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April 1st, 2010
Renesas Electronics Corporation

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RENESAS

MOS INTEGRATED CIRCUIT

PD75P3116

4-BIT SINGLE-CHIP MICROCONTROLLER

The PD75P3116 replaces the PD753108's internal mask ROM with a one-time PROM, and features expanded ROM capacity.

Because the PD75P3116 supports programming by users, it is suitable for use in evaluation of systems in the development stage using the PD753104, 753106, or 753108, and for use in small-scale production.

Detailed information about functions is provided in the following User's Manual. Be sure to read it before designing:

PD753108 User's Manual: U10890E

FEATURES

- ○ Compatible with PD753108
- ○ Memory capacity:
  - PROM: 16384 8 bits
  - RAM: 512 4 bits
- ○ Can be operated in same power supply voltage range as the mask version PD753108
  - V_{DD} = 1.8 to 5.5 V
- ○ On-chip LCD controller/driver
- ○ QTOP™ microcontroller

Remark QTOP microcontrollers are microcontrollers with on-chip one-time PROM that are totally supported by NEC Electronics. This support includes writing application programs, marking, screening, and verification.

ORDERING INFORMATION

	Part Number	Package
	PD75P3116GC-AB8	64-pin plastic QFP (14 14)
	PD75P3116GK-8A8	64-pin plastic LQFP (12 12)
★	PD75P3116GC-8BS	64-pin plastic LQFP (14 14)
★	PD75P3116GC-8BS-A	64-pin plastic LQFP (14 14)

Caution This device does not provide an internal pull-up resistor connection function by means of mask option.

Remark Products with "-A" at the end of the part number are lead-free products.

Document No. U11369EJ3V1DS00 (3rd edition)
Date Published August 2005 N CP(K)
Printed in Japan

The mark ★ shows major revised points.

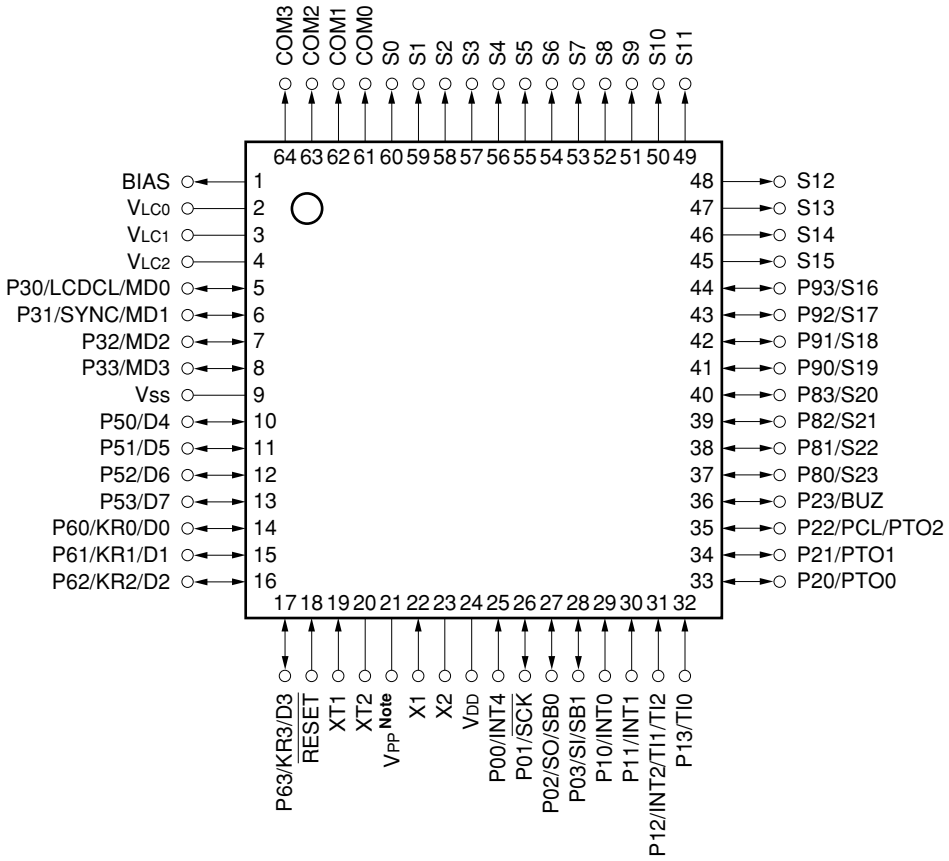
FUNCTION OUTLINE

Item		Function	
Instruction execution time		• 0.95, 1.91, 3.81, or 15.3 μs (main system clock: @ 4.19 MHz) • 0.67, 1.33, 2.67, or 10.7 μs (main system clock: @ 6.0 MHz) • 122 μs (subsystem clock: @ 32.768 kHz)	
Internal memory	PROM	16384 × 8 bits	
	RAM	512 × 4 bits	
General-purpose registers		• 4-bit manipulation: 8 × 4 banks • 8-bit manipulation: 4 × 4 banks	
I/O ports	CMOS input	8	Internal pull-up resistor connection can be specified by software setting: 7
	CMOS I/O	20	Internal pull-up resistor connection can be specified by software setting: 12 Shared with segment pins: 8
	N-ch open-drain I/O	4	13 V withstanding voltage
	Total	32	
LCD controller/driver		• Segment number selection: 16/20/24 segments (switchable to CMOS I/O ports in a batch of 4 pins, max. 8 pins) • Display mode selection: Static, 1/2 duty (1/2 bias), 1/3 duty (1/2 bias), 1/3 duty (1/3 bias), 1/4 duty (1/3 bias)	
Timers		5 channels: • 8-bit timer/event counter: 3 channels (Can be used as 16-bit timer/event counter, carrier generator, and timer with gate) • Basic interval timer/watchdog timer: 1 channel • Watch timer: 1 channel	
Serial interface		• 3-wire serial I/O mode ··· MSB/LSB first switchable • 2-wire serial I/O mode • SBI mode	
Bit sequential buffer (BSB)		16 bits	
Clock output (PCL)		Φ, 524, 262, and 65.5 kHz (main system clock: @ 4.19 MHz) Φ, 750, 375, and 93.8 kHz (main system clock: @ 6.0 MHz)	
Buzzer output (BUZ)		• 2, 4, and 32 kHz (main system clock: @ 4.19 MHz or subsystem clock: @ 32.768 kHz) • 2.93, 5.86, 46.9 kHz (main system clock: @ 6.0 MHz)	
Vectored interrupts		• External: 3 • Internal: 5	
Test inputs		• External: 1 • Internal: 1	
System clock oscillator		• Ceramic/crystal oscillator for main system clock • Crystal oscillator for subsystem clock	
Standby function		STOP/HALT mode	
Power supply voltage		V_{DD} = 1.8 to 5.5 V	
★ Package		• 64-pin plastic QFP (14 × 14) • 64-pin plastic LQFP (12 × 12) • 64-pin plastic LQFP (14 × 14)	

CONTENTS

1. PIN CONFIGURATION (TOP VIEW)

- 64-pin plastic QFP (14 × 14): μPD75P3116GC-AB8
- 64-pin plastic LQFP (12 × 12): μPD75P3116GK-8A8
- ★ 64-pin plastic LQFP (14 × 14): μPD75P3116GC-8BS, 75P3116GC-8BS-A

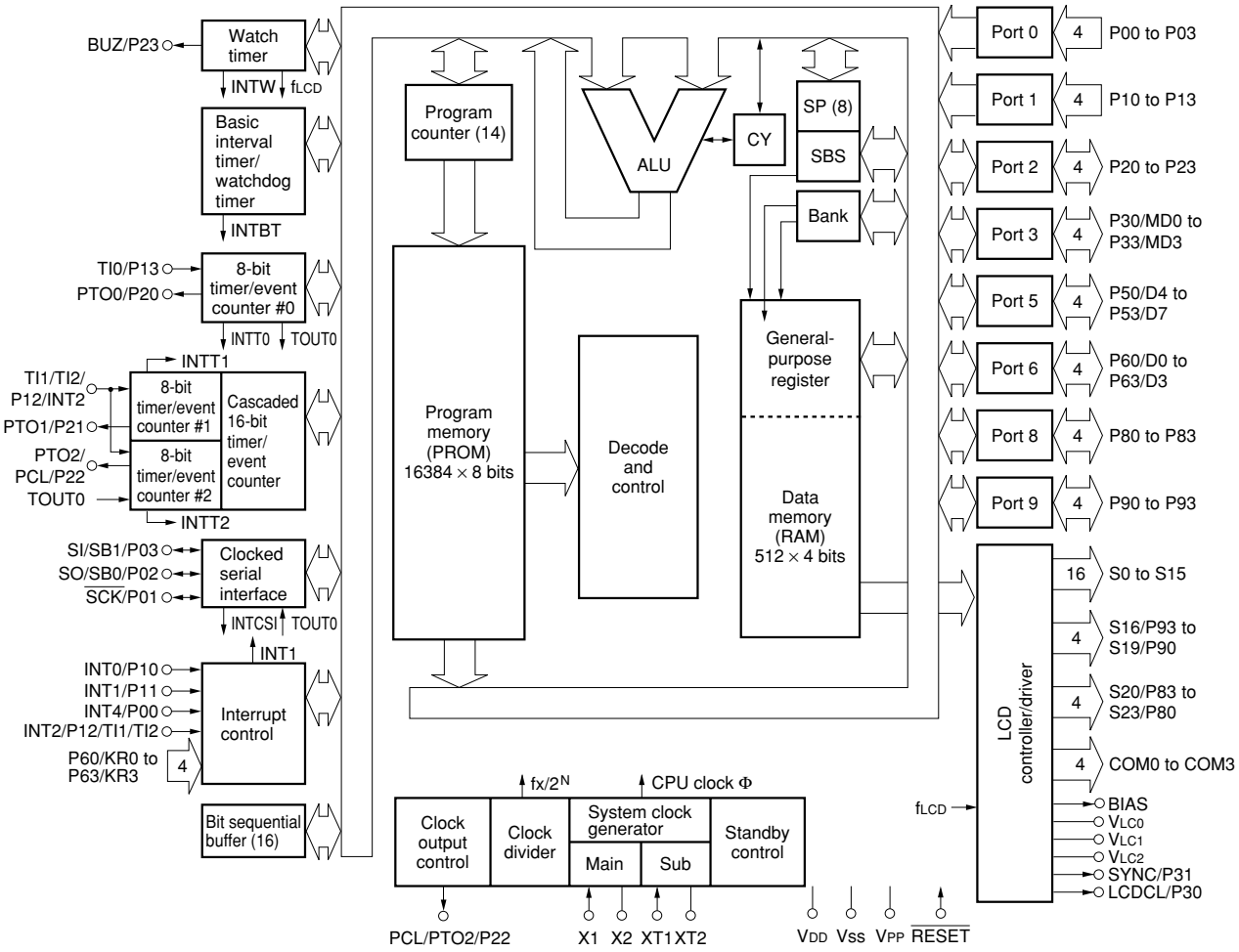


Note Always connect the V_{PP} pin directly to V_{DD} during normal operation.

PIN IDENTIFICATIONS

P00 to P03:	Port 0
P10 to P13:	Port 1
P20 to P23:	Port 2
P30 to P33:	Port 3
P50 to P53:	Port 5
P60 to P63:	Port 6
P80 to P83:	Port 8
P90 to P93:	Port 9
KR0 to KR3:	Key return 0 to 3
$\overline{SCK}$:	Serial clock
SI:	Serial input
SO:	Serial output
SB0, SB1:	Serial data bus 0, 1
$\overline{RESET}$:	Reset
MD0 to MD3:	Mode selection 0 to 3
D0 to D7:	Data bus 0 to 7
S0 to S23:	Segment output 0 to 23
COM0 to COM3:	Common output 0 to 3
V_{LC0} to V_{LC2}:	LCD power supply 0 to 2
BIAS:	LCD power supply bias control
LCDCL:	LCD clock
SYNC:	LCD synchronization
TI0 to TI2:	Timer input 0 to 2
PTO0 to PTO2:	Programmable timer output 0 to 2
BUZ:	Buzzer clock
PCL:	Programmable clock
INT0, 1, 4:	External vectored interrupt 0, 1, 4
INT2:	External test input 2
X1, X2:	Main system clock oscillation 1, 2
XT1, XT2:	Subsystem clock oscillation 1, 2
V_{PP}:	Programming power supply
V_{DD}:	Positive power supply
Vss:	Ground

2. BLOCK DIAGRAM



3. PIN FUNCTIONS

3.1 Port Pins (1/2)

Pin Name	I/O	Alternate Function	Function	8-Bit I/O	Status After Reset	I/O Circuit Type[Note 1]
P00	Input	INT4	4-bit input port (Port 0) Connection of an internal pull-up resistor can be specified by a software setting in 3-bit units.	—	Input	<B>
★ P01		$\overline{SCK}$				<F>-A
★ P02		SO/SB0				<F>-B
★ P03		SI/SB1				<M>-C
P10	Input	INT0	4-bit input port (Port 1) Connection of an internal pull-up resistor can be specified by a software setting in 4-bit units. P10/INT0 can be used to select a noise eliminator.	—	Input	<B>-C
P11		INT1				
P12		TI1/TI2/INT2				
P13		TI0				
P20	I/O	PTO0	4-bit I/O port (Port 2) Connection of an internal pull-up resistor can be specified by a software setting in 4-bit units.	—	Input	E-B
P21		PTO1				
P22		PCL/PTO2				
P23		BUZ				
P30	I/O	LCDCL/MD0	Programmable 4-bit I/O port (Port 3) Input and output can be specified in 1-bit units. Connection of an internal pull-up resistor can be specified by a software setting in 4-bit units.	—	Input	E-B
P31		SYNC/MD1				
P32		MD2				
P33		MD3				
P50[Note 2]	I/O	D4	N-ch open-drain 4-bit I/O port (Port 5) When set to open-drain, the withstanding voltage is 13 V.	—	High impedance	M-E
P51[Note 2]		D5				
P52[Note 2]		D6				
P53[Note 2]		D7				

Notes 1. Circuit types enclosed in angle brackets indicate Schmitt-triggered input.

2. The low-level input leakage current increases when input instructions or bit manipulation instructions are executed.

3.1 Port Pins (2/2)

Pin Name	I/O	Alternate Function	Function	8-Bit I/O	Status After Reset	I/O Circuit Type[Note 1]
P60	I/O	KR0/D0	Programmable 4-bit I/O port (Port 6) Input and output can be specified in 1-bit units. Connection of an internal pull-up resistor can be specified by a software setting in 4-bit units.	—	Input	<F>-A
P61		KR1/D1				
P62		KR2/D2				
P63		KR3/D3				
P80	I/O	S23	4-bit I/O port (Port 8) Connection of an internal pull-up resistor can be specified by a software setting in 4-bit units[Note 2].	√	Input	H
P81		S22				
P82		S21				
P83		S20				
P90	I/O	S19	Programmable 4-bit I/O port (Port 9) Connection of an internal pull-up resistor can be specified by a software setting in 4-bit units[Note 2].		Input	H
P91		S18				
P92		S17				
P93		S16				

Notes 1. Circuit types enclosed in angle brackets indicate Schmitt-triggered input.

2. Do not connect an internal pull-up resistor by software when these pins are used as segment signal outputs.

3.2 Non-Port Pins (1/2)

Pin Name	I/O	Alternate Function	Function		Status After Reset	I/O Circuit Type[Note 1]
TI0	Input	P13	External event pulse input to timer/event counter		Input	<B>-C
TI1		P12/INT2/TI2				
TI2		P12/INT2/TI1				
PTO0	Output	P20	Timer/event counter output		Input	E-B
PTO1		P21				
PTO2		P22/PCL				
PCL		P22/PTO2	Clock output			
BUZ		P23	Frequency output (for buzzer or system clock trimming)			
$\overline{SCK}$	I/O	P01	Serial clock I/O		Input	<F>-A
SO/SB0		P02	Serial data output Serial data bus I/O			<F>-B
SI/SB1		P03	Serial data input Serial data bus I/O			<M>-C
INT4	Input	P00	Edge detection vectored interrupt input (valid for detecting both rising and falling edges)			<B>
INT0	Input	P10	Edge detection vectored interrupt input (detection edge is selectable) INT0/P10 can be used to select a noise eliminator.	With noise eliminator/ asynchronous is selectable	Input	<B>-C
INT1		P11		Asynchronous		
INT2	Input	P12/TI1/TI2	Rising edge detection testable input	Asynchronous		
KR0 to KR3	I/O	P60 to P63	Parallel falling edge detection testable input		Input	<F>-A
X1	Input	—	Ceramic/crystal resonator connection for main system clock oscillation. If using an external clock, input the signal to X1 and input the inverted signal to X2.		—	—
X2	—					
XT1	Input	—	Crystal resonator connection for subsystem clock oscillation. If using an external clock, input the signal to XT1 and input the inverted signal to XT2. XT1 can be used as a 1-bit (test) input.		—	—
XT2	—					
$\overline{RESET}$	Input	—	System reset input (low-level active)		—	<B>
MD0 to MD3	Input	P30 to P33	Mode selection for program memory (PROM) write/verify		Input	E-B
D0 to D3	I/O	P60/KR0 to P63/KR3	Data bus for program memory (PROM) write/verify		Input	<F>-A
D4 to D7		P50 to P53				M-E
V_{PP}[Note 2]	—	—	Programmable power supply voltage applied for program memory (PROM) write/verify. During normal operation, connect directly to V_{DD}. Apply +12.5 V for PROM write/verify.		—	—
V_{DD}	—	—	Positive power supply		—	—
Vss	—	—	Ground potential		—	—

Notes 1. Circuit types enclosed in angle brackets indicate Schmitt-triggered input.

2. The V_{PP} pin does not operate correctly when it is not connected to the V_{DD} pin during normal operation.

3.2 Non-Port Pins (2/2)

Pin Name	I/O	Alternate Function	Function	Status After Reset	I/O Circuit Type
S0 to S15	Output	—	Segment signal output	**Note 1**	G-A
S16 to S19	Output	P93 to P90	Segment signal output	Input	H
S20 to S23	Output	P83 to P80	Segment signal output	Input	H
COM0 to COM3	Output	—	Common signal output	**Note 1**	G-B
V_{LC0} to V_{LC2}	—	—	Power supply for driving LCD	—	—
BIAS	Output	—	Output for external split resistor cut	**Note 2**	—
LCDCL**Note 3**	Output	P30/MD0	Clock output for driving external expansion driver	Input	E-B
SYNC**Note 3**	Output	P31/MD1	Clock output for synchronization of external expansion driver	Input	E-B

Notes 1. V_{LCX} (X = 0, 1, 2) is selected as the input source for the display outputs as shown below.
S0 to S23: V_{LC1}, COM0 to COM2: V_{LC2}, COM3: V_{LC0}

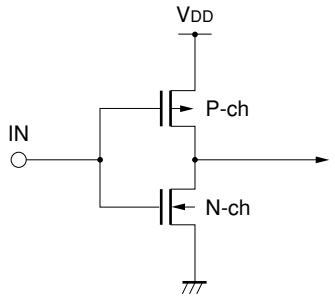
2. When the split resistor is incorporated: Low level
When the split resistor is not incorporated: High impedance

3. These pins are provided for future system expansion. Currently, only P30 and P31 are used.

3.3 Pin I/O Circuits

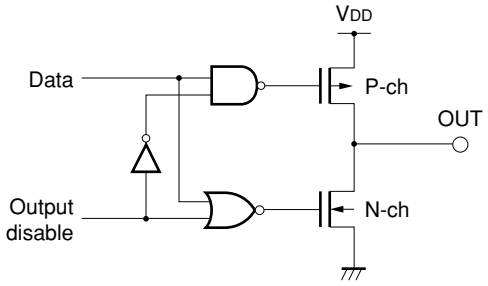
The I/O circuits for the μPD75P3116's pins are shown in abbreviated form below.

Type A



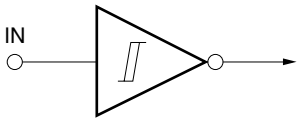
CMOS standard input buffer

Type D



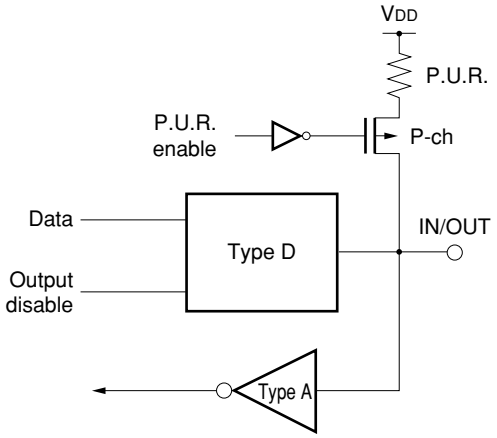
Push-pull output that can be set to high impedance output (with both P-ch and N-ch OFF).

Type B



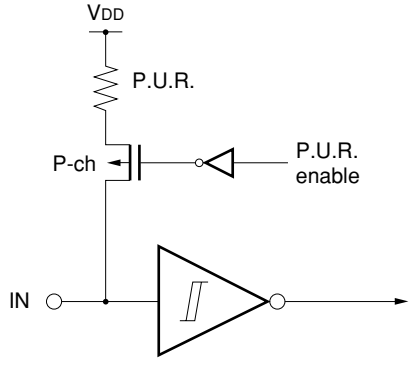
Schmitt-triggered input with hysteresis characteristics.

Type E-B



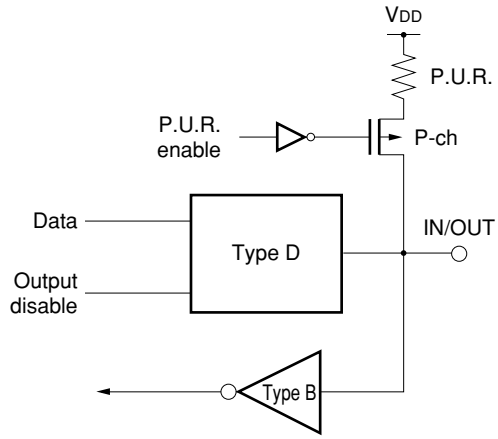
P.U.R. : Pull-Up Resistor

Type B-C



P.U.R. : Pull-Up Resistor

Type F-A

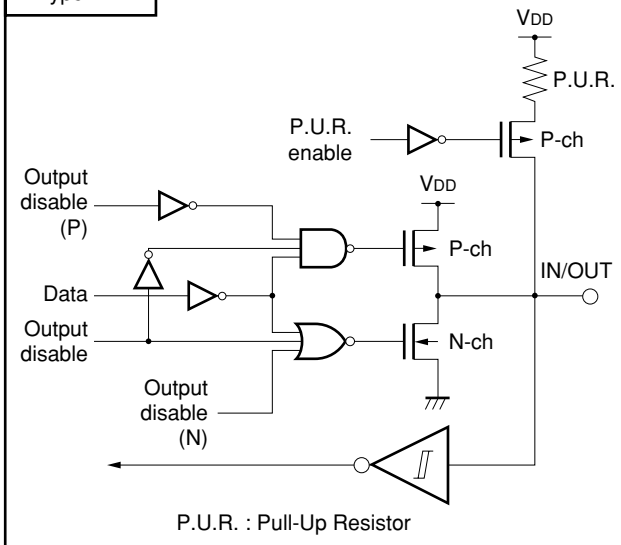


P.U.R. : Pull-Up Resistor

(Continued)

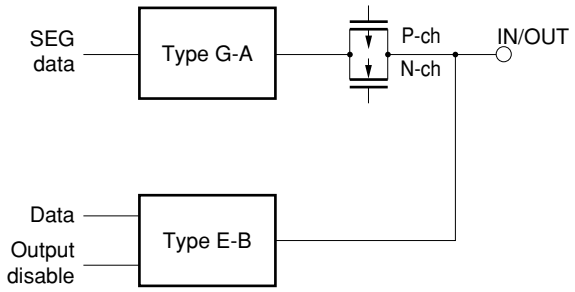
(Continued)

Type F-B

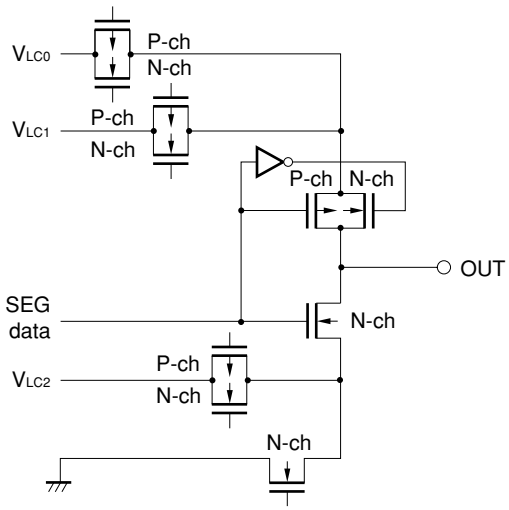


P.U.R. : Pull-Up Resistor

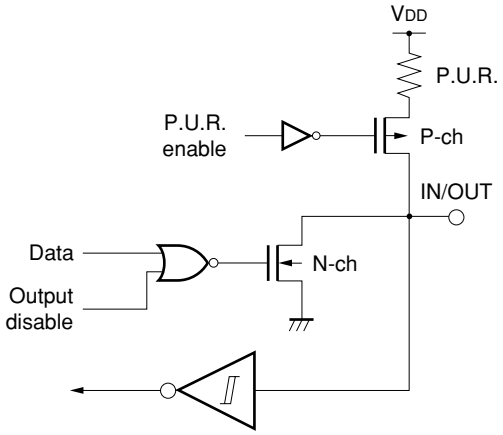
Type H



Type G-A

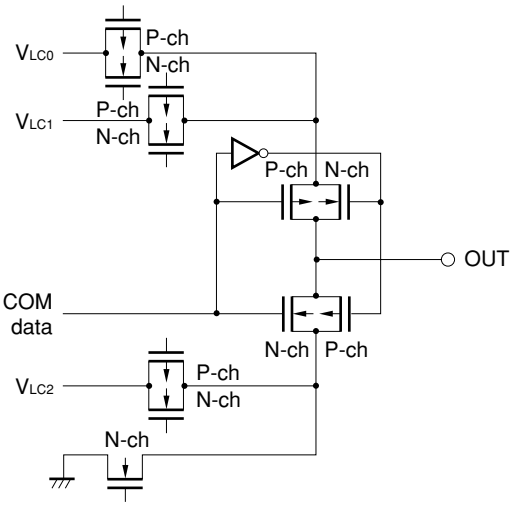


Type M-C

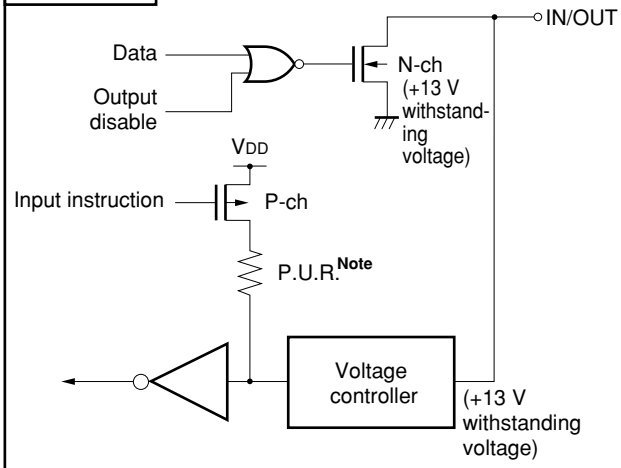


P.U.R. : Pull-Up Resistor

Type G-B



Type M-E



Note Pull-up resistor that operates only when an input instruction is executed. (The current flows from V_{DD} to a pin when the pin is at low level.)

3.4 Recommended Connection of Unused Pins

★ **Table 3-1. List of Unused Pin Connections**

Pin	Recommended Connection
P00/INT4	Connect to Vss or V_{DD}.
P01/$\overline{SCK}$	Input: Independently connect to Vss or V_{DD} via a resistor.
P02/SO/SB0	Output: Leave open.
P03/SI/SB1	Connect to Vss.
P10/INT0 and P11/INT1	Connect to Vss or V_{DD}.
P12/TI1/TI2/INT2	
P13/TI0	
P20/PTO0	Input: Independently connect to Vss or V_{DD} via a resistor.
P21/PTO1	Output: Leave open.
P22/PTO2/PCL	
P23/BUZ	
P30/LCDCL/MD0	
P31/SYNC/MD1	
P32/MD2	
P33/MD3	
P50/D4 to P53/D7	Input: Connect to Vss. Output: Connect to Vss.
P60/KR0/D0 to P63/KR3/D3	Input: Independently connect to Vss or V_{DD} via a resistor. Output: Leave open.
S0 to S15	Leave open.
COM0 to COM3	
S16/P93 to S19/P90	Input: Independently connect to Vss or V_{DD} via a resistor.
S20/P83 to S23/P80	Output: Leave open.
V_{LC0} to V_{LC2}	Connect to Vss.
BIAS	Connect to Vss only when none of V_{LC0}, V_{LC1} or V_{LC2} is used. In other cases, leave open.
XT1[Note]	Connect to Vss.
XT2[Note]	Leave open.
V_{PP}	Always connect to V_{DD} directly.

Note When the subsystem clock is not used, select SOS.0 = 1 (on-chip feedback resistor not used).

4. Mk I AND Mk II MODE SELECTION FUNCTION

Setting the stack bank selection (SBS) register for the μPD75P3116 enables the program memory to be switched between the Mk I mode and Mk II mode. This function is applicable when using the μPD75P3116 to evaluate the μPD753104, 753106, or 753108.

When bit 3 of SBS is set to 1: Sets the Mk I mode (supports the Mk I mode for the μPD753104, 753106, and 753108)
When bit 3 of SBS is set to 0: Sets the Mk II mode (supports the Mk II mode for the μPD753104, 753106, and 753108)

4.1 Differences Between Mk I Mode and Mk II Mode

Table 4-1 lists the differences between the Mk I mode and the Mk II mode for the μPD75P3116.

Table 4-1. Differences Between Mk I Mode and Mk II Mode

Item		Mk I Mode	Mk II Mode
Program counter		PC_{13-0}	
Program memory (bytes)		16384	
Data memory (bits)		512 × 4	
Stack	Stack bank	Selectable via memory banks 0 and 1	
	No. of stack bytes	2 bytes	3 bytes
Instruction	BRA !addr1 instruction CALLA !addr1 instruction	Not available	Available
Instruction execution time	CALL !addr instruction	3 machine cycles	4 machine cycles
	CALLF !faddr instruction	2 machine cycles	3 machine cycles
Supported mask ROM products		When set to Mk I mode: μPD753104, 753106, and 753108	When set to Mk II mode: μPD753104, 753106, and 753108

Caution The Mk II mode supports a program area exceeding 16 KB for the 75X and 75XL Series. Therefore, this mode is effective for enhancing software compatibility with products that have a program area of more than 16 KB.

With regard to the number of stack bytes during execution of subroutine call instructions, the usable area increases by 1 byte per stack compared to the Mk I mode when the Mk II mode is selected.

However, when the CALL !addr and CALLF !faddr instructions are used, the machine cycle becomes longer by 1 machine cycle. Therefore, if more emphasis is placed on RAM use efficiency and processing performance than on software compatibility, the Mk I mode should be used.

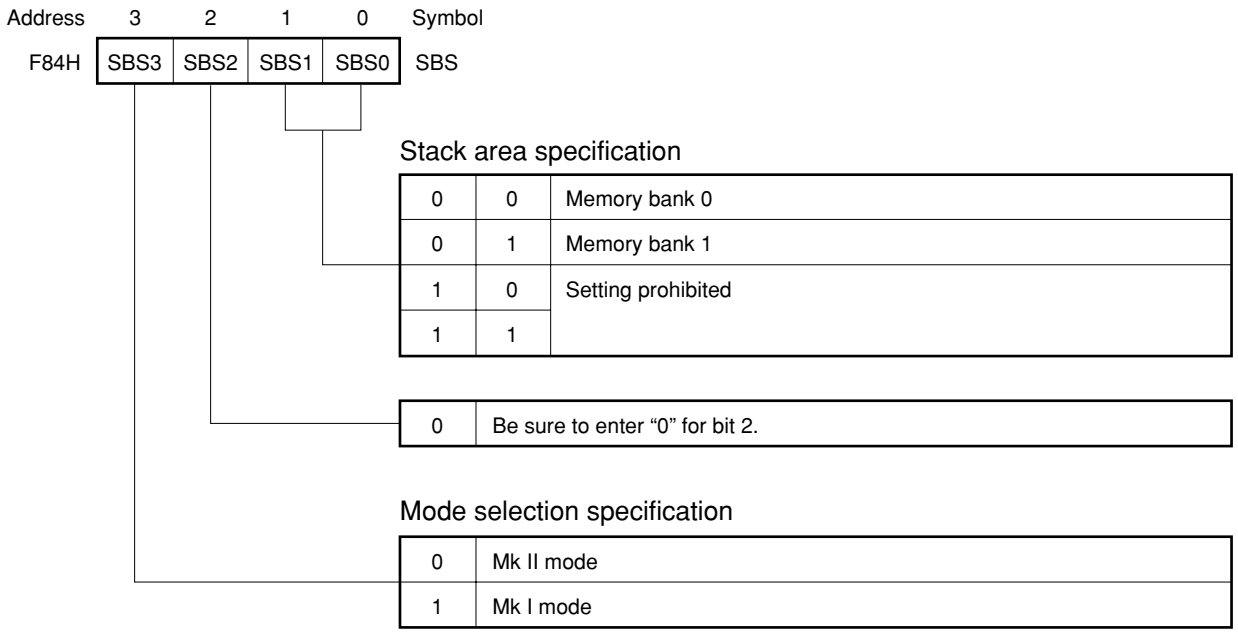
4.2 Setting of Stack Bank Selection (SBS) Register

Use the stack bank selection register to switch between the Mk I mode and Mk II mode. Figure 4-1 shows the format of the stack bank selection register.

The stack bank selection register is set using a 4-bit memory manipulation instruction. When using the Mk I mode, be sure to initialize the stack bank selection register to 100×B[Note] at the beginning of the program. When using the Mk II mode, be sure to initialize it to 000×B[Note].

Note Set the desired value for ×.

Figure 4-1. Format of Stack Bank Selection Register



Caution SBS3 is set to 1 after $\overline{\text{RESET}}$ input, and consequently the CPU operates in the Mk I mode. When using instructions for the Mk II mode, set SBS3 to 0 and set the Mk II mode before using the instructions.

5. DIFFERENCES BETWEEN μPD75P3116 AND μPD753104, 753106, 753108

The μPD75P3116 replaces the internal mask ROM in the μPD753104, 753106, and 753108 with a one-time PROM and features expanded ROM capacity. The μPD75P3116's Mk I mode supports the Mk I mode in the μPD753104, 753106, and 753108 and the μPD75P3116's Mk II mode supports the Mk II mode in the μPD753104, 753106, and 753108.

Table 5-1 lists differences between the μPD75P3116 and the μPD753104, 753106, and 753108. Be sure to check the differences between these products before using them with PROMs for debugging or prototype testing of application systems or, later, when using them with a mask ROM for full-scale production.

For details of the CPU functions and internal hardware, refer to the **User's Manual**.

Table 5-1. Differences Between μPD75P3116 and μPD753104, 753106, and 753108

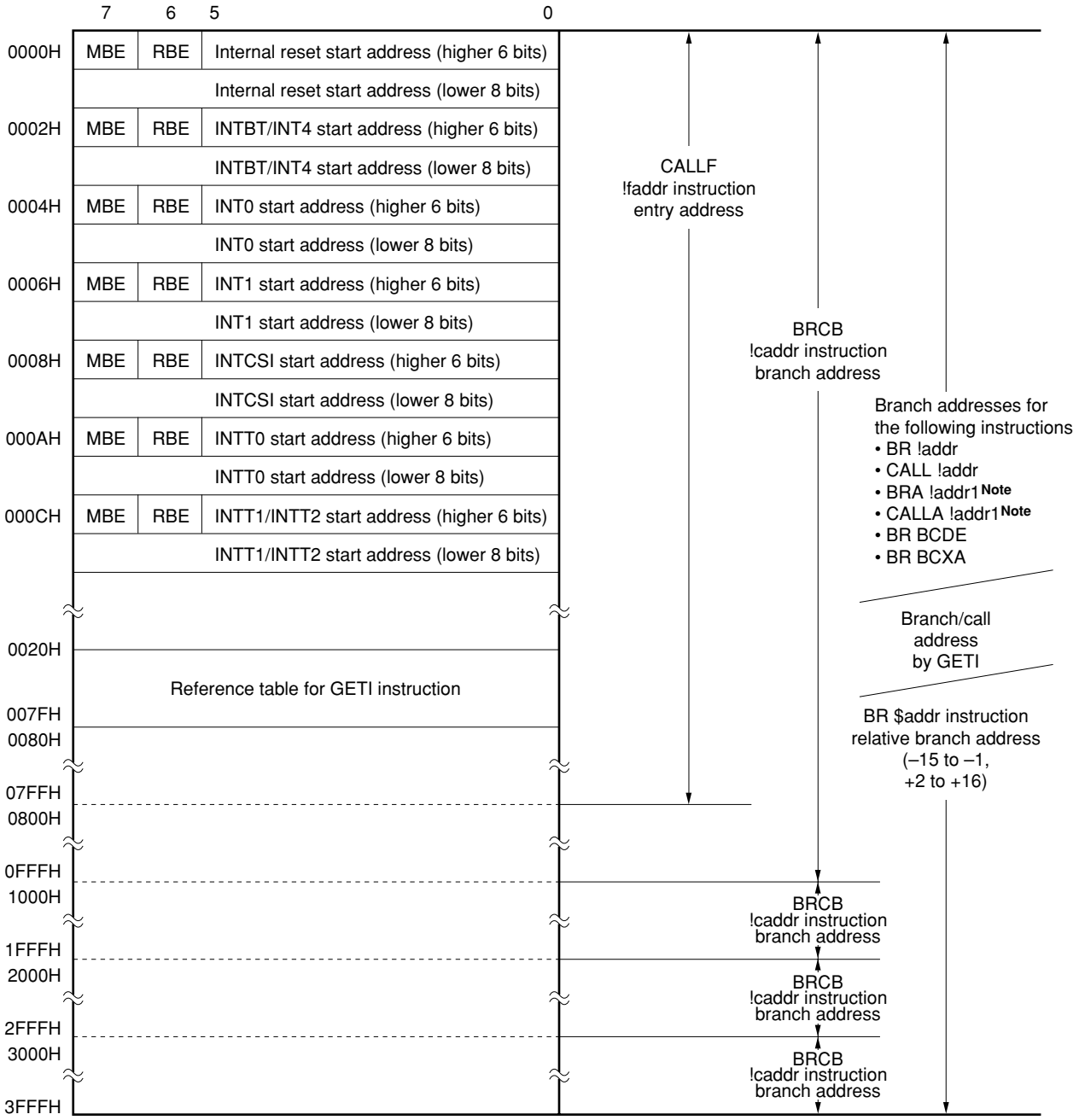
Item		μPD753104	μPD753106	μPD753108	μPD75P3116
Program counter		12 bits	13 bits		14 bits
Program memory (bytes)		Mask ROM 4096	Mask ROM 6144	Mask ROM 8192	One-time PROM 16384
Data memory (× 4 bits)		512			
Mask options	Pull-up resistor for Port 5	Available (On chip/not on chip can be specified.)			Not available (Not on chip)
	Split resistor for LCD driving power supply				
	$\overline{\text{RESET}}$ Wait time after	Available (Selectable between 2^{17}/fx and 2^{15}/fx)Note			Not available (Fixed to 2^{15}/fx)Note
	Feedback resistor of subsystem clock	Available (Use/not use can be selected.)			Not available (Enable)
Pin configuration	Pins 5 to 8	P30 to P33			P30/MD0 to P33/MD3
	Pins 10 to 13	P50 to P53			P50/D4 to P53/D7
	Pins 14 to 17	P60/KR0 to P63/KR3			P60/KR0/D0 to P63/KR3/D3
	Pin 21	IC			V_{PP}
Other		Noise resistance and noise radiation may differ due to the different circuit sizes and mask layouts.			

Note 2^{17}/fx: 21.8 ms at 6.0 MHz operation, 31.3 ms at 4.19 MHz operation
2^{15}/fx: 5.46 ms at 6.0 MHz operation, 7.81 ms at 4.19 MHz operation

Caution There are differences in the amount of noise tolerance and noise radiation between flash memory versions and mask ROM versions. When considering changing from a flash memory version to a mask ROM version during the process from experimental manufacturing to mass production, make sure to sufficiently evaluate commercial samples (CS) (not engineering samples (ES)) of the mask ROM versions.

6. MEMORY CONFIGURATION

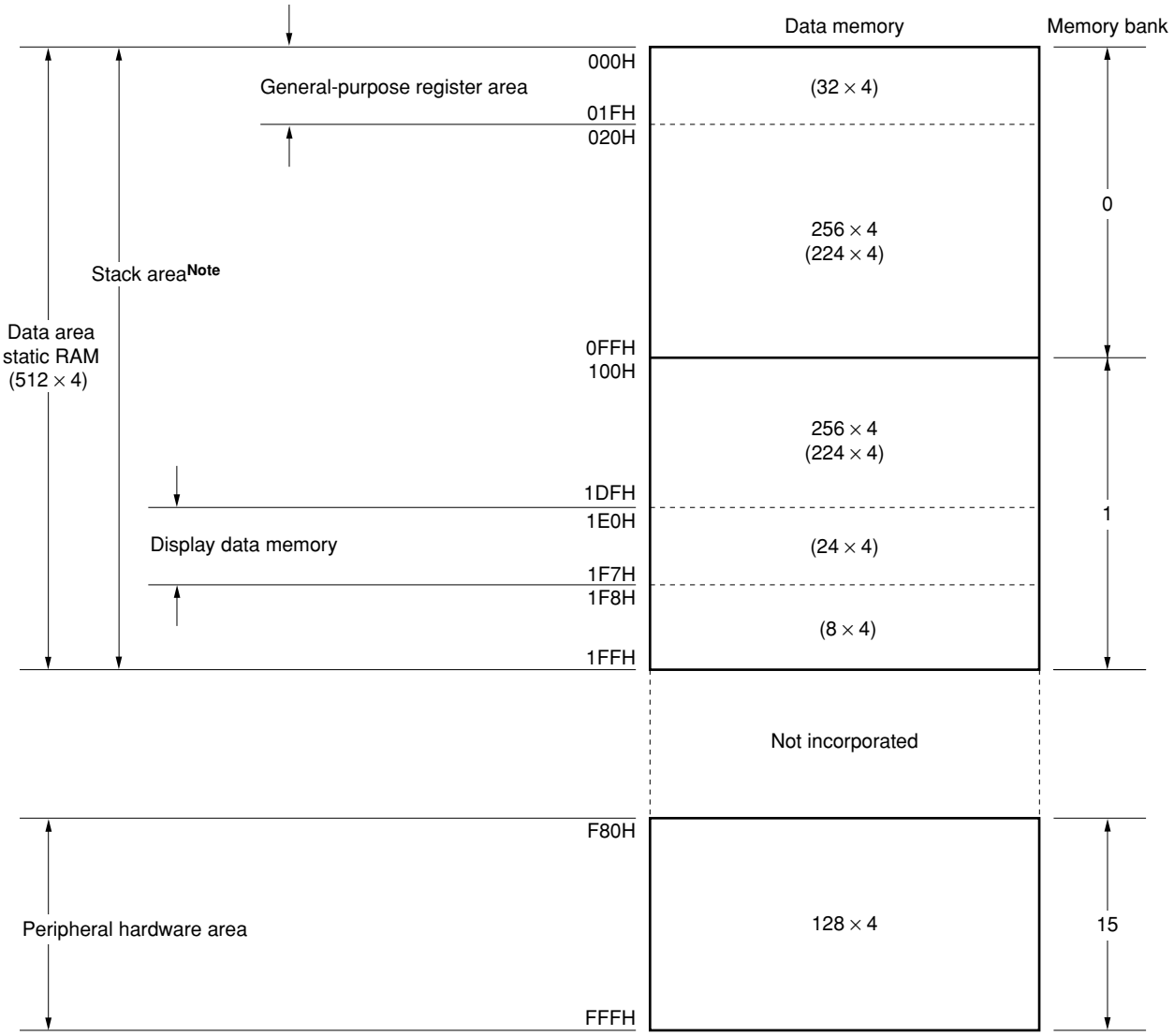
Figure 6-1. Program Memory Map



Note Can only be used in the Mk II mode.

Remark For instructions other than those noted above, the BR PCDE and BR PCXA instructions can be used to branch to addresses with changes in the PC's lower 8 bits only.

Figure 6-2. Data Memory Map



Note Memory bank 0 or 1 can be selected as the stack area.

7. INSTRUCTION SET

(1) Representation and coding formats for operands

In the instruction's operand area, use the following coding format to describe operands corresponding to the instruction's operand representations (for further details, refer to the **RA75X Assembler Package Language User's Manual (U12385E)**). When there are several codes, select and use just one. Codes that consist of uppercase letters and + or – symbols are keywords that should be entered as they are.

For immediate data, enter an appropriate numerical value or label.

Enter register flag symbols as label descriptors instead of mem, fmem, pmem, bit, etc. (for further details, refer to the **User's Manual**). The number of labels that can be entered for fmem and pmem are restricted.

Representation	Coding Format
reg	X, A, B, C, D, E, H, L
reg1	X, B, C, D, E, H, L
rp	XA, BC, DE, HL
rp1	BC, DE, HL
rp2	BC, DE
rp'	XA, BC, DE, HL, XA', BC', DE', HL'
rp'1	BC, DE, HL, XA', BC', DE', HL'
rpa	HL, HL+, HL–, DE, DL
rpa1	DE, DL
n4	4-bit immediate data or label
n8	8-bit immediate data or label
mem	8-bit immediate data or label[Note]
bit	2-bit immediate data or label
fmem	FB0H to FBFH, FF0H to FFFH immediate data or label
pmem	FC0H to FFFH immediate data or label
addr	0000H to 3FFFH immediate data or label
addr1	0000H to 3FFFH immediate data or label (Mk II mode only)
caddr	12-bit immediate data or label
faddr	11-bit immediate data or label
taddr	20H to 7FH immediate data (however, bit 0 = 0) or label
PORTn	Port 0 to Port 3, Port 5, Port 6, Port 8, Port 9
IE×××	IEBT, IECSI, IET0 to IET2, IE0 to IE2, IE4, IEW
RBn	RB0 to RB3
MBn	MB0, MB1, MB15

Note When processing 8-bit data, only even-numbered addresses can be specified.

(2) Operation conventions

A:	A register; 4-bit accumulator
B:	B register
C:	C register
D:	D register
E:	E register
H:	H register
L:	L register
X:	X register
XA:	Register pair (XA); 8-bit accumulator
BC:	Register pair (BC)
DE:	Register pair (DE)
HL:	Register pair (HL)
XA':	Expansion register pair (XA')
BC':	Expansion register pair (BC')
DE':	Expansion register pair (DE')
HL':	Expansion register pair (HL')
PC:	Program counter
SP:	Stack pointer
CY:	Carry flag; bit accumulator
PSW:	Program status word
MBE:	Memory bank enable flag
RBE:	Register bank enable flag
PORTn:	Port n (n = 0 to 3, 5, 6, 8, 9)
IME:	Interrupt master enable flag
IPS:	Interrupt priority selection register
IE××:	Interrupt enable flag
RBS:	Register bank selection register
MBS:	Memory bank selection register
PCC:	Processor clock control register
.:	Delimiter for address and bit
(××):	Data addressed with ××
××H:	Hexadecimal data

(3) Description of symbols used in addressing area

*1	MB = MBE • MBS MBS = 0, 1, 15	Data memory addressing
*2	MB = 0	
*3	MBE = 0: MB = 0 (000H to 07FH) MB = 15 (F80H to FFFH) MBE = 1: MB = MBS MBS = 0, 1, 15	
*4	MB = 15, fmem = FB0H to FBFH, FF0H to FFFH	
*5	MB = 15, pmem = FC0H to FFFH	
*6	addr = 0000H to 3FFFH	Program memory addressing
*7	addr, addr1 = (Current PC) – 15 to (Current PC) – 1 (Current PC) + 2 to (Current PC) + 16	
*8	caddr = 0000H to 0FFFH ($PC_{13, 12}$ = 00B) or 1000H to 1FFFH ($PC_{13, 12}$ = 01B) or 2000H to 2FFFH ($PC_{13, 12}$ = 10B) or 3000H to 3FFFH ($PC_{13, 12}$ = 11B)	
*9	faddr = 0000H to 07FFH	
*10	taddr = 0020H to 007FH	
*11	addr1 = 0000H to 3FFFH (Mk II mode only)	

Remarks 1. MB indicates access-enabled memory banks.

2. In area *2, MB = 0 for both MBE and MBS.

3. In areas *4 and *5, MB = 15 for both MBE and MBS.

4. Areas *6 to *11 indicate corresponding address-enabled areas.

(4) Description of machine cycles

S indicates the number of machine cycles required for skipping skip-specified instructions. The value of S varies as shown below.

- No skip ..... S = 0
- Skipped instruction is 1-byte or 2-byte instruction .... S = 1
- Skipped instruction is 3-byte instruction[Note] ..... S = 2

Note 3-byte instructions: BR !addr, BRA !addr1, CALL !addr, and CALLA !addr1

Caution The GETI instruction is skipped for one machine cycle.

One machine cycle equals one cycle (= t_{CY}) of the CPU clock Φ. Use the PCC setting to select from among four cycle times.

Instruction Group	Mnemonic	Operand	No. of Bytes	Machine Cycle	Operation	Addressing Area	Skip Condition
Transfer	MOV	A, #n4	1	1	A ← n4		String-effect A
		reg1, #n4	2	2	reg1 ← n4		
		XA, #n8	2	2	XA ← n8		String-effect A
		HL, #n8	2	2	HL ← n8		String-effect B
		rp2, #n8	2	2	rp2 ← n8		
		A, @HL	1	1	A ← (HL)	*1	
		A, @HL+	1	2+S	A ← (HL), then L ← L+1	*1	L = 0
		A, @HL–	1	2+S	A ← (HL), then L ← L–1	*1	L = FH
		A, @rpa1	1	1	A ← (rpa1)	*2	
		XA, @HL	2	2	XA ← (HL)	*1	
		@HL, A	1	1	(HL) ← A	*1	
		@HL, XA	2	2	(HL) ← XA	*1	
		A, mem	2	2	A ← (mem)	*3	
		XA, mem	2	2	XA ← (mem)	*3	
		mem, A	2	2	(mem) ← A	*3	
		mem, XA	2	2	(mem) ← XA	*3	
		A, reg	2	2	A ← reg		
		XA, rp’	2	2	XA ← rp’		
		reg1, A	2	2	reg1 ← A		
		rp’1, XA	2	2	rp’1 ← XA		
	XCH	A, @HL	1	1	A ⟷ (HL)	*1	
		A, @HL+	1	2+S	A ⟷ (HL), then L ← L+1	*1	L = 0
		A, @HL–	1	2+S	A ⟷ (HL), then L ← L–1	*1	L = FH
		A, @rpa1	1	1	A ⟷ (rpa1)	*2	
		XA, @HL	2	2	XA ⟷ (HL)	*1	
		A, mem	2	2	A ⟷ (mem)	*3	
		XA, mem	2	2	XA ⟷ (mem)	*3	
		A, reg1	1	1	A ⟷ reg1		
		XA, rp’	2	2	XA ⟷ rp’		
Table reference	MOVT	XA, @PCDE	1	3	XA ← $(PC_{13-8}+DE)_{ROM}$		
		XA, @PCXA	1	3	XA ← $(PC_{13-8}+XA)_{ROM}$		
		XA, @BCDE[Note]	1	3	XA ← $(BCDE)_{ROM}$	*6	
		XA, @BCXA[Note]	1	3	XA ← $(BCXA)_{ROM}$	*6	

Note Only the lower 3 bits in the B register are valid.

Instruction Group	Mnemonic	Operand	No. of Bytes	Machine Cycle	Operation	Addressing Area	Skip Condition
Bit transfer	MOV1	CY, fmem.bit	2	2	CY ← (fmem.bit)	*4	
		CY, pmem.@L	2	2	CY ← (pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$))	*5	
		CY, @H+mem.bit	2	2	CY ← (H+mem$_{3-0}$.bit)	*1	
		fmem.bit, CY	2	2	(fmem.bit) ← CY	*4	
		pmem.@L, CY	2	2	(pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$)) ← CY	*5	
		@H+mem.bit, CY	2	2	(H+mem$_{3-0}$.bit) ← CY	*1	
Arithmetic	ADDS	A, #n4	1	1+S	A ← A+n4		carry
		XA, #n8	2	2+S	XA ← XA+n8		carry
		A, @HL	1	1+S	A ← A+(HL)	*1	carry
		XA, rp'	2	2+S	XA ← XA+rp'		carry
		rp'1, XA	2	2+S	rp'1 ← rp'1+XA		carry
	ADDC	A, @HL	1	1	A, CY ← A+(HL)+CY	*1	
		XA, rp'	2	2	XA, CY ← XA+rp'+CY		
		rp'1, XA	2	2	rp'1, CY ← rp'1+XA+CY		
	SUBS	A, @HL	1	1+S	A ← A–(HL)	*1	borrow
		XA, rp'	2	2+S	XA ← XA–rp'		borrow
		rp'1, XA	2	2+S	rp'1 ← rp'1–XA		borrow
	SUBC	A, @HL	1	1	A, CY ← A–(HL)–CY	*1	
		XA, rp'	2	2	XA, CY ← XA–rp'–CY		
		rp'1, XA	2	2	rp'1, CY ← rp'1–XA–CY		
	AND	A, #n4	2	2	A ← A ∧ n4		
		A, @HL	1	1	A ← A ∧ (HL)	*1	
		XA, rp'	2	2	XA ← XA ∧ rp'		
		rp'1, XA	2	2	rp'1 ← rp'1 ∧ XA		
	OR	A, #n4	2	2	A ← A ∨ n4		
		A, @HL	1	1	A ← A ∨ (HL)	*1	
		XA, rp'	2	2	XA ← XA ∨ rp'		
		rp'1, XA	2	2	rp'1 ← rp'1 ∨ XA		
	XOR	A, #n4	2	2	A ← A ∀ n4		
		A, @HL	1	1	A ← A ∀ (HL)	*1	
		XA, rp'	2	2	XA ← XA ∀ rp'		
		rp'1, XA	2	2	rp'1 ← rp'1 ∀ XA		
Accumulator manipulation	RORC	A	1	1	CY ← A$_0$, A$_3$ ← CY, A$_{n-1}$ ← A$_n$		
	NOT	A	2	2	A ← $\overline{A}$		
Increment/ decrement	INCS	reg	1	1+S	reg ← reg+1		reg = 0
		rp1	1	1+S	rp1 ← rp1+1		rp1 = 00H
		@HL	2	2+S	(HL) ← (HL)+1	*1	(HL) = 0
		mem	2	2+S	(mem) ← (mem)+1	*3	(mem) = 0
	DECS	reg	1	1+S	reg ← reg–1		reg = FH
		rp'	2	2+S	rp' ← rp'–1		rp' = FFH

Instruction Group	Mnemonic	Operand	No. of Bytes	Machine Cycle	Operation	Addressing Area	Skip Condition
Comparison	SKE	reg, #n4	2	2+S	Skip if reg=n4		reg = n4
		@HL, #n4	2	2+S	Skip if (HL)=n4	*1	(HL) = n4
		A, @HL	1	1+S	Skip if A=(HL)	*1	A = (HL)
		XA, @HL	2	2+S	Skip if XA=(HL)	*1	XA = (HL)
		A, reg	2	2+S	Skip if A=reg		A = reg
		XA, rp'	2	2+S	Skip if XA=rp'		XA = rp'
Carry flag manipulation	SET1	CY	1	1	CY ← 1		
	CLR1	CY	1	1	CY ← 0		
	SKT	CY	1	1+S	Skip if CY=1		CY = 1
	NOT1	CY	1	1	CY ← $\overline{CY}$		
Memory bit manipulation	SET1	mem.bit	2	2	(mem.bit) ← 1	*3	
		fmem.bit	2	2	(fmem.bit) ← 1	*4	
		pmem.@L	2	2	(pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$)) ← 1	*5	
		@H+mem.bit	2	2	(H+mem$_{3-0}$.bit) ← 1	*1	
	CLR1	mem.bit	2	2	(mem.bit) ← 0	*3	
		fmem.bit	2	2	(fmem.bit) ← 0	*4	
		pmem.@L	2	2	(pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$)) ← 0	*5	
		@H+mem.bit	2	2	(H+mem$_{3-0}$.bit) ← 0	*1	
	SKT	mem.bit	2	2+S	Skip if(mem.bit)=1	*3	(mem.bit) = 1
		fmem.bit	2	2+S	Skip if(fmem.bit)=1	*4	(fmem.bit) = 1
		pmem.@L	2	2+S	Skip if(pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$))=1	*5	(pmem.@L) = 1
		@H+mem.bit	2	2+S	Skip if(H+mem$_{3-0}$.bit)=1	*1	(@H+mem.bit) = 1
	SKF	mem.bit	2	2+S	Skip if(mem.bit)=0	*3	(mem.bit) = 0
		fmem.bit	2	2+S	Skip if(fmem.bit)=0	*4	(fmem.bit) = 0
		pmem.@L	2	2+S	Skip if(pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$))=0	*5	(pmem.@L) = 0
		@H+mem.bit	2	2+S	Skip if(H+mem$_{3-0}$.bit)=0	*1	(@H+mem.bit) = 0
	SKTCLR	fmem.bit	2	2+S	Skip if(fmem.bit)=1 and clear	*4	(fmem.bit) = 1
		pmem.@L	2	2+S	Skip if(pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$))=1 and clear	*5	(pmem.@L) = 1
		@H+mem.bit	2	2+S	Skip if(H+mem$_{3-0}$.bit)=1 and clear	*1	(@H+mem.bit) = 1
	AND1	CY, fmem.bit	2	2	CY ← CY ∧ (fmem.bit)	*4	
		CY, pmem.@L	2	2	CY ← CY ∧ (pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$))	*5	
		CY, @H+mem.bit	2	2	CY ← CY ∧ (H+mem$_{3-0}$.bit)	*1	
	OR1	CY, fmem.bit	2	2	CY ← CY ∨ (fmem.bit)	*4	
		CY, pmem.@L	2	2	CY ← CY ∨ (pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$))	*5	
		CY, @H+mem.bit	2	2	CY ← CY ∨ (H+mem$_{3-0}$.bit)	*1	
	XOR1	CY, fmem.bit	2	2	CY ← CY ∀ (fmem.bit)	*4	
		CY, pmem.@L	2	2	CY ← CY ∀ (pmem$_{7-2}$+L$_{3-2}$.bit(L$_{1-0}$))	*5	
		CY, @H+mem.bit	2	2	CY ← CY ∀ (H+mem$_{3-0}$.bit)	*1	

Instruction Group	Mnemonic	Operand	No. of Bytes	Machine Cycle	Operation	Addressing Area	Skip Condition
Branch	BR[Note 1]	addr	—	—	PC_{13-0} ← addr Use the assembler to select the most appropriate instruction among the following. • BR !addr • BRCB !caddr • BR $addr	*6	
		addr1	—	—	PC_{13-0} ← addr1 Use the assembler to select the most appropriate instruction among the following. • BRA !addr1 • BR !addr • BRCB !caddr • BR $addr1	*11	
		!addr	3	3	PC_{13-0} ← addr	*6	
		$addr	1	2	PC_{13-0} ← addr	*7	
		$addr1	1	2	PC_{13-0} ← addr1		
		PCDE	2	3	PC_{13-0} ← PC_{13-8}+DE		
		PCXA	2	3	PC_{13-0} ← PC_{13-8}+XA		
		BCDE	2	3	PC_{13-0} ← BCDE[Note 2]	*6	
		BCXA	2	3	PC_{13-0} ← BCXA[Note 2]	*6	
	BRA[Note 1]	!addr1	3	3	PC_{13-0} ← addr1	*11	
	BRCB	!caddr	2	2	PC_{13-0} ← $PC_{13, 12}$+$caddr_{11-0}$	*8	

Notes 1. The sections in double boxes are only supported in the Mk II mode. The other sections are only supported in the MK I mode.

2. Only the lower two bits in the B register are valid.

Instruction Group	Mnemonic	Operand	No. of Bytes	Machine Cycle	Operation	Addressing Area	Skip Condition
Subroutine stack control	CALLA[Note]	!addr1	3	3	(SP–6)(SP–3)(SP–4) ← PC_{11-0} (SP–5) ← 0, 0, $PC_{13, 12}$ (SP–2) ← X, X, MBE, RBE PC_{13-0} ← addr1, SP ← SP–6	*11	
	CALL[Note]	!addr	3	3	(SP–4)(SP–1)(SP–2) ← PC_{11-0} (SP–3) ← MBE, RBE, $PC_{13, 12}$ PC_{13-0} ← addr, SP ← SP–4	*6	
				4	(SP–6)(SP–3)(SP–4) ← PC_{11-0} (SP–5) ← 0, 0, $PC_{13, 12}$ (SP–2) ← X, X, MBE, RBE PC_{13-0} ← addr, SP ← SP–6		
	CALLF[Note]	!faddr	2	2	(SP–4)(SP–1)(SP–2) ← PC_{11-0} (SP–3) ← MBE, RBE, $PC_{13, 12}$ PC_{13-0} ← 000+faddr, SP ← SP–4	*9	
				3	(SP–6)(SP–3)(SP–4) ← PC_{11-0} (SP–5) ← 0, 0, $PC_{13, 12}$ (SP–2) ← X, X, MBE, RBE PC_{13-0} ← 000+faddr, SP ← SP–6		
	RET[Note]		1	3	MBE, RBE, $PC_{13, 12}$ ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2) SP ← SP+4		
					X, X, MBE, RBE ← (SP+4) PC_{11-0} ← (SP)(SP+3)(SP+2) 0, 0, $PC_{13, 12}$ ← (SP+1) SP ← SP+6		
	RETS[Note]		1	3+S	MBE, RBE, $PC_{13, 12}$ ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2) SP ← SP+4 then skip unconditionally		Unconditional
					X, X, MBE, RBE ← (SP+4) PC_{11-0} ← (SP)(SP+3)(SP+2) 0, 0, $PC_{13, 12}$ ← (SP+1) SP ← SP+6 then skip unconditionally		
	RETI[Note]		1	3	MBE, RBE, $PC_{13, 12}$ ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2) PSW ← (SP+4)(SP+5) SP ← SP+6		
					0, 0, $PC_{13, 12}$ ← (SP+1) PC_{11-0} ← (SP)(SP+3)(SP+2) PSW ← (SP+4)(SP+5), SP ← SP+6		

Note The sections in double boxes are only supported in the Mk II mode. The other sections are only supported in the Mk I mode.

Instruction Group	Mnemonic	Operand	No. of Bytes	Machine Cycle	Operation	Addressing Area	Skip Condition
Subroutine stack control	PUSH	rp	1	1	(SP–1)(SP–2) ← rp, SP ← SP–2		
		BS	2	2	(SP–1) ← MBS, (SP–2) ← RBS, SP ← SP–2		
	POP	rp	1	1	rp ← (SP+1)(SP), SP ← SP+2		
		BS	2	2	MBS ← (SP+1), RBS ← (SP), SP ← SP+2		
Interrupt control	EI		2	2	IME(IPS.3) ← 1		
		IE×××	2	2	IE××× ← 1		
	DI		2	2	IME(IPS.3) ← 0		
		IE×××	2	2	IE××× ← 0		
I/O	IN[Note 1]	A, PORTn	2	2	A ← PORTn (n=0 to 3, 5, 6, 8, 9)		
		XA, PORTn	2	2	XA ← PORTn+1, PORTn (n=8)		
	OUT[Note 1]	PORTn, A	2	2	PORTn ← A (n=2 to 3, 5, 6, 8, 9)		
		PORTn, XA	2	2	PORTn+1, PORTn ← XA (n=8)		
CPU control	HALT		2	2	Set HALT Mode(PCC.2 ← 1)		
	STOP		2	2	Set STOP Mode(PCC.3 ← 1)		
	NOP		1	1	No Operation		
Special	SEL	RBn	2	2	RBS ← n (n=0 to 3)		
		MBn	2	2	MBS ← n (n=0, 1, 15)		
	GETI[Notes 2, 3]	taddr	1	3	• When using TBR instruction PC13-0 ← (taddr)5-0+(taddr+1)	*10	
					• When using TCALL instruction (SP–4)(SP–1)(SP–2) ← PC11-0 (SP–3) ← MBE, RBE, PC13, 12 PC13-0 ← (taddr)5-0+(taddr+1) SP ← SP–4		
					• When using instruction other than TBR or TCALL Execute (taddr)(taddr+1) instructions		Determined by referenced instruction
			1	3	• When using TBR instruction PC13-0 ← (taddr)5-0+(taddr+1)	*10	
				4	• When using TCALL instruction (SP–6)(SP–3)(SP–4) ← PC11-0 (SP–5) ← 0, 0, PC13, 12 (SP–2) ← X, X, MBE, RBE PC13-0 ← (taddr)5-0+(taddr+1) SP ← SP–6		
				3	• When using instruction other than TBR or TCALL Execute (taddr)(taddr+1) instructions		Determined by referenced instruction

Notes 1. Setting MBE = 0 or MBE = 1, MBS = 15 is required during the execution of the IN or OUT instruction.

2. The TBR and TCALL instructions are assembler quasi-directives for the GETI instruction table definitions.

3. The sections in double boxes are only supported in the Mk II mode. The other sections are only supported in the Mk I mode.

8. ONE-TIME PROM (PROGRAM MEMORY) WRITE AND VERIFY

The program memory contained in the μPD75P3116 is a 16384 × 8-bit one-time PROM that can be electrically written one time only. The pins listed in the table below are used for this PROM's write/verify operations. Clock input from the X1 pin is used instead of address input as a method for updating addresses.

Pin	Function
V_{PP}	Pin where program voltage is applied during program memory write/verify (usually V_{DD} potential)
X1, X2	Clock input pins for address updating during program memory write/verify. Input the X1 pin's inverted signal to the X2 pin.
MD0 to MD3	Operation mode selection pin for program memory write/verify
D0/P60 to D3/P63 (lower 4 bits) D4/P50 to D7/P53 (higher 4 bits)	8-bit data I/O pins for program memory write/verify
V_{DD}	Pin where power supply voltage is applied. Apply 1.8 to 5.5 V in normal operation mode and +6 V for program memory write/verify.

Caution Pins not used for program memory write/verify should be connected to Vss.

8.1 Operation Modes for Program Memory Write/Verify

When +6 V is applied to the V_{DD} pin and +12.5 V to the V_{PP} pin, the μPD75P3116 enters the program memory write/verify mode. The following operation modes can be specified by setting pins MD0 to MD3 as shown below.

Operation Mode Specification						Operation Mode
V_{PP}	V_{DD}	MD0	MD1	MD2	MD3	
+12.5 V	+6 V	H	L	H	L	Zero-clear program memory address
		L	H	H	H	Write mode
		L	L	H	H	Verify mode
		H	×	H	H	Program inhibit mode

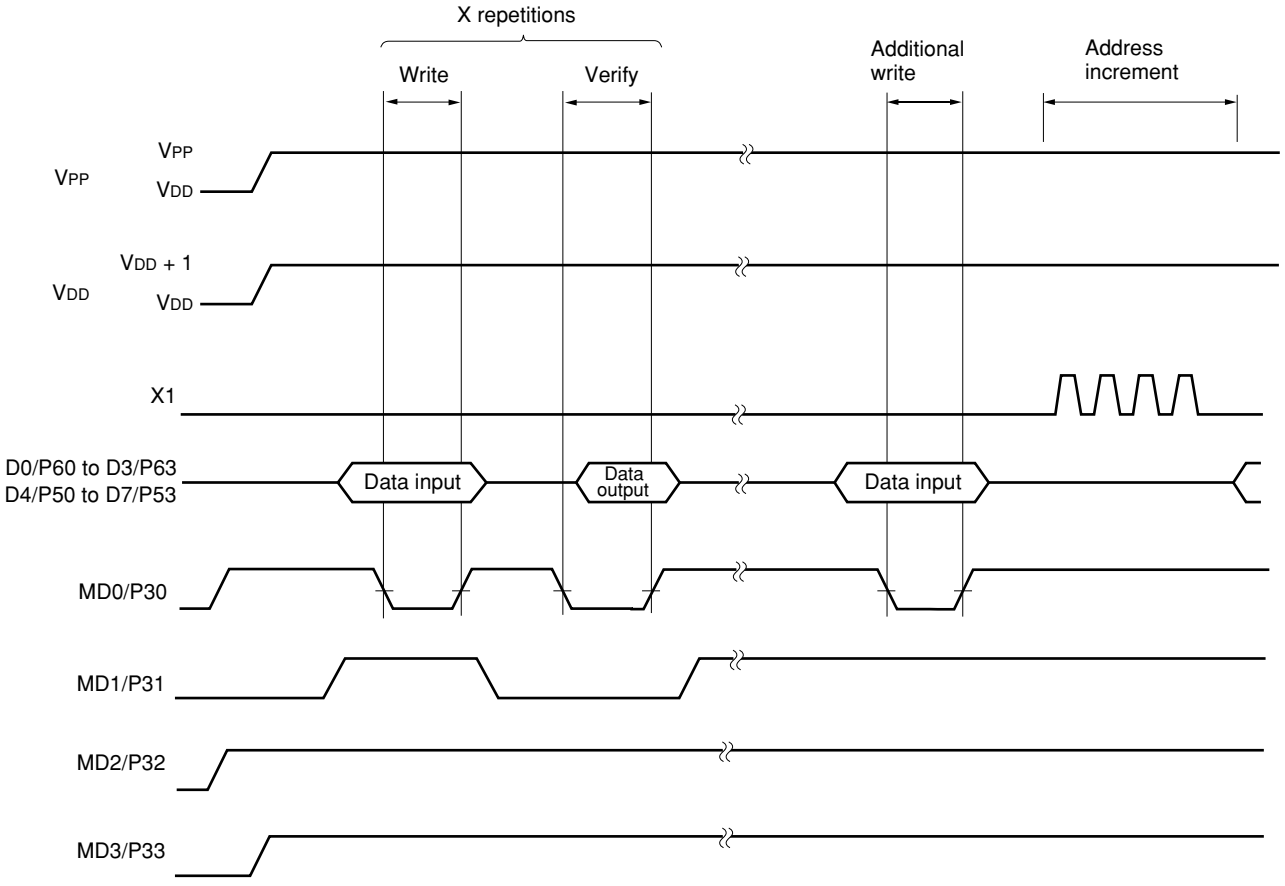
×: L or H

8.2 Program Memory Write Procedure

Program memory can be written at high speed using the following procedure.

(1) Pull down unused pins to Vss via resistors. Set the X1 pin to low.
(2) Supply 5 V to the V_{DD} and V_{PP} pins.
(3) Wait 10 μs.
(4) Select the program memory address zero-clear mode.
(5) Supply 6 V to V_{DD} and 12.5 V to V_{PP}.
(6) Write data in the 1 ms write mode.
(7) Select the verify mode. If the data is written, go to (8) and if not, repeat (6) and (7).
(8) Additional write. (X: Number of write operations from (6) and (7)) × 1 ms
(9) Apply four pulses to the X1 pin to increment the program memory address by one.
(10) Repeat (6) to (9) until the end address is reached.
(11) Select the program memory address zero-clear mode.
(12) Return the V_{DD}- and V_{PP}-pin voltages to 5 V.
(13) Turn off the power.

The following figure shows steps (2) to (9).

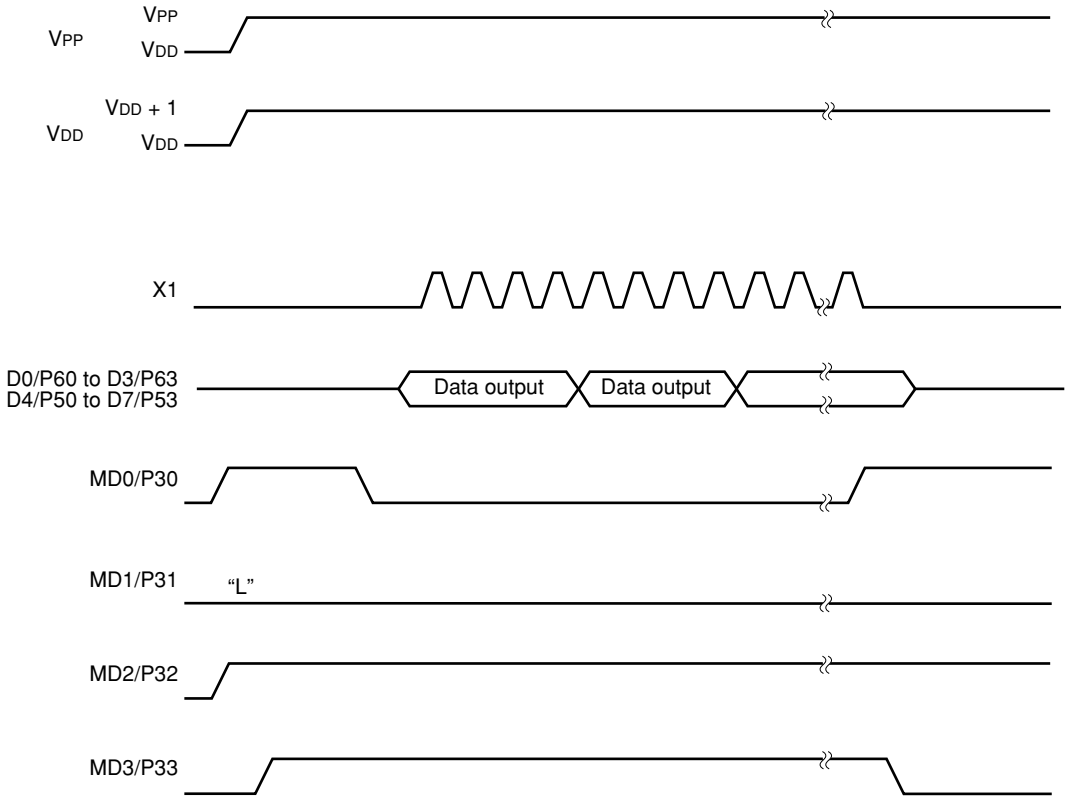


8.3 Program Memory Read Procedure

The μPD75P3116 can read program memory contents using the following procedure.

(1) Pull down unused pins to V_{SS} via resistors. Set the X1 pin to low.
(2) Supply 5 V to the V_{DD} and V_{PP} pins.
(3) Wait 10 μs.
(4) Select the program memory address zero-clear mode.
(5) Supply 6 V to V_{DD} and 12.5 V to V_{PP}.
(6) Select the verify mode. Apply four pulses to the X1 pin. The data stored in one address will be output every four clock pulses.
(7) Select the program memory address zero-clear mode.
(8) Return the V_{DD}- and V_{PP}-pin voltages to 5 V.
(9) Turn off the power.

The following figure shows steps (2) to (7).



8.4 One-Time PROM Screening

Due to its structure, the one-time PROM cannot be fully tested before shipment by NEC Electronics. Therefore, NEC Electronics recommends that after the required data is written and the PROM is stored under the temperature and time conditions shown below, the PROM should be verified via screening.

Storage Temperature	Storage Time
125˚C	24 hours

NEC Electronics offers QTOP microcontrollers for which one-time PROM writing, marking, screening, and verification are provided at additional cost. For further details, contact an NEC Electronics sales representative.

9. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = 25°C)

Parameter	Symbol	Test Conditions	Rating	Unit
Power supply voltage	V_{DD}		–0.3 to +7.0	V
PROM power supply voltage	V_{PP}		–0.3 to +13.5	V
Input voltage	V_{I1}	Except port 5	–0.3 to V_{DD} + 0.3	V
	V_{I2}	Port 5 (N-ch open drain)	–0.3 to +14	V
Output voltage	V_O		–0.3 to V_{DD} + 0.3	V
Output current, high	I_{OH}	Per pin	–10	mA
		Total of all pins	–30	mA
Output current, low	I_{OL}	Per pin	30	mA
		Total of all pins	220	mA
Operating ambient temperature	T_A		–40 to +85[Note]	°C
Storage temperature	T_{stg}		–65 to +150	°C

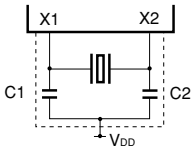
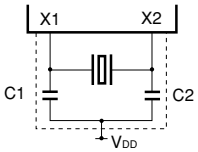
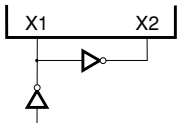
Note When LCD is driven in normal mode: T_A = –10 to +85°C

Caution Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

Capacitance (T_A = 25°C, V_{DD} = 0 V)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Input capacitance	C_{IN}	f = 1 MHz			15	pF
Output capacitance	C_{OUT}	Unmeasured pins returned to 0 V.			15	pF
I/O capacitance	C_{IO}				15	pF

Main System Clock Oscillator Characteristics (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Resonator	Recommended Constant	Parameter	Test Conditions	MIN.	TYP.	MAX.	Unit
Ceramic resonator		Oscillation frequency (fx)Note 1		1.0		6.0Note 2	MHz
		Oscillation stabilization timeNote 3	After V_{DD} reaches oscillation voltage range MIN.			4	ms
Crystal resonator		Oscillation frequency (fx)Note 1		1.0		6.0Note 2	MHz
		Oscillation stabilization timeNote 3	V_{DD} = 4.5 to 5.5 V			10	ms
			V_{DD} = 1.8 to 5.5 V			30	
External clock		X1 input frequency (fx)Note 1		1.0		6.0Note 2	MHz
		X1 input high-/low-level width (t_{XH}, t_{XL})		83.3		500	ns

Notes 1. Indicates only oscillator characteristics. Refer to **AC Characteristics** for instruction execution time.

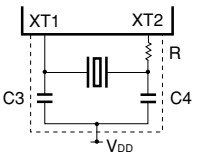
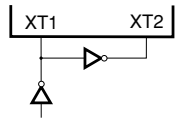
2. When the power supply voltage is 1.8 V ≤ V_{DD} < 2.7 V and the oscillation frequency is 4.19 MHz < fx ≤ 6.0 MHz, setting the processor clock control register (PCC) to 0011 makes 1 machine cycle less than the required 0.95 μs. Therefore, set PCC to a value other than 0011.

3. The oscillation stabilization time is necessary for oscillation to stabilize after applying V_{DD} or releasing the STOP mode.

Caution When using the main system clock oscillator, wire as follows in the area enclosed by the broken lines in the above figures to avoid an adverse effect from wiring capacitance.

- **Keep the wiring length as short as possible.**
- **Do not cross the wiring with the other signal lines.**
- **Do not route the wiring near a signal line through which a high fluctuating current flows.**
- **Always make the ground point of the oscillator capacitor the same potential as V_{DD}.**
- **Do not ground the capacitor to a ground pattern through which a high current flows.**
- **Do not fetch signals from the oscillator.**

Subsystem Clock Oscillator Characteristics (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Resonator	Recommended Constant	Parameter	Test Conditions	MIN.	TYP.	MAX.	Unit
Crystal resonator		Oscillation frequency (f_{XT})Note 1		32	32.768	35	kHz
		Oscillation stabilization timeNote 2	V_{DD} = 4.5 to 5.5 V		1.0	2	s
			V_{DD} = 1.8 to 5.5 V			10	
External clock		XT1 input frequency (f_{XT})Note 1		32		100	kHz
		XT1 input high-/low-level width (t_{XTH}, t_{XTL})		5		15	μs

Notes 1. Indicates only oscillator characteristics. Refer to **AC Characteristics** for instruction execution time.

2. The oscillation stabilization time is necessary for oscillation to stabilize after applying V_{DD}.

Caution When using the subsystem clock oscillator, wire as follows in the area enclosed by the broken lines in the above figures to avoid an adverse effect from wiring capacitance.

- **Keep the wiring length as short as possible.**
- **Do not cross the wiring with the other signal lines.**
- **Do not route the wiring near a signal line through which a high fluctuating current flows.**
- **Always make the ground point of the oscillator capacitor the same potential as V_{DD}.**
- **Do not ground the capacitor to a ground pattern through which a high current flows.**
- **Do not fetch signals from the oscillator.**

The subsystem clock oscillator is designed as a low amplification circuit to provide low consumption current, and is more liable to misoperation by noise than the main system clock oscillator. Special care should therefore be taken regarding the wiring method when the subsystem clock is used.

DC Characteristics (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
Output current, low	I_{OL}	Per pin				15	mA
		Total of all pins				150	mA
Input voltage, high	V_{IH1}	Ports 2, 3, 8, and 9	2.7 ≤ V_{DD} ≤ 5.5 V	0.7V_{DD}		V_{DD}	V
			1.8 ≤ V_{DD} < 2.7 V	0.9V_{DD}		V_{DD}	V
	V_{IH2}	Ports 0, 1, 6, $\overline{\text{RESET}}$	2.7 ≤ V_{DD} ≤ 5.5 V	0.8V_{DD}		V_{DD}	V
			1.8 ≤ V_{DD} < 2.7 V	0.9V_{DD}		V_{DD}	V
	V_{IH3}	Port 5	2.7 ≤ V_{DD} ≤ 5.5 V	0.7V_{DD}		13	V
		(N-ch open-drain)	1.8 ≤ V_{DD} < 2.7 V	0.9V_{DD}		13	V
	V_{IH4}	X1, XT1		V_{DD} – 0.1		V_{DD}	V
Input voltage, low	V_{IL1}	Ports 2, 3, 5, 8, and 9	2.7 ≤ V_{DD} ≤ 5.5 V	0		0.3V_{DD}	V
			1.8 ≤ V_{DD} < 2.7 V	0		0.1V_{DD}	V
	V_{IL2}	Ports 0, 1, 6, $\overline{\text{RESET}}$	2.7 ≤ V_{DD} ≤ 5.5 V	0		0.2V_{DD}	V
			1.8 ≤ V_{DD} < 2.7 V	0		0.1V_{DD}	V
	V_{IL3}	X1, XT1		0		0.1	V
Output voltage, high	V_{OH}	$\overline{\text{SCK}}$, SO, Ports 2, 3, 6, 8, and 9 I_{OH} = –1.0 mA		V_{DD} – 0.5			V
Output voltage, low	V_{OL1}	$\overline{\text{SCK}}$, SO, Ports 2, 3, 5, 6, 8, and 9	I_{OL} = 15 mA, V_{DD} = 4.5 to 5.5 V		0.2	2.0	V
			I_{OL} = 1.6 mA			0.4	V
	V_{OL2}	SB0, SB1	When N-ch open-drain pull-up resistor ≥ 1 kΩ			0.2V_{DD}	V
Input leakage current, high	I_{LIH1}	V_{IN} = V_{DD}	Pins other than X1, XT1			3	μA
	I_{LIH2}		X1, XT1			20	μA
	I_{LIH3}	V_{IN} = 13 V	Port 5 (N-ch open-drain)			20	μA
Input leakage current, low	I_{LIL1}	V_{IN} = 0 V	Pins other than X1, XT1, and Port 5			–3	μA
	I_{LIL2}		X1, XT1			–20	μA
	I_{LIL3}		Port 5 (N-ch open-drain) When another instruction than input instruction is executed			–3	μA
			Port 5 (N-ch open-drain) When input instruction is executed	V_{DD} = 1.8 to 5.5 V		–30	μA
				V_{DD} = 5.0 V	–10	–27	μA
				V_{DD} = 3.0 V	–3	–8	μA
Output leakage current, high	I_{LOH1}	V_{OUT} = V_{DD}	$\overline{\text{SCK}}$, SO/SB0, SB1, Ports 2, 3, 6, 8, and 9			3	μA
	I_{LOH2}	V_{OUT} = 13 V	Port 5 (N-ch open-drain)			20	μA
Output leakage current, low	I_{LOL}	V_{OUT} = 0 V				–3	μA
On-chip pull-up resistor	R_L	V_{IN} = 0 V	Ports 0, 1, 2, 3, 6, 8, and 9 (Excluding P00 pin)	50	100	200	kΩ

DC Characteristics (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Parameter	Symbol	Test Conditions			MIN.	TYP.	MAX.	Unit
LCD drive voltage	V_{LCD}	VAC0 = 0	T_A = –40 to +85°C		2.7		V_{DD}	V
			T_A = –10 to +85°C		2.2		V_{DD}	V
		VAC0 = 1			1.8		V_{DD}	V
VAC current[Note 1]	I_{VAC}	VAC0 = 1, V_{DD} = 2.0 V ±10%				1	4	μA
LCD output voltage deviation[Note 2] (common)	V_{ODC}	Io = ±1.0 μA	$V_{LCD0} = V_{LCD}$ $V_{LCD1} = V_{LCD} \times 2/3$ $V_{LCD2} = V_{LCD} \times 1/3$ 1.8 V ≤ V_{LCD} ≤ V_{DD}		0		±0.2	V
LCD output voltage deviation[Note 2] (segment)	V_{ODS}	Io = ±0.5 μA			0		±0.2	V
Supply current[Note 3]	I_{DD1}	6.00 MHz[Note 4] Crystal oscillation	V_{DD} = 5.0 V ±10%[Note 5]			3.2	9.5	mA
			V_{DD} = 3.0 V ±10%[Note 6]			0.55	1.6	mA
	I_{DD2}	C1 = C2 = 22 pF	HALT mode	V_{DD} = 5.0 V ±10%		0.7	2.0	mA
				V_{DD} = 3.0 V ±10%		0.25	0.8	mA
	I_{DD1}	4.19 MHz[Note 4] Crystal oscillation	V_{DD} = 5.0 V ±10%[Note 5]			2.5	7.5	mA
			V_{DD} = 3.0 V ±10%[Note 6]			0.45	1.35	mA
	I_{DD2}	C1 = C2 = 22 pF	HALT mode	V_{DD} = 5.0 V ±10%		0.65	1.8	mA
				V_{DD} = 3.0 V ±10%		0.22	0.7	mA
	I_{DD3}	32.768 kHz[Note 7] Crystal oscillation	Low-voltage mode[Note 8]	V_{DD} = 3.0 V ±10%		45	130	μA
				V_{DD} = 2.0 V ±10%		20	55	μA
				V_{DD} = 3.0 V, T_A = 25°C		45	90	μA
			Low current consumption mode[Note 9]	V_{DD} = 3.0 V ±10%		42	120	μA
				V_{DD} = 3.0 V, T_A = 25°C		42	85	μA
	I_{DD4}		HALT mode	Low-voltage mode[Note 8] V_{DD} = 3.0 V ±10%		5.5	18	μA
				Low-voltage mode[Note 8] V_{DD} = 2.0 V ±10%		2.2	7	μA
				Low-voltage mode[Note 8] V_{DD} = 3.0 V, T_A = 25°C		5.5	12	μA
				Low current consumption mode[Note 9] V_{DD} = 3.0 V ±10%		4.0	12	μA
				Low current consumption mode[Note 9] V_{DD} = 3.0 V, T_A = 25°C		4.0	8	μA
	I_{DD5}	XT1 = 0 V[Note 10] STOP mode	V_{DD} = 5.0 V ±10%			0.05	10	μA
			V_{DD} = 3.0 V ±10%	T_A = –40 to +85°C		0.02	5	μA
				T_A = 25°C		0.02	3	μA

Notes 1. Set to VAC0 = 0 when the low current consumption mode and the stop mode are used. If VAC0 = 1 is set, the current increases for approx. 1 μA.

2. The voltage deviation is the difference from the output voltage corresponding to the ideal value of the segment and common outputs (V_{LCDn}; n = 0, 1, 2).

3. Not including currents flowing through on-chip pull-up resistors.

4. Including oscillation of the subsystem clock.

5. When the processor clock control register (PCC) is set to 0011 and the device is operated in the high-speed mode.

6. When PCC is set to 0000 and the device is operated in the low-speed mode.

7. When the system clock control register (SCC) is set to 1001 and the device is operated on the subsystem clock, with main system clock oscillation stopped.

8. When the sub-oscillator control register (SOS) is set to 0000.

9. When SOS is set to 0010.

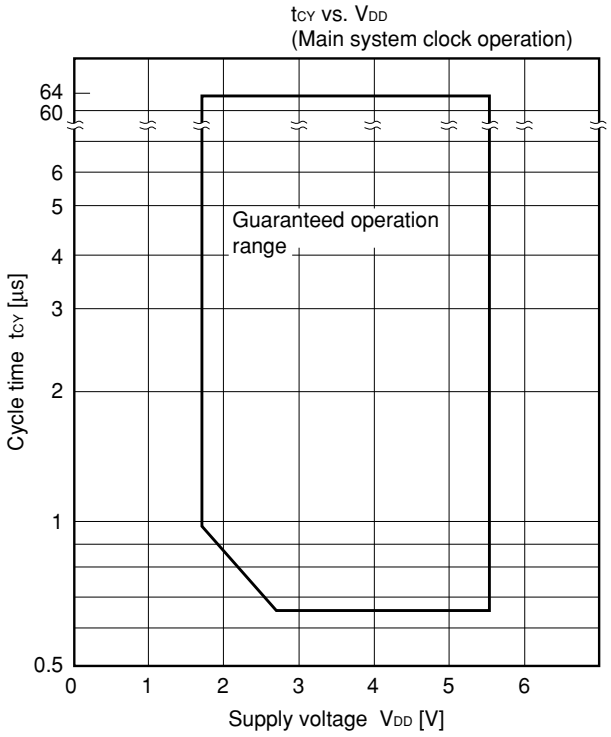
10. When SOS is set to 00×1 and the feedback resistor of the sub-oscillator is not used (×: Don't care).

AC Characteristics (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
CPU clock cycle time[Note 1] (Min. instruction execution time = 1 machine cycle)	t_{CY}	Operating on main system clock	V_{DD} = 2.7 to 5.5 V	0.67		64	μs
			V_{DD} = 1.8 to 5.5 V	0.95		64	μs
		Operating on subsystem clock		114	122	125	μs
TI0, TI1, TI2 input frequency	f_{TI}	V_{DD} = 2.7 to 5.5 V		0		1.0	MHz
		V_{DD} = 1.8 to 5.5 V		0		275	kHz
TI0, TI1, TI2 input high-/low-level width	t_{TIH}, t_{TIL}	V_{DD} = 2.7 to 5.5 V		0.48			μs
		V_{DD} = 1.8 to 5.5 V		1.8			μs
Interrupt input high-/low-level width	t_{INTH}, t_{INTL}	INT0	IM02 = 0	**Note 2**			μs
			IM02 = 1	10			μs
		INT1, 2, 4		10			μs
		KR0 to KR7		10			μs
$\overline{\text{RESET}}$ low-level width	t_{RSL}			10			μs

Notes 1. The cycle time (minimum instruction execution time) of the CPU clock (Φ) is determined by the oscillation frequency of the connected resonator (and external clock), the system clock control register (SCC) and the processor clock control register (PCC). The figure on the right indicates the cycle time t_{CY} versus supply voltage V_{DD} characteristics with the main system clock operating.

2. $2t_{CY}$ or 128/fx is set by setting the interrupt mode register (IM0).



Serial Transfer Operation

2-wire and 3-wire serial I/O mode ($\overline{SCK}$...Internal clock output): (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK}$ cycle time	t_{KCY1}	V_{DD} = 2.7 to 5.5 V		1300			ns
		V_{DD} = 1.8 to 5.5 V		3800			ns
$\overline{SCK}$ high-/low-level width	t_{KL1}, t_{KH1}	V_{DD} = 2.7 to 5.5 V		t_{KCY1}/2–50			ns
		V_{DD} = 1.8 to 5.5 V		t_{KCY1}/2–150			ns
SI[Note 1] setup time (to $\overline{SCK}$↑)	t_{SIK1}	V_{DD} = 2.7 to 5.5 V		150			ns
		V_{DD} = 1.8 to 5.5 V		500			ns
SI[Note 1] hold time (from $\overline{SCK}$↑)	t_{KSI1}	V_{DD} = 2.7 to 5.5 V		400			ns
		V_{DD} = 1.8 to 5.5 V		600			ns
SO[Note 1] output delay time from $\overline{SCK}$↓	t_{KSO1}	R_L = 1 kΩ,	V_{DD} = 2.7 to 5.5 V	0		250	ns
		C_L = 100 pF[Note 2]	V_{DD} = 1.8 to 5.5 V	0		1000	ns

Notes 1. In 2-wire serial I/O mode, read this parameter as SB0 or SB1 instead.

2. R_L and C_L are the load resistance and load capacitance of the SO output lines, respectively.

2-wire and 3-wire serial I/O mode ($\overline{SCK}$...External clock input): (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK}$ cycle time	t_{KCY2}	V_{DD} = 2.7 to 5.5 V		800			ns
		V_{DD} = 1.8 to 5.5 V		3200			ns
$\overline{SCK}$ high-/low-level width	t_{KL2}, t_{KH2}	V_{DD} = 2.7 to 5.5 V		400			ns
		V_{DD} = 1.8 to 5.5 V		1600			ns
SI[Note 1] setup time (to $\overline{SCK}$↑)	t_{SIK2}	V_{DD} = 2.7 to 5.5 V		100			ns
		V_{DD} = 1.8 to 5.5 V		150			ns
SI[Note 1] hold time (from $\overline{SCK}$↑)	t_{KSI2}	V_{DD} = 2.7 to 5.5 V		400			ns
		V_{DD} = 1.8 to 5.5 V		600			ns
SO[Note 1] output delay time from $\overline{SCK}$↓	t_{KSO2}	R_L = 1 kΩ,	V_{DD} = 2.7 to 5.5 V	0		300	ns
		C_L = 100 pF[Note 2]	V_{DD} = 1.8 to 5.5 V	0		1000	ns

Notes 1. In 2-wire serial I/O mode, read this parameter as SB0 or SB1 instead.

2. R_L and C_L are the load resistance and load capacitance of the SO output lines, respectively.

SBI mode ($\overline{SCK}$...Internal clock output (master)): (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK}$ cycle time	t_{KCY3}	V_{DD} = 2.7 to 5.5 V		1300			ns
		V_{DD} = 1.8 to 5.5 V		3800			ns
$\overline{SCK}$ high-/low-level width	t_{KL3}, t_{KH3}	V_{DD} = 2.7 to 5.5 V		$t_{KCY3}/2-50$			ns
		V_{DD} = 1.8 to 5.5 V		$t_{KCY3}/2-150$			ns
SB0, 1 setup time (to $\overline{SCK}\uparrow$)	t_{SIK3}	V_{DD} = 2.7 to 5.5 V		150			ns
		V_{DD} = 1.8 to 5.5 V		500			ns
SB0, 1 hold time (from $\overline{SCK}\uparrow$)	t_{KSI3}			$t_{KCY3}/2$			ns
SB0, 1 output delay time from $\overline{SCK}\downarrow$	t_{KSO3}	R_L = 1 kΩ, C_L = 100 pF[Note]	V_{DD} = 2.7 to 5.5 V	0		250	ns
			V_{DD} = 1.8 to 5.5 V	0		1000	ns
SB0, 1↓ from $\overline{SCK}\uparrow$	t_{KSB}			t_{KCY3}			ns
$\overline{SCK}\downarrow$ from SB0, 1↓	t_{SBK}			t_{KCY3}			ns
SB0, 1 low-level width	t_{SBL}			t_{KCY3}			ns
SB0, 1 high-level width	t_{SBH}			t_{KCY3}			ns

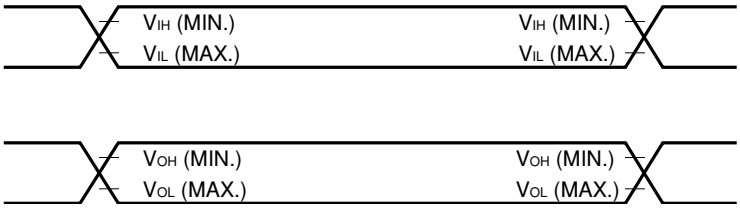
Note R_L and C_L are the load resistance and load capacitance of the SB0 and SB1 output lines, respectively.

SBI mode ($\overline{SCK}$...External clock input (slave)): (T_A = –40 to +85°C, V_{DD} = 1.8 to 5.5 V)

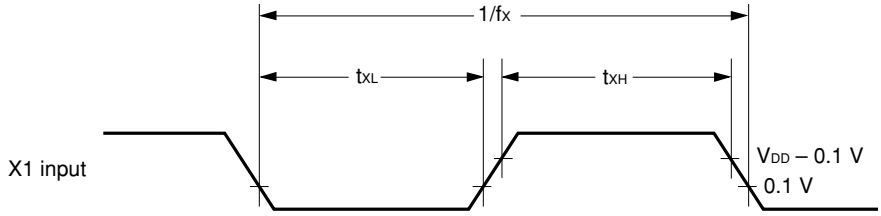
Parameter	Symbol	Test Conditions		MIN.	TYP.	MAX.	Unit
$\overline{SCK}$ cycle time	t_{KCY4}	V_{DD} = 2.7 to 5.5 V		800			ns
		V_{DD} = 1.8 to 5.5 V		3200			ns
$\overline{SCK}$ high-/low-level width	t_{KL4}, t_{KH4}	V_{DD} = 2.7 to 5.5 V		400			ns
		V_{DD} = 1.8 to 5.5 V		1600			ns
SB0, 1 setup time (to $\overline{SCK}\uparrow$)	t_{SIK4}	V_{DD} = 2.7 to 5.5 V		100			ns
		V_{DD} = 1.8 to 5.5 V		150			ns
SB0, 1 hold time (from $\overline{SCK}\uparrow$)	t_{KSI4}			$t_{KCY4}/2$			ns
SB0, 1 output delay time from $\overline{SCK}\downarrow$	t_{KSO4}	R_L = 1 kΩ, C_L = 100 pF[Note]	V_{DD} = 2.7 to 5.5 V	0		300	ns
			V_{DD} = 1.8 to 5.5 V	0		1000	ns
SB0, 1↓ from $\overline{SCK}\uparrow$	t_{KSB}			t_{KCY4}			ns
$\overline{SCK}\downarrow$ from SB0, 1↓	t_{SBK}			t_{KCY4}			ns
SB0, 1 low-level width	t_{SBL}			t_{KCY4}			ns
SB0, 1 high-level width	t_{SBH}			t_{KCY4}			ns

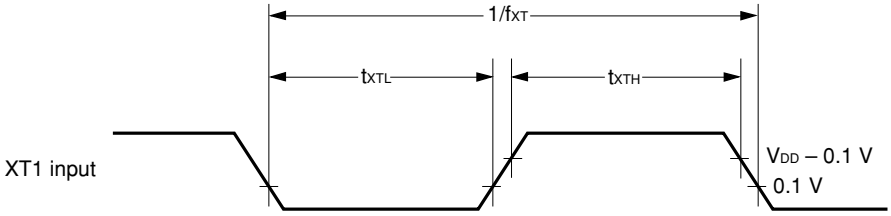
Note R_L and C_L are the load resistance and load capacitance of the SB0 and SB1 output lines, respectively.

AC Timing Test Points (Excluding X1, XT1 Input)

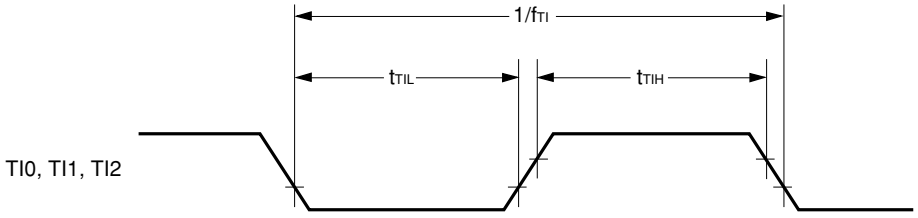


Clock Timing



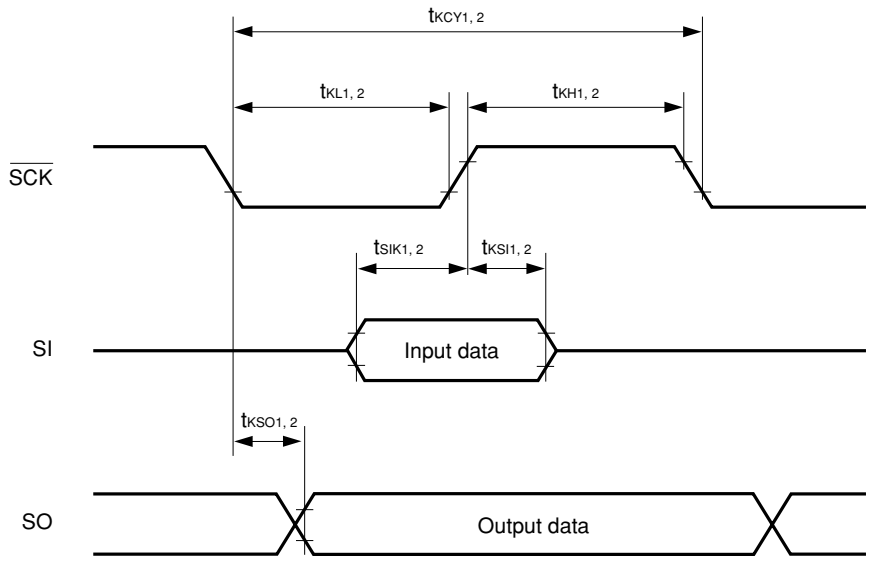


TI0, TI1, TI2 Timing

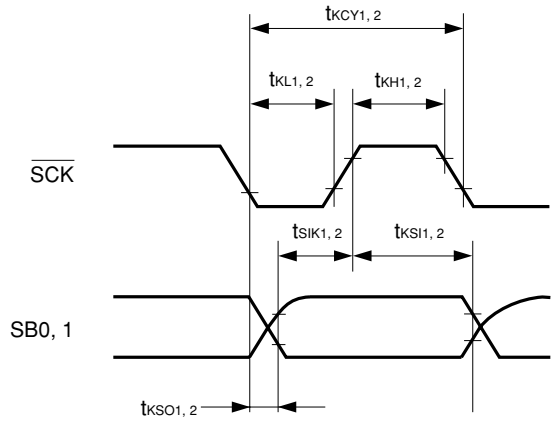


Serial Transfer Timing

3-wire serial I/O mode

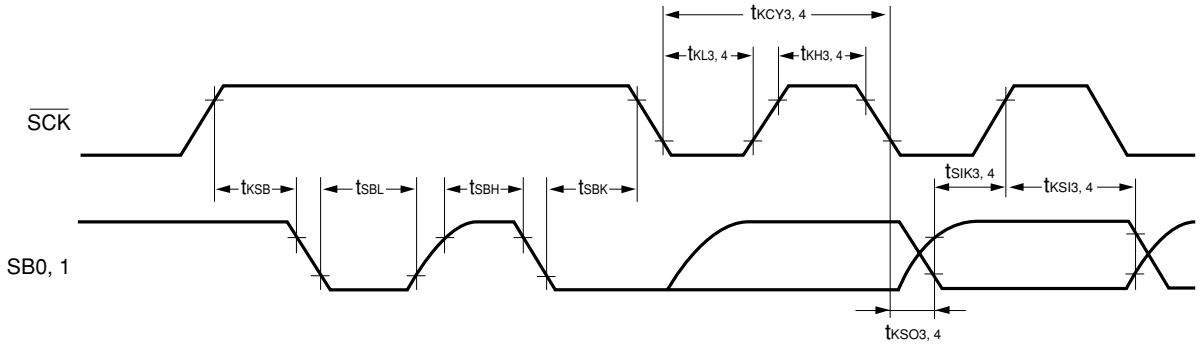


2-wire serial I/O mode

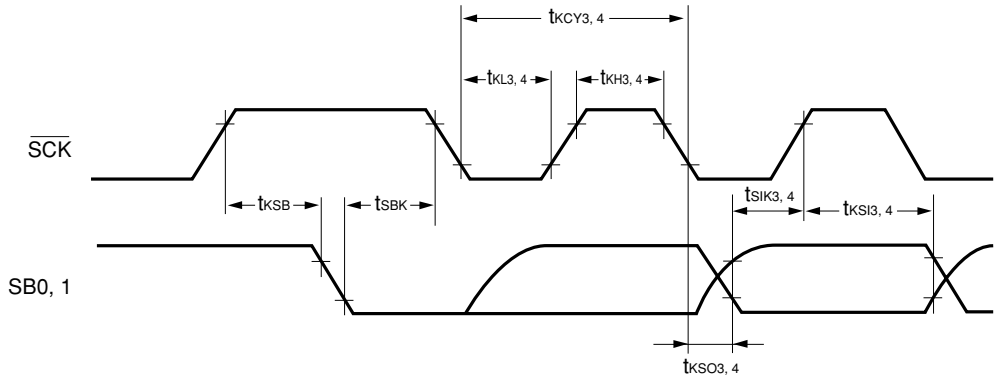


Serial Transfer Timing

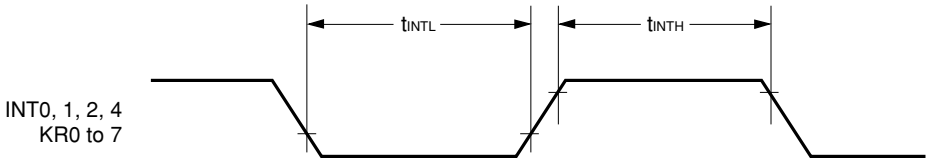
Bus release signal transfer



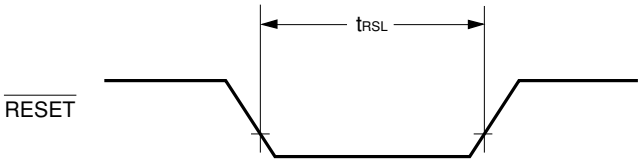
Command signal transfer



Interrupt input timing



RESET input timing



Data Memory Stop Mode Low Supply Voltage Data Retention Characteristics (T_A = –40 to +85°C)

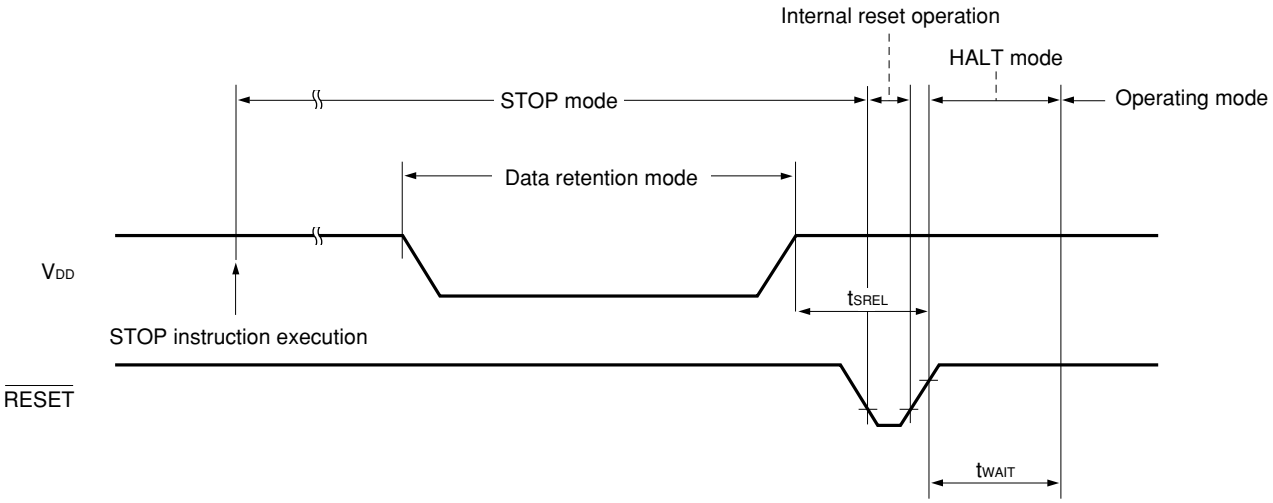
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Release signal set time	t_{SREL}		0			μs
Oscillation stabilization wait time[Note 1]	t_{WAIT}	Release by $\overline{\text{RESET}}$		$2^{15}/f_X$		ms
		Release by interrupt request		**Note 2**		ms

Notes 1. The oscillation stabilization wait time is the time during which the CPU operation is stopped to prevent unstable operation at the start of oscillation.

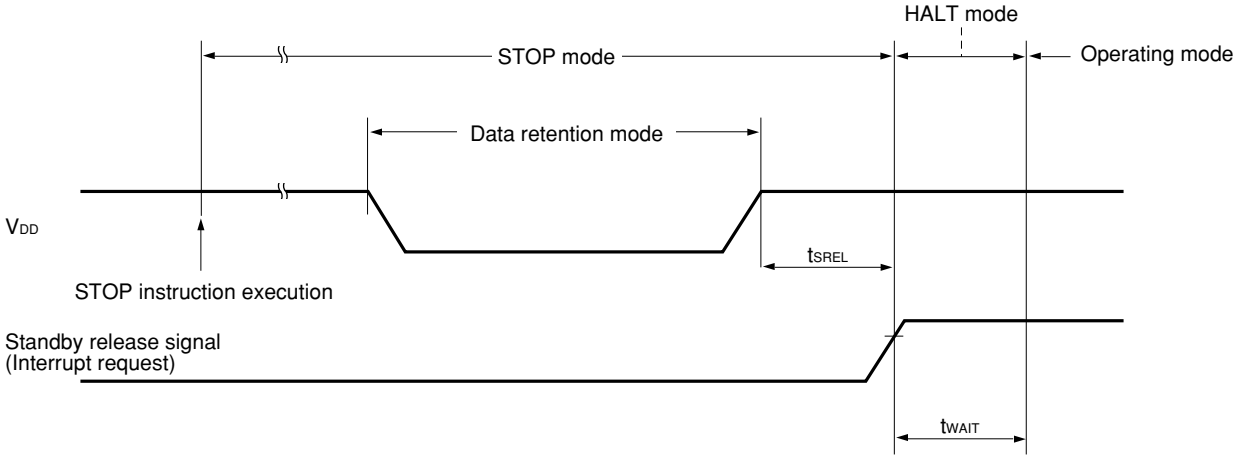
2. Depends on the basic interval timer mode register (BTM) settings (see the table below).

BTM3	BTM2	BTM1	BTM0	Wait Time	
				fx = 4.19 MHz	fx = 6.0 MHz
—	0	0	0	$2^{20}/f_X$ (approx. 250 ms)	$2^{20}/f_X$ (approx. 175 ms)
—	0	1	1	$2^{17}/f_X$ (approx. 31.3 ms)	$2^{17}/f_X$ (approx. 21.8 ms)
—	1	0	1	$2^{15}/f_X$ (approx. 7.81 ms)	$2^{15}/f_X$ (approx. 5.46 ms)
—	1	1	1	$2^{13}/f_X$ (approx. 1.95 ms)	$2^{13}/f_X$ (approx. 1.37 ms)

Data Retention Timing (STOP Mode Release by $\overline{\text{RESET}}$)



Data Retention Timing (Standby Release Signal: STOP Mode Release by Interrupt Signal)



DC Programming Characteristics (T_A = 25 ±5°C, V_{DD} = 6.0 ±0.25 V, V_{PP} = 12.5 ±0.3 V, V_{SS} = 0 V)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Input voltage, high	V_{IH1}	Except X1 and X2 pins	0.7V_{DD}		V_{DD}	V
	V_{IH2}	X1, X2	V_{DD} – 0.5		V_{DD}	V
Input voltage, low	V_{IL1}	Except X1 and X2 pins	0		0.3V_{DD}	V
	V_{IL2}	X1, X2	0		0.4	V
Input leakage current	I_{LI}	V_{IN} = V_{IL} or V_{IH}			10	μA
Output voltage, high	V_{OH}	I_{OH} = –1 mA	V_{DD} – 1.0			V
Output voltage, low	V_{OL}	I_{OL} = 1.6 mA			0.4	V
V_{DD} power supply current	I_{DD}				30	mA
V_{PP} power supply current	I_{PP}	MD0 = V_{IL}, MD1 = V_{IH}			30	mA

Cautions 1. Do not exceed +13.5 V for V_{PP}, including the overshoot.

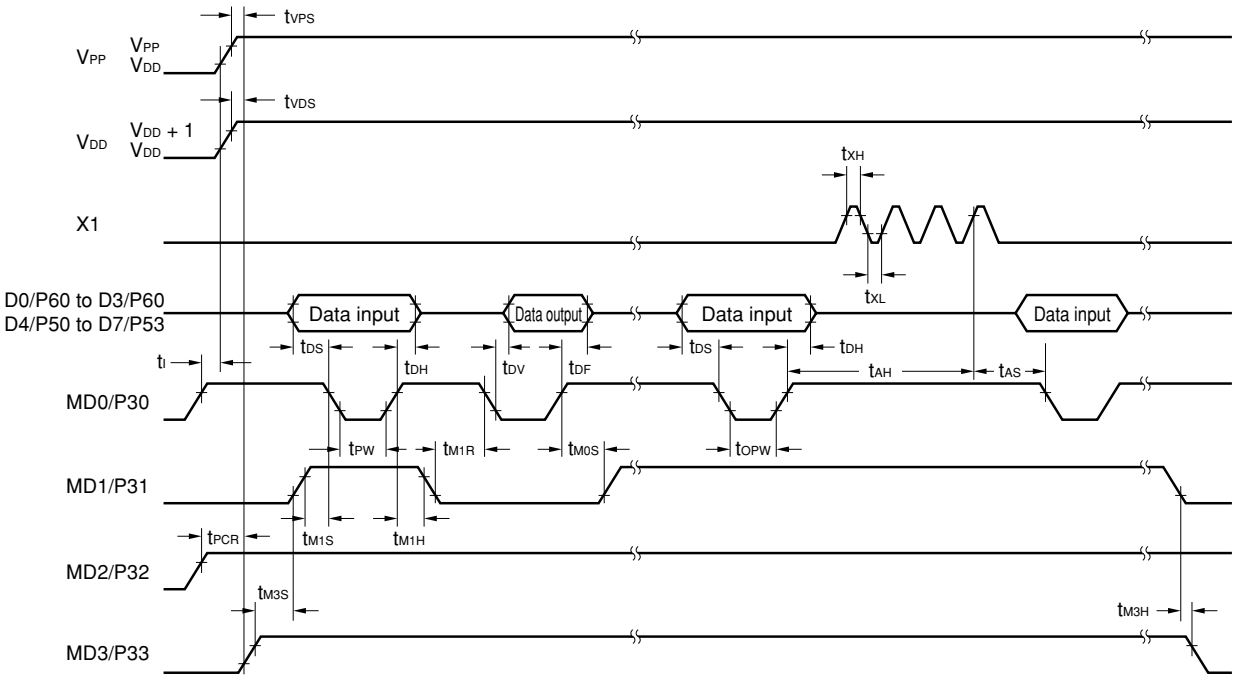
2. V_{DD} must be applied before V_{PP}, and cut after V_{PP}.

★ **AC Programming Characteristics (T_A = 25 ±5°C, V_{DD} = 6.0 ±0.25 V, V_{PP} = 12.5 ±0.3 V, V_{SS} = 0 V)**

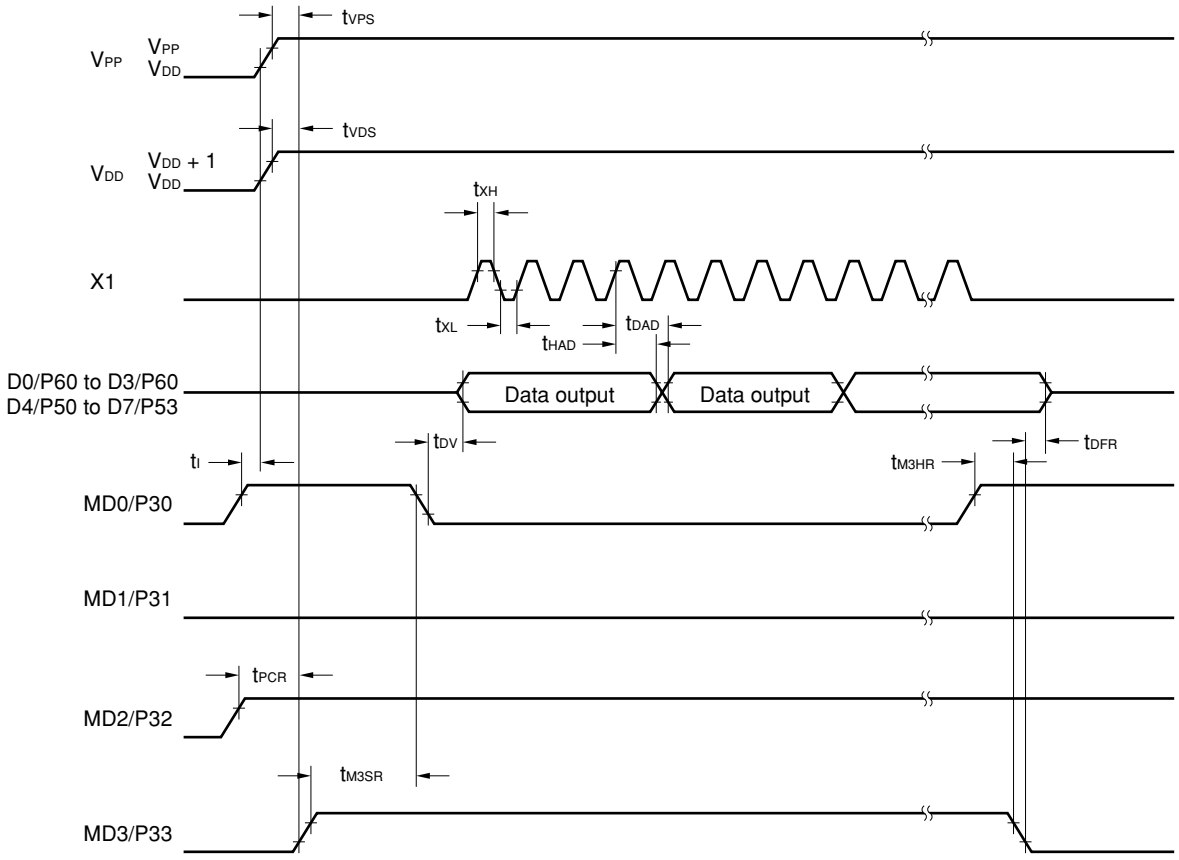
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Address setup time[Note] (to MD0↓)	t_{AS}		2			μs
MD1 setup time (to MD0↓)	t_{M1S}		2			μs
Data setup time (to MD0↓)	t_{DS}		2			μs
Address hold time[Note] (from MD0↑)	t_{AH}		2			μs
Data hold time (from MD0↑)	t_{DH}		2			μs
Data output float delay time from MD0↑	t_{DF}		0		130	ns
V_{PP} setup time (to MD3↑)	t_{VPS}		2			μs
V_{DD} setup time (to MD3↑)	t_{VDS}		2			μs
Initial program pulse width	t_{PW}		0.95	1.0	1.05	ms
Additional program pulse width	t_{OPW}		0.95		21.0	ms
MD0 setup time (to MD1↑)	t_{M0S}		2			μs
Data output delay time from MD0↓	t_{DV}	MD0 = MD1 = V_{IL}			1	μs
MD1 hold time (from MD0↑)	t_{M1H}	t_{M1H} + t_{M1R} ≥ 50 μs	2			μs
MD1 recovery time (from MD0↓)	t_{M1R}		2			μs
Program counter reset time	t_{PCR}		10			μs
X1 input high-/low-level width	t_{XH}, t_{XL}		0.125			μs
X1 input frequency	f_X				4.19	MHz
Initial mode set time	t_I		2			μs
MD3 setup time (to MD1↑)	t_{M3S}		2			μs
MD3 hold time (from MD1↓)	t_{M3H}		2			μs
MD3 setup time (to MD0↓)	t_{M3SR}	During program memory read	2			μs
Data output delay time from Address[Note]	t_{DAD}	During program memory read			2	μs
Data output hold time from Address[Note]	t_{HAD}	During program memory read	0		130	ns
MD3 hold time (from MD0↑)	t_{M3HR}	During program memory read	2			μs
Data output float delay time from MD3↓	t_{DFR}	During program memory read			2	μs

Note The internal address signal is incremented by 1 at the rising edge of the fourth X1 input and is not connected to a pin.

Program Memory Write Timing

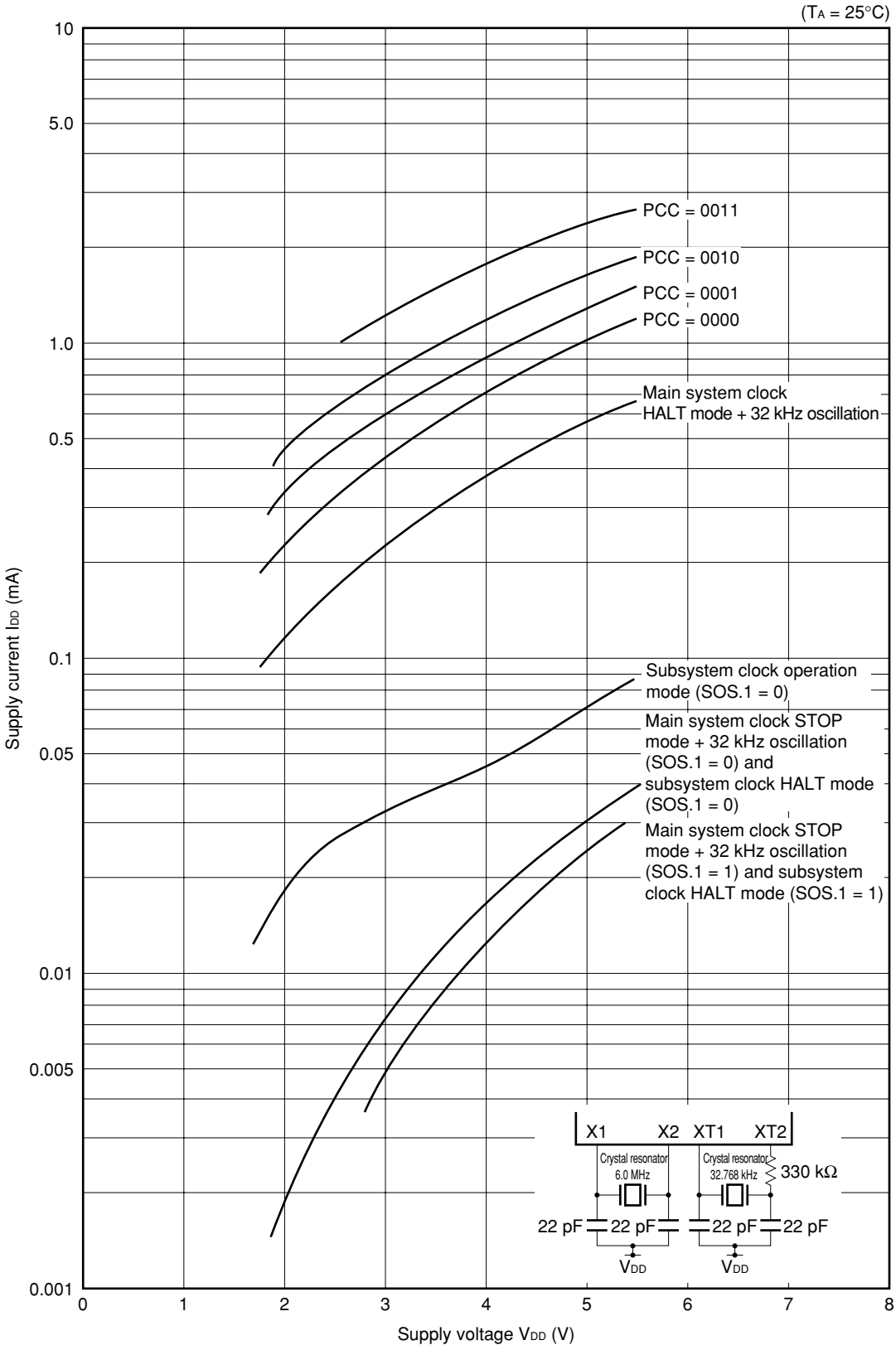


Program Memory Read Timing

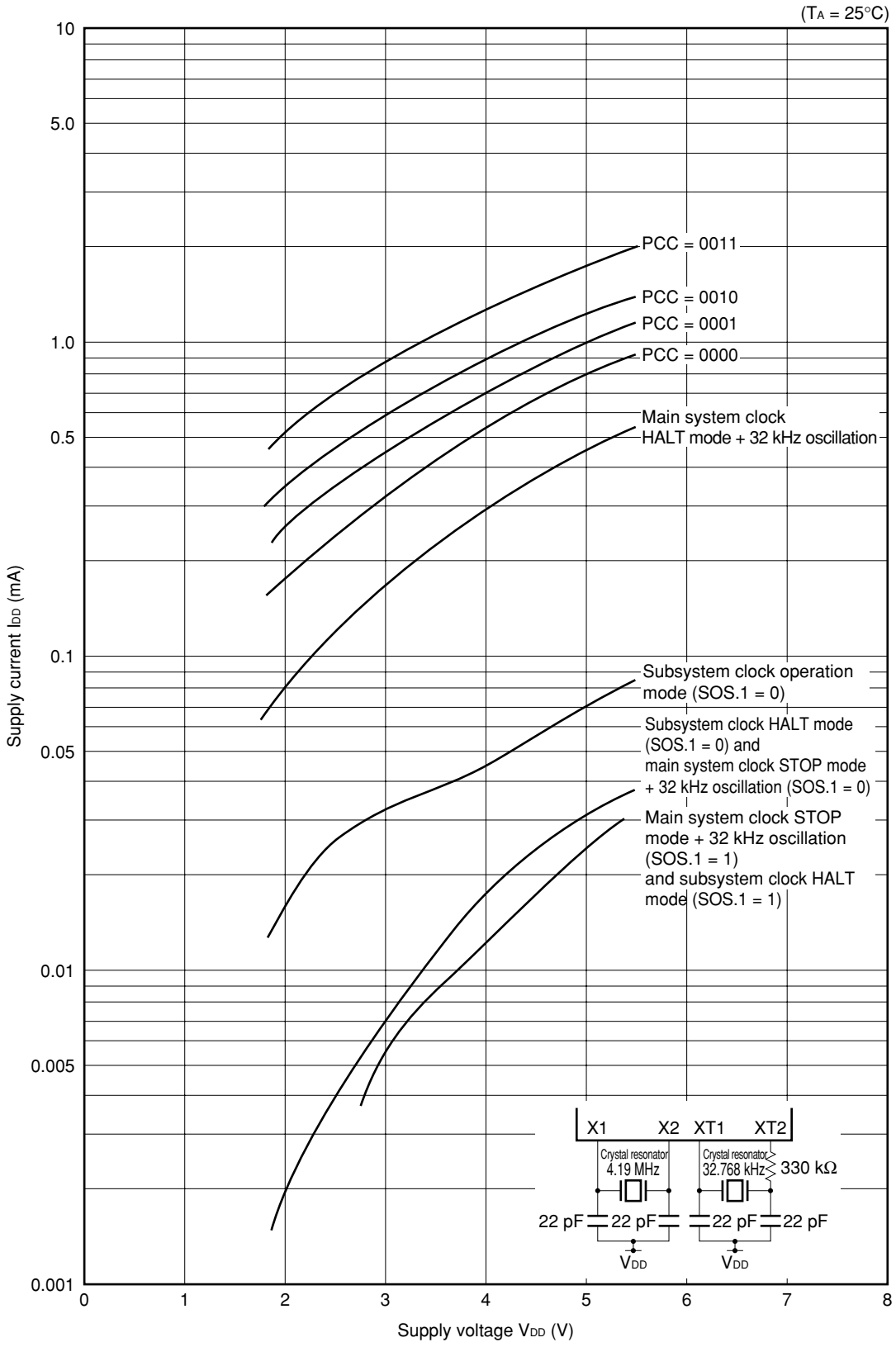


10. CHARACTERISTIC CURVES (REFERENCE VALUES)

I_{DD} vs V_{DD} (Main System Clock: 6.0 MHz Crystal Resonator)

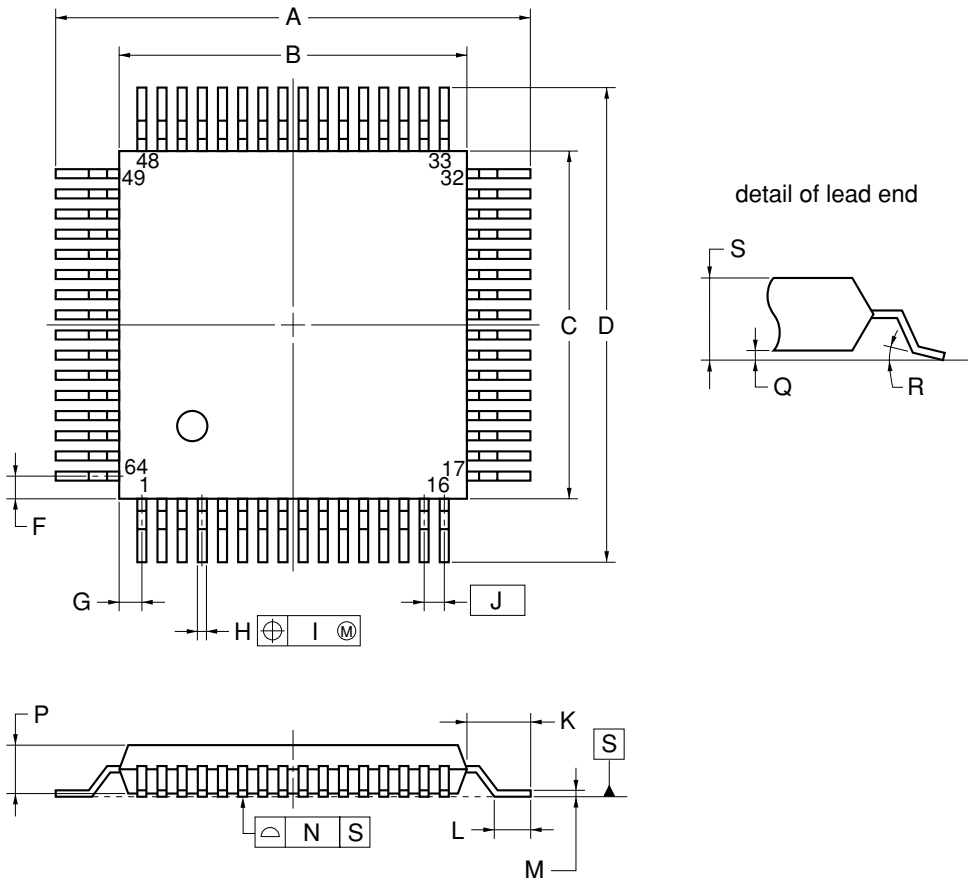


I_{DD} vs V_{DD} (Main System Clock: 4.19 MHz Crystal Resonator)



11. PACKAGE DRAWINGS

★ 64-PIN PLASTIC QFP (14x14)



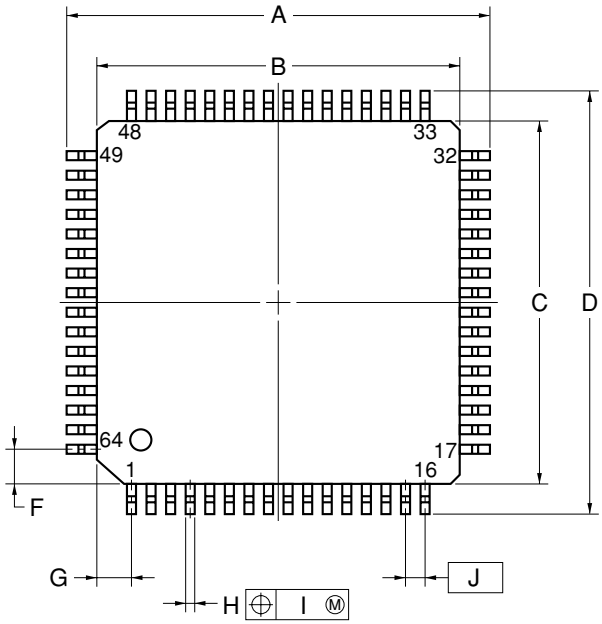
NOTE

Each lead centerline is located within 0.15 mm of its true position (T.P.) at maximum material condition.

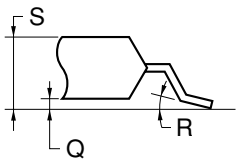
ITEM	MILLIMETERS
A	17.6±0.4
B	14.0±0.2
C	14.0±0.2
D	17.6±0.4
F	1.0
G	1.0
H	$0.37^{+0.08}_{-0.07}$
I	0.15
J	0.8 (T.P.)
K	1.8±0.2
L	0.8±0.2
M	$0.17^{+0.08}_{-0.07}$
N	0.10
P	2.55±0.1
Q	0.1±0.1
R	5°±5°
S	2.85 MAX.

P64GC-80-AB8-5

⋆ 64-PIN PLASTIC LQFP (12x12)



detail of lead end



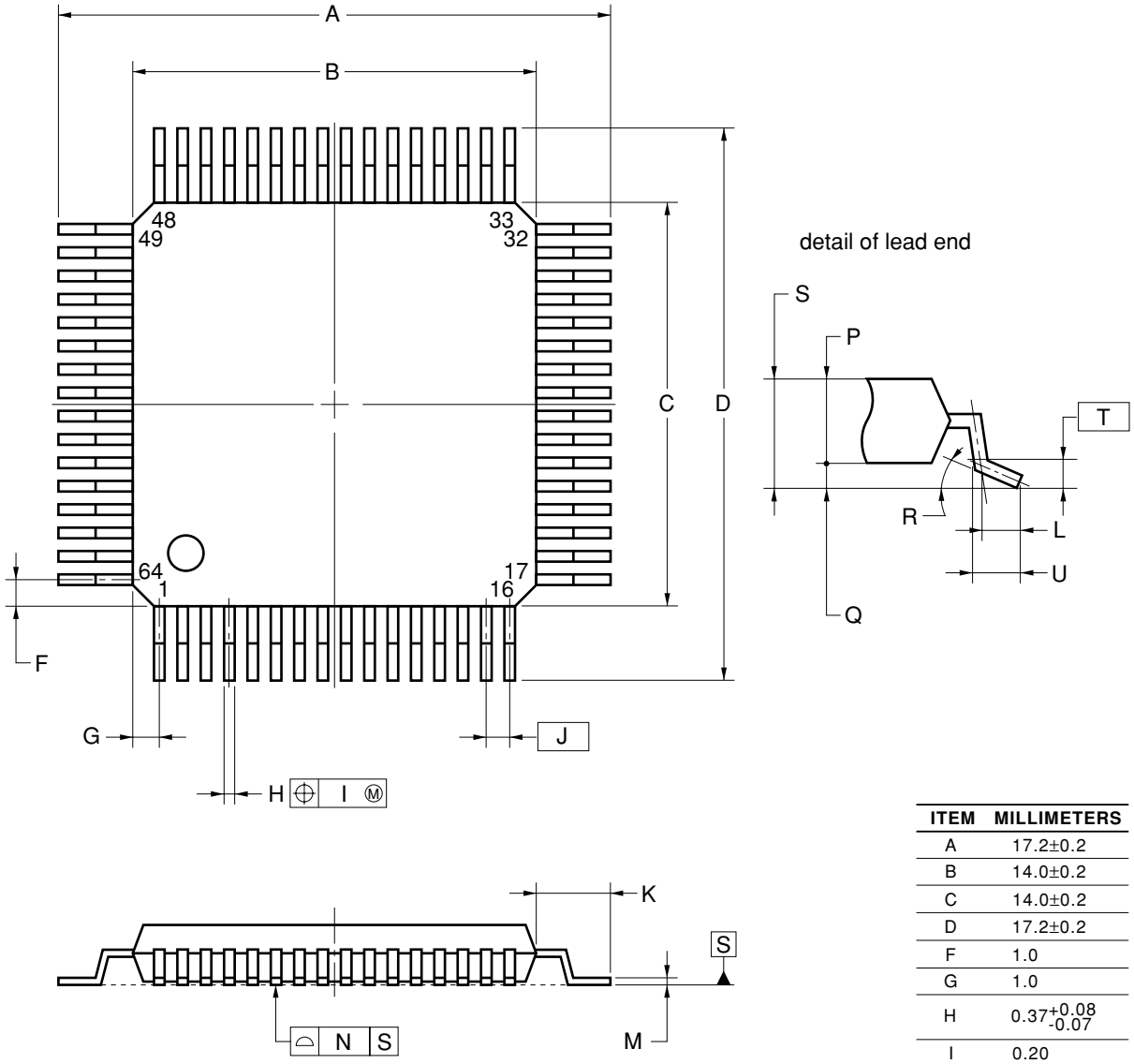
NOTE

Each lead centerline is located within 0.13 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	14.8±0.4
B	12.0±0.2
C	12.0±0.2
D	14.8±0.4
F	1.125
G	1.125
H	0.32±0.08
I	0.13
J	0.65 (T.P.)
K	1.4±0.2
L	0.6±0.2
M	$0.17^{+0.08}_{-0.07}$
N	0.10
P	1.4±0.1
Q	0.125±0.075
R	5°±5°
S	1.7 MAX.

P64GK-65-8A8-3

★ 64-PIN PLASTIC LQFP (14x14)



ITEM	MILLIMETERS
A	17.2±0.2
B	14.0±0.2
C	14.0±0.2
D	17.2±0.2
F	1.0
G	1.0
H	$0.37^{+0.08}_{-0.07}$
I	0.20
J	0.8 (T.P.)
K	1.6±0.2
L	0.8
M	$0.17^{+0.03}_{-0.06}$
N	0.10
P	1.4±0.1
Q	0.127±0.075
R	$3^{\circ}{}^{+4^{\circ}}_{-3^{\circ}}$
S	1.7 MAX.
T	0.25
U	0.886±0.15

P64GC-80-8BS

NOTE

Each lead centerline is located within 0.20 mm of its true position (T.P.) at maximum material condition.

12. RECOMMENDED SOLDERING CONDITIONS

The PD75P3116 should be soldered and mounted under the following recommended conditions.
For technical information, see the following website.

Semiconductor Device Mount Manual (http://www.necel.com/pkg/en/mount/index.html)

Table 12-1. Surface Mounting Type Soldering Conditions (1/2)

(1) PD75P3116GC-AB8: 64-pin plastic QFP (14 14)

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Three times or less	IR35-00-3
VPS	Package peak temperature: 215°C, Time: 40 seconds max. (at 200°C or higher), Count: Three times or less	VP15-00-3
Wave soldering	Solder bath temperature: 260°C max., Time: 10 seconds max., Count: Once Preheating temperature: 120°C max. (package surface temperature)	WS60-00-1
Partial heating	Pin temperature: 350°C max., Time: 3 seconds max. (per pin row)	–

Caution Do not use different soldering methods together (except for partial heating).

Remark For soldering methods and conditions other than those recommended above, contact an NEC Electronics sales representative.

(2) PD75P3116GK-8A8: 64-pin plastic LQFP (12 12)

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Twice or less, Exposure limit: 7 days[Note] (after that, prebake at 125°C for 10 to 72 hours)	IR35-107-2
VPS	Package peak temperature: 215°C, Time: 40 seconds max. (at 200°C or higher), Count: Twice or less, Exposure limit: 7 days[Note] (after that, prebake at 125°C for 10 to 72 hours)	VP15-107-2
Wave soldering	Solder bath temperature: 260°C max., Time: 10 seconds max., Count: Once Preheating temperature: 120°C max. (package surface temperature) Exposure limit: 7 days[Note] (after that, prebake at 125°C for 10 to 72 hours)	WS60-107-1
Partial heating	Pin temperature: 350°C max., Time: 3 seconds max. (per pin row)	–

Note After opening the dry pack, store it at 25°C or less and 65% RH or less for the allowable storage period.

Caution Do not use different soldering methods together (except for partial heating).

Remark For soldering methods and conditions other than those recommended above, contact an NEC Electronics sales representative.

Table 12-1. Surface Mounting Type Soldering Conditions (2/2)

★ **(3) PD75P3116GC-8BS: 64-pin plastic LQFP (14 14)**

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Twice or less	IR35-00-2
VPS	Package peak temperature: 215°C, Time: 40 seconds max. (at 200°C or higher), Count: Twice or less	VP15-00-2
Wave soldering	Solder bath temperature: 260°C max., Time: 10 seconds max., Count: Once Preheating temperature: 120°C max. (package surface temperature)	WS60-00-1
Partial heating	Pin temperature: 350°C max., Time: 3 seconds max. (per pin row)	–

Caution Do not use different soldering methods together (except for partial heating).

Remark For soldering methods and conditions other than those recommended above, contact an NEC Electronics sales representative.

★ **(4) PD75P3116GC-8BS-A: 64-pin plastic LQFP (14 14)**

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 260°C, Time: 60 seconds max. (at 220°C or higher), Count: Three times or less, Exposure limit: 7 days[Note] (after that, prebake at 125°C for 20 to 72 hours)	IR60-207-3
Wave soldering	For details, contact an NEC Electronics sales representative.	–
Partial heating	Pin temperature: 350°C max., Time: 3 seconds max. (per pin row)	–

Note After opening the dry pack, store it at 25°C or less and 65% RH or less for the allowable storage period.

Caution Do not use different soldering methods together (except for partial heating).

Remarks 1. Products with “-A” at the end of the part number are lead-free products.

2. For soldering methods and conditions other than those recommended above, contact an NEC Electronics sales representative.

Table 12-1. Surface Mounting Type Soldering Conditions (2/2)

★ (3) μPD75P3116GC-8BS: 64-pin plastic LQFP (14 × 14)

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C, Time: 30 seconds max. (at 210°C or higher), Count: Twice or less	IR35-00-2
VPS	Package peak temperature: 215°C, Time: 40 seconds max. (at 200°C or higher), Count: Twice or less	VP15-00-2
Wave soldering	Solder bath temperature: 260°C max., Time: 10 seconds max., Count: Once, Preheating temperature: 120°C max. (package surface temperature)	WS60-00-1
Partial heating	Pin temperature: 300°C max., Time: 3 seconds max. (per pin row)	—

Caution Do not use different soldering methods together (except for partial heating).

APPENDIX A. LIST OF μPD75308B, 753108, AND 75P3116 FUNCTIONS

Parameter		μPD75308B	μPD753108	μPD75P3116
Program memory		Mask ROM 0000H to 1F7FH (8064 × 8 bits)	Mask ROM 0000H to 1FFFH (8192 × 8 bits)	One-time PROM 0000H to 3FFFH (16384 × 8 bits)
Data memory		000H to 1FFH (512 × 4 bits)		
CPU		75X Standard	75XL CPU	
Instruction execution time	When main system clock is selected	0.95, 1.91, 15.3 μs (during 4.19 MHz operation)	• 0.95, 1.91, 3.81, 15.3 μs (during 4.19 MHz operation) • 0.67, 1.33, 2.67, 10.7 μs (during 6.0 MHz operation)	
	When subsystem clock is selected	122 μs (during 32.768 kHz operation)		
Stack	SBS register	None	SBS.3 = 1: Mk I mode selection SBS.3 = 0: Mk II mode selection	
	Stack area	000H to 0FFH	000H to 1FFH	
	Subroutine call instruction stack operation	2-byte stack	When Mk I mode: 2-byte stack When Mk II mode: 3-byte stack	
Instruction	BRA !addr1 CALLA !addr1	Unavailable	When Mk I mode: Unavailable When Mk II mode: Available	

	MOVT XA, @BCDE
	MOVT XA, @BCXA
	BR BCDE
	BR BCXA
			Available	

	CALL !addr	3 machine cycles	Mk I mode: 3 machine cycles Mk II mode: 4 machine cycles	
	CALLF !faddr	2 machine cycles	Mk I mode: 2 machine cycles Mk II mode: 3 machine cycles	
I/O ports	CMOS input	8	8	
	CMOS I/O	16	20	
	Bit port output	8	0	
	N-ch open-drain I/O	8	4	
	Total	40	32	
LCD controller/driver		Segment selection: 24/28/32 (can be changed to CMOS I/O port in 4-bit units; max. 8)	Segment selection: 16/20/24 segments (can be changed to CMOS I/O port in 4-bit units; max. 8)	
		Display mode selection: Static, 1/2 duty (1/2 bias), 1/3 duty (1/2 bias), 1/3 duty (1/3 bias), 1/4 duty (1/3 bias)		
		On-chip split resistor for LCD driver can be specified by using mask option.		No on-chip split resistor for LCD driver
Timer		3 channels • Basic interval timer: 1 channel • 8-bit timer/event counter: 1 channel • Watch timer: 1 channel	5 channels • Basic interval timer/watchdog timer: 1 channel • 8-bit timer/event counter: 3 channels (can be used as 16-bit timer/event counter) • Watch timer: 1 channel	

Parameter		μPD75308B	μPD753108	μPD75P3116
Clock output (PCL)		Φ, 524, 262, 65.5 kHz (Main system clock: during 4.19 MHz operation)	• Φ, 524, 262, 65.5 kHz (Main system clock: during 4.19 MHz operation) • Φ, 750, 375, 93.8 kHz (Main system clock: during 6.0 MHz operation)	
BUZ output (BUZ)		2 kHz (Main system clock: during 4.19 MHz operation)	• 2, 4, 32 kHz (Main system clock: during 4.19 MHz operation or subsystem clock: during 32.768 kHz operation) • 2.93, 5.86, 46.9 kHz (Main system clock: during 6.0 MHz operation)	
Serial interface		3 modes are available • 3-wire serial I/O mode ··· MSB/LSB can be selected for transfer first bit • 2-wire serial I/O mode • SBI mode		
SOS register	Feedback resistor cut flag (SOS.0)	None	Contained	
	Sub-oscillator current cut flag (SOS.1)	None	Contained	
Register bank selection register (RBS)		None	Yes	
Standby release by INT0		No	Yes	
Vectored interrupts		External: 3, Internal: 3	External: 3, Internal: 5	
Supply voltage		V_{DD} = 2.0 to 6.0 V	V_{DD} = 1.8 to 5.5 V	
Operating ambient temperature		T_A = –40 to +85°C		
★ Package		• 80-pin plastic QFP (14 × 20) • 80-pin plastic QFP (14 × 14) • 80-pin plastic TQFP (Fine pitch) (12 × 12)	• 64-pin plastic QFP (14 × 14) • 64-pin plastic LQFP (12 × 12) • 64-pin plastic TQFP (12 × 12) • 64-pin plastic LQFP (14 × 14)	• 64-pin plastic QFP (14 × 14) • 64-pin plastic LQFP (12 × 12) • 64-pin plastic LQFP (14 × 14)

APPENDIX B. DEVELOPMENT TOOLS

The following development tools have been provided for system development using the μPD75P3116.
In the 75XL Series, a common relocatable assembler is used in combination with a device file dedicated to each model.

★

RA75X relocatable assembler	Host Machine		Part Number (Product Name)
	OS	Supply Medium	
	PC-9800 Series	MS-DOS™ (Ver.3.30 to Ver.6.2[Note])	3.5" 2HD	μS5A13RA75X
	IBM PC/AT™ or compatibles	Refer to **OS for IBM PCs**	3.5" 2HC	μS7B13RA75X

★

Device file	Host Machine		Part Number (Product Name)
	OS	Supply Medium	
	PC-9800 Series	MS-DOS (Ver.3.30 to Ver.6.2[Note])	3.5" 2HD	μS5A13DF753108
	IBM PC/AT or compatibles	Refer to **OS for IBM PCs**	3.5" 2HC	μS7B13DF753108

Note Ver. 5.00 and later include a task swapping function, but this function cannot be used in this software.

Remark Operation of the assembler and device file is guaranteed only when using the host machine and OS described above.

PROM Write Tools

Hardware	PG-1500	This is a PROM writer that can program a single-chip microcontroller with PROM in stand-alone mode or under the control of a host machine when connected with the supplied accessory board and optional programmer adapter. It can also program typical PROMs in capacities ranging from 256 Kb to 4 Mb.			
★	PA-75P3116GC	This is a PROM programmer adapter for the μPD75P3116GC-AB8. It can be used when connected to the PG-1500.			
★	PA-75P3116GK	This is a PROM programmer adapter for the μPD75P3116GK-8A8. It can be used when connected to the PG-1500.			
★	PA-75P3116GC-8BS	This is a PROM programmer adapter for the μPD75P3116GC-8BS. It can be used when connected to the PG-1500.			
Software	PG-1500 controller	Connects the PG-1500 to the host machine via serial and parallel interfaces and controls the PG-1500 on the host machine.			
		Host machine			Part number (Product name)
			OS	Supply medium	
		PC-9800 Series	MS-DOS (Ver.3.30 to Ver.6.2[Note])	3.5" 2HD	μS5A13PG1500
		IBM PC/AT or compatible	Refer to **OS for IBM PCs**	3.5" 2HD	μS7B13PG1500

Note Ver. 5.00 and later include a task swapping function, but this function cannot be used in this software.

Remark Operation of the PG-1500 controller is guaranteed only when using the host machine and OS described above.

Debugging Tools

An in-circuit emulator (IE-75001-R) is provided as a program debugging tool for the μPD75P3116.

The system configuration using this in-circuit emulator is shown below.

★

Hardware	IE-75001-R	The IE-75001-R is an in-circuit emulator to be used for hardware and software debugging during development of application systems using the 75X or 75XL Series products. The IE-75001-R is used in combination with an emulation board (IE-75300-R-EM) and emulation probe (EP-753108GC-R or EP-753108GK-R) (both sold separately). Highly efficient debugging can be performed when connected to the host machine and PROM programmer.		
	IE-75300-R-EM	This is an emulation board for evaluating application systems using the μPD75P3116. It is used in combination with the IE-75001-R.		
	EP-753108GC-R EV-9200GC-64	This is an emulation probe for the μPD75P3116GC. When being used, it is connected with the IE-75001-R and the IE-75300-R-EM. It includes a 64-pin conversion socket (EV-9200GC-64) to facilitate connection with the target system.		
	EP-753108GK-R TGK-064SBW Note 1	This is an emulation probe for the μPD75P3116GK. When being used, it is connected with the IE-75001-R and the IE-75300-R-EM. It includes a 64-pin conversion adapter (TGK-064SBW) to facilitate connection with the target system.		
Software	IE control program	This program can control the IE-75001-R on a host machine when connected to the IE-75001-R via an RS-232C or Centronics interface.		
		Host machine	OS	Supply medium	Part number (Product name)
		PC-9800 Series	MS-DOS (Ver.3.30 to Ver.6.2 Note 2)	3.5" 2HD	μS5A13IE75X
		IBM PC/AT or compatible	Refer to **OS for IBM PCs**	3.5" 2HC	μS7B13IE75X

★ **Notes 1.** This is a product of TOKYO ELETECH CORPORATION.

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Osaka Electronic Department (TEL: +81-6-6244-6672)

2. Ver. 5.00 and later include a task swapping function, but this function cannot be used in this software.

Remarks 1. Operation of the IE control program is guaranteed only when using the host machine and OS described above.

2. The μPD753104, 753106, 753108, and 75P3116 are generically called the μPD753108 Subseries.

OS for IBM PCs

The following operating systems for IBM PCs are supported.

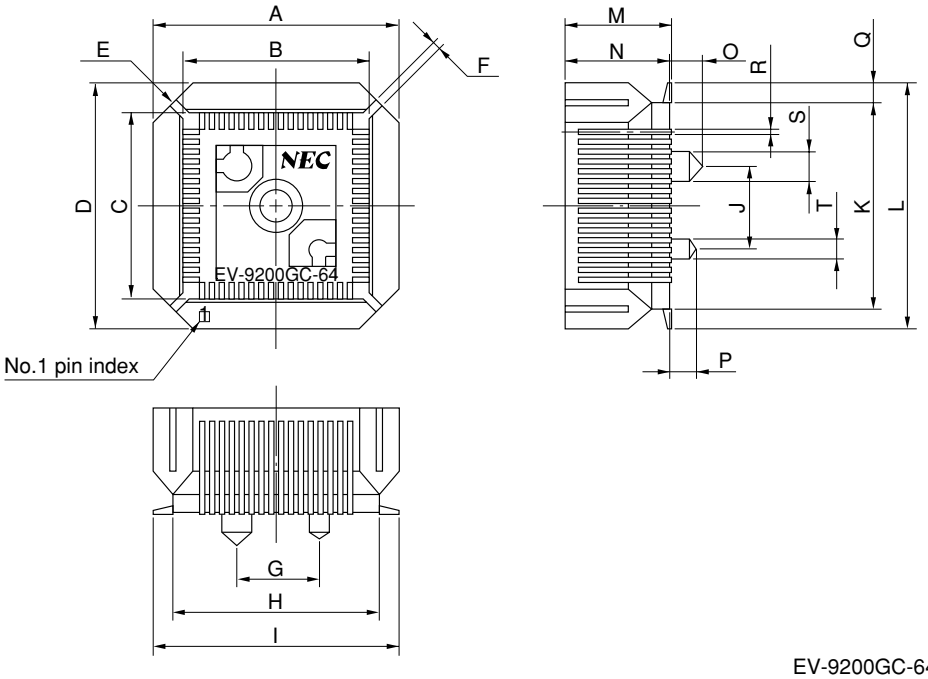
OS	Version
PC DOS™	Ver.3.1 to 6.3 J6.1/V[Note] to J6.3/V[Note]
MS-DOS	Ver.5.0 to 6.2 5.0/V[Note] to 6.2/V[Note]
IBM DOS™	J5.02/V[Note]

Note Only English mode is supported.

Caution Ver. 5.0 and later include a task swapping function, but this function cannot be used in this software.

★ **Package Drawing and Recommended Footprint of Conversion Socket (EV-9200GC-64)**

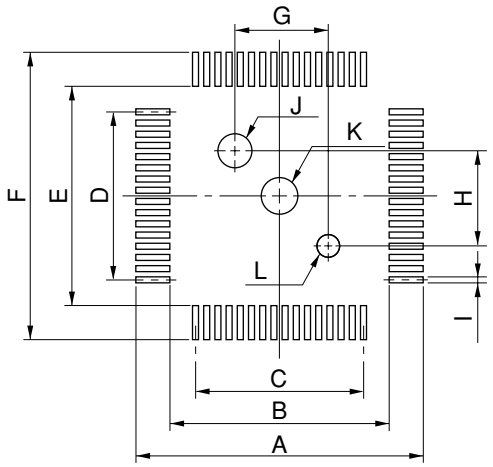
Figure B-1. EV-9200GC-64 Package Drawing (For Reference Only)



EV-9200GC-64-G0E

ITEM	MILLIMETERS	INCHES
A	18.8	0.74
B	14.1	0.555
C	14.1	0.555
D	18.8	0.74
E	4-C 3.0	4-C 0.118
F	0.8	0.031
G	6.0	0.236
H	15.8	0.622
I	18.5	0.728
J	6.0	0.236
K	15.8	0.622
L	18.5	0.728
M	8.0	0.315
N	7.8	0.307
O	2.5	0.098
P	2.0	0.079
Q	1.35	0.053
R	0.35±0.1	$0.014^{+0.004}_{-0.005}$
S	φ2.3	φ0.091
T	φ1.5	φ0.059

Figure B-2. EV-9200GC-64 Recommended Footprint (For Reference Only)



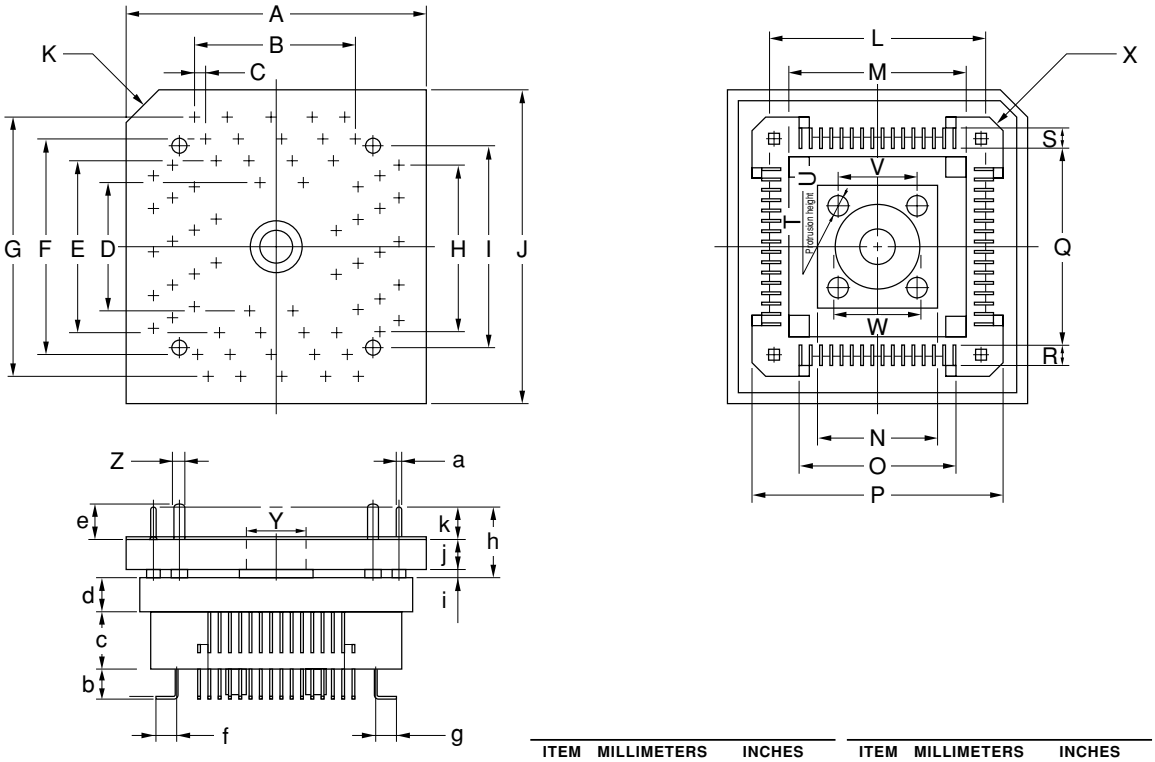
EV-9200GC-64-P1E

ITEM	MILLIMETERS	INCHES
A	19.5	0.768
B	14.8	0.583
C	$0.8\pm0.02\times15=12.0\pm0.05$	$0.031^{+0.002}_{-0.001}\times0.591=0.472^{+0.003}_{-0.002}$
D	$0.8\pm0.02\times15=12.0\pm0.05$	$0.031^{+0.002}_{-0.001}\times0.591=0.472^{+0.003}_{-0.002}$
E	14.8	0.583
F	19.5	0.768
G	6.00 ± 0.08	$0.236^{+0.004}_{-0.003}$
H	6.00 ± 0.08	$0.236^{+0.004}_{-0.003}$
I	0.5 ± 0.02	$0.197^{+0.001}_{-0.002}$
J	$\phi2.36\pm0.03$	$\phi0.093^{+0.001}_{-0.002}$
K	$\phi2.2\pm0.1$	$\phi0.087^{+0.004}_{-0.005}$
L	$\phi1.57\pm0.03$	$\phi0.062^{+0.001}_{-0.002}$

Caution Dimensions of mount pad for EV-9200 and that for target device (QFP) may be different in some parts. For the recommended mount pad dimensions for QFP, refer to "SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL" (C10535E).

★ **Package Drawing of Conversion Adapter (TGK-064SBW)**

Figure B-3. TGK-064SBW Package Drawing (For Reference Only)



ITEM	MILLIMETERS	INCHES
A	18.4	0.724
B	0.65x15=9.75	0.026x0.591=0.384
C	0.65	0.026
D	7.75	0.305
E	10.15	0.400
F	12.55	0.494
G	14.95	0.589
H	0.65x15=9.75	0.026x0.591=0.384
I	11.85	0.467
J	18.4	0.724
K	C 2.0	C 0.079
L	12.45	0.490
M	10.25	0.404
N	7.7	0.303
O	10.02	0.394
P	14.92	0.587
Q	11.1	0.437
R	1.45	0.057
S	1.45	0.057
T	4-ϕ1.3	4-ϕ0.051
U	1.8	0.071
V	5.0	0.197
W	ϕ5.3	ϕ0.209
X	4-C 1.0	4-C 0.039
Y	ϕ3.55	ϕ0.140
Z	ϕ0.9	ϕ0.035

ITEM	MILLIMETERS	INCHES
a	ϕ0.3	ϕ0.012
b	1.85	0.073
c	3.5	0.138
d	2.0	0.079
e	3.9	0.154
f	1.325	0.052
g	1.325	0.052
h	5.9	0.232
i	0.8	0.031
j	2.4	0.094
k	2.7	0.106

TGK-064SBW-G1E

★ Notes on Target System Design

The following shows a diagram of the connection conditions between the emulation probe, conversion connector and conversion socket or conversion adapter.

Design your system making allowances for conditions such as the form of parts mounted on the target system, as shown below.

Table B-1. Distance Between In-Circuit Emulator and Conversion Socket

Emulation Probe	Conversion Socket/ Conversion Adapter	Distance Between In-Circuit Emulator and Conversion Socket or Conversion Adapter
EP-753108GC-R	EV-9200GC-64	700 mm
EP-753108GK-R	TGK-064SBW	700 mm

Figure B-4. Distance Between In-Circuit Emulator and Conversion Socket or Conversion Adapter (1)

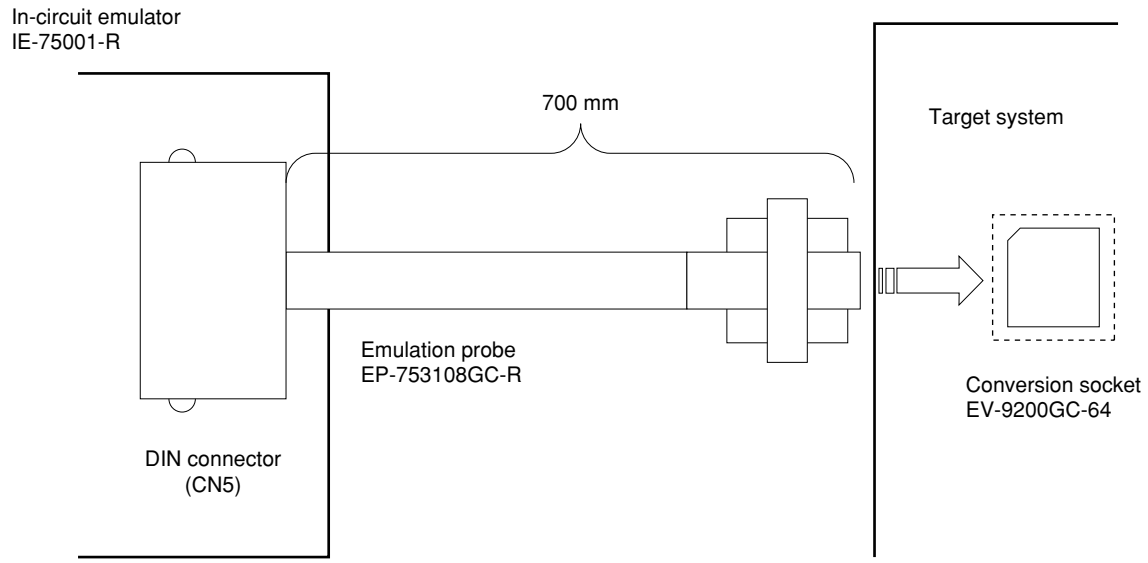


Figure B-5. Distance Between In-Circuit Emulator and Conversion Socket or Conversion Adapter (2)

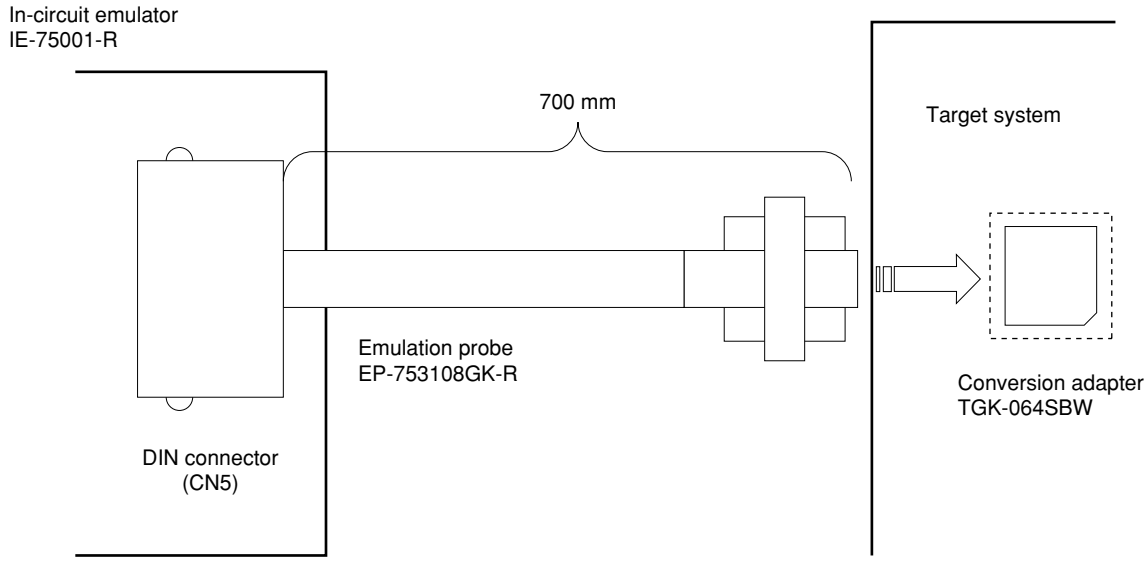


Figure B-6. Connection Conditions of Target System (1)

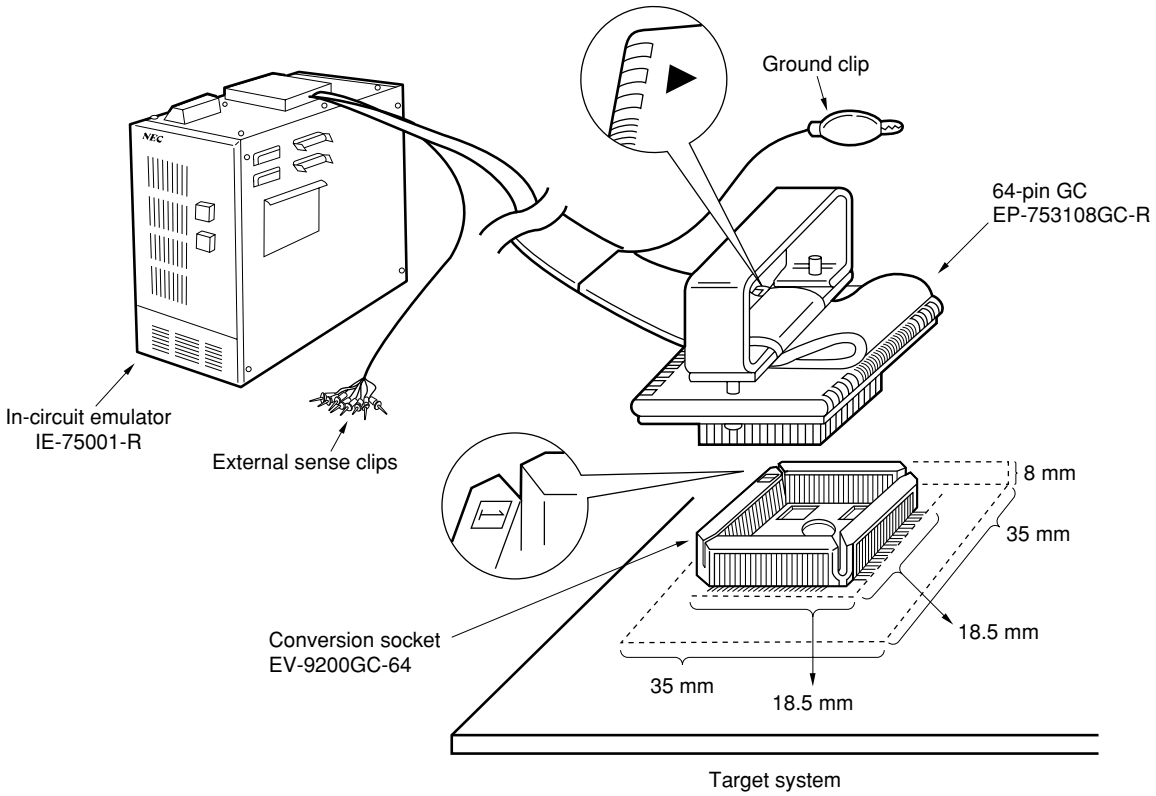
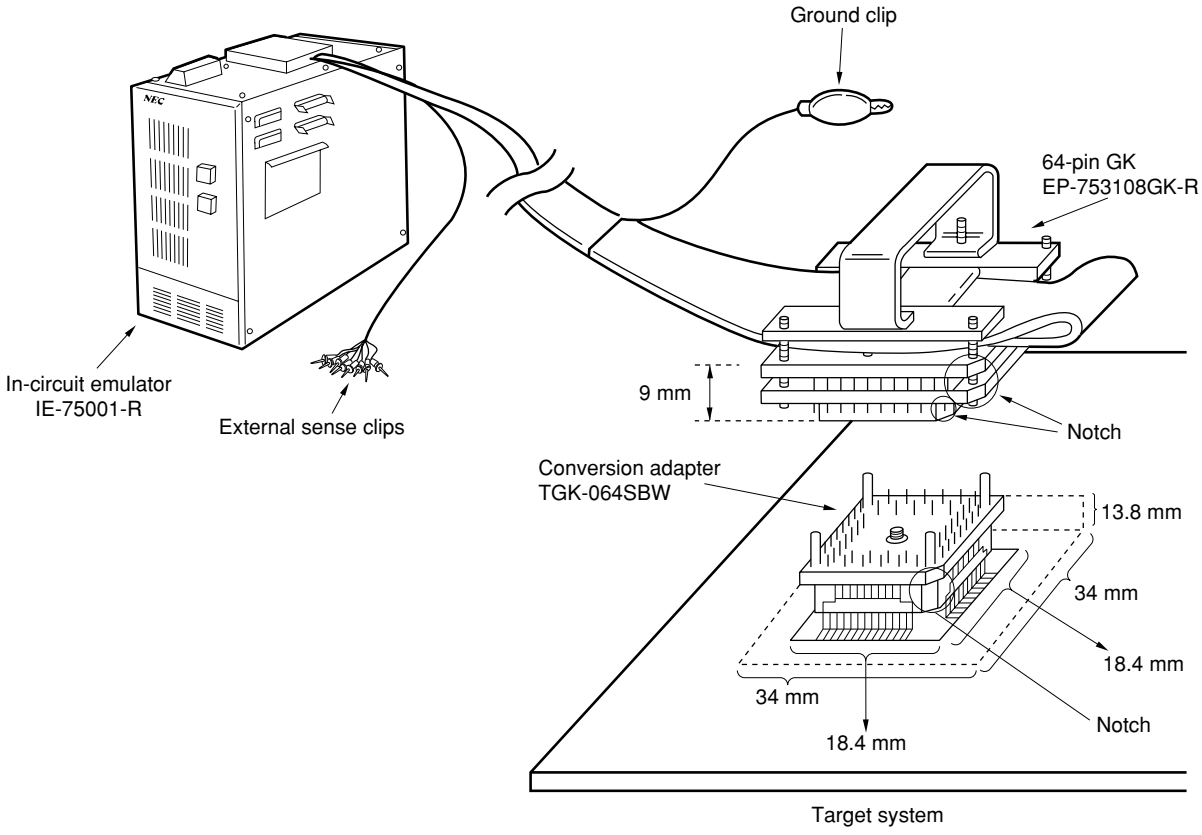


Figure B-7. Connection Conditions of Target System (2)



★ APPENDIX C. RELATED DOCUMENTS

The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.

Documents Related to Devices

Document Name	Document No.
μPD753104, 753106, 753108 Data Sheet	U10086E
μPD75P3116 Data Sheet	This document
μPD753108 User's Manual	U10890E
75XL Series Selection Guide	U10453E

Documents Related to Development Tools (Software) (User's Manuals)

Document Name		Document No.
RA75X Assembler Package	Operation	U12622E
	Language	U12385E
	Structured Assembler Preprocessor	U12598E

Documents Related to Development Tools (Hardware) (User's Manuals)

Document Name	Document No.
IE-75000-R, IE-75001-R In-Circuit Emulator	EEU-1455
IE-75300-R-EM Emulation Board	U11354E
EP-753108GC-R, EP-753108GK-R Emulation Probe	EEU-1495

Documents Related to PROM Writing (User's Manuals)

Document Name		Document No.
PG-1500 PROM Programmer		U11940E
PG-1500 Controller	PC-9800 Series (MS-DOS) Based	EEU-1291
	IBM PC Series (PC DOS) Based	U10540E

Caution The related documents listed above are subject to change without notice. Be sure to use the latest version of each document for designing.

Other Related Documents

Document Name	Document No.
SEMICONDUCTOR SELECTION GUIDE – Products & Packages –	X13769E
Semiconductor Device Mounting Technology Manual	C10535E
Quality Grades on NEC Semiconductor Devices	C11531E
NEC Semiconductor Device Reliability/Quality Control System	C10983E
Guide to Prevent Damage for Semiconductor Devices by Electrostatic Discharge (ESD)	C11892E

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NOTES FOR CMOS DEVICES

① VOLTAGE APPLICATION WAVEFORM AT INPUT PIN

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (MAX) and V_{IH} (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (MAX) and V_{IH} (MIN).

② HANDLING OF UNUSED INPUT PINS

Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

③ PRECAUTION AGAINST ESD

A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

④ STATUS BEFORE INITIALIZATION

Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

⑤ POWER ON/OFF SEQUENCE

In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current.

The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

⑥ INPUT OF SIGNAL DURING POWER OFF STATE

Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements.

Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

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