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R8C/10, R8C/11, R8C/12, R8C/13 Group

A/D Key Read

1. Abstract

This application note describes a program that handles multiple key inputs on a single analog input by using the A/D converter.

2. Introduction

The explanation of this issue is applied to the following condition:

Microcomputer	: R8C/10, R8C/11, R8C/12, R8C/13 Group
Main clock input oscillation frequency	:16MHz
VCC, AVCC/VREF	:5V

This program can also be used when operating other microcomputers within the R8C/Tiny, provided they have the same SFR (Special Function Registers) as the R8C/11 microcomputers. However, some functions may have been modified.
Refer to the Hardware Manual for details. Use functions covered in this Application Note only after careful evaluation.

3. Contents

Specifications for key input and its determination are described below.

(1) The P07/AN0 pin is used for analog input. The circuit is configured by connecting multiple keys and resistors as shown in Figure 1, so that the voltage applied to the P07/AN0 pin will vary with each depressed key.

(2) Following settings are selected: A/D operation mode = one-shot mode, ϕAD frequency = divided-by-2 of fAD, and A/D resolution = 10 bits.

(3) The A/D conversion results are sampled every 5 ms. The timer X is used to measure 5 ms. The valid conversion result is determined from the sum total of 10 conversion results obtained (variable ad_sum) by averaging eight of the conversion results, with the maximum value (variable ad_max) and minimum value (variable ad_min) excluded. Therefore, the valid A/D value is determined (variable flag.bit.b_ad_fix) every 50 ms.

(4) When the valid A/D value is determined, the variable ad_fix is inspected to identify which key has been pressed. Key codes are determined to be valid when they match twice. The valid key code determined last (last_ad_key) and the valid key code determined this time are compared. If they match, the key code is set in ad_key_code. Table 1 lists the values used for key determination and the key codes.

Table 1 Values Used for Key Determination and Key Codes

Depressed key	None	KEY1	KEY2	KEY3	KEY4	KEY5
Ideal voltage value of AN0	5V	4V	3.75V	3.333V	2.5V	0V
Ideal A/D converted value	1023	820	769	684	514	0
Values used for determination	1023 to 921	920 to 794	793 to 726	725 to 599	598 to 257	256 to 0
Key code	0	1	2	3	4	5

Note that for reasons of SFR bit assignments, operation in this sample program may involve manipulating some bits whose functions are unused. Make sure the values of these bits are set according to the working condition in the user system.

3.1 Pins Used

Table 2. List of Pins Used and Their Functions

Pin name	I/O	Fuction
P07/AN0	Input	A/D input 0

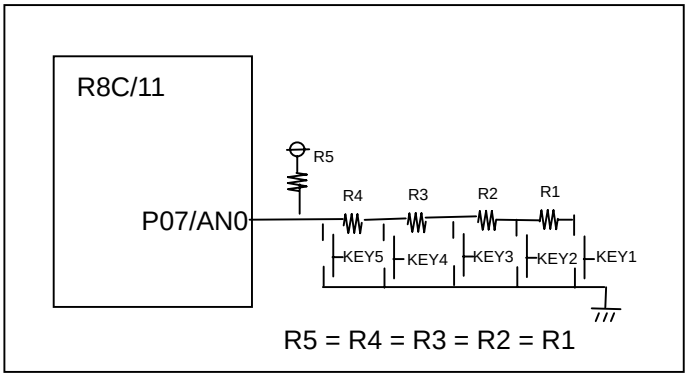


Figure 1. Key Input

3.2 Memory Usage

Table 3. Memory Usage

Memory Usage	Size	Remarks
ROM	301 bytes	In only the main.c module
RAM	13 bytes	In only the main.c module
Maximum user stack used	20 bytes	sfr_init function: 3 bytes ad_in function: 3 bytes ad_keyin function: 17 bytes
Maximum interrupt stack used	0 byte	Unused

The size of the used memory differs with the C compiler version and compile options. The above applies to the conditions given below.

- C compiler: M3T-NC30WA V.5.20 Release 1
- Compile option: -g -O -finfo [Note] - R8C

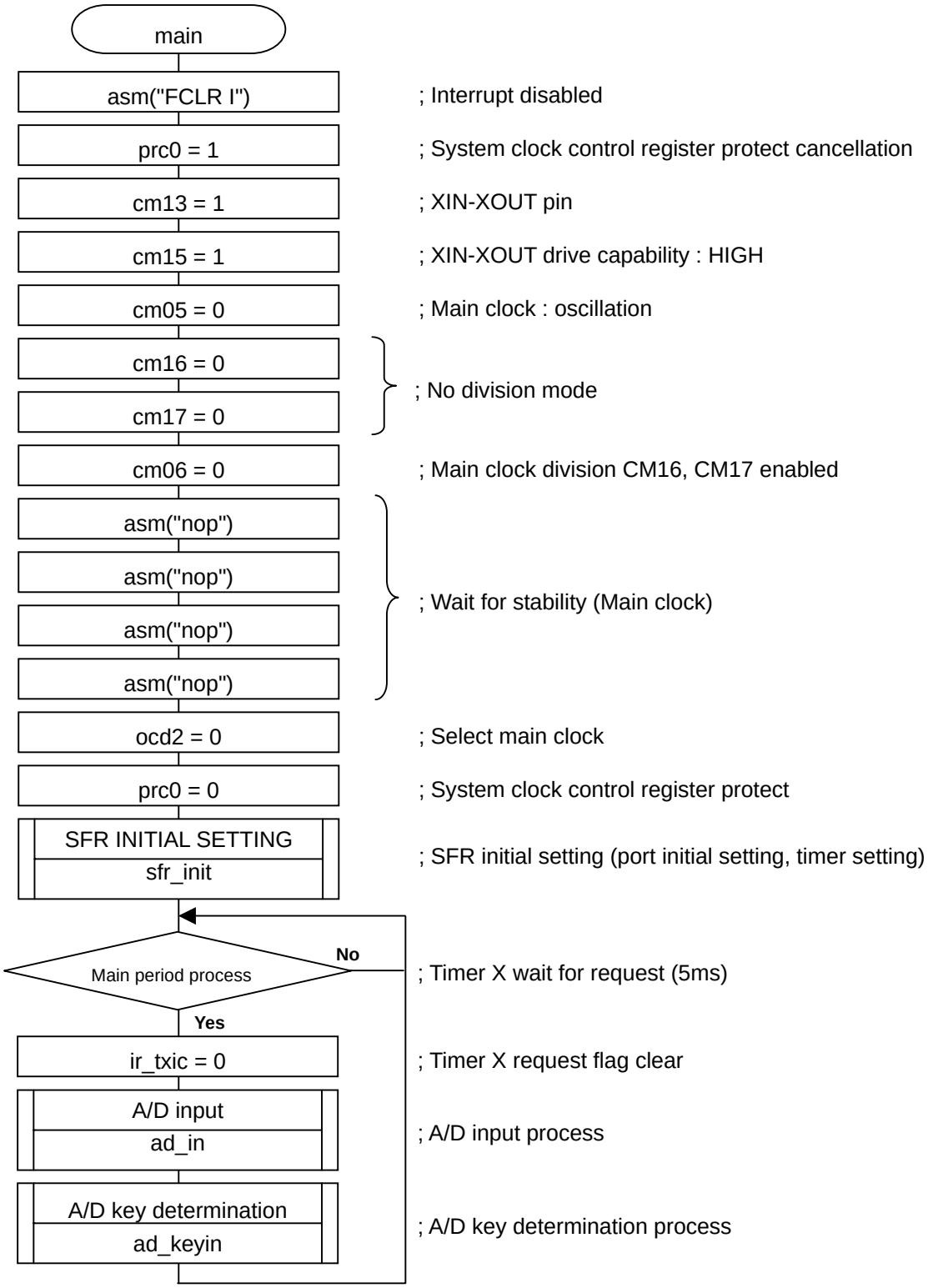
Note: Unusable in the R8C/Tiny-only free version.

Table 4. RAM Usage and Definition

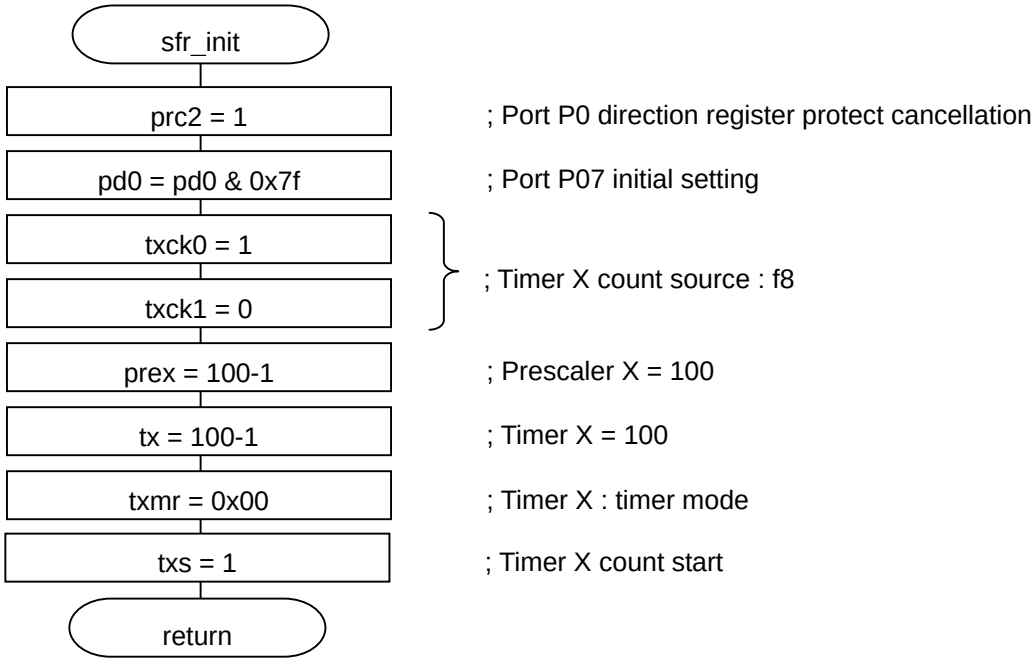
Symbol	Type	Size	Content
flag.bit.b_ad_fix	unsigned char :1	1 byte	Valid A/D value flag
ad_sum	unsigned int	2 bytes	LED display data
ad_cnt	unsigned int	2 bytes	A/D conversion count counter
ad_max	unsigned int	2 bytes	Maximum sampled A/D value
ad_min	unsigned int	2 bytes	Minimum sampled A/D value
ad_fix	unsigned int	2 bytes	Valid A/D value determined
ad_key_code	unsigned char	1 byte	Valid key code determined this time
last_ad_key	unsigned char	1 byte	Valid key code determined last

4. Flow Chart

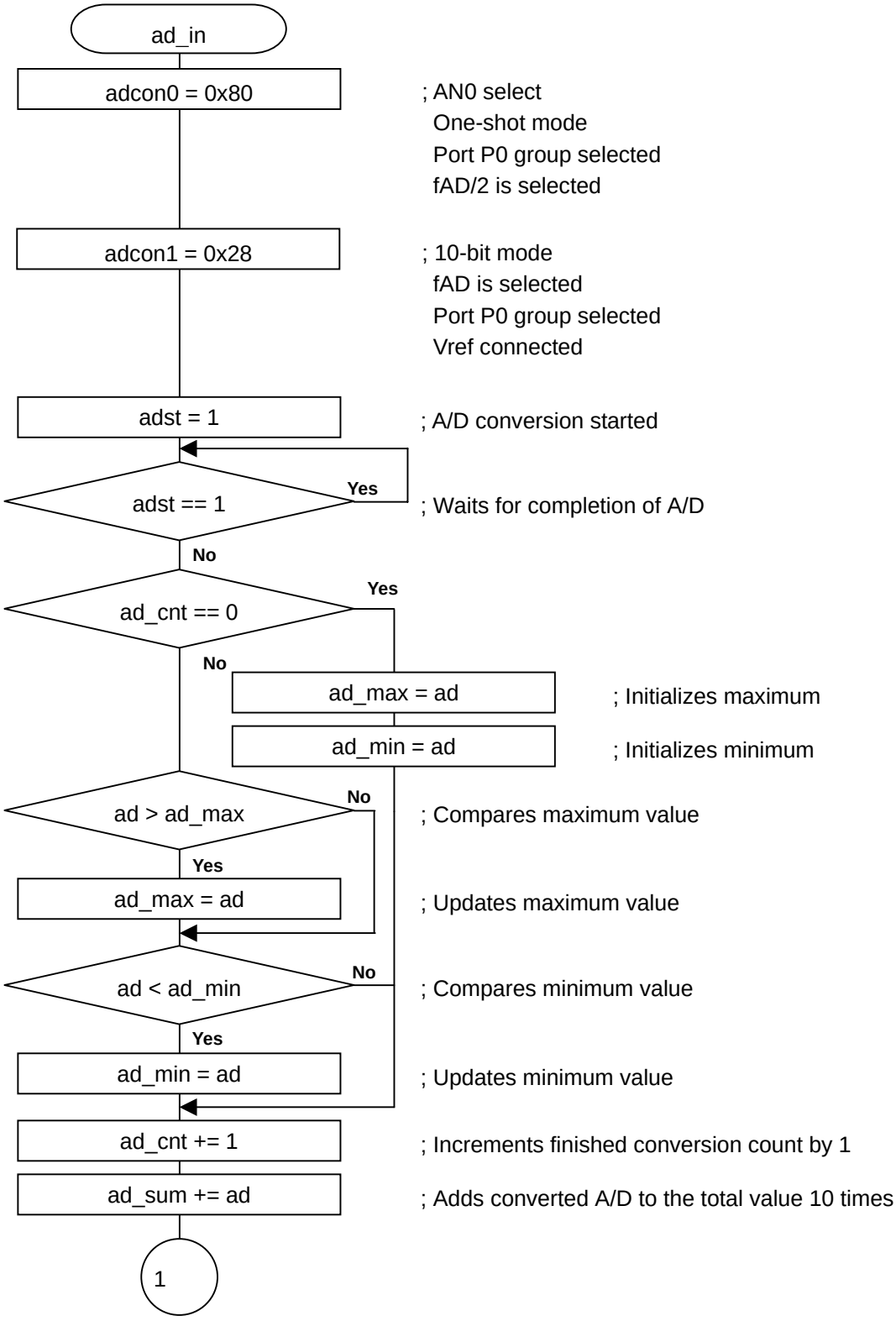
4.1 Initial Operation and Main Loop

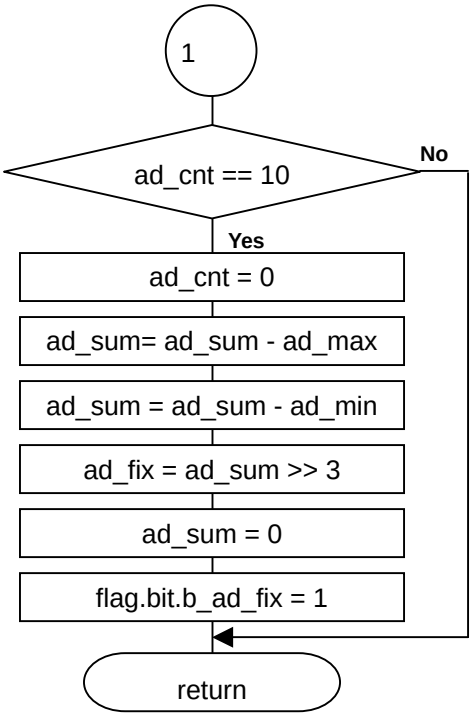


4.2 SFR Initial Setting



4.3 A/D Conversion and Valid Result Determination Process





; Determines that conversion finished 10 times

; Clears finished conversion count

; Subtracts maximum value from the 10 times

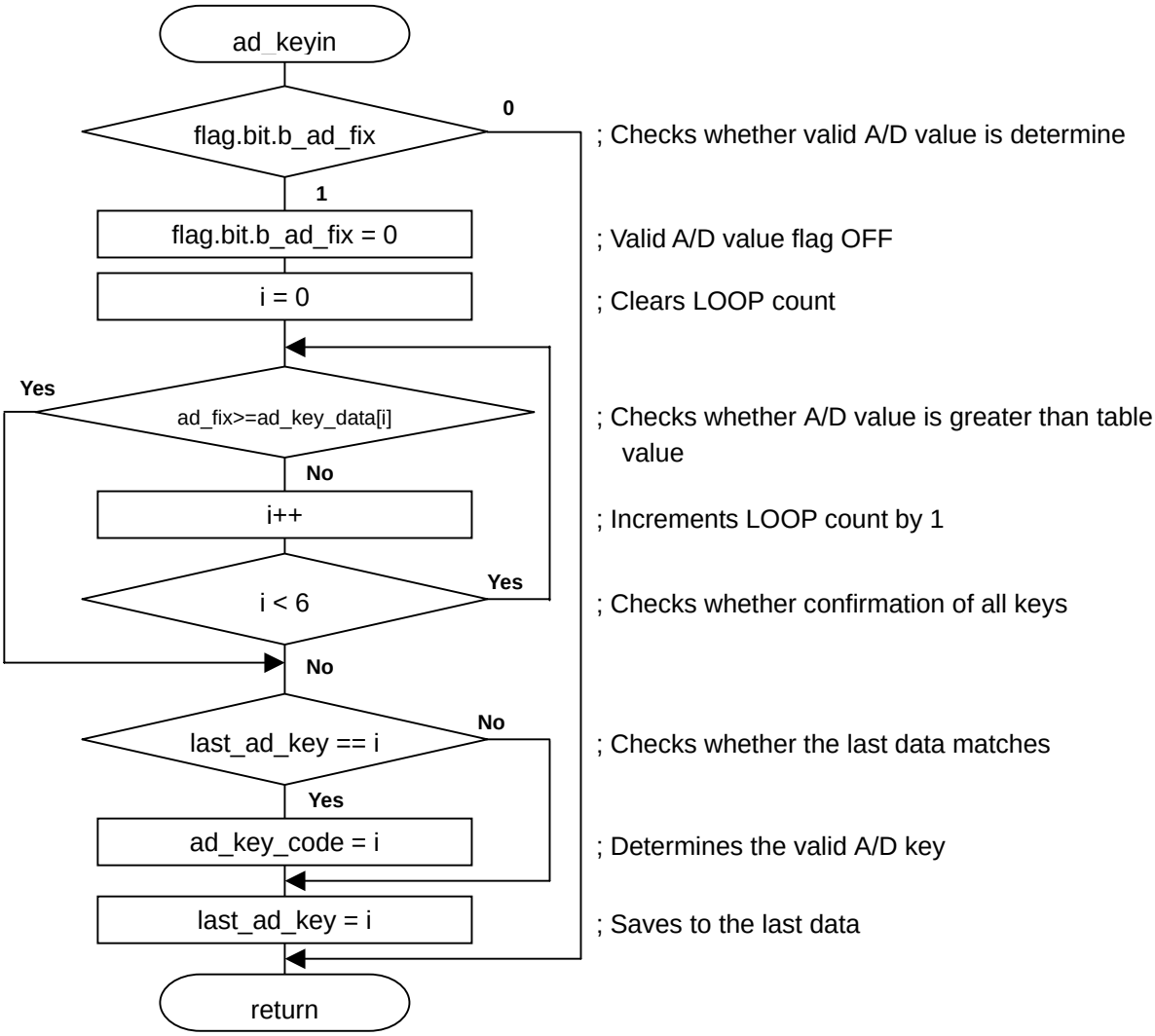
; Subtracts minimum value from the 10 times

; Shifts 3 bits right to reduce to 1/8

; Clears the 10 times total value

; Sets valid A/D conversion value flag ON

4.4 A/D Key Determination Processing



5. Programming Code

```
/************************************************************************************
*                                                                                   *
*   File Name   : main.c                                                            *
*   Contents    : Main program of the sample program No.6 R8C/11 Group              *
*   Copyright(C)2003, Renesas Technology Corp.                                      *
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*   All rights reserved.                                                            *
*   Version     : 1.10                                                              *
*   note       : 0.01 : First version                                               *
*              : 1.10(2004.08.02): Comment is revised                              *
************************************************************************************/
#include "sfr_r811.h"                           /* Definition of the R8C/11 SFR */

/* Definition of RAM area */
typedef union{
        unsigned char all;
        struct BFIELD{
                unsigned char b_ad_fix    :1;     /* A/D value fixed flag */
                unsigned char undefined   :7;
        }bit;
}flag_union;
flag_union              flag;
unsigned int     ad_sum;                        /* Summation of A/D conversion results */
unsigned int     ad_cnt;                        /* A/D conversion counter */
unsigned int     ad_max;                        /* Maximum value of A/D conversion result */
unsigned int     ad_min;                        /* Minimum value of A/D conversion result */
unsigned int     ad_fix;                        /* Fixed value of A/D conversion result */
unsigned char    ad_key_code;                   /* Fixed key code */
unsigned char    last_ad_key;                   /* Fixed key code last time */

/* Declaration of function prototype */
void sfr_init(void);                            /* Initial setting of SFR registers */
void ad_in(void);                               /* Set A/D fixed value */
void ad_keyin(void);                            /* Set key code */

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 */
```

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

        /*----------------------------------
        -       Loop of main               -
        ----------------------------------*/
        while(1){                                   /* Main processing */
                while(ir_txic == 0){}               /* Main cycle 5ms */
                ir_txic = 0;
                ad_in();                            /* Set A/D fixed value */
                ad_keyin();                         /* Set key code */
        }
}
/***********************************************************************************
Name:       sfr_init
Parameters:  None
Returns:    None
Description: Initial setting of SFR registers
***********************************************************************************/
void sfr_init(void){
        /* Setting port direction registers */
        prc2 = 1;                                   /* Protect off */
        pd0 = pd0 & 0x7f;                           /* AN0 port direction = input */

        txck0 = 1;                                  /* Timer X count source = f8 */
        txck1 = 0;

        /* Setting main cycle timer */
        /* 16Mhz * 1/8 * 100 * 100 =5ms */
        prex = 100-1;                               /* Setting Prescaler X register */
        tx = 100-1;                                 /* Setting timer X register */

        txmr = 0x00;                                /* Setting timer X mode register = timer mode */
        txs = 1;                                    /* Timer X count start flag = start */
}
```

```
/************************************************************************************
Name:       ad_in
Parameters:  None
Returns:    None
Description: input A/D
************************************************************************************/
void ad_in(void){

        /* Set a A/D control registers */
        adcon0 = 0x80;                              /* Analog input pin : AN0 is selected */
                                                    /* One-shot mode */
                                                    /* Port P0 group is selected */
                                                    /* Frequency : fad 1/2 selected */

        adcon1 = 0x28;                              /* 10-bit mode */
                                                    /* Frequency : fad 1/2 selected */
                                                    /* Vref connected */

        adst = 1;                                   /* Conversion start */

        /* Wait A/D conversion */
        while(adst == 1){}                          /* Wait A/D conversion */

        /* Refresh a max and min ad value */
        if (ad_cnt == 0){                           /* If it is the first conversion */
                ad_max = ad;                        /* Save the maximum value */
                ad_min = ad;                        /* Save the minimum value */
        }else{
                if (ad > ad_max){ ad_max = ad; }    /* Renew the maximum value */
                if (ad < ad_min){ ad_min = ad; }    /* Renew the minimum value */
        }

        /* Up a count of ad sampling count */
        ad_cnt += 1;                                /* Conversion counter +1 */
        ad_sum += ad;

        /* Set a fixed  ad value */
        if (ad_cnt == 10){                          /* If it is the last conversion value */
                ad_cnt = 0;                         /* A/D conversion counter clear */
                ad_sum = ad_sum - ad_max;
                ad_sum = ad_sum - ad_min;
                ad_fix = ad_sum >> 3;               /* A/D value fixed */
                ad_sum = 0;
                flag.bit.b_ad_fix = 1;              /* Set A/D value fixed flag */
        }
}
```

```
/************************************************************************************
Name:       ad_keyin
Parameters:  None
Returns:    None
Description: Set key code
************************************************************************************/
void ad_keyin(void){

        unsigned int i;
        const int ad_key_data [6] = {921,794,726,599,257,0};

        /* Check a fix of ad data */
        if (flag.bit.b_ad_fix == 1){                /* A/D value fixed ? */
                flag.bit.b_ad_fix = 0;              /* A/D value fixed flag off */

                /* Decode ad-value to ad-keycode */
                for(i = 0;i < 6 ;i++){
                        if (ad_fix >= ad_key_data[i]){
                                break;
                        }
                }

                /* Check the last key data */
                if (last_ad_key == i){              /* Is it the same key as the last one ? */
                        ad_key_code = i;            /* ad_key_code fixed */
                }
                last_ad_key = i;                    /* Save the key code as the last one */
        }
}
```

6. Reference

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Hardware Manual

R8C/10 Group Hardware Manual
R8C/11 Group Hardware Manual
R8C/12 Group Hardware Manual
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		Page	Summary
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