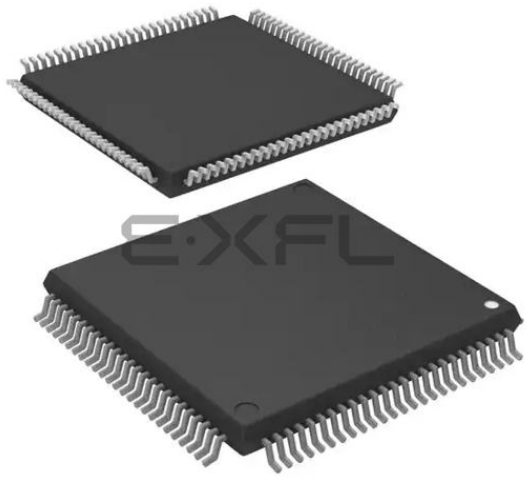

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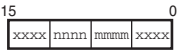
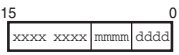
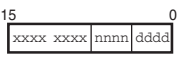
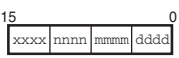
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Not For New Designs
Core Processor	SH-2
Core Size	32-Bit Single-Core
Speed	64MHz
Connectivity	CANbus, EBI/EMI, SCI, SSU
Peripherals	POR, PWM, WDT
Number of I/O	57
Program Memory Size	512KB (512K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	16K 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	100-LQFP
Supplier Device Package	100-LFQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/df71476bd80fpv

Instruction Format	Source Operand	Destination Operand	Sample Instruction
nm type 	mmmm: register direct	nnnn: register direct	ADD Rm,Rn
	mmmm: register direct	nnnn: register indirect	MOV.L Rm,@Rn
	mmmm: post-increment register indirect (multiply-and-accumulate operation) nnnn: * post-increment register indirect (multiply-and-accumulate operation)	MACH, MACL	MAC.W @Rm+,@Rn+
	mmmm: post-increment register indirect	nnnn: register direct	MOV.L @Rm+,Rn
	mmmm: register direct	nnnn: pre-decrement register indirect	MOV.L Rm,@-Rn
	mmmm: register direct	nnnn: index register indirect	MOV.L Rm,@(R0,Rn)
md type 	mmmmdddd: register indirect with displacement	R0 (register direct)	MOV.B @(disp,Rm),R0
nd4 type 	R0 (register direct)	nnnndddd: register indirect with displacement	MOV.B R0,@(disp,Rn)
nmd type 	mmmm: register direct	nnnndddd: register indirect with displacement	MOV.L Rm,@(disp,Rn)
	mmmmdddd: register indirect with displacement	nnnn: register direct	MOV.L @(disp,Rm),Rn

3.2 Input/Output Pins

Table 3.2 describes the configuration of operating mode related pin.

Table 3.2 Pin Configuration

Pin Name	Input/Output	Function
MD0	Input	Designates operating mode through the level applied to this pin
MD1	Input	Designates operating mode through the level applied to this pin
FWE	Input	Enables, by hardware, programming/erasing of the on-chip flash memory

Bit	Bit Name	Initial Value	R/W	Description
3	IRQ11S	0	R/W	IRQ1 Sense Select
2	IRQ10S	0	R/W	Set the interrupt request detection mode for pin IRQ1. 00: Interrupt request is detected at the low level of pin IRQ1 01: Interrupt request is detected at the falling edge of pin IRQ1 10: Interrupt request is detected at the rising edge of pin IRQ1 11: Interrupt request is detected at both the falling and rising edges of pin IRQ1
1	IRQ01S	0	R/W	IRQ0 Sense Select
0	IRQ00S	0	R/W	Set the interrupt request detection mode for pin IRQ0. 00: Interrupt request is detected at the low level of pin IRQ0 01: Interrupt request is detected at the falling edge of pin IRQ0 10: Interrupt request is detected at the rising edge of pin IRQ0 11: Interrupt request is detected at both the falling and rising edges of pin IRQ0

6.3.3 IRQ Status register (IRQSR)

IRQSR is a 16-bit register that indicates the states of the external interrupt input pins IRQ0 to IRQ3 and the status of interrupt request.

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	-	-	-	-	IRQ3L	IRQ2L	IRQ1L	IRQ0L	-	-	-	-	IRQ3F	IRQ2F	IRQ1F	IRQ0F
Initial value:	1	1	1	1	*	*	*	*	0	0	0	0	0	0	0	0
R/W:	R	R	R	R	R	R	R	R	R	R	R	R	R/W	R/W	R/W	R/W

Note: * The initial value is 1 when the level on the corresponding IRQ pin is high, and 0 when the level on the pin is low.

Origin of Activation Source	Activation Source	Vector Number	DTC Vector Address Offset	DTCE*1	Transfer Source	Transfer Destination	Priority
Synchronous serial communication unit	SSRXI	233	H'7A4	DTCERE7	SSRDR0 to SSRDR3	Any location*2	High
	SSTXI	234	H'7A8	DTCERE6	Any location*2	SSTDR0 to SSTDR3	
RCAN-ET_0	RM0_0	242	H'7C8	DTCERE3	CONTROL0H to CONTROL1L*3	Any location*2	
RCAN-ET_1*4	RM0_1	246	H'7D8	DTCERE2	CONTROL0H to CONTROL1L*3	Any location*2	Low

Notes: 1. The DTCE bits with no corresponding interrupt are reserved, and the write value should always be 0. To leave software standby mode with an interrupt, write 0 to the corresponding DTCE bit.

2. An external memory, a memory-mapped external device, an on-chip memory, or an on-chip peripheral module (except for DTC, BSC, UBC, AUD, and FLASH) can be selected as the source or destination. Note that at least either the source or destination must be an on-chip peripheral module; transfer cannot be done among an external memory, a memory-mapped external device, and an on-chip memory.
3. Read to a message control field in mailbox 0 by using a block transfer mode or etc.
4. Available only in the SH7142.

8.7 Examples of Use of the DTC

8.7.1 Normal Transfer Mode

An example is shown in which the DTC is used to receive 128 bytes of data via the SCI.

1. Set MRA to fixed source address (SM1 = SM0 = 0), incrementing destination address (DM1 = 1, DM0 = 0), normal transfer mode (MD1 = MD0 = 0), and byte size (Sz1 = Sz0 = 0). The DTS bit can have any value. Set MRB for one data transfer by one interrupt (CHNE = 0, DISEL = 0). Set the RDR address of the SCI in SAR, the start address of the RAM area where the data will be received in DAR, and 128 (H'0080) in CRA. CRB can be set to any value.
2. Set the start address of the transfer information for an RXI interrupt at the DTC vector address.
3. Set the corresponding bit in DTCER to 1.
4. Set the SCI to the appropriate receive mode. Set the RIE bit in SCR to 1 to enable the receive end (RXI) interrupt. Since the generation of a receive error during the SCI reception operation will disable subsequent reception, the CPU should be enabled to accept receive error interrupts.
5. Each time reception of one byte of data ends on the SCI, the RDRF flag in SSR is set to 1, an RXI interrupt is generated, and the DTC is activated. The receive data is transferred from RDR to RAM by the DTC. DAR is incremented and CRA is decremented. The RDRF flag is automatically cleared to 0.
6. When CRA becomes 0 after the 128 data transfers have ended, the RDRF flag is held at 1, the DTCE bit is cleared to 0, and an RXI interrupt request is sent to the CPU. Termination processing should be performed in the interrupt handling routine.

8.7.2 Chain Transfer when Transfer Counter = 0

By executing a second data transfer and performing re-setting of the first data transfer only when the counter value is 0, it is possible to perform 256 or more repeat transfers.

An example is shown in which a 128-Kbyte input buffer is configured. The input buffer is assumed to have been set to start at lower address H'0000. Figure 8.16 shows the chain transfer when the counter value is 0.

1. For the first transfer, set the normal transfer mode for input data. Set the fixed transfer source address, CRA = H'0000 (65,536 times), CHNE = 1, CHNS = 1, and DISEL = 0.
2. Prepare the upper 8-bit addresses of the start addresses for 65,536-transfer units for the first data transfer in a separate area (in ROM, etc.). For example, if the input buffer is configured at addresses H'200000 to H'21FFFF, prepare H'21 and H'20.

Table 10.11 TPSC0 to TPSC2 (Channel 2)

Channel	Bit 2 TPSC2	Bit 1 TPSC1	Bit 0 TPSC0	Description
2	0	0	0	Internal clock: counts on MPϕ/1
			1	Internal clock: counts on MPϕ/4
		1	0	Internal clock: counts on MPϕ/16
			1	Internal clock: counts on MPϕ/64
	1	0	0	External clock: counts on TCLKA pin input
			1	External clock: counts on TCLKB pin input
		1	0	External clock: counts on TCLKC pin input
			1	Internal clock: counts on MPϕ/1024

Note: This setting is ignored when channel 2 is in phase counting mode.

Table 10.12 TPSC0 to TPSC2 (Channels 3 and 4)

Channel	Bit 2 TPSC2	Bit 1 TPSC1	Bit 0 TPSC0	Description
3, 4	0	0	0	Internal clock: counts on MPϕ/1
			1	Internal clock: counts on MPϕ/4
		1	0	Internal clock: counts on MPϕ/16
			1	Internal clock: counts on MPϕ/64
	1	0	0	Internal clock: counts on MPϕ/256
			1	Internal clock: counts on MPϕ/1024
		1	0	External clock: counts on TCLKA pin input
			1	External clock: counts on TCLKB pin input

Table 10.24 TIORL_0 (Channel 0)

				Description	
Bit 3 IOC3	**Bit 2 IOC2**	**Bit 1 IOC1**	**Bit 0 IOC0**	**TGRC_0 Function**	**TIOC0C Pin Function**
0	0	0	0	Output compare register*2	Output retained*1
			1		Initial output is 0 0 output at compare match
		1	0		Initial output is 0 1 output at compare match
			1		Initial output is 0 Toggle output at compare match
	1	0	0		Output retained
			1		Initial output is 1 0 output at compare match
		1	0		Initial output is 1 1 output at compare match
			1		Initial output is 1 Toggle output at compare match
1	0	0	0	Input capture register*2	Input capture at rising edge
			1		Input capture at falling edge
		1	x		Input capture at both edges
	1	x	x		Capture input source is channel 1/count clock Input capture at TCNT_1 count-up/count-down

[Legend]

x: Don't care

Notes: 1. After power-on reset, 0 is output until TIOR is set.

2. When the BFA bit in TMDR_0 is set to 1 and TGRC_0 is used as a buffer register, this setting is invalid and input capture/output compare is not generated.

Table 10.29 TIORH_4 (Channel 4)

				Description	
Bit 3 IOA3	**Bit 2 IOA2**	**Bit 1 IOA1**	**Bit 0 IOA0**	**TGRA_4 Function**	**TIOC4A Pin Function**
0	0	0	0	Output compare register	Output retained*
			1		Initial output is 0 0 output at compare match
		1	0		Initial output is 0 1 output at compare match
			1		Initial output is 0 Toggle output at compare match
	1	0	0		Output retained
			1		Initial output is 1 0 output at compare match
		1	0		Initial output is 1 1 output at compare match
			1		Initial output is 1 Toggle output at compare match
1	x	0	0	Input capture register	Input capture at rising edge
			1		Input capture at falling edge
		1	x		Input capture at both edges

[Legend]

x: Don't care

Note: * After power-on reset, 0 is output until TIOR is set.

10.3.15 Timer Start Register (TSTR)

TSTR is an 8-bit readable/writable register that selects operation/stoppage of TCNT for channels 0 to 4.

TSTR_5 is an 8-bit readable/writable register that selects operation/stoppage of TCNTU_5, TCNTV_5, and TCNTW_5 for channel 5.

When setting the operating mode in TMDR or setting the count clock in TCR, first stop the TCNT counter.

- TSTR

Bit:	7	6	5	4	3	2	1	0
	CST4	CST3	-	-	-	CST2	CST1	CST0
Initial value:	0	0	0	0	0	0	0	0
R/W:	R/W	R/W	R	R	R	R/W	R/W	R/W

Bit	Bit Name	Initial Value	R/W	Description
7	CST4	0	R/W	Counter Start 4 and 3
6	CST3	0	R/W	These bits select operation or stoppage for TCNT. If 0 is written to the CST bit during operation with the TIOC pin designated for output, the counter stops but the TIOC pin output compare output level is retained. If TIOR is written to when the CST bit is cleared to 0, the pin output level will be changed to the set initial output value. 0: TCNT_4 and TCNT_3 count operation is stopped 1: TCNT_4 and TCNT_3 performs count operation
5 to 3	—	All 0	R	Reserved These bits are always read as 0. The write value should always be 0.

Table 10.60 MTU2 Interrupts

Channel	Name	Interrupt Source	Interrupt Flag	DTC Activation	Priority
0	TGIA_0	TGRA_0 input capture/compare match	TGFA_0	Possible	High
	TGIB_0	TGRB_0 input capture/compare match	TGFB_0	Possible	
	TGIC_0	TGRC_0 input capture/compare match	TGFC_0	Possible	
	TGID_0	TGRD_0 input capture/compare match	TGFD_0	Possible	
	TCIV_0	TCNT_0 overflow	TCFV_0	Not possible	
	TGIE_0	TGRE_0 compare match	TGFE_0	Not possible	
	TGIF_0	TGRF_0 compare match	TGFF_0	Not possible	
1	TGIA_1	TGRA_1 input capture/compare match	TGFA_1	Possible	
	TGIB_1	TGRB_1 input capture/compare match	TGFB_1	Possible	
	TCIV_1	TCNT_1 overflow	TCFV_1	Not possible	
	TCIU_1	TCNT_1 underflow	TCFU_1	Not possible	
2	TGIA_2	TGRA_2 input capture/compare match	TGFA_2	Possible	
	TGIB_2	TGRB_2 input capture/compare match	TGFB_2	Possible	
	TCIV_2	TCNT_2 overflow	TCFV_2	Not possible	
	TCIU_2	TCNT_2 underflow	TCFU_2	Not possible	
3	TGIA_3	TGRA_3 input capture/compare match	TGFA_3	Possible	
	TGIB_3	TGRB_3 input capture/compare match	TGFB_3	Possible	
	TGIC_3	TGRC_3 input capture/compare match	TGFC_3	Possible	
	TGID_3	TGRD_3 input capture/compare match	TGFD_3	Possible	
	TCIV_3	TCNT_3 overflow	TCFV_3	Not possible	
4	TGIA_4	TGRA_4 input capture/compare match	TGFA_4	Possible	
	TGIB_4	TGRB_4 input capture/compare match	TGFB_4	Possible	
	TGIC_4	TGRC_4 input capture/compare match	TGFC_4	Possible	
	TGID_4	TGRD_4 input capture/compare match	TGFD_4	Possible	
	TCIV_4	TCNT_4 overflow/underflow	TCFV_4	Possible	
5	TGIU_5	TGRU_5 input capture/compare match	TGFU_5	Possible	
	TGIV_5	TGRV_5 input capture/compare match	TGFV_5	Possible	
	TGIW_5	TGRW_5 input capture/compare match	TGFW_5	Possible	Low

Note: This table shows the initial state immediately after a reset. The relative channel priorities can be changed by the interrupt controller.

Operation when Error Occurs during PWM Mode 1 Operation, and Operation is Restarted in PWM Mode 1: Figure 10.144 shows an explanatory diagram of the case where an error occurs in PWM mode 1 and operation is restarted in PWM mode 1 after re-setting.

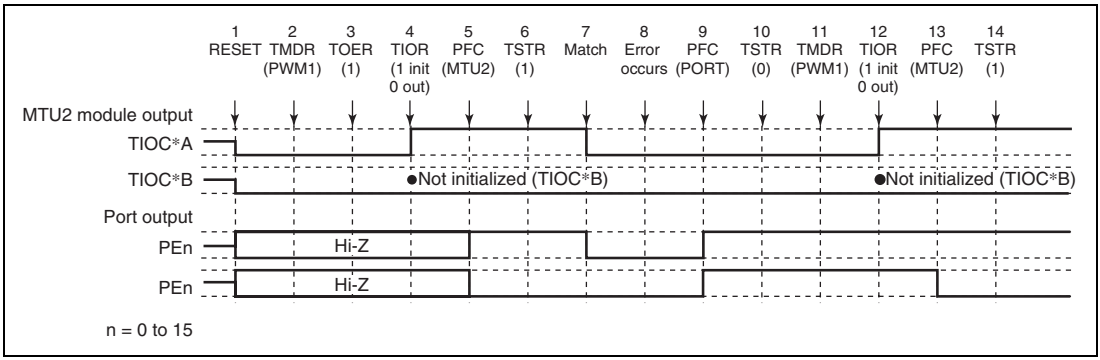


Figure 10.144 Error Occurrence in PWM Mode 1, Recovery in PWM Mode 1

1 to 10 are the same as in figure 10.143.

11. Not necessary when restarting in PWM mode 1.
12. Initialize the pins with TIOR. (In PWM mode 1, the TIOC*B side is not initialized.)
13. Set MTU2 output with the PFC.
14. Operation is restarted by TSTR.

11.3.6 Software Port Output Enable Register (SPOER)

SPOER is an 8-bit readable/writable register that controls high-impedance state of the pins.

Bit:	7	6	5	4	3	2	1	0
	-	-	-	-	-	MTU2S HIZ	MTU2 CH0HIZ	MTU2 CH34HIZ
Initial value:	0	0	0	0	0	0	0	0
R/W:	R	R	R	R	R	R/W	R/W	R/W

Bit	Bit Name	Initial value	R/W	Description
7 to 3	—	All 0	R	Reserved These bits are always read as 0. The write value should always be 0.
2	MTU2SHIZ	0	R/W	MTU2S Output High-Impedance This bit specifies whether to place the special pins for the MTU2S in the high-impedance state. 0: Does not place the pins in the high-impedance state [Clearing conditions] • Power-on reset • By writing 0 to MTU2SHIZ after reading MTU2SHIZ = 1 1: Places the pins in the high-impedance state [Setting condition] • By writing 1 to MTU2SHIZ
1	MTU2CH0HIZ	0	R/W	MTU2 Channel 0 Output High-Impedance This bit specifies whether to place the pins for channel 0 in the MTU2 in the high-impedance state. 0: Does not place the pins in the high-impedance state [Clearing conditions] • Power-on reset • By writing 0 to MTU2CH0HIZ after reading MTU2CH0HIZ = 1 1: Places the pins in the high-impedance state [Setting condition] • By writing 1 to MTU2CH0HIZ

12.5 Usage Note

12.5.1 WTCNT Setting Value

If WTCNT is set to H'FF in interval timer mode, overflow does not occur when WTCNT changes from H'FF to H'00 after one cycle of count clock, but overflow occurs when WTCNT changes from H'FF to H'00 after 257 cycles of count clock.

If WTCNT is set to H'FF in watchdog timer mode, overflow occurs when WTCNT changes from H'FF to H'00 after one cycle of count clock.

14.3.5 SS Status Register (SSSR)

SSSR is a status flag register for interrupts.

Bit:	7	6	5	4	3	2	1	0
	-	ORER	-	-	TEND	TDRE	RDRF	CE
Initial value:	0	0	0	0	0	1	0	0
R/W:	R	R/W	R	R	R/W	R/W	R/W	R/W

Bit	Bit Name	Initial Value	R/W	Description
7	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.
6	ORER	0	R/W	Overrun Error If the next data is received while RDRF = 1, an overrun error occurs, indicating abnormal termination. SSRDR stores 1-frame receive data before an overrun error occurs and loses data to be received later. While ORER = 1, consecutive serial reception cannot be continued. Serial transmission cannot be continued, either. [Setting condition] • When one byte of the next reception is completed with RDRF = 1 [Clearing condition] • When writing 0 after reading ORER = 1
5, 4	—	All 0	R	Reserved These bits are always read as 0. The write value should always be 0.

Section 15 A/D Converter (ADC)

This LSI includes a successive approximation type 12-bit A/D converter.

15.1 Features

- 12-bit resolution
- Input channels

  16 channels (two independent A/D conversion modules)
- Two operating modes
  - Single-cycle scan mode: Continuous A/D conversion on one to eight channels
  - Continuous scan mode: Repetitive A/D conversion on one to eight channels
- Sixteen 12-bit A/D data registers

  Both A/D_0 and A/D_1 have eight registers and a total of sixteen 16-bit A/D data registers (ADDR) are included. A/D conversion results are stored in A/D data registers (ADDR) that correspond to the input channels.
- Sample-and-hold function

  A sample-and-hold circuit is built into the A/D converter of this LSI, simplifying the configuration of the external analog input circuitry. Multiple channels can be sampled simultaneously because sample-and-hold circuits can be dedicated for channels 0 to 2 and 8 to 10.
  - Group A (GrA): Analog input pins selected from channels 0, 1, and 2 can be simultaneously sampled.
  - Group B (GrB): Analog input pins selected from channels 8, 9, and 10 can be simultaneously sampled.
- Three methods for starting conversion

  Software: Setting of the ADST bit in ADCR

  Timer: TRGAN, TRG0N, TRG4AN, and TRG4BN from the MTU2
  TRGAN, TRG4AN, and TRG4BN from the MTU2S

  External trigger: $\overline{\text{ADTRG}}$ (LSI pin)
- Selectable analog input channel

  A/D conversion of a selected channel is accomplished by setting the A/D analog input channel select registers (ADANSR).
- A/D conversion end interrupt and DTC transfer function is supported

  On completion of A/D conversion, A/D conversion end interrupts (ADI_3 and ADI_4) can be generated and the DTC can be activated by ADI_3 and ADI_4.

16.5.3 Conflict between Word-Write and Count-Up Processes of CMCNT

Even when the count-up occurs in the T2 cycle while writing to CMCNT in words, the writing has priority over the count-up. In this case, the count-up is not performed. Figure 16.6 shows the timing to write to CMCNT in words.

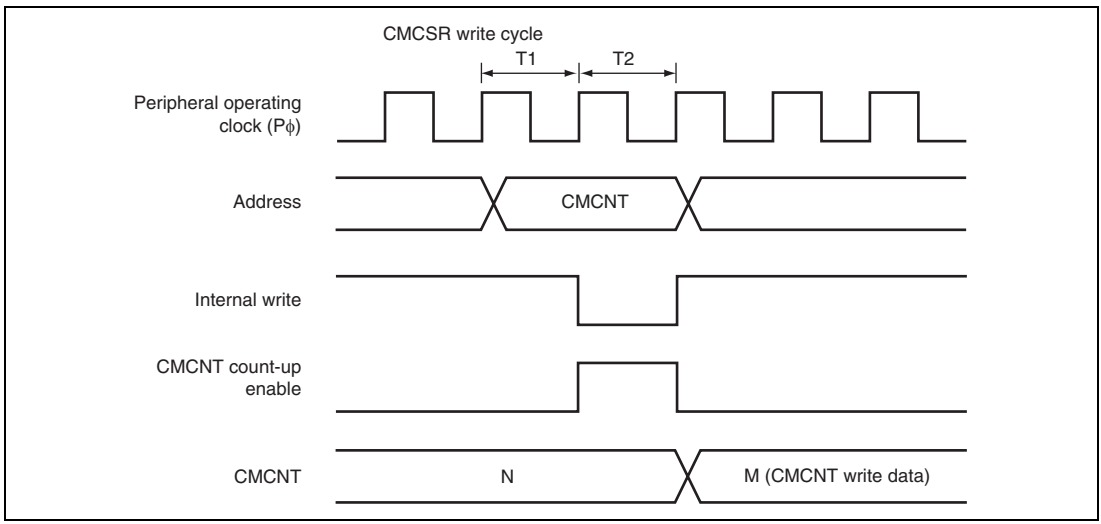


Figure 16.6 Conflict between Word-Write and Count-Up Processes of CMCNT

Bit	Bit Name	Initial Value	R/W	Description
3	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.
2	PE16MD2	0	R/W	PE16 Mode
1	PE16MD1	0	R/W	Select the function of the PE16/$\overline{\text{WAIT}}$/TIOC3BS pin.
0	PE16MD0	0	R/W	000: PE16 I/O (port) 001: TIOC3BS I/O (MTU2S) 010: $\overline{\text{WAIT}}$ input (BSC)* Other than above: Setting prohibited

Note: * This function is enabled only in the on-chip ROM enabled/disabled external-extension mode. Do not set 1 in single-chip mode.

- Port E Control Register L4 (PECRL4)

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	-	PE15 MD2	PE15 MD1	PE15 MD0	-	PE14 MD2	PE14 MD1	PE14 MD0	-	-	PE13 MD1	PE13 MD0	-	PE12 MD2	PE12 MD1	PE12 MD0
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	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	PE15MD2	0	R/W	PE15 Mode
13	PE15MD1	0	R/W	Select the function of the PE15/TIOC4D/$\overline{\text{IRQOUT}}$ pin.
12	PE15MD0	0	R/W	000: PE15 I/O (port) 001: TIOC4D I/O (MTU2) 011: $\overline{\text{IRQOUT}}$ output (INTC) Other than above: Setting prohibited
11	—	0	R	Reserved This bit is always read as 0. The write value should always be 0.

- Erasure

Erasure is performed by issuing the erasure selection command and then one or more block erasure commands.

Firstly, the host sends the erasure selection command to select erasure; after that, it sends a block erasure command to actually erase a specific block. To erase multiple blocks, send further block erasure commands. To terminate erasure, the host should send a block erasure command with the block number H'FF. After this, the boot program waits for the next programming/erasure selection command.

The sequence of erasure by the erasure selection command and block erasure command is shown in figure 20.27.

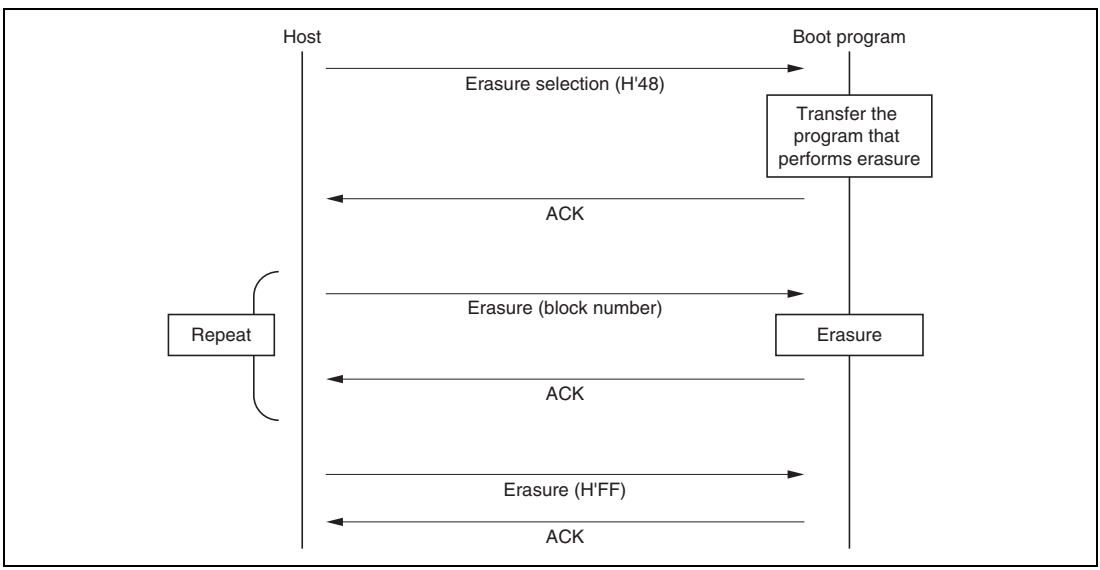


Figure 20.27 Sequence of Erasure

Table 25.3 DC Characteristics (wide-range specifications)

Conditions (wide-range specifications): V_{CC} = 3.0 V to 3.6 V, PV_{CC} = 4.5 V to 5.5 V,
AV_{CC} = 4.5 V to 5.5 V, AV_{refh} = 4.5 V to AV_{CC},
V_{SS} = $PLLV_{SS}$ = AV_{SS} = AV_{refh} = 0 V,
T_a = –40°C to +125°C

Item		Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Input high-level voltage (except Schmitt trigger input voltage)	$\overline{RES}$, $\overline{HSTBY}$, NMI, FWE, MD1, MD0, EXTAL	V_{IH}	PV_{CC}–0.6	—	PV_{CC}+0.3	V	
	Analog pins		2.2	—	AV_{CC}+0.3	V	
	Other input pins		2.2	—	PV_{CC}+0.3	V	
Input low-level voltage (except Schmitt trigger input voltage)	$\overline{RES}$, $\overline{HSTBY}$, NMI, FWE, MD1, MD0, EXTAL	V_{IL}	–0.3	—	0.4	V	
	Other input pins		–0.3	—	0.8	V	
Schmitt trigger input voltage	IRQ3 to IRQ0, $\overline{POE0}$ to $\overline{POE2}$, $\overline{POE4}$ to $\overline{POE6}$, $\overline{POE8}$, TCLKA to TCLKD, TIOC0A to TIOC0D, TIOC1A, TIOC1B, TIOC2A, TIOC2B, TIOC3A to TIOC3D, TIOC4A to TIOC4D, TIOC3BS, TIOC3DS, TIOC4AS to TIOC4DS, TIC5US, TIC5VS, TIC5WS, SCK0 to SCK2, RXD0 to RXD2, SSCK, $\overline{SCS}$, SSI, SSO	V_{T+}	PV_{CC}–0.5	—	—	V	
		V_{T-}	—	—	1.0	V	
		V_{T+}–V_{T-}	0.4	—	—	V	
Input leak current	All input pins (except $\overline{HSTBY}$)	$\lvert I_{in} \rvert$	—	—	1.0	µA	
Input pull-up MOS current	$\overline{HSTBY}$	$-I_{pu}$	—	—	800	µA	V_{in} = 0 V
Three-state leak current (OFF state)	Ports A, B, D, E	$\lvert I_{tsi} \rvert$	—	—	1.0	µA	

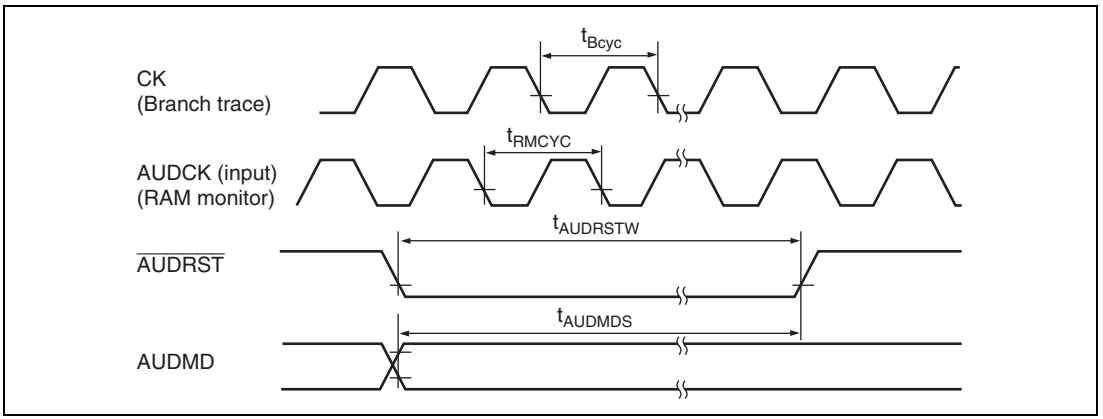


Figure 25.31 AUD Reset Timing

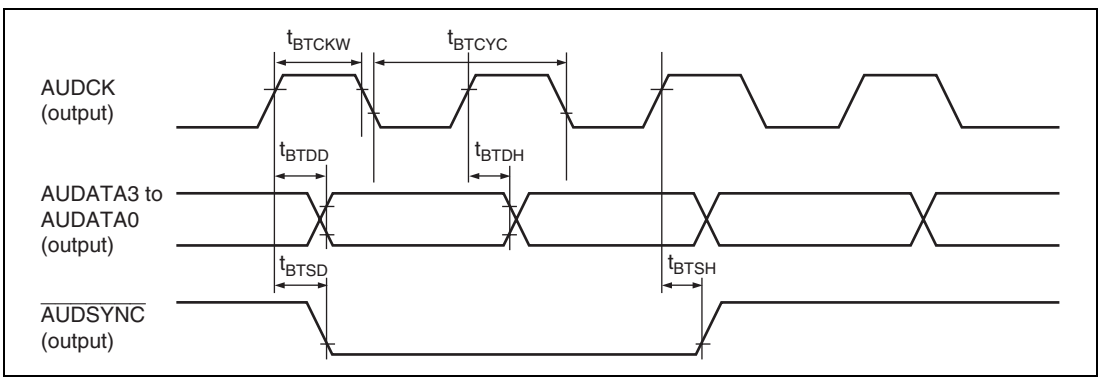


Figure 25.32 Branch Trace Timing