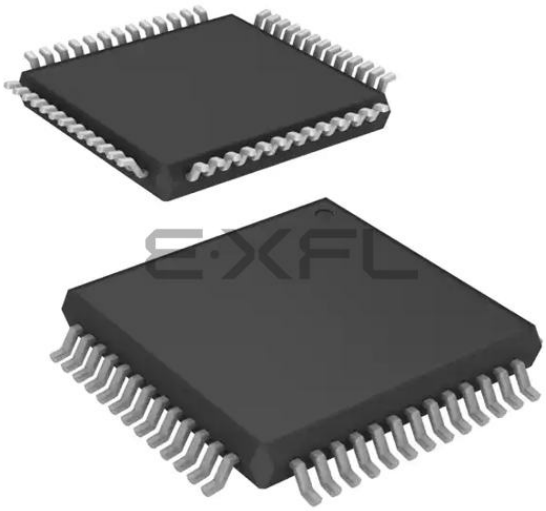
Renesas Electronics America Inc - UPD78F0421GB-GAG-AX Datasheet



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Details	
Product Status	Active
Core Processor	78K/0
Core Size	8-Bit
Speed	10MHz
Connectivity	3-Wire SIO, LINbus, UART/USART
Peripherals	LCD, LVD, POR, PWM, WDT
Number of I/O	34
Program Memory Size	16KB (16K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	768 x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	52-LQFP
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/upd78f0421gb-gag-ax

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An outline of the timer is shown below.

		16-Bit Timer/ Event Counters 00	8-Bit Timer/ Event Counters 50, 51, and 52			8-Bit Timers H0, H1, and H2			Real-time Counter	Watchdog Timer
		TM00	TM50	TM51	TM52	TMH0	TMH1	TMH2		
Function	Interval timer	1 channel	1 channel	1 channel	1 channel	1 channel	1 channel	1 channel	1 channel Note 1	–
	External event counter	1 channel Note 2	–	–	1 channel Note 2	–	–	– Note 2	–	–
	PPG output	1 output	–	–	–	–	–	–	–	–
	PWM output	–	–	–	–	1 output	1 output	–	–	–
	Pulse width measurement	2 inputs	–	–	–	–	–	–	–	–
	Square-wave output	1 output	–	–	–	1 output	1 output	–	–	–
	Carrier generator	–	–	– Note 3	–	–	1 output Note 3	–	–	–
	Calendar function	–	–	–	–	–	–	–	1 channel Note 1	
	RTC output	–	–	–	–	–	–	–	2 outputs Note 4	–
	Watchdog timer	–	–	–	–	–	–	–	–	1 channel
Interrupt source		2	1	1	1	1	1	1	1	–

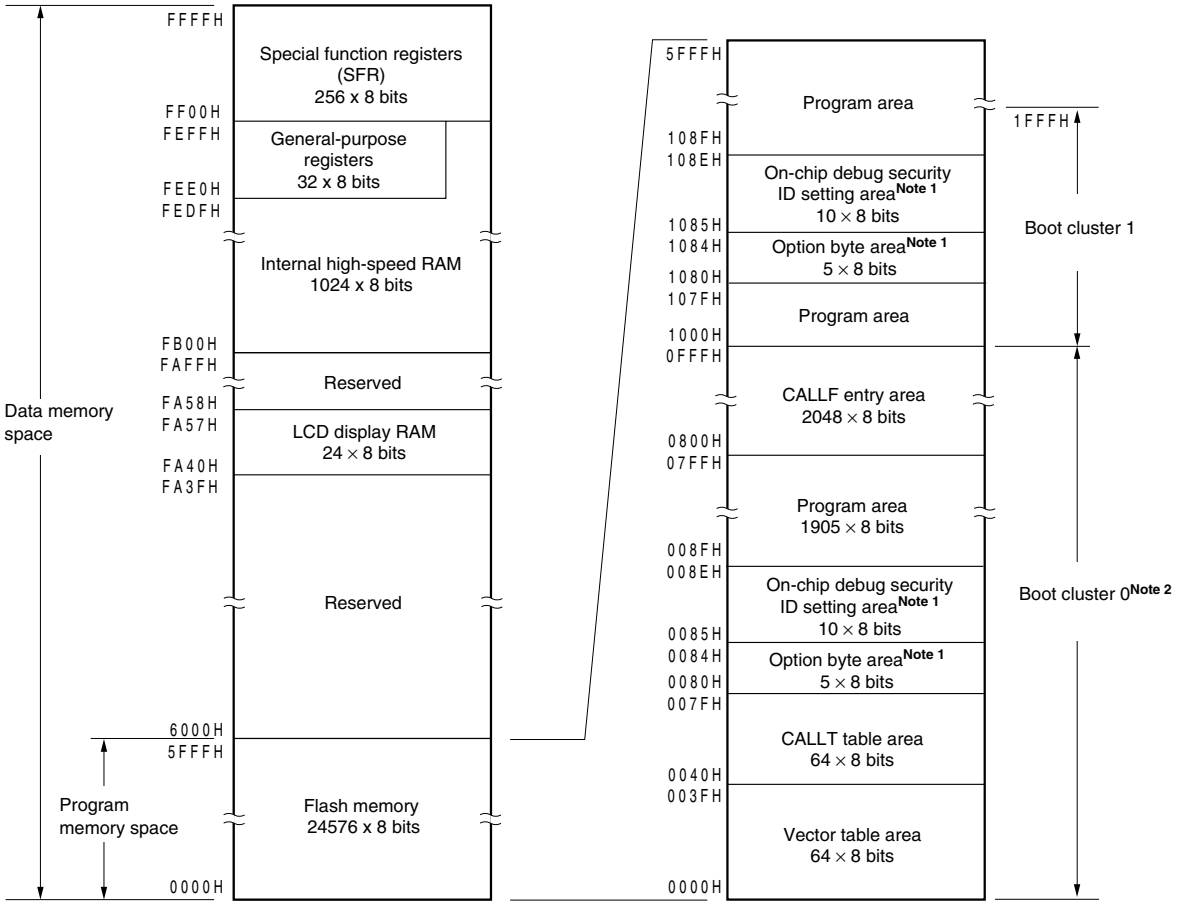
Notes 1. In the real-time counter, the Interval timer function and calendar function can be used simultaneously.

2. TM52 and TM00 can be connected in cascade to be used as a 24-bit counter. Also, the external event input of TM52 can be input enable-controlled via TMH2.

3. TM51 and TMH1 can be used in combination as a carrier generator mode.

4. A 1 Hz output can be used as one output and a 512 Hz, 16.384 kHz, or 32.768 kHz output can be used as one output.

Figure 3-3. Memory Map (μPD78F0422, 78F0432)



Notes 1. When boot swap is not used: Set the option bytes to 0080H to 0084H, and the on-chip debug security IDs to 0085H to 008EH.

When boot swap is used: Set the option bytes to 0080H to 0084H and 1080H to 1084H, and the on-chip debug security IDs to 0085H to 008EH and 1085H to 108EH.

2. Writing boot cluster 0 can be prohibited depending on the setting of security (see **26.7 Security Setting**).

Remark The flash memory is divided into blocks (one block = 1 KB). For the address values and block numbers, see **Table 3-2 Correspondence Between Address Values and Block Numbers in Flash Memory**.

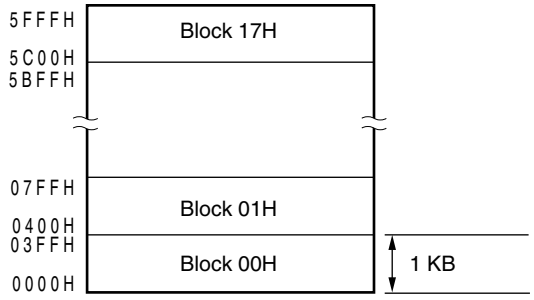
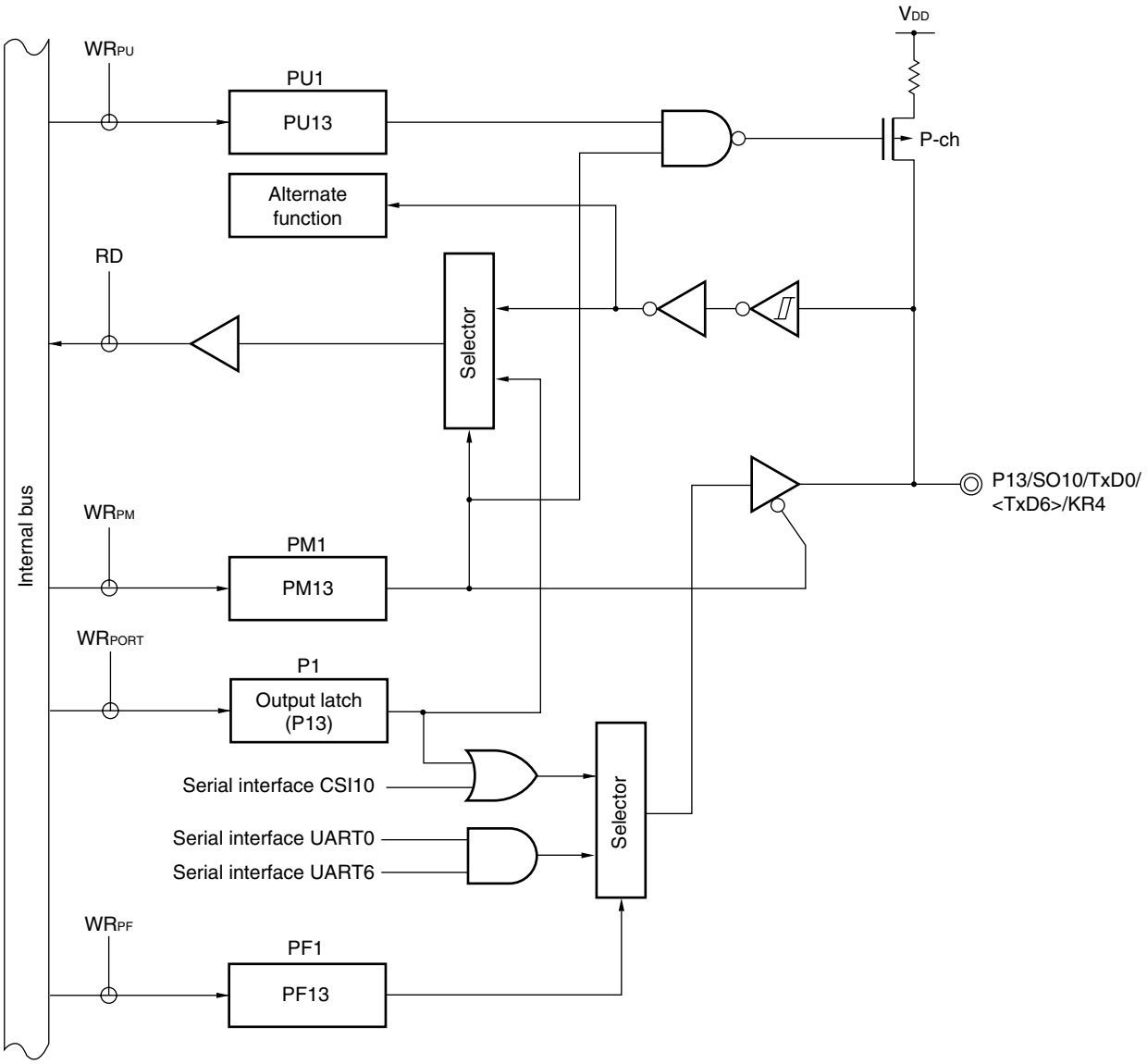
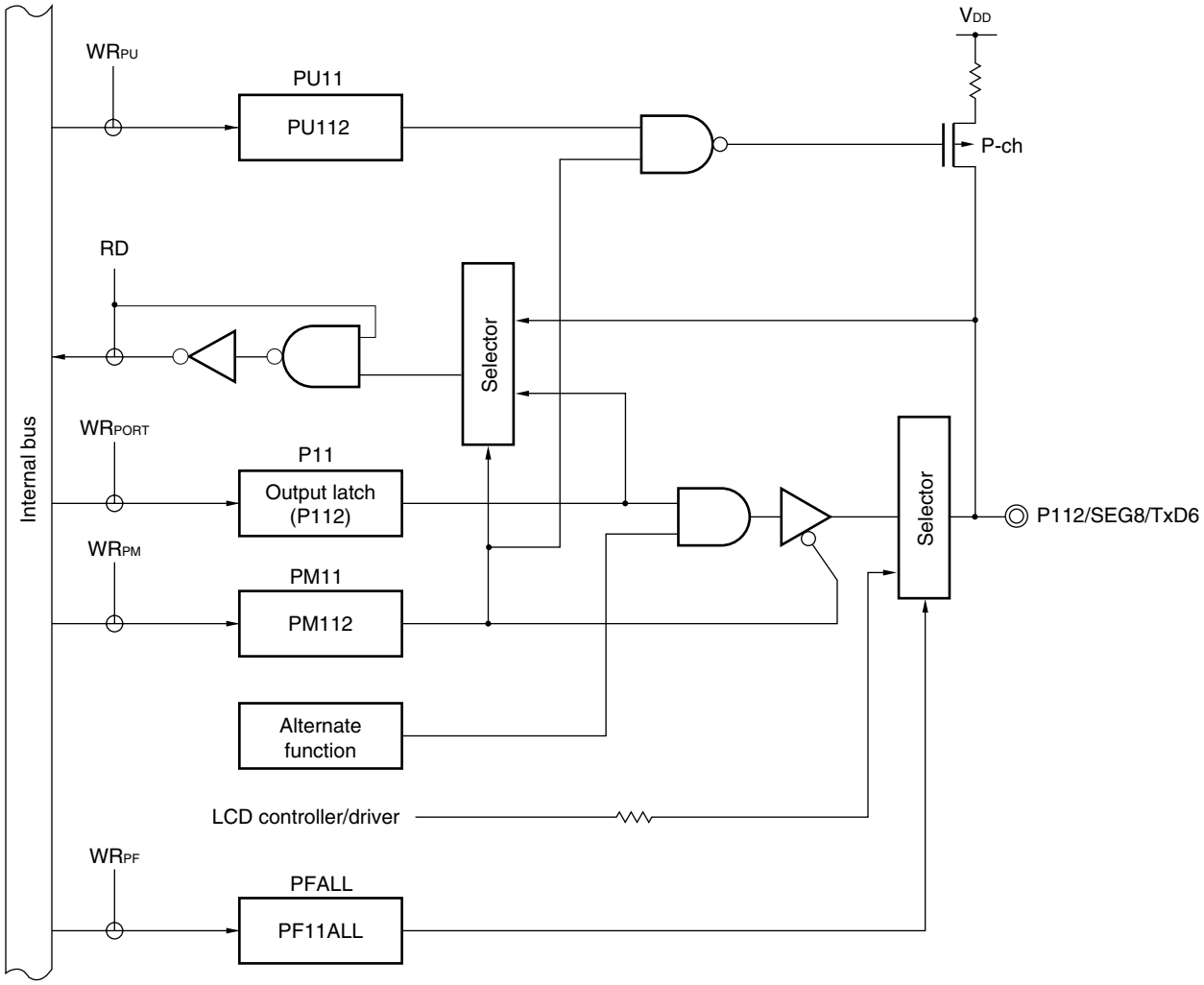


Figure 4-4. Block Diagram of P13



P1: Port register 1
PU1: Pull-up resistor option register 1
PM1: Port mode register 1
RD: Read signal
WR××: Write signal

Figure 4-13. Block Diagram of P112



P11: Port register 11
PU11: Pull-up resistor option register 11
PM11: Port mode register 11
PFALL: Port function register ALL
RD: Read signal
WR××: Write signal

Figure 6-9. Format of Prescaler Mode Register 00 (PRM00)

Address: FFBBH After reset: 00H R/W

Symbol	7	6	5	4	3	2	1	0
PRM00	ES101	ES100	ES001	ES000	0	PRM002	PRM001	PRM000

ES101	ES100	TI010 pin valid edge selection
0	0	Falling edge
0	1	Rising edge
1	0	Setting prohibited
1	1	Both falling and rising edges

ES001	ES000	TI000 pin valid edge selection
0	0	Falling edge
0	1	Rising edge
1	0	Setting prohibited
1	1	Both falling and rising edges

PRM002	PRM001	PRM000	Count clock selection[Note1]			
				f_{PRS} = 2 MHz	f_{PRS} = 5 MHz	f_{PRS} = 10 MHz
0	0	0	f_{PRS}[Note2]	2 MHz	5 MHz	10 MHz
0	0	1	$f_{PRS}/2$	1 MHz	2.5 MHz	5 MHz
0	1	0	$f_{PRS}/2^2$	500 kHz	1.25 MHz	2.5 MHz
0	1	1	$f_{PRS}/2^4$	1.25 MHz	2.5 MHz	625 kHz
1	0	0	$f_{PRS}/2^8$	7.81 kHz	19.53 kHz	39.06 kHz
1	0	1	f_{SUB}	32.768 kHz		
1	1	0	TI000 valid edge[Note 3]			
1	1	1	TM52 output			

Notes 1. If the peripheral hardware clock (f_{PRS}) operates on the high-speed system clock (f_{XH}) (XSEL = 1), the f_{PRS} operating frequency varies depending on the supply voltage.
- V_{DD} = 2.7 to 5.5 V: $f_{PRS} \leq$ 10 MHz
- V_{DD} = 1.8 to 2.7 V: $f_{PRS} \leq$ 5 MHz

2. If the peripheral hardware clock (f_{PRS}) operates on the internal high-speed oscillation clock (f_{RH}) (XSEL = 0), when 1.8 V $\leq V_{DD} <$ 2.7 V, the setting of PRM002 = PRM001 = PRM000 = 0 (count clock: f_{PRS}) is prohibited.

3. The external clock from the TI000 pin requires a pulse longer than twice the cycle of the peripheral hardware clock (f_{PRS}).

Caution Do not select the valid edge of TI000 as the count clock during the pulse width measurement.

Remarks 1. 8-bit timer/event counter 52 (TM52) output can be selected as the TM00 count clock by setting PRM002, PRM001, PRM000 = 1, 1, 1. Any frequency can be set as the 16-bit timer (TM00) count clock, depending on the TM52 count clock and compare register setting values.

2. f_{PRS}: Peripheral hardware clock frequency
f_{SUB}: Subsystem clock frequency

Figure 7-8. Format of Timer Clock Selection Register 52 (TCL52)

Address: FF5BH After reset: 00H R/W

Symbol	7	6	5	4	3	2	1	0
TCL52	0	0	0	0	0	TCL522	TCL521	TCL520

TCL522	TCL521	TCL520	Count clock selection[Note 1]			
				f_{PRS} = 2 MHz	f_{PRS} = 5 MHz	f_{PRS} = 10 MHz
0	0	0	Falling edge of clock selected by ISC2			
0	0	1	Rising edge of clock selected by ISC2			
0	1	0	f_{PRS}[Note 2]	2 MHz	5 MHz	10 MHz
0	1	1	$f_{PRS}/2$	1 MHz	2.5 MHz	5 MHz
1	0	0	$f_{PRS}/2^4$	125 kHz	312.5 kHz	625 kHz
1	0	1	$f_{PRS}/2^6$	31.25 kHz	78.13 kHz	156.25 kHz
1	1	0	$f_{PRS}/2^8$	7.81 kHz	19.53 kHz	39.06 kHz
1	1	1	$f_{PRS}/2^{12}$	0.49 kHz	1.22 kHz	2.44 kHz

Notes 1. If the peripheral hardware clock (f_{PRS}) operates on the high-speed system clock (f_{XH}) (XSEL = 1), the f_{PRS} operating frequency varies depending on the supply voltage.

- V_{DD} = 2.7 to 5.5 V: $f_{PRS} \leq$ 10 MHz
- V_{DD} = 1.8 to 2.7 V: $f_{PRS} \leq$ 5 MHz

2. If the peripheral hardware clock (f_{PRS}) operates on the internal high-speed oscillation clock (f_{RH}) (XSEL = 0), when 1.8 V $\leq V_{DD} <$ 2.7 V, the setting of TCL522, TCL521, TCL520 = 0, 1, 0 (count clock: f_{PRS}) is prohibited.

Cautions 1. When rewriting TCL52 to other data, stop the timer operation beforehand.

2. Be sure to clear bits 3 to 7 to 0.

Remark f_{PRS}: Peripheral hardware clock frequency

(4) Port mode registers 3 (PM3)

This register sets port 3 input/output in 1-bit units.

When using the P34/TI52/TI010/TO00/RTC1HZ/INTP1 pin for timer input, set PM34 to 1. The output latch of PM34 at this time may be 0 or 1.

PM3 can be set by a 1-bit or 8-bit memory manipulation instruction.

Reset signal generation sets these registers to FFH.

Figure 7-13. Format of Port Mode Register 3 (PM3)

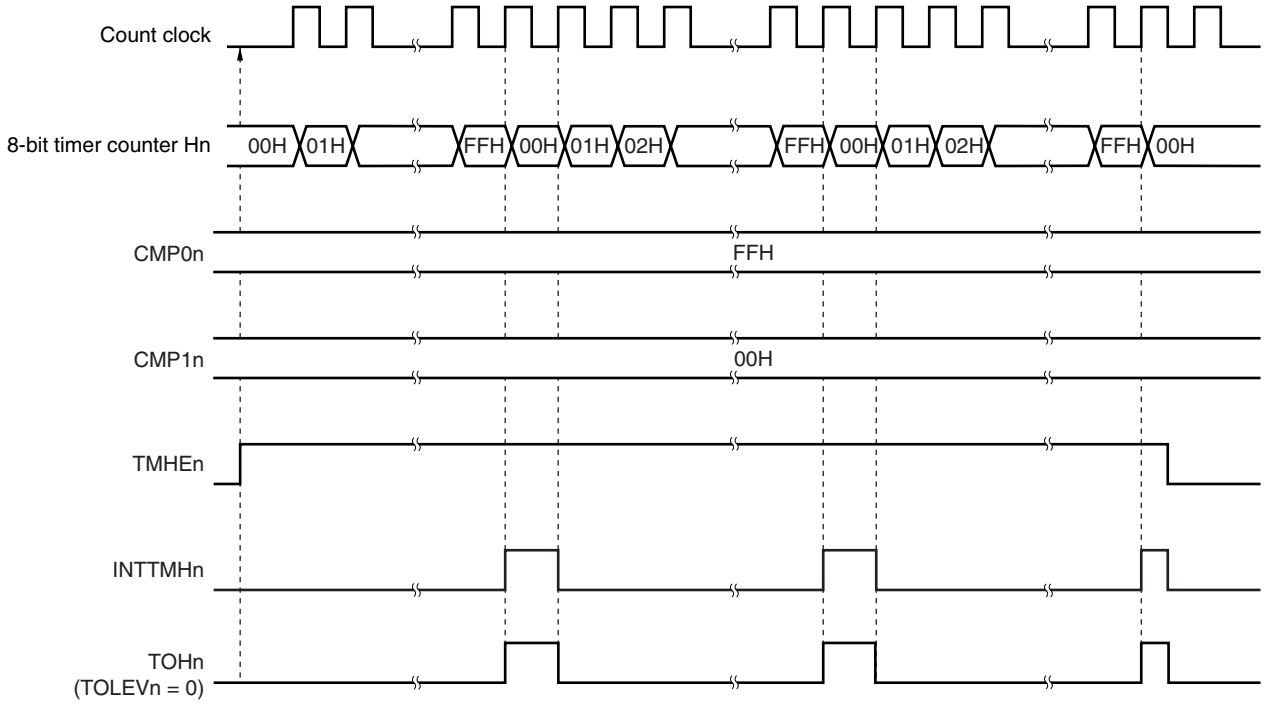
Address: FF23H After reset: FFH R/W

Symbol	7	6	5	4	3	2	1	0
PM3	1	1	1	PM34	PM33	PM32	PM31	1

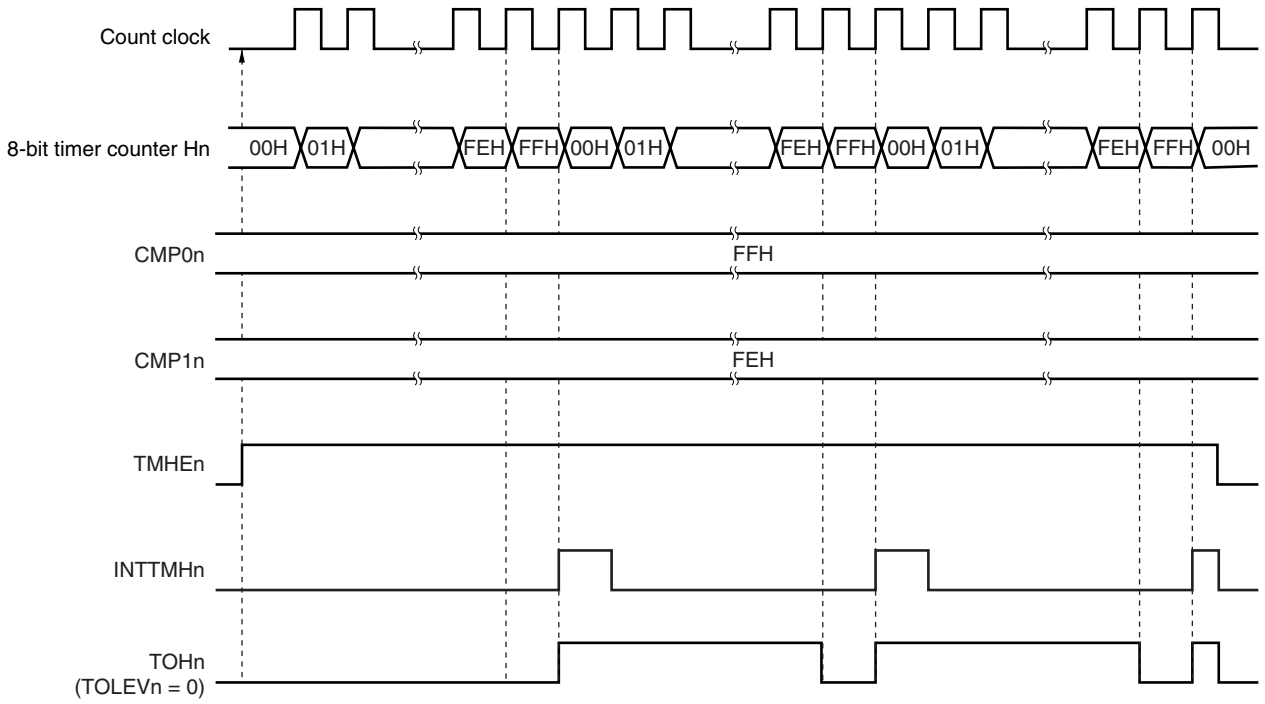
PM3n	P1n pin I/O mode selection (n = 1 to 4)
0	Output mode (output buffer on)
1	Input mode (output buffer off)

Figure 8-14. Operation Timing in PWM Output Mode (2/4)

(b) Operation when CMP0n = FFH, CMP1n = 00H



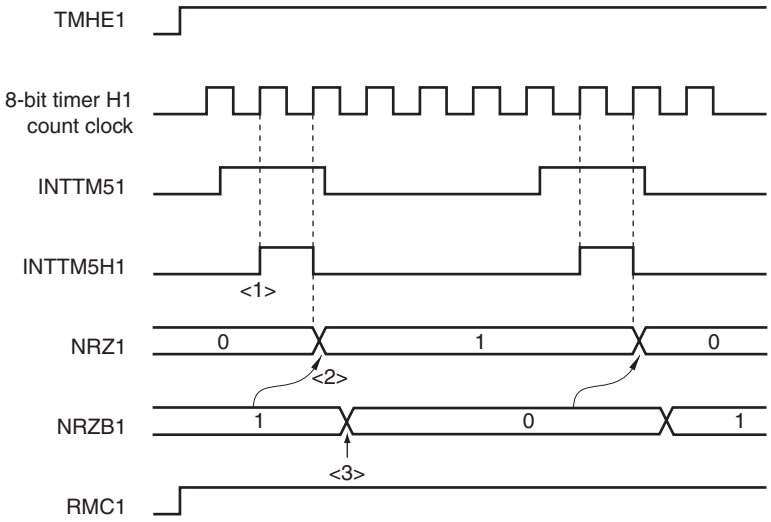
(c) Operation when CMP0n = FFH, CMP1n = FEH



Remark n = 0 to 2, however, TOH0 and TOH1 only for TOHn

To control the carrier pulse output during a count operation, the NRZ1 and NRZB1 bits of the TMCYC1 register have a master and slave bit configuration. The NRZ1 bit is read-only but the NRZB1 bit can be read and written. The INTTM51 signal is synchronized with the 8-bit timer H1 count clock and is output as the INTTM5H1 signal. The INTTM5H1 signal becomes the data transfer signal of the NRZ1 bit, and the NRZB1 bit value is transferred to the NRZ1 bit. The timing for transfer from the NRZB1 bit to the NRZ1 bit is as shown below.

Figure 8-15. Transfer Timing



<1> The INTTM51 signal is synchronized with the count clock of the 8-bit timer H1 and is output as the INTTM5H1 signal.

<2> The value of the NRZB1 bit is transferred to the NRZ1 bit at the second clock from the rising edge of the INTTM5H1 signal.

<3> Write the next value to the NRZB1 bit in the interrupt servicing program that has been started by the INTTM5H1 interrupt or after timing has been checked by polling the interrupt request flag. Write data to count the next time to the CR51 register.

Cautions 1. Do not rewrite the NRZB1 bit again until at least the second clock after it has been rewritten, or else the transfer from the NRZB1 bit to the NRZ1 bit is not guaranteed.

2. When the 8-bit timer/event counter 51 is used in the carrier generator mode, an interrupt is generated at the timing of <1>. When the 8-bit timer/event counter 51 is used in a mode other than the carrier generator mode, the timing of the interrupt generation differs.

Remark INTTM5H1 is an internal signal and not an interrupt source.

CHAPTER 10 WATCHDOG TIMER

10.1 Functions of Watchdog Timer

The watchdog timer operates on the internal low-speed oscillation clock.

The watchdog timer is used to detect an inadvertent program loop. If a program loop is detected, an internal reset signal is generated.

Program loop is detected in the following cases.

- If the watchdog timer counter overflows
- If a 1-bit manipulation instruction is executed on the watchdog timer enable register (WDTE)
- If data other than “ACH” is written to WDTE
- If data is written to WDTE during a window close period
- If the instruction is fetched from an area not set by the IMS register (detection of an invalid check while the CPU hangs up)
- If the CPU accesses an area that is not set by the IMS register (excluding FB00H to FFFFH) by executing a read/write instruction (detection of an abnormal access during a CPU program loop)

When a reset occurs due to the watchdog timer, bit 4 (WDTRF) of the reset control flag register (RESF) is set to 1. For details of RESF, see **CHAPTER 22 RESET FUNCTION**.

The setting methods are described below.

<1> Set bit 0 (ADCE) of the A/D converter mode register (ADM) to 1.
<2> Set the channel to be used in the analog input mode by using bits 2 to 0 (ADPC02 to ADPC00) of the A/D port configuration register 0 (ADPC0) and bits 5 to 0 (PM25 to PM20) of port mode register 2 (PM2).
<3> Select conversion time by using bits 6 to 1 (FR3 to FR0, LV1, and LV0) of ADM.
<4> Select a channel to be used by using bits 2 to 0 (ADS2 to ADS0) of the analog input channel specification register (ADS).
<5> Set bit 7 (ADCS) of ADM to 1 to start A/D conversion.
<6> When one A/D conversion has been completed, an interrupt request signal (INTAD) is generated.
<7> Transfer the A/D conversion data to the A/D conversion result register (ADCR, ADCRH).

<Change the channel>

<8> Change the channel using bits 2 to 0 (ADS2 to ADS0) of ADS to start A/D conversion.
<9> When one A/D conversion has been completed, an interrupt request signal (INTAD) is generated.
<10> Transfer the A/D conversion data to the A/D conversion result register (ADCR, ADCRH).

<Complete A/D conversion>

<11> Clear ADCS to 0.
<12> Clear ADCE to 0.

Cautions 1. Make sure the period of <1> to <5> is 1 μs or more.
2. <1> may be done between <2> and <4>.
3. <1> can be omitted. However, ignore data of the first conversion after <5> in this case.
4. The period from <6> to <9> differs from the conversion time set using bits 6 to 1 (FR3 to FR0, LV1, LV0) of ADM. The period from <8> to <9> is the conversion time set using FR3 to FR0, LV1, and LV0.

(e) Reception error

Three types of errors may occur during reception: a parity error, framing error, or overrun error. If the error flag of asynchronous serial interface reception error status register 0 (ASIS0) is set as a result of data reception, a reception error interrupt (INTSR0) is generated.

Which error has occurred during reception can be identified by reading the contents of ASIS0 in the reception error interrupt (INTSR0) servicing (see **Figure 13-3**).

The contents of ASIS0 are cleared to 0 when ASIS0 is read.

Table 13-3. Cause of Reception Error

Reception Error	Cause
Parity error	The parity specified for transmission does not match the parity of the receive data.
Framing error	Stop bit is not detected.
Overrun error	Reception of the next data is completed before data is read from receive buffer register 0 (RXB0).

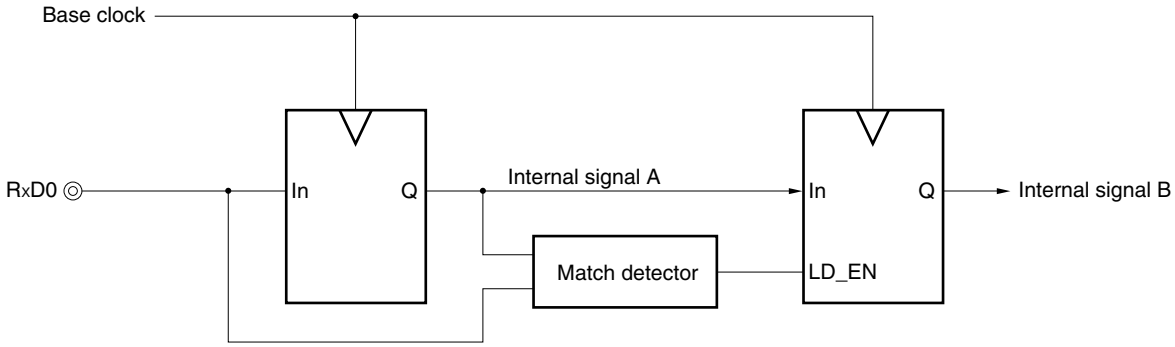
(f) Noise filter of receive data

The RxD0 signal is sampled using the base clock output by the prescaler block.

If two sampled values are the same, the output of the match detector changes, and the data is sampled as input data.

Because the circuit is configured as shown in Figure 13-11, the internal processing of the reception operation is delayed by two clocks from the external signal status.

Figure 13-11. Noise Filter Circuit



(c) Normal transmission

When bit 7 (POWER6) of asynchronous serial interface operation mode register 6 (ASIM6) is set to 1 and bit 6 (TXE6) of ASIM6 is then set to 1, transmission is enabled. Transmission can be started by writing transmit data to transmit buffer register 6 (TXB6). The start bit, parity bit, and stop bit are automatically appended to the data.

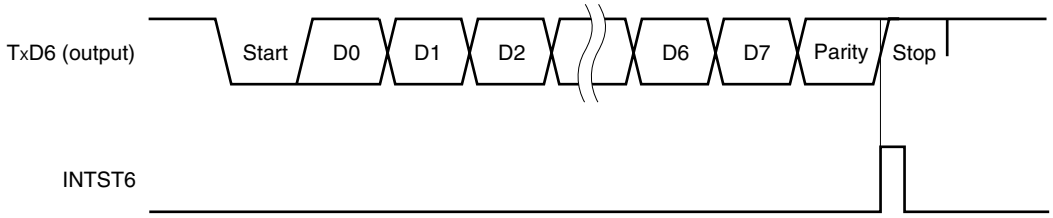
When transmission is started, the data in TXB6 is transferred to transmit shift register 6 (TXS6). After that, the transmit data is sequentially output from TXS6 to the TxD6 pin. When transmission is completed, the parity and stop bits set by ASIM6 are appended and a transmission completion interrupt request (INTST6) is generated.

Transmission is stopped until the data to be transmitted next is written to TXB6.

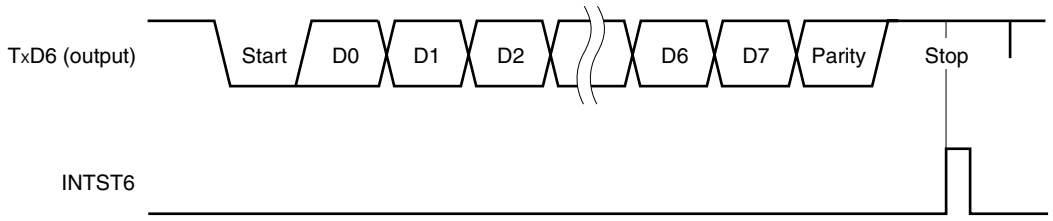
Figure 14-17 shows the timing of the transmission completion interrupt request (INTST6). This interrupt occurs as soon as the last stop bit has been output.

Figure 14-17. Normal Transmission Completion Interrupt Request Timing

1. Stop bit length: 1



2. Stop bit length: 2



(2) LCD display mode register (LCDM)

LCDM specifies whether to enable display operation. It also specifies whether to enable segment pin/common pin output, gate booster circuit control, and the display mode.

LCDM is set using a 1-bit or 8-bit memory manipulation instruction.

Reset signal generation sets LCDM to 00H.

Figure 16-3. Format of LCD Display Mode Register

Address: FFB1H After reset: 00H R/W

Symbol	<7>	<6>	5	<4>	3	2	1	0
LCDM	LCDON	SCOC	0	VAON	0	LCDM2	LCDM1	LCDM0

LCDON	LCD display enable/disable
0	Display off (all segment outputs are deselected.)
1	Display on

SCOC	Segment pin/common pin output control[Note 1]
0	Output ground level to segment/common pin
1	Output deselect level to segment pin and LCD waveform to common pin

VAON	Gate booster circuit control[Notes 1, 2]
0	No gate voltage boosting
1	Gate voltage boosting

LCDM2	LCDM1	LCDM0	LCD controller/driver display mode selection	
			Resistance division method	
			Number of time slices	Bias mode
1	1	1	8	1/4[Note 3]
0	0	0	4	1/3
0	0	1	3	1/3
0	1	0	2	1/2
0	1	1	3	1/2
1	0	0	Static	
Other than above			Setting prohibited	

(Note and Caution are listed on the next page.)

Figure 16-18. Three-Time-Slice LCD Drive Waveform Examples (1/2 Bias Method)

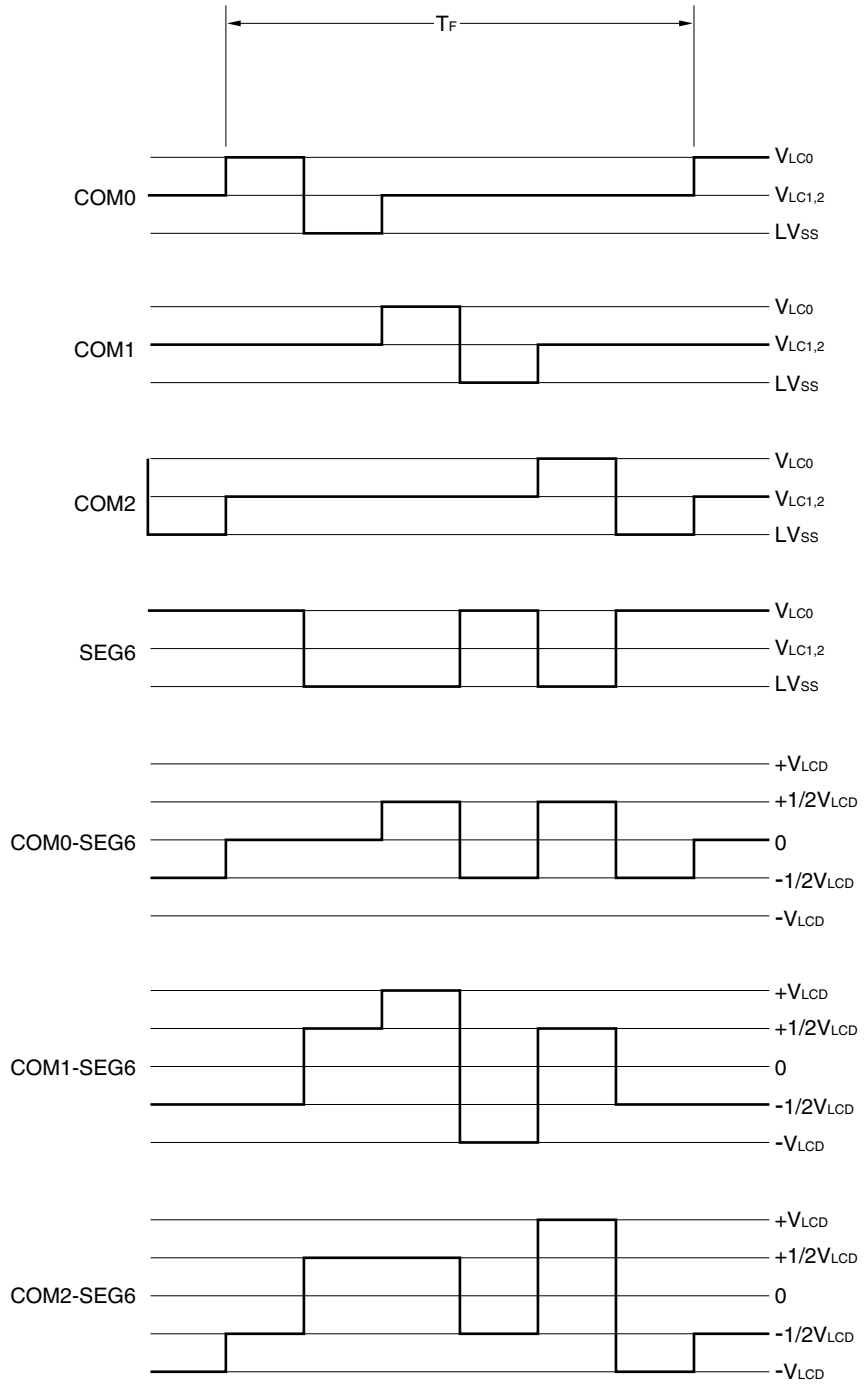
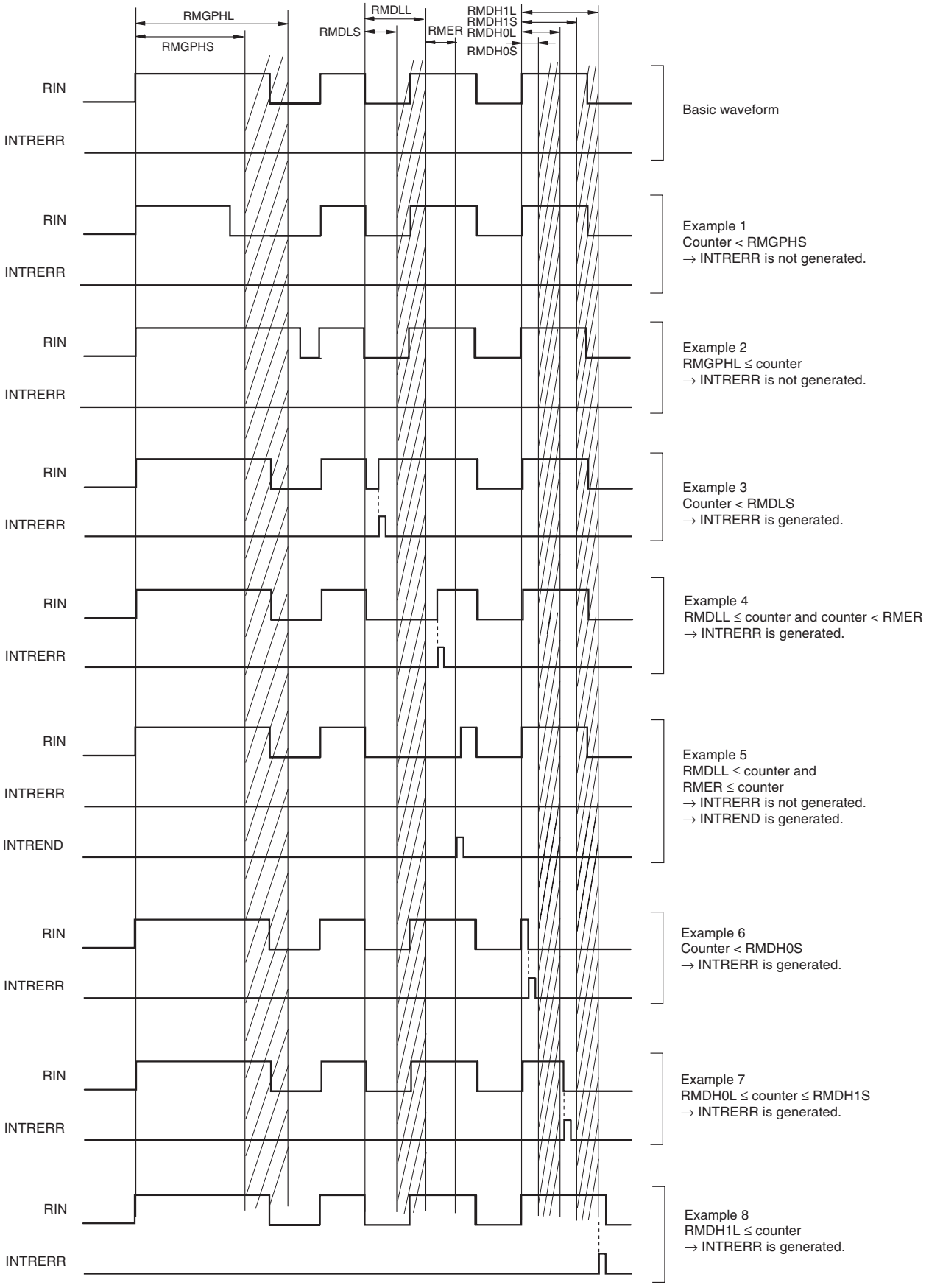


Figure 18-9. Generation Timing of INTRERR Signal



(2) Oscillation stabilization time select register (OSTS)

This register is used to select the X1 clock oscillation stabilization wait time when the STOP mode is released.

When the X1 clock is selected as the CPU clock, the operation waits for the time set using OSTS after the STOP mode is released.

When the internal high-speed oscillation clock is selected as the CPU clock, confirm with OSTC that the desired oscillation stabilization time has elapsed after the STOP mode is released. The oscillation stabilization time can be checked up to the time set using OSTC.

OSTS can be set by an 8-bit memory manipulation instruction.

Reset signal generation sets OSTS to 05H.

Figure 21-2. Format of Oscillation Stabilization Time Select Register (OSTS)

Address: FFA4H After reset: 05H R/W

Symbol	7	6	5	4	3	2	1	0
OSTS	0	0	0	0	0	OSTS2	OSTS1	OSTS0

OSTS2	OSTS1	OSTS0	Oscillation stabilization time selection	
				f_X = 10 MHz
0	0	1	$2^{11}/f_X$	204.8 μs
0	1	0	$2^{13}/f_X$	819.2 μs
0	1	1	$2^{14}/f_X$	1.64 ms
1	0	0	$2^{15}/f_X$	3.27 ms
1	0	1	$2^{16}/f_X$	6.55 ms
Other than above			Setting prohibited	

Cautions 1. To set the STOP mode when the X1 clock is used as the CPU clock, set OSTS before executing the STOP instruction.

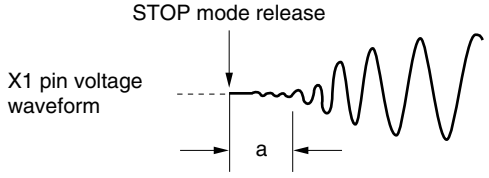
2. Do not change the value of the OSTS register during the X1 clock oscillation stabilization time.

3. The oscillation stabilization time counter counts up to the oscillation stabilization time set by OSTS. If the STOP mode is entered and then released while the internal high-speed oscillation clock is being used as the CPU clock, set the oscillation stabilization time as follows.

- **Desired OSTC oscillation stabilization time ≤ Oscillation stabilization time set by OSTS**

Note, therefore, that only the status up to the oscillation stabilization time set by OSTS is set to OSTC after STOP mode is released.

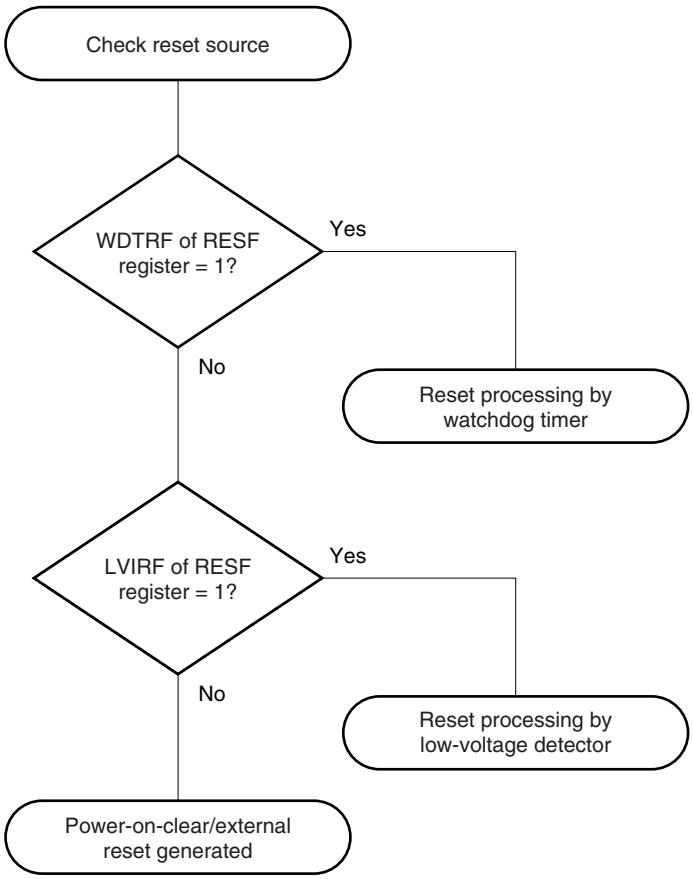
4. The X1 clock oscillation stabilization wait time does not include the time until clock oscillation starts (“a” below).



Remark f_X: X1 clock oscillation frequency

Figure 23-3. Example of Software Processing After Reset Release (2/2)

• Checking reset source



CHAPTER 26 FLASH MEMORY

The 78K0/LD3 incorporates the flash memory to which a program can be written, erased, and overwritten while mounted on the board.

26.1 Internal Memory Size Switching Register

The internal memory capacity can be selected using the internal memory size switching register (IMS).
IMS is set by an 8-bit memory manipulation instruction.
Reset signal generation sets IMS to CFH.

Caution Be sure to set each product to the values shown in Table 26-1 after a reset release.

Figure 26-1. Format of Internal Memory Size Switching Register (IMS)

Address: FFF0H After reset: CFH R/W

Symbol	7	6	5	4	3	2	1	0
IMS	RAM2	RAM1	RAM0	0	ROM3	ROM2	ROM1	ROM0

RAM2	RAM1	RAM0	Internal high-speed RAM capacity selection
0	0	0	768 bytes
0	1	0	512 bytes
1	1	0	1024 bytes
Other than above			Setting prohibited

ROM3	ROM2	ROM1	ROM0	Internal ROM capacity selection
0	0	1	0	8 KB
0	1	0	0	16 KB
0	1	1	0	24 KB
1	0	0	0	32 KB
Other than above				Setting prohibited

Table 26-1. Internal Memory Size Switching Register Settings

Flash Memory Version (78K0/LD3)	IMS	ROM Capacity	Internal High-Speed RAM Capacity
μPD78F0420, 78F0430	42H	8 KB	512 bytes
μPD78F0421, 78F0431	04H	16 KB	768 bytes
μPD78F0422, 78F0432	C6H	24 KB	1 KB
μPD78F0423, 78F0433	C8H	32 KB	