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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Obsolete
Core Processor	M16C/60
Core Size	16-Bit
Speed	16MHz
Connectivity	CANbus, SIO, UART/USART
Peripherals	WDT
Number of I/O	37
Program Memory Size	64KB (64K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	3K x 8
Voltage - Supply (Vcc/Vdd)	4.2V ~ 5.5V
Data Converters	A/D 12x10b; D/A 1x8b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	48-LQFP
Supplier Device Package	48-LQFP (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/m301n2f8tfp-u3

1.2 Performance Overview

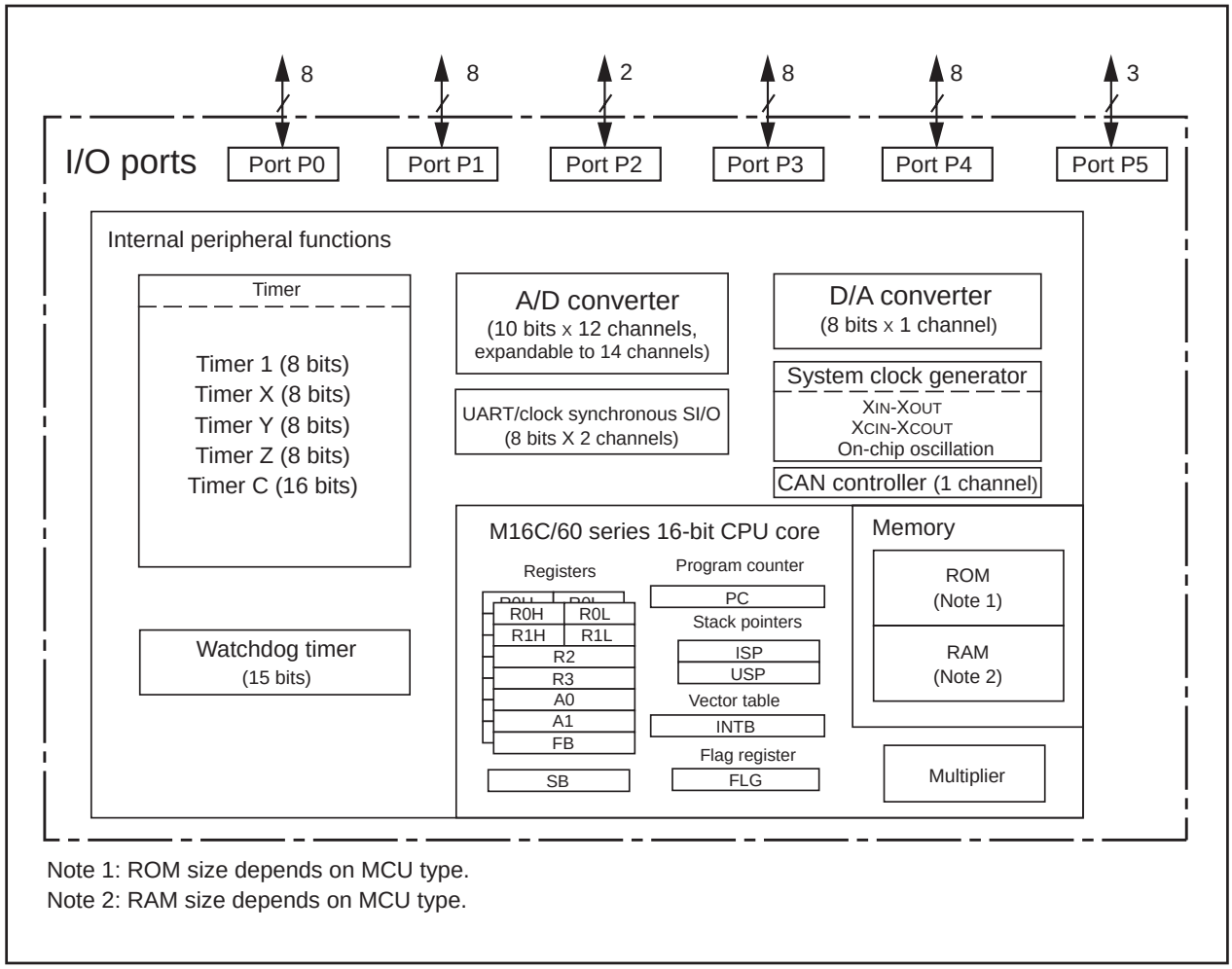
Table 1.1 gives an overview of the M16C/1N group performance specification.

Table 1.1 Performance overview

Item		Performance
Number of basic instructions		91 instructions
Shortest instruction execution time		62.5 ns (when f(XIN)=16MHz)
Memory size	ROM	See **Table 1.2 Performance overview**
	RAM	See **Table 1.2 Performance overview**
I/O port		P0 to P5: 37 lines
Multifunction timer	T1	8 bits x 1
	TX, TY, TZ	8 bits x 3
	TC	16 bits x 1
Serial I/O (UART or clock synchronous)		x 2
A/D converter (maximum resolution: 10 bits)		x 12 channels (Expandable up to 14 channels)
D/A converter		8 bits x 1
CAN controller		1 channel, 2.0B active
Watchdog timer		15 bits x 1 (with prescaler)
Interrupts		15 internal causes, 8 external causes, 4 software causes
Clock generating circuits		3 internal circuits
Power supply voltage		4.2 V to 5.5V (when f(XIN)=16MHz)
Power consumption		70mW(VCC=5.0V, f(XIN)=16MHz)
I/O characteristics	I/O withstand voltage	5V
	Output current	5mA (10mA:LED drive port)
Device configuration		CMOS silicon gate
Package		48-pin LQFP

1.3 Block Diagram

Figure 1.1 shows block diagram of the M16C/1N group.

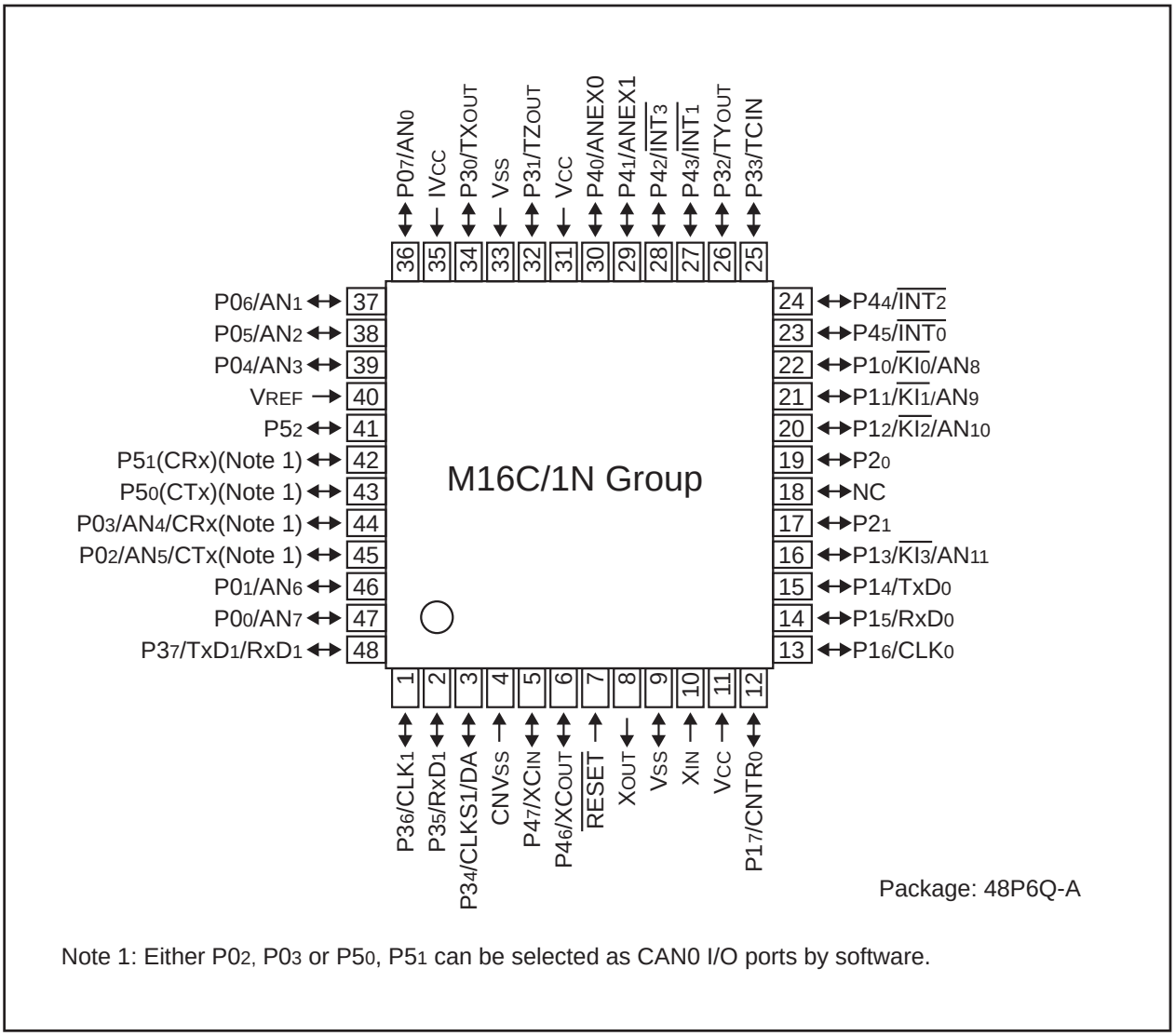


Note 1: ROM size depends on MCU type.
Note 2: RAM size depends on MCU type.

Figure 1.1 Block diagram

1.5 Pin Configuration

Figure 1.3 shows pin configurations (top view) of the M16C/1N group.



Note 1: Either P02, P03 or P50, P51 can be selected as CAN0 I/O ports by software.

Figure 1.3 Pin configuration diagram (top view)

1.6 Pin Description

Table 1.3 shows the pin description.

Table 1.3 Pin Description

Pin name	Signal name	I/O type	Function
VCC, VSS	Power supply input	Input	Supply 4.2 to 5.5 V to the VCC pin. Supply 0 V to the VSS pin.
IVCC	IVCC	Input	Connect a capacitor (0.1 µF) between this pin and VSS.
CNVSS	CNVSS	Input	Connect it to the VSS pin via resistance (about 5 kΩ).
$\overline{\text{RESET}}$	Reset input	Input	A "L" on this input resets the microcomputer.
XIN	Clock input	Input	These pins are provided for the main clock oscillation circuit. Connect a ceramic resonator or crystal between the XIN and XOUT pins. To use an externally derived clock, input it to the XIN pin and leave the XOUT pin open.
XOUT	Clock output	Output	
VREF	Reference voltage input	Input	This pin is a reference voltage input for the A/D converter.
$P0_0$ to $P0_7$	I/O port P0	Input/output	This is an 8-bit CMOS I/O port. It has an input/output port direction register that allows the user to set each pin for input or output individually. When set for input, the user can specify in units of four bits via software whether or not they are tied to a pull-up resistor. These pins are shared with analog input pins. $P0_2$ and $P0_3$ function as CAN0 I/O pins by using software.
$P1_0$ to $P1_7$	I/O port P1	Input/output	This is an 8-bit I/O port equivalent to P0. $P1_0$ to $P1_3$ are shared with analog inputs and key input interrupts. $P1_4$ to $P1_6$ are shared with serial I/O pins. $P1_7$ is shared with timer input. Can be used as an LED drive port.
$P2_0$ to $P2_1$	I/O port P2	Input/output	This is a 2-bit I/O port equivalent to P0.
$P3_0$ to $P3_7$	I/O port P3	Input/output	This is a 8-bit I/O port equivalent to P0. $P3_0$ to $P3_3$ are shared with timer input/output. $P3_4$ to $P3_7$ are shared with serial I/O. $P3_4$ is shared with analog outputs.
$P4_0$ to $P4_7$	I/O port P4	Input/output	This is a 8-bit I/O port equivalent to P0. $P4_0$ to 4_1 are shared with analog inputs. $P4_2$ to $P4_5$ are shared with interrupt inputs. $P4_6$ to $P4_7$ are shared with the I/O pin of the clock oscillation circuit for the clock.
$P5_0$ to $P5_2$	I/O port P5	Input/output	This is a 3-bit I/O port equivalent to P0. $P5_0$ and $P5_1$ function as CAN0 I/O pins by using software.

2. Central Processing Unit (CPU)

Figure 2.1 shows the CPU registers. The CPU has 13 registers. Of these, R0, R1, R2, R3, A0, A1 and FB comprise a register bank. There are two register banks.

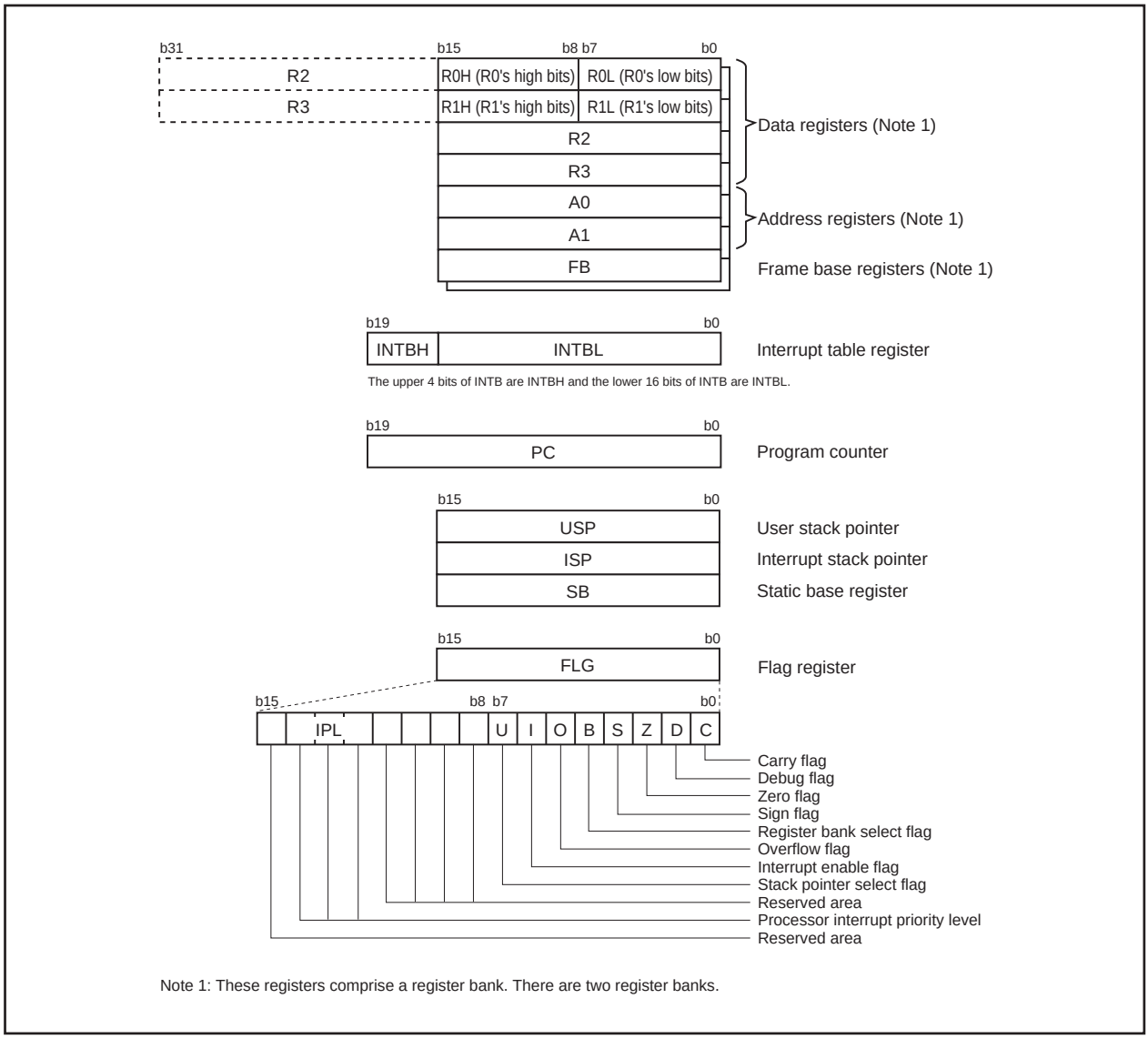


Figure 2.1 CPU Registers

2.1 Data Registers (R0, R1, R2, and R3)

The R0 register consists of 16 bits, and is used mainly for transfers and arithmetic/logic operations. R1 to R3 are the same as R0.

The R0 register can be separated between high (R0H) and low (R0L) for use as two 8-bit data registers. R1H and R1L are the same as R0H and R0L. Conversely R2 and R0 can be combined for use as a 32-bit data register (R2R0). R3R1 is the same as R2R0.

2.2 Address Registers (A0 and A1)

The A0 register consists of 16 bits, and is used for address register indirect addressing and address register relative addressing. They also are used for transfers and arithmetic/logic operations. A1 is the same as A0.

In some instructions, A1 and A0 can be combined for use as a 32-bit address register (A1A0).

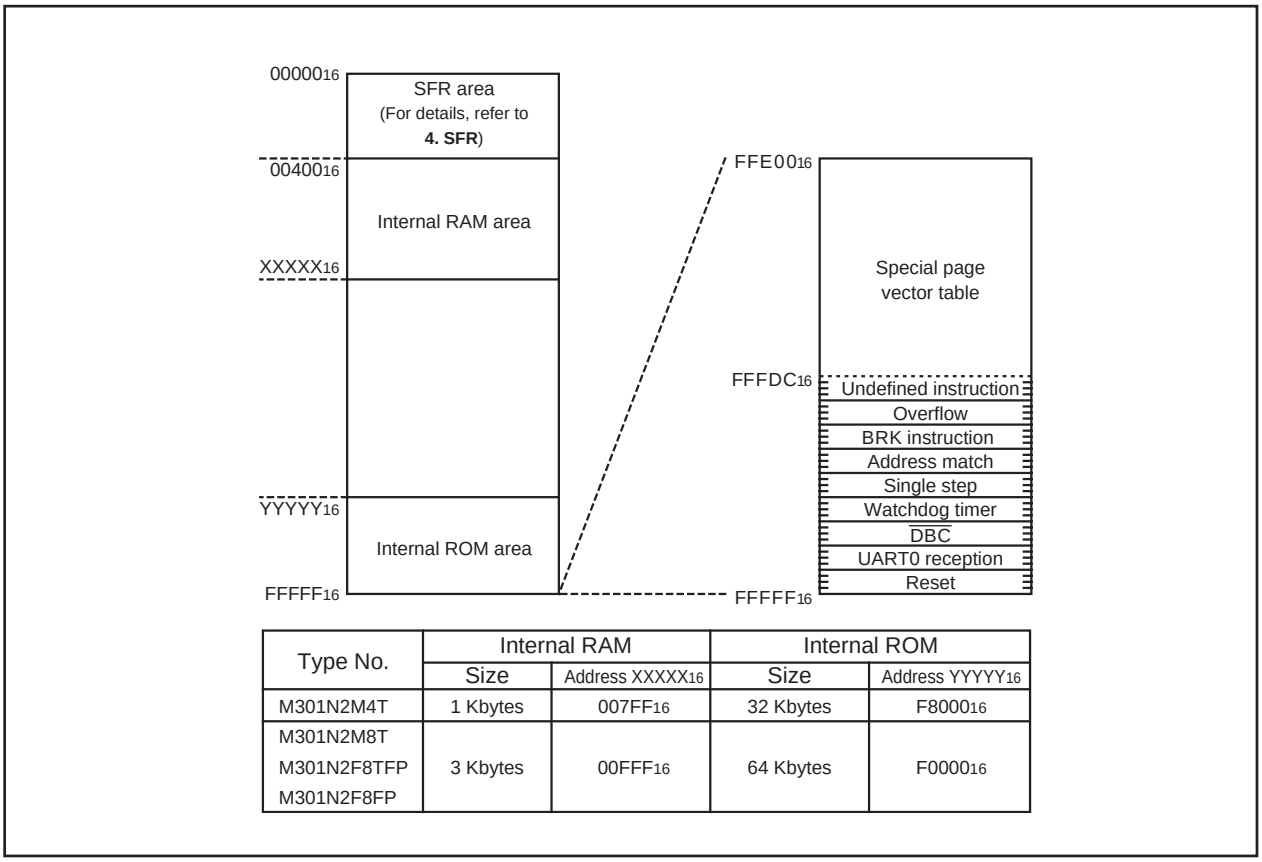
3. Memory

Figure 3.1 is a memory map. The address space extends the 1M bytes from address 00000$_{16}$ to FFFFF$_{16}$. From FFFFF$_{16}$ down is ROM. For example, in the M301N2M4T-XXXFP, there is 32K bytes of internal ROM from F8000$_{16}$ to FFFFF$_{16}$. The vector table for fixed interrupts such as the reset are mapped to FFFDC$_{16}$ to FFFFF$_{16}$. The starting address of the interrupt routine is stored here. The address of the vector table for timer interrupts, etc., can be set as desired using the internal register (INTB). See the section on interrupts for details.

From 00400$_{16}$ up is RAM. For example, in the M301N2M4T-XXXFP, there is 1K byte of internal RAM from 00400$_{16}$ to 007FF$_{16}$. In addition to storing data, the RAM also stores the stack used when calling subroutines and when interrupts are generated.

The SFR area is mapped to 00000$_{16}$ to 003FF$_{16}$. This area accommodates the control registers for peripheral devices such as I/O ports, A/D converter, serial I/O, and timers, etc. Any part of the SFR area that is not occupied is reserved and cannot be used for other purposes.

The special page vector table is mapped to FFE00$_{16}$ to FFFDB$_{16}$. If the starting addresses of subroutines or the destination addresses of jumps are stored here, subroutine call instructions and jump instructions can be used as 2-byte instructions, reducing the number of program steps.



Type No.	Internal RAM		Internal ROM	
	Size	Address XXXXX$_{16}$	Size	Address YYYYY$_{16}$
M301N2M4T	1 Kbytes	007FF$_{16}$	32 Kbytes	F8000$_{16}$
M301N2M8T M301N2F8TFP M301N2F8FP	3 Kbytes	00FFF$_{16}$	64 Kbytes	F0000$_{16}$

Figure 3.1 Memory map

Address	Register	Symbol	After reset
0040$_{16}$			
0041$_{16}$			
0042$_{16}$			
0043$_{16}$			
0044$_{16}$			
0045$_{16}$	CAN0 wakeup interrupt control register	C01WKIC	XXXXX000$_2$
0046$_{16}$	CAN0 state/error interrupt control register	C01ERRIC	XXXXX000$_2$
0047$_{16}$			
0048$_{16}$	CAN0 reception successful interrupt control register	C0RECIC	XXXXX000$_2$
0049$_{16}$	CAN0 transmission successful interrupt control register	C0TRMIC	XXXXX000$_2$
004A$_{16}$			
004B$_{16}$			
004C$_{16}$			
004D$_{16}$	Key input interrupt control register	KUPIC	XXXXX000$_2$
004E$_{16}$	A/D conversion interrupt control register	ADIC	XXXXX000$_2$
004F$_{16}$			
0050$_{16}$			
0051$_{16}$	UART0 transmit interrupt control register	S0TIC	XXXXX000$_2$
0052$_{16}$	UART0 receive interrupt control register	S0RIC	XXXXX000$_2$
0053$_{16}$	UART1 transmit interrupt control register	S1TIC	XXXXX000$_2$
0054$_{16}$	UART1 receive interrupt control register	S1RIC	XXXXX000$_2$
0055$_{16}$	Timer 1 interrupt control register	T1IC	XXXXX000$_2$
0056$_{16}$	Timer X interrupt control register	TXIC	XXXXX000$_2$
0057$_{16}$	Timer Y interrupt control register	TYIC	XXXXX000$_2$
0058$_{16}$	Timer Z interrupt control register	TZIC	XXXXX000$_2$
0059$_{16}$	CNTR0 interrupt control register	CNTR0IC	XXXXX000$_2$
005A$_{16}$	TCIN interrupt control register	TCINIC	XXXXX000$_2$
005B$_{16}$	Timer C interrupt control register	TCIC	XXXXX000$_2$
005C$_{16}$	INT3 interrupt control register	INT3IC	XXXXX000$_2$
005D$_{16}$	INT0 interrupt control register	INT0IC	XX00X000$_2$
005E$_{16}$	INT1 interrupt control register	INT1IC	XX00X000$_2$
005F$_{16}$	INT2 interrupt control register	INT2IC	XX00X000$_2$
0060$_{16}$			
0061$_{16}$			
0062$_{16}$			
0063$_{16}$			
0064$_{16}$			
0065$_{16}$			
0066$_{16}$			
0067$_{16}$			
0068$_{16}$			
0069$_{16}$			
006A$_{16}$			
006B$_{16}$			
006C$_{16}$			
006D$_{16}$			
006E$_{16}$			
006F$_{16}$			
0070$_{16}$			
0071$_{16}$			
0072$_{16}$			
0073$_{16}$			
0074$_{16}$			
0075$_{16}$			
0076$_{16}$			
0077$_{16}$			
0078$_{16}$			
0079$_{16}$			
007A$_{16}$			
007B$_{16}$			
007C$_{16}$			
007D$_{16}$			
007E$_{16}$			
007F$_{16}$			

Note 1: Location in the SFR area where nothing is allocated are reserved areas. Do not access these areas for read or write.

X : Undefined

Address	Register	Symbol	After reset
0080_{16}	Timer Y, Z mode register	TYZMR	$000000X0_2$
0081_{16}	Prescaler Y	PREY	FF_{16}
0082_{16}	Timer Y secondary	TYSC	FF_{16}
0083_{16}	Timer Y primary	TYPR	FF_{16}
0084_{16}	Timer Y, Z waveform output control register	PUM	00_{16}
0085_{16}	Prescaler Z	PREZ	FF_{16}
0086_{16}	Timer Z secondary	TZSC	FF_{16}
0087_{16}	Timer Z primary	TZPR	FF_{16}
0088_{16}	Prescaler 1	PRE1	XX_{16}
0089_{16}	Timer 1	T1	XX_{16}
$008A_{16}$	Timer Y, Z output control register	TYZOC	$XXXXX000_2$
$008B_{16}$	Timer X mode register	TXMR	00000000_2
$008C_{16}$	Prescaler X	PREX	FF_{16}
$008D_{16}$	Timer X	TX	FF_{16}
$008E_{16}$	Timer count source set register	TCSS	00_{16}
$008F_{16}$	Clock prescaler reset flag	CPSRF	$0XXXXXXX_2$
0090_{16}	Timer C counter	TC	XX_{16}
0091_{16}			XX_{16}
0092_{16}			
0093_{16}			
0094_{16}			
0095_{16}			
0096_{16}	External input enable register	INTEN	00_{16}
0097_{16}			
0098_{16}	Key input enable register	KIEN	00_{16}
0099_{16}			
$009A_{16}$	Timer C control register 0	TCC0	$0XX00000_2$
$009B_{16}$	Timer C control register 1	TCC1	$XXXXXX11_2$
$009C_{16}$	Time measurement register	TM	XX_{16}
$009D_{16}$			XX_{16}
$009E_{16}$			
$009F_{16}$			
$00A0_{16}$	UART0 transmit/receive mode register	U0MR	00_{16}
$00A1_{16}$	UART0 bit rate generator	U0BRG	XX_{16}
$00A2_{16}$	UART0 transmit buffer register	U0TB	XX_{16}
$00A3_{16}$			XX_{16}
$00A4_{16}$	UART0 transmit/receive control register 0	U0C0	08_{16}
$00A5_{16}$	UART0 transmit/receive control register 1	U0C1	$XXXX0010_2$
$00A6_{16}$	UART0 receive buffer register	U0RB	XX_{16}
$00A7_{16}$			XX_{16}
$00A8_{16}$	UART1 transmit/receive mode register	U1MR	00_{16}
$00A9_{16}$	UART1 bit rate generator	U1BRG	XX_{16}
$00AA_{16}$	UART1 transmit buffer register	U1TB	XX_{16}
$00AB_{16}$			XX_{16}
$00AC_{16}$	UART1 transmit/receive control register 0	U1C0	08_{16}
$00AD_{16}$	UART1 transmit/receive control register 1	U1C1	$XXXX0010_2$
$00AE_{16}$	UART1 receive buffer register	U1RB	XX_{16}
$00AF_{16}$			XX_{16}
$00B0_{16}$	UART transmit/receive control register 2	UCON	$X0000000_2$
$00B1_{16}$			
$00B2_{16}$			
$00B3_{16}$			
$00B4_{16}$			
$00B5_{16}$			
$00B6_{16}$			
$00B7_{16}$			
$00B8_{16}$			
$00B9_{16}$			
$00BA_{16}$			
$00BB_{16}$			
$00BC_{16}$			
$00BD_{16}$			
$00BE_{16}$			
$00BF_{16}$			

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X : Undefined

Address	Register	Symbol	After reset
00C0$_{16}$	A/D register	AD	XX$_{16}$
00C1$_{16}$			XX$_{16}$
00C2$_{16}$			
00C3$_{16}$			
00C4$_{16}$			
00C5$_{16}$			
00C6$_{16}$			
00C7$_{16}$			
00C8$_{16}$			
00C9$_{16}$			
00CA$_{16}$			
00CB$_{16}$			
00CC$_{16}$			
00CD$_{16}$			
00CE$_{16}$			
00CF$_{16}$			
00D0$_{16}$			
00D1$_{16}$			
00D2$_{16}$			
00D3$_{16}$			
00D4$_{16}$	A/D control register 2	ADCON2	XXXX0000$_2$
00D5$_{16}$			
00D6$_{16}$	A/D control register 0	ADCON0	00000XXX$_2$
00D7$_{16}$	A/D control register 1	ADCON1	00$_{16}$
00D8$_{16}$	D/A register	DA	XX$_{16}$
00D9$_{16}$			
00DA$_{16}$			
00DB$_{16}$			
00DC$_{16}$	D/A control register	DACON	XXXXX0X0$_2$
00DD$_{16}$			
00DE$_{16}$			
00DF$_{16}$			
00E0$_{16}$	Port P0 register	P0	XX$_{16}$
00E1$_{16}$	Port P1 register	P1	XX$_{16}$
00E2$_{16}$	Port P0 direction register	PD0	00$_{16}$
00E3$_{16}$	Port P1 direction register	PD1	00$_{16}$
00E4$_{16}$	Port P2 register	P2	XX$_{16}$
00E5$_{16}$	Port P3 register	P3	XX$_{16}$
00E6$_{16}$	Port P2 direction register	PD2	XXXXXX00$_2$
00E7$_{16}$	Port P3 direction register	PD3	00$_{16}$
00E8$_{16}$	Port P4 register	P4	XX$_{16}$
00E9$_{16}$	Port P5 register	P5	XX$_{16}$
00EA$_{16}$	Port P4 direction register	PD4	00$_{16}$
00EB$_{16}$	Port P5 direction register	PD5	XXXXX000$_2$
00EC$_{16}$			
00ED$_{16}$			
00EE$_{16}$			
00EF$_{16}$			
00F0$_{16}$			
00F1$_{16}$			
00F2$_{16}$			
00F3$_{16}$			
00F4$_{16}$			
00F5$_{16}$			
00F6$_{16}$			
00F7$_{16}$			
00F8$_{16}$	CAN0 I/O port select register	CIOSR	XXXXXXX0$_2$
00F9$_{16}$			
00FA$_{16}$			
00FB$_{16}$			
00FC$_{16}$	Pull-up control register 0	PUR0	00X00000$_2$
00FD$_{16}$	Pull-up control register 1	PUR1	XXXXX000$_2$
00FE$_{16}$	Port P1 drive capacity control register	DRR	00$_{16}$
00FF$_{16}$			

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X : Undefined

Address	Register	Symbol	After reset
0280$_{16}$	CAN0 slot 2: Identifier / DLC		XX$_{16}$
0281$_{16}$			XX$_{16}$
0282$_{16}$			XX$_{16}$
0283$_{16}$			XX$_{16}$
0284$_{16}$			XX$_{16}$
0285$_{16}$			XX$_{16}$
0286$_{16}$	CAN0 slot 2: Data Field		XX$_{16}$
0287$_{16}$			XX$_{16}$
0288$_{16}$			XX$_{16}$
0289$_{16}$			XX$_{16}$
028A$_{16}$			XX$_{16}$
028B$_{16}$			XX$_{16}$
028C$_{16}$			XX$_{16}$
028D$_{16}$			XX$_{16}$
028E$_{16}$	CAN0 slot 2: Time Stamp		XX$_{16}$
028F$_{16}$			XX$_{16}$
0290$_{16}$	CAN0 slot 3: Identifier / DLC		XX$_{16}$
0291$_{16}$			XX$_{16}$
0292$_{16}$			XX$_{16}$
0293$_{16}$			XX$_{16}$
0294$_{16}$			XX$_{16}$
0295$_{16}$			XX$_{16}$
0296$_{16}$	CAN0 slot 3: Data Field		XX$_{16}$
0297$_{16}$			XX$_{16}$
0298$_{16}$			XX$_{16}$
0299$_{16}$			XX$_{16}$
029A$_{16}$			XX$_{16}$
029B$_{16}$			XX$_{16}$
029C$_{16}$			XX$_{16}$
029D$_{16}$			XX$_{16}$
029E$_{16}$	CAN0 slot 3: Time Stamp		XX$_{16}$
029F$_{16}$			XX$_{16}$
02A0$_{16}$	CAN0 slot 4: Identifier / DLC		XX$_{16}$
02A1$_{16}$			XX$_{16}$
02A2$_{16}$			XX$_{16}$
02A3$_{16}$			XX$_{16}$
02A4$_{16}$			XX$_{16}$
02A5$_{16}$			XX$_{16}$
02A6$_{16}$	CAN0 slot 4: Data Field		XX$_{16}$
02A7$_{16}$			XX$_{16}$
02A8$_{16}$			XX$_{16}$
02A9$_{16}$			XX$_{16}$
02AA$_{16}$			XX$_{16}$
02AB$_{16}$			XX$_{16}$
02AC$_{16}$			XX$_{16}$
02AD$_{16}$			XX$_{16}$
02AE$_{16}$	CAN0 slot 4: Time Stamp		XX$_{16}$
02AF$_{16}$			XX$_{16}$
02B0$_{16}$	CAN0 slot 5: Identifier / DLC		XX$_{16}$
02B1$_{16}$			XX$_{16}$
02B2$_{16}$			XX$_{16}$
02B3$_{16}$			XX$_{16}$
02B4$_{16}$			XX$_{16}$
02B5$_{16}$			XX$_{16}$
02B6$_{16}$	CAN0 slot 5: Data Field		XX$_{16}$
02B7$_{16}$			XX$_{16}$
02B8$_{16}$			XX$_{16}$
02B9$_{16}$			XX$_{16}$
02BA$_{16}$			XX$_{16}$
02BB$_{16}$			XX$_{16}$
02BC$_{16}$			XX$_{16}$
02BD$_{16}$			XX$_{16}$
02BE$_{16}$	CAN0 slot 5: Time Stamp		XX$_{16}$
02BF$_{16}$			XX$_{16}$

Note 1: Location in the SFR area where nothing is allocated are reserved areas. Do not access these areas for read or write.

X : Undefined

Address	Register	Symbol	After reset
02C0$_{16}$	CAN0 slot 6: Identifier / DLC		XX$_{16}$
02C1$_{16}$			XX$_{16}$
02C2$_{16}$			XX$_{16}$
02C3$_{16}$			XX$_{16}$
02C4$_{16}$			XX$_{16}$
02C5$_{16}$			XX$_{16}$
02C6$_{16}$	CAN0 slot 6: Data Field		XX$_{16}$
02C7$_{16}$			XX$_{16}$
02C8$_{16}$			XX$_{16}$
02C9$_{16}$			XX$_{16}$
02CA$_{16}$			XX$_{16}$
02CB$_{16}$			XX$_{16}$
02CC$_{16}$			XX$_{16}$
02CD$_{16}$			XX$_{16}$
02CE$_{16}$	CAN0 slot 6: Time Stamp		XX$_{16}$
02CF$_{16}$			XX$_{16}$
02D0$_{16}$	CAN0 slot 7: Identifier / DLC		XX$_{16}$
02D1$_{16}$			XX$_{16}$
02D2$_{16}$			XX$_{16}$
02D3$_{16}$			XX$_{16}$
02D4$_{16}$			XX$_{16}$
02D5$_{16}$			XX$_{16}$
02D6$_{16}$	CAN0 slot 7: Data Field		XX$_{16}$
02D7$_{16}$			XX$_{16}$
02D8$_{16}$			XX$_{16}$
02D9$_{16}$			XX$_{16}$
02DA$_{16}$			XX$_{16}$
02DB$_{16}$			XX$_{16}$
02DC$_{16}$			XX$_{16}$
02DD$_{16}$			XX$_{16}$
02DE$_{16}$	CAN0 slot 7: Time Stamp		XX$_{16}$
02DF$_{16}$			XX$_{16}$
02E0$_{16}$	CAN0 slot 8: Identifier / DLC		XX$_{16}$
02E1$_{16}$			XX$_{16}$
02E2$_{16}$			XX$_{16}$
02E3$_{16}$			XX$_{16}$
02E4$_{16}$			XX$_{16}$
02E5$_{16}$			XX$_{16}$
02E6$_{16}$	CAN0 slot 8: Data Field		XX$_{16}$
02E7$_{16}$			XX$_{16}$
02E8$_{16}$			XX$_{16}$
02E9$_{16}$			XX$_{16}$
02EA$_{16}$			XX$_{16}$
02EB$_{16}$			XX$_{16}$
02EC$_{16}$			XX$_{16}$
02ED$_{16}$			XX$_{16}$
02EE$_{16}$	CAN0 slot 8: Time Stamp		XX$_{16}$
02EF$_{16}$			XX$_{16}$
02F0$_{16}$	CAN0 slot 9: Identifier / DLC		XX$_{16}$
02F1$_{16}$			XX$_{16}$
02F2$_{16}$			XX$_{16}$
02F3$_{16}$			XX$_{16}$
02F4$_{16}$			XX$_{16}$
02F5$_{16}$			XX$_{16}$
02F6$_{16}$	CAN0 slot 9: Data Field		XX$_{16}$
02F7$_{16}$			XX$_{16}$
02F8$_{16}$			XX$_{16}$
02F9$_{16}$			XX$_{16}$
02FA$_{16}$			XX$_{16}$
02FB$_{16}$			XX$_{16}$
02FC$_{16}$			XX$_{16}$
02FD$_{16}$			XX$_{16}$
02FE$_{16}$	CAN0 slot 9: Time Stamp		XX$_{16}$
02FF$_{16}$			XX$_{16}$

Note 1: Location in the SFR area where nothing is allocated are reserved areas. Do not access these areas for read or write.

X : Undefined

5. Electrical Characteristics

Table 5.1 Absolute maximum ratings

Symbol	Parameter		Condition	Rated value	Unit
V_{CC}	Supply voltage			- 0.3 to 6.5	V
V_I	Input voltage	$\overline{RESET}$, V_{REF}, X_{IN} $P0_0$ to $P0_7$, $P1_0$ to $P1_7$, $P2_0$, $P2_1$, $P3_0$ to $P3_7$, $P4_0$ to $P4_7$, $P5_0$ to $P5_2$, CNVss (Note 1)		- 0.3 to Vcc + 0.3	V
V_O	Output voltage	$P0_0$ to $P0_7$, $P1_0$ to $P1_7$, $P2_0$, $P2_1$, $P3_0$ to $P3_7$, $P4_0$ to $P4_7$, $P5_0$ to $P5_2$, X_{OUT}		- 0.3 to Vcc + 0.3	V
		IV_{CC}		- 0.3 to 2.8V	V
P_d	Power dissipation		Topr = 25 °C	300	mW
T_{opr}	Operating ambient temperature			- 40 to 85 (Note 2)	°C
T_{stg}	Storage temperature			- 65 to 150	°C

Note 1: CNVSS pin of flash memory version: -0.3 to 6.5 V

Note 2: When flash memory version is program/erase mode: 0 to 60 °C

Table 5.2 Recommended operating conditions
(Unless otherwise noted: Vcc = 4.2V to 5.5V, Topr = -40 to 85°C)

Symbol	Parameter			Standard			Unit
				Min	Typ.	Max.	
Vcc	Supply voltage			4.2	5.0	5.5	V
Vss	Supply voltage				0		V
VIH	HIGH input voltage	P00 to P07, P10 to P17, P20, P21, P30 to P37, P40 to P47, P50 to P52, XIN, RESET, CNVSS		0.8Vcc		Vcc	V
VIL	LOW input voltage	P00 to P07, P10 to P17, P20, P21, P30 to P37, P40 to P47, P50 to P52, XIN, RESET, CNVSS		0		0.2Vcc	V
IOH (peak)	HIGH peak output current	P00 to P07, P10 to P17, P20, P21, P30 to P37, P40 to P47, P50 to P52				- 10.0	mA
IOH (avg)	HIGH average output current	P00 to P07, P10 to P17, P20, P21, P30 to P37, P40 to P47, P50 to P52				- 5.0	mA
IOL (peak)	LOW peak output current	P00 to P07, P20, P21, P30 to P37, P40 to P47, P50 to P52				10.0	mA
		P10 to P17	HIGH POWER			20.0	mA
			LOW POWER			10.0	
IOL (avg)	LOW average output current	P00 to P07, P20, P21, P30 to P37, P40 to P47, P50 to P52				5.0	mA
		P10 to P17	HIGH POWER			10.0	mA
			LOW POWER			5.0	
f (XIN)	Main clock input oscillation frequency (Note 3)		Vcc=4.2V to 5.5V	0		16	MHz
f (XCIN)	Subclock oscillation frequency				32.768	50	kHz

Note 1: The average output current is an average value measured over 100ms.

Note 2: Keep output current as follows:

The sum of port P00 to P03, P13 to P17, P21, P34 to P37, P46, P47, P50 to P52 IOL (peak) is under 60 mA. The sum of port P00 to P03, P13 to P17, P21, P34 to P37, P46, P47, P50 to P52 IOH (peak) is under 60 mA. The sum of port P04 to P07, P10 to P12, P20, P30 to P33, P40 to P45 IOL (peak) is under 60 mA. The sum of port P04 to P07, P10 to P12, P20, P30 to P33, P40 to P45 IOH (peak) is under 60 mA.

Note 3: Relationship between main clock oscillation frequency and supply voltage is shown as below.

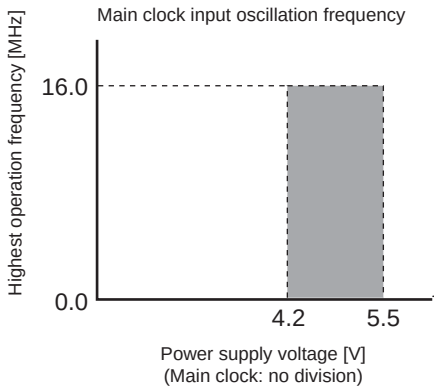


Table 5.3 Electrical characteristics (1)
(Unless otherwise noted: V_{CC} = 5V, V_{SS} = 0V at Topr = -40 to 85°C, f(X_{IN}) = 16MHz)

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 $P2_1$, $P3_0$ to $P3_7$,$P4_0$ to $P4_7$,$P5_0$ to $P5_2$		I_{OH} = - 5 mA	3.0			V
			I_{OH} = - 200 µA	4.7			
V_{OH}	HIGH output voltage X_{OUT}	HIGH POWER	I_{OH} = - 1 mA	3.0			V
		LOW POWER	I_{OH} = - 0.5 mA	3.0			
V_{OH}	HIGH output voltage X_{COUT}	HIGH POWER	No load		2.5		V
		LOW POWER	No load		1.6		
V_{OL}	LOW output voltage $P0_0$ to $P0_7$,$P2_0$,$P2_1$,$P3_0$ to $P3_7$, $P4_0$ to $P4_7$,$P5_0$ to $P5_2$		I_{OL} = 5 mA			2.0	V
			I_{OL} = 200 µA			0.45	
V_{OL}	LOW output voltage $P1_0$ to $P1_7$	HIGH POWER	I_{OL} = 10 mA			2.0	V
		LOW POWER	I_{OL} = 5 mA			2.0	
V_{OL}	LOW output voltage X_{OUT}	HIGH POWER	I_{OH} = 1 mA			2.0	V
		LOW POWER	I_{OH} = 0.5 mA			2.0	
V_{OL}	LOW output voltage X_{COUT}	HIGH POWER	No load		0		V
		LOW POWER	No load		0		
V_{T+} -V_{T-}	Hysteresis $\overline{CNTR_0}$,$\overline{TCIN}$, $\overline{INT_0}$ to $\overline{INT_3}$,$\overline{CLK_0}$,$\overline{CLK_1}$,$P4_5$ RxD_0,RxD_1,$\overline{KI_0}$ to $\overline{KI_3}$,CRX_0			0.2		0.8	V
V_{T+} -V_{T-}	Hysteresis $\overline{RESET}$			0.2		1.8	V
I_{IH}	HIGH input current $P0_0$ to $P0_7$,$P1_0$ to $P1_7$,$P2_0$,$P2_1$, $P3_0$ to $\overline{P3_7}$,$P4_0$ to $P4_7$,$P5_0$ to $P5_2$, X_{IN},$\overline{RESET}$,CNVss		V_I = 5V			5.0	µA
I_{IL}	LOW input current $P0_0$ to $P0_7$,$P1_0$ to $P1_7$,$P2_0$,$P2_1$, $P3_0$ to $\overline{P3_7}$,$P4_0$ to $P4_7$,$P5_0$ to $P5_2$, X_{IN},$\overline{RESET}$,CNVss		V_I = 0V			-5.0	µA
R_{PULLUP}	Pull-up resistor $P0_0$ to $P0_7$,$P1_0$ to $P1_7$,$P2_0$,$P2_1$, $P3_0$ to $P3_7$,$P4_0$ to $P4_7$,$P5_0$ to $P5_2$		V_I = 0V	30.0	50.0	167.0	kΩ
R_{fXIN}	Feedback resistor X_{IN}				1.0		MΩ
R_{fXCIN}	Feedback resistor X_{CIN}				15.0		MΩ
V_{RAM}	RAM retention voltage		When clock is stopped	2.0			V
R_{OSC}	Oscillation frequency of On-chip oscillator	Mask ROM		300	600	1200	kHz
		Flash memory					

Table 5.6 Flash memory version electrical characteristics
(Unless otherwise noted: Vcc = 4.2 to 5.5 V, Topr= 0 to 60°C)

Symbol	Parameter		Standard			Unit
			Min.	Typ. (Note 1)	Max.	
-	Erase/write cycle (Note 2)		100 (Note 3)			cycle
-	Word programming time			75	600	µs
-	Block erasing time	2Kbyte block		0.2	9	s
		8Kbyte block		0.4	9	s
		16Kbyte block		0.7	9	s
		32Kbyte block		1.2	9	s
td(SR-ES)	Transition time from erasure operation to erase-suspend				20	ms
-	Data retention		10			year

Note1: Vcc=5.0V, Topr=25°C
Note2: Definition of Programming and erasure times
The Programming and erasure times are defined to be per-block erasure times. For example a case where a 2K-byte block is programmed in 1,024 operations by writing one word at a time and erased thereafter. Performing multiple programs to the same address before an erase operation is prohibited.
Note 3: Minimum number of programming/erasure for which operation is guaranteed.

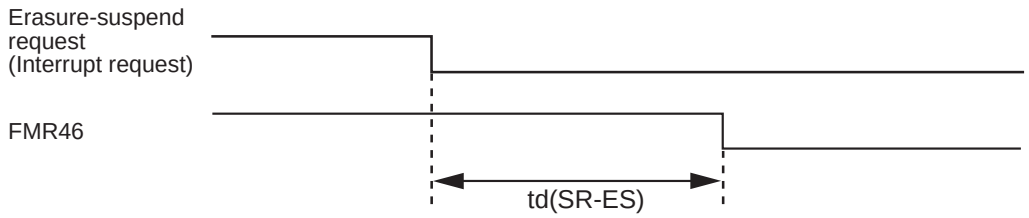


Table 5.7 A/D conversion characteristics
(Unless otherwise noted: V_{CC} = V_{REF} = 5V, V_{SS} = 0V at Topr = 25°C, f(X_{IN}) = 16MHz)

Symbol	Parameter		Measuring condition		Standard			Unit
					Min.	Typ.	Max.	
–	Resolution		V_{REF} =V_{CC}				10	Bits
–	Absolute accuracy	Sample & hold function not available	V_{REF} =V_{CC} = 5V				±3	LSB
		Sample & hold function available(10bit)	V_{REF} =V_{CC} = 5V	AN_0 to AN_{11} input			±3	LSB
				$ANEX_0$, $ANEX_1$ input, external op-amp connected mode			±7	LSB
		Sample & hold function available(8bit)	V_{REF} =V_{CC} = 5V				±2	LSB
R_{LADDER}	Ladder resistance		V_{REF} =V_{CC}		10		40	kΩ
t_{CONV}	Conversion time(10bit)		f(X_{IN})=10MHz, $Ø_{AD}$=f_{AD}=10MHz		3.3			µs
t_{CONV}	Conversion time(8bit)		f(X_{IN})=10MHz, $Ø_{AD}$=f_{AD}=10MHz		2.8			µs
t_{SAMP}	Sampling time		f(X_{IN})=10MHz, $Ø_{AD}$=f_{AD}=10MHz		0.3			µs
V_{REF}	Reference voltage		f(X_{IN})=10MHz, $Ø_{AD}$=f_{AD}=10MHz		2		V_{CC}	V
V_{IA}	Analog input voltage		f(X_{IN})=10MHz, $Ø_{AD}$=f_{AD}=10MHz		0		V_{REF}	V

Note 1: Divide the f_{AD} if f(X_{IN}) exceeds 10MHz, and make AD operation clock frequency ($Ø_{AD}$) equal to or lower than 10MHz.

Table 5.8 D/A conversion characteristics
(Unless otherwise noted: V_{CC} = V_{REF} = 5V, V_{SS} = 0V at Topr = 25°C, f(X_{IN}) = 16MHz)

Symbol	Parameter	Measuring condition	Standard			Unit
			Min.	Typ.	Max.	
–	Resolution				8	Bits
–	Absolute accuracy				1.0	%
t_{su}	Setup time				3	µs
R_O	Output resistance		4	10	20	kΩ
I_{VREF}	Reference power supply input current	(Note 1)			1.5	mA

Note 1: The A/D converter's ladder resistance is not included.
When D/A register contents are not "00$_{16}$", the current I_{VREF} always flows even though V_{REF} may have been set to be unconnected by the A/D control register.

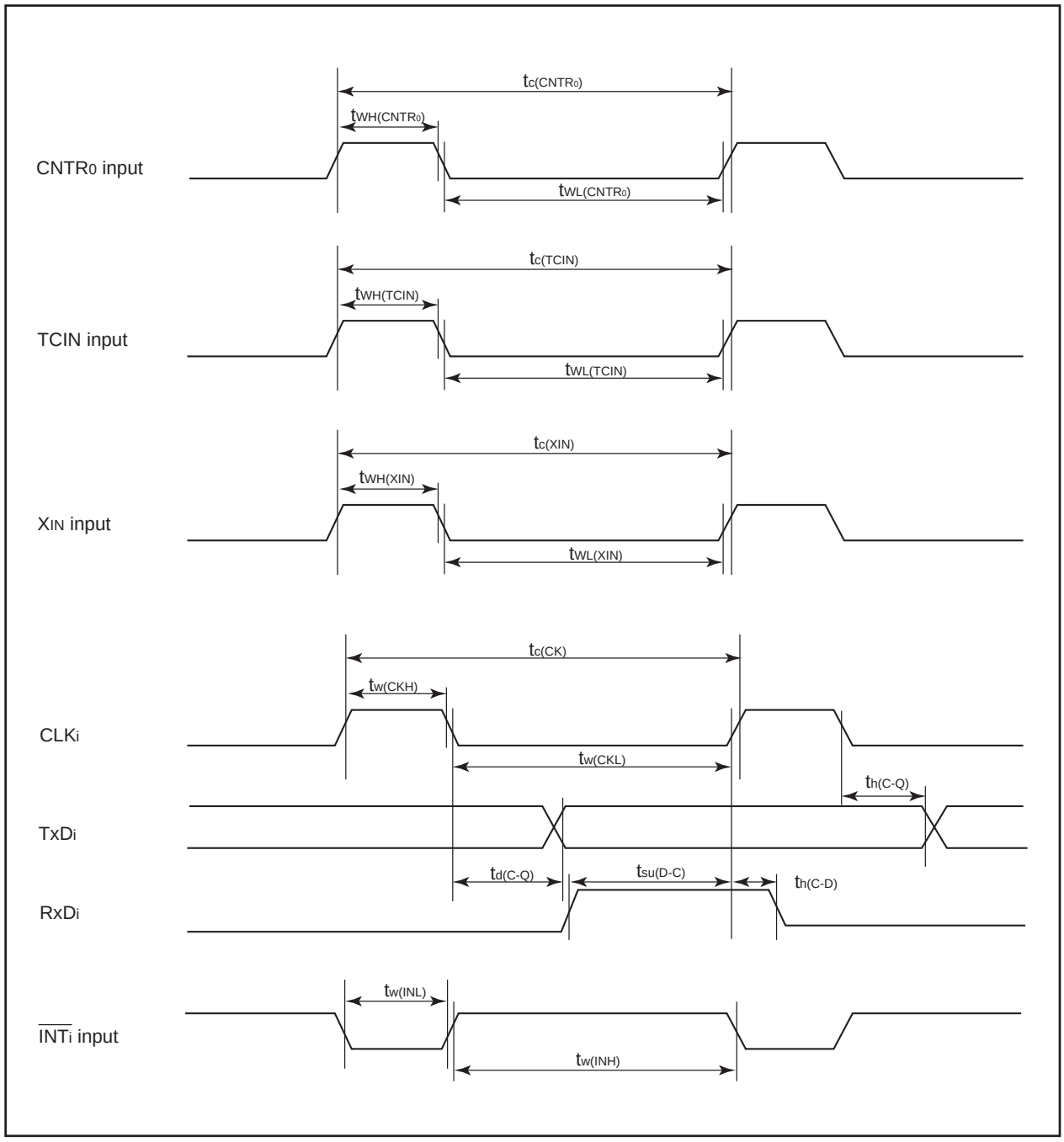


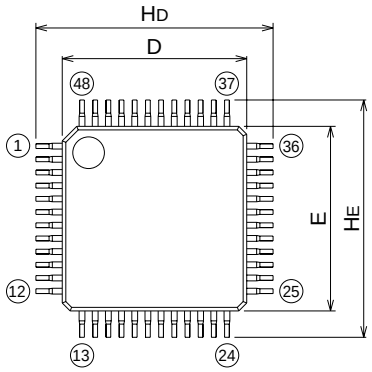
Figure 5.2 Vcc=5V timing diagram

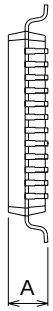
Package Dimension

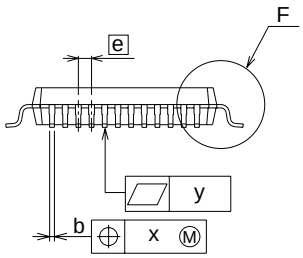
48P6Q-A Recommended

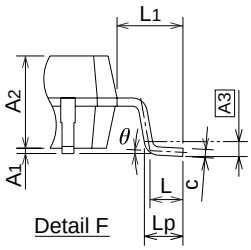
Plastic 48pin 7×7mm body LQFP

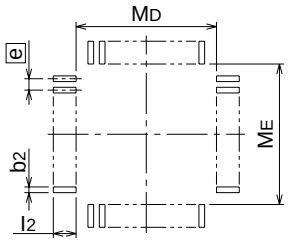
EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
LQFP48-P-77-0.50	–	–	Cu Alloy











Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	–	–	1.7
A1	0	0.1	0.2
A2	–	1.4	–
b	0.17	0.22	0.27
c	0.105	0.125	0.175
D	6.9	7.0	7.1
E	6.9	7.0	7.1
e	–	0.5	–
HD	8.8	9.0	9.2
HE	8.8	9.0	9.2
L	0.35	0.5	0.65
L1	–	1.0	–
Lp	0.45	0.6	0.75
A3	–	0.25	–
x	–	–	0.08
y	–	–	0.1
θ	0°	–	8°
b2	–	0.225	–
I2	1.0	–	–
MD	–	7.4	–
ME	–	7.4	–

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Rev.	Date	Description	
		Page	Summary
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