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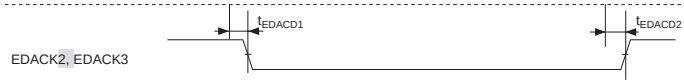
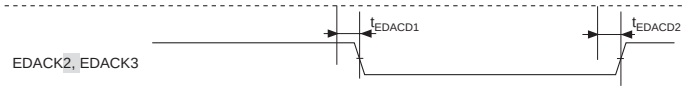
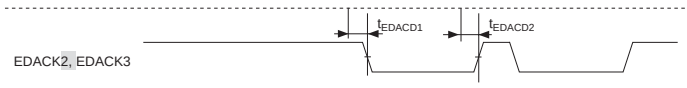
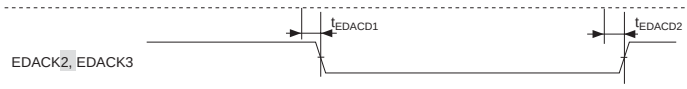
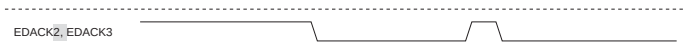
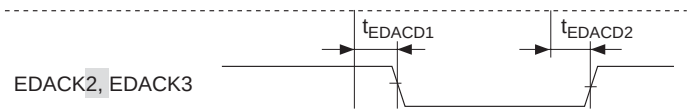
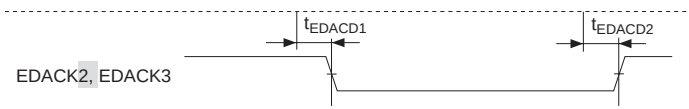
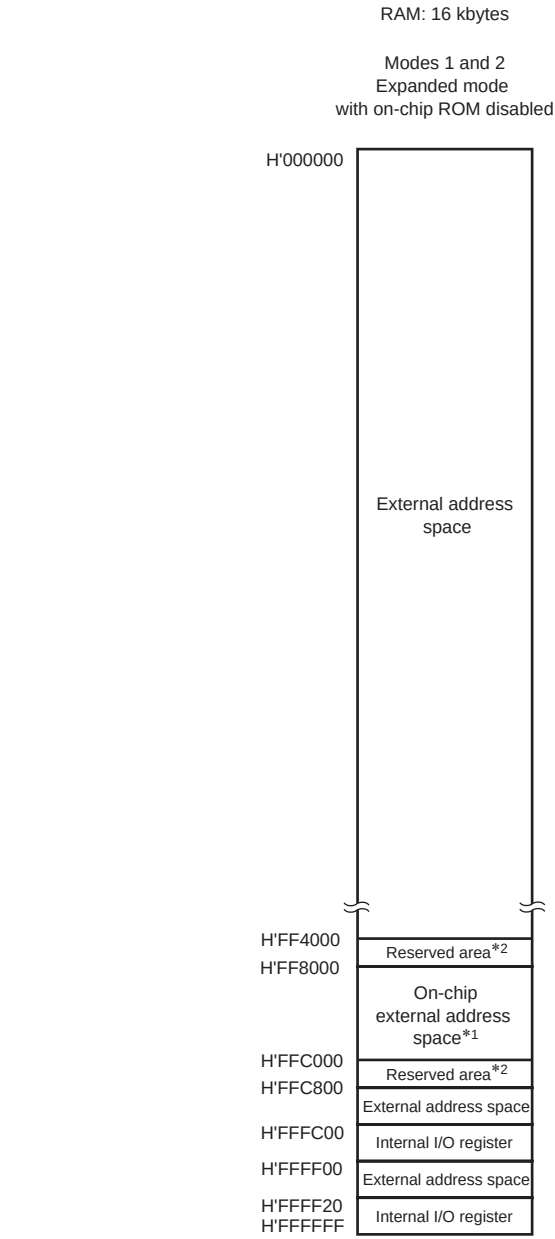
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	H8S/2000
Core Size	16-Bit
Speed	33MHz
Connectivity	I²C, IrDA, SCI, SmartCard
Peripherals	DMA, POR, PWM, WDT
Number of I/O	96
Program Memory Size	384KB (384K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	24K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 16x10b; D/A 6x8b
Oscillator Type	External
Operating Temperature	-20°C ~ 75°C (TA)
Mounting Type	Surface Mount
Package / Case	144-LQFP
Supplier Device Package	144-LQFP (20x20)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/df2377rvfq33v

Item	Page	Revision (See Manual for Details)
26.4.3 Bus Timing Figure 26.11 Basic Bus Timing: Three-State Access (CS Assertion Period Extended)	1074	Figure amended 
Figure 26.14 DRAM Access Timing: Two-State Access	1077	Figure amended 
Figure 26.15 DRAM Access Timing: Two-State Access, One Wait	1078	Figure amended 
Figure 26.16 DRAM Access Timing: Two-State Burst Access	1079	Figure amended 
Figure 26.17 DRAM Access Timing: Three-State Access (RAST = 1)	1080	Figure amended 
Figure 26.18 DRAM Access Timing: Three-State Burst Access	1081	Figure amended 
26.4.4 DMAC and EXDMAC Timing Figure 26.28 DMAC and EXDMAC Single Address Transfer Timing: Two-State Access	1088	Figure amended 
Figure 26.29 DMAC and EXDMAC Single Address Transfer Timing: Three-State Access	1089	Figure amended 



Notes: 1. This area is specified as external address space by clearing the RAME bit in SYSCR to 0.
2. A reserved area should not be accessed.

Figure 3.9 Memory Map for H8S/2373 and H8S/2373R

Set a value in RTCOR and bits RTCK2 to RTCK0 that will meet the refreshing interval specification for the synchronous DRAM used.

When bits RTCK2 to RTCK0 are set, RTCNT starts counting up. RTCNT and RTCOR settings should therefore be completed before setting bits RTCK2 to RTCK0. Auto refresh timing is shown in figure 6.54.

Since the refresh counter operation is the same as the operation in the DRAM interface, see section 6.6.12, Refresh Control.

When the continuous synchronous DRAM space is set, access to external address space other than continuous synchronous DRAM space cannot be performed in parallel during the auto refresh period, since the setting of the CBRM bit of REFCR is ignored.

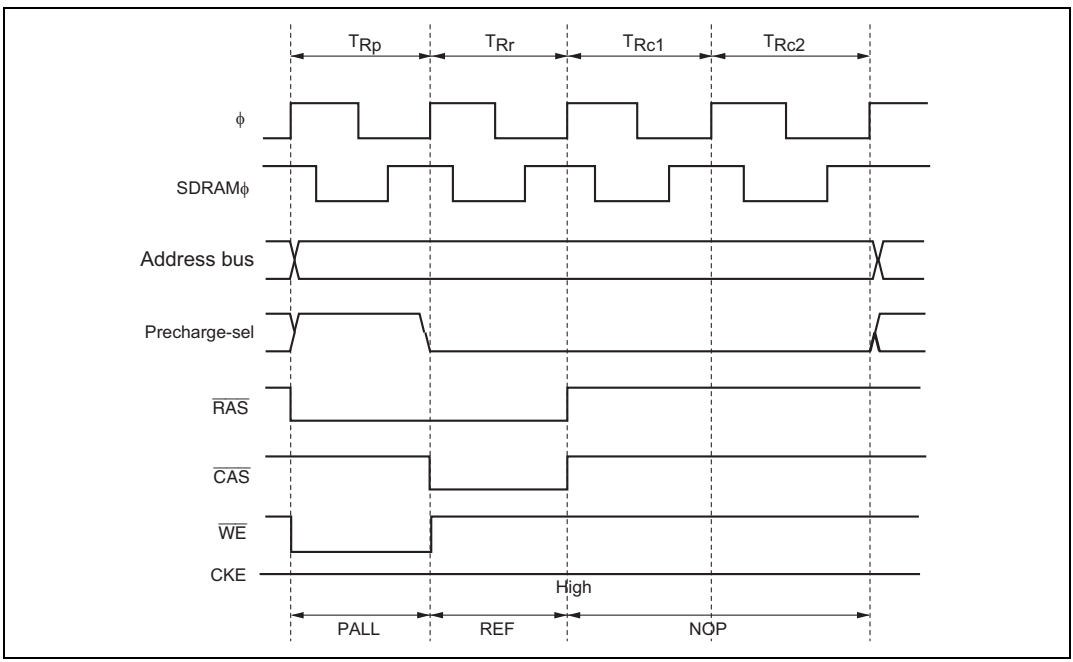


Figure 6.54 Auto Refresh Timing

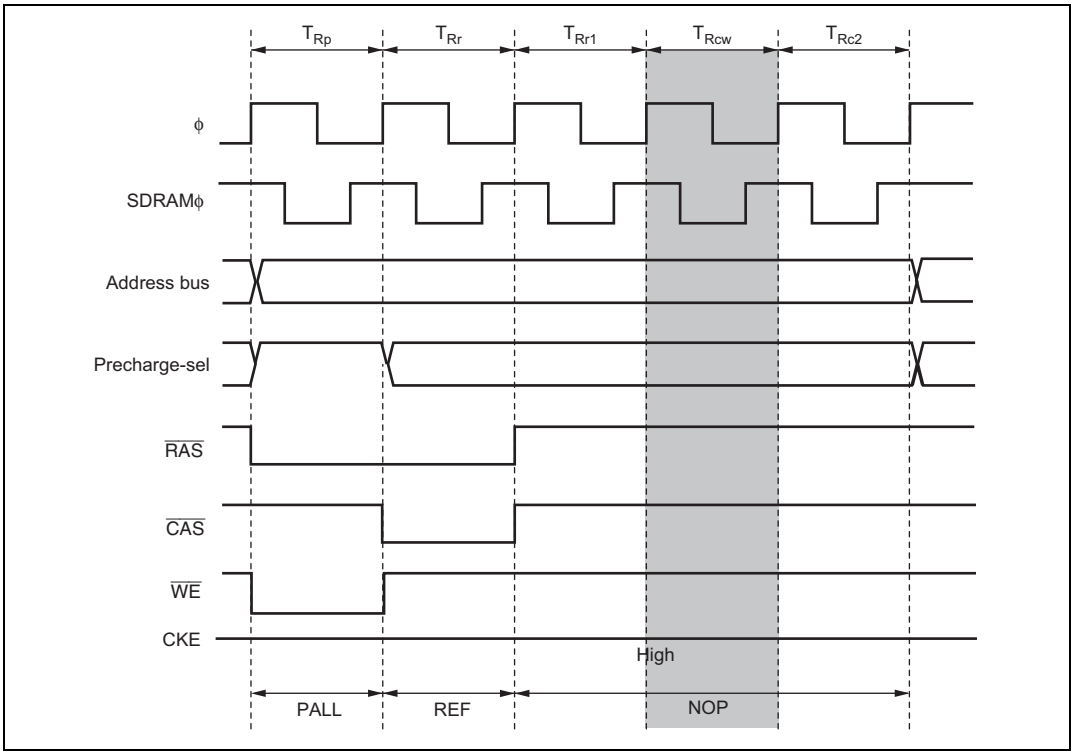


Figure 6.56 Auto Refresh Timing
(TPC = 0, TPC0 = 0, RLW1 = 0, RLW0 = 1)

Self-Refreshing: A self-refresh mode (battery backup mode) is provided for synchronous DRAM as a kind of standby mode. In this mode, refresh timing and refresh addresses are generated within the synchronous DRAM.

To select self-refreshing, set the RFSHE bit to 1 in REFCR. When a SLEEP instruction is executed to enter software standby mode, the SELF command is issued, as shown in figure 6.57.

When software standby mode is exited, the SLFRF bit in REFCR is cleared to 0 and self-refresh mode is exited automatically. If an auto refresh request occurs when making a transition to software standby mode, auto refreshing is executed, then self-refresh mode is entered.

When using self-refresh mode, the OPE bit must not be cleared to 0 in SBYCR.

Relationship between Chip Select ($\overline{CS}$) Signal and Read ($\overline{RD}$) Signal: Depending on the system's load conditions, the $\overline{RD}$ signal may lag behind the $\overline{CS}$ signal. An example is shown in figure 6.68. In this case, with the setting for no idle cycle insertion (a), there may be a period of overlap between the bus cycle A $\overline{RD}$ signal and the bus cycle B $\overline{CS}$ signal. Setting idle cycle insertion, as in (b), however, will prevent any overlap between the $\overline{RD}$ and $\overline{CS}$ signals. In the initial state after reset release, idle cycle insertion (b) is set.

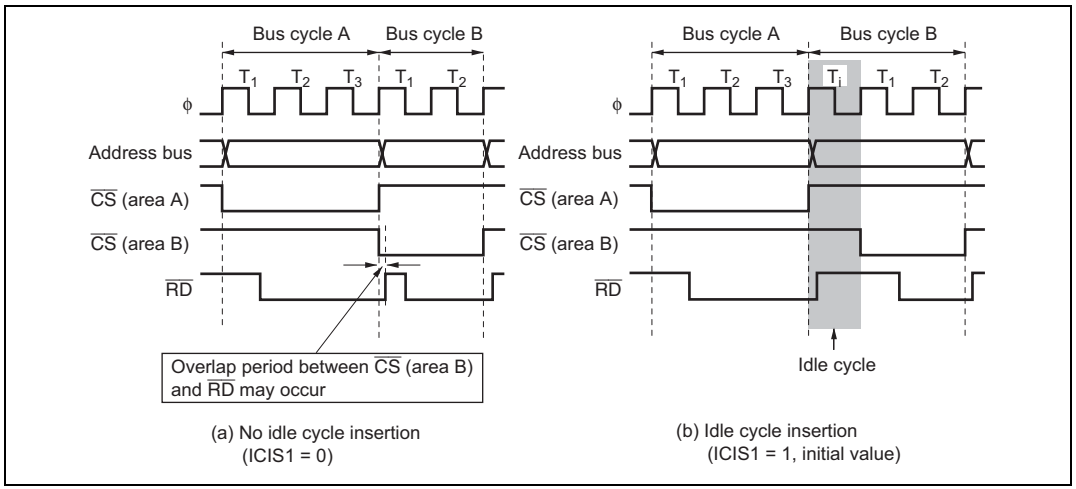


Figure 6.68 Relationship between Chip Select ($\overline{CS}$) and Read ($\overline{RD}$)

- Normal space access after DRAM space write access

  While the ICIS2 bit is set to 1 in BCR and a normal space read access occurs after DRAM space write access, idle cycle is inserted in the first read cycle. The number of states of the idle cycle to be inserted is in accordance with the setting of the IDLC bit. It does not depend on the DRMI bit in DRACCR. Figure 6.78 shows an example of idle cycle operation when the ICIS2 bit is set to 1.

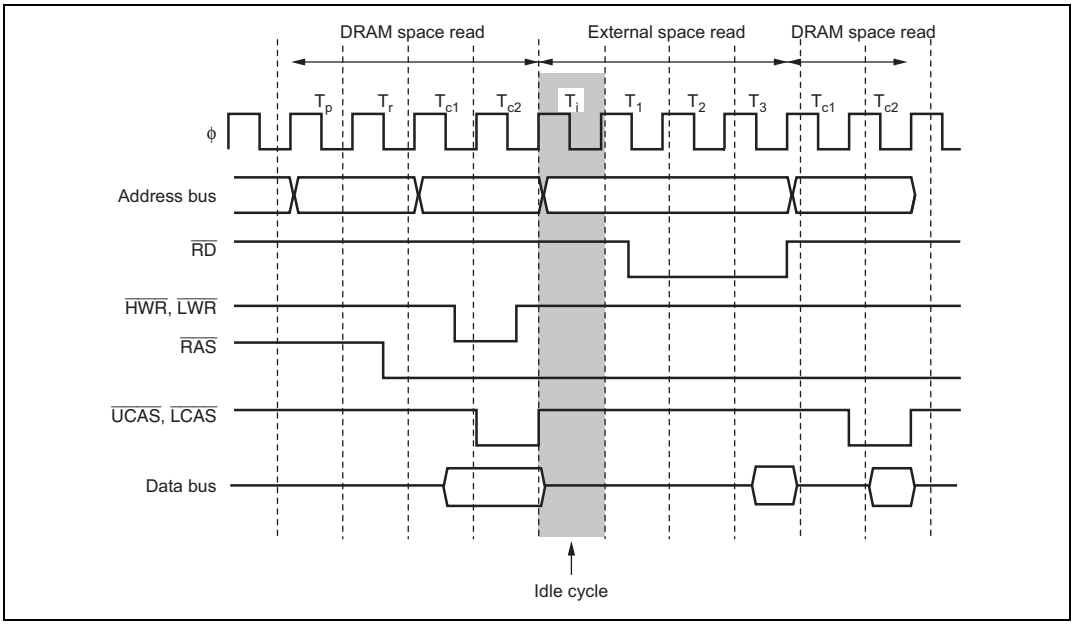


Figure 6.78 Example of Idle Cycle Operation after DRAM Write Access (IDLC = 0, ICIS1 = 0, RAST = 0, CAST = 0)

Idle Cycle in Case of Normal Space Access after Continuous Synchronous DRAM Space Access:

Note: In the H8S/2378 Group, the synchronous DRAM interface is not supported.

- Normal space access after a continuous synchronous DRAM space read access

  While the DRMI bit is cleared to 0 in DRACCR, idle cycle insertion after continuous synchronous DRAM space read access is disabled. Idle cycle insertion after continuous synchronous DRAM space read access can be enabled by setting the DRMI bit to 1. The conditions and number of states of the idle cycle to be inserted are in accordance with the settings of bits ICIS1, ICIS0, and IDLC in RCR. Figure 6.79 shows an example of idle cycle operation when the DRMI bit is set to 1. When the DRMI bit is cleared to 0, an idle cycle is

6.11.1 Operation

In externally expanded mode, the bus can be released to an external device by setting the BRLE bit to 1 in BCR. Driving the $\overline{\text{BREQ}}$ pin low issues an external bus request to this LSI. When the $\overline{\text{BREQ}}$ pin is sampled, at the prescribed timing the $\overline{\text{BACK}}$ pin is driven low, and the address bus, data bus, and bus control signals are placed in the high-impedance state, establishing the external bus released state.

In the external bus released state, internal bus masters except the EXDMAC can perform accesses using the internal bus. When an internal bus master wants to make an external access, it temporarily defers initiation of the bus cycle, and waits for the bus request from the external bus master to be canceled. If a refresh request is generated in the external bus released state, or if a SLEEP instruction is executed to place the chip in software standby mode or all-module-clocks-stopped mode, refresh control and software standby or all-module-clocks-stopped control is deferred until the bus request from the external bus master is canceled.

If the BREQOE bit is set to 1 in BCR, the $\overline{\text{BREQO}}$ pin can be driven low when any of the following requests are issued, to request cancellation of the bus request externally.

- When an internal bus master wants to perform an external access
- When a refresh request is generated
- When a SLEEP instruction is executed to place the chip in software standby mode or all-module-clocks-stopped mode

When the $\overline{\text{BREQ}}$ pin is driven high, the $\overline{\text{BACK}}$ pin is driven high at the prescribed timing and the external bus released state is terminated.

If an external bus release request and external access occur simultaneously, the order of priority is as follows:

(High) External bus release > External access by internal bus master (Low)

If a refresh request and external bus release request occur simultaneously, the order of priority is as follows:

(High) Refresh > External bus release (Low)

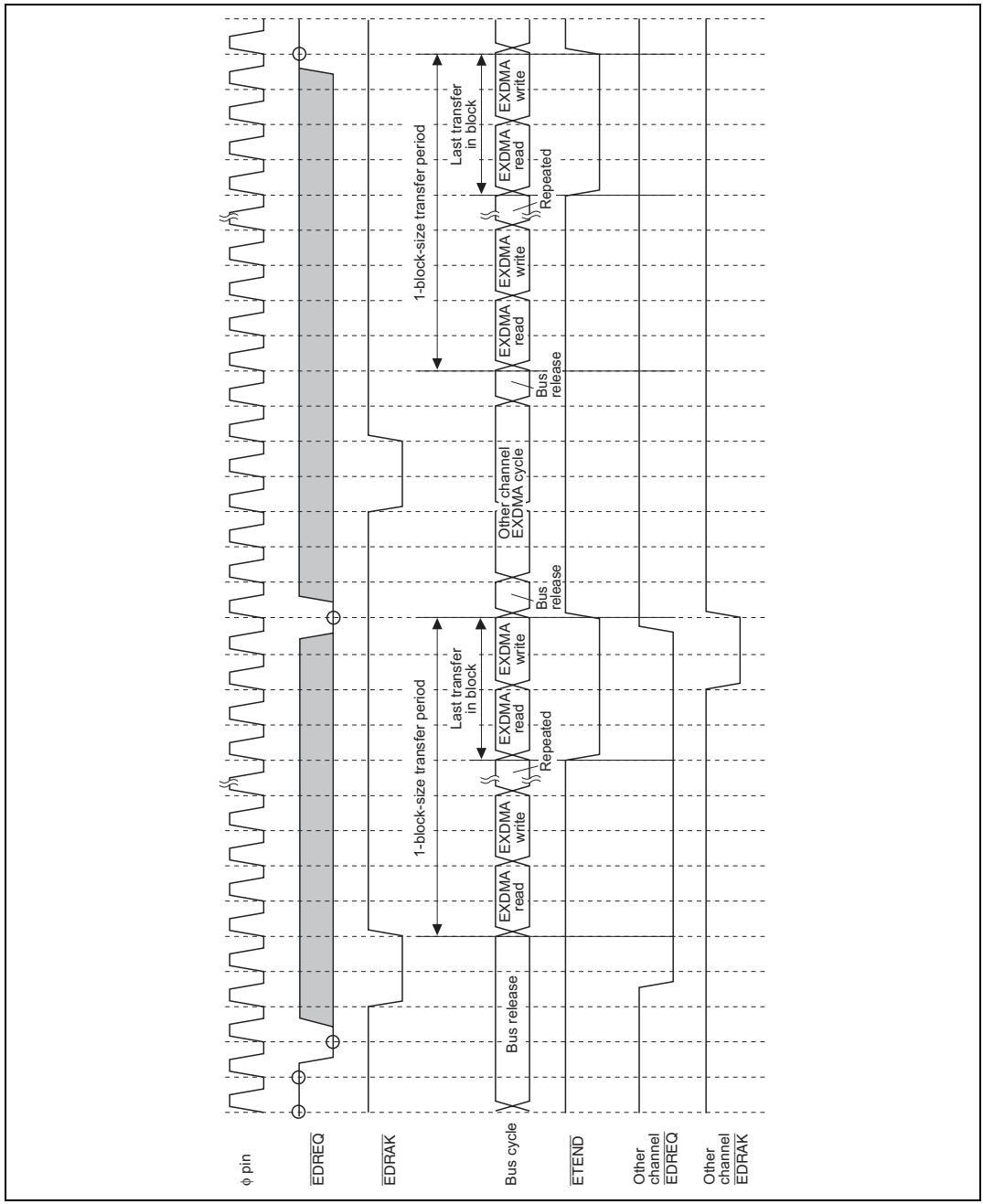


Figure 8.44 External Request/Cycle Steal Mode/Block Transfer Mode (Contention with Another Channel/Dual Address Mode/Low Level Sensing)

10.3.2 Port 3 Data Register (P3DR)

P3DR stores output data for the port 3 pins.

Bit	Bit Name	Initial Value	R/W	Description
7, 6	—	All 0	—	Reserved These bits are always read as 0 and cannot be modified.
5	P35DR	0	R/W	Output data for a pin is stored when the pin function is specified to a general purpose I/O.
4	P34DR	0	R/W	
3	P33DR	0	R/W	
2	P32DR	0	R/W	
1	P31DR	0	R/W	
0	P30DR	0	R/W	

10.3.3 Port 3 Register (PORT3)

PORT3 shows the pin states.

PORT3 cannot be modified.

Bit	Bit Name	Initial Value	R/W	Description
7, 6	—	All 0	—	Reserved These bits are always read as 0 and cannot be modified.
5	P35	—*	R	If a port 3 read is performed while P3DDR bits are set to 1, the P3DR values are read. If a port 1 read is performed while P3DDR bits are cleared to 0, the pin states are read.
4	P34	—*	R	
3	P33	—*	R	
2	P32	—*	R	
1	P31	—*	R	
0	P30	—*	R	

Note: * Determined by the states of pins P35 to P30.

Table 11.7 TPSC2 to TPSC0 (Channel 2)

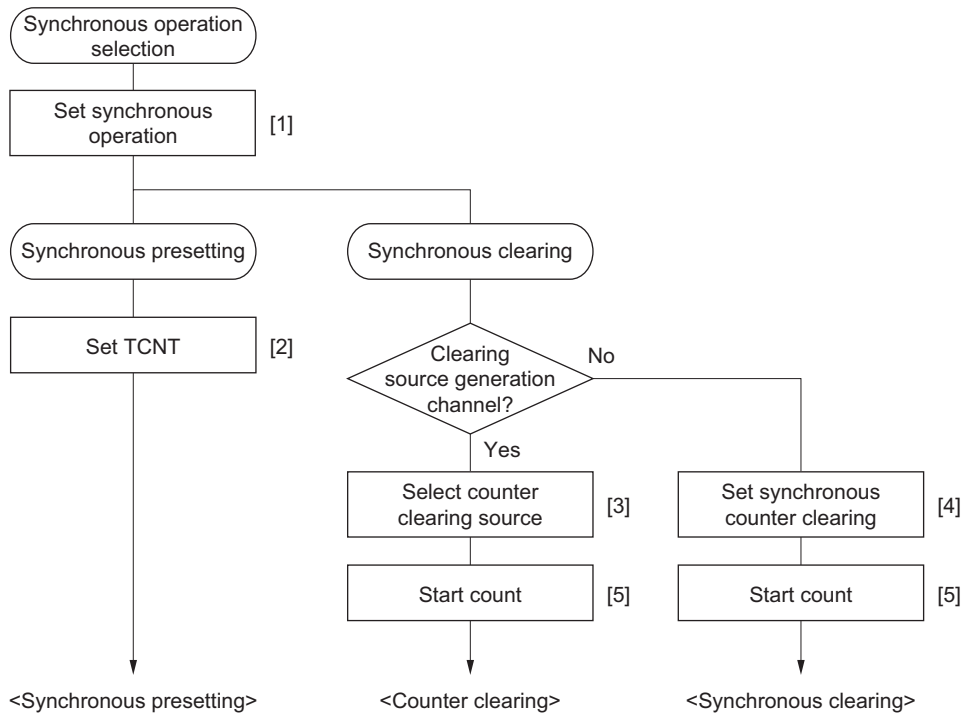
Channel	Bit 2 TPSC2	Bit 1 TPSC1	Bit 0 TPSC0	Description
2	0	0	0	Internal clock: counts on ϕ/1
			1	Internal clock: counts on ϕ/4
		1	0	Internal clock: counts on ϕ/16
			1	Internal clock: counts on ϕ/64
	1	0	0	External clock: counts on TCLKA pin input
			1	External clock: counts on TCLKB pin input
		1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

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

Table 11.8 TPSC2 to TPSC0 (Channel 3)

Channel	Bit 2 TPSC2	Bit 1 TPSC1	Bit 0 TPSC0	Description
3	0	0	0	Internal clock: counts on ϕ/1
			1	Internal clock: counts on ϕ/4
		1	0	Internal clock: counts on ϕ/16
			1	Internal clock: counts on ϕ/64
	1	0	0	External clock: counts on TCLKA pin input
			1	Internal clock: counts on ϕ/1024
		1	0	Internal clock: counts on ϕ/256
			1	Internal clock: counts on ϕ/4096

Example of Synchronous Operation Setting Procedure: Figure 11.10 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.

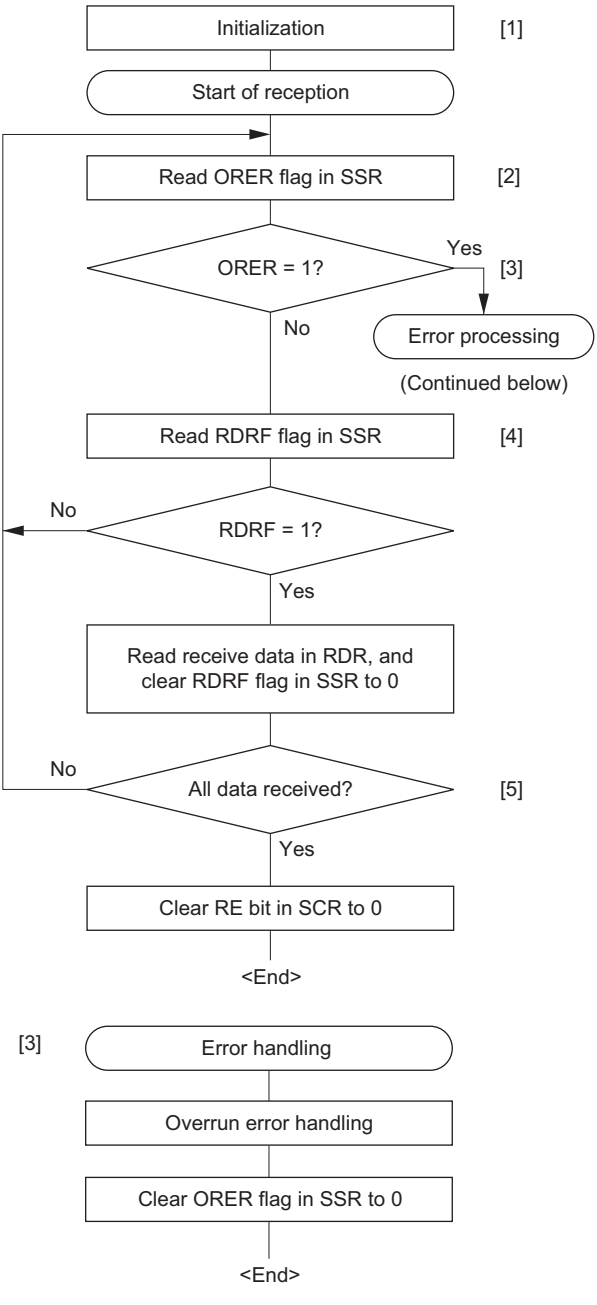
[2] When the TCNT counter of any of the channels designated for synchronous operation is written to, the same value is simultaneously written to the other TCNT counters.

[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 11.10 Example of Synchronous Operation Setting Procedure



[1] SCI initialization:
The RxD pin is automatically designated as the receive data input pin.

[2] [3] Receive error handling:
If a receive error occurs, read the ORER flag in SSR, and after performing the appropriate error handling, clear the ORER flag to 0. Transfer cannot be resumed if the ORER flag is set to 1.

[4] SCI status check and receive data read:
Read SSR and check that the RDRF flag is set to 1, then read the receive data in RDR and clear the RDRF flag to 0. Transition of the RDRF flag from 0 to 1 can also be identified by an RXI interrupt.

[5] Serial reception continuation procedure:
To continue serial reception, before the MSB (bit 7) of the current frame is received, finish reading the RDRF flag, reading RDR, and clearing the RDRF flag to 0. The RDRF flag is cleared automatically when the DMAC or DTC is activated by a receive-data-full interrupt (RXI) request and the RDR value is read.

Figure 15.19 Sample Serial Reception Flowchart

Bit	Bit Name	Initial Value	R/W	Description
4	NACKF	0	R/W	No acknowledge detection flag [Setting condition] • When no acknowledge is detected from the receive device in transmission while the ACKE bit in ICIER is 1 [Clearing condition] • When 0 is written in NACKF after reading NACKF = 1
3	STOP	0	R/W	Stop condition detection flag [Setting condition] • In master mode, when a stop condition is detected after frame transfer • In slave mode, when a stop condition is detected after the general call address or the first byte slave address, next to detection of start condition, accords with the address set in SAR [Clearing condition] • When 0 is written in STOP after reading STOP = 1
2	AL	0	R/W	Arbitration Lost Flag This flag indicates that arbitration was lost in master mode. When two or more master devices attempt to seize the bus at nearly the same time, if the I²C bus interface detects data differing from the data it sent, it sets AL to 1 to indicate that the bus has been taken by another master. [Setting conditions] • If the internal SDA and SDA pin disagree at the rise of SCL in master transmit mode • When the internal SDA high in master mode while a start condition is detected [Clearing condition] • When 0 is written in AL/OVE after reading AL/OVE=1

17.3.3 A/D Control Register (ADCR)

ADCR enables A/D conversion start by an external trigger input.

Bit	Bit Name	Initial Value	R/W	Description
7	TRGS1	0	R/W	Timer Trigger Select 1 and 0
6	TRGS0	0	R/W	These bits select enabling or disabling of the start of A/D conversion by a trigger signal. 00: A/D conversion start by external trigger is disabled 01: A/D conversion start by external trigger (TPU) is enabled 10: A/D conversion start by external trigger (TMR) is enabled 11: A/D conversion start by external trigger pin (ADTRG) is enabled
5	SCANE	0	R/W	Scan Mode
4	SCANS	0	R/W	Selects single mode or scan mode as the A/D conversion operating mode. 0 u Single mode 10: Scan mode. A/D conversion is performed continuously for channels 1 to 4 11: Scan mode. A/D conversion is performed continuously for channels 1 to 8.
3	CKS1	0	R/W	Clock Select 1 to 0
2	CKS0	0	R/W	Sets the A/D conversion time. Only set bits CKS1 and CKS0 while conversion is stopped (ADST = 0). 00: A/D conversion time = 530 states (max) 01: A/D conversion time = 266 states (max) 10: A/D conversion time = 134 states (max) 11: A/D conversion time = 68 states (max)
1, 0	—	All 0	—	Reserved These bits are always read as 0 and cannot be modified.

Legend: u Don't care.

Table 2.11 Addressing Modes

No.	Addressing Mode	Symbol
1	Register direct	Rn
2	Register indirect	@ERn
3	Register indirect with displacement	@(d:16,ERn)/@(d:32,ERn)
4	Register indirect with post-increment	@ERn+
	Register indirect with pre-decrement	@–ERn
5	Absolute address	@aa:8/@aa:16/@aa:24/@aa:32
6	Immediate	#xx:8/#xx:16/#xx:32
7	Program-counter relative	@(d:8,PC)/@(d:16,PC)
8	Memory indirect	@@aa:8

2.7.1 Register Direct—Rn

The register field of the instruction code specifies an 8-, 16-, or 32-bit general register which contains the operand. R0H to R7H and R0L to R7L can be specified as 8-bit registers. R0 to R7 and E0 to E7 can be specified as 16-bit registers. ER0 to ER7 can be specified as 32-bit registers.

2.7.2 Register Indirect—@ERn

The register field of the instruction code specifies an address register (ERn) which contains the address of a memory operand. If the address is a program instruction address, the lower 24 bits are valid and the upper 8 bits are all assumed to be 0 (H'00).

2.7.3 Register Indirect with Displacement—@(d:16, ERn) or @(d:32, ERn)

A 16-bit or 32-bit displacement contained in the instruction code is added to an address register (ERn) specified by the register field of the instruction, and the sum gives the address of a memory operand. A 16-bit displacement is sign-extended when added.

2.7.4 Register Indirect with Post-Increment or Pre-Decrement—@ERn+ or @-ERn

Register Indirect with Post-Increment—@ERn+: The register field of the instruction code specifies an address register (ERn) which contains the address of a memory operand. After the operand is accessed, 1, 2, or 4 is added to the address register contents and the sum is stored in the address register. The value added is 1 for byte access, 2 for word access, and 4 for longword access. For word or longword transfer instructions, the register value should be even.

Bit	Bit Name	Initial Value	R/W	Description
2	MXC2	0	R/W	111: 11-bit shift
1	MXC1	0	R/W	• When 8-bit access space is designated: Row address bits A23 to A11 used for comparison • When 16-bit access space is designated: Row address bits A23 to A12 used for comparison The precharge-sel is A15 to A12 of the column address.
0	MXC0	0	R/W	

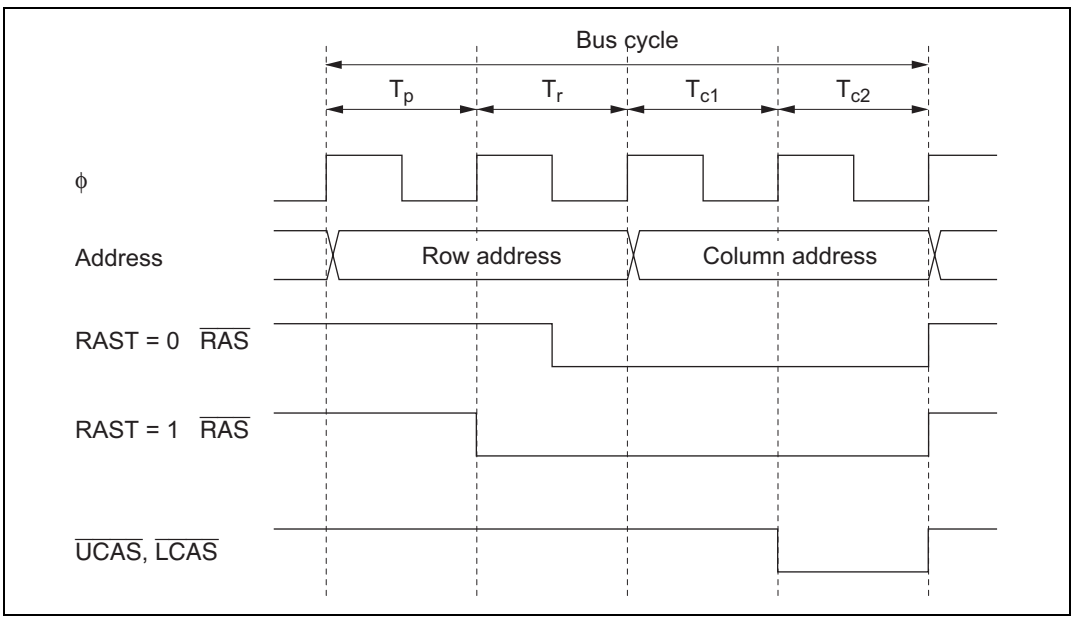


Figure 6.4 $\overline{\text{RAS}}$ Signal Assertion Timing (2-State Column Address Output Cycle, Full Access)