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Renesas Electronics Corporation

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R8C/27

Consumer IR (CIR) & Consumer Electronics Control (CEC) function sample code

Introduction

This sample code demonstrates CIR and CEC functions in R8C/27 RSK. In the R8C/27, it adopts timer RC to handle CIR and CEC functions. For timer RC, CIR and CEC data are received in input capture mode. As CEC data transmission, the timer RC is in output compare mode. In the document, section 1 describes the hardware and software environment. For section 2, it describes the CIR introduction and program flow chart. Lastly, description of CEC function is shown in the section 3.

Target Devices

R8C/26, 27

Contents

1. Introduction

The application is applied to the following configuration:

R8C/27

The R8C/27, part name R5F21276, is a group of the R8C Series based on the R8C CPU core used in the application system with a maximum operating frequency at 40MHz.

ROM: (32k + 1k*2) bytes

RAM: 1.5k bytes

ROM Type: Flash Memory

Timer RC: Timer RC is a 16-bit timer with four I/O pins: TRCIOA, TRCIOB, TRCIOC, and TRCIOD.

R8C/27 RSK Platform

R8C/27 RSK is used as a main processor which incorporates R8C operating at a maximum frequency of 40MHz.

The basic functions of the R8C/27 RSK, Part Name R0K330879000BE, are as following.

- Input Clock Main: 20MHz
- Sub: 32.768 kHz
- Switch Reset x 1 User/Boot x 1 User x 2
- Potentiometer Single-turn, 10kΩ
- Power indicator LED: green x 1
- Boot indicator LED: orange x 1
- User LED: green x 1, orange x 1, red x 2
- Input E8 Header 14-pin box header
- RS232 Serial Connector 9-pin DSUB
- LCD Display Connector 14-pin socket
- Reset circuit

C Compiler

High Performance Embedded Workshop V4.05 by Renesas Technology Corp.
M16C standard tool chain V.5.41.01 by Renesas Technology Corp.

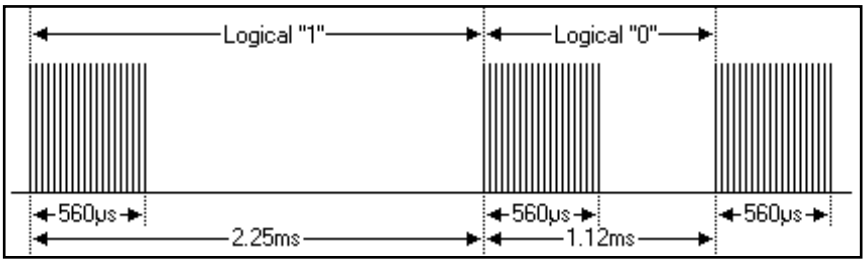
2. CIR Receiver Function

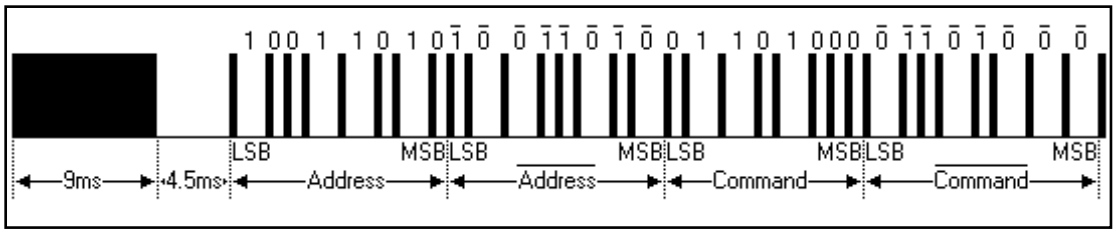
In the section, it describes the CIR introduction in RSK and shows which protocol is adopted, what is the IR receiver API function and how to use the function. Besides, the sample code provides a monitor to present the CIR function status.

In the sample code, CIR protocol adopts NEC protocol. Below shows some information about NEC protocol.

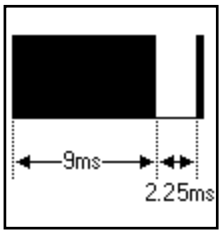
- 8 bit address and 8 bit command length
- Address and command are transmitted twice for reliability
- Pulse distance modulation
- Carrier frequency of 38kHz
- Bit time of 1.12ms or 2.25ms

The following picture presents the logical 0 and how to send a command. The NEC protocol uses pulse distance encoding of the bits. Each pulse is a 560µs long 38kHz carrier burst (about 21 cycles). A logical "1" takes 2.25ms to transmit, while a logical "0" is only half of that, being 1.125ms. The recommended carrier duty-cycle is 1/4 or 1/3.

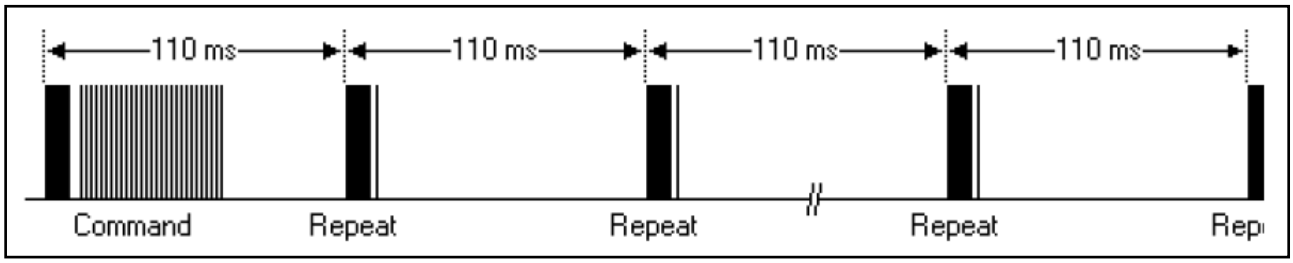




The picture above shows a typical pulse train of the NEC protocol. With this protocol the LSB is transmitted first. In this case Address $59 and Command $16 is transmitted. A message is started by a 9ms AGC burst, which was used to set the gain of the earlier IR receivers. This AGC burst is then followed by a 4.5ms space, which is then followed by the Address and Command. Address and Command are transmitted twice. The second time all bits are inverted and can be used for verification of the received message. The total transmission time is constant because every bit is repeated with its inverted length. If you're not interested in this reliability you can ignore the inverted values, or you can expand the Address and Command to 16 bits each! In here, please notice that a command is transmitted only once, even when the key on the remote control pressed. Every 110 ms a repeat code is transmitted for as long as the key remained. This repeat code is simply a 9ms AGC pulse followed by a 2.25ms space and burst. The repeat command is as shown in below.

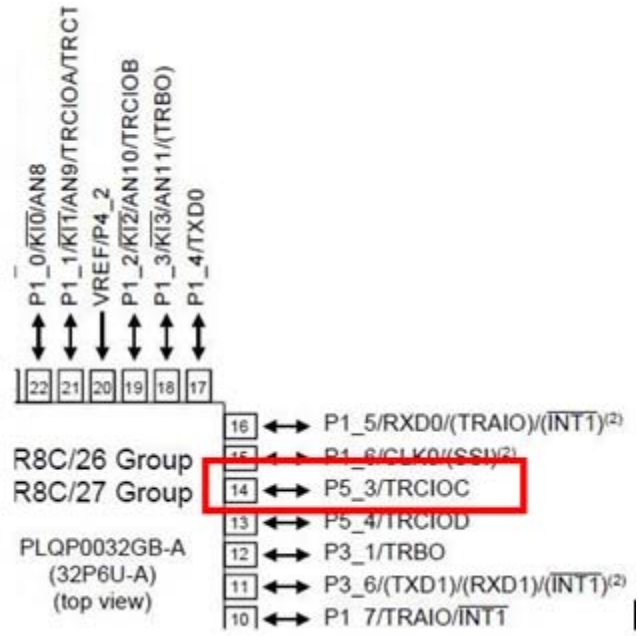


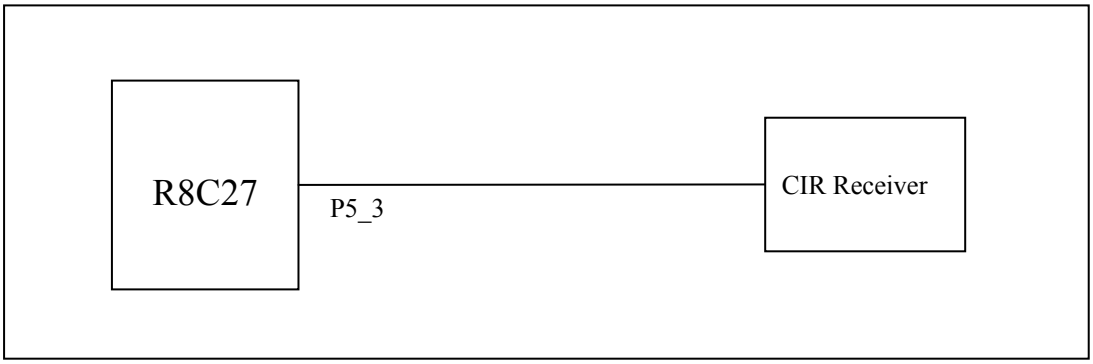
A command is transmitted only once, even when the key on the remote control remains pressed. Every 110ms a repeat code is transmitted for as long as the key remains down. This repeat code is simply a 9ms AGC pulse followed by a 2.25ms space and a 560µs burst.



Hardware circuit:

For the R8C/27 RSK, please sets P5_3 be a CIR input pin. Below show the block diagram.





Software API:

Below are the functions calls contained in the ir**.h** and ir**.c** C source code files.

Function Type	Function name	note

Initialization functions	void ir_rece3_sfr(void)
	void IR_Struct_Reset(void);
	void IR_Timer_RC_initital(void);	

Receive functions	void IR_Receiver(void)	
Process receive data	void IR_Verify_data(void) void IR_Verify_Leader(void) void Check_Level(unsigned short count_ir)	
Interrupt handle	void timer_rc_int_func3(void)	

2.1 CIR function Program flow

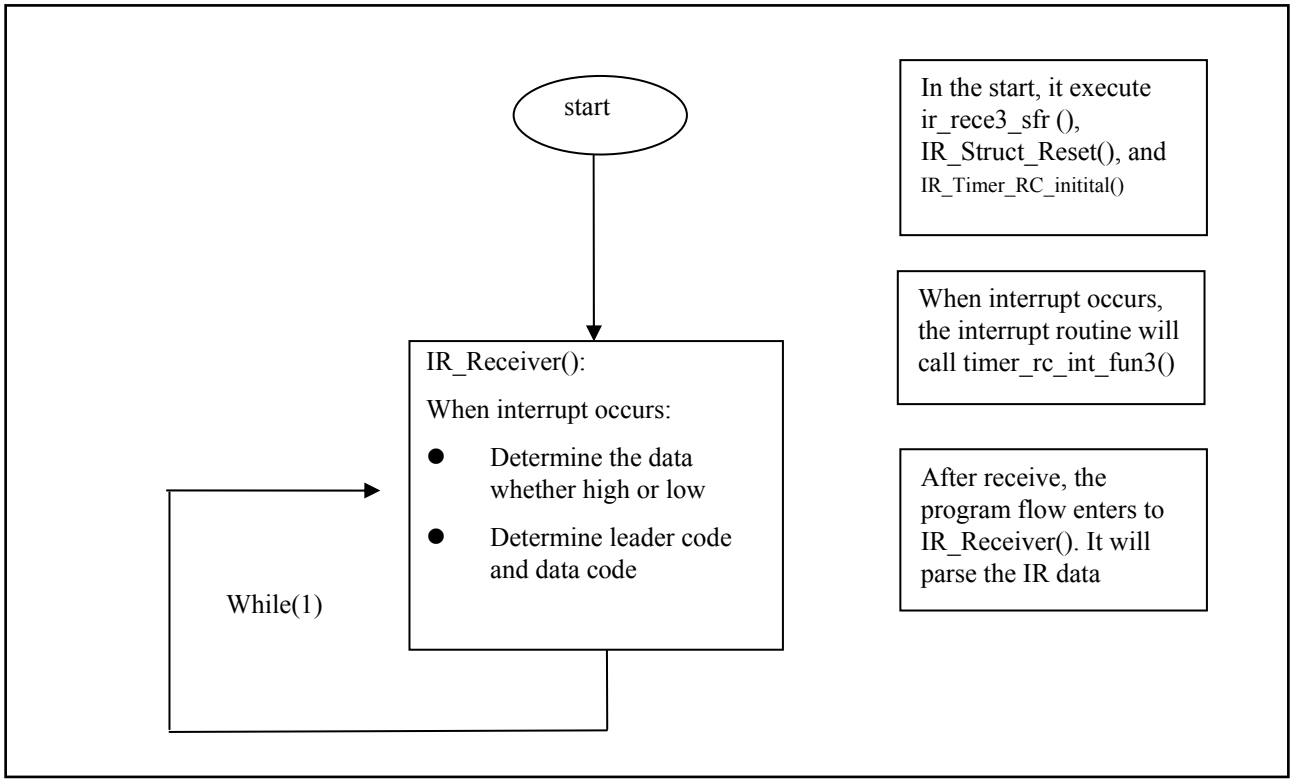
1 Initial IR function: the initial method is IR_Timer_RC_initital() function. The method includes two functions.
- 1.1 ir_rece3_sfr (); the ir_rece3_sfr () function is used to initial MCU register,
- 1.2 IR_Struct_Reset(); the IR_Struct_Reset() function is used to reset some structure about IR function.

2 And then IR_Receiver() is used to receive the IR command which receives from interrupt handle: timer_rc_int_func3() function.

3 When the interrupt occurs, the MCU starts to receive remote controller data. That is, MCU gets the CIR data from timer_rc_int_fun3() function. In the function, it will receive the CIR data and determine the data is from whether CEC or CIR module.

4 After MCU gets IR data, the IR_Receiver() processes the data. In the function, it includes two functions
- 4.1 IR_Verify_data(); the IR data includes some dummy data, like repeat code.
- 4.2 IR_Verify_Leader(); the IR data needs to verify the format whether correct or not.

5 Finally, the CIR data will be saved in “IR_flag.irdata” parameter. The lead code and the address code saves in the “IR_flag.customer_data” parameter



2.2 CIR data monitor

In the sample code provides CIR data monitor, if you want to monitor the CIR data status, please follow below environment setting into your terminal and R8C/27.

ENVIORNMENT

In R8C/27:

P3_7 pin is TXD

P4_5 pin is RXD

In Terminal:

Baud rate: 9600

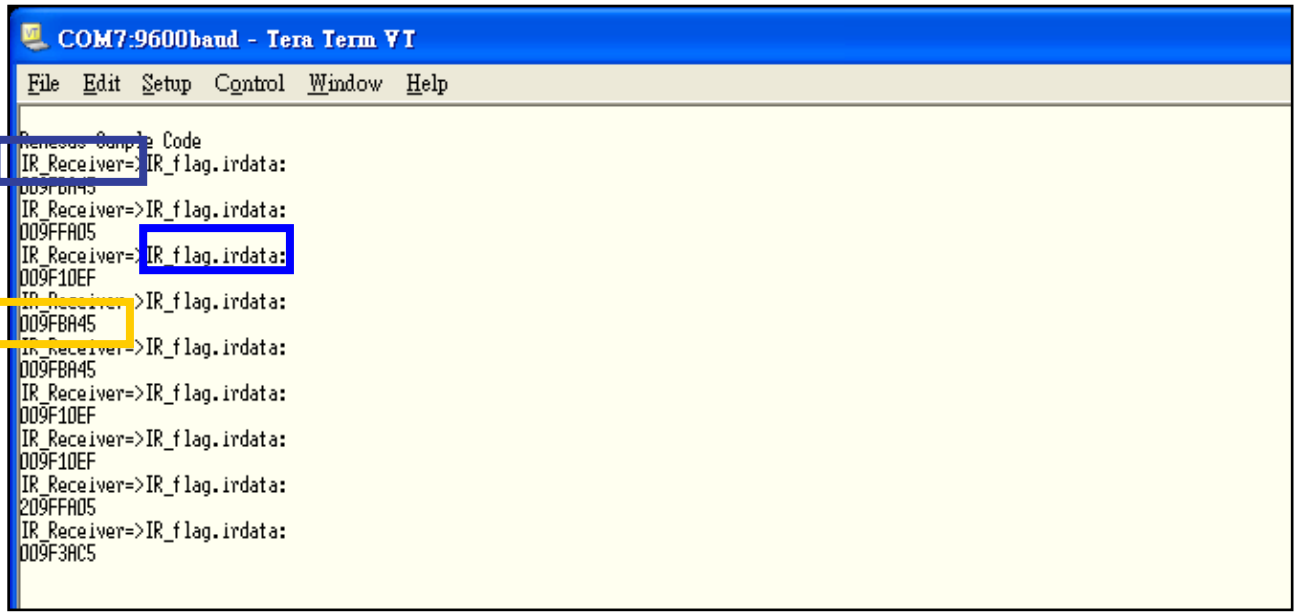
Data: 8 bits

Parity: none

Stop: 1 bit

Flow control: none

Below picture shows the monitor:



In the red block, “IR_Receiver” means function name in the program.

In the blue block, “IR_flag.irdata:” means the parameter name which stores the CIR data in the program.

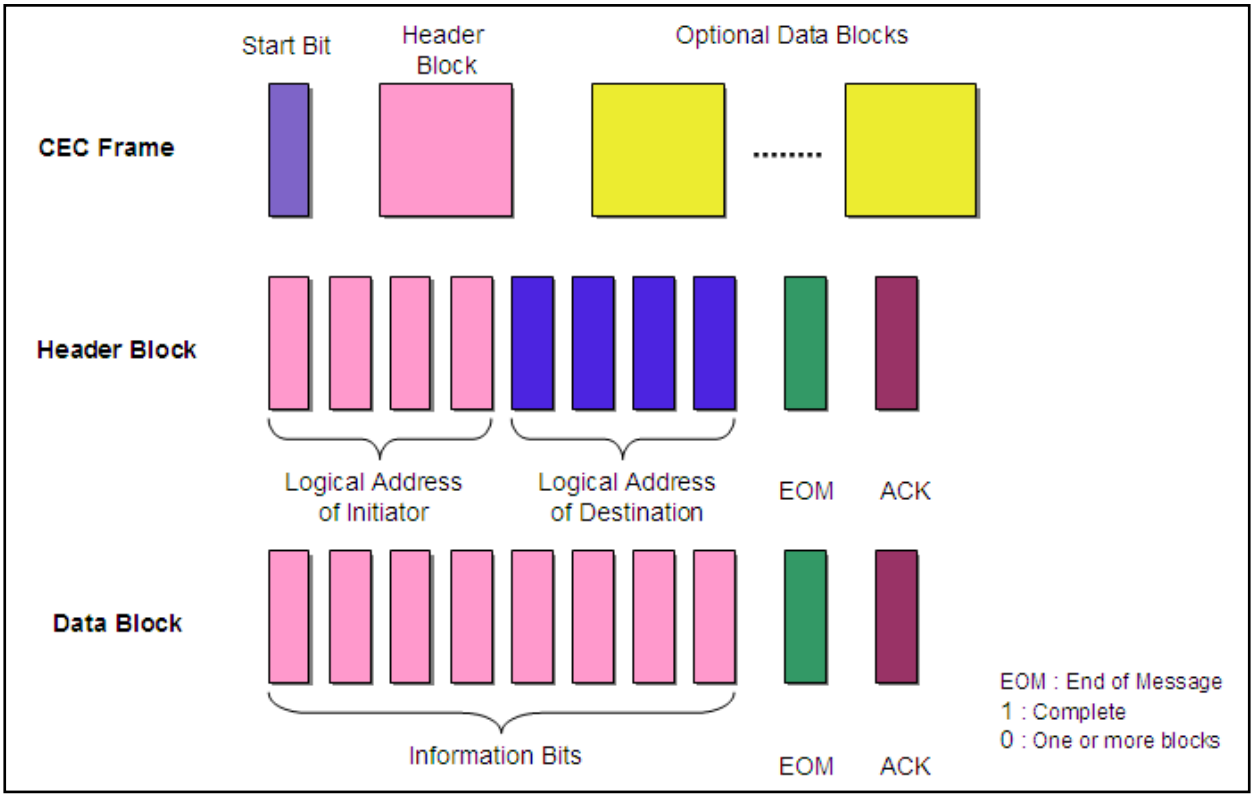
In the yellow block, the number means the CIR data which receives from CIR module.

3. CEC introduction

Consumer Electronics Control (CEC) wiring is mandatory, although implementation of CEC in a product is optional. CEC uses the industry-standard AV Link protocol, is used for remote control functions, is a one-wire bidirectional serial bus, and was defined in HDMI Specification 1.0 and updated in HDMI 1.2, HDMI 1.2a, and HDMI 1.3a (added timer and audio commands). The CEC feature is designed to allow the user to command and control multiple CEC-enabled boxes with one remote control and for individual CEC-enabled devices to command and control each other without user intervention.

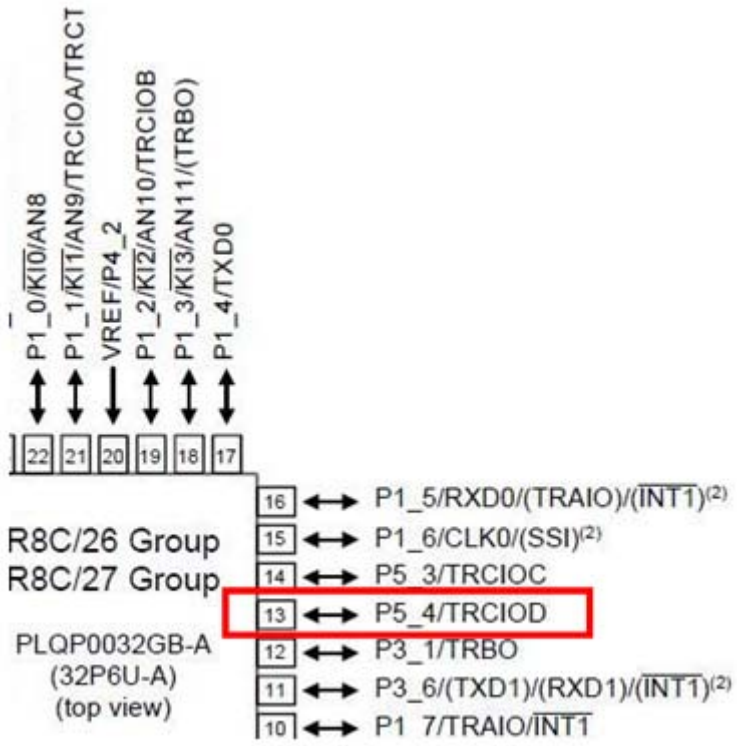
Alternative names for CEC are Anynet (Samsung); Aquos Link (Sharp); BRAVIA Theatre Sync (Sony); Kuro Link (Pioneer); CE-Link and Regza Link (Toshiba); RIHD (Remote Interactive over HDMI) (Onkyo); Simplink (LG); HDAVI Control, EZ-Sync, and VIERA Link (Panasonic); EasyLink (Philips); and NetCommand for HDMI (Mitsubishi).

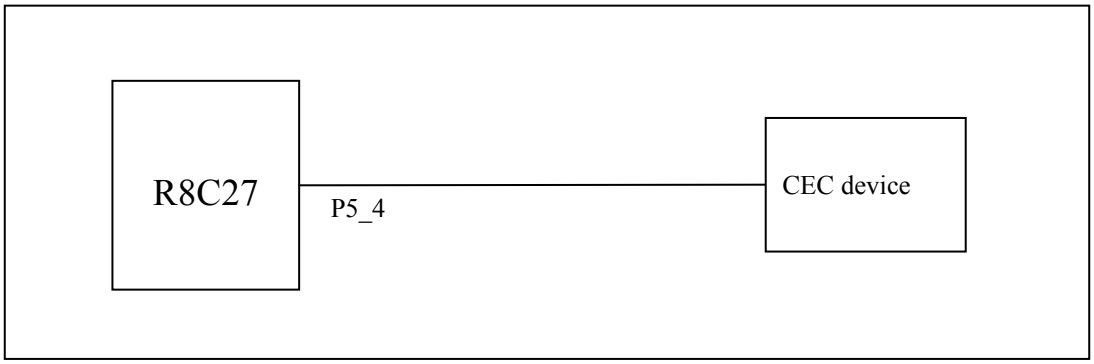
For the CEC frame protocol is as shown in below, it is easy to understand the protocol which includes start bit, header block, and option data blocks. Besides, the sample code not only handles the protocol frame parsing, but also provides test function by UART in the sample code.



Hardware circuit:

For the R8C/27RSK, please sets P5_4 as a CEC line. Below shows the block diagram.



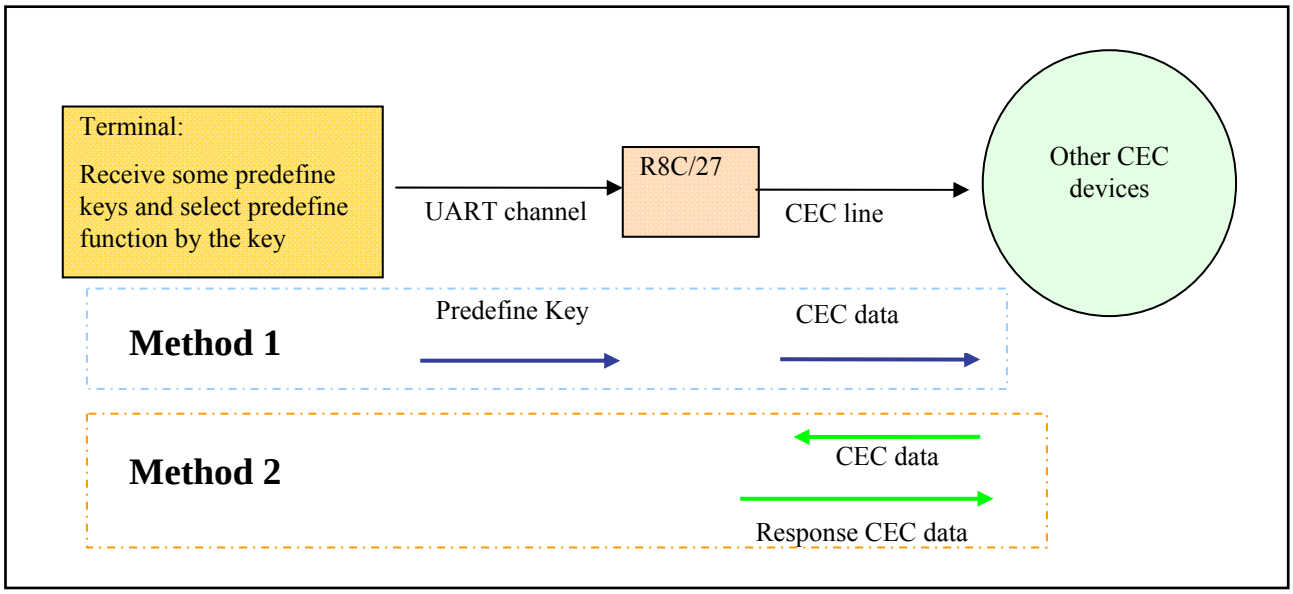


3.1 CEC API Function

In the sample code, CEC command can be transmitted by two methods:

1. Receive predefine function from UART and then transmit CEC data by CEC line.
2. CEC line.

For the first method, the sample code provides some predefine CEC function to use. User can use some predefine function to send CEC command. The predefine function which is received from UART used to determine what CEC command will be transmitted. In the second method, when some devices (like player, etc.) in the CEC line, the sample code of R8C/27 can receive the CEC command from the device and then responses it. Below figure shows the block diagram.



After receiving the command (may be from above 1. or 2. source), there are three operations to process the command in the program.

- MCU responses by CEC line.
- MCU responses by UART.
- MCU do some operations and do not response anything to CEC line or UART.

Therefore, in the section 3.1, it will show the sample code how to receive the command by UART and response method, and then the section 3.2 describes the CEC line send data to MCU and MCU and how to response it. Finally, in the last section, it shows how to transmit CEC command in CEC line by UART.

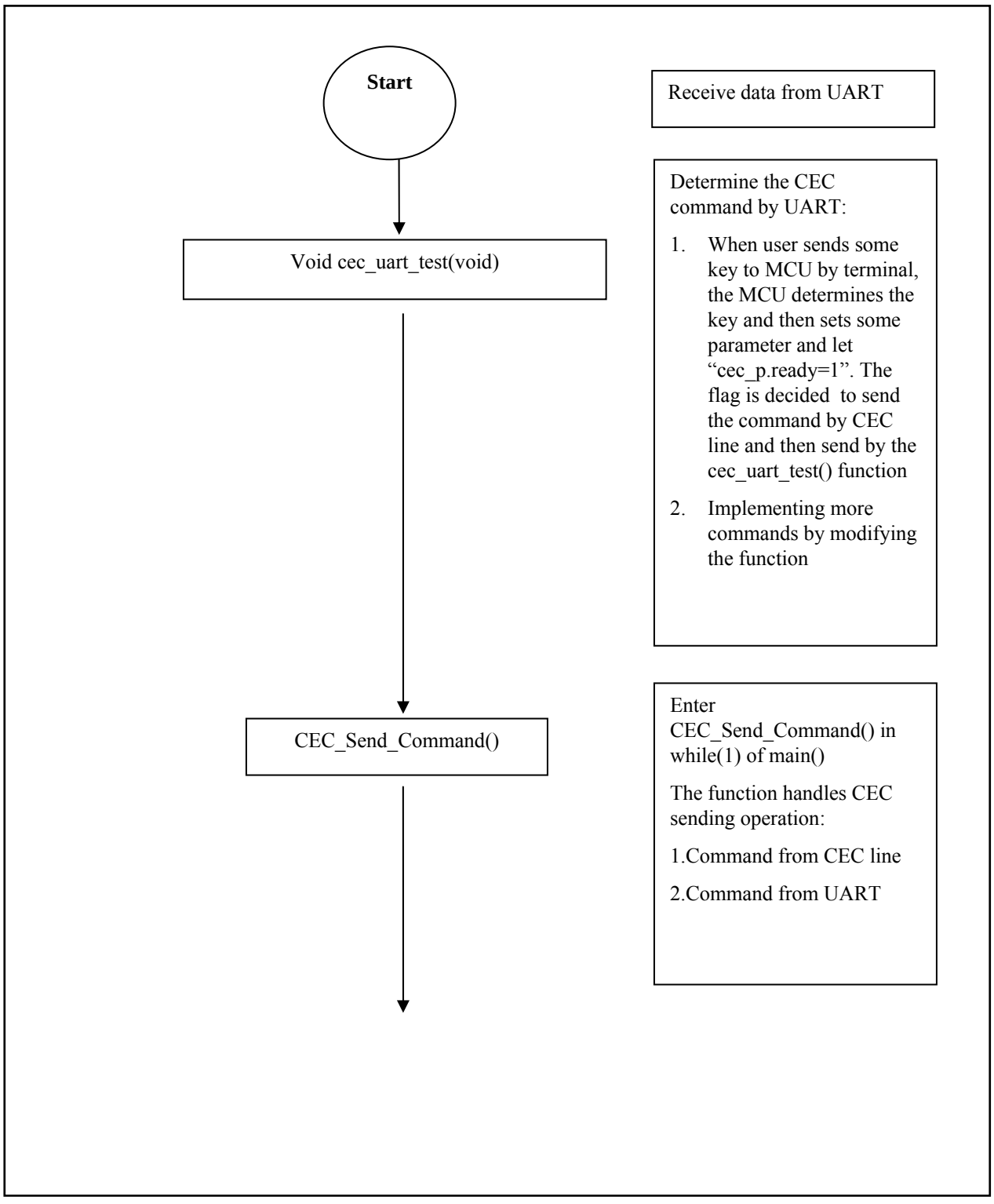
In the function “CEC_Fun_Init()”, it sets some initial status. Ex. Physical address, virtual address, initiator, follower, power status and etc. Of course you can modify by yourself.

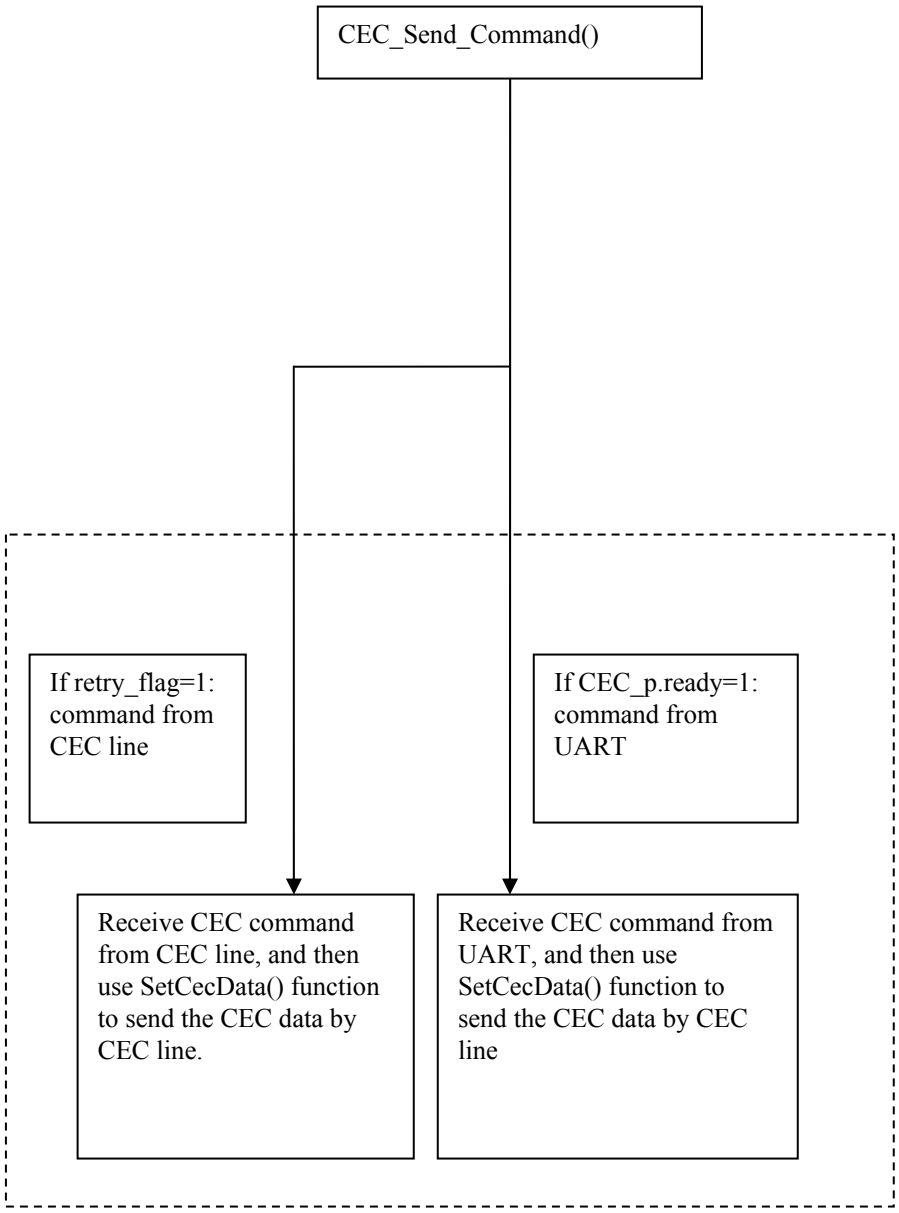
Below are the functions calls contained in the cec_ap**.h,** cec_ap**.c**, cec_drv.c, and cec_drv.h source code files.

Function Type	Function name	note
Initialization functions	void CecInitialize(void) void CEC_Fun_Init(void)	
Receive functions	void CyclicCec (void) unsigned char Chk_CEC_Rxdata(unsigned char *cecdata,unsigned char num)	
Transmit function	void Chk_CEC_Txdata(void) void R8C_send_to_CEC_from_UART(void) void CEC_Send_Command(void)	
Test function	unsigned char CEC_UART_Test(unsigned char uart_cec_test)	
Interrupt handle	void timer_rc_int_func3(void)	The function in the Ir.c

3.2 Receive from UART

Below shows the flow chart about the receive function.



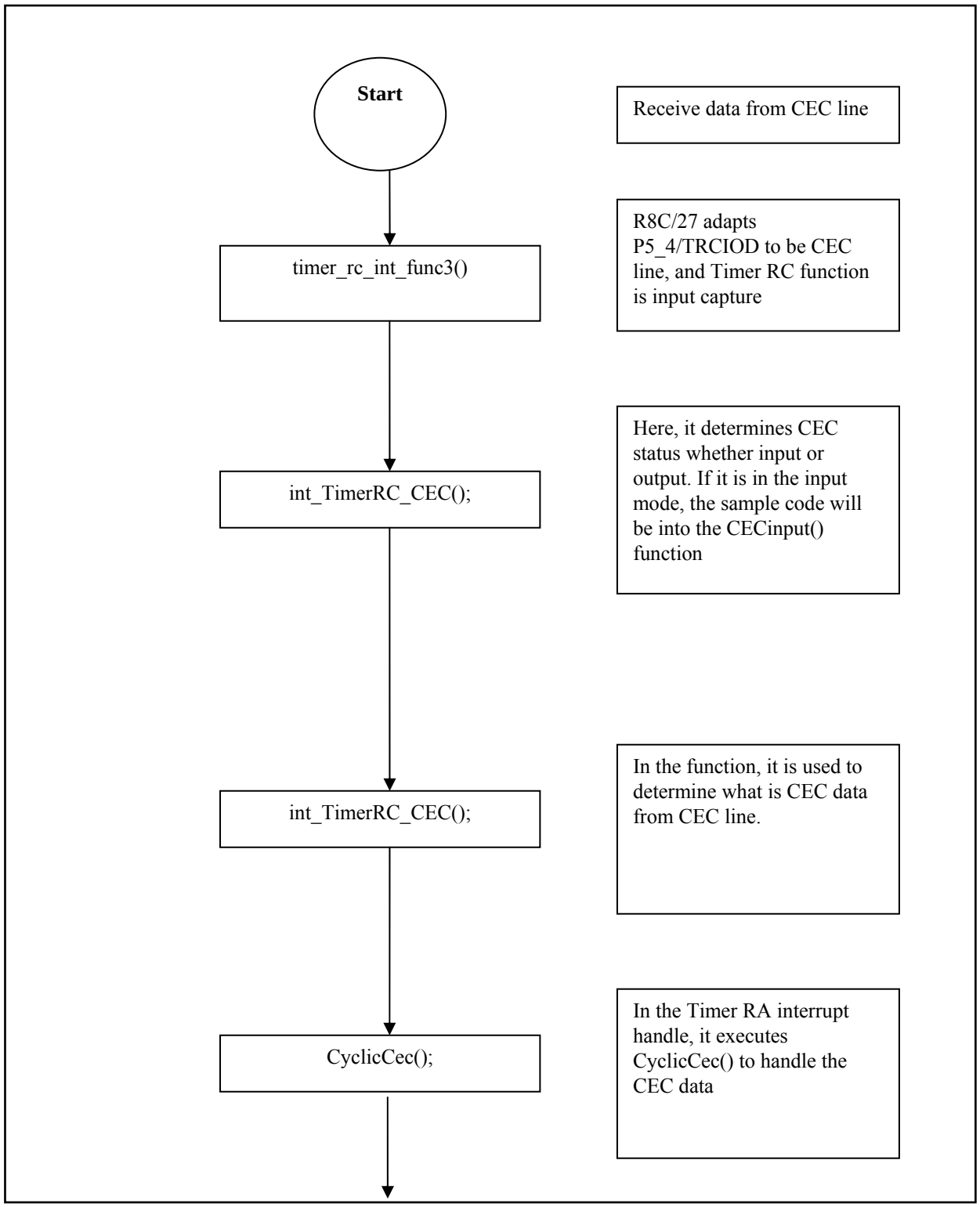


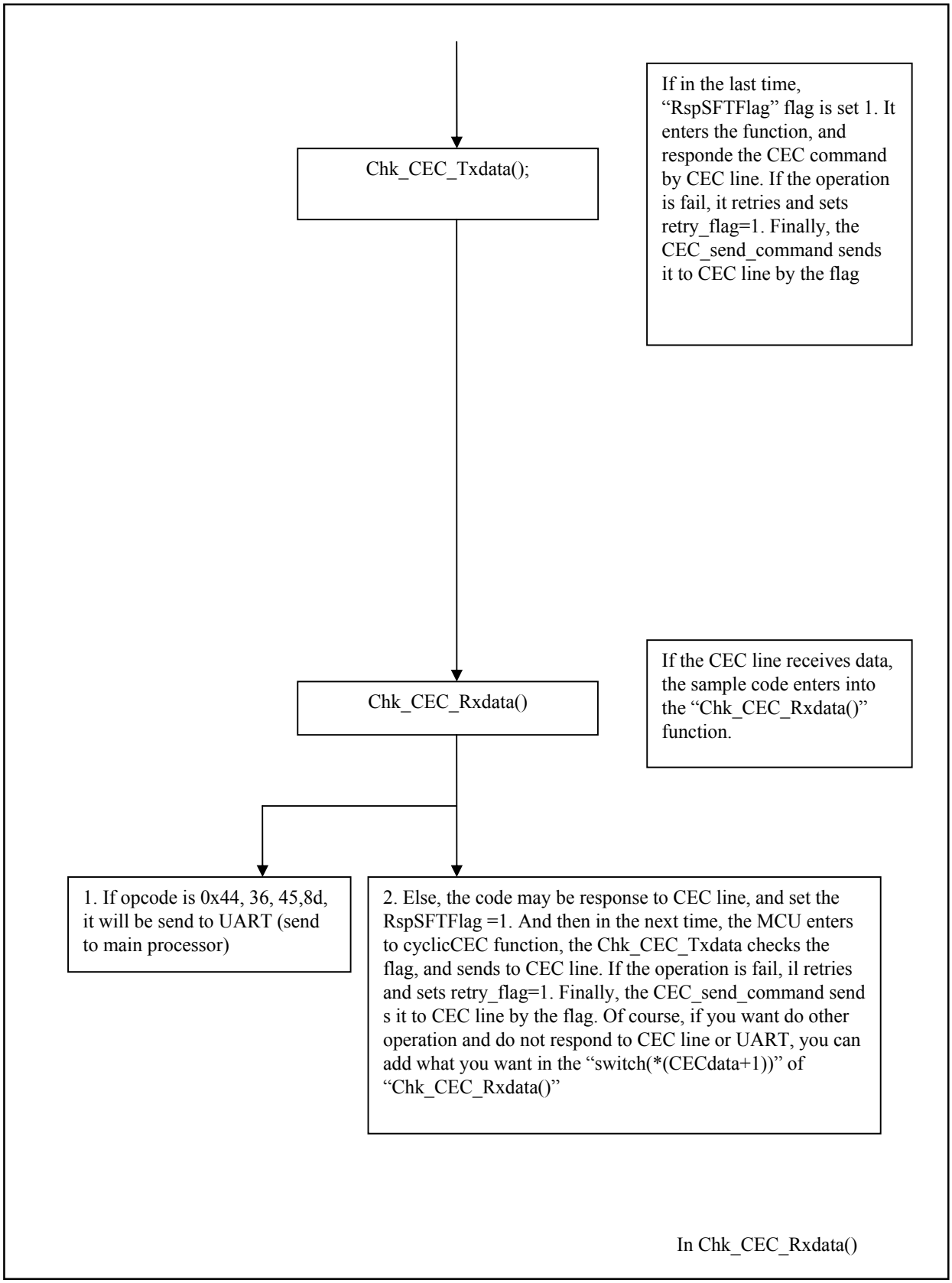
In CEC_Send_Command()

PS. In the sample code, it always adapts Tx parameter to store the CEC data which will be transmitted by CEC line

4.2 Receive from CEC Line

Below shows the flow chart about the receive function.




Chk_CEC_Txdata();
If in the last time, "RspSFTFlag" flag is set 1. It enters the function, and responde the CEC command by CEC line. If the operation is fail, it retries and sets retry_flag=1. Finally, the CEC_send_command sends it to CEC line by the flag
Chk_CEC_Rxdata()
If the CEC line receives data, the sample code enters into the "Chk_CEC_Rxdata()" function.
1. If opcode is 0x44, 36, 45,8d, it will be send to UART (send to main processor)
2. Else, the code may be response to CEC line, and set the RspSFTFlag =1. And then in the next time, the MCU enters to cyclicCEC function, the Chk_CEC_Txdata checks the flag, and sends to CEC line. If the operation is fail, il retries and sets retry_flag=1. Finally, the CEC_send_command send s it to CEC line by the flag. Of course, if you want do other operation and do not respond to CEC line or UART, you can add what you want in the "switch(*(CECdata+1))" of "Chk_CEC_Rxdata()"
In Chk_CEC_Rxdata()

3.3 Transfer CEC Data by UART

In the sample code, it provides CEC test function. The function predefines some key which receives from UART and then sends the CEC command. Finally, you can see the result in the terminal. In order to enable the function, please set some parameters into your terminal and R8C/27

ENVIORNMENT

In R8C/27:

P3_7 pin is TXD

R4_5 pin is RXD

In Terminal:

Baud rate: 9600

Data: 8 bits

Parity: none

Stop: 1 bit

Flow control: none

In the Workspace:

Please modify some information of device depends on your environment in Cec_ap.h file.

Default setting:

#define phyaddr 0x1234

#define device_typ 0x00

#define cec_v 0x04

#define langu01 0xff

#define langu02 0xff

#define langu03 0xff

#define power_status_cec 0x00

#define UART_CEC_Test 1

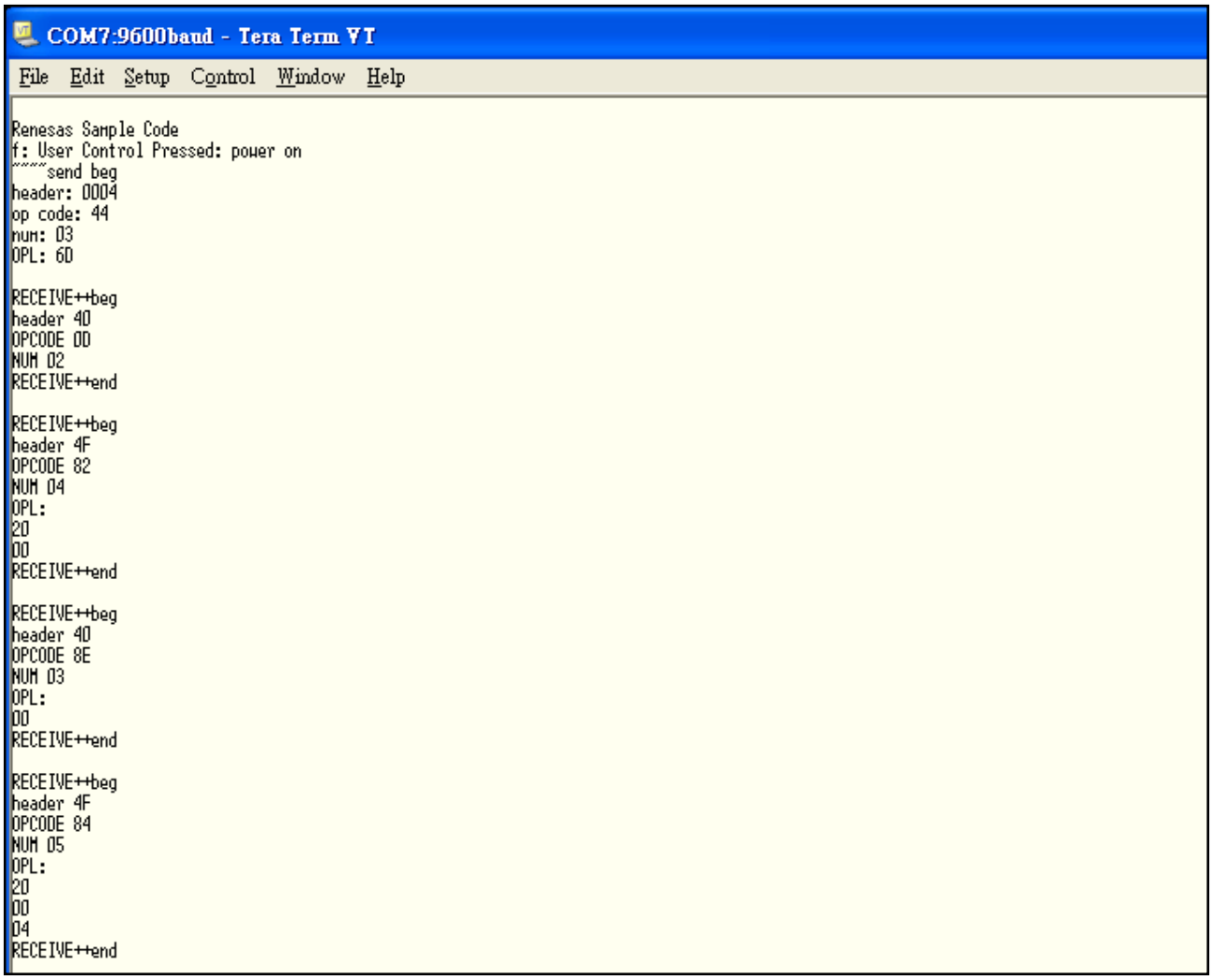
Below table presents the definition

Define item	Definition
#define phyaddr 0x1234	Define physical address
#define device_typ 0x00	Define device type (Default is TV)
#define cec_v 0x04	Define CEC version
Define item	**Definition**

#define langu02 0xff	Define language
#define langu01 0xff	Define language
#define langu03 0xff	Define language
#define power_status_cec 0x00	Define power status of the device
#define UART_CEC_Test 1	Define test function on/off

In the default setting, the R8C/27 could be TV, and the physical address is 0x1234. Besides, if you do not want to use the function please set UART_CEC_Test 0.

Below picture shows the CEC test function



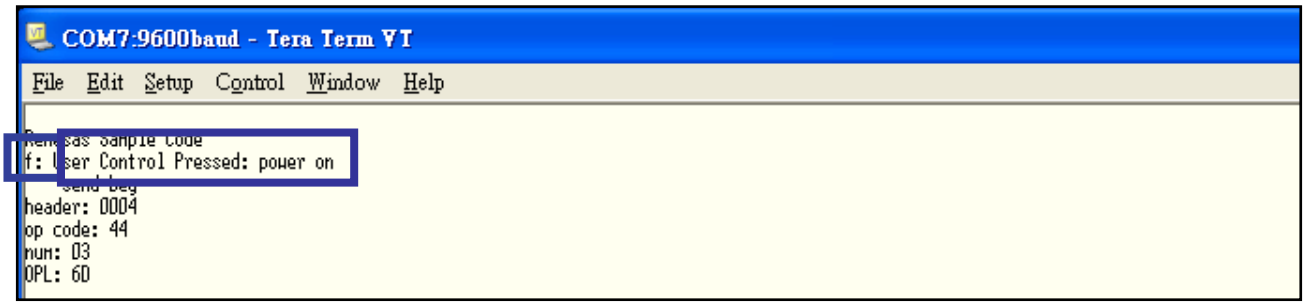


Figure 1.

In the red block of figure 1, “f:” means the predefine key (in your key board) which receives from UART.

In the blue block, “User Control Pressed: Power on:” means the CEC command which is transmitted to other device by CEC line (User can see the command from CEC spec)

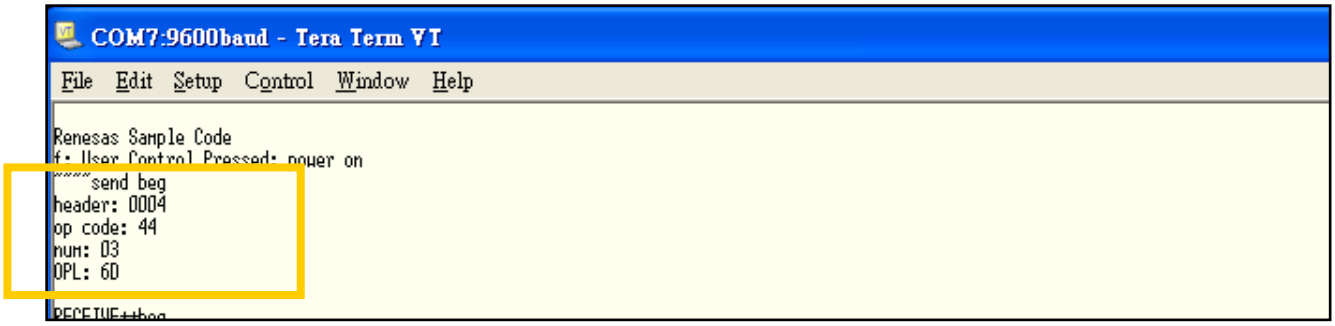


Figure 2.

In the yellow block of figure 2, “ ”””” send beg ” means CEC transmit operation is beginning.

“header: 0004” means the header block is 0004 in the CEC command frame

“op code: 44” means the op code data is 44 in the CEC command frame

“OPL: 6D” means the parameter data is 6D in the CEC command frame

“num: 03” means the number of transmission byte is 3 in the CEC command frame

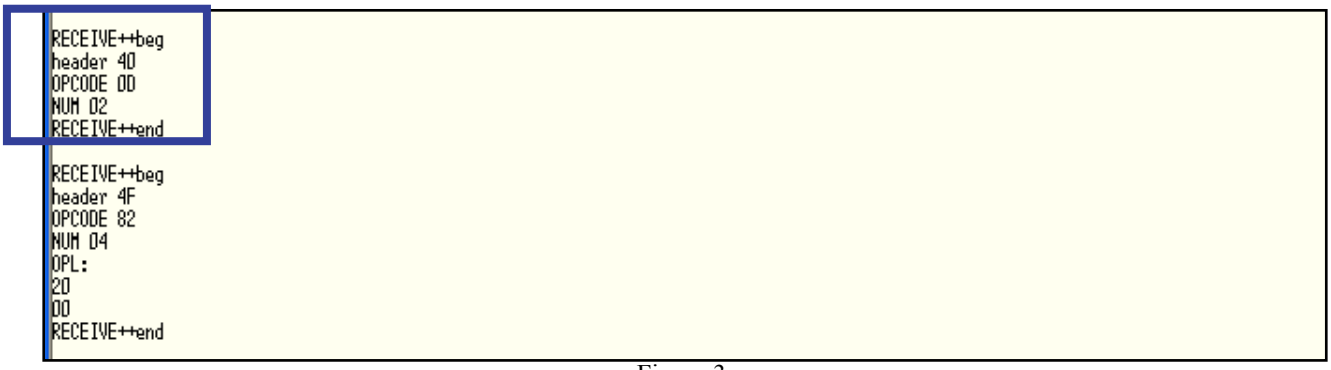


Figure 3.

In the red block of figure 3, " RECEIVE++beg " means R8C/27 receives CEC command from CEC line.

"header 40 " means the header block is 40 in the CEC command frame

"op code: 00" means the op code data is 00 in the CEC command frame

" RECEIVE++end" means the command finish..

"num: 02" means the number of transition byte is 3 in the CEC command frame

In the test function, it provides some commands.

Predefine Key (receives from UART)	**CEC command**
"z"	Abort
"x"	Stand By
"a"	Text View ON
"s"	Active Source
"d"	Give Device Power Status
"f"	User Control Pressed <power on>
"g"	User Control Pressed <power off>
"q"	User Control Pressed <play forward>
"w"	User Control Pressed <play min forward>
"e"	User Control Pressed <play min forward >
"r"	User Control Pressed <play reverse >
"c"	Deck Control<stop>
"v"	Deck Control<eject>

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csc@renesas.com

Revision Record of R8C/27 CIR & CEC function ample code

		Description	
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