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April 1st, 2010
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3858 Group

Operation of Timer Z1 (Pulse Period Measurement Mode)

1. Abstract

The following article describes how to use the pulse period measurement function of timer Z1 and shows a sample of the infrared receive by this function.

2. Introduction

The application explained in this document applies to the following MCU and parameter(s):

- Applicable MCU: M3858 Group
- Oscillation frequency: 8 MHz

3. Contents

3.1 Description of the Pulse Period Measurement Mode

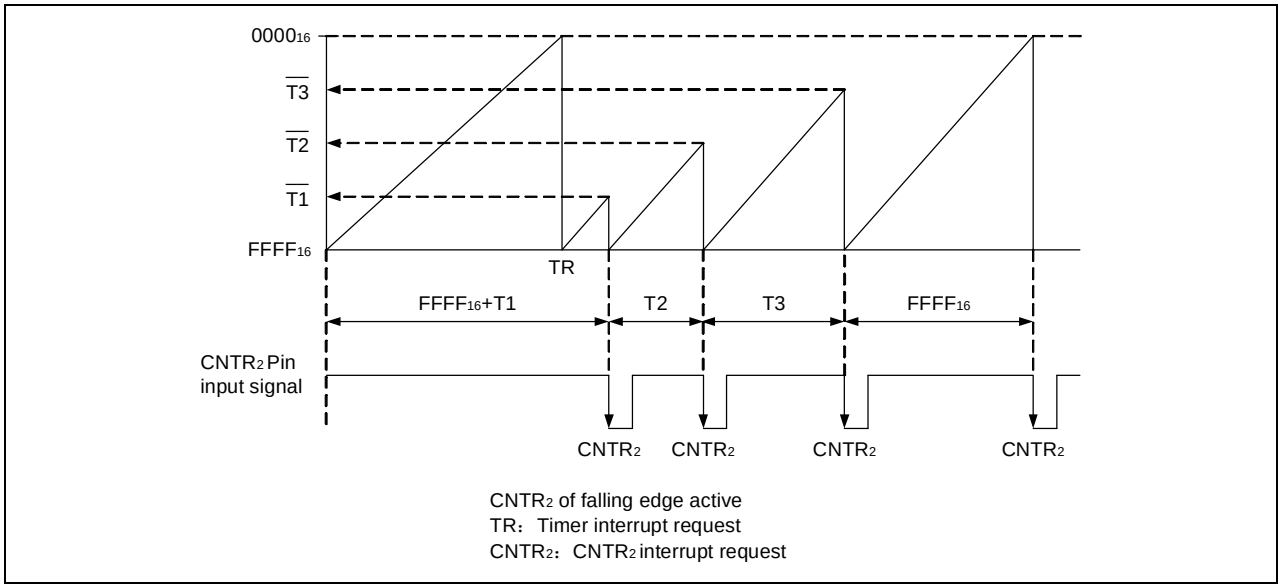


Figure 1 Timing Chart of Pulse Period Measurement Mode

(Measuring Time between Two Falling Edges)

- Description
  (1) This mode can be selected by setting "010" to the timer Z1 operating mode bits (bits 2 to 0) and setting "0" to the timer/event counter mode switch bit (b7) in the timer Z1 mode register (address 0028_{16}).
  (2) In high- or middle-speed mode, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 or 1/1024 of $f(X_{IN})$; or $f(X_{CIN})$ can be selected as the count source. In low-speed mode, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 or 1/1024 of $f(X_{CIN})$; or $f(X_{CIN})$ can be selected as the count source.
  (3) The cycle of the pulse which is input from the $CNTR_2$ pin is measured. When the $CNTR_2$ active edge switch bit (bit 5) of the timer Z1 mode register (address 0028_{16}) is set to "0", the timer counts during time from one falling edge of the $CNTR_2$ pin input to the next falling edge. When it is set to "1", the timer counts during time from one rising edge input to the next rising edge input.
  (4) When the valid edge of measurement completion/start is detected, the 1's complement of the timer value is written to the timer latch and "$FFFF_{16}$"is set to the timer. Furthermore, when the timer underflows, the timer Z1 interrupt request occurs and "$FFFF_{16}$" is set to the timer.
  (5) When reading the timer Z1, the value of the timer latch (measured value) is read. The measured value is retained until the next measurement is completed.

3.2 Infrared Remote Control Code Waveform

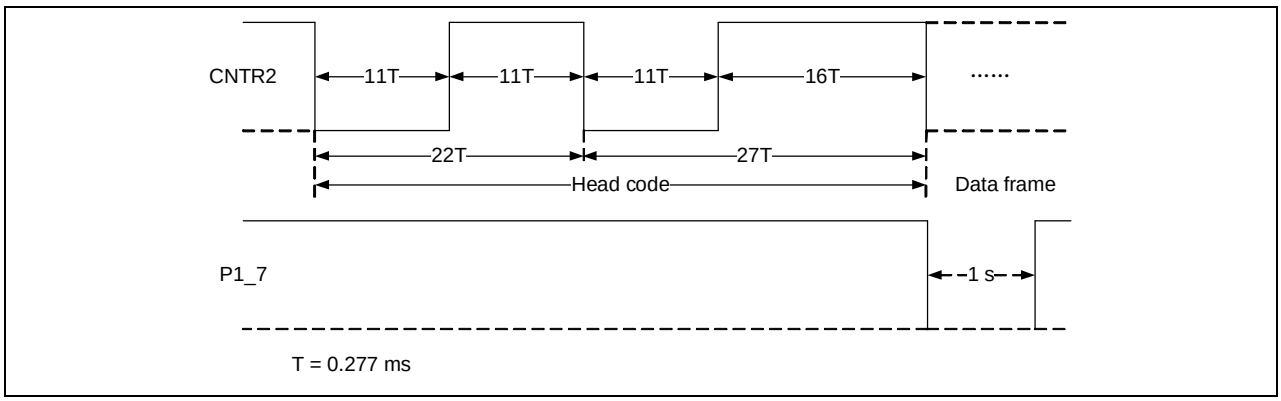


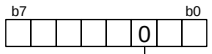
Figure 2 Waveform of the Infrared Remote Control Code

- Description
  (1) The remote control signal is inputted to the CNTR2 pin. The waveform is shown above.
  (2) The head code of this remote control signal is defined by two pulses. The period of the first pulse is 22T (6.094 ms ± 5%), the period of the second pulse is 27T (7.479 ms ± 5%).
  (3) The validity of a remote control signal is determined by the value of the two pulse period. A valid remote control signal will be processed. In this sample program, the MCU will output "L" level for 1 second at Port P1_7 to light the LED when the valid signal is received.

3.3 Register Settings

Register settings are shown below.

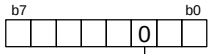
(1) Set the port P2 pull-up control register.



PULL2 [Address 0012_{16}]

P22/CNTR2 No pull-up

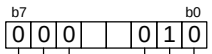
(2) Set the port P2 register.



P2D [Address 0005_{16}]

P22/CNTR2 input mode

(3) Set the timer Z1 mode register.



TZ1M [Address 0028_{16}]

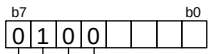
Timer Z1 operating mode bits
0 0 0 : Timer/event counter mode
0 0 1 : Pulse output mode
0 1 0 : Pulse period measurement mode
0 1 1 : Pulse width measurement mode
1 0 0 : Programmable waveform generating mode
1 0 1 : Programmable one-shot generating mode
1 1 0 : Not available
1 1 1 : Not available

CNTR2 active edge switch bit
0: Pulse period measurement mode: measurement between two falling edges

Timer Z1 count stop bit

Timer/event counter mode switch bit

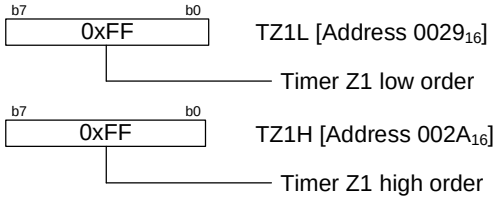
(4) Set the timer Y and Z1 count source selection register.



TYZ1CSS [Address $002F_{16}$]

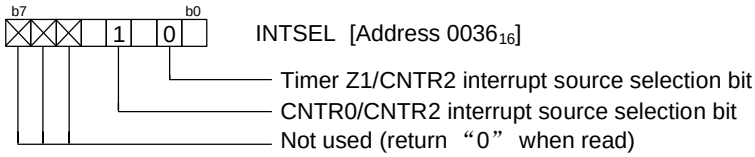
Timer Z1 count source selection bit
0 0 0 0 : f(xin)/2 or f(xcin)/2
0 0 0 1 : f(xin)/4 or f(xcin)/4
0 0 1 0 : f(xin)/8 or f(xcin)/8
0 0 1 1 : f(xin)/16 or f(xcin)/16
0 1 0 0 : f(xin)/32 or f(xcin)/32
0 1 0 1 : f(xin)/64 or f(xcin)/64
0 1 1 0 : f(xin)/128 or f(xcin)/128
0 1 1 1 : f(xin)/256 or f(xcin)/256
1 0 0 0 : f(xin)/512 or f(xcin)/512
1 0 0 1 : f(xin)/1024 or f(xcin)/1024
1 0 1 0 : f(xcin)
1 0 1 1 :
1 1 0 0 :
1 1 0 1 :
1 1 1 0 :
1 1 1 1 : } Not used

(5) Set the timer Z1 register.

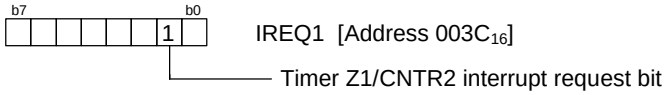


Notes: When reading/writing to the timer Z1, read/write to both the high-order and low-order bytes.
When reading the timer Z1, read from the high-order byte first, followed by the low-order byte.
When writing to the timer Z1, write to the low-order byte first, followed by the high-order byte.

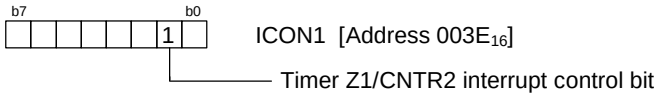
(6) Set the interrupt source selection register.



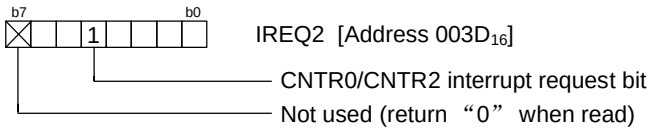
(7) Set the interrupt request register 1.



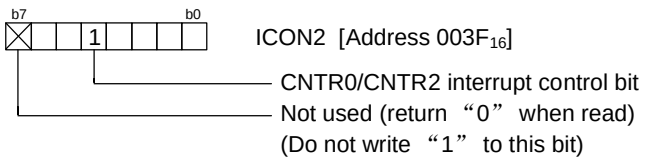
(8) Set the interrupt control register 1.



(9) Set the interrupt request register 2.

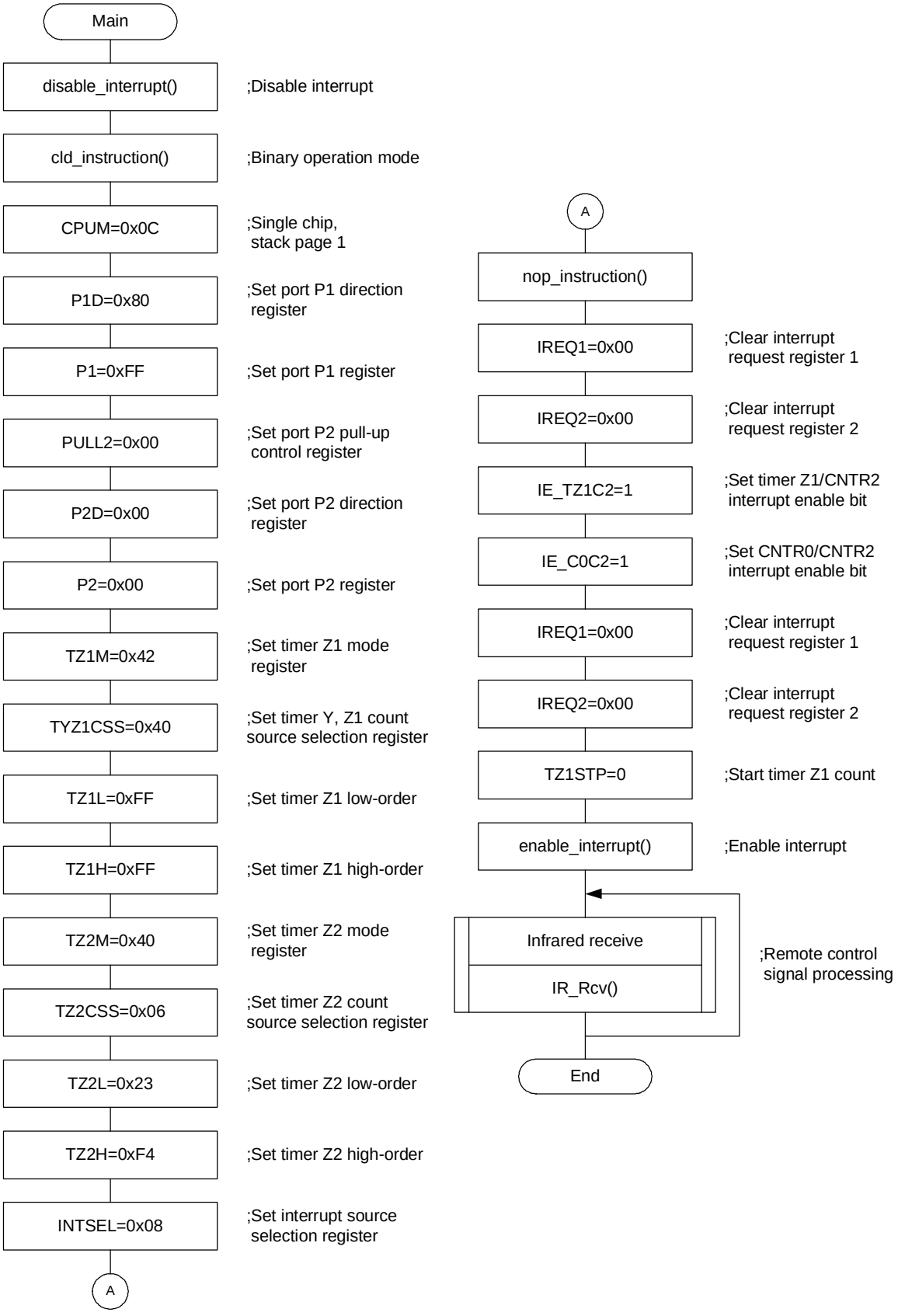


(10) Set the interrupt control register 2.

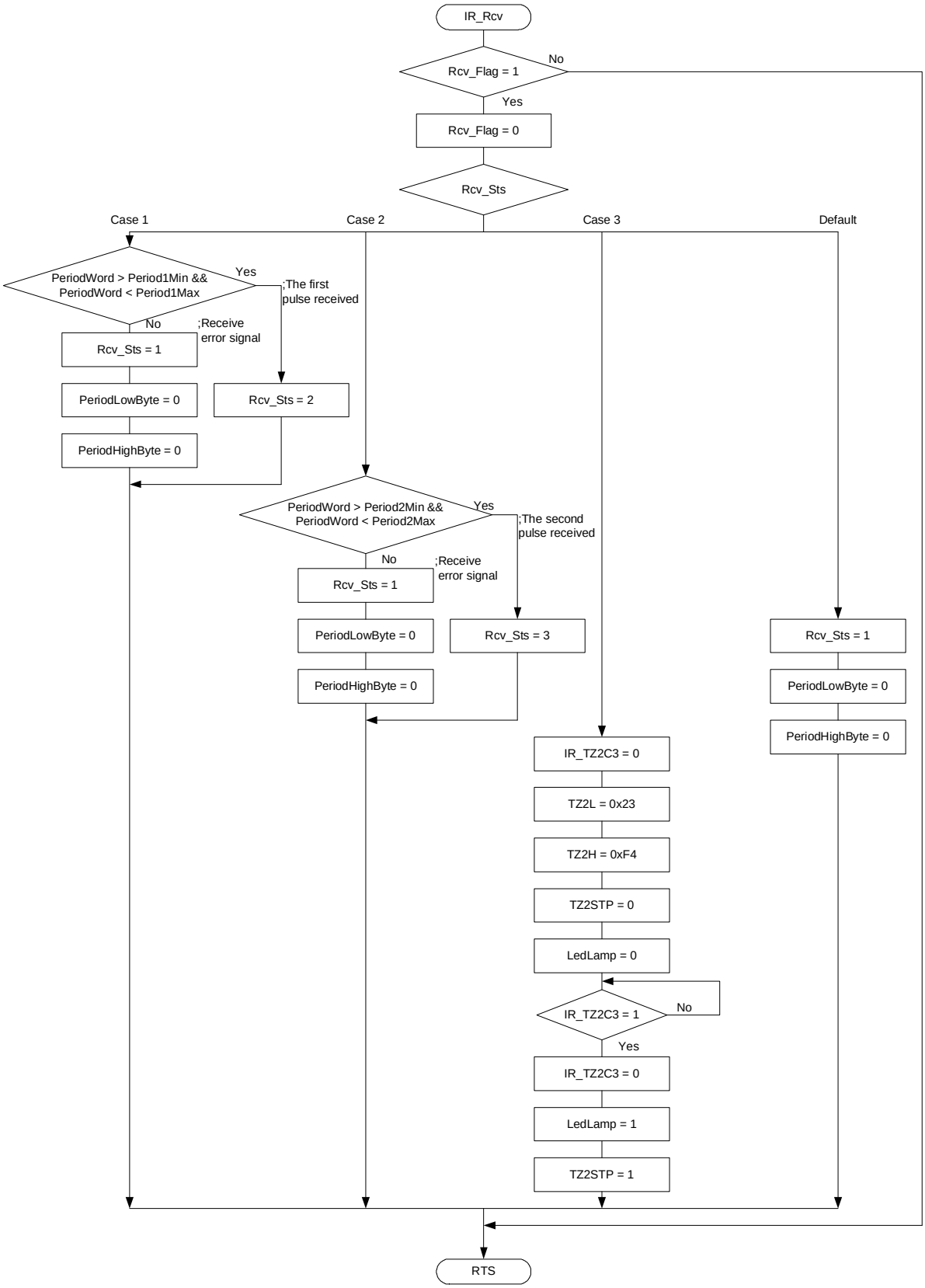


4. Flow Chart

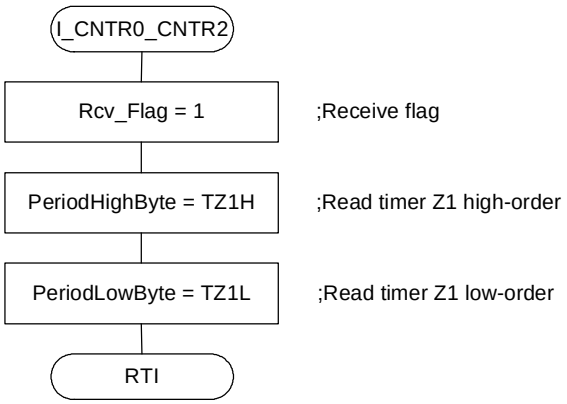
4.1 Main Function



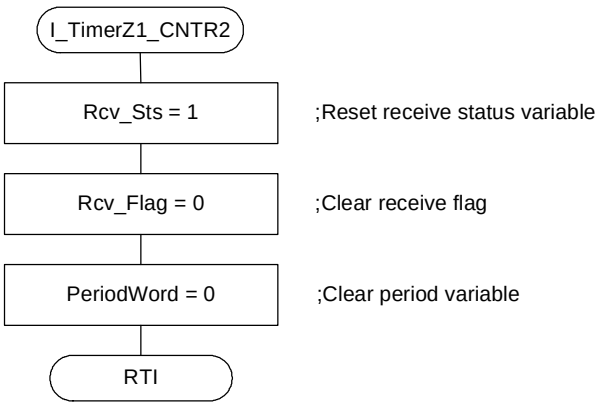
4.2 Infrared Remote Control Signal Process Subroutine (IR_Rcv)



4.3 CNTR2 Interrupt Service Handling (I_CNTR0_CNTR2)



4.4 Timer Z1 Interrupt Service Handling (I_TimerZ1_CNTR2)



5. Sample Program Code

```
/************************************************************************
 *
 *   File name   : rec05b0031_0100_source.c
 *   Contents    : Timer Z1 (Pulse Period Measurement Mode)
 *
 *   Copyright(C) 2007. Renesas Technology Corp., All rights reserved.
 *
 *   Version     : 1.00 (2007-6-22)
 *
************************************************************************/
/************************************************************************
 *
 *   Include
 *
************************************************************************/
#include <stdio.h>
#include <intr740.h>
#include "sfr_3858.h"

/************************************************************************
 *
 *   Definition
 *
************************************************************************/
void  IR_Rcv(void);
#define  LedLamp      P1_7                /* Led lamp */
#define  Period1Max   1599                /* 6.094ms*(1+5%) */
#define  Period1Min   1447                /* 6.094ms*(1-5%) */
#define  Period2Max   1963                /* 7.479ms*(1+5%) */
#define  Period2Min   1776                /* 7.479ms*(1-5%) */

typedef union {                           /* Define a type */
   unsigned int Word;
   struct {
      unsigned char LowByte;
      unsigned char HighByte;
   }Byte_Def;
}TwoByteUnion_Def;
zpage TwoByteUnion_Def   PeriodValue;     /* Declare an union */
#define PeriodWord       PeriodValue.Word
#define PeriodLowByte    PeriodValue.Byte_Def.LowByte
#define PeriodHighByte   PeriodValue.Byte_Def.HighByte

zpage unsigned char Rcv_Sts;              /* Declare a variable */
zpage unsigned char Rcv_Flag = 0;         /* Declare a variable */

/************************************************************************
 *
 *   Main
 *
************************************************************************/
void main(void){
   disable_interrupt();      /* Interrupt disable */
   cld_instruction();        /* Binary mode */
   CPUM = 0x0c;              /* Stack 1 page */
```

```
    P1D = 0x80;              /* Set Port P1 direction register */
    P1 = 0xff;               /* Set Port P1 register */
    PULL2 = 0x00;            /* Set Port P2 pull-up control register */
    P2D = 0x00;              /* Set Port P2 direction register */
    P2 = 0x00;               /* Set Port P2 register */
    TZ1M = 0x42;             /* Set Timer Z1 mode register */
    TYZ1CSS = 0x40;          /* Set Timer YZ1 Count register */
    TZ1L = 0xff;             /* Set Timer Z1(low) */
    TZ1H = 0xff;             /* Set Timer Z1(high) */
    TZ2M = 0x40;             /* Set Timer Z2 mode register */
    TZ2CSS = 0x06;           /* Set Timer Z2 Count register */
    TZ2L = 0x23;             /* Set Timer Z2(low) */
    TZ2H = 0xf4;             /* Set Timer Z2(high) */
    INTSEL = 0x08;           /* Set Interrupt source selection register */
    nop_instruction();
    IREQ1 = 0x00;            /* All Interrupt Request Bit are cleared */
    IREQ2 = 0x00;
    IE_TZ1C2 = 1;            /* TimerZ1 Interrupt enable */
    IE_C0C2 = 1;             /* CNTR2 Interrupt enable */
    IREQ1 = 0x00;            /* All Interrupt Request Bit are cleared */
    IREQ2 = 0x00;
    TZ1STP = 0;              /* Timer Z1 count start */
    enable_interrupt();      /* Interrupt enable */
    while(1){
       IR_Rcv();
    }
}

/************************************************************************
 *
 *   Infrared Receive
 *
************************************************************************/
void IR_Rcv(void){
    if (Rcv_Flag){
      Rcv_Flag = 0;
      switch(Rcv_Sts){
         case 1:
            if ((PeriodWord > Period1Min) &&(PeriodWord < Period1Max)){
               Rcv_Sts = 2;           /* Turn to case2 */
            }
            else{
               Rcv_Sts = 1;
               PeriodLowByte = 0;
               PeriodHighByte = 0;
            }
            break;
         case 2:
            if ((PeriodWord > Period2Min) &&(PeriodWord < Period2Max)){
               Rcv_Sts = 3;           /* Turn to case3 */
            }
            else{
               Rcv_Sts = 1;
               PeriodLowByte = 0;
               PeriodHighByte = 0;
            }
            break;
```

```
          case 3:
             IR_TZ2C3 = 0;              /* TimerZ2 Interrupt Request bit */
             TZ2L = 0x23;               /* Set Timer Z2(low) */
             TZ2H = 0xf4;               /* Set Timer Z2(high) */
             TZ2STP = 0;                /* Timer Z2 count start */
             LedLamp = 0;               /* Output "0", light LED lamp */
             while (!IR_TZ2C3){}        /* 1 second */
             IR_TZ2C3 = 0;              /* TimerZ2 Interrupt Request bit */
             LedLamp = 1;               /* Output "1", close LED lamp */
             TZ2STP = 1;                /* Timer Z2 count stop */
             break;
          default:
             Rcv_Sts = 1;
             PeriodLowByte = 0;
             PeriodHighByte = 0;
             break;
       }
    }
}

/************************************************************************
 *
 *   Interrupt CNTR2
 *
************************************************************************/
void interrupt[6] I_CNTR0_CNTR2(void){
   Rcv_Flag = 1;                        /* Receive request flag */
   PeriodLowByte = TZ1L;                /* Read period measure value */
   PeriodHighByte = TZ1H;
}

/************************************************************************
 *
 *   Interrupt TimerZ1
 *
************************************************************************/
void interrupt[28] I_TimerZ1_CNTR2(void){
   Rcv_Sts = 1;                         /* Reset receive status */
   Rcv_Flag = 0;                        /* Clear receive request flag */
   PeriodWord = 0;                      /* Clear variable value */
}
```

6. Reference Documents

Hardware Manual
M3858 Group Datasheet
The latest version can be downloaded from the Renesas Technology website.

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