
SH7216 Group

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Rev.1.02

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Controller Area Network, Configuration to Transmit Remote Frames

Summary

This application note describes the configuration example of the SH7216 microcomputers (MCUs) to transmit remote frames using the controller area network (RCAN-ET).

Target Device

SH7216 MCU

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1. Introduction

1.1 Specifications

- Transmission speed: 1 Mbps
- Receive mailbox: Mailbox 1
- Transmit mailbox: Mailbox 0
- Transmits a remote frame with following specifications
Identifier: 0; standard remote frame; DLC: 2
- Receives a 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	SH7216
	Internal clock: 200 MHz
Operating Frequencies	Bus clock: 50 MHz
	Peripheral clock: 50 MHz
Integrated Development Environment	Renesas Electronics Corporation High-performance Embedded Workshop Ver.4.05.01
C compiler	Renesas Electronics SuperH RISC engine Family C/C++ Compiler Package Ver.9.03 Release 00
Compiler options	-cpu=sh2afpu -fpu=single -include="\$(WORKSPDIR)\inc" - 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:

- SH7216 Group Controller Area Network, Configuration to Receive Data Frames
- SH7216 Group Controller Area Network, Configuration to Transmit Data Frames
- SH7216 Group Controller Area Network, Configuration to Receive Remote Frames

2. Applications

This application note uses the CAN module to transmit a standard remote frame with identifier 0, DLC: 2. Then, it receives a standard data frame with identifier 0.

2.1 CAN Overview

The SH7216 includes the CAN module which is compliant with the CAN protocol, version 2.0B active, and ISO 11898.

The CAN module has 15 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 the Controller Area Network chapter in the SH7216 Group Hardware Manual.

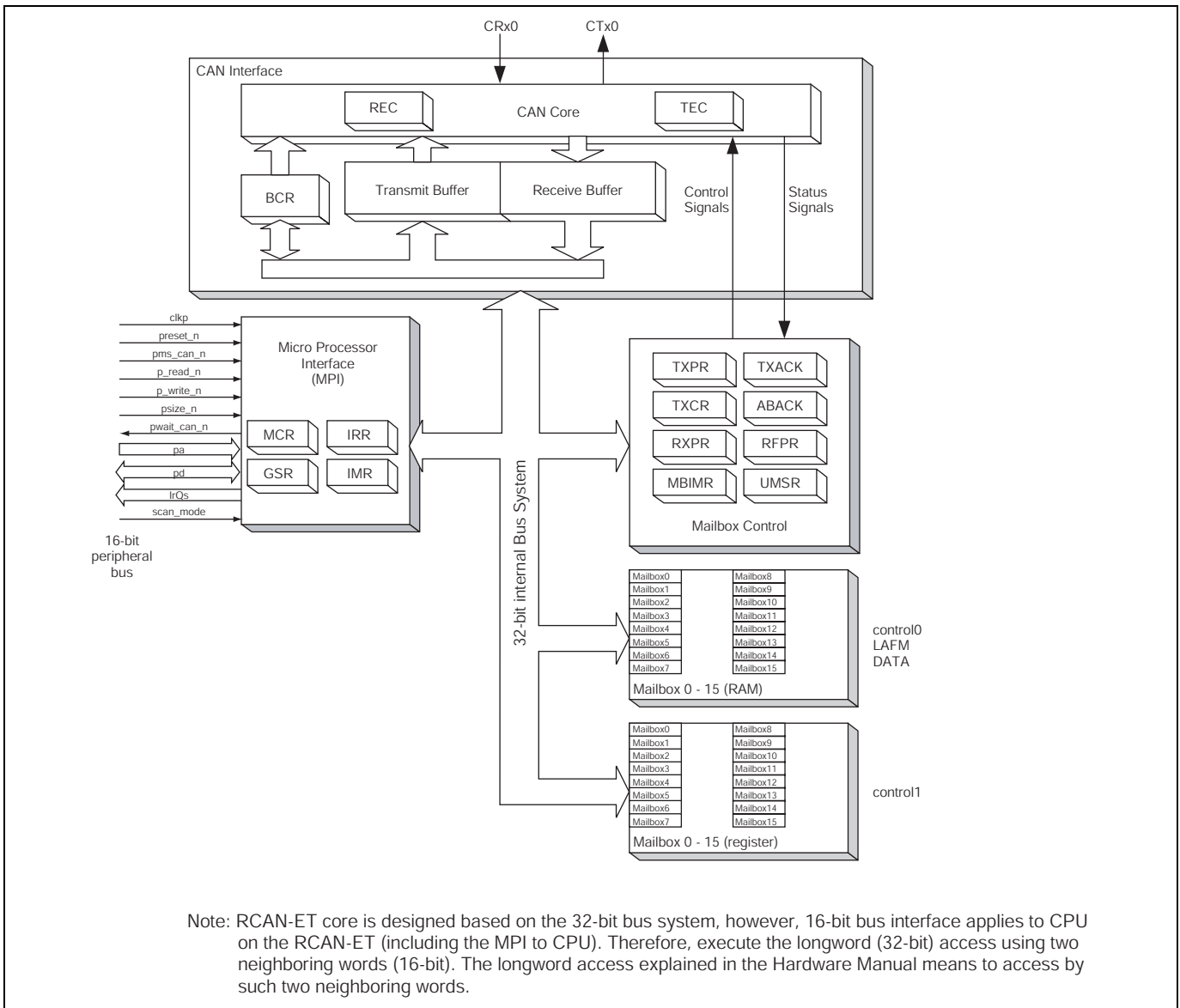


Figure 1 CAN Block Diagram

2.2 Configuration Procedure

This section describes how to configure the SH7216 MCU to receive remote frames using the CAN module.

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 configures mailbox 1 for both transmitting data frames and receiving remote frames. **Figure 2** and **Figure 3** show the flow charts for configuring the CAN module. For details on register settings, refer to the SH7216 Group Hardware Manual.

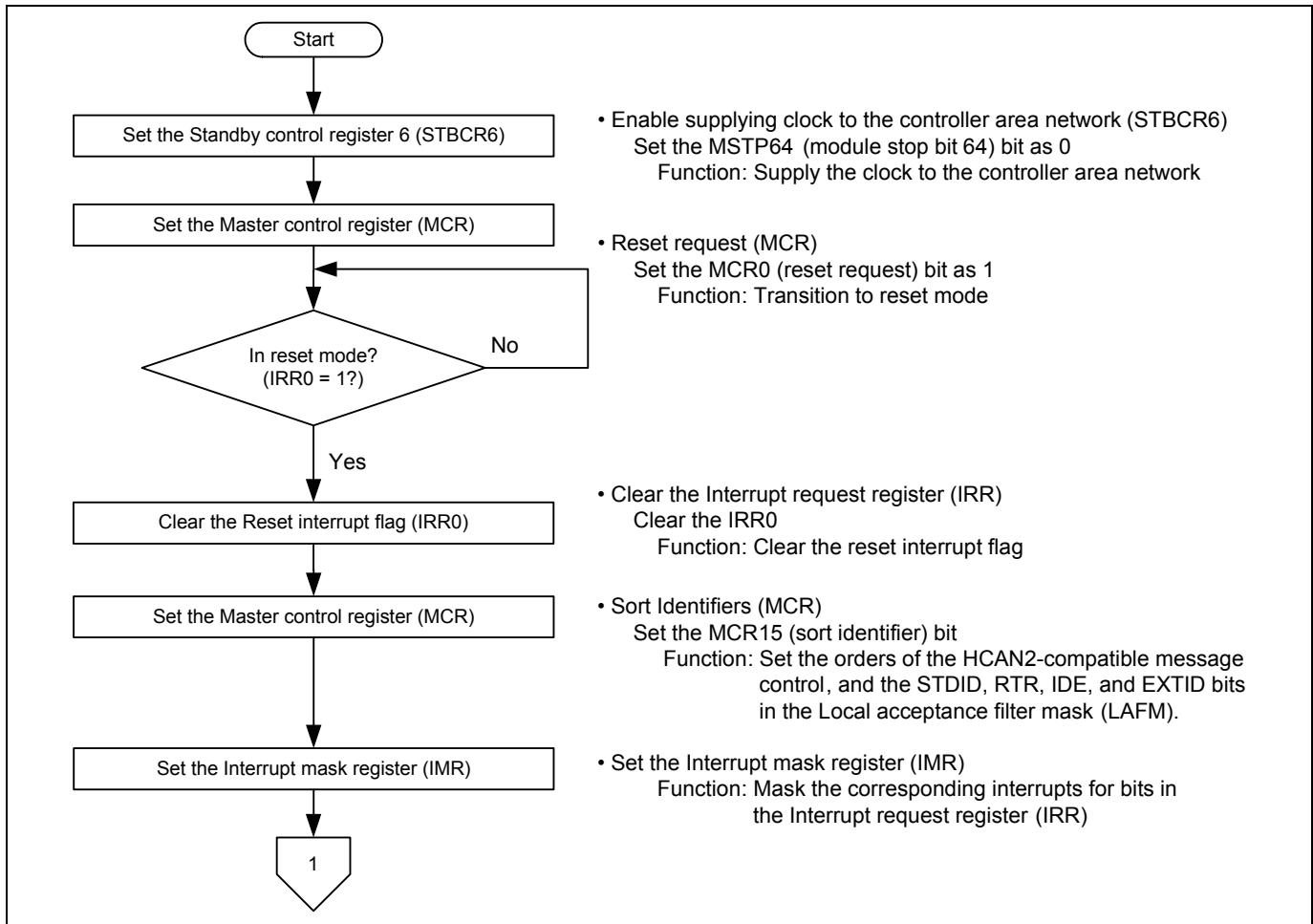


Figure 2 Flow Chart for Configuring the CAN Module (1/2)

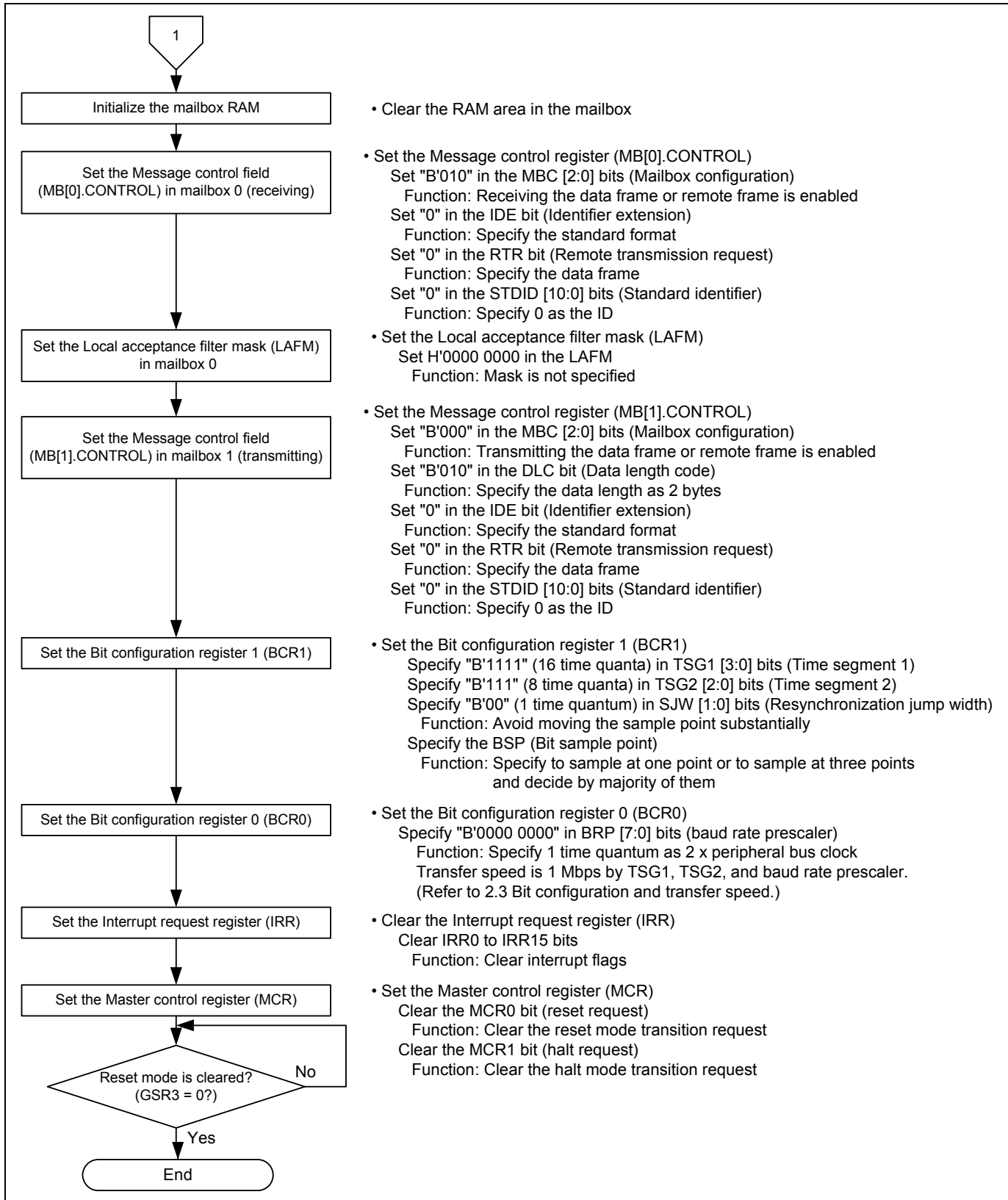


Figure 3 Flow Chart for Configuring the CAN Module (2/2)

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 $SS = T_q$, $PRSEG = 8 T_q$, $PHSEG1 = 8 T_q$, and $PHSEG2 = 8 T_q$.

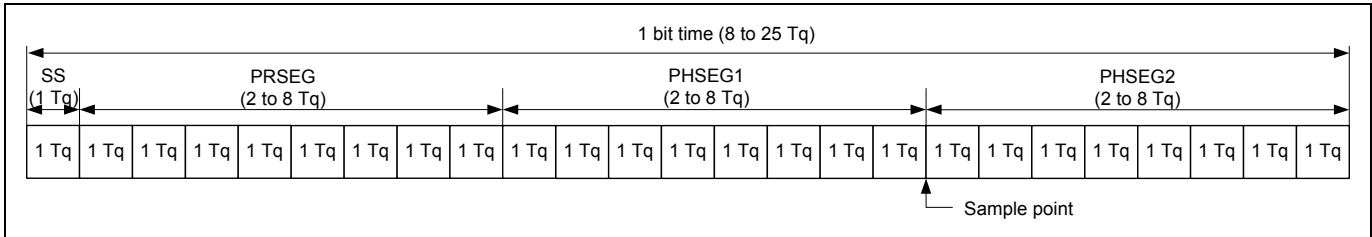


Figure 4 Bit Configuration

The CAN module sets the number of T_q s of $PRSEG + PHSEG1$ to bits TSG1 [3:0] in the BCR1, 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.

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 SH7216 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:

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

Following is the restriction 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 50 MHz, BRP = 0, TSEG 1 = 15, and TSEG2 = 7, the transmission speed is calculated as follows:

$$\text{Transmission speed} = \frac{50M}{(2 \times (0 + 1) \times (15 + 1) + (7 + 1) + 1)} = 1M...1 \text{ Mbps}$$

2.4 Sample Program Operation

This sample program transmits a standard remote frame with identifier 0, DLC: 2 from mailbox 1 at 1 Mbps. Then it receives a standard data frame with identifier 0 in mailbox 0. **Figure 5** shows the transmission waveform of a remote frame.

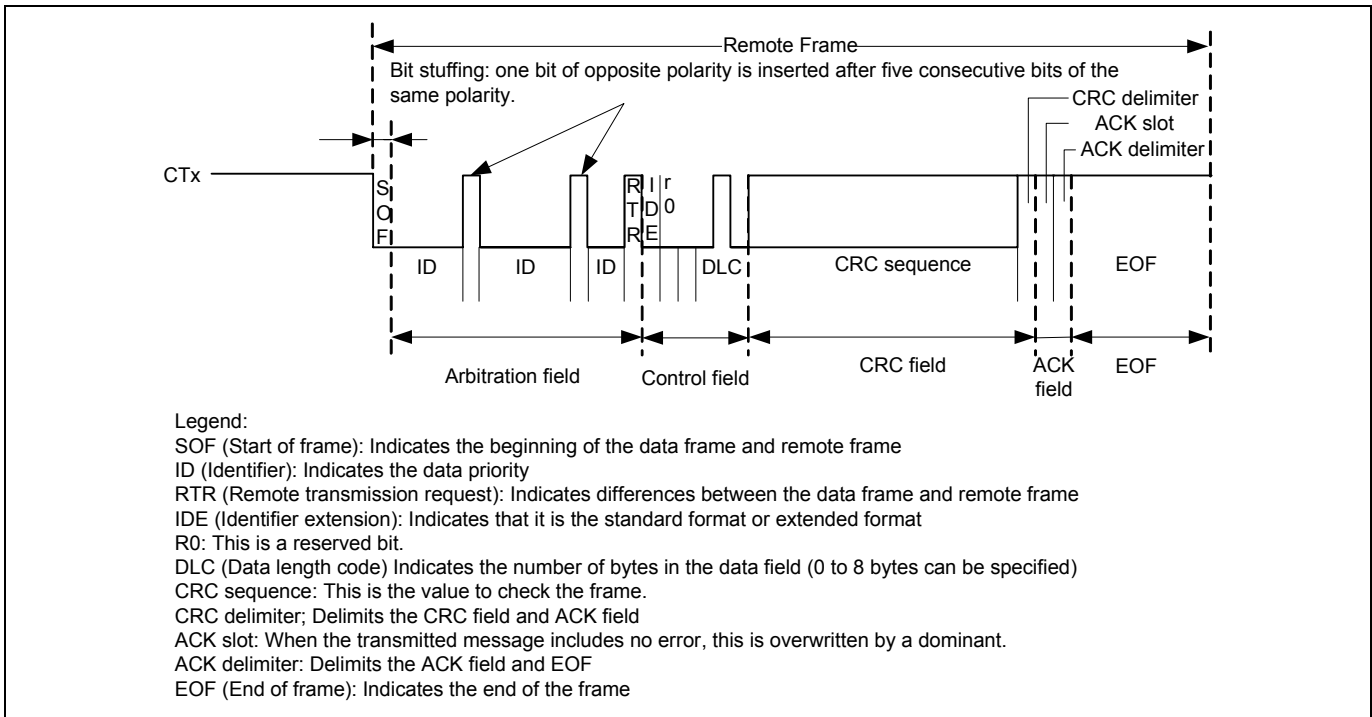


Figure 5 CAN Transmission Waveform

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.

Table 1 CAN Setting

Register Name	Address	Setting	Description
Standby control register (STBCR6)	H'FFFE 041C	H'8F	MSTP64 = "0": CAN is operating
Master control register (MCR)	H'FFFF D000	H'0001	MCR0 = "1": Reset mode transition request
		H'8001	MCR15 = "1": The order of the RCAN-ET message and of the HCAN2 message are different
		H'8000	MCR0 = "0": Reset mode is cleared
Interrupt mask register(IMR)	H'FFFF D00A	H'FFFF	All interrupts in the controller area network is disabled
Bit configuration register 1 (BCR1)	H'FFFF D004	H'F700	TSEG1 [3:0] = "B'1111": PRSEG + PHSEG1 = 16 Tq TSEG2 [2:0] = "B'111": PHSEG2 = 8 Tq SJW="0": SJW = 1 Tq BSP = "0": Bit sampling at one point
Bit configuration register 0 (BCR0)	H'FFFF D006	H'0000	BRP [7:0] = "0": 1 Tq = 2 x Pφ
Message control field in mailbox 0 (MB[0].CONTROL1H)	H'FFFF D110	H'0200	MBC [2:0] = "B'010": Receiving the data frame or remote frame is enabled
Message control field in mailbox 1 (MB[1].CONTROL1H)	H'FFFF D130	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
Mailbox 1 control field in mailbox 0 (MB[1].CONTROL0H)	H'FFFF D120	H'4000 0000	IDE = "0": Standard format RTR = "1": Remote frame STDID [10:0] = "0": Standard identifier is 0
Local acceptance filter mask in mailbox 0 (MB[0].LAFMH)	H'FFFF D104	H'0000 0000	Clear: Mask is not specified
Transmit pending register 1 (TXPR1)	H'FFFF D020	H'0000 0002	TXPR [31:0] = H'0000 0002: A transmission request occurred in mailbox 1
Transmit acknowledge register 0 (TXACK0)	H'FFFF D032	H'0002	Clear the transmit acknowledge flag
Data frame receive pending register (RxPR0)	H'FFFF D042	H'0001	RXPR[31:0] = H'0001: Clear the data frame receive pending flag

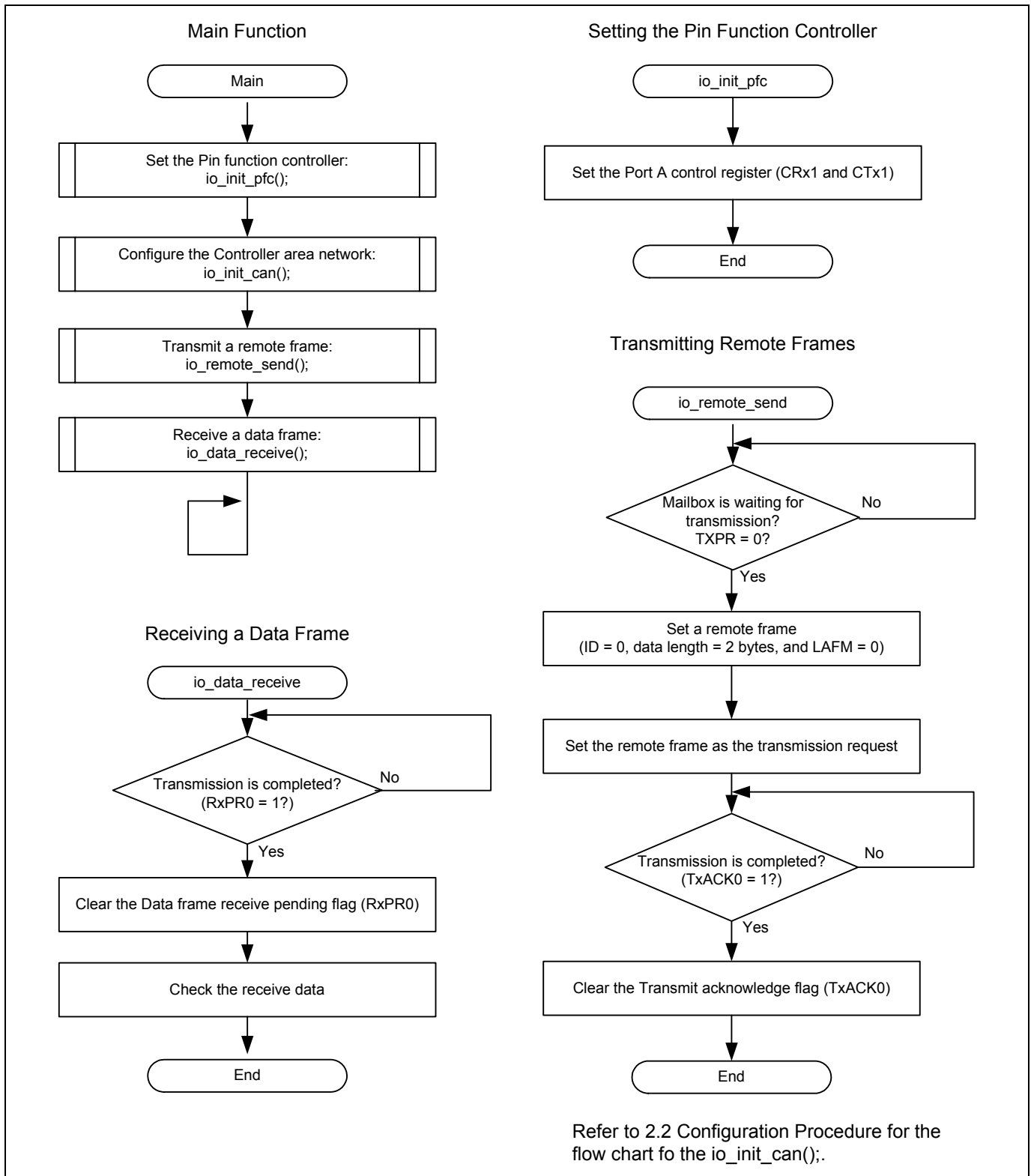


Figure 6 Sample Program Flow Chart

3. Sample Program Listing

3.1 Sample Program Listing "main.c" (1/7)

```

1  /*****
2  *   DISCLAIMER
3  *
4  *   This software is supplied by Renesas Electronics Corp. and is only
5  *   intended for use with Renesas products.  No other uses are authorized.
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24 *   By using this software, you agree to the additional terms and
25 *   conditions found by accessing the following link:
26 *   http://www.renesas.com/disclaimer
27 *****/
28 *   Copyright (C) 2009(2010) Renesas Electronics Corporation.
29 *   All rights reserved.
30 *"FILE COMMENT"***** Technical reference data *****
31 *   System Name   : SH7216 Sample Program
32 *   File Name     : main.c
33 *   Abstract      : CAN Module Application (Remote Frame Transmit).
34 *   Version       : 1.01.00
35 *   Device        : SH7216
36 *   Tool-Chain    : High-performance Embedded Workshop (Ver.4.07.00).
37 *                 : C/C++ compiler package for the SuperH RISC engine family
38 *                 :                               (Ver.9.03 Release00).
39 *   OS            : None
40 *   H/W Platform  : R0K572167 (CPU board)
41 *   Description   :
42 *****/
43 *   History       : Jun.29,2009 Ver.1.00.00
44 *                 : Jun.21,2010 Ver.1.01.00  Changing the corporate name and
45 *                 :                               the copyright format
46 *                 :                               - Dividing FRQCR setting into
47 *                 :                               subroutine "io_set_cpg_frqcr"
48 *                 :                               which is allocated to on-chip RAM
49 *                 :                               - Adding processing of section copy
50 *                 :                               function "_seccpy"

```

3.2 Sample Program Listing "main.c" (2/7)

```

51  *"FILE COMMENT END"*****
52  #include "iodefine.h"
53
54  /* ---- prototype declaration ---- */
55  void main(void);
56  void io_init_pfc(void);
57  void io_init_can(void);
58  void io_remote_send(void);
59  void io_data_receive(void);
60
61  /* ---- symbol definition ---- */
62  #define CAN_GSR3 0x0008
63  #define CAN_IRR0 0x0001
64  #define CAN_MB0 0x0001
65  #define CAN_MB1 0x0002
66  #define CAN_MB01 0x00000002
67
68  /* ---- RAM allocation variable declaration ---- */
69  unsigned char  nIDE = 0;          /* ide */
70  unsigned char  nRTR = 0;         /* rtr */
71  unsigned char  nDLC = 0;         /* dlc */
72  unsigned int   nSID = 0;         /* sid */
73  unsigned int   nEID = 0;         /* eid */
74  unsigned char  gRcv_data[8];     /* data of message */
75
76  /*"FUNC COMMENT"*****
77  * ID          :
78  * Outline     : Sample program main
79  *-----
80  * Include     : "iodefine.h"
81  *-----
82  * Declaration : void main(void);
83  *-----
84  * Description : Set the PFC and configure the RCAN to receive a remote frame
85  *              : and transmit a data frame.
86  *-----
87  * Argument    : void
88  *-----
89  * Return Value : void
90  *-----
91  * Note        :
92  *"FUNC COMMENT END"*****
93  void main(void)
94  {
95      /* ==== Setting of PFC ==== */
96      io_init_pfc();
97

```

3.3 Sample Program Listing "main.c" (3/7)

```

98     /* ==== Initializing CAN module ==== */
99     io_init_can();
100
101     /* ==== CAN remote frame transmission ==== */
102     io_remote_send();
103
104     /* ==== CAN data frame reception ==== */
105     io_data_receive();
106
107     while(1){
108         /* loop */
109     }
110 }
111
112 /*"FUNC COMMENT"*****
113 * ID          :
114 * Outline     : PFC setting
115 *-----
116 * Include     : "iodefine.h"
117 *-----
118 * Declaration : void io_init_pfc(void);
119 *-----
120 * Description : Set pin functions.
121 *             : CRx0 input, CTx0 output
122 *-----
123 * Argument    : void
124 *-----
125 * Return Value : void
126 *-----
127 * Note        :
128 *"FUNC COMMENT END"*****/
129 void io_init_pfc(void)
130 {
131     /* ==== Setting of PFC ==== */
132     /* ---- Port A control register L2 ---- */
133     PFC.PACRL1.BIT.PA0MD = 0x5;    /* Set CRx0 */
134     PFC.PACRL1.BIT.PA1MD = 0x5;    /* Set CTx0 */
135 }
136

```

3.4 Sample Program Listing "main.c" (4/7)

```

137  /*"FUNC COMMENT"*****
138  * ID      :
139  * Outline   : RCAN setting
140  *-----
141  * Include    : "iodefine.h"
142  *-----
143  * Declaration : void io_init_can(void);
144  *-----
145  * Description : Configure the Controller area network (RCAN).
146  *              : Transfer rate is at 1 Mbps.
147  *              : Mailbox 0: Receiving a data frame is enabled
148  *              : Mailbox 1: Transmitting a remote frame is enabled
149  *-----
150  * Argument   : void
151  *-----
152  * Return Value : void
153  *-----
154  * Note       :
155  *"FUNC COMMENT END"*****/
156  void io_init_can(void)
157  {
158      int i, j;
159
160      /* ==== Setting of power down mode(RCAN) ==== */
161      STB.CR6.BYTE = 0x8f;          /* Module Standby Clear */
162                                  /* RCAN */
163      /* ==== Initializing CAN module ==== */
164      RCANET.MCR.WORD |= 0x0001;   /* CAN Interface reset mode */
165      while((RCANET.IRR.WORD & CAN_IRR0) != CAN_IRR0){
166          /* Reset state waiting */
167      }
168      /* ==== IRR = 1, GSR = 1 (Auto SET) ==== */
169
170      /* ---- Clear IRR0 ---- */
171      RCANET.IRR.WORD = 0x0001;
172
173      /* ---- RCAN mode selection(MCR15) ---- */
174      RCANET.MCR.WORD |= 0x8000;   /* RCAN-ET is not same as HCAN2 */
175

```

3.5 Sample Program Listing "main.c" (5/7)

```

176     /* ---- Disable all can interrupt ---- */
177     RCANET.IMR.WORD = 0xffff;
178
179     /* ----All mailbox init ---- */
180     for(i = 0; i < 16; i++){
181         RCANET.MB[i].CTRL0.LONG = 0x00000000;
182         RCANET.MB[i].LAFM.LONG = 0x00000000;
183         for(j = 0; j < 8; j++){
184             RCANET.MB[i].MSG_DATA[j] = 0x00;
185         }
186     }
187
188     /* ---- Config mailbox0 as reception slot ---- */
189     RCANET.MB[0].CTRL1.WORD = 0x0200;      /* Receiving a data frame or remote frame */
190                                           /* is enabled */
191     RCANET.MB[0].CTRL0.LONG = 0x00000000; /* Initialize the Message Control Field */
192     RCANET.MB[0].LAFM.LONG = 0x00000000;
193     for(i = 0; i < 8; i++){                /* Data clear */
194         RCANET.MB[0].MSG_DATA[i] = 0x00;
195     }
196     /* ---- Config mailbox1 as transmission slot ---- */
197     RCANET.MB[1].CTRL1.WORD = 0x0002;      /* Transmitting a data frame or remote frame */
198                                           /* with dlc=2 is enabled */
199     RCANET.MB[1].CTRL0.LONG = 0x00000000; /* Standard data frame, id=0x000 */
200     RCANET.MB[1].LAFM.LONG = 0x00000000;
201     for(i = 0; i < 8; i++){                /* Data clear */
202         RCANET.MB[1].MSG_DATA[i] = 0x00;
203     }
204
205     /* ---- Config baudrate ---- */
206     RCANET.BCR1.WORD = 0xf700;             /* tsg1=15(16-bit),tsg2=7(8-bit),sjw=0(1-bit),bsp=0 */
207     RCANET.BCR0.WORD = 0x0000;           /* 1 Mbps */
208     // RCANET.BCR0.WORD = 0x0001;        /* 500 Kbps */
209     // RCANET.BCR0.WORD = 0x0003;        /* 250 Kbps */
210     // RCANET.BCR0.WORD = 0x0007;        /* 125 Kbps */
211
212     /* ---- Clear interrupt flags ---- */
213     RCANET.IRR.WORD = 0xffff;
214
215     /* ---- Clear reset and halt ---- */
216     RCANET.MCR.WORD &= 0xf8fc;
217
218     while( (RCANET.GSR.WORD & CAN_GSR3) != 0x0000 ){
219         /* Reset state is end */
220     }
221 }
222

```

3.6 Sample Program Listing "main.c" (6/7)

```
223  /*"FUNC COMMENT"*****
224  * ID      :
225  * Outline : Remote frame transmit
226  *-----
227  * Include : "iodefine.h"
228  *-----
229  * Declaration : void io_remote_send(void);
230  *-----
231  * Description : Transmits a remote frame.
232  *-----
233  * Argument   : void
234  *-----
235  * Return Value : void
236  *-----
237  * Note       :
238  *"FUNC COMMENT END"*****/
239 void io_remote_send(void)
240 {
241     /* ---- Transmission waiting ---- */
242     while((RCANET.TXPR10.LONG & CAN_MB01) == CAN_MB01){
243     }
244
245     /* ---- Transmission data set ---- */
246     RCANET.MB[1].CTRL1.WORD = 0x0002; /* Transmitting data frame or remote frame */
247                                     /* with dlc=2 is enabled */
248     RCANET.MB[1].CTRL0.LONG = 0x40000000; /* Standard remote frame, id=0x000 */
249
250     /* ---- Transmit the data ---- */
251     RCANET.TXPR10.LONG = CAN_MB01;
252
253     /* ---- Transmission completion waiting ---- */
254     while((RCANET.TXACK0.WORD & CAN_MB1) != CAN_MB1){
255     }
256
257     /* ---- Transmit pending flag clear ---- */
258     RCANET.TXACK0.WORD = CAN_MB1;
259 }
260
```

3.7 Sample Program Listing "main.c" (7/7)

```
261  /*"FUNC COMMENT"*****
262  * ID      :
263  * Outline : Data frame receive
264  *-----
265  * Include : "iodefine.h"
266  *-----
267  * Declaration : void io_data_receive(void);
268  *-----
269  * Description : Receives a data frame.
270  *-----
271  * Argument   : void
272  *-----
273  * Return Value : void
274  *-----
275  * Note       :
276  *"FUNC COMMENT END"*****/
277 void io_data_receive(void)
278 {
279     int i;
280
281     /* ---- Reception completion waiting ---- */
282     while((RCANET.RXPR0.WORD & CAN_MB0) != CAN_MB0){
283     }
284
285     /* ---- Receive data storage ---- */
286     nIDE = RCANET.MB[0].CTRL0.BIT.IDE;
287     nRTR = RCANET.MB[0].CTRL0.BIT.RTR;
288     nDLC = RCANET.MB[0].CTRL1.BIT.DLC;
289     nSID = RCANET.MB[0].CTRL0.BIT.STDID;
290     nEID = RCANET.MB[0].CTRL0.BIT.EXDID;
291     if(nDLC > 8){
292         nDLC = 8;
293     }
294     for(i = 0; i < nDLC; i++){
295         gRcv_data[i] = RCANET.MB[0].MSG_DATA[i];
296     }
297
298     /* ---- Receive pending flag clear ---- */
299     RCANET.RXPR0.WORD = CAN_MB0;
300 }
301
302 /* 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
SH7216 Group Hardware Manual Rev. 3.00
The latest version of the hardware manual can be downloaded from the Renesas website.

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Jul. 24, 2009	—	First edition issued
1.01	Jun. 24, 2010	—	Changing the corporate name and the copyright format
1.02	Jan.16, 2012	—	Changing the R-number and the copyright format.

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins

Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

- The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

The state of the product is undefined at the moment when power is supplied.

- The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

- The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

After applying a reset, only release the reset line after the operating clock signal has become stable.

When switching the clock signal during program execution, wait until the target clock signal has stabilized.

- When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

Before changing from one product to another, i.e. to one with a different type number, confirm that the change will not lead to problems.

- The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

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