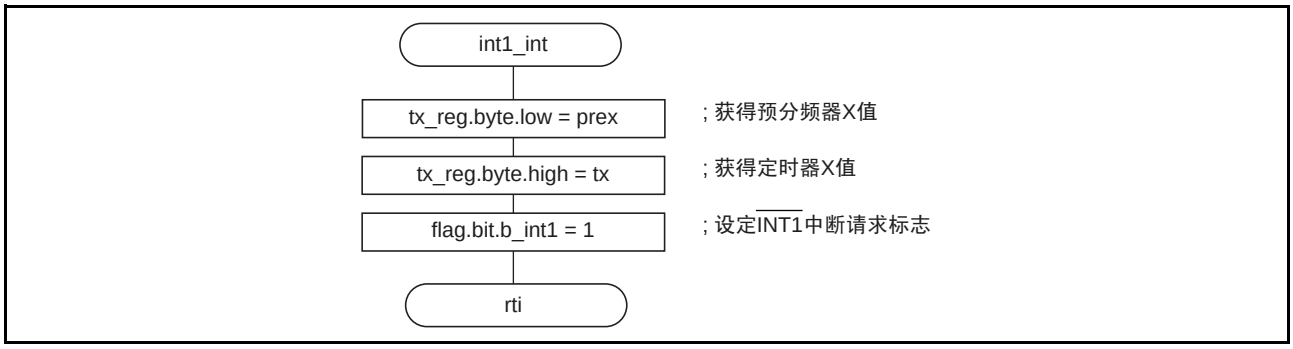

sfr_init
p1 = p1 | 0x1e
; 端口P11～P14的初始设定
pd1 = pd1 | 0x1e
; 端口P11～P14方向位的初始设定
pd1 = pd1 & 0x7e
; 端口P10、P17方向位的初始设定
txck0 = 0
txck1 = 0
; 定时器X计数源：f1
prex = 255
; 预分频器X的设定
tx = 63
; 定时器X的设定（1024μs）
txmr = 0x07
; 脉冲宽度测定模式
txic = 5
; 允许定时器X中断（优先级5）
ir_txic = 0
; 清除定时器X中断请求
rts


key_in
p1_0 = 0
No
; 是否按下SW2?
Yes
i = 0
i = 1
sw2_bit = sw2_bit << 1
; 键输入数据左移1位
sw2_bit = sw2_bit | i
; 键输入数据的设定
sw2_bit = sw2_bit & 0x07
; 获取低3位数据
sw2_bit = 0
No
; SW2按下是否3次读匹配?
flag.bit.b_sw2 = 0
; 清除键按下初次判定标志
Yes
flag.bit.b_sw2 = 0
No
; SW2按下初次判定
Yes
flag.bit.b_sw2 = 1
; 设定键按下初次判定标志
txs = 0
No
; 定时器X是否计数停止?
Yes
txs = 1
txs = 0
; 定时器X计数
开始设定
; 定时器X计数
停止设定
int1ic = 6
int1ic = 0
; 允许INT1中断
（优先级6）设定
; 允许INT1中断
（优先级0）设定
rts


count_processing
txs = 1
No
; 定时器X是否计数开始?
Yes
flag.bit.b_int1 = 1
No
; 是否设定INT1中断标志?
Yes
①
flag.bit.b_int1 = 0
; 清除INT1中断标志
flag.bit.b_timer_x = 1
No
; 是否有定时器X中断?
Yes
flag.bit.b_timer_x = 0
; 清除定时器X中断标志
timerX_data += 0x4000
; 前一次的数据+ 4000h
tx_cmp = timerX_data – tx_reg.word
; 本次脉冲宽度的保持
timerX_data = tx_reg.word
; 本次数据的保持
②


②
①
flag.bit.b_timer_x = 0
; 清除定时器X中断标志
tx_reg.byte.low = 255
; 预分频器X的设定
tx_reg.byte.high = 63
; 定时器X的设定（1024μs）
tx_cmp = 0x0000
; 熄灭LED1～4
tx_cmp &= 0x000f
; 清除高12位
display_data = tx_cmp << 1
; 显示数据左移1位（为了设定到P14～P11）
display_data = ～display_data
; 设定掩模数据
p1 |= 0x1e
; LED OFF
p1 &= (unsigned char)display_data
; LED显示处理
rts


timer_x
flag.bit.b_timer_x = 1
; 设定定时器X中断请求标志
rti


int1_int
tx_reg.byte.low = prex
; 获得预分频器X值
tx_reg.byte.high = tx
; 获得定时器X值
flag.bit.b_int1 = 1
; 设定INT1中断请求标志
rti

5. 参考程序例

```
/***********************************************************************************************
*                                                                                              *
*   File Name      : main.c                                                                    *
*   Contents       : R8C/10 Timer X Pulse width measurement mode test program                  *
*   Copyright, 2004 RENESAS TECHNOLOGY CORPORATION                                             *
*                     AND RENESAS SOLUTIONS CORPORATION, All rights reserved.                  *
*   Version        : 0.01                                                                      *
*   note           : 0.01 : First version                                                      *
***********************************************************************************************/
#include "sfr_r810.h"               /* Definition of the R8C/10 SFR */

/* Definition of RAM area */
unsigned char sw2_bit;              /* Input SW2 data */
unsigned int timerX_data;           /* Timer X data */
unsigned int tx_cmp;                /* Differential data */
typedef union{
        unsigned char all;
        struct BFIELD{
                unsigned char b_timer_x  :1;         /* Timer X interruption flag */
                unsigned char b_int1         :1;     /* Int1 interruption flag */
                unsigned char b_sw2          :1;     /* sw2 continuing being pushed flag */
                unsigned char undefined  :5;
        }bit;
}flag_union;
flag_union flag;                                     /* Flag data */
typedef union{
        unsigned short word;
        struct low_high{
                unsigned char low;                   /* Prescaler data */
                unsigned char high;                  /* Timer data */
        }byte;
}timer_register;
timer_register tx_reg;                               /* Timer X data */

/* Declaration of function prototype */
void sfr_init(void);                                 /* Initial setting of SFR registers */
void key_in(void);                                   /* Key input */
void count_processing(void);                         /* Processing count */
```

```
main() {
        asm("FCLR I");              /* Interrupt disable */

    /*-----------------------------------------------
    -Change on-chip oscillator clock to Main clock  -
    -----------------------------------------------*/
        prc0 = 1;                   /* Protect off */
        cm13 = 1;                   /* Xin Xout */
        cm15 = 1;                   /* XCIN-XCOUT drive capacity select bit : HIGH */
        cm05 = 0;                   /* Xin on */
        cm16 = 0;                   /* Main clock = No division mode */
        cm17 = 0;
        cm06 = 0;                   /* CM16 and CM17 enable */
        asm("nop");                 /* Waiting for stable of oscillation */
        asm("nop");
        asm("nop");
        asm("nop");
        ocd2 = 0;                   /* Main clock change */
        prc0 = 0;                   /* Protect on */

        /*-----------------------------------
        -       RAM Clear           -
        -----------------------------------*/
        sw2_bit = 0;                /* SW2 data initialization */
        timerX_data = 0;            /* Display data initialization */

        /*-----------------------------------
        -       Initialize SFR      -
        -----------------------------------*/
        sfr_init();                 /* Initial setting of SFR registers */

        asm("FSET I");              /* Interrupt enable */

        /*-----------------------------------
        -       Loop of main        -
        -----------------------------------*/
        while(1){                   /* Main processing */
                key_in();           /* Key input */
                count_processing(); /* Count processing */
        }
}
```

```
/************************************************************************************************
Name:           sfr_init
Parameters:     None
Returns:        None
Description:    Initial setting of SFR registers
************************************************************************************************/
void sfr_init(void){
        /* Setting port registers */
        p1 = p1 | 0x1e;                         /* P14-P11 = H(Led 4.3.2.1) */

        /* Setting port direction registers */
        pd1 = pd1 | 0x1e;                       /* P14-P11 port direction = output */
        pd1 = pd1 & 0x7e;                       /* P17, P10 port direction = input */

        txck0 = 0;                              /* Timer X count source = f1 */
        txck1 = 0;

        /* Setting timer x counter contents */
        /* 16MHz * 1/1 * (255 + 1) * (63 + 1) = 1024us */
        prex = 255;                             /* Setting Prescaler X register */
        tx = 63;                                /* Setting timer X register */

        txmr = 0x07;                            /* Timer X : Pulse width measurement mode */
        txic = 5;                               /* Interrupt priority level = 5 */

        ir_txic = 0;                            /* Interrupt request flag clear */
}
```

```
/************************************************************************************************
Name:           key_in
Parameters:     None
Returns:        None
Description:    Key input
************************************************************************************************/
void key_in(void){

        unsigned char i;
        /* Determination of input level SW2 */
        if (p1_0 == 0) {                        /* SW2 pushed ? */
                i = 0;
        } else {                                /* SW2 not pushed ? */
                i = 1;
        }
        /* Check pulses matching a trigger input level 3 times */
        sw2_bit = sw2_bit << 1;
        sw2_bit = sw2_bit | i;
        sw2_bit = sw2_bit & 0x07;

        if (sw2_bit == 0){                      /* Determination of input SW2 */
            if (flag.bit.b_sw2 == 0) {          /* Input SW2 not continued ? */
                flag.bit.b_sw2 = 1;             /* Setting input SW2 continued flag on */
                switch( txs ) {
                case    0:                      /* Timer X count stop ? */
                        txs = 1;                /* Starting timer X count */
                        int1ic = 6;             /* Interrupt priority level = 6 */
                        break;
                default:                        /* Timer X count start ? */
                        txs = 0;                /* Stopping timer X count */
                        int1ic = 0;             /* Interrupt priority level = 0 */
                        break;
                }
            }
        } else {
            flag.bit.b_sw2 = 0;                 /* Setting input SW2 continued flag off */
        }
}
```

```
/************************************************************************************************
Name:           count processing
Parameters:     None
Returns:        None
Description:    Count processing
************************************************************************************************/
void count_processing(void){

        unsigned int display_data;

        switch( txs ) {
        case    1:                                      /* Timer X count start ? */
                if ( flag.bit.b_int1 == 1 ) {           /* INT1 interruption occurred ? */
                        flag.bit.b_int1 = 0;            /* INT1 interruption flag clear */
                        if ( flag.bit.b_timer_x == 1 ) { /* Timer X interruption occurred ? */
                                flag.bit.b_timer_x = 0;  /* Timer X interruption flag clear */
                                timerX_data += 0x4000;   /* Adding 0x4000 up */
                        }
                        tx_cmp = timerX_data - tx_reg.word;  /* Subtracting a present data */
                                                             /* from last data */
                        timerX_data = tx_reg.word;           /* Setting last data */
                }
                break;
        default:                                        /* Timer X count stop ? */
                flag.bit.b_timer_x = 0;                 /* Clearing timer x interruption flag */
                tx_reg.byte.low = 255;                  /* Initializing prescaler X */
                tx_reg.byte.high = 63;                  /* Initializing timer X */
                tx_cmp = 0x0000;                        /* LED all off */
                break;
        }

        tx_cmp &= 0x000f;                               /* Mask LED display data */
        display_data = tx_cmp << 1;                     /* Display data shift */
        display_data = ~display_data;                   /* Display data set */
        p1 |= 0x1e;                                     /* LED Clear */
        p1 &= (unsigned char)display_data;              /* LED On */
}
```

```
/************************************************************************************************
Name:            interrupt Timer X
Parameters:      None
Returns:         None
Description:     Timer X
************************************************************************************************/
#pragma interrupt timer_x
void timer_x(void){
        flag.bit.b_timer_x = 1;                 /* Setting timer X interruption flag */
}
/************************************************************************************************
Name:            interrupt INT1
Parameters:      None
Returns:         None
Description:     INT1
************************************************************************************************/
#pragma interrupt int1_int
void int1_int(void){
        tx_reg.byte.low = prex;                 /* Setting prescaler X */
        tx_reg.byte.high = tx;                  /* Setting timer X */
        flag.bit.b_int1 = 1;                    /* Setting int1 interruption flag */
}
```

6. 参考文档

硬件手册

R8C/10群硬件手册

（最新版请从瑞萨科技公司主页获取。）

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Rev.	发行日	修订内容	
		页	要点
1.00	2007.06.20	—	初版发行

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