Renesas Electronics America Inc - M30302FCPFP#U5 Datasheet

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Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	M16C/60
Core Size	16-Bit
Speed	16MHz
Connectivity	I²C, IEBus, UART/USART
Peripherals	DMA, POR, PWM, WDT
Number of I/O	85
Program Memory Size	128KB (128K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	5K x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 5.5V
Data Converters	A/D 18x10b
Oscillator Type	External
Operating Temperature	-20°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	100-BQFP
Supplier Device Package	100-QFP (14x20)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/m30302fcpfp-u5

1. Overview

The M16C/30P Group of single-chip microcomputers is built using the high-performance silicon gate CMOS process using a M16C/60 Series CPU core and is packaged in a 100-pin plastic molded QFP.
These single-chip microcomputers operate using sophisticated instructions featuring a high level of instruction efficiency. With 1 Mbyte of address space, they are capable of executing instructions at high speed. In addition, these microcomputers contain a multiplier and DMAC which combined with fast instruction processing capability, make it suitable for control of various OA, communication, and industrial equipment which requires high-speed arithmetic/logic operations.

1.1 Applications

Audio, cameras, TV, home appliance, office/communications/portable/industrial equipment, etc.

1.2 Performance Outline

Table 1.1 lists Performance Outline of M16C/30P Group.

Table 1.1 Performance Outline of M16C/30P Group

Item		Performance
CPU	Number of Basic Instructions	91 instructions
	Minimum Instruction Execution Time	62.5ns(f(XIN)=16MHz, VCC1=VCC2=3.0 to 5.5V, no wait) 100ns(f(XIN)=10MHz, VCC1=VCC2=2.7 to 5.5V, no wait)
	Operation Mode	Single-chip, memory expansion and microprocessor mode
	Memory Space	1 Mbyte
	Memory Capacity	See **Table 1.2 Product List**
Peripheral Function	Port	Input/Output : 87 pins, Input : 1 pin
	Multifunction Timer	Timer A : 16 bits x 3 channels, Timer B : 16 bits x 3 channels
	Serial Interface	1 channels Clock synchronous, UART, I2CBus(1), IEBus(2) 2 channels Clock synchronous, UART, I2CBus(1)
	A/D Converter	10-bit A/D converter: 1 circuit, 18 channels
	DMAC	2 channels
	CRC Calculation Circuit	CCITT-CRC
	Watchdog Timer	15 bits x 1 channel (with prescaler)
	Interrupt	Internal: 20 sources, External: 7 sources, Software: 4 sources, Priority level: 7 levels
	Clock Generating Circuit	2 circuits Main clock generation circuit (*), Subclock generation circuit (*), (*)Equipped with a built-in feedback resistor.
Electric Characteristics	Supply Voltage	VCC1=VCC2=3.0 to 5.5 V (f(XIN)=16MHz) VCC1=VCC2=2.7 to 5.5 V (f(XIN)=10MHz, no wait)
	Power Consumption	10 mA (VCC1=VCC2=5V, f(XIN)=16MHz) 8 mA (VCC1=VCC2=3V, f(XIN)=10MHz) 1.8 μA (VCC1=VCC2=3V, f(XCIN)=32kHz, wait mode) 0.7 μA(VCC1=VCC2=3V, stop mode)
One time flash version	Program Supply Voltage	3.3±0.3 V or 5.0±0.5 V
Flash memory version	Program/Erase Supply Voltage	3.3±0.3 V or 5.0±0.5 V
	Program and Erase Endurance	100 times (all area)
Operating Ambient Temperature		-20 to 85°C, -40 to 85°C
Package		100-pin plastic mold QFP, LQFP

NOTES:
1. I2C bus is a registered trademark of Koninklijke Philips Electronics N. V.
2. IEBus is a registered trademark of NEC Electronics Corporation.
3. Use the M16C/30P on VCC1 = VCC2.

Table 1.5 Product Code of One Time Flash version, Flash Memory version, and ROM-less version for M16C/30P

	Product Code	Package	Internal ROM		Operating Ambient Temperature
			Program and Erase Endurance	Temperature Range	
One Time Flash version	U3	Lead-free	0	0°C to 60°C	-40°C to 85°C
	U5				-20°C to 85°C
Flash Memory version	U3	Lead-free	100	0°C to 60°C	-40°C to 85°C
	U5				-20°C to 85°C
ROM-less version	U3	Lead-free	–	–	-40°C to 85°C
	U5				-20°C to 85°C

NOTES:The one time flash version can be written once only.

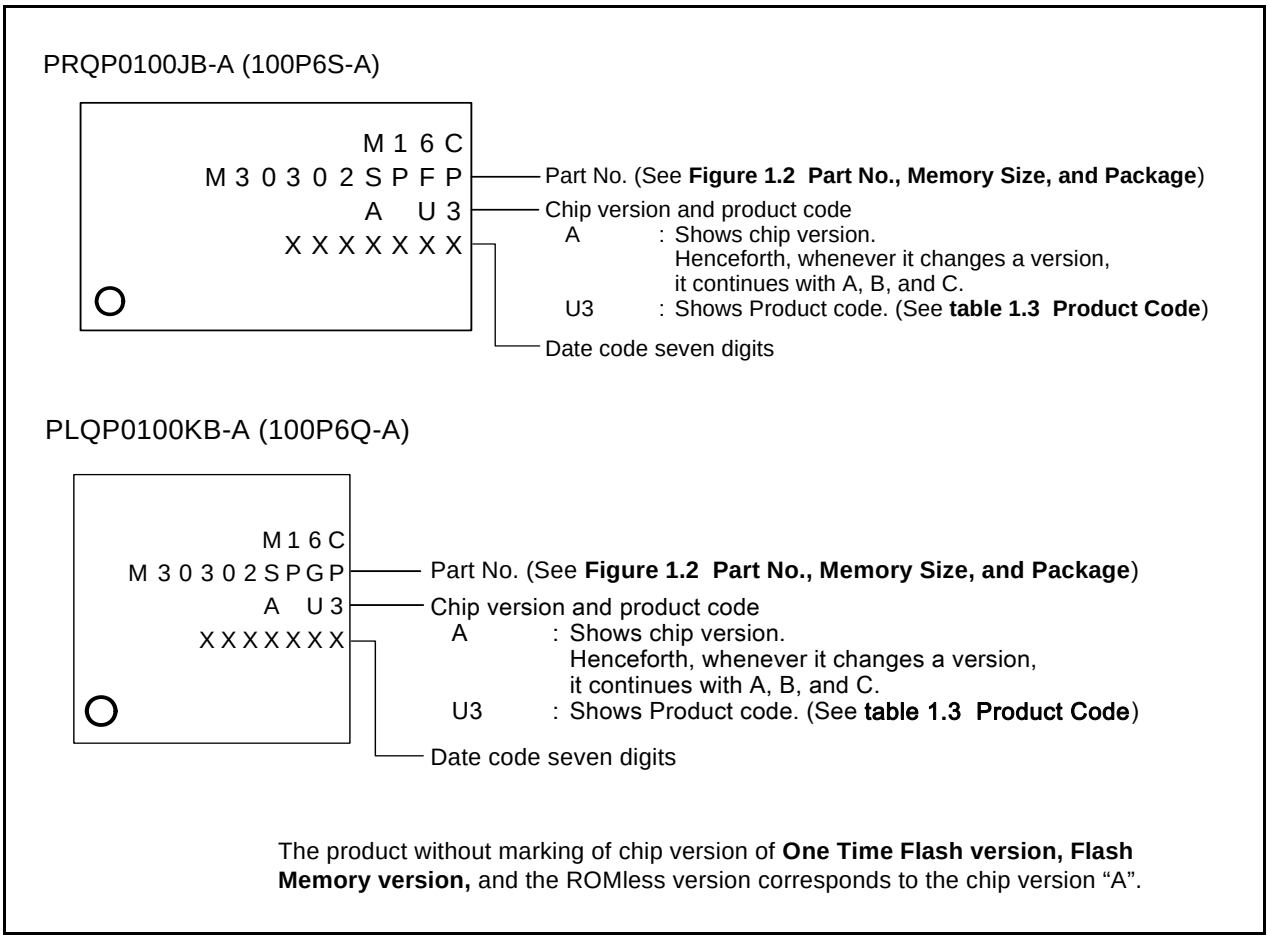


Figure 1.4 Marking Diagram of One Time Flash version, Flash Memory version, and ROM-less Version for M16C/30P (Top View)

Table 1.6 Pin Characteristics (1)

Pin No.		Control Pin	Port	Interrupt Pin	Timer Pin	UART Pin	Analog Pin	Bus Control Pin
FP	GP							
1	99		P9_6				ANEX1	
2	100		P9_5				ANEX0	
3	1		P9_4					
4	2		P9_3					
5	3		P9_2		TB2IN			
6	4		P9_1		TB1IN			
7	5		P9_0		TB0IN			
8	6	BYTE						
9	7	CNVSS						
10	8	XCIN	P8_7					
11	9	XCOUT	P8_6					
12	10	$\overline{\text{RESET}}$						
13	11	XOUT						
14	12	VSS						
15	13	XIN						
16	14	VCC1						
17	15		P8_5	$\overline{\text{NMI}}$				
18	16		P8_4	$\overline{\text{INT2}}$				
19	17		P8_3	$\overline{\text{INT1}}$				
20	18		P8_2	$\overline{\text{INT0}}$				
21	19		P8_1					
22	20		P8_0					
23	21		P7_7					
24	22		P7_6					
25	23		P7_5		TA2IN			
26	24		P7_4		TA2OUT			
27	25		P7_3		TA1IN	$\overline{\text{CTS2}}/\overline{\text{RTS2}}$		
28	26		P7_2		TA1OUT	CLK2		
29	27		P7_1		TA0IN	RXD2/SCL2		
30	28		P7_0		TA0OUT	TXD2/SDA2		
31	29		P6_7			TXD1/SDA1		
32	30		P6_6			RXD1/SCL1		
33	31		P6_5			CLK1		
34	32		P6_4			$\overline{\text{CTS1}}/\overline{\text{RTS1}}/\overline{\text{CTS0}}$/CLKS1		
35	33		P6_3			TXD0/SDA0		
36	34		P6_2			RXD0/SCL0		
37	35		P6_1			CLK0		
38	36		P6_0			$\overline{\text{CTS0}}/\overline{\text{RTS0}}$		
39	37		P5_7					$\overline{\text{RDY}}$/CLKOUT
40	38		P5_6					ALE
41	39		P5_5					$\overline{\text{HOLD}}$
42	40		P5_4					$\overline{\text{HLDA}}$
43	41		P5_3					BCLK
44	42		P5_2					$\overline{\text{RD}}$
45	43		P5_1					$\overline{\text{WRH}}/\overline{\text{BHE}}$
46	44		P5_0					$\overline{\text{WRL}}/\overline{\text{WR}}$
47	45		P4_7					$\overline{\text{CS3}}$
48	46		P4_6					$\overline{\text{CS2}}$
49	47		P4_5					$\overline{\text{CS1}}$
50	48		P4_4					$\overline{\text{CS0}}$

Table 1.9 Pin Description (2)

Signal Name	Pin Name	I/O Type	Description
Main clock input	XIN	I	I/O pins for the main clock generation circuit. Connect a ceramic resonator or crystal oscillator between XIN and XOUT. To use the external clock, input the clock from XIN and leave XOUT open.
Main clock output	XOUT	O	
Sub clock input	XCIN	I	I/O pins for a sub clock oscillation circuit. Connect a crystal oscillator between XCIN and XCOUT. To use the external clock, input the clock from XCIN and leave XCOUT open.
Sub clock output	XCOUT	O	
Clock output	CLKOUT	O	The clock of the same cycle as fC, f8, or f32 is outputted.
$\overline{\text{INT}}$ interrupt input	$\overline{\text{INT0}}$ to $\overline{\text{INT4}}$	I	Input pins for the $\overline{\text{INT}}$ interrupt.
$\overline{\text{NMI}}$ interrupt input	$\overline{\text{NMI}}$	I	Input pin for the $\overline{\text{NMI}}$ interrupt.
Key input interrupt input	$\overline{\text{KI0}}$ to $\overline{\text{KI3}}$	I	Input pins for the key input interrupt.
Timer A	TA0OUT to TA2OUT	I/O	These are timer A0 to timer A2 I/O pins. (however, the output of TA0OUT for the N-channel open drain output.)
	TA0IN to TA2IN	I	These are timer A0 to timer A2 input pins.
Timer B	TB0IN to TB2IN	I	These are timer B0 to timer B2 input pins.
Serial interface	$\overline{\text{CTS0}}$ to $\overline{\text{CTS2}}$	I	These are send control input pins.
	$\overline{\text{RTS0}}$ to $\overline{\text{RTS2}}$	O	These are receive control output pins.
	CLK0 to CLK2	I/O	These are transfer clock I/O pins.
	RXD0 to RXD2	I	These are serial data input pins.
	TXD0 to TXD2	O	These are serial data output pins. (however, TXD2 for the N-channel open drain output.)
	CLKS1	O	This is output pin for transfer clock output from multiple pins function.
I^2C mode	SDA0 to SDA2	I/O	These are serial data I/O pins. (however, SDA2 for the N-channel open drain output.)
	SCL0 to SCL2	I/O	These are transfer clock I/O pins. (however, SCL2 for the N-channel open drain output.)
Reference voltage input	VREF	I	Applies the reference voltage for the A/D converter.
A/D converter	AN0 to AN7, AN0_0 to AN0_7	I	Analog input pins for the A/D converter.
	$\overline{\text{ADTRG}}$	I	This is an A/D trigger input pin.
	ANEX0	I/O	This is the extended analog input pin for the A/D converter, and is the output in external op-amp connection mode.
	ANEX1	I	This is the extended analog input pin for the A/D converter.
I/O port	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P9_0 to P9_7, P10_0 to P10_7	I/O	8-bit I/O ports in CMOS, having a direction register to select an input or output. Each pin is set as an input port or output port. An input port can be set for a pull-up or for no pull-up in 4-bit unit by program. (however, P7_0 and P7_1 for the N-channel open drain output.)
	P8_0 to P8_4, P8_6, P8_7	I/O	I/O ports having equivalent functions to P0.
Input port	P8_5	I	Input pin for the $\overline{\text{NMI}}$ interrupt. Pin states can be read by the P8_5 bit in the P8 register.

I : Input O : Output I/O : Input and output

2.8.8 Stack Pointer Select Flag (U Flag)

ISP is selected when the U flag is “0”; USP is selected when the U flag is “1”.
The U flag is cleared to “0” when a hardware interrupt request is accepted or an INT instruction for software interrupt Nos. 0 to 31 is executed.

2.8.9 Processor Interrupt Priority Level (IPL)

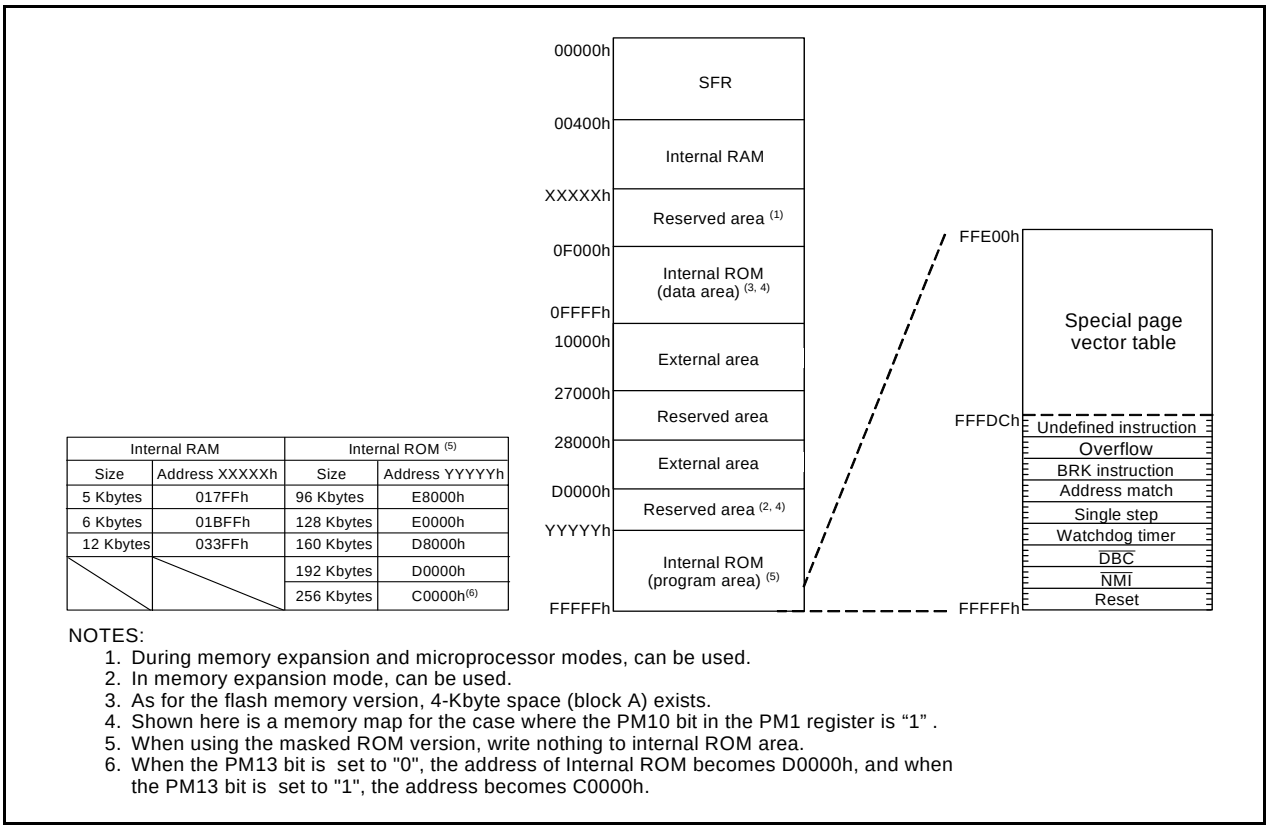
IPL is configured with three bits, for specification of up to eight processor interrupt priority levels from level 0 to level 7.
If a requested interrupt has priority greater than IPL, the interrupt is enabled.

2.8.10 Reserved Area

When write to this bit, write “0”. When read, its content is indeterminate.

3. Memory

Figure 3.1 is a Memory Map of the M16C/30P group. The address space extends the 1 Mbyte from address 00000h to FFFFFh.
The internal ROM is allocated in a lower address direction beginning with address FFFFFh. For example, a 64-Kbyte internal ROM is allocated to the addresses from F0000h to FFFFFh.
The fixed interrupt vector table is allocated to the addresses from FFFDCh to FFFFFh. Therefore, store the start address of each interrupt routine here.
The internal RAM is allocated in an upper address direction beginning with address 00400h. For example, a 5-Kbyte internal RAM is allocated to the addresses from 00400h to 017FFh. In addition to storing data, the internal RAM also stores the stack used when calling subroutines and when interrupts are generated. The SFR is allocated to the addresses from 00000h to 003FFh. Peripheral function control registers are located here. Of the SFR, any area which has no functions allocated is reserved for future use and cannot be used by users.
The special page vector table is allocated to the addresses from FFE00h to FFFDBh. This vector is used by the JMPS or JSRS instruction. For details, refer to the **M16C/60 and M16C/20 Series Software Manual**.



Internal RAM		Internal ROM (5)	
Size	Address XXXXXh	Size	Address YYYYYh
5 Kbytes	017FFh	96 Kbytes	E8000h
6 Kbytes	01BFFh	128 Kbytes	E0000h
12 Kbytes	033FFh	160 Kbytes	D8000h
		192 Kbytes	D0000h
		256 Kbytes	C0000h(6)

NOTES:
1. During memory expansion and microprocessor modes, can be used.
2. In memory expansion mode, can be used.
3. As for the flash memory version, 4-Kbyte space (block A) exists.
4. Shown here is a memory map for the case where the PM10 bit in the PM1 register is “1” .
5. When using the masked ROM version, write nothing to internal ROM area.
6. When the PM13 bit is set to "0", the address of Internal ROM becomes D0000h, and when the PM13 bit is set to "1", the address becomes C0000h.

Figure 3.1 Memory Map

4. Special Function Register (SFR)

SFR(Special Function Register) is the control register of peripheral functions. Tables 4.1 to 4.5 list the SFR information.

Table 4.1 SFR Information (1) (1)

Address	Register	Symbol	After Reset
0000h			
0001h			
0002h			
0003h			
0004h	Processor Mode Register 0 (2)	PM0	00000000b(CNVSS pin is "L") 00000011b(CNVSS pin is "H")
0005h	Processor Mode Register 1	PM1	00XXX0X0b
0006h	System Clock Control Register 0	CM0	01001000b
0007h	System Clock Control Register 1	CM1	00100000b
0008h	Chip Select Control Register	CSR	00000001b
0009h	Address Match Interrupt Enable Register	AIER	XXXXXX00b
000Ah	Protect Register	PRCR	XX000000b
000Bh			
000Ch			
000Dh			
000Eh	Watchdog Timer Start Register	WDTS	XXh
000Fh	Watchdog Timer Control Register	WDC	00XXXXXXb
0010h 0011h 0012h	Address Match Interrupt Register 0	RMAD0	00h 00h X0h
0013h			
0014h 0015h 0016h	Address Match Interrupt Register 1	RMAD1	00h 00h X0h
0017h			
0018h			
0019h			
001Ah			
001Bh			
001Ch			
001Dh			
001Eh			
001Fh			
0020h 0021h 0022h	DMA0 Source Pointer	SAR0	XXh XXh XXh
0023h			
0024h 0025h 0026h	DMA0 Destination Pointer	DAR0	XXh XXh XXh
0027h			
0028h 0029h	DMA0 Transfer Counter	TCR0	XXh XXh
002Ah			
002Bh			
002Ch	DMA0 Control Register	DM0CON	00000X00b
002Dh			
002Eh			
002Fh			
0030h 0031h 0032h	DMA1 Source Pointer	SAR1	XXh XXh XXh
0033h			
0034h 0035h 0036h	DMA1 Destination Pointer	DAR1	XXh XXh XXh
0037h			
0038h 0039h	DMA1 Transfer Counter	TCR1	XXh XXh
003Ah			
003Bh			
003Ch	DMA1 Control Register	DM1CON	00000X00b
003Dh			
003Eh			
003Fh			

NOTES:
1. The blank areas are reserved and cannot be accessed by users.
2. The PM00 and PM01 bits do not change at software reset.

X : Nothing is mapped to this bit

Table 4.2 SFR Information (2) (1)

Address	Register	Symbol	After Reset
0040h			
0041h			
0042h			
0043h			
0044h	INT3 Interrupt Control Register	INT3IC	XX00X000b
0045h			
0046h	UART1 BUS Collision Detection Interrupt Control Register	U1BCNIC	XXXXX000b
0047h	UART0 BUS Collision Detection Interrupt Control Register	U0BCNIC	XXXXX000b
0048h			
0049h	INT4 Interrupt Control Register	INT4IC	XX00X000b
004Ah	UART2 Bus Collision Detection Interrupt Control Register	BCNIC	XXXXX000b
004Bh	DMA0 Interrupt Control Register	DM0IC	XXXXX000b
004Ch	DMA1 Interrupt Control Register	DM1IC	XXXXX000b
004Dh	Key Input Interrupt Control Register	KUPIC	XXXXX000b
004Eh	A/D Conversion Interrupt Control Register	ADIC	XXXXX000b
004Fh	UART2 Transmit Interrupt Control Register	S2TIC	XXXXX000b
0050h	UART2 Receive Interrupt Control Register	S2RIC	XXXXX000b
0051h	UART0 Transmit Interrupt Control Register	S0TIC	XXXXX000b
0052h	UART0 Receive Interrupt Control Register	S0RIC	XXXXX000b
0053h	UART1 Transmit Interrupt Control Register	S1TIC	XXXXX000b
0054h	UART1 Receive Interrupt Control Register	S1RIC	XXXXX000b
0055h	Timer A0 Interrupt Control Register	TA0IC	XXXXX000b
0056h	Timer A1 Interrupt Control Register	TA1IC	XXXXX000b
0057h	Timer A2 Interrupt Control Register	TA2IC	XXXXX000b
0058h			
0059h			
005Ah	Timer B0 Interrupt Control Register	TB0IC	XXXXX000b
005Bh	Timer B1 Interrupt Control Register	TB1IC	XXXXX000b
005Ch	Timer B2 Interrupt Control Register	TB2IC	XXXXX000b
005Dh	INT0 Interrupt Control Register	INT0IC	XX00X000b
005Eh	INT1 Interrupt Control Register	INT1IC	XX00X000b
005Fh	INT2 Interrupt Control Register	INT2IC	XX00X000b
0060h to 01AFh			
01B0h			
01B1h			
01B2h			
01B3h			
01B4h			
01B5h	Flash Memory Control Register 1 (2)	FMR1	0X00XX0Xb
01B6h			
01B7h	Flash Memory Control Register 0 (3)	FMR0	00000001b
01B8h			
01B9h			
01BAh			
01BBh			
01BCh			
01BDh			
01BEh			
01BFh			
01C0h to 024Fh			
0250h			
0251h			
0252h			
0253h			
0254h			
0255h			
0256h			
0257h			
0258h			
0259h			
025Ah			
025Bh			
025Ch			
025Dh			
025Eh	Peripheral Clock Select Register	PCLKR	00000011b
025Fh			
0260h to 033Fh			

NOTES:
1. The blank areas are reserved and cannot be accessed by users.
2. This register is included in the flash memory version.
3. This register is included in the flash memory version and one time flash version.

X : Nothing is mapped to this bit

Table 4.4 SFR Information (4) (1)

Address	Register	Symbol	After Reset
0380h	Count Start Flag	TABSR	000XX000b
0381h	Clock Prescaler Reset Fag	CPSRF	0XXXXXXXb
0382h	One-Shot Start Flag	ONSF	00XXX000b
0383h	Trigger Select Register	TRGSR	XXXX0000b
0384h	Up-Down Flag	UDF	XX0XX000b (2)
0385h			
0386h 0387h	Timer A0 Register	TA0	XXh XXh
0388h 0389h	Timer A1 Register	TA1	XXh XXh
038Ah 038Bh	Timer A2 Register	TA2	XXh XXh
038Ch			
038Dh			
038Eh			
038Fh			
0390h 0391h	Timer B0 Register	TB0	XXh XXh
0392h 0393h	Timer B1 Register	TB1	XXh XXh
0394h 0395h	Timer B2 Register	TB2	XXh XXh
0396h	Timer A0 Mode Register	TA0MR	00h
0397h	Timer A1 Mode Register	TA1MR	00h
0398h	Timer A2 Mode Register	TA2MR	00h
0399h			
039Ah			
039Bh	Timer B0 Mode Register	TB0MR	00XX0000b
039Ch	Timer B1 Mode Register	TB1MR	00XX0000b
039Dh	Timer B2 Mode Register	TB2MR	00XX0000b
039Eh			
039Fh			
03A0h	UART0 Transmit/Receive Mode Register	U0MR	00h
03A1h	UART0 Bit Rate Generator	U0BRG	XXh
03A2h 03A3h	UART0 Transmit Buffer Register	U0TB	XXh XXh
03A4h	UART0 Transmit/Receive Control Register 0	U0C0	00001000b
03A5h	UART0 Transmit/Receive Control Register 1	U0C1	00000010b
03A6h 03A7h	UART0 Receive Buffer Register	U0RB	XXh XXh
03A8h	UART1 Transmit/Receive Mode Register	U1MR	00h
03A9h	UART1 Bit Rate Generator	U1BRG	XXh
03AAh 03ABh	UART1 Transmit Buffer Register	U1TB	XXh XXh
03ACh	UART1 Transmit/Receive Control Register 0	U1C0	00001000b
03ADh	UART1 Transmit/Receive Control Register 1	U1C1	00000010b
03AEh 03AFh	UART1 Receive Buffer Register	U1RB	XXh XXh
03B0h	UART Transmit/Receive Control Register 2	UCON	X0000000b
03B1h			
03B2h			
03B3h			
03B4h			
03B5h			
03B6h			
03B7h			
03B8h	DMA0 Request Factor Select Register	DM0SL	00h
03B9h			
03BAh	DMA1 Request Factor Select Register	DM1SL	00h
03BBh			
03BCh 03BDh	CRC Data Register	CRCD	XXh XXh
03BEh	CRC Input Register	CRCIN	XXh
03BFh			

NOTES:
1. The blank areas are reserved and cannot be accessed by users.
2. Bit 5 in the Up-down flag is “0” by reset. However, The values in these bits when read are indeterminate.

X : Nothing is mapped to this bit

Table 5.4 Flash Memory Version Electrical Characteristics (1)

Symbol	Parameter		Standard			Unit
			Min.	Typ.	Max.	
–	Program and Erase Endurance (2)		100(3)			cycle
–	Word Program Time (V_{CC1}=5.0V)			25	200	µs
–	Lock Bit Program Time			25	200	µs
–	Block Erase Time (V_{CC1}=5.0V)	4-Kbyte block		0.3	4	s
–		8-Kbyte block		0.3	4	s
–		32-Kbyte block		0.5	4	s
–		64-Kbyte block		0.8	4	s
t_{PS}	Flash Memory Circuit Stabilization Wait Time				15	µs
–	Data Hold Time (4)		10			year

NOTES:
1. Referenced to V_{CC1}=4.5 to 5.5V, 3.0 to 3.6V at Topr = 0 to 60 °C (U3, U5) unless otherwise specified.
2. Program and Erase Endurance refers to the number of times a block erase can be performed.
   If the program and erase endurance is 100, each block can be erased 100 times.
   For example, if a 4 Kbytes block A is erased after writing 1 word data 2,048 times, each to a different address, this counts as one program and erase endurance. Data cannot be written to the same address more than once without erasing the block. (Rewrite prohibited)
3. Maximum number of E/W cycles for which operation is guaranteed.
4. Topr = -40 to 85 °C (U3) / -20 to 85 °C (U5).

Table 5.5 Flash Memory Version Program / Erase Voltage and Read Operation Voltage Characteristics

Flash Program, Erase Voltage	Flash Read Operation Voltage
V_{CC1} = 3.3 ± 0.3 V or 5.0 ± 0.5 (T_{opr} = 0°C to 60°C)	V_{CC1}=2.7 to 5.5 V (T_{opr} = -40°C to 85°C (U3) -20°C to 85°C (U5))

Table 5.8 Power Supply Circuit Timing Characteristics

Symbol	Parameter	Measuring Condition	Standard			Unit
			Min.	Typ.	Max.	
$t_{d(P-R)}$	Time for Internal Power Supply Stabilization During Powering-On	V_{CC}=2.7V to 5.5V			2	ms
$t_{d(R-S)}$	STOP Release Time				1500	µs
$t_{d(W-S)}$	Low Power Dissipation Mode Wait Mode Release Time				1500	µs

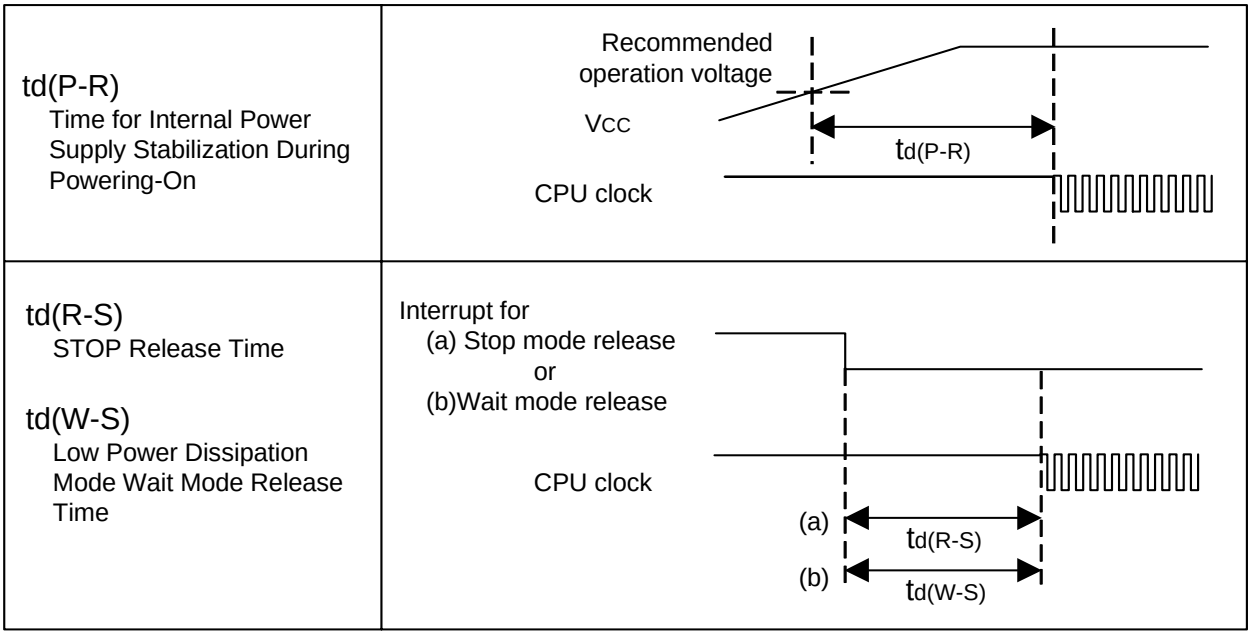


Figure 5.1 Power Supply Circuit Timing Diagram

$V_{CC1}=V_{CC2}=5V$

Table 5.9 Electrical Characteristics(1) (1)

Symbol	Parameter		Measuring Condition	Standard			Unit
				Min.	Typ.	Max.	
V_{OH}	HIGH Output Voltage	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7	I_{OH}=–5mA	V_{CC}–2.0		V_{CC}	V
V_{OH}	HIGH Output Voltage	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7	I_{OH}=–200µA	V_{CC}–0.3		V_{CC}	V
V_{OH}	HIGH Output Voltage XOUT	HIGHPOWER	I_{OH}=–1mA	V_{CC}–2.0		V_{CC}	V
		LOWPOWER	I_{OH}=–0.5mA	V_{CC}–2.0		V_{CC}	
	HIGH Output Voltage XCOUT	HIGHPOWER	With no load applied		2.5		V
		LOWPOWER	With no load applied		1.6		
V_{OL}	LOW Output Voltage	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7	I_{OL}=5mA			2.0	V
V_{OL}	LOW Output Voltage	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7	I_{OL}=200µA			0.45	V
V_{OL}	LOW Output Voltage XOUT	HIGHPOWER	I_{OL}=1mA			2.0	V
		LOWPOWER	I_{OL}=0.5mA			2.0	
	LOW Output Voltage XCOUT	HIGHPOWER	With no load applied		0		V
		LOWPOWER	With no load applied		0		
V_{T+}-V_{T-}	Hysteresis	TA0IN to TA2IN, TB0IN to TB2IN, $\overline{INT0}$ to $\overline{INT4}$, $\overline{NMI}$, $\overline{ADTRG}$, $\overline{CTS0}$ to $\overline{CTS2}$, CLK0 to CLK2, TA0OUT to TA2OUT, $\overline{KI0}$ to $\overline{KI3}$, RXD0 to RXD2, SCL0 to SCL2, SDA0 to SDA2		0.2		1.0	V
V_{T+}-V_{T-}	Hysteresis	$\overline{RESET}$		0.2		2.5	V
I_{IH}	HIGH Input Current	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_7, P9_0 to P9_7, P10_0 to P10_7, XIN, $\overline{RESET}$, CNVSS, BYTE	V_I=5V			5.0	µA
I_{IL}	LOW Input Current	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_7, P9_0 to P9_7, P10_0 to P10_7, XIN, $\overline{RESET}$, CNVSS, BYTE	V_I=0V			–5.0	µA
R_{PULLUP}	Pull-Up Resistance	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7	V_I=0V	30	50	170	kΩ
R_{fXIN}	Feedback Resistance XIN				1.5		MΩ
R_{fXCIN}	Feedback Resistance XCIN				15		MΩ
V_{RAM}	RAM Retention Voltage		At stop mode	2.0			V

NOTES:
1. Referenced to $V_{CC1}=V_{CC2}$=4.2 to 5.5V, V_{SS} = 0V at T_{opr} = –20 to 85°C / –40 to 85°C, f(XIN) =16MHz unless otherwise specified.

Table 5.10 Electrical Characteristics (2) (1)

Symbol	Parameter		Measuring Condition		Standard			Unit
					Min.	Typ.	Max.	
I_{CC}	Power Supply Current (V_{CC1}=V_{CC2}=4.0V to 5.5V)	In single-chip mode, the output pins are open and other pins are V_{SS}	Mask ROM	f(XIN)=16MHz No division		10	15	mA
			One Time Flash	f(XIN)=16MHz, No division		10	18	mA
			Flash Memory	f(XIN)=16MHz, No division		12	18	mA
			One Time Flash	f(XIN)=10MHz, VCC1=5.0V		15		mA
			Flash Memory Program	f(XIN)=10MHz, VCC1=5.0V		15		mA
			Flash Memory Erase	f(XIN)=10MHz, VCC1=5.0V		25		mA
			Mask ROM	f(XCIN)=32kHz Low power dissipation mode, ROM (3)		25		µA
			One Time Flash	f(XCIN)=32kHz Low power dissipation mode, RAM (3)		25		µA
				f(XCIN)=32kHz Low power dissipation mode, Flash Memory (3)		350		µA
			Flash Memory	f(XCIN)=32kHz Low power dissipation mode, RAM (3)		25		µA
				f(XCIN)=32kHz Low power dissipation mode, Flash Memory (3)		420		µA
			Mask ROM One Time Flash Flash Memory	f(XCIN)=32kHz Wait mode (2), Oscillation capability High		7.5		µA
				f(XCIN)=32kHz Wait mode (2), Oscillation capability Low		2.0		µA
				Stop mode Topr =25°C		0.8	3.0	µA

NOTES:
1. Referenced to V_{CC1}=V_{CC2}=4.2 to 5.5V, V_{SS} = 0V at T_{opr} = –20 to 85°C / –40 to 85°C, f(XIN)=16MHz unless otherwise specified.
2. With one timer operated using fC32.
3. This indicates the memory in which the program to be executed exists.

$V_{CC1}=V_{CC2}=5V$

Timing Requirements

(V_{CC1} = V_{CC2} = 5V, V_{SS} = 0V, at T_{opr} = –20 to 85°C / –40 to 85°C unless otherwise specified)

Table 5.13 Timer A Input (Counter Input in Event Counter Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN Input Cycle Time	100		ns
$t_{w(TAH)}$	TAiIN Input HIGH Pulse Width	40		ns
$t_{w(TAL)}$	TAiIN Input LOW Pulse Width	40		ns

Table 5.14 Timer A Input (Gating Input in Timer Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN Input Cycle Time	400		ns
$t_{w(TAH)}$	TAiIN Input HIGH Pulse Width	200		ns
$t_{w(TAL)}$	TAiIN Input LOW Pulse Width	200		ns

Table 5.15 Timer A Input (External Trigger Input in One-shot Timer Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN Input Cycle Time	200		ns
$t_{w(TAH)}$	TAiIN Input HIGH Pulse Width	100		ns
$t_{w(TAL)}$	TAiIN Input LOW Pulse Width	100		ns

Table 5.16 Timer A Input (External Trigger Input in Pulse Width Modulation Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{w(TAH)}$	TAiIN Input HIGH Pulse Width	100		ns
$t_{w(TAL)}$	TAiIN Input LOW Pulse Width	100		ns

Table 5.17 Timer A Input (Counter Increment/Decrement Input in Event Counter Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(UP)}$	TAiOUT Input Cycle Time	2000		ns
$t_{w(UPH)}$	TAiOUT Input HIGH Pulse Width	1000		ns
$t_{w(UPL)}$	TAiOUT Input LOW Pulse Width	1000		ns
$t_{su(UP-TIN)}$	TAiOUT Input Setup Time	400		ns
$t_{h(TIN-UP)}$	TAiOUT Input Hold Time	400		ns

Table 5.18 Timer A Input (Two-phase Pulse Input in Event Counter Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN Input Cycle Time	800		ns
$t_{su(TAIN-TAOUT)}$	TAiOUT Input Setup Time	200		ns
$t_{su(TAOUT-TAIN)}$	TAiIN Input Setup Time	200		ns

$V_{CC1}=V_{CC2}=5V$

Switching Characteristics

(V_{CC1} = V_{CC2} = 5V, V_{SS} = 0V, at T_{opr} = –20 to 85°C / –40 to 85°C unless otherwise specified)

Table 5.25 Memory Expansion and Microprocessor Modes (for setting with no wait)

Symbol	Parameter		Standard		Unit
			Min.	Max.	
td(BCLK-AD)	Address Output Delay Time	See **Figure 5.2**		25	ns
th(BCLK-AD)	Address Output Hold Time (in relation to BCLK)		–3		ns
th(RD-AD)	Address Output Hold Time (in relation to RD)		0		ns
th(WR-AD)	Address Output Hold Time (in relation to WR)		(NOTE 2)		ns
td(BCLK-CS)	Chip Select Output Delay Time			25	ns
th(BCLK-CS)	Chip Select Output Hold Time (in relation to BCLK)		–3		ns
td(BCLK-ALE)	ALE Signal Output Delay Time			15	ns
th(BCLK-ALE)	ALE Signal Output Hold Time		–4		ns
td(BCLK-RD)	RD Signal Output Delay Time			25	ns
th(BCLK-RD)	RD Signal Output Hold Time		0		ns
td(BCLK-WR)	WR Signal Output Delay Time			25	ns
th(BCLK-WR)	WR Signal Output Hold Time		0		ns
td(BCLK-DB)	Data Output Delay Time (in relation to BCLK)			40	ns
th(BCLK-DB)	Data Output Hold Time (in relation to BCLK) (3)		4		ns
td(DB-WR)	Data Output Delay Time (in relation to WR)		(NOTE 1)		ns
th(WR-DB)	Data Output Hold Time (in relation to WR) (3)		(NOTE 2)		ns
td(BCLK-HLDA)	HLDA Output Delay Time			40	ns

NOTES:

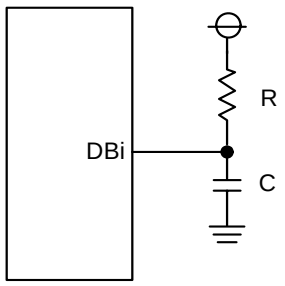
1. Calculated according to the BCLK frequency as follows:

$$\frac{0.5\times10^9}{f(BCLK)} - 40[ns]$$ f(BCLK) is 12.5MHz or less.

2. Calculated according to the BCLK frequency as follows:

$$\frac{0.5\times10^9}{f(BCLK)} - 10[ns]$$

3. This standard value shows the timing when the output is off, and does not show hold time of data bus.
   Hold time of data bus varies with capacitor volume and pull-up (pull-down) resistance value.
   Hold time of data bus is expressed in
   $t = -CR \times \ln(1 - V_{OL} / V_{CC1})$
   by a circuit of the right figure.
   For example, when $V_{OL} = 0.2V_{CC1}$, C = 30pF, R = 1kΩ, hold time of output "L" level is
   $t = -30pF \times 1k\Omega \times \ln(1 - 0.2V_{CC1} / V_{CC1})$
   = 6.7ns.



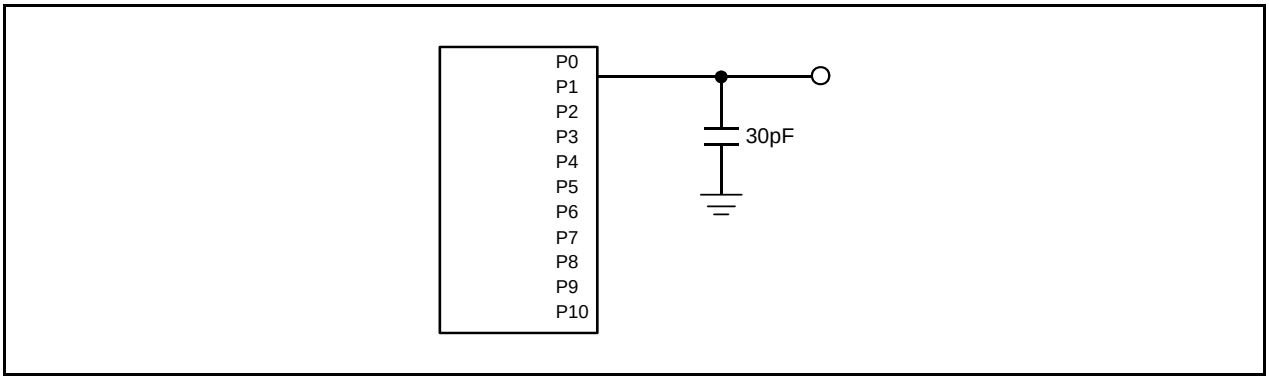
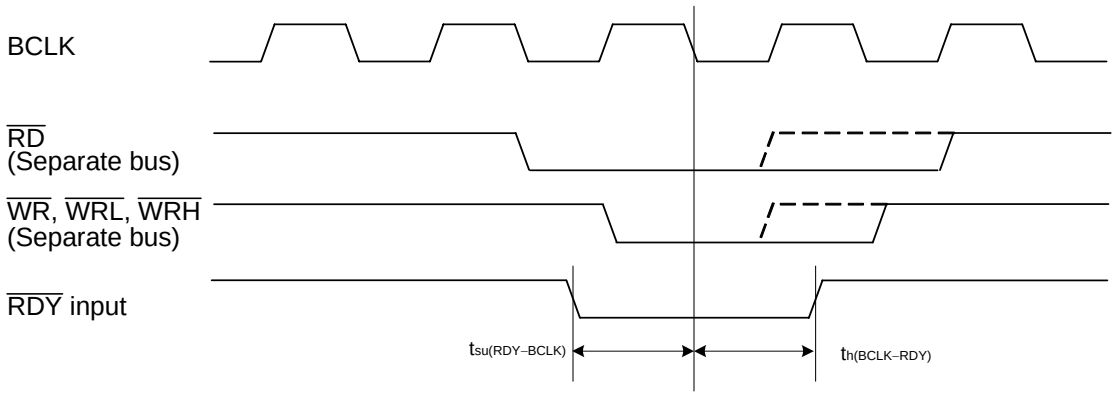


Figure 5.2 Ports P0 to P10 Measurement Circuit

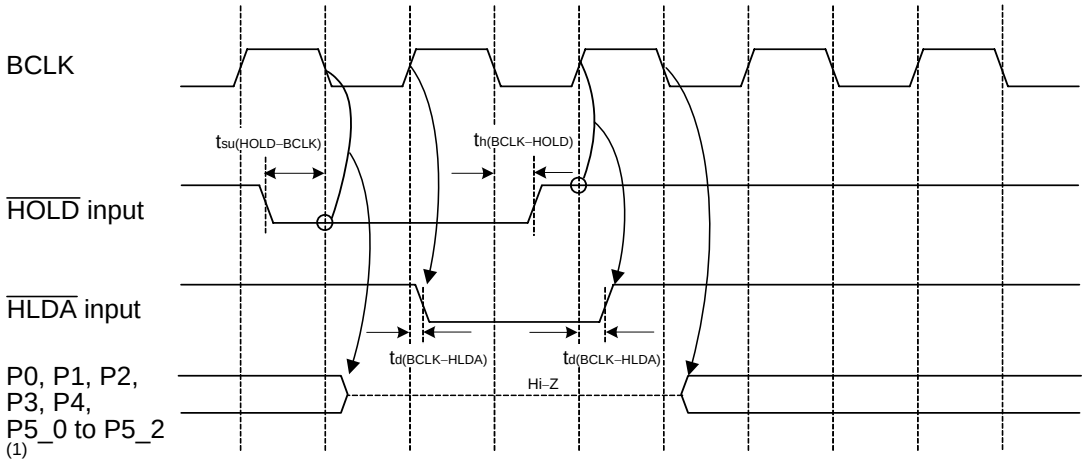
$V_{CC1}=V_{CC2}=5V$

Memory Expansion Mode, Microprocessor Mode

(Effective for setting with wait**)**



(Common to setting with wait and setting without wait**)**



NOTES:

1. These pins are set to high-impedance regardless of the input level of the BYTE pin, PM06 bit in PM0 register.

· Measuring conditions :
· $V_{CC1}=V_{CC2}=5V$
· Input timing voltage : Determined with $V_{IL}=1.0V$, $V_{IH}=4.0V$
· Output timing voltage : Determined with $V_{OL}=2.5V$, $V_{OH}=2.5V$

Figure 5.5 Timing Diagram (3)

$V_{CC1}=V_{CC2}=3V$

Timing Requirements
(V_{CC1} = V_{CC2} = 3V, V_{SS} = 0V, at T_{opr} = –20 to 85°C / –40 to 85°C unless otherwise specified)

Table 5.31 Timer A Input (Counter Input in Event Counter Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN Input Cycle Time	150		ns
$t_{w(TAH)}$	TAiIN Input HIGH Pulse Width	60		ns
$t_{w(TAL)}$	TAiIN Input LOW Pulse Width	60		ns

Table 5.32 Timer A Input (Gating Input in Timer Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN Input Cycle Time	600		ns
$t_{w(TAH)}$	TAiIN Input HIGH Pulse Width	300		ns
$t_{w(TAL)}$	TAiIN Input LOW Pulse Width	300		ns

Table 5.33 Timer A Input (External Trigger Input in One-shot Timer Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN Input Cycle Time	300		ns
$t_{w(TAH)}$	TAiIN Input HIGH Pulse Width	150		ns
$t_{w(TAL)}$	TAiIN Input LOW Pulse Width	150		ns

Table 5.34 Timer A Input (External Trigger Input in Pulse Width Modulation Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{w(TAH)}$	TAiIN Input HIGH Pulse Width	150		ns
$t_{w(TAL)}$	TAiIN Input LOW Pulse Width	150		ns

Table 5.35 Timer A Input (Counter Increment/Decrement Input in Event Counter Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(UP)}$	TAiOUT Input Cycle Time	3000		ns
$t_{w(UPH)}$	TAiOUT Input HIGH Pulse Width	1500		ns
$t_{w(UPL)}$	TAiOUT Input LOW Pulse Width	1500		ns
$t_{su(UP-TIN)}$	TAiOUT Input Setup Time	600		ns
$t_{h(TIN-UP)}$	TAiOUT Input Hold Time	600		ns

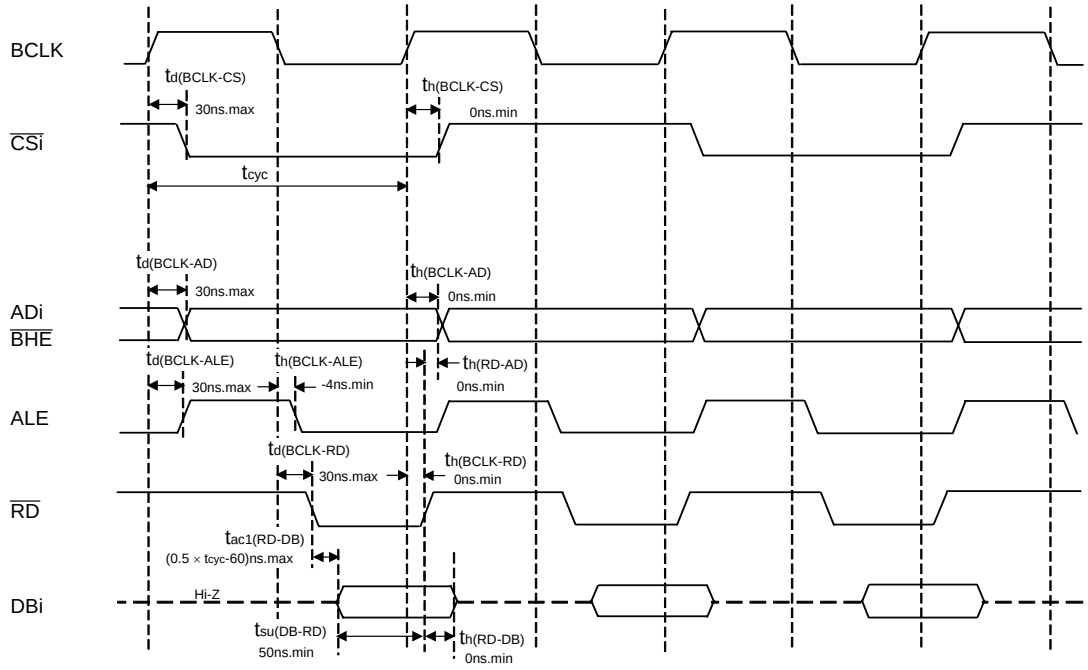
Table 5.36 Timer A Input (Two-phase Pulse Input in Event Counter Mode)

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN Input Cycle Time	2		µs
$t_{su(TAIN-TAOUT)}$	TAiOUT Input Setup Time	500		ns
$t_{su(TAOUT-TAIN)}$	TAiIN Input Setup Time	500		ns

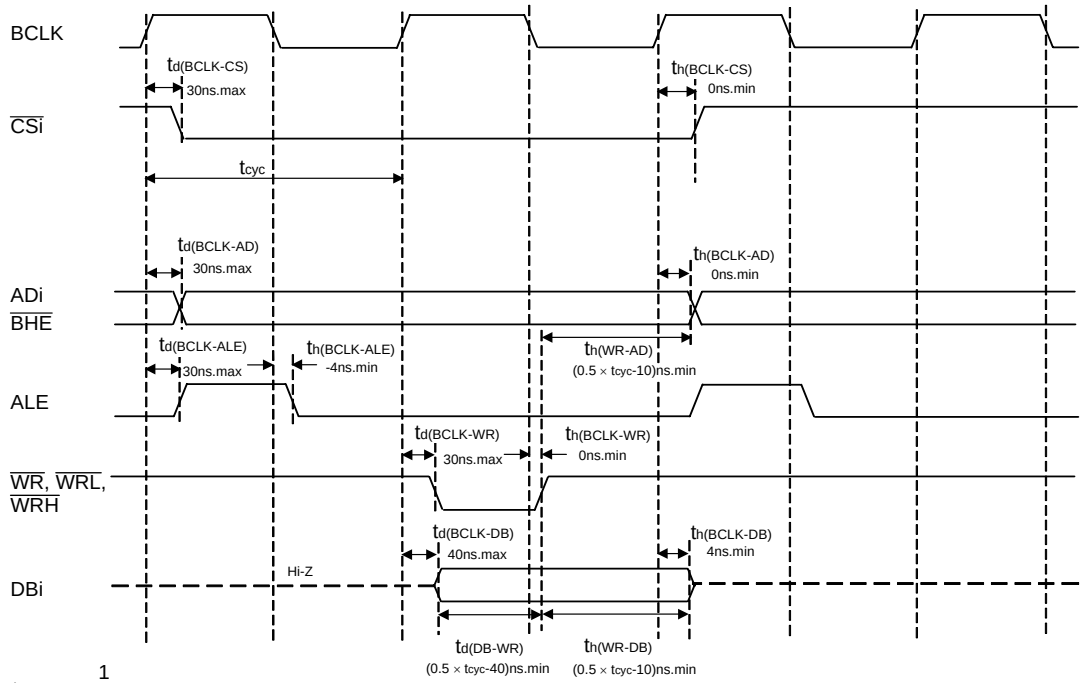
Memory Expansion Mode, Microprocessor Mode
(for setting with no wait**)**

$V_{CC1}=V_{CC2}=3V$

Read timing



Write timing



$$t_{cyc}=\frac{1}{f(BCLK)}$$

Measuring conditions
· $V_{CC1}=V_{CC2}=3V$
· Input timing voltage : $V_{IL}=0.6V$, $V_{IH}=2.4V$
· Output timing voltage : $V_{OL}=1.5V$, $V_{OH}=1.5V$

Figure 5.12 Timing Diagram (4)

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