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Details	
Product Status	Not For New Designs
Core Processor	SH2A
Core Size	32-Bit Single-Core
Speed	100MHz
Connectivity	CANbus, SCI, SPI, UART/USART
Peripherals	DMA, POR, PWM, WDT
Number of I/O	85
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	32K x 8
Voltage - Supply (Vcc/Vdd)	4.5V ~ 5.5V
Data Converters	A/D 16x12b
Oscillator Type	External
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	120-LQFP
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f72374bdfp-v0

6.3.5 Bank Control Register (IBCR)

IBCR is a 16-bit register that enables or disables use of register banks for each interrupt priority level.

IBCR is initialized to H'0000 by a power-on reset.

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	E15	E14	E13	E12	E11	E10	E9	E8	E7	E6	E5	E4	E3	E2	E1	-
Initial value:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R/W:	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R

Bit	Bit Name	Initial Value	R/W	Description
15	E15	0	R/W	Enable These bits enable or disable use of register banks for interrupt priority levels 15 to 1. However, use of register banks is always disabled for the user break interrupts. 0: Use of register banks is disabled 1: Use of register banks is enabled
14	E14	0	R/W	
13	E13	0	R/W	
12	E12	0	R/W	
11	E11	0	R/W	
10	E10	0	R/W	
9	E9	0	R/W	
8	E8	0	R/W	
7	E7	0	R/W	
6	E6	0	R/W	
5	E5	0	R/W	
4	E4	0	R/W	
3	E3	0	R/W	
2	E2	0	R/W	
1	E1	0	R/W	
0	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.

Section 11 Multi-Function Timer Pulse Unit 2 (MTU2)

This LSI has an on-chip multi-function timer pulse unit 2 (MTU2) that comprises six 16-bit timer channels.

11.1 Features

- Maximum 16 pulse input/output lines and three pulse input lines
- Selection of eight counter input clocks for each channel (four clocks for channel 5)
- The following operations can be set for channels 0 to 4:
  - Waveform output at compare match
  - Input capture function
  - Counter clear operation
  - Multiple timer counters (TCNT) can be written to simultaneously
  - Simultaneous clearing by compare match and input capture is possible
  - Register simultaneous input/output is possible by synchronous counter operation
  - A maximum 12-phase PWM output is possible in combination with synchronous operation.
- Buffer operation settable for channels 0, 3, and 4
- Phase counting mode settable independently for each of channels 1 and 2
- Cascade connection operation
- Fast access via internal 16-bit bus
- 28 interrupt sources
- Automatic transfer of register data
- A/D converter start trigger can be generated
- Module standby mode can be settable
- A total of six-phase waveform output, which includes complementary PWM output, and positive and negative phases of reset PWM output by interlocking operation of channels 3 and 4, is possible.
- AC synchronous motor (brushless DC motor) drive mode using complementary PWM output and reset PWM output is settable by interlocking operation of channels 0, 3, and 4, and the selection of two types of waveform outputs (chopping and level) is possible.
- Dead time compensation counter available in channel 5
- In complementary PWM mode, interrupts at the crest and trough of the counter value and A/D converter start triggers can be skipped.

(b) Free-Running Count Operation and Periodic Count Operation:

Immediately after a reset, the MTU2's TCNT counters are all designated as free-running counters. When the relevant bit in TSTR is set to 1 the corresponding TCNT counter starts up-count operation as a free-running counter. When TCNT overflows (from H'FFFF to H'0000), the TCFV bit in TSR is set to 1. If the value of the corresponding TCIEV bit in TIER is 1 at this point, the MTU2 requests an interrupt. After overflow, TCNT starts counting up again from H'0000.

Figure 11.5 illustrates free-running counter operation.

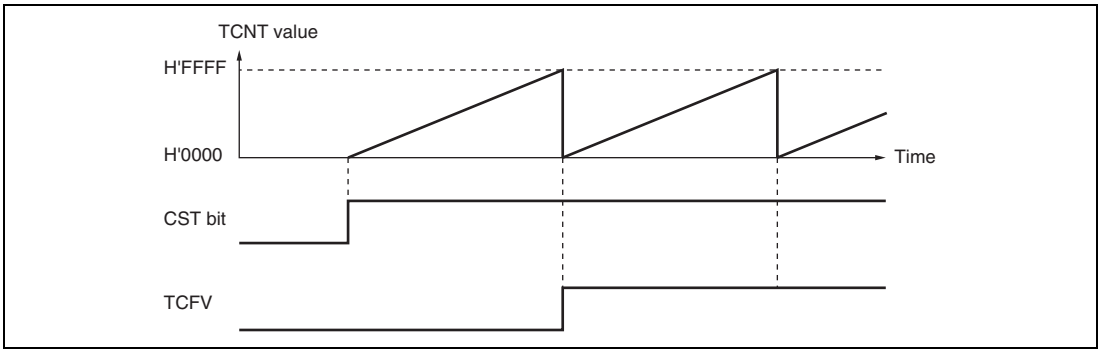


Figure 11.5 Free-Running Counter Operation

When compare match is selected as the TCNT clearing source, the TCNT counter for the relevant channel performs periodic count operation. The TGR register for setting the period is designated as an output compare register, and counter clearing by compare match is selected by means of bits CCLR0 to CCLR2 in TCR. After the settings have been made, TCNT starts up-count operation as a periodic counter when the corresponding bit in TSTR is set to 1. When the count value matches the value in TGR, the TGF bit in TSR is set to 1 and TCNT is cleared to H'0000.

If the value of the corresponding TGIE bit in TIER is 1 at this point, the MTU2 requests an interrupt. After a compare match, TCNT starts counting up again from H'0000.

11.4.2 Synchronous Operation

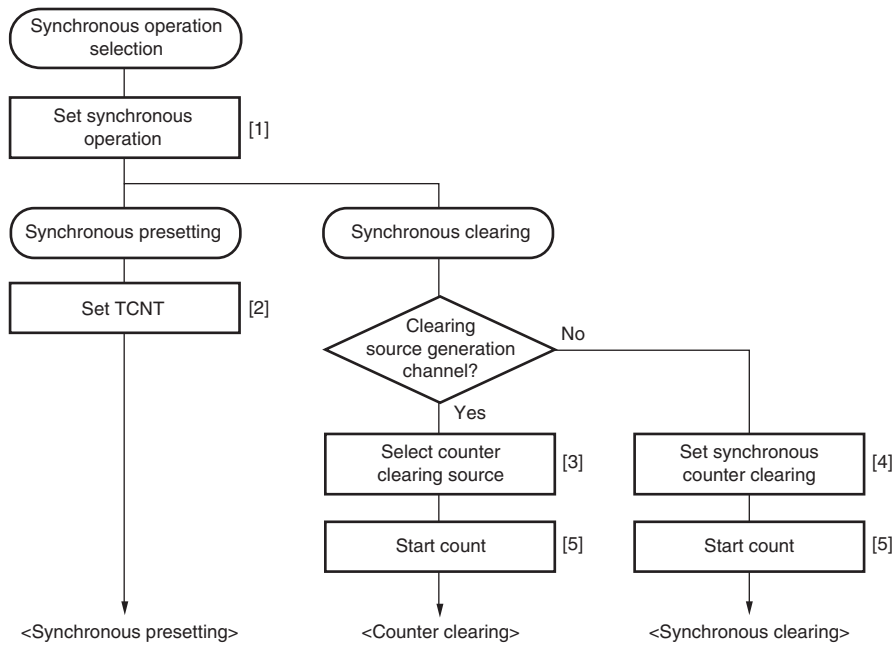
In synchronous operation, the values in a number of TCNT counters can be rewritten simultaneously (synchronous presetting). Also, a number of TCNT counters can be cleared simultaneously by making the appropriate setting in TCR (synchronous clearing).

Synchronous operation enables TGR to be incremented with respect to a single time base.

Channels 0 to 4 can all be designated for synchronous operation. Channel 5 cannot be used for synchronous operation.

(1) Example of Synchronous Operation Setting Procedure

Figure 11.12 shows an example of the synchronous operation setting procedure.



[1] Set to 1 the SYNC bits in TSYR corresponding to the channels to be designated for synchronous operation.
[2] When the TCNT counter of any of the channels designated for synchronous operation is written to, the same value is simultaneously written to the other TCNT counters.
[3] Use bits CCLR2 to CCLR0 in TCR to specify TCNT clearing by input capture/output compare, etc.
[4] Use bits CCLR2 to CCLR0 in TCR to designate synchronous clearing for the counter clearing source.
[5] Set to 1 the CST bits in TSTR for the relevant channels, to start the count operation.

Figure 11.12 Example of Synchronous Operation Setting Procedure

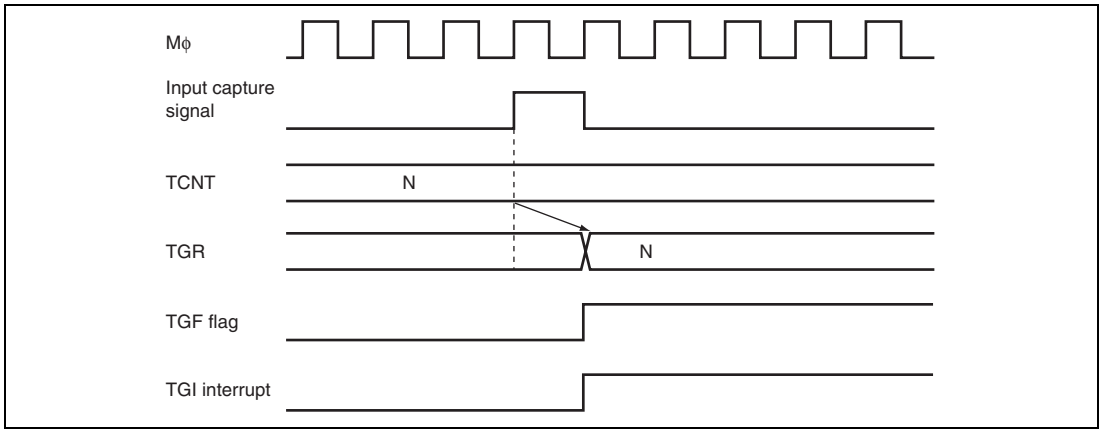


Figure 11.112 TGI Interrupt Timing (Input Capture) (Channel 5)

(3) TCFV Flag/TCFU Flag Setting Timing

Figure 11.113 shows the timing for setting of the TCFV flag in TSR on overflow, and TCIV interrupt request signal timing.

Figure 11.114 shows the timing for setting of the TCFU flag in TSR on underflow, and TCIU interrupt request signal timing.

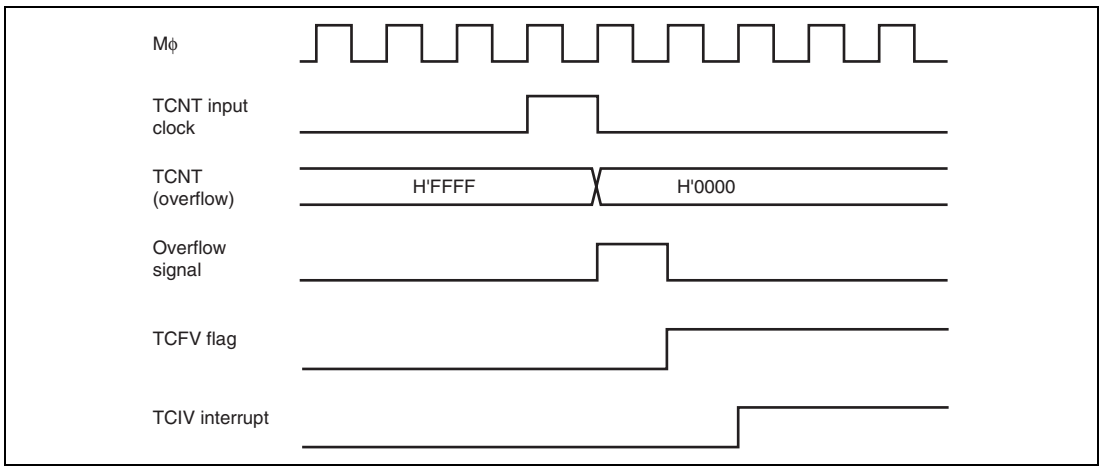


Figure 11.113 TCIV Interrupt Setting Timing

11.7.6 Contention between TGR Write and Compare Match

If a compare match occurs in the T2 state of a TGR write cycle, the TGR write is executed and the compare match signal is also generated.

Figure 11.123 shows the timing in this case.

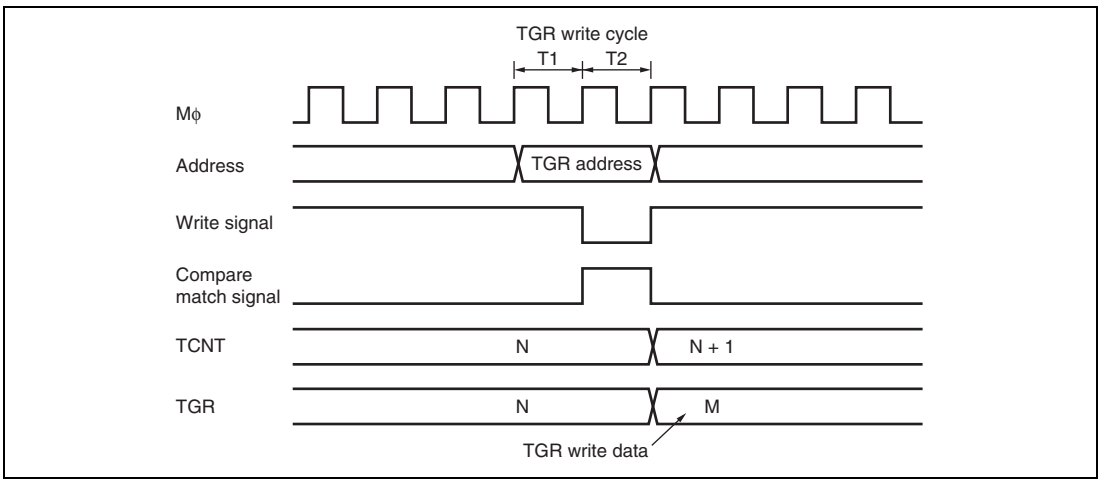


Figure 11.123 Contention between TGR Write and Compare Match

(25) Operation when Error Occurs during Complementary PWM Mode Operation, and Operation is Restarted in Reset-Synchronized PWM Mode

Figure 11.163 shows an explanatory diagram of the case where an error occurs in complementary PWM mode and operation is restarted in reset-synchronized PWM mode.

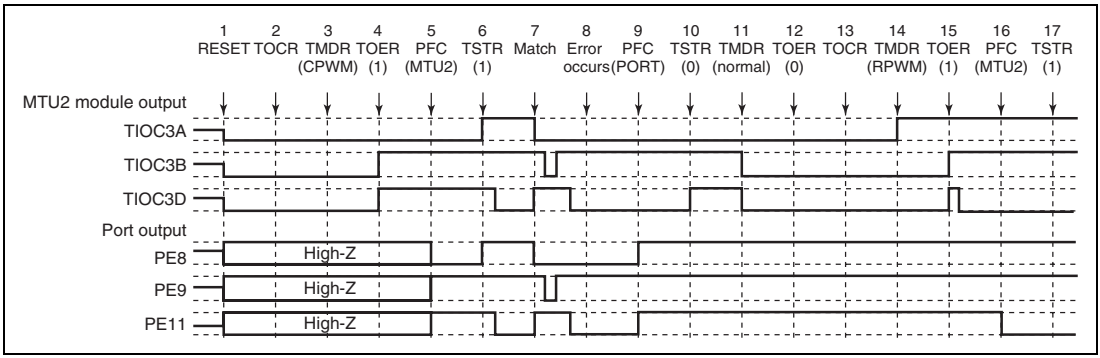


Figure 11.163 Error Occurrence in Complementary PWM Mode, Recovery in Reset-Synchronized PWM Mode

1 to 10 are the same as in figure 11.159.

11. Set normal mode. (MTU2 output goes low.)
12. Disable channel 3 and 4 output with TOER.
13. Select the reset-synchronized PWM mode output level and cyclic output enabling/disabling with TOCR.
14. Set reset-synchronized PWM.
15. Enable channel 3 and 4 output with TOER.
16. Set MTU2 output with the PFC.
17. Operation is restarted by TSTR.

Bit	Bit Name	Initial Value	R/W	Description
9	MTU2SP2CZE	1	R/(W)*[1]	MTU2S Port 2 Output Comparison/High-Impedance Enable Specifies whether to compare output levels for the MTU2S high-current PE0/TIOC4AS and PE2/TIOC4CS pins and to place them in high-impedance state when the OSF2 bit is set to 1 while the OCE2 bit is 1 or when either the selected $\overline{\text{POE}}$ pin flag*[2] or MTU2SHIZ bits is set to 1. 0: Does not compare output levels or place the pins in high-impedance state. 1: Compares output levels and places the pins in high-impedance state.
8	MTU2SP3CZE	1	R/(W)*[1]	MTU2S Port 3 Output Comparison/High-Impedance Enable Specifies whether to compare output levels for the MTU2S high-current PE1/TIOC4BS and PE3/TIOC4DS pins and to place them in high-impedance state when the OSF2 bit is set to 1 while the OCE2 bit is 1 or when either the selected $\overline{\text{POE}}$ pin flag*[2] or MTU2SHIZ bits is set to 1. 0: Does not compare output levels or place the pins in high-impedance state. 1: Compares output levels and places the pins in high-impedance state.
7	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.
6	MTU2SP4CZE	0	R/(W)*[1]	MTU2S Port 4 Output Comparison/High-Impedance Enable Specifies whether to compare output levels for the MTU2S high-current PD10/TIOC3BS and PD11/TIOC3DS pins and to place them in high-impedance state when the OSF2 bit is set to 1 while the OCE2 bit is 1 or when either the selected $\overline{\text{POE}}$ pin flag*[2] or MTU2SHIZ bits is set to 1. 0: Does not compare output levels or place the pins in high-impedance state. 1: Compares output levels and places the pins in high-impedance state.

Bit	Bit Name	Initial value	R/W	Description
5	ORER	0	R/(W)*	Overrun Error Indicates that an overrun error occurred during reception, causing abnormal termination. 0: Indicates that reception is in progress or was completed successfully*[1] [Clearing conditions] • By a power-on reset or in module standby mode • When 0 is written to ORER after reading ORER = 1 1: Indicates that an overrun error occurred during reception*[2] [Setting condition] • When the next serial reception is completed while RDRF = 1 Notes: 1. The ORER flag is not affected and retains its previous value when the RE bit in SCSCR is cleared to 0. 2. The receive data prior to the overrun error is retained in SCRDR, and the data received subsequently is lost. Subsequent serial reception cannot be continued while the ORER flag is set to 1.

Table 16.11 Maximum Bit Rates for Various Frequencies with Baud Rate Generator (Clock Synchronous Mode)

	Non-Continuous Transmission/Reception			Continuous Transmission/Reception		
	Maximum Bit Rate	Settings		Maximum Bit Rate	Settings	
Pϕ (MHz)	(bits/s)	n	N	(bits/s)	n	N
10*[1]	2500000	0	0	1250000	0	1
12*[1]	3000000	0	0	1500000	0	1
14*[1]	3500000	0	0	1750000	0	1
16*[1]	4000000	0	0	2000000	0	1
18*[1]	4500000	0	0	2250000	0	1
20	5000000	0	0	2500000	0	1
22	5500000	0	0	2750000	0	1
24	6000000	0	0	3000000	0	1
26*[1]	6500000	0	0	3250000	0	1
28*[1]	7000000	0	0	3500000	0	1
30*[1]	7500000	0	0	3750000	0	1
32*[1]	8000000	0	0	4000000	0	1
34*[1]	8500000	0	0	4250000	0	1
36*[1]	9000000	0	0	4500000	0	1
38*[1]	9500000	0	0	4750000	0	1
40	10000000	0	0	5000000	0	1
50*[2]	12500000	0	0	6250000	0	1

Notes: 1. Cannot be set for this LSI.
2. This is only available for the SH7239B and SH7237B.

18.4.9 SPI Operation

(1) Slave Mode Operation

(1-1) Starting a Serial Transfer

If the CPHA bit in RSPI command register 0 (SPCMD0) is 0, when detecting an SSL0 input signal assertion, the RSPI needs to start driving valid data to the MISO output signal. For this reason, the asserting of the SSL0 input signal triggers the start of a serial transfer.

If the CPHA bit is 1, when detecting the first RSPCK edge in an SSL0 signal asserted condition, the RSPI needs to start driving valid data to the MSO signal. For this reason, when the CPHA bit is 1, the first RSPCK edge in an SSL0 signal asserted condition triggers the start of a serial transfer.

When detecting the start of a serial transfer in a condition in which the shift register is empty, the RSPI changes the status of the shift register to "full", so that data cannot be copied from the transmit buffer to the shift register when serial transfer is in progress. If the shift register was full before the serial transfer started, the RSPI leaves the status of the shift register intact, in the full state.

Irrespective of CPHA bit settings, the timing at which the RSPI starts driving MISO output signals is the SSL0 signal assertion timing. The data which is output by the RSPI is either valid or invalid, depending on CPHA bit settings.

For details on the RSPI transfer format, see section 18.4.4, Transfer Format. The polarity of the SSL0 input signal depends on the setting of the SSL0P bit in the RSPI slave select polarity register (SSLP).

(1-2) Terminating a Serial Transfer

Irrespective of the CPHA bit in RSPI command register 0 (SPCMD0), the RSPI terminates the serial transfer after detecting an RSPCK edge corresponding to the final sampling timing. When the SPRF bit in the RSPI status register (SPSR) is 0 and free space is available in the receive buffer, upon termination of serial transfer the RSPI copies received data from the shift register to the receive buffer of the RSPI data register (SPDR). Irrespective of the value of the SPRF bit, upon termination of a serial transfer the RSPI changes the status of the shift register to "empty". A mode fault error occurs if the RSPI detects an SSL0 input signal negation from the beginning of serial transfer to the end of serial transfer (see section 18.4.7, Error Detection).

The final sampling timing changes depending on the bit length of the transfer data. In slave mode, the RSPI data length depends on the settings in bits SPB3 to SPB0 bits in SPCMD0. The polarity

(2-4) Initialization Flowchart

Figure 18.28 shows an example of initialization flowchart for using the RSPI in master mode during clock synchronous operation. For a description of how to set up an interrupt controller, the DTC/DMAC, and input/output ports, see the descriptions given in the individual blocks.

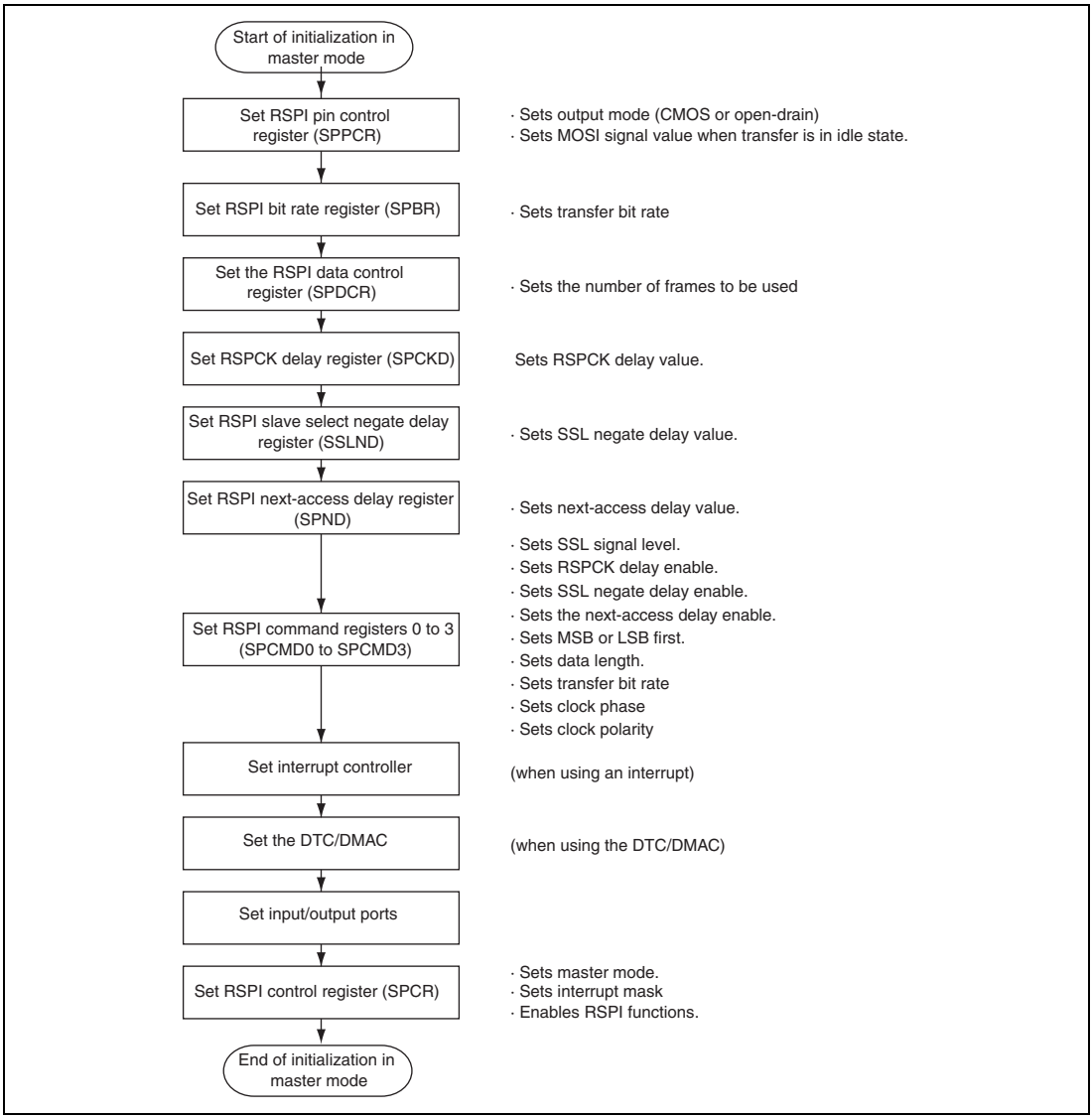


Figure 18.28 Example of Initialization Flowchart in Master Mode

21.1.11 Port D Control Registers L1 to L4 (PDCRL1 to PDCRL4)

PDCRL1 to PDCRL4 are 16-bit readable/writable registers that are used to select the functions of the multiplexed pins on port D.

(1) Port D Control Register L4 (PDCRL4)

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	-	PD15MD[2:0]			-	PD14MD[2:0]			-	PD13MD[2:0]			-	PD12MD[2:0]		
Initial value:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R/W:	R	R/W	R/W	R/W	R	R/W	R/W	R/W	R	R/W	R/W	R/W	R	R/W	R/W	R/W

Bit	Bit Name	Initial Value	R/W	Description
15	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.
14 to 12	PD15MD[2:0]	000	R/W	PD15 Mode 000: PD15 I/O (port) 001: D15 I/O (BSC)* 010: Setting prohibited 011: Setting prohibited 100: Setting prohibited 101: TIOC4DS I/O (MTU2S) 110: Setting prohibited 111: Setting prohibited
11	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.

(4) Port D Control Register L1 (PDCRL1)

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	-	PD3MD[2:0]			-	PD2MD[2:0]			-	PD1MD[2:0]			-	PD0MD[2:0]		
Initial value:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R/W:	R	R/W	R/W	R/W	R	R/W	R/W	R/W	R	R/W	R/W	R/W	R	R/W	R/W	R/W

Bit	Bit Name	Initial Value	R/W	Description
15	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.
14 to 12	PD3MD[2:0]	000	R/W	PD3 Mode 000: PD3 I/O (port) 001: D3 I/O (BSC)* 010: Setting prohibited 011: Setting prohibited 100: TIC5V input (MTU2) 101: Setting prohibited 110: TXD2 output (SCI) 111: Setting prohibited
11	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.
10 to 8	PD2MD[2:0]	000	R/W	PD2 Mode 000: PD2 I/O (port) 001: D2 I/O (BSC)* 010: Setting prohibited 011: Setting prohibited 100: TIC5U input (MTU2) 101: Setting prohibited 110: RXD2 input (SCI) 111: Setting prohibited
7	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.

(7) User Boot MAT Information Inquiry

In response to a user boot MAT information inquiry command sent from the host, this LSI returns the number of user boot MATs and their addresses.

Command

H'24

Response

H'34	Size	MAT count
MAT start address		
MAT end address		
MAT start address		
MAT end address		
:		
MAT start address		
MAT end address		
SUM		

[Legend]

Size (1 byte): Total number of bytes in the MAT count, MAT start address, and MAT end address fields

MAT count (1 byte): Number of user boot MATs (consecutive areas are counted as one MAT)

MAT start address (4 bytes): Start address of a user boot MAT

MAT end address (4 bytes): End address of a user boot MAT

SUM (1 byte): Checksum

Figure 23.31 shows how erasure processing is suspended in erasure-priority mode (with the ESUSPMD bit in FCPSR being 1). The operation for suspending erasure processing in erasure-priority mode (the ESUSPMD bit in FCPSR is 1) is equivalent to that for suspending programming processing.

In erasure-priority mode, if the FCU accepts a P/E suspend command while applying an erasing pulse, the FCU always continues applying the pulse. As processing to reapply an erasing pulse never takes place in this mode, the total time required for erasure processing is shorter than in suspension-priority mode.

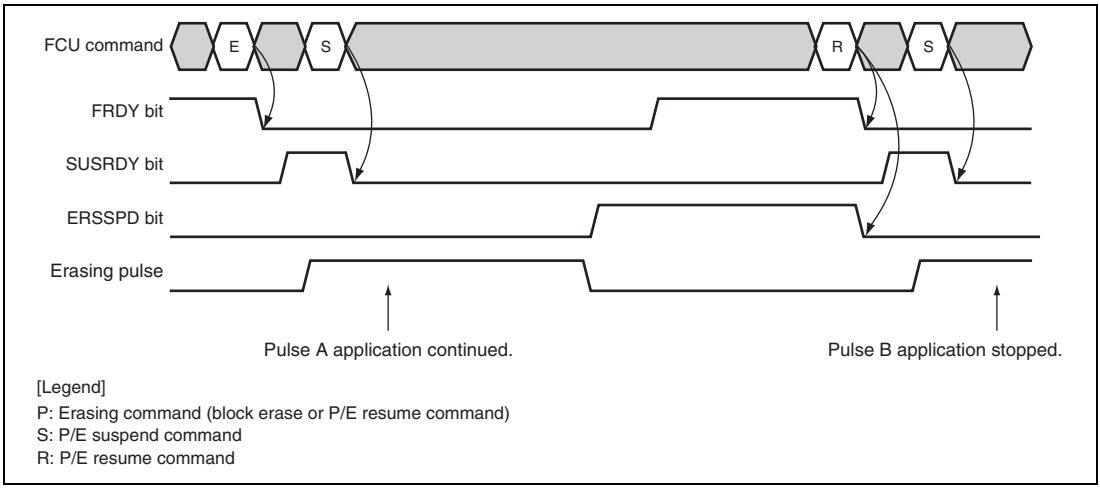


Figure 23.31 Suspending Erasure Processing (Erasure-Priority Mode)

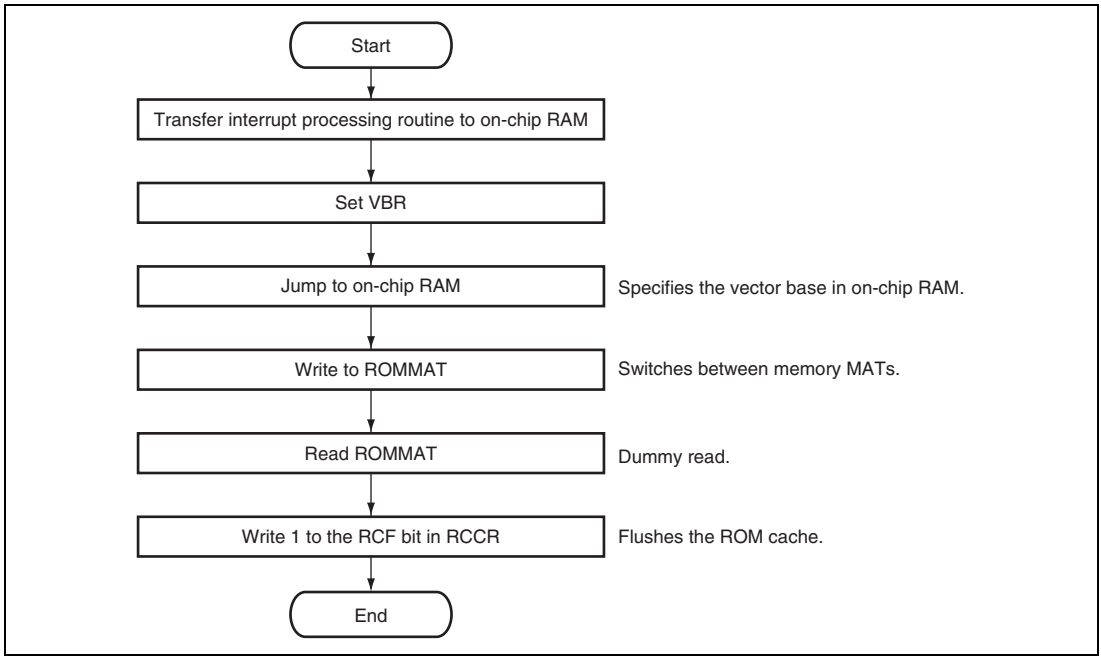


Figure 23.34 Example of MAT Switching Steps

25.2.1 System Control Register 1 (SYSCR1))

SYSCR1 is an 8-bit readable/writable register that enables or disables access to the on-chip RAM. SYSCR1 is initialized to H'FF by a power-on reset but retains its previous value by a manual reset or in software standby mode. Only byte access is valid.

When an RAME bit is set to 1, the corresponding on-chip RAM area is enabled. When an RAME bit is cleared to 0, the corresponding on-chip RAM area cannot be accessed. In this case, an undefined value is returned when reading data or fetching an instruction from the on-chip RAM, and writing to the on-chip RAM is ignored. The initial value of an RAME bit is 1.

Note that when clearing the RAME bit to 0 to disable the on-chip RAM, be sure to execute an instruction to read from or write to the same arbitrary address in each page before setting the RAME bit. If such an instruction is not executed, the data last written to each page may not be written to the on-chip RAM. Furthermore, an instruction to access the on-chip RAM should not be located immediately after the instruction to write to SYSCR1. If an on-chip RAM access instruction is set, normal access is not guaranteed.

Additionally, note that when setting the RAME bit to 1 to enable the on-chip RAM, be sure to locate an instruction to read SYSCR1 immediately after the instruction to write to SYSCR1. If an on-chip RAM access instruction is set, normal access is not guaranteed.

Bit:	7	6	5	4	3	2	1	0
	—	—	RAME5	RAME4	—	—	RAME1	RAME0
Initial value:	1	1	1	1	1	1	1	1
R/W:	R	R	R/W	R/W	R	R	R/W	R/W

29.3.7 POE2 Module Timing

Table 29.16 POE2 Module Timing

Item	Symbol	Min.	Max.	Unit	Figure
$\overline{\text{POE}}$ input setup time	t_{POES}	50	—	ns	Figure 29.20
$\overline{\text{POE}}$ input pulse width	t_{POEW}	1.5	—	t_{pcyc}	

Note: t_{pcyc} indicates peripheral clock (Pϕ) cycle.

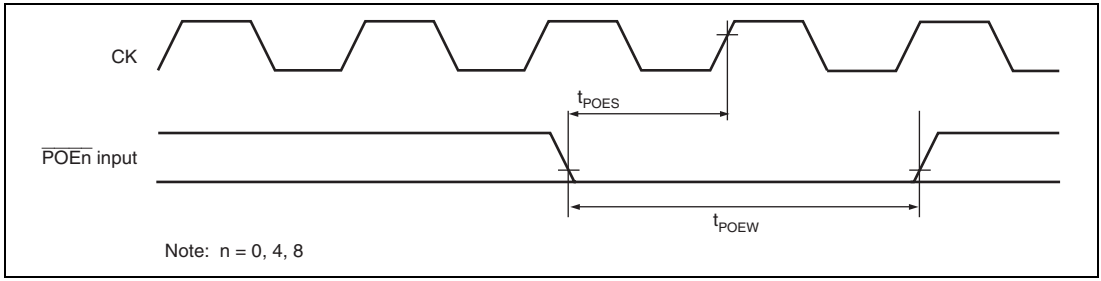


Figure 29.20 POE2 Input Timing

29.3.12 Controller Area Network (RCAN-ET) Timing

Table 29.21 Controller Area Network (RCAN-ET) Timing

Item	Symbol	Min.	Max.	Unit	Figure
Transmit data delay time	t_{CTxD}	—	100	ns	Figure 29.31
Receive data setup time	t_{CRxS}	100	—	ns	
Receive data hold time	t_{CRxH}	100	—	ns	

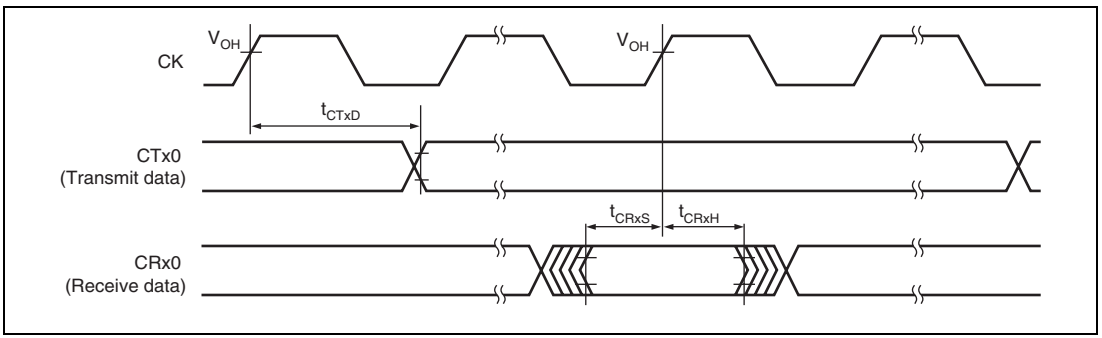


Figure 29.31 RCAN-ET Input/Output Timing