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SH7262/SH7264 Group

Controller Area Network, Configuration to Transmit Data Frames

Summary

This application note describes the configuration example of the SH7264 microcomputers (MCUs) to transmit data frames using the Controller Area Network.

Target Device

SH7264 MCU (In this document, SH7262/SH7264 are described as "SH7264".)

Contents

1. Introduction.....	2
2. Applications	3
3. Sample Program Listing	10
4. References	18

1. Introduction

1.1 Specifications

- Uses the Controller Area Network channel 0
- Transmission speed: 1 Mbps
- Transmit mailbox: Mailbox 1
- Transmits the data frame with following specifications
Identifier: 0; standard data frame; DLC: 2; Data: H'C1C2

1.2 Modules Used

- Controller Area Network (CAN) module

1.3 Applicable Conditions

MCU	SH7262/SH7264 Internal clock: 144 MHz
Operating Frequencies	Bus clock: 72 MHz Peripheral clock: 36 MHz
Integrated Development Environment	Renesas Technology Corp. High-performance Embedded Workshop Ver.4.07.00
C Compiler	Renesas Technology SuperH RISC engine Family C/C++ Compiler Package Ver.9.03 Release 00 Default setting in the High-performance Embedded Workshop
Compiler Options	(-cpu=sh2afpu -fpu=single -object="\$(CONFIGDIR)\\$(FILELEAF).obj" -debug -gbr=auto -chgincpath -errorpath -global_volatile=0 -opt_range=all -infinite_loop=0 -del_vacant_loop=0 -struct_alloc=1 -nologo)

1.4 Related Application Notes

For more information, refer to the following application notes:

- SH7262/SH7264 Group Controller Area Network, Configuration to Receive Data Frames
- SH7262/SH7264 Group Controller Area Network, Configuration to Transmit Remote Frames
- SH7262/SH7264 Group Controller Area Network, Configuration to Receive Remote Frames

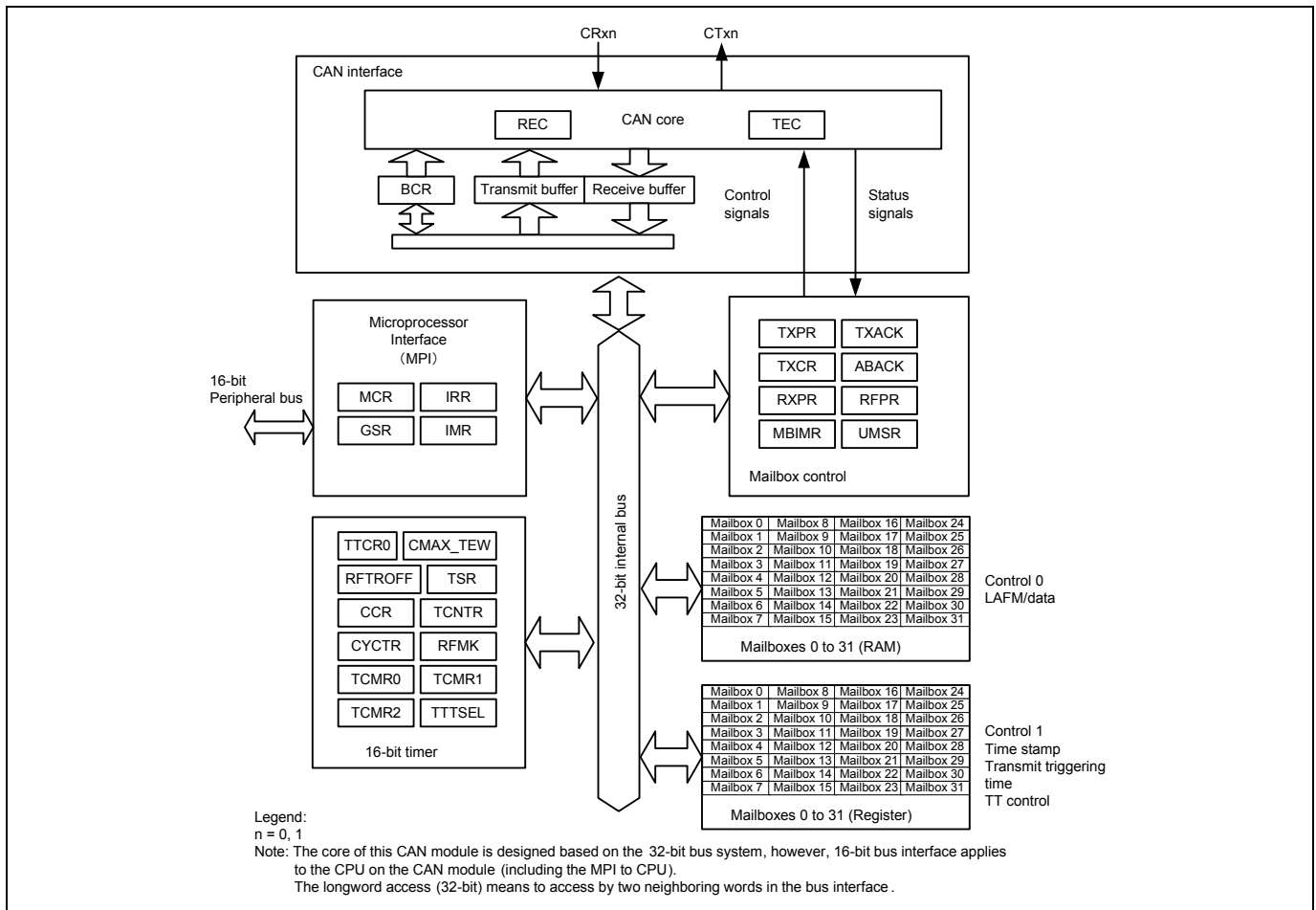
2. Applications

This application note uses the CAN module to transmit a standard data frame with identifier 0, DLC 2, and H'C1C2 data.

2.1 CAN Overview

The SH7264 includes two channels of a CAN module which is compliant with the CAN protocol, version 2.0B active, and ISO 11898.

The CAN module has 31 programmable mailboxes for transmission/reception, one mailbox for reception, and a programmable receive filtering mask to provide flexible communication procedure. Figure 1 shows the CAN block diagram. For more details, refer to Controller Area Network chapter in the SH7262 Group, SH7264 Group Hardware Manual.



2.2 Configuration Procedure

This section describes how to configure the SH7264 MCU to transmit data frames using the CAN module channel 0.

Configure the CAN module in reset mode (configuration mode). After configuration is complete, clear the reset mode to join the CAN bus activity. The sample program sets two mailboxes in SH7264 - one transmit mailbox and one receive mailbox. Figure 2 and Figure 3 show the flow charts for configuring the CAN module. For details on register settings, refer to the Controller Area Network chapter in the SH7262 Group, SH7264 Group Hardware Manual.

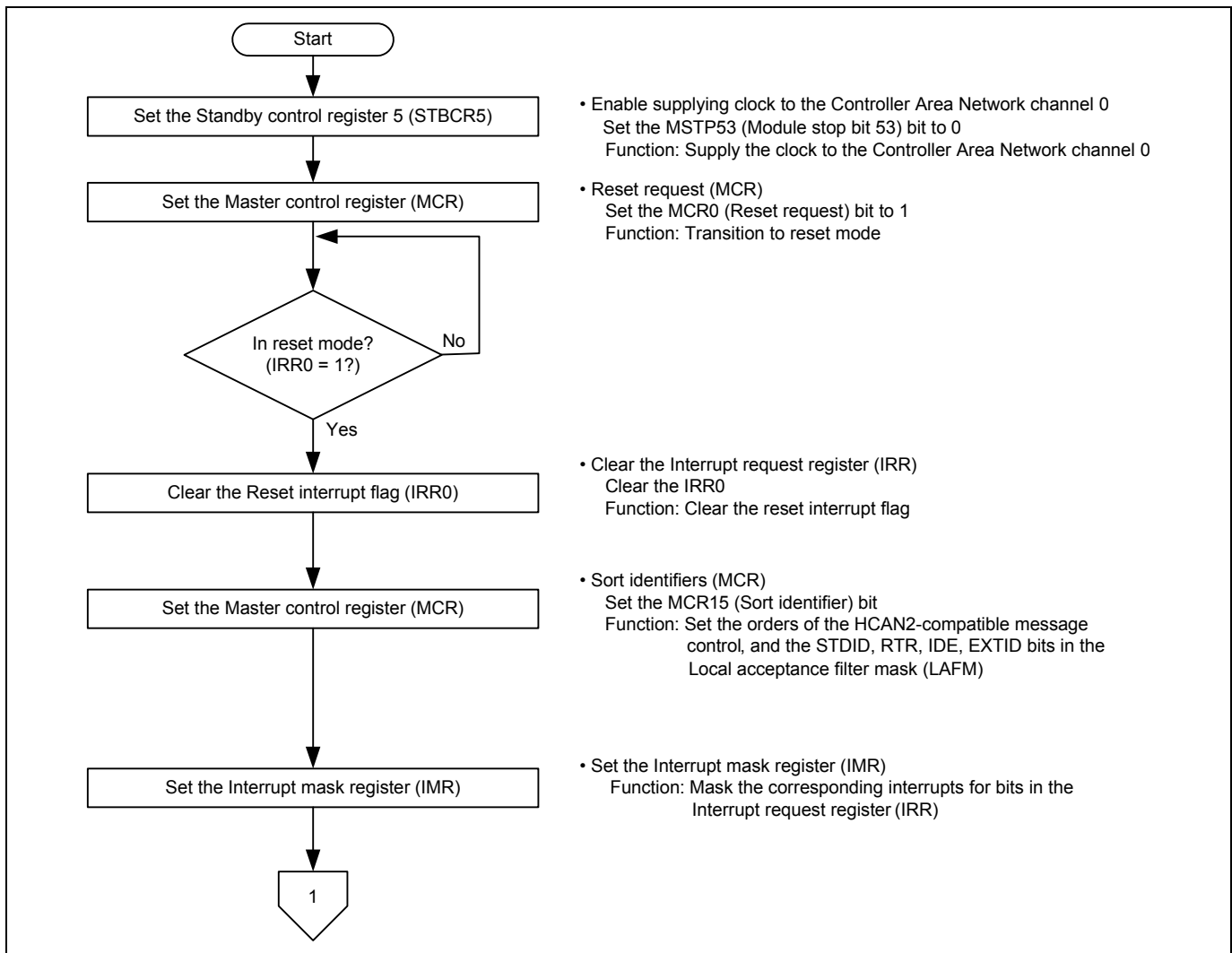


Figure 2 Flow Chart for Configuring the CAN Module (1/2)

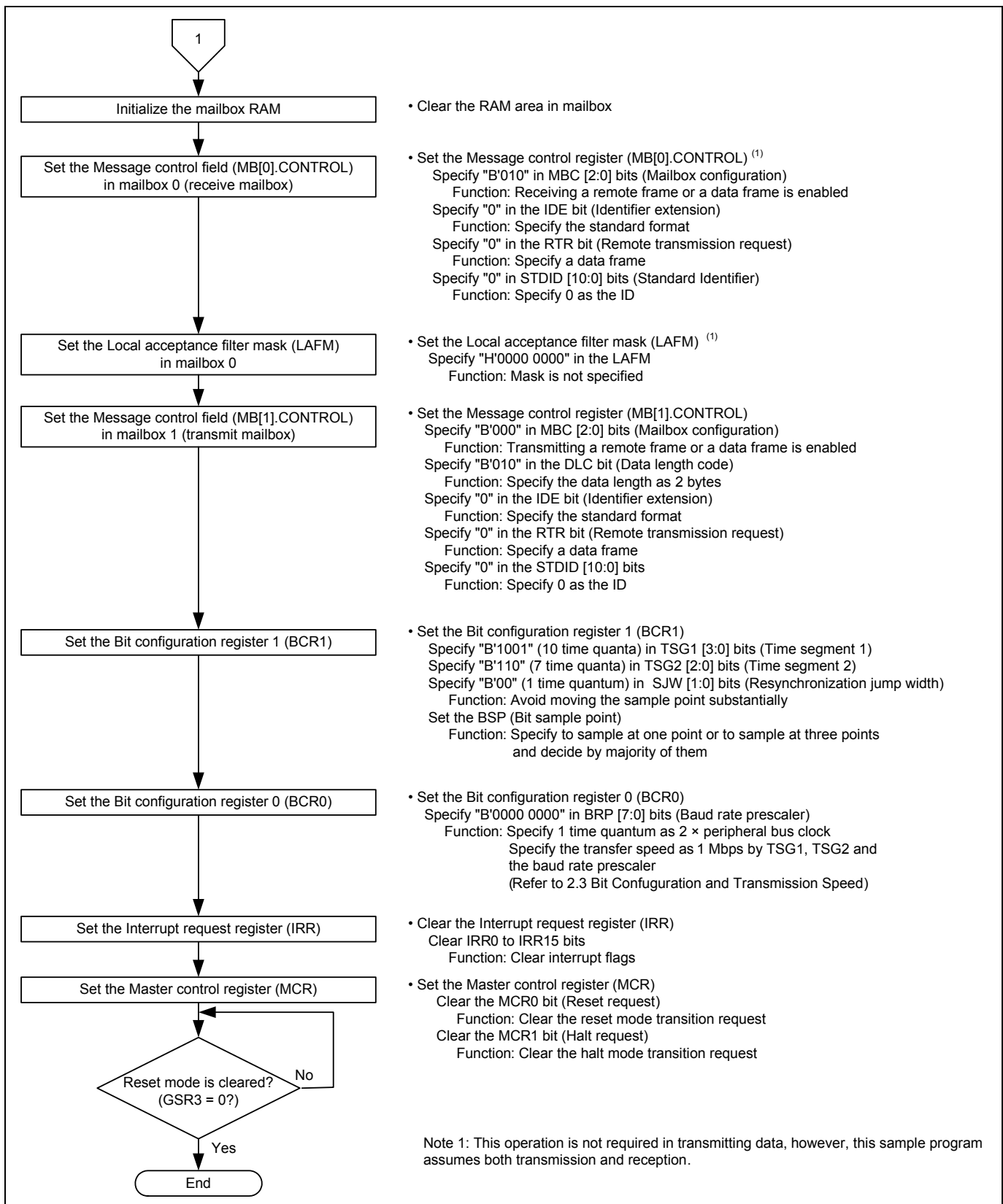


Figure 3 Flow Chart for Configuring the CAN Module (2/2)

2.3 Bit Configuration and Transmission Speed

One bit in the CAN module consists of the following four segments:

1. Synchronization segment (SS)
2. Propagation time segment (PRSEG)
3. Phase buffer segment 1 (PHSEG1)
4. Phase buffer segment 2 (PHSEG2)

Each segment is composed of the reference time T_q (time quanta). Figure 4 shows the bit configuration example when $SS = 1 T_q$, $PRSEG = 8 T_q$, $PHSEG1 = 8 T_q$, and $PHSEG2 = 8 T_q$.

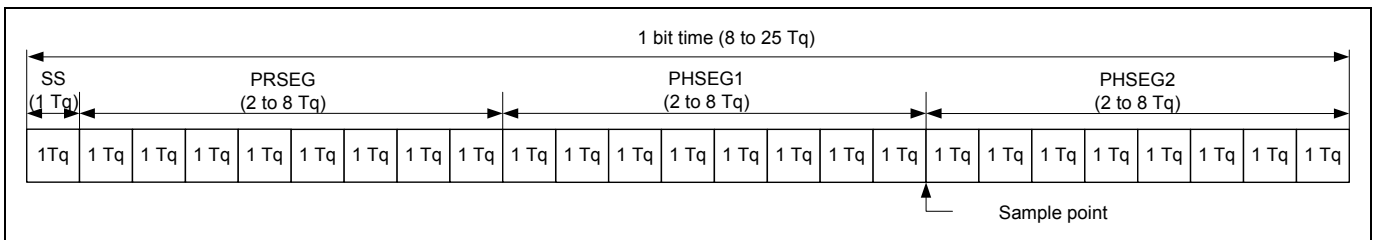


Figure 4 Bit Configuration

The CAN module sets the number of T_q s of $PRSEG + PHSEG1$ to bits TSG1 [3:0] in the BCR1 register, and the number of T_q s of PSEG2 to bits TSG2 [2:0] in this register (Value + 1 is the number of T_q s). Also, the number of peripheral bus clocks for 1 T_q is set to bits BRP [7:0] in the BCR0 register.

In the following description, bits BRP [7:0], TSEG1 [3:0], and TSEG2 [2:0] are register values, and bits BRP, TSEG1, TSEG2, and SJW are the corresponding values for the register values. For the corresponding values for register values, refer to the Controller Area Network chapter in the SH7262 Group, SH7264 Group Hardware Manual.

The CAN module defines $1 T_q = \frac{2 \times (BRP[7:0] + 1)}{\text{Peripheral bus clock}}$ By this formula, the transmission speed is calculated as follows:

$$\begin{aligned} \text{Transmission speed} &= \frac{\text{Peripheral bus clock}}{2 \times (BRP[7:0] + 1) \times \text{the number of } T_q\text{/bit}} \\ &= \frac{\text{Peripheral bus clock}}{2 \times (BRP[7:0] + 1) \times \{(TSEG[3:0] + 1) + (TSEG2[2:0] + 1) + 1\}} \end{aligned}$$

Following is the restrictions on setting the bit configuration register.

$$TSEG1 (\text{Min.}) > TSEG2 \geq SJW (\text{Max.}) \quad (SJW = 1 \text{ to } 4)$$

SJW is the resynchronization jump width. It is a segment that lengthens phase buffer segment 1 or shortens phase buffer segment 2 to correct the phase difference.

$$\begin{aligned} 8 \leq TSEG1 + TSEG2 + 1 \leq 25 \text{ time quanta} \\ TSEG2 \geq 2 \end{aligned}$$

As this sample program specifies the peripheral bus clock as 36 MHz, $BRP[7:0] = 0$, $TSEG1[3:0] = 9$, and $TSEG2[2:0] = 6$, the transmission speed is calculated as follows:

$$\text{Transmission speed} = \frac{36M}{2 \times (0+1) \times \{(9+1) + (6+1) + 1\}} = 1M...1 \text{ Mbps}$$

2.4 Sample Program Operation

This sample program transmits a standard data frame from mailbox 1 with identifier 2, DLC 2, and H'C1C2 data at 1 Mbps. Figure 5 shows the transmission waveform.

Note: The sample program transmits and receives data frames, however, this application note describes only the transmission.

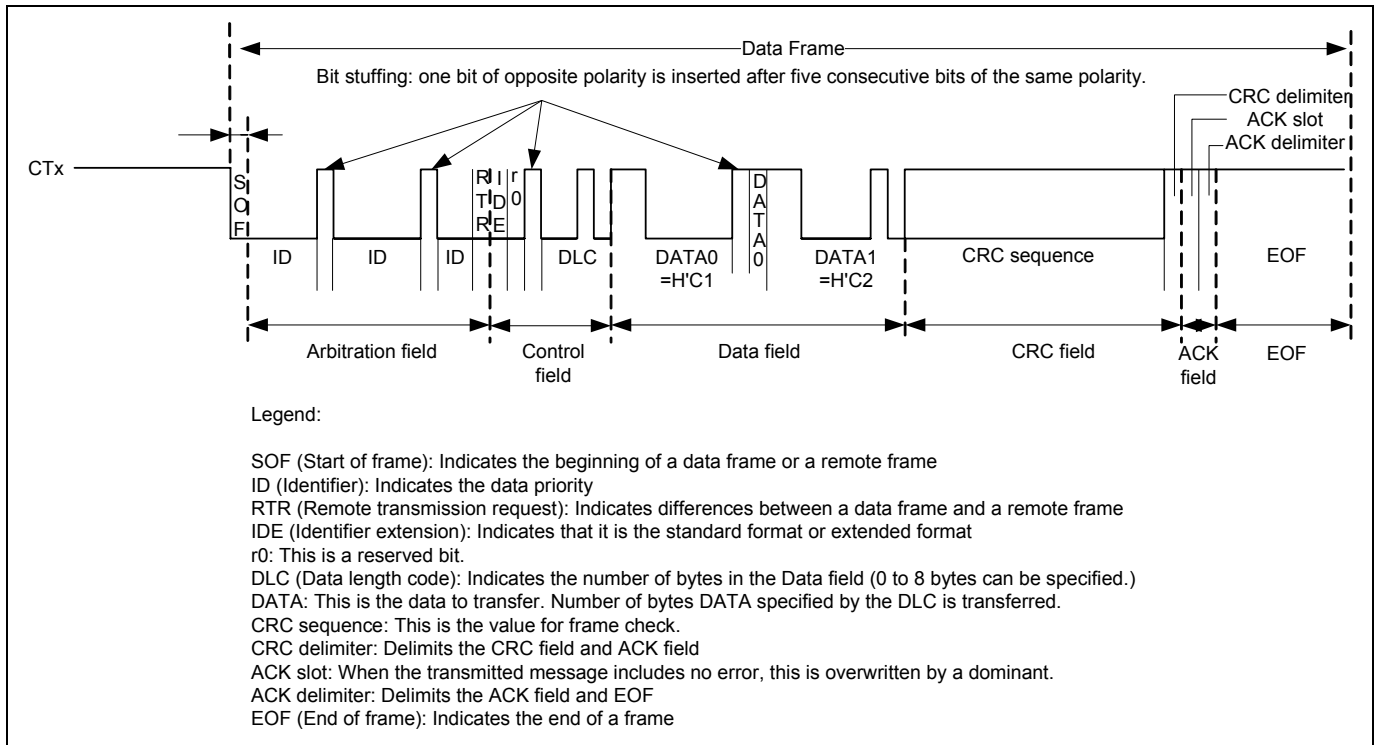


Figure 5 CAN Transmission Waveform

2.5 Sample Program Procedure

The following table lists setting example of the CAN. Figure 6 shows the configuration flow chart of this sample program.

Note: The sample program transmits and receives data frames, however, this application note describes only the transmission.

Table 1 Controller Area Network Settings

Register Name	Address	Setting	Description
Standby control register (STBCR5)	H'FFFE 0410	H'F7	MSTP53 = "0": Controller Area Network channel 0 is operating
Master control register (MCR)	H'FFFF 5000	H'0001	MCR0 = "1": Reset mode transition request
		H'8001	MCR15 = "1": The order of the RCAN message and of the HCAN2 message are different
		H'8000	MCR0 = "0": Reset mode is cleared
Interrupt mask register(IMR)	H'FFFF 500A	H'FFFF	All interrupts in the Controller Area Network are disabled
Bit configuration register 1 (BCR1)	H'FFFF 5004	H'9600	TSEG1 [3:0] = "B'1001": PRSEG + PHSEG1 = 10 T _q TSEG2 [2:0] = "B'110": PHSEG2 = 7 T _q SJW = "0": SJW = 1 T _q BSP = "0": Bit sampling at one point
Bit configuration register 0 (BCR0)	H'FFFF 5006	H'0000	BRP [7:0] = "0": 1 T _q = 2 × P _φ
Message control field in mailbox 0 (MB[0].CONTROL1)	H'FFFF 5110	H'0200	MBC [2:0] = "B'010": Receiving the data frame or remote frame is enabled
Message control field in mailbox 0 (MB[0].CONTROL0)	H'FFFE 5100	H'0000 0000	IDE = "0": Standard format RTR = "0": Data frame STDID [10:0] = "0": Standard identifier is 0
Message control field in mailbox 1 (MB[1].CONTROL1)	H'FFFF 5130	H'0002	MBC [2:0] = "B'000": Transmitting the data frame or remote frame is enabled DLC [3:0] = "B'0010": Data length is 2 bytes
Message control field in mailbox 1 (MB[1].CONTROL0)	H'FFFF 5120	H'0000 0000	IDE = "0": Standard format RTR = "0": Data frame STDID[10:0] = "0": Standard identifier is 0
Local acceptance filter mask in mailbox 0 (MB[0].LAFM)	H'FFFF 5104	H'0000 0000	Clear: Mask is not specified
Message data field in mailbox 1 (MB[1].MSG_DATA_0)	H'FFFF 5128	H'C1C2	Specify "H'C1C2" as the transmit data
Transmit pending register (TXPR)	H'FFFF 5020	H'0000 0002	TXPR [31:0] = H'0000 0002: A transmission request occurred in Mailbox 1
Transmit acknowledge register 0 (TXACK0)	H'FFFF 5032	H'0002	Clear the transmit acknowledge flag

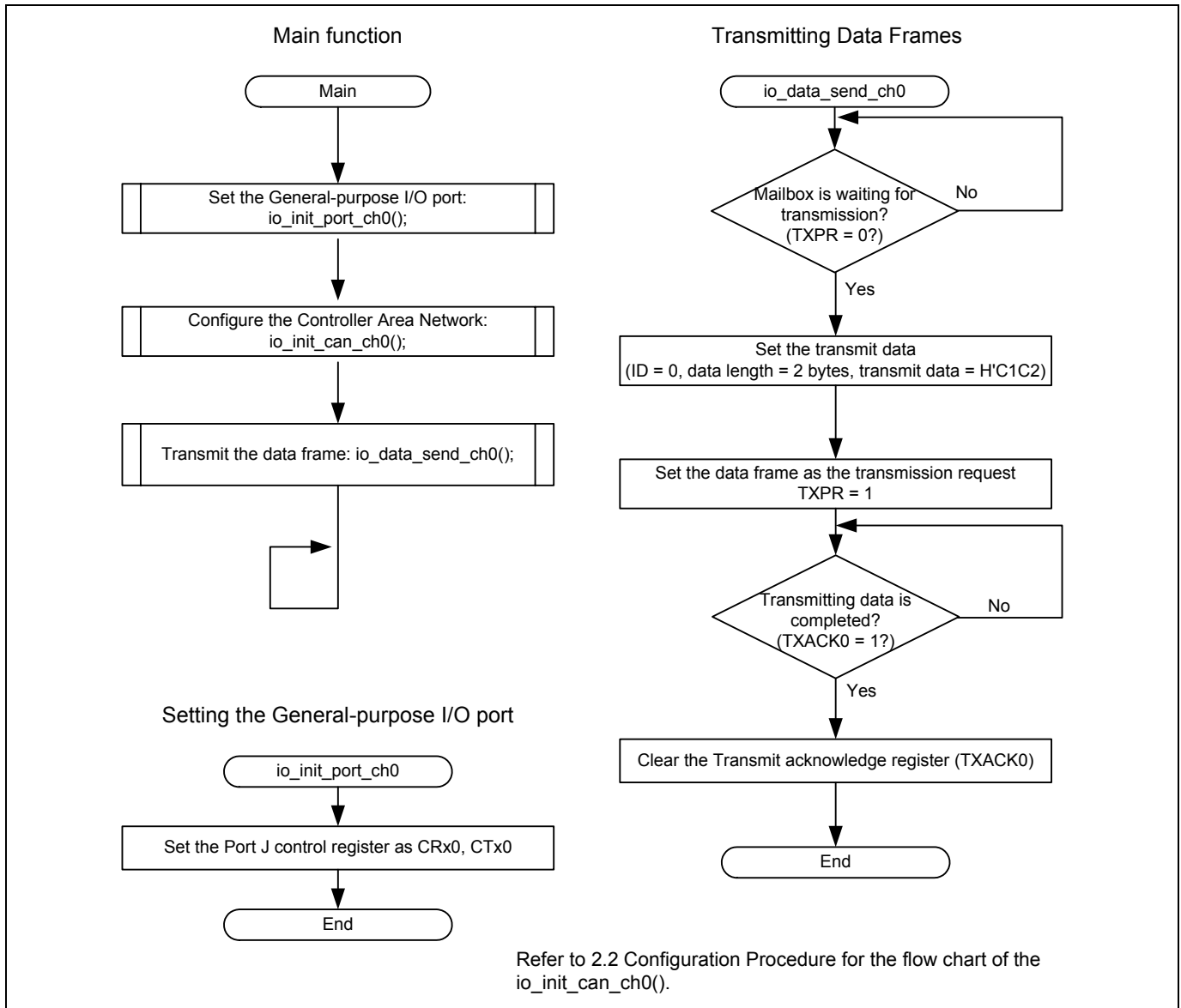


Figure 6 Sample Program Flow Chart

3. Sample Program Listing

3.1 Supplement to the Sample Program

As the capacity of the SH7264 large-capacity internal RAM varies as 1 MB or 640 KB, depending on the MCU type, the section alignment and register setting must be partly altered. To support both MCU types, this application note provides two types of sample programs (workspaces) for 1-MB RAM and 640-KB RAM.

As the MCU with 640-KB RAM must be write-enabled before writing data in the data-retention RAM, the System control register 5 (SYSCR5) is set to write-enable the RAM in the sample program for 640-KB RAM.

Review your product and use the appropriate workspace.

3.2 Sample Program Listing "main.c" (1/2)

```

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27     *****/
28     *   Copyright (C) 2009. Renesas Technology Corp., All Rights Reserved.
29     *""FILE COMMENT""***** Technical reference data *****
30     *   System Name : SH7264 Sample Program
31     *   File Name   : main.c
32     *   Abstract    : CAN Module Application (Data Frame Transmit and Receive)
33     *   Version     : 1.00.00
34     *   Device      : SH7262/SH7264
35     *   Tool-Chain  : High-performance Embedded Workshop (Ver.4.07.00).
36     *               : C/C++ compiler package for the SuperH RISC engine family
37     *               :                               (Ver.9.03 Release00).
38     *   OS          : None
39     *   H/W Platform: M3A-HS64G50 (CPU board) + M3A-HS64G02 (IO board)
40     *   Description :
41     *****/
42     *   History     : Nov.20,2009 ver.1.00.00
43     *""FILE COMMENT END""*****/
44     #include "iodefine.h"      /* SH7264 iodefine */
45

```

3.3 Sample Program Listing "main.c" (2/2)

```

46  /* ---- prototype declaration ---- */
47  void main(void);
48  extern void io_init_port_ch0(void);
49  extern void io_init_port_ch1(void);
50  extern void io_init_can_ch0(void);
51  extern void io_init_can_ch1(void);
52  extern void io_data_send_ch0(void);
53  extern void io_data_receive_ch1(void);
54
55  /*"FUNC COMMENT"*****
56  * ID          :
57  * Outline     : Sample program main
58  *-----
59  * Include     : "iodefine.h"
60  *-----
61  * Declaration : void main(void);
62  *-----
63  * Description : After configuring the Controller Area Network (RCAN), channel 0
64  *              : transmits the data frame, and channel 1 receives the data frame.
65  *-----
66  * Argument    : void
67  *-----
68  * Return Value : void
69  *-----
70  * Note        :
71  *"FUNC COMMENT END"*****/
72  void main(void)
73  {
74      /* ==== Initializing port ==== */
75      io_init_port_ch1();
76      io_init_port_ch0();
77
78      /* ==== Initializing CAN module ==== */
79      io_init_can_ch1();
80      io_init_can_ch0();
81
82      /* ==== CAN data frame transmission ==== */
83      io_data_send_ch0();
84
85      /* ==== CAN data frame reception ==== */
86      io_data_receive_ch1();
87
88      while(1){
89          /* loop */
90      }
91  }
92
93  /* End of File */

```

3.4 Sample Program Listing "can0.c" (1/5)

```

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29 *****"FILE COMMENT"***** Technical reference data *****
30 *   System Name : SH7264 Sample Program
31 *   File Name   : can0.c
32 *   Abstract    : CAN Module Application (Data Frame Transmit)
33 *   Version     : 1.00.00
34 *   Device      : SH7262/SH7264
35 *   Tool-Chain  : High-performance Embedded Workshop (Ver.4.07.00).
36 *               : C/C++ compiler package for the SuperH RISC engine family
37 *               :                               (Ver.9.03 Release00).
38 *   OS          : None
39 *   H/W Platform: M3A-HS64G50 (CPU board) + M3A-HS64G02 (IO board)
40 *   Description :
41 *****
42 *   History     : Nov.20,2009 ver.1.00.00
43 *****"FILE COMMENT END"*****/
44 #include "iodefine.h"          /* SH7264 iodefine */
45

```

3.5 Sample Program Listing "can0.c" (2/5)

```

46  /* ---- prototype declaration ---- */
47  void io_init_port_ch0(void);
48  void io_init_can_ch0(void);
49  void io_data_send_ch0(void);
50
51  /* ---- symbol definition ---- */
52  #define CAN_GSR3 0x0008
53  #define CAN_IRR0 0x0001
54  #define CAN_MB0 0x0001
55  #define CAN_MB1 0x0002
56  #define CAN_MB01 0x00000002
57
58  /*"FUNC COMMENT"*****
59  * ID          :
60  * Outline     : PORT setting
61  *-----
62  * Include     : "iodefine.h"
63  *-----
64  * Declaration : void io_init_port_ch0(void);
65  *-----
66  * Description : Set pin functions (CRx0 input, and CTx0 output).
67  *-----
68  * Argument    : void
69  *-----
70  * Return Value : void
71  *-----
72  * Note        :
73  *"FUNC COMMENT END"*****/
74  void io_init_port_ch0(void)
75  {
76      /* ==== Setting of PORT ==== */
77      PORT.PJCR0.BIT.PJ0MD = 0x1; /* Set CTx0 */
78      PORT.PJCR0.BIT.PJ1MD = 0x1; /* Set CRx0 */
79  }
80

```


3.6 Sample Program Listing "can0.c" (3/5)

```

81  /*"FUNC COMMENT"*****
82  * ID          :
83  * Outline     : RCAN setting
84  *-----
85  * Include     : "iodefine.h"
86  *-----
87  * Declaration : void io_init_can_ch0(void);
88  *-----
89  * Description : Configure the Controller Area Network (RCAN) channel 0.
90  *             : Transfer rate is set as 1 Mbps.
91  *-----
92  * Argument    : void
93  *-----
94  * Return Value : void
95  *-----
96  * Note        :
97  *"FUNC COMMENT END"*****/
98  void io_init_can_ch0(void)
99  {
100     int i, j;
101
102     /* ==== Setting of power down mode(RCAN) ==== */
103     CPG.STBCR5.BIT.MSTP53 = 0;          /* Module Standby Clear (RCAN0)*/
104
105     /* ==== Initializing CAN module ==== */
106     RCAN0.MCR.WORD |= 0x0001;          /* CAN Interface reset mode */
107     while((RCAN0.IRR.WORD & CAN_IRR0) != CAN_IRR0){
108         /* Reset state waiting */
109     }
110     /* ==== IRR = 1, GSR = 1 (Auto SET) ==== */
111
112     /* ---- Clear IRR0 ---- */
113     RCAN0.IRR.WORD = 0x0001;
114
115     /* ---- RCAN mode selection(MCR15) ---- */
116     RCAN0.MCR.WORD |= 0x8000;          /* RCAN is not same as HCAN2 */
117
118     /* ---- Disable all can interrupt ---- */
119     RCAN0.IMR.WORD = 0xffff;
120

```

3.7 Sample Program Listing "can0.c" (4/5)

```

121     /* ----All mailbox init ---- */
122     for(i = 0; i < 32; i++){
123         RCAN0.MB[i].CONTROL0.LONG = 0x00000000;
124         RCAN0.MB[i].LAFM.LONG = 0x00000000;
125         for(j = 0; j < 8; j++){
126             RCAN0.MB[i].MSG_DATA[j] = 0x00;
127         }
128     }
129
130     /* ---- Config mailbox0 as reception slot ---- */
131     RCAN0.MB[0].CONTROL1.WORD = 0x0200;      /* CAN receive data and remote frame */
132     RCAN0.MB[0].CONTROL0.LONG = 0x00000000; /* Initialize the Message Control Field */
133     RCAN0.MB[0].LAFM.LONG = 0x00000000;
134     for(i = 0; i < 8; i++){                  /* data clear */
135         RCAN0.MB[0].MSG_DATA[i] = 0x00;
136     }
137     /* ---- Config mailbox1 as transmission slot ---- */
138     RCAN0.MB[1].CONTROL1.WORD = 0x0002;      /* CAN send data or remote frame, dlc=2 */
139     RCAN0.MB[1].CONTROL0.LONG = 0x00000000; /* standard data frame, id=0x000 */
140     RCAN0.MB[1].LAFM.LONG = 0x00000000;
141     for(i = 0; i < 8; i++){                  /* data clear */
142         RCAN0.MB[1].MSG_DATA[i] = 0x00;
143     }
144
145     /* ---- Config baudrate ---- */
146     RCAN0.BCR1.WORD = 0x9600;      /* tsg1=9(10bit),tsg2=6(7bit),sjw=0(1bit),bsp=0 */
147     RCAN0.BCR0.WORD = 0x0000;      /* 1 Mbps */
148     // RCAN0.BCR0.WORD = 0x0001;    /* 500 Kbps */
149     // RCAN0.BCR0.WORD = 0x0003;    /* 250 Kbps */
150     // RCAN0.BCR0.WORD = 0x0007;    /* 125 Kbps */
151
152     /* ---- Clear interrupt flags ---- */
153     RCAN0.IRR.WORD = 0xffff;
154
155     /* ---- Clear reset and halt ---- */
156     RCAN0.MCR.WORD &= 0xf8fc;      /* MCR0, MCR1 clear */
157     while( (RCAN0.GSR.WORD & CAN_GSR3) != 0x0000 ){
158         /* Reset state is end */
159     }
160 }
161

```

3.8 Sample Program Listing "can0.c" (5/5)

```

162  /*"FUNC COMMENT"*****
163  * ID          :
164  * Outline     : Data frame transmit
165  *-----
166  * Include     : "iodef.h"
167  *-----
168  * Declaration : void io_data_send_ch0(void);
169  *-----
170  * Description : Transmit 2-byte data stored in mailbox 1.
171  *-----
172  * Argument    : void
173  *-----
174  * Return Value : void
175  *-----
176  * Note        :
177  *"FUNC COMMENT END"*****/
178  void io_data_send_ch0(void)
179  {
180      /* ---- Transmission waiting ---- */
181      while((RCAN0.TXPR0.LONG & CAN_MB01) == CAN_MB01){
182      }
183
184      /* ---- Transmission data set ---- */
185      RCAN0.MB[1].CONTROL1.WORD = 0x0002;          /* CAN send data or remote frame, dlc=2 */
186      RCAN0.MB[1].CONTROL0.LONG = 0x00000000;     /* standard data frame, id=0x000 */
187      RCAN0.MB[1].MSG_DATA[0] = 0xc1;
188      RCAN0.MB[1].MSG_DATA[1] = 0xc2;
189
190      /* ---- Transmit the data ---- */
191      RCAN0.TXPR0.LONG = CAN_MB01;
192
193      /* ---- Transmission completion waiting ---- */
194      while((RCAN0.TXACK0.WORD & CAN_MB1) != CAN_MB1){
195      }
196
197      /* ---- Transmission completion flag clear ---- */
198      RCAN0.TXACK0.WORD = CAN_MB1;
199  }
200
201  /* End of File */

```

4. References

- Software Manual
SH-2A/SH2A-FPU Software Manual Rev. 3.00
The latest version of the software manual can be downloaded from the Renesas website.
- Hardware Manual
SH7262 Group, SH7264 Group Hardware Manual Rev. 2.00
The latest version of the hardware manual can be downloaded from the Renesas website.

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Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jan 08, 2010	—	First edition issued

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