Renesas Electronics America Inc - UPD78F1142AGB-GAH-AX Datasheet

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	78K/0R
Core Size	16-Bit
Speed	20MHz
Connectivity	3-Wire SIO, I²C, LINbus, UART/USART
Peripherals	DMA, LVD, POR, PWM, WDT
Number of I/O	50
Program Memory Size	64KB (64K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	A/D 8x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-LQFP
Supplier Device Package	-
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/upd78f1142agb-gah-ax

2.2.18 FLMD0

This is a pin for setting flash memory programming mode.

Perform either of the following processing.

(a) In normal operation mode

It is recommended to leave this pin open during normal operation.

The FLMD0 pin must always be kept at the V_{SS} level before reset release but does not have to be pulled down externally because it is internally pulled down by reset. However, pulling it down must be kept selected (i.e., FLMDPUP = "0", default value) by using bit 7 (FLMDPUP) of the background event control register (BECTL) (see **23.5 (1) Back ground event control register**). To pull it down externally, use a resistor of 200 kΩ or smaller.

Self programming and the rewriting of flash memory with the programmer can be prohibited using hardware, by directly connecting this pin to the V_{SS} pin.

(b) In self programming mode

It is recommended to leave this pin open when using the self programming function. To pull it down externally, use a resistor of 100 kΩ to 200 kΩ.

In the self programming mode, the setting is switched to pull up in the self programming library.

(c) In flash memory programming mode

Directly connect this pin to a flash memory programmer when data is written by the flash memory programmer. This supplies a writing voltage of the V_{DD} level to the FLMD0 pin.

The FLMD0 pin does not have to be pulled down externally because it is internally pulled down by reset. To pull it down externally, use a resistor of 1 kΩ to 200 kΩ.

Table 4-2. Port Functions (1/2)

Function Name	I/O	Function	After Reset	Alternate Function
P00	I/O	Port 0. 7-bit I/O port. Input of P03 and P04 can be set to TTL input buffer. Output of P02 to P04 can be set to N-ch open-drain output (V_{DD} tolerance). Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting.	Input port	TI00
P01				TO00
P02				SO10/TxD1
P03				SI10/RxD1/SDA10
P04				$\overline{\text{SCK10}}$/SCL10
P05				TI05/TO05
P06				TI06/TO06
P10	I/O	Port 1. 8-bit I/O port. Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting.	Input port	$\overline{\text{SCK00}}$
P11				SI00/RxD0
P12				SO00/TxD0
P13				TxD3
P14				RxD3
P15				RTCDIV/RTCCL
P16				TI01/TO01/INTP5
P17				TI02/TO02
P20 to P27	I/O	Port 2. 8-bit I/O port. Input/output can be specified in 1-bit units.	Digital input port	ANI0 to ANI7
P30	I/O	Port 3. 2-bit I/O port. Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting.	Input port	RTC1HZ/INTP3
P31				TI03/TO03/INTP4
P40[Note]	I/O	Port 4. 4-bit I/O port. Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting.	Input port	TOOL0
P41				TOOL1
P42				TI04/TO04
P43				–
P50	I/O	Port 5. 6-bit I/O port. Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting.	Input port	INTP1
P51				INTP2
P52				–
P53				–
P54				–
P55				–

Note If on-chip debugging is enabled by using an option byte, be sure to pull up the P40/TOOL0 pin externally (see **Caution** in **2.2.5 P40 to P43 (port 4)**).

5.6.7 Time required for switchover of CPU clock and main system clock

By setting bits 0 to 2, 4, and 6 (MDIV0 to MDIV2, MCM0, CSS) of the system clock control register (CKC), the CPU clock can be switched (between the main system clock and the subsystem clock), main system clock can be switched (between the internal high-speed oscillation clock and the high-speed system clock), and the division ratio of the main system clock can be changed.

The actual switchover operation is not performed immediately after rewriting to CKC; operation continues on the pre-switchover clock for several clocks (see Table 5-6 to Table 5-9).

Whether the CPU is operating on the main system clock or the subsystem clock can be ascertained using bit 7 (CLS) of CKC. Whether the main system clock is operating on the high-speed system clock or internal high-speed oscillation clock can be ascertained using bit 5 (MCS) of CKC.

When the CPU clock is switched, the peripheral hardware clock is also switched.

<R> **Table 5-6. Maximum Time Required for Main System Clock Switchover**

Clock A	Switching directions	Clock B	Type
f_{MAINC}	◀⟶ (Changing the division ratio)	f_{MAINC}	Type 1 (see **Table 5-7**)
f_{IH}	◀⟶	f_{MX}	Type 2 (see **Table 5-8**)
f_{MAINC}	◀⟶	$f_{SUB}/2$	Type 3 (see **Table 5-9**)

Table 5-7. Maximum Number of Clocks Required in Type 1

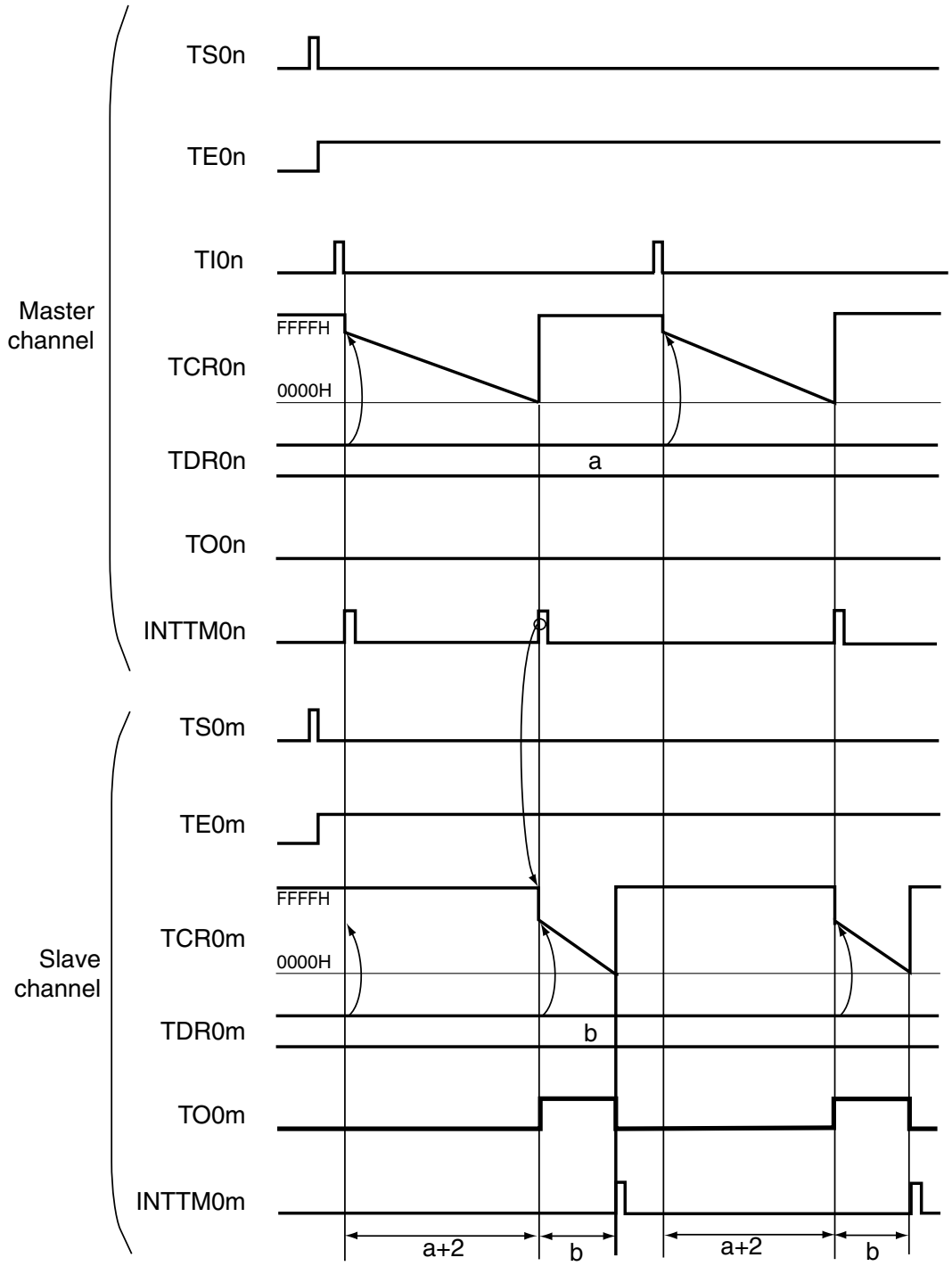
Set Value Before Switchover	Set Value After Switchover	
	Clock A	Clock B
Clock A		$1 + f_A/f_B$ clock
Clock B	$1 + f_B/f_A$ clock	

<R> **Table 5-8. Maximum Number of Clocks Required in Type 2**

Set Value Before Switchover		Set Value After Switchover	
MCM0		MCM0	
		0 ($f_{MAIN} = f_{IH}$)	1 ($f_{MAIN} = f_{MX}$)
0 ($f_{MAIN} = f_{IH}$)	$f_{MX} \geq f_{IH}$		$1 + f_{IH}/f_{MX}$ clock
	$f_{MX} < f_{IH}$		$2f_{IH}/f_{MX}$ clock
1 ($f_{MAIN} = f_{MX}$)	$f_{MX} \geq f_{IH}$	$2f_{MX}/f_{IH}$ clock	
	$f_{MX} < f_{IH}$	$1 + f_{MX}/f_{IH}$ clock	

(Remarks are listed on the next page.)

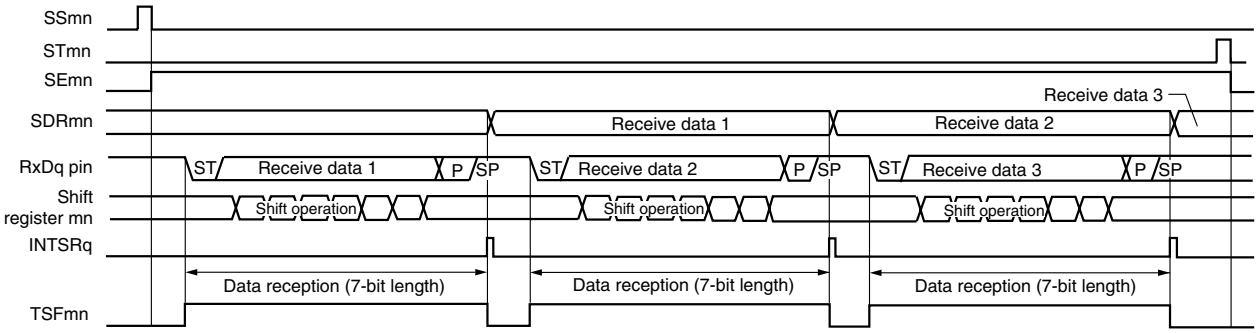
Figure 6-61. Example of Basic Timing of Operation as One-Shot Pulse Output Function



Remark n = 0, 2, 4
m = n + 1

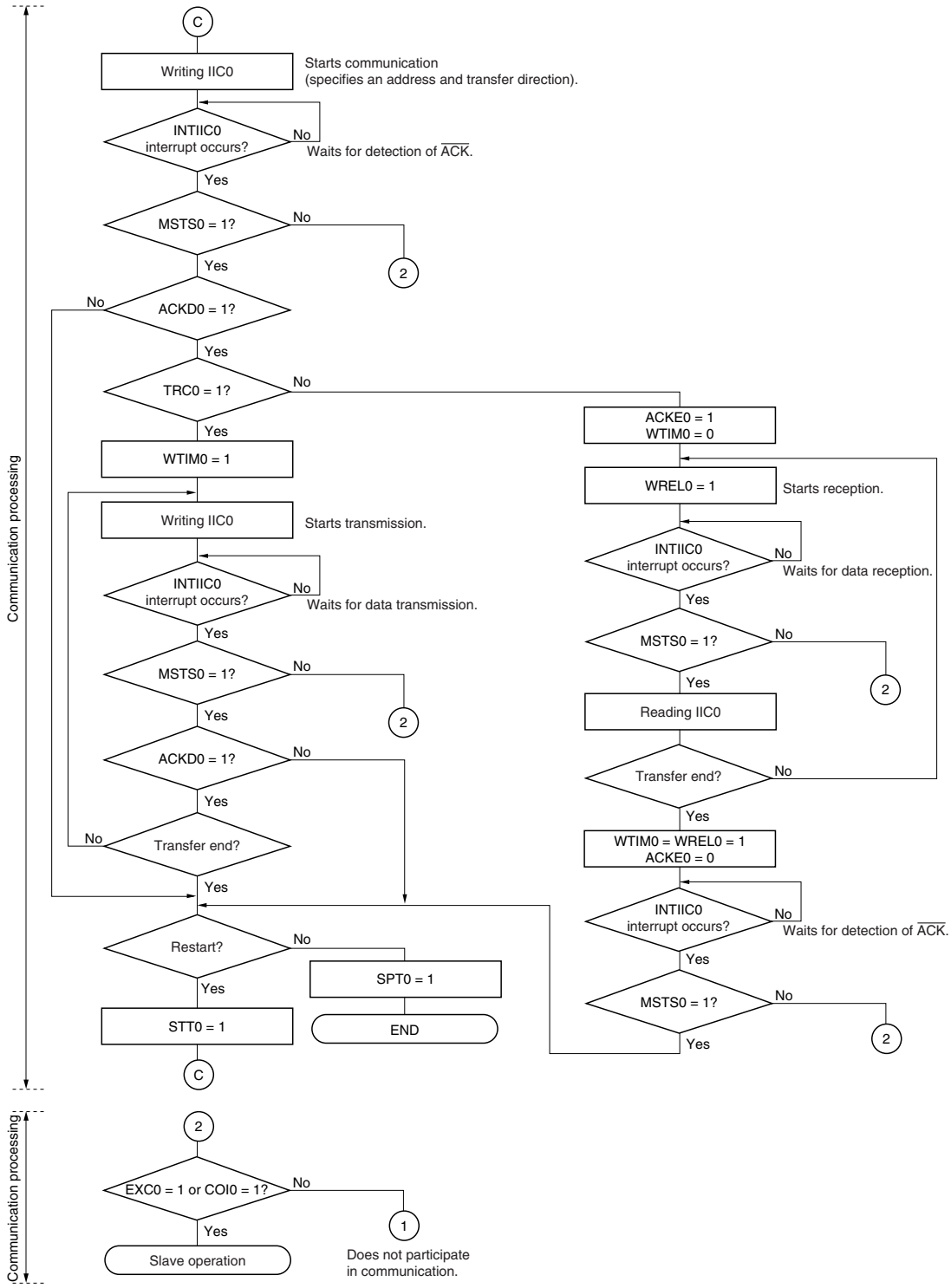
(3) Processing flow

Figure 11-83. Timing Chart of UART Reception



Remark m: Unit number (m = 0, 1), n: Channel number (n = 1, 3), mn = 01, 03, 13,
q: UART number (q = 0, 1, 3)

Figure 12-25. Master Operation in Multi-Master System (3/3)



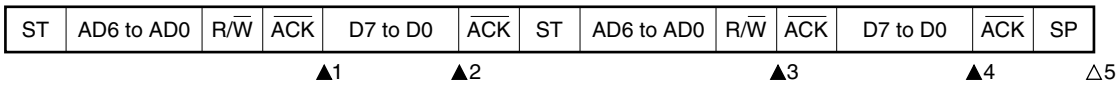
Remarks 1. Conform to the specifications of the product that is communicating, with respect to the transmission and reception formats.

2. To use the device as a master in a multi-master system, read the MSTS0 bit each time interrupt INTIIC0 has occurred to check the arbitration result.

3. To use the device as a slave in a multi-master system, check the status by using the IICS0 and IICF0 registers each time interrupt INTIIC0 has occurred, and determine the processing to be performed next.

(c) Start ~ Address ~ Data ~ Start ~ Code ~ Data ~ Stop

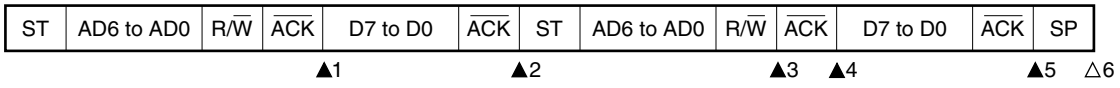
(i) When WTIM0 = 0 (after restart, does not match address (= extension code))



▲1: IICS0 = 0001×110B
▲2: IICS0 = 0001×000B
▲3: IICS0 = 0010×010B
▲4: IICS0 = 0010×000B
△5: IICS0 = 00000001B

Remark ▲: Always generated
△: Generated only when SPIE0 = 1
×: Don't care

(ii) When WTIM0 = 1 (after restart, does not match address (= extension code))

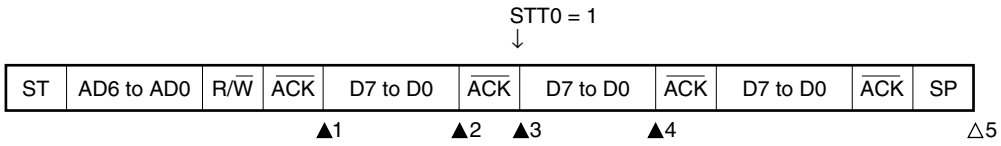


▲1: IICS0 = 0001×110B
▲2: IICS0 = 0001××00B
▲3: IICS0 = 0010×010B
▲4: IICS0 = 0010×110B
▲5: IICS0 = 0010××00B
△6: IICS0 = 00000001B

Remark ▲: Always generated
△: Generated only when SPIE0 = 1
×: Don't care

(f) When arbitration loss occurs due to low-level data when attempting to generate a restart condition

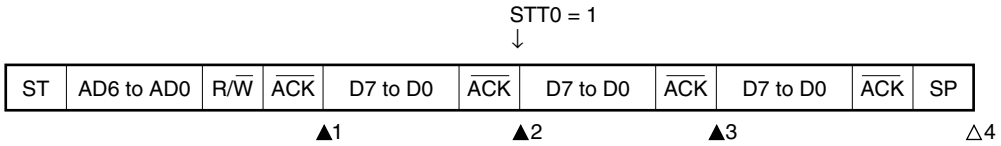
(i) When WTIM0 = 0



▲1: IICS0 = 1000×110B
▲2: IICS0 = 1000×000B (Sets WTIM0 to 1)
▲3: IICS0 = 1000×100B (Clears WTIM0 to 0)
▲4: IICS0 = 01000000B
△5: IICS0 = 00000001B

Remark ▲: Always generated
△: Generated only when SPIE0 = 1
×: Don't care

(ii) When WTIM0 = 1

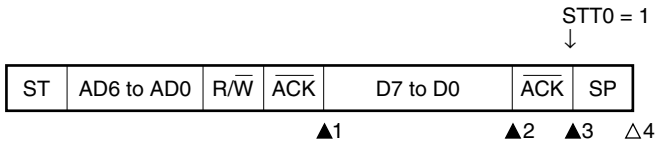


▲1: IICS0 = 1000×110B
▲2: IICS0 = 1000×100B (Sets STT0 to 1)
▲3: IICS0 = 01000100B
△4: IICS0 = 00000001B

Remark ▲: Always generated
△: Generated only when SPIE0 = 1
×: Don't care

(g) When arbitration loss occurs due to a stop condition when attempting to generate a restart condition

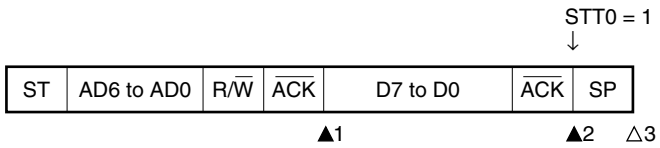
(i) When WTIM0 = 0



▲1: IICS0 = 1000×110B
▲2: IICS0 = 1000×000B (Sets WTIM0 to 1)
▲3: IICS0 = 1000××00B (Sets STT0 to 1)
△4: IICS0 = 01000001B

Remark ▲: Always generated
△: Generated only when SPIE0 = 1
×: Don't care

(ii) When WTIM0 = 1



▲1: IICS0 = 1000×110B
▲2: IICS0 = 1000××00B (Sets STT0 to 1)
△3: IICS0 = 01000001B

Remark ▲: Always generated
△: Generated only when SPIE0 = 1
×: Don't care

14.3 Registers Controlling DMA Controller

DMA controller is controlled by the following registers.

- DMA mode control register n (DMCn)
- DMA operation control register n (DRCn)

Remark n: DMA channel number (n = 0, 1)

15.3 Registers Controlling Interrupt Functions

The following 6 types of registers are used to control the interrupt functions.

- Interrupt request flag registers (IF0L, IF0H, IF1L, IF1H, IF2L, IF2H)
- Interrupt mask flag registers (MK0L, MK0H, MK1L, MK1H, MK2L, MK2H)
- Priority specification flag registers (PR00L, PR00H, PR01L, PR01H, PR02L, PR02H, PR10L, PR10H, PR11L, PR11H, PR12L, PR12H)
- External interrupt rising edge enable registers (EGP0, EGP1)
- External interrupt falling edge enable registers (EGN0, EGN1)
- Program status word (PSW)

Table 15-2 shows a list of interrupt request flags, interrupt mask flags, and priority specification flags corresponding to interrupt request sources.

Table 15-2. Flags Corresponding to Interrupt Request Sources (1/2)

Interrupt Source	Interrupt Request Flag		Interrupt Mask Flag		Priority Specification Flag	
		Register		Register		Register
INTWDTI	WDTIIF	IF0L	WDTIMK	MK0L	WDTIPR0, WDTIPR1	PR00L, PR10L
INTLVI	LVIIF		LVIMK		LVIPR0, LVIPR1	
INTP0	PIF0		PMK0		PPR00, PPR10	
INTP1	PIF1		PMK1		PPR01, PPR11	
INTP2	PIF2		PMK2		PPR02, PPR12	
INTP3	PIF3		PMK3		PPR03, PPR13	
INTP4	PIF4		PMK4		PPR04, PPR14	
INTP5	PIF5		PMK5		PPR05, PPR15	
INTST3	STIF3	IF0H	STMK3	MK0H	STPR03, STPR13	PR00H, PR10H
INTSR3	SRIF3		SRMK3		SRPR03, SRPR13	
INTSRE3	SREIF3		SREMK3		SREPR03, SREPR13	
INTDMA0	DMAIF0		DMAMK0		DMAPR00, DMAPR10	
INTDMA1	DMAIF1		DMAMK1		DMAPR01, DMAPR11	
INTST0 Note	STIF0 Note		STMK0 Note		STPR00, STPR10 Note	
INTCSI00 Note	CSIIF00 Note		CSIMK00 Note		CSIPR000, CSIPR100 Note	
INTSR0	SRIF0		SRMK0		SRPR00, SRPR10	
INTSRE0	SREIF0		SREMK0		SREPR00, SREPR10	

Note Do not use UART0 and CSI00 at the same time because they share flags for the interrupt request sources. If one of the interrupt sources INTST0 and INTCSI00 is generated, bit 5 of IF1H is set to 1. Bit 5 of MK0H, PR00H, and PR10H supports these three interrupt sources.

CHAPTER 16 KEY INTERRUPT FUNCTION

16.1 Functions of Key Interrupt

A key interrupt (INTKR) can be generated by setting the key return mode register (KRM) and inputting a falling edge to the key interrupt input pins (KR0 to KR7).

Table 16-1. Assignment of Key Interrupt Detection Pins

Flag	Description
KRM0	Controls KR0 signal in 1-bit units.
KRM1	Controls KR1 signal in 1-bit units.
KRM2	Controls KR2 signal in 1-bit units.
KRM3	Controls KR3 signal in 1-bit units.
KRM4	Controls KR4 signal in 1-bit units.
KRM5	Controls KR5 signal in 1-bit units.
KRM6	Controls KR6 signal in 1-bit units.
KRM7	Controls KR7 signal in 1-bit units.

16.2 Configuration of Key Interrupt

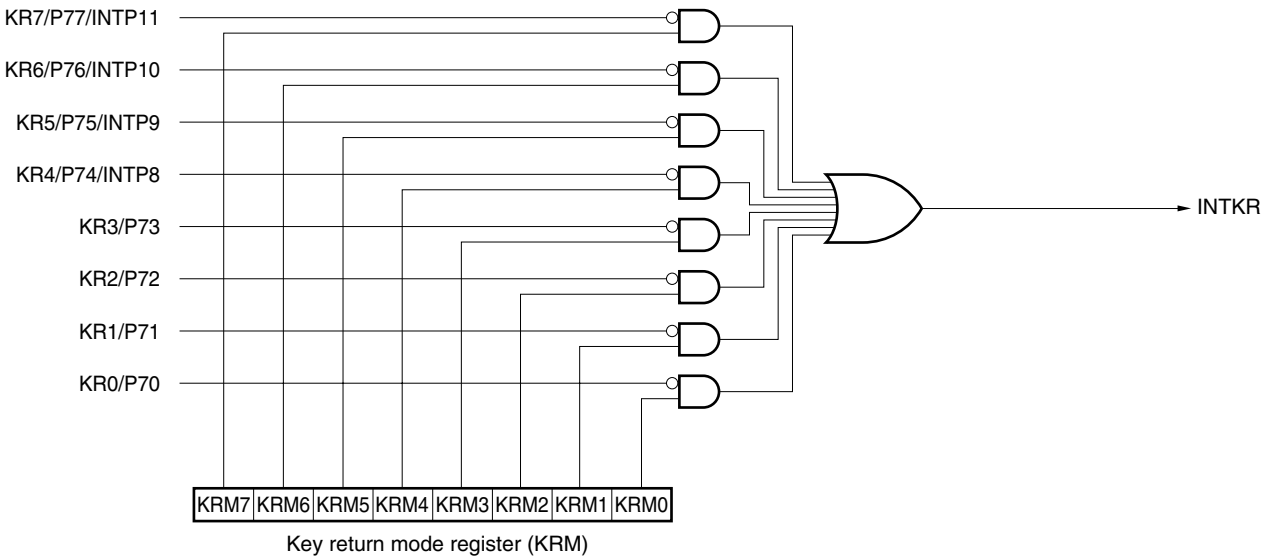
The key interrupt includes the following hardware.

Table 16-2. Configuration of Key Interrupt

<R>

Item	Configuration
Control register	Key return mode register (KRM) Port mode register 7 (PM7)

Figure 16-1. Block Diagram of Key Interrupt



22.4 Setting of Option Byte

The user option byte and on-chip debug option byte can be set using the RA78K0R or PM+ linker option, in addition to describing to the source. When doing so, the contents set by using the linker option take precedence, even if descriptions exist in the source, as mentioned below.

See the **RA78K0R Assembler Package User's Manual** for how to set the linker option.

A software description example of the option byte setting is shown below.

```
OPT   CSEG        OPT_BYTE
      DB          10H     ; Does not use interval interrupt of watchdog timer,
                          ; Enables watchdog timer operation,
                          ; Window open period of watchdog timer is 25%,
                          ; Overflow time of watchdog timer is 2^10/fIL,
                          ; Stops watchdog timer operation during HALT/STOP mode
      DB          0FFH    ; Stops LVI default start function
      DB          0FFH    ; Reserved area
      DB          85H     ; Enables on-chip debug operation, does not erase flash memory
                          ; data when security ID authorization fails
```

When the boot swap function is used during self programming, 000C0H to 000C3H is switched to 010C0H to 010C3H. Describe to 010C0H to 010C3H, therefore, the same values as 000C0H to 000C3H as follows.

```
OPT2  CSEG   AT   010C0H
      DB          10H     ; Does not use interval interrupt of watchdog timer,
                          ; Enables watchdog timer operation,
                          ; Window open period of watchdog timer is 25%,
                          ; Overflow time of watchdog timer is 2^10/fIL,
                          ; Stops watchdog timer operation during HALT/STOP mode
      DB          0FFH    ; Stops LVI default start function
      DB          0FFH    ; Reserved area
      DB          85H     ; Enables on-chip debug operation, does not erase flash memory
                          ; data when security ID authorization fails
```

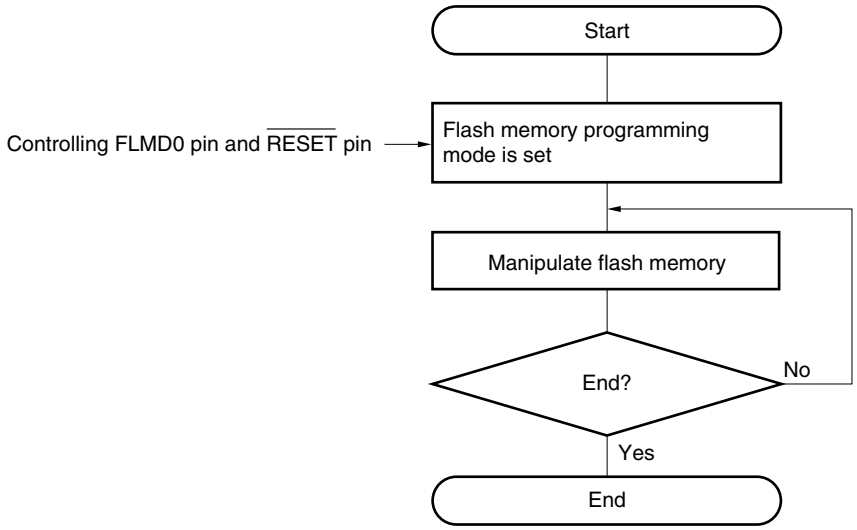
Caution To specify the option byte by using assembly language, use OPT_BYTE as the relocation attribute name of the CSEG pseudo instruction. To specify the option byte to 010C0H to 010C3H in order to use the boot swap function, use the relocation attribute AT to specify an absolute address.

23.6 Programming Method

23.6.1 Controlling flash memory

The following figure illustrates the procedure to manipulate the flash memory.

Figure 23-7. Flash Memory Manipulation Procedure



23.6.2 Flash memory programming mode

To rewrite the contents of the flash memory by using the dedicated flash memory programmer, set the 78K0R/KE3 in the flash memory programming mode. To set the mode, set the FLMD0 pin and TOOL0 pin to V_{DD} and clear the reset signal.

Change the mode by using a jumper when writing the flash memory on-board.

Figure 23-8. Flash Memory Programming Mode

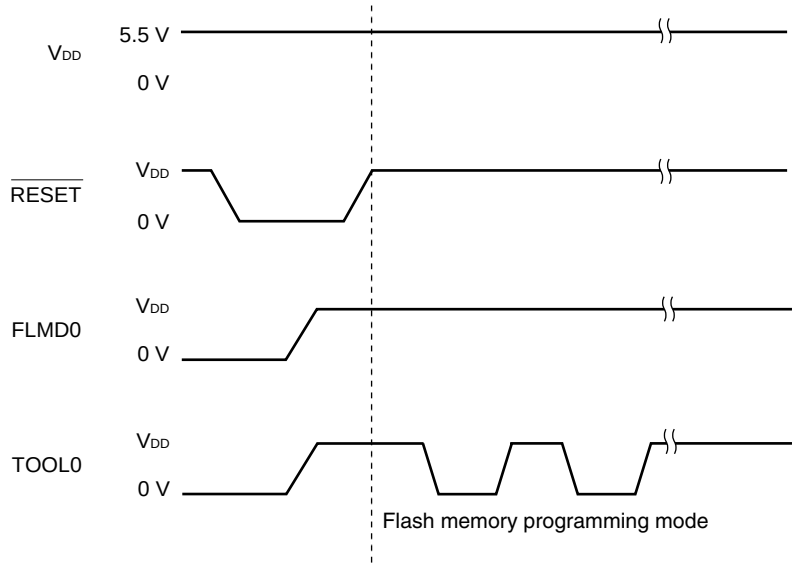


Table 23-5. Flash Memory Control Commands

Classification	Command Name	Function
Verify	Verify	Compares the contents of a specified area of the flash memory with data transmitted from the programmer.
Erase	Chip Erase	Erases the entire flash memory.
	Block Erase	Erases a specified area in the flash memory.
Blank check	Block Blank Check	Checks if a specified block in the flash memory has been correctly erased.
Write	Programming	Writes data to a specified area in the flash memory.
Getting information	Silicon Signature	Gets 78K0R/KE3 information (such as the part number and flash memory configuration).
	Version Get	Gets the 78K0R/KE3 firmware version.
	Checksum	Gets the checksum data for a specified area.
Security	Security Set	Sets security information.
Others	Reset	Used to detect synchronization status of communication.
	Baud Rate Set	Sets baud rate when UART communication mode is selected.

The 78K0R/KE3 return a response for the command issued by the dedicated flash memory programmer. The response names sent from the 78K0R/KE3 are listed below.

Table 23-6. Response Names

Response Name	Function
ACK	Acknowledges command/data.
NAK	Acknowledges illegal command/data.

Table 26-5. Operation List (14/17)

Instruction Group	Mnemonic	Operands	Bytes	Clocks		Operation	Flag		
				Note 1	Note 2		Z	AC	CY
Bit manipulate	XOR1	CY, saddr.bit	3	1	–	CY ← CY ⩛ (saddr).bit			×
		CY, sfr.bit	3	1	–	CY ← CY ⩛ sfr.bit			×
		CY, A.bit	2	1	–	CY ← CY ⩛ A.bit			×
		CY, PSW.bit	3	1	–	CY ← CY ⩛ PSW.bit			×
		CY, [HL].bit	2	1	4	CY ← CY ⩛ (HL).bit			×
		CY, ES:[HL].bit	3	2	5	CY ← CY ⩛ (ES, HL).bit			×
	SET1	saddr.bit	3	2	–	(saddr).bit ← 1			
		sfr.bit	3	2	–	sfr.bit ← 1			
		A.bit	2	1	–	A.bit ← 1			
		!addr16.bit	4	2	–	(addr16).bit ← 1			
		PSW.bit	3	4	–	PSW.bit ← 1	×	×	×
		[HL].bit	2	2	–	(HL).bit ← 1			
		ES:!addr16.bit	5	3	–	(ES, addr16).bit ← 1			
		ES:[HL].bit	3	3	–	(ES, HL).bit ← 1			
	CLR1	saddr.bit	3	2	–	(saddr.bit) ← 0			
		sfr.bit	3	2	–	sfr.bit ← 0			
		A.bit	2	1	–	A.bit ← 0			
		!addr16.bit	4	2	–	(addr16).bit ← 0			
		PSW.bit	3	4	–	PSW.bit ← 0	×	×	×
		[HL].bit	2	2	–	(HL).bit ← 0			
		ES:!addr16.bit	5	3	–	(ES, addr16).bit ← 0			
		ES:[HL].bit	3	3	–	(ES, HL).bit ← 0			
	SET1	CY	2	1	–	CY ← 1			1
	CLR1	CY	2	1	–	CY ← 0			0
	NOT1	CY	2	1	–	CY ← $\overline{CY}$			×

Notes 1. When the internal RAM area, SFR area, or extended SFR area is accessed, or for an instruction with no data access.

2. When the program memory area is accessed.

Remarks 1. One instruction clock cycle is one cycle of the CPU clock (f_{CLK}) selected by the system clock control register (CKC).

2. This number of clocks is for when the program is in the internal ROM (flash memory) area. When fetching an instruction from the internal RAM area, the number of clocks is twice the number of clocks plus 3, maximum.

(2) Serial interface: Serial array unit (2/18)

(T_A = –40 to +85°C, 1.8 V ≤ V_{DD} = EV_{DD} ≤ 5.5 V, V_{SS} = EV_{SS} = AV_{SS} = 0 V)

<R> **(b) During communication at same potential (CSI mode) (master mode, $\overline{SCKp}$... internal clock output)**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
$\overline{SCKp}$ cycle time	t_{KCY1}	4.0 V ≤ V_{DD} ≤ 5.5 V	200 Note 1			ns
		2.7 V ≤ V_{DD} < 4.0 V	300 Note 1			ns
		1.8 V ≤ V_{DD} < 2.7 V	600 Note 1			ns
$\overline{SCKp}$ high-/low-level width	t_{KH1}, t_{KL1}	4.0 V ≤ V_{DD} ≤ 5.5 V	t_{KCY1}/2 – 20			ns
		2.7 V ≤ V_{DD} < 4.0 V	t_{KCY1}/2 – 35			ns
		1.8 V ≤ V_{DD} < 2.7 V	t_{KCY1}/2 – 80			ns
SIp setup time (to $\overline{SCKp}$↑) Note 2	t_{SIK1}	4.0 V ≤ V_{DD} ≤ 5.5 V	70			ns
		2.7 V ≤ V_{DD} < 4.0 V	100			ns
		1.8 V ≤ V_{DD} < 2.7 V	190			ns
SIp hold time (from $\overline{SCKp}$↑) Note 3	t_{KSI1}		30			ns
Delay time from $\overline{SCKp}$↓ to SOp output Note 4	t_{KSO1}	C = 30 pF Note 5			40	ns

Notes 1. The value must also be 4/f_{CLK} or more.

2. When DAP0n = 0 and CKP0n = 0, or DAP0n = 1 and CKP0n = 1. The SIp setup time becomes "to $\overline{SCKp}$↓" when DAP0n = 0 and CKP0n = 1, or DAP0n = 1 and CKP0n = 0.

3. When DAP0n = 0 and CKP0n = 0, or DAP0n = 1 and CKP0n = 1. The SIp hold time becomes "from $\overline{SCKp}$↓" when DAP0n = 0 and CKP0n = 1, or DAP0n = 1 and CKP0n = 0.

4. When DAP0n = 0 and CKP0n = 0, or DAP0n = 1 and CKP0n = 1. The delay time to SOp output becomes "from $\overline{SCKp}$↑" when DAP0n = 0 and CKP0n = 1, or DAP0n = 1 and CKP0n = 0.

5. C is the load capacitance of the $\overline{SCKp}$ and SOp output lines.

Caution When using CSI10, select the normal input buffer for SI10 and the normal output mode for SO10 and $\overline{SCK10}$ by using the PIM0 and POM0 registers.

Remark p: CSI number (p = 00, 10), n: Channel number (n = 0, 2)

DC Characteristics (2/10)

(T_A = –40 to +85°C, 1.8 V ≤ V_{DD} = EV_{DD} ≤ 5.5 V, 1.8 V ≤ AV_{REF} ≤ V_{DD}, V_{SS} = EV_{SS} = AV_{SS} = 0 V)

Items	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Output current, low[Note 1]	I_{OL1}	Per pin for P00 to P02, P05, P06, P10 to P17, P30, P31, P40 to P43, P50 to P55, P70 to P77, P120, P130, P140, P141	4.0 V ≤ V_{DD} ≤ 5.5 V			8.5	mA
			2.7 V ≤ V_{DD} < 4.0 V			1.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			0.5	mA
		Per pin for P03, P04	4.0 V ≤ V_{DD} ≤ 5.5 V			8.5	mA
			2.7 V ≤ V_{DD} < 4.0 V			1.5	mA
			1.8 V ≤ V_{DD} < 2.7 V			0.6	mA
		Per pin for P60 to P63	4.0 V ≤ V_{DD} ≤ 5.5 V			15.0	mA
			2.7 V ≤ V_{DD} < 4.0 V			3.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			2.0	mA
		Total of P00 to P04, P40 to P43, P120, P130, P140, P141 (When duty = 70%[Note 2])	4.0 V ≤ V_{DD} ≤ 5.5 V			20.0	mA
			2.7 V ≤ V_{DD} < 4.0 V			15.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			9.0	mA
		Total of P05, P06, P10 to P17, P30, P31, P50 to P55, P60 to P63, P70 to P77 (When duty = 70%[Note 2])	4.0 V ≤ V_{DD} ≤ 5.5 V			45.0	mA
			2.7 V ≤ V_{DD} < 4.0 V			35.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			20.0	mA
		Total of all pins (When duty = 60%[Note 2])	4.0 V ≤ V_{DD} ≤ 5.5 V			65.0	mA
			2.7 V ≤ V_{DD} < 4.0 V			50.0	mA
			1.8 V ≤ V_{DD} < 2.7 V			29.0	mA
	I_{OL2}	Per pin for P20 to P27	AV_{REF} ≤ V_{DD}			0.4	mA

Notes 1. Value of current at which the device operation is guaranteed even if the current flows from an output pin to EV_{SS}, V_{SS}, and AV_{SS} pin.

2. Specification under conditions where the duty factor is 60% or 70%.

The output current value that has changed the duty ratio can be calculated with the following expression (when changing the duty factor from 70% to n%).

- Total output current of pins = (I_{OL} × 0.7)/(n × 0.01)

<Example> Where I_{OL} = 20.0 mA and n = 50%

Total output current of pins = (20.0 × 0.7)/(50 × 0.01) = 28.0 mA

However, the current that is allowed to flow into one pin does not vary depending on the duty factor. A current higher than the absolute maximum rating must not flow into one pin.

Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of port pins.

(2) Serial interface: Serial array unit (15/18)

Caution Select the TTL input buffer for SI10 and $\overline{SCK10}$ and the N-ch open drain output (V_{DD} tolerance) mode for SO10 by using the PIM0 and POM0 registers.

Remarks 1. R_b[Ω]:Communication line (SO10) pull-up resistance,
C_b[F]: Communication line (SO10) load capacitance, V_b[V]: Communication line voltage

2. f_{MCK}: Serial array unit operation clock frequency
(Operation clock to be set by the CKS02 bit of the SMR02 register.)

3. V_{IH} and V_{IL} below are observation points for the AC characteristics of the serial array unit when communicating at different potentials in CSI mode.
$4.0\ V \le V_{DD} \le 5.5\ V$, $2.7\ V \le V_b \le 4.0\ V$: $V_{IH} = 2.2\ V$, $V_{IL} = 0.8\ V$
$2.7\ V \le V_{DD} \le 4.0\ V$, $2.3\ V \le V_b \le 2.7\ V$: $V_{IH} = 2.0\ V$, $V_{IL} = 0.5\ V$

4. CSI00 cannot communicate at different potential. Use CSI10 for communication at different potential.

(15/15)

Edition	Description	Chapter
8th edition	Addition of chapter	CHAPTER 30 RECOMMENDED SOLDERING CONDITIONS
	Change of **A.4.1 When using flash memory programmers PG-FP5, FL-PR5, PG-FP4 and FL-PR4**	APPENDIX A DEVELOPMENT TOOLS
	Addition of chapter	APPENDIX B LIST OF CAUTIONS