1. Summary

This sample program performs remote control transmission/reception by using the Renesas Starter Kit for M16C/26A (R0K33026AS000BE).

2. Introduction

The example described in this document applies to the microcomputers listed below:

Microcomputers: M16C26A

This sample program runs on the Renesas Starter Kit for M16C/26A (R0K33026AS000BE).
Prepare an extension board available for the Renesas Starter Kit or create a circuit similar to the one shown in the circuit diagram on page 15 and then connect it to the Starter Kit.

This program uses RSK_LIB. For details about RSK_LIB, see the RSK_LIB reference manual. (RSK_LIB is the library software provided for use with the Renesas Starter Kit for M16C/26A.)
3. Port Arrangement

The key matrix, infrared-ray transmitter/receiver and the buzzer are the facilities mounted on an extension board for the Renesas Starter Kit. To use these facilities, connect an extension board to the Starter Kit.

4. Remote Control Specification

4.1 Remote Control Format
4.2 Determination of the Leader and Data Sections

When the received waveform falls within one of the ranges shown below, it is determined to be a leader or a data section.

**Leader section**

- Leader low-level duration (10 ms): 8ms - 12ms
- Leader pulse width (20 ms): 18ms - 22ms

**Data section**

- Data “0” (2ms): 1.0ms - 3.0ms
- Data “1” (4ms): 3.0ms - 5.0ms

4.3 Carrier Frequency

- Carrier Frequency: 38.46kHz
- 13us
- 26us
5. Operational Outline

<Remote control transmission>
Each time a switch is depressed, the buzzer is sounded and remote control code is transmitted from the infrared LED.

<Remote control reception>
The transmitted code is received in the remote control photodetector, and the received data is shown on liquid crystal display.

The operation described above is accomplished using the following microcomputer facilities:

- **Timer A0** (timer mode, main 2 ms cycle)
  This timer counts 2 milliseconds using the main clock of the microcomputer as the count source. It is used as the basic timer of RSK_LIB.
  Time management, key scan and LCD display management are performed using this timer.
- **Timer A4** (timer mode, carrier output)
  This timer counts 26 microseconds using the main clock of the microcomputer as the count source. It generates a carrier (frequency 38.46 kHz) that is output during transmission.
- **Timer B0** (timer mode, remote control transmission “500 µs”)
  This timer counts 500 microseconds using the main clock of the microcomputer as the count source. It turns carrier output on and off in a 500 microsecond cycle to generate a remote control transmission waveform.
- **Timer B2** (timer mode, remote control reception “250 µs”)
  This timer counts 250 microseconds using the main clock of the microcomputer as the count source. It generates remote control receive data from the port input level in a 250 microsecond cycle.
- **Timer A1** (pulse modulation mode, buzzer output)
  This timer outputs a waveform with different high and low pulse widths using the main clock of the microcomputer as the count source. It is used to sound a buzzer each time a key is touched.
6. Operational Specification

<Remote control transmission>
When a switch is depressed, the remote control code (hex code) corresponding to the switch and the inverted data (hex code) of the remote control code are transmitted. While a switch is held down, data is transmitted successively at 100 millisecond intervals.

Note: In this program, pressing two or more switches at the same time has no effect (i.e., ignored).

<Remote control reception>
(1) Immediately after the reset switch is depressed, the LCD shows “-----.”
(2) While remote control code is being received, the LCD shows the received code.
* If the length of reception period is less than or equal to 500 ms, the received code is displayed for 500 ms.
7. Definition of the RSK Functionality and the RSK_LIB APIs and Common Functions Used by Remote Control Transmission/Reception

7.1 Definition of the RSK Functionality

RSKdefine.h file

In this application, the following functionalities (those shown in red) are set.

```c
#define _CPU_M16C26A_NORMAL_MOD
/* Use in low power mode can be performed. */
#ifndef _CPU_M16C26A_32KHZ_MOD
/* Use of access of a flash can be performed. */
#ifndef _CPU_M16C26A_DATAFLASH_USE

#define _USE_KEY
#define _USE_BUZZER
#ifndef _OPTION_USE_AD
#ifndef _OPTION_USE_COM_RX
#ifndef _OPTION_USE_COM_TX
#define _OPTION_USE_INFRAEDRX
#define _OPTION_USE_INFRAEDTX
#ifndef _OPTION_USE_SW
#ifndef _OPTION_USE_LED
#ifndef _OPTION_USE_IO

Individual definition of each selected functionality

#if defined _USE_KEY
/* A key matrix continues pushing and existence is defined. */
/* When not using -USE_KEY_CONTINU is made a comment. */
#define _USE_KEY_CONTINU
#endif

#define _CONTINU_SW1 _KEY_CONTINU_ON
#define _CONTINU_SW2 _KEY_CONTINU_ON
#define _CONTINU_SW3 _KEY_CONTINU_ON
#define _CONTINU_SW4 _KEY_CONTINU_ON
#define _CONTINU_SW5 _KEY_CONTINU_ON
#define _CONTINU_SW6 _KEY_CONTINU_ON
#define _CONTINU_SW7 _KEY_CONTINU_ON
#define _CONTINU_SW8 _KEY_CONTINU_ON
#define _CONTINU_SW9 _KEY_CONTINU_ON
#define _CONTINU_SW10 _KEY_CONTINU_ON
#define _CONTINU SW11 _KEY_CONTINU_ON
#define _CONTINU_SW12 _KEY_CONTINU_ON
#define _CONTINU_SW13 _KEY_CONTINU_ON
#define _CONTINU_SW14 _KEY_CONTINU_ON
#define _CONTINU_SW15 _KEY_CONTINU_ON
#define _CONTINU_SW16 _KEY_CONTINU_ON
#else

Continuous key depressions are accepted.
```

M16C/26A Group
Sample Program (Remote Control Transmission/Reception)
7.2 APIs and Common Functions Used

ApiStatusType RL_SetTimerReq( unsigned int TimerValue, char TimerMode, int *TimerNo, int *ERcode );
ApiStatusType RL_StartTimer( int TimerNo, int *ERcode );
ApiStatusType RL_CheckTimer( int TimerNo, int *ERcode );
ApiStatusType RL_Get_Key( int *Inkey, int *ERcode );
ApiStatusType RL_Getc_Ir( int *IrCode, int *ERcode );
ApiStatusType RL_Putc_Ir( int IrCode, int *ERcode );
ApiStatusType RL_Start_Buzzer( char freqNo, int *ERcode );
ApiStatusType RL_Stop_Buzzer( int *ERcode );
ApiStatusType RL_Putc_Lcd( char Ylocation, char outc, int *ERcode );
ApiStatusType RL_Puts_LcdLoc( char Xlocation, char Ylocation, char RvTime, const char far* outc, int *ERcode );
ApiStatusType RL_Putc_LcdLoc( char Xlocation, char Ylocation, char RvTime, char outc, int *ERcode );
void RL_ErrorHook( int FuncNo, int ErrorNo );

For details about the APIs and common functions used by the sample program (remote control transmission/reception), see the Renesas Starter Kit Library V.1.00 Reference Manual.
8. Flowchart

[Diagram showing flowchart for remote control transmission/reception process]

- Remote control transmission/reception
- Clear display on LCD
- Show the initial screen
- Request timer setup
- Start timers
- Input keys
- Process buzzer
- Keys input?
  - NO
  - YES
- Transmit key code
- Check reception
- Check reception

NO
9. **Tutorial**

- Launch the HEW by double-clicking its icon.

- Change the session name from “default Session” to “SessionM16C_E8_System.”
Select “M30260F8A” for Device.
Select “Download emulator firmware” for Mode.
Check the box labeled “Power supply is carried out. (MAX 300mA)” and then select “5.0V.”
In the program and the work RAM text boxes of Firmware Location Address, enter “FA0” and “0B8” respectively.
Leave the box labeled “Debug a program using the WDT” unchecked.
Choose Download from the Debug tab and download a module.
The upper-side choices for Download show the location from which a project was downloaded.
- Click “Start after Reset” to start program execution.

- Please do "Cancellation" when "The file is opened" window opens.
10. Circuit Diagram

![Circuit Diagram]

11. Part List

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<tr>
<th>Part name</th>
<th>Part No.</th>
<th>Q’ty</th>
<th>Manufacturer</th>
<th>Type number</th>
<th>Value</th>
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<td>Remote control</td>
<td>U1</td>
<td>1</td>
<td>SHARP</td>
<td>GP1UM281YK</td>
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<td>photodetector</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
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<td>LNA2801L</td>
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<tr>
<td>Transistor</td>
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<td>ROHM</td>
<td>2SD1898T100Q</td>
<td>1A/0.5W</td>
<td></td>
</tr>
<tr>
<td>Tact switch</td>
<td>SW1 - SW16</td>
<td>16</td>
<td>OMRON</td>
<td>B3FS-1000P</td>
<td></td>
<td></td>
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<tr>
<td>Switching diode</td>
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<td>4</td>
<td>ROHM</td>
<td>1SS355TE-17</td>
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<td></td>
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<tr>
<td>Electrolytic capacitor</td>
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<td>1</td>
<td>Panasonic</td>
<td>ECE-V1HS010SR</td>
<td>1uF/50V</td>
<td></td>
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<tr>
<td>Chip resistor</td>
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<td>1</td>
<td>ROHM</td>
<td>MCR10EZHF470</td>
<td>47</td>
<td>1/8W, 1%(5% also acceptable)</td>
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<tr>
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<td>1</td>
<td>ROHM</td>
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<td>1/8W, 1%(5% also acceptable)</td>
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<td>1W,5%</td>
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12. Web Site

Renesas Technology Web site

http://www.renesas.com/
## Revision History

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<th>Date of issue</th>
<th>Page</th>
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<td>1.00</td>
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<td>-</td>
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<td>1.10</td>
<td>2007.12.03</td>
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