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April 1st, 2010
Renesas Electronics Corporation

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H8S Family

Using the HCAN (1): Standard Format, One Byte of Data

Introduction

The Controller Area Network (HCAN) module is used to control the Controller Area Network (CAN), which provides a means for real-time communications in automobiles and industrial equipment systems.

This application note presents an example of communications operation using the H8S/2636’s on-chip HCAN module and is offered to users for reference in the software and hardware design processes.

Although the operation of the sample application and programs provided in this application note has been confirmed, please verify operation in your environment before actually using them.

Target Device

H8S/2636

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1. Specifications

Between two H8S/2636 devices, one byte of data is transmitted and received in a standard format message.

(1) Specifications common to the transmitter and receiver
- Channel 0 (HCAN0) is used
- Baud rate: 250 Kbps (in 20-MHz operation)
- Message identifier: H'555

(2) Specifications of the transmitter
- Uses mailbox 1
- Data length is one byte, and data for transmission is H'AA
- Polls the transmission-complete flag during transmission
- After confirming that the transmission-complete flag has been set, clears the flag as the final operation

(3) Specifications of the receiver
- Uses mailbox 0
- Sets the message identifier masks so that messages are only received if the identifier matches the mask setting
- Stores the received data in on-chip RAM and ends
2. Functional Descriptions of the Transmitter and Receiver

Table 1 lists the function assignment of the relevant pins and registers.

### Table 1 Function Assignment for the HCAN Module

<table>
<thead>
<tr>
<th>Pin Usage</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin</td>
<td>HTxD0</td>
</tr>
<tr>
<td></td>
<td>HRxD0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relevant Registers</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registers common to transmission and reception</td>
<td>MSTPCRC</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IRR</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BCR</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MBCR</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MCR</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GSR</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>MCx[n] Message control registers (x = mailbox number)</td>
<td></td>
</tr>
<tr>
<td>n = 1</td>
<td></td>
</tr>
<tr>
<td>n = 2 to 4</td>
<td>Reserved</td>
</tr>
<tr>
<td>n = 5</td>
<td></td>
</tr>
<tr>
<td>n = 6</td>
<td></td>
</tr>
<tr>
<td>n = 7</td>
<td></td>
</tr>
<tr>
<td>n = 8</td>
<td></td>
</tr>
<tr>
<td>MDx[n] Message data registers (x = mailbox number)</td>
<td></td>
</tr>
<tr>
<td>n = 1 to 8</td>
<td>Hold CAN message data for transmission or received CAN message data.</td>
</tr>
</tbody>
</table>

| Transmission-related registers | TXPR | Transmit wait register  |
|                               |     | After a message for transmission has been stored in the mailbox, the corresponding bit in this register is set, indicating a transmission-wait state.  |
|                               | TXACK | Transmit acknowledge register  |
|                               |     | Each bit in this register indicates whether or not the message in the corresponding mailbox has been transmitted normally.  |

| Reception-related registers | RXPR | Receive complete register  |
|                            |     | Each bit in this register indicates that a message has been received normally in the corresponding mailbox.  |
| LAFMH, LAFML Identifier filter mask settings for the mailboxes configured for reception.  |
3. Flowchart for the Transmitter

![Flowchart for the Transmitter]

**Figure 1** Flowchart for the Transmitter
4. Description of Software (Transmitter)

4.1 Module

Table 2 Description of Module

<table>
<thead>
<tr>
<th>Module</th>
<th>Label</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Routine</td>
<td>t_main</td>
<td>Initialize the HCAN and makes settings for transmission.</td>
</tr>
</tbody>
</table>

4.2 Registers

Table 3 Description of Registers

<table>
<thead>
<tr>
<th>Register</th>
<th>Function</th>
<th>Setting</th>
<th>Used in</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSTP.CRC.BYTE</td>
<td>Takes HCAN0 out of module stop mode.</td>
<td>H'F7</td>
<td>Main routine</td>
</tr>
<tr>
<td>HCAN0.IRR.WORD</td>
<td>The reset interrupt flag in this register is cleared.</td>
<td>H'0100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Clearing condition: writing a 1 to the bit)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCAN0.BCR.WORD</td>
<td>Sets the bit rate to 250 Kbps when $\phi = 20$ MHz</td>
<td>H'0334</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MBCR.WORD</td>
<td>Sets mailbox 1 for transmission.</td>
<td>H'FDFF</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MCR.BYTE</td>
<td>Selects transmission in mailbox-number order and takes the HCAN module out of configuration mode.</td>
<td>H'04</td>
<td></td>
</tr>
<tr>
<td>HCAN0.GSR.BYTE</td>
<td>Checked to confirm that HCAN0 is out of configuration mode.</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MC[1][4]</td>
<td>For mailbox 1, sets the frame type to data frame and the frame format to standard format. Also holds the message identifier bits, STD_ID2 to STD_ID0 (for message ID = H'555).</td>
<td>H'A0</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MC[1][5]</td>
<td>Holds the message identifier bits, STD_ID10 to STD_ID3 H'AA (for message ID = H'555).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCAN0.MC[1][0]</td>
<td>Sets the data length for transmission from mailbox 1 to one byte.</td>
<td>H'01</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MD[1][0]</td>
<td>Holds the 1st byte for transmission from mailbox 1.</td>
<td>H'AA</td>
<td></td>
</tr>
<tr>
<td>HCAN0.TXPR.WORD</td>
<td>Places mailbox 1 in the transmission-wait state.</td>
<td>H'0200</td>
<td></td>
</tr>
<tr>
<td>HCAN0.TXACK.WORD</td>
<td>Checked to see if the transmission-complete flag for mailbox 1 is set; when set, the flag is cleared. (Clearing condition: writing a 1 to the bit)</td>
<td>H'0200</td>
<td></td>
</tr>
</tbody>
</table>

Note: * The register names shown above are defined in a header file which is available for downloading from the following web page.

http://download.renesas.com/eng/mpumcu/sample_codes/h8sx_h8s_h8_family/io_register/index.html
5. Program Listing (Transmission)

/***************************************************************************************/
/*  HCAN Transmission Program (No.1)                                                 */
/***************************************************************************************/
#include <stdio.h>                          /* Header file for library functions     */
#include <machine.h>                        /* Header file for library functions     */
#include "2636S.h"                          /* Header file of peripheral register definitions */

void t_main(void){
    unsigned char i,j;

    /* Initialization */
    MSTP.CRC.BYTE = 0xF7;                   /* Cancel module stop mode of HCAN       */
    HCAN0.IRR.WORD = 0x0100;                /* Initialize reset flag for HCAN module  */
    HCAN0.BCR.WORD = 0x0334;                /* Bit rate: 250 kbps                    */
    HCAN0.MBCR.WORD = 0xFDFF;               /* Set mailbox 1 for transmission        */

    for(i=0; i<=15; i++){                   /* Initialize mailboxes (RAM)            */
        for(j=0; j<=7; j++){
            HCAN0.MC[i][j] = 0x00;
        }
    }

    for(i=0; i<=15; i++){                   /* Initialize mailboxes (RAM)            */
        for(j=0; j<=7; j++){
            HCAN0.MD[i][j] = 0x00;
        }
    }

    HCAN0.MCR.BYTE = 0x04;                  /* Transmission in mailbox No. order;    */
    /*                             cancel config. mode */
    while(HCAN0.GSR.BYTE & 0x08);           /* Configuration mode cancellation check */

    /* Transmit data setting */
    HCAN0.MC[1][4] = 0xA0;                  /* Standard format, data frame, and       */
    /*                             identifier setting */
    HCAN0.MC[1][5] = 0xAA;                  /* Identifier setting                      */
    HCAN0.MC[1][0] = 0x01;                  /* Data length: 1 byte                     */
    HCAN0.MD[1][0] = 0xAA;                  /* Data for transmission: 10101010         */

    /* Message transmission */
    HCAN0.TXPR.WORD = 0x0200;               /* Place mailbox 1 in a transmission wait state */
    while(HCAN0.TXACK.WORD & 0x0200) != 0x0200);
    /* Wait until transmission is complete */

    /* Transmission-complete flag clearing */
    HCAN0.TXACK.WORD &= 0x0200;             /* Clear transmission-complete flag       */
    while(1);
}
6. Flowchart for the Receiver

- Main routine for reception

  - Take the HCAN out of module stop mode.

  - Clear the IRR0 bit.

  - Set the bit rate.

  - Set the mailbox for reception.

  - Initialize the mailbox (RAM).

  - Take the HCAN out of configuration mode.

  - Set the mode of reception.

  - Set the identifier filter mask.

  - Reception complete?

    - No
      - Store the received data to on-chip RAM.
      - End of reception
    - Yes
      - Store the received data to on-chip RAM.
      - End of reception

Figure 2  Flowchart for the Receiver
7. Description of Software (Receiver)

7.1 Module

Table 4 Description of Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Label</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Routine</td>
<td>r_main</td>
<td>Initializes the HCAN and makes settings for reception.</td>
</tr>
</tbody>
</table>

7.2 Registers

Table 5 Description of Registers*

<table>
<thead>
<tr>
<th>Register</th>
<th>Function</th>
<th>Setting</th>
<th>Used in</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIL_BOX0</td>
<td>Storage for the received data</td>
<td>—</td>
<td>Main routine</td>
</tr>
<tr>
<td>MSTP.CRC.BYTE</td>
<td>Takes HCAN0 out of module stop mode.</td>
<td>H'F7</td>
<td></td>
</tr>
<tr>
<td>HCAN0.IRR.WORD</td>
<td>The reset interrupt flag in this register is cleared.</td>
<td>H'0100</td>
<td></td>
</tr>
<tr>
<td>HCAN0.BCR.WORD</td>
<td>Sets the bit rate to 250 Kbps when ( \phi = 20 ) MHz</td>
<td>H'0334</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MBCR.WORD</td>
<td>Sets mailbox 0 for reception.</td>
<td>H'0100</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MCR.BYTE</td>
<td>Takes HCAN0 out of configuration mode.</td>
<td>H'FE</td>
<td></td>
</tr>
<tr>
<td>HCAN0.GSR.BYTE</td>
<td>Checked to confirm that HCAN0 is out of configuration mode.</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MC[0][4]</td>
<td>For mailbox 0, sets the frame type to data frame and the frame format to standard format. Also holds the message identifier bits, STD_ID2 to STD_ID0 (for message ID = H'555).</td>
<td>H'A0</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MC[0][5]</td>
<td>Holds the message identifier bits, STD_ID10 to STD_ID3 (for message ID = H'555).</td>
<td>H'AA</td>
<td></td>
</tr>
<tr>
<td>HCAN0.LAFMH.WORD</td>
<td>Provides the filter mask setting.</td>
<td>H'0000</td>
<td></td>
</tr>
<tr>
<td>HCAN0.MD[0][0]</td>
<td>Reception register for mailbox 0</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>HCAN0.RXPR.WORD</td>
<td>The reception-complete flag for mailbox 0 in this register is cleared. (Clearing condition: writing a 1 to the bit)</td>
<td>H'0100</td>
<td></td>
</tr>
</tbody>
</table>

Note: * The register names shown above are defined in a header file which is available for downloading from the following web page.
http://download.renesas.com/eng/mpumcu/sample_codes/h8sx_h8s_h8_family/io_register/index.html
8. Program Listing (Reception)

```c
#include <stdio.h>                          /* Header file for library functions               */
#include <machine.h>                        /* Header file for library functions               */
#include "2636S.h"                          /* Header file of peripheral register definitions  */

/* Definitions of Constants                                                                   */
#define MAIL_BOX0    (*(unsigned char *) 0xFFE000)
    /* Received data storage for mailbox 0             */

void r_main(void){
    unsigned char i,j;
    /* Initialization */
    MSTP.CRC.BYTE = 0xF7;                   /* Cancel module stop mode of HCAN                 */
    HCAN0.IRR.WORD = 0x0100;                /* Initialize reset flag for HCAN module           */
    HCAN0.BCR.WORD = 0x0334;                /* Bit rate: 250 kbps                              */
    HCAN0.MBCR.WORD = 0x0100;               /* Set mailbox 0 for reception                     */
    for(i=0; i<=15; i++){                   /* Initialize mailboxes (RAM)                      */
        for(j=0; j<=7; j++){
            HCAN0.MC[i][j] = 0x00;
        }
    }
    for(i=0; i<=15; i++){                   /* Initialize mailboxes (RAM)                      */
        for(j=0; j<=7; j++){
            HCAN0.MD[i][j] = 0x00;
        }
    }
    HCAN0.MCR.BYTE &= 0xFE;                 /* Cancel configuration mode                       */
    while(HCAN0.GSR.BYTE & 0x08);           /* Configuration mode cancellation check           */

    /* Reception data settings */
    HCAN0.MC[0][4] = 0xA0;                  /* Standard format, data frame, and                */
    while(HCAN0.GSR.BYTE & 0x08);           /* Configuration mode cancellation check           */
    /* identifier setting */
    HCAN0.MC[0][5] = 0xAA;                  /* Identifier setting                             */
    HCAN0.LAFMH.WORD = 0x0000;              /* Set identifier filter mask for mailbox 0        */
    while((HCAN0.RXPR.WORD & 0x0100) != 0x0100);
    /* Wait until reception is complete */
    MAIL_BOX0 = HCAN0.MD[0][0];             /* Store received data                            */
    while(1);
}
```
9. Waveforms during Operation (Transmission and Reception)

Figure 3 shows the waveforms seen during the execution of this application.

![Waveforms during Operation Diagram]

Figure 3  Waveforms during Operation
## Revision Record

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Jul.22.05</td>
<td>—</td>
<td>First edition issued</td>
</tr>
</tbody>
</table>


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