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2010年4月1日
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R8C/2G/2H Power Meter Platform

R8C Tiny Series – MCU

Microcomputer Development Environment System

User's Manual

Rev.2.00
Oct. 30, 2007

Renesas Technology
www.renesas.com

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Power Meter Platform

(R8C/2G/2H)

User's Manual

RS-SH

2nd Edition

Published by: Renesas System Solutions (Beijing) Co., Ltd., Shanghai Branch
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IMPORTANT INFORMATION

- ✧ **READ this user's manual before using this dashboard platform.**
- ✧ **KEEP the user's manual handy for future reference.**

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MCU:

Throughout this document, the term "MCU" shall be defined as the Renesas M16C Tiny series, R8C/2G/2H microcomputers.

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PREFACE

About this manual

This user's manual is written for Renesas R8C/2G/2H Platform Demonstration Board. It describes the hardware and software specifications of this platform. Please use this user's manual to understand the hardware and how to design R8C/2G/2H-software for the power meter application.

Section 1 Overview and Features

Give an introduction to the hardware and software specifications of the platform.

Section 2 System Requirements

Introduce the requirements of the system.

Section 3 Block Diagram

Give an overview on the functional modules of the platform.

Section 4 Schematic Diagram

Give a description of each circuits or modules schematically and functionally.

Section 5 Bill of Components

Give a detailed list of the components included in the system.

Section 6 Software Description

Give a function description of each software module and peripherals used by the sample software.

Section 7 Sample Software Flowchart

Give the detailed Sample Software flowchart description for the power meter application.

Section 8 Using E8 Emulator for Debugging

Demonstrate how to debug in HEW environment by using E8 emulator.

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Contents

1. Overview & Features

The R8C/2G/2H power meter platform is used to promote R8C/2G/2H for the single-phase power meter application. Emulator E8 is used for software development. The demonstration package should be given to customers with a demonstration board, a reference manual and a software package.

Hardware Specification:

- Main clock circuitry, MAX 8MHz (onchip)
- Reset circuitry
- DC 6-9V input for DC5V regulation
- Internal Real-Time Clock (RTC)
- External 8Kb EEPROM (controlled by IIC)
- ADE7755 connector circuitry
- RS485 connector circuitry
- Infrared circuitry
- Two LED
- Dot-matrix LCD (controlled by HC164)
- Temperature measurement circuit

Software Specification:

- SCI, LCD drivers
- Infrared driver
- EEPROM driver
- ADE7755 driver
- Power Meter Emulation
- RS485 driver
- Watchdog
- Oscillator frequency turning

Reference Manual Specification:

- Demonstration board schematic
- Description of each hardware functions
- Material list
- Description of each software module in the software package

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2. System Requirements

- 220VAC power supply
- Emulator, E8
- HEW installed in PC

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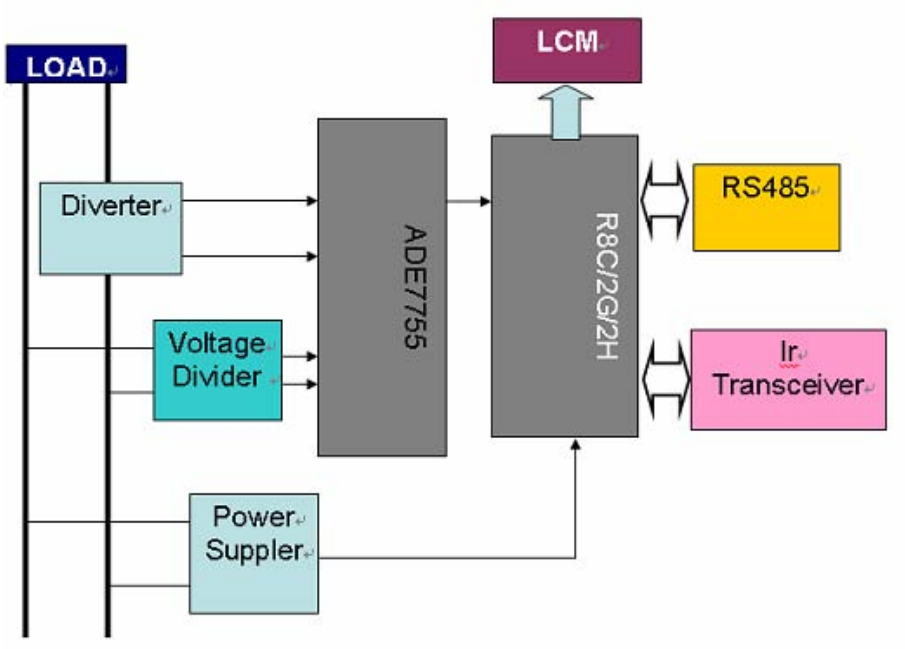
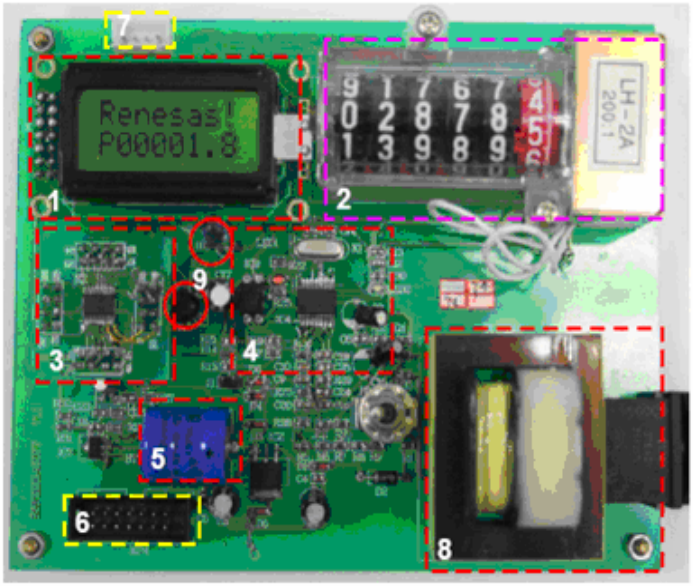
3. Block Diagram

The following diagram describes the system blocks and the figure shows the system components, they help you have a general concept of this application.





1. LCD displayer
2. Counter
3. MCU
4. ADE7755
5. Batter
6. E8 interface
7. 485 interface
8. Transformer
9. Ir emitter & receiver

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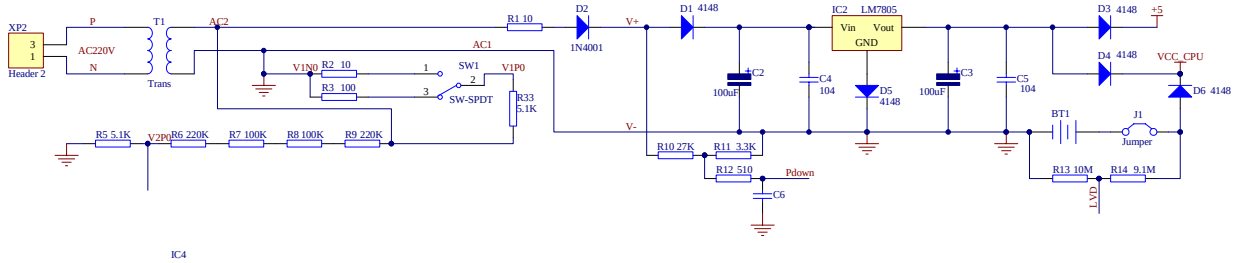
4. Schematic Diagram

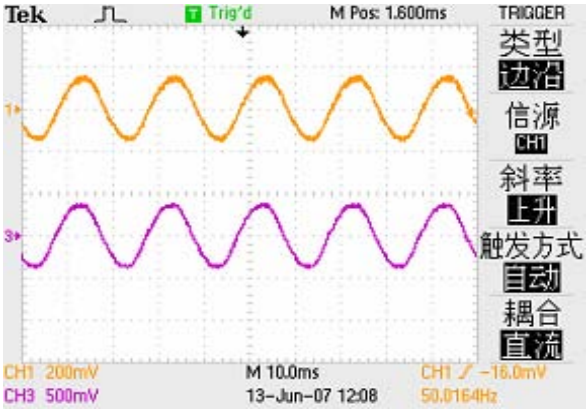
4.1 Sampling and low voltage detecting



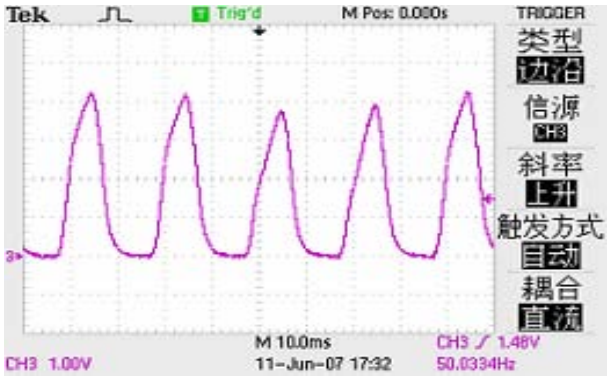
For safety purpose, we use a transformer on this platform. In actual application, and for cost down, there is such transformer. This part is the sampling and low voltage detecting circuit.

The current circuit consists of R2, R3 and R33. It gives sine current signal to ADE7755's V1P pin and V1N pin.

The voltage circuit consists of R5, R6, R7, R8 and R9. It gives sine voltage signal to ADE7755's V2P pin and V2N pin.



Power off circuit consists of R10, R11 and R12. If power off, MCU will not detect plus signal in a short time.



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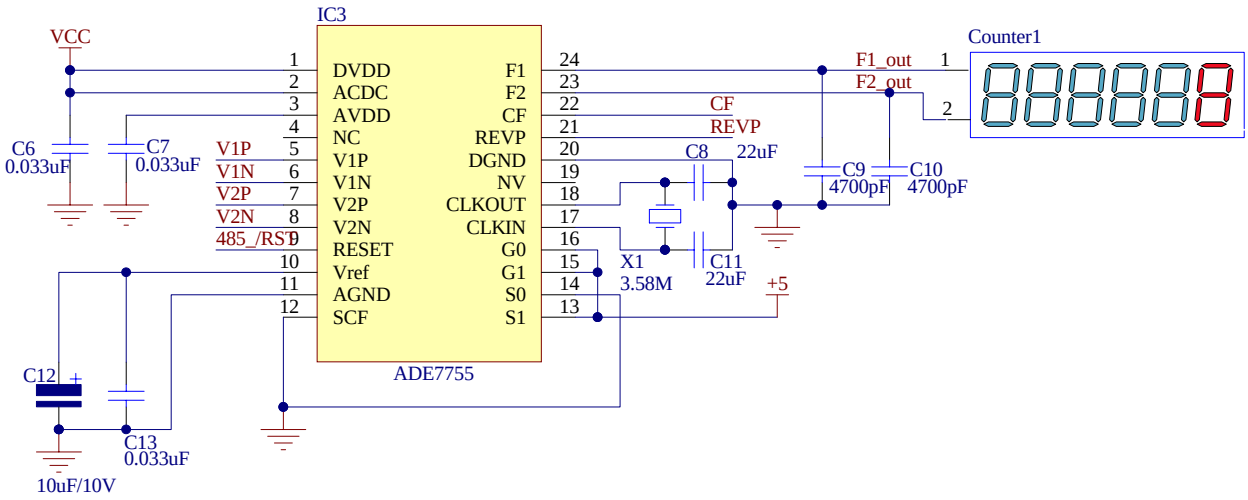
The low voltage circuit consists of R13 and R14. It sends a voltage signal to MCU's voltage compare port. If the voltage of batter is below 2.4V, an interrupt will occur.

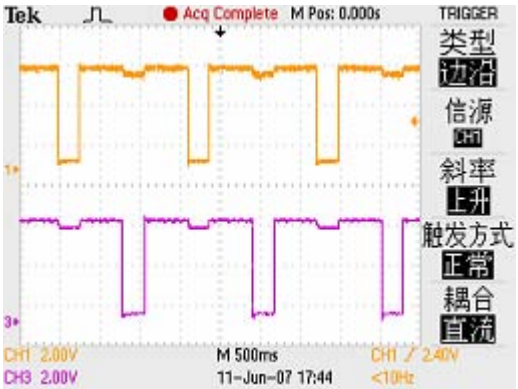
4.2 ADE7755 circuit



This part is the ADE7755 circuit; it executes current and voltage sampling and output power measurement pluses.

This power meter platform has a LCD display module except the mechanical counter.

The ADE7755 is an accurate electrical energy measurement IC intended for use in single-phase distribution systems. It provides instantaneous and average real power based on line current and voltage. The part specifications surpass the accuracy requirements as stated in the IEC61036 standard. The only analog circuitry used in the ADE7755 is in the ADCs and reference circuit. All other signal processing (e.g., multiplication and filtering) is carried out in the digital domain. This approach provides superior stability and accuracy over extremes in environmental conditions and over time.



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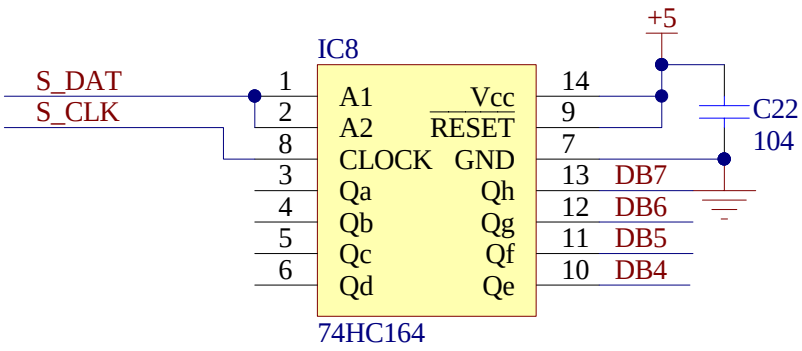
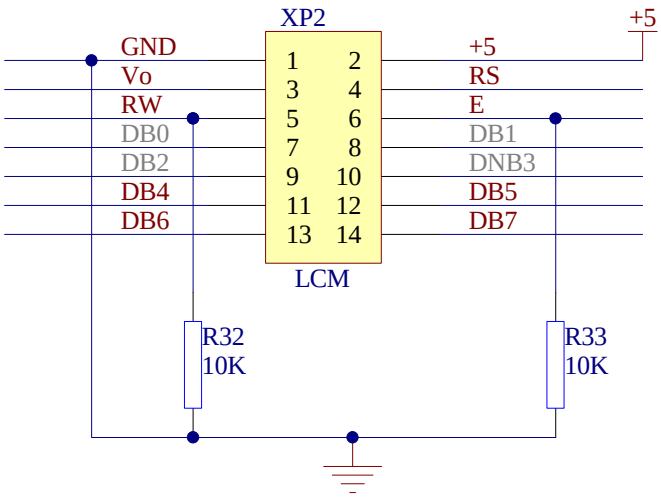
Pluse sent to counter (F1_out/F2_out)

4.3 LCM display module





MCU drivers HC164, and expands I/O to driver LCD module. LCD module is used to display power counter.

4.4 MCU Part

For general purpose, I/Os of R8C/2G is assigned the same as R8C/2H's. The following figure shows the MCU part, which belong to both of R8C/2G and R8C/2H, and these parts are used in this application.

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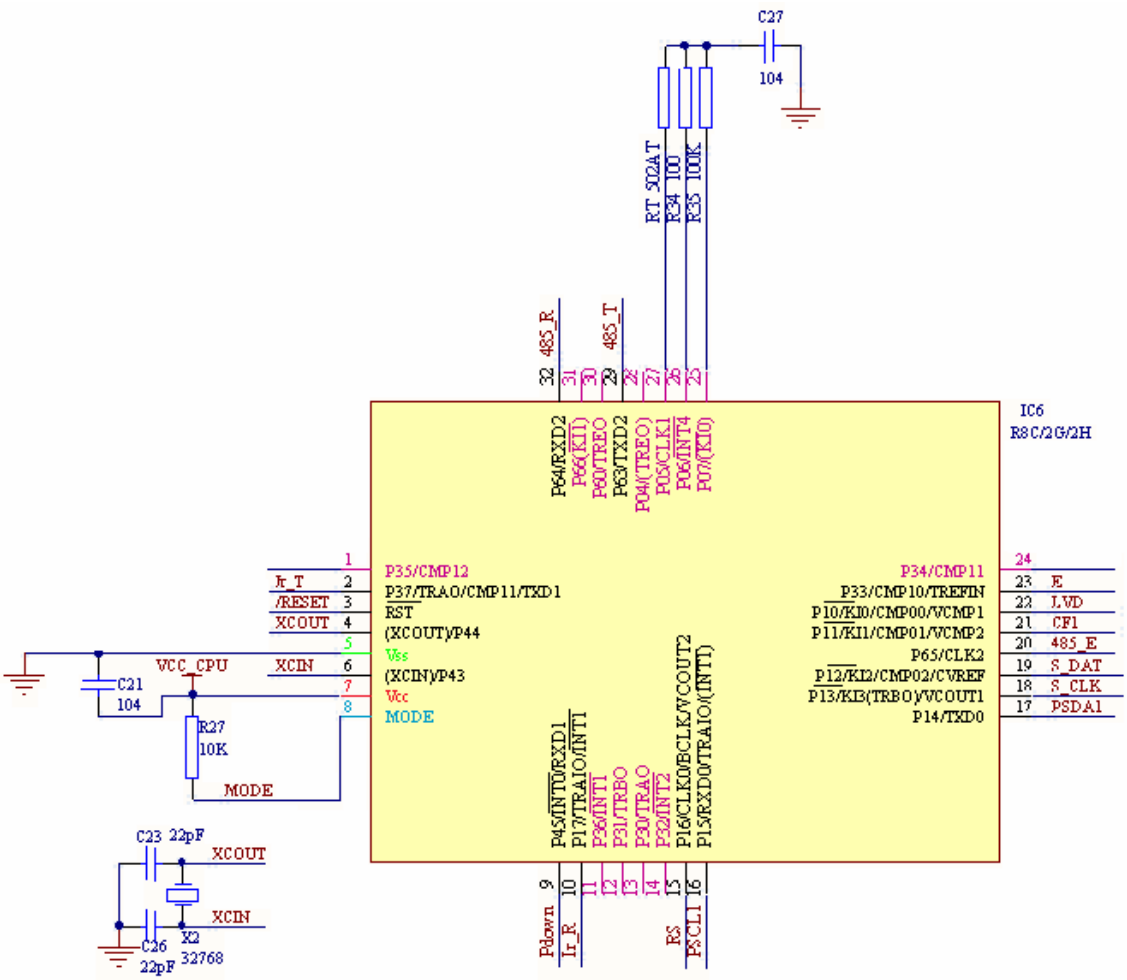
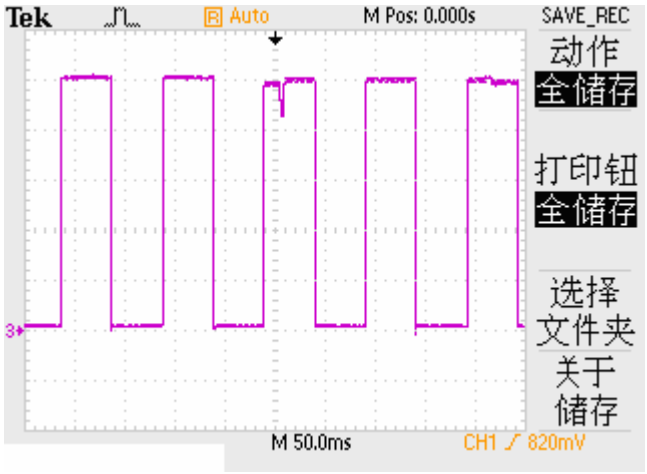


MCU (R8C/2G or R8C/2H) detects the signal from ADE7755, counts the electrical energy and displays it on LCD.



For total system, MCU detects power off signal, low voltage signal, and according to these

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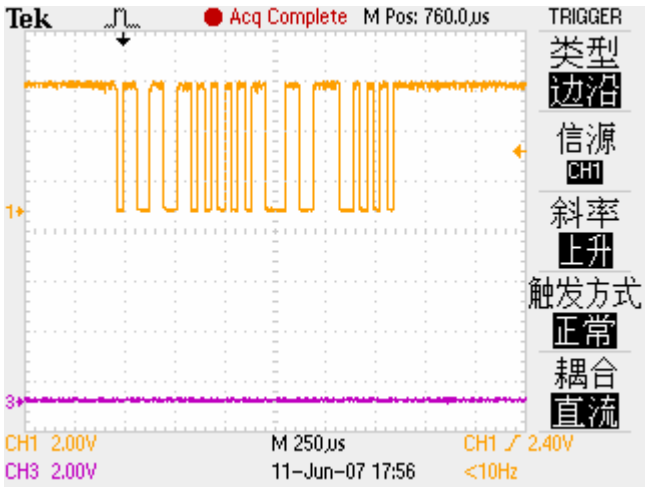
signals, it will execute the low power consumption function.

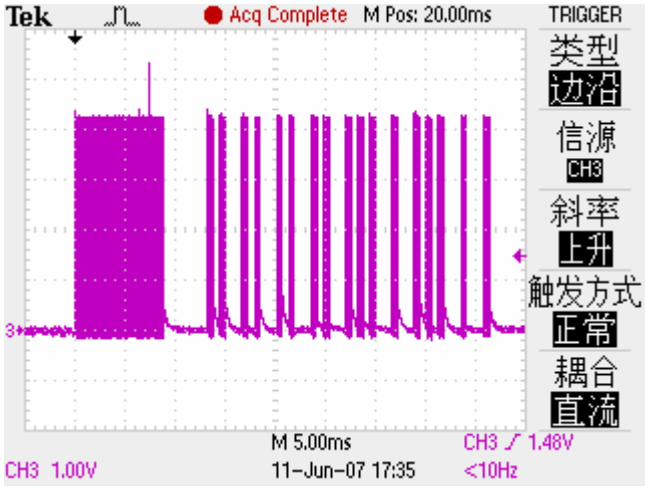
MCU reads and writes system data to EEPROM (24C0X).

MCU communicates with outers through ADE485 and infrared transmitting and receiving circuits.

MCU transmits UART signals through P64 and receivers signals from P63, The waveform looks like as below:



P37 and P17 are Infrared output and input ports. In order to sending infrared, the timer A and timer B are used. Timer A is use to generate 38KHZ carrier wave. Timer B is used to count widths of the pluses.



Transmitting waveform

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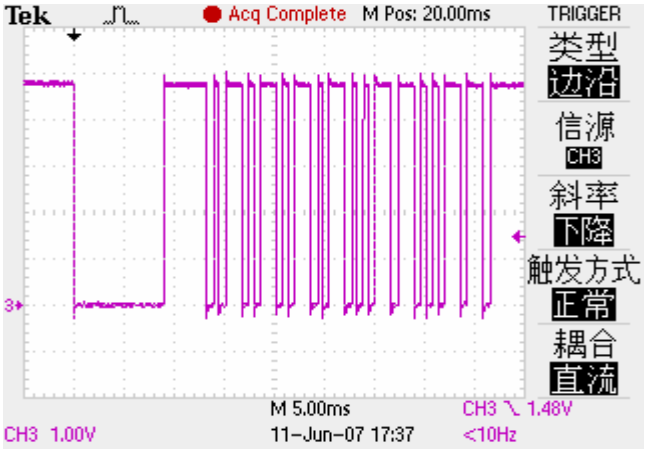
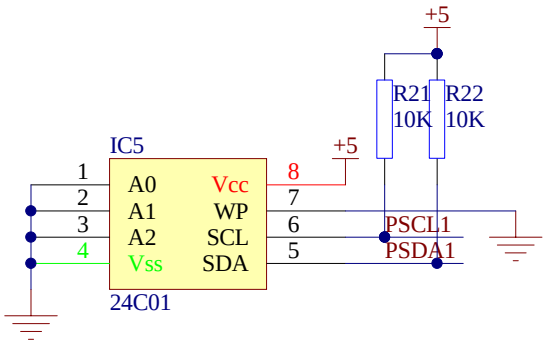


Receiving waveform

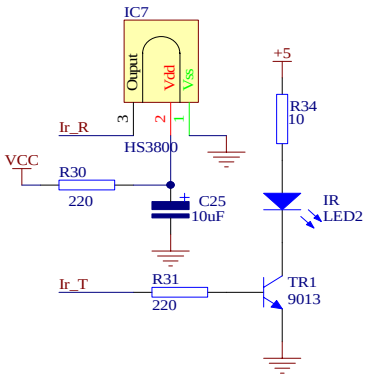
4.5 EEPROM Circuit

Utilize two I/Os to drive 24C0X. 24C0X is used to store system setting data and power measurement data.



4.6 Infrared Transceiver Circuit

This circuit executes setting and modifying parameters of power meter, and reads data from customer through it.



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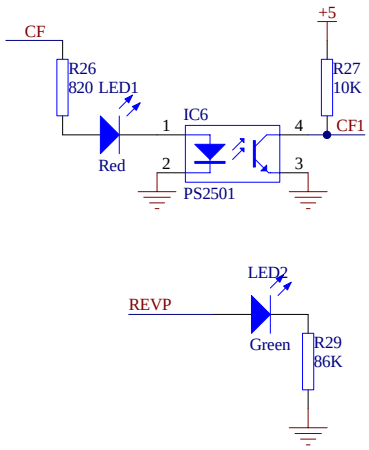
HS0038 is a receiver; it is a 38 kHz infrared demodulator, it outputs pulse to MCU's INT1 pin.

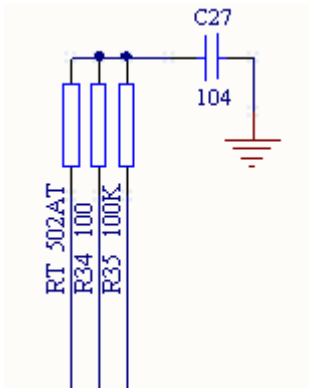
Timer RA is used as a carry-wave generator, it outputs 38 kHz PWM. MCU sends the data through the infrared diode.

4.7 Power pulse input circuit

The power pulse of ADE7755 output is sent to MCU by opt-isolator for calculating.



4.8 Temperature measurement logic circuit



Use three pins of MCU, one exact resistance R35, one thermal-sensitive-resistance RT, one normal resistance and one capacitance for temperature measurement.

Temperature measurement process:

This circuit generally shows the basic logic of temperature measurement. Charge C27 through R34 and let it then discharge through R35 or RT, record the discharging time T1 and

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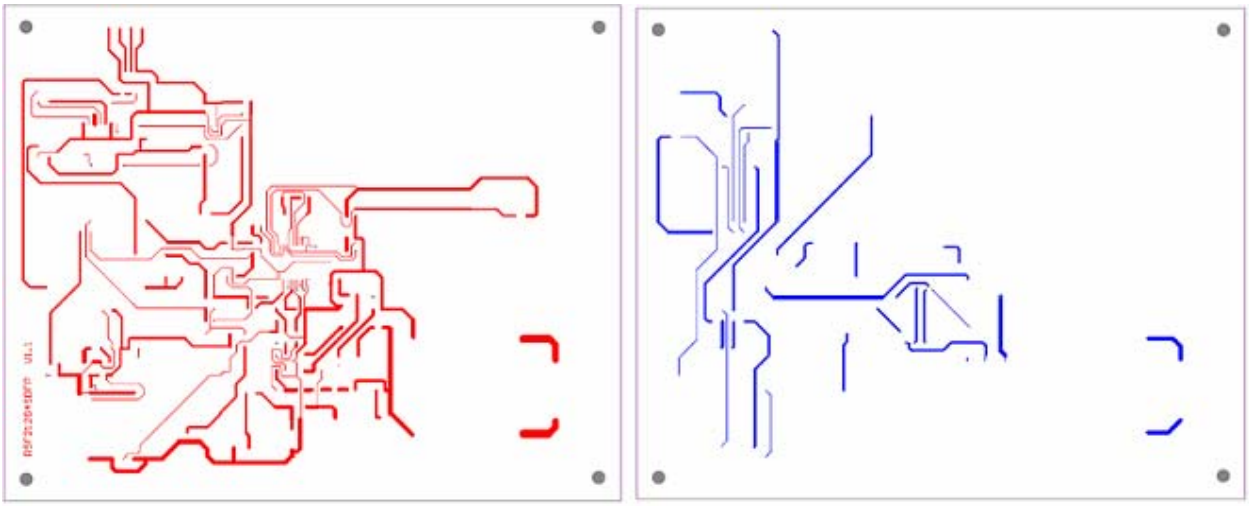
T2 respectively. R35/T1=RT/T2, get the RT value since R35 is known already (exact resistance, 100k ohm). Look up the R-T table which provided according to the thermal-sensitive-resistance characteristic and obtain the current temperature.

4.9 Circuit Board Layout

The following figure shows the outline of the board.



Top layer and bottom layer

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5. Bill of Components

Designator	Footprint	LibRef	Quantity
BT1	Battery	Battery	1
C1	RC 0805_1/10W	CAP [SMT]	1
C2	CAP(5mm_D6.3)	ELECTRONIC2	1
C3	CAP(5mm_D6.3)	ELECTRONIC2	1
C4	RC 0805_1/10W	CAP [SMT]	1
C5	RC 0805_1/10W	CAP [SMT]	1
C6	RC 0805_1/10W	CAP [SMT]	1
C7	RC 0805_1/10W	CAP [SMT]	1
C8	CAP(5mm_D6.3)	ELECTRONIC2	1
C9	RC 0805_1/10W	CAP [SMT]	1
C10	RC 0805_1/10W	CAP [SMT]	1
C11	RC 0805_1/10W	CAP [SMT]	1
C12	RC 0805_1/10W	CAP [SMT]	1
C13	RC 0805_1/10W	CAP [SMT]	1
C14	RC 0805_1/10W	CAP [SMT]	1
C15	CAP(5mm_D6.3)	ELECTRONIC2	1
C16	RC 0805_1/10W	CAP [SMT]	1
C17	CAP(5mm_D6.3)	ELECTRONIC2	1
C18	RC 0805_1/10W	CAP [SMT]	1
C19	RC 0805_1/10W	CAP [SMT]	1
C20	RC 0805_1/10W	CAP [SMT]	1
C21	RC 0805_1/10W	CAP [SMT]	1
C22	RC 0805_1/10W	CAP [SMT]	1
C23	RC 0805_1/10W	CAP [SMT]	1
C24	RC 0805_1/10W	CAP [SMT]	1
C25	RC 0805_1/10W	CAP [SMT]	1
C26	RC 0805_1/10W	CAP [SMT]	1
Counter1	Counter	Counter	1
D1	Diode 1206	Diode	1
D2	DIODE(10.16)	Diode	1
D3	Diode 1206	Diode	1
D4	Diode 1206	Diode	1
D5	Diode 1206	Diode	1
D6	Diode 1206	Diode	1
IC1	SOP8	ADM485	1
IC2	TO263 D-PAK	Volt Reg	1
IC3	SOP8	24XX	1
IC4	TSSO8X6-G24	AD7755	1
IC5	Receiver	RECEIVER	1
IC6	R8C2G_Aduptor	R8C/2G/2H	1
IC7	SOT89	Header 3	1
IC8	SOP14	74HC164	1
IC9	DIP4	Optoisolator1	1
IR1	LED .3	LED2	1

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J1	HDR1X2	Jumper	1
LED1	Diode 0805	LED2	1
LED2	Diode 0805	LED2	1
P1	HDR1X3	Header 3	1
R1	RC 0805_1/10W	RES2 [SMT]	1
R2	RC 0805_1/10W	RES2 [SMT]	1
R3	RC 0805_1/10W	RES2 [SMT]	1
R5	RC 0805_1/10W	RES2 [SMT]	1
R6	RC 0805_1/10W	RES2 [SMT]	1
R7	RC 0805_1/10W	RES2 [SMT]	1
R8	RC 0805_1/10W	RES2 [SMT]	1
R9	RC 0805_1/10W	RES2 [SMT]	1
R10	RC 0805_1/10W	RES2 [SMT]	1
R11	RC 0805_1/10W	RES2 [SMT]	1
R12	RC 0805_1/10W	RES2 [SMT]	1
R13	RC 0805_1/10W	RES2 [SMT]	1
R14	RC 0805_1/10W	RES2 [SMT]	1
R15	RC 0805_1/10W	RES2 [SMT]	1
R16	RC 0805_1/10W	RES2 [SMT]	1
R17	RC 0805_1/10W	RES2 [SMT]	1
R18	RC 0805_1/10W	RES2 [SMT]	1
R19	RC 0805_1/10W	RES2 [SMT]	1
R20	RC 0805_1/10W	RES2 [SMT]	1
R21	RC 0805_1/10W	RES2 [SMT]	1
R22	RC 0805_1/10W	RES2 [SMT]	1
R23	RC 0805_1/10W	RES2 [SMT]	1
R24	RC 0805_1/10W	RES2 [SMT]	1
R25	RC 0805_1/10W	RES2 [SMT]	1
R26	RC 0805_1/10W	RES2 [SMT]	1
R27	RC 0805_1/10W	RES2 [SMT]	1
R28	RC 0805_1/10W	RES2 [SMT]	1
R29	RC 0805_1/10W	RES2 [SMT]	1
R30	RC 0805_1/10W	RES2 [SMT]	1
R31	RC 0805_1/10W	RES2 [SMT]	1
R32	RC 0805_1/10W	RES2 [SMT]	1
R33	RC 0805_1/10W	RES2 [SMT]	1
SW1	SW [MTS-102]	SW-SPDT	1
T1	Transformer TDA-8-103	Trans	1
TR1	SOT23-G3	NPN	1
X1	Crystal_1	XTAL	1
X2	HDR1X2	XTAL	1
XP1	XH4(2)	Header 4	1
XP2	Power connectorLN	Header 2	1
XP3	HDR2X7	Header 7X2	1
XP4	E8 CONNECTOR	Header 7X2	1

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6. Software Description

The R8C/2G/2H Demonstration Set accompanies with a software package, which contains 20 software modules. Designers may use these modules as a reference to start their design. The following figure illustrates the software structure. Some of the modules utilize the MCU peripherals and I/O. The following table describes the function of each software module.

Table– The Function of Software Module

	File name	Software Modules	Function
1	hwsetup.c	Oscillator selection	Provide main clock, substance clock and on-chip oscillator clocks, three modes for choices
		LVD	Provide a low voltage detection interface
		timerA_init	Initialize timer RA, timer RA is used to output 38 kHz PWM.
		timerB_init	Initialize timer RB, timer RB is used as a timer to count widthes of infrared plus.
		timerE_init	Initialize timer RE, timer RE is used as a RTC; it will be interrupted every second.
		UART485_init	Initialize TXD and RXD ports; both of the two ports are used as UART ports.
		Comparator_init	Set p10 as a voltage compare port, the detection voltage is set to1.24V
		timerF_init	Set timer RF as a timer, the timer of interrupt exacting is 0.1ms, it is used to count the width of infrared pulses.
		Int1_init	Int1 is used as infrared input port. It is used to detect infrared plus.
		WDT_init	Set WDT interval time.
2	I2C.c	I2C	Provide a standard I2C protocol interface to the upper module
3	interrupt_2G.c	Infrared send	Provide a infrared data sending interface
4	lcd.c	Infrared receive	Provide a infrared data receiving interface
		UART	Provide an interface to transmit/receive data to/from the UART2
		ADE7755	Provide an interface to count the pulses from the ADE7755
		LCD	Provide a Man to Machine Interface (MMI) for displaying message
5	Rtimer.c	HC164	Provide an interface to drive LCD using a serial-in parallel-out shift register
		Real-Time Clock	Provide a real-time clock to the system

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6	Turn_f.c	Frequency Turning	Provide an interface to adjust the oscillator frequency error.
7	RDB_28_2G.c	Power Down	Provide wait and stop-mode to lower power consumption

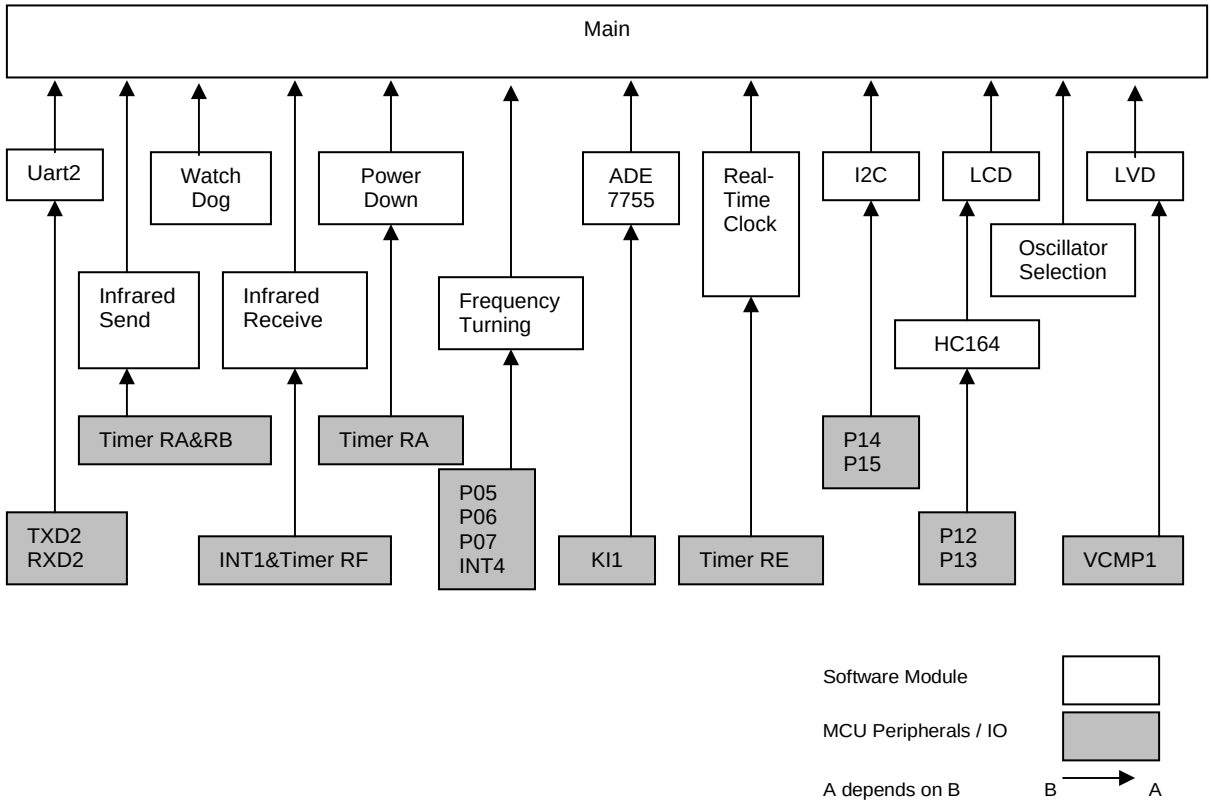

Figure- Software Structure

6.1 I2C

Software Module: I2C
Included in: `I2C.c`
Dependencies: `global.h`
Functions: Provide an interface for the upper module to control/access the external module through the I2C.

Procedure call

Procedure Name: i2cread
Function: Read data from the external device through the I2C
Parameter return: None
Parameter Input:

Parameter	Type	Function
`Raddress`	`char`	The device address of external device
`Rrampoint`	`char*`	The start location where the data start
`Rbytelength`	`char`	The length of data to read

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Procedure Name:	i2cwrite		
Function:	Write data to the external device through the I2C		
Parameter return:	None		
Parameter Input:	Parameter	Type	Function
	`Waddress`	`char`	The device address of external device
	`Wrampoint`	`char*`	The start location where the data start
	`Wbytelength`	`char`	The length of data to write

6.2 UART

Software Module: UART
Included in: `Interrrupt_2G.c & hwsetup.c`
Dependencies: `global.h`
Functions: Provide an interface for the upper module to access the MCU peripheral UART.

Procedure call

Procedure Name:	UART485_init
Function:	It is the initialization process, which should be run before using any UART2
Parameter return:	None
Parameter Input:	None

Procedure Name:	uart2T_int
Function:	Send the data from the UART2 port to the external device
Parameter return:	None
Parameter Input:	None

Procedure Name:	uart2R_int
Function:	The data receive of UART2 port from the external device
Parameter return:	None
Parameter Input:	None

6.3 LCD

Software Module: LCD
Include in: lcd.c
Dependencies: global.h
Functions: Provide an interface for the user to display the message on the LCD

Procedure call

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Procedure Name:	InitialiseDisplay
Function:	It is the initialization process, which should be run before using any LCD procedures
Parameter return:	None
Parameter Input:	None

Procedure Name:	DisplayString		
Function:	Display the data on the LCD		
Parameter return:	None		
Parameter Input:	Parameter	Type	Function
	`position`	`unsigned char`	The device address of external device
	`string`	`_far char*`	The start position of the LCD to display

6.4 HC164

Software Module:	HC164
Included in:	`lcd.c`
Dependencies:	`global.h`
Functions:	Provide an interface to drive LCD using a serial-in parallel-out shift register

Procedure call

Procedure Name:	HC164
Function:	Provide an interface to drive LCD using a serial-in parallel-out shift register
Parameter return:	None
Parameter Input:	None

6.5 ADE7755

Software Module:	ADE7755 Driver
Included in:	`Interrrupt_2G.c`
Dependencies:	`global.h`
Functions:	Provide a function to count the pulses from the ADE7755, after calculation they would be displayed on LCD.

Procedure call

Procedure Name:	Key_int
Function:	Provide a function to count the pulses from the ADE7755, after calculation they would be displayed on LCD
Parameter return:	None
Parameter Input:	None

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6.6 Infrared Send

Software Module:	Infrared Send
Included in:	`Interrrupt_2G.c & hwsetup.c`
Dependencies:	`global.h`
Functions:	Provide an interface for the upper module to transmit data through the infrared. The Infrared Waveform is transmitted through the TRAO port and generated by timer RA, RB. Timer RA is used to generate the carrier frequency, Timer RB is used to control the sending data.

Procedure call

Procedure Name:	timerA_init
Function:	It is the initialization process, which should be run before using any infrared send procedures
Parameter return:	None
Parameter Input:	None

Procedure Name:	timerB_int
Function:	It controls the carrier frequency to generate data code for transmission
Parameter return:	None
Parameter Input:	None

Procedure Name:	code_trans
Function:	It is a subroutine called in timerB_int, for code transmission
Parameter return:	None
Parameter Input:	None

6.7 Infrared Receive

Software Module:	Infrared Receive
Included in:	`Interrrupt_2G.c & hwsetup.c`
Dependencies:	`global.h`
Functions:	Provide an interface for the upper module to receive data through the infrared. Timer RF is used to generate 0.1ms timer, INT1 receive the infrared data.

Procedure call

Procedure Name:	timerF_init
Function:	It is the initialization process, which should be run before using any infrared receive procedures
Parameter return:	None
Parameter Input:	None

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Procedure Name:	int1
Function:	The data receive of the infrared circuitry from the external device
Parameter return:	None
Parameter Input:	None

Procedure Name:	S_code
Function:	It is a subroutine called in int1, for code receiving
Parameter return:	None
Parameter Input:	None

6.8 Real-Time Clock

Software Module:	Real-Time Clock
Included in:	`Rtimer.c`
Dependencies:	`global.h`
Functions:	Provide an interface for the upper module to obtain a real-time clock. User is able to select the procedure to get the current time or date. It is generated by Timer RE.

Procedure call

Procedure Name:	timerE_init
Function:	It is the initialization process, which should be run before using any real-time clock procedures, user could set the current time and data here.
Parameter return:	None
Parameter Input:	None

Procedure Name:	Rtimer_E
Function:	Read the updated time value, data value (including second, minute, hour, day, month, year and also week), they could be displayed onto LCD.
Parameter return:	None
Parameter Input:	None

6.9 Frequency Turning

Software Module:	frequency turning
Included in:	`Turn_f.c`
Dependencies:	`global.h`
Functions:	Provide an interface for the upper module to correct the oscillator frequency cause by temperature variate. User is able to select the procedure to adjust the frequency.

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Procedure call

Procedure Name:	get_error
Function:	According to the current temperature calculate out the error of the oscillator frequency.
Parameter return:	None
Parameter Input:	None

Procedure Name:	get_T
Function:	Through temperature measurement logic circuit get the current temperature.
Parameter return:	None
Parameter Input:	None

Procedure Name:	Abs_Error
Function:	According to the difference of each oscillator itself, calculate out the error of its frequency.
Parameter return:	None
Parameter Input:	None

Procedure Name:	Adjust_RTC
Function:	Adjust RTC clock per hour according to the sum of absolute error of oscillator itself and error cause by temperature variate.
Parameter return:	None
Parameter Input:	None

6.10 Power Down

Software Module:	Power Down
Included in:	`RDB_28_2G.c`
Dependencies:	`global.h`
Functions:	Control the power down mode of the MCU

Procedure call

Procedure Name:	wait_mode_set
Function:	Enter wait mode.
Parameter return:	None
Parameter Input:	None

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Procedure Name:	stop_mode_set
Function:	Enter stop mode.
Parameter return:	None
Parameter Input:	None

6.11 Low Voltage Detection

Software Module:	LVD
Included in:	`hwsetup.c`
Dependencies:	`global.h`
Functions:	Monitor the VCC input voltage.

Procedure call

Procedure Name:	Comparator_init
Function:	When VCMP1 reaches reference voltage or below, VCMP1 interrupt happened.
Parameter return:	None
Parameter Input:	None

6.12 Watchdog

Software Module:	Watchdog
Included in:	`hwsetup.c & RDB_28_2G.c`
Dependencies:	`global.h`
Functions:	Control the watchdog timer.

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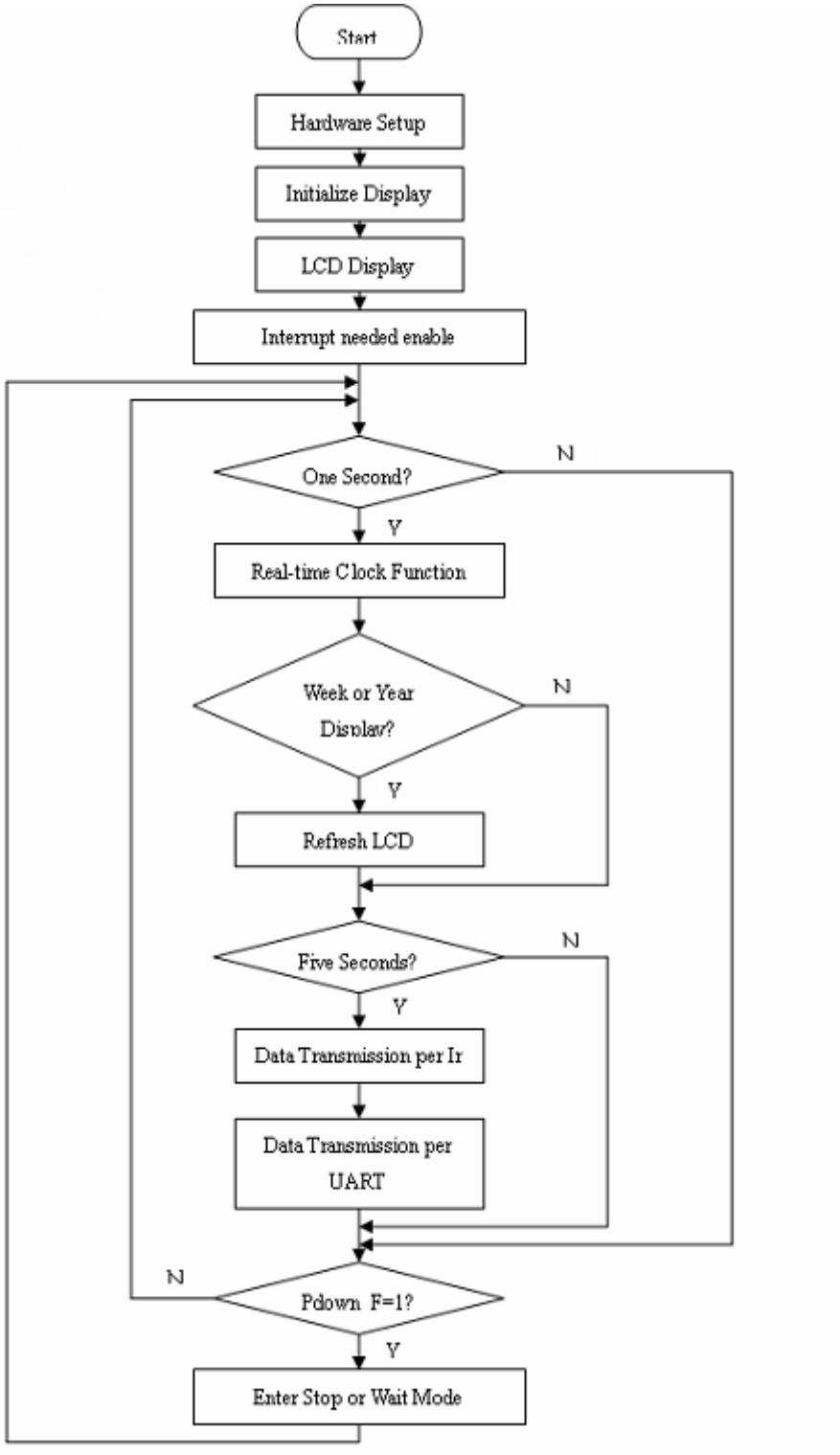
7. Sample Software Flowchart

7.1 Main Function



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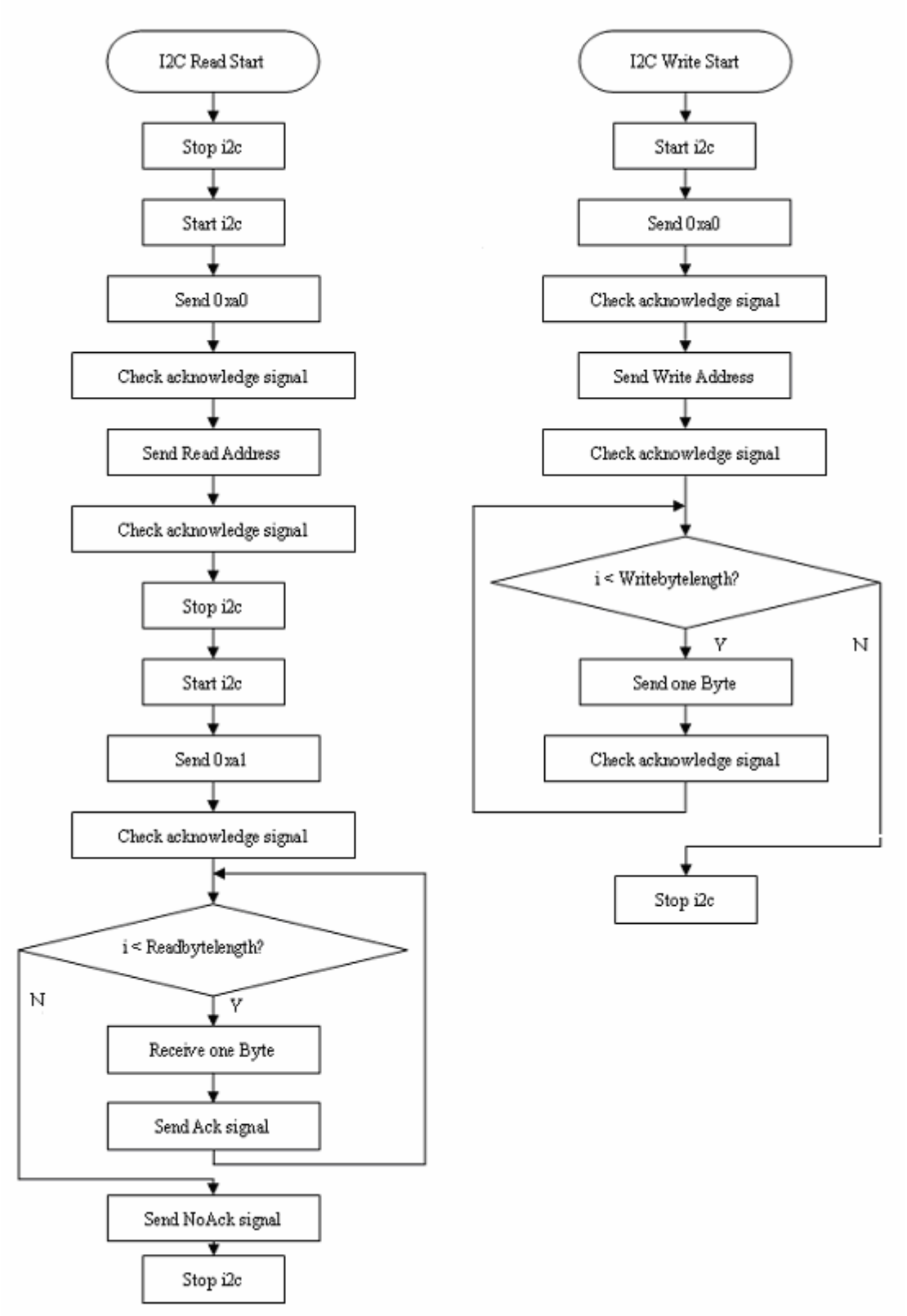
7.2 I2C



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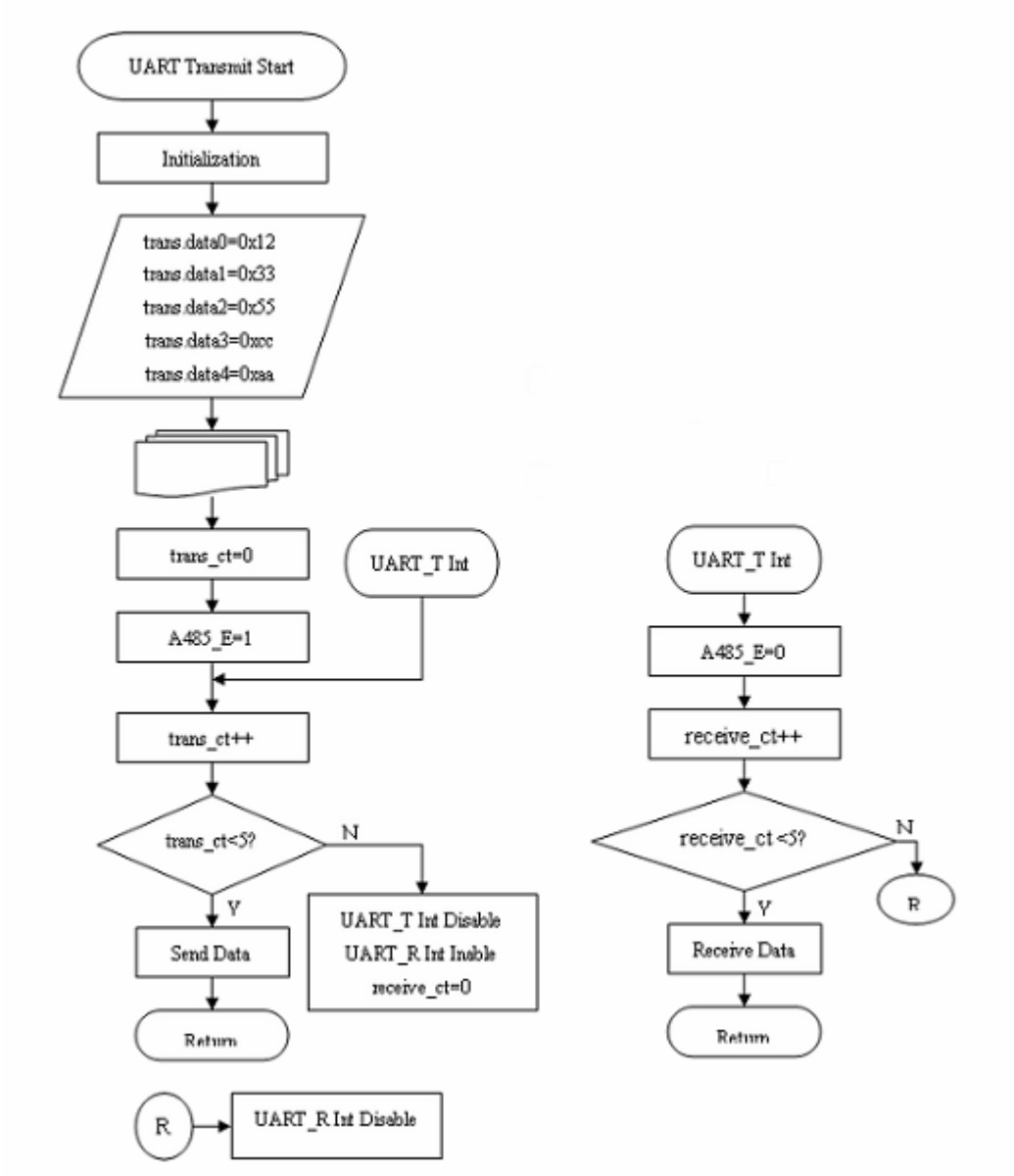
7.3 UART



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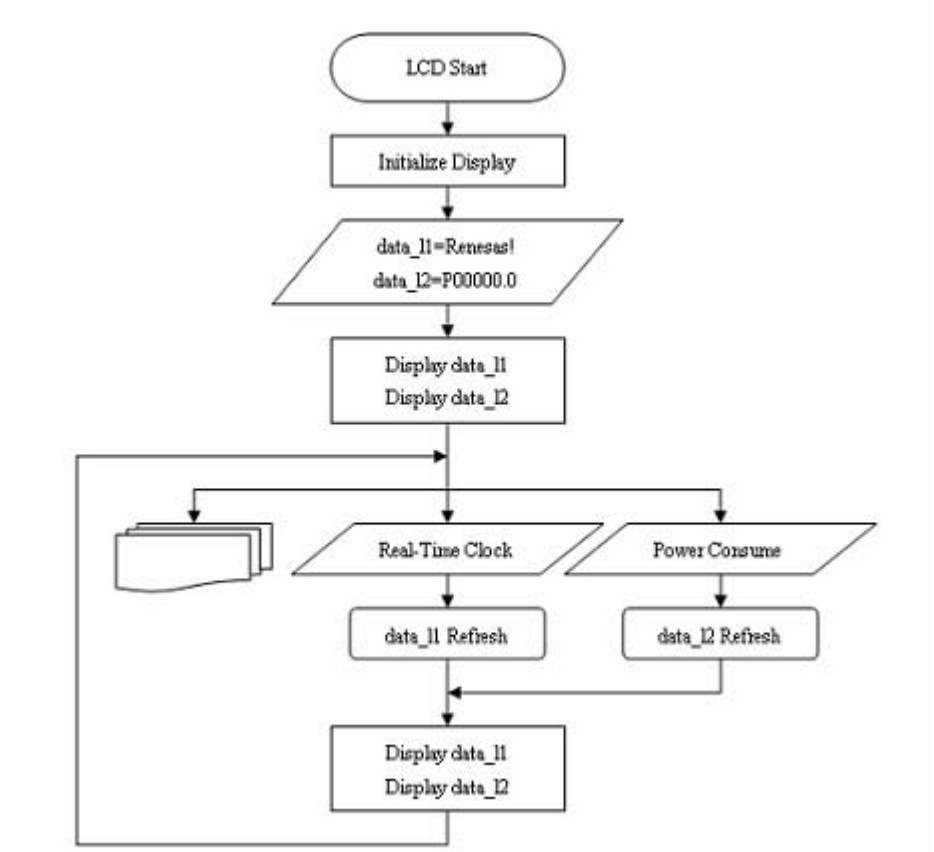
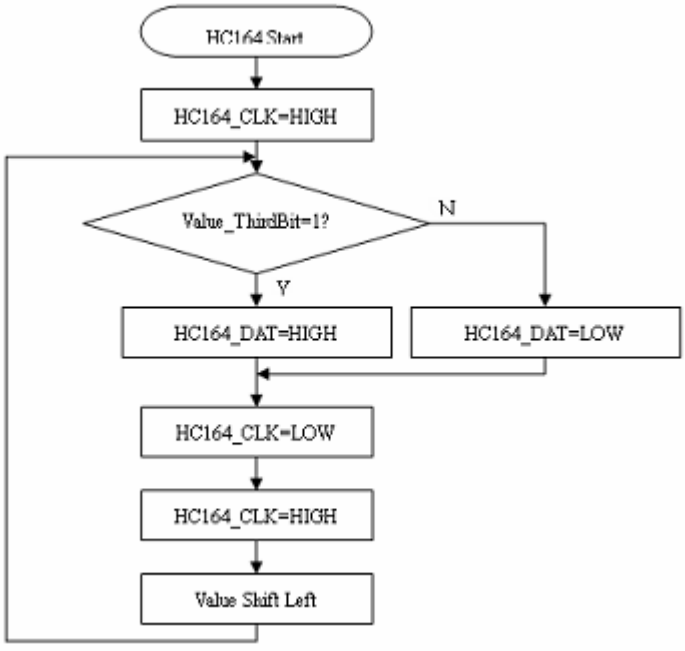
7.4 LCD



7.5 HC164



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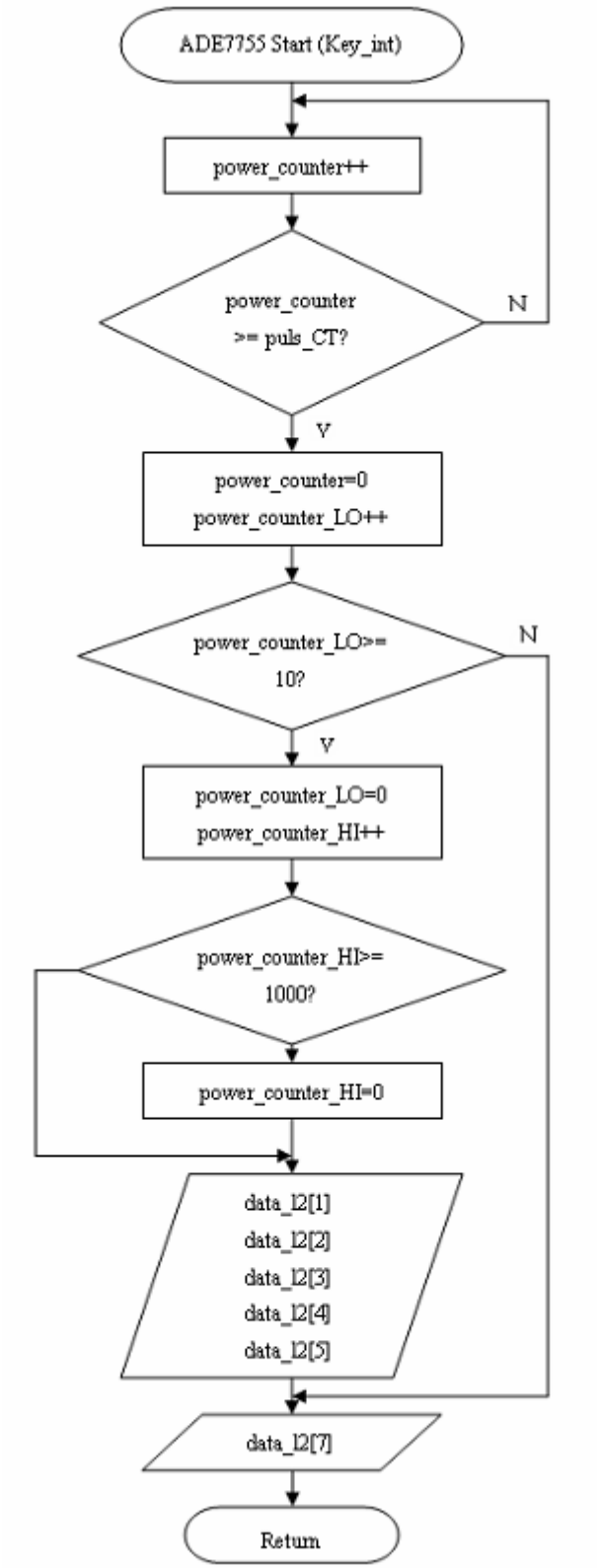
7.6 ADE7755



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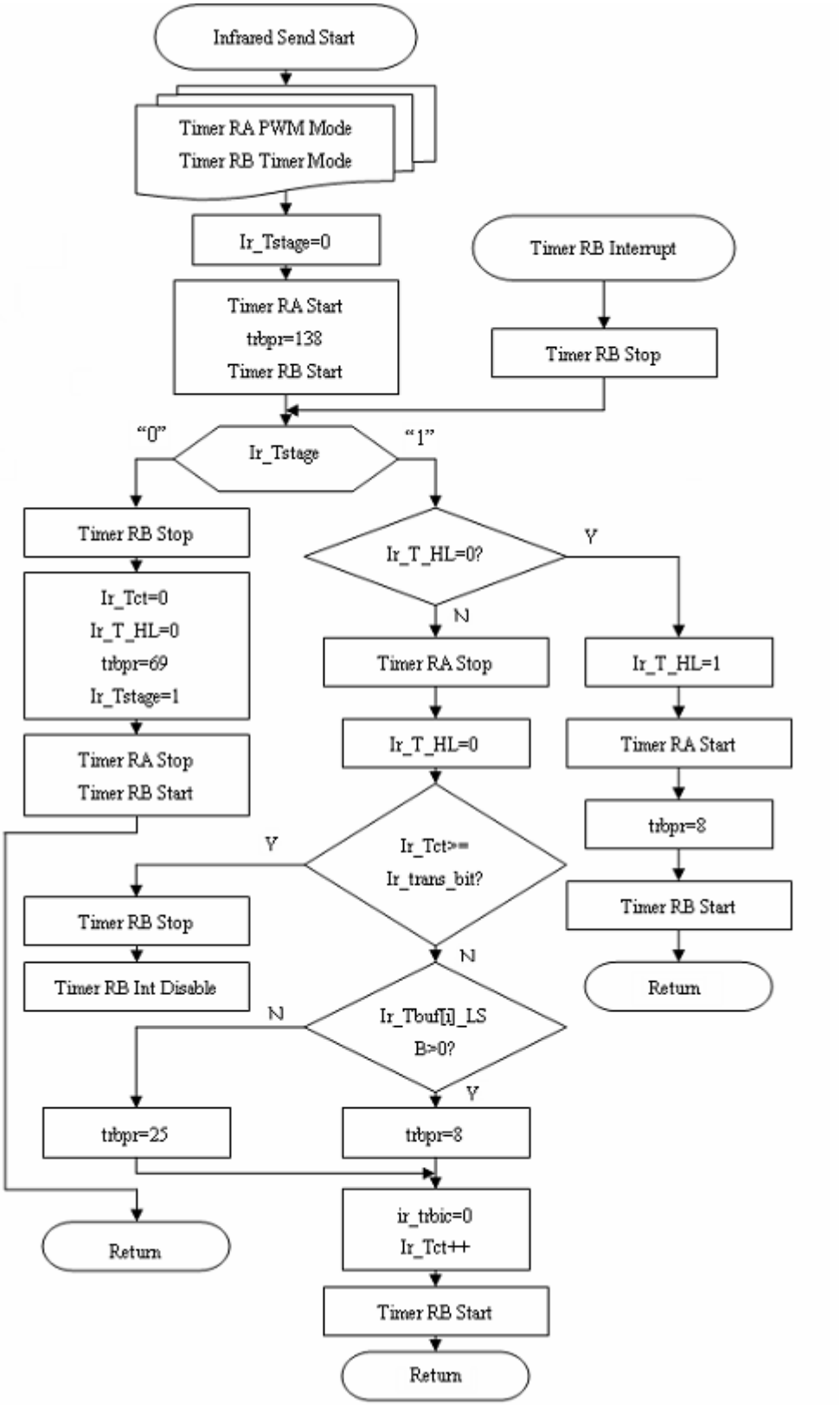
7.7 Infrared Send



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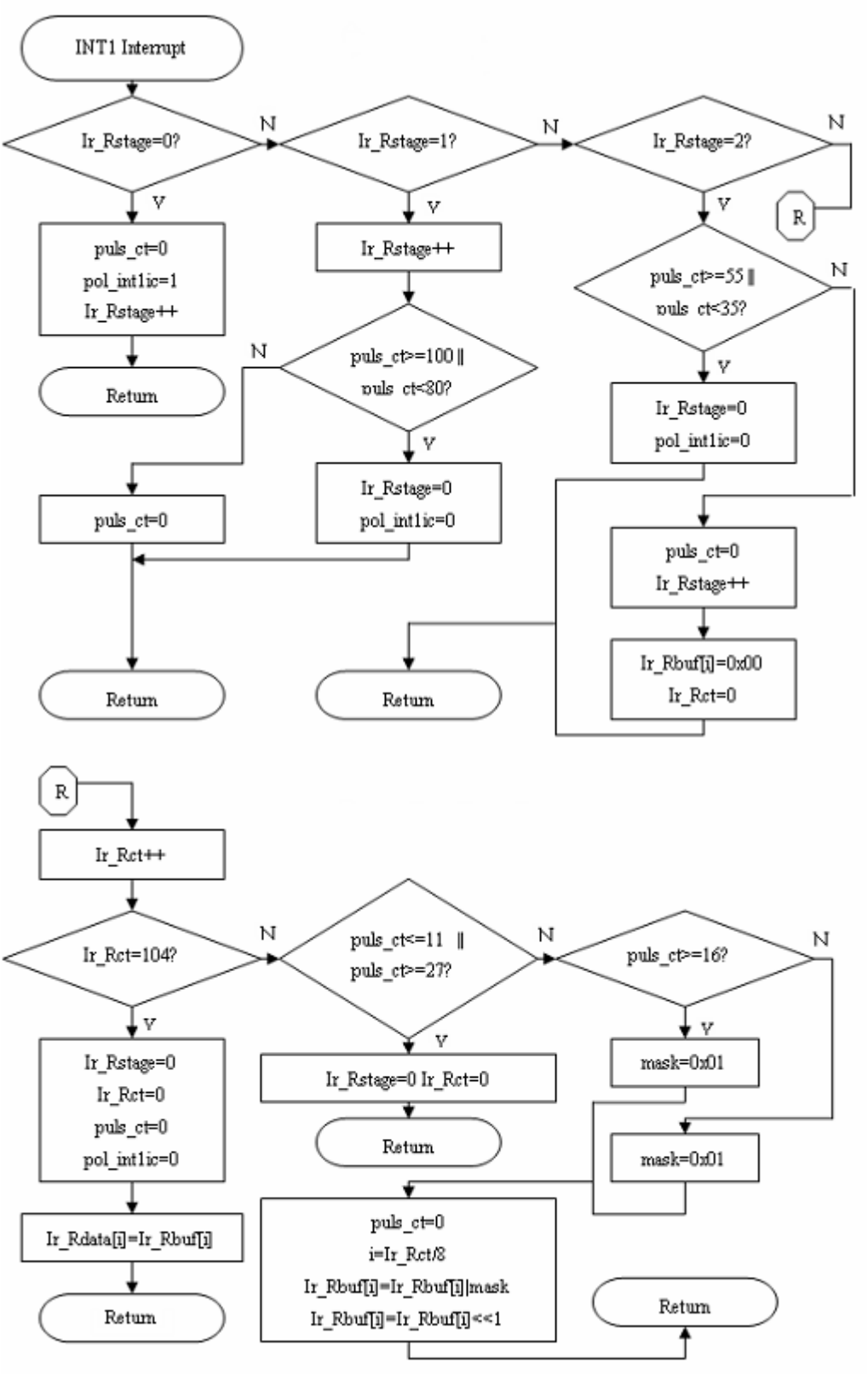
7.8 Infrared Receive



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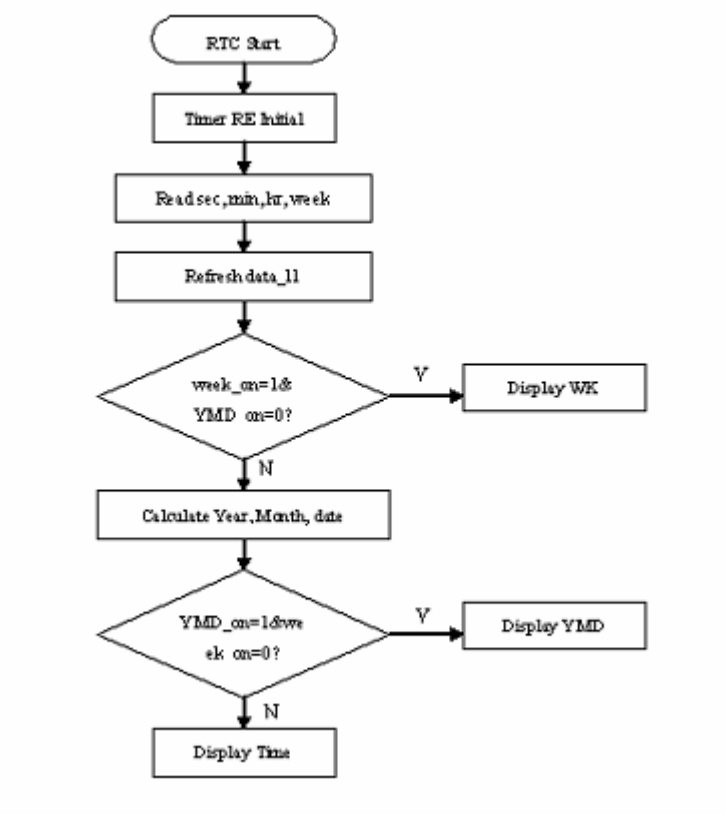
7.9 Real-time Clock



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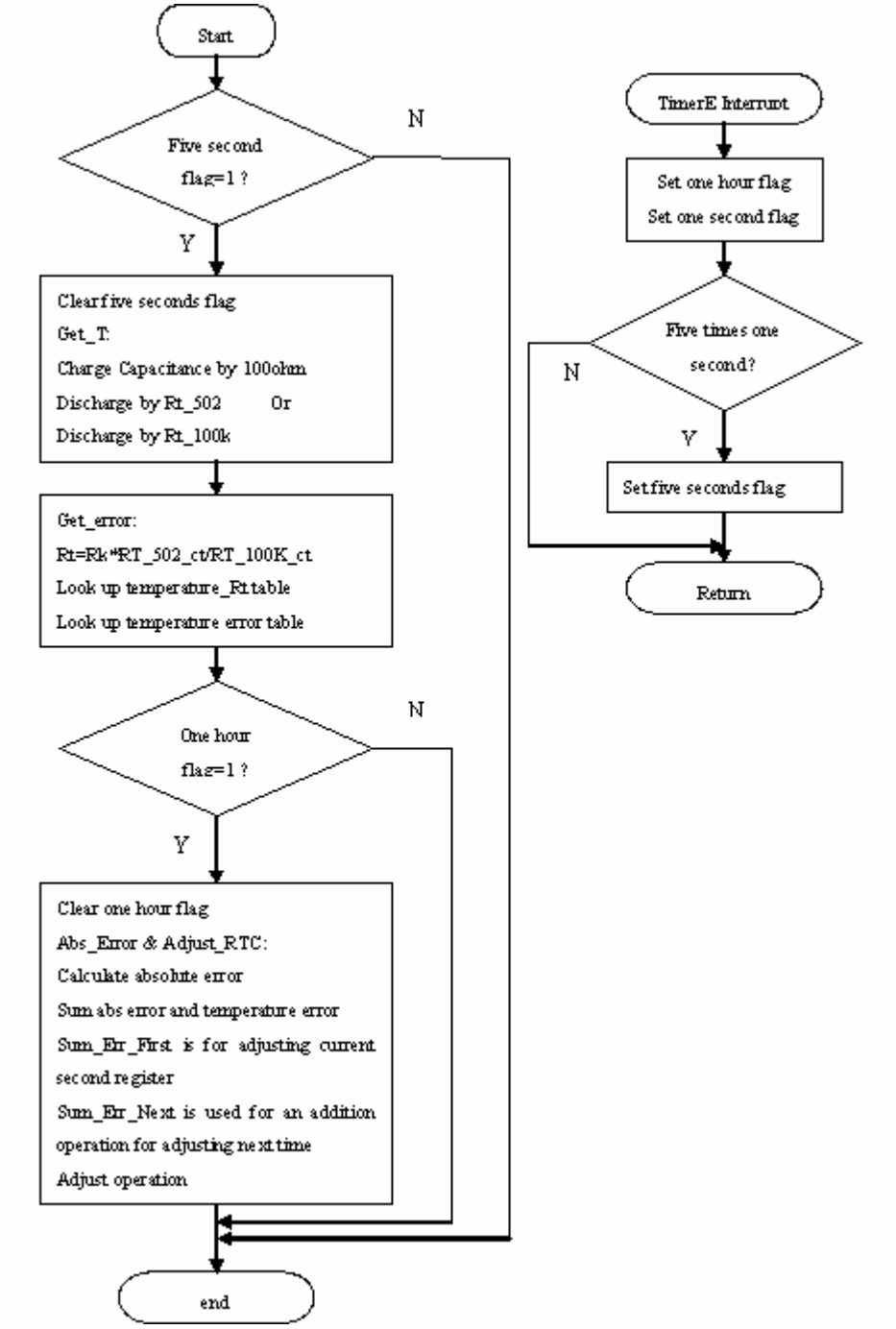
7.10 Oscillator Frequency Turning



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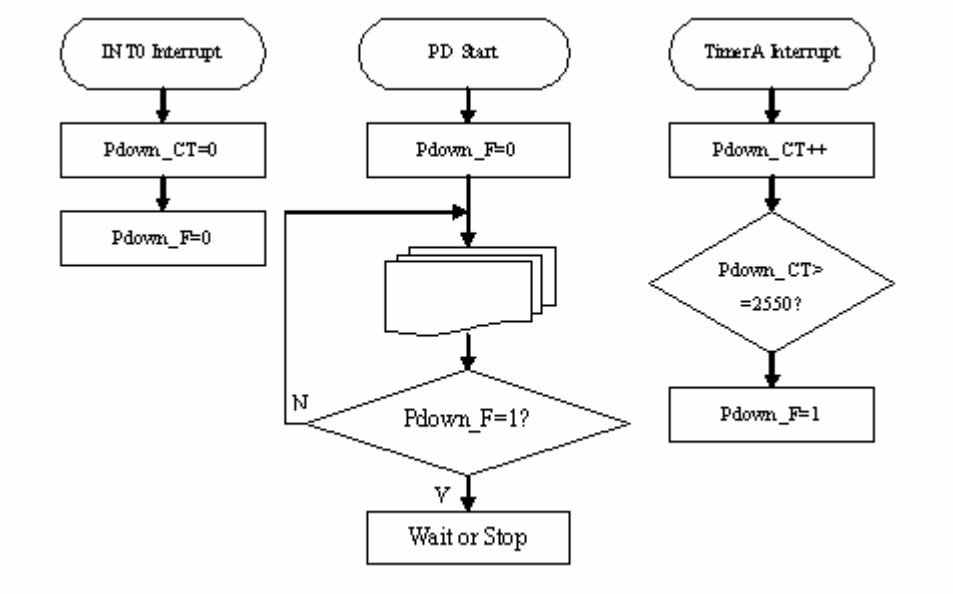
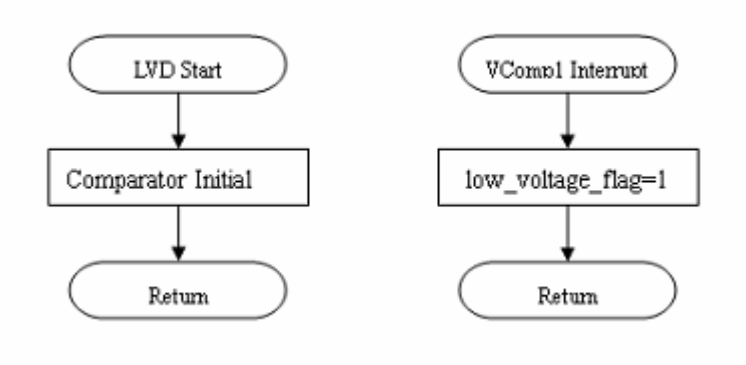
7.11 Power Down



7.12 Low Power Detection



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8. Using E8 Emulator for Debugging

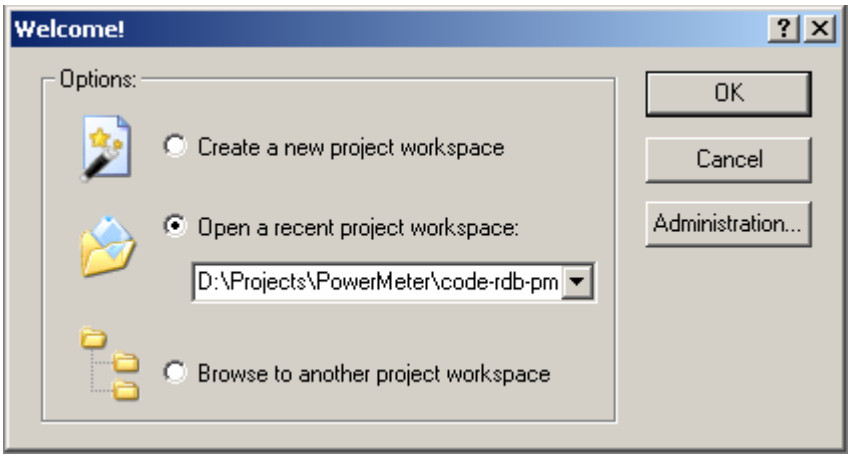
In this section it demonstrates how to use the power meter platform, and how to use the E8 Emulator for debugging.

Please follow these steps:

1. Bring out R8C/2G/2H power meter platform.
2. Connect E8 to the platform. Insert the E8 plug into XP4 connector on the platform.
3. Provide power supply to the platform.
4. Insert the power plug into XP2 connector on the platform.
5. Copy the sample software from the CD-ROM to your PC.

   Note: Do not include blank or Chinese font in the folder name.

6. Open HEW, the following picture appears.



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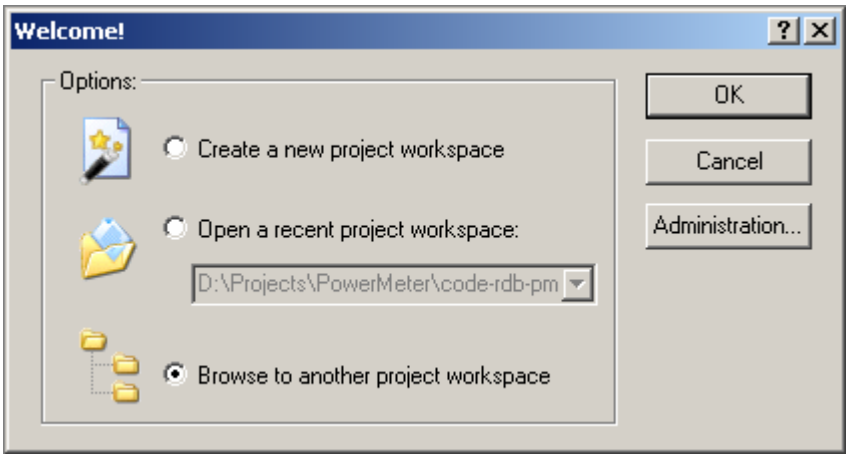
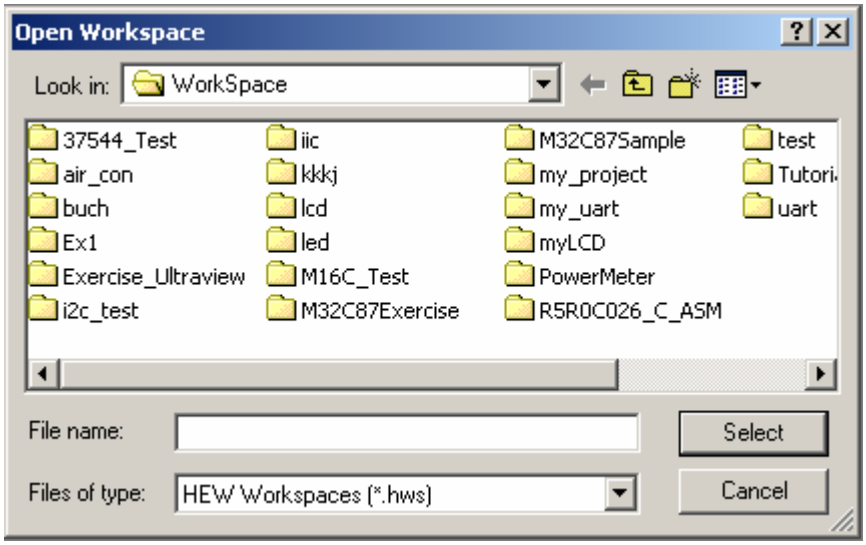
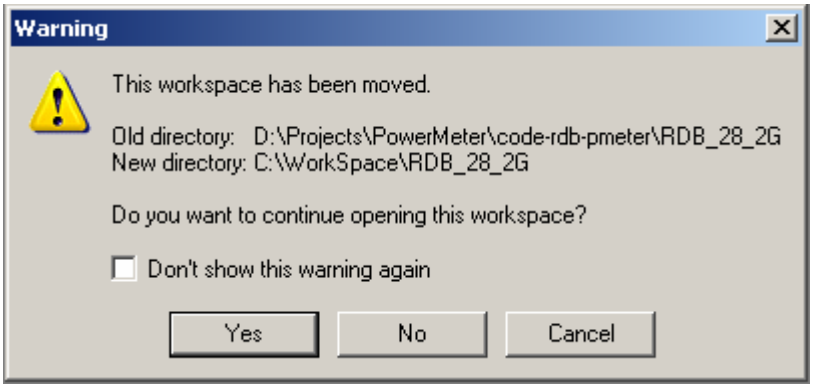
7. Choose the sample project.







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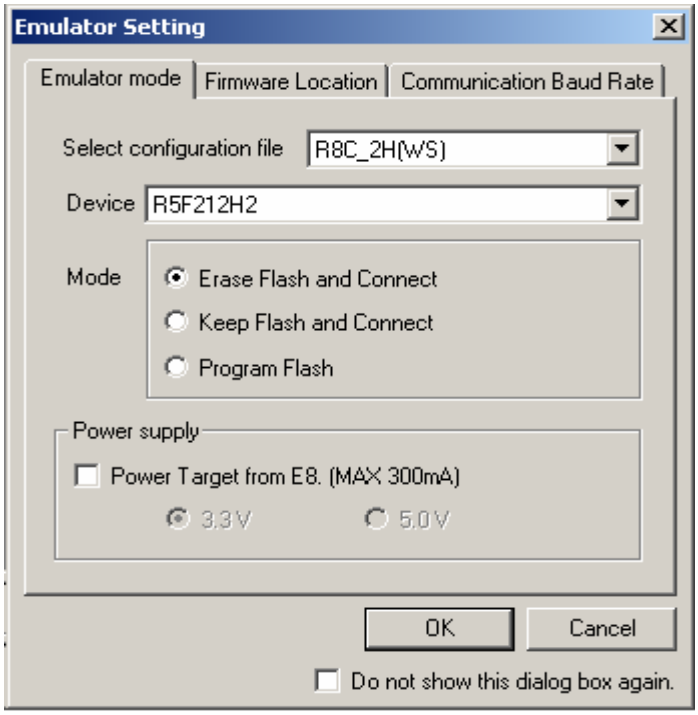
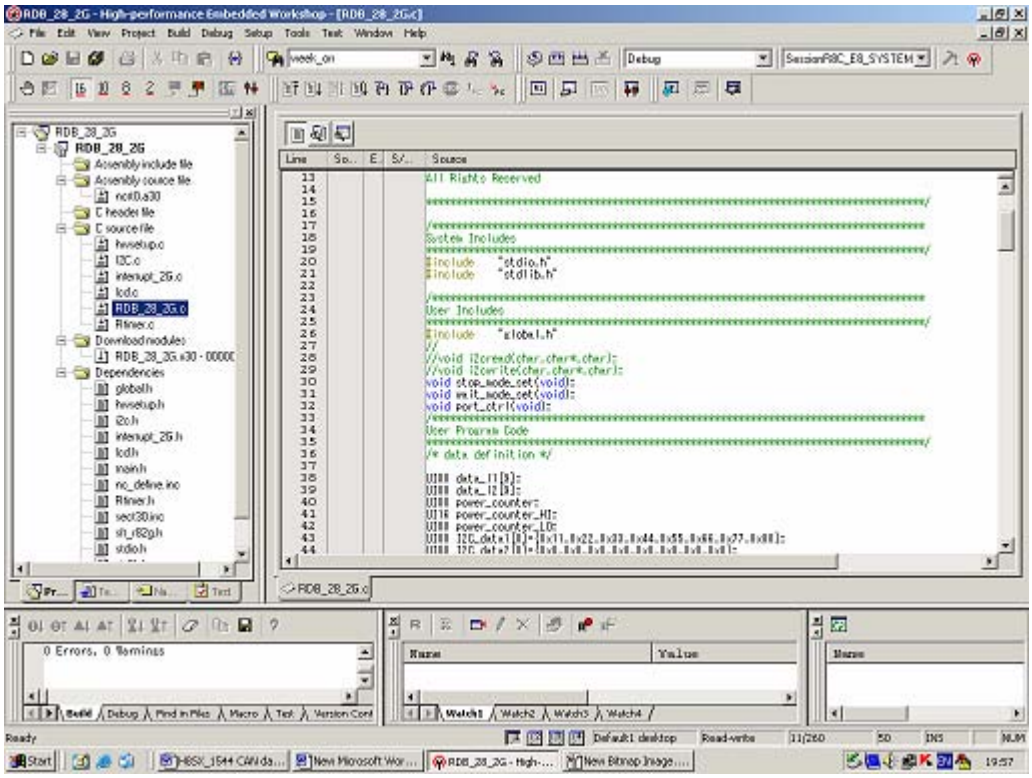
8. Choose E8 Emulator, set emulator mode.



9. Build all.



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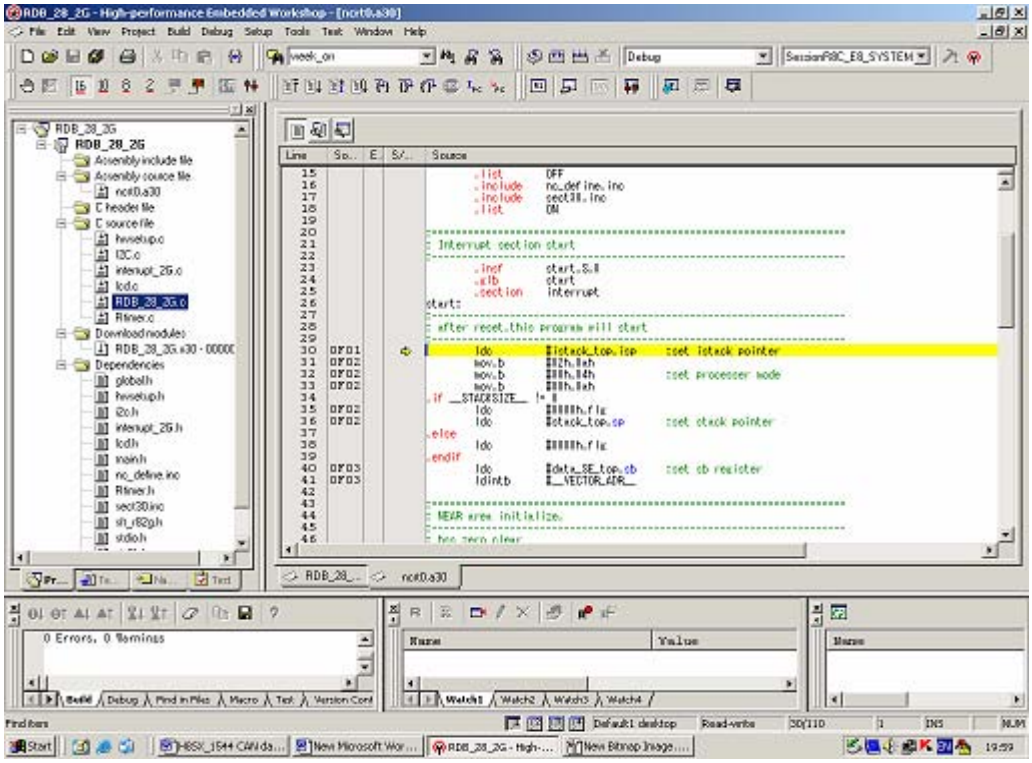
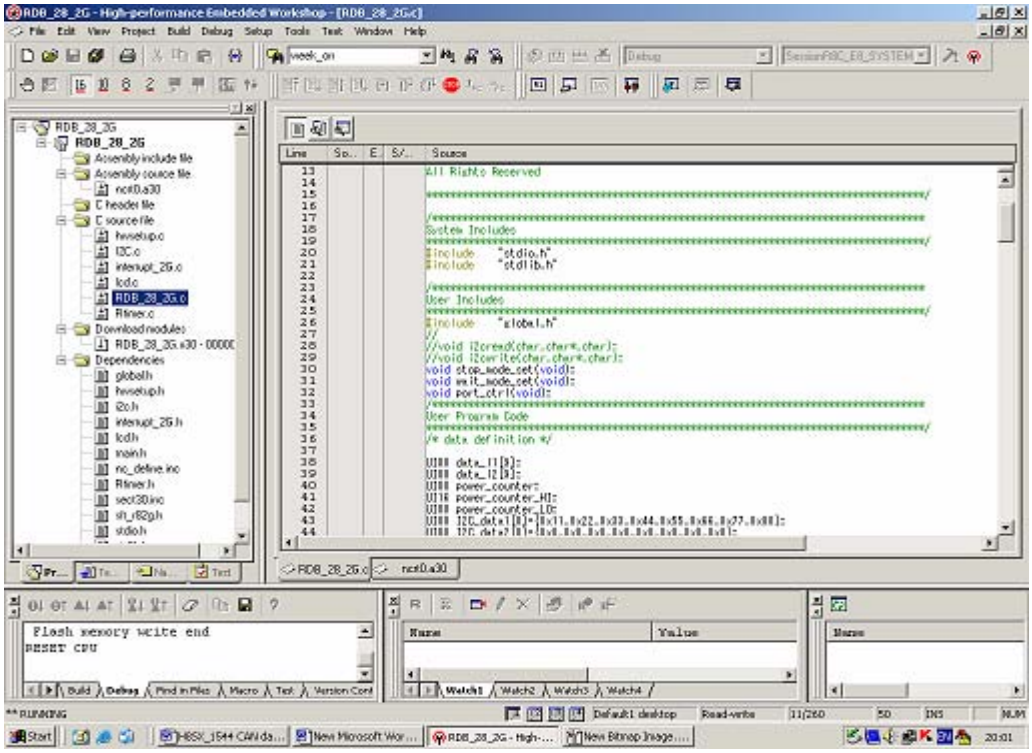
10. Reset.



11. Run.



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Now you can debug and evaluate the platform.

Note: About how to use HEW, please refer to the user manual of HEW.

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Renesas 16-Bit RISC Microcomputer
R8C/2G/2H Power Meter Platform
User's manual

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Colophon 6.0

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Microcomputer Development Environment System
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