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32176 Group

Application of the CAN Module (Remote Frame Transmission)

1. Overview

The sample task described in this document uses the 32176 Group microcomputer's on-chip CAN (Controller Area Network) module.

2. Introduction

The sample task described in this document uses the following microcomputers, under the respective conditions.

- Microcomputer: 32176 Group (M32176FnVFP, M32176FnTFP)
- Operating Frequency: 20 to 40 MHz (The sample program is compiled assuming a frequency of 40 MHz.)
- Operating Board: Starter kit for 32176 Group

3. Explanation of the Technology Applied

3.1 Outline of the CAN Module

The 32176 includes a 2-channel Full CAN module which conforms to the CAN Specification V2.0B active. By using 16 message slots and three mask registers effectively, the load on the CPU during data processing can be reduced.

For details on CAN functions, refer to the 32176 Group User's Manual and the 32176 Group Outline of the CAN Module Application Note.

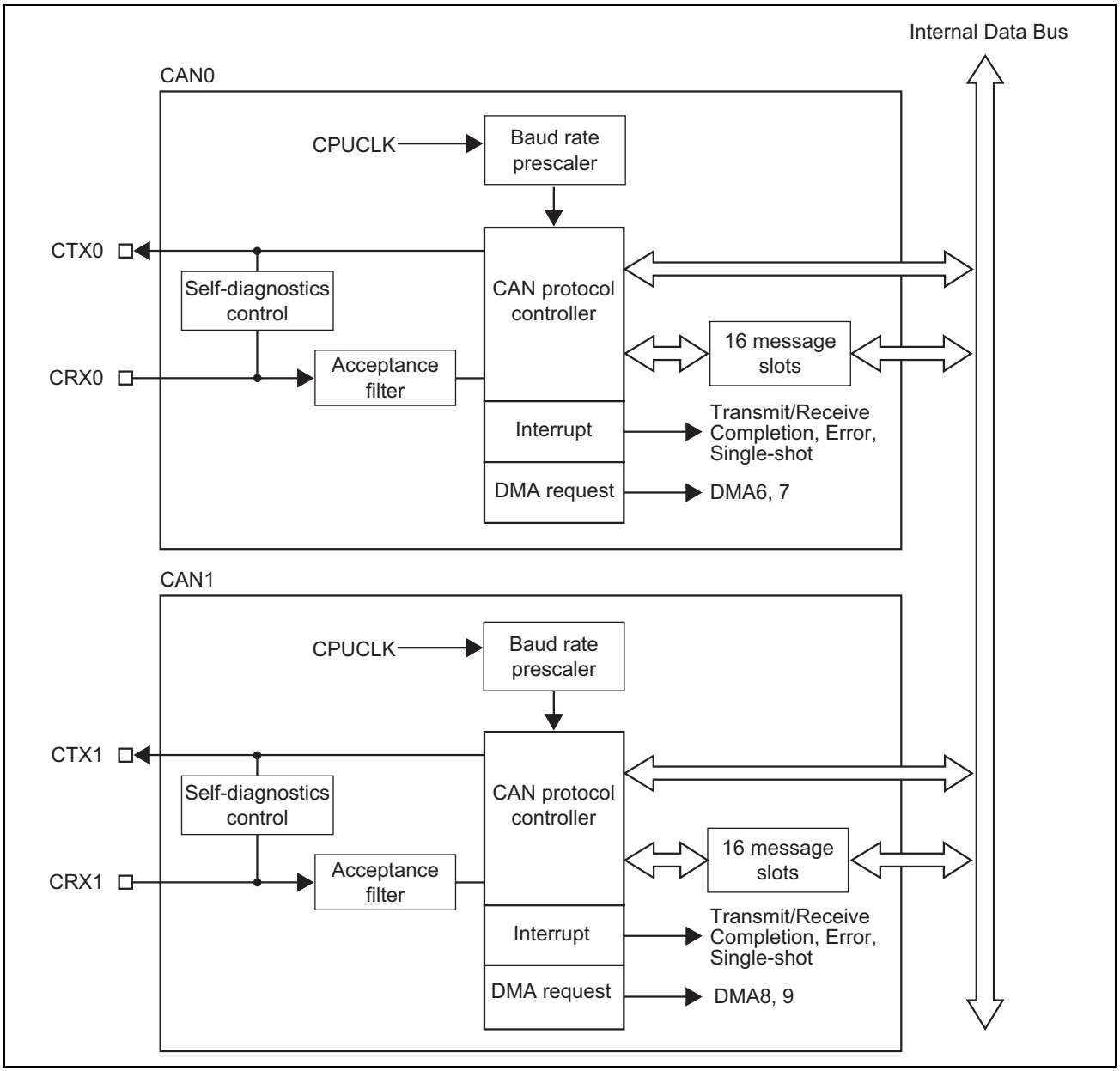

Figure 3.1.1 CAN Module Block Diagram

4. CAN Remote Frame Transmission Sample Program

4.1 Outline of the Sample Program

In this sample program, the CAN bus speed is at 125 kbps, and the standard format Remote Frame of ID: 0, DLC: 1, are transmitted once from the CAN0 slot 0 and the data frame sent back from other node is received.
After receiving data frame, the data is read out on the RAM.

Interrupts and DMA transmission are not used.

4.2 Initial Setting Processing

Figure 4.2.1 shows the flowchart for the CAN module initial settings.

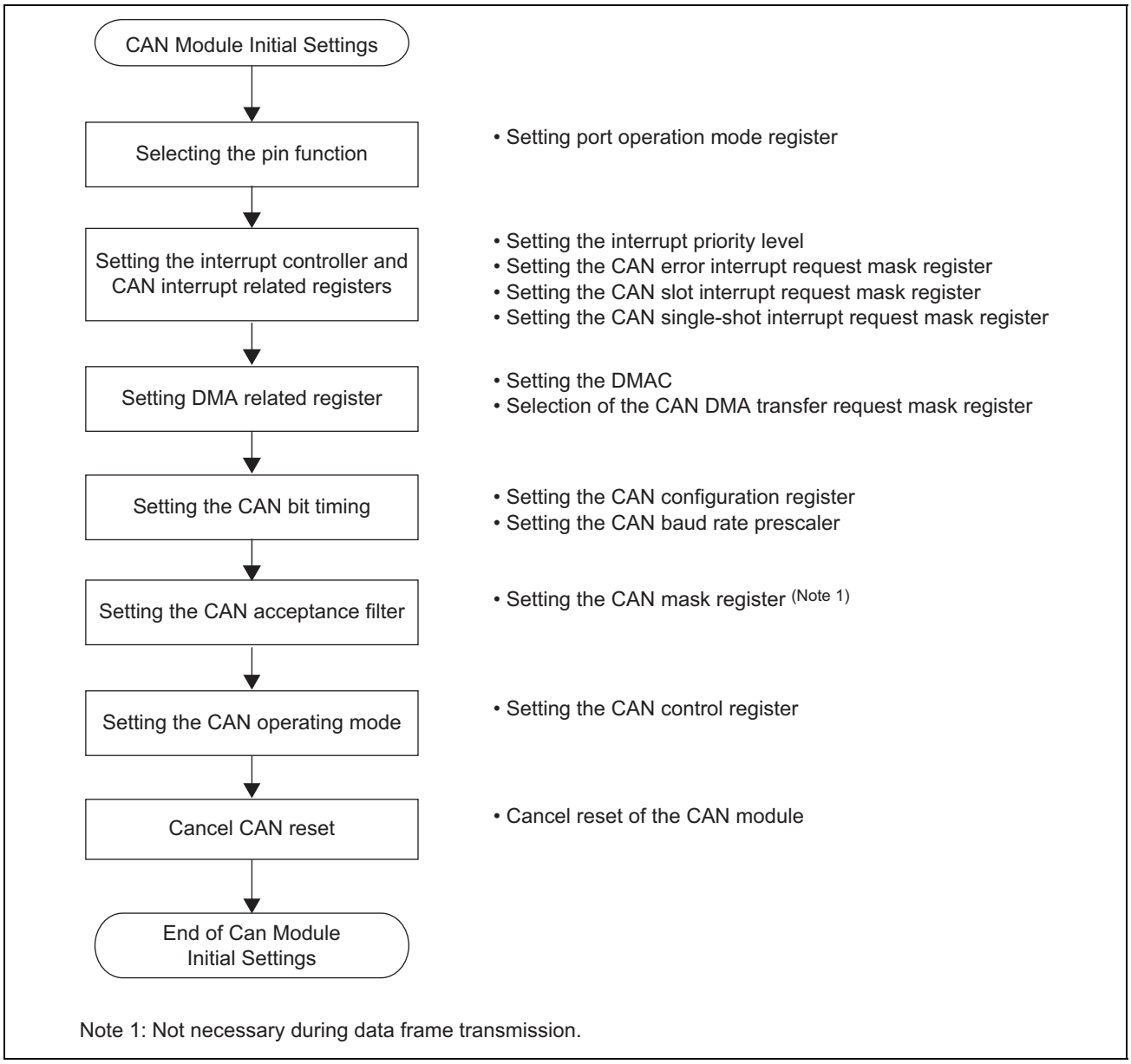

Figure 4.2.1 CAN Module Initial Setting

4.3 Transmission Processing

Figure 4.3.1 shows the flowchart for Remote Frame transmission processing.

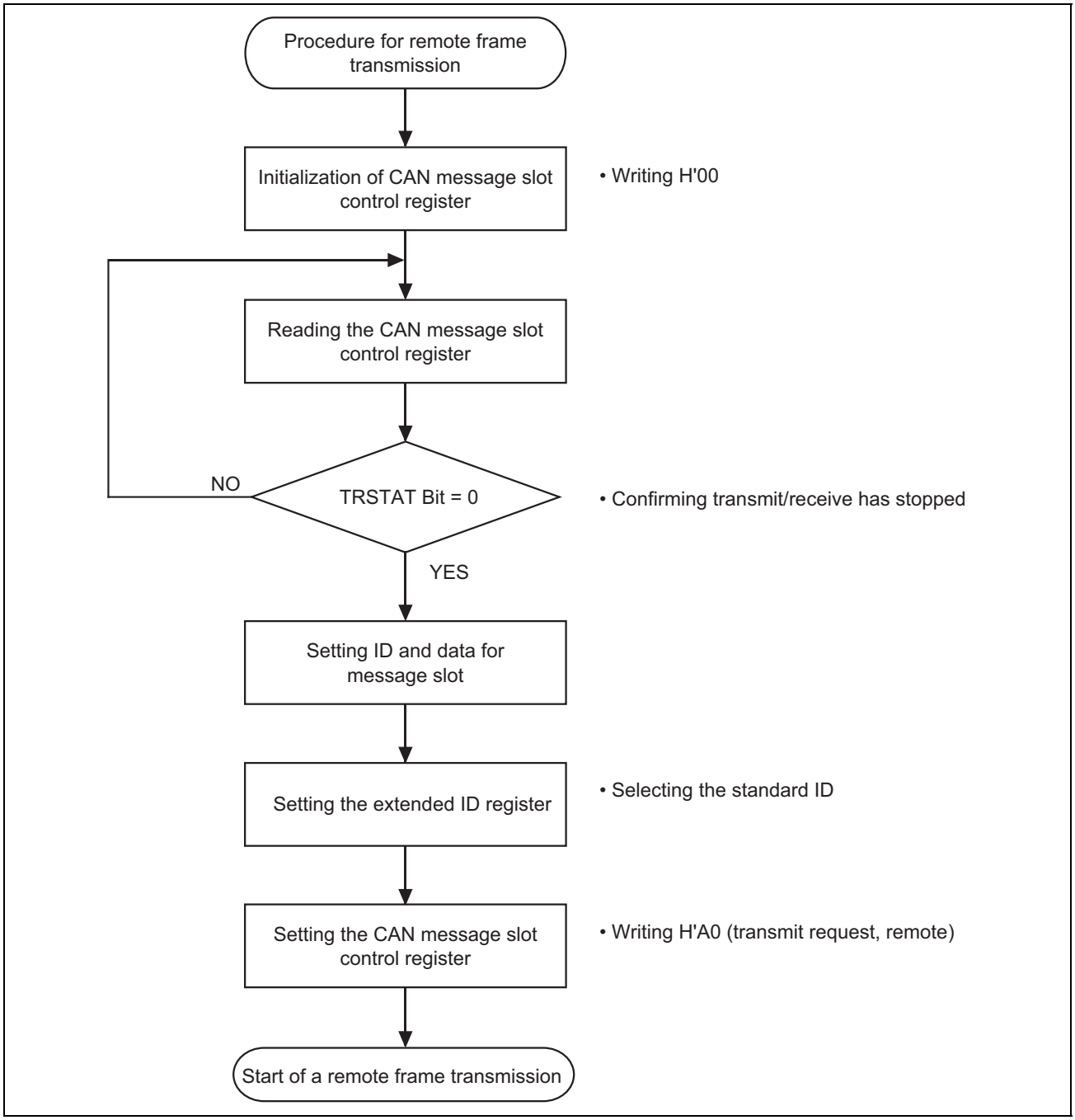

Figure 4.3.1 Remote Frame Transmission Processing

4.4 The State of CAN Message Slot Control Register

Figure 4.4.1 shows the state transition diagram of CAN message slot control registers during Remote Frame transmission.

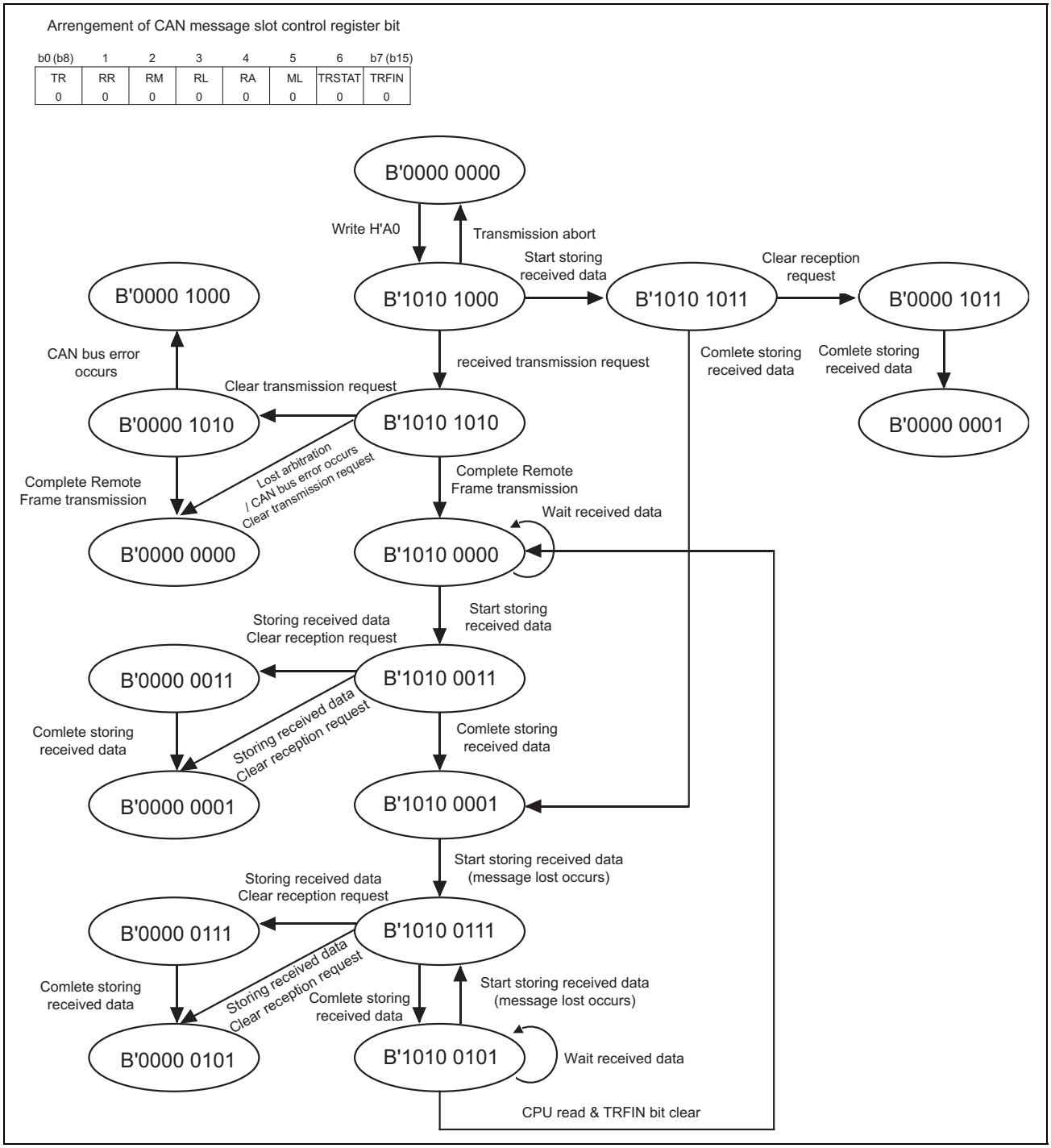

Figure 4.4.1 The State of CAN Message Slot Control Registers during Remote Frame Transmission

4.5 Interpretation of the Sample Program

Note: The registers used are indicated as (register name: bit name).

4.5.1 CAN Module Initialization Function (can_init ())

(1) Setting the pin function.

- Set the port P220 operation mode bit in the P22 operation mode register to "1" (CTX0). (P22MOD: P220MOD)

Note: When using CAN1, add the processing for setting port input enable bit of port input special function control register (PICNT: PIEN0) to "1" (input enabled).

(2) Setting the interrupt.

- Set the CAN0 transmit/receive & error interrupt control register to interrupts disabled.(ICAN0CR: ILEVEL)

(3) Setting the CAN0 interrupt-related registers.

- Clear the CAN0 slot interrupt request status register. (CAN0SLIST)
- Clear the CAN0 error interrupt request status register. (CAN0ERIST)
- Set the CAN0 slot interrupt request mask register to interrupt request disabled. (CAN0SLIMK)
- Set the CAN0 error interrupt request mask register to CAN bus error interrupt disabled, error passive interrupt disabled and bus off interrupt disabled. (CAN0ERIMK: EIM, PIM, OIM)

(4) Setting the CAN0 configuration register. (CAN0CONF: SJW, PH2, PH1, PRB, SAM)

- Set the propagation segment (PRB) to 5 Tq.
- Set phase segment 1 (PH1) to 7 Tq.
- Set phase segment 2 (PH2) to 7 Tq.
- Set the reSynchronization Jump Width (SJW: resynchronization width) to 1Tq.
- Set the number of samplings to once.

In the above settings the number of Tq within 1 bit is 20 and the sampling point is 65%.
Figure 5 shows the bit timing.

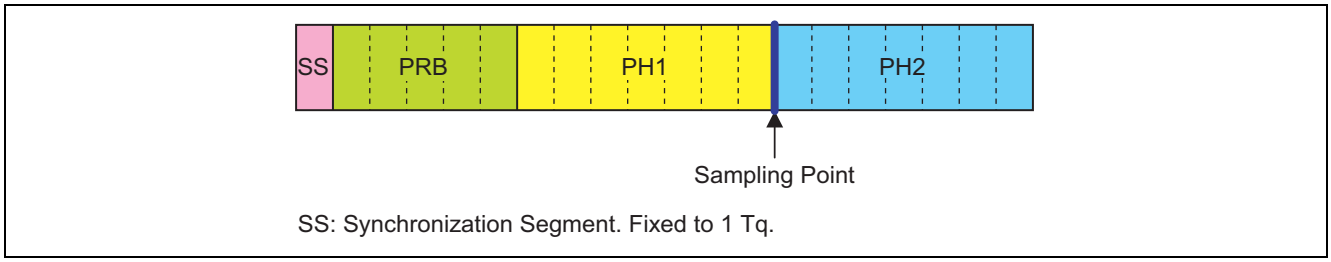

Figure 4.5.1 Bit Timing

(5) Setting the CAN0 baud rate prescaler (CAN0BRP)

- Set the baud rate prescaler to "15" (40 MHz / (125 kbps × 20 Tq) – 1 = 15)
  The formula for calculating the setup value in the baud rate prescaler (BRP) is given below

$$\text{BRP setup value} = \frac{\text{CPUCLK}}{\text{Baud rate (bps)} \times \text{the number of Tq within 1 bit}} - 1$$

(6) Setting the CAN0 acceptance filter.

ID check by acceptance filter is not performed when the CAN module acts as a transmission node. However, the following registers are all set to perform ID checks because this sample task conducts CAN transmit/receive processing.

- CAN0 Global Mask Register Standard ID. (C0GMSKS0, C0GMSKS1)
- CAN0 Global Mask Register Extended ID. (C0GMSKE0, C0GMSKE1, C0GMSKE2)
- CAN0 Local Mask Register A Standard ID. (C0LMSKAS0, C0LMSKAS1)
- CAN0 Local Mask Register A Extended ID. (C0LMSKAE0, C0LMSKAE1, C0LMSKAE2)
- CAN0 Local Mask Register B Standard ID. (C0LMSKBS0, C0LMSKBS1)
- CAN0 Local Mask Register B Extended ID. (C0LMSKBE0, C0LMSKBE1, C0LMSKBE2)

(7) Setting the CAN0 extended ID register.

- Set all slots to the standard ID format. (CAN0EXTID)

(8) Setting the CAN0 control register. (CAN0CNT: TSP, FRST, BCM, LBM, RST)

- Select the CAN bus bit clock in the timestamp prescaler.
- Cancel forcible reset.
- Set the BasicCAN function to disabled.
- Set the loopback function to disabled.
- Cancel CAN reset.

4.5.2 Main Function (main ())

(1) Calling the CAN module initialization function.
(2) Calling the Remote Frame transmit processing function.
(3) Confirm completing transmission of Remote Frame.

- Confirm CAN0 slot0 interrupt request bit (CAN0SLIST: SSB0)

(4) Clear CAN0 slot interrupt request bit (CAN0SLIST)
(5) Confirm completing reception of Data Frame.

- Confirm CAN0 slot0 interrupt request bit (CAN0SLIST: SSB0)

(6) Calling the Data read out processing function.

4.5.3 The Remote Frame Transmit Processing Function (remote_send ())

(1) Initialization of the CAN0 message slot 0 control register.

- Clear all flags and stop transmitting/receiving. (C0MSL0CNT)

(2) Confirm the transmit/receive operation stopped.

- Confirm transmit/receive status bit is "0". (C0MSL0CNT: TRSTAT)

(3) Creating data to be transmitted from slot 0.

- Set the ID to “0”. (C0MSL0SID0, C0MSL0SID1)
- Set the data length to "1". (C0MSL0DLC)

(4) Setting the CAN0 extended ID register.

- Set all the slots to standard ID format. (CAN0EXTID)

(5) Setting the CAN0 message slot 0 control register.

- Set the Remote Frame transmit request. (C0MSL0CNT: TR, RM)

4.5.4 The Data read out processing Function (remote_send_read_data ())

(1) Clearing transmit/receive complete bit. (C0MSL0CNT: TRFIN)
(2) Read out data received. (C0MSL0DT0 to C0MSL0DT7)
(3) Confirming transmit/receive complete bit. (C0MSL0CNT: TRFIN)

When the complete transmit/ receive bit is set, it indicates that new received data was stored during reading out received data. In this case, since the indefinite value is included in the value read out, it restarts from the clearing the complete transmit/ receive bit.

4.6 Sample Program

The sample program for the CAN0 Remote Frame transmission is shown below.

Note that the sample program below requires the SFR definition file. The latest SFR definition file can be downloaded from Renesas Technology website. When using the SFR definitions file, adjust the path setting to match the operating computer environment.

4.6.1 init.c

```
/*""FILE COMMENT""*****************************************************
 *      M32R C Programming              Rev. 1.01
 *              < Sample Program for 32176 >
 *              < CAN init >
 *
 *      Copyright (c) 2004 Renesas Technology Corporation
 *                         All Rights Reserved
 **********************************************************************/

/**********************************************************************/
/*              Include file                                          */
/**********************************************************************/

#include                "..\inc\sfr32176_pragma.h"

/**********************************************************************/
/*              Function prototype declaration                        */
/**********************************************************************/

        void            can_init(void);

/*""FUNC COMMENT""*****************************************************
 * Function name: void can_init(void)
 *---------------------------------------------------------------------
 * Description  : Initializes CAN module
 *---------------------------------------------------------------------
 * Argument     : -
 *---------------------------------------------------------------------
 * Returns      : -
 *---------------------------------------------------------------------
 * Notes        :
 *""FUNC COMMENT END""************************************************/
void can_init(void)
{
        /* Setting input/output port operation mode register (CRX pin does not need to be set) */
        P22MOD |= 0x80u;                        /* P220 used as CTX */

        /* To use CAN1, set it up here */
        /*
         * - P7MOD  &= ~0x03u
         * - P7SMOD |=  0x03u
         * - P7MOD  |=  0x03u
         * - PICNT  |=  0x01u
         */

        /* Setting interrupt controller */
        ICAN0CR = 0x07;                         /* CAN0 interrupt priority level 7 (interrupt disabled
) */


        /* Setting CAN0 related interrupt mask register */
        CAN0SLIST = 0x0000;                     /* Clear CAN0 slot transmit/receive-finished interrupt
 request */
        CAN0ERIST = 0x00;                       /* Clear CAN0 error interrupt request */
        CAN0SLIMK = 0x0000;                     /* Disable CAN0 slot transmit/receive-finished interru
pt */
        CAN0ERIMK = 0x00;                       /* Disable CAN0 error interrupt */


        /* Setting CAN configuration register */
        CAN0CONF = 0x3680;                      /* SJW=1, Sync(1)+Prop(5)+PH1(7)+PH2(7), sampling coun
t = 1 */
        CAN0BRP = (16 - 1);                     /* Baud rate: 40 MHz / divided by 16 / 20 Tq -> 125 Kb
ps */

```

```
   61          /* Setting ID mask register */
   62          C0GMSKS0 = 0xff;                        /* Global mask register */
   63          C0GMSKS1 = 0xff;
   64          C0GMSKE0 = 0xff;
   65          C0GMSKE1 = 0xff;
   66          C0GMSKE2 = 0xff;
   67          C0LMSKAS0 = 0xff;                       /* Local mask register A */
   68          C0LMSKAS1 = 0xff;
   69          C0LMSKAE0 = 0xff;
   70          C0LMSKAE1 = 0xff;
   71          C0LMSKAE2 = 0xff;
   72          C0LMSKBS0 = 0xff;                       /* Local mask register B */
   73          C0LMSKBS1 = 0xff;
   74          C0LMSKBE0 = 0xff;
   75          C0LMSKBE1 = 0xff;
   76          C0LMSKBE2 = 0xff;
   77
   78          /* To use in BasicCAN mode, set it up here. */
   79          /*
   80           *      - Set IDE14/15 of CAN0EXTID
   81           *      - Set ID of slots 14/15
   82           *      - Set local mask registers A/B
   83           *      - Set slots 14/15 for data frame reception
   84           */
   85
   86          /* Setting CAN operation mode */
   87          CAN0EXTID = 0x0000;                     /* Select standard format frame */
   88
   89          /* Negating CAN reset */
   90          CAN0CNT = 0x0000;                       /* Clear FRST and RST bits and disable BasicCAN functi
on */
   91                                                  /* Disable loopback function and select timestamp divi
de-by-1 */
   92  }
```

4.6.2 remote_send.c

```
/*""FILE COMMENT""*****************************************************
 *      M32R C Programming              Rev. 1.01
 *              < Sample Program for 32176 >
 *              < CAN remote_send >
 *
 *      Copyright (c) 2004 Renesas Technology Corporation
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 **********************************************************************/

/**********************************************************************/
/*              Include file                                          */
/**********************************************************************/

#include                "..\inc\sfr32176_pragma.h"

/**********************************************************************/
/*              Function prototype declaration                        */
/**********************************************************************/

        void            main(void);
        void            remote_send(void);
        void            remote_send_read_data(void);
extern  void            can_init(void);

/**********************************************************************/
/*              Externally referenced variable                        */
/**********************************************************************/

        UCHAR           CAN_DATA[8];                        /* Used to store received data */

/*""FUNC COMMENT""*****************************************************
 * Function name: void main(void)
 *---------------------------------------------------------------------
 * Description  : Remote frame transmission sample program
 *---------------------------------------------------------------------
 * Argument     : -
 *---------------------------------------------------------------------
 * Returns      : -
 *---------------------------------------------------------------------
 * Notes        :
 *""FUNC COMMENT END""************************************************/
void main(void)
{
        /* Initialize CAN module */
        can_init();

        /* CAN module operation */
        remote_send();

        /* Wait until remote frame is sent */
        while( ( C0SLIST & SSB0) == 0u){
                ;
        }
        C0SLIST = 0x0000;

        /* Wait until data frame is received */
        while( ( C0SLIST & SSB0) == 0u){
                ;
        }

        /* Read out received data frame */
        remote_send_read_data();


        while( 1 ){
                ;
        }
}

/*""FUNC COMMENT""*****************************************************
 * Function name: void remote_send(void)
 *---------------------------------------------------------------------
 * Description  : Sends remote frame from slot 0
 *---------------------------------------------------------------------
```

```
   75   * Argument      : -
   76   *-------------------------------------------------------------------------
   77   * Returns       : -
   78   *-------------------------------------------------------------------------
   79   * Notes         :
   80   *""FUNC COMMENT END""*************************************************/
   81  void remote_send(void)
   82  {
   83          C0MSL0CNT = 0x00;                               /* Initialize CAN message slot control
register */
   84          while ( ( C0MSL0CNT & TRSTAT) != 0u){           /* Verify that transmit operation is idle */
   85                  ;
   86          }
   87
   88          /* Set ID and DLC in message slot 0 */
   89          C0MSL0SID0 = 0x00;                              /* ID : 0 */
   90          C0MSL0SID1 = 0x00;
   91          C0MSL0DLC = 0x01;                               /* DLC : 1 */
   92
   93          /* Set extended ID register */
   94          CAN0EXTID = 0x0000;                             /* Select standard format */
   95
   96          /* Set CAN message slot control register */
   97          C0MSL0CNT = 0xA0;                               /* Request transmission of remote frame */
   98  }
   99
  100  /*""FUNC COMMENT""*******************************************************
  101   * Function name: void remote_send_read_data(void)
  102   *-------------------------------------------------------------------------
  103   * Description  : Reads out received data frame when CAN module has been set for remote frame
transmission
  104   *-------------------------------------------------------------------------
  105   * Argument      : -
  106   *-------------------------------------------------------------------------
  107   * Returns       : -
  108   *-------------------------------------------------------------------------
  109   * Notes         :
  110   *""FUNC COMMENT END""*************************************************/
  111  void remote_send_read_data(void)
  112  {
  113          do {
  114                  C0MSL0CNT = 0xAE;                        /* Clear TRFIN bit */
  115
  116                  /* Read out message slot 0 */
  117                  CAN_DATA[0] = C0MSL0DT0;
  118                  CAN_DATA[1] = C0MSL0DT1;
  119                  CAN_DATA[2] = C0MSL0DT2;
  120                  CAN_DATA[3] = C0MSL0DT3;
  121                  CAN_DATA[4] = C0MSL0DT4;
  122                  CAN_DATA[5] = C0MSL0DT5;
  123                  CAN_DATA[6] = C0MSL0DT6;
  124                  CAN_DATA[7] = C0MSL0DT7;
  125
  126
  127          } while( ( C0MSL0CNT & TRFIN) != 0u );          /* Redo if TRFIN is set */
  128
  129          /* If necessary, check ML bit to see if message is lost
  130           *
  131           * if( (C0MSL0CNT & ML) != 0)
  132           *       (Processing for messages lost);
  133           */
  134  }
```

5. Reference Documents

- 32176 Group User's Manual (Rev.1.01)
- 32176 Group Outline of CAN Module (Rev.1.00)
- M32R Family Software Manual (Rev.1.20)
- M3T-CC32R V.4.30 User's Manual (Compiler)
- M3T-CC32R V.4.30 User's Manual (Assembler)

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